EXHIBIT 4

As required by 2.983(d)(8), the following is a copy of the instruction manual.

800MHz Compact Power Amplifier

1 Introduction

Eagle's 800MHz Power Amplifier is a compact, rack mountable and rated at 150W (CW) from 851 to 866MHz. It features LDMOS technology, microprocessor monitoring and power control.

2 Detail Description

The amplifier unit is divided into two sections, power amplification and power control.

The power amplification consists of a preamp and two main amp stages (See figure 1). There are protection fuses for both amp stages. The fuses are instrumented with LED indicators to provide easy visibility as to their status.

The power control board provides various monitor and control functions such as forward and reflected power (VSWR), heatsink temperature and power monitor. An on-board 87C522 microprocessor is used to accomplish these monitor and control functions.

Monitor analog signals are sampled after suitable scaling in the operational amplifier stages. The gain of most of these operational amplifiers is controlled by feedback potentiometers. Adjustments are factory preset and should not require any adjustment. The following is a summary of these potentiometers and their functions (See figure 2).

R8	Reflected output power calibration	Sets the gain between the reflected power sensor and the input to the microprocessor. This input is used to control the VSWR protection circuit.
R22	Input RF threshold adjustment	Sets the input RF level at which the fan, high VSWR and high temp is activated
R28	Forward output power calibration	Sets the gain between the forward power sensor and the input to the microprocessor. This input is used to control the VSWR protection circuit.
R33	Output RF power level adjustment	This control is used to adjust a control voltage to the preamp stage that ultimately controls the level of the output forward RF power.

Power output and heatsink temperature is monitored to protect the amplifier. The microprocessor will automatically shut down the amplifier if the VSWR exceeds the preset threshold level set in the software. The amplifier will also be shut down if the heatsink temperature reaches 70°C. When this occurs, the fan will continue to run and should the temperature drop to 50°C the processor will automatically re-enable the amplifier for full power. There is, however, a built in delay of 2 minutes and 20 seconds before the reset condition can occur to allow adequate cooling for an excessively hot ambient condition.

The amplifier is capable of detecting low power output. A low power detected at the amplifier's output will turn on the low power LED display. This low power threshold is normally set in the software to approximately 25% of rated power.

3 Specifications

Electrical

Frequency Range:	851-866MHz
Input Power:	500 mW nominal, 2W max
Output Power:	150W nominal
Spur:	-65 dBC
Operating Voltage:	28VDC @ 20A
Operating Temperature:	-30 to +60°C
Input Impedance:	50 Ohm
Output Impedance:	50 Ohm

Mechanical

Input Connector:	Type N receptacle
Output Connector:	Type N receptacle
Dimensions:	
Length:	19"
Height:	7"
Depth:	7"
Mounting:	19" rack mount

4 Options

- Circulator
- System Connector: 9-pin D sub outputs include: temperature alarm, high VSWR alarm, forward and reflected voltage sample.

Figure 1 – Power Amplifier Block Diagram

Figure 2 – Power Control Board

Limited Warranty

1. The product line of paging and mobile equipment, base stations/power amplifiers, receivers, transmitters, security and transmitter control equipment sold by **EAGLE WIRELESS INTERNATIONAL, INC.** is warranted to the original buyer to meet the then current published specifications, drawings and/or such modifications thereof as Buyer and Seller have agreed to in writing and to be free from defects in workmanship and materials. Seller's entire warranty obligations are limited to making adjustments by repairing or replacing any product which fails to meet this warranty and which is returned to Seller. Replacement, repairs, or adjustment under this warranty shall be **F.O.B. Houston, Texas and does not reinstate the warranty set forth herein.** Under all circumstances, the warranty will expire not later than one (1) year after date of such first shipment.

2. This warranty is void and adjustment will not be allowed for products which have been subjected to abuse, improper application or installation, unauthorized alteration, or accidental/negligent damage in use, storage, transportation or handling.

3. This warranty does not apply to:

   a. Incandescent lamps, LEDs, batteries, fuses and other consumable type goods, operable upon arrival only.

   b. Parts and accessories (other than those in the equipment) sold by Eagle Wireless International, Inc.

   c. Service calls and/or shipping charges necessary to transport the equipment between customer's location and the factory.

   d. Routine checkout and/or tuning equipment.

   e. Equipment damaged by an act of God and/or nature, war or terrorism.

   f. Equipment that has been sold, rented, or acquired in bankruptcy proceedings.

   g. Equipment where the serial number has been removed, defaced, or changed.

4. The Seller shall have the right of final determination as to the following: (a) existence of cause and defect, (b) whether adjustment will be allowed, and (c) if allowed, whether adjustment will be by repair or replacement. When adjustment is not allowed, a reasonable charge will be made to the Buyer to cover the Seller's cost of inspection and handling. During the first 30 days from the date of original shipment the seller may elect to accept a returned item for full credit less all shipping charges. After this thirty day period the buyer will be required to pay a restocking fee of twenty five percent of the invoice amount if the Seller elects to accept the returned item.

5. In the event the Seller determines that any product claimed to be defective is not subject to the warranty provisions set forth herein, the Buyer will be notified that the product is not subject to adjustment. Unless the Buyer furnishes disposition instructions for the product within thirty (30) days after such notification, Seller may return product "as is" to Buyer, transportation collect.

6. In returning products under this warranty, Buyer shall comply with terms set forth in the Warranty Return Procedures. Buyer shall comply with terms set forth in the Warranty Return Procedures. Buyer in all cases will obtain and comply with Seller's packaging and shipping instructions. Buyer will pay for packing, transportation and transit insurance costs for return of products. Where adjustment is not allowed, products will be returned to the Buyer, transportation collect.

7. Replacement parts may be secured on an immediate exchange basis, with the Buyer being billed F.O.B. Houston, Texas for parts and shipping. Credit will be issued for exchange items and shipping upon their receipt, shipping prepaid, at **Eagle Wireless International, Inc**.

8. There are no warranties, express or implied, that extend beyond the description on the face of this contract. Seller shall not be liable for consequential damages. No change in this warranty shall be binding upon the Seller unless it shall be in writing and signed by a duly authorized representative of **Eagle Wireless International, Inc**.

Preface

Scope

This system manual contains a high level description of the Compact Series Base Station as well as a detailed technical description. The scope of this document is to provide the reader with a general understanding of the system architecture and major features of the EWI Quantum Series II of paging and link transmitters.

Section 2 – Highlights the major features of the system.

Section 3 – Provides a system overview with subsections outlining system technical configuration.

Section 4 – Outlines the major system components.

Section 5 – Appendices and Schematics.

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For after hours emergencies, call (281) 538-6000 for instructions. If you reach voice mail, please leave a message and your call will be returned promptly.

Customers should maintain a stock of replacement parts or units for emergency backup.

Eagle Wireless International's factory trained field service engineers are available for system installation and optimization. For assistance, write or call:

EAGLE WIRELESS INTERNATIONAL, INC.
101 Courageous – League City, TX 77573
Telephone (281) 538-6000
Fax (281) 334-5629 Toll Free 1-800-628-3910

Cautions & Safety Regulations

All RF power transistor and RF termination resistors in this power amplifier contain the toxic substance beryllium oxide. These assemblies are located on the combiner, splitter and power amplifier boards. The fumes and dust of beryllium oxide is also toxic and should only be treated by trained personnel using proper precautions. Federal law and most state laws strictly prohibit disposal of beryllium oxide as a public waste.

FCC Requirements

FCC regulations state that:

1. Radio transmitters may be tuned or adjusted only by persons holding a general class commercial radiotelephone operator's license, a registered engineer or by personnel working under their immediate supervision.

2. The RF power output of a radio transmitter shall be no more than that required for satisfactory technical operation considering the area to be covered and local conditions.

3. The frequency, deviation, and power of a base station transmitter must be maintained within specified limits. It is recommended, therefor, that these three parameters be checked before the station is placed in service.

4. The power input to the final radio frequency stage shall not exceed the maximum figure specified on the current station authorization. This power input shall be measured and the results recorded:

    a. When the transmitter is initially installed.
    b. When any change is made in the transmitter which may increase the power input.
    c. At intervals not to exceed on year.

FCC Interference Warning

FCC regulations state that:

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance with the limits for Class A computing devices pursuant to Sub-part J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

OSHA Safety Standards

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act, has established an electromagnetic energy safety standard with applies to the use of this equipment. Proper use of this radio equipment will result in exposure below the OSHA limit. The following precautions are recommended:

DO NOT operate the transmitter of a fixed radio (base station, radio paging transmitter RF equipment) when someone is within two feet (0.6 meters) of the antenna.

DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition, all equipment must be properly grounded according to National & Local Electrical Codes.

Lightning Protection Considerations

The Extend-A-Page transmitter and receiver and the Quantum Series Power Amplifier have protection against high voltages but for all external connections, added protection against lightning attack should be considered. For Transmitters used for high power applications with tower antennas, the following measures will provide sufficient protection against minor lighting attacks.

- Keep the antenna tower grounding resistance as low as possible.
- The ground rods should be made of copper and be at least eight feet long. Multiple rods should be used over a single rod, if possible.
- All transmission line bends should be made according to manufacturer's exact specifications. All ground line bend should be made as large as possible.
- Ground the transmission line sheath at every opportunity. Also, ground the transmission line where it is supported on poles and where it enters the building.
- Whenever possible, run at leas a part of the transmission line through a length of ground conduit.
- Tie all equipment grounds together to a single point. Then, ground that point to a grounding rod using as short and as straight a ground wire as possible.
- The ground wire must never be bundled with other wires in the system. Also, ground wires must not run along a metal plane.

Integrated Circuit Handling Procedure

Care should be taken in handling the circuit boards during installation and service. A number of IC's (Integrated Circuits) used in the equipment are from the MOS (Metal Oxide Semiconductor) family and are vulnerable to damage from static discharges.

Exercise the following precautions when handling these components.

- Before handling components, ground yourself by touching a ground rod or the grounded chassis of the equipment momentarily.

- Whenever, either installing or servicing the equipment, take proper static protection (e.g. wearing a conductive wrist-strap) and stand on a conductive mat, which is connected to the ground through a 100K ohm resistor.

- Ground all test equipment and soldering stations that are electrically powered.

