EXHIBIT 2a

PUBLICATION TIM 6900-200

Related Publications:

TECHNICAL INSTRUCTIONS
*for
LARCAN-TTC FM TRANSLATOR
MODEL XL10-FM

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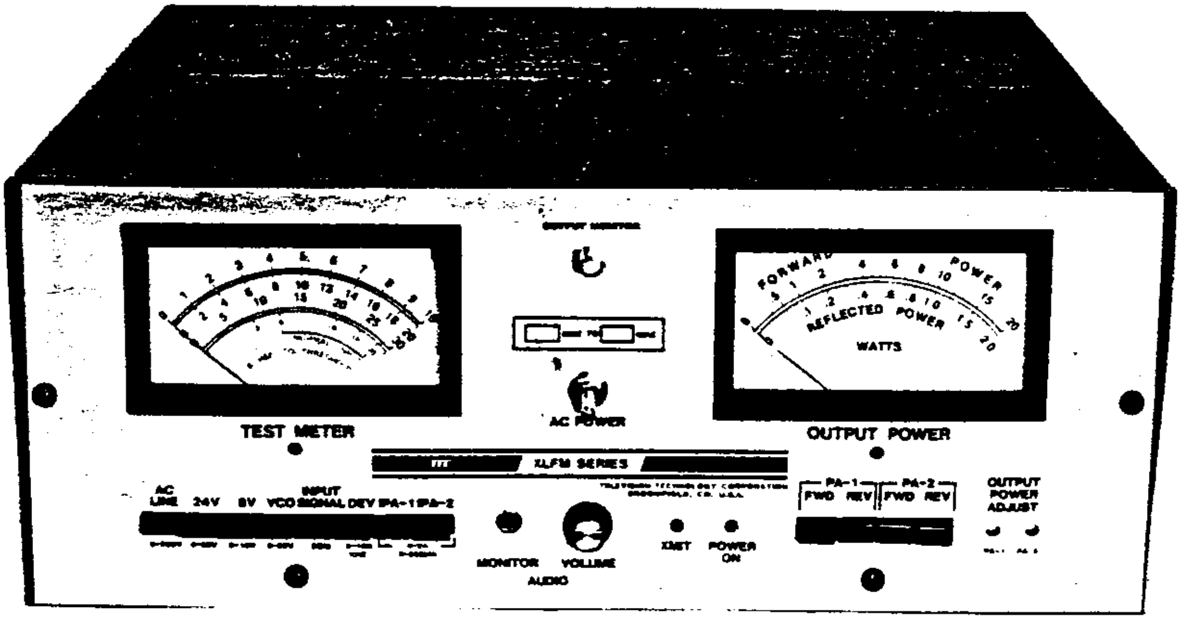

F M TRANSLATOR

XLFM SERIES

1 WATT
AND
10 WATT

R10

TABLE OF CONTENTS

LIST OF SCHEMATICS

LARCAN TTC

LIMITED WARRANTY

All LARCAN-TTC-manufactured Equipment, except as otherwise noted below, is warranted against defects in material and/or workmanship which arise under proper and normal use within two (2) years after the date of shipment. LARCAN-TTC's liability excludes any and all labor charges and is limited to the repair or replacement at its plant of part(s) or product(s) found by LARCAN-TTC in its sole judgment to be defective. LARCAN-TTC shall pay normal outbound freight from factory to Customer locations during this warranty period. All other shipping and related charges in connection with this warranty shall be borne by the Customer. This warranty does not cover fuses, lamps, used equipment, or reconditioned Equipment. LARCAN-TTC may request the return of defective parts replaced under warranty. Should Customer not return such parts within 60 days from Date of Request, Customer shall be responsible to pay LARCAN-TTC the full value of the replacement parts.

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The manufacturer's warranty on each major component of the Equipment produced by other manufacturers, including, but not limited to, tubes, klystrons, and beam/power supplies, shall apply in lieu of this warranty.

This warranty is not transferable and may not be altered or amended in any manner.

Effective February 3, 1994

SECTION 1

SPECIFICATIONS

1.1: INTRODUCTION

1.1.1: The Television Technology Corporation XL1FM and XL10FM translators are designed to meet the most stringent performance standards in use today. They are designed for the utmost in performance, versatility, and reliability. The XLFM translators will accept a signal on a single predetermined FM channel, convert it to another FM channel and provide up to two outputs of one or ten watts at this new FM channel. Both input and output channels may be anywhere between 88.1 and 107.9 MHz and they may be within 600 kHz of each other (400 kHz on special option). The XL10FM is rated for 10 watts output and the XL1FM has 1 watt output.

1.1.2: These translators have many features which make it the best FM translator available today. Among these features are the following:

1. Up to two, 1 or 10 watts output. Two independent output stages with their own ALC loops incorporated.

2. Rugged, unconditionally stable power amplifiers. Each power amplifier was carefully designed to be unconditionally stable into any load. The output has 100% reserve power to ensure that the full rated power can be delivered into antennas with up to 2:1 SWR without retuning.

3. Unique phase-locked loop upconverter. This sophisticated circuit eliminates all the spurious signals developed in the conventional heterodyne upconversion. The PLL (phase-locked loop) also provides unequaled interference rejection while still being transparent to the desired signal, including the SCA subcarrier. Because of the PLL, the noise output off channel is suppressed to the point where it will never be a factor in a translator installation.

4. Linear Phase Filtering. The I.F. incorporates two 5 pole Bessel filters to provide outstanding selectivity with negligible distortion of the desired signal.

5. High dynamic range front end. A careful gain distribution along with utilizing a balanced FET mixer and high power I.F. amplifier stages give the input of the translator an unprecedented amount of overload resistance. At the same time the front end attains a noise figure under 3dB.

6. Stereo Audio Monitor. A byproduct of the PLL upconverter, the audio is demodulated and is available at the headphone jack.

7. Rugged ferroresonant Power Supply. The ferroresonant transformer is immune to power surges while allowing a wide variation in line voltage.

8. Simplified local modulation capability. For local origination, no separate RF modulator is needed. Instead, the PLL upconverter is directly modulated from the audio while still using the incoming signal as a reference. As a result, no elaborate switching is needed, the output frequency will not change when switching from the local source to the incoming signal.

9. Modular construction. All the major subassemblies can easily be removed with a screwdriver.

1.1.3: Television Technology and its authorized distributors maintain stocks of spare parts. In case you desire to contact the factory directly, write or phone:

1.1.4: We reserve the right to make minor changes to our equipment without notice, including (but not necessarily limited to) the substitution of components and changes of circuitry. Such changes may or may not be incorporated in this Instruction Manual.

1.2: ELECTRICAL SPECIFICATIONS

Power Output	
XL10FM	Up to two (2) 10 W average outputs
XL1FM	Up to two (2) 1 W average outputs
Input/Output Frequency	88.1 to 107.9 MHz (U.S. Channels 201-300)
Emission Type	F-3
Operating Temp. Range	-40°C to +50°C ambient
Carrier Freq. Stability	± .002% (-30°C to +50°C)
AGC	60dB input variation for .1dB change in output

SELECTIVITY (Standard)

400kHz (Alternate Channel)	80dB minimum
600kHz (3rd Adjacent)	100dB minimum
(Optional):	
200kHz (Adjacent Channel)	70dB minimum
400kHz (Alternate)	100dB minimum
INPUT/OUTPUT SEPARATION	600kHz minimum
	400kHz (w/high selectivity option)

INPUT

Input Impedance	75Ω with 'F' type connector (50Ω with BNC connector optional)
Return Loss	16dB typical
Noise Figure	2.5dB typical 3.0dB maximum
Dynamic Input Range	No degradation of a 50uV signal with two 50mV alternate channel signals
Undesired Signal Overload	100mV typical
Image Rejection (F_c + 21.4 MHz)	70dB typical
	90dB optional
I.F. Frequency	10.7MHz
Minimum Signal for turn on	Standard 30uV Adjustable 10uV to 150uV

1.2.1: AUDIO PERFORMANCE: (Maximum degradation of audio thru the translator)

Sensitivity	25uV for 50dB stereo quieting typical	
Stereo Separation	40dB at 20Hz to 10kHz	
THD	.25% 30Hz to 15kHz	Standard Selectivity
	<1% 30Hz to 15kHz	Optional Selectivity
Frequency Response	± .5dB 20Hz to 75kHz	

OUTPUT

Output Impedance	
XL10FM	75Ω w/'N' type connectors (50Ω optional)
XL1FM	75Ω w/'F' type connectors (50Ω BNC optional)
Output Power (per output)	
XL10FM	10 W with 100% reserve power
XL1FM	1 W with 100% reserve power
Harmonics	2nd harmonic -80dB minimum 3rd harmonic -70dB minimum

	Spurious Output	LO (F_C + 10.7MHz) - 75dB minimum (F_C - 10.7MHz) - 75dB minimum All others -100dB minimum
	Noise Output (100kHz bandwidth)	(F_C ± 600kHz) -120dB minimum
	Stability	Unconditionally stable for any VSWR magnitude and angle Forward power will not vary more than ±10% for any change in load SWR up to 2:1
	Forward Power Metering Accuracy	±5% at rated output ±10% of half scale for all other outputs Over temperature: ±10% -30°C to +50°C
1.3:	POWER REQUIREMENTS	105 to 135 VAC 60Hz
	Operating	50 watts (single output XL10FM) 75 watts (dual output XL10FM) 30 watts (XL1FM)
	Standby	25 watts
	Operating Temperature Range	-40°C to +50°C
	Storage	-50°C to +80°C
1.4:	MECHANICAL SPECIFICATIONS	
	Weight	30 lbs
	Dimensions	19" wide 17" depth 7" height

MANUAL UPDATE MEMORANDUM
SOLAR POWERED XLFM SERIES FM TRANSLATORS

If your XLFM is a solar powered model, please make the following changes to your parts lists and on the schematics as appropriate:

On the INPUT CONVERTOR Board...
R205 is 470 ohms, 1/4 watt
R209 is 1K ohms, 1/4 watt
R210 is 100 ohms, 1/4 watt

On the IF Board...
R303 and R309 are 1.5 K, 1/4 watt
R305 and R311 are 750 ohms, 1/2 watt
R306 and R308 are 750 ohms, 1/4 watt

On the PLL board...
R416, R420 and R512 are 3.3 K, 1/4 watt
R423 and R439 are 6.8 K, 1/4 watt
R424 and R438 are 5.6 K, 1/4 watt
R497 is 130 ohms, 1 watt
R502 is 33 ohms, 1/4 watt
R506 and T401 are REMOVED
L422 is an 8T22E (8 turns #22 enamel wire)

On the 1 Watt POWER AMPLIFIER...
R901 is 6.8 K, 1/2 watt
R908 is 2.7 K, 1/2 watt
L904 is a 5T18E 5/16 I.D. coil (5 turns of #18 enamel wire)
L905 is a 6T18E 5/16 I.D. coil (6 turns of #18 enamel wire)
L906 is a 5T18E 5/16 I.D. coil (5 turns of #18 enamel wire)

NOTE re above three coils: All are wound same direction; all same for 50 or 75 ohm output.

On the METERING Board...
R640 and R641 are REMOVED
All ICs, including IC605, are REMOVED.

....

Thank you.
9-17-84

R16 SPECIAL

SECTION 2

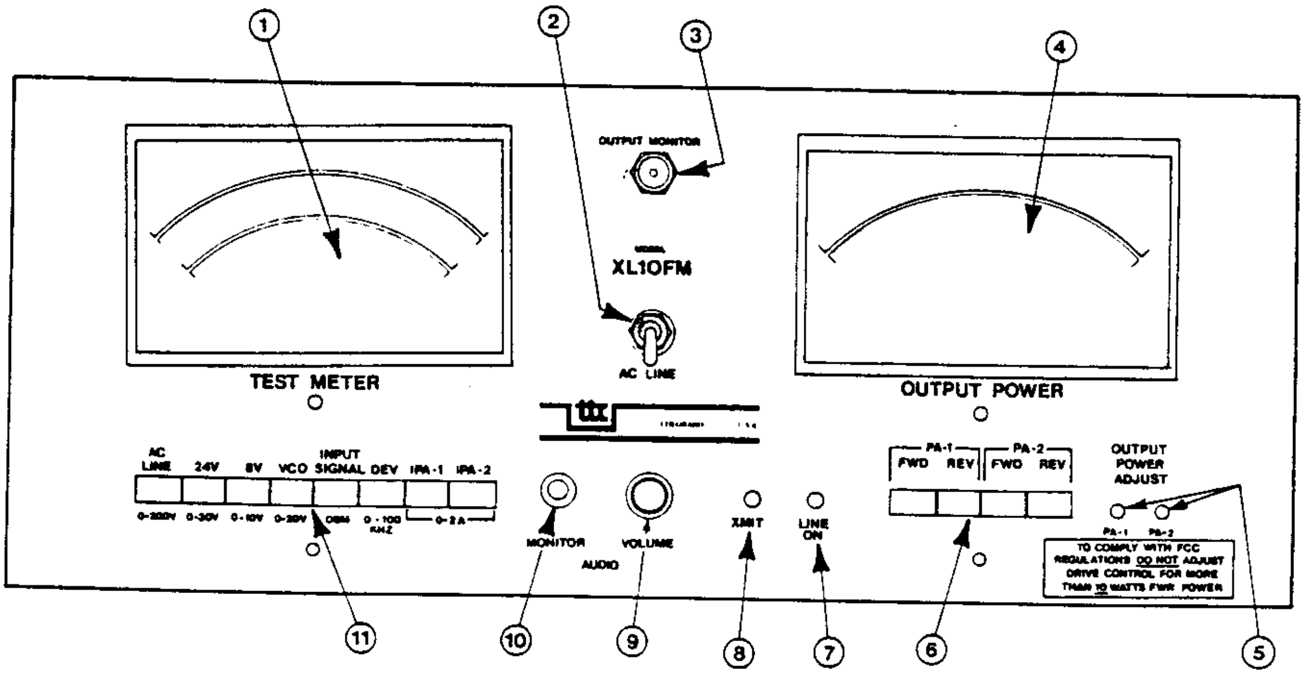
OPERATING INSTRUCTIONS

2.1: Controls, Switches, Indicators, Meter Positions

2.1.1: Front Panel. Refer to Figure 2.1.1 for the part location. Both the one and ten watt models have identical front panels with different silkscreen markings.

FIGURE 2.1.1

FRONT PANEL



1. MULTIMETER:

   This meter is used in indicating the various test voltages and current selected by S601.

2. AC LINE SWITCH:

   Main power switch of unit.

3. OUTPUT MONITOR:

   This 'F' connector is connected to a sample of the output when the unit is transmitting. The signal level is approximately 100mV.

4. POWER METER:

   The power meter has two scales. The 0 - 20 watts (0 - 2) scale measures the forward power and the 0 - 2 watts (0 - .2) scale is used for the reverse power.

5. OUTPUT POWER ADJUSTMENTS:

   These are screwdriver adjustments for setting the output power of both final amplifiers independently. When only one output amplifier is installed the PA-2 adjustment is not used.

6. S602 - OUTPUT POWER SWITCH:

   Switches the power meter. When only one amplifier is installed, the PA-2 position is inoperative.

7. LINE ON INDICATOR:

   This will light when the AC line switch is on.

8. XMIT INDICATOR:

   This will light if the translator is transmitting, i.e. adequate input signal is present to turn the unit on.

9. VOLUME:

This control adjusts the audio level present at the monitor jack.

10. MONITOR JACK:

This is a stereo headphone jack so the incoming signal may be monitored. Only stereo headphones, such as the KOSS PRO 4 AA should be plugged into this jack.

11. S601 - MULTIMETER TEST SWITCH:

The following positions are described:

AC LINE: Measures the incoming AC line voltage. The 0 - 20 scale is used normally, indicating 0 - 200 volts. When the 240 VAC option is used, the 0 - 30 scale, indicating 0 - 300 volts is used. The reading is average responding, and therefore may potentially be in error for nonsinesoidal input waveforms. The meter must read 100 to 135 VAC (200 to 270 VAC for 240 volt applications) for proper operation.

+24V: Measures the internal 24 volt supply voltage. Using the 0 - 30 volt scale, this will read 24 ±1 volt if the supply is functioning properly.

-8V: Measures the internal -8 volt supply. Using the 0 - 10 volt scale the meter should read 8 ±.5 volts.

VCO: This position measures the DC voltage across the varicap diode in the voltage controlled oscillator (VCO). The meter should read 11 ±1 volt using the 0 - 20 volt scale.

DEV: The input audio modulation is monitored by this position. The meter reads 0 - 100 kHz and should always be below 75 kHz. This position does not operate when the input signal is disconnected.

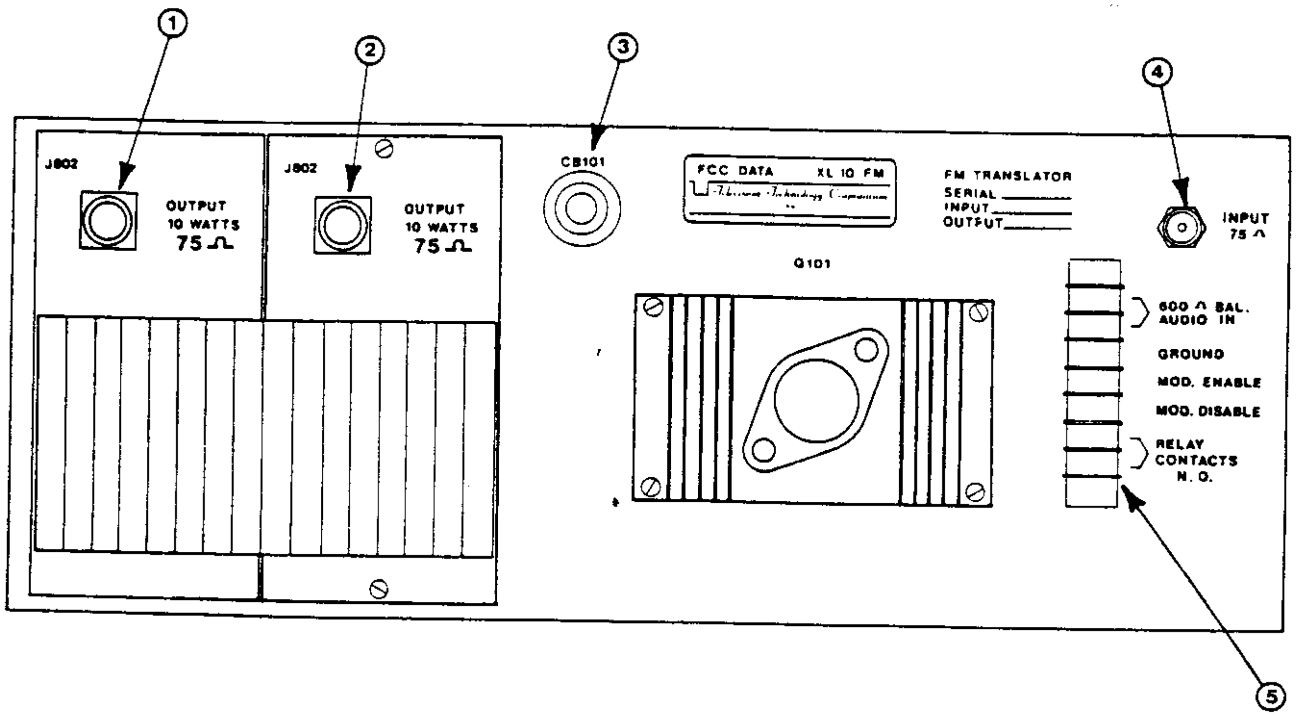
INPUT SIGNAL: The input signal level is displayed by this position. The meter uses the dB scale. 0dB is the turn-on threshold and is set at the factory 30uV. Therefore, -3dB on the meter corresponds to 20uV and +6dB is equal to 60uV. Remember these are correct only if thethreshold adjustment inside the translator has not been readjusted.

$I_{PA\ 1}$, $I_{PA\ 2}$: These two positions read the power amplifiers final current. For the XL10, the meter reads 0 - 2A and will normally be at 1 amp when transmitting the close to 0 or at standby. On the 1 watt models, the meter reads 0 - 200mA. It will normally be around 140mA when transmitting and near or standby. If the second amplifier is not installed, the $I_{PA\ 2}$ will read zero.

2.1.2: Back Panel. Refer to Figure 2.1.2 for part location.

FIGURE 2.1.2

BACK PANEL



1 & 2: OUTPUT CONNECTORS:

For the 10 watt models these are 75 ohm 'N', as shown. The 1 watt model has 75 ohm 'F' type connectors that are located near the bottom of each amplifier panel. When there is only one output model the outer panel is blank. 50 ohm 'N' and 50 ohm BNC are available for the 10 and 1 watt models respectively.

3: 2 AMP CIRCUIT BREAKER:

This is connected to the primary side of the power transformer.

4: INPUT CONNECTOR:

This is a 75 ohm 'F' type connector. 50 Ohm BNC is available.

5. TERMINAL STRIP FOR MODULATOR OPTION:

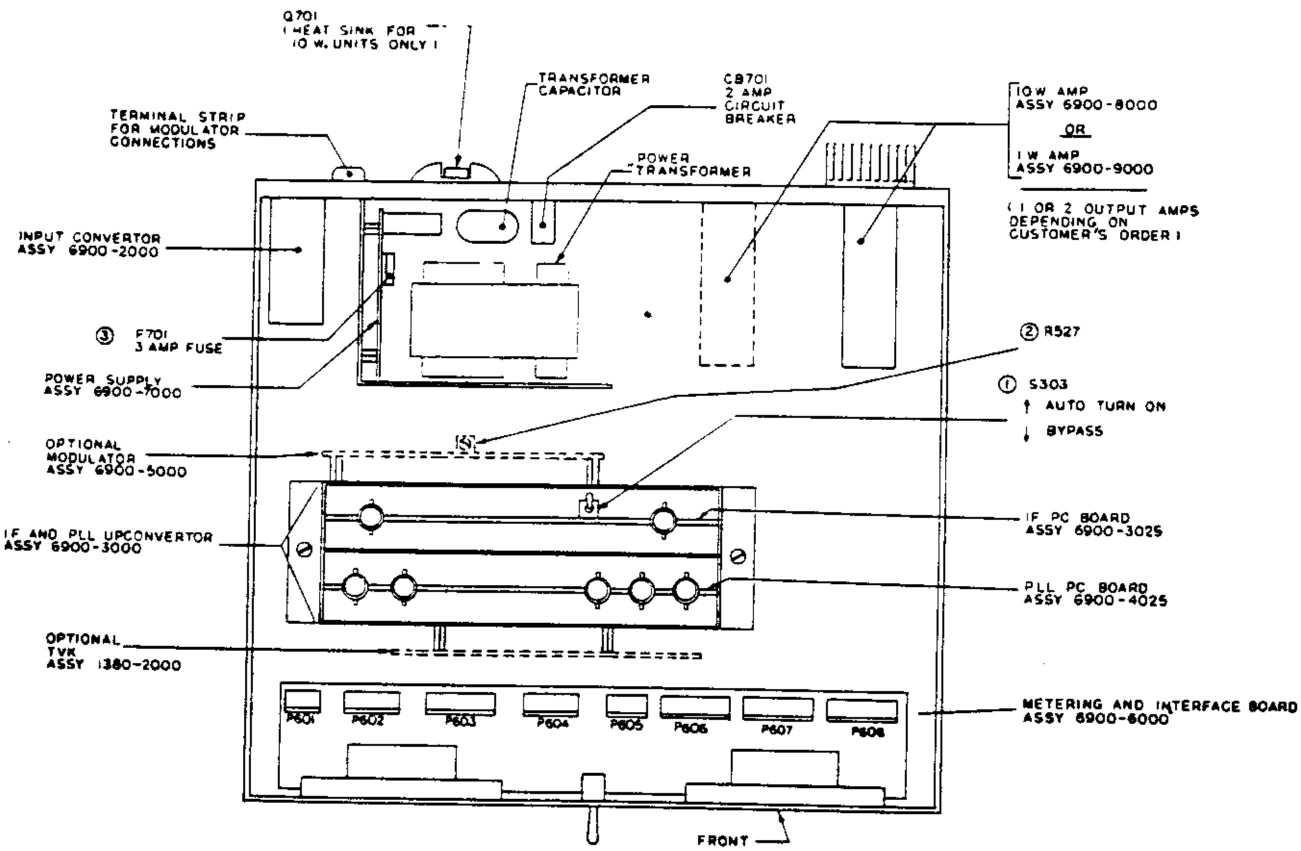
This terminal strip is used only on models with the modulator option. It has the following connections:

600 Ω BAL. AUDIO IN:	This accepts audio at a nominal 0 dBm level. It is internally terminated with 600 Ω.
GROUND:	Ground connection for the audio.
MOD. ENABLE:	Grounding this pin will switch the translator input to the modulator.
MOD. DISABLE:	Grounding this pin will switch the translator back to normal from the modulator input.
RELAY CONTACTS N.O.:	These are connected to internal relay. These contacts are contacts normally open and will close momentarily when the modulator is enabled.

2.1.3: Interior. Refer to Figure 3.1.3 for the part location.

FIGURE 2.1.3

INTERIOR



1. S303 BYPASS SWITCH:

   This switch bypasses the automatic turnon circuitry of the translator, leaving the output on regardless of the presence of input signal. This switch must be in the AUTO position (toward the back of the unit) for normal operation.

2. R527 MODULATION LEVEL:

   This control adjusts the audio input sensitivity for the optional modulator. It is factory set to give 75 kHz deviation with a 0 dBm audio input.

3. F701 3 AMP FUSE:

   This fuses the +24 volt power supply.

2.2: INSTALLATION

Temperature and Cooling Considerations

2.2.1: The translator is designed to withstand extreme environmental abuse. However, it is obvious a translator outside on top of a telephone pole in the middle of the desert will not last as long as one inside a temperature-controlled building in Denver, Colorado. Therefore, some care in selecting the location and type of shelter will prolong the life of the translator.

2.2.2: The translator will operate over -30° to +50°C. It is not recommended that these extremes be exceeded for any length of time or that they be approached continuously. The translator prefers the lower temperatures over the higher; operation at a continuous temperature of -10° is preferable to +40°C. What does shorten life however; is rapid, frequent temperature variations of over 30°C. These excursions, called thermal cycling, stress the internal bonding in semiconductors and is known to be a primary failure mechanism. A location subject to daily temperature variations of this magnitude should have some temperature control (i.e. airconditioning or heating).

2.2.3: There should be no obstructions to air flow around the heat sinks in the back of and through the unit. A minimum of 6 inches clearance between the back of the unit to any wall is recommended. The unit should never be put in any enclosure of any size which does not have several large ventilation holes. If rackmounted, no more than three (3) translators should be stacked without having a 6" spacer panel between them.

2.2.4: In locations where 40°C to 50°C ambient is common and airconditioning is not practical, a small fan blowing over the power amp's heat sink will be beneficial to the life of the unit.

2.2.5: The translator normally dissipates a lot of heat and the heat sinks in the back do tend to feel hot to the touch. There is a general rule of thumb for situations where you are not sure of proper ventilation. If you can hold the power amp heat sink for more than 5 seconds, then ventilation is adequate for the translator.

Line Power

2.2.6: The XL10FM consumes 75 watts for a dual 10W output and 50 watts for a single. The XL1FM consumes 20 watts for both dual and single outputs. Standby power is about 25 watts. Because of the ferroresonant power transformer, a wide variation in line voltage can be tolerated. The specified rating is 100 to 135 volts and the unit can withstand an occasional jump in voltage to 145 volts. The single output model may be able to operate properly at a line voltage much lower than 100 volts as it presents a lesser load to the transformer.

2.2.7: It is not recommended to run this unit off of an A.C. generator unless it has some sort of frequency regulation. The ferroresonant transformer's output varies with frequency. The generator may have a frequency far enough away from 60 Hz to reduce the output of the ferroresonant transformer to disrupt the regulated voltages.

Input Signal

2.2.8: The recommended signal strength for the translator is 50uV to 2000uV at 75 ohms. The translator's turn on threshold is factory set to 30uV. The turn-off threshold is 3dB below the turnon threshold or around 20uV. At operations below 75uV input, a mast mounted preamp is recommended since this is the level at which every decibel of line loss adds one decibel of stereo noise. Operation below 30uV input is possible by adjusting the threshold control inside the unit according to Section 2.3. However, a preamp is mandatory at this level to get the best signal to noise ratio. Use of a preamp will raise the input signal at the translator to higher than 30uV, making the threshold adjustment unnecessary.

2.2.9: The maximum signal allowed at the input is limited only by the non-linear limiting of the I.F. amplifier stages within the unit. This occurs at an input signal level of about 75,000uV -- far above levels normally encountered. However, it is not recommended to feed the translator with more than 10000uV.

This is because the translator could be triggered on by unusually strong nearby stations when the desired station goes off-the-air. One way to prevent this is to raise the translator's threshold adjustment; or attenuate the input signal until it is under 10000uV.

2.2.10: In booster applications it is mandatory that there is enough isolation between the receiving and transmitting antennas so that the transmitted signal is at least 15dB below the station's signal at the receiving antenna. The threshold of the translator must be set at 10dB below the below the input signal or the translator will oscillate when the station goes off-the-air. See Section 2.4 for more detailed setup instructions for booster applications.

2.2.11: Though the translator is unusually resistant to undesired signals, some guidelines should be followed. Table 2.1 gives the maximum recommended undesired signal levels to the translator:

Frequency Relative to a minimum 50µV Desired Signal:	Maximum signal level and/or (maximum relative strength to desired signal) whichever is less.
F_c ± 200kHz (Standard)	30uV (-40dB) w/o threshold adj. 1000uV (-40dB) w threshold adj.
F_c ± 200kHz (High Selectivity Option)	3000uV (+40dB) w/o threshold adj. 10,000uV (+40dB) w/threshold adj.
F_c ± 400kHz	25,000uV (+50dB)
F_c ± 400kHz (High Selectivity Option)	25,000uV (+60dB)
F_c ± 600kHz (Both Options)	25,000uV (+60dB)
Any Other FM Signal	30,000uV (+60dB)

TABLE 2.1

MAXIMUM RECOMMENDED UNDESIRED SIGNAL STRENGTH AT TRANSLATOR INPUT

2.2.12: The table gives the maximum signal strength both in absolute level and in relative level to the desired signal in decibels, whichever is less. It is important to scan the FM band with a field-strength meter to make sure these levels are not exceeded. These levels given are calculated to be 6dB below the maximum the translator is capable of accepting. Note that higher levels are sometimes given if the threshold of the translator is raised to 20dB below the desired signal level. One important undesired signal usually overlooked is the transmitted output of the translator itself. It also should be under the levels given in Table 2.1. If not, the receiving antenna should be moved to get more isolation.

Output

2.2.13: The output connector(s) on the 10W model is a 75 ohm 'N' type female jack. * It will accept only a 75 'N' type plug. NEVER USE A 50 OHM CONNECTOR as it will spread and ruin the pin inside the output connector. The 75 ohm 'N' type connector is the best in terms of VSWR, insertion loss, and in ruggedness. It is recommended to use this connector in all the antenna lines to preserve the highest level of performance throughout. 'F' type connectors are almost as good as the 'N' type and since they cost a lot less are a good compromise in budget installations. 'UHF' type connectors are strongly discouraged since their VSWR performance are lacking at this frequency. Remember 'UHF' connectors were developed in the days when 30 MHz was considered 'UHF'. The (1) watt unit uses 'F' type connectors.

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* A 50 ohm output impedance using 50 ohm 'N' type connectors is available on special order.

2.2.14: The power amplifier is designed to withstand an infinite SWR and to put out the full rated power into a SWR as high as 2.1. Most antennas used for transmitting have better than a 12dB return loss, so the worst reflected power to the translator would be under 10% forward power. A check of the reverse power position on the translator when transmitting should confirm this.

2.2.15: The power output of the translator is factory set to 10W (1W) and should not need to be reset. If a power change is desired, the power control on the front panel can be adjusted with a screw driver. The translator is designed to automatically turn down when the reverse power exceeds 2W (.2W for 1W units). If low forward power is observed one should check the reverse power to make sure it is below 2 (.2) watts.

2.3: INITIAL OPERATING PROCEDURE

2.3.1: The following procedure is given for the initial turn on. It is provided so that persons unfamiliar with the unit or even translators in general will be able to install the translator without difficulty. However, it is also important that you read Sections 2.1 and 2.2 if you are not familiar with the unit before following this procedure. If this translator has the internal modulator option, follow this procedure first and then refer to Section 2.4 to set-up the modulator. The booster model has its own initial procedure in Section 2.5. Read this entire procedure over before starting.

2.3.2: Make sure all guidelines in Section 2.2 are followed. Turn the power switch on the front panel OFF. Push the AC LINE button on the multimeter switch. Do NOT connect any input or output cables to the unit.

2.3.3: Plug in the power cord to the AC line. The multimeter should indicate between 100 to 135 VAC. (This is read on the 0 - 200V scale). If the meter reads outside this range, do not proceed farther as the line voltage is outside the range this unit can operate. If the meter reads '0' make sure the AC LINE putton is pushed or the circuit breaker on the back panel is reset.

2.3.4: Push the +24V button on the multimeter. Again make sure no cable is connected to the input. Turn on the power switch. The AC power light should light and the multimeter should read 24 ± 1 volts (0-30 volt scale). The transmit light should stay off.

2.3.5: Press the following buttons on the multimeter and observe the readings.

1. -8V: Meter should read 8 ±.5 volts (0 - 10 volt scale).
2. VCO VTG: 11 ±1 volt (0 - 20 volt scale).
3. INPUT SIGNAL: May read slightly upscale but should be way less than -3dB. NOTE: In the field situations where the input field strength is unusually high (> 10mV/meter) the input signal meter may read as high as -3dB and may fluctuate considerably. This is caused by direct radiation into the cabinet.
4. DEV: Will read anywhere from 0 to full scale as this position is inoperative without an input signal.
5. I_{PA-1}: XL1FM: Under 12mA (0-20mA Scale)
   XL10FM: Under .05A (0-2A Scale)
6. I_{PA-2}: XL1FM: Under 12mA (0-200mA Scale)
   XL10FM: Under .05A (0-2A Scale)

2.3.6: Press the four power meter buttons and observe the power meter indicating zero for all positions.

