INSTRUCTION MANUAL
FOR
FM TRANSLATOR
XLFM SERIES
1 AND 10 WATT

TTC

An International Company Serving Radio and Television

TELEVISION TECHNOLOGY DIVISION
WILKINSON RADIO DIVISION
SATELLITE TECHNOLOGY DIVISION
AMPRO/SCULLY DIVISION

TELEVISION TECHNOLOGY DIVISION
WILKINSON RADIO DIVISION
SILVERLINE DIVISION
AMPRO AUDIO DIVISION
SCULLY TAPE DIVISION

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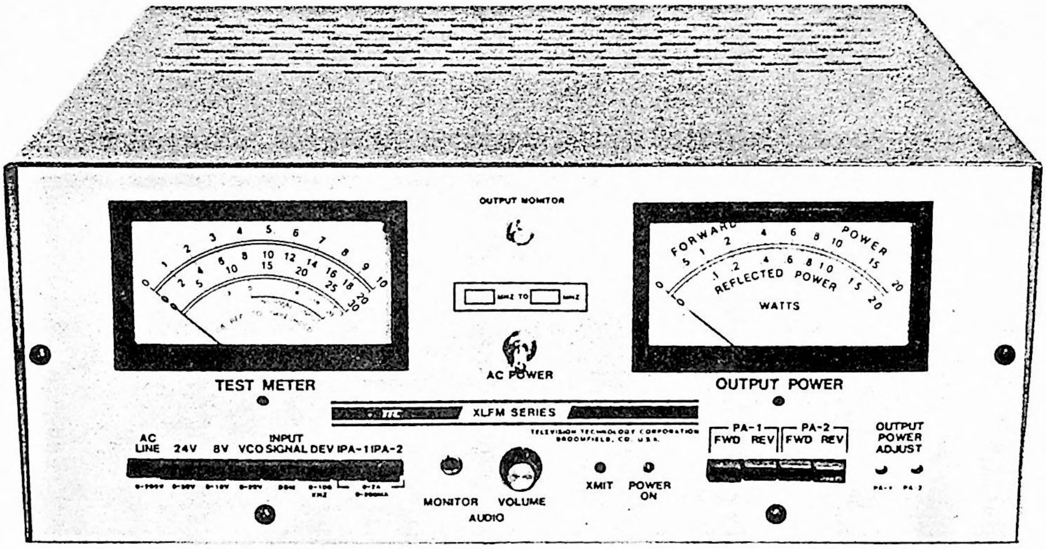
WARNING

The following servicing instructions are for use by all qualified personnel only. To avoid personal injury, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

Serial Number ______________



F M TRANSLATOR

XLFM SERIES

1 WATT
AND
10 WATT

R10

FACTORY TEST DATA

FOR MODEL XL___FM___

JOB #____________ SERIAL #____________

DATE COMPLETE____________

INPUT CHANNEL____________ FREQUENCY ____________MHz

OUTPUT CHANNEL____________ FREQUENCY ____________MHz

OPTIONS:

MODULATOR ☐

TVK ☐

DECODER ☐

CONDITION OF TEST:

INPUT SIGNAL

OUTPUT POWER ☐ 1W ☐ 10W (No. 1) 91% 100 Hz Modulation (L + R)

OUTPUT POWER ☐ 1W ☐ 10W (No. 2) 9% 19 Hz Pilot

FRONT METER READINGS:

MULTIMETER		FULL SCALE XL1	XL10
LINE VOLTS	________	200V	
+24	________	30V	
- 8	________	10V	
INPUT SIGNAL	________	20dB	
VCO VOLTAGE	________	20V	
Ipa 1	________	200mA	2A
Ipa 2	________	200mA	2A
DEVIATION	________	100kHz	

SERIAL NO. PA-1 ________

SERIAL NO. PA-2 ________

POWER METER			FULL SCALE XL1	XL10
FWD	PA-1	______	2W	20W
REV	PA-1	______	.2W	2W
FWD	PA-2	______	2W	20W
REV	PA-2	______	.2W	2W

MODULATOR P.C. BOARD (6900-5025)

TONE DECODER FREQUENCY ________

DEVIATION LIMIT SET ________kHz

INPUT CONVERTER (6900-2000)

SERIAL NUMBER ____________

LO FREQUENCY ____________MHz

GAIN ____________dB

LO VOLTAGE (TP202) ________Volts

UPCONVERTER P.C. BOARD (6900-4025)

LO FREQUENCY ____________MHz

OUTPUT POWER ____________dBm

LO VOLTAGE (TP407)________Volts

OUTPUT SPURIOUS PRODUCTS	PA-1	PA-2	SPECIFICATION LIMIT
2nd HARMONIC	_____dB	_____dB	(REFERENCED TO RATED POWER) Min. -80 dB
3rd HARMONIC	_____dB	_____dB	(REFERENCED TO RATED POWER) Min. -70 dB
OUTPUT 10.7 MHz	_____dB	_____dB	(REFERENCED TO RATED POWER) Min. -70 dB
ALL OTHER SPURIOUS	_____dB	_____dB	(REFERENCED TO RATED POWER) Min.-100 dB

TTC/SILVERLINE/WILKINSON LIMITED WARRANTY

All TTC/Silverline/Wilkinson (TTC) equipment, except as otherwise noted below, carries a warranty against defects in material or workmanship, which arise under proper and normal use from the date of installation per the attached Schedule A. This limited warranty begins upon installation or within two (2) months from the date of factory shipment, whichever occurs first.

Liability is limited to repairing/replacing at its plant part(s) or product(s) found by TTC in its sole judgement to be defective. All shipping charges in connection with such repair or replacement of part(s) are the responsibility of the purchaser. Tubes, klystrons and semiconductors are warranted by the respective manufacturers. Fuses and lamps are not covered by warranty.

Failure to maintain equipment properly, including failure to perform recommended service or operation of equipment without proper ventilation or at ambient temperatures outside the published temperature range will void this warranty. Damage caused by, but not limited to acts of God (such as lightning, wind, earthquake, flood, rain, snow), shipping, abuse, accidents, water, incorrect power application, over voltage or under voltage, are specifically excluded from this warranty. This warranty may be cancelled at TTC's option when equipment is found to be altered without prior authorization by TTC.

TTC products designed for three-phase AC line operation specify closed Delta or Wye power service to be used. Operation of TTC three-phase transmitters on open Delta power service will void TTC's limited warranty.

This warranty with respect to TTC equipment is in lieu of all other warranties, expressed or implied (except as to title) and constitutes all of TTC's liability with respect to its equipment. Equipment produced by other manufacturers and used as an integral part of a TTC system is warranted under the terms of that manufacturer's limited warranty, and the warranty provided by such manufacturer shall be the measure of TTC's obligation. All TTC 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. TTC assumes no liability for injury, death or damages arising from the use, operation or installation of these products.

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WARNING!

THIS EQUIPMENT CONTAINS HAZARDOUS VOLTAGES WHICH CAN CAUSE INSTANT DEATH. NO ATTEMPT SHOULD BE MADE TO DEFEAT THE PROTECTIVE INTERLOCK SYSTEM OR ANY OTHER PROTECTIVE CIRCUITS OR 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 TRANSMITTING EQUIPMENT.

SCHEDULE A TO TTC/SILVERLINE/WILKINSON LIMITED WARRANTY

TTC/SILVERLINE/WILKINSON WARRANTY PERIODS

TTC Silverline UHF-TV Transmitters	2 Years
TTC Translators/Boosters/Low Power TV Transmitters	1 Year
TTC/Wilkinson Model X FM Exciter	2 Years
TTC/Wilkinson AM/FM Transmitters	1 Year
TTC/Wilkinson AM/FM Transmitters (When used with S1A Series AC Line Surge Protector)	2 Years
TTC/Wilkinson Rectifier Stack Assemblies	1 Year
All Other TTC/Silverline/Wilkinson Products	1 Year

Note: TTC may request the return of defective parts replaced under warranty. Should such defective parts not be returned in a timely manner, TTC will bill customer for the full value of the parts.

****

CAUTION!

International (IEC) Standards require the owner of broadcast equipment to employ broadcast 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.

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TTC/SILVERLINE/WILKINSON SERVICE

During normal business hours (Mountain Time Zone) TTC provides telephone service and parts ordering support through TTC's business telephone number. Outside of normal business hours, including weekends and holidays, TTC service personnel may be reached through TTC's emergency answering service/pager number. Normal business hours are 8:00 AM to 5:00 PM weekdays.

TTC business telephone number is (303) 665-8000.
FAX (303) 673-9900.

After-hours emergency service number is (303) 692-6099.

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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 oonnector 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 <1% 30Hz to 15kHz	Standard Selectivity 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

SECTION 2

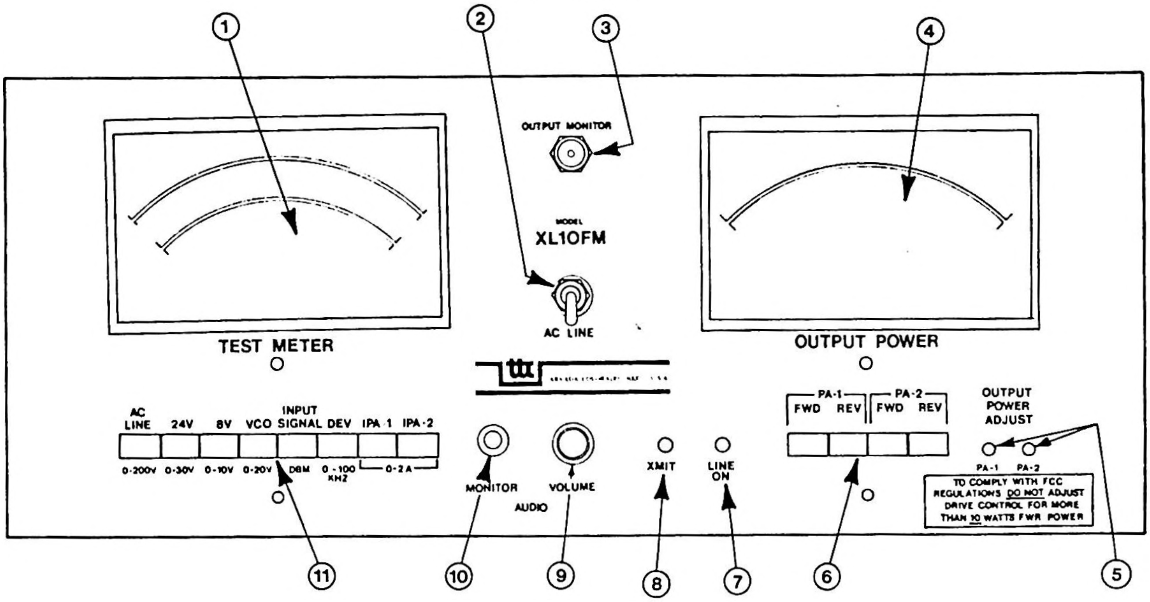
OPERATING INSTRUCTIONS

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.

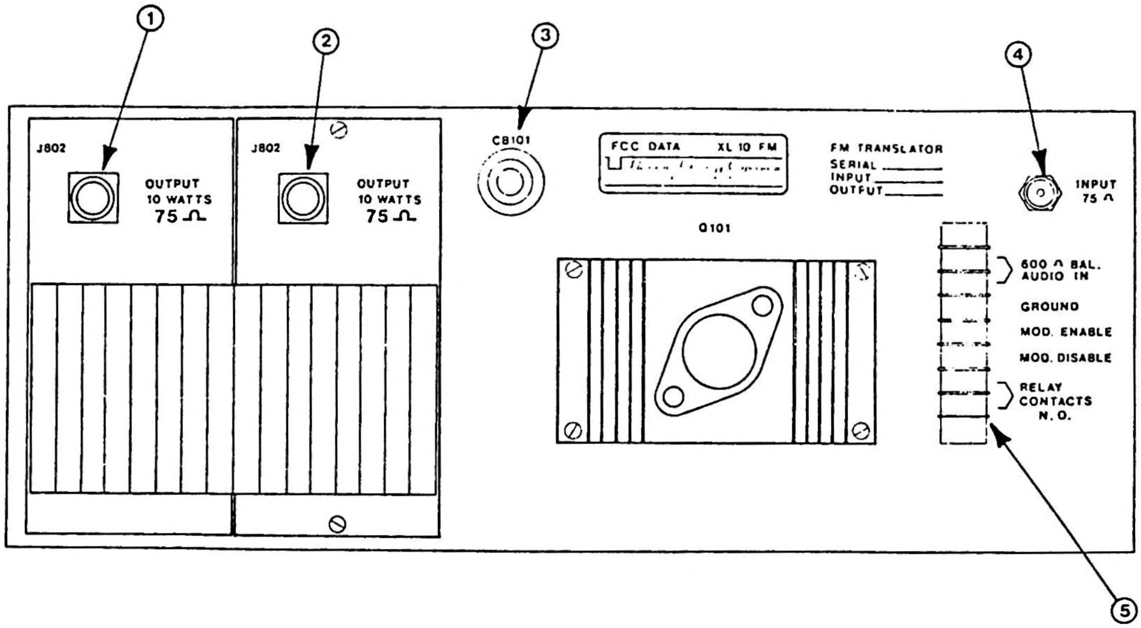
INPUT SIGNAL: The input signal level is displayed by this position. The meter uses the dB scale. 0dB is the turn-on threshold and is set at the factory 30uV. Therefore, -3dB on the meter corresponds to 20uV and +6dB is equal to 60uV. Remember these are correct only if thethreshold adjustment inside the 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.

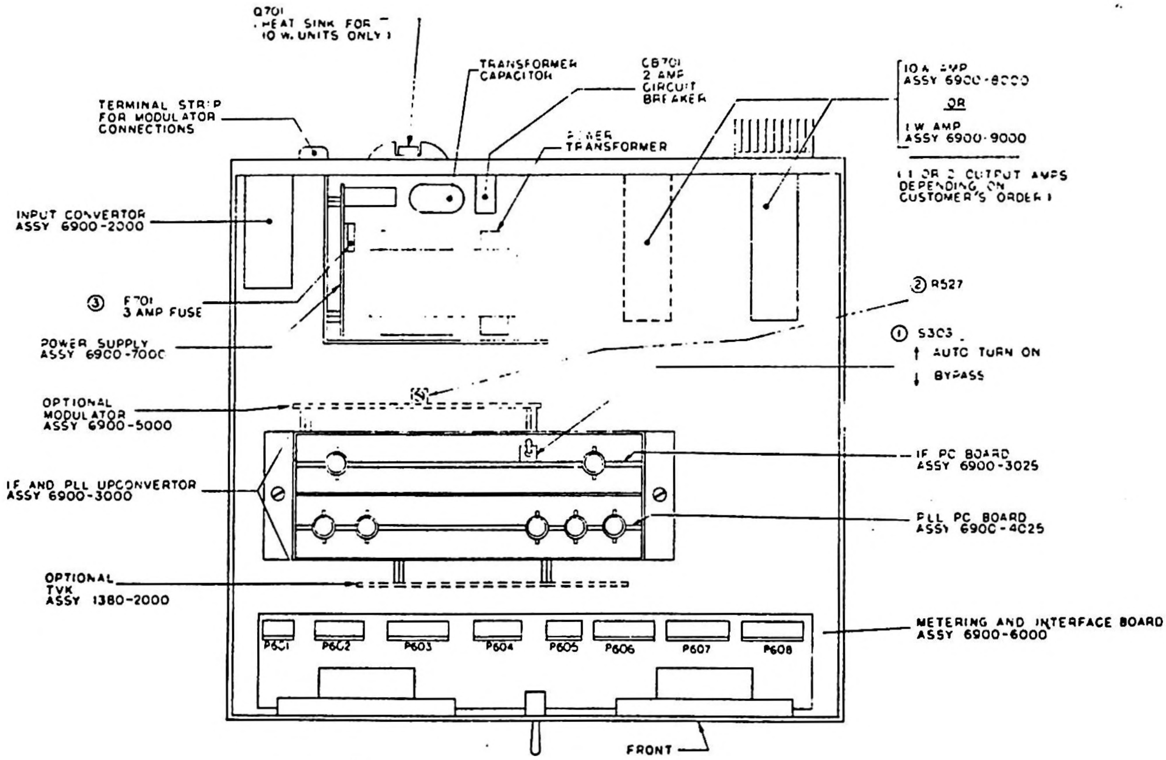
5. TERMINAL STRIP FOR MODULATOR OPTION:

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.

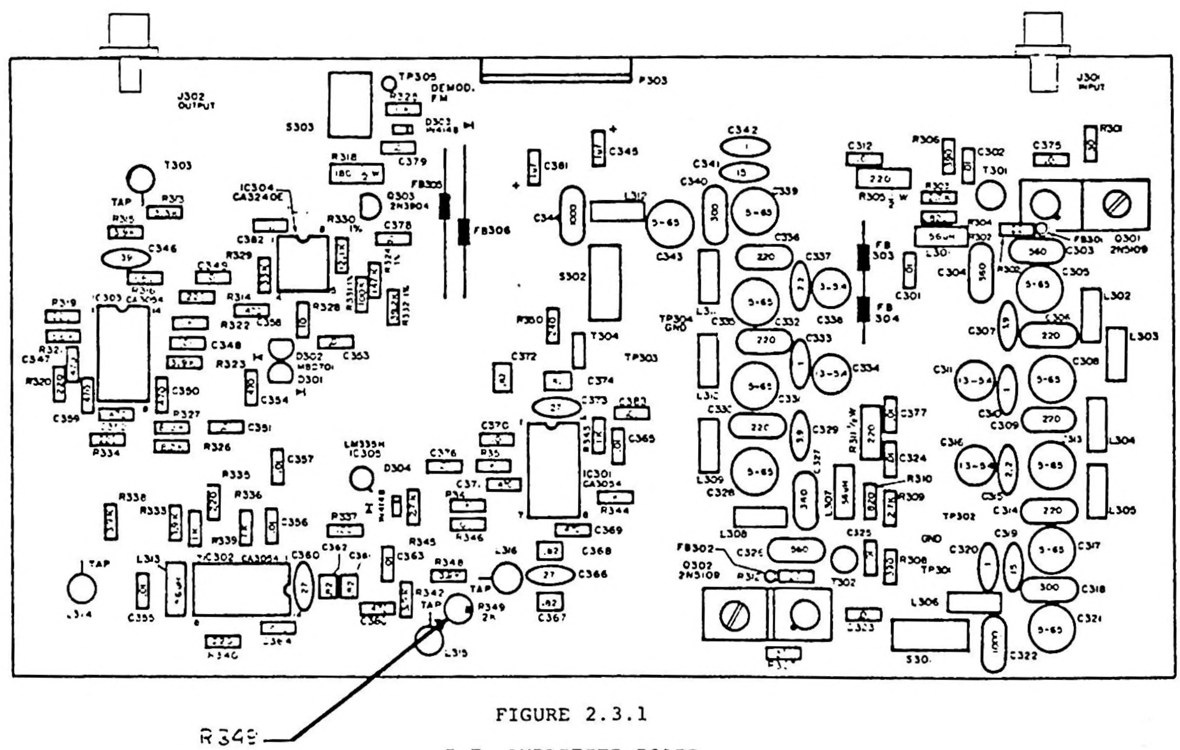


FIGURE 2.3.1

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.

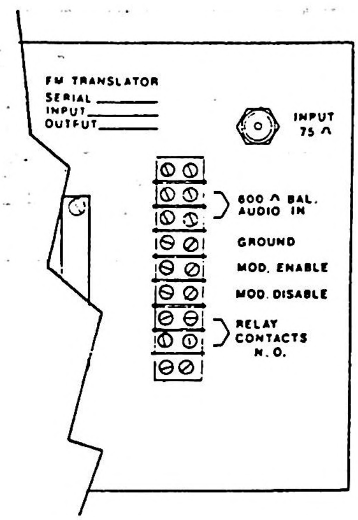
2.4.3: The FCC requires the connection of the locally generated signal be controlled by a time switch which will automatically limit the transmission no more than 30 seconds. Such a switch is incorporated within this modulator and should not be overridden.