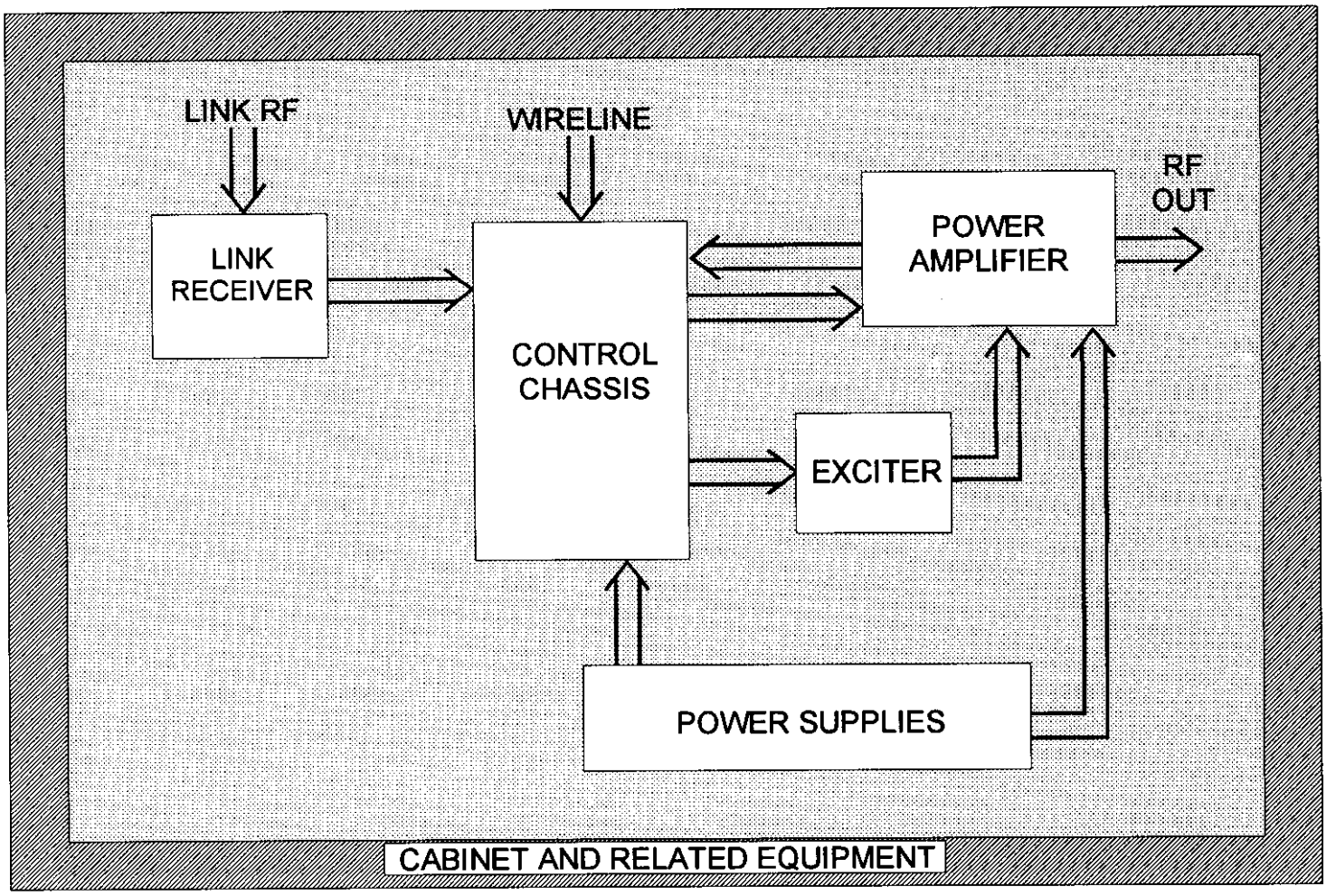
Always connect the ground lead of the test equipment to the Base Station, Extend-A-Page, and/or Power Amplifier, (which ever is being serviced) first and then the test probe. While disconnecting, remove the test probe prior to the ground lead.

Equipment Unpacking and Inspecting

Remove all hardware from the shipping carton and inspect the unit for damage. If shipping damage has occurred, contact the carrier immediately. Obtain an RMA number from Eagle Wireless International and return the damaged unit. Use the original customized package for shipment. All damages must be reported within 15 days of shipment.

Section 2 – Major System Features

Compact Series
Base Station and Link Transmitter



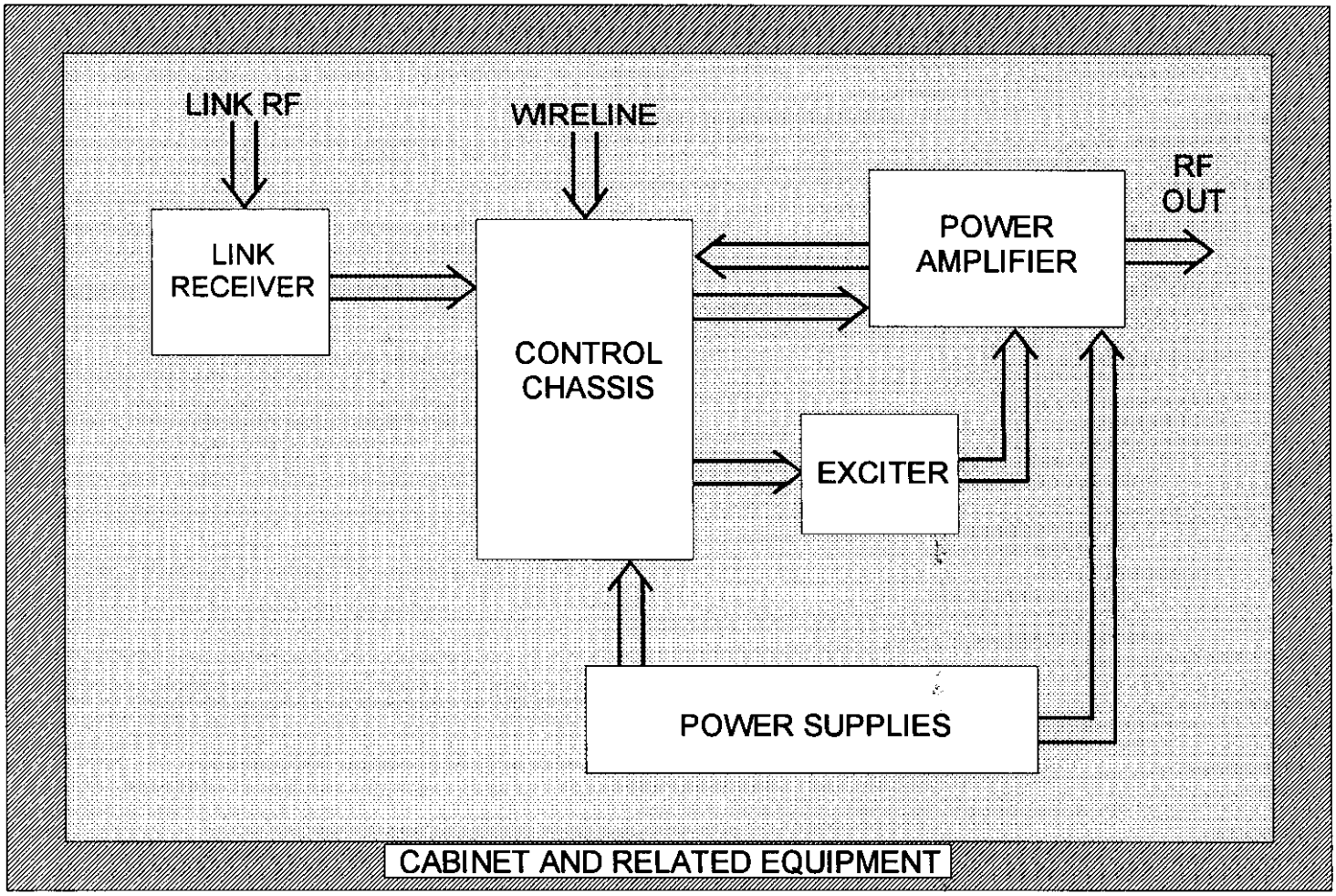
Major features of the Compact Series Base Station are:

- Analog and Digital Capability (High Speed)
- Advanced State-of-the-Art Technology
- 100% Solid State continuous Duts
- High Stability Simulcast Compatibility
- Extensive Monitoring & Display
- Modular Design
- Multi-channel Capability*
- Modular Link Receivers
- Remote Monitoring & Status Reporting Capability*
- Analog & Digital Phase Delay
- Supports most popular transmitter controller formats through option packages

* Optional

Section 3 – System Configuration

Compact Series
Base Station and Link Transmitter



Both paging and control link stations are structurally the same except in their modulation characteristics, their RF power output and the addition of hot standby features. The simulcast paging transmitter version is built with a very high stability oscillator for accurate simulcasting. A typical paging system block diagram using Quantum and Stealth Series transmitters and receivers is shown in Figure 4.

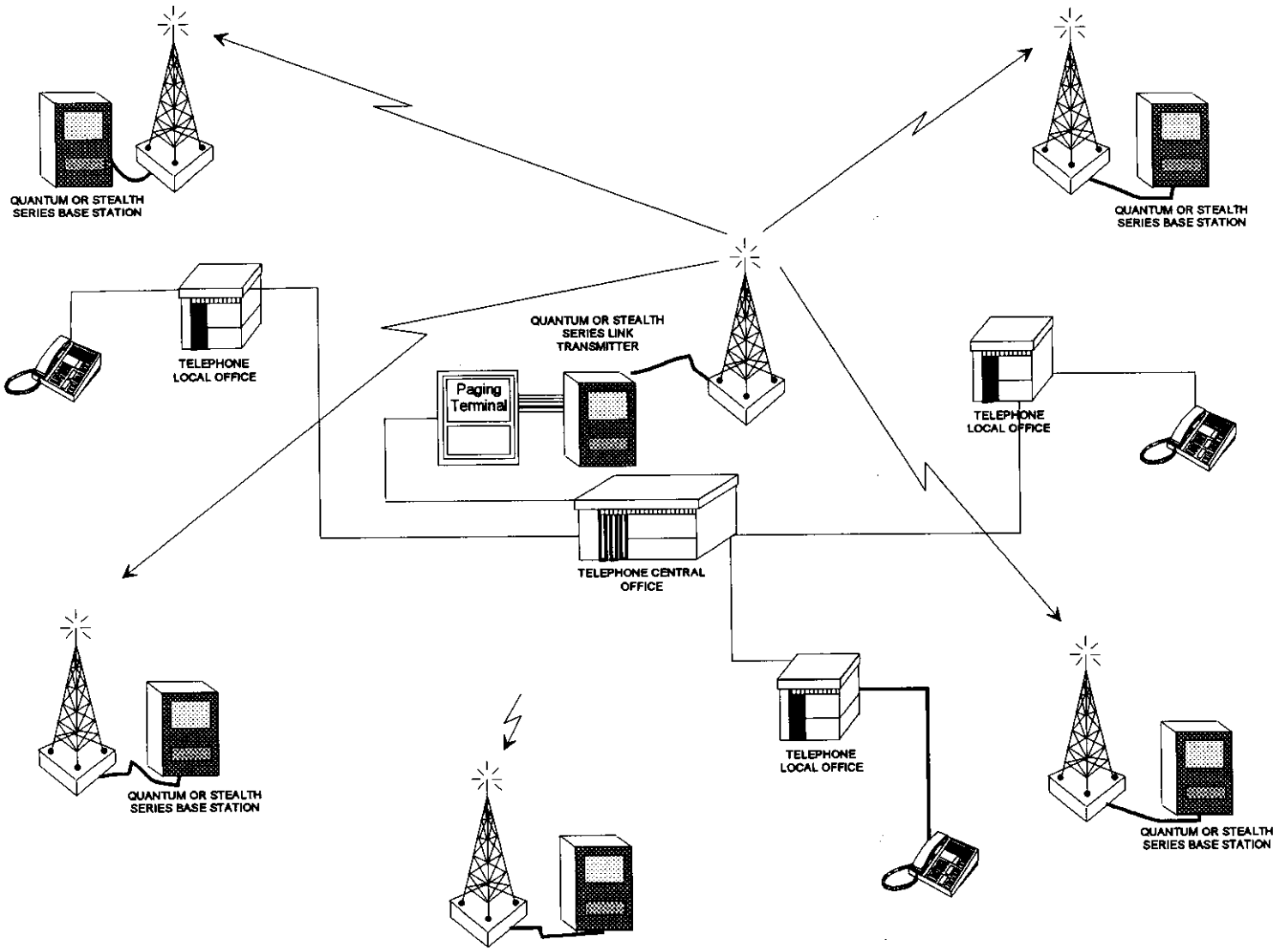


Figure 4 – Typical Paging System Using Quantum and Stealth Series Transmitters

In the Compact Series Base Station, the Link Receiver Unit processes all Control Link RF signals and prepares the audio signals for transmission to the transmitter unit. The audio input to the transmitter unit could, as an alternative, be provided by a satellite receiver, or a conventional wireline telephone circuit. If a phase delay board is utilized it will normally be mounted in the transmitter. The phase delay board can be adjusted for signal time delay up to 5000 microseconds, both for analog and digital data and larger delays up to 40, 000 microseconds can be accommodated on an optional basis. The composite audio signal is amplified and buffered in the receiver unit and is output to the transmitter unit. After receipt, the transmitter unit decodes the transmitter control format (Microlink LINK 20X digital format). Other transmitter control formats are also available to operate with other popular industry standard formats. The transmitter also contains the RF modulator and low level RF Exciter equipment. The normal output power for all Quantum and Stealth Series exciters is 2 watts of RF power. The RF output of the exciter is then applied to the input of the RF Power Amplifier located in the back section of the transmitter to produce the overall required output power level.

