TECHNICAL MANUAL
888-2001-909

LIQUID COOLED
DX200 TRANSMITTER
994 9855 001

T.M. No. 888-2001-909

Rev. A: 12/14/10

Returns And Exchanges

Damaged or undamaged equipment should not be returned unless written approval and a Return Authorization is received from HARRIS CORPORATION, Broadcast Systems Division. Special shipping instructions and coding will be provided to assure proper handling. Complete details regarding circumstances and reasons for return are to be included in the request for return. Custom equipment or special order equipment is not returnable. In those instances where return or exchange of equipment is at the request of the customer, or convenience of the customer, a restocking fee will be charged. All returns will be sent freight prepaid and properly insured by the customer. When communicating with HARRIS CORPORATION, Broadcast Systems Division, specify the HARRIS Order Number or Invoice Number.

Unpacking

Carefully unpack the equipment and preform a visual inspection to determine that no apparent damage was incurred during shipment. Retain the shipping materials until it has been determined that all received equipment is not damaged. Locate and retain all PACKING CHECK LISTs. Use the PACKING CHECK LIST to help locate and identify any components or assemblies which are removed for shipping and must be reinstalled. Also remove any shipping supports, straps, and packing materials prior to initial turn on.

Technical Assistance

HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service during normal business hours (8:00 AM - 5:00 PM Central Time). Emergency service is available 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Systems Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. Technical Support by e-mail: *tsupport@harris.com*. The HARRIS factory may also be contacted through a FAX facility (217/221-7096).

Replaceable Parts Service

Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Systems Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a FAX facility (217/221-7096).

NOTE

The # symbol used in the parts list means used with (e.g. #C001 = used with C001).

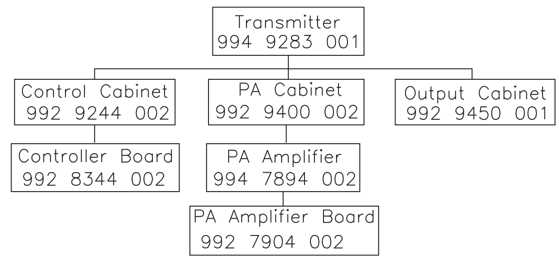
MANUAL REVISION HISTORY DX200 LIQUID COOLED 888-2001-909			
Rev.	Date	ECN	Description
A	12/14/10	P49093	Created book.

Guide to Using Harris Parts List Information

The Harris Replaceable Parts List Index portrays a tree structure with the major items being leftmost in the index. The example below shows the Transmitter as the highest item in the tree structure. If you were to look at the bill of materials table for the Transmitter you would find the Control Cabinet, the PA Cabinet, and the Output Cabinet. In the Replaceable Parts List Index the Control Cabinet, PA Cabinet, and Output Cabinet show up one indentation level below the Transmitter and implies that they are used in the Transmitter. The Controller Board is indented one level below the Control Cabinet so it will show up in the bill of material for the Control Cabinet. The tree structure of this same index is shown to the right of the table and shows indentation level versus tree structure level.

Example of Replaceable Parts List Index and equivalent tree structure:

	Replaceable Parts List Index		
Table 7-1.	Transmitter	994 9283 001	7-2
Table 7-2.	Control Cabinet	992 9244 002	7-3
Table 7-3.	Controller Board	992 8344 002	7-6
Table 7-4.	PA Cabinet	992 9400 002	7-7
Table 7-5.	PA Amplifier	994 7894 002	7-9
Table 7-6.	PA Amplifier Board	992 7904 002	7-10
Table 7-7.	Output Cabinet	992 9450 001	7-12



The part number of the item is shown to the right of the description as is the page in the manual where the bill for that part number starts.

Inside the actual tables, four main headings are used:

Table #-#. ITEM NAME - HARRIS PART NUMBER -this line gives the information that corresponds to the Replaceable Parts List Index entry;

HARRIS P/N column gives the ten digit Harris part number (usually in ascending order);

DESCRIPTION column gives a 25 character or less description of the part number;

REF. SYMBOLS/EXPLANATIONS column 1) gives the reference designators for the item (i.e., C001, R102, etc.) that corresponds to the number found in the schematics (C001 in a bill of material is equivalent to C1 on the schematic) or 2) gives added information or further explanation (i.e., “Used for 208V operation only,” or “Used for HT 10LS only,” etc.).

Inside the individual tables some standard conventions are used:

A # symbol in front of a component such as #C001 under the REF. SYMBOLS/EXPLANATIONS column means that this item is used on or with C001 and is not the actual part number for C001.

In the ten digit part numbers, if the last three numbers are 000, the item is a part that Harris has purchased and has not manufactured or modified. If the last three numbers are other than 000, the item is either manufactured by Harris or is purchased from a vendor and modified for use in the Harris product.

The first three digits of the ten digit part number tell which family the part number belongs to - for example, all electrolytic (can) capacitors will be in the same family (524 xxxx 000). If an electrolytic (can) capacitor is found to have a 9xx xxxx xxx part number (a number outside of the normal family of numbers), it has probably been modified in some manner at the Harris factory and will therefore show up farther down into the individual parts list (because each table is normally sorted in ascending order). Most Harris made or modified assemblies will have 9xx xxxx xxx numbers associated with them.

The term “SEE HIGHER LEVEL BILL” in the description column implies that the reference designated part number will show up in a bill that is higher in the tree structure. This is often the case for components that may be frequency determinant or voltage determinant and are called out in a higher level bill structure that is more customer dependent than the bill at a lower level.

HARRIS Broadcast Systems Division
P.O. Box 4290, QUINCY, IL 62305

PARTS ORDER FORM

HARRIS PHONE: 217-222-8200
HARRIS FAX: 217-221-7096

BILLING INFORMATION

CUSTOMER NAME: ____________________

ADDRESS: ____________________

____

____

____

TELEPHONE NUMBER: ____________________

FAX NUMBER: ____________________

PREFERRED PAYMENT METHOD: ____________________

FREQUENCY (If required): ____________________

EQUIPMENT NAME: ____________________

EQUIPMENT PART NUMBER: ____________________

EQUIPMENT SERIAL NUMBER: ____________________

SHIPPING INFORMATION

SHIP TO: (if different from billing information) ____________________

ADDRESS: ____________________

____

____

____

TELEPHONE NUMBER: ____________________

FAX NUMBER: ____________________

SHIPPING METHOD PREFERRED: ____________________

GUIDE FOR ORDERING PARTS

Please use the following parts order form, filling is as much information as possible. The complete informaiton will allow double checking the part number for correctness or locating a substitude if the part is not available.
The equipment name, part number, and serial number will be found on the metal ID plate on the back of the unit. The serial number MUST be included for any parts ordered under warranty.
Describe the part using the description in the parts list if possible. Include the schematic information, schematic number, or number of next higher assembly. The next higher assembly is usually a 992-xxxx-00x type.

ITEM #	QTY ORD	HARRIS PART NUMBER	DESCRIPTION OF PART (PART'S NAME, DESCRIPTION, SPECIFICATION FROM PARTS LIST IF AVAILABLE)	SCHEMATIC REFERENCE REFERENCE NAME (e.g. C001, R100, etc)	ITEM USED ON (NEXT HIGHER ASSEMBLY IF KNOWN) (e.g. C001 used on 992 8025 001, SCHEMATIC 839 8099 991)	COMMENTS

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY WARNINGS, INSTRUCTIONS AND REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as reference:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

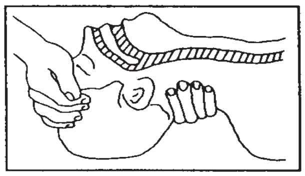
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

(A) AIRWAY

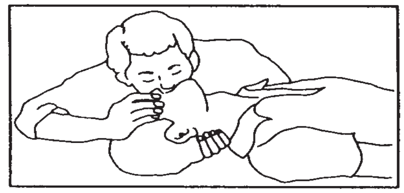
IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

(B) BREATHING

IF NOT BREATHING,
BEGIN ARTIFICIAL BREATHING

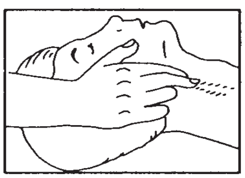


TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

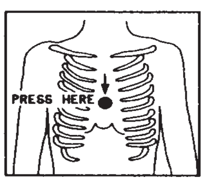
CHECK
CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

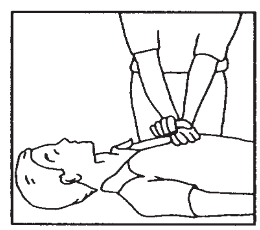
(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES



APPROX. RATE OF COMPRESSIONS --80 PER MINUTE { ONE RESCUER: 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE { TWO RESCUERS: 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

WARNING: Disconnect primary power prior to servicing.

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is a brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

    a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)

    b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.

    c. Treat victim for shock as required.

    d. Arrange transportation to a hospital as quickly as possible.

    e. If arms or legs are affected keep them elevated.

NOTE

If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

    a. Apply cool (not ice cold) compresses using the cleanest available cloth article.

    b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.

    c. Apply clean dry dressing if necessary.

    d. Treat victim for shock as required.

    e. Arrange transportation to a hospital as quickly as possible.

    f. If arms or legs are affected keep them elevated.

REFERENCE:

ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

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WARNING: Disconnect primary power prior to servicing.

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WARNING: Disconnect primary power prior to servicing.

Appendix A
DX Digital Modulation Technology and Concepts

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1.1 Scope and Purpose

This technical manual contains the information pertaining to the 200 kW Liquid Cooled Transmitter.

The various sections of this technical manual provide the following types of information.

Section I, Introduction/Specifications, provides general manual layout, frontispiece, equipment description, block diagram.

Section II, Installation/Initial Turn on, provides physical and electrical installation procedures of the transmitter.

Section III-A, Controls/Indicators, provides identification and functions of all external panel controls and indicators, plus multimeter reading log sheets.

Section IV, Overall System Theory provides block diagram and detailed theory of operation of the Transmitter:

RF Section
Predriver Splitter (A46) and Driver Drive Cables
RF Splitter (A6) and RF Drive Cables
Output Network
Low Voltage Power Supply
Driver Multimeter (A9)
Control Multimeter (A41)

Section V, Maintenance, provides preventative and corrective maintenance information.

Section V-A, Cabinet Views, provides drawings that show the location of major components and modules in the cabinets.

Section VI, Troubleshooting, provides simplified flow style troubleshooting procedures down to the board level.

Section VI-A, Emergency Operating Procedures, provides methods to maintain on-air operation of the Transmitter in the event of certain failures.

Section VII, Parts List, provides a parts list for the overall Transmitter as well as individual modules.

The following subsections provide principles of operations for boards and modules in the transmitter:

Section A, Oscillator (A1) (A2)
Section B, Oscillator Interface (A3)
Section C, Driver Combiner Motherboard (A5)
Buffer Amplifier (A4)
Predriver (PD1)
Drivers (D1-D14)
Section D, Predriver Band Select (A54)
Section E, Driver Encoder (A7)
Section F, RF Combiner Motherboards
Main Combiner Motherboards (A11-A19) (A20-A23 -EPAC)
Binary Combiner Motherboard (A10)
Section G, RF Amplifier Module
Section H,
Output Monitor (A21)
RF Power Sample (3A1)
Section J, Analog Input (A22)
Section K, Analog To Digital Converter (A32)
Section L, Modulation Encoders
Big Step Modulation Encoders (A26-A29) (A30-A31 EPAC)
Binary Modulation Encoder (A25)
Air Flow Monitors (A3, A24, A47)
Section M,
Controller (A31)
LED (A42)
Switch Board/Meter Panel (A35)
Section N, Power Block Interface (A23)
Section P, Extended Transmitter Interface (A30)
Section R, Power Block Cooling System
Section S, Low Voltage Power Supply (A56)
Section T, Heat Exchanger/Air Plenum
Section U, Rectifier Assembly
Section W, AC Input System & Transformer Cabinet
Appendices:
Appendix A, Digital Terms and Concepts
Appendix B, Lightning Protection

1.2 Equipment Description

The Transmitter is a 200 kW solid state medium wave amplitude modulation unit. The Transmitter requires only a power supply, frequency source, and audio source for operation.

1.3 Block Diagram

See Figure 1-2, this chapter, for a copy of the Transmitter Block Diagram. A Block Diagram description is also contained in Section IV, Overall System Theory.

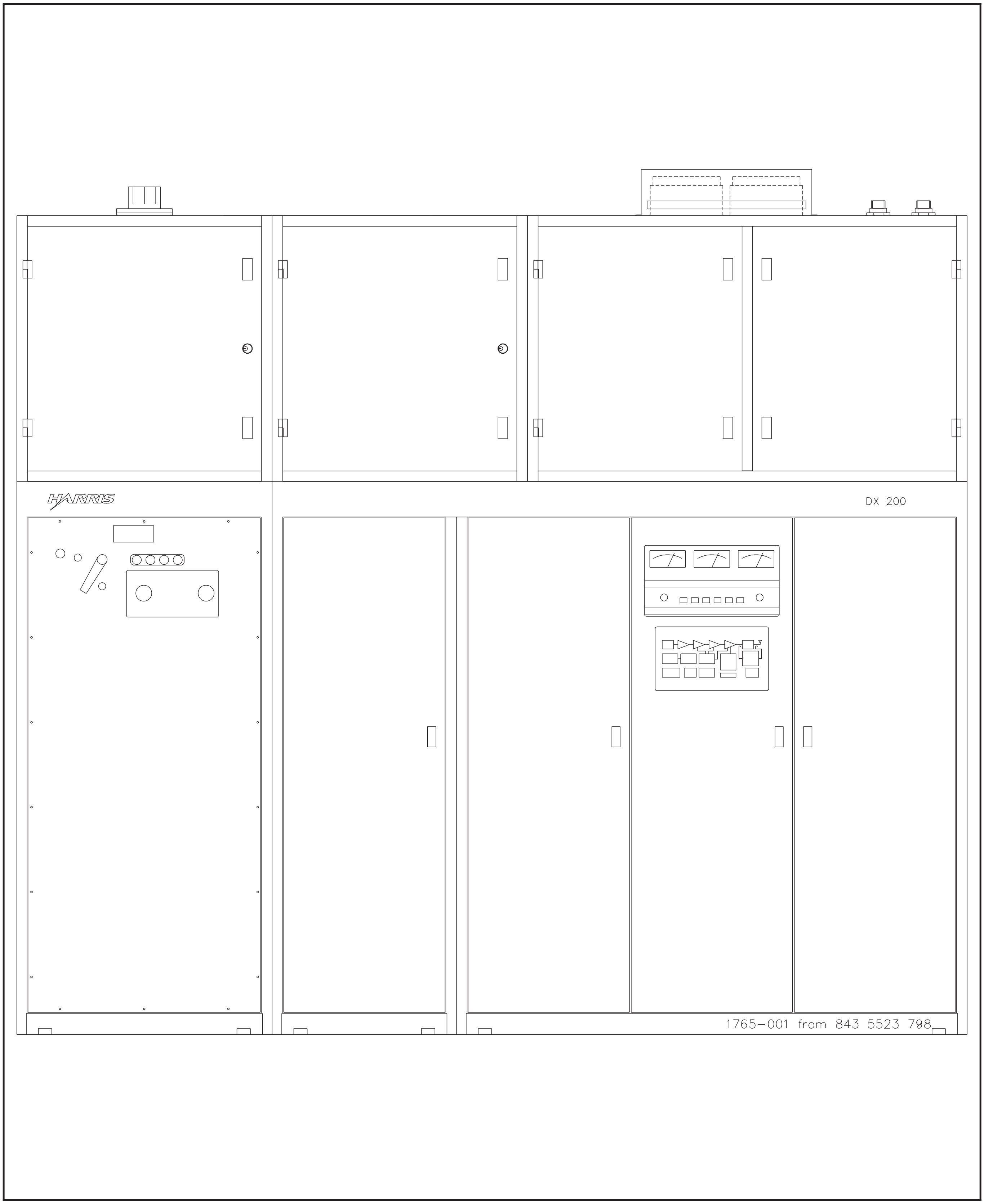


Figure 1-1. Front View of Transmitter

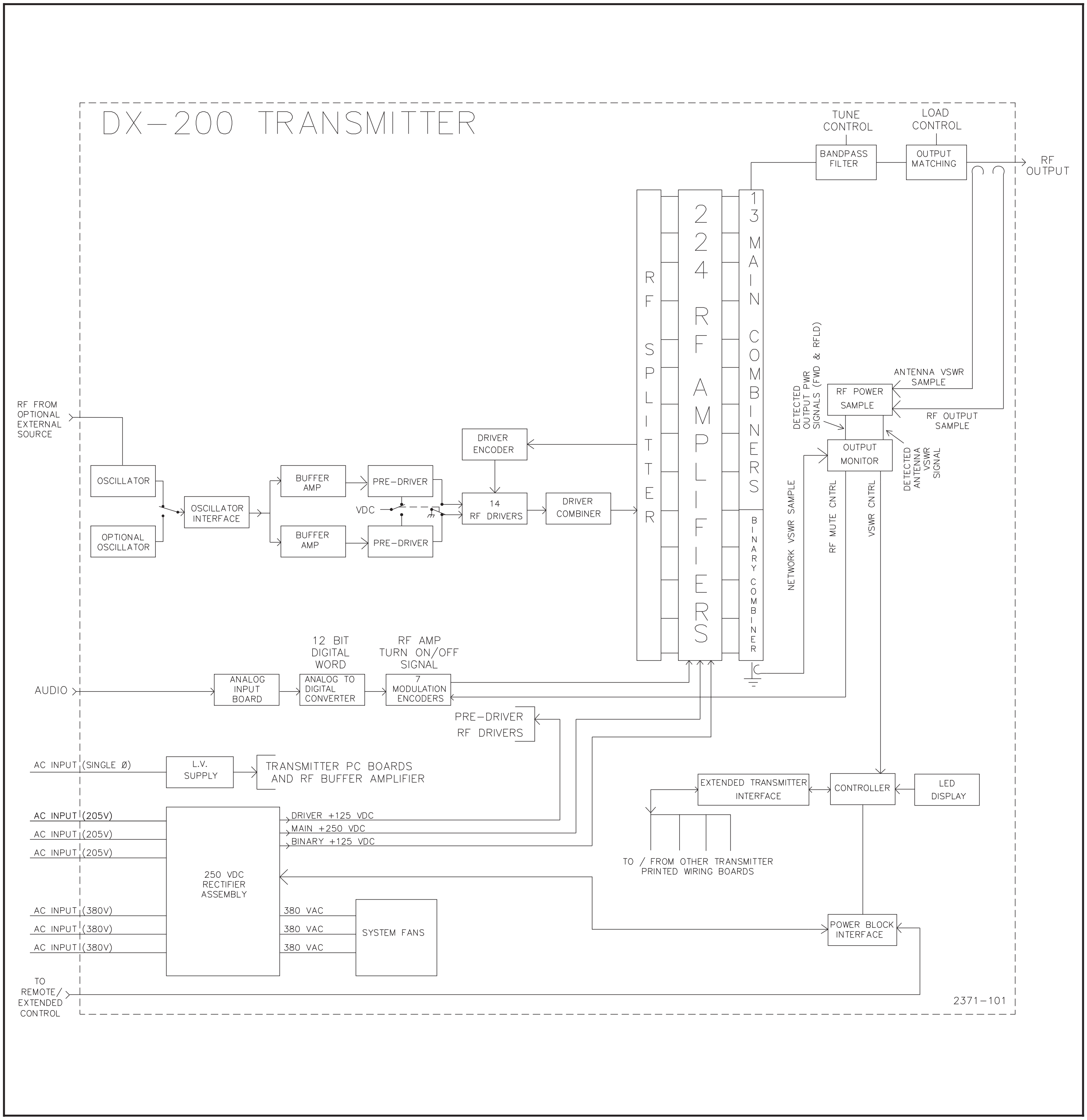


Figure 1-2. DX-200 PB Block Diagram

2.1 Introduction

This section provides information and instructions necessary for the installation of the HARRIS DX-200 MEDIUM WAVE TRANSMITTER. Each piece of equipment should be inspected for shipping damage. Inventory all equipment and the contents of each box and compare to the packing list.

2.2 Delivery And Storage

The DX-200 Transmitter is normally delivered in 6 cabinet sections mounted on shipping skids, shipping weights are:

The PA section (PAC + EPAC) weighs 3340 lbs (1515 kg).
The Output Matching (OMC) section weighs 250 lbs (114 kg).
The Rectifier Cabinet section weighs 1650 lbs (748 kg).
The Heat Exchanger Cabinet (HEC) weighs 950 lbs (431 kg).
The Output Network Cabinet (ONC) Top weighs 225 lbs (102 kg).
The Output Network Cabinet (ONC) Bottom weighs 1025 lbs (465 kg).

Smaller components are shipped in cardboard cartons. Any obvious damage should be noted at the time of receipt and claims filed with the carrier. Equipment capable of handling a 5,500 pounds (2,500 kg) load will be needed to unload the transmitter. Extreme care should be taken during the unloading operation to prevent injury to personnel or damage to the equipment. If the transmitter is to be temporarily stored, all units require inside storage. Do not stack items except for small cardboard cartons.

2.3 Returns And Exchanges

Damaged or undamaged equipment should not be returned unless a Return Authorization is issued. When communicating with Harris Corporation, Broadcast Division, specify the order number or invoice number. Include complete details regarding circumstances and reasons for return in the request. Custom or special order equipment is not returnable. In instances where return or exchange of equipment is at the request or convenience of the customer, a restocking fee will be charged. Special shipping instructions and coding will be provided to insure proper handling. All returns will be sent freight prepaid and properly insured by the customer.

2.4 Unpacking

Carefully unpack the transmitter and save all packing material. Inspect thoroughly for any damage incurred in shipment. Retain all PACKING CHECK LISTS to help locate and identify any components or assemblies removed for shipping. Remove any shipping supports, and straps prior to initial turn on.

All access/exhaust holes should be covered during installation. The top of the transmitter should remain covered until the initial turn on.

2.5 Installation

NOTE:

An Installation Checklist is provided at the end of this section to aid in completion of the Installation. This list is the suggested order in which the Installation should proceed. Refer to the separate sub-sections for information on completing a step on the checklist.

2.5.1 Factory Test Data

Locate and retain the FACTORY TEST DATA. During installation and initial turn on procedures, reference will be made to FACTORY TEST DATA. This data is normally packed in an envelope and may be inserted in the technical manual, or may be packed with the transmitter. This data includes meter readings, measured performance data, information and data measured with external equipment, frequency determined parts and adjustments specifically for your transmitter's operating frequency.

2.5.2 Transmitter Placement

When necessary, refer to drawings titled DX-200 Cabinet Outline, Rectifier Cabinet drawings, and PA & Output cabinet drawings in your drawing package for important DIMENSIONS, WEIGHT, AIR FLOW, and ELECTRICAL information.

The DX-200 Transmitter consists of:

- PA CABINET (PAC) which consists of the Left PA Cubicle (LPAC), Center PA Cubicle (CPAC), and Right PA Cubicle (RPAC)
- EXTENDED PA CABINET (EPAC)
- OUTPUT MATCHING CABINET (OMC)
- RECTIFIER CABINET
- HEAT EXCHANGER CABINET (HEC)
- OUTPUT NETWORK CABINET (ONC) TOP
- OUTPUT NETWORK CABINET (ONC) BOTTOM

NOTE:

The EPAC and PAC are configured in a common frame sometimes identified as the EPAC/PAC.

The EPAC/PAC, OMC, ONC, and HEC are bolted together after the location has been determined and after having been properly aligned and leveled.

The cabinets are designated as Units 1, 2, 3, 4, and 6 with the PA cabinet being Unit #1, the EPAC is unit #2, the OMC is Unit #3,

WARNING: Disconnect primary power prior to servicing.

the HEAT EXCHANGER is Unit #4, and the Rectifier Cabinet is Unit #6. Output Network Cabinet Top is Unit #7 and the Output Network Cabinet Bottom is Unit #8.

Depending on the height of the entrance at the site, the cabinets may have to be removed from their skids prior to bringing them into the transmitter building.

NOTE:
Whether the EPAC/PAC or Rectifier Cabinet is placed first is dependent upon building and equipment orientation. This procedure assumes that EPAC/PAC placement is initially required. If Rectifier Cabinet positioning should occur first, start with Procedure 2.5.6. After placing the Rectifier Cabinet, return to and complete Procedure 2.5.5. If, however, a Power Transformer Cabinet is to be mounted adjacent to the Rectifier Cabinet, because the Power Transformer Cabinet is the heaviest of the cabinets, it might be helpful to position it first, although this is not a requirement.

2.5.3 Moving Recommendations

It is recommended that the cabinets be removed from the shipping skids for final placement, because of the weight of the cabinets and changes to the wood as they age. This may be done after they are moved into the building and near the final location. Due to the weight of the cabinets, a forklift or hoist is recommended for lifting. Lifting points are built into the tops of the HEC, OMC and ONC Top cabinets only. Use of a spreader bar is recommended for safety and stability when lifting. See Transmitter Placement section for more details.

NOTE:
This installation description assumes the use of a specific lifting hoist available from Harris Broadcast as Lift Kit (992-9772-001). Notation will be made for removing floor mounted cabinets from skids by other means, but given the need to place Heat Exchanger Cabinets (HEC) and Output Matching Cabinets (OMC) on top of the EPAC/PAC, emphasis will be placed on the use of the Lift Kit.

2.5.4 Lift Kit Assembly

Assemble the Lift from materials in Lift Kit (992-9772-001) made up of I-beams, eye bolts, shackles, slings, & come-alongs (ratcheted cable pullers).

2.5.5 EPAC/PAC Placement

a. Using the appropriate keylock system key, unlock/open the EPAC/PAC doors..
b. Locate and remove the four shipping bolts, (located inside of each cabinet floor at the four corners).
c. Using crowbar(s,) at one or more of the four EPAC/PAC recessed leverage points, raise the EPAC/PAC corners individually about 3/4” above the shipping skid to allow placement of roller bars (a two foot section of 1/2” or 3/4” rigid pipe is appropriate) , one diagonally at each corner.
d. Straddle the EPAC/PAC with the Lift.
e. Slide the two slings between the raised EPAC/PAC and shipping skid, one sling about two feet from each cabinet end and then attach the sling ends to the appropriate come-along cable hooks.
f. Operate the four come-a-long ratchet handles simultaneously and carefully, lift the EPAC/PAC sufficiently high to allow removal of the roller bars and shipping skid, then moving the lift so as to place the EPAC/PAC approximately at the predetermined position. Reverse the ratchet action, again simultaneously and carefully, until the EPAC/PAC is resting on the floor.

NOTE:
Whenever hoisting a cabinet up or down, do so with extreme care so as to not cause scraping or scratching of the cabinet due to positional imbalance, cause breakage or deformation to internally mounted components, or loosen hardware unnecessarily.

g. Once the EPAC/PAC is approximately positioned, refine the positioning footprint by using crowbar(s) at the cabinet recessed leverage points to move the cabinet a small amount at a time, as necessary.

2.5.6 Rectifier Cabinet Placement

a. Since the Rectifier Cabinet is much lighter and smaller than the EPAC/PAC, use of the Lift to remove the cabinet from the skid is not necessary. Position the shipping skid/Rectifier cabinet combination near the predetermined floor position.
b. Using the appropriate keylock system key, unlock the Rectifier Cabinet doors.

NOTE:
Use the special screwdriver bit (supplied) to remove the back panel to gain access to the skid bolts.

c. Locate and remove the four shipping bolts, (located inside of the cabinet at the four corners).
d. Remove the Rectifier cabinet from the shipping skid by tilting the cabinet slightly, using the cabinet front edge as the pivot surface, so that the rear of the cabinet raises sufficiently to allow two 1/2” or 3/4” rigid roller pipes to be slid under the cabinet, one near the cabinet base front and one about the cabinet base middle.
e. Carefully roll the Rectifier cabinet gradually toward the front of the skid, progressively off of the skid in the process while allowing the cabinet’s front edge to slide toward the floor. Once the cabinet front edge rests on the floor, then and only then, pull the shipping skid and roller pipes from underneath the cabinet and allow the cabinet base to tilt back slowly until the full cabinet base rests on the floor.
f. Once the Rectifier cabinet is approximately positioned, refine the positioning footprint by using crowbar(s) at the cabinet recessed leverage points to move the cabinet a small amount at a time or by pushing the cabinet in small increments not using the crowbar(s), as necessary.

2.5.7 ONC Bottom Cabinet Placement

a. Since the ONC Bottom Cabinet is much lighter and smaller than the EPAC/PAC, use of the Lift to remove the cabinet from the skid is not necessary. Position the shipping skid/ONC Bottom cabinet combination near the predetermined floor position.

b. Using the appropriate key lock system key, unlock the ONC Bottom Cabinet door.

c. Locate and remove the four shipping bolts, (located inside of the cabinet at the four corners).

d. Remove the ONC Bottom cabinet from the shipping skid by tilting the cabinet slightly, using the cabinet front edge as the pivot surface, so that the rear of the cabinet raises sufficiently to allow two 1/2” or 3/4” rigid roller pipes to be slid under the cabinet, one near the cabinet base front and one about the cabinet base middle.

e. Carefully roll the ONC Bottom cabinet gradually toward the front of the skid, progressively off of the skid in the process while allowing the cabinet’s front edge to slide toward the floor. Once the cabinet front edge rests on the floor, then and only then, pull the shipping skid and roller pipes from underneath the cabinet and allow the cabinet base to tilt back slowly until the full cabinet base rests on the floor.

f. Once the ONC Bottom cabinet is approximately positioned, refine the positioning footprint by using crowbar(s) at the cabinet recessed leverage points to move the cabinet a small amount at a time or by pushing the cabinet in small increments not using the crowbar(s), as necessary.

2.5.8 Transformer Cabinet Placement

Refer to the overall transmitter floor plan drawing for the placement of the transformer cabinets.

NOTE:

Regarding the Transformer Cabinet Shut Off: With all Transformer Cabinets there is an associated disconnect/shutoff device. This device varies site dependently based on current and voltage ratings required. See that device’s manual for installation and operation instructions.

2.5.9 EPAC/PAC and Rectifier Cabinet Inter-Cabinet Attachment

a. With appropriate use of various thicknesses of shimstock (various thicknesses of pieces of small areas of sheet aluminum) align and level the floor mounted cabinets. Already provided and in place on either the EPAC/PAC or Rectifier Cabinet side panels, or in a box within the EPAC/PAC are 1” diameter x 3” long intercoupling aluminum cylindrical posts (917-2413-206).

NOTE:

Before aligning cabinets, identify the inter-connecting bolt locations between Units 1, 2, 3, 4, 7 and 8. There are 18 bolt locations in the Unit 4 (Output Section), 2 in front and 2 in back along the floor that adjoins the EPAC section (Unit 2) and 2 in front and two in back along the wall that adjoins the HEAT EXCHANGER CABINET. In the RECTIFIER CABINET (Unit 2) there are 5 bolt locations, 3 in front and 2 in back along the wall that adjoins the PA Cabinet. It will be necessary to remove the front and rear RECTIFIER CABINET covers to gain access to these locations. In the OUTPUT NETWORK CABINET top there are 4. In the OUTPUT NETWORK CABINET bottom there are 6.

b. After the cabinets are leveled and aligned, using the 5/16”-18 x 1” bolts provided (302-0307-000) and associated 5/16” split (314-0010-000) and flat (310-0010-000) washers, secure the cabinets together. There are three securing positions up the inner side panels toward the transmitter front and two positions up the inner side panels toward the transmitter rear. When attaching a EPAC/PAC and Rectifier cabinet with the same combination number, i.e., EPAC/PAC 1 with Rectifier Cabinet 1 or EPAC/PAC 2 with Rectifier Cabinet 2, etc., the EPAC/PAC is shipped with the intercoupling cylindrical post already mounted on the RPAC sidewall. The 5/16” bolts are driven into the threaded center of the posts from inside the Rectifier cabinet through the holes already mentioned in the adjacent sidewall of the Rectifier Cabinet. When attaching a EPAC/PAC and Rectifier cabinet with differing combination numbers, i.e., Rectifier Cabinet 2 with EPAC/PAC 1 or Rectifier Cabinet 1 with EPAC/PAC 2, etc., The intercoupling posts must be retrieved from the shipping carton located in the back of the EPAC/PAC and bolted into the EPAC/PAC free end sidewall prior to placing the next Rectifier Cabinet against that EPAC/PAC. Once the Rectifier Cabinet is properly positioned, the 5/16” hardware stackup is again driven into the intercoupling posts from inside the Rectifier Cabinet.

2.5.10 HEC Placement

a. Position the HEC/shipping skid properly oriented (cabinet front with cabinet front) on the floor with the EPAC/PAC/Rectifier combination and to the appropriate end of that combination using a pallet jack, forklift, roller pipes, or Lift.

b. Using the appropriate keylock system key, unlock the HEC doors.

c. Locate and remove the two shipping bolts, (located inside of cabinet at the left front and right front corners).

d. Straddle the HEC with the Lift.

e. Attach the Lift come-along hooks through the lifting point rings located in the four corners of the HEC top.

f. Operate the four come-along ratchet handles simultaneously and carefully, lift the HEC to a level sufficiently above the EPAC/PAC so that when positioned over the EPAC/PAC the HEC will not conflict with EPAC/PAC subassemblies extending above the EPAC/PAC mounting frame.

g. Push the Lift such that it straddles the EPAC/PAC to the point of alignment for positioning the HEC and EPAC/PAC together. Then slowly and carefully lower the HEC onto the EPAC/PAC upper frame such that the EPAC/PAC extended subassemblies fit correctly into the HEC.

h. Using the bolts provided, using the 5/16”-18 x 1” bolts provided (302-0307-000) and associated 5/16” split (314-0010-000) and flat (310-0010-000) washers, secure the HEC to the EPAC/PAC. There are two bolt hole positions in the front of the mating surfaces of these two cabinets and three bolt hole positions in the rear mating surfaces; the bolts in the front drive down from the HEC into pem nuts located in the EPAC/PAC, while the bolts in the rear drive up from the EPAC/PAC into pem nuts located in the HEC.

2.5.11 OMC Placement

a. With two exceptions, by using the same procedure described for lifting and mounting the HEC, the OMC is positioned on the EPAC/PAC and secured; the two exceptions being:

1. There are two skid shipping bolts which are located in the left front and right rear cabinet corners,
2. The presence of two hole positions at the rear of the OMC and EPAC/PAC mating surfaces instead of three as in the HEC and EPAC/PAC combination; the two bolts in the front driven down from the OMC into pem nuts located in the EPAC/PAC, while the bolts in the rear are driven up from the EPAC/PAC into pem nuts located in the OMC.

2.5.12 ONC TOP Placement

a. Position the ONC TOP/shipping skid properly oriented (cabinet front with cabinet front) on the floor with the ONC Bottom/EPAC/PAC/Rectifier combination and to the appropriate end of that combination using a pallet jack, forklift, roller pipes, or Lift.

b. Locate and remove the Four shipping bolts, (located inside of cabinet at the corners).

c. Straddle the ONC TOP with the Lift.

d. Attach the Lift come-along hooks through the lifting point rings located in the four corners of the ONC TOP top.

e. Operate the four come-along ratchet handles simultaneously and carefully, lift the ONC TOP to a level sufficiently above the ONC Bottom so that when positioned over the ONC Bottom the ONC TOP will not conflict with ONC Bottom subassemblies extending above the ONC Bottom mounting frame.

f. Push the Lift such that it straddles the ONC Bottom to the point of alignment for positioning the ONC TOP and ONC Bottom together. Then slowly and carefully lower the ONC TOP onto the ONC Bottom upper frame such that the ONC Bottom extended subassemblies fit correctly into the ONC TOP.

g. Using the screws provided, using the 1/4”-20 x 1” screws provided (302-0217-000) and associated 1/4” split (314-0012-000) and flat (310-0015-000) washers, secure the ONC TOP to the ONC Bottom. There are ten bolt hole positions of the mating surfaces.

h. Using the screws provided, using the 1/4”-20 x 1” screws provided (302-0217-000)and associated 1/4” split (314-0012-000) and flat (310-0015-000)) washers, secure the ONC TOP to the OMC. There are four bolt hole positions of the mating surfaces.

2.5.13 HEC and OMC Inter-Cabinet Attachment

a. With the HEC and OMC secured to the EPAC/PAC, now bolt the OMC and HEC together using the 5/16”-18 x 1” bolts provided (302-0307-000) and associated 5/16” split (314-0010-000) and flat (310-0010-000) washers. There are two hole positions in both the front and rear of the cabinets; all bolts being driven across from the HEC into pem nuts located in the OMC.

At this point, cabinet placement installation is complete. The next section will describe the procedure for inner cabinet cable routing and termination as well as installation of several subassemblies and components that were removed for shipping.

2.5.14 Mounting of EPAC & PAC Ground Plates

a. In the rear of the EPAC there is one ground strap attached at one end on the right, viewed from the rear, upper right sidewall which other end is left floating during shipping that must be attached to a companion location just above it on the underneath bottom surface of the OMC using the preexisting pem nut terminated holes. Also, in the rear of the driver PAC cubicle there is located on the upper left sidewall, as viewed from the rear, a similar floating ground strap which floating end must be similarly attached to the underneath bottom surface of the HEC using the preexisting pem nut terminated holes.

b. Shipped in the rear compartment of the PAC is a box of miscellaneous parts to be reinstalled in the transmitter. Remove from that box the two provided rectangular copper ground plates (817-2150-037) and mount them on top of the two straps in the positions described in step using the supplied brass hardware stack-up of 1/4-20 x 1" brass screw and 1/4" split and flat washers, driving the screws into the pem nut terminated holes in the HEC and OMC.

2.5.15 Mounting of the Crossover Bar and Cover

a. Shipped in the rear compartment of the PAC is a box of miscellaneous parts to be reinstalled in the Transmitter.

Remove from that box the Crossover Output Assembly (939-7930-616) otherwise known as the Crossover Bar, and Crossover Cover (943-5450-969) and associated hardware. This associated hardware is comprised of: 8 10/32x ¼” stainless steel socket head cap screw (302-0139-000) and 8 ¼”" split (314-0007-000), and ¼” washer (310-0014-000). Attach the Crossover Bar from the Combiner Pipe in the EPAC to the input connection of the Output Network Cabinet. The Crossover Output Assembly is used to connect the EPAC Combiner Pipe to the Output Network.

b. If a torque wrench is available, tighten the connection points at both ends of the Crossover Bar to a torque figure of 80 in-lbs. If no wrench is available, torque tightly, but not to the point of shearing the bolt head. Remember that a tight fit is necessary here; a snug fit is not good enough.

2.5.16 ONC Top RF Output Feedthough

Locate RF Output Feedthrough copper transmission line assembly. Place assembly inside ONC Top cabinet connecting the ONC Bottom output to the transmitter top. Use supplied hardware and tighten.

2.5.17 RF Output Connection

The RF Output connection in the transmitter is a 4-1/16 inch EIA flange connector, (male). This connector is located in the rear of the Output Network cabinet. Refer to the Cabinet Outline Diagram for the exact location of the connector. A bullet and O-ring are provided and packed separately. This combination allows mating to a male or female transmission line connector.

The transmitter output network is configured to see a 50 Ohm load with little or no reactance.

2.5.18 Dummy Load Considerations

It is very useful to be able to switch the transmitter RF output to a dummy antenna for testing. This testing frequently includes modulating with tones. With tone modulation, 100% modulation of a 220 kW carrier produces an average power of 330 kW in the load. Sustained asymmetrical modulation of a 200 kW carrier, with -100% and +135% peaks, will produce approximately 400 kW of average power that must be absorbed and dissipated by the load. When selecting a dummy load, a power rating sufficient for the type of testing to be done must be selected. The instantaneous PEAK power under these conditions will be approximately 1200 kW. The peak power should be considered when sizing a liquid cooled load using a system with a low flow rate.

2.5.19 Component Installation

Some of the Output cabinet components have been removed for shipment, and will have to be installed after the transmitter is in place. Refer to the Cabinet Outline drawings, the Overall Schematic, the Packing Check List, Factory Test Data, and the Frequency Determined Chart as needed to install these components.

2.5.20 Transmitter Grounding

Refer to Transmitter and Rectifier outline drawings 843-5523-798 and 843-5523-523 for the following discussions for transmitter grounding.

NOTE:

All grounding points in the transmitter have a brass block assembly for establishing intercabinet ground and station ground system connections.

2.5.20.1 Rectifier Cabinet Adjacent to Power Amplifier Cabinet

2.5.20.1.1 Cabinet Ground

Rectifier to PAC:

Route a 2" strap from the right sidewall termination block (6E1) of the Rectifier cabinet, through the associated slot into the RPAC. Terminate that strap on the unlabeled termination block (1E10) located on the left sidewall (as viewed from the rear) of the RPAC.

PAC to EPAC:

A 2 inch copper strap, is to be run from the termination block of the PA cabinet, interconnecting 1E2 (unlabeled) to the EPAC cabinet 2E13 (unlabeled) (see VIEWs 7, 8).

EPAC to ONC Bottom:

A 2 inch copper strap, is to be run from the termination block of the PA cabinet, interconnecting 8E2 (unlabeled) to the EPAC cabinet 2E14 (unlabeled) (see VIEWs 7, 8).

EPAC to OMC:

A 2 inch copper strap, is to be run from the termination block of the EPAC cabinet, interconnecting 2E17 to the OMC 3E18 (see VIEW 7). This strap resides wholly within the EPAC, attaching to the OMC by way of a cutout in the EPAC cabinet top.

Rectifier Cabinet to EPAC:

Where a Rectifier Cabinet side panel is located adjacent to a RPAC side panel, a 2" copper strap is to be run from 6E4 in the Rectifier Cabinet to 2E14 (unlabeled) on the EPAC sidewall loacated adjacent to the Rectifier Cabinet.

PAC to HEC:

A 2 inch copper strap is to be run from 2E11, in the Driver cubicle, to 4E19 in the HEC cabinet.

2.5.20.1.2 System Ground

At the inside rear of the PA cabinet center compartment and ONC Bottom is a block for a 4 inch wide ground strap (.020 inches thick minimum), that is to be bolted and soldered to the station earth ground. This will insure a low impedance to ground for lightning and power line transients.

The rectifier has provisions for connecting a 2" wide ground strap for connection to the station ground (Use of two 2" ground straps is required). Route a ground strap from the ground block (6E4) on the left sidewall (as viewed from the rear) of the rectifier cabinet through the sidewall slot, just above 6E4. Route, bolt, and solder this double 2" strap configuration to the station ground system common strap (see view 24). This common strap is to be no less than 4", but 6" is recommended

NOTE:

This double strap run must be physically routed (prior to positioning any cabinet adjacent to the Rectifier cabinet) to the side panel ground location, 6E4.

CAUTION:

THE TRANSMITTER MUST BE GROUNDED WITH A LOW IMPEDANCE PATH. THE OUTER CONDUCTOR OF THE RF TRANSMISSION LINE IS NOT AN ADEQUATE GROUND FOR THIS PURPOSE.

2.5.21 Coolant Hose Connections

2.5.21.1 Drain System Hose Connections

a. In the bottom front section of the HEC, there are short sections of hoses attached to the HEC header/manifold which opposite ends are wrapped in plastic bags secured by hose clamps. Remove the hose clamps and discard the plastic bags. Slide the hose open ends of their respective in-line chiller

b. Repeat the same process for the four hoses in the OMC as for Step 1.

2.5.21.2 Chiller Block Hoses

- Connect all water hoses to the Chiller-Blocks.

2.6 Electrical Connections

Refer to the transmitter and Rectifier overall schematics, and transmitter and Rectifier outline drawings, as well as site specific drawings for the following connections.

NOTE:

When a line leaves one drawing and continues on to another, symbols at the end of the line reveal where it continues. Example: 2/B8 means "Go to sheet 2 at coordinates B8".

2.6.1 AC Power Connections

2.6.1.1 Three Phase Inputs

There are 2 separate three phase AC Power feeds needed for the DX-200 Transmitter.

- 205 VAC, 3 Phase, input from the Transformer Cabinet to provide high energy power to the Rectifier Cabinet.

NOTE:

205VAC Secondary transformers are wired in a Delta-Wye or in an extended Delta-Wye configuration depending upon overall System Configuration.

- Nominal 380VAC 3 Phase input for the Blowers and single phase 220VAC for DC low voltage power supply source.

Rectifier Cabinet step-down transformers (Transformer Cabinet), tapping information will be found on a site specific or vendor supplied drawing.

NOTE:

Always refer to the supplied drawing packages for the transmitter. Variations exist from previous versions of this equipment, and the schematics will provide the correct information.

The Low Voltage Supply transformer primary is also tapped to match the line voltage. The information on what taps are available is in the Low Voltage Supply section of this manual. It is important that the single phase voltage be measured and the trasformer taps set correctly prior to the turn on of the transmitter.

2.6.2 Rectifier Cabinet

For Rectifier Cabinet component locations, see VIEWs 1 and 2 at end of section 5A.

- Connect 380VAC 3 phase blower supply from Rectifier Low Voltage AC Disconnect switch to 4FL1 in Heat Exchanger Cabinet.
- Connect 220VAC neutral and equipment ground lines from Rectifier Low Voltage AC Disconnect switch to 4FL1 in Heat Exchanger Cabinet.
- Connect transformer temperature sensor (in Transformer Cabinet) to 6TB2-3 and 4.
- Connect the 3 phase 205VAC from the Transformer Cabinet to the appropriate SCR bus bar in the Rectifier Cabinet.

NOTE:

Depending on the 205VAC entry configuration, these 205VAC cables may enter through the cabinet bottom, pass through current transformer (6T1), and be terminated directly on the SCR terminal mounting bars. See the site specific drawings for power cable entry locations, power cable sizes, and termination connector details.

- Connect the floating neutral connection from the Transformer Cabinet to the end of the F4 fuse clip that is not connected directly to terminal 6TB3-1.

2.6.3 250 Volt Connections

2.6.3.1 Supply Lines

2.6.3.1.1 Cabinet Top Routing Option (Rectifier Cabinet Separate From EPAC/PAC)

Site specific instructions to be provided if this option is used.

2.6.3.1.2 Cabinet Bottom Routing Option

When the Rectifier cabinet is next to the EPAC/PAC, the 205VDC lines may run through the access hole towards the bottom of the cabinet. In this case there will be four connections at L2-one for each PA cabinet. See paragraph 2.6.3.3 for further details.

2.6.3.2 Return Lines

2.6.3.2.1 Cabinet Top Routing Option

Site specific instructions to be provided if this option is used.

2.6.3.2.2 Cabinet Bottom Routing Option

- When the 205VDC wires run through the right sidewall (as viewed from the rear) access hole into the EPAC/PAC, the return wires connect to the meter shunt located near the base of the RPAC.
- Install 125VDC wiring from the Rectifier Cabinet through the right sidewall (as viewed from the rear) access hole into the EPAC/PAC and terminating in the RPAC.

2.6.3.3 DC 350mcm Cables Installation

a. Shipped in the EPAC/PAC plenum is a 2nd box that has only connection point labeled 350mcm cables and hardware, precut with appropriately sized cytolock connectors attached. Gray plastic stacking clamps are already mounted on the floor of each EPAC/PAC section. The hardware stack-up used for each connector is: [1/2"-13 X 2-1/4" bolt (302-0341-000), split (314-0015-000) and flat (310-0026-000) washers, and 1/2" nut (306-0034-000]. All cables are labeled at each end. The EPAC, LPAC, CPAC and RPAC cable ends are bolted to the fuse bar of the respective cabinet on the lower left sidewall mounted fuse board.

b. For ease of installation, start by removing the innerhinged lift-off doors from all EPAC/PAC cubicles. Lay the longest cables first. The EPAC and LPAC cables lay on the floor passing through the floor mounted cable clamps nearest the floor one cable on either side of the clamp stack in each EPAC/PAC cabinet section and passing under the driver cabinet mounted meter shunt before passing into the

Table 2-1 Torque Specifications

SPECIFICATION, XMTR HARDWARE TORQUES

COMPONENT	TORQUE SETTING
COMBINER PIPE/CONDUCTOR HARDWARE:	80 in-lbs
COMBINER PIPE CROSSOVER HARDWARE:	80 in-lbs
RF AMPLIFIER TRANSISTOR:	3 in-lbs
NSI INDUSTRIES, POLARIS MULTI-CABLE CONNECTOR BOX:	
#1000 with wire size 800-1000	500 in-lbs
#1000 with wire size 500-750	375 in-lbs
#500 with wire size 500	375 in-lbs
#500 with wire size 250-400	325 in-lbs
CYTOLOK COMPRESSION CABLE CONNECTOR BOLTS:	47 ft-lbs

If torque equipment not available, follow procedure as described:

Position Cytolok cable connector on stud and tighten nut with standard wrench until metal-to-metal contact of the two components is reached and they are bolted tightly. Give the nut an additional ¼ to ½ turn to put spring tension on the bolt and assure complete closure of the connector.

Check cable connections monthly for the first six months of operation, then yearly there after.

NOTE:

For use with 646MCM cable, the Cytolock connector used is the 700-750mm rated connector. For fine locomotive cable, the connector cylindrical head is positioned so the "xxx" stamp is visible; for plated conductor cable, the cylindrical head is position so the "ooo" stamp is visible. There are other cable/connector combinations for which the "ooo" stamp show, but where fine wire (welding or locomotive) cables are used, the cable/connector combination should result in a tight fit with the "xxx" stamp showing on the connector cylindrical head.

Rectifier Cabinet and being terminated on the +250VDC buss bar (four cables mount back-to-back on this buss bar). The same process applies for the CPAC and RPAC cables except they lay on top of the initially laid EPAC and LPAC cables.

c. The meter shunt resides near the floor of the driver cabinet (RPAC next to the Rectifier Cabinet). The three cable ends labeled shunt reside on top of the stack of 350mcm cables and are bolted to the left side of the meter shunt, one on the underneath side and two on the top side (no connection is made to the right side of the shunt). The opposite ends of those cables are labeled return. They are routed into the Rectifier Cabinet and up the right sidewall, as viewed from the cabinet rear, and are terminated on the return buss bar on the right side of the cabinet, as viewed from the rear, near the cabinet top.

d. Restore the inner hinged doors, previously removed, to their appropriate locations.

Upon completion of these installation procedures, recheck all screws and bolts throughout all cabinets both cabinet and electrical, for adequate tightness and dress all cables with appropriately positioned tywraps.

2.6.4 Driver and Binary Supply

See Figure 2-3.

Install 125VDC wiring from the Rectifier Cabinet.

- 6TB1-5 (125VDC - Driver Power Supply) to 1TB6-1 (RPAC)
- 6TB1-6 (Return - Driver Power Supply) to 1TB6-3
- 6TB1-14 (Binary Power Supply) to 1TB6-2.

See site specific drawings for wire size and type definition.

2.6.5 Blower Supply

See Figure 2-4.

- Connect TB1 8, 10 and 12 from the Rectifier Cabinet to the Blower Supply input in the transmitter Heat Exchanger Cabinet at 4F3, 4F4 and 4F5. Push on style connectors are required to reminate the wires at 4F3, 4F4, and 4F5. The connector part number is 354-0252-000.
- Connect 380VAC 3 phase blower supply from 4F12, 13, 14 to J1 rear door.

2.6.6 Single Phase Input

- Connect wire #2050 from 6TB6 to A2TB1.

2.6.7 Interconnect and Control Cabling

NOTE:

Refer to Figure 2-5 for WAGO style terminal block wire termination detail.

Refer to the Overall wiring diagram for a guide for the cabinet interconnections. The cables are tywrapped inside the cabinets and are run through nearby access holes to the terminal strip or connector.

2.6.7.1 PAC to HEC Cable Interconnect

a. From the front of the HEC, rolled up in bags and attached by ty wrap, one to the upper left front sidewall and one to the upper right front sidewall of the PAC are floating cables with in- line WAGO connectors attached.

b. Through an opening in the HEC base just above the location of the blue wires in the HEC cabinet, route those blue wires and their in-line WAGO connector, 4P11, to just above the base. There connect 4P11 with another wired in-line connector, 4J11, that is located just outside a plastic cable channel.

c. Through a similar opening in the HEC base just above the normal location of the four bundled gray cables attached to its WAGO connector, route that cable bundle to a gray plastic cable channel, running along a center partition, through an opening about one foot from the left end and continuing in the channel to its end on the right side of the HEC. At this point connect this cable's in-line connector (4P12/4J12) with its mating WAGO connector and cable that is located near the end of the cross cabinet channel just traversed.

2.6.8 Output Cabinet Intercabinet Wiring

2.6.8.1 Routing of 7 cable group from the ONC Bottom to the Output Monitor Printed Wiring Assembly (PWA)

a. Shipped in the rear section of the ONC Bottom is a bag of seven cables, terminated at one end in the ONC. Route the unterminated end of all of these cables into the EPAC/PAC plenum and then through the hole over the right rear door, as viewed from the rear, into the rear of the left, as viewed from the front, PAC cubicle.

b. Route the remainder of the cables from the ONC straight ahead through the hole in the center divider. The Output Monitor PWA termination points are accessible from there. Those terminations cannot yet be made, however.

c. Route the cable labeled 401-1A21J3, through a hole in the upper right sidewall of the EPAC into the left front cubicle of the PAC.

d. Remove the Output Monitor PWA from the left sidewall in the left front section of the PAC.

e. Mate the connectors of the seven cables from the ONC to the appropriate connector header on the rear of the Output Monitor PWA.

f. Remount the Output Monitor PWA to the left front PAC sidewall.

2.6.8.2 Controller Battery Backup

The transmitter's controller remembers the LOW, MED, HIGH power settings, previous Fault Status, and AC Restart Status. If the AC main power is disconnected, energy storage capacitors will provide backup power to these memory circuits for at least 5-10 minutes. If longer backup time is desired, 4 AA alkaline batteries can be installed to give backup time of over 6 days. The batteries should not be installed until the transmitter is powered up. Batteries will be installed during Initial Turn-On Procedures.

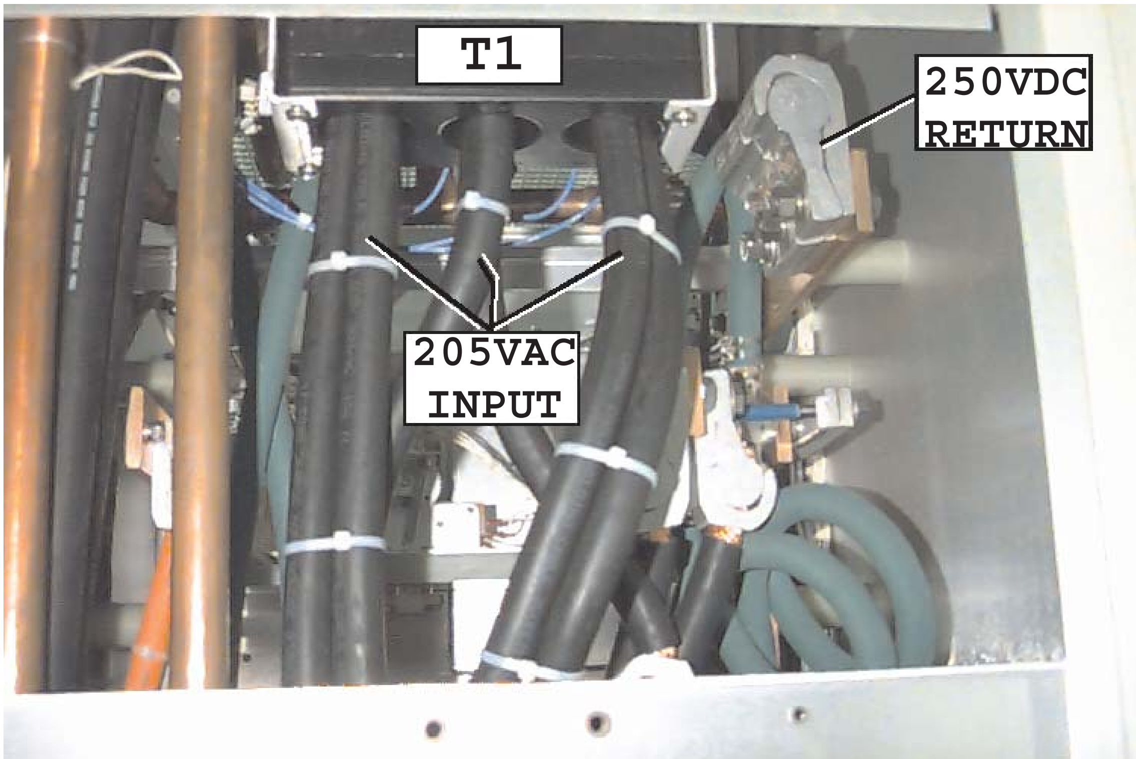


Figure 2-1. Upper Rear Rectifier Cabinet

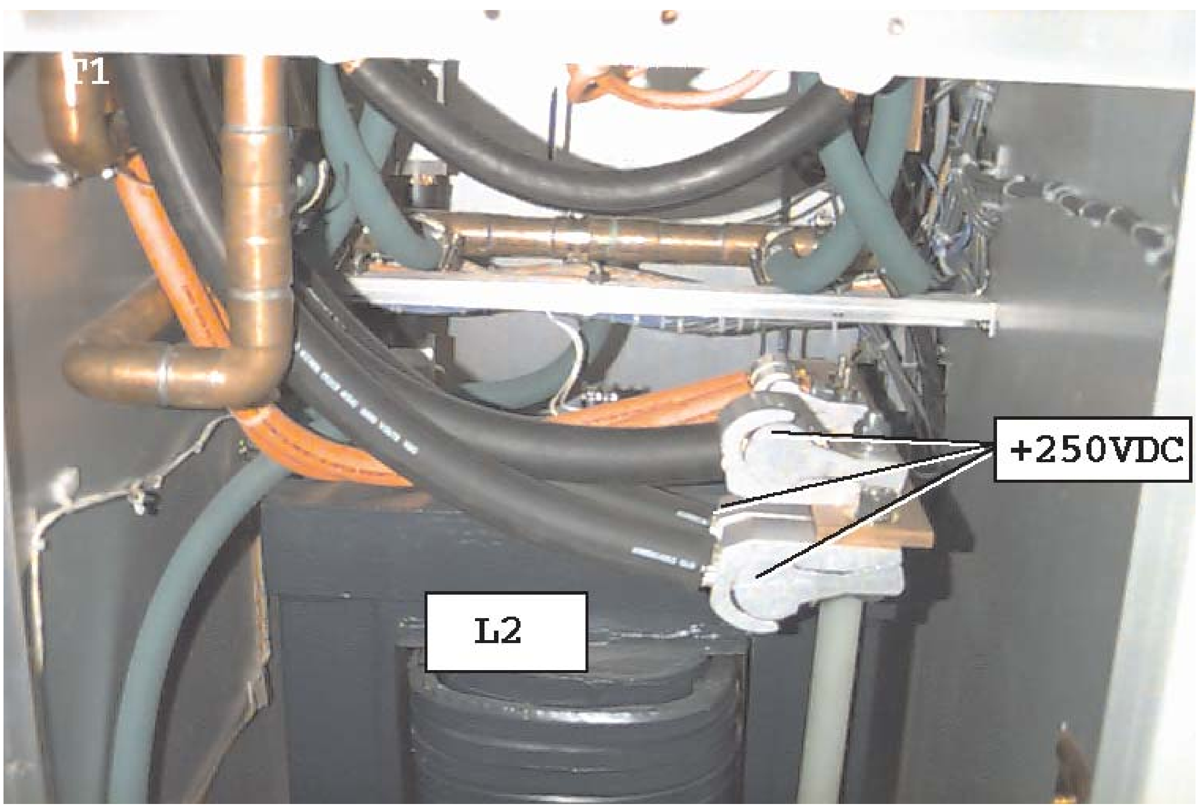


Figure 2-2. Lower Rear Rectifier Cabinet

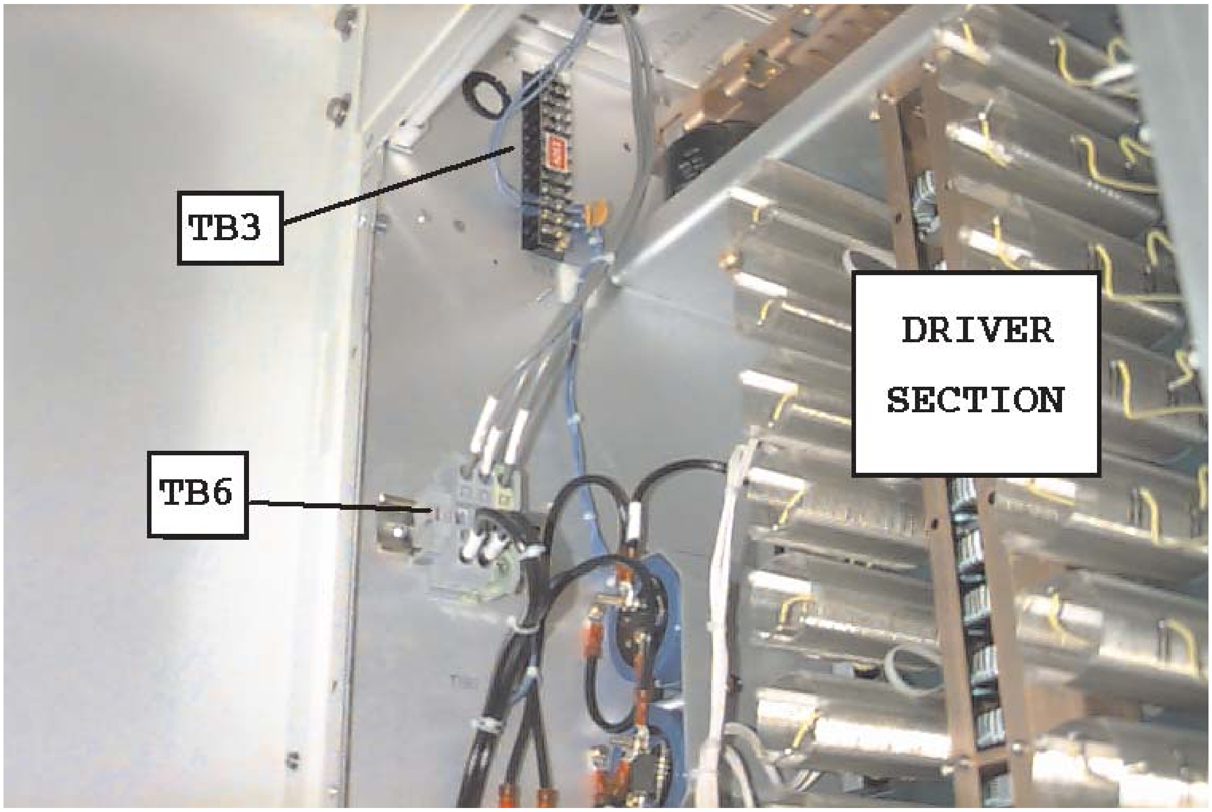


Figure 2-3. TB6

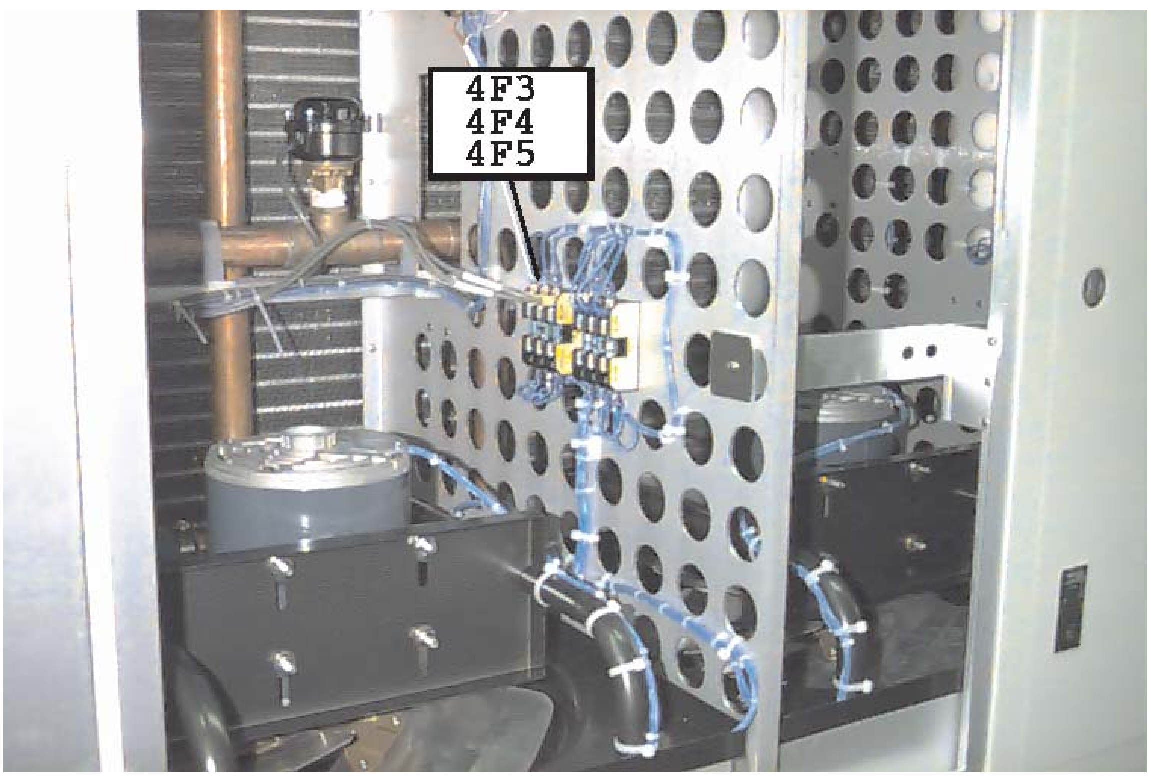


Figure 2-4. Blower Connection

2.7 Pre-Turn ON Checks

2.7.1 Mechanical

When installation has been completed, and before applying primary power for the first time, the transmitter should be inspected again, including checks in the following paragraphs and in the paragraphs on Electrical pre-turn on checks.

NOTE:

These recommended mechanical checks apply to items installed in the field and items installed in the factory. The integrity of component security and electrical connections can be compromised in the shipping process. Therefore, these checks are required for confirmation of on-site integrity.

The transmitter should be inspected for:

a. any debris
b. loose hardware
c. loose connections
d. in all of the cabinets before applying primary power. Pre-turn on checks and inspection should include checking for loose connections, in particular at the following:
e. RF Amp 250VDC Rectifier Cabinet connections, Output Cables, and Busbar Connections.
f. Output network connections and coil taps, especially at high current points. (Over tightening can strip threads or break bolts, especially where brass hardware is used). Ensure that no shipping ties, blocks, or tape remain.
g. Filter capacitors
h. Low Voltage Supplies
i. Check RF drive cable connectors. Ensure that they are seated and locked into their printed circuit board connectors.
j. Ribbon cable connectors. Ensure that cable connectors are properly locked into their printed circuit board. Connect High voltage and low voltage supply rectifier diodes.
k. Proper securing of all cooling system hoses.

2.7.2 Electrical

Before initial turn-on, ensure that the following items have been completed:

NOTE:

Ensure that the frequency setting of the Enerpro board is correct by referring to Section U.

a. A ground strap must be properly connected to the station earth ground from the EPAC/PAC and Rectifier Cabinet.
b. AC input wiring must be properly connected and connections must be tight.
c. If a frequency synthesizer, or other RF source equipment is used, it must be installed and operational.
d. The transmitter RF output must be properly terminated with a suitable load capable of handling rated output power. This can be either an antenna system or a dummy load.
e. All transmitter cabinet interconnections have been made.
f. External interlocks must be satisfied.
g. Audio input is properly connected.
h. Monitoring equipment is properly connected.
i. The Controls and Indicators section of the Section III, Operation, in this technical manual should be read and understood.
j. The REMOTE/LOCAL switch on the transmitter's Status Panel should be in the LOCAL mode.

2.8 Initial Turn-On Procedures

WARNING

IF ANY PART OF THE TRANSMITTER EXCEPT THE FRONT NON-INTERLOCKED COMPARTMENTS MUST BE ENTERED, TURN OFF THE TRANSMITTER BY DEPRESSING THE "OFF" PUSHBUTTON, SET THE REMOTE/LOCAL SWITCH ON THE STATUS PANEL TO "LOCAL," AND REMOVE PRIMARY POWER BY TURNING THE WALL DISCONNECT SWITCHES OFF. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP RECTIFIER ASSEMBLY IS DISCHARGED BY CHECKING "PA +VDC" ON THE FRONT PANEL MULTIMETER.

CAUTION

IF ANY ABNORMALITIES ARE ENCOUNTERED IN THE FOLLOWING STEPS, STOP THE PROCEDURE, REMOVE ALL POWER, AND REFER TO TROUBLESHOOTING SECTION OF THE TECHNICAL MANUAL.

Refer to View Drawings in section 5A of this manual.

The initial turn on sequence provides checks or adjustments for the following items:

a. Low voltage supplies
b. Underdrive overload test
c. Rectifier Cabinet
d. Fan rotation
e. RF driver operation
f. PA turn on
g. Matching the transmitter into its termination impedance
h. Setting modulation monitor levels
i. Modulation check and audio input level
j. Recording all meter readings
k. Controller battery backup installation

If all pertinent Installation Procedures up to this point have been completed, the transmitter is ready to begin powering up per the following sequence.

2.8.1 Using The Control Multimeter

Ensure that the frequency setting of the Enerpro board is correct. Refer to Section U, para U3.4

Control Multimeter A41 (see VIEW 4), in the Center PA Compartment, has three switch positions for reading DC voltages. These are +/-22, +/-8, and B+/B-. These three positions normally read the (+) voltage for that supply. To read the Negative voltages you must push the momentary pushbutton switch, S1 on the Extended Transmitter Interface board, A30. While the switch is activated the meter will read the negative voltage associated with that multimeter position. For example, to check the +8VDC supply, simply rotate the multimeter selector switch to the +/-8VDC position. The meter is now reading the voltage of the +8VDC supply. To read the Negative supply, push A30-S1, and as long as the button is pressed the meter will indicate the -8VDC supply.

NOTE:

There is a probe supplied as an integral component with both the Control Multimeter (Figure 3A-4) and Driver Multimeter (Figure 3A-5). These probes provide some flexibility in measurement when used with the "PROBE" position associated with each multimeter. The probes have a 60VDC maximum rating and, therefore, should never be used in any attempt to measure the 250VDC voltage applied to the PA modules.

2.8.2 Low Voltage Power Supplies Check

Find the packet shipped with the transmitter entitled "Factory Test Data." Factory data for the seven Low Voltage supplies (under no carrier or low power conditions) will be listed and is the reference for the following observations. Use the following procedure to check the Low Voltage power supplies:

a. Ensure that the transmitter's REMOTE/LOCAL switch is in the LOCAL position.
b. Ensure that Low Voltage Supplies Main circuit breakers CB1 and CB2 are in the ON position.
c. Open the Center PA Compartment Front door to gain access to the Multimeter, A41 on the left hand wall (see VIEW 4). Switch the multimeter to the +8 VDC position.
d. Apply single phase AC power to the transmitter at the main disconnect wall switch. DO NOT energize either of the 3-phase AC mains at this time. Open the RPAC's front door; on the Low Voltage Power Supply, the supply LEDs should be illuminated green.
e. Switch the multimeter to -8, +8, -22, +22, B+, B-, and +12 VDC positions and check the readings against the factory test data.

NOTE

If the readings except B+ and B-, are not within 5% of the factory test readings, remove ac power at the wall disconnect switch and review the ac power connections to the Low Voltage Power Supply Assembly. See the Low Voltage Power Supply section for the tap settings on the A3 24V transformer.

f. Check to see if the +15,-15 and +5 Power Supply indicators on the following boards are illuminated green: Modulation Encoders (A25, A26, A27, A28, A29, A30 & A31), Analog Input (A22), A/D Converter (A32), Output Monitor (A21), Power Block Interface (A23), Controller (A31), and Extended Transmitter Interface (A30). If any of these supplies are missing, refer to the Transmitter Troubleshooting Section.

Also, the ColorStat™ front panel display LEDs should then illuminate red or green. Depress the Reset Button on the ColorStat™ front panel display. All LEDs should illuminate green.

2.8.3 AC Phase Monitor And Underdrive Overload Check

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Turn off A56 CB1 and A56 CB2 in the RPAC (See VIEW 2).
b. Remove F1 through F8 on the Fuse Boards A36 through A42 (See Views 9, 11, 12, 13).
c. On Fuse Board A36 (see VIEW 13) remove F9.
d. Remove F1 and F2 on the upper half of the left sidewall.
e. Open the RPAC front door and remove the Buffer Amp A4 (See VIEW 2). Remove F1 and F2 from the Buffer Amp and replace the Amp back in the transmitter. Close the Right PA compartment inner door.

Now all of the power supplies have been removed for the RF Amplifiers, Binary Amplifiers, Predriver Amplifier and the Buffer Amplifier.

Apply an RF Mute using switch S1, located on the Controller board A31 (see VIEW 3), by moving it to the mute position. This will not allow any of the RF Amplifiers to be turned on. Adjust the front meter panel multimeter switch to PA +VDC.

NOTE:

There are two 3-phase feeds to the transmitter. One is for the fan motors and one is for the feed to the Rectifier. Both must be activated.

2.8.3.1 Test Sequence

a. Turn Single phase AC Mains ON and both 3-phase AC Mains ON.
b. On the Rectifier Cabinet Display panel, the 3-phase AC Mains and 1-phase Input Monitor AC Mains indicators-must be illuminated green. If any one of these indicators is not green, refer to the A/C Control - A/C Mains LED Illuminated paragraph in the Troubleshooting Section, Section VI.
c. The remainder of the Rectifier Cabinet Display LED Panel should have all LEDs illuminated green; if there are any red LEDs illuminated depress the RESET button. If any red indication does not reset, resolve the problem before proceeding.
d. Depress the HI, MED, or LOW power level push button, and note the following:
    1. The Step Start contactor K1 will energize momentarily.
    2. The PA +VDC meter on the front panel should deflect upscale about half way and quickly return to 0 VDC each time K1 de-energizes.

There should be no deflection of the front panel Current Meter.

3. The LEDs assigned to the RF AMP LOW DRIVE, FUSE, BUFFER AMP, PREDRIVER, RF MUTE and A/D CONVERTER CONVERSION ERROR will change to red and remain red until the display is reset again.
4. K2 run contactor should not have energized.
5. These events should all occur within 1 second.

If the sequence was not correct, refer to the Troubleshooting Section for determining the cause of the problem before executing the next step.

2.8.4 Driver Section Check

This test will verify the 250 and 125 VDC supply voltages as well as proper operation of the driver section. This test is also done with the all the fuses removed from the Fuse boards. The Driver Supply fuses F1 and F2, and Predriver Supply fuses F1 and F2 located on the Buffer Amp are to be reinstalled.

2.8.4.1 Test Sequence

a. Remove all AC power from the transmitter.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RECTIFIER CABINET IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. Open the right PA compartment rear door and install F1 and F2 in the fuse block. Close the rear door.
c. Open the right PA compartment inner door and replace F1 and F2 on the Buffer Amp A4. Close and secure the right PA compartment inner door.
d. Turn Single phase AC Mains and both 3-phase AC Mains feeds ON.
e. Turn on A56 CB1 and A56 CB2.
f. Clear any Faults on the ColorStat™ Panel by pressing the Reset button.
g. Depress the LOW power level push button and observe the following:
   1. Step start sequence completes (two small "clicks", simultaneously) and PA +VDC voltage rises up to a nominal 250VDC on the front panel meter. RF Mute and Fuse Indicator fault on the ColorStat™ front panel display will illuminate red. This is normal for this stage of the procedure.
   2. Step start sequence does not complete due to an RF AMP LOW DRIVE or other fault, check the ColorStat™ front panel to see the fault(s) causing the overload. Refer to the troubleshooting section of the manual to determine the cause, and correct before proceeding to the next section.
   3. Step start sequence does not complete due to an RF AMP HIGH DRIVE or RF AMP RECTIFIER ASSEMBLY VOLTAGE FAULT. Refer to the troubleshooting section of this manual to determine the cause, and correct before proceding to the next section.
h. Depress the OFF pushbutton, while looking at the PA+VDC position and observe that the voltage drops to near zero within about 2 seconds. If the voltage bleeds off slowly, refer to the Troubleshooting Section on the RF AMP RECTIFIER ASSEMBLY Discharge Circuit (Crowbar).
i. If the Step Start and Discharge checks are correct, depress any of the power level pushbuttons and change the front panel multimeter selector switch to RELATIVE RF DRIVE and compare it to the Factory Test Data.
j. Compare the parameters on the Driver Multimeter, A9 (VIEW 1) to the Factory Test Data. The positions are:
   1. PREDRIVER IDC
   2. PREDRIVER +VDC
   3. BUFFER +VDC
   4. DRIVER +VDC
   5. DRIVER IDC.
   6. LEFT DRIVER +VDC
   7. RIGHT DRIVER +VDC

NOTE:

If these readings are not within 10% of Factory Test Data, refer to the Troubleshooting Section and resolve the problem before continuing.

2.8.5 Power Amplifier Turn On

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP RECTIFIER ASSEMBLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

Replace all fuses removed in the previous sections, close all doors and replace all panels. On the Analog Input board A22 (see VIEW 3) rotate potentiometer R66, R67, R65, and R68 fully counter-clockwise (CCW). Verify that P4 (power control) is jumpered 2-3, and move S1 to the calibrate position.

2.8.5.1 Low Power Checkout (20 kW)

a. Single phase AC Mains OFF, both 3 phase AC Mains OFF.
b. Reverse VSWR sample polarity on the RF Power Sample Board in the ONC by switching S7 to the CAL position.

NOTE:

Failure to turn transmitter off, prior to reversing the VSWR sample polarity, may result in damage to the sample toroid.

c. Single phase AC Mains ON, both 3 phase AC Mains ON.

d. Depress the LOW power push button. The transmitter PA power supplies should come up as before, and recheck all meter readings with Factory Test Data. Change the Multimeter selection switch from PA +VDC to NETWORK NULL. Power meter selector switch should be in FWD. On the Controller move S1 from MUTE to NORM and begin raising the RF forward power by slowly turning R66 clock-wise. Observe that Power and Current should increase, and the green LED (DS3) on the center of those RF amps that are turned on should be illuminated.

NOTE:

Stop increasing power when Forward power of 20 kilowatts is reached or VSWR trips occur.

e. At approximately 14 kW, check that a VSWR trip occurs and power is reduced. Once this condition occurs, turn the transmitter OFF. Return the VSWR sample to the original position by switching S7 on the RF Power Sample board to NORM and skip to paragraph (f.).

If the transmitter hasn't tripped by the time the Forward power reading reaches 20kW, the VSWR sample/detector circuitry operation must be checked and/or corrected before proceeding. Refer to the Troubleshooting and Alignment procedures for the RF Power Sample board in Section H of this manual. After restoring the VSWR detector to correct operation, restart this Low Power checkout procedure.

f. Using the front panel meters, verify the following conditions:

1. PA +VDC = 240 to 250 volts
2. PA Current = 115 to 135 amps.
3. # of RF Amps ON = 23 to 27. Following the View Drawings 2, 4, 5 and 6, count the number of illuminated green LED's on the RF Amplifiers.

g. If not within these parameters, adjust the TUNE control for a peak in power output. This adjustment can be somewhat broad at frequencies lower that 900 kHz. Reverify the above conditions.

h. Do an RF Amp feel test by moving your hand about 1 inch in front of the RF Amp doors to feel the air temperature. It should only be slightly warm. The purpose of this test is to locate a noticeable difference between modules that would indicate a loose drive cable, efficiency coil problem, etc.

1. If the Network Null is 2 or higher (0-10 scale), adjust loading and tuning to null. If less than 2 proceed with this test. NETWORK NULL and ANTENNA NULL may begin to rise depending upon how much of a mismatch there is between the station load and the factory test load. The antenna VSWR detector may have to be renulled if ANTENNA VSWR trips occur at a certain power level. The NETWORK NULL should null when the TUNE and LOAD controls are adjusted. If you are unable to reach 20 kW due to an ANTENNA VSWR or NETWORK VSWR, refer to the Output Monitor alignment paragraphs in Section H. This section will have you match the transmitter into the load at lower power levels and adjust the ANTENNA NULL and/or NETWORK NULL if needed. Complete the alignment procedure described in section H, before proceeding.

NOTE:

To measure Antenna Null, you must connect a multimeter to the VSWR Detector Output TP16 on the RF Power Sample Board, or TP36 on the Output Monitor Board. If the transmitter has a front panel multimeter with an ANTENNA NULL position, that may be used instead.

2.8.5.2 Low Power Checkout (50 kW)

a. Adjust R66 for 50 kW.

b. Check the 50 kW meter readings with the readings on the Factory Test data sheets. If all are within 10%, adjust R66 for the desired Low power level and proceed with the 50 kW checkout.

c. If meter readings are not within 10%, adjust the TUNE and LOAD controls as follows:

1. Adjust the TUNE control for a peak in power output. This adjustment can be somewhat broad at frequencies lower that 900kHz.
2. Count the number of RF Amps ON, as described earlier. Adjust the power level control until the proper number of RF Amps are turned ON and then adjust the LOAD control for the correct power output. Example - if the number of RF Amps ON is 42 and the Factory Test Data lists 45, raise the power until 45 RF Amps are ON. Adjust the LOAD control for 50 kW.
3. Readjust TUNE and LOAD if required.

2.8.5.3 Medium Power Checkout (100 kW)

a. Press the MED power push button, and adjust R67 clockwise until 100 kW is reached. Repeat the tuning and loading steps at 100kW as were performed for 50kW.

b. Repeat the Temperature feel test as performed during the Low Power Checkout. Compare the meter readings with the Factory Test Data.

c. If all meter readings are within 10% of the Factory readings, adjust R67 for the desired MED power level.

d. If meter readings are not within 10%, adjust the TUNE and LOAD controls as follows:

Adjust the TUNE control for a peak in power output. This adjustment can be somewhat broad at frequencies lower that 900kHz.

Table 2-2 Power vs. PA Level vs. Modules On

Power	PA +VDC	PA Current	Modules On
20 kW	240-250 VDC	115 - 135A	23 - 27
50 kW	240-250 VDC	215 - 235A	41 - 45
100 kW	240-250 VDC	435 - 465A	65 - 68
200 kW	240-250 VDC	880 - 920A	92 - 103

Count the number of RF Amps ON, as described previoiusly. Adjust the power level control until the proper number of RF Amps are turned ON and then adjust the LOAD control for the correct power output. Example - if the number of RF Amps ON is 65 and the Factory Test Data lists 67, raise the power until 67 RF Amps are ON. Adjust the LOAD control for 100kW.
Readjust TUNE and LOAD if required.

2.8.5.4 High Power Checkout (200 kW)

a. Press the HIGH power push button, and adjust R65 clockwise until the 200 kW level is reached or R65 runs out of range. If the power can be increased to 200 kW, the PA Supply Current should be between 880 Amps and 920 Amps depending on the AC line voltage.
b. Verify all meter readings are within 10% of the Factory readings.
c. If 200 kW cannot be reached and R65 is out of range the transmitter is not tuned correctly into the load. Proceed to the Final Match into the Test Load section.
d. If meter readings are not within 10%, adjust the TUNE and LOAD controls as follows:

   Adjust the TUNE control for a peak in power output. This adjustment can be somewhat broad at frequencies lower that 900kHz.
   Count the number of RF Amps ON, as described previoiusly. Adjust the power level control until the proper number of RF Amps are turned ON and then adjust the LOAD control for the correct power output. Example - if the number of RF Amps ON is 98 and the Factory Test Data lists 102, raise the power until 102 RF Amps are ON. Adjust the LOAD control for 50 kW.
   Readjust TUNE and LOAD if required.

NOTE

R68 is the Power Control Bypass Potentiometer. This should be left in the full counterclockwise position. In the event that the Normal power control mode becomes inoperative, refer to the bypass procedures in the Emergency Operating Procedures, Section VIA.

2.8.6 Air Flow And Temperature Check

If there is moderately insufficient air flow for cabinet flushing, the transmitter will continually execute a POWER FOLDBACK protection function. This is displayed on the ColorStat™ front panel display as ANALOG INPUT POWER FOLDBACK, and COOLING REDUCED.

If there is excessively insufficient air flow, the transmitter will eventually shut OFF and display COOLING FAULT. COOLING reduced/fault and/or TEMP fault can indicate insufficient air.

The same COOLING/TEMP fault indications can occur as the result of insufficient heat removal by way of the liquid cooling system or leaks in that system, and/or ONC TUNING control misadjustment.

2.8.7 Setting Modulation Monitor Sample Levels

The Modulation Monitor sample is set for the proper level for use at the LOW power setting by selection of the appropriate values of capacitors for the Modulation Monitor capacitve voltage divider 8C92, 8C93, & 8C94 in the ONC. This is accomplished in the factory, therefore eliminating the need for any field modifications or adjustments of the Modulation Monitor Sampling network when shifting from one output power to another.

NOTE:

The maximum safe modulation monitor sample voltage is 10 volts rms, into a 50 Ohm load. The coaxial cable from the Transmitter's modulation monitor sample output, J1, should be terminated with a 50 Ohm termination. This termination should have at least a three watt rating.

2.8.8 Modulation Check

Before applying RF to the Modulation Monitor, check its specification for the maximum allowable RF input amplitude that can be applied. Condition the input path accordingly.

For operational monitoring or non-critical tone testing, place JP6 on the Ouput Monitor board to the AGC position. The AGC action maintains equal Modulation Monitor sample amplitude, regardless of the power level of the transmitter.

For critical distortion testing of the transmitter, place Output Monitor JP6 in the Bypass mode. Adjust the carrier amplitude control of the Modulation Monitor to establish the proper operational level for the LOW, MEDIUM, or HIGH power mode being used.

The transmitter is now ready for modulation. During this check, monitor the RF envelope by connecting an oscilloscope in parallel with the modulation monitor RF input.

Check for proper modulation at various power levels, as follows:

a. Connect an audio oscillator into the transmitter's audio input.
b. Turn the transmitter on at LOW power.
c. Apply a low level audio signal (a sine wave at about 400 Hz to 1 kHz), while observing the modulation monitor and the oscilloscope.
d. Increase the oscillator output until modulation level is about 50%.
e. Observe the modulated RF signal on the oscilloscope; the modulation envelope should be a smooth sine wave, with no steps, notches, or other distortion.
f. Switch to MEDIUM power. The transmitter will maintain the same modulation level.
g. Again, observe the modulated RF signal on the oscilloscope. The modulation envelope should still be a smooth sine wave.
h. Switch to HIGH power. The modulation level will still be the same.
i. Once more, observe the modulated RF signal. The modulation envelope should still be a smooth sine wave.

j. Increase the modulation to 95% negative peak modulation. Observe the waveform again.

k. If a distorted envelope is observed in any of these steps check the audio oscillator output with the oscilloscope before referring to the transmitter Troubleshooting Section.

l. Verify that output power and modulation level are the same as used for the factory test, and adjust if necessary.

m. Check all meter readings against the factory test data sheets. Meter readings should be close to factory readings for the same High Power level and modulation level. Note that the front panel "CURRENT" meter reading depends on power output AND modulation level. This meter reads the average current returning to the high voltage supply. Because PA voltage is fixed, PA current depends on total transmitter power output, which varies with modulation.

2.8.9 Setting Audio Input Level - ACC Option Not Active

The Audio Input sensitivity of the transmitter can be adjusted with the AUDIO GAIN ADJ control on the Analog Input board, so that audio input levels of -10 dBm to +10 dBm at 600 Ohms will produce 100% modulation. This is Factory set for +10 dBm. If a level other than +10 dBm is desired, use the following procedure for this adjustment:

a. Set the Audio Generator for the desired audio level for 100% modulation. (Typical levels are 0 dBm or +8 dBm, but the transmitter can accommodate reference levels from -10 dBm to +10 dBm at 600 Ohms.)

b. Switch the transmitter to HIGH power. Locate the "Audio Gain Adjust" control, on the Analog Input Board. This control is R54.

c. Adjust the "Audio Gain Adjust" so that modulation level is 100%, as read on the modulation monitor.

d. This completes audio input level adjustment.

2.8.10 Performance Tuning

The TUNE control may be adjusted slightly off the power peak in either direction for optimum performance.

NOTE:

THE TUNING CONTROL SHOULD NOT BE ADJUSTED MORE THAN 8000W OFF OF THE POWER PEAK WHEN OPERATING AT 200 kW.

Most efficient operation occurs at the power peak or slightly on the inductive side of resonance. At the high end of the AM band this could be 2-3 turns CCW and at the low end of the AM band this could be as many as 20 turns. TUNING OFF THE POWER PEAK IN THE CAPACITIVE DIRECTION (clockwise) can produce lower transmitter efficiency and higher RF Amp dissipation.

2.8.11 Asymmetrical Audio Phasing Verification

Connect a program source or audio frequency generator with asymmetrical output to the transmitter audio input terminals. Turn the transmitter on, at any power level, and modulate with asymmetrical audio. Adjust the program level so that negative peaks just reach -100%. Observe positive peak modulation levels.

If positive peaks are about 100%, the program source is not capable of higher positive peaks than negative peaks, or possibly the processing equipment is not adjusted properly. If positive peaks are GREATER than 100%, your audio input phasing is correct. If positive peaks are LESS than 100%, try reversing the two audio signal leads, either at the audio output supplying the transmitter or at the transmitter audio input terminals.

2.8.12 Recording Normal Meter Readings

Harris highly recommends that a permanent record of ALL meter readings be made on a routine basis, with carrier only (no modulation) and with modulation at one or more levels (-95% should be one level). A sample form for meter readings is contained in the Controls/Indicators section of this manual. Data should be taken using the primary or main antenna system and a dummy antenna (dummy load) if one is available. A dummy load will provide the most repeatable set of conditions.

2.8.13 Battery Backup

If Battery Backup for the Controller's power mode and power level memory is desired, the batteries should now be installed in the Extended Transmitter Interface board. This will allow the Controller to maintain its memory setting for an extended period with the 220VAC removed. Without the batteries, or some other +6VDC 100mA source being in place, the Controller will typically store the the fine power setting for approximately 20 minutes.

2.8.13.1 Installing Batteries

The batteries should be installed while the supply voltage is ON. If the batteries are installed without the low voltage on the action of charging up the capacitor back up will drain them rapidly. Check battery polarity on the holder, and simply insert 4 AA size alkaline cells in the battery holders on the Extended Transmitter Interface board. Do NOT use Carbon Zinc or other rechargeable batteries, such as NiCad batteries.

2.8.14 Adaptive Carrier Control (ACC) (optional)

If the Adaptive Carrier Control (ACC) option is incorporated in transmitter system, the audio input adjustment on Analog Input board is different from that of a non-ACC transmitter. For ACC circuit discussion and setup procedures, see the ACC manual.

2.9 Remote/Extended I/O Connections

Transmitter extended/remote control interface occurs on the Power Block Interface board. This includes interfacing elements of what might traditionally be found on what is often called the "customer interface" board or "user interface" board. This would include signals for functions of control, monitoring, audio source, and interlock, etc.

Drawing 839-8154-008 (Power Block Interface board) details these interfacing specifics for individual power block functions, as those functions affect a transmitter. Also, the drawing details the fundamental treatment of how the individual Power Block relates to the Transmitter Control Unit (TCU) used in multiple power block systems.

2.9.1 Customer Connections to Power Block Interface Board

In the Installation Parts Bag, there is connector (PN 612-1456-000). This connector is to be wired as per customer needs and be connected to 1A23J3 on the Power Block Interface Board.

See 843-5547-102 for J3 Remote Control I/O.

For reference, below are denoted the several types of electronic interface facilitation circuits used. Simple relay contact closures and opens and/or electronic voltage two state sources satisfy the particular requirements of these interfacing circuits.

Figure 2-5: Status outputs at “x” are open-collector integrated circuit outputs to ground. When the corresponding, externally located, status indicator is illuminated, the transistor inside the IC turns on providing a current sink from the status output to ground. Maximum safe voltage at a status output terminal is +15VDC, and a maximum safe current into a status output is 100mA.

Figure 2-6: Monitor Voltage metering outputs are nominally a fixed VDC value from a low impedance source, for a normal Transmitter meter reading at 200kW output. Connecting metering outputs to any input other than a high impedance circuit will reduce this level.

The Transmitter FWD and REFLD power meter indications are not linear. The voltage outputs at forward power output and reflected power output are proportional to the Transmitter RF output voltage, and are proportional to the square root of the respective output power value. Reflected power will be zero if no reflected power exists

The RF amp supply volts/current outputs correspond to the Transmitter current and PA +VDC meter indications. They are uncalibrated samples from the +250VDC power supply and will vary depending upon output power level present.

NOTE:

The load impedance connected from the outside world, at any of the J3-17 through J3-20 terminals, must be greater than or equal to 1000 Ohms.

Figure 2-7: This is an extended/remote control, optically isolated input to the Transmitter. To initiate the described action, a momentary (i.e. >100mSec) ground (0V) must be applied to the “x” terminal. The ground sink must sustain 15 VDC at 40mA.

To prevent the described action from occuring, the diode/cathode voltage must be less than 1 VDC.

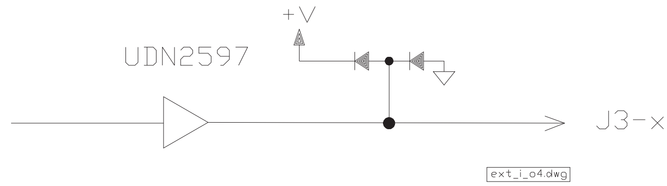


Figure 2-5

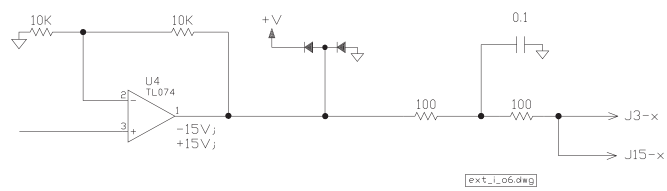


Figure 2-6

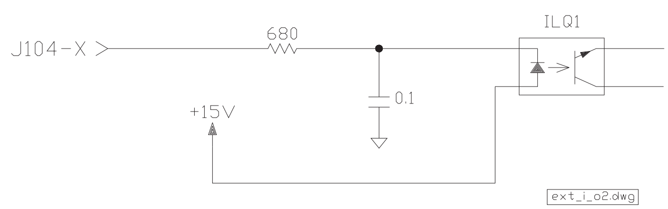


Figure 2-7

2.10 Key Interlock System

2.10.1 Function

The function of the Keylock system is to prevent inadvertent access to the higher power/voltage areas of the transmitter while power is still applied. This is accomplished by having these areas secured by keylocked assemblies.

The key(s) that activate a given assemblyÀÀs safe position reside in the preceding assembly, according to system logic, when in the normal transmitter operational mode. In order to acquire a particular key, the power must be removed from the preceding stage(s).

2.10.2 Location

The various components of the keylock system are located on most of the major assemblies making up the DX©200 Transmitter [AC Main Distribution Switch, Rectifier Low Voltage AC Mains Disconnect Switch, Rectifier Cabinet, Output Network Cabinet, and EPAC/PAC].

2.10.3 Block Diagram Description

The following discussion describes the method to service a typical system. The AC Mains Distribution switch is always site specific, therefore a site specific keylock system drawing is provided for reference in the drawing package for each site. In some applications, the switch cabinet may be a circuit breaker within an AC distribution panel.

2.10.4 Transmitter Servicing

Reference is made to Figure 2-8, Typical DX-200 Keylock System Diagram, throughout this discussion.

Keylock system flow is as follows: To perform transmitter service the AC Mains distribution switch is deenergized (turned-off). Then the Main Distribution (**MD**) key is rotated and removed. This key is taken to the Rectifier Low Voltage AC Mains Disconnect keylock assembly. Once inserted and rotated, the Rectifier Cabinet (**REC**) keys are available for removal. The **REC** keys provide two possible functions, (1) Rectifier Cabinet access by way of front and/or rear doors, (2) Output Network and EPAC/PAC access by way of the Rectifier Cabinet DC Earthing Switch (**PSR**) key and the Output Network Earthing Switch (**TX**) keys. Four **TX** slave keys are available to open the rear door of the Output Network Cabinet and/or any of eight EPAC/PAC Cabinets doors.

2.10.4.1 Routing Example 1 - Transmitter

The following example will provide further familiarization with the keylock system routing as well as describe how the keylock system assures the safety of the technician:

2.10.4.2 Routing Path

Assume that you wish access to the Center PAC Rear Cabinet.

a. This cabinet requires a key labeled **TX** which is released by the Output Network Earthing Switch.
b. In order to engage the RF Earthing Switch, a key labeled **PSR** must be obtained from the Rectifier cabinet.

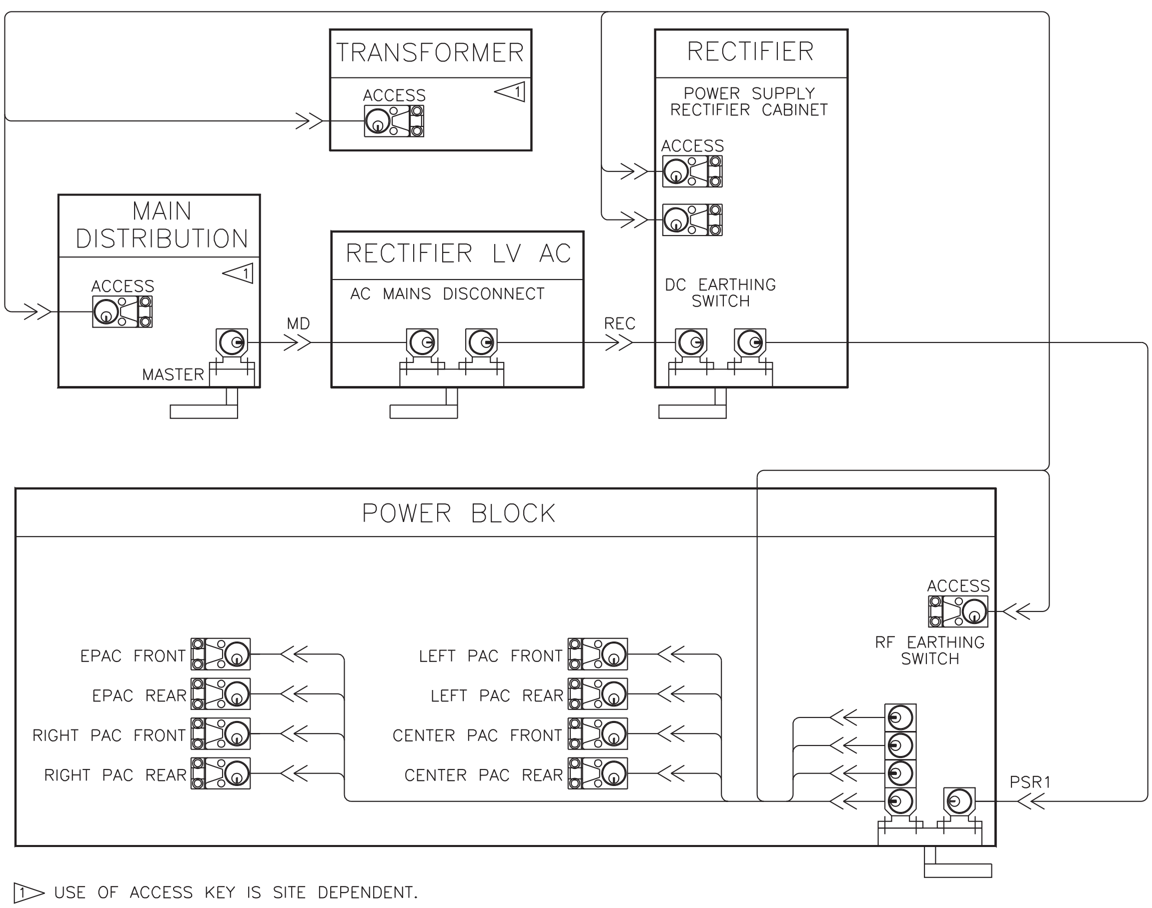


Figure 2-8 Typical DX-200 Keylock System Diagram

c. In order to release the **PSR** key, the Rectifier Cabinet DC Earthing Switch must be engaged.

d. In order to engage the DC Earthing Switch, a key labeled **REC** must be obtained from the Rectifier Low Voltage AC Mains Disconnect Switch.

e. To release this key, another key, labeled **MD**, must be obtained from the Main Distribution Switch Cabinet.

f.

2.10.4.3 Routing Path Details

a. Rotating the **MD** key from its transmitter on position allows the key to be removed moving a keylock plunger into appropriate position to inhibit the application of 205VAC to the Rectifier Cabinet SCR power supply.

b. Inserting and rotating the **MD** key in the Rectifier Low Voltage AC Mains Disconnect Switch locking assembly physically inhibits the switch from applying 380/220VAC to the Rectifier Cabinets and Transmitter once the manually operated switch has been moved to the open position, and releases the **REC** keys for removal from the Keylock transfer assembly.

c. In this example, one **REC** key is inserted into the DC Earthing Switch locking assembly. Rotating the key allows the switch mechanism to then be positioned such that an earth (ground) is placed on the Rectifier 250VDC output line while simultaneously releasing the **PSR** key for removal.

d. The **PSR** key is then rotated and removed for insertion into the RF Earthing Switch locking assembly in the Output Network Cabinet.

e. Insertion and rotation of the **PSR** key allows the switch mechanism to then be positioned such that an earth (ground) is placed on the RF output line while simultaneously releasing the **TX** keys for removal from the Output Network keylock transfer assembly.

f. Rotation and removal of an **TX key can then occur which subsequently is inserted in Center PAC Rear Door lock unit for key rotation there and release of the door for opening.**

The process for returning the system to transmitter ready status is the reverse of the immediately preceding steps.

2.10.4.4 Routing Example 2 - Rectifier Cabinet

Assume that you wish access to the Rectifier Cabinet.

a. First, the AC Mains distribution switch is deenergized (turned-off). Rotating the **MD** key from its transmitter on position in the Main Distribution Switch Cabinet allows the key to be removed moving a keylock plunger into appropriate position to inhibit the application of 205VAC to the Rectifier Cabinet SCR power supply.

b. Inserting and rotating the **MD** key in the Rectifier Low Voltage AC Mains Disconnect Switch locking assembly physically inhibits the switch from applying 380/220VAC to the Rectifier Cabinets and Transmitter and releases the **REC** keys for removal from the Keylock transfer assembly.

c. An **REC** key is rotated and removed from the Rectifier Low Voltage AC Mains Disconnect Switch transfer assembly, and subsequently inserted into the Access-Front or Access-Rear Rectifier Cabinet Door locking assembly, as desired, and rotated facilitating the opening of the door.

The process for returning the system to transmitter ready status is the reverse of the immediately preceding steps.

2.10.5 Overall Safety Integrity

The integrity of this system is predicated on the exercise of personal and corporate discipline with respect to the use of the keys. Paramount to this reality, is the handling of the **MD** key anytime it is removed from the Main Distribution Switch Cabinet lock assembly. This can happen, for example, when the antenna system is to be worked on, which would not require the **MD** key to be captured elsewhere in the keylock system, which capture would naturally take place if the transmitter, itself, was being serviced.

The **MD** key must be secured such that only a designated person can retrieve the key from a secure location, otherwise that key might be inadvertently and accidentally used to energize the transmitter while external RF systems were being serviced.

WAGO Clamp Operation

To prepare wire, strip insulation back approximately 1/2" and then twist strands back into their natural position. A small size flat blade screwdriver is an appropriate tool to operate the cage-clamp.

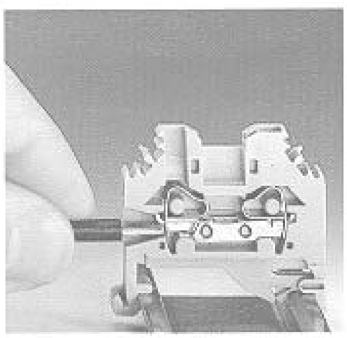
Side-entry:

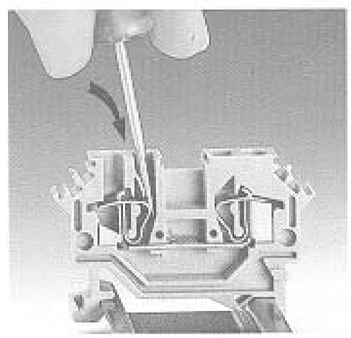
Depression of the cage-clamp spring from the top, wire entry from the side.

Front-entry:

Depression of the cage-clamp spring and wire entry from the front, both under visual control of the operator.

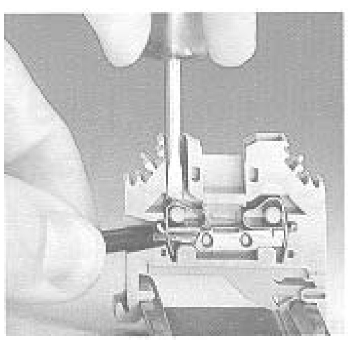
1. The stripped wire is introduced up to the cage-clamp.

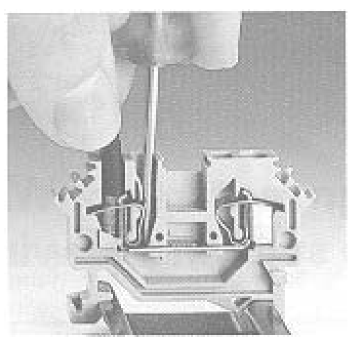




1. The screwdriver is inserted into the operating slot with a rocking motion, up to the stop.

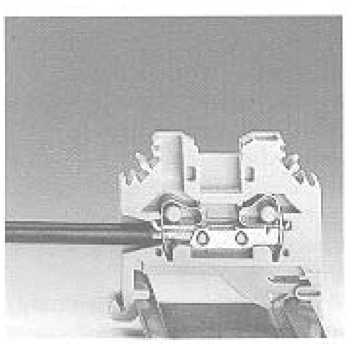
2. The cage-clamp is pressed down with screwdriver blade, and the wire is fully inserted.

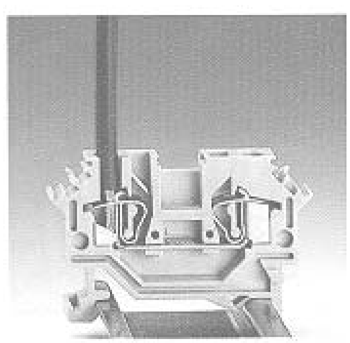




2. The screwdriver is captivated, holding the clamping spring open while the stripped wire is fully inserted.

3. The screwdriver is withdrawn and the wire is automaticlly clamped.





3. The screwdriver is withdrawn and the wire is automatically clamped.

Figure 2-9 Operation of WAGO clamp

Table 2-3 Installation Check List - DX200 Transmitter

<u>Initial Tasks</u>

- ☐ Unpacked and Shipping Damage Inspection
- ☐ Factory Test Data

<u>Transmitter Placement</u>

- ☐ Transformer Cabinet (If mounted adjacent to Rectifier Cabinet. If not, this is an independent task)
- ☐ Rectifier Cabinet
- ☐ EPAC/PAC Cabinet
- ☐ Heat Exchanger Cabinet (HEC)
- ☐ Output Matching Cabinet (OMC)
- ☐ Output Network Cabinet (ONC) Top
- ☐ Output Network Cabinet (ONC) Bottom
- ☐ Bolt Rectifier Cabinet to PA Cabinet
- ☐ Bolt OMC to HEC
- ☐ Bolt HEC to PA Cabinet
- ☐ Bolt EPAC/PAC to OMC
- ☐ Bolt ONC Top
- ☐ Bolt ONC Bottom

<u>Transmitter Interconnect Cabling</u>

- ☐ Rectifier Cabinet to PA Cabinet
  - ☐ Intercabinet Ground - 6E1 to 1E10 (RPAC)
  - ☐ Intercabinet Ground - 6E4 to 2E14 (EPAC)
  - ☐ 6TB1 to 1TB6
  - ☐ 6TB2 to 1A23J2 on Power Block Interface board
  - ☐ 250VDC Bus Bar Output (E2) to each of: 1E20, 1E22, 1E24, and 1E26
  - ☐ 250VDC Bus Bar Return (E3) to 1E12
- ☐ Rectifier Cabinet to HEC
  - ☐ 6TB1 (Fan/Blower) to 4F3, 4F4, and 4F5
- ☐ PA Cabinet to HEC
  - ☐ Intercabinet ground - 1E11 to 4E19
  - ☐ 4P11 to 1A56A4
  - ☐ TB5 (4P12) to 4J12
  - ☐ Plumbing hoses
- ☐ EPAC/PAC to OMC
  - ☐ Intercabinet Ground - 2E17 to 3E18
  - ☐ Plumbing hoses
- ☐ EPAC/PAC to ONC
  - ☐ Output Monitor (A21) Connections (7ea)
  - ☐ Earthing Switch Assembly
  - ☐ Output Connection Feed Through
  - ☐ 8P8 to 8J8
- ☐ HEC to OMC
  - ☐ Plumbing hoses
- ☐ External Rack to RPAC (if required)
  - ☐ External RF source to Oscillator board

<u>Connect AC Input Power</u>

- ☐ 3 phase 205VAC - From Transformer Cabinet to Rectifier Cabinet TB5 through TB7
- ☐ 205VAC Floating neutral - From Transformer Cabinet Neutral terminal to 6FL3 in Rectifier Cabinet
- ☐ 3 phase 380VAC - From customer supplied AC source to Rectifier Low Voltage Mains Disconnect Switch
- ☐ 3 phase 380VAC - From Rectifier Low Voltage Mains Disconnect Switch to 6FL1
- ☐ 220VAC from Rectifier Cabinet, to 1A56A2 in PAC R
- ☐ 3 phase 380VAC from Rectifier Cabinet TB1 to Heat Exchanger Cabinet Fuse Block

<u>Remaining Overall Transmitter Installation Tasks</u>

- ☐ RF Output Transmission Line to feed through in ONC top and output to load or antenna system
- ☐ Liquid Cooling System
- ☐ Station Ground connected to Rectifier Cabinet
- ☐ Station Ground connected to PA Cabinet
- ☐ Audio Input
- ☐ Audio Source Impedance Selection
- ☐ Auxiliary (External) Interlock (if used - otherwise insert jumper)
- ☐ Modulation Monitor Connection (if used)
- ☐ Frequency Monitor Connection (if used)
- ☐ Vacuum and Clean Transmitter.
- ☐ Pre Turn on Checks Mechanical Completed
- ☐ Pre Turn on Checks Electrical Completed

<u>Transmitter Energizing Tasks</u>

- ☐ Initial Turn on Procedures
  - ☐ Set transformer taps for +24VDC unregulated power supply (A56A3)
  - ☐ Low Voltage Power Supply Check completed
  - ☐ Fan Rotation and Underdrive Check Completed
  - ☐ Driver Operation Check Completed
  - ☐ Low Power Checkout Completed
  - ☐ Med Power Checkout Completed
  - ☐ High Power Checkout Completed
  - ☐ Final Match to Antenna through Multiport Combiner Completed
  - ☐ Set Modulation Monitor Levels (if used)
  - ☐ Modulation and Audio Level Check
- ☐ Audio Proof of Performance (Recommended)
- ☐ Remote Control Installation and Checkout (if desired)

NOTE:

This installation check list emphasizes a single transmitter (OMC, HEC, EPAC/PAC, Rectifier Cabinet) of a multi-transmitter configuration. For multi-transmitter applications, the final adjustments will depend upon the tuning and alignment of the multiport Combiner used.

3.1 Introduction

This section contains information on day-to-day operation for the non-technical operator.

3.2 Operating Procedures

These procedures describe normal daily operation of the DX-200 TRANSMITTER, including:

a. Daily pre-operational checkout
b. Transmitter turn-on procedures.
c. Transmitter turn-off procedures.
d. Transmitter operations.

It is important that the operator be aware of normal transmitter operation and performance, and note any changes or fault indications. Changes in operation may indicate a need for maintenance or corrective action before more serious problems develop.

NOTE:

Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5

WARNING

ALL SERVICE SHOULD ONLY BE PERFORMED BY QUALIFIED PERSONNEL. DANGEROUS VOLTAGES OR CURRENTS MAY BE PRESENT INSIDE WHEN DOORS ARE OPEN.

Normal operation and monitoring of the transmitter is accomplished through front panel controls, meters, and indicators. Read Section IIIA: Controls and Indicators.

NOTE:

If remote/extended control of the transmitter is used, the station chief engineer or qualified technical staff member should provide instructions for operator use.

3.3 Daily Preoperational Checkout

The following paragraphs describe checks to be made before normal daily turn-on.

a. Check the transmitter maintenance log to make sure that maintenance performed on the transmitter, or other abnormal conditions, do not place any restrictions on transmitter operation. An example is a requirement to operate at reduced power.
b. Ensure that the transmitter RF output is properly terminated into the antenna system or load. This may include determining that antenna pattern switching is correct.
c. Apply A/C input power to the transmitter by activating all external A/C source switch gear and Transformer Cabinet Switch. Activate the Low Voltage Power Supply Assembly (A56) by turning on circuit breakers CB1 and CB2 in the Power Amplifier Cabinet right compartment.
d. Observe the Power Supply Display Panel located near the top of that cabinet. All indicators should be illuminated GREEN. If any LEDs are red, note which indicators are red so that information may be entered into the station maintenance log, then press the RESET button. All indicators should change to green when the RESET button is pushed and released. If any indicators are still red after operating the RESET button, do not attempt to turn on the transmitter and contact qualified maintenance personnel.

NOTE:
In the "REMOTE CONTROL" COLORSTAT™ Indicator panel block, the LOCAL LED indicator will always glow red if local transmitter control is active. Normal transmitter operation is indicated by all other COLORSTAT LEDs glowing green.

e. Check the ColorStat™ front panel on the center front of the transmitter. If the transmitter is ready for operation, all the status, interlock, and overload LEDs will be green. If any LEDs are red, note which indicators are red so that information may be entered into the station maintenance log, then press the RESET button. All indicators should change to green when the RESET button is pushed and released. If any indicators are still red (except the LOCAL LED) after operating the RESET, do not attempt to turn on the transmitter and contact qualified maintenance personnel.
f. If no LEDs other than the LOCAL LED are lit and the Low Voltage Enable switch is in the NORMAL MODE continue with the following steps.

3.4 Transmitter Turn-On Procedure

When the Preoperational Checkout has been completed and no problems are present, the transmitter is ready to turn on.

a. Set the selector switch below the POWER meter on the meter panel to FORWARD, if it is not already in that position.

b. Depress the LOW, the MEDIUM, or the HIGH pushbutton on the meter panel, depending on power level desired. Each of these pushbuttons will turn the transmitter on at the power level which has been preset.

c. The pushbutton you have operated should illuminate green, and power will come up the preset level. (You should also hear 2 very closely spaced ‘clicks’ as driver supply contactors operate, then the blowers should start, then power will come up).

NOTE:

During the Step Start sequence, you should see the following: RF Mute LED turns red for an instant, the VSWR test LED turns red for 4 seconds, and the Power meter will then ramp through several ever increasing steps until the desired output level is achieved.

d. Should FORWARD POWER be incorrect, verify that you have selected the correct power level (LOW, MEDIUM, or HIGH). If not, depress the proper power level button, and check forward power again.

e. When the correct power level has been selected, but an adjustment in power is still needed, press the RAISE button to INCREASE power, or the LOWER button to DECREASE power. When you hold the button depressed and watch the FORWARD POWER indication, the power will change slowly. Hold the button until the power is correct.

NOTE:

RAISE and LOWER buttons will only change power level if the transmitter is operating in the HIGH, MEDIUM, or LOW function. This new power level will become the preset power until it is changed again. The Raise and Lower pushbuttons will adjust power +-10% of the selected power level.

f. Check transmitter panel meter readings for normal values. If an abnormal meter reading is obtained, qualified maintenance should be contacted.

3.5 Transmitter Turn-Off Procedure

a. To turn off (de-energize) the transmitter, depress the OFF pushbutton.

b. The HIGH, MEDIUM or LOW lamp will go out, you should hear the Driver Supply Run contactor as it de-energizes, and the blowers will stop.

c. With the POWER switch in the FORWARD position, the Power meter should indicate zero power. Supply voltage and supply current meters should both indicate zero readings.

3.6 Transmitter Operations

The following is intended to make the operator aware of some basic operational characteristics of the transmitter.

3.6.1 Routine Meter Readings

A sample logsheet is provided on in Section IIIA, Controls and Indicators. Copies can be made of the logsheet for station records. We suggest these readings be taken monthly at a minimum, however more frequent logs can be an important tool in assisting maintenance personnel.

3.6.2 Fault Conditions

The following describes normal transmitter actions for certain possible fault conditions. It is very important that operators log all abnormal operation, such as incorrect meter readings, overloads, fault indications, and transmitter shut-downs. A log or record of abnormal operating conditions will be useful to technical personnel in locating and correcting transmitter or other system problems.

3.6.2.1 Transmitter Shuts Off

The operator should first check for overload or fault indications that are RED and log any fault indications that are found. Press the RESET buttons on the Power Amplifier Cabinet ColorStat™ Status Panel and/or Power Supply Display Panel to clear fault indications. All Power Amplifier Cabinet and Power Supply Cabinet indicator displays on the respective front panels should change from RED to GREEN.

If any LEDs are still RED, contact qualified maintenance personnel.

When the fault indicators are GREEN, follow the normal turn-on procedure.

If the transmitter shuts off again, and the same overload or fault indication comes on, try turning the transmitter on by using the LOW power button. Under some conditions, a transmitter may operate satisfactorily at reduced power. If it will not come on at LOW power, contact qualified maintenance personal.

3.6.2.2 AC Power Failure

If Battery Backup has been installed into the transmitter, no operator action is required for ac power failures of less than about 96 hours. The transmitter will automatically return to an on-air condition, at the same power level as before the power failure.

If AC power is off for more than about 10 minutes and the AC MAINS indicators on the Power Supply Cabinet and PA Cabinet status panels are glowing green without the DX-200 having returned to air, Battery Backup has not been installed. Normal operator turn-on procedures will be required to manually turn on the transmitter again.

3.6.2.3 RF Amp Power Supply Current Fault

During a Current Fault condition the transmitter will shut off and the indicator will change to RED. The transmitter will attempt to restart by itself when the fault is no longer present.

a. If the transmitter turns back on and stays on, check program modulation level. If overmodulating on positive peaks, reduce audio level to reduce modulation.

b. If the transmitter shuts off again and no longer automatically restarts. Log or record the fault, RESET the fault indicator, and try turning the transmitter on.
c. If the fault occurs again, try operating at LOW power. If the transmitter will operate at LOW power, operation may continue on a temporary, emergency basis.

3.6.2.4 Power Reduction

The transmitter will reduce the power output in steps during certain faults. When the fault is no longer present, the transmitter will increase the power output in steps back to the original level. This is done automatically by the transmitter and no operator intervention is required.

If the fault was only a temporary condition, the recovery process can be advanced by depressing the FAULT RESET pushbutton. If the indicator will not reset or the power level of the transmitter has been lowered drastically, contact qualified maintenance personnel immediately.

If the power output has been reduced and the Analog Input Power Foldback indicator is RED, the transmitter has responded to one of the following faults.

3.6.2.5 VSWR Faults

If the OUTPUT MONITOR NETWORK VSWR OR VSWR TEST indicators are RED or are flashing RED, the following may be the cause:

a. This may be a normal occurrence during a thunderstorm, rain storm, blowing sand, or under conditions of ice on the antenna and will stop when the weather conditions improve.
b. The indicators may flash RED when overmodulation occurs. Reducing modulation to normal levels may correct the condition.
c. If the indicators remain RED and weather conditions or overmodulation are not the cause, transmitter and/or antenna problems are indicated. See the Output Monitor board to determine VSWR type.

3.6.2.6 Temperature Faults

If the RF AMP TEMP, TRANSFORMER CABINET TEMPERATURE FAULT, RECTIFIER ASSEMBLY TEMPERATURE FAULT or RF AMPLIFIER POWER SUPPLY CHOKE TEMPERATURE indicator(s) is/are RED, the following may be the cause:

a. Failure of the building cooling system (high ambient temperatures).
b. Possible transmitter mistuning

3.6.2.7 Air Flow Faults

If the PA Cabinet AIR FLOW REDUCED indicator and/or Power Supply Cabinet COOLING FAULT indicator are RED, the following may be the cause:

a. Obstruction of air flow within the closed loop air system.
b. Dirty or clogged fans on the heat exchanger.

3.6.2.8 RF Amp Fuse

The transmitter will continue to operate safely, although power output will be slightly reduced. The fault indication can not be RESET. The fault must be corrected to clear the fault indication. Continue normal operation and contact qualified maintenance personnel.

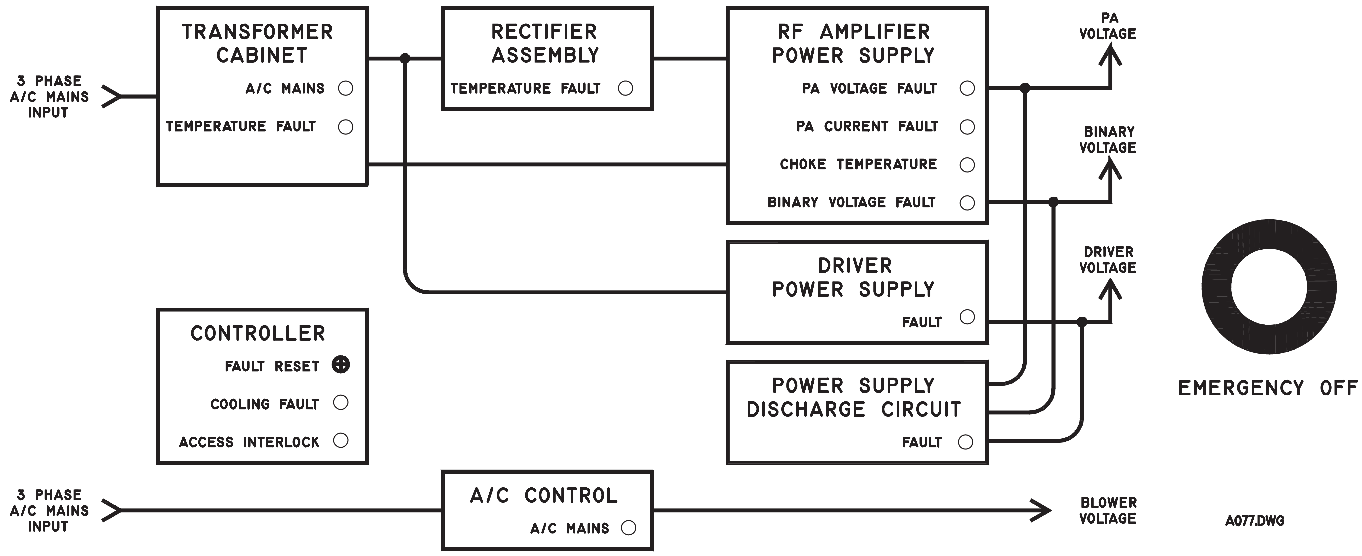


Figure 3A-1
Power Supply Status Panel Controls and Indicators

Table 3A-1
Power Supply Status Panel Controls and Indicators

CONTROL/INDICATOR	FUNCTION
TRANSFORMER CABINET	
A/C MAINS	GREEN indicates normal operation. RED indicates an A/C Mains fault has been detected.
TEMPERATURE FAULT	GREEN indicates normal temperature. RED indicates an overtemperature condition has been sensed in the SCR Assembly in the Rectifier Cabinet.
RECTIFIER ASSEMBLY	
TEMPERATURE FAULT	GREEN indicates normal temperature. RED indicates an overtemperature condition has been sensed in the SCR Assembly in the Rectifier Cabinet.
RF AMPLIFIER POWER SUPPLY	
PA VOLTAGE FAULT	GREEN indicates normal PA Voltage. RED indicates a PA Voltage fault has been detected.
PA CURRENT FAULT	GREEN indicates normal PA Current. RED indicates a PA Current fault has been detected.
CHOKE TEMPERATURE	GREEN indicates normal choke temperature. RED indicates an overtemperature condition of the choke has been detected.
BINARY VOLTAGE FAULT	GREEN indicates normal Binary Voltage. RED indicates a Binary Voltage fault has been detected.
DRIVER POWER SUPPLY	
FAULT	GREEN indicates normal Driver Supply Voltage. RED indicates a Driver Supply Voltage fault has been detected.
POWER SUPPLY DISCHARGE CIRCUIT	
FAULT	GREEN indicates normal operation of the Power Supply Discharge Circuit. RED indicates a fault has been detected in the Power Supply Discharge Circuit.
CONTROLLER	
FAULT RESET button	Button is used to reset all memorized faults. If fault condition no longer exists, all LEDs will return to GREEN. If fault still exists, the faulted LED will return to RED.
COOLING FAULT	Green indicates normal coolant flow and no detected leaks in the Power Block. Red indicates a coolant flow or leak fault has been detected.
ACCESS INTERLOCK	GREEN indicates access interlock is in normal condition. RED indicates an open interlock has been sensed.
A/C CONTROL	
A/C MAINS	GREEN indicates normal A/C mains for the blowers is present. RED indicates a fault has been sensed.

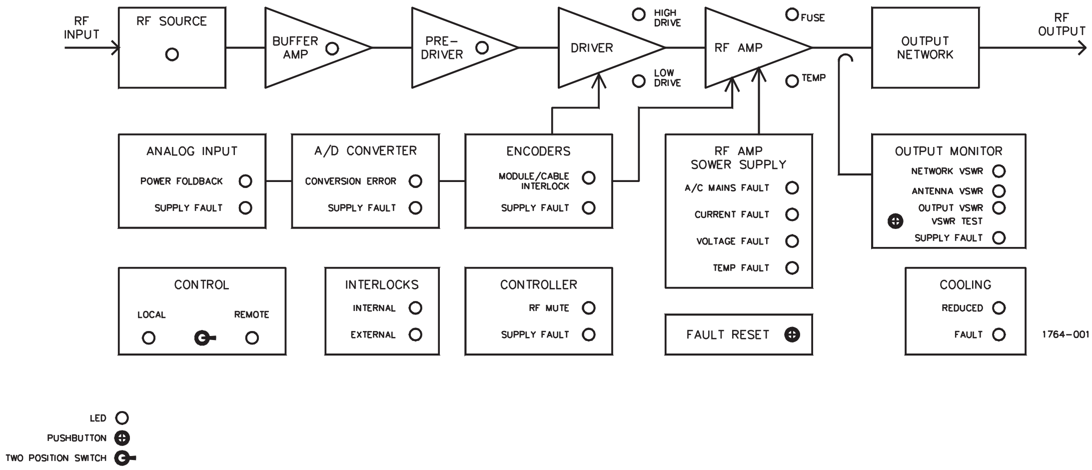


Figure 3A-2
Control Front Panel Controls and Indicators

Table 3A-2
Control Front Panel Controls and Indicators

CONTROL/INDICATOR	FUNCTION
EXTERNAL RF INTERFACE	Indicates External RF Source RF output status. GREEN indicates normal RF output. RED indicates low or no RF output.
BUFFER AMP	Indicates Buffer Amplifier RF output status. GREEN indicates normal RF output. RED indicates low or no RF output.
PREDRIVER	Indicates Predriverr RF output status. GREEN indicates normal RF output. RED indicates low or no RF output.
DRIVER	
HIGH DRIVE	GREEN indicates normal drive level. RED indicates excessive RF drive to the Power Amplifiers
LOW DRIVE	GREEN indicates normal drive level. RED indicates low RF drive to the Power Amplifiers
RF AMP	
FUSE	GREEN indicates a normal, no fault condition. RED indicates a failure of a fuse on an RF Amplifier.
TEMP	GREEN indicates normal temperature of RF1. RED indicates excessive temperature of RF1.
ANALOG INPUT	
POWER FOLDBACK	GREEN indicates normal operation. RED indicates transmitter has responded to a fault by reducing current power level.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply failure.
A/D CONVERTER	
CONVERSION ERROR	GREEN indicates normal operation of A/D converter. RED indicates conversion error in the A/D Converter.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply failure.
ENCODERS	
MODULE/CABLE INTERLOCK	GREEN indicates all cables and modules are properly installed. RED indicates that a cable of module is not installed or connected.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply failure.
RF AMP POWER SUPPLY	
A/C MAINS FAULT	GREEN indicates normal operation. RED indicates a fault in the RF Amp Power Supply.
CURRENT FAULT	GREEN indicates normal status. RED indicates either average or peak RF Amp Power Supply overcurrent.
VOLTAGE FAULT	GREEN indicates normal status. RED indicates RF Amp Power Supply voltage is not within limits.

Table 3A-2 - (Continued)
Control Front Panel Controls and Indicators

CONTROL/INDICATOR	FUNCTION
TEMP FAULT	GREEN indicates normal operation. RED indicates an overtemperature of RF Amp Power Supply.
OUTPUT MONITOR	
NETWORK VSWR (ANTENNA VSWR)	GREEN indicates that there is an acceptable detected VSWR level. RED indicates excessive VSWR is detected. See Output Monitor board to determine VSWR type, either antenna or network. (Earlier transmitters utilized 2 LEDs on Front Panel, indicating VSWR type - See figure 3A-2)
VSWR TEST - pushbutton	Used to test operation of VSWR logic, result of test is displayed on VSWR TEST indicator. When the pushbutton is depressed, the VSWR TEST indicator will turn RED for 4 seconds. If it returns to GREEN, a successful VSWR TEST has been performed. IF it remains RED, a VSWR TEST has failed.
VSWR TEST - indicator	Indicates result of VSWR TEST. GREEN indicates VSWR protection logic is functioning normally. RED indicates VSWR logic fault.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply failure.
TRANSMITTER CONTROL	
LOCAL/REMOTE switch	Selects LOCAL or REMOTE control of the transmitter.
LOCAL	RED LED indicates Transmitter Control Switch is in LOCAL position. In this position remote control inputs to the transmitter are disabled and only local control is possible.
REMOTE	GREEN LED indicates that the transmitter remote control inputs are active. (The transmitter may still be controlled with the panel pushbuttons as well.)
INTERLOCKS	
INTERNAL	GREEN indicates that the Transmitter earthing switch is in the normal condition, RED indicates the Transmitter earthing switch is in the earthed position or a key is missing from the correct position in the Transmitter.
EXTERNAL	GREEN indicates External Interlock circuitry satisfied. RED indicates External Interlock circuitry is not satisfied.
CONTROLLER	
RF MUTE	GREEN indicates normal operation. RED indicates the controller has responded to a fault by reducing power to 0.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply failure.
FAULT RESET - pushbutton	Resets the overload indicators. When depressed, fault indicators will change from RED to GREEN if the cause of the fault has been cleared.
COOLING	
REDUCED	GREEN indicates normal cooling system operation. RED indicates less than normal cooling system efficiency.
FAULT	GREEN indicates normal, RED indicates there is a cooling flow or leak related problem, and/or much less cabinet flushing air flow than required, or no air flow.

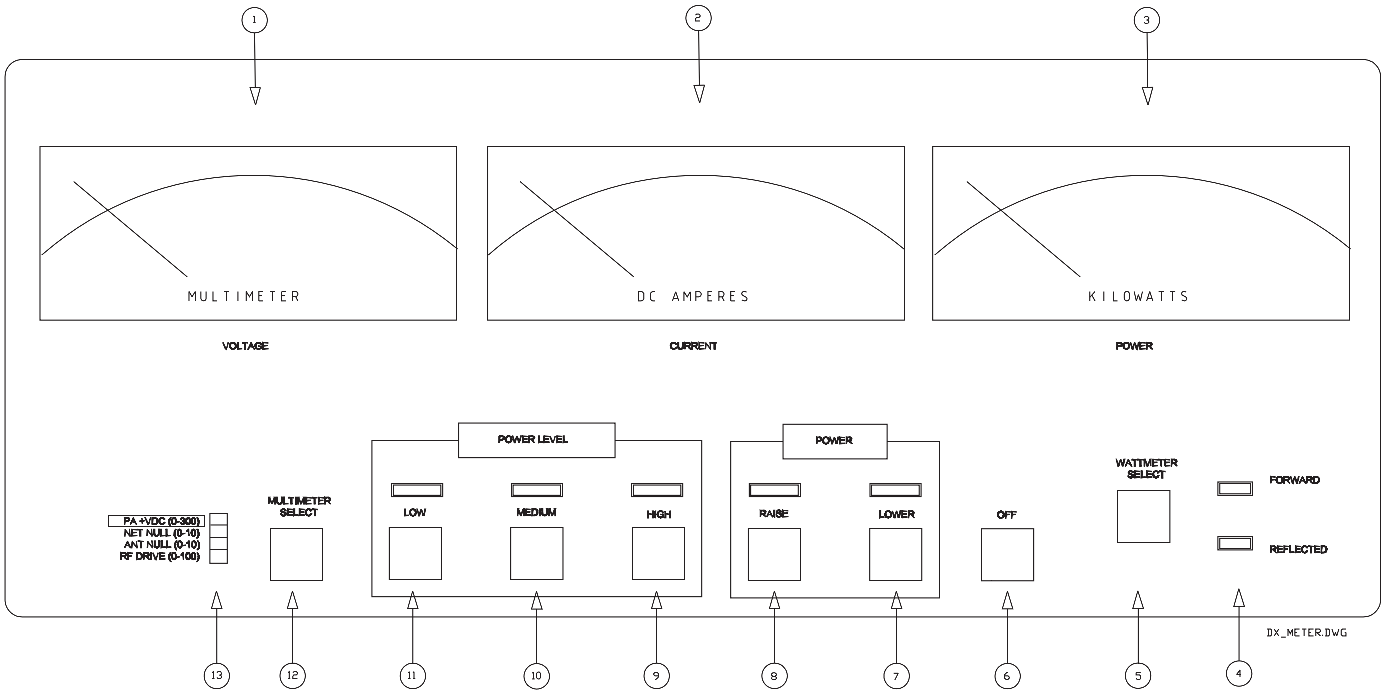


Figure 3A-3
Switchboard/Meter Panel Controls and Indicators

Table 3A-3
Switchboard/Meter Panel Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	VOLTAGE multimeter	Indicates voltages at points selected by the Multimeter Switch (Ref. 11).
2	SUPPLY CURRENT meter	Indicates the 250V supply current being supplied to the Power Amplifier.
3	POWER meter	Indicates either FORWARD or REFLECTED power at the transmitter output, whichever is selected by the POWER METER selector switch (Ref. 4).
4	POWER selector	Selects Forward Power Output or Reflected Power Output, to be read on the POWER meter.
5	OFF pushbutton	Used to turn the transmitter off.
6	LOWER pushbutton	Used to adjust power level. When the transmitter is in the LOW, MEDIUM or HIGH power mode, depress to LOWER power output and hold until desired power is reached. INDICATOR illuminates while power is being lowered.
7	RAISE pushbutton	Used to adjust power level. When the transmitter is in the LOW, MEDIUM or HIGH power mode, depress to RAISE power output and hold until desired power is reached. INDICATOR illuminates while power is being raised.
8	HIGH pushbutton	Used to turn the transmitter on at the preset HIGH power level, or to change power to the preset HIGH power level. The pushbutton will illuminate when in the HIGH power mode.
9	MEDIUM pushbutton	Used to turn the transmitter on at the preset MEDIUM power level, or to change power to the preset MEDIUM power level. The pushbutton will illuminate when in the MEDIUM power mode.
10	LOW pushbutton	Used to turn the transmitter on at the preset LOW power level, or to change power to the preset LOW power level. The pushbutton will illuminate when in the LOW power mode.
11	MULTIMETER switch	Selects the desired function to be monitored by the VOLTAGE multimeter.

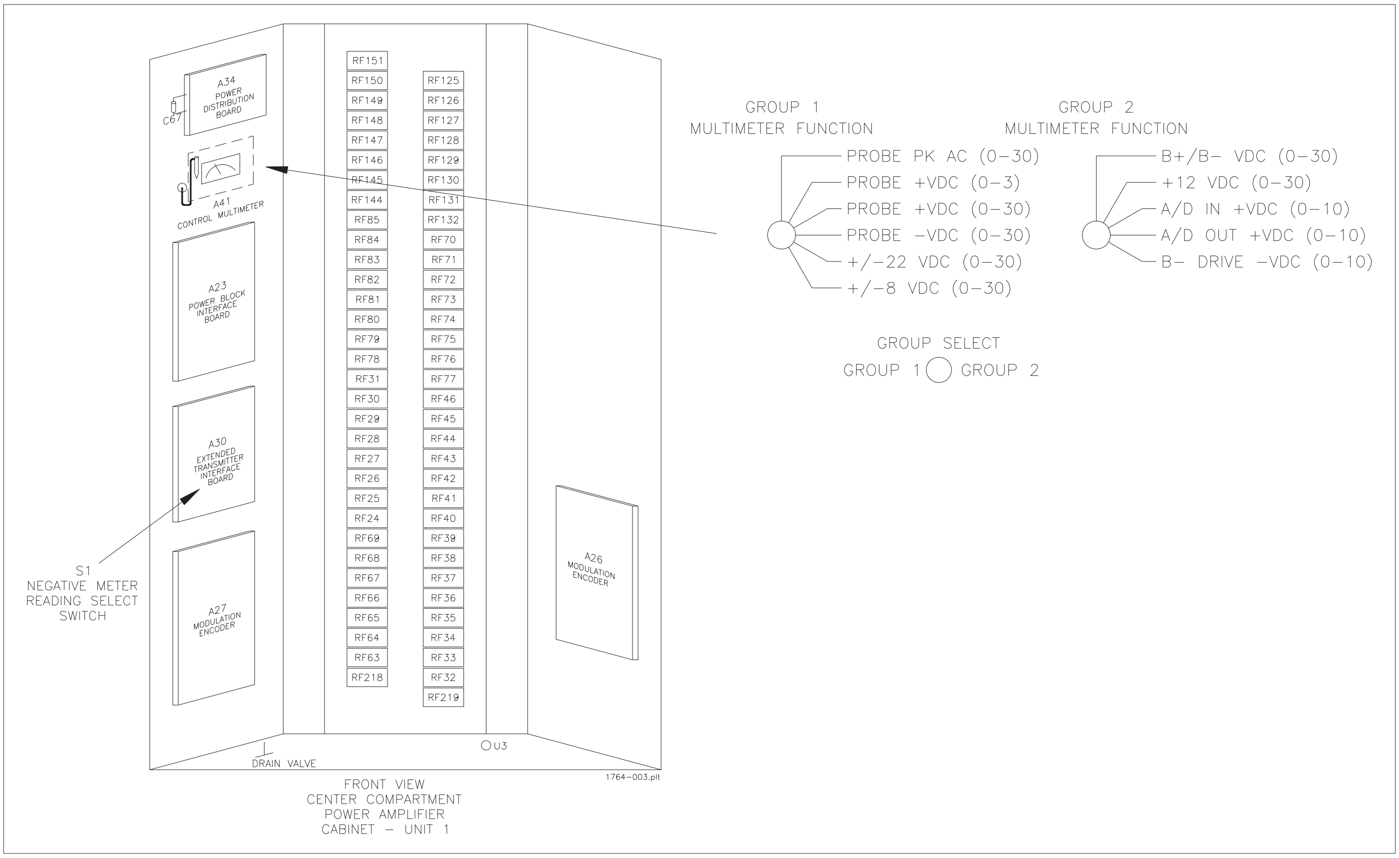


Figure 3A-4
Control Mulitmeter Functions

Table 3A-4
Control Mulitmeter Functions

CONTROL MULTIMETER	
POSITION	FUNCTION - GROUP 1
PROBE PK AC	Probe will measure peak alternating current voltages - 0 to 30 VAC
PROBE +VDC	Probe will measure direct current voltages - 0 to 3 VDC
PROBE +VDC	Probe will measure direct current voltages - 0 to +30 VDC
PROBE -VDC	Probe will measure direct current voltages - 0 to +30 VDC
+/- 22 VDC	Normally measures the +22 VDC power supply voltages - 0 to +30 VDC. When S1 on the Transmitter Interface is pressed and held down, measures the -22 VDC power supply voltage - 0 to -30VDC
+/- 8VDC	Normally measures the +8 VDC power supply voltages - 0 to +10 VDC. When S1 on the Transmitter Interface is pressed and held down, measures the -8 VDC power supply voltage - 0 to -10VDC
POSITION	FUNCTION - GROUP 2
B+/B- VDC	Normally measures the B+ VDC power supply voltages - 0 to +30 VDC. When S1 on the Transmitter Interface is pressed and held down, measures the B- VDC power supply voltage - 0 to -30VDC
+12VDC	Measures the +12 VDC power supply voltage - 0 to 30 VDC
A/D IN +VDC	Measures the Audio +DC input to the A/D Converter - 0 to +10 VDC
A/D OUT +VDC	Measures the reconstructed Audio +DC output of the A/D Converter - 0 to +10 VDC
B- DRIVE -VDC	Measures the B- drive signal out of the analog input - 0 to -10 VDC

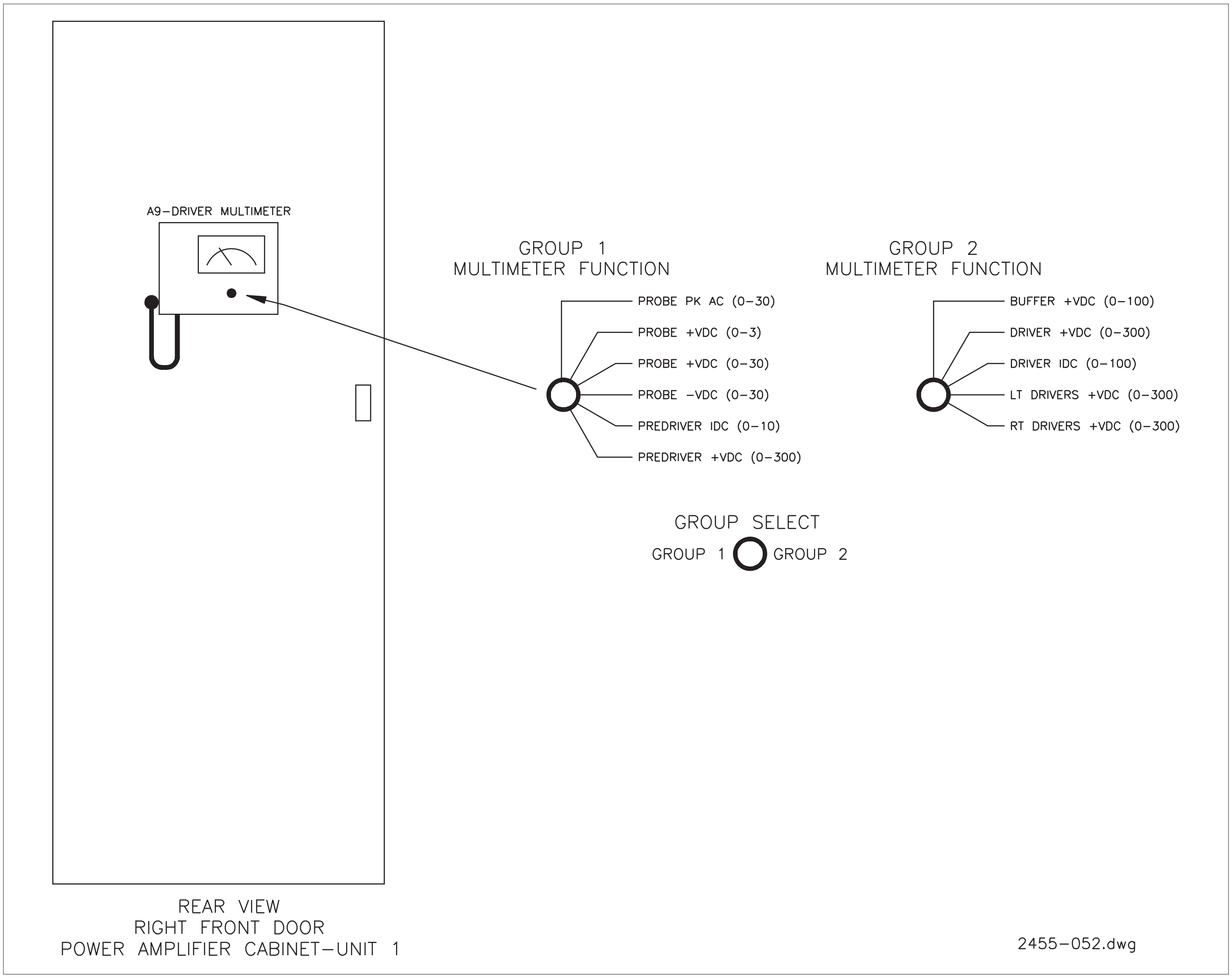


Figure 3A-5
Drive Multimeter Positions

Table 3A-5
Drive Multimeter Functions

DRIVER MULTIMETER	
POSITION	FUNCTION - GROUP 1
PROBE PK AC	Probe will measure peak alternating current voltages - 0 to 30 VAC
PROBE +VDC	Probe will measure direct current voltages - 0 to +3 VDC
PROBE +VDC	Probe will measure direct current voltages - 0 to +30 VDC
PROBE -VDC	Probe will measure direct current voltages - 0 to +30 VDC
PREDRIVER IDC	Measures Predriver current - 0 to +10 A
PREDRIVER +VDC	Measures Predriver voltage - 0 to +300 VDC
POSITION	FUNCTION - GROUP 2
BUFFER +VDC	Measures Buffer voltage - 0 to +100 VDC
DRIVER +VDC	Measures Driver voltage - 0 to +300 VDC
DRIVER IDC	Measures Driver supply current - 0 to +100 A
LT DRIVER +VDC	Measures Driver D-7-D-14 supply voltage - 0 to +300 VDC
RT DRIVER +VDC	Measures Driver D1-D6 supply voltage - 0 to +300 VDC

DX 200kW POWER BLOCK ROUTINE METER READINGS			
DATE:			
UNIT NUMBER			
TEST CONDITIONS:			
MODULATION:			
POWER LEVEL	**LOW**	**MEDIUM**	**HIGH**
FRONT PANEL METERS			
FORWARD POWER			
REFLECTED POWER			
PA CURRENT			
FRONT PANEL MULTIMETER			
PA VOLTS			
NETWORK NULL			
ANTENNA NULL			
RF DRIVE			
CONTROL MULTIMETER			
-22V			
+22V			
-8V (-12V)			
+8V (+7.5V)			
B+			
B-			
+12V			
A/D INPUT			
A/D OUTPUT			
B- DRIVE			
DRIVER MULTIMETER			
PREDRIVER CURRENT			
PREDRIVER VOLTAGE			
DRIVER CONTROL			
DRIVER SUPPLY VOLTS			
DRIVER SUPPLY CURRENT			
LT DRIVER VOLTS			
RT DRIVER VOLTS			

4.1 Introduction

This section of the technical manual will present the overall principles of operation for the 200 kW transmitter, including a description of circuits not included on circuit boards described in sections A through U of this technical manual.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

This section is organized as follows:

- Block Diagram Description
- Digital Modulation Process
- Protection of Personnel
- Transmitter Protection
- RF Circuits in the transmitter
  - RF Driver Combiner
  - Output Matching
- AC Source and Power Supply Circuits in the transmitter
  - Controller Power Supply
  - Low Voltage Power Supply
- Drive Multimeter
- Control Multimeter

4.2 Block Diagram Description

If you refer to Figure 4-1, the Overall Block Diagram, you can see that there are two signal paths to the RF Amplifier section. One is an RF signal path, and the other is a digital audio signal path.

Most of the blocks in the diagram represent printed circuit boards in the transmitter.

4.2.1 RF Section

The RF Section includes the Oscillator board through the Output Network Cabinet.

The RF Section accepts the external RF carrier input or crystal operation, then amplifies the signal to a level adequate to drive the RF Amplifier stage. The RF Amplifier outputs are combined and routed through an Output Network to the RF output connector.

4.2.1.1 Buffer Amplifier

The plug in Buffer Amplifier module amplifies the External RF Interface output from a TTL level to approximately 25-30 Vp-p. There are two separate amplifiers on the Buffer Amplifier module. Buffer A and Buffer B are driven in parallel.

4.2.1.2 Predriver

The Predriver amplifies the Buffer signal to a level adequate to drive the 14 RF Amplifiers used in the RF Driver section. There are two Predriver sections; Predriver A and Predriver B (each is one-half of the same RF Amplifier module). Only one of the Predrivers is active at any one time. The Predriver module is interchangeable with the 14 Driver RF Amplifiers, and any of the 220 Big Step and 4 Binary RF Amplifiers.

4.2.1.3 Predriver Band Select

Frequency determined band selection is accomplished by manually switching in capacitance to resonate the Predriver output.

4.2.1.4 RF Drivers

There are 14 RF Amplifiers used as RF Drivers in the transmitter to amplify the RF signal from the Predriver to provide the proper RF drive level for the 220 Big Step and 4 Binary RF Amplifiers. These 14 RF Drivers are interchangeable with any of the 220 Big Step and 4 Binary RF Amplifiers and the Predriver.

4.2.1.5 Driver Combiner

The outputs from the RF Drivers are combined in the Driver Combiner. Each RF Driver feeds its own combiner transformer and the outputs are added together by a copper pipe and connected to the RF Splitter. Selectable inductance is provided on the motherboard to cancel stray capacitance depending on carrier frequency, thus improving efficiency.%0

4.2.1.6 Driver Tuning

Driver Tuning resonates the RF Driver output.

4.2.1.7 RF Splitter

The purpose of the RF Splitter is to divide the combined output of the Driver Combiner and provide each RF Power Amplifier with the proper RF drive level.

4.2.1.8 Driver Encoder

The Driver Encoder provides the control signals for the Predriver, and RF Drivers D1-D14. The switch for Buffer/Predriver A or Buffer/Predriver B is located on this board. The Driver Encoder board also contains Buffer, Predriver, and High/Low Fault Sense & metering circuitry.

4.2.1.9 RF Power Amplifiers

The RF Power Amplifiers consists of 220 plug-in modules. Encoded audio signals from the Modulation Encoder turns on as many RF Amplifiers as required at any instant by the required carrier level and the modulating signal. Of the 224 RF Amplifiers, 220 are used as Big Step Amplifiers and 4 are used as Binary Amplifiers. 160 of the RF Amplifiers are located in the Power Amplifier Cabinet and

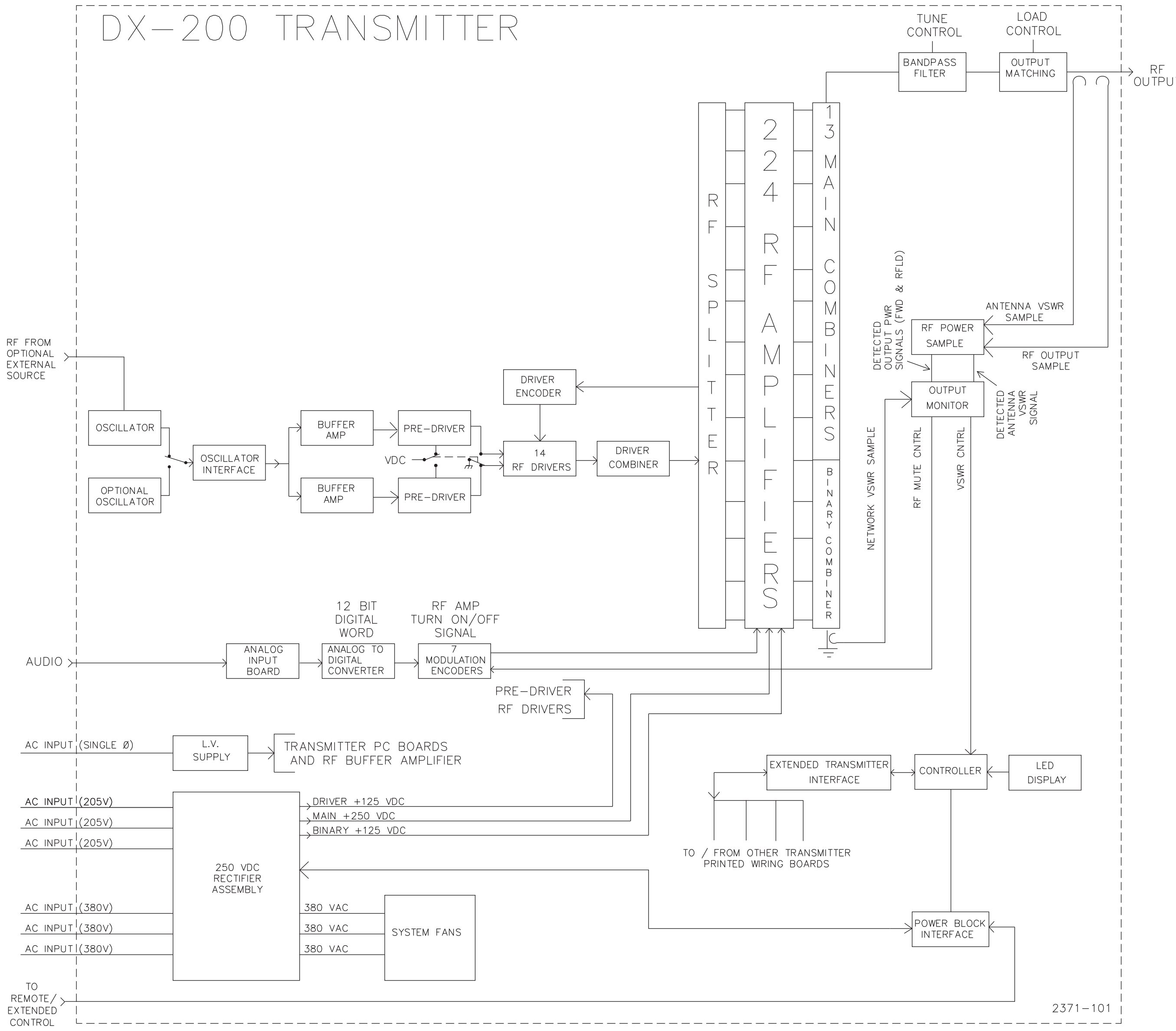


Figure 4-1. Overall Block Diagram

the other 64 Power Amplifiers are located in the Extended Power Amplifier Cabinet. The method of digital modulation employed in the transmitter uses a combination of whole Big Steps and fractional Binary Steps.

4.2.1.10 Main Combiners and Binary Combiner

13 Main Combiners and 1 Binary Combiner make up the PA Combiner (9 Main Combiners and the Binary Combiner are located in the Power Amplifier Cabinet, 4 Main Combiners are located in the Extended Power Amplifier Cabinet). The output of each RF Power Amplifier Big Step or Binary Step feeds its own combiner transformer and the outputs are added together and connected to the Output Network. Efficiency coils on the motherboard provide selectable inductance to cancel stray capacitance in the circuit depending on carrier frequency.

4.2.1.11 Output Network

The Output Network circuitry transforms the impedance of the PA Combiner output, from about 3-10 Ohms (depending on frequency), to 50 Ohms. This is done in a combination L-Net/Pi-Net. The Pi-Net includes the 3^{rd} harmonic filter.

4.2.1.12 RF Sample

The RF Power Sample board develops voltage and current samples from the transmitter output line. These samples drive forward and reflected power detectors for metering and the antenna VSWR detector for transmitter protection. These detected signals are routed to the Output Monitor Board.

4.2.1.13 Output Monitor

The Output Monitor detects any VSWR fault condition in the Output Matching. If the VSWR is high enough, the Output Monitor board will generate an RF Mute that will turn all RF Power Amplifiers OFF momentarily; then resume operation. If high VSWR persists, the transmitter will foldback power to a safe operating level and return to normal power if the VSWR fault condition was temporary. For continuing severe VSWR, the transmitter will shut off. Air Flow and Arc Detector fault integration, Low Voltage Power Supply fault detection and Reconstructed Audio is developed on this board.

4.2.2 Modulation Section

The purpose of the modulation section is to turn on and turn off the RF Amplifiers as required to create the proper carrier and modulation level simultaneously.

4.2.2.1 Analog Input Board

The Analog Input Board takes the audio input (program information), conditions it, adds a DC component and passes it along to the A/D Converter. It is also responsible for establishing the power levels by varying the DC component.

4.2.2.2 Analog To Digital Converter

The A/D (ANALOG TO DIGITAL) Converter board converts the (Audio + DC) signal from the Analog Input Board into a 12 bit digital audio signal.

4.2.2.3 Modulation Encoders

The 7 Modulation Encoders convert the 12-bit digital audio information into control signals which turn the PA RF Power Amplifier modules on and off, as required by the transmitter carrier power level and the instantaneous modulation level.

4.2.2.4 Adaptive Carrier Control (ACC) (optional)

Adaptive Carrier Control (ACC) reduces the carrier power of the transmitter during periods of low audio modulation.

For ACC circuit discussion and setup procedures, see the ACC manual.

4.2.3 Control Section

The Control section consists of the Controller board, LED board, Extended Transmitter Interface board and transmitter Interface board.

4.2.3.1 Controller

The Controller provides transmitter turn on and turn off functions, fault and overload sensing, and executes operations to protect the transmitter if necessary.

4.2.3.2 LED Board

The LED Board provides LED status indications. All status indications are latched, to provide fault indications until they are “reset”, even if the transmitter is turned off.

4.2.3.3 Extended Transmitter Interface

The Extended Transmitter Interface routes and distributes signals to and from the controller, and other boards in the transmitter. It does not deal with the EPAC, however.

4.2.3.4 Power Block Interface

The Power Block Interface routes the remote control inputs, signals to and from the Rectifier cabinets, and provides a communication interface between the transmitter controller and the PLC if used. It does not integrate the signals from the Left, middle and right PA cabinets. This is done on the Extended Transmitter Interface.

4.2.4 Power Supplies

The power supplies section includes the low voltage supplies and the RF Amplifier power supplies.

4.2.4.1 B+ and B-

The B+ and B- supplies are used by the Modulation Encoder.

4.2.4.2 Low Voltage Power Supplies

The Low Voltage Power Supply Board regulates +7.5VDC, +/-12VDC, +/-18VDC and +35VDC. All of the printed circuit boards in the transmitter operate from the low voltage supplies.

4.2.4.3 RF Amplifier Power Supplies

There are three 3 phase-driven RF Amplifier Main Power Supplies; (1A) PA SCR Main at +250 VDC, (1B) Binary Main at +125 VDC, (2) Driver at +125 VDC. The Predriver, RF Drivers, and RF Amplifiers operate from the RF Amplifier power supplies. The Buffer operates from the +35VDC output of the Low Voltage Power Supply board.

4.2.5 Digital Modulation Overview

A general review of the Digital Modulation process is included here for users that may not be familiar with this technology. For Digital Terms and Concepts explanation see Appendix A. The amplitude modulation process in the transmitter takes place in three steps.

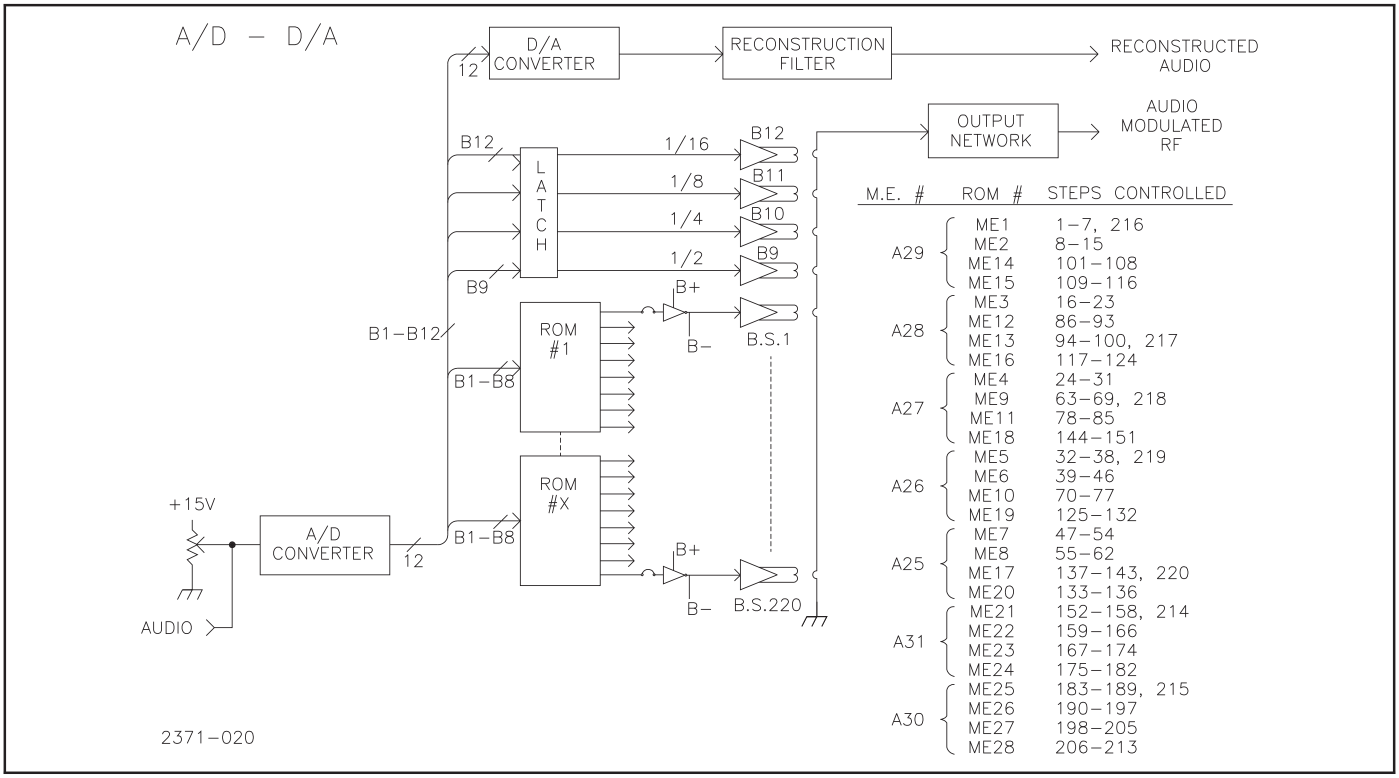


Figure 4-2. Power Block A/D - D/A

1. The audio input signal is converted into a series of 12 bit digital words, in an Analog to Digital Converter. This digital data stream is a “digital audio” signal.
2. The digital data stream from the A/D Converter is changed by the Modulation Encoders into on/off commands to the 224 RF Power Amplifiers.
3. The individual RF Power Amplifier outputs are summed in the RF Power Combiner. The amplitude of the RF output signal is varied higher or lower by the number of RF Power Amplifiers switched on according to the incoming digitized audio signal. This is Digital Amplitude Modulation.

4.2.6 Digital Modulation In More Detail

Refer to Figure 4-2, transmitter A/D-D/A for the following discussion.

4.2.6.1 A/D Conversion

The Analog to Digital (A/D) Conversion process takes place in two steps. First, the amplitude (voltage) of the input signal is sampled. Secondly, for each sample a digital word (i.e. 1010 0100 0001) is constructed that represents the input signal.

4.2.6.1.1 A/D Input - Audio And DC Voltage

The input signal to the A/D Converter is a combination of a positive DC voltage (presented on the wiper of the potentiometer) and the audio input.

4.2.6.1.2 A/D Output - Digital Audio Signal

The digital audio signal consists of a stream of 12-bit digital words on the 12 outputs of the A/D Converter. The 12 bits are referred to as B1 through B12, where B1 is the Most Significant Bit (MSB) and B12 is the Least Significant Bit (LSB).

4.2.6.2 Modulation Encoding

The control signals from the Modulation Encoder Latch and ROM outputs turn the 220 Big Step and 4 Binary RF Amplifiers on and off. Each digital word consists of two groups of information to be encoded, B1 through B8 and B9 through B12.

4.2.6.2.1 Bits 9-12, Binary Step Control

The 4 fractional Binary Step RF Amplifiers are directly controlled by bits B9-B12, via Latches. B9 controls the 1/2 Step, B10 controls the 1/4 Step, B11 control the 1/8 Step, and B12 controls the 1/16 Step.

4.2.6.2.2 Bits 1-8, Big Step Control

The 220 equal Big Step RF Amplifiers are directly controlled by the bits B1-B8, via ROM # 1 through ROM # 28. The eight MSB of the digital word address memory locations in each of the ROM’s, and the information stored in each ROM memory location turns on the required Big Step RF Amplifier. Each ROM has eight outputs and therefore controls eight Big Steps, the chart shown in Figure 4-2 lists the Mod Encoder Number, the ROM number and the Steps Controlled.

4.2.6.2.3 A/D Converter Output Chart

Refer to Figure 4-3, A/D Converter Output Chart for the following discussion.

The top of the chart lists the 12 outputs B1 through B12 of the A/D Converter and the RF Amplifiers turned “ON. With 0 VDC at the input of the A/D Converter, the first line shows that all

(MSB)											(LSB)	RF
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	AMPS
												ON
128	64	32	16	8	4	2	1	1/2	1/4	1/8	1/16	(DECIMAL EQUIVALENT)
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	1	1/16
0	0	0	0	0	0	0	0	0	0	1	0	1/8
0	0	0	0	0	0	0	0	0	0	1	1	1/8+1/16
0	0	0	0	0	0	0	0	0	1	0	0	1/4
0	0	0	0	0	0	0	0	0	1	0	1	1/16+1/4
0	0	0	0	0	0	0	0	0	1	1	0	1/4+1/8
0	0	0	0	0	0	0	0	0	1	1	1	1/4+1/8+1/16
0	0	0	0	0	0	0	0	1	0	0	0	1/2
0	0	0	0	0	0	0	0	1	0	0	1	1/2+1/16
0	0	0	0	0	0	0	0	1	0	1	0	1/2+1/8
0	0	0	0	0	0	0	0	1	0	1	1	1/2+1/8+1/16
0	0	0	0	0	0	0	0	1	1	0	0	1/2+1/4
0	0	0	0	0	0	0	0	1	1	0	1	1/2+1/4+1/16
0	0	0	0	0	0	0	0	1	1	1	0	1/2+1/4+1/8
0	0	0	0	0	0	0	0	1	1	1	1	1/2+1/4+1/8+1/16
0	0	0	0	0	0	0	1	0	0	0	0	BS1
0	0	0	0	0	0	0	1	0	0	0	1	BS1+1/16
0	0	0	0	0	0	0	1	0	0	1	0	BS1+1/8
0	0	0	0	0	0	1	0	0	0	0	0	BS1+BS2
0	0	0	0	0	0	1	1	0	0	0	0	BS1+BS2+BS3
0	0	0	0	0	1	0	0	0	0	0	0	BS1+BS2+BS3+BS4

Figure 4-3. Power Block A/D Converter Output Chart

WARNING: Disconnect primary power prior to servicing.

outputs will be 0 or a logic low and that no RF Amplifiers are on.

1. As the input voltage begins to go slightly positive (by turning the potentiometer), B12 will be 1 or a logic high and the latch will turn on the 1/16 Step.
2. As the input goes more positive, B12 will go to 0 and B11 will be 1. The 1/16 Step will turn off and the 1/8 Step will turn on.
3. As the input goes more positive, both B12 and B11 will be 1, and both the 1/16 and 1/8 Steps will be turned on.
4. As the input continues to increase, the digital audio signal will continue to count up in a binary fashion until, B12 through B9 will be 1 and the 1/16, 1/8, 1/4, and 1/2 Steps are all turned on.
5. As the input goes more positive, B12 through B9 will be 0 and the 1/16, 1/8, 1/4, and 1/2 Steps are all turned off. B8 will be 1, and the first output from ROM #1 will turn on Big Step #1.
6. As the input goes more positive, B8 will remain 1 and B12 will go from 0 to 1. Big Step #1 and the 1/16 Step will be on.
7. As the input continues to increase, the digital audio signal will continue to count up in a binary fashion until, B12 through B8 will be 1 and Big Step #1 and the 1/16, 1/8, 1/4, and 1/2 Steps are all turned on.
8. As the input goes more positive, B12 through B8 will go to 0 and B7 will be 1. The 1/16, 1/8, 1/4, and 1/2 Steps will all turn off, however the first output of ROM #1 will keep Big Step #1 on and the second output from ROM #1 will turn on Big Step #2. The important point to note is that the ROMs basically convert B1-B8 into the Big Step decimal equivalent. B8 is the 1's column, B7 is the 2's, B6 is the 4's, B5 is the 8's, B4 is the 16's, B3 is the 32's, B2 is the 64's, and B1 is the 128's column (as shown on the chart).

For example, if B1 through B12 respectively was 0100/0000/0000, ROMs 1 through 28 would recognize this as having a decimal equivalent of 64 and signals would go out to the first 64 equal Big Step RF Amplifiers turning them on.

If B1 through B12 respectively was 0110/0110/0000, ROMs 1 through 28 would recognize this as having a decimal equivalent of 102 and signals would go out to the first 102 RF Amps to turn on. This occurs when the A/D Converter input voltage is approximately 2.0VDC and is the 200 kW condition. The "0000" in the B9 through B12 positions would hold off all 4 binary amplifiers.

If B1 through B12 respectively was 1101/1100/1111, ROMs 1 through 28 would recognize this as having a decimal equivalent of 220 and signals would go out to all 220 equal Big Step RF Amplifiers turning them on. The latch will also turn on the 1/2, 1/4, 1/8, and 1/16 fractional Binary Step RF Amplifiers. This occurs when the A/D Converter input voltage is approximately 5.0VDC and is the maximum power output obtainable.

4.2.6.3 RF Power Combiner

The RF Power Combiner sums all the individual Power Amplifier outputs into a single amplitude modulated RF output.

4.2.6.3.1 RF Power Amplifier Combiner

The summing or combining of the individual PA module outputs is done by a multi-turn primary/single turn secondary transformer/combiner. Each RF Power Amplifier is connected to its own toroid. The secondary of this circuit is a copper rod which is connected to ground on one end and to the Output Filter on the other end. The RF energy is coupled by the multi-turn primary toroids to the single turn secondary (copper rod). The copper rod passes through the center of the toroids, receives the RF energy and carries it to the Bandpass Filter.

The RF voltage is low or zero at the ground point of the secondary rod and increases along the way to the Output Network.

The dual action of the combiner and Big Step RF Amplifiers produces EQUAL RF VOLTAGE steps at the output, not RF power steps. Switching on twice as many Big Step RF Amplifiers will produce twice the RF VOLTAGE output (and four times the power output).

The Binary RF Amplifiers produce FRACTIONAL RF VOLTAGES when compared to the Big Steps. The 1/2 Step produces 1/2 the RF voltage of a Big Step, the 1/4 Step produces 1/4 the RF voltage of a Big Step, the 1/8 Step produces 1/8 the RF voltage of a Big Step, and the 1/16 Step produces 1/16 the RF voltage of a Big Step. The Binary Amplifiers are the same RF modules as used in the Big Step RF Amplifiers however the fractional Big Step voltage is obtained by running the modules at lower DC voltage and by using a different turns ratio on their toroids.

4.2.6.3.2 Output Network

The RF output of the Combiner then passes through a Output Network which smooths the digitally created AM signal so that the AM signal is now identical to a standard analog AM signal except for its improved quality.

4.2.6.3.3 Digital Amplitude Modulation Summary

Any desired transmitter output from zero to 220 kW can be produced by turning on the appropriate number of equal RF Voltage Big Step and fractional RF Voltage Binary RF Amplifiers. Turning on more RF Amplifiers increases the transmitter's RF output, normally 102 RF Amplifiers are turned on for 200 kW RF output.

Refer to the Flexpatch and Module Encoding VIEWs 20 through 26 in section L and Modulation Encoder Counting Order Diagram (843-5155-162). Refer to VIEWS 2, 4, 5 and 6 in Section 5A for the following discussion.

Each of the 220 Big Step RF Amplifiers is numbered, from RF1 thought RF220 and the Binary Step RF Amplifiers are numbered B9 (1/2) through B12 (1/16).

The Big Step RF Amplifiers turn on in numerical order from 0 to full output power. Refer to figure 4-4 RF Amplifier and Mod Encoder Locations for their locations.

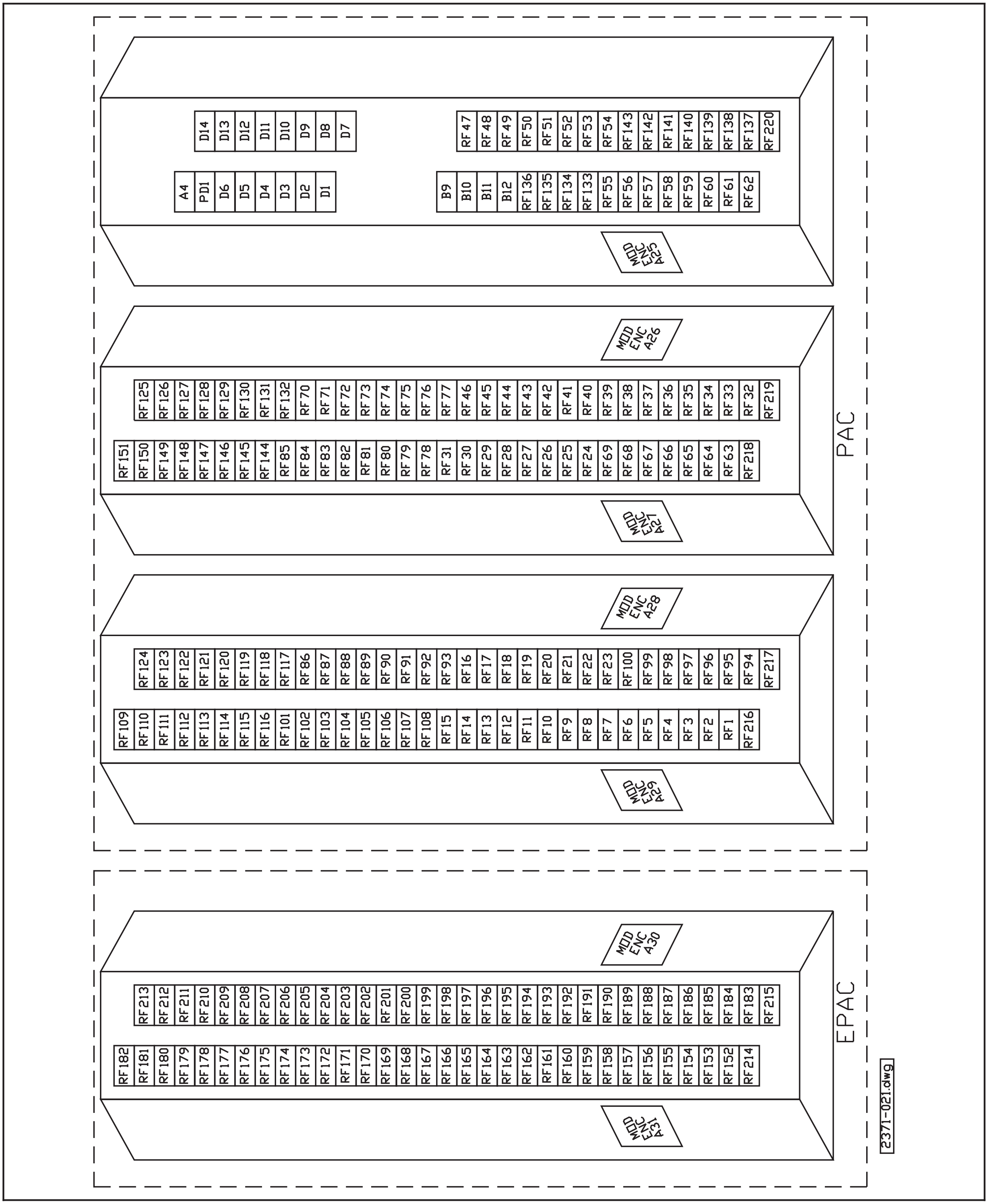


Figure 4-4. RF Amplifier and Mod Encoder Locations

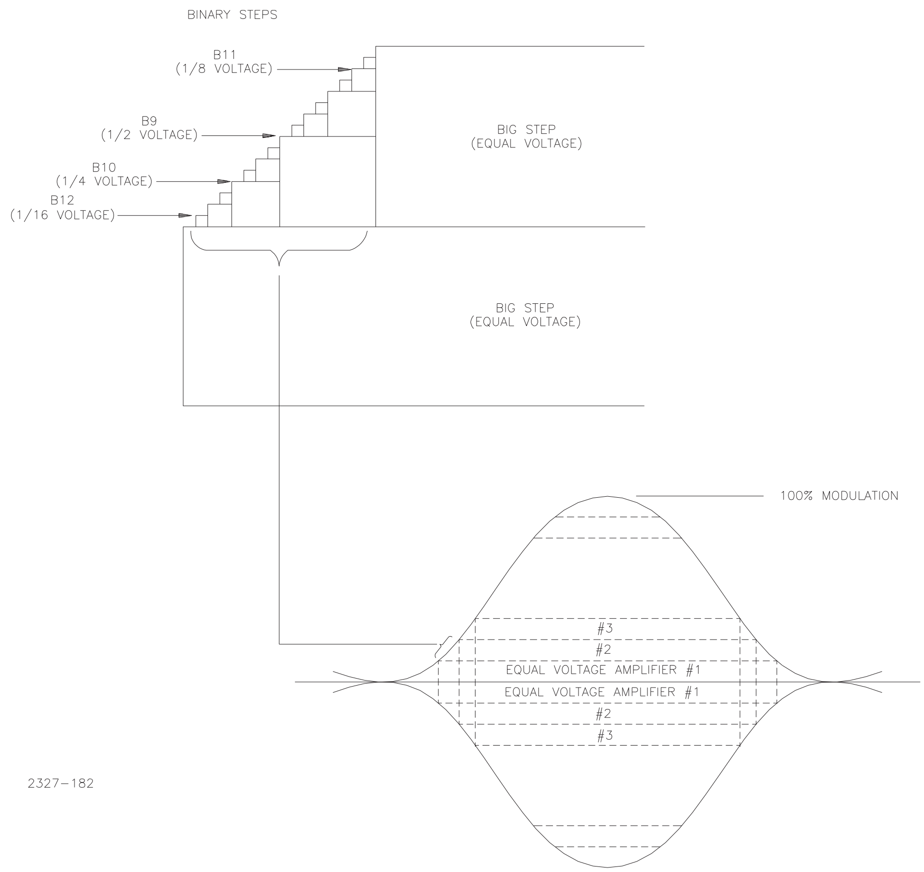


Figure 4-5. Digital AM Modulation

4.2.6.3.4 *Audio Modulation*

Refer to Figure 4-5, Digital AM Modulation for the following discussion.

If an audio signal is summed together with the DC voltage at the A/D input and begins to increase, more RF Amplifiers will be turned on. If the audio signal decreases, some of the RF Amplifiers will be turned off. As the audio signal changes from instant to instant, the number of RF Amplifiers that are switched on also changes.

For a positive modulation peak, which requires a high RF voltage (and power) at the transmitter output, a large number of RF Amplifiers are turned on. For a 100% negative modulation peak, which corresponds to zero transmitter RF voltage (and power) output, all the RF Amplifiers are turned off.

An important point to note is that the transmitter reaches it's positive peak modulation capability when all the RF Power Amplifiers are turned on and their negative peak (-100%) when all the modules are turned off.

4.2.6.4 *Conclusion*

The transmitter uses Digital Amplitude Modulation for superior audio performance and highest AC to RF efficiency.

Digital Amplitude Modulation is created by a two step process.

1. Audio +DC (carrier level) is converted into digital words by an A/D Converter.
2. The digital words are used to turn on/off the 220 Big Step and 4 Binary RF Power Amplifiers which create amplitude variations of the RF according to the incoming audio signal and carrier set level.

The positive peak modulation of the transmitter occurs when all 220 RF Power Amplifiers are turned on.

The peak negative modulation (-100%) occurs when all the RF Power Amplifiers are turned off.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

4.3 Protection Of Personnel

The following is a list of protection devices installed in the transmitter designed for the safety of maintenance personnel. It includes a brief discussion of each device and references to other sections of this manual where applicable.

4.3.1 Doors And Panels

Inner front and rear access doors and panels are secured with quarter-turn fasteners, and tools are required to remove them. Additionally, a keylock safety system prevents access to any area where 250V is present or where high power RF signals are present without turning off or disconnecting the voltage.

4.3.2 Auxiliary (External) Interlock

The Auxiliary Interlock will turn off the transmitter the instant the interlock continuity is opened. The External Interlock circuit requires that the transmitter be turned back on manually after an interruption. Refer to Section N, Power Block Interface.

4.3.3 Covers And Shields

Inside the transmitter, protective covers and plastic shields prevent accidental contact with hazardous voltages, including AC primary power voltages. Most circuit boards in the transmitter operate from low voltages under 25 VDC, and are located in the non-interlocked PA compartments.

4.3.4 RF Amplifier Power Supply Discharging

The RF Amplifier Power Supply consists of the +250 VDC and +125 VDC supplies. Each electrolytic supply filter capacitor for these supplies has its own discharge resistor mounted directly across the terminals of the capacitor. The +250VDC and +125VDC supplies are also discharged by the Power Supply Discharge Assembly, which connects these supplies to ground through 10 Ohms of resistance when ever the OFF button is depressed or the transmitter shuts itself off. Refer to the Discharge circuit description later in this section.

4.3.5 Key-Lock System

A key-lock system is installed to assure that no areas of the transmitter that have +250V present can be accessed without first turning off and grounding the +250VDC and grounding the RF output from the transmitter.

4.4 Transmitter Protection

The following is a list of protection devices installed in the transmitter designed to protect the transmitter from undesirable external conditions. It includes a brief discussion of each device.

4.4.1 +250 VDC Overvoltage

If the incoming +250 VDC is too high, circuits that monitor the RF Amplifier Power Supply +250 VDC will turn off the transmitter.

4.4.2 Single Phase AC Undervoltage And Overvoltage

IC voltage regulators on printed circuit boards include protection against low regulated output voltages.

4.4.3 Air Flow Monitors

Air Flow Monitors are located in the Left, Center, and Right PA Compartments and in the EPAC. If the reduction of air flow is severe enough, the transmitter will continually foldback power output until a safe operating level is reached. If air flow reduction is severe enough, the transmitter will shut OFF.

4.4.4 Spark Gap

A spark gap at the transmitter's RF output protects the transmitter against high transient voltages caused by lightning or electrostatic discharge.

4.4.5 ARC Detector

Arc detectors are used in the transmitter's Output Network and Combiner Cabinets to detect any arcing that may occur. A detected arc will trigger an RF Mute at the Modulation Encoder.

4.4.6 Discharge Ground

In the front of the EPAC, and rear of the EPAC plenum, discharge sticks are provided for ensuring that any residual voltages have been depleted. Additionally, a manual switch permanently grounds the ONC RF output when the Transmitter is being serviced. Likewise, a manual switch grounds the DC output lines of the Rectifier Cabinet when the transmitter is being serviced.

4.4.7 VSWR

If a VSWR fault is detected in the output network, the transmitter will foldback power until a safe operating range is reached. If the VSWR is severe, the transmitter will shut off.

4.4.8 Temperature Sensing

A temperature sensor is attached to the heat sink of RF Amplifier, RF1. A temperature sensor is also mounted on the Transmitter Interface. If the ambient air intake temperature increases above 70 degrees C, or the transmitter is severely mistuned, the heat sink temperature will also increase. If the output of either sensor rises above the preset threshold, the transmitter will foldback power to a safe operating range. If the temperature increase is severe, the transmitter will shut off.

4.4.9 Coolant Sensing

4.4.9.1 Leak Detection

Leak detectors are located in the RPAC (U2), CPAC (U3), LPAC (U4), and EPAC (U5). These leak detectors are self contained

Table 4-1 DX High Power Spark Gap Settings

DX High Power Spark Gap Setting	Less than 1000 meters	Greater than 1000 meters
	200kW 50 Ω	200kW 50 Ω
ONC 8E6	1/4"	1/4"

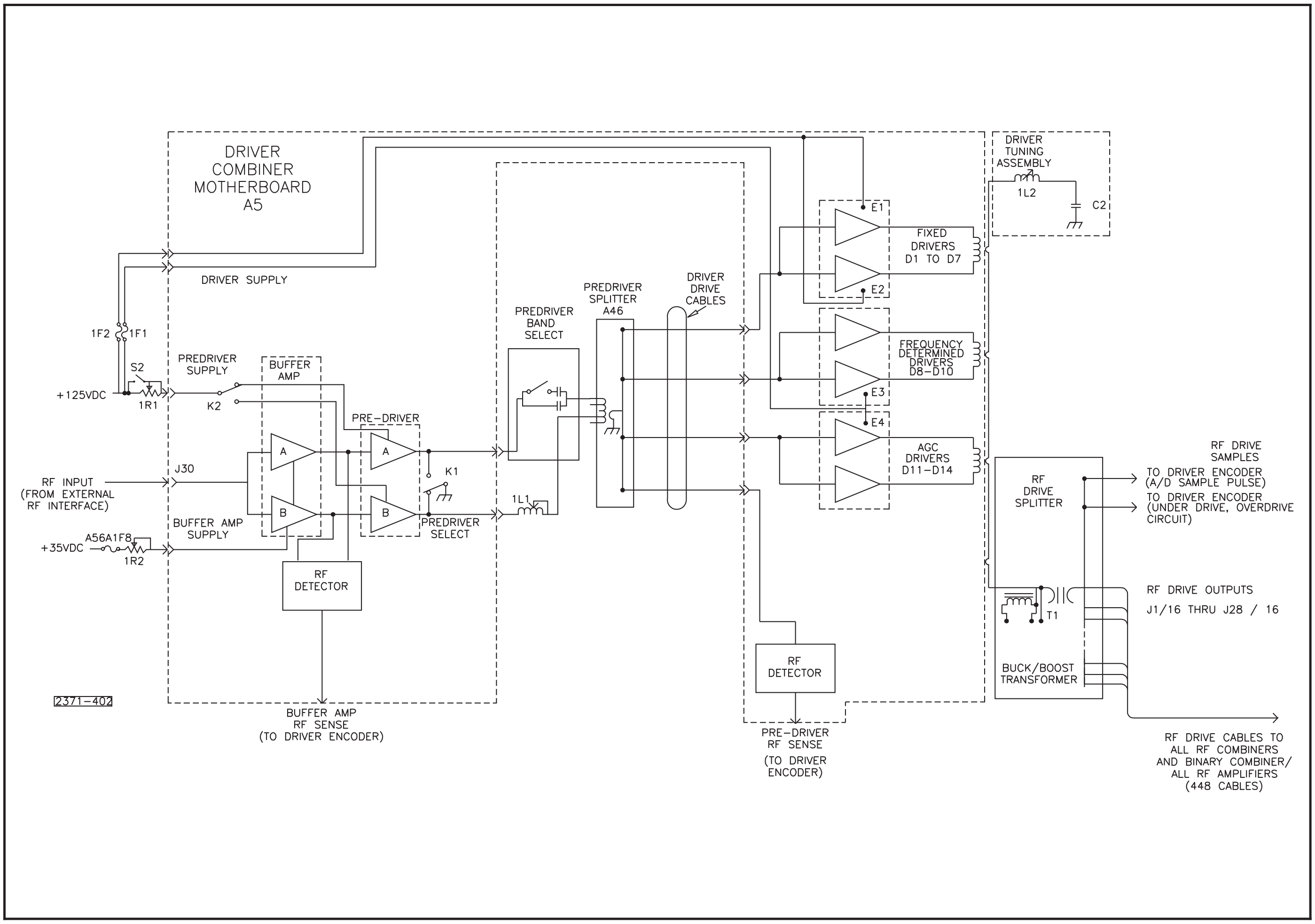


Figure 4-6. RF Driver Section

optical units that detect the presence of liquid on the cabinet base and activate the COOLING FAULT on the LED Mimic Panel.