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

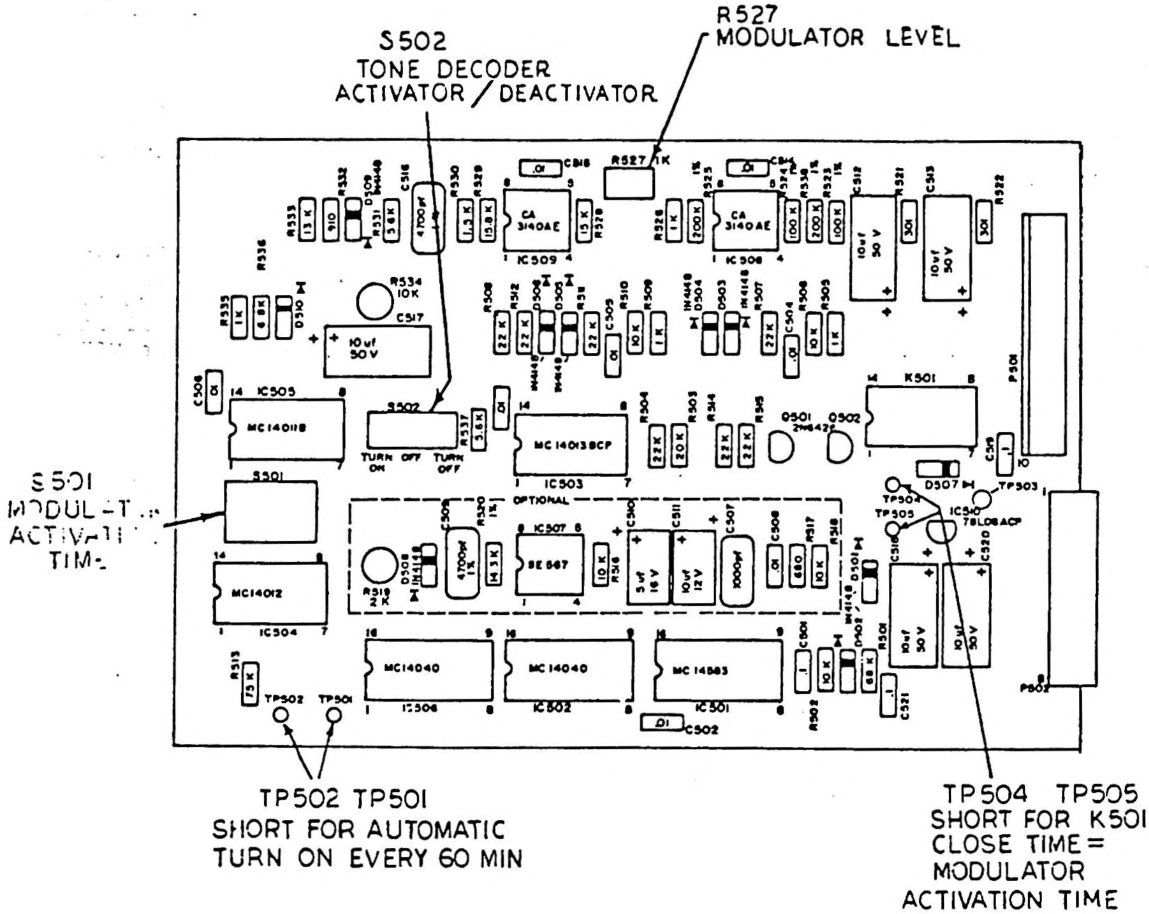


2.4.5: The modulator may also be activated automatically once every hour by an internal timer. This timer and the 30 second timer utilize the line frequency as their reference. Therefore, you should ensure the line frequency is stable to within ± one Hertz when using the modulator. This requirement is 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.

R29

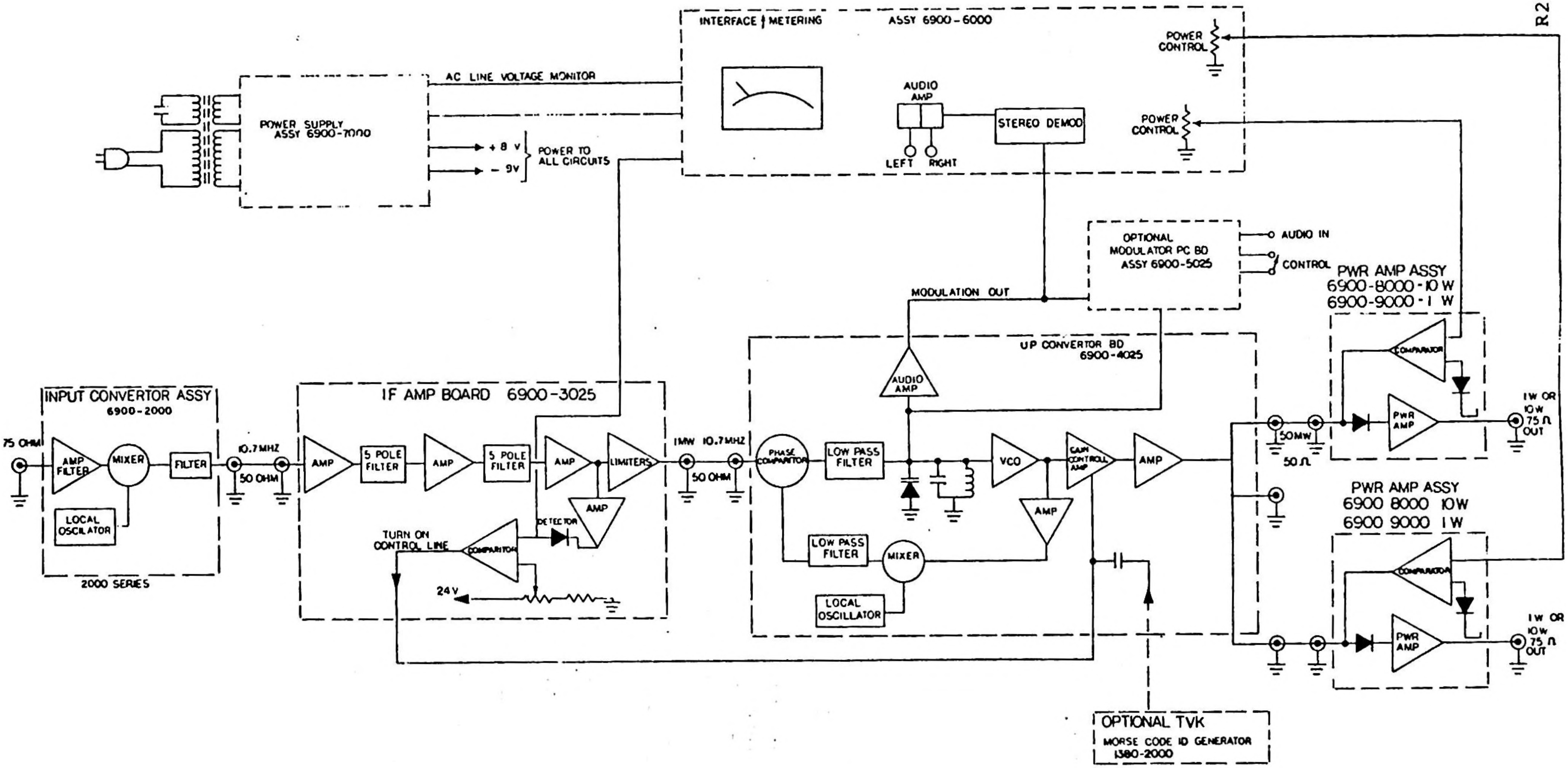


FIGURE 3.1.1

BLOCK DIAGRAM OF XL1FM, XL10FM

CONVERSION CHART

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.

3.5.9: 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: 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.

3.5.18: 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 .ldB 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 encounted 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.

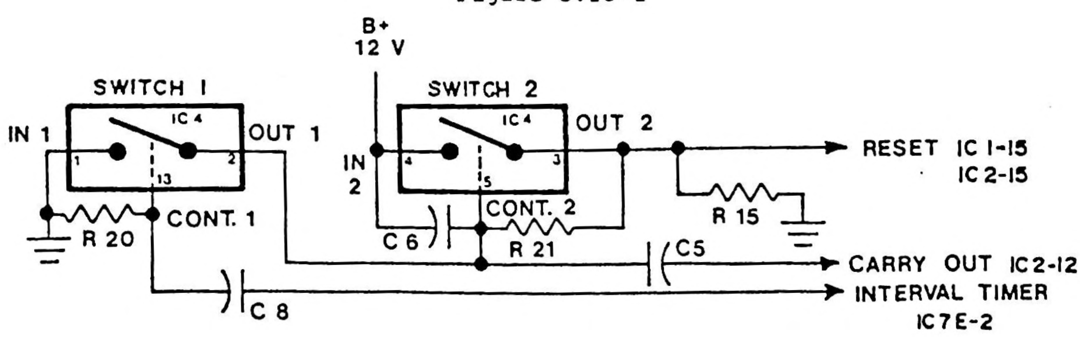
3.13.3: The set/reset circuit requires a positive pulse to start up the character generator, so IC7E is used to invert the output of the divider. The output of this inverter is differentiated by C8 and R20 to produce the necessary positive pulse. Transistor Q2 is used to suppress this pulse when power 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: CODE KEYER, TVK-1 (cont'd.)

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

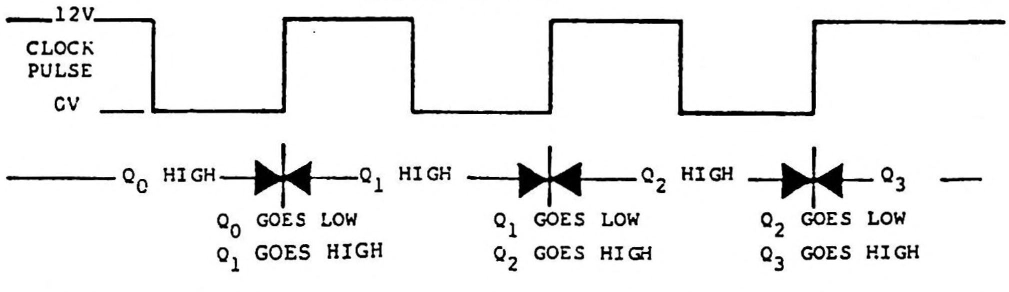
3.13.7: The character generator is designed with two (2) C-MOS 14017 IC decade counters. Each counter has the following input/output pins:

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.

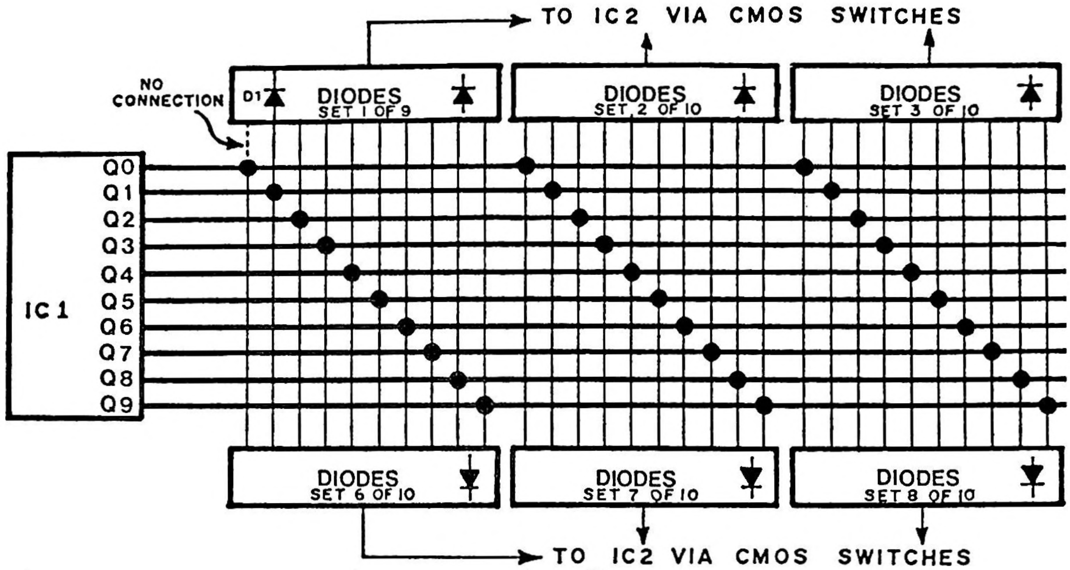
FIGURE 3.13-2



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

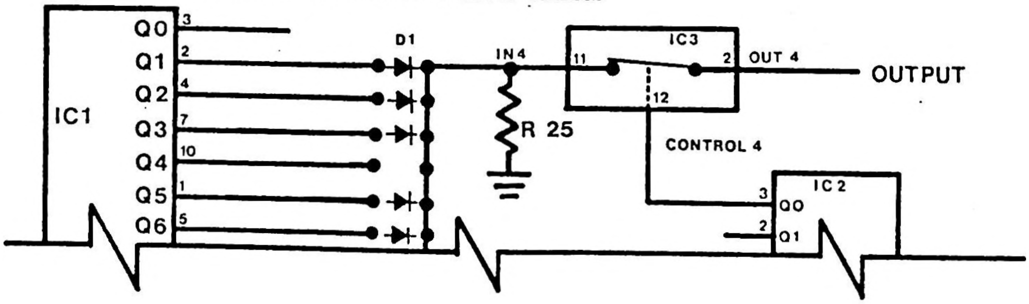


3.13.11: Each set of diodes is energized by C-MOS switches which are part of IC3, IC4 or IC5. Paragraph 3.13.5 explains their operation. Each switch is turned on by the output (Q) lines of IC2. When a positive voltage is not present at the control line of these switches, they act as an open circuit. 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 up-convertor. 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 re-adjust 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 volt-meter 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.

<u>4.2.9:</u> 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

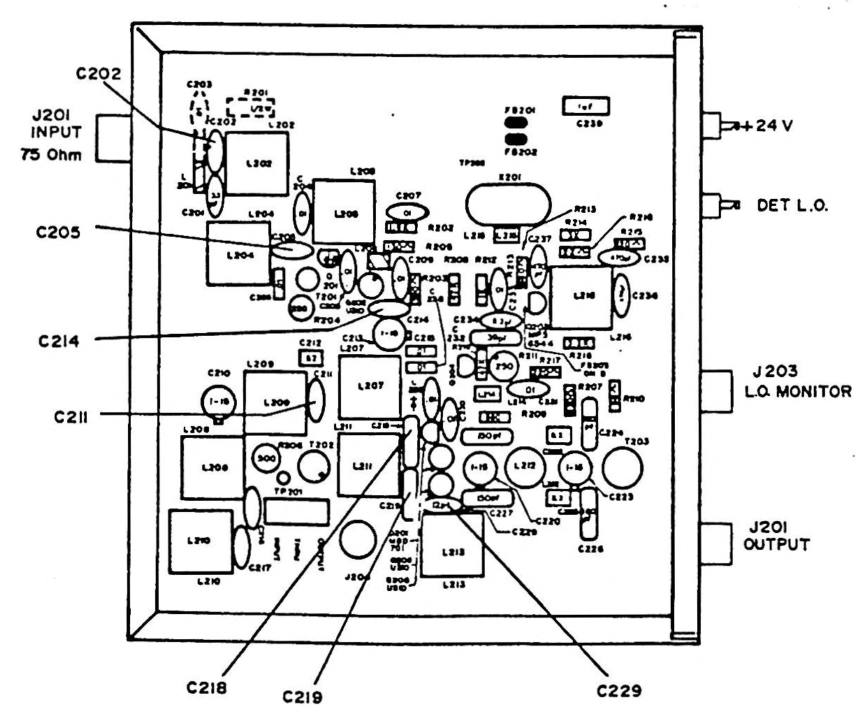
Local Oscillator:

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

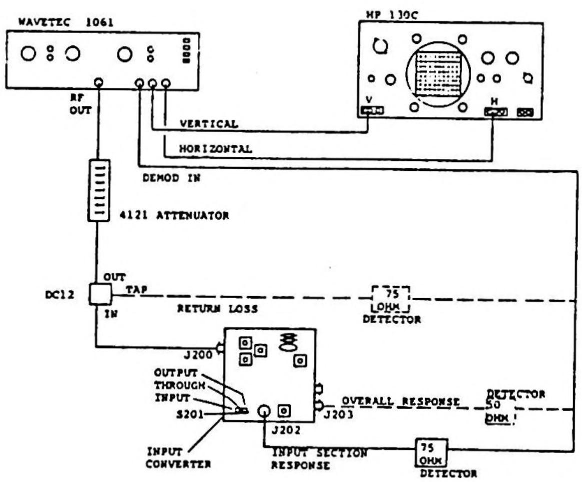
VARIABLE FREQUENCY COMPONENT CHART

	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

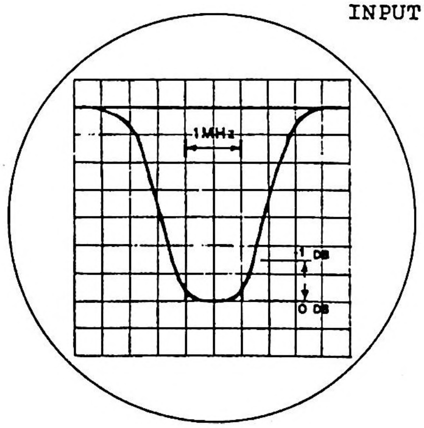


FIGURE 4.4.3
INPUT SECTION RESPONSE

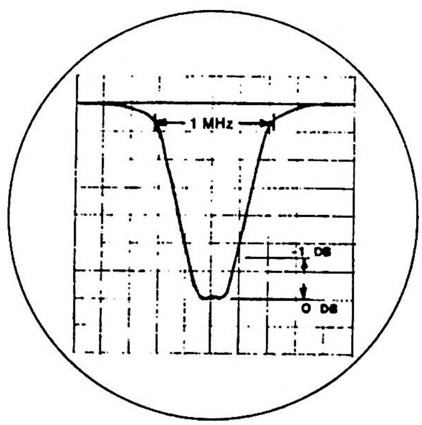


FIGURE 4.4.4
INPUT CONVERTER
OVERALL RESPONSE

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.

Input/Mixer Stage

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.

Table 4.5.1

Recommended Equipment List for IF Board Repair

1. 3-1/2 digit DVM (Data Precision Model 185).
2. Field-strength meter or signal level meter capable of measuring 1mV to 100mV at 88 to 220 MHz. The Sadelco Model FSC-733B or equivalent.
3. 1 foot RG58 test cable with alligator clips on one end.

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 ±.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 ± .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.

