Principle of Operation

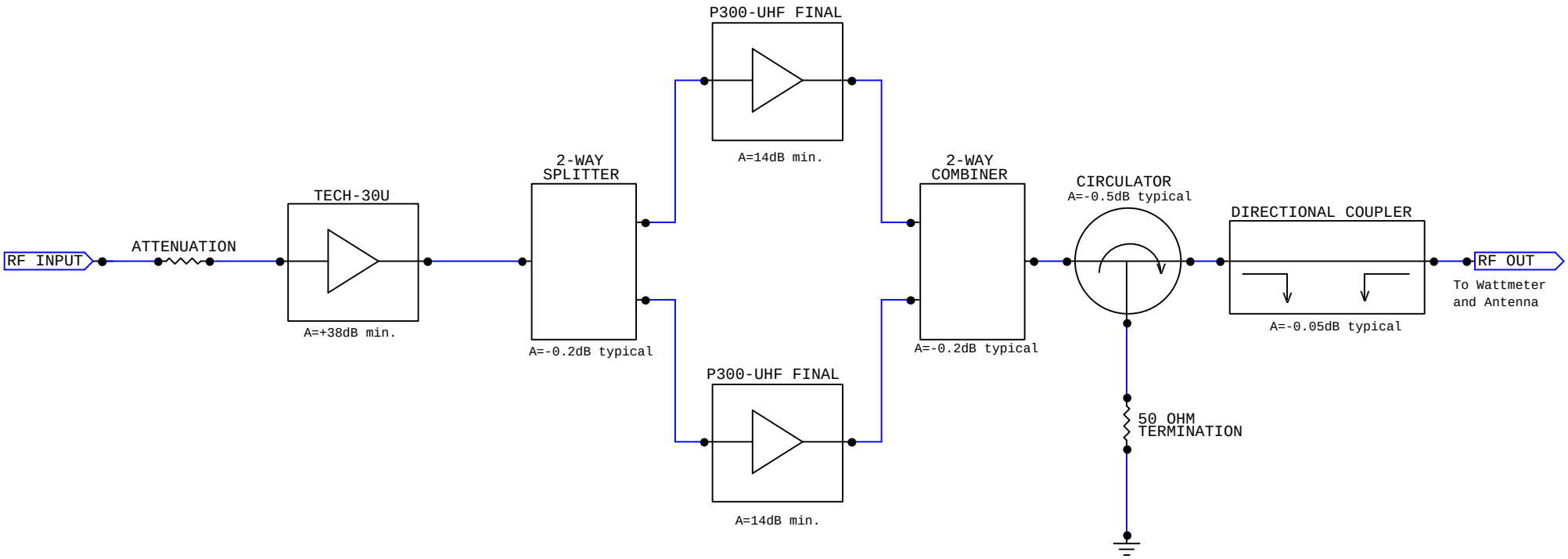
The TAU-500 power amplifier supplies a 500-watt peak video signal with an aural carrier level 10 to 13 dB below visual carrier (dBc) on any of the UHF television channels 14 through 69. Please note that channel selection must be made at time of order, as the transmitter or translator is calibrated and tested to the channel requested and is not field tuneable. The TAU-500 power amplifier is a modular solid-state 500-watt broadcast amplifier utilizing readily available RF components wherever possible, thus enhancing the serviceability of the equipment.

The TAU-500 is comprised of a TECH-30U driver pallet and (2) P300 final pallets that are combined to create 500 watts of peak visual power in addition to the aural carrier power.

The TAU-500 features ultra linear amplification and individual channel RF output bandpass filtering. The amplifier modules are stable for high reliability and long service life.

Block Diagram

The RF signal enters through the RF Input connector on the power amplifier enclosure from the modulator or processor. It then passes through an RF attenuator to limit the output power level of the power amplifier and to help buffer any transients that may come into the power amplifier. After attenuation, the signal gets preamplified through the driver pallet before the signal gets split into (2) signals for final amplification. The output of the (2) final amplifier pallets get combined and passes through an isolator and a bandpass filter. Finally, the signal passes through a dual directional coupler for monitoring purposes before heading out to an antenna for broadcast.



