TECHNICAL MANUAL

MX-15 FM EXCITER

994 7950 003

HARRIS

T.M. No. 888-2164-010

Printed: April 29, 1986

HARRIS

MX-15

Maximum Signal FM Exciter

- Improved ultra linear VCO yields −80 dB FM S/N, and .02% Intermodulation Distortion for maximum signal clarity
- DSM (Digitally Synthesized Modulation) Stereo Generator provides 50 dB separation minimum—typically 60 dB midband—for increased stereo realism
- DTR* (Dynamic Transient Response) stereo generator filter maximizes modulation level without overmodulating
- Automatic stereo pilot phase control* and digital circuitry provide long term adjustment-free performance
- Multipurpose SCA generator to meet the expanded needs of today's aural and data services.
- Available as an FCC type accepted 15 watt transmitter

Patented

HARRIS MX-15 . . .

Continuing in its trend-setting tradition, Harris has incorporated state-of-the-art refinements in exciter technology to introduce the MX-15 FM Exciter. Using various advanced techniques, such as DRT (Dynamic Transient Response) and DSM (Digitally Synthesized Modulation), the MX-15 Exciter provides the broadcaster with new levels of excellence in audio performance.

ULTRA-LINEAR VCO

The unique VCO (Voltage Controlled Oscillator) of the MX-15 features superb linearity and extremely low signal-to-noise, not found in conventional modulated oscillator designs.

Wideband Composite Intermodulation Distortion is an exceptionally low .02%, with all CCIF Intermodulation distortion products down at least 80 dB. This important criterion shows the quality of the VCO—the heart of any exciter. Distortion, as a result of nonlinearities, severely limits stereo and SCA performance. Composite input signals between 30 Hz and 53 kHz will not be slew limited even at maximum modulation capability of ±100 kHz.

Equally impressive is the MX-15's −80 dB FM Signal-To-Noise Ratio specification. An exclusive externally induced hum cancellation circuit allows the exciter to achieve this low noise floor. The MX-15's exceptionally low distortion and noise provides your station with maximum signal clarity. The unique VCO of the MX-15 features superb linearity not found in conventional modulated oscillator designs.

BALANCED FLOATING COMPOSITE INPUT

Recognizing that many FM broadcasters operate composite systems or use external stereo generators in the audio processing chain, the Harris MX-15 offers a balanced floating composite input as a standard feature. This input reduces the chance of ground loops and other system interface problems.

DIGITAL SYNTHESIZER

The MX-15 uses a 10 MHz high-stability TCXO (Temperature Compensated Reference Oscillator) and programmable divider chain in its dual-state phase

The Harris MX-15 Exciter features modular construction for maximum versatility and ease of maintenance.

NEW LEVELS OF EXCELLENCE IN FM AUDIO PERFORMANCE

locked loop AFC system.The synthesizer provides outputs at 2.5, 5, 10, 15, 20 and 25 MHz, permitting direct comparison against WWV transmissions on these frequencies. The synthesizer can be easily programmed to any carrier frequency in the 87.5 to 108 MHz band in 50 kHz increments. The dual-state AFC will acquire the VCO over a ±10 MHz range in a maximum of five seconds, starting from an unlocked condition. Once locked, the AFC passband is narrowed, maximizing FM signal to noise.

DIGITALLY SYNTHESIZED MODULATION

The Harris DSM stereo generation technique provides a clean stereo composite signal. Unlike older technology, still on the market, that suffers from degraded separation at the upper and lower audio spectrum and/or poor harmonic rejection resulting in degraded crosstalk, Harris' DSM technique has neither of these shortcomings. DSM stereo generation is essentially transparent to the program material. Separation is specified at 50 dB over the 30-15,000 Hz range.

Digital circuitry employed in the generation of the DSM signal lends itself to a minimum of adjustments. These are relatively non-critical in nature and easily maintained year after year. The Harris patented automatic pilot phasing control in the DSM stereo generator makes it virtually impossible to misadjust this critical parameter.

OVERSHOOT COMPENSATION

A Dynamic Transient Response (DTR) filter, developed by Harris, holds overshoot on any program material to 2% or less. As a result, 2 to 6 dB increased loudness can be achieved with no degradation of audio quality. Controlled transient response, high stereo separation, low crosstalk and low intermodulation distortion are all maintained with the increased loudness. The DTR filter can be switched off for stations whose formats do not require maximim modulation density.

MULTIPURPOSE SCA OPERATION

The MX-15 multipurpose SCA generator is designed to meet the expanded needs of today's SCA service requirements, and is ideal for high quality aural service or for accurate transmission of digital data.

The MX-15 multipurpose SCA generator can be user programmed to operate on 67 kHz or 92 kHz by simply positioning a jumper plug. Other operating frequencies can be easily accommodated upon request. Two SCA generators, one on 67 kHz and the other on 92 kHz, can simultaneously operate with stereo. The MX-15 exciter accommodates additional SCA channels through the composite input.

The transformerless audio input stage improves aural performance in comparison with other designs. Stations will note lower harmonic distortion for improved SCA fidelity.

The transformerless input stage is low pass filtered to meet the technical needs of the SCA information transmitted. A 4.5 kHz low pass response is provided as standard. This can be easily changed for 3 kHz, 5 kHz or 7.5 kHz response, or may be defeated if desired.

The MX-15 multipurpose SCA generator meets the transmission requirements of stations transmitting digital information. A rear mounted BNC input connector DC couples the digital data to the SCA generator's FM modulator for transmission quality.

SCA operators recognize that abrupt muting of the SCA carrier may cause an annoying "pop" in the SCA receivers. Harris has incorporated a carrier mute decay circuit to eliminate this objectionable noise.

In addition to the mute decay circuit, stations may select the mute delay time constant they desire—anywhere between 0.5 seconds and 20 seconds. Automatic mute threshold level can also be adjusted between 0 and −30 dBm in order to meet varying input levels.

The MX-15 exciter and multipurpose SCA generator work as an effective patented system to automatically maintain maximum main channel modulation at all times. Here's how: When the SCA generator is activated, the composite level is automatically lowered to allow for insertion of the SCA channel. The converse is also true. Stations need not compromise 10% to 30% of modulation when SCA is not used continuously.

Whether you are planning to use your SCA channel for conventional aural services (such as background music), or are looking at some of the new expanded applications possible today, the Harris MX-15 multipurpose SCA generator meets your needs.

POWER AMPLIFIER

The power amplifier module is conservatively rated at 15 watts output, and requires no tuning. VSWR protection prevents accidental damage to the module.

The Harris DSM Stereo Generator, with Digitally Synthesized Modulation (DSM) and DTR filter, provides 50 dB stereo separation minimum, 30-15,000 Hz, and overshoot no greater than 2%.

STATUS AND MONITORING

Status and LED indicators are used throughout to aid in troubleshooting. Metering is provided to monitor 10 DC and 10 audio parameters. A peak reading audio voltmeter aids in setting up the exciter on tones, and can serve as an accurate peak program indicator, with accuracy approaching that of a modulation monitor. When fully equipped, the MX-15 contains 27 front panel status indicators for quick "go/no-go" service checks.

ADDITIONAL BENEFITS

The MX-15 mainframe is ruggedly constructed, with all major printed circuit boards housed in their own shielded, plug-in enclosure.

A positive guidance system permits easy removal and reinsertion of all modules. All module signals and components can be checked during operation using the extender card supplied with the exciter.

Composite wideband, Mono and Stereo audio inputs are transformerless and balanced to give maximum common mode rejection while maintaining excellent response. Inputs will withstand high transients or steady state voltages above or below ground reference.

The basic MX-15 Exciter is wideband and can be used without interface, directly with a composite stereo studio/transmitter link (STL) or external stereo generator.

The exciter is configured to accept a plug-in quadraphonic FM generator, and provides metering of Left Rear and Right Rear audio inputs.

