Instruction Manual

Innovator® HXB Series

Digital UHF
Solid State
Transmitter

Volume 2
UHF Amplifier Cabinet

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Axcera®

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Chapter 1: Introduction

The Innovator® HXB Series UHF digital solid-state transmitter is comprised of two cabinet types: An exciter/control cabinet and a UHF amplifier cabinet. Every Innovator® HXB includes one or more of each cabinet type, dependent upon the power configuration ordered. This volume, Volume 2, of the manual describes the UHF amplifier cabinet portion of the transmitter. The system and the exciter/control assemblies are covered in Volume 1.

1.1: Manual Overview

Volume 2, of the Innovator HXB Series Digital UHF Transmitter Instruction Manual, is divided into three chapters and supporting appendices. **Chapter 1**, Introduction, contains information on safety, return procedures, and warranties. **Chapter 2,** Amplifier Cabinet, describes the UHF amplifier cabinet. **Chapter 3,** UHF Amplifier Tray Assembly and Cabinet Assemblies Circuit Descriptions, contains a detailed discussion of the UHF amplifier module and power supply assemblies that are contained in the cabinet. **Appendix A** contains the RF amplifier cabinet assembly drawings and parts lists. **Appendix B** contains the UHF amplifier Tray assembly drawings and parts lists. **Appendix C** contains the top and bottom +48VDC power supply assemblies' drawings and parts lists.

1.2: Safety

The HXB Series UHF transmitters manufactured by Axcera are designed to be easy to use and repair while providing protection from electrical and mechanical hazards. Listed throughout the manual are notes, cautions, and warnings concerning possible safety hazards that may be encountered while operating or servicing the transmitter. It is important that users review these warnings and become familiar with the operation and servicing procedures before working on the transmitter.

Hazardous Accessibility – Axcera has made attempts to provide appropriate connectors, wiring and shields to minimize hazardous accessibility.

Circuit Breakers and Wiring – All circuit breakers and wire are UL and CE rated and are rated for maximum operating conditions.

Single Point Breaker or Disconnect - The customer should provide a single point breaker or disconnect at the breaker box for the main AC input connection to the transmitter.

Transmitter Ratings - The transmitter ratings are provided in the text of this manual along with voltage and current values for the equipment.

Protective Earthing Terminal – A main protective earthing terminal is provided for equipment required to have protective earthing.

Read All Instructions – All of the operating and safety instructions should be read and understood before operating this equipment.

Retain Manuals – The manuals for the equipment should be retained at the site in which the equipment is operating for future reference. We provide two sets of manuals for this purpose; one set can be left at the office while one set can be kept at the site.

Heed all Notes, Warnings, and Cautions – All of the notes, warnings, and cautions listed in this safety section and throughout the manual must be followed.

Follow Instructions – All of the operating and use instructions for the product should be followed.

Cleaning – Unplug or otherwise disconnect all power from the equipment before cleaning. Do not use liquid or aerosol cleaners. Use a damp cloth for cleaning.

Ventilation – Openings in the cabinet and module front panels are provided for ventilation. To ensure the reliable operation of the transmitter, and to protect the unit from overheating, these openings must not be blocked.

Servicing – Do not attempt to service this product yourself until becoming familiar with the equipment. If in doubt, refer all servicing questions to qualified Axcera service personnel.

Replacement Parts – When replacement parts are needed, be sure that the parts have the same functional and performance characteristics as the original part. Unauthorized substitutions may result in fire, electric shock, or other hazards. Please contact the Axcera Technical Service Department if you have any questions regarding service or replacement parts.

1.3: Assembly Designators

Axcera has assigned assembly numbers, Ax designations such as A1, where x=1,2,3…etc, to all assemblies, modules, and boards in the system. These designations are referenced in the text of this manual and shown on the block diagrams and interconnect drawings provided in the appendices. The Block Diagrams, Interconnects, Schematics, Assembly Drawings and Parts Lists are arranged in increasing numerical order in the appendices. Section titles in the text for assembly or module descriptions or alignment procedures contain the associated part number(s) and the relevant appendix that contains the drawings for that item.

The cables that connect between the boards within a tray or assembly and that connect between the trays, racks and cabinets are labeled using markers. Figure 1 is an example of a marked cable. There may be as few as two or as many as four Markers on any one cable. These markers are read starting farthest from the connector. If there are four Markers, the marker farthest from the connector is the system number such as system 1 or translator 2. The next or the farthest Marker is the rack or cabinet "A" number on an interconnect cable or the board "A" number when the cable is within a tray. The next number on an interconnect cable is the Tray location or Board "A" number. The marker closest to the connector is the jack or connector "J" number on an interconnect cable or the jack or connector "J" number on the board when the cable is within a tray.

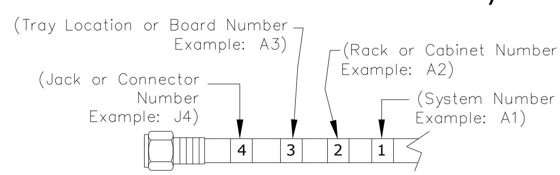


Figure 1-1: Marker Identification Drawing

1.4: Material Return Procedure

To insure the efficient handling of equipment or components that have been returned for repair, Axcera requests that each returned item be accompanied by a Return Material Authorization Number (RMA#).

The RMA# can be obtained from any Axcera Service Engineer by contacting the Axcera Technical Service Department at 1-724-873-8100 or by fax at 1-724-873-8105. This procedure applies to all items sent to the Technical Service Department regardless of whether the item was originally manufactured by Axcera.

When equipment is sent to the field on loan, the RMA# is included with the unit. The RMA# is intended to be used when the unit is returned to Axcera. In addition, all shipping material should be retained for the return of the unit to Axcera.

Replacement assemblies are also sent with the RMA# to allow for the proper routing of the exchanged hardware. Failure to close out this type of RMA# will normally result in the customer being invoiced for the value of the loaner item or the exchange assembly.

When shipping an item to Axcera, please include the RMA# on the packing list and on the Axcera-provided shipping container. The packing slip should also include contact information and a brief description of why the unit is being returned.

Please forward all RMA items to:

Axcera
Customer Service Department
103 Freedom Drive
P.O. Box 525
Lawrence, PA 15055-0525 USA

For more information concerning this procedure, call the Axcera Technical Service Department.

Service can also be contacted through e-mail at **service@axcera.com** and on the Web at **www.axcera.com**.

1.5: Limited One-Year Warranty for Axcera Products

Axcera warrants each new product that it has manufactured and sold against defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment from Axcera's plant, when operated in accordance with Axcera's operating instructions. This warranty shall not apply to tubes, fuses, batteries, or bulbs.

Warranties are valid only when and if (a) Axcera receives prompt written notice of breach within the period of warranty, (b) the defective product is properly packed and returned by the buyer (transportation and insurance prepaid), and (c) Axcera determines, in its sole judgment, that the product is defective and not subject to any misuse, neglect, improper installation, negligence, accident, or (unless authorized in writing by Axcera) repair or alteration.

Axcera's exclusive liability for any personal and/or property damage (including direct, consequential, or incidental) caused by the breach of any or all warranties, shall be limited to the following: (a) repairing or replacing (in Axcera's sole discretion) any defective parts free of charge (F.O.B. Axcera’s plant) and/or (b) crediting (in Axcera's sole discretion) all or a portion of the purchase price to the buyer.

Equipment furnished by Axcera, but not bearing its trade name, shall bear no warranties other than the special hours-of-use or other warranties extended by or enforceable against the manufacturer at the time of delivery to the buyer. **NO WARRANTIES, WHETHER STATUTORY, EXPRESSED, OR IMPLIED, AND NO WARRANTIES OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR FREEDOM FROM INFRINGEMENT, OR THE LIKE, OTHER THAN AS SPECIFIED IN PATENT LIABILITY ARTICLES, AND IN THIS ARTICLE, SHALL APPLY TO THE EQUIPMENT FURNISHED HEREUNDER.**

☞ WARNING!!!

≺ HIGH VOLTAGE ≻

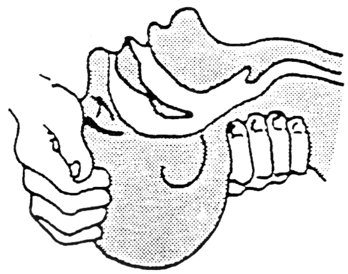
DO NOT ATTEMPT TO REPAIR OR TROUBLESHOOT THIS EQUIPMENT UNLESS YOU ARE FAMILIAR WITH ITS OPERATION AND EXPERIENCED IN SERVICING HIGH VOLTAGE EQUIPMENT. LETHAL VOLTAGES ARE PRESENT WHEN POWER IS APPLIED TO THIS SYSTEM. IF POSSIBLE, TURN OFF POWER BEFORE MAKING ADJUSTMENTS TO THE SYSTEM.

★ RADIO FREQUENCY RADIATION HAZARD ★

MICROWAVE, RF AMPLIFIERS AND TUBES GENERATE HAZARDOUS RF RADIATION THAT CAN CAUSE SEVERE INJURY INCLUDING CATARACTS, WHICH CAN RESULT IN BLINDNESS. SOME CARDIAC PACEMAKERS MAY BE AFFECTED BY THE RF ENERGY EMITTED BY RF AND MICROWAVE AMPLIFIERS. NEVER OPERATE THE TRANSMITTER SYSTEM WITHOUT A PROPERLY MATCHED RF ENERGY ABSORBING LOAD ATTACHED. KEEP PERSONNEL AWAY FROM OPEN WAVEGUIDES AND ANTENNAS. NEVER LOOK INTO AN OPEN WAVEGUIDE OR ANTENNA. MONITOR ALL PARTS OF THE RF SYSTEM FOR RADIATION LEAKAGE AT REGULAR INTERVALS.

EMERGENCY FIRST AID INSTRUCTIONS

Personnel engaged in the installation, operation, or maintenance of this equipment are urged to become familiar with the following rules both in theory and practice. It is the duty of all operating personnel to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.



RESCUE BREATHING

1. Find out if the person is breathing.

You must find out if the person has stopped breathing. If you think he is not breathing, place him flat on his back. Put your ear close to his mouth and look at his chest. If he is breathing you can feel the air on your cheek. You can see his chest move up and down. If you do not feel the air or see the chest move, he is not breathing.

2. If he is not breathing, open the airway by tilting his head backwards.

Lift up his neck with one hand and push down on his forehead with the other. This opens the airway. Sometimes doing this will let the person breathe again by himself.

3. If he is still not breathing, begin rescue breathing.

-Keep his head tilted backward. Pinch nose shut.
-Put your mouth tightly over his mouth.
-Blow into his mouth once every five seconds.
-DO NOT STOP rescue breathing until help arrives.

LOOSEN CLOTHING - KEEP WARM

Do this when the victim is breathing by himself or help is available. Keep him as quiet as possible and from becoming chilled. Otherwise treat him for shock.

BURNS

SKIN REDDENED: Apply ice cold water to burned area to prevent burn from going deeper into skin tissue. Cover area with a clean sheet or cloth to keep away air. Consult a physician.

SKIN BLISTERED OR FLESH CHARRED: Apply ice cold water to burned area to prevent burn from going deeper into skin tissue. Cover area with clean sheet or cloth to keep away air. Treat victim for shock and take to hospital.

EXTENSIVE BURN - SKIN BROKEN: Cover area with clean sheet or cloth to keep away air. Treat victim for shock and take to hospital.

Chapter 2: Amplifier Cabinet

2.1: Cabinet Overview

The fully populated amplifier cabinets used in Innovator HXB Transmitters contain eight UHF amplifiers connected in parallel (Figure 2-1). The number of amplifiers varies according to the needed output power for the transmitter. The amplifiers operate, without the need for tuning or alignment, on the UHF channel designated.

All equipment in the cabinet is fully solid-state and designed for high-operational reliability and a service-friendly layout. The cabinet is cooled by external air cooling equipment. The cooling air is ducted into and out of the top of the cabinet.

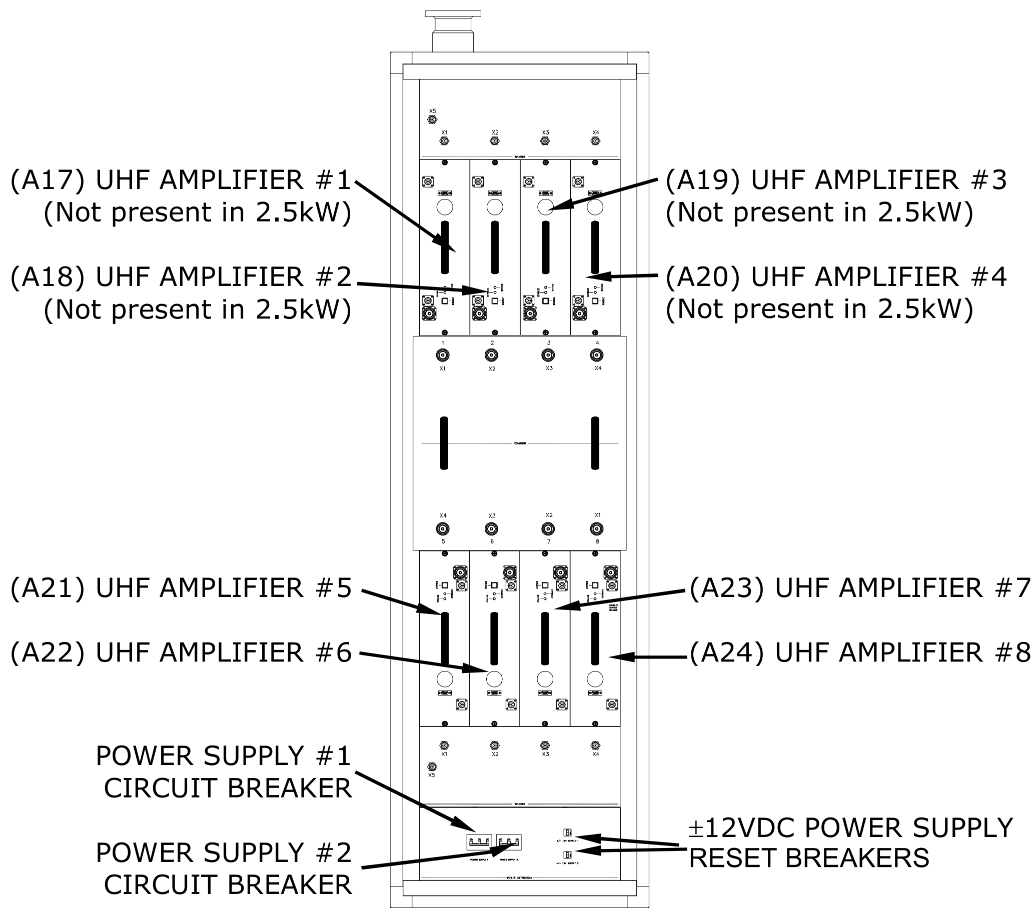


Figure 2-1: Typical 8 Way UHF Amplifier Cabinet (Front View)

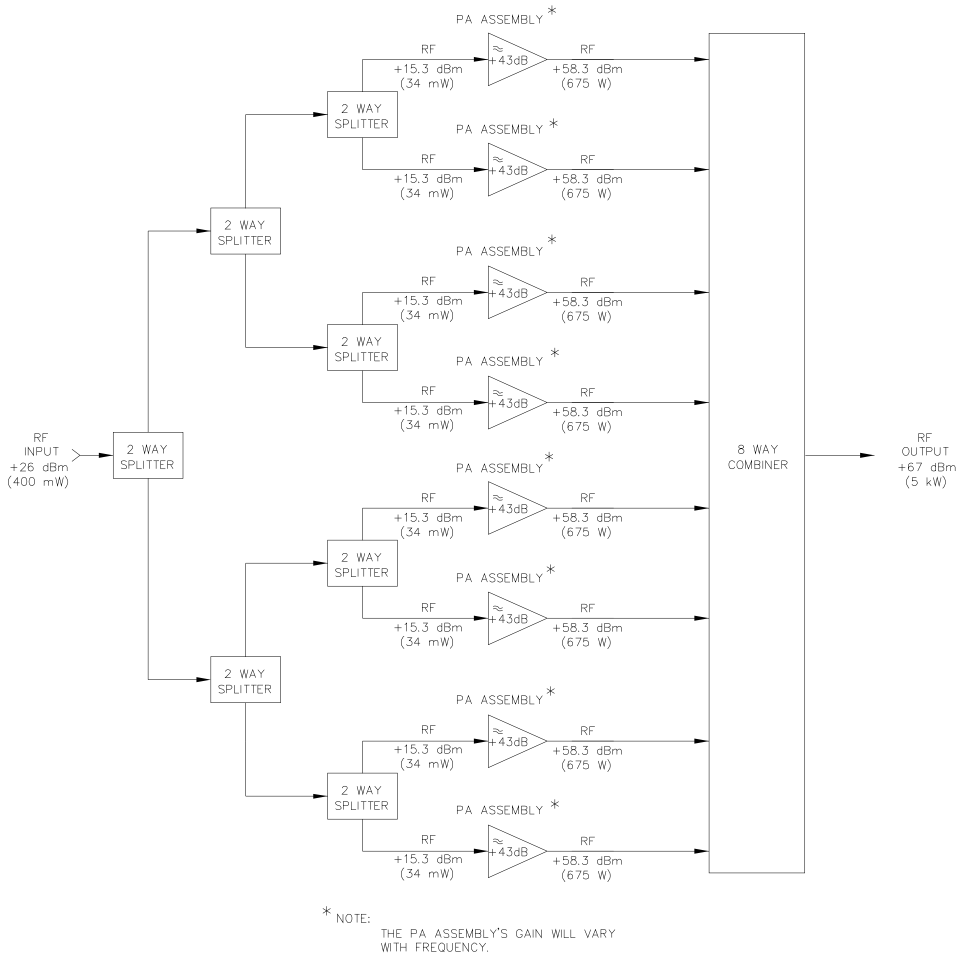


Figure 2-2: Block Diagram of the typical UHF Amplifier Cabinet 8 Way (5kW)

2.2: Description of the UHF Amplifier Cabinet

The features of the amplifier cabinet include: 1) Amplifiers that are 100% transistors. 2) High redundancy due to the parallel connection of power transistors. 3) A mean junction temperatures less than 120° C. 4) Multiple fault protection circuitry in each amplifier. 5) A power supply for Amplifiers 1 thru 3 (3.7kW) and 4 (5kW). 6) A separate power supply for Amplifiers 6 thru 8 (1.8kW) and 5 (2.5kW & 5kW). 7) Amplifiers that operate over the selected band of UHF frequencies without the need for alignment. 8) The important operating parameters are displayed in the transmitter touch screen control unit. 9) There are multiple test points in the signal path. 10) It has air cooling, with the input and output air connections on the top of the amplifier cabinet.

The amplifier assemblies in each amplifier cabinet (see Figure 2-3) are slide-in units, inserted from the front. In a 5kW cabinet, two 4 way splitters are installed, one in the top and one in the bottom half of the cabinet. In a 2.5 kW cabinet, just the bottom 4 way splitter is present. These splitters distribute the RF input to each of the amplifiers. In a 3.7kW cabinet, 3 way splitters are installed in the top and bottom half of the cabinet. In a 1.8 kW cabinet, just the bottom 3 way splitter is present. These distribute the RF input to each of the amplifiers. A 3, 4, 6 or 8 way combiner is installed in the middle of the cabinet. The lower part of the cabinet accommodates a power distribution panel that contains two 480

VAC 30 Amp 3 Phase or 208 VAC 50 Amp 3 Phase circuit breakers for 3.7 & 5 kW or one circuit breaker for 1.8 & 2.5 kW. The left breaker, if present, distributes the main AC voltage to the top power supply and the right circuit breaker controls the bottom power supply. The top power supply provides the +48 VDC to the top three or four amplifier assemblies. The bottom power supply provides the +48 VDC to the bottom three or four amplifier assemblies

There is also either one or two 1 Amp reset circuit breakers, mounted on the power distribution panel that protect the AC voltage to the switching power supply, located in the bottom and top power supply. If one breaker is present, it connects to the bottom power supply, for 1.8 & 2.5 kW. If 2 one Amp reset breakers are present, the second one amp breaker connects to the top power supply for 3.7 & 5 kW. The switching supply provides the ±12 VDC to the top and bottom amplifier assemblies.

2.2.1: 5 kW Amplifier Cabinet with 8 Amplifier Assemblies

Refer to Figure 2-2. The DTV RF signal from the exciter/control cabinet is connected through RG-55 cable through an opening in the roof in the UHF amplifier cabinet. The RF (+26 dBm, 400 mW) from the output of the exciter control cabinet connects to the SMA “S” input on (A14) a 2 way splitter with each of the two outputs connecting to a 4 way splitter panel (A15 top & A16 bottom). The four outputs of the (A15-A1) Top 4 way splitter are at the “N” connectors X1-X4.