TAU-500 Block Diagram	
Rev	ID
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Specifications

The following specifications were taken with a Technalogix modulator/processor. Should a different modulator or processor be used, specifications could vary. For this reason, we recommend that any different modulator/processor be shipped to Technalogix so the system can be matched and set up optimally. In addition, the audio/video ratio the input to the power amplifier needs to be –10 dB in order for the software and LCD readout to be accurate.

RF Characteristics

Frequency range	any specified UHF Channel 14 to 60**
Frequency Response (one channel)	±0.5 dB
Frequency Stability	±250 Hz
Selectivity	60 dB (adjacent channel)
Minimum Input Level	0 dBmV
Rated Visual Output Power	500 Watts
Rated Aural Output Power	10% of peak visual power
IF Output Level	+35 dBmV nominal
Input Impedance	75 Ohms
Output Impedance	50 Ohms
Harmonics	> 60 dB below rated power
Predominant Intermodulation Distortion	dBc = decibels below visual carrier
+ 920 kHz	> -53 dBc
- 920 kHz	> -53 dBc
+ 2.66 MHz	> -53 dBc
- 2.66 MHz	> -53 dBc
+ 5.42 MHz	> -53 dBc
+ 7.16 MHz	> -53 dBc
3rd Order Intermodulation Distortion	
+ 4.5 MHz	> -60 dBc
+ 9.0 MHz	> -60 dBc
All others	> -60 dBc
Spurious Emissions	> -60 dBc

** Stand-alone power amplifier will operate from channels 14-69.

PAL Video Characteristics

Input Level to modulator (for 87.5% modulation)	1.0 V_{PP}
Differential Phase (at 87.5% modulation)	±2 Degrees
Differential Gain (at 87.5% modulation)	2%
Group Delay	< ±40 nS
Video Group Delay Pre-emphasis	Conforms to IC/FCC specifications
K-Factor	1.9% for 2T Pulse
Hum and Noise	> 60 dB below rated power

Aural Characteristics

Input Level for 25 kHz Deviation	0.3 V_{PP}
Frequency Response (Standard Pre-emphasis)	±1 dB
Harmonic Distortion (25 kHz Deviation)	< 1% 50 Hz to 15 kHz
Amplitude Modulation Noise	> 50 dB
Frequency Modulation Noise	> 60 dB
Intercarrier Stability	±250 Hz

Physical Characteristics

Power Requirements	
Power Supply	230 V_{AC}, 10 A_{AC}
Operating Temperature	0 - 50°C
Dimensions	
TAU-500 Power Amplifier	W-19" flange (17" encl.), D-25-¼", H-8-¾" (5U)
Power Supply	W-19" flange (17" encl.), D-2-¼", H-7" (4U)

Section IV – RF Components

Amplifier Pallets

The TECH-30U driver pallet consists of (2) separate printed circuit board stages – The first stage is an ultra-linear class-A stage with (3) gain sections providing a typical adjustable power gain of 26dB to 37dB at 10-watts peak. This stage typically draws 2.5 Adc quiescent and a maximum drain current of 5 Adc. The second stage is a linear class AB stage with a typical gain of 13 dB. This stage typically draws 1.0 Adc quiescent and a maximum drain current of 10 Adc. The currents on both stages can be found by measuring the voltage drop across the +30 Vdc input and the I sense connector. The resistance separating these connections is 0.01 ohms, providing a 10 mV per ampere ratio.

The P300-UHF pallets used in the final amplification stage use LDMOS (Laterally Diffused Metal Oxide Semiconductor) technology. LDMOS technology offers higher gain, efficiency and linearity over standard MOSFET and Bipolar devices and enhances ruggedness and reliability. LDMOS transistors have the added advantage of not having BEO (Beryllium Oxide) in their construction. The P300-UHF amplifier pallets have a typical gain of 15dB (14dB minimum) and draw no more than 23Adc. Currents for these pallets must be measured with an ammeter in series with the power supply lead.