4.4.9.2 Flow Detection

Coolant Flow Switch (4S1) is located in the HEC. In the event of no coolant or excessively low coolant flow, the affected transmitter is disabled by command to the transmitter Interface board from 4S1-1.

4.5 RF Circuits In The Transmitter

4.5.1 RF Driver Section

The RF Driver section accepts a 5Vp-p input signal, at the Transmitter's operating frequency, from the Oscillator board or from the use of internal crystals. The RF Driver section includes three basic stages of amplification to provide enough RF drive for the 220 Big Step and 4 Binary RF Amplifiers. The section normally operates below its capacity, and is capable of providing the additional RF drive when required.

The RF Driver section is contained in the Right PA compartment. The components that make up the section are located in the top half and in the rear of this compartment behind interlocked doors.

See VIEWS 2 & 13 for a more exact location of the components.

NOTE

The following sections describe the RF signal flow in general, for more detail refer to the Buffer Amplifier, Predriver, and RF Drivers in Section C, Driver Combiner Motherboard, of this manual.

Refer to Figure 4-6, RF Driver Section for the following discussion.

4.5.1.1 Buffer Amplifier

A plug in Buffer Amplifier amplifies the RF Interface output from a TTL level to approximately 20 Vp-p. There are two separate amplifiers on the Buffer Amplifier board, Buffer A and Buffer B, which are driven in parallel. Buffer A output drives Predriver A, while Buffer B output drives Predriver B. Buffer A and Buffer B are both active at the same time. However, only one half of the Buffer is in the RF chain at any one time. The use of Buffer A or Buffer B is selected by the Predriver A/Predriver B control on the Driver Encoder board.

4.5.1.2 Predriver RF Amplifier

The Predriver amplifies the Buffer signal to a level adequate to drive the 14 Driver RF Amplifiers via the Predriver Tuning board. There are two Predrivers, Predriver A and Predriver B (each is one-half of the same RF Amplifier module), which are constantly being driven by their respective Buffer Amplifier output. Only one of the Predrivers is active at any one time. Predriver A or Predriver B is selected on the Driver Encoder board. The Predriver RF Amplifier is interchangeable with any of the 14 Driver RF Amplifiers and any of the 220 Big Step and 4 Binary RF Amplifiers.

4.5.1.3 Predriver Tuning

The input of the Predriver Tuning board is driven by the Predriver Amplifier. The selected Predriver RF output passes through a series-tuned inductive/capacitive network and the primary windings of the transformer on the Predriver Splitter. The value of inductance and capacitance (C1) is frequency determined, the value of C1 is selected by switches on the Predriver Band Select board. This board also controls the Predriver voltage by switch contacts across dropping resistor R1.

4.5.1.4 Predriver Splitter A46 and Driver Drive Cables

The secondary of the Predriver Splitter divides the RF signal and drives the 14 Driver RF Amplifiers, D1-D14. There are 4 connectors on the outside of the splitter to which the Driver Drive Cables connect. The other end of these cables connect to the Driver Combiner Motherboard.

4.5.1.5 RF Drivers

The RF Driver consists of fourteen Driver RF Amplifiers, D1 through D14. The RF drive inputs are from the Predriver Splitter, and the RF outputs go to the RF Driver Combiner.

The number of Drivers used between D1 and D10 is determined by jumpers on the Driver Encoder board. The number of AGC drivers activated (D11-D14), is determined by the setting of the AGC control on the Driver Encoder board. By varying the number of Drivers turned on, the Driver Encoder regulates the RF drive to the 220 Big Step and 4 Binary RF Amplifiers.

These 14 Driver RF Amplifiers are interchangeable with the Predriver and any of the 220 Big Step and 4 Binary RF Amplifiers.

4.5.1.6 RF Driver Combiner

Each Driver RF Amplifier feeds its own ferrite toroidal combiner transformer primary and a copper rod passing through the fourteen toroids acts as secondary windings connected in series.

The combiner toroids add RF voltages from the Drivers as the secondary passes from one transformer to the next. The RF voltage is low or zero at the ground point of the secondary rod and increases along the way to the RF Splitter.

4.5.1.7 Driver Tuning

The Driver Tuning Assembly provides variable inductive and capacitive tuning to resonate the combiner pipe.

4.5.1.8 Buck/Boost Transformer

Toroid transformer T1 facilitates amplitude optimization of the Driver section RF Module’s input amplitude, and Driver Combiner loading. Its optimum operation in the circuit is established by selecting the appropriate tapping configuration; BOOST mode or BUCK mode or NEUTRAL mode. The need for a particular mode of operation is ultimately frequency dependant.

4.5.1.9 RF Drive Splitter A6 And RF Drive Cables

The purpose of the RF Splitter is to divide the combined output of the Driver Combiner and provide each Big Step and Binary RF Amplifier with the proper RF drive level.

The bottom end of the combiner rod bolts to the A6 board, which contains a large ferrite toroid transformer and conductive RF and ground planes.

There are 28 connectors, J1 through J28, which provide a total of 448 outputs, one for each half-quad on each of the 220 Big Step and 4 Binary RF Amplifiers. Each connector provides connections for two sets of eight coaxial cables, the sixteen cables from each connector form two cable bundles which go to the input connectors on Big Step and Binary Combiner Motherboards.

An additional connector, J29, on the splitter assembly provides RF sample signals to other parts of the Power Block as follows:

- A synchronizing RF signal is connected to the Driver Encoder, and is used for the A/D Conversion process.
- An RF drive sample for Low Drive and High Drive Fault sensor circuits, and the Relative RF Drive metering also on the Driver Encoder.

4.5.2 Output Network Description

The Output Network transforms the impedance of the RFCombiner output, at about 8-18 Ohms, to 50 Ohms. This is done in two basic sections, the Bandpass Filter stage and the “L” Matching stage.

The RF Output Network is contained in the Output Network Cabinet (SEE VIEW 8).

Note

The RF Power Sample board and ARC Detectors aredetailed in Section H.

4.5.2.1 Bandpass Filter

The bandpass filter/output network is both a filter and an impedance matching network. The combiner output impedance is low (between 8 and 18 ohms, with the specific value being frequency dependant) and is matched or stepped up to 50 ohms. The bandpass filter section of the Output Network consists of L1, C1A, and C1B. C1A is a vacuum variable capacitor and is brought out to the front of the transmitter as the TUNE control. This impedance transformation is fixed, and is set during bandpass filter tuning and adjustment at the factory or after a frequency change.

The bandpass filter also smooths the small steps that are present in the PAÀÀs output; the small steps result from sidebands outside the audio frequency range which are attenuated in the filter. Any other harmonic and spurious signals in the RF power amplifier section output are also attenuated by the bandpass filter.

4.5.2.2 Third Harmonic Filter

Third harmonic attenuation is accomplished by the parallel resonant circuit, formed by L2 and C3, that is inserted in series with the RF output line center conductor after the Bandpass Filter.

4.5.2.3 "L" Matching Network

Matching Network consists of the bandpass filter and the C2 capacitor. C2 is comprised of a combination of capacitors in parallel that are band switched to form the shunt leg of the "L" matching network. A static drain choke and spark gap provide further protection at the RF Output connector.

4.5.2.4 PA Output Combiner RF Samples

A number of RF samples are picked up from various points in the PA Combiner and distributed to circuits elsewhere in the Transmitter.

4.5.2.4.1 T3 - Network Current Sample

At the ground point of the combiner, an RF current sample is picked up by a current transformer and compared to the RF voltage sample at the input of the Bandpass Filter. R5 is made up of 3 three Watt resistors in parallel to provide a termination across T3 and to set the sample level.

4.5.2.4.2 Network Voltage Sample

At the input of the Bandpass Filter, an RF voltage sample is coupled by 3 capacitors and compared to the RF current sample at the ground end of the combiner pipe

4.5.2.4.3 RF Synchronization Sample

On the base of the RPAC, coupled closely to the RF Combiner pipe, is pick©up coil T4. This sample is routed to the Oscillator board at J3 to facilitate synchronization of Oscillator and Combiner pipe RF in the event of loss of Oscillator RF.

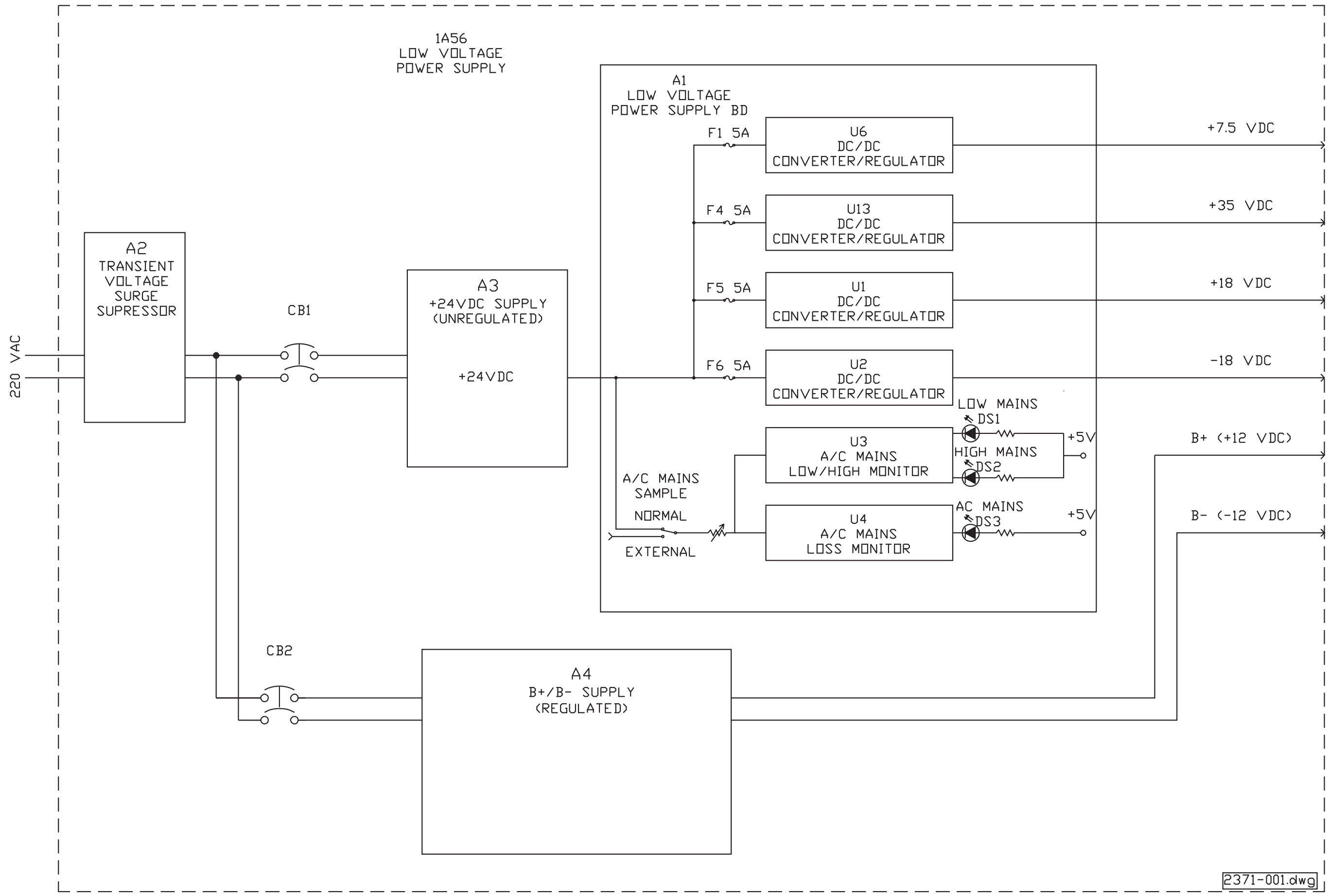


Figure 4-7. Low Voltage Power Supply
Simplified Block Diagram

4.6 AC Power Circuits In The Transmitter

NOTE

220 VAC is used in the following text for simplicity, however the Single Phase AC MAINS can be from 198-251 VAC.

4.6.1 Single Phase AC Input

Refer To Figures 4-7 and 4-8 for the following discussion. Single phase 220VAC is routed from 6TB6 in the Rectifier cabinet, and terminated at TB1-1, 2 on the Transient Voltage Surge Protector (A56A2), which protects the low voltage supplies from AC transients.

The output of the surge Protector is connected to circuit breakers CB1 and CB2. CB1 applies 220VAC to the +24 VDC unregulated supply (A56A3) and CB2 applies 220 VAC to the B+/B- (+/- 12 VDC) regulated supply, A56A4. The output of the 24 VDC unregulated supply is the source voltage for the Low Voltage Power Supply board.

4.6.1.1 Low Voltage Power Supply board

The Low Voltage Power Supply provides four different regulated DC voltages; +8 VDC, +/-18 VDC and +35 VDC. All Transmitter logic and other circuits, except the Buffer, Predriver, and RF Power Amplifiers operate from the Low Voltage supply. The input is surge protected by a Surge Protector and CB1. The Low Voltage Power Supply Board has fused inputs and outputs. The B+/B-Supply is protected through the surge protector and CB2.

4.6.1.1.1 +24_A/24_B VDC Power Supply

The 24 VDC output from the unregulated 24 V supply passes through two poly switches, which act as resettable fuses, and out to J1-13,15.

4.6.1.1.2 Unregulated B+/B- Power Supply

The B+/B- voltage is supplied by a switching power supply. +12 VDC at 65a output is at J3 and -12 VDC at 20a is at J5. This supply is the + and -12 VDC or unregulated B+/B-supply.

4.6.1.2 Power Distribution Boards

The Power Distribution Board distributes +7.5VDC, +/-18VDC and +35VDC from the Low Voltage Power Supply board and +/-12 VDC (B+/B) from the B+/B- Power Supply to other Transmitter printed circuit boards. The only components on the Power Distribution board are ten connectors.

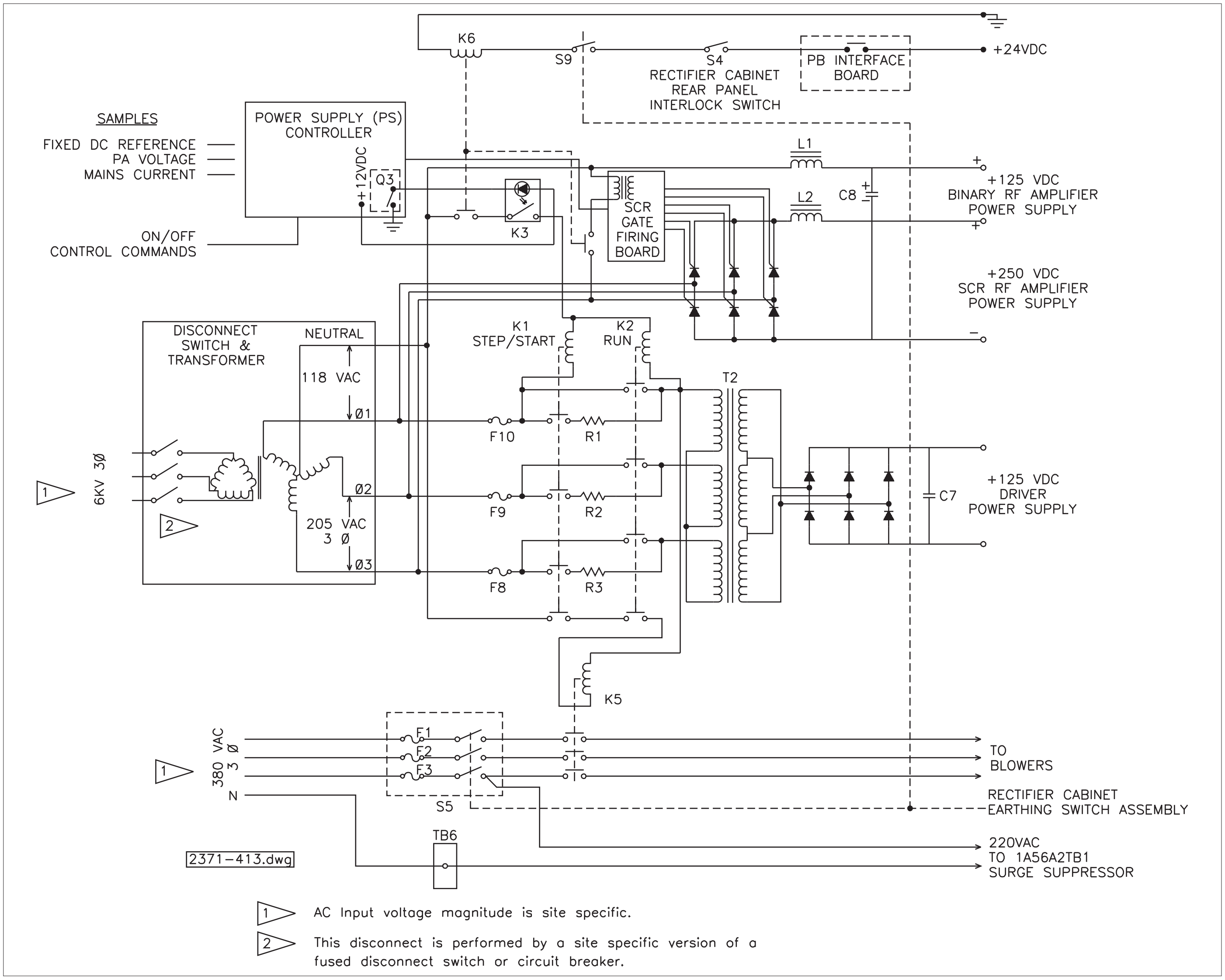


Figure 4-8. Simplified RF Amp Power Supplies Diagram

4.6.2 3 Phase AC Input

Refer to Figure 4-8 for the following discussion. The AC input comes from the Transformer Cabinet with a primary disconnect/AC step-down transformer (refer to the Section W of this manual for further explanation of the Transformer Cabinet) to provide 205 VAC to the Rectifier cabinet that supplies 250 VDC @ 1400 ADC to each Transmitter. The system uses a keylock interlock system that prevents opening a cabinet when high voltage is still present usually requiring the preceeding cabinet be disconnected and the load grounded before the key is released.

The 250 volt supply is regulated and self-protected by the Power Supply Controller.

The Power Supply uses an Enerpro SCR firing board to provide gate drive for the SCR recifiers. This board phase-modulates the SCR conduction angle based on a control voltage input to the board.

The Power Supply Controller board generates the control voltage for the SCR Firing board as required for voltage regulation.

4.6.3 RF Amplifier Power Supplies

See Figure 4-8. The voltages generated by the RF Amplifier Power Supplies are:

a. +250VDC, for the PA RF Amplifiers.
b. +125VDC for the Binary Amplifiers.
c. +125VDC, for the Predriver, RF Drivers D1-D14.

4.6.3.1 PA SCR Main Power Supply

The 250 VDC Power Supply is a "six phase" supply in which the rectification is accomplished in a full wave configuration.

The initial 3 Ø input is conditioned by a Unit Transformer Cabinet.

1. A Switch Cabinet that allows manual on/off control of the source voltage and

2. A transformer cabinet which provides step down of the source to the 205 VAC that is terminated at the A/C input terminals of the rectifier cabinet.

The rectification function is performed by SCR's Q1 through Q6 and filtered by L2 and numerous capacitors. Instead of a lumped filter capacitance/capacitance bank in the power supply itself, the shunt filter capacitors are at locations throughout the 250 VDC distribution system that are closer to the points of application for improved distribution system filtering effectiveness and fuse incorporation. SCR Power Supplies inherently provide regulation for an overvoltage condition but do not provide undervoltage regulation.

The SCR Gate Firing Board phase-modulates the SCR Conduction angle in response to a control signal generated on the Power Supply Controller Board.

The SCR gate applied control signal created on the Power Supply Controller Board is primarily a function of a DC reference voltage that establishes the 250 VDC output voltage. This control reference is further refined by samples of PA voltage and sample rectified AC input current.

4.6.3.2 Power Supply Interlock Relay

The Rectifier Cabinet output will be neutralized when the output earthing switch is in the earthed position.

24VDC is applied to the coil of K6 when the output earthing switch is in the ready position, and the Rectifier Cabinet rear door is in place with its associated interlock switch closed. The closed contacts of K6 will supply 120 volts to the power transformer on the SCR Gate Firing Board enabling it. When the interlock is in the earthed position, the voltage to the SCR Firing board is interrupted and the output of the Rectifier cabinet goes to 0 volts.

4.6.3.3 Binary Main Power Supply

The +125 VDC source for binary power amplifiers uses a phase to neutral connection from the same 205 VAC input applied to the PA SCR Main Power Supply. This connection facilitates the use of three of the main power supply SCRs in combination with L2 and the additionally added components C8 and L1 to provide +125 VDC across C8, the C8 terminals being the Binary Power Supply output terminals. This half wave configuration outputs a nominal current of 10 amps.

4.6.3.4 Driver Power Supply

The Driver Power Supply is a conventional "6 phase" transformer driven circuit resulting in a +125 VDC output; the transformer configuration being Δ Y with a 205 VAC three phase source. The 205 VAC input is applied through a step/start relay system; K1 providing current through current limiting resistors R1, R2 and R3 followed by the shunting of those resistors by contacts of K2. Solid State Relay K3 receives a command from the Transmitter controller to initiate the step/start sequence which operates the previously mentioned K1. K2 will energize when the voltage through R3 increases above the coil turn-on voltage.

4.6.3.5 +250 VDC Supply Current Meter

The negative side of the SCR Controller power supply is tied to one end of the +250VDC power supply current meter shunt SH1. The total +250 VDC supply current returns to ground at this point.

Meter shunt SH1 is located in lower rear section of the right PA compartment. The Supply Current meter (M2) is located on the center PA compartment front door, and is connected across the shunt.

The voltage across the shunt, which is proportional to supply current, also goes to the supply current overload circuit on the Analog Input board, through the switch board/meter panel. The current overload circuit provides a remote supply current metering output as well.

4.6.4 +250VDC Power Supply Discharge Circuit

This circuit is comprised of four power MOSFET's operating in parallel to discharge the +250VDC and +125VDC supply anytime a fault condition occurs. Q1, Q2, Q3, and Q4 function as switches which will be open when the supply is energized. When a fault condition occurs, a control voltage is applied to each gate to activate the MOSFET's. This control voltage comes from the power suply board to the individual gate circuits. Therefore the discharge path is self contained, i.e. no additional supply is needed to activate the circuit. R13, R14, R15, and R16 are in series with each MOSFET for current limiting. Each MOSFET has a zener diode across the gate source to limit the gate voltage to 10V. The 125VDC supply will discharge through CR5 and CR6 when the Crowbar activates.

4.6.5 Blower Supplies

Four blowers (4B1 through 4B4) are located in the Heat Exchanger Cabinet (HEC). Their function is to provide flushing air for removing residual heat from the PAC/EPAC and ONC, not removed by the liquid cooling system.

These 4 HEC located blowers operate from 3 Phase 380VAC. This supply is obtained through the externally mounted Rectifier Low Voltage AC Mains Disconnect Switch, AC line filter 6FL1 located in the Rectifier Cabinet, and 6S5 also in the Rectifier Cabinet. Should a blower failure occur, the associated air flow monitor will sense the lowered air flow and initiate power foldback to a safe level. An airflow monitor is present on one Modulation Encoder in each cabinet; Left, Center and Right compartments of the PA Cabinet, Extended PA cabinet and a separate Air Flow Monitor in the ONC. See VIEWS 2, 4, 5, 6, and 8 for component locations.

Each blower phase is individually fused in the Heat Exchanger Cabinet.

Additional blowers are located on the rear door of the lower ONC circulating air from top to bottom of the ONC cabinet. 4B4 forces air through the partitioned OMC and Upper ONC cabinets to the rear of the lower ONC cabinet. This cool air mixes in with the circulating air of the ONC. Heated air flows out the top front, through the partitioned Upper ONC and OMC cabinets mixing with the PA cabinet output air before going through the liquid cooled radiator.

The ONC rear door also contains fuses for each individual phase feeding the rear door blowers.

4.7 Drive Multimeter

4.7.1 Introduction

See Figure 4-9. This section describes the Drive Multimeter board.

The Drive Multimeter provides metering of the Predriver and RF Driver sections of the Transmitter. A probe, with four meter positions, is also provided for AC and DC voltage measurements on printed circuit boards in the Transmitter's non-interlocked compartment.

4.7.2 Location

The Drive Multimeter is located on the back side of the right PA compartment front door. (VIEW 1).

4.7.3 Principles of Operation

The meter has a 100 microampere movement, and two scales, 0-3 and 0-10. The meter switch positions are labeled with the name of the metered function and the scale used. For some positions, a X10 or X100 multiplier is applied to the meter scale reading.

Refer to the Drive Multimeter schematic diagram for the following circuit discussion. Meter M1 is protected against excessive voltages and currents by 1-Amp rectifier diodes CR4 and CR5. Capacitor C3 provides RF bypassing around the meter movement.

4.7.3.1 Metering Driver Section Parameters

For 0-3 Volt, 0-30 Volt, and 0-300 Volt DC ranges, the multimeter is a 10,000 Ohm per Volt meter. For current ranges, the meter acts as a voltmeter, measuring the voltage drop across a resistor in the DC current path. One side of the meter is grounded through a section of switch S1 for driver section voltage measurements. The meter is isolated from ground for current measurements.

The Drive Multimeter positions are defined and detailed in the Sections where the meter resistors are located.

4.7.4 Multimeter Probe

The multimeter uses a flexible coiled patch cord with a clip-on probe for convenient measurement of voltages in the non-interlocked compartment. Measurement ranges available are 0 to 30 VAC Peak, 0 to +3 VDC, 0 to +30 VDC, and 0 to -30 VDC.

Resistor R5, 29.4K 1%, is the multiplier resistor for the 0-3 Volt range. The total 30K resistance required for this range includes the meter resistance.

Resistor R3, a 301K 1% resistor, is the multiplier resistor for the 0-30 Volt range. Positive and negative voltage ranges are obtained by grounding either the negative or positive meter terminal through S1.

For AC Voltage measurements, CR1, R4, C1 and R1 make up a peak detector. Resistor R2 is the multiplier resistor for the AC voltage range.

4.7.5 Maintenance

There are no maintenance adjustments on the Drive Multimeter board.

4.7.6 Troubleshooting

The following information contains general troubleshooting tips and any precautions if applicable.

Check connectors to be certain they are properly and firmly inserted. Check ribbon cables for possible damage, such as crimping.

Visually check S1. Liquid or spray contact cleaners should be used with caution; don't use any cleaner that could leave a residue that might collect dirt and dust.

Use an accurate digital multimeter to measure resistances. It may be necessary to remove plug-in modules or other connectors to eliminate parallel resistance paths that could affect the measurement.

CAUTION

WHEN MEASURING RESISTANCES IN ANY METERING CIRCUIT, CHANGE THE MULTIMETER POSITION TO THE LOW OHMS RANGE. OHMMETERS COULD PROVIDE ENOUGH CURRENT TO DAMAGE THE SENSITIVE METER MOVEMENT.

Remove all power from the Transmitter and disconnect P4 and P5 from the multimeter board to eliminate any possible parallel current paths. Use a battery or low-voltage DC power supply and current limiting resistor to provide a low current (50 to 100 microamperes) through the meter movement, with a low-current meter of known accuracy in series with M1.

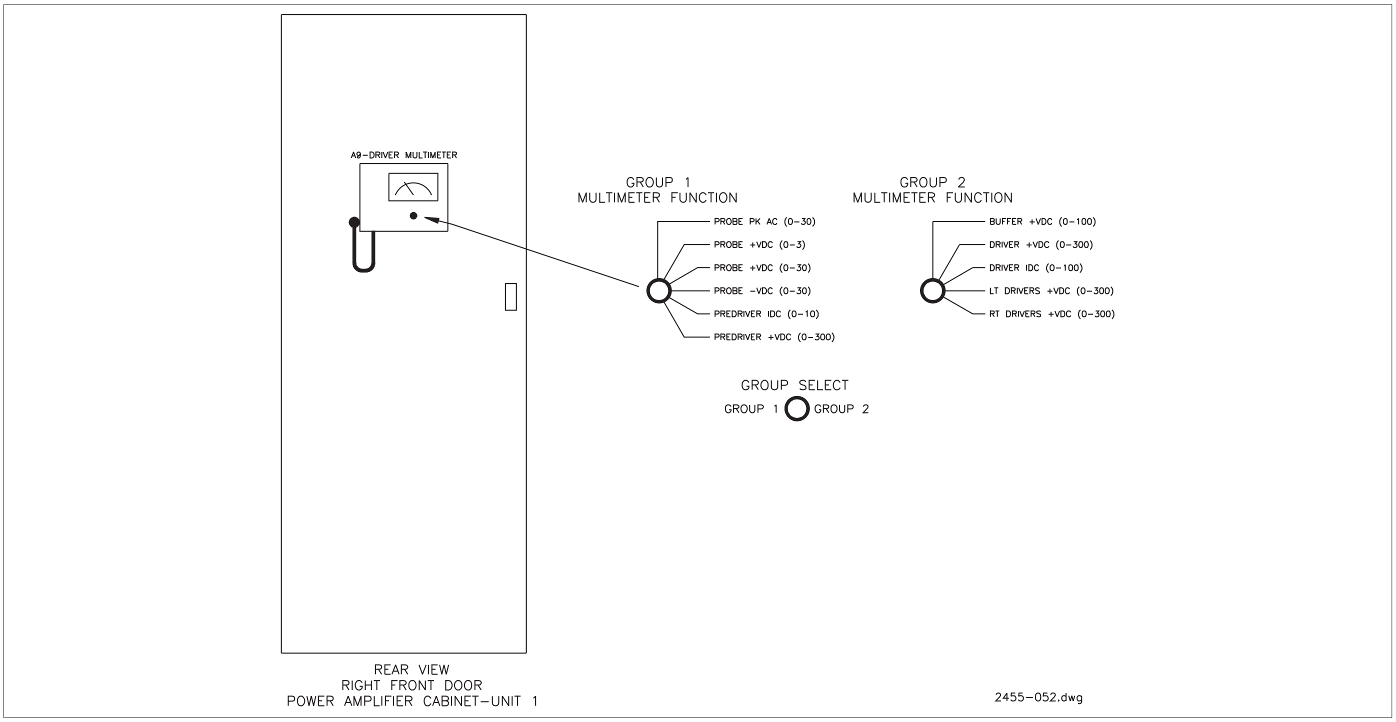


Figure 4-9
Drive Multimeter Location and Positions
(Multimeter Assembly Part #992-6752-005)

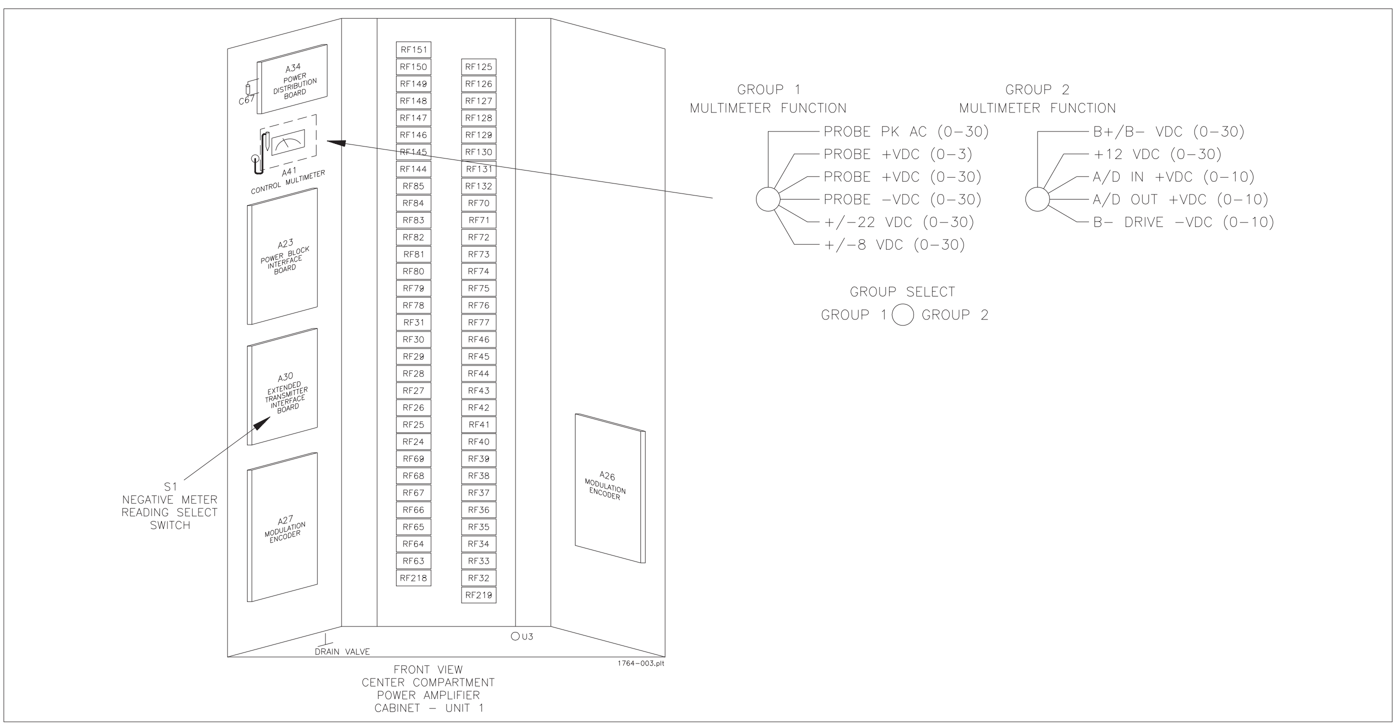


Figure 4-10
Control Multimeter Location and Positions
(Multimeter Assembly Part #992-6752-005)

4.8 Control Multimeter

4.8.1 Introduction

See Figure 4-10. This section describes only the inputs to the Control Multimeter. Since the Control Multimeter is exactly the same as the Drive Multimeter except for the inputs to the meter, please refer to the Drive Multimeter section for a more detailed description of the actual meter circuits.

4.8.2 Location

The Control Multimeter is mounted in the center PA compartment on the upper left hand side (See Fig. 4-10).

4.8.3 Control Multimeter Inputs

Refer to the Control Multimeter schematic diagram for the following circuit discussion.

The Control Multimeter has eleven (11) inputs as follows:

Group 1

1. Probe Peak AC
2. Probe +VDC
3. Probe +VDC
4. Probe -VDC
5. +22(+18)/-22(-18) VDC
6. +8(+7.5) VDC

Group 2

1. B+/B- VDC
2. +12 VDC
3. A/D IN + VDC
4. A/D OUT +VDC
5. B- Drive -VDC

5.1 Introduction

This Section provides general system preventative maintenance information.

NOTE:

Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

5.2 Maintenance

5.2.1 Maintenance and Daily Records

It is strongly recommended that a station keep separate logbooks for daily operation and for maintenance. The daily logbook should consist of routine meter readings and note any discrepancies that are found during normal operation. The maintenance logbook should contain more detailed information concerning external meter voltage readings taken from boards and components, any action taken during the routine maintenance period, and a record of repairs and observations made during maintenance.

5.2.2 Antistatic Meter Treatment

Inaccuracies in meter readings can be caused by static electricity on the lens. If this is a problem in your area, it is suggested that the lenses be wiped with any readily available antistatic lens treatment.

5.3 Preventive Maintenance

Preventive maintenance should mainly consist of three operations: inspecting, cleaning, and tightening.

5.3.1 Inspecting

This is a visual and physical inspection of the Transmitter looking for loose connections, signs of corrosion and dirt, broken or overheated components and wear on moving parts.

5.3.2 Cleaning

This is the stage in which the dirt and/or corrosion is removed from the Transmitter and the air filters are cleaned and/or replaced. The Transmitter should be cleaned using an approved solvent and/or vacuum or compressed air device. The air system should be checked and the filters cleaned or replaced as needed.

5.3.3 Tightening

This is the stage when the loose component connections discovered during inspection and cleaning are tightened. Areas to pay particular attention to are high current points, high power compartments and moving parts such as fans and tuning controls. Caution should be taken not to overtighten a connection as this may damage the connection. See Table 2-1 for proper torque specifications.

5.4 Measuring RF Drive Level And Phase

The following procedures will be referred to from other parts of the Tuning/Frequency Change Procedures and from other sections in this manual. Refer to Making Safe Measurements in Section VI, before proceeding with the following measurements.

5.4.1 Measuring RF Drive Level

Remember that there are two sections of each RF Amplifier and each will have an individual drive signal applied to the input.

NOTE

When measuring RF Amplifier drive amplitude, the amplifier to be measured must be turned “ON” to give a correct drive measurement. The drive waveform of an “OFF” amplifier will be below 0.0VDC and the peaks will probably be clipped. LED indicators DS3 will illuminate GREEN when an amplifier is on and drive level is high enough.

NOTE

For maximum protection of personnel it is recommended to use the Harris scope probe (610-1131-000) or equivalent X10 scope probe to access this point since the long tip will reach through the air slots in the inner door.

a. Connect the probe to the scope set up to measure an RF waveform at approximately 24Vp-p, and ensure that the scope case is properly grounded.
b. Connect the ground clip of the probe to the edge of the inner front door of the Transmitter nearest to the RF Amplifier being measured.
c. With the insulated extended tip securely fastened to the X10 scope probe, insert the tip of the probe through the rectangular cutout and touch TP3 (left side as viewed on a component-side-up module) which is located in front of the heatsink.
d. Make the measurement while holding the scope probe tip on TP3 and be careful not to touch other parts of the circuit.
e. Make the same measurement on TP4 (left side).

NOTE:

Representative waveforms are located in Section G, RF Amplifier Module.

5.4.2 Measuring RF Drive Phasing

Remember that there are two sections of each RF Amplifier module and each have an individual drive signal fed into them.

Measure the RF Drive Phase using the following procedure and precautions.

NOTE:

When measuring RF Amplifier drive amplitude, the amplifier to be measured must be turned "ON" to give a correct drive measurement. The drive waveform of an "OFF" amplifier will be below 0.0VDC and the peaks will probably be clipped. LED indicators DS3 will illuminate GREEN when an amplifier is on and drive level is high enough.

NOTE:

For maximum protection of personnel it is recommended to use the Harris scope probe (610-1131-000) or equivalent X10 scope probe to access this point since the long tip will reach through the air slots in the inner door.

a. Connect the probe to the scope set up to measure an RF waveform at approximately 24Vp-p, and ensure that the scope case is properly grounded.

b. Connect the ground clip of the probe to the edge of the inner front door of the Transmitter nearest to the RF Amplifier being measured.

c. With the insulated extended tip securely fastened to the X10 scope probe, insert the tip of the probe through the rectangular cutout and touch TP3 (left side, as viewed on a component-side-up module), or TP4 (left side) which is located in front of its respective heatsink.

d. Scope Setup - set the scope on DC coupled, 5V per division and the trace is at center of the screen. Connect the external sync of the scope to J6 on the External RF Interface board A3 and make sure the scope sync is set to External. Adjust the horizontal vernier on the scope so that one full RF cycle occupies 7.2 divisions on the screen. Each division now equals 50 degrees of phase shift. Using the Horizontal positioning and triggering level on the scope place the zero crossing of the waveform on the center crossing of the vertical and horizontal lines of the scope. Increase the vertical sensitivity of the scope to expand the waveform. Switch the scope to the X10 position and readjust the horizontal position so that the RF transition again crosses the center line of the scope. This will be the reference for the phase measurements. If another Rf Amp transition occurs at the first large division on the left, this amplifier is operating at 5 degrees lagging from the reference.

e. Now that a reference phase has been established, without changing any of the scope settings, move the scope probe to the desired RF Amp to be measured. It is usually a good idea to first measure the drive phase of the A side of Big Step PA modules 1 - 6, then set your reference phase to the module that is typical of the six. There may be 4 modules operating at or near the same phase, and the other two may be a few degrees off.

f. Again set the reference to the most common phase. Also note that there will be some phase difference between the A side and B side of the same module, but typically the A sides of the RF Amps should all line up as well as all the B sides should be within specifications. Typically there may be 2 to 4 degrees difference between A and B sides and there should not be more than +/-4 degrees difference between all the A sides when referenced to an A side. +/-4 degrees is also maximum phase difference between B sides when referenced to a B side. Also keep the ground lead of the probe close to the same RF Amplifier being measured.

5.5 Measuring RF Drain Waveform And Phase

The following procedures will be referred to from other sections in this manual. Refer to Making Safe Measurements in Section VI, before proceeding with the following measurements.

5.5.1 Measuring RF Drain Waveform

Remember that there are two sections of each RF Amplifier and each will have an individual drain signal at the output.

NOTE:

When measuring RF Amplifier drain waveform, the amplifier to be measured must be turned "ON" to give a correct measurement. There will be no drain waveform of an "OFF" amplifier. LED indicators DS3 will illuminate GREEN when an amplifier is on.

NOTE:

For maximum protection of personnel it is recommended to use the Harris scope probe (610-1131-000) or equivalent X10 scope probe to access this point since the long tip will reach through the air slots in the inner door.

a. Connect the probe to the scope set up to measure an RF waveform at approximately 250Vp-p, and ensure that the scope case is properly grounded.

b. Connect the ground clip of the probe to the edge of the inner front door of the Transmitter nearest to the RF Amplifier being measured.

c. With the insulated extended tip securely fastened to the X10 scope probe, insert the tip of the probe through the rectangular cutout and touch TP1 which is located in front of the heatsink.

d. Make the measurement while holding the scope probe tip on TP1 and be careful not to touch other parts of the circuit.

e. Make the same measurement on TP2.

5.5.2 Measuring RF Drain Phasing

Remember that there are two sections of each RF Amplifier module and each has an individual drive signal fed into them. Measure the RF Drain Phase using the same procedure and precautions as above.

a. Scope Setup - set the scope on AC coupled, 50V per division, and the trace is at center of the screen.

b. Measure RF Drain Phase using the same procedure found in paragraph "Measuring RF Drive Phasing" in this Section.

DWG NO.	817 2413 931 .				
LTR	ZONE	DATE	DFTM	ENG	ECO NBR
A	.	.	.	.	NEW DWG
COPIED FROM 817 2413 929					
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. .					

REV

VIEW	TITLE	REV	FILE
INDEX	VIEW LOCATION DIAGRAM	A	8172413929-2
1	PAC RIGHT FRONT DOOR	A	8172413929-3
2	PAC RIGHT FRONT COMPARTMENT	A	8172413929-4
3	PAC CENTER FRONT DOOR	A	8172413929-5
4	PAC CENTER FRONT COMPARTMENT	A	8172413929-6
5	PAC LEFT FRONT COMPARTMENT	A	8172413929-7
6	EPAC FRONT COMPARTMENT	A	8172413929-8
7	ONC LOWER FRONT COMPARTMENT	A	8172413929-9
8	ONC LOWER REAR COMPARTMENT	A	8172413929-10
9	EPAC REAR COMPARTMENT	A	8172413929-11
10	PLENUM/OMC REAR VIEW	A	8172413929-12
11	PAC LEFT REAR COMPARTMENT	A	8172413929-13
12	PAC CENTER REAR COMPARTMENT	A	8172413929-14
13	PAC RIGHT REAR COMPARTMENT	A	8172413929-15
14	HEC FRONT COMPARTMENT	A	8172413929-16
15	OMC FRONT COMPARTMENT	A	8172413929-17
16	ONC UPPER FRONT COMPARTMENT	A	8172413929-18
17	ONC UPPER REAR COMPARTMENT	A	8172413929-19
18	OMC REAR COMPARTMENT	A	8172413929-20
19	HEC REAR COMPARTMENT	A	8172413929-21
20	FLEXPATCH LEFT MOD ENC, LEFT COMP.	A	8172413929-22
21	FLEXPATCH RIGHT MOD ENC, LEFT COMP.	A	8172413929-23
22	FLEXPATCH LEFT MOD ENC, CTR COMP.	A	8172413929-24
23	FLEXPATCH RIGHT MOD ENC, CTR COMP.	A	8172413929-25
24	FLEXPATCH MOD ENC, RIGHT COMP.	A	8172413929-26
25	FLEXPATCH LEFT MOD ENC, EXTENDED	A	8172413929-27
26	FLEXPATCH RIGHT MOD ENC, EXTENDED	A	8172413929-28

THIS COVER DRAWING CONTAINS A CHART OF 'COMPONENT LOCATION VIEWS' INFORMATION. EACH 'VIEW' FILE IS IN AUTOCAD FORMAT BUT DOES NOT INCLUDE A STANDARD HARRIS FORMAT. THE HARRIS PART NUMBER - REVISION LEVEL HOWEVER, DOES APPEAR IN THE LOWER RIGHT CORNER. WHEN REVISING A 'VIEW', THE REVISION LEVEL MUST BE UPDATED ON THE 'VIEW' DRAWING AND THIS COVER DRAWING.

HARRIS

HARRIS CORPORATION
BROADCAST DIVISION
P.O. BOX 4290
QUINCY, ILLINOIS 62305

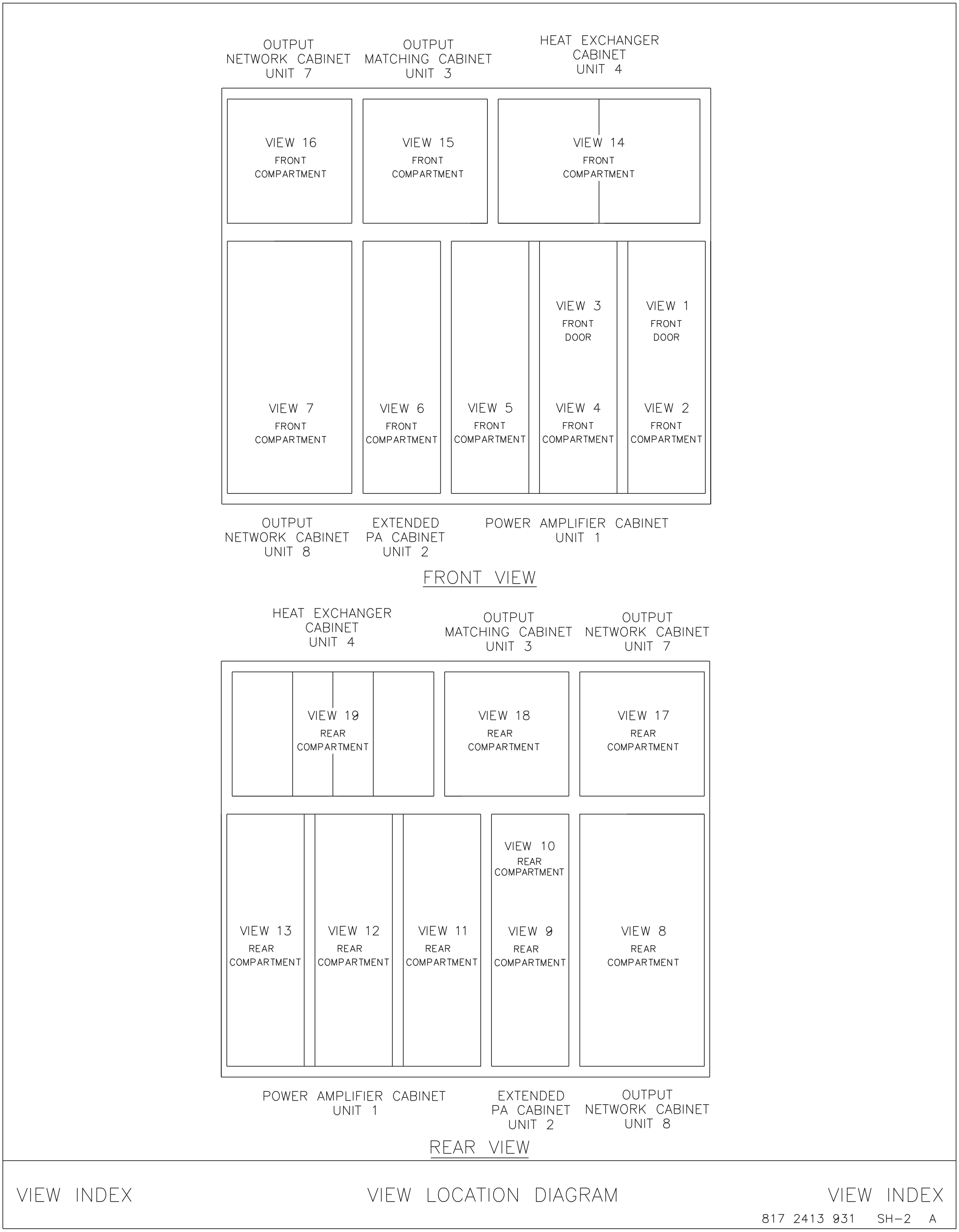
DRAWN BY	B KLESNER
DATE	12-1-10
ENG CHK	B KLESNER
PROJ ENG	B KLESNER
MFG ENG	.
A	SHEET 1 OF 28

TITLE
COMPONENT LOCATION VIEWS
DX200 LIQUID COOLED XMTR
MEDIUM WAVE

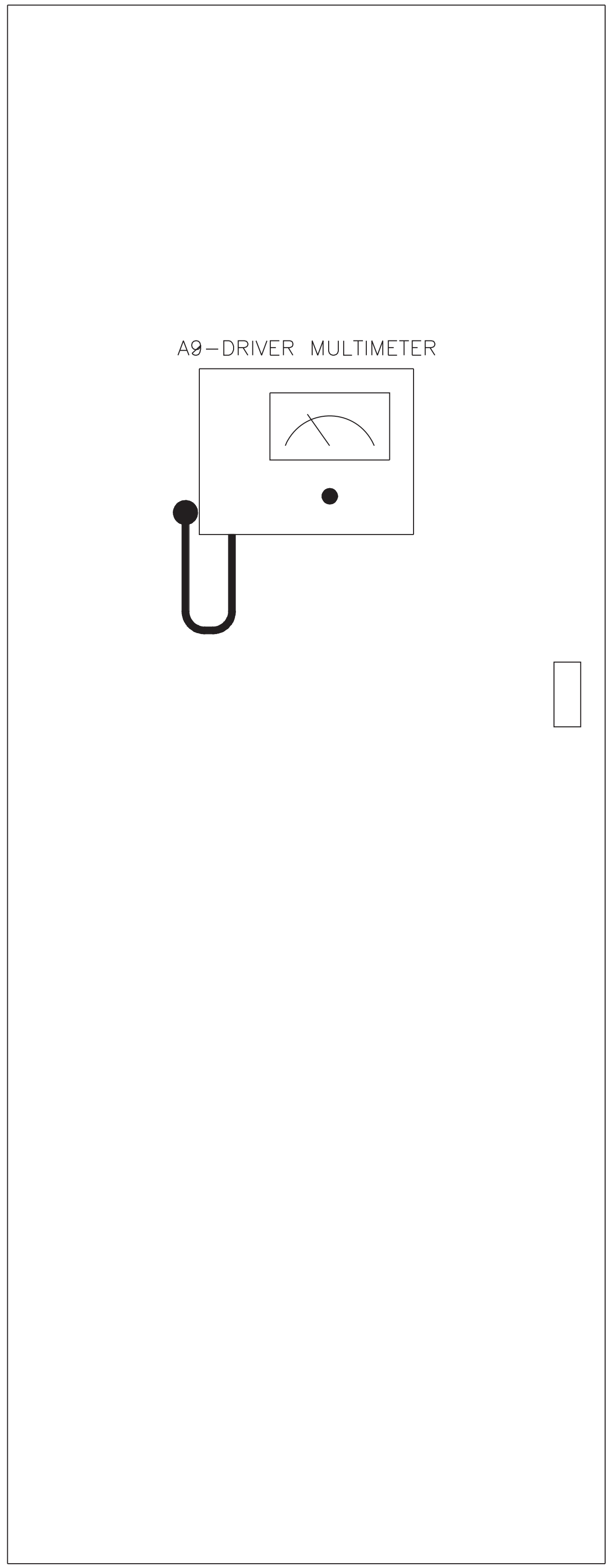
DWG NO. 817 2413 931 . REV A

Figure 5-1 Views Index

WARNING: Disconnect primary power prior to servicing.



WARNING: Disconnect primary power prior to servicing.

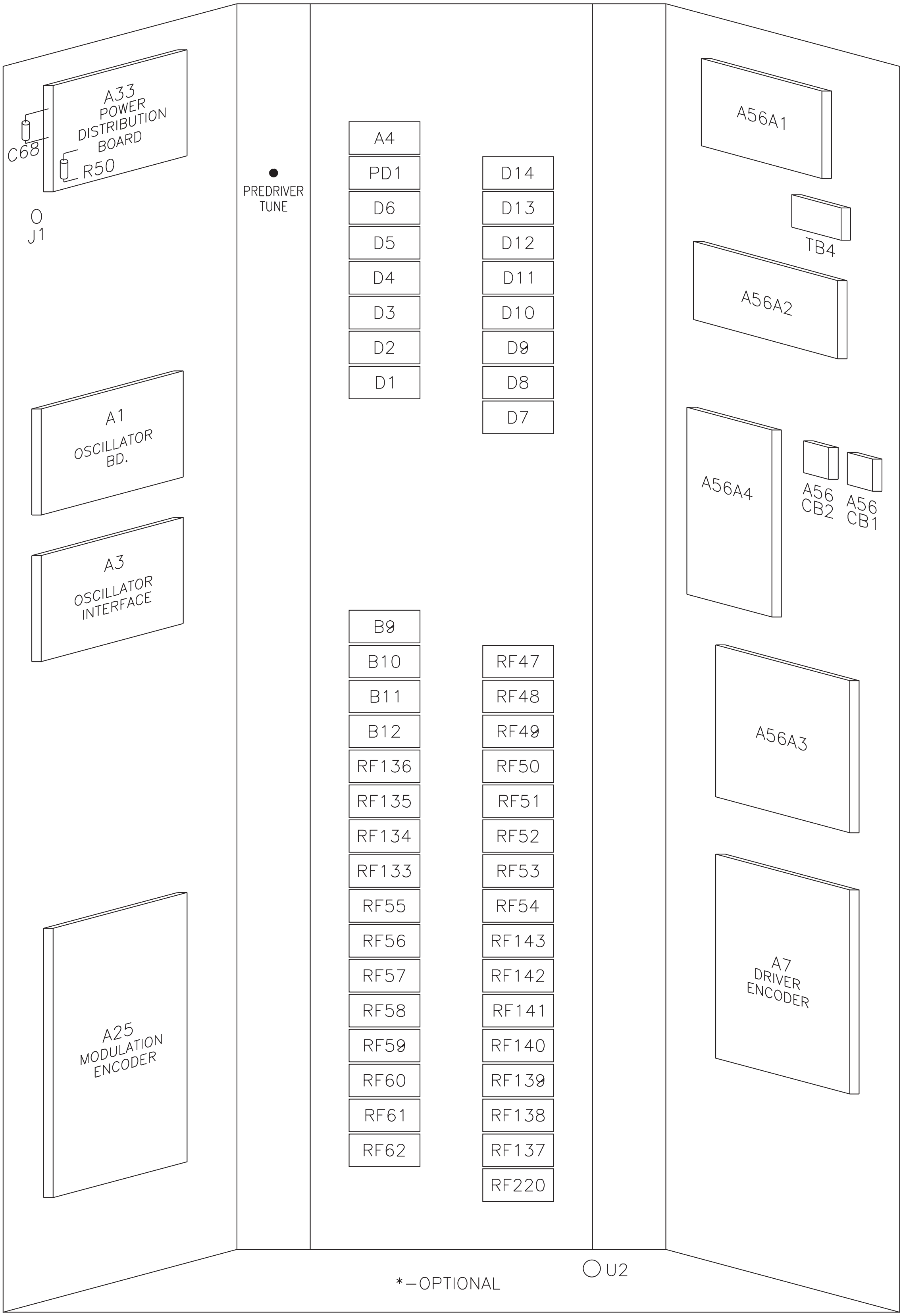


FRONT VIEW
RIGHT FRONT DOOR
POWER AMPLIFIER CABINET-UNIT 1

VIEW 1 | VIEW 1

817 2413 931 SH-3 A

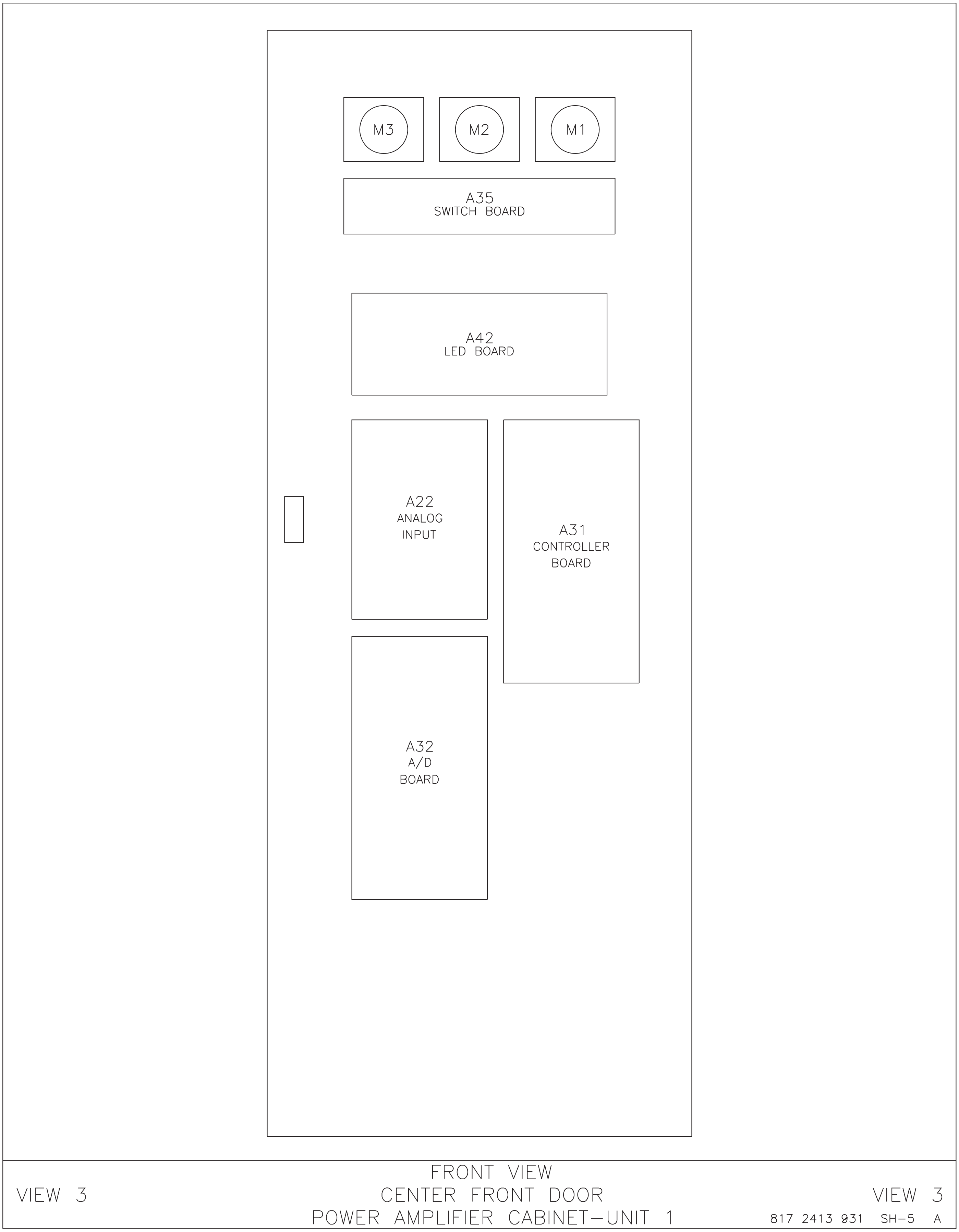
WARNING: Disconnect primary power prior to servicing.



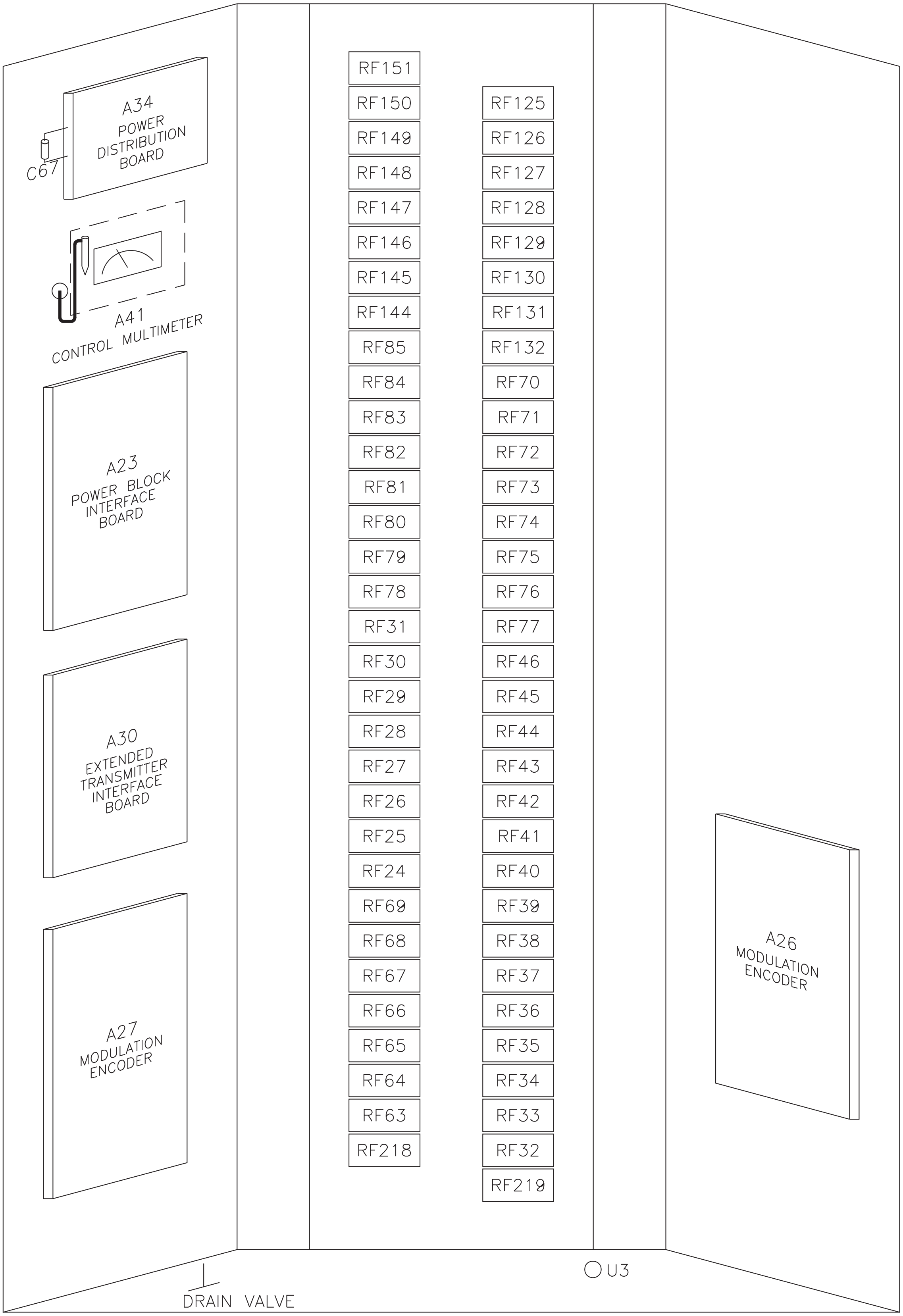
VIEW 2 FRONT VIEW RIGHT COMPARTMENT POWER AMPLIFIER CABINET—UNIT 1 VIEW 2

817 2413 931 SH-4 A

WARNING: Disconnect primary power prior to servicing.



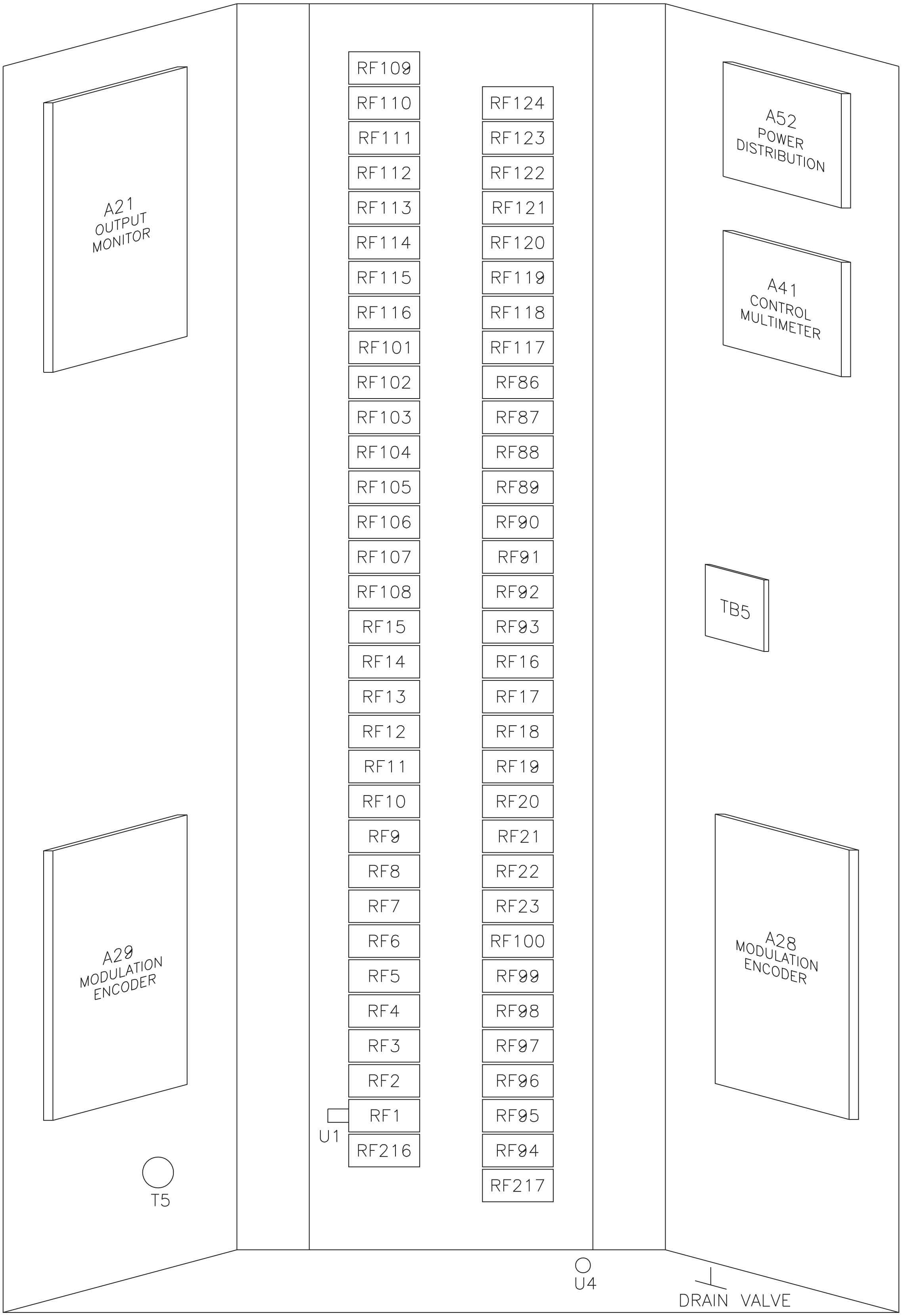
WARNING: Disconnect primary power prior to servicing.



VIEW 4 FRONT VIEW
CENTER COMPARTMENT
POWER AMPLIFIER CABINET—UNIT 1 VIEW 4

817 2413 931 SH-6 A

WARNING: Disconnect primary power prior to servicing.



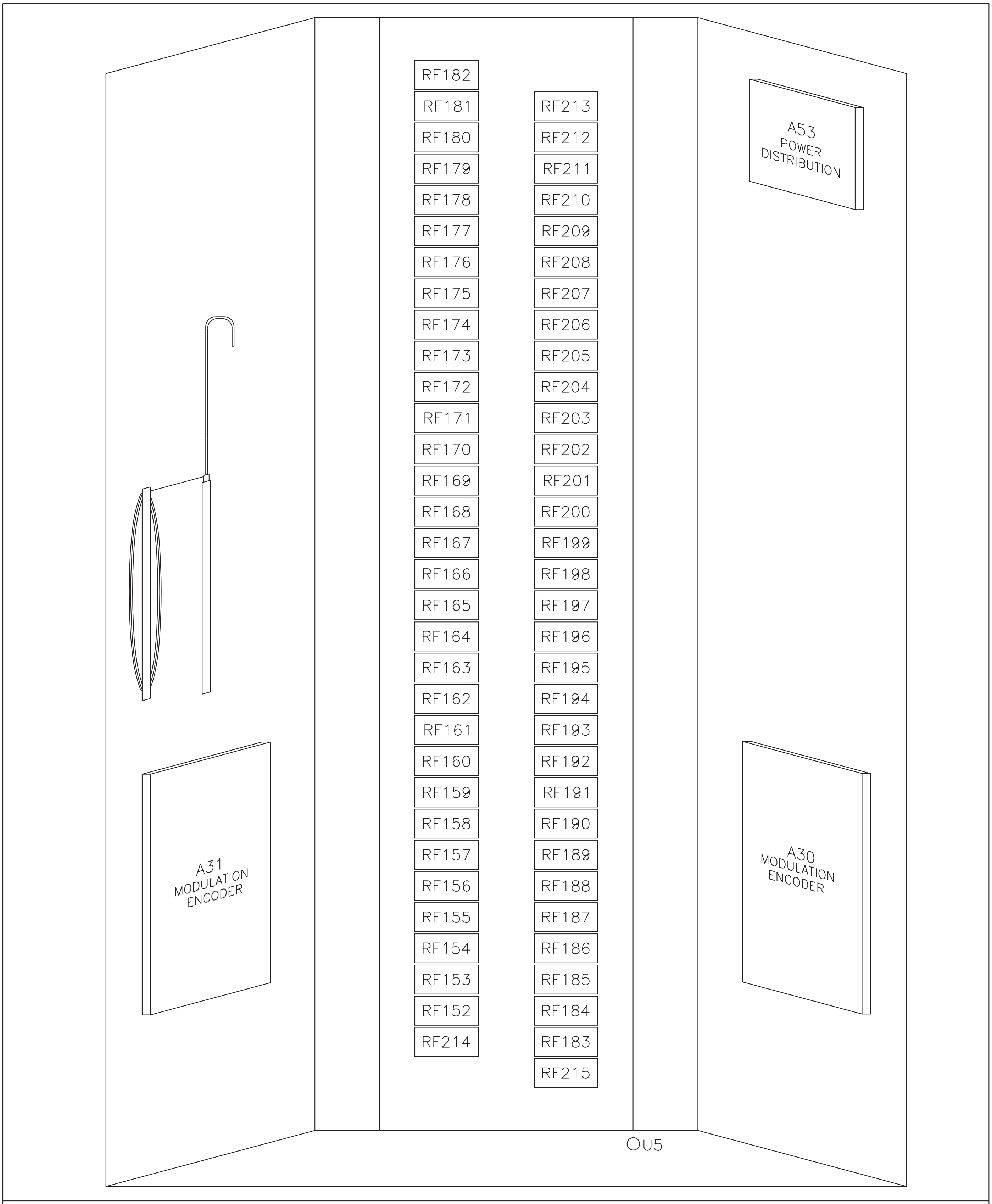
VIEW 5

FRONT VIEW
LEFT COMPARTMENT
POWER AMPLIFIER CABINET–UNIT 1

VIEW 5

817 2413 931 SH–7 A

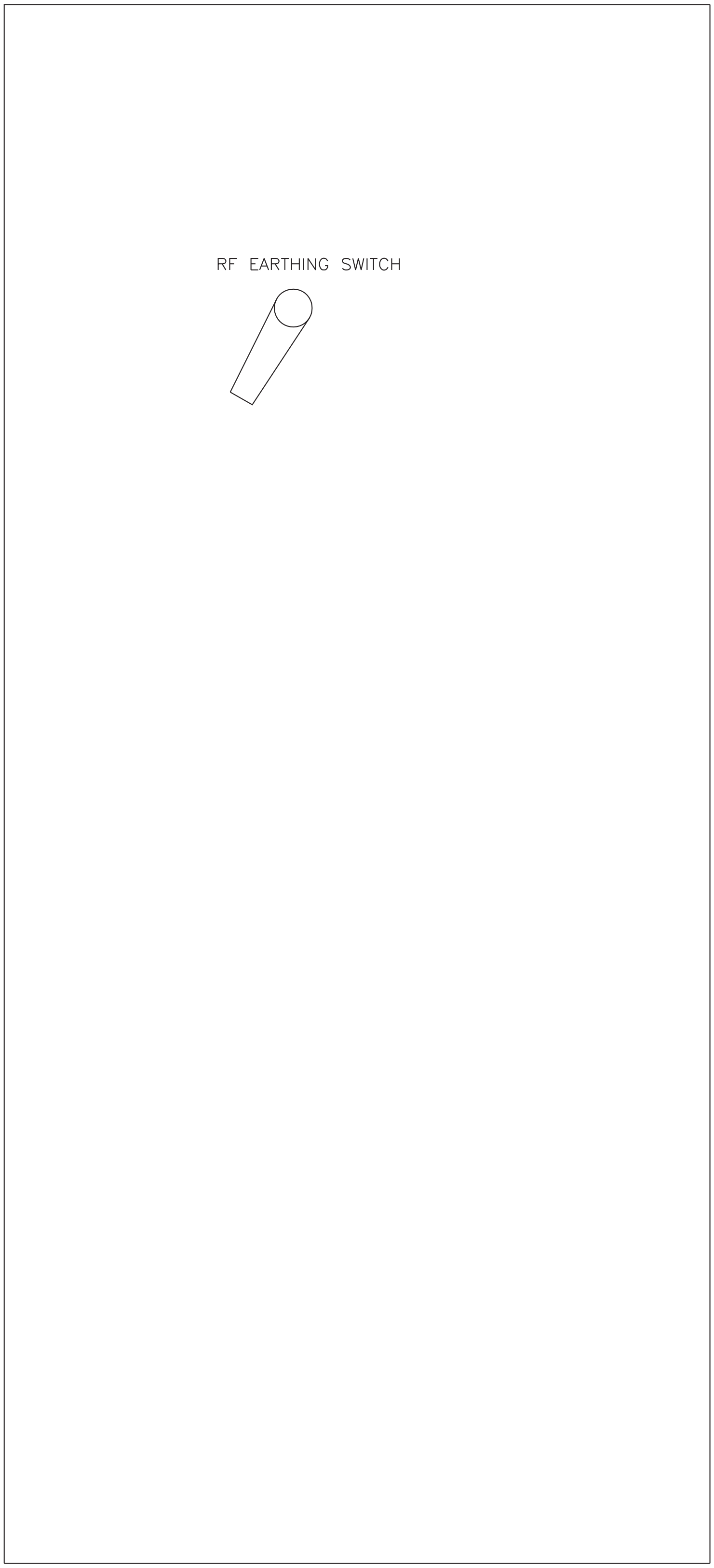
WARNING: Disconnect primary power prior to servicing.



VIEW 6 FRONT VIEW VIEW 6

EXTENDED POWER AMPLIFIER CABINET—UNIT 2 817 2413 931 SH-8 A

WARNING: Disconnect primary power prior to servicing.



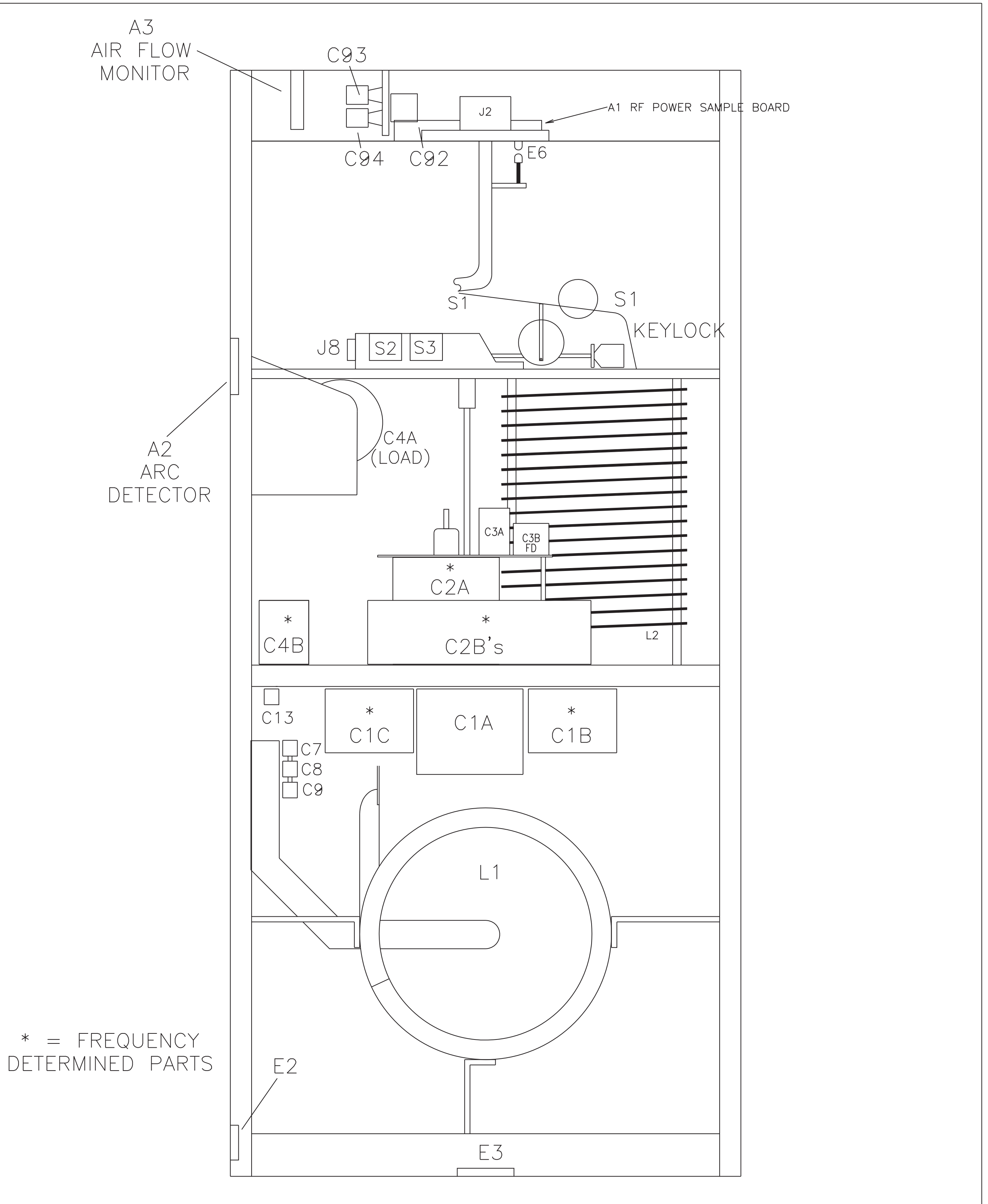
VIEW 7

FRONT VIEW
LOWER OUTPUT NETWORK
CABINET—UNIT 8

VIEW 7

817 2413 931 SH-9 A

WARNING: Disconnect primary power prior to servicing.



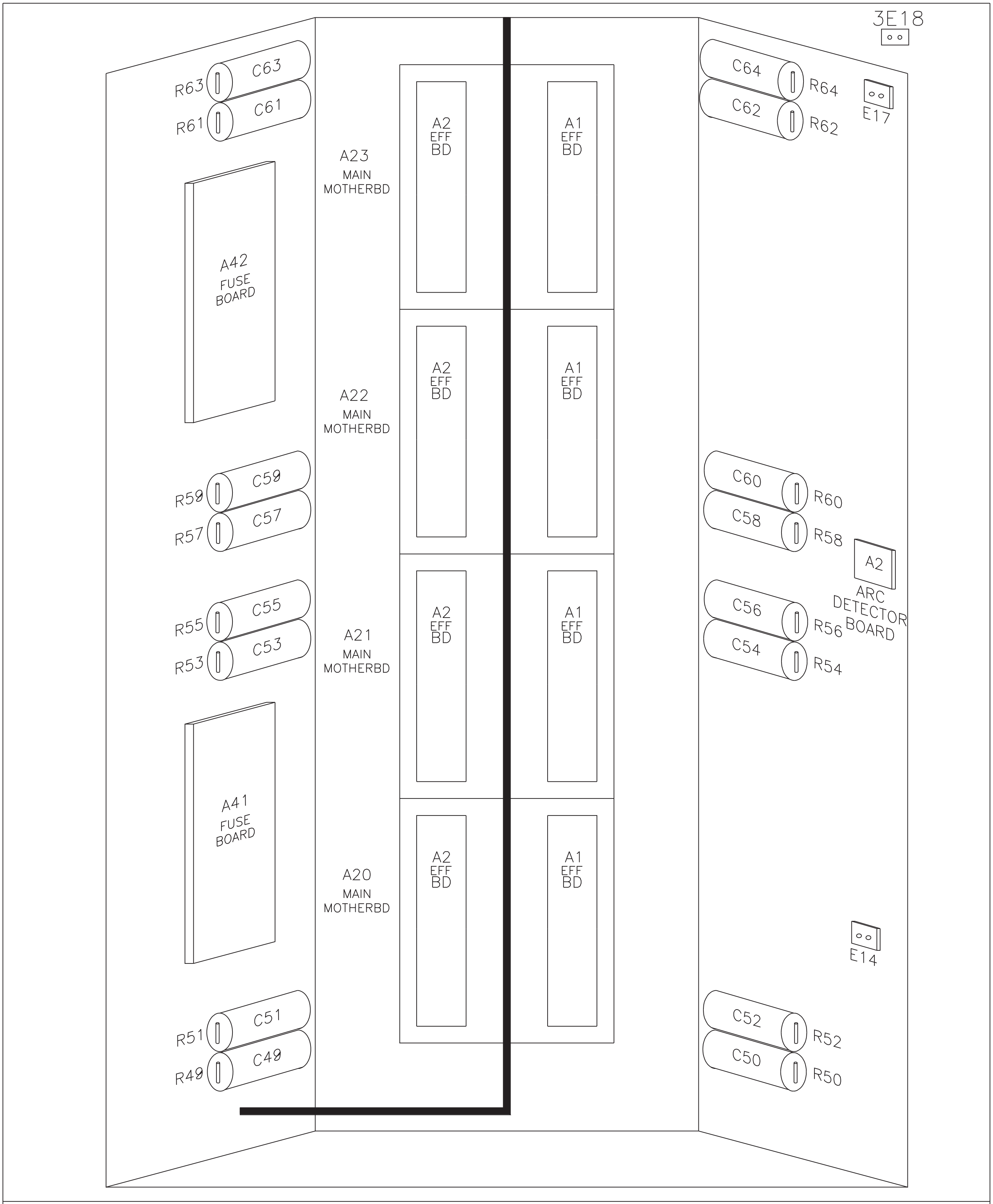
VIEW 8

REAR VIEW
LOWER OUTPUT NETWORK
CABINET—UNIT 8

VIEW 8

817 2413 931 SH-10 A

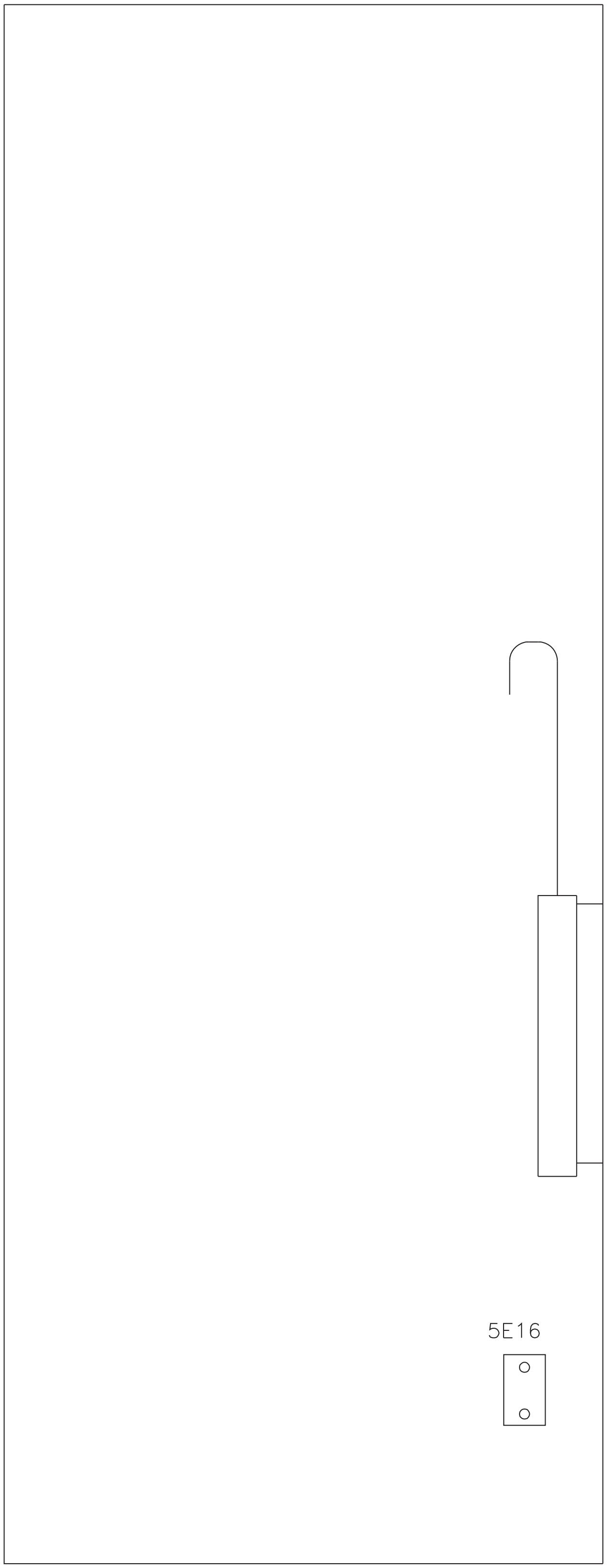
WARNING: Disconnect primary power prior to servicing.



VIEW 9 REAR VIEW VIEW 9

EXTENDED POWER AMPLIFIER CABINET—UNIT 2 817 2413 931 SH-11 A

WARNING: Disconnect primary power prior to servicing.



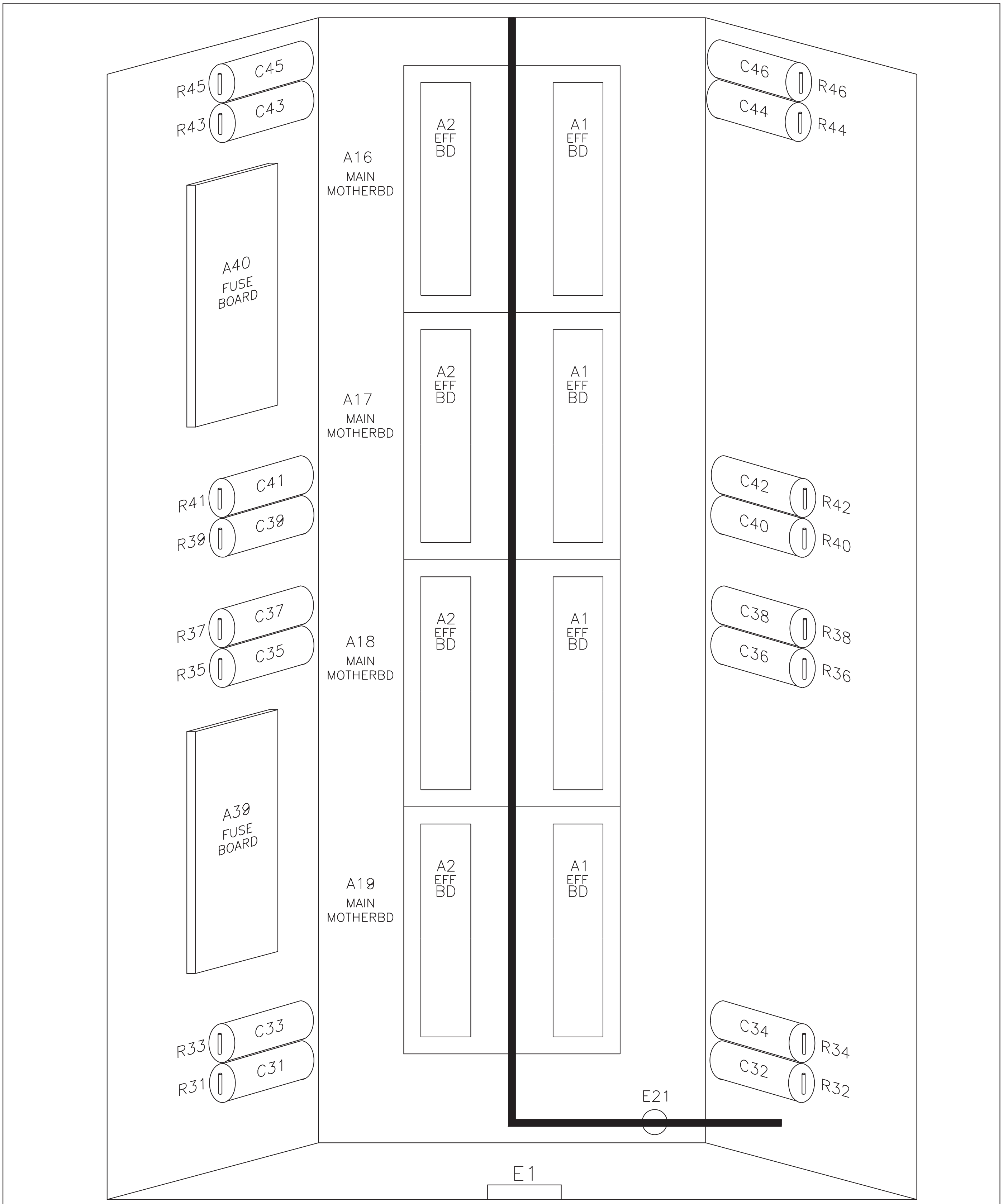
VIEW 10

REAR VIEW
PLENUM
POWER AMPLIFIER CABINET—UNIT 5

VIEW 10

817 2413 931 SH-12 A

WARNING: Disconnect primary power prior to servicing.



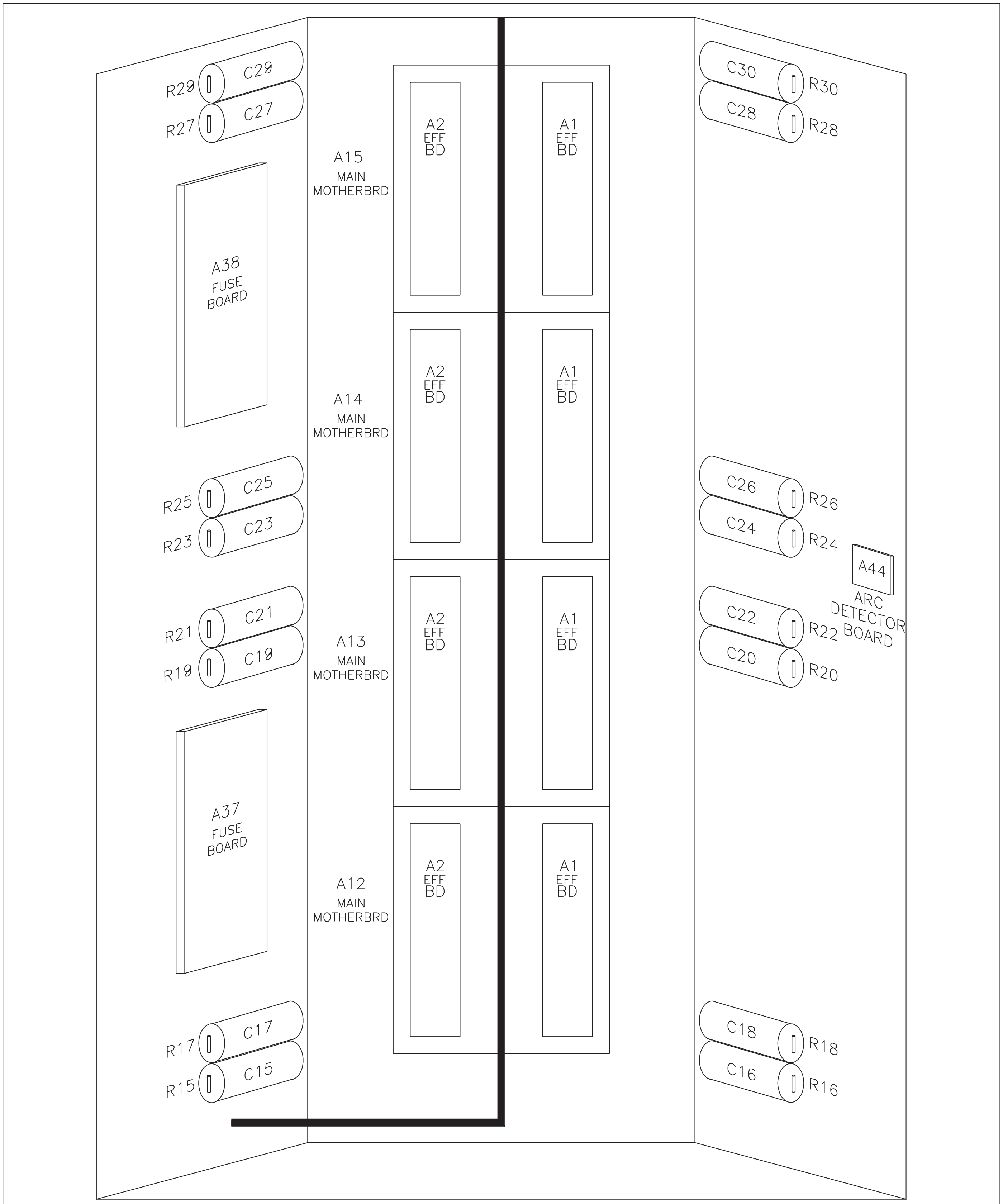
REAR VIEW

VIEW 11 LEFT COMPARTMENT VIEW 11

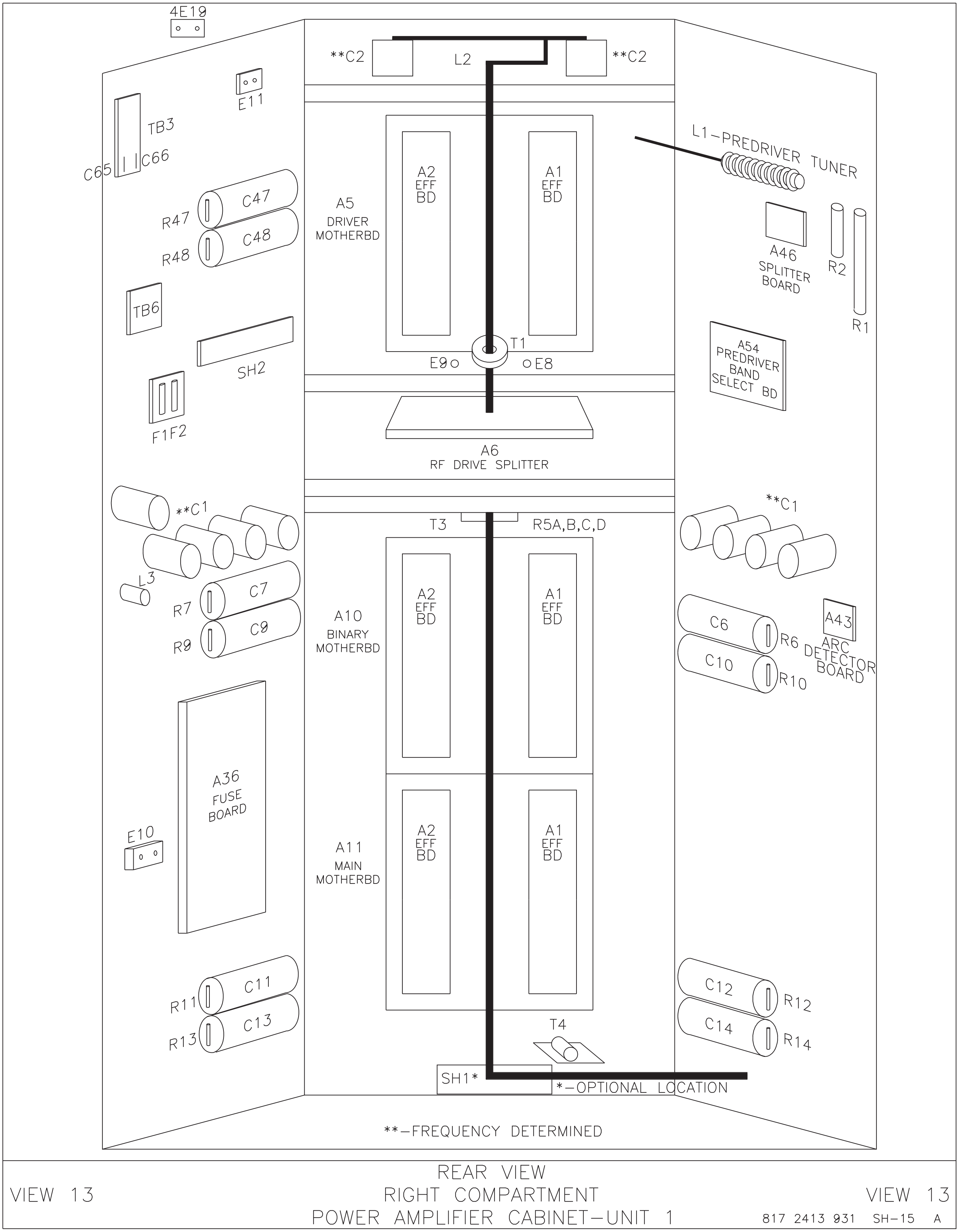
POWER AMPLIFIER CABINET—UNIT 1

817 2413 931 SH-13 A

WARNING: Disconnect primary power prior to servicing.



REAR VIEW
VIEW 12 CENTER COMPARTMENT VIEW 12
POWER AMPLIFIER CABINET—UNIT 1
817 2413 931 SH-14 A

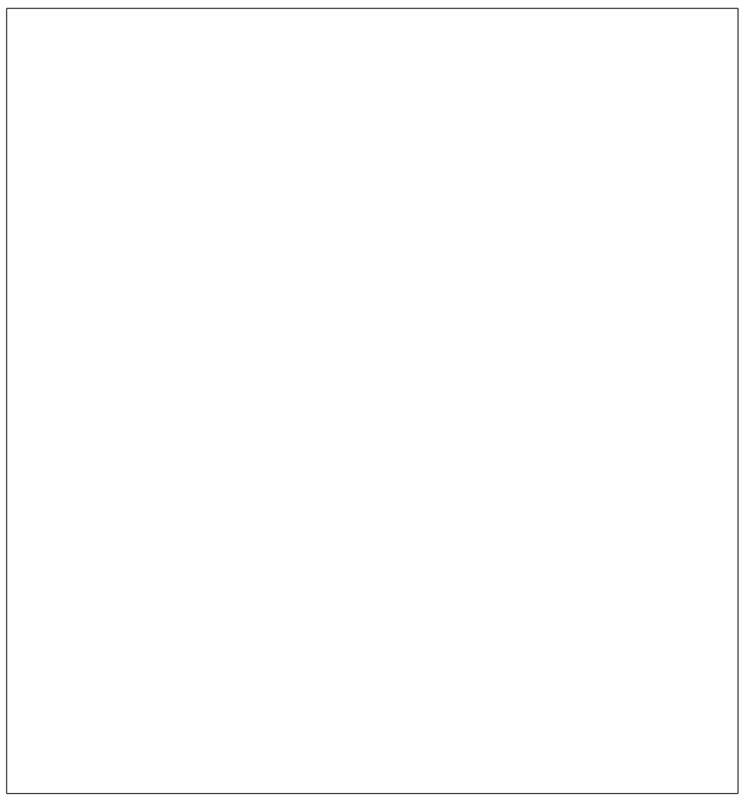

4E19
**C2
L2
**C2
E11
TB3
C65
C66
L1-PREDRIVER TUNER
A2 EFF BD
A1 EFF BD
A5 DRIVER MOTHERBD
R47
C47
R48
C48
A46 SPLITTER BOARD
R2
R1
TB6
SH2
T1
E9
E8
A54 PREDRIVER BAND SELECT BD
F1F2
A6 RF DRIVE SPLITTER
**C1
**C1
T3
R5A,B,C,D
L3
R7
C7
R9
C9
A10 BINARY MOTHERBD
C6
R6
A43
ARC DETECTOR BOARD
C10
R10
A36 FUSE BOARD
E10
A11 MAIN MOTHERBD
R11
C11
R13
C13
C12
R12
C14
R14
T4
SH1*
*-OPTIONAL LOCATION
**-FREQUENCY DETERMINED
REAR VIEW
RIGHT COMPARTMENT
POWER AMPLIFIER CABINET-UNIT 1
VIEW 13
VIEW 13
817 2413 931 SH-15 A

VIEW 14 FRONT VIEW VIEW 14

HEAT EXCHANGER CABINET—UNIT 4

817 2413 931 SH-16 A

WARNING: Disconnect primary power prior to servicing.



NOTE: NO COMPONENTS LOCATED IN THIS CABINET

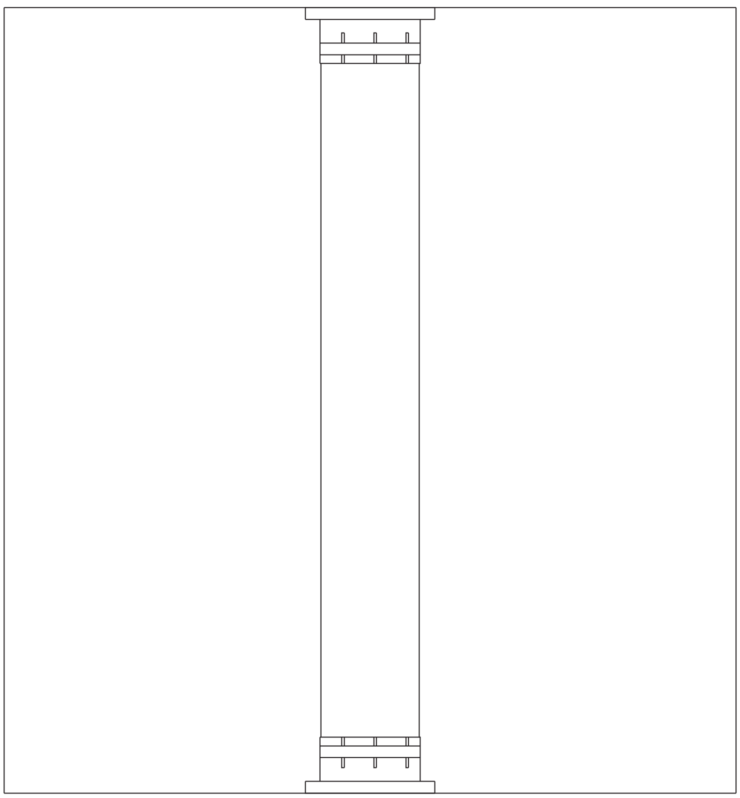
VIEW 15

FRONT VIEW
OUTPUT MATCHING CABINET—UNIT 3

VIEW 15

817 2413 931 SH-17 A

WARNING: Disconnect primary power prior to servicing.



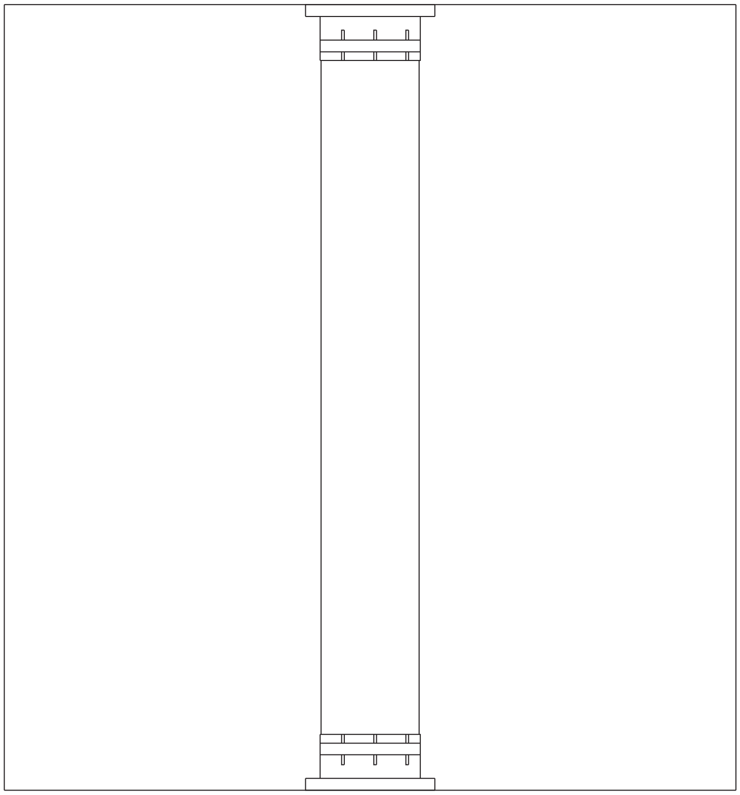
NOTE: NO COMPONENTS LOCATED IN THIS CABINET
EXCEPT PASS-THROUGH TRANSMISSION LINE

VIEW 16

FRONT VIEW
UPPER OUTPUT NETWORK CABINET-UNIT 7

VIEW 16

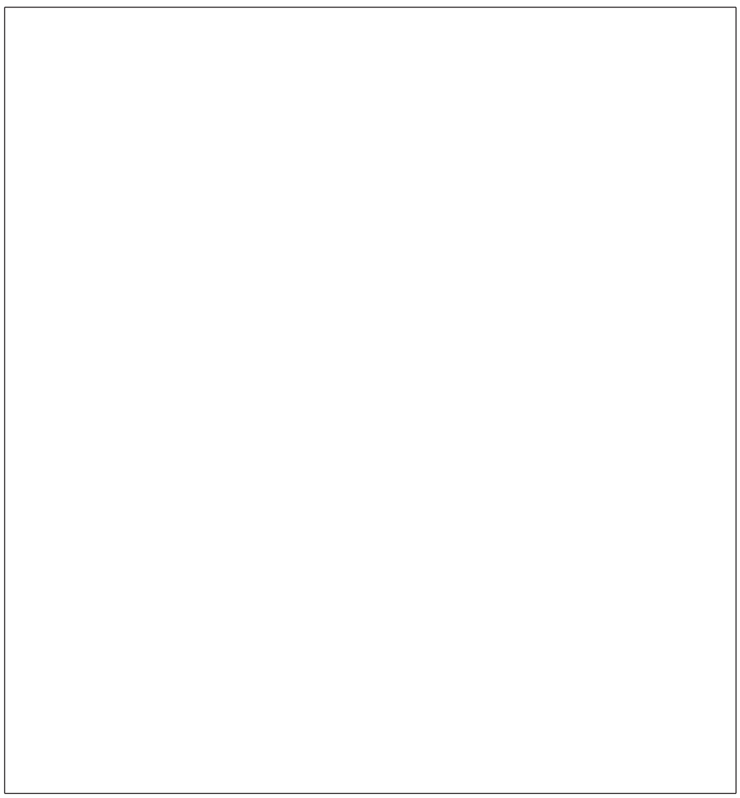
817 2413 931 SH-18 A



NOTE: NO COMPONENTS LOCATED IN THIS CABINET
EXCEPT PASS-THROUGH TRANSMISSION LINE

VIEW 17	REAR VIEW UPPER OUTPUT NETWORK CABINET-UNIT 7	VIEW 17 817 2413 931 SH-19 A

WARNING: Disconnect primary power prior to servicing.



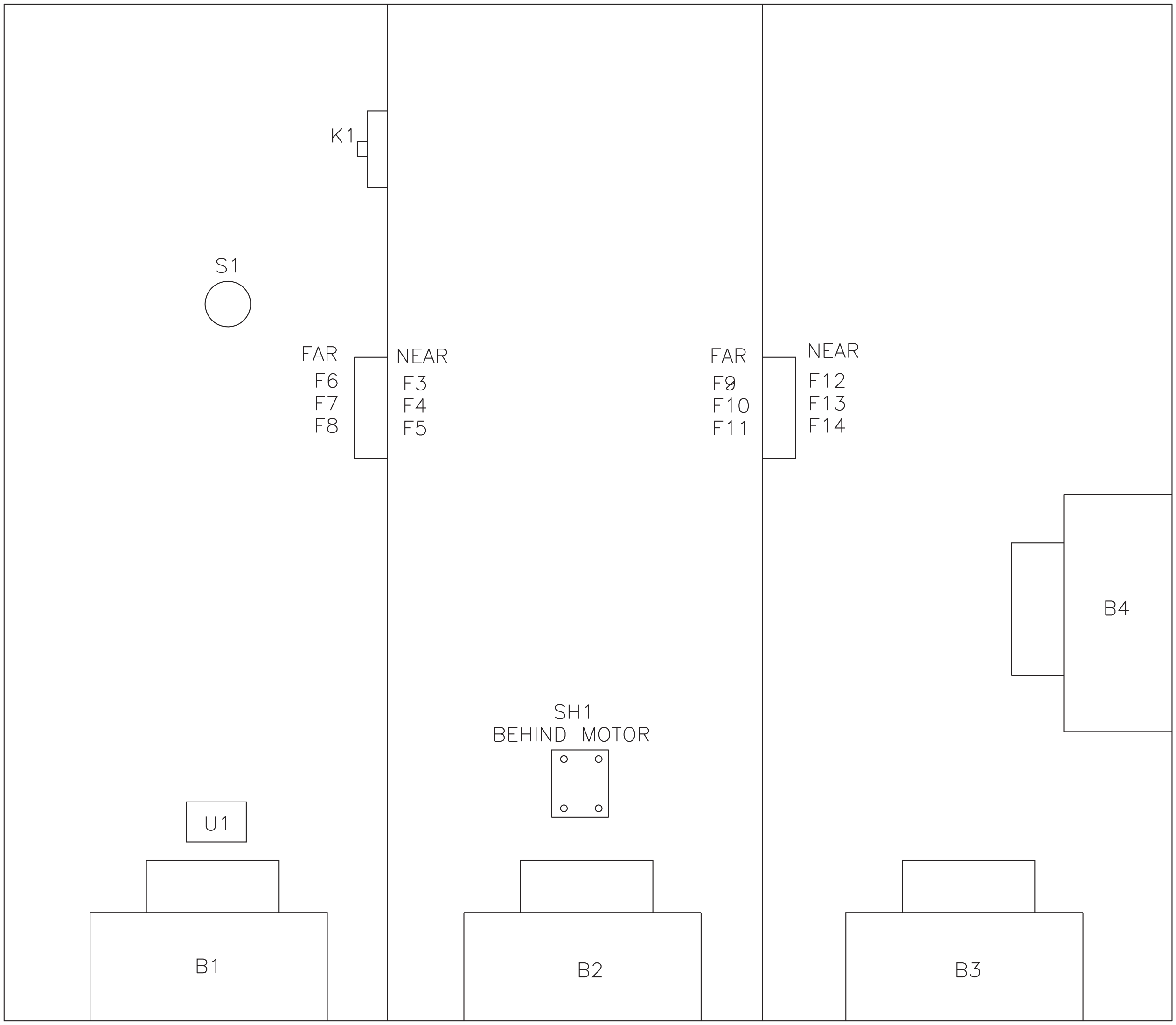
NOTE: NO COMPONENTS LOCATED IN THIS CABINET

VIEW 18

REAR VIEW
OUTPUT MATCHING CABINET—UNIT 3

VIEW 18
817 2413 931 SH-20 A

WARNING: Disconnect primary power prior to servicing.



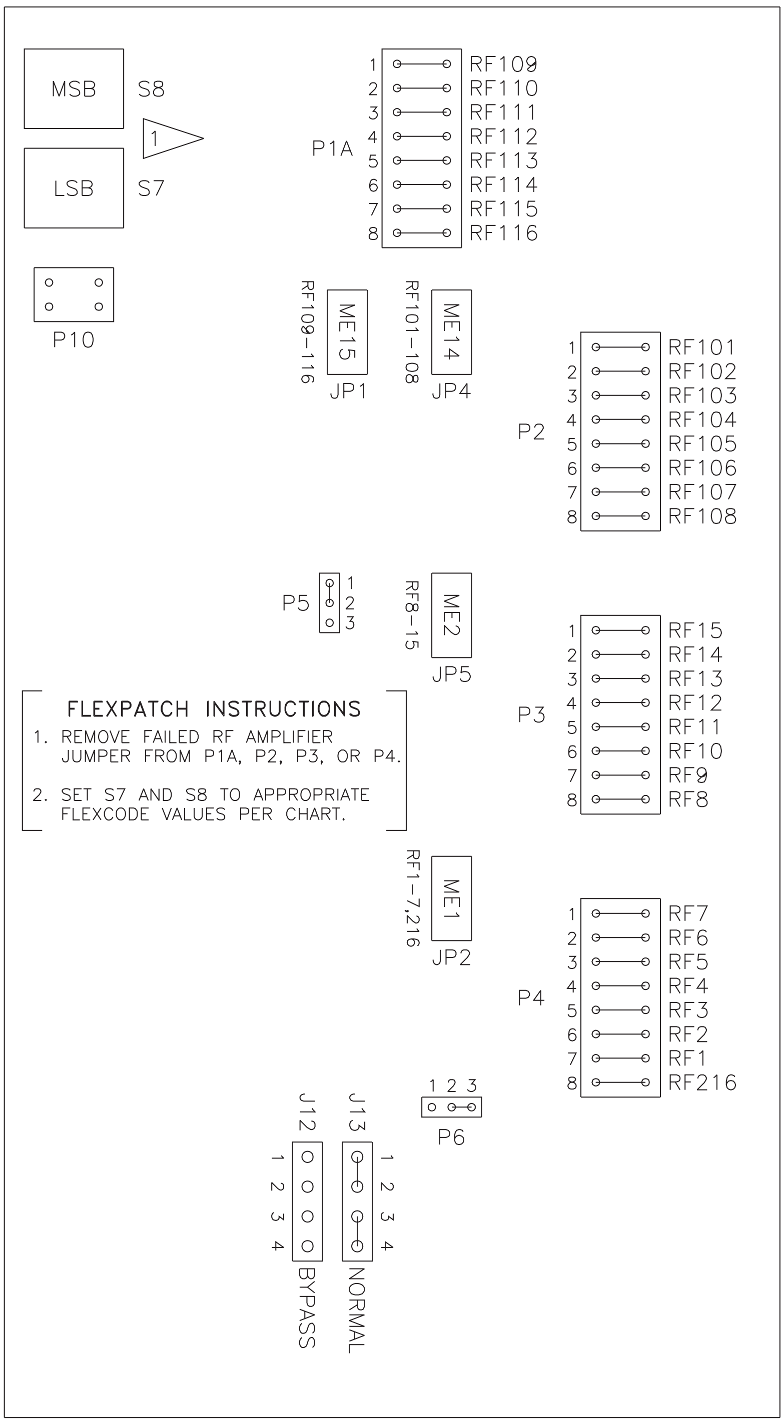
VIEW 19 | REAR VIEW | VIEW 19

HEAT EXCHANGER CABINET—UNIT 4

817 2413 931 SH-21 A

WARNING: Disconnect primary power prior to servicing.

A29-MODULATION ENCODER



RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF116	7	4
RF115	7	3
RF114	7	2
RF113	7	1
RF112	7	0
RF111	6	15
RF110	6	14
RF109	6	13
RF108	6	12
RF107	6	11
RF106	6	10
RF105	6	9
RF104	6	8
RF103	6	7
RF102	6	6
RF101	6	5
RF15	0	15
RF14	0	14
RF13	0	13
RF12	0	12
RF11	0	11
RF10	0	10
RF9	0	9
RF8	0	8
RF7	0	7
RF6	0	6
RF5	0	5
RF4	0	4
RF3	0	3
RF2	0	2
RF1	0	1
RF216	13	8

2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

1 RF216-PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

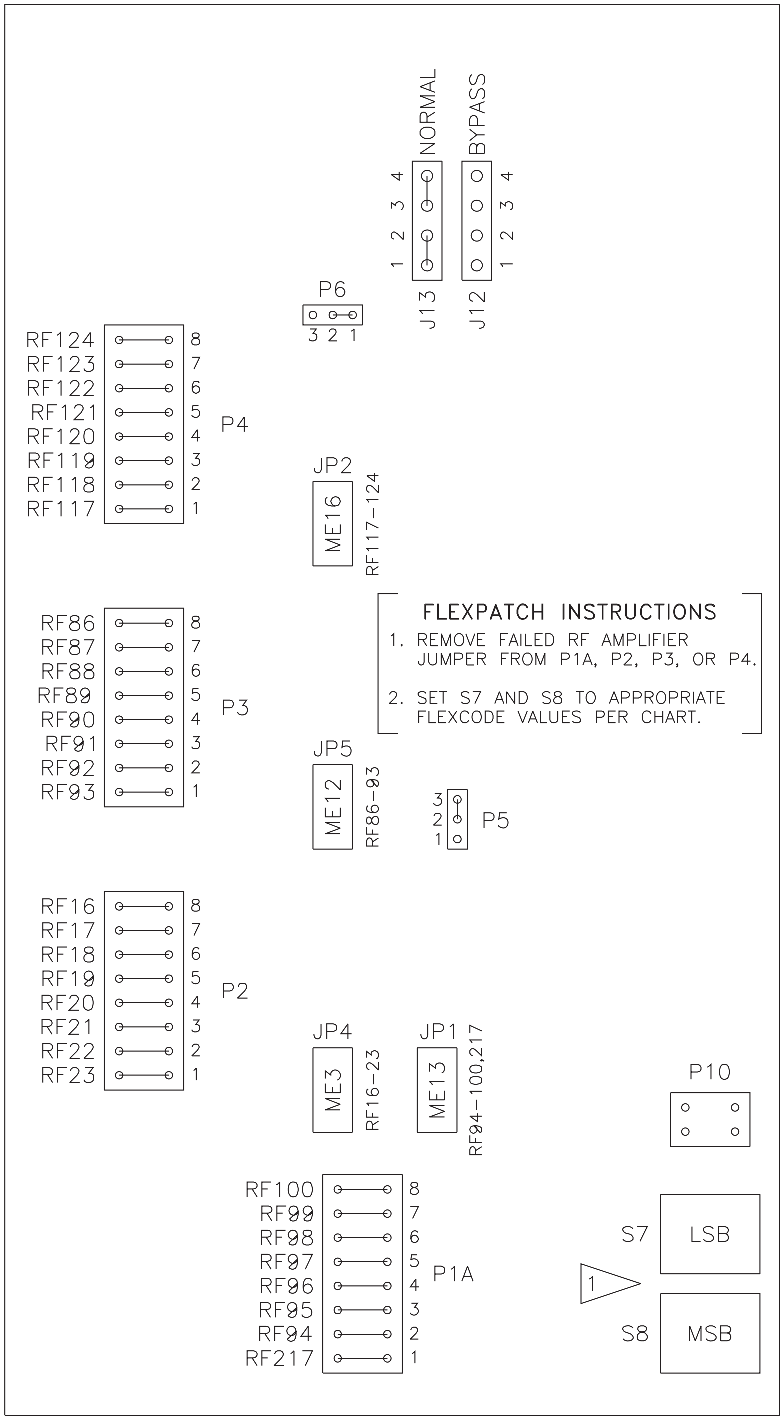
VIEW 20 FLEXPATCH AND MODULE ENCODING COMPONENT VIEW-LEFT MODULTION ENCODER BOARD LEFT COMPARTMENT-POWER AMPLIFIER CABINET-UNIT 1 VIEW 20

817 2413 931 SH-22 A

WARNING: Disconnect primary power prior to servicing.

RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF124	7	12
RF123	7	11
RF122	7	10
RF121	7	9
RF120	7	8
RF119	7	7
RF118	7	6
RF117	7	5
RF93	5	13
RF92	5	12
RF91	5	11
RF90	5	10
RF89	5	9
RF88	5	8
RF87	5	7
RF86	5	6
RF23	1	7
RF22	1	6
RF21	1	5
RF20	1	4
RF19	1	3
RF18	1	2
RF17	1	1
RF16	1	0
RF100	6	4
RF99	6	3
RF98	6	2
RF97	6	1
RF96	6	0
RF95	5	15
RF94	5	14
(1) RF217	13	9

A28–MODULATION ENCODER



2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP3, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

(1) RF217–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

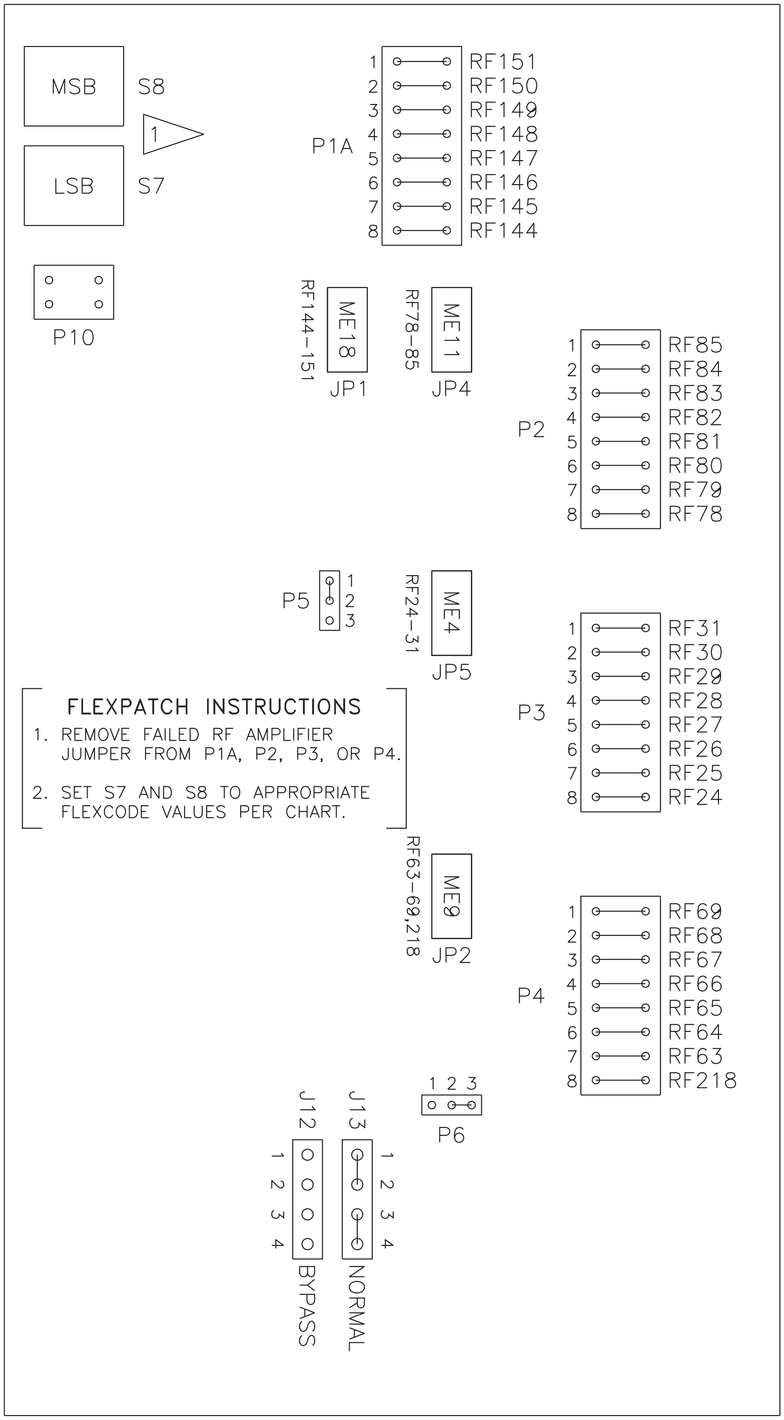
FLEXPATCH AND MODULE ENCODING

VIEW 21 COMPONENT VIEW–RIGHT MODULATION ENCODER BOARD VIEW 21

LEFT COMPARTMENT–POWER AMPLIFIER CABINET–UNIT 1 817 2413 931 SH–23 A

WARNING: Disconnect primary power prior to servicing.

A27—MODULATION ENCODER



RF AMP #	FLEXCODE S8 MSB	FLEXCODE S7 LSB
RF151	9	7
RF150	9	6
RF149	9	5
RF148	9	4
RF147	9	3
RF146	9	2
RF145	9	1
RF144	9	0
RF85	5	5
RF84	5	4
RF83	5	3
RF82	5	2
RF81	5	1
RF80	5	0
RF79	4	15
RF78	4	14
RF31	1	15
RF30	1	14
RF29	1	13
RF28	1	12
RF27	1	11
RF26	1	10
RF25	1	9
RF24	1	8
RF69	4	5
RF68	4	4
RF67	4	3
RF66	4	2
RF65	4	1
RF64	4	0
RF63	3	15
1 RF218	13	10

2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

1 RF218—PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

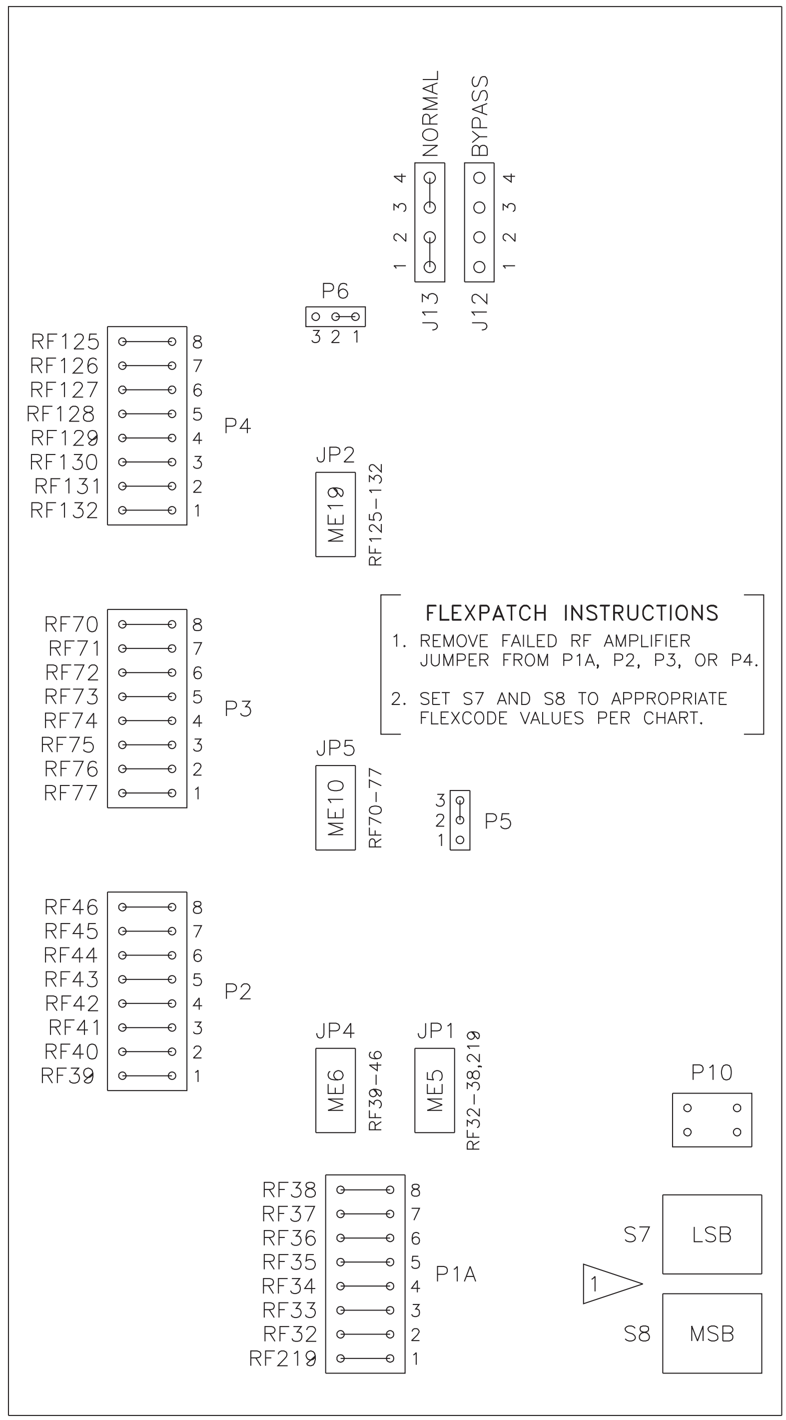
FLEXPATCH AND MODULE ENCODING

VIEW 22 COMPONENT VIEW—LEFT MODULATION ENCODER BOARD VIEW 22

CENTER COMPARTMENT—POWER AMPLIFIER CABINET—UNIT 1 817 2413 931 SH-24 A

RF AMP #	FLEXCODE S8 MSB	FLEXCODE S7 LSB
RF132	8	4
RF131	8	3
RF130	8	2
RF129	8	1
RF128	8	0
RF127	7	15
RF126	7	14
RF125	7	13
RF77	4	13
RF76	4	12
RF75	4	11
RF74	4	10
RF73	4	9
RF72	4	8
RF71	4	7
RF70	4	6
RF46	2	14
RF45	2	13
RF44	2	12
RF43	2	11
RF42	2	10
RF41	2	9
RF40	2	8
RF39	2	7
RF38	2	6
RF37	2	5
RF36	2	4
RF35	2	3
RF34	2	2
RF33	2	1
RF32	2	0
(1) RF219	13	11

A26–MODULATION ENCODER



2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

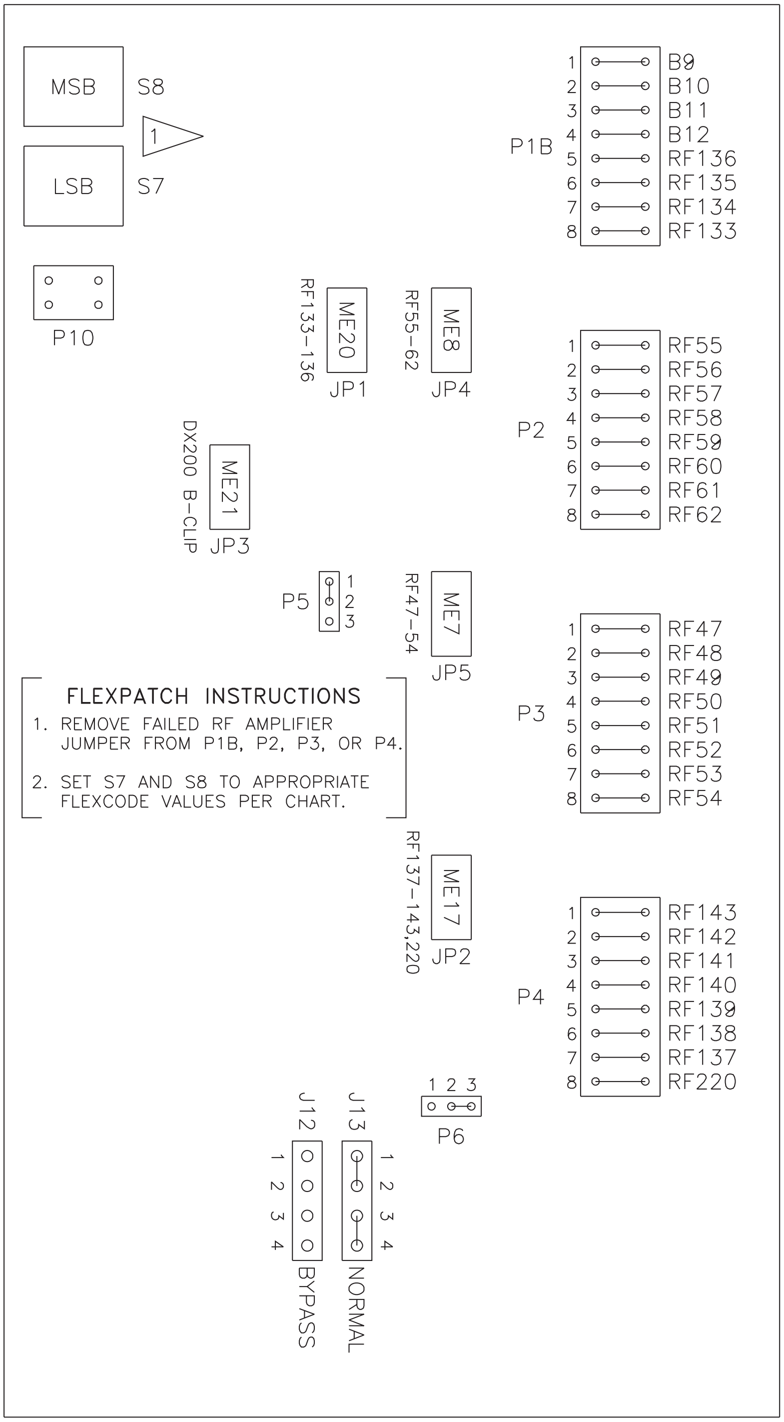
(1) RF219–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

FLEXPATCH AND MODULE ENCODING

VIEW 23 COMPONENT VIEW–RIGHT MODULATION ENCODER BOARD VIEW 23

CENTER COMPARTMENT–POWER AMPLIFIER CABINET–UNIT 1 817 2413 931 SH-25 A

A25–MODULATION ENCODER



RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF136	8	8
RF135	8	7
RF134	8	6
RF133	8	5
RF62	3	14
RF61	3	13
RF60	3	12
RF59	3	11
RF58	3	10
RF57	3	9
RF56	3	8
RF55	3	7

RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF54	3	6
RF53	3	5
RF52	3	4
RF51	3	3
RF50	3	2
RF49	3	1
RF48	3	0
RF47	2	15
RF143	8	15
RF142	8	14
RF141	8	13
RF140	8	12
RF139	8	11
RF138	8	10
RF137	8	9
(1) RF220	13	12

2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP3, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

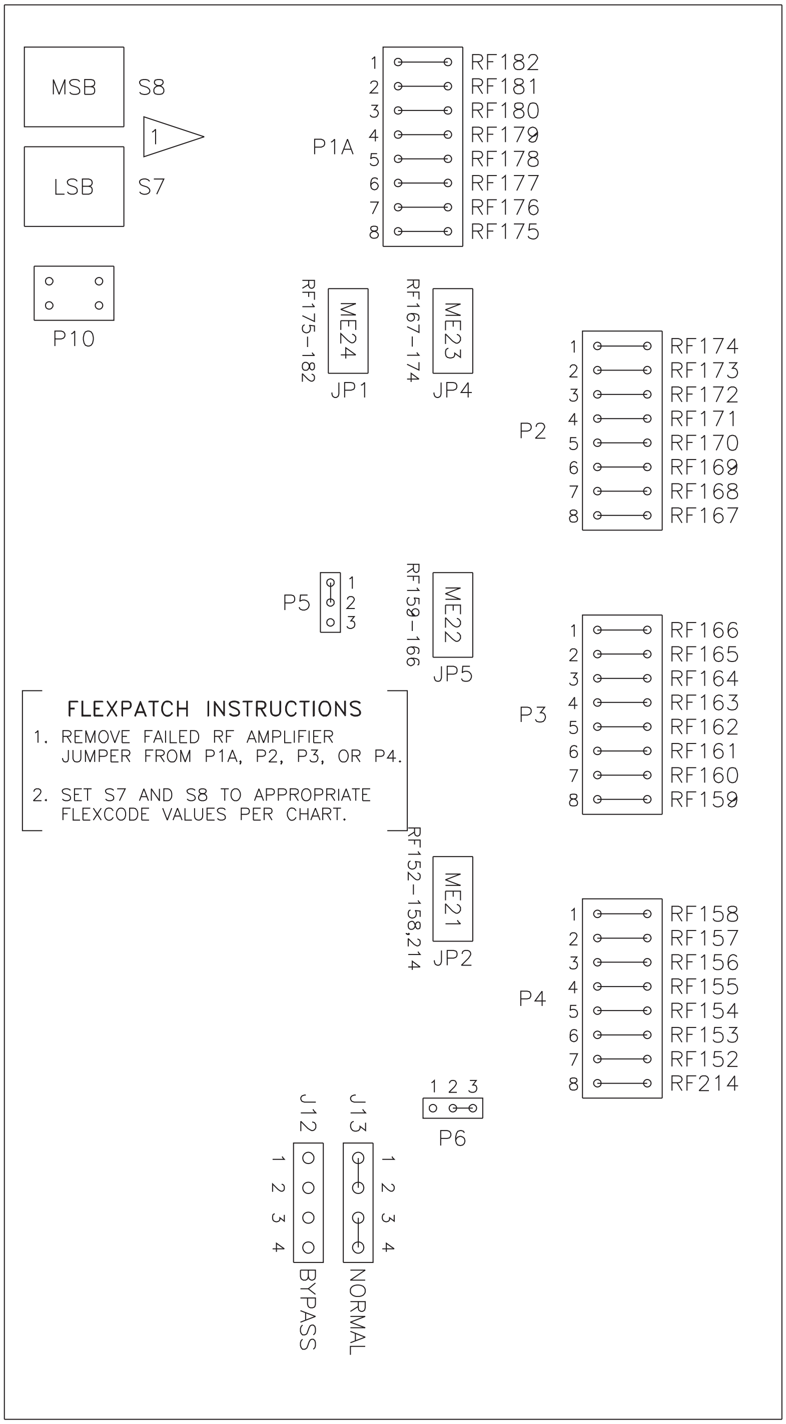
(1) RF220–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

VIEW 24 — FLEXPATCH AND MODULE ENCODING
COMPONENT VIEW–MODULATION ENCODER BOARD
RIGHT COMPARTMENT–POWER AMPLIFIER CABINET–UNIT 1 — VIEW 24

817 2413 931 SH–26 A

WARNING: Disconnect primary power prior to servicing.

A31–MODULATION ENCODER



RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF182	11	6
RF181	11	5
RF180	11	4
RF179	11	3
RF178	11	2
RF177	11	1
RF176	11	0
RF175	10	15
RF174	10	14
RF173	10	13
RF172	10	12
RF171	10	11
RF170	10	10
RF169	10	9
RF168	10	8
RF167	10	7
RF166	10	6
RF165	10	5
RF164	10	4
RF163	10	3
RF162	10	2
RF161	10	1
RF160	10	0
RF159	9	15
RF158	9	14
RF157	9	13
RF156	9	12
RF155	9	11
RF154	9	10
RF153	9	9
RF152	9	8
(1) RF214	13	6

2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

(1) RF214–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

VIEW 25 FLEXPATCH AND MODULE ENCODING VIEW 25

COMPONENT VIEW–LEFT MODULTION ENCODER BOARD

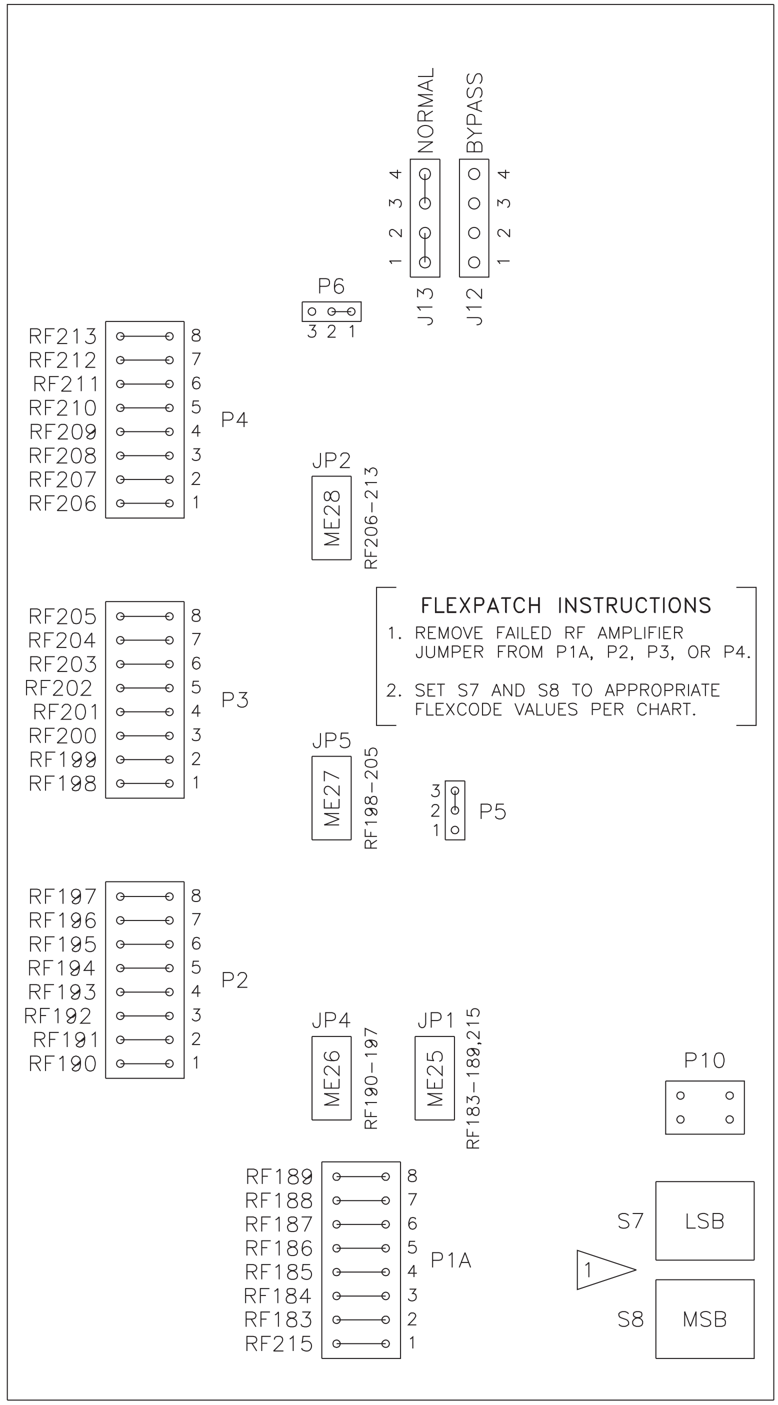
EXTENDED–POWER AMPLIFIER CABINET–UNIT 2

817 2413 931 SH–27 A

WARNING: Disconnect primary power prior to servicing.

RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF213	13	5
RF212	13	4
RF211	13	3
RF210	13	2
RF209	13	1
RF208	13	0
RF207	12	15
RF206	12	14
RF205	12	13
RF204	12	12
RF203	12	11
RF202	12	10
RF201	12	9
RF200	12	8
RF199	12	7
RF198	12	6
RF197	12	5
RF196	12	4
RF195	12	3
RF194	12	2
RF193	12	1
RF192	12	0
RF191	11	15
RF190	11	14
RF189	11	13
RF188	11	12
RF187	11	11
RF186	11	10
RF185	11	9
RF184	11	8
RF183	11	7
(1) RF215	13	7

A30–MODULATION ENCODER



2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP3, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

(1) RF215–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

VIEW 26 — FLEXPATCH AND MODULE ENCODING — COMPONENT VIEW–RIGHT MODULATION ENCODER BOARD — EXTENDED–POWER AMPLIFIER CABINET–UNIT 2 — VIEW 26

817 2413 931 SH–28 A

WARNING: Disconnect primary power prior to servicing.

DWG NO. 817 2413 483 .

LTR	ZONE	DATE	DFTM	ENG	ECO NBR
M	.	8/2/01	KAG	BAK	47508
ADDED RESISTOR R21					
N	.	9/6/01	BAK	TLH	47579
ADDED F18, SHEET 3					
P	.	MAR 08, 2003	SEC	SEC	49037
REVISED F18/F4 , UPDATED REVISION SH-2					

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VIEW	TITLE	REV	FILE
1	FRONT VIEW FRONT DOOR	P	483-2
2	FRONT VIEW	P	483-3
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THIS COVER DRAWING CONTAINS A CHART OF 'COMPONENT LOCATION VIEWS' INFORMATION. EACH 'VIEW' FILE IS IN AUTOCAD FORMAT BUT DOES NOT INCLUDE A STANDARD HARRIS FORMAT. THE HARRIS PART NUMBER - REVISION LEVEL HOWEVER, DOES APPEAR IN THE LOWER RIGHT CORNER. WHEN REVISING A 'VIEW', THE REVISION LEVEL MUST BE UPDATED ON THE 'VIEW' DRAWING AND THIS COVER DRAWING.

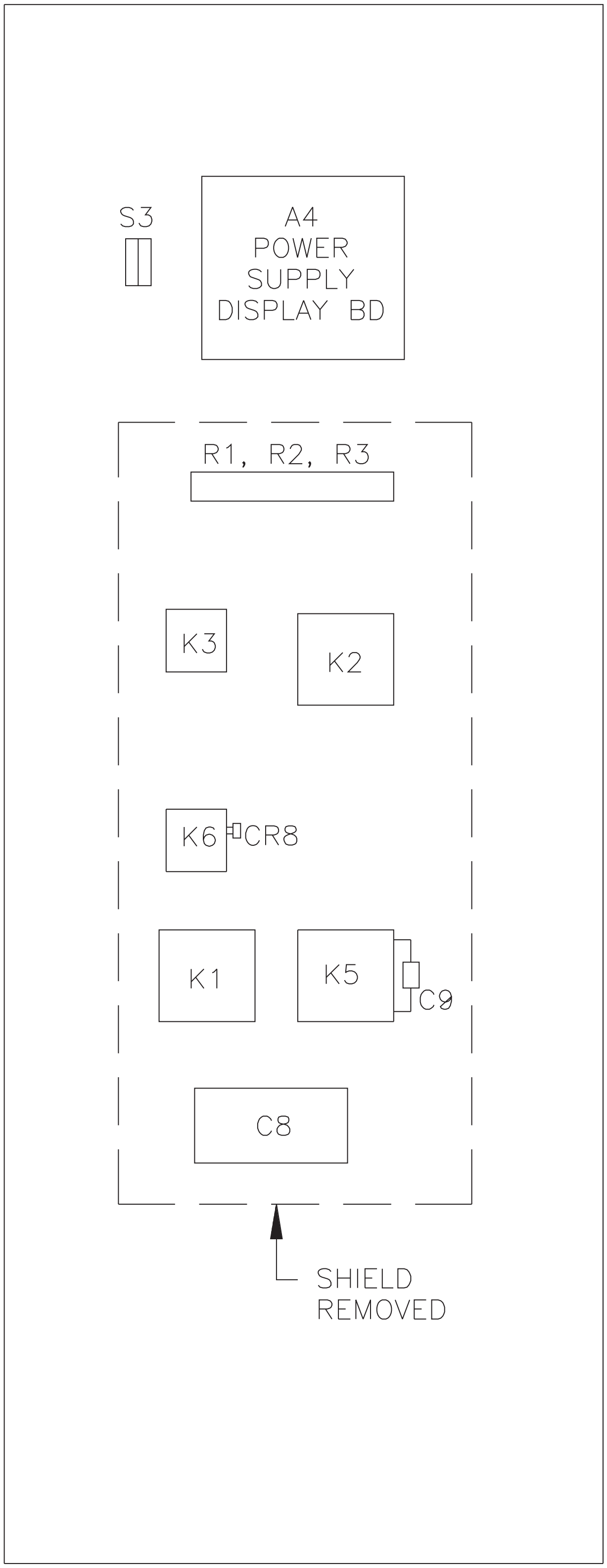
HARRIS

HARRIS CORPORATION
BROADCAST COMMUNICATIONS
P.O. BOX 4290
QUINCY, ILLINOIS 62305

DRAWN BY	K HARRIS
DATE	4-10-97
ENG CHK	D KOONTZ
PROJ ENG	J MALEC
MFG ENG	S CORNWELL
A	SHEET 1 OF 3

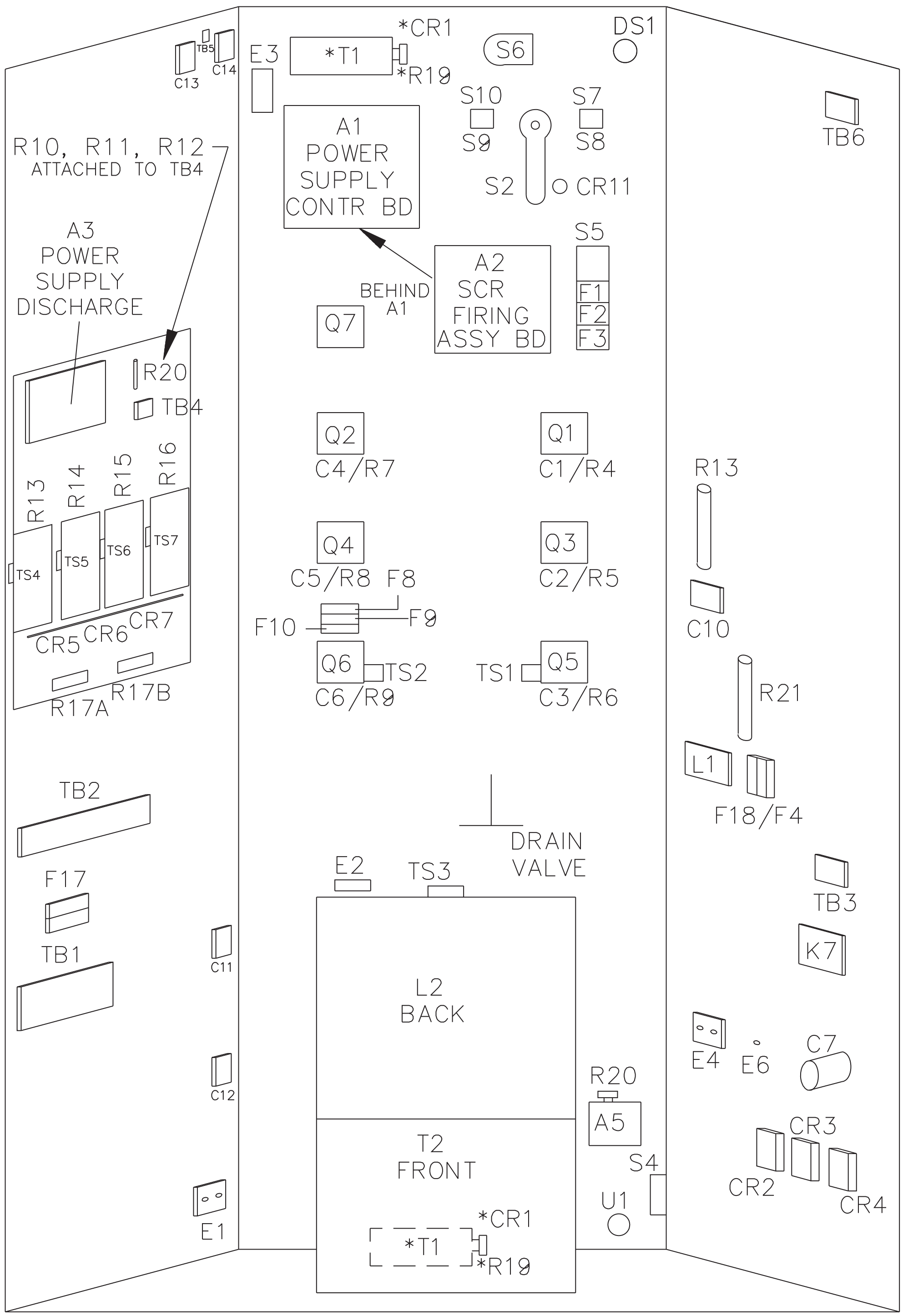
TITLE
COMPONENT LOCATION VIEWS
LIQUID RECTIFIER CABINET

DWG NO. 817 2413 483 . REV P



VIEW 1	FRONT VIEW FRONT DOOR RECTIFIER CABINET	VIEW 1 817 2413 483 SH-2 P

WARNING: Disconnect primary power prior to servicing.



* – CUSTOMER SELECTED LOCATION

VIEW 2 | FRONT VIEW
RECTIFIER CABINET | VIEW 2

817 2413 483 SH–3 P

WARNING: Disconnect primary power prior to servicing.

6.1 Introduction

This section of the technical manual will contain troubleshooting procedures for the transmitter.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

This troubleshooting section is divided as follows:

a. Troubleshooting Colorstat™ Status Panel Indicators
b. Troubleshooting Faults In The RF Drivers
c. Rectifier Cabinet Status Panel Controls and Indications
d. System Faults With No Indication On The Front Panel
e. Measuring RF Drive Level And Phase

This section is a troubleshooting guide for the transmitter as a system. The purpose of this section is to isolate the problem to a board or circuit then the troubleshooting for that board will be covered in the section of the manual for that particular board.

6.2 Making Safe Measurements

This equipment to be opened, operated, and maintained by authorized personnel only.

Never work when alone or tired.

Read safety warning and first aid information in the front of this manual before proceeding.

After the transmitter has been turned off, verify that the RF AMP Power Supply is discharged by checking "PA+VDC" on the front panel multimeter.

Use breakers or disconnect switches to remove all primary power to the transmitter and peripheral equipment before opening enclosures, or removing any panel or shield.

Do not rely on internal contactors, relays, interlock, or switching devices to remove all dangerous voltages.

Use a voltmeter to verify the power supplies have been discharged prior to touching any components.

If a voltage reading or waveform analysis is required, route test leads through an opening in the cabinet to the desired measurement point. Secure leads away from any circuit with voltages beyond the break down point of their insulation or the insulation rating of the measurement device.

Do not hold the measuring device in your hand while the equipment is energized. Securely ground the chassis of any scope, analyzer, or other test equipment.

Do not operate with doors, shields or panels removed.

After taking reading, use breakers or disconnect switches to again remove all primary power to transmitter and peripheral equipment before opening the enclosure where test leads were routed or connected. Verify the discharge of all high voltage points and points where test leads are attached before touching any points or removing test leads.

6.3 Troubleshooting ColorStat™ Status Panel Indicator Faults

Refer to the Table Of Contents to locate the correct paragraph describing various ColorStat™ Status Panel indications on the transmitter.

NOTE:
Study Figure 6-1. This diagram outlines the locations for the RF chain fault sensing and follows them through their routes on the way to the Controller board. Locating where and how the overloads are sensed should speed up your diagnoses, in the event a fault occurs.

The following is a list of all the transmitter indications that appear on the Colorstat™ Status Panel of the transmitter. When troubleshooting faults in the RF chain, all stages after the faulty stage will also indicate a fault. If the fault sensing circuitry has failed, the transmitter will still be on, with an RF Mute applied. Begin troubleshooting at the first stage of an indicated fault.

6.3.1 RF Source LED Illuminated Red

The RF source for the transmitter comes from the Oscillator board. This Indicator monitors the RF output of this board. If illuminated, it may indicate a fault on the Oscillator board. Check the output of the Oscillator board to determine whether the fault is on the Oscillator board.

6.3.2 Buffer Amp LED Illuminated Red

If this Colorstat™ Status Panel LED is illuminated RED, it indicates that the Buffer Amplifier output RF drive to the Predriver is low.

6.3.2.1 Select Buffer Amplifier B

The Transmitter is equipped with two Buffer Amplifiers in a single module. To select B:

a. Move S1, Predriver Select Switch, on the Driver Encoder to the B position or provide the correct control input. (Note that the Buffer and Predriver switch together).

b. Turn the Transmitter on again, and observe the Colorstat™ Status Panel.

6.3.2.2 Defective Buffer Amplifier A

a. If the Transmitter returns with no fault, refer to the Troubleshooting section for the Buffer Amplifier.

NOTE

The Transmitter can be operated normally with Buffer Amplifier B, until time can be scheduled to continue troubleshooting Buffer Amplifier A.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. Check for open fuses on the Buffer Amplifier. If open fuses are found, replace and troubleshoot the Buffer Amplifier.

6.3.2.3 No Buffer Amplifier Power Supply

a. Use the Driver Multimeter to measure the Buffer Voltage.

b. If the supply is not present, troubleshoot the +35VDC section of the LVPS board, and associated distribution to the Buffer Amplifier.

6.3.2.4 No Buffer Amplifier RF Input

a. With an oscilloscope, determine that the waveform on TP2 of the RF Interface Board is present and at the correct frequency.

b. With an oscilloscope, look at the input to the Buffer Amplifier on the ungrounded end of R16.

   1. The level should measure 4-4.5Vpp.
   2. If not refer to the overall diagram to troubleshoot the circuit back to the External RF Interface Board.

6.3.3 Predriver LED Illuminated Red

If this Colorstat™ Status Panel LED is illuminated RED, it would indicate that the RF drive level to the Driver stage is low.

6.3.3.1 Select Predriver B

The Transmitter is equipped with two Predrivers in a single module. To select B:

a. Move S1, Predriver Select Switch, on the Driver Encoder to the B position or provide the correct control input. (Note that the Buffer and Predriver switch together).

b. Turn the Transmitter on again, and observe the Colorstat™ Status Panel.

6.3.3.2 Defective Predriver A

a. If the Transmitter returns with no fault, refer to the Troubleshooting section for the RF Amplifier.

NOTE

The Transmitter can be operated normally with Predriver B, until time can be scheduled to continue troubleshooting Predriver A.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

NOTE

The power supply for the Predrivers is fused on the Buffer Amplifier. F1 supplies Predriver A and F2 supplies Predriver B.

b. Check for open Predriver supply fuses on the Buffer Amplifier. If open fuses are found, replace the fuses and troubleshoot the Predriver.

6.3.3.3 No Predriver Power Supply

a. Use the Driver Multimeter to measure the Predriver Voltage during the step-start sequence. During step-start there should be a +90-125VDC signal.

b. If the supply is not present, troubleshoot the +125VDC power supply.

6.3.3.4 Observe DS3

a. If DS3 on the Predriver is not illuminated GREEN during the step-start sequence:

6.3.3.5 No Predriver RF Input

NOTE

Refer to "Measuring RF Drive" at the end of this section for the following discussion.

a. With an oscilloscope, determine that the RF drive waveform on the Predriver is present and at the correct frequency.

   1. If there is little or no RF drive, refer to the overall diagram to troubleshoot the circuit back to the Buffer Amplifier.

6.3.3.6 Loss of Turn-On Command

a. Measure J1-5 on the Driver Encoder, this point should be at least -2VDC.

   1. If it is not, refer to the Troubleshooting portion for the Driver Encoder.

b. If the voltage is correct, use the overall wiring diagram and the Driver Combiner schematic to check continuity up to the Predriver input.

6.3.3.7 Failed Predriver Tuning Components

It is possible for one of the components on the Predriver Tuning Board to have failed and therefore de-tune the output. Failed components like capacitors and inductors can sometimes be identified by checking for abnormal heating after operating for a short time. If the setting of the Predriver Tuning coil L1 has been adjusted, it can be retuned for maximum Predriver Current on the Drive multimeter.

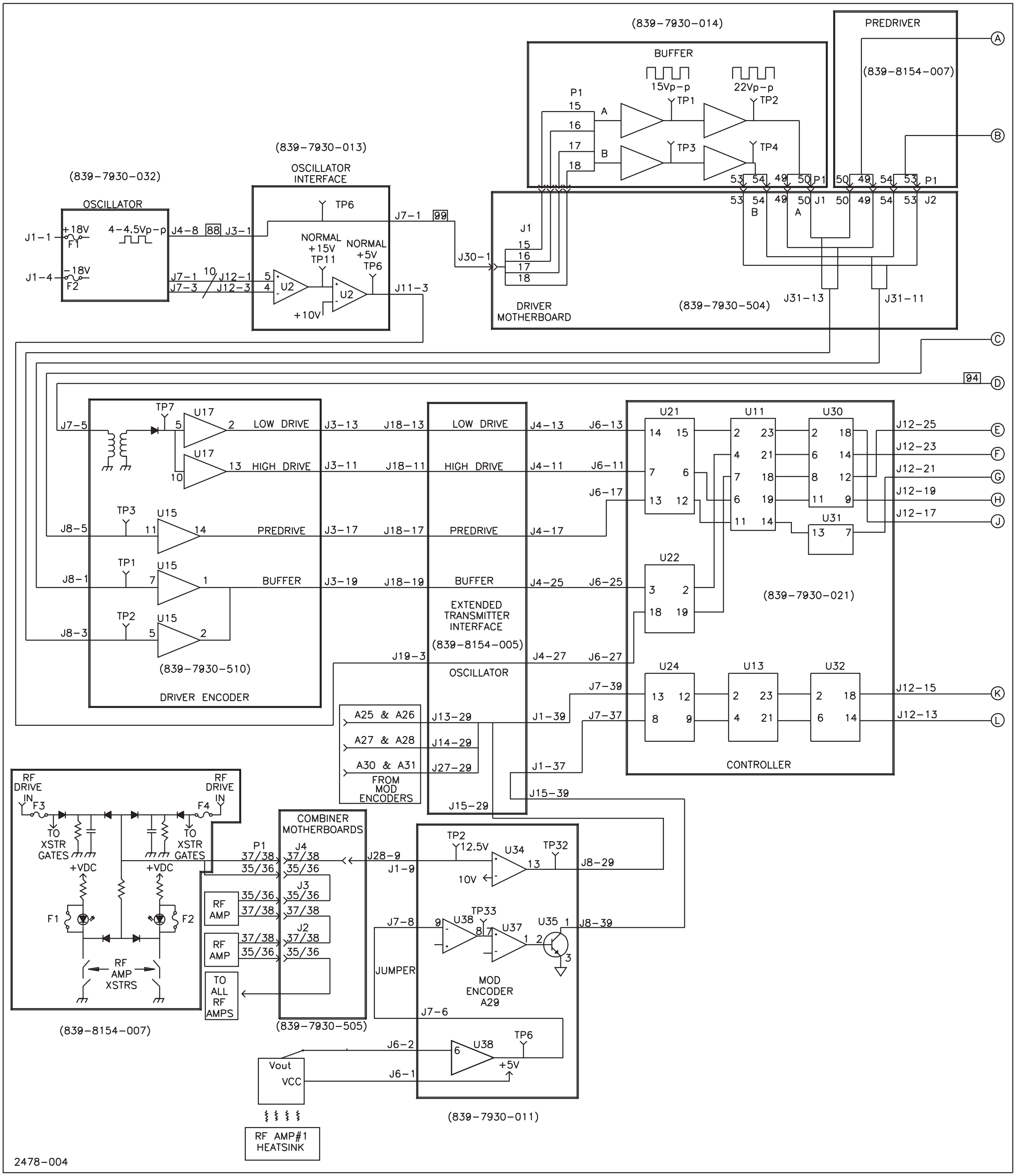


Figure 6-1 RF Chain Fault Sensing (Sheet 1 of 2)

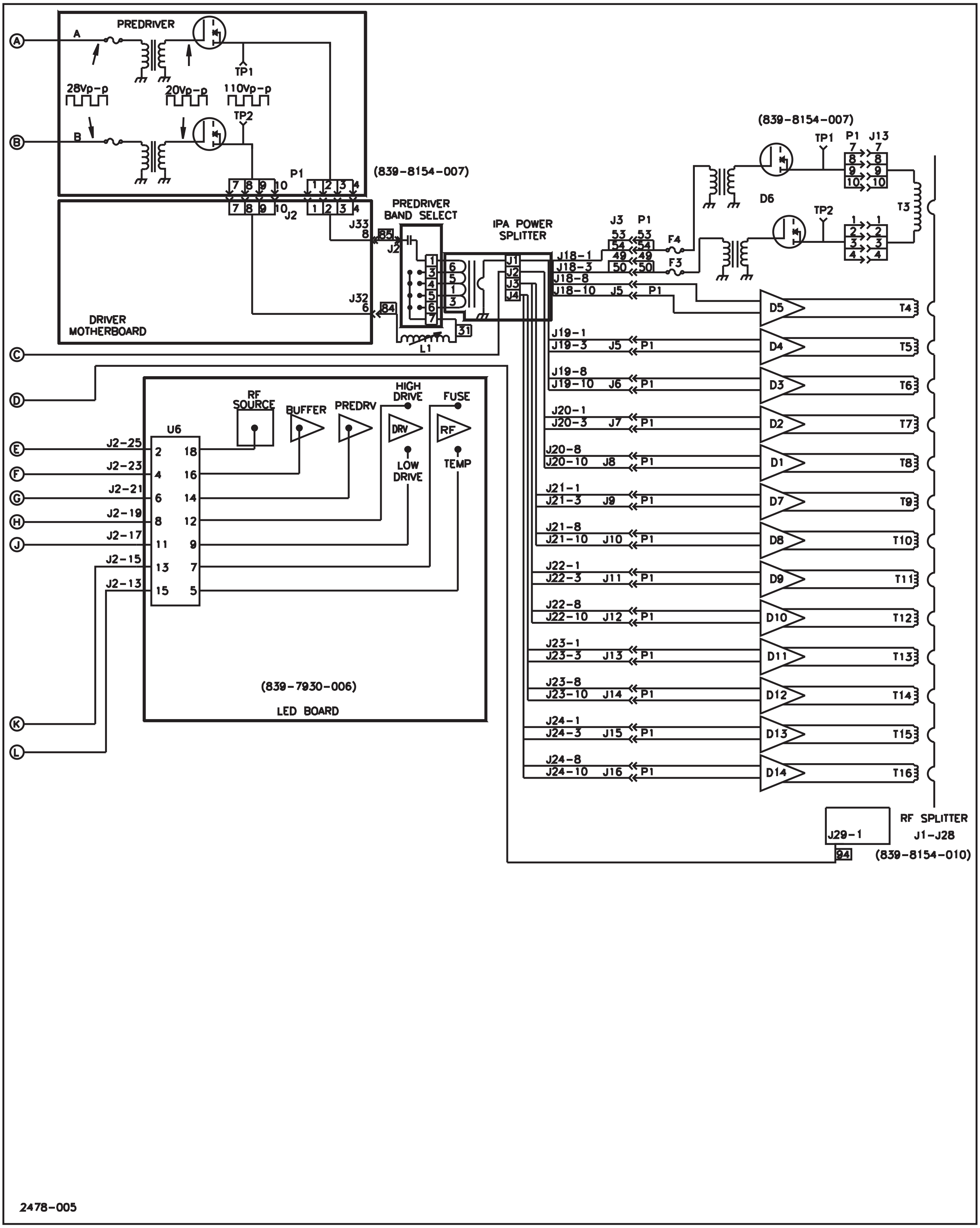


Figure 6-2 RF Chain Fault Sensing (Sheet 2 of 2)

6.3.4 Driver - High Drive LED Illuminated Red

If the Transmitter has turned itself off, and the HIGH DRIVE Control panel LED is illuminated RED, the RF drive level to the RF Amplifiers is over the upper limit. If there is too much drive:

6.3.4.1 Too Many Drivers Turned On

Troubleshoot as follows:

a. Turn on the Transmitter and observe DS3 on each Driver that is not normally operational at the current frequency.

b. If DS3 turns GREEN during the step-start sequence, monitor the turn-on lines at JP2 on the Driver Encoder for the Drivers that are turned on but should not be in service.

c. If during the step-start sequence, any of these lines go to -2VDC, refer to the Troubleshooting section of the Driver Encoder.

d. If the turn-on signals for these Drivers does not go to -2VDC, but DS3 is illuminated GREEN during the step-start sequence, troubleshoot the turn-on/turn-off circuits on those Drivers. Refer to the Troubleshooting section of the RF Amplifier.

e. Determine if AGC action is causing the extra amplitude. This may be caused by AGC circuitry malfunctioning or by R100, on the Driver Encoder board, being adjusted such that an additional but unneeded Driver Module is turning on.

f. If all the Driver modules are on, pull the jumper at JP2 that supplies the on-command to one of the Drivers D8 - D10. Turn on the Transmitter again. Repeat until drive level has been reduced to a sufficient level until the source of the trouble can be located.

6.3.4.2 Fault Sensing

a. If the above checks do not reveal the source of the problem, it is possible that the RF drive level sensing circuit has failed. Refer to the Troubleshooting section of the Driver Encoder, to determine the fault.

6.3.5 Driver - Low Drive LED Illuminated Red

Low Drive Colorstat™ Status Panel LED is illuminated RED.

This would alert you that the RF drive to the RF Amplifiers is not sufficient.

The Transmitter is equipped with AGC circuits on the Driver Encoder, such that if Driver Amplifiers fail, others will take their place and RF drive level will be maintained. However, if too many Drivers have failed, it may not be possible for the Driver Encoder to keep the RF drive level within the lower limit.

6.3.5.1 Loss of Driver Amplifiers

a. Turn the Transmitter on, and observe DS1 and DS2 on all Driver Amplifiers.

   1. If any of these indicators turn RED during the step-start sequence the Driver Amplifier side associated with the indicator will need to be repaired. Refer to the Troubleshooting section for the RF Amplifier.

NOTE

If Driver amplifiers have failed, it may be possible to return to normal operation without repairing the RF Amplifiers immediately. Refer to Section 6A, Emergency Operating Procedures, Paragraph Title: Driver Amplifier Failure.

b. Determine if AGC action is causing the lower amplitude. This may be caused by AGC circuitry malfunctioning or by R100, on the Driver Encoder board, being adjusted such that a needed Driver Module is not turning on.

6.3.5.2 Loss of 125VDC Supply.

a. Separately select LEFT and RIGHT DRIVER +VDC positions on the Driver Multimeter and turn on the Transmitter.

   1. If the 125VDC supply is present but reads lower than normal, check the fuses in the primary circuit of the Driver transformer, located in the rectifier cabinet.

   2. If the meter does not deflect upscale, troubleshoot the +125VDC power supply.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. If the supply is ok, check fuses F1 and F2 in the rear of the Driver Compartment.

c. If the fuse(s) check ok, test for continuity from the F1 and F2 clips to the respective fuse clips on the Driver Amplifiers.

d. If either fuse is open, measure the resistance from the fuse clip to ground.

e. If a short is found, pull all of the Driver Amplifiers and recheck.

f. If still shorted, suspect a filter capacitor.

6.3.5.3 Observe DS3 on All Driver Amplifiers

a. If DS3 on the Driver Amplifier(s) is not illuminated GREEN during the step-start sequence:

6.3.5.4 No Driver Amplifier(s) RF Input

NOTE

Refer to "Measuring RF Drive" at the end of this section for the following discussion.

a. With an oscilloscope, determine that the RF drive waveform on all Driver Amplifiers is present and at the correct frequency.

   1. If there is little or no RF drive, refer to the overall diagram to troubleshoot the circuit back to the Predriver Tuning circuits.

6.3.5.5 Loss of Encoder Turn On Signals

a. Check the Driver turn-on signals from the Driver Encoder board. Most of the GREEN DS3 LEDs on the Drivers should illuminate when the +125VDC power supply is energized, if the modules have RF drive and the correct turn-on signals. Monitor J1-3, J1-1, J1-17, J1-15, J1-13, J1-11, J2-17 on the Driver Encoder. Each point should be approximately -2VDC during the step-start sequence. If these voltages are not present during step-start, use the Troubleshooting portion of Section D, Driver Encoder, Paragraph Title: Driver Turn On, to determine the problem.

b. Check the Driver Amplifier turn-on signals on the Driver Encoder Board at J2-11, 13 and 15.

Driver Amplifiers D8 through D10 are frequency determined. Refer to the Detailed Circuit Description in the Driver Encoder section to determine if these Driver Amplifiers should be turned on.

c. Check the Driver Amplifier turn-on signals on the Driver Encoder Board at J2-1, 3, 5, and 7.

   1. Only D11 and D12 should be turned on during the step-start sequence.

NOTE

If Driver Encoder outputs are not correct, it may be possible to return to normal operation. Refer to Section 6A, Emergency Operating Procedures, Paragraph Title: Driver Encoder Bypassing.

6.3.5.6 Failed Driver Tuning Components

It is possible for one of the components in the Driver Tuning Board to have failed and therefore de-tune the output. Failed components like capacitors and inductors can sometimes be identified by checking for abnormal heating after operating for a short time.

6.3.5.7 Fault Sensing

a. If the above checks do not reveal the source of the problem, it is possible that the RF drive level sensing circuit has failed. Refer to the Troubleshooting section of the Driver Encoder, to determine the fault.

6.3.6 RF Amp - Fuse LED Illuminated Red

If the Transmitter is operating at reduced power and/or the RF AMP FUSE Colorstat™ Status Panel LED is illuminated RED, then:

a. One or more fuses (250VDC or RF Drive) on one or more RF Amplifiers is open.

b. RF drive on one or more RF Amplifiers is low, or

c. One or more 250VDC fuses on a Fuse Board is open or any combination of the above.

NOTE

The fuse detector circuit has no function other than to illuminate the LED.

To determine which RF Amplifier(s) has an open fuse(s):

a. Open the left, center, and right front doors of the PAC and the door of the EPAC and observe each of the seven Modulation Encoders.

b. If any of these Modulation Encoders has DS6 illuminated RED, then an RF Amplifier(s) connected to that Modulation Encoder has an open fuse(s).

   For example:

   Suppose that DS6 is illuminated RED on Modulation Encoder A29, then any RF Amplifier, RF1 through RF15 or RF101 through RF116 or RF216, could have an open fuse(s).

We will be using this example for the rest of the discussion, it applies to all other Modulation Encoders. Which type fuse(s) is open depends upon the symptoms or other indicators.

a. Turn on the Transmitter and observe DS1 and DS2 on RF Amplifiers RF1 through RF15, RF101 through RF116, and RF216, if any of these indicators is illuminated RED, then the +250VDC fuse associated with that RF Amplifier is open. To repair the module refer to the Troubleshooting portion of Section G, RF Amplifiers.

b. If DS1 and DS2 are not illuminated RED on any of these RF Amplifiers, then use the Control Multimeter Probe on the PROBE +VDC (0-30) scale and measure the voltages on TP2, TP16, TP17, and TP18 on the A29 Modulation Encoder. Normally these test points should measure 12.5VDC. If one measures 7.5VDC or less then check all of the fuses for that group of eight RF Amplifiers.

   For example:

   If TP2 measures 7.5VDC, then ohmmeter check all of the fuses (+250VDC and RF) on RF Amplifiers RF109 through RF116. If an open fuse(s) is found, troubleshoot the module(s) referring to the Troubleshooting portion of Section G, RF Amplifier. If needed, refer to the overall wiring diagram and the Modulation Encoder section to determine which groups of eight RF Amplifiers are connected to each fuse detector.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

c. If no open fuse(s) were found on the RF Amplifiers, open the left PA cabinet rear door and ohmmeter test all of the 35A fuses on the Fuse Boards A39 and A40 for the above example.

d. If an open fuse(s) is found, replace it with the proper size and ohmmeter test the fuse clip to ground. This will also test the filter capacitors associated with that fuse. A shorted capacitor will open the 35A fuse each time the +250VDC supply is present.

e. If no open 35A fuses were found, check for RF Drive on both sides of all eight RF Amplifiers. Refer to paragraph entitled "Measuring RF Drive Level" in this section.

f. If drive is low or not present, ohmmeter check the drive fuses F3 and F4 on the modules.

g. If no open fuses are found, use the Drive Cable Interconnect Diagram, 843-5450-095, to determine which cables connect the modules to the RF Splitter, A6. Use an ohmmeter to test the continuity of the cables in question.

h. In the event all of the above tests check ok, and TP2, TP16, TP17, or TP18 on the Modulation Encoder still measures 7.5VDC, measure TP32.
   1. If this test point is 0VDC, troubleshoot the comparators on the Modulation Encoder.
   2. If this test point is +5VDC, troubleshoot the fault latches and fault handling IC's on the Controller.

6.3.7 RF Amp - Temp LED Illuminated Red

If the Transmitter is operating at reduced power or has shut itself off, and the RF AMP TEMP/COOLING REDUCED OR FAULT ColorStat™ front panel LEDs or the AMBIENT OVER TEMP LED on the Extended Transmitter Interface (DS7) are illuminated RED, then the temperature of RF1 or the ambient air has exceeded 70^{o}C. The amount of power reduction depends upon how long the Transmitter has been operating in the overtemperature condition. A prolonged over-temperature condition will eventually turn the Transmitter off.

a. External Cooling (Dry Cooler) is not working properly.
b. Check the Extended Transmitter Interface board for COOLANT LEAK (DS5) and LOW FLOW (DS9) LEDs, if either is illuminated red, correct as needed. Verify the FLOW ON LED (DS8) is illuminated green.
c. Check the tuning of the Transmitter. Mistuning of the Transmitter can cause the RF Amplifiers to run less efficiently therefore generating more heat.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

   1. Turn off the Transmitter and open the left cabinet inner front door.
   2. Remove RF1 and feel the heatsink. If it is extremely hot compared to the other RF Amplifier heatsinks, troubleshoot the amplifier using the Troubleshooting portion of Section G, RF Amplifier.

d. If the amplifier is not hot, it is possible that the temperature detector circuit, or the temperature sensor and cable assembly is defective.
   1. Turn on the Transmitter, and monitor TP33 on the Modulation Encoder A29 with a voltmeter.
   2. If voltage at TP33 is less than the voltage at U37-8 or U37-6, refer to the Troubleshooting portion of Section L, Modulation Encoder to determine the cause.

6.3.8 Analog Input - Power Foldback LED Illuminated Red

This LED is not a fault indicator, but rather an indication that the Transmitter is, or has been, in a self protection mode.

6.3.8.1 Reset the Fault

a. If the FAULT RESET pushbutton on the Colorstat™ Status Panel is pressed and the LED returns to GREEN, then the fault that caused the foldback is no longer present and the condition should be monitored.
b. If the LED remains RED after the FAULT RESET pushbutton is pressed, then the fault that caused the foldback is still present.
   1. The Transmitter will normally be in the foldback mode due to Antenna/Network VSWR or ARC, RF Amp/Power Supply Temp, or Air Flow Reduced faults.

The Transmitter can also be in this mode due to failures of the sensing and control circuitry. Refer to the appropriate fault section or to the troubleshooting guide of the Controller and/or Analog Input Board as needed.

6.3.9 Analog Input - Supply Fault LED Illuminated Red

If the Transmitter has shut itself off or is operating with an RF Mute indication, and the Analog Input Supply Fault LED on the ColorStat™ panel is illuminated RED, then one or more power supplies has failed on this board. With the low voltage on, measure the following voltages on the Analog Input Board.

a. F1 should measure +7.5VDC,
b. F2 should measure -18VDC and
c. F3 should measure +18VDC.

If any one of these supplies is not present, troubleshoot the low voltage power supplies.

If all of these supplies are present, refer to the Troubleshooting portion of Section J, Analog Input Board.

6.3.10 A/D Converter - Conversion Error LED Illuminated Red

If the Transmitter is operating but has 0W output, and the RF MUTE and A/D Converter Conversion Error LEDs on the ColorStat™ front panel are illuminated RED, then the RF sample required by the A/D Converter is not present or there is a fault in the A/D conversion process.

a. With an oscilloscope, measure the RF squarewave signal across R11, on the A/D Converter. If the RF squarewave signal is present across R11, refer to the Troubleshooting section for the A/D Converter.
b. If no signal is present, check the RF signal at TP4 A/D Phase on the Driver Encoder. If the signal is present at TP4, then check the continuity of the cable that connects the A/D Converter to the Driver Encoder, through the Power Block Interface.
c. If the RF signal is not present at TP4, check for an RF signal across R106 on the Driver Encoder.
d. If there is no signal across R106, then check continuity of the cable that connects the Driver Encoder to the RF Splitter.

If the signal is present at R106 but not at TP4, refer to the Troubleshooting section for the Driver Encoder.

6.3.11 A/D Converter - Supply Fault LED Illuminated Red

If the Transmitter has shut itself off or is operating with an RF Mute indicator lit, and the A/D Converter Supply Fault LED on the Control panel is illuminated RED, then one or more power supplies has failed on this board. With the low voltage on, measure the following voltages on the A/D Converter Board.

a. F1 should measure +18VDC,
b. F2 should measure -18VDC,
c. F3 should measure +7.5VDC and
d. F4 should measure -12VDC.

If any one of these supplies is not present, troubleshoot the low voltage power supplies.

If all of these supplies are present, refer to the Troubleshooting portion of Section K, A/D Converter Board.

6.3.12 Encoders - Module/Cable Interlock LED Illuminated Red

If the Transmitter has shut itself off and the above LED is illuminated RED on the Colorstat™ Status Panel, an RF Amplifier(s), Driver(s), or encoder cable(s) has been disconnected.

a. Open all of the front doors and observe DS2-Interlock 4, DS3-Interlock 3, DS4-Interlock 2, and DS5-Interlock 1 on all Modulation Encoders and DS8-Interlock on the Driver Encoder.
b. If any one of these LEDs are illuminated RED, the cause of the fault has been detected by that circuit.
c. If no indicator is lit, then an open exists between the different Modulation encoders or the fault sensing circuit has failed.
    1. Check the inputs and output of U3 on the Extended Transmitter Interface Board to discover which signal is being interrupted.
    2. Ohmmeter check the appropriate cable if an input is missing or low.
    3. Refer to the Troubleshooting Section of the Controller if the output of U3 is high.

For example:

If DS3 is illuminated RED on the A26 Modulation Encoder, then RF Amplifiers RF70 through RF77 or the encoder cable is not connected or open. This example will be used for the rest of the troubleshooting procedures, and applies to any other interlock that is illuminated RED.

To find a Module/Cable interlock fault, based on the above example, use the following procedures:

a. Use an ohmmeter to measure for continuity from Cathode of CR39 to R122 (J3-9 to J3-19). If the resistance measures open, then disconnect the J3 plug and measure for continuity from J3-9 to J3-10 and the continuity from J3-19 to J3- 20.
    1. If the resistance from 9 to 10 is open, the cable that connects to J18 on RF Combiner Motherboard, A13, is open or RF Amplifiers RF70 through RF73 are not properly making connection to the RF Combiner Motherboard edge connectors.
    2. If the resistance from 19 to 20 is open, the cable that connects to J19 on RF Combiner Motherboard, A13, is open or RF Amplifiers RF74 through RF77 are not properly making connection to the RF Combiner Motherboard edge connectors.
    3. Try pulling out each RF Amplifier and pushing it back into the connector, verify that the cables are properly inserted into the connectors on the RF Combiner Motherboard, and if needed ohmmeter check the encoder cable wires.

If the ohmmeter resistance from J3-9 to J3-19 measures 0 Ohms, disconnect the J3 plug and check the resistance across CR39. A normal diode reading should be obtained. If not then troubleshoot the Modulation Encoder by referring to the Troubleshooting portion of Section L, Modulation Encoder.

6.3.13 Encoders - Supply Fault LED Illuminated Red

If the Transmitter has shut itself off, and the above LED is illuminated RED, a power supply on one of the Modulation Encoders, or on the Driver Encoder has failed. The first step is to determine if it is a Modulation Encoder or Driver Encoder Fault.

a. Depress S6, and observe DS9 on each Modulation Encoder and DS7 on the Driver Encoder.

6.3.13.0.1 Modulation Encoder Supply Fault

a. If DS9 on a Modulation Encoder is illuminated RED, depress S6 on that encoder and hold for a few seconds while observing DS8, B+ and DS11, B-.
b. DO NOT DEPRESS S6 FOR LONGER THAN 1 MINUTE.
    1. If either of the LEDs do not illuminate GREEN, check for -10VDC at TP22 and +10VDC at TP10. If either of these voltages are not present, troubleshoot the low voltage supplies.

Note

The B- LED, DS11, will probably be dimmer than the B+ LED, DS8.

NOTE

It is possible to bypass a failed Modulation Encoder and operate the Power Block at a reduced power level. Refer to the Emergency Bypass section in the manual for the proper procedure.

    2. If the supplies are present, troubleshoot the B+/B- regulators referring to the Troubleshooting section for the Modulation Encoders.

If both LEDs illuminate GREEN, troubleshoot the B+/B-fault comparators referring to the Troubleshooting section for the Modulation Encoders.

6.3.14 RF Amp Power Supply - A/C Mains Fault LED Illuminated Red

This indicator is a summation of faults detected in the Rectifier cabinet. It will illuminate if:

a. 220V single phase is out of tolerance by +/- 15%
b. 3 phase power to Rectifier cabinet is detected as high/low/missing by the SCR Controller Board.

6.3.15 RF Amp Power Supply - Current Fault LED Illuminated Red

This is also a summary fault. It will illuminate if:

a. A current overload & foldback is detected by the Analog Input Board (Peak or Average overload).
b. An external overload is detected in the Rectifier Cabinet.

6.3.16 RF Amp Power Supply - Voltage Fault LED Illuminated Red

This is also a summary fault. It will illuminate if:

a. An over or under voltage is detected in the Rectifier Cabinet.
b. An over or under voltage is detected by the Analog Input Board. (This function has been partially disabled due to the ramp-up sequence used in the Rectifier Cabinet. The alarm points are set to 10V and 280V.)

6.3.17 RF Amp Power Supply - Temp Fault LED Illuminated Red

This is also a summary fault of over temperature detection in the Rectifier Cabinet. It will illuminate if:

a. An over-temperature SCR is detected.
b. The Transformer Temperature is detected as high.