The outputs (+15.3 dBm, 34 mW) connect to the (A17) UHF amplifier #1, (A18) UHF amplifier #2, (A19) UHF amplifier #3 and (A20) UHF amplifier #4. Each amplifier tray has a gain of approximately +40.5dB. The four outputs of the (A16-A1) Bottom 4 way splitter, at “N” connectors X1-X4, connect to the (A21) UHF amplifier #5, (A22) UHF amplifier #6, (A23) UHF amplifier #7, and (A24) UHF amplifier #8. The eight outputs of the amplifier modules at 7/16” connectors (+58.3 dBm, 675W) are cabled to the (A24) 8 way combiner. The output of the combiner connects to the (A26) RF coupler. The output of the cabinet is approximately (+67.2 dBm, 5.2kW) at the 3-1/8” output connector of the (A26) RF Coupler Assembly.

2.2.2: 3.7 kW Amplifier Cabinet with 6 Amplifier Assemblies

The DTV RF signal from the exciter/control cabinet is connected through RG-55 cable through an opening in the roof in the UHF amplifier cabinet. The RF (+27 dBm, 500 mW) from the output of the exciter control cabinet connects to the SMA “S” input on (A14) a 2 way splitter with each of the two outputs connecting to a 3 way splitter panel (A15 top & A16 bottom). The three outputs of the (A15) Top 3 way splitter are at the “N” connectors X1-X3.

The outputs (+18 dBm, 63 mW) connect to the (A17) UHF amplifier #1, (A18) UHF amplifier #2 and (A19) UHF amplifier #3. The three outputs of the (A16) Bottom 3 way splitter, at “N” connectors X2-X4, connect to the (A22) UHF amplifier #6, (A23) UHF amplifier #7, and (A24) UHF amplifier #8. Each amplifier tray has a gain of approximately +40.5dB. The six outputs of the amplifier modules at 7/16” connectors (+58.5 dBm, 700W) are cabled to the (A24) 6 way combiner. The output of the combiner connects to the (A26) RF coupler. The output of the cabinet is approximately (+65.7 dBm, 3.7 kW) at the 3-1/8” output connector of the (A26) RF Coupler Assembly.

2.2.3: 2.5 kW Amplifier Cabinet with 4 Amplifier Assemblies

Refer to Figure 2-3. The DTV RF signal from the exciter/control cabinet is connected through RG-55 cable through an opening in the roof in the UHF amplifier cabinet. The RF (+26 dBm, 400 mW) from the output of the exciter control cabinet connects to the 4 way splitter panel (A16) mounted at the bottom of the cabinet. The four outputs of the (A16-A1) 4 way splitter, at "N" connectors X1-X4, connect to the (A21) UHF amplifier #5, (A22) UHF amplifier #6, (A23) UHF amplifier #7, and (A24) UHF amplifier #8. Each amplifier tray has a gain of approximately +40.5dB. The four outputs of the amplifier modules at 7/16" connectors (+58.5 dBm, 700W) are cabled to the (A25) 4 way combiner assembly. The combiner produces a single output that connects to the (A26) RF Coupler Assembly. The RF output for the cabinet, approximately +64.1 dBm, 2570 Watts, is at the 3-1/8" output connector of the RF Coupler Assembly.

2.2.4: 1.8 kW Amplifier Cabinet with 3 Amplifier Assemblies

The DTV RF signal from the exciter/control cabinet is connected through RG-55 cable through an opening in the roof in the UHF amplifier cabinet. The RF (+27 dBm, 500 mW) from the output of the exciter control cabinet connects to the 3 way splitter panel (A16) mounted at the bottom of the cabinet. The three outputs of the (A16) 3 way splitter, at "N" connectors X2-X4, connect to the (A22) UHF amplifier #6, (A23) UHF amplifier #7, and (A24) UHF amplifier #8. Each amplifier tray has a gain of approximately +40.5dB. The three outputs of the amplifier modules at 7/16" connectors (+58.5 dBm, 700W) are cabled to the (A25) 3 way combiner assembly. The combiner produces a single output that connects to the (A26) RF Coupler Assembly. The RF output for the cabinet, approximately +62.6 dBm, 1800 Watts, is at the 3-1/8" output connector of the RF Coupler Assembly.

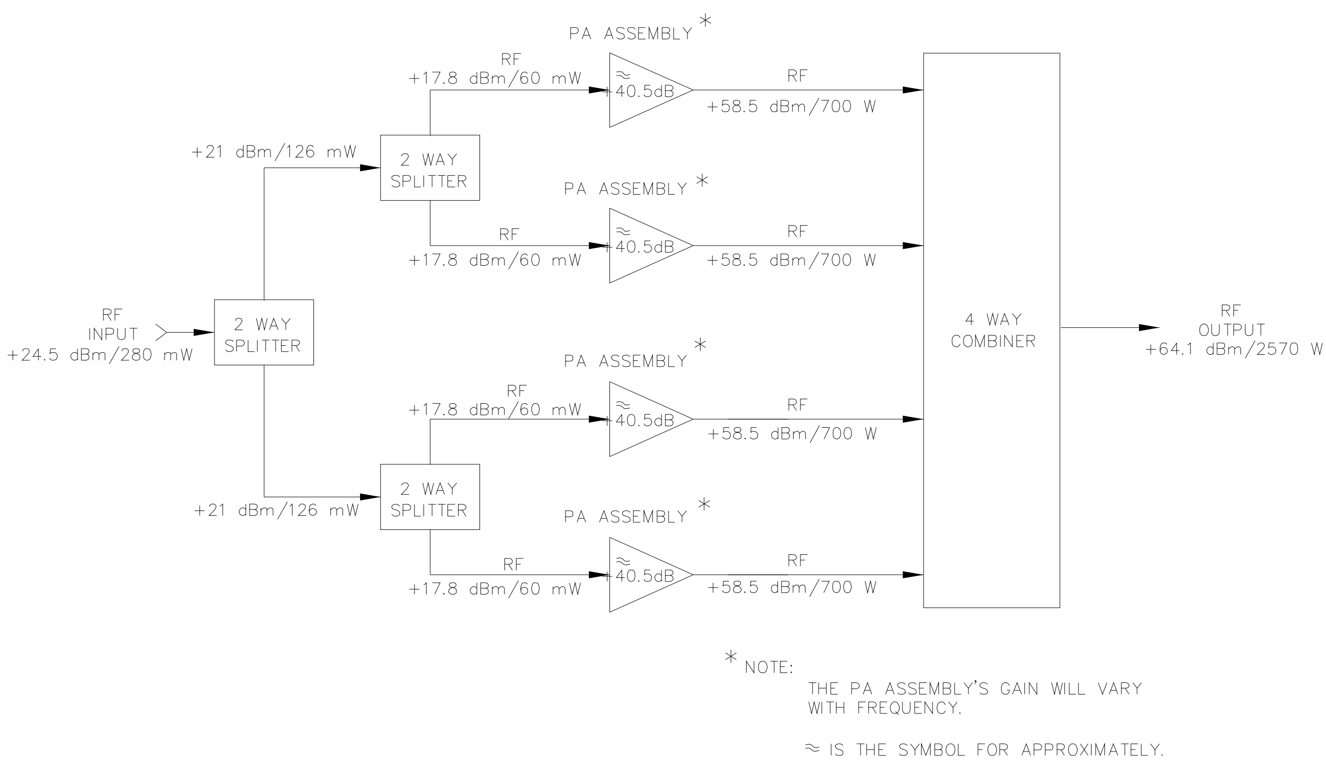


Figure 2-3: Block Diagram of the typical UHF Amplifier Cabinet 4 Way (2.5kW)

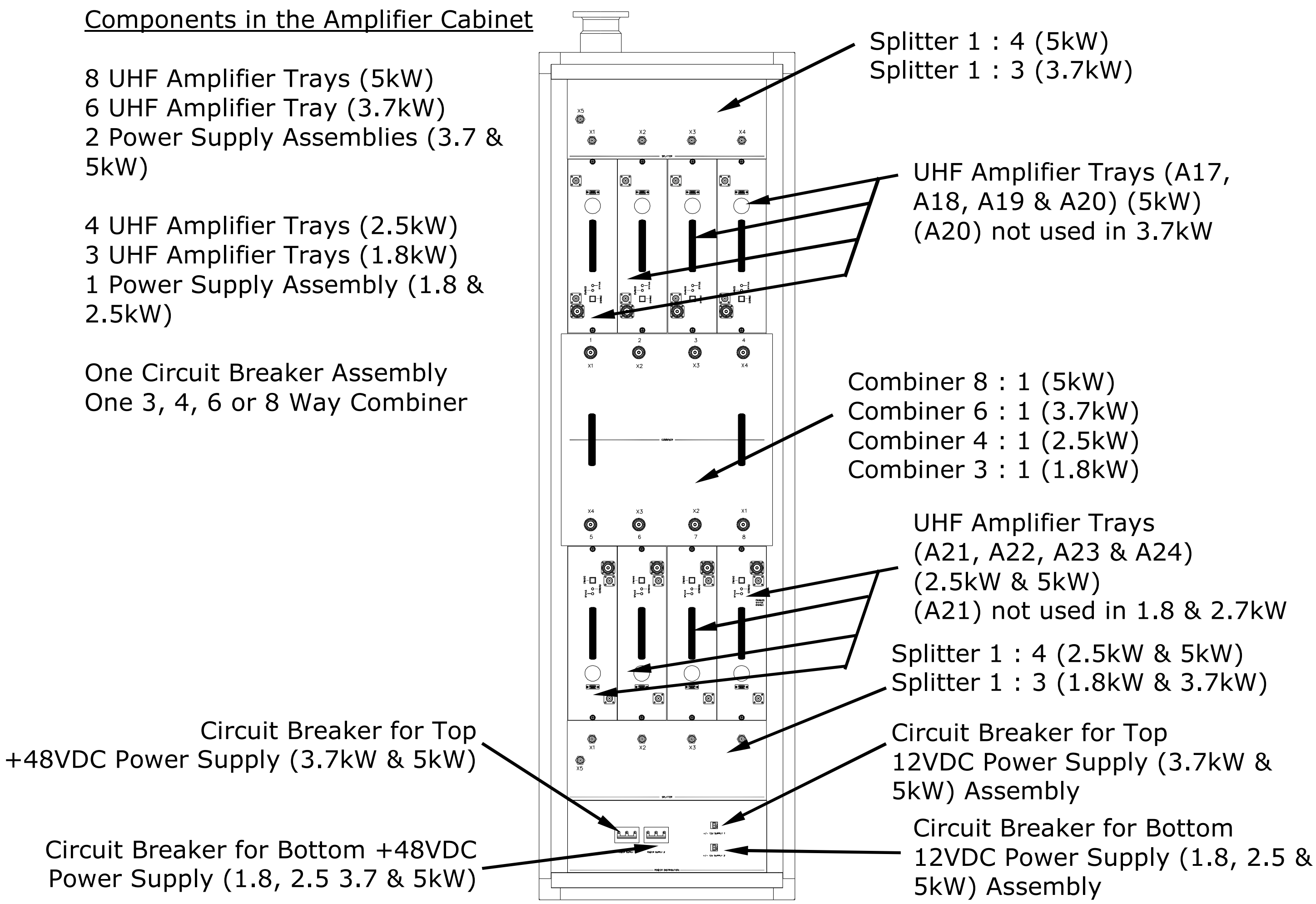


Figure 2-4: Components in the Amplifier Cabinet

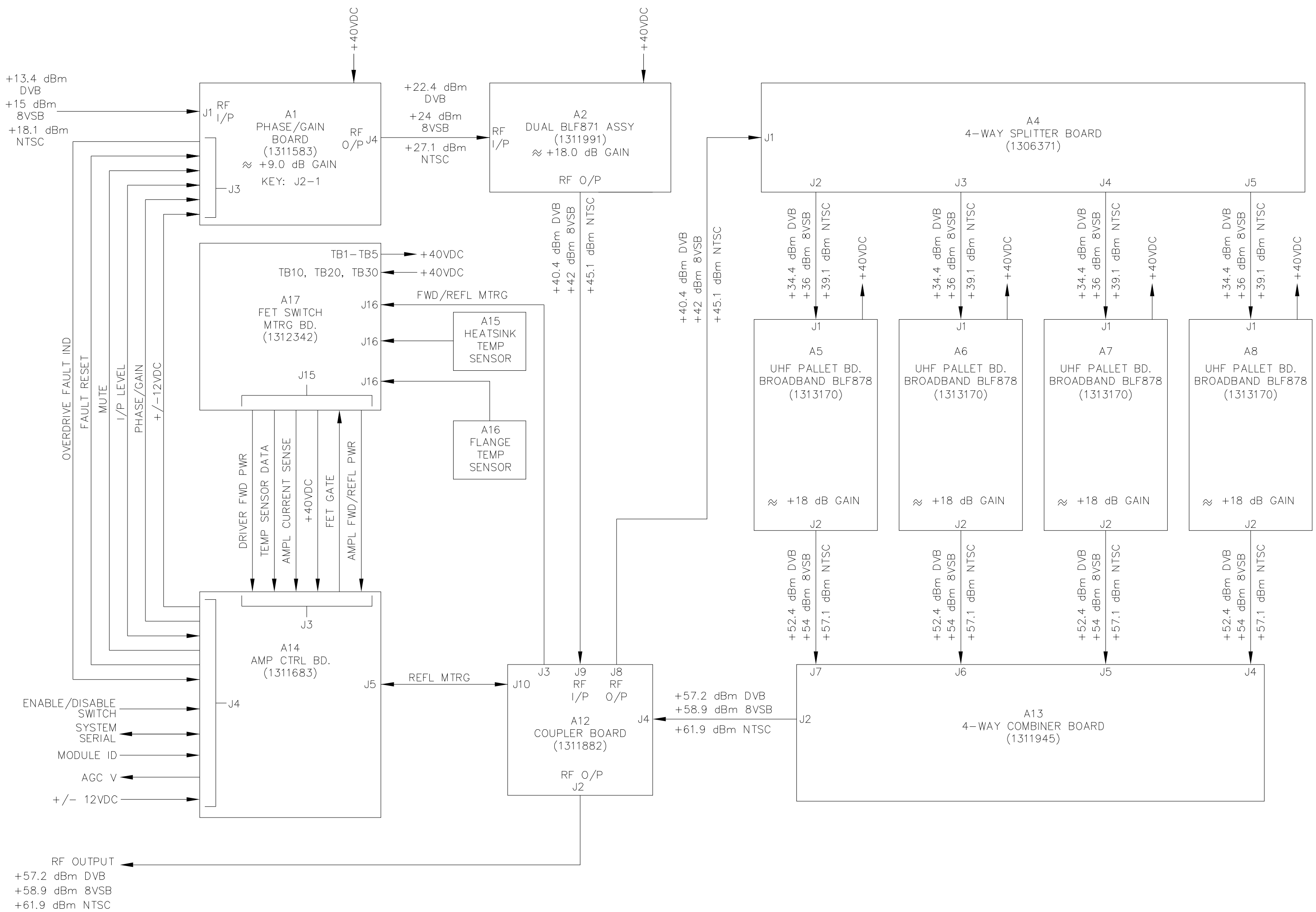


Figure 2-5: Block Diagram Typical UHF Amplifier Tray Assembly

2.3: Description of the HXB UHF Amplifier Tray (1311943; Appendix B)

There are eight of these trays in an 8 way Amplifier Cabinet Assembly for 5kW, six in a 6 way Amplifier Cabinet Assembly for 3.7 kW, four in a 4 way Amplifier Cabinet Assembly for 2.5 kW, or three in a 3 way Amplifier Cabinet Assembly for 1.8 kW. The Amplifier Tray has an approximate gain of +40.5 dB.

The RF input (+15 dBm ATSC) at the "N" connector J1 on each UHF amplifier assembly is fed to the RF input connections on (A1) the Phase/Gain Board (1311583), whichprovides phase adjustment and gain control of the RF signall. The Phase/Gain Board is also a predriver with ≈9 dB gain. The output (+24 dBm) is cabled to the RF input connections on (A2) a Dual BLF871 Amplifier Pallet Assembly (1311991) with ≈18 dB gain. The output (+42 dBm) is fed to J9 on (A12) a Coupler Board (1311882) that supplies a driver forward power sample out of J3-5 to the FET switch/metering board at J1-1. The sample is not used on the FET switch/metering board (1312342); it is just fed through to J15-1 that is wired to J3-13 on the (A14) amplifier control board (1311683) where it is used in the amplifier protection circuitry. The output of the coupler board at J8 (+42 dBm) is fed to J1 on (A4) the 4 Way Splitter Board (1306371) where it is split. Each output of the splitter (+36 dBm) is cabled to the RF Input jack of one of the four (A5-A8), UHF pallet broadband amplifier boards, BLF878 (1313170). Each pallet board has ≈+18 dB of gain. The outputs of each amplifier board (+54 dBm) are combined on (A13) the 4 way broadband combiner assembly, (1311945).

The RF output jack J2, of the 4 way combiner assembly (+58.9 dBm), is Bus wire jumpered to J4 on the (A12) Coupler Board (131882) that supplies a RF sample out at J1, that connects to the front panel. Also, the Coupler Board provides a final amp forward metering sample at J3-1 and a final amp reflected metering sample at J3-2. The samples are connected to (A17) the FET switch/ metering board (1312342) at J1-6 and J1-7. The samples are not used on the FET switch/metering board, they are just fed through to J15-2 and J15-14 that are wired to J3-12 and J3-25 on the amplifier control board where they are used in the amplifier protection circuitry. The RF output of the coupler board is at J2 that is Bus wire connected to J2 the 7/16" connector RF Output Jack of the amplifier assembly. Typical output level is +58.9 dBm ATSC.

2.3.1: Description of the 8 Way Combiner Assembly (5 kW Amplifier Cabinet)

The RF outputs of the eight amplifiers are combined by means of an 8:1 combiner assembly that is mounted in the middle of the cabinet. The 8 way combiner is made up of two identical 4 way combiners and a two way combiner. Refer to Figure 2-6.

The outputs of the top four amplifier trays, ≈+58.9 dBm in level, connect to the (A1) 4 Way combiner. The outputs of the bottom four amplifier trays, ≈+58.9 dBm in level, connect to the (A2) 4 Way combiner. Each 4 Way combiner has three dummy loads, two 600W and a 1200W, connected to them, which dissipate any power due to an imbalance or mismatch during the combining of the amplifiers. The outputs of the two 4 way combiners, each ≈+64.1 dBm, connect to the (A3) Two Way Combiner. The 2 Way combiner has a 2500W load connected to it. The output of the 2 Way Combiner, which is the output of the 8 Way Combiner Assembly, is at the 3 1/8" RF output jack, typically ≈+67 dBm.

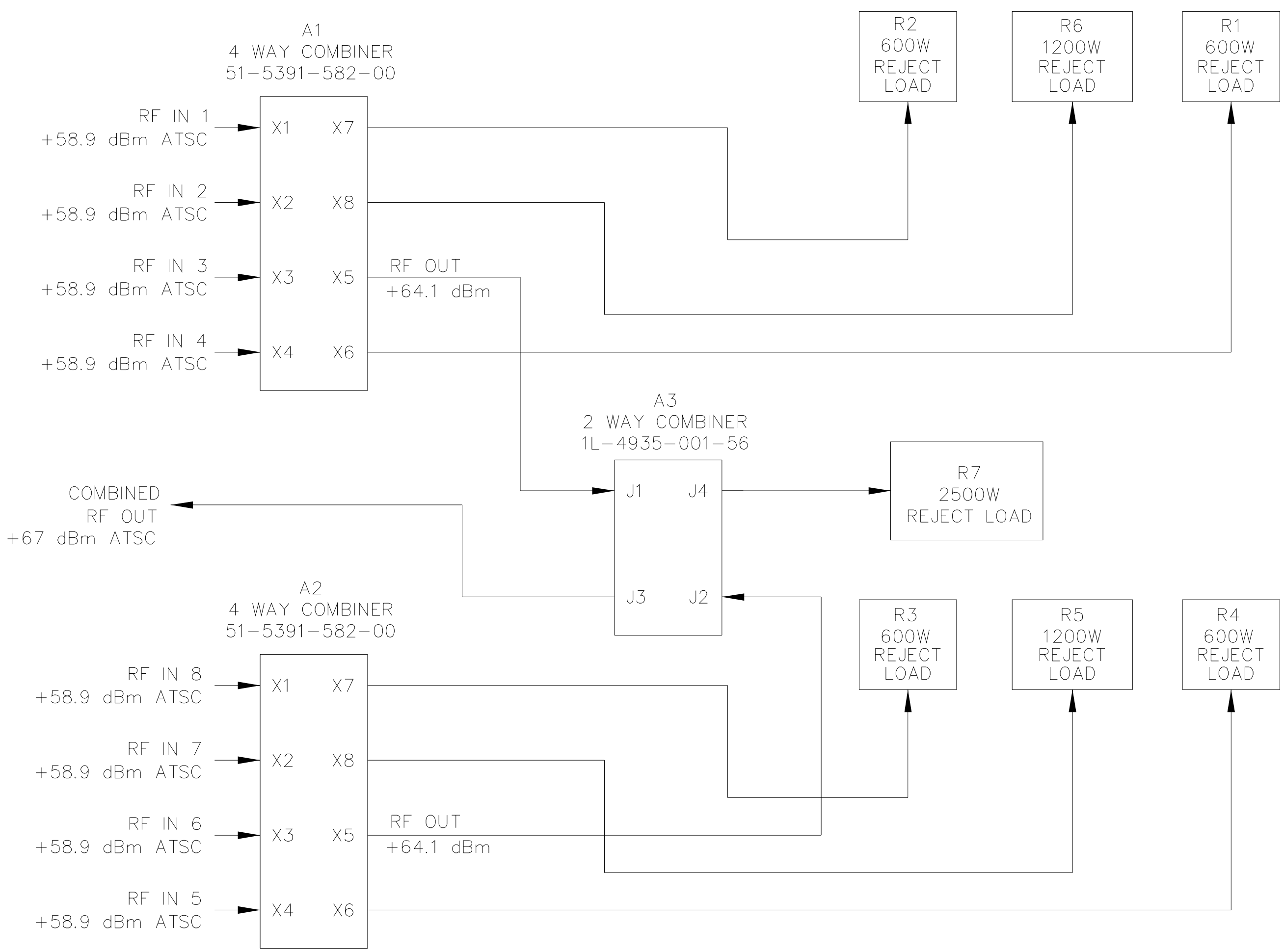


Figure 2-6: Block Diagram Typical 8 Way UHF Combiner Assembly

2.3.1.1: Description of the 6 Way Combiner Assembly (3.7 kW Amplifier Cabinet)

The RF outputs of the six amplifiers are combined by means of an 6:1 combiner assembly that is mounted in the middle of the cabinet. The 6 way combiner is made up of two identical 3 way combiners and a two way combiner.