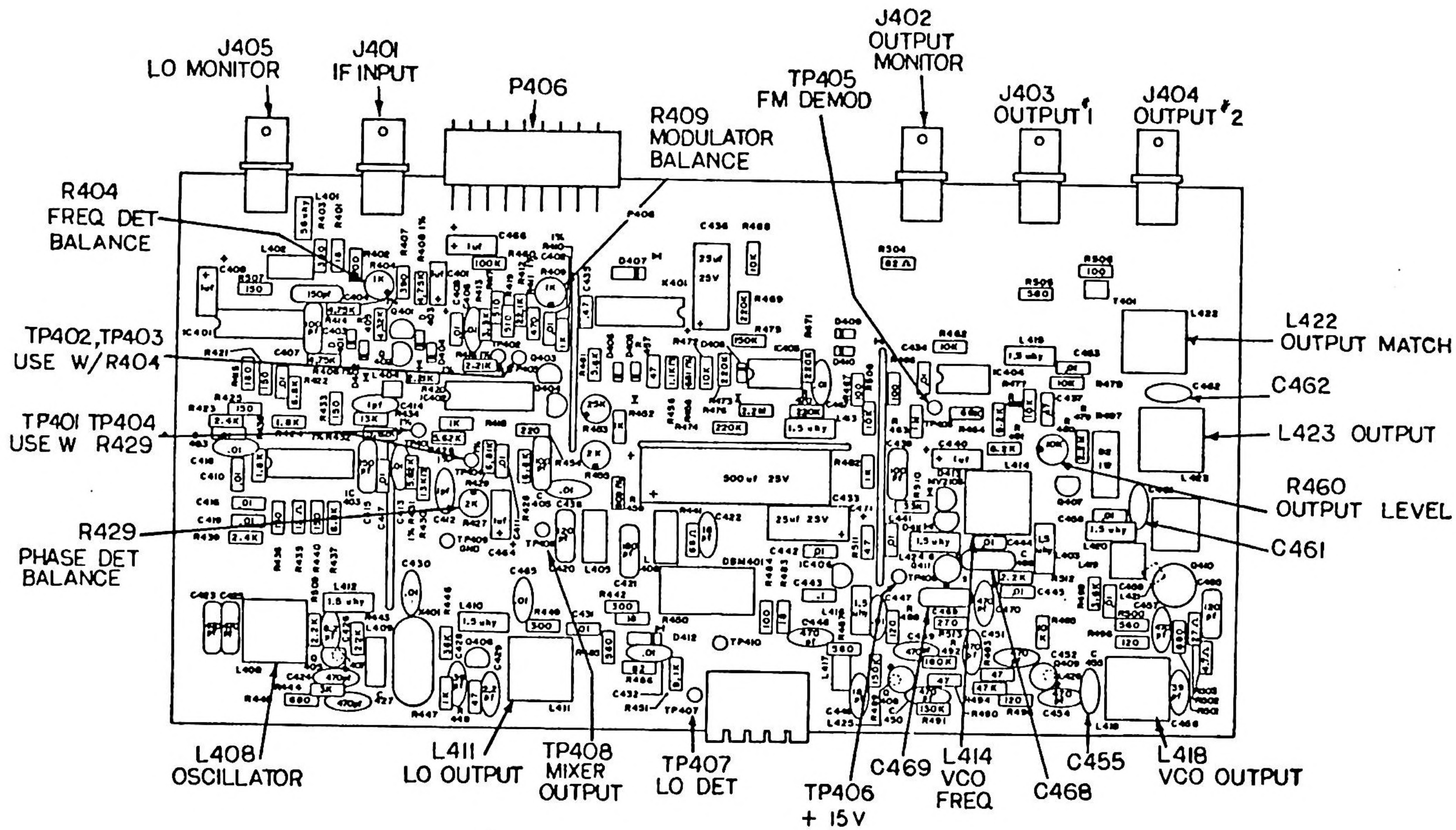


Figure 4.6.1

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

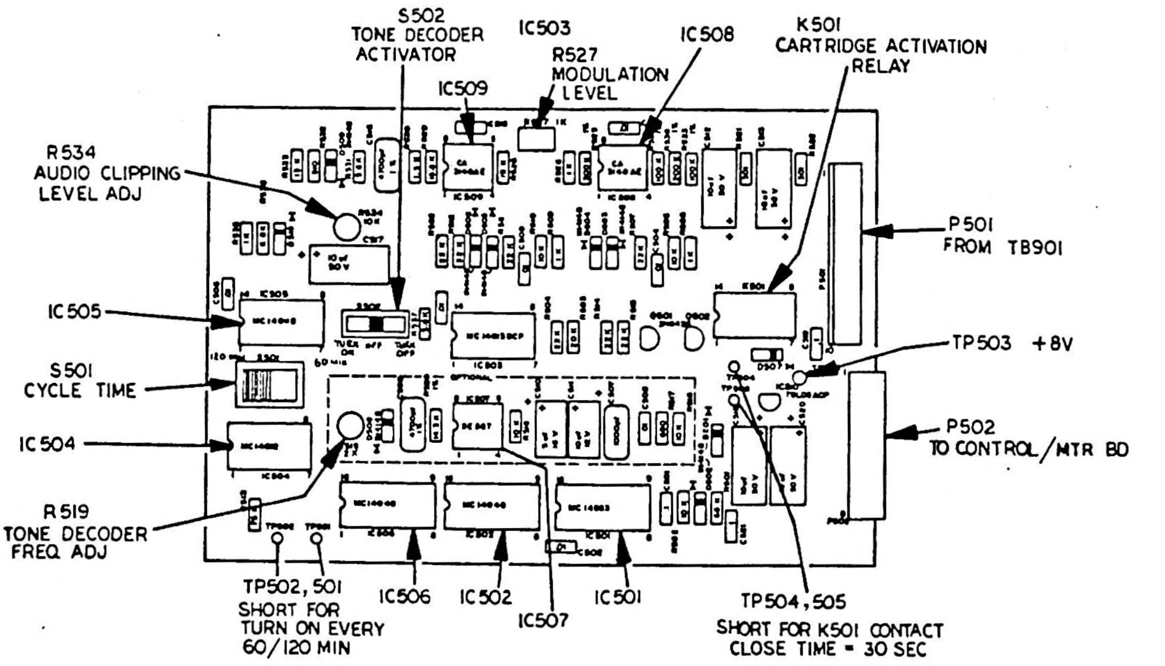
Tone Decoder:
- Activation Frequency.................15kHz ±150Hz standard
Any other freq. ±2% optional
- Activation Time......................1 second nominal

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:

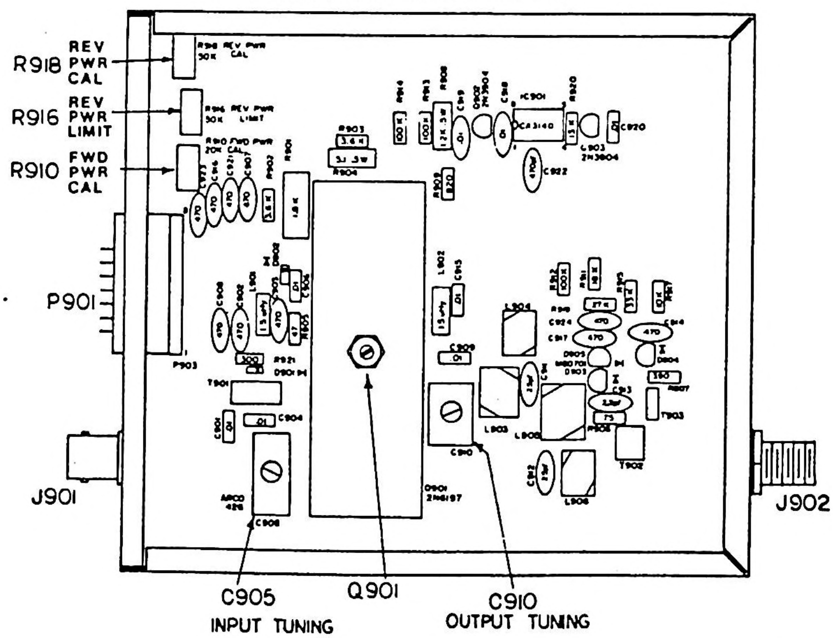
Maximum Power Gain...........17dB typical
AGC Range....................10dB minimum
Power Requirement............24 VDC @ .14 amps

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. I 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:

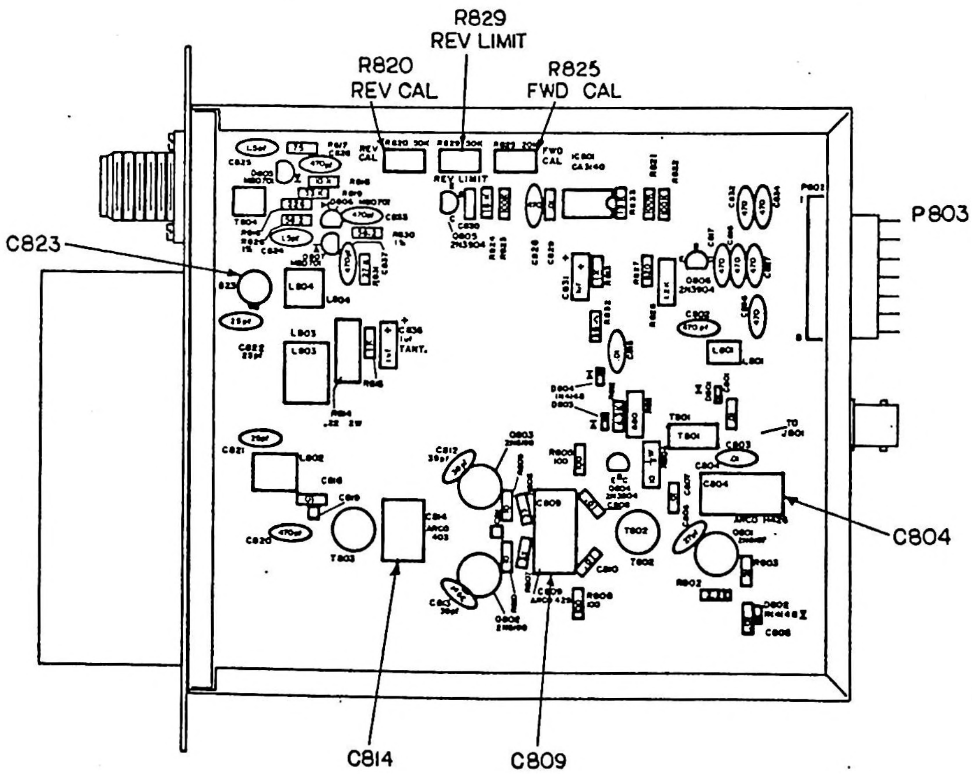
Maximum Power Gain...........23dB typical
AGC Range....................10dB minimum
Power Requirements...........24 VDC @ 1.2 amps.

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

<u>4.9.3:</u> 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.

<u>4.9.4:</u> 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.

<u>4.9.5:</u> 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.

<u>4.9.6:</u> 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.

<u>4.9.7:</u> 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).

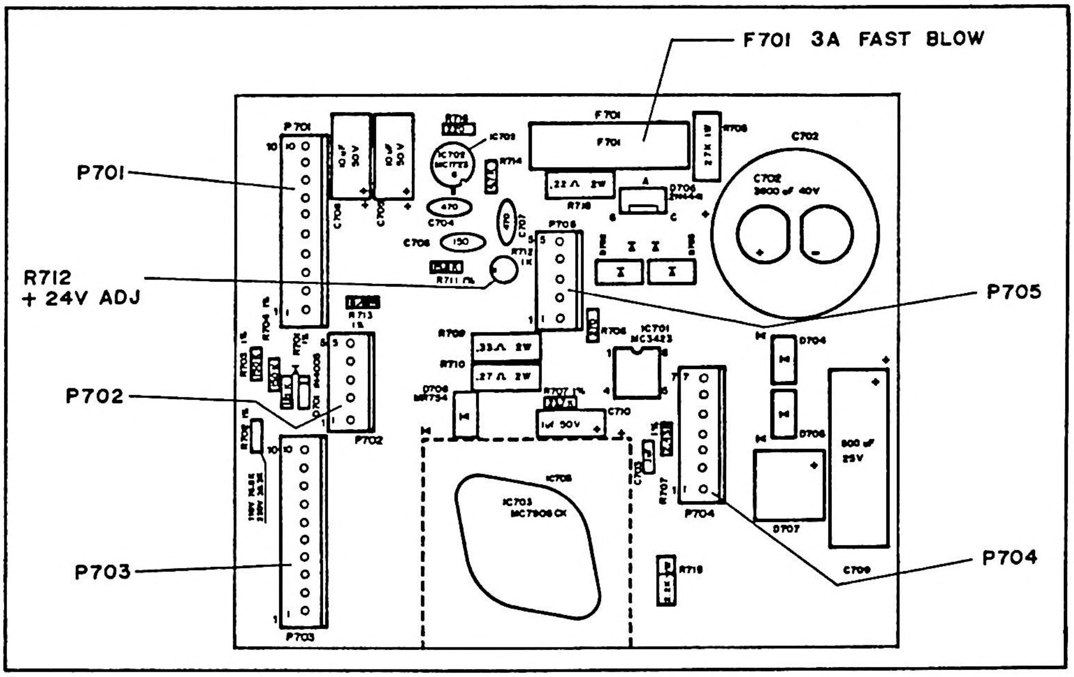
4.10: POWER SUPPLY BOARD

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 $\pm$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.

<u>-8 Volt Supply</u>

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 $\pm$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 $\pm$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.

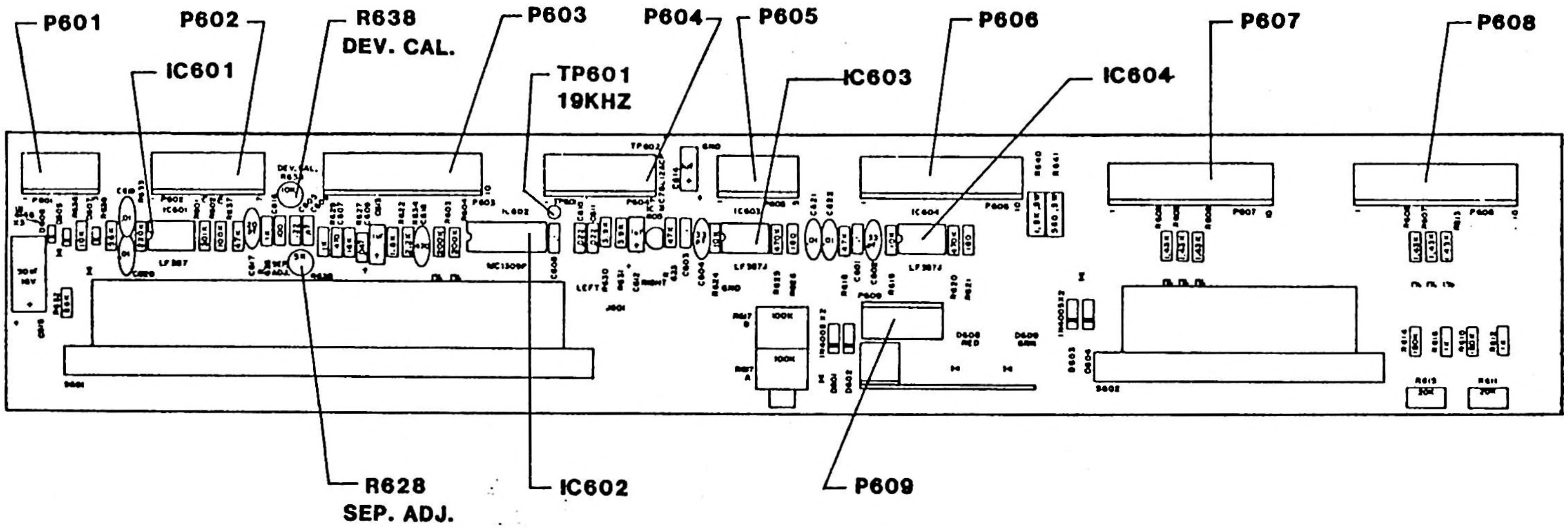


FIGURE 4.11.1

CONTROL & METERING BOARD

SECTION 5

PARTS LISTS

5.0: Guidelines for obtaining replacement parts.

Replacement of Components

5.0.1: Television Technology Corporation will supply replacement components at current prices. Some components, notably fixed resistors and capacitors, may be available locally. You may utilize these sources of components only if the part obtained locally is the exact equivalent. Capacitors and resistors should be replaced only with the same type and tolerance. For instance, a 22pF NPO disk ceramic capacitor may not be replaced with a 22pF Z5U disk capacitor or even with a 22pF silver mica capacitor.

5.0.2: Use of replacement type semiconductors (i.e. HEP, EGC, SK Series) is discouraged. If you have to use these types, use them only in control and DC circuits. Use of replacement semiconductors in RF circuitry may cause it to become completely inoperable.

5.0.3: When ordering parts from our factory, please supply the model and serial number of the equipment for which you require the parts.

5.0.4: On the parts list itself, the TTC part number is shown in the column identified as "part number" or "TTC part number." When ordering, please supply that number AND the description of the part...such as ".22 µF monolithic capacitor". Additionally, the circuit board, circuit area and circuit designator would also be most helpful...such as "C430 in the UHF Upconvertor." This allows us to be responsive if any technical changes or updates have occurred in the equipment.

5.0.5: To assure speedy routing and handling of any mailed parts orders or confirmations of orders, mark the front of your envelope "PARTS ORDER" and any mailed confirmations of telephone or TWX orders should be so marked on the document to avoid unnecessary duplication.

5.0.6: Mail orders to:

TELEVISION TECHNOLOGY CORPORATION

650 S. Taylor Louisville, CO 80027	Mail: P.O. Box 1385 Broomfield, CO 80020 - 8385

Telephone: 303-665-8000
FAX: 673-9900
Telex: 910-9380396 TTC COLO

5.0.7: IMPORTANT...The technical improvements made in some modules may produce parts lists that vary with the frequency range of the module. Those modules that may be so affected, such as the ULO local oscillator module, have their parts lists all in the same section of the manual, but the section is further subdivided. For example, the ULO module's parts are all listed in Section 5.6 of the manual, but sections a, b, c, and d of Section 5.6 refer to different frequency ranges of the same module. BE SURE YOU ARE LOOKING AT THE PARTS LIST FOR THE MODULE YOU HAVE.

5.2: CHASSIS ASSEMBLY - XL1FM 6900-0500 / XL10FM 6900-1500

Circuit Symbol	Description	Part Number
C100,101	Capacitor, Electrolytic, 1.5μF, 660 VAC, Oil	8131-330
CB101	Circuit Breaker, 2 amp., w/hardware	8228-020
D702	Bridge Rectifier	8216-010
Q101	Transistor, 2N6059	8218-2N6059
	Transistor Cover TO-3 (w/2 hole plugs)	8174-439
T101	Transformer, Ferroresonant	8162-293
TB101	Terminal Strip, 7 Terminal	8139-109
	Miscellaneous	
	Chassis	6900-1025
	Cover	6900-1027
	Cover (for Ract Mount only)	6900-1062
	Mounting Bracket (for 8131-330)	8131-305
	Knob	8000-023
	Hole Cover, Single Output	6900-1028
	Heat Shield	6900-1029
	Heat Sink	8174-436
	Strain Relief, Bushing	8000-939
	Mica Washer	8140-504
	Bushing	8140-503
	Cable, Ribbon, Power Supply to Q101	6900-1042
	Clamp, Cable, 3/8 Dia.	8138-205
	Clamp, Flat Cable (for ribbon cable)	8138-240
	Bumpers, Rubber (large)	8000-103
	Rack Handles (Ract Mount Version Only)	8108-512
	Equipment Handle, Ferrules (Rack Mt. Version)	8108-511
	Cable, Ribbon, Input Conv. to Interface PCB	6900-1037
	Cable, Ribbon, IF PCB to Interface PCB	6900-1038
	Cable, Ribbon, PLL PCB to Interface PCB	6900-1039
	Cable, Ribbon, 1 Watt PA to Interface PCB	6900-1045
	Cable, Ribbon, 10 Watt PA to Interface PCB	6900-1040
	Cable, Coax. 50Ω, Input Converter to IF PCB	6900-1050
	Cable, Coax. 50Ω, IF PCB to PLL PCB	6900-1051
	Cable, Coax. 75Ω, PLL PCB to Front Panel	6900-1053
	Cable, Coax. 50Ω, PLL to 10W PA	6900-1052
	Power Meter, XL10FM	8137-204
	Power Meter, XL1FM	8137-206
	Test Meter, XL1FM, XL10FM	8137-205
	Switch, Thermostat NC to 170F	8148-710

5.3: INPUT CONVERTER, XL1FM & XL10FM, 6900-2000

Schematic Diagram - C6900-2035

Circuit Symbol	Description	Part Number
C201	Capacitor, Disc Ceramic, 33pF	8133-33R0
C202,205,211,214, C218, 219,229	Capacitor, Value Depends on Channel See Variable Component Chart	
C203,204,228,230, C231,233	Capacitor, Disc Ceramic, .01μF, 50V	8131-010
C206,207,208,209, C215,238	Capacitor, Monolithic, .01μF	8130-605
C210,213,220,223	Capacitor, Air Variable, 1.0 - 15.7 pF	8131-719
C212	Capacitor, Tubular, .62 pF	8132-R62
C216,217	Capacitor, Optional for Trap	
C221,227	Capacitor, Silver Mica, 150 pF, 5%	8133-150R0
C222,225	Capacitor, Tubular Ceramic, 9.1pF, 5%	8132-9R1
C224,226	Capacitor, Mica, 180 pF, 5%	8133-180R0
C232	Capacitor, Disc Ceramic, 39 pF	8133-39R0
C234	Capacitor, Disc Ceramic, 8.2 pF	8133-8R2
C235,236	Capacitor, Silver Mica, 470 pF	8133-470R0
C237	Capacitor, Disc Ceramic, 470 pF	8134-470R0
C239	Capacitor, Tantalum, 1μF @ 50 VDC	8130-379
C240,241	Capacitor, Feed Thru, 470 pF	8131-094
D201	Diode, MBD701	8216-037
FB201,202,203	Ferrite Bead, #43, Small	8232-040
J201,204	Connector, Coax., 'F' P.C. Mount, 75Ω	8151-692
J202,203	Connector, BNC Panel Mount, 50Ω	8151-726
L201,203,206,215	Coil, Air Core	8232-715
L202	Coil, Tunable	8232-526
L204,213	Coil, Tunable	8232-522
L205	Coil, Tunable	8232-534
L207	Coil, Air Core	8232-503
L208	Coil, Tunable	8232-533
L209	Coil, Air Core	8232-504
L210	Coil, (Optional for Trap)	
L211	Coil, Tunable (Special)	6900-2037
L212	Coil, Toroidal	8232-607
L214	Choke, RF Wide Band	8232-011
L216	Coil, Tunable	8232-525
Q201	Transistor, FET J309	8219-009
Q202	Transistor, FET U310	8219-029
Q203,204	Transistor, MPS 6544	8219-035
Q205,206	Transistor, U310 (Matched Pair)	8219-040
R201	Resistor, (Optional, use for diplexer on input)	
R202	Resistor, Carbon, 1.6K Ω, 1/4W, 5%	8602-1.6K5
R203	Resistor, Carbon, 390 Ω, 1/4W, 5%	8602-390A5
R204,211	Resistor, Var. Mini Pot, 250 Ω	8154-822
R205	Resistor, Carbon, 130 Ω, 1/4W, 5%	8602-130A5
R206	Resistor, Var. Mini Pot, 500 Ω	8154-823
R207	Resistor, Carbon, 330 Ω, 1/4W, 5%	8602-330A5
R208,219	Resistor, Carbon, 47K Ω, 1/4W, 5%	8602-47K5
R209	Resistor, Carbon, 560 Ω, 1/4W, 5%	8602-560A5
R210	Resistor, Carbon, 56 Ω, 1/4W, 5%	8602-56A5