2.3.7: The unit is now ready to accept an input signal. Connect the transmitting antenna to the output of the unit. (Connect both antennas to both outputs on models with two power amplifiers). Push the INPUT SIGNAL button on the multimeter and the FWD POWER No. 1 button on the power meter.

2.3.8: Connect the receiving antenna to the input. Observe the following:

1. The multimeter will swing upscale above 0dB. If it doesn't your input signal is less than 30uV and a preamp is strongly recommended. If a preamp is not used the threshold level must be adjusted according to Section 2.3.12 before proceeding.
2. The transmit light will turn on after a delay of about 5 seconds. The light will not turn on if the input signal indication is less than 0dB.
3. The power meter will read 10 watts ± 1 W (1W ± .1W on the XL1FM). If the power meter reads substantially less than that, push the NO. 1 REV PWR button. The reverse power will probably read more than 1 (.1) watt, indicating your transmitting antenna system is defective. This must be

mended before proceeding. Remember, this unit will not operate into a coat hanger, folded twin lead, or any other makeshift antenna! You must have a commercially made and properly installed transmitting antenna especially designed for the FM band.

4. The NO. 2 FWD PWR should read 10W ±1W (1 ±.1W on the XL1FM) when that button is pressed. If the second amplifier is not installed, then this position should read 0.

2.3.9: Push NO. 1 REV PWR. It should read less than 1W (.1). If the meter indicated more than .5 (.05) watts reverse power then a thorough check of the transmitting antenna and feed line is recommended. The use of UHF type connectors will seriously degrade the VSWR of the antenna system and should be avoided.

2.3.10: Repeat 2.3.9 for the amplifier number two if it is installed.

2.3.11: Push the NO. 1 FWD PWR button. With a small screwdriver or tuning tool, adjust the No forward power control unitl the power meter reads 10 ±.25 (1 ±.025) watts. Repeat this for the other amplifier if it is installed.

Translator Threshold Adjustment

2.3.12: The following should only be done if the information in Section 2.2 or 2.3.8 warrants it.

2.3.13: Remove the four screws holding the translator cover and lift the cover off the chassis. Locate the IF amplifier P.C. Board (see Figure 4). Pull the board out, using the P.C. card pullers, and locate R349 (see Figure 2.3.1). With the Input Signal button depressed and the input antenna connected, adjust R349 until the multimeter reads between 10dB and 20dB.

2.3.14: Push the IF board back in and replace the translator cover.

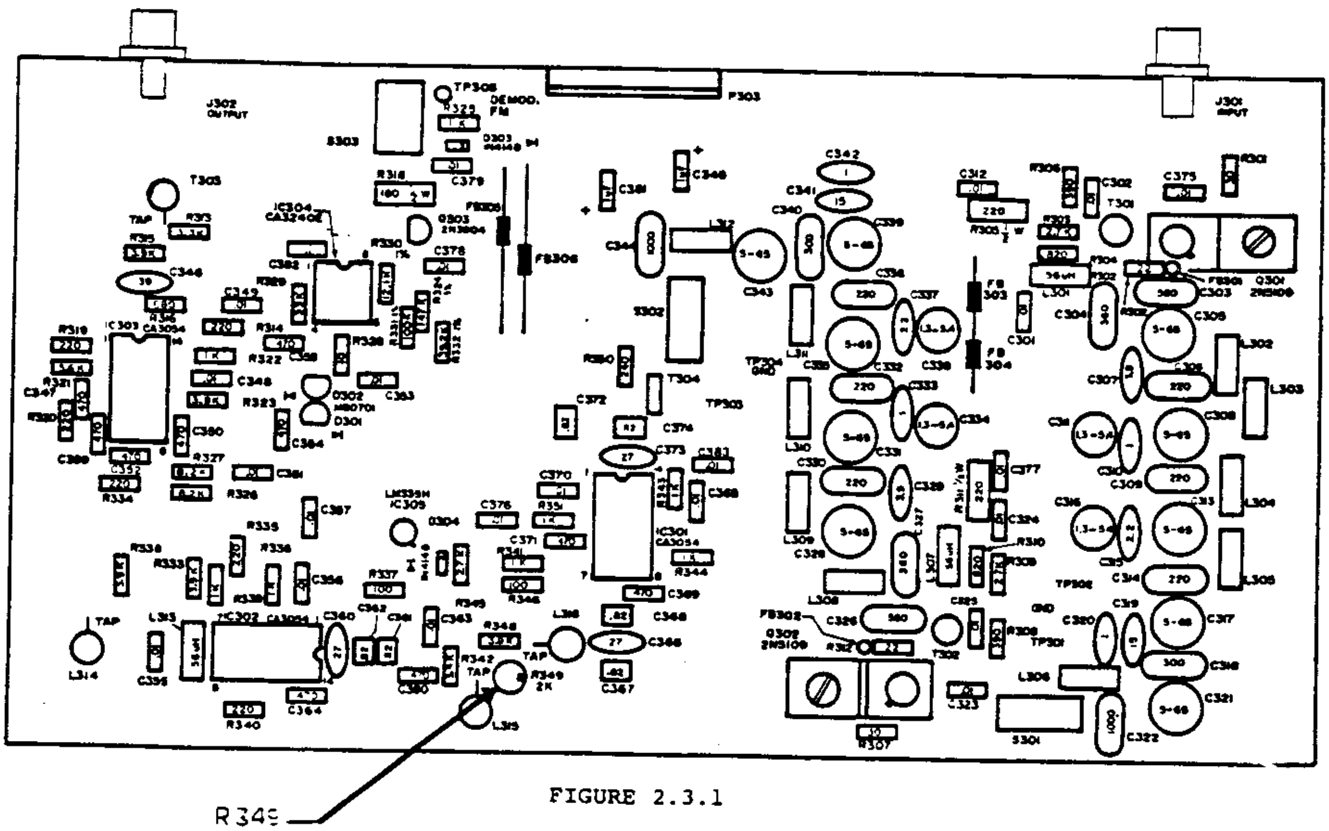


FIGURE 2.3.1

I.F. AMPLIFIER BOARD

2.4: MODULATOR SET UP PROCEDURE

2.4.1: This procedure is to be used when setting the translator up for local origination. The procedure applies only to modulator equipped translators. Before proceeding, follow the initial operating procedure in Section 2.3 to ensure the translator is operating properly.

FCC Rules and Regulations

2.4.2: Part 74.123(f) and (g) of the FCC Rules and Regulations allows the use of a locally generated FM signal to be applied to a translator for the purpose of generating voice announcements. Such transmissions shall not exceed 30 seconds at intervals of no less than one hour. The aural information that is transmitted is limited to seeking or acknowledging financial support for the operating of the translator. The acknowledgements may include identification of the contributors, the size or nature of the contributors, and advertising messages of the contributors.

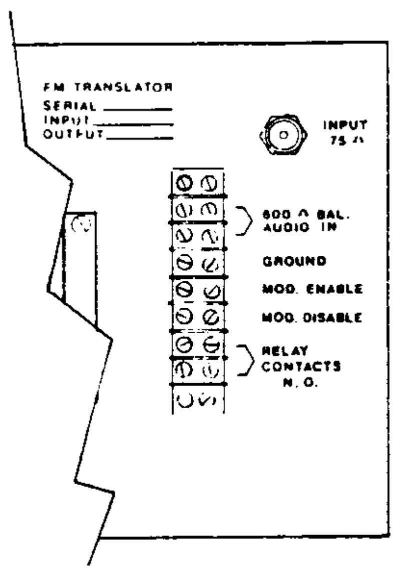
2.4.3: The FCC requires the connection of the locally generated signal be controlled by a time switch which will automatically limit the transmission no more than 30 seconds. Such a switch is incorporated within this modulator and should not be overridden.

Activation of the Modulator

2.4.4: The modulator may be activated by three methods: manually, automatically, and tone activation. To manually activate the modulator, briefly ground the MOD ENABLE terminal of the terminal block in the back of the unit. (Refer to Figure 2.4.1.) The modulator will activate immediately and will stay on until either it is deactivated or 30 seconds has elapsed. Leaving the MOD ENABLE terminal grounded will not cause the modulator to remain on.

FIGURE 2.4.1

TERMINAL BLOCK

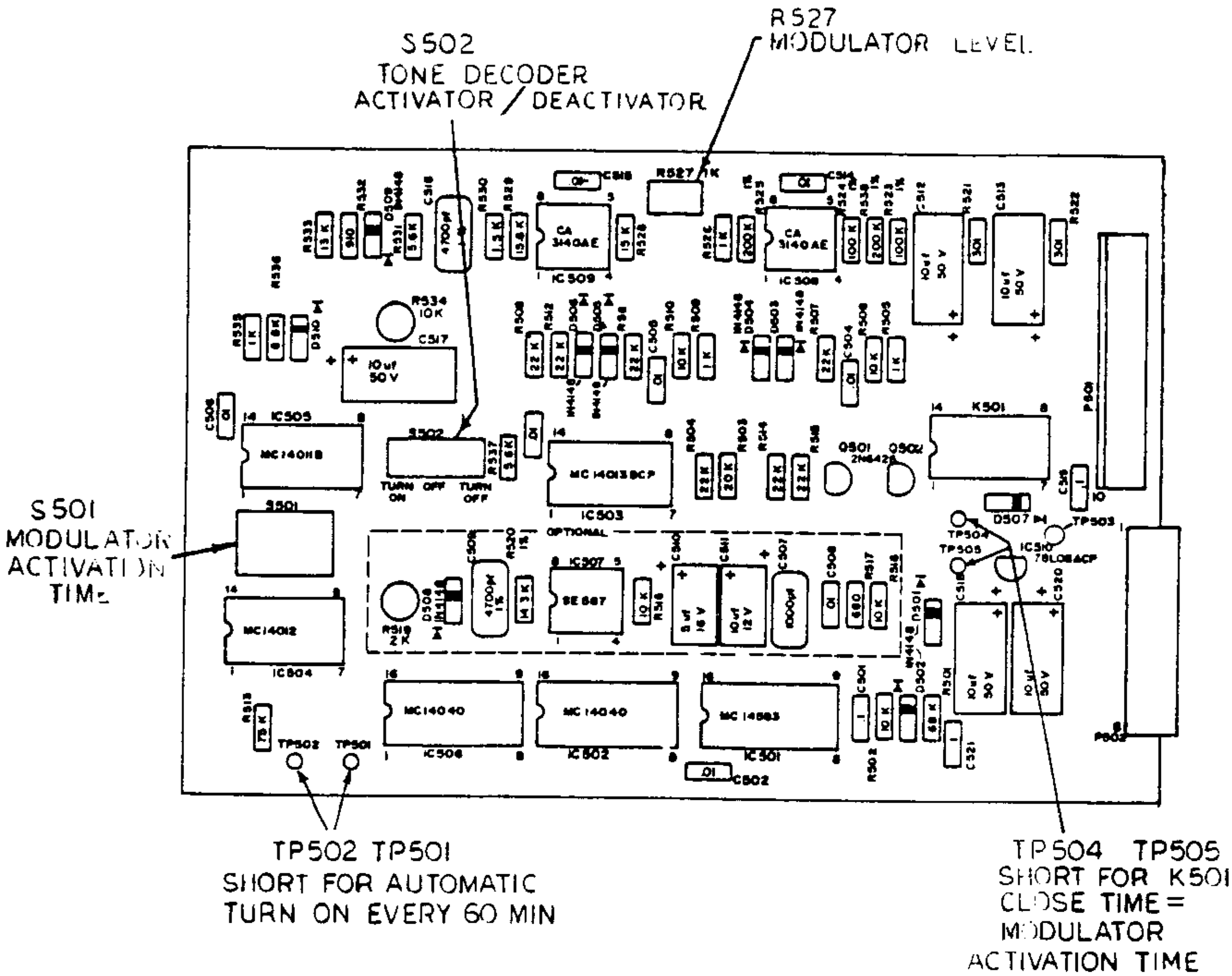


2.4.5: The modulator may also be activated automatically once every hour by an internal timer. This timer and the 30 second timer utilize the line frequency as their reference. Therefore, you should ensure the line frequency is stable to within ± one Hertz when using the modulator. This requirement is fulfilled when the line voltage is supplied by a public utility. The 60 minute interval timer is activated by connecting a jumper across TP502 and TP501 on the modulator board. (Refer to Figure 2.4.2.) The modulator may still be manually activated when the 60 minute timer is wired. Whenever the modulator is manually activated, the 60 minute timer is reset. If the cycle time switch is set for 60 seconds on time, the 60 minute timer becomes a 120 minute timer.

2.4.6: A tone decoder is included in the modulator board so the modulator may be activated by the originating station. The tone decoder is set at the factory for 15 kHz. For activation, a 15 kHz ±100Hz tone at 25% or more modulation should be transmitted for a minimum of .5 seconds. For other activation frequencies, contact Television Technology Corporation. The tone decoder may be wired in by switching S502 on the modulator board to the TURN ON position.

FIGURE 2.4.2

MODULATOR BOARD



Modulator Deactivation

2.4.7: Once on, the modulator can be turned off before the allowed 30 seconds by grounding the MOD DISABLE terminal on TB901 in the back of the unit. No matter how the modulator is deactivated, the 60/120 minute timer will reset if it is connected. Leaving the MOD DISABLE terminal grounded will not prevent the modulator from being activated manually, automatically, or by the tone decoder.

2.4.8: The tone decoder may be used to turn off the modulator. The input to the tone decoder monitors the modulating signal being transmitted, whether it is the originating station or locally generated. Therefore, a .5 second 15 kHz ±100 Hz tone at 25% modulation level (20 kHz deviation) on your locally generated source will trigger the tone decoder, S502 should be in the TURN ON position to enable the tone decoder to shut off the modulator. Note the tone decoder cannot simultaneously be used to both activate and deactivate the modulator.

Triggering an External Source by the Modulator

2.4.9: A set of relay contacts is brought out to TB901 at the back of the translator from the modulator board. These contacts are normally open and will close for approximately one second whenever the modulator is activated. If you want the contacts to remain closed during the full interval of the modulator is activated, connect a jumper across TP504 and TP505 on the modulator board. The relay contacts are rated at 24 volts up to .1 amp. A normally closed relay can by supplied by Television Technology Corporation if it is needed.

Audio Requirements

2.4.10: The modulator is monophonic and cannot generate or accept sterophonic material. The frequency response is reasonably flat out to 15 kHz so the resultant FM signal is of good fidelity. If a composite baseband signal is the only source available, Television Technology Corporation can modify the modulator's frequency response to accept this. However, the signal to noise ratio is degrated significantly compared to a monophonic signal.

2.4.11: The modulator accepts balanced audio at 600 ohm impedance. The audio is applied at TB901 and is terminated internally to 600 ohms. If an unbalanced audio source is only available, it may be connected to one side of the input and ground. Note the input impedance of this connection is halved to 300 ohms and the required audio level is doubled.

2.4.12: The modulator is factory set so that a +5dBm audio level will produce 100% (±75 kHz deviation) modulation. It is recommended you adjust your program source to this level. However you may adjust R527 on the modulator board to obtain a ±6dB change from the factory set level.

2.4.13: When setting levels, monitor the DEV position on the front panel meter. In this position the meter reads deviation of 0 - 100 kHz. 100% modulation corresponds to 75 kHz deviation and you should not allow the meter to read higher than this. The modulator board contains a limiter circuit to clip anything above 100% modulation. The limiter will generate distortion if it is activated.

SECTION 3

THEORY OF OPERATION

3.1: GENERAL

3.1.1: Figure 3.1.1 is a block diagram of the XL1FM and the XL10FM translator. One should also make reference to Figures 2.1.1, 2.1.2, and 2.1.3 for the location of the controls and modules. A general overview will be given followed by a detailed description of each module or P.C. board.

3.1.2: The signal at the input enters the input converter module (6900-2000) where it is amplified and mixed down to a 10.7 MHz I.F. Both the amplifier and the mixer employ junction FETs to maximize dynamic range. The local oscillator is a crystal oscillator followed by a buffer amplifier. The input converter module has an overall gain of about 20dB.

3.1.3: From the input converter, the 10.7 MHz signal is fed to the I.F. amplifier board (6900-3025) via a 50 ohm cable. Here it is first amplified and then goes thru two 5 pole Bessel Filters, separated from each other by an isolation amplifier. After the filters the signal enters another amplifier, configured to act also as a limiter at higher signal levels. The output of this amplifier is tapped off and fed to a detector, which rectifies the signal for the front panel signal strength meter. The output of this detector also is fed to a comparator that sends a shutdown signal to the output converter when the incoming station goes off-the-air.

3.1.4: Finally the signal at the output of the amplifier/limiter goes thru several cascaded hard limiters to remove any amplitude modulation before being sent to the output converter. The signal level at the output of these limiters is approximately 1mW.

3.1.5: From the output of the I.F. Board, the 10.7 MHz signal enters the upconverter board. Here it is upconverted to the output frequency by a phase-locked loop (PLL). The 10.7 MHz signal from the I.F. board is fed to one input of a phase comparator. The other input of the phase comparator is a sample of a voltage controlled oscillator running at the output frequency. This sample is first mixed down to 10.7 MHz by a double balanced mixer and local oscillator. The output of the phase comparator is a D.C. voltage which is related to the difference (error) in phase of the two 10.7 MHz inputs.

3.1.6: This D.C. voltage is fed to the input of the VCO and will cause the VCO to "lock" on to the phase changes of the 10.7 MHz input. This feedback system makes sure the output has exactly the same FM modulation as the input. As a result, the D.C. control voltage at the output of the phase comparator contains a superimposed A.C. signal that is the demodulated F.M. This A.C. signal is amplified and sent up to the metering board.

3.1.7: The output of the VCO enters a gain controlled amplifier. The gain control input of this amplifier is connected to the comparator on the I.F. board that produces the shutdown signal. The control input of this amplifier is also A.C. coupled to the 400Hz output of the optional international identifier board (TVK, 1380-2000). This amplitude modulates the output when the I.D. is activated.

3.1.8: The output of the gain controlled amplifier is amplified up to 100mW and into two 50 ohm outputs. Each of these outputs is fed to their respective power amplifier module (6900-8000 or 6900-9000). A monitoring tap is taken off here and is sent up to the front panel.

3.1.9: Each power amplifier has its own AGC loop which monitors the output power and keeps it constant. The AGC loop uses a directional coupler at the output and a pin diode on the input. The directional coupler also provides forward and reverse power metering.

3.1.10: The power supply is conventional and supplies both +24V and -8V to the circuitry. A ferroresonant transformer is used to maximize the ruggedness of the supply while allowing the translator to operate over a very wide range of line voltages.

3.1.11: The metering board (6900-6025) contains all the metering functions in addition to the stereo demodulator and headphone amplifier.

3.1.12: The following sections of this chapter deal with each subassembly in detail.

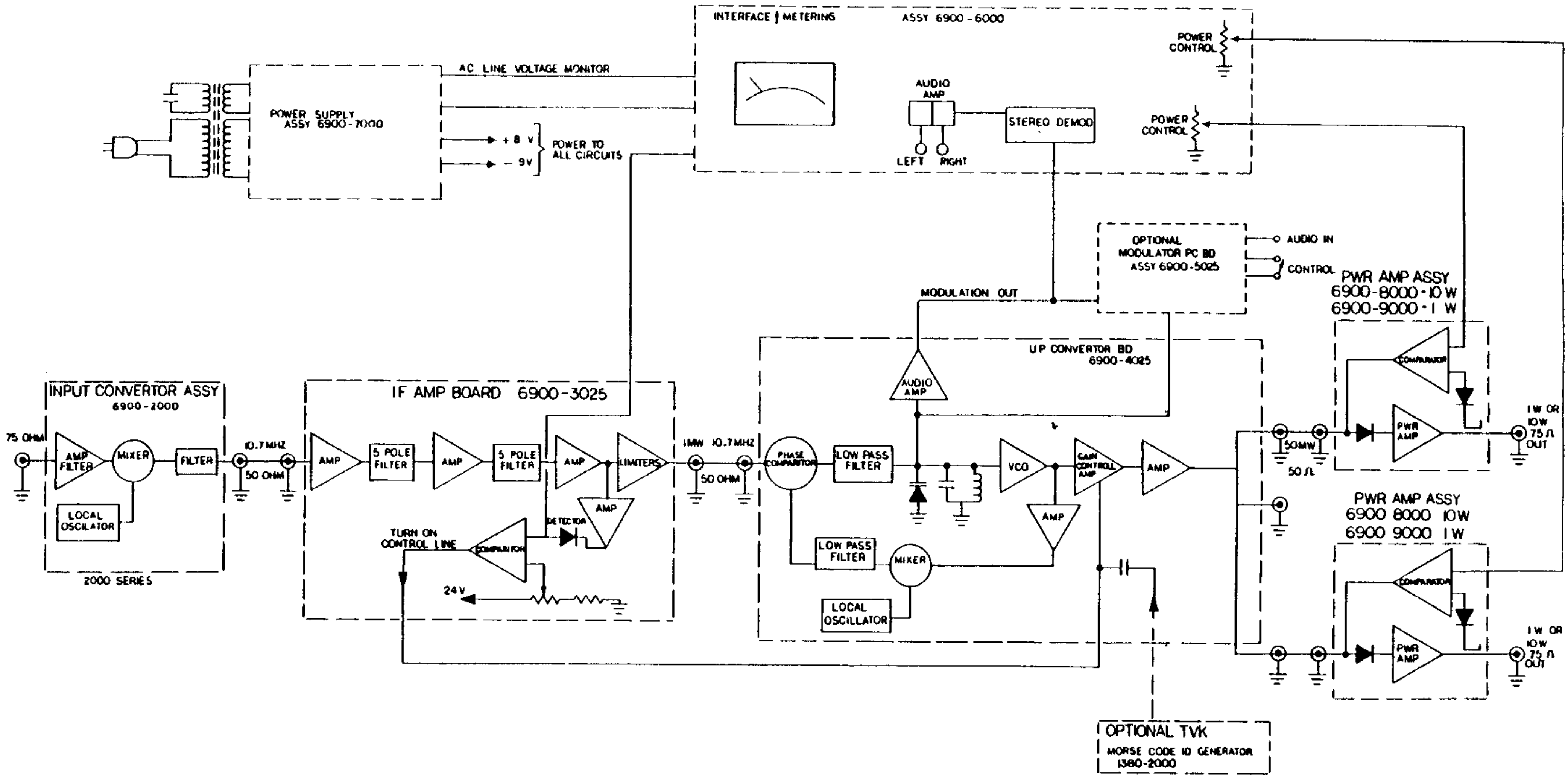


FIGURE 3.1.1

BLOCK DIAGRAM OF XL1FM, XL10FM

Crystal and Injection Frequencies Required
To Convert FM Channels To Or From 10.7 MHZ

FM CHANNELS		INJECTION BELOW FM BAND		INJECTION ABOVE FM BAND	
Channel No.	Frequency	Crystal Frequency	Injection Frequency	Crystal Frequency	Injection Frequency
201	88.1	38.7	77.4	49.4	98.8
202	88.3	38.8	77.6	49.5	99.0
203	88.5	38.9	77.8	49.6	99.2
204	88.7	39.0	78.0	49.7	99.4
205	88.9	39.1	78.2	49.8	99.6
206	89.1	39.2	78.4	49.9	99.8
207	89.3	39.3	78.6	50.0	100.0
208	89.5	39.4	78.8	50.1	100.2
209	89.7	39.5	79.0	50.2	100.4
210	89.9	39.6	79.2	50.3	100.6
211	90.1	39.7	79.4	50.4	100.8
212	90.3	39.8	79.6	50.5	101.0
213	90.5	39.9	79.8	50.6	101.2
214	90.7	40.0	80.0	50.7	101.4
215	90.9	40.1	80.2	50.8	101.6
216	91.1	40.2	80.4	50.9	101.8
217	91.3	40.3	80.6	51.0	102.0
218	91.5	40.4	80.8	51.1	102.2
219	91.7	40.5	81.0	51.2	102.4
220	91.9	40.6	81.2	51.3	102.6
221	92.1	40.7	81.4	51.4	102.8
222	92.3	40.8	81.6	51.5	103.0
223	92.5	40.9	81.8	51.6	103.2
224	92.7	41.0	82.0	51.7	103.4
225	92.9	41.1	82.2	51.8	103.6
226	93.1	41.2	82.4	51.9	103.8
227	93.3	41.3	82.6	52.0	104.0
228	93.5	41.4	82.8	52.1	104.2
229	93.7	41.5	83.0	52.2	104.4
230	93.9	41.6	83.2	52.3	104.6
231	94.1	41.7	83.4	52.4	104.8
232	94.3	41.8	83.6	52.5	105.0
233	94.5	41.9	83.8	52.6	105.2
234	94.7	42.0	84.0	52.7	105.4
235	94.9	42.1	84.2	52.8	105.6
236	95.1	42.2	84.4	52.9	105.8
237	95.3	42.3	84.6	53.0	106.0
238	95.5	42.4	84.8	53.1	106.2
239	95.7	42.5	85.0	53.2	106.4
240	95.9	42.6	85.2	53.3	106.6
241	96.1	42.7	85.4	53.4	106.8
242	96.3	42.8	85.6	53.5	107.0
243	96.5	42.9	85.8	53.6	107.2
244	96.7	43.0	86.0	53.7	107.4
245	96.9	43.1	86.2	53.8	107.6
246	97.1	43.2	86.4	53.9	107.8
247	97.3	43.3	86.6	54.0	108.0
248	97.5	43.4	86.8	54.1	108.2
249	97.7	43.5	87.0	54.2	108.4
250	97.9	43.6	87.2	54.3	108.6

CONVERSION CHART(Continued)

Crystal and Injection Frequencies Required
To Convert FM Channels To Or From 10.7 MHZ

FM CHANNELS		INJECTION BELOW FM BAND		INJECTION ABOVE FM BAND	
Channel No.	Frequency	Crystal Frequency	Injection Frequency	Crystal Frequency	Injection Frequency
251	98.1	43.7	87.4	54.4	108.8
252	98.3	43.8	87.6	54.5	109.0
253	98.5	43.9	87.8	54.6	109.2
254	98.7	44.0	88.0	54.7	109.4
255	98.9	44.1	88.2	54.8	109.6
256	99.1	44.2	88.4	54.9	109.8
257	99.3	44.3	88.6	55.0	110.0
258	99.5	44.4	88.8	55.1	110.2
259	99.7	44.5	89.0	55.2	110.4
260	99.9	44.6	89.2	55.3	110.6
261	100.1	44.7	89.4	55.4	110.8
262	100.3	44.8	89.6	55.5	111.0
263	100.5	44.9	89.8	55.6	111.2
264	100.7	45.0	90.0	55.7	111.4
265	100.9	45.1	90.2	55.8	111.6
266	101.1	45.2	90.4	55.9	111.8
267	101.3	45.3	90.6	56.0	112.0
268	101.5	45.4	90.8	56.1	112.2
269	101.7	45.5	91.0	56.2	112.4
270	101.9	45.6	91.2	56.3	112.6
271	102.1	45.7	91.4	56.4	112.8
272	102.3	45.8	91.6	56.5	113.0
273	102.5	45.9	91.8	56.6	113.2
274	102.7	46.0	92.0	56.7	113.4
275	102.9	46.1	92.2	56.8	113.6
276	103.1	46.2	92.4	56.9	113.8
277	103.3	46.3	92.6	57.0	114.0
278	103.5	46.4	92.8	57.1	114.2
279	103.7	46.5	93.0	57.2	114.4
280	103.9	46.6	93.2	57.3	114.6
281	104.1	46.7	93.4	57.4	114.8
282	104.3	46.8	93.6	57.5	115.0
283	104.5	46.9	93.8	57.6	115.2
284	104.7	47.0	94.0	57.7	115.4
285	104.9	47.1	94.2	57.8	115.6
286	105.1	47.2	94.4	57.9	115.8
287	105.3	47.3	94.6	58.0	116.0
288	105.5	47.4	94.8	58.1	116.2
289	105.7	47.5	95.0	58.2	116.4
290	105.9	47.6	95.2	58.3	116.6
291	106.1	47.7	95.4	58.4	116.8
292	106.3	47.8	95.6	58.5	117.0
293	106.5	47.9	95.8	58.6	117.2
294	106.7	48.0	96.0	58.7	117.4
295	106.9	48.1	96.2	58.8	117.6
296	107.1	48.2	96.4	58.9	117.8
297	107.3	48.3	96.6	59.0	118.0
298	107.5	48.4	96.8	59.1	118.2
299	107.7	48.5	97.0	59.2	118.4
300	107.9	48.6	97.2	59.3	118.6

3.3: Input Converter (6900-2000)

3.3.1: The input converter amplifies the input signal and mixes it down to a 10.7 MHz IF. It consists of a FET cascode amplifier followed by a FET balanced mixer. A crystal oscillator is also included within the unit. Refer to the Schematic 6900-2035. The input converter has an overall gain of 20dB nominal.

3.3.2: The input signal from the antenna or mast mounted preamp comes in at J201. This jack is either at DC ground or at 24 VDC, depending on whether L201 or L203 is used. Normally (when a preamp is not cable powered from this unit), L201 is used, and J201 is at DC ground. This prevents any static buildup on the antenna. However, when a preamp is being cable powered, L203 connects the input to the 24 volt supply and L201 is not used.

3.3.3: The input signal is matched to the input of Q201 by a two pole matching network. The network consists of C201, C202, C205, L202, and L204 and is designed to provide equal attenuation above and below the FM band. L205 provides neutralization for Q201. Q201 and Q202 form a cascade amplifier. T201 provides feedback from the source of Q201 to its gate. The transformer feedback allows the device to be both noise and powere matched. This means the amplifier is matched for optimum noise figure while still having a very good input VSWR. Q201's bias current is set by R204.

3.3.4: The output of Q201 is fed directly into Q202 through C208. The topology of this circuit i.e. a common source amplifier feeding a common gate stage directly, is called a cascode amplifier. This type of amplifier provides a very high level of isolation between input and output. The isolation in this particular amplifier is further enhanced by neutralizing Q201.

3.3.5: Bias for Q202 is set by R205. At the output of Q202 the signal enters a highly selective two pole filter. L207, C214, and C213 form one resonator and L209 with C210 and C211 form the other. Coupling is controlled by C212 and the loaded 'Q' or selectivity is controlled by L208. C216, C217, and L210 are an optional trap set at the image frequency for situations where there is strong interference at this frequency.

3.3.6: At the output of the filter, the signal is at a 75 ohm impedance and goes through a three selector switch. With the switch in the center position, the signal is connected directly to the mixer stage. When the switch is set to the left position, the output of the amplifier is connected to J204 to facilitate alignment of the input stage. Setting the switch to the right side connects the input of the mixer stage to J204, allowing alignment of that stage.

3.3.7: The mixer consists of a matched pair of FETs, Q205 and Q206, and is of the singly balanced type. The LO is fed in-phase at the gates, and the input is fed 180° out-of-phase at the source. The IF output developing at the drains is also 180° out-of-phase. This type of mixer is used to maximize the dynamic range of the input section.

3.3.8: T202 splits the signal coming from the preceding stage into two signals, 180° out-of-phase. These two signals are fed to the source of Q205 and Q206. The center top of T202 is at RF ground and is connected to ground by R206. R206 is a variable resistor that sets the bias current through Q205 and Q206. L211 is connected across the two sources of Q205 and Q206. This inductor resonates with C218 and C219 at the input signal's frequency. Note that C218 and C219 appear in series at the input frequency, yet appear in parallel to the local oscillator's signal which is in-phase at the gates of Q205 and Q206. Therefore, C218 and C219 provide a relatively low impedance to ground for the local oscillator current at the source while at the same time not bypassing the input signal since they are resonated with L211.

3.3.9: The IF signal appearing at the drain of Q205 and Q206 enters a two pole filter consisting of L212 and T203, and the capacitors around them. T203 also matches the balanced signal to the unbalanced output. The coupling of this filter is controlled by C222 and C225 and is set to be slightly over coupled. The 3dB bandwidth of the filter is about 400 kHz. C221 and C227 resonate with L212 at the IF frequency. They also provide a low impedance to ground for both the input and the LO signal current. The center top of L212 is at RF ground and connects the drains of Q205 and Q206 to the B+ supply through R207.

3.3.10: The gates of Q205 and Q206 are tied together and are at virtual ground at both the input and IF frequency. The gate capacitance of these two devices are resonated with L213 at the LO frequency. The LO voltage present at the gates, nominally 1 to 3 volts, is detected by D201 and fed to the external test point for monitoring. This detected voltage is compared to the DC voltage at TP-1 when the unit is aligned. A sample of the LO voltage is also taken at this point by R209 and R210 and is connected to the LO monitor jack (J203).

3.3.11: The LO is developed directly from a crystal oscillator operating at 10.7 MHz above the input frequency. No frequency multiplication is used as it allows the generation of potentially troublesome spurious products. The oscillator consists of Q203 in a Colpitts configuration, with the crystal, X201, operating at its series resonant point. L215 is used to resonate out the inter-plate capacitance of the crystal. The ferrite bead on the base of Q203 prevents spurious oscillation at UHF. Otherwise the base is bypassed to ground by C237. The collector of Q203 is resonated by L216 and the series combination of C234 and L232. This 'tapped' capacitor matches the high impedance at Q203's collector to the low impedance necessary to drive the crystal. L216 has a slight effect on the oscillator's frequency and is adjusted at the factory in setting the frequency.

3.3.12: The output of the oscillator is taken across C232. This output is buffered by Q204. Base bias for Q204 is provided by R212. Q204 operates as a common emitter amplifier, with its gain set by R211. R211 is variable and is adjusted as part of the alignment procedure. The output of Q204 is taken at its collector through C230. L214 is a choke connecting Q204's collector to the 24 volt supply.

3.4: IF AMPLIFIER PC BOARD (6900-3000)

3.4.1: The IF amplifier PC board contains most of the amplification and filtering in the translator. The board also contains limiting to remove any AM component on the input signal. A slignal level detector is also provided with the turn-on/turn-off control circuitry. Refer to Schematic 6900-3035.