The outputs of the top thee amplifier trays, ≈+58.9 dBm in level, connect to the (A1) 3 Way combiner. The outputs of the bottom three amplifier trays, ≈+58.9 dBm in level, connect to the (A2) 3 Way combiner. Each 3 Way combiner has two 600W dummy loads, which dissipate any power due to an imbalance or mismatch during the combining of the amplifiers. The outputs of the 3 way combiners, each +64.1 dBm, connect to the (A5) Two Way Combiner. The 2 Way combiner has a 2500W load connected to it. The output of the 2 Way Combiner, which is the output of the 6 Way Combiner Assembly is at the 3 1/8" RF output jack, typically ≈+65.7 dBm.

2.3.1.2: Description of the 4 Way Combiner Assembly (2.5 kW Amplifier Cabinet)

The RF outputs of the four amplifiers are combined by means of a 4:1 combiner assembly that is mounted in the middle of the cabinet.

The four RF inputs, ≈+58.9 dBm Digital in level connect to the 4 way combiner. The 4 Way combiner has three dummy loads, two 600W and a 1200W, which dissipate any power due to an imbalance or mismatch during the combining of the amplifiers. The output of the 4 Way Combiner Assembly is at the 1 5/8" RF output jack, typically ≈+64.1 dBm Digital.

2.3.1.3: Description of the 3 Way Combiner Assembly (1.8 kW Amplifier Cabinet)

The RF outputs of the three amplifiers are combined by means of a 3:1 combiner assembly that is mounted in the middle of the cabinet.

The three RF inputs, ≈+58.9 dBm Digital in level, each connect to an input to the 3 Way combiner. The combiner has two 600W dummy loads, which dissipate any power due to an imbalance or mismatch during the combining of the amplifiers. The output of the 3 Way Combiner Assembly is at the 1 5/8" RF output jack, typically ≈+62.6 dBm Digital.

2.3.2: Removal of an Amplifier Assembly

The amplifiers are of broadband design and cover the frequencies for the entire UHF band without the need for alignment or adjustment.

For reasons of safety, amplifier modules **MUST** be in standby (RF disabled) before any connections are removed. If the amplifier control board is loaded with software version 2.4 or higher, an Axcera Amplifier disable plug (1308219) can be used to place an individual module in standby. If your amplifier module has a front panel disable switch, this switch can be used to disable the amplifier. Regardless of the version of code, any power amplifier may safely be removed by disabling its power supply. The power supply, either the top power supply #1 for the top four Amplifier assemblies, or the bottom power supply #2 for the bottom three Amplifier assemblies, may be isolated from main AC power by switching off the appropriate front panel circuit breaker. This is accomplished by tripping the respective breaker located on the circuit breaker assembly panel, at the bottom of the amplifier cabinet.

To remove a disabled amplifier assembly, first remove the input cable connected to the top connector then the output cable connected to the bottom connector on the front panel of the assembly. They must be removed in this sequence to prevent damage to the amplifier assemblies. Then loosen the two fixing screws, one located at the top, middle and one at the bottom, middle of the assembly. The amplifier can then be pulled from the cabinet. To replace the assembly, insert the assembly into the slots and replace the two fixing screws. Then connect the RF output cable first and the RF input cable last, they must be replaced in this sequence to prevent damage to the amplifier assemblies.

The paralleling network of the amplifier cabinet with its load balancing resistors is designed so that operation continues at reduced power when one or more amplifiers are removed or failed.

All RF cables from the outputs of the first splitter up to the output of the output combiner assembly are phase matched (in phase) to the particular frequency and their lengths must again be determined when a change in operating frequency is made. All amplifier cabinets of a transmitter, from cabinet input to cabinet output, are also aligned to the same phase with equal length cables.

2.3.3: Amplifier Cabinet Power Supply Assemblies

The voltages to the UHF Amplifier Trays are supplied by two +48 VDC power supply assemblies. One supply, the top power supply #1, provides the +48 VDC to the three or four UHF amplifier assemblies mounted at the top of the cabinet (3.7 kW or 5 kW). The other supply, the bottom power supply #2, provides the +48 VDC to the three or four UHF amplifier assemblies mounted at the bottom of the cabinet (1.8 kW, 2.5 kW, 3.7 kW, & 5 kW).

The AC input voltages to the power supplies are controlled through two 480 VAC 30 Amp 3 Phase or two 208 VAC 50 Amp 3 Phase circuit breakers located on the AC distribution panel mounted at the bottom of the cabinet (3.7 kW & 5 kW). There is only one 480 VAC or 208 VAC circuit breaker in a 1.8 kW & 2.5 kW amplifier cabinet.

2.3.4: Control and Monitoring

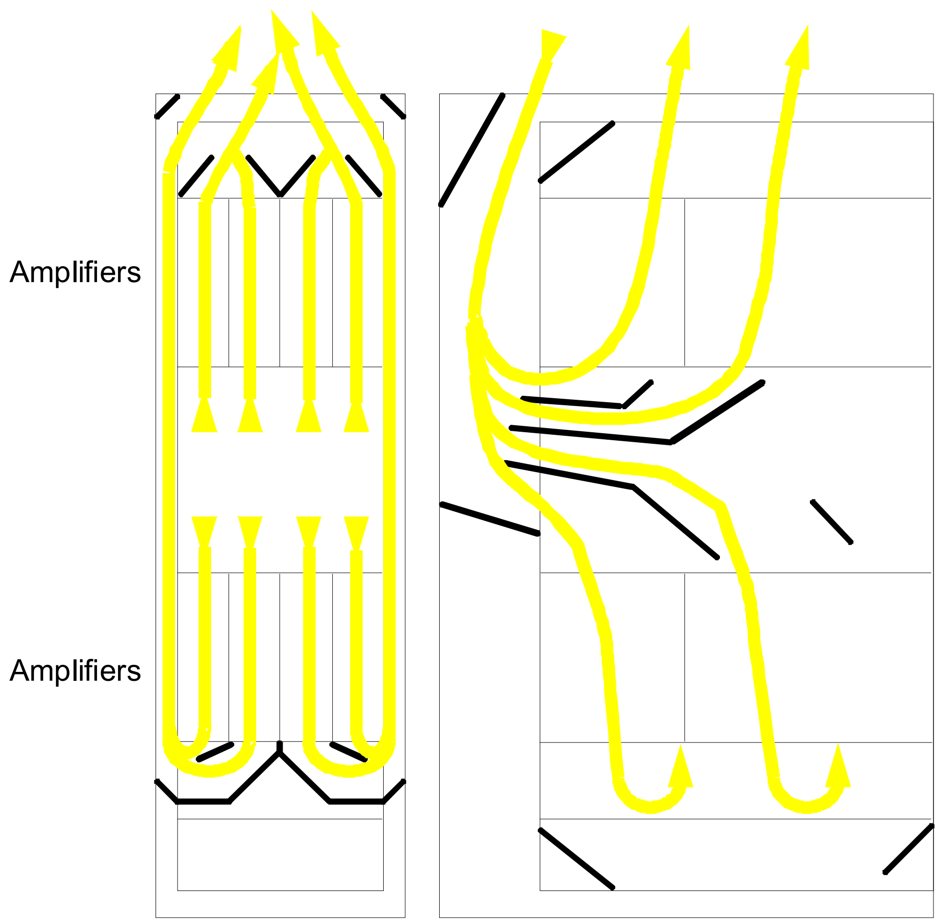
Each amplifier has multiple-fault protection circuitry that prevents damage to or destruction of the power transistors during critical operating conditions, such as high reflected power, overtemperature, overcurrent, or overvoltage. Furthermore, the operating voltages and currents of the amplifiers are monitored in the power supply units as well as the mains voltage. All important amplifier operating parameters, such as drain currents, RF power, and heat sink temperatures, are connected to the control unit.

2.3.5: Cabinet Cooling

The amplifier cabinet is exclusively air cooled as shown in Figure 2-7. The cooling system is exemplified by low airflow requirements, low noise levels, and high efficiency. With an inlet air temperature of +25° C, the junction temperatures of the RF power transistors remain under 120°C, resulting in a high amplifier service life.

A major fraction of the heat is dissipated by the amplifiers and their power supplies. This heat is carried away by an external cooling system. Connections are available on the top of the amplifier cabinet for the intake and exhaust of the air. The amplifiers are equipped with highly efficient finned heat sinks, which radiate, into the vertically flowing air stream, the heat generated by the power transistors. By utilizing special construction techniques in the cabinet, as well as employing conservatively dimensioned ducting, a uniform distribution of cooling air over the various heat sinks is achieved. This ensures that all of the power transistors are at essentially the same temperature. Temperature test points connected to special monitoring circuits are located in the amplifiers and power supply units. Under over temperature conditions, the monitoring circuits respond and switch off the respective unit. In addition, a fault indication and the measured value are passed to the control unit.

Control connections to the Blower is through the terminal block TB1 located at the rear upper right of the amplifier cabinets. TB1-1 is +12 VDC and TB1-3 is Blower Control that connect to the Fan Control in the Blower Cabinet.



Example for the connection of air ducting to the roof of the cabinet

Figure 2-7: Air Flow in the Amplifier Cabinet

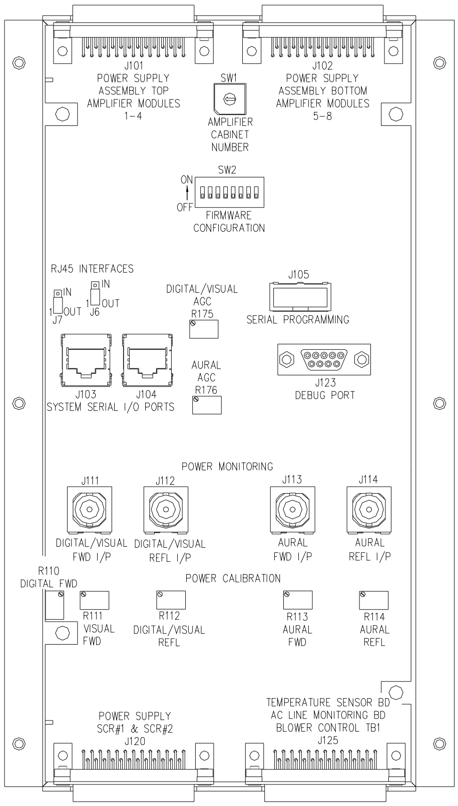


Figure 2-8: Full Cabinet Controller Assembly

2.4: Cabinet Controller Assembly

The Innovator HXB cabinet controllers are designed to control and monitor components contained in the amplifier cabinet. A full cabinet controller, Figure 2-8, monitors and controls all components of the amplifier cabinet while a half cabinet controller, Figure 2-9, monitors and controls only half of the cabinet. Two half cabinet controller assemblies are used in single amplifier cabinet configurations to give the transmitter redundancy by allowing the top or the bottom amplifiers to operate if the other half cabinet controller assembly should malfunction. When two half cabinet controller assemblies are needed, they are mounted on the power supply covers in the rear of the amplifier cabinet. The wire harness connection of J120 pin 8 is used by the half cabinet controller to determine if it is installed as an upper half cabinet controller or a lower half cabinet controller.

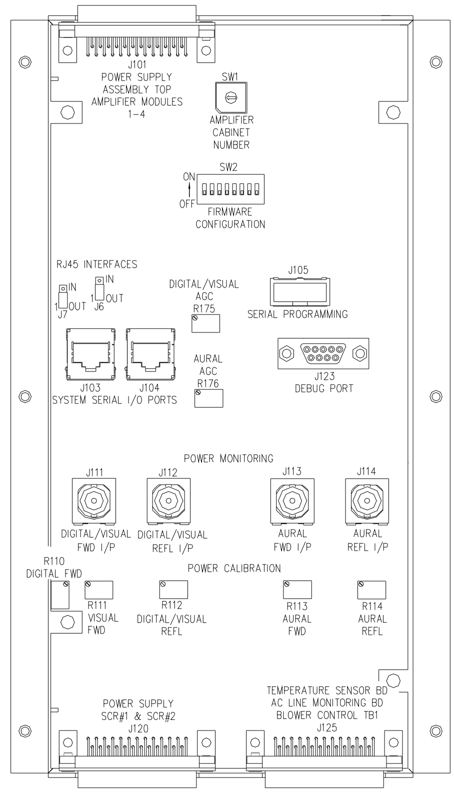


Figure 2-9: Half Cabinet Controller Assembly

Status and control of each amplifier cabinet is implemented through serial commands that are transferred between the transmitter's system controller and the amplifier cabinet controller(s). Both types of cabinet controller assemblies contain two UARTs, Universal Asynchronous Receiver-Transmitter ICs. One of the controller's UARTs is used exclusively to communicate with amplifiers within the cabinet. The second UART provides status and control of the cabinet to the transmitter's control system. Serial debug port J108 is a standard read only RS-232 serial port that is designed only for use with Axcera factory test software. Status and control of devices within the amplifier cabinet is implemented through discrete wired connections and serial messages sent between the amplifier control boards, located in the individual amplifier modules, and the cabinet controller(s).

The full cabinet controller obtains +15VDC and -15VDC from one or two switching power supplies located in the lower front portion of the amplifier cabinet. The half cabinet controller obtains +15VDC and -15VDC from either the top or bottom power supply assembly in the amplifier cabinet Cabinet controllers contain linear voltage regulators that convert the $\pm$15 VDC to $\pm$12 VDC. The $\pm$12 VDC power is supplied to each of the amplifier modules through self-resetting fuses.

The top and bottom high voltage power supplies of the power amplifier cabinet are regulated by SCR controllers located in the lower front area of the cabinet. The cabinet controller monitor the AC supply voltage to the SCR controllers and the health of the controllers. Half cabinet controllers monitor the AC supply to the upper or lower SCR controller and the health of the specific SCR controller.

Early systems used potentiometers located in the cabinet controller assembly to set the voltage output of the high power supplies. Later systems have the voltage level adjust potentiometers located within the power supply assembly. If voltage adjust potentiometers are located within the power supply, adjustment holes will be visible through the rear cover of the power supply assembly labeled, R120-123.

RF power monitoring of the amplifier cabinet is monitored through detectors located on the cabinet controller board. Separate aural and visual detectors are available for externally diplexed systems, however in earlier models of the cabinet controller, the forward/visual reflected power detection was obtained using the aural reflected power port. In systems with half cabinet controllers, RF samples are first split before they are routed to each half cabinet controller.

Power amplifier modules mounted in the amplifier cabinet are number referenced in this document and the transmitter control system from left to right and top to bottom as observed from the front of the amplifier cabinet. The number one high voltage power supply is located in the top of the amplifier chassis. It is controlled by SCR #1, and circuit protected by the left breaker located on the power distribution assembly, in the lower front of the cabinet. The High voltage power supply number two is located in the bottom of the amplifier cabinet. It is controlled by SCR #2, and circuit protected by the right breaker located on the power distribution assembly. Power supply one, top supply, feeds amplifiers one through four while power supply two, bottom supply, powers amplifiers five through eight.

2.4.1: Controller Connections to the Transmitter's System Controller

Each cabinet controller has a unique serial address that is determined by the setting of a rotary switch that is centrally located at the top of the cabinet controller assembly. The RS-485 serial address of the cabinet controller is the switch position times ten plus nine. Example: Amplifier Cabinet Number 1 uses serial address 19.

Serial messages between the cabinet controller(s) and the transmitter's system controller are transported over a CAT-5 twisted pair cable using serial ports J103 and J104. Either port can be used as an input or output to the next amplifier cabinet. The wiring of the CAT-5 cables is a simple pin x to pin x connection. If a replacement cable or patch cable are needed, a simple straight-thru Ethernet cable with two RJ45 plugs can be used.

Table 2-1: Serial Cable Pin out

Pin	Function
1	System Visual AGC #2
2	Ground
3	No Connection
4	System Serial +
5	System Serial -
6	No Connection
7	System Aural AGC #2
8	Ground

The CAT-5 cable is also used to transport two analog reference voltages: Aural AGC #2 and Visual AGC #2. Each amplifier module produces a reference voltage that is proportional to the power output of the module. The amplifier circuits and amplifier cabinet wiring are configured such that the highest measured reference voltage is selected and wired to the amplifier cabinet controller. The cabinet controller board has circuitry that presents the highest measured reference voltage to the transmitter's system controller and upconverter. In multiple amplifier cabinet systems, the highest measured amplifier reference voltage is the voltage on the CAT-5 cable. In analog systems, the aural amplifier reference voltages are separate from the reference voltage of the visual amplifier modules.

2.4.2: Controller Connections to Amplifier Cabinet Components

2.4.2.1: Power Amplifiers

Power connections, serial connections and reference voltage signals are sent from the cabinet controller to the top and bottom power supply assemblies and then to each of the amplifier modules through one of two DB25 connectors. J101 is used to interface through the amplifier wiring harness to the power supply assembly, top which connects to the amplifiers one through four. J102 is used to interface to the power supply assembly, bottom which connects to the amplifiers five through eight.

Status and control of each amplifier module is implemented through serial messages sent between the amplifier's control board and the cabinet controller assembly. The serial address of each amplifier module is determined by the wiring of the amplifier chassis. The module knows which serial address to use based on where it is located within the system. The cabinet controller board provides +12VDC and -12VDC to each of the amplifier modules through individual self-resetting fuses. The +12VDC supplies of the first four amplifiers are powered from one voltage regulator (U14) that is supplied by +15VDC. A separate voltage regulator (U17) is used to power the +12VDC lines of the last four amplifiers. U19 is used to generate the -12VDC supply to all of the amplifier positions.

Since some systems have separate aural and visual power amplifiers, the chassis wiring of position four and eight can be wired for either an aural or a visual amplifier. The reference AGC#2 voltage of amplifier position four and eight is wired through pin 22 of J101 / J102 in digital systems or through pin 25 in analog systems, where this amplifier position is used for aural power amplification. Amplifier modules are enabled and disabled using a general broadcast serial message. If an amplifier does not properly receive the message or for any other reason it is not in the desired state, the controller will individually command the amplifier into the desired state.

2.4.2.2: High Power Voltage Supply Controllers

The power amplifier high power voltage supplies of the amplifier cabinet are regulated with SCR controllers located in the lower front area of the cabinet. The cabinet controller monitors the AC supply voltage to the SCR controllers and the health of the controllers. Early systems used potentiometers located in the cabinet controller to set the voltage output of the high power supplies. Later systems have the voltage level adjust potentiometers located within the power supply assembly. If the voltage adjust potentiometers are located within the power supply, adjustment holes are visible through the rear cover of the power supply assembly.

The amplifier cabinet wire harness connects J120 of the cabinet controller assembly to the power supply SCR controllers. If the cabinet controller is not enabled, the SCR controllers are held Off with a logic low on position nine of their terminal block. If the SCR controller detects an output short, has an over current fault, or is otherwise not ready for operation, the specific SCR controller is held Off. **NOTE**: Do not remove power from the cabinet controllers or disconnect J120 from the cabinet controller with power applied to the power amplifier high power supplies. To allow the power supply to stabilize, an amplifier module is not enabled until five seconds after their associated high power voltage supply has been enabled.

2.4.2.3: Low Power Voltage Supply and AC Line Monitoring

The cabinet controller obtains its operating power and power for operation of the amplifier modules from a $\pm$15 VDC power supply located in the lower front area of the control cabinet. This supply also contains a +5 VDC output, which at this time does not have any significant use. If redundant power supplies are installed, the system will operate if only one supply is operational. Diodes located in the cabinet controller prevent one supply from disabling the second power supply. **WARNING**: THE HIGH POWER VOLTAGE SUPPLY LINES ARE LOCATED BEHIND THE FRONT COVER. REMOVE POWER FROM THIS AREA BY LOCKING OUT THE HIGH POWER VOLTAGE FEEDS TO THE AMPLIFIER CABINET.
The cabinet controller obtains AC line monitoring samples from a circuit board located in the front of the amplifier chassis. These signals are line to ground samples obtained by resistor dividers. Two unique board assemblies are used: one for systems that operate around 220VAC input and another for systems that are operating around 440VAC. An internal DIP switch located on the cabinet controller board is used to scale the input values from the AC monitoring board. Switch 2 position four needs to be OFF for 220 VAC systems and ON for 440 VAC systems.