6.3.18 Output Monitor - Network VSWR LED Illuminated Red

This LED is a summary fault indication. There are two VSWR Detectors in the Transmitter. They monitor the input VSWR to the Output Network and the output VSWR from the Output Network. The Antenna Null DC signal is presented to the Antenna trip threshold portion of the Output Monitor Board, while the Network RF voltage and current samples are applied to J10 and J2 repectively on the Output Monitor Board.

There are also two ARC Detectors that are monitored. They are located in the ONC Cabinet and the back of the EPAC. Their two outputs are fed to the UPPER and LOWER detectors on the Output Monitor Board.

Finally, the output of the two VSWR detector outputs are summed with the summation output of the arc detectors. The result of this summation operates the Output Monitor Network VSWR LED and OUTPUT VSWR LED.

6.3.18.1 Network VSWR

6.3.18.1.1 Multiple VSWR or ARC Conditions

If the Transmitter is operating at reduced power or has shut itself off, and the OUTPUT MONITOR, NETWORK VSWR and/or OUTPUT VSWR, and ANALOG INPUT POWER FOLDBACK Colorstat™ Status Panel LEDs are illuminated RED, then more than five VSWR or ARC trips have occurred within twenty seconds in the Transmitter output network. If enough successive VSWR conditions have occurred, the Transmitter will foldback in power and eventually shut off.

6.3.18.1.2 Single VSWR or ARC

a. If the VSWR TEST Colorstat™ Status Panel LED is illuminated RED and eventually returns to GREEN, less than five VSWR or ARC conditions have occurred within twenty seconds in the Transmitter output network.
b. The NETWORK NULL position on the front panel will normally be at or near 0 on the meter if the Transmitter is properly tuned. Any Network VSWR will show up as an upscale meter deflection on this position.
c. The OUTPUT NULL position on the front panel will normally be at or near 0 on the meter if the Transmitter is properly tuned. Any Output VSWR will show up as an upscale meter deflection on this position.
d.

NOTE:
The Network VSWR circuit is inhibited during any Antenna VSWR condition.

6.3.18.1.3 Clear The Fault

a. The first step is to clear the fault by pressing the RESET switch on the Colorstat™ Status Panel.
b. If the fault clears, the Transmitter should return to the normal power level and the OUTPUT MONITOR NETWORK VSWR and/or OUTPUT VSWR LEDs should return to GREEN. If this occurs, then VSWR or Arcing is no longer present but should be monitored in the future.

6.3.18.1.4 Fault Will Not Clear

a. If the fault remains RED, the source of the VSWR or ARC must be located and cleared before full power operation can continue.

6.3.18.1.5 Network VSWR

a. Observe DS3 on the Output Monitor. If this indicator is flashing RED for 0.5 seconds, an Output Network VSWR fault is being detected. If DS3 does not flash red then refer to paragraph 6.3.19.5, Testing the Antenna VSWR Detector, for additional information to facilitate clearing the VSWR TEST LED.

6.3.18.1.6 Network ARC

a. Observe DS4 on the Output Monitor. If this indicator is illuminated RED, an Upper Arc fault is being detected, which is sensed by the ONC Arc Detector (8A2).
b. Observe DS5 on the Output Monitor, if this indicator is illuminated RED, a Lower Arc fault is being detected. This may be sensed by any of the following Arc Detectors: RPAC (A43), CPAC (A44), or EPAC (A2).
c. Press the S5 reset switch, if the fault does not clear:

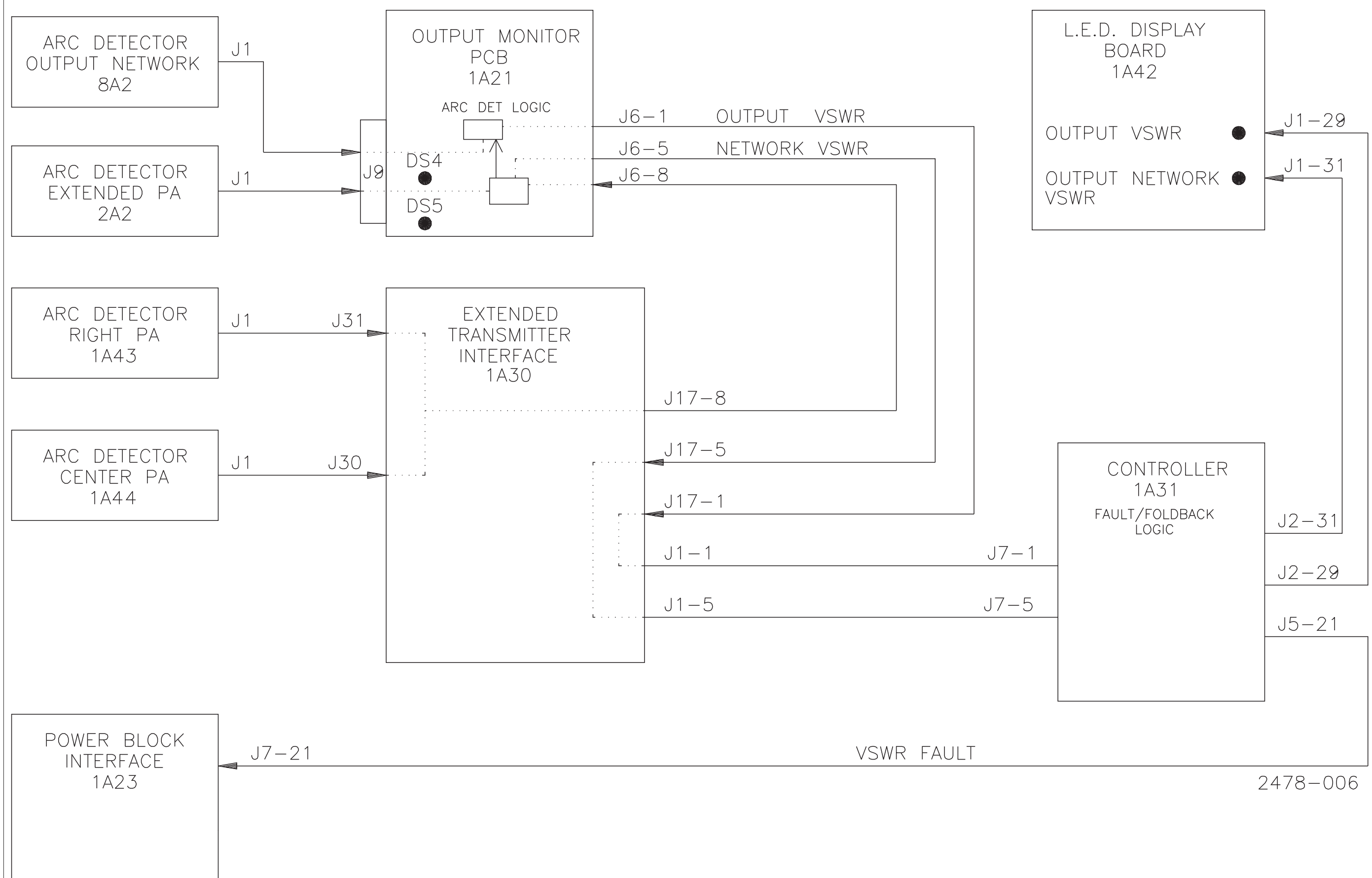


Figure 6-3

Simplified Block Diagram ARC Detector

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

d. Turn off the Transmitter and visually inspect and feel the output network components.

e. Components that are arcing will leave a black residue and possibly leave pitting marks on the inner walls, shelves and components in the Transmitter.

f. If any capacitors have failed, they may feel warmer than the rest of the components in the output network.

g. If no component failures can be detected, turn on the Transmitter with the air filters removed from the rear door. It might be possible to determine where the arcing is occurring by looking into the output network through the blowers.

It is possible for the network VSWR detector to be at fault.

6.3.18.1.7 Testing the Network VSWR Detector:

a. Turn on the Transmitter and apply an RF Mute by selecting the RF MUTE position of S1 on the Controller. This keeps the power in the output network at 0W and therefore no actual VSWR should be generated.

b. Press the NET VSWR TEST pushbutton (S1) on the Output Monitor Board. The OUTPUT NETWORK VSWR TEST LED (DS3) on the Output Monitor Board should turn RED for 5 seconds and then return to GREEN.

c. If it does not change or remains RED, the NET VSWR Detector or the NET VSWR TEST circuit is not operating correctly, and the Transmitter should not be operated until the problem is resolved.

6.3.19 Output Monitor Antenna VSWR Illuminated Red

If only the OUTPUT MONITOR ANTENNA VSWR LED (DS2) is illuminated red and the transmitter is still at the normal power, less than five VSWR events have occurred within twenty seconds.

If the transmitter is operating at reduced power or has shut itself off, and the OUTPUT MONITOR ANTENNA VSWR LED (DS2 on the Output Monitor board) and ANALOG INPUT POWER FOLDBACK ColorStat™ Status Panel LEDs are illuminated red, then more than five VSWR events have occurred within twenty seconds. If enough successive VSWR conditions have occurred, the transmitter will foldback in power and eventually shut off.

The ANT NULL position on the front panel, and/or both TP36 (Output Monitor Board) and TP16 (Rf Sample Board) will normally be at or near 0 on the meter if the transmitter is properly tuned into the antenna. If that front panel metering positioning is not available, measure TP16 on the RF Power Sample Board for the desired near-zero null result. Any antenna VSWR will show up as an upscale meter deflection.

6.3.19.1 Clear the Fault

a. The first step is to clear the fault indication by pressing the RESET switch on the ColorStat™ Status Panel.

b. If the fault indication clears, the transmitter, following turn-on, should return to the normal power level and the OUTPUT MONITOR NETWORK LED will then be GREEN. If this occurs, then VSWR is no longer present and should be monitored in the future.

6.3.19.2 Fault Will Not Clear

If the fault remains RED, the source of the VSWR fault must be located and cleared before full power operation can continue.

6.3.19.3 Antenna VSWR

Observe DS2 on the Output Monitor. If this indicator is flashing RED for 0.5 seconds, a VSWR fault is being detected. If DS2 does not flash red then refer to paragraph 6.3.18.1.7, Testing the Network VSWR Detector, for additional information to facilitate clearing the VSWR TEST LED.

6.3.19.4 Some possible causes of antenna VSWR are:

a. ARCING

1. Static discharge or discharge due to lightning across ball gaps, guy wire insulators, or possibly across components already operating close to their voltage ratings.
2. Static charge buildup can occur on towers that do not have provision made for static discharge, such as static drain chokes.
3. Static charge buildup can occur during conditions of rain, snow, or even blowing dust or sand.
4. Dirt build up or moisture (including condensation) on insulating surfaces and inside transmission line can cause the voltage breakdown rating to be reduced. This can occur if pressurized gas filled lines lose pressure or if the dehydrator in the line pressurization unit fails.
5. In new systems, insufficient voltage rating of components, such as capacitors or insulators, or spark gaps being set too close may cause arcing.

b. TRANSIENT signal pickup may occur during thunderstorms, even from distant lightning strikes in some cases. Lightning strikes may induce currents in towers, causing currents on the transmission lines that can reach the phase detectors and give a VSWR overload indication.

c. INTERFERENCE: Other nearby stations' signals can also induce voltages and currents in antenna systems that are large enough to be detected by the phase detector and cause VSWR overloads. The solution in such cases may be a trap or filter in the antenna impedance matching network or phaser.

d. LOAD IMPEDANCE CHANGES - The Reflected Power reading and Antenna Null position on the front panel multimeter is the best indication of the antenna operating impedance once initially tuned into the antenna. If the Reflected Power and Antenna null indications change, this indicates an impedance change of the transmitter load. The load impedance should be checked with proper impedance measuring equipment, and the improper load should be corrected if possible.

It is possible for the network VSWR detector to be at fault.

6.3.19.5 Testing the Antenna VSWR Detector

a. Turn on the Transmitter and apply an RF Mute by selecting the RF MUTE position of S1 on the Controller. This keeps the power in the output network at 0W and therefore no actual VSWR should be generated.

b. Press the ANT VSWR TEST pushbutton (S2) on the RF Power Sample Board. The ANTENNA VSWR TEST LED (DS2) on the Output Monitor Board should turn RED for 5 seconds and then return to GREEN.

c. If it does not change or remains RED, the ANT VSWR Detector or the ANT VSWR TEST circuit is not operating correctly, and the Transmitter should not be operated until the problem is resolved.

6.3.19.6 VSWR Test

The VSWR TEST LED is an indicator that the transmitter is performing a VSWR TEST, a VSWR has just occurred, or that the VSWR detector has failed. When the transmitter is first turned on or when a different power level is selected, this LED should illuminate RED for 4 seconds and then return to GREEN. If during normal operation, the LED is illuminated RED and does not return to green within 4 seconds, the VSWR circuits may have failed and should be tested to determine if they are operating properly.

NOTE:

Pressing the front panel reset has no effect on this indicator. This LED can only be reset by a successful completion of the VSWR test. If the LED remains RED after 4 seconds, troubleshoot the VSWR TEST circuit.

a. If the VSWR TEST pushbutton is pressed, while S6 is depressed and held down on the Output Monitor, the VSWR TEST LED should remain RED. If this occurs, the VSWR TEST circuit (which is Inhibited by S6) will not have detected a VSWR and should remain illuminated RED indicating that the circuit failed the test. This is a way of being sure that the detector circuit will return a fault to the front panel, if one does occur.

6.3.20 Output Monitor Supply Fault LED Illuminated Red

If the Transmitter has shut itself off or is operating with an RF Mute indicator lit, and the OUTPUT MONITOR SUPPLY FAULT LED on the Colorstat™ Status Panel is illuminated RED, then one or more power supplies has failed on this board. With the low voltage on, measure the following voltages on the Output Monitor.

a. F3 should measure +18VDC, F1 should measure -18VDC, and F2 should measure +7.5VDC. If any one of these supplies is not present, troubleshoot the low voltage power supplies.

b. If all of these supplies are present, refer to the Troubleshooting section of the Output Monitor Board.

6.3.21 Control - Local LED Illuminated Red

This indicator shows that the local/remote switch is in the “Local” condition. When illuminated, the Transmitter will ignore all commands from any Remote Control EXCEPT for the OFF Command which will turn the Transmitter off.

6.3.22 Control - Remote LED Illuminated Green

This indicator shows that the local/remote switch is in the “Remote” position. Remote Control has full control of the Transmitter in this condition. All local controls will still function while in the Remote condition but the Remote Control can still control the Transmitter

6.3.23 Interlocks - External LED Illuminated Red

If the Transmitter has shut itself off and this LED is illuminated RED on the Colorstat™ Status Panel, at least one external interlock is open.

The following three Interlocks must be satisfied (as required to allow Transmitter On operation) to, in turn, satisfy the overall External Interlock function: Emergancy Off, Auxiliary Interlock, and TCU Interlock (in the single Power Block/Transmitter configuration, the TCU Interlock is satisfied by factory hardwiring).

a. Auxiliary Interlock integrity - Measure the resistance of the wires connecting to J4-10 and J4-11 on the Power Block Interface board.

NOTE:

If no system External Interlocks are used, a jumper must be position between J4-10 and J4-11 on the Power Block Interface board.

WARNING

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1. If the resistance measurement is open, check all devices connected to these terminals, (phaser door interlock, dummy load, etc.) to make sure that the device is providing closed contacts, as required, in the normal operating condition.
2. If the resistance measurement is 0 Ohms, the Auxiliary Interlock integrity is OK.

b. Check the position of the Emergency Off switch on the Rectifier Cabinet Display Panel; Transmitter Off = Contacts closed from switch having been depressed. Transmitter Ready = Contacts open from switch not being depressed. Be sure the switch is in the not-depressed position for normal Transmitter operation to occur.

If the Emergency Off and Auxiliary Interlock positions are correct for normal operation, measure the voltage at TP4 on the Power Block Interface board

1. This voltage should be +24VDC.
2. If no voltage is present, troubleshoot the low voltage supplies.
3. If voltage is present, check the overall Interlock circuitry as shown in Figure N-1 and/or sheet 6 of Power Block Interface drawing 839-8154-008.
4. If the above seems satisfactory, check the input of U24 on the Controller. If this is a logic high, refer to the Controller Section for troubleshooting.

6.3.24 Interlocks - Internal LED Illuminated Red

This indicator shows the status of the internal Transmitter interlocks. These include the ONC RF Earthing Switch, RF Ready Switch, and TCU Interlock in concert with the External Auxiliary Interlock

The presence of an ONC RF Earth switch low state, one RF Ready high state, or the ANDed result of TCU (low) and Auxiliary Interlock (high) signals will result in an active Internal Interlock Fault indication. Refer to sheet 6 of Drawing 839-8154-008, Power Block Interface board, to track the particular fault(s) states.

The integrity of the ONC RF Earth Switch and RF Ready Switch positioning are the more likely fault creators, although the absence of test load or ACU door Interlock satisfaction will also cause an Interlock fault condition to exist.

6.3.25 Controller - RF Mute LED Illuminated Red

If the Transmitter is operating at 0W output and the above LED is illuminated RED on the ColorStat™ front panel, the Transmitter is responding to another fault by applying an RF MUTE or a control input has been activated. Check that an external RF Mute or S1 on the controller is not in the Mute position.

If no other indicators are lit, refer to the Controller Section of the Manual for troubleshooting the Controller.

6.3.26 Controller - Supply Fault LED Illuminated Red

If above LED is illuminated RED on the ColorStat™ front panel, then one of the power supplies on this board has failed. With the low voltage on, measure the following voltages on the Controller.

a. If P53 on the Controller is jumpered 2-3, TP21 should measure +12VDC.
b. If P53 is jumpered 1-2, TP22 should measure +10VDC.
c. If any one of these supplies is not present, troubleshoot the low voltage power supplies.

If all of these supplies are present, refer to the Troubleshooting portion of Section M, Controller Board.

6.3.27 Cooling - Reduced LED Illuminated Red

If the Transmitter is operating at a reduced power level, and the above LED along with the ANALOG INPUT POWER FOLDBACK is illuminated RED on the Colorstat™ Status Panel, then cooling for the Transmitter is reduced.

To determine which cabinet(s) have reduced airflow, open all front doors and observe DS7 on all Modulation Encoders and DS1 on the Output Monitor.

a. Modulation Encoder A30 monitors the EPAC Cabinet
b. Modulation Encoder A28 monitors the Left PA Cabinet
c. Modulation Encoder A26 monitors the Center PA Cabinet
d. Modulation Encoder A25 monitors the Right PA Cabinet
e. The Output Monitor Board monitors the Output Network Cabinet

If any of these LEDs is illuminated RED, perform the following checks for that cabinet.

a. Verify the blowers are operational and that no blades are loose.

6.3.28 Cooling - Fault LED Illuminated Red

This LED indicates a more serious cooling problem which will shut off the Transmitter. Check:

- Water Flow,
- Leak Detectors
- Ambient Air Temperature

Go to the Extended Transmitter Interface Board and observe DS9 - Low Flow, DS5 -Leak, and DS7 - Ambient over temperature. This will direct you to the appropriate area of the Transmitter to continue troubleshooting.

6.4 Troubleshooting Faults In The RF Drivers

6.4.0.1 Driver Encoder Module/Cable Interlock

If DS8 is illuminated RED on the Driver Encoder, then one of the Driver amplifiers or the encoder cables is not connected or open.

a. Using an ohmmeter, measure for continuity from J2-20 to J2-9. If continuity exists, then disconnect J2 and repeat the measurement. The resistance should rise. If not, troubleshoot the Cable Interlock circuitry by referring to the Troubleshooting section for the Driver Encoder.
b. If there is no continuity between J2-20 and J2-9 then disconnect J2 from the Driver Encoder and measure for continuity between P2-20 and P2-19 and between P2-9 and P2-10.
   1. If the resistance from P19 to P20 is open, the cable that connects to the Driver Combiner Motherboard is open or one of 4 Driver Amplifiers is not properly making connection.
   2. If the resistance from P9 to P10 is open, the cable that connects to the Driver Combiner Motherboard is open

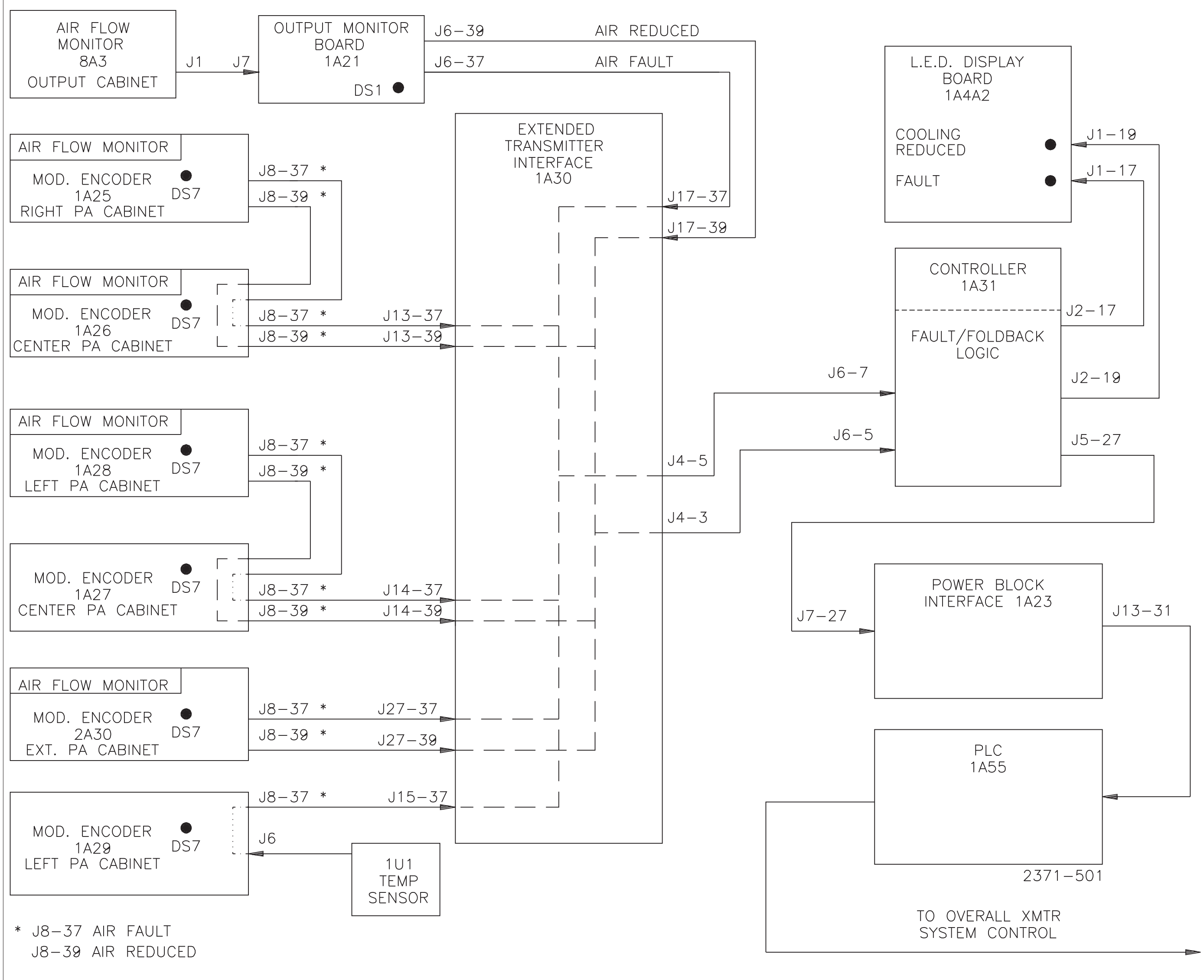


Figure 6-4

Simpllified Block Diagram Airflow

or one of 4 Driver Amplifiers is not properly making connection.

c. Using an ohmmeter, measure for continuity from J1-20 to J1-9. If continuity exists, then disconnect J1 and repeat the measurement. The resistance should rise. If not, troubleshoot the Cable Interlock circuitry by referring to the Troubleshooting section for the Driver Encoder.

d. If there is no continuity between J1-20 and J1-9 then disconnect J1 from the Driver Encoder and measure for continuity between P1-20 and P1-19 and between P1-9 and P1-10.

   1. If the resistance from P19 to P20 is open, the cable that connects to the Driver Combiner Motherboard is open or one of 4 Driver Amplifiers is not properly making connection.
   2. If the resistance from P9 to P10 is open, the cable that connects to the Driver Combiner Motherboard is open or one of 4 Driver Amplifiers is not properly making connection.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING “PA+VDC” ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

e. Try pulling out each Driver Amplifier and pushing it back into the connector, verify that the cables are properly inserted into the connectors on the Driver Combiner Motherboard, and if needed, ohmmeter check the Encoder cable wires.

6.4.0.2 Driver Encoder Supply Fault

DS8 on the Driver Encoder is illuminated RED.

a. Check for +18VDC on J5-1, +7.5VDC on J5-5, and -18VDC on J5-7. If any of these voltages are not present, troubleshoot the low voltage power supplies.

   1. If the supplies are present, troubleshoot the regulators referring to the Troubleshooting section for the Driver Encoder.

6.5 Rectifier Cabinet Status Panel Controls and Indications

All alarm conditions generated in the Rectifier Cabinet are sent to the Transmitter for monitoring and display by the ColorStat™ Front Panel

6.5.1 Transformer Cabinet - A/C Mains LED Illuminated Red

Indicates absence or a severe imbalance of the 205 VAC (phase to phase). Generates an RF Amp Supply A/C Mains Fault that is sent to the Transmitter.

6.5.2 Transformer Cabinet - Temperature Fault LED Illuminated Red

Indicates an overtemperature of a transformer in the Transformer Cabinet. Generates an RF Amp Power Supply Temperature Fault that is sent to the Transmitter.

6.5.3 Rectifier Assembly - Temperature Fault LED Illuminated Red

Indicates one of the SCR Assembly thermal sensors (one for each bank of SCRs) is detecting an overtemperature. Generates a Temperature Fault that is sent to the Transmitter.

6.5.4 RF Amplifier Power Supply - PA Voltage Fault LED Illuminated Red

Indicates that the window comparator that monitors the 250 VDC line has detected an out of tolerance condition. Generates a Power Supply RF Voltage Fault that is sent to the Transmitter.

6.5.5 RF Amplifier Power Supply - PA Current Fault LED Illuminated Red

Indicates that peak and/or average current of the DC output is high or that the input current on the AC Lines is high. Generates a current fault that is sent to the Transmitter.

6.5.6 RF Amplifier Power Supply - Choke Temperature LED Illuminated Red

Indicates an overtemperature condition has been detected in the Choke. Generates a temperature fault that is sent to the Transmitter.

6.5.7 RF Amplifier Power Supply - Binary Voltage Fault LED Illuminated Red

Indicates the window comparator that monitors the 125VDC has detected an out of tolerance conditions. Generates a voltage fault that is sent to the Transmitter.

6.5.8 Driver Power Supply - Fault LED Illuminated Red

Indicates a fault has been detected in the Driver Power Supply. This is monitored using the secondary contacts on the contactors. Generates a voltage fault that is sent to the Transmitter.

6.5.9 Controller - Fault Reset Button

Used to reset fault latching circuits. If, after pushing the button, the fault reappears, continue troubleshooting.

6.5.10 Controller - Cooling Fault LED Illuminated Red

Indicates an under flow condition has been detected by the water flow switch or Leak Detector fault. Generates a Cooling Fault that is sent to the Transmitter.

6.5.11 Power Supply Discharge Circuit - Fault LED Illuminated Red

Indicates that a MOSFET is shorted, or a high temperature is present on a crowbar MOSFET heatsink. Generates a voltage fault that is sent to the Transmitter.

6.5.12 A/C Control - A/C Mains LED Illuminated Red

Indicates absence or a severe imbalance of the 380/480 VAC (phase to phase) Blower/Control Voltage Supply. Generates an A/C Mains Fault that is sent to the Transmitter.

6.5.12.1 AC Phase Monitor Check-out Procedure

Refer to drawing 843-55523-672 and figure 6-5 for the following discussion.

Verify the presence of 380/480VAC at 6FL1 input. If present, verify the integrity of Switch S5 (part of Rectifier Cabinet Earthing Switch), followed by the servicability of AC Phase Monitor (K7).

a. With Transmitter Blower power OFF, turn the adjustment dial to minimum (CCW).
b. Turn Blower/Controller power ON. The internal output relay should energize and the LED (if applicable) should illuminate. On manual reset models, depress reset button to energize. On models without a LED, an audible “click” should be heard when the internal output relay energizes. A continuity tester can be placed across the normally open contacts to check operation on all models.
c. If the internal output relay and LED do not energize, turn power OFF and swap any two (2) of the three (3) AC input wires. This corrects the phase sequence if the monitor was connected in the reverse rotation.
d. Turn Blower power ON. When the internal output relay and LED energize, the phase sequence is correct and the voltage on all three phases are above the minimum voltage set point.

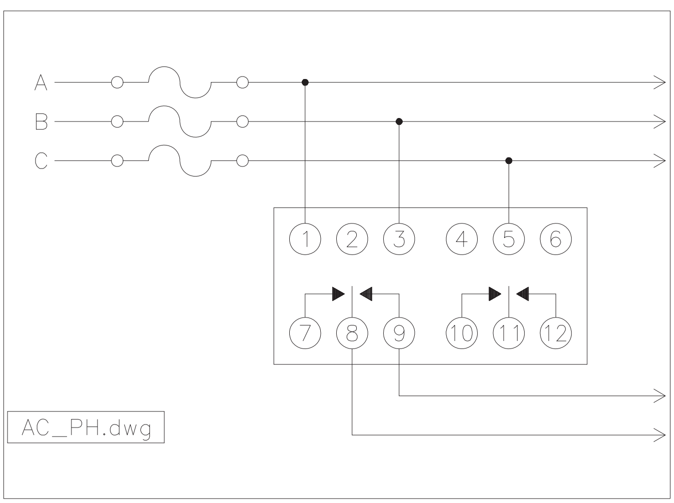


Figure 6-5 AC Phase Monitor

e. Select the proper voltage trip point. SLOWLY rotate the adjustment dial clockwise until the LED extinguishes and the internal output relay de-energizes.

   NOTE: Some high line and unloaded conditions may prevent maximum (CW) adjustment beyond the point where the LED extinguishes, and the internal output relay de-energizes.
f. Next, SLOWLY rotate the adjustment dial counter clockwise (CCW) until the LED stays on steady state and/or the internal ouput relay energizes. This procedure assures that the monitor is set at your exact line-to-line voltage.

   NOTE: It may be necessary to slightly lower the adjustment dial (CCW) to prevent nuisance tripping.
   CAUTION: Lowering the adjustment dial setting more than 10-12° (CCW) below the precise set point may interfere with proper operation.

6.6 System Faults With No Indication On The Front Panel

6.6.1 Distortion

The areas of the Transmitter that have an effect on distortion are:

a. Output Network Tuning
b. RF Amp failures (missing steps)
c. Analog Input Board
d. Driver Encoder (A/D Phasing)
e. A to D Converter (spikes, spurious pulses) and,
f. Modulation Encoders (missing steps).

Refer to the Installation Section for Optimizing Tuning for Best distortion and the alignment or Troubleshooting sections of the individual boards as needed.

A suggested order to check the sections is

a. RF Amp Failures
b. Output Network Tuning
c. A/D Converter Phasing
d. Analog Input Board
e. Modulation Encoders, and
f. A/D Converter

6.7 Measuring RF Drive Level And Phase

The following procedures will be referred to from other parts of the Troubleshooting section and from other sections in this manual.

6.7.1 Measuring RF Drive Level

Remember that there are two sections of each RF Amplifier and each will have an individual drive signal applied to the input.

NOTE

When measuring RF Amplifier drive amplitude, the amplifier to be measured must be turned "ON" to give a correct drive measurement. The drive waveform of an "OFF" amplifier will be below 0.0VDC and the peaks will probably be clipped. LED indicators DS3 will illuminate GREEN when an amplifier is on and drive level is at an adequate level.

NOTE

For maximum protection of personnel it is recommended to use scope probe (610-1131-000) or equivalent X10 scope probe to access this point since the long tip will reach through the air slots in the inner door.

a. Connect the probe to the scope set up to measure an RF waveform at approximately 24Vp-p, and ensure that the scope case is properly grounded.

b. Connect the ground clip of the probe to the edge of the inner front door of the Transmitter nearest to the RF Amplifier being measured.

c. With the insulated extended tip securely fastened to the X10 scope probe, insert the tip of the probe through the rectangular cutout and touch TP3 (left side) which is located in front of the heatsink.

d. Make the measurement while holding the scope probe tip on TP3 and be careful not to touch other parts of the circuit.

e. Make the same measurement on TP4 (left side).

6.7.2 Measuring RF Drive Phasing

Remember that there are two sections of each RF Amplifier module and each section has an individual drive signal fed into it. Measure the RF Drive Phase using the same procedure and precautions as above.

a. Scope Setup - set the scope on DC coupled, 5V per division and the trace is at center of the screen. Connect the external sync of the scope to J6 on the External RF Interface Board and make sure the scope sync is set to External. Adjust the horizontal vernier on the scope so that one full RF cycle occupies 7.2 divisions on the screen. Each division now equals 50 degrees of phase shift. Using the Horizontal positioning and triggering level on the scope place the zero crossing of the waveform on the center crossing of the vertical and horizontal lines of the scope. Increase the vertical sensitivity of the scope to expand the waveform. Switch the scope to the X10 position and readjust the horizontal position so that the RF transition again crosses the center line of the scope. This will be the reference for the phase measurements. If another RF Amp transition occurs at the first large division on the left, this amplifier is operating at 5 degrees lagging from the reference.

b. Now that a reference phase has been established, without changing any of the scope settings, move the scope probe to the desired RF Amp to be measured. It is usually a good idea to first measure the drive phase of the Steps 1-6A then set your reference phase to the module that is typical of the six. There may be 4 modules operating at near the same phase and the other two may a few degrees off.

c. Again set the reference to the most common phase. Also note that there will be some phase difference between the A side and B side of the same module, but typically the A sides of the RF Amps should all line up as well as all the B sides should be within specifications. Typically there may be 2 to 4 degrees difference between A and B sides and there should be no more than +/-4 degrees difference between all the A sides when referenced to an A side. +/-4 degrees is also maximum phase difference between B sides when referenced to a B side. Also keep the ground lead of the probe close to the RF Amplifier being measured.

6.7.3 Measuring RF Drain Waveform And Phase

6.7.3.1 Measuring RF Drain Waveform

Remember that there are two sections of each RF Amplifier and each will have an individual drain signal at the output.

NOTE

When measuring RF Amplifier drain waveform, the amplifier to be measured must be turned "ON" to give a correct measurement. There will be no drain waveform from an "OFF" amplifier. LED indicators DS3 will illuminate GREEN when an amplifier is on.

NOTE

For maximum protection of personnel it is recommended to use scope probe (610-1131-000) or equivalent X10 scope probe to access this point since the long tip will reach through the air slots in the inner door.

a. Connect the probe to the scope set up to measure an RF waveform at approximately 250Vp-p, and ensure that the scope case is properly grounded.

b. Connect the ground clip of the probe to the edge of the inner front door of the Transmitter nearest to the RF Amplifier being measured.

c. With the insulated extended tip securely fastened to the X10 scope probe, insert the tip of the probe through the rectangular cutout and touch TP1 which is located in front of the heatsink.

d. Make the measurement while holding the scope probe tip on TP1 and be careful not to touch other parts of the circuit.

e. Make the same measurement on TP2.

6.7.3.2 Measuring RF Drain Phasing

Remember that there are two sections of each RF Amplifier module and each has an individual drive signal fed into it. Measure the RF Drain Phase using the same procedure and precautions as above.

a. Scope Setup - set the scope on AC coupled, 50V per division, and center the trace on the screen.

b. Measure RF Drain Phase using the same procedure found in paragraph "Measuring RF Drive Phasing" in this section.

6A.1 Introduction

The following section is intended to make the maintenance personnel aware of some of the bypass modes of operation that are possible in the Transmitter. If certain failures occur, it is possible to temporarily bypass the source of the problem and remain operational at the highest possible power level until proper maintenance can be performed.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5

6A.2 RF System Bypassing

6A.2.1 Buffer/Predriver Failure

The transmitter is equipped with two Buffer/Predriver Amplifiers. Normally Buffer/Predriver A is selected for operation.

6A.2.1.1 Select Buffer/Predriver B

To select Buffer/Predriver Amplifier B, move S1 on the Driver Encoder A7 (See VIEW 2) to the B position or provide the correct control input.

6A.2.2 Driver Amplifier Failure

The Transmitter is equipped with an AGC system and depending upon the transmitter's frequency, Drivers D8-D10 may also be used as spares.

6A.2.3 Driver Failure

If a single Driver fails, the Driver Encoder turns on one of the AGC Drivers D11-D14.

If two Drivers fail, the Driver Encoder will turn on another AGC Driver, if available.

NOTE:
For specific information on the Driver Encoder board see Section E of this manual.

If three or more Drivers fail, all AGC Drivers may be turned on and the reamining drive power may not be sufficient to maintain the proper RF drive level. The transmitter may turn OFF due to a Low Drive Fault. After using the Troubleshooting Section to determine the location of the failed Drivers it is possible to:

6A.2.3.1 Utilize Spare Drivers, if available

There are 14 Driver Amplifiers which are categorized as follows:

Fixed Frequency Application

D1 - D10	Manually Selectable
D11 - D14	AGC Selectable

Depending upon the carrier frequency, one or more of the D1 - D10 amplifiers may not be used. On the Driver Encoder, for Drivers not in use, their associated "Command ON / OFF" jumper has been removed (one jumper per module using either JP2 for D1 - D6, or JP3 for D7 - D10).

NOTE:
Any such jumpers removed during factory testing will be in a plastic bag secured to one of the Driver Encoder mounting posts.

Installing any of these factory removed jumpers will activate the associated Driver.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

6A.2.3.2 Change RF Amplifier/Driver Positions

If additional Drivers are required, they can be switched with the highest Big Step RF Amplifiers. RF220 should be used first, RF219 second, and so on.

6A.2.4 Big Step RF Amplifier Failure

FLEXPATCH

Flexpatch is a method of substituting a failed Big Step RF Amplifier's turn on/off control line with one of the Programmable Big Steps. There are seven Programmable Big Steps in the Transmitter, their locations are:

a. EPAC Compartment, the very bottom left and right amplifier slots. Normally programmed to be Big Steps RF 214(L) by Modulation Encoder A31 and RF215(R) by Modulation Encoder A30.
b. Left Compartment, the very bottom left and right amplifier slots. Normally programmed to be Big Steps RF 216(L) by Modulation Encoder A29 and RF217(R) by Modulation Encoder A28.
c. Center Compartment, the very bottom left and right amplifier slots. Normally programmed to be Big Steps RF 218(L) by Modulation Encoder A27 and RF219(R) by Modulation Encoder A26.

d. Right Compartment, the very bottom right amplifier slot. Normally programmed to be Big Step RF220(R) by Modulation Encoder A25.

These Programmable Steps are the seven highest steps in the transmitter. If they are substituted for lower steps, only a slight reduction in positive peak modulation will occur.

To substitute a failed step, the gold jumper for the step will have to be removed and the switch positions on S7 and S8 will have to be reset on the Modulation Encoder controlling the highest available RF Amplifier.

USING FLEXPATCH

a. Example - Step 9 has failed AND no other RF Amplifiers have been patched.

   The Modulation Encoder for this step is A29 (See VIEW 5), refer to VIEW 20 for the following discussion.

   1. The gold jumper for Step 9 is P3-7, as shown on the right side of P3. Carefully remove this jumper.
   2. Then, going to Mod Encoder A25 and using the FLEXCODE chart, rotate S7 from 12 to 9 and rotate S8 from 13 to 0.
   3. Now the Step that was RF220 is effectively Step 9.

b. Example - Step 133 has failed AND RF220 has already been patched for a previous module failure.

   The Modulation Encoder for this step is A25 (See VIEW 2), refer to VIEW 24 for the following discussion.

   1. The gold jumper for Step 133 is P1B-8, as shown on the right side of P1B. Carefully remove this jumper.
   2. Then, going to Mod Encoder A26 and using the FLEXCODE chart, rotate S7 from 11 to 5 and rotate S8 from 13 to 8.
   3. Now the Step that was RF219 is effectively Step 133.

6A.3 Audio/Digital Modulation System Bypassing

6A.3.1 Analog Input Bypassing

On the Analog Input board, three types of bypassing are possible without compromising Transmitter protection. They are as follows:

6A.3.1.1 Power Control

If it has been determined that the HIGH, MED, and LOW power level control is not operating properly, a fourth Bypass Power Level control can be made operational as follows:

a. Apply an RF Mute with S1 on the Controller and turn the Transmitter on HIGH.

b. Move JP4 from the Normal position of 2-3 to the Bypass position of 2-1.

c. Turn R68 Bypass Power Level fully counterclockwise.

d. Remove the RF Mute and adjust R68 to the desired power level.

NOTE

R68 can adjust the power level from 10 to 200 kW. If the power level needs to be changed while in the Bypass mode, it must be done manually by adjusting R68.

CAUTION

WHILE OPERATING IN THE BYPASS MODE, DO NOT SWITCH TO THE MEDIUM OR LOW POWER LEVELS - THE MODULATION MONITOR SAMPLE WILL BE MUCH HIGHER AND COULD POSSIBLY DAMAGE SOME EQUIPMENT.

6A.3.1.2 Fine Power Control

If it has been determined that the Fine Power Control is not operating properly, it can be bypassed as follows:

a. Turn off the Main Breaker for the Low Voltage Power Supplies.

b. Move P6 from the Normal position of 2-3 to the Bypass position of 2-1.

c. Turn on the Transmitter at the desired power level.

NOTE

To make fine adjustments to the power level, use R66 for LOW, R67 for MED, and R65 for HIGH.

6A.3.1.3 Correction

If it has been determined that the Correction signal is causing Power Block problems, it can be bypassed as follows:

a. Turn off the circuit breakers for the Low Voltage Power Supply Assembly, A56CB1 and A56CB2.

b. Move JP5 from the Normal position of 2-1 to the Bypass position of 2-3.

c. Turn on the Transmitter at the desired power level.

NOTE

It may be necessary on adjustments to readjust the power level with the Raise/Lower control.

6A.3.2 Modulation Encoder Bypass

If a Modulation Encoder has generated a Supply Fault that has turned off the Transmitter, it is possible to bypass the encoder and operate at a lower power level. The amount of power reduction depends upon the failed encoder.

After using the Troubleshooting Section to determine the location of the encoder to bypass:

a. Turn off the circuit breakers for the Low Voltage Power Supply Assembly, A56CB1 and A56CB2.

b. Move the jumper plug on the encoder from the Normal position J13 and place it in the Bypass position J12.

NOTE

To remove the jumper, grasp the ends while pressing on the outside tabs and pull the jumper straight out. To reinstall the jumper, simply aligning and press straight in until the tabs click when they are properly seated.

c. Turn on the circuit breakers again, and operate the Transmitter at the reduced power level.

NOTE:

If an Encoder has failed, it is still possible to bypass the board and run full power with a lower level of modulation to prevent distortion.

6A.3.3 Changing Modulation Encoder ROM'S

If one of the A31, A30, A29, A28, A27 or A26 encoders has failed, it is possible to bypass the board and move it's ROM determining jumpers to another Modulation encoder. This will make the other Modulation encoder control the steps of the bypassed encoder and allow higher level of carrier power and modulation before distortion due to the lost encoder.

Refer to the Modulation Encoder firing order in the drawing package.

Use the following procedure:

a. Turn off the circuit breakers for the Low Voltage Power Supply Assembly, A56CB1 and A56CB2.

NOTE:

Use an IC extraction tool or a small screwdriver to carefully pull the plug straight out of the socket without bending any of the leads.

b. Carefully remove JP1, JP2, JP4, and JP5 from the bypassed Modulation Encoder. These dip jumper plugs are labeled ME(xx) (The ME(xx) numbers vary depending upon the individual position on a specific board, as well as the Modulation Encoder board's location - See VIEWS 20-26).

c. Bypass the encoder using the procedure described earlier.

d. Replace the higher numbered ME(xx) jumper plugs with the lower number plugs.

NOTE:

Carefully align pin 1 of the jumper to pin 1 of the socket and ensure the rest of the pins are in the correct position. Push the jumper straight into the socket until all pins are seated into the socket.

This will re-assign the RF amplifiers that were on the failed Modulation Encoder to a new area in the Power Block. Modulation level or carrier power will have to be lowered since there are fewer usable RF amplifiers.

Section 7

Parts List

7

7.1 Replacable Parts List

WARNING: Disconnect primary power prior to servicing.

For table above and in tables that follow in this section the (X) or (XX) after the table title part number is the revision level of that bill of material and is for reference only.

Table 7-1 DX200, PB/XTMR LC MW - 994 9855 001 (H)

Harris PN	Description	Qty UM	Reference Designators
504 0353 000	CAP 3000PF 12KV 5% (293)	0 EA	
504 0364 000	CAP 100,000PF 3KV 5%	0 EA	
504 0374 000	CAP 2000PF 15KV 5% (293)	0 EA	
504 0400 000	CAP .047UF 5KV	0 EA	
504 0420 000	CAP 3900 PF 12KV 5% (293)	0 EA	
504 0440 000	CAP 10,000PF 8KV 5% (293)	0 EA	
504 0446 000	CAP 12,000PF 5KV 5% (293)	0 EA	
504 0454 000	CAP 1600PF 15KV 5% (293)	0 EA	
504 0523 000	CAP 22000PF 5KV 5%	0 EA	
504 0525 000	CAP, MICA, .039UF 5KV 5%	0 EA	
504 0531 000	CAP 30,000PF 3KV 5% (293)	0 EA	
516 1031 000	CAP HV 1500PF 20KV 5%	0 EA	
516 1032 000	CAP HV 2000PF 14KV 5%	0 EA	
817 2311 130	FAMILY TREE DX200LC PB/XMTR	0 DWG	
817 2413 483	VIEWS, COMPONENT LOCATION,	0 DWG	
817 2413 931	COMPONET LOCATION VIEWS, DX200LC	0 DWG	
839 8154 698	FD CHART, 200KW PB, LIQ	0 DWG	
843 5492 198	FAMILY TREE, RECTIFIER CABINET	0 DWG	
843 5523 523	OUTLINE DWG, LIQUID RECTIFIER	0 DWG	
843 5523 672	SCH, RECTIFIER CABINET	0 DWG	
843 5547 102	SCH, OVERALL DX200LC XMTR	0 DWG	
843 5578 244	OUTLINE, DX200LC XMTR	0 DWG	
917 2332 841	KIT, SYSTEM CABLE, XMTR, LIQ	0 EA	
917 2413 264	STRAP, CAP COND.	0 EA	#1C001
939 7930 169	INDUCTOR	0 EA	
939 8154 220	STRAP,INDUCTOR CONNECTING	0 EA	
939 8154 221	STRAP,INDUCTOR CONNECTING	0 EA	#3L1
939 8154 227	INDUCTOR	0 EA	
943 5450 992	PLATE, C1/C2 CAP MOUNTING	0 EA	#3C1A,#3C2A
943 5450 993	STRAP, C1 TO C1A	0 EA	#3C1,#3C1A
943 5450 994	STRAP, C2 TO C2A	0 EA	#3C2,#3C2A
943 5451 292	STRAP, C1 TO C1A	0 EA	#3C1,#3C1A
943 5451 293	STRAP, C2 TO C2A	0 EA	#3C2,#3C2A
943 5451 294	STRAP, C1/C2	0 EA	#3C1A,#3C2A
943 5451 295	STRAP, C1/C2	0 EA	#3C1A,#3C2A
989 0099 001	PKG CHECK LIST, DX200PBLM	1 EA	
990 1147 001	*KIT, R-SK-DX200PBLM REC S/C	0 EA	
992 7285 060	KIT, XMTR UNIQUE PARTS MW	0 EA	
992 9074 001	PWB, RF AMPLIFIER 3X LC	3 EA	
992 9263 001	KIT, DC CABLE TOP ENTRY	0 EA	
992 9263 002	KIT,DC CABLE BOTTOM ENTRY	0 EA	
992 9263 003	KIT, DC CABLE SIDE ENTRY	1 EA	
992 9266 002	KIT, SPARE HARDWARE,	1 EA	
992 9267 001	KIT, INSTALLATION,DX HIGH	1 EA	
992 9764 285	DISC SW, 1+1 LOCKS, 16A, NEUT		
994 9740 202	KIT, DX200 XTMR LC MW BRDS	0 EA	
994 9741 001	*KIT,R-PK-DX200PBLM REC PARTS	0 EA	
992 9764 321	ACC+ KIT	1 EA	
994 9855 002	BASIC, PB/XTMR LC MW	1 EA	
512 0325 000	CAP 1000PF 15KV TEST	0 EA	

512 0350 000	CAP VAC 2000PF 15KV	0 EA	
917 2413 521	STRAP, CAP	0 EA	
922 1238 022	STRAP, CAP CONNECTING	0 EA	#3C1,#3C2
939 8154 216	STRAP, CAPACITOR	0 EA	#3C1A,#3C2A
943 5450 364	PLATE, CAPACITOR MTG.	0 EA	

Table 7-2 KIT, XMTR UNIQUE PARTS MW - 992 7285 060 (N)

Harris PN	Description	Qty UM	Reference Designators
358 3582 000	STDOFF, 1/4 HEX 6-32 X 5/8 M/F	3 EA	USED TO MT PCB A002
614 0056 000	TERM BLK, 2ROW 12-TERM 20A	3 EA	1TB3
917 2180 071	CABLE, OSC RF MUTE	1 EA	
917 2332 727	CABLE PKG, STAND-ALONE XMTR	1 EA	
922 1204 008	CABLE, RIBBON	1 EA	
939 8154 171	PLATE, PLC MTG.	1 EA	
943 5293 261	ASSY, CABINET TRIM	1 EA	
917 2413 942	VIEWS LOCATION LABEL	1 EA	
939 8154 708	VIEWS SUB-ASSEMBLY LABEL	1 EA	
943 5492 258	ASSY, RECTIFIER CABINET TRIM	1 EA	
943 5523 518	DX 200 CABINET TRIM	1 EA	
988 2001 909	DP, DX200LC TRANSMITTER	0 EA	
992 7285 062	CABLE, OSC & OSC INTERFACE	1 EA	
992 8069 004	PWA, OSCILLATOR, AUTO	1 EA	
992 8195 001	PWA, OSC INTERFACE	1 EA	
992 9820 002	CABINET, OUTPUT NETWORK	1 EA	
994 9855 205	KIT, OMC, XMTR	1 EA	
994 9855 206	TOP ONC DX200 AIR COOL MW	1 EA	

Table 7-3 PWA, OSCILLATOR, AUTO - 992 8069 004 (I--)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	18 EA	E001,E002,E003,E004,TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP0010,TP0011,TP0012,TP0013,TP0014
358 2399 000	STUD, PC BD 4-40 X 1/2	2 EA	#Y001,#Y002
380 0083 000	*XSTR, 2N2369 (TO-18)	8 EA	Q001,Q002,Q003,Q004,Q005,Q006,Q007,Q010
380 0125 000	XSTR, NPN 2N4401 ESD	2 EA	Q008,Q009
382 0130 000	IC, IL74/MCT2	1 EA	U010
382 0360 000	IC, LM7915C (TO-220)	1 EA	U006
382 0581 000	IC, 74LS123 ESD	1 EA	U007
382 0708 000	*IC, 74LS86 ESD	1 EA	U009
382 0783 000	IC, 74HC76 ESD	2 EA	U001,U002
382 1010 000	IC, DS0026CN/MMH0026CP1 ESD	3 EA	U003,U005,U11
382 1077 000	IC 301 ANALOG SWITCH SPDT ESD	2 EA	U004,U008
384 0205 000	*DIODE, RECT 1N4148/914	9 EA	CR002,CR003,CR006,CR007,CR008,CR009,CR010,CR014,CR015
384 0431 000	*DIODE, RECT 1N4001	1 EA	CR005

WARNING: Disconnect primary power prior to servicing.

384 0679 000	LED, YEL T1-3/4 VERT	1 EA	DS1
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	1 EA	CR018
386 0082 000	*ZENER 1N4744A 15V 5% 1W	1 EA	CR001
386 0093 000	*ZENER 1N4728A 3.3V 5% 1W	2 EA	CR011,CR012
386 0135 000	*ZENER 1N4733A 5.1V 5% 1W	1 EA	CR004
386 0429 000	*ZENER 1N5346B 9.1V 5% 5W	1 EA	CR013
398 0015 000	FUSE,FAST CART .500A 250V	1 EA	F002
398 0017 000	FUSE, FAST CART 1A 250V	1 EA	F001
402 0129 000	CLIP, 1/4 DIA FUSE	4 EA	#F001,#F002
404 0513 000	HEAT SINK PA1-1CB	1 EA	#U006
404 0599 000	SOCKET, DIP, 6 PIN (DL)	1 EA	XU010
404 0673 000	SOCKET, DIP, 8 PIN (DL)	4 EA	#S001,#U003,#U005,#U011
404 0674 000	SOCKET, DIP, 14 PIN (DL)	3 EA	XU004,XU008,XU009
404 0675 000	SOCKET, DIP, 16 PIN (DL)	3 EA	XU001,XU002,XU007
404 0790 000	HEATSINK, 8-PIN DIP	1 EA	#U003
414 0087 000	BEAD FERRITE SHIELD	2 EA	L001,L002
492 0889 002	IND, VAR 1.27-3.25UH, 44Q MIN	1 EA	
494 0196 000	INDUCTOR, 100UH 10% (9250)	1 EA	L003
500 0756 000	CAP MICA 330PF 500V 5%	1 EA	C040
500 0761 000	CAP MICA 150PF 500V 5%	1 EA	C007
500 0812 000	CAP MICA 30PF 500V 5%	2 EA	C002,C004
500 0837 000	CAP MICA 510PF 500V 5%	1 EA	C005
500 0838 000	CAP MICA 560PF 300V 5%	1 EA	C041
500 0841 000	CAP MICA 750PF 300V 5%	1 EA	C042
500 0888 000	CAP, MICA, 3900PF 500V 5%	1 EA	C037
500 0912 000	CAP, MICA, 820PF 500V 5%	1 EA	C044
506 0230 000	CAP 1000PF 5% 100V	9 EA	C013,C014,C017,C018,C027, C029,C030,C047,C049
506 0232 000	CAP 0.010UF 5% 100V	2 EA	C009,C019
506 0234 000	CAP 2200PF 5% 100V	1 EA	C031
506 0236 000	CAP 4700PF 5% 100V	2 EA	C012,C032
506 0237 000	CAP 6800PF 5% 100V	1 EA	C033
506 0246 000	CAP 0.470UF 5% 63V	1 EA	C006
516 0375 000	*CAP 0.010UF 20% 50V Z5U	2 EA	C023,C024
516 0453 000	CAP 0.100UF 10% 100V X7R	17 EA	C011,C015,C016,C020,C021, C026,C028,C034,C035,C038, C043,C045,C046,C051,C052, C053,C054
516 0516 000	CAP 1UF 100V 20%	1 EA	C048
516 0725 000	CAP 1.0UF 50V 20%	1 EA	C050
516 0736 000	CAP 1000PF 10% 100V X7R	1 EA	C039
520 0439 000	CAP, AIR VAR 2.4-24.5PF, 500V	2 EA	C001,C003
522 0531 000	CAP 1UF 50V 20% 5MM NON-POLAR	2 EA	C022,C025
526 0342 000	CAP 2.7UF 35V 10%	2 EA	C008,C036
526 0358 000	CAP 22UF 35V 10%	1 EA	C010
540 1600 111	RES 27 OHM 3W 5%	1 EA	R039
540 1600 209	RES 220 OHM 3W 5%	4 EA	R011,R012,R076,R078
540 1600 212	RES 300 OHM 3W 5%	2 EA	R006,R007
546 0295 000	RES, WW, 50 OHM 3W 5% (AXIAL)	5 EA	R013,R017,R031,R037,R038
548 2400 126	RES 18.2 OHM 1/2W 1%	2 EA	R066,R067
548 2400 130	RES 20 OHM 1/2W 1%	1 EA	R003

548 2400 169	RES 51.1 OHM 1/2W 1%	4 EA	R029,R040,R041,R054
548 2400 193	RES 90.9 OHM 1/2W 1%	4 EA	R055,R056,R057,R058
548 2400 201	RES 100 OHM 1/2W 1%	3 EA	R022,R025,R051
548 2400 230	RES 200 OHM 1/2W 1%	2 EA	R036,R042
548 2400 239	RES 249 OHM 1/2W 1%	1 EA	R072
548 2400 242	RES 267 OHM 1/2W 1%	1 EA	R004
548 2400 285	RES 750 OHM 1/2W 1%	2 EA	R009,R035
548 2400 301	RES 1K OHM 1/2W 1%	14 EA	R005,R015,R016,R026,R027, R028,R030,R032,R044,R053, R059,R060,R061,R062
548 2400 326	RES 1.82K OHM 1/2W 1%	1 EA	R049
548 2400 334	RES 2.21K OHM 1/2W 1%	2 EA	R008,R023
548 2400 341	RES 2.61K OHM 1/2W 1%	1 EA	R047
548 2400 366	RES 4.75K OHM 1/2W 1%	2 EA	R010,R034
548 2400 368	RES 4.99K OHM 1/2W 1%	1 EA	R070
548 2400 373	RES 5.62K OHM 1/2W 1%	3 EA	R024,R050,R052
548 2400 401	RES 10K OHM 1/2W 1%	10 EA	R019,R021,R033,R043,R045, R063,R071,R073,R074,R077
548 2400 430	RES 20K OHM 1/2W 1%	1 EA	R014
548 2400 458	RES 39.2K OHM 1/2W 1%	1 EA	R001
548 2400 501	RES 100K OHM 1/2W 1%	4 EA	R046,R065,R068,R069
548 2400 601	RES 1MEG OHM 1/2W 1%	3 EA	R002,R018,R020
550 0858 000	TRIMPOT 5K OHM 1/2W 10%	1 EA	R048
550 0961 000	TRIMPOT 50K OHM 1/2W 10%	1 EA	R064
558 0041 000	OVEN, XTAL HC6/U 19VDC	2 EA	#Y001,#Y002
559 0053 000	THERMISTOR, NTC 10K OHM 1%	1 EA	RT001
560 0121 003	POSISTOR 0.2 AMP 60VDC 8MM DISC	1 EA	R075
604 0852 000	SW, RKR DIP 4-SPST	1 EA	S001
610 0679 000	PLUG, SHORTING, .25" CTRS	7 EA	P001,P002,P004,P005,P006,P 007,P008
610 0877 000	HDR, 2C VERT 1ROW UNSHR	3 EA	JP4,JP5,JP6
610 0900 000	HDR, 3C VERT 1ROW UNSHR	1 EA	JP1
610 0979 000	*HDR 10C 2ROW VERT TOP LATCH	1 EA	J007
610 0999 000	HDR, 10 PIN, PC BD	2 EA	J001,J004
610 1110 000	HDR, 8C VERT 2ROW UNSHR	1 EA	JP2
610 1455 000	HDR, 3C VERT 1ROW FRICTION	1 EA	J003
612 0904 000	JACK, PC MT GOLD PLATED	21 EA	
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	3 EA	XJP1,XJP2,XJP4
612 1206 000	JACK, PC MT FOR .050 PINS	4 EA	#Y001,#Y002
614 0909 000	TERM BLK, PCB, 3-POLE, GREY (237)	2 EA	J6,J8
620 1677 000	JACK, BNC STRAIGHT PCB	2 EA	J002,J005
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
829 9009 051	BRACKET, OSC. HEATER	2 EA	
843 5155 851	SCH, OSCILLATOR, AUTO	0 DWG	
843 5155 853	PWB, OSCILLATOR	1 EA	
999 2450 002	HARDWARE LIST	1 EA	

Table 7-4 PWA, OSC INTERFACE - 992 8195 001 (K)

Harris PN	Description	Qty UM	Reference Designators
300 1486 000	SCREW, PHMS 4-40 X 3/8 BRASS	2 EA	1/U003 1/U004
304 0087 000	NUT, HEX 4-40	2 EA	1/U003 1/U004
308 0003 000	*WASHER, FLAT #4 BRASS (ANSI NARROW)	2 EA	1/U003 1/U004
312 0045 000	LOCKWASHER, SPLIT #4 PH-BRZ (ANSI)	2 EA	1/U003 1/U004
354 0309 000	TERM SOLDER	16 EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016
358 1726 000	SPRING, HOLD DOWN	1 EA	#K001
358 1928 000	JUMPER 1/4 LG 1/8H	1 EA	P054
380 0083 000	*XSTR, 2N2369 (TO-18)	1 EA	Q002
380 0125 000	XSTR, NPN 2N4401 ESD	1 EA	Q001
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	U003
382 0359 000	IC, LM340/LM7815C (TO-220)	1 EA	U004
382 1084 000	IC, LP339 (DIP-14)	1 EA	U002
382 1204 000	IC TC4423 ESD	1 EA	U001
384 0321 000	*DIODE, SCHOTTKY, 5082-2800	2 EA	CR004,CR005
384 0431 000	*DIODE, RECT 1N4001	3 EA	CR002,CR009,CR010
384 0612 000	DIODE 1N3070 ESD	1 EA	CR008
384 0661 000	LED, GRN T1-3/4 RTANG	4 EA	DS001,DS002,DS003,DS004
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	1 EA	CR007
386 0082 000	*ZENER 1N4744A 15V 5% 1W	1 EA	CR003
386 0135 000	*ZENER 1N4733A 5.1V 5% 1W	2 EA	CR001,CR006
398 0015 000	FUSE,FAST CART .500A 250V	1 EA	F001
402 0129 000	CLIP, 1/4 DIA FUSE	2 EA	XF001
404 0161 000	SOCKET RELAY 4PDT PCB	1 EA	XK001
404 0513 000	HEAT SINK PA1-1CB	2 EA	#U003,#U004
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1 EA	XU001
404 0674 000	SOCKET, DIP, 14 PIN (DL)	1 EA	XU002
492 0929 016	IND, VAR 1.54-2.86UH, 65Q MIN	1 EA	L001
506 0232 000	CAP 0.010UF 5% 100V	2 EA	C009,C011
506 0233 000	CAP 0.100UF 5% 63V	1 EA	C019
506 0236 000	CAP 4700PF 5% 100V	1 EA	C007
506 0237 000	CAP 6800PF 5% 100V	1 EA	C008
506 0238 000	CAP 0.015UF 5% 100V	1 EA	C010
516 0453 000	CAP 0.100UF 10% 100V X7R	7 EA	C002,C003,C004,C005,C006,C013,C018
516 0530 000	CAP 0.010UF 10% 100V X7R	3 EA	C015,C016,C017
522 0548 000	CAP 10UF 50V 20% (5X11)	1 EA	C001
540 0563 000	*RES 10 OHM 2W 10%	1 EA	R019
540 1380 000	RES NETWORK 10K OHM 2%	4 EA	R008,R009,R011,R017
546 0295 000	RES, WW, 50 OHM 3W 5% (AXIAL)	1 EA	R023
548 2400 169	RES 51.1 OHM 1/2W 1%	1 EA	R006
548 2400 201	RES 100 OHM 1/2W 1%	1 EA	R002
548 2400 242	RES 267 OHM 1/2W 1%	1 EA	R003
548 2400 251	RES 332 OHM 1/2W 1%	1 EA	R016
548 2400 269	RES 511 OHM 1/2W 1%	1 EA	R004
548 2400 285	RES 750 OHM 1/2W 1%	1 EA	R005
548 2400 301	RES 1K OHM 1/2W 1%	3 EA	R007,R014,R015

548 2400 318	RES 1.5K OHM 1/2W 1%	1 EA	R018
548 2400 334	RES 2.21K OHM 1/2W 1%	2 EA	R021,R022
548 2400 401	RES 10K OHM 1/2W 1%	1 EA	R020
548 2400 434	RES 22.1K OHM 1/2W 1%	2 EA	R013,R024
548 2400 466	RES 47.5K OHM 1/2W 1%	2 EA	R010,R012
550 0947 000	TRIMPOT 1K OHM 1/2W 10%	1 EA	R001
574 0156 000	RELAY 12VDC 4PDT	1 EA	K001
604 0852 000	SW, RKR DIP 4-SPST	1 EA	S001
604 1089 000	SW, TGL SPDT VERT PCB MT	1 EA	S002
610 0679 000	PLUG, SHORTING, .25" CTRS	3 EA	P001,P002,P003
610 0978 000	*HDR 10C 2ROW RT ANG TOP LATCH	3 EA	J010,J011,J012
610 0999 000	HDR, 10 PIN, PC BD	2 EA	J003,J008
610 1106 000	HDR, 8C VERT 1ROW FRICTION	3 EA	J001,J002,J009
612 0904 000	JACK, PC MT GOLD PLATED	9 EA	XP001,XP002,XP003
620 0515 000	RECP, SCREW ON SMC	1 EA	J007
620 1677 000	JACK, BNC STRAIGHT PCB	3 EA	J004,J005,J006
839 7930 013	SCHEM, OSC INTERFACE	0 DWG	
843 5155 013	PWB, OSC INTERFACE	1 EA	

Table 7-5 CABINET, OUTPUT NETWORK - 992 9820 002 (R)

Harris PN	Description	Qty UM	Reference Designators
007 4030 023	BRZ, PH GND BAR 97-744-05	16 EA	
328 0070 000	WASHER CUPPED BLACK WEAR	4 EA	
328 0073 000	WASHER, RETAINER	4 EA	
358 1098 000	HOSE CLAMP, SST, SAE-104	1 EA	
358 1852 000	STANDOFF, HEX M/F 6-32 X 1.000 AL	4 EA	
358 3089 000	STANDOFF-MALE/FEMALE 6-32	3 EA	
358 3190 000	PLUG, WHT .500" HOLE	0 EA	
358 3236 000	DRIVE, RIGHT ANGLE GEAR	1 EA	
358 3293 000	RING RETAINING .300 ID	4 EA	
358 3325 000	STUD 1/4 TURN PHILLIPS HD	4 EA	
358 3474 000	RING RETAINING, SST, 1/2"	1 EA	
396 0217 000	LAMP, 28V 757	1 EA	
398 0456 000	FUSE, CART 0.4X1.5" 1A SLOW	6 EA	
402 0004 000	CLIP, FUSE .812 60A 250V	2 EA	
402 0130 000	FUSE HOLDER, 3 POLE	2 EA	
406 0525 000	LAMPHOLDER, BAYONET BASE	1 EA	
406 0526 000	LENS, CLEAR	1 EA	
424 0602 000	GROMMET 1-1/4 MTG DIA	2 EA	
430 0199 000	FAN BLADE, 12"DIA, 4 BLADE	2 EA	
436 0289 000	MOTOR, 1/3HP 50/60 HZ 3PH	2 EA	
448 0957 000	HINGE DOOR POSITIONING	3 EA	
448 0958 000	FILTER,AIR 11.50 X 20.25 X 0.5	6 EA	
452 0127 000	BEVEL GEAR SET, NYLON	2 EA	
456 0144 000	SPRING, EJECTOR	4 EA	
456 0146 000	SPRING EXTENSION	1 EA	
500 0846 000	CAP, MICA 8200PF 100V 5%	2 EA	C093,C094
514 0240 000	CAP, VAR 2300PF 15KV TEST	1 EA	
514 0266 000	CAP, VAR 1500PF 40KV TEST	2 EA	
514 0339 000	CAP. VAR-12-500PF 15KV	1 EA	
516 0207 000	CAP, RF, 25PF 15KV 10% NPO	1 EA	C092
516 0413 000	CAP, RF, 10PF 7.5KV 10% NPO	3 EA	

530 0006 000	FLG MTG TERM FM2B	1 EA	#3C003A
530 0007 000	FLG MTG TERM FM2D	1 EA	#3C003A
604 1026 000	SW DPDT 15A 125/250 VAC	2 EA	
620 0602 000	ADAPTER 6-1/8 IN	1 EA	
620 0638 000	FLANGE, FXD 6-1/8	1 EA	
620 1240 000	FLANGE, FIXED 4-1/16	1 EA	
620 2139 000	ADAPTER, 4-1/16"	1 EA	
646 1253 201	LABEL, WARNING	2 EA	
646 1662 030	NAMEPLATE, HARRIS	1 EA	
648 0073 000	COUNTER, HORIZ 5 POS	2 EA	
650 0303 000	KNOB ROUND .378 DIA SHAFT	2 EA	
817 2150 001	STANDOFF	6 EA	
817 2150 037	GROUNDING PLATE	3 EA	
817 2150 044	FLOW MONITOR ANGLE	1 EA	
817 2150 056	RUNNING LIST, ONC	0 DWG	
822 0922 084	STDOFF	14 EA	
822 0922 148	ANGLE BRACKET	2 EA	
822 0922 167	STDOFF	2 EA	
822 0999 020	DRIVE ANGLE	1 EA	
822 0999 027	COUPLING 3/8-3/8	4 EA	
822 0999 030	CYCLOMETER SHAFT	2 EA	
822 0999 078	SHAFT	1 EA	
822 0999 079	SHAFT	1 EA	
822 0999 080	SHAFT	1 EA	
822 0999 085	SPARK GAP BAR	1 EA	
822 0999 087	HINGE PLATE	3 EA	
822 0999 093	STRAP	1 EA	
822 0999 111	CONNECTION PLATE	1 EA	#C001
822 0999 112	STRAP C2B-A1C15, 16	1 EA	#3C007,#3C008,#3C009
822 0999 125	OUTPUT SUPPORT	1 EA	
839 7930 111	ONC REAR DOOR COVER	2 EA	
839 7930 112	ONC FAN ACCESS PLATE	1 EA	
843 5155 159	PLATE, ONC CAP MTG	1 EA	#C001A
843 5155 160	TOP CAP CONTACT PLT	1 EA	#C001A
843 5523 658	SCHEMATIC, OVERALL DX 200	0 DWG	
914 3468 003	COUPLING INS FLEXIBL	2 EA	
917 1377 003	CLIP, 150 AMP COIL	1 EA	
917 2150 063	STRAP, CAPACITOR	1 EA	
917 2150 537	WASHER	2 EA	#L001
917 2150 538	WASHER	4 EA	#L001
917 2332 151	BAR, CONDUCTOR MTG.	2 EA	
917 2332 152	SPACER, CONDUCTOR MTG.	4 EA	
917 2332 185	CABLE, WIRE #455, KOREA	1 EA	
917 2332 186	CABLE, WIRE #402, KOREA	1 EA	
917 2332 187	CABLE, WIRE #403, KOREA	1 EA	
917 2332 630	CABLE, OUTPUT CAB DX-200	1 EA	
917 2332 700	SPACER, 1.0 HEX X 1.5L 5/16-18	0 EA	
917 2332 702	SCREEN, WINDOW	1 EA	
917 2413 230	SHAFT, SWITCH HANDLE	1 EA	
917 2413 231	PLATE, SWITCH LOCKING	1 EA	
917 2413 320	INSULATOR, COIL ASSY	2 EA	
922 0965 066	SHIM, LOCK	1 EA	

922 0999 541	LT COIL MTG CHNL	2 EA	#L001
922 0999 542	BTM COIL MTG CHAN.	1 EA	#L001
922 0999 557	GND HOOK MTG ANGLE	1 EA	
922 0999 561	MODIFIED BULLET	1 EA	
922 0999 577	SUPPORT BAR MTG ANGLE	2 EA	#L001
922 1203 245	BRACKET, LOCK MTG.	1 EA	
922 1203 247	ANGLE, COIL MTG.	4 EA	
922 1203 251	ASSY, CONDUCTOR ROD	1 EA	
922 1203 254	ASSY, CROSSOVER, OUTPUT	1 EA	
922 1203 256	SPACER, OUTPUT NETWORK	1 EA	
922 1203 269	CONNECTION POST	1 EA	
922 1203 272	BRACKET, LAMP MTG.	1	
922 1203 310	CABLE, RIBBON	1 EA	
922 1203 311	CABLE RIBBON	1 EA	
922 1203 961	WINDOW, OUTPUT CABINET	1 EA	
922 1238 024	BRACKET, TRIM MTG.	2 EA	
922 1238 026	ANGLE, LOCK MTG, EPAC	3 EA	
922 1238 051	SUPPORT BAR MNTG ANGLE	8 EA	
922 1238 320	PLATE, CAP MOUNTING	1 EA	#C092
929 8440 151	CABLE, GND VIS. PA.	1 EA	
938 4203 025	ASSY GROUND HOOK	1 EA	
939 7930 059	SHELF ANGLE	1 EA	
939 7930 121	LOAD & TUNE TRIM PNL	1 EA	
939 7930 131	CYCLOMETER MTG BRKT	2 EA	
939 7930 169	INDUCTOR	1 EA	L001
939 7930 591	COND. SUPPORT BAR	1 EA	#L001
939 7930 593	INDUCTOR LEAD	1 EA	#L001
939 8058 001	PLATE 4-1/16" INPUT	1 EA	
939 8118 503	FRAME, OUTPUT SAMPLE	1 EA	
939 8118 504	COVER, OUTPUT SAMPLE BD	1 EA	
939 8118 505	UPPER SHIELD, COND ROD	1 EA	
939 8118 507	BRACKET, CAPACITOR MTG.	1 EA	
939 8118 621	BRACKET, SWITCH MTG.	1 EA	
939 8154 160	BRACKET, LOCK SPRING	1 EA	
939 8154 166	HANDLE ASSY	1 EA	
939 8154 339	ROD, GROUNDING SWITCH	1 EA	
939 8154 343	STRAP, INDUCTOR	3 EA	
939 8154 581	ANGLE, CAP SAMPLE	1 EA	#C092
939 8154 583	STRAP, INPUT	1 EA	#3C002,#L001
939 8154 584	PLATE, CAP DISTRIBUTION	1 EA	#3C004A
939 8154 586	STRAP, CAP TUBING	1 EA	#3C003
939 8154 694	PLATE, CAP SUPPORT	1 EA	#3C002,#3C003
943 5155 075	ONC BASE SHIELD	1 EA	
943 5293 250	STRAP, INDUCTOR	1 EA	
943 5293 254	PANEL, RIGHT INNER, ONC	1 EA	
943 5293 260	SHIELD, CONDUCTOR ROD	1 EA	
943 5293 261	ASSY, CABINET TRIM	1 EA	
943 5293 273	ASSY, OUTPUT CABINET	1 EA	
943 5293 417	CABLE NET E SAMPLE COAX	1 EA	
943 5293 418	CABLE RF SAMPLE	1 EA	
943 5450 400	TAB	1 EA	
943 5450 549	PANEL, FRONT	1 EA	

943 5450 550	CHASSIS, SWITCHING	1 EA	
943 5450 551	FLAP, GROUNDING	1 EA	
943 5492 182	SHELF, LOWER, OUTPUT CABINET	1 EA	
943 5492 183	SHELF, UPPER, OUTPUT CABINET	1 EA	
943 5492 201	PNL, LEFT INNER, OMC	1 EA	
943 5492 276	STIFFENER, ANGLE	1 EA	
943 5578 235	ASSY, REAR DOOR, ONC	1 EA	
943 5578 239	TOP, ONC	1 EA	
992 8363 001	AIR FLOW MONITOR	1 EA	A003
992 8677 003	PWA, ARC DETECTOR	1 EA	
992 9038 002	PWB, RF POWER SAMPLE	1 EA	
999 2665 001	HARDWARE LIST	1 EA	

Table 7-6 AIR FLOW MONITOR - 992 8363 001 (H)

Harris PN	Description	Qty UM	Reference Designators
356 0084 000	CABLE TY RAP	1 EA	
382 0428 000	*IC, LM358 (DIP-8)	1 EA	U003
382 1199 000	IC, LM35 ESD	1 EA	U002
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1 EA	XU003
516 0453 000	CAP 0.100UF 10% 100V X7R	6 EA	C001,C002,C003,C006,C007, C008
526 0050 000	CAP 1UF 35V 20%	2 EA	C004,C005
544 1662 000	RES 30 OHM 20W 1% TO-220	1 EA	R001
548 2400 142	RES 26.7 OHM 1/2W 1%	1 EA	R008
548 2400 185	RES 75 OHM 1/2W 1%	2 EA	R004,R005
548 2400 501	RES 100K OHM 1/2W 1%	2 EA	R003,R006
548 2400 589	RES 825K OHM 1/2W 1%	2 EA	R002,R007
610 0978 000	*HDR 10C 2ROW RT ANG TOP LATCH	1 EA	J001
839 7930 022	SCHEM, AIR FLOW MON	0 DWG	
843 5155 022	PWB, AIR FLOW MON	1 EA	
917 2542 001	ASSY, AIR SENSOR	1 EA	#R001,U001
999 2657 001	HARDWARE LIST	1 EA	

Table 7-7 PWA, ARC DETECTOR - 992 8677 003 (C--)

Harris PN	Description	Qty UM	Reference Designators
335 0244 000	WASHER, SHLDR 5/16 SCREW	1 EA	#R001
358 1928 000	JUMPER 1/4 LG 1/8H	2 EA	JP001,JP002
516 0453 000	CAP 0.100UF 10% 100V X7R	4 EA	C001,C002,C003,C004
548 2400 142	RES 26.7 OHM 1/2W 1%	2 EA	R003,R004
610 0978 000	*HDR 10C 2ROW RT ANG TOP LATCH	1 EA	J001
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
670 0056 000	RESISTOR-PHOTO, UV SENSITIVE	1 EA	R001
839 7930 517	SCHEM, ARC DETECTOR BD	0 DWG	
843 5155 517	PWB, ARC DETECTOR	1 EA	

Table 7-8 PWB, RF POWER SAMPLE - 992 9038 002 (B--)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	6 EA	TP011,TP012,TP013,TP014,TP015,TP016
356 0106 000	CABLE CLAMP, NYLON 0.500" DIA	4 EA	
358 1928 000	JUMPER 1/4 LG 1/8H	1 EA	JP016
384 0612 000	DIODE 1N3070 ESD	7 EA	CR001,CR002,CR003,CR004,CR008,CR010,CR012
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	2 EA	CR021,CR022
386 0123 000	*ZENER 1N4732A 4.7V 5% 1W	1 EA	CR013
386 0430 000	*ZENER 1N5365B 36V 5% 5W	2 EA	CR005,CR006
492 0775 000	IND, FXD RF, 100MH	2 EA	L002,L003
494 0391 000	INDUCTOR, 3.90UH 10% (9250)	1 EA	L001
494 0413 000	INDUCTOR, 330UH 10% (9250)	1 EA	L005
500 0759 000	CAP MICA 100PF 500V 5%	1 EA	C011
500 0784 000	CAP MICA 300PF 500V 5%	2 EA	C029,C093
500 0829 000	CAP MICA 180PF 500V 5%	1 EA	C013
500 0837 000	CAP MICA 510PF 500V 5%	1 EA	C002
500 0840 000	CAP MICA 680PF 300V 5%	2 EA	C008,C016
500 0845 000	CAP, MICA, 2000PF 500V 5%	1 EA	C001
500 0852 000	CAP, MICA, 1000PF 500V 5%	1 EA	C005
500 0883 000	CAP, MICA, 4700PF 500V 5%	1 EA	C014
500 0913 000	CAP, MICA, 1200PF 500V 5%	2 EA	C010,C021
500 1201 000	CAP, MICA, 2400PF 500V 5%	1 EA	C012
500 1375 000	CAP, MICA VAR 300-1000PF 175V	4 EA	C015,C017,C018,C019
516 0453 000	CAP 0.100UF 10% 100V X7R	2 EA	C031,C094
516 0792 000	CAP NETWORK .1UF 10%	1 EA	C020
526 0094 000	CAP 0.1UF 50V 10%	1 EA	C030
540 1365 000	RES NETWORK 36 OHM 2%	1 EA	R076
540 1600 122	RES 75 OHM 3W 5%	2 EA	R006,R007
540 1600 124	RES 91 OHM 3W 5%	2 EA	R003,R004
548 2400 069	RES 5.11 OHM 1/2W 1%	1 EA	R010
548 2400 137	RES 23.7 OHM 1/2W 1%	1 EA	R026
548 2400 330	RES 2K OHM 1/2W 1%	1 EA	R123
548 2400 389	RES 8.25K OHM 1/2W 1%	2 EA	R008,R012
548 2400 451	RES 33.2K OHM 1/2W 1%	1 EA	R022
548 2400 466	RES 47.5K OHM 1/2W 1%	2 EA	R018,R019
600 0579 000	SW, ROTARY 4PDT	2 EA	S001,S003
604 0859 000	SW, TGL DPDT	2 EA	S007,S008
604 0866 000	SWITCH, PB SPDT MOM RTANG	1 EA	S002
604 1064 000	SWITCH, ROCKER DIP 2-SPST	1 EA	S004
610 0679 000	PLUG, SHORTING, .25" CTRS	1 EA	JP003
610 0750 000	TEST PROBE, TYPE C	4 EA	TP002,TP003,TP005,TP007
612 0904 000	JACK, PC MT GOLD PLATED	3 EA	
612 1350 000	JACK, SMB STRAIGHT PCB	3 EA	J001,J002,J003
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
843 5458 111	SCH, RF POWER SAMPLE BD	0 DWG	
843 5458 113	PWB, RF POWER SAMPLE	1 EA	
916 6270 001	XMFR COIL ASSY	2 EA	T002,T004
917 2150 656	SENSING PLATE	3 EA	C006,C007,C009

917 2413 455	STANDOFF, 0.375 X 3.25 X	3 EA	C006,C007,C009
922 0999 679	XFMR MTG SHIELD	2 EA	#T002,T004
929 9009 216	XFMR	1 EA	T001
999 2826 001	HARDWARE LIST, RF POWER	1 EA	

Table 7-9 PWB, RF AMPLIFIER 3X LC - 992 9074 001 (AA-)

Harris PN	Description	Qty UM	Reference Designators
328 0071 000	WASHER, STEEL COMPRESSION	8 EA	
354 0309 000	TERM SOLDER	5 EA	TP001,TP002,TP003,TP004,TP005
354 0846 000	TERMINAL, SOLDER	2 EA	
380 0126 000	XSTR, PNP 2N4403 ESD	2 EA	Q017,Q018
380 0653 000	XSTR, NPN MPS6602 ESD	2 EA	Q009,Q010
380 0708 000	XSTR MPS6652 40V 1A ESD	4 EA	Q011,Q012,Q013,Q014
380 0712 000	XSTR, NPN 2N6718 ESD	2 EA	Q015,Q016
380 0722 000	XSTR IRFP360 ESD	8 EA	Q001,Q002,Q003,Q004,Q005,Q006,Q007,Q008
384 0253 000	DIODE, RECT 1N4007	4 EA	CR011,CR012,CR017,CR018
384 0612 000	DIODE 1N3070 ESD	2 EA	CR019,CR020
384 0661 000	LED, GRN T1-3/4 RTANG	1 EA	DS003
384 0802 000	DIODE, TVS (BIDIR), P6KE18CA ESD	4 EA	CR001,CR002,CR003,CR004
384 0803 000	RECT MUR-120 200V ESD	8 EA	CR007,CR008,CR009,CR010,CR015,CR016,CR021,CR022
384 0810 000	LED, RED T1 RTANG	2 EA	DS001,DS002
384 0817 000	RECT, SCHOTTKY, CRSH2-3 ESD	2 EA	CR005,CR006
386 0100 000	*ZENER 1N4747A 20V 5% 1W	1 EA	CR025
398 0465 000	FUSE, FAST CART 2A 250V	2 EA	F003,F004
398 0556 000	FUSE, FAST 8 AMP 600V	2 EA	F001,F002
402 0194 000	FUSE CLIP, 13/32", 30 AMP, PCB MT	4 EA	
402 0198 000	CLIP, FUSE 5MM DIA FUSE	4 EA	
410 0427 000	THERMAL INTERFACE 1.9 X 2.432	2 EA	
410 0440 000	INSULATOR PAD FOR TO-247,	8 EA	
414 0280 000	FERRITE TOROID, LINER	8 EA	#Q001,#Q002,#Q003,#Q004,#Q005,#Q006,#Q007,#Q008
414 0343 000	FERRITE TOROID, 0.155 OD	4 EA	#Q005,#Q006,#Q007,#Q008
494 0249 000	CHOKE 10UH 5% AXIAL	6 EA	L001,L002,L003,L004,L005,L006
494 0404 000	INDUCTOR, 33.0UH 10% (9250)	1 EA	L011
500 0754 000	CAP MICA 220PF 500V 5%	0 EA	C009,C010
500 0759 000	CAP MICA 100PF 500V 5%	0 EA	C009,C010
500 0784 000	CAP MICA 300PF 500V 5%	0 EA	C009,C010
500 0787 000	CAP MICA 200PF 500V 5%	0 EA	C009,C010
500 0834 000	CAP MICA 430PF 500V 5%	0 EA	C009,C010
500 0839 000	CAP MICA 680PF 300V 5%	0 EA	C009,C010
500 0842 000	CAP MICA 820PF 300V 5%	0 EA	C009,C010
500 0844 000	CAP MICA 1000PF 100V 5%	0 EA	C009,C010
500 1164 000	CAP, MICA, 1800PF 500V 5%	2 EA	C005,C006

506 0235 000	CAP 3300PF 5% 100V	2 EA	C021,C022
506 0239 000	CAP 0.022UF 5% 100V	2 EA	C011,C012
506 0240 000	CAP 0.033UF 5% 100V	2 EA	C013,C014
506 0264 000	CAP 2.2UF 10% 400VDC	2 EA	C001,C002
508 0550 000	CAP .1UF 600V 5%	1 EA	C015
516 0419 000	CAP DISC 0.05UF 500V -20/+80%	2 EA	C003,C004
516 0966 000	CAP 1800PF 2% 100V C0G	1 EA	C016
540 1600 017	RES 4.7 OHM 3W 5%	2 EA	R007,R008
540 1600 412	RES 30K OHM 3W 5%	1 EA	R031
540 1600 419	RES 56K OHM 3W 5%	2 EA	R001,R002
542 1600 000	RES 0.1 OHM 5W 5%	2 EA	R027,R028
546 0313 000	RES 50 OHM 5W 5%	2 EA	R013,R014
548 2400 101	RES 10 OHM 1/2W 1%	4 EA	R003,R004,R005,R006
548 2400 201	RES 100 OHM 1/2W 1%	2 EA	R025,R026
548 2400 218	RES 150 OHM 1/2W 1%	6 EA	R021,R022,R023,R024,R029, R030
548 2400 230	RES 200 OHM 1/2W 1%	2 EA	R017,R018
548 2400 342	RES 2.67K OHM 1/2W 1%	2 EA	R015,R016
548 2400 430	RES 20K OHM 1/2W 1%	2 EA	R019,R020
548 2400 566	RES 475K OHM 1/2W 1%	2 EA	R011,R012
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 8154 007	SCH RF AMPLIFIER 3X LC	0 DWG	
843 5450 007	PWB, RF AMPLIFIER 3X LC	1 EA	
917 2413 561	PLATE, RF AMP INTERFACE	2 EA	
922 0922 156	TRANSFORMER	2 EA	T001,T002
922 1238 062	INTERFACE SPRING	1 EA	
922 1238 388	BLOCK, RF AMP INTERFACE	2 EA	
999 2829 001	HARDWARE LIST, RF AMP 3X	1 EA	

Table 7-10   DISC SW, 1+1 LOCKS, 16A, NEUT - 992 9764 285 (E)

Harris PN	Description	Qty UM	Reference Designators
2520007000A	*WIRE, MIL, 12AWG 3000V WHITE	0 FT	
302 0219 000	SCR, 1/4-20 X 1-1/4	1 EA	
302 0746 000	SCREW, SHMS 10-32 X 5/8 SST	25 EA	
310 0009 000	WASHER, FLAT 1/4 SST (ANSI REGULAR)	1 EA	
314 0012 000	WASHER, INT LOCK 1/4	1 EA	
358 3133 000	STUD, 1/4-20 X 1-1/2 BRASS	3 EA	
358 3186 000	PLUG, WHT 1.375" HOLE	3 EA	
604 1186 000	SWITCH, ROTARY DISCONNECT 600V	1 EA	
606 1137 160	CKT BRKR 16 AMPS 3P 480VAC	1 EA	N/A
646 0665 000	LABEL, INSPECTION	1 EA	
646 1301 000	LABEL, DANGER HI VOLTAGE	1 EA	
839 8220 410	WIRING DIAG, LOW VOL AC DIS SW	0 DWG	
917 2413 481	SPACER	2 EA	
917 2435 060	STANDOFF, AC DIST 4-WIRE	1 EA	
922 1195 010	RAIL TERM BLOCK MTG	2 EA	
922 1238 026	ANGLE, LOCK MTG, EPAC	3 EA	
922 1238 082	TRANSFER SWITCH, MODIFIED	1 EA	
922 1238 289	STANDOFF	2 EA	
939 8154 420	CHASSIS	1 EA	
939 8154 421	PANEL, LEFT/RIGHT	2 EA	

939 8154 422	PLATE, MTG	1 EA	
939 8154 423	THROW MECHANISM	1 EA	
939 8220 082	COVER, 1 LOCK SLOT REC	1 EA	

Table 7-11 ACC+ KIT - 992 9764 321 (D)

Harris PN	Description	Qty UM	Reference Designators
253 0059 000	CABLE, 2C 22AWG AUDIO	15 FT	
253 0095 000	CABLE 3C 20AWG 300V	10 FT	N/A
354 0003 000	LUG RING #10 22-18AWG RED	3 EA	
354 0006 000	LUG SPADE #8 22-18AWG RED	24 EA	
464 0349 000	TOOL, ADJUSTMENT	2 EA	
542 1735 000	RES 25 OHM 1% 10W	2 EA	
614 0505 000	TERM BD 12 TERM	1 EA	
843 5523 792	ACC+ AUDIO CONNECTION DIAGRAM DX	0 DWG	
917 2332 586	CABLE, ACC INTERCONNECT	1 EA	
939 8220 414	PANEL, ACC MOUNTING	1 EA	
992 9764 319	ACC+ BOARD	1 EA	

Table 7-12 ACC+ BOARD - 992 9764 319 (B--)

Harris PN	Description	Qty UM	Reference Designators
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	N/A
917 2332 718	FIRMWARE, ACC+	1 EA	
988 2509 002	DOC PKG, ACC +	1 EA	
992 9511 413	PWA, ACC+	1 EA	

Table 7-13 PWA, ACC+ - 992 9511 413 (F)

Harris PN	Description	Qty UM	Reference Designators
404 0908 000	*HEATSINK, VERTICAL, TO-220	3 EA	
522 0588 000	CAP 100UF 25V 20% 8MM NON-POLAR	1 EA	THRU
610 1069 000	HDR, 9C 1ROW VERTICAL UNSHR	1 EA	
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	5 EA	N/A
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	N/A
817 2551 014	PROGRAMMING INSTR, ACC/DELAY	0 DWG	
614 0953 005	*TERMINAL STRIP, 6 TERM	1 EA	
620 1677 000	JACK, BNC STRAIGHT PCB	1 EA	
614 0909 000	TERM BLK, PCB, 3-POLE, GREY (237)	7 EA	THRU
614 0953 006	*TERMINAL STRIP, 12 TERM	1 EA	
610 0900 000	HDR, 3C VERT 1ROW UNSHR	5 EA	THRU
492 0881 000	CHOKE, 10MH 20% 89MA RADIAL	2 EA	
382 1633 000	IC, LT1033 ESD	1 EA	
382 1328 000	IC, 1085 ESD	1 EA	THRU
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	THRU
566 0037 000	CONVERTER, DC/DC 5V .75W ESD	1 EA	THRU
992 9511 414	PWA, ACC+ SMT	1 EA	
843 5400 771	SCH, ACC+	0 DWG	

Table 7-14 BASIC, PB/XTMR LC MW - 994 9855 002 (C)

Harris PN	Description	Qty UM	Reference Designators
646 1353 000	NAMEPLATE, XMTR EQUIPMENT	1 EA	
917 2558 079	PATENT LABEL- AM XMTRS	1 EA	
922 1238 024	BRACKET, TRIM MTG.	3 EA	

922 1238 169	PLATE, DC SIDE CLOSEOUT	2 EA	
922 1238 353	ANGLE, SHIPPING	2 EA	
992 9028 001	CABINET, RECTIFIER	1 EA	
994 9855 004	CABINET, HEAT EXCHANGER MW	1 EA	
994 9855 005	CABINET, POWER AMPLIFIER,	1 EA	

Table 7-15 CABINET, RECTIFIER - 992 9028 001 (CK)

Harris PN	Description	Qty UM	Reference Designators
063 0002 007	COMPOUND, JOINT	0 EA	#Q001,#Q002,#Q003,#Q004, #Q005,#Q006,#Q007
2000000000000000833	FUSE, CART 0.4X1.5" 25A SLOW	3 EA	F001,F002,F003
2000000000000001025	FUSEBLOCK, 2P 30A TYPE CC FUSE	1 EA	XF019,XF020
2000000000000001026	FUSE, CART 0.4X1.5" 1.5A SLOW	2 EA	F019,F020
296 0259 000	TUBING, TEFLON 18AWG STD WALL	0.250 FT	#C009
302 0551 000	SCR, SOC HD SHOULDER	1 EA	
302 0745 000	SCREW, 1/4-20 X 5/8	10 EA	
302 0746 000	SCREW, SHMS 10-32 X 5/8 SST	10 EA	
303 4104 008	SCREW, PHMS M4-0.7 X 8 SST	2 EA	
315 0023 040	WASHER, EXT LOCK M4	2 EA	
328 0070 000	WASHER CUPPED BLACK WEAR	2 EA	
328 0073 000	WASHER, RETAINER	2 EA	
354 0003 000	LUG RING #10 22-18AWG RED	2 EA	#C009
354 0664 000	LUG, TERM, 3/8 BOLT SIZE	1 EA	#E006
358 0003 000	BRACKET RESISTOR MTG	8 EA	#R001,#R002,#R003,#R013
358 0004 000	BRACKET, RES MTG, FOR 0.75 ID CORE	2 EA	#R021
358 1217 000	HOSE CLAMP, SST, SAE-12	52 EA	
358 1731 000	SUPPORT, 5/16-18, FOR 7/8 COAX	10 EA	
358 2426 000	PLUG, WHITE 2" HOLE	12 EA	
358 2635 000	CABLE TIE, PUSH MOUNT SNAP IN	55 EA	
358 3000 000	PLATE, END STOP, DIN RAIL MT	4 EA	(2)#TB001,(2)#TB006
358 3171 000	STUD 1/4 TURN PHILLPS HD	2 EA	
358 3185 000	PLUG WHT 1.093/1.125 HOLE	2 EA	
358 3186 000	PLUG, WHT 1.375" HOLE	6 EA	
358 3247 000	PLUG, WHITE 1" HOLE	1 EA	
358 3466 000	FLANGE, GREY (264)	1 EA	#TB004
358 3490 000	END STOP, 264 TERM BLOCK	4 EA	#TB002,#TB003
358 3491 000	END PLATE, ORANGE (264)	2 EA	#TB002,#TB003
358 3734 000	SCREWLOCK KIT, DSUB 4-40 HEX	2 EA	#6J12,#FL004
358 3839 000	NUT, DRESS 1/4-40 UNS	1 EA	#A004S1
384 0431 000	*DIODE, RECT 1N4001	1 EA	CR008
384 0694 000	LED RED CART 12V	1 EA	CR011
384 0871 000	BRIDGE, FW 3PH 1200V 35AMP	1 EA	CR001
384 0925 000	RECTIFIER, R9G21215AS ESD	1 EA	Q007
384 0926 000	RECT, VSKD56, 1000V 55A	3 EA	CR002,CR003,CR004
384 0927 000	SCR, C450PB ESD	6 EA	Q001,Q002,Q003,Q004,Q005 ,Q006
398 0407 000	FUSE, DUAL 60A 250V	1 EA	F017
398 0470 000	FUSE TIME DELAY 3A 250VAC	1 EA	F018
398 0525 000	FUSE, TIME DELAY 20A	1 EA	F004
398 0629 000	FUSE, DUAL CART 25A TD CLASS-RK5	3 EA	F008,F009,F010

402 0014 000	FUSE HOLDER, 2 POLE	1 EA	#F004,#F018
402 0202 000	FUSE HOLDER, 2 POLE	1 EA	XF017
402 0234 000	FUSEBLOCK, 3P 30A 250V CLASS-R	1 EA	#F008,#F009,#F010
404 0707 000	SOCKET RELAY 2PDT PANEL	1 EA	#K006
404 0870 000	HEAT SINK CLAMP CROSS BAR	7 EA	#Q001,#Q002,#Q003,#Q004, #Q005,#Q006,#Q007
404 0871 000	HEATSINK CLAMP SPRING ASY	7 EA	#Q001,#Q002,#Q003,#Q004, #Q005,#Q006,#Q007
404 0883 000	HEATSINK, WATER COOLED	14 EA	#Q001,#Q002,#Q003,#Q004, #Q005,#Q006,#Q007
406 0491 000	PLUG WIRING FOR LED CART	1 EA	#CR011
414 0318 000	FERRITE SHIELD BEAD	1 EA	
442 0125 000	THERMOSTAT 175'F +/- 5'F	2 EA	TS001,TS002
448 0884 000	LATCH, FLUSH, LIFT & TURN	2 EA	
448 0938 000	HANDLE, CONCEALED PULL	2 EA	
448 1033 000	HINGE, CONCEALED	2 EA	
456 0144 000	SPRING, EJECTOR	2 EA	
456 0146 000	SPRING EXTENSION	1 EA	
472 1814 000	XFMR, CTL 208/120V	0 EA	T003
472 1821 000	XFMR, CTL 240/120V	1 EA	T003
476 0416 000	CHOKE, FLTR 10MHY 12.5ADC	1 EA	L001
476 0424 000	TRANSFORMER ISOLATION	1 EA	T002
476 0426 000	CHOKE, 120UH, 1400A WATER	1 EA	L002
476 0434 000	TRANSFORMER 3PH CURRENT	1 EA	T001
484 0477 000	FILTER, POWER LINE 1PH	1 EA	FL003
508 0578 000	CAP 0.5UF 1000V 10%	5 EA	C010,C011,C012,C013,C014
522 0523 000	CAP 470UF 16V	1 EA	C009
522 0589 000	CAP 220UF 16V 20% BIPOLAR	1 EA	C015
524 0219 000	CAP 5500 UF 200V -10, +50%	1 EA	C007
524 0360 000	CAP 18000 UF 200VDC	1 EA	C008
526 0376 000	CAP 10UF 660VAC 6%	6 EA	C001,C002,C003,C004,C005, C006
530 0092 000	BRACKET, CAP, 3" ID	3 EA	#C007,#C008
540 1600 420	RES 62K OHM 3W 5%	2 EA	R011,R012
542 0095 000	RES 10K OHM 5% 12W	1 EA	R020
542 0284 000	RES 3 OHM 5% 100W	3 EA	R001,R002,R003
542 0360 000	RES 1.5K OHM 5% 225W	1 EA	R021
542 1600 000	RES 0.1 OHM 5W 5%	1 EA	R019
546 0015 000	RES 5 OHM 40W 10 PCT	1 EA	R013
548 0402 000	RES .5 OHM 10W 1%	6 EA	R004,R005,R006,R007,R008, R009
548 2349 000	RES, 120K OHM 1% 2W	1 EA	R010
570 0279 000	CONTACTOR, 40A 3P 600V	1 EA	K005
570 0324 000	CNTR 40A, 4P 50/60HZ 208-240V	1 EA	K002
570 0349 000	CONTACTOR, 4P 120V NO	1 EA	K001
574 0436 000	RELAY, SS, AC, 10A, SPST	2 EA	K003,K004
574 0513 000	RELAY DPDT 24VDC	1 EA	K006
598 0482 000	SW, OPERATOR, PB PILOT 22MM	1 EA	#S003

598 0483 000	SWITCH, CONTACT BLOCK N.O.	2 EA	S003
600 0622 001	SWITCH, 3PH DISCONNECT, FUSED	1 EA	S005
604 0624 001	SW, SIMLTD ROLLER, SPDT, 11A	2 EA	S007,S009
604 1079 000	SW DPST 15A 125/250 VAC	1 EA	S004
604 1081 000	FLOW SWITCH, SPDT, 1 IN	1 EA	S006
604 1172 000	SW, ELECTRO-OPTIC LEVEL	1 EA	U001
610 1375 000	PLUG/RECP, D, 9C FILTERED	1 EA	6J12
612 0200 000	*RECP, XLR, 3C CIRCULAR	4 EA	6J7,6J9,6J11,6J14
612 1451 000	PLUG, FEMALE 4C 1ROW STRAIGHT	6 EA	
614 0002 000	TERM BD 2 TERM	1 EA	TB005
614 0808 000	*TERM BLK, THRU, 2-POLE GREY (283) 12MM	14 EA	(10)#TB001,(4)#TB006
614 0810 000	JUMPER, ADJACENT 2-POLE (283:283) 12MM	5 EA	(2)#TB006,(3)#TB001
614 0884 000	TERM BLK, THRU, 2-POLE, GREY (264)	5 EA	#TB004
614 0885 000	TERM BLK, THRU, 4-POLE, BLUE (264)	1 EA	#TB004
614 0892 000	TERM BLK, THRU, 4-POLE, BLUE (264)	9 EA	#TB002,#TB003
614 0893 000	TERM BLK, THRU, 2-POLE, GREY (264)	26 EA	#TB002,#TB003
614 0896 000	TERM BLK, GROUND, 4-POLE, GRN/YEL (264)	2 EA	#TB002
614 0898 000	*TERM BLK, GND, 2-POLE GRN/YEL (283) 12MM	2 EA	(1)#TB001,(1)#TB006
614 0906 000	TERM BLK, INTERFACE, 10C HDR	1 EA	A005
620 0455 000	ADAPTER, BNC JACK-JACK	3 EA	#6J8,#6J10,#6J13
646 0665 000	LABEL, INSPECTION	1 EA	
646 1301 201	LABEL, DANGER HI VOLT	1 EA	#FL003
646 1426 000	END PLATE 283 FRONT ENTRY	2 EA	(1)#TB001,(1)#TB006
646 1587 000	LABEL, CAUTION,	1 EA	
736 0264 000	*THREE PHASE SCR FIRING BD	1 EA	A002
740 0837 000	MON, PH 350-440V 3 PH	1 EA	K007
813 5007 034	STDOFF 6-32X2 1/4 DIA	2 EA	
813 5606 011	STUD, BRS 10-32 X 1	3 EA	#C007
816 7932 001	INSULATOR-SWITCH	2 EA	#S009
817 2150 037	GROUNDING PLATE	2 EA	E001,E004
817 2413 483	VIEWS, COMPONENT LOCATION,	0 DWG	
822 0922 033	FRT DOOR HINGE PLATE	1 EA	
822 0922 075	DOOR HINGE PIN	1 EA	
822 0999 038	DOOR STOP ARM	1 EA	
822 0999 040	DOOR STOP BLOCK	1 EA	
822 0999 104	STRAP	1 EA	
843 5492 198	FAMILY TREE, RECTIFIER CABINET	0 DWG	
843 5523 523	OUTLINE DWG, LIQUID RECTIFIER	0 DWG	
843 5523 672	SCH, RECTIFIER CABINET	0 DWG	
913 5010 047	SPACER, .50D X .75LG #10	2 EA	
917 2244 001	SPACER, 1.0 LG .75 DIA	2 EA	
917 2332 616	SPACER, SHIELD	2 EA	#FL003
917 2413 300	SPACER, SHIELD MTG.	4 EA	
917 2413 302	SPACER, BUS BAR	10 EA	
917 2413 303	BRACKET, CONNECTOR MTG.	6 EA	
917 2413 304	BRACKET, LOCK MTG.	1 EA	
917 2413 306	PLATE, SWITCH LOCKING	1 EA	
917 2413 307	ROD, GROUNDING SWITCH	1 EA	
917 2413 353	STRAP, CONNECTING	2 EA	
917 2413 355	PLATE, CONNECTING	1 EA	
917 2413 356	SPACER, LOCKING PLATE	1 EA	
917 2413 383	STUD, 3/8-16 X 3.0 LG	1 EA	

917 2413 388	CARRIER RAIL, 2.5 IN	1 EA	#TB004
917 2413 389	CARRIER RAIL, 11.7 IN	1 EA	#TB002
917 2413 398	STANDOFF, BUS BAR	2 EA	
917 2413 454	BRACKET, SENSOR MTG.	1 EA	
917 2413 468	JUMPER LIST	1 EA	
917 2413 503	RAIL, CARRIER, 5.6"	1 EA	#TB006
917 2413 562	JUMPER LIST, RECTIFIER CABINET	1 EA	
917 2413 707	SLEEVE, STANDOFF, SWITCH	2 EA	#S002
917 2413 748	STANDOFF, CAPACITOR	2 EA	#C011,#C012
917 2413 922	SPACER, OPTIMA PLATE	4 EA	
917 2413 923	ROD, STOP	2 EA	
922 0922 212	INSULATION, DOOR 21 X 48	1 EA	
922 0922 214	INSULATION, DOOR 21 X 6	1 EA	
922 1203 898	BRACKET, FILTER MTG.	1 EA	#FL003
922 1203 900	SHIELD, FILTER	1 EA	#FL003
922 1225 022	CLAMP, CAPACITOR	6 EA	#C001,#C002,#C003,#C004,#C005,#C006
922 1238 019	WINDOW, CAVITY ACCESS PNL	2 EA	
922 1238 024	BRACKET, TRIM MTG.	2 EA	
922 1238 026	ANGLE, LOCK MTG, EPAC	2 EA	
922 1238 078	SHIELD, CONTACT	1 EA	
922 1238 079	SHIELD, CONTACT	1 EA	
922 1238 082	TRANSFER SWITCH, MODIFIED	1 EA	
922 1238 085	DRAIN FITTING	1 EA	
922 1238 086	DOOR STOP BRACE	1 EA	
922 1238 087	SHIELD, FIRING BOARD	1 EA	
922 1238 088	BRACKET, SHIELD MTG.	2 EA	
922 1238 090	HINGE, PWB ACCESS PANEL	1 EA	
922 1238 091	DOOR, PWB ACCESS	1 EA	
922 1238 093	RESISTOR SHIELD	1 EA	
922 1238 094	BRACKET, LOCK MTG.	1 EA	
922 1238 096	BAR ASSY, SHORTING SWITCH	1 EA	
922 1238 100	DOOR STOP, PWB DOOR	1 EA	
922 1238 101	DOOR STOP, ACCESS DOOR	1 EA	
922 1238 141	RAIL T-BLOCK	1 EA	#A005
922 1238 195	ASSY, SHORTING SWITCH	1 EA	
922 1238 220	SUPPORT, STRAP	1 EA	
922 1238 221	STRAP, CONNECTING	1 EA	
922 1238 222	BAR, CONNECTING	1 EA	
922 1238 232	BAR, HEATSINK	7 EA	
922 1238 234	CARRIER RAIL, 9"	1 EA	#TB001
922 1238 236	BRACKET, CAPACITOR MTG.	2 EA	
922 1238 242	BUS BAR	1 EA	
922 1238 265	BAR, CONNECTING	1 EA	
922 1238 312	KIT, HOSE, RECTIFIER CAB.	1 EA	
922 1238 318	BAR, HEATSINK	7 EA	
922 1238 321	CABLE, RIBBON	1 EA	
922 1238 366	PLATE, DC TOP CLOSEOUT	1 EA	
922 1238 392	COVER	1 EA	
922 1238 394	PLATE, AC CLOSEOUT	1 EA	
922 1238 527	PLATE, DRAIN BASE CLOSEOUT	1 EA	

922 1238 594	PLATE, SWITCH MTG	1 EA	
922 1238 595	COVER, SWITCH	1 EA	
929 8440 151	CABLE, GND VIS. PA.	2 EA	
929 9009 153	DOOR RESTRAINT	2 EA	
939 8154 190	SHIELD, ACCESS DOOR	1 EA	
939 8154 191	DISPLAY PANEL, RECT. CAB.	1 EA	
939 8154 459	CABLE CLAMP	2 EA	
939 8187 057	PANEL I/O RECT CABINET	1 EA	
943 5450 262	RECTIFIER CABINET ASSY	1 EA	
943 5450 269	FRT DOOR PNL, RECT. CAB	1 EA	
943 5450 270	FRT DOOR SHLD, RECT. CAB	1 EA	
943 5450 273	REAR PNL ASSY, RECT. CAB	1 EA	
943 5450 274	SUPPORT CHANNEL	2 EA	
943 5450 276	PANEL, ACCESS DOOR	1 EA	
943 5450 278	INPUT PLUMBING ASSEMBLY	1 EA	
943 5450 279	OUTPUT PLUMBING ASSEMBLY	1 EA	
943 5450 280	PLATE, SWITCH MTG.	1 EA	
943 5450 282	BUS BAR, RECTIFIER CAB.	1 EA	
943 5450 335	SUPPORT, SHORTING PLATE	1 EA	
943 5450 336	HOUSING, FIRING BOARD	1 EA	
943 5450 337	SHIELD, FRONT ACCESS	1 EA	
943 5450 340	SHIELD, DRIVER	1 EA	
943 5450 343	SUPPORT, PLUMBING	2 EA	
943 5450 344	LT. SIDE PNL, RECT. CAB.	1 EA	
943 5450 345	PNL, RIGHT SIDE, RECT CAB	1 EA	
943 5450 346	TOP, RECTIFIER CABINET	1 EA	
943 5450 348	ASSEMBLY, SPRING PLATE	1 EA	
943 5450 505	BUS BAR	1 EA	
943 5450 697	CLAMP SUPPORT	1 EA	
943 5450 857	STRAP, CONNECTING	1 EA	
943 5450 858	BRACKET, CAP. MTG.	5 EA	#C010,#C011,#C012,#C013,#C014
943 5450 860	CHANNEL, CAP. MTG.	6 EA	#C001,#C002,#C003,#C004,#C005,#C006
943 5507 400	BRACKET, FUSE BLOCK	1 EA	
992 7220 107	*POWER SUPPLY DISCHARGE	1 EA	
992 9048 001	PS CONTROLLER	1 EA	A001
992 9161 001	REC CAB CABLE PKG	1 EA	
992 9188 001	PWB,PWR SUPPLY DISPLAY BD	1 EA	A004
999 2848 001	HARDWARE LIST, CABINET, RECTIF	1 EA	

Table 7-16 *POWER SUPPLY DISCHARGE - 992 7220 107 (C)

Harris PN	Description	Qty UM	Reference Designators
358 0002 000	*BRACKET RESISTOR MTG	4 EA	#R017,#R018
384 0705 000	RECT 85A 1000V PIV ESD	3 EA	CR005,CR006,CR007
442 0118 000	THERMOSTAT 65 DEG C, N.O.	4 EA	TS004,TS005,TS006,TS007
542 0180 000	RES 1K OHM 5% 25W	2 EA	R017,R018
542 1727 000	RESISTOR, 40 OHM 250W 5%	4 EA	R013,R014,R015,R016
917 2332 569	JUMPER WIRE KIT, PS DISCHARGE	1 EA	
917 2545 001	PLATE, DIODE MOUNTING	1 EA	

943 5547 017	CHASSIS, PWR SUP DISCHARGE	1 EA	
992 8684 005	POWER SUPPLY DISCHARGE	1 EA	A003

Table 7-17 POWER SUPPLY DISCHARGE - 992 8684 005 (D)

Harris PN	Description	Qty UM	Reference Designators
328 0071 000	WASHER, STEEL COMPRESSION	4 EA	#Q001,#Q002,#Q003,#Q004
380 0722 000	XSTR IRFP360 ESD	4 EA	Q001,Q002,Q003,Q004
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	1 EA	CR010
386 0085 000	*ZENER 1N4740A 10V 5% 1W	4 EA	CR004,CR005,CR008,CR009
410 0413 000	THERMAL INTERFACE, TO-247	4 EA	#Q001,#Q002,#Q003,#Q004
508 0539 000	CAP 2 UF 400VDC 10%	1 EA	C001
516 0453 000	CAP 0.100UF 10% 100V X7R	1 EA	C002
516 0864 000	CAP DISC .02UF 1KV +/-20%	4 EA	C008,C009,C013,C014
540 1600 001	RES 1 OHM 3W 5%	1 EA	R001
540 1600 110	RES 24 OHM 3W 5%	4 EA	R008,R009,R013,R014
540 1600 213	RES 330 OHM 3W 5%	4 EA	R006,R007,R011,R012
540 1600 308	RES 2K OHM 3W 5%	1 EA	R002
614 0727 000	TERM BD 8C 1ROW PC MT	2 EA	TB001,TB002
839 7930 518	SCHEM, PWR SUP DISCHARGE	0 DWG	
843 5155 518	PWB, PWR SUPPLY DISCHARGE	1 EA	
917 2413 466	HEATSINK, DISCHARGE	1 EA	

Table 7-18 PS CONTROLLER - 992 9048 001 (V)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	10 EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010
358 1928 000	JUMPER 1/4 LG 1/8H	5 EA	JP001,JP002,JP003,JP004,JP005
380 0189 000	*XSTR, NPN, MMBT3904	4 EA	Q001,Q002,Q009,Q012
380 0190 000	*XSTR, PNP, MMBT3906	2 EA	Q010,Q011
380 0726 000	XSTR, 2N7000 ESD	5 EA	Q003,Q004,Q005,Q007,Q008
380 0728 000	XSTR, NMOS IRL520 ESD	1 EA	Q006
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	U015
382 0406 000	IC, LM340/LM7812C (TO-220)	1 EA	U014
382 0514 000	IC, MM74C906N ESD	2 EA	U017,U018
382 0626 000	IC, 4093B/14093B ESD	1 EA	U021
382 0648 000	IC, LM339 (DIP-14)	3 EA	U005,U012,U016
382 0719 000	*IC, LM324A (DIP-14)	4 EA	U001,U002,U003,U006
382 0774 000	IC 74HC14 ESD	4 EA	U007,U010,U011,U020
382 0897 000	IC, ULN2803 DIP-18	1 EA	U008
382 1020 000	IC, 4N33 OPTO-COUPLER ESD	2 EA	U013,U022
382 1070 000	IC, ILQ1	1 EA	U004
382 1332 000	IC DAC-08 ESD	1 EA	U009
384 0205 000	*DIODE, RECT 1N4148/914	9 EA	CR001,CR002,CR003,CR004,CR006,CR009,CR010,CR011,CR012
384 0321 000	*DIODE, SCHOTTKY, 5082-2800	1 EA	CR008
384 0663 000	RECT BRIDGE 1A 200V DIP ESD	1 EA	CR007

404 0513 000	HEAT SINK PA1-1CB	2 EA	U014,U015
404 0674 000	SOCKET, DIP, 14 PIN (DL)	14 EA	XU001,XU002,XU003,XU005,XU006,XU007,XU010,XU011,XU012,XU016,XU017,XU018,XU020,XU021
404 0675 000	SOCKET, DIP, 16 PIN (DL)	2 EA	XU004,XU009
404 0766 000	SOCKET, DIP, 18 PIN (DL)	1 EA	XU008
500 0759 000	CAP MICA 100PF 500V 5%	1 EA	C019
506 0230 000	CAP 1000PF 5% 100V	3 EA	C007,C008,C015
506 0236 000	CAP 4700PF 5% 100V	1 EA	C005
506 0244 000	CAP 0.220UF 5% 63V	1 EA	C028
506 0246 000	CAP 0.470UF 5% 63V	1 EA	C025
516 0453 000	CAP 0.100UF 10% 100V X7R	27 EA	C006,C018,C020,C021,C024,C026,C033,C034,C035,C039,C040,C041,C042,C043,C044,C045,C046,C047,C048,C049,C051,C052,C053,C063,C064,C065,C066
516 0484 000	CAP 0.100UF 10% 100V X7R CK06	1 EA	C013
516 0509 000	CAP 2.2UF 50V 10% X7R	1 EA	C011
516 0530 000	CAP 0.010UF 10% 100V X7R	4 EA	C009,C012,C014,C031
516 0813 000	NTWK, CAP .01UF 50V 20% SIP	3 EA	C030,C055,C060
516 0939 000	CAP 0.033UF 10% 50V X7R CK05	2 EA	C003,C004
516 0953 000	CAP 1.000UF 10% 50V X7R CK06	4 EA	C001,C010,C023,C027
522 0528 000	CAP 470UF 63V 20%	1 EA	C038
522 0548 000	CAP 10UF 50V 20% (5X11)	4 EA	C022,C029,C036,C037
522 0550 000	*CAP 100UF 35V 20% (6.3X11)	2 EA	C002,C017
522 0574 000	CAP 22UF 50V 20%	2 EA	C016,C032
522 0578 000	CAP 1UF 100V 20% (5X11)	1 EA	C050
540 1332 000	RES NETWORK 100K OHM	1 EA	R014
540 1356 000	RES NETWORK 10K OHM 2%	6 EA	R002,R003,R004,R005,R012,R101
540 1370 000	RES NETWORK 220 OHM 2%	1 EA	R011
540 1380 000	RES NETWORK 10K OHM 2%	1 EA	R057
540 1429 000	RES NETWORK 680 OHM	1 EA	R080
542 1600 000	RES 0.1 OHM 5W 5%	1 EA	R025
548 2051 000	RES ZERO OHM	1 EA	R015
548 2400 201	RES 100 OHM 1/2W 1%	2 EA	R035,R056
548 2400 269	RES 511 OHM 1/2W 1%	2 EA	R030,R031
548 2400 271	RES 536 OHM 1/2W 1%	1 EA	R052
548 2400 280	RES 665 OHM 1/2W 1%	1 EA	R049
548 2400 281	RES 681 OHM 1/2W 1%	4 EA	R067,R072,R084,R085
548 2400 301	RES 1K OHM 1/2W 1%	8 EA	R026,R036,R037,R039,R046,R048,R050,R069
548 2400 331	RES 2.05K OHM 1/2W 1%	1 EA	R051
548 2400 338	RES 2.43K OHM 1/2W 1%	2 EA	R059,R060
548 2400 343	RES 2.74K OHM 1/2W 1%	1 EA	R106
548 2400 358	RES 3.92K OHM 1/2W 1%	1 EA	R019
548 2400 365	RES 4.64K OHM 1/2W 1%	1 EA	R018

548 2400 368	RES 4.99K OHM 1/2W 1%	3 EA	R053,R064,R088
548 2400 376	RES 6.04K OHM 1/2W 1%	1 EA	R058
548 2400 393	RES 9.09K OHM 1/2W 1%	1 EA	R024
548 2400 401	RES 10K OHM 1/2W 1%	19 EA	R001,R009,R17,R020,R033,R040,R042,R061,R066,R068,R073,R076,R078,R079,R081,R082,R086,R087,R089
548 2400 418	RES 15K OHM 1/2W 1%	1 EA	R047
548 2400 422	RES 16.5K OHM 1/2W 1%	1 EA	R071
548 2400 430	RES 20K OHM 1/2W 1%	3 EA	R010,R038,R063
548 2400 434	RES 22.1K OHM 1/2W 1%	2 EA	R029,R077
548 2400 451	RES 33.2K OHM 1/2W 1%	3 EA	R013,R016,R070
548 2400 453	RES 34.8K OHM 1/2W 1%	1 EA	R055
548 2400 454	RES 35.7K OHM 1/2W 1%	1 EA	R022
548 2400 469	RES 51.1K OHM 1/2W 1%	1 EA	R062
548 2400 481	RES 68.1K OHM 1/2W 1%	3 EA	R006,R007,R008
548 2400 501	RES 100K OHM 1/2W 1%	1 EA	R043
548 2400 532	RES 210K OHM 1/2W 1%	1 EA	R021
548 2400 601	RES 1MEG OHM 1/2W 1%	10 EA	R023,R027,R028,R032,R034,R041,R044,R045,R054,R065
548 2400 651	RES 3.32MEG OHM 1/2W 1%	2 EA	R074,R083
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	1 EA	R105
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	1 EA	R104
550 0961 000	TRIMPOT 50K OHM 1/2W 10%	1 EA	R075
610 0900 000	HDR, 3C VERT 1ROW UNSHR	1 EA	JP007
610 0979 000	*HDR 10C 2ROW VERT TOP LATCH	1 EA	J009
610 0980 000	*HDR 20C 2ROW RT ANG TOP LATCH	2 EA	J004,J008
610 1106 000	HDR, 8C VERT 1ROW FRICTION	1 EA	J001
610 1107 000	HDR, 12C VERT 1ROW FRICTION	2 EA	J003,J010
610 1145 000	HDR, 6C VERT 1ROW FRICTION	1 EA	J002
610 1172 000	HDR, 2C VERT 1ROW FRICTION	1 EA	J007
610 1244 000	HDR, MALE 20C 1ROW VERTICAL	1 EA	J006
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	1 EA	
843 5458 001	SCH, PS CONTROLLER	0 DWG	
843 5458 003	PWB, PS CONTROLLER	1 EA	
999 2831 001	HARDWARE LIST, P.S.	1 EA	

Table 7-19 PWB,PWR SUPPLY DISPLAY BD - 992 9188 001 (M--)

Harris PN	Description	Qty UM	Reference Designators
358 2177 000	SPACER, LED MOUNT .380 LG	12 EA	DS001,DS002,DS003,DS004,DS005,DS006,DS007,DS009,DS010,DS011,DS012,DS013
380 0726 000	XSTR, 2N7000 ESD	2 EA	Q001,Q002
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	2 EA	U013,U014
382 0406 000	IC, LM340/LM7812C (TO-220)	1 EA	U015
382 0497 000	* IC 74C32 ESD	1 EA	U001
382 0897 000	IC, ULN2803 DIP-18	2 EA	U010,U011
382 1016 000	*IC, 74C240 (DIP-20)	6 EA	U006,U007,U008,U009,U016,U017

382 1210 000	IC CD4538B ESD	1 EA	U012
382 1244 000	IC CD4043B ESD	4 EA	U002,U003,U004,U005
384 0205 000	*DIODE, RECT 1N4148/914	1 EA	CR004
384 0253 000	DIODE, RECT 1N4007	4 EA	CR001,CR002,CR003,CR005
384 0806 000	LED, RED/GRN T1-3/4 VERT	12 EA	DS001,DS002,DS003,DS004, DS005,DS006,DS007,DS009, DS010,DS011,DS012,DS013
404 0513 000	HEAT SINK PA1-1CB	3 EA	U013,U014,U015
404 0674 000	SOCKET, DIP, 14 PIN (DL)	1 EA	XU001
404 0675 000	SOCKET, DIP, 16 PIN (DL)	5 EA	XU002,XU003,XU004,XU00 5,XU012
404 0766 000	SOCKET, DIP, 18 PIN (DL)	2 EA	XU010,XU011
404 0767 000	SOCKET, DIP, 20 PIN (DL)	6 EA	XU006,XU007,XU008,XU00 9,XU016,XU017
516 0453 000	CAP 0.100UF 10% 100V X7R	22 EA	C001,C002,C004,C005,C006, C007,C008,C009,C010,C011, C012,C013,C014,C015,C016, C017,C018,C020,C021,C022, C023,C024
522 0548 000	CAP 10UF 50V 20% (5X11)	1 EA	C003
526 0374 000	CAP 1.0F 5.5V	1 EA	C019
540 1457 000	RES NETWORK 330 OHM 2%	2 EA	R003,R004
540 1493 000	RES NETWORK 100K OHM	4 EA	R001,R002,R014,R016
548 2400 301	RES 1K OHM 1/2W 1%	1 EA	R009
548 2400 401	RES 10K OHM 1/2W 1%	3 EA	R006,R011,R013
548 2400 469	RES 51.1K OHM 1/2W 1%	1 EA	R012
548 2400 501	RES 100K OHM 1/2W 1%	2 EA	R005,R008
548 2400 601	RES 1MEG OHM 1/2W 1%	3 EA	R007,R010,R015
604 0905 001	SWITCH, PB SPDT MOM VERT	1 EA	S001
610 0980 000	*HDR 20C 2ROW RT ANG TOP LATCH	2 EA	J001,J002
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
843 5458 011	SCH,PWR SUPPLY DISPLAY BD	0 DWG	
843 5458 013	PWB,PWR SUPPLY DISPLAY BD	1 EA	
999 2828 001	HARDWARE LIST,P.S.DISPLAY	1 EA	

Table 7-20 CABINET, HEAT EXCHANGER MW - 994 9855 004 (C)

Harris PN	Description	Qty UM	Reference Designators
302 0745 000	SCREW, 1/4-20 X 5/8	2 EA	
358 1315 000	HOSE CLAMP, SST, SAE-16	7 EA	
358 1316 000	HOSE CLAMP, SST, SAE-24	8 EA	
358 3186 000	PLUG, WHT 1.375" HOLE	2 EA	
358 3247 000	PLUG, WHITE 1" HOLE	1 EA	
359 1090 000	SUPPORT CLAMP, 3/4"COPPER	1 EA	
359 1091 000	SUPPORT CLAMP, 1" COPPER	7 EA	
359 1092 000	SUPPORT CLAMP, 1-1/4"	2 EA	
359 1093 000	SUPPORT CLAMP, 1-1/2"	3 EA	
359 1098 000	SUPPORT CLAMP, 25MM DIA	1 EA	
384 0431 000	*DIODE, RECT 1N4001	1 EA	CR1
398 0456 000	FUSE, CART 0.4X1.5" 1A SLOW	3 EA	F012,F013,F014

398 0499 000	FUSE, CART 0.4X1.5" 2A SLOW	9 EA	F003,F004,F005,F006,F007,F008,F009,F010,F011
402 0130 000	FUSE HOLDER, 3 POLE	4 EA	XF003,XF004,XF005,XF006,XF007,XF008,XF009,XF010,XF011,XF012,XF013,XF014
404 0672 000	SOCKET RELAY 3PDT PANEL	1 EA	#K001
424 0506 000	HOSE .500 ID, .875 OD	5 FT	
424 0507 000	HOSE .75 ID, 1.125 OD	2 FT	
424 0642 000	HOSE, SILICONE 1-1/4 ID X	12 FT	
424 0643 000	HOSE, SILICONE 1" ID X	2 FT	
430 0199 000	FAN BLADE, 12"DIA, 4 BLADE	1 EA	
430 0237 000	FAN GUARD, 17.6 DIA	3 EA	
432 0418 000	HEAT EXCHANGER COIL	1 EA	
432 0443 000	FAN BLADE, 16" DIA,	3 EA	
436 0289 000	MOTOR, 1/3HP 50/60 HZ 3PH	1 EA	
436 0315 000	MOTOR, 3/4HP 3PH 50/60HZ	3 EA	
448 1025 000	RING, RECESSED LASHING	4 EA	
448 1026 000	HINGE, METAL LIFT-OFF	4 EA	
448 1027 000	LATCH, FLUSH, LIFT & TURN	8 EA	
448 1032 000	HINGE, METAL LIFT-OFF	4 EA	
484 0472 000	FILTER, POWER LINE, 3PH-Y	1 EA	FL001
574 0470 000	RELAY 3PDT 12VDC COIL 10A	1 EA	K001
604 1081 000	FLOW SWITCH, SPDT, 1 IN	1 EA	S001
646 1587 000	LABEL, CAUTION,	1 EA	
822 1238 331	SKID, HEAT EXCHANGER	1 EA	
917 2413 327	BRKT SENSOR MTG.	1 EA	
922 0922 142	MODIFIED FAN FRAME	1 EA	
922 0999 521	MODIFIED FAN FRAME	3 EA	
922 1203 820	SPACER, SHIELD MTG.	2 EA	#FL001
922 1238 157	BRACKET, LOCK MTG.	2 EA	
922 1238 176	MOUNT, 1.5 INCH CLAMP	2 EA	
922 1238 180	BRKT, LOCK, TOP, HEC	1 EA	
922 1238 181	BRKT, LOCK, BTM, HEC	1 EA	
922 1238 182	COVER, DRIVER ACCESS, HEC	1 EA	
922 1238 188	COVER, RELAY, HEC	1 EA	#K001
939 8154 234	SHELF, PLUMBING, RETURN	1 EA	
939 8154 241	BACKING PLATE, HEC	4 EA	
939 8154 242	TRIM, OUTER, HEC	4 EA	
939 8154 243	TRIM, OUTER, CENTER, HEC	2 EA	
939 8154 244	TRIM, INNER, REAR, CTR,	1 EA	
939 8154 245	TRIM, INNER, FRT, CTR,	1 EA	
939 8154 246	CHNL, CABLE, MOUNT, HEC	2 EA	
939 8154 247	SUPPORT, DOOR, CTR, HEC	2 EA	
939 8154 250	CHNL, CABLE MOUNT, HEC	4 EA	
939 8154 251	CHNL, CABLE MOUNT, HEC	1 EA	
939 8154 252	STIFFENER, TOP, HEC	2 EA	
939 8154 257	DOOR, LEFT FRONT, HEC	1 EA	
939 8154 258	DOOR, RIGHT FRONT, HEC	1 EA	
939 8154 259	DOOR, LEFT REAR, HEC	1 EA	
939 8154 260	DOOR, RIGHT REAR, HEC	1 EA	
939 8154 393	ASSY, LEAK DETECTOR 4U1	1 EA	

939 8154 395	MOUNT, LOCK, HEC	1 EA	
939 8220 201	SHIELD	1 EA	#FL001
943 5450 310	TOP, HEAT EXCHANGER CAB	1 EA	
943 5450 313	HEC, PANEL, RIGHT, CENTER	1 EA	
943 5450 314	HEC, PANEL, LEFT, CENTER	1 EA	
943 5450 315	SUPPORT, FAN	3 EA	
943 5450 316	FACE PLATE, H-COIL	1 EA	
943 5450 317	BASE PLATE, HEC	1 EA	
943 5450 318	HEC, SUPPORT, BOTTOM,	1 EA	
943 5450 319	HEC, COIL END BRACKETS	2 EA	
943 5450 329	LEFT SIDE PANEL, HEC	1 EA	
943 5450 330	RIGHT SIDE PANEL, HEC	1 EA	
943 5450 331	TOP, HEAT EXCHANGER CAB	1 EA	
943 5450 392	MANIFOLD, PB MAIN SUPPLY	1 EA	
943 5450 393	MANIFOLD, RETURN,SWITCHED	1 EA	
943 5450 394	MANIFOLD, RETURN, CHILLER	1 EA	
943 5450 395	MANIFOLD, INPUT, CHILLER	1 EA	
943 5450 397	PLUMBING, PB MAIN RETURN	1 EA	
943 5450 404	BASE, FRONT, HEC	1 EA	
943 5450 548	FRAME, FAN MTG	1 EA	
952 9195 029	CABLE, BLOWER AC	1 EA	
952 9195 030	CABLE, HEC CONTROL	1 EA	
952 9195 036	CABLE, WATER CONTROL	1 EA	
999 2850 001	HARDWARE LIST, CAB HEAT EXCH	1 EA	

Table 7-21 CABINET, POWER AMPLIFIER, - 994 9855 005 (A)

Harris PN	Description	Qty UM	Reference Designators
992 9154 001	AIR PLENUM, ASSY	1 EA	
994 9855 006	PAC DX200,	1 EA	
994 9855 007	EPAC, DX200, EXTENDED PWR	1 EA	

Table 7-22 PAC DX200, - 994 9855 006 (C1)

Harris PN	Description	Qty UM	Reference Designators
007 4020 024	FINGERSTOCK, 97-952/CUSTOM	21 EA	
007 4030 023	BRZ, PH GND BAR 97-744-05	45 EA	
0416030010A	CHANNEL, RUBBER, 1/16" SLOT	15.25 FT	
041 6030 014	CHANNEL 1/16 MTL	5 FT	
043 8030 010	PLASTIC CHAN NO 190	34 FT	
302 0551 000	SCR, SOC HD SHOULDER	3 EA	
328 0070 000	WASHER CUPPED BLACK WEAR	6 EA	
328 0073 000	WASHER, RETAINER	6 EA	
336 1137 000	PIN, SPRING	3 EA	
356 0106 000	CABLE CLAMP, NYLON 0.500" DIA	1 EA	#T004
358 1217 000	HOSE CLAMP, SST, SAE-12	23 EA	
358 2426 000	PLUG, WHITE 2" HOLE	6 EA	
358 2628 000	CABLE PUSH MOUNT	3 EA	
358 3093 000	STUD, 6-32 X 1/2 BRASS	176 EA	#A005,#A010,#A011,#A012, #A013,#A014,#A015,#A016, #A017,#A018,#A019
358 3246 000	STUD 1/4 TURN PHILLIPS HD	6 EA	
359 1090 000	SUPPORT CLAMP, 3/4"COPPER	6 EA	

448 0224 000	HANDLE ALUM	6 EA	
448 0884 000	LATCH, FLUSH, LIFT & TURN	3 EA	
456 0144 000	SPRING, EJECTOR	6 EA	
494 0424 000	CHOKE RF 8.8UH	1 EA	T004
632 1133 000	AMMETER, 0-3ADC, 4.5",[W]	1 EA	M001
632 1191 000	AMMETER, 0-1500ADC, 4.5",[W]	1 EA	M002
632 1192 000	WATTMETER, 0-300KW, 4.5",[W]	1 EA	M003
646 1587 000	LABEL, CAUTION,	2 EA	
813 4999 034	STDOFF 6-32X2.00 1/4 HEX	176 EA	
822 0922 033	FRT DOOR HINGE PLATE	3 EA	
822 0922 075	DOOR HINGE PIN	3 EA	
822 0965 079	STUD, LOCK MTG.	6 EA	
822 0999 018	PAC/PSC DISPLAY TRIM	2 EA	
822 0999 019	PAC METER TRIM	2 EA	
822 0999 038	DOOR STOP ARM	3 EA	
822 0999 040	DOOR STOP BLOCK	3 EA	
822 0999 071	SHIELD 8.5 X 16.5	1 EA	#A031
822 0999 072	SHIELD 8.5 X 12.5	1 EA	
829 9009 142	CLIP, METER MTG	6 EA	#M001,#M003
917 2150 029	TEMP SENSOR	1 EA	U001
917 2413 338	HOSE 1/2 NOM X 8.20 LG	6 EA	
917 2413 339	HOSE 3/4 NOM X 8.00 LG	3 EA	
917 2413 340	HOSE 1/2 NOM X 28.00 LG	2 EA	
917 2413 382	BRKT, SENSOR MTG.	3 EA	
917 2413 409	HOSE 3/4 NOM X 12.25 LG	1 EA	
917 2413 410	HOSE 3/4 NOM X 9.50 LG	1 EA	
917 2413 563	CABLE, WIRE #58	1 EA	
922 0922 212	INSULATION, DOOR 21 X 48	3 EA	
922 0922 213	INSULATION, DOOR 21 X 21	2 EA	
922 0965 131	SHIM, LOCK	3 EA	
922 0999 039	DOOR STOP BRACE	3 EA	
922 0999 598	STANDOFF	14 EA	
922 1238 391	STANDOFF, DOOR LATCH STOP	2 EA	
922 1238 512	SHIELD, 8.5 X 11.5	1 EA	#A032
922 1238 535	PLATE, RF SAMPLE	1 EA	#T004
939 7930 618	TOP CROSSOVER COND	1 EA	
939 7930 624	BASE RBN SHLD	3 EA	
939 7930 626	RBN CBL SHIELD	2 EA	
939 7930 627	RBN CBL SHIELD	7 EA	
939 7930 628	RBN CBL SHIELD	2 EA	
939 7930 664	LT OUTER PNL RBN SHLD	1 EA	
939 7930 665	RT INNER PNL RT RBN SHLD	1 EA	
939 8154 100	COVER, CROSSOVER	1 EA	
939 8154 206	PANEL, LEFT INNER, RIGHT	1 EA	
939 8154 228	DRIVE CBL SUPPORT CHNL	2 EA	
939 8154 229	PAC CAP PLATE, 4-HOLE	1 EA	#C002
939 8154 394	SHIELD, UPPER RIBBON CBL	3 EA	
939 8154 407	PNL, AIR DEFLECTOR END	10 EA	
939 8154 408	PNL, AIR DEFLECTOR END,	1 EA	
939 8154 414	PNL, AIR DEFLECTOR END	1 EA	
939 8154 456	HOUSING, DRIVER MULTIMETER	1 EA	#A009
939 8220 192	WRAP, SHIELD	1 EA	#A004

939 8220 193	END PLATE, SHIELD	1 EA	#A004
939 8220 194	END PLATE, SHIELD	1 EA	#A004
943 5450 113	DOOR, PAC CENTER FRONT	1 EA	
943 5450 114	DOOR, PAC RIGHT FRONT	1 EA	
943 5450 115	SHIELD, RIGHT FRONT DOOR	1 EA	
943 5450 116	SHIELD, CENTER FRONT DOOR	1 EA	
943 5450 117	DOOR, PAC LEFT FRONT	1 EA	
943 5450 118	SHIELD, PAC LEFT FRONT	1 EA	
943 5450 352	RT OUTER PNL RBN SHLD	1 EA	
943 5450 355	DRIVER DRIVE CABLE	4 EA	
943 5450 356	RF DRIVE CABLE	28 EA	
943 5450 363	SPLITTER PLT	2 EA	
943 5450 366	TOP, PAC	1 EA	
943 5450 381	MANIFOLD ASSY LEFT & RT	1 EA	
943 5450 382	MANIFOLD 2 LEFT BASE PB	1 EA	
943 5450 383	MANIFOLD 2 RT BASE PB	1 EA	
943 5450 605	DEFLECTOR, AIR, LOWER	2 EA	
943 5450 606	DEFLECTOR, AIR UPPER	2 EA	
943 5450 608	DEFLECTOR, AIR LOWER PA	4 EA	
943 5450 609	DEFLECTOR, AIR, UPPER PA	4 EA	
943 5450 854	PLATE, DRIVER AIR	1 EA	
943 5450 855	PLATE, AIR DEFLECTOR, PAL	2 EA	
943 5450 975	CAB,PA,METER/DISPLAY PANEL	1 EA	
992 6784 003	PWA, DX SWITCHBOARD	1 EA	A035
992 8188 001	LED BD	1 EA	A042
992 8189 002	CONTROLLER BD	1 EA	A031
992 8191 004	PWA, A/D BOARD	1 EA	A032
992 8196 001	PWA, BUFFER AMP BD, DX-HP	1 EA	A004
992 8882 003	BD, ANALOG INPUT	1 EA	A022
992 9074 001	PWB, RF AMPLIFIER 3X LC	175 EA	RF,RF001,RF002,RF003,RF004,RF005,RF006,RF007,RF008,RF009,RF010,RF011,RF012,RF013,RF014,RF015,RF016,RF017,RF018,RF019,RF020,RF021,RF022,RF023,RF024,RF025,RF026,RF027,RF028,RF029,RF030,RF031,RF032,RF033,RF034,RF035,RF036,RF037,RF038,RF039,RF040,RF041,RF042,RF043,RF044,RF045,RF046,RF047,RF048,RF049,RF050,RF051,RF052,RF053,RF054,RF055,RF056,RF057,RF058,RF059,RF060,RF061,RF062,RF063,RF064,RF065,RF066,RF067,RF068,RF069,RF070,RF071,RF072,RF073,RF074,RF075,RF076,RF077,RF078,RF079,RF080,RF081,RF082,RF083,RF084,RF085,RF086,RF087,RF088,RF089,RF090,RF091,RF092,RF093,RF094,RF095,RF0

			96,RF097,RF098,RF099,RF100,RF101,RF102,RF103,RF104,RF105,RF106,RF107,RF108,RF109,RF110,RF111,RF112,RF113,RF114,RF115,RF116,RF117,RF118,RF119,RF120,RF121,RF122,RF123,RF124,RF125,RF126,RF127,RF128,RF129,RF130,RF131,RF132,RF133
992 9195 001	ASSY, LV POWER SUPPLY	1 EA	
992 9316 001	KIT,PAC,PRIORITY ONE PARTS	1 EA	
992 9316 002	KIT,PAC,PRIORITY TWO PARTS	1 EA	

Table 7-23 PWA, DX SWITCHBOARD - 992 6784 003 (F--)

Harris PN	Description	Qty UM	Reference Designators
358 1928 000	JUMPER 1/4 LG 1/8H	1 EA	JP2
358 3545 003	STANDOFF, PEM 3/8"H SNAP-TOP BRASS	4 EA	
380 0189 000	*XSTR, NPN, MMBT3904	4 EA	Q2,Q3,Q4,Q5
380 0190 000	*XSTR, PNP, MMBT3906	1 EA	Q1
382 0463 000	IC, 4051/14051 ESD	2 EA	U3,U10
382 0774 000	IC 74HC14 ESD	1 EA	U7
382 0781 000	*IC, 74HC74 (DIP-14)	1 EA	U11
382 0791 000	IC, 74HC138 ESD	1 EA	U8
382 0800 000	IC, 74HC161 ESD	1 EA	U6
382 0882 000	*IC, LM340LA/LM78L05AC (TO-92)	1 EA	U12
382 1043 000	IC UDN2595 ESD	1 EA	U1
382 1210 000	IC CD4538B ESD	1 EA	U13
382 1387 000	IC MAX637 ESD	1 EA	U14
382 1542 000	*IC, OP490 (DIP-14)	4 EA	U2,U4,U5,U9
384 0725 000	RECT 1N5818 ESD	1 EA	CR2
384 0827 000	LED LIGHT BAR, GREEN ESD	5 EA	DS1,DS2,DS3,DS4,DS5
384 0849 000	LED LIGHT BAR, GREEN ESD	1 EA	DS8
384 0854 000	DIODE ARRAY, 8 ISOLATED ESD	1 EA	CR1
384 0858 000	LED LIGHT BAR, YELLOW ESD	1 EA	DS9
384 0892 000	LED 4 SEG LIGHTBAR, GRN ESD	1 EA	DS6
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1 EA	#U14
404 0674 000	SOCKET, DIP, 14 PIN (DL)	6 EA	#U2,#U4,#U5,#U7,#U9,#U11
404 0675 000	SOCKET, DIP, 16 PIN (DL)	7 EA	#CR1,#DS6,#U3,#U6,#U8,#U10,#U13
404 0766 000	SOCKET, DIP, 18 PIN (DL)	1 EA	#U1
404 0829 000	SOCKET, SIP20, STRAIGHT	3 EA	#DS1,#DS2,#DS3,#DS4,#DS5,#DS8,#DS9
492 0839 000	IND 330 UH 10%	1 EA	L001
516 0453 000	CAP 0.100UF 10% 100V X7R	30 EA	C2,C4,C7,C10,C11,C12,C13,C14,C15,C16,C17,C18,C19,C20,C21,C23,C24,C27,C28,C29,C30,C34,C35,C36,C37,C38,C39,C40,C41,C42
516 0530 000	CAP 0.010UF 10% 100V X7R	1 EA	C22

516 0792 000	CAP NETWORK .1UF 10%	2 EA	C31,C32
516 0907 000	CAP 0.330UF 10% 50V X7R CK06	1 EA	C25
522 0531 000	CAP 1UF 50V 20% 5MM NON-POLAR	1 EA	C3
522 0548 000	CAP 10UF 50V 20% (5X11)	6 EA	C1,C5,C6,C9,C26,C33
522 0569 000	<*>CAP 100UF 63V 20% (10X12.5)	1 EA	C8
540 1383 000	RES NETWORK 100K OHM 2%	2 EA	R6,R7
540 1387 000	RES NETWORK 10K OHM 2%	4 EA	R1,R5,R12,R23
540 1408 000	RES NETWORK 2000 OHM 2%	1 EA	R3
540 1440 000	RES NETWORK 2000 OHM 2%	1 EA	R2
540 1461 000	RES NETWORK 100 OHM 2%	9 EA	R4,R26,R27,R28,R29,R30,R32,R33,R34
540 1462 000	RES NETWORK 1000 OHM 2%	1 EA	R24
548 2400 401	RES 10K OHM 1/2W 1%	2 EA	R10,R16
548 2400 456	RES 37.4K OHM 1/2W 1%	2 EA	R11,R15
548 2400 477	RES 61.9K OHM 1/2W 1%	1 EA	R25
548 2400 530	RES 200K OHM 1/2W 1%	2 EA	R9,R17
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	2 EA	R13,R14
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	1 EA	R8
604 1111 000	SW PB GRAY MOM W/O LED	2 EA	S7,S8
604 1119 000	SW PB RED MOM W/O LED	1 EA	S6
604 1121 000	SW PB BLUE MOM W/O LED	2 EA	S4,S5
604 1152 000	SW PB GRN MOM W/O LED	3 EA	S1,S2,S3
610 0933 000	TEST POINT, OVAL-LOOP THRU	8 EA	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8
610 0991 000	HDR, 6C VERT 1ROW FRICTION	1 EA	J2
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	1 EA	J1
610 1210 000	JUMPER, FLEX 10C X 2" LG	3 EA	FS1,FS2,FS3
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 6208 301	SCH, SWITCH/METER	0 DWG	
843 4038 201	PWB, SWITCH/METER	1 EA	

Table 7-24 LED BD - 992 8188 001 (J)

Harris PN	Description	Qty UM	Reference Designators
335 0262 000	DF137A INSULATING WASHER	2 EA	U005
354 0309 000	TERM SOLDER	6 EA	TP001,TP002,TP003,TP004,TP005,TP006
358 1928 000	JUMPER 1/4 LG 1/8H	5 EA	JP001,JP007,JP008,JP010,JP012
358 2177 000	SPACER, LED MOUNT .380 LG	29 EA	#DS001,#DS002,#DS003,#DS004,#DS005,#DS006,#DS007,#DS008,#DS009,#DS010,#DS011,#DS012,#DS013,#DS014,#DS015,#DS016,#DS017,#DS018,#DS019,#DS020,#DS021,#DS022,#DS023,#DS024,#DS025,#DS026,#DS027,#DS028,#DS029
380 0319 000	XSTR, MPS-A14 ESD	1 EA	Q001

382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	U005
382 0817 000	*IC, 74HC244 (DIP-20)	4 EA	U006,U007,U008,U009
382 1171 000	IC, 74HC540 ESD	4 EA	U001,U002,U003,U004
384 0610 000	LED, GRN T1-3/4 VERT	1 EA	DS029
384 0611 000	LED, RED T1-3/4 VERT	1 EA	DS028
384 0651 000	DIODE, RECT 1N5401	2 EA	CR003,CR004
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	1 EA	CR002
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	1 EA	CR001
384 0806 000	LED, RED/GRN T1-3/4 VERT	27 EA	DS001,DS002,DS003,DS004,DS005,DS006,DS007,DS008,DS009,DS010,DS011,DS012,DS013,DS014,DS015,DS016,DS017,DS018,DS019,DS020,DS021,DS022,DS023,DS024,DS025,DS026,DS027
404 0513 000	HEAT SINK PA1-1CB	1 EA	#U005
404 0675 000	SOCKET, DIP, 16 PIN (DL)	4 EA	XR001,XR002,XR003,XR004
404 0767 000	SOCKET, DIP, 20 PIN (DL)	8 EA	XU001,XU002,XU003,XU004,XU006,XU007,XU008,XU009
410 0405 000	THERMAL INTERFACE, TO220	1 EA	U005
516 0453 000	CAP 0.100UF 10% 100V X7R	10 EA	C002,C003,C004,C005,C006,C007,C008,C009,C010,C011
522 0550 000	*CAP 100UF 35V 20% (6.3X11)	1 EA	C001
540 1434 000	RES NETWORK 330 OHM 2%	1 EA	R009
540 1457 000	RES NETWORK 330 OHM 2%	4 EA	R001,R002,R003,R004
548 2400 401	RES 10K OHM 1/2W 1%	2 EA	R006,R007
548 2400 566	RES 475K OHM 1/2W 1%	2 EA	R005,R008
604 0905 000	SWITCH, PB SPDT MOM VERT	2 EA	S002,S003
604 1089 000	SW, TGL SPDT VERT PCB MT	1 EA	S001
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	2 EA	J001,J002
839 7930 006	SCHEM, LED BOARD	0 DWG	
843 5155 006	PWB, LED BOARD	1 EA	
999 2624 001	HARDWARE LIST	1 EA	

Table 7-25 CONTROLLER BD - 992 8189 002 (J--)

Harris PN	Description	Qty UM	Reference Designators
000 0000 010	B/M NOTE:	0 DWG	R33,R57
354 0309 000	TERM SOLDER	31 EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031
358 3423 000	JUMPER 0.4" LG 1/8" HEIGHT	4 EA	JP061,JP055 JP056 JP057
380 0125 000	XSTR, NPN 2N4401 ESD	1 EA	Q001

380 0126 000	XSTR, PNP 2N4403 ESD	2 EA	Q002,Q003
380 0678 000	*XSTR, NPN, MPQ2222A	4 EA	U040,U041,U042,U043
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	2 EA	U051,U052
382 0739 000	*IC, SE555	1 EA	U020
382 0800 000	IC, 74HC161 ESD	5 EA	U015,U016,U017,U018,U019
382 0817 000	*IC, 74HC244 (DIP-20)	5 EA	U030,U031,U032,U033,U034
382 0882 000	*IC, LM340LA/LM78L05AC (TO-92)	1 EA	U053
382 1065 000	IC 74HCT273 ESD	6 EA	U021,U022,U023,U024,U025,U026
382 1084 000	IC, LP339 (DIP-14)	2 EA	U036,U037
382 1171 000	IC, 74HC540 ESD	1 EA	U014
384 0321 000	*DIODE, SCHOTTKY, 5082-2800	5 EA	CR102,CR105,CR107,CR129,CR130
384 0431 000	*DIODE, RECT 1N4001	5 EA	CR143,CR144,CR148,CR153,CR155
384 0610 000	LED, GRN T1-3/4 VERT	2 EA	DS005,DS006
384 0612 000	DIODE 1N3070 ESD	46 EA	CR007,CR017,CR018,CR019,CR021,CR025,CR026,CR027,CR028,CR035,CR036,CR038,CR039,CR040,CR041,CR042,CR043,CR046,CR047,CR048,CR049,CR058,CR059,CR060,CR061,CR062,CR063,CR064,CR065,CR066,CR067,CR068,CR069,CR070,CR071,CR072,CR073,CR125,CR127,CR131,CR132,CR133,CR142,CR157,CR158,CR159
384 0651 000	DIODE, RECT 1N5401	2 EA	CR140,CR141
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	24 EA	CR001,CR002,CR003,CR004,CR006,CR014,CR015,CR016,CR029,CR030,CR031,CR032,CR033,CR034,CR037,CR092,CR093,CR094,CR095,CR109,CR110,CR126,CR139,CR145
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	1 EA	CR160
384 0806 000	LED, RED/GRN T1-3/4 VERT	4 EA	DS001,DS002,DS003,DS004
386 0078 000	*ZENER 1N4734A 5.6V 5% 1W	2 EA	CR122,CR123
386 0135 000	*ZENER 1N4733A 5.1V 5% 1W	47 EA	CR008,CR009,CR010,CR011,CR012,CR013,CR020,CR022,CR023,CR052,CR053,CR054,CR055,CR056,CR057,CR074,CR075,CR076,CR077,CR078,CR079,CR080,CR081,CR082,CR083,CR084,CR085,CR086,CR087,CR088,CR089,CR090,CR091,CR096,CR097,CR098,CR099,CR100,CR

			101,CR111,CR114,CR116,CR117,CR118,CR119,CR124,CR128
386 0428 000	DIODE LM385-1.2 1.235V 1% ESD	1 EA	CR138
398 0465 000	FUSE, FAST CART 2A 250V	6 EA	F001,F002,F003,F004,F005,F006
402 0198 000	CLIP, FUSE 5MM DIA FUSE	12 EA	
404 0513 000	HEAT SINK PA1-1CB	2 EA	#U051,#U052
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1 EA	XU020
404 0674 000	SOCKET, DIP, 14 PIN (DL)	6 EA	XU036,XU037,XU040,XU041,XU042,XU043
404 0675 000	SOCKET, DIP, 16 PIN (DL)	5 EA	XU015,XU016,XU017,XU018,XU019
404 0767 000	SOCKET, DIP, 20 PIN (DL)	12 EA	XU014,XU021,XU022,XU023,XU024,XU025,XU026,XU030,XU031,XU032,XU033,XU034
404 0797 000	SOCKET, DIP, 24 PIN (DL)	13 EA	XU001,XU002,XU003,XU004,XU005,XU006,XU007,XU008,XU009,XU010,XU011,XU012,XU013
506 0234 000	CAP 2200PF 5% 100V	1 EA	C070
506 0245 000	CAP, 0.33UF 63VDC 5%	1 EA	C045
516 0453 000	CAP 0.100UF 10% 100V X7R	47 EA	C001,C002,C003,C004,C005,C006,C007,C008,C009,C010,C011,C012,C013,C014,C015,C016,C017,C019,C020,C021,C022,C023,C024,C025,C026,C027,C030,C031,C032,C033,C034,C036,C037,C038,C039,C040,C042,C043,C044,C048,C050,C051,C059,C060,C063,C065,C071
516 0530 000	CAP 0.010UF 10% 100V X7R	1 EA	C064
516 0736 000	CAP 1000PF 10% 100V X7R	8 EA	C052,C053,C054,C055,C066,C067,C068,C073
516 0790 000	CAP NTWK 1000PF 10% 50V	9 EA	C101,C103,C104,C105,C106,C107,C108,C109,C110
516 0792 000	CAP NETWORK .1UF 10%	1 EA	C102
522 0550 000	*CAP 100UF 35V 20% (6.3X11)	4 EA	C049,C061,C062,C072
526 0108 000	CAP 4.7UF 35V 20%	1 EA	C069
526 0374 000	CAP 1.0F 5.5V	2 EA	C046,C047
540 1353 000	RES NETWORK 4700 OHM 2%	1 EA	R145
540 1356 000	RES NETWORK 10K OHM 2%	11 EA	R102,R107,R108,R109,R110,R122,R127,R128,R129,R130,R168

WARNING: Disconnect primary power prior to servicing.

540 1359 000	RES NETWORK 3300 OHM	2 EA	R170,R171
540 1365 000	RES NETWORK 36 OHM 2%	2 EA	R105,R125
540 1366 000	RES NETWORK 100 OHM 2%	8 EA	R101,R103,R104,R106,R121, R123,R124,R126
540 1382 000	RES NETWORK 47K OHM 2%	1 EA	R165
540 1386 000	RES NETWORK 10K OHM 2%	1 EA	R143
540 1457 000	RES NETWORK 330 OHM 2%	1 EA	R169
540 1493 000	RES NETWORK 100K OHM	6 EA	R142,R146,R147,R148,R149, R150
548 2400 151	RES 33.2 OHM 1/2W 1%	2 EA	R035,R049
548 2400 201	RES 100 OHM 1/2W 1%	13 EA	R011,R012,R027,R028,R031, R037,R074,R082,R083,R084, R085,R096,R097
548 2400 251	RES 332 OHM 1/2W 1%	3 EA	R014,R054,R062
548 2400 301	RES 1K OHM 1/2W 1%	1 EA	R047
548 2400 318	RES 1.5K OHM 1/2W 1%	1 EA	R045
548 2400 366	RES 4.75K OHM 1/2W 1%	3 EA	R034,R052,R056
548 2400 380	RES 6.65K OHM 1/2W 1%	1 EA	R046
548 2400 401	RES 10K OHM 1/2W 1%	31 EA	R001,R002,R003,R004,R005, R006,R007,R008,R013,R022, R023,R025,R026,R040,R041, R055,R060,R063,R064,R075, R076,R077,R078,R081,R086, R087,R088,R089,R090,R091, R094
548 2400 405	RES 11K OHM 1/2W 1%	1 EA	R015
548 2400 412	RES 13K OHM 1/2W 1%	1 EA	R042
548 2400 430	RES 20K OHM 1/2W 1%	1 EA	R095
548 2400 447	RES 30.1K OHM 1/2W 1%	1 EA	R048
548 2400 455	RES 36.5K OHM 1/2W 1%	1 EA	R043
548 2400 458	RES 39.2K OHM 1/2W 1%	1 EA	R061
548 2400 466	RES 47.5K OHM 1/2W 1%	6 EA	R029,R036,R039,R050,R051, R092
548 2400 474	RES 57.6K OHM 1/2W 1%	1 EA	R016
548 2400 485	RES 75K OHM 1/2W 1%	1 EA	R093
548 2400 501	RES 100K OHM 1/2W 1%	11 EA	R009,R010,R017,R019,R021, R024,R059,R067,R073,R079, R080
548 2400 542	RES 267K OHM 1/2W 1%	1 EA	R044
548 2400 547	RES 301K OHM 1/2W 1%	2 EA	R053,R069
548 2400 558	RES 392K OHM 1/2W 1%	1 EA	R066
548 2400 566	RES 475K OHM 1/2W 1%	1 EA	R071
548 2400 581	RES 681K OHM 1/2W 1%	1 EA	R072
548 2400 601	RES 1MEG OHM 1/2W 1%	2 EA	R065,R070
604 0905 000	SWITCH, PB SPDT MOM VERT	5 EA	S002,S003,S004,S005,S006
604 1089 000	SW, TGL SPDT VERT PCB MT	1 EA	S001
610 0679 000	PLUG, SHORTING, .25" CTRS	1 EA	P053
610 0900 000	HDR, 3C VERT 1ROW UNSHR	1 EA	#P050

610 0918 000	HDR, 16C VERT 1ROW UNSHR	1 EA	J016
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	2 EA	J004,J014
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	9 EA	J001,J002,J003,J005,J006,J007,J008,J012,J013
610 1070 000	HDR, 6C VERT 2ROW UNSHR	1 EA	#P052
610 1107 000	HDR, 12C VERT 1ROW FRICTION	3 EA	J009,J010,J011
612 0904 000	JACK, PC MT GOLD PLATED	3 EA	#P053
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	2 EA	P050,P052
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 7930 021	SCHEM, CONTROLLER	0 DWG	
843 5155 021	PWB, CONTROLLER	1 EA	
917 2210 001	FBTIM 8.0 FIRMWARE	1 EA	U002
917 2210 002	FGATE1 8.0 FIRMWARE	1 EA	U009
917 2210 003	FGATE2 8.0 FIRMWARE	1 EA	U010
917 2210 004	FLDBK 8.0 FIRMWARE	1 EA	U001
917 2210 005	FLT1 8.0 FIRMWARE	1 EA	U003
917 2210 006	FTIM 8.0 FIRMWARE	1 EA	U004
917 2210 007	LR 8.0 FIRMWARE	1 EA	U006
917 2210 008	OPR 8.0 FIRMWARE	1 EA	U005
917 2210 009	PTIM 8.0 FIRMWARE	1 EA	U008
917 2210 010	PWR 8.0 FIRMWARE	1 EA	U007
917 2210 011	LATCH 8.0 FIRMWARE	3 EA	U011,U012,U013
999 2626 001	HARDWARE LIST	1 EA	

Table 7-26 PWA, A/D BOARD - 992 8191 004 (J--)

Harris PN	Description	Qty UM	Reference Designators
300 1485 000	SCREW, PHMS 4-40 X 5/16 BRASS	3 EA	
304 0087 000	NUT, HEX 4-40	3 EA	
308 0003 000	*WASHER, FLAT #4 BRASS (ANSI NARROW)	3 EA	
312 0045 000	LOCKWASHER, SPLIT #4 PH-BRZ (ANSI)	3 EA	
354 0309 000	TERM SOLDER	21 EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP009,TP010,TP011,TP012,TP013,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024
358 1928 000	JUMPER 1/4 LG 1/8H	4 EA	JP008,JP014,JP018,JP019
380 0125 000	XSTR, NPN 2N4401 ESD	5 EA	Q001,Q002,Q003,Q005,Q006
380 0126 000	XSTR, PNP 2N4403 ESD	1 EA	Q004
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	U023
382 0359 000	IC, LM340/LM7815C (TO-220)	1 EA	U021
382 0360 000	IC, LM7915C (TO-220)	1 EA	U022
382 0472 000	IC, LM318 ESD	3 EA	U016,U018,U019
382 0646 000	* IC DAC0808 ESD	1 EA	U015
382 0749 000	IC NE5532A ESD	2 EA	U012,U014
382 0781 000	*IC, 74HC74 (DIP-14)	1 EA	U004
382 0817 000	*IC, 74HC244 (DIP-20)	2 EA	U008,U009
382 0865 000	IC, 74HC4538 ESD	1 EA	U030
382 0882 000	*IC, LM340LA/LM78L05AC (TO-92)	1 EA	U026
382 0965 000	IC, AD565A (DIP-24)	1 EA	U011
382 1065 000	IC 74HCT273 ESD	2 EA	U006,U007

382 1080 000	IC 74HCT04 HEX INVERTER ESD	1 EA	U010
382 1084 000	IC, LP339 (DIP-14)	1 EA	U025
382 1627 000	*IC OP27G (DIP-8)	3 EA	U001,U031,U032
382 1628 000	IC LM4040AIZ-5.0 ESD	1 EA	CR001
383 0287 000	IC ADC12662 1.5MHZ ESD	1 EA	U003
384 0431 000	*DIODE, RECT 1N4001	5 EA	CR005,CR006,CR007,CR021,CR022
384 0612 000	DIODE 1N3070 ESD	6 EA	CR002,CR003,CR004,CR008,CR009,CR013
384 0661 000	LED, GRN T1-3/4 RTANG	3 EA	DS001,DS002,DS003
384 0662 000	LED, RED T1-3/4 RTANG	2 EA	DS005,DS006
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	1 EA	CR016
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	2 EA	CR017,CR019
398 0465 000	FUSE, FAST CART 2A 250V	3 EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6 EA	
404 0513 000	HEAT SINK PA1-1CB	3 EA	XU021,XU022,XU023
404 0673 000	SOCKET, DIP, 8 PIN (DL)	8 EA	XU001,XU012,XU014,XU016,XU018,XU019,XU031,XU032
404 0674 000	SOCKET, DIP, 14 PIN (DL)	3 EA	XU004,XU010,XU025
404 0675 000	SOCKET, DIP, 16 PIN (DL)	2 EA	XU015,XU030
404 0682 000	SOCKET, DIP, 24 PIN (DL)	1 EA	XU011
404 0767 000	SOCKET, DIP, 20 PIN (DL)	4 EA	XU006,XU007,XU008,XU009
404 0797 000	SOCKET, DIP, 24 PIN (DL)	1 EA	XU005
404 0830 000	SOCKET, PLCC-44, THROUGH HOLE	1 EA	XU003
484 0334 000	LINE,DELAY 60+/-2.0 NSEC	1 EA	DL001
494 0218 000	CHOKE, WIDE BAND 2.5 TURN	1 EA	
494 0411 000	INDUCTOR, 220UH 10% (9250)	1 EA	L003
494 0418 000	INDUCTOR, 820UH 10% (9250)	2 EA	L001,L002
500 0754 000	CAP MICA 220PF 500V 5%	2 EA	C002,C004
500 0756 000	CAP MICA 330PF 500V 5%	2 EA	C024,C049
500 0759 000	CAP MICA 100PF 500V 5%	1 EA	C081
500 0805 000	CAP MICA 12PF 500V 5%	1 EA	C012
500 0814 000	CAP MICA 36PF 500V 5%	1 EA	C041
500 0834 000	CAP MICA 430PF 500V 5%	1 EA	C034
500 0844 000	CAP MICA 1000PF 100V 5%	2 EA	C032,C033
506 0239 000	CAP 0.022UF 5% 100V	1 EA	C085
516 0453 000	CAP 0.100UF 10% 100V X7R	39 EA	C005,C007,C009,C011,C013,C014,C015,C016,C017,C018,C019,C020,C021,C023,C025,C027,C028,C030,C031,C037,C038,C039,C040,C044,C045,C051,C052,C055,C056,C062,C066,C070,C071,C072,C075,C076,C077,C078,C084
516 0530 000	CAP 0.010UF 10% 100V X7R	15 EA	C006,C008,C022,C026,C029,

			C043,C046,C047,C050,C053, C054,C057,C073,C082,C083
516 0725 000	CAP 1.0UF 50V 20%	11 EA	C001,C003,C036,C042,C060, C061,C064,C065,C068,C069, C086
516 0765 000	CAP 10PF 5% 100V C0G	4 EA	C035,C048,C058,C080
522 0548 000	CAP 10UF 50V 20% (5X11)	5 EA	C010,C074,C079,C087,C088
522 0555 000	*CAP 100UF 50V 20% (8X11.5)	4 EA	C059,C063,C067,C089
540 1600 215	RES 390 OHM 3W 5%	1 EA	R077
548 2400 169	RES 51.1 OHM 1/2W 1%	3 EA	R010,R011,R082
548 2400 201	RES 100 OHM 1/2W 1%	3 EA	R029,R073,R074
548 2400 251	RES 332 OHM 1/2W 1%	3 EA	R047,R071,R072
548 2400 268	RES 499 OHM 1/2W 1%	2 EA	R038,R048
548 2400 269	RES 511 OHM 1/2W 1%	2 EA	R033,R036
548 2400 277	RES 619 OHM 1/2W 1%	2 EA	R019,R022
548 2400 301	RES 1K OHM 1/2W 1%	6 EA	R013,R044,R046,R055,R056, R069
548 2400 309	RES 1.21K OHM 1/2W 1%	2 EA	R045,R084
548 2400 326	RES 1.82K OHM 1/2W 1%	2 EA	R075,R076
548 2400 337	RES 2.37K OHM 1/2W 1%	2 EA	R017,R037
548 2400 342	RES 2.67K OHM 1/2W 1%	1 EA	R059
548 2400 351	RES 3.32K OHM 1/2W 1%	4 EA	R012,R039,R041,R050
548 2400 358	RES 3.92K OHM 1/2W 1%	1 EA	R018
548 2400 369	RES 5.11K OHM 1/2W 1%	1 EA	R001
548 2400 373	RES 5.62K OHM 1/2W 1%	3 EA	R023,R024,R025
548 2400 385	RES 7.5K OHM 1/2W 1%	2 EA	R034,R035
548 2400 389	RES 8.25K OHM 1/2W 1%	1 EA	R051
548 2400 393	RES 9.09K OHM 1/2W 1%	1 EA	R066
548 2400 401	RES 10K OHM 1/2W 1%	26 EA	R004,R006,R007,R014,R015, R016,R020,R021,R030,R031, R040,R053,R057,R058,R063, R064,R067,R068,R070,R083, R086,R088,R089,R090,R092, R093
548 2400 402	RES 10.2K OHM 1/2W 1%	1 EA	R002
548 2400 419	RES 15.4K OHM 1/2W 1%	1 EA	R003
548 2400 428	RES 19.1K OHM 1/2W 1%	1 EA	R060
548 2400 434	RES 22.1K OHM 1/2W 1%	4 EA	R052,R054,R062,R065
548 2400 442	RES 26.7K OHM 1/2W 1%	1 EA	R049
548 2400 451	RES 33.2K OHM 1/2W 1%	1 EA	R042
548 2400 501	RES 100K OHM 1/2W 1%	6 EA	R026,R032,R043,R078,R080, R087
548 2400 577	RES 619K OHM 1/2W 1%	1 EA	R005
548 2400 581	RES 681K OHM 1/2W 1%	2 EA	R079,R081
604 1064 000	SWITCH, ROCKER DIP 2-SPST	1 EA	S001
610 0811 000	PROGRAM HEADER 16 PIN DIP	2 EA	R027,R028
610 0900 000	HDR, 3C VERT 1ROW UNSHR	1 EA	JP017
610 0979 000	*HDR 10C 2ROW VERT TOP LATCH	1 EA	J004
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	1 EA	J001

610 1107 000	HDR, 12C VERT 1ROW FRICTION	1 EA	J002
610 1121 000	HDR, 4C VERT 2ROW UNSHR	1 EA	JP011
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	3 EA	
620 0515 000	RECP, SCREW ON SMC	1 EA	J003
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
843 5458 471	SCH, A/D BOARD	0 DWG	
843 5458 473	PWB, A/D	1 EA	
917 2210 014	FIRMWARE, A/D FAULT DETECT	1 EA	#U005

Table 7-27 PWA, BUFFER AMP BD, DX-HP - 992 8196 001 (J)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	5 EA	TP001,TP002,TP003,TP004,TP005
380 0728 000	XSTR, NMOS IRL520 ESD	4 EA	Q001,Q002,Q003,Q004
382 1204 000	IC TC4423 ESD	2 EA	U001,U002
384 0612 000	DIODE 1N3070 ESD	4 EA	CR002,CR004,CR007,CR009
384 0661 000	LED, GRN T1-3/4 RTANG	2 EA	DS002,DS004
384 0662 000	LED, RED T1-3/4 RTANG	4 EA	DS001,DS003,DS005,DS006
384 0802 000	DIODE, TVS (BIDIR), P6KE18CA ESD	4 EA	CR003,CR005,CR008,CR010
386 0085 000	*ZENER 1N4740A 10V 5% 1W	1 EA	CR015
386 0297 000	*ZENER 1N5338B 5.1V 5% 5W	6 EA	CR001,CR006,CR011,CR012,CR013,CR014
398 0019 000	FUSE, FAST CART 2A 250V	2 EA	F003,F004
398 0021 000	FUSE, FAST CART 4A 250V	2 EA	F001,F002
402 0129 000	CLIP, 1/4 DIA FUSE	8 EA	
404 0513 000	HEAT SINK PA1-1CB	4 EA	#Q001,#Q002,#Q003,#Q004
404 0673 000	SOCKET, DIP, 8 PIN (DL)	2 EA	XU001,XU002
494 0377 000	INDUCTOR, 0.270UH 10% (9250)	2 EA	L001,L003
494 0378 000	INDUCTOR, 0.330UH 10% (9250)	2 EA	L002,L004
506 0233 000	CAP 0.100UF 5% 63V	4 EA	C008,C010,C018,C020
506 0246 000	CAP 0.470UF 5% 63V	6 EA	C002,C004,C006,C012,C014,C016
508 0378 000	CAP .22 UF 100V 10%	2 EA	C009,C019
516 0081 000	CAP, DISC 0.01UF 1KV 20%	4 EA	C003,C005,C013,C015
522 0566 000	<*>CAP 100UF 63V 20% (10X12.5)	2 EA	C001,C011
526 0342 000	CAP 2.7UF 35V 10%	2 EA	C007,C017
540 1600 017	RES 4.7 OHM 3W 5%	8 EA	R010,R013,R015,R020,R026,R029,R031,R036
540 1600 101	RES 10 OHM 3W 5%	6 EA	R009,R012,R014,R025,R028,R030
540 1600 316	RES 4.3K OHM 3W 5%	2 EA	R005,R021
540 1600 401	RES 10K OHM 3W 5%	4 EA	R001,R002,R003,R004
542 0051 000	RES 3 OHM 5% 12W	2 EA	R007,R023
542 0062 000	RES 200 OHM 5% 12W	4 EA	R006,R022,R037,R038
546 0313 000	RES 50 OHM 5W 5%	1 EA	R016
548 2400 101	RES 10 OHM 1/2W 1%	4 EA	R011,R019,R027,R035
548 2400 201	RES 100 OHM 1/2W 1%	4 EA	R008,R018,R024,R034
839 7930 014	SCHEM, BUFFER AMP	0 DWG	

843 5155 014	PWB, BUFFER AMP	1 EA	
939 5695 054	TRANSFORMER, TOROID	2 EA	T001,T002
999 2629 001	HARDWARE LIST	1 EA	

Table 7-28 BD, ANALOG INPUT - 992 8882 003 (N)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	41 EA	TP001,TP002,TP003,TP004,TP005,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031,TP032,TP033,TP034,TP035,TP036,TP037,TP038,TP039,TP040,TP041,TP042
358 1928 000	JUMPER 1/4 LG 1/8H	8 EA	JP010,JP011,JP012,JP013,JP014,JP015,JP016,JP017
380 0125 000	XSTR, NPN 2N4401 ESD	3 EA	Q001,Q002,Q003
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	U022
382 0359 000	IC, LM340/LM7815C (TO-220)	1 EA	U024
382 0360 000	IC, LM7915C (TO-220)	1 EA	U023
382 0463 000	IC, 4051/14051 ESD	1 EA	U012
382 0594 000	*IC TL074ACN ESD	3 EA	U009,U011,U027
382 0648 000	IC, LM339 (DIP-14)	1 EA	U013
382 0676 000	IC, 74LS05N (DIP-14)	2 EA	U014,U026
382 0711 000	*PRECISION IC MULTIPLIER ESD	1 EA	U016
382 0742 000	IC AD7524 ESD	1 EA	U018
382 0749 000	IC NE5532A ESD	7 EA	U001,U002,U003,U004,U007,U008,U010
382 0774 000	IC 74HC14 ESD	1 EA	U025
382 0867 000	IC, 4053BC ESD	1 EA	U017
382 0882 000	*IC, LM340LA/LM78L05AC (TO-92)	1 EA	U029
382 1011 000	IC, 14541/4541 ESD	1 EA	U028
382 1084 000	IC, LP339 (DIP-14)	1 EA	U015
384 0321 000	*DIODE, SCHOTTKY, 5082-2800	4 EA	CR004,CR028,CR030,CR031
384 0431 000	*DIODE, RECT 1N4001	5 EA	CR017,CR018,CR019,CR020,CR027
384 0612 000	DIODE 1N3070 ESD	9 EA	CR006,CR007,CR012,CR013,CR022,CR023,CR024,CR025,CR026
384 0661 000	LED, GRN T1-3/4 RTANG	3 EA	DS001,DS002,DS003
384 0662 000	LED, RED T1-3/4 RTANG	2 EA	DS004,DS005
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	1 EA	CR015
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	2 EA	CR016,CR021
384 0731 000	* DIODE, SWITCHING 1N4607 ESD	1 EA	CR005
384 0799 000	DIODE, BIPOLAR ESD	2 EA	CR009,CR010
386 0123 000	*ZENER 1N4732A 4.7V 5% 1W	1 EA	CR014

386 0135 000	*ZENER 1N4733A 5.1V 5% 1W	3 EA	CR001,CR002,CR011
386 0427 000	ZENER LM-313H 1.22VDC ESD	1 EA	CR029
398 0465 000	FUSE, FAST CART 2A 250V	3 EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6 EA	
404 0513 000	HEAT SINK PA1-1CB	3 EA	#U022,#U023,#U024
404 0673 000	SOCKET, DIP, 8 PIN (DL)	7 EA	XU001,XU002,XU003,XU004,XU007,XU008,XU010
404 0674 000	SOCKET, DIP, 14 PIN (DL)	9 EA	XU009,XU011,XU013,XU014,XU015,XU025,XU026,XU027,XU028
404 0675 000	SOCKET, DIP, 16 PIN (DL)	3 EA	XU012,XU017,XU018
404 0797 000	SOCKET, DIP, 24 PIN (DL)	5 EA	XU005,XU006,XU019,XU020,XU021
494 0415 000	INDUCTOR, 470UH 10% (9250)	2 EA	L005,L006
494 0418 000	INDUCTOR, 820UH 10% (9250)	2 EA	L007,L008
500 0844 000	CAP MICA 1000PF 100V 5%	3 EA	C004,C010,C053
500 0845 000	CAP, MICA, 2000PF 500V 5%	2 EA	C054,C056
506 0230 000	CAP 1000PF 5% 100V	1 EA	C050
506 0232 000	CAP 0.010UF 5% 100V	8 EA	C002,C034,C038,C046,C057,C059,C063,C109
506 0236 000	CAP 4700PF 5% 100V	2 EA	C020,C021
506 0238 000	CAP 0.015UF 5% 100V	2 EA	C022,C023
506 0246 000	CAP 0.470UF 5% 63V	6 EA	C024,C025,C026,C027,C048,C049
516 0453 000	CAP 0.100UF 10% 100V X7R	47 EA	C006,C007,C016,C017,C018,C019,C037,C045,C047,C058,C062,C066,C067,C071,C072,C073,C074,C075,C076,C077,C078,C079,C084,C085,C086,C087,C088,C089,C090,C091,C092,C093,C094,C095,C096,C097,C098,C099,C100,C101,C102,C103,C104,C105,C106,C107,C108
516 0765 000	CAP 10PF 5% 100V C0G	10 EA	C003,C032,C033,C040,C041,C042,C044,C060,C061,C064
516 0774 000	CAP 56PF 5% 100V C0G	6 EA	C028,C029,C030,C031,C051,C055
516 0792 000	CAP NETWORK .1UF 10%	2 EA	C001,C008
522 0554 000	CAP 4.7UF 50V 20%	1 EA	C011
522 0561 000	*CAP 100UF 63V 20% (10X12.5)	4 EA	C065,C068,C069,C070
522 0570 000	CAP 2.2UF 50V 20%	3 EA	C012,C013,C014
526 0108 000	CAP 4.7UF 35V 20%	3 EA	C036,C039,C052
526 0321 000	CAP 3.3UF 15/16V 20%	1 EA	C009
526 0359 000	CAP 47UF 25V 10%	1 EA	C005

540 1380 000	RES NETWORK 10K OHM 2%	12 EA	R001,R002,R003,R010,R011, R014,R015,R016,R020,R021, R134,R152
540 1386 000	RES NETWORK 10K OHM 2%	2 EA	R013,R100
540 1386 000	RES NETWORK 10K OHM 2%	2 EA	R006,R028
540 1421 000	RES NETWORK 4700 OHM 2%	1 EA	R018
540 1496 000	RES NETWORK 100 OHM	5 EA	R005,R007,R008,R009,R012
540 1600 221	RES 680 OHM 3W 5%	1 EA	R096
540 1600 408	RES 20K OHM 3W 5%	1 EA	R095
548 2400 001	RES 1 OHM 1/2W 1%	1 EA	R057
548 2400 101	RES 10 OHM 1/2W 1%	2 EA	R034,R062
548 2400 143	RES 27.4 OHM 1/2W 1%	3 EA	R082,R098,R148
548 2400 155	RES 36.5 OHM 1/2W 1%	1 EA	R174
548 2400 205	RES 110 OHM 1/2W 1%	7 EA	R038,R039,R045,R048,R179, R180,R181
548 2400 218	RES 150 OHM 1/2W 1%	1 EA	R109
548 2400 251	RES 332 OHM 1/2W 1%	2 EA	R044,R047
548 2400 254	RES 357 OHM 1/2W 1%	2 EA	R090,R126
548 2400 258	RES 392 OHM 1/2W 1%	3 EA	R043,R046,R097
548 2400 269	RES 511 OHM 1/2W 1%	2 EA	R059,R147
548 2400 279	RES 649 OHM 1/2W 1%	1 EA	R159
548 2400 281	RES 681 OHM 1/2W 1%	2 EA	R049,R050
548 2400 285	RES 750 OHM 1/2W 1%	3 EA	R053,R175,R176
548 2400 295	RES 953 OHM 1/2W 1%	1 EA	R165
548 2400 301	RES 1K OHM 1/2W 1%	4 EA	R022,R036,R156,R157
548 2400 312	RES 1.3K OHM 1/2W 1%	3 EA	R089,R131,R160
548 2400 330	RES 2K OHM 1/2W 1%	4 EA	R023,R084,R085,R105
548 2400 332	RES 2.1K OHM 1/2W 1%	1 EA	R094
548 2400 335	RES 2.26K OHM 1/2W 1%	1 EA	R086
548 2400 342	RES 2.67K OHM 1/2W 1%	1 EA	R122
548 2400 347	RES 3.01K OHM 1/2W 1%	2 EA	R027,R093
548 2400 351	RES 3.32K OHM 1/2W 1%	5 EA	R037,R075,R081,R091,R141
548 2400 354	RES 3.57K OHM 1/2W 1%	1 EA	R061
548 2400 364	RES 4.53K OHM 1/2W 1%	1 EA	R158
548 2400 366	RES 4.75K OHM 1/2W 1%	1 EA	R074
548 2400 368	RES 4.99K OHM 1/2W 1%	1 EA	R110
548 2400 369	RES 5.11K OHM 1/2W 1%	2 EA	R078,R083
548 2400 373	RES 5.62K OHM 1/2W 1%	1 EA	R145
548 2400 389	RES 8.25K OHM 1/2W 1%	1 EA	R140
548 2400 401	RES 10K OHM 1/2W 1%	34 EA	R004,R030,R031,R032,R040, R041,R042,R060,R063,R064, R073,R077,R101,R112,R115, R117,R121,R123,R133,R136, R137,R138,R142,R146,R149, R150,R151,R154,R162,R163, R166,R167,R169,R177
548 2400 405	RES 11K OHM 1/2W 1%	1 EA	R103
548 2400 407	RES 11.5K OHM 1/2W 1%	1 EA	R024
548 2400 411	RES 12.7K OHM 1/2W 1%	1 EA	R132
548 2400 418	RES 15K OHM 1/2W 1%	4 EA	R055,R099,R124,R178

548 2400 425	RES 17.8K OHM 1/2W 1%	1 EA	R092
548 2400 426	RES 18.2K OHM 1/2W 1%	1 EA	R058
548 2400 430	RES 20K OHM 1/2W 1%	1 EA	R120
548 2400 434	RES 22.1K OHM 1/2W 1%	1 EA	R017
548 2400 438	RES 24.3K OHM 1/2W 1%	1 EA	R072
548 2400 439	RES 24.9K OHM 1/2W 1%	1 EA	R130
548 2400 442	RES 26.7K OHM 1/2W 1%	2 EA	R125,R153
548 2400 443	RES 27.4K OHM 1/2W 1%	1 EA	R135
548 2400 454	RES 35.7K OHM 1/2W 1%	1 EA	R080
548 2400 458	RES 39.2K OHM 1/2W 1%	1 EA	R071
548 2400 466	RES 47.5K OHM 1/2W 1%	1 EA	R102
548 2400 469	RES 51.1K OHM 1/2W 1%	1 EA	R116
548 2400 477	RES 61.9K OHM 1/2W 1%	1 EA	R139
548 2400 480	RES 66.5K OHM 1/2W 1%	1 EA	R164
548 2400 485	RES 75K OHM 1/2W 1%	2 EA	R106,R108
548 2400 489	RES 82.5K OHM 1/2W 1%	1 EA	R070
548 2400 493	RES 90.9K OHM 1/2W 1%	1 EA	R144
548 2400 501	RES 100K OHM 1/2W 1%	6 EA	R025,R079,R128,R129,R155,R168
548 2400 520	RES 158K OHM 1/2W 1%	1 EA	R069
548 2400 547	RES 301K OHM 1/2W 1%	1 EA	R119
548 2400 566	RES 475K OHM 1/2W 1%	1 EA	R076
548 2400 581	RES 681K OHM 1/2W 1%	2 EA	R033,R114
548 2400 601	RES 1MEG OHM 1/2W 1%	8 EA	R051,R052,R087,R088,R107,R111,R127,R161
550 0858 000	TRIMPOT 5K OHM 1/2W 10%	1 EA	R056
550 0914 000	POT 10K OHM 1/2W 10%	2 EA	R065,R067
550 0941 000	POT 50K OHM 1/2W 10%	1 EA	R066
550 0949 001	TRIMPOT 100K OHM 1/2W 10%	3 EA	R029,R054,R068
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	2 EA	R113,R118
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	3 EA	R035,R104,R143
550 0961 000	TRIMPOT 50K OHM 1/2W 10%	1 EA	R173
550 0984 000	TRIMPOT 500K OHM 1/2W 10%	1 EA	R171
550 1070 000	TRIMPOT 100 OHM 1/2W 10%	2 EA	R019,R026
604 1089 000	SW, TGL SPDT VERT PCB MT	1 EA	S001
610 0900 000	HDR, 3C VERT 1ROW UNSHR	5 EA	JP004,JP005,JP006,JP007,JP008
610 0979 000	*HDR 10C 2ROW VERT TOP LATCH	2 EA	J003,J005
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	1 EA	J001
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	1 EA	J002
610 1070 000	HDR, 6C VERT 2ROW UNSHR	2 EA	JP001,JP002
610 1107 000	HDR, 12C VERT 1ROW FRICTION	1 EA	J004
610 1121 000	HDR, 4C VERT 2ROW UNSHR	1 EA	JP009
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	8 EA	#JP001,#JP002,#JP004,#JP005,#JP006,#JP007,#JP008,#JP009
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 7930 534	SCHEM, ANALOG INPUT BD	0 DWG	
843 5155 534	PWB, ANALOG INPUT BD	1 EA	

917 2210 013	TRIM 8.0 FIRMWARE	3 EA	U019,U020,U021
917 2413 133	PRGM, RAMP1 PWR BLOCK,	1 EA	U006
917 2413 134	PRGM, FOLD BACK COMPARATOR PWR	1 EA	U005
999 2766 001	HARDWARE LIST, ANALOG	1 EA	

Table 7-29 ASSY, LV POWER SUPPLY - 992 9195 001 (T)

Harris PN	Description	Qty UM	Reference Designators
358 3000 000	PLATE, END STOP, DIN RAIL MT	2 EA	
606 1136 080	CKT BRKR 8 AMPS 2P 480VAC	1 EA	CB001
606 1136 160	CKT BRKR 16 AMPS 2P 480VAC	1 EA	CB002
646 1255 201	LABEL WARN REMOVE PWR	1 EA	
736 0268 000	POWER SUPPLY 24V@20A	1 EA	A003
917 2332 372	SPACER	4 EA	
922 1238 141	RAIL T-BLOCK	1 EA	
939 8154 203	CV SUPPLY PLT	1 EA	
939 8154 435	CABLE, XFMR TAP	1 EA	#A003
943 5450 362	CV XFMR CVR	1 EA	#A003
981 0006 002	PSU MODULE, DX-200 PB	1 EA	A004
992 8544 022	ASSY,MOUNTING SURGE SUPPRESSOR	1 EA	A002
992 9067 001	BD, LV POWER SUPPLY	1 EA	A001

Table 7-30 ASSY,MOUNTING SURGE SUPPRESSOR - 992 8544 022 (B)

Harris PN	Description	Qty UM	Reference Designators
302 0053 000	SCREW, PHMS 4-40 X 5/16 SST	4 EA	
302 0054 000	SCREW, PHMS 4-40 X 3/8 SST	4 EA	
302 0130 000	SCR, 8-32 X 3/8	2 EA	
306 0017 000	LOCKNUT, HEX KEP 8-32 SST	2 EA	
310 0003 000	WASHER, FLAT #4 SST (ANSI NARROW)	8 EA	
310 0006 000	WASHER, FLAT #8 SST (ANSI NARROW)	2 EA	
314 0003 000	LOCKWASHER, SPLIT #4 SST (ANSI)	8 EA	
356 0004 000	CABLE CLAMP, NYLON 0.250" DIA	2 EA	
358 3466 000	FLANGE, GREY (264)	2 EA	
614 0884 000	TERM BLK, THRU, 2-POLE, GREY (264)	4 EA	
614 0885 000	TERM BLK, THRU, 4-POLE, BLUE (264)	2 EA	
740 1232 000	*TRANSIENT PROTECTION UN 220V	1 EA	
917 2256 050	MOUNTING BRKT,SURGE SUPPRESSOR	1 EA	

Table 7-31 BD, LV POWER SUPPLY - 992 9067 001 (V--)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	3 EA	TP007,TP008,TP009
358 1928 000	JUMPER 1/4 LG 1/8H	6 EA	JP005,JP006,JP007,JP008,JP009,JP010
358 3475 000	STANDOFF, PEM, 6-32 X 0.5 (KFSE-632-16)	24 EA	
380 0125 000	XSTR, NPN 2N4401 ESD	1 EA	Q002
380 0189 000	*XSTR, NPN, MMBT3904	1 EA	Q001
382 0770 000	IC, 74HC04 ESD	1 EA	U012
382 0882 000	*IC, LM340LA/LM78L05AC (TO-92)	1 EA	U014
382 1349 000	IC 74HC03 CMOS ESD	2 EA	U005,U008
382 1446 000	IC, MAX8216 ESD	2 EA	U010,U011
382 1451 000	IC, MAX933 ESD	2 EA	U003,U004

382 1467 000	IC MAX791CPE ESD	1 EA	U007
384 0431 000	*DIODE, RECT 1N4001	11 EA	CR001,CR002,CR003,CR004,CR005,CR006,CR011,CR018,CR020,CR021,CR022
384 0661 000	LED, GRN T1-3/4 RTANG	5 EA	DS004,DS005,DS006,DS007,DS009
384 0662 000	LED, RED T1-3/4 RTANG	2 EA	DS003,DS008
384 0664 000	LED, YEL T1-3/4 RTANG	2 EA	DS001,DS002
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	1 EA	CR007
384 0736 000	DIODE, RECT 100V 6AMP (AXIAL)	4 EA	CR014,CR015,CR017,CR019
384 0838 000	DIODE, TVS (UNIDIR), ICTE-36	1 EA	CR023
386 0078 000	*ZENER 1N4734A 5.6V 5% 1W	2 EA	CR008,CR009
386 0082 000	*ZENER 1N4744A 15V 5% 1W	4 EA	CR010,CR012,CR013,CR016
398 0502 000	FUSE, FAST CART 5A 125V	5 EA	F001,F004,F005,F006,F007
398 0503 000	FUSE, FAST CART 3A 250V	3 EA	F008,F009,F010
402 0198 000	CLIP, FUSE 5MM DIA FUSE	16 EA	
404 0673 000	SOCKET, DIP, 8 PIN (DL)	2 EA	XU003,XU004
404 0674 000	SOCKET, DIP, 14 PIN (DL)	5 EA	XU005,XU008,XU010,XU011,XU012
404 0675 000	SOCKET, DIP, 16 PIN (DL)	1 EA	XU007
404 0821 000	SOCKET, DIP, 28 PIN (DL)	1 EA	XK001
404 0878 000	HEAT SINK 0.9" HIGH	1 EA	U013
404 0879 000	HEAT SINK 0.9" HIGH, FOR	3 EA	U001,U002,U006
404 0880 000	PAD, GRAFOIL 0.01" THK	1 EA	U013
404 0881 000	PAD, GRAFOIL 0.01" THK	3 EA	U001,U002,U006
506 0236 000	CAP 4700PF 5% 100V	8 EA	C003,C004,C019,C021,C022,C023,C024,C025
516 0453 000	CAP 0.100UF 10% 100V X7R	12 EA	C013,C014,C026,C027,C028,C029,C030,C042,C043,C044,C046,C047
516 0530 000	CAP 0.010UF 10% 100V X7R	4 EA	C016,C017,C018,C020
516 0792 000	CAP NETWORK .1UF 10%	1 EA	C012
522 0531 000	CAP 1UF 50V 20% 5MM NON-POLAR	4 EA	C002,C006,C009,C011
522 0574 000	CAP 22UF 50V 20%	4 EA	C001,C007,C008,C010
522 0586 000	CAP 3300UF 50V 20%	1 EA	C015
526 0018 000	CAP .33UF 35V 10%	1 EA	C005
526 0374 000	CAP 1.0F 5.5V	1 EA	C049
540 1395 000	RES NETWORK 10K OHM 1%	2 EA	R100,R101
540 1480 000	RES NETWORK 180 OHM 2%	1 EA	R018
548 2400 001	RES 1 OHM 1/2W 1%	4 EA	R005,R027,R028,R030
548 2400 069	RES 5.11 OHM 1/2W 1%	1 EA	R062
548 2400 138	RES 24.3 OHM 1/2W 1%	4 EA	R004,R008,R023,R032
548 2400 147	RES 30.1 OHM 1/2W 1%	4 EA	R003,R007,R024,R033
548 2400 201	RES 100 OHM 1/2W 1%	1 EA	R067
548 2400 226	RES 182 OHM 1/2W 1%	1 EA	R031
548 2400 258	RES 392 OHM 1/2W 1%	5 EA	R044,R045,R050,R061,R069
548 2400 301	RES 1K OHM 1/2W 1%	3 EA	R058,R060,R068
548 2400 312	RES 1.3K OHM 1/2W 1%	3 EA	R016,R042,R072

548 2400 330	RES 2K OHM 1/2W 1%	1 EA	R015
548 2400 334	RES 2.21K OHM 1/2W 1%	1 EA	R019
548 2400 347	RES 3.01K OHM 1/2W 1%	1 EA	R006
548 2400 384	RES 7.32K OHM 1/2W 1%	1 EA	R014
548 2400 401	RES 10K OHM 1/2W 1%	4 EA	R047,R049,R051,R074
548 2400 422	RES 16.5K OHM 1/2W 1%	1 EA	R013
548 2400 426	RES 18.2K OHM 1/2W 1%	1 EA	R064
548 2400 428	RES 19.1K OHM 1/2W 1%	1 EA	R036
548 2400 433	RES 21.5K OHM 1/2W 1%	1 EA	R009
548 2400 446	RES 29.4K OHM 1/2W 1%	1 EA	R001
548 2400 466	RES 47.5K OHM 1/2W 1%	2 EA	R020,R025
548 2400 470	RES 52.3K OHM 1/2W 1%	2 EA	R022,R029
548 2400 476	RES 60.4K OHM 1/2W 1%	2 EA	R065,R066
548 2400 480	RES 66.5K OHM 1/2W 1%	1 EA	R038
548 2400 501	RES 100K OHM 1/2W 1%	6 EA	R017,R048,R054,R057,R059, R073
548 2400 513	RES 133K OHM 1/2W 1%	1 EA	R041
548 2400 518	RES 150K OHM 1/2W 1%	2 EA	R037,R039
548 2400 523	RES 169K OHM 1/2W 1%	1 EA	R055
548 2400 539	RES 249K OHM 1/2W 1%	1 EA	R056
548 2400 558	RES 392K OHM 1/2W 1%	1 EA	R011
548 2400 559	RES 402K OHM 1/2W 1%	1 EA	R012
548 2400 630	RES 2MEG OHM 1/2W 1%	6 EA	R002,R010,R021,R026,R035, R040
550 1016 000	POT 500K OHM 1/4W 10%	1 EA	R034
560 0121 011	POSISTOR 1.1 AMP 60VDC 13MM DISC	1 EA	R046
560 0121 015	POSISTOR 1.6 AMP 60VDC 17MM DISC	1 EA	R043
566 0023 000	CONVERTER,DC/DC 18.5V/50W	2 EA	U001,U002
566 0024 000	CONVERTER, DC/DC 7.5V/25W	1 EA	U006
566 0025 000	CONVERTER, DC/DC 36V/150W	1 EA	U013
574 0478 000	RELAY 4PDT 24VDC 2A NON-LATCH	1 EA	K001
610 0750 000	TEST PROBE, TYPE C	6 EA	TP001,TP002,TP003,TP004,T P005,TP006
610 0900 000	HDR, 3C VERT 1ROW UNSHR	1 EA	JP001
610 1235 000	HDR, MALE 4C 1ROW VERTICAL	1 EA	J003
610 1236 000	HDR, MALE 8C 1ROW VERTICAL	1 EA	J002
610 1245 000	HDR, MALE 24C 1ROW VERTICAL	1 EA	J001
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	1 EA	JP001
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
843 5458 291	SCH, LV POWER SUPPLY BD	0 DWG	
843 5458 293	PWB, LV POWER SUPPLY BD	1 EA	
999 2830 001	HARDWARE LIST, LV POWER	1 EA	

Table 7-32 KIT,PAC,PRIORITY ONE PARTS - 992 9316 001 (B)

Harris PN	Description	Qty UM	Reference Designators
026 6010 003	GROMMET STRIP, 0.125	80 FT	
041 6030 014	CHANNEL 1/16 MTL	18 FT	
354 0010 000	LUG RING #10 16-14AWG BLU	2 EA	#R050
358 0002 000	*BRACKET RESISTOR MTG	2 EA	#R002

358 0004 000	BRACKET, RES MTG, FOR 0.75 ID CORE	2 EA	#R001
358 0437 000	BUSHING PANEL .252 ID	1 EA	#L002
358 0960 000	COUPLER, 1/4 X 1/4 SHAFT	1 EA	#L002
358 2511 000	STANDOFF, 10-32 X 3/4	42 EA	#A036,#A040
358 2598 000	CABLE TIE MOUNT, 4-WAY	100 EA	
358 3000 000	PLATE, END STOP, DIN RAIL MT	4 EA	
358 3122 000	STUD, 10-32 X 1-1/4 BRASS	4 EA	
358 3131 000	STUD, 1/4-20 X 1 BRASS	1 EA	#C004
358 3300 000	FLAT CABLE MOUNT - BASE	4 EA	
358 3301 000	FLAT CABLE MOUNT - COVER	4 EA	
358 3490 000	END STOP, 264 TERM BLOCK	2 EA	
358 3491 000	END PLATE, ORANGE (264)	1 EA	
358 3498 000	PLATE, END COVER (280 SPECIAL)	1 EA	
398 0186 000	FUSE 1 TIME 30A 250V	2 EA	F001,F002
402 0014 000	FUSE HOLDER, 2 POLE	1 EA	XF1,XF2
424 0023 000	GROMMET 1.000 GROOVE DIA	1 EA	
448 1032 000	HINGE, METAL LIFT-OFF	12 EA	
492 0309 000	INDUCTOR VAR 28UH	1 EA	L001
522 0586 000	CAP 3300UF 50V 20%	2 EA	C067,C068
542 1731 000	RES 5.0 OHM 25W 1%	1 EA	R050
552 0085 000	RES, ADJ 50 OHM 50W	1 EA	R002
552 0173 000	RES, ADJ 10 OHM 175W	1 EA	R001
610 1262 000	JUMPER, 2-POLE, GREY (264)	2 EA	
614 0808 000	*TERM BLK, THRU, 2-POLE GREY (283) 12MM	2 EA	
614 0892 000	TERM BLK, THRU, 4-POLE, BLUE (264)	4 EA	
614 0893 000	TERM BLK, THRU, 2-POLE, GREY (264)	3 EA	
614 0896 000	TERM BLK, GROUND, 4-POLE, GRN/YEL (264)	1 EA	
614 0898 000	*TERM BLK, GND, 2-POLE GRN/YEL (283) 12MM	1 EA	
614 0899 000	TERM BLOCK, 3C	9 EA	
614 0919 000	JUMPER, 2-POLE ADJACENT 280	14 EA	
620 0455 000	ADAPTER, BNC JACK-JACK	1 EA	J001
638 0029 000	SHUNT, METER 30A 250MV	1 EA	SH002
646 0665 000	LABEL, INSPECTION	1 EA	
646 1426 000	END PLATE 283 FRONT ENTRY	1 EA	
650 0028 000	KNOB RD SKIRT 1.135" DIA	4 EA	
813 4999 030	STDOFF 6-32X1.00 1/4 HEX	6 EA	#A052
813 4999 031	STDOFF 6-32X1-1/4 1/4 HEX	55 EA	#A025,#A026,#A027,#A028, #A029,R031
813 5000 030	STDOFF 8-32X1 5/16 HEX	4 EA	#A046
813 5007 041	STDOFF 6-32 X 1.63 X .25D	11 EA	
817 2150 005	CAP STDOFF	42 EA	
817 2150 037	GROUNDING PLATE	5 EA	#E001,#E002,#E003
822 0922 018	SPLITTER INS SHT	2 EA	#A046
822 0922 112	STDOFF 1 X 1 X 1/4-20	1 EA	#A046
822 0922 165	SHAFT 3.3"	1 EA	#L002
822 0999 023	PAC CAP BRACKET	21 EA	
822 0999 024	CABLE MTG CHANNEL	7 EA	
822 0999 031	OUTPUT MONITOR SPACER	2 EA	
822 0999 032	OUTPUT MONITOR SPACER	2 EA	
822 0999 104	STRAP	5 EA	
829 9009 250	ADJUSTMENT COUPLING	1 EA	#L002

839 7930 072	AIR FLOW SENSOR DUCT	5 EA	
839 7930 090	PAC INNER PNL ANG FRT	2 EA	
913 5007 054	STANDOFF 6-32 X 2.94 LG	6 EA	
917 2413 206	STANDOFF	21 EA	
917 2413 213	PLATE, CROSSOVER	1 EA	
917 2413 310	JUMPER, CAP TO MOTHERBD	4 EA	
917 2413 330	HINGE SPACER	8 EA	
917 2413 341	CARRIER RAIL - 6.3"	1 EA	
917 2413 458	STRAP, GROUND	1 EA	
922 0999 016	Z BRACE	8 EA	
922 0999 109	DRAIN CHOKE	1 EA	L003
922 0999 605	TRANSFORMER	1 EA	
922 1238 009	SLEEVE, CROSSOVER	1 EA	
922 1238 010	ANGLE, LOCK MOUNTING	3 EA	
922 1238 057	SUPPORT, MOTHERBOARD M/D	38 EA	
922 1238 058	SUPPORT, MOTHERBOARD END	14 EA	
922 1238 065	PLATE CAP MNTG	1 EA	#C001
922 1238 263	BLOCK, CHILLER MTG.	36 EA	
922 1238 290	RAIL, SENSOR BLOCK MTG.	1 EA	
939 7930 616	PA CROSSOVER COND	1 EA	
939 8154 102	SHIELD, PAC CAP RF	2 EA	
939 8154 192	COND, PA/EPA CROSSOVER	1 EA	
939 8154 239	FUSE BD BUS BAR	2 EA	
939 8154 240	FUSE BD BUS BAR	1 EA	
943 5155 656	PREDRIVER TUNE MTG PLT	1 EA	#A054
943 5285 132	RAIL, WAGO BLOCK,	1 EA	
943 5450 102	SHIELD,FRONT PA CROSSOVER	1 EA	
943 5450 103	SHIELD, REAR PA CROSSOVER	1 EA	
943 5450 104	COVER, FRONT PA/EPA	1 EA	
943 5450 105	COVER, REAR PA/EPA	1 EA	
943 5450 154	PAC INNER PNL ANGLE REAR	2 EA	
943 5450 253	PAC LT OUTER PANEL	1 EA	
943 5450 268	PAC RT OUTER PNL	1 EA	
943 5450 298	SHELF, SPLITTER	1 EA	
943 5450 299	SHELF, BOTTOM DRIVER	1 EA	
943 5450 300	SHELF, TOP DRIVER	1 EA	
943 5450 361	SHIELD, PAC BASE	1 EA	
943 5450 371	PAC RT INNER PNL	1 EA	
943 5450 402	WELDMENT, PAC CABINET	1 EA	
943 5450 498	PLATE, CHILLER, CENTER	3 EA	
943 5450 499	PLATE, CHILLER, END	6 EA	
943 5450 561	PANEL, FRONT INNER	2 EA	
943 5450 580	PANEL, FRT INNER, RT BAY	1 EA	
943 5450 694	PANEL, PA CAB LEFT INNER	1 EA	
952 9180 004	UPPER FUSE BD CABLE	2 EA	
952 9180 005	LOWER FUSE BD CABLE	3 EA	
992 5889 002	PWA, IPA PWR SPLITTER,ESD SAFE	1 EA	A046
992 6752 005	PWA, MULTIMETER/PROBE,ESD SAFE	2 EA	A009,A041
992 8007 003	PWA, FUSE, ESD SAFE	1 EA	A036
992 8007 004	PWA, FUSE, ESD SAFE	4 EA	A037,A038,A039,A040
992 8187 001	PWA, PWR DISTRIBUTION,ESD SAFE	3 EA	A033,A034,A052
992 8193 006	PWB, MOD ENCODER MAIN	4 EA	A026,A027,A028,A029

992 8193 007	PWB, MOD ENCODER BINARY	1 EA	A025
992 8536 003	*PWA, OUTPUT MONITOR,	1 EA	A021
992 8537 002	DRIVER ENCODER BRD,	1 EA	A007
992 8677 002	PWA, ARC DETECTOR	2 EA	A043,A044
992 8979 001	PRE-DRVR BAND SELECT, ESD SAFE	1 EA	A054
992 8989 001	BD,XMTR INTERFCE EXTENDED	1 EA	A030
992 9116 005	ASSEMBLY, PA FILTER CAP	1 EA	
992 9163 003	PWA, POWER BLOCK INTERFACE	1 EA	A023
992 9196 001	CABLE PACKAGE, PA CAB	1 EA	

Table 7-33 PWA, MULTIMETER/PROBE,ESD SAFE - 992 6752 005 (B--)

Harris PN	Description	Qty UM	Reference Designators
384 0431 000	*DIODE, RECT 1N4001	2 EA	CR004,CR005
384 0612 000	DIODE 1N3070 ESD	1 EA	CR001
516 0530 000	CAP 0.010UF 10% 100V X7R	1 EA	C003
516 0555 000	CAP 0.047UF 10% 100V X7R	1 EA	C001
548 2400 401	RES 10K OHM 1/2W 1%	1 EA	R004
548 2400 446	RES 29.4K OHM 1/2W 1%	1 EA	R005
548 2400 543	RES 274K OHM 1/2W 1%	1 EA	R002
548 2400 547	RES 301K OHM 1/2W 1%	1 EA	R003
548 2400 550	RES 324K OHM 1/2W 1%	1 EA	R001
600 0606 000	SW, ROTARY 2P 6 POS	2 EA	S001,S002
604 0605 000	SW, TGL DPDT ALT ACTION	1 EA	S003
610 0978 000	*HDR 10C 2ROW RT ANG TOP LATCH	1 EA	J005
610 0980 000	*HDR 20C 2ROW RT ANG TOP LATCH	1 EA	J004
610 1210 000	JUMPER, FLEX 10C X 2" LG	1 EA	FS001
632 1133 000	AMMETER, 0-3ADC, 4.5",[W]	1 EA	M001
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
700 1305 000	PROBE W/BLACK LEAD, 5 FT	1 EA	E001
839 6208 302	SCH, MULTIMETER	0 DWG	
843 4038 202	PWB, MULTIMETER	1 EA	
999 2446 001	HARDWARE LIST	1 EA	

Table 7-34 PWA, FUSE, ESD SAFE - 992 8007 003 (F--)

Harris PN	Description	Qty UM	Reference Designators
324 0257 000	NUT, CAPTIVE 6-32	2 EA	
324 0321 000	NUT, CAPTIVE 10-32	14 EA	
384 0341 000	DIODE, RECT 1N5404	8 EA	CR001,CR002,CR003,CR005,CR006,CR007,CR008,CR009
398 0436 000	FUSE 1 TIME 20A 250VAC	1 EA	F009
398 0458 000	FUSE, 35A 250V CRTG.	7 EA	F001,F002,F003,F005,F006,F007,F008
402 0004 000	CLIP, FUSE .812 60A 250V	14 EA	
402 0069 000	CLIP, FUSE BRONZE	2 EA	
540 1600 419	RES 56K OHM 3W 5%	2 EA	R025,R026
542 0095 000	RES 10K OHM 5% 12W	1 EA	R010
542 0121 000	RES 150 OHM 5% 20W	8 EA	R001,R002,R003,R005,R006,R007,R008,R009

WARNING: Disconnect primary power prior to servicing.