3.4.2: The 10.7 MHz from the front end enters at J301. It first is amplified by Q301 before being filtered. Q301 has negative feedback provided by T301 and the emitter resistor, R301. This feedback stabilizes the gain and impedance of the stage. An additional effect of T301 is to increase the reverse isolation of the stage. Q301 has a power gain of 8dB.

3.4.3: The output of Q301 enters a 5 pole bessel filter. L301, L302, L313, L304, L305, and their associated capacitors make up the filter. Coupling the poles C703, C310, C311, C315, C316, C320, and C319. Both C311 and C316 are variable to enable the coupling to be adjusted to optimum. The filter is tuned at the factory for a 2dB bandwidth of 200 kHz. The filter's insertion loss is about 5dB, making the overall signal gain from J301 to the input of Q302 about 3dB.

3.4.4: The input of Q302 is at 50 ohms impedance. The signal connection at this point is brought out to TP302 to facilitate alignment at the factory. Q302's configuration is identical to Q301. The output of Q302 also enters a 5 pole filter identical to the preceding filter. Since Q302's gain is 8dB and the filter's insertion loss is 5dB, the overall gain from J301 to S302 is about 6dB.

3.4.5: The output of the filter goes through S302 and is applied to a set-up transformer, T304. The output of T304 is then connected to the input of IC301A. IC301 contains two differential amplifier stages. Each differential stage contains three transistors, two (Qa, Qb) doing the amplifying and the third (Qc) providing the bias for the other two. The output of the differential stage is at the collectors of Qa and Qb. This output is tuned by L316 and C373. C374 neutralizes the collector base capacitance of Qa. R349 on the output adjusts the gain of the stage. It is used to set the turn-on threshold of the translator.

3.4.6: The balanced output of IC301B via C371 and C369. IC301B is identical to the preceding stage except the input to it is balanced. Because of this, there are two neutralizing capacitors, C367 and C368. R344 and B341 on the inputs of IC301B provide a ground return for the bases of Qa and Qb respectively. The output of IC301B is tuned by L315 and C366. This output is fed to both inputs of two differential stages. IC302A and IC302B. IC302A is a stage identical to the preceding one. The output of it is fed to another stage, IC303A.

3.4.7: The output of IC302B is fed to a diode detector consisting of D301 and D302. The output of the detector is a DC current which is fed to the inverting input of IC304A. IC304A is an op amp configured as a current to voltage converter. The output of IC304A varies from 0 to 20 volts, depending on the input signal strength and the setting of R349. This voltage is fed to IC304B, which compares it to a reference. The output of IC304B switches to +20 volts when IC304A's output is raised above 8 volts. IC304B switches to 0 volts when IC304A's output is dropped below 5.2 volts. This hysterisis is caused by R324 and allows the turn-off point to be 3dB lower than the turn-on point. The output of IC304B is fed to an emitter follower, Q303 before being sent to the PLL board via P301-4. When S303 is in the BYPASS position, P301-4 is connected directly to 24 volts.

3.4.8: The output of IC303A is fed to the input of IC303B. From the output of IC303B the signal travels to the output connector, J302 via the step down transformer T303.

3.5: PLL UPCONVERTER P.C. BOARD

3.5.1: The PLL (phase-locked loop) Upconverter P.C. Board takes the 10.7 MHz output from the IF P.C. Board and upconverts it to the output frequency. The upconversion utilizes a voltage controlled oscillator (VCO) that is phase-locked to the IF input. The output of this VCO is then amplified before being sent out to the power amplifiers. The board also contains protection circuitry that will shut off the output if some fault is present in the phase-locked loop. This protection circuitry also provides the shutdown mechanism when the originating station goes off the air. The PLL board has three (3) outputs. Two 50 ohm +16dBM outputs go to the power amplifiers. The third output is connected to the front panel monitor jack. A monitor output of the local oscillator is also provided. The following paragraphs give a detailed description of the circuitry. Refer to Schematic 6900-5035, Voltage Controlled Oscillator.

3.5.2: Q411 is a voltage controlled oscillator (VCO) that is operating at the output frequency. The oscillator is in a Colpitts configuration with the tank circuit at the drain and feedback present between the drain and the source. The tank circuit consists of L414 and the series combination of D411 and D413. Feedback to the source is provided by a capacitive voltage divider consisting of C468 and C469.

3.5.3: The capacitance of D411 and D413 is dependent upon the voltage present at their cathodes. This means the tank circuit's resonant frequency and hence the oscillator's output frequency is controlled by the voltage present at the junction of D411 and D413. The values of the tank circuit are set so a voltage change of approximately .25 volts across D411 and D413 will shift the oscillator's output frequency by 75 kHz.

3.5.4: DC is supplied to Q411 via a choke (L424) from a 15 volt, 3 terminal regulator, IC406. The 15 volt output of IC406 goes through an RC low pass filter consisting of R511 and C471 before it is applied to Q411. This filter removes any audio noise from the regulator's output, preventing it from modulating the oscillator. Bias current is set by R512 at Q411's source. Noise on the -8 volt supply does not modulate the oscillator so an audio filter is not necessary.

3.5.5: The voltage controlled oscillator's (VCO) output is taken at Q411's source. It goes through C470 and C451 before being applied to the gates of Q408 and Q409. R513, at the junction of C470 and C451, loads the VCO to swamp out any effect that Q418 or Q409 will have on the VCO. A voltage divider, consisting of R492 and R494, supplies a bias voltage to the gates of both transistors. Both Q408 and Q409 are enhancement type dual gate MOSFETS.

3.5.6: The output amplifier, Q409, amplifies the VCO's output and applies it to the base of Q410 through a tuned matching network. This network is of a PI configuration and consists of C455, L418, and C456. R498 loads the output of Q409 while providing a DC return to the supply. The gain of Q409 is controlled by the DC voltage on it's No. 2 gate. This voltage is approximately 10 volts during normal operation and -2 volts when the output is shut down. The No. 2 gate of Q409 is connected to the turn on/off circuitry through R495.

3.5.7: Q410 amplifies the signal at its base to about +20dBm. R503 and C460 provide emitter degeneration at the output frequency. Negative feedback is also provided by R560 and L419. The transistor is biased by R499 and R501 at the base, and R502 at the emitter. R497 drops the 24 volt supply to about 18 volts. This 18 volts supplies both Q409 via R498 and Q410 through L420. The output of Q410 enters a tuned circuit through C461. This tuned circuit, consisting of C461, C462, L423, and L422, suppresses all harmonics while matching Q410's output down to a 25 ohm impedance at the input of T401. T401 splits the output to two (2) outputs, each connected to a 50 ohm jack (J403 and J404). The monitor jack, J402 is connected to the input of T401 through an 'L' pad consisting of R506 and R404.

VCO RF Feed Back Path

3.5.8: While Q409 sends the VCO's signal on to the output, Q408 sends it back to the phase comparator. Q408's configuration is the same as Q409's except its No. 2 gate voltage is fixed by a voltage divider to the 24 volt supply. This voltage divider consists of R489 and R491 and sets Q408's gate voltage at 10 volts. The output of Q408 at the drain is matched down to 50 ohms by L417 and C448. The signal then goes through a PI attenuator consisting of R487, R483, and R484. R487 also serves as a return to the 24 volt supply for Q408.

3.5.9: After the pad, the signal enters a double-balanced mixer, DBM-401, which mixes it with the local oscillator to produce a 10.7 MHz sample of the VCO. The local oscillator is supplied by a conventional crystal oscillator with a buffer amplifier.

Local Oscillator

3.5.10: Q405 and its associated circuitry forms a crystal oscillator operating between 98 and 118 MHz. The crystal, X401, is a series resonant fifth overtone type. L409 tunes out the interplate capacitance of the crystal. The crystal presents a feedback path from the collector of Q405 to its emitter. The base of Q405 is RF grounded by C424 so Q405 acts as a common base amplifier. The collector of Q405 is tuned by L408 and the series combination of C426 and C428. These two capacitors match the high impedance of Q405's collector to the low impedance of the crystal.

3.5.11: The output of the oscillator is taken across C428 and is applied to the base of Q406. R446 and R447 bias Q406 just at its turn on point. Q406 amplifies the crystal oscillator output. The output of Q406 at the collector is matched down to 50 ohms by L411 and C429. It then enters a PI attenuator consisting of R449, R450, and R442. The LO port of the DBM-401 is connected to the output of this PI attenuator. R449 also supplies DC current to Q406 from a +24 volt jack, J405 is connected to Q406's output through an L-pad consisting of R485 and R486.

3.5.12: The 10.7 MHz output of DBM-401 at Pins 3 and 4 is connected to a low pass filter consisting of L406, C421, L405, and C420. This low pass filter has a cut off frequency of 20 MHz. C422 and R441 terminate the mixer's output at the LO and VHF image frequencies. The output of the low pass filter is fed to two (2) mixers, IC403 and IC401. The other inputs of these two mixers come from the IF amplifier board via J401.

3.5.13: The IF input at J401 first goes through a 3dB pad consisting of R401, R402, and R403. L401 is a choke to ground. From here the 10.7 MHz enters a network consisting of L402, C404, R507, R433, and C415. This network serves to feed the inputs of IC401 and IC403 at Pin 8 in quadrature (90° out-of-phase) from each other.

3.5.14: The outputs of IC403 and IC401 are balanced and come out at Pins 6 and 12. During normal operation, these outputs are a DC voltage that is proportional to the phase difference between the 10.7 MHz input and the 10.7 MHz sample of the output. Since the IC's are fed in quadrature at one input, the DC outputs are opposite in polarity from each other.

3.5.15: The output of IC403 is fed to one set of inputs of IC402 at Pins 1 and 4 via R430 and R434. IC402 is identical to IC403 and IC401 except it operates with DC voltages. Because of this it can be considered to be a multiplier. Its output voltage at Pins 6 and 12 is a product of the voltages at Pins 8 and 10 and Pins 1 and 4. Note that all inputs are balanced. Pins 1 and 4 are connected to the output of IC403 while Pins 8 and 10 are connected indirectly to IC401.

3.5.16: The output of IC401 first goes through a limiter, and then an amplifier before entering the input of IC402 at Pins 10 and 8. The limiter consists of two pairs of back to back diodes (D401, D402, and D403, D404). The amplifier stage is a differential pair of transistors, Q401 and Q402. This combination of limiters and amplifiers maintains a constant voltage at the input of IC402 regardless of the DC output of IC401. Therefore, during normal operation IC401 and its associated amplifier and limiters does not do anything to affect the output of IC403. One can consider the output of IC403 to be the input from IC402 multiplied by one (1). IC401 only comes into play when a fault occurs and the VCO is off frequency. This will be discussed later.

3.5.17: Only one output of IC402 is used. This output at Pin 6 is connected to a constant current source consisting of Q404 and Q403. Q403 temperature compensates Q404. The current at the collector is equal to the voltage across both R411 and R409 divided by R410, or about 1mA. The constant current source is used to magnify the DC output of IC402. The output at Pin 6 enters a low pass network consisting of R452, R453, and C439. The cut off frequency of this network is adjusted by R453. The AC gain of IC402 is controlled by R454 and R455. C433 bypasses these resistors to ground. The output of the low pass network across C439 is applied to the varicap diodes, D411 and D413.

3.5.13: To consolidate the operation of this feedback loop; if the VCO's output changes in phase related to the IF input, this will cause the DC voltage at the output of IC403 to change. The output of IC402 at the collector will also change correspondingly since IC401 has no effect. This change or error voltage is sent to the varicap diodes, D411 and D413 via the low pass network. The varicap diodes will cause the output frequency of the VCO to change. The VCO must change frequency in the magnitude and direction which would cause the error voltage on the output of IC403 to be minimum. Therefore, the VCO's output will follow exactly the input frequency deviations of the IF input (ie the translator's input). The VCO's phase is locked to the IF input by the feedback loop of IC403 and IC402. This gives the term phase-locked loop.

3.5.19: The voltage across D411 and D413 will vary with audio modulation as the VCO's frequency tracks with the input frequency. This audio voltage is amplified by IC404B and sent out to the control and metering board. IC404A is configured as a voltage follower to buffer the varicap voltage from the window detector (discussed later) and the front panel metering.

Out of Lock Operation

3.5.20: IC401 comes into play whenever the VCO's output is not locked to the input. This occurs when the translator is first turned on or when some short-term fault exists (the supply voltage is accidently shorted, for example). This also occurs when the modulator is activated. When the VCO is not locked, the outputs of IC401 and IC403 are no longer DC voltages. Instead, they are an AC voltage whose frequency is precisely the difference in frequency between the input 10.7 MHz IF and the mixed down sample of the VCO's output. Since one of the inputs of IC401 and IC403 are 90° out-of-phase, the AC signals at their outputs are also 90° out-of-phase. The outputs of IC403 are connected directly to the inputs of IC402 and no additional phase shift occurs.

3.5.21: The output of IC401, however, is partially bypassed by C403, and an additional phase shift occurs to the AC signal present. This phase shift is proportional to the frequency of the AC signal. The limiters and amplifier following IC401 remove the varying amplitude of the signal caused by C403 while preserving the additional phase shift. The inputs of IC402 at Pins 8 and 10 will see a constant amplitude AC signal with a phase shift proportional to the frequency of that signal. The other inputs at Pins 1 and 4 of IC402 will see an AC signal whose frequency is exactly identical to the other input, but whose phase is constant. Remember IC402 is identical to IC401 and IC403 and is a phase detector. Because of this, the output of IC402 at Pin 6 is a DC voltage proportional to the phase difference between the AC signals from IC401 and IC403. This phase difference is proportional to the difference frequency of the VCO's sample and the IF input. Therefore the DC voltage at IC402's Pin 6 will depend on the frequency difference between the VCO's output and the correct output frequency. This error voltage will tend to bring the VCO back on frequency so the phase-locked loop mechanism will take over.

3.5.22: Additional protection circuitry is used to ensure the translator will not transmit if, due to some fault, the VCO goes off frequency. If a fault occurs the output of IC402 will want to swing to either 24 volts or ground. This will occur because of the constant current source magnifying any change in IC402's DC output. When this happens either D405 or D406 will conduct, causing C433 to charge to +8 or discharge to +14 volts depending on the voltage at Pin 6 of IC402. IC405A is a "window detector" in the sense that its output will only be high if its input is between 8 and 14 volts. The input of the window detector is connected to Pin 6 of IC402. The output of the window detector is at the junction of D409 and D410. This output is fed to an emitter follower, Q407, through R480. The output of Q407 is connected to the gate of Q409. So if a fault occurs, the window detectors output will drop to ground, turning off Q409 which kills the output of the board.

3.5.23: The turn on/off control line from the IF P.C. Board is connected to one input of the window detector. When this line drops to ground, the output of the window detector drops to ground, shutting off the translator's output.

Translator Identification

3.5.24: The audio tone from the TVK morse code identifier is AC coupled to the gate of Q409. When this tone is present, Q409 will amplitude modulate the output.

Modulator Operation

3.5.25: When the optional modulator is activated, the MOD Turn On at P406-4 line will go to ground, causing the relay, K401, to activate. When K401 activates R455 and R454 are shorted, causing C433 to be connected directly to IC402's output. This drops the AC gain of IC402 to essentially zero and the PLL drops out of lock. The action of IC401, however, will keep the VCO's frequency within a few kHz of the correct frequency. Any modulation on the IF input will not travel through to the output because of C433. Another set of contacts on K401 will connect audio from the modulator board at P406-5 to the input of the VCO via R461 and C435. The VCO's output will vary with the audio input but will swing around the correct output frequency because of IC401.

3.6: MODULATOR BOARD

3.6.1: The modulator board contains all the circuitry necessary for locally generated audio to modulate the translator's output. This includes the timing circuitry required to meet Part 74.1231(f) of the FCC Rules and Regulations. A tone decoder is also on the board, enabling remote activation/deactivation of the modulator. Refer to Schematic 6900-5035 for the following circuit description.

Timing Circuitry

3.6.2: The modulator board contains both a 30 second timer and a 60 minute timer. The 30 second timer uses the 60Hz line frequency as its reference and it is the reference for the 60 minute timer. The 60Hz reference is taken off the power transformer's secondary and comes in at P502-2. It is clamped at both +8 volts and ground by D501 and D502. An RC low pass filter consisting of R502 and C501 removes any high frequency noise before the 60Hz is applied to the input of IC501. IC501 is a Schmitt trigger. It generates a square wave at its output from the 60Hz sine wave at its input. This square wave at Pin 4 is now applied to the 30 second timer.

3.6.3: The 30 second timer consists of IC502, IC504A, and IC505A. The timer generates a pulse every 30 seconds at Pin 10 of IC505A. To do this it must divide the 60Hz line frequency by 1800. IC502 is a 12 bit binary counter. It has 12 outputs which correspond to a 12 bit binary number whose value is the number of pulses counted at the IC's input since it has been reset. The outputs at Pins 5, 12, 14, and 15 are the 4th, 9th, 10th, and 11th bit position of the binary number respectively. The first time all four of these outputs go high, after the IC has been reset, is when 1800 pulses have been counted.

3.6.4: These four outputs of IC502 are connected to IC504A. IC504A is a four input NAND gate. This means its output at Pin 13 will go low only when all four of its inputs are high. The output of IC504A is connected to one input of IC505A. The other input of IC505A is tied to +8V by R507 and can be considered to be always high. IC505A's output will go high if either of its inputs go low. The output of IC505A, therefore, will go high when all four outputs of IC502 go high, corresponding to a count of 1800. When this happens, IC502 will be reset because IC505A's output is tied to IC502's reset input at Pin 11. All the outputs will then go low, enabling IC502 to start counting again. IC505A's output will be high only long enough to reset IC502. This period is only about one microsecond, occuring once every thirty seconds.

3.6.5: These reset pulses are connected to the 60 minute timer. The 60 minute timer, consisting of IC506, IC504B, and IC505C is very similar in operation to the 30 second timer. The only difference is the input is divided by 120 instead of 1800. The outputs of IC502 at Pins 5, 3, 2, and 4 correspond to the 4th, 5th, 6th, and 7th bit of the binary number respectively. These outputs will go high after 120 pulses have been counted. As with the 30 second counter, a reset pulse is present at Pin 11 of IC506 every 60 minutes.

Modulator Turn On

3.6.6: This reset pulse also goes to the set input of a 'D' flip-flop, IC503A. The 'Q' output of the flip-flop normally is low. When the reset pulse from the 60 minute timer occurs, the 'Q' output of the flip-flop goes high. This will turn on Q501, which pulls P502-5 to ground. P502-5 is connected to the modulator relay on the PLL Upconverter Board. When P502-5 is grounded, the relay is activated. This switches the translator to modulator input.

3.6.7: The 'Q' output of IC503 will stay high until either the reset input goes high, or the clock input is pulsed. The clock input is connected to the output of the 30 second timer at Pin 11 of IC502. Since a pulse occurs at this output every 30 seconds, flip-flop IC503A will return to ground after 30 seconds has elapsed. The reset input of the flip-flop is connected to the output of IC505B. Since R511 pulls the input of IC505B high, the output of IC505B will be low. When the MOD DISABLE pin of TB901 is grounded, C505 charges up to +24 volts. This pulls the inputs of IC505B to ground briefly. As a result a positive pulse appears on the output of IC505B, causing the flip-flop to reset.

3.6.8: The reset pulse of the 60 minute timer is also connected to the clock input of the flip-flop IC503B. The 'Q' output of the flip-flop is normally low, but will go high when the reset pulse of the timer occurs. This will turn on Q502, activating relay K501 and the relay contacts will close. After about a second, Pin 4 of IC502 will go high, reseting flip-flop IC503B which will then deactivate the relay. If a jumper is present across TP504 and TP505, the relay will be controlled by Q501. This will cause the relay to remain activated for the full 30 seconds.

Manual Turn On

3.6.9: When the MOD TURN ON of TB901 is grounded, a negative pulse appears at the input of IC505A as C504 charges up to +24 volts. This negative pulse resets both the 30 second and 60 minute counters. The 'Q' output of flip-flop IC503A will go high, activating the modulator. After 30 seconds or when the MOD DISABLE Pin is grounded, IC503A's output will return to ground.

3.6.10: If S501 is switched to the 120 minute position, IC502 will divide by 3600 instead of 1800. This means the 30 second counter is now 60 seconds and the 60 minute timer is 120 minutes. Otherwise the operation of the timers remains the same.

Tone Decoder

3.6.11: IC507 is a tone decoder. Whenever a tone at a predetermined frequency is present on its input at Pin 3, the output of Pin 8 will go low. The activating frequency is determined by R519, R520, and C509. The activation delay time is set by C511. The input of IC507 is connected to the FM demodulated signal from the PLL Upconverter Board. The FM demodulated signal goes through an RC low pass filter (R518 and C508) to remove the stereo subcarrier before it is applied to IC507.

3.6.12: IC507's output is connected to S502 through D508. Depending on the position of S502, IC507's output is connected to either the MOD ENABLE or MOD DISABLE input. When IC507's output goes to ground, it simulates the grounding of the appropriate MOD input.

Audio Path

3.6.13: The balanced audio input from TB901 comes in at P501-9 and P501-10. It is terminated by R521 and R522. IC508 converts the balanced input to an unbalanced output. The IC has a voltage gain of two, which is set by the ratio of R525 to R524. R538 is returned to the +8 volt supply, causing IC508 to swing around +8 volts at its output.

3.6.14: From the output of IC508 the signal is applied to the input of IC509 via the level control, R527. IC509 is configured as a voltage follower. C516 and R529 form a pole in IC509's feed back, increasing its gain at the higher audio frequencies. The amount of high frequency boost is set to match the standard preemphasis curve for FM.

3.6.15: The audio at the output of IC509 is connected to the modulator input on the PLL Upconverter Board through R531 and R534. D509, D510, and their associated resistor dividers serve to clip the audio to prevent overmodulation. The clipping point is set by R534.

+8 Volt Supply

3.6.16: IC510 is an 8 volt regulator that feeds off the 24 volt supply. The output of IC510 is bypassed to ground by C518. The 8 volt supply runs all the logic circuitry, in addition to both the tone decoder and the audio ICs.

3.7: 1 WATT POWER AMPLIFIER - 6900-9000

3.7.1: The 1 watt power amplifier amplifies the 50mW output of the upconverter P.C. Board (6900-4025) to the 1 watt output level. The amplifier has one stage and contains an internal AGC loop to maintain constant output power. Additionally, the forward and reverse power measuring circuitry are contained within the module.

3.7.2: Refer to Schematic 6900-9035. The 50mW signal from the upconverter enters at J901. Here it first passes through D901 which is a pin diode. A pin diode acts as a DC current controlled variable resistance for RF current. It's forward resistance is controlled by the feedback from the AGC loop, to be discussed later. The controlling current from the AGC loop travels through L901, through D901, and to ground through T901.

3.7.3: From D901 the input signal is transformed from 50 ohms down to 12.5 ohms impedance by T901. The matching section is an 'L' section consisting of ℓ901, and C905. The components represented by 'ℓ' are microstrip transmission lines etched on the P.C. board. For the purposes of discussion they may be considered here as lumped inductors.

3.7.4: C904 is a DC block since the base of the transistor is not at DC ground. Though FM RF amplifiers can be biased class 'C', they are not used here. Instead, the stage is biased class 'B' so that the input impedance of the device remains reasonably constant over different power levels. (This variation in impedances make turning more difficult, especially when one starts at a power level of only 50mW.) The loss in efficiency in a class 'B' stage is far outweighed by the easier tuning realized.

3.7.5: Q901 is biased class 'B' by D902 and R901. D902 maintains thermal tracking and R902 sets the quiescent current at a few mA. R905 swamps out the remaining variation in Q901's input impedance while feeding it bias from D902.

3.7.6: The collector of Q901 is connected to the 24 volt supply through an RF choke, L902. The collector current also travels through R904. The voltage drop across R904 is sent up to the metering board so that the collector current of Q901 can be measured. The metering lines are connected to P903-2 and P903-5.

3.7.7: The RF output of Q901 goes through a DC blocking capacitor, C909, and is resonated by C910 and L903. The output then travels through a five pole low pass filter consisting of L904, L905, L906, C911 and C912. No impedance matching is necessary since the 75 ohms at the output is very close to the optimum impedance for the transistor.

3.7.8: The output of the low pass filter goes through a directional coupler before going to the output jack, J902. The directional coupler (T902) is a hybrid with both forward and reverse outputs. The forward power is detected by D903. R906 at the input of D903 terminates the output of T902 while C913 provides frequency compensation. D905 generates harmonics opposite in phase to those of D903 to cancel them out.

3.7.9: The reverse power output of T902 enters a 1 to 4 balun, T903, before being detected by D904. The balun is needed to double T902's output since the reverse power scale is more sensitive than the forward. R907 terminates the balun.

3.7.10: The detected forward power at the cathode of D903 is sent up to the metering board through R911 and the forward power calibration potentiometer, R910. This detected voltage also is sent to the input of IC901 via R912. IC901 compares this voltage to the DC voltage at its non-inverting input. The voltage at the non-inverting input is determined by the front panel power control, and can vary between 0 and 5 volts. The output of IC901 will try to keep both of its inputs at the same voltage by changing D901's resistance and hence output power. For instance, if the output power is at .8 volts, the detected voltage at the inverting input of IC801 will be around +2 volts. If the front panel control is set so that the non-inverting input is at 2.5 volts, IC901's output will rise, raising D901's DC current. This will lower it's RF impedance, and therefore raise the output power until the detected voltage rises to 2.5 volts.

3.7.11: Q902 is simply an emitter follower for IC901's output and provides the necessary current amplification. R908 limits the maximum current of Q902 to a safe level. C918 effectively raises IC801 time constant much higher than any other time constant in the circuit to ensure stability.

3.7.12: The strobe input of IC901 is also connected to the collector of Q903. Q903 is usually off and therefore doesn't affect the normal AGC action of IC901. However, when the reverse power reaches a set level, Q903 turns on, causing the output of IC901 to drop to ground. This is an automatic shutdown circuit when the reverse power exceeds a set limit. The output stage can withstand VSWR, but thermal considerations dictate this shutdown feature at the upper ambient temperatures. The threshold point is set at the factory for .2 watts reverse power, corresponding to a SWR of 3 to 1.

3.8: 10 WATT POWER AMPLIFIER - 6900-8000

3.8.1: The 10 watt power amplifier amplifies the 50mW output of the upconverter P.C. Board (6900-4025) to the 10 watt output level. The amplifier has two stages and contains an internal AGC loop to maintain constant output power. Additionally, the forward and reverse power measuring circuitry are contained within the module.

3.8.2: Refer to Schematic 6900-8035. The 50mW signal from the upconverter enters at J801. Here it first passes through D801 which is a pin diode. A pin diode acts as a current controlled variable resistance at RF. It's forward resistance is controlled by the feedback from the AGC loop, to be discussed later. The controlling current from the AGC loop travels through L801, through D801, and to ground through T801.

3.8.3: From D801 the input signal is transformed from 50 ohms down to 12.5 ohms impedance by T801. The output of T801 is matched to the input of the first transistor, Q801. The matching section is a 'L' section consisting of ℓ809, and C804. The components represented by 'ℓ' are microstrip transmission lines etched on the P.C. Board. For the purposes of discussion they may be considered here as lumped inductors.

3.8.4: C803 is a DC block since the base of the transistor is not at DC ground. Though FM amplifiers can be biased class 'C', they are not used here. Instead, both stages are biased class 'B' so that the input impedance of the devices remains reasonably constant at different power levels. This variation in impedances make tuning more difficult, especially when one starts at a power level of only 50mW. The slight loss in efficiency in a class 'B' stage is far outweighted by the easier tuning realized.

3.8.5: Q801 is biased class 'B' by D802 and R802. D802 maintains thermal tracking and R802 sets the quiescent current at a few mA. R803 swamps out the remaining variations in Q801's input impedance while feeding it bias form D802.

3.8.6: The output of Q801 at the collector is resonated by ℓ810 and C806. Here it enters an unbalanced to balanced transformer, T802. (Unbalanced to balanced transformation means the same as single ended to push pull.)

3.8.7: The final amplifier stage is push pull and biased class 'B' like its driver. The outputs of T802 go through two DC blocking capacitors, C808 and C810 and then are matched to the inputs of Q803 and Q802. 'L' sections again are used, ℓ811 and ℓ812 are the series impedances, while C809 is the shunt. Swamping resistors to ground are used both at the output of T802 (R805 and R808) and at the inputs of Q802 and Q803. DC bias is fed to the two outputs through R806 and R810. The bias comes from emitter follower Q804. The base of Q804 is raised slightly more than two diode voltage drops (1.5V) above ground by D803 and D804. One diode drop is for Q804's emitter to base drop and the other for the RF output transistor's base to emitter drop. R812 and R811 sets the quiescence current of the RF transistors to a few mA. R811 on the collector of Q804 limits the maximum current through Q804 to a safe level.

3.8.8: The output's of Q802 and Q803 are tuned by ℓ815 and both C812 and C813. The output is matched up to the input of T803 by 'L' section consisting of ℓ813, ℓ814, and C814. T803 performs the balanced to unbalanced transformation.

3.8.9: The 24 volt supply is fed to the outputs through ℓ815. The feedpoint is exactly in the middle of ℓ815 where the RF voltage is theoretically zero. Nevertheless, the feedpoint is bypassed to ground by C819 and C818. The current from this point to the supply travels through R814 which provides a voltage drop proportional to the final current for the front panel meter.

3.8.10: The RF output of T803 enters a five (5) section .1dB Chebyschev low pass filter consisting of L802, L803, L804, C821, and C822. The filter has a cut off frequency of 120 MHz to effectively eliminate the highter harmonics. C823, across L804 is a trap at the second harmonic frequency.

3.8.11: The output of the low pass filter goes through a directional coupler before going to the output jack, J802. The directional coupler (T804) is a hybrid with both forward and reverse outputs. The forward power output goes through a PI attenuator consisting of R816, R826, and R830. It is then detected by D806 and D807. D807 detects the negative peaks while D806 detects the positive peaks. However, the power metering comes off D806 while D807's output is loaded by R831. These diodes generate significant second harmonics, but since they detect 180° out of phase the harmonics produced cancel each other out.

3.8.12: The reverse power output of T804 is terminated by R817 and is detected by D805.

3.8.13: The detected forward power at the cathode of D806 is sent up to the metering board through R824 and the forward power calibration potentiometer, R825. This detected voltage also is sent to the input of IC801 via R823. IC801 compares this voltage to the DC voltage at its input. This voltage at the minus input is determined by the front panel power control, and can vary between 0 and 5 volts. The output of IC801 will try to keep both of its inputs at the same voltage by changing D801's resistance and hence output power. For instance, if the output power is at 8 watts, the detected voltage at the inverting input of IC801 will be around +2 volts. If the front panel control is set so that the noninverting input is at 2.5 volts, IC801's output will rise, raising D801's DC current, this will lower it's RF impedance, and therefore, raise the output power until the detected voltage rises to 2.5 volts.

3.8.14: Q806 is simply an emitter follower for IC801's output to provide the necessary current amplification. R828 limits the maximum current of Q806 to a safe level. C829 effectively raises IC801 time constant much higher than any other time constant in the circuit to ensure stability.

3.8.15: The strope input of IC801 is connected to the collector of Q805. Q805 is usually off and therefore doesn't affect the normal AGC action of IC801. However, when the reverse power reaches a set level, Q805 turns on, making the strobe input of IC805 drop to ground. IC801's output will therefore drop to ground, reducing the forward power. This is an an automatic shutdown circuit when the reverse power exceeds a set limit. Though output stage can withstand VSWR, thermal considerations dictate this shutdown feature at the upper ambient temperatures. The threshold point is set at the factory for 2 watts reverse power, corresponding to a SWR of 3 to 1.

3.9: CONTROL AND METERING BOARD (6900-6000)

3.9.1: The control and metering board contains the interconnections and metering for all the subassemblies in the translator. Additionally it contains the stereo demodulator and audio amplifier for the headphone jack. A peak detector monitoring deviation is also included. Refer to Schematic 6900-6035 for the following paragraphs.

Metering

3.9.2: Both the power meter and multimeter are 100uA full scale meters with a DC resistance of 1000 ohms. Each meter has back to back diodes across them for protection in the event of a fault in the metering circuitry. These diodes are D601/D602 for multimeter and D603/D604 for the power meter. S601 is a eight position switch for the multimeter. Each position has two poles to switch both sides of the meter at once. The power meter switch, S602, has four (4) positions similar to the multimeter switch.

Audio Monitor

3.9.3: The demodulated FM from the PLL upconverter board comes in at P603-6. It enters IC602 through a voltage divider, R634 and R622, and a capacitor, C613. IC602 is a stereo multiplex decoder. The left and right channel outputs come out a pins 4 and 5 respectively. C611 and C610 perform the necessary deemphasis function on each channel. IC602 generates its own 19kHz pilot and phaselocks it with the incoming pilot carrier. R628 sets the free running oscillator frequency, monitored at TP1. IC602 requires +12 volts, which is supplied by a three terminal regulator. IC605.

3.9.4: The two channel outputs across R630 and R631 enter the volume control (R617A and R617B) via DC blocking capacitors, C601 and C603. The outputs of the volume control are amplified by OP amps IC604 and IC603. The voltage gain of these amplifiers is set at 10 by R618 and R620 on the left channel and R623 and R625 on the right. Since the OP amps are decompensated, a network is needed on their input to prevent them from oscillating. This network consists of C602 and R618 on the right channel, and C604 and R624 on the left. The outputs of these amplifiers is at DC ground and are connected directly to the earphone jack through protective resistors (R621 and R626).

Peak Detector

3.9.5: The demodulated FM from the PLL upconverter also is connected to a peak detector circuit. This circuit consists of IC601 and its associated components. IC602 operates similar to the audio amplifiers except there are two feed back paths, each path containing a diode, D605 and D607, in addition to a resistor. Because of the diodes, one path is used for the negatively going signal and the other is for the positively going signal. The positively going output is rectified by D606. The rectified outputs if filtered by C615 and is sent up to the metering switch via R632. R639 provides a ground return for C615 when the DEV switch is not selected. The discharge time of C615 is controlled by R632 and is designed to enable the meter to accurately read the shortest peaks encountered in the audio.