When a system is configured to operate around 220 VAC, a phase loss fault is generated if one or more input phases measure less than 176 VAC. For systems operating around 440 VAC, a phase loss fault is generated if one or more input phases measure less than 353 VAC.

2.4.2.4: Air Temperature and Amplifier Temperature Monitoring

The amplifier cabinet inlet air temperature is monitored by a thermistor located in the cabinet controller. A small remote circuit board is used to monitor the exhaust temperature of the amplifier chassis. The exhaust temperature is measured in the front top center of the amplifier chassis. At this time, neither the inlet air temperature nor exhaust air temperature is used for fault detection.

A cabinet cooling fault is only generated by the detection of an over temperature fault in two or more modules of the amplifier chassis. If an over temperature fault occurs, all amplifiers are placed in standby and the fault is latched. The fault is only cleared when the amplifier cabinet is placed into standby mode.

2.4.2.5: RF Power Monitoring

The separate amplifiers modules of the cabinet are combined prior to connection to couplers that measure the cabinet's

RF output power. Separate aural and visual detectors are available, however in early models of the cabinet controller, visual reflected power detection was implemented using aural reflected power port J114 instead of J112. Please refer to cabinet controller settings section, for proper setting of the DIP switch two position five.

Sample ports are available to monitor the RF output energy and the energy reflected back into the cabinet. Digital systems monitor forward power on J111 and reflected power on J114. In analog systems, the aural forward power is measured on J113, the visual forward power detection uses J111, and the visual reflected power is measured using J112. If an aural system is externally diplexed, the aural reflected power is monitored using J114.

2.4.2.6: Reject Load Monitoring

Select UHF amplifier systems require the use of circulators within the amplifier cabinet combiner. The reject loads of these circulators have a limited power rating therefore the energy into these loads is monitored.

J120 Pin 10, on the amplifier cabinet controller, is used to monitor a signal that is proportional to the highest reject load energy of amplifier positions one through four. Pin 13 is used to monitor the highest reject load energy of amplifier positions five through eight.

If the reject load voltage of a set of amplifiers exceeds a preset that is typically 0.8 VDC, the power supply of the associated amplifiers and the amplifiers themselves will be disabled. **NOTE**: Reject load faults can only be cleared by placing the amplifier cabinet in standby.

2.4.3: Cabinet Controller Settings

Within the cabinet controller assembly is an eight position DIP switch, SW2 that is used to enable select features. See Table 2-2.

Table 2-2: Cabinet Controller SW2 DIP Switch Settings

Switch Number	Function	Position	Normal Operating Position
SW2-1	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off
SW2-2	Allow Power Supply Enable on Cooling FLT	0 = Off 1 = Allow	Off - Must be Off
SW2-3	Allow Power Supply Enable on RFL PWR FLT	0 = Off 1 = Allow	Off
SW2-4	High Voltage Supply Range	0 = 220 1 = 440	System dependent
SW2-5	Reflected Power RF Source	0 = J112 1 = J114 (If not Externally Diplexed)	System dependent
SW2-6	Allow Power Supply Enable on Reject Load Faults	0 = Off 1 = Allow	Off
SW2-7	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off
SW2-8	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off

NOTE: These switch positions are factory set and should not be changed.

2.4.4: Cooling Blower Control

The cabinet controller board provides signals that can be used to operate a cabinet cooling blower relay. On the board, Pin 16 provides +5VDC through a 0.5 amp self-resetting fuse. J125 pin 20, on the board, provides an open-drain connection for cabinet cooling blower control. Pin 19 provides +12VDC through a 0.5 amp self-resetting fuse. These two connections are wired to the Terminal Block TB1 located in the rear, right side, near the top of the amplifier cabinet. TB1-1, +12VDC, and TB1-3, Blower Control, need to be connected by 22AWG wire to the Fan Control Board mounted in the blower cabinet to operate the Blower.

2.4.5: Cabinet Controller Problem Resolution Guide

Table 2-3: Cabinet Controller Assembly Problem Resolution Guide

Condition	Possible Cause
Transmitter is enabled but either the Amplifiers and/or the Power Supplies are not enabled.	• One of the three AC input phases may not be present or at least one may be low in voltage. • Serial communication with the cabinet controller may not be operational thus, the amplifiers and power supplies are remaining in their last state. • Reject load levels of an UHF system may be greater than the programmed fault threshold. • If two or more amplifier modules report an over temperature condition, all amplifiers are placed into standby and the fault is latched until the cabinet is placed into standby mode. • High voltage power supply SCR controller(s) may not be operational. • Amplifiers are not enabled until the power supplies are enabled for five seconds. • Cabinet Controller internal DIP switch position one may be in the ON position. This position causes the controller to ignore serial communication commands thus the amplifiers and power supplies are remaining in their last state.
All LEDs of Amplifier Modules are Off.	• If tripped, reset the 110 VAC circuit breaker(s) of the ±15 VDC supply(s) located in the lower front of the control cabinet. If redundant power supplies are installed, the system will operate if only one supply is operational. Diodes located in the cabinet controller prevent one supply from disabling the second power supply. • Determine if the ±15 VDC supply located in the lower front of the control cabinet has valid input and output levels. **WARNING:** THE HIGH VOLTAGE SUPPLY LINES ARE LOCATED BEHIND THE FRONT COVER. REMOVE POWER FROM THIS AREA BY LOCKING OUT THE HIGH VOLTAGE FEEDS TO THE AMPLIFIER CABINET. • Disconnect and pull each amplifier module forward a few inches to disengage it from the supply connector. Determine if one amplifier may be the source of the problem. Each amplifier is powered through a self-resetting 0.5 amp fuse.

Table 2-3: Cabinet Controller Assembly Problem Resolution Guide - Continued

<table>
<tr><th>Condition</th><th>Possible Cause</th></tr>
<tr><td>Amplifier Module Status LED is blinking. (LED located nearest to the amplifier handle.)</td><td>
The module status LED is blinked to show various fault states:
<table>
<tr><th>Blinks</th><th>Fault</th><th>Type</th></tr>
<tr><td>1</td><td>Pallet(s) Over Current</td><td>3 Fault w/ 5 second min and 5 Minute Retest</td></tr>
<tr><td>2</td><td>Over Temperature</td><td>1 Fault with 5 Minute Retest</td></tr>
<tr><td>3</td><td>High Power Supply Over Voltage</td><td>1 Fault without retest. Requires standby to clear.</td></tr>
<tr><td>4</td><td>High Power Supply Under Voltage</td><td>3 Fault w/ 5 second min and 5 Minute Retest</td></tr>
<tr><td>5</td><td>Reflected Power Fault</td><td>3 Fault w/ 5 second min and 5 Minute Retest</td></tr>
<tr><td>6</td><td>±12 VDC Supply Fault</td><td>Faulted only while supply is out of range</td></tr>
<tr><td>7</td><td>Overdrive Fault</td><td>3 Fault w/ 5 second min and 5 Minute Retest</td></tr>
</table>
NOTES: 3 Fault means that if the fault occurs three times within 30 seconds, the fault is latched.
5 second min means that the fault is held for a minimum of 5 seconds.
A 5 Minute Retest means that the fault is held active for five minutes. After five minutes, the fault is cleared and the amplifier is re-enabled.
If the amplifier module is placed in standby, fault counters and latched states are immediately cleared thus allowing the system to return to operate mode.
</td></tr>
<tr><td>Amplifiers or Cabinet Controller not reporting on transmitter's System Controller</td><td>

Verify amplifier module is fully seated in amplifier chassis.
If entire amplifier cabinet is not responding, check serial cable between the amplifier cabinet and transmitter system controller.
If multiple amplifier cabinets are present, disconnect cable from first amplifier cabinet to second cabinet. If communication resumes, reconnect the serial cable and remove the next amplifier cabinet serial cable. Continue through the system until the source of communication error is identified.
Exchange amplifier module with another position in the system. If the error travels with the amplifier module, it needs serviced. If the error remains in the same position, either the amplifier cabinet wire harness has been damaged or the cabinet controller board has been damaged. If the problem does not return when the amplifier modules are exchanged, a software update may be needed for either the cabinet controller or the amplifier module(s).
Does amplifier respond to serial operate and standby commands. If so, a software update may be needed for the amplifier module(s).

</td></tr>
<tr><td>Cabinet Controller reports a reflected power fault.</td><td>

Verify that the cabinet reflected power fault threshold is not set too low.
If possible, use J114 for visual reflected power fault monitoring. This problem should only occur on cabinet controller boards 1305306 version A and B.

</td></tr>
</table>

2.5: Functional Description of the Amplifier Cabinet

2.5.1: Signal Path

The RF signal delivered by the exciter (≈+27 dBm) is connected through RG-55 cable to the amplifier cabinet and distributed to the inputs of the power amplifiers (PAs) through one 2 way splitter, then two 3 or 4 way splitter panels. The top 3 or 4 way panel supplies the RF to the top 3 or 4 amplifier trays and the bottom 3 or 4 way panel supplies RF to the bottom 3 or 4 amplifier trays.

The power amplifier tray is a three-stage design comprised of a predriver (≈9 dB gain), a driver (≈18 dB gain), and the final stage (≈18 dB gain). The RF signal (≈15 dBm ATSC) is first preamplified in the predriver, which is part of the phase/gain board (≈24 dBm), and driver (≈42 dBm) before it is passed through a coupler board to the splitter where it is split four ways (≈36 dBm) and distributed to the four final-stage modules. The outputs of the final stages (≈54 dBm) are summed in a combiner. The output of the combiner (≈58.9 dBm) connects to a directional coupler that couples out voltages proportional to the forward and reflected power at the output of the amplifier. The output of the amplifier tray is typically +58.9 dBm ATSC. The coupler also provides a forward power sample that is passed to J3 on the front panel to provide an RF sample for test purposes. The same coupler also supplies a voltage proportional to the forward power from the driver stage, which is used in the monitoring and control circuitry. In addition, the reflected power at the amplifier output is monitored in the control board of the amplifier and, if the set threshold value is exceeded, the operating voltages for the predriver and driver are switched off and a fault indication of the high reflected condition is stored.

2.5.2: Test Signal Evaluation

The RF samples test voltages are passed to the control board of the amplifier for internal evaluation and partly for interrogation by the control unit. The test values for the forward power at the amplifier outputs are passed to the control unit.

The following test points are available for external measuring equipment or transmitter control equipment:

- RF test point at the amplifier outputs at "N" connector (J3).
- RF test points at the output side of the amplifier through a directional coupler downstream of the cabinet combiner.

2.5.3: Regulation of Transmitter Output Power

The regulation of output power takes place in the Digital Exciter. The actual value for the automatic level control (ALC) is taken from test voltages in the amplifier trays that are dependent on the output power of each individual tray.

If an amplifier fails, transmitter operation continues at reduced output power. In order to prevent the ALC from correspondingly increasing the output power of the Digital Exciter during reduced power operation, the test outputs of the individual amplifiers are circuited in parallel so that only the test voltage of the amplifier that delivers the highest output power is used in the ALC control loop.

2.5.4: Fault Protection Circuitry

The amplifiers possess fault protection circuitry, which, if necessary, initiates the switching Off, of the respective unit and simultaneously issues a fault indication to the control unit.
The protective circuits in the amplifiers monitor the following values:

- Drain currents of the final stage transistors
- Operating voltage
- Temperature
- Reflected power at the output

If a threshold value is exceeded, the amplifier shuts down. Following a one-off fault, the amplifier automatically switches on again after a delay of about 1 second. When repeated faults occur (more than 5 within 10 seconds), the amplifier switches on again after a delay of 5 minutes. In addition, the amplifier can be switched on, at any time, by a command from the transmitter control.

The protective circuits in the power supply units monitor the following values:

- 480/208 VAC Mains voltage
- 480/208 VAC Mains phase
- Primary voltage
- Primary current
- Output voltage
- Temperature

2.5.5: Capture of Operating Values in the Amplifiers

The following operating values are captured and processed in the amplifier control board and prepared for transmission to the exciter/control cabinet controller.

- Drain currents of the final-stage transistors
- Operating voltage
- Temperature
- Forward power at the output
- Reflected power at the output

2.5.6: Amplifier Cabinet Connections

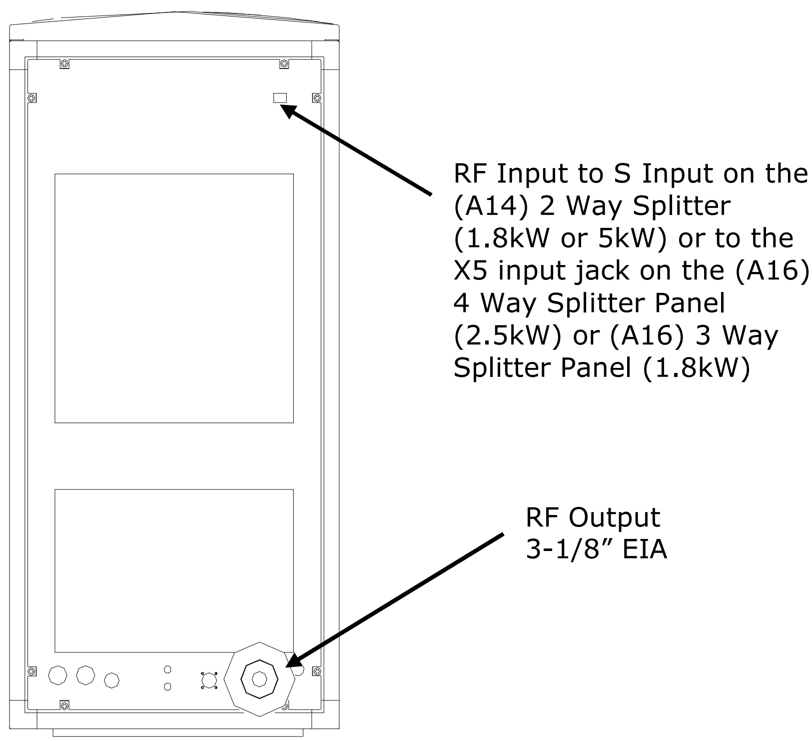


Figure 2-10: Amplifier Cabinet Connections

Table 2-4: Amplifier Cabinet Connections

Connector	**Assignment**	**Type**
S on (A14) 2 Way Splitter (1.8kW or 5kW) or to the X5 input jack on the (A16) 4 Way Splitter Panel (2.5kW) or (A16) 3 Way Splitter Panel (1.8k)	RF Input	RF SMA-type female connector
RF O/P of (A25) Combiner	RF Output	3-$^{1}/_{8}$ EIA

2.6: Service

The amplifier cabinet is user-friendly and designed for operational safety. The paralleling networks in the cabinet ensure that if an amplifier fails or is removed, transmitter operation continues at reduced power without degradation of performance.

The amplifiers are factory aligned and can be inserted in the cabinet without the need for retuning or adjustment.

2.6.1: Safety Information

The amplifier cabinet is maintenance free; however, in order to ensure trouble-free operation, it must be checked and serviced at regular intervals, taking into account the local environmental conditions. Operational reliability depends on proper service. This is especially relevant when checking grounding and power connections.

Work on the amplifier cabinet must only be performed by trained personnel. Take note of the following precautions:

- Before working on or removing a component, make sure that it is isolated from power.
- Carry out all work with extreme caution.

2.6.1.1: Labeling of Dangerous Substances

Components containing substances dangerous to health are labeled as such. The label is either glued on the component itself or in its immediate vicinity.

In drawings (e.g., component layouts of PC boards) and circuit diagrams, parts containing toxic substances, such as beryllium oxide (BeO), are labeled as shown in Figure 2-11.

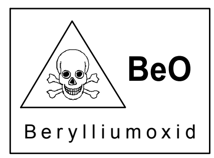


Figure 2-11: Labeling of Toxic Substances in Drawings

2.6.2: Test Point Evaluation

Various RF test points in the signal path in the amplifier cabinet are available for evaluation and can be polled and displayed through the control unit. RF test points for external measuring equipment are also available at the amplifiers and the directional coupler at the output of the amplifier cabinet.

2.6.3: Display of Operating Values

Aside from RF powers, the following operating values can be polled and displayed in the transmitter control unit:

- Forward & Reflected power at the output of the amplifiers
- Amplifier operating voltage
- Amplifier currents
- Amplifier temperatures
- Forward power at the output of the amplifier cabinet

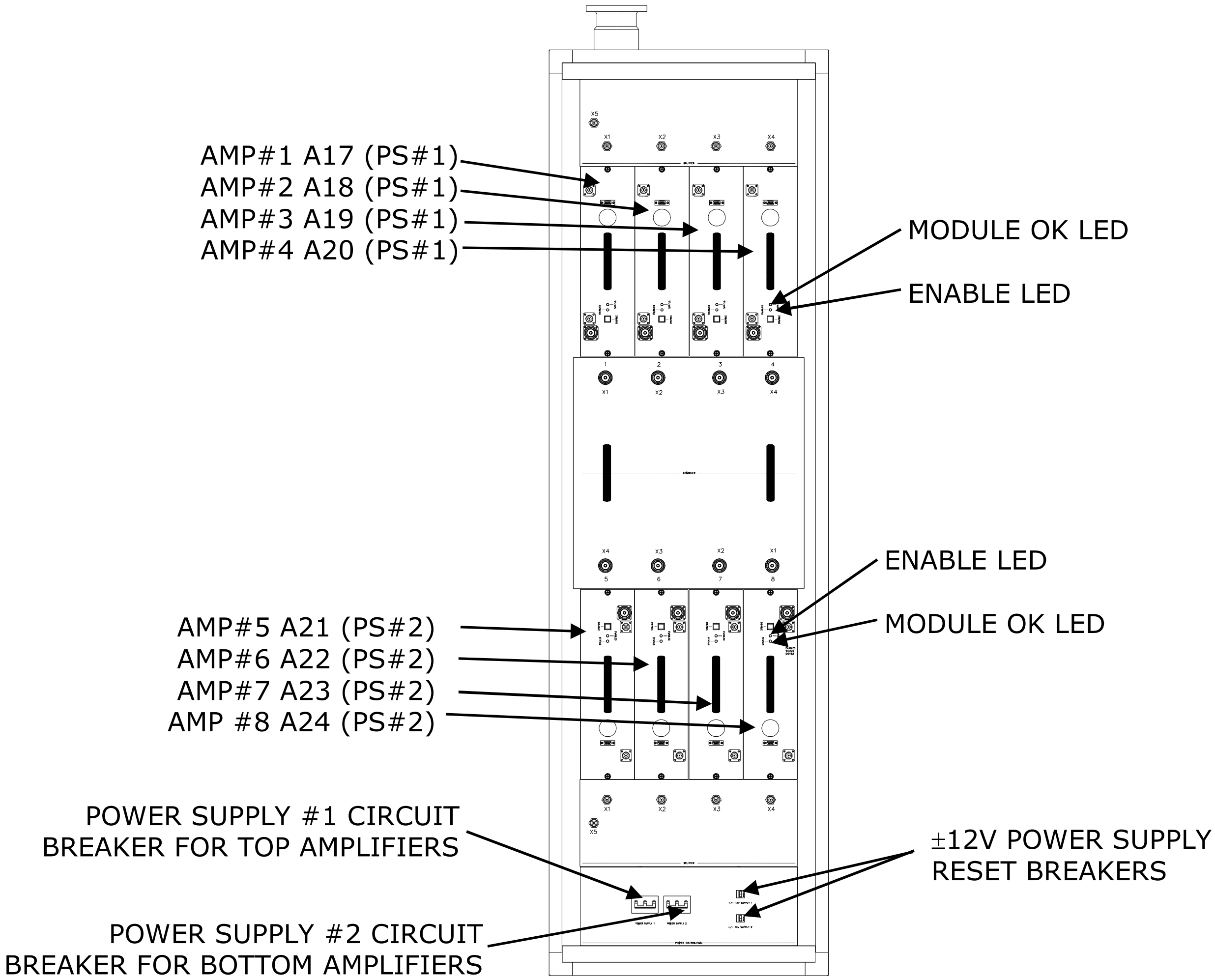


Figure 2-12: Location and Assignment of the Circuit Breakers and LEDs

2.7: Exchange of an Amplifier Tray

For reasons of safety, amplifier trays **MUST** be in standby (RF disabled) before any connections are removed. If the amplifier control board is loaded with software version 2.4 or high, an Axcera Amplifier disable plug (1308219) can be used to place an individual tray in standby. If your amplifier tray has a front panel disable switch, this switch can be used to disable the amplifier. Regardless of the version of code, any power amplifier may safely be removed by disabling its power supply. The power supply, either the top power supply #1 for the top four Amplifier assemblies, or the bottom power supply #2 for the bottom four Amplifier assemblies, may be isolated from main AC power by switching off the appropriate front panel circuit breaker. This is accomplished by tripping the respective breaker located on the circuit breaker assembly panel, at the bottom of the amplifier cabinet. Disconnect the RF cables.

NOTE: To prevent damage to the tray, you must first disconnect the Input Cable and then disconnect the Output Cable.