646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 7930 030	SCHEMATIC, FUSE BOARD	0 DWG	
843 5100 029	PWB, FUSE	1 EA	
999 2576 003	HARDWARE LIST	1 EA	

Table 7-35 PWA, FUSE, ESD SAFE - 992 8007 004 (G--)

Harris PN	Description	Qty UM	Reference Designators
324 0321 000	NUT, CAPTIVE 10-32	16 EA	
384 0341 000	DIODE, RECT 1N5404	8 EA	CR001,CR002,CR003,CR004,CR005,CR006,CR007,CR008
398 0458 000	FUSE, 35A 250V CRTG.	8 EA	F001,F002,F003,F004,F005,F006,F007,F008
402 0004 000	CLIP, FUSE .812 60A 250V	16 EA	#F001,#F002,#F003,#F004,#F005,#F006,#F007,#F008
508 0549 000	CAP .33UF 5% 400VDC	1 EA	C003
542 0095 000	RES 10K OHM 5% 12W	1 EA	R010
542 0121 000	RES 150 OHM 5% 20W	8 EA	R001,R002,R003,R004,R005,R006,R007,R008
548 2400 385	RES 7.5K OHM 1/2W 1%	1 EA	R021
548 2400 401	RES 10K OHM 1/2W 1%	1 EA	R024
548 2400 407	RES 11.5K OHM 1/2W 1%	1 EA	R018
548 2400 466	RES 47.5K OHM 1/2W 1%	2 EA	R022,R023
548 2400 518	RES 150K OHM 1/2W 1%	4 EA	R016,R017,R019,R020
548 2400 547	RES 301K OHM 1/2W 1%	1 EA	R027
610 0999 000	HDR, 10 PIN, PC BD	1 EA	J002
620 0515 000	RECP, SCREW ON SMC	1 EA	J001
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 7930 030	SCHEMATIC, FUSE BOARD	0 DWG	
843 5100 029	PWB, FUSE	1 EA	
999 2576 004	HARDWARE LIST	1 EA	

Table 7-36 PWB, MOD ENCODER MAIN - 992 8193 006 (J--)

Harris PN	Description	Qty UM	Reference Designators
324 0281 000	NUT, CAPTIVE 4-40	2 EA	#U042
354 0309 000	TERM SOLDER	35 EA	#CR055,#CR056,TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031,TP032,TP033
356 0084 000	CABLE TY RAP	1 EA	
358 2684 000	STANDOFF, PEM, 4-40 X 0.125 (KFSE-440-4)	6 EA	
380 0125 000	XSTR, NPN 2N4401 ESD	4 EA	Q002,Q003,Q004,Q005
380 0126 000	XSTR, PNP 2N4403 ESD	1 EA	Q001

380 0678 000	*XSTR, NPN, MPQ2222A	1 EA	U035
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	2 EA	U043,U046
382 0443 000	IC, CD4053BE ESD	1 EA	U044
382 0594 000	*IC TL074ACN ESD	1 EA	U038
382 0746 000	*IC, LM79L05AC (TO-92)	1 EA	U039
382 0749 000	IC NE5532A ESD	1 EA	U047
382 0774 000	IC 74HC14 ESD	4 EA	U003,U015,U048,U049
382 1031 000	IC, LM338K ESD	1 EA	U042
382 1065 000	IC 74HCT273 ESD	5 EA	U001,U016,U021,U022,U033
382 1084 000	IC, LP339 (DIP-14)	3 EA	U034,U036,U037
382 1150 000	IC 74HC682 (ESD)	1 EA	U004
382 1199 000	IC, LM35 ESD	1 EA	U040
382 1202 000	IC PA 02 ESD	1 EA	U045
382 1204 000	IC TC4423 ESD	16 EA	U007,U008,U009,U010,U011,U012,U013,U014,U023,U024,U027,U028,U029,U030,U031,U032
384 0431 000	*DIODE, RECT 1N4001	4 EA	CR005,CR042,CR043,CR058
384 0612 000	DIODE 1N3070 ESD	24 EA	CR002,CR003,CR004,CR006,CR007,CR008,CR017,CR021,CR024,CR025,CR026,CR027,CR028,CR029,CR030,CR031,CR035,CR038,CR044,CR045,CR046,CR047,CR048,CR051
384 0661 000	LED, GRN T1-3/4 RTANG	5 EA	DS008,DS011,DS012,DS013,DS014
384 0662 000	LED, RED T1-3/4 RTANG	8 EA	DS002,DS003,DS004,DS005,DS006,DS007,DS009,DS010
384 0664 000	LED, YEL T1-3/4 RTANG	1 EA	DS001
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	7 EA	CR033,CR034,CR036,CR037,CR041,CR054,CR057
384 0838 000	DIODE, TVS (UNIDIR), ICTE-36	2 EA	CR049,CR050
386 0016 000	ZENER 1N2974A 10V 10W 10% ESD	1 EA	CR055
386 0082 000	*ZENER 1N4744A 15V 5% 1W	4 EA	CR018,CR020,CR022,CR039
386 0100 000	*ZENER 1N4747A 20V 5% 1W	4 EA	CR019,CR023,CR032,CR040
386 0123 000	*ZENER 1N4732A 4.7V 5% 1W	1 EA	CR001
386 0425 000	ZENER 1N2974(R) 10V 10W ESD	1 EA	CR056
398 0020 000	FUSE, FAST CART 3A 250V	1 EA	F004
398 0021 000	FUSE, FAST CART 4A 250V	1 EA	F002
398 0022 000	FUSE, FAST CART 5A 250V	1 EA	F003
398 0465 000	FUSE, FAST CART 2A 250V	3 EA	F001,F005,F006
402 0129 000	CLIP, 1/4 DIA FUSE	6 EA	XF002,XF003,XF004
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6 EA	XF001,XF005,XF006
404 0509 000	SOCKET, DIP, 28 PIN (DL)	4 EA	XU005,XU006,XU025,XU026
404 0513 000	HEAT SINK PA1-1CB	2 EA	#U043,#U046

404 0673 000	SOCKET, DIP, 8 PIN (DL)	17 EA	XU007,XU008,XU009,XU010,XU011,XU012,XU013,XU014,XU023,XU024,XU027,XU028,XU029,XU030,XU031,XU032,XU047
404 0674 000	SOCKET, DIP, 14 PIN (DL)	11 EA	XU003,XU015,XU019,XU020,XU034,XU035,XU036,XU037,XU038,XU048,XU049
404 0675 000	SOCKET, DIP, 16 PIN (DL)	8 EA	XS007,XS008,XU044
404 0767 000	SOCKET, DIP, 20 PIN (DL)	8 EA	XU001,XU004,XU016,XU017,XU018,XU021,XU022,XU033
404 0790 000	HEATSINK, 8-PIN DIP	16 EA	#U007,#U008,#U009,#U010,#U011,#U012,#U013,#U014,#U023,#U024,#U027,#U028,#U029,#U030,#U031,#U032
404 0797 000	SOCKET, DIP, 24 PIN (DL)	1 EA	XU002
410 0382 000	WASHER SHLDR 0.115 ID NYLON	2 EA	#U042
410 0385 000	INSULATOR TO-3 SILICON	1 EA	#U042
410 0440 000	INSULATOR PAD FOR TO-247,	2 EA	#U043,#U046
494 0196 000	INDUCTOR, 100UH 10% (9250)	2 EA	L001,L002
500 0753 000	CAP MICA 56PF 500V 5%	3 EA	C039,C065,C066
500 0837 000	CAP MICA 510PF 500V 5%	1 EA	C069
500 0845 000	CAP, MICA, 2000PF 500V 5%	1 EA	C067
506 0235 000	CAP 3300PF 5% 100V	32 EA	C020,C021,C022,C026,C028,C030,C032,C034,C036,C038,C040,C092,C093,C094,C095,C096,C097,C098,C099,C100,C101,C102,C103,C104,C105,C106,C107,C108,C109,C112,C113,C114
516 0453 000	CAP 0.100UF 10% 100V X7R	77 EA	C013,C014,C015,C016,C023,C024,C041,C042,C043,C044,C045,C046,C047,C048,C049,C051,C054,C057,C059,C061,C062,C063,C068,C070,C073,C076,C077,C080,C081,C082,C083,C086,C087,C090,C091,C111,C115,C116,C117,C118,C119,C120,C121,C122,C123,C124,C125,C126,C127,C128,C129,C130,C131,C132,C133,C134,C135,C136,C137,C138,C139,C140,C141,C147,C148,C149,C151,C152,C153,C154,C156,C157,C158,C159,C160,C163,C165
516 0511 000	CAP 0.47UF 100V 20%	1 EA	C164

516 0530 000	CAP 0.010UF 10% 100V X7R	15 EA	C001,C002,C003,C004,C009, C010,C011,C012,C056,C142, C143,C144,C145,C146,C162
522 0550 000	*CAP 100UF 35V 20% (6.3X11)	7 EA	C052,C058,C060,C064,C072, C155,C161
526 0050 000	CAP 1UF 35V 20%	16 EA	C005,C006,C007,C008,C017, C018,C019,C071,C074,C075, C078,C079,C084,C085,C088, C089
526 0108 000	CAP 4.7UF 35V 20%	1 EA	C055
526 0109 000	CAP 22UF 25V 20%	1 EA	C110
540 1380 000	RES NETWORK 10K OHM 2%	8 EA	R020,R038,R049,R053,R097, R118,R135,R205
540 1386 000	RES NETWORK 10K OHM 2%	4 EA	R025,R029,R035,R040
540 1430 000	RES NETWORK, 10K OHM 2%	4 EA	R012,R028,R034,R062
540 1443 000	RES NETWORK 27 OHM 2%	2 EA	R021,R022
540 1493 000	RES NETWORK 100K OHM	2 EA	R051,R052
540 1496 000	RES NETWORK 100 OHM	4 EA	R044,R045,R046,R054
540 1600 115	RES 39 OHM 3W 5%	32 EA	R001,R004,R006,R013,R024, R031,R037,R043,R047,R064, R066,R068,R071,R074,R076, R078,R079,R082,R136,R179, R180,R182,R184,R187,R188, R191,R193,R195,R196,R197, R198,R199
540 1600 201	RES 100 OHM 3W 5%	32 EA	R002,R003,R005,R007,R008, R009,R010,R011,R027,R033, R041,R063,R065,R067,R069, R070,R072,R073,R075,R077, R080,R081,R112,R147,R181, R183,R185,R186,R189,R190, R192,R194
540 1600 208	RES 200 OHM 3W 5%	2 EA	R166,R168
542 0051 000	RES 3 OHM 5% 12W	3 EA	R132,R133,R211
542 1600 000	RES 0.1 OHM 5W 5%	1 EA	R144
544 1662 000	RES 30 OHM 20W 1% TO-220	1 EA	R115
548 2400 030	RES 2 OHM 1/2W 1%	1 EA	R145
548 2400 185	RES 75 OHM 1/2W 1%	3 EA	R105,R110,R114
548 2400 201	RES 100 OHM 1/2W 1%	2 EA	R143,R171
548 2400 219	RES 154 OHM 1/2W 1%	1 EA	R125
548 2400 230	RES 200 OHM 1/2W 1%	1 EA	R226
548 2400 251	RES 332 OHM 1/2W 1%	6 EA	R059,R092,R093,R094,R095, R096
548 2400 258	RES 392 OHM 1/2W 1%	5 EA	R116,R155,R163,R172,R212
548 2400 266	RES 475 OHM 1/2W 1%	2 EA	R085,R138
548 2400 269	RES 511 OHM 1/2W 1%	2 EA	R139,R169
548 2400 281	RES 681 OHM 1/2W 1%	2 EA	R126,R156

548 2400 285	RES 750 OHM 1/2W 1%	1 EA	R124
548 2400 301	RES 1K OHM 1/2W 1%	11 EA	R016,R050,R055,R056,R057, R058,R060,R083,R084,R146, R152
548 2400 321	RES 1.62K OHM 1/2W 1%	1 EA	R221
548 2400 330	RES 2K OHM 1/2W 1%	2 EA	R157,R161
548 2400 334	RES 2.21K OHM 1/2W 1%	4 EA	R014,R158,R200,R202
548 2400 339	RES 2.49K OHM 1/2W 1%	1 EA	R222
548 2400 347	RES 3.01K OHM 1/2W 1%	1 EA	R107
548 2400 351	RES 3.32K OHM 1/2W 1%	3 EA	R099,R102,R103
548 2400 366	RES 4.75K OHM 1/2W 1%	1 EA	R203
548 2400 385	RES 7.5K OHM 1/2W 1%	1 EA	R130
548 2400 389	RES 8.25K OHM 1/2W 1%	2 EA	R201,R207
548 2400 401	RES 10K OHM 1/2W 1%	37 EA	R015,R017,R018,R019,R023, R061,R088,R091,R098,R117, R120,R122,R123,R127,R128, R137,R149,R153,R154,R159, R160,R165,R167,R175,R176, R177,R178,R204,R206,R208, R216,R218,R219,R220,R223, R224,R225
548 2400 413	RES 13.3K OHM 1/2W 1%	1 EA	R129
548 2400 430	RES 20K OHM 1/2W 1%	1 EA	R100
548 2400 434	RES 22.1K OHM 1/2W 1%	2 EA	R140,R142
548 2400 438	RES 24.3K OHM 1/2W 1%	1 EA	R131
548 2400 440	RES 25.5K OHM 1/2W 1%	1 EA	R104
548 2400 451	RES 33.2K OHM 1/2W 1%	4 EA	R086,R089,R101,R119
548 2400 458	RES 39.2K OHM 1/2W 1%	1 EA	R164
548 2400 469	RES 51.1K OHM 1/2W 1%	2 EA	R148,R151
548 2400 501	RES 100K OHM 1/2W 1%	8 EA	R109,R113,R141,R209,R210, R214,R215,R217
548 2400 512	RES 130K OHM 1/2W 1%	4 EA	R087,R090,R106,R121
548 2400 589	RES 825K OHM 1/2W 1%	2 EA	R108,R111
548 2400 601	RES 1MEG OHM 1/2W 1%	4 EA	R134,R170,R173,R174
550 0858 000	TRIMPOT 5K OHM 1/2W 10%	1 EA	R150
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	1 EA	R213
600 0579 000	SW, ROTARY 4PDT	2 EA	S007,S008
604 0905 000	SWITCH, PB SPDT MOM VERT	1 EA	S006
610 0870 000	PLUG, NON-INS SHORTING	34 EA	#P002,#P003,#P004,#P010,#P 001A
610 0900 000	HDR, 3C VERT 1ROW UNSHR	2 EA	XP005,XP006
610 0980 000	*HDR 20C 2ROW RT ANG TOP LATCH	4 EA	J001,J002,J003,J004
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	1 EA	J009
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	1 EA	J008
610 1054 000	HEADER STRAIGHT MNT 8 PIN	1 EA	J006
610 1098 000	HDR, 4 PIN IN-LINE	2 EA	J012,J013
610 1106 000	HDR, 8C VERT 1ROW FRICTION	1 EA	J007
610 1107 000	HDR, 12C VERT 1ROW FRICTION	1 EA	J005
612 0904 000	JACK, PC MT GOLD PLATED	1 EA	P011

612 1176 000	DIP STRIP, FEMALE 10 POS	4 EA	P002,P003,P004,P001A
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	2 EA	P005,P006
612 1369 000	JACK, PCB MT, .051 PIN	10 EA	XU042,XU045
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 7930 011	SCHEM, MOD ENCODER	0 DWG	
839 7930 105	MOD ENCODER HS	1 EA	
843 5155 011	PWB, MOD ENCODER	1 EA	
917 2150 803	4 PIN PLUG, JUMPER PIN1-2, 3-4	1 EA	P012
917 2413 101	EPROM, MOD ENCODER 200KW	4 EA	U005,U006,U025,U026
917 2413 102	HEADER, MOD ENCODER 200KW	4 EA	JP001,JP002,JP004,JP005
917 2542 001	ASSY, AIR SENSOR	1 EA	#R115,U041
999 2660 001	HARDWARE LIST	1 EA	

Table 7-37 PWB, MOD ENCODER BINARY - 992 8193 007 (J--)

Harris PN	Description	Qty UM	Reference Designators
324 0281 000	NUT, CAPTIVE 4-40	2 EA	#U042
354 0309 000	TERM SOLDER	35 EA	#CR055,#CR056,TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031,TP032,TP033
356 0084 000	CABLE TY RAP	1 EA	
358 2684 000	STANDOFF, PEM, 4-40 X 0.125 (KFSE-440-4)	6 EA	
380 0125 000	XSTR, NPN 2N4401 ESD	4 EA	Q002,Q003,Q004,Q005
380 0126 000	XSTR, PNP 2N4403 ESD	1 EA	Q001
380 0678 000	*XSTR, NPN, MPQ2222A	1 EA	U035
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	2 EA	U043,U046
382 0443 000	IC, CD4053BE ESD	1 EA	U044
382 0580 000	IC, 74LS32 ESD	2 EA	U019,U020
382 0594 000	*IC TL074ACN ESD	1 EA	U038
382 0746 000	*IC, LM79L05AC (TO-92)	1 EA	U039
382 0749 000	IC NE5532A ESD	1 EA	U047
382 0774 000	IC 74HC14 ESD	4 EA	U003,U015,U048,U049
382 1031 000	IC, LM338K ESD	1 EA	U042
382 1065 000	IC 74HCT273 ESD	7 EA	U001,U016,U017,U018,U021,U022,U033
382 1084 000	IC, LP339 (DIP-14)	3 EA	U034,U036,U037
382 1150 000	IC 74HC682 (ESD)	1 EA	U004
382 1199 000	IC, LM35 ESD	1 EA	U040
382 1202 000	IC PA 02 ESD	1 EA	U045
382 1204 000	IC TC4423 ESD	16 EA	U007,U008,U009,U010,U011,U012,U013,U014,U023,U024,U027,U028,U029,U030,U031,U032
384 0431 000	*DIODE, RECT 1N4001	4 EA	CR005,CR042,CR043,CR058

384 0612 000	DIODE 1N3070 ESD	24 EA	CR002,CR003,CR004,CR006,CR007,CR008,CR017,CR021,CR024,CR025,CR026,CR027,CR028,CR029,CR030,CR031,CR035,CR038,CR044,CR045,CR046,CR047,CR048,CR051
384 0661 000	LED, GRN T1-3/4 RTANG	5 EA	DS008,DS011,DS012,DS013,DS014
384 0662 000	LED, RED T1-3/4 RTANG	8 EA	DS002,DS003,DS004,DS005,DS006,DS007,DS009,DS010
384 0664 000	LED, YEL T1-3/4 RTANG	1 EA	DS001
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	7 EA	CR033,CR034,CR036,CR037,CR041,CR054,CR057
384 0838 000	DIODE, TVS (UNIDIR), ICTE-36	2 EA	CR049,CR050
386 0016 000	ZENER 1N2974A 10V 10W 10% ESD	1 EA	CR055
386 0082 000	*ZENER 1N4744A 15V 5% 1W	4 EA	CR018,CR020,CR022,CR039
386 0100 000	*ZENER 1N4747A 20V 5% 1W	4 EA	CR019,CR023,CR032,CR040
386 0123 000	*ZENER 1N4732A 4.7V 5% 1W	1 EA	CR001
386 0425 000	ZENER 1N2974(R) 10V 10W ESD	1 EA	CR056
398 0020 000	FUSE, FAST CART 3A 250V	1 EA	F004
398 0021 000	FUSE, FAST CART 4A 250V	1 EA	F002
398 0022 000	FUSE, FAST CART 5A 250V	1 EA	F003
398 0465 000	FUSE, FAST CART 2A 250V	3 EA	F001,F005,F006
402 0129 000	CLIP, 1/4 DIA FUSE	6 EA	XF002,XF003,XF004
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6 EA	XF001,XF005,XF006
404 0509 000	SOCKET, DIP, 28 PIN (DL)	4 EA	XU005,XU006,XU025,XU026
404 0513 000	HEAT SINK PA1-1CB	2 EA	#U043,#U046
404 0673 000	SOCKET, DIP, 8 PIN (DL)	17 EA	XU007,XU008,XU009,XU010,XU011,XU012,XU013,XU014,XU023,XU024,XU027,XU028,XU029,XU030,XU031,XU032,XU047
404 0674 000	SOCKET, DIP, 14 PIN (DL)	11 EA	XU003,XU015,XU019,XU020,XU034,XU035,XU036,XU037,XU038,XU048,XU049
404 0675 000	SOCKET, DIP, 16 PIN (DL)	8 EA	XS007,XS008,XU044
404 0767 000	SOCKET, DIP, 20 PIN (DL)	8 EA	XU001,XU004,XU016,XU017,XU018,XU021,XU022,XU033
404 0790 000	HEATSINK, 8-PIN DIP	16 EA	#U007,#U008,#U009,#U010,#U011,#U012,#U013,#U014,#U023,#U024,#U027,#U028,#U029,#U030,#U031,#U032
404 0797 000	SOCKET, DIP, 24 PIN (DL)	1 EA	XU002

410 0382 000	WASHER SHLDR 0.115 ID NYLON	2 EA	#U042
410 0385 000	INSULATOR TO-3 SILICON	1 EA	#U042
410 0440 000	INSULATOR PAD FOR TO-247,	2 EA	#U043,#U046
494 0196 000	INDUCTOR, 100UH 10% (9250)	2 EA	L001,L002
500 0753 000	CAP MICA 56PF 500V 5%	3 EA	C039,C065,C066
500 0837 000	CAP MICA 510PF 500V 5%	1 EA	C069
500 0845 000	CAP, MICA, 2000PF 500V 5%	1 EA	C067
506 0235 000	CAP 3300PF 5% 100V	32 EA	C020,C021,C022,C026,C028, C030,C032,C034,C036,C038, C040,C092,C093,C094,C095, C096,C097,C098,C099,C100, C101,C102,C103,C104,C105, C106,C107,C108,C109,C112, C113,C114
516 0453 000	CAP 0.100UF 10% 100V X7R	77 EA	C013,C014,C015,C016,C023, C024,C041,C042,C043,C044, C045,C046,C047,C048,C049, C051,C054,C057,C059,C061, C062,C063,C068,C070,C073, C076,C077,C080,C081,C082, C083,C086,C087,C090,C091, C111,C115,C116,C117,C118, C119,C120,C121,C122,C123, C124,C125,C126,C127,C128, C129,C130,C131,C132,C133, C134,C135,C136,C137,C138, C139,C140,C141,C147,C148, C149,C151,C152,C153,C154, C156,C157,C158,C159,C160, C163,C165
516 0511 000	CAP 0.47UF 100V 20%	1 EA	C164
516 0530 000	CAP 0.010UF 10% 100V X7R	15 EA	C001,C002,C003,C004,C009, C010,C011,C012,C056,C142, C143,C144,C145,C146,C162
522 0550 000	*CAP 100UF 35V 20% (6.3X11)	7 EA	C052,C058,C060,C064,C072, C155,C161
526 0050 000	CAP 1UF 35V 20%	16 EA	C005,C006,C007,C008,C017, C018,C019,C071,C074,C075, C078,C079,C084,C085,C088, C089
526 0108 000	CAP 4.7UF 35V 20%	1 EA	C055
526 0109 000	CAP 22UF 25V 20%	1 EA	C110
540 1380 000	RES NETWORK 10K OHM 2%	8 EA	R020,R038,R049,R053,R097, R118,R135,R205
540 1386 000	RES NETWORK 10K OHM 2%	4 EA	R025,R029,R035,R040
540 1430 000	RES NETWORK, 10K OHM 2%	4 EA	R012,R028,R034,R062
540 1443 000	RES NETWORK 27 OHM 2%	2 EA	R021,R022
540 1493 000	RES NETWORK 100K OHM	2 EA	R051,R052
540 1496 000	RES NETWORK 100 OHM	4 EA	R044,R045,R046,R054

540 1600 115	RES 39 OHM 3W 5%	32 EA	R001,R004,R006,R013,R024, R031,R037,R043,R047,R064, R066,R068,R071,R074,R076, R078,R079,R082,R136,R179, R180,R182,R184,R187,R188, R191,R193,R195,R196,R197, R198,R199
540 1600 201	RES 100 OHM 3W 5%	28 EA	R008,R009,R010,R011,R027, R033,R041,R063,R065,R067, R069,R070,R072,R073,R075, R077,R080,R081,R112,R147, R181,R183,R185,R186,R189, R190,R192,R194
540 1600 203	RES 120 OHM 3W 5%	1 EA	R003
540 1600 204	RES 130 OHM 3W 5%	1 EA	R005
540 1600 205	RES 150 OHM 3W 5%	2 EA	R002,R007
540 1600 208	RES 200 OHM 3W 5%	2 EA	R166,R168
542 0051 000	RES 3 OHM 5% 12W	3 EA	R132,R133,R211
542 1600 000	RES 0.1 OHM 5W 5%	1 EA	R144
544 1662 000	RES 30 OHM 20W 1% TO-220	1 EA	R115
548 2400 030	RES 2 OHM 1/2W 1%	1 EA	R145
548 2400 185	RES 75 OHM 1/2W 1%	3 EA	R105,R110,R114
548 2400 201	RES 100 OHM 1/2W 1%	2 EA	R143,R171
548 2400 219	RES 154 OHM 1/2W 1%	1 EA	R125
548 2400 230	RES 200 OHM 1/2W 1%	1 EA	R226
548 2400 251	RES 332 OHM 1/2W 1%	6 EA	R059,R092,R093,R094,R095, R096
548 2400 258	RES 392 OHM 1/2W 1%	5 EA	R116,R155,R163,R172,R212
548 2400 266	RES 475 OHM 1/2W 1%	2 EA	R085,R138
548 2400 269	RES 511 OHM 1/2W 1%	2 EA	R139,R169
548 2400 281	RES 681 OHM 1/2W 1%	2 EA	R126,R156
548 2400 285	RES 750 OHM 1/2W 1%	1 EA	R124
548 2400 301	RES 1K OHM 1/2W 1%	11 EA	R016,R050,R055,R056,R057, R058,R060,R083,R084,R146, R152
548 2400 321	RES 1.62K OHM 1/2W 1%	1 EA	R221
548 2400 330	RES 2K OHM 1/2W 1%	2 EA	R157,R161
548 2400 334	RES 2.21K OHM 1/2W 1%	4 EA	R014,R158,R200,R202
548 2400 339	RES 2.49K OHM 1/2W 1%	1 EA	R222
548 2400 347	RES 3.01K OHM 1/2W 1%	1 EA	R107
548 2400 351	RES 3.32K OHM 1/2W 1%	3 EA	R099,R102,R103
548 2400 366	RES 4.75K OHM 1/2W 1%	1 EA	R203
548 2400 385	RES 7.5K OHM 1/2W 1%	1 EA	R130
548 2400 389	RES 8.25K OHM 1/2W 1%	2 EA	R201,R207
548 2400 401	RES 10K OHM 1/2W 1%	37 EA	R015,R017,R018,R019,R023, R061,R088,R091,R098,R117, R120,R122,R123,R127,R128, R137,R149,R153,R154,R159, R160,R165,R167,R175,R176,

			R177,R178,R204,R206,R208, R216,R218,R219,R220,R223, R224,R225
548 2400 413	RES 13.3K OHM 1/2W 1%	1 EA	R129
548 2400 430	RES 20K OHM 1/2W 1%	1 EA	R100
548 2400 434	RES 22.1K OHM 1/2W 1%	2 EA	R140,R142
548 2400 438	RES 24.3K OHM 1/2W 1%	1 EA	R131
548 2400 440	RES 25.5K OHM 1/2W 1%	1 EA	R104
548 2400 451	RES 33.2K OHM 1/2W 1%	4 EA	R086,R089,R101,R119
548 2400 458	RES 39.2K OHM 1/2W 1%	1 EA	R164
548 2400 469	RES 51.1K OHM 1/2W 1%	2 EA	R148,R151
548 2400 501	RES 100K OHM 1/2W 1%	8 EA	R109,R113,R141,R209,R210, R214,R215,R217
548 2400 512	RES 130K OHM 1/2W 1%	4 EA	R087,R090,R106,R121
548 2400 589	RES 825K OHM 1/2W 1%	2 EA	R108,R111
548 2400 601	RES 1MEG OHM 1/2W 1%	4 EA	R134,R170,R173,R174
550 0858 000	TRIMPOT 5K OHM 1/2W 10%	1 EA	R150
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	1 EA	R213
600 0579 000	SW, ROTARY 4PDT	2 EA	S007,S008
604 0905 000	SWITCH, PB SPDT MOM VERT	1 EA	S006
610 0870 000	PLUG, NON-INS SHORTING	34 EA	#P002,#P003,#P004,#P010,#P 001B
610 0900 000	HDR, 3C VERT 1ROW UNSHR	2 EA	XP005,XP006
610 0980 000	*HDR 20C 2ROW RT ANG TOP LATCH	4 EA	J001,J002,J003,J004
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	1 EA	J009
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	1 EA	J008
610 1054 000	HEADER STRAIGHT MNT 8 PIN	1 EA	J006
610 1098 000	HDR, 4 PIN IN-LINE	2 EA	J012,J013
610 1106 000	HDR, 8C VERT 1ROW FRICTION	1 EA	J007
610 1107 000	HDR, 12C VERT 1ROW FRICTION	1 EA	J005
612 0904 000	JACK, PC MT GOLD PLATED	1 EA	P011
612 1176 000	DIP STRIP, FEMALE 10 POS	4 EA	P002,P003,P004,P001B
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	2 EA	P005,P006
612 1369 000	JACK, PCB MT, .051 PIN	10 EA	XU042,XU045
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 7930 011	SCHEM, MOD ENCODER	0 DWG	
839 7930 105	MOD ENCODER HS	1 EA	
843 5155 011	PWB, MOD ENCODER	1 EA	
917 2150 803	4 PIN PLUG, JUMPER PIN1-2, 3-4	1 EA	P012
917 2413 101	EPROM, MOD ENCODER 200KW	4 EA	U005,U006,U025,U026
917 2413 102	HEADER, MOD ENCODER 200KW	5 EA	JP001,JP002,JP003,JP004,JP0 05
917 2413 103	PAL, CLIP 200KW	1 EA	U002
917 2542 001	ASSY, AIR SENSOR	1 EA	#R115,U041
999 2660 002	HARDWARE LIST	1 EA	

Table 7-38 *PWA, OUTPUT MONITOR, - 992 8536 003 (L)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	42 EA	TP001,TP004,TP005,TP006,T

			P007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031,TP032,TP033,TP034,TP035,TP036,TP037,TP038,TP039,TP040,TP041,TP042,TP043,TP044
358 1928 000	JUMPER 1/4 LG 1/8H	2 EA	JP001,JP050
380 0125 000	XSTR, NPN 2N4401 ESD	7 EA	Q010,Q011,Q012,Q013,Q014,Q022,Q023
380 0126 000	XSTR, PNP 2N4403 ESD	2 EA	Q007,Q018
380 0678 000	*XSTR, NPN, MPQ2222A	1 EA	U029
380 0728 000	XSTR, NMOS IRL520 ESD	5 EA	Q001,Q002,Q003,Q019,Q020
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	U027
382 0359 000	IC, LM340/LM7815C (TO-220)	1 EA	U022
382 0360 000	IC, LM7915C (TO-220)	1 EA	U031
382 0409 000	IC, 74C221 ESD	1 EA	U024
382 0428 000	*IC, LM358 (DIP-8)	1 EA	U011
382 0594 000	*IC TL074ACN ESD	3 EA	U010,U019,U020
382 0676 000	IC, 74LS05N (DIP-14)	1 EA	U005
382 0746 000	*IC, LM79L05AC (TO-92)	1 EA	U015
382 0769 000	IC 74HC02 ESD	1 EA	U030
382 0774 000	IC 74HC14 ESD	4 EA	U001,U014,U021,U033
382 0781 000	*IC, 74HC74 (DIP-14)	1 EA	U023
382 0882 000	*IC, LM340LA/LM78L05AC (TO-92)	1 EA	U016
382 0990 000	*IC, LH0002CN ESD	2 EA	U013,U034
382 1011 000	IC, 14541/4541 ESD	1 EA	U025
382 1084 000	IC, LP339 (DIP-14)	3 EA	U003,U009,U032
382 1297 000	IC, INA110 OP-AMP ESD	1 EA	U028
382 1427 000	IC, LM360 (DIP-08)	2 EA	U017,U018
384 0321 000	*DIODE, SCHOTTKY, 5082-2800	5 EA	CR026,CR027,CR033,CR039,CR040
384 0431 000	*DIODE, RECT 1N4001	5 EA	CR022,CR037,CR044,CR049,CR050
384 0612 000	DIODE 1N3070 ESD	19 EA	CR002,CR003,CR005,CR006,CR014,CR015,CR017,CR018,CR019,CR029,CR030,CR031,CR034,CR035,CR036,CR041,CR042,CR043,CR048
384 0661 000	LED, GRN T1-3/4 RTANG	4 EA	DS008,DS009,DS010,DS011
384 0662 000	LED, RED T1-3/4 RTANG	6 EA	DS001,DS002,DS003,DS004,DS005,DS007
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	4 EA	CR020,CR021,CR038,CR051
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	6 EA	CR007,CR008,CR009,CR010,CR023,CR045

384 0743 000	DIODE ARRAY DUAL 8 ESD	2 EA	U004,U008
384 0847 000	*LED 10 SEG BARGRAPH, GRN ESD	1 EA	DS006
386 0123 000	*ZENER 1N4732A 4.7V 5% 1W	4 EA	CR013,CR016,CR028,CR032
386 0430 000	*ZENER 1N5365B 36V 5% 5W	2 EA	CR001,CR004
398 0465 000	FUSE, FAST CART 2A 250V	3 EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6 EA	
404 0513 000	HEAT SINK PA1-1CB	3 EA	#U022,#U027,#U031
404 0673 000	SOCKET, DIP, 8 PIN (DL)	3 EA	XU011,XU017,XU018
404 0674 000	SOCKET, DIP, 14 PIN (DL)	17 EA	XU001,XU003,XU004,XU005,XU008,XU009,XU010,XU014,XU019,XU020,XU021,XU023,XU025,XU029,XU030,XU032,XU033
404 0675 000	SOCKET, DIP, 16 PIN (DL)	2 EA	XU024,XU028
404 0797 000	SOCKET, DIP, 24 PIN (DL)	1 EA	XU026
492 0775 000	IND, FXD RF, 100MH	2 EA	L005,L010
494 0196 000	INDUCTOR, 100UH 10% (9250)	2 EA	L002,L003
494 0401 000	INDUCTOR, 18.0UH 10% (9250)	1 EA	L009
494 0403 000	INDUCTOR, 27.0UH 10% (9250)	1 EA	L008
494 0404 000	INDUCTOR, 33.0UH 10% (9250)	1 EA	L007
494 0405 000	INDUCTOR, 56.0UH 10% (9250)	1 EA	L006
494 0407 000	INDUCTOR, 82.0UH 10% (9250)	1 EA	L001
500 0755 000	CAP MICA 270PF 500V 5%	1 EA	C025
500 0759 000	CAP MICA 100PF 500V 5%	3 EA	C023,C060,C084
500 0787 000	CAP MICA 200PF 500V 5%	2 EA	C061,C085
500 0818 000	CAP MICA 50PF 500V 5%	1 EA	C096
500 0823 000	CAP MICA 82PF 500V 5%	1 EA	C022
500 0827 000	CAP MICA 130PF 500V 5%	1 EA	C035
500 0840 000	CAP MICA 680PF 300V 5%	1 EA	C001
500 0844 000	CAP MICA 1000PF 100V 5%	1 EA	C097
500 0845 000	CAP, MICA, 2000PF 500V 5%	1 EA	C002
500 0854 000	CAP, MICA VAR 300-1000PF 175V	2 EA	C004,C053
500 0888 000	CAP, MICA, 3900PF 500V 5%	1 EA	C075
500 0913 000	CAP, MICA, 1200PF 500V 5%	1 EA	C003
500 1187 000	CAP, MICA, 8200PF 100V 5%	1 EA	C129
506 0232 000	CAP 0.010UF 5% 100V	2 EA	C076,C110
506 0246 000	CAP 0.470UF 5% 63V	1 EA	C126
516 0453 000	CAP 0.100UF 10% 100V X7R	57 EA	C009,C010,C011,C012,C014,C015,C017,C018,C019,C020,C021,C029,C031,C032,C033,C034,C041,C042,C047,C048,C051,C052,C054,C056,C058,C062,C063,C064,C069,C070,C071,C072,C077,C078,C079,C081,C082,C089,C092,C093,C094,C098,C099,C100,C102,C103,C104,C105,C109,C114,C117,C119,C121,C123,C127,C128,C131
516 0530 000	CAP 0.010UF 10% 100V X7R	8 EA	C016,C030,C057,C067,C068,C086,C087,C107

WARNING: Disconnect primary power prior to servicing.

516 0736 000	CAP 1000PF 10% 100V X7R	9 EA	C055,C080,C088,C112,C113, C115,C120,C122,C124
516 0765 000	CAP 10PF 5% 100V C0G	2 EA	C046,C050
516 0774 000	CAP 56PF 5% 100V C0G	4 EA	C045,C049,C065,C066
522 0531 000	CAP 1UF 50V 20% 5MM NON-POLAR	1 EA	C125
522 0561 000	*CAP 100UF 63V 20% (10X12.5)	4 EA	C083,C095,C106,C116
526 0050 000	CAP 1UF 35V 20%	1 EA	C101
526 0238 000	CAP 33UF 35V 20%	2 EA	C073,C074
526 0318 000	CAP 10UF 35V 20%	2 EA	C090,C091
526 0359 000	CAP 47UF 25V 10%	1 EA	C108
540 1365 000	RES NETWORK 36 OHM 2%	2 EA	R016,R018
540 1380 000	RES NETWORK 10K OHM 2%	6 EA	R014,R055,R077,R089,R090, R138
540 1387 000	RES NETWORK 10K OHM 2%	1 EA	R046
540 1394 000	RES NETWORK 100 OHM 2%	1 EA	R168
540 1416 000	RES NETWORK 10K OHM 2%	1 EA	R161
540 1422 000	RES NETWORK 330 OHM 2%	2 EA	R019,R020
540 1461 000	RES NETWORK 100 OHM 2%	1 EA	R013
540 1496 000	RES NETWORK 100 OHM	1 EA	R042
540 1560 000	RES NETWORK 1K OHM	1 EA	R137
540 1600 101	RES 10 OHM 3W 5%	2 EA	R011,R154
540 1600 115	RES 39 OHM 3W 5%	2 EA	R141,R142
540 1600 201	RES 100 OHM 3W 5%	4 EA	R012,R139,R143,R145
540 1600 222	RES 750 OHM 3W 5%	1 EA	R153
540 1600 301	RES 1K OHM 3W 5%	1 EA	R094
540 1600 305	RES 1.5K OHM 3W 5%	1 EA	R159
546 0295 000	RES, WW, 50 OHM 3W 5% (AXIAL)	1 EA	R080
548 2400 042	RES 2.67 OHM 1/2W 1%	1 EA	R165
548 2400 066	RES 4.75 OHM 1/2W 1%	1 EA	R164
548 2400 081	RES 6.81 OHM 1/2W 1%	1 EA	R163
548 2400 101	RES 10 OHM 1/2W 1%	1 EA	R171
548 2400 139	RES 24.9 OHM 1/2W 1%	1 EA	R096
548 2400 201	RES 100 OHM 1/2W 1%	7 EA	R017,R092,R108,R130,R146, R147,R170
548 2400 230	RES 200 OHM 1/2W 1%	1 EA	R095
548 2400 251	RES 332 OHM 1/2W 1%	2 EA	R009,R010
548 2400 254	RES 357 OHM 1/2W 1%	3 EA	R007,R008,R024
548 2400 255	RES 365 OHM 1/2W 1%	1 EA	R102
548 2400 258	RES 392 OHM 1/2W 1%	3 EA	R006,R021,R025
548 2400 279	RES 649 OHM 1/2W 1%	1 EA	R070
548 2400 281	RES 681 OHM 1/2W 1%	1 EA	R031
548 2400 301	RES 1K OHM 1/2W 1%	8 EA	R005,R064,R068,R071,R083, R101,R136,R152
548 2400 312	RES 1.3K OHM 1/2W 1%	3 EA	R022,R023,R069
548 2400 330	RES 2K OHM 1/2W 1%	10 EA	R079,R107,R111,R112,R120, R122,R123,R128,R140,R144
548 2400 333	RES 2.15K OHM 1/2W 1%	1 EA	R075
548 2400 335	RES 2.26K OHM 1/2W 1%	1 EA	R048

548 2400 347	RES 3.01K OHM 1/2W 1%	1 EA	R050
548 2400 351	RES 3.32K OHM 1/2W 1%	2 EA	R038,R051
548 2400 365	RES 4.64K OHM 1/2W 1%	1 EA	R072
548 2400 366	RES 4.75K OHM 1/2W 1%	4 EA	R060,R078,R100,R124
548 2400 368	RES 4.99K OHM 1/2W 1%	2 EA	R001,R002
548 2400 401	RES 10K OHM 1/2W 1%	25 EA	R003,R004,R026,R029,R032, R033,R034,R036,R043,R044, R047,R052,R053,R058,R062, R065,R085,R086,R097,R110, R118,R119,R127,R132,R133
548 2400 411	RES 12.7K OHM 1/2W 1%	1 EA	R054
548 2400 418	RES 15K OHM 1/2W 1%	1 EA	R084
548 2400 425	RES 17.8K OHM 1/2W 1%	1 EA	R074
548 2400 430	RES 20K OHM 1/2W 1%	1 EA	R037
548 2400 458	RES 39.2K OHM 1/2W 1%	1 EA	R114
548 2400 462	RES 43.2K OHM 1/2W 1%	1 EA	R066
548 2400 466	RES 47.5K OHM 1/2W 1%	3 EA	R091,R125,R135
548 2400 469	RES 51.1K OHM 1/2W 1%	4 EA	R061,R103,R113,R115
548 2400 489	RES 82.5K OHM 1/2W 1%	1 EA	R067
548 2400 501	RES 100K OHM 1/2W 1%	8 EA	R059,R063,R093,R131,R134, R155,R156,R169
548 2400 526	RES 182K OHM 1/2W 1%	1 EA	R151
548 2400 530	RES 200K OHM 1/2W 1%	5 EA	R087,R104,R105,R106,R121
548 2400 551	RES 332K OHM 1/2W 1%	1 EA	R157
548 2400 566	RES 475K OHM 1/2W 1%	3 EA	R028,R056,R126
548 2400 568	RES 499K OHM 1/2W 1%	1 EA	R088
548 2400 601	RES 1MEG OHM 1/2W 1%	8 EA	R035,R039,R049,R073,R076, R109,R129,R149
548 2400 609	RES 1.21MEG OHM 1/2W 1%	1 EA	R150
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	2 EA	R148,R158
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	4 EA	R098,R099,R116,R117
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	1 EA	R030
550 0984 000	TRIMPOT 500K OHM 1/2W 10%	2 EA	R027,R081
578 0026 000	RELAY 2PDT 12VDC 2A NON-LATCH	5 EA	K001,K002,K005,K008,K009
604 0905 000	SWITCH, PB SPDT MOM VERT	3 EA	S001,S005,S006
604 1093 000	SW, RKR DIP 6-SPST	2 EA	S003,S007
610 0679 000	PLUG, SHORTING, .25" CTRS	1 EA	#JP006
610 0979 000	*HDR 10C 2ROW VERT TOP LATCH	1 EA	J007
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	2 EA	J001,J009
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	2 EA	J006,J008
610 1107 000	HDR, 12C VERT 1ROW FRICTION	1 EA	J005
610 1160 000	HDR, 4C VERT 1ROW FRICTION	1 EA	J014
612 0904 000	JACK, PC MT GOLD PLATED	3 EA	
612 1350 000	JACK, SMB STRAIGHT PCB	3 EA	J011,J012,J013
620 0515 000	RECP, SCREW ON SMC	1 EA	J002
620 1677 000	JACK, BNC STRAIGHT PCB	3 EA	J003,J004,J010
670 0045 000	LDR VTL5C4	1 EA	CR024
839 8154 012	SCH, OUTPUT MONITOR BD.	0 DWG	
843 5450 012	PWB, OUTPUT MONITOR BD.	1 EA	
917 2210 015	VSWR 8.0 FIRMWARE	1 EA	U026

929 9009 216	XFMR	2 EA	T002,T003
999 2720 001	HARDWARE LIST	1 EA	

Table 7-39 DRIVER ENCODER BRD, - 992 8537 002 (M--)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	18 EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023
358 1928 000	JUMPER 1/4 LG 1/8H	2 EA	JP012,JP013
380 0125 000	XSTR, NPN 2N4401 ESD	5 EA	Q004,Q005,Q006,Q008,Q009
380 0653 000	XSTR, NPN MPS6602 ESD	1 EA	Q003
380 0726 000	XSTR, 2N7000 ESD	1 EA	Q002
380 0728 000	XSTR, NMOS IRL520 ESD	1 EA	Q001
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	U030
382 0359 000	IC, LM340/LM7815C (TO-220)	1 EA	U029
382 0594 000	*IC TL074ACN ESD	2 EA	U019,U020
382 0605 000	IC, LM7905C (TO-220)	1 EA	U031
382 0774 000	IC 74HC14 ESD	4 EA	U012,U013,U016,U024
382 0817 000	*IC, 74HC244 (DIP-20)	1 EA	U022
382 0882 000	*IC, LM340LA/LM78L05AC (TO-92)	1 EA	U033
382 1084 000	IC, LP339 (DIP-14)	5 EA	U002,U014,U015,U017,U032
382 1112 000	*IC, 74HCT74 (DIP-14)	1 EA	U021
382 1204 000	IC TC4423 ESD	9 EA	U003,U004,U005,U006,U008,U009,U010,U011,U023
384 0431 000	*DIODE, RECT 1N4001	5 EA	CR011,CR012,CR013,CR016,CR017
384 0612 000	DIODE 1N3070 ESD	7 EA	CR001,CR003,CR004,CR005,CR010,CR021,CR023
384 0661 000	LED, GRN T1-3/4 RTANG	3 EA	DS004,DS005,DS006
384 0662 000	LED, RED T1-3/4 RTANG	2 EA	DS007,DS008
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	4 EA	CR008,CR015,CR018,CR019
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	1 EA	CR014
384 0847 000	*LED 10 SEG BARGRAPH, GRN ESD	1 EA	DS003
386 0082 000	*ZENER 1N4744A 15V 5% 1W	3 EA	CR009,CR020,CR025
386 0100 000	*ZENER 1N4747A 20V 5% 1W	2 EA	CR022,CR024
386 0135 000	*ZENER 1N4733A 5.1V 5% 1W	1 EA	CR002
398 0465 000	FUSE, FAST CART 2A 250V	3 EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6 EA	
404 0513 000	HEAT SINK PA1-1CB	3 EA	#U029,#U030,#U031
404 0673 000	SOCKET, DIP, 8 PIN (DL)	9 EA	XU003,XU004,XU005,XU006,XU008,XU009,XU010,XU011,XU023
404 0674 000	SOCKET, DIP, 14 PIN (DL)	12 EA	XU002,XU012,XU013,XU014,XU015,XU016,XU017,XU0

			19,XU020,XU021,XU024,XU032
404 0675 000	SOCKET, DIP, 16 PIN (DL)	2 EA	XS002,XS003
404 0767 000	SOCKET, DIP, 20 PIN (DL)	1 EA	XU022
404 0797 000	SOCKET, DIP, 24 PIN (DL)	3 EA	XU001,XU007,XU018
484 0415 000	LINE, DELAY 20-620NS ESD	1 EA	U018
494 0392 000	INDUCTOR, 4.70UH 10% (9250)	1 EA	L006
494 0404 000	INDUCTOR, 33.0UH 10% (9250)	2 EA	L004,L005
500 0753 000	CAP MICA 56PF 500V 5%	3 EA	C056,C057,C058
500 0852 000	CAP, MICA, 1000PF 500V 5%	1 EA	C026
500 0903 000	CAP, MICA, 2700PF 500V 5%	3 EA	C031,C032,C042
500 1227 000	CAP, MICA, 6800PF 100V 5%	1 EA	C004
506 0235 000	CAP 3300PF 5% 100V	15 EA	C001,C003,C005,C006,C007,C008,C009,C010,C014,C015,C016,C017,C018,C019,C020
516 0453 000	CAP 0.100UF 10% 100V X7R	50 EA	C002,C022,C028,C029,C033,C037,C039,C040,C041,C043,C051,C052,C053,C054,C065,C066,C067,C069,C070,C071,C073,C074,C077,C078,C079,C080,C081,C082,C083,C084,C085,C086,C087,C088,C089,C090,C091,C092,C093,C094,C095,C096,C097,C099,C100,C103,C104,C105,C106,C107
516 0530 000	CAP 0.010UF 10% 100V X7R	3 EA	C012,C027,C034
516 0736 000	CAP 1000PF 10% 100V X7R	1 EA	C021
516 0792 000	CAP NETWORK .1UF 10%	2 EA	C030,C038
522 0561 000	*CAP 100UF 63V 20% (10X12.5)	5 EA	C023,C068,C072,C075,C076
526 0097 000	CAP 47UF 35V 20%	2 EA	C024,C025
526 0238 000	CAP 33UF 35V 20%	1 EA	C035
526 0311 000	CAP 2.2UF 35V 10%	1 EA	C011
526 0358 000	CAP 22UF 35V 10%	1 EA	C036
540 1365 000	RES NETWORK 36 OHM 2%	1 EA	R003
540 1366 000	RES NETWORK 100 OHM 2%	1 EA	R030
540 1380 000	RES NETWORK 10K OHM 2%	11 EA	R005,R006,R007,R008,R028,R029,R076,R132,R134,R146,R157
540 1383 000	RES NETWORK 100K OHM 2%	2 EA	R004,R133
540 1416 000	RES NETWORK 10K OHM 2%	1 EA	R072
540 1443 000	RES NETWORK 27 OHM 2%	1 EA	R144
540 1460 000	RES NETWORK 510 OHM 2%	1 EA	R009
540 1493 000	RES NETWORK 100K OHM	3 EA	R018,R032,R042
540 1600 105	RES 15 OHM 3W 5%	1 EA	R109
540 1600 201	RES 100 OHM 3W 5%	1 EA	R108
540 1600 205	RES 150 OHM 3W 5%	1 EA	R061
540 1600 213	RES 330 OHM 3W 5%	2 EA	R066,R106
548 2400 126	RES 18.2 OHM 1/2W 1%	1 EA	R051
548 2400 158	RES 39.2 OHM 1/2W 1%	15 EA	R001,R011,R014,R016,R019,

			R021,R023,R026,R031,R034, R036,R038,R040,R043,R045
548 2400 169	RES 51.1 OHM 1/2W 1%	3 EA	R078,R090,R093
548 2400 201	RES 100 OHM 1/2W 1%	17 EA	
			R002,R013,R015,R017,R020, R022,R024,R025,R033,R035, R037,R039,R041,R044,R046, R047,R184
548 2400 254	RES 357 OHM 1/2W 1%	2 EA	R164,R167
548 2400 258	RES 392 OHM 1/2W 1%	1 EA	R176
548 2400 269	RES 511 OHM 1/2W 1%	4 EA	R012,R111,R112,R182
548 2400 279	RES 649 OHM 1/2W 1%	1 EA	R173
548 2400 285	RES 750 OHM 1/2W 1%	1 EA	R082
548 2400 301	RES 1K OHM 1/2W 1%	7 EA	
			R053,R055,R073,R074,R105, R171,R179
548 2400 312	RES 1.3K OHM 1/2W 1%	2 EA	R159,R174
548 2400 330	RES 2K OHM 1/2W 1%	1 EA	R075
548 2400 334	RES 2.21K OHM 1/2W 1%	2 EA	R162,R165
548 2400 340	RES 2.55K OHM 1/2W 1%	1 EA	R168
548 2400 351	RES 3.32K OHM 1/2W 1%	3 EA	R161,R163,R166
548 2400 369	RES 5.11K OHM 1/2W 1%	1 EA	R050
548 2400 373	RES 5.62K OHM 1/2W 1%	1 EA	R081
548 2400 377	RES 6.19K OHM 1/2W 1%	1 EA	R088
548 2400 381	RES 6.81K OHM 1/2W 1%	1 EA	R095
548 2400 385	RES 7.5K OHM 1/2W 1%	1 EA	R083
548 2400 388	RES 8.06K OHM 1/2W 1%	1 EA	R136
548 2400 401	RES 10K OHM 1/2W 1%	29 EA	
			R049,R052,R054,R056,R057, R058,R059,R060,R065,R069, R080,R089,R091,R092,R094, R098,R099,R101,R102,R103, R104,R110,R130,R156,R158, R175,R178,R181,R183
548 2400 413	RES 13.3K OHM 1/2W 1%	1 EA	R160
548 2400 418	RES 15K OHM 1/2W 1%	2 EA	R064,R135
548 2400 451	RES 33.2K OHM 1/2W 1%	2 EA	R177,R180
548 2400 462	RES 43.2K OHM 1/2W 1%	1 EA	R085
548 2400 466	RES 47.5K OHM 1/2W 1%	2 EA	R096,R097
548 2400 469	RES 51.1K OHM 1/2W 1%	1 EA	R087
548 2400 485	RES 75K OHM 1/2W 1%	1 EA	R010
548 2400 501	RES 100K OHM 1/2W 1%	6 EA	
			R027,R048,R071,R122,R131, R137
548 2400 530	RES 200K OHM 1/2W 1%	1 EA	R079
548 2400 601	RES 1MEG OHM 1/2W 1%	5 EA	R063,R068,R169,R170,R172
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	1 EA	R086
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	2 EA	R084,R100
578 0026 000	RELAY 2PDT 12VDC 2A NON-LATCH	1 EA	K001
600 0579 000	SW, ROTARY 4PDT	2 EA	S002,S003
604 0904 000	SW, TGL SPDT VERT PCB MNT	1 EA	S001
610 0870 000	PLUG, NON-INS SHORTING	16 EA	
610 0900 000	HDR, 3C VERT 1ROW UNSHR	2 EA	JP001,JP009

610 0979 000	*HDR 10C 2ROW VERT TOP LATCH	1 EA	J008
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	2 EA	J001,J002
610 1027 000	HEADER, 12C, 1ROW, VERTICAL	1 EA	J007
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	3 EA	J003,J004,J009
610 1106 000	HDR, 8C VERT 1ROW FRICTION	1 EA	J005
612 1176 000	DIP STRIP, FEMALE 10 POS	2 EA	JP002,JP003
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	2 EA	#JP001,#JP009
620 0515 000	RECP, SCREW ON SMC	1 EA	J006
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 7930 510	SCHEMATIC, DRIVER ENCODER	0 DWG	
843 5155 510	PWB, DRIVER ENCODER	1 EA	
917 2150 733	FIRMWARE, LEFT DRIVERS	1 EA	U007
917 2150 734	FIRMWARE, RIGHT DRIVERS	1 EA	U001
922 0922 156	TRANSFORMER	1 EA	T001
999 2708 001	HARDWARE LIST	1 EA	

Table 7-40 PWA, ARC DETECTOR - 992 8677 002 (B--)

Harris PN	Description	Qty UM	Reference Designators
335 0244 000	WASHER, SHLDR 5/16 SCREW	2 EA	XR001,XR002
358 1928 000	JUMPER 1/4 LG 1/8H	2 EA	JP001,JP002
516 0453 000	CAP 0.100UF 10% 100V X7R	4 EA	C001,C002,C003,C004
548 2400 142	RES 26.7 OHM 1/2W 1%	2 EA	R003,R004
610 0978 000	*HDR 10C 2ROW RT ANG TOP LATCH	1 EA	J001
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
670 0049 000	PHOTOCELL TO-8 HERMETIC	2 EA	R001,R002
839 7930 517	SCHEM, ARC DETECTOR BD	0 DWG	
843 5155 517	PWB, ARC DETECTOR	1 EA	

Table 7-41 PRE-DRVR BAND SELECT, ESD SAFE - 992 8979 001 (B1)

Harris PN	Description	Qty UM	Reference Designators
2540004000A	*BUS WIRE, 16AWG, SOLID TINNED CU	0.600 FT	#C001,#C002,#JP002
354 0010 000	LUG RING #10 16-14AWG BLU	2 EA	#C001,#C002
504 0267 000	CAP 2000PF 5KV 5% (272)	1 EA	C001
504 0368 000	CAP 3000PF 3 KV 5% (272)	1 EA	C002
604 1161 000	SW, TGL DPDT ON-NC-ON	2 EA	S001,S002
610 1098 000	HDR, 4 PIN IN-LINE	1 EA	J003
614 0727 000	TERM BD 8C 1ROW PC MT	1 EA	TB001
620 1677 000	JACK, BNC STRAIGHT PCB	1 EA	J002
839 8154 001	SCH, PRE-DRIVER BAND	0 DWG	
843 5450 001	PWB, PRE-DRIVER BAND	1 EA	
999 2780 001	HARDWARE LIST, PRE-DRIVER	1 EA	

Table 7-42 BD,XMTR INTERFCE EXTENDED - 992 8989 001 (Z--)

Harris PN	Description	Qty UM	Reference Designators
000 0000 010	B/M NOTE:	0 DWG	
302 0346 000	SCR, 2-56 X 3/8	2 EA	#B001
306 0001 000	NUT, HEX 2-56 SST	2 EA	#B001
310 0001 000	WASHER, FLAT #2 SST (ANSI REGULAR)	2 EA	#B001
314 0001 000	LOCKWASHER, SPLIT #2 SST (ANSI)	2 EA	#B001
354 0309 000	TERM SOLDER	12 EA	
			TP008,TP009,TP012,TP013,T

WARNING: Disconnect primary power prior to servicing.

			P014,TP015,TP016,TP017,TP018,TP019,TP020,TP021
358 1928 000	JUMPER 1/4 LG 1/8H	10 EA	JP005,JP050,JP051,JP052,JP053,JP054,JP055,JP056,JP057,JP061
358 3327 000	BATTERY HOLDER, 4 AA CELL	1 EA	#B001
380 0189 000	*XSTR, NPN, MMBT3904	1 EA	Q002
382 0676 000	IC, 74LS05N (DIP-14)	1 EA	U008
382 0749 000	IC NE5532A ESD	2 EA	U001,U002
382 0770 000	IC, 74HC04 ESD	1 EA	U007
382 0773 000	IC 74HC11 ESD	2 EA	U003,U006
382 0817 000	*IC, 74HC244 (DIP-20)	1 EA	U004
382 1084 000	IC, LP339 (DIP-14)	1 EA	U009
382 1446 000	IC, MAX8216 ESD	1 EA	U010
384 0431 000	*DIODE, RECT 1N4001	1 EA	CR016
384 0610 000	LED, GRN T1-3/4 VERT	1 EA	DS008
384 0612 000	DIODE 1N3070 ESD	6 EA	CR001,CR002,CR003,CR004,CR005,CR006
384 0662 000	LED, RED T1-3/4 RTANG	7 EA	DS001,DS002,DS003,DS005,DS006,DS007,DS009
384 0763 000	RECT, SCHOTTKY 1045 ESD	2 EA	CR007,CR008
386 0123 000	*ZENER 1N4732A 4.7V 5% 1W	1 EA	CR020
386 0345 000	*ZENER 1N5342B 6.8V 5% 5W	1 EA	CR012
404 0673 000	SOCKET, DIP, 8 PIN (DL)	2 EA	XU001,XU002
404 0674 000	SOCKET, DIP, 14 PIN (DL)	6 EA	XU003,XU006,XU007,XU008,XU009,XU010
404 0767 000	SOCKET, DIP, 20 PIN (DL)	1 EA	XU004
404 0797 000	SOCKET, DIP, 24 PIN (DL)	1 EA	U011
442 0116 000	THERMOSTAT, 70 DEG C +/-5	1 EA	S002
506 0230 000	CAP 1000PF 5% 100V	2 EA	C002,C003
516 0453 000	CAP 0.100UF 10% 100V X7R	19 EA	C004,C005,C006,C007,C008,C009,C010,C011,C012,C016,C017,C020,C024,C025,C026,C027,C028,C029,C030
516 0530 000	CAP 0.010UF 10% 100V X7R	2 EA	C019,C023
516 0792 000	CAP NETWORK .1UF 10%	3 EA	C001,C021,C022
540 1365 000	RES NETWORK 36 OHM 2%	5 EA	R012,R013,R054,R057,R059
540 1380 000	RES NETWORK 10K OHM 2%	1 EA	R063
540 1386 000	RES NETWORK 10K OHM 2%	2 EA	R058,R060
540 1408 000	RES NETWORK 2000 OHM 2%	1 EA	R061
540 1416 000	RES NETWORK 10K OHM 2%	1 EA	R005
540 1427 000	RES NETWORK 4700 OHM 2%	1 EA	R007
540 1434 000	RES NETWORK 330 OHM 2%	2 EA	R055,R056
540 1455 000	RES NETWORK 220K OHM 2% DIP	1 EA	R062
540 1493 000	RES NETWORK 100K OHM	1 EA	R008
540 1530 000	RES NETWORK 10 OHM 2%	1 EA	R053
548 2400 001	RES 1 OHM 1/2W 1%	2 EA	R043,R044
548 2400 066	RES 4.75 OHM 1/2W 1%	1 EA	R066

548 2400 068	RES 4.99 OHM 1/2W 1%	1 EA	R004
548 2400 154	RES 35.7 OHM 1/2W 1%	2 EA	R031,R032
548 2400 251	RES 332 OHM 1/2W 1%	1 EA	R046
548 2400 269	RES 511 OHM 1/2W 1%	1 EA	R067
548 2400 301	RES 1K OHM 1/2W 1%	3 EA	R006,R064,R070
548 2400 366	RES 4.75K OHM 1/2W 1%	1 EA	R041
548 2400 369	RES 5.11K OHM 1/2W 1%	1 EA	R011
548 2400 401	RES 10K OHM 1/2W 1%	6 EA	R001,R014,R019,R024,R029,R034
548 2400 447	RES 30.1K OHM 1/2W 1%	6 EA	R017,R018,R022,R023,R027,R028
548 2400 501	RES 100K OHM 1/2W 1%	14 EA	R009,R010,R020,R025,R030,R033,R036,R037,R038,R039,R040,R045,R050,R065
548 2400 547	RES 301K OHM 1/2W 1%	4 EA	R015,R016,R021,R026
548 2400 601	RES 1MEG OHM 1/2W 1%	3 EA	R042,R068,R069
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	2 EA	R002,R003
604 1070 000	SWITCH, PB 3PDT MOM VERT	1 EA	S001
610 0877 000	HDR, 2C VERT 1ROW UNSHR	2 EA	JP007,JP008
610 0978 000	*HDR 10C 2ROW RT ANG TOP LATCH	2 EA	J019,J022
610 0979 000	*HDR 10C 2ROW VERT TOP LATCH	3 EA	J011,J030,J031
610 0980 000	*HDR 20C 2ROW RT ANG TOP LATCH	1 EA	J025
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	2 EA	J005,J006
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	11 EA	J001,J004,J010,J012,J013,J014,J015,J017,J018,J026,J027
610 1107 000	HDR, 12C VERT 1ROW FRICTION	3 EA	J008,J009,J016
610 1117 000	HDR, 10C VERT 1ROW FRICTION	4 EA	J020,J021,J023,J028
610 1237 000	HDR, MALE 12C 1ROW VERTICAL	2 EA	J007,J029
610 1265 000	HDR, MALE 2C 1ROW RT ANG	1 EA	J032
612 1184 000	JUMPER SHUNT, 2C, 0.1" PITCH	2 EA	#JP007,#JP008
620 0515 000	RECP, SCREW ON SMC	3 EA	J002,J003,J024
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 8154 005	SCH,TRANSMITTER INTERFACE	0 DWG	
843 5450 005	PWB, XMTR INTERFACE BD,	1 EA	
917 2413 112	FIRMWARE, COOLING PBLM	1 EA	U011
999 2712 001	HARDWARE LIST	1 EA	

Table 7-43 ASSEMBLY, PA FILTER CAP - 992 9116 005 (A)

Harris PN	Description	Qty UM	Reference Designators
358 3122 000	STUD, 10-32 X 1-1/4 BRASS	58 EA	
524 0219 000	CAP 5500 UF 200V -10, +50%	2 EA	C047,C048
524 0341 000	CAP 5100UF 350WVDC -10, +50%	55 EA	2C049,2C050,2C051,2C052,2C053,2C054,2C055,2C056,2C057,2C058,2C059,2C060,2C061,2C062,2C063,2C064,C007,C009,C010,C011,C012,C013,C014,C015,C016,C017,C018,C019,C020,C021,C022,C

WARNING: Disconnect primary power prior to servicing.

			023,C024,C025,C026,C027,C028,C029,C030,C031,C032,C033,C034,C035,C036,C037,C038,C039,C040,C041,C042,C043,C044,C045,C046
524 0360 000	CAP 18000 UF 200VDC	1 EA	C006
540 1600 405	RES 15K OHM 3W 5%	2 EA	R047,R048
540 1600 422	RES 75K OHM 3W 5%	56 EA	2R049,2R050,2R051,2R052,2R053,2R054,2R055,2R056,2R057,2R058,2R059,2R060,2R061,2R062,2R063,2R064,R006,R007,R009,R010,R011,R012,R013,R014,R015,R016,R017,R018,R019,R020,R021,R022,R023,R024,R025,R026,R027,R028,R029,R030,R031,R032,R033,R034,R035,R036,R037,R038,R039,R040,R041,R042,R043,R044,R045,R046
917 2413 310	JUMPER, CAP TO MOTHERBD	58 EA	
917 2413 311	JUMPER, CAP TO GROUND	58 EA	

Table 7-44 PWA, POWER BLOCK INTERFACE - 992 9163 003 (L)

Harris PN	Description	Qty UM	Reference Designators
354 0309 000	TERM SOLDER	17 EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017
358 1928 000	JUMPER 1/4 LG 1/8H	20 EA	JP001,JP002,JP003,JP004,JP005,JP006,JP007,JP008,JP009,JP011,JP013,JP014,JP015,JP16,JP017,JP019,JP023,JP024,JP025,JP026
358 3634 000	KEY, 9C 1ROW	3 EA	
380 0125 000	XSTR, NPN 2N4401 ESD	1 EA	Q001
382 0184 000	*IC, LM340A/LM7805AC (TO-220)	1 EA	U039
382 0359 000	IC, LM340/LM7815C (TO-220)	2 EA	U030,U031
382 0360 000	IC, LM7915C (TO-220)	1 EA	U033
382 0594 000	*IC TL074ACN ESD	5 EA	U001,U002,U003,U004,U036
382 0711 000	*PRECISION IC MULTIPLIER ESD	2 EA	U034,U035
382 0774 000	IC 74HC14 ESD	5 EA	U016,U020,U021,U023,U029
382 1070 000	IC, ILQ1	7 EA	U011,U012,U017,U018,U019,U022,U032
382 1097 000	IC, 74HCT05 (DIP-14)	2 EA	U015,U025
382 1307 000	IC, 2597 SINK DRIVER ESD	6 EA	U006,U007,U009,U010,U014,U026
382 1309 000	IC, ADG508F/MAX378	1 EA	U024
382 1482 000	IC AUDIO AMPLIFIER ESD	1 EA	U038

384 0431 000	*DIODE, RECT 1N4001	7 EA	CR001,CR002,CR003,CR004,CR005,CR006,CR010
384 0610 000	LED, GRN T1-3/4 VERT	5 EA	DS001,DS002,DS004,DS005,DS006
384 0612 000	DIODE 1N3070 ESD	6 EA	CR017,CR018,CR019,CR020,CR021,CR022
384 0679 000	LED, YEL T1-3/4 VERT	2 EA	DS007,DS008
384 0719 000	DIODE, TVS (UNIDIR), ICTE-5	1 EA	CR008
384 0720 000	DIODE, TVS (UNIDIR), ICTE-15	3 EA	CR007,CR012,CR014
384 0743 000	DIODE ARRAY DUAL 8 ESD	4 EA	U005,U008,U013,U027
384 0763 000	RECT, SCHOTTKY 1045 ESD	1 EA	CR024
384 0799 000	DIODE, BIPOLAR ESD	2 EA	CR015,CR016
384 0823 000	LED 10 SEG BARGRAPH, RED ESD	1 EA	DS003
384 0838 000	DIODE, TVS (UNIDIR), ICTE-36	3 EA	CR009,CR011,CR013
386 0123 000	*ZENER 1N4732A 4.7V 5% 1W	1 EA	CR023
398 0465 000	FUSE, FAST CART 2A 250V	3 EA	F001,F002,F003
398 0503 000	FUSE, FAST CART 3A 250V	1 EA	F004
402 0198 000	CLIP, FUSE 5MM DIA FUSE	8 EA	XF001,XF002,XF003,XF004
404 0674 000	SOCKET, DIP, 14 PIN (DL)	17 EA	XU001,XU002,XU003,XU004,XU005,XU008,XU013,XU015,XU016,XU020,XU021,XU023,XU025,XU027,XU029,XU036,XU038
404 0675 000	SOCKET, DIP, 16 PIN (DL)	8 EA	XU011,XU012,XU017,XU018,XU019,XU022,XU024,XU032
404 0767 000	SOCKET, DIP, 20 PIN (DL)	6 EA	XU006,XU007,XU009,XU010,XU014,XU026
404 0836 000	SOCKET, PLCC-84, THROUGH HOLE	1 EA	XU037
500 0837 000	CAP MICA 510PF 500V 5%	2 EA	C070,C071
516 0453 000	CAP 0.100UF 10% 100V X7R	41 EA	C026,C044,C045,C053,C054,C055,C056,C061,C062,C063,C064,C065,C066,C067,C068,C069,C074,C075,C076,C077,C078,C079,C080,C081,C082,C083,C084,C085,C086,C087,C088,C089,C090,C091,C092,C093,C094,C095,C096,C097,C098
516 0725 000	CAP 1.0UF 50V 20%	5 EA	C024,C025,C027,C072,C073
516 0792 000	CAP NETWORK .1UF 10%	12 EA	C001,C002,C006,C007,C008,C010,C011,C012,C013,C014,C015,C018
522 0554 000	CAP 4.7UF 50V 20%	1 EA	C060
522 0561 000	*CAP 100UF 63V 20% (10X12.5)	5 EA	C019,C020,C021,C022,C023
522 0573 000	CAP 47UF 63V 20%	1 EA	C059

526 0318 000	CAP 10UF 35V 20%	2 EA	C057,C058
540 1356 000	RES NETWORK 10K OHM 2%	1 EA	R002
540 1365 000	RES NETWORK 36 OHM 2%	6 EA	R021,R022,R024,R030,R039, R104
540 1366 000	RES NETWORK 100 OHM 2%	3 EA	R001,R008,R027
540 1380 000	RES NETWORK 10K OHM 2%	2 EA	R007,R043
540 1386 000	RES NETWORK 10K OHM 2%	7 EA	R016,R023,R025,R028,R032, R038,R081
540 1408 000	RES NETWORK 2000 OHM 2%	2 EA	R108,R109
540 1429 000	RES NETWORK 680 OHM	5 EA	R014,R015,R019,R020,R031
540 1443 000	RES NETWORK 27 OHM 2%	1 EA	R009
540 1457 000	RES NETWORK 330 OHM 2%	1 EA	R029
540 1496 000	RES NETWORK 100 OHM	2 EA	R017,R036
540 1549 000	RES NETWORK 1M OHM 2%	2 EA	R003,R006
548 2400 001	RES 1 OHM 1/2W 1%	15 EA	R042,R064,R066,R068,R070, R71,R072,R073,R074,R075,R 076,R077,R078,R079,R080
548 2400 043	RES 2.74 OHM 1/2W 1%	1 EA	R060
548 2400 101	RES 10 OHM 1/2W 1%	4 EA	R040,R041,R090,R091
548 2400 201	RES 100 OHM 1/2W 1%	1 EA	R005
548 2400 251	RES 332 OHM 1/2W 1%	2 EA	R089,R095
548 2400 255	RES 365 OHM 1/2W 1%	1 EA	R004
548 2400 281	RES 681 OHM 1/2W 1%	1 EA	R013
548 2400 301	RES 1K OHM 1/2W 1%	5 EA	R012,R044,R045,R046,R049
548 2400 303	RES 1.05K OHM 1/2W 1%	3 EA	R093,R094,R096
548 2400 338	RES 2.43K OHM 1/2W 1%	1 EA	R097
548 2400 401	RES 10K OHM 1/2W 1%	9 EA	R010,R018,R057,R058,R059, R069,R101,R103,R106
548 2400 466	RES 47.5K OHM 1/2W 1%	1 EA	R011
548 2400 468	RES 49.9K OHM 1/2W 1%	2 EA	R047,R062
548 2400 501	RES 100K OHM 1/2W 1%	4 EA	R050,R051,R065,R092
548 2400 566	RES 475K OHM 1/2W 1%	2 EA	R048,R063
548 2400 601	RES 1MEG OHM 1/2W 1%	1 EA	R061
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	3 EA	R098,R099,R102
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	2 EA	R054,R055
560 0121 015	POSISTOR 1.6 AMP 60VDC 17MM DISC	1 EA	R067
574 0497 000	RELAY 2PDT 24VDC 2A NON-LATCH	2 EA	K001,K002
610 0979 000	*HDR 10C 2ROW VERT TOP LATCH	2 EA	J005,J011
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	2 EA	J006,J008
610 1043 000	*HDR 40C 2ROW VERT TOP LATCH	5 EA	J007,J009,J012,J013,J014
610 1107 000	HDR, 12C VERT 1ROW FRICTION	1 EA	J010
610 1235 000	HDR, MALE 4C 1ROW VERTICAL	1 EA	J016
610 1237 000	HDR, MALE 12C 1ROW VERTICAL	2 EA	J004,J015
610 1245 000	HDR, MALE 24C 1ROW VERTICAL	3 EA	J001,J002,J003
612 1476 000	JACK, HEADPHONE STEREO	1 EA	J017
839 8154 008	SCH,POWER BLOCK INTERFACE	0 DWG	
843 5450 008	PWB,POWER BLOCK INTERFACE	1 EA	
917 2413 127	FIRMWARE, PWR BLOCK INTERFACE	1 EA	
999 2837 001	HARDWARE LIST, PWR BLOCK	1 EA	

Table 7-45 KIT,PAC,PRIORITY TWO PARTS - 992 9316 002 (A)

Harris PN	Description	Qty UM	Reference Designators
302 0411 000	SCR, 6-32 X 3/8	150 EA	
302 0693 000	SCREW, 1/4-28 X .625	18 EA	
302 0723 000	SCREW, 6-32 X 1	33 EA	
328 0070 000	WASHER CUPPED BLACK WEAR	6 EA	
328 0073 000	WASHER, RETAINER	6 EA	
358 3110 000	STUD, 8-32 X 1-1/4 BRASS	2 EA	#R005
358 3120 000	STUD, 10-32 X 3/4 BRASS	36 EA	
358 3171 000	STUD 1/4 TURN PHILLPS HD	6 EA	
410 0008 000	INSULATOR ROUND NS5W 0205	2 EA	#R005
456 0144 000	SPRING, EJECTOR	6 EA	
540 1600 018	RES 5.1 OHM 3W 5%	3 EA	R005A,R005B,R005C
817 2150 041	CONNECTION PLATE	1 EA	
817 2150 042	STDOFF 1.0 X 1.5 X 1/4-20	2 EA	#C002
817 2150 043	STDOFF 1.0 X 4.25 X1/4-20	1 EA	#C002
822 0922 027	MIDDLE RF COND	4 EA	
822 0999 001	BINARY RF COND	1 EA	
822 0999 002	BTM RF COND	3 EA	
822 0999 003	MID RF COND	2 EA	
822 0999 124	CONDUCTOR, DRIVER RF	1 EA	
839 7855 086	RF AMP ACCESS PNL HINGE	3 EA	
839 7930 082	CAP COND	2 EA	#C001
917 2150 566	STANDOFF, SPLITTER	4 EA	#A006
917 2332 372	SPACER	3 EA	#A004
917 2413 201	PLATE, BOTTOM CONTACT	3 EA	#A011,#A012,#A019
917 2413 202	PLATE, RIGHT TOP CONTACT	1 EA	#A010
917 2413 203	PLATE, CONTACT	16 EA	#A005,#A010,#A019
917 2413 204	PLATE, CONTACT	6 EA	#A005,#A015,#A016
917 2413 208	STANDOFF, BUCK BOOST	1 EA	#T001
917 2413 476	STRAP, BUCK BOOST	2 EA	
922 0922 161	TRANSFORMER	1 EA	T003
922 0999 620	BRK'T, STRAIN RELIEF	4 EA	#A006
922 0999 622	RING, DRIVE CABLE SUPPORT	1 EA	#A006
922 1186 027	RETAINER, TUNING ANGLE	1 EA	#C002
922 1186 028	CLAMP, TUNING ANGLE	1 EA	#C002
922 1186 029	CLAMP, TUNING STRAP	1 EA	#C002
922 1238 002	COVER, COMB.TOP MTG PLATE	4 EA	
922 1238 147	CLOSEOUT ANGLE	3 EA	
922 1238 328	SHIELD, SPLITTER	1 EA	
922 1238 329	BOOST XFMR	1 EA	T001
939 7930 087	CAP MTG PLT	2 EA	#C001
939 7930 150	CAP RF COND BRKT L	1 EA	#C001
939 7930 151	CAP RF COND BRKT R	1 EA	#C001
939 8106 008	DRIVE TUNE ANGLE	1 EA	#C002
939 8154 103	COVER, BOTTOM RF COND.	2 EA	
939 8154 104	COVER, BOTTOM RF COND,	2 EA	
939 8154 105	COVER, BOTTOM RF COND,	1 EA	
939 8154 106	COVER, BOTTOM RF COND,	1 EA	
939 8154 107	COVER, MIDDLE RF COND	4 EA	
939 8154 110	PLATE, CAP RF COND.	1 EA	#C001

939 8154 178	HANDLE, RF AMP ACCESS PNL	3 EA	
939 8154 179	HINGE, RF AMP ACCESS PANEL	3 EA	
939 8154 202	CROSSOVER DUCT	3 EA	
939 8154 249	DRIVE TUNE PLATE	1 EA	#C002
943 5450 120	SHIELD, PAC CAP RF REAR	1 EA	
943 5450 121	SHIELD, PAC CAP RF FRONT	1 EA	
943 5450 122	COVER, DRIVER RF COND.	2 EA	
943 5450 123	COVER, RIGHT TOP RF COND.	1 EA	
943 5450 124	COVER, RIGHT TOP RF COND.	1 EA	
943 5450 125	COVER, TOP RF COND	2 EA	
943 5450 126	COVER, TOP RF COND	2 EA	
943 5450 127	COVER, RF COND	4 EA	
943 5450 237	PANEL, RF AMP ACCESS	2 EA	
943 5450 260	SUPPORT, LEFT DOOR	3 EA	
943 5450 261	SUPPORT, RIGHT DOOR	3 EA	
943 5450 288	SUPPORT, LT FRT, LT BAY	1 EA	
943 5450 289	SUPPORT, RT FRT, LT BAY	1 EA	
943 5450 290	SUPPORT LT FRT CENTER BAY	1 EA	
943 5450 291	SUPPORT RT FRT CENTER BAY	1 EA	
943 5450 292	SUPPORT, UPPER LT, RT BAY	1 EA	
943 5450 293	SUPPORT, UPPER RT, RT BAY	1 EA	
943 5450 294	SUPPORT, LOWER LT, RT BAY	1 EA	
943 5450 295	SUPPORT, LOWER RT, RT BAY	1 EA	
943 5450 297	PANEL, RF AMP ACCESS	1 EA	
943 5450 593	SUPPORT, LEFT DOOR	3 EA	
943 5450 594	ANGLE	3 EA	
943 5450 708	DEFLECTOR, AIR, PA CAB, UP LT	2 EA	
943 5450 709	DEFLECTOR, AIR, PA CAB, UP RT	2 EA	
943 5450 710	DEFLECTOR, AIR, PA CAB, LOW LT	2 EA	
943 5450 711	DEFLECTOR, AIR, PA CAB, LOW RT	2 EA	
943 5450 712	DEFLECTOR, AIR, DRVR, UP LT	1 EA	
943 5450 713	DEFLECTOR, AIR, DRVR, UP RT	1 EA	
943 5450 714	DEFLECTOR, AIR, DRVR, LOW LT	1 EA	
943 5450 715	DEFLECTOR, AIR, DRVR, LOW RT	1 EA	
952 9180 007	ENCODER CABLES	1 EA	
992 8538 003	PWA, DRIVER MOTHERBD, ESD SAFE	1 EA	A005
992 8548 003	PWA, MAIN MOTHERBD, ESD SAFE	9 EA	A011,A012,A013,A014,A015,A016,A017,A018,A019
992 8549 003	PWA, BINARY MOTHERBD, ESD SAFE	1 EA	A010
992 8980 001	EFFICIENCY COIL OCTAL,ESD SAFE	21 EA	A005A1,A005A2,A010A2,A011A1,A011A2,A012A1,A012A2,A013A1,A013A2,A014A1,A014A2,A015A1,A015A2,A016A1,A016A2,A017A1,A017A2,A018A1,A018A2,A019A2,A109A1
992 8980 002	EFFICIENCY COIL OCTAL,ESD SAFE	1 EA	A010A1
992 9112 001	PWA, RF SPLITTER, ESD SAFE	1 EA	A006

Table 7-46 PWA, DRIVER MOTHERBD, ESD SAFE - 992 8538 003 (F--)

Harris PN	Description	Qty UM	Reference Designators

324 0257 000	NUT, CAPTIVE 6-32	4 EA	
358 1928 000	JUMPER 1/4 LG 1/8H	2 EA	
358 2714 000	STUD, PC BD 6-32 X 3/8	16 EA	
358 2837 000	STUD, PC BD 4-40 X 5/16	2 EA	
358 3164 000	CARD GUIDE	32 EA	
384 0431 000	*DIODE, RECT 1N4001	1 EA	CR007
384 0612 000	DIODE 1N3070 ESD	3 EA	CR001,CR003,CR005
494 0392 000	INDUCTOR, 4.70UH 10% (9250)	1 EA	L003
494 0404 000	INDUCTOR, 33.0UH 10% (9250)	2 EA	L001,L002
500 0852 000	CAP, MICA, 1000PF 500V 5%	1 EA	C011
500 0903 000	CAP, MICA, 2700PF 500V 5%	2 EA	C012,C013
508 0562 000	CAP, 1.0UF +/- 10% 400VDC	1 EA	C007
516 0453 000	CAP 0.100UF 10% 100V X7R	3 EA	C009,C010,C014
522 0630 000	CAP 100UF 400V 20% SNAP-MT	7 EA	C001,C002,C003,C004,C005, C006,C008
540 1600 207	RES 180 OHM 3W 5%	2 EA	R011,R012
540 1600 422	RES 75K OHM 3W 5%	4 EA	R001,R002,R003,R004
548 1505 000	RES .2 OHM 10 W 1%	1 EA	R020
548 2400 201	RES 100 OHM 1/2W 1%	1 EA	R013
548 2400 335	RES 2.26K OHM 1/2W 1%	2 EA	R005,R006
548 2400 391	RES 8.66K OHM 1/2W 1%	2 EA	R022,R023
548 2400 401	RES 10K OHM 1/2W 1%	3 EA	R015,R017,R019
548 2400 501	RES 100K OHM 1/2W 1%	3 EA	R014,R016,R018
548 2400 601	RES 1MEG OHM 1/2W 1%	11 EA	R007,R009,R021,R024,R025, R026,R027,R028,R030,R031, R032
548 2400 630	RES 2MEG OHM 1/2W 1%	3 EA	R008,R010,R029
574 0472 000	*RELAY SPDT 12VDC 10AMP (PCB MT)	2 EA	K001,K002
610 0981 000	*HDR 20C 2ROW VERT TOP LATCH	2 EA	J031,J034
610 1051 000	HOUSING 28 DUAL POSITIONS	16 EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016
610 1084 000	HDR 10 PIN/ACTION PINS	4 EA	J025,J026,J027,J028
610 1088 000	LATCH .576 FOR EJECTION	8 EA	
610 1106 000	HDR, 8C VERT 1ROW FRICTION	2 EA	J029,J032
610 1141 000	HEADER 10 POS RIGHT ANGLE	8 EA	J017,J018,J019,J020,J021,J022,J023,J024
610 1143 000	PLUG, RIVET TYPE BANANA	30 EA	P013,P014,P021,P022,P023,P024,P031,P032,P033,P034,P041,P042,P043,P044,P051,P052,P053,P054,P061,P062,P063, P064,P071,P072,P073,P074,P081,P082,P083,P084
620 0515 000	RECP, SCREW ON SMC	1 EA	J030
620 1677 000	JACK, BNC STRAIGHT PCB	1 EA	J033
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
817 2150 053	STRAP	2 EA	
839 7930 504	SCHEM, COMBINER MB,DRIVER	0 DWG	

843 5155 504	PWB, COMBINER MB, DRIVER	1 EA	
917 2150 603	SPACER	16 EA	
922 0922 156	TRANSFORMER	1 EA	T020
922 0999 617	XFMR PAIR	6 EA	
922 0999 618	XFMR PAIR	2 EA	
922 0999 625	DRIVER RF COND SUPPORT	3 EA	
922 1238 001	SUPPORT, COMBINER COVER	2 EA	
999 2717 001	HARDWARE LIST	1 EA	

Table 7-47 PWA, MAIN MOTHERBD, ESD SAFE - 992 8548 003 (F--)

Harris PN	Description	Qty UM	Reference Designators
2000000000000000024	SCR, #4 X 5/8 PPH SELF-TAP	32 EA	2#J001,2#J002,2#J003,2#J004,2#J005,2#J006,2#J007,2#J008,2#J009,2#J010,2#J011,2#J012,2#J013,2#J014,2#J015,2#J016
324 0257 000	NUT, CAPTIVE 6-32	4 EA	
358 2714 000	STUD, PC BD 6-32 X 3/8	16 EA	
358 2837 000	STUD, PC BD 4-40 X 5/16	2 EA	
358 3164 000	CARD GUIDE	32 EA	
522 0630 000	CAP 100UF 400V 20% SNAP-MT	8 EA	C001,C002,C003,C004,C005,C006,C007,C008
540 1600 422	RES 75K OHM 3W 5%	4 EA	R001,R002,R003,R004
610 1051 000	HOUSING 28 DUAL POSITIONS	16 EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016
610 1084 000	HDR 10 PIN/ACTION PINS	4 EA	J025,J026,J027,J028
610 1088 000	LATCH .576 FOR EJECTION	8 EA	
610 1141 000	HEADER 10 POS RIGHT ANGLE	8 EA	J017,J018,J019,J020,J021,J022,J023,J024
610 1143 000	PLUG, RIVET TYPE BANANA	32 EA	P011,P012,P013,P014,P021,P022,P023,P024,P031,P032,P033,P034,P041,P042,P043,P044,P051,P052,P053,P054,P061,P062,P063,P064,P071,P072,P073,P074,P081,P082,P083,P084
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 7930 505	SCHEM, COMBINER MB, MAIN	0 DWG	
843 5155 505	PWB, COMBINER MB, MAIN	1 EA	
917 2150 603	SPACER	16 EA	
922 0999 100	XFMR PAIR	8 EA	
922 0999 624	RF COND SUPPORT	3 EA	
922 1238 001	SUPPORT, COMBINER COVER	2 EA	

Table 7-48 PWA, BINARY MOTHERBD, ESD SAFE - 992 8549 003 (D1-)

Harris PN	Description	Qty UM	Reference Designators
2540004000A	*BUS WIRE, 16AWG, SOLID TINNED CU	0.100 FT	J033
324 0257 000	NUT, CAPTIVE 6-32	4 EA	
358 2714 000	STUD, PC BD 6-32 X 3/8	16 EA	
358 2837 000	STUD, PC BD 4-40 X 5/16	2 EA	
358 3164 000	CARD GUIDE	32 EA	
522 0630 000	CAP 100UF 400V 20% SNAP-MT	8 EA	C001,C002,C003,C004,C005,C006,C007,C008
540 1600 422	RES 75K OHM 3W 5%	6 EA	R001,R002,R003,R004,R005,R006
610 1005 000	PLUG, SHORTING .040 PINS	3 EA	P030,P031,P032
610 1051 000	HOUSING 28 DUAL POSITIONS	16 EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016
610 1084 000	HDR 10 PIN/ACTION PINS	4 EA	J025,J026,J027,J028
610 1088 000	LATCH .576 FOR EJECTION	8 EA	
610 1141 000	HEADER 10 POS RIGHT ANGLE	8 EA	J017,J018,J019,J020,J021,J022,J023,J024
610 1143 000	PLUG, RIVET TYPE BANANA	32 EA	P011,P012,P013,P014,P021,P022,P023,P024,P031,P032,P033,P034,P041,P042,P043,P044,P051,P052,P053,P054,P061,P062,P063,P064,P071,P072,P073,P074,P081,P082,P083,P084
612 1012 000	JACK PC MT .040 PINS	12 EA	
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
817 2150 024	JUMPER	2 EA	
839 7930 506	SCHEM, COMBINER MB,BINARY	0 DWG	
843 5155 506	PWB, COMBINER MB, BINARY	1 EA	
917 2150 603	SPACER	16 EA	
922 0999 624	RF COND SUPPORT	3 EA	
922 1238 001	SUPPORT, COMBINER COVER	2 EA	
992 9142 001	XFMR PKG	1 EA	
999 2718 001	HARDWARE LIST	1 EA	

Table 7-49 EFFICIENCY COIL OCTAL,ESD SAFE - 992 8980 001 (C)

Harris PN	Description	Qty UM	Reference Designators
051 0001 023	*ADHESIVE, DP-190 GRAY	0 EA	
2520247000A	WIRE, STRD 18AWG YEL	16 FT	
356 0082 000	CABLE TIE TY RAP	4 EA	
598 0457 000	COVER, SWITCH, WHITE	4 EA	S001,S003,S005,S007
598 0458 000	COVER, SWITCH, BLUE	4 EA	S002,S004,S006,S008
604 1161 000	SW, TGL DPDT ON-NC-ON	8 EA	S001,S002,S003,S004,S005,S006,S007,S008

612 1376 000	JACK, PANEL MOUNT BANANA	16 EA	J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016,J017,J018
839 8154 003	SCH,EFFICIENCY COIL OCTAL	0 DWG	
843 5450 003	PWB,EFFICIENCY COIL OCTAL	1 EA	
943 5597 005	COIL, AIR 40TURN	8 EA	L001,L002,L003,L004,L005,L006,L007,L008

Table 7-50 EFFICIENCY COIL OCTAL,ESD SAFE - 992 8980 002 (C)

Harris PN	Description	Qty UM	Reference Designators
051 0001 023	*ADHESIVE, DP-190 GRAY	0 EA	
2520247000A	WIRE, STRD 18AWG YEL	16 FT	
356 0082 000	CABLE TIE TY RAP	4 EA	
598 0457 000	COVER, SWITCH, WHITE	4 EA	S001,S003,S005,S007
598 0458 000	COVER, SWITCH, BLUE	4 EA	S002,S004,S006,S008
604 1161 000	SW, TGL DPDT ON-NC-ON	8 EA	S001,S002,S003,S004,S005,S006,S007,S008
612 1376 000	JACK, PANEL MOUNT BANANA	16 EA	J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016,J017,J018
839 8154 003	SCH,EFFICIENCY COIL OCTAL	0 DWG	
843 5450 003	PWB,EFFICIENCY COIL OCTAL	1 EA	
943 5597 005	COIL, AIR 40TURN	8 EA	L001,L002,L003,L004,L005,L006,L007,L008

Table 7-51 PWA, RF SPLITTER, ESD SAFE - 992 9112 001 (D)

Harris PN	Description	Qty UM	Reference Designators
414 0310 000	TOROID, FERRITE	2 EA	
610 0998 000	HDR, 6 PIN, PC BD	1 EA	J029
610 1086 000	HDR 34 PIN/ACTION PINS	28 EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016,J017,J018,J019,J020,J021,J022,J023,J024,J025,J026,J027,J028
610 1088 000	LATCH .576 FOR EJECTION	56 EA	
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
817 2099 044	TRANSFORMER STAPLE	24 EA	
839 8154 010	SCH, RF SPLITTER	0 DWG	
843 5450 010	PWB, RF SPLITTER	1 EA	

Table 7-52 EPAC, DX200, EXTENDED PWR - 994 9855 007 (A)

Harris PN	Description	Qty UM	Reference Designators
007 4020 024	FINGERSTOCK, 97-952/CUSTOM	7 EA	
007 4030 023	BRZ, PH GND BAR 97-744-05	15 EA	
302 0551 000	SCR, SOC HD SHOULDER	1 EA	
328 0070 000	WASHER CUPPED BLACK WEAR	2 EA	
328 0073 000	WASHER, RETAINER	2 EA	

336 1137 000	PIN, SPRING	1 EA	
358 1217 000	HOSE CLAMP, SST, SAE-12	7 EA	
358 2426 000	PLUG, WHITE 2" HOLE	6 EA	
358 2628 000	CABLE PUSH MOUNT	2 EA	
358 3093 000	STUD, 6-32 X 1/2 BRASS	64 EA	#A020,#A021,#A022,#A023
358 3246 000	STUD 1/4 TURN PHILLIPS HD	2 EA	
359 1090 000	SUPPORT CLAMP, 3/4"COPPER	2 EA	
402 0107 000	CLIP, FUSE 0.562DIA	2 EA	
448 0224 000	HANDLE ALUM	2 EA	
448 0884 000	LATCH, FLUSH, LIFT & TURN	1 EA	
456 0144 000	SPRING, EJECTOR	2 EA	
813 4999 034	STDOFF 6-32X2.00 1/4 HEX	64 EA	
814 7797 001	ROD, GND HOOK	1 EA	
814 7916 002	HOOK, GND ROD	1 EA	
822 0922 033	FRT DOOR HINGE PLATE	1 EA	
822 0922 075	DOOR HINGE PIN	1 EA	
822 0965 079	STUD, LOCK MTG.	2 EA	
822 0999 038	DOOR STOP ARM	1 EA	
822 0999 040	DOOR STOP BLOCK	1 EA	
917 2413 338	HOSE 1/2 NOM X 8.20 LG	2 EA	
917 2413 339	HOSE 3/4 NOM X 8.00 LG	1 EA	
917 2413 382	BRKT, SENSOR MTG.	1 EA	
922 0922 212	INSULATION, DOOR 21 X 48	1 EA	
922 0922 213	INSULATION, DOOR 21 X 21	1 EA	
922 0965 131	SHIM, LOCK	1 EA	
922 0999 039	DOOR STOP BRACE	1 EA	
922 1238 132	CABLE, RIBBON	1 EA	
922 1238 133	CABLE, RIBBON	1 EA	
922 1238 140	CABLE, RIBBON	1 EA	
922 1238 319	STRAP, GROUND, 18.25" LG	1 EA	
929 9009 153	DOOR RESTRAINT	1 EA	
939 7930 624	BASE RBN SHLD	1 EA	
939 7930 626	RBN CBL SHIELD	2 EA	
939 7930 627	RBN CBL SHIELD	3 EA	
939 8154 126	SHIELD, LEFT OUTER PANEL	1 EA	
939 8154 392	ASSY, LEAK DETECTOR 2U5	1 EA	
939 8154 394	SHIELD, UPPER RIBBON CBL	1 EA	
939 8154 401	CABLE, GROUND HOOK	1 EA	
939 8154 407	PNL, AIR DEFLECTOR END	2 EA	
943 5450 117	DOOR, PAC LEFT FRONT	1 EA	
943 5450 118	SHIELD, PAC LEFT FRONT	1 EA	
943 5450 223	CABINET, EXTENDED PA, TOP	1 EA	
943 5450 381	MANIFOLD ASSY LEFT & RT	1 EA	
943 5450 387	CORD REEL	1 EA	
943 5450 607	DEFLECTOR, AIR, EXTENDED	2 EA	
943 5450 856	PLATE, AIR DEFLECTOR,EPAC	1 EA	
992 9074 001	PWB, RF AMPLIFIER 3X LC	64 EA	
			RF152,RF153,RF154,RF155, RF156,RF157,RF158,RF159, RF160,RF161,RF162,RF163, RF164,RF165,RF166,RF167, RF168,RF169,RF170,RF171, RF172,RF173,RF174,RF175,

			RF176,RF177,RF178,RF179, RF180,RF181,RF182,RF183, RF184,RF185,RF186,RF187, RF188,RF189,RF190,RF191, RF192,RF193,RF194,RF195, RF196,RF197,RF198,RF199, RF200,RF201,RF202,RF203, RF204,RF205,RF206,RF207, RF208,RF209,RF210,RF211, RF212,RF213,RF214,RF215
992 9117 002	KIT, EPAC, PRIORITY ONE PARTS	1 EA	
992 9117 003	KIT, EPAC, PRIORITY TWO PARTS	1 EA	

Table 7-53 KIT, EPAC, PRIORITY ONE PARTS - 992 9117 002 (C)

Harris PN	Description	Qty UM	Reference Designators
358 2511 000	STANDOFF, 10-32 X 3/4	16 EA	#A041,#A042
448 1032 000	HINGE, METAL LIFT-OFF	4 EA	
612 0317 000	RECEPTACLE BNC UG-1094/U	1 EA	
813 4999 031	STDOFF 6-32X1-1/4 1/4 HEX	18 EA	#A030,#A031
817 2150 005	CAP STDOFF	16 EA	
817 2150 037	GROUNDING PLATE	5 EA	
822 0999 023	PAC CAP BRACKET	8 EA	
822 0999 024	CABLE MTG CHANNEL	2 EA	
839 7930 072	AIR FLOW SENSOR DUCT	2 EA	
913 5007 054	STANDOFF 6-32 X 2.94 LG	2 EA	
917 2413 206	STANDOFF	6 EA	
917 2413 458	STRAP, GROUND	1 EA	
922 0999 016	Z BRACE	2 EA	
922 1238 010	ANGLE, LOCK MOUNTING	1 EA	
922 1238 057	SUPPORT, MOTHERBOARD M/D	12 EA	
922 1238 058	SUPPORT, MOTHERBOARD END	6 EA	
922 1238 067	PLATE, REAR PA/EPA XOVER	1 EA	
922 1238 069	COMB COVER TOP MTG. PLATE	1 EA	
922 1238 263	BLOCK, CHILLER MTG.	12 EA	
939 8154 239	FUSE BD BUS BAR	1 EA	
943 5450 227	PANEL, LEFT INNER, EPAC	1 EA	
943 5450 231	BASE SHIELD, EPAC	1 EA	
943 5450 232	PANEL, RIGHT INNER, EPAC	1 EA	
943 5450 283	COVER, FRT PA/EPA XOVER	1 EA	
943 5450 284	COVER, REAR PA/EPA XOVER	1 EA	
943 5450 401	WELDMENT, EPAC CABINET	1 EA	
943 5450 498	PLATE, CHILLER, CENTER	1 EA	
943 5450 499	PLATE, CHILLER, END	2 EA	
943 5450 561	PANEL, FRONT INNER	1 EA	
952 9180 004	UPPER FUSE BD CABLE	1 EA	
952 9180 005	LOWER FUSE BD CABLE	1 EA	
992 8007 004	PWA, FUSE, ESD SAFE	2 EA	A041,A042
992 8187 001	PWA, PWR DISTRIBUTION,ESD SAFE	1 EA	A053
992 8193 006	PWB, MOD ENCODER MAIN	2 EA	A030,A031

Table 7-54 PWA, ARC DETECTOR - 992 8677 001 (E--)

Harris PN	Description	Qty UM	Reference Designators
335 0244 000	WASHER, SHLDR 5/16 SCREW	2 EA	XR001,XR002
358 1928 000	JUMPER 1/4 LG 1/8H	2 EA	JP001,JP002
516 0453 000	CAP 0.100UF 10% 100V X7R	4 EA	C001,C002,C003,C004
548 2400 142	RES 26.7 OHM 1/2W 1%	2 EA	R003,R004
610 0978 000	*HDR 10C 2ROW RT ANG TOP LATCH	1 EA	J001
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
670 0049 000	PHOTOCELL TO-8 HERMETIC	2 EA	R001,R002
839 7930 517	SCHEM, ARC DETECTOR BD	0 DWG	
843 5155 517	PWB, ARC DETECTOR	1 EA	

Table 7-55 KIT, EPAC, PRIORITY TWO PARTS - 992 9117 003 (C)

Harris PN	Description	Qty UM	Reference Designators
302 0411 000	SCR, 6-32 X 3/8	96 EA	
302 0706 000	SOCKET HD. CAP SCREW S.S.	6 EA	
302 0723 000	SCREW, 6-32 X 1	12 EA	
328 0070 000	WASHER CUPPED BLACK WEAR	2 EA	
328 0073 000	WASHER, RETAINER	2 EA	
358 3120 000	STUD, 10-32 X 3/4 BRASS	12 EA	
358 3171 000	STUD 1/4 TURN PHILLPS HD	2 EA	
456 0144 000	SPRING, EJECTOR	2 EA	
839 7855 086	RF AMP ACCESS PNL HINGE	1 EA	
917 2413 201	PLATE, BOTTOM CONTACT	1 EA	
917 2413 203	PLATE, CONTACT	6 EA	
917 2413 204	PLATE, CONTACT	2 EA	
922 1238 147	CLOSEOUT ANGLE	1 EA	
922 1238 165	TOP RF COND.	1 EA	
922 1238 166	MIDDLE RF COND.	2 EA	
922 1238 167	BOTTOM RF COND.	1 EA	
939 8154 178	HANDLE, RF AMP ACCESS PNL	1 EA	
939 8154 179	HINGE, RF AMP ACCESS PANEL	1 EA	
939 8154 193	MID RF COND COVER	2 EA	
939 8154 194	BTM RF COND COVER CTR	1 EA	
939 8154 195	BTM RF COND COVER CTR	1 EA	
939 8154 202	CROSSOVER DUCT	1 EA	
943 5450 237	PANEL, RF AMP ACCESS	1 EA	
943 5450 257	SUPPORT, LEFT FRONT	1 EA	
943 5450 258	SUPPORT, RIGHT FRONT	1 EA	
943 5450 260	SUPPORT, LEFT DOOR	1 EA	
943 5450 261	SUPPORT, RIGHT DOOR	1 EA	
943 5450 285	TOP RF COND COVER	1 EA	
943 5450 286	TOP RF COND COVER	1 EA	
943 5450 287	RF COND COVER	2 EA	
943 5450 593	SUPPORT, LEFT DOOR	1 EA	
943 5450 594	ANGLE	1 EA	
943 5450 704	DEFLECTOR, AIR, EXTD PA CAB,	1 EA	
943 5450 705	DEFLECTOR, AIR, EXTD PA CAB,	1 EA	
943 5450 706	DEFLECTOR, AIR, EXTD PA CAB,	1 EA	
943 5450 707	DEFLECTOR, AIR, EXTD PA CAB,	1 EA	
952 9195 022	CABLES, ENCODER	1 EA	
992 8980 001	EFFICIENCY COIL OCTAL,ESD SAFE	8 EA	

992 9158 001	PWA, EPAC MOTHERBD, ESD SAFE	4 EA	A020,A021,A022,A023

Table 7-56 PWA, EPAC MOTHERBD, ESD SAFE - 992 9158 001 (G--)

Harris PN	Description	Qty UM	Reference Designators
2000000000000024	SCR, #4 X 5/8 PPH SELF-TAP	32 EA	2#J001,2#J002,2#J003,2#J004,2#J005,2#J006,2#J007,2#J008,2#J009,2#J010,2#J011,2#J012,2#J013,2#J014,2#J015,2#J016
324 0257 000	NUT, CAPTIVE 6-32	4 EA	
358 2714 000	STUD, PC BD 6-32 X 3/8	16 EA	
358 3164 000	CARD GUIDE	32 EA	
522 0630 000	CAP 100UF 400V 20% SNAP-MT	8 EA	C001,C002,C003,C004,C005,C006,C007,C008
540 1600 422	RES 75K OHM 3W 5%	4 EA	R001,R002,R003,R004
610 1051 000	HOUSING 28 DUAL POSITIONS	16 EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016
610 1084 000	HDR 10 PIN/ACTION PINS	4 EA	J025,J026,J027,J028
610 1088 000	LATCH .576 FOR EJECTION	8 EA	
610 1141 000	HEADER 10 POS RIGHT ANGLE	8 EA	J017,J018,J019,J020,J021,J022,J023,J024
610 1143 000	PLUG, RIVET TYPE BANANA	32 EA	P011,P012,P013,P014,P021,P022,P023,P024,P031,P032,P033,P034,P041,P042,P043,P044,P051,P052,P053,P054,P061,P062,P063,P064,P071,P072,P073,P074,P081,P082,P083,P084
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
839 8154 011	SCH, MOTHER BOARD, EPAC,	0 DWG	
843 5450 011	PWB, MOTHER BOARD EPAC,	1 EA	
917 2150 603	SPACER	16 EA	
922 1238 068	COMBINER COVER SUPPORT	2 EA	
922 1238 075	XFMR PAIR	8 EA	
922 1238 164	RF COND SUPPORT	3 EA	

A.1 Introduction

This section covers the Oscillator board. Topics include function, location, block diagram description, detailed diagram description, and troubleshooting.

Assembly #	992-8069-004
PWB #	843-5155-853
Schematic #	843-5155-851

NOTE: Maintenance for this board is covered in Section V and Parts List in Section VII.

A.2 Function

The Oscillator board includes a crystal oscillator stage, frequency dividers, and amplifier/driver stages. The Oscillator board provides an RF signal at the transmitter operating frequency to be amplified by the Buffer Amplifier. Normally Oscillator A is selected by the Oscillator Interface. If optional Oscillator B is installed it can also be selected for operation.

The Oscillator board assembly provides an auto/man switch of the rf to the Internal crystal and a duty cycle adjustment.

A.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100kW with no modulation at 1575kHz carrier frequency.

NOTE:

Some signal magnitudes vary with carrier frequency, therefore expect some differences in magnitude for some frequencies other than 1575 kHz

A.4 Location

The Oscillator(s) is mounted in the RPAC on the left sidewall (See VIEW 2).

A.5 Block Diagram Description

A.5.1 RF Flow

Two crystals, with manual switch-over, are used to generate a sinewave RF signal that is either four or eight times the transmitter frequency. A buffer/squaring amplifier converts the sinewave into a squarewave which is then divided down to the transmitter frequency by the Frequency Divider. Jumper plugs and buffer/driver amplifiers allow the use of an external oscillator source, and there are also provisions for combined transmitter operation. The Oscillator output, at the carrier frequency, is sent to the Buffer Amplifier via the Oscillator Interface board. The Oscillator board also has an output signal to operate a frequency monitor or counter. RF presence signals are sent to the Oscillator Interface board for fault sensing.

A.5.2 VSWR Switching

A VSWR-H input signal operates an analog switch when a VSWR fault occurs. During this time, the Oscillator output will be switched from the crystal or External oscillator output, to an RF current sample taken from the output network for combined systems.

A.5.3 Power Supplies

+22Vdc is regulated down to +15Vdc, +9Vdc, and +5Vdc for on board circuits, while -22Vdc is regulated down to -15Vdc to power the crystal ovens.

A.5.4 Auto Switching

When the loss of the External RF signal is detected the Oscillator board when in Auto mode will switch to the Internal Crystal.

A.5.5 Duty Cycle Adjust

In combined type systems this circuit is used to help NULL out harmonics in the output spectrum.

A.6 Detailed Circuit Description

This section contains circuit descriptions for the Oscillator board. Refer to 843-5155-851 schematic.

A.6.1 Oscillator Stage

The crystal oscillator stage, Q1, is a standard Pierce circuit, operating at 4 or 8 times the carrier frequency. The crystal operates in its parallel resonant mode. Jumper plug, P1, allows selecting either one of two crystals. If one crystal should fail, this jumper allows quick selection of the backup crystal (the oven jumper must also be changed).

For each crystal, small frequency adjustments can be made with C1 (for crystal Y1) or C3 (for Y2).

For carrier frequencies of 1250 kHz and below, the crystal frequency is eight times the carrier frequency, and for carrier frequencies above 1250 kHz, the crystal operates at four times the carrier frequency.

Each crystal is contained in a sleeve type oven, which maintains temperature at 70°C (+/-3°C, approximately). Oven jumper plug P6 supplies -15Vdc to either oven. Note that crystal jumper plug P1 and oven jumper plug P6 must both be in the same position, otherwise the crystal in use will not be at the correct temperature and may be off frequency (P1 and P6 must both be in the upper position, or both in the lower position).

A.6.2 Buffer/Squaring Amplifier

Buffer amplifier Q2 is coupled to the oscillator output, and operates as an overdriven amplifier, with a +5 volt supply voltage. The output of Q2 is a TTL-level square wave which drives the frequency divider. Diodes CR2 and CR3 protect Q2 against reverse voltages.

A.6.3 Frequency Divider

Integrated circuits U1 and U2 are dual J-K flip-flops, used as frequency dividers. Each IC section is connected as a divide-by-two circuit. The signal at U2-11 and P2-2, is one-fourth of the crystal frequency. Half of U1 divides this frequency by two, so the signal at U1-15 output, and P2-3, is at 1/8 of the crystal frequency. Jumper plug P2 is then installed to route either the divide-by-four or the divide-by-eight output to buffer-driver U5A, pin 2. The output of U5A-7, at P3-3, is a TTL-level square wave at the transmitter operating frequency.

A.6.4 External Input

An AM stereo generator or high-stability external oscillator can be connected to BNC jack J2, which is located on the Oscillator board. The external input impedance is either 50 ohms or approximately 20k ohms, depending on the position of jumper plug P5. The high impedance input is for use with TTL level (4 to 4.5 volt peak-to-peak square wave). With a 50 ohm input impedance, RF input levels from 0 to +25 dBm can be accommodated. (At 50 ohms, 0 to +25 dBm is 1 mW to 316 mW, or 0.22 V rms to 4 V rms).

Amplifier Q3 and buffer/driver U5B provide a logic-level signal to P3-2. Diodes CR8 and CR9 at Q3 input provide protection against excessive input voltages.

A.6.5 Internal/External Oscillator and Combined Transmitter Operation

Jumper plugs JP4, JP5, JP6 are used to select either an external oscillator, the internal oscillator or Automatic, respectively. The signals at this point are 4 to 4.5 volt peak-to-peak square wave signals (logic level signals) at the transmitter’s operating frequency. JP4 selects the external crystal oscillator, JP5 selects the internal oscillator source and JP6 puts the board in Automatic mode.

JP1 is used to invert the signal, used only in combine mode when needed.

When JP6 is installed then the Oscillator Board is in the AUTO Mode. When an Ext RF Signal is applied at J2 and a signal is present at TP8 this causes a retriggerable monostable vibrator to have a Logic “1” on the Q output. This output turns “ON” Q10 which then applies a Logic Low to the U10 Pin 2 when P8 is in Position 1-2. When U10 is enabled this provides a low to U9 pin 10 and 13. Pin 8 of U9 will be low and Enable DS1 And the CMOS switch (U8) which switches to the External RF signal.

A.6.5.1 DUTY CYCLE

The output of U8 drives the duty cycle adjustment circuit. In combined type systems this circuit is used to help NULL out harmonics in the output spectrum.

A.6.6 AUTO/MANUAL

P7 and P8 provide active High or Active Low logic for manual switching of the Ext RF to internal Crystals.

A.6.6.1 Switch Delay

There is an RC time Constant on the Input of U8 (CMOS switch) this is set to 6-10ms.

A.6.7 MUTE

Anytime a switch takes place a 35-40ms pulse is generated. Connect this line J8-2 to your transmitter Ext RF Mute connection. The RF mute occurs before the RF switch takes place to insure that when the Ext RF signal is reapplied and it is out of phase with the Internal crystal that damage is not done to the transmitter.

A.6.8 EXT STATUS

When U8 (CMOS switch) is switched to the External RF Signal J8-1 will be Low. This is an Open Collector Transistor.

A.6.8.1 Single Combined Mode

Jumper plug P4 is used to select either normal or combined transmitter operation. For normal operation, P4-1 and P4-3 are jumpered, and the RF signal from buffer/driver U5A or U5B is fed to U4 pin 4. For combined operation, P4-1 and P4-2 are connected.

A.6.9 Frequency Monitor Output

Buffer/driver U3B provides an output signal to a frequency monitor or counter. Resistor R17 sets the driver output impedance at 50 ohms. The frequency monitor output signal, at BNC connector J5, will be a 4-4.5 volt peak-to-peak square wave at the transmitter operating frequency when the load impedance is 50 ohms.

A.6.10 VSWR Switching

The combiner output current sample from T4, is brought to the Oscillator board at J3. R37 provides a 50-ohm input impedance, and zener diodes CR11 and CR12 protect Q4 from transient voltages. R40, R41, L4, and DIP-switch selected capacitors C30 through C33 form a phase shift network. Q4 amplifies this phase-shifted RF sample and feeds it to pin 11 of CMOS analog switch U4.

Integrated Circuit U4 is a CMOS analog switch, which selects one of two RF signals. During normal operation, the signal from P4-3 is routed through U4 to buffer-driver U3 and the transmitter RF drive section. During a VSWR fault, U4 pin 6 goes low, and U4 switches so that the output current sample is used as the transmitter’s RF drive.

A.6.11 Output Buffer/Driver

Integrated circuit U3A is a logic buffer-driver. Its input, at U3-2, is a TTL level logic signal, and its output, at U3-7, is a square wave (8-9v p-p). The output impedance of U3A is very low, and resistor R31 sets the 50-ohm output impedance of the Oscillator board. Resistor, R31, is one half of a voltage divider with the other half being R16 (to ground) on the input of the Buffer

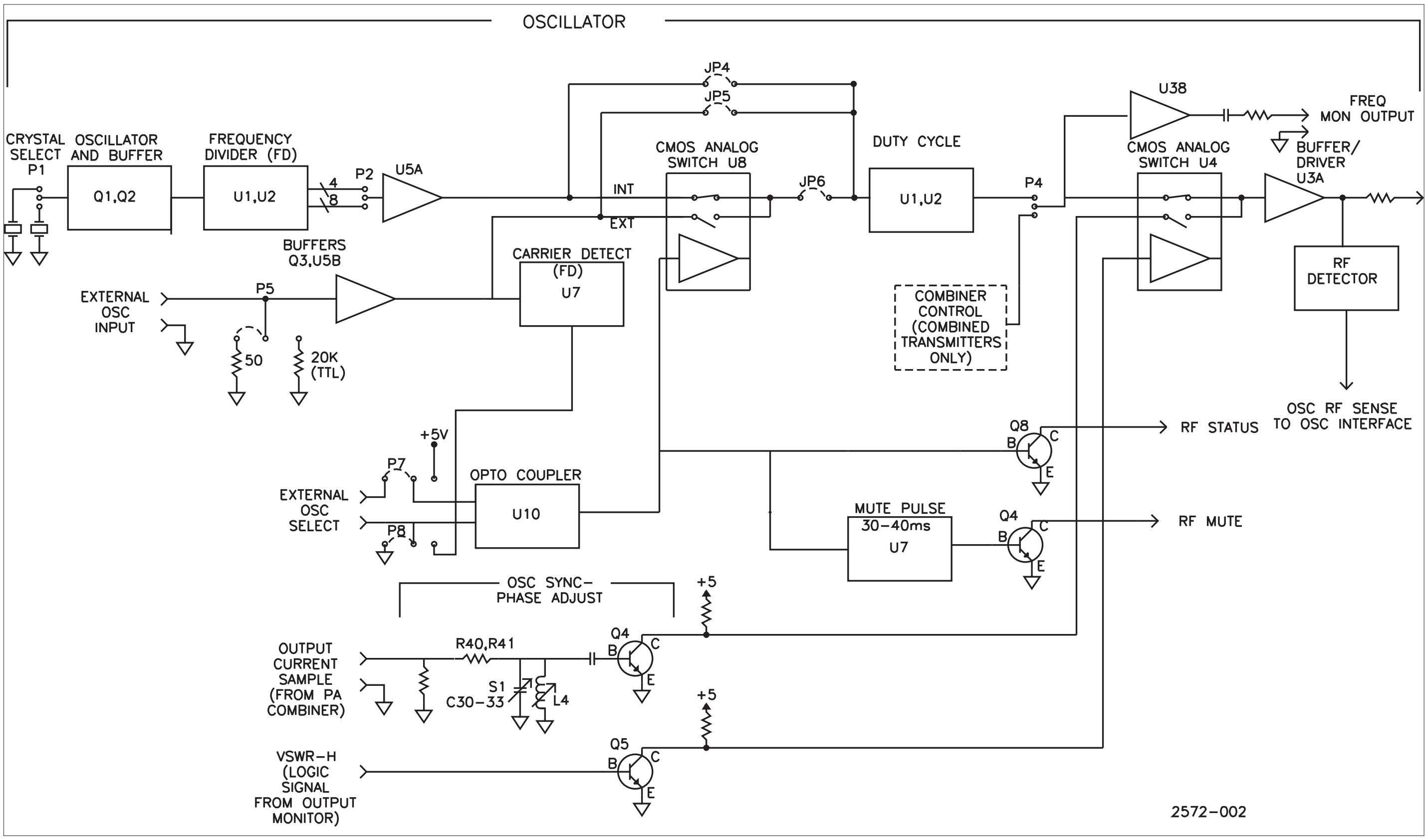


Figure A-1
Oscillator, Simplified Block Diagram -004 assembly.

Amplifer. The output signal at J4-8 is a 4-4.5 vp-p square wave and goes to the Oscillator Interface.

A.6.12 RF Present Output

The RF output from buffer/driver U3A is converted to positive and negative dc voltages by peak detectors CR7-C18 and CR6-C17. These dc voltages go to a fault circuits on Oscillator Interface, through resistors R19 and R21.

If the RF output from the Oscillator board is lost, there will be no “RF Present” voltages.

A.6.13 Power Supplies

Input voltages for the Oscillator board, from the transmitter low-voltage power supply, are +22 volts and -22 volts, unregulated, at J1-1 and J1-4; J1-2 is “ground.” Voltage regulator U6 provides -15 volts for the crystal ovens. All positive voltages used on the Oscillator board are shunt regulated by zener diodes, and include +15 volts (from CR1), +9 volts (from CR13), and +5 volts (from CR4).

A.7 Troubleshooting

The following information contains general troubleshooting tips and any precautions if applicable.

Failure of an oscillator will result in an OSC FAULT and possibly a LOW DRIVE FAULT

A.7.1 Measure The Power Supplies

a. Check the dc voltage at each side of F1 and F2. Both +22 volts and -22 volts should be present any time low voltage ac power is on provided the Low Voltage Power Supply is in the “TEST” mode. The Control multimeter will indicate whether transmitter low voltage power supply voltages, including +22 V and -22 V are present.
b. Check the voltages at TP1 +15Vdc, TP2 +5Vdc, TP3 +9Vdc, and P6-1 -15Vdc. If one voltage is missing, a zener diode may be shorted or there may be a short in a circuit supplied by that voltage.

A.7.2 Measure the VSWR-H Input

Observe the voltage at J7-5, if this voltage is more than about +1 volts when the transmitter is off, there is probably a fault on the Output Monitor board. (When VSWR faults are detected, logic high pulses will appear at J7-5.).

A.7.3 Measure the RF Output

Using an oscilloscope, check for RF output at J4-8 (a convenient place to check this is at the end of R31 which is furthest from the BNC connector J5, on the left side of the board). A square wave of 4-4.5 volts peak-to-peak at the transmitter carrier frequency should be present.

A.7.4 No Signal Present

If no RF signal is present, sequentially check the following test points until RF is found.

a. Check TP5 and the frequency divider outputs at P2-1. A 4-4.5 V p-p square wave should be present at the transmitter frequency

b. Check the signals at Q1 and Q2 collectors. Typically 8 volts of sinewave RF should appear at Q1 output. The Q2 output should be a slightly distorted squarewvae of approximately 5-6 volts p-p. Waveforms at these points should be at the crystal frequency.

c. If no RF signal is present, try moving P1 to the other crystal position.

d. If RF output returns, one crystal is defective. (If you are going to operate with the alternate crystal, don't forget to change the crystal oven plug P6 as well).

A.8 Oscillator Alignment

A.8.1 Oscillator Frequency Fine Adjustment

a. Connect a frequency counter or frequency monitor to the Oscillator to the Oscillator board Frequency Monitor Output (BNC Jack J5).

b. Select the crystal to be adjusted, make sure its oven is operating and warmed up.

c. Adjust C1 (for crystal Y1) or C3 (for crystal Y2) for the desired frequency. Only a small range of adjustment of frequency is possible.

NOTE:
Crystal jumper plug P1 and Oven jumper J6 must both be in the same position during adjustment or operation. Do not adjust frequency for either crystal until its oven has had sufficient time to warm up, allowing at least 15 minutes.

A.8.2 Oscillator Sync Adjustment

Using a dual trace scope:

a. Connect channel 1 to TP5.

b. Connect channel 2 to TP4.

c. Sync the scope to channel 1.

d. Set the sweep speed on the scope to display one or two cycles of RF.

e. Operate the transmitter at 100kW, and note that at this time, channel 2 will also have a 5Vp-p squarewave displayed.

f. If the positive going edges of the two waveforms are lined up, no further adjustments are required.

1. If the trace on channel 2 is not aligned in phase, adjust L4 to bring them into phase with each other.
2. If by adjusting L4 the two waveforms will not line up, then different combinations of capacitance as selected by S1 can be switched in to provide various amounts of phase shift.
3. If it appears that the two signals are 180 degrees apart then the plug P3 can be reversed at J3. This should not be the case if the board is simply being replaced assuming the plug position was noted before removal.

Table A-1

Freq (kHz)	500	540	640	740	840	940	1040	1140	1240	1340	1440	1540	1640	1740
Ohms (k)	23	21	17	14	11	9	8	7	6	5	4	4	3	3

Table A-2 Oscillator Jumper Positions

Oscillator Board Jumper #	Jumper Position Description	
	Pins 1-2	Pins 1-3
P1	Activates Crystal Y1	Activates Crystal Y2
P2	For 1251kHz & Above, selects divide by 4	For 1250kHz and below, selects divide by 8
P3	Not used.	Not used.
P4	Can be used for Combined Transmitter Operation	Selects Normal Single Transmitter Operation
P5	Sets Input Impedance for External Oscillator. Input at 20k Ohms for TTL Levels	Sets input Z for External Oscillator Input at 50 Ohms for 0-25dBm Input
P6	Activates Oven for Crystal Y1	Activates Oven for Crystal Y2
P7	+5V External Failsafe Disabled.	+5V External Failsafe Enabled.
P8	External Carrier Detect ON.	External Carrier Detect OFF.
JP4 (see note at right)	Selects External Oscillator Inputs from J2	**NOTE:** ONLY one of these three jumpers can be installed at a time
JP5 (see note at right)	Selects Internal Crystal	
JP6 (see note at right)	Uses CMOS switch of RF Signals	

NOTE:

When switching in different values of capacitance, try to use the least amount of capacitance (S1-1, 2, and 3) to achieve phase alignment of the two signals. If too much capacitance is used there may not be enough signal input to produce a signal at TP4.

A.8.3 Carrier Detect adjustments

Depending on your Transmitter's Frequency, R64 must be adjusted for proper Carrier loss Detection. Refer to Table A-1

NOTE

R64 must be adjusted with Power off. Place a multimeter on TP13 and R70. Make sure you are on the junction of R70 and R64. To achieve this place your meter on either side of R70. The side with 5k Ohms less is the correct side.

This adjustment is used to detect the loss of the External RF signal. When RF is lost for 5-8 cycles U7 will be set causing the "Q" output to go low. This in turn causes the CMOS switch to switch to the Internal Crystal.

A.9 Oscillator Replacement

The oscillator contains six jumpers, one four section DIP switch, one variable inductance, and the frequency trimmer capacitors, all of which must be properly set up when a new board is installed. To preset the replacement board before installation, place the jumpers shown in Table A-2 in the same positions as in the board to be replaced.

a. Locate Oscillator Sync Adj., S1, a four section DIP switch, and set each section to the same setting as the board to be replaced.
b. Locate L4 and using a non-inductive tuning tool set the slug in the coil for approximately the same amount of penetration into the coil.
c. Set the two variable trimmer capacitors (C2 and C4) to about the same position as on the board being replaced.
d. Carefully remove the crystals Y1 and Y2 from their holders:
    1. First remove the heater assemblies from the crystals. An angle bracket that bolts to the PC board holds the crystal heaters in place.
    2. Carefully remove the crystals and reinstall them on the new board.
    3. Place the crystal heater assemblies over each crystal and replace the mounting brackets.

NOTE:

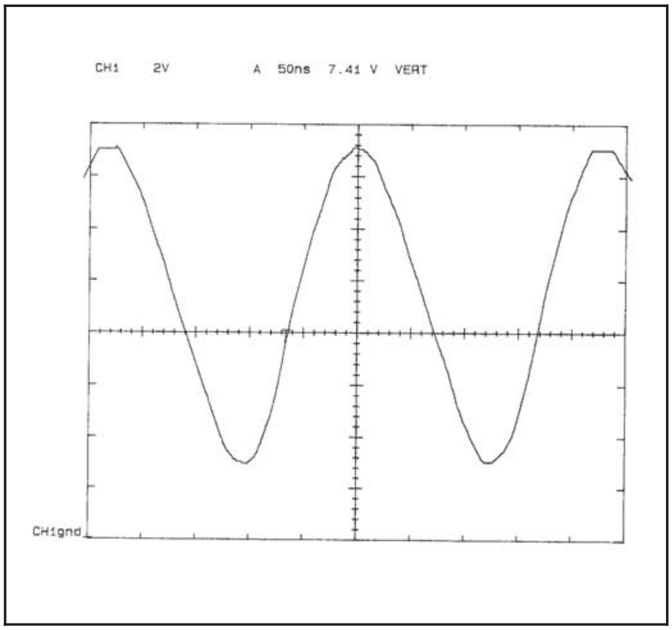
When replacing the old oscillator board, note in which direction the plug P3 attaches to J3 on the oscillator board. This connector can be reversed from the wiring diagram to allow proper phasing of the Oscillator Sync circuit.

A.9.1 Final Adjustments

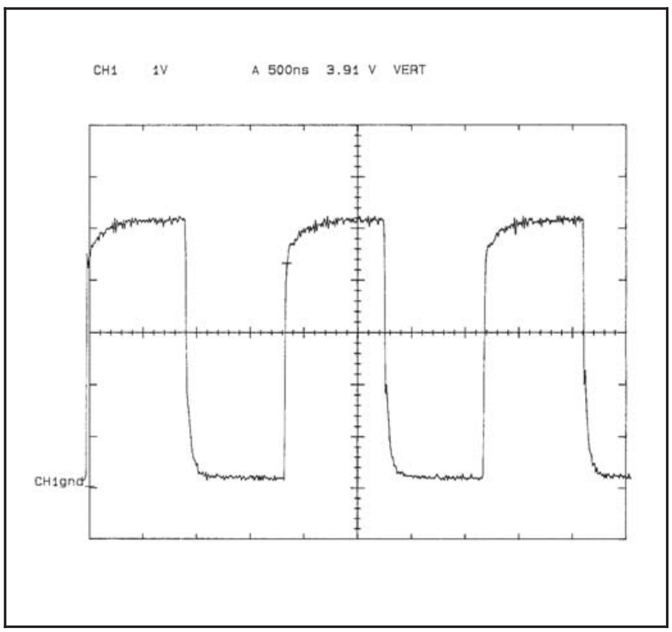
Two adjustments are now required once the new board has been installed and made operational.

a. Carrier Frequency Adjust C1 and C3
b. Oscillator Sync Adjustment S1 and L4

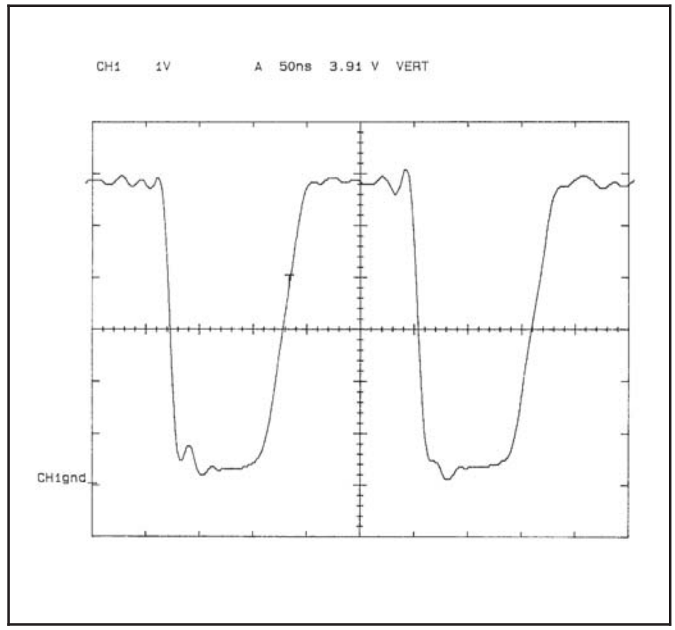
Refer to appropriate sections above to perform these adjustments.



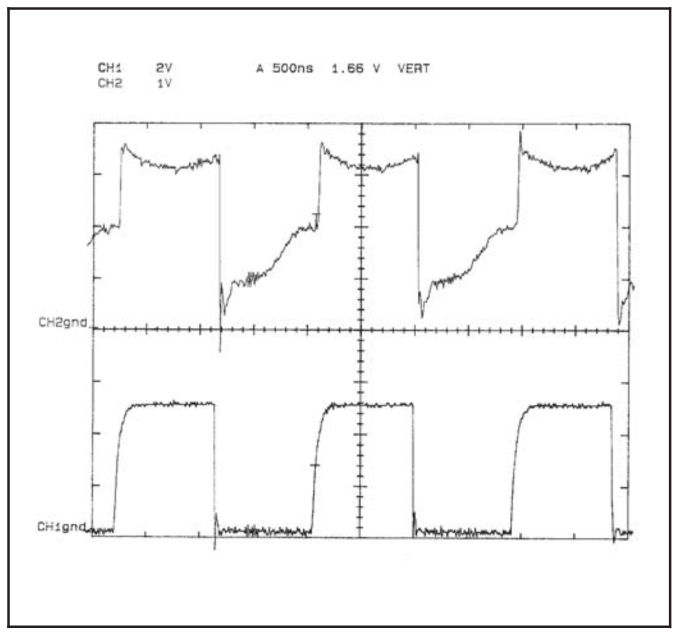
Q1 Base



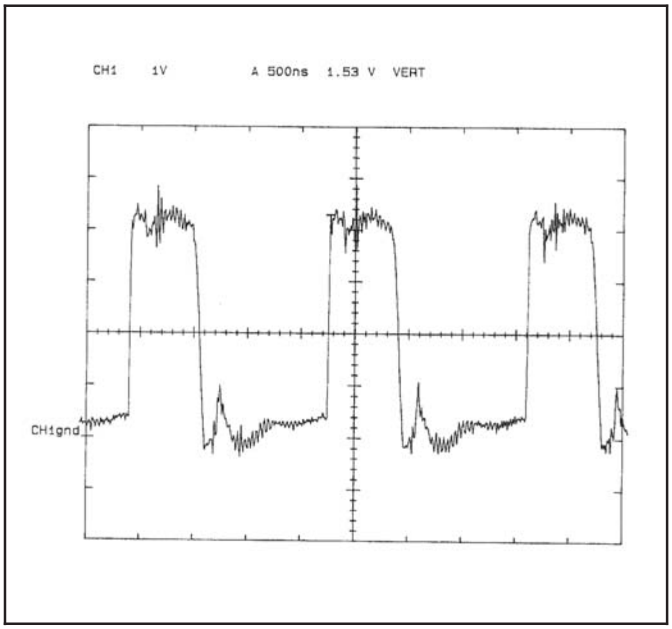
P2-1



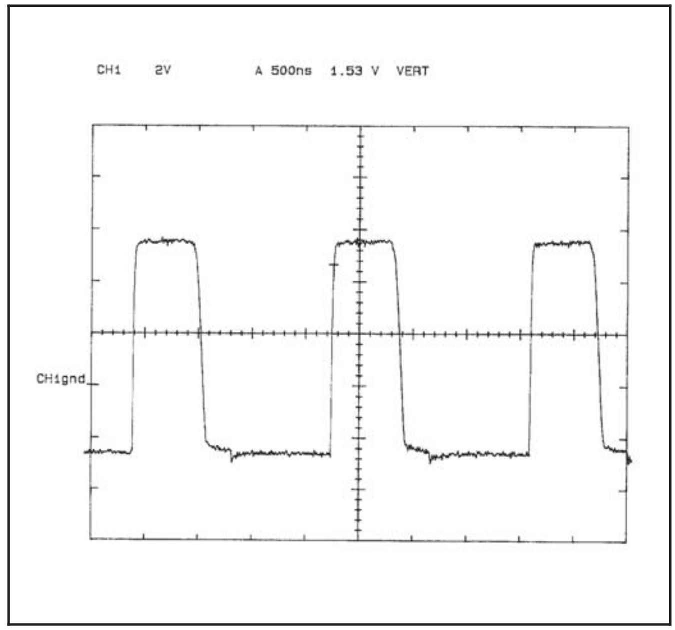
Q2 Collector



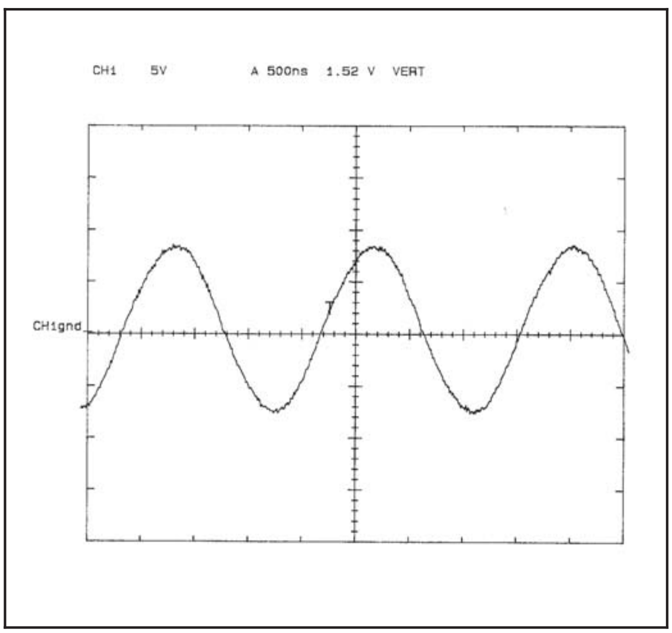
Upper Trace CH2 TP5
Lower Trace CH1 TP4



J4-8



J5-1



J3-1

WARNING: Disconnect primary power prior to servicing.

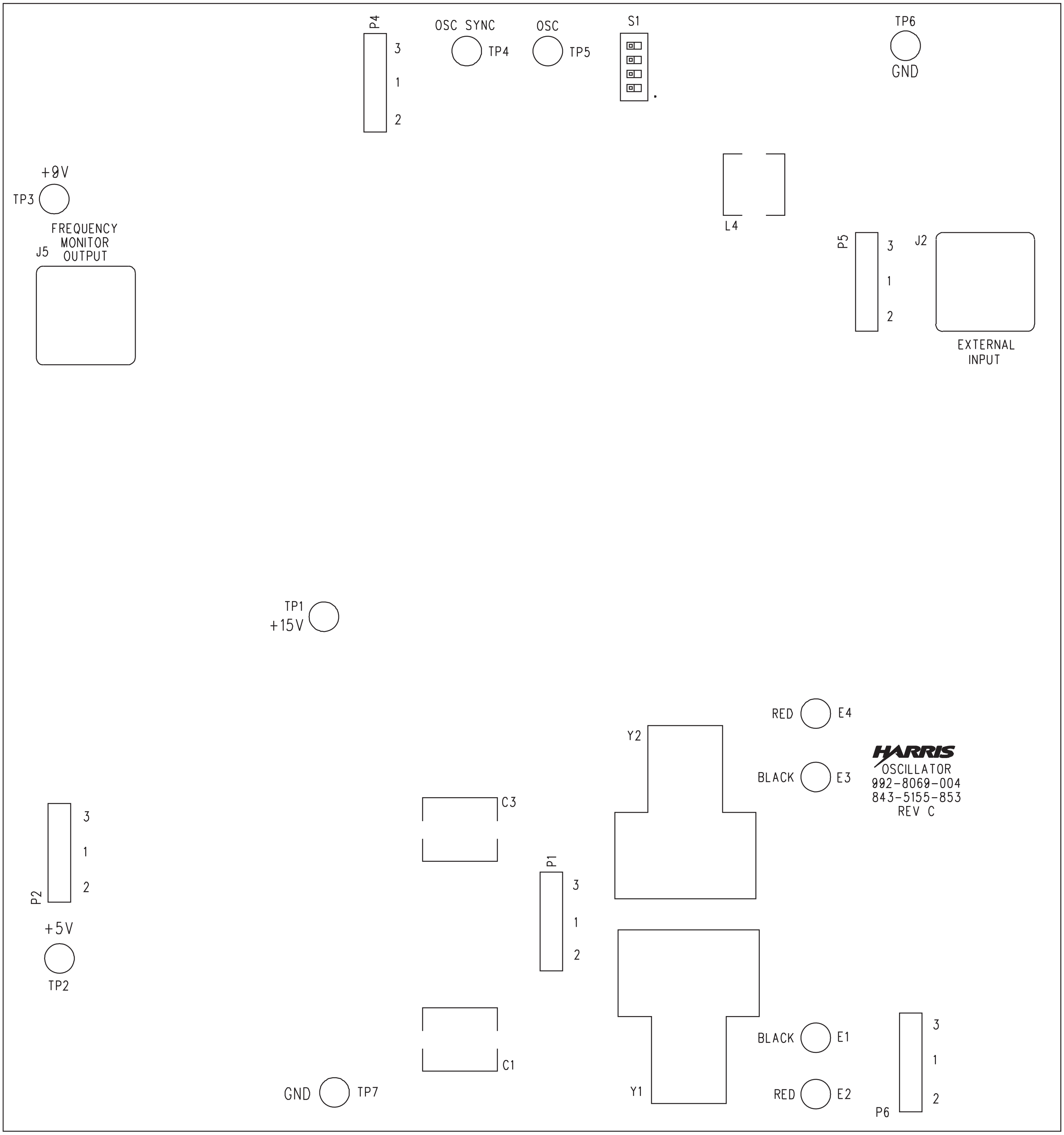


Figure A-2. Oscillator Board Controls and Indicators

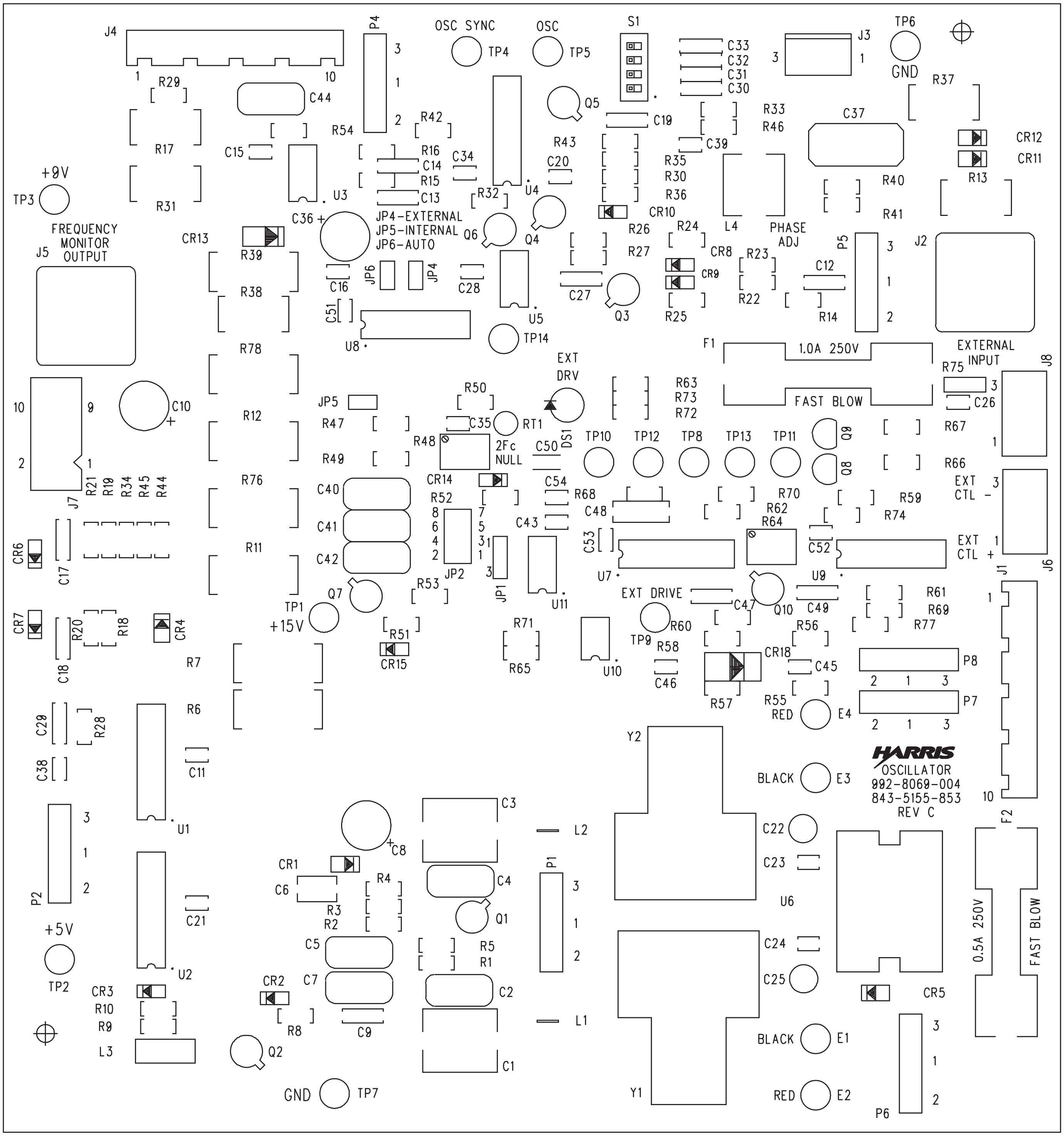


Figure A-3. Oscillator Board Component Locator

Section B
Oscillator Interface (A3)

B.1 Introduction

This section covers the Oscillator Interface board. Topics include function, location, block diagram description, detailed circuit description, and troubleshooting.

Assembly #	992-8195-001
PWB #	843-5155-013
Schematic #	839-7930-013

NOTE: Maintenance for this board is covered in Section V; and Parts List in Section VII.

B.2 Function

The Oscillator Interface board contains circuits for selecting Oscillator A or optional Oscillator B, combined transmitter Oscillator switching and interfacing, and active Oscillator fault sensing. The RF output of this board goes to the Buffer Amplifier via the Driver Combiner Motherboard.

B.3 Location

The Oscillator Interface board is mounted in the RPAC on the left sidewall. (See VIEW 2)

B.4 Block Diagram Description

B.4.1 Oscillator Switching

Normally, Oscillator A is selected for operation and a relay on the Oscillator Interface supplies Oscillator A with +22Vdc and -22Vdc in addition to selecting Oscillator A output. Optional Oscillator B, if installed, can be selected by switching the relay to the opposite position.

B.4.2 Fault Sensing

Fault sensing for the active Oscillator is accomplished by applying the RF Present output from the Oscillator to a comparator. If the Oscillator output is not present, the comparator sends an Oscillator Fault to the Controller board. The inactive oscillator RF Present output is inhibited from causing an Oscillator fault.

B.4.3 Power Supplies

+22Vdc is regulated down to +15Vdc and +5Vdc to power circuits on the board.

B.4.4 Combined Transmitter RF Switching

Several circuits on the board are reserved for combined transmitter applications and are not used in a single system transmitter. Refer to the combiner manual for information regarding the use and function of these circuits.

B.5 Detailed Circuit Description

Refer to the schematic diagram for the Oscillator Interface board (839-7930-013) for all descriptions in this section.

B.5.1 Power Supply Switching

Relay K1 and Oscillator Select switch S2 are shown in the normal Oscillator A selected position. +22Vdc and -22Vdc are connected to Oscillator A at J2 by K1 contacts 9 and 1 and K1 contacts 10 and 2 respectively. Indicator DS3, Oscillator A Selected, is connected to the +22Vdc supply and will be illuminated green. When K1 is energized, the supplies are connected to Oscillator B at J9 and DS4, Oscillator B Selected, will illuminate.

Crystal Heater Select jumpers P1 and P2 are normally connected 1-2 so that the inactive Oscillator board has -22Vdc to keep the crystals heaters active. It can be jumpered otherwise if it is not required that heater be continuously active.

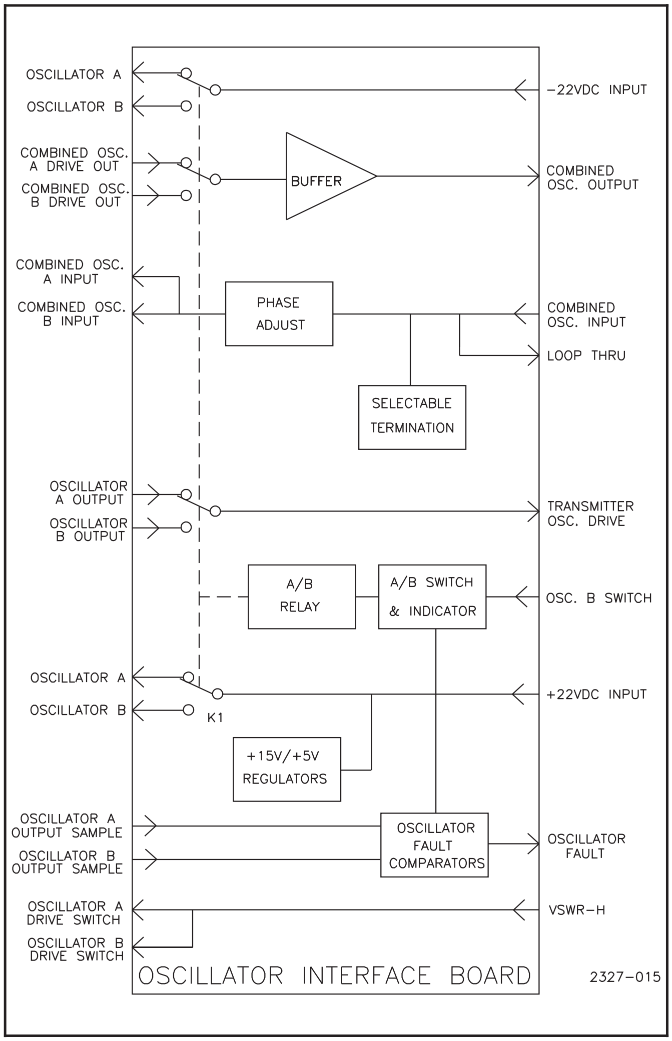


Figure B-1. Oscillator Interface Block Diagram

Warning: Disconnect primary power prior to servicing.

B.5.2 Oscillator Output Switching

Transmitter Drive Out (From Oscillator A) enters at J3-1 and passes through the K1 contacts 3 and 11 to TP5 Oscillator Out and J7-1. Transmitter Oscillator Drive at J7-1 then connects to the Driver Combiner Motherboard and eventually to the Buffer Amplifier.

If selected, Transmitter Drive Out (From Oscillator B), enters at J8-1 and passes through the K1 contacts 7 and 11 to TP5 and J7-1.

Zener diodes CR1 and CR6 are connected to the +22Vdc, and are in series with the relay coil. This drops the +22Vdc to +12Vdc for the relay coil at pin 13. If the Oscillator Select switch, S1, is in the B position, a ground is applied to the relay coil at pin 14 and the relay energizes. Likewise, a remote/extended control input will deliver +5Vdc to J11-7 that turns Q1 fully on and also applies a ground to K1.

B.5.3 Fault Sensing Comparators

Normally, when Oscillator A is selected, the RF(-) input at J12-3 is -.6Vdc and RF(+) input at J12-1 is +3.5Vdc, and comparator U2-2 output at TP11 is +5Vdc.

Should Oscillator A fail, the RF(-) voltage will be greater than the RF(+) voltage and TP11 will go to 0Vdc. The voltage at U2-9 will be 2.6Vdc, established by a resistor divider, R8 and R10.

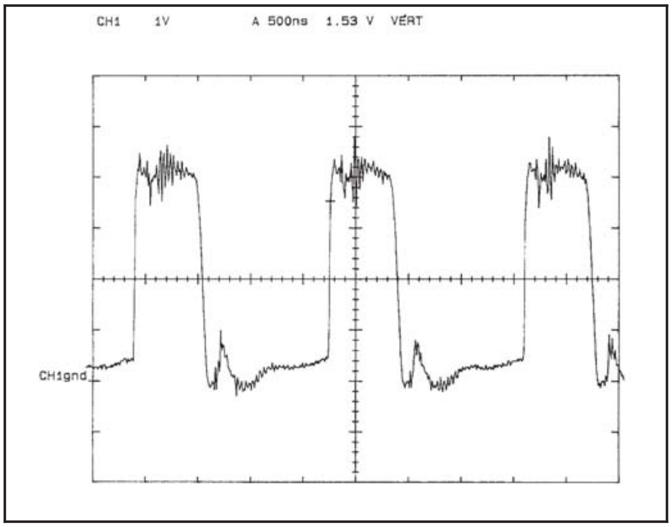
When Oscillator B is selected, the same voltages are supplied to J10-3 and J10-1, and the output of U2-1 at TP12 is +5Vdc. If a failure occurs, the voltage at U2-11 will be 2.6Vdc.

B.5.4 Fault Sensing Selection

B.5.4.1 Oscillator A Selected

K1 is de-energized and approximately +10Vdc is supplied to U2-8 through the relay coil. Normally U2-9 is +15Vdc and the output of U2-14 at TP6 Oscillator Fault is +5Vdc. When TP11 goes low and U2-9 goes to +2.6Vdc, the output of U2-14 goes LOW and TP6 is 0Vdc. An Oscillator Fault-L is generated and sent to the Controller via the Transmitter Interface.

Diode CR8 pulls up U2-11 to the +10Vdc supply, so a fault is not generated by U2-13 (Oscillator B Fault).



TP5

B.5.4.2 Oscillator B Selected

K1 is energized and 0Vdc is applied to U2-8 to prevent U2-14 (Oscillator A Fault) from going low. Diode CR8 is reversed biased, and the voltage at U2-10 is set at +4.6Vdc by R13 and R8. Should Oscillator B fail, U2-11 goes to +2.6Vdc and U2-13 goes LOW, generating an Oscillator Fault-L to the Controller via the Transmitter Interface.

B.5.5 Power Supplies

+22Vdc passes through F1 and is regulated down to +15Vdc by U4. U3 is connected to the +15Vdc and forms a +5Vdc supply. Indicators DS2 and DS1 illuminate green when the respective supplies are operational.

B.5.6 VSWR Control Line

When the Controller generates a VSWR-H signal, +5Vdc appears at J5-1 and TP16 for 250nS. This voltage is distributed to Oscillator A at J12-5 and optional Oscillator B at J10-5.

B.6 Oscillator Interface Troubleshooting

Any Problems on these board can be classified into three areas. These are:

a. Power Supply
b. Signal Switching, and
c. Fault Sensing.

Refer to the Oscillator Interface Schematic (839-7930-013) as needed for this section. Troubleshooting the circuitry associated with the combined transmitter mode is covered in the combined transmitter manual.

B.6.1 Power Supply

Begin troubleshooting by:

a. Checking that the +15V (DS2) and +5v (DS1) LED's are lit with the low voltage on only.
b. If DS1 is out but DS2 is lit:
    1. Check TP1 for +5Vdc.
    2. If not present, check U3, and associated circuitry.
c. If both indicators are out:
    1. Check F1, and replace if open.
    2. If F1 is not open, then check for +22Vdc on J1-1 and -22 Vdc on J1-3.
    3. If not present, refer to the Transmitter Troubleshooting section to troubleshoot the Low Voltage Supply.
    4. If +22Vdc is present, check TP2 for +15Vdc.
    5. If not present, check U4 and associated circuitry.

After repairs are made to the Power Supply, check the output of the supplies to ground with an ohmmeter for shorts before applying power to the board.

Warning: Disconnect primary power prior to servicing.

B.6.2 Signal Switching

If the transmitter will not switch between Oscillator A and Oscillator B and/or there is no signal at TP5 (Osc Out), the Oscillator Select Circuit may have failed.

NOTE:

If remotely switched to Oscillator B, local control will not have any effect.

a. Toggle the Osc Select Switch (S2).
   1. The Osc Selected indicator (DS3 or DS4) should light and extinguish as the switch is activated and relay K1 should change states.
   2. If no indicator lights and K1 does not change states, then check TP3 for +22Vdc and TP4 for -22Vdc.
   3. If not present, refer to the Transmitter troubleshooting section for troubleshooting the Low Voltage Supplies.

b. If the indicators switch and K1 changes state but there is no signal at TP5, check for the presence of RF at the contacts of K1. Pins 3 and 7 are the input to the relay and pin 11 is the output.
   1. If there is no input check the connector associated with the selected oscillator for a signal.
   2. If not present, refer to the trouble shooting section of the Oscillator and/or check cable for an open or short.

c. If the input is present, but there is no output at pin 12, disconnect J7 on the board.
   1. If the signal returns, refer to the troubleshooting section of the Driver Combiner and/or check the cable for a short.
   2. If the signal is still not present, replace K1.

d. If DS3 indicator remains on and K1 does not change states when S2 is toggled, check the cathode of CR2 for +12Vdc.
   1. If not present, check CR1, CR6 and F1.
   2. If the +12Vdc is present, check for +8 volt on the anode of CR2 when Oscillator A is selected and 0Vdc volts when Oscillator B is selected.
   3. If the voltage changes but no action is seen on K1 or the LED’s fail to switch, replace K1.
   4. If voltage on the anode of CR2 does not change from +8 volts, verify low resistance to ground when S2 is in the B position.
   5. If no change is seen in resistance, replace S2.

e. If DS4 is lit and the voltage at the anode of CR2 remains at 0Vdc, verify that the Osc B Select line from the Transmitter Interface board is not active (High), to be sure it is the local control causing K1 to activate not a remote control input.
   1. If active, refer to the Transmitter Interface section of the manual.
   2. If not active, check U1 and/or CR3.

B.6.3 Fault Sensing

Begin Troubleshooting as follows:

a. Check the state of TP6 (Osc Fault).
   1. If this is logic high, the transmitter should not display a fault on the ColorStat™ Front Panel.
   2. If a fault is displayed, refer to the Controller section of the manual for further troubleshooting.

b. If this line is a logic low, select Osc B (if equipped) on S2.
   1. Verify that DS4 lights indicating that Osc B is selected.
   2. If not, refer to Signal Switching Section of this procedure.

c. After selecting Oscillator B, check TP6 for a logic high.
   1. If present, troubleshoot Oscillator A sensing circuit.
   2. If there is no change, troubleshoot Oscillator B sensing circuit.
   3. If the transmitter is not equipped with Oscillator B troubleshoot Oscillator A sensing.

B.6.4 Oscillator A Sensing

a. Check the voltage on TP11 for a logic high.
   1. If the high is present, unplug J12 and monitor TP11, the voltage should go to a logic low.
   2. If not, change U2.

b. If the high is not present on TP11, check the input to U2-4. It should be approximately -0.6Vdc.
   1. Check the input to U2-5 it should be approximately +3.5Vdc.
   2. If these are not correct, refer to the Oscillator Section for Troubleshooting the Oscillator sample lines. Also check the cabling for opens or shorts.

c. If the inputs to U2 are correct, replace U2.

d. If TP11 changes states when J12 is unplugged, check the inputs to U2-9 and U2-9.
   1. U2-8 should be approximately 2.6Vdc and U2-9 should be the logic high presented at TP11.
   2. If U2-8 is greater than 2.6Vdc check CR3 and U2.
   3. If U2-8 is zero or low check CR3, U2, R8, and U1.

B.6.5 Oscillator B Sensing

a. Check the voltage on TP12 for a logic high.
   1. If the high is present, unplug J10 and monitor TP12, the voltage should go to a logic low.
   2. If not, change U2 and/or check CR8.

b. If the high is not present on TP12, check the input to U2-6. It should be approximately -.6Vdc.
   1. Check the input to U2-7 it should be approximately +3.5Vdc.
   2. If these are not correct refer to the Oscillator Section for Troubleshooting the Oscillator sample lines. Also check the cabling for an open or short.

c. If the inputs to U2 are correct, replace U2.
   1. If TP12 changes states when J10 is unplugged, check the inputs at U2-10 and U2-11.
   2. U2-10 should be approximately 2.6Vdc and U2-11 should be the high presented at TP12.
   3. If U2-10 is greater than 2.6Vdc check the voltage divider (R13 and R8) and U2.
   4. If U2-10 is zero or low check, U2, C18, and R13.

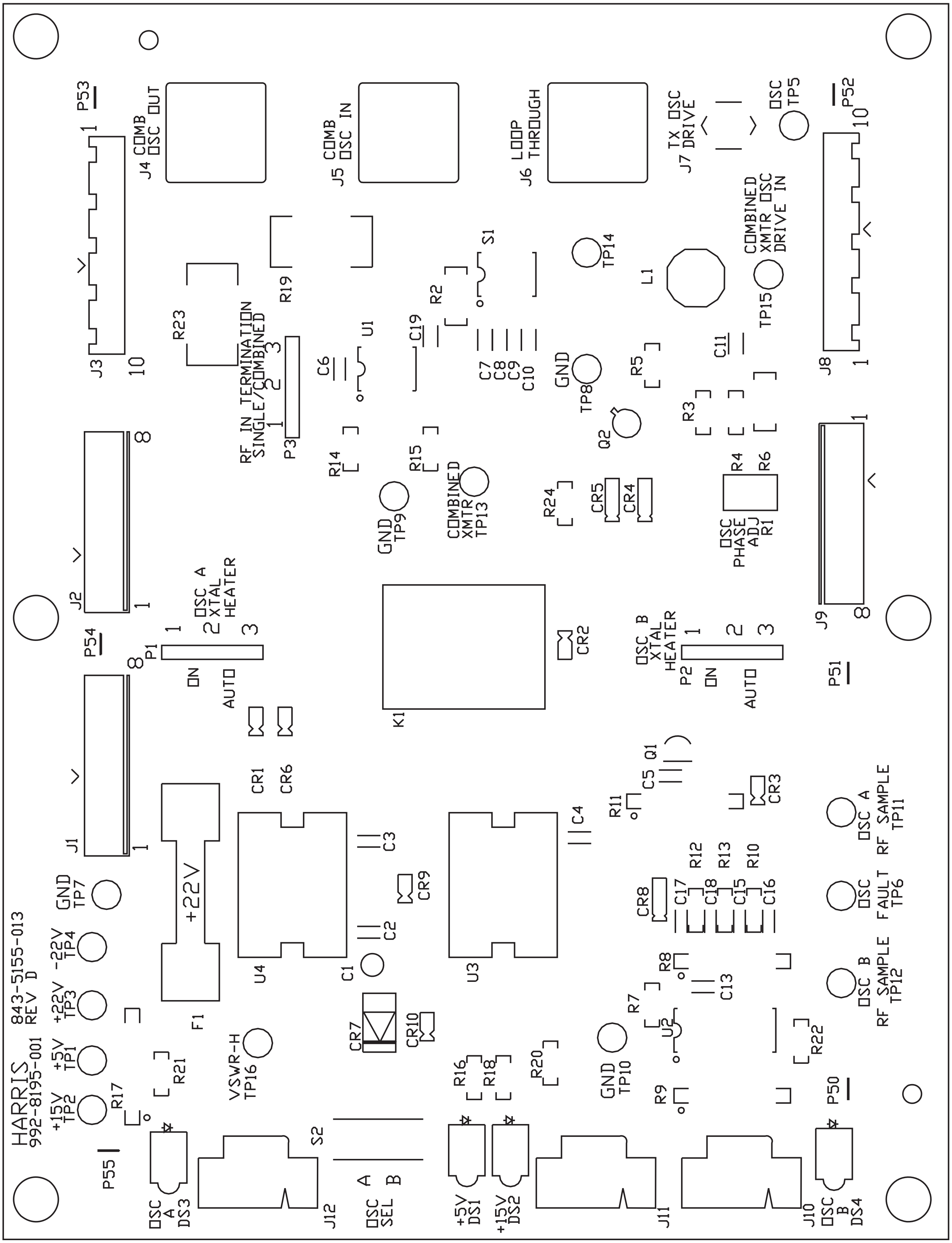


Figure B-2. Oscillator Interface Component Locator

Section C
Driver Combiner Motherboard (A5)

C.1 Introduction

This section describes the Driver Combiner Motherboard. Topics include function, location, detailed circuit description, troubleshooting, and removal/replacement.

> **NOTE:**
> *Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.*

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

NOTE: For more information about the RF Driver Section, refer to the Overall System Theory Section.

NOTE: Parts List for this board is in Section VII.

C.2 Function

The function of the Driver Combiner Motherboard is to provide the input/output connections for the Buffer, Predriver, and the 14 RF Driver amplifiers. Other functions include Predriver Switching, Buffer and Predriver RF Sense, and RF Driver Combining.

C.3 Location

The Driver Combiner Motherboard is located in the upper center of the RPAC. (See VIEWS 13)

C.4 Detailed Circuit Description

Refer to Driver Combiner Motherboard Schematic Diagram (839-7930-504), and Figure C-1 Driver Combiner Motherboard for the following discussion.

Assembly #	992-8538-003
PWB	843-5155-504
Schematic	839-7930-504

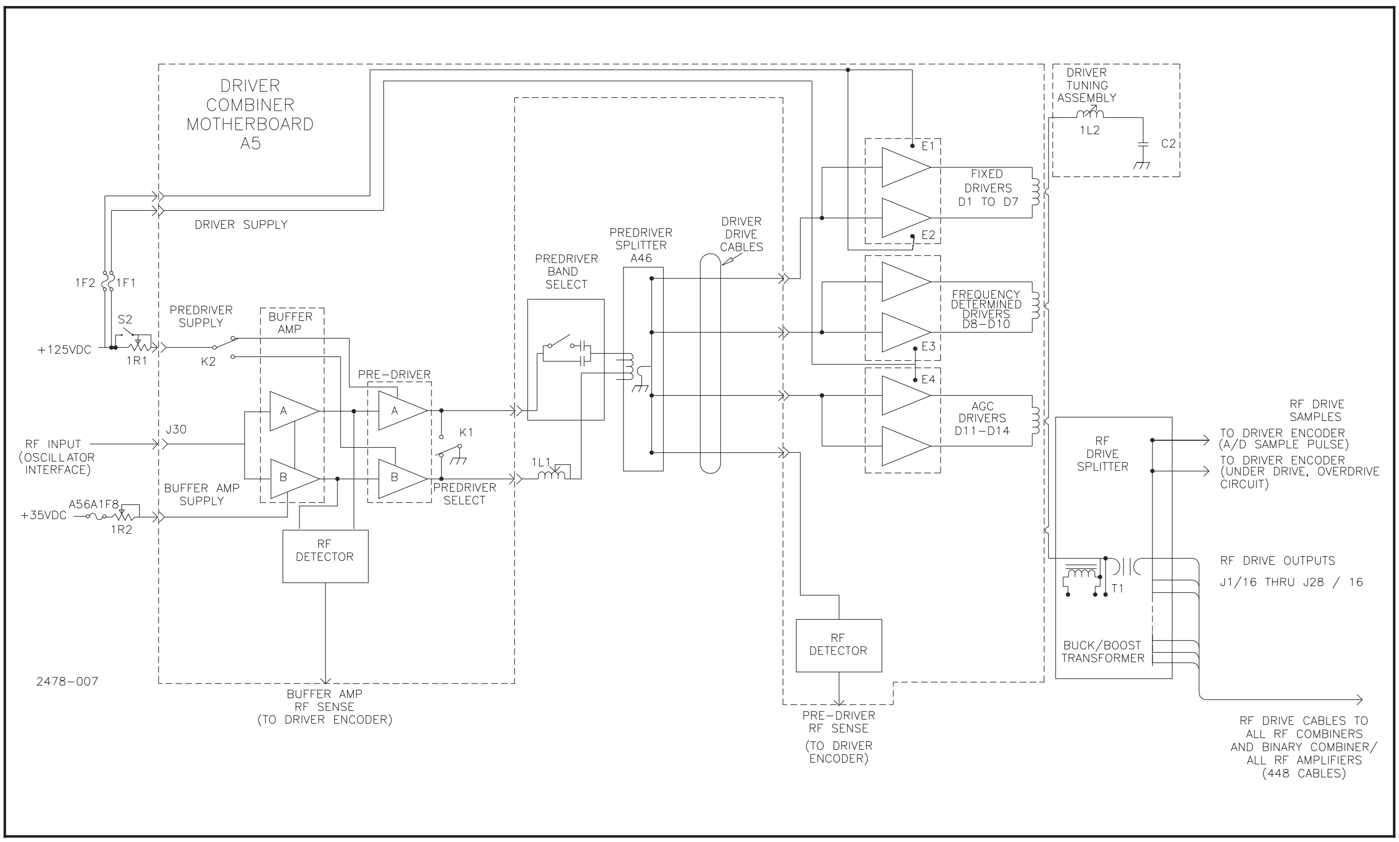


Figure C-1. Driver Combiner Motherboard

C.4.1 Buffer Amplifier Connections - J1

C.4.1.1 RF Input

The signal from the Oscillator Interface board enters the Driver Combiner Motherboard at J30, and is routed directly to the Buffer Amplifier RF input at J1-15.

C.4.1.2 Power Supply

A +60VDC line from the RF Amp Power Supply passes through R37 & tapped resistor R2, and enters the Driver Combiner Motherboard at J32-3. It is connected to the Buffer Amplifier at J1-41, and can be varied from 20 to 45VDC by R2, Buffer Voltage Adjust.