Each of the amplifier pallets is connectorized to optimize servicing and accessibility. All amplifier pallets must have the transistor drain voltages reach at least 26Vdc before the RF drive is applied.

Splitter/Combiner

The splitter and combiner are used to split the RF signal into, and combine the amplified RF signal out of the (2) final amplifier pallets. The connectorized designs are based on the simple isolated Wilkinson combiner design. Due to its electrical and mechanical symmetry, the Wilkinson design's performance over moderate bandwidths is superior to other types.

Directional Coupler

The Technalogix dual directional couplers provide DC voltages proportional to forward and reflected RF power monitoring. These analog voltages are converted for processing using analog-to-digital converters and provide the control system with valuable data for monitoring purposes. The directional couplers installed in the power amplifier and filter enclosures have peak detection circuits on the forward RF power side of the coupler and average detection circuits on the reflected RF power side of the coupler. This is to allow the end user to set power in a manner that is more independent of modulation and closer to a true tip-of-sync meter. Hence the readings on the displays in the power amplifier system are peak for forward and average for reflected. Output power should be set following the operating procedure found elsewhere in this manual.

The directional coupler has a typical insertion loss of 0.5dB and its Type N connectors can handle 1,500 watts peak. The coupler requires 8 to 8.5Vdc to power the internal electronics of the coupler and is supplied from the control printed circuit board at the front of each enclosure.

Isolator

The power amplifier pallets are protected in part by the isolator located in the filter enclosure. It is actually made up of a circulator and 50-ohm dump resistor. The circulators' specifications include an insertion loss of less than 0.2dB with an isolation rating better than 20dB. Any reflected power gets dumped into the flanged power resistor. Even though the flanged power resistor is rated for only 150-watts, and there could potentially be 500-watts being reflected back into the circulator, the software will recognize quickly that reflected power is present and turn the carrier off. This way, there is instantaneous protection due to the isolator setup and long term protection due to the software.

Filter

The passive bandpass filter rejects spurious and harmonic output products and passes the UHF channel RF output. The cavity resonator uses aperture coupling and is a linear resonator design. Typical insertion loss is 0.6 dB to 1.0 dB depending on channel frequency. Average roll off is –33 dBc at a point 4.5 MHz below the peak visual carrier frequency and –30 dBc 9.0 MHz above the peak visual carrier frequency. The filter is DC grounded on both the input and output for additional lightning protection.

Section V – Power Supply

Switching AC-DC power supplies are used to power the amplifier pallets, the control circuits, and all of the fans. There are (2) power supplies paralleled in the power supply enclosure to generate the necessary current for the amplifier pallets. These (2) supplies are paralleled at 31.0 Vdc nominally and fed to the power amplifier enclosure via 4-AWG multi-stranded conductors and high current connectors. There are no power supplies internal to the power amplifier enclosure, with the exception of those found on the Series IIG control PCB. All fans run off of this same supply, though they pass through a series dropping resistor to lower the supply voltage down, as the fans are 24Vdc.

The power supplies in the power supply enclosure are (2) Mean Well PSP-1000. The switching power supplies are fully protected against short circuit and output overload. Short circuit protection is a cycling type power limit. The internal AC fuse is designed to blow only on a catastrophic failure in the unit – the fuse does not blow on overload or short circuit. The thermal shutdown automatically recovers when the power supply chassis cools down.

AC (220Vac) is fed into the power supply enclosure via a filtered AC entry and then through a resettable circuit breaker. It is then current limited with a resettable circuit breaker before passing through a rocker switch. This switch turns the AC on and off to the switching power supply.