Caution: The amplifier weighs approximately 60 pounds. Use extreme care when removing it from the cabinet.

Undo the two holding, fixing, screws and pull the amplifier out to the end stop. Find and release the mechanical lock, located on the bottom of the top four amplifier trays and on the top of the bottom four amplifier trays. See Figure 2-13. Pushing the release down on bottom amps and up on top amps releases the catch. Carefully pull the amplifier completely out of the cabinet assembly.

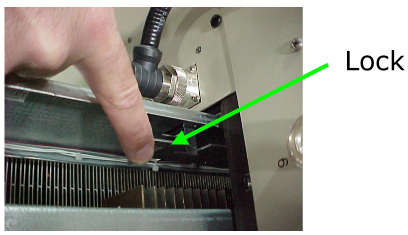


Figure 2-13: Amplifier Tray Lock Location

Caution: After the amplifier is pulled out, a high voltage may still be present at its output.

Insert and secure the new amplifier. Note the vertical position of the amp tray, do not try to insert upside down. Carefully push the amplifier into the rear connectors making certain that solid connection is made.

NOTE: If a replacement amplifier is not available, then an Air Blocking Plate should be installed in the slot where the amplifier assembly was removed and a fake front panel should be installed on the cabinet. This is to insure proper air flow through the cabinet and cooling of the remaining amplifier trays.

Connect the RF cables. **NOTE:** You must connect the Output Cable first and then connect the Input Cable.

Engage the respective circuit breaker, Power Supply #, 1 for amplifiers (1-4, A17-A20) or Power Supply #2, for amplifiers (5-8, A21-A24).

Amplifier Adjustments

There are no customer adjustments.

Information on a Change of Channel Frequency

The following work must be carried out at the amplifier cabinet when changing the channel frequency:

- The length of RF cables between the splitters and the amplifiers needs to be altered.
- The coupling attenuation needs to be checked.
- The output powers of the amplifiers must also be checked.

NOTE: It may be necessary to make further adjustments at other cabinets and assemblies in the transmitter when a change in channel frequency is made.

Chapter 3: UHF Amplifier Tray Assembly and Cabinet Assemblies Circuit Descriptions

3.1: Amplifier Tray Assembly Overview

Each UHF amplifier tray assembly serves to amplify the RF signal delivered by the exciter to the power level needed to attain the full rated output power of the transmitter. Nominal transmitter output power is achieved by adding the parallel connection of individual amplifier tray assemblies, within a cabinet assembly, and then the adding of a number of multiple amplifier cabinets.

The amplifier operates over the UHF TV frequency spectrum without any special tuning requirements. It is a three-stage amplifier design formed by a predriver, mounted on the phase/gain board, driver, and final stage as shown in Figure 3-1. The driver is a single stage amplifier module whose output is split four ways. The final stage is made up of four identical power modules. The four outputs are connected to a 4-way combiner assembly whose output is the RF output of the individual amplifier tray assembly.

The features of the UHF amplifier tray assembly include:

- All amplifying stages are equipped with transistors
- Operates over the UHF frequency band without special tuning requirements
- High redundancy due to the parallel connection of many power transistors
- Mean junction temperature <120° C.
- Important operating parameters, such as drain currents, operating voltages, RF powers, and temperatures are polled and displayed in the transmitter control assembly.
- The amplifier possesses multiple fault-protection circuits that prevent damage to the power transistors during critical operating conditions, such as high mismatch, overtemperature, over-current, or over-voltage.

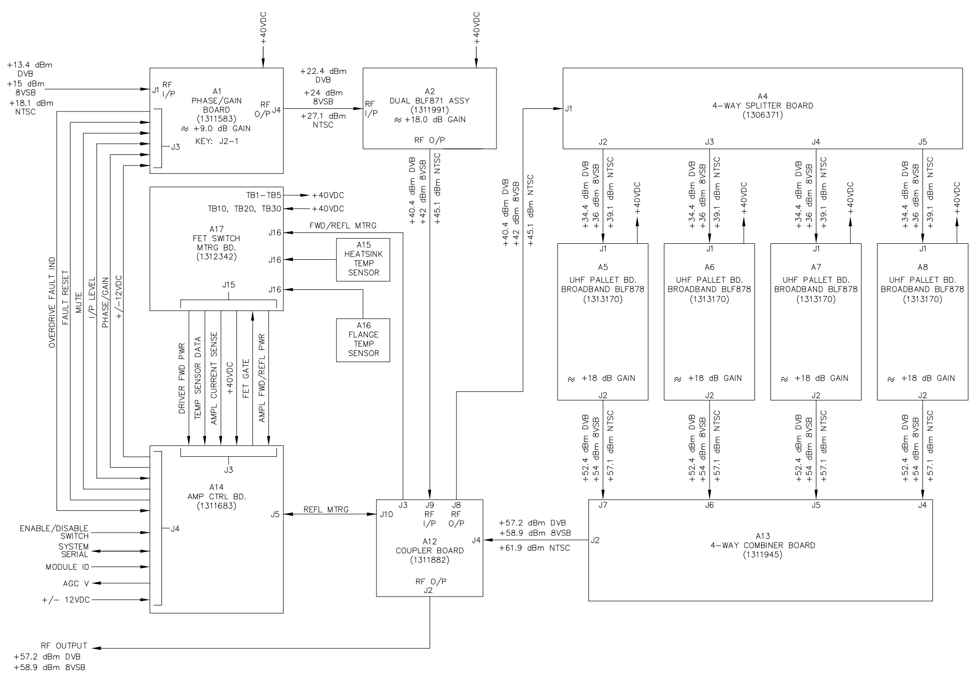


Figure 3-1: UHF Amplifier Assembly

The paralleling network of the amplifier is arranged so that it continues to operate at reduced power if a module fails. The remaining available power is given by:

$$P_{rem} = P_{nom} \cdot ([m - n] / m)^2$$

where:

P_{rem} = remaining power
P_{nom} = nominal power
m = number of modules
n = number of failed modules

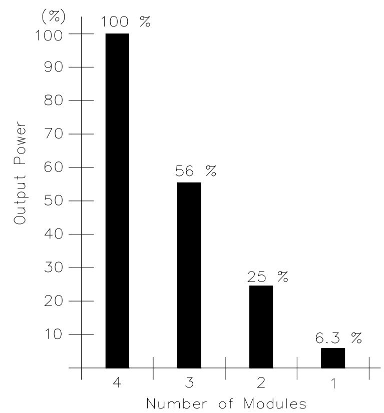


Figure 3-2: Remaining Power after Failure of Amplifier Modules

3.2: Design of the UHF Amplifier

The amplifier tray assembly is designed as a slide-in unit. The mechanical support structure is formed by a finned heat sink on which the individual assemblies are mounted. The amplifier assemblies are listed in Table 3-1.

All RF connectors are located on the front panel, while the control and power connectors are mounted at the rear panel. The amplifier control board is mounted vertically behind the front panel. Two LEDs, Module OK and Enable, are mounted on the amplifier control board and are visible through the front panel, indicate the operating status of the amplifier tray.

Table 3-1: Assemblies in the UHF Amplifier Tray

Position	Assembly	Remarks
A14	Amp Control Board	For control, monitoring, and test signal capture
A1	Phase/Gain Board	Provides phase and gain control of the RF through the tray and also acts as a Predriver, (≈9 dB gain).
A2	Dual BLF871 Amplifier Module Assembly	Driver power amplifier to the splitter, (≈18 dB gain).
A12	Coupler Board	Provides Driver forward, final amplifier peak and average forward and reflected power samples.
A4	Splitter (1:4)	Distributes the RF input from the coupler board to the final amplifier pallets A5 to A8, (≈36 dBm).
A5 to A8	UHF Pallet Boards, Broadband BLF878	Four final amplifier boards with ≈18 dB gain and an output of ≈54 dBm.
A13	Combiner (4:1)	Sums the amplified outputs of the 4 UHF Pallet Boards. (≈58.9 dBm Output)
A17	FET Switch/Metering Board	Takes the three +48VDC inputs and switches them to the predriver, driver and the amplifier pallets. In addition, the forward and reflected metering samples connect through the board.

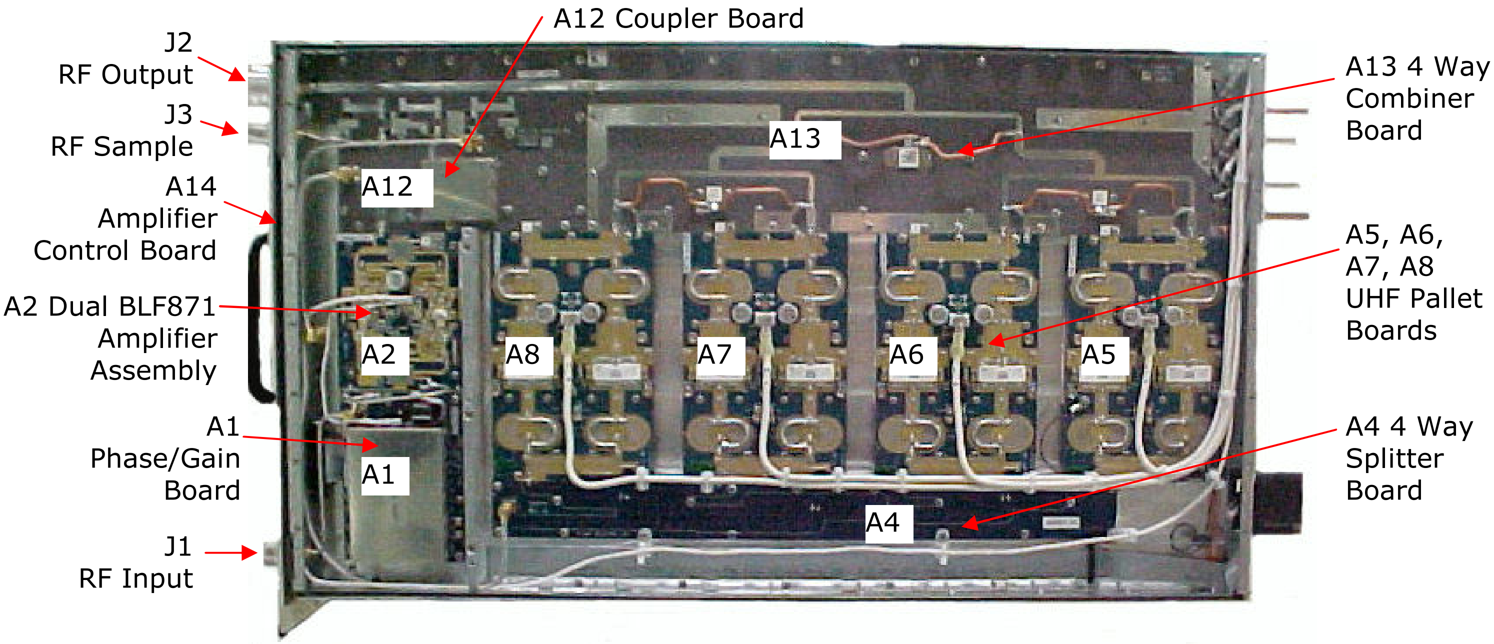


Figure 3-3: Location of the Assemblies in the UHF Amplifier

The amplifier is a three-stage design with a predriver, mounted on the phase/gain board, a dual BLF871 amplifier driver pallet and four UHF BLF878 amplifier pallet final stages. (See Figure 3-3)

The RF input signal (≈+15 dBm ATSC) is fed to the amplifier through connector J1 on the front panel. The signal is preamplified by the (A1) phase/gain board (predriver) (+24 dBm), amplified by the (A2) dual BLF 871 amplifier module (driver) (+42 dBm) before it is passed through the (A12) coupler assembly to the (A4) 4 way splitter (+42 dBm). The outputs of the splitter (+36 dBm) are distributed to the four UHF amplifier pallets BLF878 (A5 - A8). The outputs of each of the final stage modules (+54 dBm) are combined in the (A13) 4 way combiner and the resultant signal is passed through the (A12) coupler board to the RF output connector J2 (≈+58.9 dBm ATSC).

The outputs of the predriver and the 4 way combiner connect through the (A12) directional coupler. The coupler supplies detected voltages proportional to the forward powers at the input to the 4 way splitter and at the output of the 4 way combiner. The directional coupler also provides a detected voltage proportional to the reflected power at the output of the 4 way combiner. These test voltages are passed to the amplifier control board, mounted behind the front panel, for internal evaluation and partly for interrogation by the control unit. In addition, the reflected power at the amplifier output is monitored in the amplifier control board and if the threshold value is exceeded, the operating voltages for the predriver and driver are switched off and a fault indication is stored. The output coupler also supplies a signal proportional to the forward power at the output of the 4 way combiner, which is connected to J3, located on the front panel, for testing purposes.

Test voltages derived from the forward power of the amplifier are generated in the amplifier control board to provide automatic level control (ALC) in the exciter stage of the transmitter. The ALC is a function of the rms value of the output power.

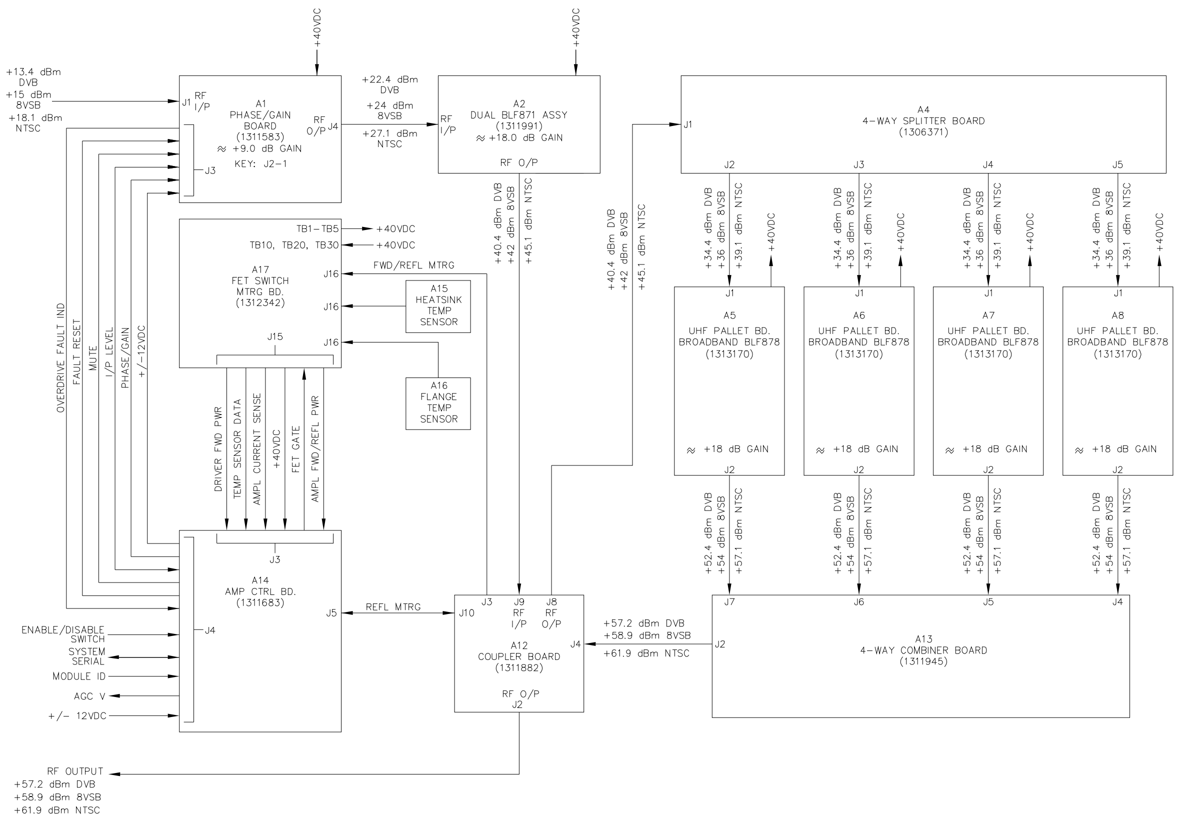


Figure 3-4: Block Diagram of the UHF Amplifier

The amplifier trays can be replaced during transmitter operation and no new alignment work is necessary. The frequency-dependent operating parameters for the complete frequency range are stored in the controller and are automatically enabled by the frequency setting of the exciter. The RS 232 port is used for the factory alignment of operating parameters, e.g., calibration of RF and drain current test values.

The operating voltage U_{op} of +48 volts is distributed to the final amplifier modules by a current bus underneath the combiner. In addition to U_{op} for the modules, the amplifier requires auxiliary voltages of ±12 volts for the amplifier control board. The operating voltage and current consumption of the individual modules are captured in the combiner board and passed to the control board where they are available for interrogation by the control unit. Furthermore, threshold values are monitored in the control board and, if a fault condition arises, the operating voltage for predriver mounted on the phase/gain board A1 and driver A2 is disconnected by the action of field effect transistors mounted on the A17 FET switch metering board. The fault indication is stored and passed to the control unit.

The measured values of the temperature sensors (A15), mounted on the front of the driver amplifier, and (A16), mounted on the rear of the final amplifier, are passed to the control board where they are monitored and available for interrogation by the control unit.

The amplifier control board possesses a number of LEDs that indicate the status of the amplifier. Two of these LEDs are visible through the front panel. The green Module OK LED indicates fault-free operation. The Green Enable LED indicates that the enable is applied to that assembly. It will not be lit if the

Enable is removed. It will be lit Amber if the Enable is applied but the amplifier is not operating.

A fault condition is indicated by a Red Module OK, either continuously illuminated or flashing Red. The flashing Red LED interprets as follows:

Table 3-2: Module OK LED Red and Blinking interpretation

Red LED Blinking	Meaning
1 Blink	Indicates Amplifier Current Fault
2 Blinks	Indicate Temperature Fault
3 Blinks	Indicate Power Supply Over Voltage Fault
4 Blinks	Indicate Power Supply Under Voltage Fault
5 Blinks	Indicate Reflected Power Fault
6 Blinks	Indicate +12V or –12V Power Supply Fault
7 Blinks	Indicate AGC Overdrive

3.2.1: Capture of Test Values in the UHF Amplifier Tray Assembly

The following test values are passed to the transmitter control unit:

- Forward power at the amplifier output – rms output power
- Reflected power at the transmitter output – peak level
- Operating voltage
- Current consumption of the modules
- Temperatures

The following test values are used only for internal purposes on the control board:

- Forward driver power A2 (not displayed in the control unit)

The following test points are available for external equipment:

- RF Output Sample test jack J3 on the front panel.
- Output power (A2) driver module (Used for factory measurements only.)

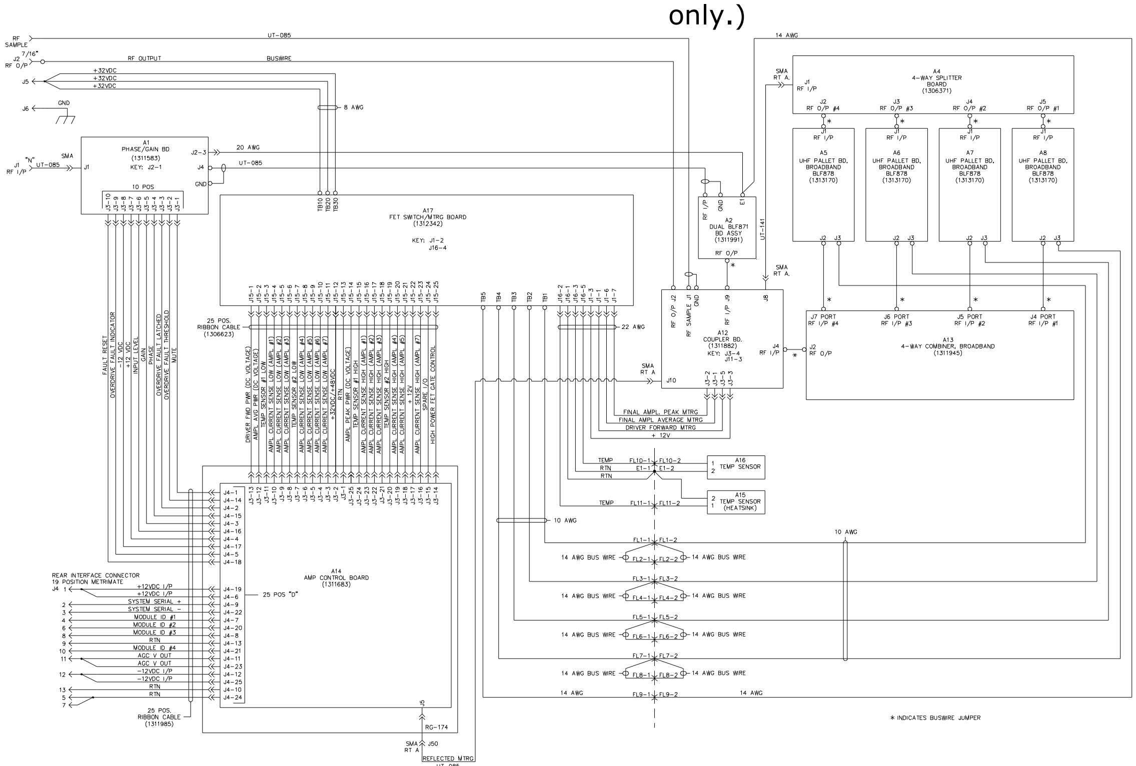


Figure 3-5: Interconnect Typical UHF Amplifier Assembly

3.2.2: Functional Description of the Boards in the UHF Amplifier Tray Assembly

3.2.2.1: (A1) Phase/Gain Board (1311583; Appendix B)

This board is mounted in a Phase/Gain Assembly (1311993). It performs a variety of functions, such as amplifying the incoming RF signal to the level needed to drive the amplifier tray to full power. It adjusts the phase shift through the board so that parallel amplifier trays combine correctly. The board also contains protection circuitry to quickly mute RF drive in the event of an overdrive or reflected power fault. Finally, it contains DC/DC converters that generate various needed power supply voltages for the board.