Circuit Symbol	Description	Part Number
R212	Resistor, Carbon, 1K Ω, 1/4W, 5%	8602-1.0K5
R213	Resistor, Carbon, 680 Ω, 1/4W, 5%	8602-680A5
R214	Resistor, Carbon, 3K Ω, 1/4W, 5%	8602-3.0K5
R215	Resistor, Carbon, 120 Ω, 1/4W, 5%	8602-120A5
R216	Resistor, Carbon, 22K Ω, 1/4W, 5%	8602-22K5
R217	Resistor, Carbon, 220 Ω, 1/4W, 5%	8602-220A5
R218	Resistor, Carbon, 2.2K Ω, 1/4W, 5%	8602-2.2K5
S201	Switch, Sub-Min. S.P., 3-Position	8125-102
T201	Transformer, Mini Toridal	8232-601
T202	Transformer, Mini Toridal	8232-603
T203	Transformer, Mini Toridal	8232-605
TP201,202	Test Point	8124-178
X201	Crystal	8182-210
	Miscellaneous	
	Cable Assembly	6900-1037
	Enclosure, 5" Universal	7001-1310
	Top & Bottom Covers	7001-1315
	End Piece	7001-1312
	Augat Pin, Large	8156-441
	Heatsink, Fan Top	8174-398
	Teflon Tubing, #20	8990-020
	Buss Wire, #20	8770-8020

VARIABLE COMPONENT CHART

INPUT CONVERTER

	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
C214	20 pF	8133-20R0	15 pF	8133-15R0
C211	15 pF	8133-15R0	12 pF	8133-12R0
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

5.4: IF AMPLIFIER P.C. BOARD ASSEMBLY 6900-3025

Schematic D6900-3035

Circuit Symbol	Description	Part Number
C301,302,312,323, C324,325,348,349, C351,353,355,356, C357,363,365,370, C375,376,377,378, C379,383	Capacitor, Monolithic, .01μF	8130-605
C303,326	Capacitor, Silver Mica, 560μF	8133-560R0
C304,327	Capacitor, Silver Mica, 360pF	8133-360R0
C305,308,313,317, C321,328,331,335, C339,343	Capacitor, Dielectric Trim., 5.5 - 65pF	8131-724
C306,309,314,330, C332,336	Capacitor, Silver Mica, 220pF	8133-220R0
C307,329 *	Capacitor, Disc Ceramic, 3.9pF	8133-3R9
C310,333 **	Capacitor, Disc Ceramic, 1.0pF	8133-1R0
C320,342 ***	Capacitor, Disc Ceramic, 1.0pF	8133-1R0
C311,316,334,338	Capacitor, Air Variable, 1.3 - 5.4pF	8131-717
C315,337 **	Capacitor, Disc Ceramic, 2.2pF	8133-2R2
C318,340 ****	Capacitor, Silver Mica, 300pF	8133-300R0
C319,341 **	Capacitor, Disc Ceramic, 15pF	8133-15R0
C322,344 *****	Capacitor, Silver Mica, 1000pF	8133-1000R0
C345,381	Capacitor, Tantalum, 1μF, 50VDC	8130-379
C346	Capacitor, Disc Ceramic, 39pF	8133-39R0
C347,350,352,354, C358,359,364,369, C371,380	Capacitor, Disc Ceramic, 470pF	8134-470R0
C360,366,373	Capacitor, Disc Ceramic, 27pF	8133-27R0
C361,362,367,368, C372,374	Capacitor, Tubular, .82pF	8132-R82
C382	Capacitor, Monolithic, .1μF	8130-620
D301,302	Diode, Hot Carrier, MBD-701	8216-037
D303,304	Diode, Switching, 1N4148	8217-1N4148
FB301,303,304,305, FB306,307	Ferrite Bead	8232-040
IC301,302,303	Integrated Circuit, CA3054	8220-038
IC304	Integrated Circuit, CA3240	8220-031
IC305	Integrated Circuit, LM335	8220-035
J301,302	Connector, BNC, 50Ω	8151-726
L301,307,313	Choke, RF, 56μH	8232-001
L302,303,304,305, L306,308,309,310, L311,312	Coil, Toroidal	8232-417
L314,315,316	Coil, Toroidal, Miniature	8232-425
P303	Connector, Molex 7 Pin Male, Right Angle	8151-609
Q301,302	Transistor, 2N5109	8218-2N5109
Q303	Transistor, 2N3904	8218-2N3904

* Use 8131-717 for high selectivity option.
** Delete for high selectivity option.
*** Use 8131-718 for high selectivity option.
**** Use 8133-270R0 for high selectivity option.
***** Use 8133-2000R0 for high selectivity option.

Circuit Symbol	Description	Part Number
R301,307	Resistor, Carbon, 30Ω, .25W, 5%	8602-30A5
R302,312	Resistor, Carbon, 22Ω, .25W, 5%	8602-22A5
R303+,309+,345	Resistor, Carbon, 2.7K Ω, .25W, 5%	8602-2.7K5
R304,310	Resistor, Carbon, 820Ω, .25W, 5% (Delete for high selectivity option)	8602-820A5
R305++,311++	Resistor, Carbon, 220Ω, .25W, 5%	8605-220A5
R306+++,308+++	Resistor, Carbon, 390Ω, .25W, 5%	8602-390A5
R313	Resistor, Carbon, 3.3KΩ, .25W, 5%	8602-3.3K5
R314,319,320,334, R335,340	Resistor, Carbon, 220 Ω, .25W, 5%	8602-220A5
R315,323,333,338, R342,348	Resistor, Carbon, 3.9KΩ, .25W, 5%	8602-3.9K5
R316	Resistor, Carbon, 680 Ω, .25W, 5%	8602-680A5
R317,347	Resistor, (NOT USED)	
R318	Resistor, Carbon, 180 Ω, .50W, 5%	8605-180A5
R321	Resistor, Carbon, 5.6KΩ, .25W, 5%	8602-5.6K5
R322,325,336,339, R341,343,344,351	Resistor, Carbon, 1K Ω, .25W, 5%	8602-1K5
R324	Resistor, Carbon, 147K Ω, .25W, 5%	8602-147K1
R326,327	Resistor, Carbon, 8.2KΩ, .25W, 5%	8602-8.2K5
R328	Resistor, Carbon, 10 Ω, .25W, 5%	8602-10A5
R329	Resistor, Carbon, 33K Ω, .25W, 5%	8602-33K5
R330	Resistor, Carbon, 12.1K Ω,.25W, 1%	8602-12.1K1
R331	Resistor, Carbon, 100K Ω, .25W, 1%	8602-100K1
R332	Resistor, Carbon, 39.2K Ω,.25W, 1%	8602-39.2K1
R337,346	Resistor, Carbon, 100 Ω, .25W, 5%	8602-100A5
R349	Resistor, Pot, 2K Ω	8154-825
R350	Resistor, Carbon, 240 Ω, .25W, 5%	8602-240A5
S301,302	Switch	8125-102
S303	Switch	8125-604
T301,302	Transformer	8232-611
T303	Transformer	8232-609
T304	Transformer	8239-626
TP301,302,303,304	Terminal, Swaged, Turret	8124-179
TP305	Terminal, Swaged, Forked	8124-178

\+ For Solar Power Mod, use 8602-1.5K5

++ For Solar Power Mod, use 8605-750A5

+++ For Solar Power Mod, use 8602-750A5

5.5: PLL UPCONVERTER P.C. BOARD ASSEMBLY - 6900-4025

Schematic Diagram - 6900-4035

Circuit Symbol	Description	Part Number
C401,408,440,464, C466	Capacitor, Tantalum, 1µF	8130-379
C402,407,409,410, C411,416,417,419, C431,434,441,442, C444,445,453,458, C459,463	Capacitor, Monolithic, .01µF	8130-605
C403,405,439	Capacitor, Silver Mica, 100pF	8133-100R0
C404,415	Capacitor, Silver Mica, 150pF	8133-150R0
C406,413,418,430, C432,438,447,465, C467	Capacitor, Disc Ceramic, .01µF	8131-010
C412,414	Capacitor, Disc Ceramic, 1.0pF	8133-1R0
C420,460	Capacitor, Silver Mica, 120pF	8133-120R0
C421	Capacitor, Silver Mica, 180pF	8133-180R0
C422,448	Capacitor, Disc Ceramic, 18pF	8133-18R0
C423,425	Capacitor, Silver Mica, 470pF	8133-470R0
C424,427,446,449, C450,451,452,454, C457,470	Capacitor, Disc Ceramic, 470pF	8134-470R0
C426	Capacitor, Disc Ceramic, 8.2pF	8133-8R2
C428,456	Capacitor, Silver Mica, 39pF	8133-39R0
C429	Capacitor, Disc Ceramic, 2.2pF	8133-2R2
C433	Capacitor, Electrolytic, 500µF, 25V	8131-234
C435,437	Capacitor, Monolithic, .47µF	8130-630
C436,471	Capacitor, Electrolytic, 25µF, 25V	8131-206
C443	Capacitor, Monolithic, .1µF	8130-620
C455,461,462,468, C469	Capacitor, See Variable Component Chart	
D401,402,403,404, D405,406,408,409, D410	Diode, Silicon, 1N4148	8217-1N4148
D407	Diode, Silicon, 1N4005	8217-1N4005
D411,413	Diode, Varicap, MV2105	8216-050
D412	Diode, Germanium Detector, 1N82A	8217-1N82
DBM401	Double Balanced Mixer	8220-003
IC401,402,403	Integrated Circuit, MC1596L	8220-081
IC404,405	Integrated Circuit, CA3240B	8220-031
IC406	Integrated Circuit, MC78L15	8220-055
J401,402,403,404, J405	Connector	8151-726
K401	Relay, Dip	8148-301
L401	Choke, 56µH, Miller	8232-001
L402	Coil, Toroidal	8232-418
L403,409,410,412, L413,415,416,420, L424	Choke, 1.5µH, Miller	8232-003
L404,407,421,425, L426	Ferrite Bead	8232-040
L405	Coil, Toroidal	8232-415
L406	Coil, Toroidal	8232-413
L408,423	Coil, Tunable	8232-525
L411	Coil, Tunable	8232-528
L414	Coil, Tunable	8232-523
L417	Coil, 4T22E4	8232-704
L418	Coil, Tunable	8232-526
L419	Coil, 7T22E4	8232-707
L422	Coil, Tunable	8232-530

Circuit Symbol	Description	Part Number
P401	Connector, 10-Pin, Male Right Angle Molex	8151-615
Q401,402,403,404, Q407	Transistor, 2N3906	8218-2N3906
Q405,406	Transistor, MPS6544	8219-035
Q408,409	Transistor, MFE521	8219-004
Q410	Transistor, 2N5109	8218-2N5109
Q411	Transistor, U310	8219-029
R401,450,483	Resistor, Carbon, 18 Ω, 1/4W, 5%	8602-18A5
R402,403,442,449	Resistor, Carbon, 300 Ω, 1/4W, 5%	8602-300A5
R404,409	Resistor, Pot., 1KΩ,	8154-824
R405	Resistor, Carbon, 4.32KΩ, 1/4W, 1%	8602-4.32K1
R406,408,414	Resistor, Carbon, 4.75KΩ, 1/4W, 1%	8602-4.75K1
R407	Resistor, Carbon, 390 Ω, 1/4W, 5%	8602-390A5
R410	Resistor, Carbon, 1KΩ, 1/4W, 1%	8602-1.0K1
R411	Resistor, Carbon, 470 Ω, 1/4W, 5%	8602-470A5
R412	Resistor, Carbon, 22.1KΩ, 1/4W, 1%	8602-22.1K1
R413	Resistor, Carbon, 3.3 KΩ, 1/4W, 5%	8602-3.3K5
R415	Resistor, Carbon, 180 Ω, 1/4W, 5%	8602-180A5
R416*,420*	Resistor, Carbon, 2.21KΩ, 1/4W, 1%	8602-2.21K1
R417,419	Resistor, Carbon, 510 Ω, 1/4W, 5%	8602-510A5
R418,447,452,482	Resistor, Carbon, 1KΩ, 1/4W, 5%	8602-1K5
R421,425,433,436, R440,507	Resistor, Carbon, 150 Ω, 1/4W, 5%	8602-150A5
R422,428,437	Resistor, Carbon, 6.8K Ω, 1/4W, 5%	8602-6.8K5
R423**,439**	Resistor, Carbon, 2.4K Ω, 1/4W, 5%	8602-2.4K5
R424***,438***	Resistor, Carbon, 1.8K Ω, 1/4W, 5%	8602-1.8K5
R426,431,432	Resistor, Carbon, 5.62KΩ, 1/4W, 1%	8602-5.62K1
R427,455	Resistor, Pot., 2KΩ	8154-825
R429	Resistor, Carbon, 6.81KΩ,	8602-6.81K1
R430,434	Resistor, Carbon, 13KΩ, 1/4W, 1%	8602-13.0K1
R435	Resistor, Carbon, 12 Ω, 1/4W, 5%	8602-12A5
R441	Resistor, Carbon, 68 Ω, 1/4W, 5%	8602-68A5
R443	Resistor, Carbon, 22KΩ, 1/4W, 5%	8602-22K5
R444	Resistor, Carbon, 3KΩ, 1/4W, 5%	8602-3K5
R445,501	Resistor, Carbon, 680 Ω, 1/4W, 5%	8602-680A5
R446	Resistor, Carbon, 36KΩ, 1/4W, 5%	8602-36K5
R448,457,490,511, R493	Resistor, Carbon, 47 Ω, 1/4W, 5%	8602-47A5
R451	Resistor, Carbon, 9.1K Ω, 1/4W, 5%	8602-9.1K5
R453	Resistor, Pot., 25KΩ	8154-828
R454	Resistor, Carbon, 220 Ω, 1/4W, 5%	8602-220A5
R456	Resistor, Carbon, 1.1K Ω, 1/4W, 1%	8602-1.1K1
R458	Resistor, Carbon, 681 Ω, 1/4W, 1%	8602-681A1
R459	Resistor, Carbon, 909 Ω, 1/4W, 1%	8602-909A1
R460	Resistor, Carbon, 100KΩ, 1/4W, 5%	8602-100K5
R461	Resistor, Carbon, 5.6K Ω, 1/4W, 5%	8602-5.6K5
R462,468,472,477, R478,495,508	Resistor, Carbon, 10KΩ, 1/4W, 5%	8602-10K5
R463	Resistor, Carbon, 1 Meg Ω, 1/4W, 5%	8602-1M5
R464	Resistor, Carbon, 68KΩ, 1/4W, 5%	8602-68K5
R465,481	Resistor, Carbon, 8.2K Ω, 1/4W, 5%	8602-8.2K5
R466,467,484,506	Resistor, Carbon, 100 Ω, 1/4W, 5%	8602-100A5
R471,473		
R474	Resistor, Carbon, 220KΩ, 1/4W, 5%	8602-220K5
R475,489	Resistor, Carbon, 150KΩ, 1/4W, 5%	8602-150K5
R476,479	Resistor, Carbon, 2.2 Meg Ω, 1/4W, 5%	8602-2.2M5
R480	Resistor, Pot., 10KΩ	8154-827
R485,487,500,505	Resistor, Carbon, 560 Ω, 1/4W, 5%	8602-560A5
R486,504	Resistor, Carbon, 82 Ω, 1/4W, 5%	8602-82A5
R488,496,498	Resistor, Carbon, 120 Ω, 1/4W, 5%	8602-120A5
R491	Resistor, Carbon, 130KΩ, 1/4W, 5%	8602-130K5
R492	Resistor, Carbon, 180KΩ, 1/4W, 5%	8602-180K5
R494,470,469	Resistor, Carbon, 47KΩ, 1/4W, 5%	8602-47K5
R497	Resistor, Carbon, 82 Ω, 1W, 5%	8610-82A5
R499	Resistor, Carbon, 3.6 KΩ, 1/4W, 5%	8602-3.6K5

* For Solar Power Mod, use 8602-3.3K5
** For Solar Power Mod, use 8602-6.8K5
*** For Solar Power Mod, use 8602-5.6K5

Circuit Symbol	Description			Part Number
R502	Resistor, Carbon, 27 Ω,	1/4W,	5%	8602-27A5
R503	Resistor, Carbon, 4.7 Ω,	1/4W,	5%	8602-4.7A5
R512	Resistor, Carbon, 2.2KΩ,	1/4W,	5%	8602-2.2K5
R510	Resistor, Carbon, 33KΩ,	1/4W,	5%	8602-33K5
R513	Resistor, Carbon, 270 Ω,	1/4W,	5%	8602-270A5
R509	Resistor, Carbon, 1.5KΩ,	1/4W,	5%	8602-1.5K5
T401	Transformer, Bifilar Wound			8232-009
TP401,402,403,404, TP405,406,407,408	Test Point			8124-178
TP409,410	Test Point			8124-179
X401	Crystal			
	Miscellaneous			
	Socket, Large, Augat			8156-441
	Socket, Dip, 8 Pin			8156-417
	Socket, Low Profile Dip, 14 Pin			8156-414
	Tulip Heatsink Bracket			A7001-1010
	Heatsink, Fan Top			8174-398
	Heatsink, Tulip			8174-402