C.4.1.3 RF Output

The Buffer Amplifier RF output for Section A enters the Driver Combiner Motherboard at J1-49 and is routed to J2-49.

The Buffer Amplifier RF output for Section B enters the Driver Combiner Motherboard at J1-53 and is routed to J2-53.

C.4.1.4 Buffer RF Sense

Peak detectors provide a Buffer Amplifier RF Sense signal for Section A and Section B outputs to fault and overload circuits on the Driver Encoder board.

The Section A goes to a peak detector formed by CR3 and C9. When RF is present, J31-13 will have a positive voltage approximately 1/2 the peak-to-peak waveform.

The Section B detector is formed by CR5/C8, connected to J31-11.

C.4.2 Predriver Connections - J2

C.4.2.1 RF Input

The RF output from Buffer Amplifier Section A enters the Predriver Section A RF Input at J2-49.

The RF output from Buffer Amplifier Section B enters the Predriver Section B RF Input at J2-53.

C.4.2.2 Power Supply

A +125VDC line from the RF Amp Power Supply passes through tapped resistor R1, and enters the Driver Combiner Motherboard at J32-1. It can be varied from 90 to 125VDC by R1, Predriver Voltage Adjust.

It passes through metering circuit resistor R20 and is connected to the common of K1.

C.4.2.3 Predriver Switching

Relays K1 and K2 are controlled by the Driver Encoder and select which Section of the Predriver is active. A Predriver Relay Supply of +15 VDC is supplied to both relays at J31-19.

C.4.2.3.1 Predriver A Selected

Normally Predriver Section A is selected, and the Predriver Relay Drive input at J31-17 is an open circuit. Both relays are in the de-energized state as drawn.

K1 switches the supply voltage to J1-1 which loops through the Predriver A fuse on the Buffer Amplifier and is sent to J2-23.

K2 grounds the inactive Predriver B output at J2-8.

Predriver A RF output at J33 is connected to Predriver Tuning board at J2 and returned through a series-tuned L1 to ground at J32-6.

C.4.2.3.2 Predriver B Selected

If Predriver Section B is selected, and the Predriver Relay Drive input at J31-17 is grounded. Both relays are energized and connected opposite as drawn.

K1 switches the supply voltage to J1-8 which loops through the Predriver B fuse on the Buffer Amplifier and is sent to J2-29.

K2 grounds the inactive Predriver A output at J2-2.

Predriver B RF output at J32-6 passes through L1 and to Predriver Tuning board TB1-7 and returns to ground at J33-1.

C.4.2.4 Predriver Metering

The voltage drop across R20 depends on the Predriver current, and when the RF Multimeter is switched to the “Predriver IDC” position, it acts as a voltmeter, measuring this voltage drop; R23 and R22 are the voltmeter’s series multiplier resistors. Resistors R21 and R24-R26 are the voltmeter multiplier resistors when the RF Multimeter is switched to the “Predriver +VDC” position.

C.4.2.5 Predriver RF Sense

One of the RF feeds from the A46 Predriver Splitter is used to provide the Predriver RF sense sample. The sample enters the Motherboard at J17-1 and is routed the Predriver Output Sense network and the primary of T20. A peak detector is formed by a secondary winding of T20, CR1, and C10. When RF is present, J31-15 will have a positive voltage approximately 1/2 the peak-to-peak waveform.

C.4.2.6 Predriver Band select

The Predriver Band select board adds capacitance and inductance in series with L1, Predriver Tune and adjusts the Predriver level, depending on the operating frequency. For frequencies 525-1080KHz, S1 and S2 are in the low position, 1081-1620KHz, S1 and S2 are in the high position. These two settings are factory set.

C.4.3 Driver Connections - J3 through J16

C.4.3.1 RF Input

The RF drive inputs are obtained from the A46 Predriver Splitter secondary and the driver drive cables that are connected to J18 through J24. Each Driver is provided two equal amplitude and phase RF drive inputs at pins 49 and 53 of each RF Driver connector.

C.4.3.2 Power Supply

Four fused +125VDC lines from the RF Amp Power Supply enters the Driver Combiner Motherboard at E1 through E4. It is connected to each Driver connector at pin 23 and can not be adjusted.

C.4.3.3 RF Output

Each Driver output is connected to a combiner toroid T3 through T16 at pins 1 and 7. The Efficiency Coil boards plug into the Driver Combiner Motherboard at J3-J16 at pins 1 and 7, and their taps are frequency determined.

C.4.4 Driver Encoder Connections - J25 through J28

C.4.4.1 Turn-On Control Signals

On each of the four Driver Encoder connectors, pins 1, 3, 5, and 7 are connected to pin 45 on four Driver connectors. When the voltage is -2VDC on a pin, the Driver is turned on. The same is true for the Predriver on J25-5.

C.4.4.2 Cable Interlock

When an amplifier is properly inserted a connection is made between pins 35/36 and pins 37/38 on the amplifier connector. On each of the four Driver Encoder connectors, pin 9 will loop-through connecting traces/amplifiers/connectors and return to pin 10 with very low resistance. If an amplifier is disconnected, pin 9 and pin 10 will be open circuit.

C.4.4.3 Efficiency coils

Selectable inductance is provided on the motherboard to cancel stray capacitance. Two toggle switches select the proper inductance depending on carrier frequency. See schematic #839-8154-003 for the frequency chart.

C.5 Troubleshooting

Most failures on this board can usually be visually identified as burned resistors, open traces, cracked toroids, and loose or damaged connectors. To speed up locating the fault, this section is grouped by major symptom.

CAUTION

THE TRANSMITTER MUST NOT BE OPERATED UNLESS THE COMBINER COVER IS IN PLACE AND ALL SCREWS HOLDING THE COVER TO THE GROUNDING BLOCKS ARE INSTALLED AND PROPERLY TIGHTENED. THE COMBINER COVER CARRIES MOST OF THE COMBINER RETURN CURRENTS.

C.5.1 Driver Troubleshooting

C.5.1.1 No +125VDC to a Driver Amplifier(s)

a. Check the +125VDC supply by watching the DRIVER +VDC position on the Driver Multimeter. It should deflect upscale during step start. If not, then refer to Section VI, Troubleshooting, to troubleshoot the +125VDC supply.

b. If the +125VDC is present on the meter, but it is suspected that one or more modules is not receiving voltage, then shut the Transmitter off for the following checks.

   1. Check continuity of the +125VDC supply fuses and connections to each of the driver modules.

CAUTION

It may be necessary to remove the Efficiency Coil Board to accomplish this. DO NOT attempt to turn on the Transmitter with this board removed, as amplifier damage will result.

   2. If the continuity check does not reveal the problem, then suspect either the capacitors on the module side of the motherboard or the filter capacitors.

C.5.1.2 No Output from a Driver Amplifier

a. Drivers D8, D9, and D10 may not be turned on because the number of active amplifiers required is frequency determined.

b. Check the DRIVER IDC position on the Driver multimeter, and compare to the factory test data sheet, or a previous log reading.

   1. If the reading is low, this indicates that one or more modules is not operating. Be sure that the Auto Spare driver is off when taking this reading.
   2. Another indication a module is not operating would be the Regulated Driver, 14A and 14B +VDC positions on the Driver multimeter. The 14A +VDC reading will have increased and the 14B +VDC reading may have also increased, to compensate for the lower drive level.

c. If it is suspected that one or more modules is not operating then:

   1. Look for illuminated red blown fuse LEDs on the driver modules either while the Transmitter is running or during step start. Repair any module with a red LED illuminated.
   2. If no red indicators are illuminated on the modules, then check for illuminated Green indicators on the drivers that are supposed to be turned on.
   3. A module that is supposed to be turned on, but does not have the green LED illuminated has either lost RF Drive or the module Turn On signal from the Driver Encoder.
   4. To check RF Drive on the drivers, Refer to Section VI, Troubleshooting Paragraph Title "MEASURING RF DRIVE."
   5. If no Drive problem is found, refer to the Driver Encoder Troubleshooting section to trace the lost turn on signal.

d. If the amplifier has RF drive, control signal and supply voltage, inspect the motherboard for a bad connector, open trace or cracked toroid.

C.5.1.3 Amplifier Fails in Same Position Repeatedly

If an amplifier position repeatedly fails a Driver Amplifier the most likely causes are:

a. No or low drive on the amplifier
b. Cracked output toroid
c. Bad module connector on motherboard
d. Improperly tapped or connected efficiency coil, or
e. An open Drive trace on the motherboard.
f. Low or missing RF Drive. Check the level of RF drive on the amplifier. Refer to Section VI, Troubleshooting, Paragraph Title "Measuring RF Drive Level".

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. If RF Drive is low or missing inspect the RF drive cable, RF drive connector, and the Predriver Splitter (A46) for a short or open.

g. To locate a cracked toroid, bad connector, or open Drive trace on the motherboard:
   1. A visual inspection should be done first.
   2. If the visual inspection has revealed nothing, an ohmmeter check should be conducted of the traces leading to that amplifier position.

C.5.2 Predriver Troubleshooting

C.5.2.1 No Predriver A or B Voltage

This section starts by assuming there is no voltage to either side of the Predriver Amplifier when the Predriver select control is operated.

a. If there is no Multimeter reading of Predriver Voltage, verify that the supply is present on the Predriver when Step Start sequence is initiated by observing the PREDRIVER IDC position on the Driver Multimeter. If the voltage is present then there will be a current indication.
   1. If not, refer to the Troubleshooting section of the manual for troubleshooting the supply.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

   2. If the supply is present, check R20, on the Driver Combiner Motherboard board, for an open.
   3. If R20 checks correct, then check for continuity (low resistance) from J32-1 to pins 1 through 4 on Buffer connector J1.
   4. If no continuity, refer to paragraphs that follow.

CAUTION

It may be necessary to remove the Efficiency Coil Board to accomplish this. DO NOT attempt to turn on the Transmitter with this board removed, as amplifier damage will result.

   5. If continuity exists, check for continuity from pins 1 through 4 on the Buffer connector J1 to pins 23 through 26 on Predriver connector J2. (The Buffer Amplifier should be in its connector).
   6. If continuity exists, suspect a bad connector.
   7. If this line measures open, check for continuity between pins 1 through 4 on J1 to pins 23 through 26 on Buffer connector J1 with Buffer Amplifier in place.
   8. If continuity exists, then a trace is open between J1 and J2.
   9. If no continuity, then suspect a bad J1 or open F1 on the Buffer Amplifier.
   10. If no continuity exists between J32-1 and Pins 1 through 4 on J1, then remove the Buffer and Predriver modules.

C.5.2.2 Verify Predriver Select Relay Operation, K1 and K2

a. Switch between Predriver A and B on the Driver Encoder Board and verify that K1 and K2 are operating.
   1. If only one relay operates, the non-switching relay is defective or a trace is open.
   2. If K1 operates but there is no continuity between J32-1 and Pins 1 through 4 on J1 in the "A" position, then suspect bad contacts of K1 or an open trace.
   3. If K1 operates and there is no continuity between J32-1 and Pins 7 through 12 on J1 in the "B" position, suspect bad contacts of K1 or an open trace.

b. If K1 and K2 do not operate, check for +15VDC on J31-17 when A is selected and for 0 VDC when B is selected.
   1. If J31-17 does not change states, check for an open trace on the board or open cable coming from the Driver Encoder. Refer to the Driver Encoder Troubleshooting Section to continue.

c. If the signal changes state but the relays do not operate, an open coil on K1 or K2, or a shorted CR7 may be at fault.

C.5.2.3 No RF Out of Predriver A or B

a. Verify that it is not an amplifier fault by swapping the Predriver with another position Driver Amplifier.

b. If still no output, check for turn on signal presence during step start (Green LED on).
   1. If no signal is present, check for an open trace on the motherboard or open cable from Driver Encoder.
   2. If no problem is found, refer to the Driver Encoder Troubleshooting Section.

c. Check for Supply Voltage for the Predriver during Step Start sequence with the PREDRIVER +VDC position on the Driver Multimeter.
   1. If the voltage is present at the meter, then check the PREDRIVER IDC reading. No current indication would mean the voltage is not getting to the Predriver module.

2. If the voltage or current reading is not present, then refer to “No Predriver A or B Voltage” of this section to troubleshoot loss of the supply.

d. Remove Predriver Module and verify that K2 on the Motherboard operates when the Predrivers are selected on the Driver Encoder.

1. If K2 does not operate, refer to previous paragraph titled “Verify Predriver Select Relay Operation, K1 and K2".

e. Determine that RF drive is getting to the Predriver during the Step Start sequence. Refer to Section VI, Troubleshooting, Paragraph Title “Measuring RF Drive Level”.

1. If no Drive is present at the Predriver, refer to the Buffer Amplifier Troubleshooting Section and/or inspect the motherboard for an open trace or bad connector.

C.5.3 Loss of Metering and or RF Sensing

The metering and RF sensing circuits are all connected to J31 on the motherboard.

To begin:

a. Verify the presence of the signal on the connector.

1. If missing, an open resistor, shorted diode, or open trace associated with that metering circuit on the motherboard may be at fault.
2. If present refer to the overall wiring diagram to trace the wiring to the proper board.

C.6 Driver Combiner Motherboard Removal/Replacement

C.6.1 Removal

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING “PA+VDC” ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Remove the Buffer, Predriver and 14 Driver RF Amplifiers from the front.

b. Remove the four Efficiency Coil Boards from the motherboard.

c. Disconnect all wiring and cables from the motherboard.

d. Remove the 24 Allen screws and pull the combiner cover out the rear of the Transmitter.

CAUTION

LOCATE AND REMOVE ANY HARDWARE THAT IS DROPPED. IF LOST HARDWARE IS REPLACED, MAKE SURE NONE OF IT HAS LODGED ON ANY RF AMPLIFIER.

e. The secondary combiner rod will have to be removed through the top of the Transmitter.

1. Remove the bolt that attaches the combiner rod to the RF Splitter.
2. Remove the access plate on top of the Transmitter above the L1/C2 assembly.
3. Disconnect the L1 assembly from the top of the combiner rod.
4. Loosen the two set screws that are on the fiberglass supports on the motherboard that hold the rod in place.
5. Lift the combiner rod out the top of the Transmitter.

f. Remove the following motherboard fastening hardware.

1. Two 4-40 screws in the front center card guide support. The 4-40 screws to be removed can be identified by the 6 inch (15cm) aluminum rods attached to the card guide support bar.
2. Six screws on the outside right and left sides of the motherboard.
3. Four screws on the inside top and bottom of the motherboard.

g. Carefully remove the motherboard out the rear of the Transmitter, tilting it somewhat to clear the driver drive cables housing unit.

C.6.2 Replacement

Replacement of the Driver Combiner Motherboard is essentially the reverse of the removal procedure, however note the following:

a. During installation of a motherboard, it may not appear to fit in as easily as it came out. This is due to the blue card guides not fitting back in their slots at the same time. It is recommended that the board be installed and just a few of the screws be installed that mount the board to the supports. Then from the front of the compartment, place the card guides into their respective slots.

b. Tighten the hex head screws on the copper rod to 80 inch/lbs.

c. Retighten the set screws on the motherboard.

d. Set S1-S8 on the efficiency coils to the same settings as on the board being removed. See schematic #839-8154-003 for the frequency chart for S1-S8.

CAUTION

REPLACE ALL COMBINER COVER SCREWS. THE MAJORITY OF COMBINER RF GROUND CURRENT FLOWS THROUGH THE COMBINER COVERS.

C.7 Buffer Amplifier (A4)

Assembly #	992-8196-001
PWB #	843-5155-014
Schematic #	839-7930-014

C.7.1 Introduction

This section covers the Buffer Amplifier board. Topics include function, location, block diagram description, detailed circuit description, troubleshooting, and removal/replacement.

NOTE: For more information about the RF Driver Section, refer to the Overall System Theory Section.

NOTE: Parts List for this board are covered in Section VII.

C.7.2 Function

The Buffer Amplifier includes Buffer and Push Pull Amplifiers used to amplify the RF signal. The Buffer Amplifier RF input comes from the RF Interface, and the amplified RF output signal drives both sections of the Predriver. All connections to and from the Buffer Amplifier as well as Buffer Amplifier Fault Sensing are made on the Driver Combiner Motherboard.

C.7.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 200kW with no modulation at 1575kHz carrier frequency.

C.7.4 Location

The Buffer Amplifier board is located inside the right PA compartment, behind the inner door, at the top left hand corner. (See VIEW 2)

C.7.5 Block Diagram Description

C.7.5.1 RF Flow

Refer to Buffer Amplifier Block Diagram, Figure C-2 for the following discussion.

The Buffer Amplifier board contains two identical halves, Section A and Section B each of which are always actively driving corresponding halves of the Predriver. Each section has two levels of amplification. Buffers accept the 4 to 4.5Vp-p RF input from the RF Interface board and drive the second stage using coupling Transformers. Class D Push-Pull Amplifiers stages are Filtered and drive both sections of the Pre-Driver board.

C.7.5.2 Power Supplies

A single variable DC supply (+20 to +45VDC) is regulated to +15VDC for the Buffers and is applied directly to the Push-Pull Amplifiers.

C.7.5.3 Predriver Supply

The Predriver Supply voltage is fused on the Buffer Amplifier before being sent to the Predriver. Only one half of the Predriver has DC voltage at a time. This is determined by switch S5, on the Driver Encoder Board, and relay K1, on the Driver Combiner Motherboard.

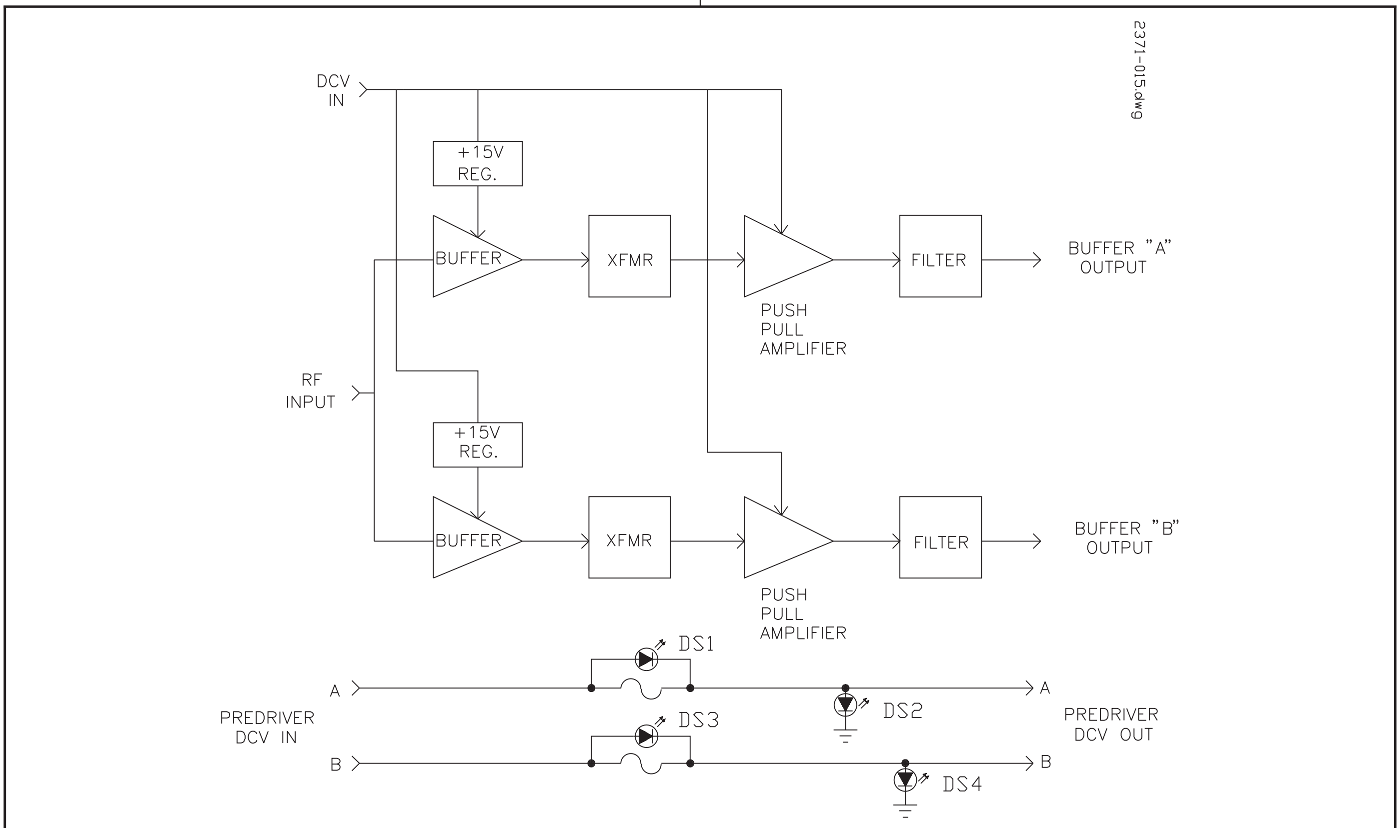


Figure C-2. Buffer Amplifier Block Diagram

C.7.6 Detailed Circuit Description

Refer to the Buffer Amplifier Schematic Diagram (839-7930-014), for the following discussion.

Since the two sections of the Buffer Amplifier Module are identical only Section A will be described here.

C.7.6.1 Buffer Amplifier

The RF input at P1-15 from the RF Interface board is a 4 to 4.5 Vp-p square wave into the 50 Ohm impedance provided by R16. The first RF amplifier stage consists of U1, two parallel drivers, used as a buffer-driver stage. The output of U1 is a square wave at TP1 A drive, with an amplitude of approximately 15 Vp-p. Diodes CR2 and CR4 provide protection against possible transients and overvoltages.

C.7.6.2 Transformer

C8, C10, L1, and R12 are a broadband series tuned coupling network, between amplifier U1 and the primary winding of coupling transformer T1. The upper secondary is connected to the gate of Q1 and the output at TP2, the lower secondary is connected to the gate of Q2 and ground.

C.7.6.3 Push-Pull Amplifier

This RF amplifier stage consists of two power MOSFETs in series, which are driven in Class D (switching) mode. The two RF drive signals to the MOSFET gates are 180° out of phase. Q1 and Q2 are therefore turned on alternately, and the output of the stage alternates between ground and the supply voltage.

CR3 and CR5 protect the MOSFET gates against overvoltages and resistors R9 and R14 are for parasitic suppression.

C.7.6.4 Filter

The output of the Q1-Q2 amplifier stage at TP2, A Out, is applied to a broad-band coupling network formed by C9, L2 and a swamping resistor network. RF OUT SIDE A at P1-49 is connected to the Driver Combiner Motherboard, where it is sent to the Predriver.

C.7.6.5 Power Supplies

The Buffer Amplifier is connected to the +35VDC supply through F8 (on the LVPS board), Buffer Supply Adjust 1R2, and enters the Driver Combiner Motherboard at J32-3. The supply voltage input at P1-41 can vary between +20 to 45 VDC and is used to set the RF drive level to the Predriver.

The input is fused with 2 Amp fuses F3 and F4. Red LED indicators DS5 and DS6 will illuminate when F3 or F4 are open, and are visible from the non-interlocked compartment.

The Push-Pull Amplifier stage operates directly from the input supply. R7 and the associated capacitors form a decoupling network.

U1 operates from +15VDC, regulated by three 5.1V zener diodes CR1, CR11 and CR12 and dropping resistors R6 and R37.

C.7.6.6 Predriver Supply

The Predriver supply voltage is fused on the Buffer Amplifier by F1 and F2 in order to provide proper fusing of 4 Amps (fuses on the RF Amplifier Module are 8A). This allows any of the RF Amplifiers to be used in the Predriver position. Red LED indicators DS1 and DS3 will illuminate when F1 or F2 are open. Green LED indicator DS2 will illuminate when Predriver A supply is present, and DS4 when Predriver B supply is present. All indicators are visible from the Transmitter's noninterlocked compartment.

C.7.7 Troubleshooting

The Buffer Amplifier supply voltage will not be present when the Transmitter is off. The first step in troubleshooting this board is to observe the red LEDs on the module during Step Start.

C.7.7.1 Switch To Predriver B

If Buffer Amplifier Section A has failed, there will be no RF drive to Predriver A. Switching to Predriver B will select Buffer Amplifier Section B output for operation. Move the Predriver Select Switch S5 on the Driver Encoder to the B position, and turn on the Transmitter again. If the Transmitter stays on with no Buffer Amplifier fault, Buffer Amplifier Section A has failed.

C.7.7.1.1 DS5 illuminated

If DS5 is illuminated, F3 has failed.

a. Check MOSFET's Q1 and Q2 for a short and replace as needed.
b. If the MOSFET's measure correctly with an Ohmmeter, check for a shorted CR1, CR11, and/or CR12.
c. If the diodes check okay, measure the capacitors C1 through C5 on that line to ground.

C.7.7.1.2 DS6 Illuminated

If DS6 is illuminated, F4 has failed.

a. Check MOSFET's Q3 and Q4 for a short and replace as needed.
b. If the MOSFET's measure correctly with an Ohmmeter, check for a shorted CR6, CR13, and/or CR14.
c. If the diodes check okay, measure the capacitors C12 through C15 on that line to ground.

C.7.7.1.3 DS1 or DS2 Illuminated

If these LEDs are illuminated, F1 or F2 respectively has failed.

This indicates that the Predriver or the Driver Combiner has a fault. Refer to the RF Amp Section to troubleshoot the Predriver Module and the Driver Combiner Section to continue.

C.7.7.1.4 No Red Indicators Illuminated

Note

Buffer A and Buffer B are identical, therefore only Buffer A will be discussed here. To Troubleshoot Buffer B simply use the appropriate component or Test Points as they relate to Buffer B.

If Buffer A has no output and DS5 is not illuminated during Step Start:

a. First determine if the Buffer is receiving RF Drive.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

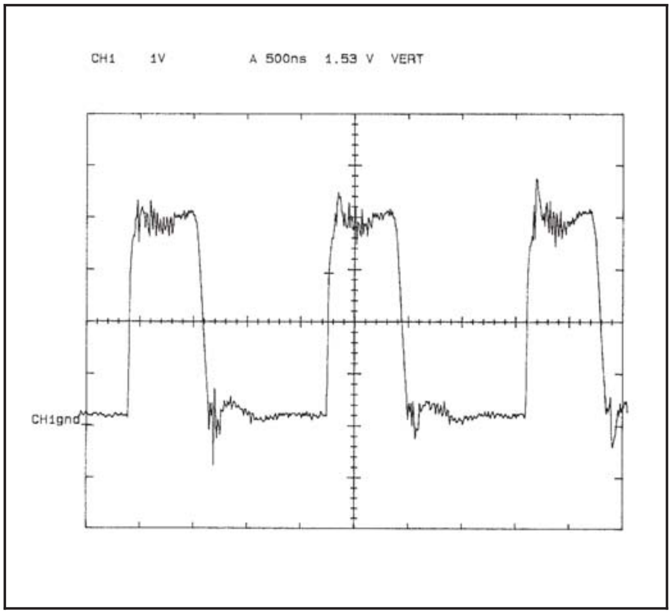
1. Pull out the Buffer module and place a clip lead onto the front end of R16.
2. Route the clip lead through the air holes in the inner door so the door can be closed.
3. Connect a scope probe to the clip lead, and turn on only the Low voltage. There should be a 4 to 4.5Vp-p RF signal present.
4. If not, then refer to the overall wiring diagram to trace the loss of signal.
5. If the RF is present, then check the DC supply voltage to the Buffer.

b. Determining that the DC Supply voltage is present on the module during Step Start sequence can be done by placing the HARRIS probe (610-1131-000) or equivalent X10 probe on the Drain of Q1. During Step Start you should see a +20 to 45VDC signal.

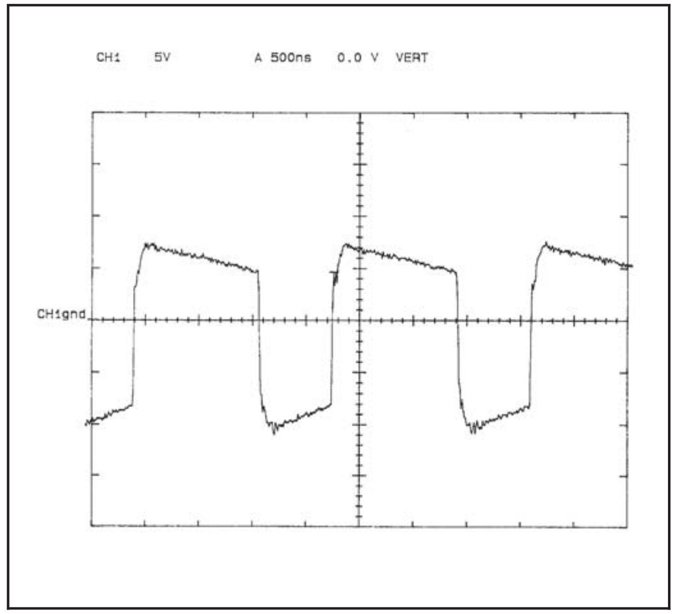
   1. If this is not present refer to Section VI, Troubleshooting, the Overall wiring diagram, and the Driver Combiner schematic to trace the missing voltage.

c. If the supply voltage is present, verify that an RF drive waveform is present at the output of Buffer A during the Step Start sequence.

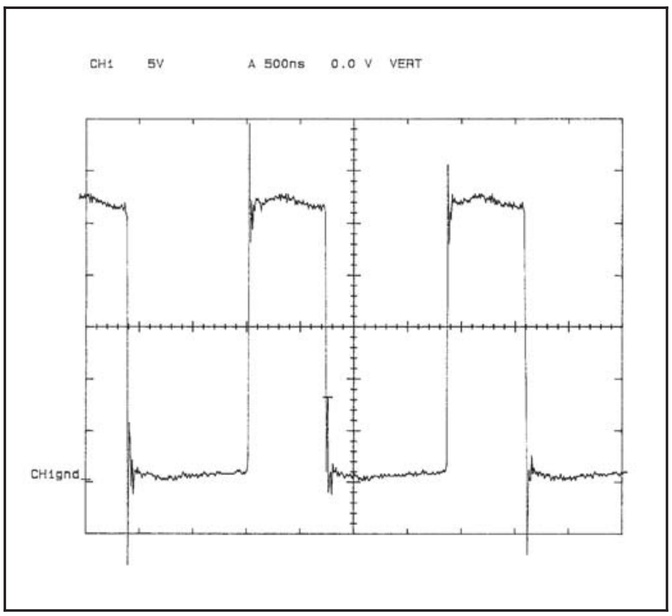
   1. Then look at Buffer B output and verify the presence of the same waveform.
   2. If both outputs have an RF signal, refer to the Driver Combiner Schematic to locate a missing trace or bad connector.
   3. If both outputs do not have an RF signal, check TP1 for a 15Vp-p RF signal during step start and replace U1 if missing. (RF Drive to the input of U1 was verified in a previous step).



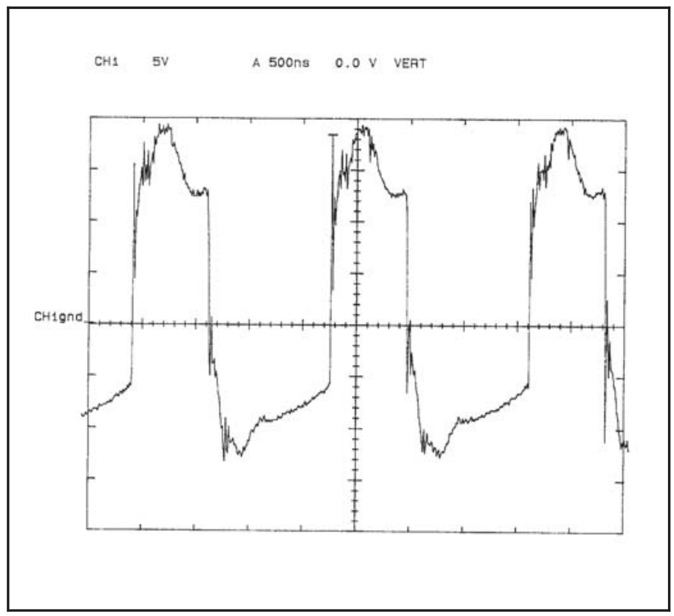
P1-15



TP1



TP2



P1-49

WARNING: Disconnect primary power prior to servicing.

C.8 Predriver, PD1

C.8.1 Introduction

This section describes the Predriver module. Topics include Function, Location, and Troubleshooting.

NOTE:

For more information about the RF Driver Section, refer to the Overall System Theory Section.

NOTE:

For detailed circuit description and troubleshooting refer to Section G, RF Amplifiers.

C.8.2 Function

The Predriver module, PD1, is used to amplify the Buffer Amplifier output and provide RF Drive to Drivers D1-D14. The Predriver module is a plug in RF Amplifier identical to and interchangeable with any of the RF Amplifiers.

C.8.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 200kW with no modulation at 1575kHz carrier frequency.

C.8.4 Location

The Predriver module (PD1) is located in the right PA compartment behind the inner door on the upper left hand side. (See VIEW 2)

C.8.5 Block Diagram Description

Refer to Figure C-3, Predriver Select, Simplified Block Diagram.

C.8.5.1 Predriver Switching

The Predriver module is used in the Single-ended or Half Quad configuration, which means that only one half of the amplifier is activated at a time. Each half of the Predriver receives RF drive from the corresponding half of the Buffer amplifier. The output of the Predriver goes through the Predriver Tuning board then to Predriver Splitter, A46, which feeds the RF Drivers, D1-D14.

C.8.6 Power Supply

The Predriver DC supply is switched by the Predriver Tuning board and R1, Predriver Voltage Adjust. The Predriver DC supply voltage, fuses and indicators are on the Buffer Amplifier. This makes the Predriver interchangeable with the other RF Amplifiers in the Transmitter without having to change the fuses on the RF Amplifier Board.

Predriver Voltage and current metering samples are taken from the Driver Combiner/Motherboard, and can be checked at the Driver Multimeter.(See VIEW 1)

C.8.7 Troubleshooting

C.8.7.1 Predriver Select

Predriver A should be selected for normal operation. If Predriver A should happen to fail, it will be necessary to switch to Predriver B. This can be done by remote control or manually by activating S5 on the Driver Encoder. S5 will activate K1 and K2 on the Driver Combiner/Motherboard. K1 switches the Predriver supply from Predriver A to Predriver B and K2 removes the ground from Predriver B output and places the ground on Predriver A output.

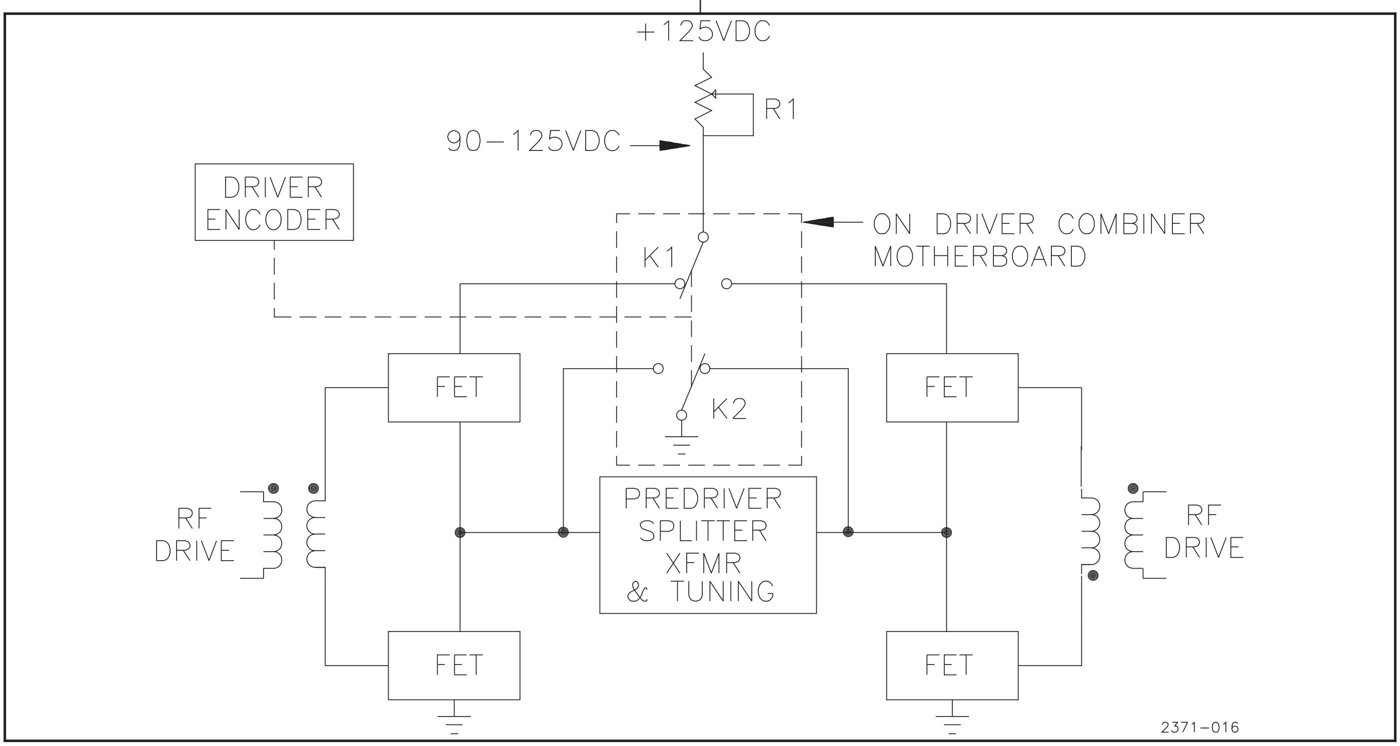
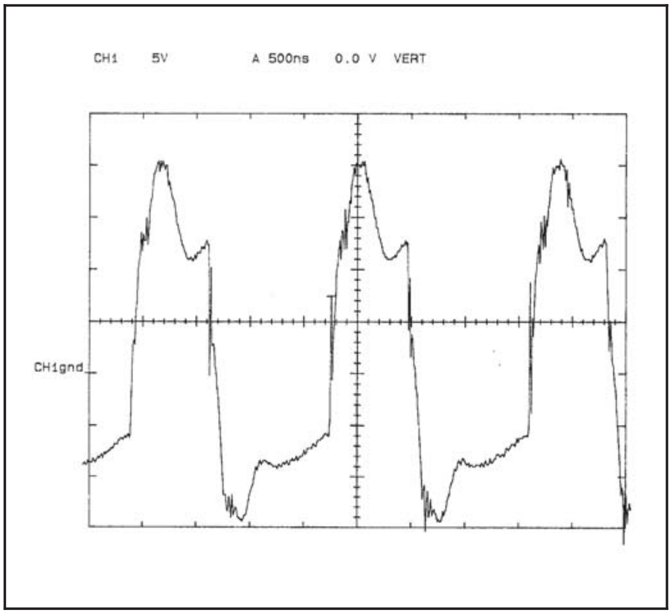
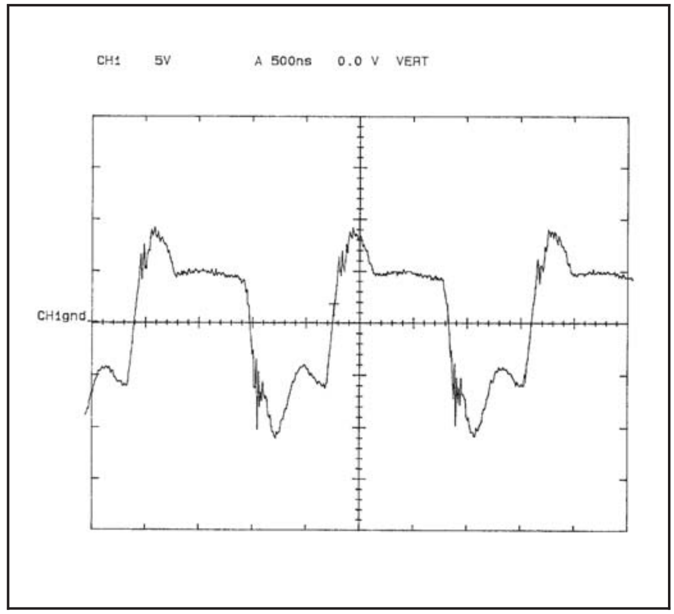


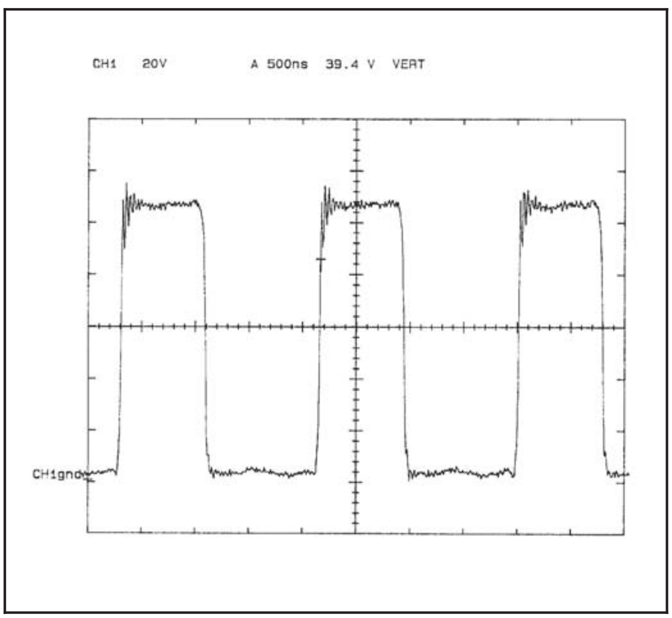
Figure C-3. Predriver Select Simplified Block Diagram



P1-50



Q7 Gate



TP1

C.9 Drivers, D1 through D14

C.9.1 Introduction

This section describes the Driver Amplifiers. Topics include, Function and Location.

NOTE: For more information about the RF Driver Section, refer to the Overall System Theory Section and to the Driver Encoder.

NOTE: For detailed circuit description and troubleshooting refer to Section G, RF Amplifiers.

C.9.2 Function

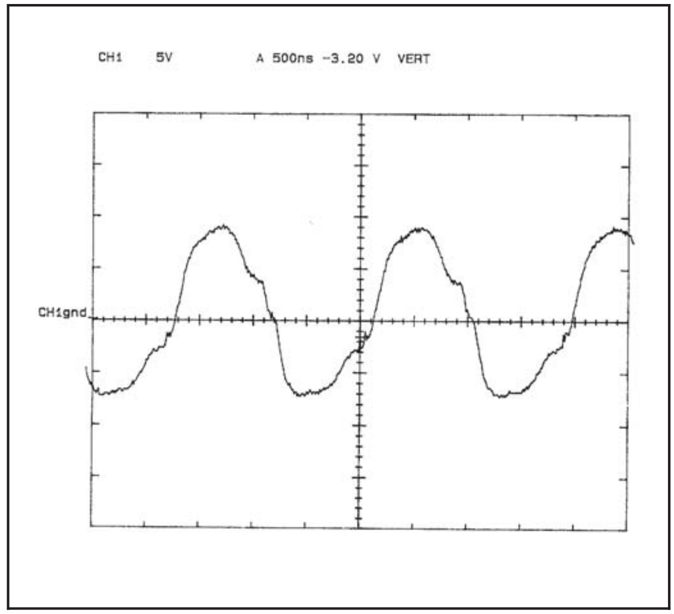
The Driver RF Amplifiers, D1 through D14 are used to amplify the Predriver output and provide RF Drive to all Big Step and Binary RF Amplifiers. The Driver RF Amplifiers are plug in RF Amplifiers identical to and interchangeable with any of the Big Step and Binary RF Amplifiers and the Predriver.

C.9.3 Oscilloscope Waveform Plots

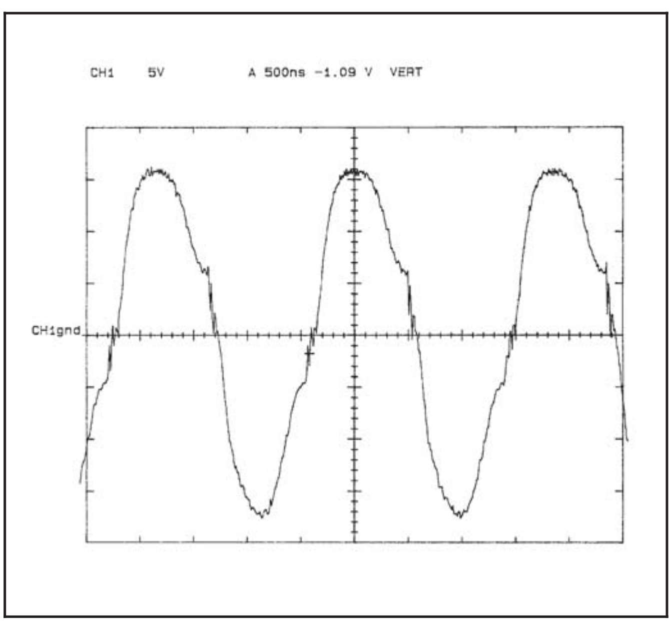
Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 200kW with no modulation at 1575kHz carrier frequency.

C.9.4 Location

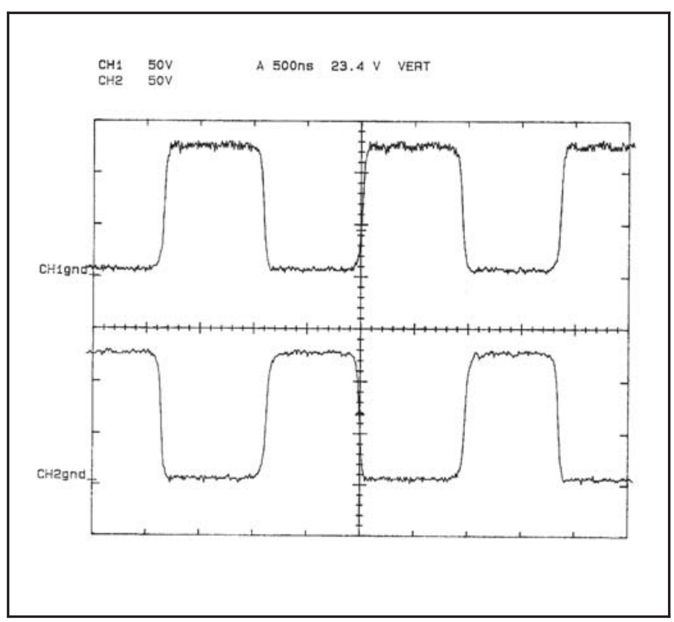
The Driver RF Amplifiers are located behind the inner front door in the left, center, and right Compartments. (See VIEW 2).



Q7 Gate



P1-50



CH1 TP1

WARNING: Disconnect primary power prior to servicing.

D.1 Introduction

This section covers the Predriver Band Select board. Topics include function, location, detailed circuit description, troubleshooting, and removal\replacement.

NOTE:

Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Assembly	992-8979-001
PWB	843-5450-001
Schematic	839-8154-001

NOTE: Parts List for this board are covered in Section VII.

D.2 Function

The function of the Predriver Band Select board is to series tune the output of the Predriver amplifier to resonance at the carrier frequency of the Transmitter. The Predriver Band Select board contains the tuning inductance and selectable capacitance. The Predriver Band Select board also contains the Predriver Level Adjust switch.

D.3 Location

The Predriver Band Select board is located in the right rear PA compartment on the upper right side. (See VIEW 13)

D.4 Detailed Circuit Description

Refer to the schematic diagram for the Predriver Band Select board (839-8154-001) for all descriptions in this section.

D.4.1 RF Input

The Predriver amplifier RF output from J33 on the Driver Combiner Motherboard, is connected to this board via a BNC J2. It is connected to C1 and S1.

D.4.2 Tuning Components

Series tuning through the frequency range is accomplished by switching in inductors and/or capacitors. TB1 is used to tap different values of inductance, inductor L1 is variable, while C1 is fixed and C2 is selectable.

D.4.3 RF Output

The output of the tuning assembly is a terminal strip TB1 which allows a direct connection to the Predriver Splitter transformer. The remainder of the series tuned circuit is completed with the variable inductor L1 which is used for fine adjustment of resonance during initial setup.

The taps on the Predriver Splitter transformer JP1 through JP4 allow selection of optimum loading of the Predriver. This adjustment is intended to be a one time adjustment.

D.4.4 Predriver Level Adjustment

This board also controls the switchable resistor on the Predriver input voltage for optimizing Predriver output depending on the Transmitter frequency. The Predriver Level Adjust is Switch S2. When closed, the switch will short out resistor R1 that is in series with the Predriver power supply.

D.5 Predriver Band Select Board Troubleshooting

The following information contains general troubleshooting tips and any precautions as applicable.

Failure of the Predriver Band Select board would most likely result in a Predriver and Low Drive Fault.

D.5.1 Visual Inspection

With the assembly removed, visually inspect the tapped inductor connections and the capacitor mounting hardware for loose contacts.

D.6 Removal\Replacement

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

NOTE

The Predriver Band Select board is mounted to a metal angle bracket assembly that is held in place by 3 screws.

Remove all connectors and the single front screw from the inside of the right PA compartment. Remove the 2 remaining screws from the rear of the Transmitter and lift out the assembly from behind. Remove connections from TB1.

When installing a new board, verify that all jumpers are in the same position as the original board.

D.7 Alignment

There are no alignments on this board.

The board is factory tuned and should not require readjustment. However if mistuning of the Predriver is suspected, adjust the Predriver Band Select Coil L1 for a peak in the Predriver current as indicated on the Drive Multimeter.

E.1 Introduction

This section covers the Driver Encoder board. Topics include function, location, block diagram description, detailed circuit description, troubleshooting, removal/replacement, and alignment.

> **NOTE:**
> *Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.*

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Assembly #	992-8537-002
PWB	843-5155-510
Schematic	839-7930-510

NOTE: Parts List for this board is in Section VII.

E.2 Function

The main function of the Driver Encoder board is to provide turn-on control signals to the Predriver and 14 RF Driver Amplifiers. The driver encoding scheme utilizes PALS to provide flexibility of programming the individual driver outputs for the desired location. The two PALS used are; L DRIVERS to program the drivers on the left side of the driver column including the predriver, R DRIVERS to program the drivers on the right column. It also monitors RF drive levels and provides Buffer, Predriver, and High/Low Drive Fault sensing and metering. The board provides for selection of Predriver A or B, and monitors Module and Cable Interlock status lines. It receives an RF drive sample and processes the sample for the A/D Converter. This board also has circuitry to monitor the temperature of the +250VDC RF Amplifier Power Supply rectifier heat sinks.

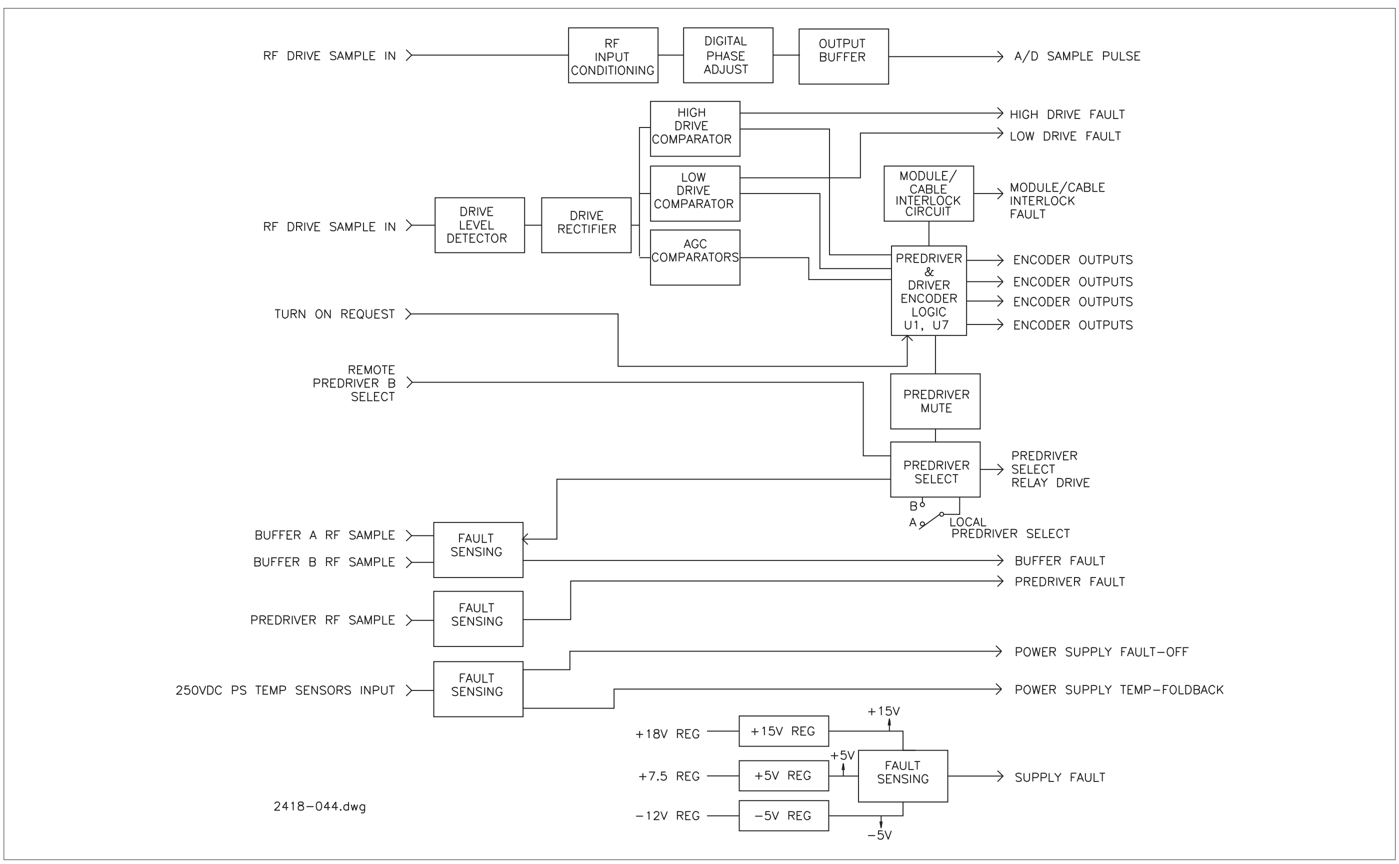


Figure E-1 Driver Encoder Block Diagram

E.3 Location

The Driver Encoder is located inside the right front PA compartment on the lower right hand side. (See VIEW 2)

E.4 Block Diagram Description

Refer to Sheet 1 of the schematic for the Driver Encoder board 839-7930-510 for the following discussion.

E.4.1 A/D Sample Drive

The RF Drive Sample In from the RF Splitter is applied to the Digital Phase Adjustment circuits and a Programmable Frequency Divider will divide the frequency if required.

The Output Buffer connects the RF phase shifted TTL level squarewaves that form the A/D Sample Drive, to the A/D Converter board.

A/D Phase Data Inputs are used to control the amount of phase adjustment, while the A/D Frequency Data Input controls the divider. Band indicators allow a visual indication of input data.

E.4.2 Encoder Outputs

When a Turn On Request is received from the Controller, the Driver Encoder Logic will turn on the fixed Drivers, Bandswitched Drivers, AGC Drivers, and the Predriver through the Encoder Output Drivers. The number of RF Drivers turned on will be determined by the Driver Level Band Data, the Driver AGC Comparators, and the Run Contactor Status input.

When the Turn On Request is removed, the Predriver and all RF Drivers are turned off.

E.4.3 RF Drive Level Sensing

An RF Drive Sample from the RF Splitter is applied to the Drive Input Circuit, which simulates the input of an RF Amplifier. The output of this circuit feeds a Drive Rectifier, which converts the RF signal to a DC voltage proportional to the RF drive level applied to all RF Amplifiers.

This DC voltage is applied to a High Drive Comparator and a Low Drive Comparator. If the RF drive level is too high, it will be detected by the High Drive Comparator and a High Drive Fault will be sent to the Controller. If the RF drive level is too low, it will be detected by the Low Drive Comparator and a Low Drive Fault will be sent to the Controller.

The same DC voltage is connected to the Driver AGC Comparators whose outputs are used by the Driver Encoder Logic to control the AGC Drivers.

The same DC voltage is applied to a Sample Buffer that provides a Driver Sample for metering purposes.

The Auto Driver On/Off Comparator and the Auto Driver Select switch are installed on the board, however they are not being used in this configuration.

E.4.4 Module/Cable Interlock

The Driver Encoder Board provides a Module/Cable Interlock status output signal to the Controller. If the Predriver, or any one of the 14 RF Driver Amplifiers modules is removed (or not fully connected), a Cable Interlock Fault will prevent the Transmitter from being turned on.

If an encoder cable between the Driver Encoder board and the Driver Combiner Motherboard is disconnected, the same fault occurs.

E.4.5 Predriver B Select

Predriver A is normally in operation, but should it be necessary, Predriver B can be used. This is accomplished by either the Predriver Select switch or Remote Predriver B Select control input. Either input to the Predriver Select circuits will generate a Predriver Mute while a Predriver Relay Drive output switches to Predriver B.

E.4.6 Buffer/Predriver Sensing

RF output samples are taken from the Driver Combiner Motherboard for Buffer Amplifier A and Buffer Amplifier B and applied to Fault Sensing circuits. Both Buffer Amplifiers are continuously operating and normally Predriver A is selected for operation. Fault Sensing therefore monitors Buffer A output, until Predriver B is selected at which time Buffer B is monitored. Should the Buffer Amplifier sample being monitored not be present, a Buffer Fault will be sent to the Controller.

The same DC voltages are applied to a Sample Buffer that provides a Buffer Sample for metering purposes.

An RF output sample is taken from the Driver Combiner Motherboard for the active Predriver A or B and applied to a Fault Sensing circuit. Should the active Predriver sample not be present, a Predriver Fault will be sent to the Controller.

The same DC voltages are applied to a Sample Buffer that provides a Predriver Sample for metering purposes.

E.4.7 Power Supplies

Unregulated +18VDC, +8VDC and -12VDC are regulated down to +15VDC, +5VDC and -5VDC respectively to power circuits on the board.

A Fault Sensing circuit monitors these supplies and will generate a Supply Fault for the Controller.

E.5 Detailed Circuit Description

Refer to the schematic diagram for the Driver Encoder board (839-7930-510) for all descriptions in this section.

E.5.1 Driver Amplifier Control

The Driver Amplifier control uses 2 PALS that provide the turn-on/off control voltages for the 14 Driver Amplifiers. It is used so that approximately 24Vp-p of RF drive is applied to all 224 Big Step and Binary RF Amplifiers over the entire frequency band. Drivers D1 though D7 are always turned on, the activation of Drivers D8 through D10 is frequency determined, and Drivers D11 through D14 are part of the AGC system.

E.5.2 L DRIVERS PAL

Refer to Figure E-2, L DRIVERS PAL, for the following discussion.

NOTE

Many of the inputs to U7 are not being used by the PAL.

E.5.2.1 Predriver Control

Normally the PD_On input is logic HIGH, and when the Transmitter is turned on, the TX On Enable input at J3 will go logic HIGH. The D0 output of the PAL will also be logic HIGH and the Predriver is turned on.

Whenever the Predriver Select switch S1 is changed, the PD_On input will momentarily go logic LOW and mute the Predriver while the relays on the Driver Encoder are switched. The input will go back to logic HIGH and the Predriver will be turned on again.

When the Transmitter is OFF, the TX On Enable will go logic LOW, and the Predriver is turned off.

E.5.2.2 Driver D1 - D6 Control

Whenever the +5VDC supply is present, the D1 through D6 outputs will be logic HIGH. These Drivers will always be turned on.

E.5.3 R DRIVERS PAL

Refer to Figure E-3, R DRIVERS PAL, for the following discussion.

E.5.3.1 Driver D7 Control

Whenever the +5VDC supply is present, the D7 output will be logic HIGH. This Driver will always be turned on.

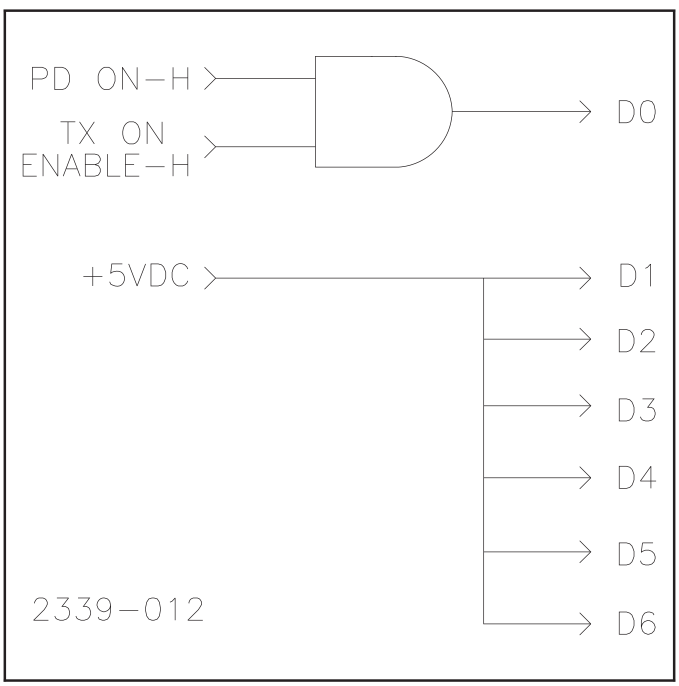


Figure E-2. L Drivers PAL

E.5.3.2 Driver D8 - D10 Control

Driver Level Inputs Bit 0 (LSB) and Bit 1 (MSB) enter the board at J9 for external drive level control (frequency agile application). Both are connected to an Encoder inside the PAL and depending upon the input, control Drivers D8 - D10. When external drive level control is not used (fixed frequency application) J9-21 and J9-23 are held high by pull up resistors R30. When the output is a logic HIGH, the Driver is turned on. The following chart lists the function of the encoder:

Inputs		Outputs			Drivers On (Outputs HIGH)
B0	B1	D8	D9	D10	
0	0	0	0	0	0
1	0	1	0	0	D8
0	1	1	1	0	D8, D9
1	1	1	1	1	D8, D9, and D10

E.5.3.3 Driver D11 - D14 Control

These Drivers are controlled by the AGC 0 through AGC 3 inputs from the comparators. The TX On Enable and the Run Status inputs are also used in the control of these Drivers.

When the Transmitter is first turned on, the TX On Enable input is logic HIGH, and the Run Status input is logic HIGH. At this point in the step-start sequence, Drivers D11 and D12 will be turned on by the OR gate, while D13 and D14 will be held off by the AND gate.

After the step-start sequence has energized the Run contactor, the Run Status input will go logic LOW. If any one of the AGC

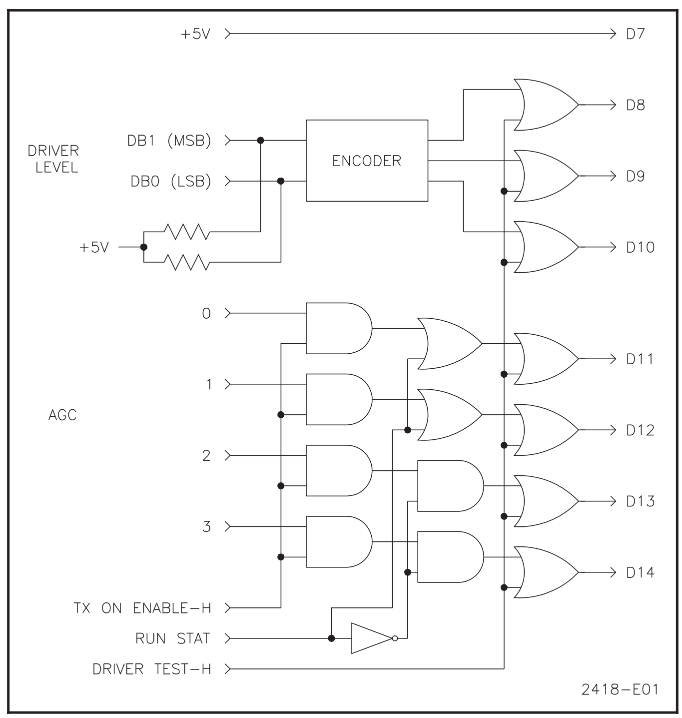


Figure E-3. R Drivers PAL

inputs goes logic HIGH, the corresponding Driver output will also be logic HIGH and turn on the appropriate Driver.

When the Transmitter is OFF, the TX On Enable input will be logic LOW, and all Drivers will be turned off.

E.5.3.4 Driver Test

Turn on signals can be applied to all Drivers without turning on the Transmitter. This feature is provided as an aid to troubleshooting and is accomplished through the use of Driver Test. When JP9 is in the 2-3 Test position, a logic HIGH is supplied to the PAL and all outputs from the PAL should be logic HIGH. All Driver Amplifier Driver outputs at J1 should be a negative voltage.

P1 is normally left in the 2-1 position and the TX ON enable input is used for control of the Drivers.

E.5.4 Driver Amplifier Drivers

The Drivers U3 through U6 and U8 through U11 convert logic HIGH or LOW PAL outputs to the proper voltages for each Driver.

E.5.4.1 Jumper Plugs

A jumper plug is in series with the input to each inverter, and can be used during troubleshooting and in emergency bypass operations.

If the jumper plug is removed and a logic HIGH, from JP3-1, supplied to the input pin of the inverter, the Driver will be turned on.

If the jumper plug is removed and a logic LOW supplied to the input pin of the inverter, the Driver will be turned off.

Pull-down resistors on each input holds the input LOW if the gold jumper plug is removed.

E.5.4.2 Inverters

Each inverter output goes to a voltage divider, made up of a series resistor and a second resistor to the -5VDC supply. The junction of the resistors is the Driver RF Amplifier turn-on/turn- off control circuit's input.

When the input is LOW, the inverter output is connected to +5VDC. Due to the voltage divider action, the output to the Driver is about +2.2VDC and the Driver is turned OFF.

When the input is HIGH, the inverter output is connected to ground. Due to the voltage divider action, the output to the Driver is about -1.4VDC and the Driver is turned ON.

Connectors J1 and J2 carry the turn on/off signals to the Driver Combiner Motherboard where it is distributed to each Driver Amplifier.

NOTE

For more detailed information on the inverter and voltage divider, refer to the Modulation Encoder section.

E.5.5 Predriver B Select

Predriver A is normally in operation. Should it be necessary, Predriver B can be selected. This is accomplished by either the Local Predriver Select switch or with a Remote Predriver B Select control input. Either will generate a Predriver Mute, while the Predriver Select Relay on the Driver Combiner Motherboard switches between the Predrivers. The RF Mute is lifted after the relay has closed.

E.5.5.1 Predriver Relay Supply

The positive (+) inputs to the Predriver relays coils are supplied +15VDC at J8. The other sides (-) of the coils are returned to the board on the Predriver Relay On line.

E.5.5.2 Predriver Select Switch

Normally, S1 is in the Predriver A open position and the switch is open. The Predriver Relay Drive line will be +15VDC and the relays will de-energized.

If S1 is moved from the Predriver A to the Predriver B position, the Predriver relays will be energized through S1 and R51, selecting Predriver B. The current through the resistor will develop a positive voltage and charge C23 through the base/emitter of Q4. This will cause the collector of the transistor and the PD_ON input to the L DRIVERS PAL to be pulled logic LOW momentarily. The D0 output of the PAL will go LOW turning off the Predriver while the output is switched. When the capacitor is charged, the PD_ON input will go back to a logic HIGH and turn on the Predriver again.

If S1 is moved from the Predriver B to the Predriver A position, the Predriver relays will be de-energized, selecting Predriver A. The PD Relay On line will be +15VDC and charge C24 through the base/emitter of Q5. This will cause the collector of the transistor and the PD_ON input to the L DRIVERS PAL to be pulled logic LOW momentarily. The D0 output of the PAL will go LOW turning off the Predriver while the output is switched. When the capacitor is charged, the PD_ON input will go back to a logic HIGH and turn on the Predriver again.

E.5.5.3 Remote Predriver Select Transistor

Transistor Q3 is used as a switch that is in parallel with S1. When the Predriver Select - H input at J3 is logic HIGH, Q3 will be turned on and Predriver B will be selected.

E.5.6 Drive Level Detector

An RF Sample from the RF Splitter board is applied to the Drive Level Detector input at J7. The transformer and components on its primary, simulate the input of an RF Amplifier. One of the transformer secondaries is connected to a rectifier and filter capacitor. This rectifier converts the RF signal to a DC voltage proportional to the RF drive level applied to all Big Step and Binary RF Amplifiers and can be measured at TP7 Drive.

E.5.7 Driver AGC

The RF drive level DC voltage from TP7 is connected to a buffer amplifier and to one input of a differential amplifier formed by U20. The other input of the differential amplifier is an adjustable Automatic Gain Control DC voltage set by R100. It is adjusted such that approximately 24Vp-p of RF drive is applied to all 224 RF Amplifiers over the entire frequency band. The output of the differential amplifier is connected to 4 comparators.

E.5.8 AGC Comparators

The RF drive level DC voltage from TP7 is connected to the (+) inputs of 4 comparators labeled AGC0 through AGC3. The (-)

inputs of the comparators are connected to resistive voltage divider that supplies +2VDC, +3VDC, +4VDC, and +5VDC as the threshold inputs.

When the output of the differential amplifier goes more positive than the threshold of each comparator, the output of the comparator will go logic HIGH.

When the output of the differential amplifier goes less positive than the threshold of each comparator, the output of the comparator will go logic LOW.

These 4 outputs are used by the R DRIVERS PAL to control the D11 through D14 Driver Amplifiers.

E.5.9 Drive Level Fault Sensing

Drive Level Fault Sensing is used to protect the Transmitter under two fault conditions.

E.5.9.1 High Drive Comparator

The RF drive level DC voltage from TP7 is also connected to the to the negative (-) input of the High Drive Fault comparator. A reference voltage is set, on the positive (+) input of the comparator at TP5 High Drive, with the High Drive Adjust control R84. Normally the voltage at the positive (+) input will be higher than the voltage at the negative (-) terminal, and the output of the comparator will be logic HIGH.

If the RF drive level DC voltage increases above the reference voltage, the comparator output will go logic LOW. This sends a High Drive Fault - LOW to the Controller at J3, which is an Overload fault.

The HIGH_D output of the other comparator is not being used in this configuration.

E.5.9.2 Low Drive Comparator

This RF drive level DC voltage from TP7 is sent to the positive (+) input of the Low Drive Fault comparator. A reference voltage is set on the negative (-) input of the comparator at TP6 Low Drive by the Low Drive Adjust R86. Normally the voltage at the positive (+) input will be higher than the voltage at the negative (-) terminal, and the output of the comparator will be logic HIGH.

If the RF drive level DC voltage drops below the reference voltage, the comparator output will go logic LOW. A Low Drive Fault - LOW will be sent to the Controller at J3, which is an Overload fault.

The LOW_D output of the other comparator is not being used in this configuration.

E.5.9.3 Low Drive Comparator Threshold

Transistor Q6 is used to disable the Low Drive Fault comparator while the Transmitter is OFF.

When the Transmitter is OFF, the TX_ON_EN input is logic LOW and anode of CR3 is pulled logic HIGH by the inverter. Capacitor C36 charges from ground through resistors and the transistor is turned on. The collector of the transistor and the (-) input of the comparator is pulled logic LOW. This disables the Low Drive Fault sensing.

When the Transmitter is turned on, the TX_ON_EN line will be logic LOW. This will reverse bias the diode and allow the capacitor to discharge through the base of the transistor. The transistor slowly turns off, allowing the reference voltage to rise on (-) input of the comparator and enables the Low Drive fault comparator. This delay allows time for the RF drive system to reach normal operating parameters during the step-start sequence.

E.5.10 Driver Level Output

The RF drive level DC voltage from TP7 is also connected to a Drive Sample Buffer and eventually becomes the Relative Drive Level reading on the front panel multimeter and the Driver Sample on the Frequency Control board Multimeter.

E.5.11 Buffer Level Sensing

Separate rectified RF output samples from Buffer Amplifier A and B from the Driver Combiner Motherboard are applied to the fault sensing circuit inputs at J8.

Both Buffer Amplifiers are normally in operation. The Buffer Fault Sensing circuit however, will monitor only the Buffer Amplifier being used. This is determined by the Predriver Relay Drive signal.

E.5.11.1 Buffer A

Normally Predriver A is selected for operation and +15VDC is present on the Predriver Relay Drive (PD_Relay_On) output at J8. This +15VDC provides a reference voltage at the (-) input of Buffer A fault comparator U15 through a resistive voltage divider.

The RF level DC voltage sample from Buffer A output supplies a positive voltage at the (+) input of the comparator at TP2 Buffer A. Normally the voltage at the positive (+) input will be higher than the voltage at the negative (-) terminal, and the output of the comparator will be logic HIGH.

If this DC voltage drops below the reference voltage, the output of the comparator will go logic LOW and a Buffer Fault - L will be sent to the Controller at J3. An RF MUTE will be applied to the Transmitter.

The same +15VDC disables the Buffer B Fault sensor by pulling the (+) input of the comparator logic HIGH through CR1.

E.5.11.2 Buffer B

If Predriver B is selected, the Predriver Relay Drive line will be 0VDC. This will disable Buffer A Fault sensor by lowering the reference voltage on the (-) input to a logic LOW. With the Predriver Relay Drive line logic LOW, the diode is reverse biased and Buffer Amplifier B output is monitored at TP1 Buffer B.

If the Buffer Amplifier sample drops below the reference voltage, a Buffer Fault - L will be sent to the Controller and an RF Mute will be applied to the Transmitter.

E.5.12 Predriver Level Sensing

A rectified RF level DC voltage sample from the active Predriver (A or B) is taken from the Driver Combiner Motherboard. This DC voltage at TP3 Predriver is applied to the (+) input of a

Table E-1. I/O Connections Description

J#	PIN	FUNCTION	DESTINATION	CONN. TYPE
J1	1	DRIVER 2 ENCODER OUTPUT	DRIVER COMBINER MOTHERBOARD	20 PIN RIBBON RIGHT ANGLE
	3	DRIVER 1 ENCODER OUTPUT		
	5	PREDRIVER ENCODER OUTPUT		
	7	N.C.		
	9	CABLE INTERLOCK		
	10	CABLE INTERLOCK		
	11	DRIVER 6 ENCODER OUTPUT		
	13	DRIVER 5 ENCODER OUTPUT		
	15	DRIVER 4 ENCODER OUTPUT		
	17	DRIVER 3 ENCODER OUTPUT		
	19			
	20	CABLE INTERLOCK		
	2-18 EVEN	GROUND		
J2	1	DRIVER 14 ENCODER OUTPUT	DRIVER COMBINER MOTHERBOARD	20 PIN RIBBON RIGHT ANGLE
	3	DRIVER 13 ENCODER OUTPUT		
	5	DRIVER 12 ENCODER OUTPUT		
	7	DRIVER 11 ENCODER OUTPUT		
	9	CABLE INTERLOCK		
	10	CABLE INTERLOCK		
	11	DRIVER 10 ENCODER OUTPUT		
	13	DRIVER 9 ENCODER OUTPUT		
	15	DRIVER 8 ENCODER OUTPUT		
	17	DRIVER 7 ENCODER OUTPUT		
	19	CABLE INTERLOCK		
	20	CABLE INTERLOCK		
	2-18 EVEN	GROUND		
J3	1	TX ON ENABLE-H	TRANSMITTER INTERFACE BOARD	40PIN RIBBON
	3	SUPPLY FAULT-L		
	5	PREDRIVER B SELECT -H		
	7	N.C.		
	9	CABLE INTERLOCK-L		
	11	HIGH DRIVE FAULT-L		
	13	LOW DRIVE FAULT-L		
	15	RELATIVE DRIVE LEVEL		
	17	PREDRIVER FAULT-L		
	19	BUFFER FAULT-L		
	21	POWER SUPPLY TEMP FAULT-L		
	23	POWER SUPPLY TEMP FOLDBACK-L		
	25	STEP START SSR DRIVE-L		
	27	RUN SSR DRIVE - L		
	29	CLOCK INPUT		
	31	LV SUPPLY SSR DRIVE- L		
	33	AC MAINS FAULT-L		
	35	FAN LOSS STATUS-L FOLDBACK		
	37	STEP START STATUS-H		
	39	RUN STATUS STATUS-H		
	2-40 EVEN	GROUND		

WARNING: Disconnect primary power prior to servicing.

Table E-2. I/O Connections Description

J#	PIN	FUNCTION	DESTINATION	CONN. TYPE
J4	1	TEMP SENSE POWER SUPPLY A	TRANSMITTER INTERFACE BOARD	40PIN RIBBON
	3	TEMP SENSE +5V		
	5	TEMP SENSE POWER SUPPLY A		
	7	TEMP SENSE +5V		
	9	TEMP SENSE POWER SUPPLY B		
	11	TEMP SENSE +5V		
	13	TEMP SENSE POWER SUPPLY B		
	15	TEMP SENSE +5V		
	17	N.C.		
	19	N.C.		
	21	N.C.		
	23	N.C.		
	25	STEP START SSR DRIVE-L		
	27	RUN SSR DRIVE - L		
	29	N.C.		
	31	LV SUPPLY SSR DRIVE- L		
	33	AC MAINS FAULT-L		
	35	FAN LOSS STATUS-L FOLDBACK		
	37	STEP START STATUS-H		
	39	RUN STATUS STATUS-H		
	2-40 EVEN	GROUND		
J5	1	+18VDC REGULATED INPUT	POWER DISTRIBUTION BOARD	8 PIN MTA
	3	N.C.		
	4	KEY		
	5	+7.5V REGULATED INPUT		
	7	-7.5V REGULATED INPUT		
	2,6,8	GROUND		
J6	1	A/D SAMPLE OUTPUT	TRANSMITTER INTERFACE	SMC
	2	GROUND		
J7	1	N.C. (COMBINER I SAMPLE IN)	DRIVER SPLITTER	12 PIN AMP
	2	N.C. (COMBINER I SAMPLE IN)		
	3	RF DRIVE SAMPLE (A/D PHASE)		
	4	RF DRIVE SAMPLE (A/D PHASE)		
	5	RF DRIVE SAMPLE (DRIVER)		
	6	RF DRIVE SAMPLE (DRIVE)		
	7	KEY		
	7-12	N.C.		
J8	1	BUFFER B RF SAMPLE	DRIVER COMBINER MOTHERBOARD	10 PIN RIBBON RT ANGLE
	3	BUFFER A RF SAMPLE		
	5	PREDRIVER RF SAMPLE		
	7	PREDRIVER RELAY DRIVE		
	9	PREDRIVER RELAY SUPPLY		
	2-10 EVEN	GROUND		

comparator. The (-) input is a fixed voltage from a resistive voltage divider.

Should the active Predriver sample drop below the reference, a Predriver Fault will be sent to the Controller and an RF Mute will be applied to the Transmitter.

E.5.13 A/D Phasing

A sample of the RF drive to all 224 RF Amplifiers is also used as a Start Encode pulse squarewave for the A/D Converter board. Depending upon the frequency of operation, the signal will either be at the carrier or 1/2 the carrier frequency.

E.5.14 RF Drive Input Conditioning

The RF drive sample from J21 on the RF Splitter board is connected to the Driver Encoder at J7. An input resistor provides a 330-Ohm input impedance. The RF is clamped to TTL levels by the diodes CR5 and CR10. The RF squarewave is inverted by U13-4 and connected to U18-6.

E.5.15 Digital Phase Adjustment

U18 is a programmable digital delay line that will change the phase lag delay of a TTL input signal in discrete nS steps depending on the Bit 0 through Bit 5 inputs.

Normally the phase shifted output at U18-2 passes through K1 9-13 and is connected to the A/D Frequency Switch. If a complete 180 degree phase shift is required, the relay that is activated by the bit 5 input will energize and the output will be shifted 180 degrees.

In the fixed frequency application, the BIT0 through BIT5 data is created by switches S2 and S3.

E.5.16 A/D Frequency Switch

The phase shifted carrier frequency squarewave output at JP10-2 is connected to a divide by 2 circuit and a tri-state buffer.

E.5.16.1 Divider

The Q output of the frequency divider U21 will be 1/2 the carrier frequency and is connected to a tri-state buffer.

E.5.16.2 Tri-State Buffer Switch

The A/D Frequency Bit 0 input from the Frequency Control Interface Board enters the board at J9 and is connected to tri-state buffer U22.

When the A/D Frequency Bit 0 from the frequency Interface board at J9 is logic LOW, JP10-2 is connected to the output at TP4 A/D Phase via U22-9. Inverter U13 supplies the other half of U22 with a logic HIGH, and the output at U22-18 is disconnected.

When Bit 0 is logic HIGH, U21-5 is connected to the output at TP4 A/D Phase via U22-18 and the output at U22-9 is disconnected.

JP10 is not being used on this configuration.

E.5.17 Output A/D Sample

The output at TP4 A/D Phase signal, that is either at carrier or 1/2 carrier frequency, is connected to the Power Block Interface and then passed on to the A/D Converter board.

E.5.18 A/D Phase Data Input

The BIT0 (LSB) through BIT5 (MSB) enter the board on J9; pins 11, 9, 7, 5, 3 and 1. Bits 0 through 4 are applied to U18. Bit5 is applied to Q1 which acts as a relay driver for K1. K1 contacts 13-9 (energized) are used to select an inverted or non-inverted output from U18. S2 and S3 are used in place of BIT data in non-frequency agile installations for manual A/D alignment.

E.5.19 Band Indicators

A 10 segment Band Indicator LED is used to give a visual indication of the A/D Phase Data Input, Driver Level Data Input, and FC or 1/2 FC operation. If the BIT input is a logic HIGH, an inverter applies a logic LOW to the cathode of the appropriate LED, illuminating the indicator RED. The operational tri-state buffer provides +5VDC for the appropriate division indicator.

The BIT data inputs are manually (hardwired) created in the fixed frequency Power Block application.

E.5.20 Drive Sample Buffers

Operational amplifier U19-1 takes the Driver Level DC voltage from the Drive Level Detectors and buffers the signal. The Relative Drive Level output at J3 is connected to the front panel Relative RF Drive multimeter position. The samples at J9 are connected to the TUNE multimeter on the Frequency Control Board.

E.5.21 Module/Cable Interlock Function

Refer to Figure E-4, Driver Cable Interlock Detection Circuit for the following discussion.

E.5.21.1 Closed Loop

The cable interlock function is provided by two sets of series connections. When all the Drivers and Driver Encoder cables are properly installed, a closed circuit is established from J2-20 to

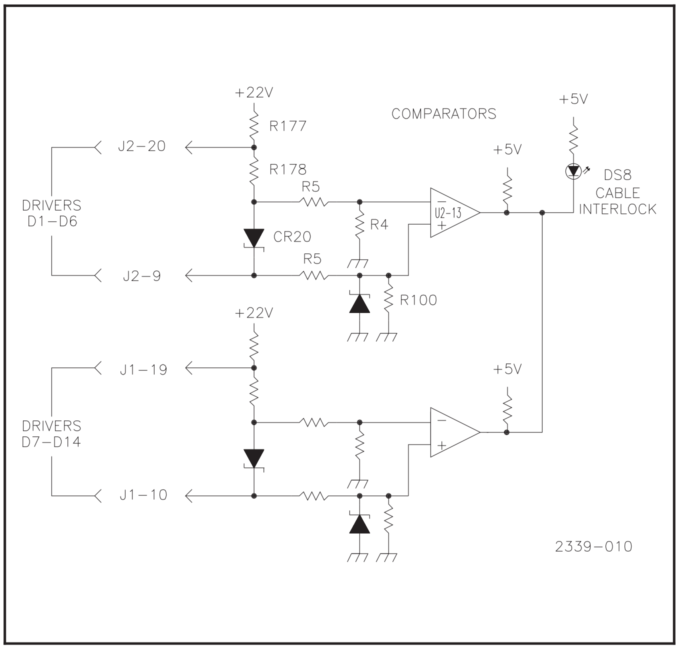


Figure E-4. Driver Cable Interlock Detection Circuit

Table E-4. I/O Connections Description

J#	PIN	FUNCTION	DESTINATION	CONN. TYPE
J9	1	A/D PHASE BIT 5 DRIVE	FREQUENCY CONTROL INTERFACE	40 PIN RIBBON
	3	A/D PHASE BIT 4 DRIVE		
	5	A/D PHASE BIT 3 DRIVE		
	7	A/D PHASE BIT 2 DRIVE		
	9	A/D PHASE BIT 1 DRIVE		
	11	A/D PHASE BIT 0 DRIVE		
	13	A/D FREQ BIT 0 DRIVE		
	15	BUFFER SAMPLE		
	17	PREDRIVER SAMPLE		
	19	DRIVER SAMPLE		
	21	DRIVER LEVEL BIT 1		
	23	DRIVER LEVEL BIT 0		
	25-39 ODD	N.C.		
	2-40 EVEN	GROUND		

Table E-3. Left Drivers PAL I/O Description

The left drivers pal includes the predriver output which will be turned on with the tx on enable and can be shut off when the predriver select switch is activated to keep from switching the relay hot. The remaining drivers are assigned D1-D6 and will always be turned on as long as the tx on enable command is active. The remaining inputs such as driver level control and AGC are not used on this pal.

GROUP	FUNCTION	IC PIN #	ACTIVE	DESCRIPTION
INPUTS				
SUPPORT	CLOCK INPUT	1	CLOCK	4KHZ clock (currently not used)
PREDRIVER CONTROL	PD_ON	2	H	Enables predriver. Used to shut down predriver when predriver relay is switched
FAULT INPUTS	HIGH_D	3	H	High drive warning (drive level near fault threshold)
	LOW_D	4	H	Low drive warning (drive level near fault threshold)
DRIVER LEVEL CONTROL INPUTS	D_LEVEL_B1	5	H	Driver level adjust Bit1. (Not used on this PAL)
	D_LEVEL_B0	6	H	Driver level adjust Bit0. (not used on this pal)
	AGC3	7	H	Driver amp AGC control. (not used on this pal)
	AGC2	8	H	Driver amp AGC control. (not used on this pal)
	AGC1	9	H	Driver amp AGC control. (not used on this pal)
	AGC0	10	H	Driver amp AGC control. (not used on this pal)
OTHER CONTROL INPUTS	RUN_STATUS	11	L	Indicates when run contactor is energized
	TX_ON_EN	13	H	Indicates when tx on enable is active
	AUTO_SPR	14	H	Auto spare control input (not used due to use of agc)
OUTPUTS				
DRIVER OUTPUTS	PD	23	H	PREDRIVER OUTPUT
	D1	22	H	DRIVER 1 OUTPUT
	D2	21	H	DRIVER 2 OUTPUT
	D3	20	H	DRIVER 3 OUTPUT
	D4	19	H	DRIVER 4 OUTPUT
	D5	18	H	DRIVER 5 OUTPUT
	D6	17	H	DRIVER 6 OUTPUT

Table E-5. Right Drivers PAL I/O Description

The right drivers pal outputs are for drivers D7-D14. D7,D8,D9 and D10 are bandswitched drivers that are enabled depending on which frequency the transmitter is at. The program for this information is on the D_LEVEL inputs. The two bit binary input information is converted to the turn on for the 4 drivers. Drivers D11-D14 are the AGC drivers and are individually switched to keep the drive level constant as determined by the agc circuit. The 4 AGC inputs directly turn on a driver as indicated below				
GROUP	FUNCTION	IC PIN #	ACTIVE	DESCRIPTION
INPUTS				
SUPPORT	CLOCK INPUT	1	CLOCK	4KHZ clock (currently not used)
	NOT USED	2		
FAULT INPUTS	HIGH_D	3	H	High drive warning (used to turn off drivers if needed)
	LOW_D	4	H	Low drive warning (used to turn on drivers if needed)
DRIVER LEVEL CONTROL INPUTS	D_LEVEL_B1	5	H	Driver level adjust Bit1. (programs steps D7-D10)
	D_LEVEL_B0	6	H	Driver level adjust Bit0. (programs steps D7-D10)
	AGC3	7	H	Driver amp AGC control. (controls D14)
	AGC2	8	H	Driver amp AGC control. (controls D13)
	AGC1	9	H	Driver amp AGC control. (controls D12)
	AGC0	10	H	Driver amp AGC control. (controls D11)
OTHER CONTROL INPUTS	RUN_STATUS	11	L	Indicates when run contactor is energized
	TX_ON_EN	13	H	Indicates when tx on enable is active
	AUTO_SPR	14	H	Auto spare control input (not used due to use of agc)
OUTPUTS				
DRIVER OUTPUTS	D7	23	H	DRIVER 7 OUTPUT
	D8	22	H	DRIVER 8 OUTPUT
	D9	21	H	DRIVER 9 OUTPUT
	D10	20	H	DRIVER 10 OUTPUT
	D11	19	H	DRIVER 11 OUTPUT
	D12	18	H	DRIVER 12 OUTPUT
	D13	17	H	DRIVER 13 OUTPUT
	D14	16	H	DRIVER 14 OUTPUT

J2-9 via the Predriver & Drivers D1 through D6 and from J1-19 to J1-10 via Drivers D7 through D14. Since both interlock circuits are the same, only one will be discussed.

E.5.21.2 Voltage Divider

Due to the voltage divider action of R177, R178, R5(7,8), R4(5,6), R5(5,6) and R4(3,4), the voltage at the positive (+) input of comparator will be greater than the voltage at the negative (-) input. Under these conditions, the output of the comparator will be logic HIGH and DS8 will be off.

E.5.21.3 Open Loop

When an interlock connection between J2-20 and J2-9 is opened, by removing a Driver Encoder cable or unplugging a Driver, the voltage at the positive (+) input of the comparator will be lower than the voltage at the negative (-) terminal due to the additional voltage drop provided by CR20.

Under these conditions, the output of the comparator will go logic LOW. DS8 Cable Interlock will be illuminated RED and transistor Q9 will turn on, pulling the voltage at J3-9 LOW.

This will cause the Transmitter to turn OFF, and the Encoder Module/Cable Interlock LED on the Control front panel will be illuminated RED.

E.5.22 Power Supplies

DC supply inputs to the board are +18VDC, +7.5VDC, and -12VDC, from the low voltage power supply. Each input is fused, with 2A fuses F1, F2 and F3, and regulated to +15VDC, +5VDC, and -5VDC using regulators U29, U30, and U31. Each regulator output has a GREEN Status LED that illuminates when the regulator is operational. The output of the regulators are transient protected by zeners CR14, CR15, and CR18.

E.5.22.1 Regulator Status

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a supply voltage on the board that does not depend on the regulated supplies. The +18VDC supply goes to CR9 and CR11 and +7.5VDC goes through CR12 to a 5 Volt regulator, U33. This +5 Volts is designated +5VB and can be measured at TP19.

The +5VB is used as a reference to inputs of comparator U32 through a series voltage divider network. Each supply is con-

Table E-6. Left Drivers PAL Truth Table

STATE	INPUTS													OUTPUTS						
	CLOCK	PD ON	FAULT INPUTS		DRIVER LEVEL CONTROL INPUTS						CONTROL INPUTS			DRIVER OUTPUTS						
			HIGH DRIVE	LOW DRIVE	DRIVER LEVEL B1	DRIVER LEVEL B0	AGC3	AGC2	AGC1	AGC0	RUN STS	TX ON EN	AUTO	PD	D1	D2	D3	D4	D5	D6
CODE	clk	pd_on	high_d	low_d	d_level_b1	d_level_b0	agc3	agc2	agc1	agc0	run	tx_on	auto	pd	d1	d2	d3	d4	d5	d6
active		1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
	NC	0										0		0						
		1										0		0						
		0										1		0						
		1										1		1						
												0			0	0	0	0	0	0
NOTE: A BLANK SPACE IN TRUTH TABLE INDICATES DON'T CARE																				

Table E-7. Right Drivers PAL Truth Table

STATE	INPUTS												OUTPUTS							
	CLOCK	FAULT INPUTS		DRIVER LEVEL CONTROL INPUTS						CONTROL INPUTS			DRIVER OUTPUTS							
		HIGH DRIVE	LOW DRIVE	DRIVER LEVEL B1	DRIVER LEVEL B0	AGC3	AGC2	AGC1	AGC0	RUN STS	TX ON EN	AUTO	D7	D8	D9	D10	D11	D12	D13	D14
CODE	clk	high_d	low_d	d_level_b1	d_level_b0	agc3	agc2	agc1	agc0	run	tx_on	auto	pd	d1	d2	d3	d4	d5	d6	d14
active		1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
	NC	X	X	X	X	X	X	X	X	X	0		0	0	0	0	0	0	0	0
										X	1		1							
				0	0					X	1			0	0	0				
				0	1					X	1			1	0	0				
				1	0					X	1			1	1	0				
				1	1					X	1			1	1	1				
						X	X	X	X	1	1						1	1	1	1
						0	0	0	0	0	1						0	0	0	0
						0	0	0	1	0	1						1	0	0	0
						0	0	1	1	0	1						1	1	0	0
						0	1	1	1	0	1						1	1	1	0
						1	1	1	1	0	1						1	1	1	1

nected to a voltage divider and then connected to the other inputs of the comparator. With the non-inverting inputs more positive than the inverting inputs the comparator output is a logic HIGH. This is the NORMAL condition with no faults.

If one of the regulated supplies fails or drops low by more than 20%, the corresponding comparator output will go logic LOW. DS7 Supply Fault will be illuminated RED and transistor Q8 will turn on, pulling the voltage at J3-3 LOW.

This will cause the Transmitter to turn OFF, and the Encoder Supply Fault LED on the Control front panel will be illuminated RED.

E.6 Troubleshooting

Circuitry on this board can be classified into these major areas:

a. Power Supply
b. Fault Sensing
c. Driver Control
d. A/D Phasing and
e. Cable Interlock.

Refer to the corresponding section for the area being addressed.

E.6.1 Power Supply

If an Encoder supply fault is displayed on the Control front panel, and with only the low voltage on, check the LED indicators on the Driver Encoder:

a. DS1 (+5V)
b. DS2 (-5V)
c. DS3 (+15V)

Each of these LED indicators should be Lit if the individual supplies are operating normally.

a. If DS7 is illuminated RED:
b. Use the Multimeter to measure the +15VDC, +5VDC, and -5VDC power supplies.
c. If either supply has been reduced by 20% or more:
   1. Check the input fuse and replace if necessary.
   2. If fuse is not open, measure input TP for the input voltage.
   3. If the input is correct, replace the regulator.
d. If all supplies measure correct:
   1. Check TP10 for +5VDC and replace U11 if necessary.
   2. If TP10 is okay, measure the voltages on the comparator inputs and outputs to determine if the comparator is faulty.

E.6.2 Fault Sensing

E.6.2.1 High Drive Sensing

With the Transmitter OFF, and only the Low Voltage ON, begin troubleshooting as follows:

a. Measure the output J3-11 on this board. A logic LOW indicates a fault.
   1. If this point is LOW, unplug J7 from the board and recheck the output.
   2. If this point goes to a logic HIGH, a fault may exist in the wiring, Power Block Interface, or Controller.
   3. If the output remains LOW, check the voltage on TP5. If it is more positive than TP7, (TP7 should read 0 Volts with the Transmitter off) replace U17.
b. If the comparator checks okay, then the drive sample could be the problem.
   1. Check the RF Drive Splitter RF Sample level across the input at J7 during the step-start sequence.
   2. If it is higher than normal, inspect the transformer assembly and associated circuitry on the Driver Encoder and the sample connection and cables coming to the Driver Encoder. Refer to the overall wiring diagram as needed.

E.6.2.2 Low Drive Sensing

With the Transmitter OFF, and only the Low Voltage ON, begin troubleshooting as follows:

a. Measure the output at J3 on this board. A logic LOW indicates a fault.
   1. If this point goes to a logic HIGH, then a fault exists in the wiring, Power Block Interface, or Controller.
b. If the output is LOW, the following should be checked during the step-start sequence.
   1. Compare the voltages at TP7 and TP6. TP7 should be greater than TP6.
   2. If it is, and the output is still logic LOW, replace U17.
c. If the comparator checks okay, then the drive sample could be the problem.
   1. Check the RF Drive Splitter RF Sample level across the input at J7 during the step-start sequence.
   2. If it is lower than normal, inspect the transformer assembly and associated circuitry on the Driver Encoder and the sample connection and cables coming to the Driver Encoder. Refer to the overall wiring diagram as needed.

E.6.2.3 Buffer Fault Sensing

If a Buffer Fault indicator is illuminated on the Control front panel and the Transmitter may be turned on with an RF MUTE applied, start troubleshooting as follows.

a. If the Buffer Fault output is logic LOW at J3, measure the reference voltages when Predriver A is selected.
   1. U15-4 should be +2.5VDC and TP1 should be +4.3VDC.
   2. If not present, check for a defective CR1 or CR2.
b. Check for the Buffer sample.
   1. Measure TP1 and TP2 for a voltage greater than the previously measured reference voltage.
   2. If the sample is not greater than the reference, check for a failed U1, an open cable, or a fault on the Driver Combiner Motherboard. Refer to the overall wiring diagram and the Driver Combiner Section as needed.
   3. If the sample is greater than the reference, replace the comparator.
c. If the Buffer Fault output at J3 is a logic HIGH, refer to the overall wiring diagram, Power Block Interface, and the Controller schematics to determine the cause of the logic LOW.

E.6.2.4 Predriver Fault Sensing

If a Predriver Fault indicator is illuminated on the Control front panel and the Transmitter may be turned on with an RF MUTE applied, start troubleshooting as follows:

a. Check the Predriver Fault output at J3 for a logic LOW.
b. If LOW, check the reference voltage on the (-) input of the comparator, should be 2VDC.
   1. If the voltage is less than 2VDC, remove the comparator and re-check.
c. Check the Predriver sample.
   1. If the voltage on TP3 is less than the reference, check for a failed U1, an open cable, or a fault on the Driver Combiner Motherboard. Refer to the overall wiring diagram and the Driver Combiner Section as needed.
   2. If the sample is greater than the reference, replace the comparator.

d. If the Predriver Fault output at J3 is logic HIGH, refer to the overall wiring diagram, Power Block Interface, and the Controller schematics to determine the cause of the logic LOW.

E.6.3 Driver Control

There are two types of driver control present on the Driver Encoder Board:

a. Predriver Select
b. Driver Turn On

Refer to the corresponding section below for problem being addressed.

E.6.3.1 Predriver Select

If the Predriver cannot be switched on when S1 is toggled, begin troubleshooting as follows:

a. Check for +15VDC on the collector of Q3 when S1 is in the Predriver A position.
   1. If missing, check J8-9 on this board for +15VDC.
   2. If J8-9 has +15VDC refer to the overall wiring diagram and Driver Combiner Motherboard schematic to trace where the +15VDC is being lost. J8-9 supplies +15VDC to the Predriver Select relays on the Driver Combiner Motherboard, while J8-7 is the return line back to the Driver Encoder.
b. If Q3 has +15VDC present, then switch to the Predriver B position and check to see that the collector has gone logic LOW.
   1. If not, the switch could be defective or R51 could be open.
c. If the above circuits and components check good, the Predriver Select relay on the Driver Combiner may have failed. Refer to the Driver Combiner Troubleshooting Section to continue.

E.6.3.2 Predriver and Drivers D1 - D6 Will Not Turn On

a. If the Predriver is not being turned on, check the D0 output of the PAL for a logic HIGH, when JP9 is in the TEST position.
   1. If logic LOW, check U7-2. If also logic LOW check transistors and capacitors connected to the input.
   2. If logic HIGH, replace the PAL.
b. If D0 is a logic HIGH, then check the output at J1 for a -1.4VDC.
   1. If J1 is +2.2VDC, replace the inverter driver.
c. If Drivers D1 through D6 are not being turned on, check the D1 thorough D6 outputs of the PAL for a logic HIGH.
   1. If any outputs are logic LOW, replace the PAL.
d. If D0 is a logic HIGH, then check the output at J1 for a -1.4VDC.
   1. If J1 is +2.2VDC, replace the inverter driver.

E.6.3.3 Drivers D7 - D14 Will Not Turn On

If any or all of the Drivers will not turn on, begin troubleshooting as follows:

a. Place the Driver Test Jumper JP9 in the TEST position.
b. Measure the D7 through D14 outputs of the PAL.
   1. If the outputs are not all logic HIGH, replace the PAL.
c. If the outputs are all HIGH, measure the outputs of the inverter.
   1. All outputs at J1 should be -1.4VDC, if any one is not, replace the inverter driver.
   2. If the negative voltages are present, inspect connector J2 and refer to the Driver Combiner Troubleshooting section to continue.
d. Measure the AGC inputs to the PAL. With the Transmitter OFF, all inputs should be logic HIGH. If they are not, replace U14 and U20.
e. Return the Driver Test Jumper back to the Normal position.
f. Measure the TX On Enable during the step-start sequence.
   1. This input at J3 should go logic HIGH when the Transmitter is turned on. If it does not, refer to the overall wiring diagram and the Power Block Interface Section as needed.

E.6.3.4 Cable Interlock

If DS8 is illuminated RED on the Driver Encoder, there are three basic possibilities,

a. Start by ensuring that the RF modules and cables are firmly inserted into the Driver Encoder and Driver Combiner Motherboard.
b. If the fault remains, use a clip lead to jumper the cathode of CR20 to R177 (J2-20 to J2-9).
   1. If the LED extinguishes, refer to the Overall wiring diagram and the Driver Combiner section to trace the open.
c. If the LED is still illuminated, use another clip lead and jumper R180 to the cathode of CR25 (J1-19 and J1-10).
   1. If DS7 goes out refer to the Overall wiring diagram and the Driver Combiner Section to trace the open.
d. If the LED remains illuminated when both clip leads are in place, measure the voltages at the (+) input and (-) inputs to the comparators.
   1. If the (+) input voltage is greater than the (-) input, replace the comparator.
   2. If the (+) input voltage is less than the (-) input, check the resistors and diodes.
e. If the output at J3 is logic HIGH, refer to the overall wiring diagram and the Power Block Interface schematic section to locate the fault.

E.6.4 A/D Phasing

a. Check for a carrier frequency or 1/2 carrier frequency squarewave signal at TP4 of 5Vp-p when the Transmitter is on.
   1. If not present, check JP10-2. If a carrier frequency (or 1/2 carrier frequency) signal is present, check the divider and the tri-state buffer.

b. If a carrier frequency (or 1/2 carrier frequency) signal is not present JP10-2, check for a carrier frequency (or 1/2 carrier frequency) squarewave signal at the input of U18 of 0.7V to 4.3 Volts peak to peak when the Transmitter is on. If a signal is present, replace U18.
    1. If not present at the U18 input, check the input circuitry. There should be an RF signal detected across the input resistor.
    2. If there is no signal present, refer to the overall wiring diagram to find the loss of signal from the RF Splitter.

c. If the correct output at TP4 is present, refer to the overall wiring diagram and the A/D Converter Troubleshooting section to continue.

E.7 Removal and Replacement

With the low voltage power supplies shut off, remove all connectors and top outside mounting screws. The cable connectors are keyed for identification during replacement. When installing the replacement board, reverse the above procedure. Ensure that all jumpers and switches on the new board are set to the same position as corresponding ones on the original board.

E.8 Alignments

E.8.1 High & Low Drive Thresholds

Measure the voltage on TP5, High Drive, and adjust R84 to the same as the recorded value from the factory test data sheet.

Measure the voltage on TP6, Low Drive with the Transmitter on, and adjust R86 to the same as the recorded value from the factory test data sheet.

High drive voltage at TP5 is typically adjusted to 120% of the voltage at TP7.

Low drive voltage is typically 80% of that of TP7.

NOTE

If the Transmitter turns OFF due to a Low Drive Fault, turn R86 clock-wise 1 turn and repeat the adjustment.

E.8.2 AGC

The drive level is maintained with the 4 AGC drive amplifiers that may be turned ON or OFF as required to maintain drive level. The AGC drivers are D11, D12, D13 and D14.

Turn on the Transmitter and observe the Relative RF Drive on the front panel meter. Adjust R100 for the same reading as obtained from the factory test data sheet for the specified frequency.

R100 should be set so that 2 AGC amplifiers are ON at full carrier power (no modulation). Measure the peak to peak RF drive level on the scope monitoring the drive at Step 151, the proper RF drive should be 22-24 Vp-p.

F.1 Introduction

This section describes the Main, EPAC and Binary RF Combiner Motherboards. Topics include function, location, detailed circuit description, and removal/replacement.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Main Combiner Motherboard	
Assembly #	992-8548-003
PWB	843-5155-505
Schematic	839-7930-505
EPAC Combiner Motherboard	
Assembly #	992-9158-001
PWB	843-5450-011
Schematic	839-8154-011
Binary Combiner Motherboard	
Assembly #	992-8549-003
PWB	843-5155-506
Schematic	839-7930-506

NOTE: For more information about the RF Combiner, refer to the Overall System Theory Section.

NOTE: Parts Lists for these boards are covered in Section VII, and RF Amplifiers are described in Section G.

F.2 Function

The purpose of the Main and EPAC RF Combiner Motherboards is to provide the input/output connections for 16 Big Step RF Amplifiers.

The purpose of the Binary RF Combiner Motherboard is to provide the input/output connections for 12 Big Step RF Amplifiers, and 4 Binary RF Amplifiers.

F.3 Location

The A10 Binary RF Combiner Motherboard and the A11 Main RF Combiner Motherboard are located in the right compartment. (See VIEW 13).

The A12 through A15 Main RF Combiner Motherboards are located in the center compartment. (See VIEW 12).

The A16 through A19 Main RF Combiner Motherboards are located in the left compartment. (See VIEW 11).

The A20 through A23 Main RF Combiner Motherboards are located in the Extended Power Amplifier Cabinet.(See VIEW9)

F.4 Detailed Circuit Description - Main and EPAC RF Combiner Motherboards

Refer to the Main Combiner Motherboard Schematic Diagram (drawing 839-7930-505) and EPAC Combiner Motherboard (drawing 839-8154-011) for the following description.

Each RF Combiner Motherboard contains combiner transformer toroids (T1 through T16 on each board) and a printed circuit board socket for 16 RF Amplifiers. The RF Amplifiers are mounted in two rows of 8 connectors.

F.4.1 Big Step RF Amplifier Connections - J1 through J16

F.4.1.1 RF Input

The RF drive inputs are obtained from the A6 RF Splitter secondary and the RF drive cables that are connected to J17 through J24. There is a separate RF drive cable for each half-quad, so there are two separate RF drive cables for each amplifier. All RF drive coaxial cables are the same length, so all RF drive signals are in phase. Each RF Amplifier is provided two equal amplitude and phase RF drive inputs at pins 49 and 53 of each RF Drive connector.

F.4.1.2 Power Supply

Four fused +250VDC lines from the RF Amp Power Supply enter the Main RF Combiner Motherboard at E1 through E4. It is connected to each RF Amplifier connector at pin 23 through 32, and can not be adjusted.

F.4.1.3 RF Output

Each RF Amplifier output is connected to a combiner toroid T1 through T16 at pins 1 and 7. All of the toroids have a turns ratio of 16:1, sixteen turns for the primary winding and one turn for the secondary. The Efficiency Coil boards plug into plugs parallel with the output on the Main and EPAC RF Combiner Motherboard and their taps are frequency determined.

F.4.1.4 Modulation Encoder Connections - J25 through J28

F.4.1.4.1 Turn-On Control Signals

On each of the seven Modulation Encoder connectors, pins 1, 3, 5, and 7 are connected to pin 45 on the RF Amplifier connectors. When the voltage is -2VDC on that pin, the RF Amplifier is turned on.

F.4.1.4.2 Cable Interlock

When an amplifier is properly inserted a connection is made between pins 35/36 and pins 37/38 on the amplifier connector. On each of the four Modulation Encoder connectors, pin 9 will loop-through connecting traces/amplifiers/connectors and return to pin 10 with very low resistance. If an amplifier is disconnected, pin 9 and pin 10 will be an open circuit.

F.5 Detailed Circuit Description - Binary RF Combiner Motherboard

Refer to the Binary RF Combiner Motherboard Schematic Diagram (drawing 839-7930-506) for the following description.

The Binary RF Combiner Motherboard is similar to the Main Combiner Motherboard, with some additional components and differences.

F.5.1 Binary RF Amplifier Connections J1 through J4

F.5.1.1 Power Supply

The B9 1/2 Step and B10 1/4 Step operate from +125VDC that enters at E5. The B11 1/8 Step and B12 1/16 Step operate from +60VDC that enters at E1.

NOTE

+250VDC is connected to E2 and loops through E7/E8 and E9/E10 to supply the other twelve Big Step RF Amplifiers.

F.5.1.2 RF Output

The Binary Steps employ tapped transformer primary windings for fine adjustments. The tap positions depend on operating frequency and are selected with P30, P31, P32 and P33.

F.6 Octal Efficiency Coils

Efficiency coils are provided on the Binary and Main combiner motherboards to provide selectable inductance to cancel stray capacitance in the circuits. S1-S8 select the inductance needed to cancel the capacitance at the carrier frequency, see schematic #839-8154-003 for the frequency chart when replacing the Efficiency Coil board.

F.7 Troubleshooting

Troubleshooting on the RF Combiner Motherboards consists essentially of visual inspection. Possible problem areas include:

a. Inspect connectors carefully, including removing RF Amplifiers if necessary to inspect PC Board edge connectors.

b. Physically check connectors; plugs should be properly inserted into jacks or sockets.
   1. Connectors loose
   2. Connector damage

NOTE

Replacement edge connector sockets will have to be soldered in place.

c. Damage to printed circuit traces.

d. Cracked ferrite toroid cores
   1. The shield over the combiner must be removed to check combiner transformer cores. (If transformers must be replaced, be certain that the replacement has the same number of turns of wire as the original).
   2. Possible dirt build up around toroids and combiner pipe after several years of operation and unfiltered air.

e. Loose taps, or incorrectly set taps on air-core inductors L1 through L16.

f. Loose connections where combiner rod sections join.

g. Failed electrolytic capacitors, used in the RC filtering in supply voltage lines on each board.

F.8 RF Combiner Motherboard Removal

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

All RF Combiner Motherboards are of similar construction and therefore will require the same basic procedure.

a. Remove all 16 RF Amplifier modules from the front.

b. Disconnect all wiring and cables from the motherboard that is being replaced.

c. Remove all screws on the Efficiency Coil supports.

d. Remove Efficiency Coil supports.

e. Remove Efficiency Coil support standoffs (1/4" hex).

f. Remove Efficiency Coil interconnect cables from J1 and J2.

g. Use Lifting Loops to pull Efficiency Coil boards from Motherboard. (NOTE: Try to progressively "walk" the board from the Motherboard to prevent damage to banana connectors located along the board.)

h. Remove only as much of the combiner cover as necessary from the rear of the Transmitter.

CAUTION

LOCATE AND REMOVE ANY HARDWARE THAT IS DROPPED. IF LOST HARDWARE IS REPLACED, MAKE SURE NONE OF THE DROPPED HARDWARE HAS LODGED ON ANY RF AMPLIFIER MODULE.

i. Remove the 2 end screws from the combiner secondary rod.

j. Remove the motherboard fastening hardware beginning with the two 4-40 screws in the front center card guide support. The 4-40 screws to be removed can be identified by the 6 inch (15cm) aluminum rods attached to the card guide support bar.

   1. Six screws on the outside right and left sides of the motherboard.
   2. Four screws on the inside top and bottom of the motherboard.

k. Carefully remove the motherboard out the rear of the Transmitter.

F.9 RF Combiner Motherboard Replacement

Replacement of the Main Combiner/Motherboards is essentially the reverse of the removal procedure.

a. During installation of a motherboard, it may not appear to fit in as easily as it came out. This is due to all of the blue card guides not fitting back in their respective slots at the same time. It is recommended that the board be installed and just a few of the screws be installed that mount the board to the supports. Then from the front of the compartment, place the card guides into their respective slots.

b. Once the motherboard has been fully mounted, insert the Allen screws that bolt the Combiner rods together in place but do not fully tighten.

c. Loosen the two set screws that are on the fiberglass supports on the motherboard that hold the rod in place. Tighten the Allen screws on the copper rod to 150 inch/lbs.

d. Retighten the set screws on the motherboard. Replace the Combiner cover, RF Amplifier modules, and the interconnection plugs.

e. Reverse of Removal Procedure.

CAUTION

REPLACE ALL COMBINER COVER SCREWS. THE MAJORITY OF COMBINER RF GROUND CURRENT FLOWS THROUGH THE COMBINER COVERS.

F.9.1 Adjustments

The only adjustments available are efficiency coil tap positions and the four Binary transformer tap settings, refer to the Frequency Change Procedure in Section V.

G.1 Introduction

This section covers the RF Amplifier module. Topics include function, location, block diagram description, detailed circuit description, and troubleshooting.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Assembly #	992-9074-001
PWB	843-5450-007
Schematic	839-8154-007

NOTE: Parts List for this board is covered in Section VII.

G.2 Function

The 200 kW Transmitter contains a total of 239 RF Amplifier modules. Each module is a plug-in RF power amplifier which includes Class D Switching MOSFETs, RF Drive Transformers, On/Off Control Switches, and Cable Interlock/Fuse Fault Detectors. See Figure G-1 RF Amplifier and Mod Encoder Locations for the following discussion.

All 239 RF Amplifiers are identical, and can be used in any of the following locations:

a. One (1) RF Amplifier Module, is used to amplify the Buffer Amplifier output and provide RF drive to the Drivers, D1-D14. It is called the Predriver, PD1.
b. Fourteen (14) RF Amplifier modules, D1-D14, are used to amplify the Predriver output and provide RF drive to the Big Step and Binary Steps, they are called the Drivers.
c. Four (4) RF Amplifier modules, B9-B12, are used to generate part of the RF Output signal, they are called the Binary Steps.
d. 220 RF Amplifier modules, RF1-RF220, are used to generate the major part of the RF output signal, they are called the Big Step Amplifiers.

G.3 Location

All RF Amplifier modules plug into combiner/motherboards, and are accessible from the front of the Transmitter behind interlocked doors.

The Predriver (PD1), Drivers (D1-D14), Binary Steps, (B9-B12), and Big Steps RF47 to RF62, RF 133 to RF 143, and RF220 are located in the right compartment behind the inner door. (See VIEW 2)

Big Steps RF24 to RF46, RF 63 to RF85, RF125 to RF151, RF218, and RF219 are located in the center compartment behind the inner door. (See VIEW 4)

Big Steps RF1 to RF23, RF86 to RF124, RF216, and RF217 are located in the left compartment behind the inner door. (See VIEW 5)

Big Steps RF 152 to RF215 are located in the Extended Power Amplifier Cabinet behind the inner door. (See VIEW 6)

NOTE
Each RF Amplifier module contains identical circuits, regardless of whether it is used as a Predriver, Driver, Binary Step, or Big Step. The only difference will be the inputs to and outputs from the module as determined by the function required. The following discussion applies to all RF Amplifiers, regardless of their location.

Cooling of the RF Amplifiers is accomplished by a closed loop liquid cooling system. The MOSFETS are physically connected to aluminum blocks which serve to transfer heat from the MOSFETS to the chiller pipes that run down both sides of the racks into which the RF Amplifiers are inserted. These blocks are pressed against the chiller pipes by a spring tensioning device. When the RF Amplifier is inserted into it’s slot, the screw of the spring tensioning device is tightened and this presses the blocks more tightly against the chiller pipes thereby allowing for more efficient heat transfer.

G.4 Block Diagram Description

The RF amplifier module is a Class D, Quad Bridged configuration.

Refer to Fig. G-2, RF Amplifier Block diagram for the following discussion.

G.4.1 RF Flow

G.4.1.1 RF Drive

Two separate, (but equal in Phase and Amplitude), RF drive sinewave signals enter the module, and each is applied to an RF Transformer. Each RF Transformer in turn, feeds pairs of MOSFET Switches with signals that are 180^{o} out of phase with each other.

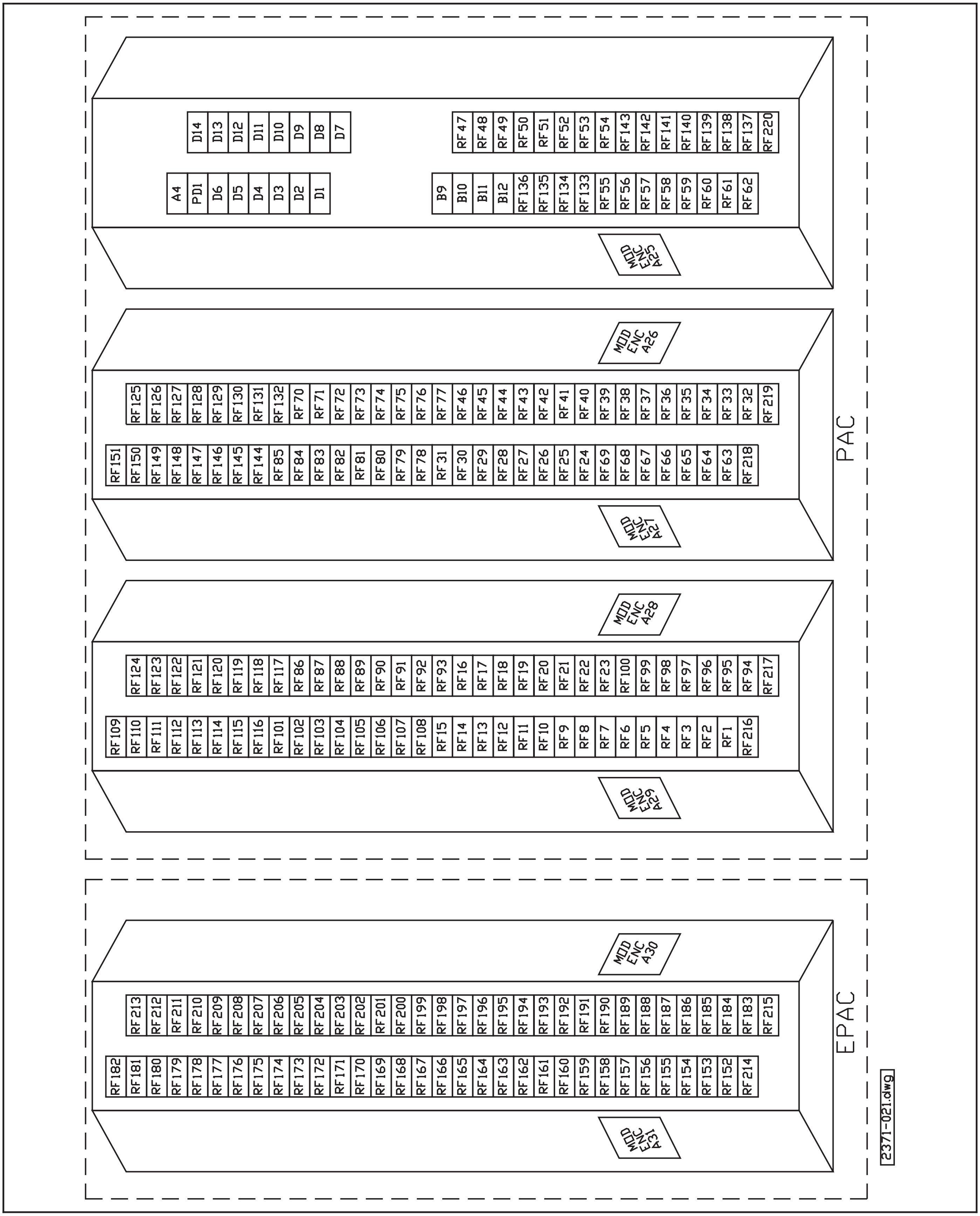


Figure G-1. RF Amplifier and Mod Encoder Locations

G.4.1.2 MOSFET Switches

The module is divided in half, into Section A and Section B. Section A consists of a pair of MOSFET switches (with each switch consisting of two paralleled MOSFETs) which are in series from the Supply Voltage to ground. Section B is identical, but is driven 180^{o} out of phase with Section A. A Combiner Transformer Primary is connected across the two pairs, in between the MOSFET switches. This is referred to as a Quad Bridged Configuration. Each MOSFET Switch is alternately driven into cutoff or saturation by the phase of the signal from the RF Transformer, thereby acting like a switch. The MOSFETs require a positive voltage on the Gate with respect to Source to turn ON. Therefore the MOSFETs Turn ON for one half of the RF input cycle, and turn OFF for the other half.

For example, (See Figure G-3) for the first half cycle of the RF Drive input, if the upper switch in Section A is ON then the lower switch is OFF. Section B would be exactly opposite, in that the lower switch would be ON and the upper switch would be OFF. For the next half cycle of the RF Drive input, the lower switch in Section A would be ON and the upper switch would be OFF. Section B again would be the opposite and the upper switch would be ON and the lower switch would be OFF. The output signal across the Combiner Transformer Primary, for either half cycle, is then switched between ground, (about zero Volts) and the positive supply voltage at an RF rate. Since the amplifier is a bridged configuration, the effective voltage across the Combiner Transformer Primary will be approximately twice the supply voltage.

G.4.1.3 On/Off Control Switches

The Turn ON/OFF Signal is applied to Control Switches that are connected to the drive signal on the lower pair of MOSFET Switches and ground. When the Turn ON/OFF Signal is high (positive), the module is turned “OFF” and the Control Switches are closed. Drive to the lower pair of MOSFET Switches is removed and therefore they remain in an open condition. When the Turn ON/OFF Signal is low (negative), the module is turned “ON” and the Control Switches are open. This allows drive on the lower pair of MOSFET Switches.

G.4.2 Cable Interlock

A single trace on the printed circuit board connects two pins of the corresponding edge connector together. If the module is missing or not properly connected to the edge connector, the Cable Interlock string will be broken and the Power Block cannot be turned on. Front Panel Module/Cable Interlock LED will be lit.

G.4.3 Fuse Open Detector

RF Drive and Supply Voltage Fuses are located on the module for protection of other circuits in the Transmitter. Should any one of the fuses open, a lower than normal voltage is present on the Cable Interlock line that will activate Fuse Fault detection circuits.

G.5 Detailed Circuit Description

Refer to the RF Amplifier Schematic Diagram (839-8154-007), for the following discussion.

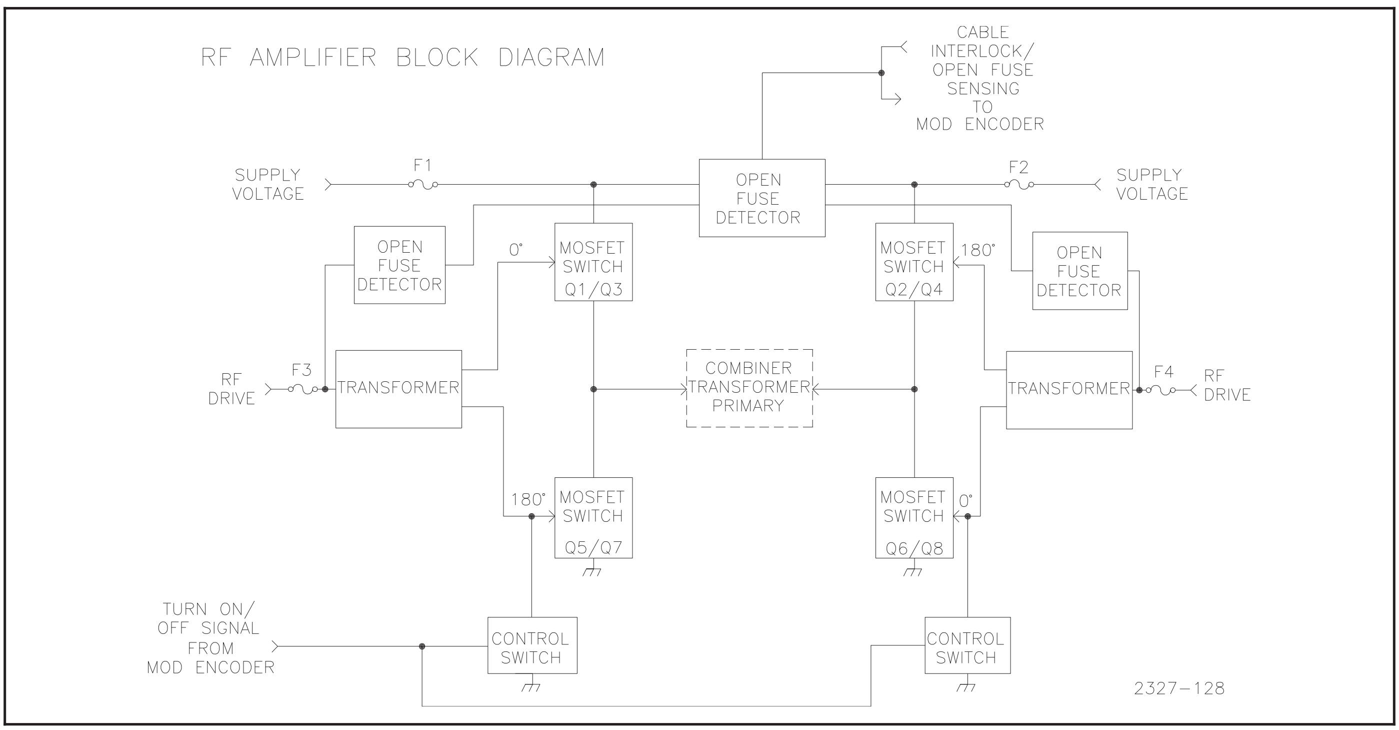


Figure G-2. RF Amplifier Block Diagram

Refer to other Simplified Diagrams as requested.

G.5.1 RF Drive

G.5.1.1 Primary

RF drive for section A enters the module at P1-49 and RF drive for section B enters at P1-53. There is a separate RF fuse (F3 and F4) for each section, so that if a section should fail, the fuse opens and the failed section is disconnected from the driving source.

A network in parallel with each RF drive transformer primary broadbands the input circuit, so that no component changes are required for operation at any frequency in the AM broadcast band. For T1, this network consists of all the inductors, capacitors, and resistors drawn to the left of T1. The same is true for all the components drawn to the right of T2.

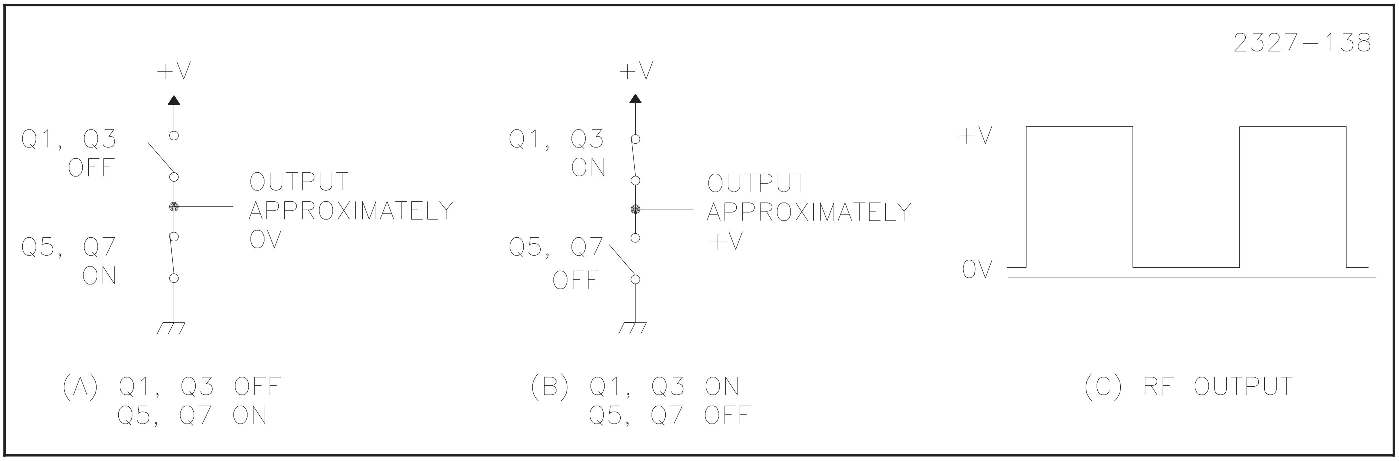


Figure G-3. RF Amplifier Half Quad Operation

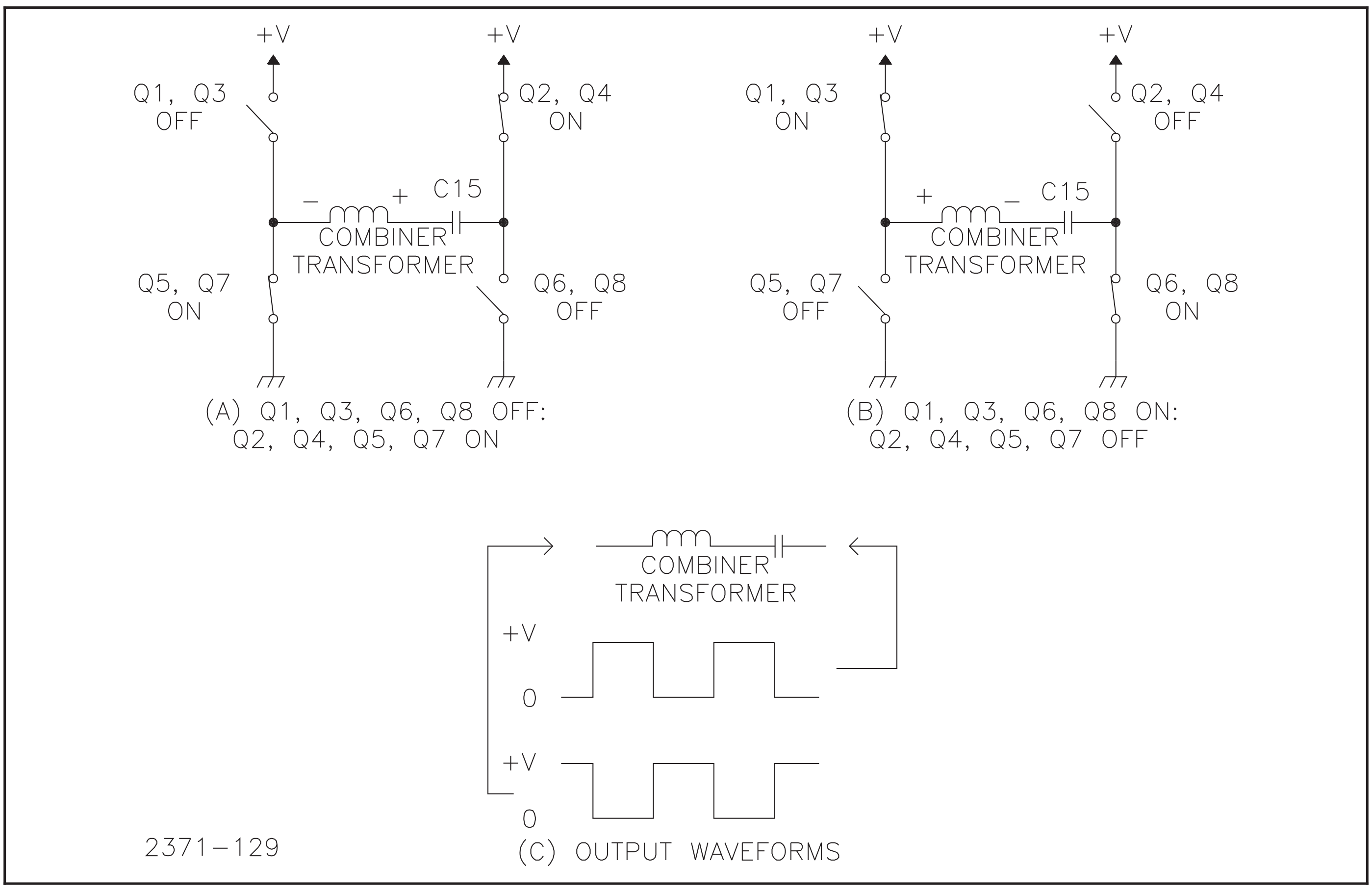


Figure G-4. RF Amplifier Full Quad Bridged Operation

When the module is turned "OFF", the voltage at the base of Q15 and Q17 is positive. Q15 is saturated and connects R7 and C5 to ground, meanwhile Q17 is turned off.

When the module is turned "ON", the voltage at the base of Q15 and Q17 is negative. Q15 is turned off and opens the ground for R7 and C5, while Q17 is saturated and grounds the base of Q15.

This action presents the same RF impedance to the driving source when the module is "OFF" that it has when the module is "ON". The same is true of Q16, Q18, R8, and C6 for section B.

G.5.1.2 Secondary

Each RF drive transformer has two pairs of secondary windings, which provide two pairs of drive signals, 180° out of phase, for the upper and lower MOSFET pairs in each section. On the schematic diagram, small circles at one end of each transformer winding indicate RF phasing.

Tranzorbs (Back-to-back zener diodes) CR1, CR2, CR3, and CR4 protect the MOSFET gates against overvoltages, including possible transient voltages. Each of these diodes conducts if the voltage across them exceeds 20 Volts, either positive or negative.

G.5.2 MOSFET Switches - Full Quad, Bridged Configuration

Figure G-4 shows the four pairs of MOSFETs as switches. The phase of the RF drive signals is such that only two combinations are possible for the switches when the module is "ON". During one half of the RF cycle (Figure G-4A), Q1/Q3 and Q6/Q8 are both driven to cutoff (open), while Q2/Q4 and Q5/Q7 are saturated (closed). During the other half of the cycle (Figure G-4B), Q1/Q3 and Q6/Q8 are saturated, and Q2/Q4 and Q5/Q7 are cut off.

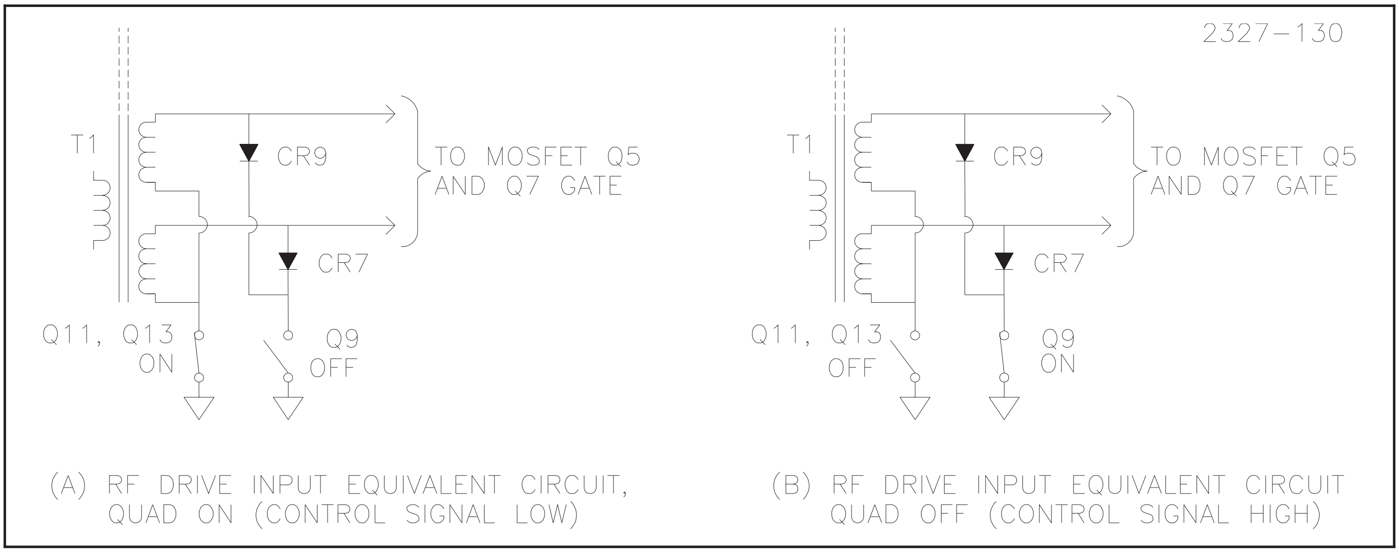


Figure G-5. RF Amplifier Simplified Control Circuit

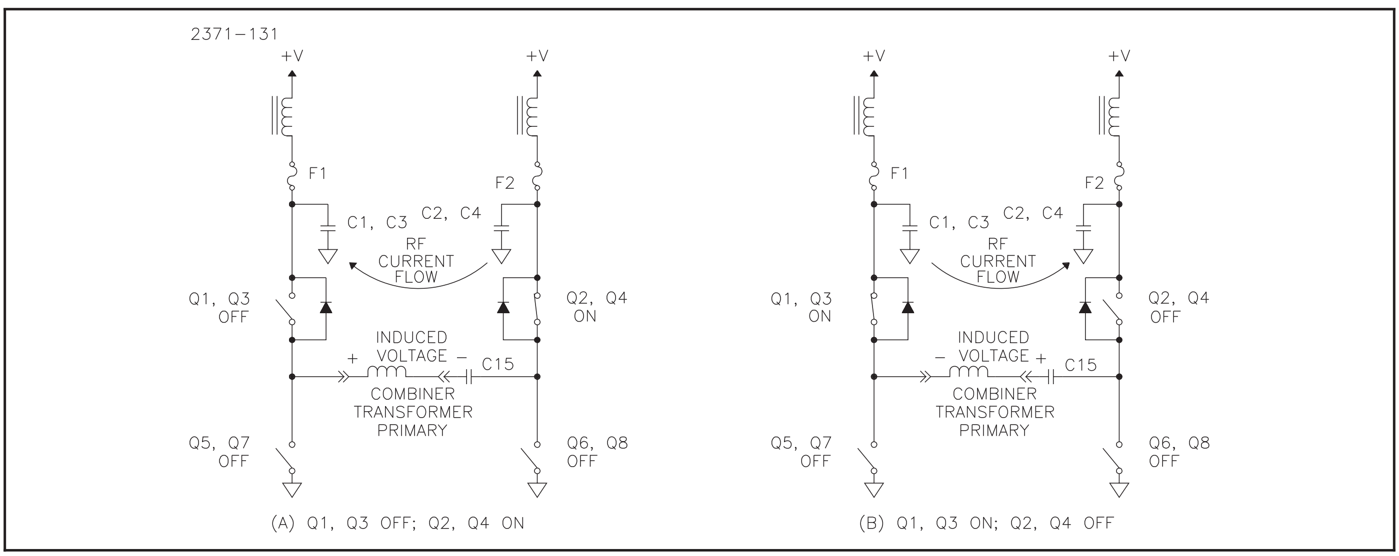


Figure G-6. Induced RF Current Path for Module OFF Condition

WARNING: Disconnect primary power prior to servicing.

Each section produces a square wave output, but the two square waves are 180° out of phase. This switching action effectively applies the full supply voltage across the combiner transformer primary winding with opposite polarities on each half cycle of the RF Drive signal. Being a Bridged amplifier, this gives an effective RF output of twice the power supply voltage. Section A output at TP1 leaves the module through P1-1, and section B output at TP2 leaves the module through P1-7. The combiner motherboard connects the transformer to these two points. To prevent a direct DC current path through the combiner transformer winding to ground (for example if MOSFET's should fail), a capacitor C15 is placed in series with one section's RF output.

Small ferrite beads have been placed on the drain leads of MOSFETs Q5, Q6, Q7 and Q8, to prevent high frequency currents or oscillations. (RFC1, 2, 3 and 4)

G.5.3 MOSFET Switches - Half Quad, Single Ended

The RF Amplifier was designed to have separate supply voltage and RF drive inputs for each amplifier half to allow the "A" half to operate independently of the "B" half. This feature of the RF module is utilized in the Regulated Driver Module D14A and D14B, and in the Predriver module PD1. Figure G-4 shows the MOSFETs as switches for Section "A." Section "B" is identical in operation except, Q2/Q4 and Q6/Q8 are used.

The squarewave RF output waveform, at the junction of Q1/Q3 source and Q5/Q7 drain, will be approximately from 0 Volts to the supply voltage, at the Transmitter's RF operating frequency. In this mode the RF output voltage is about half of the Bridged mode of operation. This provides some degree of redundancy because it is possible that one of the Full Quad, Bridged RF amplifiers could have a failure of only section "A," or only Section "B." Since a failure of either section would most likely be either a shorted MOSFET or an open fuse, the other half of the module would continue to operate normally. In this case it becomes a Half Quad module and would operate at reduced RF output voltage.

G.5.4 Control Switches

Figure G-5 shows the control switches for section A in the "ON" and "OFF" conditions. The same principles apply to section B circuitry. ON/OFF control signals (from the appropriate Mod Encoder) enter at P1-45 and P1-46.

G.5.4.1 Module Turned "ON"

A negative control signal input (about -2 to -5 Volts) will saturate PNP transistors Q11 and Q13, so they act essentially as a short circuit. NPN transistor Q9 will be cut-off and effectively an open circuit.

A ground is therefore applied to the lower part of the two secondary windings of T1 and RF drive is then provided to Q5 and Q7 so they switch on when gate drive is positive. Diodes CR7 and CR9 rectify the positive RF gate drive and illuminate DS3 "RF AMPLIFIER ON" GREEN.

G.5.4.2 Module Turned "OFF"

A positive control signal of about +4.5V will cut-off Q11 and Q13, so they act as an open circuit, and will saturate Q9 essentially making it a short circuit. By shutting off Q11 and Q13, the ground for T1 is removed, and the RF drive to the gates of MOSFET's Q5 and Q7 are clamped to a diodes drop above ground by Q9 through CR7 and CR9. The positive voltage required to turn ON the MOSFET's (approximately +2 to +4 Volts gate relative to source) is taken away, therefore they remain open switches.

Schottky diode CR5 connected to Q11/Q13 and diode CR15 connected to Q9, protect the transistors from transient voltages.

Capacitor C16, connected between Q11/Q13 collector and Q12/Q14 collector on section B, improves the turn-on/turn-off characteristics of the amplifier.

Refer to Figure G-6.

When an RF Amplifier module is "OFF," there is no current flow from the supply through the combiner transformer primary, therefore, the module does not supply any power to the combiner. However, current will still flow through the combiner secondary, and will induce RF voltages in the toroidal transformer primary windings for all inactive modules.

When the polarity of the induced voltage in the combiner transformer is as shown in the diagram, a low-impedance RF current path is available through the reverse diodes inside Q1/Q3, bypass capacitors C1, C3, C4, and C2, through MOSFETs Q2/Q4, which are "ON," and through C15.

When the polarity of the voltage induced in the transformer winding reverses, Q1/Q3 must turn ON, and the current flow will now be through the reverse diodes in Q2/Q4.

G.5.5 Cable Interlock

The cable interlock control signal loops through the RF Amplifier on pins P1-35/36 and P1-37/38. The interlock signal originates and is processed on the Mod Encoder controlling the RF Amplifier.

G.5.6 Supply Voltage

The supply voltage for Section A goes through P1-23, and through P1-29 for Section B. Resistors R27 and R28 are placed in the supply line for filtering, and the drains of Q1/Q3 and Q2/Q4 are bypassed to ground by C1 and C3, and C2 and C4.

A separate 8 Ampere fuse is used for each section, and a RED LED indicator is across each fuse. DS1-R1 are for F1 and DS2-R2 are for F2. R1 and R2 limit LED current based on 250 VDC. The LED will always illuminate when a fuse opens due to a short circuit (i.e. failed MOSFET's or bypass capacitors).

The LED will also illuminate when the circuit is okay with the fuse open and the amplifier switched "ON". This also means that the LED may not be illuminated when a fuse is open of an amplifier assigned near the peak of modulation which is seldom switched "on".

G.5.7 Fuse Open Detector

The Fuse Open Detector circuit is formed by diodes CR11/CR12 for Supply voltage fuses and by CR17/CR18 for RF fuses.

Normally P1-35 is established at about +15VDC by circuitry on the encoder when all fuses are ok.

G.5.8 RF Drive Fuse Open Detector

RF Drive passed by F3 will conduct through CR19 and charge C11 to about 20VDC. CR17 is therefore reversed biased and P1-35 remains at +15VDC. If F3 opens, the charge on C11 will be removed and 20K Ohms of resistance will effectively be placed to ground through CR17 and R19. This will lower the voltage going to the Mod Encoder and is used to trip a fault comparator which lights the RF Amp Fuse LED on the Front Panel. The same operation applies to circuitry connected to F4.

G.5.9 DC Supply Fuse Open Detector

If F1 opens due to shorted MOSFETs on section A, the voltage at P1-35 (normally +15VDC) will be shunted to ground through R11 and CR11. This will lower the voltage going to the Mod Encoder and is used to trip a fault comparator which lights the RF Amp Fuse LED on the Front Panel. The same operation applies to circuitry connected to F2. If CR11 or CR12 short, R31 and CR25 will clamp the 250 VDC present at F1 or F2 down to 20 Volts on the fuse open detector line (P1-35), thereby protecting the Mod Encoder.

NOTE: For more information on the Fuse Fault circuitry refer to Section L, Modulation Encoders.

G.6 Maintenance

G.6.1 Handling MOSFETs

Due to the fragile nature of the gate of a MOSFET, special care in their handling is required. The gate junction may be destroyed by static electricity if static electricity is allowed to discharge through the MOSFET. For example, walking across a carpet to pick up a MOSFET that is not protected by antistatic packaging could result in the destruction of the MOSFET. A static charge could build up on a person while walking across the carpet. This static charge will eventually have to be discharged. Discharging to the MOSFET could damage/destroy the MOSFET.

NOTE

MOSFET transistors which are in circuit are immune to this damage.

The MOSFET transistors are shipped in antistatic packaging. The transistors should remain in this packaging until they are to be used or tested.

G.6.2 Testing MOSFETs

The MOSFETs will have to be removed from the circuit in order to perform the following test.

Observe the precautions in the paragraph entitled “Handling MOSFETs” in this section.

The following test applies to all MOSFETs used in the Transmitter, but is not necessarily applicable to MOSFETs used in other equipment.

The MOSFETs used in the Transmitter may be checked with an ohmmeter. However there is a requirement which restricts the use of some ohmmeters. If the battery voltage is too low (under 3V) or too high (over 20V) the ohmmeter cannot be used. A battery voltage less than 3V will not give an operational check of the transistor and a battery voltage greater than 20V may result in damage to the transistor under test. A Simpson 260, which uses a 9V battery on the Rx10k scale works quite well.

This test will show how a MOSFET can be switched “on” and “off” by charging and discharging the gate of the MOSFET.

Refer to Figure G-7 for the following test. Connect the positive lead of the ohmmeter to the drain or case of the transistor. Connect the negative lead to source. Alternately touch a jumper from gate to source and then from gate to drain. The ohmmeter should read towards infinity or at least 2 megohms when the MOSFET is switched off and less than 90k Ohms when the MOSFET is switched on. (To switch the MOSFET on hard (near zero Ohms) use +5 VDC gate to source signal.) When doing this test, lay the MOSFET on a flat surface or hold sides of the case. The resistance of your finger tips and skin will effect the readings when you touch the leads.

G.6.3 Replacing MOSFETs

When repairing an RF Amplifier, it is recommended that all four MOSFET’s of the failed half of a module be replaced. Even though only one or two of the four MOSFETs are found to be shorted, the remaining MOSFETs may have been stressed internally and may fail when supply voltage is reapplied. The repair process would then have to be repeated which can be very frustrating.

Blowing a fuse on one half of the amplifier does not affect the other half of the amplifier.

MOSFETs that appear to be undamaged after testing should be kept as spares for use if new replacements are not available. Also keep in mind that the amplifiers used in the Driver and PA are identical except that the Driver amplifiers operate at half voltage. This allows you to rotate a repaired module into the Driver position if so desired.

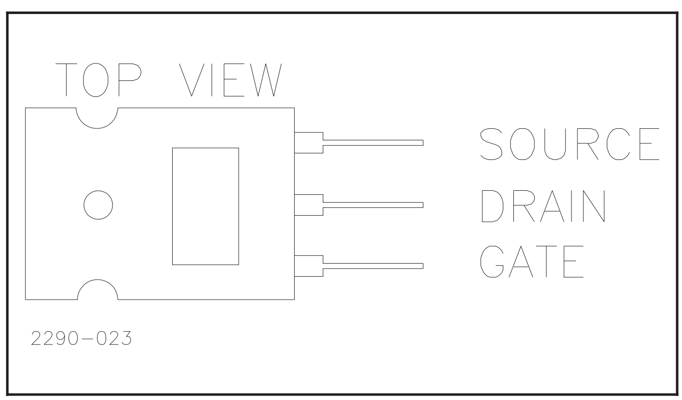


Figure G-7. Pin Identification of MOSFET

NOTE

In most cases, the transistor will stick to the heatsink because of seal created by the transistor pad. This seal will have to be broken before a heatsink can be removed. Pry the transistor out, away from its heatsink. DO NOT TRY TO PRY THE HEATSINK AWAY FROM THE PC BOARD WITH TRANSISTORS STUCK TO THE HEATSINK OR THE PC BOARD MAY BE DAMAGED AND THE HEATSINK MAY DISTORT. Sometimes the transistor pad will tear when the seal is broken, Remove stuck pieces and replace pad.

a. Remove all the screws from heatsinks outer cover and transistors.
b. Break the seal between the cover and the transistors and remove the cover.
c. Remove the transistors from the PC board.

NOTE:

Be careful not to lose the small ferrite bead.

d. Remove the remaining transistors still attached inside the heat sink together. Remove the transistor screws.
e. Break the seal and remove the inner MOSFETs from the heatsink.
f. Replace failed transistors. Save and reuse the ferrite bead on the center leads of Q5/Q7 and Q6/Q8. Do not solder leads until heatsinks are in place.
g. Reattach heatsinks in reverse order as they were removed in step b. Tighten heatsink and pc board screws first and then tighten transistor screws (torque to 3 inch-lbs).
h. Make sure the ferrite beads are on the center leads of Q5/Q7 and Q6/Q8.
i. Solder transistor leads and trim.
j. Replace blown fuse(s).

G.7 Troubleshooting RF Amp Modules

This section deals with faults on a single module. For problems involving multiple modules refer to the Transmitter Troubleshooting Section first.

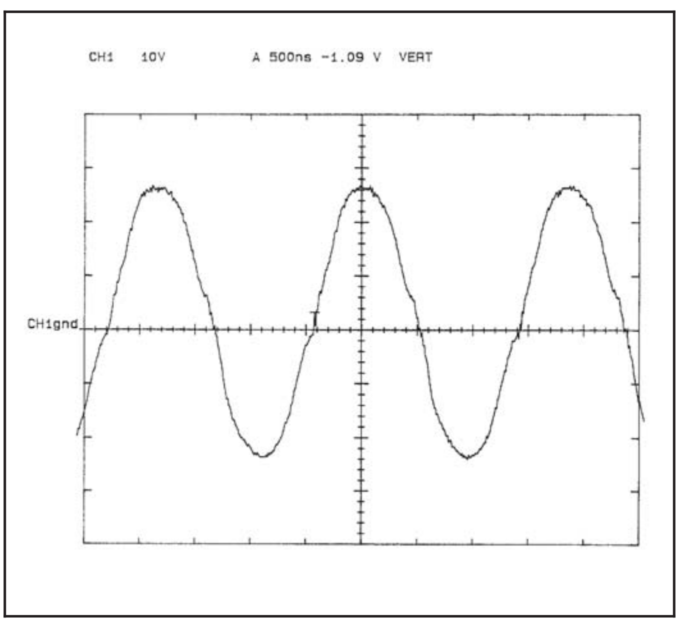
Before troubleshooting the module, verify that the problem exists on the module by swapping the suspected bad module with another working module in the Transmitter. If the problem does not follow the module refer to the Combiner Section to continue.

After it has been verified that the problem is on the module, begin Troubleshooting by observing the LEDs on the Module when the Transmitter is running.

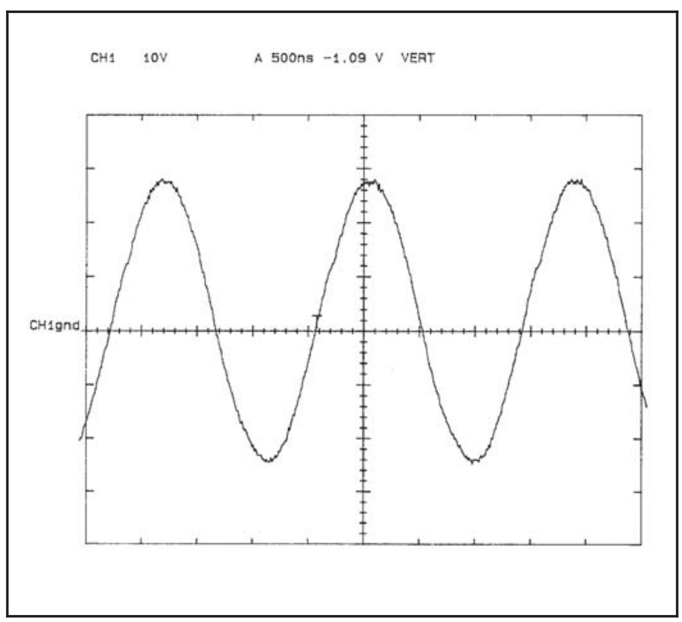
G.7.1 DS3 Not Illuminated

If this LED is not illuminated, the module is not being turned on or no RF drive is present.

a. Move the module to a position that has DS3 illuminated.
   1. If the LED still does not light, check F3 and F4.
   2. If the fuse(s) are open, check for a shorted T1, T2, C11 or C12.
b. If the fuses are not open:
   1. Verify the presence of RF drive on the RF Amplifier. Refer to Section VI, Troubleshooting paragraph title “Measuring RF Drive.”
   2. It should be 22 to 25 Volts peak to peak with a negative DC offset.
   3. If the RF Drive waveform has no DC offset (is centered on the 0VDC axis) that side is on, check Q9 and Q10 and DS3 for a short.



P1-50



P1-50 (RFA OFF)

WARNING: Disconnect primary power prior to servicing.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING “PA+VDC” ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

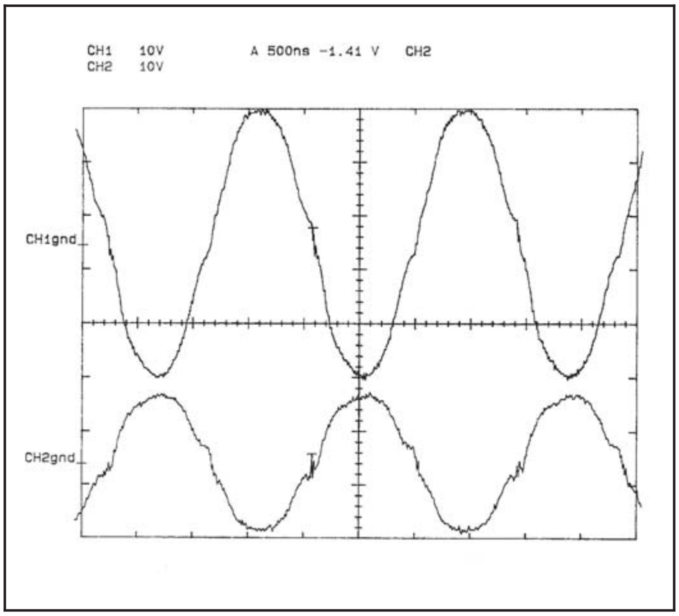
4. If the signal on CR3 and/or CR4 is negative, turn off the Transmitter and remove the module.
5. Using an Ohmmeter check Q15, Q17, Q13, Q11, Q9 for side A and Q10, Q12, Q14, Q18, and Q16 for side B.

G.7.2 DS3 Illuminated

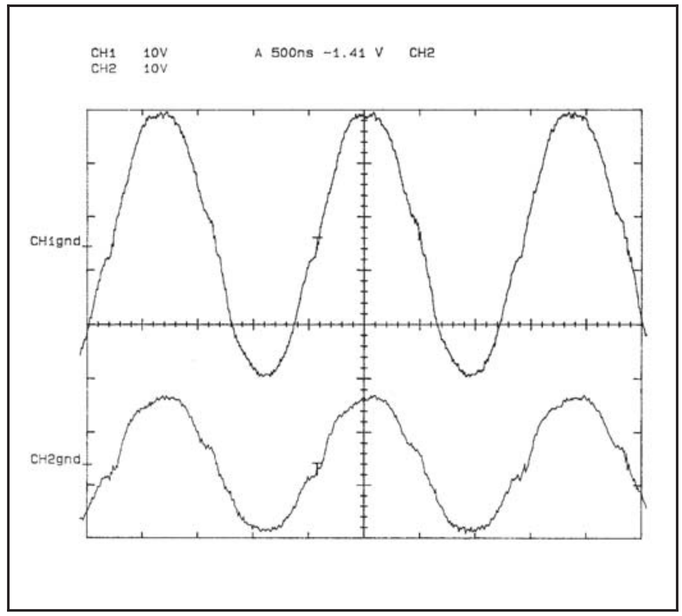
This is a normal condition when the step should be turned on.

a. If the LED will not extinguish when the module should be turned off:

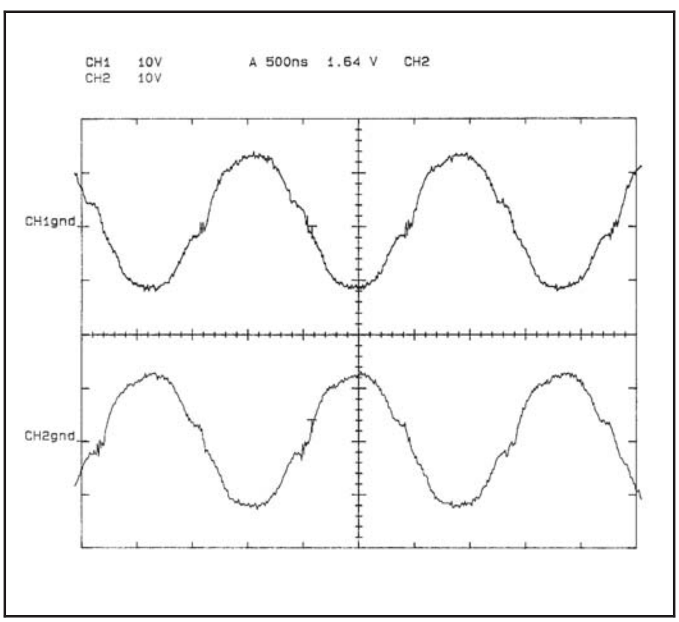
1. Turn off the Transmitter and remove the module.
2. Using an Ohmmeter check Q15, Q17, Q13, Q11, Q9 for side A and Q10, Q12, Q14, Q18,and Q16 for side B.



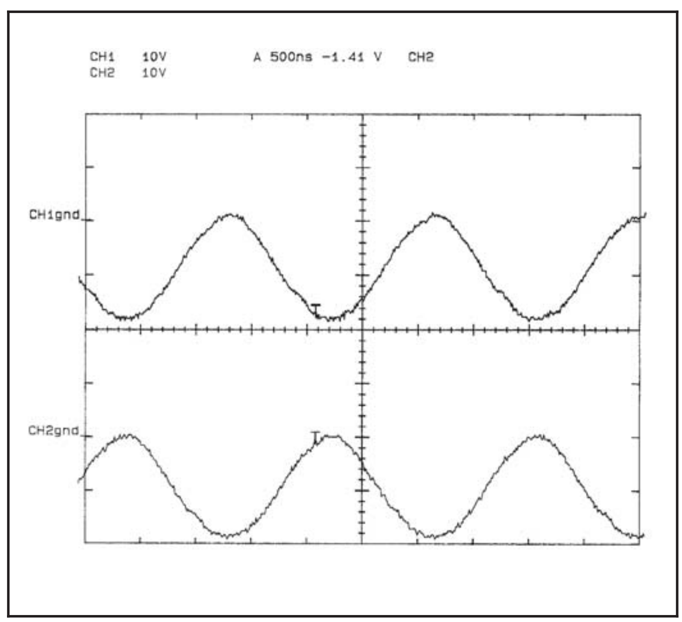
CH1 P1-50
CH2 Q7 Gate



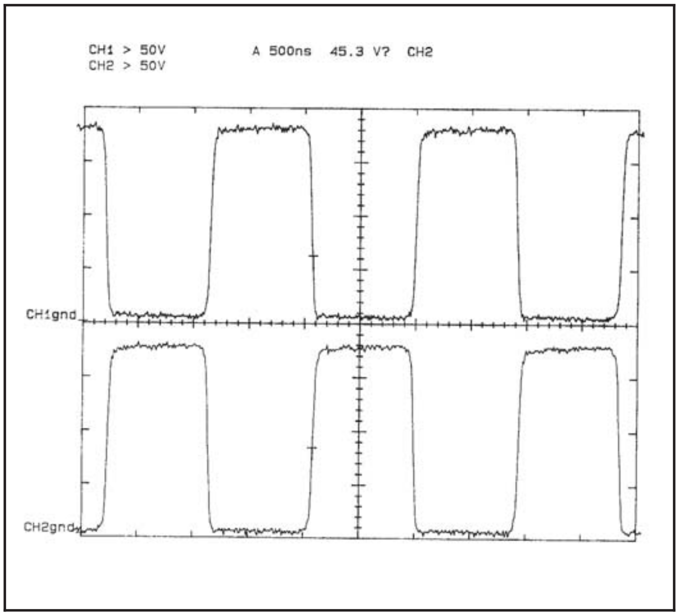
CH1 P1-50
CH2 Q8 Gate



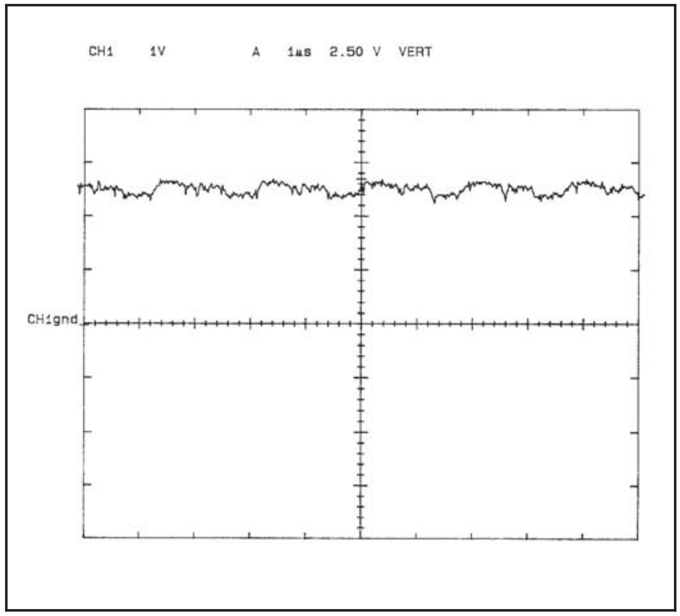
CH1 Q7 Gate
CH2 Q8 Gate



CH1 Q7 Gate
CH2 Q8 Gate



CH1 TP1
CH2 TP2
(250 V p-p)



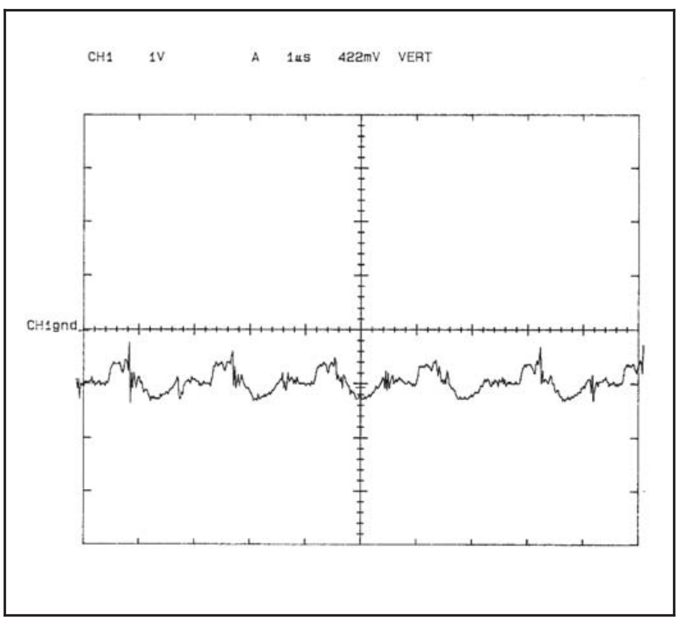
P1-45 (RFA OFF)

G.7.3 DS1 Illuminated RED

If DS1 is illuminated, this indicates that F1 is open and that the MOSFETs Q1, Q3, Q5, and/or Q7 may have failed.

a. Remove the module from the Transmitter and ohmmeter check the transistors using the Testing MOSFETs steps in the Maintenance part of this section.

b. If a single MOSFET in a section is found to have failed (Example Q3 shorted Q1, Q5 and Q7 okay), the entire set of 4 MOSFETs should be replaced.



Junction of L11 and C17 (RFA OFF)

G.7.4 DS2 Illuminated RED

If DS2 is illuminated this indicates that F2 is open and that the MOSFET's Q2, Q4, Q6, and/or Q8 may have failed.

a. Remove the module from the Transmitter and ohmmeter check the transistors using the Testing MOSFETs steps in the Maintenance part of this section.

b. If a single MOSFET in a section is found to have failed (Example Q2 shorted Q4, Q6 and Q8 okay), the entire set of 4 MOSFETs should be replaced.

G.7.5 Excessive Drive Phase Difference

a. Measure the drive phase on the RF Amplifier using the procedure provided in Section V.

b. If a module is out of specifications on drive phasing, first substitute in a new module.

c. If the module is the problem it is most likely caused by:

   1. A defective drive transformer, T1 or T2 or
   2. A defective MOSFET, or associated circuitry.

d. If a module has just been repaired, check the ON/OFF components, such as transistors and diodes. A poor solder connection can cause a drive phase problem on an RF module. Substitution is the only way to troubleshoot this problem.

G.7.6 Excessive Drain Phase Difference

a. Measure the drain phase on the RF Amplifier using the procedure provided in Section V.

b. If a module is out of specifications on drain phasing, first substitute in a new module.

c. If the module is the problem the drive phasing should be checked.

WARNING: Disconnect primary power prior to servicing.

d. The only other cause of drain phasing problems on a module would be the MOSFETs themselves. Substitution is the only way to troubleshoot this problem.

G.7.7 Open Fuse Sensing Failure

If the Control front panel displays an RF AMP fuse fault and it has been traced to a failure in the module sensing, use an ohmmeter and check diodes CR11, CR12, CR25, CR17, CR18, CR19, CR20. Check C11 and C12 for a short if the diodes test correctly.

H.1 Introduction

This section covers the Output Monitor and RF Power Sample Boards. Topics include function, location, block diagram description, detailed circuit description, troubleshooting and removal/replacement.

The Output Monitor Board is designed for use in frequency agile and non-agile applications. In a frequency agile environment, data lines from a Frequency Control Interface board provide the commands to switch in/out tuning components for the Net VSWR functions. In a non-agile environment (i.e. DX-200 Transmitter) these switching commands are by the positioning of switches S3 and S7. See Table H-1 for a cross reference of switches and command names.

Output Monitor Board

Assembly #	992-8536-003
PWB #	843-5450-012
Schematic #	839-8154-012

RF Power Sample Board

Assembly #	992-9038-001
PWB #	843-5458-113
Schematic #	843-5458-111

Note: Parts List for this board is covered in Section VII.

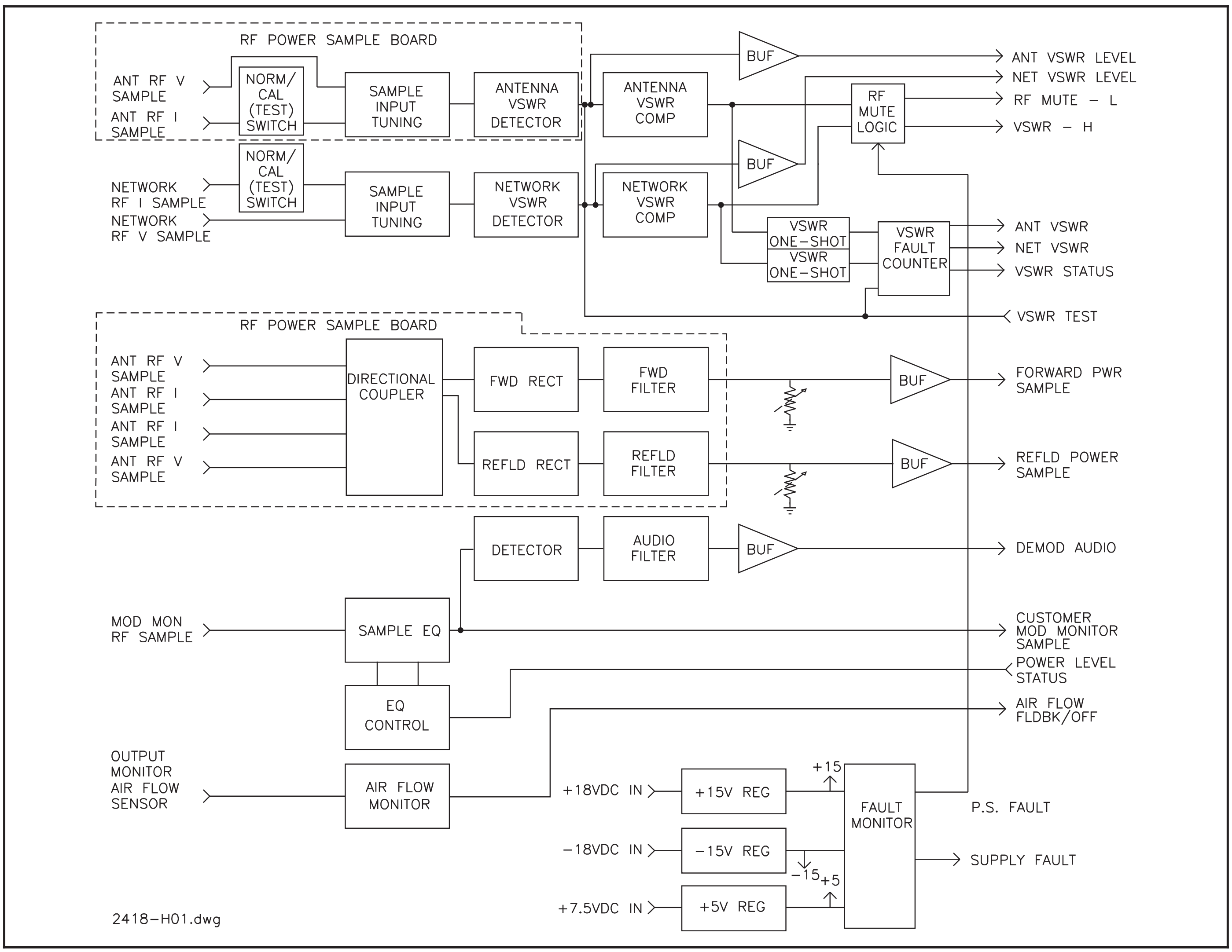


Figure H-1. Output Monitor Block Diagram

NOTE:

Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

H.2 Function

The Output Monitor Board includes VSWR Detectors, VSWR Self Test, Arc Detectors, Directional Coupler, Modulation Monitor Sample Equalization circuits, Audio Detector, Airflow Monitoring and Supply Fault circuits.

H.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located in this section. All plots were taken at 200 kW with no modulation at 1575 kHz carrier frequency.

H.4 Location

The Output Monitor Board is located in the left side of the Left PA compartment. (See VIEW 5)

H.5 Block Diagram Description

H.5.1 VSWR Detectors

Network RF Voltage and RF Current Samples from the Output Sample Board are applied to Amplitude/Phase Adjustments, VSWR Calibration, and Sample Frequency Tuning circuits. The Network Bandswitch Inputs are used to make tuning adjustments for the selected frequency of operation. In this application, these inputs are replaced by switches S3 and S7. Should a Network VSWR fault occur, Detectors rectify these changes and provide a DC output that is buffered and metered on the front panel multimeter, and is simultaneously available at a Detector output test point.

H.5.2 Arc Detectors

Upper/Lower Arc Sensor Inputs are connected to their respective Arc Detectors and connected to the VSWR Test Logic circuits. Either type fault is treated as a Network VSWR Fault.

H.5.3 VSWR Logic

If a detected VSWR is severe enough, VSWR Comparators will generate signals that are applied to the VSWR Logic. This will cause the VSWR Pulse Generator to produce an RF Mute and activate the VSWR Synthesizer Sync Switchover function. If VSWR is severe, the VSWR Foldback will produce Network VSWR Faults that will cause power level Foldback, until a safe operating level is reached.

H.5.4 VSWR Self Test

When a VSWR Self Test Request is received, the VSWR Self Test and VSWR Test Logic will purposely create a Network VSWR Fault. The VSWR Test Status output is used to indicate the condition of the protection circuits.

H.5.5 Directional Couplers

The Output Monitor Board directional couplers are only partially utilized. The Forward and Reverse Power detected DC signals are created on the RF Power Sample Board and routed to the RF inputs of the respective Output Monitor Board directional couplers for pass-through, and magnitude adjustments only.

H.5.6 Modulation Monitor Sample

An RF Sample from the output is connected to Sample Equalization circuits. The AGC Control takes a sample of the Demodulated Audio to control the amount of Equalization so that the External Modulation Monitor Sample is the same over the three power levels.

H.5.7 Audio Detector

A Detector, Audio Filter, and Buffer Amplifier are connected to the Sample Equalization circuit and provides a Demodulated Audio signal for testing purposes.

H.5.8 Air Flow Monitor

An Air Flow Sensor in the Output Cabinet is connected to the Air Flow Monitor. The Monitor can generate an Air Flow Foldback Fault if the Sensor determines it is required.

H.5.9 Power Supplies

An regulated +18VDC, -18VDC and +7.5VDC inputs are regulated to +15VDC, -15VDC and +5VDC respectively to power circuits on the board.

A Supply Fault Monitor monitors these supplies and can generate a Supply Fault to the Controller.

H.6 Detailed Circuit Description

Refer to the schematic diagram for the Output Monitor Board (839-8154-012) for all descriptions in this section.

H.6.1 VSWR Detectors Overview

This description of the VSWR Detector circuits operation applies to the VSWR detector on both Output Monitor and RF Power Sample Boards.

WARNING: Disconnect primary power prior to servicing.

Refer to Figure H-2, Network VSWR Detector or Figure H-4, Antenna VSWR Detector, for the following discussion.

NOTE

All variable capacitors in figures H-2 and H-4 are multiple fixed value capacitors that are incremently switched to change the overall capacitance value.

When an RF source is properly terminated with a resistive load, the voltage and current in the line will be in phase and will usually have different amplitudes.

These VSWR detectors are balanced or “nulled” for the phase and amplitude relationships that exist when the source is properly terminated.

An RF voltage sample is applied to one end of the primary winding of the VSWR detector’s transformer. The sample’s amplitude is adjusted by a variable capacitance across the lower half of a capacitive voltage divider.

An RF current sample is applied to opposite end of the primary winding of the VSWR detector’s transformer. The current sample appears across a parallel L-C circuit, changing the value of the capacitance will change both the phase and amplitude of the sample.

To eliminate any interaction between voltage and current samples, the primary winding is tuned to parallel resonance at the Transmitter’s operating frequency, providing a high impedance between the samples.

With the Transmitter properly tuned, the detector is balanced by these adjustments until the RF voltages at opposite ends of the detector transformer primary have equal amplitude and are in phase. There will be no RF current flow through the transformer, and the DC output of the detector will be zero.

If the load resistance changes, the current and voltage amplitude relationship will change. If the load reactance changes, the current and voltage phase relationship will change.

If the phase and/or amplitude of either sample changes, current will flow through the transformer primary winding and a voltage will be induced in the secondary winding. A full-wave rectifier will then produce a DC output voltage at the phase angle detector output.

H.6.2 Amplitude and Phase Control - Network VSWR Detector

Switch-selected capacitors and inductor’s are used for tunning the VSWR Detectors’ transformer primary winding resonances. See Table H-1 for information on which switches control the following Control Signals.

The Bit0 through Bit4 Amplitude Adjust input (for frequency agile Power Blocks) from the Frequency Control Interface Board at J8 is connected to the Network VSWR Tuning relays, the VSWR ENCODER PAL U12, and the Band Indicators. It is then labeled and referred to as NET0 through NET4.

NETE0 and NETE1 are used to adjust the amplitude of the Output Network Voltage Sample as determined by a portion of S7.

NETPH0, NETPH1 and NETPH2 are used to adjust the phase relationship between the Output Network Current Sample and the Output Network Voltage Sample as determined by a portion of S7.

NET0, NET1, NET2, NET3 and NET4 are used to tune the Net VSWR circuitry on fixed frequency Transmitters, as determined by S3 - instead of the Bit programming described in paragraph 2 of this section.

H.6.3 Network VSWR Tuning

The Network VSWR Tuning will resonate the primary of T2, the Network VSWR Detector. If the input is logic HIGH, the relay will be energized. The NET0 though NET2 inputs will only add or subtract inductance, while the NET3 and NET4 inputs select different values of inductance and capacitance.

H.6.3.1 Network Voltage Sample Adjustments

The NETE0 and NETE1 signals are used by MOSFET switches to connect/disconnect fixed value capacitors to ground on the input at J10 and adjusts the sample amplitude. If the switch is in the on position, the capacitor is connected to ground.

H.6.3.2 Network Current Sample Adjustments

The NETPH0 through NETPH2 switch outputs are used by MOSFET switches to connect/disconnect fixed value capacitors to ground on the input at J2 and adjusts the sample phase. If the switch output is logic HIGH, the capacitor is connected to ground.

When the Transmitter frequency is 1500 kHz and above, a Comparator will turn on a transistor that connects R160 to ground. This slightly changes the gain of the buffer to correct the Forward Power sample at these frequencies.

H.6.4 Network VSWR Detector

The secondary winding of T2 is connected to a full wave rectifier and filter capacitor. The output DC voltage can be measured at TP28 Network VSWR and is connected to the Network VSWR Comparator and the Network VSWR Buffer.

Table H-1. VSWR Tuning Switches & Data Labels

Data Input Name	Switch	Control Data Name
NET0	S3 1-12	NET0
NET1	S3 2-11	NET1
NET2	S3 3-10	NET2
NET3	S3 4-9	NET3
NET4	S3 5-8	NET4
	S7 5-8	NETE1
	S7 4-9	NETE0
	S7 3-10	NETPH0
	S7 2-11	NETPH1
	S3 7-6	NETPH2

H.6.5 Network Fault Comparator

This circuit uses a very high-speed differential comparator, U17. One input to the comparator is an adjustable positive reference voltage from the Output Network VSWR Threshold control, R99, and the other input is the DC signal from the detector. Diodes protect the comparator's input from transient voltages. Normally, the detector output will be essentially zero Volts, and the comparator's output will be logic LOW. When the detector output exceeds the reference voltage during a VSWR fault condition, the comparator output will go logic HIGH.

H.6.6 Network VSWR Buffer

The detector output is buffered and connected to the NET NULL position on the front panel multimeter. This is a relative reading only and when the detector is properly balanced, the meter should read near zero.

H.6.7 Antenna VSWR Detector Null Signal

In this application, the Antenna VSWR Detector on the RF Power Sample Board is used. The Output Monitor Board Antenna VSWR processing and detector circuitry is bypassed by routing the detected VSWR DC from the RF Power Sample Board to the Output Monitor Board's J11. From there it is routed through JP1, to the junction of R82 and R83.

H.6.8 Antenna Fault Generator

This circuit uses a very high-speed differential comparator, U18. One input to the comparator is an adjustable positive reference voltage from the Antenna VSWR Threshold control, R98, and the other input is the DC signal from the detector. Diodes protect the comparator's input from transient voltages. Normally, the detector output will be essentially zero Volts, and the comparator's output will be logic LOW. When the detector output exceeds the reference voltage during a VSWR fault condition, the comparator output will go logic HIGH.

H.6.9 Antenna VSWR Buffer

The detector output is buffered and connected to the ANT NULL position on the front panel multimeter. This is a relative reading only, and when the detector is properly balanced, the meter should read near zero.

H.6.10 Band Indicators

Indicator DS6 is used to monitor the status of the NET0 through NET4 inputs. If the input is logic HIGH, the associated indicator will be illuminated RED.

H.6.11 VSWR Pulse Generator

When the Network VSWR Comparator output goes active HIGH, several events occur:

H.6.11.1 Local RF MUTE

The active HIGH output turns on transistor U29 that generates an active HIGH RF MUTE Local at TP23. This serves two functions:

a. First, transistor Q23 turns on pulling the RF MUTE line J6-21 and TP14 LOW for 12mS. This action turns all the Big Step and Binary RF Amplifiers off for 12ms.

b. Second, transistor Q22 is turned on for 250nS and its output is inverted. The 250nS VSWR-H signal at TP16 and J6-19 is sent to the Synthesizer Interface Board for activating the Synthesizer Sync circuit.

H.6.11.2 VSWR One-Shot

a. At the same time, the B input of the one-shot U24 also goes logic HIGH, and this starts a timing cycle that lasts 0.5 seconds.

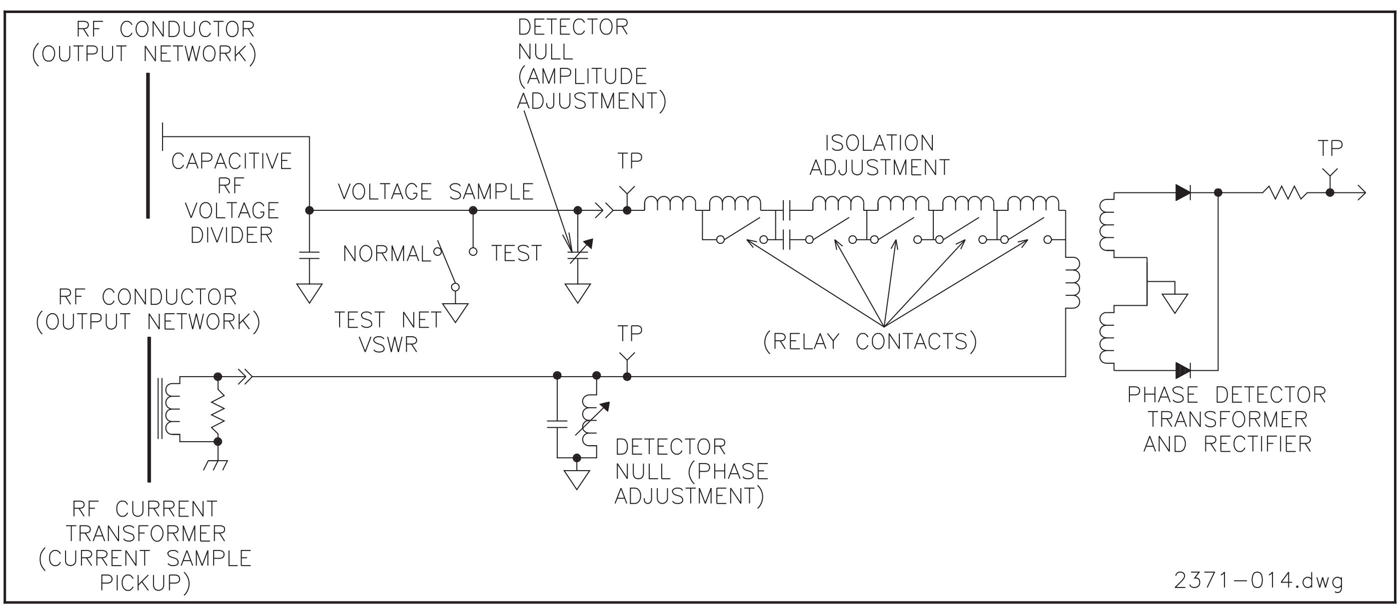


Figure H-2. VSWR Detector

b. The Output Network VSWR LED will be illuminated RED for this duration to give a visual indication of the fault.

1. The input to the VSWR PAL U26 will also go logic HIGH for this duration and be counted by the PAL as 1 VSWR trip.

NOTE:

In the case of Antenna VSWR only, an inverter disables the Network VSWR Input to the PAL.

H.6.11.3 Power-Up Reset

When low voltage is first applied to the board, the Power-Up Reset supplies a logic LOW that clears the one-shots.

H.6.12 VSWR PAL

This PAL contains resettable VSWR trip counters.

H.6.12.1 Single VSWR Trip

When the VSWR PAL U26 receives a single active HIGH VSWR trip signal from U-24 one-shot, it executes the following functions:

a. The 4 Second Timer Request output will go logic HIGH and start the 4 Second Timer. The 4 Second Timer U25 output will go logic HIGH, and is connected back into the PAL.

b. During the 4 Second long Timeout, the Blink output is logic HIGH, and the VSWR Test Status and J6-9 is logic LOW. This LOW pulse holds the VSWR Test Status LED on the Control front panel RED for 4 seconds. This keeps the LED on long enough for the operator to see that a VSWR trip occurred.

c. The VSWR Pal will count to one internally.

d. After the Timeout pulse goes LOW, the LED will return to GREEN and the PAL counter will reset itself to zero.

H.6.12.2 Multiple VSWR Trips

If 5 VSWR trips occur within approximately 20 seconds, the Transmitter will Foldback power by one step. One VSWR trip is uncounted or removed every 4 seconds.

Refer to Figure H-3, VSWR Logic Timing Diagram, for the following discussion.

When the VSWR PAL receives more than one VSWR trip signals from the one-shot, the PAL will continually count the number of trips.

a. If only two trips occur, as shown on the left side of the drawing, the Blink output will only go HIGH for 4 seconds, and 8 seconds after the last Antenna VSWR pulse, the counter will be reset to zero.