The power amplifier in the transmitter is designed to provide high quality signal output with high efficiency and continuous duty. Automatic protection is provided against over temperature conditions as well as high VSWR. All major functions of the Quantum and Stealth Series transmitter are contained on a series of modular plug in function cards located in the front section of the transmitter. These function cards include the PA Control Card, the Digital Control Card, the Analog Control Card and the Phase Delay Card (The Phase delay card may optionally be located in the stand-alone receiver on some models.

3.1 FCC Type Acceptance

All Quantum and Stealth Series Transmitters sold for use in the United States have received full type aceptance by the FCC for paging and control link applications in all specified frequency bands.

3.2 System Configuration – Base Station & Link Transmitters

The Compact Series Base Stations and Link Transmitters consist of four major components or assemblies. The first component is the link receiver. The second component is the transmitter section, the third component is the basic rack and its associated equipment, and the fourth component is the power supply. Each of these assemblies works with the other to provide the overall Quantum and Stealth Series functions and features.

The receiver unit may be standard 19-inch rack unit, three rack units high, or a modular plug-in board. The transmitter unit contains all of the modules or cards that control the Quantum or Stealth Series as well as

produce the low-level RF. These units perform such functions as transmitter control, phase delay, basic RF signal generation, analog and digital signal interfaces, and display. The combined use of all of these function cards provides a very powerful and intelligent exciter/controller that give the Quantum and the Stealth Series its personality and features.

The RF output of the transmitter exciter is used to drive a RF power amplifier housed in the back of the transmitter. This power amplifier provides the high power output required to drive the antenna. All Quantum and Stealth Series transmitter power amplifiers are designed for continuous duty under extreme environmental conditions.

The major structural component of the Compact Series Base Stations is the support rack and various related equipment. This rack is a heavy-duty cabinet with such important features as forced air cooling with filtered air intakes, security locks, easily removable doors, and all welded construction. In addition, all Quantum and Stealth Series cabinets come with a heavy-duty power distribution strip and three-way lightning protection as standard features. The power supply in all Compact Series Base Stations is a heavy switching power supply capable of supplying up 28 VDC with sufficient current to power the entire Base Station.

3.2.1 Electrical Configuration

The main power cord is brought out externally via a pass-through at the rear bottom of the Quantum cabinet or through the side of the Stealth Cabinet. The main AC input is fed through a common surge protector. The power supplies vary in design to accommodate the different sized power amplifiers. All equipment in the cabinet shares a common ground through the power panel and chassis ground. All coaxial inputs to the cabinet have built-in lightning surge protection with common chassis grounding.

3.2.2 Mechanical Configuration

EIA standard 19-inch rack mount construction is the basis of the Quantum and Stealth Series mechanical configuration. The receiver, transmitter and the power supply are all configured in rack mount.

RF connectors to receiving and transmitting antennas are brought out via surge protected feed throughs at the top or side of the unit. All internal connectors are SMA, BNC, or type N. Antenna connectors are typically Type N. Special orders can be accommodated.

Fans mounted to the cabinet provide forced air-cooling. The number of fans may vary according to RF power levels. The entry to the system is secured with a lock at the front and rear of the unit with three point contacts.

3.2.3 Specifications (Non-Redundant Configurations)

3.2.3a Transmitter Unit

Frequency Range	851 - 866MHz
Power Output	150W
RF Output	50 Ohms (Type N Female)
Impedance	
Frequency Stability	±0.2 ppm (-30°C to +60°C) standard ±30 ppb (-30°C to +60°C) high ±5 ppb (-30°C to +60°C) ultra high
Emission Designators	16K0F1D, 16K0F3E
Duty Cycle	100% at full rated power
Modulation	Analog and Digital
Audio Response	±1 dB, 20-3000 Hz @ ±3.3 KHz deviation
Distortion	Less than 1.5% for any frequency in audio pass band at ±3.3 KHz deviation
Audio Input Impedance	Voice & Tone: 600 Ohms Balanced
Channels	One standard, up to 4 optional
Primary Power	26 - 28 VDC
Power Consumption	300 W, 28V @ 10A
Dimensions	19 in rack mount 19 in L 7 in H 10 in D

3.2.3b Receiver Module

Frequency Range	72, VHF, UHF & 928-960 MHz
Frequency Stability	±0.0002% (-30°C to +60°C)
Sensitivity	0.60μV, 12dB SINAD; 1.8μV, 20dB quieting
Audio Response	± 1 dB, 20-3000 Hz
Audio Distortion	1.5% max @ 66% modulation
Audio Output	-5 dBM nominal
Digital Capability	0-4800 bps

‡ Where X = 72MHz
150MHz
450MHz
900MHz

* Optional

3.2.3c Transmitter Controller

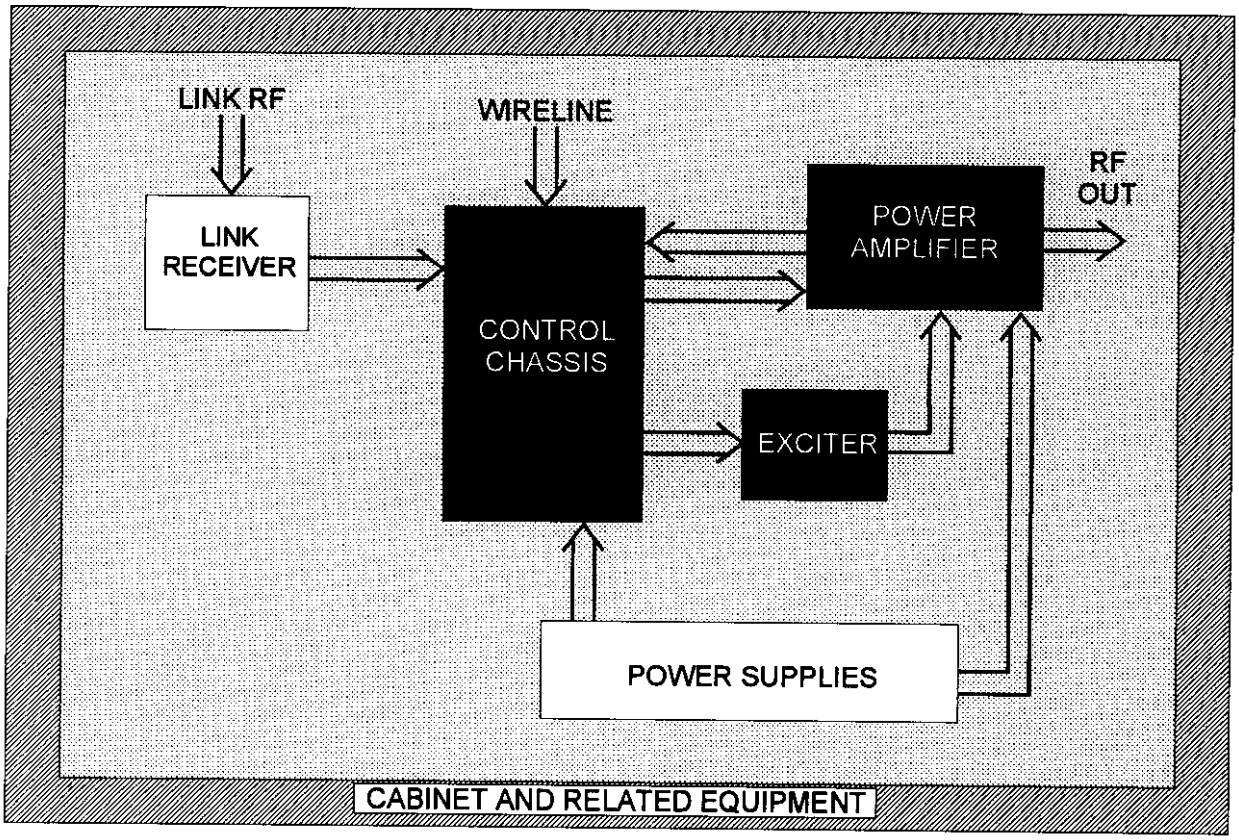
Controller Type	LINK 20TX (Standard)
Digital Control Format	LINK 20X (Microlink) Other Formats (Optional)
FSK Modem	CCITT V.23 Standard
Control Word Transmission Time	650 μS for ALL CALL 1800 μS for maximum address 750 μS typical
Mode Select/Switch	250 μS
Audio Response	±1dB over 300-3000Hz
Address Selection	256 Address

3.2.3d Phase Delay Module

Analog Delay Time	65 to 5000 μS, 1 mS step (40,000 μS optional)
Digital Delay Time	65 to 5000 μS, 1 mS step (40,000 μS optional)
Audio Response	± 1 dB over 300 to 3000 Hz

Section 4B – Transmitter Unit
Compact Series Base Station

B.1 Transmitter Unit – General



The Eagle's Compact Series transmitter is a compact base station that is ideal for applications where space is a premium and a full size cabinet is not required.

The transmitter unit is built around heat sink cooled by a high capacity cooling fan. The front section of the transmitter contains modular assembly containing plug-in boards providing overall analog and digital control, power amplifier control and monitoring and an optional Phase Delay Board. This composite set of control, monitoring, and display electronics provides all the features and capability required to support and control the power amplifier. A modular receiver plug-in board is available for direct plug in to the transmitter cabinet.

The power amplifier is mounted to the heat sink and is accessible from the backside of the transmitter. All components of the power amplifier are contained in a RF-tight enclosure such that only the input and output RF coaxial connectors directly penetrate the enclosure. All other penetrations are by filtered feed through which is designed for the RF environment. An overall block diagram of the transmitter unit is shown in Figure 9. A view of the front and rear of the transmitter is shown in Figures 10 and 11a. The power amplifier functional bock diagram is shown in figure 11b.