VARIABLE COMPONENT CHART

PLL UPCONVERTER

	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

5.6: METERING & INTERFACE BOARD - 6900-6000

Schematic 6900-6035

Circuit Sybmol	Description	Part Number
C601,603,608	Capacitor, Monolithic, 0.1μF	8130-620
C602,604	Capacitor, Disc Ceramic, 33pF	8133-33R0
C605	Capacitor, Monolithic, .22μF	8130-625
C606	Capacitor, Monolithic, .47μF	8130-630
C607	Capacitor, Silver Mica, 470pF	8133-470R0
C609	Capacitor, Monolithic, .047μF	8130-615
C610,611	Capacitor, Monolithic, .022μF	8130-610
C612,613,614	Capacitor, Tantalum, 1μF, 50V	8130-379
C615	Capacitor, Electrolytic, 50μF, 16V	8131-155
C616	Capacitor, Dipped Mica, 100pF,	8133-100R0
C617	Capacitor, Disc Ceramic, 20pF	8133-20R0
C618	Capacitor, Disc Ceramic, 470pF	8134-470R0
C619,620,621,622	Capacitor, Disc Ceramic, .01μF, 50V	8131-010
D601,602,603,604	Diode, 1N4005 Rectifier, 600V	8217-1N4005
D605,606,607	Diode, 1N4148 Switching	8217-1N4148
D608	LED, Red	8155-010
D609	LED, Green	8155-009
IC601,603,604	Integrated Circuit, LF357N	8220-028
IC602	Integrated Circuit, MC1309P	8220-084
IC605	Integrated Circuit, MC78L12CP	8220-054
J601	Phone Jack, 3 Conductor	8151-754
P601,605,609	Connector, Molex, 5 Pin, Male	8151-610
P602,604	Connector, Molex, 7 Pin, Male	8151-602
P603,606,607,608	Connector, Molex, 10 Pin, Male	8151-604
R601	Resistor, Carbon, 301K Ω, 1/4W, 1%	8602-301K1
R602	Resistor, Carbon, 100K Ω, 1/4W, 1%	8602-100K1
R603,604	Resistor, Carbon, 200K Ω, 1/4W, 1%	8602-200K1
R605,606,607,608, R609,613	Resistor, Carbon, 1.43K Ω, 1/4W, 1%	8602-1.43K1
R610,614	Resistor, Carbon, 180K Ω, 1/4W, 5%	8602-180K5
R611,615	Resistor, Edge Mt., Mini Pot, 20K	8154-842
R612,616,629,635	Resistor, Carbon, 1.0K Ω, 1/4W, 5%	8602-1.0K5
R617	Resistor, Pot, Dual PC Mt., Audio Taper, 100K	8154-995
R618,623,637	Resistor, Carbon, 47K Ω, 1/4W, 5%	8602-47K5
R619,624,636	Resistor, Carbon, 10K Ω, 1/4W, 5%	8602-10K5
R620,625	Resistor, Carbon, 470K Ω, 1/4W, 5%	8602-470K5
R621,626	Resistor, Carbon, 180 Ω, 1/4W, 5%	8602-180A5
R622	Resistor, Carbon, 1.5K Ω, 1/4W, 5%	8602-1.5K5
R627	Resistor, Carbon, 16K Ω, 1/4W, 5%	8602-16K5
R628	Resistor, Pot., 5K Ω	8154-826
R630,631	Resistor, Carbon, 3.9K Ω, 1/4W, 5%	8602-3.9K5
R632,639	Resistor, Carbon, 56K Ω, 1/4W, 5%	8602-56K5
R633	Resistor, Carbon, 220K Ω, 1/4W, 5%	8602-220K5
R634	Resistor, Carbon, 2.2K Ω, 1/4W, 5%	8602-2.2K5
R638	Resistor, Pot., 10K Ω	8154-827
R640	Resistor, Carbon, 1.5K Ω, 1/2W, 5%	8605-1.5K5
R641	Resistor, Carbon, 560 Ω, 1/2W, 5%	8605-560A5
S601	Switch, Push Button, 8 Station	8125-323
S602	Switch, Push Button, 4 Station	8125-321
TP601,602	Terminal	8124-178
	Miscellaneous	
	Bracket, Keystone	8140-471
	Pot Mounting Bracket	A7001-1015
	Phone Jack Mounting Bracket	A7001-1016
	Spacer, for LED	8141-127
	Quick Disconnect Pin, Right Angle	8124-009
	Socket, Low Profile Dip, 14 Pin	8156-414
	Socket, Dip, 8 Pin	8156-417

5.7: FM MODULATOR COMPLETE ASSEMBLY - 6900-5000

Schematic Diagram D6900-5035

Circuit Symbol	Description	Part Number
C501,519	Capacitor, Monolithic, 0.1μF	8130-620
C502,503,504,505, C506,508,514,515	Capacitor, Monolithic, 0.01μF	8130-605
C507	Capacitor, Silver Mica, 1000pF, 5%	8133-1000R0
C509,516	Capacitor, Silver Mica, 4700pF, 1%	8133-4700R0
C510	Capacitor, Electrolytic, 5μF, 16V	8131-150
C511	Capacitor, Electrolytic, 10μF, 12V	8131-120
C512,513,517,518, C520	Capacitor, Electrolytic, 10μF, 50V	8131-510
D501,502,503,504, D505,506,507,508, D509,510	Diode, Switching, 1N4148	8217-1N4148
IC501	IC, Dual, MC14583	8220-039
IC502,506	IC, 12 Bit Binary Counter, MC14040	8220-040
IC503	IC, Dual, MC14013BCP	8220-021
IC504	IC, Dual, MC14012	8220-041
IC505	IC, Quad Nand Gate, MC14011BCP	8220-083
IC507	IC, Tone Decoder, SE567	8220-042
IC508,509	IC, CA3140AE	8220-025
IC510	IC, 8 Volt LV Reg., 78L08ACP	8220-010
K501	Relay, Dip, 24V	8148-301
P501	Connector, 10 Pin, Molex Male	8151-604
P502	Connector, 8 Pin, Molex Male, Right Angle	8151-613
Q501,502	Transistor, 2N6426	8218-2N6426
R501	Resistor, Carbon, 68K Ω, 1/4W, 5%	8602-68K5
R502,506,510,516, R518	Resistor, Carbon, 10K Ω, 1/4W, 5%	8602-10K5
R503	Resistor, Carbon, 20K Ω, 1/4W, 5%	8602-20K5
R504,507,508,511, R512,514,515	Resistor, Carbon, 22K Ω, 1/4W, 5%	8602-22K5
R505,509,526,535	Resistor, Carbon, 1.0K Ω, 1/4W, 5%	8602-1.0K5
R513	Resistor, Carbon, 75K Ω, 1/4W, 5%	8602-75K5
R517	Resistor, Carbon, 680 Ω, 1/4W, 5%	8602-680A5
R519	Resistor, Potentiometer, 2K Ω	8154-825
R520	Resistor, Carbon, 14.3K Ω, 1/4W, 1%	8602-14.3K1
R521,522	Resistor, Carbon, 301 Ω, 1/4W, 1%	8602-301A1
R523,524	Resistor, Carbon, 100K Ω, 1/4W, 1%	8602-100K1
R525	Resistor, Carbon, 200K Ω, 1/4W, 1%	8602-200K1
R527	Resistor, Edge Mount, 1K	8154-838
R528	Resistor, Carbon, 15K Ω, 1/4W, 5%	8602-15K5
R529	Resistor, Carbon, 15.8K Ω, 1/4W, 1%	8602-15.8K1
R530	Resistor, Carbon, 1.5K Ω, 1/4W, 5%	8602-1.5K5
R531,537	Resistor, Carbon, 5.6K Ω, 1/4W, 5%	8602-5.6K5
R532	Resistor, Carbon, 910 Ω, 1/4W, 5%	8602-910A5
R533	Resistor, Carbon, 13K Ω, 1/4W, 5%	8602-13K5
R534	Resistor, Potentiometer, 10K Ω	8154-827
R536	Resistor, Carbon, 6.8K Ω, 1/4W, 5%	8602-6.8K5
R538	Resistor, Carbon, 200 K Ω, 1/4W, 1%	8602-200K1
S501	Switch, DPDT, Slide	8125-103
S502	Switch, Slide	8125-102
	Miscellaneous	
	Cable, Interface	B6900-5020
	Cable, Terminal Block	B6900-5021
	Socket, Dip, 8 Pin	8156-417
	Socket, Low Profile Dip, 14 Pin	8156-414
	Socket, Low Profile Dip, 16 Pin	8156-416
	Test Point	8124-178

5.8: POWER SUPPLY ASSEMBLY - 6900-7000

Schematic 6900-7035

Circuit Symbol	Description	Part Number
C701	Capacitor, (Not Used)	
C702	Capacitor, Electrolytic, 3600µF, 40V	8131-427
C703	Capacitor, Monolithic, 0.1µF	8130-620
C704,707	Capacitor, Disc Ceramic, 470pF	8134-470R0
C705,708	Capacitor, Electrolytic, 10µF, 50V	8131-510
C706	Capacitor, Silver Mica, 150pF	8133-150R0
C709	Capacitor, Electrolytic, 500µF, 25V	8131-234
C710	Capacitor, Electrolytic, 1µF, 50V	8131-501
D701	Diode, Silicon, 1N4005	8217-1N4005
D708	Rectifier, Hi-Current Lead Mount	8216-060
D706	Thyristor, (SCR) 8A, 600V	8218-2N4441
D707	Rectifier Bridge, 6A, Power Comp.	8216-309
F701	Fuse, 4 Amp., Fast Blo	8166-400
IC701	Integrated Circuit, MC3423U	8220-036
IC702	Integrated Circuit, MC1723G	8220-001
IC703	Integrated Circuit, MC7908CK	8220-057
R701	Resistor, Carbon, 121 K Ω 1/4W, 1%	8602-121K1
R702	Resistor, Carbon, 76.8 K Ω, 1/4W, 1% (117V Operation Only)	8602-76.8K1
R702	Resistor, Carbon, 39.2 K Ω, 1/4W, 1% (240V Operation Only)	8602-39.2K1
R703,704	Resistor, Carbon, 150 K Ω, 1/4W, 1%	8602-150K1
R705	Resistor, Carbon, 2.7 K Ω, 1W, 5%	8610-2.7K5
R706	Resistor, Carbon, 270 Ω, 1/4W, 5%	8602-270A5
R707	Resistor, Carbon, 2.43K Ω, 1/4W, 1%	8602-2.43K1
R708	Resistor, Carbon, 23.7 K Ω, 1/4W, 1%	8602-23.7K1
R709	Resistor, Wirewound, 0.33 Ω, 2W, 5%	8154-033
R710	Resistor, Wirewound, 0.27 Ω, 2W, 5%	8154-027
R711	Resistor, Carbon, 15.8 K Ω, 1/4W, 1%	8602-15.8K1
R712	Resistor, Pot., 1 K Ω	8154-824
R713	Resistor, Carbon, 6.49K Ω, 1/4W, 1%	8602-6.49K1
R714	Resistor, Carbon, 4.7 K Ω, 1/4W, 5%	8602-4.7K5
R715	Resistor, Carbon, 2.2 K Ω, 1/2W, 5%	8605-2.2K5
R716	Resistor, Carbon, 220 Ω, 1/4W, 5%	8602-220A5
R717	Varistor, 130V	8215-130
R718	Resistor, Wirewound, 0.22 Ω, 2W, 5%	8154-022
	Miscellaneous	
	Standoff, 6-32 x 1/2 Hex	8140-708
	Tubing, Teflon, #20	8990-020
	P.C. Mount Fuse Clip	8228-401
	Heatsink, "Space Saver"	8174-437
	Socket, Dip, 8 Pin	8156-417
	Socket, IC, 10 Pin	8156-430
	Connector, 7 Pin, Male	8151-602
	Connector, 10 Pin, Male	8151-604
	Connector, 5 Pin, Male	8151-610

5.9: 1 WATT POWER AMPLIFIER ASSEMBLY - 6900-9000

Schematic Diagram 6900-9035

Circuit Symbol	Description	Part Number
C901,904,906,909, C915,920	Capacitor, Monolithic, .01μF	8130-605
C902,907,908,914, C916,917,921,922, C923,924	Capacitor, Disc Ceramic, 470pF, 20%	8134-470R0
C903	Capacitor, Dipped Mica, 470pF	8133-470R0
C905	Capacitor, Trimmer, 37 - 250 pF	8131-906
C910	Capacitor, Min. Trimmer, 15 - 115 pF	8131-186
C911,912	Capacitor, Disc Ceramic, 25 pF	8133-25R0
C913	Capacitor, Disc Ceramic, 2.2 pF	8133-2R2
C918,919	Capacitor, Disc Ceramic, .01μF, 50V	8131-010
D901	Diode, Silicon, HP5082-3081	8216-038
D902	Diode, Switching, 1N4148	8217-1N4148
D903,904,905	Diode, Hot Carrier, MBD-701	8216-037
IC901	Integrated Circuit, CA3140	8220-025
L901,902	Choke, 1.5 μH	8232-003
L903,904,906	Air Coil	8232-722
L905	Air Coil	8232-721
L907	Coil, Toroid, 17T22E on 8232-042 Core	8232-417
P903	Connector, 8 Pin Male, Right Angle	8151-613
Q901	Transistor, 2N6197	8218-2N6197
Q902,903	Transistor, 2N3904	8218-2N3904
R901	Resistor, Carbon, 1.8 K Ω, 1W, 5%	8610-1.8K5
R902,903	Resistor, Carbon, 3.6 K Ω, 1/4W, 5%	8602-3.6K5
R904	Resistor, Carbon, 5.1 Ω, 1/2W, 5%	8605-5.1A5
R905	Resistor, Carbon, 47 Ω, 1/4W, 5%	8602-47A5
R906	Resistor, Carbon, 75 Ω, 1/4W, 5%	8602-75A5
R907	Resistor, Carbon, 390 Ω, 1/4W, 5%	8602-390A5
R908	Resistor, Carbon, 1.2 K Ω, 1/2W, 5%	8605-1.2K5
R909	Resistor, Carbon, 820 Ω, 1/4W 5%	8602-820A5
R910	Potentiometer, Edge Mt. 20KΩ	8154-842
R911	Resistor, Carbon, 18 K Ω, 1/4W, 5%	8602-18K5
R912,913,914	Resistor, Carbon, 100 K Ω, 1/4W, 5%	8602-100K5
R915	Resistor, Carbon, 33 K Ω, 1/4W, 5%	8602-33K5
R916,918	Potentiometer, Edge Mt. 50KΩ	8154-850
R917	Resistor, Carbon, 10 K Ω, 1/4W, 5%	8602-10K5
R919	Resistor, Carbon, 27 K Ω, 1/4W, 5%	8602-27K5
R920	Resistor, Carbon, 13 K Ω, 1/4W, 5%	8602-13K5
R921	Resistor, Carbon, 300 Ω, 1/4W, 5%	8602-300A5
T901	Balun, 3:1 Toroidal	8232-620
T902	Directional Coupler, Toroidal	8232-614
T903	Balun, Miniature Toroidal	8232-624
	Miscellaneous	
	'F' Connector, P.C. Mount, Female	8151-692
	'BNC' Connector, Chassis Mount, Female	8151-726
	Back Mounting Plate Assembly	6900-9005
	Socket, Dip, 8 Pin	8156-417
	Heat Sink, Top Piece	A6900-9007
	Heat Sink, Bottom Piece	A6900-9008

5.10: 10 WATT POWER AMPLIFIER ASSEMBLY - 6900-8000

Schematic Diagram 6900-8035

Circuit Symbol	Description	Part Number
C801,805,807,808, C810,818,829,830	Capacitor, Monolithic, .01µF	8130-605
C802,816,817,820, C826,827,828,832, C833,834,836,837	Capacitor, Disc Ceramic, 470pF	8134-470R0
C803,815	Capacitor, Disc Ceramic, .01µF, 50V	8131-010
C804	Capacitor, Mica Trimmer, 37 - 250 pF	8131-906
C806	Capacitor, Disc Ceramic, 27.0pF	8133-27R0
C809	Capacitor, Trimmer, 24 - 200pF	8131-905
C811,819	Capacitor, Chip, 1600pF	8131-070
C812,813	Capacitor, Disc Ceramic, 39pF	8133-39R0
C814	Capacitor, Mica Trimmer, 4 - 40 pF	8131-183
C821,822	Capacitor, Disc Ceramic, 25pF	8133-25R0
C823	Capacitor, Air Variable, 1.9 - 15.7pF	8131-746
C824,825	Capacitor, Disc Ceramic, 1.5pF	8133-1R5
C831,835	Capacitor, Tantalum, 1µF	8130-379
C838 ,839	Capacitor, Electrolytic 100µF @ 50V	8131-517
D801	Diode, Hot Carrier	8216-038
D802,803,804	Diode, 1N4148, Switching	8217-1N4148
D805,806,807	Diode, Hot Carrier, MBD-701	8216-037
IC801	Integrated Circuit, CA3140	8220-025
L801	Choke, RF Wide Band, 9 Turns	8232-011
L802,804	Coil, Air Core	8232-721
L803	Coil, Air Core	8232-722
L804	Coil, Toroid, 7T22E on 8232-042	8232-417
P803	Connector, Right Angle Male, P.C. Mt., 8 Pin	8151-613
Q801	Transistor, RF Power, 2N6197	8218-2N6197
Q802,803	Transistor, RF Power, 2N6199	8218-2N6199
Q804,805,806	Transistor, Small Signal, 2N3904	8218-2N3904
R801	Resistor, (Not Used)	
R802	Resistor, Carbon, 2.2 K Ω, 1/4W, 5%	8602-2.2K5
R803	Resistor, Carbon, 51 Ω, 1/4W, 5%	8602-51A5
R804	Resistor, Carbon, 10 Ω, 1W 5%	8610-10A5
R805,808	Resistor, Carbon, 100 Ω, 1/4W, 5%	8602-100A5
R806,807	Resistor, Carbon, 33 Ω, 1/4W, 5%	8602-33A5
R809,810	Resistor, Carbon, 10 Ω, 1/4W, 5%	8602-10A5
R811	Resistor, Carbon, 680 Ω, 1/2W, 5%	8605-680A5
R812	Resistor, Carbon, 4.3 K Ω, 1/4W, 5%	8602-4.3K5
R813,815	Resistor, Carbon, 1.0 K Ω, 1/4W, 5%	8602-1.0K5
R814	Resistor, Wirewound, 0.22 Ω, 2W, 5%	8154-022
R816	Resistor, Carbon, 226 Ω, 1/4W, 1%	8602-226A1
R817	Resistor, Carbon, 75 Ω, 1/4W, 5%	8602-75A5
R818	Resistor, Carbon, 10 K Ω, 1/4W, 5%	8602-10K5
R819	Resistor, Carbon, 33 K Ω, 1/4W, 5%	8602-33K5
R820,829	Potentiometer, 50 K Ω,	8154-850
R821,822,823	Resistor, Carbon, 100 K Ω, 1/4W, 5%	8602-100K5
R824	Resistor, Carbon, 18 K Ω, 1/4W, 5%	8602-18K5
R825	Potentiometer, 20 K Ω	8154-842
R826,830	Resistor, Carbon, 56.2 Ω, 1/4W, 1%	8602-56.2A1
R827	Resistor, Carbon, 820 Ω, 1/4W, 5%	8602-820A5
R828	Resistor, Carbon, 1.2 K Ω, 1/2W, 5%	8605-1.2K5
R831	Resistor, Carbon, 27 K Ω, 1/4W, 5%	8602-27K5
R832	Resistor, Carbon, 39 Ω, 1/4W, 5%	8602-39A5
R833	Resistor, Carbon, 13 K Ω, 1/4W, 5%	8602-13K5
T801	Balun, 3:1 Toroidal	8232-620
T802,803	Balun, Toroidal	8232-622
T804	Directional Coupler, 20dB, Toroidal	8232-615

Miscellaneous

Heatsink, 4W UHF Driver Amplifier	B1342-1008
Heatsink Plate	B6900-8011
Back Mounting Plate	B6900-8012
Connector, 75 Ω N, Female, Chassis Mount	8151-165
Connector, 50 Ω, BNC Chassis Mount	8151-726
Ground Strap, for J802	A7001-1776
Socket, Dip, 8 Pin	8156-417