MX-15 SPECIFICATIONS

GENERAL

POWER OUTPUT: 3 watts to 15 watts continuously variable.
FREQUENCY RANGE: 87.5 MHz to 108 MHz tested to one specified frequency. (exciter programmable to 50 kHz channel spacing).
RF OUTPUT IMPEDANCE: 50 ohms, open and short circuit proof.
OUTPUT CONNECTION: Female BNC.
FREQUENCY STABILITY: ±300 Hz 0° to 50°C temperature compensated reference oscillator.
TYPE OF MODULATION: Direct carrier frequency modulation (DCFM).
MODULATION CAPABILITY: ±100 kHz.
AC INPUT POWER: 100 to 130 VAC or 200 to 250 VAC, 60 Hz or 50 Hz, 150 watts.
RF HARMONICS: Suppression meets all FCC requirements for 10 watt and 15 watt educational transmitter requirements.
ALTITUDE RANGE: 15,000 feet.
AMBIENT TEMPERATURE RANGE: 0° to 50°C (operational to −20°C).
OVERALL CABINET SIZE: 17.7" Wide (44 cm) × 14" High (35 cm) × 12" Deep (30 cm). 19" EIA rack mounting standard.
FINISH: Black.
CONSTRUCTION: Main printed circuit boards individually enclosed, plug-in modules. Module service extender board included.
AUDIO/CONTROL CONNECTIONS: Two 18 terminal barrier strips paralleled by 36 pin and socket connectors. RFI bypassing on input/output lines.
MODULATION METER: 10 position, fast rise time AC metering (adjustable to meet FCC ballistics).
MULTIMETER: 10 position, DC metering.
TOTAL METERING FUNCTIONS: 20.
REMOTE METERING PROVISIONS: PA voltage, PA current, forward power, reflected power.
STATUS INDICATION: 27 independent LED indicators (when equipped with all options).

WIDEBAND COMPOSITE OPERATION

COMPOSITE INPUT: One balanced floating input.
COMPOSITE INPUT IMPEDANCE: 2000 ohms resistive.
COMPOSITE INPUT CONNECTOR: Female BNC.
COMPOSITE INPUT LEVEL: 1.0 volt RMS nominal for ±75 kHz deviation.
EXTERNAL SCA GENERATOR INPUTS: Up to two unbalanced inputs (optional).
COMPOSITE FM SIGNAL TO NOISE: 80 dB below 100% modulation (reference 400 Hz @ ±75 kHz deviation with 75 microsecond de-emphasis, 20 Hz to 200 kHz bandwidth).
COMPOSITE HARMONIC DISTORTION: .08%.
COMPOSITE INTERMODULATION DISTORTION: .02% (60 Hz/7 kHz 1:1 tone pairs).
COMPOSITE CCIF INTERMODULATION DISTORTION: All distortion products below 80 dB (reference 14 kHz/15 kHz test tone pair).
COMPOSITE AMPLITUDE RESPONSE: ±0.1 dB, 30 Hz-53 kHz.
ASYNCHRONOUS AM SIGNAL TO NOISE: 73 dB below referenced carrier AM modulation: 100% output power: 15 watts.
SYNCHRONOUS AM SIGNAL TO NOISE: 51 dB below referenced carrier with 100% AM modulation @ 400 Hz, 75 microsecond de-emphasis (FM modulation +75 kHz @ 400 Hz).

MONAURAL OPERATION

AUDIO INPUT IMPEDANCE: 600 ohms, balanced, resistive, transformerless, adaptable to other impedances.
INPUT FILTER: Controlled response low pass filter, defeatable.
AUDIO INPUT LEVEL: +10 dBm, ±1 dB for 100% modulation at 400 Hz.
AUDIO FREQUENCY RESPONSE: Standard 75 microsecond FCC pre-emphasis curve ±0.5 dB, 30 Hz-15 kHz. Selectable: flat, 25 or 50 microsecond pre-emphasis.
HARMONIC DISTORTION: 0.15%, 30 Hz to 15 kHz de-emphasized.
INTERMODULATION DISTORTION: .045%, 60 Hz/7 kHz test tone pair, 4:1 ratio.
CCIF INTERMODULATION DISTORTION: All distortion products down 70 dB (reference 14 kHz/15 kHz test tone pair).
FM SIGNAL TO NOISE RATIO: 80 dB below 100% modulation (reference 400 Hz @ ±75 kHz deviation, measured 20 Hz to 200 kHz bandwidth, 75 microsecond de-emphasis).

STEREO OPERATION

TYPE OF MODULATION: Digitally Synthesized Modulation (DSM).
AUDIO INPUT IMPEDANCE: Left and right channels: 600 ohms, balanced, resistive, transformerless, adaptable to other impedances.
AUDIO INPUT LEVEL: +10 dBm, ±1 dB for 100% modulation.
AUDIO FREQUENCY RESPONSE: (Left and right) standard 75 microsecond FCC pre-emphasis curve ±0.5 dB, 30 Hz-15 kHz. Selectable: flat, 25 or 50 microsecond pre-emphasis.
INPUT FILTERING: 15 kHz low pass filter, 45 dB rejection at 19 kHz.
OVERSHOOT PROTECTION: Harris patented Dynamic Transient Response (DTR) filter. Defeatable for test purposes.
AUDIO TRANSIENT RESPONSE: 2% maximum overshoot beyond steady state.
HARMONIC DISTORTION: (Left or right) 0.2% or less, 30-15,000 Hz.
INTERMODULATION DISTORTION: (Left or right) 0.1% 60 Hz/7 kHz test tone pair, 4:1 ratio.
CCIF INTERMODULATION DISTORTION: (Left or right) all distortion products down 80 dB (reference 14 kHz/15 kHz test tone pair).
STEREO SEPARATION: 50 dB, 30 Hz-15 kHz; typically 60 dB at midband frequencies.
DYNAMIC STEREO SEPARATION: 48 dB under normal programming conditions.
LINEAR CROSSTALK: −52 dB.
NON-LINEAR CROSSTALK: −60 dB.
76 KHZ SUPPRESSION: −68 dB.
38 KHZ SUPPRESSION: −73 dB.
FM NOISE: (Left or right) −74 dB minimum below 100% modulation. Reference: 400 Hz, 75 microsecond de-emphasis, ±75 kHz deviation, measured 30 Hz to 15 kHz bandwidth.
PILOT OSCILLATOR: Crystal controlled.
PILOT PHASE: Harris patented automatic pilot phasing circuit.
PILOT STABILITY: 19 kHz ±1 Hz 0° to 50°C.
OPERATIONAL MODES: Stereo, mono (left and right), mono (left), mono (right) — remoteable.

SCA OPERATION

MODULATION: Direct FM.
FREQUENCY OF OPERATION: 67 or 92 kHz programmable, any frequency between 25 and 92 kHz on special order.
FREQUENCY STABILITY: ±500 Hz.
MODULATION CAPABILITY: ±7.5 kHz.
AUDIO FREQUENCY RESPONSE: 67 kHz and 92 kHz AC coupled input, 150 microsecond pre-emphasis ±1 dB, standard. Selectable flat, 50 or 75 microsecond pre-emphasis. DC coupled input: No pre-emphasis: DC to 4 kHz ±0.5 dB.
AUDIO INPUT IMPEDANCE: 600 ohms balanced (AC coupled). Also 2000 ohms DC coupled unbalanced input through rear BNC connector.
AC INPUT LEVEL: +10 dBm, ±1 dB for 100% modulation at 400 Hz @ 600 ohms.
DC INPUT LEVEL: 1.0 volt peak for 5 kHz deviation.
INPUT FILTERING: Programmable LPF, 4.5 kHz standard. 3 kHz, 5 kHz, 7.5 kHz selectable. Low pass filter defeatable.
HARMONIC DISTORTION: 0.5%, 30-4,500 Hz ±5 kHz deviation.
INTERMODULATION DISTORTION: 1%, 60 Hz/7 kHz, 1:1 ratio (audio low pass filter and pre-emphasis bypassed).
FM NOISE: (Main channel not modulated) −63 dB (reference: 100% modulation = ±5 kHz deviation at 400 Hz).
CROSSTALK: (SCA to main or stereo sub-channel) −60 dB or better.
CROSSTALK: (Main or stereo sub-channel to SCA) 57 dB below ±5 kHz deviation of SCA with mono or stereo channels modulated by frequencies 30 Hz-15 kHz, SCA demodulated with 150 microsecond de-emphasis.
CROSSTALK: SCA to SCA (67 kHz/92 kHz) 50 dB demodulated with 150 microsecond de-emphasis.
AUTOMATIC MUTE LEVEL: Variable from 0 to −30 dBm.
MUTE DELAY: Adjustable 0.5 to 20 seconds.
INJECTION LEVEL: 1% to 30% of composite level (adjustable).

Harris maintains a policy of continuous improvement on its equipment, and therefore reserves the right to change specifications without notice.