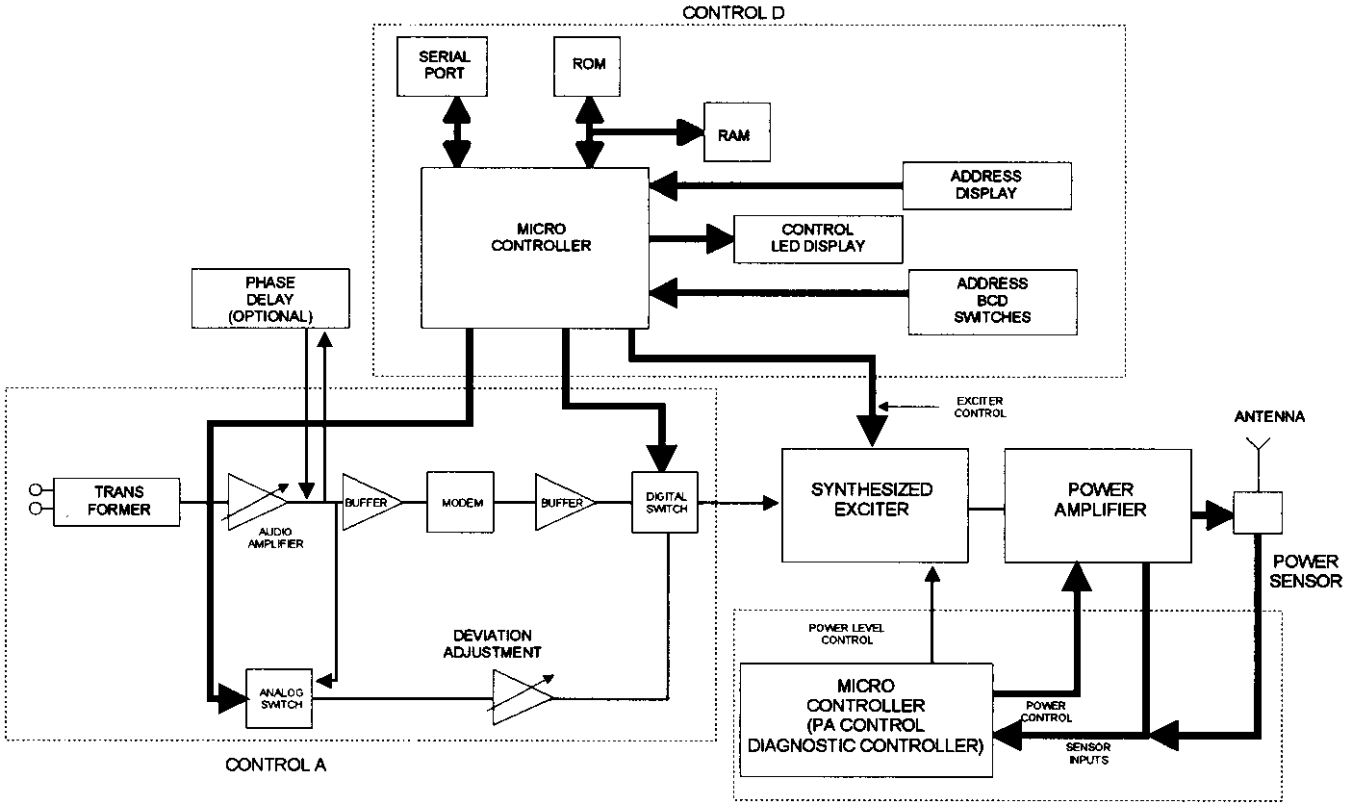


Figure 9. Compact Series Transmitter Unit Block Diagram

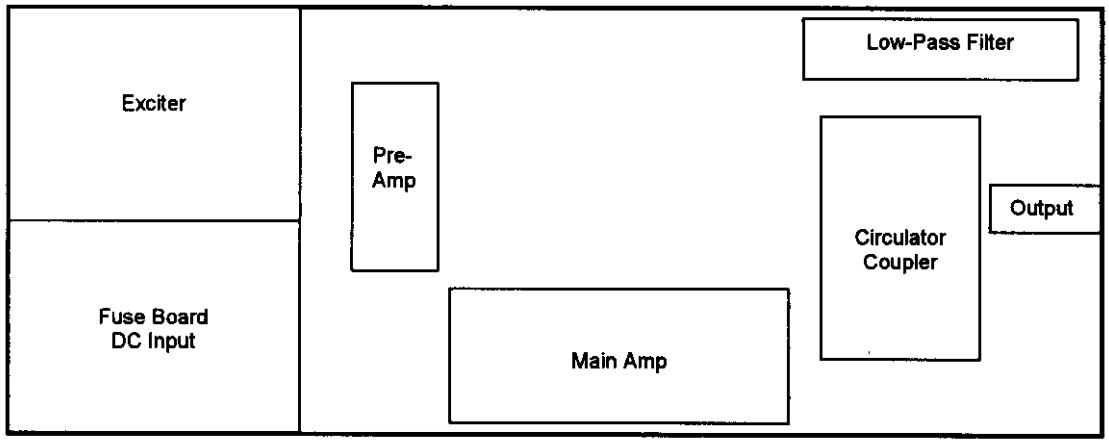


Figure 10. Front View

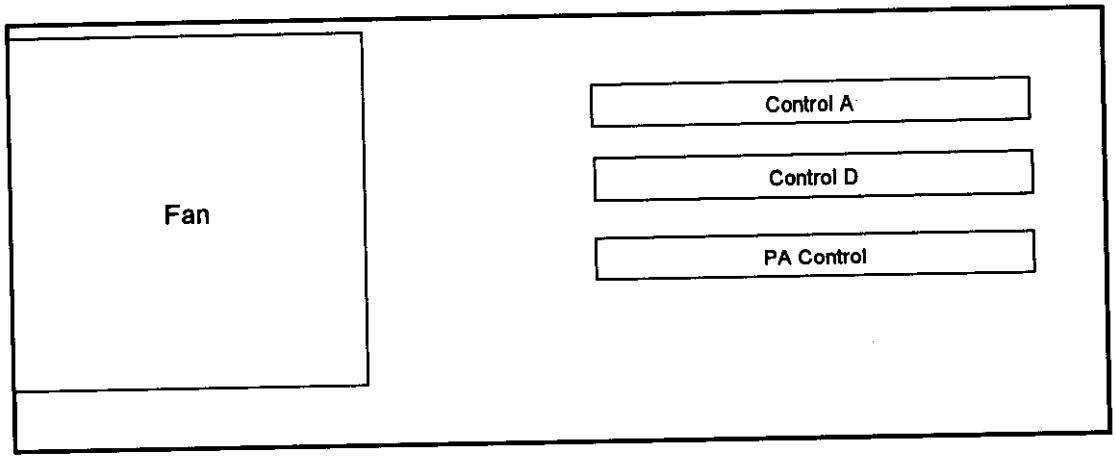


Figure 11a. Rear View

B.2 Transmitter Unit – General Circuit Description

The transmitter control circuitry is contained on four separate plug-in circuit boards: PA Control/Diagnostic Controller, Control D, Control A, and Phase Delay. These four boards plug into a backplane board that provides the necessary interconnections. These boards are interconnected in a manner to provide control of the transmitter. Their physical relationship is shown in Figure 10. Although each of the boards contains a dedicated microcontroller, the master controller for the entire transmitter is contained on the Control D (or digital board). The Control D board is responsible for all of the overall control and coordination among the other components of the transmitter unit. Specifically, the processor on this board decodes the incoming transmitter control commands, provides analog or digital keying, frequency select in the exciter, display control, and site address control. The controller also interfaces over the backplane board with the Control A (or analog) board to accomplish all analog functions such as audio gain, filtering, notch filtering, tone detection, modem functions, and audio switching. In particular, many different signals pass back and forth between the Control A and Control D boards and both are essential for the minimum operational configuration.

B.2.1 Synthesized Exciter

The synthesized exciter generates a low RF carrier and is primarily controlled by the Control D interface. This exciter is capable of outputting 0.1 to 2 Watts. The basic exciter configuration comes with a TCO frequency reference and is capable of simulcast operation in most applications. For those applications requiring the ultimate in stability and control, the exciter is provided with an external ultra high stability reference that may originate as a GPS time base, a satellite transmitted reference, or an ultra high stability ovenized crystal source.

B.2.2 Power Amplifier Control

The PA control board contains all of the hardware and software necessary to provide the following control functions. See Figure 11b for block diagram.

a. Variable DC control voltage that drives the pre-amp to control the output power level of the PA.

b. Bias supply generation for amplifier configurations that requires external bias.

c. Monitoring of forward power, reflected power, temperature, VSWR conditions, DC power levels, and various alarm conditions.

d. Fan control and sensing.

e. DC power regulation.

f. Input power detection.

g. PA key and de-key.

h. Front panel meter display.

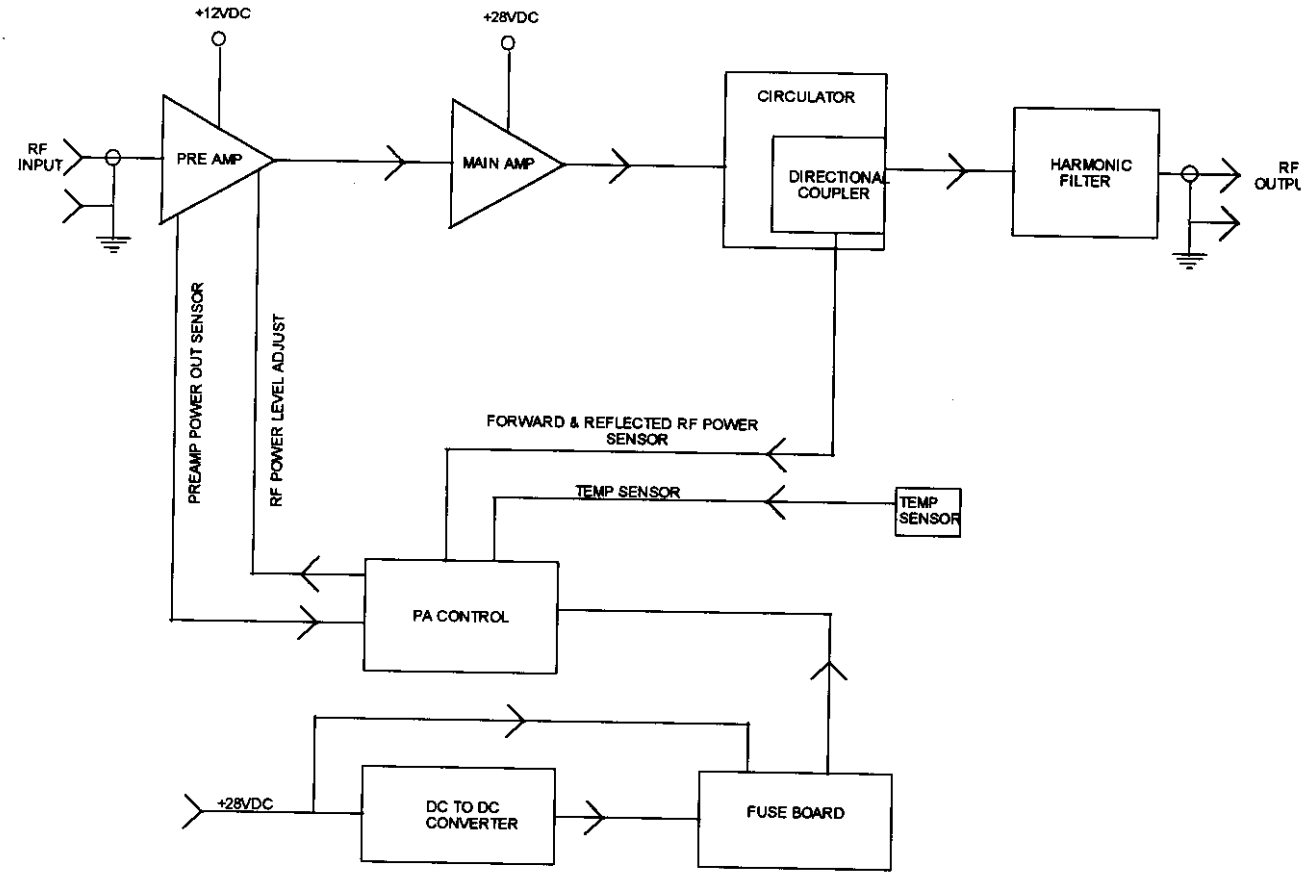


Figure 11b. PA Functional Block Diagram

B.2.3 Power Amplifier

The power amplifier circuitry is primarily located in the rear RF compartment that provides RF shielding for all of the RF circuitry. The exact configuration of the power amplifier circuitry will depend on the particular frequency and power level of the base station. The particular configuration for your base station will be found in the power amplifier Appendix at the back of this manual. All power transistors are mounted on special high thermal performance board material and employ copper heat spreaders. The output of the power transistor is fed into circulator and then a low pass harmonic filter

to eliminate unwanted harmonics. The pre-amp and main amp is fused on an independent basis. An LED indicator is located next to each fuse to provide easy visibility as to the health and status of the fuse for that circuit.

