Principle of Operation

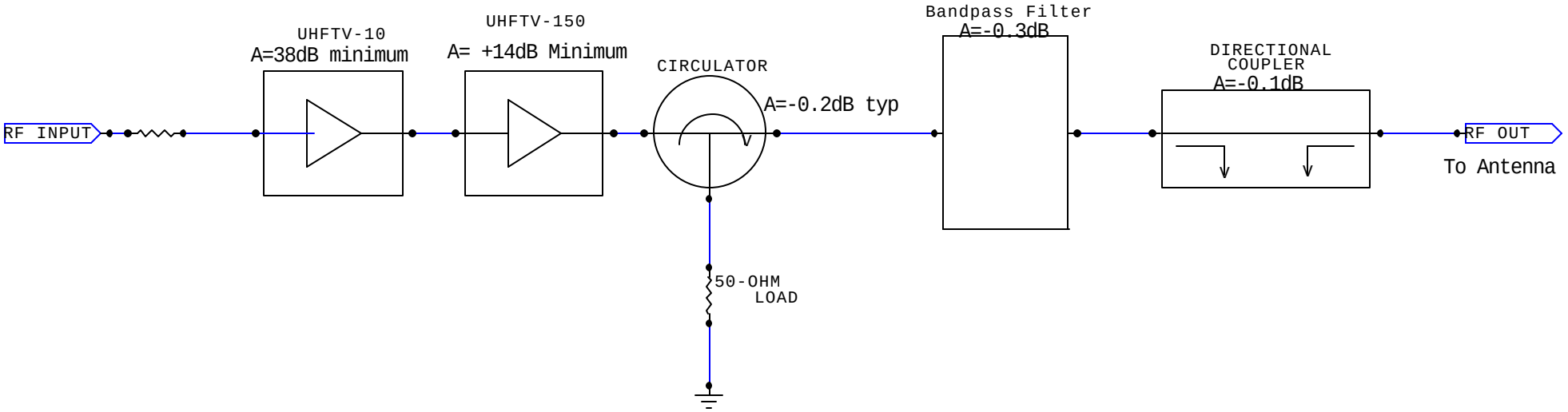
The TAU-100 power amplifier supplies a 100 watt peak video signal with 10% aural power on any of the UHF television channels 14 through 69. Please note that channel selection must be made at time of order, as the transmitter or translator is calibrated and tested to the channel requested and is not field tuneable. The TAU-100 power amplifier is a modular solid-state 100-watt broadcast amplifier utilizing readily available RF components wherever possible, thus enhancing the serviceability of the equipment.

The TAU-100 is comprised of a UHFTV-10 driver and UHFTV-150 final amplifier. The unique zero sync compression technology ensures digital ready operation.

The TAU-100 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 is amplified through the UHFTV-10 driver and UHFTV-150 T final pallets before the signal passes through an isolator (circulator with load) and a bandpass filter. Finally, the amplified signal passes through a dual directional coupler for monitoring purposes. After the directional coupler, the signal exits the power amplifier enclosure before heading out to an antenna for broadcast.



TAU-100 Block Diagram	
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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 69
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	100 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	> -50 dBc
- 920 kHz	> -50 dBc
+ 2.66 MHz	> -50 dBc
- 2.66 MHz	> -50 dBc
+ 5.42 MHz	> -50 dBc
+ 7.16 MHz	> -50 dBc
3rd Order Intermodulation Distortion	
+ 4.5 MHz	> -60 dBc
+ 9.0 MHz	> -60 dBc
All others	> -60 dBc
Spurious Emissions	> -60 dBc

NTSC 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	100-130,210-230 vac, 50/60 Hz
Operating Temperature	0 - 50°C
Dimensions (power amplifier only)	W-19”,D -21 ¼”, H-5 ¼”, 3U-high

Section IV – RF Components

Amplifier Pallets

The UHFTV-10 pallet is a two stage ultra linear class-A linear pallet. It has a minimum gain of 38dB and draws no more than 2.75Adc total drain current (the exact bias and drain currents of your system are found in the spec sheet supplied with each manual). The quiescent and drain currents can be measured on the UHFTV-10 pallet by measuring the voltage drop across the current sense resistor found directly at the DC power supply lead input to the pallet. This resistance is 0.01-ohms, providing a 10mV per ampere ratio.

The UHFTV-150 pallet used in the driver and final amplification stages use LDMOS (Laterally Diffused Metal Oxide Semiconductor) technology. LDMOS technology offers higher gain, efficiency and linearity over standard MOSFET and Bipolar devices. LDMOS transistors have the added advantage of not having BEO (Beryllium Oxide) in their construction. These pallets are split into (2) frequency bands based on the channel ordered (channels 14-38 and channels 33 to 70). The UHFTV-150 amplifier pallet have a typical gain of 14dB and draw no more than 16Adc (again, the exact bias and drain currents of your system are found in the spec sheet supplied with each manual). Currents for these pallets must be measured with an ammeter in series with the power supply lead. Temperature compensated biasing helps ensure steady operating levels over wide temperature ranges.