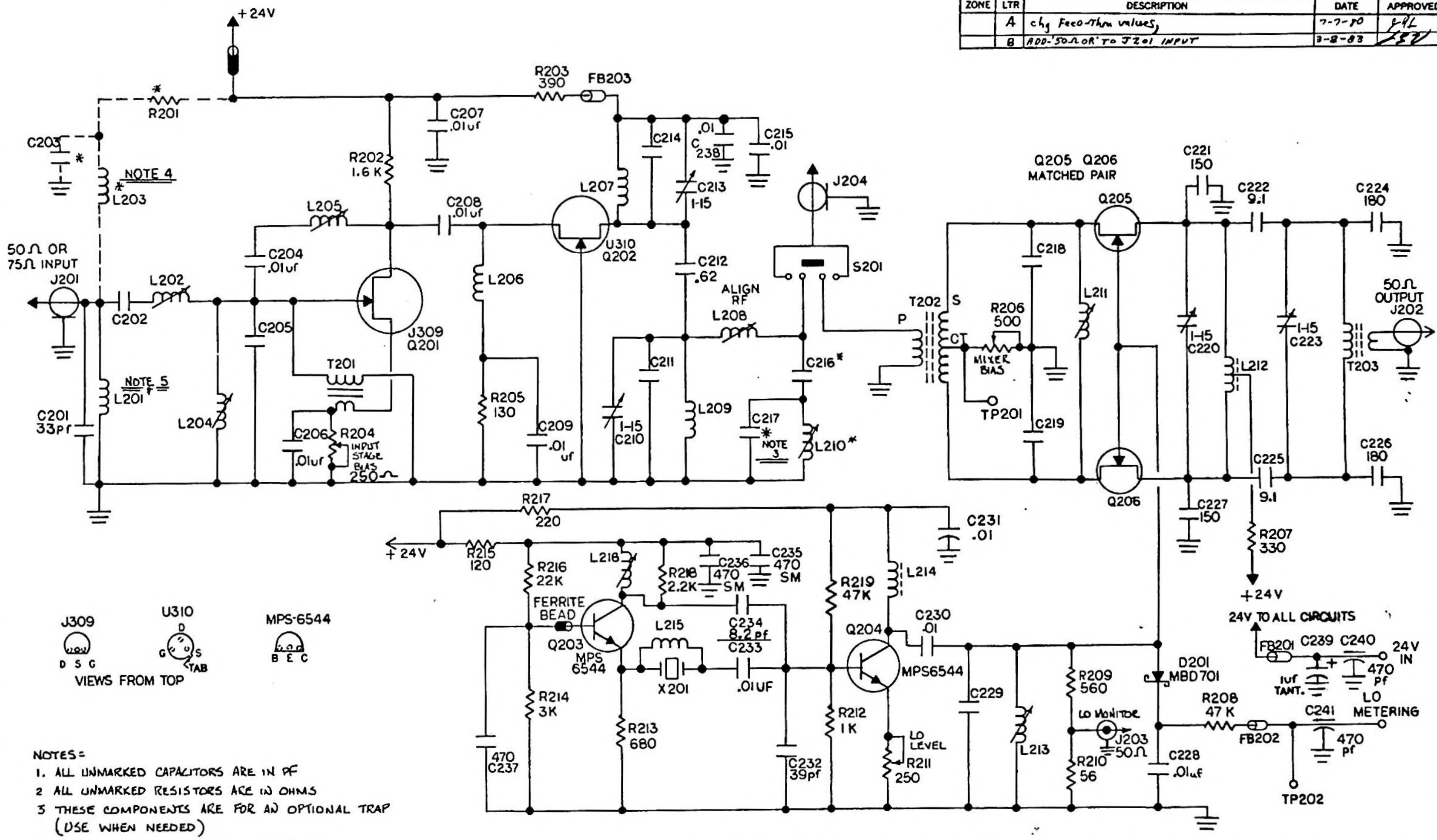
5.11: CODE KEYER, TVK-1 1380-2002

Schematic Diagram D1380-2010

Circuit Symbol	Description	Part Number
C1	Capacitor, Disc Ceramic, 750 pF	8134-750RO
C2,9,24,26	Capacitor, Monolithic, .1 μF	8130-620
C3,4	Capacitor, Polycarbonate, .047 μF, 100V	8131-545
C5,6,10,11,20, C22,23	Capacitor, Disc Ceramic, .01 μF, 50V	8131-010
C7,13,14,19,21, C25	Capacitor, Disc Ceramic, 470 pF	8134-470RO
C8	Capacitor, Disc Ceramic, .001 μF	8131-001
C12,16	Capacitor, Polycarbonate, .01 μF	8131-540
C15	Capacitor, Tantalum, 4.7 μF, 50V	8130-587
C17	Capacitor, Electrolytic, 10 μF, 25V	8131-202
D1,2,3	Diode, Switching, 1N4148	8217-1N4148
D5	Diode, Light Emitting (Red)	8155-010
IC1,2	IC, C-MOS, Motorola MC14017BCP	8220-022
IC3,4,5	IC, C-MOS, Motorola MC14016BCP	8220-027
IC6	IC, C-MOS, Motorola MC14020BCP	8220-023
IC7	IC, C-MOS, Motorola MC14049BCP	8220-024
IC8	IC, C-MOS OP AMP, RCA CA3140	8220-025
IC9	IC, Regulator, Motorola, MC7812C, 12V	8220-014
Q1,2	Transistor, 2N3904	8218-2N3904
Q3,4	Transistor, 2N6426	8218-2N6426
R1	Resistor, Carbon, 4.7M Ω, 1/4W, 5%	8602-4.7M5
R2 *	Resistor, Carbon, 470K Ω, 1/4W, 5%	8602-470K5
R3 *	Resistor, Carbon, 240K Ω, 1/4W, 5%	8602-240K5
R4 *	Resistor, Carbon, 4.7M Ω, 1/4W, 5%	8602-4.7M5
R5 *	Resistor, Carbon, 820K Ω, 1/4W, 5%	8602-820K5
R6 *	Resistor, Carbon, 100K Ω, 1/4W, 5%	8602-100K5
R7	Resistor, Carbon, 10 K Ω, 1/4W, 5%	8602-10K5
R8	Resistor, Carbon, 24 K Ω, 1/4W, 5%	8602-24K5
R9	Resistor, Variable, Miniature Type, 250K Ω	8154-829
R10,11	Resistor, Carbon, 82 K Ω, 1/4W, 5%	8602-82K5
R12	Resistor, Carbon, 39 K Ω, 1/4W, 5%	8602-39K5
R13,18,19,23	Resistor, Carbon, 15 K Ω, 1/4W, 5%	8602-15K5
R14,20	Resistor, Carbon, 100K Ω, 1/4W, 5%	8602-100K5
R15	Resistor, Carbon, 1.0M Ω, 1/4W, 5%	8602-1.0M5
R16,17	Resistor, Carbon, 560 Ω, 1/4W, 5%	8602-560A5
R21	Resistor, Carbon, 47 K Ω, 1/4W, 5%	8602-47K5
R22	Resistor, Carbon, 470K Ω, 1/4W, 5%	8602-470K5
R24,25,26,27, R28,29,30,31, R32,33	Resistor, Carbon, 180K Ω, 1/4W, 5%	8602-180K5
S1	Switch, Miniature Toggle, SPDT	8125-602
S2	Switch, Miniature Momentary, SPDT	8125-305
TP1,2,3,4,5,6	Solder Terminal, Swadged Turret	8124-179
TP7,8	Solder Terminal, Swadged Forked	8124-178
XIC1,2,6,7	Socket, Dip, 16 Pin, IC	8156-416
XIC3,4,5	Socket, Dip, 14 Pin, IC	8156-414
XIC8	Socket, Dip, 8 Pin, IC	8156-417
XIC9	Socket, Dip, 14 Pin, IC, Matrix (14 each)	8156-414
	Miscellaneous	
	Spacer, #4 Clear, Mounts IC9	8140-671

* Values given are for normal clock frequency and code speed of 20 WPM. Values may be adjusted for other requirements.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	chg Feed-thru values,	7-7-80	
	B	ADD-'50Ω OR' TO J201 INPUT	3-8-83	



NOTES:

1. ALL UNMARKED CAPACITORS ARE IN PF
2. ALL UNMARKED RESISTORS ARE IN OHMS
3. THESE COMPONENTS ARE FOR AN OPTIONAL TRAP (USE WHEN NEEDED)
4. THESE COMPONENTS ARE FOR DIPLEXING DC POWER ON THE ANTENNA LINE (DOTTED LINE ONLY)
5. NOT USED WHEN DIPLEXING DC POWER ON THE ANTENNA LINE.
6. CAPACITORS WITH NO VALUE VARY WITH FREQUENCY

LAST NUMBER USED
C – 241
D – 201
J – 203
L – 216
Q – 206
R – 219
S – 201
T – 203
X – 201

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS		DATE
DRAWN	MAJOR	11-6-79
CHECKED		3-24-80

TELEVISION TECHNOLOGY CORP.
ARVADA COLO., 80003

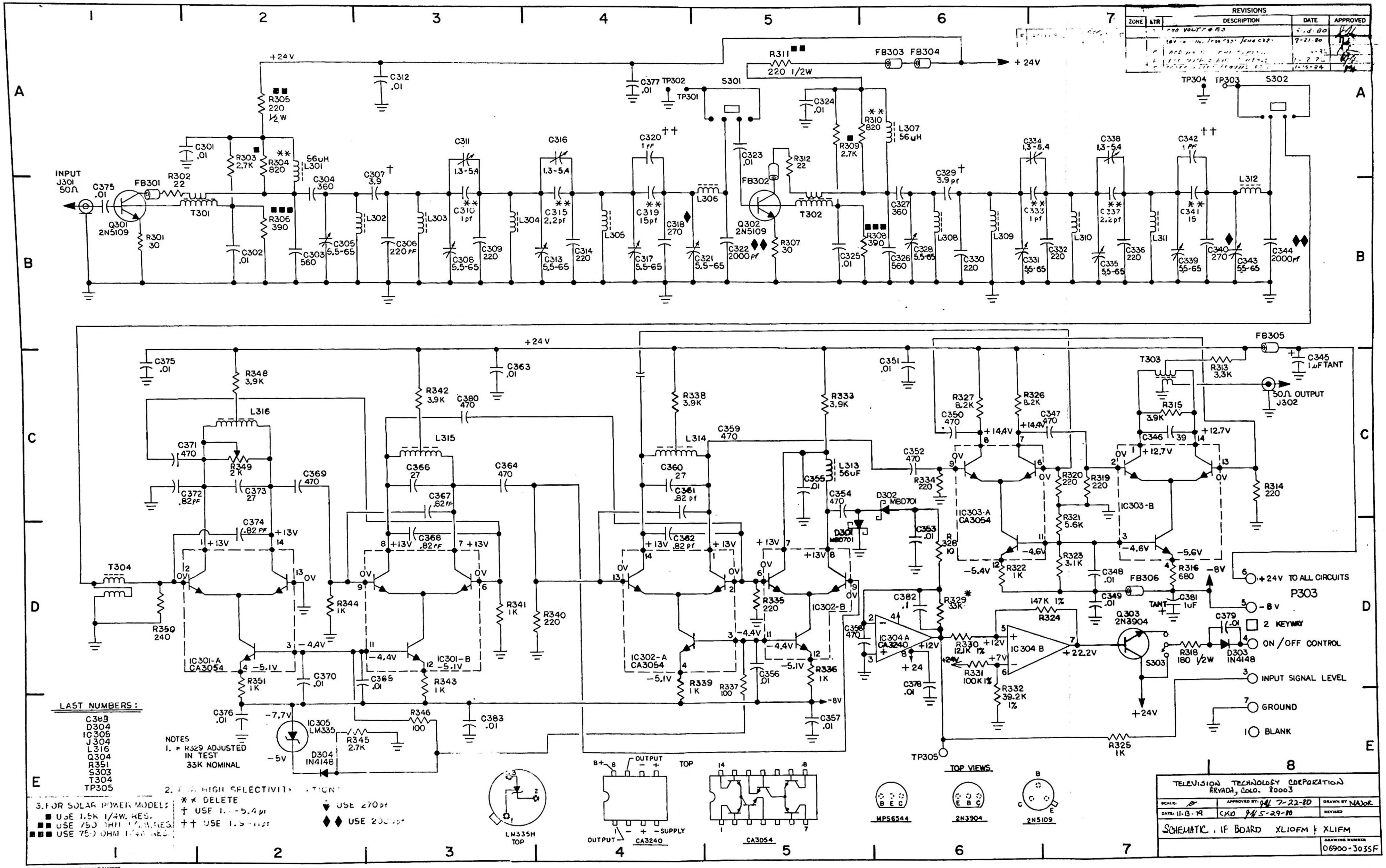
INPUT CONVERTOR
XL1FM , XL10FM
SCHEMATIC

SIZE	CODE IDENT NO.	DRAWING NO.
C		C6900-2035 B

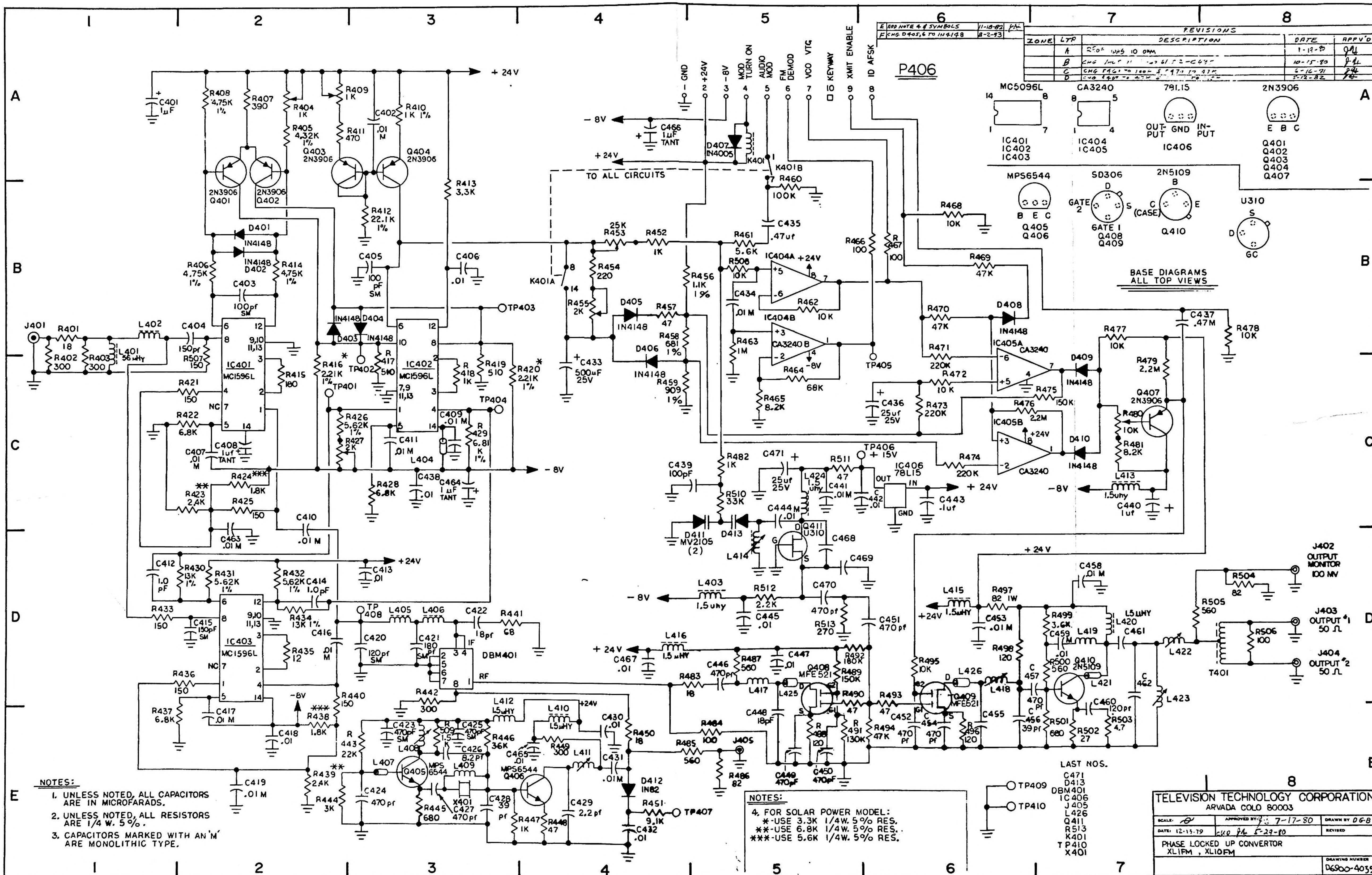
SCALE (?) SHEET 1 OF 1

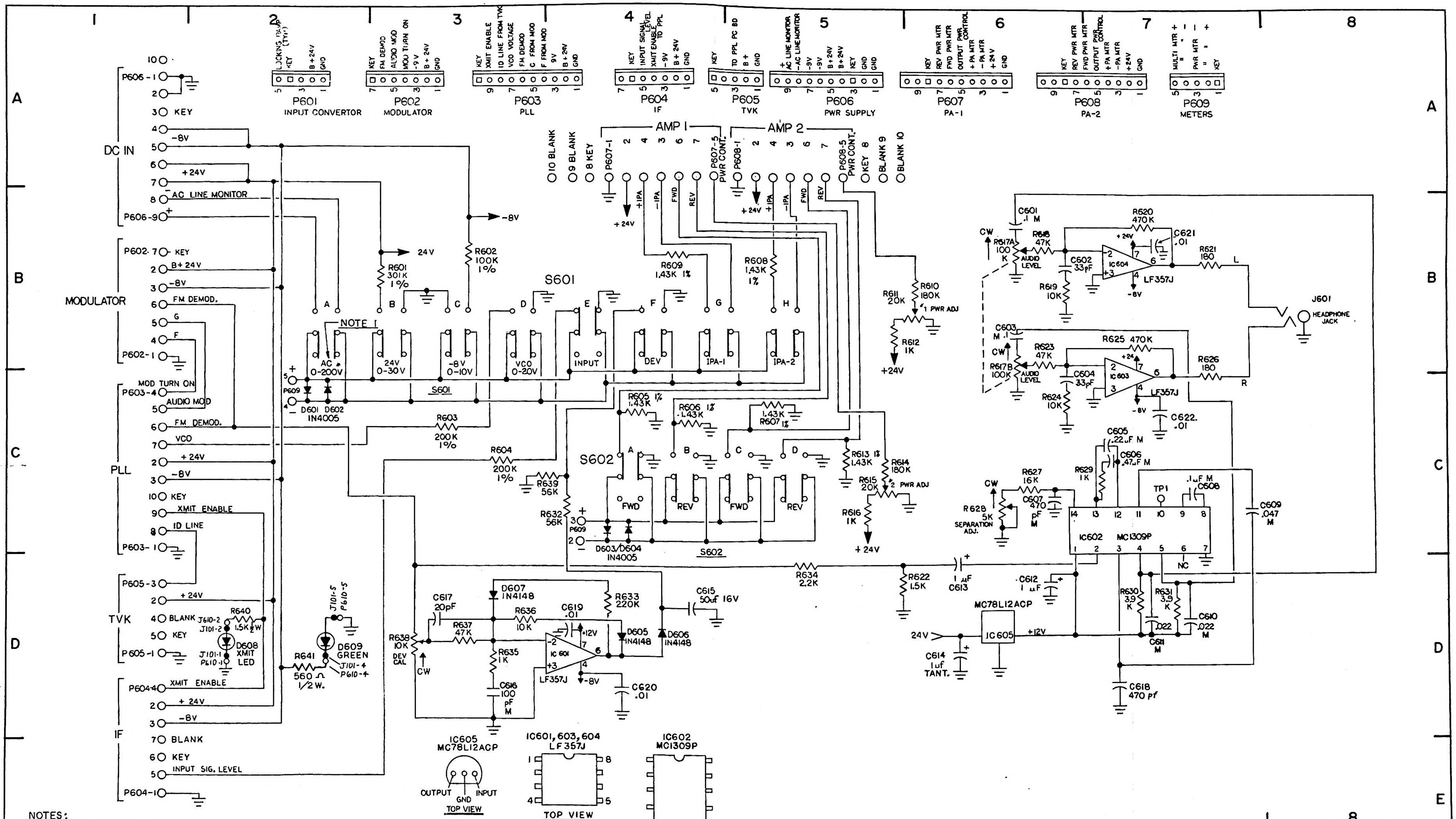
NEXT ASSY | USED ON
APPLICATION

DO NOT SCALE DRAWING



REVISIONS
ZONE
LTR
DESCRIPTION
DATE
APPROVED
INPUT J301 50Ω
+24V
50Ω OUTPUT J302
+24V TO ALL CIRCUITS
P303
-8V
2 KEYWAY
ON / OFF CONTROL
INPUT SIGNAL LEVEL
GROUND
BLANK
LAST NUMBERS:
C383
D304
IC305
J304
L316
Q304
R351
S303
T304
TP305
NOTES
1. * R329 ADJUSTED IN TEST 33K NOMINAL
** DELETE
DELETE
TOP VIEWS
LM335H TOP
CA3240
CA3054
MPS6544
2N3904
2N5109
TELEVISION TECHNOLOGY CORPORATION
ARVADA, COLO. 80003
DATE: 11-13-79
SCHEMATIC, IF BOARD XL10FM & XL1FM
DRAWING NUMBER
06900-3035F


P406
1 - GND
2 +24V
3 -8V
4 MOD TURN ON
5 AUDIO MOD
6 FM DEMOD
7 VCO VTG
10 KEYWAY
9 XMIT ENABLE
8 ID AFSK
E ADD NOTE 4 & SYMBOLS 11-18-82
F CHG D405,6 TO IN4148 8-2-83
REVISIONS
ZONE LTR DESCRIPTION DATE APPV'D
A 1-19-80
B 10-15-80
C 6-16-81
D 5-12-82
MC5096L
IC401 IC402 IC403
CA3240
IC404 IC405
78L15
OUT-PUT GND IN-PUT
IC406
2N3906
E B C
Q401 Q402 Q403 Q404 Q407
MPS6544
B E C
Q405 Q406
SD306
GATE 2 S D GATE 1
Q408 Q409
2N5109
B C (CASE) E
Q410
U310
S D GC
BASE DIAGRAMS ALL TOP VIEWS
+24V
-8V
TO ALL CIRCUITS
J401
J402 OUTPUT MONITOR 100 MV
J403 OUTPUT #1 50 Ω
J404 OUTPUT #2 50 Ω
J405
TP401 TP402 TP403 TP404 TP405 TP406 TP407 TP408 TP409 TP410
IC401 MC1596L
IC402 MC1596L
IC403 MC1596L
IC404A IC404B CA3240
IC405A IC405B CA3240
IC406 78L15
DBM401
T401
X401
NOTES:
1. UNLESS NOTED, ALL CAPACITORS ARE IN MICROFARADS.
2. UNLESS NOTED, ALL RESISTORS ARE 1/4 W. 5%.
3. CAPACITORS MARKED WITH AN 'M' ARE MONOLITHIC TYPE.
NOTES:
4. FOR SOLAR POWER MODEL:
*-USE 3.3K 1/4W. 5% RES.
**-USE 6.8K 1/4W. 5% RES.
***-USE 5.6K 1/4W. 5% RES.
LAST NOS.
C471 D413 DBM401 IC406 J405 L426 Q411 R513 K401 TP410 X401
TELEVISION TECHNOLOGY CORPORATION
ARVADA COLO 80003
SCALE:
APPROVED BY: 7-17-80
DRAWN BY DGB
DATE: 12-13-79
CKD 5-29-80
REVISED
PHASE LOCKED UP CONVERTOR
XL1FM, XL10FM
DRAWING NUMBER
D6900-4035F



NOTES:

1. ✻ = 0-300V SCALE FOR 240V INPUT MODELS.
2. UNLESS NOTED, ALL RESISTORS ARE 1/4W. 5%.
3. UNLESS NOTED, ALL CAPACITORS ARE IN MICROFARADS.
4. CAPACITORS MARKED M ARE MONOLITHIC TYPE.