B.2.4 Phase Delay Board

The Phase Delay Board is also plugged into the backplane board in the transmitter unit and provides the time delay of the audio signal (i.e. signal containing both the analog and digital information) to allow the simulcasting of overlapping base station coverage. This board contains all of the required circuitry to digitize the incoming audio at high speed and to delay the digitized samples.

B.3 Detailed Circuit Description – Circuit Boards

B.3.1 Backplane Board

The backplane board's mechanical and electrical details are shown in Figure 13. The schematic for the motherboard may be found in the Appendix of this manual. There are four separate card slots on the motherboard and any of the plug-in boards may be installed in the first four slots in any order that is convenient. The fifth card slot is reserved for a modular plug in link receiver card. This backplane board has a number of additional connectors and headers that are used for different applications and some of these are not required for the base station configuration. In general, the base station configuration utilizes a PA Control Board (typically in the top slot), a Control D board (typically in the second slot from the top), and a Control A board (typically in the third slot). If the optional link receiver board is utilized, it plugs into the single connector slot at the bottom the backplane board. Also contained on the backplane is the DC/DC converter and/or regulator required to provide the +5VDC supply to the various plug in circuit boards and the exciter module. The backplane also contains the interface for the exciter from the various plug-in circuit boards. This interface is by way of the DB25 connector J3 and its associated ribbon cable over to the exciter.

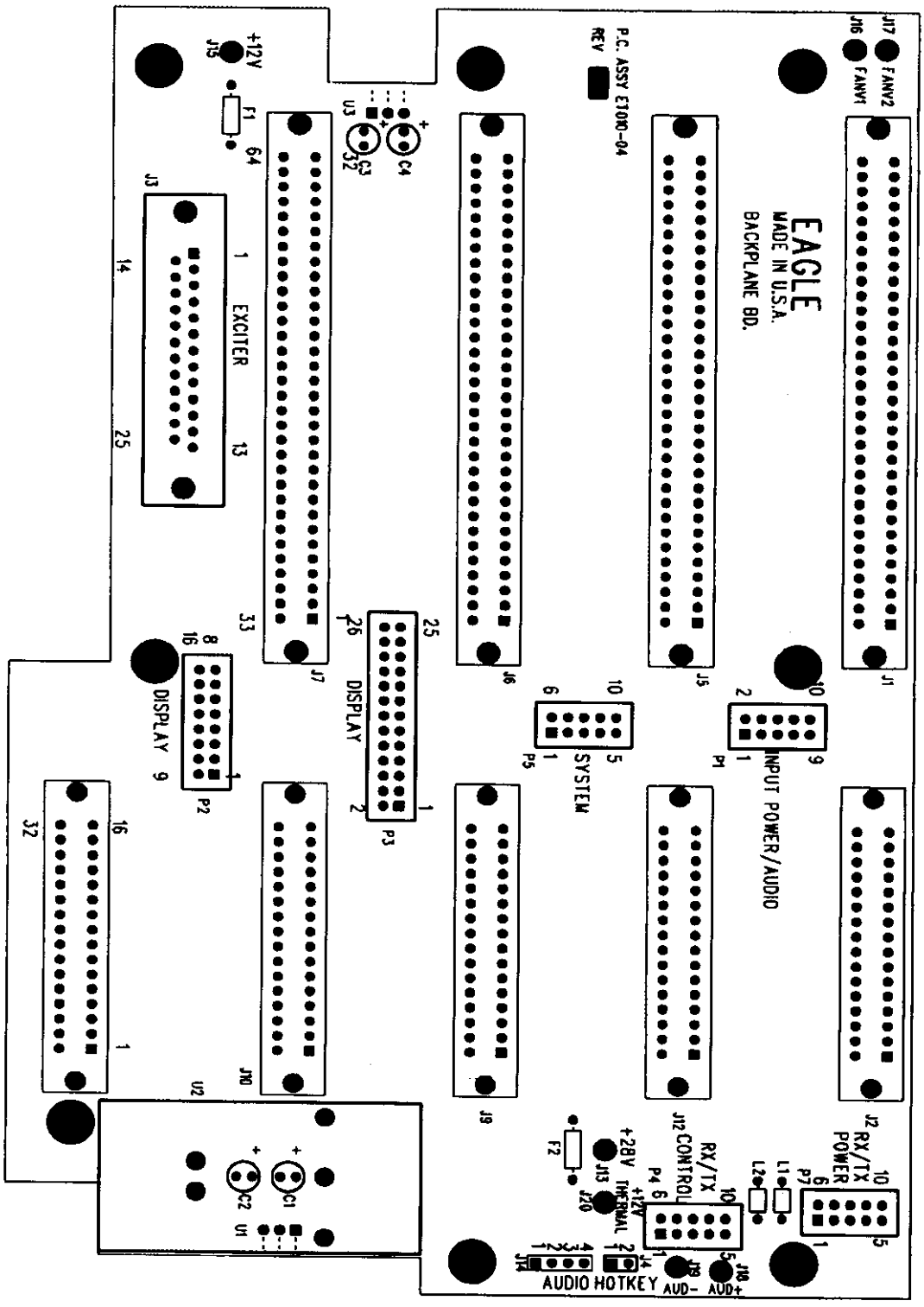


Figure 13. Transmitter Backplane Board

B.3.2 Power Amplifier Control Board

The Power Amplifier Control Board provides all of the Power Amplifier control functions necessary to operate any of the Eagle power amplifier configurations.

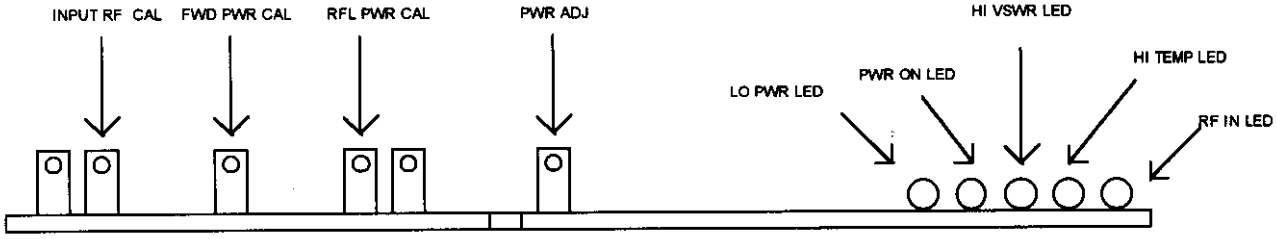


Figure 14. Power Amplifier Control Board

The power amplifier control Functions are accomplished by the 87C552 master processor in conjunction with a variety of support circuitry. All of the major power amplifier parameters such as forward and reflected power, heat sink temperature, input drive RF power, drive stage voltage, and the master power supply voltage are monitored in this board by the processor. The 87C552 has a built in A/D converter for these analog signals and they are sampled after suitable scaling in the operational amplifier stages of U6 through U8. The gain of most of these operational amplifiers is controlled by a potentiometer located in one of the feedback stages as can be observed on the schematic located in Appendix. Each of these adjustment points can also be located in Figures 14 and 15. The majority of these adjustments are factory preset and should not require adjustment. However, for convenience, the following is a summary of these potentiometers and their function.

R24	Driver Voltage Meter Calibration	Adjust for proper reading on meter with external voltmeter.
R33	Input RF Threshold Adjustment	Sets the input RF level at which fan, high VSWR and high temp is activated.
R43	Forward Output Power Calibration	Sets the gain between the forward power sensor and the input to the microprocessor. Setting depends on frequency and power options and is factory preset. This input is used to control the VSWR protection circuit.
R18	Input DC Voltage Meter Calibration	This control is used in conjunction with a voltmeter to set the input DC voltage reading on the display meter.
R19	Output RF Power Level Adjustment	Adjust a control voltage to the pre-amp stage that ultimately controls the level of the output forward RF power

The microprocessor, U1, on the power amplifier control board also provides the monitoring of the VSWR using the forward and reflected power levels and will automatically shut the amplifier down if the VSWR exceeds the threshold level set in the software. In addition, the microprocessor also continuously monitors the temperature of the heat sink near the high power final stage and will shut the amplifier down if this temperature reaches 70°C. Should this event occur, the fan will continue to run and should the temperature drop to 50°C, the processor will automatically re-enable the amplifier for full power. There is, however, a built in delay of two minutes and twenty seconds before the reset condition can occur to allow adequate cooling for an excessively hot ambient condition. The microprocessor also has a software threshold to determine the minimum acceptable output power for a normal transmitting condition. When the output power is below this limit a fault indications provided (i.e. low power), but otherwise the amplifier operates normally. This low power threshold is normally set in software to 25% of full rated power unless the customer makes a special request.

The power amplifier control board also contains all the drive circuitry for the on-board displays as well as the circuitry for the front panel display option. For the complete adjustment procedure for all of the display functions consult the Appendix for this option.

Most Eagle amplifiers and base station configurations employ class C amplifiers and as such they require no external bias circuitry.