3.9.6: IC601 must overcome D607's turn on voltage (.6V) since D607 is in its feedback path. This extra offset voltage on the output of IC601 also virtually overcomes the turn on voltage of D606, making that detector very precise. C617 on the input of IC601 boosts the high frequencies to compensate for IC601's drop in gain. The RC network consisting of R635 and C616 stabilizes IC601 at high frequency.

3.9.7: The power control inputs from the power amplifiers come in at P607-5 and P608-5. Each line is connected to its own respective control (R615 and R610) via R610 and R614 respectively. The control lines are referenced to ground, i.e. 0 volts on the control lines represents zero output. The power control potentiometers can adjust the voltage on the line from zero to a voltage limited by R612 and R616. This correlates to a power control range from 0 to about 12 watts.

3.10: POWER SUPPLY

3.10.1: The power supply is designed to supply 24 volts at up to 3.5 amps and -8 volts at .25 amps to the circuitry of the translator. It is of conventional design with the exception that a ferroresonant transformer is used. The supply can be powered either by 120 VAC, 60 Hz or 240 VAC 50 Hz. Refer to Schematic 6900-7035.

3.10.2: The hot line from the power line first goes through the circuit breaker, CB701, and then is connected to the P.C. Board via P702-3. The neutral line is connected directly to the board via P702-5. R717 is a varistor and is connected across the line to limit surge voltages. D701 rectifies the voltage from the hot to the neutral lines. The rectifier voltage is applied to a voltage divider, R701 and R702. The DC voltage across R702 is sent up to the meter via two metering resistors, R703 and R704. This metering circuit is sensitive to the average of the AC input. The neutral line on the P.C. Board is connected directly to the power transformer via P703-3. Note that for 120 VAC inputs the two transformer primary winding are connected in parallel and are connected in series for 240 VAC. The hot side of the AC line is connected to the other side of T701's primary windings.

3.10.3: T701 is a ferroresonant transformer. The voltage at the secondary windings are relatively constant over a large range of input voltage. The ferroresonant transformer also has another benefit of having a square wave on the secondary windings, thus reducing the filtering requirement of the DC supply.

3.10.4: The 30 volt winding of T701 enters a bridge rectifier, consisting of D702 through D705. The DC output is filtered by C702. R705 is a bleeder resistor for C702. From C702 the supply current must go through a fuse, F101, and a thermal switch, S702. S702 is mounted on the back panel and will open when its case temperature exceeds 70°C.

3.10.5: The +24V regulator uses IC702 and a series pass transistor, Q701. IC702 compares a sample of the regulators output with its internal 7.1 volt reference at Pin 4 and then applies a corrective signal to the base of Q701. A voltage divider is used at the 24 volt output to drop the 24 volts down to the 7.1 volts required by IC702. This voltage divider consists of R711, R713, and R712 which provides the fine adjustment of output voltage. Pins 1 and 10 sense the voltage drop across R709 and R710. Since the current drawn from the supply must flow through these two resistors, the voltage drop across them is proportional to this current. When this voltage drop reaches approximately .65 volts, IC702 turns off Q701, thus providing current limiting.

3.10.6: Another voltage divider, R708 and R707, is used to send another sample of the regulators output to Pin 2 of IC701. IC701 monitors this sample and when it exceeds approximately 2.6 volts triggers SCR D706. When D706 triggers, it blows F701, which kills the 24 volt supply. The 2.6 volts triggers point corresponds to about 26 volts at the output of the power supply. This circuit thus protects the translator's circuitry if the 24 volt regulator fails.

3.10.7: The -8 volt supply essentially consists of a packaged bridge rectifier, D707, filter rectifier, C709, and a three (3) terminal IC regulator, IC703. C710 on the output of IC703 prevents IC703 from oscillating.

3.13: CODE KEYER, TVK-1 DRAWING D1380-2010 and 1370-8012

3.13.1: The technical description of the TVK-1 Code Keyer will be broken down into the following subgroups. (Refer to Drawing Number D1380-2010.)

System Clocks (3.13.2, 3.13.4 ff)
Set/Reset Circuitry (3.13.5 ff)
Character Generator (3.13.7 ff)
Outputs (3.13.14)
Audio Oscillator (3.13.15 ff)
Power Supply (3.13.17)

System Clocks

3.13.2: The time between station identification (ID) transmissions is controlled by the interval clock (IC7C and D) and its frequency divider (IC6). IC7 is a hex inverter. Two of these inverters are wired to form a square wave generator operating at a frequency of 10Hz to 30Hz depending on the desired interval time. Capacitor C4 is the feed back capacitor with series resistors R5 and R6 controlling the time required by C4 to charge up. This square wave is fed directly into the clock input (Pin 10) of ripple counter IC6 (MC 14020). This IC divides the basic clock frequency by 16,384. The output of IC6 (Pin 3) goes high at count 8,192 and back to ground again at count number 16,384.

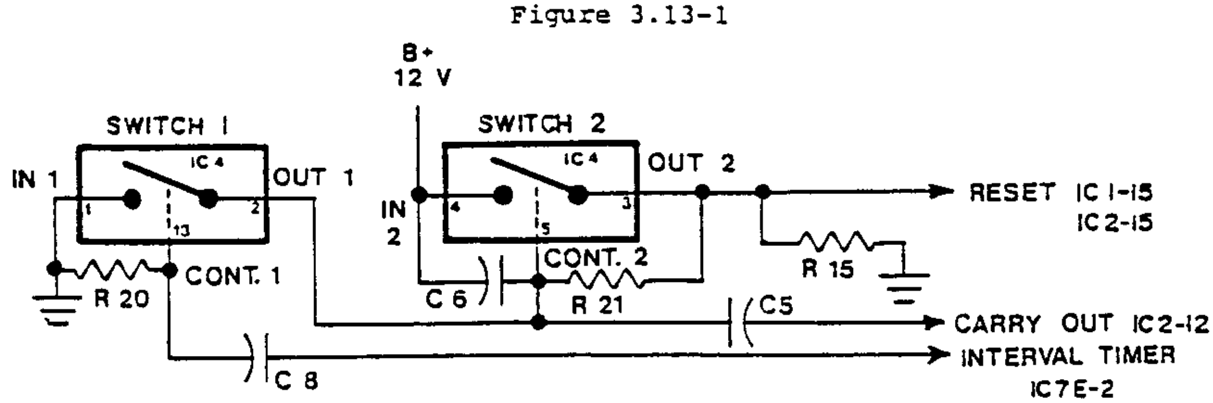
3.13.3: The set/reset circuit requires a positive pulse to start up the character generator, so IC7E is used to invert the output of the divider. The output of this inverter is differentiated by C8 and R20 to produce the necessary positive pulse. Transistor Q2 is used to suppress this pulse when power is first applied. In this way the character generator always comes on in the reset mode, ready to be triggered after the desired interval time. R14 and C10 reset divider IC6 when power is first applied so that it will always divide by its full 16,348 capability. Switch S2 is used to trigger the code generator at any desired time regardless of the interval timer and will not affect the timing of this circuit. C7 is a RF bypass capacitor used to remove any RF component from long lines to a remote test switch (if used).

3.13.4: Two more inverters are used as a code speed clock (IC7A and B) to run the character generator and the frequency of this clock directly determines the code speed at the output. Capacitor C3 is the feedback capacitor with series resistors R2 and R3 controlling the time required by C3 to charge up. This square wave is fed directly into the clock input of the first character generator (IC1). Provision is made for two (2) code speeds to be built-in to the TVK-1. Switch S1 selects another capacitor (C2) to parallel C3 and slows down the code transmission rate. Normally, R3 and C3 are adjusted for code transmission speed just under 20 words per minute (WPM), the fast position. Slow position is about one-half that rate or a rate specified by the user or owner. Proper selection of components will result in code speeds for any requirement.

Set/Reset Circuitry

3.13.5: The set/reset flip-flop is constructed from two C-MOS switches, each 1/4 of IC4. (See Figure 3.13-1) The resistance between the input and output pins is near infinity when the control pin is grounded and very low when a positive voltage is applied to the control pin.

Figure 3.13-1



3.13.6: When power is first applied, C5 and C6 are discharged and act to pull up the control line of Switch Number 2 as they charge up. This causes the output of Switch 2 to go positive. Once this happens, Resistor R21 acts as a pull-up resistor to keep the output positive. This is a stable state and the output line of Switch 2 will stay positive until the interval timer sends a positive pulse via IC7E to the control pin of Switch 1. When this happens, the output of Switch 1 (which is at ground potential) pulls the control pin of Switch 2 to low, turning it off. When Switch 2 is off, R15 pulls both counter reset lines low, starting the character generator. After the character generator has completed its sequence, the carryout line of IC2 (Pin 12) goes positive. This positive voltage transistion is differentiated by C5 and causes Switch 2 to conduct; thereby raising the reset line positive and holding it there by the pull-up action of R21.

Character Generator IC1 and IC2

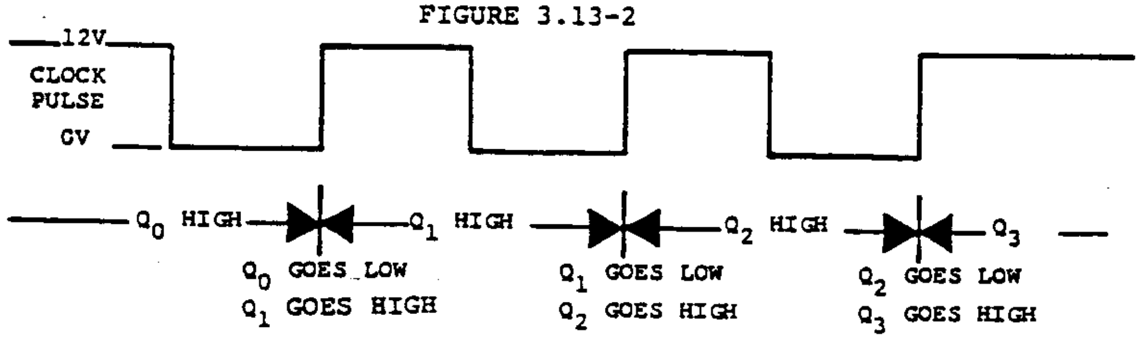
3.13.7: The character generator is designed with two (2) C-MOS 14017 IC decade counters. Each counter has the following input/output pins:

Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q8, Q9 - Decoded output lines of counter - only one (1) of these lines will be high at any given time.

Reset line -	(Pin 15) Itilializes counter - brings Q0 high and inhibits counting until reset line goes to ground.
Carryout line -	(Pin 12) Supplies a positive (0 to 12V) clock pulse at the end of each complete counting sequence (Q9 goes low and Q0 goes high).
Enable Line -	(Pin 13) Inhibits counting without affecting internal operation. It must be grounded to allow IC to operate.
Clock Input -	(Pin 14) Input signal to drive IC through its counting sequence.

3.13.8: When the reset line is high (+12V) the Q0 line goes high and the counter is inhibited. When the reset line goes low, the counter will advance one (1) count (starting from Q0) as the clock input goes from a low to a high state (0V to +12V). See Figure 3.13-2.

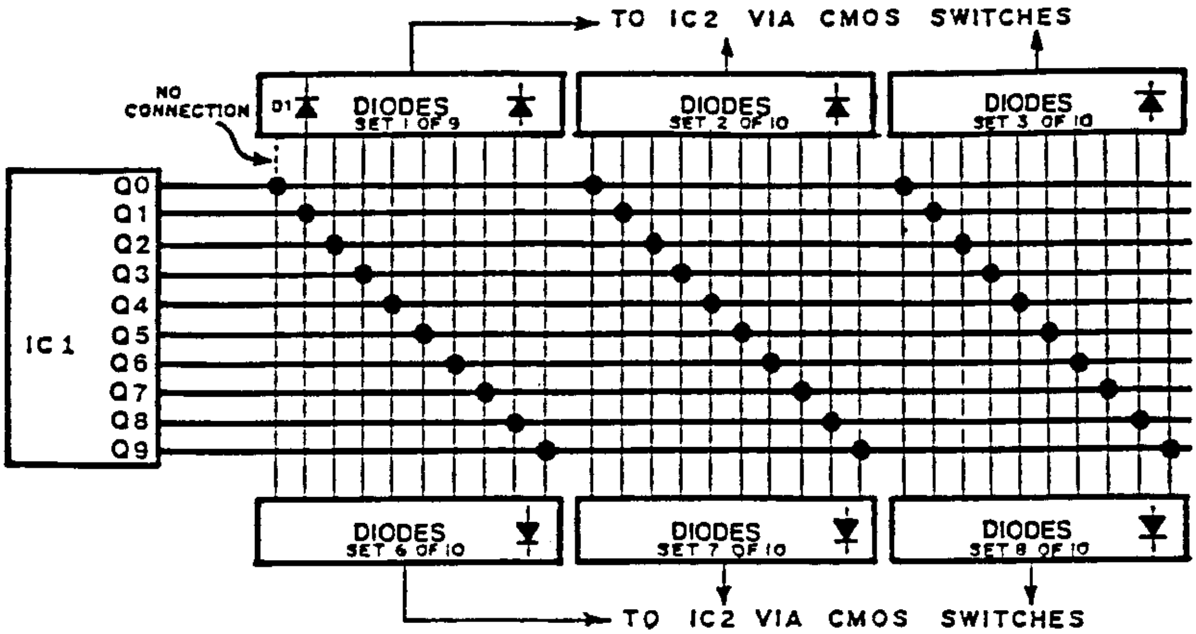
FIGURE 3.13-2



3.13.9: After the counter reaches Q9, the next positive clock transition (0 to +12V) will cause the counter to raise Q0 high and the entire sequence will start over. At the same time Q0 goes high, the carryout line (Pin 12) goes from the low to high state (0 to +12V). This signal is used as a clock signal to drive the next counter stage or as a reset signal.

3.13.10: The generation of a series of Morse Code characters is accomplished by using a series of diodes arranged in ten groups of ten diodes each. The operation of the first two groups of diodes will be explained. The operation of the remainder of the groups is the same as the first two. The output lines of counter ICI are wired to each set of 10 diodes as shown in Figure 3.13-3. Q0 is not connected in the first set because it is a standby posistion.

FIGURE 3.13-3

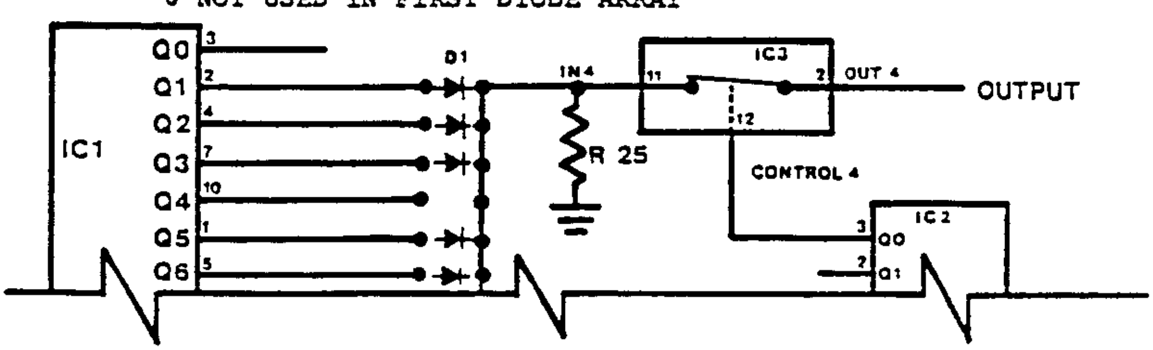


3.13.11: Each set of diodes is energized by C-MOS switches which are part of IC3, IC4 or IC5. Paragraph 3.13.5 explains their operation. Each switch is turned on by the output (Q) lines of IC2. When a positive voltage is not present at the control line of these switches, they act as an open circuit. In this way we can select individual diodes with IC1 and each group of diodes can be selected by IC2 via the C-MOS switches.

3.13.12: Refer to Figure 3.13-4. When the character generator is in the standby position the reset lines of IC1 and IC2 are high, causing the Q0 line of both IC's to be high. This causes IC2 to turn on the C-MOS switch (IC3 Pin 11) connected to the first set of diodes so IC1 can enable the first diode in that set of nine (9). Note, however, that there isn't a place for a diode to be connected to Q0 (Pin 3) of IC1. If this was not done, the output of the generator would always be high in the standby position. When the code sequence is initialized, (either by Switch S2 or by the interval timer), IC1 begins to count. When the Q1 line of IC1 goes high, it will pull the output line high if there is a diode in this position. This forms a dit (dot) at the output. If a diode is not plugged in, the output stays low due to pull down resistor R25. This action continues until IC1 counts high enough to go from Q9 back to Q0. When this happens, the carry-out line of IC1 (Pin 12) goes from a low to a high state (0 to +12V). This causes IC2 to count from Q0 to Q1, thus disabling the first set of 9 diodes and enabling the next set of 10 diodes through another C-MOS switch IC3 Pin 8. Now IC1 goes through its counting sequence until another Q9 to Q0 transition occurs and the next set of 10 diodes is selected.

FIGURE 3.13-4

Q_0 NOT USED IN FIRST DIODE ARRAY



3.13.13: Capacitor C1 is used to slow down the rise time of Q0. If this capacitor were left out, a short duration spike would be generated when IC1 went from Q9 to Q0. This is due to propagation delays in the carry-out line of IC1. When IC2 reaches count Q9 and IC1 goes from Q9 to Q0, the carry-out line of IC2 goes from a low to a high (0 to +12V) state. This transition is differentiated by capacitor C5 to form a positive pulse. This pulse is used by the set/reset flip-flop to raise the reset line of both counters to the high state (+12V), thereby resetting and disabling the circuit.

Outputs

3.13.14: The output line of the character generator is fed to two Darlington transistor pairs via R18 and R19. One Darlington transistor, Q4 is used to energize a LED for code monitoring. The other Darlington transistor, Q3, is used to drive a reed relay, K1, for isolated outputs or to sink currents up to 400mA. Relay K1 is not installed when Q3 is used as a current sink switch. REPLACING K1 with a 2K resistor, R34, allows the operator to drive TTL circuitry. K1 is supplied as an option for those situations requiring it. Diode D4 is used to protect Q3 from the switching transients generated by the coil inductance of K1. It must be in place if K1 is used. If Q3 is used to switch an external inductive load, a similar diode must be placed across that external inductance. The output line is also fed to 1/6 for IC7 where it is inverted and used to switch the code oscillator via transistor Q1.

Audio Oscillator

3.13.15: The tone oscillator is of the Wien Bridge type built around a RCA CA3140 OP-AMP, IC8. This OP-AMP has a very high input impedance due to its P-MOS field-effect input transistor while still providing a low impedance output. Resistors R7, R8, and R9 provide DC gain adjustment of the OP-AMP with diodes D1 and D2 acting as a peak limiter to provide good operational stability. Capacitor C15 is used as a DC blocking capacitor because the OP-AMP is being run on an unbalanced power supply. Resistors R10, R11, and R12 along with capacitors C12 and C16 form the Wien feedback loop and thereby determine the oscillator frequency. When transistsor Q1 is conducting, it pulls capacitor C11 into the circuity thereby unbalancing the bridge circuit and stopping oscillation. Capacitors C13, C14, and C19 are RF bypass caps and C17 is an AC coupling cap to provide DC isolation for the OP-AMP. The base of Q1 is brought to an output pin to allow manual keying of the oscillator.

Power Supply

3.13.16: The power supply consists of a Motorola MC7812C IC voltage regulator, IC9. By using this chip, any DC input voltage from 15V to 35V can be used. A heatsink is not required for this regulator as the power dissipation is so small that the IC runs cold during normal operation. Capacitor C26 is required if the regulator is located far from the main B+ filter capacitor while C24 provides improved transient response. C20, C21, C22, C23, and C25 are RF bypass capacitors that are distributed around the P.C. Board. An external filter capacitor is connected between E6 and ground, E7, if AC voltage is used to power the TVK-1. Diode D6 is permanently installed to prevent an accidental power supply lead reversal from destroying the active circuit components. D6 will, also, halfwave rectify the AC to supply the regulator. C18 is an RF bypass. The external filter capacitor should have a minimum capacity of 150uF and a 50 volt rating.

Factory Options

3.13.17: When the TVK-1 is supplied as part of Television Technology Corporation translator equipment, the TVK-1 output will be tailored for the equipment it is to be used with. Therefore, a television translator's TVK-1 normally will not contain the audio oscillator parts, while an FM translator's will. Relay K1 is always an option for situations requiring isolation such as positive ground equipment or voltages that cannot be handled by Q3.

3.13.18: Parts may be added to the TVK-1 to provide functions that are not factory installed. Consult the parts list for what you require and submit a list of Television Technology Corporation. The parts will be provided under normal terms and at current cost. Technical help is available for adapting or modifying your TVK-1. For installation instructions and suggestions consult Section 2 of this manual.

SECTION 4

MAINTENANCE AND REPAIR

4.1: GENERAL INFORMATION

FCC Requirements

4.1.1: A current copy of the FCC Rules and Regulations, Volume III (Part 73 and Part 74) and, in cases where antenna marking is required, Volume I (Part 17) must be available for use by the "operator in charge" of the translator. Both the "licensee" and the "operator in charge" are expected to be familiar with those rules relating to the operation of a translator station. Copies of the Commission's Rules may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, at nominal cost. (FCC Rules, Part 74.769)

4.1.2: Station maintenance records are required. The style or form of the maintenance record is left up to the operator or licensee (Part 74.1281). Nevertheless, it is suggested that such log or maintenance record show a continuous and reasonable effort to operate the translator station for best quality broadcasting and within the FCC Rules. In any event, log entries are required by Part 17.49 of the rules for daily observations of tower lights and quarterly inspections of the condition of the tower lights and associated control equipment. Also, an entry must be made when towers are cleaned or repainted as required by Part 17.50 of the rules. All station records, including maintenance records have to be retained for at least two years.

Repair Information

4.1.3: The translator is designed to be repaired and rechanneled in the field. The front end of the translator is similar in configuration to a two-way land mobile equipment. A person who has experience troubleshooting and aligning FM tuners, or two-way mobile equipment should have no difficulty repairing and aligning the translator. However, the phase-locked loop upconvertor used in the translator is of sophisticated and complex design. It is not recommended for a person to repair this module without extensive experience in radio repair, and then only if he has some exposure to phase-locked loops.

4.1.4: If the equipment is still under warranty it is mandatory to check with Television Technology Corporation before attempting any specific module repair. However, one should narrow the trouble down to a particular module by following the procedure starting in Chapter 4.2. The additional information obtained by this procedure along with the front panel meter readings should be relayed to the factory. For non-warranty repairs it is still best to contact the factory first, especially when one is unfamiliar with the unit. Again it will help the factory to have the front panel meter readings and the information obtained in Chapter 4.2.

Rechanneling

4.1.5: In order to obtain proper performance, some components change with FM channel frequency. The components are found in the input and output convertor boards. The input convertor components change with changing input frequency; the output convertor components with varying output frequency. According to the variable parts list in Section Six of this book, the low and high portions of the FM broadcast band are divided at 98 MHz and the variable components will be different from one another above and below that point.

4.1.6: The two bands do overlap somewhat so a input channel change from say 94.1 MHz to 99.1 MHz will not require one to change the six capacitors in the input convertor. When a new input or output falls close to but is different from the original band, it is best to first attempt to realign the module to the new channel. If the module tunes to the new frequency, then it is not necessary to replace the frequency sensitive capacitors. When replacing these components use only the same type component i.e. a NPO disk capacitor should not be replaced with a silver mica or even with a Z5U type disk capacitor. Better yet, obtain the new parts from the factory.

4.1.7: The translator is crystal controlled and the rechanneling operation will require the replacement of the input and/or the output crystal. It is manditory, in order to ensure the translator will meet the frequency tolerance specification, to obtain the new crystals from the factory. Field rechanneling a translator under warranty will void the warranty. For modulator equipped translators, the procedure outlined in Section 4.6 must be followed first before rechanneling is done.

Test Equipment Requirements

4.1.8: Table 4.1 gives the recommended and the minimum test equipment needed for various maintenance procedures. The catagory for 'minimum' is the test equipment required to perform the specific procedure while ensuring the translator will still meet the FCC specifications for FM translators. The translator may not meet Television Technology Corporation's specifications unless test equipment in the 'recommended' catagory is used. The list in Table 4.1 is for the overall translator. Individual modules may be repaired or rechanneled without needing all the equipment in Table 4.1. Each section pertaining to a specific module has its own minimum and recommended test equipment list.

TABLE 4.1

MINIMUM AND RECOMMENDED TEST EQUIPMENT

(A) Rechanneling - (This assumes the translator is operating properly before rechanneling.)

MINIMUM	RECOMMENDED
1. Signal at input frequency (may be the originating FM station).	1. Signal at input frequency (may be the originating FM station).
2. Calibrated 75 ohm attenuator (Blonder Tongue Model 4121).	2. 75 ohm sweep generator at the FM band with 1 MHz harmonic markers (Wavetek Model 1061 with 50, 10, 1 marker option is recommended).
3. Multimeter with either 100uA scale or 1 megohm input resistance.	3. Spectrum analyzer (Hewlett-Packard or equivalent).
4. Two (2) BNC to 'F' adapters with two 2 ft. 75 ohm test cables.	4. Calibrated 75 ohm attenuator (Blonder Tongue Model 4121).
	5. 50 ohm or 75 ohm detector. (WBE Model A33.)
	6. Return loss bridge or hybrid directional coupler. (WBE Model A57T or Jerrold Model DC-12.)
	7. Oscilloscope with 5mV/div sensitivity and 0-400 kHz response (Hewlett-Packard Model 130C).
	8. 3-1/2 digit DVM (Data Precision Model 185).
	9. Two (2) BNC to 'F' adapters sith two 2 ft. 75 ohm test cables.
	10. FM tuner with audio outputs to connect to oscilloscope. *
	11. Audio signal generator. *
	* Needed for the modulator option only.

(B) Repairing

MINIMUM	RECOMMENDED
1. Single at input frequency (may be the originating FM station).	1. Signal at input frequency (may be the originating FM station).
2. Field-strength meter or signal lever meter capable of measuring 1mV to 100mV at 10.7 MHz, and 88 to 220 MHz. The Sadelco Model FSC-733B with the MK-3 low frequency adapter is an example.	2. 75 ohm sweep generator at the FM band with 1 MHz harmonic markers (Wavetek Model 1061 with 50, 10, 1 marker option is recommended).
3. 3-1/2 digit DVM (Data Precision Model 185).	3. Spectrum analyzer (Hewlett-Packard or equivalent).
4. Two (2) BNC to 'F' adapters with two 2ft. 75 ohm test cables.	4. Calibrated 75 ohm attenuator (Blonder Tongue Model 4121).
5. 50 ohm or 75 ohm detector. (WBE Model A33.)	5. 50 ohm or 75 ohm detector (WBE Model A33.)
	6. Return loss bridge or hybrid directional coupler. (WBE Model A57T or Jerrold Model DC-12.)
	7. Oscilloscope with 5mV/div sensitivity and 0-400 kHz response (Hewlett-Packard Model 130C).
	8. 3-1/2 digit DVM (Data Precision Model 185).
	9. Two (2) BNC to 'F' adapters with two 2 ft. 75 ohm test cables. One 75 ohm R659 cable terminated with a RCA male phone connector or one end and an 'F' type connector on the other.
	10. FM tuner with audio outputs to connect to oscilloscope. *
	11. Audio signal generator. *
	* Needed for the modulator option only.

4.2: INITIAL TROUBLE SHOOTING PROCEDURE

4.2.1: In the event of trouble, the first thing is to check all the meter positions of the translator. Any significant variations from the readings given in the test data at the front of the manual should be noted. The procedure given in the following paragraphs should then be followed to narrow the trouble done to a specific module. It also makes sure the problem is not external to the translator. If the translator is under warranty, follow this procedure but stop when it refers you to another section. At this point you should contact the factory.

4.2.2: The -8V and the +24V meter positions should read -8V ±1 volt and 24 ±1 volts. If they do go on to paragraph 4.2.5. If either supply reads higher than the above limits, it almost always means that particular supply is bad. Refer to Section 4.10 to repair the supply.

4.2.3: If either supply reads low, they may be in current limiting, which may mean a defect in some module is pulling down the supply. One possibility might be the power output control(s) are turned way past the 10W (or 1W) point. The overdriven amplifier(s) can pull the supply down due to their significantly increased current. To check for this, make sure either I_{PA} positions on the multimeter switch are not pegged. If one or both are, and the forward power on the offending amplifier is a rated power or less, then that amp is probably bad. Refer to Section 4.7 or 4.8 depending on whether it is a 1 or 10 watt amp.

4.2.4: If the I_{PA} readings are around normal, the next thing is to check the other modules. To do this, remove the top cover of the translator. Locate the interface and metering P.C. board (Fig. 2.3). While monitoring the affected supply voltage on the multimeter, unplug and replug the following one at a time: P603, P604, P605 (if used), P607, P602 (if used), and P608 (if used). If the supply voltage jumps back to its correct value when any of these plugs are disconnected, it means the module connected to that plug is probably the culprit. Make sure the supply rises all the way to its correct value as it may rise somewhat for each disconnection. If the supply does not return to its original value for any disconnection, that means the supply is probably defective. However, if the supply voltage is only a few volts off and does not change with any disconnection it might be that either the metering or the supply voltage reference has changed (i.e. did someone bang on the meter?!). If possible, double check the supply with an accurate meter, preferably a digital one. If it is off, refer to Section 4.10 to readjust it. Note a supply voltage change of 10% will not cause, but may aggravate, an operational fault.

4.2.5: At this point it is assumed the supply voltages are correct. Each of the following paragraphs give a different type common problem or symptom. Refer to the paragraph that best fits your difficulty.

4.2.6: ZERO OR VERY LOW OUTPUT POWER.

A. Transmit light off

1. Check the INPUT SIGNAL position on the multimeter. It should be above 0dB. If it isn't then the problem is in the input sections. Refer to 4.2.7. If it is above 0dB the fault is in the turn on/off circuitry on the IF board or a short/open on the line between the IF board and the metering board. Refer to Chapter 4.4.

B. Transmit light on

1. Check the reverse power position of the power meter. It should be below 2 watts. (.2 watts for the 1 watt translator). If it is not the fault lies in the transmitting antenna system.

2. Check the VCO position on the multimeter. It should be 11 ±2 volts. If it isn't the problem is in the VCO circuitry and the window detector has shut down the output. Refer to Section 4.8 for repairing the VCO upconvertor board.

3. If the VCO position is 11 $\pm$ 2V, the problem resides in the output circuits. With a field-strength meter, measure the signal at the monitor output jack on the front panel. It should be 90mV $\pm$30mV. If it isn't, the fault is in the PLL upconvertor. Refer to Chapter 4.5.

4. If the monitor signal is within specification specification, the fault is in the power amplifier module. Refer to Section 4.7 or 4.8.

4.2.7: VERY LITTLE OR NO INPUT SIGNAL (TRANSLATOR IS SHUT DOWN).

1. The input Signal position should read less than 0dB. If it does not, follow the steps in 4.2.8.

2. Check the signal at the input of the translator. The receiving antenna system may be at fault or the originating station may have gone off-the-air!

3. If adequate signal is present (as given in Chapter 2.2) the threshold control may have been tampered with or have been set to low. To check this, refer to the procedure in Paragraph 2.3.12 to readjust the threshold control.

4. If the problem is not the threshold control, then it is in the input convertor or in the input circuitry on the IF board. Remove the top cover of the unit and locate the Input Convertor module (Fig. 2.1.3). Measure the voltage at the LO monitor pin (see Fig. 4.3.1) using the voltmeter with a minimum of 1 megohm input resistance. Alternately one can use a 100uA current meter. The voltage at this point should be 1.5 volts or 30uA minimum. If the voltage is low or zero, then the local oscillator is not working. Refer to Chapter 4.3.

5. If a field-strength meter with a low frequency adapter or a spectrum analyzer is available, measure the output of the input convertor at 10.7 MHz. It should be approximately 20dB higher than the input signal. If it is not, the fault resides in the input convertor. Refer to Chapter 4.3. If the signal is present, then the IF board is at fault. Refer to Chapter 4.5.

4.2.8: NOISY OUTPUT (AUDIO REMAINS RELATIVELY UNDISTORTED)

1. Note - this assumes the output is noisy at the translator, not at a remote receiving site. Monitoring the audio at the earphone jack will tell what the audio is at the output of the translator. If the signal received from the translator at a remote site suddenly becomes noisy, it may be caused by either a reduction of power output of the translator or a defective transmitting antenna system. These possibilities should be checked first before resorting to this procedure.

2. If the translator's signal is noisy at its output then it must be caused either by a reduction in the received signal to the input of the translator or to a fault in the input circuitry of the translator. The former is more likely, and to investigate it, one should measure the receiving antenna's signal with a field-strength meter or even a FM tuner. If one uses the translator's input signal meter, it should also indicate the level of input signal. The

danger here, however, is the possibility of a fault in the translator itself, causing the input signal to read inaccurately. It is still best, though, to check the receiving array before preceding.

3. If the input signal level is sufficient, there is still a chance that an unusually strong and close station has come on-the-air causing the input circuitry to overload. If this is an initial installation, make sure the guidelines in Section 2.2 are followed regarding input signal. Use of an FM tuner to check the input will confirm this since a commercial FM tuner is more susceptable to overload than the translator.

4. If by all indications the problem is not the input signal, the translator probably is at fault. Follow the procedure starting at Step 4 in Paragraph 4.2.7 to isolate the fault to a specific module.

4.2.9: DISTORTED AUDIO, WITH LITTLE NOISE (AT THE TRANSLATOR)

1. Distorted audio usually is caused by an excessive amount of multipath of the input signal or by an interfering signal overloading the input. Both of these possibilities may be checked with an FM tuner connected to the input from the receiving antenna.

2. If the use of the FM tuner has ruled out multipath or overload, then the fault is in the translator. This usually will be in the PLL Board. Refer to Section 4.5.