ORDERING INFORMATION

MX-15 Exciter for wideband composite operation, 19-inch rack mounted	994-7950-004
Mono option (add for mono operation)	994-8019-001
DSM Stereo Generator with DTR Filter (add one for stereo operation)	994-8020-002
SCA Generator (add one for each SCA service, specify 67 kHz or 92 kHz)	994-7992-001
External SCA Generator Jumper Card (for use with externally mounted SCA Generator)	994-8377-001

HARRIS CORPORATION BROADCAST DIVISION
P. O. BOX 4290, QUINCY, ILLINOIS 62305-4290 U.S.A. 217/222-8200

FREQUENCY CHANGE INSTRUCTIONS
MX-15 EXCITER

Equipment List.

1. Audio Generator
2. Distortion Analyzer capable of measuring IMD.
3. Modulation Monitor
4. Line Sampler or Directional Coupler with a voltage sample output capable of driving the modulation monitor and frequency counter.
5. 50 watt dummy load.
6. Bird Wattmeter with 25 and 5 watt elements.
7. RF spectrum analyzer.
8. Frequency Counter

A. AFC Programming

Strap the frequency divider circuit in the AFC module for the proper frequency using the frequency program chart on page 13 in the AFC section of the instruction book.

B. Modulated Oscillator Adjustments

Put the Modulated Oscillator on the extender board. Connect the exciter RF output through the Line Sampler or Directional Coupler to the 50 ohm dummy load. Apply A.C. power to the exciter. Depress AFC on the Multimeter switch. Tune AFC voltage adjust (C3) for an AFC voltage as near to 7 volts as possible on the Multimeter. Check for AFC lock in five (5) seconds. At the top or bottom of the band, if the AFC won't lock, try adjusting the voltage a bit lower than 7V.

Connect the frequency counter to the line sampler or the directional coupler forward port. Adjust frequency adjust control (R18) on the front of the AFC module for the exact carrier frequency.

With the Modulated Oscillator still on the Extender board, apply one (1) volt RMS (2.83Vp-p) at 1kHz to the composite input jack, (J4) on the back of the exciter. With the modulation switch in the B-Band position, adjust the B-Band level control (R25) on the Modulated Oscillator for 100 percent modulation reading on the B-Band Meter on the exciter. Adjust the VCO Gain Control (R52) for 100 percent modulation reading on a separate modulation monitor as read through the RF Line Sampler or Directional Coupler forward port. Disconnect the signal from the COMPOSITE INPUT (J4) on the rear of the exciter and apply a 2.83v P-P SMPTE intermodulation test signal into J4. Connect an intermodulation distortion analyzer to the modulation monitor composite output or the audio output with the de-emphasis disabled. Adjust the Distortion Null Control (R74) for minimum intermodulation distortion (less than .02%).

C. RF Amp Adjustments

Connect a spectrum analyzer to the line sampler or directional coupler forward port. Using the spectrum analyzer, adjust C31 for minimum amplitude of the second harmonic. The harmonic must be -53dB down from the carrier reference.

Connect the exciter RF output to a 50 ohm load through an accurately calibrated wattmeter capable of measuring forward and reflected power.

Switch the AGC control to ON. Adjust the wattmeter to measure forward power and adjust the OUTPUT ADJ control (R13) to obtain a 10 + 0.1 watt indication on the external wattmeter.

Do not use the extender board. Alternately remove and replace the RF AMP module from the exciter while making these calibration adjustments.

Depress the MULTIMETER FWD PWR switch and calibrate the FORWARD power adjust (R47) until the indication matches the external wattmeter indication.

Pull out the MOD OSC module and the carrier should be muted. Note: Multimeter indication in FWD PWR.

Insert the MOD OSC and the carrier must remain muted until the AFC/PLL locks. (4.5 seconds).

Disconnect RF output cable from J3 on the rear of the exciter.

Adjust VSWR threshold control R18 to set the MULTIMETER FWD PWR indication to five (5) watts.

Switch to REF PWR range and adjust reflected power calibrate(R37) on the RF AMP for the same indication as read on the FWD PWR range.

Re-connect the output cable to the 50 ohm load. The Multimeter must indicate less than or equal to 0.5 watts on the REF PWR range.

This completes the MX-15 frequency change.

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA	FREQ MHZ	JUMPERS LKJI	HGFE	DCBA	FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
87.50	1001	0010	1011	90.10	1000	1111	0111	92.70	1000	1100	0011
87.55	1001	0010	1010	90.15	1000	1111	0110	92.75	1000	1100	0010
87.60	1001	0010	1001	90.20	1000	1111	0101	92.80	1000	1100	0001
87.65	1001	0010	1000	90.25	1000	1111	0100	92.85	1000	1100	0000
87.70	1001	0010	0111	90.30	1000	1111	0011	92.90	1000	1011	1111
87.75	1001	0010	0110	90.35	1000	1111	0010	92.95	1000	1011	1110
87.80	1001	0010	0101	90.40	1000	1111	0001	93.00	1000	1011	1101
87.85	1001	0010	0100	90.45	1000	1111	0000	93.05	1000	1011	1100
87.90	1001	0010	0011	90.50	1000	1110	1111	93.10	1000	1011	1011
87.95	1001	0010	0010	90.55	1000	1110	1110	93.15	1000	1011	1010
88.00	1001	0010	0001	90.60	1000	1110	1101	93.20	1000	1011	1001
88.05	1001	0010	0000	90.65	1000	1110	1100	93.25	1000	1011	1000
88.10	1001	0001	1111	90.70	1000	1110	1011	93.30	1000	1011	0111
88.15	1001	0001	1110	90.75	1000	1110	1010	93.35	1000	1011	0110
88.20	1001	0001	1101	90.80	1000	1110	1001	93.40	1000	1011	0101
88.25	1001	0001	1100	90.85	1000	1110	1000	93.45	1000	1011	0100
88.30	1001	0001	1011	90.90	1000	1110	0111	93.50	1000	1011	0011
88.35	1001	0001	1010	90.95	1000	1110	0110	93.55	1000	1011	0010
88.40	1001	0001	1001	91.00	1000	1110	0101	93.60	1000	1011	0001
88.45	1001	0001	1000	91.05	1000	1110	0100	93.65	1000	1011	0000
88.50	1001	0001	0111	91.10	1000	1110	0011	93.70	1000	1010	1111
88.55	1001	0001	0110	91.15	1000	1110	0010	93.75	1000	1010	1110
88.60	1001	0001	0101	91.20	1000	1110	0001	93.80	1000	1010	1101
88.65	1001	0001	0100	91.25	1000	1110	0000	93.85	1000	1010	1100
88.70	1001	0001	0011	91.30	1000	1101	1111	93.90	1000	1010	1011
88.75	1001	0001	0010	91.35	1000	1101	1110	93.95	1000	1010	1010
88.80	1001	0001	0001	91.40	1000	1101	1101	94.00	1000	1010	1001
88.85	1001	0001	0000	91.45	1000	1101	1100	94.05	1000	1010	1000
88.90	1001	0000	1111	91.50	1000	1101	1011	94.10	1000	1010	0111
88.95	1001	0000	1110	91.55	1000	1101	1010	94.15	1000	1010	0110
89.00	1001	0000	1101	91.60	1000	1101	1001	94.20	1000	1010	0101
89.05	1001	0000	1100	91.65	1000	1101	1000	94.25	1000	1010	0100
89.10	1001	0000	1011	91.70	1000	1101	0111	94.30	1000	1010	0011
89.15	1001	0000	1010	91.75	1000	1101	0110	94.35	1000	1010	0010
89.20	1001	0000	1001	91.80	1000	1101	0101	94.40	1000	1010	0001
89.25	1001	0000	1000	91.85	1000	1101	0100	94.45	1000	1010	0000
89.30	1001	0000	0111	91.90	1000	1101	0011	94.50	1000	1001	1111
89.35	1001	0000	0110	91.95	1000	1101	0010	94.55	1000	1001	1110
89.40	1001	0000	0101	92.00	1000	1101	0001	94.60	1000	1001	1101
89.45	1001	0000	0100	92.05	1000	1101	0000	94.65	1000	1001	1100
89.50	1001	0000	0011	92.10	1000	1100	1111	94.70	1000	1001	1011
89.55	1001	0000	0010	92.15	1000	1100	1110	94.75	1000	1001	1010
89.60	1001	0000	0001	92.20	1000	1100	1101	94.80	1000	1001	1001
89.65	1001	0000	0000	92.25	1000	1100	1100	94.85	1000	1001	1000
89.70	1000	1111	1111	92.30	1000	1100	1011	94.90	1000	1001	0111
89.75	1000	1111	1110	92.35	1000	1100	1010	94.95	1000	1001	0110
89.80	1000	1111	1101	92.40	1000	1100	1001	95.00	1000	1001	0101
89.85	1000	1111	1100	92.45	1000	1100	1000	95.05	1000	1001	0100
89.90	1000	1111	1011	92.50	1000	1100	0111	95.10	1000	1001	0011
89.95	1000	1111	1010	92.55	1000	1100	0110	95.15	1000	1001	0010
90.00	1000	1111	1001	92.60	1000	1100	0101	95.20	1000	1001	0001
90.05	1000	1111	1000	92.65	1000	1100	0100	95.25	1000	1001	0000