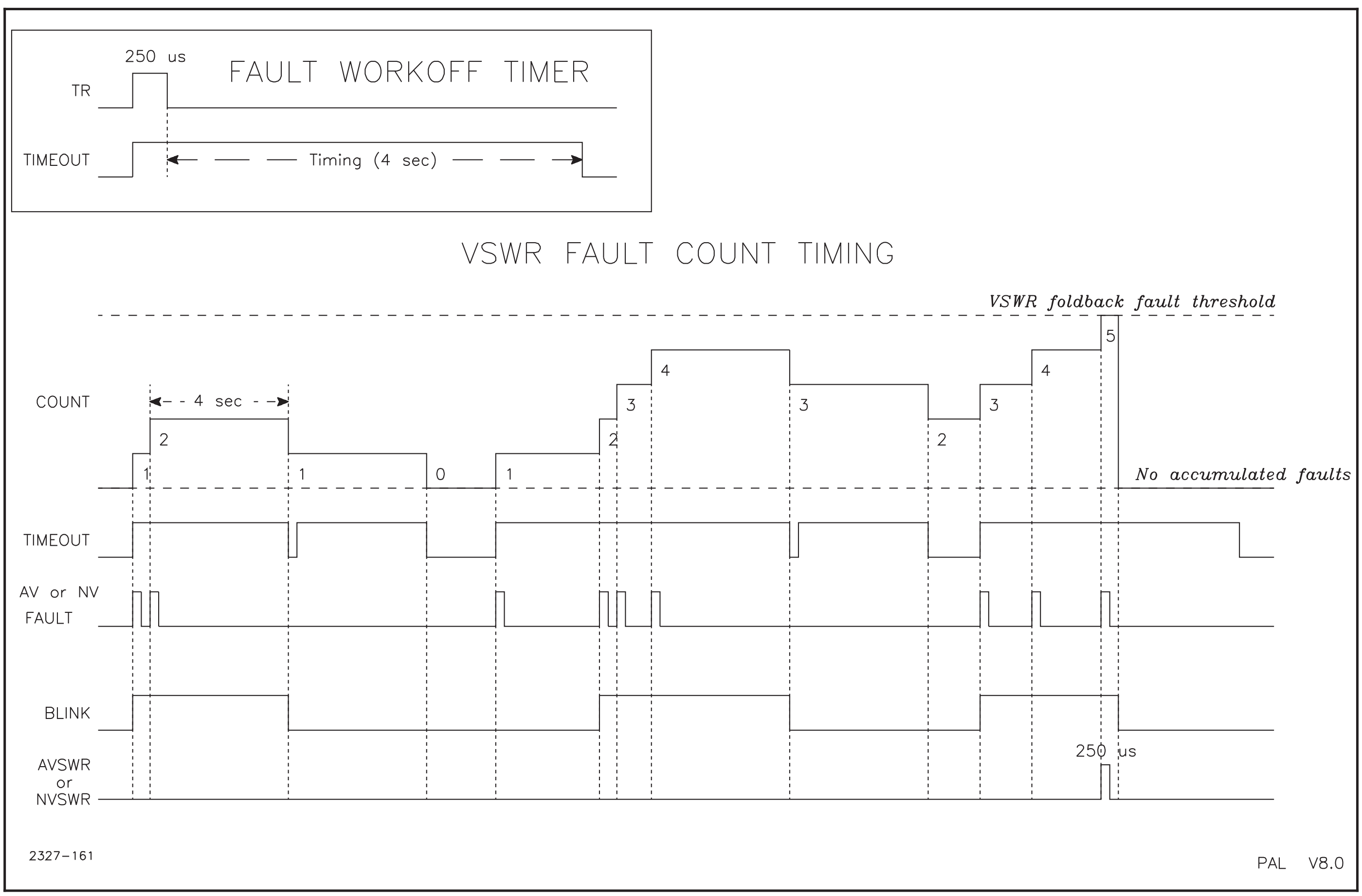


Figure H-3. VSWR Logic Timing Diagram

WARNING: Disconnect primary power prior to servicing.

b. If four trips occur as shown in the center of the drawing, the counter will count up to four and begin counting down again if no additional trips occur.
c. The right side of the drawing shows that if the counter is set to two and three more trips are registered, the Antenna VSWR output goes HIGH for 250uS.

When Antenna VSWR goes HIGH, TP11 Antenna VSWR Foldback goes LOW and generates a 250uS Antenna VSWR-L at J6.

a. This will cause the Controller to foldback the power level by one increment (0.5 dB is the first increment) and latch the Antenna VSWR and Analog Input Power Foldback LED's on the Control front panel RED.
b. Each time five more VSWR trips occur, the power output is reduced by one additional step.

Operation for Network VSWR is the same, except the output is at J6-5.

Refer to the Controller Section for more information concerning the foldback levels and recovery time.

H.6.13 VSWR Self Test

The VSWR Self Test logic circuits are located on the Controller and Output Monitor Board. The Controller generates a VSWR Test Request-L pulse, whenever any of these conditions occurs:

a. The Transmitter is turned on at any power level.
b. The power level is changed. For example, LOW to MED or MED to HIGH.
c. The VSWR TEST push-button on the LED Board is depressed.

H.6.13.1 Successful VSWR Test

On the Output Monitor Board, the incoming VSWR Test Request-L pulse at J6 performs the following:

a. Both VSWR Test Circuit Drivers pulls the inverting input of the VSWR Comparator HIGH, simulating a VSWR fault.
b. U26-4 goes logic HIGH, which triggers the 4 Second Timer and activates the Blink output to turn the VSWR Test LED RED.

H.6.13.2 Unsuccessful VSWR Test

a. If the VSWR PAL does not detect a VSWR trip before the Timeout, the Latch output will go HIGH and remain HIGH. This will latch the VSWR Test Status LED RED to indicate that the test failed.

NOTE

The only way to clear the LED is to pass a successful test.

H.6.13.3 Testing The VSWR Test Circuit

A method of testing the VSWR Self Test logic is as follows:

a. Press and hold the VSWR Inhibit switch S6 on the Output Monitor.
b. Press the VSWR Self Test push-button on LED Board.
c. After 4 Seconds, the VSWR Self Test LED should remain RED.
d. Release the VSWR Inhibit and press the Self Test again.
e. After 4 Seconds, the VSWR Self Test LED should return to GREEN.

H.6.14 Manual Output Network VSWR Test

A manual VSWR Test push-button switch is available on the Output Monitor Board to test the VSWR trip comparator and VSWR fault counting logic. Test Net VSWR switch (S1) is a manual trip mechanism for the Network VSWR logic. Momentarily depressing the switch simulates a VSWR by grounding one side of the detector transformer. This causes current to flow through the transformer which is rectified into a positive DC voltage which trips the comparator thereby simulating a VSWR. This condition illuminates Ouput Network VSWR LED (DS3) on the Output Monitor Board. Upon Transmitter foldback to extremely low power levels, this switch has no effect because the samples have been lowered enough not to trip the detectors.

H.6.15 VSWR Inhibit

Push-button switch S6 shunts the input of the VSWR Comparator to ground through a diode. This keeps the VSWR Comparator from being able to detect a VSWR fault. It should only be used when testing the VSWR Self Test.

H.6.16 Directional Coupler

The Directional Coupler, like the VSWR Detectors, depends on phase and amplitude relationships of voltage and current samples to provide a DC output voltage. In the Directional Coupler, the current and voltage samples are applied to opposite ends of a diode. The sample and detection circuitry actually used are on the RF Power Sample board.

H.6.16.1 Forward Power

The already detected Forward Power DC signal, from the RF Power Sample Board, is applied to the RF input port (J13) of the forward directional coupler. This detected signal is applied in place of the normally applied RF voltage sample (No RF current sample is applied in this application). Control R81 sets the magnitude of the forward power meter driving signal applied to the input of voltage follower at U10-5.

The voltage follower U10 drives the Forward Power Meter on the Switch Board/Meter Panel and the Remote Metering amplifier on the Power Block Interface Board. The Forward Power calibration adjustment is located on the Switch Board/Meter Panel.

H.6.16.2 Reflected Power

The already detected Reflected Power DC signal, from the RF Power Sample Board, is applied to the RF input port (J12) of the reflected directional coupler. This detected signal is applied in place of the normally applied RF voltage sample (No RF current sample is applied in this application). Control R27 sets the magnitude of the forward power meter driving signal applied to the input of voltage follower at U10-3.

The voltage follower U10 drives the Reflected Power Meter on the Switch Board/Meter Panel and the Remote Metering amplifier on the Power Block Interface Board. The Reflected Power calibration adjustment is located on the Switch Board/Meter Panel.

H.6.17 Arc Detectors

There are two detectors, a Lower Arc Detector and an Upper Arc Detector. Both detector outputs are treated exactly as an Output Network VSWR Fault.

H.6.17.1 Lower Arc Detector

One of three Arc Detector source assemblies can activate the Lower Arc Detector Indicator; RPAC (A43), CPAC (A44), or EPAC (A2). A photocell is connected from +15VDC to the input of a comparator on each of the assemblies. The Lower Detector Threshold control R117 sets the threshold voltage for these comparators. If an Arc occurs, the voltage at the (-) input will be greater than the (+) input and the output will go logic LOW. This inverted output is connected to the Network VSWR Test line that will trip the Output Network VSWR Comparator. This output will also latch the DS5 Lower Arc indicator RED for a visual indication, until manually reset by the Arc Fault Indicator Reset switch S5. If the cable at J9 is disconnected, a ground for the interlock is removed, and the fault will be generated.

H.6.17.2 Upper Arc Detector

The Upper Arc Detector 8A2 monitors the Output Network.

H.6.17.2.1 Reference Sensor

The reference sensor photocell output is connected to the input of differential amplifier U28. The Sensor Balance control R148 is used to adjust this voltage at TP43, Arc Reference.

H.6.17.2.2 Arc Sensor

The actual Arc sensor photocell output is also connected to the input of differential amplifier U28. This voltage can be measured at TP39, Upper Arc Sense.

H.6.17.2.3 Differential Amplifier

U28 is a differential amplifier that has the outputs of both sensors connected to its inputs. The Sensor Balance control is adjusted so that the reference sensor voltage is the same as the actual sensor output, and therefore the output of the differential amplifier, at TP40 Arc Level, will be 0VDC.

H.6.17.2.4 Compensated Comparator

Should an actual Arc occur, the output of the differential amplifier will increase and the voltage at the (-) input of the comparator will be greater than the (+) input, and the comparator output will go logic HIGH. This output will perform the same functions as the Lower Arc Detector.

H.6.17.2.5 Absolute Comparator

If the amount of ambient light entering through the top of the Output Network is too great, Arc detection might not be possible. Under these conditions, an Absolute Comparator will generate the same fault.

H.6.18 Modulation Monitor Sample Equalization

The modulation monitor sample input at J3 is taken from a capacitive voltage divider in the output network compartment. This input is buffered by U34 and connected to the Modulation Monitor Sample output at J4. A light dependent resistor (LDR) CR24 is connected from the buffer input to ground. The resistance of this device will change due to the AGC circuit from the Audio Demodulator, which will maintain a constant RF output over the entire frequency and power range of the Transmitter. If the AGC function is undesirable or defective, the circuit may be bypassed, by moving JP6 from 1-2 to 2-3.

The modulation monitor should provide a 50-Ohm termination for the mod monitor sample output. It may be necessary to use a 50-Ohm termination at the monitor to meet this requirement.

H.6.19 Audio Demodulator

The primary of transformer T3 is also connected to the modulation monitor sample at J4. Full wave rectifiers demodulate the amplitude modulated secondary windings of the transformer. Carrier filter capacitors leave TP38 with a recovered audio signal. A direct coupled unbalanced to balanced amplifier provides Demod Audio (+) and Demod Audio (-) at J6. This balanced signal is connected to the External Transmitter Interface via traces on the Power Block Interface.

H.6.20 Modulation Monitor AGC Action

A sample of the Demod Audio (+) is connected to an active high pass filter that will remove the audio component while passing a DC voltage proportional to the carrier level. This output becomes one input to a comparator that drives transistor Q18. The other input of the comparator is an adjustable positive DC voltage that is set by R158 AGC. The output of the comparator controls the conduction of the transistor, which varies the voltage applied to the LED internal to the LDR. When the AGC voltage is set, the LDR will maintain a constant RF output at J4.

H.6.21 Air Flow Monitoring

The Air Flow sense circuitry is used to monitor the air flow in the Output Network Cabinet. Air flow Monitor 8A3 is connected to the Output Monitor at J7.

For a circuit description of the Air Flow Monitor refer to the Modulation Encoder Section, Onboard Air Flow Monitor.

When the Transmitter is turned on, the TX Enable-H will turn on a transistor and supply B+ to the Air Flow Monitor.

The incoming Air Flow voltage is applied to amplifier U11 with an adjustable gain control R30, Air Flow Calibration. The voltage at TP4 Air is fed to the (+) inputs of two comparators.

The cable connecting the Air Flow Monitor presents J7-7 Interlock with +5 VDC and establishes voltages at the (-) inputs of the comparator through a voltage divider network.

If airflow in the Output Network Cabinet is reduced, the voltage at TP4 will eventually be greater than the reference and the comparator output will go logic HIGH. Transistors are turned on illuminating DS1 Air Flow Fault RED and sending an Air Reduced-L LOW signal at J6 to the Controller. If TP4 continues to rise, an Air Flow Fault-L LOW will turn the Transmitter OFF.

H.6.22 Power Supplies

DC supply inputs from the low voltage power supply to the Board are +18VDC, +7.5VDC and -18VDC, and are regulated to +15VDC, +5VDC and -15VDC using regulators U22, U27, and U31. Each input is fused, with 2A fuses F1, F2 and F3. Each regulator output has a GREEN Status LED that illuminates when the regulator is operational. The outputs of the regulators are transient protected by zeners CR45, CR38, and CR23.

H.6.22.1 Power Supply Fault Sensing

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a supply voltage on the board that does not depend on the regulated supplies. The +18VDC supply goes to R153 and CR50 and +7.5VDC goes through CR49 to a 5 volt regulator, U16. This +5 Volts is designated B+ and can be measured at TP19.

The B+ is used as a reference to inputs of comparator U9 through a series voltage divider network. Each supply is connected to a voltage divider and then connected to the other inputs of the comparator. With the non-inverting inputs more positive than the inverting inputs the comparator output is a logic HIGH. This is the NORMAL condition with no faults.

If one of the regulated supplies fails or drops low by more than 20%, the corresponding comparator output will go logic LOW. DS7 Supply Fault will be illuminated RED and the Supply Fault output at J6 will be logic LOW.

This will cause the Transmitter to apply an RF Mute, and the Output Monitor Supply Fault LED on the Control front panel will be illuminated RED.

H.7 Troubleshooting the Output Monitor Board

The circuitry contained on this board can be classified into the following sections:

a. Power Supply.
b. VSWR Sensing.
c. Airflow monitor.
d. Power Metering.
e. Monitor Equalization.
f. Audio Demodulator.

Refer to the proper section for the circuit being addressed.

H.7.1 Power Supply

If an Output Monitor supply fault is displayed on the Control front panel, with only the low voltage on, check the LED indicators on the Output Monitor:

DS8 (+15V)

DS10 (+5V)

DS9 (-15V)

Each of these LED indicators should be lit if the individual supplies are operating normally.

a. If DS7 is illuminated RED:
b. Use a multimeter to measure the +15VDC, +5VDC, and -15VDC power supplies.
c. If any supply voltage has been reduced by 20% or more:
    1. Check the input fuse and replace if necessary.
    2. If the fuse is not open, measure the input TP for the unregulated voltage.
    3. If the unregulated input is correct, replace the regulator.
d. If all supplies measure correct:
    1. Check TP19 for +5VDC and replace U16 if necessary.
    2. If TP19 is okay, measure the voltages on the comparator inputs and outputs to determine if the comparator is faulty.

H.7.2 Output Network VSWR

If the Transmitter Control front panel displays an Output Network VSWR and ANALOG INPUT POWER FOLDBACK, check for an upscale reading on the Output Network NULL position on the front panel multimeter when the Transmitter is operating.

H.7.2.1 Output Network NULL Reads Upscale

a. The first step is to verify that the Load for the Transmitter is of the proper output impedance. It should be thoroughly checked and any problems repaired before troubleshooting the Transmitter.

H.7.2.2 TP1 and TP31 not equal in Phase and/or Amplitude

While monitoring TP28 with a DMM, check adustment of Network VSWR Detector Null for a near-zero indication while adjusting S7, S3, C4, and C53. If not successful, refer to Network VSWR Detector Adjustments - Ouput Monitor Board section.

H.7.2.3 TP1 and TP31 matched in Phase and Amplitude

a. Check TP28 for a null or minimum signal (less than 0.5V p-p at 200kW carrier). The signal should be composed of only RF harmonics.
    1. If the null is not present and both TP1 and TP31 are equal in phase and amplitude, check CR26, CR27 and T2.
b. If there is a DC level, check the cathode of CR35 for a logic HIGH.
    1. If present, refer to the Controller Section and troubleshoot the VSWR Test Request Line.

H.7.2.4 Output Network NULL Reads Zero

a. Check for a logic HIGH on U17-6.
b. If present, check the voltage on TP33 and compare this to the Test data readings.
    1. If the voltage on TP33 agrees with the Test Data replace U17.
    2. If TP33 does not agree with the Test Data, check the voltage divider and replace U17.

H.7.2.5 Output Network NULL Reads Zero, RF MUTE LED Illuminated Only

a. To verify that the RF mute is coming from this board, check TP23 for a logic HIGH.
    1. If TP23 is LOW, check Q23, Q22, and U14.
    2. If TP23 is a logic HIGH, check U29, U14, and U24.

H.7.2.6 Output Network NULL Reads Zero, VSWR, and Foldback Illuminated Only

If only these faults are displayed and return soon after the reset is pressed:

a. Start by checking U24-10, U24-12, and observe DS3.
   1. If U24-10 is logic HIGH and DS3 is not illuminated, replace U24.
b. U24-12 should be logic HIGH when U24-10 is LOW, if not replace U24.
c. If U26-2 is logic LOW, and U26-22 is HIGH, replace U26.

H.7.2.7 DS5 Lower Arc Illuminated RED

a. If it has been determined that no arcing is occurring in the EPAC Cabinet, troubleshoot as follows:
b. Check that the cable is correctly inserted into J9.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

c. Check that the cable is correctly inserted into the 2A2 EPAC Arc Detector Board, the 1A43 RPAC Arc Detector board, the 1A44 CPAC Arc Detector board.
d. If the voltage at TP40 is not 0VDC, check the alignment of the Sensor Balance and replace U28 and the sensors if needed.
e. If TP40 is 0VDC, and the voltage at TP34 matches the factory test data, replace U32 and/or U33.
f. If the indicator can not be reset, replace U23.

H.7.2.8 DS4 Upper Arc Illuminated RED

a. If it has been determined that no arcing is occurring in the Output Network Cabinet and the ambient light is not above normal, troubleshoot as follows:
b. Check that the cables are correctly inserted into J9 and J6.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

c. Check that the cable is correctly inserted into the 8A2 ONC Arc Detector Board.
d. Replace U32 if needed.

H.7.3 Power Metering Circuitry - Output Monitor Board (Loss of Indication)

NOTE:

For Power Metering system calibration procedure, see the Power Metering Calibration section of this Output Monitor discussion.

H.7.3.1 Forward Power

a. Check for a DC voltage at U10-5 with carrier only. This voltage should change as the power is raised or lowered.
b. If there is no DC voltage or the level does not change, check J13 for the presence of the DC signal and its varying magnitude as the Transmitter output power varies.
c. If the DC signal *is* found at J13, check all diodes, passive components, and U10 in the Forward Power metering section of this board.
d. If there is no DC signal at J13, refer to the Overall wiring diagram to trace the loss of signal from J13 back to the RF Power Sample Board. Refer to the Power Metering portion of the RF Power Sample Board section to continue.

H.7.3.2 Reflected Power

a. Turn off the Transmitter and put S8 (on RF Power Sample Board) in the CAL position.
b. Turn on the Transmitter and check for a DC level at U10-3 with carrier only. This voltage should change as the power is raised or lowered.
c. If there is no DC or the level does not change, check J12 for the presence of the DC signal and its varying magnitude as the Transmitter output power varies.
d. If this DC signal is found at J12, check all diodes, passive components, and U10 in the Reflected Power metering section of this board.
e. If there is no DC signal at J12, refer to the Overall wiring diagram to trace the loss of signal from J12 back to the RF Power Sample Board. Refer to the Power Metering portion of the RF Power Sample Board section to continue.

H.7.4 Air Flow Sensing

If the Control front panel displays an Air Reduced or Air Flow indication and DS1 is illuminated on this board:

a. If no air flow problem actually exists, begin troubleshooting by checking TP4 for a DC voltage less than 2.5VDC.
b. If TP4 is greater than 2.5 Volts check TP5 for less than 0.6VDC.
   1. If TP5 is greater than 0.6 Volts troubleshoot the Air Flow Sensor Board in the Output Network Compartment.
   2. If TP5 is 0.6 Volts or less, check or replace U11.
c. If TP4 is 2.5VDC or less measure the voltage on U3-6. It should be approximately 3 Volts.
   1. If the voltage is missing, suspect an open cable running to the Output Network Air Flow Sensor. Refer to the Overall wiring diagram to trace the cable.
d. If the voltage is correct, replace U3 and check Q11 and Q13 as needed.

H.7.5 Monitor Equalization

Failures of this circuit would be noticed as no modulation monitor level change as each power level is activated (if Output Monitor board AGC action is selected).

H.7.5.1 Incorrect Modulation Sample

a. If the modulation level is incorrect on J4, check for the presence of RF on J3. (This can be done by checking the center solder connection to ground since J3 is on the back side of the board.)

b. If RF is present on J3 but not J4, replace U34.

   1. If there is no RF present on J3 refer to the overall wiring diagram to trace the cable to 2L3.

c. If RF is present on J3, measure the voltage across the LED inside the LDR when changing the power.

   1. If the voltage changes, replace the LDR.
   2. If the voltage does not change, replace U20 and check Q18.

H.7.6 Audio Demodulator

a. Begin by checking for the presence of RF on the cathode of CR39.

   1. If RF is not present, check for a shorted T3 or a problem in the Modulation equalization circuit.

b. If RF is present on CR39, check TP38 for a clean audio signal.

   1. If the signal is distorted check CR39, and CR40.

c. If the signal at TP38 is correct, check U10-8 and U10-14.

   1. If the signal is incorrect, replace U10.

H.8 Removal and Replacement

With the low voltage power supplies shut off, remove all connectors and top outside mounting hardware.

Carefully pull the board forward and unplug J1, J3, J7 and J9 from the back of the board.

When installing the replacement board, reverse the above procedure. Ensure that all jumpers and switches on the new board are set to the same positions as the jumpers and switches on the original board.

H.9 Alignment

The following alignments should be done when the Output Monitor Board has been replaced.

H.9.1 Network VSWR Detector Measurements and Considerations

VSWR detector measurements can be made with a DMM by monitoring the detector output test point alone, and/or by RF signal comparison of the amplitude and phase of the output network reference voltage and current samples.

Before starting these procedures make sure that the vertical sensitivity of both vertical input channels of the scope are equal. Connect both scope probes to a common RF reference point, i.e., a RF test point on the Power Block Interface or Oscillator Interface Bd, and ensure that both traces are the same amplitude and phase. This coherence in amplitude and phase must exist in order for alignment measurements of VSWR Detectors to be of value.

Nulling the detector output to zero or near zero as monitored by DMM, at the specific VSWR detector in question, or monitoring of antenna null and network null front panel monitoring positions is normally sufficient for detectors aligned previously at the factory into a test load. However, if a RF Power Sample Board or Output Monitor Board is being replaced, a complete alignment using an oscilloscope may be required.

For the sake of this discussion, it is assumed that these Boards have just been replaced in the field and require a complete alignment.

NOTE:

This series of Network VSWR adjustments for a replacement board, will need to be accomplished initially at a lower output power than normal (25kW to 50kW possibly lower, depending on whether the Transmitter trips off due to excessive VSWR.). At higher power levels (100kW-200kW), the null adjustment per step (d.) will need to be checked and likely refined. At the 200kW power level the "final" adjustments may be performed. This null adjustment will need further refinement when switching from Test Load to Antenna Load operation. Also realize that after the "final" adjustment, any subsequent antenna load changes will lessen the depth of the null, requiring touch-up adjustments.

H.9.2 Network VSWR Detector Adjustments - Ouput Monitor Board

a. Tune the Network VSWR Detector T1 primary circuit to resonance.

   1. Using a dual trace scope connect the channel 1 probe to TP1 and the channel 2 probe to TP31 on the Output Monitor board. Depress and hold the momentary Net VSWR Test pushbutton switch S1 while selecting the appropriate combination of S3-8 through 12 for achieving maximum voltage at TP28. Release the Net VSWR Test switch.

b. Equalize the amplitudes of the RF voltage and current samples.

   1. Adjust the scope time base to display two to four cycles of RF. Adjust the Net E Null variable capacitor C4 and select the combination of S7-4 & 5 to equalize the signal amplitude of TP1 to that of TP31. Note that the two signals are probably not in phase with each other at this time.

c. Adjust the RF voltage and current sample phases to the condition of coherency.

   1. Adjust the combination of S7-1, 2 & 3; S3-6 and Net I Null variable capacitor C53 to achieve zero or near zero phase difference between the signals at TP1 and TP31.

It may be necessary to readjust Net E Null variable capacitor C4 to reestablish amplitude equalization.

d. Accomplish a finer adjustment of these Phase and Amplitude controls to minimize the DMM reading at TP28 to zero or near zero. To achieve the deepest null possible, several iterations of this process may be necessary, while viewing the nulled signal at TP28.

e. If matched amplitudes and coherant phases cannot be at least nearly achieved, then the MOSFETs, switches, and inductive and capacitive components must be checked for value accuracy and part intergrity.

H.9.3 Network VSWR Foldback/Trip Set

a. Set the Transmitter output power to 10KW.

b. Turn off the Transmitter.

c. Reverse the network current sample leads of coax cable 172, connected across 1R5. 1R5 is located in the rear of the right PA cabinet just below the RF Splitter (1A6).

d. Turn on the Transmitter.

e. Adjust the Network VSWR Threshold control, R99, to initiate the foldback/trip sequence. The foldback/trip initiate point is recognized as the point where the power output indication begins to drop. Then reverse the adjustment of R99 slightly so the initiate reference voltage (at TP33) is slightly less then that required for foldback operation. This value is recorded on the factory test data sheet.

f. Turn off the Transmitter.

g. Return the wires of cable 172 to their normal terminals.

H.9.4 Antenna VSWR Detector Adjustments

NOTE:

Refer to Antenna VSWR Detector Measurements and Considerations, and/or Antenna VSWR Detector Adjustments - RF Power Sample Board portion in the RF Power Sample Board section of this chapter for this alignment procedure.

H.9.5 Antenna VSWR Foldback/Trip Set

a. Set the Transmitter output power to 12kW.

b. Adjust the Antenna VSWR Threshold control, R98, to initiate the foldback/trip sequence. The foldback/trip initiate point is recognized as the point where the power output indication begins to drop. Then reverse the adjustment of R98 slightly so the initiate reference voltage (at TP32) is slightly less then that required for foldback operation. This value is recorded on the factory test data sheet.

c. Turn off the Transmitter.

H.9.6 Upper And Lower Arc Detector Threshold

a. Observe the voltage on TP34, Upper Arc Threshold, and adjust R116 to the same as the recorded value from the factory test data sheet.

b. Observe the voltage on TP35, Lower Arc Threshold, and adjust R117 to the same as the recorded value from the factory test data sheet.

c. For adjustment of Arc Detector 1 (CPAC 1A44), and Arc Detector 2 (RPAC 1A43), see Section P, Extended Transmitter Interface, of this manual.

H.9.7 Sensor Balance

a. Adjust the Sensor Balance control R148 for minimum voltage at TP40, Arc Level.

H.9.8 AGC

a. With the Transmitter operating at 200kW, adjust R158 AGC for 6Vp-p of RF at J4.

H.9.9 Forward and Reflected Power Null Adjustments

NOTE:

Refer to Power Null Adjustments portion of RF Power Sample board section, later in this chapter, for this procedure.

H.9.10 Power Metering Calibration

NOTE:

Perform the following Power Calibration procedures after *completion of the previous Power Null adjustments.*

H.9.10.1 Foward Power Calibration

a. Switch S8 on the RF Power Sample Board to the NORM position.

b. Set Power Meter to the FORWARD position.

c. Activate Transmitter to 200kW per the previously field-determined coincidental value of PA Current or number of PA modules turned on.

d. Adjust R81 on the Output Monitor board to 7.5 VDC as measured at J3-17 on the Power Block Interface board.

e. Calibrate the Forward Power Meter to read 200kW by adjusting R14 on Switchboard/Meter board.

f. Turn off Transmitter.

H.9.10.2 Reflected Power Calibration

a. With the Transmitter turned off, switch S8 on the RF Power Sample board to the CAL position.

b. Set Power Meter to the REFLECTED position.

c. Activate Transmitter to 200kW per the previously field-determined coincidental value of PA Current or number of PA modules turned on.

d. Adjust R27 on the Output Monitor board to 7.5 VDC as measured at J3-18 on the Power Block Interface board.

e. Calibrate the Forward Power Meter to read 200kW by adjusting R13 on Switchboard/Meter board.

f. Turn off Transmitter.

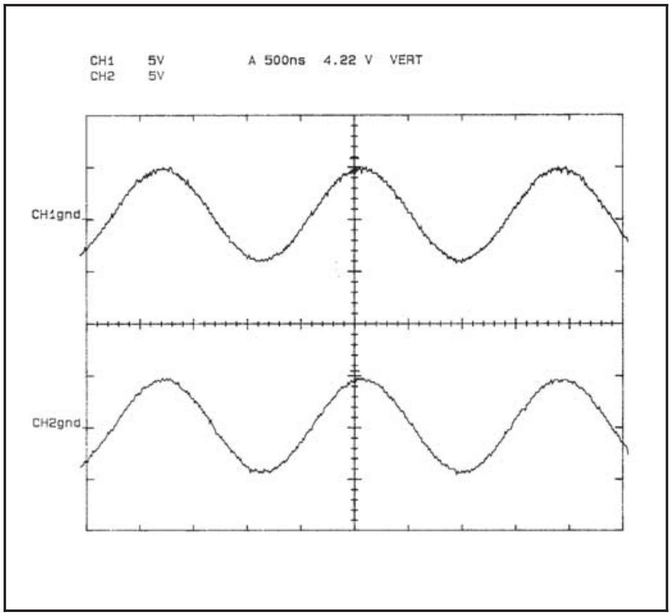
g. Reposition S8 to the NORM position.

H.9.11 Air Flow Calibration

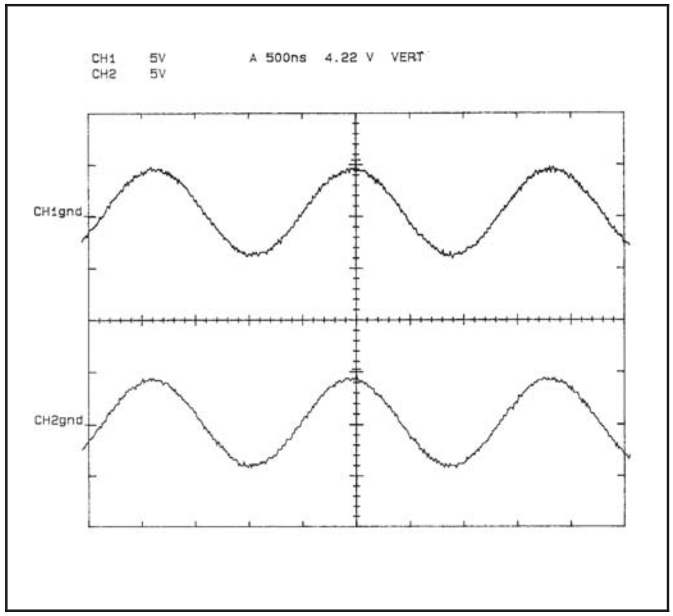
a. Verify that all fans are operational.

b. Operate the Transmitter at 200kW with normal program material.

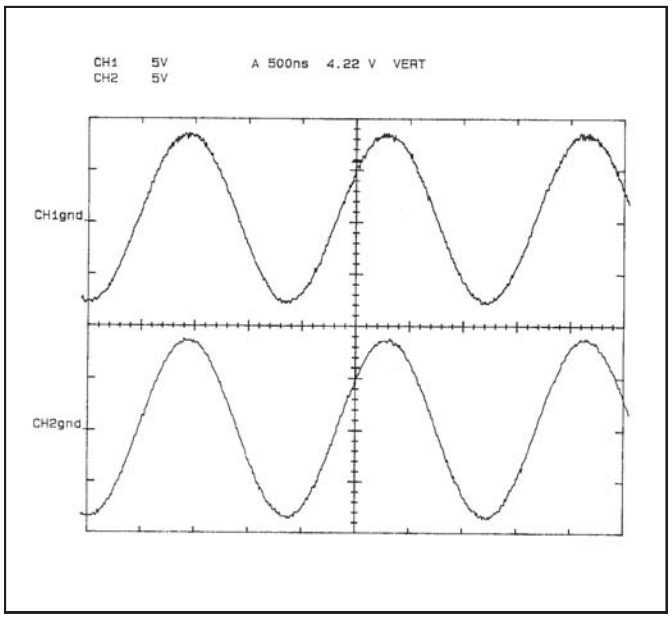
c. Measure the DC voltage at TP4 on the Output Monitor Board.



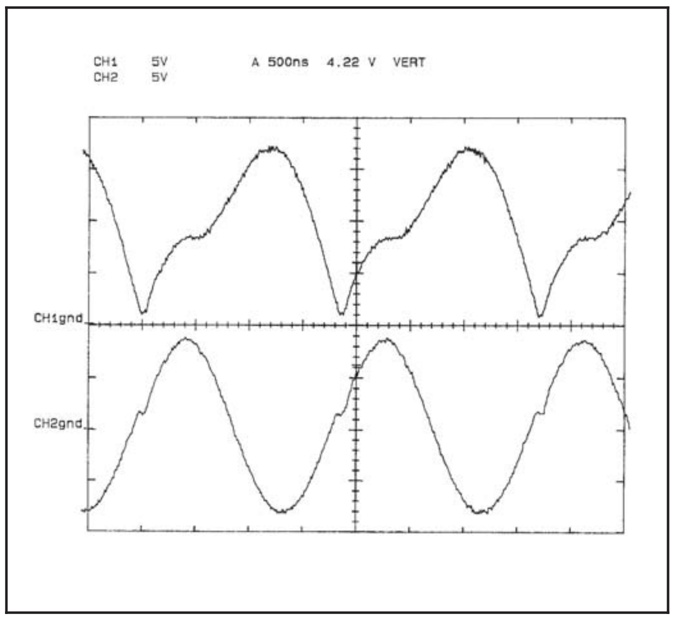
RF Power Sample Board - CH1 = TP15
CH2 = TP14



Output Monitor Board - CH1 = TP31
CH2 = TP1

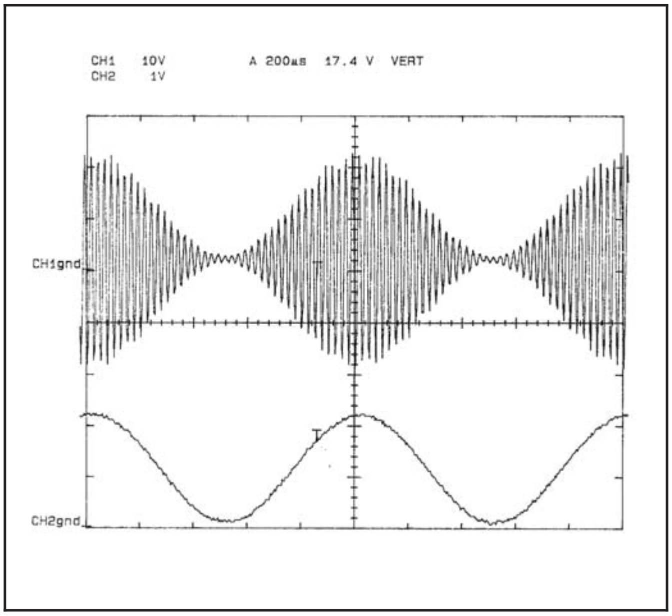


RF Power Sample Board - CH1 = S8-4
CH2 = R6

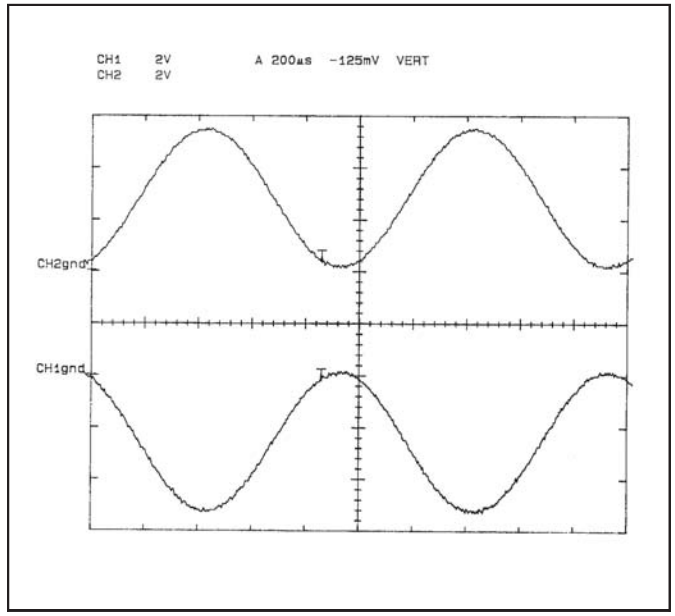


RF Power Sample Board - CH1 = S8-6
CH2 = R7

d. This voltage should be +2.5VDC. If it is not, adjust R30 Air Flow Calibration until the voltage at TP4 is +2.5VDC or the pot reaches the end of range.



Output Monitor Board - CH1 = J4-1
CH2 = TP38



Output Monitor Board - CH1 = J6-33
CH2 = J6-31

H.10 RF Power Sample Board

H.11 Introduction

This Section describes the RF Power Sample Board. Topics include function, location, detailed circuit description, troubleshooting, and removal/replacement.

H.12 Location

The RF Power Sample Board is located in the Output Network Cabinet (See VIEW 8).

NOTE: Parts List for this board is in Section VII.

H.13 Function

The RF Power Sample Board includes current sample and voltage sample circuits for VSWR fault phase angle detectors and the power meter's directional couplers.

H.14 Detailed Circuit Description

H.14.1 RF Current Samples

H.14.1.1 VSWR Phase Angle RF Current Sample

The current sample for the phase angle detector includes a current transformer, with the copper rod carrying the RF current as the primary, and a toroid or ferrite core inductor, T4, as the secondary. Resistors R2 through R5 are connected across the secondary to load the winding and to convert the current sample in the secondary winding to a voltage sample for the phase angle detector.

H.14.1.2 Directional Coupler Current Sample

The current sample for the directional coupler comes from current transformer T2 on the Output Sample Board. The current transformer's primary winding is the copper tube in the output network. Resistors R6 and R7 convert the current into two RF voltages, 180_ out of phase with each other, and also load the winding to prevent the high voltages that would appear across the unloaded winding. The 2 voltages are used as the Forward and Reflected samples for the Directional Coupler.

H.14.2 RF Voltage Samples

H.14.2.1 Forward Voltage Sample

The Forward Voltage Sample is taken from a capacitive divider made up of capacitors C3, C24 and C19 and paddle capacitor C7. It is sent to the Output Monitor Board via J2, and will be used for the Forward Power meter reading.

H.14.2.2 Reflected Voltage Sample

The Reflected Voltage Sample is taken from a capacitive divider made up of capacitors C23 and C18 and paddle capacitor C9. It is sent to the Output Monitor Board via J1, and will be used for the Reflected Power meter reading.

H.14.2.3 Antenna VSWR Voltage Sample

The Antenna VSWR Voltage Sample is taken from a paddle capacitor C6. It is sent to the Output Monitor Board, via J3, where it will be used by the Antenna VSWR Sense circuit.

H.14.2.4 Antenna VSWR Sample

The VSWR circuit uses voltage and current samples to detect VSWR. A voltage sample is applied to one side of transformer T1 primary and a current sample is applied to the other.

The RF voltage sample is adjustable in amplitude by both switched capacitance (C21, C16) and a mica trimmer cap (C17). The current sample has adjustable phase via both switched (C8, C10, C12, C14) and variable (C15) capacitances across a shunt inductor (L1). The sample's phase and amplitude are compensated so the sample to the transformer is of equal phase and amplitude. Under this condition, no current will flow through the primary of T1. When a VSWR occurs, the phase or amplitude of either sample will change creating primary current into T1. This current is coupled to the secondary and goes through a full wave rectifer consisting of CR8 and CR10.

The output is a DC voltage that is proportional to the amount of voltage and current sample imbalance, and is routed by way of J3 on its way to J11 of the Output Monitor Board; which null level is measured at TP16 on the RF Power Sample Board and/or TP 36 on the Output Monitor Board.

H.14.3 Manual Antenna VSWR Test

A manual VSWR Test push-button switch is available on the RF Power Sample Board to test the VSWR trip comparator and VSWR fault counting logic. VSWR Test switch (S2) is a manual trip mechanism for the Antenna VSWR logic. Momentarily depressing the switch simulates a VSWR by grounding one side of the detector transformer. This causes current to flow through the transformer which is rectified into a positive DC voltage which trips the comparator thereby simulating a VSWR condition. This condition illuminates the Antenna VSWR LED (DS2) on the Output Monitor Board. Upon Transmitter foldback to extremely low power levels, this switch has no effect because the samples have been lowered enough not to trip the detectors.

H.15 Troubleshooting

Troubleshooting this board would mainly involve a visual inspection looking for a cracked toroid, open or broken capacitor, or a loose connection.

H.15.1 Antenna VSWR

If the Transmitter Control front panel displays an ANTENNA

VSWR and ANALOG INPUT POWER FOLDBACK, check for an upscale reading on the ANT NULL position on the front panel multimeter when the Transmitter is operating.

H.15.1.1 ANT NULL (or TP16 on the RF Power Sample Board) Reads Upscale

The first step is to verify that the Load for the Transmitter is of the proper output impedance. It should be thoroughly checked and any problems repaired before troubleshooting the Power Block.

H.15.1.2 TP15 and TP14 not equal in Phase and/or Amplitude

While monitoring TP16 with a DMM, check adustment of Antenna VSWR Detector Null for a near-zero indication while adjusting S4, S3, C15, and C17. If not successful, refer to Antenna VSWR Detector Adjustments - RF Power Sample Board section.

H.15.1.3 TP15 and TP14 matched in Phase and Amplitude

a. Check TP16 for a null or minimum signal (less than 0.5V p-p at 200kW carrier). The signal should be composed of only RF harmonics.
   1. If the null is not present and both TP15 and TP14 are equal in phase and amplitude, check CR8, CR10 and T1.
   2. If the DC null is present at TP16, check TP36 on the Output Monitor Board.

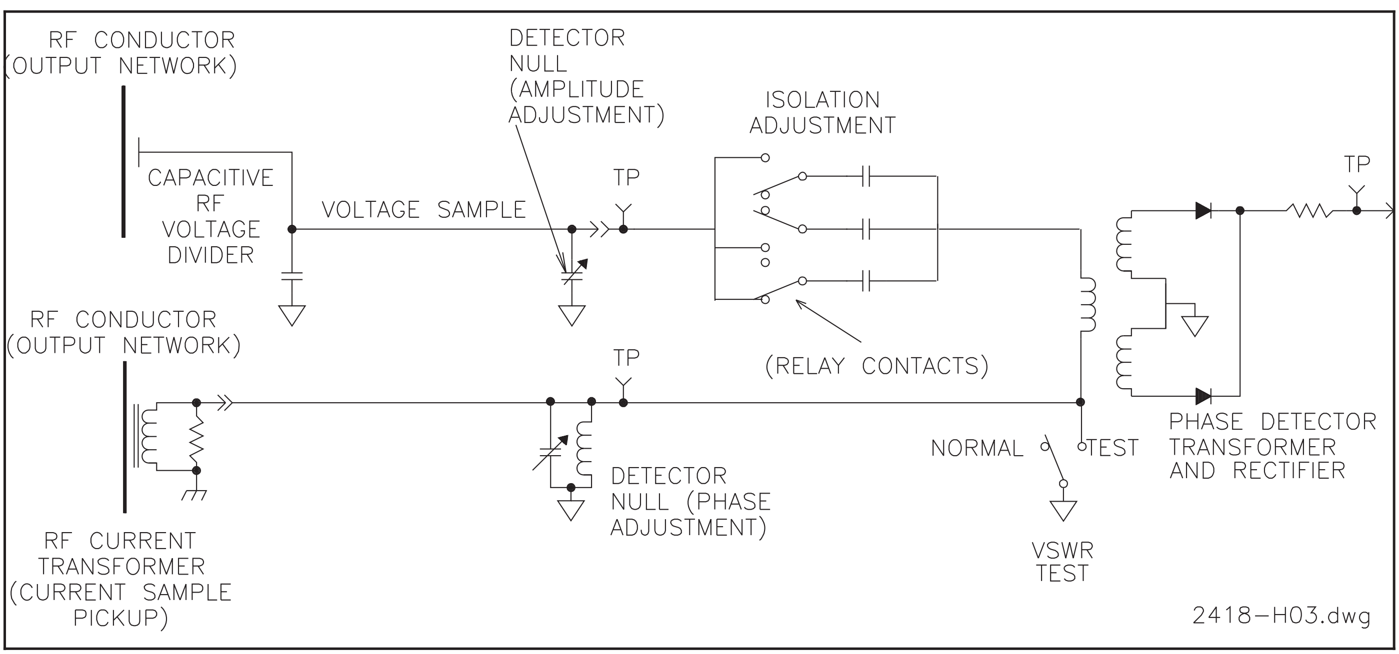


Figure H-4 Antenna VSWR Detector

b. If there is a DC level, check the cathode of CR31 (Output Monitor Board) for a logic HIGH.
   1. If present, refer to the Controller Section and troubleshoot the VSWR Test Request Line. If the voltage on TP32 on the Output Monitor Board agrees with the Test Data replace U18.
   2. If not present, check the integrity of the interconnection line between TP36 (Output Monitor board) and TP16 (RF Power Sample board).

H.15.1.4 Ant Null Reads Zero

a. Check for a logic HIGH on U18-6 (Output Monitor Board)
b. If present, check the voltage on TP32 and compare this to the Test Data readings
   1. If TP32 (Output Monitor Board) agrees with the Test Data, replace U18.
   2. If TP32 (Output Monitor Board) does not agree with the Test Data, check the voltage divider or replace U18.

H.15.1.5 ANT NULL Reads Zero, RF MUTE LED Illuminated Only

a. To verify that the RF mute is coming from the Output Monitor board, check TP23 for a logic HIGH.
   1. If TP23 is LOW, check Q23, Q22, and U14.
   2. If TP23 is a logic HIGH, check U29, U14, and U24.

H.15.1.6 ANT NULL Reads Zero, VSWR, and Foldback Illuminated Only

If only these faults are displayed and return soon after the reset is pressed, make the following Output Monitor board checks:

a. Start by checking U24-2, U24-13, and observe DS2.
   1. If U24-2 is logic HIGH and DS2 is not illuminated, replace U24.
b. U24-13 should be logic LOW when U24-2 is LOW, if not replace U24.
c. If U26-3 is logic LOW, and U26-23 is HIGH, replace U26.

H.15.2 Power Metering - RF Power Sample Board

H.15.2.1 Forward Power

a. Turn on the Transmitter and check for a DC level at TP3 with carrier only. This voltage should change as the power is raised or lowered.
b. If there is no DC or the level does not change, check CR1 anode for an RF signal.
   1. If there is no RF signal, refer to the RF Power Sample Board schematic diagram to trace the loss of signal.
   2. If there is RF on CR1, check CR1, the other diodes, and all other passive components in the Forward Power metering section on this board for problem resolution.

H.15.2.2 Reflected Power

a. Turn off the Transmitter and put S8 in the CAL position.
b. Turn on the Transmitter and check for a DC level at TP2 with carrier only. This voltage should change as the power is raised or lowered.
c. If there is no DC or the level does not change, check CR2 anode for an RF signal.
   1. If there is no RF signal refer to the RF Power Sample Board schematic to trace the loss of signal.
   2. If there is RF on CR2, check CR2, the other diodes and all other passive components on this board.
d. When proper operation has been restored, return S8 to the NORM position.

H.16 Removal and Replacement

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Remove the connectors.
b. Remove the mounting screws. Reverse this procedure for installing the replacement.

H.17 Alignments

The Amplitude adjustments (fine and coarse) along with the Phase adjustments (fine and coarse) are set for minimum detector output when the Transmitter is operated into a 40 ohm load.

H.17.1 Antenna Current Sample Adjustments

S6-1 through S6-4 are used to connect/disconnect fixed value capacitors to ground on the output of T4 and adjust the sample phase.

H.17.2 Antenna Voltage Sample Adjustments

S4-1 and S4-2 are used to connect/disconnect fixed value capacitors to ground on the output of C6 and adjust the sample amplitude.

H.17.3 Antenna VSWR Detector

The secondary winding of T1 is connected to a full wave rectifier and filter capacitor. The output DC voltage can be measured at TP16 Antenna VSWR and is connected to the Antenna VSWR Comparator and the Antenna VSWR Buffer.

H.17.4 Antenna VSWR Detector Measurements and Considerations

VSWR detector measurements can be made with a DMM by monitoring the detector output test point alone, and/or by RF signal comparison of the amplitude and phase of the output network reference voltage and current samples.

Before starting these procedures make sure that the vertical sensitivity of both vertical input channels of the scope are equal. Connect both scope probes to a common RF reference point, i.e., a RF test point on the Power Block Interface or Oscillator Interface Bd, and ensure that both traces are the same amplitude and phase. This coherence in amplitude and phase must exist in order for alignment measurements of VSWR Detectors to be of value.

Nulling the detector output to zero or near zero as monitored by DMM, for the specific VSWR detector in question, or monitoring of antenna null and network null front panel monitoring positions is normally sufficient for detectors aligned previously at the factory into a test load. However, if a RF Power Sample Board or Output Monitor Board is being replaced, a complete alignment using an oscilloscope may be required.

For the sake of this discussion, it is assumed that these Boards have just been replaced in the field and require a complete alignment.

NOTE:

This series of Network VSWR adjustments for a replacement board, will need to be accomplished initially at a lower output power than normal (25kW to 50kW possibly lower, depending on whether the Transmitter trips off due to excessive VSWR.). At higher power levels (100kW-200kW), the null adjustment per step (d.) will need to be checked and likely refined. At the 200kW power level the "final" adjustments may be performed. This null adjustment will need further refinement when switching from Test Load to Antenna Load operation. Also realize that after the "final" adjustment, any subsequent antenna load changes will lessen the depth of the null, requiring touch-up adjustments.

H.17.5 Antenna VSWR Detector Adjustments - RF Power Sample Board

a. Tune the Antenna VSWR Detector T1 primary circuit to resonance.

   1. Using a dual trace scope connect the channel 1 probe to TP15 and the channel 2 probe to TP14 on the RF Power Sample board. Depress and hold the momentary VSWR Test pushbutton switch S2 while trimming C22, if installed, and selecting the appropriate combination of S1 positions for achieving maximum voltage at TP16. After the resonance condition has been achieved, release the VSWR Test switch.

NOTE:

The RF Power Sample board is located inside and near the top of the lower ONC (See VIEW 8). Either extra long scope leads will be required or the scope will need to be placed on top of the ONC. It will also be necessary to access the lower ONC through the top access panel located inside the upper ONC to make some of these adjustments. A partner will be needed to turn the Transmitter on and off, as required, for safety reasons while adjustments are being made.

b. Equalize the amplitudes of the RF voltage and current samples.

   1. Set the Normal/Calibrate jumper JP3 and S7 to their NORM position. Adjust the scope time base to display two to four cycles of RF. Adjust the Fine Amplitude Adjust variable capacitor C17 and select the combination of S4 positions to equalize the signal amplitude of TP15 to that of TP14. Note that the two signals are probably not in phase with each other at this time.

c. Adjust the RF voltage and current sample phases to the condition of coherency.

   1. Adjust the combination of S3 positions and Fine Phase Adjust variable capacitor C25 to achieve zero or near zero phase difference between the signals at TP15 and TP14. It may be necessary to readjust Fine Amplitude Adjust variable capacitor C17 to reestablish amplitude equalization.

d. Accomplish a final adjustment of these Phase and Amplitude controls to minimize the DMM reading at TP16 to zero or near zero. To achieve the deepest null possible, several iterations of this process may be necessary, while viewing the nulled signal at TP16.

e. If matched amplitudes and coherant phases cannot be at least nearly achieved, then the MOSFETs, switches, and inductive and capacitive components must be checked for value accuracy and part intergrity.

NOTE:

Following this procedure, if necessary, return to Antenna VSWR Foldback/Trip Set portion of the Output Monitor Board section earlier in this chapter.

H.17.6 Power Null Adjustment

H.17.6.1 Forward Power Null Adjustment

a. With the Transmitter operating at 800 to 840A of PA current, select the Reflected power position on the front panel meter.

b. Adjust C18(23), Reflected Balance control, on the RF Power Sample Board to null the meter indication to zero.

c. Depress the front panel OFF button to turn off the Transmitter.

H.17.6.2 Reflected Power Null Adjustment

a. Switch S8 to the CAL position.

b. Turn the Transmitter back on at 800 to 840A of PA current. Note that the Reflected power meter position now indicates forward power.

c. Move the Forward/Reflected meter switch to the FORWARD power position. Note that it now indicates reflected power.

d. Adjust C19(24), Forward Balance control,on the RF Power Sample Board to null out this indication to zero.

e. Depress the OFF button and reposition S8 to the NORM position.

f. Forward and Reflected directional couplers are now nulled.

H.17.6.3 Power Meter Calibration

NOTE:

Refer to Power Metering Calibration portion of Ouput Monitor Board section, earlier in this chapter, to continue alignment procedures.

J.1 Introduction

This section describes the Analog Input Board. Topics include Function, Location, Block Diagram Description, Detailed Circuit Description, Troubleshooting, Removal/Replacement and Oscilloscope plots of key points.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Assembly # 992-8882-003
PWB # 843-5155-534
Schematic # 839-7930-534

NOTE: Parts List for this board is in Section VII.

J.2 Function

The Analog Input Board includes an audio input amplifier, power control adjustments, circuits for optimizing audio performance, and +250VDC current overload and monitoring. The output signal from this board is an audio signal with a DC component, which goes to the A/D Converter Board. The DC component determines the Transmitter's unmodulated or carrier power output, and the audio component changes the instantaneous power output.

J.3 Location

The Analog Input board is located in the center PA cabinet, on the back of the front door. (See VIEW 3)

J.4 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 200 kW with 100% 1 kHz modulation at 1575 kHz carrier frequency, unless otherwise noted.

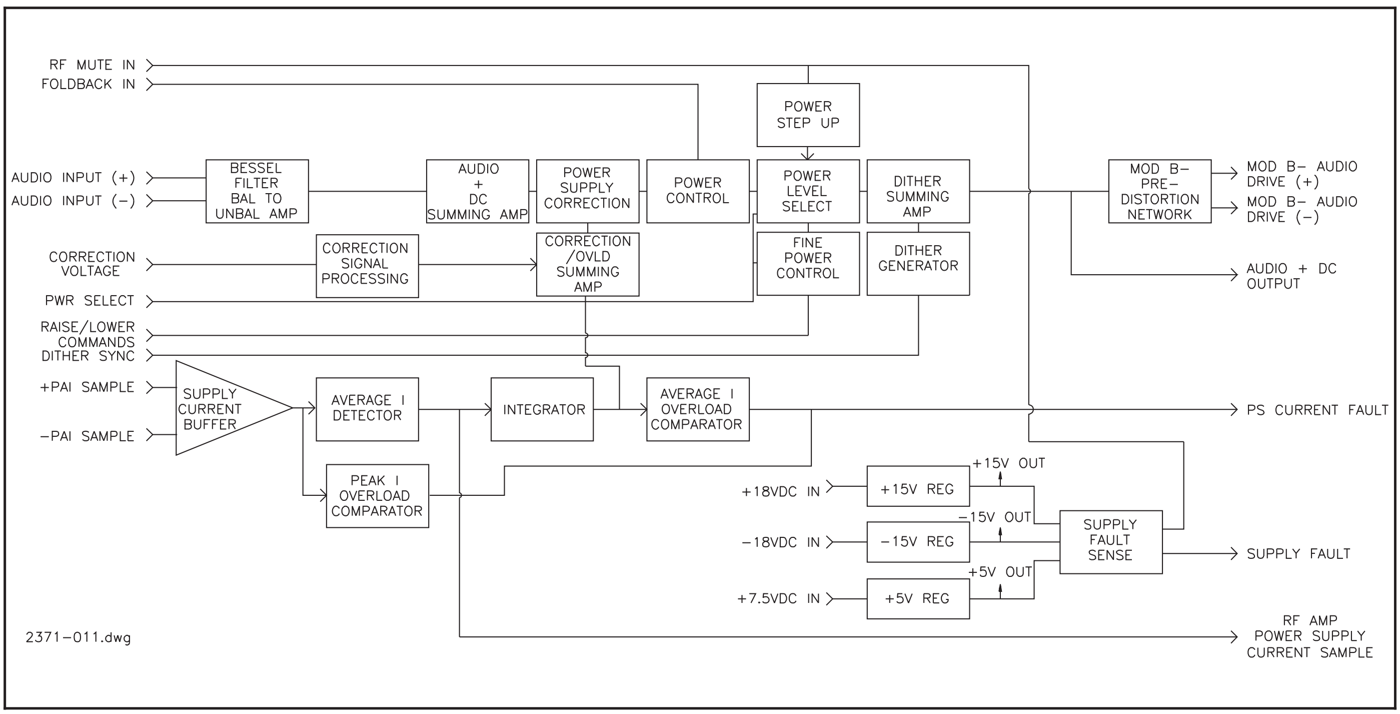


Figure J-1. Analog Input Block Diagram

J.5 Block Diagram Description

J.5.1 Audio Flow

The audio input signal passes through a Bessel filter to the transformerless Balanced To Unbalanced Amplifier.

An (Audio + DC) Power Level Summer adds a negative DC offset that sets the maximum unmodulated carrier power level.

A +250VDC power supply sample correction voltage is processed by the Correction Signal Processor and is sent to the Correction/Overload Summing Amplifier to improve low frequency distortion. This signal is added to the (Audio + DC) signal in the Power Supply Correction circuit to correct for changes in the power supply voltage in order to maintain a constant carrier level.

Power Foldback is accomplished by a resistive attenuator which will reduce the (Audio + DC) signal should the carrier level need to be reduced due to VSWR or other faults.

Power control attenuates or increases the (Audio + DC) signal to provide High, Medium and Low power output.

Fine Power Control will raise or lower the (Audio + DC) by plus or minus 10% of the current power level.

Any time the Transmitter is turned ON, the current power level is changed to HIGH, MED, or LOW, or when an RF Mute is applied, the Power Step Up will hold the power level to one quarter of the current power level for one second then allow the power to come up to full current power level (via the Ramp-Up circuitry) after the RF Mute is removed.

A 72 kHz triangle wave signal from the Dither Generator controlled by the Dither Sync signal is added to the (Audio + DC) signal in the Dither Summing amplifier to improve Transmitter signal to noise ratio (S/N).

The output from the Dither Summing amplifier is applied to the A/D Converter board and is also applied to the Mod B-Predistortion Network. This network will process the (Audio + DC) signal such that it will be ready to drive each Modulation Encoder with a balanced Mod B- Audio Drive.

J.5.2 +250VDC Current Monitoring

A sample of the voltage across the +250VDC power supply current shunt is amplified by the Supply Current Buffer and fed to an Average I Detector and a Peak I Overload Comparator.

The output of the Average I Detector is sent to the Power Block Interface board for the Remote +250VDC Supply Current Sample and is also applied to an Integrator. The Integrator further averages the current sample and sends a current limiting signal to the Correction/Overload Summing Amplifier if current limiting is required due to overmodulation. The output of the Integrator also feeds an Average I Overload Comparator.

Should the average or peak voltages across the shunt trip these comparators, a Power Supply Fault will be generated.

J.5.3 Power Supplies

+18VDC, -18VDC and +7.5VDC are regulated down to +15VDC, -15VDC and +5VDC respectively by separate regulators to power circuits on the board.

A Supply Fault Sense circuit monitors these supplies and will generate a Supply Fault for the Controller and an RF Mute which will drop the current power level to 0 kW until the fault is cleared.

J.6 Detailed Circuit Description

J.6.1 Audio Input

The audio input signal connection to the Transmitter is made at TB1-1(+) and TB1-2(-) on the Power Block Interface board. Back-to-back zener diodes on the Power Block Interface board provide protection against transients and excessive voltage at the input. A shielded audio cable carries the audio to connector J1-19(+) and J1-17(-) on the Analog Input board. Jumpers P1 and P2 are used to select the correct input impedance for the audio source. Refer to the Installation Section for determining the proper termination.

J.6.1.1 Bessel Filter

The first circuit in the audio signal path is a Bessel Filter, using passive components L5 through L8, C20 through C23, and terminating resistors R49 and R50.

J.6.1.2 Input Coupling

The audio signal from the Bessel Filter is AC coupled to the input amplifier, through C26/C27 and C24/C25. Input Coupling jumpers P7 and P8 are normally connected 2-1. If they are jumpered 2-3, the audio input is directly coupled. Back-to-back zener diodes CR10 and CR9, and shunt resistors R51 and R52, provide additional overvoltage protection.

J.6.1.3 Balanced To Unbalanced Amplifier

The first section of the amplifier includes two non-inverting amplifiers with high-impedance inputs U1-5 and U1-3. Both non-inverting amplifiers have the same gain, which can be adjusted with Audio Gain Adjust control R54. This control allows audio input levels from -10 dBm to +10 dBm to be used. The second section of the amplifier is a differential amplifier U2-1, which has two balanced inputs at U2-2 and U2-3 and a single unbalanced output at U2-1.

J.6.2 (Audio + DC) Summation

The output of U2-1 goes through a voltage divider to the input of Buffer Amplifier U3-3. The audio input to the buffer amplifier can be observed at TP12. U3-7 is a summing amplifier, the (+) input is an adjustable negative voltage. The output at TP15 will be the audio signal with a negative DC component. This signal will be referred to as (Audio + DC) for discussion purposes.

The Maximum Power Adjust control R56, limits the highest power level obtainable to 220 kW when the raise control is at maximum.

J.6.3 Power Supply Correction

A Power Supply Correction circuit compensates for power supply variations. The (Audio + DC) signal from U3-7 is the Z input of multiplexer, U16 at pin 6, and the correction voltage sample is the X input. If the +250VDC supply sags, the power supply sample decreases slightly, and the (Audio + DC) output of U16-8 at TP11 increases to compensate.

J.6.3.1 Correction Voltage Sample

The Correction Voltage at J1-9 is determined by the Supply Voltage Sample Divider sample on Fuse board A39, and is connected to JP5. When JP5 is in the NORMAL position the Correction Input Sample, at TP28, is applied to a DC amplifier U27-2 and an AC amplifier U27- 9.

The DC Amplifier has fixed gain, and there will be a negative DC voltage at the output pin 1, TP-31. This voltage is normally -5.5VDC and changes with the incoming Correction Voltage.

The AC amplifier is a low pass filter with adjustable gain. At low modulation frequencies (30Hz), the output at pin 8 (TP-32), has a small audio component of less that 1Vp-p with no DC offset. At higher modulation frequencies, the audio component is less due to the rolloff characteristics of the amplifier. The AC amplifier has an adjustable gain control R143 Low Frequency THD Null, this control is adjusted to improve low frequency distortion.

The outputs of the DC amplifier and the AC amplifier are combined and applied to U27-13. A current limit voltage is also added to U27-13 and will be discussed later. U27-14 is a buffer amplifier, its output is the correction voltage and goes to input X1 of multiplexer U16.

This circuit induces a Pre-Distortion component to cancel any power supply ripple or hum and power supply variations caused by the lower frequency modulation signals. The 100K variable resistor R29 (THD Null) may be adjusted for minimum output distortion.

J.6.3.1.1 Power Up Circuit

Diodes CR12 and CR13, capacitor C39, and the resistive voltage divider comprised of R61 and R62 form a power up circuit such that when supply voltage is applied U16 will properly respond to the Correction signal.

J.6.4 Differential Amplifier

The output of the power supply correction divider U16-4 is buffered by a section of U4. R64 connects this signal to Foldback through R10-6 and sends the signal to the (+) input of differential amplifier U4-5. The (-) input of the differential amplifier U4-6 is connected to P6-2.

The Power Step Up and Foldback circuits are connected to the (+) input at U4-5. The Fine Power Control circuit is normally connected to the (-) input at P6-3.

The purpose of the differential amplifier U4-7 is to amplify the difference between the (+) input and the (-) input to allow the three functions described above.

J.6.5 Foldback

Power levels upon startup and during any foldback series of commands are controlled using resistive attenuation of the (Audio + DC). This is accomplished using U12 and resistors R69 through R75. Switch U12 is given binary instructions (FBOUT1, 2 & 3) and it in turn connects one of the above resistors to R64. This gives another path for the (Audio + DC) to ground and controls the level of (Audio + DC) that reaches the input of U4-5 (Power Control).

U5 (Foldback Comparator) receives 3 sets of inputs; Master Foldback, Internal Foldback and Ramp.

NOTE:

Master Foldback inputs Bits 1, 2 & 3 are not used in this configuration so they are always low.

This Comparator determines which request has priority and feeds that to FBOUT1, 2 & 3 which is in turn fed to U12, discussed in previous paragraph.

In the normal on-air non-foldback condition, DB1, DB2 and DB3 are all low, as are RAMP1, RAMP2 and RAMP3 and the switch is not connected, effectively an open circuit.

If the Controller has determined that the Transmitter should be in foldback -.5 dB, DB1 (J2-17) will go high and the switch will be connected from U12-3 to U12-14. This connects R69 and the voltage divider action reduces the power to 178 kW. The following chart lists the Foldback steps and power levels.

Foldback Level	DB1	DB2	DB3	U12-3 connected to	Power
0 dB	L	L	L	U12-13	200 kW
-0.5 dB	H	L	L	U12-14	178 kW
-1.0 dB	H	H	L	U12-15	158 kW
-2.0 dB	L	H	L	U12-12	126 kW
-3.0 dB	L	H	H	U12-1	100 kW
-6.0 dB	H	H	H	U12-5	50 kW

J.6.6 Power Ramp Up

Ramp up is the process of starting the Transmitter at a relatively low power level and then advancing the power level (in steps) to full power. The rate of the steps (and therefore the time required to come to full power) is adjustable by using Jumper JP9.

The 16 Hz clock comes into U5 at Pin 1. JP9 is a three position jumper set. The three positions are Fast, Normal and Slow. The table below shows the approximate times for each setting of JP9:

Speed	JP9	Approx. Time
Fast	2-4	0.5 Seconds
Normal	3-4	2 Seconds
Slow	1-2	3 Seconds

This is fed to the clock input (pin 1) of U6, the Ramp PAL.

J.6.7 Fine Power Control

Fine Power Control allows the power output to be varied plus or minus 10 percent by using the Raise and Lower front panel controls which activate PAL U21, U20 or U19 depending upon the power level selected. The PAL's are programmed to act as up / down counters which send a digital word to the digital potentiometer. The Fine Power Controls are centered in its 3 ranges by placing S1 in the Calibrate position, and adjusting the three power levels for the desired output. R65 sets the HIGH power level, R67 sets MED, and R66 for LOW.

J.6.7.1 Digital Potentiometer

A signal from U4-1 is applied to buffer input U7-3 and is then fed to the input of a digital potentiometer U18-15. U18 is a digitally Controlled potentiometer. That is the value of the digital word on the input pins results in an attenuation of the signal on the output. The output of the digital potentiometer U18-1 is buffered by U7-7 and connected to P6-3. When P6 is in the NORMAL position, this signal is connected to the (-) input of differential amplifier U4-6.

When the resistance of the digital pot changes, the voltage at the (-) input of the differential amplifier varies and so does the output. U18 is controlled by the eight bit digital word DB0 (LSB) through DB7 (MSB) on the input pins U18-11 through U18-4 that comes from the Trim PALS.

When S1 is in the calibrate position and the unmodulated power output is set to 200 kW, the voltage U4-7 is 1.47VDC and U4-6 is - .64VDC.

If S1 is returned to the Normal position and the Raise control is depressed and held until the power output is 220 kW, the voltage at U4-7 is 1.54VDC and U7-7 is -1.28VDC.

If the Lower control is depressed and held until the power output is 180 kW, the voltage at U4-7 is 1.40VDC and U7-7 is 0VDC.

J.6.7.2 Trim PALS

The eight bit digital word for the digital pot is supplied by the Trim PALS. They function as Up/Down counters with a reset to center range control. Each PAL has the same program. U21 is used for HIGH power, U20 for MED, and U19 for LOW. The operation of each PAL is the same, so only High power PAL U21 will be discussed.

When the Transmitter is on at the HIGH power level, J2-27 receives a high signal from the Controller. This signal is sent to U21-6 and activates the PAL, at this time U20 and U19 are inactive.

When the Raise control is depressed, J2-15 receives a high signal from the Controller. This signal is sent to U21-4 and the PAL begins to count up in binary fashion until U21-14 through U21-21 are all high. At this point the power output should be 220 kW and the upper limit of the Fine Power Control has been reached.

When the Lower control is depressed, J2-13 receives a high signal from the Controller. This signal is sent to U21-5 and the PAL begins to count down in binary fashion until U21-14 through U21-21 are all low. At this point the power output should be 180 kW and the lower limit has been reached.

J.6.7.3 S1 Calibrate

When S1 is placed in the Calibrate position, U21-2 is grounded. This resets the PAL to the center range, regardless of previous Raise or Lower commands. U21-14 through U21-20 will be low and U21- 21 will be high, and the three power levels can be set.

When S1 is switched back to the normal position, U21 is still in the center range. The PAL can then respond to Raise or Lower controls.

J.6.7.4 Fine Power Control Bypass

If P6 is moved from 2-3 to 2-1, Fine Power Control is Bypassed. The previous differential amplifier U4-7 now becomes a non-inverting amplifier with the (-) input connected to ground through R164. Power Step Up and Foldback functions are still active.

Refer to the Emergency Operating Procedures Section VI - A for the bypass procedure.

J.6.8 Power Control

The output of the differential amplifier is normally connected through P4 2-3, to distribute the signal to three switches inside U17. The switch U17 is shown in the Transmitter OFF condition.

When the Transmitter is turned on at HIGH power, the Controller places a HIGH (+5VDC) on J2-27. Level Shifters U25-12 and U14-12 convert the HIGH to +15VDC at U17-11. This causes switch "A" to close, connecting U17-14 to U17-13. Potentiometer R65 HIGH is now part of a voltage divider along with R76. Clockwise rotation will raise power output and counter-clockwise rotation will lower power output.

When the Transmitter is turned on at MED power, the Controller places a HIGH on J2-29. Level Shifters U25-10 and U14-10 apply a HIGH at U17-10. This causes switch "B" to close, connecting U17-15 to U17-1. Potentiometer R67 MED is now part of a voltage divider along with R76. Clockwise rotation will raise power output and counter-clockwise rotation will lower power output.

When the Transmitter is turned on at LOW power, the Controller places a HIGH on J2-31. Level Shifters U25-8 and U14-8 apply a HIGH at U17-9. This causes switch "C" to close, connecting U17-4 to U17-3. Potentiometer R66 LOW is now part of a voltage divider along with R76. Clockwise rotation will raise power output and counter-clockwise rotation will lower power output.

J.6.8.1 Power Control Bypass

If P4 is moved to the Bypass position 2-1, the Bypass Power Level pot R68 remains in the voltage divider circuit regardless of the power level.

Refer to the Emergency Operating Procedures Section VI - A for the bypass procedure.

J.6.9 Output Amplifier

The output of the power control voltage divider is connected to the (-) input of Output Amplifier U8-2. Summed together with the (Audio + DC) is a small Dither signal on the (+) input U8-3. The output of U8-1 -(Audio + DC) has Bias and Null adjustments to produce better THD at high modulation levels approaching

200 Kw, then is connected to J3-5 where it continues on to the A/D Converter Board.

J.6.10 Modulated B- Drive

The output of U8-1 also is fed to the (+) input of amplifier U8 at pin 5. The (-) input of U8-6 is a positive voltage, adjustable with OFFSET control R104. The output of U8-7 is an audio signal with an adjustable DC offset. The signal passes through a Non-linearity circuit formed by several resistors and diodes. The purpose of this network is to reshape the waveform to control RF Amplifier turn on/off times on the Modulation Encoders.

When the -(Audio + DC) output of U8-7 is small (corresponding to a negative modulation peak), changes in the voltage result in roughly proportional changes in the voltage at the output.

As the -(Audio + DC) output becomes more negative (corresponding to a positive modulation peak), it is clipped more and more heavily and changes in the output of U8-7 result in much smaller changes in the voltage at the input to U10-6 and in the Modulated B- supply output voltage.

The output of the predistortion network is connected single ended to balanced amplifiers at U10-6 and U10-3. This balanced output signal at U10-7 and U10-1 (J1-3 (+) and J1-1 (-)) goes to each Modulation Encoder where it modulates a negative supply to provide the Modulated B- Supply.

J.6.11 Dither Circuits

The Dither signal optimizes noise performance in the Power Block by introducing a small 72 kHz triangle wave on the -(Audio + DC) signal.

J.6.11.1 Dither Oscillator

The Dither Oscillator is made up of an integrator U9-8 and a square wave generator U9-1. The output of the Dither Oscillator at U9-8 is a triangle wave with an amplitude of 1 Vp-p. Dither Frequency Adjust, R19, sets the Dither frequency to a nominal 72 kHz. A voltage divider R25 and Dither Level Adjust potentiometer R26 reduces the Dither signal to a very low level at U8-3.

J.6.11.2 Dither Sync

A Dither Sync signal from A/D Converter on J3-8 is buffered by U9-7. This signal synchronizes the Dither signal so that it increases just as the Transmitter output switches from a condition where all Binary Steps are ON to the next step where a Big Step turns ON and all Binary Steps turn OFF. The A/D input is forced higher quickly enough to prevent switching back and forth between the two conditions.

When the Transmitter output is decreasing, the dither signal is synchronized so that it is also decreasing just as the RF Amplifiers switch from a state with all Binary Steps OFF to the next step down, where a Big Step turns off and all the Binary Steps turn ON.

J.6.12 RF Mute

An RF MUTE signal from the Controller board or generated by the Analog Input Board presents a low at J2-9. A low signal turns the RF Amplifiers off by inhibiting the Power Control switch U17 and the Digital Potentiometer U18. This action takes the Analog Input Board’s output to zero. When the RF Mute is lifted, the Power Step Up is activated.

J.6.13 Overcurrent Protection

Either a Peak Current Overload or an Average Current Overload will cause an RF Amplifier Current Fault.

U11-1 is a differential amplifier, which amplifies the voltage drop across +250VDC current shunt SH1. The signals from opposite ends of current shunt SH1 are routed to the differential amplifier inputs. The current shunt is between the negative side of the +250VDC Power Supply and ground. Zero Adjust resistor R35 is used to zero the output to the remote indicator under conditions of no RF Power being transmitted. The output of the differential amplifier U11-1 is connected to TP25 RF Amp Power Supply Current and applied to the peak and average current comparators.

J.6.13.1 Peak Current Overload

Comparator U13-1 senses peak current overloads. The comparator voltage reference is set by Peak Current Threshold control R113. The comparator has an open collector output which goes to +5 Volts through R162. Normally the comparator output is HIGH but if peak supply current exceeds the preset threshold, the comparator output goes LOW. This sends an RF Amp Current Fault -L to the Controller via J2-5.

J.6.13.2 Average Current Overload And Supply Current Metering

Resistor R15 and capacitor C52 form a low-pass filter which removes audio frequency components from the supply current sample, so that only the average supply current remains at the output of voltage follower U11-14. The voltage follower output goes to U13-9 (input for current sensing) and provides a Remote RF Amp Supply Current output, at J1-5, to the Power Block Interface for remote metering. This output may be “zeroed” by applying an RF Mute to the operating Transmitter and adjusting R35 “Zero Adjust”. R35, R33 and R34 make up an offset circuit for zeroing the sensed RF Amp Supply Current from the Controller.

The voltage follower also goes to the noninverting input of comparator U13-9. The comparator’s inverting input is a reference voltage set by R118, the Average Current Threshold control. If the average current exceeds the preset threshold, the comparator output at U13-14 goes HIGH. C9 begins charging thru CR23 and as long as U13-14 remains HIGH, the Current Limit voltage increases. This voltage is applied to two comparators and one amplifier. If the (-) input at U13-10 becomes greater than the (+) input, U13-13 goes LOW and illuminates Current Limit indicator DS5 RED.

Average current limiting is activated, producing a foldback signal at U27-7 that reduces the power output to keep the current at a safe level. Further increases in the voltage will cause U13-2, and TP30 Current Fault, to go LOW. This sends an RF Amp Current Fault -L to the Controller via J2-5.

J.6.14 Power Supplies

DC supply inputs from the Low Voltage Power Supply to the Analog Input Board are +18, -18 and +7.5 Volts, and are regulated to +15, - 15 and +5 Volts respectively using regulators U24, U22, and U23. Each input is fused, with 2A fuses F1, F2 and F3. Each regulator output has a GREEN Status LED that illuminates when the regulator is operational. The output of the regulators are transient protected by zeners CR21, CR16, AND CR15.

J.6.14.1 Regulator Status

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a Supply voltage on the board that does not depend on the regulated supplies. The +18 Volt supply goes to R96 and CR20 and +7.5 Volts goes thru CR27 to a 5 Volt regulator, U29. This +5 Volts is designated +5VB.

The +5VB is used as the reference to the inverting input for comparator U15 thru a series voltage divider network. Each supply is connected to a voltage divider and then connected to the input of U15. With the non-inverting inputs more positive than the inverting inputs the outputs of U15 are at +5 VDC. This is the NORMAL condition with no faults. This is also fed to the - input of the third comparator, U15-10, and (+) input is referenced at +2.5 VDC. In normal conditions, the output of U15-13 will be 0 VDC. If one of the regulated supplies fails or drops too low, the corresponding comparator output will go to 0 VDC and illuminate DS4 Supply Fault RED. This will cause output of U15-13 to go LOW and two commands are sent to the Controller. One is an RF MUTE at the collector of Q2 to turn all Big Step and Binary RF Amplifiers off. The other is a Supply Fault, when Q1 turns on, which shuts the Transmitter OFF.

J.7 Troubleshooting

J.7.1 Power Supply

If an Analog Input supply fault is displayed on the Control front panel, then with only the low voltage on, check the LED indicators on the Analog Input Board:

a. DS1 (+5V)
b. DS2 (-15V)
c. DS3 (+15V)

Each of these LED indicators should be Lit, if the individual supplies are operating normally.

J.7.1.1 DS4 Illuminated

DS4 will light under 2 basic conditions,

a. If any of the Low Voltage supplies or regulators fail, or
b. If one of the regulated outputs is less than 80% of normal. This means that DS1, DS2, or DS3 could be lit and a supply fault still be detected, turning on DS4. The input supply voltages and the regulated supply voltages will have to be checked closely to determine why DS4 is lit.

J.7.1.2 No +5V (DS1 out)

a. If DS1 is not illuminated, check fuse F2 and replace if necessary.
b. If F2 is not open, measure TP18 for +7.5VDC.
c. If TP18 does measure +7.5VDC, replace U22.
d. If TP18 does not measure +7.5VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

J.7.1.3 No -15V (DS2 out)

a. If DS2 is not illuminated, check fuse F1 and replace if necessary.
b. If F1 is not open, measure TP17 for -18VDC.
c. If TP17 does measure -18VDC, replace U23.
d. If TP17 does not measure -18VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

J.7.1.4 No +15V (DS3 out)

a. If DS3 is not illuminated, check fuse F3 and replace if necessary.
b. If F3 is good, measure TP29 for +18VDC.
c. If TP29 does measure +18VDC, replace U24.
d. If TP29 does not measure +18VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

J.7.1.5 All LED Indicators lit (except DS4)

If all the LED indicators are lit, it is possible the fault sensing circuitry has failed. Proceed as follows,

a. Check TP22 for +5VDC and replace U29 if necessary.
b. If TP22 is okay, measure the voltage on TP42.
c. If this is a logic high, the signal is correct and no fault exists on this board. Refer to the Controller section of the manual and to the Transmitter overall wiring diagram to continue troubleshooting this fault.
d. If the TP42 is low, and TP19, TP20, and TP21 have the correct voltages, then troubleshoot U15 and associated circuitry and replace if necessary.

J.7.2 Audio Input

Problems in this circuit would be characterized by:

a. Poor High Frequency Response, or
b. No Audio with Carrier Present

J.7.3 Poor High Frequency Response

The circuitry that would effect this problem on the Analog Input Board is the Bessel Filter.

a. Verify that P1 and P2 are in the correct position for the source impedance of the generator.
b. For more information on this, see the Installation section on setting Audio Source Impedance.

c. If the proper position is selected, check R39, R49, C20 thru C23 and L5 through L7.

J.7.4 No Audio but Normal Carrier is Present

a. Verify that audio is connected to the Transmitter and P1 and P2 are in the correct position.

b. Check TP12 for an audio signal.

1. If present, suspect U3.
2. If the signal at TP12 is not symmetrical suspect U1.
3. If it is not present, replace U1.

J.7.5 RF Amp Power Supply Current Fault

Several areas on this board could cause an RF Amplifier Power Supply Current Fault. These include:

a. Overcurrent Sensing

b. Max Power Adjust

c. Power Supply Correction

J.7.5.1 Overcurrent Sensing

If the Control front panel displays an RF Amp Power Supply Current fault, apply an RF Mute with S1 on Controller Board and turn on the Transmitter.

J.7.5.1.1 RF AMP Supply Fault Does Not Return

a. If the RF Amp supply fault does not return after the RF Mute is applied, check the voltage on TP23 and TP24 and compare them against the factory test data.

b. If they are not correct check R113 and R118.

c. If these voltages are correct, a true Supply Fault exists. Refer to the Transmitter Troubleshooting Section to locate the Supply fault.

J.7.5.1.2 RF Amp Supply Fault Returns

a. If the fault returns and the Supply current meter does not deflect upward, start troubleshooting by checking the voltage on TP30 of the Analog Input Board.

b. If this is a logic high, the Analog Input board is not generating the fault. Refer to the Controller, Power Block Interface Sections and Overall Wiring Diagram to isolate the fault.

c. If TP30 is a logic LOW, check the voltages on TP23 and TP24 and compare them against the Factory test data.

d. If the voltage on either test point is different from the test data check R113, R118, U13 and the +15 Volt supply.

e. If TP23 and TP24 measure correctly, check TP4 for a logic HIGH when the Transmitter is turned on.

f. If TP4 is HIGH, DS5 should also illuminate.

g. If TP4 is a logic HIGH check TP25 for a voltage less than what was measured on TP23 when the Transmitter is turned on.

h. If TP25 is greater than TP23 then, suspect a failed U11 or incorrect sample from the Controller.

i. If TP25 is less than TP23, measure the voltage on TP26 when the Transmitter is turned on and compare it to the voltage on TP24.

j. If TP26 is higher than TP24 suspect a failed U11.

k. If TP26 is less than TP24, suspect a failed U13.

J.7.5.2 Max Power Adjust

If the fault is a true power supply current fault, and not a sensing problem, then there could be a problem with the DC level being added to the audio. Proceed as follows:

a. First, with the Transmitter OFF, check the Max Power Adjust circuit.

b. Measure TP15 for -1.15VDC (within 0.2VDC) with no audio. A voltage reading more negative than -1.35VDC would indicate a malfunction of U3 or a misadjustment of the MAX POWER ADJUST, R56.

c. If TP15 is too far off, measure TP14. It should measure one half of the voltage on TP15. If not, replace U3.

d. If TP15 is within range, move on to the Power Supply Correction circuit.

J.7.5.3 Power Supply Correction

a. If TP15 measures correctly, check TP11. It should measure -1.25VDC (within 0.2VDC).

b. If not, measure TP2. It should be approximately 0VDC.

c. If TP2 measures correctly, and TP11 does not, replace U16.

d. If TP11 and TP2 both measure correctly, then with the RF Mute ON, turn the Transmitter on and measure TP2 again.

e. TP2 should measure approximately 5.6VDC.

f. If not, place jumper J5 in the Bypass position, 2-3, and again check TP2 for approximately 5.6VDC.

g. If present, refer to the overall wiring diagram to trace the missing correction voltage.

NOTE

If the sample is in the Bypass Mode, power level will not track changes in power line variances, and higher than normal low frequency THD may be noticed.

J.7.6 Power Control

Power control faults can be classed into four areas: Power Control, Fine Power Control, Power Step Up and Foldback. These areas all have an effect on the (Audio + DC) circuitry.

J.7.6.1 Power Control

If the Transmitter appears “stuck” in one power mode even though the front panel indicators show a different power level has been selected:

a. Turn off the Transmitter and move P4 to the Bypass position.

b. Turn the Transmitter back on and adjust Bypass Power Level (R68) for the power output desired.

1. If R68 has no effect suspect U8 and or a fault on the A-D Converter Board.
2. If the power can be changed by R68, turn off the Transmitter and put P4 back in the normal position.

c. Turn on the Transmitter and adjust the potentiometer on the Analog Input Board R65, R67 or R66 for the selected power level.

WARNING: Disconnect primary power prior to servicing.

d. If this has no effect on the power output, check the input of U17 for a HIGH (+15V) on pins 9 (LOW), 10 (MED), or 11 (HIGH) when a power level is selected.
e. If the high is present change U17.
f. If the HIGH is not present when a power level is selected suspect U14 or U25.

J.7.6.2 Fine Power Control

a. If the fine power control (Raise, Lower function) does not operate on any power level, suspect U18 or U7.
b. If the fine power control does not work at some power levels, suspect the PAL for that power level. (U21 for High, U20 for Medium and U19 for Low power.) These PALS have the same program and can be interchanged to verify that a PAL is defective.

J.7.6.3 Foldback

If the Power Block is in Foldback check the inputs to U5 at pins 5, 6, and 7 to verify that a fault with this board exists.

a. If any of these pins are a logic HIGH a fault is being generated from the Controller. Refer to the Controller and Transmitter Troubleshooting Section to Continue.
b. If the inputs to U5 are low check TP36, TP35 and TP34 for a high of +15 VDC.
c. If any of these inputs are HIGH, suspect U5 or U6.
d. If the testpoints measure a logic LOW, suspect U14.

J.7.6.4 Modulated B-

If a Modulated B- problem occurs, use the plots and voltages from another Encoder to determine where the differences are. Also, verify the proper B-voltage from the test data sheets.

J.8 Removal and Replacement

Remove the 8 screws and 4 connectors from the board. When installing a replacement board, before operating the Transmitter perform the Alignment for this board listed in this section of the manual.

J.9 Alignments

J.9.1 Audio Gain

J.9.1.1 Setting Audio Input Level

The Audio Input sensitivity of the Transmitter can be adjusted with the AUDIO GAIN ADJ control on the Analog Input board, so that audio input levels of -10 dBm to +10 dBm at 600 Ohms will produce 100% modulation. This is factory set for +10dBm. If a level other than +10dBm is desired, use the following procedure to for this adjustment:

a. Set the Audio Generator for the desired audio level for 100% modulation. (Typical levels are 0 dBm or +8 dBm, but the Transmitter can accommodate reference levels from -10 dBm to +10 dBm at 600 Ohms.)
b. Switch the Transmitter to HIGH power.
c. Adjust the“Audio Gain Adjust” control (R54, on the Analog Input Board) so that modulation level is 100%, as read on the modulation monitor.
d. This completes audio input level adjustment.

J.9.2 Maximum Power Adjustment

a. Turn on the Transmitter at HIGH power.
b. Set S1 to the Calibrate position.
c. Slowly adjust R65 fully CW or until the Transmitter power reaches 220 kW.
d. Adjust the maximum power pot R56 for 200 kW. This will allow the Transmitter to operate to 220 kW when the Fine Power adjustment is at maximum (+10%).
e. Switch to LOW power and adjust R37 until the desired Low power level is reached.
f. Switch to MEDIUM power and adjust R67 until the desired power level is reached.
g. Set S1 back to the Normal position.

J.9.3 Bypass Power Level Adjustment

a. Apply an RF Mute with S1 on the Controller and turn the Transmitter on HIGH.
b. Move P4 from the Normal position of 2-3 to the Bypass position of 2-1.
c. Turn R68 Bypass Power Level fully counterclockwise.
d. Remove the RF Mute and adjust R68 to the desired power level.

NOTE

R68 can adjust the power level from 10 to 200 kW. If the power level needs to be changed while in the Bypass mode, it must be done manually by adjusting R68.

CAUTION

DO NOT SWITCH TO THE MEDIUM OR LOW POWER LEVELS -THE MODULATION MONITOR SAMPLE WILL BE MUCH HIGHER AND COULD POSSIBLY DAMAGE SOME EQUIPMENT.

J.9.4 THD Null

Operate the Transmitter at low and medium power levels and modulate using an IMD 4:1 signal. Adjust R29 for minimum IMD Distortion.

J.9.5 High Power THD Null

For High Power THD Null, adjust R170 (Null 1) and R172 (Bias 1) for best THD responce. Null 2 and Bias 2 are not used.

J.9.6 Low Frequency THD Null

Operate the Transmitter at 200 kW, 95% modulation at a frequency between 30 and 60 Hz. If the low frequency THD is not acceptable readjust R143 for minimum.

J.9.7 Dither Frequency

Connect a frequency counter to TP1 on the Analog Input Board and adjust R19 for 72 kHz. The frequency is not critical but should be within 70 to 74 kHz.

J.9.8 Dither Level

a. Modulate the Transmitter at 200 kW with a 1 kHz sinewave to 95% negative peaks.

b. Set a reference level on the distortion analyzer from the demodulated audio out of the modulation monitor.

c. Turn the audio off and measure noise.

d. Adjust R26 on the Analog Input Board for minimum noise.

J.9.9 Modulated B- Drive Adjustment

a. Modulate the Transmitter at 200 kW with a 1 kHz sine wave at 95% negative peak modulation.

b. Connect a scope to TP27 MOD B- Drive on the Analog Input Board. Displayed will be the Modulated B- Drive waveform.

c. Set the scope for 200mV per division, 500uS sweep, DC coupled and the 0.0VDC line on the top graticule, since this is a waveform at a negative voltage.

d. The positive peak of this waveform should be from -.5 to -.7VDC. The negative peak should occur between -1.5 and -1.6VDC.

e. The Offset adjustment R104 will affect the positive peak of the Modulated B-signal. When this control is fully CW the B- waveform will begin to flatten at the positive most portion and when then adjusted in a CCW direction, the flattening will decrease until it disappears and the B- will begin to become more negative going.

f. If the B- waveform is not within the range specified above adjust R130 B-Voltage Adjust per the Test Data Sheet. Use the Plots as a second option.

J.9.10 Peak And Average Current Overload

a. Turn the Average current overload R17 fully CW.

b. Preset the Peak current overload R113 for 9.5VDC measured at TP23.

c. Operate the Transmitter at 200kW and modulate with a 50Hz sinewave at 100% negative peaks.

d. Increase the audio level by 1.4 dB, PA current should be between 750 and 850 A.

e. Adjust the Average current overload R118 until the current limit LED DS5 just begins to illuminate RED with modulation.

f. Reset the audio for 100% negative peaks.

g. Increase the audio by .5 dB and adjust the Average current overload R17 until DS5 just begins to illuminate RED.

h. Increase the audio in 1dB steps noting the PA current should not increase further than near full scale on the PA current meter.

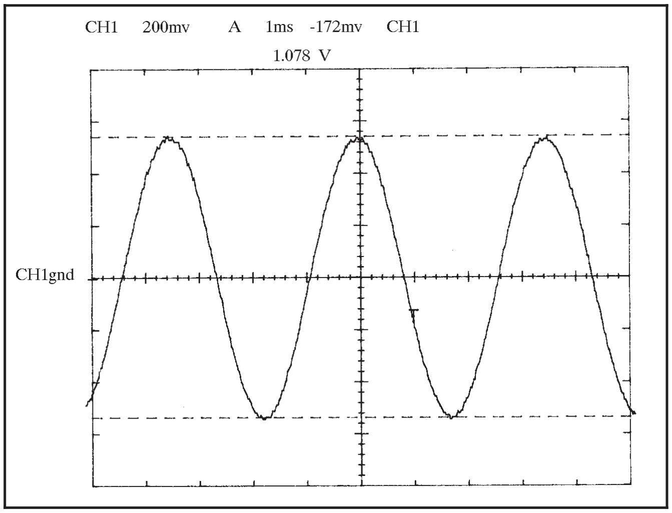
i. Keep increasing audio level until the Transmitter shuts off and recycles back on. If the audio level is not reduced, it may shut off and stay off at this time.

j. The Overcurrent LED will illuminate RED and can be reset from the LED panel.

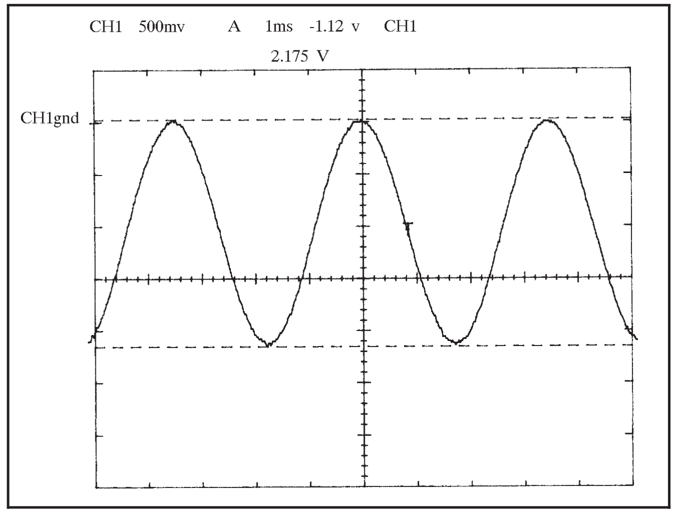
k. Turn the Transmitter back on and verify that the Transmitter should take at least 10dB of audio overdrive before shutting off.

J.9.11 Zero Adjust

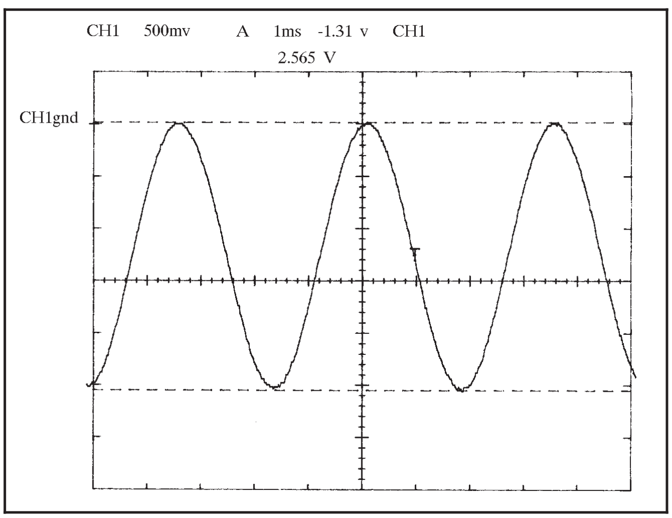
Operate the Transmitter at 200 kW and apply an RF Mute. Adjust R35 Zero Adjust for a zero indication at the Remote Indicator.



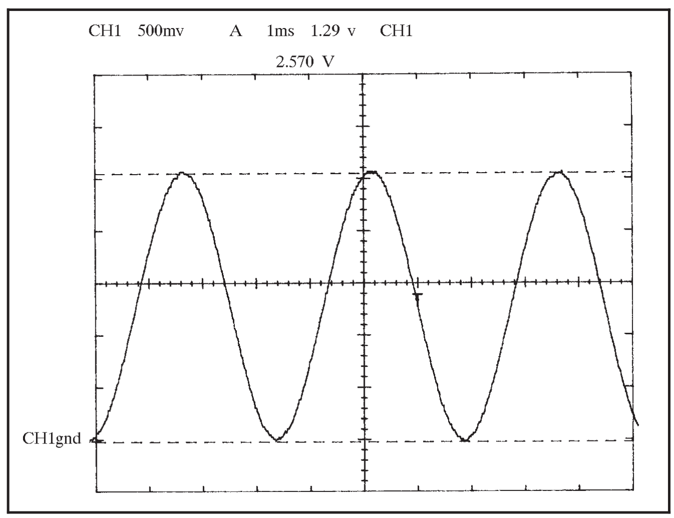
TP12



TP15

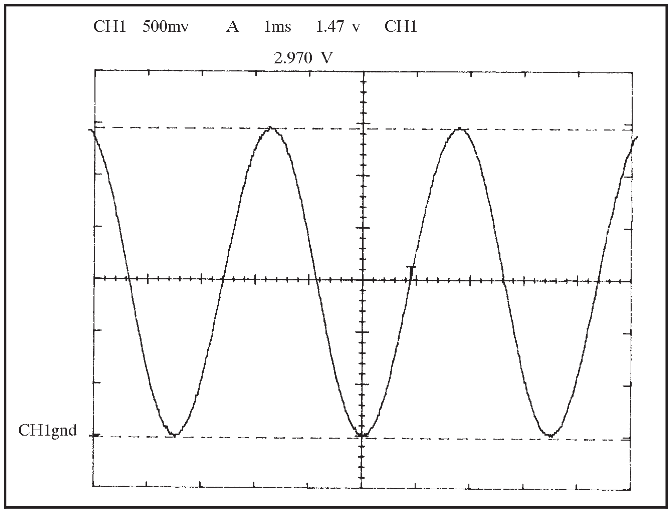


TP11

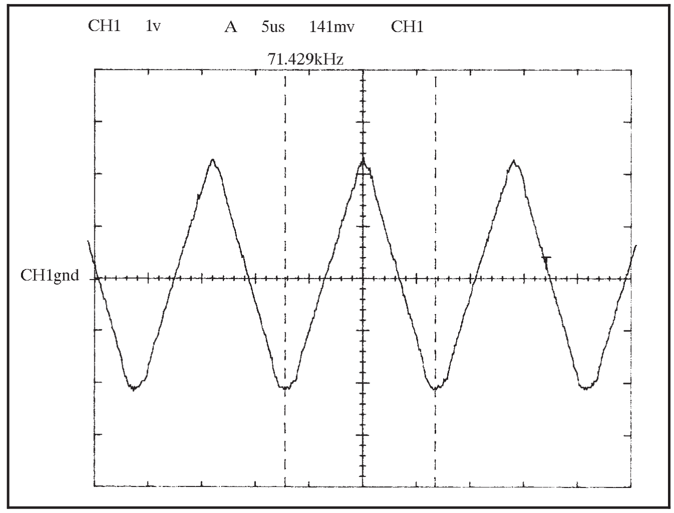


TP5

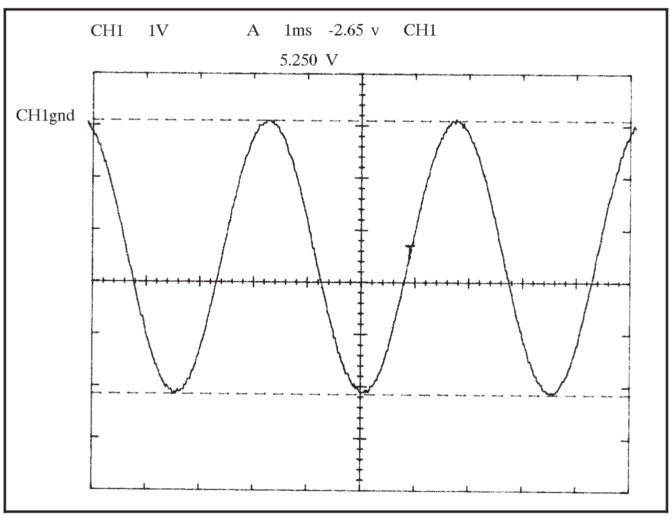
WARNING: Disconnect primary power prior to servicing.



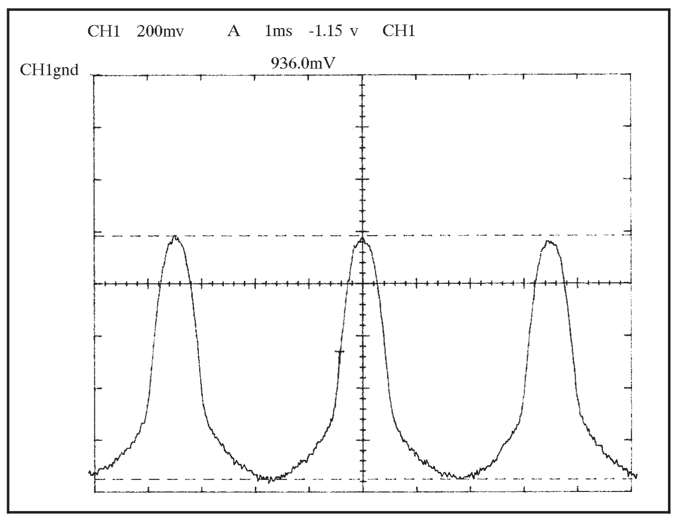
TP16



TP1

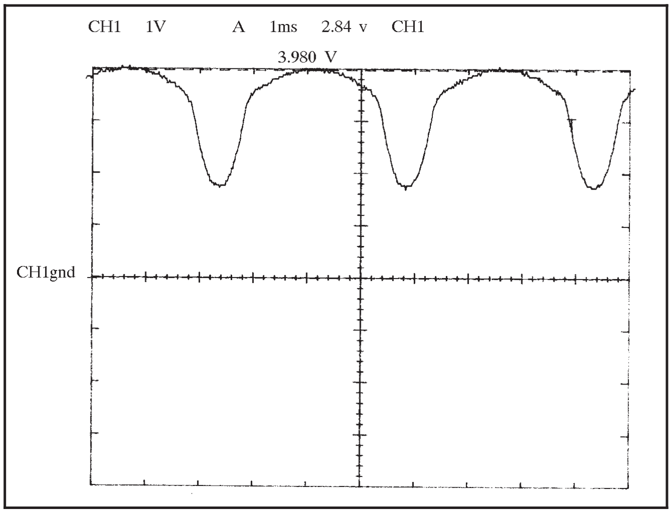


TP7

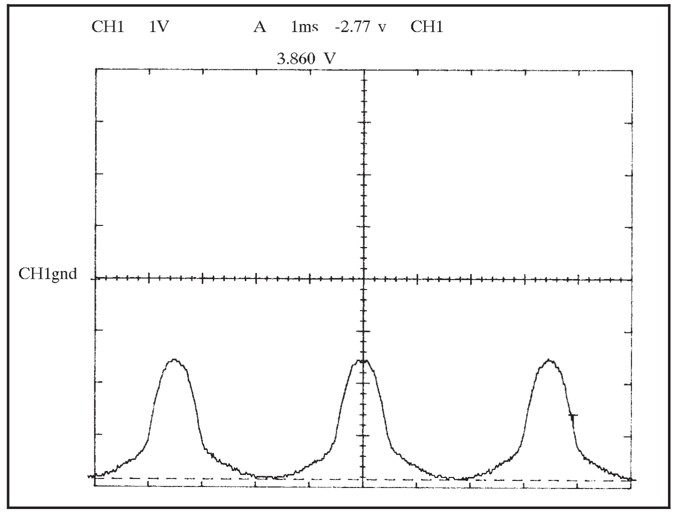


TP27

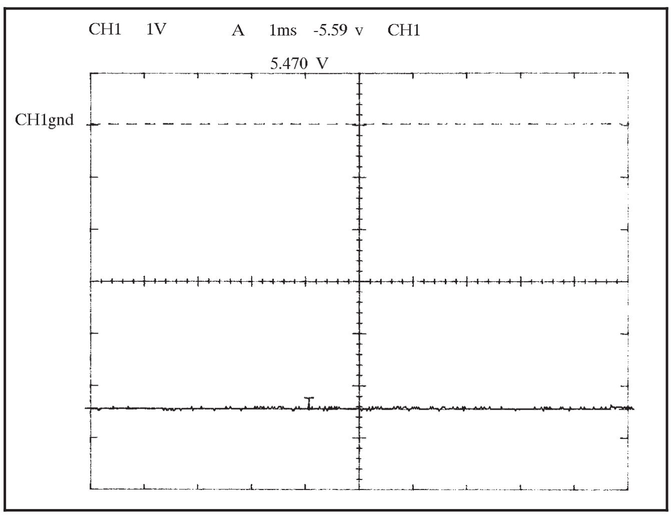
WARNING: Disconnect primary power prior to servicing.



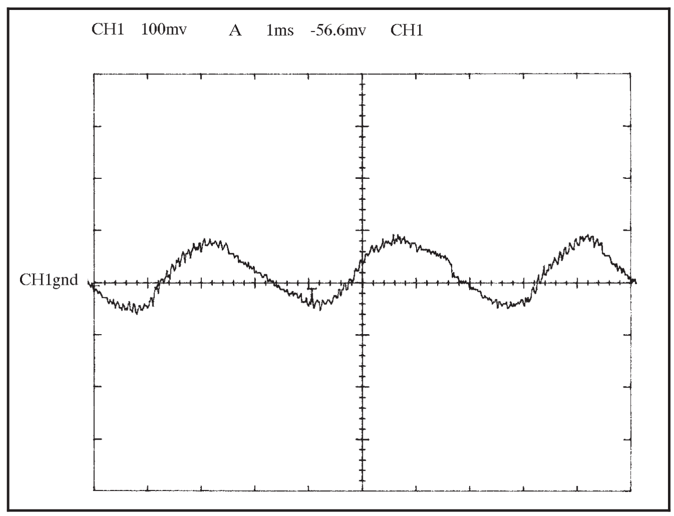
U10-7



U10-1

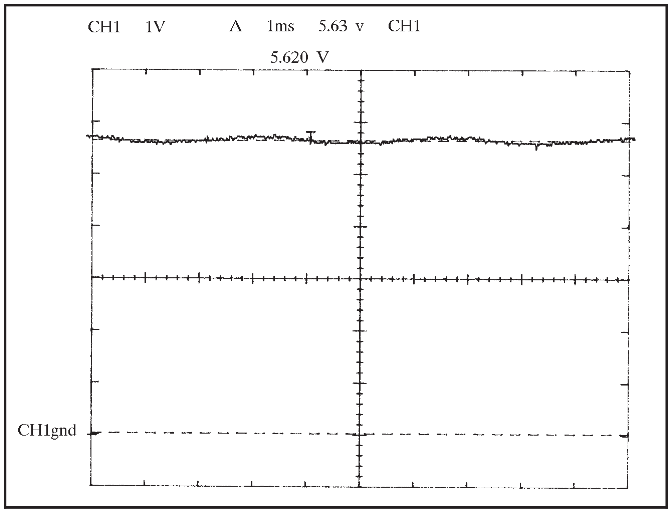


TP31

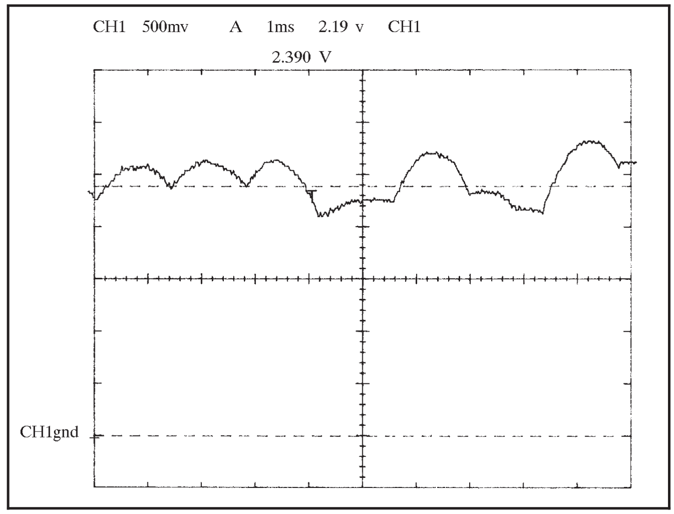


TP32

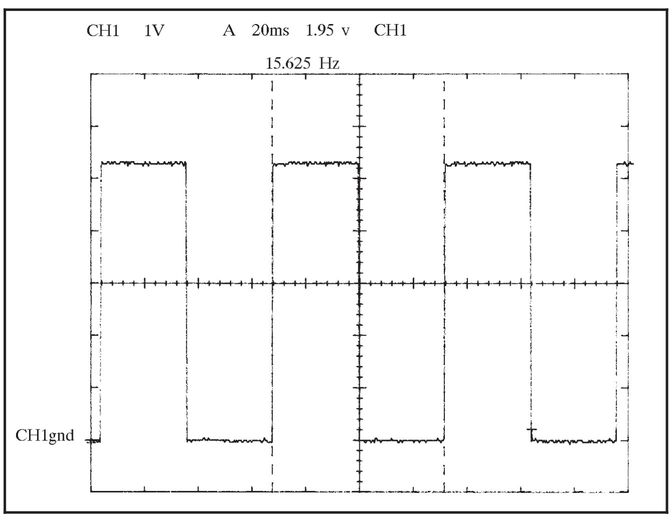
WARNING: Disconnect primary power prior to servicing.


CH1 1V A 1ms 5.63 v CH1
5.620 V
CH1gnd

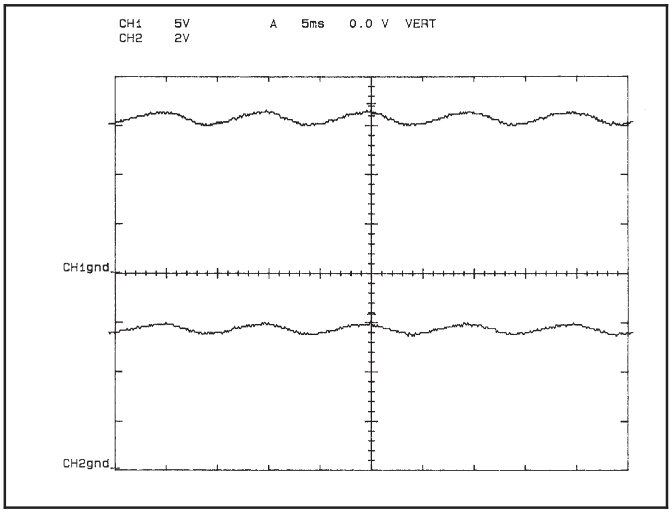
TP2


CH1 500mv A 1ms 2.19 v CH1
2.390 V
CH1gnd

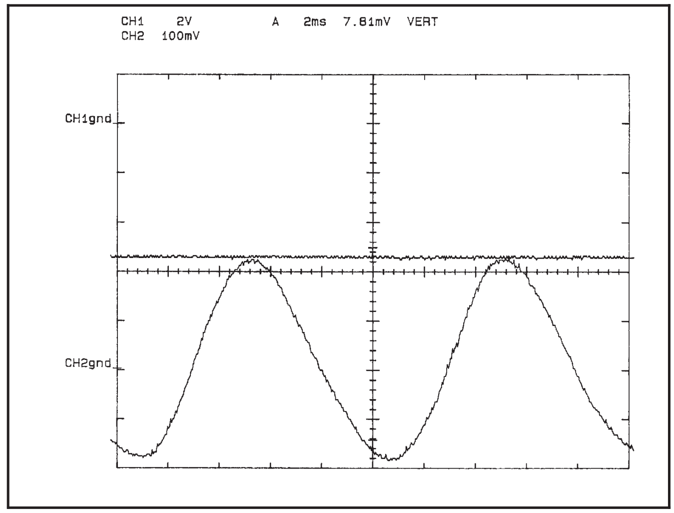
TP25


CH1 1V A 20ms 1.95 v CH1
15.625 Hz
CH1gnd

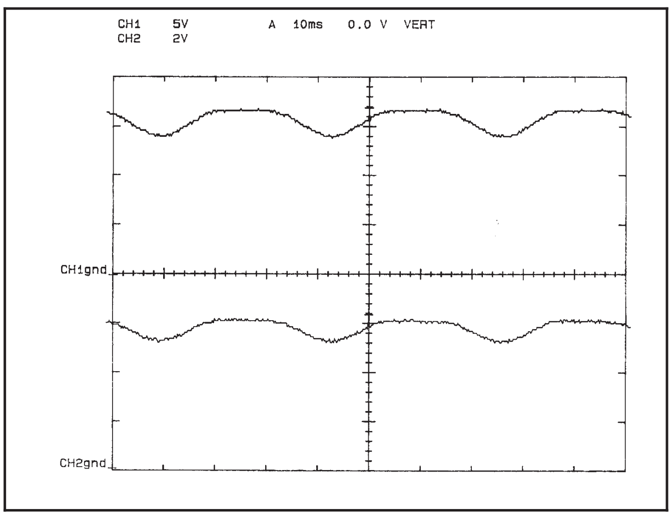
TP9



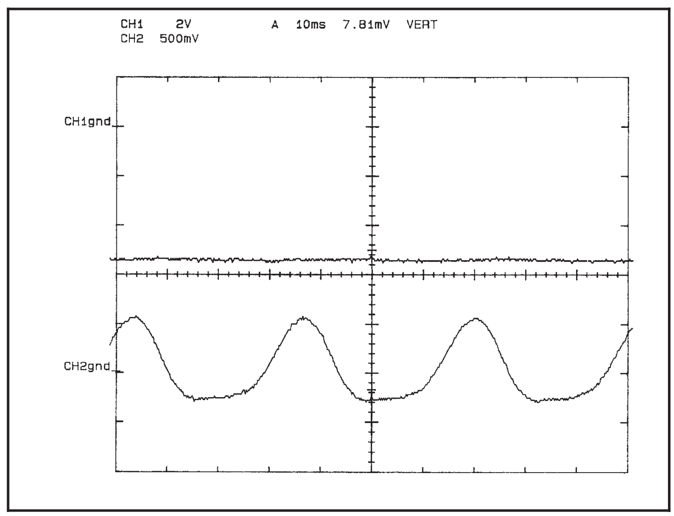
Upper Trace - CH1 - TP28
Lower Trace - CH2 - TP2
NOTE - 100Hz 95% Modulation 200kW



Upper Trace - CH1 - TP31
Lower Trace - CH2 - TP32
NOTE - 100Hz 95% Modulation 200kW



Upper Trace - CH1 - TP28
Lower Trace - CH2 - TP2
NOTE - 30Hz 95% Modulation 200kW



Upper Trace - CH1 - TP31
Lower Trace - CH2 - TP32
NOTE - 30Hz 95% Modulation 200kW

K.1 Introduction

This section describes the Analog to Digital Converter board, and includes maintenance and troubleshooting information and oscilloscope plots of key points.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Assembly #	992-8191-004
PWB #	843-5458-473
Schematic #	843-5458-471

Note: Parts List for this board is covered in Section VII.

K.2 Function

The Analog to Digital Converter board converts the (Audio + DC) signal from the Analog Input Board into a Digital Audio Signal.

The Digital Audio Signal determines how many RF Amplifiers are to be turned on at any instant, via the Modulation Encoders.

Conversion functions, conversion fault logic, and data latches are included to accommodate these functions. Big Step Sync and Reconstructed Audio signals are also generated by circuits on this board, for use in other sections of the Transmitter.

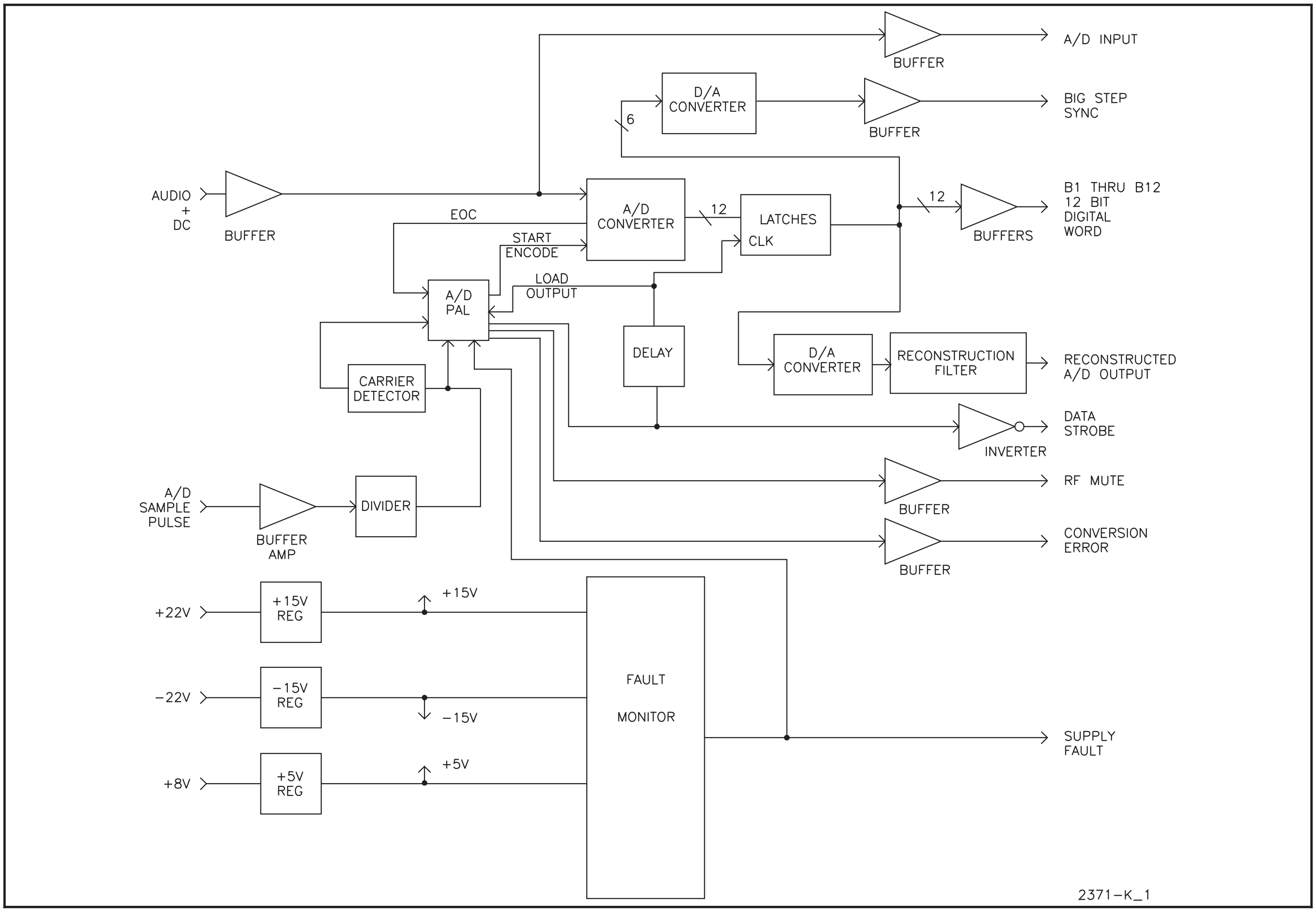


Figure K-1. Analog To Digital Converter Block Diagram

K.3 Location

The Analog to Digital board is located in the center control compartment on the back of the front door (See VIEW 3).

K.4 Block Diagram Description

K.4.1 RF Flow

An A/D Sample Pulse that is processed on the Driver Encoder is applied to a buffer amplifier. The output frequency of the buffer amplifier is at the carrier or 1/2 the carrier depending upon the Transmitter frequency and goes to a Carrier Detector and the A/D PAL. The divider is not being used in this application.

The Carrier Detector will send a fault signal to the A/D PAL should no RF signal be present.

K.4.2 (Audio + DC) Flow

The (Audio + DC) signal from the Analog Input is buffered by a buffer amplifier and sent to the A/D Converter. The analog signal is sampled approximately once every two microseconds (the sampling rate depends on the Transmitter frequency) and converted into a 12-bit digital audio signal by a high-speed analog to digital (A/D) converter. A buffer amplifier is also driven by the (Audio + DC) and its output is called A/D Input. It is sent to the Control Multimeter for testing purposes.

K.4.3 A/D Converter

The A/D Converter and the A/D PAL operate in sync with each other. (Audio + DC) from the buffer and a START ENCODE signal from the A/D PAL allows the A/D Converter to convert the instantaneous (Audio + DC) analog signal to a 12 bit digital word that digitally represents the analog signal. When the A/D Converter has finished the conversion process, it sends a EOC signal back to the A/D PAL and the 12 bit digital word is present at the 12 outputs B1-B12 of the A/D Converter.

K.4.4 Latches And Buffers

The 12 bit digital word is transferred into the Latches by the LOAD OUTPUT signal from the A/D PAL. Data Latches store the digital data after each conversion and hold the data until the next conversion is completed. These 12 data lines are sent to buffers and applied to each Modulation Encoder.

K.4.5 A/D PAL

The A/D PAL accepts the A/D Sample Pulse from the divider and provides the A/D Converter with START ENCODE signals. When the conversion process is finished by the A/D Converter, a EOC pulse is sent back to the A/D PAL.

A LOAD OUTPUT from the A/D PAL is used to transfer in the 12 bit digital word into the Latches.

A DATA STROBE output from the A/D PAL is inverted by an inverter and applied to each Modulation Encoder to latch in the current 12 bit digital word.

The A/D PAL also monitors the timing sequence described above and can generate an RF MUTE, CONVERSION ERROR, or stop the START ENCODE signals if a carrier loss or supply fault is detected.

K.4.6 D/A Outputs

A full 12 bit digital word is applied to a D/A Converter which converts the digital word back into an analog signal. The output, after passing through a Reconstruction Filter, (Audio + DC) is present at the output of the filter. The reconstructed signal is buffered and sent to the Control Multimeter position labeled A/D OUTPUT. This meter position is used for troubleshooting purposes.

A second D/A Converter accepts the 6 most significant bits B1-B6 and converts this partial digital word into pulses. These Big Step Sync pulses are buffered and sent to the Analog Input Board to trigger the Dither Oscillator.

K.4.7 Power Supplies

+18VDC, -18VDC, and +7.5VDC are regulated down to +15VDC, -15VDC, and +5VDC respectively to power circuits on this board.

A Supply Fault Sense circuit monitors these supplies and can generate a Supply Fault for the A/D PAL and the Controller.

K.5 Detailed Circuit Description

Refer to the schematic diagram for the A/D Converter (843-5458-471) for all descriptions in this section.

K.5.1 Analog Input

The A/D Converter analog input signal, at J4-3 & 5, is the (Audio + DC) from the Analog Input Board. The DC component determines the unmodulated Transmitter power output by turning on the required number of Big Step RF Amplifiers via the Modulation Encoders. (Typically 102 Big Steps RF Amplifiers on at 200 kilowatts).

The analog signal level at the board's input is high so that inverting amplifier U1, which has a gain of less than 1, can provide the proper signal level to the A/D Converter.

A very small amount of "Big Step Sync" is added to the input signal at the inverting input of U1 (pin 2, via R5). When a Big Step RF Amplifier turns on a small amount of the Big Step Sync component forces the input to the A/D higher, just enough to ensure that the A/D Converter will not switch back to the previous step. When a Big Step RF Amplifier turns off a small negative amount of the Big Step Sync component forces the input to the A/D lower, just enough to ensure that the A/D Converter will not switch back to the previous step.

K.5.2 A/D Converter

A high-speed 12-bit analog to digital converter is used. The analog input voltage range is 0 to +5 Volts. An input of zero Volts gives a digital output of "0000 0000 0000." An input of +5 Volts gives an output of "1111 1111 1111".

The Analog to Digital Converter has two signal inputs, an analog signal input at pin 22, and a TTL logic START CONVERT input at pin 18. The conversion is started by the START CONVERT pulse.

K.5.2.1 A/D Converter Timing

The Start Encode pulse at TP2 (see plots and A/D Timing Sequence) goes HIGH for 840 nSec and then returns LOW. The EOC pulse at TP3 that is normally HIGH, goes LOW 528 nSec after the START ENCODE signal. The EOC remains LOW for 140 nSec. The DATA STROBE which is an inverted output of U5-15 at U10-2 is normally high. 564 nSec after the START ENCODE the line goes LOW for 140 nSec. The LOAD OUTPUT is normally LOW and it goes HIGH for 140 nSec, approximately 624 nSec after the START ENCODE signal.

The twelve TTL level output lines are at pins 31 through 33 and 35 through 43 on U3. Pin 31 is the least significant binary bit (LSB), and pin 43 is the most Significant bit (MSB). Pin 30 is a EOC TTL logic output.

K.5.3 Data Latches

The digital Data Latches store the digitized audio information while the A/D converter is performing the next conversion. When the next conversion is completed, the LOAD OUTPUT signal from the TIMFLT PAL clocks the data latches and stores the new digital audio information.

U6 stores the 6 most significant bits (MSB's), and U7 stores the 6 least significant bits (LSB's).

A logic LOW signal to the Data Latches clear the latches at Pin 1, will cause all outputs to go LOW. All outputs will remain LOW as long as the CLEAR input remains LOW, no matter what the data or clock inputs are. The CLEAR input is normally High, and will only go LOW when a timing fault has occurred. The Clock input to the Data Latches is the LOAD OUTPUT pulse. The positive-going edge of the pulse is the Clock input, which causes the output of each data latch to go to the same state as its input at that instant. The outputs will then remain in that state, storing the data, until another clock input, or until the latch's CLEAR input goes low.

K.5.4 Buffers

Buffers provide data outputs to drive the inputs on the Modulation Encoder Boards. Hex buffers U8 and U9 each contain eight sections, When a buffer input is high, its output is also HIGH and when a buffer input is LOW (logic 0), its output is also LOW.

K.5.5 Clock Pulse

The A/D Sample that originated on the Driver Encoder Board enters at J3-1 to clock the A/D Converter and the Data Latches. The Pulse drives the base of Q1 and is buffered by U10. The frequency divider's output at TP4, CLOCK, is the input frequency, because the jumper plug is installed in JP17 1 to 2 in this application.

The frequency divider output goes to the TIMFLT PAL and to the carrier detector.

K.5.6 Data Strobe

The DATA STROBE signal Clocks the data latches on the Modulation Encoders, so that digital audio data is stored in the Modulation Encoders after the A/D conversion is complete.

The Data Strobe signal is derived from the LOAD OUTPUT signal from the TIMFLT PAL. When the conversion process is completed, the LOAD OUTPUT signal is delayed 60 nanoseconds by DL1, and becomes the Data Strobe signal at J1-35. Buffer U10-1 inverts the DATA STROBE signal and drives the circuits on the Modulation Encoder board.

K.5.7 Conversion Error Logic

Conversion Error logic on the TIMFLT PAL generates a DATA CLEAR logic signal which clears all digital data in latches U6 and U7 on the Modulation Encoder boards, and also generates a "Conversion Error" logic input, via the data strobe, to the Controller. The LOAD OUTPUT is measurable at TP13 and goes to the CLOCK inputs of latches U6 and U7.

K.5.8 Big Step Sync

The Big Step Sync circuit produces a pulse each time a Big Step RF Amplifier turns on. A Big Step occurs whenever one or more of the eight most significant bits (MSB's) in the digital audio signal changes. The Big Step Sync pulses synchronize the Dither oscillator on the Analog Input Board, and a small amount of Big Step signal is also added to the analog input (Audio + DC) signal at the A/D Converter input.

K.5.9 D/A Converter/Big Step Sync

An 8-bit D/A converter is used to convert the eight most significant bits of the digital audio signal back into an analog signal for big step sync. The D/A converter output, at U15-4, is a zero to -1 Volt signal, made up only of Big Steps.

Switch S1 is provided for use in other Power Blocks / Transmitter applications. Both sections of S1 are open in this application.

The output of the D/A converter is amplified by U16-U18. Low-pass filter R39-C49 removes any sample frequency and other high frequency components. A small stepped "Big Step Sync" signal which is added, through R5, to the Analog Input Signal. R41 and C81 form a differentiator, which produces a pulse each time a Big Step transition occurs. The pulses can be observed at the output of U19 at TP21, BIG STEP SYNC. The output signal from U19 goes to the Dither Oscillator circuit on the Analog Input board.

K.5.10 D/A Converter/Audio Reconstruction Filter

The 12-bit digital audio signal is converted back to an analog signal in by D/A converter circuit U11. The unfiltered D/A converter circuit's output is at U12-7, and is available for viewing at test point TP9. The unfiltered output at TP9 includes a DC component, and at full power with 100% modulation varies between zero and approximately +5 Volts. At lower power levels and/or lower modulation levels, the signal amplitude at TP9 will be smaller.

The Reconstruction Filter is a low-pass filter which passes the audio components and removes the higher frequency components in the "steps," effectively smoothing the output. Two 619-Ohm resistors, R19 and R22, are the terminating resistances at the input and output of the filter. Operational amplifier U12 drives the A/D output meter position on the Control Multimeter, and Reconstructed audio is present at TP19.

K.5.11 Power Supplies

Three regulated voltages are provided by on-board regulators. Each regulator circuit is fused and transient protected.

a. U22 is used as a -15 Volt regulator
b. U21 provides a +15 Volt output
c. U23 provides a +5 Volt output.

DC supply inputs to the A/D Converter are:

a. +18 Volts
b. -18 Volts
c. +7.5 Volts

Each of these is from the low voltage power supply. The inputs are fused with 2A fuses F1, F2, and F3 respectively and regulated to +15, -15, and +5 Volts using regulators U21, U22, and U24. Each regulator output has a green Status LED that lights when the regulator is operational. The output of the regulators are transient protected by tranzorbs CR16, CR17, and CR19.

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a supply voltage on the board that does not depend on the regulated supplies. The +18 and +7.5 Volt supplies go through diodes CR21 and CR22 to regulator U26. The supply will be active if either F1 or F3 opens. This +5VB is used as the reference to the inputs of comparator U25 thru series voltage divider networks. The output of U25-1,2 will go LOW if either the +15VDC or +5VDC supply is lost. The output of U25-13,14 will go LOW if the -15VDC supply is missing. The LOW output turns Q4 on and establishes +2.5VDC at the base of Q5. TP11, Supply Fault will go LOW illuminating DS6 RED when Q5 turns on. This Supply Fault-L signal is applied to the TIMFLT PAL U5 and goes to the controller via J1-1.

K.6 Troubleshooting

K.6.1 Power Supply

If an A/D Converter supply fault is displayed on the Control front panel, then with the low voltage on only, check the LED indicators DS1 (+15V), DS2 (-15V), and DS3 (+5V) on the A/D Board.

Each of these LED indicators should be on if the individual supplies are operating normally.

K.6.1.1 DS6 Illuminated

DS6 will light under 2 basic conditions,

a. If any of the Low voltage supplies or regulators fail, or
b. If one of the regulated outputs is more than 20% low. This means that DS1, DS2, or DS3 could be lit and a supply fault still be detected, turning on DS6. The input supply voltages and the regulated supply voltages will have to be checked closely to determine why DS6 is lit.

K.6.1.2 No +5V (DS3 out)

a. If DS3 is not illuminated, check fuse F3 and replace if necessary.
b. If F3 is not open, measure F3 for +7.5VDC.
c. If F3 does measure +7.5VDC, replace U23.
d. If F3 does not measure +7.5VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

K.6.1.3 No +15V (DS1 out)

a. If DS1 is not illuminated, check fuse F1 and replace if necessary.
b. If F1 is not open, measure F1 for +18VDC.
c. If F1 does measure +18VDC, replace U21.
d. If F1 does not measure +18VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

K.6.1.4 All LED Indicators Lit

If all the LED indicators are lit, it is possible the fault sensing circuitry has failed. Proceed as follows;

a. Check TP24 for +5VDC and replace U26 if necessary.
b. If TP24 is okay, measure the voltage on TP11.
c. If this is a logic HIGH, the signal is correct and no fault exists on this board. Refer to the Controller section of the manual and to the Transmitter overall wiring diagram to continue troubleshooting this fault.
d. If TP11 is low, and TP5, TP6, and TP7 all have the correct voltages, then troubleshoot U25 and associated circuitry and replace if necessary.

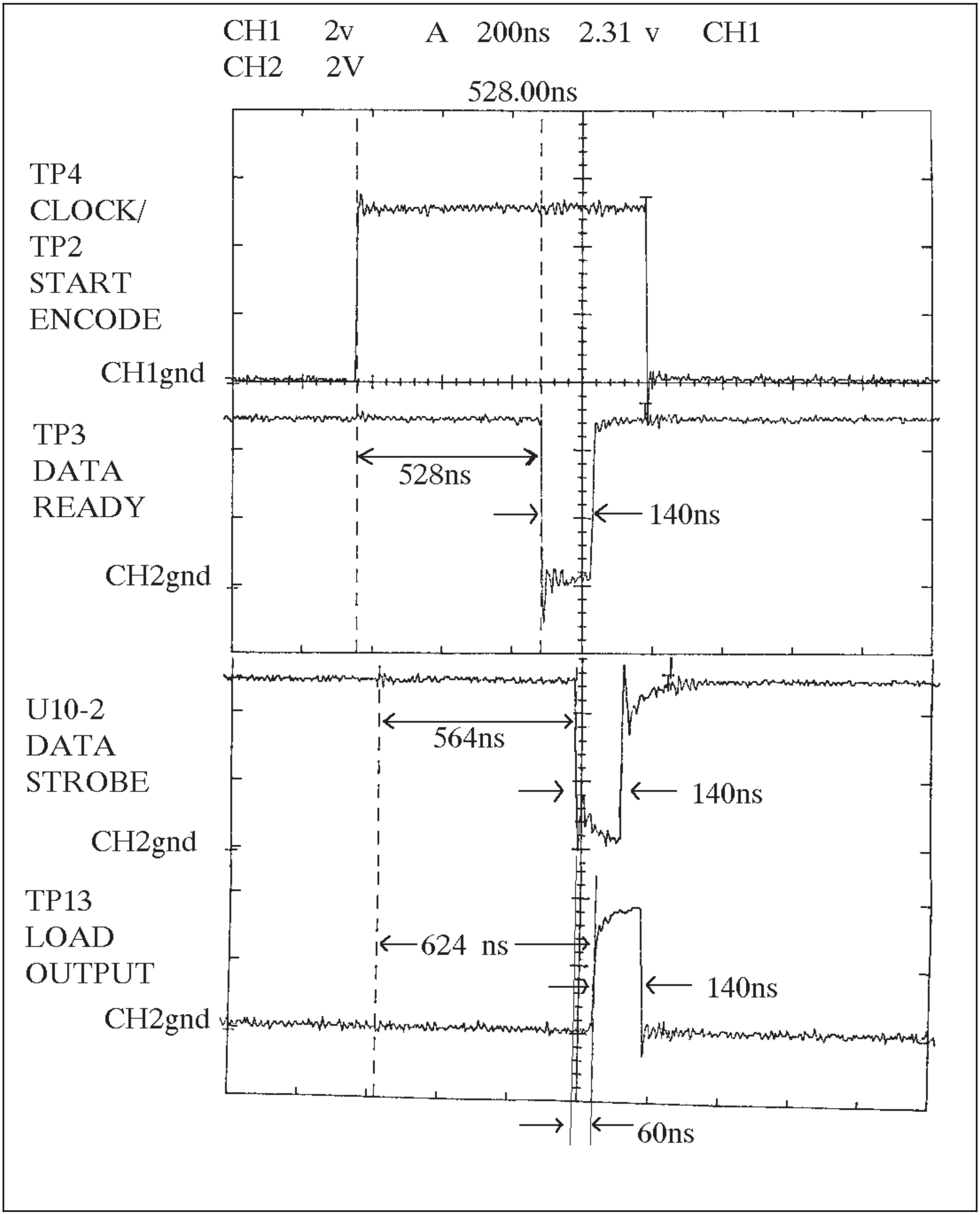
K.6.2 Big Step Sync

Begin troubleshooting this circuit by:

a. Turn on the Transmitter and modulate it with a 400 Hz tone to 95%. Observe the waveform at U16-6. **(see plot).**
b. If this audio signal is not present check for a signal on U16-3.
c. If an audio signal is not present on U16-3, replace U15.
d. If a signal is present at U16-3 replace U16.
e. If U16-6 is correct check for an audio signal at U18-6. (see plot).
f. If this signal is not present replace U18.
g. If present check TP21 for a series of pulses **(see plot)**.
h. If these pulses are not present replace U19.

K.6.3 A/D Converter

Faults with the A/D converter IC would be characterized by no or full output or by a series of voltage spikes on the audio.



A/D Timing Sequence

NOTE

To provide maximum protection to the Transmitter during troubleshooting of A to D faults, it is recommended to unplug J1 on the A/D board. This will display an RF MUTE, A/D Supply Fault and Conversion Error on the Control front panel when the Transmitter is turned on.

K.6.3.1 Transmitter goes to maximum power (All RF Amps on)

a. Check the A/D input meter on the Driver Multimeter located in the Right PA compartment.

b. Compare this to normal reading from the Factory Test Data or the station log.

c. If this is not correct, check for the (Audio +DC) signal at TP22.

d. If this signal is correct check U1, CR1, CR2, and U14. If the A/D input is correct:

e. Apply an RF MUTE with S1 on the Controller. The meter reading should drop to zero.

f. Check the inputs to Latches U6 and U7. They should all be at logic LOW.

g. If any of these are HIGH suspect a bad U3.

h. If these are all LOW check the output pins of U6 and U7 for a logic LOW.

i. If any of these are HIGH, replace the Latch (U6 or U7) and or check U15.

j. If these outputs are LOW, check U8 and U9 for correct action.

K.6.3.2 No power output

Begin by observing if Conversion Error DS5 is illuminated on the A/D Board when the Transmitter is turned on.

K.6.3.2.1 DS5 Illuminated

If the conversion fault is present, then while the Transmitter is on:

a. Check TP4 for a clock pulse.

b. If this pulse is not present check for the pulses coming from the Driver Encoder at R12 of this board.

c. If the pulses are not present at R12, refer to the overall wiring diagram and the Driver Encoder Section to continue.

d. If the pulses are present check Q1, CR3, U10 and U4.

e. If the clock pulse is present on TP4, check for a series of Start Encode pulses at TP2 with the Transmitter on.

f. If the start encode pulses are not present suspect a bad U5.

g. If the start encode pulses are present on TP2, apply audio to the Transmitter and check the A/D input meter on the Driver Multimeter located in the Right PA compartment.

h. Compare this to normal reading from the Factory Test Data or station log.

i. If this is not correct, check for the (Audio + DC) signal at TP22.

j. If this signal is correct check U1, CR1, CR2, and U14.

k. If the A/D input is correct, replace U5, and if fault remains replace U3.

K.6.3.3 Spikes or glitches on the audio

D/A converter U11 is used for troubleshooting a faulty D/A converter. Reconstructed audio can be observed at TP19.

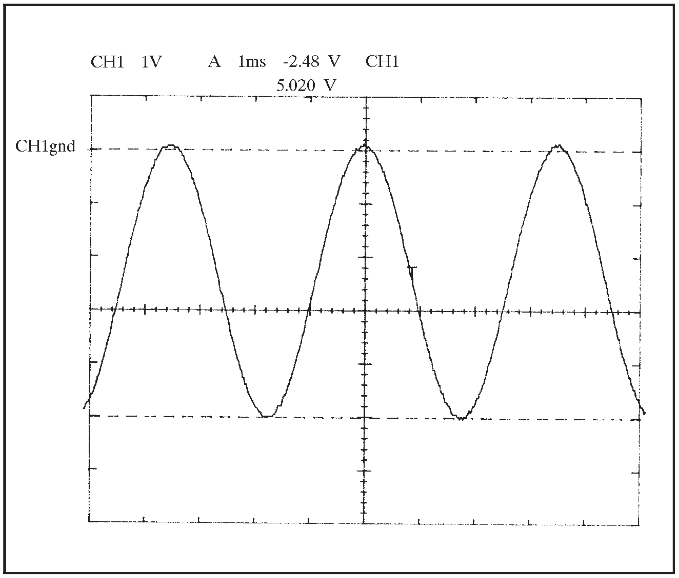
a. If the signal at TP19 has glitches and spikes and the input audio does not, replace U3 A/D converter.

K.7 Removal and Replacement

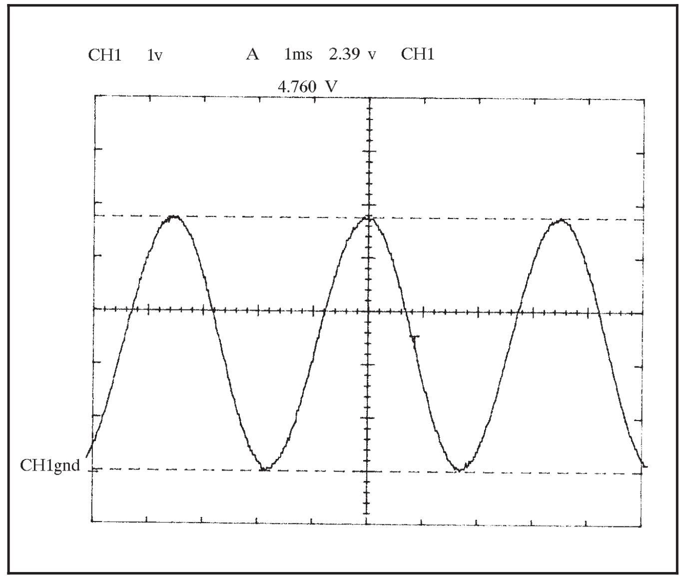
Remove the 10 screws and 4 connectors from the board. Reverse the procedure for replacement. When replacing the board set S1, JP11 and JP17 to the same setting as the removed board.

K.8 Alignments

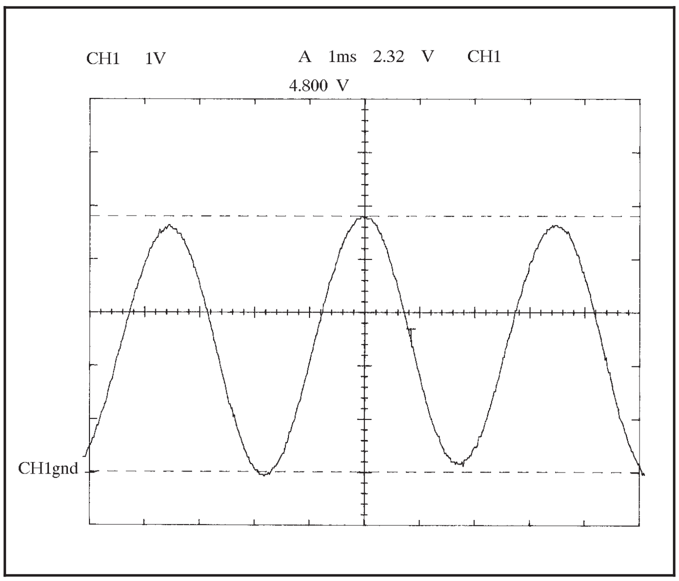
There are no alignments on this board.



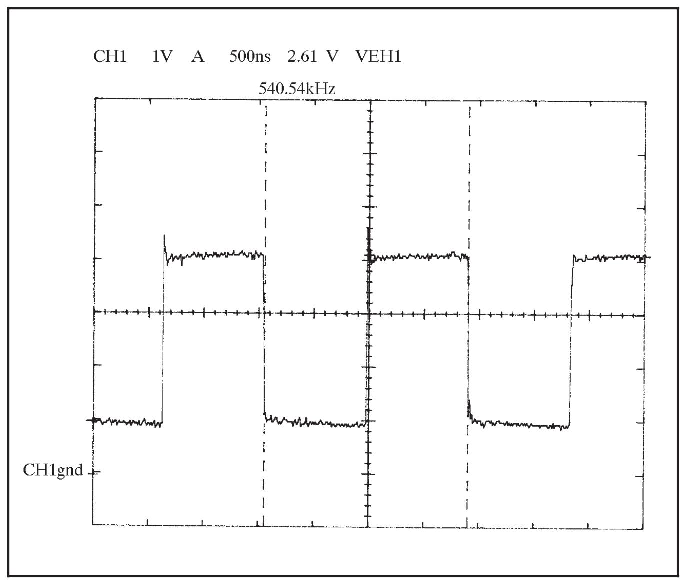
TP22



U3-22

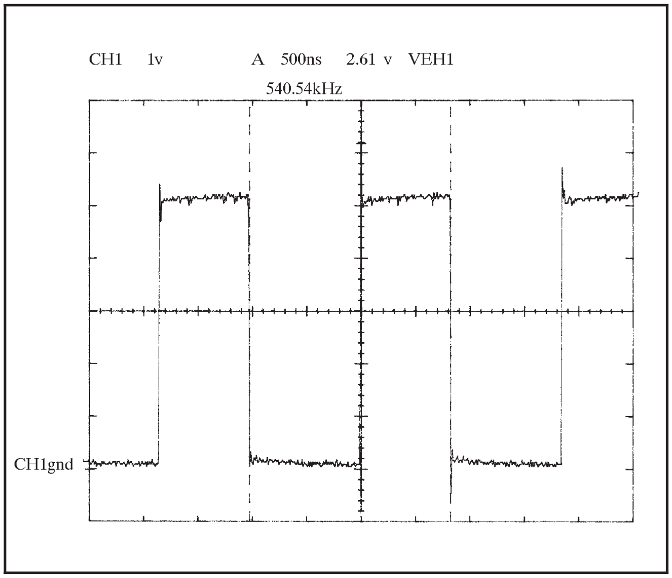


TP1

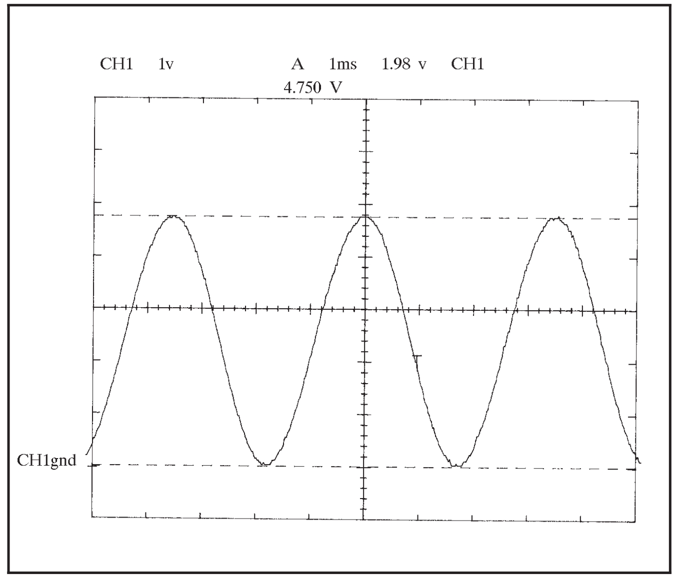


J3-1

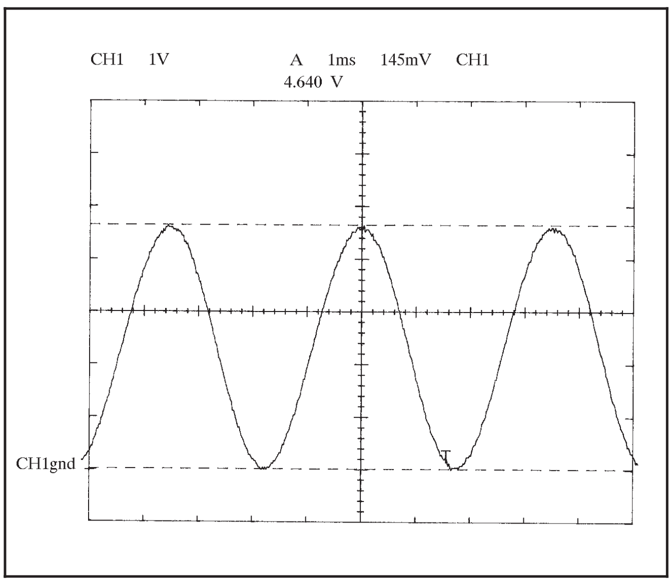
WARNING: Disconnect primary power prior to servicing.



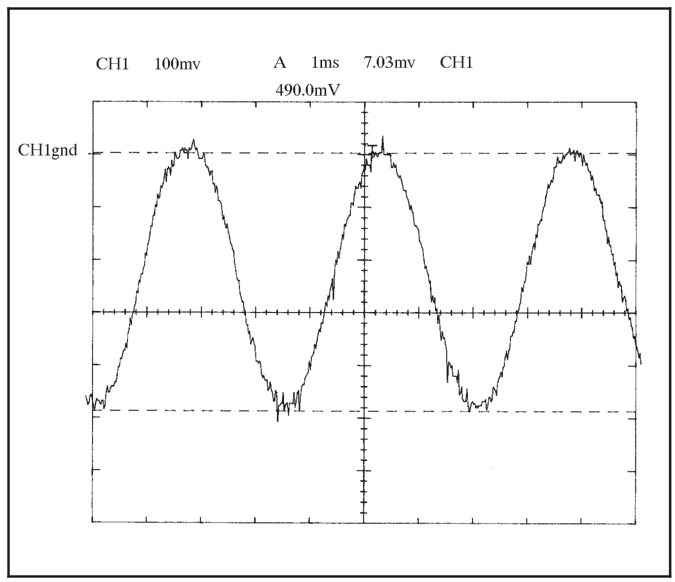
TP4



U12-7

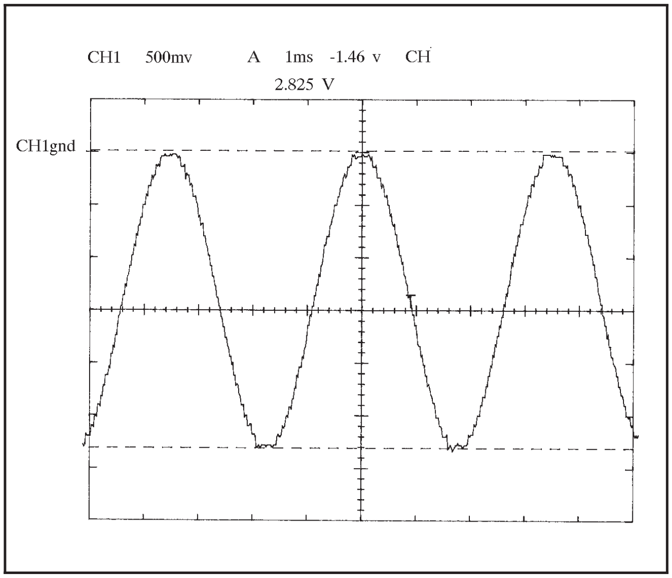


TP19

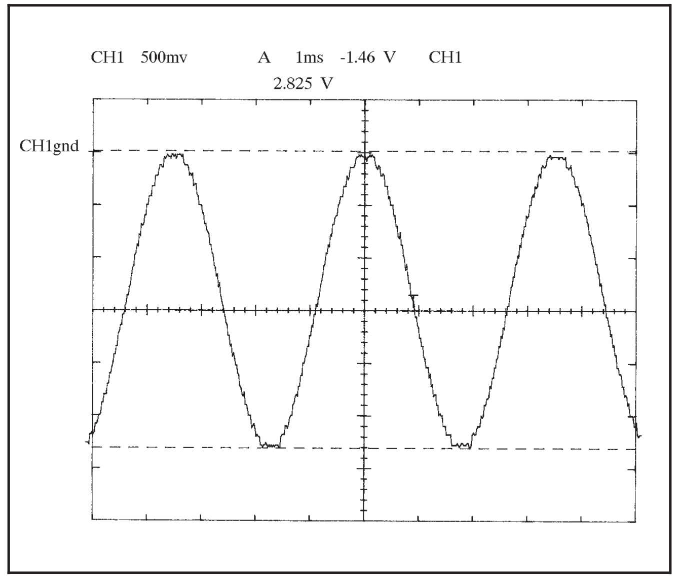


U15-4

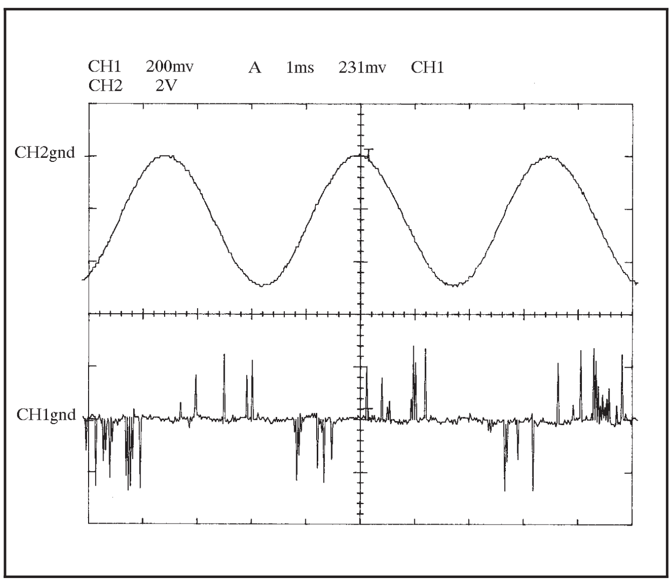
WARNING: Disconnect primary power prior to servicing.



U16-6



U18-6



Upper Trace - CH2 - TP22
Lower Trace - CH1 - TP21

WARNING: Disconnect primary power prior to servicing.

L.1 Introduction

This section describes the Big Step Modulation Encoder and the Binary Encoder Boards. Topics include Function, Location, Block Diagram Description, Detailed Circuit Description, Troubleshooting, and Removal/Replacement.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Binary Modulation Encoder

Assembly #	992-8193-007
PWB #	843-5155-011
Schematic #	839-7930-011

Modulation Encoder

Assembly #	992-8193-006
PWB #	843-5155-011
Schematic #	839-7930-011

Note: Parts Lists for these boards are covered in Section VII.

L.2 Function

The Modulation Encoder Board's main function is to convert the 12 bit digital audio signal from the A/D converter into Turn ON/Turn OFF signals for the 220 Big Step and 4 Binary Step RF Amplifiers.

Each Modulation Encoder also has Module/Cable Interlock, Fuse Fault Detectors, and a Programmable Big Step RF Amplifier. Four Encoders monitor Air Flow and one detects RF Amp Temperature. If an RF Mute is applied, the Modulation Encoders will turn-off all RF Amplifiers and the power will drop to zero Watts, without turning off the RF Amp Power Supply.

Each 200KW Transmitter uses seven Modulation Encoder boards (A25-A31).

The Modulation Encoders also monitor air flow and temperature. See the Modulation Encoder firing order for the Big Step amplifiers controlled be each Modualtion Encoder.

A31 controls 31 Big Steps and RF 214.

A30 controls 31 Big Steps and RF 215 and monitors the air flow in the EPAC.

A29 controls 31 Big Steps and RF216 and monitors the temperature of RF1.

A28 controls 31 Big Steps and RF217 and monitors the air flow in the left PA compartment.

A27 controls 31 Big Steps and RF218.

A26 controls 31 Big Steps and RF219 and monitors the air flow in the center PA compartment.

A25 controls 27 Big Steps and RF220, Binary Amplifiers B9-B12 and monitors the air flow in the right PA compartment.

Big Steps RF214-RF220 are the Programmable RF Amplifiers.

L.3 Location

Modulation Encoders A30 and A31 are located in the EPAC cabinet.(See VIEW 6)

Modulation Encoders A29 and A28 are located in the left PA compartment (See VIEW 5).

Modulation Encoders A27 and A26 are located in the center PA compartment (See VIEW 4).

Modulation Encoder A25 is located in the right PA compartment (See VIEW 2).

L.4 Big Step Modulation Encoders

L.4.1 Block Diagram Description

Refer to Figure L-1 Modulation Encoder block diagram for the following discussion.

L.4.1.1 Digital Audio Flow

The Digital Audio Input from the A/D Converter is transferred into the Input Latches on each Modulation Encoder board.

The Data Strobe signal drives the clock input of the Input Latches and EPROM Encoder Latches. It transfers the data present at the inputs to the Latch outputs and holds the outputs to a constant level until the next Data Strobe signal from the A/D Converter occurs.

The eight Most Significant Bits of the Digital Audio Input B1 through B8 address EPROM Encoders. Each EPROM encodes the 8 bits and provides 8 outputs in a counting pattern determined by the Program Selector. One EPROM Encoder controls 8 RF Amplifiers, with 4 EPROMs per Modulation Encoder. The outputs of the EPROM are stored by Latches until the next Data Strobe.

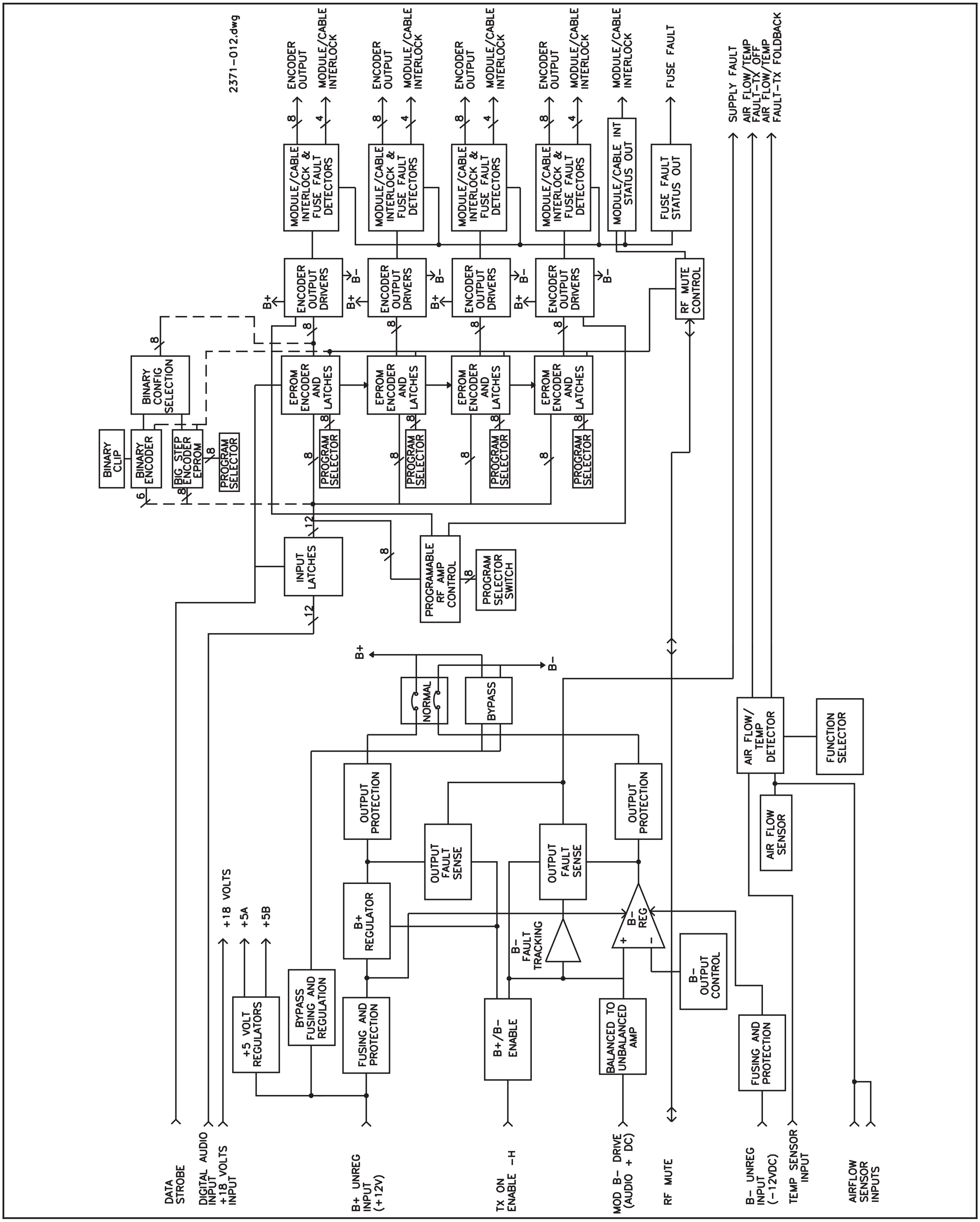


Figure L-1. Mod Encoder, Simplified Block Diagram

The outputs of the Latches go to Encoder Output Drivers which are powered by the B+ and B-voltages. Their outputs provide proper Turn-On/Turn-Off voltages for the RF Amplifiers assigned to that Modulation Encoder.

A Program Selector Switch and a Programmable RF Amplifier Control circuit will allow the technician to substitute a designated programmable RF Amplifier in place of another RF Amplifier should it be required.

If an RF Mute is received or generated by the RF Mute Control, the Encoder Outputs will turn off all RF Amplifiers.

L.4.1.2 B+/B- Regulators

When the TX On Enable input goes HIGH from the Controller the B+/B- Enable switch will on the B+ and B- Regulators and the Output Fault Sense detectors for both supplies. Should either supply be incorrect, a Supply Fault will be sent to the Controller and the Transmitter will be shut OFF.

When the TX On Enable input goes LOW, the B+/B- Enable switch will shut down the B+/B-Regulators and disable the Output Fault Sense detectors.

+12VDC is applied to the B+ Unregulated Input, where it supplies the +5 Volt Regulators, Bypass Fusing and Regulation for the Bypass mode, and Fusing And Protection for the B+ Regulator.

The output of the B+ Regulator is a constant voltage that passes through output protection and is applied to the Normal Mode jumper. -12VDC is applied to Fusing And Protection and supplies the B- Regulator. +12VDC from the Fusing And Protection also supplies the B- Regulator.

Modulated B- Drive from the Analog Input Board feeds a Balanced To Unbalanced Amplifier that drives the B-Regulator and the B- Fault Tracking circuit.

The output B- voltage from the B- Regulator varies with modulation and passes through Output Protection and is applied to the Normal Mode jumper.

Since the B- signal is constantly changing, the B- Fault Tracking circuit provides a reference for the Output Fault Sense.

L.4.1.3 Normal And Bypass Mode

When the Modulation Encoder is operated in the Normal mode, B+ and B- is distributed to all Encoder Output Drivers. If the jumper is moved to the Bypass mode, B+ is supplied to all Encoder Output Drivers and all RF Amplifiers are turned OFF.

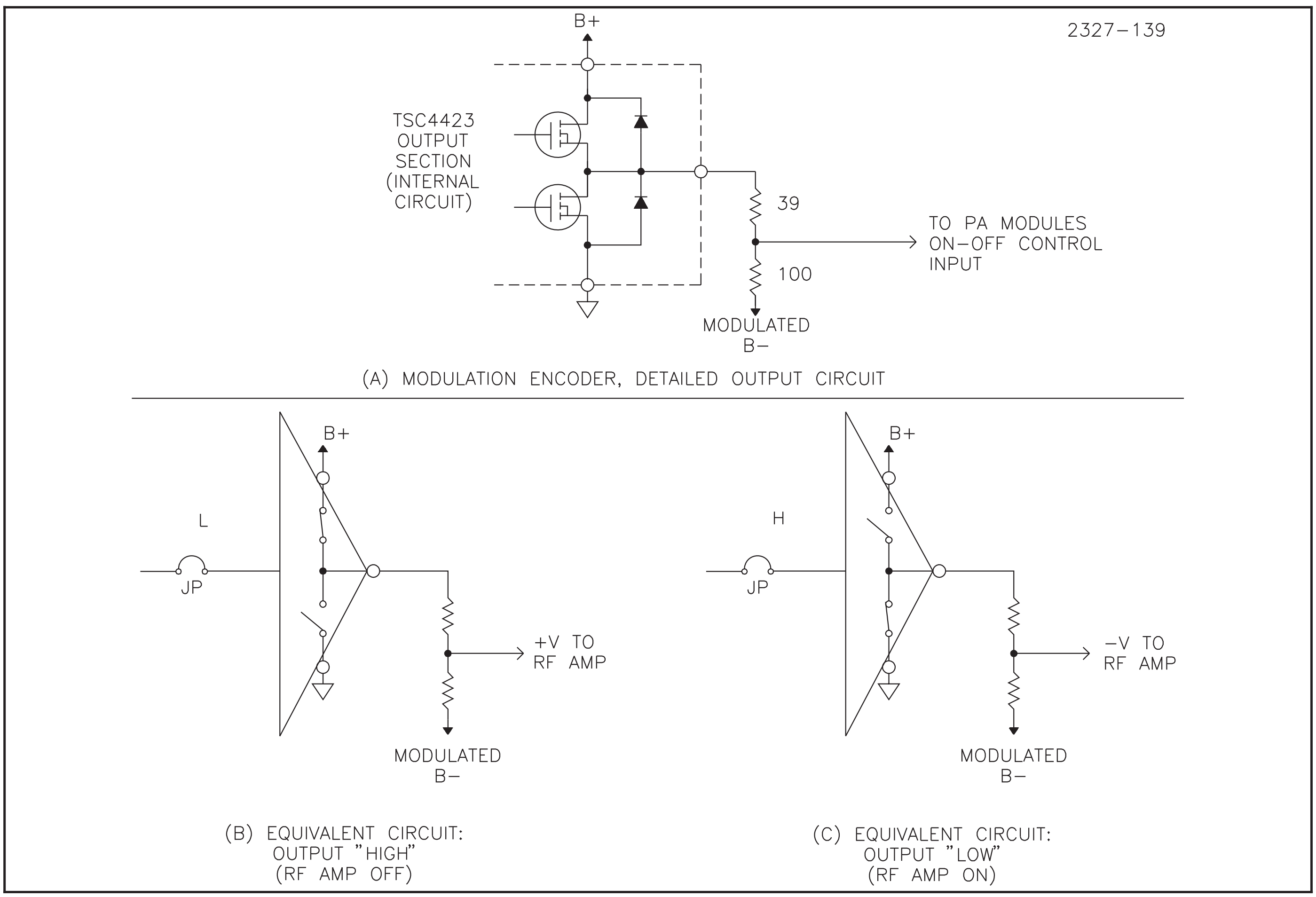


Figure L-2. Simplified Encoder Output Drivers

L.4.1.4 Module/Cable Interlock And Fuse Fault Detectors

L.4.1.4.1 Module/Cable Interlock Detector

The Module/Cable Interlock Detector circuits on each Modulation Encoder board will generate a Module/Cable Interlock fault that will turn the Transmitter OFF whenever an RF Amplifier is not inserted or an Encoder Output cable is disconnected. The Module/Cable interlock line from all 7 Modulation Encoders, as well as from the Driver Encoder, are combined with AND gates on the Extended Transmitter Interface, and a single fault line is then sent to the Controller.

L.4.1.4.2 Fuse Fault Detector

The Fuse Fault Detector circuits on each Modulation Encoder board will indicate an RF or +250VDC fuse(s) has opened on an RF Amplifier. This will illuminate the RF AMP FUSE indicator RED on the Control front panel.

L.4.1.5 Air Flow/Temperature Sensing

The Function Selector on the A25, A26, A28 and A30 Modulation Encoders is jumpered for Air Flow monitoring. An onboard Air Flow Sensor and up to 2 additional Air Flow Sensor Inputs are combined and sent to the Air Flow Detector.

If air flow is reduced to a certain level, the Air Flow Detector will generate an Air Flow Fault-TX Foldback that will cause the Controller to foldback power output until a safe operating level is reached.

If a further reduction in air flow occurs, the Air Flow Detector will generate an Air Flow Fault-TX OFF, which will turn OFF the Transmitter.

The Function Selector on the A29 Modulation Encoder is jumpered for temperature sensing. An external thermal monitor U1 mounted on RF1 is connected to the Temperature Sensor Input and fed to the Temperature Detector.

Similar to the Air Flow Detector, the Temperature Detector can generate a TX Foldback and TX OFF if the temperature reaches certain levels.

L.4.1.6 Power Supplies

The +5 Volt Regulators generate a +5A supply to power the digital audio circuits and a +5B supply to power control circuits on the board.

+18VDC is supplied to power the Module/Cable Interlock and Fuse Fault Detectors.

L.4.2 Detailed Circuit Description

Refer to the schematic diagram for the Modulation Encoder Board (839-7930-011) for the following discussion.

L.4.2.1 Input Latch

The 12-bit digital audio input from the A/D Convertor Board is connected to J8 pins 1 through 23 (all odd numbered pins) on each Modulation Encoder Board.

Big Step Modulation Encoders only use the eight most significant bits (B1 through B8) for control of the Big Step RF Amplifiers. They are connected to the input of Data Latch U1, which latches the data when a Data Strobe signal is present.

U17, U18, and U19 are not installed in the Big Step Modulation Encoder Boards.

The LOW-to-HIGH transition at the leading edge of each Data Strobe pulse causes the outputs of U1 to change to the same logic state as its input. All outputs will then remain in that state until the next Data Strobe pulse.

The output of U1 is distributed to the input of the four EPROM Encoders and to the Programmable RF AMP Selector.

L.4.2.2 EPROM Encoders

The eight bits (B1 through B8) from the Input Latch U1 are connected to the input of EPROMs U5, U6, U26 and U25 on pins 3 through 10.

Each EPROM contains the same program and has eight outputs, pins 11 through 19. A single spare EPROM can be used in any location on any Modulation Encoder (Big Step or Binary).

Each EPROM encodes the incoming 8 bits by outputting a digital counting pattern that controls eight RF Amplifiers.

The Program Selector jumper plugs are installed into each Modulation Encoder in JP1, JP2, JP4, and JP5. They determine which eight bit word the EPROM responds to and in which sequence.

The outputs of the EPROMs are connected to Output Latches U1, U21, U22 and U33.

L.4.2.3 Output Latches

The output of each EPROM U5, U6, U25, and U26 is connected to Output Latches U21, U1, U33, and U22 respectively.

The LOW-to-HIGH transition at the leading edge of each Data Strobe pulse causes the outputs of the Latches to change to the same logic state as its input. All outputs will then remain in that state until the next Data Strobe pulse.

The outputs of the latches go to Encoder Output Drivers, which provide Turn-On/Turn-Off signals for Big Step RF Amplifiers.

A logic HIGH on any output will turn on the associated RF Amp. A logic LOW turns the RF Amp off.

L.4.2.4 Encoder Positioning Jumpers

Refer to the Modulation Encoder Order Diagram (843-5450-096) and to VIEWs 20 through 26 for the following discussion.

Modulation Encoders on the left hand wall of the EPAC, Left and Center Compartments are pointing upward (the heatsink is toward the bottom). P5 is jumpered 2-1 and P6 is jumpered 2-3 so that counting order sequence is from the second pin from the bottom of P4 straight up through to the top pin of P1A.

Modulation Encoders on the right hand wall of the EPAC, Left and Center Compartments are pointing downward (the heatsink is toward the top). P5 is jumpered 2-3 and P6 is jumpered 2-1 so that counting order sequence is from the second pin from the bottom of P1A straight up through to the top pin of P4.

Observing the rectangular blue jumpers with the gold plugs installed into P1A, P2, P3, and P4 is the fastest way to verify counting order and use the RF Amp Test function.

The blue jumper plug will always be installed in the P1A position for a Big Step Modulation Encoder, because it will always control 8 Big Step RF Amplifiers.

A logic HIGH on any pin will turn on the associated RF Amp. A logic LOW or removal of the gold plug turns the RF Amp off.

L.4.2.5 Encoder Output Drivers

Up to this point the Turn-On/Turn-Off logic signal for each RF Amp is a TTL level (0 to +5VDC).

The Encoder Output Drivers U7 through U14, U23, U24, and U27 through U32 convert this level to proper voltages for RF Amp Turn-On/Turn-Off control. There is one driver for each RF Amp.

Pull-down resistors on each input holds the input LOW if the gold jumper plug is removed.

L.4.2.5.1 Inverters

Refer to Figure L-2, Simplified Encoder Output Drivers for the following discussion.

The output circuits of the *TSC4426* drivers used have two internal MOSFETs, one to the IC's V+ terminal (B+) and one to the GND terminal (ground).

The driver's output goes to a voltage divider, made up of a resistor from the driver output and a second resistor to the Modulated B- Supply.

The junction of the resistors is the RF Amp Turn-On/Turn-Off control circuit's input.

When the input is LOW, the upper MOSFET switch is closed and the inverter output is connected to B+. Due to the voltage divider action, the output to the RF Amp is about +2.5VDC and the RF Amp is turned OFF.

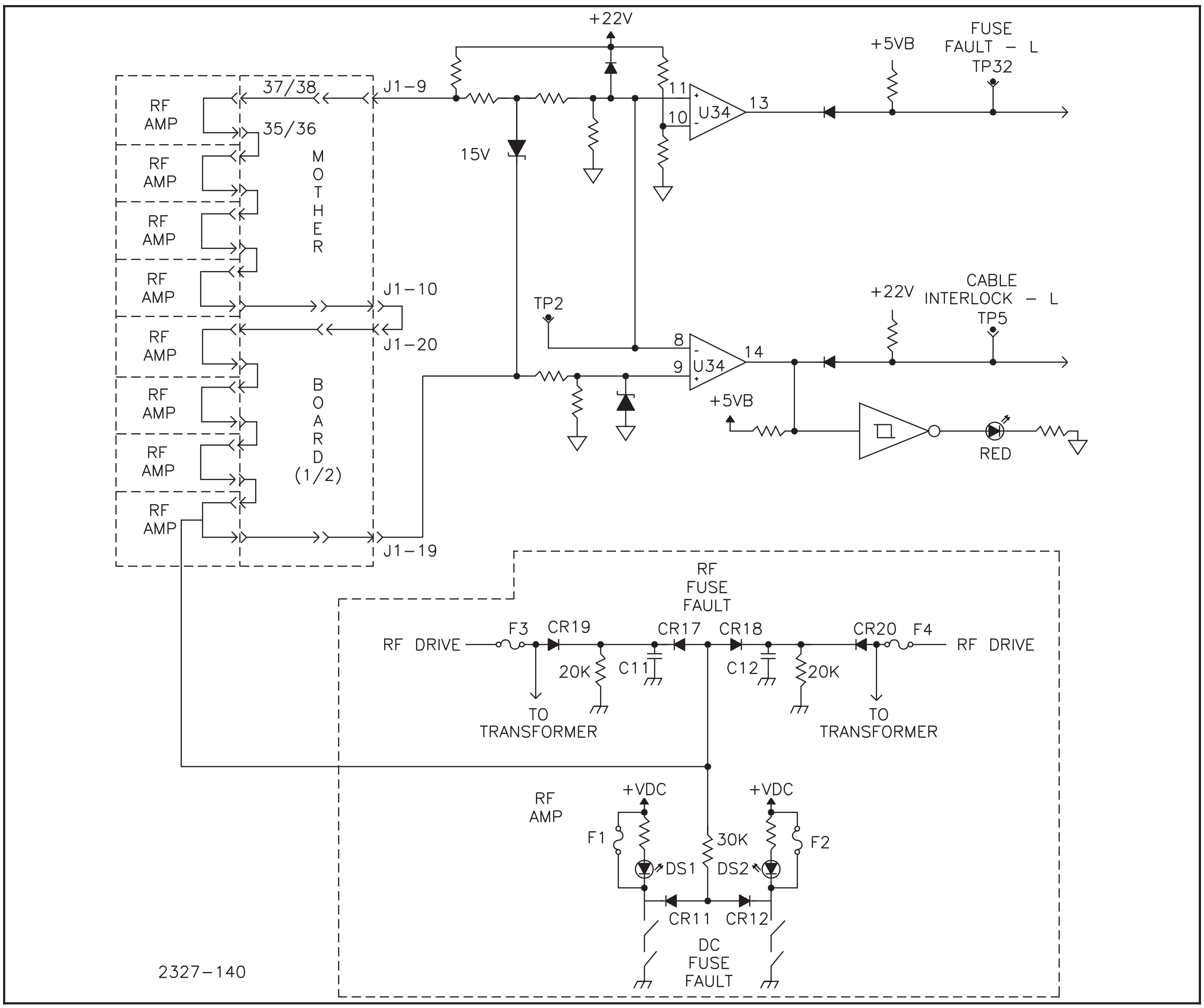


Figure L-3. Cable Interlock and Fuse Fault Detection Circuits

When the input is HIGH, the lower MOSFET switch is closed and the inverter output is connected to ground. Due to the voltage divider action, the output to the RF Amp is about -1VDC (depending upon the Modulated B- Voltage) and the RF Amp is turned ON.

Connectors J1, J2, J3, and J4 carry the signal to the Big Step Combiner Motherboards where it is distributed to each RF Amp.

L.4.2.6 Programmable RF Amp Selector

A Programmable RF Amplifier is assigned to each Modulation Encoder, therefore there are a total of seven available in the Transmitter.

This Programmable RF Amp is always at the bottom of the lowest Combiner Motherboard and therefore it's Turn-On/Turn-Off control line is the very bottom gold jumper plug on the associated Modulation Encoder.

Normally the Program Selector switches on each Modulation Encoder designate the steps as RF Amps RF214 through RF220, the highest possible steps in the Transmitter.

If an RF Amp should fail, one of these Programmable RF Amps can be substituted in its place. Only a slight reduction in positive peak modulation capability will result.

L.4.2.6.1 Digital Comparator

U4 is a Digital Comparator that controls the Programmable RF Amplifier.

Program Selector Switches S7 (LSB) and S8 (MSB) are used to provide an eight bit digital word to the Q comparator inputs Q0 through Q7.

The eight bit digital audio inputs (B1-B8) from U1 are applied to the P comparator inputs P0 through P7.

When the incoming eight bit digital word value from U1 is lower than the programmed eight bit digital word value, both U4-1 and U4-19 are HIGH and the Programmable RF Amp is turned OFF.

When the incoming eight bit digital word from U1 matches the programmed eight bit digital word, U4-19 goes LOW.

The anode of CR2 is grounded and a voltage divider applies +3VDC to the base of Q1.

This saturates the transistor and the collector is pulled HIGH. This HIGH signal is applied to Encoder Positioning Jumpers P5 and P6, and will turn ON the Programmable RF Amp.

When the incoming eight bit digital word from U1 is greater than the programmed eight bit digital word, U4-19 goes HIGH and U4-1 goes LOW. The Programmable RF Amp is still turned ON. For more information on setting the Programmable RF Amp see the Emergency Bypass procedures in Section 6A.

L.4.2.7 Data Strobe

A Data Strobe signal from the A/D Board enters at J8-25 and drives the Clock inputs of the Latches.

Each Latch is clocked by a LOW-to-HIGH transition, so the Data Strobe-L pulse must be inverted.

Inverter U15-2 provides the LOW-to-HIGH transition at the beginning of the Data Strobe-L pulse. This results in the eight bit digital word present at the inputs of the Latches being transferred to the outputs at the same constant level until the next Data Strobe signal occurs.

L.4.2.8 RF Mute

The RF Mute line is tied to the Clear input on all Latches.

When the RF mute line is LOW all latch outputs go LOW, turning OFF all Big Step RF Amplifiers. Inverter U15-6 goes HIGH and DS1 RF Mute is illuminated YELLOW.

An RF Mute signal is generated when any of the following occur:

a. The Transmitter is turned off and in the Test Mode.
b. A Manual RF Mute is activated on the Controller board.
c. A Remote Control RF Mute is activated via the Power Block Interface Board.
d. A Cable Interlock-L fault exists on any of the 7 Modulation Encoder Boards.
e. The Output Monitor Board detects excessive VSWR.
f. The A/D Converter detects a conversion error.

L.4.2.9 RF Amplifier Test

The RF Amp Test allows testing of the Encoder Output Drivers, connecting cables, and the RF Amp Turn-On/Turn-Off control circuits by presenting a HIGH on the input to the Encoder Output Drivers.

The circuit consists of P10 1-4 which is connected to +5VA through limiting resistor R85. Pull the gold jumper servicing the RF Amp to be tested and supply +5A from P10 to test the Amplifier.

L.4.2.10 Module/Cable Interlock

Refer to Figure L-3 Cable Interlock and Fuse Fault Detection Circuits for the following discussion.

The Cable Interlock circuit will turn the Transmitter OFF if any of the interconnecting cables between the Modulation Encoder Boards and Combiner Motherboards are disconnected or any RF Amplifiers are not installed. If any circuit generates a fault, the Encoder Cable Interlock LED will illuminate RED in addition to any on board indicator. A Cable Interlock Fault will not allow the Transmitter to be turned ON until the fault is cleared.

There are 4 interlock circuits on each Modulation Encoder, each interlock monitors 8 RF Amplifier modules.

Since all interlock and associated control circuits are the same, only one interlock will be discussed.

The cable interlock function is provided by two series connections. When all the RF Amps and Modulation Encoder cables are properly connected, a closed circuit is established from J1-9 to J1-10 (by four RF Amps and one cable) and from J1-20 to J1-19 (by four RF Amps and one cable).

Due to the voltage divider action of R89, R91, R53(7,8), R52(6,1), and R53(5,6) and R52(4,1), the voltage at the + input of comparator U34-9 will be greater than the voltage at the - input U34-8.

When the interlock connection between J1-9 and J1-19 is opened by removing the encoder cable or unplugging an RF Amplifier, the voltage at the + input will be lower than the voltage at the -input due to the additional voltage drop provided by CR22.

The output of U34-14 would go LOW and diode CR25 will conduct and establish about 0.6VDC at the input of U48-11.

Inverter U3-2 will go HIGH and the Interlock 1 indicator DS5 will be illuminated RED.

Whenever U48-11 is pulled LOW by CR25, CR27, CR29, CR31, or CR4: Inverter U48-12 goes HIGH and saturates transistor Q2. An RF MUTE-L is applied to turn ALL Big Step and Binary RF Amplifiers OFF.

Inverter U48-10 goes HIGH and saturates the transistor inside U35-8. J7-7 goes LOW and the Controller will shut the Transmitter OFF.

a. example; if the Cable Interlock on the front panel was illuminated, Modulation Encoder A29 had DS5, Interlock 1 illuminated, the RF Amplifiers 109-116 interlock had been broken.

L.4.2.10.1 *Interconnection Cable Interlock*

When J8 is connected, J8-31 receives +5VDC from the Power Block Interface. If this cable is disconnected, inverters U48-2/U48-4 and diode CR4 will pull U48-11 Cable Interlock LOW.

Due to the diode gating, none of the Interlock indicators will be illuminated RED.

L.4.2.11 Fuse Fault Detectors

Refer to Figure L-3 Cable Interlock and Fuse Fault Detection Circuits for the following discussion.

The open fuse detector circuits will cause the RF Amp Fuse LED to illuminate RED when any one or more of the 220 Big Step or 4 Binary RF Amplifiers has an open Supply Voltage or RF Drive fuse.

No other action is taken by the Transmitter, other than the visual indication.

L.4.2.11.1 *Supply Voltage Open Fuse Detection*

There are 4 detector circuits on each Modulation Encoder, each detector monitors 8 RF Amplifier modules. Since all detector and associated control circuits are the same, only one detector will be discussed.

The cable interlock function is provided by two series connections. When all the RF Amps and Modulation Encoder cables are properly connected, a closed circuit is established from J1-9 to J1-10 (by four RF Amps and one cable) and from J1-20 to J1-19 (by four RF Amps and one cable).

Due to the voltage divider action of R89, R91, R53(7,8), R52(6,1), and R53(5,6) and R52(4,1), the voltage at the + input of comparator U34-11 will be greater than the voltage at the -input U34-10.

The voltage established at J1-9 and J1-19 is about 15VDC.

Normally when the Transmitter is ON, on the RF amp the +250VDC is shorted around the 56k resistors and LEDs by the fuses.

This reverse biases diodes CR11 & CR12 which does not allow any current to flow from the +18 Volt Supply through the 30k resistor on the RF Amp.

Typically what causes a supply voltage fuse to open is one or more shorted MOSFETs on the same side of the RF Amp.

For example, shorted MOSFETs on the “A” side of the RF Amp applies a ground to the cathodes of the diode CR11 and LED DS1.

The supply fuse will open and current flows through the 56K resistor from the supply voltage illuminating the indicator RED on the RF Amp with the open fuse.

Current also flows from the +18V Supply on the Modulation Encoder Board through the 30k resistor and diode on the RF Amp.

Therefore the voltage level at U34-11 drops below that at U34-10 forcing the output at U34-13 to go LOW.

When the output of U34-11 goes LOW, diode CR24 will conduct and establish about 0.6VDC at U48-9, Fuse Fault-L.

Whenever U48-9 is pulled LOW by CR24, CR26, CR28, CR30:

- Inverter U48-8 goes HIGH and saturates the transistor inside U35-14. A Fuse Fault-L at J9-29 is sent to the Controller.
- Inverter U48-6 goes LOW illuminating the Fuse Fault indicator DS6 RED.
- The Cable Interlock line U34-14 will not go LOW because when U34-11 voltage decreases the reference at U34-8 also decreases, and U34-14 will stay HIGH.

L.4.2.11.2 *RF Drive Open Fuse Detection*

The RF Drive Fuse detection circuits operate on the same daisy chain as the supply fuses, and in basically the same manner.

Normally, with good fuses, the RF Drive is rectified by CR19, allowing C11 on the RF amp to charge up to about +17V.

This reverse biases CR17 and the detector chain is unaffected.

If F3 were to open, the voltage on C11 would discharge through R19 20k Ohms.

This causes CR17 to be forward biased, which pulls the voltage on the Interlock chain to ground through CR17 and R19.

This pulls U34-11 lower than U34-10, which causes U34-13 to go low, causing the same Transmitter action as explained in the previous paragraphs.

L.4.2.11.3 *Fuse Fault Enable*

When the Transmitter is ON, the B+/B- Enable switch U44 supplies +5VDC at pin 12. This voltage is connected to the anode of DS6 Fuse Fault via R96. The Fuse Fault indicator is enabled at this time.

When the Transmitter is OFF, the +250VDC supply and the RF Drive to each RF Amplifier is also off.

However, the Fuse Fault indicator DS6 will not illuminate RED because the supply from the B+/B-Enable switch U44-12 will be 0VDC.

L.4.2.12 Air Flow Monitoring - Modulation Encoder A25, A26, A28 and A30 Only

The Air Flow Sense circuitry on the A25, A26, A28 and A30 Modulation Encoders consists of an Onboard Air Flow Monitor and an External Air Flow Monitor that are summed together.

Modulation Encoder A25, A26, A28 and A30 have jumpers between pins J9-2 and J9-4 since external Air Flow Monitors are not used.

Modulation Encoder A25 monitors the Right compartment using the Onboard Air Flow Monitor.

Modulation Encoder A26 monitors the Center compartment using the Onboard Air Flow Monitor.

Modulation Encoder A28 monitors the Left compartment using the Onboard Air Flow Monitor.

Modulation Encoder A30 monitors the EPAC compartment using the Onboard Air Flow Monitor.

Loss of a blower or restriction of air flow due to dirty filters or a loose fan blade will cause an Air Flow Reduced - TX Foldback.

The Controller will Foldback the power -6dB (1/4 the selected power).

Further losses will cause an Air Flow Fault - TX OFF.

L.4.2.12.1 Onboard Air Flow Monitor

The Onboard Air Flow Monitor consists of a ambient temperature sensor, a “heated” temperature sensor, and a differential amplifier.

The ambient temperature sensor U40 is mounted under the board.

Its output is connected to the differential amplifier U38-2 - input.

The heated temperature sensor U41 is thermally connected to a 30 Ohm 20W resistor R115 by an angle bracket. Both are mounted underneath the board, in front of the heatsink that is cooled by the air channel in the compartment. Its output is connected to the differential amplifier U38-3 + input.