4.4: INPUT CONVERTER

4.4.1: Converter Specifications

Input:

Frequency.....................Single Channel 88 - 108 MHz
Return Loss...................16dB typical, 12dB minimum
Noise Figure..................3 dB maximum
Impedance.....................75 Ω
Section Bandwidth.............3 MHz at -3dB
Section Gain..................15 dB minimum

Output:

Frequency.....................10.7 MHz
Impedance.....................50 Ω
Return Loss...................6 dB typical
1 dB Compression Point........+10 dBm typical
Section Bandwidth.............400 kHz at 3 dB
Section Conversion Gain.......5 dB minimum

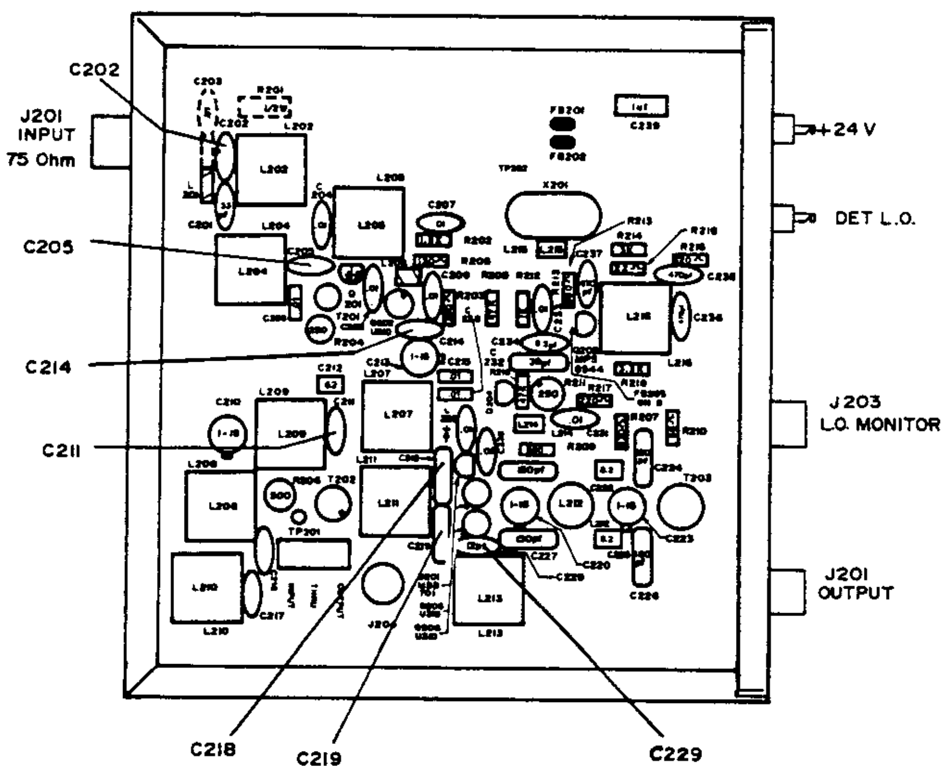
Local Oscillator:

Frequency.....................Input Frequency +10.7 MHz
Generation....................5th overtone crystal oscillator with a nonmultiplying buffer
Monitor Voltage...............100 mV minimum into 50 Ω
Detected Voltage..............1.5 VDC minimum

4.4.2: This procedure should be used for rechanneling with the test equipment in the recommended equipment list. This procedure assumes the converter is operating properly.

FIGURE 4.4.1

XLFM INPUT CONVERTER



4.4.3: Input Section Alignment

1. Unbolt the converter from the back of the chassis and remove the top cover of the unit. Check the values of the frequency sensitive parts, to those in Table 4.4.1 to ensure they are correct for the channel you are tuning it to. Refer to Figure 4.4.1 for part location.

TABLE 4.4.1

INPUT CONVERTER

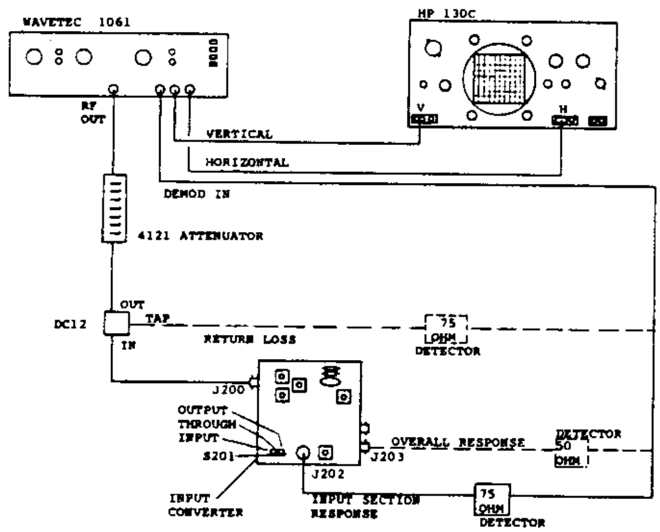
VARIABLE FREQUENCY COMPONENT CHART

	88 - 98 MHz		98 - 108 MHz	
C202	7.5 pF	8133-7R5	5.6 pF	8133-5R6
C205	12 pF	8133-12R0	6.8 pF	8133-6R8
C211	15 pF	8133-15R0	12 pF	8133-12R0
C214	20 pF	8133-20R0	15 pF	8133-15R0
C218	130 pF	8133-130R0	100 pF	8133-100R0
C219	130 pF	8133-130R0	100 pF	8133-100R0
C229	20 pF	8133-20R0	12 pF	8133-12R0

2. Connect the sweep generator and detector as in Figure 4.4.2. With the detector connected to the 'IN' jack of the hybrid coupler, set a reference with the step attenuator switched out. The scope should be at a vertical sensitivity of 5mV/div or less. The frequency width of the sweep generator should be set at one to two MHz per division. Note the use of a 75 to 50 ohm transformer or pad if a 50 ohm detector is used. If the converter has been modified to remote power a preamp, then a DC block (BT 4512 or equivalent) must be inserted between the input of the converter and the directional coupler. The presence of L203 and R201 is indicative that the module has been modified.

FIGURE 4.4.2

TEST EQUIPMENT SET-UP FOR INPUT CONVERTER ALIGNMENT



3. If Q201 has been changed, turn R204 all the way counterclockwise. Otherwise <u>do not</u> adjust this control.

4. Connect the detector to J204 and switch S201 to the 'INPUT' position. Tune C210 and C213 for maximum response on the scope. Since the filters these capacitors tune are very sharp, it is best to adjust these capacitors slowly and equally. Switch in the attenuator to keep the response viewable.

5. When C210 and C213 are peaked, tune L202 and L204 for maximum gain. Note that the tuning of these coils is relatively broad. If Q201 has been replaced, turn R203 for maximum gain, and then turn it back counterclockwise until the gain drops 1/2 dB.

6. The overall response of the input section should be similar to Figure 4.4.3. The bandwidth is determined by L208. To narrow the response, tune L208's slug out (less inductance) while compensating by adjusting C210. Tune the slug in to broaden (overcouple) the response. The final response should be maximally flat or slightly overcoupled. Note the adjusting of L208 affects the gain.

7. Connect the detector to the tap of the directional coupler. While using the maximum scope sensitivity, tune L202 and L204 for maximum return loss.

8. Terminate or short the output at J204. This should not change the return loss display. If it does, adjust the neutralizing coil, L205. L205's adjustment will need to be compensated by retuning L202 or L204. Repeat this step until there is minimal change in the return loss display when going from an open to a terminated or shorted connection at J204.

9. The properly aligned input section should have a minimum 15dB gain and 12dB return loss at the input. If the gain is under 15dB, retune L208 and C210 to reduce the bandwidth and raise the gain.

4.4.4: Oscillator Tune-up

10. Connect a voltmeter to TP201 (see Figure 4.4.1). Measure and note the voltage measured. This should be between 1 and 4 volts. If Q205 and Q206 were replaced, then turn R206 all the way counterclockwise before measuring the voltage at TP201.

11. Connect a high impedance voltmeter to the LO detected voltage point. Alternatively, a 100uA current meter may be used.

12. Turn R211 all the way counterclockwise. Tune L218 for a maximum meter reading. Repeat for L213.

13. Adjust R211 so that the detected voltage at TP202 is the same as what was measured in Step 10 above. 100uA equals 5 volts if a current meter is used at TP202.

14. The LO frequency will be within .002% by following the above steps. However, if a frequency counter is available, it may be connected to J203 to measure the LO frequency. Adjust L216 to change the frequency.

INPUT AMP SECTION

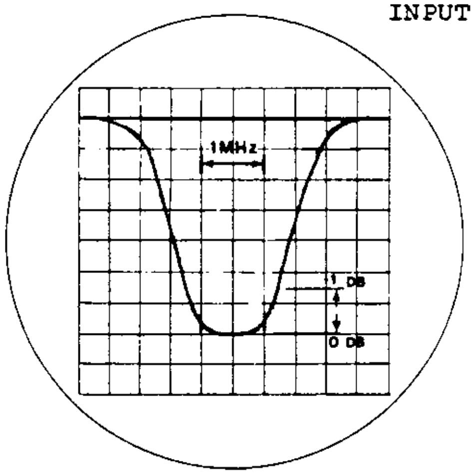


FIGURE 4.4.3
INPUT SECTION RESPONSE

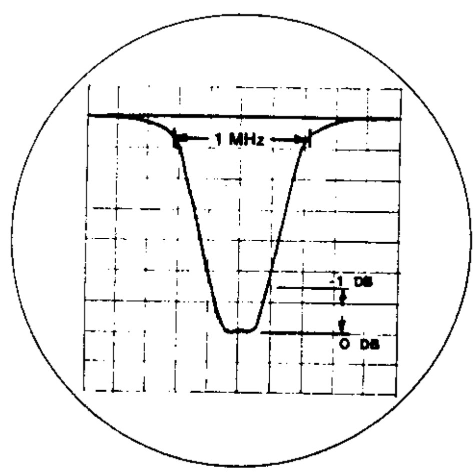


FIGURE 4.4.4
INPUT CONVERTER
OVERALL RESPONSE

4.4.5: Output Section Alignment

15. Switch S201 to the center position (THROUGH). Connect a 50 ohm detector to the output jack. A 50 ohm to 75 ohm transformer or pad should be used if a 75 ohm detector is used. The sweep generator attenuator should remain connected to the input jack (J201).

16. Tune L211 for maximum gain. If R206 has been initially set fully counterclockwise, then adjust it for maximum gain. You may notice some baseline shift. Remember gain is measured between the maximum point of the display to the baseline. You must not include any baseline shift when measuring gain.

17. Turn R206 counterclockwise until the gain drops about 1/4 dB. The overall response of the converter should look like Figure 4.4.4. C220 and C223 should not need to be adjusted. However, if the response is slightly skewed, it may be corrected by adjusting C220 and C223 slightly. Since the response is very narrow, be careful not to tune C220 and C223 off frequency -- especially if your sweep generator does not have 100 kHz harmonic markers.

18. The overall gain should be 20dB minimum.

Alignment with Minimal Test Equipment

4.4.6: This procedure should be used for rechanneling the input with the test equipment in the minimum test equipment list. This procedure assumes the translator is operating properly on the original channel.

1. Unbolt the converter from the back of the chassis and remove the top cover of the unit. Check the values of the frequency sensitive parts with Table 4.4.1 to ensure they are correct for the channel.

2. Measure and note the input signal strength from the antenna at the new input channel. If a signal generator is used, then set its output at 1000uV.

   NOTE: Most field-strength meters are relatively broad and will respond to signals that might and/or alternate channels to the desired signal. If this is true in your case, then you may use the composite reading as your reference. However, some other means should be used to verify the interfering stations are within the guidelines as set forth in Chapter 2.2 of this manual.

3. Connect the input signal to J201. Switch S201 to the 'INPUT' position and connect the field-strength meter to J204.

4. Depending on the initial alignment channel, the field-strength meter may or may not indicate anything. Switch the meters sensitivity for an on scale reading.

5. Turn L208's slug almost all the way out, then peak the meter reading by tuning C213 and C210. You may have to switch ranges on the field-strength meter in order to keep the reading on scale.

6. Tune L202 and L204 for a maximum reading on the meter. These coils are somewhat interactive so go from one to another a few times.

7. Do not adjust L205. Unless Q204 has been replaced, do not adjust R204. If, and only if, Q204 has been replaced, then adjust R204 for a maximum on the meter. Then turn it counterclockwise for a 1/2 dB drop on the meter reading.

8. The meter should indicate a level at least 15 dB higher than the input.

9. Connect a voltmeter to TP201 (see Figure 4.4.1). Measure and note the voltage measured. This should be between 1 and 4 volts. If Q205 and Q206 were replaced, then turn R206 all the way counterclockwise before measuring the voltage at TP201.

10. Connect a high impedance voltmeter to the LO detected voltage point. Alternatively, a 100uA current may be used.

11. Turn R211 all the way counterclockwise. Tune L216 for a maximum meter reading. Repeat for L213.

12. Adjust R211 so that the detected voltage at TP202 is the same as what was measured in Step 10 above. 100uA equals 5 volts if a current meter is used at TP202.

13. The LO frequency will be within .002% by following the above steps. However, if a frequency counter is available, it may be connected to J203 to measure the LO frequency. Adjust L216 to change the frequency.

14. Switch S201 to the center (THROUGH) position. Reconnect the cable to the IF board to J202.

15. Push the INPUT SIGNAL position on the front panel of the translator. The front panel meter swings upscale. Reduce the input signal with the switch attenuator until the meter reads about +10dB.

16. Tune L211 for a maximum reading.

17. Replace the cover on the converter and install it back in the translator.

18. The INPUT SIGNAL position on the front panel meter should read 0dB when the input signal is about 35uV. If the translator threshold adjustment has been changed, then ignore this step.

Troubleshooting

4.4.7: TP202 on the outside of the converter should first be measured with a voltmeter to check the operation of the local oscillator. The DC voltage at TP202 should be between 1 and 4 volts. If it is in this range then the fault probably is either in the input or the mixer sections. Skip to Paragraph 4.4.8.

Local Oscillator

4.4.8: The most common cause of failure in the local oscillator is the crystal. To verify this, measure the voltage to ground at the emitter of Q204. (Make sure R211 1/2 to fully counterclockwise.) It should be more than .05 volts (typically .25V). If it is zero, then the problem is in the oscillator stage. If, however, you do get some voltage here skip to Paragraph 4.4.10, then make sure the collector of Q204 is above 15 volts. If it is, then the problem is at the output of the local oscillator. (Q205/Q206 may even be shorted.)

4.4.9: If the emitter of Q204 is zero, remove the crystal and measure the base of Q204 to ground. It should be .5 volts ±.1 volts. If it isn't then Q204 is probably bad. Next, check the emitter of Q203. It should be 2 ±.5 volts. The base should be .7 volts higher. If it isn't and the collector voltage is above 20 volts, then Q203 is bad.

4.4.10: If you still haven't found the culprit, insert a 33 to 47 ohm, 1/4 or 1/2 watt resistor in the crystal socket, keep the lead length at a minimum. If the oscillator stage is not operating, then the emitter of Q204 will be at zero volts. This will means the crystal is not at fault. If, however, the emitter of Q204 is above .05 volts the crystal is defective.

4.4.11: To check the input section, connect a field-strength meter to J204 and switch S201 to the INPUT position. The signal should be more than 15dB higher than the input, if it is then skip to Paragraph 4.4.12.

4.4.12: The drain of Q202 should be at 20 volts. The source of Q202 should be 1.3 ±.5 volts above ground. Measure this across R205. The drain of Q201 will vary depending on the setting of R204. However, it should be between 5 and 17 volts. If it is out of this range, try to bring it back by adjusting R204. If you can't then Q201 is bad.

4.4.13: Measure the voltage at TP201. It should be between 1 and 5 volts. The drains of Q205/Q206 should be above 15 volts.

4.5: IF AMPLIFIER BOARD (6900-3000)

4.5.1: Specifications

Input:

Frequency............................10.7 MHz
Return Loss..........................20 dB
Impedance............................50 Ω
7dB compression point
(referred to the input).........1 volt typical

Section bandwidth (per filter).......200kHz @ -2dB
400kHz @ -20dB

Optional.........200kHz @ -3dB
400kHz @ -40dB

Gain (per stage).....................3dB typical

Output:

Impedance............................50 Ω
Level................................+3dBm typical
Return Loss..........................16dB typical

Alignment

4.5.2: There is no alignment required for rechanneling. Replacement of any component other than within the filters does not require any alignment. The two (2) LC filters are factory aligned and cannot be aligned in the field. The high selectivity option cannot be field installed. If any alignment is necessary on the LC filters, the board should be returned to Television Technology Corporation.

Repair

4.5.3: Follow the procedure in Chapter 4.2 to ensure the problem is in the IF Board. To repair this board one should obtain the equipment in Table 4.5.1. The two groupings of failure modes are treated separately. Follow the one which best describes your situation.

Loss of Signal Through Board

4.5.4: With the field-strength meter, measure the signal from the input converter at J301. Then switch S301 to the Input setting and measure the signal at TP301. This should be about 3dB higher than what you measure at the input. Repeat this measurement at TP303. Make sure S301 is switched back to the 'Through' position and S302 is switched to the 'Input' position. The level at TP303 should be 3dB higher than the level at TP301 or 6dB higher than the input. Switch S302 back to the through position.

4.5.5: If signal loss is not in the input sections, then the next recourse is to measure the DC voltages on the pins of IC301, 302, and IC305 and compare them to the voltages on the schematic.

Turn On Circuitry Inoperative

4.5.6: Switch S303 to the bypass position. The transmit light on the front panel should light. If it does not, then the fault lies between the IF board and the metering and control board.

4.5.7: Remove IC304 and measure the voltage at the anode of D302 to ground. (The board should be connected and adequate signal should be present at the input.) If more than .2 volt is measured, then IC304 is probably bad. If no voltage is measured, check the voltage on the pins of IC301 and IC302.

Recommended Test Equipment List
for
IF PC Board Repair

Table - 4.5.1

TEST EQUIPMENT LIST

1. Digital Multimeter, Fluke Model 77 or equal
2. Field Strength Meter, Sadelco Model FSC-733B or equal to measure 1 mV to 100 mV
3. 1' length, 50 Ohm BNC to Alligator Clips Test Cable, RG-58/U

4.6: PHASE LOCK UPCONVERTER P.C. BOARD

4.6.1: Specifications

Input:

Frequency.....................10.7 MHz
Impedance.....................50 ohms
Signal Level..................0 dBm minimum

Output:

Frequency.....................88 - 108 MHz
Impedance.....................50 ohms
Level.........................2 x +16 dBm nominal
Monitor Impedance.............75 ohms
Monitor Level.................100mV nominal

LO Oscillator:

Frequency.....................Output Frequency +10.7 MHz
Generation....................5th overtone crystal oscillator with a non-multiplying buffer
Monitor Voltage (J405).........100mV typical
Detected Voltage (TP407).......1 volt typical

Alignment (Rechanneling)

4.6.2: You must have the test equipment in Table 4.6.2 before proceeding.

Table 4.6.2

MINIMUM EQUIPMENT FOR RECHANNELING

1. Signal at input frequency (may be the originating FM station).
2. 3-1/2 digit DVM (Data Precision Model 185).
3. Field-strength meter or signal level meter capable of measuring 1mV to 100mV at 88 to 120 MHz. The Sadelco Model FSC-733B or equivalent.

1. Pull the board out and check the values of the frequency sensitive components with Table 4.6.1 to ensure they are correct for the channel you are tuning it to. Refer to Figure 4.6.1 for part location.

Table 4.6.1

VARIABLE FREQUENCY COMPONENT CHART

	88 - 98 MHz			98 - 108 MHz		
C455	7.5	pF	8133-7R5	6.8	pF	8133-6R8
C461	6.8	pF	8133-6R8	4.7	pF	8133-4R7
C462	18	pF	8133-18R0	12	pF	8133-12R0
C468	20	pF	8133-20R0	18	pF	8133-18R0
C469	75	pF	8133-75R0	68	pF	8133-68R0

2. Pull the PLL board out of its enclosure, but keep the cables attached to it.
3. Connect the voltmeter to TP407. Plug the new crystal in. Tune L408 for a maximum reading on the meter. Then tune L411 for maximum. Go back and retune L408.
4. The LO frequency will be within .002% at this point. However, if a 120 MHz frequency counter is available, it may be connected to J405 to measure the frequency. Adjust L408 to zero frequency.

5. Push the VCO voltage button on the front panel. The meter will read either 8 or 14 volts. Make sure there is adequate input signal to the translator. Both the input converter and the IF board must be operating properly and should be interconnected with each other. The output of the IF board should be connected to J401.

6. VERY SLOWLY turn L414 until the multimeter swings away from its position. Then slowly adjust L414 so the meter reads +11 $\pm$.5 volts.

7. Connect a field-strength meter to either J403 or J404. Tune L418, L423, and L422 for maximum signal.

8. The field-strength meter should read 1.5 volts minimum. If it doesn't, adjust R480.

4.6.3: The following adjustments should be made only if the circuitry associated with IC401, IC402 or IC403 have been repaired or tampered with. Skip these steps if you are rechanneling the unit.

1. Connect a 10 to 30 K resistor in series with your voltmeter. This resistor will serve to prevent the voltmeter from loading down the circuit at RF.

2. The board should be operating properly according to the above steps. If you are unable to make the board operate, check to see if R427, R404, or R407 is centered. Center them only if they are at one extreme. Now adjust L414 just until the loop drops out of lock. This can be observed when the VCO voltage is at 8 or 14 volts or the output of J404 drops.

3. Adjust R427 to make the voltages at TP401 and TP404 identical.

4. Adjust R404 to make the voltages at TP402 and TP403 identical. Now retune L414 until the VCO VTG is at 11 $\pm$ .5 volts.

5. Connect a field-strength meter to the monitor jack on the front panel. Tune the meter off to one side so the meter reads about one half of its peaked value. The meter is acting like a slope detector.

6. Intermittently short Pin 4 of P406 to ground. Adjust R409 so the meter does not more when Pin 4 is shorted.

7. Alternatively an FM receiver can be used instead of the field-strength meter. With the receiver, adjust R409 so there is a minimum of clicks when Pin 4 of P401 is shorted.

8. R455 and R453 should not be adjusted in the field. These potentiometers adjust the loop bandwidth of the phase-locked loop and affect the overall stereo separation and subcarrier level.

Repairing

4.6.4: The test equipment in Table 4.6.3 must be available.

Table 4.6.3

MINIMUM TEST EQUIPMENT FOR REPAIR

1. Signal at input frequency (may be the originating FM station).

2. 3-1/2 digit DVM (Data Precision Model 185).

3. Field-strength meter or signal level meter capable of measuring 1mV to 100mV at 88 to 120 MHz. The Sadelco Model FSC-733B or equivalent.

4. DC-15 MHz oscilliscope with 10mV/div minimum sensitivity and 10X probes Tektronix T922 or equivalent.

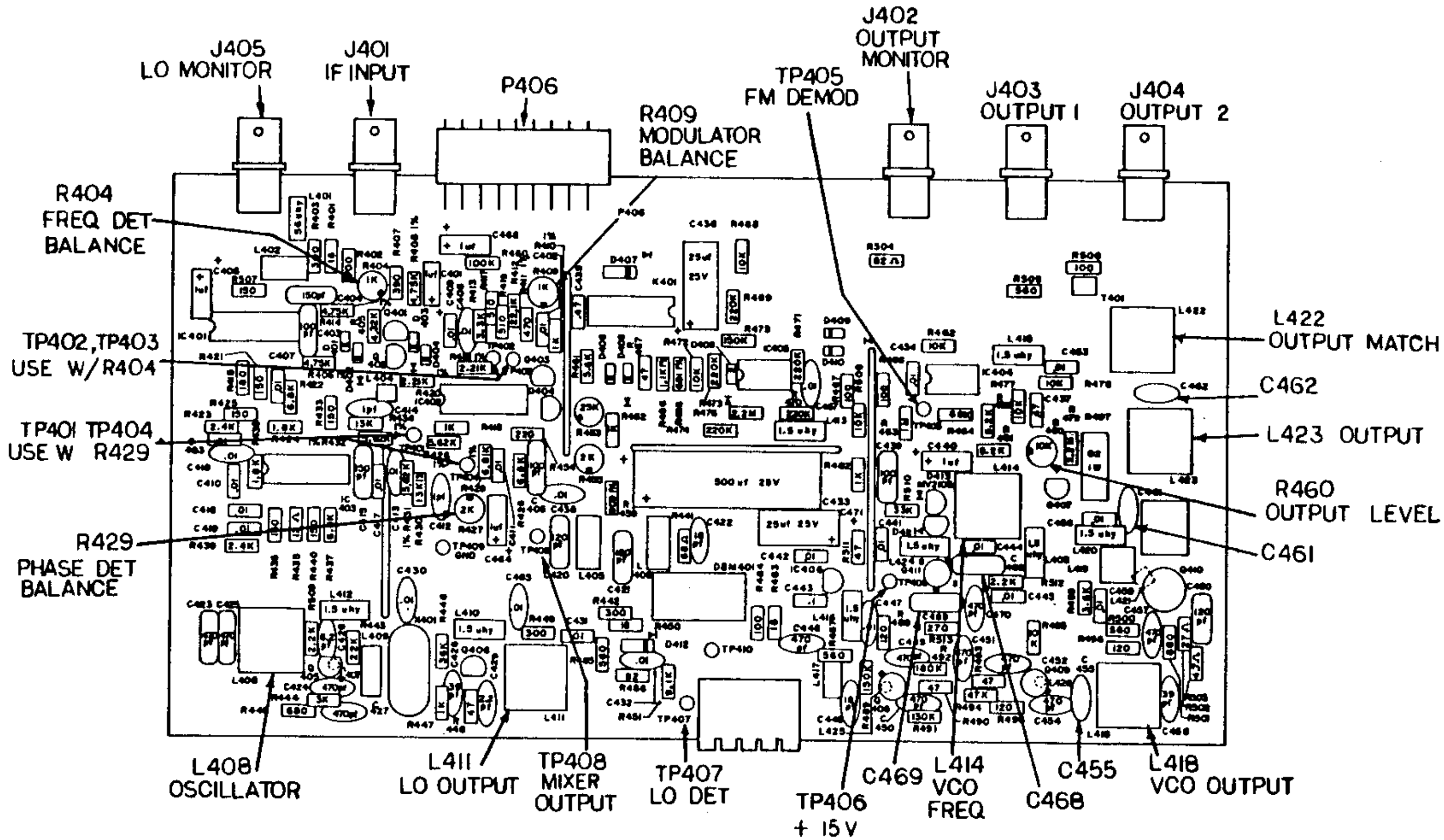


Figure 4.6.1

PHASE-LOCKED LOOP P.C. BOARD

4.7: MODULATOR BOARD

4.7.1: Specifications

Audio Performance:
- Frequency Response.................. ±2dB 50Hz - 15kHz
- Total Harmonic Distortion............ 2%
- Signal to Noise Ratio................ 40dB minimum
- Input Impedance...................... 600 Ω ±1% balanced
- Input Level for 75kHz deviation...... +3dBm nominal, adjustable ±6dB

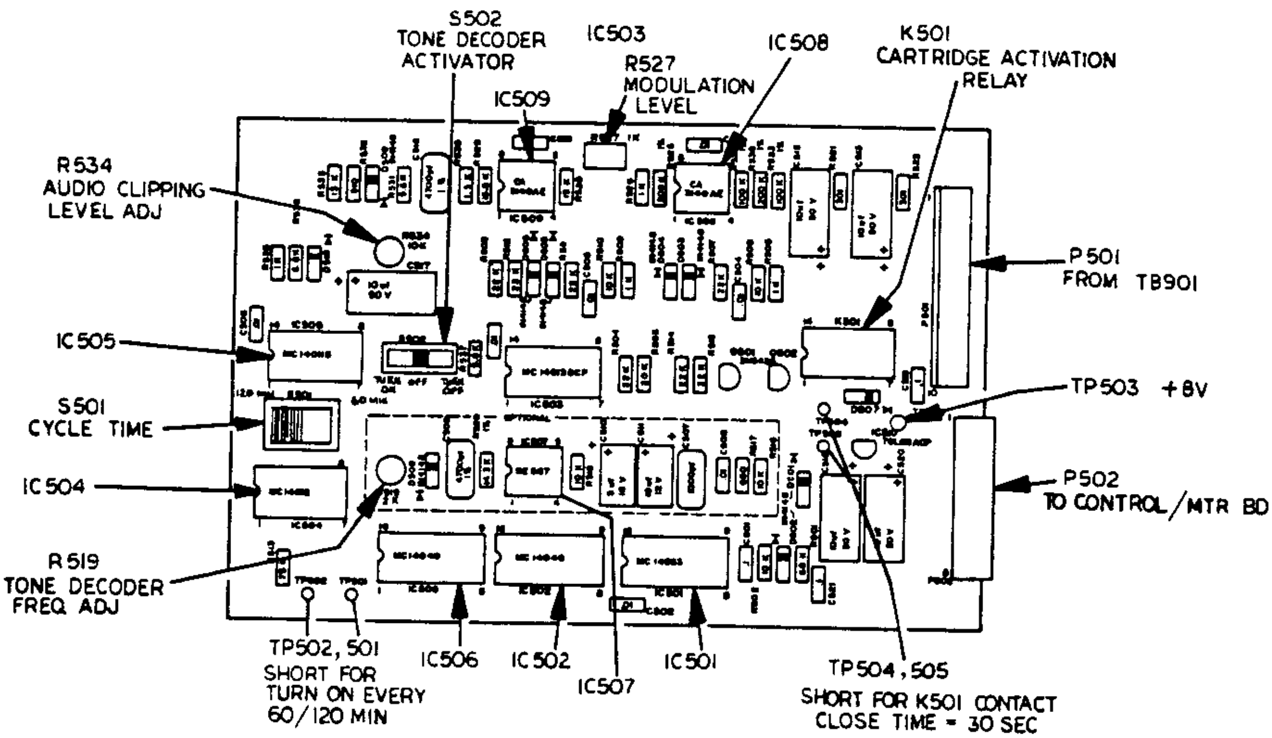
Tone Decoder:
- Activation Frequency................. 15kHz ±150Hz standard
  Any other freq. ±2% optional
- Activation Time...................... 1 second nominal

Power Supply Requirements............... +24 volts @ 20mA

Relay Contacts:
- Closure Time......................... 1 second minimum
  30/60 seconds optional
- Contact Rating....................... 350mA @ 8VA

FIGURE 4.7.1

MODULATOR BOARD



4.7.2: The deviation metering must be recalibrated if the output channel is changed. To do so, you need to obtain a reference reading at the original channel frequency. You must have the test equipment listed in Table 4.7.1 before proceeding.

TABLE 4.7.1

MINIMUM EQUIPMENT FOR RECHANNELING

1. FM Tuner with audio outputs for connection to oscilloscope or AC voltmeter.
2. Audio Signal Generator capable of producing 1 volt RMS into 600 ohms at 1kHz.
3. AC voltmeter or oscilloscope.

4.7.3: Operate the translator at the original output channel frequency into a dummy load. If a dummy load is not available, then disconnect the output jacks (J403 and J404) of the PLL Upconverter Board. An input signal must be present at the translators input jack. Press the DEV position on the multimeter switch. Commence the following procedure:

1. Connect the tuner's RF input to the OUTPUT MONITOR jack on the front panel. Alternatively, a short length of wire may also be used to pickup the translator's output.
2. Tune the tuner to the translators output frequency. Connect the oscilloscope or AC voltmeter to the tuner's output. Adjust the range switch of the scope/voltmeter to get an on screen/scale reading.
3. Connect the audio signal generator to the audio input terminals of TB901 on the back panel. Set the generator's frequency to 1kHz and its output level at 1 volts RMS. If the generator's output is unbalanced, then connect the output to one side and ground on TB901. In this case the generator must supply 2 volts RMS into 300 ohms.
4. Ground the MOD ENABLE terminal of TB901. Adjust the signal generator's output to obtain 75kHz DEV on the multimeter.
5. Measure the output level of the tuner on the oscilloscope or AC voltmeter. Write this level down.
6. You may now rechannel the output section of the translator according to Sections 4.6 and 4.8 or 4.9. When the translator is operating on the new channel frequency, reconnect the tuner, voltmeter, and signal generator as in Steps 1, 2, and 3.
7. Ground the MOD ENABLE terminal on TB901 again. Adjust the signal generator's level to obtain the same level at the output of the tuner you measured in Step 5.
8. Adjust R638 the DEV CAL pot on the Control and Metering Board (see Figure 4.11.1) so the DEV position reads 75kHz.
9. The deviation metering is now recalibrated. You may now adjust R527, the MODULATOR LEVEL ADJUSTMENT to match the audio input sensitivity to the program source.

Troubleshooting and Repair

4.7.4: The test equipment in Table 4.7.2 must be available for troubleshooting the modulator board. The areas of difficulty are broken down in the following paragraphs. Go to the paragraph that most accurately describes your problem. Refer to Figure 4.7.1 for component/test point locations. The first thing to do in any difficulty is to ensure the board is being powered from the supply. With the unit operating, check the +24 volt at P502-7. Also check the +8 volt regulated voltage on the board at TP503.

TABLE 4.7.2

MINIMUM TEST EQUIPMENT FOR REPAIRING/TROUBLESHOOTING

1. Triggered sweep DC coupled oscilloscope. Tektronix T922 or equivalent.
2. Multimeter, Data Precision, Model 185 or equivalent.
3. Audio Signal/Function Generator.

4.7.5: No Audio, Modulator Activates. This usually means the trouble is in the audio circuitry. The first thing is to ensure R527 the MOD LEVEL control is not fully counterclockwise. Connect the audio signal generator to T901 at the back of the translator. Set the generator's output level at 1 volt RMS and its frequency at 1kHz. Measure the voltage at P501-9 and/or P501-10 on the modulator board. It should be the same as the output of the generator. Next check the output of IC508 at Pin 6. The voltage should be at +8 volts DC, with an AC component that is twice the voltage difference between P502-9 and P502-10. If the DC voltage is either at +22 or 0 volts or no audio is present, then IC508 is probably bad.