The RF Input to the tray (+15 dBm ATSC) is connected to the SMA Jack J1 located on the phase/gain board. The RF is applied to a PIN diode attenuator circuit consisting of CR9, CR10 and the hybrid coupler U6. This attenuator is used to set the overall output level of the tray. Increasing the voltage at TP2 will increase the gain of the tray.

The output of the PIN attenuator circuit drives a high speed PIN switch consisting of CR7, CR8 and associated components. This switch is used to remove RF drive quickly in the event of a fault. The switch is controlled by a mute command from the Amplifier Control Board.

The output of the PIN switch drives a phase shifter circuit consisting of hybrid coupler U25 and its associated components. The phase shifter has a range of about 135° which adjusts the output phase of the tray to the required value for best combining of multiple amplifier trays.

The output of the phase shifter, RF_A, is connected to a LDMOS amplifier, Q6, which amplifies the RF output signal to an approximate level of +24 dBm for ATSC, which is applied to the Directional Coupler U31. The direct RF output of the coupler, ≈+24 dBm, connects to J4 the RF output jack of the board. The coupler also supplies a signal to the comparator IC U32, that compares the output level sample with a fault threshold setting and produces an overdrive fault, OD FLT, if the signal increases above the preset level. The OD FLT is connected to the flip-flop IC U29, whose output connects to the high speed PIN switch, cutting it back which cuts back the output of the board and therefore the tray.

+42 VDC needed for operation of the board connects to the board at J2-3 & 2 and is fed to the amplifier Q6 for biasing and to the +24 VDC regulator IC U28. The +24 VDC regulated output of U28 is used by the IC U24 for biasing. +12 VDC connects to the board at J3-7 and is fed to Q1 and U8 where it is used for biasing the devices. The +12 VDC is also connected to the +5 VDC regulator IC U30. The regulated +5 VDC output is fed to various parts of the board for use in biasing and level control. -12 VDC connects to the board at J3-8 and is fed through voltage divider networks to U32 and U33 where the values are used to set up reference levels to the devices.

3.2.2.2: (A2) Dual BLF871 Amplifier Board (1311578; Appendix B)

This board is mounted in a Dual BLF871 Amplifier Module Assembly (1311991).

This board consists of a two single stage amplifiers operating in parallel. The board has an overall gain of approximately 18 dB. The RF input to the board connects to U3 a hybrid splitter which produces two equal outputs. One output of the splitter is fed thru a matching and response network to the gain stage, which consists of the LDMOS transistor Q1 operating in Class AB. C11 is adjustable for best response. The bias voltage for the transistor is generated from +42VDC that connects through the resistor R3 to the drain on

Q1 and through the voltage regulator U1. The regulated voltage at the output of U1 is adjusted with the pots R7 and R6 before it is connected to the drain on Q1. The Diode CR1 provides temperature compensation for the transistor. The transistor is capable of producing an output of over 20 Watts ATSC. The amplified output is connected thru a matching network to one input of U4 a hybrid combiner.

The other output of the input splitter is fed thru an identical amplifier circuit as described for the Q1 transistor, except it is for the Q2 transistor. C45 is adjustable for best response, R16 and R17 are the bias adjustment pots and CR2 is the temperature compensating diode for the Q2 amplifier circuit. The amplified output of Q2 is connected thru a matching network to the other input of the U4 hybrid combiner. The hybrid combiner combines the two amplified outputs of the Q1 and Q2 LDMOS devices and produces a single RF output (≈+42dBm) of the board and the assembly, which a cabled to the (A12) Coupler Board.

3.2.2.3: (A12) Coupler Board (1311882; Appendix B)

The UHF coupler board assembly provides forward power samples of the output of the (A2) Dual BLF871 amplifier module assembly and also the output of the (A13) 4 way combiner. It also provides a reflected sample of the output of the (A13) 4 way combiner. The forward samples connect through the FET switch metering board to the amplifier control board where they connect to the overdrive protection circuit. The reflected sample connects directly to the amplifier control board.

The RF input to the UHF coupler assembly, from the Dual BLF871 Amplifier assembly, connects to jack J9. The RF is fed thru a strip line track to the RF Output jack J8 that is cabled to the 4 way splitter. A hybrid coupler circuit picks off a power sample that is connected to J3-5 as the forward driver power sample metering output.

Another RF input from the output of the 4 way combiner board connects to jack J4. The RF is connected by a strip line track to the RF Output jack J2 that connects to the front panel RF output jack, J2 which is the RF output for the UHF amplifier tray. Three hybrid coupler circuits in the RF output path on the coupler board pick off power samples, two forward samples and one reflected sample. One forward sample connects to a divider network that splits the output. One output is connected to the detector IC U1 whose output is peak detected by U2 and associated circuitry and amplified by U3A to produce the final amplifier peak metering output at J3-2 that connects to the FET switch metering board. The other output of the divider network is connected to the detector IC U4 whose output is amplified by U3B and connected to J3-1 the average power metering output that connects to the FET switch metering board. The other forward sample connects through J1 on the board that is cabled to the RF sample jack J3 located on the front panel of the amplifier tray, which can be used for test purposes. The reflected sample of the RF output connects out of J10 on the board to the amplifier control board.

3.2.2.4: (A4) 4 Way Splitter Board (1306371; Appendix B)

The (A4) 4-way splitter splits the output signal (+42 dBm ATSC) of the driver module assembly (A2) that was coupled through the (A12) coupler board to J1 on the splitter board. These four outputs connect to the four parallel UHF Pallet Boards (A5 - A8).

The splitter circuit is in the form of micro strips mounted on a Teflon board. The actual splitter network does not incorporate tuning elements. The network provides for an equal splitting, over the frequency range of the UHF band, of the input RF signal at the connector J1. The input signal is first split in a ratio of 1:2. After this, both partial powers are split in a second stage in the ratio of 1:2. The load (balancing) resistor of the initial 1:2 stage is formed by the series connection of a 100Ω/10W power resistor. The balancing resistors of both secondary 1:2 stages are also in the form of 100Ω/10W resistors. Each of the four outputs of the splitter board is typically +36 dBm in level.

3.2.2.5: (A5-A8) UHF Broadband Pallet Board, BLF878 (1313170; Appendix B)

The (A5, A6, A7 & A8) UHF Pallet Dual Stage Amplifier Boards provide approximately 18 dB of gain each.

This board is a LDMOS UHF power amplifier consisting of two parallel power transistor stages operating in parallel. The amplifier operates on a power supply voltage of +42 VDC supplied to the board from the FET switch metering board. The voltage regulator U1 steps down the voltage to provide a bias voltage to the transistors. The diodes CR1 for Q2 and CR3 for Q1 are used to temperature compensate the bias voltages. As the RF transistors heat up, the associated diode also heats up, causing the voltage across it to drop, lowering the bias voltage to the RF transistor so that the biasing remains constant with device temperature changes.

The transistors are operated in quadrature, with one transistor pair operating 90 degrees out of phase of the other pair, which provides for a very good return loss across the UHF band on both the input and output of the board.

The RF input at a level of approximately +36 dBm connects to J1 on the board. The input is applied to a hybrid splitter that produces two outputs, one at 0° and one at -90°. Each output connects to identical circuits. The -90° signal is applied to a Balun assembly that produces two 180° out of phase outputs. The two outputs connect to Q1 a dual FET, configured in a push pull arrangement, with approximately 16 dB of gain. The amplified outputs of the FETs connect to a Balun assembly that combines the two 180° out of phase signals into a single -90° output. The -90° output connects to one input of the output hybrid combiner circuit.

The 0° signal is applied to a Balun assembly that produces two 180° out of phase outputs. The two outputs connect to Q2 a dual FET, configured in a push pull arrangement, with approximately 16 dB of gain. The amplified outputs of the FETs connect to a Balun assembly that combines the two 180° out of phase signals into a single 0° output. The 0° output connects to the other input to the output hybrid combiner circuit.

The 0° and the -90° signals are combined by the output hybrid combiner circuit and connected to J2 the RF output jack on the board (≈+54 dBm).

The +42 VDC, from the FET switch metering board, connects to J3 on the board. The voltage is applied through the resistors, R24 to Q2 and R31 to Q1, and the Baluns to the drains of the devices. The +42 VDC is also connected to the regulator IC U1 that supplies the source voltages through the Baluns to Q1 and Q2. R26 & R27 for Q2 and R42 & R43 for Q1 are adjusted at the factory to set up the optimum drain currents of the devices and should not be readjusted.

3.2.2.6: (A13) 4 Way Combiner Board (1311945)

The (A13) 4-way combiner combines the output signals of the UHF broadband amplifier pallet boards typically +54 dBm into a single output typically +58.9 dBm ATSC, which connects through the coupler board to the output jack for the tray at J2.

The combiner circuit is in the form of Baluns mounted on a Teflon board. The actual combiner network does not incorporate tuning elements. The network provides for equal combining, over the entire UHF band, of the four inputs at connectors J4-J7. The signals at J4 and J5 are combined at a ratio of 2:1 and the signals at J6 and J7 are combined at a ratio of 2:1. After this, both combined powers are combined again in a second stage in the ratio of 2:1. The load (balancing) resistors of the first two 2:1 stages are 50Ω/250W power resistors, and for the second stage 2:1 stage is a 50Ω/350W power resistor. The combined RF output of the board is at J2 and is typically +58.9 dBm 775 Watts ATSC in level.

3.2.2.7: (A17) FET Switch/Metering Board (1312342; Appendix B)

The FET switch/metering board provides protection of the +40 VDC to the amplifier modules in the tray, feed through connections of the driver and final amplifier forward power samples and feed through connections of the temperature sensors A15 and A16 mounted on the heatsink assembly.

The (A12) coupler board provides voltages proportional to the peak and average forward output power of the 4 way combiner. These test voltages are coupled through and passed to the amplifier control board through J15-2 for average output power and J15-14 for peak output power. A sample of the (A2) Dual BLF871 driver amplifier assembly forward power connects through the FET Switch/Metering Board at J15-1 that is supplied as a driver forward power sample to the amplifier control board.

3.2.2.7.1: Operating Voltages for the Amplifier Boards

The operating voltage of +40 volts is distributed to each of the UHF pallet amplifier boards, TB4 to A8, TB3 to A7, TB2 to A6, and TB1 to A5. The +40 volts is also distributed to the (A2) Dual BLF871 amplifier assembly and the (A1) phase/gain board TB5.

The FET switch/metering board will remove the +40 VDC from the amplifier boards during hot replacement of the UHF Amplifier Tray Assembly. The FETs Q1, Q2 and Q3 are controlled, switched On and Off, by the high power gate control that is applied to J15-25 from the Amplifier Control Board. The drain currents of the power transistors mounted on the UHF broadband amplifier pallet boards are captured by .005Ω precision resistors connected in their supply lines. The voltage drops across these resistors are passed to the amplifier control board through two 43.2kΩ bleeder resistors in parallel. In addition, the +40 VDC operating voltage at J15-12 is also passed to the amplifier control board for monitoring purposes.

Critical operating parameters, including current high or low and the temperature, of the amplifiers are monitored on the amplifier control board through the FET switch metering board. If threshold values are exceeded, the amplifier control board switches Off the operating voltages for the predriver, driver and final amplifiers using the high power gate control that turns Off the FETs Q1, Q2 and Q3 on the FET switch metering board.

3.2.2.8: (A14) Amplifier Control Board (1311683; Appendix B)

All protective, switching, display, and monitoring functions required for the operation of the UHF amplifier tray assembly are realized by the amplifier control board. The amplifier control board is mounted vertical in a RF enclosure behind the front panel of the amplifier tray. The amplifier control board performs the following tasks:

- Capture and processing of test values
- Fault protection for the amplifier modules
- Generating the actual value for transmitter ALC
- Communication with the transmitter control unit

The circuits in the amplifier control board do not contain elements that can be adjusted. All of the required settings are software implemented at the factory during initial setup through a RS 232 port, located on the front panel of the tray, and must not be altered.

3.2.2.8.1: Schematic Drawing 1311684 Page 1:

Located in the upper center of page one of the schematic is U2, which is the microcontroller. This in-circuit Atmel microcontroller is operated at 3.6864 MHz. Programming of this device is performed through J2. PF4 and PF5 are analog inputs for ICs U33 and U34 located on page 4 of the schematic. The desired analog channels of U33 and U34 are selected by the settings of PA0, PA1, & PA2. PA3 of U2 drives a processor operating LED, DS1, which is lit to show continued operation. PF0 for +12V and PF1 for -12V are used to monitor the supplies to the board. PF3 is connected to a via V3 for future access. PB3, 4, 5, 6 and 7 are used to indicate different hardware revisions to the operating software by placing a high, +5V, or a Low, Ground, on the line.

U6 is a standard serial to RS-485 driver IC. The resistor R25 sets U6 to transmit mode when U2, the microcontroller, is held in reset or PE2 is configured as an input.

U4 is a watchdog IC used to hold the U2 microcontroller in reset if the supply voltage is less than 4.21 VDC; {(1.25 VDC < Pin 4 (IN) < Pin 2 (Vcc)}. U4 momentarily resets the U2 microcontroller if Pin 6 is not clocked every second.

U3 is a RS-232 serial port on UART 1 of the U2 microcontroller. J1 is used to provide front panel RS-232 access (without hardware handshaking). A standard NULL modem cable is needed to connect to a PC. For test and debug, all data into and out of the RS-485 interface of UART0 is transmitted through pin 9 of J1. **NOTE:** This pin is usually not used unless hardware handshaking is implemented.

U1, located in the Upper left corner of the schematic, is used to determine where the amplifier control board is located. Module ID 1, 2 and 3 inputs require an external pull-down to ground to set the logic state but Module ID 4 requires an external pull-up. Diodes such as CR1, located in the Module ID 1 line, found on Page 5 of the schematic, prevent un-powered modules from pulling down the Module ID lines of other installed modules. The external pull-down to ground connections are made in the amplifier cabinet wiring harness.

U36 below U1 is used to reset faults that are detected on Pages 2 and 5. Circuits found on Pages 2 and 5 hold a fault condition so that theU2 microcontroller has enough time to detect the fault and perform the necessary operation.

U5 is below U36 and is used to control the board's status LEDs, DS3 Amplifier Enabled and DS4 Module OK (See Table 3-3), and other circuits that are not allowed to change state during a microcontroller reset. The LEDs are controlled by FETs, Q3-Q6, that when the FET is turned on, it shuts current away from the LED to turn it Off or when the FET is turned off, current is fed through the LED to turn it On.

U7 is located below U5 and is used to transfer the latched fault conditions into the microcontroller U2.

Table 3-3: DS4 Module OK LED Red and Blinking interpretation

Red LED Blinking	Meaning
1 Blink	Indicates Amplifier Current Fault
2 Blinks	Indicate Temperature Fault
3 Blinks	Indicate Power Supply Over Voltage Fault
4 Blinks	Indicate Power Supply Under Voltage Fault
5 Blinks	Indicate Reflected Power Fault
6 Blinks	Indicate +12V or −12V Power Supply Fault
7 Blinks	Indicate AGC Overdrive Fault

3.2.2.8.2: Schematic Page 2:

In the upper center section of page 2 are circuits with ICs U35A, U35B, U11 and U12. When the cabinet high power supply is enabled, U35A generates a regulated voltage that is approximately 7.5 Volts less than the +48 Volt high power supply voltage. U11 and U12 generate a regulated voltage output that is about 10 Volts higher than the high power supply voltage. This voltage is regulated to produce a voltage level that is about 4.4 VDC above the high power supply voltage. The PS +4.4VDC regulated output is used to power the unity gain op-amp circuits, U15, U17, U19, U21 and U23, located on Page 3 of the schematic.

The PS +10VDC output is also used to drive the gate of two external power FETs. These FETs are located within the amplifier module and are used to control the high power supply current to the amplifier pallets. Since the high power supply voltage can be +48 Volts and the 2N7002LT1 is rated for a maximum Drain to Source voltage of 60 Volts, Q9 along with Q8 make a circuit that controls the high power supply control voltage of the two external power FETs. Q13 allows the hardware to automatically disable the external power FETs on detection of a critical fault. Q19 quickly reduces the drive level when a fault is detected.

U50 detects the high power supply voltage and generates a high power supply voltage, high fault if it is too high. U51 detects the high power supply voltage and generates a high power supply voltage, low fault if it is too low. U58 is a digital potentiometer that sets the over voltage to U50 and under voltage to U51 fault thresholds. U37 latches the fault so that the U2 microcontroller can observe the fault condition even after the cause of the fault is removed.

3.2.2.8.3: Schematic Page 3:

Located on Page 3 there are four identical current monitoring circuits for checking the four output final amplifier UHF pallet boards, BLF878. A 0.01 Ω resistor is used within the amplifier tray module for monitoring the current through several sections of the amplifier. The voltage developed across this resistor is provided to the amplifier control board through current limiting resistors. The amplifier control board also has two 43.2 kΩ current limiting resistors mounted in parallel and a diode on the inputs to the current monitoring circuits. Due to the input bias current of the Linear Technology LT1787HVCS8 precision high side current sense amplifiers, U18, U20, U22 and U24, the current sense amplifiers can not be directly connected to the resistive components. Unity gain low input offset op-amps, U17, U19, U21 and U23,are used in both the high and low side sense lines. Voltage supplied to these parts must be above the high voltage supply rail and the V- pin must be less than the high voltage supply but not as far down as ground. Digital potentiometers, U38 and U39, are connected to each of the high current monitoring circuits to allow for calibration of the measured current prior to the over current detection circuits.

3.2.2.8.4: Schematic Page 4:

The upper left corner contains U33 and U34, which are analog multiplexer ICs that are used to route selected analog signals into the U2 microcontroller.

U32B converts the detected forward power sample level into a module AGC output voltage. CR51 allows the module's AGC output voltage to be connected to other module trays AGC voltages. If this module tray has the highest detected forward power in a multi-amplifier system, it will have the highest forward power signal and this signal level into U32B pin 5 will be used to set the AGC output voltage of the system. If another amplifier has a higher forward power, the level into U32B pin 6 will be higher than pin 5 and this amplifiers output signal will not be used to set the AGC voltage level.

High speed comparators U52, U53, U54, and U55 monitor the current of the RF final amplifier pallets. If any level is greater than the fault level set by the digital potentiometer U43, the fault is detected and held by U41.

U44 is a digital potentiometer that sets the AGC voltage level, the over drive fault threshold and the module forward power level.

3.2.2.8.5: Schematic Page 5:

The trays reflected power is monitored through a RF detection circuit located on Page 5 of the schematic. If the reflected power level is greater than the fault threshold level set by U43 pin 10, located on Page 4 of the schematic, which connects to U56 pin 1, U56 will indicate a reflected power fault output at pin 5. The fault is latched for detection by the U2 microcontroller and also biases On the switching diode CR66, located on Page 2. This turns On the FET Q13, which biases On Q8. +10VDC, the High Power FET Gate Control, is connected through Q8 to the main control FET, located on the FET switch metering board. The control FET is biased Off and immediately removes the supply voltages to the output amplifier pallets.

In the lower left corner of the page are voltage regulator circuits. U29 is a +12 VDC to +7V regulator that is rated for 0.14 amps of power using its 92° C/W rating if Ta = 60°C max and Tj = 125°C max. 0.26 amps can be obtained from U29 if the thermal mounting pad is 0.5 square inches. The U2 controller does not typically need this much current. U30 and U31 are low drop-out voltage regulators with a tolerance greater than or equal to 1%. U30 is the +7V to +5Vanalog regulator and U31 is the +7V to +5Vdigital regulator. 100 mA of current is available from each of the devices.

3.3: Troubleshooting and Repair of the Amplifier

3.3.1: Safety Information

Work on the amplifier must only be carried out by qualified personnel according to good electrical engineering practice, taking into account all relevant safety precautions. Furthermore, the following should be noted:

- Before working on an amplifier, e.g., removing cables, removing the front panel etc., ensure that the amplifier is disconnected from the operating voltages. Carry out all work with extreme caution.

3.3.2: Troubleshooting

3.3.2.1: Front Panel LEDs

A visual indication of the operating status of the UHF amplifiers is signaled by two front panel LEDs. Fault free operation is signaled by the lit Green Module OK LED, located nearest the handle. A fault condition is indicated by a Module OK, either continuously illuminated Red or flashing Red.