LEGEND: JUMPER IN = 0
JUMPER OUT = 1

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
95.30	1000	1000	1111
95.35	1000	1000	1110
95.40	1000	1000	1101
95.45	1000	1000	1100
95.50	1000	1000	1011
95.55	1000	1000	1010
95.60	1000	1000	1001
95.65	1000	1000	1000
95.70	1000	1000	0111
95.75	1000	1000	0110
95.80	1000	1000	0101
95.85	1000	1000	0100
95.90	1000	1000	0011
95.95	1000	1000	0010
96.00	1000	1000	0001
96.05	1000	1000	0000
96.10	1000	0111	1111
96.15	1000	0111	1110
96.20	1000	0111	1101
96.25	1000	0111	1100
96.30	1000	0111	1011
96.35	1000	0111	1010
96.40	1000	0111	1001
96.45	1000	0111	1000
96.50	1000	0111	0111
96.55	1000	0111	0110
96.60	1000	0111	0101
96.65	1000	0111	0100
96.70	1000	0111	0011
96.75	1000	0111	0010
96.80	1000	0111	0001
96.85	1000	0111	0000
96.90	1000	0110	1111
96.95	1000	0110	1110
97.00	1000	0110	1101
97.05	1000	0110	1100
97.10	1000	0110	1011
97.15	1000	0110	1010
97.20	1000	0110	1001
97.25	1000	0110	1000
97.30	1000	0110	0111
97.35	1000	0110	0110
97.40	1000	0110	0101
97.45	1000	0110	0100
97.50	1000	0110	0011
97.55	1000	0110	0010
97.60	1000	0110	0001
97.65	1000	0110	0000
97.70	1000	0101	1111
97.75	1000	0101	1110
97.80	1000	0101	1101
97.85	1000	0101	1100
97.90	1000	0101	1011
97.95	1000	0101	1010
98.00	1000	0101	1001
98.05	1000	0101	1000
98.10	1000	0101	0111
98.15	1000	0101	0110
98.20	1000	0101	0101
98.25	1000	0101	0100
98.30	1000	0101	0011
98.35	1000	0101	0010
98.40	1000	0101	0001
98.45	1000	0101	0000
98.50	1000	0100	1111
98.55	1000	0100	1110
98.60	1000	0100	1101
98.65	1000	0100	1100
98.70	1000	0100	1011
98.75	1000	0100	1010
98.80	1000	0100	1001
98.85	1000	0100	1000
98.90	1000	0100	0111
98.95	1000	0100	0110
99.00	1000	0100	0101
99.05	1000	0100	0100
99.10	1000	0100	0011
99.15	1000	0100	0010
99.20	1000	0100	0001
99.25	1000	0100	0000
99.30	1000	0011	1111
99.35	1000	0011	1110
99.40	1000	0011	1101
99.45	1000	0011	1100
99.50	1000	0011	1011
99.55	1000	0011	1010
99.60	1000	0011	1001
99.65	1000	0011	1000
99.70	1000	0011	0111
99.75	1000	0011	0110
99.80	1000	0011	0101
99.85	1000	0011	0100
99.90	1000	0011	0011
99.95	1000	0011	0010
100.00	1000	0011	0001
100.05	1000	0011	0000
100.10	1000	0010	1111
100.15	1000	0010	1110
100.20	1000	0010	1101
100.25	1000	0010	1100
100.30	1000	0010	1011
100.35	1000	0010	1010
100.40	1000	0010	1001
100.45	1000	0010	1000
100.50	1000	0010	0111
100.55	1000	0010	0110
100.60	1000	0010	0101
100.65	1000	0010	0100
100.70	1000	0010	0011
100.75	1000	0010	0010
100.80	1000	0010	0001
100.85	1000	0010	0000
100.90	1000	0001	1111
100.95	1000	0001	1110
101.00	1000	0001	1101
101.05	1000	0001	1100
101.10	1000	0001	1011
101.15	1000	0001	1010
101.20	1000	0001	1001
101.25	1000	0001	1000
101.30	1000	0001	0111
101.35	1000	0001	0110
101.40	1000	0001	0101
101.45	1000	0001	0100
101.50	1000	0001	0011
101.55	1000	0001	0010
101.60	1000	0001	0001
101.65	1000	0001	0000
101.70	1000	0000	1111
101.75	1000	0000	1110
101.80	1000	0000	1101
101.85	1000	0000	1100
101.90	1000	0000	1011
101.95	1000	0000	1010
102.00	1000	0000	1001
102.05	1000	0000	1000
102.10	1000	0000	0111
102.15	1000	0000	0110
102.20	1000	0000	0101
102.25	1000	0000	0100
102.30	1000	0000	0011
102.35	1000	0000	0010
102.40	1000	0000	0001
102.45	1000	0000	0000
102.50	0111	1111	1111
102.55	0111	1111	1110
102.60	0111	1111	1101
102.65	0111	1111	1100
102.70	0111	1111	1011
102.75	0111	1111	1010
102.80	0111	1111	1001
102.85	0111	1111	1000
102.90	0111	1111	0111
102.95	0111	1111	0110
103.00	0111	1111	0101
103.05	0111	1111	0100

FREQ MHZ	JUMPERS LKJI	HGJE	DCBA
103.10	0111	1111	0011
103.15	0111	1111	0010
103.20	0111	1111	0001
103.25	0111	1111	0000
103.30	0111	1110	1111
103.35	0111	1110	1110
103.40	0111	1110	1101
103.45	0111	1110	1100
103.50	0111	1110	1011
103.55	0111	1110	1010
103.60	0111	1110	1001
103.65	0111	1110	1000
103.70	0111	1110	0111
103.75	0111	1110	0110
103.80	0111	1110	0101
103.85	0111	1110	0100
103.90	0111	1110	0011
103.95	0111	1110	0010
104.00	0111	1110	0001
104.05	0111	1110	0000
104.10	0111	1101	1111
104.15	0111	1101	1110
104.20	0111	1101	1101
104.25	0111	1101	1100
104.30	0111	1101	1011
104.35	0111	1101	1010
104.40	0111	1101	1001
104.45	0111	1101	1000
104.50	0111	1101	0111
104.55	0111	1101	0110
104.60	0111	1101	0101
104.65	0111	1101	0100
104.70	0111	1101	0011
104.75	0111	1101	0010
104.80	0111	1101	0001
104.85	0111	1101	0000
104.90	0111	1100	1111
104.95	0111	1100	1110
105.00	0111	1100	1101
105.05	0111	1100	1100
105.10	0111	1100	1011
105.15	0111	1100	1010
105.20	0111	1100	1001
105.25	0111	1100	1000
105.30	0111	1100	0111
105.35	0111	1100	0110
105.40	0111	1100	0101
105.45	0111	1100	0100
105.50	0111	1100	0011
105.55	0111	1100	0010
105.60	0111	1100	0001
105.65	0111	1100	0000

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
105.70	0111	1011	1111
105.75	0111	1011	1110
105.80	0111	1011	1101
105.85	0111	1011	1100
105.90	0111	1011	1011
105.95	0111	1011	1010
106.00	0111	1011	1001
106.05	0111	1011	1000
106.10	0111	1011	0111
106.15	0111	1011	0110
106.20	0111	1011	0101
106.25	0111	1011	0100
106.30	0111	1011	0011
106.35	0111	1011	0010
106.40	0111	1011	0001
106.45	0111	1011	0000
106.50	0111	1010	1111
106.55	0111	1010	1110
106.60	0111	1010	1101
106.65	0111	1010	1100
106.70	0111	1010	1011
106.75	0111	1010	1010
106.80	0111	1010	1001
106.85	0111	1010	1000
106.90	0111	1010	0111
106.95	0111	1010	0110
107.00	0111	1010	0101
107.05	0111	1010	0100
107.10	0111	1010	0011
107.15	0111	1010	0010
107.20	0111	1010	0001
107.25	0111	1010	0000
107.30	0111	1001	1111
107.35	0111	1001	1110
107.40	0111	1001	1101
107.45	0111	1001	1100
107.50	0111	1001	1011
107.55	0111	1001	1010
107.60	0111	1001	1001
107.65	0111	1001	1000
107.70	0111	1001	0111
107.75	0111	1001	0110
107.80	0111	1001	0101
107.85	0111	1001	0100
107.90	0111	1001	0011
107.95	0111	1001	0010
108.00	0111	1001	0001
108.05	0111	1001	0000