4.7.6: Next, trace the audio through R527 and to the input (Pin 3) of IC509 The AC voltage at Pin 3 of IC509 should be one-half the voltage at Pin 6 of IC508 when R527 is fully clockwise. The AC voltage at the output of IC509 (Pin 6) should be the same as on its input (Pin 3). As with IC508, the DC voltage on the output of IC509 should be at +8 volts. From the output of IC509, check the AC voltage at P502-4. It should be from 1/7 to 1/2 the AC voltage at the output of IC509. If the AC voltage is present, the fault is either in the interconnection between this board and the PLL Upconverter Board, or on that board itself. Refer to Section 4.6.

4.7.7: Modulator does not turn off once activated. If the modulator turns off when the MOD DISABLE terminal is grounded, then the problem is in the timer circuitry. Go to the next paragraph. However, if the modulator does not manually deactivate, the problem is either IC505 or IC503. Connect the scope to Pin 12 or 13 of IC505. The voltage should be at +8 volts. If it is less than 7 volts, IC505 is bad. Ground the MOD DISABLE terminal with the scope connected to Pin 12 of IC505. The voltage should briefly drop to ground and return to +8 volts. If no drop in voltage is seen, the problem is in the input network of IC505B or the connection from TB901 to the board. Finally, check the voltage at Pin 4 of IC503. This point should be at ground and will rise to +8 volts briefly when the MOD DISABLE terminal is grounded. If this pulse is present, IC503 is probably bad. If it is not, then IC505 is bad.

4.7.8: With an oscilloscope, check the 60Hz at P502-2. It should be at least 8 volts peak to peak. Verifying this, check the voltage at Pin 4 of IC501. It should be a 60Hz square wave that swings from 0 to +8 volts. If no voltage is present, IC501 is probably bad.

4.7.9: To check the 30 second timer, look at Pins 5, 12, 14 and 15 of IC502 with the oscilloscope. You should see a square wave with a lower frequency than the 60Hz. The period of the waves at Pins 12, 14, and 15 should be 7.5, 15, and 30 seconds respectively. If no square waves are present and Pin 11 is at ground, then IC502 is bad.

4.7.10: The voltage at Pin 9 of IC505 should be at +8 volts. If this voltage is low, then IC505 is bad. Next, check to see if a reset pulse is present at Pin 11 of IC502. The best way to do this is to set the trigger on the scope to normal (not the auto) position. If the reset pulse is present, the trace should appear once every 30 seconds. If no reset pulse is present either IC504 or IC505 is bad.

4.7.11: Tone Decoder not operational. The first thing to do is to check if S502 is not in the center position. Manually activate the modulator and apply a tone at the AUDIO INPUT terminals with the signal generator. Set the signals generator's frequency to the same as the activation frequency. Adjust the level for 75kHz deviation. With the oscilloscope, check for the presence of the signal at Pin 3 of IC507. It should be approximately .3 volts peak to peak. If no signal is present the fault is in the PLL Upconverter Board. Next connect the scope to Pin 6 of IC507. A sawtooth waveform should be present at a frequency very close to the activation frequency. If no sawtooth wave is present, IC507 is bad. Finally, connect the scope to Pin 8 of IC507. If Pin 8 is not at ground try turning R519 slowly. If Pin 8 does not drop to ground IC507 is probably bad.

4.7.12: 60 Minute Timer does not work. Check the 30 second timer by manually activating the modulator and observing it shut off after 30 seconds. If it does not, the problem is in the 30 second timer. Refer to Paragraph 4.7.8. Next check to see if TP501 and TP502 are shorted together. If they are, then IC506 is probably bad.

4.8: 1 WATT POWER AMPLIFIER BOARD

4.8.1: Specifications

Input:

Frequency....................	88 to 108 MHz
Impedance....................	50 ohms
Return Loss..................	10dB typical
Drive Power..................	+16dBm nominal

Output:

Power........................	1 watt
Impedance....................	75 ohms
Harmonics....................	-80dB 2nd Harmonic
	-70dB 3rd Harmonic
VSWR Capability..............	2:1 for 1 watt output
	∞:1 indefinate

Overall:

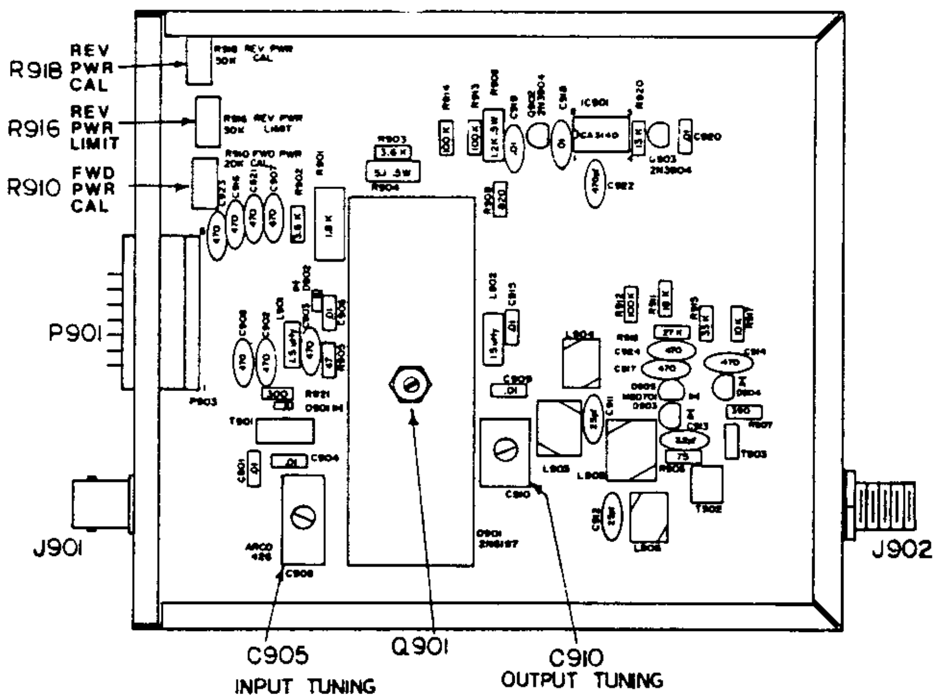
Maximum Power Gain...........	17dB typical
AGC Range....................	10dB minimum
Power Requirement............	24 VDC @ .14 amps

Alignment (Rechanneling)

4.8.2: No test equipment is needed for rechanneling. Refer to Figure 4.8.1 for component location.

Figure 4.8.1

1 WATT POWER AMPLIFIER



1. The PLL Upconverter Board should first be aligned and operating. Remove the module from the chassis and connect the antenna or dummy load to J902.
2. Connect the driving signal from the PLL Upconverter Board to J901. Turn the power level control on the front panel all the way up. Press the FWD power button for the module being aligned. Also, monitor I_{PA} for the module.
3. Tune C905 and C910 respectively to peak the output. Repeat these adjustments as they are somewhat interactive. The output power should be above 2 watts.

4. Turn the power level control down to 1 watt. I_{PA} should be below 160mA.

5. Disconnect the output. Push the REV PWR button for the module being tested. The power meter should read from .15 to .2 watts. Adjust R916, REV PWR TURN DOWN, if the REV PWR is outside these limits.

6. The FWD and REV CAL pots do not need to be adjusted.

Repairing

4.8.3: The most common complaint is little or not output power. The output level from the PLL Upconverter Board should first be checked and must be above 16dBm. Verifying this, check the REV PWR position to ensure the reverse power is under .1 watt.

4.8.4: Turn the OUTPUT PWR control on the front panel all the way up. Measure the voltage at the emitter of Q902. It should be over 20 volts. If it is, go to the next paragraph. Measure the output (Pin 6) of IC901. If it is above 20 volts then Q902 is bad. If it is well below 20 volts, IC901 is probably bad. To verify this measure the voltages at Pins 2 and 3. If IC901 is bad, Pin 3 will be higher than Pin 2. If it isn't the fault lies somewhere in the line to the output level control.

4.8.5: Measure the voltage across R909. It should be approximately 1.5 volts. If it is under .5 volt or over 3 volts, then D901 is bad.

4.8.6: With RF drive disconnected, measure the voltage at Q901's base. It should be above .5 volt. If it is below this, then Q901 is bad.

4.9: 10 WATT POWER AMPLIFIER BOARD

4.9.1: Specifications

Input:

Frequency....................88 to 108 MHz
Impedance....................50 ohms
Return Loss..................10dB typical
Drive Power..................+16dBm nominal

Output:

Power........................10 watts
Impedance....................75 ohms
Harmonics....................-80dB 2nd Harmonic
-70dB 3rd Harmonic
VSWR Capability..............2:1 for 1 watt output
∞:1 indefinate

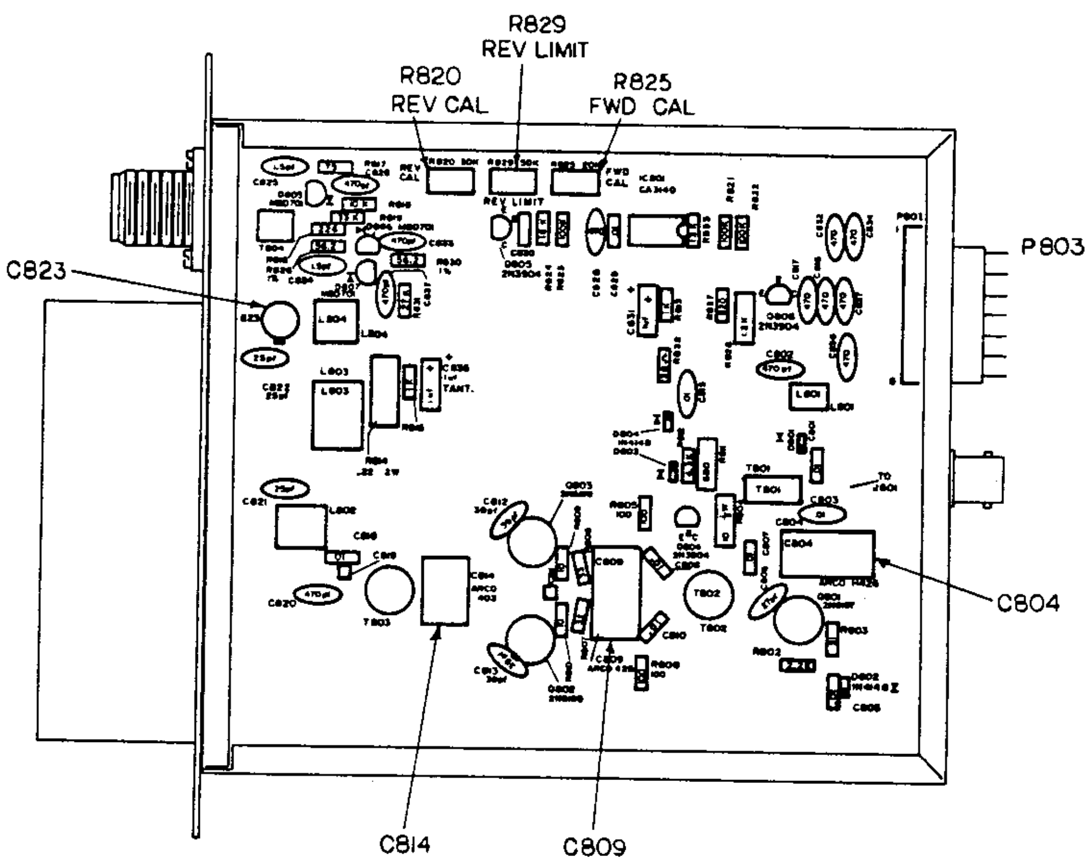
Overall:

Maximum Power Gain...........23dB typical
AGC Range....................10dB minimum
Power Requirements...........24 VDC @ 1.2 amps.

Alignment (Rechanneling)

4.9.2: No test equipment is needed for rechanneling. Refer to Figure 4.9.1 for component location.

Figure 4.9.1
10 WATT POWER AMPLIFIER



1. The PLL Upconverter Board should first be aligned and operating. Remove the module from the chassis and connect the antenna or dummy load to J802.

2. Connect the driving signal from the PLL Upconverter Board to J801. Turn the power level control on the front panel all the way up. Press the FWD power button for the module being aligned. Also, monitor I_{PA} for the module.

3. Tune C804, C809, and C814 respectively to peak the output. Repeat these adjustments as they are somewhat interactive. The output power should be above 18 watts.

4. Turn the power level control down to 10 watts. I_{PA} should be below 1.3A

5. Disconnect the output. Push the REV PWR button for the module being tested. The power meter should read from 1.5 to 2. watts. Adjust R916, REV PWR TURN DOWN, if the REV PWR is outside these limits.

6. The FWD and REV CAL pots do not need to be adjusted.

Repairing

4.9.3: The most common complaint is little or no output power. The output level from the PLL Upconverter Board should first be checked and must be above 16dBm. Verifying this, check the REV PWR position to ensure the reverse power is under 1 watt.

4.9.4: Turn the OUTPUT PWR control on the front panel all the way up. Measure the voltage at the emitter of Q806. It should be over 20 volts. If it is, go to the next paragraph. Measure the output (Pin 6) of IC801. If it is above 20 volts, then Q806 is bad. If it is well below 20 volts, IC801 is probably bad. To verify this measure the voltages at Pins 2 and 3. If IC801 is bad, Pin 3 will be higher than Pin 2. If it isn't the fault lies somewhere in the line to the output level control.

4.9.5: Measure the voltage across R827. It should be approximately 1.5 volts. If it is under .5 volt or over 3 volts, then D801 is bad.

4.9.6: With RF drive disconnected, measure the voltage at Q801's base. It should be above .5 volt. If it is below this then Q801 is bad.

4.9.7: Likewise, measure the voltages at the bases of Q802 and Q803. They should be .6 volt. If it is below .5 volt, check the voltage at Q804's base and emitter. It should be 1.3 and .8 volts respectively. If the voltages at Q804 are near normal and the voltage at Q802 and Q803 bases are low, it usually means either Q802 or Q803 are bad. To find which one is bad, disconnect one lead of either R809 or R810 from its pad and disconnect both R805 and R808. Remove the RF drive from the PLL Upconverter Board. While monitoring the I_{PA} position, turn on the translator. The I_{PA} should indicate from .1 to .4 amps. Measure the base's of Q802 and Q803. A reading below .5 volt or above .75 will mean that transistor is bad. Remember you must have an accurate meter (preferably a DVM).

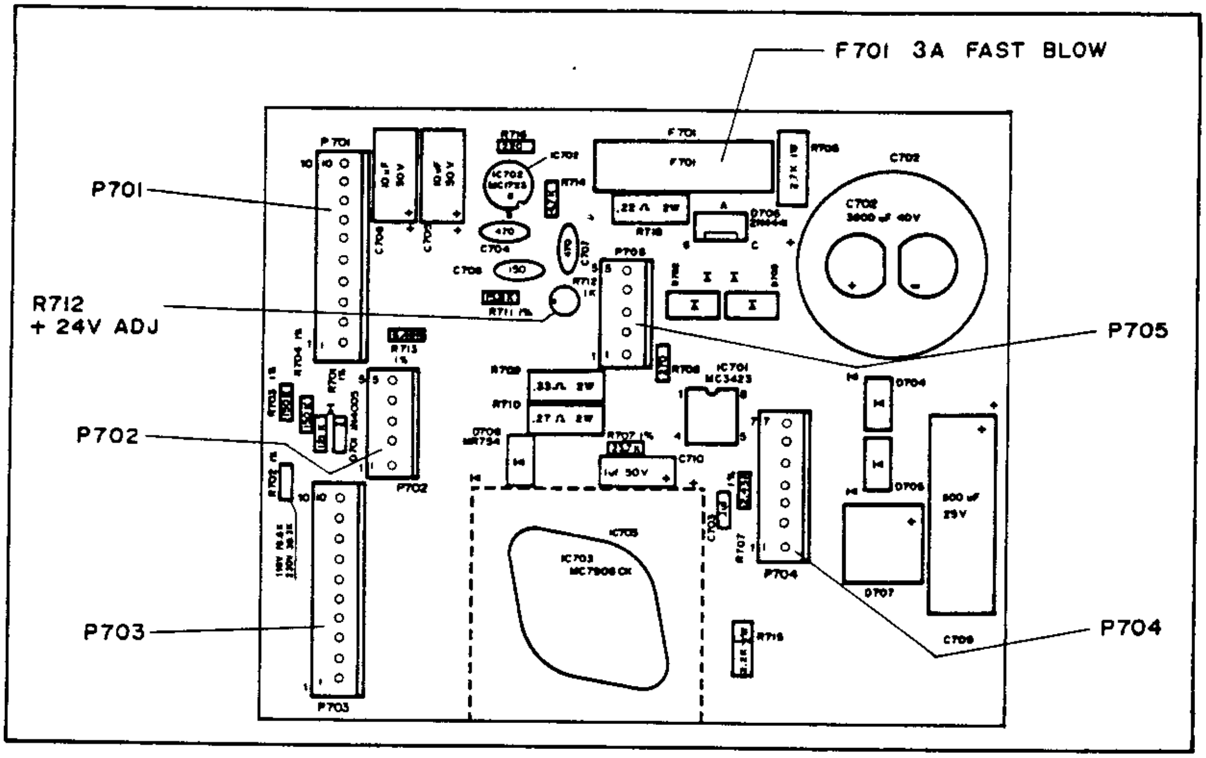
4.10: POWER SUPPLY BOARD

4.10.1: Specifications

Output Voltage..............................	24V	±.5V, -8V ±.5V
Nominal Output Current....................	24V:	3A maximum
	-8V:	
Current Limit Point.......................	24V:	4.5A
	-8V:	1A
Overvoltage Trip Point....................	28V	±1.5V
Thermal Switch Cutout Point...............	70°C	

Figure 4.10.1

POWER SUPPLY P.C. BOARD



Alignment

4.10.2: No adjustment is necessary for rechanneling. Adjustment of the +24V is necessary only if IC702 is replaced. Adjust R712 so the +24V position on the multimeter reads 24 ± .5V or the same value that is indicated on the Factory Test Data Sheet. Make sure the multimeter is mechanically zeroed. Refer to Figure 4.10.1 for the location of R712. The -8 volt supply voltage is fixed by IC703.

Repair

4.10.3 When troubleshooting the power supply, disconnect P701 to remove the rest of the translator circuitry from the Power Supply. Refer to the paragraph which describes the problem.

+24 Volt Supply

1. Check the fuse, F701. If it is not blown, go to Step 4. If so, it usually means the overvoltage crowbar has been activated. Remove IC901 from its socket and unplug P705. Replace the fuse and turn on the translator. If the fuse blows again, D706 is shorted. Replace it (or cut it out temporarily) and go to the next step.

2. Remove IC702 from its socket and plug P705 back in. Measure the voltage at P701-6; if it is above +28V, Q101 is shorted. IC702 will probably be bad also.

3. If the voltage measured in step two is near zero volts, plug IC702 back in and measure the voltage at P701-6 again. If it now is 28 volts or above, IC702 is bad. If the voltage is 24 ±1 volt, the overvoltage crowbar was triggered by a line surge or transient. Replug IC701 back in its socket.

4. Measure the voltage across C702. It should be above 28 volts. If it is not, the rectifiers, D702 through D705, may be bad or the problem is in the primary circuit.

5. Measure the voltage at P705-4. If it is more than 1.5 volts above the voltage at P701-6, Q101 is bad. However, if it is less than 1.5 volts, IC702 is bad.

-8 Volt Supply

1. Check the voltage across C709. If it is under 10 volts, D707 may be bad. Otherwise IC703 is open.

4.11: CONTROL & METERING BOARD

4.11.1: Specifications

Audio Monitor:

Output Level........................3.5 volts RMS open circuit
2.5 volts RMS into 600 ohms
Frequency Response.................100Hz - 15kHz ±3dB
THD................................Nominally 2%
19kHz Suppression..................> 20dB
Separation.........................26dB

Deviation Monitor:

Frequency Response.................+1, -2dB 30Hz - 75kHz

Rechanneling

4.11.2: No adjustment is needed when rechanneling. However, the deviation metering must be recalibrated when changing channels on modulator equipped translators. Refer to Chapter 4.7 for calibration instructions.

Alignment

4.11.3: The only alignment required is the adjustment of R628 whenever IC602 is replaced. Adjustment of this pot is optional and requires the use of an audio frequency counter. If you do not adjust R628 after replacing IC602 you may suffer a slight loss of stereo separation at the audio monitor output. R628 does not affect the stereo separation of the signal traveling through the translator.

Adjustment of R628

4.11.4: Connect a frequency counter to TP601. Refer to Figure 4.11.1. Remove the input signal to the translator and adjust R628 for a frequency of 19.0kHz.

Repair

4.11.5: Loss of Audio. Using an oscilloscope, check for audio at P603-6. The voltage should be at least 3 volts peak to peak. If there is no audio at this point, then the problem is back at the PLL Upconverter Board. Refer to Chapter 4.6.

4.11.6: If there is audio at P603-6, then check the voltage at Pin 1 of IC602. It should be 12 ±1.5 volts. Very low or zero volts at this point means IC605 is probably bad.

4.11.7: Check for audio at Pins 4 and 5 of IC604. The oscilloscope should be AC coupled. The signal at these points should be approximately 1 volt peak to peak. If no signal exists at either of these pins, IC602 is bad.

4.11.8: Trace the audio from Pins 4 and 5 of IC602 through R617 to Pin 2 of IC603 and IC604. There should be no audio at this pin. If audio is present, the respective IC is bad. Usually, when either IC603 or IC604 is bad, the output at Pin 6 goes either to +22 or -7 volts. Normally the output of these IC's swing around ground.

4.11.9: Loss of Deviation Metering. Check for audio at P603-6 as per Paragraph 4.11. Also check the voltage at Pin 1 of IC602 per Paragraph 4.11.6.

NOTE: The DEV position does not operate when there is no input signal to the translator.

4.11.10: IC601 usually is the culprit, if the checks in Paragraph 4.11.8 are ok. If IC601 is bad, its output at Pin 6 usually is at either +10 volts or -8 volts.

EXHIBIT 2b

PUBLICATION TIM 4501-210

Related Publications:
IM XLFM

TECHNICAL INSTRUCTIONS
for
500 WATT FM TRANSLATOR
MODEL XL500 FM

LARCAN-TTC INC.
650 South Taylor Avenue
Louisville, Colorado 80027
USA

PHONE: (303) 665-8000
FAX: (303) 673-9900

Rev 0, March 1998

LIMITED WARRANTY

All LARCAN-manufactured Equipment, except as otherwise noted below, is warranted against defects in material and/or workmanship which arise under proper and normal use within two (2) years after the date of shipment. LARCAN's liability excludes any and all labor charges and is limited to the repair or replacement at its plant of part(s) or product(s) found by LARCAN in its sole judgment to be defective. LARCAN shall pay normal outbound freight from factory to Customer locations during this warranty period. All other shipping and related charges in connection with this warranty shall be borne by the Customer. This warranty does not cover fuses, lamps, used equipment, or reconditioned Equipment. LARCAN may request the return of defective parts replaced under warranty. Should Customer not return such parts within 60 days from Date of Request, Customer shall be responsible to pay LARCAN the full value of the replacement parts.

Customer's failure to maintain or operate the Equipment properly, including, but not limited to, failure to perform recommended service, operation of the Equipment without proper ventilation, operation of the Equipment at ambient temperatures outside the published temperature range, etc., will void this warranty. LARCAN Equipment designed for three-phase AC line operation requires closed Delta or Wye power service. Operation of this Equipment on an open Delta power service will void this warranty. When the sales contract includes turn-on service or proof-of-performance testing provided by LARCAN, this warranty will be void if power is applied before LARCAN's representative is present and approves the Equipment installation. This warranty shall not apply to any Equipment which has been modified or repaired by anyone other than LARCAN without LARCAN's written authorization.

ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY EXCLUDED. UNDER NO CIRCUMSTANCES SHALL LARCAN BE LIABLE TO CUSTOMER OR ANY OTHER PERSON FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO DAMAGES FOR OFF-AIR TIME, WHETHER ARISING OUT OF BREACH OF WARRANTY, BREACH OF CONTRACT, OR OTHERWISE, AND WHETHER OR NOT LARCAN HAS NOTICE THAT CUSTOMER MAY INCUR SUCH DAMAGES. LARCAN'S LIABILITY, WHETHER BASED ON WARRANTY, CONTRACT, NEGLIGENCE OR OTHERWISE, SHALL NOT IN ANY CASE EXCEED THE PRICE PAID TO LARCAN FOR THE EQUIPMENT. SOME STATES DO NOT ALLOW EXCLUSION OF IMPLIED WARRANTIES, AND SOME STATES DO NOT ALLOW EXCLUSIONS OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE EXCLUSIONS MAY NOT APPLY TO A CUSTOMER. THIS WARRANTY PROVIDES SPECIFIC LEGAL RIGHTS, AND A CUSTOMER MAY ALSO HAVE OTHER RIGHTS THAT VARY FROM STATE TO STATE.

The manufacturer's warranty on each major component of the Equipment produced by other manufacturers, including, but not limited to, tubes, klystrons, and beam/power supplies, shall apply in lieu of this warranty.

This warranty is not transferable and may not be altered or amended in any manner.

Effective February 3, 1994

XL500 FM TECHNICAL INSTRUCTIONS

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1. INTRODUCTION

1.1 DOCUMENTATION

We supply technical manuals with our products that describe the use and operation of the equipment. All but the functional description in this manual should be understood before operating or using the equipment.

This manual has been organized in a logical, easy-to-use manner as follows:

- Introduction describes company practices and contains general information.
- Overview describes the equipment in general terms.
- Installation contains procedures for positioning equipment and connecting cables for operation.
- Initial checkout contains operating instructions and general trouble-shooting.
- Functional description describes the circuitry from input to output.

Each circuitry section is organized to include the following items in the order listed, if available:

- Section title page with assembly part number and schematic/drawing numbers
- Technical description of circuit
- Alignment/tuning procedure
- Schematic
- PC board layout
- Parts list

Please make a copy of the Factory Test Data Sheet and keep the copy with the station/site files. The operator, owner, and service personnel must read the hazard warning and the legal notices.

1.2 CUSTOMER SERVICE

We are committed to providing customers with the finest value products available. This begins with engineering the product to meet the customer's needs and governmental regulations. Our factory is ever vigilant in finding better ways to build products. Our customer service department is ready to assist you with information to help solve installation and service problems. We have field service engineers available for on-site service and installation.

After hours, weekends, and holidays, you can contact us at our regular telephone number for service assistance. You will be given a procedure to contact the on-duty service engineer. If you need emergency replacement parts shipped to you, you must have a valid Visa or Master Card credit card with enough account credit for the parts to be shipped to you. However, if you have an account established with us and the account is current with a sufficient amount of credit available to cover the cost of the parts and all shipping costs, the parts can be shipped and charged to your account. Be sure to check with our accounting department to arrange an adequate credit limit to cover the highest expected parts order and attendant shipping and handling charges.

Normal business hours are Monday thru Friday from 8 AM to 5:00 PM Mountain time.

1.3 Product Service Bulletins

We issue letters periodically that describe improvements in equipment performance and reliability, or notify customers of pertinent information. Your name and address must be on file with us to receive these mailings.

1.4 Warranty Registration

A warranty registration form is included with the packing materials. If you do not find the form, notify Customer Service to obtain another, or supply the following information:

- Equipment model # and serial #
- Frequency or channel and input voltage and frequency
- Customer/User name and address
- Contact person's name and phone number
- Address of person to receive technical bulletins, if different from customer
- Dealer/Representative name
- Would you like to open an account for parts?
- Remarks or comments

1.5 Shipping

When you receive the equipment, you should examine the packaging for any obvious damage to the shipping container. If there is damage, it should be noted on the receiving documents. The cartons or crates should be opened to inspect for hidden damage immediately. If hidden damage is found, it MUST BE reported to the shipping company **within 7 days** of receipt to become a valid claim. It would be a good idea to gather the particulars of the situation, including but not limited to:

- Waybill number
- Shipping contractor
- Destination
- Customer name
- Dealer name
- Equipment type
- Value
- Description of damage
- Polaroid pictures

Shipping damage is the responsibility of the carrier, not LARCAN. We cannot guarantee a carrier's performance.

We cannot stress too strongly the importance of IMMEDIATE, careful inspection of your newly received goods and the subsequent IMMEDIATE filing of any claims against the carrier in the event of a damaged or incomplete shipment. ICC regulations in the United States require notification to the carrier of any claims **within 7 days** of receipt of the shipment.

In the presence of the shipper's delivery person, inspect for the following:

- Damage to the carton(s)
- Signs of carton repacking

While inspecting for damage, use the packing slip to be sure the shipment is complete and that no equipment items have been left in the packing materials. Because the foam-filled packing boxes make an excellent container for shipping the equipment around, we recommend retaining the shipping cartons for future use.

We may use devices to monitor the "G" forces to which equipment is subjected in shipping. Do not refuse shipment because the device has been triggered, but please make note of the triggering on the shipping documents and keep a copy of the receiving documents for your own protection. Please send a photocopy of your receiving papers with the notation of device triggering to our Customer Service. This helps us determine which shipping companies to use.

1.6 UNPACKING

Within 7 days of delivery, check the Exciter for the following and file claims with the carrier:

- Concealed damage
- Missing items - check ALL items against the shipping documents

Look carefully for small items, such as connectors and cables, within the packing materials.

Remember, the carrier is your first recourse in the event of damage or loss. We would like to know about any problems you have with the carrier so reliability and performance can be established. If the carrier doesn't handle the claim reasonably, please provide us with copies of any correspondence, shipping documents, and extra copies of damage photos. We must be notified within 30 days of the delivery to be of any help.

If, for ANY reason, the unit must be returned to the factory, a RETURN AUTHORIZATION must be obtained from the Customer Service department. We cannot accept returns without Return Authorization.

After giving notice of damage to the carrier, notify our customer service department of the situation. Sometimes we can provide a loaner exciter to get your station back on-the-air.

1.7 PRODUCT SAFETY

All of our products are manufactured to commercial and industrial standards. Safety precautions have been incorporated with the express intent that users will be knowledgeable and experienced in the operation of this type of equipment. We assume no liability for injury, death or damages arising from the use, operation or installation of these products.

Caution!

International Standards (IEC 215) require the owners of broadcast equipment to employ technicians familiar with the operation and maintenance of this type of industrial equipment. If the technician is not familiar with this equipment, the owner must provide adequate supervision and training for the technician's safety - including hazardous materials handling, first aid, and RF radiation exposure hazards.

Warning!

THIS EQUIPMENT CONTAINS HAZARDOUS VOLTAGES WHICH CAN CAUSE INSTANT DEATH. NO ATTEMPT SHOULD BE MADE TO DEFEAT THE PROTECTIVE SYSTEMS. INSTALLATION, ADJUSTMENT, AND MAINTENANCE OF THIS EQUIPMENT MUST BE PERFORMED BY A QUALIFIED BROADCAST TECHNICIAN FAMILIAR WITH THE OPERATIONS AND HAZARDS OF HIGH POWER RF TRANSMITTING EQUIPMENT.

1.8 HAZARD WARNINGS!

Modern electronic circuits use exotic materials in order for them to operate efficiently and last a long time. Follow all warnings listed in this section as well as those listed in various places throughout this manual.

1.8.1 Fire/Smoke

Materials used in the manufacture of electronic components may give off poison gases when burned. If electronic equipment catches fire, put out the fire with a Class B rated fire extinguisher. Avoid breathing any fumes or smoke from the fire. If fumes are inadvertently inhaled, proceed to a hospital emergency room or physician's office for appropriate treatment.

1.8.2 RF Radiation

IEC and ANSI standards have been set for human exposure to high level RF fields. The Federal Communications Commission has adopted rules on safe exposure levels and time periods of exposure.

In many areas of this unit and its associated modules, potentially lethal RF levels exist. These areas are normally shielded. However, these same areas must be uncovered for servicing and the potential for serious RF burns exists.

1.8.3 Solder

Solder is made of a tin and lead alloy. Lead is a soft metal and rubs off on hands easily. Wash your hands after handling solder. Lead is poisonous and is known to cause brain damage with constant exposure. Do not breath smoke from the soldering process.

1.9 EQUIPMENT SERVICING

When servicing this equipment, observe these cautions and procedures:

- Deactivate all equipment for several minutes prior to servicing.
- Verify that all power is disconnected from the unit and cannot be accidentally or intentionally reapplied by any person other than yourself.
- Tag and ground all hazardous voltage and RF points to assure discharge of capacitors and prevent electrocution in the event the RF Driver should inadvertently be turned ON.
- Power transistors and regulators must have an even coating of heatsink compound and be mounted snugly.
- Handle FETs with great care. Static charges can destroy them. Ground yourself and your tools before handling them. Keep the FETs in their protective wrapping until installation time and move them to the PC board with the leads shorted together. Do not install FETs in "live" equipment.

1.9.1 Drawings/Schematics

Schematics may not show power and ground connections to all integrated circuits. When this is the case, a table will be given where IC pin numbers are listed with the appropriate connections for DC voltage(s) and ground. Pentagonal flags are used when a circuit is continued somewhere else in the drawing, including those circuits on a second sheet of the drawing.

1.9.2 Replacement Parts

We will supply replacement components at current prices. Some components, such as fixed resistors and capacitors, may be available locally. You may use these sources of components only if the part obtained is the exact equivalent. Capacitors and resistors should be replaced only with the same type, tolerance, and temperature ratings. For example, a 22 pF NP0 disc ceramic capacitor may not be replaced with a 22 pF Z5U or a 22 pF silver mica capacitor.

Use of equivalent replacement semiconductors is discouraged in any RF socket since it may fail FCC specifications or even fail to operate at all. Use equivalent replacement semiconductors in the power supplies, DC circuits and non-critical control circuits only.

When ordering parts from our factory, please specify the equipment model and serial number. This will allow us to give you information on new parts.

The part number is listed in the last column on the parts list. Please supply that number and the description, such as C404 .22uF monolithic capacitor, when ordering parts. It is also helpful to know where the component is used, what module or PC board. When engineering makes production changes to improve performance, we can let you know and supply the current value part and any information associated with it.

If the parts are used in a standard or frequency selective module or PCB, be sure the parts ordered are used in the frequency range where the equipment operates, or on the standard used in your country. If there is any doubt, contact our customer service department for clarification.