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

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. 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. Typical insertion loss is 0.3 dB to 0.6 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.

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 a 10-bit analog to digital converter. The microcontroller system monitors power supply voltage, forward and reflected RF power, amplifier module temperature, the input video signal and the "VIEW" display request button. The LCD is based on the industry standard HD44780 controller and contains 4 lines with 20 characters per line. The LCD communicates with serial-to-parallel latches on the monitor and control circuit board and the latches communicate with the microcontroller via a custom serial interface.

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 is (1) power supply used to generate the necessary current for the amplifier pallets, set to 28.3 Vdc nominally.

The power supply is a Mean Well SP-500-27. This switching power supply is 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 (115Vac) is fed into the enclosure via a filtered EMI AC entry. 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.

Section VI – Monitor and Control System

Control Board Overview (Series II-H)

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-H PCBs. The main purpose of the Series II-H 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-H 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-H 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. +8Vdc for the directional coupler supply

The +5Vdc is generated from a small switching power supply comprised of C1, C2, D2, L1, and U1. This power supply accepts DC input voltages up to 40Vdc and outputs +5Vdc at up to 1Adc. This voltage is always on, as the ON/OFF pin on U1 is hard-wired to the on configuration.

The +4Vdc is generated from a small switching power supply comprised of components C3, C4, D3, L2, and U2. This power supply accepts DC input voltages up to 40Vdc and outputs +5Vdc at up to 1Adc. The voltage then gets dropped down to +4Vdc through R1. This backlight voltage can be turned on and off via the ON/OFF pin on U2. The PCB is setup in a manner that allows this voltage to be hard-wired on all the time or controlled from the microcontroller through latch U11. This selection is made with jumper J2.

The -4Vdc is generated using a switched capacitor voltage converter design, using components C6, C7, R2, R3, U4, and VR1. U4 accepts +5Vdc from the general purpose +5Vdc supply and generates -4Vdc. This voltages then gets dropped across the voltage divider (R2, R3) to generate the contrast voltage specific to the LCD that is installed in the system.

The +8Vdc required by the directional coupler is generated with a standard linear voltage regulator, U3. C5 helps clean up any ripple or noise that might be on the output voltage.

Interface Components

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

The (3) momentary 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 U5 and U6, in addition to components R4…R15 create the necessary isolation to the sensitive microcontroller. By depressing any momentary switch, a ground (0V) is applied to the input of the optoisolators. The optoisolators will, in turn, output a ground (0V) to the microcontroller.

The membrane tactile 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 fan and switching power supply input, but the amplifiers are still turned off. In order to turn the amplifiers 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 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 approximately 2 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 approximately 2 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 pushbutton 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 5 on microcontroller U14. The control signal turns on the base of transistor Q1, which allows current to flow through the single tone magnetic buzzer. Jumper J4

simply turns off the buzzer.

The carrier disable circuit simply applies a shutdown voltage to the driver pallet in the system. The U14 generates the signal out of pin 21 and controls relay Q2 through R17. When Q2 is turned off, the shutdown voltage to the driver is floating and the carrier is on. During a fault condition, when Q2 is turned on, the shutdown voltage is applied to the carrier disable on the driver.

Signal Conditioning Components

The signal processing section of the Series II-H 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 28Vdc power supply sample gets dropped to a level below the +5Vdc supply voltage of the ADC. After the voltage dividers, the analog signals get buffered with U7 and U8, 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.

In the power amplifier and filter enclosures, there are (3) analog voltages that get conditioned and processed: DC power supply sample, forward RF power, and reflected RF power. Specifically, the components for the power amplifier and filter enclosure conditioning are as follows:

DC power supply sample – J7 (pin8), F9, D11, R32, R33, U8, C33, C34, C35, and U10.
Forward RF power – J7 (pin7), F8, D10, R30, R31, U8, C29, C30, C31, and U10.
Reflected RF power – J7 (pin6), F7, D9, R28, R29, U8, C26, C27, C28, AND U10.

In the power supply enclosure, there are (2) power supplies, but they are both paralleled together. Hence, only (1) analog voltage is conditioned and processed for the LCD. Specifically, the components for the power supply sample are as follows:

DC power supply sample- J7 (pin8), F9, D11, R32, R33, U8, C33, C34, C35, and U10.

Display Components

The display section of the Series II-H 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 U11 and U12 and converted to a parallel data stream. The parallel data then transfers directly to the LCD through connector J8. J8 also carriers the power supply for the LCD.

Microcontroller Components

The heart of the monitor and control system found in Series II-H PCBs is microcontroller U14. 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 U13. 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 CR1. If the software is running, LED D12 will be lit. Finally, U15 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