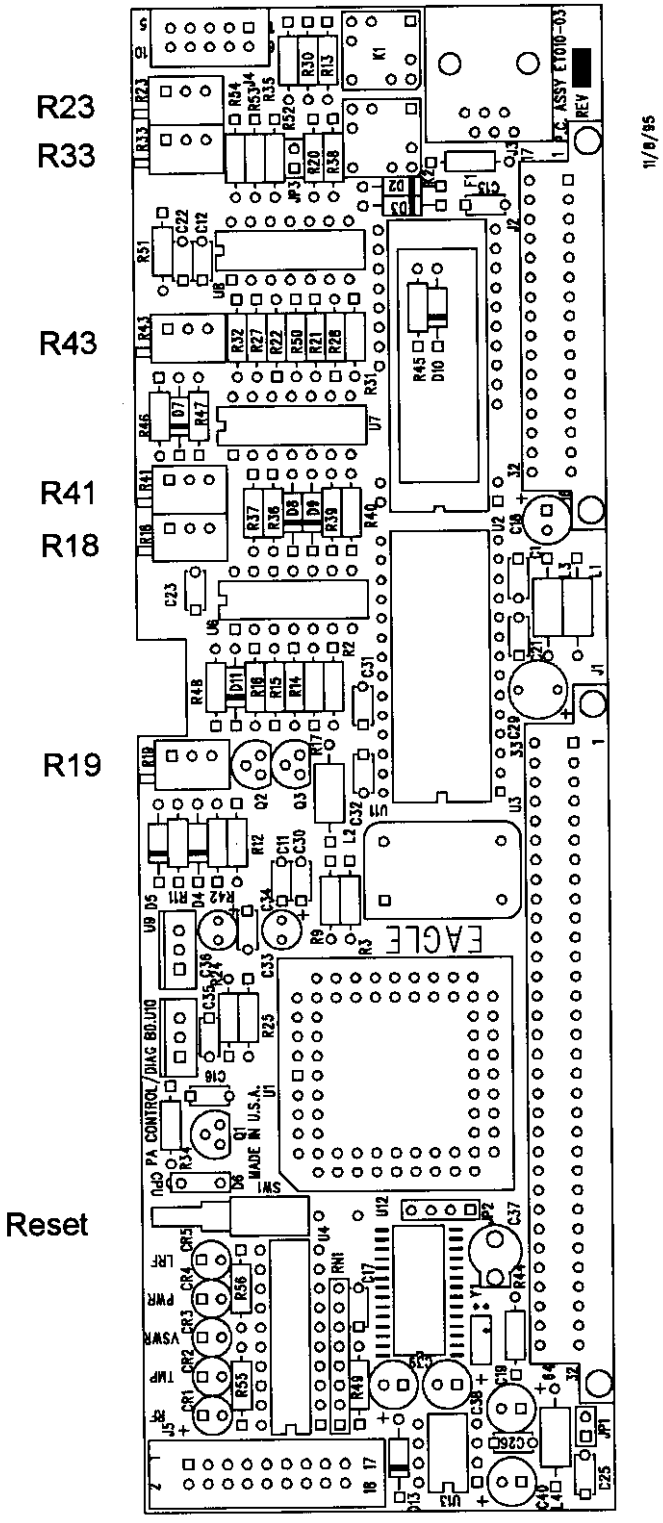


Figure 15. Power Amplifier Control Board

B.3.3 Control D Board

The Control A (digital) board provides the master control functions for the entire transmitter unit. This board is based on a 87C451 microprocessor (U1) that provides the computational power to monitor all incoming signals for control or data, respond to transmitter control requests, and to interface these signals with the Control A (analog) board for processing and sensing. All of the operational software for these functions is contained in an external 27C256 EPROM (U3). In addition, for some control formats requiring reconfigured parameters over the control channel, a separate RAM chip is provided in U4. For most control formats U4 is not required. The initial Control A signal flow is typically, either from a local data stream being received from an audio source (i.e. local RF link receiver or wireline source or possibly satellite receiver or directly form a paging terminal in the form of data). In either case, once the processor has received the control information, it determines the nature of the request using the stored program in U3 and then performs the required task. This task might be to prepare the exciter for an analog or digital page, to delay the data by a known amount, or to deactivate the power amplifier. In responding to this type of command the processor normally first determines if the incoming request is addressed for that particular transmitter by comparing the address of the command with a stored address that is resident on the Control A board. This digital addressing technique is available on the L20X format, DCU 3.x and DCU 4.x. This stored address is in the form of a hexadecimal number that has been selected by two mechanical address switches (SW1 and SW2). A transmitter can be assigned to any address between 1 and 256. If the switches are set to "0" "0", the transmitter has been addressed as "ALL CALL" and will respond to any address. A typical transmitter address setting is shown in Figure 16 below.

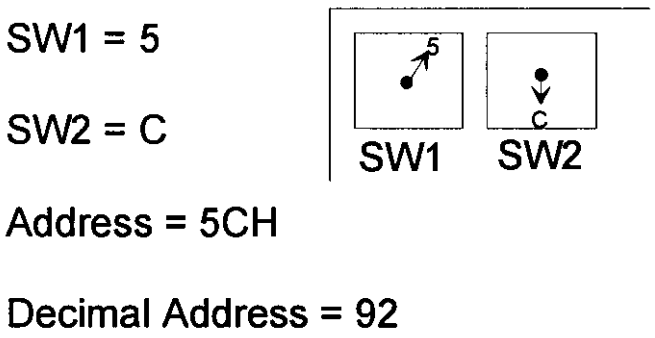


Figure 16. Typical Address Switch Setting For Transmitter Address

Besides the two address switches, the actual address selected is displayed on the two displays located on the front edge of the Control A. When the address in the Hex switch is changed the address in the display will automatically be updated in approximately one second.

Along with the address display, the Control A board also has LED indicators to provide visual indication of the status to the paging activity. These LED indicators include a digital and analog key LEDs, a data LED that pulsates at the data rate and a two multi-color system LED that indicate the system health and status (Steady Red = not functioning, Steady Green = Normal). There are a number of two and three pin jumper fields on the Control A board that provide alternate selection for different functions that mostly are associated with different control formats that may be selected. Normally these jumpers are factory preset for the particular format being utilized and should not require reconfiguration. A listing of all such jumper selections is included in the Appendix for reference. However, note should be taken of jumper JP2. If the transmitter functions normally when first activated but the pages still will not respond there may be a problem with data polarity. Most

pagers require the data to be of a particular polarity with respect to the first sync bit. Jumper JP2 has been provided to allow either data polarity to be selected by simply moving the jumper to one or the other of its possible locations. It should also be noted that some jumpers may not require any shorting post for some configurations.

One of the features of the Control A board is its ability to operate under a wide range of circumstances. One familiar problem with software based products in high RF environments is the occasional lock up of a microprocessor that has been subjected to excess RF levels. The location of the microprocessor is normally shielded against the RF, but an occasional interference is unavoidable. The Control A board incorporates a software structure such that it is continually communicating with a hardware timer (watchdog circuit). If this communication stops for any reason the 87C451 microprocessor is automatically reset and normal operation resumes. This feature is extremely important for equipment that is remotely located and/or inaccessible. As mentioned previously, the Control A and the Control A boards are really a set and cannot be operated independently of one another. Should any problems be suspected with the Control A board, always check the Control A for proper operation at that time also.

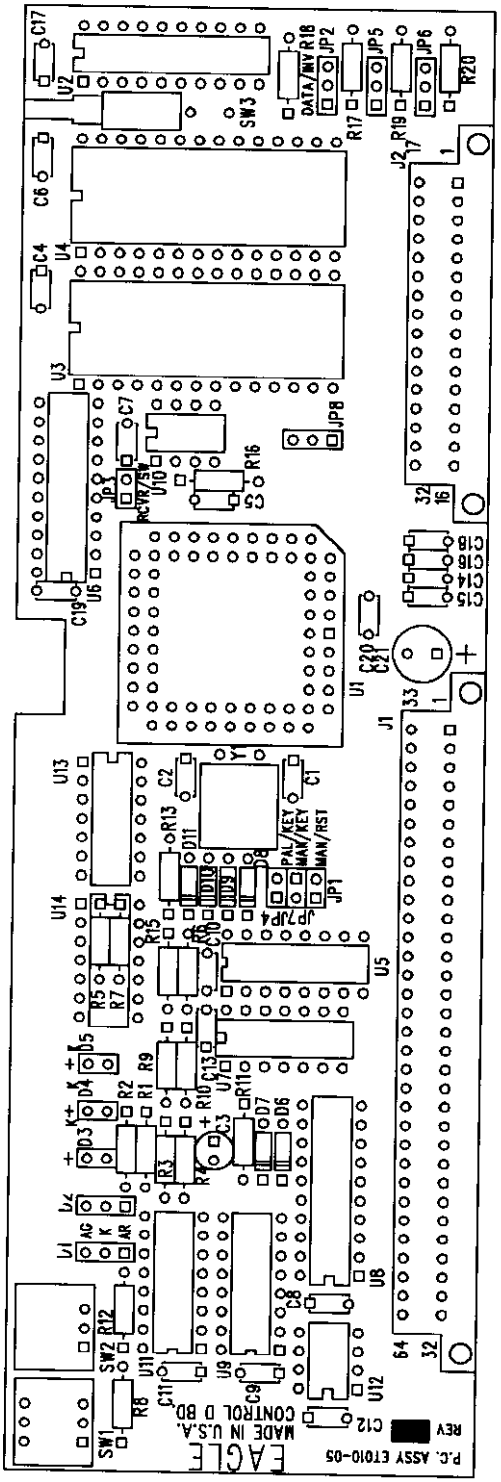


Figure 17. Transmitter Unit Control D Board

B.3.4 Control A Board

The Control A (Analog) board is the only board in the control shelf that does not contain a microprocessor. This board is simply a collection of all of the analog functions required by the transmitter to accomplish its tasks. The Control A board is typically the first point in the transmitter that all audio (analog) signals are routed to. All incoming audio is transformer coupled (600 Ohm) on transformer T1. The full schematic for the Control A board is contained in the Appendix.

The signal flow of the Control A board can be divided into multiple distinct paths that perform various tasks on the incoming audio signal. After the audio is received by the input transformer T1 it is gated by a processor controlled digital switch U2. The control of this switch originates with the master processor on the Control A board and is passed over to the Control A board via the motherboard backplane. The U2 switch allows the processor to route the audio to different locations for different purposes depending on the type of control format being supported. Typically, incoming audio is routed by U2 to an input buffer amplifier U8A where the level is raised sufficiently to drive the other audio circuits. A simplified flow diagram of the audio and data paths through the Control A board is shown below in Figure 19a. Figure 19 shows the physical location and function of all of the adjustment potentiometers on the Control A board. It can be seen from this flow diagram and the detailed schematic in the Appendix that the Control A board is a multifunction board. For those having a digital control format (i.e. L20X, DCU, etc.) the function of the Control A board is mostly that of analog buffering and modem detection. The optional notch filter and guard tone detectors are not utilized. However, for combined analog and digital paging the switching of the appropriate modulation signal at the correct time is accomplished by the processor controlled switch. Also the selection of the audio path either through or not through the Phase Delay Board is a manual jumper selection (JP8) on the Control A board.

For control formats utilizing tone control, the notch filter and guard tone detector are selected (i.e. PURC, SCU/SCM, etc.). The digital logic level output of the guard tone detector is utilized in conjunction with certain other software detectors and filters to accomplish the appropriate mode switching and keying functions required for these formats.

Typically, for any of the formats very few adjustments should be required in the field, as most adjustments have been factory preset. However, some of the flexibility of the Control A board also requires some adjustments to accommodate uncertain field conditions. For example, the input audio level into the first audio amplifier is somewhat dependent on its source and other external factors. Typically, the audio level at TP5 should be set for 3 volts Peak to Peak under normal input conditions by adjusting R14. Also, the input to the modem U11 pin 2 should be set, by adjusting R6, to a level of 1 VPTP.

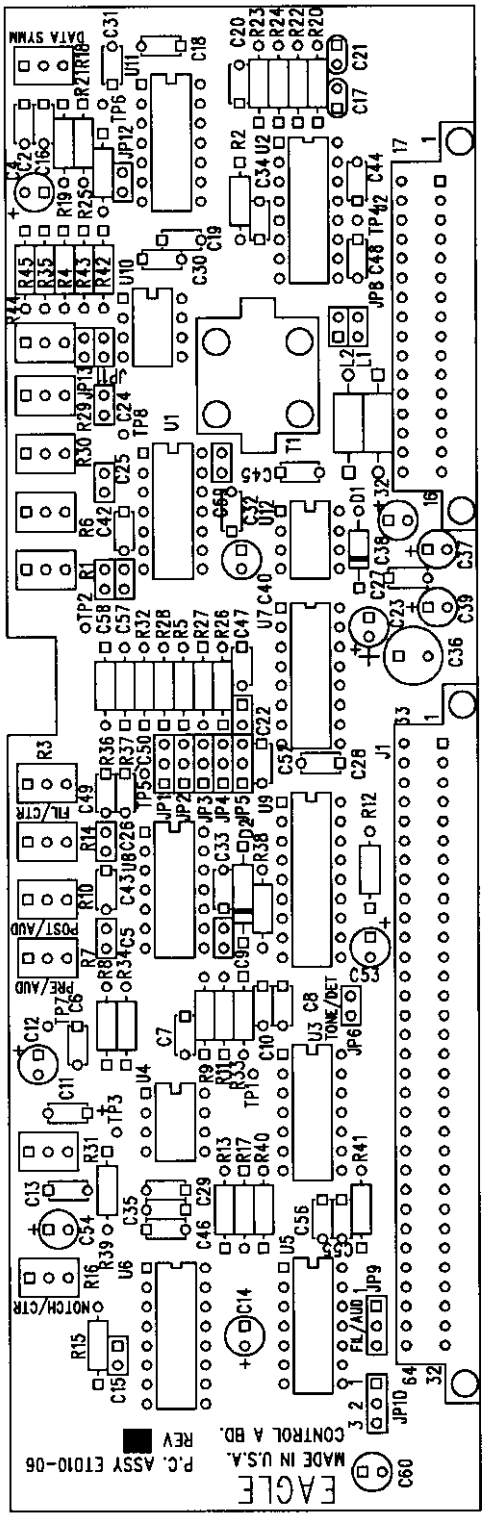


Figure 19. Transmitter Unit – Control A Board

Adjusting RP1 sets the analog deviation while the digital deviation is set by R30. If an offset adjustment in the DC level of the digital data is required (normally not required) this is accomplished by R29. The other adjustments on the Control A board are associated with specific types of control formats and normally should not be attempted in the field without first consulting the factory for technical assistance.