The flashing Red Module OK LED interprets as follows:

Table 3-4: DS4 Module OK LED Red and Blinking interpretation

Red LED Blinking	Meaning
1 Blink	Indicates Amplifier Current Fault
2 Blinks	Indicate Temperature Fault
3 Blinks	Indicate Power Supply Over Voltage Fault
4 Blinks	Indicate Power Supply Under Voltage Fault
5 Blinks	Indicate Reflected Power Fault
6 Blinks	Indicate +12V or −12V Power Supply Fault
7 Blinks	Indicate AGC Overdrive

The other LED, on the front panel, is the Enable LED, located nearest the edge. It is Green when an Enable is applied to that amplifier and it is operating. It will not be lit if the Enable is removed. It will be lit Amber if the Enable is applied but the amplifier is not operating.

3.3.2.2: Polling Fault Indications

Detected fault conditions are passed to the system control unit. The fault indications are entered in a list and can be viewed at any time during transmitter operation.

The system control unit is used for polling stored fault indications and reading actual operating parameters.

3.4: Exchanging Amplifiers

For reasons of safety, amplifier tray assemblies **MUST** be in standby (RF disabled) before any connections are removed. An Axcera Amplifier disable plug (1308219) can be used to place an individual tray in standby. Regardless of the version of the code, any power amplifier may safely be removed by disabling its power supply. The power supply, either the top power supply #1 for the top four Amplifier assemblies, or the bottom power supply #2 for the bottom four Amplifier assemblies, may be isolated from the main AC power by switching off the associated circuit breaker located on the circuit breaker assembly panel, at the bottom of the amplifier cabinet.

3.4.1: Exchange of a Module within a Tray Assembly

Caution: The load (balancing) resistors in the modules contain Beryllium Oxide.

Remove the amplifier from the cabinet as described in the Chapter 2 section 2.7 of this volume of the instruction manual.

Undo the covers panel of the amplifier tray.

Unsolder the connections for the operating voltage as well as the RF input and output connections of the defective module.

NOTE: The temperature sensors A15 or A16 may need to be unscrewed to remove the module.

After undoing the screws, the module can be lifted from the heat sink. Remove the old heat-transfer paste from the heat sink.

NOTE: In order to ensure proper heat conduction, the contact surface of the heat sink must be clean and free of foreign particles.

3.4.2: Mounting a New Module

Apply a thin film of heat-transfer paste to the contact surface.

Fix the module into position with the mounting screws. At first, only tighten the screws by hand.

Next, tighten the screws, in repeated steps, to a torque of 0.8 Nm (7 in/lb).

Caution: A torque of 1.2 Nm (10 in/lb) must not be exceeded.
(1.2 NM ≈ 10 in/lb)
(0.8 Nm ≈ 7 in/lb)

3.4.3: Final Steps

Replace the cover on the amplifier, insert the tray assembly into the transmitter cabinet, and make the RF input and output connections as described in Chapter 2 section 2.7 of this volume of the instruction manual.

NOTE: Alignment work on the amplifier is not required. They are set at the factory for both phase and gain control and provide less than 0.5 dB difference between the amplifiers. The exchange of a module should be reported to Axcera with information on the cause of the fault, module location, identification number of the amplifier, and the type of transmitter.

3.4.4: External Connections to Amplifier Assembly

Table 3-5: RF Connectors on the Front Panel

Connector	Assignment	Type
J1	RF Input	Female N-type
J2	RF Output	Female HF 7/16"
J3	RF Test Point	Female N-type
RS 232 C	**reserved for factory alignment only!**	

Table 3-6: Operating Voltage Connection (Rear Panel)

Pin	Assignment
J5	+48 V
J6	Ground

3.5: Power Supply Assembly

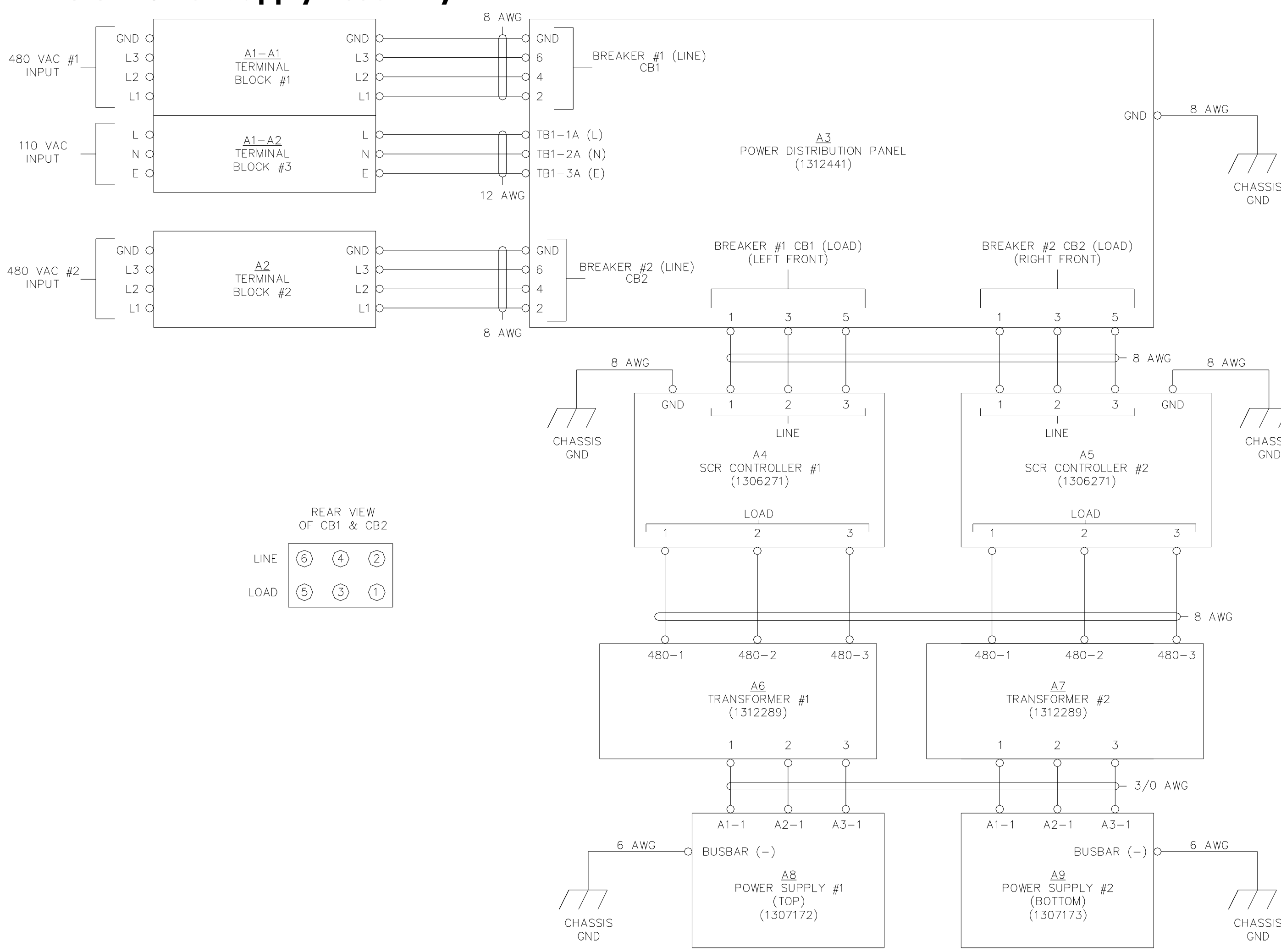


Figure 3-6: AC Wiring Harness UHF Amplifier Cabinet

3.5.1: +48 VDC Power Supplies Overview

The DC voltages to the UHF amplifier tray assemblies mounted in each UHF amplifier cabinet are supplied by either one or two linear power supply assemblies. One supply, titled the top power supply #1, provides +48 VDC to the four UHF amplifier tray assemblies mounted at the top of the cabinet for 5 kW amplifier cabinets or three UHF amplifier assemblies mounted at the top of the cabinet for 3.7 kW amplifier cabinets. The other supply, titled the bottom power supply #2, provides +48 VDC to the four UHF amplifier tray assemblies mounted at the bottom of the cabinet for 2.5 & 5 kW amplifier cabinets or to three UHF amplifier tray assemblies mounted at the bottom of the cabinet for 1.8 or 3.7 kW amplifier cabinets.

Refer to Figure 3-6 while reading the following description. Two input AC connections of 480 VAC, 3 phase or 208 VAC 3 phase and one 110 VAC input connection are needed to operate each UHF Amplifier Cabinet. The 110 VAC input connects to the (A1-A2) Terminal Block #3 mounted at the top left side, at the rear of the cabinet. The 110 VAC is wired directly to a terminal block TB1 located in the AC power distribution panel mounted at the bottom of the cabinet. One of the 480/208 VAC, 3 phase inputs connects to the (A1-A1) Terminal Block #1 and the other to the (A2) Terminal Block #2 mounted top left side, at the rear of the cabinet. The two 480/208 VAC inputs are wired directly to the circuit breakers (A1-A1) Terminal Block #1 to CB1 and (A2) Terminal Block #2 to CB2 located in the AC power distribution panel mounted at the bottom of the cabinet. The AC input voltages to the two power supplies are controlled through the two 480 VAC 30 Amp or 208 VAC 50 Amp 3 Phase circuit breakers located on the (A3) AC power distribution panel. The left front circuit breaker controls the voltage to power supply #1 and the right front circuit breaker controls the voltage to power supply #2.

The two +48 VDC power supplies, (A8) #1 and (A9) #2, are identical with each containing a SCR Controller, a transformer and a linear power supply.

3.5.2: SCR Controllers

The two SCR controllers, (A4) SCR Controller #1 and (A5) SCR Controller #2 are manufactured by Control Concepts, Inc. The SCR controller is of a phase angle, pulse width, control design. The output power is regulated by varying the point at which the SCR is turned on within each half cycle. **NOTE:** More detailed information is supplied in the manufacturer instruction manual that is supplied with the SCR Controller.

3.5.3: Step Down Transformers

The outputs of the two SCR controllers connect to one of the two three phase 480/208 VAC step down transformers. The (A6) Transformer #1 or (A7) Transformer #2, whose input connections are set at the factory depending on the input voltage provided and supplies three outputs that connect directly to the input of the linear power supply assemblies.

3.5.4: +48 VDC Linear Power Supply Assemblies (1307172 Top or 1307173 Bottom; Appendix C)

(Refer to Figures 3-7 & 3-8) Both of the Power Supply Assemblies, Top #1 and Bottom #2, are identical in operation, the only differences are in the physical assembly itself. The three stepped down outputs of the transformer, approximately 100 VAC, connect to one of the three Rectifier Modules (A1-A3). The rectifier modules are full wave rectifiers that each produce +46.5 VDC, which are summed in parallel at the Bus Bars B and 3. The +46.5 VDC outputs are filtered by the eight A4-A11 100,000µF capacitors. Capacitors A4-A7 through Bus Bar C are for Amps #1 and #2, with the top power supply, or Amps #5 and #6, with the bottom power supply. Capacitors A8-A11 through Bus Bar E are for Amps #3 and 4, with the top power supply or Amps #7 and #8, with the bottom power supply.

3.5.4.1: Power Supply Monitoring Board (1307059; Appendix C)

Each amplifier assembly has (A12) a power supply monitoring board, which contains the range adjustment using R6 and the feedback adjustment using R8 potentiometers for the power supply in which the board is contained. These adjustments control the SCR Controller Assembly which in turn controls the output voltage level of the power supply. **NOTE:** The settings of these two pots were completed at the factory and should not be adjusted because damage may occur to the amplifier devices.

The board samples the 3 phase AC input lines at J1, J2 and J3. Each AC leg is full wave rectified by diodes CR1-CR6 and filtered by C1. This DC voltage counted to the SCR controller assembly which causes more or less turn on time for the cycles, that increases or decreases the AC input to the power supply affected which increases or decreases the DC voltage output of the power supply.

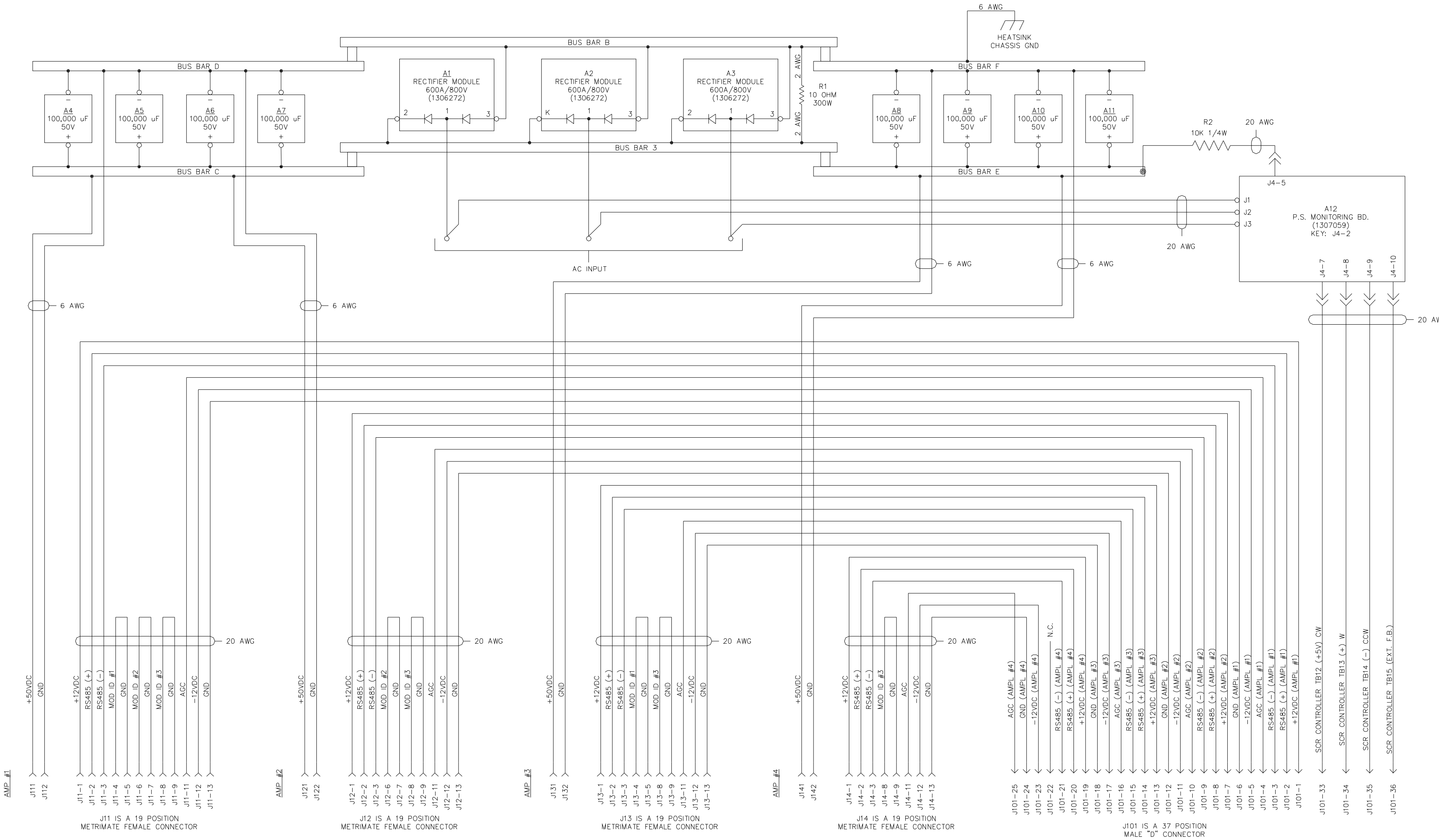


Figure 3-7: +48 VDC Linear Power Supply #1, Top

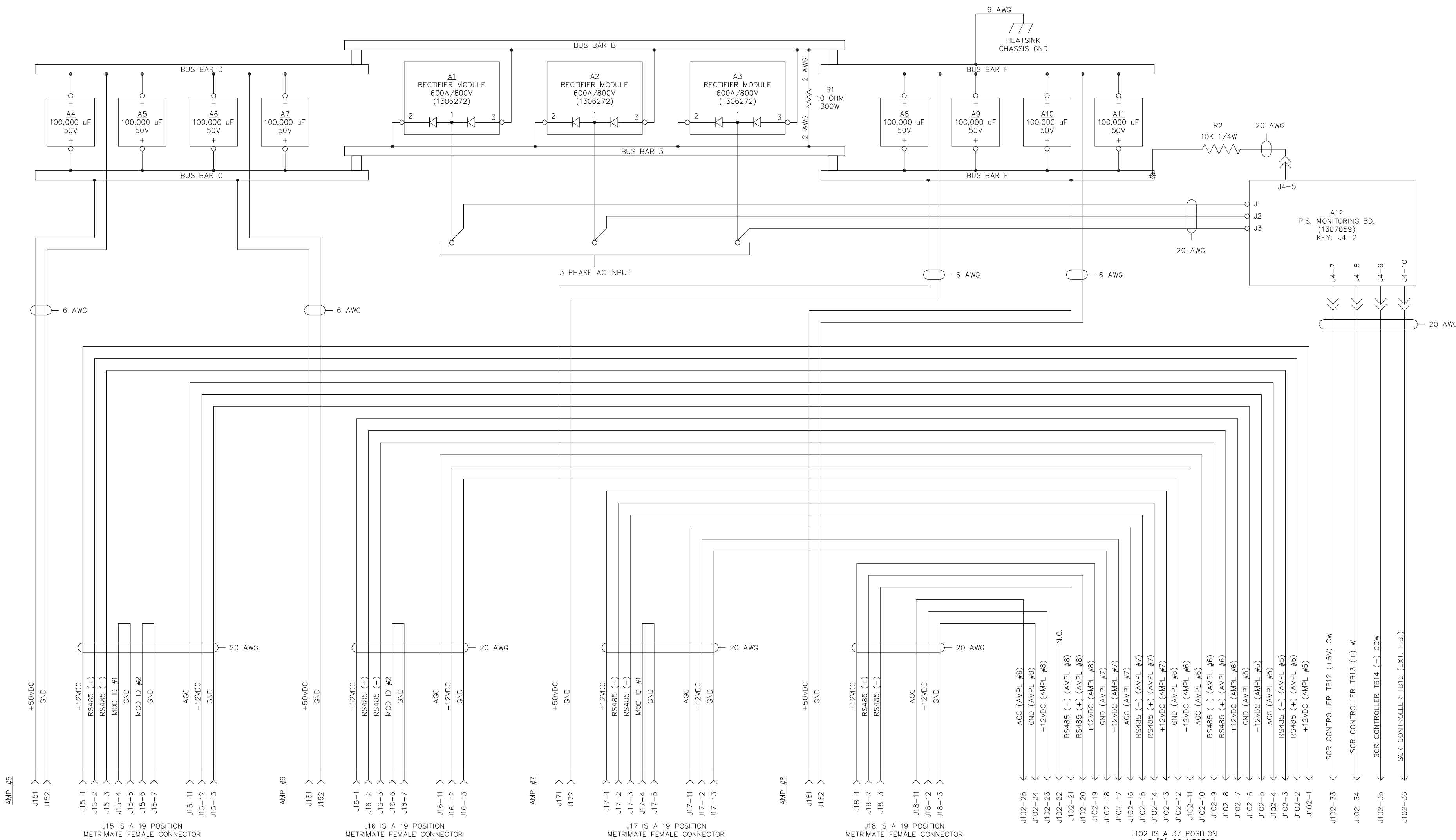


Figure 3-8:+48 VDC Linear Power Supply #2, Bottom

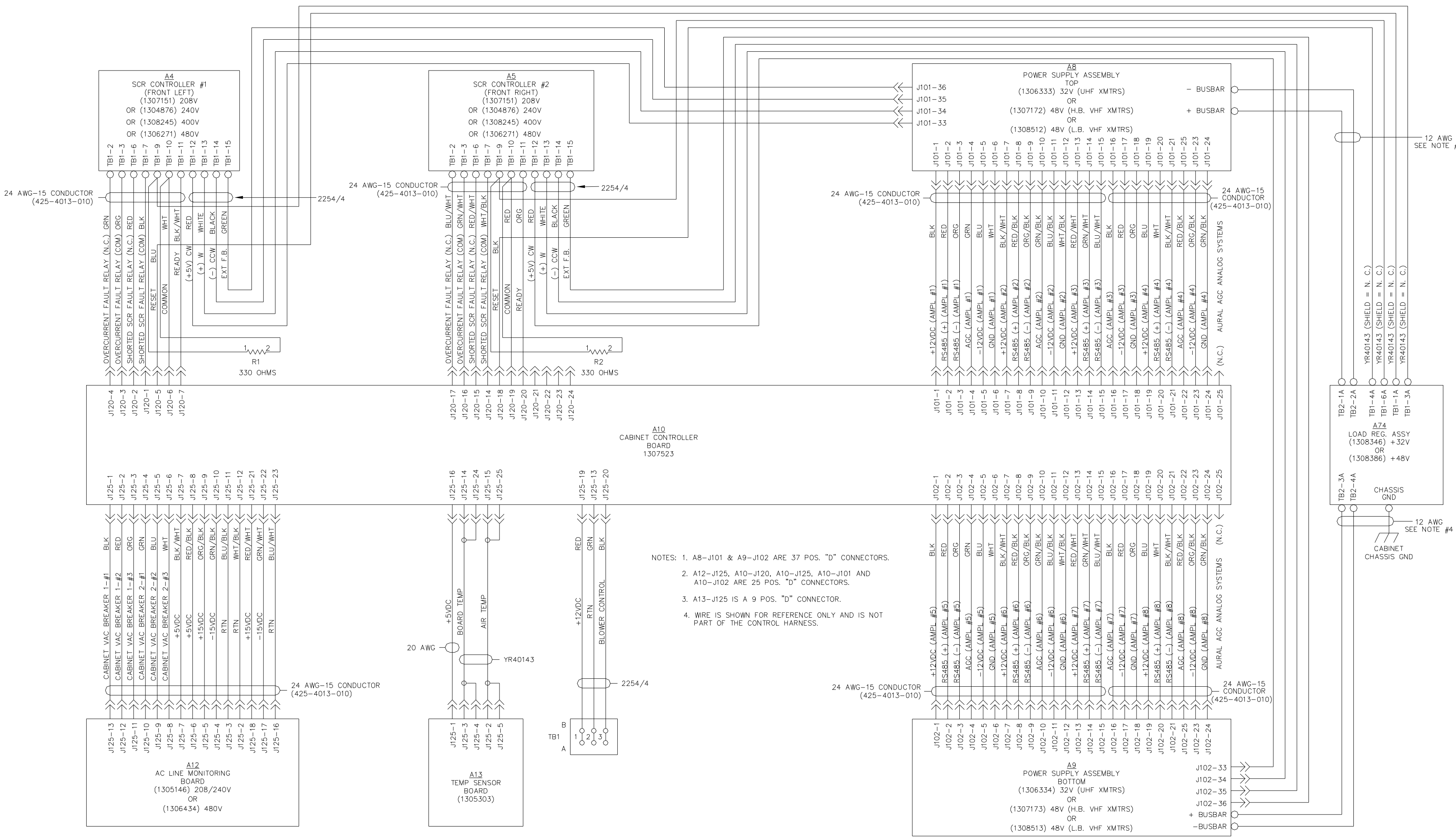


Figure 3-9: Full Cabinet Controller System Interconnect

3.6: Full Amplifier Cabinet Controller Board (1307523; Appendix A)

Your amplifier cabinet will contain the full amplifier cabinet controller assembly or the half amplifier cabinet controller assembly. The half amplifier cabinet controller assembly is described in the next section.