MANUAL REVISION HISTORY
MX-15 FM EXCITER
888-2164-0xx

REV. #	DATE	ECN	PAGES AFFECTED
002	6-23-83	27606	6-5 (2A4 changed to 992 5983 002)
003	10-25-83	27734	Replaced the following pages: Title Page 6-6 and 6-22 Added Manual Revision History Page
004	11-07-83	27744	Replaced the following pages: Title Page and Manual Revision History Page 7-7//7-8
005	11-14-83	27835	Replaced the following pages: Title Page and Manual Revision History Page 1-3, 2-1, 3-9, 4-1, 4-13, 4-18, 4-20, 4-24, 5-3, 5-5, 5-7, 6-1, 6-16, 6-24, 7-1/7-2
006	02-03-84	27854	Replaced the following pages: Title Page and Manual Revision History Page 6-6 and 7-7/7-8 Changed part number for CB1 to 992 6557 001
007	06-18-84	29006	Replaced the following pages: Title Page and Manual Revision History Page 1-3, 1-4, 2-3, 4-3/4-4, 4-14, 4-15, 4-17, 4-18, 6-2 & 6-30
008	09-21-84	27944	Replaced the following pages: Title Page and Manual Revision History Page 6-6
009	08-21-85	29552	Replaced the following pages: Title Page and Manual Revision History Page 6-18
010	04-29-86	30079	Replaced the following pages: Title Page and Manual Revision History Page i & ii, 5-7, 6-1 & 6-7

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

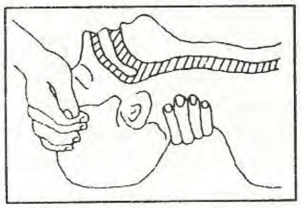
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

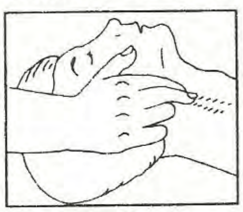
(A) AIRWAY

IF UNCONSCIOUS.
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

CHECK
CAROTID PULSE



IF PULSE ABSENT.
BEGIN ARTIFICIAL
CIRCULATION

(B) BREATHING

IF NOT BREATHING.
BEGIN ARTIFICIAL BREATHING

TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

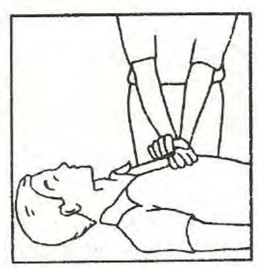
REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES

APPROX. RATE OF COMPRESSIONS --80 PER MINUTE { ONE RESCUER, 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE { TWO RESCUERS, 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

   NOTE

   If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Paragraph		Page
	APPENDIX A. MANUFACTURER'S DATA	

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

WARNING: Disconnect primary power prior to servicing.

LIST OF ILLUSTRATIONS

WARNING: Disconnect primary power prior to servicing.

SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION

1-2. This technical manual contains information necessary to install, operate, maintain, and service the MX-15 FM EXCITER. Sections in this technical manual provide the following information:

a. SECTION I, GENERAL DESCRIPTION, provides a description of equipment features, identifies major components, and lists operating parameters and specifications.

b. SECTION II, INSTALLATION, provides unpacking, inspection, and installation information, preoperational checks, and power on checks to ensure correct operation.

c. SECTION III, OPERATION, identifies controls and indicators and provides equipment setup and operation.

d. SECTION IV, PRINCIPLES OF OPERATION, provides a functional description and detailed block diagram with theory of operation.

e. SECTION V, MAINTENANCE, provides preventive and corrective maintenance information and troubleshooting with instructions for equipment servicing.

f. SECTION VI, PARTS LIST, provides information for ordering replacement components and assemblies.

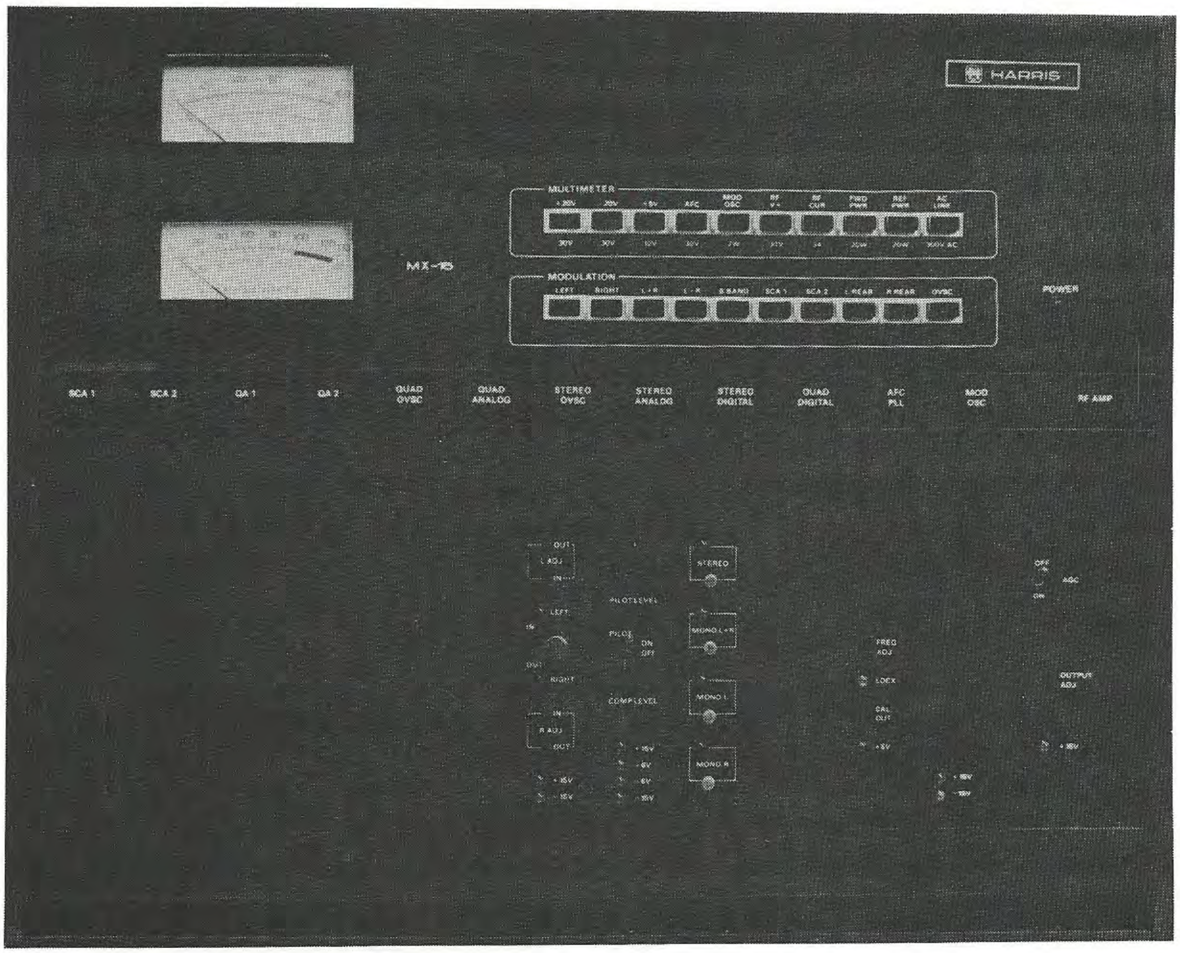
g. SECTION VII, DIAGRAMS, provides block, logic, schematic diagrams, and other drawings required for equipment maintenance.

1-3. EQUIPMENT PURPOSE

1-4. The HARRIS MX-15 FM EXCITER (figure 1-1) produces a 15 watt maximum frequency modulator signal into a 50 ohm load on any channel in the 87.5 MHz to 108 MHz commercial FM broadcast band. Operational modes include up to two SCA channels monophonic, stereophonic, and provisions for quadraphonic transmission.

1-5. PHYSICAL DESCRIPTION

1-6. The MX-15 FM EXCITER is both electrically and mechanically modular in concept. Each discrete function is implemented within individual plug-in modules. Each module is provided with an insertion/extraction lever to aid in module servicing. All modules are placarded with nomenclature to prevent use in the incorrect slot. A hinged front panel drops down to access the chassis mounted and non-modular components such as the input and output RFI filters, the metering circuits, and the power supply components. The entire exciter mounts in 14 vertical inches of standard 19 inch rack space.