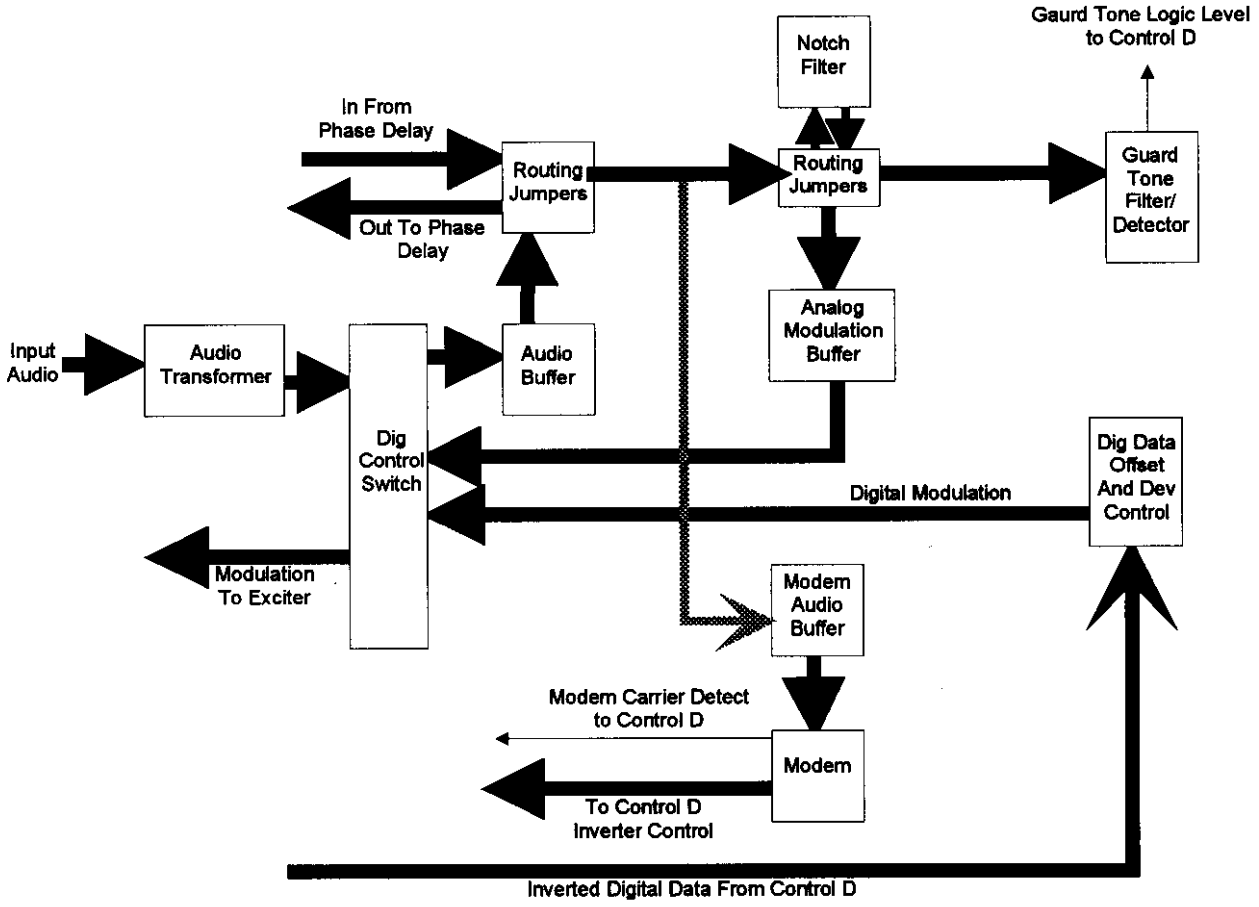
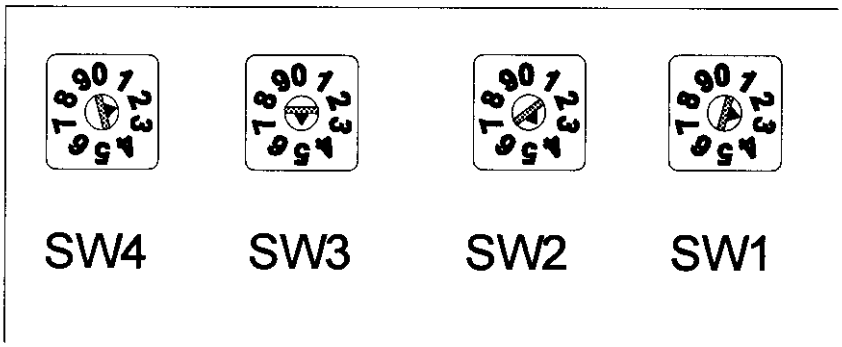


Figure 19a. Control A Board Flow Diagram

B.3.5 Phase Delay Board

The optional Phase Delay board is required in those applications where two or more transmitters are being orated in a simulcast system. The function of this board is to delay the incoming audio signal containing both analog and digital information a sufficient amount of time to allow all the transmitters to transmit simultaneously (i.e. within a window of 10-50 microseconds). Incoming audio is first transformer coupled into the board by audio transformer T1. The output of this transformer is next reduced in amplitude and buffered by operational amplifier U9A before being input into a sampling A/D converter U4 at a minimum sample rate of 64 Kbytes/sec. The data samples are

next clocked through delay circuit U5 under the control of 87C451 microprocessor U1. The manner in which the total delay is implemented is ultimately controlled by gate array U7 which contains the proper firmware program to implement the proper sample rate and pattern. The exact amount of delay time for the samples is determined by a bit pattern that is read on sixteen port pins of the microprocessor. These sixteen bits are realized from two possible sources. First of all, there are four decimal rotary switches located on the lower edge of the Phase Delay board as illustrated below in Figure 21.



Example: 2543 microseconds

- SW4 = 2
- SW3 = 5
- SW2 = 4
- SW1 = 3

Figure 21. Phase Delay Board Switches

Each of these switches is connected to four of the port pins on the processor and presents a four-bit address that corresponds to the particular setting of the switch. Each of the switches is associated with a particular in a four digit number representing the total delay setting as illustrated on the previous page (i.e. SW1 = Units, SW2 = Tens, SW3 = Hundreds, SW4 = Thousands). By simply setting the switched to the appropriate setting the phase delay is achieved. It should be noted that there is a built-in delay in the Phase Delay board even with all the switches set to zero. This delay is 65 microseconds if the unfiltered output is selected. These base numbers should be subtracted from any required delay settings prior to their implementation. A second method for setting the delay amounts is available if the remote diagnostics option has been selected. With this option, all of the four switches should be set to zero. The master processor on the Control D board via the I2C bus to the two I2C bus chips V10 and V11 then provide the proper bit pattern. In this manner a remote location can set the phase delay via a dial up line or over the control link. After sampled data bits have been delayed they are then presented to the D/A converter (U6) where a smoothed stepwise approximation to the original signal is provided at its output. If the delayed signal is a modem tone

containing digital information only then would no additional filtering be required. However, if the signal contains mostly voice paging filtering may be desirable although the quality without filtering is excellent at these sample rates. If filtering is required, JP1 and JP2 are configured to route the audio through the audio filter (U8), otherwise the audio signal is amplified by a factor of ten by operational amplifier (U9B) and coupled back to the Control A board by audio transformer T2. In standard configuration, 0 to 4999 milliseconds delay can be achieved.

There are some applications where higher delay amounts more that 5000 microseconds are required, contact the factory for assistance. Delay cards with maximum delay up to 40,000 microseconds are available upon request. However, for the higher delays the step resolution of 1 microsecond per step will have to be increased to 4 microseconds per step. Otherwise, all other features of the high delay version of the Phase Delay board remain the same.

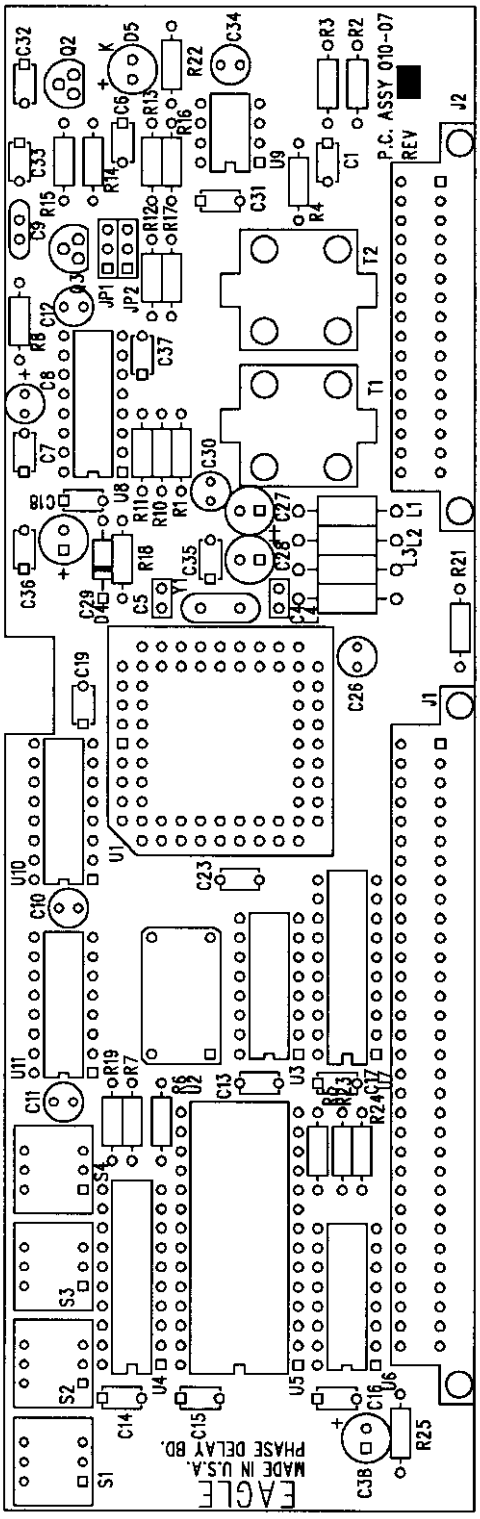


Figure 22. Phase Delay Board

B.3.6 Transmitter Unit Exciter

The exciter module of the transmitters is produced in two different models. The standard model utilizes a synthesized signal source to produce a high quality signal output with data rates available up to 2400 baud. This model is appropriate for link transmitters, individual transmitters, and standard two level FSK simulcast systems. The second model of the exciter utilizes advanced direct digital synthesis techniques to achieve ultra-high stability four level FSK output at modulation rates to 6.4 Kbaud. Detailed design information on the advanced version will be appended to the manual at that time.