MEAN WELL

SWITCHING POWER SUPPLY

ISO-9001 CERTIFIED MANUFACTURER

PSP-1000 SERIES

.LOW COST, HIGH RELIABILITY

.BUILT IN EMI FILTER, CURRENT SHARING CIRCUIT

.BUILT IN REMOTE CONTROL, REMOTE SENSE, POWER GOOD SIGNAL

.SHORT CIRCUIT, OVERLOAD, OVER VOLTAGE, OVER TEMP. PROTECTED

.100% FULL LOAD BURN-IN TEST

.105°C OUTPUT CAPACITOR

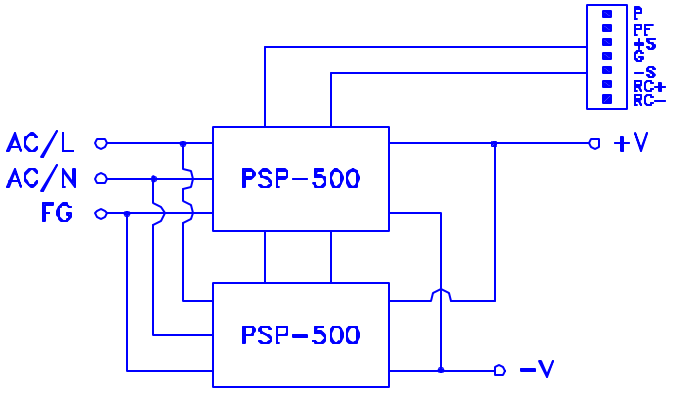
.BUILT IN PFC CIRCUIT PFC>=0.95, COMPLIES WITH EN61000-3-2

MODEL / SPECIFICATION	PSP-1000 -5	PSP-1000 -12	PSP-1000 -13.5	PSP-1000 -15	PSP-1000 -24	PSP-1000 -27	PSP-1000 -48
DC OUTPUT VOLTAGE	5V	12V	13.5V	15V	24V	27V	48V
OUTPUT V. TOLERANCE	±2%	±1%	±1%	±1%	±1%	±1%	±1%
OUTPUT RATED CURRENT	145A	75A	67A	60A	37.6A	33.6A	19A
OUTPUT CURRENT RANGE	0-145A	0-75A	0-67A	0-60A	0-37.6A	0-33.6A	0-19A
RIPPLE & NOISE	200mVp-p	200mVp-p	200mVp-p	200mVp-p	200mVp-p	200mVp-p	200mVp-p
LINE REGULATION	±1%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%
LOAD REGULATION	±2%	±1%	±1%	±1%	±1%	±1%	±1%
DC OUTPUT POWER	725W	900W	904.5W	900W	902.4W	907.2W	912W
PEAK OUTPUT POWER	800W	1000W	1000W	1000W	1000W	1000W	1000W
EFFICIENCY	76%	82%	82%	82%	84%	84%	86%
DC VOLTAGE ADJ.	4.75-5.5V	10-13.2V	12-15V	13.5-18V	20-26.4V	24-30V	41-56V
INPUT VOLTAGE RANGE	90~264VAC 47~63Hz; 127~370VDC						
AC CURRENT	14A/115V 7A/230V						
POWER FACTOR	0.95/230VAC						
INRUSH CURRENT	35A/115V 70A/230V						
LEAKAGE CURRENT	<2mA/240VAC						
OVERLOAD PROTECTION	115%~140% TYPE:CONSTANT CURRENT LIMITING RESET:AUTO RECOVERY						
OVER VOLTAGE PROTECTION	5.75~6.75	13.8~16.2V	15.5~18.2V	18~21V	27.6~32.4V	31~36.5V	57.6~67.2V
OVER TEMP.PROTECTION	RTH2>=95°C OUTPUT SHUTDOWN						
REMOTE CONTROL	RC+/RC-: 0~0.8V=POWER ON; 4~10V=POWER OFF SINK CURRENT 4~10mA						
TEMP. COEFFICIENT	±0.03% / °C (0~50°C)						
SETUP, RISE, HOLD UP TIME	1.5s, 50ms, 15ms						
VIBRATION	10~500Hz, 2G 10min./1cycle, PERIOD FOR 60min. EACH AXES						
WITHSTAND VOLTAGE	I/P-O/P:3KVAC I/P-FG:1.5KVAC O/P-FG:0.5KVAC						
ISOLATION RESISTANCE	I/P-O/P, I/P-FG, O/P-FG:500VDC / 100M Ohms						
WORKING TEMP., HUMIDITY	-10°C~+60°C(REFER TO OUTPUT DERATING CURVE), 20%~90% RH						
STORAGE TEMP., HUMIDITY	-20°C~+85°C, 10%~95% RH						
DIMENSION	278*129*127mm						
WEIGHT	4.7 Kgs						
SAFETY STANDARDS	MEET UL1950						
EMC STANDARDS	MEET CISPR22, EN61000-3-2, EN61000-4-2,3,4,5,6,8,11						