2164-1

Figure 1-1. MX-15 FM EXCITER (Shown with Optional Stereo Generator)

WARNING: Disconnect primary power prior to servicing.

1-7. FUNCTIONAL DESCRIPTION

1-8. The HARRIS MX-15 FM EXCITER produces a frequency modulated output continuously variable from three to 15 watts for any channel assignment within the 87.5 to 108 MHz commercial FM broadcast band (see figure 1-2). Servicing is simplified as the exciter is modular in concept and discrete functions are complete within individual plug-in modules. The metering panel contains a true peak reading audio meter and multimeter which monitors important audio, rf, and control voltages. Light emitting diode status indicators monitor critical functions on each plug-in module. Many design features provide operational characteristics superior to conventional FM equipment.

1-9. STEREOPHONIC OPTION

1-10. The stereophonic option consists of the STEREO DIGITAL module, the STEREO ANALOG module, and the STEREO OVSC module. Features of the stereophonic option are discussed in the following text.

1-11. DIGITALLY SYNTHESIZED MODULATION (DSM) STEREOPHONIC GENERATOR. The STEREO ANALOG and STEREO DIGITAL modules comprising the DSM stereophonic generator eliminate the compromise existing between other popular types of stereophonic generators. The switching type of stereophonic modulator produces poor separation at high frequencies. Poor harmonic rejection and SCA crosstalk are problems experienced with the balanced modulator type of stereophonic generator. The HARRIS developed DSM stereophonic generator typically produces 50 dB of stereophonic signal separation from 30 Hz to 15 kHz with an exceptionally clean baseband signal which promotes minimal interaction between stereophonic and SCA service. An automatic phase control circuit adjusts the stereophonic pilot phase to maintain stereophonic signal separation. Selectable FLAT, 25, 50, and 75 microsecond pre-emphasis is provided for use as desired.

1-12. DYNAMIC TRANSIENT RESPONSE (DTR) FILTER. A HARRIS developed low-pass filter comprising the STEREO OVSC module operates independently of limiters or stereophonic generators to limit the overshoot on FM stereophonic or future quadraphonic transmission to two percent maximum on any input program material processed by any limiter. The filter is transparent to audio within $\pm$0.5 dB of its passband of 30 Hz to 15 kHz and provides over 50 dB of attenuation at 19 kHz and above. The filter inaudibly reduces modulation overshoots to less than two percent. Typically, elimination of overshoot allows a two to six dB increase in loudness with no other audible effect.

1-13. MONOPHONIC OPTION

1-14. When the monaural option is used, the three stereophonic modules must be removed and the MONO module plugged into the STEREO ANALOG module position. Solid state input circuitry provides high common mode rejection and selectable pre-emphasis similar to the stereophonic module is provided. A built-in defeatable linear-phase low-pass filter provides optimal linear control of overshoot and protects the 67 kHz and/or 92 kHz SCA channels.

1-15. SCA OPTION

1-16. High quality SCA is provided by dual frequency SCA generators which operate at frequencies of 67 kHz or 92 kHz. The filter includes a seven pole Butterworth audio low-pass filter which allows use of full 150 microsecond pre-emphasis without degrading SCA to stereophonic isolation. Bandpass filters allow both the 67 kHz and 92 kHz SCA channels to be operated simultaneously without harmonic interference. Modulation can be dc coupled to allow SSTV and data transmission without special outboard units. Selectable manual or automatic variable level muting and selectable pre-emphasis are provided. An optional External SCA Generator Jumper Card is available which allows an external SCA generator to be connected to the MX-15. This card can be plugged into slot marked SCA 1 or SCA 2 dependent upon frequency of external SCA generator (67 kHz for SCA 1 and 92 kHz for SCA 2).

1-17. FREQUENCY SYNTHESIZER

1-18. All FM channels are synthesized from a highly stable 10.0 mHz temperature compensated crystal oscillator (TCXO) in the AFC/PLL module which eliminates requirements for an oven, thereby reducing warmup time to zero. Channel frequency is field programmable in 50 kHz increments to accommodate future domestic or international channel assignments. As the frequency reference is obtained from 10.0 mHz, stations may compare their frequency directly with a broadcast frequency standard such as WWV for calibration. A front panel test point provides a convenient point for frequency comparisons using a short-wave receiver.

1-19. A phase locked loop with dual characteristics provides frequency correction and reduces frequency lockup time to a minimum. The loop employs high rate feedback control when power is turned on as the loop is initially unlocked. As soon as the lock detector perceives lock, loop correction is slowed for optimum transmission of low frequencies.

1-20. The broadbanded MOD OSC module VCO assembly and a synthesizer with a wide lockup range delete the requirement for a center frequency adjustment. A predistortion network modifies the incoming signal and linearizes the VCO output to less than 0.1% distortion. The VCO assembly output is amplified to a 250 milliwatt level as required to drive the RF AMP module.

1-21. AUTOMATIC LEVEL SWITCHING

1-22. With many comparable systems, main channel loudness is sacrificed when the SCA channels mute or when the transmission mode is switched between monaural and stereophonic service. With the HARRIS automatic level switching circuit, discrepancies in total modulation caused by pilot and SCA injection are noiselessly compensated by an automatic composite gain switcher in the MOD OSC module which maintains 100% peak modulation for all standard combinations of stereophonic, monaural, L, R, or L+R, and 0, 1, or 2 SCA channels. Automatic level switching only occurs with the MX-15's plug in SCA Generator. This feature is not applicable if the optional External SCA Generator Jumper Card is used to connect an external SCA generator to the MX-15.