The basic RF generation starts with a command being issued by the master microprocessor on the Control D board. This command will be result of either a manual key request, a control format key request, or a locally generated key request (i.e. such as a local generated Station ID). This command is interconnected between the Control D board and the exciter via the motherboard and a ribbon cable from the motherboard to the exciter. The command is received by the control circuitry on the exciter and decoded and used to program the divisor ratios for the phase lock loop as well as to apply drive power to the VCO (Voltage Controlled Oscillator), the pre-amp transistor stages, and power module. The power to the frequency reference TCXO (Temperature Controlled Crystal Oscillator) has previously been applied at power up and the crystal is stabilized at its 50°C reference point. The last part of the command is the actual key command and is used to enable the VCO. It should be noted that there are actually two steps in the keying process. The first step keys the VCO and brings the RF output up to a level of approximately –50dBm. After all transients have died out (approximately 100 milliseconds) the power level is brought up to its full power. Although, in theory, any frequency or group of frequencies could be generated for a given reference frequency, the Quantum and Stealth Series exciters are limited in software to frequencies that are divisible by either 5 KHz or 6.25 KHz. This ratio supports all of the popular channel spacing formats.

Once the carrier frequency has been established by the phase lock loop, the data for the modulation is applied to the VCO through a series of interface circuits. For two-level FSK the magnitude of the modulating signal determines the deviation level and is normally adjusted on the Control A board to a level between ±4.5 and ±5 KHz. In order to achieve the desired modulation characteristics required to work in a simulcast environment sample of the modulation is inverted and fed back to the TCXO. In the TCXO this signal is used to slightly "pull" the frequency of the reference being supplied to the VCO in a manner to shape the modulation characteristics.

The output of the VCO is a FSK modulated carrier at a level of approximately –10dBm. This signal is filtered and amplified in multiple stages to achieve a signal of approximately +10dBm at the input to the main power module. The main power module as well as the preamp stages receives their main DC power from a separate source from the rest of the circuitry. This is to provide DC isolation and output power adjustment. This adjustment is normally required only at the time of initial setup and should not be required in the field.

The final power module in the exciter provides a high gain linear amplification of the RF drive level at it's input and depending on the DC power adjustment levels in the range of 100 milliwatts to 2.5 watts are easily achievable. The power module output is passed through a low pass filter of three stages of L/C tuned circuitry to eliminate any unwanted harmonics and is finally provided to a RF connector in the wall of the RFI (Radio Frequency Interference) shielded enclosure containing the exciter. The exciter is normally sealed to prevent any unwanted radiation and should not be opened unless absolutely necessary.

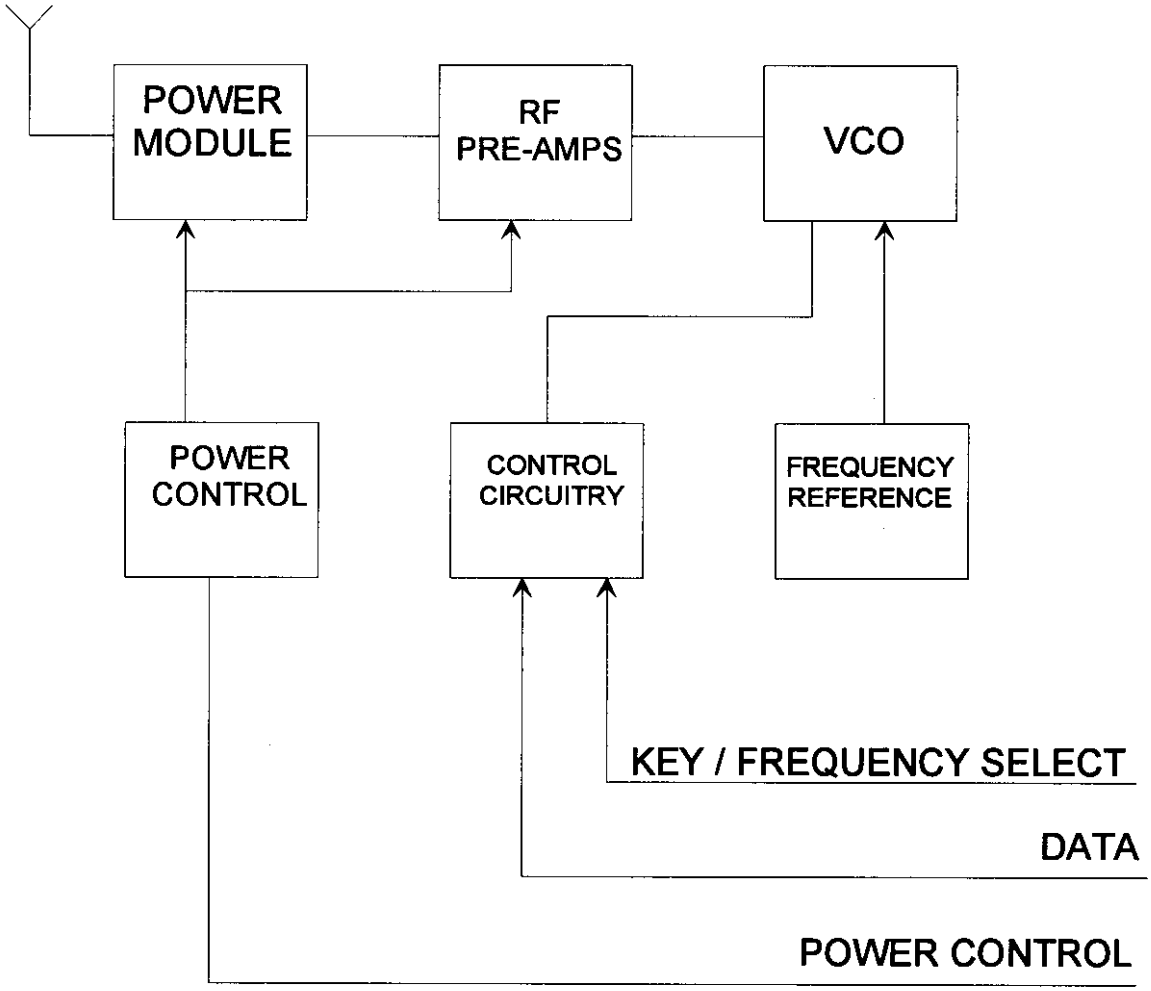


Figure 24. Transmitter Unit Exciter Module Block Diagram

B.3.7 Power Amplifier

The power amplifier section of is available in all frequency bands and power levels ranging from 40 to 500 watts. It would be difficult to adequately describe the technical details of all of the amplifiers in one technical document even though they all utilize the same support and control equipment described in the other sections of this manual. Therefore, this manual will only expand on the power amplifier configuration of your current transmitter described below:

The input from the exciter (approximately 400 to 500 milliwatts) is fed directly into the Pre-Amp module. The pre-amp module is a high gain amplifier with positive gain control through the use of its bias voltage. This bias voltage is provided by the PA Control board and is manually adjustable from the front of the transmitter as well as being controlled by the PA Control board main processor for VSWR and thermal shutdown. A RF power sensor at the output of the Pre-amp provides the input power sensing to alert the control electronics when a "power-up" condition is detected. This information is utilized for a variety of purposes such as fan control and VSWR validation.

The output of the pre-amp board is connected to the main amp. The main amp consists of a LDMOS transistor soldered to a high thermal capacity circuit board/copper heat spreader assembly. This circuit board material is thermally bonded to a heavy-duty copper heat spreader for added thermal capacity. The heat sink is instrumented to allow the microprocessor on the Power Amplifier Control board to continually monitor the thermal performance of the unit.

Should the main amp ever require replacement, the entire assembly, including the heat spreader, is easily replaced as a subassembly.

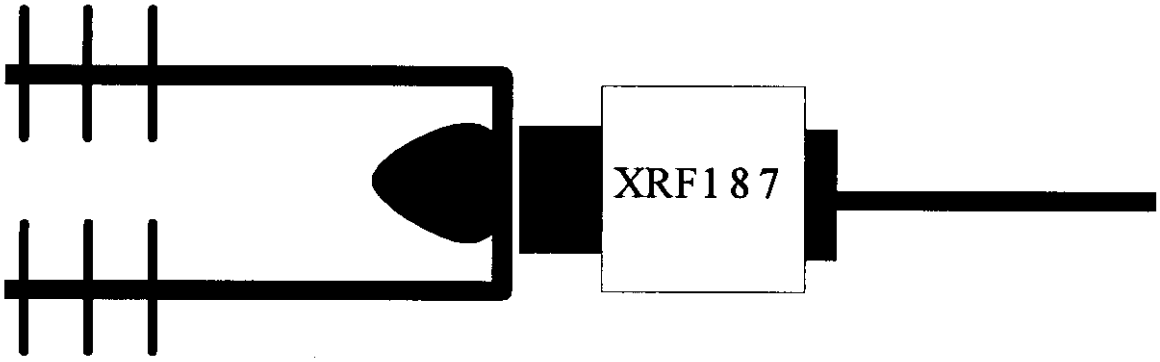


Figure 27. Main Amp Circuit Board Layout

The output of the main amp is fed into an isolator for protection. The output of the isolator is connected to a low pass filter. The directional couplers for forward and reflected power measurement are etched into the board containing the isolator design.

The final item in the 80-Watt 900 MHz power amplifier is the fuse board located in the fuse compartment as shown in Figure 25. This fuse board is utilized in all models of EAGLE power amplifiers up to 500 watts. Therefore, in the 80-Watt version there are a number of unused fuse locations as shown in Figure 29.

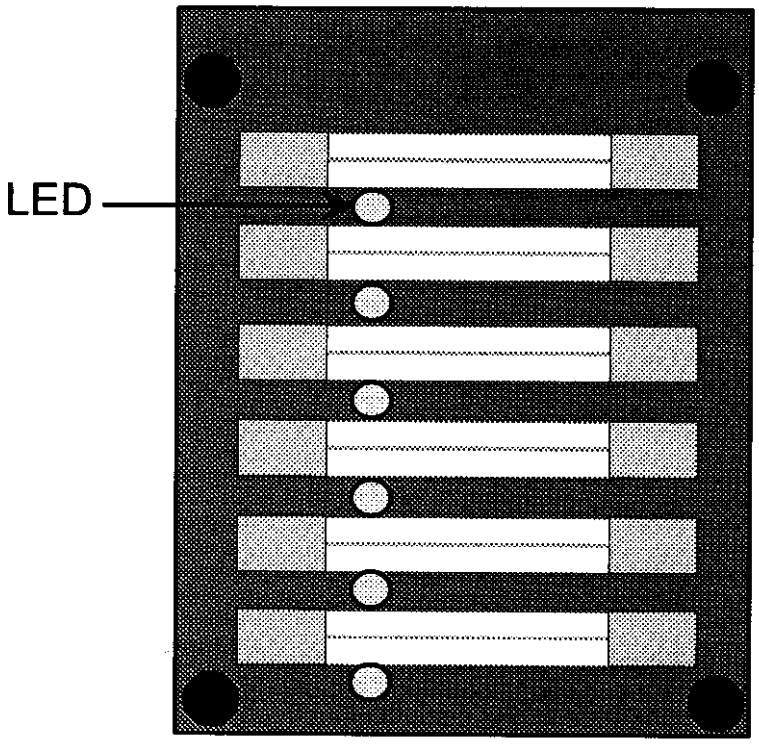


Figure 29. Fuse Board

Each of these fuse locations is instrumented with an LED to provide a quick visual indication of the health and status of that particular fuse. Most importantly, in the entire Power Amplifier section of the transmitter, there are no item requiring adjustment or tuning.