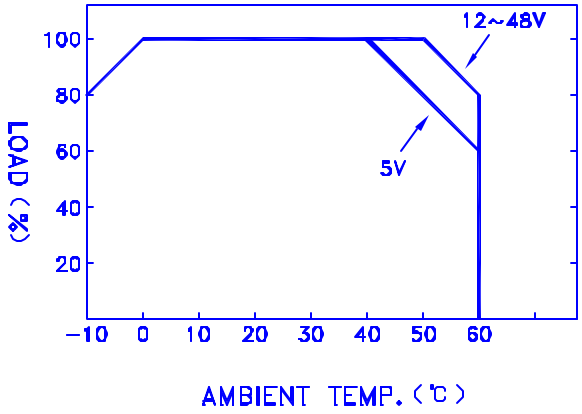
NOTE :
1. ALL PARAMETERS ARE SPECIFIED AT 230VAC INPUT, RATED LOAD, 25°C 70% RH. AMBIENT.
2. TOLERANCE GINCLUDE SET UP TOLERANCE, LINE REGULATION, LOAD REGULATION.
3. RIPPLE & NOISE ARE MEASURED AT 20MHz BY USING A 12" TWISTED PAIR TERMINATED WITH A 0.1uF & 47uF CAPACITOR.
4. LINE REGULATION IS MEASURED FROM LOW LINE TO HIGH LINE AT RATED LOAD.
5. LOAD REGULATION IS MEASURED FROM 0% TO 100% RATED LOAD.
6. REFER TO OUTPUT DERATING CURVE VS INPUT VOLTAGE.
7. PEAK OUTPUT POWER LASTING <30 SECONDS WITH A MAX. 10% DUTY CYCLE.

2002-01-28

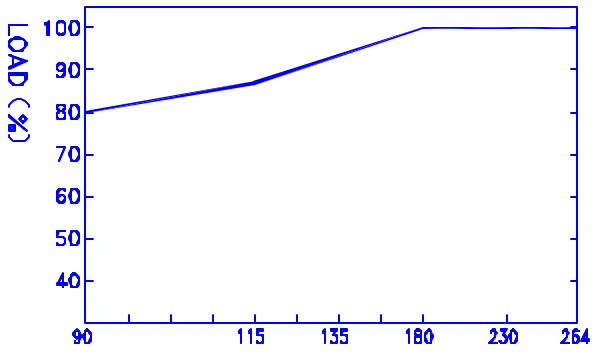
BLOCK DIAGRAM



OUTPUT DERATING VS Ta



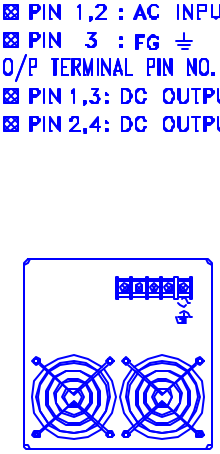
OUTPUT DERATING VS INPUT VOLTAGE

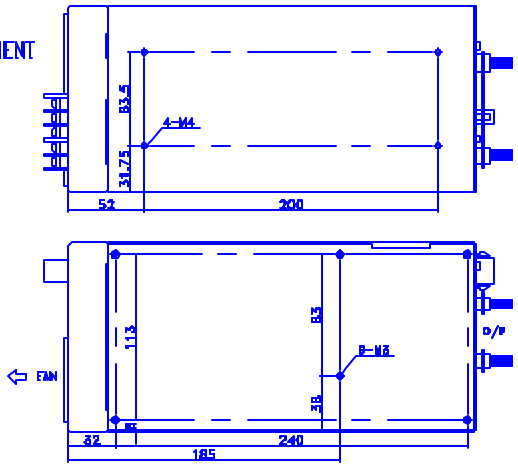


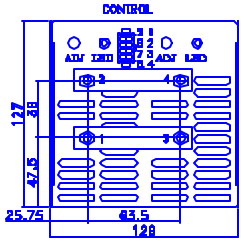
DIMENSION (mm)