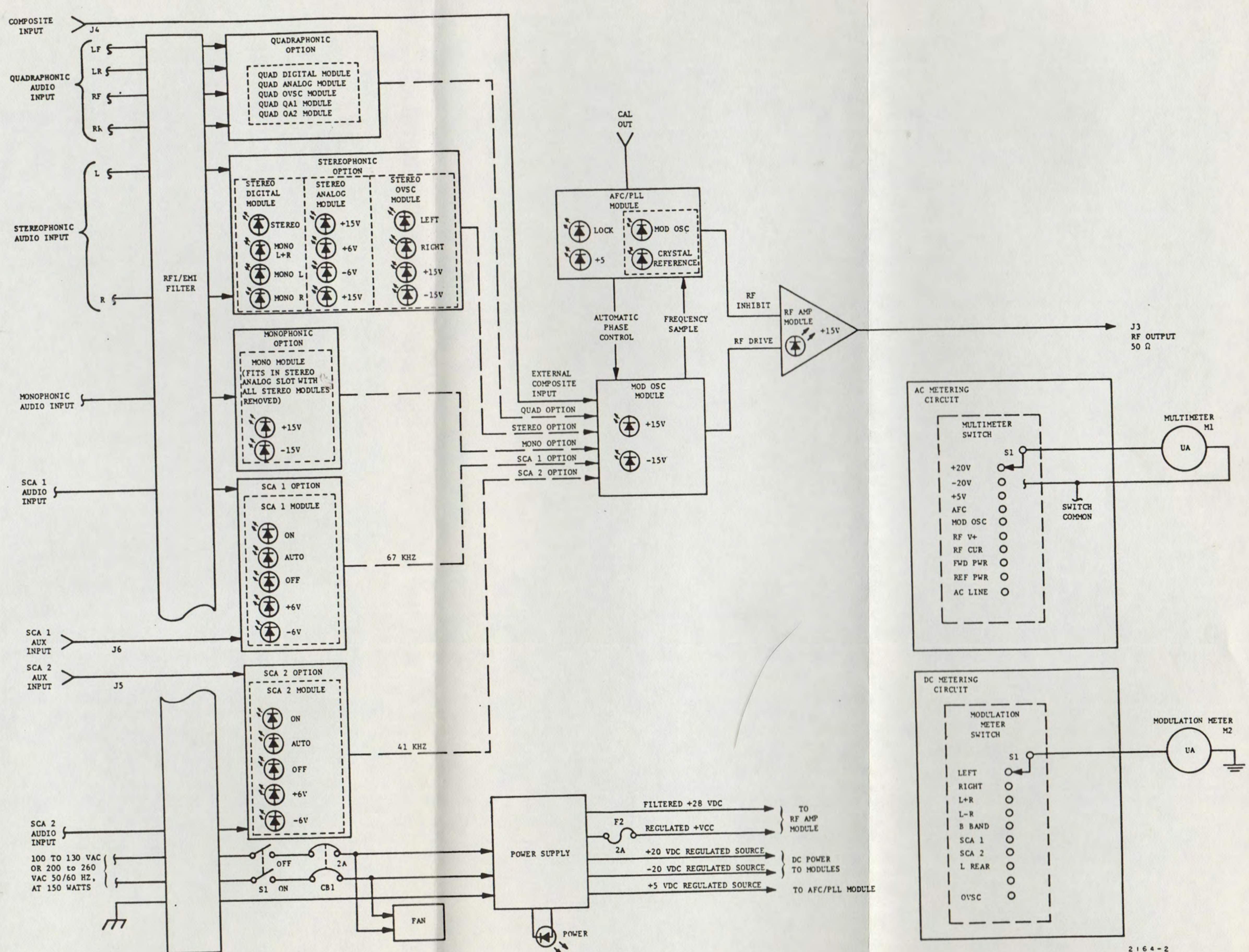


FIGURE 1-2. SIMPLIFIED BLOCK DIAGRAM

1-23. QUADRAPHONIC OPTION

1-24. Because of the extremely clean baseband provided by the DSM system of stereo generation and the stable digitally synthesized nature of the system, compatibility with any of the proposed discrete quadraphonic transmission systems is assured. The MX-15 FM EXCITER mainframe is already wired for plug-in quadraphonic modules, facilitating the transition from stereophonic to quadraphonic transmission.

1-25. POWER AMPLIFIER

1-26. The RF AMP module is broadbanded from 87.5 MHz to 108 MHz and requires no tuning. An AGC circuit stabilizes the output power to a level which is adjustable from three watts to 15 watts. A VSWR circuit senses load faults and provides shutdown to protect the power amplifier from load mismatch. Off frequency transmission is prevented by a circuit which automatically inhibits rf output whenever the frequency synthesizer loop is in an unlocked condition.

1-27. POWER SUPPLY CIRCUIT

1-28. All exciter inputs and outputs, including the power supply ac input, are buffered by the RFI/EMI filter with the exception of the SCA-1 AUX INPUT (J6), SCA-2 AUX INPUT (J5), COMPOSITE INPUT (J4), and the exciter RF OUTPUT (J3) which interface via coaxial (shielded) lines.

1-29. Switch S1 and circuit breaker CB1 provide power supply overload protection and control. A fan which operates when power is on provides cooling of internal high power components. The power supply develops a positive 34 Vdc potential fused at three amperes which operates the RF AMP module. Preregulated ±20 Vdc potentials and a regulated positive five volt dc potential are also produced to operate the remaining portion of the exciter internal circuitry.

1-30. EQUIPMENT CHARACTERISTICS

1-31. Refer to the MX-15 MAXIMUM SIGNAL FM EXCITER brochure at the front of this technical manual for pertinent electrical and mechanical characteristics of the MX-15 FM EXCITER.

NOTE

Specifications subject to change without notice.

SECTION II

INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information required to unpack, inspect, and install the MX-15 FM EXCITER. Preoperational checks and power on checks will ensure correct exciter operation. Components or modules removed from the exciter after final test, for transport, are tagged and provided with appropriate instructions for reinstallation.

2-3. UNPACKING

2-4. Carefully unpack the MX-15 FM EXCITER and perform a visual inspection to determine that no apparent damage was incurred during shipment. Retain the shipping materials until it has been determined that the unit is not damaged. The contents of the shipment should be as indicated on the packing list. If the contents are incomplete or if the unit is damaged electrically or mechanically, notify the carrier and HARRIS CORPORATION, Broadcast Transmission Division.

2-5. All packing materials must be removed from the equipment and the modules. The removal of components varies due to the method and requirements for shipment. All removed components are tagged to permit easy reinstallation in the equipment. Symbol numbers and descriptions are provided on each removed component corresponding to the schematic diagram, parts list, packing list and reference designator or nomenclature stenciled at the cabinet location of each removed item. Cables and small parts may be taped or tied in place for shipment. Remove all tape, string, and packing materials used for this purpose. Install any removed components in the interior of the cabinet and arrange the modules in a separate container according to the order in which each module installs in the equipment.

2-6. INSTALLATION

2-7. Prior to installation, the manual should be carefully studied to get a thorough understanding of the principles of operation, circuitry and nomenclature. This will facilitate proper installation and initial checkout. Installation of the MX-15 FM EXCITER will be accomplished in four steps: 1) exciter placement, 2) module installation, 3) exciter wiring, and 4) preliminary checkout.

2-8. EXCITER PLACEMENT

2-9. The HARRIS MX-15 FM EXCITER is manufactured to directly retrofit the HARRIS TE-3 FM exciter or any similar FM exciter. The exciter requires 14 vertical inches of standard 19 inch rack space and should be placed in a location which provides convenient access to the rear panel near power, rf, and control cables. As cooling air enters the equipment through vents in the bottom panel, the exciter should not be placed directly above heat generating equipment such as an amplifier stage. The equipment is thoroughly RFI shielded and no special isolation precautions are required.

2-10. MODULE INSTALLATION

2-11. Several modules required jumper-plug programming which initializes the module to operate in a predetermined mode at power application. Refer to table 2-1 and ensure each jumper listed is correctly installed in each respective module to produce the desired mode of operation. After the module programming is completed, each module should be inserted in its respective slot in the exciter case.

2-12. EXCITER WIRING

2-13. External wiring of the exciter will differ between units depending upon the options purchased with each individual exciter. Refer to table 2-2 and figure 2-1 for information required to connect inputs, remote control lines, and monitoring equipment to the FM exciter.

2-14. After wiring of the inputs, control lines, and monitoring equipment is completed, the following additional external connections must be made. Power connections will be wired last.

a. GROUND: Connect the GND LUG terminal on the rear of the exciter to station ground.

b. RF LOAD: Connect the exciter load to the RF OUTPUT 50 ohm terminal (J3) on the rear of the exciter.

c. COMPOSITE INPUT: If a composite input is to be used with the exciter, connect the input to the COMPOSITE INPUT terminal (J4) on the rear of the exciter.

d. SCA AUXILIARY INPUT: If an auxiliary SCA input such as teletype is required, connect the inputs to SCA-1 AUX INPUT (J6) and SCA-2 AUX INPUT (J5) as necessary when the MX-15 is equipped with optional SCA Generator. If the optional External SCA Generator Jumper Card is used, the auxiliary input must be applied to the external SCA generator.

WARNING

DO NOT APPLY POWER TO THE EXCITER IN STEP e.

e. PRIMARY AC: Prepare plug P2 for connection to either 115 Vac or 230 Vac as shown in figure 2-2. After the plug is correctly wired to either the 115 Vac or the 230 Vac configuration, connect plug P2 to the AC POWER input on the exciter rear (J2). Do not connect the power cord to the ac source at this time.

Table 2-1. Module Programming

MODULE	JUMPER	NOMENCLATURE	PURPOSE
SCA 1 and SCA 2	J1	67 KHZ/92 KHZ	Selects SCA frequency.
	J2	67 KHZ/92 KHZ	Selects SCA filter freq.
	J3	67 KHZ/92 KHZ	Selects SCA filter freq.
	J4	POWER UP: OFF/ON/AUTO	Determines operational status at power application
	J5	150/75/50/0	PREMPH: Selects SCA input pre-emphasis
STEREO DIGITAL	J1	POWER UP: STEREO/LEFT/ RIGHT/L+R	Selects the mode in which the module will initialize when power is applied
	J2	SCA INTERLOCK L+R/LEFT/RIGHT	Selects monaural mode STEREO DIGITAL Module will enter if simultaneous 41 KHZ SCA-2 and stereophonic operation is attempted. For 67 or 92 kHz operation of SCA-2, remove jumper J2 from board.
STEREO ANALOG	J1	FLAT/25/50/75	Selects stereo input pre-emphasis.
	J2	FLAT/25/50/75	Selects stereo input pre-emphasis.
	J3	DTR/INT	Selects the internal low pass filter or enables the DTR filter.
	J4	DTR/INT	Selects the internal low pass filter or enables DTR filter.
	J5	DTR/INT	Selects the internal low pass filter or enables the DTR filter.
	J6	DTR/INT	Selects the internal low pass filter or enables the DTR filter.

Table 2-1. Module Programming (Continued)

MODULE	JUMPER	NOMENCLATURE	PURPOSE
MONO	J1	A/B/C/D	Selects mono input pre-emphasis. A: 75 us B: 50 us C: 25 us D: FLAT
	J2	A/B/C/D	Enables or bypasses the linear phase low pass filter. Enable: A to B, C to D. Bypass: A to C, B to D.