To assure speedy routing and order handling, please mark the envelope or fax "Attention: Customer Service - Parts Order". If the order is confirming a telephone or fax order, mark the order "CONFIRMING - DO NOT DUPLICATE".

Table 1. SPECIFICATIONS

RF OUTPUT	
Frequency Range:	88 to 108 MHz
Power Output, Nominal:	500 Watts
Limits:	525 Watts Maximum, 15 Watts Minimum
RF Output Connector & Impedance:	50 ohm N connector
VSWR, Maximum Operating:	Approximately 2:1
RF Harmonics:	- 70 dB below carrier
RF INPUT	
RF Drive Requirement:	8 Watts, Average
RF Drive, Maximum:	12 watts or Test Sheet #
RF Input Connector & Impedance:	50 ohm N connector
NOISE PERFORMANCE	
AM	>- 70 dB, Async.; - dB, Sync.
FM	- 80 dB
ENVIRONMENTAL	
Ambient Temperature	-30 deg. C to +45 deg. C
Relative Humidity	0 to 95%, non condensing
Altitude	7,000 Feet, AMSL
Cooling	Forced Air, 200 CFM including AC Power Supply
ELECTRICAL	
Voltage Input:	117 or 234 VAC, +/-15%; Auto-ranging
AC Line Frequency:	50/60 Hz
Power Consumption:	1000 VA, transmitter 900 VA, Amplifier only
DIMENSIONS	
Amplifier:	7" High, 19" Wide, 17" Deep
Transmitter:	17.5" High, 19" Wide, 19" Deep
Power Supply:	5.25" High, 19" Wide, 12" Deep
WEIGHT	
Amplifier:	20 lbs, 9.1 kg. (29 lbs boxed)
Transmitter:	66 lbs, 30 kg. (90 lbs boxed)
Power Supply:	23 lbs, 10.5 kg. (32 lbs boxed)

2. XL500 FM OVERVIEW

General

The XL500 FM consists of three parts; a 500-watt Amplifier Drawer, an XL10 FM Exciter, and a PS 500 AC Power Supply.

In the amplifier drawer, there is the 500-watt PA Module, the Harmonic/Low Pass Filter, control and metering circuitry, and a muffin fan. The PS 500 is the companion, switchmode power supply that produces +48 VDC for the PA Enclosure. The packaged power supply incorporates its own over-temperature, over- current, and over-voltage protection. The AC power switch, power on LED and 15 amp circuit breaker are mounted on the power supply front panel.

The PA Module contains two RF transistors, each of which produce about 250 watts of RF power. These devices operate in the Class AB mode for better audio performance. A Wilkinson-type In-phase splitter and combiner split the RF drive to feed the two RF devices and in-turn combine their two outputs to reach the 500-watt RF output level.

2.1 PA ASSEMBLY

RF input from the Exciter to the rear of the PA Module input N connector. The RF signal is amplified by the power amplifier and is sent through a Directional Coupler to measure forward and reflected power. Next the RF passes through the Harmonic Filter to a 50 ohm N connector on the rear of the PA Enclosure to feed the antenna system.

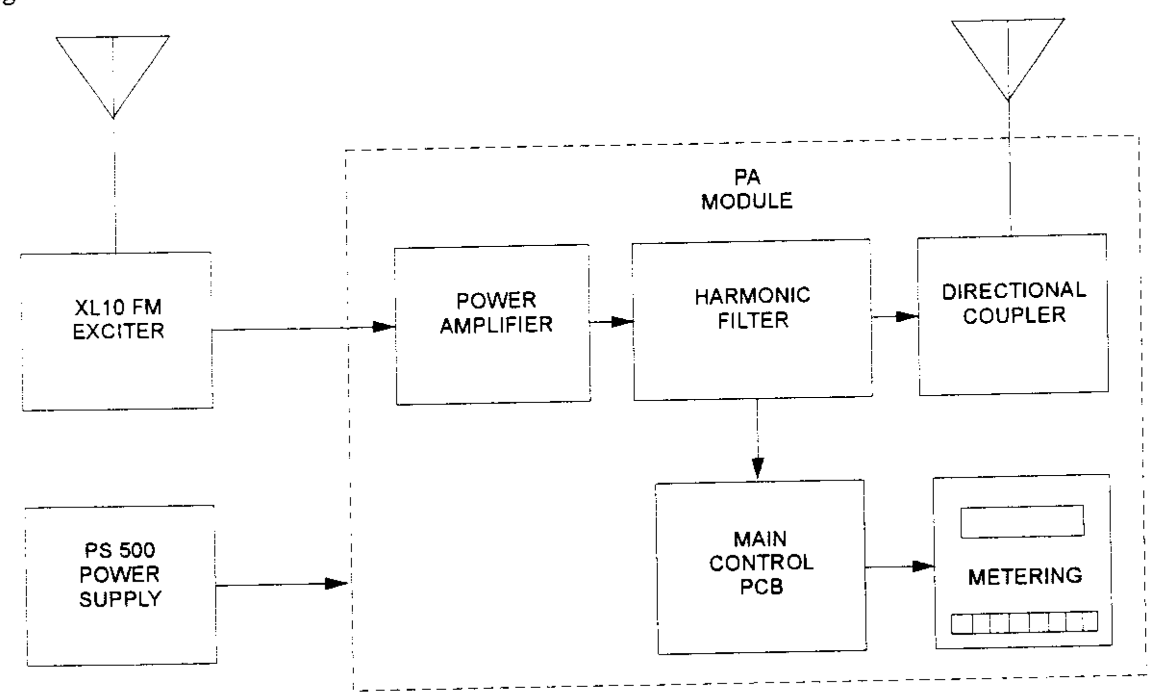

Figure 1. XL500 FM Block Diagram

RF power is controlled by a screwdriver adjustment through a hole on the exciter front panel. Directional coupler forward and reflected samples go to the Main Control PC Board for amplification and switching to the front panel Digital Multimeter. A temperature measuring IC on the PA Module feeds the Main Control PC Board for amplification and drives the temperature fault circuitry & metering.

2.1.1 Front Panel Metering

The front panel of the 500 Watt amplifier contains the Digital Multimeter, Bi-color LED status indicators, and the air inlet for PA. See Figure 2. There are seven parameters that are measured with the Digital Multimeter. The metered functions include PA 1 & PA 2 amps. These two readings allow you to see the current drawn by either RF device.

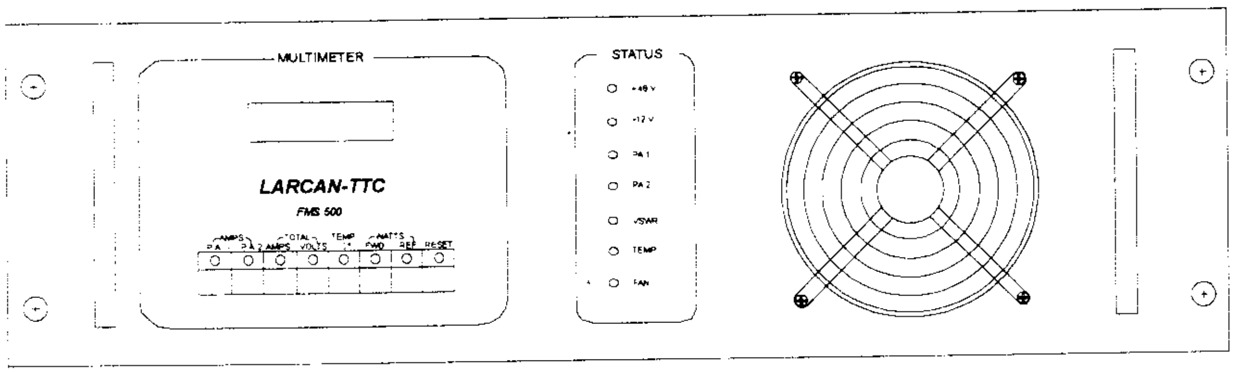

Figure 2. 500 Watt Amplifier Front Panel

The next two readings are total PA amps and total PA volts. These two readings allow you to calculate your output efficiency and look at combined PA current and the DC voltage applied to the output RF devices.The next metering function is module temperature. This reading is measured in degrees C and allows you to see the heatsink temperature of the PA module.

The last two meter readings are FORWARD and REFLECTED power. These measure the RF output power of the amplifier in watts and check the VSWR with the reverse power metering. The last selector pushbutton is for RESET. This function allows you to reset fault lamps and their associated faults control circuits so the XL500 FM may return to On-Air status.

2.1.2 Status Indicators

The front panel incorporates Bi-color LEDs that act as both status and fault indicators. The first one is + 48V, which indicates that +48 volt power is being supplied to the control board and the second is similar in function for the +12 volt supply. Bi-color LEDs turn red when the voltage is out of tolerance by more than 1 volt above the nominal voltage. The LED indicator is green when the voltage is within 1 volt of the nominal voltage and goes dark when the monitored voltage drops more than 1 volt below nominal. The third LED indicates that PA 1 has an over-current fault that exceeds a preset limit. LED four is an over-current fault indicator for PA device 2.

The fifth LED indicator is for a VSWR situation where reflected power exceeds a preset limit (typically 50 watts). Here the indicator is normally green and turns to red to indicate the fault condition. The sixth LED performs the same function to show a temperature fault. This LED turns red should temperature rise above a preset limit. The final LED is labelled "Fan". This LED changes to red if the +24 volts regulator fails. The +24 volts powers the cooling fan.

2.2 REMOTE CONTROL

The XL500 FM has extensive remote control facilities between the XL10 FM Exciter and the 500 Watt amplifier drawer itself. Use of other manufacturers exciters may truncate the remote control capability. Remote metering includes: Total PA VOLTS & PA AMPS, FORWARD and REVERSE Power, PA TEMPERATURE, PA 1 and PA 2 AMPS.

A master fault status is available on the rear panel of the 500 Watt Amplifier Assembly. This terminal is labeled RESET OUT and is wired to the XL10 Exciter so a fault condition reduces the output power of the Exciter. RF output power is controlled by the screwdriver adjustment on the front panel of the XL10FM Exciter.

The fault reset command appears on the rear panel so any resettable fault can be cleared by remote control. All fault conditions require either pressing the front panel RESET pushbutton or applying a momentary closure to ground of the RESET terminal on the rear panel.

3. UNPACKING & INSTALLATION INSTRUCTIONS

Equipment Contents:

- 500 Watt Amplifier Assembly
- XL10 FM Exciter
- PS 500 Universal AC Power Supply
- Technical Manual for the XL500 FM Transmitter
- Technical Manual for the XL10FM Exciter
- COAX-NN24"/RG142U RF Input Cable

3.1 Unpacking Instructions

There are three boxes that hold the complete transmitter. One box contains the 500 Watt Amplifier Drawer Assembly. The second holds the PS 500 Power Supply, and the third has the XL10 FM Exciter.

Open the top of each cardboard box and remove the plastic sheet/foam packing materials. Check carefully above or below the blue plastic sheet for any cables and Technical Manuals.

CAUTION

FAILURE TO FOLLOW THE ENCLOSED INSTRUCTIONS COULD JEOPARDIZE YOUR WARRANTY CLAIMS!

NOTE: International Treaty provisions (IEC 215) require qualified personnel to install, operate, and maintain industrial equipment. It is the owner's responsibility to be sure only qualified engineers and technicians operate and work on this equipment and its ancillary components. If you have any problems or questions in following these instructions, stop work immediately and call our Customer Service.

Packing materials have been installed in this equipment to minimize damage due to handling in the shipping process. These materials may interfere with proper air flow and/or operation. The removal process has been designed to eliminate back tracking and damage.

1. With a Phillips Screwdriver, carefully remove the lid to the upper 500 Watt Amplifier Drawer.
2. Carefully remove the foam plastic block on the top of the PA Amplifier Module. There is double-sided sticky tape that holds the foam block in place.
3. Reinstall the top cover using all the screws removed.
4. Double check that the cables are not damaged and that all coaxial and screw terminals are tight.
5. Refer to the appropriate instruction manuals and follow the installation procedures and initial operation instructions.
6. Check the Factory Test Data Sheet (FTDS) and verify the RF output power level is correct and that all other equipment readings match those on the FTDS.

3.2 Installation Instructions

Mount the units in a rack cabinet typically setting exciter at top, 500 Watt Amplifier in the middle, and the PS 500 Power Supply on the bottom. Be sure there is an air space between each of the cabinets. Connect the AC power cord to terminal strip on side of PS 500 Switchmode Power Supply Module. The packaged power supply is auto-switching and can operate from 110 to 230 VAC and 50/60 Hz. If the voltage falls in the range of 130 to 190 VAC, the power supply will not turn ON. We recommend extra outlet AC voltage surge protection for suppression of AC line voltage spikes. This surge protection should precede any uninterruptible power supply (UPS) system.

3.2.1 Remote Control

If a remote control system is to be installed, this is the time to connect all the circuits. The 500 Watt amplifier connections on the rear panel are shown in Figure 3.

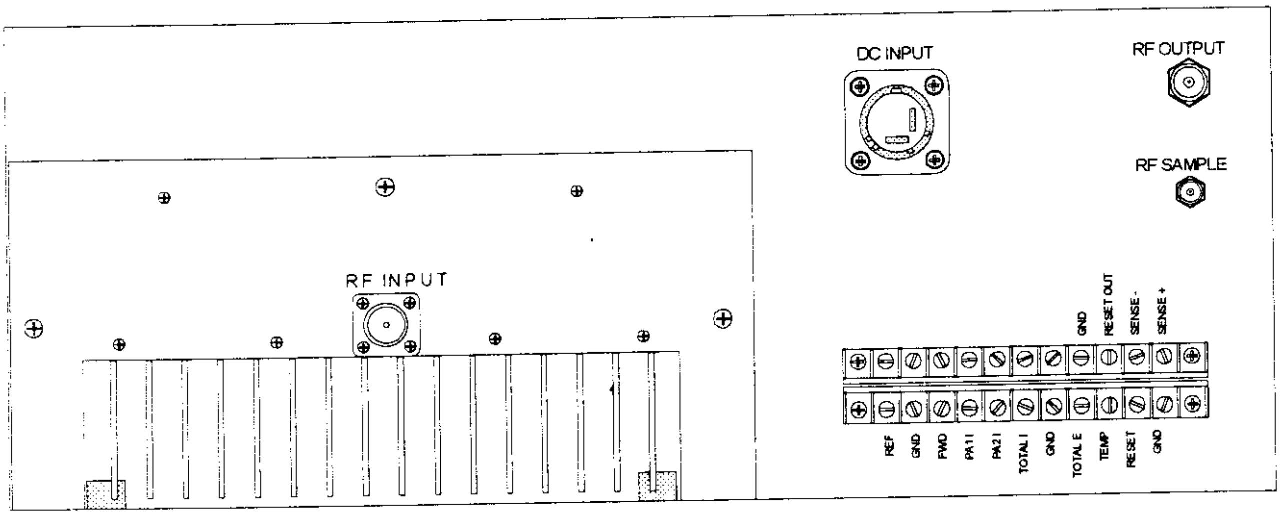

Figure 3. The 500 Watt Amplifier Rear Panel

4. OPERATING INSTRUCTIONS

The XL500 FM must be installed using the installation instructions contained in this manual and connected to the correct AC input voltage. The AC line voltage tolerance is +/- 15 %. All jumpers and interconnections, the antenna, transmission line, and all connectors must be installed correctly with no sharp bends made in the feedline. If the XL500 FM is used as an amplifier, the RF drive precautions contained in the Installation section of this manual must be followed.

The XL500 FM is an amplifier that takes the RF input and boosts its power level to some wattage up to 500 watts. There are built-in protection circuits to reduce RF drive due to over-temperature, over-current, and high VSWR conditions.

4.1 TURN-ON

1. Check all connections between the driver and the 500 Watt amplifier.
2. Check the antenna connection to the 500 Watt amplifier.
3. Be sure any remote control connections are not shorted.
4. Turn on the PS 500 power supply.
5. Turn on the XL10 Exciter.
6. Raise the RF output power to the required TPO.
7. Select REFLECTED POWER and be sure it is reading less than 3% of the rated RF output power.
8. Check all multimeter readings against the Factory Test Data Sheet.
9. If there is a remote control system, calibrate readings with the master control point personnel.

4.2 AC LINE VOLTAGE CONSIDERATIONS

It is important that the AC input voltage remain within the +/- 15% tolerance. The PS 500 Power supply is auto ranging and will operate from 90 to 132 VAC in 117 volt systems and in 220 volt systems, the limits are 190 to 260 volts AC. Outside of these two ranges, the power supply will automatically turn itself OFF.

Turn on the AC switch on the front panel of the PS 500 and check all status and metering to be sure the transmitter is functioning properly. The muffin fan will come on as soon as the AC power is turned ON. Use the Factory Test Data Sheet as the authority for proper meter readings. Check the VSWR to be sure it is low. A reflected power of 3% or less is good and below 1% is excellent.

4.3 RF SAMPLE PORT

On the rear panel of the 500 Watt Amplifier Chassis, is a BNC connector that has a sample of the amplifier's output. Its level is about 30 dB below the set RF output level. This coaxial connector can be used for monitoring by a Frequency Counter, Modulation/Frequency Monitor, or Spectrum Analyzer.

CAUTION

NEVER EXCEED 15 WATTS INPUT TO THE XL500 FM AMPLIFIER!

4.4 FINAL CHECKOUT

The RF output power should read 100% using the front panel metering of the 500 Watt amplifier. The Factory Test Data Sheet will tell what the TPO is for 100% power. Check the VSWR to be sure it is low. A reflected power of 3% or less is good and below 1% is excellent.

5. MAINTENANCE

5.1 ROUTINE MAINTENANCE

Routine maintenance is checking the status of the equipment to be sure every thing is in order. This should also include building security so unauthorized personnel do not have access to the equipment and that snakes, rodents, spiders, or other vermin do not find a home that might damage the XL500 FM. Roof water leakage may cause shorts in the equipment and void your warranty.

Weekly:

- Check and record meter readings
- Be sure that the cooling fan is operational
- Clean air filters supplying air to building
- Check XL500 FM heatsink air passages to be sure they are clear - no dust, cobwebs, critters, or twigs in dirty environments and poorly secured buildings

Monthly:

- Check XL500 FM heatsink air passages to be sure they are clear - no dust, cobwebs,critters, or twigs in clean environments
- Check antenna and transmission line system for security and damage

Semiannually:

- Check output frequency to be sure you are in compliance with FCC frequency tolerance rules
- Adjust building ventilation to maintain temperature for the next six month period

5.2 TROUBLESHOOTING

No RF output power:

- Be sure power is applied to 500 Watt amplifier and the Exciter
- Check AC Circuit Breaker and DC fuses as well as PA voltage
- Check the Exciter output to be sure there is RF drive to the Amplifier Module
- If there is RF drive and no PA current, check for lightning damage. Lightning damage will probably require replacement of the two RF FET Transistors in the PA Module.
- Check coaxial cables to be sure connectors are firmly attached
- VSWR too high:
    - Check antenna and transmission line for damage or loose connections
    - Check antenna for icing
- + 48 voltage too low or too high:
    - Check AC line voltage to be sure it is within specs
- Remote control inoperative:
    - Check remote control system for proper operation
    - Check wiring between 500 Watt amplifier and Remote Control
    - Check telephone lines for continuity and frequency response

- If one or two functions are inoperative, read the theory section on the Main Control PC Board for the 500 Watt amplifier functions.

MOSFETs usually fail by opening instead of shorting like a bipolar device. Therefore, if you have normal RF drive, but do not have RF output and the PA current is lower than the Factory Test Data Sheet value, the RF MOSFETs are probably bad.

Before calling our Customer Service Department, please have the following information readily available:

- Factory Test Data Sheet
- Has antenna system been checked?
- What are the PA voltage and current readings?
- What are the RF forward and reflected power readings?
- What color are the status lamps/LEDs?
- What is the room ambient temperature where equipment is located?
- Have symptoms occurred before? How often? What time of day?

6. CIRCUIT DESCRIPTIONS

6.1 XL500 FM PA DRAWER

Part Number: 4501-1100
Schematic: C4601-1035

General

In the XL500 FM PA Amplifier Drawer, there is the 500-watt PA Module, the Harmonic/Low Pass Filter, control and metering circuitry, and a muffin fan. The front panel contains a digital multimeter for measuring PA transistor currents, PA voltage, PA Module temperature, and forward & reflected RF power. Status lamps indicate the XL500 FM's condition such as voltages in tolerance, over-temperature, VSWR and current trips.

The description begins with the XL500 FM PA Module followed by the RF circuitry, control and metering, and the PS 500 Power Supply. Figure 4 shows the contents of the PA Drawer and the wiring connections.

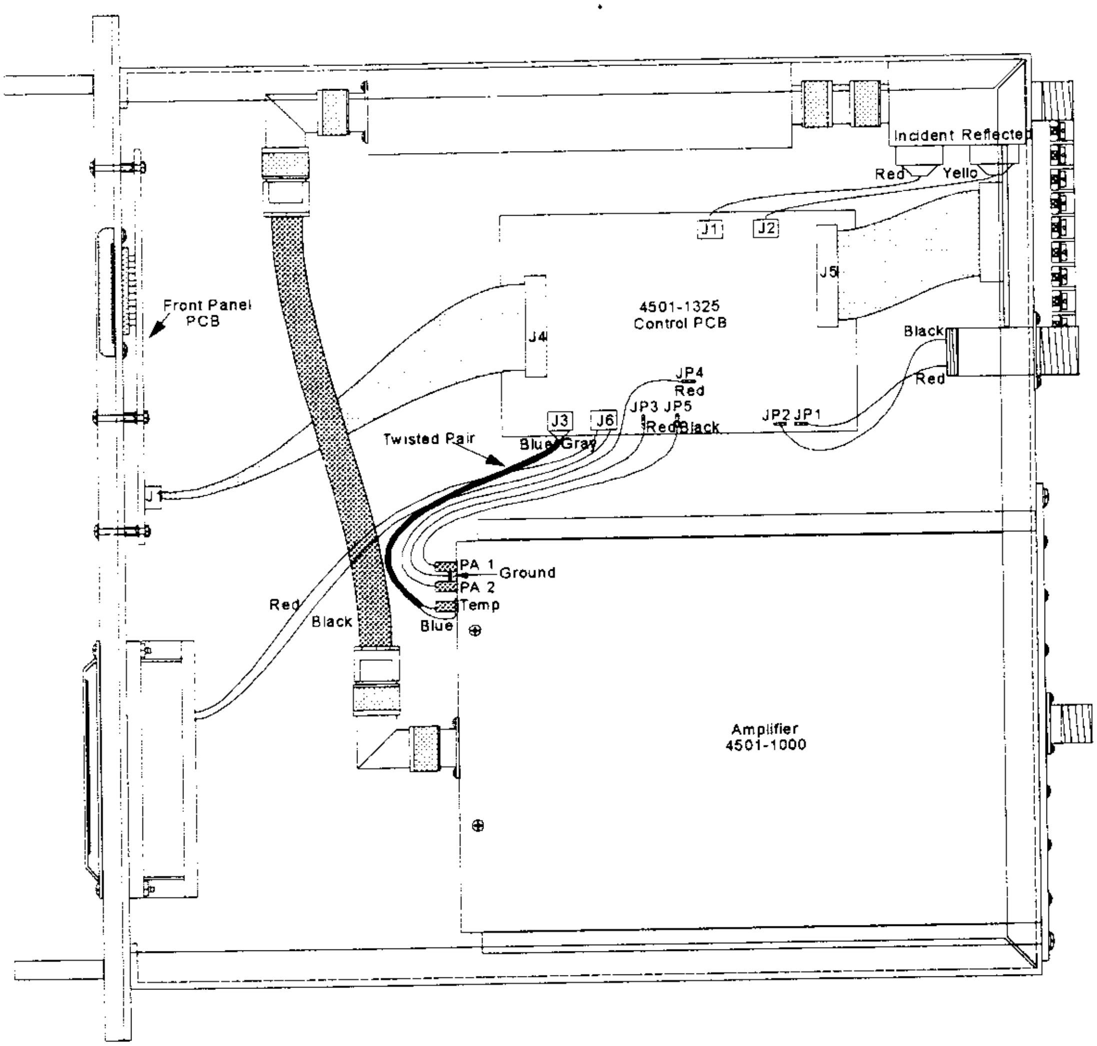

Figure 4. PA Drawer (top view - cover removed)

6.1.1 XL500 FM PA Module

Part Number: 4501-1000
Schematic: B4501-1035

The XL500 FM power amplifier consists of two Teflon PC boards mounted to a precision machined aluminum block that serves as a heatsink for the two BLF 278 MOSFET transistors. A "U" shaped aluminum cover protects service personnel from high RF fields. N connectors on each end provide the input and output connections. Feed-through capacitors bring the +48 volts into the input end of the module. The temperature sensing output is also fed to the control circuitry through a feed-through capacitor.

Two twin RF FET transistors generate the 500-watt output. The input RF signal is divided to feed the two devices. The transistors are biased in the Class AB mode so a little DC current flows with no RF drive.

A Wilkinson-type RF splitter divides the input RF and feeds a pair of BLF 278 FET RF transistors. The output of these devices is then fed into a Two-way Combiner that adds the two RF device outputs into a 50 ohm output at the desired RF output power up to 500 Watts.

Since the two amplifier circuits are essentially the same, Q101 and its associated circuitry are described in detail. Common elements such as +48 volt decoupling and the Gate Bias Supply are covered as well as the temperature sensor.

The RF input from the Wilkinson Splitter feeds a broadband balun (T101) to generate two 180 degree out-of-phase signals to drive the gates of the FETs (Q101A & B) via matching capacitors, C120 and C121. The FET drains are shunt fed from a decoupled voltage supply consisting of L103 and capacitor components C105, 106, 112, and 113.

The push-pull outputs are fed into another balun consisting of L101 and L102 that combines the two out-of-phase signals into a single unbalanced output. Both the input and output baluns are broadbanded to eliminate all tuning adjustments. L122 and C101/102 couple the "A" transistor's output while L123 and C103/104 couple the "B" side's output to L102.

RC networks are used to suppress the spurious moding in the amplifier circuits. These networks are composed of C109 and R101 for Q101A and C111 and R102 for Q101B. Gate bias is derived from the zener diode, D101. The regulated +6.2 volts is supplied to the rheostat R105 via dropping resistor R104 which bias the gates of Q101. Adjust R105 for +2 volts of bias on the gates of Q101. R103 drops the +48 volts to control the zener's dissipation. C116, C117, C118, and C119 decouple the gate bias voltage.

The bias voltage is factory adjusted and will only require adjustment when an FET transistor is replaced. C107 and C108 decouple the +48 volt supply feeding the bias circuit. L105 is not used.

Alignment Procedure

Alignment consists of setting the gate voltage to 2 volts.

6.1.2 RF System

The RF input signal enters via a 50 ohm N connector on the rear panel and connects to the PA Module INPUT N connector. The PA Module OUTPUT N connector goes to the Harmonic/Low Pass Filter and then to the Directional Coupler. The Directional Coupler mounts on the left side of the drawer and its N output and BNC RF Sample Port connectors go thru the rear panel to connect the antenna system and test equipment, respectively.

The RF sample is sent to the rear panel for monitoring purposes. The approximately -30 dB +/- 2 dB sample output is obtained by a resistive power divider.

The output DC samples of the Directional Coupler go to the Main Control PC Board where they are amplified and used for measuring forward (incident) and reflected (reverse) power.

6.1.3 Main Control PCB

Part Number: 4501-1325
Schematic: 4501-1335, Sheets 1 & 2

The Main Control PCB circuitry is divided into two parts to fit on "B" sized paper. The first sheet covers the forward and reflected power metering, current sensing, voltage sensing, and temperature measurement buffering. The second sheet covers the -12 volt switchmode power source, the logic reset function, and the RS flip-flops used to drive the status LEDs and master fault. Circuit theory will be detailed basically by going left to right and top to bottom. Where circuitry is similar, such as the RF power metering, only one circuit is described in detail plus highlighting of any differences.

RF Power Metering

Forward RF power is sampled and rectified in the Directional Coupler. This DC voltage of about 1 volt is sent to J1-2 where it drives U1C, an op amp which boosts the DC level to +4 volts for 500 watts output. The Op Amps gain is set by the ratio of R17 to R16. U1C acts as a buffer in driving U1D via R18. However, U1D is set up as a non-linear amplifier with five breakpoints to linearize the non-linear output of the power detector diode in the Directional Coupler.

D13 is a positive shunt regulator that can have its voltage set by the ratio of the resistors R32 and R33. This +10 volt reference feeds both linearizer circuits, and along with the associated resistors and Schottky diodes set the five breakpoints. R27 and R28 set the stage gain, and therefore the output calibration. U1D also drives a unity gain buffer amp, U2B, that drives the remote FORWARD RF output via R30 which is used as a fuse resistor.

D12 and D11 provide clamping for the remote metering output to +12 volts and to ground, respectively, to avoid damage to the Op Amp U2B's output. C3 and C4 are decoupling capacitors and R15 provides a load for the directional coupler's output.

Similarly, the reflected (reverse) power sample is fed from the directional coupler to J2 for amplification by U1A. R13 calibrates the reflected power and U2A buffers the voltage to drive the remote metering output. However, there is another signal going to the comparator, U7D. When reflected power reaches 50 watts, the LM339A output switches from a high level to ground, triggering the fault circuitry via a wired OR gate that includes D30. With 10% reflected power, the VSWR is 2:1.

Voltage Metering

A voltage divider, comprised of resistors R111 and R74, drops the +48 volts to about +4.5 volts to feed the unity gain buffer op amps, U3C and U3D. U3C drives the front panel multimeter thru resistor, R75. U3D drives the remote PA VOLTAGE metering output. Diodes D16 and D26 protect the op amp output from external over-voltages. The voltage sample also feeds comparator U13 for over-voltage FAULT detection. Any voltage over +49.5 volts causes the comparator output to go to ground, triggering the fault circuitry thru diode D35. R101 and R100 set the comparator's reference voltage to +5.00 volts. R98 provides some positive feedback to sharpen the transition from HIGH to LOW when a fault is detected.

PA Current Metering

Since the circuitry for PA #2 is at the top of the schematic, its circuitry will be discussed. PA #1's circuitry is identical to that of PA #2. The discussion of the ground reference supply will conclude the current metering section.

An Op Amp, U5B, operates as a current "mirror" to sense the voltage across R57 and R58 which is proportional to the current flowing thru the series resistors. This is necessary since the PA Module is at ground potential and the metering resistors are 48 volts above ground. R59 and R60 sample the 0.48 volt drop across R59 and R60. The IC U5B(7) output drives Q3 thru R61 and forms an amplifier with a gain of approximately 8.5. This gives a scaled current-to-voltage ratio of 3.2 amps per volt. This circuit forces the current in R59 to "mirror" that found in R57/R58.

Q3 drives two unity gain IC amps (U6C&D) and a comparator, U7C. U6D buffers the voltage and sends it to the front panel multimeter. U6C buffers the voltage and feeds the remote metering output for PA #2 CURRENT. D24 and D25 clamp any external voltage applied to J5-9 while R65 acts as a fuse. C14 and C15 provide RF decoupling. R64 loads the output of U6C to guarantee it doesn't operate into an open circuit.

U7C is fed a sample of the PA #2's current sensing voltage via R69. This is compared to a fixed voltage reference obtained from the voltage divider, R72/R73. When the PA #2 draws more than 9 amps, U7C switches from HIGH to LOW and triggers the fault circuitry via D28. R81 provides positive feedback to speed the switch transition. U7B's circuit performs the same function for PA #1's fault detection via diode D29.

PA #2's remote current metering output is coupled via R106 to a pair of unity gain buffer amps. Along with the current metering sample from PA #1 (via R105), U14A and U14B sum the two current samples to generate a voltage which represents the total current drawn by the two PA transistors. U14A drives the front panel digital multimeter while U14B feeds the remote TOTAL PA CURRENT terminal. R102 and R103 provide output signal isolation and C20/C21 are output decoupling capacitors. D41 and D44 protect the output of U14B from any externally applied voltages that might damage the Op Amp. The ratio of R107 to R106 (R108 to R105) determines the gain of the output buffer amplifier.

Ground Reference Supply

U5A and U5B are MC34182 Op Amps that cannot stand having +48 volts applied to them. The "current mirrors" have to accept input voltage differentials that are referenced to +48 volts, therefore some method is required to lift the ground terminal of the Op Amps so only about 30 volts is applied to the IC. This is accomplished by the ground reference supply centered around Q4.

The +48 volts is dropped 30 volts by zener diode D45 and R109. The emitter of Q4 is approximately +18.6 volts. C22 provides improved transient response and filtering for REFERENCE 1 voltage which feeds the ground terminal of the Op Amp IC. D46 and R110 produce REFERENCE 2 voltage which is 4.7 volts above REF 1 and is used as a clamp to protect the positive and negative inputs to U5A and U5B via diodes D18, D19, D22, and D23.

+12/+24 Volt Power Supplies

The two three-terminal voltage regulators supply up to 1 amp of +12 and +24 volts. Decoupling capacitors are used on the inputs to eliminate VHF oscillations and on the outputs to improve transient response. The input series resistors drop the applied voltage protecting the ICs.

Temperature Metering

The temperature measuring IC in the PA module is connected to Pin J3-1 and feeds IC U3A operating as a unity gain amplifier. The gain is set by the ratio of R36 to R37. C6 provides high frequency compensation while R34 loads the temperature sensor's output. The Op Amp, U3B also receives the temperature sensor's output and buffers it to feed the REMOTE TEMPERATURE metering output via J5-17. U3A's output drives the front panel digital multimeter via J4-7 and thru R43 the temperature fault comparator IC, U7A.

If the PA module temperature should reach 165 degrees F, the comparator output will drop to ground potential, indicating a temperature FAULT condition and trigger the fault circuitry via D27. The temperature reference is obtained from the resistive voltage divider consisting of R45 and R67.

Control Logic, Sheet 2

Outputs from each individual fault comparator are fed to the appropriate RS flip-flop formed by a pair of 2-input NAND gates in the MC14093B CMOS IC. Since all five RS flip-flops are the same, the VSWR fault circuit will be described in detail followed by the RESET circuit, master fault, and -12 volt power supply.