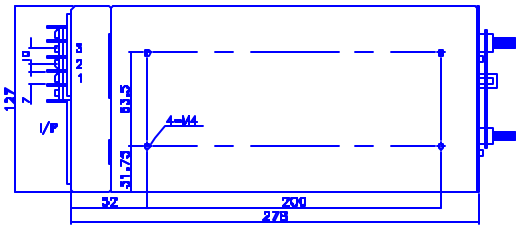
- CASE : 924
- I/P TERMINAL PIN NO. ASSIGNMENT
  - PIN 1,2 : AC INPUT
  - PIN 3 : FG ⏚
- O/P TERMINAL PIN NO. ASSIGNMENT
  - PIN 1,3: DC OUTPUT +V
  - PIN 2,4: DC OUTPUT -V

- CONTROL PIN NO. ASIGNMENT
  - Molex 5559-NP Uses 5558 Male Crimp Terminal
  - PIN 1 : P(CURRENT SHARE)
  - PIN 2 : -S
  - PIN 3 : G
  - PIN 4 : RC-
  - PIN 5 : NC
  - PIN 6 : PF(POWER FAIL SIGNAL)
  - PIN 7 : +S
  - PIN 8 : RC+
- MATING CONNECTOR
  - Molex 5557-NR Uses 5556 Female Crimp Terminal Receptacle









Section VI – Monitor and Control System

Control Board Overview (Series II-rev I)

The control printed circuit boards (PCB) are located at the front of each enclosure connected directly to the back of the liquid crystal displays (LCD) and are identified as Series II – rev I PCBs. The main purpose of the Series II - rev I PCB is to monitor the RF power and the DC supply voltages in the power amplifier and filter enclosures and to monitor just the DC supply voltages in the power supply enclosure. In all cases, a DC voltage proportional to the parameter being sampled is conditioned, protected, buffered, and then run into an analog-to-digital converter (ADC) where software processes the signal. The software processing determines if the parameters are within the predetermined safe operating levels and displays the parameters on the LCD for monitoring purposes. The Series II - rev I PCB can be broken apart into (5) main component areas: the power supply, interface, signal processing, display, and microcontroller. Schematics are found later in this section.

Power Supply Components

There are (4) power supply voltages generated on the Series II – rev I PCB:

1. +5Vdc for all logic and general purpose PCB supply voltage
2. +4Vdc for the LED backlighting on the LCD
3. -4Vdc for the contrast voltage required by the LCD
4. +5Vdc for the directional coupler supply

The +5Vdc is generated from a small switching power supply comprised of C101, C102, D102, L101, and U101. This power supply accepts DC input voltages up to 40Vdc (unless U101 is an HV option, then the maximum input voltage is +60Vdc) and outputs +5Vdc at up to 1Adc. This voltage is always on, as the ON/OFF pin on U101 is hard-wired to the ‘on’ configuration. C103, L102, and C104 form a noise choke to help filter out switching noise or RF noise that may radiate onto the control circuit board.

The +4Vdc is generated from a small switching power supply comprised of components C105, C106, D103, L103, and U102. This power supply accepts DC input voltages up to +40Vdc (unless U102 is an HV option, then the maximum input voltage is 60Vdc) and outputs +5Vdc at up to 1Adc. The voltage then gets dropped down to +4Vdc through R101. This backlight voltage can be turned on and off via the ON/OFF pin on U102. The PCB is designed in a manner that allows this voltage to be hard-wired on all the time or controlled from the microcontroller through latch U111. This selection is made with jumper J102.

The -4Vdc is generated using a switched capacitor voltage converter design, using components C109, C110, R102, R103, U104, and VR101. U4 accepts +5Vdc from the general purpose +5Vdc supply and generates -5Vdc. This voltage then gets dropped across the voltage divider (R102, R103) to generate the contrast voltage specific to the LCD that is installed in the system.