LAST NOS.

C622	P609
D609	R641
IC605	S602
J601	

SYM	DESCRIPTION	DATE	APV
C	ADD P610 + J101	11-11-85	
B	ADD LINE FROM P602 to P606, ALSO 1% VALUES	9-17-80	
A	CHG. IC605 DIAGRAM, R603, R604	7-17-80	

6 REVISIONS

TELEVISION TECHNOLOGY CORPORATION
ARVADA, COLO. 80003

SCALE: -0- APPROVED BY: 4-3-80 DRAWN BY MAJOR

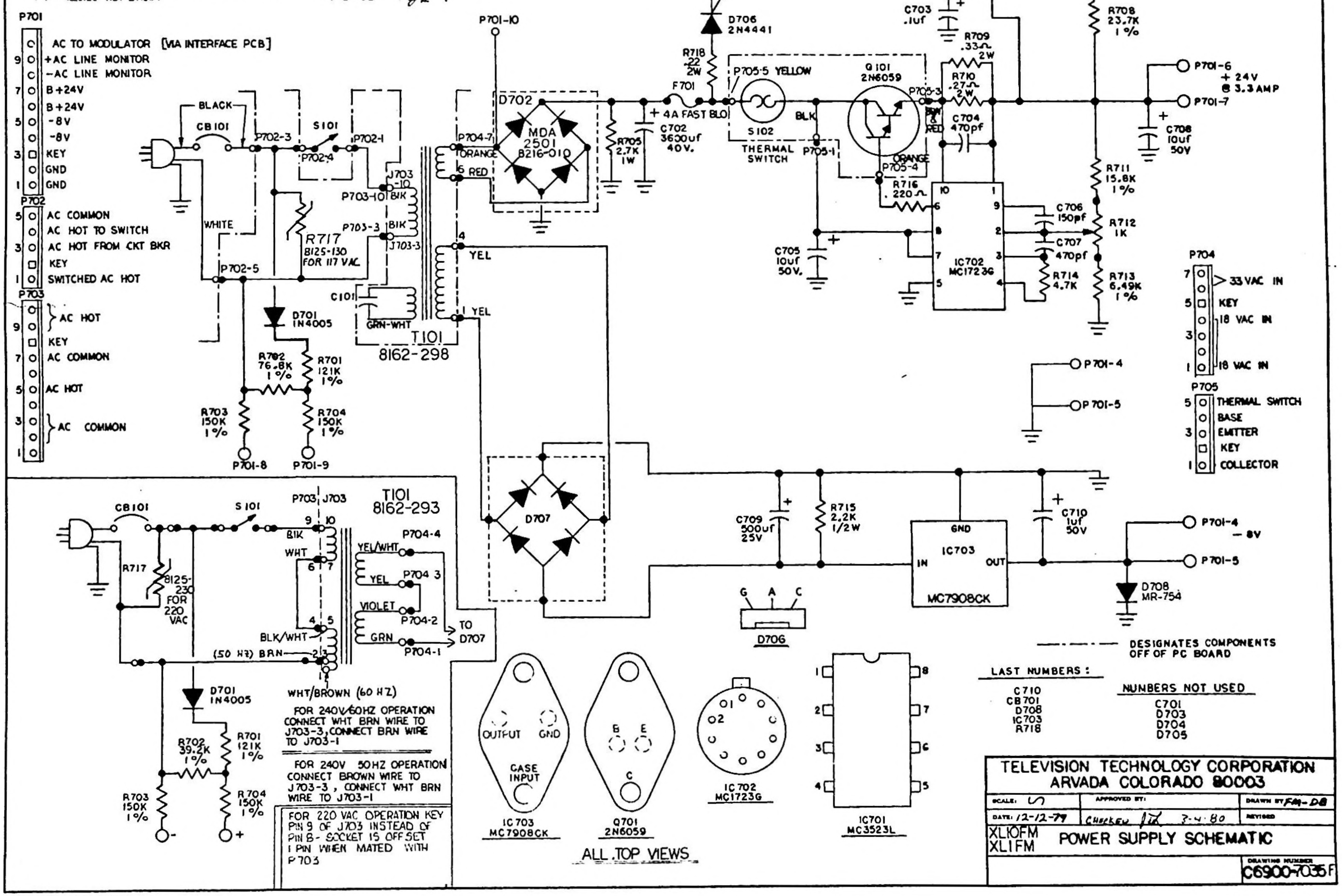
SCHEMATIC METER + CONTROL PC BD - XL1FM & XL10FM

DRAWING NUMBER D6900-6035C

BISHOP GRAPHICS, INC REORDER NO 1557

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADD R718, D708, VARIOUS COLOR CODES, REVISE PARTS DRAWN IN DETAIL, ADD PIN NUMBERS	7-15-80	[illegible]
	B	ADD MODULATOR LINE ON P701-10	9-17-80	[illegible]
	C	CHG D702	[illegible]-82	[illegible]
	D	MOVE R717	5-26-82	[illegible]
	E	ADD 4A FAST SLO AT F701	12-14-84	[illegible]
	F	REVISE T101 LAYOUT	2-27-8[illegible]	[illegible]



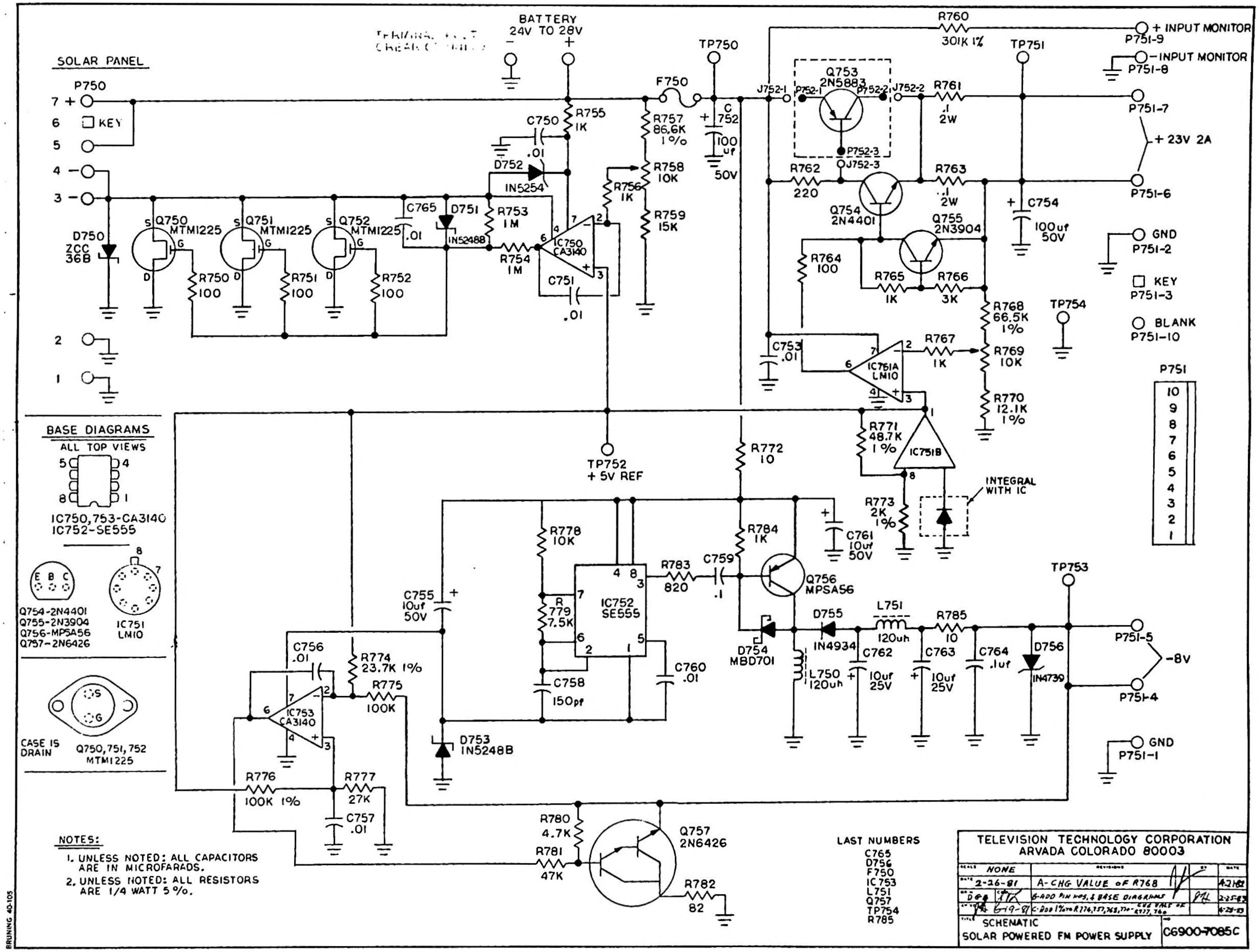
TELEVISION TECHNOLOGY CORPORATION
ARVADA COLORADO 80003

SCALE: [illegible] | APPROVED BY: | DRAWN BY FM-DB
DATE: 12-12-79 | CHECKED [illegible] 3-4-80 | REVISED

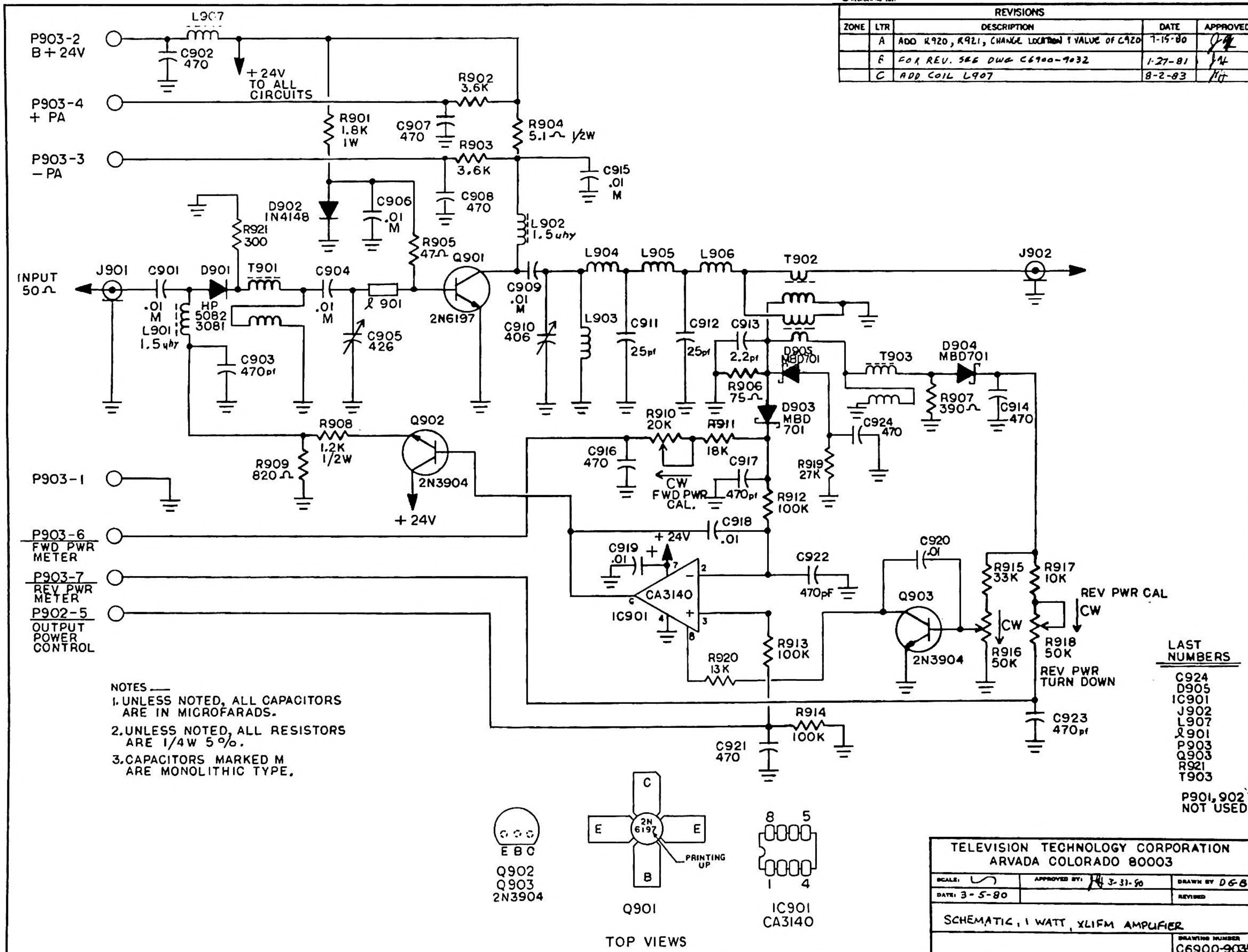
XL10FM XL1FM POWER SUPPLY SCHEMATIC

DRAWING NUMBER C6900-7035 F

PRINTED ON NO. 1000H CLEARPRINT



SOLAR PANEL
P750
KEY
D750 ZCC 36B
Q750 MTM1225
Q751 MTM1225
Q752 MTM1225
R750 100
R751 100
R752 100
C765 .01
D751 IN5248B
BATTERY 24V TO 28V
C750 .01
R755 1K
D752 IN5254
R753 1M
R754 1M
IC750 CA3140
C751 .01
R756 1K
R757 86.6K 1%
R758 10K
R759 15K
F750
TP750
C752 100uf 50V
J752-1
Q753 2N5883
P752-1
P752-2
P752-3
J752-2
J752-3
R760 301K 1%
+ INPUT MONITOR
P751-9
- INPUT MONITOR
P751-8
TP751
R761 .1 2W
P751-7
+ 23V 2A
P751-6
R762 220
R763 .1 2W
Q754 2N4401
Q755 2N3904
C754 100uf 50V
GND
P751-2
KEY
P751-3
BLANK
P751-10
R764 100
R765 1K
R766 3K
R768 66.5K 1%
TP754
C753 .01
IC751A LM10
R767 1K
R769 10K
R770 12.1K 1%
P751
10 9 8 7 6 5 4 3 2 1
BASE DIAGRAMS
ALL TOP VIEWS
IC750,753-CA3140
IC752-SE555
E B C
Q754-2N4401
Q755-2N3904
Q756-MPSA56
Q757-2N6426
IC751 LM10
CASE IS DRAIN
Q750,751,752 MTM1225
TP752 + 5V REF
R771 48.7K 1%
IC751B
R772 10
R773 2K 1%
INTEGRAL WITH IC
R778 10K
R779 7.5K
IC752 SE555
R783 820
C759 .1
R784 1K
C761 10uf 50V
Q756 MPSA56
C755 10uf 50V
C758 150pf
C760 .01
D754 MBD701
D755 IN4934
L751 120uh
L750 120uh
R785 10
TP753
C762 10uf 25V
C763 10uf 25V
C764 .1uf
D756 IN4739
P751-5
-8V
P751-4
GND
P751-1
C756 .01
R774 23.7K 1%
R775 100K
IC753 CA3140
D753 IN5248B
R776 100K 1%
R777 27K
C757 .01
R780 4.7K
R781 47K
Q757 2N6426
R782 82
NOTES:
1. UNLESS NOTED: ALL CAPACITORS ARE IN MICROFARADS.
2. UNLESS NOTED: ALL RESISTORS ARE 1/4 WATT 5%.
LAST NUMBERS
C765
D756
F750
IC753
L751
Q757
TP754
R785
TELEVISION TECHNOLOGY CORPORATION
ARVADA COLORADO 80003
NONE
2-26-81
A-CHG VALUE OF R768
SCHEMATIC
SOLAR POWERED FM POWER SUPPLY
C6900-7085C



NOTES —
1. UNLESS NOTED, ALL CAPACITORS ARE IN MICROFARADS.
2. UNLESS NOTED, ALL RESISTORS ARE 1/4W 5%.
3. CAPACITORS MARKED M ARE MONOLITHIC TYPE.

REVISIONS

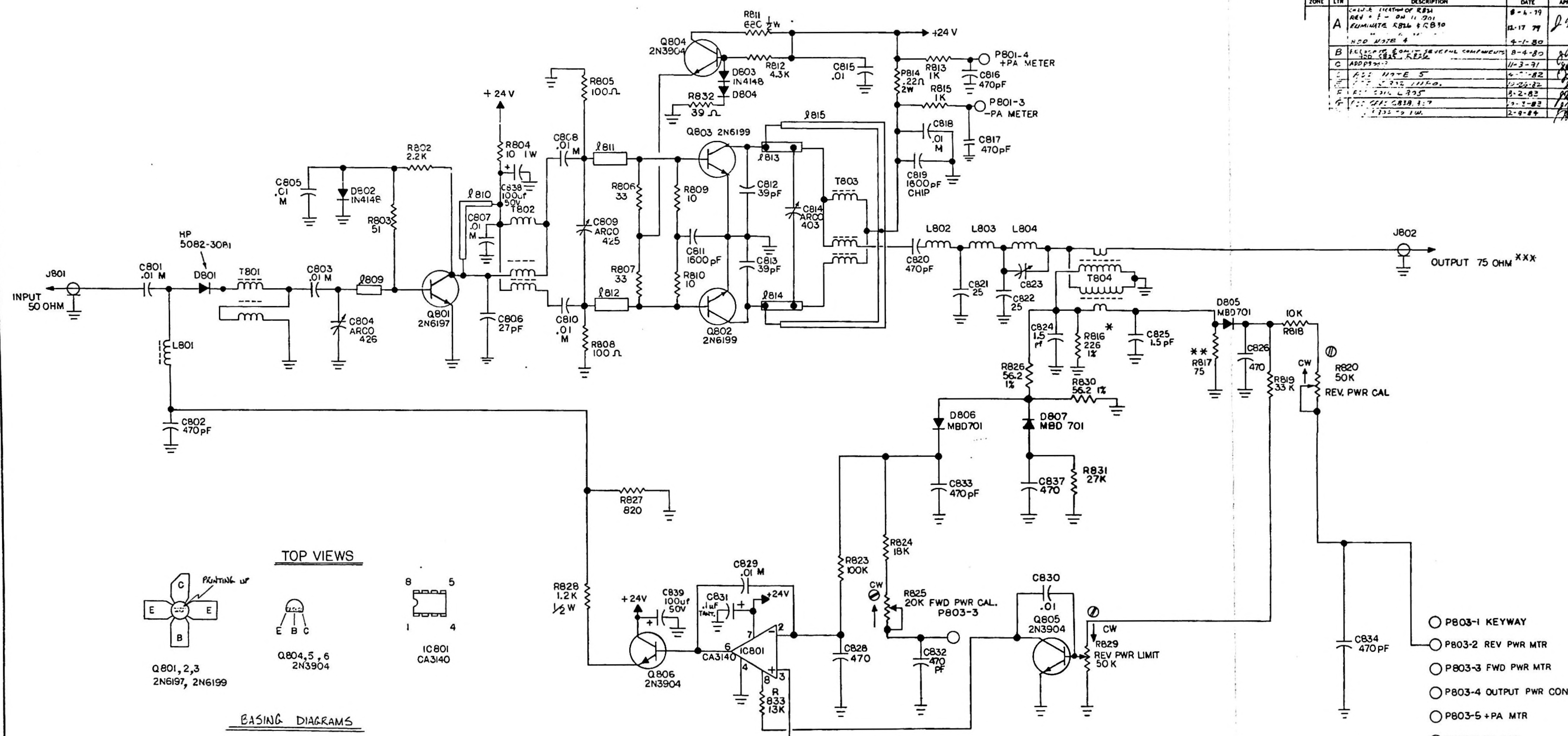
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADD R920, R921, CHANGE LOCATION & VALUE OF C920	7-15-80	[illegible]
	B	FOR REV. SEE DWG C6900-9032	1-27-81	[illegible]
	C	ADD COIL L907	8-2-83	[illegible]

TELEVISION TECHNOLOGY CORPORATION
ARVADA COLORADO 80003

SCALE: ∽ | APPROVED BY: [illegible] 3-31-80 | DRAWN BY DGB
DATE: 3-5-80 | REVISED

SCHEMATIC, 1 WATT, XL1FM AMPLIFIER

DRAWING NUMBER C6900-9035C



5. * FOR 50 OHM APPLICATION USE 91 OHM 1/4W. 5%
** FOR 50 OHM APPLICATION USE 50 OHM 1/4W. 5%
*** FOR 50 OHM APPLICATION J802 IS 50Ω N CONNECTOR.