VSWR Fault

When a VSWR fault is detected, a LOW is applied to the cathode of D40 which pulls U9B(5) to ground. R41 normally applies +12 volts to this pin. The LOW on pin 5 causes the output of U9B to go HIGH and light the red, VSWR FAULT LED on the front panel STATUS display section. R89 applies +12 volts (HIGH) to U9A(2) except when a RESET pulse to ground is applied via D17.

Reset Circuit

When power is first applied to the logic circuits, the output state is not determined. So U12A/B and the associated parts generate a reset pulse to set all five flip-flops to the non-fault condition. At power-up, R95 puts a HIGH on

U12A(1) and C18 begins charging. This forces a HIGH at U12A(3). U12B is wired as an inverter so the input HIGH is converted to a LOW at U12B(4). This pulls all RESET pins of the flip-flops to ground and therefore their outputs go LOW. Thus, the STATUS LEDs are lighted green. When +12 volts is first applied, R97 begins charging C19. R96 passes some of the charge on C19 to C18 so it can begin to charge up also. D42 and D43 are clamp diodes to protect the U12A input from any extraneous voltage applied to the RESET control line. When a reset is required to clear any fault condition, a LOW (ground) is fed from the front panel RESET pushbutton that shorts C19.

Master Fault

The Wired OR circuit on Sheet 1 sends a ground (LOW) to the terminal point labelled MAIN whenever any of the five faults are detected. Thus, U11D(12) is grounded and a LOW is sent to R88 and Q1 is turned OFF. This puts a HIGH on the Master FAULT line and output terminal. When there is no fault indication, a HIGH at U11C(10) turns ON the transistor Q1 which grounds the FAULT line. This line goes to the FAILSAFE terminal of the FM Exciter. The ground on the FAILSAFE terminal turns ON the Exciter which sends RF drive to the PA Module.

-12 volt Power Supply

The negative 12 volt power source is needed by the Op Amps in the RF power metering circuits. Plus 12 volts is applied to the two switchmode power supply ICs, U15 and U16. These ICs are paralleled to increase the output current. C39 and C40 are the charge storage capacitors. Essentially, each IC charges its storage capacitor to +12 volts and then connects the + capacitor terminal to ground while the - terminal is switched to the output pin, U15(5) for example. Since the oscillator pins are not connected together, the two switcher ICs operate asynchronously. C34 and C37 filter the -12 volts.

6.1.4 Alignment Procedures

RF Power Metering Adjustment

This adjustment is factory set for a designated broadcast channel. If any component is replaced, or the transmitter power output or channel is changed, the power metering requires recalibration.

The procedure assumes 500 watt output power. Since the metering is calibrated in percent of power, users should substitute the FCC authorized TPO wherever 500 watts is noted. If your XL500 FM system was factory adjusted for a TPO other than 500 watts, consult the Factory Test Data Sheet for actual RF output power.

Test Equipment/Tools Needed:

- Digital Voltmeter such as Fluke Model 77
- 500 watt, 50 Ohm RF Load
- In-line Wattmeter/Elements such as Bird or Coaxial Dynamics
- Coaxial interconnect cables
- Thin-bladed, Slot type Screwdriver

Procedure

1. Turn off AC power.
2. Remove top cover and locate R13, & R27.
3. Connect In-Line Wattmeter to transmitter output and RF Load.
4. Turn on AC power and raise Exciter drive until you read 500 watts or the FCC licensed TPO on the In-line Wattmeter.
5. Connect Digital Voltmeter between TP1 and ground on the Front Panel PCB. Adjust R28 on the Front Panel PCB to get exactly +5.000 volts on Test Point 1.
6. Adjust R27 on the Main Control PCB to read 500 Watts on the XL500 FM Digital Multimeter in the FORWARD position.

7. Swap the FORWARD and REFLECTED cables on the Main Control PCB at J1 and J2.
8. Reduce RF output to 50 watts and adjust R79 to the point where the circuit just trips to indicate VSWR fault. You may have to turn R79 fully clockwise and press the RESET pushbutton if R79 was misadjusted or replaced to begin this step.
9. Adjust R13 on the Main Control PCB to read 50 Watts on the XL500 FM Digital Multimeter in the REFLECTED position.
10. Swap the directional coupler cables at J1 and J2 back to their original positions.
11. Turn OFF AC power, install the top cover, remove the In-Line Wattmeter, and reconnect the antenna to the XL500 FM output.

You may stop after Step 9 and adjust the fault trip points before returning to complete Step 10.

Fault Trip Point Setting Procedure
Follow the steps below and in Step 5, select the fault test point to the DMM's + lead and adjust the appropriately labelled pot.

1. Turn off AC power and RF drive, i.e. Model X.
2. Remove top cover and locate appropriate test point(s) and adjust pot(s).
3. Connect XL500 FM to RF Load or known good antenna system.
4. Turn on XL500 FM and the RF drive and adjust drive until you read 500 watts or the FCC licensed TPO on the XL500 FM's Digital Multimeter. Note: Be sure the XL500 FM's DMM is calibrated and operating correctly. If there is any doubt, STOP and perform the RF output calibration procedure above before continuing.
5. Connect Digital Voltmeter between ground and the listed test point on the Main Control PCB. Adjust the appropriate variable resistor to get the exact voltage reading listed in the table.

TP1	Over-Voltage	+2.0 Volts
TP3	Over-Temperature	+3.50 Volts
TP4	PA 1 Over-Current	+5.0 Volts
TP5	PA 2 Over-Current	+5.0 Volts

6. Turn OFF RF drive and the XL500 FM. Install the top cover, remove the RF Load - if used, and reconnect the antenna to the XL500 FM output.

6.1.5 Interface Terminal PCB

Part Number: 4501-1225
Schematic: B4501-1235

This PCB takes the ribbon cable from J5 on the Main Control PCB and connects those wires to the TB1 and TB2 terminal strips on the rear panel of the XL500 FM Amplifier Drawer Assembly.

6.1.6 FRONT PANEL PCB

Part Number: 4501-1125
Drawing: C4501-1135

The Front Panel PC Board has three functions:

- Display voltage, current, and RF power readings
- Display status of DC voltages and faults
- Control which multimeter function is displayed and reset the fault circuitry

The XL500 FM has a Lexan-covered, aluminum front panel with a liquid crystal, digital multimeter display to the left. Selector buttons feed voltage samples to the DMM A-to-D converter chip for measuring: PA Volts, PA Currents, and RF Outputs. Green lights in the pushbuttons indicate when the parameter is selected and the printing above the button describe the measurement. See Figure 5.

The central portion of the front panel has a vertical arrangement of bi-color LEDs that monitor the amplifier parameters on a full-time basis. For the supply voltage monitoring, window detectors are used to drive LEDs that change color from the normal (green) color to (red) if the parameter goes too high or (unlit) if the parameter is too low. The next four LEDs glow green for a non fault condition and red for a fault. The FAN LED monitors the +24 volt power source which feeds the cooling fan. This LED has a window detector circuit driving it so it indicates over and under voltage conditions.

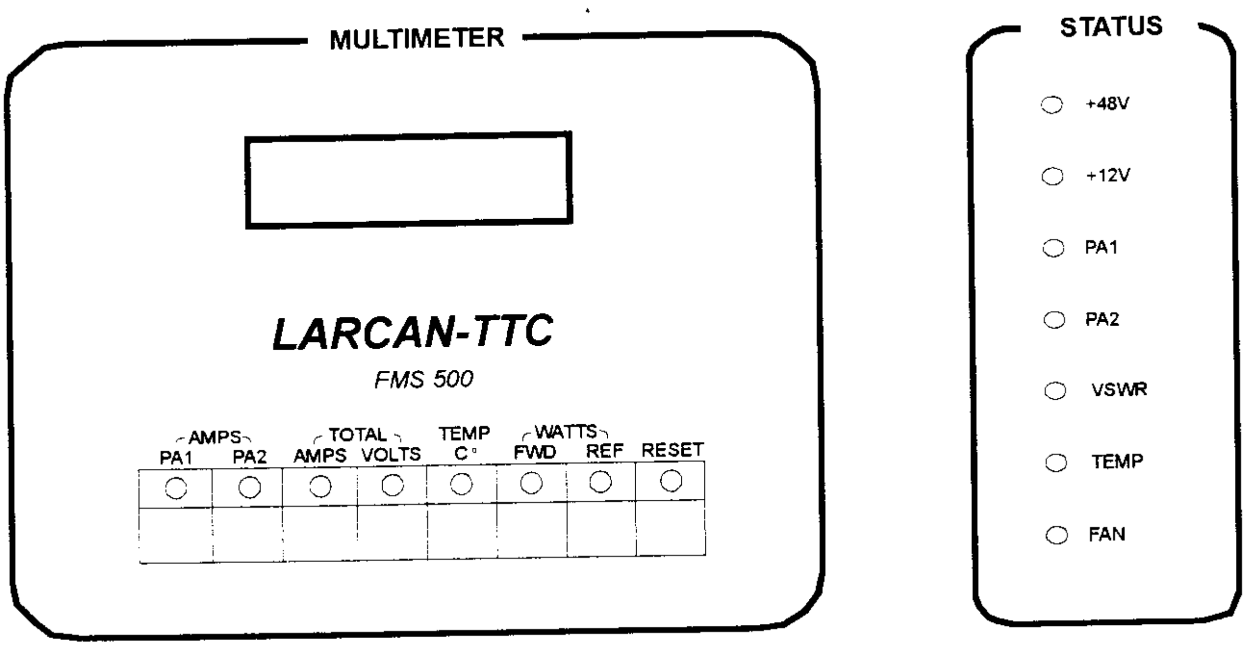

Figure 5. Multimeter & Status Indicators

On the right side of the panel, there is the cooling fan opening.

The circuit theory is keyed to starting from left to right and top to bottom. However, circuitry will be clustered together that is part of the same function. Repetitive circuits will not be covered in significant detail.

Digital Multimeter

The digital multimeter (DMM) operates with an analog to digital converter chip driving a LCD display. Inputs to the A-to-D chip are selected by a seven channel CMOS gate array. The gate array is controlled by a pushbutton switch on the front panel which selects the metered function to be measured. Since all selector circuits are the same, the description will center on the PA Volts metering with an explanation of any differences that apply to other selector circuits.

When SW1 is pressed, switch terminals 1 and 2 are connected momentarily to put a ground (LOW) on the SET pin of R-S flip-flop of the quad flip-flop IC, U1. This forces the Q output Pin 13 to go HIGH and light the green LED in the PA Volts pushbutton. Also, the HIGH feeds the control input of the quad transmission gate IC, U6C and Pin 1 of the 12-Bit Parity Tree IC, U3.

The PA Volts Metering Voltage Sample from J1-3 feeds the input pin 8 of the quad multiplexer IC, U6. All outputs of the transmission gates are wired together and feed the input of the DMM via R30 and filter capacitors C9 and C10. A HIGH on the control input to a transmission gate turns it ON so the input passes directly to the output. Only the one selected parameter is given a HIGH to pass that input through to the output at any time. U6 has one unused transmission gate.

U3, the Parity Tree IC, feeds the B input of the One-Shot IC, U4A. When another pushbutton such as SW2 is depressed for the PA #1 Current as an example, U4A(5) goes LOW and creates a short, negative-going pulse on its not-Q output which feeds all the R-S flip-flop RESET inputs. This reset function occurs before the selected pushbutton is released which sets the PA #1 Current for reading.

Normally, the liquid crystal display is set for two digits, decimal, and two digits. For the RF power readings, the display changes to three digits, decimal, and one digit. This is handled by a two input Exclusive OR gate, U10A and its associated circuitry. When Forward or Reflected RF power is selected, a HIGH is fed thru D2 or D17 to put +12 volts on R22. This puts a HIGH on the base of Q1, turning the transistor OFF and forces the Exclusive OR gate U10A's output LOW which selects the decimal point position to **XXX.X**. Otherwise, Q1 is turned ON by the resistors R21 and R22 taking the base to ground.

Power-Up Parameter Selection

When AC power is first applied to the XL500 FM Amplifier, the DMM is programmed by the placement of C15 to automatically select PA Volts for measurement without depressing a pushbutton first. This circuit works since R2 applies +12 volts to the SET input of U1(3), but capacitor C15 across it delays the +12 volts getting to the SET input until after the RESET function is complete and forces the selection of the PA Volts for reading.

Digital Meter

The liquid crystal display (LCD1) is driven by a low power CMOS analog-to-digital integrated circuit, U9. The 3 1/2 digit display is refreshed three times per second and contains a comparator to measure the incoming DC voltage. This voltage is compared to the reference generated by D1, the TL431 variable zener diode. The external voltage reference is used to improve reading stability over the operating temperature range.

The ICL7136 A-to-D chip operates from +12 volt and -2.1 volt power sources. The A-to-D converter chip uses one section the MC14070B quad Exclusive OR gate to drive the decimal points of the LCD display. The liquid crystal display is driven by the 60 Hz squarewave generated by the BP terminal of the ICL7136, U9. The 47pF, C3 and 182k, R19 components set the oscillator frequency of the converter chip for 48 kHz. The other components (C7, C8, and R29) control the integrator and C4 stores the reference voltage.

The -2.1 volt power source is derived from the -12 volt supply by a dropping resistor, R23 and a stack of three silicon diodes acting as a zener diode. C13 filters the -2.1 volt source. C9, C10, and R30 lowpass filter the DC input voltage to the A-to-D Converter IC.

The +5 volt reference voltage of the DMM circuit feeds the A-to-D Converter that drives the LCD Display. DC power is obtained from the +12 volt regulator on the Main Control PC Board and the -12 volt switching regulator on this PCB.

-12 VDC Power Supply

The negative 12 volt power source is used by the digital multimeter circuit. Plus 12 volts is fed to the switchmode power supply IC, U7. C11 is the charge storage capacitor. Essentially, the IC charges its storage capacitor to +12 volts and then connects the + capacitor terminal to ground while the - terminal is switched to the output pin, U7(5). C12 filters the -12 volts.

Status Indicators

The DC power sources are monitored by individual window detectors which drive bi-color LEDs. When a voltage is within the window, the LED is green colored. If the voltage is higher than the window, the LED is red colored. If the voltage is below the window level, the LEDs are OFF, black. The three positive voltage detectors use a common, temperature-stable voltage reference diode, D16. These three circuits are similar, therefore only the +48 volt detector is described.

Window Detector

D16 is fed by R49 to operate on the +48 volt supply and since it also measures the +24 volt and +12 volt supplies, R50 and R51 also feed the reference diode for redundancy. R41 feeds the reference +5 volts to the negative input of the comparator, U11A. This +5 volt reference also directly feeds the negative input of the second comparator, U11B. The positive inputs of the comparators are fed by a three resistor voltage divider string consisting of R44, R42, and R43.

Because U11A's + input is higher than U11B's + input, U11A's output is higher than U11B's output. The voltage difference creates current flow that turns the green LED ON. When the +48 volt supply is too low, U11A's output goes lower and U11B's output goes higher to turn the LEDs OFF. The voltage divider string determines the voltage width of the window. D10 prevents lock-up when the DC voltages are applied to the circuit.

Two-State Status LEDs

These four circuits are the same so the PA #1 FAULT lamp circuit will be detailed. These bi-color LEDs show red to indicate a fault condition and green to indicate proper operation.

A HIGH (FAULT) on J1-18 forces U12A's output LOW grounding the cathode of the red LED. U12B now has a LOW on its input forcing a HIGH on its output to feed +12 volts thru R45, a current limiting resistor, into the anode of the red LED to turn it ON. When the PA #1 current is normal, there is a ground on U12A's input and a HIGH on its output. The green LED anode is positive and U12B puts a ground on the green LED's cathode. Thus the green LED turns ON.

6.2 PS 500 POWER SUPPLY

The XL500 FM uses a Unipower Corp. switchmode power supply that is mounted in a rack panel. The forced-air cooled mainframe holds the three modules required to power the XL500 FM Transmitter. There are two modules that produce about 12 amps each of +48 volts needed to power the RF Amplifier Module. The transmitter requires about 18 amps of +48 volts. Figure 6 shows the front panel of the PS 500.

This brand of power supply was chosen for its patented circuitry improves the power factor and lower electric utility bills. These supplies have over-voltage, over-temperature, and over-current protection built-in. Be sure to select an AC mains source that does not have a voltage range between 130 and 190 volts to prevent the "smart" supplies from shutting down. These supplies automatically select the proper AC voltage operation mode without any strapping for voltage or frequency.

Unipower has a two year warranty and recommends returning any failed module for repairs. Servicing switchmode power supplies requires a significant investment in test equipment (power supplies and pulse generator) to do this work efficiently. Spare modules are available for purchase from our factory as well as Unipower to lessen the impact of a power supply module failure. Alternatively, another power supply with the same specifications as the PS 500 can be substituted while the PS 500 is repaired.

A portion of the Unipower Operating Manual was reproduced and included in the back of this manual to supply more information on troubleshooting the power supply.

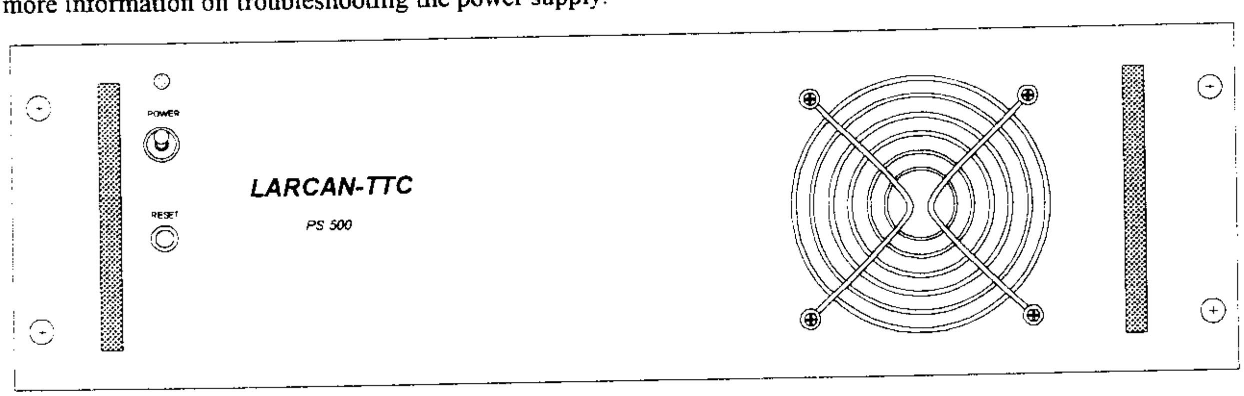

Figure 6. PS 500 Power Supply Front Panel

7. PARTS & SCHEMATIC LISTS

Table 2. 500 Watt Amplifier Parts List

Schematic: C4501-10XX Part Number: 4501-1100

Designator	Description	Part No.
	500-Watt PA Module Assembly	4501-1000
	Front Panel PCB Assembly	4501-1125
	Rear Panel Terminal PCB Assembly	4501-1225
	Main Control PCB Assembly	4501-1325
B101	100 CFM Muffin Fan, 24 VDC	8176-307
DC101	RF Directional Coupler	8518-009
HF101	Harmonic Filter w/ sample port	8520-145
J101	26-Pin Female Socket Connector	8151-671
J102	3-Pin Chassis Mount Power Connector	8151-880
J102A	Ground Terminal for Power Connector	8151-881
J102B	Positive Terminal for Power Connector	8151-882

Table 3. 500 Watt PA Module Assembly Parts List

Part Number: 4501-1000

Designator	Description	Part No.
C101/103/123/125/102/104/124/126	160 pF Chip Capacitor, 300 V	8131-051
C105/108/116/127/	.01 uF Monolithic Capacitor, 200 V	8130-605
C106/107/117/118/128/129/140/141/144/145	.001 uF Monolithic Capacitor, 200 V	8130-603
C109/111/121/131/133/137	1000 pF Chip Capacitor, 50 V	8131-065
C110/132	360 pF Chip Capacitor, 200 V	8131-057
C112/115/134/137	47 uF Electrolytic Capacitor, 50 V	8129-C100A47
C113/114/135/136	.47 uF Monolithic Capacitor, 50 V	8130-630
C119/139	470 pF Chip Capacitor, 200 V	8131-059
C120/138	43.0 pF Chip Capacitor, 500 V	8131-027
C122/143	13.0 pF Chip Capacitor, 500 V	8131-021
C146to148	1000 pF Feedthru Capacitor, 500 V	8131-092
D101/102	6.2 V Zener Diode, 5%, .5 Watt	8217-1N5234B
D103	5.1 V Zener Diode, 5%, .5 Watt	8217-1N5231B
IC101	LM35CH Temperature Sensor IC	8220-140
J101/102	N Female Panel Connector, UG-58	8151-702
L101/106	Output Coax Assembly, Left	4352-2539
L102/107	Output Coax Assembly, Right	4352-2540
Q101/102	BLF278 FET RF Transistor	8219-194
R101/102/106/107	10 ohms, 5%, 1 Watt Carbon Resistor	8610-10A5
R103/108	6.2 k ohms, 5%, .5 W Carbon Resistor	8605-6.2K5
R104/109	1.2 k ohm, 5%, .25 W Carbon Resistor	8602-1.2k5
R105/110	1 k ohm Trim Pot, Edge, .5 Watt	8154-890
R111	47 k ohms, 5%, .25 W Carbon Resistor	8602-47K5

Table 3. 500 Watt PA Module Assembly Parts List

Part Number: 4501-1000

Designator	Description	Part No.
R112	1 k ohm, 5%, .25 W Carbon Resistor	8602-1.0K5
R114	100 ohm Chip Resistor, 100 W	8152-755
R201	100 ohm Chip Resistor, 250 W, Flange	8152-852
T101/102	VHF Input Balun Transformer	4352-2541

Table 4. Interface Terminal PCB Parts List

Schematic: B4501-1235 Part Number: 4501-1225 PCB: 4501-1230

Designator	Description	Part No.
J1	26-Pin MLE Connector, PC Mount	8151-673
TB1/2	11-Terminal Barrier Block, PC Mount	8139-090

Table 5. 500 Watt Amplifier Main Control Parts List

Schematic: C4501-1335 Part Number: 4501-1325 PCB: 4501-1330

Designator	Description	Part No.
C1/2/3/4/34	470 pF Monolithic Cap., 200 V	8132-C1J470
C5	10 uF Electrolytic Cap., 35 V	8129-35M10
C6to9/12to15/18/20/21/42 to 45	.001 uF Monolithic Cap., 200V	8130-603
C10/11/16/17	.47 uF Monolithic Cap., 50 V	8130-630
C19	1.0 uF Electrolytic Cap., 50 V	8129-50M1
C22	22 uF Electrolytic Cap., 50 V	8129-50M22
C23to33	.1 uF Monolithic Cap., 100 V	8130-620
C35/36	33 uF Electrolytic Cap., 50 V	8129-50M33
C37 to 40	220 uF Electrolytic Cap., 35 V	8129-35A220
D1to8	1N5711 Schottky Diode	8216-005
D9to12/14to44	1N4148 Switching Diode, 75V	8217-1N4148
D13	TL431CLP Positive Shunt Reg.	8220-085
D45	30.0 V Zener Diode, 10%, .5 W	8217-1N5256A
D46	4.7 V Zener Diode, 5%, .5 W	8217-1N5230B
F1/2	3AG 10 A AGC, 250 V	8166-1000
F1/2A	Fuse Clip, 3AG PC Mount	8228-401
J1/2	3-Pin Header, .100" Centers	8151-217
J3/6	3-Pin Header, PC Mount, .156"	8151-634
J4/5	26-Pin MLE Connector, PC Mount	8151-673
JP1to5	Disconnect Tab, PC Mount	8124-110
Q1	2N3904 NPN, 40V Transistor	8218-2N3904
Q2/3/4	MPS-A56 Transistor, PNP, 80V	8219-045
R1/16	10 k ohm Metal Film, 1%, .25 W	8602-10K1
R2/15	5.1 k ohm Carbon Resistor, 5%, .25 W	8602-5.1K5
R3/17	40.2 k ohm Metal Film Res., 1%, .25 W	8602-40.2K1
R4/18	30.1 k ohm Metal Film Res., 1%, .25 W	8602-30.1K1

Table 5. 500 Watt Amplifier Main Control Parts List

Schematic: C4501-1335 Part Number: 4501-1325 PCB: 4501-1330

Designator	Description	Part No.
R5/19	22.1 k ohm Metal Film Res., 1%, .25 W	8602-22.1K1
R6/20	182 k ohm Metal Film Res., 1%, .25 W	8602-182K1
R7/21	18.2 k ohm Metal Film Res., 1%, .25 W	8602-18.2K1
R8/22	100 k ohm Metal Film Res., 1%, .25 W	8602-100K1
R9/11/23/25	15.8 k ohm Metal Film Res., 1%, .25 W	8602-15.8K1
R10/24	48.7 k ohm Metal Film Res., 1%, .25 W	8602-48.7K1
R12/26	36.5 k ohm Metal Film Res., 1%, .25 W	8602-36.5K1
R13/27/67/70/72/79/100	10 k ohm Trim Pot., .5 Watt	8154-827
R14/28	4.99k ohm Metal Film, 1%, .25 W	8602-4.99K1
R29/30/31/93/103	1.0 k ohm Carbon Resistor, 5%, .25 W	8602-1.0K5
R32	7.15 k ohm Metal Film Res., 1%, .25 W	8602-7.15K1
R33	2.37 k ohm Metal Film Res., 1%, .25 W	8602-2.37K1
R34/44/78/81/82/98	1.0 M ohm Carbon Resistor, 5%, .25 W	8602-1.0M5
R35, 37 to 39	47.5 k ohm Metal Film Res., 1%, .25 W	8602-47.5K1
R36	169 k ohm Metal Film Res., 1%, .25 W	8602-169K1
R40/55/65/84/102	470 ohm Carbon Resistor, 5%, .25 W	8602-470A5
R41to43/68/69/77/85 to 92/94/ 104 to108	47 k ohm Carbon Resistor, 5%, .25 W	8602-47K5
R45/71/73/80/101	7.5 k ohm Carbon Resistor, 5%, .25 W	8602-7.5K5
R46/83	100 ohm WW Resistor, 5%, 5 W	8154-301
R47/48/57/58	.03 ohm WW Resistor, 5%, 5 W	8650-.03A5
R49/59/99	10 k ohm Carbon Resistor, 5%, .25 W	8602-10K5
R50/60	220 k ohm Carbon Resistor, 5%, .25 W	8602-220K5
R51/61	33 k ohm Carbon Resistor, 5%, .25 W	8602-33K5
R52/62	1.5 k ohm Carbon Resistor, 5%, .25 W	8602-1.5K5
R53/63	39.2 k ohm Metal Film Res., 1%, .25 W	8602-39.2K1
R56/66/96/109	4.7 k ohm Carbon Resistor, 5%, .25 W	8602-4.7K5
R54/64/75	2.0 k ohm Carbon Resistor, 5%, .25 W	8602-2.0K5
R74	38.3 k ohm Metal Film Res., 1%, .25 W	8602-38.3K1
R76/113to118	20.0 k ohm Carbon Resistor, 5%, .25 W	8602-20K5
R88	51 k ohm Carbon Resistor, 5%, .25 W	8602-51K5
R95	470 k ohm Carbon Resistor, 5%, .25 W	8602-470K5
R97	100 k ohm Carbon Resistor, 5%, .25 W	8602-100K5
R110	4.7 k ohm Carbon Resistor, 5%, .5 W	8605-4.7K5
R111	1.4 k ohm Metal Film Res., 1%, .25 W	8602-1.4K1
TP1to5	1-Pin Header	8151-221
U1/2	TL084CN Quad Op Amp IC	8220-094
U3/6	LM324 Quad Op Amp IC	8220-120
U4	MC7812 +12 V, 1 A Regulator IC	8220-014
U5	MC34182 J-Fet Op Amp IC	8220-176
U7	LM339 Quad Comparator IC	8220-141
U8	MC7824 +24 V, 1 A Regulator IC	8220-017
U9to12	MC14093 Quad NAND Trigger IC	8220-165

Table 5. 500 Watt Amplifier Main Control Parts List

Schematic: C4501-1335 Part Number: 4501-1325 PCB: 4501-1330

Designator	Description	Part No.
U13	LM311 Voltage Comparator IC	8220-032
U14	LM358 Low Power Op Amp IC	8220-135
U15/16	7661 CMOS Voltage Converter IC	8220-164
UX	8-Pin DIP IC Socket	8156-417
UY	14-Pin DIP IC Socket	8156-414

Table 6. Front Panel PCB Parts List

Schematic: C4501-1135 Part Number: 4501-1125 PCB:4501-1130

Designator	Description	Part No.
C1/16/17/18	.01 uF Monolithic Cap., 200 V	8130-605
C2/15	.47 uF Monolithic Cap., 50 V	8130-630
C3	47 pF Monolithic Cap., 5%, 200 V	8132-C2J47
C4/8	.1 uF Polycarbonate Cap., 50 V	8131-577
C6	22 uF Electrolytic Cap., 50 V	8129-50M22
C7	.047 uF Polycarbonate Cap., 50 V	8131-575
C5/9/10/13/19to30	.1 uF Monolithic Cap., 100 V	8130-620
C11/12	220 uF Electrolytic Cap., 35 V	8129-35A220
C14	10 uF Electrolytic Cap., 50 V	8131-510
D1/16	TL431 Positive Shunt Reg. Diode	8220-085
D2to6/8/10/17	1N4148 Switching Diode, 75 PIV	8217-1N4148
D7/9/11to15	Red/Green Bi-Color LED	8155-007
J1	26-Pin MLE Header Connector	8151-673
LCD1	3.5 Digit Liquid Crystal Display	8155-050
LCD1A	20-Pin SIP Socket	8156-242
Q1	2N3906 Darlington PNP, 40V Transistor	8218-2N3906
R1/3/5/7/9/11/13	1.5 k ohm Carbon Res., 5%, 1/4 W	8602-1.5K5
R2/4/6/8/10/12/14	47 k ohm Carbon Res., 5%, 1/4 W	8602-47K5
R15/49	10 k Carbon Resistor, 5%, 1/4 W	8602-10K5
R16/17	976 k ohm Metal Film Res., 1%, 1/4 W	8602-976K1
R18	1.0k ohm Metal Film Res., 1%, 1/4 W	8602-1.0K1
R19	182 k ohm Metal Film Res., 1%, 1/4 W	8602-182K1
R20/21/22	20 k ohm Carbon Resistor, 5%, 1/4 W	8602-20K5
R23	1.2 k ohm Carbon Resistor, 5%, 1/4 W	8602-1.2K5
R25	4.7k ohm Carbon Resistor, 5%, 1/4 W	8602-4.7K5
R24/35/40	620 ohm Carbon Resistor, 5%, 1/4 W	8602-620A5
R26	1.0 k ohm Metal Film Res., 1%, 1/4W	8602-1.0K1
R27	732 ohm Metal Film Res., 1%, 1/4 W	8602-732A1
R28	500 ohm Trimpot, Top Adj, 1/2 W	8154-823
R29	1.5 M ohm Carbon Res., 5%, 1/4 W	8602-1.5M5
R30	180 k ohm Carbon Resistor, 5%, 1/4 W	8602-180K5
R31/36/41	12.0 k ohm Carbon Res., 5%, 1/4 W	8602-12K5
R32/37/42	523 ohm Metal Film Res., 1%, 1/4 W	8602-523A1

Table 6. Front Panel PCB Parts List

Schematic: C4501-1135 Part Number: 4501-1125 PCB:4501-1130

Designator	Description	Part No.
R33/43	4.99k ohm Metal Film Res., 1%, 1/4 W	8602-4.99K1
R34	45.3 k ohm Metal Film Res., 1%, 1/4 W	8602-45.3K1
R38	6.04 k ohm Metal Film Res., 1%, 1/4 W	8602-6.04K1
R39	23.2 k ohm Metal Film Res., 1%, 1/4 W	8602-23.2K1
R44	95.3 k ohm Metal Film Res., 1%, 1/4 W	8602-95.3K1
R45/46/47/48	820 ohm Carbon Resistor, 5%, 1/4 W	8602-820A5
R50	5.11 k ohm Metal Film Res., 1%, 1/4 W	8602-5.11K1
R51	3.3 k ohm Carbon Resistor, 5%, 1/4 W	8602-3.3K5
R52	1.0 k ohm Carbon Resistor, 5%, 1/4 W	8602-1.0K5
R53/54/55	10.7 k ohm Metal Film Res., 1%, 1/4 W	8602-10.7K1
R56	4.87 k ohm Metal Film Res., 1%, 1/4 W	8602-4.87K1
R57/58/59	500 ohm Trimpot, 1/4 W	8154-895
SW1to7	N/O PB Switch W/ Green LED, PC Mt.	8125-309
SW8	N/O PB Switch W/ No LED, PC Mt.	8125-311
TP1	1-Pin Header, .1" Centers	8151-221
U1/2	MC14044B Quad NAND R/S Latch (F-F) IC	8220-118
U3	MC14531 12-Bit Parity Tree IC	8220-130
U4	MC14538 Dual Multivibrator IC	8220-106
U5/6	MC14066B Quad CMOS Analog Switch IC	8220-157
U7	7661 CMOS Voltage Converter IC	8220-164
U8	LM324 Quad Op Amp IC	8220-120
U9	ICL7136 A-to-D Converter IC	8220-126
U9A	40-Pin DIP Socket	8156-438
U10	MC14070B Quad Exclusive OR Gate IC	8220-125
U11	LM358 Dual Op Amp IC	8220-135
U12/13	MC14049 Hex Inverter/Buffer IC	8220-024
UXA	14-Pin DIP Socket	8156-414
UYA	16-Pin DIP Socket	8156-416
UZA	8-Pin DIP Socket	8156-417

Table 7. Schematic List

Power Amplifier Schematic	4501-1035
Rear Terminal Interface	4501-1235
Main Control PCB Assembly Drawing	4501-1327
Main Control PCB Schematic	4501-1335
Front Panel PCB Schematic	4501-1135