The full amplifier cabinet controller board is mounted in the Full Amplifier Cabinet Controller Assembly (1305453). The assembly is located facing the back of the cabinet mounted on the rear of the top combiner assembly and controls the entire amplifier cabinet.

3.6.1: Schematic Drawing 1307524 Page 1:

Centered in page one of the schematic s the microcontroller (U6). This in-circuit programmable Atmel microcontroller is operated at 3.6864 MHz. Programming of this device is performed through J105. PF2 is an analog input that connects to a multiplexer U9 and PF3 is another analog input that connects to the multiplexer U5. The desired multiplexer analog channels are selected by the setting of PA0, PA1, & PA2. PF0 and PF1 are used to monitor the +12V and -12V supplies to the board.

(U12) is a watchdog IC that is used to hold the microcontroller in reset if the supply voltage is less than 4.21 VDC; (1.25 VDC < Pin 4 (IN) < Pin 2 (Vcc)). U12 will momentarily reset the microcontroller if Pin 6 is not clocked every second.

The (U6) Microcontroller UART 0 is used to communicate with each of the amplifier modules, Cabinet Serial. U10 is a RS-485 transceiver IC for cabinet serial communication to the amplifier modules. The (U6) Microcontroller UART 1 is used to communicate with the transmitter's exciter or exciter switcher, System Serial. U8 is a RS-485 transceiver IC.

The IC U2, Serial Address, located in the Upper left corner, is used to determine where the amplifier control board is located. Rotary switch SW1 determines the cabinet number and thus the cabinet's serial address. The upper three bits of U2 can be used to determine physical board characteristics. Bit 6 will be reserved for a half cabinet controller to determine if the controller is the top half controller or the bottom half controller.

The IC U3, SCR Controllers, below U2, is used to monitor the status of the SCR controllers. U7 below U3 is connected to an 8 position DIP switch, SW2, which can be used to enable select firmware options. See Table 3-7. U11, below U7, is used to control the SRC controller, the cabinet's cooling blower FET, and the Processor Operating LED, DS2. The use of this IC allows these circuits to remain stable during a microcontroller reset.

3.6.2: Schematic Page 2:

In the upper left section of Page 2 are circuits that interface with the exhaust air temperature board and the low power ±15VDC switching supply. Control of an external cooling blower relay is available through J125 pin 20. When the cabinet's RF output is enabled, the external blower relay is energized by the enabling of Q3 on page 1. Voltage samples of the cabinet's high power AC inputs are monitored through inputs of J125.

On the upper right side of the schematic, the Power Supply SCR Controller interface section routes signals need to control the high power supply. R120, R121, R122, and R123 are used to set the output voltage of the high power supply.

Amplifier module interfaces are routed through J101, for modules 1-4, and J102, for modules 5-8. Each amplifier module has independent RS-485 transceivers and power sources that are current limited with self-resetting fuses.

The RS485 interface section, located in the lower right section of the schematic, defines the RS-485 loop through connections that also contain the system's AGC signals. Circuitry in the lower portion of this block is used to convert cabinet AGC voltages into system AGC voltages. If the cabinet level voltages are greater than the system levels, U13 increases its output to drive the system level to match the cabinet level. Cabinet AGC levels are set by the highest AGC voltage of the install amplifier modules.

3.6.3: Schematic Page 3:

In the upper left portion of the schematic, R125 is used to measure the cabinet's inlet air temperature. Also defined on this page are the board's voltage regulators. The cabinet's +15V supply is used by U14 and U17 to generate +12V for all of the amplifier modules. The cabinet's -15V supply is used by U19 to generate -12V for all of the amplifier modules. The +12V signal is further regulated by U16 to +7 VDC then regulated again to separate digital +5V by U18 and analog +5V by U15. The digital +5V regulator U18 is not as precise as the analog +5V regulator U15 but it is capable of high current loads.

3.6.4: Schematic Page 4:

These circuits take the forward and reflected RF power samples and converts the signals to DC values used to provide power levels for the cabinet monitoring. The RF detection circuits are made up of diodes and separate op-amps. Once the detected voltages are amplified, the signals are fed through power calibration potentiometers, R110, R11, R112, R113 or R114, before they are fed through unity gain amplifiers, U20, U23A, U23B, U24A or U24B to the microcontroller's multiplexer.

3.6.5: Schematic Page 5:

These eight circuits are individual RS-485 transceiver ICs for serial communication with the amplifier modules. The RS-485 transceiver ICs contain components that maintain the receive channel in a high output state when the inputs are left open, shorted together or terminated with no signal. The transmit and receive channels of each transceiver are individually controlled by the microcontroller. During reset or programming of the microcontroller, pull-up and pull-down resistors are used to place the transceivers in a tri-state condition. Each amplifier RS-485 connection is terminated with a 120 Ω resistor.

Table 3-7: Firmware Configuration of SW2 on Full Amplifier Cabinet Controller Board

Switch Number	**Function**	**Position**	**Normal Operating Position**
SW2-1	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off
SW2-2	Allow Power Supply Enable on Cooling FLT	0 = Off 1 = Allow	Off - Must be Off
SW2-3	Allow Power Supply Enable on RFL PWR FLT	0 = Off 1 = Allow	Off
SW2-4	High Voltage Supply Range	0 = 220 1 = 440	System dependent
SW2-5	Reflected Power RF Source	0 = J112 1 = J114 (If not Externally Diplexed)	System dependent
SW2-6	Allow Power Supply Enable on Reject Load Faults	0 = Off 1 = Allow	Off
SW2-7	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off
SW2-8	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off

NOTE: These switch positions are factory set and should not be changed.

3.7: Half Amplifier Cabinet Controller Board (1307840; Appendix A)

The half amplifier cabinet controller board is mounted in the Half Amplifier Cabinet Controller Assembly (1307847). There are typically two assemblies, which are mounted facing the rear of the cabinet. One controller is mounted on the rear of the top combiner assembly, which controls the top power supply and amplifier module assemblies and one mounted on the rear of the bottom combiner assembly which controls the bottom power supply and amplifier module assemblies.

3.7.1: Schematic 1307841 Page 1:

Centered in page one is the microcontroller (U6). This in-circuit programmable Atmel microcontroller is operated at 3.6864 MHz. Programming of this device is performed through J105. PF2 is an analog input that connects to a multiplexer U9. PF3 is another analog input that connects to the multiplexer U5. The desired multiplexer analog channels are selected by the setting of PA0, PA1, & PA2. PF0 and PF1 are used to monitor the +12V and -12V supplies to the board.

(U12) is a watchdog IC that is used to hold the microcontroller in reset if the supply voltage is less than 4.21 VDC; (1.25 VDC < Pin 4 (IN) < Pin 2 (Vcc)). U12 will momentarily reset the microcontroller if Pin 6 is not clocked every second.

The Microcontroller UART 0 is used to communicate with each of the amplifier modules, Cabinet Serial. U10 is a RS-485 transceiver IC for cabinet serial communication to the amplifier modules.

The Microcontroller UART 1 is used to communicate with the transmitter's exciter or exciter switcher, System Serial. U8 is a RS-485 transceiver IC.

The IC U2, Serial Address, located in the Upper left corner, is used to determine where the amplifier control board is located. Rotary switch SW1 determines the cabinet number and thus the cabinet's serial address. The upper three bits of U2 can be used to determine physical board characteristics.

The IC U3, SCR Controllers, is located below U2. U3 is used to monitor the status of the SCR controllers. U7 below U3 is connected to an 8 position DIP switch, SW2, which can be used to enable select firmware options. See Table 3-7.

U11, below U7, is used to control the SRC controller, the cabinet's cooling blower FET, and the Processor Operating LED, DS2. The use of this IC allows these circuits to remain stable during a microcontroller reset.

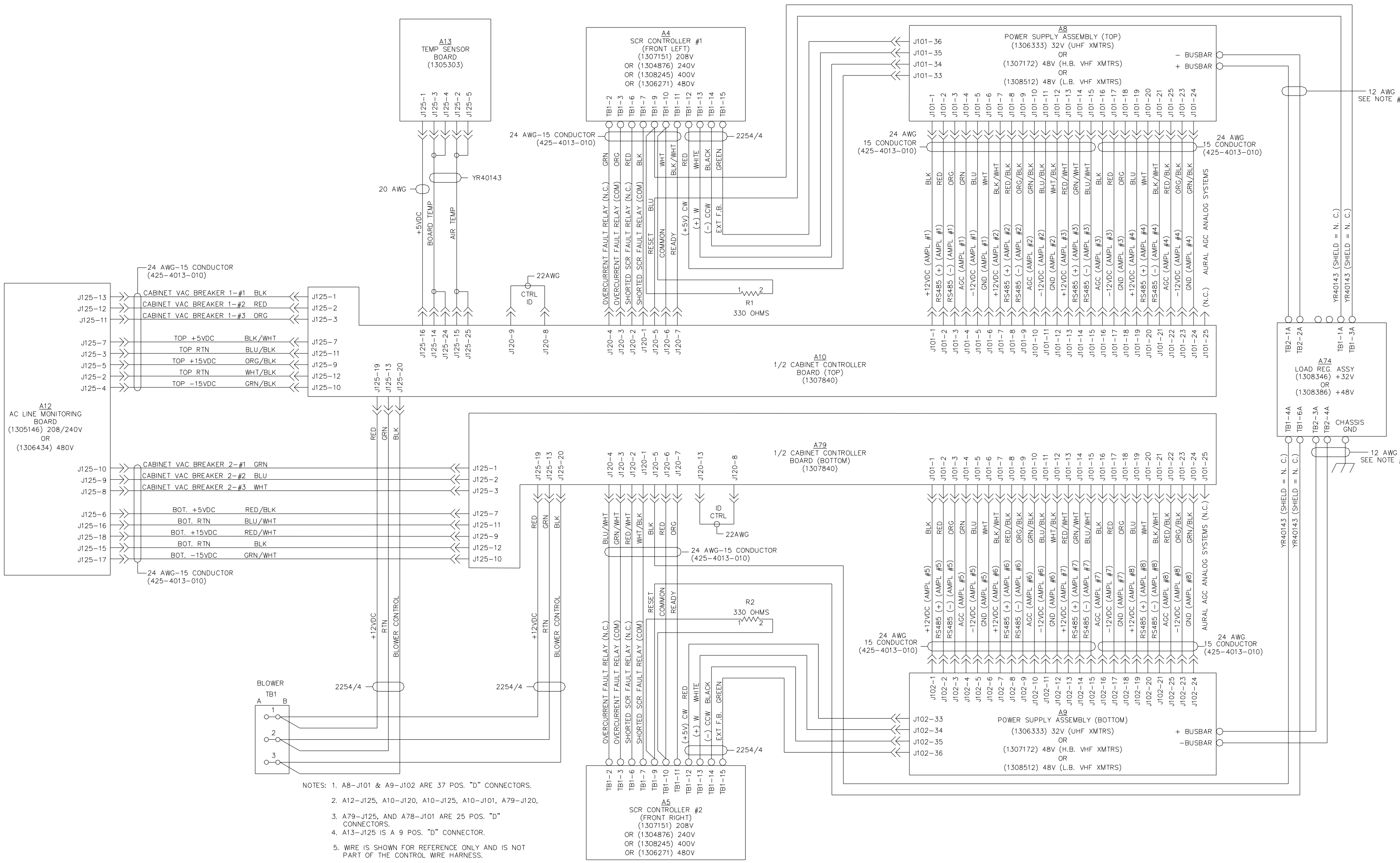


Figure 3-10: Half Cabinet Controller System Interconnect

3.7: Half Amplifier Cabinet Controller Board (1307840; Appendix A)

The half amplifier cabinet controller board is mounted in the Half Amplifier Cabinet Controller Assembly (1307847). There are typically two assemblies, which are mounted facing the rear of the cabinet. One controller is mounted on the rear of the top combiner assembly, which controls the top power supply and amplifier module assemblies and one mounted on the rear of the bottom combiner assembly which controls the bottom power supply and amplifier module assemblies.

3.7.1: Schematic 1307841 Page 1:

Centered in page one is the microcontroller (U6). This in-circuit programmable Atmel microcontroller is operated at 3.6864 MHz. Programming of this device is performed through J105. PF2 is an analog input that connects to a multiplexer U9. PF3 is another analog input that connects to the multiplexer U5. The desired multiplexer analog channels are selected by the setting of PA0, PA1, & PA2. PF0 and PF1 are used to monitor the +12V and -12V supplies to the board.

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U11, below U7, is used to control the SRC controller, the cabinet's cooling blower FET, and the Processor Operating LED, DS2. The use of this IC allows these circuits to remain stable during a microcontroller reset.

3.7.2: Schematic Page 2:

In the upper left section of Page 2 are circuits that interface with the exhaust air temperature board and the low power ±15VDC switching supply. Control of an external cooling blower relay is available through J125 pin 20. When the cabinet's RF output is enabled, the external blower relay is energized by the enabling of Q3 on page 1.

Voltage samples of the cabinet's high power AC inputs are also monitored through inputs of J125.

Power Supply SCR Controller interfaces are documented in the upper right side of the schematic. This section routes signals need to control and monitor one of the high power supply SCR controllers. Supply voltage and reject load monitoring signals are also routed through J120.

The four amplifier module interfaces are routed through J101. Each amplifier module has independent RS-485 transceivers and power sources, that are current limited with self-resetting fuses.

The RS485 interface section, located in the lower right section of the schematic, defines the RS-485 loop through connections and contains the system's AGC signals. Circuitry in the lower portion of this block is used to convert cabinet AGC voltages into system AGC voltages. If the cabinet level voltages are greater than the system levels, U13 increases its output to drive the system level to match the cabinet level. Cabinet AGC levels are set by the highest AGC voltage of the installed amplifier modules.

3.7.3: Schematic Page 3:

In the upper left portion of the schematic, R125 is used to measure the cabinet's inlet air temperature. Also defined on this page are the board's voltage regulators. The cabinet's +15V supply is used by U14 to generate +12V for all of the amplifier modules. The cabinet's -15V supply is used by U19 to generate -12V for all of the amplifier modules. The +12V signal is further regulated by U16 to +7 VDC then regulated again to separate digital +5V by U18 and analog +5V by U15. The digital +5V regulator U18 is not as precise as the analog +5V regulator U15 but it is capable of high current loads.

3.7.4: Schematic Page 4:

These circuits take the forward and reflected RF power samples and converts the signals to DC values used to provide power levels for the cabinet monitoring. The RF detection circuits are made up of diodes and separate op-amps. Once the detected voltages are amplified, the signals are fed through power calibration potentiometers, R110, R11, R112, R113 or R114, before they are fed through unity gain amplifiers, U20, U23A, U23B, U24A or U24B to the microcontroller's multiplexer.

3.7.5: Schematic Page 5:

These four circuits are individual RS-485 transceiver Ics for serial communication with the amplifier modules. The RS-485 transceiver ICs contain components that maintain the receive channel in a high output state when the inputs are left open, shorted together or terminated with no signal. The transmit and receive channels of each transceiver are individually controlled by the microcontroller. During reset or programming of the microcontroller, pull-up and pull-down resistors are used to place the transceivers in a tri-state condition. Each amplifier RS-485 connection is terminated with a 120Ω resistor.

Table 3-8: Firmware Configuration of SW2 on Half Amplifier Cabinet Controller Board

Switch Number	Function	Position	Normal Operating Position
SW2-1	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off
SW2-2	Allow Power Supply Enable on Cooling FLT	0 = Off 1 = Allow	Off - Must be Off
SW2-3	Allow Power Supply Enable on RFL PWR FLT	0 = Off 1 = Allow	Off
SW2-4	High Voltage Supply Range	0 = 220 1 = 440	System dependent
SW2-5	Reflected Power RF Source	0 = J112 1 = J114 (If not Externally Diplexed)	System dependent
SW2-6	Allow Power Supply Enable on Reject Load Faults	0 = Off 1 = Allow	Off

SW2-7	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off
SW2-8	Reserved for Factory Test	0 = Off 1 = On	Off - Must be Off

NOTE: These switch positions are factory set and should not be changed.

3.8: Temperature Sensor Board (1309460; Appendix A)

The temperature sensor board is mounted at the top of the amplifier cabinet in the airflow path inside the exhaust plenum. The board monitors the temperature of the exhausted air and reports it to the cabinet controller board.

3.9: Serial Loop-Thru Board (1307811; Appendix A)

The serial loop-thru board is mounted on the metering module assembly located on the rear middle, left side of the amplifier cabinet.

The function of the serial loop-thru board is to provide an extra serial loop-thru that connects to the second amplifier cabinet. This prevents the system controller from not recognizing any amplifier cabinets if one system controller is removed.

NOTE: In a multiple amplifier cabinet system, there will not be a serial loop-thru board in the last amplifier cabinet in the system.

3.10: Load Regulator Assembly, +48 VDC (1308386; Appendix A)

The load regulator assembly contains a load regulator board, +48 VDC (1308393). The Load Regulator Assembly is designed to temporarily activate and maintain a constant load on the output of the power supply assembly, which due to load changes, can cause the DC output from the affected power supply to rise.

The Load Regulator Assembly monitors the DC output from the power supply and adds additional load resistance if the power supply DC voltage rises above a given threshold level. The threshold level is factory pre-set on the Load Regulator Board.

3.10.1: Load Regulator Board, +48 VDC (1308393; Appendix A)

The load regulator board is mounted in the load regulator assembly (1308386).

There are two identical regulator circuits on the board. The top power supply circuit contains Q3 and the bottom power supply circuit contains Q6. Just the top power supply circuit will be described as follows.

The Load Regulator Board receives a sample of the DC voltage from the top power supply at J1. The top power supply voltage is then regulated down to a lower voltage by varistors, VR1-VR5 and powers a +12V regulator, U1 which supplies the +12VDC (+12V1) to the rest of the circuits in the top power supply control. The Trip threshold is set by R16 to +50.0 VDC for the +46.5V power supply. If the power supply voltage exceeds the above set level, the FET switch Q3 is biased on and provides a contact closure. This contact closure adds additional 1Ω/300W load resistances, R1-R3, across the DC output of the affected power supply. Once the DC voltage returns to normal, the FET switch is biased off and the switch opens, thereby removing the additional load resistance.

There are thermal switches mounted on the FETs and the power resistors that will open shut down the associated power supply should an over temperature fault occur, >70°C. Thermal Switch S1 is mounted on Q3, for the top power supply, S2 is mounted on Q6, for the bottom power supply, S3 is mounted on R1, for the top power supply and S4 is mounted on R4, for the bottom power supply.

This completes the description of the UHF Amplifier Tray Assembly and other Cabinet Assemblies.

Appendix A

RF Amplifier Cabinet Assembly, HXB Series Drawings

Appendix A
Drawing List

Appendix B

UHF Amplifier Tray Assembly, Broadband, HXB Series Drawings

Appendix B
Drawing List

Appendix C

Power Supply Assemblies, Top and Bottom, HXB Series, +48V Drawings

Appendix C
Drawing List