The voltage required by the directional coupler is generated with a standard linear voltage regulator, U103 if it is a voltage other than +5Vdc. C107 and C108 helps clean up any ripple or noise that might be on the output voltage. In the standard configuration, where the directional coupler requires +5Vdc, the +5Vdc is simply taken from the U101 filtered power supply output.

Interface Components

The interface section of the Series II – rev I PCB includes the front panel switch interfacing in addition to the buzzer and carrier disable output circuits.

The (4) membrane switches found on the front panels of each enclosure are tied to the microcontroller through an isolation stage to avoid any static discharge or noise on the switch wiring from reaching the microcontroller. Optoisolators U105 and U106, in addition to components R104…R115 create the necessary isolation to the sensitive microcontroller. By depressing any membrane switch, a ground (0V) is applied to the input of the optoisolators. The optoisolators will, in turn, output a ground (0V) to the microcontroller when any switch is depressed.

The membrane switches found on the front panels of the enclosures operate in the following manner with a depress:

POWER – When unit is plugged in, AC is supplied to the switching power supply input, but the amplifiers are still turned off. In order to turn the amplifiers on, assuming the rocker switch is turned on, wait ten seconds after plugging the PA in and push in the “POWER” tactile button. The LCD will read “Soft Start Warm Up, Please Wait”. After ten seconds the bias voltages will be turned on and you may then plug in the RF drive. Depress for (1) second to turn on and (3) seconds to turn system off. In the case of multiple enclosures, all POWER switches are tied together in each enclosure, so only one switch needs to be depressed.

NAVIGATE – Turns on backlight to LCD and displays forward and reflected RF power and DC supply voltage parameters. When power amplifier is first turned on, the LCD comes on automatically and this information is displayed. Information is displayed for several minutes before the backlight turns off and the display is cleared. This is set up so as not to burn any pixels into the LCD from extended on time. In the case of multiple enclosures, the NAVIGATE switches are individual to each enclosure.

SELECT – Turns on backlight to LCD and displays forward and reflected RF power and DC supply voltage parameters. When power amplifier is first turned on, the LCD comes on automatically and this information is displayed. Information is displayed for several minutes before the backlight turns off and the display is cleared. This is set up so as not to burn any pixels into the LCD from extended on time. In the case of multiple enclosures, the SELECT switches are individual to each enclosure.

RESET – Tactile switch resets the monitor and control system. The amplifier gets shut down for under 0.5 seconds and comes back on with each depress of the reset button. At the same time, all fault counters in the microcontroller software are reset and the LCD is reset in the same manner as it is with a depress of the NAVIGATE button. Reset switches are individual to each enclosure but may be tied together externally through the remote port, as explained later in this section.

The buzzer control comes from pin 7 on microcontroller U114. The control signal passes through R116 and turns on the base of transistor Q101, which allows current to flow through the single tone magnetic buzzer. Jumper J105 simply turns off the buzzer when removed.

The carrier disable circuit applies a shutdown voltage to the driver pallet in the system. The U114 generates the signal out of pin 21 and controls transistor Q102 through R117. When Q102 is turned off, the shutdown voltage to the driver is floating and the carrier is on. During a fault condition, when Q102 is turned on, the shutdown voltage is applied to the carrier disable on the driver. Relay K101, which outputs the carrier disable, is protected from transient spikes by D104.

Signal Conditioning Components

The signal processing section of the Series II – rev I PCBs is used to buffer potentially noisy or damaging signals from the ADC. Power supply samples and forward and reflected power from a directional coupler are then digitized.

Firstly, all analog signals are protected with a resettable fuse and transient voltage suppressor (TVS) combination. These components ensure that voltages above the Vbr breakdown voltage of the TVS get clamped and do not pass farther down the circuit. After this protection stage, the analog voltages get dropped with voltage dividers to safe levels for the buffers and ADC. For example, a +30Vdc power supply sample gets dropped to a level below the +2.5Vdc voltage reference U109 of the ADC. After the voltage dividers, the analog signals get buffered with U107 and U108, configured as unity gain voltage followers. Finally, after some further decoupling capacitors and filters, the analog signals get digitized by the 8-channel, 10-bit ADC (U10) and sent to the microcontroller through a serial interface.