The differential amplifier U38-1 will only amplify the difference between these two inputs.

Whenever the Transmitter is ON, B+ voltage is supplied to heat the resistor.

The output voltage of the heated sensor will increase as the resistor heats up and then will eventually stabilize because air flow is passing over both components.

Normal air flow in the Transmitter will cause the voltage at U38-1 to stabilize. If air flow in the Transmitter is decreased, the U38-1 output will rise.

L.4.2.12.2 Summing Amplifier

The voltage from the Onboard Air Flow Monitor at U38-1 is summed together by resistors with the voltage from the External Air Flow Monitor at R208. This summed voltage is connected to U38-13.

Summing amplifier U38-14 has an adjustable gain control R213 Air Flow Calibrate that is used to set the air flow trip point.

The voltage at U38-14 is fed to the Sensor Select Jumper J7-5.

A wire jumper on the plug J7 will connect J7-5 to J7-8 so that the Air Flow Sense circuit is connected to the Sensor Select fault comparators.

L.4.2.13 Temperature Monitor - Modulation Encoder A29 Only

The Temperature Sense circuitry on the A29 Modulation Encoder consists of an External Temperature Sensor U1 that is mounted on the heatsink of Big Step RF Amplifier RF1.

Poor cooling, high ambient temperature, or RF Amp over dissipation due to mistuning or VSWR conditions will cause an Air Flow Reduced - TX Foldback. The Controller will Foldback the power in selected steps until a safe operating level is reached. Further increases in temperature will cause an Air Flow Fault - TX OFF.

The 3 conductor cable from U1 is connected to J6. This supplies the sensor with +5VDC at J6-1 and ground at J6-4.

The Temperature Sensor In voltage from the sensor can be measured at J6-2.

The voltage from the sensor is buffered by U38-7. As the temperature of the sensor starts to increase, the voltage at TP6 Temperature will also start to increase.

The voltage at U38-7 is fed to the Sensor Select Jumper J7-6. A wire jumper on the plug J7 will connect J7-6 to J7-8 so that the Temperature Sense circuit is connected to the Sensor Select fault comparators.

If the cable is disconnected at J6, U38-5 will be pulled LOW to -6VDC and the Transmitter can not be turned ON.

NOTE: No indication of this condition will be visible.

L.4.2.14 Sensor Select Fault Comparators

Operation of the Sensor Select Fault Comparators is the same whether it is connected to Air Flow Sense or Temperature Sense circuits.

The voltage at J7-8 is buffered and inverted by U38-8 and can be measured at TP33.

U37-1 and U37-14 form a two level fault comparator circuit. A resistive voltage divider establishes voltages at the -inputs of the comparators, +3.0VDC at U37-6 and +3.5VDC at U37-8.

The + inputs U37-7 and U37-9 are connected together.

If the voltage at U37-7 and U37-9 increases, it will eventually be greater than the reference and U37-1 will go HIGH.

When the output goes HIGH, it will saturate the transistor inside U35-1 and an Air Reduced/Temperature Fault-L TX Foldback at J8-39 is sent to the Controller.

Inverter U49-6 will illuminate DS7 Air/Temp Fault RED, as a visual indication of the warning.

If the voltage at U37-9 continues to rise, the U37-14 will go HIGH and saturate the transistor inside U35-7.

An Air/Temp Fault-L TX OFF will be sent to the Controller via J8-37.

L.4.2.15 B+ Voltage

The B+ Supply provides a nominal +7.2VDC to the Encoder Output Drivers. See Factory Test Data Sheets for actual voltage. This voltage is fixed and does not vary. It is used in conjunction with the Modulated B- voltage to control the RF Amp Turn-On/Turn-Off time.

L.4.2.15.1 B+ Regulator

The input Unregulated B+ voltage at J5-7,8 can be measured at TP10 Unreg B+. This input is fused by F3, diode CR49 and capacitors C62 and C64 bypass transients and high frequency noise on the unregulated input.

The B+ Regulator U42 is a variable voltage regulator in a TO-3 case. It is mounted to the heatsink underneath the board. Pin 1 is the unregulated input, pin 2 the reference voltage, and pin 3 is the regulated output.

The output voltage is determined by the reference voltage at pin 2 that is established by the voltage sample divider R124 and R125.

Diodes CR42 and CR43 protect the regulator against incoming transient voltages.

When the B+ Regulator is Enabled, the output B+ voltage is a nominal +7.2VDC and can be measured at TP12 B+. Indicator DS8 will be illuminated GREEN.

When P13 is in the Normal position, J13 pins 2 and 1 connected B+ to all Encoder Output Drivers U7 through U14, U23 & U24, and U27 through U32. Should the B+ voltage become too positive, zener diode CR55 will clamp the line at +10VDC.

L.4.2.16 Modulated B- Voltage

The Modulated B- Supply provides a negative voltage to the Encoder Output Drivers, which varies with the Transmitter's audio input and power level.

The effect of the modulated B- voltage is to control RF Amp Turn-On/Turn-Off times. Turn-On/Turn-Off times depend on loading on each RF Amp, which in turn depends on the total number of RF Amps which are operating.

At low power levels (including negative modulation peaks), only a few Big Steps are ON, and each RF Amp is lightly loaded. As additional Big Steps turn ON, the loading changes considerably and the required Turn-On/Turn-Off times also change.

At higher power levels (more RF Amps turned ON), the loading on each RF Amp does not change nearly as rapidly when additional RF Amps turn ON (or turn OFF).

The B- voltage must be more negative on positive peaks, but must change more slowly as the Transmitter's instantaneous output becomes greater (and more RF Amps are turned ON). Therefore, the B- voltage must vary in a non-linear manner as the -(Audio + DC) sample changes.

L.4.2.16.1 Modulated B- Drive Differential Amplifier

The balanced Modulated B- Drive from the Analog Input Board, is applied to J7-1(-) and J7-3(+).

Differential Amplifier U47-1 accepts the balanced signal and converts it to a single ended output at TP15.

The signal at TP15 is used to drive the B- Regulator and the B-Fault Tracking amplifier.

L.4.2.16.2 Modulated B- Regulator

The Modulated B- Regulator U45 uses both the Unregulated B+ and Unregulated B-supplies.

The input Unregulated B+ voltage (described in the B+ Regulator section) is connected to U45-2.

The input Unregulated B- voltage at J5-10,11 can be measured at TP22 Unreg B-. This input is fused by F4, diode CR50 and capacitors C60 and C61 bypass transients and high frequency noise on the unregulated input. The voltage is connected to U45-7.

The B- Regulator U45 is a high power operational amplifier in a TO-3 case. It is mounted to the heatsink underneath the board.

U45 is connected as a non-inverting amplifier with adjustable gain control R150.

When the B- Regulator is Enabled, the output B- voltage depends on the modulated B-drive from U47-1. It can be measured at TP11 B- and indicator DS11 will be illuminated GREEN.

Should the B- voltage become too negative, zener diode CR56 will clamp the line at -10VDC.

When P13 is in the Normal position, J13 pins 4 and 3 connected B- to all Encoder Output Drivers U7 through U14, U23 & U24, and U27 through U32.

L.4.2.16.3 Approximate Modulated B- Supply Output Voltages

At an operating power of 200 kilowatts and with 1kHz 100% modulation, the instantaneous Modulated B- voltage should vary between roughly -2.5 and -6.5 Volts. The average B-voltage at TP11 should be -5.5 Volts.

At negative 100% modulation peaks, the instantaneous voltage should be about -2.5 Volts, and at positive 100% peaks, the instantaneous voltage should be about -6.5 Volts.

This voltage range will be less at lower operating powers.

For an operating power of **50 kilowatts,** instantaneous Modulated B- voltage should be on the order of **-2.8 Volts** at -100% peaks and **-6.5 Volts** at +100% peaks.

L.4.2.17 B+/B- Enable

The B+/B- Enable circuitry will turn on the B+ and B-regulators when the Transmitter is ON and shut them off when the Transmitter is OFF.

The TX-ON ENABLE-H from the Controller enters at J8-35 and is connected to the base of Q3 through the normally closed contacts of Regulator Test switch S6.

L.4.2.17.1 Regulators Enabled

When the TX-ON ENABLE line is HIGH, transistor Q3 is saturated and TP14 goes LOW causing the following actions:

a. Pins 9, 10, and 11 of U44 are pulled LOW and the 3 analog switches are in the positions as shown on the schematic.

Switch A provides +5VB for the Fuse Fault Enable.

a. Transistor Q4 is cutoff and voltage reference for U42-2 is normal.

L.4.2.17.2 Regulators Disabled

When the TX-ON ENABLE line is LOW, transistor Q3 is cutoff and the Shutdown line goes HIGH causing the following actions:

a. Pins 9, 10, and 11 of U44 are pulled HIGH and the 3 analog switches are in the opposite position as shown on the schematic.
    1. Switch A does not provide +5VB for the Fuse Fault Enable.
    2. Switch B grounds the input to the B-regulator.
    3. Switch C pulls the + inputs of the B+/B- Fault Sense comparators HIGH via CR44 and CR45, disabling the circuits.
b. Transistor Q4 is saturated and voltage reference for U42-2 is grounded.

L.4.2.17.3 Regulator Test

Regulator Test switch S6 is used for troubleshooting the B+/B-Regulators when the Transmitter is turned OFF.

If the switch is depressed and held down, DS8 B+ and DS11 B-should illuminate GREEN, DS9 Supply Fault should not be illuminated RED.

NOTE

Do not hold down the switch for longer than 1 minute without air flow cooling the heatsink.

L.4.2.18 B+/B- Fault Sense

Should the B+ voltage become too low (less positive) or the Modulated B- voltage become too low (less negative), Fault Sense comparators will generate an Encoder Supply Fault-L that will turn the Transmitter OFF.

L.4.2.18.1 B+ Comparator

U37-2 is the B+ fault comparator. A resistive voltage divider formed by R128 and R20-8 supplies one-half the B+ voltage the + input U37-5. A similar voltage divider establishes 2.8VDC threshold on the - input U37-4.

Should the B+ voltage become lower than the threshold, the output U37-2 will go LOW.

Inverter U49-2 will go HIGH and saturate Q5, causing a Supply Fault-L sent to the Controller at J8-33. Inverter U49-4 will also go HIGH and illuminate DS9 Supply Fault RED.

L.4.2.18.2 B- Comparator and B- Fault Tacking

U37-13 is the B- fault comparator. A resistive voltage divider formed by R131 and R20-5 supplies a sample of the B-voltage the - input U37-10.

The B- Fault Tracking amplifier U47-7 takes a sample of the modulated B- drive prior to the B-regulator. A similar voltage divider establishes a reference signal of the modulated B- drive on the + input U37-10.

Should the B- sample become greater than the reference signal, the output U37-13 will go LOW.

This produces the same response as a B+ fault.

L.4.2.19 Normal/Bypass Jumper

Refer to the Emergency Operating Procedures for more information on Modulation Encoder bypassing.

L.4.2.19.1 Normal Position

P13 is usually inserted into J13, the Normal position.

In this location, J13 1-2 connects regulated B+ to the B+ buss (for Encoder Output Drivers) and the B+ Fault Sense. J13 4-3 connects modulated B- to the B- bus (for Encoder Output Drivers) and the B- Fault Sense.

L.4.2.19.2 Bypass Position

When P13 is inserted into J12, the Modulation Encoder is in the Bypass mode.

In this location, J12 1-2 and 3-4 connects an unregulated B+ voltage supplied by resistors R132, R133, R211, and fused by F2 to both the B+ bus and B- bus. This will turn all RF Amps controlled by the Modulation Encoder OFF by supplying a positive voltage to the RF Amp Turn-On/Turn-Off control line.

The B- Fault Comparator is bypassed because the + input of U37-11 is pulled HIGH by CR47 and R146. When this positive unregulated B+ voltage is on the B- bus, indicator DS10 Bypass will be illuminated RED.

L.4.2.20 Power Supplies

L.4.2.20.1 +18VDC

The regulated +18VDC supply is used for the Module/Cable Interlock and Fuse Fault functions. It enters the board at J5-1 and is fused by F1. Indicator DS12 +22 will be illuminated GREEN when the supply is present and this voltage can be measured at TP9.

L.4.2.20.2 +5VDC Regulators

The Modulation Encoder uses two +5VDC supplies, +5VA and +5VB.

The +5VA supply is used to power all the digital audio circuits.

The +5VB supply is used to power the fault and control circuits.

Both supplies are identical circuits and only the +5VA regulator will be discussed.

The Unregulated B+ input from J5-7,8 is fused by F5 and connected to In terminal of U46-1. Bypass capacitors are used on the input and output terminals along with a protection diode CR58.

The output +5VDC at U46-3 can be measured at TP8 and DS13 will be illuminated GREEN when the supply is present.

L.4.2.20.3 -5VDC Regulator

U39 is a -5VDC regulator that is connected to a -12VDC supply formed by dropping resistor R171. The output -5VDC is used by the B+/B- Enable switch U44-7.

L.4.3 Troubleshooting Big Step Modulation Encoders

This board can be temporarily bypassed in an emergency. **Refer to Section 6A for Emergency Operating Procedure.**

Since all seven Modulation Encoders contain the same circuitry, use this procedure on any of the Modulation Encoders A25-A31.

Faults with an Encoder Board can be classed into:

a. Interlock/Fuse Fault
b. Air Flow Sensing

c. Supply Regulators, and
d. RF AMP turn on encoding

Refer to the proper section for the area being addressed.

L.4.3.1 Interlock/Fuse Fault

If the Control Front Panel Displays a Module/Cable Interlock Fault upon Step Start, and the Transmitter troubleshooting section has referred to this section, begin troubleshooting by observing which indicator DS1, DS2 through DS5, and DS6, is illuminated on the Modulation Encoders. This can be done with only the Low Voltage on.

L.4.3.2 Cable Interlock DS2, DS3, DS4, or DS5 illuminated

NOTE

The circuitry for each indicator is identical therefore only one example will be given. Use the example for DS2 listed and refer to the schematic for the appropriate component locators for troubleshooting DS3, DS4 and DS5 indicator illuminated.

If DS2 is illuminated RED on the Modulation Encoder, one of the RF amplifiers or the encoder cable is not connected or open, or the Interlock circuitry has failed.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Start by ensuring that all the RF modules are firmly inserted in the Combiner Motherboard.
b. If the fault remains follow the steps below.
    1. Using a clip lead, jumper the cathode of CR20 to R120 (J4-19 to J4-9).
    2. If DS2 goes out, refer to the Overall wiring diagram and the Combiner Motherboard section to trace an open cable.
    3. If DS2 is still illuminated, check the voltage on U36-2 for a logic LOW.
    4. If U36-2 is a logic LOW, check the voltage on TP18 and compare this to the voltage on U36-5.
    5. If TP18 is higher than U36-5, check CR35, R49, R120, C90 and CR32.
    6. If TP18 is lower than U36-5, replace U36.
    7. If U36-2 is a logic HIGH, replace U3.
    8. If no indicator (DS2-DS5) is illuminated then check the cathode of CR34 for a logic LOW.
    9. If CR34 is a logic HIGH, refer to the Power Block Interface and Controller Sections to continue.
    10. If CR34 is a logic LOW, check U35-9 for a logic HIGH.
    11. If U35-9 is HIGH, replace U48.
    12. If U35-9 is LOW, suspect U35 or CR34.

L.4.3.3 Fuse Fault

L.4.3.3.1 DS6 illuminated

a. If DS6 is illuminated and no RF AMPS show a blown Fuse indicator (DS1 or DS2), check TP32 for a logic LOW.
b. If TP32 is a logic HIGH, suspect U48, C110, and U35.
c. If TP32 is a logic LOW, determine which stage is producing the fault by checking for a logic LOW on the cathodes of CR24, CR26, CR28 and CR30.

NOTE

Since the circuitry is the same for all fuse faults only one (CR24 **LOW***) will be used as an example. Refer to the Modulation Encoder schematics to find the correct component for the actual stage producing the fault.*

1. If the Cathode of CR24 is LOW, compare the voltages on U34 pins 10 and 11.
2. If U34-11 is lower than pin 10, suspect R53 or CR22.
3. If these components are okay, it may be possible that the modules being protected by that circuit are not being turned on or a fuse on one of the fuse boards is blown.
4. Refer to the Transmitter Troubleshooting section on Control front panel indicators and the Overall wiring Diagram to Continue.
5. If U34-11 is higher than pin 10, replace U34.

L.4.3.3.2 None are Illuminated

If none of the LEDs are illuminated on any of the Modulation Encoders, check the Cathodes of CR33 and CR34 for a logic LOW. The diode with the logic LOW is on the board generating the fault. Check U35, CR33 and CR34 on that Encoder Board.

L.4.3.3.3 Air Flow and Temperature Sensing

There are two types of sensing circuits used on this board that are summed together to generate air flow or temperature faults.

a. The On Board Air Flow sensing for the B+ heatsink, and
b. The temperature sensor mounted on RF1.

If the Control front panel display shows an Air Flow Reduced, Air Flow fault, Temp and or a Foldback fault and the Transmitter troubleshooting section has referred to the Modulation Encoder, begin troubleshooting by observing if DS7 is illuminated on the Modulation Encoder Board.

NOTE

The Fault must be active at the time of troubleshooting. This can be determined by the fact that Fault Reset on the Control front panel does not clear the fault.

If DS7 is illuminated:

a. Check TP7 and TP6 for a voltage greater than 3VDC.
b. If TP7 is greater than 3V, then the temperature sensing circuit for RF1 is faulty.
c. If TP6 is greater than 2.5VDC, then an air flow sensing circuit has failed.

L.4.3.3.4 *RF1 Temperature Sensing*

a. If TP6 measures greater than 3VDC, the ambient air temperature is less than 50°C, and air flow is not restricted to the modules, then:

b. Check the circuitry by removing power and carefully bending **U6** out of the socket.

c. Turn on the Transmitter.

d. If the fault remains, replace **U6**.

e. If the fault clears, replace the temperature sensor on the RF amp Module.

L.4.3.3.5 *Air Flow Sensor*

If TP7 is greater than 3 Volts DC, the ambient air temperature is less than 50°C, and air flow is not restricted to the compartment or over the Modulation Encoder Board heatsink, then:

a. Check U38-2 for approximately +5VDC.

b. If not present, suspect an open cable from the external air flow sensor.

c. If the voltage is present on U38-2, check U38 pin 3.

d. If pin 2 is greater than pin 3 replace U38 or U41, or check external air flow sensor, if used.

e. If pin 2 is less than pin 3, suspect a faulty U41.

L.4.3.3.6 *Supply Regulators*

If the Encoder section of the Control front panel displays a supply fault begin troubleshooting by:

a. Observing if the indicators DS12, DS13 and DS14 are illuminated on each Modulation Encoder Board with CB3 on the Power Supply Display panel in the test position.

b. If all these indicators are illuminated, turn on the Transmitter and monitor DS9 on each board for a flash that would indicate the board generating the supply fault.

c. If DS9 does not illuminate on any board, suspect a Controller or cabling problem.

d. If DS9 flashes on all boards, suspect a fault with the Unregulated supply. Refer to the Transmitter troubleshooting section to troubleshoot the low voltage supply.

L.4.3.3.7 *DS12 not illuminated*

This indicates that the regulated +18 Volts is not present on the board. Check F1 and if not open, troubleshoot Low Voltage Supply.

L.4.3.3.8 *DS13 not illuminated*

This indicates that the +5VA supply has failed.

a. Check F5 for approximately +12VDC. If not present refer to the Transmitter troubleshooting section to troubleshoot Low Voltage supply.

b. If F5 checks okay, suspect C73, C72 or U46.

c. If U46 is replaced, check for a short on the +5VA supply by measuring the resistance from CR41 cathode to ground before applying power to the circuit.

L.4.3.3.9 *DS14 not illuminated*

This indicates that the +5VB supply has failed.

a. Check F6 for approximately +12VDC.

b. If not present, refer to the Transmitter troubleshooting section to troubleshoot Low Voltage supply.

c. If F6 checks okay, suspect C156, C155 or U43.

d. If U43 is replaced, check for a short on the +5VB supply by measuring the resistance from CR54 cathode to ground before applying power to the circuit.

L.4.3.3.10 *DS9 illuminated*

This indicates a B+ or B- supply is not active. To discover which is at fault check DS8 and DS10 for illumination when switch S6, on this board, is depressed.

CAUTION

DO NOT HOLD S6 DEPRESSED FOR LONGER THAN 1 MINUTE AT A TIME. THIS WILL PREVENT DAMAGE OR OVERHEATING OF THE REGULATORS.

L.4.3.3.11 *DS8 Not Illuminated*

If DS8 does not illuminate when S6 is depressed:

a. Check F3 for an open or +12 Volts DC.

b. If F3 is open, check CR49, C62, C64 and U42.

c. If F3 is not open, remove Jumper J13 and depress S6 again while monitoring DS8. If DS8 does not illuminate when S6 is depressed, suspect U42, Q4, C51 or C52. Verify that DS8 will illuminate before installing J13 back in the board.

d. If DS8 illuminates,suspect a short on the B+ line. Then see sheet 3 of the schematic for the IC and bypass capacitors and also check Air Flow sensor and CR55.

e. If +12 Volts is not present on F3, refer to the Transmitter troubleshooting section for the Low Voltage Supply.

L.4.3.3.12 *DS11 Not illuminated*

If DS11 is not illuminated when S6 is depressed:

a. Remove J13 and depress S6 again.

b. If DS11 illuminates, suspect a fault on the B-line. Refer to the schematic to locate the components involved.

c. If DS11 does not illuminate, measure the voltage on TP22. It should be approximately -12VDC.

d. If this voltage is not present, refer to the overall troubleshooting section to troubleshoot the Low Voltage Supply.

e. If TP22 measures correctly, check F4.

f. If F4 is open, suspect CR50, C60, C61 and U45.

g. If F4 is not open, carefully remove U44 from its socket and depress S6 again.

h. If DS11 illuminates, replace U44.

i. If DS11 does not illuminate, suspect U47 or U45 and associated components.

L.4.3.4 Supply Fault Sensing

If all supply indicators illuminate properly, suspect the fault sensing circuit. To begin:

a. Check for a logic LOW on the cathode of CR57.

b. If the LOW is not present, the board is not generating the fault. Refer to the overall wiring diagram, Power Block

Interface schematic and the Controller section as needed to trace the fault.

c. If CR57 is LOW, observe if DS9 is illuminated.
d. If DS9 is on, check Q5, C54 and CR57.
e. If DS9 is not illuminated, suspect U37 or U49 associated components.

L.4.3.5 RF Amp Turn On

L.4.3.5.1 All Off In Column

If all of the RF Amps that are controlled by the Encoder Board will not turn on, then:

a. Observe that all supply indicators are illuminated when the Transmitter is turned on.
b. If not, refer to the supply troubleshooting portion of this section.
c. If the supply checks correctly, check TP3 for Data Strobe signals.
d. If not present, check U15 and cabling from Power Block Interface Board.
e. If the Data Strobe is present, check DS1 and or TP4 for a logic LOW.
f. If the LOW is present, verify that an RF mute has not been selected by the Controller or Remote control.
g. If no RF mute is being given then suspect one of the IC Latches is pulling the line LOW. The latches can be removed one at a time to locate the failed one.

L.4.3.5.2 One or Scattered RF Amps With No Turn On

a. First verify that the RF Amp is not at fault by moving the module to another compartment.
b. If the RF Amp checks okay, then see the Modulation Encoder Counting Order diagram (843-5450-096) in the Drawing Package to trace the signal flow to the module.

As an example: RF Amp 85 does not turn on. The signal flow from the diagram indicates that the path is RF85 to P2-1 to U23-7 to U22-2 to U26-11. To troubleshoot this example:

a. Check for a turn on pulse at U23-7.
b. If present, suspect cable or Combiner Motherboard.
c. If not present, check U22-2 for a logic HIGH turn on.
d. If present, check P2 and U23.
e. If not present, check U26-11 for a logic HIGH.
f. If present, replace U22.
g. If not present, replace U26.

NOTE

The Latches and EPROMs can be swapped to another location on the board to verify if they are operating correctly without problem.

L.4.4 Removal and Replacement

a. Remove the mounting screws and cables to remove board from the Transmitter.
b. When replacing the board, ensure that the Jumpers JP1-JP5 and Plugs P5 and P6 are in the correct position for the location of the board.
c. The A-25, A-26, A-28 and A-30 boards have a jumper at J9-2 to J9-4. Remove the jumper from the old board and install onto replacement board.

L.4.5 Alignments

L.4.5.1 Air Flow Calibration

a. Operate the Transmitter at 200 kW with normal program material.
b. Measure the DC voltage at TP7 on the board. This voltage should be +2.5VDC with the front door closed.
c. If it is not, adjust R213 Air Flow Calibration on the board until the voltage at TP7 is +2.5VDC.

L.4.5.2 B- Supply

Set B- pot R150 for the Factory Test Data value as measured on TP11. If the test data is not available coarse set this for -6VDC and refer to the Analog Input Section to align the B-.

L.5 Binary Modulation Encoder (A25)

L.5.1 Introduction

This section describes the Binary Modulation Encoder Board. Topics include Function, Location, Block Diagram Description, and Detailed Circuit Description.

L.5.2 Function

A25 controls the Big Steps RF47-RF62, RF133-RF143, RF220, Binary Amplifiers B9-B12 and monitors the Air Flow in the right PA compartment.

L.5.3 Location

Modulation Encoder A25 is located in the right PA compartment (See VIEW 2).

L.5.4 Block Diagram Description

Refer to the block diagram description for the Big Step Modulation Encoders, A26-A31.

L.5.5 Detailed Circuit Description

The following description will only contain information on the differences in the Binary Modulation Encoder A25, which is designated by the dashed lines on the drawing.

L.5.5.1 Binary Encoder

The Binary RF Amplifiers are directly controlled by the four Least Significant Bits of the Digital Audio Signal, B9 through B12.

L.5.5.1.1 Input Latches

B9 through B12 enter the board on J8-1 through J8-7. They are connected to the input of Data Latch U17 on pins 14, 13, 8, and 7 which latches the data when a Data Strobe signal is present. The output of U17 is distributed to another Latch U18 that is connected to OR gates.

L.5.5.1.2 OR Gates

The other input of the OR gate U19 comes from the Binary Clip circuit. Normally this input is LOW and the Binary RF Amps are controlled by B9-B12.

If the bit is HIGH, then the associated Binary RF Amp is turned ON. If the bit is LOW, then the associated RF Amp is turned OFF.

L.5.5.1.3 P1B

In order for the board to control the Binary RF Amps, it is necessary for jumper P1 to be installed in the P1-B position. This will distribute B9 to J1-17, B10 to J1-15, B11 to J1-13 and B12 to J1-11. The other four positions are used by U5 to control Big Step RF Amps 133 through 136.

L.5.5.1.4 Connector Inversion

Connectors J3 and J4 are physically located on the back side of the board and are offset by one pin to accommodate the control of the other Big Step RF Amps.

L.5.5.2 Binary Clip PAL

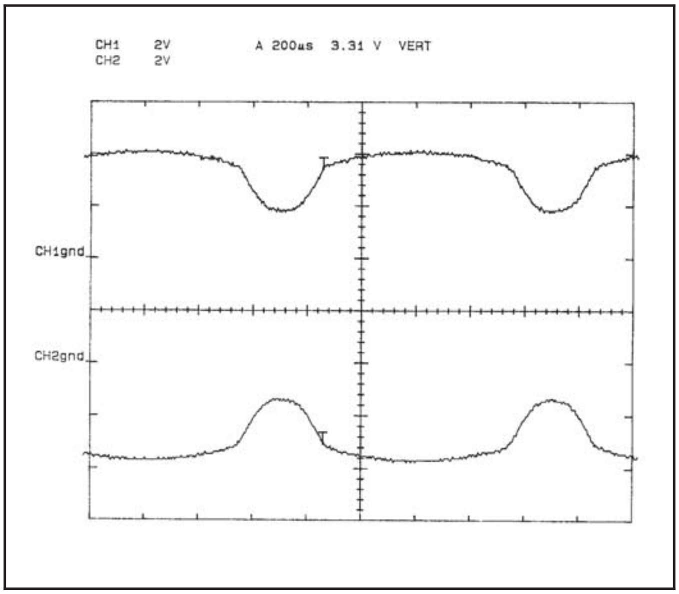
The Binary Clip PAL produces a flat topped positive peak modulation if the audio input level exceeds the maximum positive peak modulation capabilities of the Transmitter.

When all Big Step and Binary RF Amps are turned ON, a further increase in audio input will hold all Binary RF Amps ON.

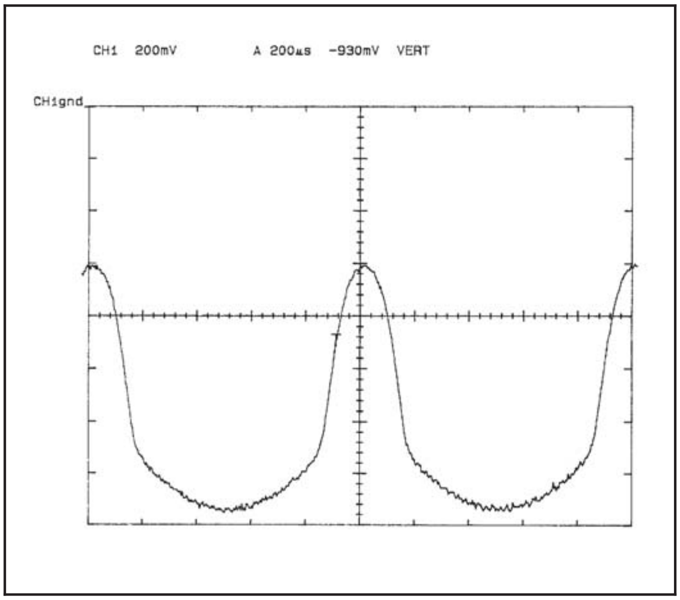
Binary Clip PAL U2-20 will go HIGH and is connected to all inputs of OR gate U19 via JP3-5.

This HIGH input holds all OR gate outputs HIGH and all Binary Steps ON, as long as the CLIP signal is present.

When the audio input level returns back to normal, the Clip output will go back LOW and the Binary RF Amps are controlled again by B9-B12.



CH1 J7-3
CH2 J7-1

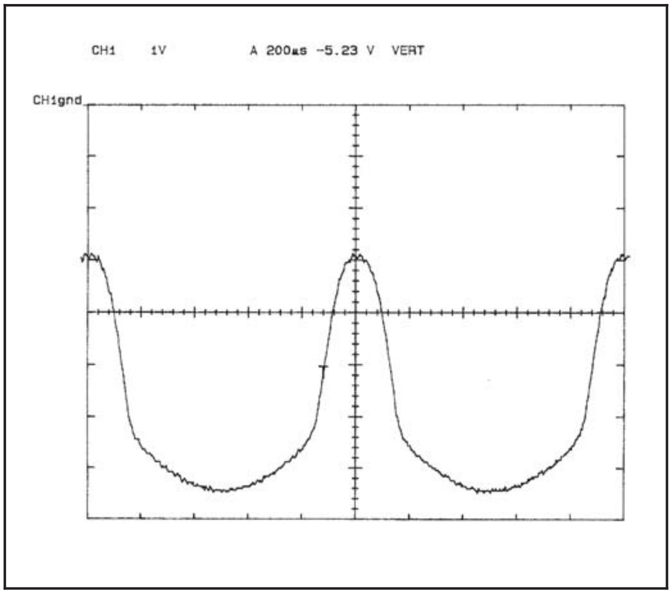


TP15

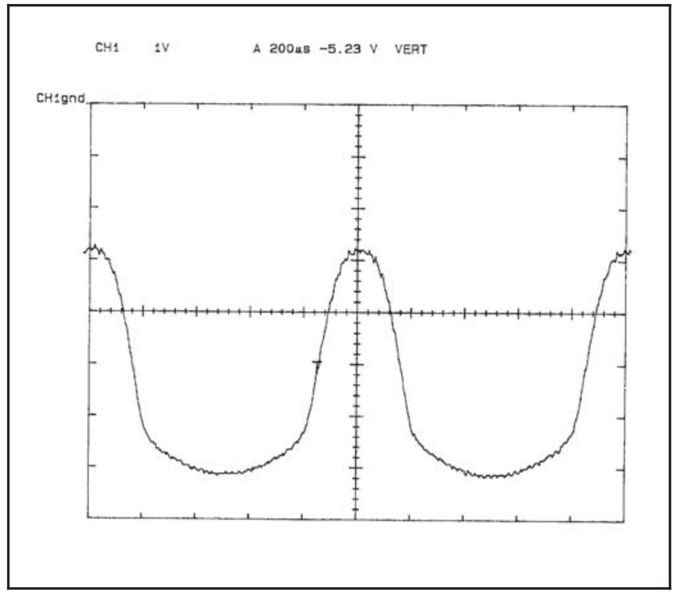
WARNING: Disconnect primary power prior to servicing.

L.5.5.3 Binary RF Amplifier Failure

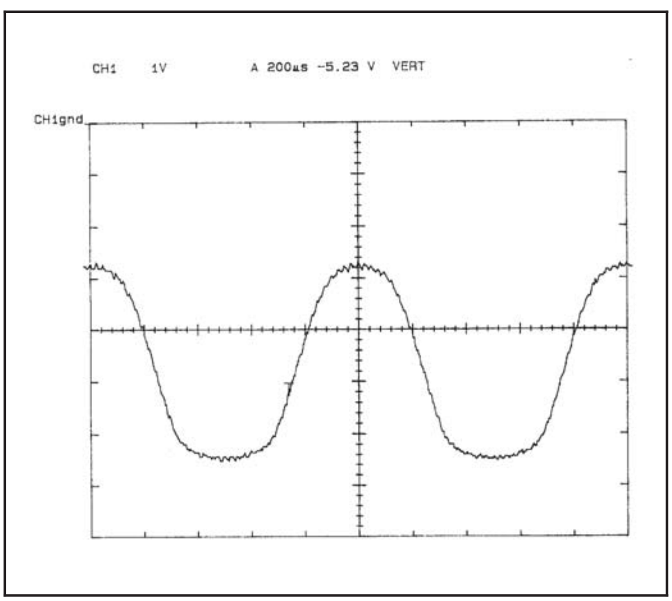
If a Binary Step fails, it is necessary to turn the Transmitter OFF and physically replace the faulty Binary Amp with a spare or move the RF Amp in Step 220 to the faulty Binary location. If the Amp from Step 220 is used, then place the failed RF Amp in Step 220 location.



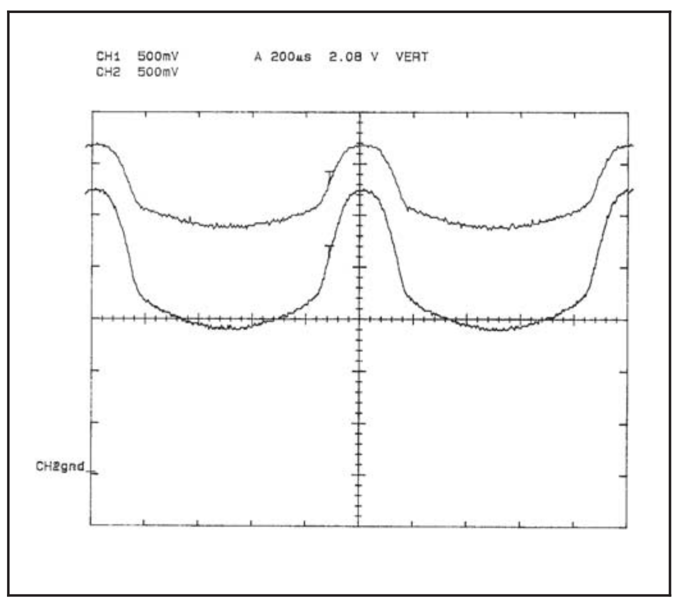
TP11



TP11 (50kW)

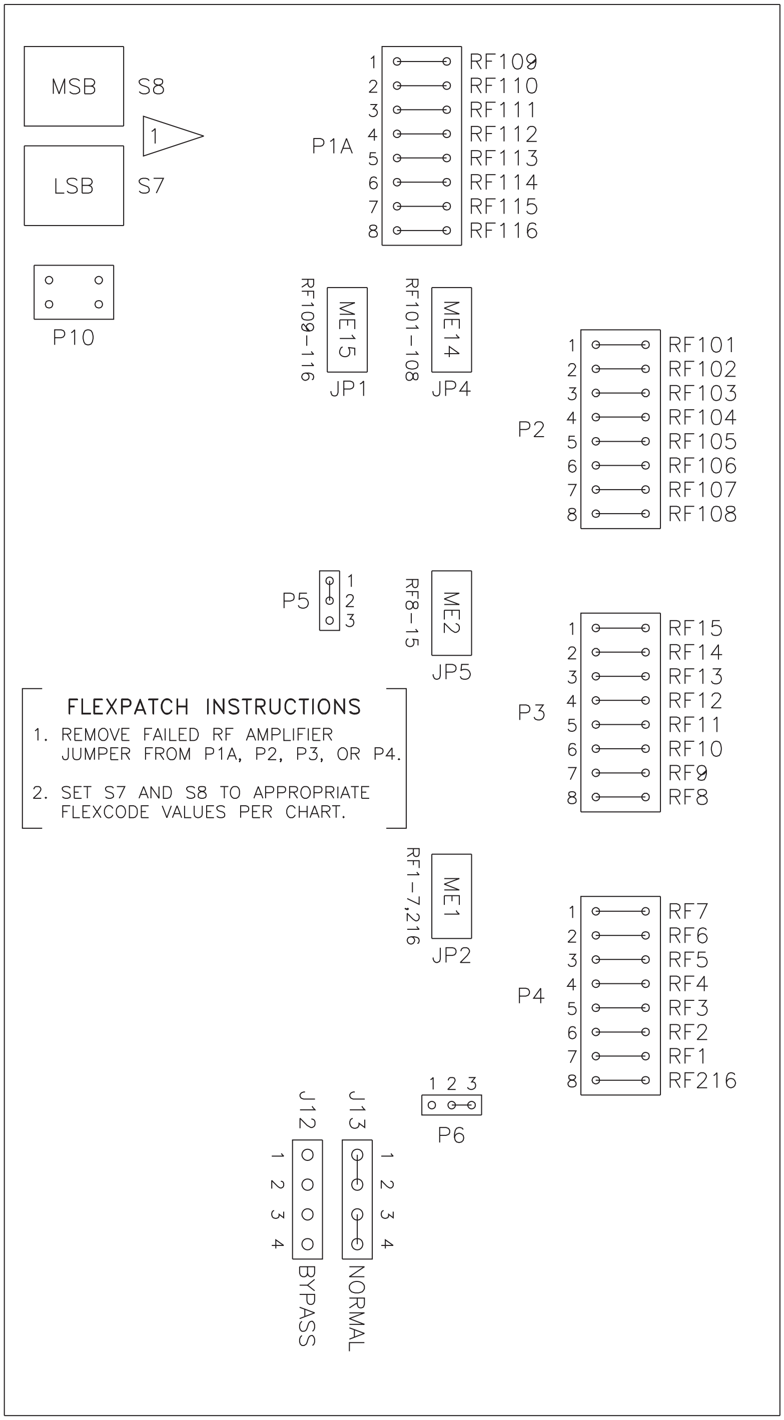


TP11 (10kW)



Upper Trace CH1 U37-11
Lower Trace CH2 U37-10

A29–MODULATION ENCODER



RF AMP #	FLEXCODE S8 MSB	FLEXCODE S7 LSB
RF116	7	4
RF115	7	3
RF114	7	2
RF113	7	1
RF112	7	0
RF111	6	15
RF110	6	14
RF109	6	13
RF108	6	12
RF107	6	11
RF106	6	10
RF105	6	9
RF104	6	8
RF103	6	7
RF102	6	6
RF101	6	5
RF15	0	15
RF14	0	14
RF13	0	13
RF12	0	12
RF11	0	11
RF10	0	10
RF9	0	9
RF8	0	8
RF7	0	7
RF6	0	6
RF5	0	5
RF4	0	4
RF3	0	3
RF2	0	2
RF1	0	1
(1) RF216	13	8

2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

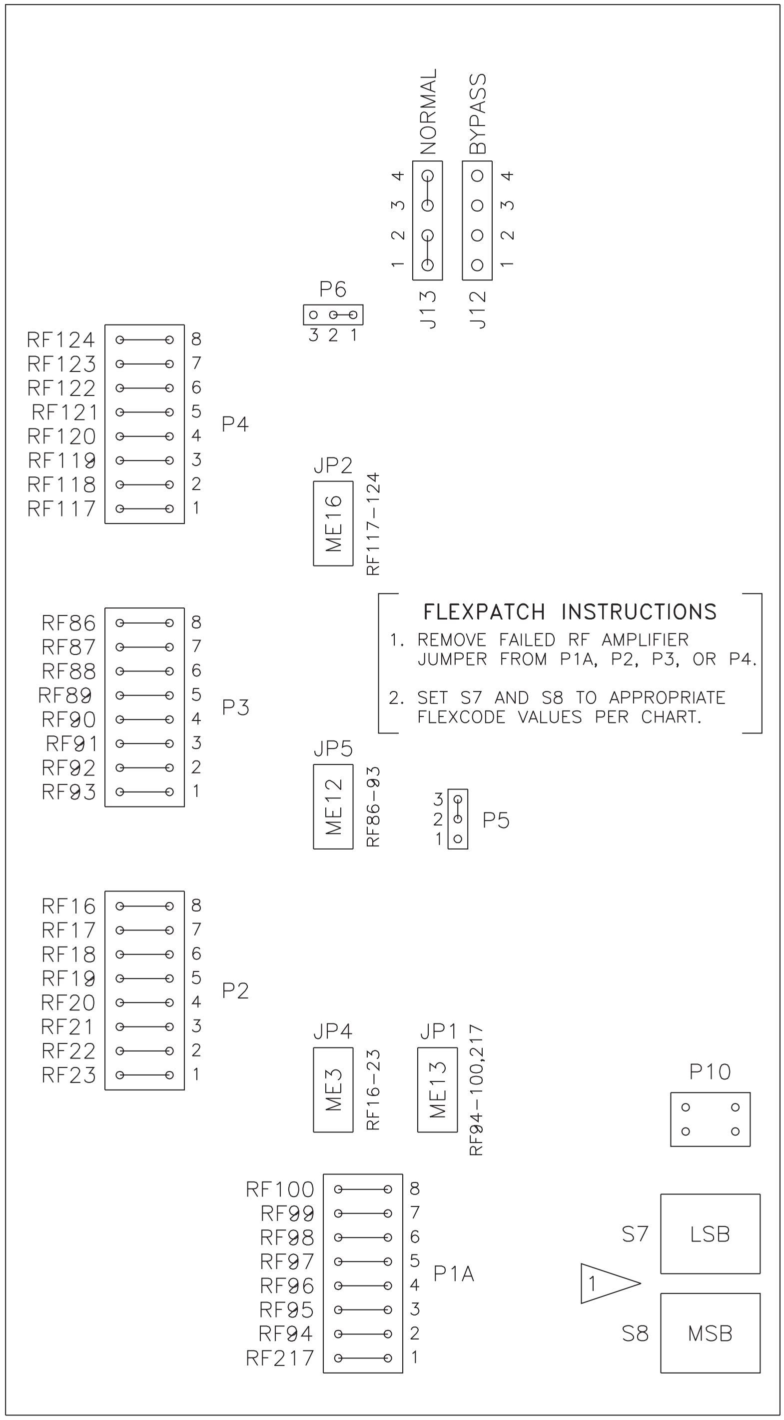
(1) RF216–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

VIEW 20 — FLEXPATCH AND MODULE ENCODING — COMPONENT VIEW–LEFT MODULTION ENCODER BOARD — LEFT COMPARTMENT–POWER AMPLIFIER CABINET–UNIT 1 — VIEW 20

817 2413 931 SH–22 A

RF AMP #	FLEXCODE S8 MSB	FLEXCODE S7 LSB
RF124	7	12
RF123	7	11
RF122	7	10
RF121	7	9
RF120	7	8
RF119	7	7
RF118	7	6
RF117	7	5
RF93	5	13
RF92	5	12
RF91	5	11
RF90	5	10
RF89	5	9
RF88	5	8
RF87	5	7
RF86	5	6
RF23	1	7
RF22	1	6
RF21	1	5
RF20	1	4
RF19	1	3
RF18	1	2
RF17	1	1
RF16	1	0
RF100	6	4
RF99	6	3
RF98	6	2
RF97	6	1
RF96	6	0
RF95	5	15
RF94	5	14
(1) RF217	13	9

A28–MODULATION ENCODER



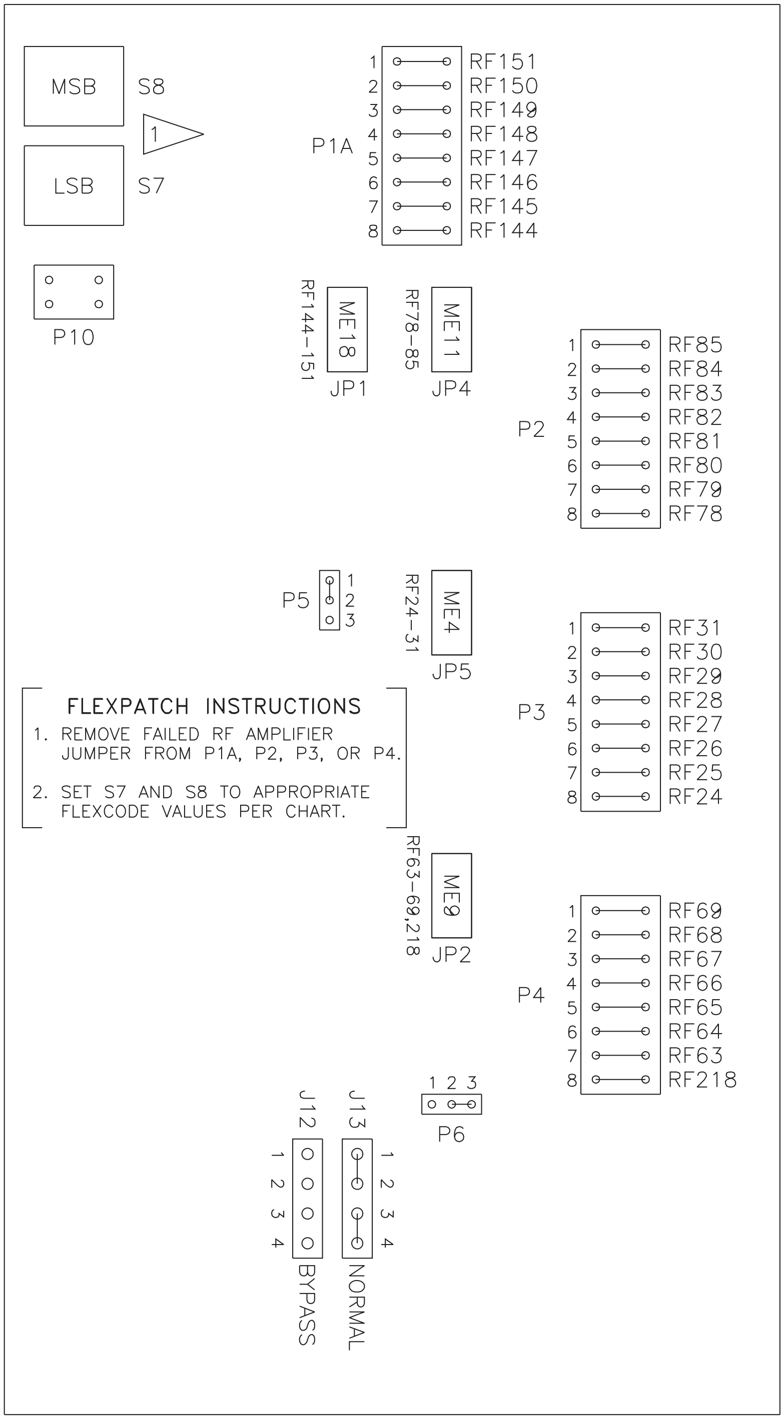
2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP3, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

(1) RF217–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

VIEW 21 — FLEXPATCH AND MODULE ENCODING — COMPONENT VIEW–RIGHT MODULATION ENCODER BOARD — LEFT COMPARTMENT–POWER AMPLIFIER CABINET–UNIT 1 — VIEW 21

817 2413 931 SH-23 A

A27–MODULATION ENCODER



RF AMP #	FLEXCODE S8 MSB	FLEXCODE S7 LSB
RF151	9	7
RF150	9	6
RF149	9	5
RF148	9	4
RF147	9	3
RF146	9	2
RF145	9	1
RF144	9	0
RF85	5	5
RF84	5	4
RF83	5	3
RF82	5	2
RF81	5	1
RF80	5	0
RF79	4	15
RF78	4	14
RF31	1	15
RF30	1	14
RF29	1	13
RF28	1	12
RF27	1	11
RF26	1	10
RF25	1	9
RF24	1	8
RF69	4	5
RF68	4	4
RF67	4	3
RF66	4	2
RF65	4	1
RF64	4	0
RF63	3	15
(1) RF218	13	10

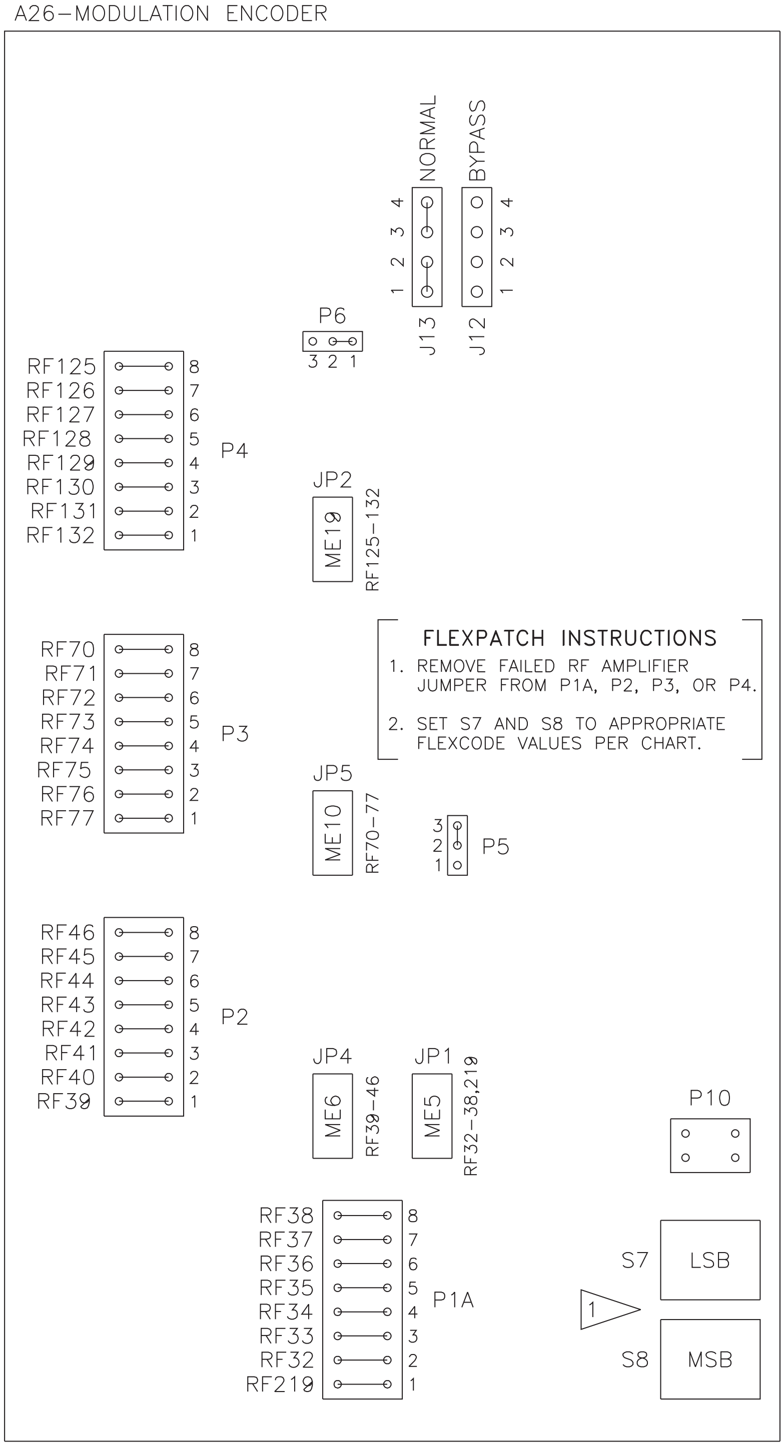
2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

(1) RF218–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

FLEXPATCH AND MODULE ENCODING
VIEW 22 COMPONENT VIEW–LEFT MODULATION ENCODER BOARD VIEW 22
CENTER COMPARTMENT–POWER AMPLIFIER CABINET–UNIT 1 817 2413 931 SH–24 A

WARNING: Disconnect primary power prior to servicing.

RF AMP #	FLEXCODE S8 MSB	FLEXCODE S7 LSB
RF132	8	4
RF131	8	3
RF130	8	2
RF129	8	1
RF128	8	0
RF127	7	15
RF126	7	14
RF125	7	13
RF77	4	13
RF76	4	12
RF75	4	11
RF74	4	10
RF73	4	9
RF72	4	8
RF71	4	7
RF70	4	6
RF46	2	14
RF45	2	13
RF44	2	12
RF43	2	11
RF42	2	10
RF41	2	9
RF40	2	8
RF39	2	7
RF38	2	6
RF37	2	5
RF36	2	4
RF35	2	3
RF34	2	2
RF33	2	1
RF32	2	0
(1) RF219	13	11



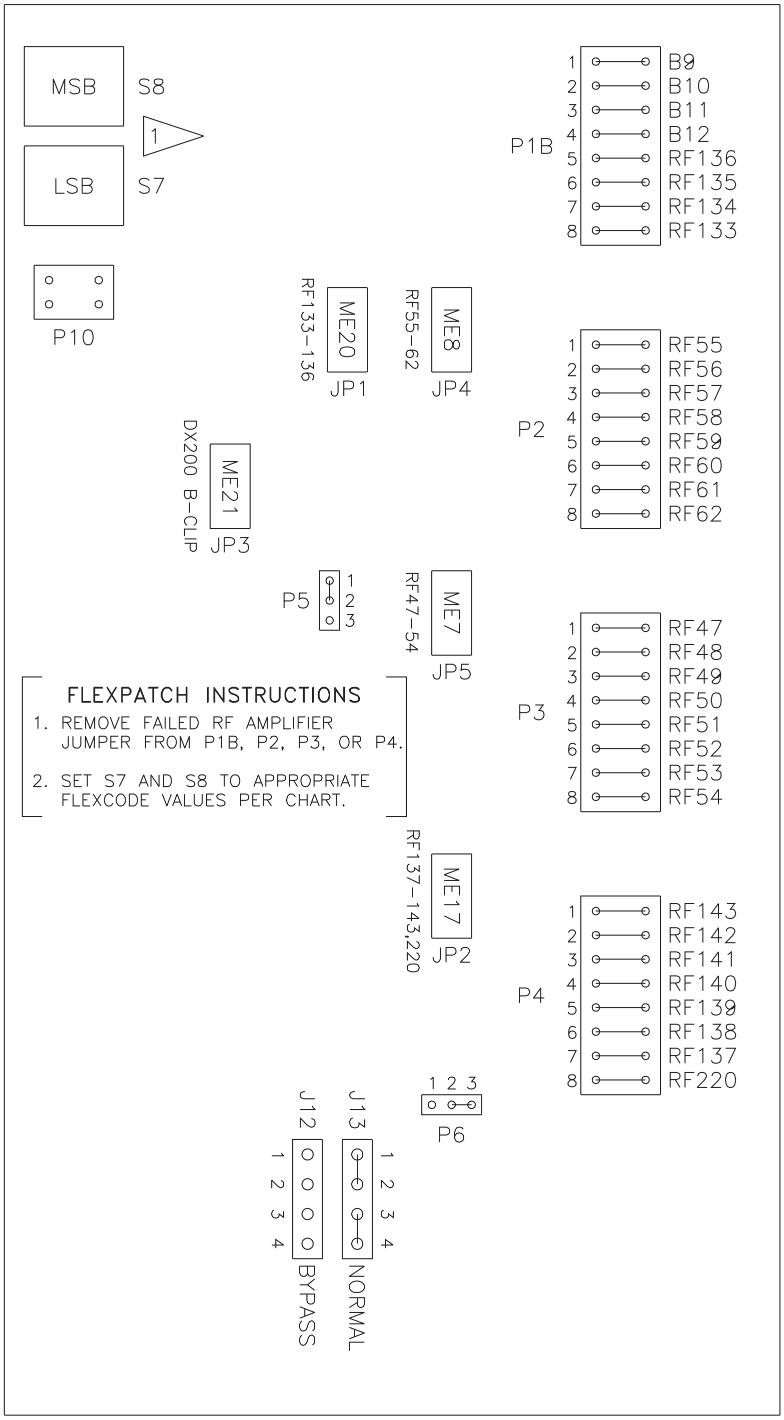
2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

(1) RF219-PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

FLEXPATCH AND MODULE ENCODING
VIEW 23 COMPONENT VIEW-RIGHT MODULATION ENCODER BOARD VIEW 23
CENTER COMPARTMENT-POWER AMPLIFIER CABINET-UNIT 1 817 2413 931 SH-25 A

WARNING: Disconnect primary power prior to servicing.

A25–MODULATION ENCODER



RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF136	8	8
RF135	8	7
RF134	8	6
RF133	8	5
RF62	3	14
RF61	3	13
RF60	3	12
RF59	3	11
RF58	3	10
RF57	3	9
RF56	3	8
RF55	3	7

RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF54	3	6
RF53	3	5
RF52	3	4
RF51	3	3
RF50	3	2
RF49	3	1
RF48	3	0
RF47	2	15
RF143	8	15
RF142	8	14
RF141	8	13
RF140	8	12
RF139	8	11
RF138	8	10
RF137	8	9
(1) RF220	13	12

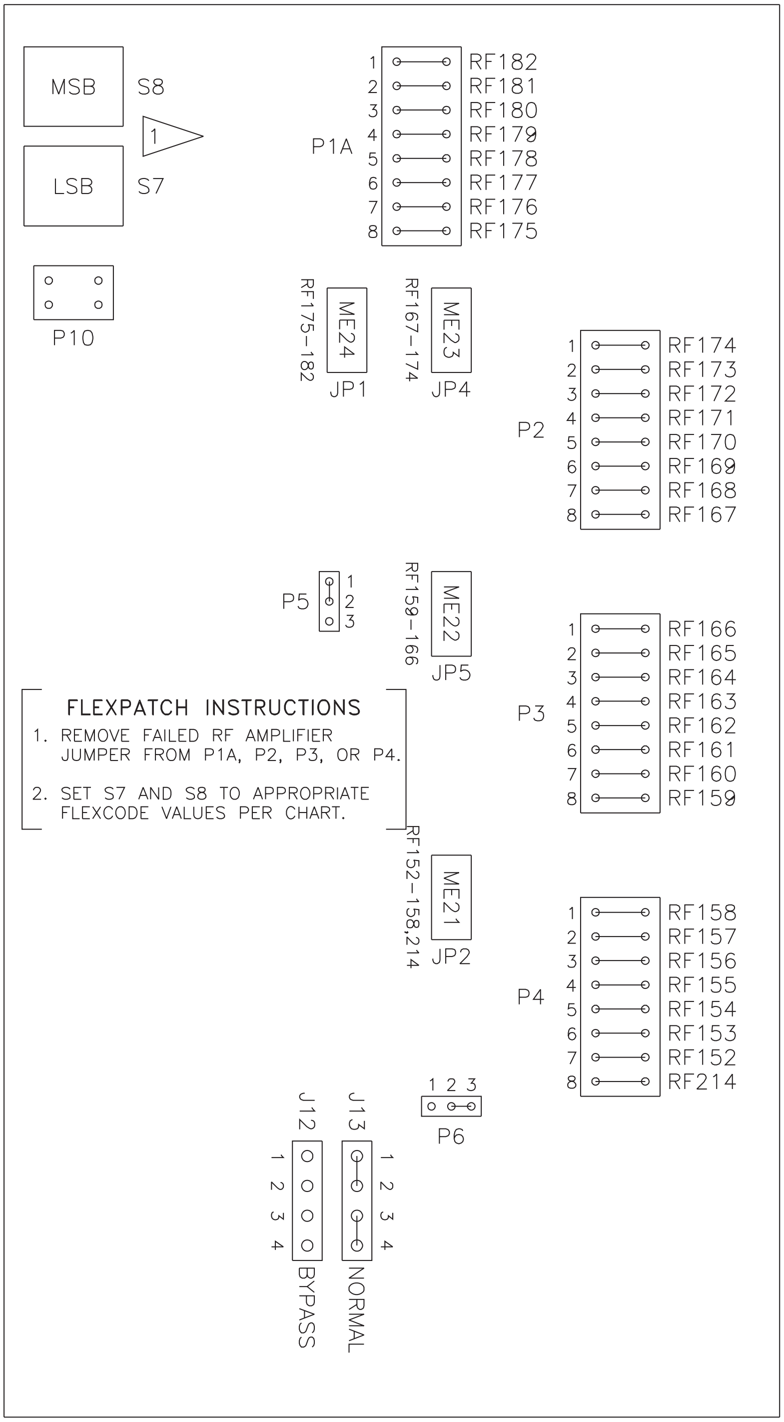
2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP3, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

(1) RF220–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

VIEW 24 — FLEXPATCH AND MODULE ENCODING — VIEW 24
COMPONENT VIEW–MODULATION ENCODER BOARD
RIGHT COMPARTMENT–POWER AMPLIFIER CABINET–UNIT 1 817 2413 931 SH–26 A

WARNING: Disconnect primary power prior to servicing.

A31–MODULATION ENCODER



RF AMP #	FLEXCODE S8 MSB	FLEXCODE S7 LSB
RF182	11	6
RF181	11	5
RF180	11	4
RF179	11	3
RF178	11	2
RF177	11	1
RF176	11	0
RF175	10	15
RF174	10	14
RF173	10	13
RF172	10	12
RF171	10	11
RF170	10	10
RF169	10	9
RF168	10	8
RF167	10	7
RF166	10	6
RF165	10	5
RF164	10	4
RF163	10	3
RF162	10	2
RF161	10	1
RF160	10	0
RF159	9	15
RF158	9	14
RF157	9	13
RF156	9	12
RF155	9	11
RF154	9	10
RF153	9	9
RF152	9	8
(1) RF214	13	6

2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP4, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

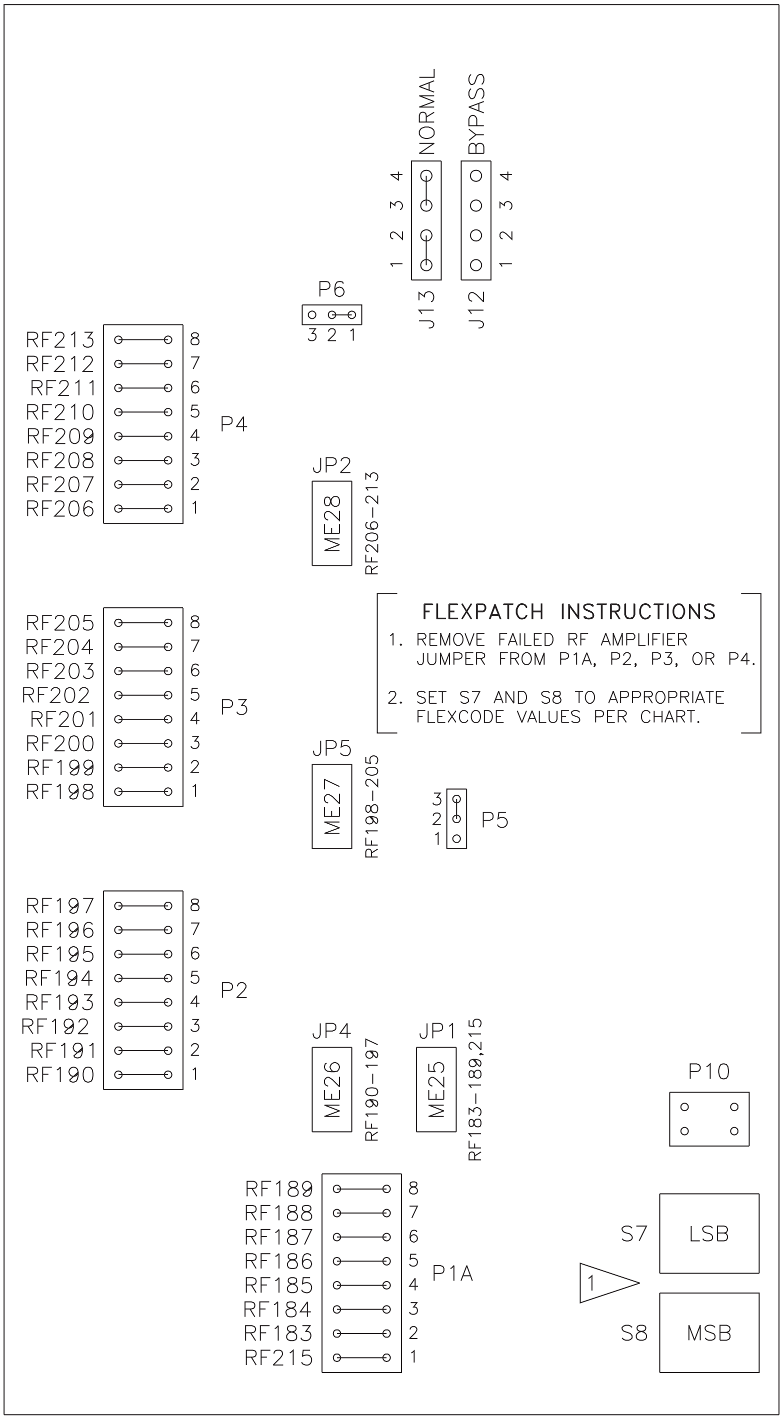
(1) RF214–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

FLEXPATCH AND MODULE ENCODING
VIEW 25 COMPONENT VIEW–LEFT MODULTION ENCODER BOARD VIEW 25
EXTENDED–POWER AMPLIFIER CABINET–UNIT 2 817 2413 931 SH–27 A

WARNING: Disconnect primary power prior to servicing.

RF AMP #	FLEXCODE	
	S8 MSB	S7 LSB
RF213	13	5
RF212	13	4
RF211	13	3
RF210	13	2
RF209	13	1
RF208	13	0
RF207	12	15
RF206	12	14
RF205	12	13
RF204	12	12
RF203	12	11
RF202	12	10
RF201	12	9
RF200	12	8
RF199	12	7
RF198	12	6
RF197	12	5
RF196	12	4
RF195	12	3
RF194	12	2
RF193	12	1
RF192	12	0
RF191	11	15
RF190	11	14
RF189	11	13
RF188	11	12
RF187	11	11
RF186	11	10
RF185	11	9
RF184	11	8
RF183	11	7
(1) RF215	13	7

A30–MODULATION ENCODER



2. MODULE ENCODING FOR THIS BOARD IS SET BY JP1, JP2, JP3, AND JP5 PROGRAMMED DEVICES, AND BY P5 AND P6 JUMPERS.

(1) RF215–PROGRAMMABLE RF AMP, NORMAL FLEXCODE SETTING

VIEW 26 — FLEXPATCH AND MODULE ENCODING
COMPONENT VIEW–RIGHT MODULATION ENCODER BOARD
EXTENDED–POWER AMPLIFIER CABINET–UNIT 2 — VIEW 26

817 2413 931 SH–28 A

WARNING: Disconnect primary power prior to servicing.

M.1 Controller Board

M.1.1 Introdution

This section describes Controller board. Topics include Function, Location, Block Diagram Description, Detailed Circuit Description, Troubleshooting, and Removal/Replacement.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Assembly # 992-8189-002
PWB # 843-5155-021
Schematic # 839-7930-021

NOTE: Parts List for this board is on Section VII.

M.2 Function

The purpose of the Controller is to provide Local/Remote Step-Start Sequence control of the Low/Med/High power levels, monitor Transmitter operation and protectively respond to external or internal fault conditions, and provide metering functions in addition to status indicators.

M.3 Location

The Controller board is located on the back of the center control compartment front door (See VIEW 3).

M.4 Block Diagram Description

The Controller uses PAL integrated circuits (Programmable Array Logic). These PALs are grouped to perform various functions. PALs are a device that can be programmed to implement complex logic functions with up to twenty-two inputs and ten outputs. The 22V10 PAL used in the Transmitter uses AND/OR logic array structure, which directly implements sum-of-products equations. The equations are programmed into the device through electrically-erasable floating-gate cells in the AND logic array. The fixed OR logic array offers a varied number of product terms per output and can be programmed as registered active HIGH or active LOW.

Refer to Figure M-1 Controller Power Control Block Diagram for the following discussion.

M.4.1 Power Level Selection and Power Lower/Raise Control - OPR and LR PALs

These PALs work together to generate the Turn On Request when a power level is selected, control the Lower/Raise function, and produce the VSWR Test signal when required.

The OFF, LOW, MED, HIGH, LOWER, and RAISE control inputs from the Power Block Interface board are processed by the OPR (Operator) PAL and the LR (Lower/Raise) PAL.

These same inputs from the Switch board on the front panel are applied to Transistor Invertors and connected to the OPR and LR PALs.

If there are no present faults, the ENTOR (Enable Turn On Request) from the FLT1 PAL will allow the LR PAL to generate a TOR (Turn-On Request) when a power level is selected. This TOR is sent to the PWR and PTIM PALs.

Both PALs provide outputs to the Switch board, Power Block Interface, and to the Analog Input board for status and control functions. Transistor Invertors provide the proper voltage levels for operation.

During power level selection, power level change, or by a Manual VSWR Test, the LR PAL generates the VSWR Test signal that is used by the Output Monitor board. The Pass/Fail results of this test are determined on the Output Monitor board.

After the Transmitter is operational on the selected power level, the Lower/Raise controls are activated and fine power level changes can be made to the Transmitter.

M.4.2 Step-Start Sequence Control - PWR and PTIM PALs

These PALs work together to generate the Enables used by the Fault Handling PALs on the Controller.

When a Turn-On Request (TOR) is received by both the PWR (Power) and PTIM (Power Timing) PALs, the PTIM PAL starts the initial sequence by sending a Time pulse to the PWR PAL 1.5 seconds after the TOR is produced. The PWR PAL sequentially controls the TX ON Enable that is used by several other boards in the Transmitter.

The PWR PAL must receive Time signals from the PTIM PAL, before executing each step.

The PWR PAL also generates the Enable 1, Enable 2, and Enable 3 signals that are used by the Fault Handing and Latch PALs.

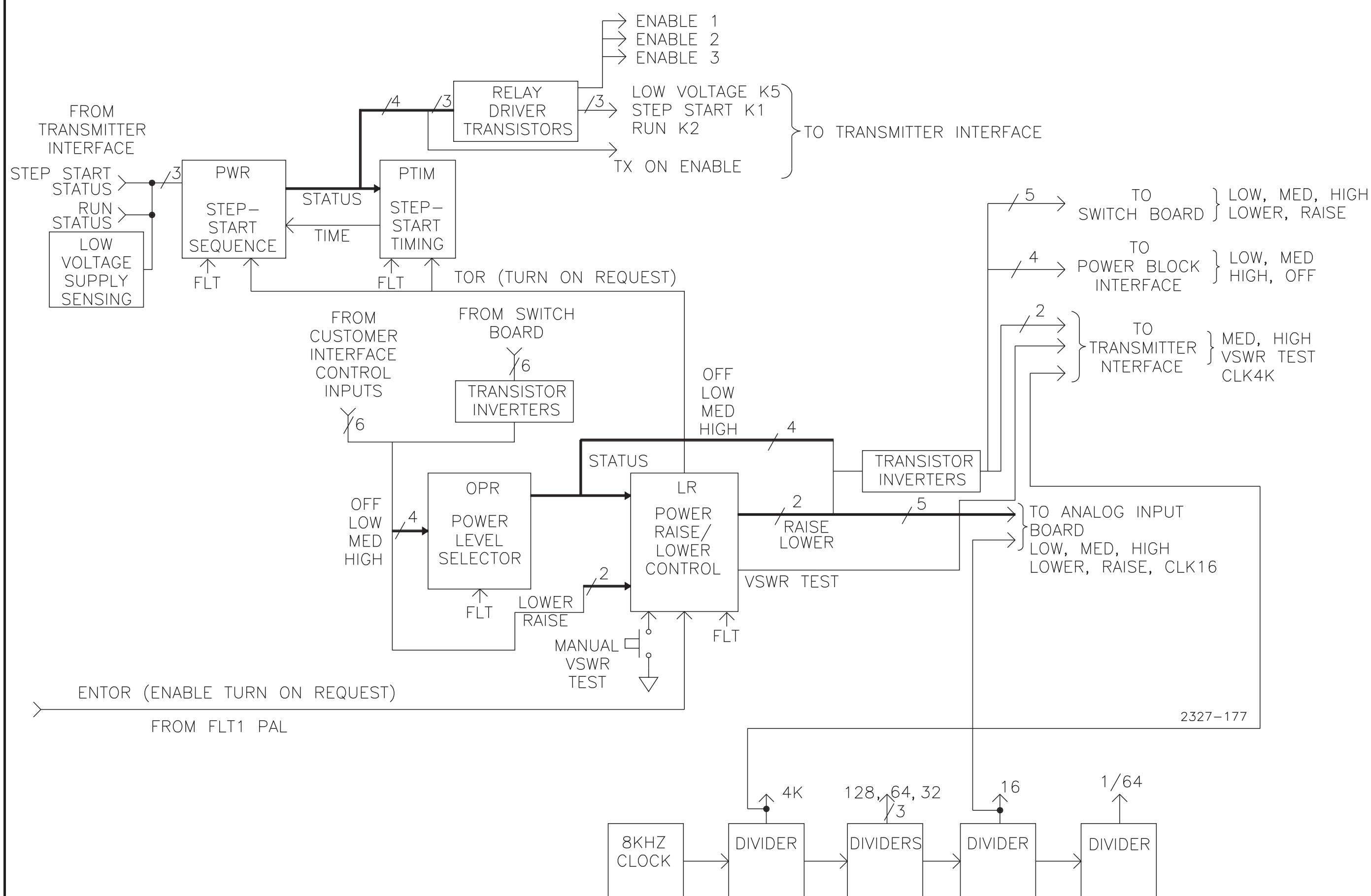


Figure M-1. Power Control Block Diagram

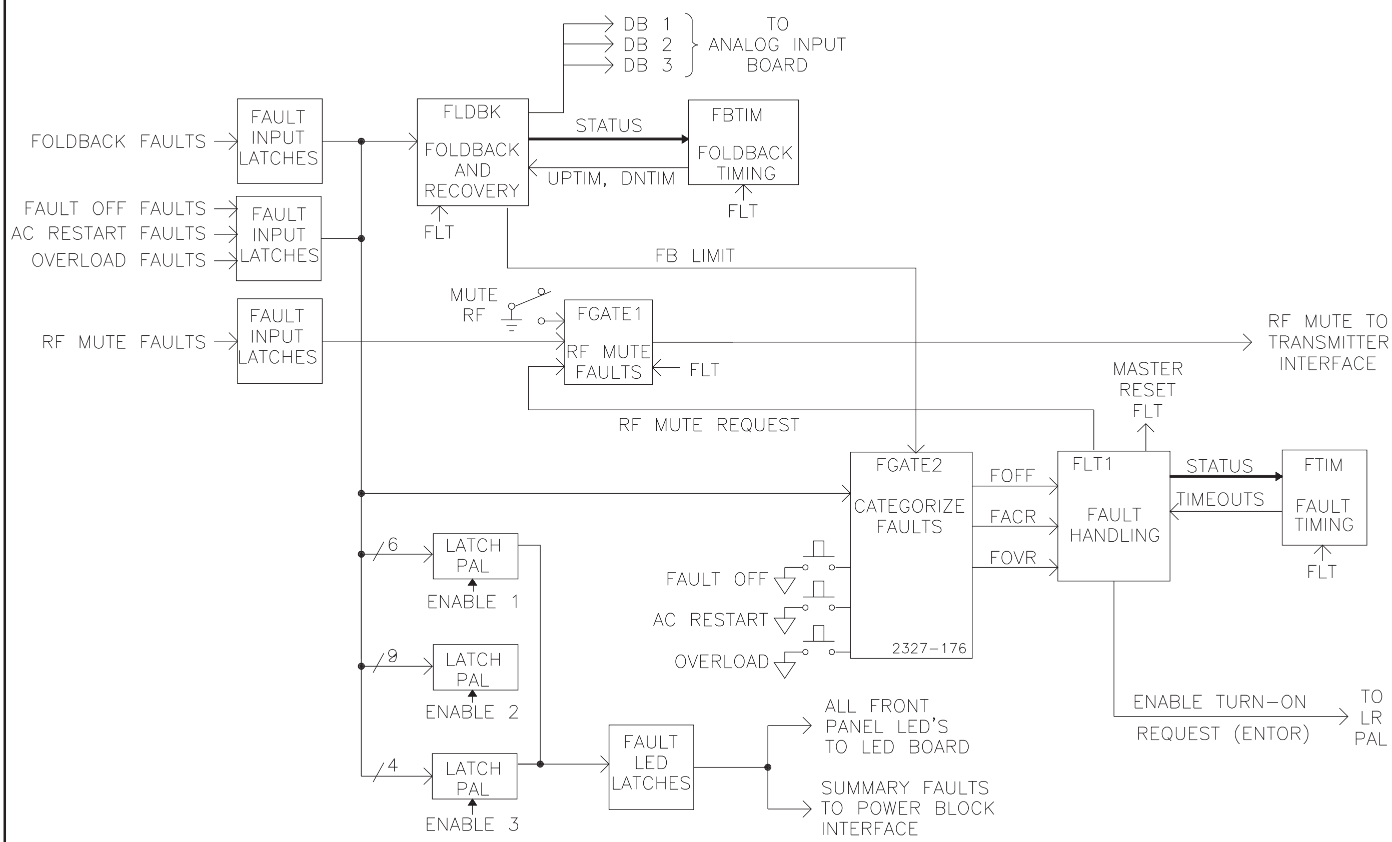


Figure M-2. Fault Handling Block Diagram

An 8 kHz Clock is Divided down several times to provide six different clock frequencies used by different PALs.

Refer to Figure M-2 Controller Fault Handling Block Diagram for the following discussion.

M.4.3 Fault Types and Fault Input Latches

All fault inputs generated by the Transmitter are applied to Fault Input Latches and can be categorized by the type of Controller response:

M.4.3.1 RF MUTE

This type fault will lower the power to zero by turning all Big Step and Binary RF Amplifiers OFF, but it does not to turn the Transmitter OFF.

M.4.3.2 FOLDBACK FAULT

Foldback faults will reduce the power output in steps, the amount of attenuation is determined by the type and length of the fault. If the original fault is of short duration or no longer present, the Transmitter can recover in steps back to the original power. If the Transmitter is at maximum foldback, and another power reduction is requested, then the Transmitter will be shut off.

M.4.3.3 A/C RESTART FAULT (FACR)

If the A/C power is lost, the Transmitter will turn OFF and wait for the A/C to return to normal. When it does, the Transmitter will automatically turn back ON at the same power level output as before.

M.4.3.4 OVERLOAD FAULT (FOVR)

This type fault turns OFF the Transmitter, the Controller attempts once to recover when the fault is removed. If the fault is not present on the retry, the Transmitter will remain ON. If the fault is still present on the retry, the Transmitter will turn OFF and remain in this condition until restarted by an operator after the fault has been corrected.

M.4.3.5 FAULT OFF (FOFF)

This type fault will turn the Transmitter OFF, and the Transmitter must be restarted by an operator after the fault has been corrected.

M.4.4 Power Foldback/Recovery Control - FLDBK and FBTIM PALs

These PALs work together to respond to Foldback Faults by controlling the Transmitter power output.

Faults that require Foldback/Recovery are applied to the FLDBK (Foldback) PAL. Outputs DB1, 2, and 3 are used to vary the Transmitter power output level via controls on the Analog Input board.

The FBTIM (Foldback Timing) PAL receives the Status of the FLDBK PAL. It sends timing signals for the Down Timing (Foldback) and the Up Timing (Recovery) to the FLDBK PAL.

If the maximum amount of Foldback is not enough to protect the Transmitter, Foldback Limit will upgrade the fault to a Fault OFF fault.

M.4.5 RF Mute Faults - FGATE 1

Faults that require the power output to be set to zero, but not to turn the Transmitter OFF are applied to FGATE 1 (Fault Gate 1).

These RF Mute faults, manual RF Mute, or requests from the FLT1 PAL are generated by this PAL and sent to the Extended Transmitter Interface where it is distributed to several boards.

M.4.6 OFF-A/C Restart-Overload Faults - FGATE 2

These type faults or manual Fault Switches designed to simulate the fault are connected to the FGATE 2 (Fault Gate 2) PAL.

The PAL categorizes these faults into FOFF, FACR, or FOVR and applies them to the FLT1 PAL for Transmitter control.

M.4.7 Fault Handling - FLT1 and FTIM

These PALs work together to control the Transmitter response to these three fault types.

The FLT1 (Fault 1) PAL accepts the FOFF, FACR, and FOVR faults from FGATE2 and the Foldback Limit from FLDBK.

It responds to these faults by controlling the Enable Turn-On Request that is sent to the LR PAL. ENTOR signals the LR PAL that no inhibitive faults are present. Conversely, loss of ENTOR recoverably faults the Transmitter OFF.

The FTIM (Fault Timing) PAL provides the Timeout signals to FLT1 based upon the Status of the fault in progress.

FLT1 is the source of the FLT Master Reset that is connected to most PALs. When activated, this signal halts all activity & clears the PALs to their off or ready state.

M.4.8 Latch PALs and Fault LED Latches

All fault inputs can be registered by the three Latch PALs when the appropriate Enable is activated.

The Latch PALs and Fault LED Latches purpose is to hold or store a fault that has occurred so that it can visibly illuminate an indicator on the LED Board and provide Summary Faults to the Power Block Interface.

Refer to Figure M-3 Controller Power Supplies/Monitoring Block Diagram for the following discussion.

M.4.9 Controller Power Supplies

The +12VDC supply powers two +5VDC Regulators that are diode “OR”ed together to form the +5VDC supply. Should either regulator fail, the other regulator is capable of providing all the required current. A Voltage Detector will generate a Controller Supply Fault that only provides a visual indication of the fault.

If the single phase A/C power fails, an Unregulated Supply Loss Detector will create a Controller Unregulated Loss Fault. This is an A/C Restart Fault that will also turn LEDs off to conserve power via the Supplies Present Detector and the LED Inhibit.

A Backup Capacitor will hold up the +5VDC supply for about 10 minutes. If the Backup Capacitor voltage begins to drop too low, a Backup Voltage Detector and Battery Backup Switch will connect +6VDC from the Battery Backup on the Extended Transmitter Interface to the Controller +5VDC supply. This will hold up the +5VDC supply for about four days.

Another +5VDC Regulator is used to supply circuits on the Extended Transmitter Interface.

M.4.10 Controller Monitoring

A sample of the +250VDC from the Recifier Cabinet is connected to an Overvoltage and Undervoltage Detector that can create a Power Supply Voltage Error if the voltage is not within the required limits.

When the Transmitter is in the Test Mode, the LV supplies are active. +7.5 VDC is connected to the Low Voltage Supply Sensing circuit which generates a HIGH KLVX output signal that is used by the PWR PAL. When the Transmitter is in the Normal Mode, the LV supplies are not active. The KLVX output will be LOW.

A Remote Control Input, ColorStat™ Status Panel Fault Reset, or the onboard Reset switch are used by the Reset Detector to produce the Reset used by the Controller.

M.5 Detailed Circuit Description

Refer to the Controller Schematic Diagram (839-7930-021), for the following discussion.

Refer to other Simplified Diagrams as requested.

NOTE

On all Simplified Diagrams if a bar is placed over the top of the input or output mnemonics, this designates the function as a active LOW signal. When the signal is LOW, the function is activated. If no bar is placed over the top of the mnemonic, the function is a active HIGH signal. When the signal is HIGH, the function is activated.

NOTE

All inputs/outputs to/from the Controller are fully transient and overvoltage protected as well as RFI filtered. This is accomplished by use of resistor voltage dividers (10k and 100k Ohm), zener diodes (5.1VDC), and capacitors (.001uF).

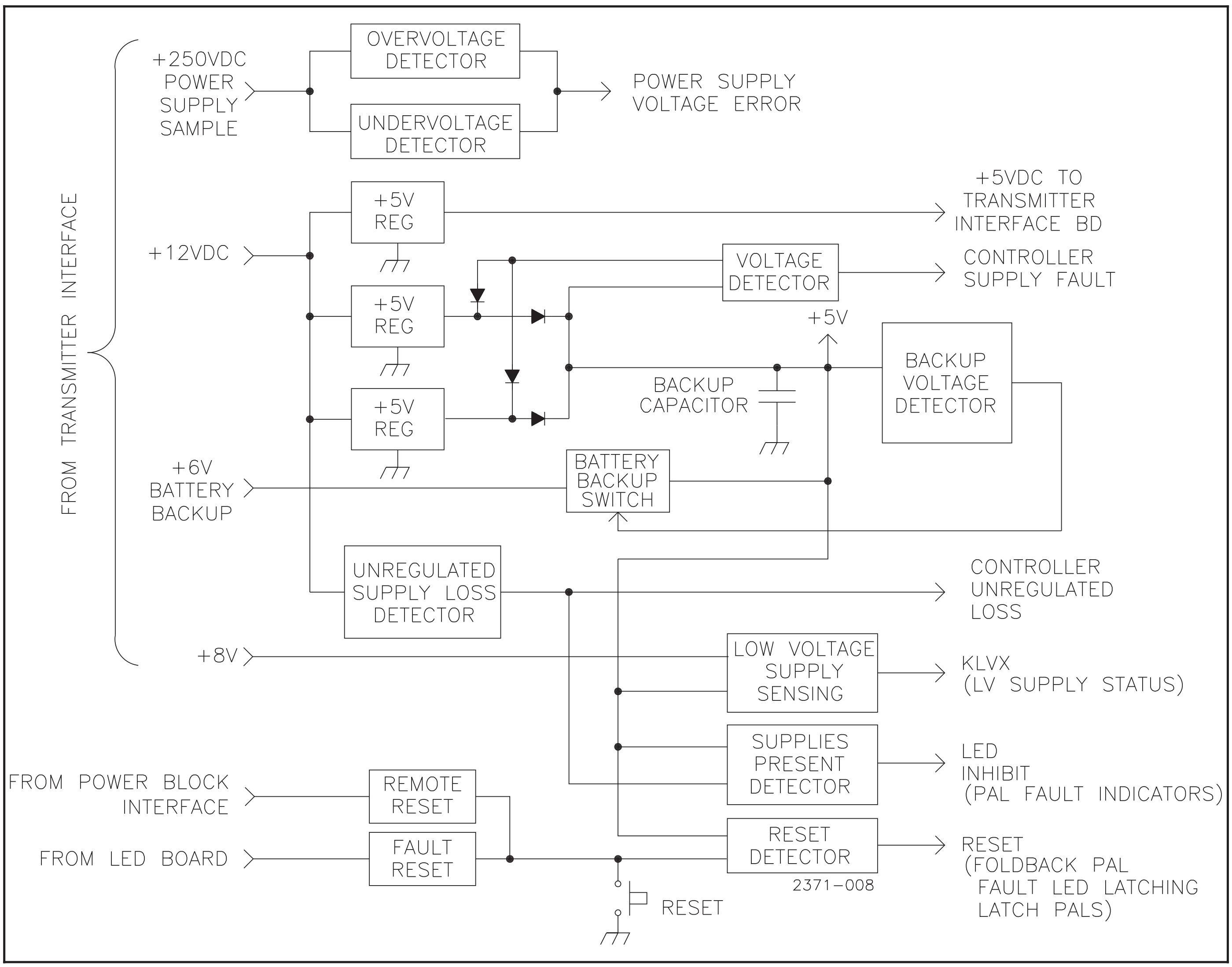


Figure M-3. Power Supplies and Monitoring

WARNING: Disconnect primary power prior to servicing.

M.5.1 LR and OPR PALs

M.5.1.1 Switch Board And Power Block Interface Inputs

From the Transmitter front panel Switch board, High, Medium, Low, Off, and Raise & Lower power level control buttons provide an active HIGH inputs to the Controller on J3-30 through J3-35. These inputs are buffered by transistor invertors U40 and U41, and passed to the LR & OPR PAL as active LOW signals labeled XXX.IN (example HIGH.IN, MED.IN, etc).

From the Power Block Interface Board, the same extended/remote control inputs provide active LOW inputs to the controller on J4-9, 11, 13, 15, 17, and 19. They are enabled by the Local/Remote ColorStat™ Status Panel switch and operate identically to the front panel switches. These active LOW signals are paralleled with the Switch board inputs.

Refer to Figure M-4, LR and OPR PALs.

M.5.1.2 Power Level Selection

When a power level is selected, the corresponding XXX.IN to the OPR PAL will go LOW.

Gating logic and a Priority Selector in the OPR PAL will generate a latched Off,Low, Med, or High logic HIGH output that is sent to the Lower/Raise (LR) PAL and Local/Remote Transmitter Status Output transistors.

If multiple XXX.IN inputs go LOW simultaneously, only a single OFF, LOW, MED, or HIGH command will be generated in this order as determined by the Priority Encoder.

M.5.1.3 Turn On Request Generation

When the power level selection is made, the HIGH input to the LR PAL will generate a HIGH Turn On Request (TOR) as long as the Enable Turn On Request (ENTOR) is HIGH.

The ENTOR comes from the FLT1 PAL, and it must be HIGH for the LR PAL to generate a TOR.

The TOR is applied to the PWR PAL and the PTIM PAL to begin the Step Start Sequence.

When the Transmitter is manually turned OFF or if the ENTOR goes LOW (from a fault condition), the TOR signal goes LOW and the Transmitter is shut OFF.

M.5.1.4 Local/Remote Transmitter Status Outputs

When the power level selection is made, the corresponding LOW, Med or High logic HIGH output from the OPR PAL will directly send a HIGH output signal to the Analog Input board via J1-27, 29, or 31. This will activate the Power Control switch on the Analog Input board that controls the power output.

This logic HIGH signal will also turn on a transistor invertor U42 that sends a LOW signal to illuminate the lamp inside the pushbutton switch on the Switch board, activate the Remote Status Output on the Power Block Interface board.

The outputs to the Switch board are on J3-25, 26, and 27. The outputs to the Power Block Interface are on J5-3, 5, and 7. A convenient place to measure these active LOW signals are at TP10 (HIGH), TP11 (MED), and TP12 (LOW).

When the Transmitter is OFF, an invertor transistor pulls TP13 LOW and this signal is sent to the Power Block Interface board via J5-1.

M.5.1.5 Lower/Raise Fine Power Control

After Enable 3 has been generated by the PWR PAL, and as long as the Keypress is LOW, the LOWER.IN and RAISE.IN inputs to the LR PAL are active. The Priority Select circuit gives the Lower command priority over the Raise command if both inputs are LOW at the same time.

The active logic HIGH LOWER output is sent to the Analog Input board via J1-1 to control the Fine Power Control PALs. A transistor invertor U41 pulls TP15 and J3-29 LOW, which illuminates the lamp inside the pushbutton switch on the Switch board.

The same action occurs for the RAISE output at J1-15, and TP14/J3-28. A transistor invertor U41 pulls TP14 and J3-28 LOW, which illuminates the lamp inside the pushbutton switch on the Switch board.

M.5.1.6 VSWR Self Test Request

When the Transmitter is first turned ON, or the selected power level is changed, or when the Manual VSWR Self Test switch S5 is depressed, the Detect Any Change circuit in the LR PAL generates a VSWR Self Test (VST).

The VST output at U6-18 will go HIGH for 8mS. This turns on Q1 and J7-9 VSWR Self Test Request goes LOW. This LOW signal is sent to the Output Monitor for testing the VSWR detectors via the Extended Transmitter Interface. The results of the test are determined on the Output Monitor.

The VSWR Self Test can also be activated by the VSWR Test switch on the ColorStat™ Status Panel, which is connected to J2-11 on the Controller.

M.5.1.7 Keypress

Anytime a XXX.IN input is LOW or if the Transmitter is in the process of an A/C Restart, the Keypress - A/C Restart Detector inside the OPR PAL will generate a HIGH Keypress signal. This signal is connected to the LR PAL and inhibits any Raise or Lower command input.

M.5.1.8 Fault Input

If the FLT line Master Reset from the FLT1 PAL goes HIGH, the Priority Select circuit on the OPR PAL is reset and the Operator Error (OPR.ERR) output will go LOW illuminating the OPR PAL Fault Indicator DS3 RED.

On the LR PAL, both the Priority Select and the Detect Any Change circuits are reset and the Lower Raise Error (LR.ERR) will go LOW illuminating the LR PAL Fault Indicator DS2 RED.

M.5.2 PWR and PTIM PALs

Refer to Figure M-5, PWR and PTIM PALs.

M.5.2.1 Turn On Request

The Turn On Request from the LR PAL is used to start the Step-Start Sequence. When the PTIM PAL receives this signal, it starts the Turn On Sequence Timer that generates a HIGH output TIME pulse 1.5 seconds later. This first Time pulse is sent to the PWR PAL which tells it to go to the Ready State.

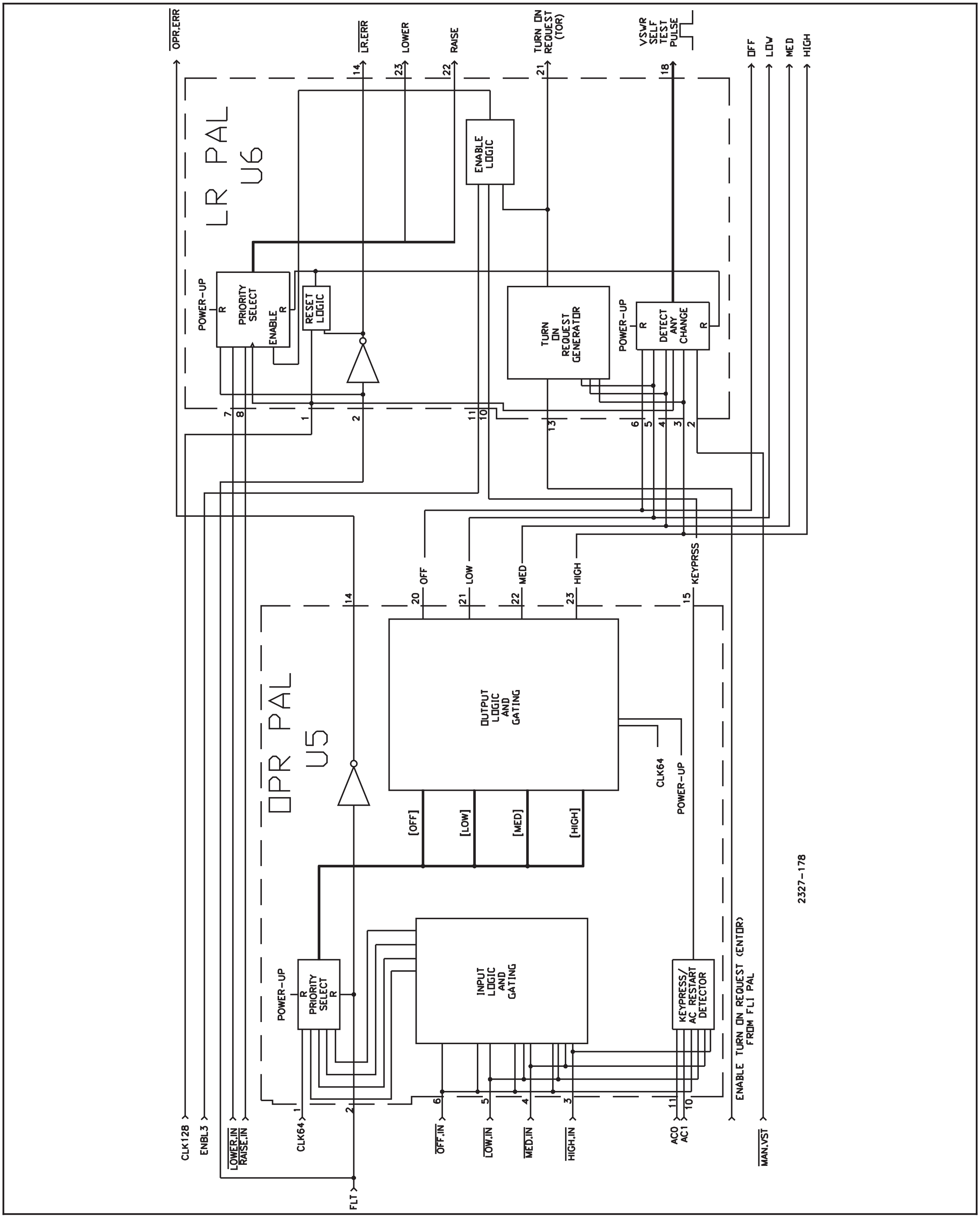


Figure M-4. LR and OPR PALs

M.5.2.2 Step Start Sequence Control

The following is a shortened version of the Turn-On Sequence, refer to this Turn On sequence at the end of this section for a more detailed explanation. Refer to the Step Start Sequence Chart as needed.

When the PWR PAL is in the ready state, Time pulses from the PTIM PAL Turn On Sequence Timer tell the Turn On Sequence Controller in the PWR PAL to execute the next step.

The following outputs from the PWR PAL are activated in this order:

M.5.2.2.1 KLV

This signal turns on the low voltage power supply(s) and they begin to charge up. The HIGH signal is also sent back to U8-6 to tell the PTIM PAL that KLV is activated. When the +8 VDC supply is charged up, the output of the Voltage Supply Sensing comparitor KLVX will go HIGH allowing the Turn On Sequence Controller to go to the next step.

M.5.2.2.2 MODENC

This signal is sent to the Extended Transmitter Interface and called the a TX ON ENABLE-H. It controls functions on the Modulation and Driver Encoder boards and the Output Monitor.

M.5.2.2.3 Enable 1

This signal is used by the Controller to activate some fault inputs connected to FGATE1 and FGATE2 in addition to clocking the Latch PAL U-12. The HIGH signal is also sent to U8-7 to tell the PTIM PAL that Enable 1 is activated.

M.5.2.2.4 K1 and K2 (Rectifier Cabinet)

The K1 signal will leave the Controller as the STEP START SSR DRIVE-L signal and go through the Power Block Interface and Extended Transmitter Interface boards to Rectifier Cabinet K3, energizing K1 and K2, returning to the Controller as RUN STATUS-H signal. U22 will generate a HIGH signals back to the Power PAL called K2X.X that allows the Turn On Sequence Controller to go to the next step.

M.5.2.2.5 Enable 2

This signal is used by the Controller to activate some fault inputs connected to FGATE1, FGATE2, FLT1, and the FLDBK PALs in addition to clocking the Latch PAL U-11. The HIGH signal is also sent to U8-8 to tell the PTIM PAL that Enable 2 is activated

M.5.2.2.6 Enable 3

This signal is used by the Controller to activate some fault inputs connected to FGATE1 and FLT1 in addition to clocking the LATCH PAL U13. When Enable 3 goes HIGH the RF Mute generated by FGATE 1 is removed.

M.5.2.3 UNFLT

This pulse is generated after the final power-up state is achieved, and every two seconds afterwards. It is used by the FLT1 PAL for overload fault timing.

This completes the Step Start Sequence, and all PAL outputs remains in this condition until loss of TOR or the FLT input is activated.

M.5.2.4 Loss Of TOR

Response to a loss of the TOR (a OFF command or fault condition) is independent of these inputs and the Transmitter is sequentially shut down. The Turn-On Sequence Controller and the Turn-On Sequence Timer are reset.

M.5.2.5 Fault Input

If the Master Reset FLT line from the FLT1 PAL goes HIGH, the Transmitter is shut down and both the Turn On Sequence Controller and the Turn On Sequence Timer are reset.

M.5.2.6 Error Output

PWR ERR (PWR Error) continuously monitors the Turn-On Sequence Controller for erroneous states.

M.5.3 Fault Input Latches

All fault inputs generated by other boards in the Transmitter are connected to either J1, J6, J7, or J8 and are applied to Fault Input Latches U21 through U25. All faults are active LOW inputs, meaning that if the input is LOW the fault condition is present.

The purpose of the Fault Input Latches is to hold the fault so the Fault Handling PALs can properly respond to the input. They are clocked by FCLK0 (Fault Clock 0) which is the 4kHz clock that has been inverted by the FGATE1 PAL.

Once the fault input has been latched it is designated as Abbreviated Fault Type.X. For example, once the Predriver Fault-L input at J6-17 is latched by U21 - it is then called PD.RF.X. From the output of the latches, each fault type is distributed to the appropriate Fault Handling PAL.

M.5.4 Fault Handling

As explained in the Block Diagram Description, fault types are broken down into four categories depending upon the Controller response to the fault. Each category has PAL(s) assigned to handle the fault type.

M.5.5 RF Mute - FGATE1 PAL

Faults that require the power output to be set to zero, but not to turn the Transmitter OFF are applied to FGATE 1 (Fault Gate 1).

When a RF MUTE is generated by FGATE 1, it will turn all Big Step and Binary RF Amplifiers OFF by setting all latches on the Modulation Encoder boards to zero.

Refer to Figure M-6, FGATE 1 PAL.

FGATE 1 PAL contains multiple input/single output RF Mute Logic. When any one of the inputs is LOW (with the exception of Enable 3), the RF MUTE A output will also be LOW.

M.5.5.1 Transmitter RF MUTE Faults

The following are RF MUTE faults and their abbreviations.

OSCILLATOR FAULT	OSC.RF.X
BUFFER AMP FAULT	BR.RF.X
PREDRIVER FAULT	PR.RF.X
OUTPUT MONITOR NETWORK VSWR	OM.ON.X
OUTPUT MONITOR ANTENNA VSWR	OM.AV.X
OUTPUT MONITOR SUPPLY FAULT	OM.SF.X

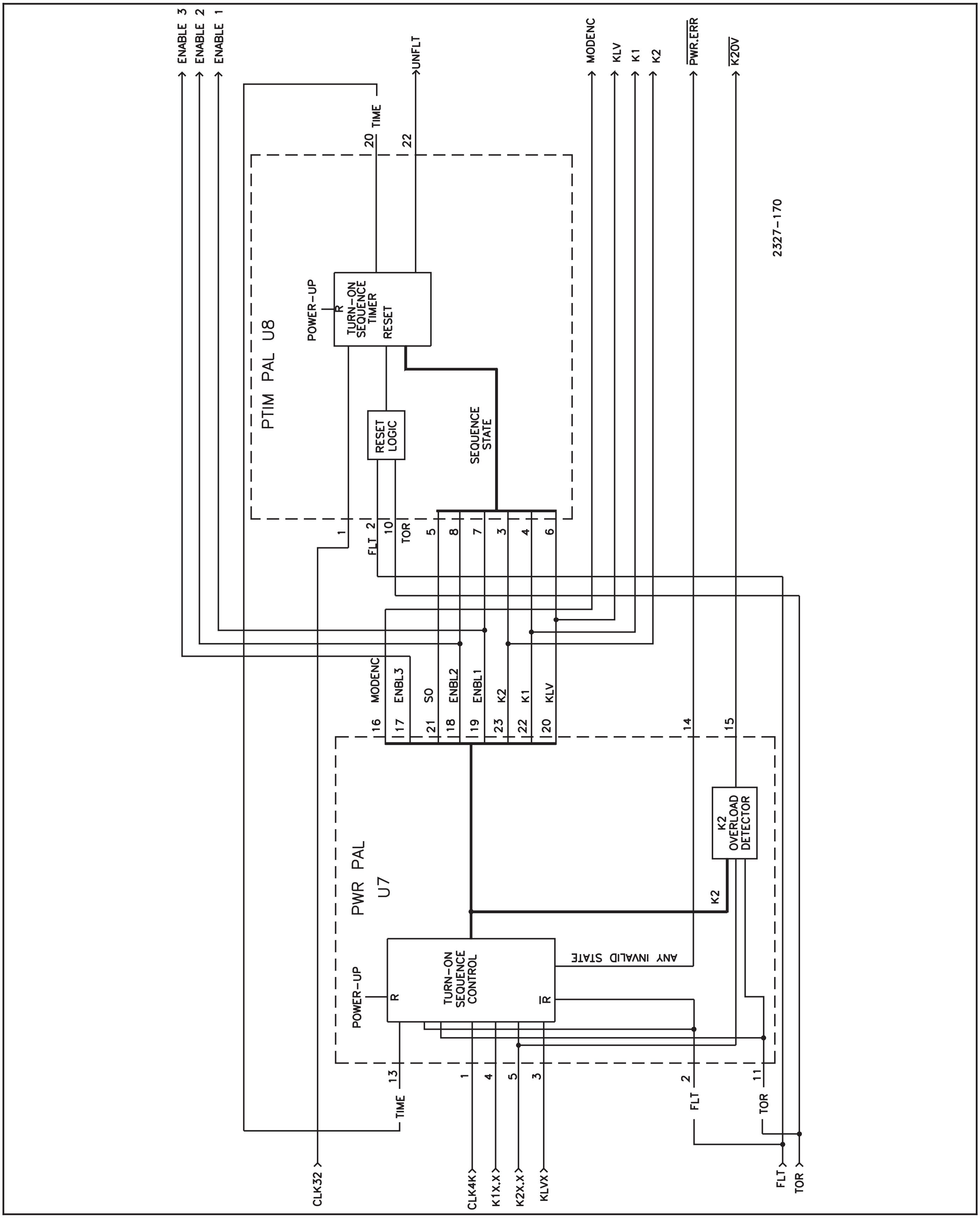


Figure M-5. PWR and PTIM PALs

ANALOG INPUT SUPPLY FAULT	AI.SF.X
A/D SUPPLY FAULT	AD.SF.X
A/D CONVERSION ERROR	AD.CE.X

M.5.5.2 Controller RF MUTE

A Manual RF MUTE can be applied by moving S1 to the MUTE position. This will apply a LOW to the MUTE PB input, and is used for troubleshooting purposes.

When the FLT 1 PAL is responding to FOFF, FOVR, or FACR faults, it will generate a MUTE Request that will generate an RF MUTE during the duration of the fault handling.

The purpose of this is to hold all Big Step and Binary RF Amplifiers OFF during the time that the RF AMP Power Supply is charging up.

M.5.5.3 RF MUTE Summing

The RF MUTE A output from FGATE 1 PAL is summed together with RF MUTE lines from the A/D Convertor board at J8-5 and the Analog Input board at J1-9.

The RF MUTE A also is connected to the FLDBK PAL however currently there is no action taken by the FLDBK PAL.

The RF MUTE used by the Modulation Encoder boards is connected to the Extended Transmitter Interface at J7-21.

The MUTE LED signal is latched by U25-16 and labeled MUTE.LED.X. It is passed on to the Fault LED Latching circuits formed by U33 and U34 and eventually to sent to the LED board at J2-15 and labeled RF MUTE.Q. When the Transmitter is OFF, an RF MUTE is still applied, however diode CR21 pulls the line HIGH so the ColorStat™ Status Panel Controller RF MUTE LED is illuminated GREEN.

M.5.5.4 Clock Invertors

There are two invertors connected to the 4kHz clock that are used to generate FCLK0 and FCLK1. Fault Clock 0 is used by the Fault Input Latches and Fault Clock 1 is connected to the Extended Transmitter Interface at J7-19 where it is sent to the VSWR PAL on the Output Monitor board.

M.5.6 Power Foldback/Recovery Control - FLDBK and FBTIM PALs

Faults that require the power output to be reduced/increased are applied to the FLDBK (Foldback) PAL. The FBTIM (Foldback Timing) PAL provides timing signals used by the FLDBK PAL.

When a fault occurs, the power output is reduced in steps and this condition is called Foldback. The amount of attenuation from the selected power level is determined by the type and length of the fault.

If the original fault is no longer present after a certain level of Foldback, the power output will be increased is steps back to the original power level. This is called Recovery.

When Foldback/Recovery is generated by the FLDBK PAL, it will control a resistive attenuator switch U12 on the Analog Input board.

Refer to Figure M-7, FLDBK and FBTIM PALs.

The following are Foldback faults and their abbreviations:

NETWORK VSWR	OM.ON.X
ANTENNA VSWR	OM.AV.X
AIR FLOW REDUCED	AF.R.X
OVERTEMP FOLDBACK	OT.FB.X

M.5.6.1 Foldback/Recovery Outputs

Depending upon the type and length of fault, the Foldback Controller in the FLDBK PAL can be up to 12 different Foldback/Recovery levels.

The outputs that are used to control the amount of Foldback/Recovery are called DB1, DB2, and DB3. They are sent to the Analog Input board via J2-17, 19, and 21 respectively.

If the Transmitter is not in Foldback, these outputs will all be LOW. If Foldback/Recovery is in progress, the following chart lists the amounts of attenuation and the DB 1, 2, and 3 logic levels.

Foldback Level	DB1	DB2	DB3	Power
0	L	L	L	200kW
-.5dB	H	L	L	178kW
-1.0	H	H	L	159kW
-2.0	L	H	L	126kW
-3.0	L	H	H	100kW
-6.0	H	H	H	50kW
-10.0	H	L	H	20kW
-12.0	L	L	H	13kW

M.5.6.2 VSWR Foldback

Antenna or Network VSWR faults are treated the same, for discussion purposes the Antenna VSWR fault will be described.

The Foldback Controller can not respond to these faults until Enable 2 has been generated by the PWR PAL (FGATE 1 is generating an RF MUTE up until the point that Enable 3 goes HIGH, so these faults should not occur until after this time anyway).

If the VSWR PAL on the Output Monitor receives five Antenna VSWR pulses within the 20 second time frame, the OM.AV.X line will go LOW for 250uS.

The Foldback Controller will immediately (within .25mS) Foldback the power -.5dB.

If additional 250uS OM.AV.X LOW pulses are received, the Foldback Controller will immediately continue to step down the power level until the pulses stop or until the Foldback Limit output goes HIGH and shuts OFF the Transmitter.

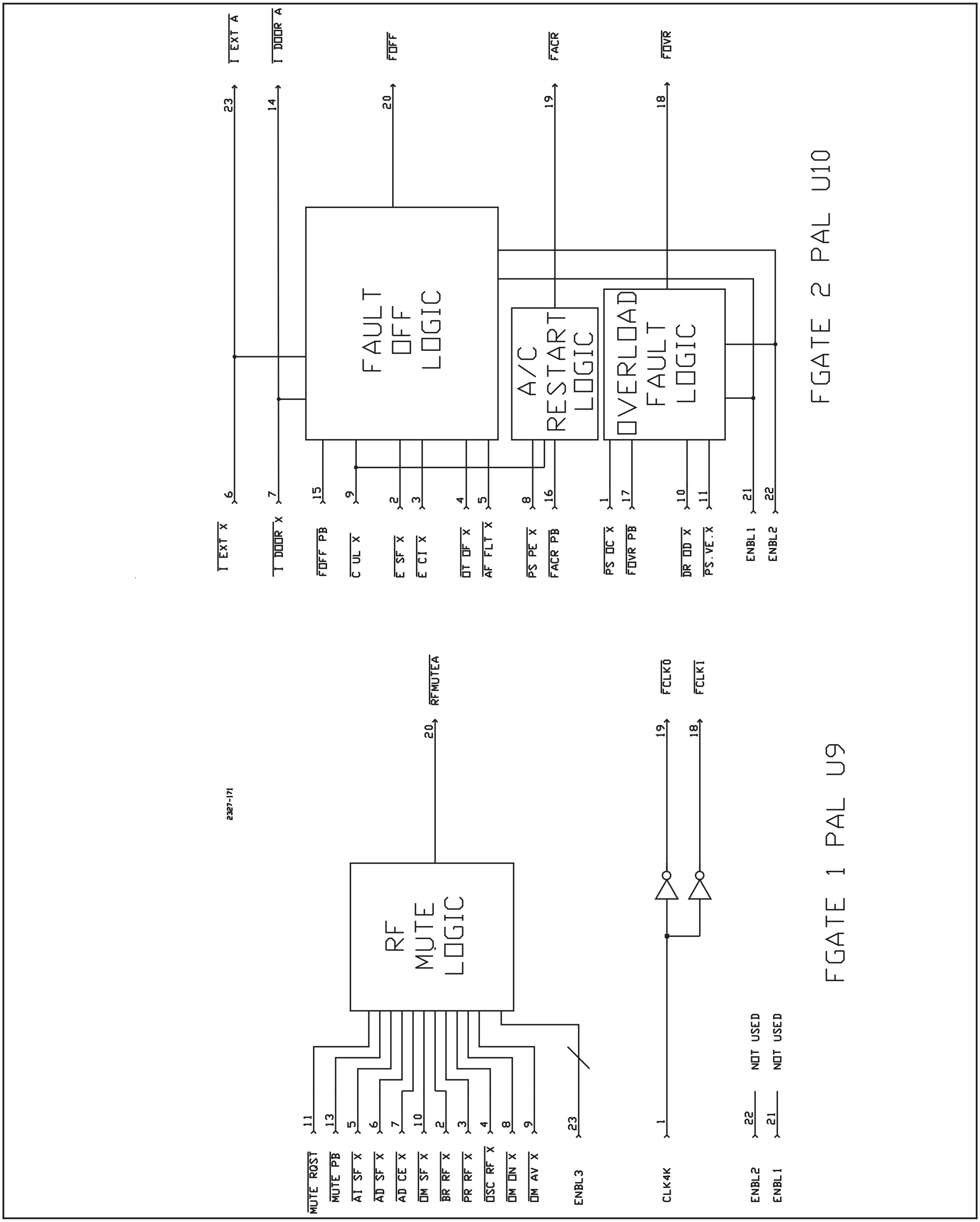


Figure M-6. FGATE 1 and FGATE 2 PALs

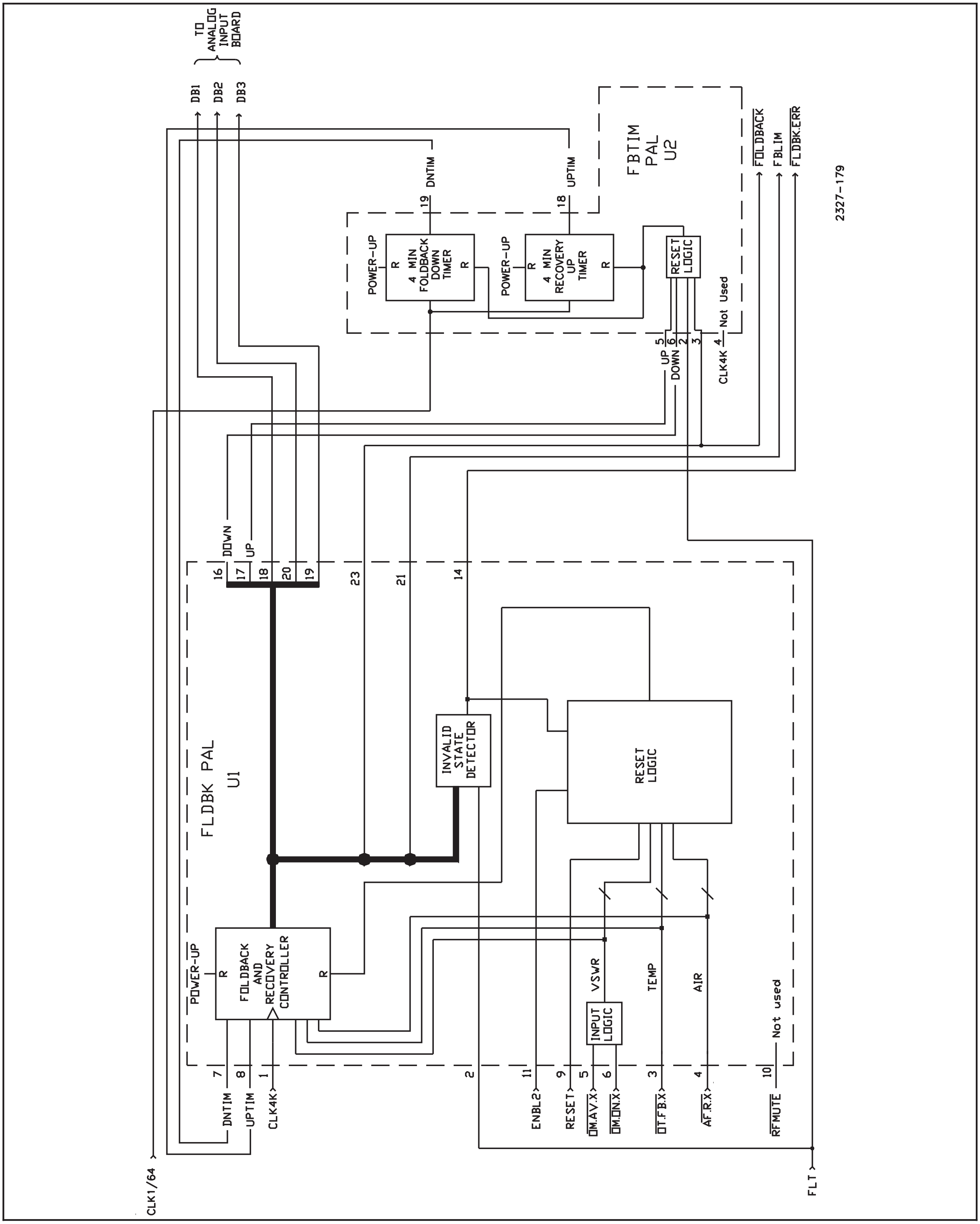


Figure M-7. FLDBK and FBTIM PALs

The following chart lists the Foldback levels for VSWR faults.

ATTEN	MINIMUM TIME
0	
.5dB	7.5S
1	7.5S
2	7.5S
3	7.5S
6	7.5S
10	7.5S
12	7.5S
OFF	

When the first Foldback level occurs, the Down output from the Foldback Controller goes HIGH for .25mS and starts the 4 Minute Foldback Down Timer in the FBTIM PAL.

If additional Foldback levels occur, the Down output will continually reset the 4 Minute Timer.

Once Foldback has reduced the power output to a safe operating level (assuming it has not shut OFF), the offending fault will no longer be present at the input.

After 4 minutes, the DNTIM (Down Timing) output from the FBTIM PAL will go HIGH for .25mS. This pulse is sent back to the Foldback Controller and signals it to look at the fault input again.

When the Foldback Controller sees that the fault input is HIGH, it will generate a .25mS Up pulse that starts the Recovery process.

M.5.6.3 VSWR Recovery

When Recovering from Foldback, the Recovery time to the next highest step is 4 minutes. For example, if there has been a -6dB Foldback - it will take 20 minutes to Recover back to 0 attenuation.

The following chart lists the Recovery levels for VSWR faults.

ATTEN	MINIMUM TIME
0	4 min.
.5dB	4 min.
1	4 min.
2	4 min.
3	4 min.
6	4 min.
10	4 min.
12	4 min.

If the Transmitter folds back to OFF there is no automatic recovery. The Transmitter must be activated by selecting a power level.

When the Foldback Controller generates the first .25mS Up pulse it will also Recover to the next step of less attenuation.

The Up pulse will start the 4 Minute Recovery Timer in the FBTIM PAL, which will sent a UPTIM (Up Timing) back to the Recovery Controller.

This UPTIM pulse will cause the Recovery Controller to move to the next step of less attenuation and generate another Up pulse of restart the 4 Minute Recovery Timer.

This process will continue in 4 minute steps until the attenuation is 0.

M.5.6.4 Temperature Foldback

Temperature Faults that can cause Foldback originate from the following sources:

a. The RF Amp temperature sensor on Big Step #1 (sensed on Modulation Encoder board A29).
b. The Ambient temperature sensor on the Extended Transmitter Interface board (this fault will illuminate the RF AMP TEMP indicator on ColorStat™ Status Panel).

These faults are summed together on the Extended Transmitter Interface board, sent to the Controller at J7-33, and called Overtemp Foldback-L. Once latched, the fault is called OT.FB.X.

The Foldback Controller can not respond to this fault until Enable 2 has been generated by the PWR PAL.

The Foldback process for the Temperature Fault is basically the same as for VSWR with only two differences.

First, the levels of attenuation are different.

Secondly, when the OT.FB.X input goes LOW the first level of Foldback is immediate. From this point on, the Foldback Controller will wait 4 minutes to check the fault input again to determine whether to Foldback again or begin to Recover. The reason for this time delay is to allow for thermal time constants.

The following chart lists the Foldback levels for the Overtemperature fault.

ATTEN	MINIMUM TIME
0	
3	.25mS
6	4 min.
10	4 min.
12	4 min.
OFF	

If Foldback is still insufficient to properly cool the Transmitter at the reduced power levels, Temperature Monitoring circuits on the Modulation Encoder board and the Driver Encoder board can still generate an Overtemperature Fault-L (OT.OFF.X)that will turn the Transmitter OFF at any time during Foldback.

Refer to the FGATE 2 PAL for more information.

M.5.6.5 Temperature Recovery

The Recovery process for the Overtemperature Fault is basically the same as for VSWR except that all steps are used for Recovery.

The following chart lists the Recovery levels for the Over Temperature fault.

ATTEN	MINIMUM TIME
0	
.5dB	4 min.
1	4 min.
2	4 min.
3	4 min.
6	4 min.
10	4 min.
12	4 min.

M.5.6.6 Air Flow Foldback

Air Flow Faults that can cause Foldback originate from the following sources:

a. The Air Flow Monitoring on the A25, A26, A28 and A30 Modulation Encoder boards.
b. The Air Flow Monitoring on the Output Monitor board.

These faults inputs are summed together on the Extended Transmitter Interface board, sent to the Controller on J6-5, and called Air Flow Reduced-L. Once latched, the fault is called AF.R.X.

The Foldback Controller can not respond to this fault until Enable 2 has been generated by the PWR PAL.

When the AF.R.X input goes low, the Foldback Controller will immediately attenuate the power output -6dB. This is the only amount of reduction possible.

ATTEN	MINIMUM TIME
0	
6dB	.25mS

If air flow is still insufficient to properly cool the Transmitter at the reduced power level, Air Flow Monitoring circuits on the Modulation Encoder boards and the Output Monitor board can still generate a Air Flow Fault-L (AF.FLT.X) that will turn the Transmitter OFF.

Refer to the FGATE 2 PAL for more information.

M.5.6.7 Air Flow Recovery

If the AR.F.X input goes HIGH, the Recovery Controller will immediately step back up to full power.

ATTEN	MINIMUM TIME
0	
6dB	.25mS

M.5.6.8 Foldback Output

When Foldback is in progress, the Foldback output will go LOW for the duration of Foldback and illuminate the Analog Input Power Foldback indicator RED on the ColorStat™ Status Panel.

This output is latched and the indicator remains RED even if Recovery has stepped the power back up to full output.

M.5.6.9 Foldback Limit

If the maximum amount of Foldback is not enough to protect the Transmitter during VSWR and Over Temperature faults, the Foldback Limit output that is sent to the FLT 1 PAL will go HIGH and turn the Transmitter OFF.

M.5.6.10 Reset Input

The Fault Reset will clear the Foldback/Recovery Controller. If the offending fault is still present, Foldback will again attenuate the power output. If the fault is no longer present, the Transmitter will return to full power.

M.5.6.11 Fault Input

If the Master Reset FLT line from the FLT1 PAL goes HIGH, the Foldback/Recovery Controller is reset and the FLDBK.ERR output will go LOW.

M.5.6.12 Error Output

If the Foldback/Recovery Controller detects any invalid state or if the FLT input goes HIGH, the FLDBK.ERR (Foldback Error) output will go LOW. This will illuminate the PAL Fault Indicator DS1 RED.

M.5.7 AC Restart-Overload-OFF Faults - FGATE 2

These type faults and manual fault switch inputs are connected to the FGATE 2 (Fault Gate 2) PAL.

They are categorized into either into FACR, FOVR, or FOFF type faults and applied to the FLT 1 PAL for processing. They can be measured at TP3, TP2, and TP1 respectively.

Refer to Figure M-6, FGATE 2 PAL.

The FGATE 2 PAL has several logic gates interconnected to accomplish the necessary fault categorization.

M.5.7.1 A/C Restart Faults

The following are FACR faults and their abbreviations.

AC MAINS FAULT	PS.PE.X
CONTROLLER UNREGULATED LOSS	C.UL.X

The PS.PE.X fault can be generated by either by the AC Mains Fault from the 3PH A/C Monitor K7 in the Rectifier Cabinet that enters the controller at J6-33 or the Controller Unregulated Loss Detector (PC.UL.ACR) U36-13 (TP19) on the Controller.

M.5.7.2 Overload Faults

The following are FOVR faults and their abbreviations:

POWER SUPPLY CURRENT FAULT	PS.OC.X
POWER SUPPLY VOLTAGE FAULT	PS.VE.X
DRIVER OVERDRIVE FAULT	DR.OD.X

The PS.VE.X fault is generated by the Power Supply Voltage Detector on the Controller.

M.5.7.3 Off Faults

The following are FOFF faults and their abbreviations.

External Interlock	I.EXT.X
Door Interlock	I.DOOR.X
Encoder Supply Fault	E.SF.X
Encoder Cable Interlock	E.CI.X
Overtemperature Fault	OT.OFF.X
Air Flow Fault	AF.FLT.X

M.5.7.4 Fault Enables

During the Step Start Sequence when most Transmitter circuits have not yet reached their steady state condition, some fault inputs must be ignored.

Faults that are active all of the time so the Controller can immediately respond to are:

PS.PE.X

C.UL.X

P.S.OC.X

I.EXT.X

I.DOOR.X

Other faults are responded to only when Enable inputs are present.

M.5.7.5 Enable 1 Input

Faults that are active only when Enable 1 is present are:

E.SF

E.CI

M.5.7.6 Enable 2 Input

Faults that are active only when Enable 2 is present are:

OT.OFF.X

AF.FLT.X

DR.OD.X

P.S.VE.X

M.5.7.7 Manual Fault Switches

The Manual Fault Switches can be used to test the Controller response to these three types of faults.

When the Manual A/C Restart switch S3 is depressed and held down, the Transmitter will shut OFF and remain that way. When the switch is released, the Transmitter will automatically return back to the same power level as before.

When the Manual Overload Fault switch S4 is depressed and held down, the Transmitter will shut off and remain that way. When the switch is released, the Transmitter will automatically return back to the same power level as before. If the switch is depressed once more within 5.5 seconds, the Transmitter will shut OFF and remain that way.

When the Manual Fault Off switch S2 is depressed the Transmitter will shut OFF and remain that way.

M.5.7.8 I.EXT.A and I.DOOR.A Outputs

These outputs are connected to the Fault LED Latching circuits.

M.5.8 Fault Handling - FLT1 and FTIM

The FLT1 (Fault 1) PAL accepts the FOFF, FACR, and FOVR faults from FGATE2 and the Foldback Limit from the FLDBK PAL.

It responds to these faults by controlling the Enable Turn-On Request that is sent to the LR PAL. ENTOR signals the LR PAL that no inhibitive faults are present. Conversely, loss of ENTOR recoverably faults the Transmitter OFF.

It is the source of the FLT Master Reset that is connected most PALs. It will halt all PAL activity and clear them to an off or ready state.

The FTIM (Fault Timing) PAL gives the timing sequence of events for the FLT1 PAL. TAC & TOV are timeout signals for FACR & FOVR recovery respectively. These signals are sent back to the FLT1 PAL to indicate fault timeouts.

Refer to Figure M-8, FLT 1 and FTIM PALs.

M.5.8.1 A/C Restart Handling

FACR triggers an immediate, fully recovering, shutdown of the Transmitter by canceling the ENTOR signal.

Loss of ENTOR to the LR PAL cancels the TOR output from LR PAL to the PWR PAL. It does not assert FLT, allowing PALs to retain memory of operation mode. In particular, OPR retains the coarse power level selection.

AC1 and AC0 provide fault status from the A/C Restart Fault Handling in the FLT 1 PAL to the 160mS A/C Restart Timer in the FTIM PAL. The TAC output of this timer is sent back to the FLT 1 PAL.

When the FACR input goes LOW, the Mute Request output goes LOW and the AC0 output will go HIGH.

One clock cycle (.25mS) later, the ENTOR output will go LOW and the AC1 output goes HIGH.

When both AC0 and AC1 outputs are HIGH, the 160mS A/C Restart Timer is started and 160mS later the TAC output will go HIGH for .25mS. The AC0 output will go back LOW at the end of the TAC pulse.

If the FACR input is not LOW at this time, .25mS later the Mute Request and ENTOR lines will go HIGH and the AC1 output will go LOW. This will generate a new TOR and the Transmitter will return back on.

If the FACR input is still LOW at this time, the outputs will remain in this state. When the input does go back HIGH (up to four days with battery backup installed), .25mS later the Mute Request and ENTOR lines will go HIGH and the AC1 output will go LOW. This will generate a new TOR and the Transmitter will return back on.

Upon reoccurrence, this fault is not upgrade to a FOFF. An FACR will co-exist with an in progress FOVR, each will recover according to its own timing and requirements.

M.5.8.2 Overload Fault Handling

FOVR triggers an immediate, fully recovering, shutdown of the Transmitter by canceling the ENTOR signal.

Loss of ENTOR to the LR PAL cancels the TOR output from LR PAL to the PWR PAL. It does not assert FLT, allowing PALs to retain memory of operation mode. In particular, OPR retains the coarse power level selection.

OV1 and OV0 provide fault status from the Overload Fault Handling in the FLT 1 PAL to the 160mS Overload Restart Timer in the FTIM PAL. The TOV output of this timer is sent back to the FLT 1 PAL.

When the FOVR input goes LOW, the Mute Request and ENTOR outputs will immediately go LOW and the AC1 output goes HIGH.

The outputs will remain in this state, until the FOVR input goes back HIGH. When the input does go back HIGH, the OV1 output will go HIGH.

When both OV0 and OV1 outputs are HIGH, the 160mS Overload Restart Timer is started and 160mS later the TOV output will go HIGH for .25mS.

The OV0 and OV1 outputs will go back LOW, and the Mute Request and ENTOR lines will go HIGH. This will generate a new TOR and the Transmitter will return back on.

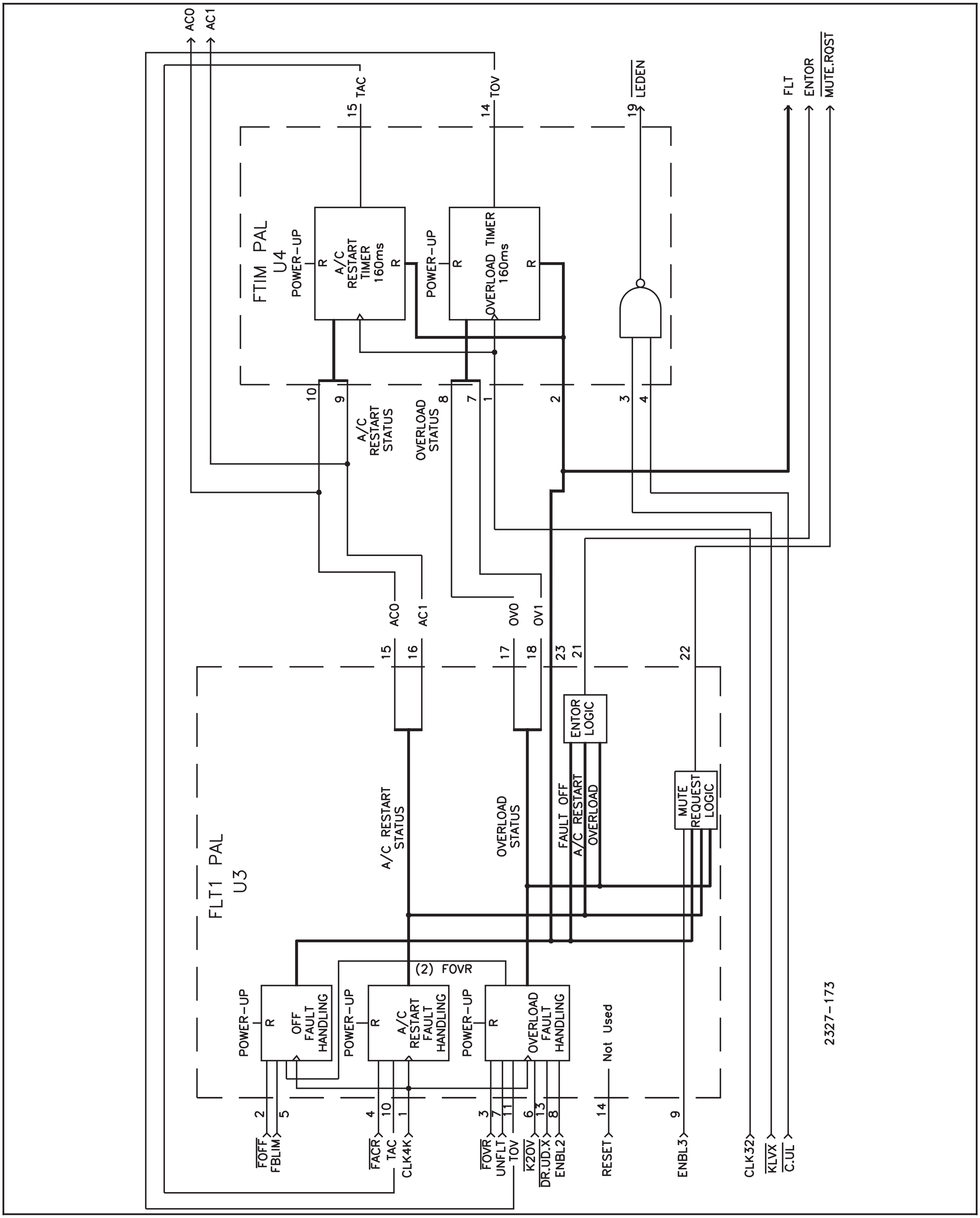


Figure M-8. FLT 1 and FTIM PALs

After 5.6 S, a HIGH UNFLT pulse from the PTIM PAL is sent to the FLT 1 PAL.

If another FOVR fault occurs within this time, the FLT 1 PAL will upgrade it to a FOFF Fault.

If another FOVR fault occurs after this time, the FLT 1 PAL will respond to it another FOVR Fault.

An FOVR will co-exist with an in progress FACR, each will recover according to its own timing and requirements.

M.5.8.3 Other Overload Faults

There are two types of special Overload Faults.

DRIVER UNDERDRIVE FAULT DR.UD.X

(LOW DRIVE)

The DR.UD.X input at J6-13 will occur anytime RF Drive to the Big Step and Binary RF Amplifiers is reduced by more than 20%. If the offending fault was created in the RF Chain, the ColorStat™ Status Panel should indicate the location.

It is recognized after ENBL2 is generated by the PWR PAL. If the fault input goes LOW, the ENTOR output is removed and then returned 160mS after a TOV pulse.

If the fault is still present after Enable 2 is generated on the retry, the FLT 1 PAL will upgrade it to a FOFF Fault.

M.5.8.4 OFF Fault Handling

Fault OFF triggers an immediate, non-recovering, shutdown of the Transmitter by generating a Mute Request and canceling the ENTOR signal.

The OFF Fault Handling asserts the FLT line to asynchronously clear all PAL state machines.

The Transmitter must be manually restarted after the fault has been corrected.

An FOFF will override an in progress FOVR or FACR.

M.5.8.5 Foldback Limit

The FBLIM input from the FLDBK PAL indicates maximum Foldback has been reached.

When this input goes HIGH, it becomes a FOFF Fault.

M.5.8.6 LED Enable

The LEDEN output controls enabling of the Fault LED Latching circuits and therefore the ColorStat™ Status Panel indicator LEDs.

KLVX Supply Low Voltage Sensing and C.UL Controller Unregulated Loss provide status of low voltage supplies. Both must be HIGH for these indicators to be illuminated.

Should either input go LOW, the LEDEN output will go HIGH and the indicators are turned off to conserve battery backup voltage.

M.5.9 PAL Fault Indicators

Bicolor indicators DS1, DS2, DS3, and DS4 are controlled by U14 and provide a visual status indication for their designated PALs.

When the LEDINH (LED Inhibit) output from U36-2 is LOW, the indicators are active.

GREEN illumination indicates normal operation, RED illumination indicates a internal fault condition.

Refer to each individual PAL for the more specific information.

When a Controller Unregulated Loss is detected, The LED Inhibit line will be HIGH and the indicators are turned off to conserve battery backup voltage.

M.5.10 Clock Generator

The 8 kHz master clock is generated by a 555 timer U20 running in a astable configuration. This clock is divided down by a string of synchronous dividers U15 through U19. Six different clock frequencies are generated and distributed, most of which can be measured on TP4 though TP8.

M.5.11 LATCH PALs

Most of the faults to which the Controller has responded to, except the RF MUTE and VSWR Test, are latched by the three LATCH PALs U11, U12, and U13.

Refer to Figure M-9, LATCH PAL.

Each of the three LATCH PALs has exactly the same internal circuits. They contain 10 fault inputs, 10 latches, and 10 alarm outputs.

After the Enable input is HIGH, if the fault input to the PAL is or goes LOW, the Alarm output will go LOW and remain in that state until the Reset input goes HIGH.

U12 is connected to Enable 1, U11 is connected to Enable 2, and U13 is connected to Enable 3, and the Reset is connected to pin 13. LATCH PAL alarm outputs are connected to the Fault LED Latching inputs.

M.5.12 Other Latches

U26 and U33 functions similar to the LATCH PALs, except that they use diode steering logic to accomplish this task and are always enabled by FCLK0.

When the input of U26 goes LOW, the output of U33 goes LOW. The input of U26 is then held LOW to +.6VDC by the diode drop, and the output of U33 remains LOW.

It is not possible for the output of U33 to go back HIGH until the Reset input is HIGH.

The I.EXT.A input from FGATE 2 PAL can be jumpered P50 2-3 for a latched fault or 2-1 for a unlatched fault. This is the only fault in the Transmitter that is programmable.

M.5.13 Fault LED Latching

Outputs from the Fault LED Latching circuits are connected to the LED board on the odd numbered pins of J2 and J12.

Octal buffers U30 through U32, and U34 will allow illuminance of the indicators on the ColorStat™ Status Panel when the LEDEN input is LOW.

When the LED Enable input from the FTIM PAL is HIGH, all outputs assume a high impedance off state and therefore disables the LED board indicators.

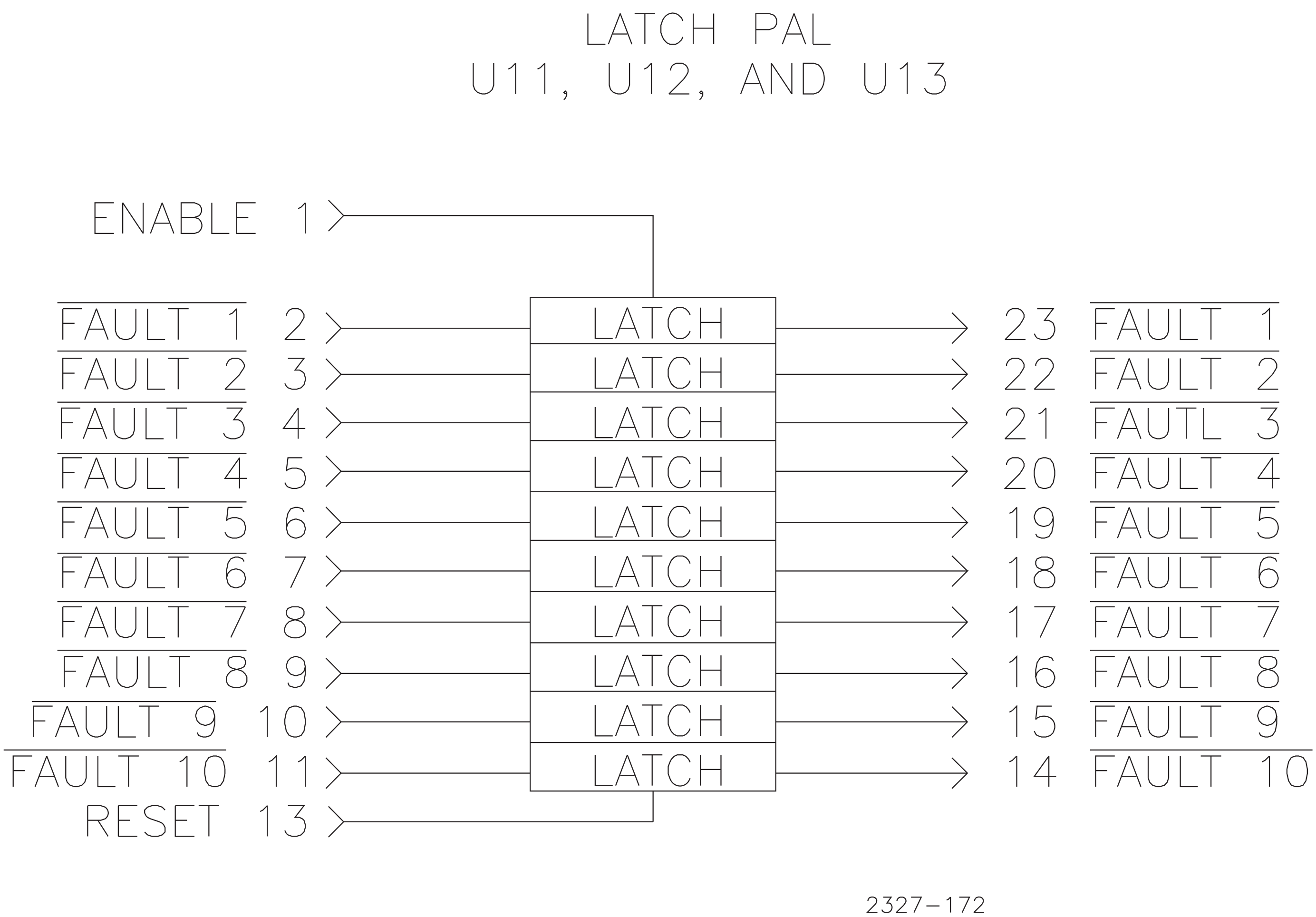


Figure M-9. LATCH PAL

M.5.14 Summary Faults and Remote Fault Indicator Outputs

Summary Fault outputs are sent to the Power Block Interface board on J5-13 through J5-31 for extended/remote indicators.

Table M-1 lists the Summary Faults and their causes.

M.5.15 Power Supplies

M.5.15.1 Input Power Distribution

A power distribution cable from the Extended Transmitter Interface board is connected to J11 on the Controller. J9 and J10 connect the low voltage supplies to the Analog Input and A/D Convertor boards.

When P53 is in the Normal position, the +12VDC Controller Supply is connected to the LED & Switch boards and to the Controller Power Supplies. The Transmitter can be operated in the Normal Mode.

If P53 is in the Bypass position, the B+ power supply is used to power these boards and the Transmitter must be in the Test Mode for operation.

M.5.15.2 Controller +5VDC Supply

Two regulators U51 and U52 are diode OR-ed together by CR141 and CR140 and supply +5VDC for all logic circuits on the Controller board.

Respectively, each regulator is separately fused by F4 & F3, offset to provide +5.6 VDC output (to overcome the OR'ing diode drops) by diodes CR148 and CR144, and indicators DS6 and DS5 provide a GREEN visual indication of operation.

The output voltage can be measured at TP16, and is connected to the Analog Input board at J1-33 where is called the +5VC supply.

If either regulator fails, the Controller can operate normally from the other regulator.

M.5.15.3 1.2VDC Reference

A dropping resistor R44 and zener diode regulator CR138 form a 1.2VDC reference supply. This voltage is connected to six comparators that use this reference as a indication of the +5VDC supply.

M.5.15.4 Controller Supply Fault Voltage Detector

Should either +5 VDC regulator fail, diodes CR130 or CR129 will be forward biased and establish +.6VDC at the + input of U36-9. The output will go LOW and Controller Supply Fault is generated. It can be measured at TP17 Supply Fault and provides a visual indication on the ColorStat™ Status Panel only.

M.5.15.5 Backup Capacitor

The backup supply uses two one farad capacitors, C46 and C47. They are initially charged from the +5 Volt supply, through diodes CR140 and CR141.

If there is a loss of Single Phase A/C power, diodes CR140 and CR141 will be reverse biased so that the backup capacitors discharge only into the circuits on the Controller and Analog Input boards.

The capacitors alone can maintain PAL memory at least 10 minutes or until the voltage at TP16 reaches 4.5 VDC.

M.5.15.6 Battery Backup Detector And Battery Backup Switch

When the voltage at TP16 lowers to 4.5 VDC, the voltage at the input of U37-7 will equal the 1.2 VDC Reference Voltage.

Comparator U37-1 will go LOW and turn on Q3 which connects the +5VDC Controller Supply to the +6VDC Battery Supply (assuming it is installed) through diodes CR131 and CR132.

The Battery IN voltage at J11-12 should maintain PAL memory for at least four days.

M.5.15.7 Extended Transmitter Interface +5VDC Supply

A third regulator U53 supplies +5 Volts for the Extended Transmitter Interface board. It is fused by F2 and connected to J7-23.

M.5.16 Controller Monitoring

NOTE

The following Controller Monitoring circuits use the 1.2 VDC Reference Voltage as an input to their fault detection process.

M.5.16.1 Controller Supply Loss

If the Single Phase A/C Mains fails, the Supply Loss Detector will create a Controller Unregulated Loss Fault.

A resistive voltage divider normally establishes 1.3VDC at the + input of U36-11. When the Controller Supply begins to discharge due to the power failure, this voltage becomes less that the 1.2VDC reference and the output of the comparator U36-19 will go LOW.

This is an A/C Restart Fault that can be measured at TP19 and is distributed to four other circuits.

a. The C.UL.ACR output is summed together with the 3 Phase A/C Mains Fault at J6-33 and latches as a PS.PE.
b. The output to the LED board at J2-3 will disable the Local and Remote LEDs on the ColorStat™ Status Panel.
c. The C.UL output will disable the LED Enable from the FTIM PAL and becomes a latched C.UL.X that is sent to the FGATE 2 PAL.
d. The output that is connected to the - input of U36-4 will generate a LED Inhibit.

When TP19 returns HIGH after the power has been restored, the A/C Restart Handling in the FLT1 PAL will restart the Transmitter.

M.5.16.2 LED Inhibit

When the C.UL input at U36-4 goes LOW, the LED INH output of U36-2 will go HIGH. The LED Inhibit will disable the PAL Fault Indicators.

M.5.16.3 Reset

The Reset output will clear any latched faults contained by the LATCH PALs and will also clear any Foldback in progress.

Each of the following will produce the Reset used by the Controller because the - input of U37-8 will be pulled LOW and therefore the output at U37-14 will go HIGH:

a. A Remote Reset-L input at J5-39 that turns on Q2.
b. The ColorStat™ Status Panel Fault Reset switch is depressed causing a LOW at J2-5.
c. The onboard Reset switch S6 is depressed.

M.5.16.4 Low Voltage Supply Sensing

When the +8VDC supply is operational, a resistive voltage divider will establish 1.6VDC reference at the + input at U36-7, U36-1 will generate a HIGH KLVX signal that tells the PWR PAL the low voltage power supplies are active. When the supply is off the Output of U36-1 will be LOW.

M.5.17 Other Controller Monitoring

M.5.17.1 RF AMP Power Supply Voltage Detector

A voltage sample of the +250VDC RF Amp Power Supply that is derived from the Supply Voltage Fault Sample on the A39 Fuse Board is connected to J6-15.

An Overvoltage Comparitor U37-2 and an Undervoltage Comparitor U37-13 can create a Power Supply Voltage Error if the +250VDC is rises over 268VDC or falls under **115VDC.** The PS.VE is treated as a Overload Fault.

Under normal +250VDC conditions, the input voltage to U37-4 and 11 is 3.0VDC, and a resistive voltage divider establishes 1.5VDC at U37-10 and 3.5VDC at U37-5.

M.5.17.2 Remote Control Interface

When P52 is jumpered 5-6, the Remote Control output voltage to the Power Block Interface at J5-9 is determined by the Remote Control switch in the ColorStat™ Status Panel. If in the Remote position, Remote Control line is HIGH and active. If in the Local position, Remote Control line is LOW and inactive.

If P52 is jumpered 3-4, Remote Control is always active.

If P52 is jumpered 3-4, Remote Control is always inactive.

M.5.18 Turn-On Sequence

The Transmitter turn-on control logic, turns the Transmitter on in stages or steps, and provides logic outputs to other parts of the Transmitter during the turn-on sequence. If something goes wrong during the turn-on sequence, turn-on will be aborted immediately.

The following procedure assumes that the Transmitter is normal or has not incurred any faults that affect the normal turn-on sequence.

The sequence of events when the Transmitter is turned-on at HIGH power while in the Normal Mode is as follows:

NOTE

Up until the point that Enable 3 goes HIGH, FGATE1 will be generating an RF Mute to hold the Big Step and Binary RF Amplifiers off during the turn-on sequence.

a. When the HIGH power pushbutton switch on the Switch Board is depressed +12VDC is applied to Controller at J3-32.
   1. This active HIGH input turns on the transistor inside U40, causing pin 8 to LOW.

b. This logic LOW is applied to the Operator PAL U5-3 (High In).
   1. U5-23 (HIGH) goes high and is sent to LR PAL U6-3 (High) to generate a TOR (Turn-On Request).
   2. U5-23 also turns on transistor U42-8 which pulls TP10 LOW. When TP10 is LOW:
      a) J3-27 illuminates the lamp inside the High power pushbutton switch.
      b) J5-3 activates the Remote Status Output on the Power Block Interface.
   3. U5-15 (Keypress) which connects to the LR PAL U6-10 goes HIGH al long as any button is pressed and inhibits any Raise or Lower command input.

c. The HIGH input at the LR PAL U6-3 (High) will generate a HIGH Turn-On Request at U6-21 (TOR) as long as U6-13 (ENTOR)is HIGH.
   1. The ENTOR (Enable Turn-On Request) comes from the FLT1 PAL U3-21. It must be HIGH for the LR PAL to generate a TOR.
   2. The VSWR Test output at U6-18 will go HIGH for 8mS, this turns on Q1 and J7-9 VSWR Self Test Request goes LOW. This LOW signal is sent to the Output Monitor for testing the VSWR detectors.

d. Refer to Figure M-10, Step-Start Timing Diagram for the following discussion.

e. The TOR from U6-21 is applied to the PWR PAL U7-11 and the PTIM PAL U8-10.

Table M-1. Summary Faults and Their Causes

Output	Caused By
Summary Fault Output	Any fault in the transmitter, it is diode OR’ed together with all outputs.
Foldback	Anytime the Controller initiates Foldback.
RF Drive Chain Fault	DR.UD.Q, BR.RF.Q, OSC.RF.Q, DR.OD.Q, PR.RF.Q.
RF Amp Fault	FUSES.Q, OT.RFA.Q.
VSWR Fault	VST.STAT.X, OM.AV.Q, OM.ON.Q.
Power Supply Fault	PS.OC.Q, PS.VE.Q, OT.PS.Q.
A/C Mains Fault	PS.PE.Q.
Air Flow Fault	AF.FLT.Q, AF.R.Q
Low Voltage Supply Fault	C.SF.Q, E.SF.Q, AI.SF.Q, OM.SF.Q, AD.CE.Q, AD.SF.Q.
Interlock Open	I.DOOR.Q, I.EXT.Q, E.CI.Q.

1. The HIGH TOR input to U8-10 generates a HIGH output pulse at U8-20 1.5 seconds later. This output is sent to U7-13 and is the signal that tells the PWR PAL to go to the Ready State.

f. 32 ms later, on the second Time pulse, the output of U7-20 (KLV) will go HIGH.

   1. The HIGH signal is also sent back to U8-6 to tell the PTIM PAL that this step has been completed.
   2. When the +8 VDC supply is charged up, the output of the Supply Voltage Sensing comparator U36-1 (KLVX) will go HIGH this signal is sent back to U7-3.

g. On the third Time pulse, 32ms later , the output of U7-16 (MODENC) will go HIGH.

   1. This signal is connected to J14-20 and a TX ON ENABLE-H is sent to the Extended Transmitter Interface. The TX ON ENABLE will:

      a) Turn on the B+ and B- regulators, activate the fault sensing, and supply the voltage for the fuse fault detector on all of the Modulation Encoders.
      b) Turn on the Predriver and applicable Drivers, delay the Auto Driver Control for 1.5 S, and delay the Low Drive Fault sensing on the Driver Encoder.
      c) Activate the Air Flow Monitor A3 in Output Cabinet via the control on the Output Monitor.

h. 32 ms later, on the fourth Time pulse, the output on U7-19 (Enable 1) will go HIGH.

   1. This signal is used by the Controller to activate some fault inputs connected to FGATE1 and FGATE2 in addition to clocking the Latch PAL U-12.
   2. The HIGH signal is also sent back to U8-7 to tell the PTIM PAL that Enable 1 is activated.

i. On the sixth Time pulse, the output on U7-18 (Enable 2) will go HIGH.

   1. This signal is used by the Controller to activate some fault inputs connected to FGATE1, FGATE2, FLT1, and the FLDBK PALs in addition to clocking the Latch PAL U-11.
   2. The HIGH signal is also sent back to U8-8 to tell the PTIM PAL that Enable 2 is activated

j. 128 ms later on the seventh time pulse, a 128 ms delay timer is started.

k. 128 ms later on the eighth time pulse a 64 ms delay timer is started

l. 64 ms later, the Time pulse, the output on U7-17 (Enable 3) will go HIGH.

   1. This signal is used by the Controller to activate some fault inputs connected to FGATE1 and FLT1 in addition to clocking the Latch PAL U-13.
   2. Up until the point that Enable 3 goes HIGH, FGATE1 has been generating a RF Mute LOW on U9-20 to hold the Big Step and Binary RF Amplifiers off during the turn-on sequence. When U9-9 goes HIGH, U9-22 goes HIGH and the RF Mute is removed. The Transmitter power output goes up to the one quarter of the power level and then to full power after 1 S, via the Power Step-Up circuit on the Analog Input board.

m. Two seconds later and repeated every two seconds afterwards an Unfault pulse is generated for the FLT1 PAL.

This completes the Turn On Sequence.

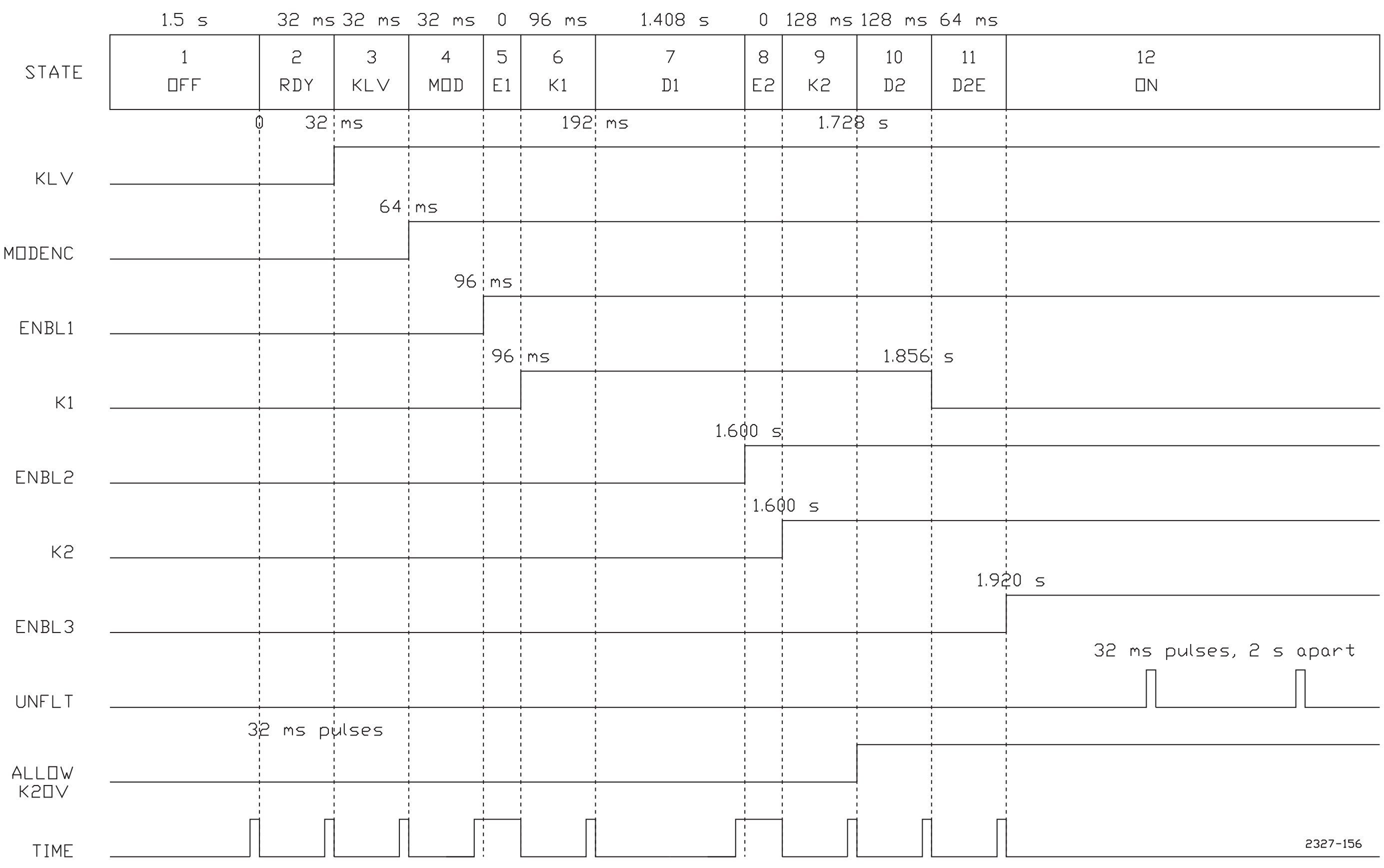


Figure M-10. Step-Start Sequence Timing Diagram

Table M-2. Fault Abbreviation Chart

Indicator Only Fault	
FUSE FAULT	
RF MUTE Faults	
OSCILLATOR FAULT (EXTERNAL RF INPUT)	OSC.RF.X
BUFFER AMP FAULT	BR.RF.X
PREDRIVER FAULT	PR.RF.X
OUTPUT MONITOR NETWORK VSWR	OM.ON.X
OUTPUT MONITOR ANTENNA VSWR	OM.AV.X
OUTPUT MONITOR SUPPLY FAULT	OM.SF.X
ANALOG INPUT SUPPLY FAULT	AI.SF.X
A/D SUPPLY FAULT	AD.SF.X
A/D CONVERSION ERROR	AD.CE.X
Foldback Faults	
NETWORK VSWR	OM.ON.X
ANTENNA VSWR	OM.AV.X
AIR FLOW REDUCED	AF.R.X (6 dB immediate reduction)
OVERTEMP FOLDBACK	OT.FB.X
A/C Restart Faults	
AC MAINS FAULT	PS.PE.X
CONTROLLER UNREGULATED LOSS	C.UL.X
Overload Faults (1 second shut off. Completely shut off at second occurance)	
RF AMP POWER SUPPLY CURRENT FAULT	PS.OC.X
RF AMP POWER SUPPLY VOLTAGE FAULT	PS.VE.X
DRIVER OVERDRIVE FAULT (High or Low Drive)	DR.OD.X
Off Faults	
External Interlock	I.EXT.X
Door Interlock (Transmitter Interlock)	I.DOOR.X
Encoder Supply Fault	E.SF.X
Encoder Cable Interlock	E.CI.X
Overtemperature Fault (Air)	OT.OFF.X
Air Flow Fault	AF.FLT.X

M.6 Troubleshooting

NOTE

Before troubleshooting the Controller it is suggested that the back up batteries be removed from the Extended Transmitter Interface. It is also suggested that the Capacitor backup be discharged by grounding TP16, before removing any components from the board. Failure to do so could result in short battery life and failure of components.

Due to the nature of PAL operation this troubleshooting procedure is grouped by symptom of problem and then list some steps that will help in determining which PAL or pair of PALs may be defective. Refer to the Controller Schematic (839-7930-021) as needed.

M.6.1 LED Observation

First step in troubleshooting a Controller problem is to turn on CB1 and CB2, located in the RPAC.

a. DS5 and DS6 should be illuminated GREEN indicating the two +5VDC Controller on-board regulated supplies are operational.

b. DS1 through DS4 should be illuminated GREEN indicating there are no faults inhibiting turn-on, and all four PALs are operational.

M.6.1.1 Troubleshooting The Controller On-Board Regulated Supplies

There are duplicate +5VDC regulated power supplies on this board. If either supply is not present, a Controller Supply Fault will be visible on the ColorStat™ Status Panel. A non-illuminated DS5 or DS6 indicates that supply, its off-board source, or its interconnecting wiring is faulty.

M.6.1.1.1 Controller On-Board VS Controller Off-Board Isolation

If either or both DS5 and DS6 are not illuminated GREEN, check the presence of active GREEN LEDs DS4 through DS7 on the LVPS board in the RPAC. If any one of these is not GREEN, then the problem is likely on or ahead of that board, and troubleshooting should begin there (See Section S.2 of this manual).

If all of these LEDs are illuminated GREEN, then the problem is likely in the interconnection routing chain, from the LVPS board through its associated Power Distribution board through the Extended Transmitter Interface board on to the Controller board, or is on the Controller board itself. Begin by checking the input fuse for the Controller on-board supply in question.

If open, check the input capacitors and the regulator before replacing this fuse.

If the fuse checks okay, while referring to the Overall Wiring Diagrams and corresponding board schematics, step through the interconnecting path just described.

M.6.1.2 All PAL Fault Indicators Are Illuminated RED

This symptom could be caused by either an External or Door Interlock. In any case, the Transmitter can not be turned on.

Begin by measuring the fault input on the appropriate Fault Input Latch. If the input is HIGH, no real fault present, sequentially replace the latch, FGATE2, and FLT1 PAL is required.

M.6.1.3 One Or More PAL Fault Indicators Are Illuminated RED

If one or more of the PAL Fault Indicators is illuminated RED, replace the PAL associated with the LED.

M.6.2 Turn-On Sequence Incorrect.

Use the information in the Turn-On Sequence procedure, described above, to aid in troubleshooting. The following information assumes that the problem exists on the Controller and is not a fault input that is aborting the sequence. The most likely cause of any problem would be a defective PAL.

NOTE

Place CB3 on the Power Supply Display Panel in the Test Mode, to activate the low voltage power supplies.

M.6.2.1 LR And OPR PALs

Problems with these PALs would be indicated by no turn-on sequence action, no Lower/Raise control, or no VSWR Self Test function.

a. Check for a logic LOW input to the OPR PAL when a Power Level pushbutton switch is depressed. If the LOW is not present, suspect U40 or a loss of signal from the pushbutton.
b. If the input is LOW, check the input to U6 for a logic HIGH. If not present check for a clock signal on pin 1 of U5. If there is no clock pulse, troubleshoot clock generator. If the clock pulse is present, replace U5.
c. If U6 input is a logic HIGH, check U6-13 (ENTOR) for a HIGH.
    1. If ENTOR is LOW, refer to troubleshooting fault PALs in this section.
    2. If ENTOR is HIGH, check U6-21 for a HIGH (TOR). If this is not present, check for a clock pulse on U6-1. If not present, troubleshoot clock generator. If clock pulse is present and U6-13 is HIGH, replace U6
d. If TOR is HIGH, check the Local/Remote Transmitter Status Output Test Point for a logic LOW. If not present suspect U42 or U6.
e. If the Raise/Lower control is not functional, check the inputs to the LR PAL.
    1. If no inputs, suspect U40, U41, and associated components.
    2. If the inputs are correct, check outputs of the PAL. If no outputs, replace U6.
    3. If the outputs are correct, suspect U41 and associated components.
f. If the VSWR Self Test function is incorrect, depress S5 on the board and observe U6-18.
    1. If the test pulse is not present, replace U6
    2. If the test pulse is present, suspect Q1 and associated components.

M.6.2.2 PWR And PTIM PALs

Problems with these PALs would be indicated by no or improper turn-on sequence action.

a. If a HIGH TOR is sent to both of these PALs, begin checking the PWR PAL outputs and the Time pulses from the PTIM PAL. If no outputs are being activated, check for a clock pulse on both PALs. If the clock is not present troubleshoot clock generator. If the clock is present, replace U7 and if needed U8.
b. If the PWR PAL is receiving Time pulses and activating outputs, but no contactor action is occurring in the Transmitter, check for active LOW outputs on J14. If not present suspect U43 and associated components.
c. Also check that the inputs from the contactors are reaching the PWR PAL. If not, suspect the Fault Input Latch.

M.6.2.3 FGATE1 And FGATE2 PALs

To troubleshoot these PALs start by verifying if the fault indicated is not an active LOW by measuring the input to the Controller board.

a. If the input is HIGH, check the input to the PAL for a logic HIGH.
    1. If a LOW is present replace the Latch for that fault.

2. If a HIGH is present, check for the clock input. If no clock input, troubleshoot the clock generator.

b. If the input is HIGH, and the fault output is LOW, replace the PAL.

M.6.2.4 FLT1 And FTIM PALs

Problems with these PALs would be indicated by an incorrect ENTOR signal or no/improper A/C Restart or Overload fault response.

a. If the ENTOR output is LOW, check the FOFF, FOVR, FACR, and FBLIM inputs.

   1. If all inputs are HIGH, check the clock inputs to both PALs. If not present, troubleshoot the clock generator. If present, replace U3 and U4 if needed.

b. If the A/C Restart and Overload functions are incorrect, replace both PALs.

M.6.2.5 FLDBK and FBTIM PALs

This should be accomplished using the same method as the Fault PALs.

M.6.2.6 Troubleshooting Clock Generator

The clock generator consists of an 8kHz clock that is divided down. Troubleshoot this circuit by using a scope and or frequency counter to measure each divider IC for the proper frequency output at TP4 through TP8.

M.7 Removal and Replacement

Remove the mounting screws and unplug all cables. In replacing the board, verify that P50, P52 and P53 are in the correct position.

M.8 Alignments

There are no alignments on this board.

M.9 LED Board

Assembly #	992-8188-001
PWB #	843-5155-006
Schematic #	839-7930-006

Note: Parts list for this board is covered in Section VII

M.9.1 Introduction

This section describes the LED board, and includes circuit functions and descriptions. For troubleshooting information, refer to Section M.6, Controller.

M.9.2 Function

The LED board includes status indicator drivers for the Transmitter Status Panel. All the Transmitter's front panel LED indicators are mounted on the LED board. The LED's are almost all Bicolor, meaning the LED can be either RED, for "Fault" or GREEN for "Normal".

M.9.3 Location

The LED board is located in the center PA cabinet on the back of the front door. (See VIEW 3)

M.9.4 Description

Refer to the LED Board schematic (839-7930-006)for the following. All LED Board inputs come from the Controller board, via J1 and J2. All Fault indicator inputs are active LOW, which means the LED will be RED when the Fault input is LOW. This means that the Fault input lines are normally HIGH, and the LED is GREEN. With no Faults present the whole Status Panel should be illuminated GREEN.

NOTE

Refer to Section M.4.3, Controller, for information on Transmitter fault types and Detailed descriptions.

M.9.4.1 Tri-State Buffers

U6, U7, U8 and U9 are used as Tri-State Buffers for all inputs to the LED board. Since it is a Buffer, the output will be the same as the input, provided the ENABLE line, pins 1 and 19 (of each chip) is LOW. If the enable line is HIGH, the LEDs will not light. This is done during Single Phase A/C failure to shut off all LEDs to save battery backup power.

The outputs of the Tri-State Buffers each go two places. Each goes to one side of the LEDs and at the same time goes to the input side of either U1, U2, U3 or U4.

M.9.4.2 Tri-State Inverters

U1, U2, U3 and U4 are used as Tri-State Inverters. The outputs of these inverters goes to the LEDs on the side opposite of the Tri-State Buffer outputs. This assures that the LEDs will have a LOW on one side and a HIGH on the other, so the LEDs have to be either RED or GREEN. For example, if the oscillator RF Present line at J2-25 was HIGH, U6-18 would be HIGH, which means the right side of DS1 would be HIGH (+5V), and the Inverter output U1-18 would be LOW making the left side of DS1 LOW, and the LED would be GREEN. This indicates a normal condition. If J2-25 was LOW, U6-18 would be LOW, which means the right side of DS1 would be LOW (0V), and the Inverter output U1-18 would be HIGH making the left side of DS1 HIGH, and the LED would be RED. This indicates a Fault condition.

M.9.5 Remote/Local Switch

Switch S1 is used to select either Remote or Local operation of the Transmitter. S1 is tied to +5.7 Volts and depending on whether it is in Remote or Local position determines which line to the Controller is also tied to +5.7 Volts, J1-9 Local or J1-7 Remote.

Provided that J1-3, Local Remote Enable is HIGH, Q1 will be saturated and will supply a ground to the cathode side of DS28 and DS29. With S1 in Local position, DS28 will light RED on the front Panel, and when in Remote position, DS29 will light GREEN. In the SLEEP mode, J1-3 Local Remote Enable, will be LOW and the Remote/Local LEDs, DS28 and DS29 will be disabled.

For more information on Remote/Local operation refer to Section M.5.1.4, Controller.

M.9.6 VSWR Test

VSWR test is a momentary switch used to test the Transmitter VSWR protection circuitry. This supplies a LOW to the Controller which will then initiate the VSWR test. For more information on VSWR test and circuitry refer to Section H, Output Monitor/Output Sample and Section M.5.1.6, Controller.

M.9.7 Fault Reset

Indications can be RESET by depressing the "RESET" pushbutton on the Transmitter's status panel or by providing, a remote "Reset" command. The indications will then change from RED to GREEN if the fault has cleared.

EXCEPTIONS: DOOR INTERLOCK and EXTERNAL INTERLOCK status indications clear as soon as the door is properly closed or the cause of the external interlock is corrected.

M.10 Switch Board/Meter Panel

Assembly #	992-6784-003
PWB #	843-4038-201
Schematic #	839-6208-301

Note: Parts list for this board is covered in Section VII

M.10.1 Introduction

This section describes the Switch Board/Meter Panel. Topics include Function, Location, Detailed Circuit Description, Alignment, and Troubleshooting.

M.10.2 Function

Components mounted on the Switch Board/Meter Panel include the Transmitter's on/off and raise/lower control pushbutton switches and status indicators, forward/reflected power metering and calibration, 250VDC power supply voltage metering and calibration control, 250VDC power supply current metering, and selection controls for multimeter and forward/reflected power readings.

M.10.3 Location

The Switch Board/Meter Panel is located on the back side of the PAC center compartment's front door. (See VIEW 3)

M.10.4 Detailed Circuit Description

Refer to the Switch Board/Meter Panel Schematic Diagram (839-6208-301), for the following discussion.

The printed wiring board itself is a 'breakaway' board, which is split in two pieces which after assembly, are folded in half, and mounted piggy-back. The half containing the switches and LEDs is mounted to the panel such that these components protrude through panel cutouts and are accessible to the operator. The second half is then mounted on the back of the first half, and it contains the control circuitry. This is done so that the height of the components on the second half of the board will not mechanically interfere with the panel since the board must be mounted closely to the panel to allow the switches and LED's to protrude through.

M.10.4.1 Power Control

See sheet 1. When any of the power control pushbuttons (OFF, LOW, MED, HIGH, RAISE, or LOWER) are depressed, a +15vdc command signal is provided to the transmitter power control section of the Controller. Refer to earlier parts of this section for ON/OFF control logic circuit descriptions.

Indicator LED's are located above each switch (with the exception of the OFF switch) which illuminate when their corresponding switch has been depressed. Each LED is connected to the +15vdc bus through a resistor. The other side of the LED's are connected to an open collector output from the Controller.

M.10.4.2 Multimeter Circuit (M1)

M.10.4.2.1 Meter Selection Circuit

See sheet 2. The multimeter selection is done by repeatedly depressing the multimeter selection pushbutton switch until the desired function is reached, indicated by an illuminated LED next to the desired function labeled on the front panel.

Each appropriate metered signal is provided to the board via the ribbon cable connected to the board at J1. Each line is terminated with the appropriate impedance and with a bypass capacitor. Each signal is interfaced via a voltage follower op amp (U2, U4, and U5) and provided to multiplexer U3, which then selects the appropriate line to be fed to the multimeter corresponding to the selection made with the front panel switch.

The corresponding LED is illuminated similarly by demultiplexer U8, which selects the appropriate LED to illuminate corresponding to the selection made with the front panel switch. The LED's are connected to the +15vdc bus via resistors, then through driver IC U1, through the demultiplexer, to ground.

Both multiplexer U3 and the demultiplexer U8 are addressed via a counter IC U6, which is incremented by each closure of the selection switch. At power up, the address is set to 000, which selects the first multimeter position automatically.

M.10.4.2.2 Metering Circuits

The 100uA movement meter used as the multimeter is driven by a final op amp (U9A) and has an RF bypass cap (C41) and a filtering cap (C1). The filtering cap helps remove any transients from the power supply, and removes any ripple from the -15vdc converter regulator IC, U14.

Each meter signal is provided from the metering circuits described following.

a. PA +VDC (+250VDC supply): Multiplier resistors are located on Fuse board 1A39.
b. ANTENNA NULL and FILTER NULL: These are detector null indications for the VSWR detector circuits on the Output Monitor. Filterfing of these signals is provided on the Extended Transmitter Interface board.
c. RF DRIVE: The Relative RF Drive signal is taken from RF drive sample circuit located on the Driver Encoder board 1A7. The 'RF drive estimate' output is routed through the Controller and Extended Transmitter Interface to the switch board.
d. Inputs J1-8, J1-10, J1-20, and J1-22 are not used in this configuration.

M.10.4.3 Supply Current Meter Circuit (M2)

The power supply current sample is taken from a shunt resistor in the negative output of the 250 volt power supply. The voltage developed across the meter shunt is proportional to the supply current (and is 50 millivolts when supply current is 1500 amperes). This voltage is brought directly to the meter and then back through the Switch Board to the Analog Input Board for overcurrent fault and overload circuits.

M.10.4.4 Power Meter Circuit (M3)

Buffering of the forward and reflected power samples is provided by two sections of op amp U5. The U5 output signals are routed through multiplexer U10, op amp U9, then to the power meter.

Selection of forward or reflected power is accomplished by multiplexer U10, which is driven by flip flop U11. Switch S8 toggles flip flop U11. Display of the selected metering function is provided by leds DS8 and DS9.

Upon application of dc power, the forward/reflected meter should be in forward power position, as determined by the Set input to flip flop U11.

M.10.4.5 Minus 15 Volt Power Source

IC U14 provides the negative power supply voltage that is needed by the various op amps. See sheet 2.

M.10.5 Adjustments

There are three adjustments on the Switch Board/Meter Panel: Forward Power Calibrate control A35R14, Reflected Power Calibrate control A35R13, and PA +VDC Calibrate control A35R8. These adjustments are made at the factory by measuring transmitter power output in a calorimetric dummy load. These calibration adjustments should not be changed unless some means of accurately measuring transmitter output power is available. Refer to the Tuning/Frequency Change Procedure for information on calibrating the reflected power meter.

M.10.6 Troubleshooting

M.10.6.1 Changing Indicator Lamps

To change indicator lamps, carefully remove the plastic cap from the pushbutton switch to gain access to the indicator lamp. The plastic cap can be removed by carefully pulling it straight out from the front of the panel.

M.10.6.2 Metering Circuit Fault

Failure of the operational amplifier driving the meter could cause either no indication or a full scale indication. If it is suspected that multiplier resistor values have changed value, they can be checked in-circuit, if the multimeter is switched to some other position to eliminate parallel resistance paths.

N.1 Introduction

This section describes the Power Block Interface Board. Topics include function, location, circuit description, troubleshooting, and removal/replacement.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Assembly #	992-9163-003
PWB #	843-5450-008
Schematic #	839-8154-008

NOTE: Parts List for this board is covered in Section VII.

N.2 Function

The Power Block Interface will interface the Transmitter with external control. This board also provides isolation for the signals in terms of opto isolators and filtering networks.

Both serial and parallel control and status signals are used in some transmitter systems. Serial control and status typically is for Power Block control and status to the PLC where a Power Block is part of a multiple Power Block Transmitter. Parallel control and status is for key Transmitter control functions.

The Power Block Interface board also provides an interface between the Transmitter and Rectifier cabinet.

The Power Block Interface board receives inputs from the Transmitter Controller and provides Control, Status/Fault and Metering Outputs.

N.3 Location

The Power Block Interface Board is mounted in the CPAC on the left sidewall (See VIEW 4).

N.4 Detailed Circuit Description

Refer to the Power Block Interface Schematic (839-8154-008) for the following discussion.

N.4.1 Status Outputs Interface

Several fault indications, as well as LOW, MEDIUM, HIGH, and OFF Transmitter modes can be monitored using the status outputs. J7 supplies inputs from the Controller to the status output drivers U6 and U7, except for the RF Mute Status.

The operation of all the output drivers are the same. These drivers provide isolation between the Controller and the PLC circuits. When the input to an output driver is pulled LOW by the Controller, the driver's output also goes LOW.

Should transient voltages develop on the remote status lines, protection diodes on the output of each driver will clamp the output at +15.6 VDC or -0.6 VDC.

A second output for LOW, MEDIUM, HIGH, and OFF is provided for combined Power Block operation through J3-11 thru 14.

N.4.2 Remote Control Inputs

All Remote Control functions are accomplished through optically isolated control inputs using opto-isolators U17, U18 and U19. The Remote Control functions attain ready status by receipt of an active HIGH from the Controller Board at J7-9. This voltage will turn on transistor Q1, which provides a ground for the emitter of each opto-isolator.

A jumper plug is provided on the input of each opto-isolator to allow programming for HIGH or LOW control logic.

The Remote Control Inputs are connected to connector J3, J14 provides inputs for the PLC. A terminal strip adapter is provided for use with the connector.

Inputs are provided via J5 for LOW, MEDIUM, HIGH, OFF and RF MUTE from the Analog Input Board.

N.4.3 Metering Outputs

N.4.3.1 Remote Metering

Operational amplifiers U4 and U36 provide PLC analog inputs for five Power Block parameters.

FORWARD POWER, SUPPLY VOLTAGE and SUPPLY CURRENT outputs will be between 2 and 4 VDC under normal operating conditions.

REFLECTED POWER and PLC MUX OUTPUT CURRENT outputs should be near 0 VDC and will increase as corresponding front panel meter readings increase.

N.4.4 Logic Circuits

The Power Block Interface utilizes an Electronically Programmable Logic Devise (EPLD) for Custom Logic Functions. U37 receives status and command inputs and has serial and parallel outputs.

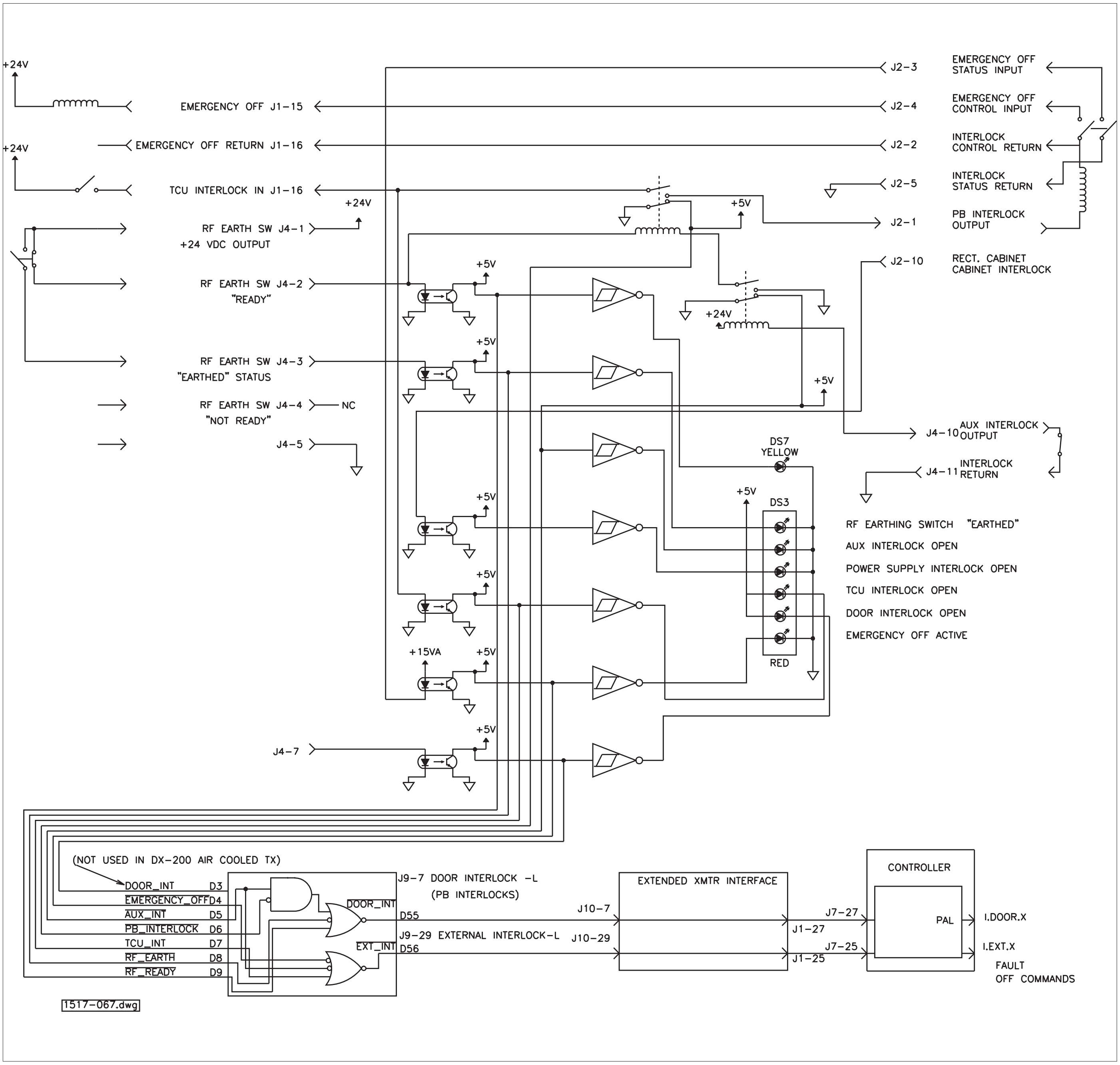


Figure N-1. Simplified Drawing - Power Block Interface - Interlock Circuits

N.4.5 Demodulated Audio Sample

A demodulated audio sample from the Output Monitor Board, is buffered by U3 and is available at the audio headphone jack J17 and J1-3 and J1-4. This audio sample, although it has reasonably low distortion, is intended for general monitoring use. A modulation monitor is recommended for performance measurements.

N.4.6 Interlock Circuits

Interlock relay K2 is held energized from the +24 Vdc power supply, through J4-10 and 11 the normally closed customer supplied Auxilliary Interlock contacts. JP17 must be jumpered and JP18 removed. This connects a ground to the low side of K1 through K2 contacts 9 and 13. The high side of K1 is connected to the +24Vdc supply when the RF Earthing switch is in the ready position. K1 contacts 9 and 13 connect +24Vdc to energize the Power Supply Rectifier Interlock Relay. These conditions are sent to Interlock Circuit Logic Circuits through Opto-Isolators U19 and U22, and LED DS3 through LED driver U23 and U16.

External Door Interlock at J4-7 are not used. JP26 supplies +24Vdc to Opto-Isolater U22, and DS3 through LED driver U16. DS7 shows the RF Earthing Switch Ready. DS3 shows RF Earthing Switch when Earthed, Auxilliary, Power Supply, and Emergency Off when a Door Interlock is opened.

NOTE

The Transmitter will not operate if there is an open circuit between the External Interlock terminals.

N.4.7 Audio Input

The audio input from the TCU is applied to J1-1 (+) and J1-2 (-). Bipolar zener diodes CR15 and CR16 from each side of the balanced audio input to ground and provide overvoltage protection. Audio is then sent to the Analog Input Board where jumpers are used to select an input impedance of between 50 Ohms and 600 Ohms.

N.4.8 Power Supplies

Three voltages are supplied from the Power Distribution Board. A +18 VDC and -18 VDC are regulated down to +15 VDC and -15 VDC by U30 and U33. The +8 VDC input is regulated down to +5 VDC. These supplies are used to power various circuits on the Power Block Interface Board. In addition, the +15 VDC and +5 VDC supplies may be used to power Remote Control Inputs and Status Outputs.

N.5 Troubleshooting

N.5.1 Remote Control Input(s) Do Not Operate

a. Check the associated power supply inputs and voltage regulator outputs.
b. While monitoring the DC voltage between the control input terminals on J3, activate the remote control equipment.
c. If the voltage between the terminals is 15 Volts or more, the problem is in the Transmitter.
d. If the voltage is small, the problem is a shorted opto-isolator input or the problem is external to the Transmitter.
e. To determine whether the opto-isolator or Transmitter logic is at fault:
    1. Monitor the voltage across the opto-isolator's output terminals or J8, while activating the remote control input again.
    2. If the voltage across the opto-isolator's output terminals drops to less than 0.5 Volts, the opto-isolator is operating properly.

Additional Notes: Current through the control input terminal circuit turns on an opto-isolator by illuminating an internal LED. A current between 40 and 70 milliamperes is required to illuminate the LED and activate the photo transistor.

N.5.2 Incorrect Status Output(s)

A positive voltage through circuits external to the Transmitter must be supplied to each status output used, at the proper terminal of J3.

For each Remote Status Output, when there is no red status indication on the Transmitter status panel or illuminated pushbutton switch, there should be a positive voltage on the corresponding terminal of J3.

a. Use a voltmeter or logic probe to check the input voltage to the status interface circuit.
b. When there is a "status" indication (red LED or illuminated pushbutton switch), the corresponding terminal should be LOW.
c. If the input is LOW, the output should also be LOW.
d. If not suspect a defective driver.
e. If the input is HIGH, the problem is in the Transmitter fault logic.