NOTES:
1. UNLESS NOTED
ALL CAPACITORS ARE IN MICROFARADS, DISC CERAMIC.
RESISTORS ARE 1/4 W. 5%.
2. Ø DENOTES SCREWDRIVER ADJ.
3. ↑ ARROW BY POT DENOTES DIRECTION OF WIPER ARM ROTATION.
4. CAPACITORS MARKED M ARE MONOLITHIC TYPE.

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	CHANGE LOCATION OF R831 REV + 3 - ON 11-701 ELIMINATE R826 & R830 ADD NOTE 4	8-6-79 12-17-79 4-1-80	
	B	RELOCATE CONN. SEVERAL COMPONENTS	8-4-80	
	C	ADDED	11-3-81	
	D	ADD NOTE 5	4-..-82	
	E		10-26-82	
	F		3-2-83	
	G		3-3-83	
			2-9-84	

ℓ	809-817
Q	806
T	805
R	833
L	805
D	807
C	839
SYM	
LAST NUMBERS	

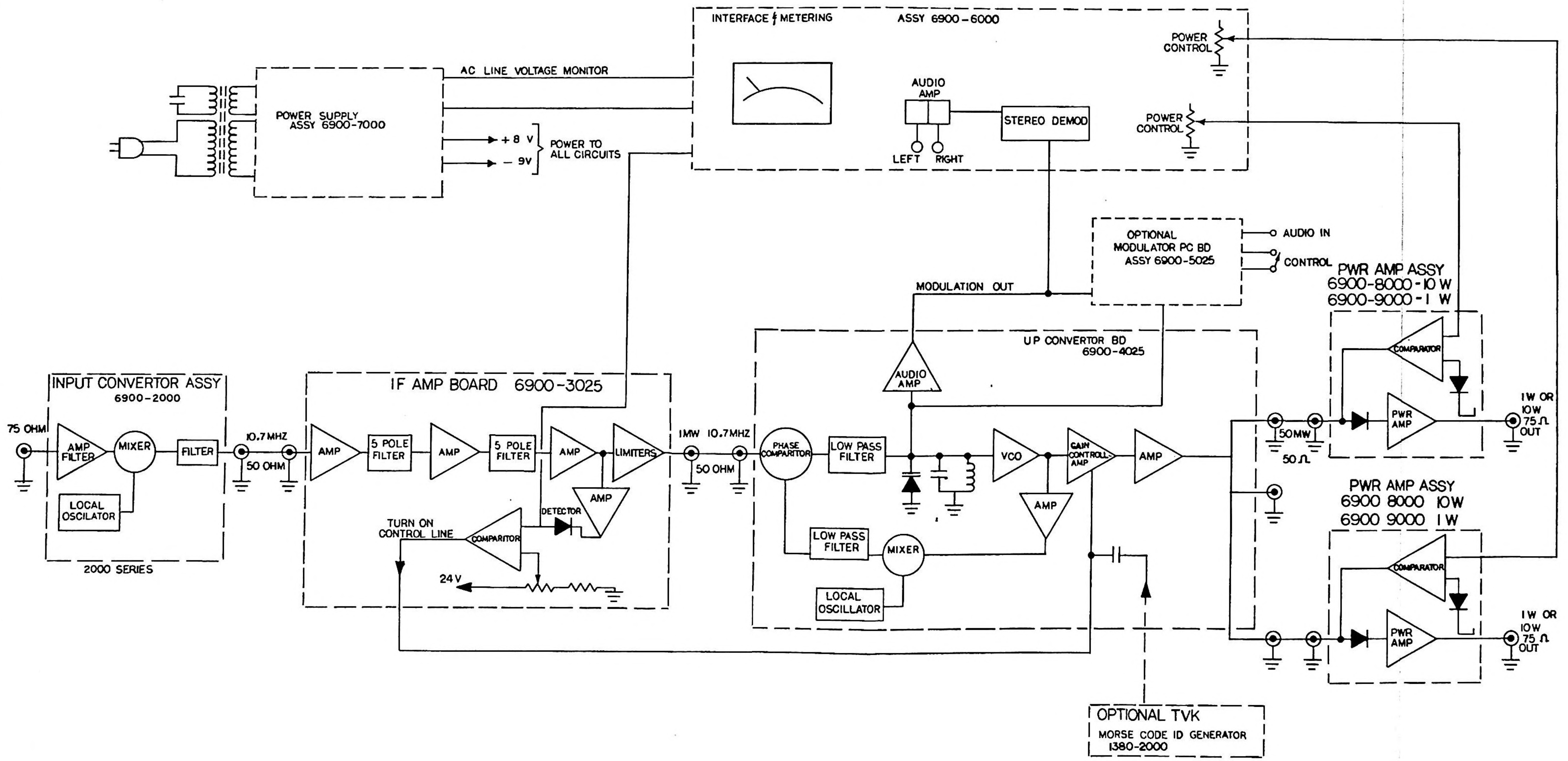
R801 NOT USED

TELEVISION TECHNOLOGY CORPORATION
ARVADA, COLO. — 80003

SCALE: Ø — DRAWN BY: MAJ
DATE: 6-7-79 — APPROVED BY: 7-31-79

SCHEMATIC -10 W. AMP.

DRAWING NUMBER: D6400-8035H

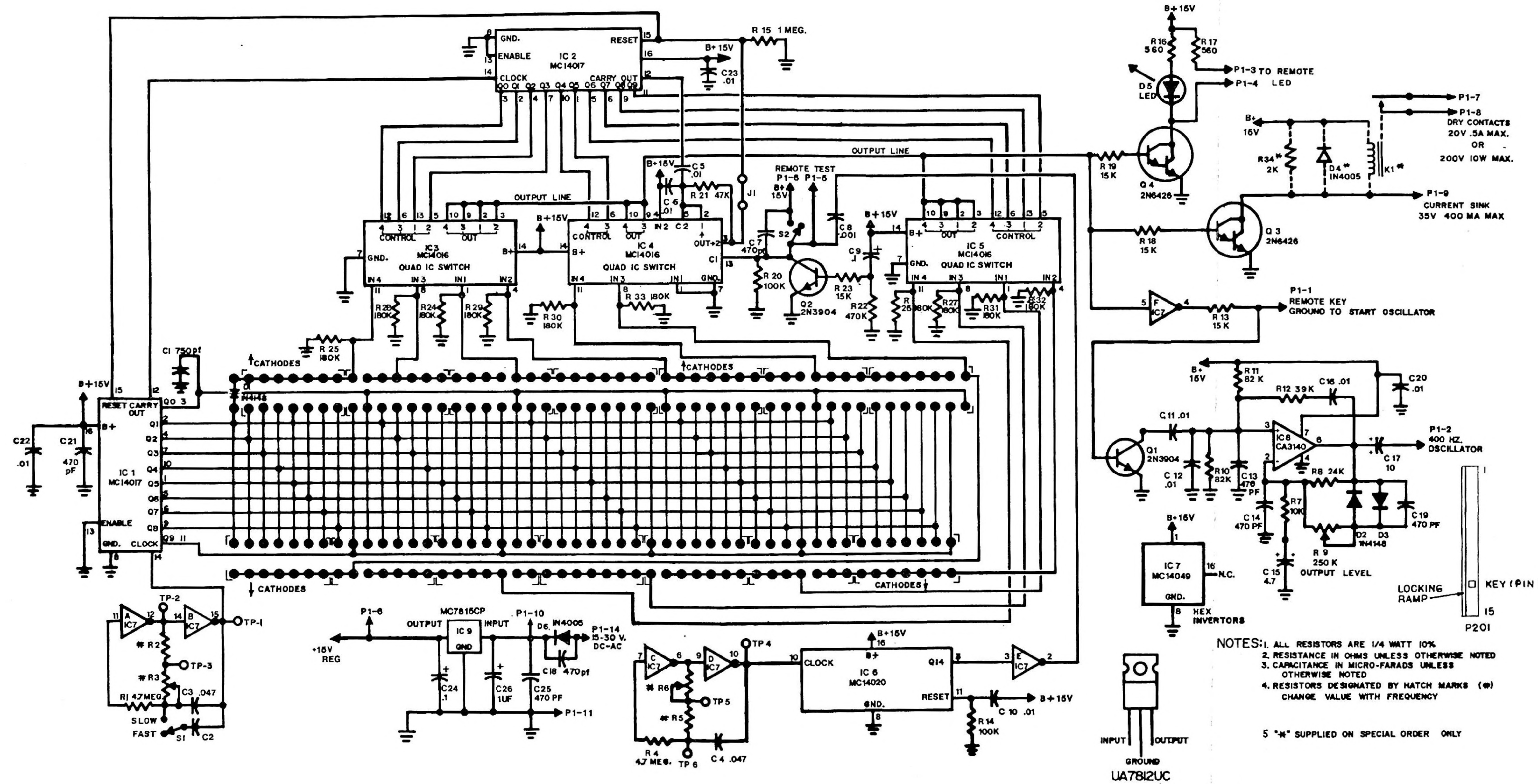


TELEVISION TECHNOLOGY CORPORATION
ARVADA, COLO. 80003

SCALE: -0- | APPROVED BY: [signature] 7-15-80 | DRAWN BY MAJOR
DATE: 12-12-79 | REVISED

XL1FM
XL 10FM
BLOCK DIAGRAM FIG 3.0

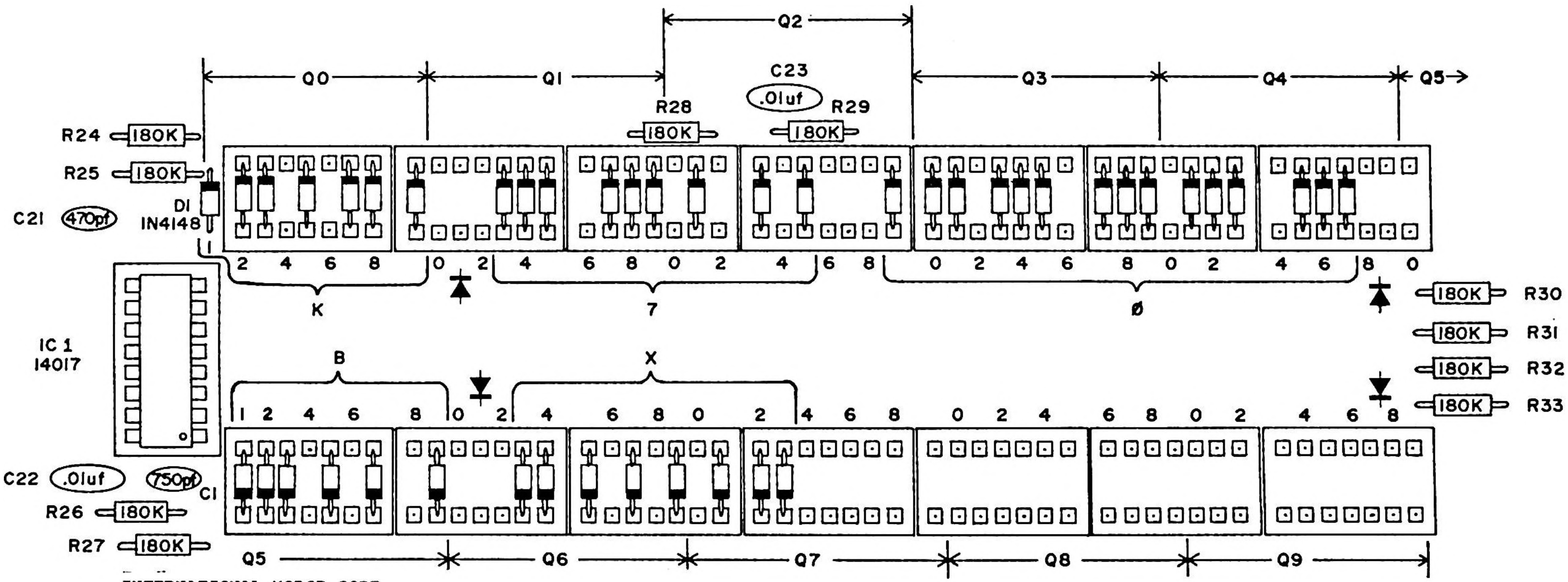
DRAWING NUMBER D6900-1005



NOTES:
1. ALL RESISTORS ARE 1/4 WATT 10%
2. RESISTANCE IN OHMS UNLESS OTHERWISE NOTED
3. CAPACITANCE IN MICRO-FARADS UNLESS OTHERWISE NOTED
4. RESISTORS DESIGNATED BY HATCH MARKS (#) CHANGE VALUE WITH FREQUENCY

5 "*" SUPPLIED ON SPECIAL ORDER ONLY

TELEVISION TECHNOLOGY CORPORATION ARVADA, COLORADO 80003		
SCALE: ~	APPROVED BY: JGR	DRAWN BY JW.
DATE 6-6-77		REVISED
TVK-1 CODE KEYER		DRAWING NUMBER D1380-2010G



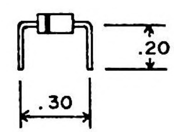
INTERNATIONAL MORSE CODE

ALPHABET				NUMERALS	
A	• —	N	— •	1	• — — — —
B	— • • •	O	— — —	2	• • — — —
C	— • — •	P	• — — •	3	• • • — —
D	— • •	Q	— — • —	4	• • • • —
E	•	R	• — •	5	• • • • •
F	• • — •	S	• • •	6	— • • • •
G	— — •	T	—	7	— — • • •
H	• • • •	U	• • —	8	— — — • •
I	• •	V	• • • —	9	— — — — •
J	• — — —	W	• — —	Ø	— — — — —
K	— • —	X	— • • —	Ø	IS READ AS "ZERO"
L	• — • •	Y	— • — —	O	IS READ AS "OH" (Ō)
M	— —	Z	— — • •		

• = DIT = DOT = 1 DIODE.

— = DA = DASH = 3 DIODES IN LINE.

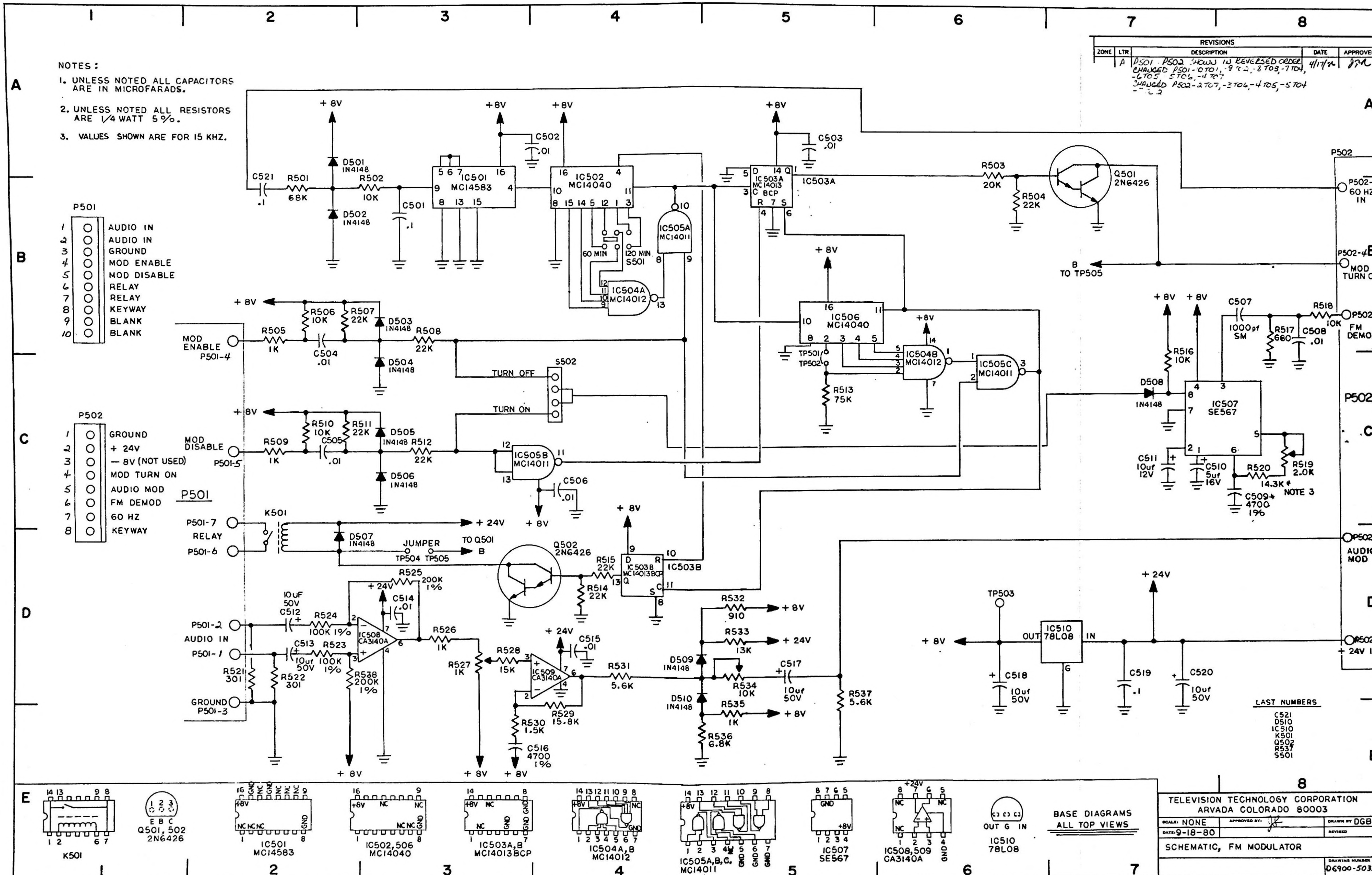
IN4148 DIODE



BEND AND TRIM PROGRAMMING DIODE LEADS AS SHOWN

DIODE ARRANGEMENT SHOWN IS FOR CODE SETTING - K7ØBX

TELEVISION TECHNOLOGY CORPORATION ARVADA, COLORADO 80003		
SCALE: 2:1	APPROVED BY: JK	DRAWN BY DGB
DATE: 2-15-78		REVISED
CODE KEYER PROGRAMMING DIAGRAM		
		DRAWING NUMBER 81370-8012



NOTES:

1. UNLESS NOTED ALL CAPACITORS ARE IN MICROFARADS.
2. UNLESS NOTED ALL RESISTORS ARE 1/4 WATT 5%.
3. VALUES SHOWN ARE FOR 15 KHZ.

TELEVISION TECHNOLOGY CORPORATION
ARVADA COLORADO 80003

SCALE: NONE
DATE: 9-18-80
DRAWN BY DGB

SCHEMATIC, FM MODULATOR

DRAWING NUMBER 06900-5035A