There are (3) analog voltages that get conditioned and processed: DC power supply sample, forward RF power, and reflected RF power. Specifically, the components are as follows:

DC power supply –	J108 (pin 1 floating and direct connection), F107, C120, L108, C121, R129, R130, VR105, U108, C122, C123, L109, C124 and U110.
Forward RF power –	J108 (pin 2), F106, D109, C117, C118, L107, C119, R127, R128, VR104, U108, C125, L110, C126, C127, and U110.
Reflected RF power –	J108 (pin 3), F105, D108, C114, C115, L106, C116, R125, R126, VR103, U108, C130, L112, C131, C132, and U110.

Display Components

The display section of the Series II – rev I PCB is comprised of the LCD and the components that make up the data bus to send the data from the microcontroller to the LCD.

Specifically, the LCD is an alphanumeric 20X4 display that uses the industry standard 44780 controller and a parallel interface for data communications. Firstly, the microcontroller sends out the data to be displayed via a serial bus where the signals are latched with U111 and U112 and converted to a parallel data stream. The parallel data then transfers directly to the LCD through connector J109. J109 also carriers the power supply for the LCD.

Microcontroller Components

The heart of the monitor and control system found in Series II - rev I PCBs is microcontroller U114. This microcontroller analyzes all RF power levels and voltages to ensure that all operating parameters are within their predetermined safe operating levels. If a fault is found, appropriate action is taken to help protect the system from damage, which may include turning the RF carriers off. A full description of all faults and their respective actions is found later in this section.

The power supply for the microcontroller is monitored closely via supervisor U113. Should the +5Vdc supply drop below +4.5Vdc, a microcontroller reset is generated to ensure there are no brown out conditions that may latch the microcontroller up to an unknown state. The front panel Reset momentary switch is also tied to this line after optoisolation. The microcontroller is run off of a 4.000MHz clock source, generated by ceramic resonator CR101. If the software is running, LED D110 will be lit. Finally, U115 stores all characters for the LCD to minimize the overhead required for the microcontroller, and also stores the current state of the power ON/OFF of the system. This is to ensure that, in the event of a power outage, the system returns to the exact state is was before power was interrupted.

Fault Shutdowns

On the LCD (Liquid Crystal Display) the following messages may appear:

If you see this message, the system will:

- shut amp down for 1 minute
- automatically turn amp on after 1 minute and check again for overdriven amplifier
- come back to the same power level that it was set

If you see this message, the system will:

- shut amp down for 5 minutes
- automatically turn amp on after 5 minutes and check again for high VSWR
- come back to the same power level that it was set

Remote Port

The remote port allows external control of the transmission system via the DB25 connector on each enclosure. All functions on the remote port are simply hard-wired or paralleled to existing wiring to provide a secondary method of control to the user, and are activated as follows:

pin 1: ground to reset microcontroller, float otherwise
pin 2: ground for 2 seconds to toggle carrier on/off, float otherwise
pin 3: common ground
pin 4: DC power supply sample

Section VII – Mechanical Section

The heat sink allows the amplifiers to operate at a cooler temperature and prevents overheating, which helps the longevity of the entire system. The heat sink has hollow fins, which help dissipate the heat from the amplifiers faster than a conventional serrated or corrugated fin.

In addition to the cooling effects of the heat sink, within the 500-watt power amplifier enclosure, there are four fans that each provide 170 cubic feet per minute (CFM) of air flow (into zero static pressure). There are two fans mounted at the front of the heat sink and two mounted at the back end of the heat sink. The fans are mounted side-by-side to produce the best cooling for the system and are operating in a push-pull configuration to assist with heat dissipation. The fans are a 24Vdc variety, so there are series dropping resistors to drop the higher power supply voltage down to a safe level.