N.5.3 Incorrect Remote Metering

Each analog voltage to the monitor output terminals is buffered by a voltage follower. Measure the +15 and -15VDC supplies, and check output zener diodes. Failure of the zener diode might result in low or no output from the op amp.

N.6 Removal and Replacement

Remove the cable connectors going to this board. Then remove the mounting screws to remove the board from the Transmitter. Reverse the above procedure when replacing the board. Note that the connectors are numbered and keyed to aid in making the connections.

Note all jumper positions and verify the replacement board is properly jumpered.

N.1 Power Block Interface Board Connections

The following tables represent the I/O connections with the associated function, signal type, nominal signal level and active state, destination, and connector type. Asterisks indicate not used in a Power Block configuration. All TCU connections are only used when optional TCU is used. A TCU is not part of a typical stand-alone transmitter configuration.

J#	PIN #	FUNCTION * = Not Used	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATE	DESTINATION / CONNECTOR TYPE
J1	1	AUDIO INPUT (+)	ANALOG INPUT	-10 TO +10dBM @ 600 OHMS	PARALLEL I/O OUTPUT 24 PIN WAGO HEADER
	2	AUDIO INPUT (-)			
	3*	DEMOD AUDIO OUTPUT	ANALOG INPUT	BALANCE AUDIO OUT (-15 TO +15V) Nom 5V p-p @ 100%	
	4*	DEMOD AUDIO OUTPUT (-)			
	5	GROUND			
	6	TCU OPTO COMMON	DC VOLTAGE INPUT	5-15 VDC (recommended: +15vdc at 50mA min.)	
	7	RF MUTE CONTROL INPUT (FAST)	TCU control inputs	Ground sink to activate. ACTIVE -L 10mA typical current	
	8	PB PARALLEL CONTROL BIT0			
	9*	PB PARALLEL CONTROL BIT1			
	10*	PB PARALLEL CONTROL BIT2			
	11	PB READY OUTPUT	TCU control outputs	Ground Sink output. ACTIVE -L 10mA typical current (max current = 500 mA)	
	12*	PB PARALLEL STATUS BIT0			
	13*	PB PARALLEL STATUS BIT1			
	14*	PB PARALLEL STATUS BIT2			
	15	EMERGENCY OFF OUTPUT	TCU INTERLOCK CONTROL	Ground sink E Off = L	
	16	EMERGENCY OFF COMMON		GROUND	
	17	TCU INTERLOCK (PB) INPUT		Interlock closed = +24VDC	
	18	GROUND			
	19*	GROUND			
	20*	GROUND			
	21	SHIELD	GROUND		
	22*	N.C.			
	23	FAST RF MUTE (same as pin 7)	CONTROL	Ground to activate	
	24	CABLE SHIELD		A GROUND	

J#	PIN#	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATE	DESTINATION / CONNECTOR TYPE
J2	1	PB INTERLOCK OUTPUT	INTERLOCK CONTROL	PB INTERLOCK CLOSED = 24VDC	POWER SUPPLY I/O (TO POWER SUPPLY RECTIFIER CABINET) 24 PIN WAGO HEADER
	2	INTERLOCK CONTROL RETURN		GROUND	
	3	EMERGENCY OFF (STATUS)	INTERLOCK STATUS	EMERGENCY OFF = GROUND	
	4	EMERGENCY OFF INPUT (CONTROL)	INTERLOCK CONTROL	EMERGENCY OFF = GROUND	
	5	INTERLOCK STATUS RETURN		GROUND	
	6	DC EARTHING SWITCH “EARTHED”	PS FAULT / STATUS INPUTS	Ground sink to activate. ACTIVE -L 10mA typical current (max = 1.5A)	
	7	RF MUTE	CONTROL OUTPUT	Open collector output. ACTIVE -L 10mA typical current (max = 500mA)	
	8	+24VDC OUTPUT (PS LAMP)	DC PS OUTPUT	+24VDC unregulated 300mA load (max = 15.A)	
	9	POWER SUPPLY OPTO COMMON	DC SUPPLY	+15V (100mA max)	
	10	PS CABINET INTERLOCK	PS FAULT / STATUS INPUTS	Ground sink to activate. ACTIVE -L 10mA typical current	
	11	AC MAINS FAULT			
	12	POWER SUPPLY OK	PS STATUS INPUT	Ground sink to activate. ACTIVE -H 10mA typical current	
	13	TEMPERATURE FAULT		Ground sink to activate. ACTIVE -L 10mA typical current	
	14	PS VOLTAGE FAULT			
	15	PS CURRENT FAULT			
	16	PS STATUS OUTPUTS RETURN	GROUND		
	17	PS FOLDBACK CONTROL BIT1	PS CONTROL OUTPUTS	Open collector output. ACTIVE -L 10mA typical current (max = 500mA)	
	18	PS FOLDBACK CONTROL BIT2			

J#	PIN#	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATE	DESTINATION / CONNECTOR TYPE
J2	19	PS FOLDBACK CONTROL BIT3	PS CONTROL OUTPUTS	Open collector output. ACTIVE -L 10mA typical current (max = 500mA)	POWER SUPPLY I/O (TO POWER SUPPLY RECTIFIER CABINET) 24 PIN WAGO HEADER
	20	PS CONTROL INPUTS RETURN	GROUND		
	21	PS ENABLE OUTPUT	PS CONTROL OUTPUTS	Open collector output. ACTIVE -L 10mA typical current (max = 500mA)	
	22	PS CONTROL OPTO COMMON	DC VOLTAGE OUTPUT	5-15VDC (recommended +15vdc at 50 mA min)	
	23	PS FAULT INDICATOR RESET	PS CONTROL OUTPUTS	Open collector output. ACTIVE -L 10mA typical current (max = 500mA)	
	24	SHIELD	GROUND		

J#	PIN#	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATE	DESTINATION / CONNECTOR TYPE
J3	1	REMOTE OFF	DIGITAL CONTROL INPUT	Ground sink to activate. ACTIVE -L 10mA typical current	PARALLEL REMOTE CONTROL (TO REMOTE CONTROL UNIT) 24 PIN WAGO HEADER Not used on typical power blocks
	2	REMOTE HIGH POWER ON			
	3	REMOTE MEDIUM POWER ON			
	4	REMOTE LOW POWER ON			
	5	REMOTE POWER RAISE			
	6	REMOTE POWER LOWER			
	7	REMOTE RF MUTE			
	8	REMOTE ALT DRIVE CHAIN SELECT			
	9	REMOTE FAULT RESET			
	10	REMOTE CONTROL OPTO SUPPLY	POWER SUPPLY OUTPUT	5-15VDC (recommended +15vdc at 150mA)	
	11	TRANSMITTER OFF ACTIVE	DIGITAL STATUS	ACTIVE -L max sink current = +150mA. max voltage 30VDC	
	12	HIGH POWER ACTIVE			
	13	MEDIUM POWER ACTIVE			
	14	LOW POWER ACTIVE			
	15	REMOTE CONTROL ACTIVE ACTIVE			
	16	SUMMARY FAULT ACTIVE			
	17	FORWARD POWER OUTPUT SAMPLE	ANALOG	4VDC NOM @ rated power	
	18	REFLECTED POWER OUTPUT SAMPLE	ANALOG	4V NOM @ rated power (CAL MODE)	
	19	RF AMPLIFIER SUPPLY VOLTAGE SAMPLE	ANALOG	4V NOM @ 250VDC	
	20	RF AMPLIFIER SUPPLY CURRENT SAMPLE	ANALOG	2.5VDC @ rated power	
	21	N.C.			
	22	GROUND		GROUND	
	23	GROUND		GROUND	
	24	GROUND		GROUND	

J#	PIN#	FUNCTION * = Not Used	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATE	DESTINATION / CONNECTOR TYPE
J4	1	INTERLOCK +24VDC SUPPLY	DC SUPPLY	+24VDC (UNREGULATED) 75 mA typical	POWER BLOCK INTERLOCK (TO TCU) 12 PIN WAGO HEADER
	2	RF EARTHING SWITCH “READY”	INTERLOCK STATUS	“READY” = 24VDC	
	3	RF EARTHING SWITCH “EARTHED”		“EARTHED” = 24VDC	
	4*	RF EARTHING SWITCH “NOT READY”		“NOT READY” = 24VDC	
	5	RF EARTHING SWITCH SHIELD GROUND		GROUND	
	6	N.C.			
	7*	DOOR INTERLOCK INPUT STATUS	Interlock CONTROL	PB DOOR CLOSED = 24VDC	
	8	DOOR INTERLOCK CONTROL RETURN		GROUND	
	9*	DOOR INTERLOCK CONTROL INPUT	Interlock CONTROL	PB DOOR CLOSED = CONTACT CLOSURE	
	10	AUX INTERLOCK CONTROL	Interlock CONTROL	AUX INTERLOCK CLOSED = CONTACT CLOSURE	
	11	AUX INTERLOCK CONTROL RETURN		GROUND	
	12	N.C.			

J#	PIN#	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATUS	DESTINATION / CONNECTOR TYPE
J5	1	PS CURRENT FAULT	CONTROL OUTPUT	OPEN COLLECTOR ACTIVE -L	ANALOG INTERFACE (TO ANALOG INPUT) 10 PIN RIBBON
	3	PB FOLDBACK LEVEL B1	CONTROL INPUTS	ACTIVE -H	
	5	PB FOLDBACK LEVEL B2			
	7	PB FOLDBACK LEVEL B3			
	9	A/D AUDIO SAMPLE	AUDIO/DC	0-4VDC (WITH AUDIO)	
	2-10 EVEN	A GROUND		A GROUND	

J#	PIN#	FUNCTION * = Not Used	DESTINATION	CONNECTOR TYPE
J6	1	CLOCK INPUT (4KHZ)	POWER BLOCK INTERFACE BOARD	20 PIN RIBBON
	3*	+5VDC (BATTERY BACKED)		
	5	COOLING MPX ADDRESS A0 (OUTPUT) -H		
	7	COOLING MPX ADDRESS A1 (OUTPUT) -H		
	9	COOLING MPX ADDRESS A2 (OUTPUT) -H		
	11	COOLING MPX ADDRESS A3 (OUTPUT) -H		
	13	COOLING MPX STATUS INPUT		
	15	COOLANT FLOW OVERRIDE -H (OUTPUT) -H		
	17	N.C.		
	19	N.C.		
	2-20 EVEN	A GROUND		

J#	PIN#	FUNCTION * = Not Used	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATUS	DESTINATION / CONNECTOR TYPE
J7	1	POWER BLOCK OFF ACTIVE	DIGITAL	ACTIVE - L	40 PIN RIBBON CONNECTOR
	3	HIGH POWER ON ACTIVE			
	5	MEDIUM POWER ON ACTIVE			
	7	LOW POWER ON ACTIVE			
	9	REMOTE CONTROL ACTIVE ACTIVE		ACTIVE - H	
	11	N.C.			
	13	SUMMARY FAULT ACTIVE		ACTIVE - L	
	15	FOLDBACK ACTIVE			
	17	RF DRIVE CHAIN FAULT ACTIVE			
	19	RF AMP FAULT ACTIVE			
	21	VSWR FAULT ACTIVE			
	23	POWER SUPPLY FAULT ACTIVE			
	25	AC MAINS FAULT ACTIVE			
	27	AIR FLOW FAULT ACTIVE			
	29	LV SUPPLY FAULT ACTIVE			
	31	INTERLOCK OPEN ACTIVE			
	33*	8KHZ MASTER CLOCK OUTPUT	DIGITAL	TTL CLOCK 8KHZ	
	35	1HZ	DIGITAL	TTL CLOCK 1HZ	
	37	N.C.			
	39	REMOTE FAULT RESET COMMAND	DIGITAL	ACTIVE -L	
	2-40 EVEN	A GROUND		A GROUND	

J#	PIN#	FUNCTION * = Not Used	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATUS	DESTINATION / CONNECTOR TYPE
J8	1*	EXTERNAL 1 METERING	ANALOG	10VDC OPEN CIRCUIT (100uA full scale)	2O PIN RIBBON (TO CONTROLLER)
	3*	EXTERNAL 2 METERING			
	5*	EXTERNAL 3 METERING			
	7*	EXTERNAL 4 METERING			
	9	LOW POWER ON REMOTE COMMAND	DIGITAL OUTPUT (TO CTRL)	ACTIVE - L OPEN COLLECTOR	
	11	MEDIUM POWER ON REMOTE COMMAND			
	13	HIGH POWER ON REMOTE COMMAND			
	15	POWER RAISE REMOTE COMMAND			
	17	POWER LOWER REMOTE COMMAND			
	19	OFF REMOTE COMMAND			
	2-20 EVEN	A GROUND		A GROUND	

J#	PIN#	FUNCTION * = Not Used	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATUS	DESTINATION / CONNECTOR TYPE
J9	1*	+5VDC INPUT	DC POWER SUPPLY	+5VDC max I = 50mA	40 PIN RIBBON (TO TRANSMITTER INTERFACE)
	3	N.C.			
	5	N.C			
	7	DOOR INTERLOCK OUTPUT (PB INTERLOCK)	DIGITAL	INTERLOCK OPEN = L	
	9	ALTERNATE DRIVE CHAIN COMMAND		ACTIVE - H	
	11	MASTER VSWR INHIBIT INHIBIT			
	13	FORWARD POWER SAMPLE INPUT	ANALOG	4VDC NOMINAL @ rated power	
	15	REFLECTED POWER SAMPLE INPUT		4VDC @ rated power (CAL MODE)	
	17	RF AMPLIFIER SUPPLY VOLTAGE SAMPLE INPUT		4V NOM @ 230 VDC	
	19	RF AMPLIFIER SUPPLY CURRENT SAMPLE INPUT		2.5VDC @ rated power	
	21	ANTENNA NULL READING		2.5VDC with VSWR TEST	
	23	NETWORK NULL READING		2.5VDC with VSWR TEST	
	25	DEMODULATED AUDIO INPUT (+)		BALANCED AUDIO OUT (-15 TO +15V) NOM 5Vp-p @ 100%	
	27	DEMODULATED AUDIO INPUT (-)			
	29	EXTERNAL INTERLOCK COMMAND OUTPUT	DIGITAL	INTERLOCK OPEN = L	
	31*	TX ON ENABLE		ACTIVE H	
	33	RF MUTE OUTPUT	DIGITAL	OPEN COLLECTOR ACTIVE -L	
	35	+5VDC SUPPLY OUTPUT (FOR TX INTERFACE)	POWER SUPPLY	+5VDC +/-5% @ 30 mA (typical load)	
	37	+15VDC SUPPLY OUTPUT (FOR TX INTERFACE)		+15VDC +/-5% 50 mA max	
	39	-15VDC SUPPLY OUTPUT (FOR TX INTERFACE)		-15VDC +/-5% 50 mA max	
	2-40 EVEN	A GROUND		A GROUND	

J#	PIN#	FUNCTION * = Not Used	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATUS	DESTINATION / CONNECTOR TYPE
J10	1	+22VDC INPUT UNREGULATED	POWER SUPPLY	+18VDC regulated for power blocks (+22vdc for transmitters)	12 PIN MTA (TO POWER DISTRIBUTION BOARD)
	2	A GROUND		A GROUND	
	3	-22VDC INPUT		-18VDC regulated for power blocks (-22vdc for transmitters)	
	4	KEY			
	5	+8VDC INPUT			
	6	A GROUND		A GROUND	
	7	N.C.			
	8	A GROUND		A GROUND	
	9*	+12VDC UNREGULATED INPUT		+10.8VDC regulated for power blocks (+12vdc for transmitters)	
	10	N.C.			
	11	N.C.			
	12	N.C.			

J#	PIN#	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATUS	DESTINATION / CONNECTOR TYPE
J11	1	MASTER FOLDBACK DATA BIT 2	DIGITAL OUTPUTS	ACTIVE - H	10 PIN RIBBON CONNECTOR
	3	MASTER FOLDBACK DATA BIT 1			
	5	MASTER FOLDBACK DATA BIT 0			
	7	AUDIO OUTPUT (-)	ANALOG OUTPUTS	-10 TO +10DBM	
	9	AUDIO OUTPUT (+)			
	2-10 EVEN	A GROUND		A GROUND	

J#	PIN #	FUNCTION * = Not Used	DESTINATION	CONNECTOR TYPE
J12	1	STEP START SSR DRIVE -L	POWER SUPPLY CONTROL INTERCONNECT EXTENDED TRANSMITTER INTERFACE BD.	40 PIN RIBBON
	3	RUN SSR DRIVE -L		
	5	STEP START STATUS -H		
	7	RUN STATUS -H		
	9	TX ON ENABLE -H		
	11*	LV SUPPLY SSR DRIVE -L		
	13	AC MAINS FAULT -L		
	15*	FAN LOSS FAULT -L		
	17*	POWER SUPPLY TEMP (FOLDBACK) -L		
	19	POWER SUPPLY TEMP FAULT -L		
	21*	4 KHZ CLOCK OUTPUT		
	23	RF MUTE OUTPUT (USED FOR MUTE STATUS)		
	25	N.C.		
	27	POWER SUPPLY VOLTAGE FAULT -L		
	29*	+5V OUTPUT		
	31	N.C.		
	33	A/D AUDIO		
	35	N.C.		
	37*	+22VDC UNREGULATED OUTPUT		
	39*	+22VDC UNREGULATED OUTPUT		
	2-40 EVEN #s	“A” GROUND		

J#	PIN #	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATUS	DESTINATION / CONNECTOR TYPE
J13	1	PLC VDC1 INPUT	POWER SUPPLY INPUT (OPTO SUPPLY)	15VDC 5.1mA per input channel - 163mA worst case	PLC DIGITAL INPUT INTERFACE (TO PLC DIGITAL INPUT MODULE) 40 PIN RIBBON
	2	PLC VDC3 INPUT			
	3	PLC VDC1 INPUT			
	4	PLC VDC3 INPUT			
	5	PLC IN0/ TRANSMITTER OFF ACTIVE	DIGITAL OUTPUTS	ACTIVE - LOW typical sink current = 5.1 mA @ 24VDC OPEN COLLECTOR	
	7	PLC IN1/ HIGH POWER ACTIVE			
	9	PLC IN2/ MEDIUM POWER ACTIVE			
	11	PLC IN3/ LOW POWER ACTIVE			
	13	PLC IN4/ REMOTE CONTROL ACTIVE			
	15	PLC IN5/ SUMMARY FAULT ACTIVE			
	17	PLC IN6/ RF MUTE ACTIVE			
	19	PLC IN7/ POWER FOLDBACK ACTIVE			
	21	PLC IN8/ RF DRIVE CHAIN FAULT ACTIVE			
	23	PLC IN9/ RF AMP FAULT ACTIVE			
	25	PLC IN10/ VSWR FAULT ACTIVE			
	27	PLC IN11/ POWER SUPPLY FAULT ACTIVE			
	29	PLC IN12/ AC MAINS FAULT ACTIVE			
	31	PLC IN13/ AIR FLOW SUMMARY FAULT			
	33	PLC IN14/ LOW VOLTAGE SUPPLY FAULT ACTIVE			
	35	PLC IN15/ INTERLOCK OPEN ACTIVE			
	6	PLC IN16/ N.C.			
	8	PLC IN17/ PB STATUS BIT0	DIGITAL OUTPUTS	ACTIVE - LOW typical sink current = 5.1 mA @ 24VDC OPEN COLLECTOR	
	10	PLC IN18/ PB STATUS BIT1			
	12	PLC IN19/ PB STATUS BIT2			
	14	PLC IN20/ PB STATUS BIT3			
	16	PLC IN21/ PB STATUS OUT1			
	18	PLC IN22/PB STATUS MUX OUT2			
	20	PLC IN23/ N.C.			
	22	PLC IN24/ N.C.			
	24	PLC IN25/ N.C.			
	26	PLC IN26/ N.C.			
	28	PLC IN27/ N.C.			
	30	PLC IN28/ N.C.			
	32	PLC IN29/ N.C.			
	34	PLC IN30/ N.C.			
	36	PLC IN31/ N.C.			
	37	PLC VDC2 INPUT	POWER SUPPLY INPUT (OPTO SUPPLY)	+15VDC 5.1 mA per input channel - 163mA worst case	
	38	PLC VDC4 INPUT			
	39	PLC VDC2 INPUT			
	40	PLC VDC4 INPUT			

J#	PIN#	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATE	DESTINATION / CONNECTOR TYPE
J14	1	PLC VDC1 INPUT	POWER SUPPLY INPUT (OUPUT REFERENCE)	+15VDC REGULATED	PLC DIGITAL OUTPUT INTERFACE (TO PLC DIGITAL OUTPUT MODULE) 40 PIN RIBBON
	2	PLC VDC2 INPUT			
	3	PLC VDC1 INPUT		+5VDC REGULATED	
	4	PLC VDC2 INPUT			
	5	PLC OUT0/ OFF CONTROL UNIT	DIGITAL INPUTS	OPEN COLLECTOR DRIVE FROM PLC (ACTIVE L) typical current = 10mA per input note: PLC outputs 0-15 are operated from a +15 vdc opto supply	
	7	PLC OUT1/ HIGH POWER CONTROL UNIT			
	9	PLC OUT2/ MEDIUM POWER CONTROL INPUT			
	11	PLC OUT3/ LOW POWER CONTROL INPUT			
	13	PLC OUT4/ POWER RAISE CONTROL INPUT			
	15	PLC OUT5/ POWER LOWER CONTROL INPUT			
	17	PLC OUT6/ RF MUTE CONTROL INPUT			
	19	PLC OUT7/ ALTERNATE DRIVE CHAIN SELECT			
	21	PLC OUT8/ REMOTE FAULT RESET			
	23	PLC OUT9/ N.C.			
	25	PLC OUT10/ SPARE INPUT			
	27	PLC OUT11/ SPARE INPUT			
	29	PLC OUT12/ SPARE INPUT			
	31	PLC OUT13/ N.C.			
	33	PLC OUT14/ N.C.			
	35	PLC OUT15/ N.C.			
	6	PLC OUT16/ PLC MPX AD0	DIGITAL OUTPUTS	OPEN COLLECTOR DRIVE FROM PLC (ACTIVE - L) typical current = 10mA per input Note: PLC outputs 0-15 are operated from a +5vdc opto supply	
	8	PLC OUT17/ PLC MPX AD1			
	10	PLC OUT18/ PLC MPX AD2			
	12	PLC OUT19/ PLC MPX AD3			
	14	PLC OUT20/ PLC MPX AD4			
	16	PLC OUT21/ PLC MPX AD5			
	18	PLC OUT22/ EPLD CONTROL B0			
	20	PLC OUT23/ EPLD CONTROL B1			
	22	PLC OUT24/ EPLD CONTROL B2			
	24	PLC OUT25/ EPLD CONTROL B3			
	26	PLC OUT26/ ANALOG MUX A0			
	28	PLC OUT27/ ANALOG MUX A1			
	30	PLC OUT28/ ANALOG MUX A2			
	32	PLC OUT29/ MASTER FB B0			
	34	PLC OUT30/ MASTER FB B1			
	36	PLC OUT31/ MASTER FB B2			
	37	PLC COM1 INPUT	PLC MODULE COMMON	GROUND REFERENCE FOR OPTOS	
	38	PLC COM1 INPUT			
	39	PLC COM2 INPUT			
	40	PLC COM2 INPUT			

J#	PIN#	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATE	DESTINATION / CONNECTOR TYPE
J15	1	PLC ANALOG IN0+/ FWD POWER	ANALOG OUTPUTS (PLC MONITORING)	7.5VDC typical at full power	PLC ANALOG INTERFACE (TO PLC) 12 PIN WAGO HEADER
	2	PLC ANALOG IN0-/ FWD POWER (GND)			
	3	PLC ANALOG IN1+/ PA VOLTAGE		7.5VDC @ 250VDC supply volts	
	4	PLC ANALOG IN1-/ PA VOLTAGE (GND)			
	5	PLC ANALOG IN2+/ PA CURRENT		7.5VDC at full scale PA current	
	6	PLC ANALOG IN2-/ PA CURRENT (GND)			
	7	PLC ANALOG IN3+/ MPX OUTPUT		7.5VDC at typical full scale reading	
	8	PLC ANALOG IN3-/ MPX OUTPUT (GND)			
	9	N.C.			
	10	N.C.			
	11	ANALOG COMMON		COMMON	
	12	SHIELD GROUND		GROUND	

J#	PIN#	FUNCTION	SIGNAL TYPE	NOMINAL LEVEL / ACTIVE STATE	DESTINATION / CONNECTOR TYPE
J16	1	+24VDC INPUT	PS DC INPUT	+24VDC (UNREGULATED) 500mA typical / 1A max	+24vdc INPUT (TO LV PS) 4 PIN WAGO HEADER
	2	+24VDC RETURN		A GROUND	
	3	SHIELD		A GROUND	
	4	N.C.			

WARNING: Disconnect primary power prior to servicing.

P.1 Introduction

This section describes the Extended Transmitter Interface Board. Topics include function, location, detailed circuit description, troubleshooting, and removal/replacement.

NOTE:

Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

Assembly #	992-8989-001
PWB #	843-5450-005
Schematic #	839-8154-005

NOTE - Parts List for this board is covered in Section VII.

P.2 Function

The primary function of the Extended Transmitter Interface Board is to act as a tie point for inputs/outputs to and from the Controller Board, to the rest of the transmitter. In this way, the Extended Transmitter Interface greatly increases reliability by decreasing the number of cables and connections to and from the circuitry mounted on the hinged front door, most of which go to the Controller.

Other functions include Cable Interlock summing, Control Multimeter monitoring, Power Supply interconnections, Battery Backup connections, and Interlocks.

P.3 Location

The Extended Transmitter Interface Board is mounted in the center PA compartment on the left hand wall (See VIEW 4).

P.4 Detailed Circuit Description

Refer to the Extended Transmitter Interface Schematic 839-8154-005 for the following discussion.

P.4.1 Cable Interlock

All Cable Interlock inputs from the Modulation Encoders and the Driver Encoder are applied to inputs of AND gate U3. Provided all of the inputs are HIGH, the output of U3-8 will also be HIGH and this will allow normal Transmitter operation. If a Cable Interlock - L is generated on any of the Modulation Encoder Boards or the Driver Encoder Board, the output of U3-8, will go LOW and the Controller will shut the Transmitter OFF.

P.4.2 Control Multimeter

Switch S1, along with U1 and U2, allows metering of 3 positive and 3 negative voltages on the Control Multimeter using only 3 of the meter positions.

With S1 relaxed, monitoring of the +18, +7.5 and B+ voltages is accomplished by moving the Control Multimeter switch to the respective positions.

With S1 depressed, monitoring of the -18, -12 and B-voltages is accomplished using the same three respective positions on the Control Multimeter.

P.4.3 Power Supply Interconnect

All power supply voltages from the Power Distribution Board pass through the Extended Transmitter Interface at J8 and J9, and on to the Controller where they are then distributed to the rest of the boards mounted on the door.

The Controller supplies +5 VDC at J1-23 to the +5VA circuits on the Extended Transmitter Interface. It can be measured at TP8. +5VDC from the Power Block Interface Board enters at J10-35 to supply the +5V circuits on this board. Both +5VDC inputs are diode “or’ed” together by CR7 and CR8 to supply the +5VB circuit and can be monitored at TP9.

The Power Block Interface supplies +15 VDC and -15 VDC for the Control Multimeter on the Transmitter Interface at J10-37 and 39. These voltages can be measured on TP12 and TP13.

P.4.3.1 Battery Back-up

Battery holder for four AA batteries BT1 is mounted on the Extended Transmitter Interface for battery back-up and sent to the controller through J16-12 and to the Low Voltage Power Supply Supervisor circuit through J7-6. External Battery input available at J32-1.

Note

Do not install back-up batteries unless C46 and C47 on the controller are charged (+5B voltage at TP16 is greater than 4.5 Volts). Current drain from the batteries during charging of C46 and C47 will shorten battery life.

P.4.3.1.1 Replacing Batteries

Because of the very low current drain, the life of back-up batteries should approach the battery shelf life. It is recommended that batteries be replaced at least once every 6 months. This will ensure that they will operate properly should they be required.

WARNING: Disconnect primary power prior to servicing.

P.4.3.1.2 External Battery Input

Any +6VDC voltage source may be connected to J32-1 (+) and J32-2 (-) to be used as a battery backup.

Both the External Battery Input and the Internal Batteries are connected to the Controller at J16-12.

P.4.4 Arc Detector Circuits

Arc Detectors are placed in the rear of the PA compartments to detect arcs that may occur. When an arc would occur the detector output voltage entering the board at J30 and J31, will increase past the arc threshold set by R2 and R3. Comparator U9 output will go LOW, indicating an arc. This signal goes through J17-8 then to the Output Monitor to operate the Lower Arc Detector indicator.

P.4.5 Leak Detectors

The leak detectors used in the water cooled power blocks are self contained optical units. The output line is a TTL compatable signal. The leak detectors are located in key positions in the power block to detect the presence of coolant. The output of leak detector is normally high or 5V when no liquid is present. If liquid is detected, the output will go low. The leak detector inputs to the Extended Transmitter Interface board come in on J29 and go to a 74HC11 AND gate array. If all leak detectors are ok then the output will be high. In the presence of a leak if any detector goes low the output of the circuit will also go low to trigger an off command to the Transmitter and show a cooling fault.

For interlocking of the circuit, There are pulldown resistors on the input which will produce a fault output if J29 is removed.

P.4.6 Circuit Board Interfaces

The rest of the Extended Transmitter Interface Board is input and output connections between the circuit boards mounted on the back of the front door and other boards in the Transmitter.

P.5 Troubleshooting the Extended Transmitter Interface

P.5.1 Metering Amps

The samples +18VDC, -18VDC, +7.5VDC, -12VDC, B+ and B- for the Control Multimeter are generated on this board.

a. If any of these are lost, verify the presence of the voltage on U1 or U2.
b. If the voltage is present replace the U1 or U2 associated with that sample.
c. If not present refer to the overall wiring diagram to trace the missing voltage.

P.5.2 Cable Interlock

The Mod Encoder Interlocks are summed on this board at U3 and U6.

a. If a fault is suspected check U3-8.
b. If this is LOW check the input pins for a logic HIGH.
c. If all the pins are HIGH replace U3.
d. If any of these are LOW check the inputs to the associated gate for a logic HIGH.
e. If all the pins are HIGH, replace U3 or U6, the gate producing the logic LOW.
f. If any of the inputs are LOW refer to the Mod Encoder section to troubleshoot an interlock fault.

The rest of the board consists of pass through connections. Refer to the Extended Transmitter Interface Schematic to trace the signal through the Interface Board.

P.6 Removal and Replacement

Remove the cable connectors going to this board. Then remove the mounting screws to remove the board from the Transmitter. Reverse the above order when replacing the board. Note that the connectors are numbered and keyed to aid in making the connections. Note all jumper positions and verify the replacement board is properly jumpered.

P.7 Alignments

There are no alignments needed on this board; however, ensure that all plugs and jumpers are in the proper position.

R.1 Scope and Purpose

The purpose of this section is to identify the liquid cooling system used in the DX-200. The Transmitter has a single cooling system to cool the Power Supply and the RF modules in the Transmitter. The Transmitter and it's associated Rectifier Cabinet is in series with each other. One cooling system circulates coolant through the Transmitter and Rectifier Cabinets. Dow Chemicals Dowtherm SR-1 is recommended as the coolant in this system. Refer to Figures R-1 and R-2 for more information.

R.2 Function

The function of the liquid cooling system is to remove heat from the RF Amplifiers and the Power Supply rectifiers and dissipate it to the outside air.

R.3 Location

The overall cooling system is distributed about the transmitter, power supply, and the exterior heat exchanger.

The liquid is pumped from the exterior heat exchanger through the internal heat collector, power amplifier cabinets, and power supply in the Rectifier Cabinet.

R.4 System Description

R.4.1 Transmitter Layout

The overall transmitter layout is such that teh Transmitter uses 15 gpm (56.8 Lpm) of coolant from the coolant source This supply of coolant enters the top of theTransmitter through a 1.5 inch (3.8cm) pipe connection; the actual connection will be compatible with each installation. From this point it is routed through several heat collecting devices in a series/parallel path and exits the Transmitter.

R.4.2 Transmitter Cooling

The cooling system of the Transmitter consists of two heat "gathering" devices. This includes a residual internal heat collector and the RF AMP chiller plate interface.

R.4.3 Residual Heat

The Heat Exchanger Cabinet cooling system is design around the concept of a close-looped air recirculating system. Components not cooled directly by the water system will be cooled indirectly by the residual heat collector. Circulating air will be utilized to convectively cool all the non-water cooled components. Since the Transmitter is an air close-looped system, the circulating air will pass by these components, remove the heat, and pass through a radiator coil which serves as the residual heat collector. Components contributing to residual heat include: combiner pipe, output\matching coil, fan motors, and RF AMP chiller interface convective losses. The Heat Exchanger Cabinet coil receives the 15 gpm (56.8 Lpm) coolant supplied to the Transmitter. The heated air passing through the coil will then transfer the heat to the coolant. Therefore, returning the air to its internal equilibrium temperature and increasing the coolant temperature. Upon exiting the coil, the flow path is divided into parallel paths which services the RF AMP cooling system.

R.4.4 RF Amplifier Cooling

The 15 gpm (56.8 Lpm) of coolant supplied to the RF AMP cooling system is divided into two parallel paths. Each parallel path serves two Transmitter sections in a series route. The total flow rate for each path is equal to one-half the total input flow, 7.5 gpm (28.4 Lpm) respectively. Upon entering the single cabinet section the flow path is split into three parallel paths servicing one center chiller plate and two outer chiller plates. The center chiller receives three-fifths of the 7.5 gpm input, 4.5 gpm (17 Lpm), while the two outer plates share the remaining two-fifths, 1.5 gpm (5.7Lpm) each. Upon exiting the section's chiller parallel path the three flow paths are combined and routed in series to the next cabinet. The flow path for this section is identical to that of the previous. After each of the two paths exit the last power amplifier cabinet, the flow paths are combined to a single path, 15 gpm (56.8 Lpm), and exit the Transmitter.

The cooling scheme is setup such that the center chiller plate serves to cool one half of each RF AMP MODULE within each section. The outer plates are then used to remove the remaining RF AMP heat. Therefore, transferring the majority of all RF AMP heat directly to the chillers.

Chiller plates and heat generating devices on the RF AMP MODULES are interfaced through a mechanical contact. Conduction through the interface is the main method of heat transfer from each device to the chiller plates; however, a small amount of heat load is lost to convection via the recirculating air. The mechanical interface relies on two mechanisms which apply the required pressure that insures adequate contact for heat transfer. One being an interference fit between the interface and chiller plate and a spring that applies an outward force perpendicular to the chiller plates.

R.4.5 Rectifer Cabinet

The coolant that exits the Transmitter chiller plates then enters the Rectifier Cabinet where it is used to cool the SCR's of the Power Supply. Both sides of the SCR is chilled by the coolant, before it returns to the Heat Exchanger outside the building.

R.5 Transmitter Summary

Since this technique of cooling requires no plumbing to be directly mounted to the board, the modularity of the RF AMPs is maintained. Leaving the cooling system independent of all electronic devices. This eliminates the need for rigid mounting of components to any coolant carrying systems. The RF AMP modules can be removed the same as in air cooled designs. Additionally, the recirculating air system is set up such that the front doors can be opened while the transmitter is running.

The overall coolant heat rise varies with coolant mixture; however, the coolant temperature rise ranges from 13 to 15 C. With the RF AMP interface and chiller plate scheme demonstrating low thermal resistance, worst case condition would yield a maximum RF AMP transistor junction temperature rise 35 C above ambient air temperatures allowing the Transmitter to operate efficiently in its ambient specification.

R.5.1 Installation, Operation, and Maintenance

See the DX Transmitter Installation Drawings for Cooling System:

- Plumbing Installation
- Leak Tests
- Electrical Installation
- Cleaning
- Draining
- Flushing
- Coolant Filling and Compression
- Routine Operation and Maintenance

R.6 System Components Description

R.6.1 Transmitter

The DX Transmitter incorporates a two stage liquid cooling system. The stages included:

a. Directly cooling the RF AMPS via a thermal interface between the RF AMP and a liquid cooled plate.

b. Removing the residual heat of other components via a closed-loop recirculating air to liquid heat transfer system.

Utilizing this type of cooling network the heat is efficiently removed from the Transmitter and transported away from the transmitter operating environment.

Figure R-3 shows the coolant and recirculating airflow paths of the Transmitter cooling system. Coolant enters the Transmitter and is routed to the residual heat coil. Critical heat dissipating components not directly cooled by the liquid are cooled utilizing the residual coil. This is accomplished by circulating air through the cabinet in a closed-loop path. The air removes the heat from these components via forced convection. This heated air is then directed through the residual heat coil. The heating of the coil by the air transfers the heat from the air to the coolant, a process which is repeated continuously during operation.

Upon exiting the residual heat coil, the coolant path is divided into two parallel paths. These paths individually direct the coolant flow through a parallel and series network of liquid cooled plates. A thermal interface conducts the heat from the RF AMP heat generating devices, MOSFETs, to the liquid cooled plates.

Figure R-1 and R-4 shows the liquid cooled RF AMP Module, interface block and liquid cooled plate. Heat is conducted from the RF AMP MOSFETs to the liquid cooled plate utilizing the interface block. The transfer of heat between the two devices is purely by conduction. Close tolerances held on the RF AMP, interface block and liquid cooled plate maintain an adequate thermal contact. The wedge shaped geometry enables the module to be easily inserted and removed from the cooling network, see figure R-4. Therefore, maintaining system modularity.

Thermal contact between the interface block and liquid cooled plate is aided by a thermally conductive pad. This pad has been designed such that it compresses under pressure and expands when heat is applied. As the RF AMP dissipates heat, the pad expands between the two surfaces and removes air gaps which may be present in the interface, therefore optimizing the interface contact area and decreasing thermal resistance.

Figure R5 shows the spring device utilized on each RF AMP within the Transmitter. As outlined, the spring is mounted between the two interface blocks located outboard on the RF AMP. Once the RF AMP is inserted into the cooling network, a screw is inserted through the hole located in the center of the spring and threaded into a fixed rigid receptacle. As the screw is torqued, a constant even force is translated outward along the spring and perpendicular to each interface block. Because of the rigidness of the liquid cooled plates and closely held network tolerances, +/-0.005", sufficient pressure between the two mating surfaces is maintained for adequate thermal transfer over the junction. Additionally, the tightly held tolerances virtually eliminates flex and/or stress of the MOSFET leads.

R.6.2 Power Supply Rectifier

The rectifier=s cooling system consists of a series parallel network of liquid cooled SCRs and a liquid cooled choke. The SCRs are cooled using a clamping device which is factory set to the required compression. No adjustment to this device should be made unless service is required. The device compression should be set at 6000 pounds of force, which is equivalent to 365 inch pounds of torque (per bolt).

R.6.3 Heat Exchanger System - Major Components

R.6.3.1 Dry Cooler

The dry cooler is used to transfer the stored energy in the coolant to the ambient air via crossflow cooling. Each dry cooler is selected based on installation site requirements. Factors such as total system heat load, required flow rate and environmental conditions are used in determining the proper unit. These are equipped with fan and pump cycling control. Service access is located under the access panel at the plumbing input/output end of the dry cooler. Located under the access panel is the system schematic, wiring information and mounting instructions.

The dry cooler is equipped with two basic control systems; flow and temperature monitoring. The control system monitors system flow rate to determine if adequate flow is being supplied. Should low flow be detected, the unit identifies this as a malfunctioning pump and switches the system over to the stand-by pump; if standby pump option is available.

The second control cycles the dry cooler fans based on input coolant temperatures. At 68^{o}F one of the two fans will be in operation and at 80^{o}F both fans will be in operation. Fan cycling temperatures can be set by opening the access panel located at the coolant input/output end of the dry cooler. Fan cycle temperatures should be set on site. Thermostat controls are located under the dry cooler access panel. The thermostat can be set by turning the indicator dial on the front to the desired temperature setting in degrees Fahrenheit.

R.6.3.2 System Pumps

The pump module follows an integrated cabinet physical format where in all of its components are located within or attached externally to the cabinet structure. In typical installations a standard 5 horsepower high head pump will be used as the main system pump. In dual pump systems a second pump is supplied as a standby in the event of main pump failure. The dry cooler control provides the logic to activate the standby pump when there is a loss of flow through the system.

R.6.3.3 Compression Tank

The compression tank=s main purpose of the cooling system is to maintain a constant system line pressure between 12 to 18 psig (Pounds per Square Inch Gauge or measure of pressure within the pipe at the point of measurement). This pressure level is measured by the pressure gauge located in the Integrated Pump Module. An indication of less than 12 psig indicates that more coolant is required in the system. A high reading above 18 psig indicates that the system has been over filled and pressurized. Higher pressures, up to 25 psig, can be used during early process testing for leak detection, if desired.

R.6.3.4 Transfer Pump

The integral transfer pump is an option which can be supplied as part of the pump module package. The transfer pump is a convenient way to fill and charge the system. The transfer pump is controlled via a switch located next to the system flow monitor.

R.6.3.5 Air Separator

The air separator provides effective separation of free air from the system fluid. The air separator causes turbulence in the flow path which causes this air to be released. The lighter air, as a result of buoyancy, rises up through the top of the air separator and follows the path upward to the compression tank.

R.6.3.6 Filtration Unit

The filtration unit utilized in the high power water cooled DX transmitter system is designed for operation with both pure water systems (distilled or reverse osmosis) and aqueous ethylene glycol solutions. Final fill water or coolant mixture must measure 50kOhms/cm or more. In addition, the ethylene-glycol must be an iron and chloride free grade; available through Walter Lewis Fluid Technologies, or confirmed equivalent product from another supplier.

R.6.3.7 Set Up

The filtration system is set-up as a side stream parallel path with the main plumbing system. It is installed across the input and output of the pump module. This will allow the filtration unit to utilize the greatest pressure differential in the system and keep the unit from being exposed to the hot side of the cooling loop.

Flow rate through the filtration unit is limited to 1 gallon per minute. Control and monitoring of the flow through the unit is located below the filter unit.

R.6.3.8 Transmitter Drainage System

Assuming a gravity type drainage system, the drain pipes leaving the PAC and Rectifier Cabinet must connect with a common drain pipe that is at an elevation lower than the Power Block. This common pipe should gradually slope to a lower elevation than the start point. Drain pipes from the Cabinets can be Tee=d into this common run-off pipe, but the gradual slope to a lower elevation must be continually adhered to until reaching the discharge point.

The remainder of the drainage system from this point will vary significantly from site to site.

R.6.4 Cooling System Controls

R.6.4.1 Transmitter & Power Supply Rectifier Cabinet

The Transmitter and power supply rectifier cabinet are each equipped with leak detectors and a flow switch. In the event that a coolant leak occurs or flow is decreased the system will automatically shut down the associated outdoor heat exchanger system.

Additionally, the Transmitter is equipped with airflow monitoring. The recirculating airflow within the Transmitter is monitored on a continuous basis. Should a decrease in airflow be detected as a result of a fan failure or a rear door not replaced, the system will fold back power until the problem has been corrected.

R.6.4.2 Dry Cooler Control Systems

The heat exchanger is equipped with two basic control systems; flow and temperature monitoring. The control system monitors system flow rate to determine if adequate flow is being supplied. Should low flow be detected, the unit identifies this as a malfunctioning pump and switches the system over to the stand-by pump.

The second control cycles the heat exchanger fans based on input coolant temperatures. At 68^{o}F one of the two fans will be in operation and at 80^{o}F both fans will be in operation. Fan cycling temperatures can be set by opening the access panel located at the coolant input/output end of the heat exchanger. Fan cycle temperatures should be set on site. Thermostat controls are located under the heat exchanger access panel. The thermostat can be set by turning the indicator dial on the front to the desired temperature setting in degrees Fahrenheit.

R.6.4.3 Cooling System Relay

The user installed solid state relay K1 574-0436-000 switches the 24 volts AC needed for the Heat Exchanger control to turn on the Heat Exchanger. See drawing 843-5523-651 and 843-5547-102 page 9.

When a leak is detected in the Transmitter K1 is de-energized turning the Heat Exchanger OFF.

R.7 System Plumbing Installation

Good plumbing equipment installation practice is required to ensure system integrity. Appropriately measured, cut, deburred, supported and soldered copper pipe sections, facilitate mechanical integrity of the coolant transportation system.

The Aglue@ that holds the system together is quality soldering. This process includes the need to condition all surfaces to be soldered by thorough cleaning with emery cloth or paper and an even application of flux, liquid flux being preferred. This applies to all common surfaces of plumbing fittings and straight pipe sections. Any improperly cleaned and poorly fluxed surfaces, either one or both, will not allow the solder to flow properly for continuous adherence of the solder to the two surfaces being soldered. After cleaning and fluxing, a continuous and evenly distributed application of heat will result in an evenly distributed flow of solder between the surfaces being soldered. Remember that solder flows from a colder surface to a hotter surface no matter the orientation of the surfaces being soldered.

Clean surfaces, evenly applied flux, sufficient heat without overheating, and evenly applied heat will result in the desired even flow and adherence of solder which produces a plumbed system that does not leak

NOTE

Keep in mind that an over application of solder can result in solder balls falling in to the associated piping with the possibility of plugged headers in the Transmitter resulting in water flow restriction and/or blockage. Also, an under application of solder can result in water leakage paths between the common surfaces of the fitting being soldered.

Propane or Mapp gas is the recommended fuel for soldering copper plumbing pieces. These gasses are available in small metallic bottles that mate directly to appropriate torches. Also, a ATurbo Torch@ or equivalent with appropriately sized regulator and hose combination can be used with larger gas tanks (large cooking stove tank). If these gas sources are not available, use of acetylene gas with an acetylene only torch is acceptable. In any event, only skilled plumbing and soldering practitioners, knowledgeable of the specific soldering equipment being used, should perform the required work.

NOTE

A soldering combination of silver bearing solder, i.e. Harris (not Harris Broadcast) Stay-Brite R (086-0004-038), and AStay Clean@ paste soldering and tinning flux (086-0026-000) or equivalent, is recommended. Also, pipe thread joints should be conditioned with Teflon tape (299-0018-000) and a thin film application of a smooth, non-hardening thread sealing, compound with integrated Teflon is recommended, i.e. AGasoila@ (690-0017-000), prior to mating any two threaded pieces together.

A final comment about the installation process centers around the need for the discipline of personnel in and around the cooling system installation area. Under no circumstances should anyone, cooling system installer and/or workers in other disciplines and areas, walk on pipes and fittings that have or have not been positioned and soldered. Although probably convenient for passage between adjacent work areas, walking on already soldered pipe can and historically has led to premature loss of solder joint integrity, among other self evident undesirable integrity results.

R.7.1 Initial Cooling System Leak Tests

These are the procedures to perform initial leak tests prior to any wiring and electrical system checkout.

R.7.1.1 Air Pressure Method

If a source of compressed air is available, initial testing for plumbing leaks can be accomplished by injecting air through the Shrader valve located near the return line coupling of the dry cooler.

a. Connect a hose to the dry cooler Shrader valve.
b. Open the compression tank line valve.
c. Close all System drain valves.
d. Open all other System gate valves.
e. Close any optional fill valves.
f. Close the vent valve located at the physical high point of the cooling distribution return and supply lines.
g. Activate the compressor to pressurize the system up to a stabilized 20 psig, as monitored on the Dry Cooler return line pressure gauge.
h. Once fully pressurized, the presence of leaks can be detected with a combination of audible air movement, and/or visible air bubbles through the application of a soapy solution to all plumbing joints in the system.

This approach is a good starting point if compressed air is available. However, the following Water Pressure Method is a more thorough evaluation of plumbing integrity, and is recommended whether or not the Air Pressure Method is used.

R.7.1.2 Water Pressure Method

When initially inputting water for coolant leak checking purposes, the external charging pump or optional transfer pump, referred to in ASystem Cleaning, Flushing, Final Charge@ section, must be used. It is recommended, however, that a complete system leak check procedure be completed and satisfied prior to turning on any of the normal system pumps.

a. After cooling system has been plumbed, connect the output of a suitable water source to:
   1. The suction port of an external pump; then the external pump=s discharge port to the boiler drain valve located on the bottom of the cooling system air separator.

   Or

   2. The optionally supplied fill pump input line.

   The charging system described in section R.8 can serve as the fill system required here. This will act as a Athrottle@ valve and be used to control the flow of leak test water. Normal tap water is suggested for use when charging the system for this testing.

b. Close all in-line gate valves in the system supply and return lines.

c. Open the globe flow regulator valve in the rectifier cabinet return line.

d. Close the compression tank line valve.

e. Close all Transmitter and rectifier cabinet drain valves.

f. Open the Transmitter supply line vent valve.

g. Fill the system via the pump, or otherwise pressurized water supply through the boiler valve mentioned in step (a.), throttling of the flow may be accomplished by adjusting this boiler valve. Avoid applying an excessive amount of pressure during filling. Typically the fill pressure should be in the range of 12 to 25 psig. The pressure may be monitored using the gauge attached to the Dry Cooler outlet discharge port.

h. Fill the system stage by stage, checking for leaks in the just-filled stage before opening the next set of in-line gate valves; continuing the process in the following stages.

   1. Cooling system pad equipment
   2. Major portion of main trunk supply and return lines
   3. Transmitter group branch supply plumbing
   4. Transmitter group internal plumbing
   5. Transmitter drainage plumbing

   Upon the establishment of a steady (no air bursts) volume of water through the supply line vent valve, that stage or multiple stages is sufficiently filled.

i. Open the compression line tank valve and charge the compression tank plumbing system.

   If leaks have developed in a given stage, effect repairs at that point before continuing the process. Depending upon the given leak=s personality, some water may have to be drained from the system before making repairs.

NOTE

Remember that this process is for initial leak detection only, and is a limited dynamic test.

R.7.2 System Electronics/Electrical Installation

Wiring details are noted on drawings specific to the given installation. The conduit to be used varies in type and configuration from job to job. Refer to the Block and Cable, Cable Running List, and Installation wiring drawings/schematics for site specific details.

NOTE

All three of these drawings are not always provided. Also, for dry cooler wiring details, refer to the dry cooler diagram located inside of the hinged cover of the dry cooler control panel, as well as the more easily followed drawing in the Installation Drawing package.

NOTE

For acceptable dry cooler control circuitry operation, the control circuitry transformer primary winding must be tapped to the voltage value closest to the nominal three phase input voltage being applied. Three primary winding tap values are provided for this purpose.

To make the electrical check-out a bit easier, when wiring the individual pumps, connect the voltage configuration wires and three phase input wires in the termination housing for both pumps exactly the same way. The pump internal wiring configuration is found on a specification plate mounted on the housing of each pump.

After the cooling system has been plumbed and all wiring is completed, the following outside cooling system pad items must be checked for appropriate operation.

a. Fan Shaft Rotation - Energize the dry cooler unit by momentarily turning on the safety disconnect switch. The fans will begin to rotate. A clockwise rotation of the fan blades is required. This motion draws the air from underneath the cooling coils exhausting that air from the top of the dry cooler.

   If the rotation is incorrect, with the safety disconnect switch in the off position, reverse two wires of the three phase input in the safety disconnect switch. Re-energize the dry cooler unit to verify accuracy in fan blade rotation.

b. Pump Shaft Rotation - Located on a printed circuit board, located in the upper left hand corner of the dry cooler control panel, is a flow turbulence time delay relay circuit. Rotate the potentiometer, mounted on the front of that PCB board, all the way counterclockwise. Remove the cover from the pump module.

   There are two pumps in a pump housing but only one is operational at any one time. Which pump is operating is identified by observing the position of the pump selector toggle switch located on a housing located in the upper left hand corner of the dry cooler control panel.

   Following the momentary energizing procedure, as followed in the fan rotation check step, note the pump shaft rotation direction of the operating pump. The pump must rotate in the direction indicated by the arrow molded into the pump housing. This can be determined as the shaft rotation slows down to a stop after allowing momentary operation by temporarily positioning the safety disconnect switch in the on position.

   If the rotation direction is incorrect, with the safety disconnect switch in the off position, reverse two wires of the three phase input at the appropriate pump wiring terminal block labeled pump one or pump two located behind the dry cooler control panel hinged cover in a left of center position. After reversing the two phase wires, re-energize the dry cooler unit momentarily to verify the correct shaft rotation direction.

c. Shaft Operation of Alternate Pump - With the dry cooler unit de-energized, switch the pump selector switch mentioned previously to the position opposite that used for the pump shaft rotation check just completed, follow the procedure (b) that immediately precedes this paragraph; the procedure used for checking the first pump in this two pump sequence.

If the same pump runs as when the pump selector switch was in the initial position, the associated coolant turbulence time delay relay may be set for too short of a time forcing the default pump to become active. After correcting this timing condition, if it was found to exist, complete the pump shaft rotation check for the alternate pump.

Upon completion of pump rotational integrity, restore the pump module cover to its normal position.

d. Located on the lower left side of the dry cooler control panel are two temperature thermostats, called Aquastats, AQ1 on the left and AQ2 on the right respectively, that control the operation of the dry cooler cooling fans. Adjust the trip setting of AQ1 for 68 degrees F (20 degrees C) and AQ2 for 80 degrees F (26.7 degrees C).

   In addition, the return line temperature sensor/controller housing (not supplied installed in the dry cooler) is placed per field determination, and may have been installed on the left inside side panel of the dry cooler adjacent to the AQ1 and AQ2. Wherever installed, its sensing bulb must be strapped to the return line and the controller set point adjusted to 147 degrees F (63.9 degrees C).

R.8 Heat Exchanger System Cleaning, Start-Up and Maintenance

The method for filling the system during initial cleaning and final charge are the same. It is necessary to clean the system for several hours, generally 5 or so hours overall, prior to filling the system with the final coolant solution. This cleaning (purge/flush) process will remove all foreign material which may have been introduced during assembly; i.e.. dirt, grease, flux, and other foreign matter. Tri -Sodium Phosphate (TSP) is the recommended cleaning product, although other equivalent commercial cleaning agents can be substituted in the initial cleaning procedure.

The TSP is to be mixed in the makeup water tank in the nominal quantity of 1% by volume amount (which for example is 50 Lb. of TSP for a tank volume of 600 gallons). TSP is used only in the initial cooling system cleaning procedure (one 600 gallon tank).

NOTE

Purging/flushing water electrical resistivity should be at least 50kOhm-cm at a temperature of 251C.

NOTE

It is imperative that the source water holding tank be clean. The charging system must not add impurities to the water. The quality of the water flowing through the coolant charge port of the cooling system, normally the discharge port of the air separator, should be the same quality as that measured at the output of the source water holding tank.

NOTE

A coolant charging system should include a transfer pump or other adequately sized fill pump (1HP capacity recommended), a holding tank (300 gallon capacity recommended), and an adequate length of hose and supply of plumbing and hose fittings.

NOTE

Whenever drawing solution from the holding tank, there must be a tank port open to air. Failure to open a port to air will result in the collapse of the tank sidewalls due to the resultant vacuum being drawn inside the tank when water is being discharged.

R.8.1 Initial System Cleaning

NOTE

Sidestream filter cartridges are not installed in the cartridge holders during shipping. Furthermore, the filter cartridges are not to be installed in the filtration unit canisters during the total cooling system cleaning process. Filtration system input and output valves are to remain open throughout all of the cleaning process, however.

Reverse Osmosis Water Processing -

If a Reverse Osmosis (RO) water processing unit was supplied, please note the following set-up and operational criteria. The use of RO processed water is a critical component of the transmitter system start-up preparation process. The output water quality of the RO unit is subject to the following:

a. RO Pump Pressure Setting - If the pressure setting is too low the water quality will suffer. If that pressure is set too high the pump seals will start leaking necessitating seal replacement; although the RO unit documentation indicates a set point of 200psig, a set point of 175psig is a refined recommendation referenced to historical field practice.

b. Reject (Waste Concentrate) Water Flow Rate - This adjustment is a function of the interrelated adjustments of product water and reject water flow rates which must be measured and adjusted correctly. For making these measurements two equal volume bottles will be needed to collect the water samples, i.e., one liter or one quart bottles. Energize the RO system and simultaneously fill one of the bottles with reject water and the other bottle with product water. Be careful to measure the reject flow at the end of the RO unit small diameter reject flow tube, otherwise the measurement will be invalid. Use the formulas provided in the RO unit technical manual for determining the calculated value. As a rough guide there should be equal amounts of product water and reject water once the working high pressure has been set.

c. Raw Water Quality - Although all three of these criteria are important, the raw water resistivity/conductivity is the most important. If this measured resistivity number is very much below 10kohm/cubic cm, it is unlikely that the resultant product water will be of sufficient quality to be used directly as the cooling system solution either as the total coolant solution end product or in a mixed environment of RO product water and ethylene-glycol end product. In this case, at least two passes of the water will have to occur (1st pass of raw water and 2nd pass of the just processed 1st pass water) which double pass procedure most often times results in very acceptable water quality, most often times approaching 1megOhm/cubic centimeter resistivity (1microSiemen conductivity). Progressively the farther the quality of the water is below 10kOhm/cubic cm, progressively the number of needed passes of the previously processed water through the RO system rises. If, the raw water is severely contaminated, extremely low resistivity values (nominally less than 1kOhm/cubic centimeter) numerous iterative passes of the water will be required to reach an acceptable resistivity/conductivity value.

If an RO unit was supplied, a Digital Conductivity Meter was also supplied to facilitate water quality evaluation. Please note that up to two newly cleaned liquid sample collection containers will also be needed; two containers when adjusting the RO unit reject flow rate, one container when measuring resistivity/conductivity. If needing more equipment specific information, refer to the RO unit and/or conductivity meter technical manuals.

R.8.1.1 Integrated Pump Module

Using a mixture of distilled or reverse osmosis water and a cleaning solution noted in the previous paragraph, proceed with the following steps:

a. Connect a hose to the fill port of the pump module, if fill system is not hard plumbed.
b. Close the tank line valve.
c. Open all other system gate valves.
d. Open the two fill valves located on the pump module. DO NOT OPEN THE DRAIN VALVE OR CHARGE VALVE.
e. Open vent valves at Transmitter. Liquid will be expelled from these points, a bucket to catch spillage and a short length of hose no longer than 1 foot will be required.
f. Fill the system via the integral fill pump. With all the valves listed above fully open, turn on the fill pump switch. Avoid applying an excessive amount of pressure during filling. This can cause the air and liquid to mix which will be time consuming and difficult to remove. Typically the internal fill pressure should be in the range of 12 to 25 psig.
g. Continue filling the system until a steady stream of water is flowing from the vent(s) in step (e).
h. Stop filling, close vent and fill valves.
i. Energize the system pumps for 30 seconds to 1 minute.
j. Repeat steps (e) through (i) until no air is expelled from the vents.
k. With the main system filled, open the bleeder valve at the bottom of the compression tank, and the tank line valve.
l. Continue to fill the system until a stream of water flows from the tank bleeder valve.

CAUTION

Do Not over fill the tank. Initially air and water will be expelled from the bleeder. Once a steady stream starts to flow from the bleeder cease filling and close bleeder.

m. In order for the system to function properly, positive pressure must be present at the pump inlet. The pressure gauge located next to the fill pump switch will give this indication. The pressure reading should be 12 to 25 psig (pound-force per square inch gauge is a unit of pressure relative to the surrounding atmosphere). If the pressure reading is lower than this, increase the system charge by adding more cleaning solution through the fill port as done previously. If the gauge reading exceeds these limits, open the tank bleeder valve to relieve the excess pressure.
n. Once the desired pressure has been achieved close both fill valves. This desired pressure is to be present with the Transmitter flow meter indicating 16 gallons per minute (GPM) by adjusting the associated rate setting globe valve accordingly and corresponding gate valve set fully open. Additionally the side stream filter network flow rate is to be 1 GPM by adjusting its input valve accordingly with its output valve set fully open.
o. Run the system for 3 hours with the cleaning solution. Check the pressure gauge hourly to ensure positive pressure is maintained.
p. Drain system of cleaning solution.

R.8.2 Compression Tank Subsystem Cleaning

Part of Initial Cooling System Cleaning Process.

Compression Tank -After the initial draining of the com-plete cooling system but prior to otherwise initiating the first of the iterative purging cycles, proceed as follows:

a. Close off the compression tank isolation valve and open the compression tank valve; this action making sure that the compression tank is completely drained.
b. Close the compression tank isolation valve and apply water pressure/volume to the compression tank by way of the open compression tank drain valve filling the compression tank while viewing the site glass.
c. Drain and fill the tank several times in this manner until the water viewed in the site glass is clear.
d. With a container positioned below the area of the pump module air separator drain plug, remove the drain plug allowing the residual liquid and any associated particulate matter in the bottom of the air separator to drain.
e. Once this residual solution is gravity released, open the compression tank isolation valve and apply water pressure/volume to the air separator, by way of the open compression tank drain valve, allowing the piping to the air separator and the air separator itself to be flushed thoroughly; liquid cleanliness to be determined viewing the liquid draining from the air separator into the previously mentioned drain container, which when clear marks the end of the process.

NOTE

It is preferable to use reverse osmosis processed water for the cleaning of the compression tank, air separator, and associated piping. As an alternative, raw intake water can be used for most of the cleaning until a clear liquid condition results. This, how-

ever, must be followed by a couple of complete flushes using reverse osmosis processed water.

f. Restore the above plumbing system to that of normal operation.

R.8.3 System Draining

a. Open drain valves (2) located on the pump module.

b. Open vent valve mentioned in step (e) of R.8.1.1 above.

c. Drain the system via the drain port which is controlled by the drain valve located on the pump module.

d. Open tank bleeder valve.

e. Transmitter and rectifier cabinet can be drained though their individual drain valves. The Transmmiter drains are located under the access panel inside the rear plenum cabinet. Drain valves are located in the front bays. One in each of the two center bays on the floor and a third in the upper right hand cabinet above the driver section. The valves are open when the handle is oriented parallel with the pipe line.

f. To assist in draining the Transmitter, the vent plug at the top of the heat coil in the top of the Transmitter can be removed. Only remove this plug after the external plumbing network has been drained and water has ceased to drain from the Transmitter. It is recommended that two wrenches are used to remove this plug to avoid damaging the heat coil. Compressed air may also be used to pressurize the Transmitter plumbing to aid in draining the system. No more than 30 psig should be used.

g. The rectifier drain is located either in the front or rear of the cabinet, depending on installation. The control valve is located through the front above the transformer.

h. Once draining is complete close all cabinet drain valves; rotating the valve handles perpendicular to the plumbing. Also close any vent valves opened during the draining process.

i. To facilitate a more complete draining of the system, the following actions should be performed:

1. Depressurize the compression tank by tripping the relief valve lever and leaving it open until the tank drains completely. After the tank has drained completely, reposition the safety lever for normal operation.
2. After drainage has diminished to a trickle from the pump module supply line drain valve, located near the pump module discharge port, energize the pump module momentarily allowing the flow through the supply line drain valve to drop to essentially zero before reenergizing the pump module. Exercise the pump module two or three times in this manner until energizing the pump no longer increases drainage flow.

R.8.4 Iterative Fill, Flush/Purge, Drain Cleaning Processes

In preparation for implementing a final coolant charge process either before initial operation of the transmitter or after the transmitter has been in operation for some time, the cooling system must be purged of most of the cleaning solution residue left following either the (1) completion of the cooling system installation process or (2) draining of the coolant following operation of the cooling system for some time. For this purging/flushing process to be effective, the process must be followed methodically and meticulously with no shortcuts. All purging/flushing should be accomplished using reverse osmosis processed quality water (distilled water being acceptable if sufficient volume is available). The use of deionized water is not recommended for purging or operational use in this system. The purging/flushing process is to be accomplished by alternately charging, circulating, and draining the system numerous times, the number of purging/circulating/flushing cycles needed being determined by the measured water resistivity/conductivity after each circulation period but prior to draining the cooling system after each circulation cycle.

NOTE

If this iterative process is not allowed to mature to the point of the water quality plateauing at or near the desired optimum, then during the first year or so there will be several otherwise unnecessary changes of coolant required and particulate filter changes required until the optimum resistivity value for the system is reached. Therefore, please be advised that the optimum coolant resistivity point will eventually be reached, either (1) prior to beginning transmitter on-air operation or (2) following the commencement of regular on-air transmission with the aggravation of off-air time being experienced several times thereafter until the optimum resistivity operating value is finally reached and the attendant several otherwise unnecessary changes of coolant filters having occurred.

Given that this coolant replacement process is taking place in an environment already flushed for a newly installed cooling system, the number of flushing cycles may be less than that normally required for a newly installed system. Harris recommends, however, that the cooling system be flushed with reverse osmosis equivalent quality water sufficiently to achieve at least a minimum of 50kOhm per cubic centimeter (50kOhm/cc) prior to creating the final cooling solution mixture and subsequently charging the system with that solution. For emphasis, please be aware that this suggested 50kOhm/cc value is definitely a minimum figure.

After each purging/flushing cycle check the conductivity/resistivity value for the system by use of the Omega Digital Conductance, Temperature and pH Tester No. PHH-10, or equivalent water conductivity/resistivity tester. The Omega instrument is standard provision with the cooling system package. Take a water sample from any convenient point in the closed circulating system. Generally, the conductivity leaving the distilled or reverse osmosis processed water source tank will be 75kOhms/cc or higher. A small residue of the TSP cleaning agent left in the circulating system is acceptable, but that amount should be no more than what would result in conductivity readings as noted here. The minimum in-system starting circulating coolant conductivity should be at least 50kOhms/cc, with greater than 60kOhms/cc being preferred. In any event, the higher the resistivity magnitude the better, and if the quality of the water presently in the system is lower than 50kOhms/cc (higher than 20microSiemens/cc), the purging operation should continue until that minimum value is attained. It is preferable, however, to continue the purging operation until a value of 60kOhm/cc (16.7 microSiemens/cc) is reached. Circulate each new coolant charge for two hours followed by the drain, recharge and measure resistivity/conductivity process until the required value is obtained. When the resistivity value levels off, when at or above 50kOhm/cc, the purging process has reached its optimum for the conditions of the system being worked. Remember, the higher the resistivity value reached the more effective the coolant system and the longer the time period will be between coolant solution changes.

NOTE

The lower the conductivity value reached when initially charging the system, the longer the duration of time before a coolant recharge will be required. After having purged/flushed and finally charged a cooling system with satisfactory results, if the coolant conductivity falls below 20kOhms/cc (rises above 50microSiemens/cc), the coolant should be drained and renewed.

Once the acceptable nominal resistivity/conductivity value has been reached, de-energize the water source system and the Cooling System. Then drain the system as described in the ASystem Draining@ section for the final time and prepare to work through the next sub section AParticulate Matter Considerations -Rectifier Choke@.

R.8.5 Particulate Matter Consideration -Rectifier Choke

Historical data has suggested that, other than the presence of cooling system piping installation process particulate matter, a particulate residue presence can remain if the 250VDC rectifier choke is not addressed specifically and separately at some point in the purging process . The rectifier choke must be disconnected from the system and pressure cleaned. Proceed as follows:

As a part of this purging process and after several flushes, remove the input and output plumbing hose connections from the liquid cooled choke in the rectifier cabinet. This removes the otherwise normally plumbed SCR=s from across the choke. Temporarily place a drain hose to the output side of the choke and force compressed air through the choke, which action will break loose and remove most of any buildup of particulate matter from the cooling path within of the choke. Then, prior to restoring the choke to the normally plumbed condition, flush a sufficient volume of properly conditioned water through the choke to optimize the choke cleansing process. Following this individual cleaning process, reconnect the rectifier choke plumbing and insert the organic and deionizing filter cartridges into their sidestream network canisters using the procedure described in ASidestream Filters Initial Installation@.

R.8.6 Sidestream Filters Initial Installation

Filters are not installed in the cartridge holders during shipping. Therefore, the following procedure is to be followed after cooling system installation and final purging/flushing cycle have occurred.

a. Close inlet and outlet valves.

NOTE

The B-Pure Pressure Cartridge System Assembly is made up of a head component, handle/ring component and a housing cannister/holder component. The following directions are for both assemblies.

b. If system uses the B-pure plastic holder, depress pressure relief button located on top of each holder.

c. Remove the canister/holder from the head by depressing the thumb lever and rotating the handle/ring 3 turn.

d. Inspect O-ring seal. If worn or torn replace.

e. Remove new cartridge from bag.

f. Install new cartridge with its small opening towards the top of the canister and its large opening at the bottom of the canister.

g. Install holder/handle subassembly into the head component. If utilizing the stainless steel housing, tighten wing nuts in a diagonal pattern to ensure even tension.

R.8.7 Filling System With Final Coolant

System coolant to be used is based on environmental conditions. Pure water or an aqueous ethylene glycol solution of up to a 55/45 mixture may be used. The mix ratio is determined per specific site. Once this ratio figure has been determined, it is not to be changed.

Filling of the coolant is done in the same manner discussed in the AInitial System Cleaning@ section.

It is important to note that the positive pressure must be maintained at the pump inlet. This may fluctuate initially, but will stabilize over time and remain constant. The positive pressure will be maintained whether the system is running or not. This pressure will only decrease as a result of a leak or the introduction of air into the system. An increase would only result if the system is initially overcharged.

If proper filling precautions are followed, only small amounts of air will be trapped and or mixed with coolant in the system. It is nearly impossible for all the air to be removed during filling; however precautions have been taken. Included in the system setup is an air separator which uses centrifugal force to remove the air from the coolant as it flows through the system. Typically, over a 30 day period all residual air should be removed and evacuated to the tank via the air separator.

R.8.7.1 Final Compression Tank Coolant Level

This adjustment procedure requires that the Airtrol fitting be closed off once the coolant draining through its bleeder valve has reached the steady stream (no air bursts present) condition.

a. Prior to beginning a coolant charge procedure, slightly open the Airtrol fitting bleeder valve. This will allow the monitoring of the amount of air resident in the compression tank as the charge process progresses to its desired level.

b. During the charging process, regularly monitor the Airtrol bleeder valve=s discharge composition. In the beginning there is only air in the tank so there will be a steady discharge of air coming from the tank at that time; this discharge passage being slightly audible. As the system receives more and more coolant charge, the compression tank begins to fill with coolant, still passing air through the bleeder valve in the process. As more coolant enters the tank, the discharge changes from air only to a mixture of coolant and air, and finally to a steady stream of coolant only.

c. At the point of the compression tank discharge flow becoming a steady stream of fluid, immediately stop the source coolant flow by turning-off the air separator drain valve, followed by closing off the compression tank exhaust flow by closing off the Airtrol fitting bleeder valve. At this point the system low side pressure, as noted earlier, is a value of somewhere between a nominal range of 12-25psig.

d. At this point the low side pressure value determined in step (c.) is to be adjusted to the recommended operating low side pressure of a nominal 18psig. To do this, open the dry cooler return line Shrader valve located in the return line adjacent to its entry into the dry cooler, until the HIGH COOLANT LEVEL light turns off, typically around 18 psig. The desired operating pressure is just less than at the point the HIGH COOLANT LEVEL light extinguishes.

R.8.8 Procedural Steps Summary For Cooling Renewal

In summary then, here are the basic steps for working through coolant initiation/replacement processes.

a. Turn-off the transmitter to which the work is being done.

b. By switch and/or circuit breaker, remove any AC power normally applied to an operating transmitter.

c. Drain the cooling system completely including all inside and outside system elements.

d. Remove the old sidestream filter cartridges and then reinstall the cartridge holder handle assembly (collar assembly) for each holder housing without inserting replacement filter cartridges at this time. The purg-ing/flushing steps will be accomplished with no cartridges located in the holder housing.

e. Clean the holding container/tank in which the reverse osmosis processed quality water will reside and later the coolant mixture will be prepared.

f. Fill the holding tank, noted in step (e), with reverse osmosis processed quality water.

g. Take a sample of the source purging/flushing water from the holding tank (the stainless steel tank) and measure the resistivity/conductivity of that water sample. The measured value of properly processed water is typically in the 70kOhm/cc to 80kOhms/cc range (a minimum value of 60kOhms/cc being preferred with a value of 70kOhms/cc being highly recommended and much preferred). If the measured value is less than 50kOhms/cc the water supply from which the sample was take should be discarded and replaced with appropriately processed water of an acceptable resistivity.

h. The purging/flushing process -The purging/flushing process is made up of steps (i-o) of this summary, the end result measured resistivity number to be as noted in the discussions of sub-Sections R.8.4 and R.10.2, no less than 50kOhm/cc for initial purging with using only reverse osmosis processed quality water as the circulating liquid. This will be a series of cycles, each cycle consisting of the following steps; (1) complete cooling system fill, (2) circulate for one hour minimum, (3) complete cooling system procedure drain procedure including all inside and outside system elements.

i. Begin the purge/flush process for the complete cooling system in a recirculatory (closed loop) manner.

j. After a couple of flushing cycles, using an air compressor blow air through the Transmitter rectifier choke for more effective removal of particulate matter within the choke.

k. Continue the purging/flushing sequences in the recirculatory mode until the measured resistivity/conductivity plateaus above the minimum 50kOhm/cc value.

l. The final one or two purge/flushing cycles should be non-recirculating. In other words, simply run the water through the system and drain simultaneously at a low point outside in the source line to the system attached to the dry cooler.

m. Drain the cooling system completely for the final time including all inside and outside system elements of the purging water.

n. On an individual basis drain the 250vdc filter choke in each rectifier cabinet followed by blowing air through the chokes individually using an air compressor.

o. Return the cooling system and valve positions to that ready for cooling system operation

p. Prepare the final coolant mixture ratio {50/50,55/45, other, 100/0 reverse osmosis (ro) processed water} in the container assigned {same container as referenced in step g of this summary}.

q. Install the replacement sidestream filter cartridges in their appropriate holder containers (one ea organic removal cartridge and one ea two bed filter cartridge per sidestream filter system) referenced in step (d).

r. Fill (charge) the transmitter cooling system with the solution prepared in step (p).

s. After circulating the coolant through the system for 15 minutes, measure the resistivity of the coolant. If ethylene-glycol,expect a measured minimum value in the area of 200kOhms/cc in Aethylene-glycol/ro water@ mixtures; 50kOhm/cc to 70kOhm/cc in 100% Reverse Osmosis or distilled processed water systems.

t. The cooling system is now ready for normal transmitter operation. Double check to see that the individual power block flow rates are 16 GPM and the sidestream filter flow rate is 1 GPM. Adjust if necessary.

R.9 System Maintenance - General

The closed loop cooling system requires very little maintenance. Since the system is closed to the environment no foreign material will be introduced into the coolant and there will be no loss of coolant through evaporation. Once the system is properly filled and charged, the system will remain in correct operating condition indefinitely with little maintenance. The following maintenance steps will ensure that the system operates at optimum performance.

a. Check the pressure gauge bi-monthly to ensure that positive system pressure is maintained. Positive pressure should be at a stable value in the range of 12 to 18 psig.

   1. If the gauge reads lower than 12 psig, inspect the system for leaks. If no leaks are present, charge the system with additional coolant.
   2. If the gauge reading is above 18 psig, relieve the pressure by opening the relief valve on the bottom of the compression tank. If too much pressure is relieved, it will be necessary to recharge the system.

b. Inspect the filtration loop. Check flow rate and resistivity indicator. Reference filtration unit operation for information.

c. Probably the single most important maintenance step: Inspect the bottom of the heat exchanger bi-monthly. Inspect the coil itself for any debris that may have become trapped on the coil face. This would block air flow and decrease cooling efficiency of the heat exchanger. Debris can be removed using a hose and pressurized water system. In dusty environments or areas where an abundance of vegetation is present this inspection will be required weekly.

d. As a general procedure, the entire system including Transmitter and rectifier cabinet should be inspected for leaks on a routine basis. And any indication of a potential leak noted and corrected. The Transmitter and rectifier cabinet are equipped to detect leaks in the overall system plumbing; however small leaks could evade detection.

   A system leak, in early stages, is detected by a slow, continuous drop in pressure, over a number of days or weeks depending upon the severity of the leak(s), as noted on the pressure gauge located in the supply line adjacent to the output port of the dry cooler.

   If a leak around a plumbed solder joint develops, the coolant should be drained, the leak point resoldered, and the system recharged.

   Repairs for a leak originating at a threaded joint may be initially attempted by tightening the affected joint without draining the system. If this tightening effort does not correct the problem, then the system must be drained, the problem area opened and replumbed as necessary, followed by a system recharge.

e. To achieve even usage time per unit and ascertain that back-up integrity exists, it is recommended that the pumps in the pump module are operated alternately one month at a time.

f. The compression tank pressure relief valve, located on top of the compression tank, should be exercised during each recharge of the system by manual tripping of the safety lever to assure that it is functioning properly.

g. On occasion, the compression tank level float switch may hang-up in the high position, giving then an erroneous indication when the coolant level is has not exceeded the high level threshold. If you question the high level indication, give the tank a solid whack or two with your hand near the float switch location. This action will release the float sensor from a stuck position if, in fact, the sensor was stuck.

h. Per the comment included in ASystem Plumbing Installation@ section, mandate a continual discipline of NOT allowing plumbing pipe, fittings, etc., to be walked on.

i. Backup Procedure - Check the resistivity of the coolant once per month with a conductivity or resistivity meter, i.e., OMEGA Digital Conductance, Temperature, and pH Tester, Model PHH-10, equivalent, or ohmmeter capable of 60k ohms by placing the test leads side by side, 1 centimeter apart, into the water sample. If the per cubic centimeter conductivity rises to 40microSiemens (drops below 25kOhms, then the coolant should be checked weekly until the value rises to 50microSiemens/cubic centimeter (drops to below 20kOhms per cubic cm).

   Upon reaching that point, change the deionizing filter (An organic cartridge change should be routinely done with every other deionizing cartridge change). If after a day or two of operation, the resistivity hasn=t improved, the coolant should be drained and the system cleaned and renewed.

R.9.1 Filter Installation and Replacement (On-Going Considerations)

The resistivity indicator lamp for the filtration system will turn on at a nominal value of 50kOhms/cc. If this occurs when the filtration system is first turned on or shortly thereafter, and all the system cleaning and flushing processes were followed completely, let the system continue to operate; eventually the system coolant quality will improve enough to extinguish the indicator lamp.

If, however, the transmitter has been operating normally for several months, in the event of a red light indication on the resistivity monitor, the filter cartridges will likely required being changed probably within 10 to 14 days of that indication or until the coolant resistivity falls to 20kOhms/cc. The resistivity indicator lamp illumination indicates that the organic filter and deionizing filter, will likely need to be changed for reasons of (1) sidestream loop pressure drop across the organic filter limiting coolant flow through that filter cartridge as well as (2) deionizing filter cartridge exhaustion (lowered ionic transfer facilitation by that cartridge). In any event the cooling system is not to be operated with a resistivity value of less than 20kOhms/cc. The organic cartridge change should be routinely accomplished with every deionizer cartridge change.

A required filter change will be indicated either by the aforementioned red light illumnination on the resistivity monitor and/or lessened or loss of flow through the filtration loop; indicated visually on the flow meter.

In the event of flow loss, check to ensure that the inlet and outlet valves are open. If the valves are open and no flow or a small rate is evident, a cartridge change is recommended. Under this situation the change may be only limited to an organic cartridge change. Change the organic cartridge per the outlined procedure. If flow problems still persist, it may be necessary to change the deionized cartridge as well and or inspect the filtration loop for clogging according to the following instructions.

a. Close inlet and outlet valves.

NOTE

The B-Pure Pressure Cartridge System Assembly is made up of a head component, handle/ring component and a housing cannister/holder component. The following directions are for both assemblies.

b. If system uses the B-pure plastic holder, depress pressure relief button located on top of each holder
c. Remove the canister/holder from the head by depressing the thumb lever and rotating the handle/ring 3 turn using an adequate container under the assembly to capture any coolant spillage.
d. Remove old filter cartridge and discard.
e. Inspect O-ring seal. If worn or torn replace.
f. Remove new cartridge from bag.
g. Install new cartridge with its small opening towards the top of the canister and its large opening at the bottom of the canister.
h. Install holder/handle subassembly into the head com-ponent.
i. If utilizing the stainless steel housing, tighten wing nuts in a diagonal pattern to ensure even tension. 10.Fully open outlet valve then open inlet valve slowly, allow canisters to fill.
j. Set inlet valve such that the flow meter reads approximately 1 GPM

NOTE

Additional Cooling System and Sidestream Filter Cartridges Processing Emphasis

After some considerable history logged at several sites, the following requirement has been created as an additional cooling system flushing action item. There have been several instances, through 2 and 3 generations, of premature sidestream filter cartridge clogging long before the expected long life characteristic of these filter cartridges becomes a reality. Inspection of several of the failed cartridges showed the presence of far more particulate material, including copper particle residue, than should be the case following the conducting of an appropriate overall flushing/purging process. Therefore, the two following action items are now deemed imperatives for completing the cooling system preparation processing prior to final charge of the system commences: (1) Before inputting any liquid into the cooling system and even before conducting the initial water based leak detection procedure, remove the sidestream filter system cartridges and leave them removed until the cooling system is ready to receive the final charge of coolant, whether the final charge coolant be in the form of properly processed water or a mixture of ethylene glycol and properly processed water (premixed solution or separately introduced solution. (2) Particular attention must be given to achieving the minimum 50kOhms/cc (higher than 20microSiemens/cc) starting point for initiating the final system charging process. Depending upon local conditions, this could require several more complete flush-ing cycles than the typical figure noted previously. Certainly, the achieving of a greater than 50kOhms/cc is encouraged, if possible, but a minimum figure of 50kOhms/cc will provide an acceptable particulate content for the experiencing of a useful life span for the sidestream filters. Time must be taken to complete the flushing/purging process as described herein, no matter the pressure(s) of other time constraints that may be in play. Otherwise premature replacement of sidestream filter cartridges and possibly other undesired cooling system artifacts may be experienced as a result of not meeting this flushing/purging process in total.

R.9.2 Coolant Testing

R.9.2.1 Glycol System

The system must be analyzed for ethylene-glycol concentration, annually. Analysis can be provided by the ethylene-glycol manufacturer. Alternately, procure a conductivity or resistivity meter, i.e., OMEGA Digital Conductance, Temperature, and pH Tester, Model PHH10, equivalent, and check the coolant quality monthly.

R.10 System Specifications

R.10.1 Operating Environment

Ambient air temperatures near the heat exchanger dry coolers should not rise above 45^{o}C (50^{o}C on special order basis) for typical installations; or higher if so specified. The heat exchangers should be located such that there is a 3 foot unobstructed perimeter around all sides. The heat exchanger coils should be free of debris and inspected bi-monthly.

R.10.2 Coolant Specification

The following section outlines the quality of the coolant used in the closed loop cooling system for the high power water cooled DX transmitter.

R.10.2.1 Processed Water Quality

Processed water electrical resistivity should be at least a minimum of 50 kOhm/cm3 (preferred higher) following a fresh system charge and purge operation. The coolant, provided by a properly operating reverse osmosis water purification system (Culligan B3L, BP Plus or equivalent), is acceptable as a source of make up water for charging a system. This is true whether the make up water is a coolant mixture of water and glycol, or 100% pure water.

R.10.2.2 Water Only System

Pure water to be used in the cooling system should be distilled or reverse osmosis processed. In a pure water cooling system the water quality must be high; free from solids and living organisms. The water must be low in chloride and sulfate ions; less than 100ppm each being required, and 25ppm being recommended. The use of reverse osmosis or distilled processed water meets these requirements if storage of the processed water product does not introduce foreign elements.

R.10.2.3 Ethylene-Glycol/Water Mixture System

For the ethylene-glycol component of the glycol/water mixture, iron and chloride-free ethylene-glycol Harris part number 051-1010-024 for 100% concentrate solution -WLFT-HP (supplied in 55 gallon drums) or confirmed equivalent is to be used. For the processed water component, the levels of chloride and sulfates should be lower than 25ppm each and the total hardness (ACa@ and AMg@) should not exceed 100 ppm which criteria are met when using the Walter Lewis ethylene-glycol products noted in this section.

NOTE

The starting point resistivity of a freshly charged cooling system with 50/50 ratio coolant typically is as high as a nominal 200kOhms/cc

If coolant of this quality is unavailable, the ethylene-glycol manufacturer (WALTER LEWIS FLUID TECHNOLOGIES) can supply pre-diluted solutions of iron and chloride free grade ethylene-glycol which meets or exceeds the required resistivity. The Harris part numbers being 051-1010-026 for the 50/50 mix ratio - WLFT HP-50 and 051-1010-025 for the 55/45 mix ratio -WLFT HP-55; both supplied in 55 gallon drums.

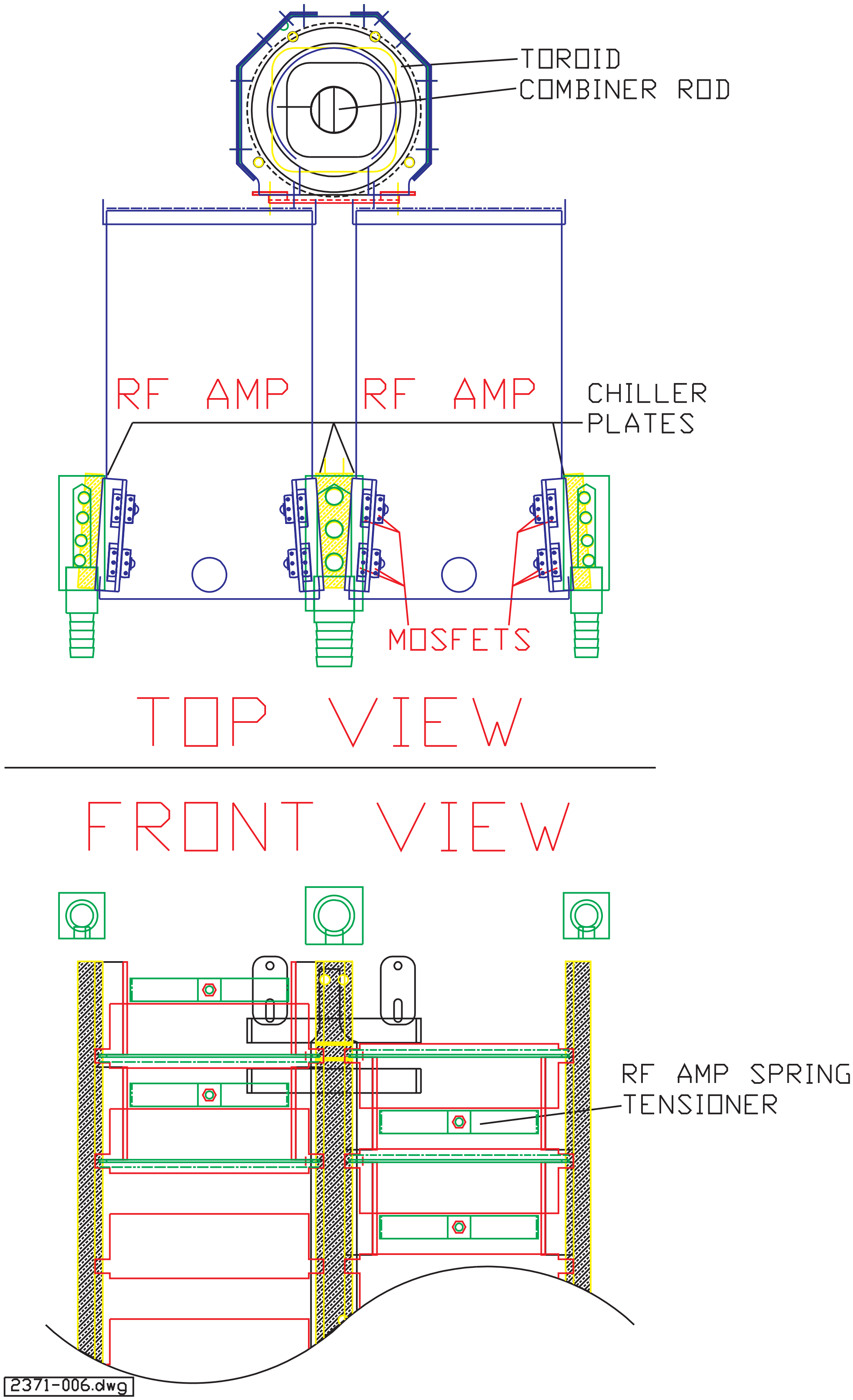
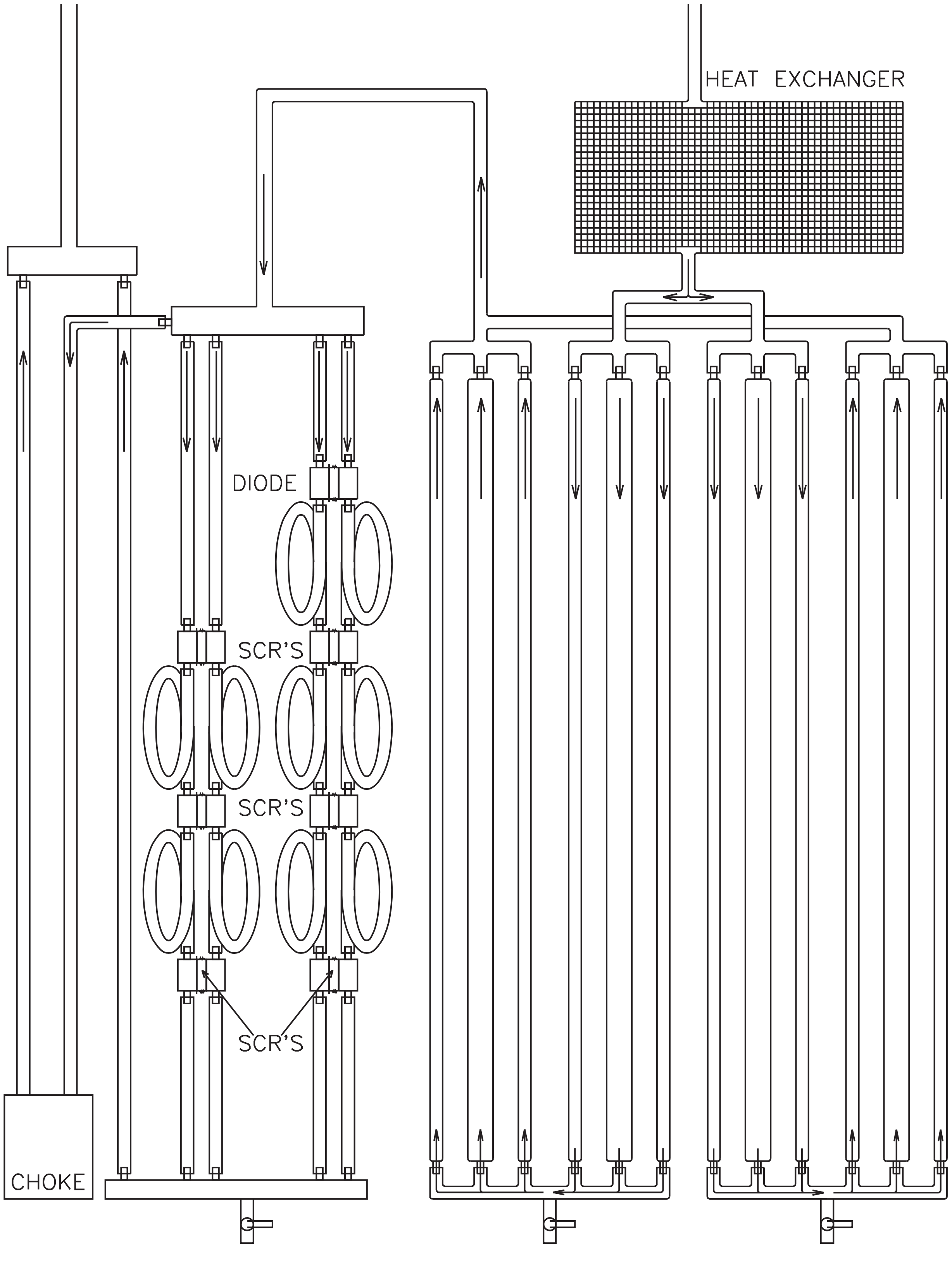
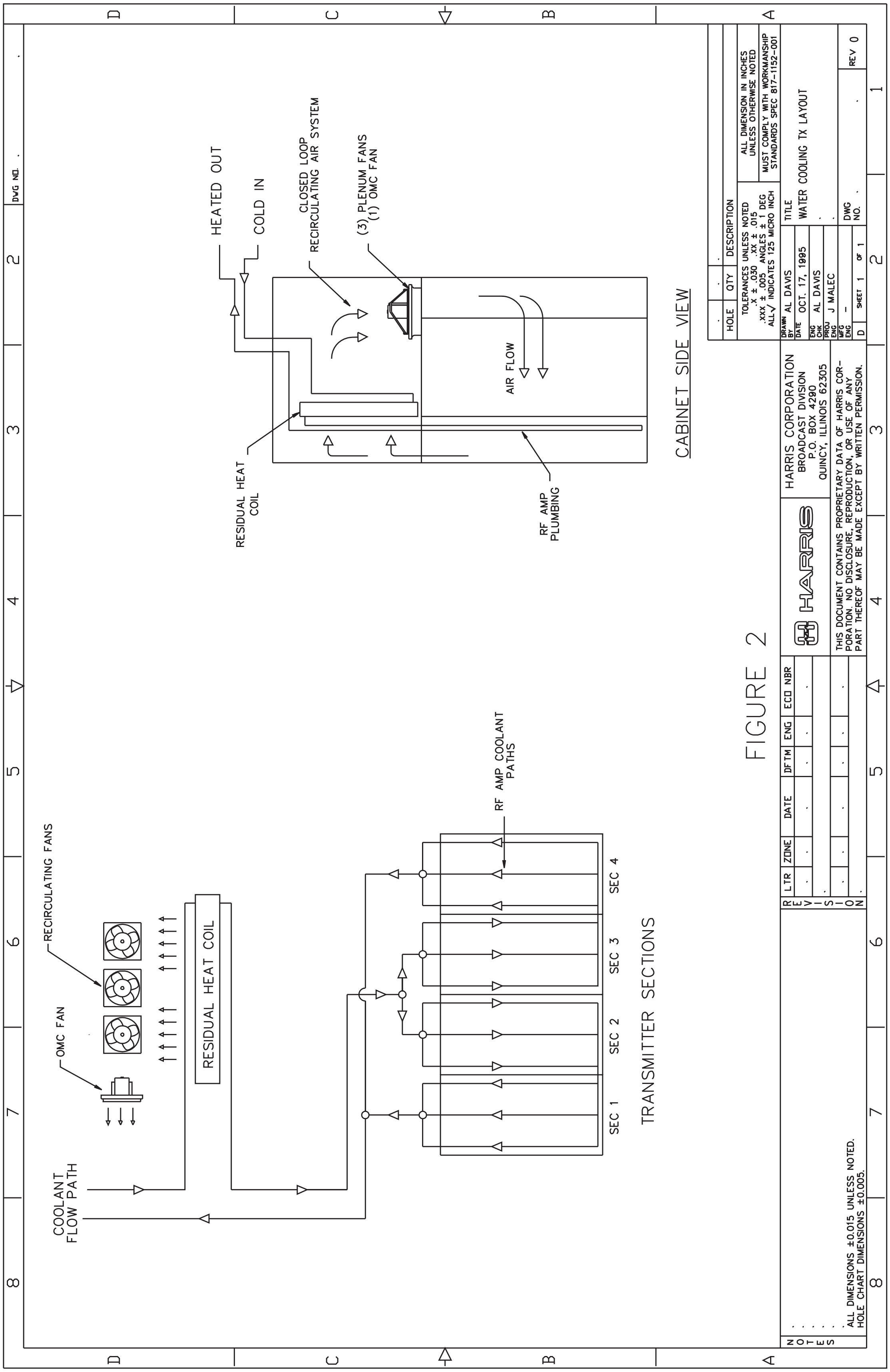

TOROID
COMBINER ROD
RF AMP
RF AMP
CHILLER
PLATES
MOSFETS
TOP VIEW
FRONT VIEW
RF AMP SPRING
TENSIONER
2371-006.dwg

Figure R-1



2374–005.dwg

Figure R-2


HEATED OUT
COLD IN
CLOSED LOOP RECIRCULATING AIR SYSTEM
(3) PLENUM FANS (1) OMC FAN
AIR FLOW
RESIDUAL HEAT COIL
RF AMP PLUMBING
CABINET SIDE VIEW
FIGURE 2
RF AMP COOLANT PATHS
RECIRCULATING FANS
OMC FAN
RESIDUAL HEAT COIL
COOLANT FLOW PATH
SEC 1
SEC 2
SEC 3
SEC 4
TRANSMITTER SECTIONS
HARRIS CORPORATION
BROADCAST DIVISION
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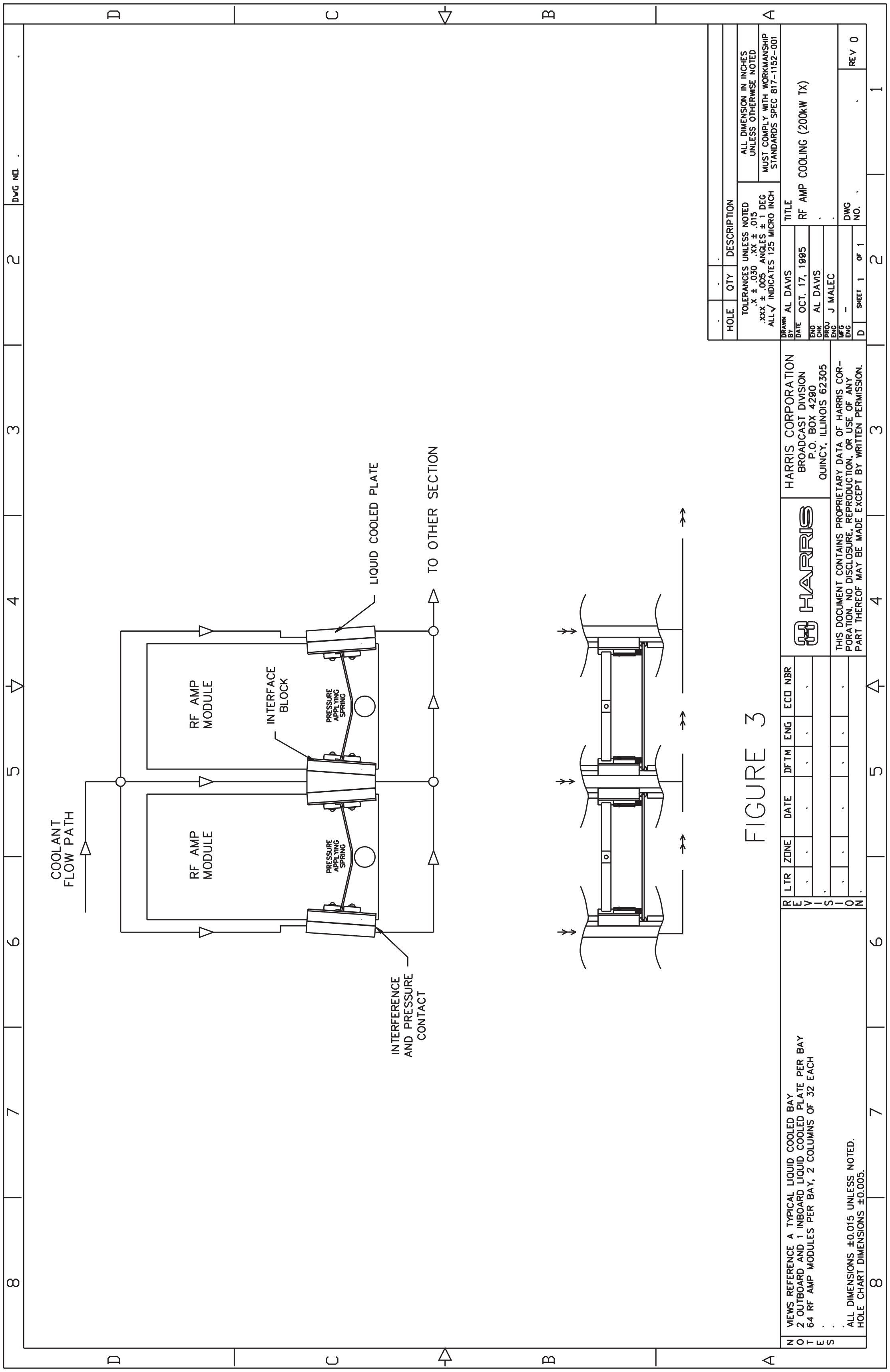
QUINCY, ILLINOIS 62305
THIS DOCUMENT CONTAINS PROPRIETARY DATA OF HARRIS CORPORATION. NO DISCLOSURE, REPRODUCTION, OR USE OF ANY PART THEREOF MAY BE MADE EXCEPT BY WRITTEN PERMISSION.
TITLE
WATER COOLING TX LAYOUT
DRAWN BY AL DAVIS
DATE OCT. 17, 1995
ENG CHK AL DAVIS
PROJ ENG J MALEC
REV 0
ALL DIMENSIONS ±0.015 UNLESS NOTED.
HOLE CHART DIMENSIONS ±0.005.

Figure R-3


COOLANT FLOW PATH
RF AMP MODULE
RF AMP MODULE
INTERFACE BLOCK
PRESSURE APPLYING SPRING
LIQUID COOLED PLATE
TO OTHER SECTION
INTERFERENCE AND PRESSURE CONTACT
FIGURE 3
HARRIS CORPORATION
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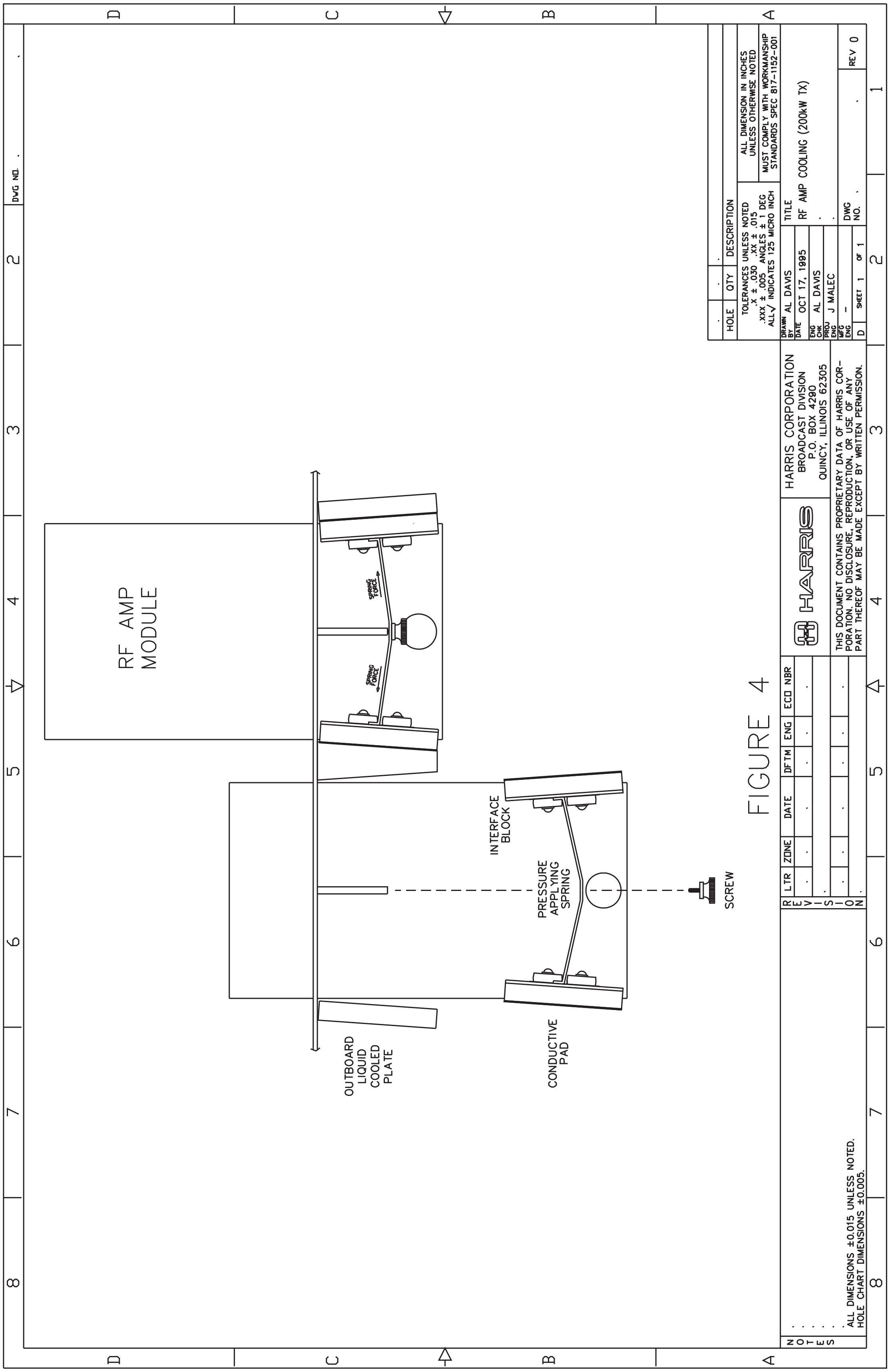
TITLE
RF AMP COOLING (200kW TX)
DRAWN BY AL DAVIS
DATE OCT. 17, 1995
ENG CHK AL DAVIS
PROJ ENG J MALEC
REV 0
TOLERANCES UNLESS NOTED
ALL DIMENSION IN INCHES UNLESS OTHERWISE NOTED
MUST COMPLY WITH WORKMANSHIP STANDARDS SPEC 817-1152-001
NOTES
VIEWS REFERENCE A TYPICAL LIQUID COOLED BAY
2 OUTBOARD AND 1 INBOARD LIQUID COOLED PLATE PER BAY
64 RF AMP MODULES PER BAY, 2 COLUMNS OF 32 EACH
ALL DIMENSIONS ±0.015 UNLESS NOTED.
HOLE CHART DIMENSIONS ±0.005.

Figure R-4


RF AMP MODULE
SPRING FORCE
SPRING FORCE
INTERFACE BLOCK
PRESSURE APPLYING SPRING
SCREW
OUTBOARD LIQUID COOLED PLATE
CONDUCTIVE PAD
FIGURE 4
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TITLE
RF AMP COOLING (200kW TX)
DRAWN BY AL DAVIS
DATE OCT 17, 1995
ENG CHK AL DAVIS
PROJ ENG J MALEC
MFG ENG –
SHEET 1 OF 1
DWG NO.
REV 0
HOLE
QTY
DESCRIPTION
TOLERANCES UNLESS NOTED
.X ± .030 .XX ± .015
.XXX ± .005 ANGLES ± 1 DEG
ALL√ INDICATES 125 MICRO INCH
ALL DIMENSION IN INCHES UNLESS OTHERWISE NOTED
MUST COMPLY WITH WORKMANSHIP STANDARDS SPEC 817-1152-001
REVISION
LTR
ZONE
DATE
DFTM
ENG
ECO NBR
NOTES
ALL DIMENSIONS ±0.015 UNLESS NOTED.
HOLE CHART DIMENSIONS ±0.005.

Figure R-5

S.1 Introduction

This section covers the Low Voltage Power Supply. Topics include function, location, block diagram and detailed circuit description.

NOTE:
Boards in this transmitter are used in Low (125 kW and below) and High Power applications. Low voltage power supplies are different in low/high power applications. Inputs to the onboard regulators are marked to reflect the lower power applications input voltages. Outputs of the regulators are the same in all applications. The following table is presented to give voltages that should be present at testpoints versus voltages shown on schematics or onboard stenciling.

Marked Voltage	Low Power (unregulated)	High Power (regulated)
+22	+22	+18
-22	-22	-18
+12	+12	+12
+8	+8	+7.5
-8	-8	-12

S.1.1 Function

The Low Voltage Power Supply provides two sets of four different regulated voltages depending on where it will be used. The outputs are selected by jumpering J1-11 to J1-12 and the monitoring is selected by jumpering J2-5 to J2-6. When used in a Transmitter, jumpers are installed at J1 and J2, the voltages are regulated +8, +18, -18 and +35 VDC.

S.1.2 Location

The low voltage power supply in the Transmitter is located on the right sidewall of the RPAC cabinet (see VIEW 2).

S.1.3 Block Diagram description

Input voltage 220 VAC comes from Rectifier Cabinet 6TB6 and passes through a CITEL MSB-HF Surge Protector supplying AC to the 24v unregulated supply through CB1 and to the B+/B-supply through CB2. The 24V Acme Transformer supply has a 24VDC output that follows the input and can be tapped for different line voltages. The Power One switching power supply is used for the B+/B- supply. The Low Voltage Power Supply Board takes the unregulated 24VDC and regulates it through four voltage regulators, the outputs can have trimmers to lower the voltage put in circuit by de-energizing K1 for use in the TCU. The AC mains are monitored as well as the DC voltages, LEDs provide visual indication of each output.

S.1.4 Transient Voltage Surge Suppression

S.1.4.1 Description

Transient voltage surge suppression is provided in the low voltage power supply by a CITEL MSB-HF Surge Protector (740-1232-000). It provides 3 stages of protection in one unit. Stage 1 utilizes a non-radioactive surge arrester gas tube for high power and high discharge capacity. The second stage incorporates a bipolar filter to protect against EMI/RFI powerline noise as caused by flourescent lighting, worn motor armatures, and other common sources. Stage 3 uses a fast semiconductor to

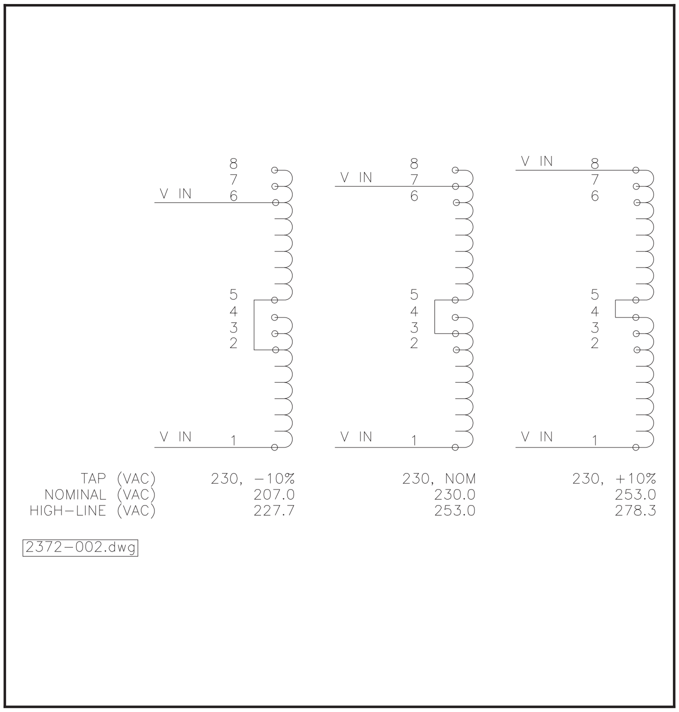


Figure S-1. B+/B- Supply Jumper Connections

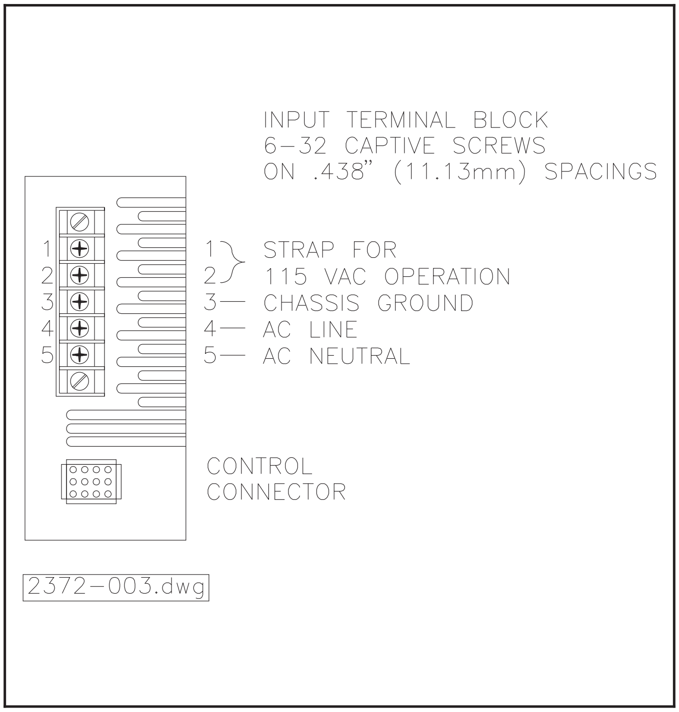


Figure S-2. AC Connections for B+/B- Supply

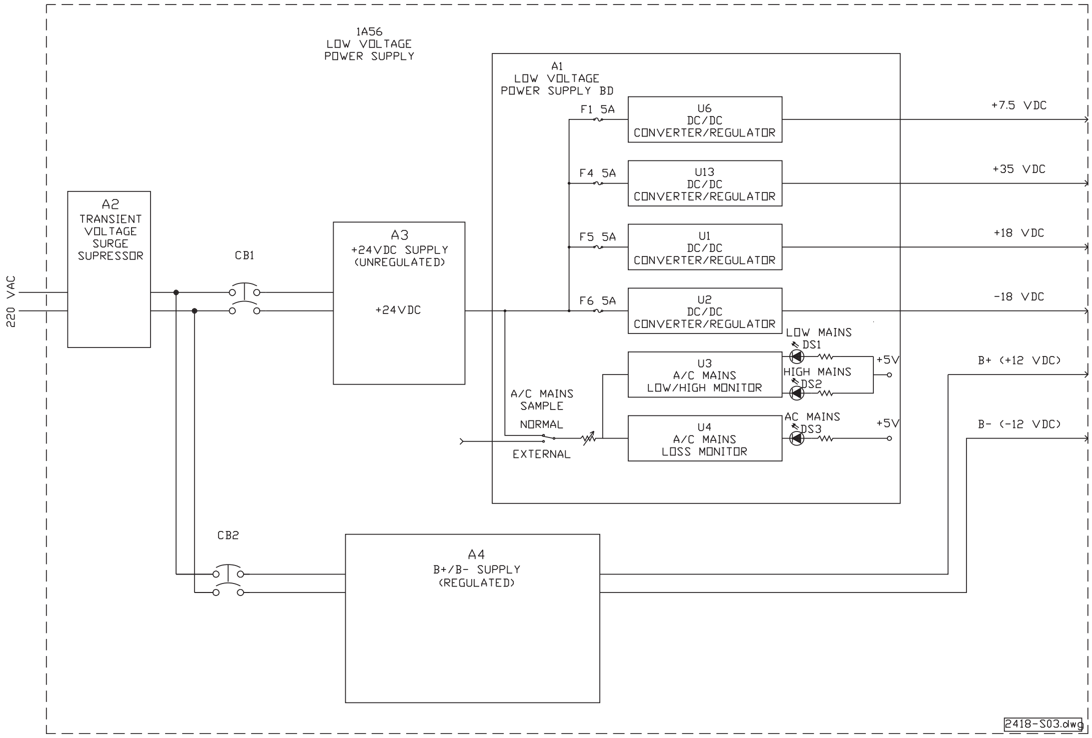


Figure S-3. Low Voltage Power Supply
Simplified Block Diagram

clamp high speed transients of lower energy in less than 5 nano-seconds.

S.1.4.2 LED Indications

The green LED on indicates protection OK; off indicates protection not available.

The amber LED on indicates ground OK; off indicates ground connection is bad.

S.1.5 B+/B- Supply

The B+/B- supply is provided in the low voltage power supply by a Power-One switching power supply. AC input enters at J1 and can be jumpered for 115Volt or 230 Volt operation, no jumper from input 1 to 2 for 230 Volt operation. +12 VDC 65A output is at J3, -12 VDC 20A output is at J5. Control and status signals are at J2, J4 and J6 for the input module, +12VDC output module and -12 VDC module respectively.

S.1.6 Unregulated +24VDC Power Supply

The unregulated supply will handle 190VAC to 270VAC, normal operation using 230VAC nominal taps and +/-10% taps. The unregulated floating output will supply the low voltage power supply board which will in turn regulate to the specified DC voltages and output +24V_A and +24V_B unregulated voltages.

S.1.7 Low Voltage Power Supply Board (A56A1)

Assembly #	992-9067-001
PWB #	843-5458-293
Schematic #	843-5458-291

NOTE: Parts list for this board is covered in Section VII.

S.1.7.1 Detailed circuit description/Low Voltage Power Supply Board

Unregulated 24VDC enters the board at J3-1, lights DS9 DC INPUT LED, and is available at J1-13,15 after passing through posistors R43 and R46 (acting as resettable fuses). The unregulated 24 volt line feeds the four regulators with fused inputs and outputs. The four voltages are indicated by LEDs and present at TP3-6. Fault monitoring IC's U10 and U11 monitor the TCU or the PB voltages depending on which circuit is enabled by J2-5, 6 jumper. A summary fault indication at DS8 and LVPS fault-L at TP8 if any voltage is under 10% regulation. With the jumper installed the Transmitter voltages are monitored, with the jumper removed the TCU voltages are monitored. The monitor jumper and the mode jumper at J1-11, 12 should both be installed for use in the Transmitter or both removed for use in the TCU. Since the unregulated 24V line is a sample of the AC mains voltage this is monitored at U3 and U4. The unregulated 24v line is sent to window comparators through JP1 in the normal position or an external sample may be monitored by installing JP1 in the external position. U3 has a window of +/- 5% and will light DS1/DS2 if the voltage is outside that window. U4 will generate a fault if the voltage is more than 15% high or low and will light DS3 AC MAINS to indicate a fault. The C output is also used to supply U14, a 5 volt regulator for +5VB. U7 monitors the +5VB line and if this voltage drops below a predetermined level will switch to the +5V battery backed output. Then the +5VB will be generated by the +15/+18.5 volt line clamped by CR9.

S.1.8 AC Input Fault Adjustment

Use the yellow upper and lower 5% LED indicators to adjust for center scale (halfway between the upper and lower LEDs being lit). For a more accurate adjustment insure the AC INPUT is at the nominal AC line voltage while the transmitter is at full power with no modulation. Adjust R34 for 4.2 volts DC.

S.2 Troubleshooting Low Voltage Supplies

Refer to the Simplified Low Voltage Supply Diagram in the Overall System Theory section to aid in troubleshooting as needed.

Begin by verifying presence of Single Phase A/C input.

a. If the AC input is present then the “A/C Mains” indicator, on the front panel, should be lit.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING “PA+VDC” ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. If the A/C input is not present, then with the Transmitter off, ohmmeter check CB1 and CB2. If either is open, reset or replace.
c. With the Transmitter still off, clip meter leads to the input side of CB1 and CB2. Route the leads outside the Transmitter and replace the cover.
d. Turn on the single phase A/C disconnect and verify A/C presence at the circuit breakers.
e. If it is not present, Check for AC entering the Transmitter at from the Rectifier cabinet 6TB6.
f. If it is not present, troubleshoot building A/C and the Disconnect.
g. If the voltage is present, ensure that all breakers on the Power Supply Panel are in the ON position.
h. Shut off the Single Phase A/C wall disconnect and remove the test leads from the Transmitter. Be sure to replace all covers before operating the Transmitter.

S.2.1 Verify the presence of 24 Volt supply by observing DS9, DC Input is lit.

If DS9 is not lit and CB1 is not tripped, check the fuse on the +24V Supply.

S.2.2 24 Volt supply breaker (CB1) trips

If CB1 trips upon applying Single phase A/C, then

a. Turn off CB2 (B+/B- Supply).
b. Apply A/C single Phase to the Transmitter,
   1. If CB1 trips suspect a shorted cable, failed +24V supply or failed CB1.
   2. If CB1 does not trip, turn on CB2.
   3. If CB1 trips and CB2 does not suspect a weak CB1.
   4. If CB2 trips, disconnect the outputs of the B+/B- supply at J3 and J5.
c. If CB2 does not trip refer to the wiring diagram to locate the problem.
d. If CB2 trips then suspect a shorted B+/B-supply.
e. If CB1 and CB2 do not trip, service the interconnecting wiring between the 24V unregulated power supply and the LVPS board. If DS9, on the LVPS board is still not illuminated when all LVPS board input cabling and discrete components have been determined to be okay, service the LVPS unregulated 24V input filter.

S.2.3 DS9 Illuminates But DC Output Indicator(s) Not Illuminated

Check the following test points for the correct corresponding value.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING “PA+VDC” ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

TP3 +5

TP4 +25

TP5 +18

TP6 -18

If these voltages are not present then check fuses F7-10 at the outputs of the regulators. If blown refer to the wiring diagram for a possible short outside the board or in the monitor circuit. If the fuses are not opened then check F1, F4, F5 and F6 at the inputs of the regulators. If open refer to the schematic and suspect the regulator associated with that fuse.

If these voltages are all present then check interconnect cabling and the Power distribution boards for an open. Refer to the Overall wiring diagram as needed.

T.1 Introduction

This section descibes the Heat Exchanger Cabinet and Air Plenum. Topics include Function and Location.

Heat Exchanger Assembly #	994-9855-004
Air Plenum Assembly #	992-9154-001

NOTE: Parts List for this board is covered in Section VII.

T.2 Function

The Heat Exchanger and Air Plenum remove heat from the ambient air circulating in the Transmitter Cabinet keeping the cabinet and components cooled. Fans in the Heat Exchanger cabinet circulate the air through the water cooled radiator and the Transmitter to remove the heat.

T.3 Location

The Air Plenum and Heat Exchanger are located at the rear and top of the Transmitter PAC cabinet.

T.4 Overall Liquid Cooling System

For further information on the Water Cooling system see Section-R Transmitter Cooling System.

T.5 Draining

When the servicing of a Transmitter or Rectifier Cabinet requires coolant to be drained, close the shut-off valve at the top of the Transmitter connecting it to the System Coolant Lines. There is an air valve (bolt) at the top of the Heat Exchanger to allow the coolant to fully drain. Two drain valves are located in the PAC bottom front (See VIEWs 4 and 5). For Rectifier Cabinet drain valve locations see VIEW 2 of the Rectifier cabinet views. Coolant is expelled from the lower rear part of each cabinet. A valve which aids in draining the PA Heat Exchanger coil is located in the lower right front corner of the heat exchanger cabinet. Open this valve during draining; close for fill and normal operation. It is recommended that any hoses, if disconnected, be plugged to eliminate residual coolant from dripping out into undesirable areas (i.e. PA Modules, etc.).

T.6 Flow Rate

T.6.1 Flow Rate Indication

The flow rate is continually displayed by an inline flow rate gauge located in the Rectifier Cabinet return line.

T.6.2 Flow Switch

Flow switch (4S1), located in the HEC, serves to disable the Transmitter if activated by a flow rate lower than a nominal 12 to 14gpm. If a low or no flow rate condition occurs, the Transmitter will be disabled through action of the Cooling PAL (U11) on the Extended Transmitter Interface board.

T.6.3 Water Solenoid/Control Relay

This system, the control devices of which are the Water Solenoid 4K2 and Control Relay 4K1, is designed for optional use.

T.6.4 Leak Detection

Leak Detector (4U1) operates the same as other Transmitter Leak Detectors. If a Transmitter coolant leak has been detected, the Transmitter will be disabled along with the outdoor Heat Exchanger system.

In order to restore the Transmitter to operation, follow the procedure stated in Section-S of this manual.

U.1 Overall

U.1.1 Introduction

This section provides the basic function, circuit description and operation of the Rectifier Cabinet. See 817-2413-483 VIEWs 1 and 2 for Rectifier Cabinet component locations.

This section contains sub units that are found in the Rectifier Cabinet consisting of both vendor and Harris manufactured units. Each sub unit will have it's own Introduction, Function and Circuit description:

- Overall
- Controller

Assembly	992-9048-001
PWB	843-5458-003
Schematic	843-5458-001

- SCR Firing Assembly

Assembly	736-0264-000
Schematic	843-5450-691

- Discharge Board

Assembly	992-7220-107
PWB	843-5155-518
Schematic	839-7930-518

- Display Board

Assembly	992-9188-001
PWB	843-5458-013
Schematic	843-5458-011

NOTE: Parts List for this board is covered in Section VII.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

U.1.2 Function

The Rectifier Cabinet receives 205V nominal 3PH AC from the Transformer Cabinet and converts it to a regulated 250 VDC for the Transmitter. It also supplies the 125 VDC Binary Supply and the 125 VDC Driver Supply.

U.1.3 Circuit Description

Refer to Drawing 843-5523-672, for the following discussion:

NOTE:
When a line leaves one drawing and continues on to another, symbols at the end of the line reveal where it continues. Example: 2/B8 means "Go to sheet 2 at coordinates B8".

Three Phase 205 VAC enters the Rectifier Cabinet through T1. Current Transformer T1 steps down and samples the incoming current for monitoring. It is rectified by CR1 and monitored by the Power Supply Controller A1 via J1. This will provide protection against overcurrent faults.

The three phase power is supplied to the SCR stack (Q1 through Q6) and to the Driver Supply through F8, F9 and F10. Step Start contactors K1 and K2 deliver the three phases to the Driver Supply transformer T2. Rectifiers CR2, CR3 and CR4 provide the 125 VDC at 50 Amps for the Driver Supply at C13 and TB5-1 to power Driver Amplifiers in the Transmitter.

K1 and K2 provide soft start through R1, R2 and R3.

These are activated by Solid State Relay K3, which pulls in K1, and charges up the capacitor bank in the power supply. K2 is pulled in by the voltage increasing through R1, R2, and R3 enough to energize the coil. Once K2 is energized, K5 is activated which provides power to the Transmitter blower motors. K5 contacts 2 and 4 provide a status signal to the power supply controller that K1, K2 and K5 are activated.

The 380/440 V 3PH AC is brought in at FL1 for the blower motors. The 3PH goes through a switched fuse block S5 which is mechanically tied in with S2 manual earthing switch on the rectifier cabinet.

Access to the rectifier cabinet is not possible until S2 manual earthing switch is closed. This switch also prevents the 3PH power from entering the system through S5 fuse block by opening S5. S2 shorts to ground the 250 VDC supply for servicing and is Key-locked so it can be shorted only after primary power has been disconnected.

The three phase 380 volts at FL1 supplies the blowers through S5 and K5. K7 AC Line Monitor sends fault status to the Power Supply Controller through Power Supply Controller J3. K7 monitors line balance of the 3Ø power and voltage or frequency deviations.

The neutral for the 205VAC routes through FL1 to 20A fuse F4 and then on to TB3.

This line is filtered through L1 providing the 125VDC Binary voltage supply at TB1, pin 10.

Relay K6 is part of the series-interlock string. If the series interlock voltage is interrupted, the Emergency Off switch pressed, the earthing switch is closed, or the cabinet interlock is opened, then this relay is opened. One pole of the relay K6 is in series with T3 step-down transformer primary and the other pole is in series with T3 secondary.

T3 provides the 120 volts AC for the Enerpro SCR Firing Board. Opening K6 removes power from this board. T3 also provides voltage for the coil of the driver supply contactor, guaranteeing that the driver supply will be disabled in the event of interrupt string disruption. K5 coil voltage also comes from T3 and is routed through K2 assuring K2 closes before K5 can be energized.

PH1, PH2 and PH3 bring in 205 VAC to rectifier circuit Q1-Q6 which forms a full wave bridge rectifier. Rectified 205 VAC, through LPF L2, produces 250 VDC @ 1400 Amps for the Power Block.

The SCR's have RC snubbers which limit noise spikes that would occur on these SCR's.

The drive signals, which operate SCR's Q1 through Q6, come from A2 SCR Firing Assembly. It generates the signals to fire SCR's that regulate the 250 VDC output voltage. This is done from a sample input voltage to this assembly from 0 - 5V corresponding to 0-250 VDC output from the supply.

The discharge assembly A3 consists of a MOSFET crowbar circuit. When activated from the power supply controller board, it discharges the capacitor bank in the Transmitter, the binary supply and the driver supply. Discharge time is about 5 seconds when A3 receives the command signal. It also discharges the various capacitor banks during the loss of AC power as a "Failsafe Circuit", that is it doesn't need an active signal to function.

For protection of circuits on this assembly, the thermostatic switches labeled TS1, TS2 and TS3 are within L2. They open in the event of excessively high temperatures. They generate a Temp fault in the power supply controller board.

Refer to 843-5523-672, sheet 3 of 3.

CR1 is a 3PH bridge rectifier that accepts the 3PH output signal of the current transformer T1 from sheet 1 of 3.

The output is rectified and applied to a current shunt R19 which produces a DC voltage level proportional to AC current consumption. This current sample is sent to the controller board providing protection in the event of over current faults.

A1 is the power supply controller. It is connected to A4, the Display Board, which provides LED indications of any faults detected in the power supply. The Water Flow Monitor S6 and Leak Detector U1 through A5 Interface Board provide fault signals to the Power Supply Controller board, A1.

The Emergency OFF Switch S3 when pressed will shut down the entire system.

TB2 is the interface terminal block for interfacing the Power Supply Controller Board to the Power Block Interface board.

U.1.3.1 Enerpro Board

This is a purchased assembly. Its purpose is to generate a phase modulated signal to drive the 3PH Full Wave SCR bridge rectifier circuit. Circuitry around U8 provides soft start during power up. U5 provides phase loss detection to shut down the system and provide a fault signal.

The on-board power supply receives 120 VAC and provides +30 VDC source to power this board, the Controller board and the Display board, as well as 24VAC to the Controller board.

U.2 Controller

U.2.1 Introduction

This section provides the basic function, location, circuit description and operation of the Power Supply Controller.

U.2.2 Function

The Rectifier utilizes a three-phase full-wave rectifier system to provide 250 VDC @ 1400 ADC to the transmitter. This 250 Volt supply is regulated and self-protected by the Power Supply Controller. The Controller Board generates the control voltage for the SCR Firing Board as required for voltage regulation. Fault signals are sent from the Controller to the LED Board.

U.2.3 Location

The Controller Board is located behind the small door at the top of the cabinet directly behind the Display Board. See Rectifier Cabinet VIEWs.

U.2.4 Circuit Description

The power supply is commanded 'ON' by the line labeled 'PS_ENABLE' at J6-13. This is buffered through an opto-isolator (U4) and Schmitt trigger inverter (U11).

The power supply output voltage is programmable in 36 Volt steps, from 0 to 250 volts (this feature is not used in this application). Three binary weighted input lines, 'BIT1', 'BIT2', and 'BIT3' at J6-9, 10 and 11. This allows the output to be regulated in 36 Volt steps. These are also opto-isolated, and Schmitt-trigger buffered. These voltage control lines feed the digital data inputs of a digital-analog converter (U9). Its output is in turn buffered by one section of op-amp U1. U1, pin 14, (TP7) is the regulator reference voltage, 5 to 10 Volts corresponding to 0 to 250 Volts at the power supply output.

The 250 Volt output of the power supply is sampled and brought into the Control Board at J1, pins 7 and 8. This signal is buffered at U1-1 (TP6). This signal is subtracted from the regulator reference voltage, and integrated at U2-1, a level shifting op-amp.

The power supply current is sampled at J1 pins 3-6 and buffered at U1-7 (TP1). This signal is summed with the integrator voltage at U2-7. The current sample voltage damps the controller closed-loop response. This control voltage is pre-distorted in one section of U3, using a diode-resistor 'curve-bender', Q-1 and Q-2 to compensate for the sine functionality of SCR bridge output voltage versus SCR conduction phase angle. This SCR Control voltage leaves the controller and provides the phase-control voltage for the SCR Firing Board (J4-12). The 250 Volt signal is also compared with the regulator reference in a window comparator, at U5-1 and U5-2, with its corresponding output signal 250V_FLT if the voltage goes outside the window.

A sample of the 125 Volt binary voltage is brought at J1-1 and is buffered at U1-8 (TP4). J1-1 provides a voltage sample of the +125V Driver Supply to insure it is within a preset operating window. This sample is compared with the regulator reference in a window comparator U5-13 and U5-14, causing the signal

125V_FLT to go low in the event of the binary voltage going outside a window.

The current sample signal is compared against a set threshold at U12-1 (LM339), for detection of peak-over-current faults. The current sample is also low-pass-filtered, and compared against the same set threshold for average-over-current faults at U12-2. Both over-current faults are OR'ed together creating the I_FLT signal. Since the SCR's operate at close to full conduction a brown-out condition would push them to full conduction and regulation may not be possible. The BROWN_OUT circuit compares the 30 Volt line (this 30V is derived from a 24VAC and rectified and filtered) against VREF at U3-14, and will fold-back the power supply output if the 30 Volt line sags below the reference. If the brown-out is more the comparators will shut down the power supply through U16-2.

Other faults observed are EARTHING SWITCH, SCR THERMOSTAT, CHOKE THERMOSTAT, CODING DRIVER CONTACTOR, 380 VAC, XFMR COOLING, XFMR THERMOSTAT, and DISCHARGE SWITCH. Each of these are open-contact-type faults, so they are provided with pull-up resistors and Schmitt-trigger buffering. The AC FAULT line is provided by the Enerpro Firing Board at J4-16, and is buffered by Q5.

U.2.5 Sequential Operation

The start-up process is as follows: On receiving the PS_ENABLE signal, the Driver Supply SSR in the Rectifier Cabinet is activated, initiating the driver supply soft-start sequence. The discharge switch on the Discharge Board is de-activated.

The Firing Board soft-start ramping sequence is initiated. A one-second fault-muting timer is activated (Q4, R34, C50). If, at any time while PS_ENABLE is present, a CABINET INTERLOCK, SCR THERMOSTAT FAULT, COOLING FAULT, CHOKE THERMOSTAT FAULT, 380 VAC, XFMR COOLING, XFMR THERMOSTAT, I_FAULT or AC FAULT appears, the fault latch flip-flop, U21 will be set, the SCR Firing Board is disabled, and the discharge switch (Q6) enabled. During the one-second fault-muting sequence, a 250V_FAULT, 125V_FAULT or DRIVER CONTACTOR STATUS will be ignored, but after the fault muting is terminated, any of these faults will be registered.

All ORing of faults is accomplished through 74C906 open-drain, non-inverting buffers, U17 and U18, with outputs tied together, creating a multi-input OR gate.

The 125 and 250 voltage faults are ORed together to create the PS_V_FLT signal at J6-6. The AC FLT and 380 VAC FLT are ORed together to create the AC_MAINS fault signal J6-3. All coolant and thermostat faults are ORed together to create the TEMP FLT signal J6-5. These are buffered with U8 open-collector drivers to provide input to the transmitter controller. A fault will turn Q-6 on to turn on the crow bar discharge switch and Q-10 will stop the SCR's from regulating. The SCR shutdown circuit will also mute the drive to the SCR's to prevent voltage overshoot, if an RF MUTE is generated from the Transmitter.

If, after the one-second fault-mute period, no faults have occurred, a PS_OK signal at J6-4 is passed to the transmitter controller, to signal that no problems are present within the power supply, and then the carrier ramp-up may begin. If any faults do occur, the PS_OK signal will be removed, all supplies disabled, and the discharge switch activated.

U.2.6 Replacement

The replacement procedure follows:

a. Remove the existing in-place board from its normal position.
b. Place all jumpers on the new board in the same locations as on the old board, paying particular attention to JP5 (Cooling Mode).
c. Adjust R104 (Gain Set) fully CCW.
d. Position the new board in the transmitter and reestablish all connections to and from the board.
e. Apply AC power to the Transmitter.
f. Verify that 205 VAC is being applied in the Rectifier Cabinet from the high energy transformer.
g. Adjust R75 (Brownout Set) for 10.5 VDC at TP3.
h. Adjust R105 (Over Current Set) for 2.5 VDC at TP2.
i. Energize the Transmitter to an RF power figure of approximately 100kW and adjust R104 (Gain Set) for +250 VDC on the front panel meter.
j. Energize the Transmitter to an RF power figure of approximately 200kW and adjust R104 for +250 VDC on the front panel meter.

U.3 SCR Firing Assembly

U.3.1 Introduction

This section provides the basic function, circuit description and operation of the Power Supply SCR Firing Assembly.

U.3.2 Function

The Rectifier utilizes a three-phase full-wave rectifier system to provide 250 VDC @ 1400 ADC to the Transmitters. The power supply uses an Enerpro SCR Firing Board to provide gate drive for the SCR rectifiers. This board phase-modulates the SCR conduction angle based on a control voltage input to the board.

Additionally, this board contains its own soft-start circuitry and phase-loss sensors. A snubber assembly limits voltage spikes on the SCR's.

U.3.3 Circuit Description

The power supply controller signal enters the SCR Firing Assembly through a 20 pin ribbon cable at J6. The SCR Firing Assembly phase-modulates the bridge rectifier SCR diodes through J1 and J2. The 205 VAC 3 phase power is rectified then filtered by L2 for the 0-250VDC output. The manual shorting switch S2D shorts the 250 Volt line to the return line during servicing.

U.3.4 Set-Up for Enerpro Firing Board

Verify that RN2 is the appropriate value for the frequency intended (120K for 60 Hz, 150K for 50 Hz)

Place P10 in the position as silk-screened on the board appropriate for the site specific DC powerline operating frequency.

Verify that the PP1 jumpers are soldered in place for positions 4, 5, 6, 7, and 8, while positions 1, 2, and 3 are unjumpered. This is necessary to achieve the greatest range of regulation control of the 250VDC output with respect to the variation of 205VAC input voltage.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

U.3.5 Maintenance

U.3.5.1 SCR Torque

The liquid cooled SCR's are supplied with a torque gauge to ensure proper torque when replacing the SCR's. Tighten the bolts to the bar that hold the SCR, to the number "6" on the gauge. This is the equivilant of 365 inch pounds of torque (per bolt). Periodically check the tightness of this bar to ensure it is tightened to the number "6" on the gauge. The bar will normally flex to achieve this reading on the gauge, this is normal. The" SCR/mounting bracket" assembly should be configured and torqued outside of the cabinet, and then installed into the cabinet.

U.3.5.2 Thermo compound

A thin coating of GE VersiLube silicon grease must be applied to the contact surfaces of the SCR on installation. The silicone grease has excellent heat transfer properties and will fill the microscopic surface imperfections allowing complete heat transfer.

U.3.5.3 SCR Removal

If an SCR must be removed for servicing of the Rectifier Cabinet, coolant in the Rectifier Cabinet must be drained. First the coolant lines from the system must be closed. The Rectifier cabinet must be drained from the rear discharge pipe. The looped hoses at the SCR must be disconnected and the whole SCR assemble removed from the copper Bus bars. The SCR assembly then can be disassembled on the work bench.

U.4 Snubber

The Snubber parts limit voltage spikes on the SCR's. RC snubbers are connected across each of the 6 SCR's. Any spike on the three-phase line would go through the RC circuit causing, excessive current that would be detected at T1 and sent to the controller.

U.5 Discharge Board

U.5.1 Introduction

This section provides the basic function, circuit description and operation of the Power Supply Discharge Board.

Refer to schematic number 839-7930-518 for the following discussion.

U.5.2 Function

Four power MOSFETs are connected as switches for the 250W current limiting resistors. When turned on, they discharge the capacitor banks through R13-R16.

U.5.3 Circuit Description

The function of the Discharge Board is to discharge the rectifier assemblies when the Transmitter is turned off. The Discharge circuit is comprised of four power MOSFET's operating in parallel to discharge the +250VDC and +125VDC supply. Q1, Q2, Q3 and Q4 function as switches which will be open when the supply is energized. When a fault condition occurs, a control voltage is applied to each gate to activate the MOSFET's. This control voltage comes from the power supply Board to the individual gate circuits. Therefore the discharge path is self contained, i.e. no additional supply is need to activate the circuit. R13, R14, R15, and R16 are in series with each MOSFET for current limiting. Each MOSFET has a zener diode across the gate to source to limit the gate voltage to 10V. The binary supply and 130 Volt driver supply will discharge through CR5 and CR6 when the crowbar activates.

U.6 Power Supply Display Panel

U.6.1 Introduction

This section provides the basic function, location and circuit description of the Power Supply Display Panel.

Refer to schematic number 843-5458-011 for the following discussions.

U.6.2 Function

The Power Supply Display Panel provides latched indications of any of the faults detected within the Power Supply Controller Board.

Faults indicated are:

- Access Interlock
- Rectifier Temp. Fault
- Choke Temp.
- Transformer AC Mains
- Driver Voltage Fault
- Blower AC Mains
- Cooling Fault
- Transformer Cooling
- Transformer Temp.
- PA Voltage Fault

- Binary Voltage Fault
- PA Current Fault
- PS Discharge Fault

U.6.3 Location

The Display Board is located on the inside of the small door towards the top of the cabinet. See Rectifier Cabinet VIEW 1.

U.6.4 Circuit Description

Input signals enter the Display Board from the controller at J1. Those signals are buffered by U16 and U17 before going into CMOS flip-flops U2 - U5.

The 250 Volt, 125 Volt and driver voltage flip-flops are muted for one second after power up to allow the supplies to stabilize. LED drivers U-6 through U-9 drive the bi-colored LEDs.

During AC power failure, the drivers are tristated to keep LED's off to conserve energy and lengthen fault back-up memory. When the 30 Volt line falls under 20 Volts Q-1 opens and disables the tri-state LED drivers through the enable line (EN). Q-2 will hold the LEDs off until the system powers up again. C19, a 1 farad capacitor provides 10-15 minutes of fault memory back-up., called +5VBU or Battery Back-Up.

Line drivers U10 and U11 are used for optional remote monitoring. LED RESET pulse goes through one section of U12 to reset the latch flip-flops.

To test the bi-colored LEDs, switch S-1 is closed triggering the other section of U-12, a one-second flip flop, illuminating the LEDs red, then green. S-1 will also reset any faults that have been cleared, if faults still exist the LED will return to the fault condition.

The latched flip-flops are also reset by the removal and reapplication of the PS_ENABLE signal.

U.6.5 Tracing a Sample Signal

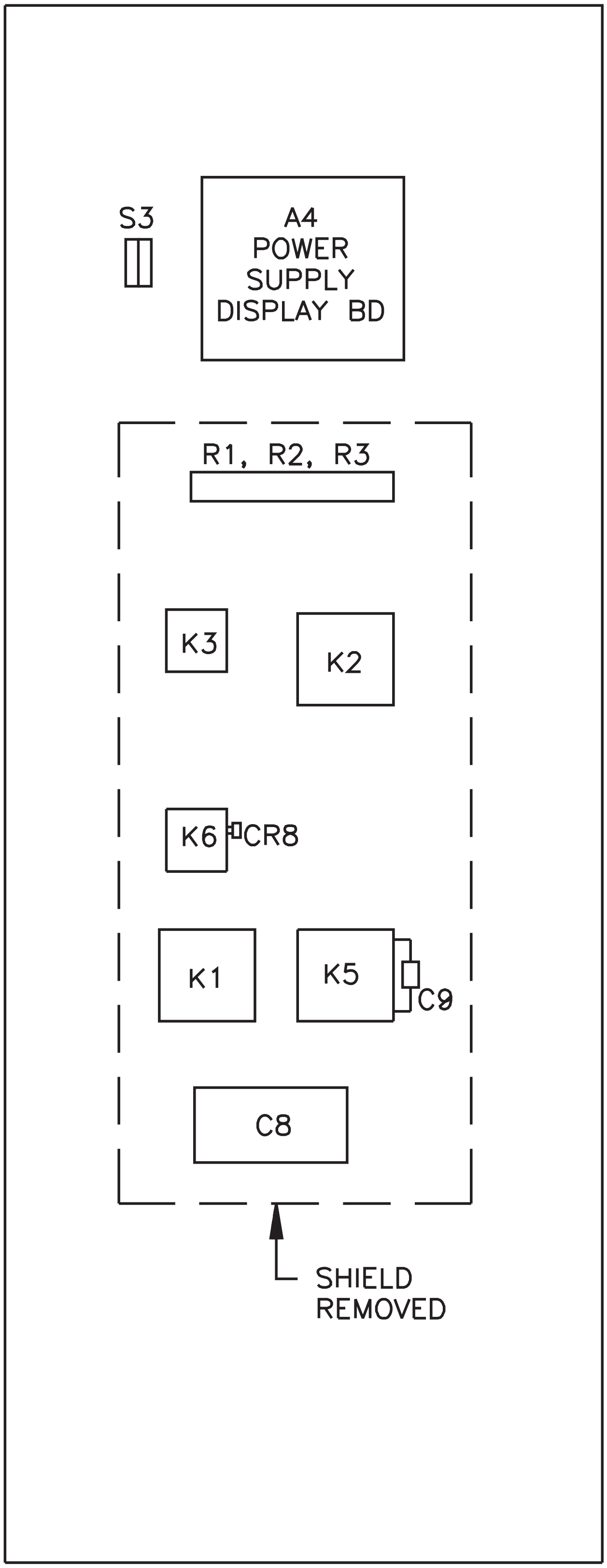
Since all sections of the display board work in the same manner only one signal will be traced through the board.

The ACCESS INTLK signal enters the board at J1-1 and is sent to U16 pin 2 . If the ENABLE signal is present on pin 1 of U16 the ACCESS INTLK signal will be inverted and passed on to pin 4 of U2.

This will cause flip-flop U2 to toggle (note that the ENABLE signal would also be present on pin 5 of U2) and present a HI to pin 2 of U6.

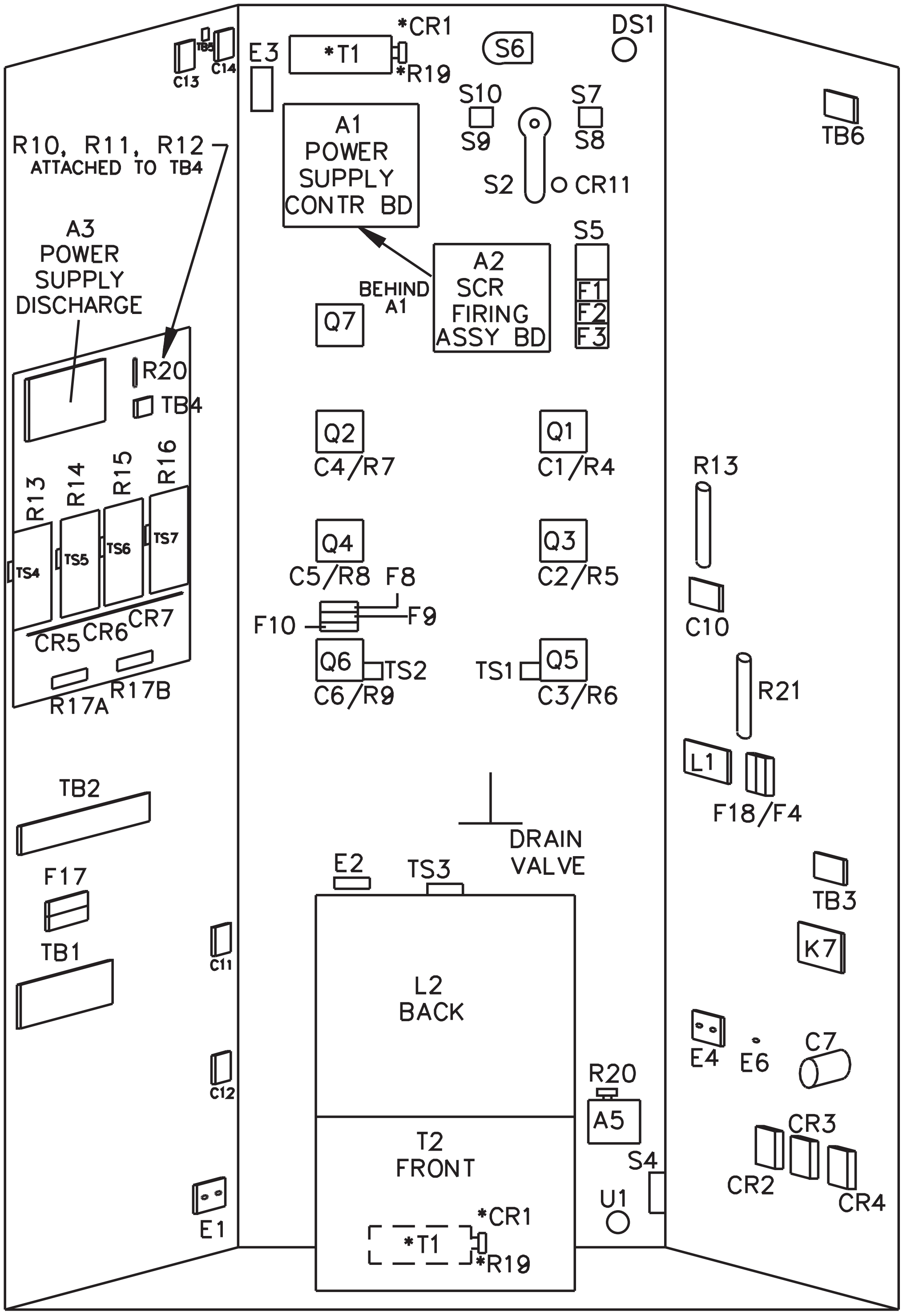
If the enable line (EN) is LO (pin 1 of U6) the inverted ACCESS INTLK would be re-inverted and exit at pin 18 as the D1 signal.

This D1 signal is presented to one end of DS1 and is inverted by U8 and presented to the opposite end of DS1 thereby causing the LED to switch from green to red. The D1 signal is also fed to pin 1 of U10 line driver, inverted and sent to pin 1 of J2. This output may be used for remote monitoring.



VIEW 1	FRONT VIEW FRONT DOOR RECTIFIER CABINET	VIEW 1 817 2413 483 SH-2 P

WARNING: Disconnect primary power prior to servicing.



* – CUSTOMER SELECTED LOCATION

VIEW 2	FRONT VIEW RECTIFIER CABINET	VIEW 2 817 2413 483 SH-3 P

WARNING: Disconnect primary power prior to servicing.

W.1 Introduction

This section provides the basic function and block diagram description of the AC Input System, including the Power Supply Transformer Cabinets System and associated AC input power conditioning equipment options.

W.2 Function

The Power Supply Transformer Cabinet serves to condition, distribute, and control AC power to the Transmitter rectifier cabinet (see figure W-1). The Transformer Cabinet (and High Energy Transformer) is fed from the Primary Fused Disconnect box or other disconnect mechanism, and supplies the Rectifier Cabinet with 205 VAC.

Each Transformer Cabinet is unique to each installation due to the availablilty of different input line voltages. Voltage enters the Primary Disconnect, Power Metering Cabinet (optional) then into the Transformer Cabinet.

W.3 Block Diagram

The site specific disconnect mechanism is used to disconnect all AC to the Transformer Cabinet, to remove any voltage from down stream equipment. Voltage then goes to the Power Metering cabinet (optional) that houses current sensing transformers, voltage transformers, a Power Monitor, and Power Factor Correction capacitors. The transformer has fused primaries as an additional means to disconnect the transformer and to protect the circuits before and after the transformer.

See figure W-1 for a Block Diagram of a single Transmitter system.

NOTE:

This is for a "TYPICAL" installation. See your "SITE SPECIFIC" drawing package for actual information.

The AC Transformer Cabinet serves to distribute and control AC power meeting the high energy requirements of the 200 kW Transmitter.

W.3.1 Primary Source Fused-Disconnect

The site specific disconnect mechanism provides the main means of disconnecting the input AC line from subsequent circuitry. This mechanism also has current limiting fuses or circuit breakers of the necessary site-specific value. Opening this mechanism removes voltage from all other components in the system; to insure no dangerous voltages will be present during servicing of downstream equipment.

W.3.2 AC Metering Cabinet (optional)

The AC Metering Cabinet contains three current sensing transformers, Two potential transformers and an Allen-Bradley AC Power Monitor. Also in this cabinet are three power-factor-correction capacitors to increase efficiency. The AC Monitoring Cabinet in turn feeds the step-down transformer.

W.3.3 Step-Down Transformer

The step-down transformer converts the 3 phase input line voltage to the 205 VAC required for the DX Rectifier Cabinets. This transformer, mounted in an individual cabinet, is usually fused both on the primary and secondary circuits.

W.3.4 Secondary Source Fused-Disconnect (optional)

The Secondary Fused-Disconnect switch allows a means of removing voltage from the MV/LV transformer and is fused at 30 Amps.

W.3.5 MV/LV Transformer (optional)

The MV/LV Transformer steps down the AC line voltage to 380/220 VAC to power the blowers, pumps, etc. required by the transmitter. Transformer kV rating is load and site dependent, but seldom less than 50kVA.

W.3.6 Alternative AC Voltage Sources/Distribution

For the disconnect switches and transformers noted above as being optional, alternate sources and distribution disconnect devices are sometimes used. See the site drawings for specific details.

W.3.7 Operator Safety

The fuses in the Transformer Cabinets are the only user-serviceable parts in that cabinet. When the Transformer Cabinet door is opened, all exposed conductors must be discharged using an insulated-handled grounding stick prior to any work on the cabinet. Any maintenance necessary in the Main Disconnect or Secondary Disconnect Switch shall only be performed by personnel qualified to work on High-Voltage equipment.

NOTE:

The "typical" safety Keylock system shown in Section 2 of the System manual is representative of a Transmitter Keylock configuration only. But the many variations possible that make a determination of which disconnect devices are Keylocked and which are not, is site dependent. Refer to site specific documentation for details.

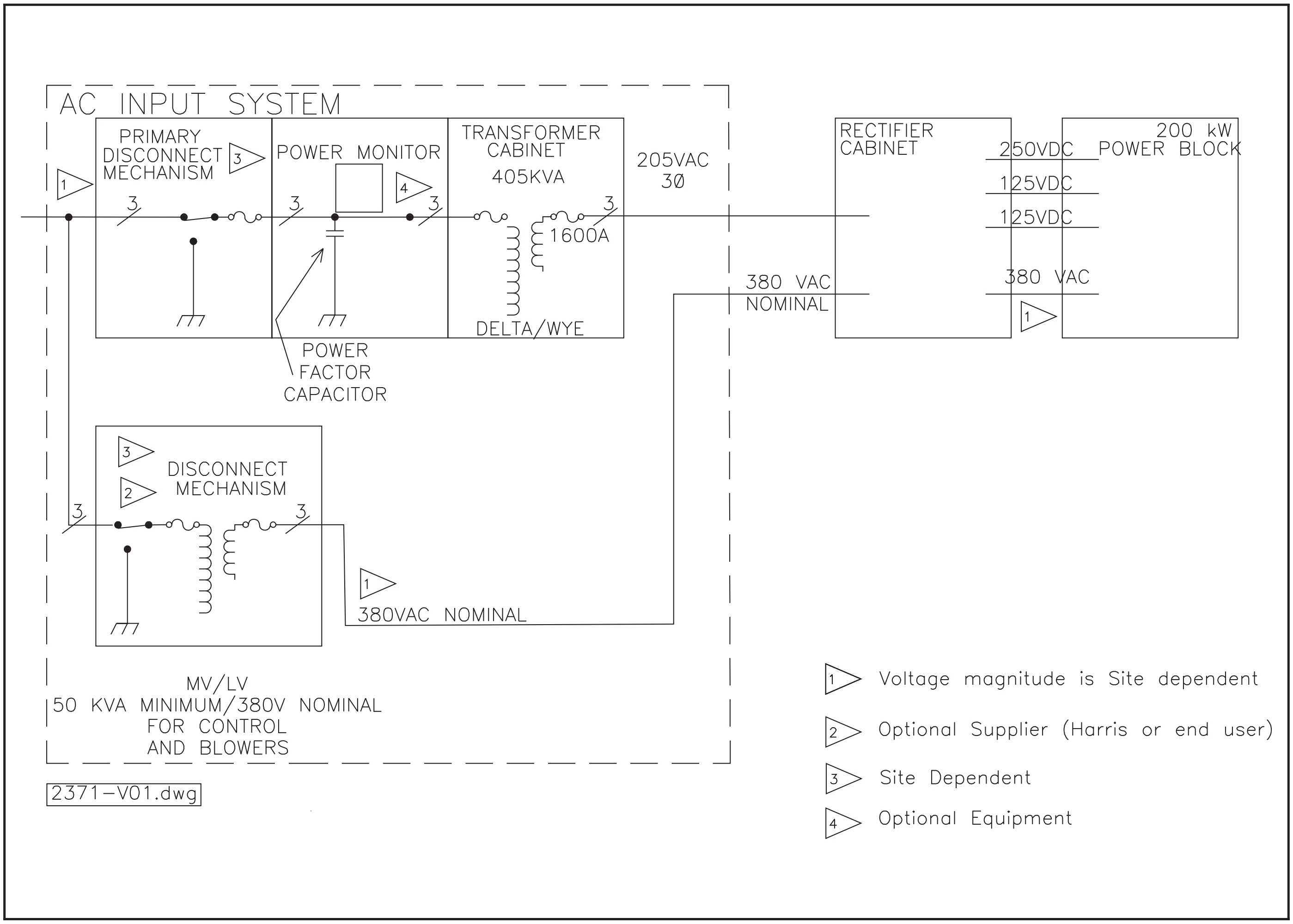


Figure W-1
High Energy (405kVA) and Low Energy (50kVA nominal) Transformer System Configuration

a.1 DX Digital Modulation Technology and Concepts

a.1.1 Digital Terms and Concepts

The discussion of Analog to Digital and Digital to Analog Conversion will include some terms, abbreviations, and concepts used in this Technical Manual which may not be familiar to some Broadcast Station engineers and technicians. A summary is included here for review or reference.

a. ANALOG refers to something that has a continuous range of values, rather than changing in steps. Examples of analog signals are the audio signals from a microphone, a turntable cartridge, or a normal tape playback head.

b. DIGITAL is related to digits, or discrete quantities. An analog signal changes continuously, but a digital signal changes in steps. An analog signal has an infinite number of possible values, and a digital signal has a finite, or limited, number of possible values.

c. BINARY: Has only two possible values. A BINARY NUMBER is a number represented using only the digits 0 and 1. This is useful in electronic circuitry because a circuit can be ON or OFF (two states). A logic signal may be one of two different voltages, referred to as HIGH (binary 1) or LOW (binary 0) in this Technical Manual.

d. BINARY can also refer to a series where each step is either multiplied or divided by two to get the next step. An example, in the transmitter, are the Binary RF combiner steps, which are 1/2 step, 1/4 step, 1/8 step, and 1/16 step. In this series, each step is divided by two to get the next step.

e. BIT: A Binary digit, 0 or 1.

f. DIGITAL WORD: A DIGITAL WORD is a series of numbers, or a group of bits, representing a complete piece of digital information. The term “DIGITAL WORD,” when used here, will always refer to a binary number, which is a series of ones and zeros. The number of BITS in a DIGITAL WORD is the total number of digits (ones and zeros). Examples of a six bit digital word are “010010" and “110101.” A 12 bit digital word is “0100 1000 1101.”

g. MSB: Abbreviation for MOST SIGNIFICANT BIT. In a digital word, as in a decimal number, the first digit represents the largest change, and is the MSB.

h. LSB: Abbreviation for LEAST SIGNIFICANT BIT. In a digital word, as in a decimal number, the last digit represents the smallest change, and is the LSB.

i. BIT 1, BIT 2, etc: In a 12-bit digital word, the bits are numbered from 1 through 12, where Bit 1 is the MSB, and Bit 12 is the LSB.

j. A/D: Also written “A to D.” Abbreviation for “Analog to Digital.”

k. D/A: Also written “D to A.” Abbreviation for “Digital to Analog.”

l. ADC: Abbreviation for “Analog to Digital Converter.

m. DAC": Abbreviation for “Digital to Analog Converter.

Some Basic Digital Circuit Concepts, which will be used in the following discussion and in circuit descriptions, are also included for review or reference.

In logic circuits, representing a digit by either zero or one is useful because it can be represented by a switch or a circuit that is either “off” or “on.” The digits “zero” and “one” may also be represented by a voltage that is LOW for “zero” and HIGH for “one.”

In circuit descriptions and on schematic diagrams, the terms “logic LOW” and “logic HIGH” are used. These terms may also be represented by the letters “L” and “H,” particularly on schematic diagrams. In most of the digital logic circuits, normal TTL (transistor-transistor logic) levels are used, and a “logic LOW” is represented by a voltage near zero (between approximately zero and one Volt), and a “logic HIGH” is represented by a voltage near +5 Volts (between approximately +3.5 and +5 Volts). On block diagrams and on schematic diagrams in this Technical Manual, when a signal description is followed by “-L” or “-H,” the letter indicates the logic state when the signal is ACTIVE. Examples: “RESET-L” indicates that when the signal is logic LOW, a RESET will occur, or a RESET command is being given. “VSWR-H” indicates that when the signal is logic HIGH, a VSWR fault has occurred.

A DIGITAL WORD can represent only a definite number of quantities or steps, depending on the number of bits in the digital word.

If n = the number of bits in the digital word, then:

2^n = the number of quantities that may be represented by that word.

If a digital word has 12 bits, it may represent 2^{12}=4096 quantities.

“VALUE” OF EACH BIT: The least significant bit (LSB) represents one unit. The next least significant bit represents two units. The most significant bit represents 2^n-1 units. Example: In a 5 bit digital word":

Bit 1 (MSB) represents 16 units

Bit 2 represents 8 units

Bit 3 represents 4 units

Bit 4 represents 2 units

Bit 5 (LSB) represents 1 unit.

The basic principles of this new modulation technique are not difficult to understand, especially if we first review some basic principles of amplitude modulation and digital electronics technology. A basic discussion is included in the following paragraphs, as an introduction or review for technical personnel who are not familiar with A/D and D/A conversion techniques. This discussion will provide a background for a discussion of these sections of the transmitter.

a.1.2 Analog to Digital Conversion Process

Before continuing with a description of transmitter circuits, the Analog to Digital (A/D) and Digital to Analog (D/A) conversion processes will be reviewed. This review will provide a background for discussing the transmitter's modulation section.

The Analog to Digital (A/D) conversion process takes place in three steps:

1. Divide the time scale into equal intervals.
2. At each time interval, the amplitude (voltage) of the analog signal is sampled and recorded.
3. For each recorded sample, a digital word is constructed that represents the analog sample.

In the following explanation of these steps, the numbers used do not represent voltages used in the transmitter, but are used only as an example.

STEP 1:

- Divide the time scale into equal intervals.

The analog input signal is a signal which changes with time. (In the transmitter, this is an audio signal). Each interval or division will be a "sample interval."

STEP 2:

Sample and record the analog signal.

The analog to digital converter takes a finite amount of time to convert the analog signal into a digital word. The input to the Analog to Digital Converter should not change during the time that the conversion is taking place. It is necessary to sample the voltage, then store or record it during the conversion. The signal is sampled at the beginning of the time interval.

STEP 3:

For each sample point, construct a digital word that best approximates the analog sample.

A digital word is represented by a series of zeros and ones. Each digit in the digital word is called a "BIT." Each digital word represents a range of analog voltages.

If a five-bit digital word is used, there are 32 possible words, from "00000" to "11111." The total analog voltage range, then, is divided into 32 equal voltage ranges and each digital word represents one of these voltage ranges. Table 4-1 shows some voltage ranges and five-bit digital words for a 0.00 to +8.00 Volt signal. Each digital word represents a range of voltages of (8.00/32=0.25) Volt.

For each time interval in Step 1 (for each "sample interval"), the digital word corresponds to the voltage at the beginning of the time interval, because the analog signal is sampled at the beginning of each time interval. Note that the analog signal amplitude has INFINITE precision (many decimal places), but the digital word has a finite word length, and each digital word length represents a range of voltages. This results in a round off or quantization error. For the 5 bit digital word in the example, the round off error could be as large as 0.25 Volts.

If a longer digital word had been used (more bits in the digital word), the round off or quantization error would be smaller. For example, if the digital word length were 8 bits, it could have any of 256 values (from 0000 0000 through 1111 1111). For an analog signal varying from 0.000 Volts through +8.000 Volts, "0000 0000" would now represent voltages from 0.000 through +0.03125 Volts; "1000 0000" would represent voltages from 4.000 through 4.03125 Volts, and so on. By increasing the digital word length from 5 bits to 8 bits, the maximum round off or quantization error would be reduced from 0.25 Volts to 0.03125 Volts.

A 12 bit digital word could have any of 4096 values, from 0000\0000\0000 through 1111\1111\1111, and would have a still smaller quantization error. As the quantization or round off error becomes smaller, the series of digital words represents the analog signal more closely.

A key point in Analog to Digital Conversion, then, is:

THE MORE BITS THERE ARE IN THE DIGITAL WORD, THE MORE ACCURATE THE REPRESENTATION OF THE ANALOG SIGNAL WILL BE.

The RESOLUTION may be expressed as the number of bits in the digital word. If "n" is the number of bits, the number of steps represented by a digital word is (2^n-1) when the "zero" step is not counted. For a 5 bit word, 2^5-1 = 31 steps; for an 8 bit word, 2^8-1 = 255 steps; and for a 12 bit word 2^{12}-1 = 4095 steps.

Sample Time Interval

The sample time interval used must be short enough so that each significant change in the analog signal is represented by a new digital word. The sample frequency must be at least two times the highest frequency for proper recovery of the analog signal. Higher sample frequencies will reproduce the analog signal more accurately. (The sample time interval, "t" is the inverse of the highest sample frequency "f" so that t=1/f.)

The sampling time interval must also be long enough to allow the analog to digital conversion process to take place. The high speed A/D converter used in the transmitter requires about 0.9 microseconds (900 nanoseconds) for a conversion.

In the transmitter, a 12 bit analog to digital converter (ADC or A/D converter) is used for high resolution. The effective resolution of the digital to analog conversion (DAC or D/A conversion) process in the transmitter's RF power amplifier stage is about 11.4 bits, or about 2,800 steps ($2^{11.4}$ is approximately 2800). RF power amplifier resolution is less than 12 bits because a linear D/A converter is not used; this will be explained later. The sample frequency is between 400 kHz and 820 kHz, depending on the transmitter carrier frequency.

a.1.3 Digital To Analog Conversion

The digital to analog conversion process (D/A conversion) is simply the reverse of the analog to digital (A/D) process, and takes place in two steps:

1. Re-create the analog voltage represented by the digital word by turning on or off units of DC voltage (or RF voltage) and holding it constant for one time interval.
2. Pass the reconstructed audio through a low pass filter to remove the steps. This low pass filter may also be called a reconstruction filter. It acts as a "smoothing filter," removing the steps to provide a high quality analog signal.

STEP 1:

Re-create the analog voltage represented by the digital word. Each bit of the digital word represents some amount of voltage. For a five bit digital word and an analog voltage range of zero to eight Volts (used in Table 1), each bit represents a voltage as follows:

Bit 1, 4.00 Volt (MSB)

Bit 2, 2.00 volt

Bit 3, 1.00 volt

Bit 4, 0.50 volt

Bit 5, 0.25 Volt (LSB)

Note that the Most Significant Bit (MSB) represents one-half of the maximum analog voltage, and each additional bit represents one-half of the voltage of the bit before it.

The analog voltage can be reconstructed by providing a voltage source, either DC or RF, for each of the voltages represented by bits in the digital word, then using these voltages as inputs to a summing circuit with a switch to turn each voltage OFF if the bit is zero or ON if the bit is one. As an example when the input to the A/D converter is +3.914 Volts, the digital word constructed is 01111. The D/A converter, then, sums (2.00 + 1.00 + 0.50 + 0.25) for a total of 3.75 Volts. If the digital word is 00101, the output of the D/A converter is (1.00 + 0.25) = 1.25 Volts.

The least significant bit in the digital word represents 0.25 Volts in this example, so that the output of the D/A converter must change in 0.25 Volt steps. Note that this is the same as the 0.25 Volt quantization error in the example of the Analog to Digital conversion used in the previous section. The analog input voltage to the Analog to Digital converter changes in continuous manner, but the output of the Digital to Analog converter changes in steps. The re-created voltage at the output of the D/A converter is an approximation of the original analog input voltage. The maximum round off or quantization error in the re-created analog voltage is the size of the steps. As the number of bits in the digital word increases, the voltage step represented by the least significant bit becomes smaller, the steps in the re-created analog voltage from the D/A converter become smaller, and the re-created voltage more closely approximates the original analog voltage.

STEP 2:

Pass the reconstructed audio through a low pass filter to remove the steps. Because the low pass filter smooths the steps, it may be called a "smoothing filter"; it is also called a "reconstruction filter" because it reconstructs a better approximation of the original audio signal from the stepped output of the D/A converter.

Sharp "corners," steps, or transitions in a waveform are caused by high frequency harmonics in the signal. The low pass filter attenuates or removes these harmonic frequencies, and therefore also smooths or removes the sharp corners or steps in the waveform.

The Digital to Analog converter output can be any desired voltage, limited only by the switching circuits in the converter. For example, the bits in the digital word could be used to switch voltages of 100, 50, 25, 12.5, and 6.25 Volts, so that the digital word 00101 would produce a D/A converter output of (25 + 6.25) = 31.25 Volts, instead of (1.00 + 0.25) = 1.25 Volts as in the example. The bits in the digital word can also be used to switch Radio Frequency signal voltages on and off to produce a varying or amplitude modulated RF signal.

Digital amplitude modulation simply takes the digital words and turns on and off units of RF voltage instead of DC voltage to create amplitude modulation. Then the transmitter output bandpass filter removes the steps to provide a high quality analog amplitude modulated signal.

Appendix B
Lightning Protection Recommendation

b.1. Introduction

What do you do with a 2 million volt pulse pushing 220,000 amps of current into your transmitting plant? Like the 500 pound gorilla you let it do what ever it wants to. There is not much that can be done to protect against a major direct lightning strike. This is called a significant impulse lightning stroke. It usually lasts less than 100 microseconds and is most destructive to electronic equipment because it contains huge amounts of high frequency energy.

Here are some examples of this damage:

- Melted ball and horn gaps.
- Ground straps burned loose.
- H.V. rectifier stacks shorted.
- Massive arc marks in the output circuit of AM transmitters.
- Ball lightning traveling into building on outer conductor of transmission line.

Figure A-1 is a map of the United States that shows the number of lightning days you can expect in any year. You fellas in Colorado, New Mexico, and Florida need lightning rods on your hats.

Figure b-2 shows the incidents to tall structures. A triggered event is one that happens because the tower was present. Without the tower the strike would not have occurred.

b.2. Environmental Hazards

There are devices and procedures that do offer protection from lessor environmental hazards than lightning. Some of these anomalies are listed and defined:

a. Over voltage/under voltage (brownout). Where the lines voltage differs from the nominal RMS for longer than one cycle.
- Remedy - Automatic voltage regulators, preferably individual regulators on each phase. This can only be accomplished when the power feed line is delta or 4/wire wye connected. (See Figure b-3.)

b. Single phasing. This is where one leg of the three phase service is open.
- Remedy - Protection afforded by a loss of phase detector. Without protection power transformers and 3 phase motors over heat.

c. Radio frequency interference (RFI). This is something we must design into all of our transmitters, however, you may purchase equipment that is susceptible, is not protected, and develop problems.
- Remedy - RFI filters on the ac lines and control lines are sometimes effective. Sometimes the entire device must be enclosed in an RF free space.

d. Electromagnetic pulse (EMP). This is a interfering signal pulse that enters the system by magnetic coupling (transformer). Generally caused by lightning.
- Lightning from cloud to cloud produces horizontally polarized waves while lightning from cloud to earth produce vertically polarized waves. The waves couple into the power lines and transmission lines causing large induced voltage that destroy high voltage rectifier stacks and output circuit faults. High frequency energy is coupled back into the transmitter causing VSWR overloads. (See Figures b-4 & b-5.)
- Remedy - Ball or horn gaps at the base of the antenna prevent the voltage from exceeding some high potential. Transient suppresser devices on the input power lines remove excessive voltage spikes. Buried power and transmission lines will reduce the amount of coupled energy to a great extent. This does not totally eliminate the problem because there are currents traveling in the earth when lightning strikes close to the station which prefer to travel on the metal conductors.

e. Surge. A rapid increase in voltage on the power lines usually caused by lightning. The duration is less than 1/2 cycle and can be very destructive.
- Remedy - Transient protectors are very effective in preventing damage to the equipment when properly designed and installed. (See Figure b-7.)

Significant Lightning Stroke Characteristics	
Charge Range	2 to 200 coulombs
Peak Currents	2,000 to 400,000 Amperes
Rise Time to 90%	300 Nanoseconds to 10 Microseconds
Duration to 50%	100 Microseconds to 10 Milliseconds
Potential Energy at 99%	1010 Joules*
* Only a small portion is manifested in a surge, usually less than 10,000 Joules.	

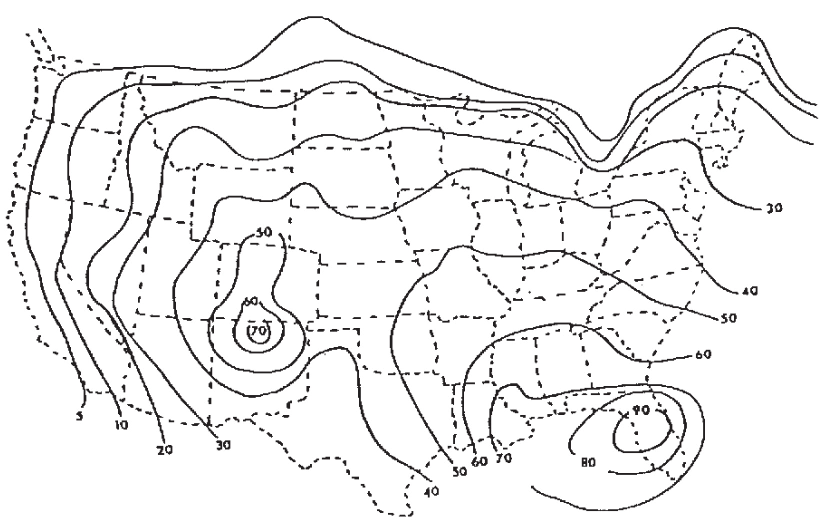


Figure b-1. Isokeraunic Map of the United States

b.3. What Can Be Done?

Installation of the transmitter building, antenna tuning unit if applicable, and antenna should be done so that the risk of destruction due to lightning is minimal and the efficiency of the over all system is maximized. To do this, separate ground systems should be installed for the building and antenna. This forces all of the RF return currents to flow in the transmission line shield. The coax can be buried below the antenna ground plane to still further reduce the RF current coupled to it.

In medium and short wave installations the antenna ground plane is very important as it is ½ of the radiating element. RF current leaving the antenna must return via the ground path (ground wave). For this reason the “antenna coupling unit” must be close to the base of the tower and securely connected to the ground plane.

Figure A-6 shows the basic elements of a properly designed antenna system.

- Good ground plane.
- Ball gap on tower.
- Series inductor in tower feeder.
- Antenna coupling unit connected to antenna ground.
- The π circuit is equivalent to the normal Tee used by Harris.
- Underground coax.
- Guy wire length broken by insulators and grounded at the bottom end.

The transmitter building must be given extra protection to insure reliable equipment operation. A low impedance safety ground system must be installed using 3 inch wide copper strap hard soldered at all joints and connected to multiple ground rods located at the perimeter of the building. The ground rods should be wet to make good connection to the earth water table. All equipment cabinets within the building must be connected to the ground straps for safety reasons.

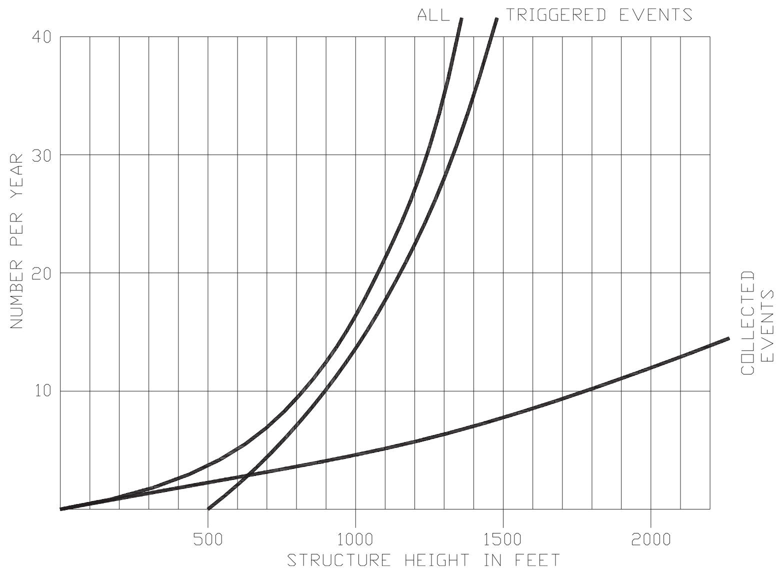


Figure b-2. Lightning Incidents to Tall Structures

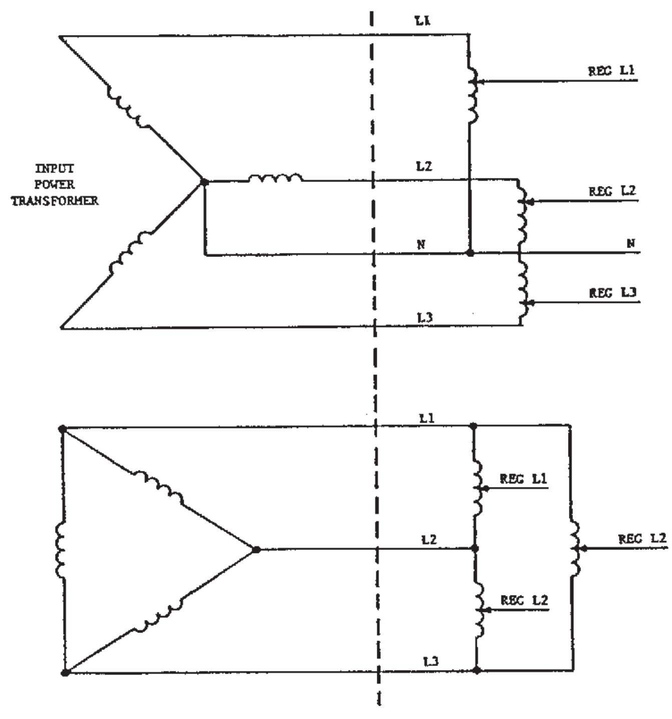


Figure b-3. Regulators in Delta and 4/Wire WYE Systems

b.4. AC Service Protection

See Figure b-7. All incoming ac lines should have a choke connected in series to limit the high frequency surges on the lines followed by a surge protector. The surge protector must be connected to the building ground system by short direct connections.

A surge protector is a solid state device that is a high impedance until the voltage across it reaches its rated clamping voltage at which time the impedance suddenly decreases. The protector will then conduct hundreds to thousands of amperes to ground. All protectors are rated for maximum voltage and maximum surge energy. If the surge energy exceeds rating of the device it will normally short and for this reason must be fused so it will disconnect itself from the line being protected. When this happens all protection is lost so some warning system must be used to tell the operators that a new protector should be installed.

Speed is essential to protect equipment from current surges with rates of rise exceeding 10,000 amps per microsecond and pulses that last no longer than 100 microseconds. Very short, low inductance ground straps are required to pass surges of this type.

The surge protectors must be selected for the line to ground voltage and the maximum energy to be diverted. Bigger is always better in this case. There are several manufacturers of surge protectors:

- Lightning Elimination Assoc., Inc.
- Current Technology
- Control Concept

WARNING: Disconnect primary power prior to servicing.

- MCG Electronics, Inc.
- EFI Corp.
- General Electric

All of these vendors provide parts and systems to protect broadcast transmitters.

All audio and control lines should be protected the same as described for ac lines with components sized accordingly.

All coaxial lines should have the shield connected to the system ground at the point of entrance and in addition have a ferrite choke around it located between the entrance point and the equipment rack. This will provide a high impedance for current flowing in the shield but does not affect the signal currents.

b.5. Conclusion

The 1% chance of a major lightning strike probably can not be protected against but the other 99% can be controlled and damage prevented. Install surge protection on all incoming and outgoing lines at the wall of the building connected to a well designed ground system. Properly install the antenna ground system with spark gap adjusted correctly and maintained. With this done you can sleep peacefully at night if your bed isn't under the feed line.

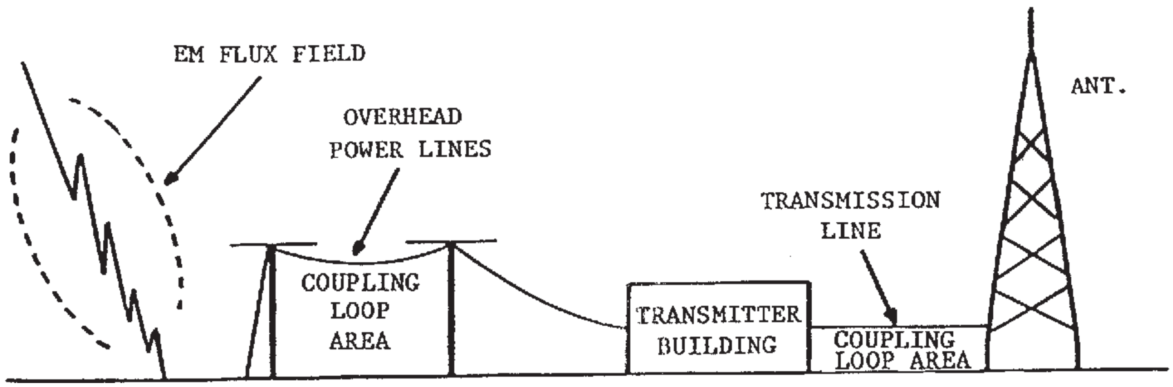


Figure b-4. EM Flux Field

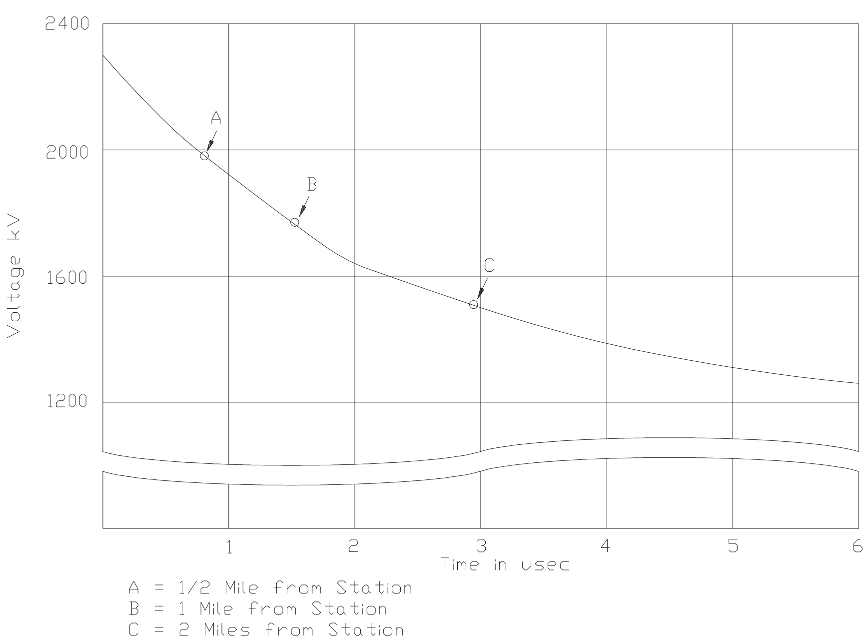


Figure b-5. Sample Surge Voltage as a Function of

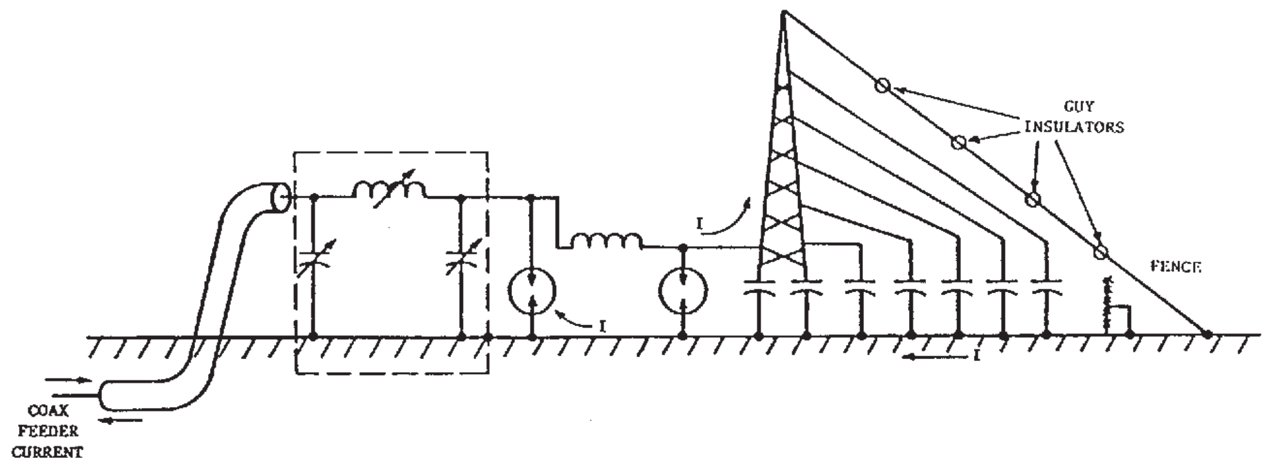


Figure b-6. Basic Elements of a Properly Designed

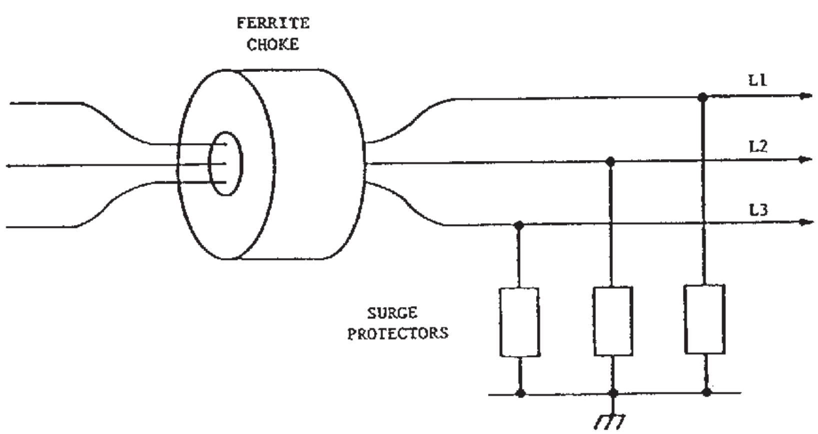


Figure b-7. Surge Protectors and Ferrite Choke