WARNING: Disconnect primary power prior to servicing.

Table 2-2. Exciter Wiring

TERMINAL	NOMENCLATURE	SIGNAL
TB1 PIN 1 2 3	LEFT FRONT + LEFT FRONT ⏚ LEFT FRONT -	(red) (shield) (black) 600 ohm balanced audio input mono, stereo left channel, or left front channel for future quad transmission.
4 5 6	RIGHT FRONT + RIGHT FRONT ⏚ RIGHT FRONT -	(red) (shield) (black) 600 ohm balanced audio input for stereo right channel or right front or right front channel for future quad transmission.
7 8 9	SCA-1 + SCA-1 ⏚ SCA-1 -	(red) (shield) (black) 600 ohm balanced audio input for SCA channel No. 1.1
10 11 12	SCA-2 OR LEFT REAR + SCA-2 OR LEFT REAR ⏚ SCA-2 OR LEFT REAR -	(red) (shield) (black) 600 ohm balanced audio input for SCA channel channel No. 2 or left rear channel for future quad transmission.
13 14 15	RIGHT REAR + RIGHT REAR ⏚ RIGHT REAR -	(red) (shield) (black) 600 ohm balanced audio input for right rear channel for future quad transmission.
16	ST.	(STEREO MODE) A momentary contact to ground will cause the equipment to transmit in the stereo mode.*
17	L+R	(STEREO MODE) A momentary contact to ground will cause the equipment to transmit a mono signal from both stereo channels.*
* See Note 1		

Table 2-2. Exciter Wiring (Continued)

TERMINAL	NOMENCLATURE	SIGNAL
18	LEFT MONO	(STEREO MODE) A momentary contact to ground will cause the equipment to transmit a mono signal from the left stereo channel and mute the right stereo channel. *
TB2 PIN 19	RIGHT MONO	(STEREO MODE) A momentary contact to ground will cause the equipment to transmit a mono signal from the right stereo channel and mute the left stereo channel.*
20	ON	(SCA-1 MODE) A momentary contact to ground will enable SCA channel No. 1.*
21	AUTO	(SCA-1 MODE) A momentary contact to ground will enable the SCA-1 module automatic muting function. (See note 1)
22	OFF	(SCA-1 MODE) A momentary contact to ground will mute SCA channel No. 1 at all times.*
23	ON	(SCA-2 MODE) A momentary contact to ground will enable SCA channel No. 2 whenever power is on.*
* See Note 1		

WARNING: Disconnect primary power prior to servicing.

Table 2-2. Exciter Wiring (Continued)

TERMINAL	NOMENCLATURE	SIGNAL
24	AUTO	(SCA-2 MODE) A momentary contact ground will enable the SCA-2 module automatic muting function. (See note 1.)
25	OFF	(SCA-2 MODE) A momentary contact to ground will mute SCA channel No. 2 at all times.
TB2 PIN 26	(I)	(P.A. METER) Provision to monitor sampled power amplifier collector current. A 20k ohm, 1/4 watt resistor and a 0-100 microammeter are required (see figure 2-1). Three amperes of supply current will produce full scale meter deflection.
27	(V)	(P.A. METER) Provision to monitor the power amplifier supply voltage. A 0-30 voltmeter is required (see figure 2-1).
28	FWD	(R.F. METER) Provision to monitor the exciter forward power output sensed by the directional coupler. A 0-100 microammeter is required (see figure 2-1).
* See Note 1.		

WARNING: Disconnect primary power prior to servicing.

Table 2-2. Exciter Wiring (Continued)

TERMINAL	NOMENCLATURE	SIGNAL
29	REF.	(R.F. METER) Provision to monitor the exciter reflected power sensed by the directional coupler. A 0-100 microammeter is required (see figure 2-1).
30	R.F. INT.	A contact to ground will inhibit the exciter carrier output until the ground is removed.
31	SPARE 1	Spare contact.
TB2 PIN 32	S.W. COM. +	A jumper from TB2 pin 34 provides a 20 Vdc potential to operate the remote mode switching circuits (see figure 2-3). If remote mode switching is not desired, the jumper may be removed.
33	SPARE 2	Spare contact.
34	S.W.P.S. +	Provides a 20 Vdc potential to operate the remote mode switching circuits through a jumper to TB2 pin 32 (see figure 2-3). If remote mode switching is not desired, the jumper may be removed.
35	N.O.AFC.INT.	Provides one set of normally open contacts or relay 2A1A4K1 which close when the AFC/PLL module achieves frequency lock. The contacts are rated at three amperes at 120 Vac.
36	N.O.AFC.INT.	

* NOTES

1. Remote control requires that terminal 34 (+ S. W. P. S.) be jumpered to terminal 32 (+ S. W. COM.) or a positive 12 Vdc to 28 Vdc potential must be jumpered between the desired terminal and terminal 32 (S. W. COM.).

WARNING: Disconnect primary power prior to servicing.

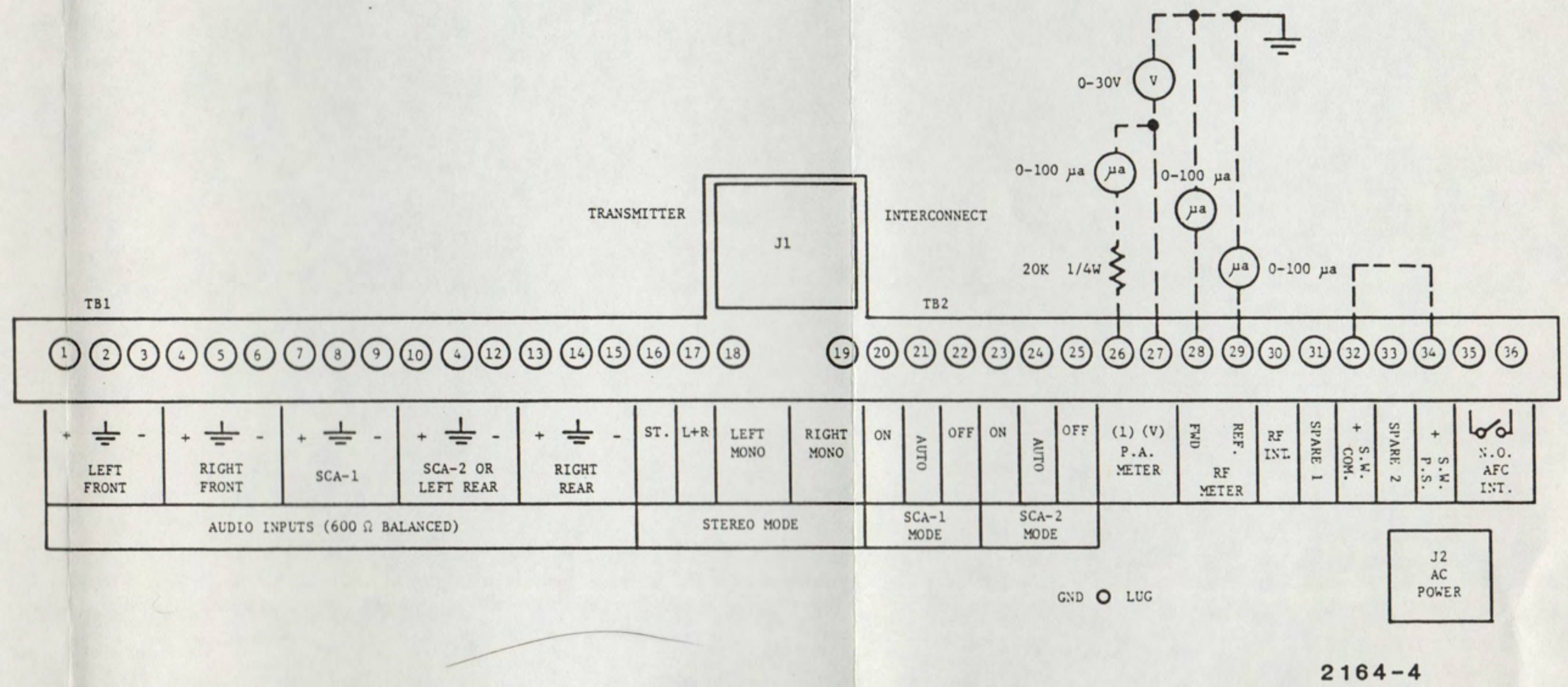


FIGURE 2-1. EXCITER WIRING

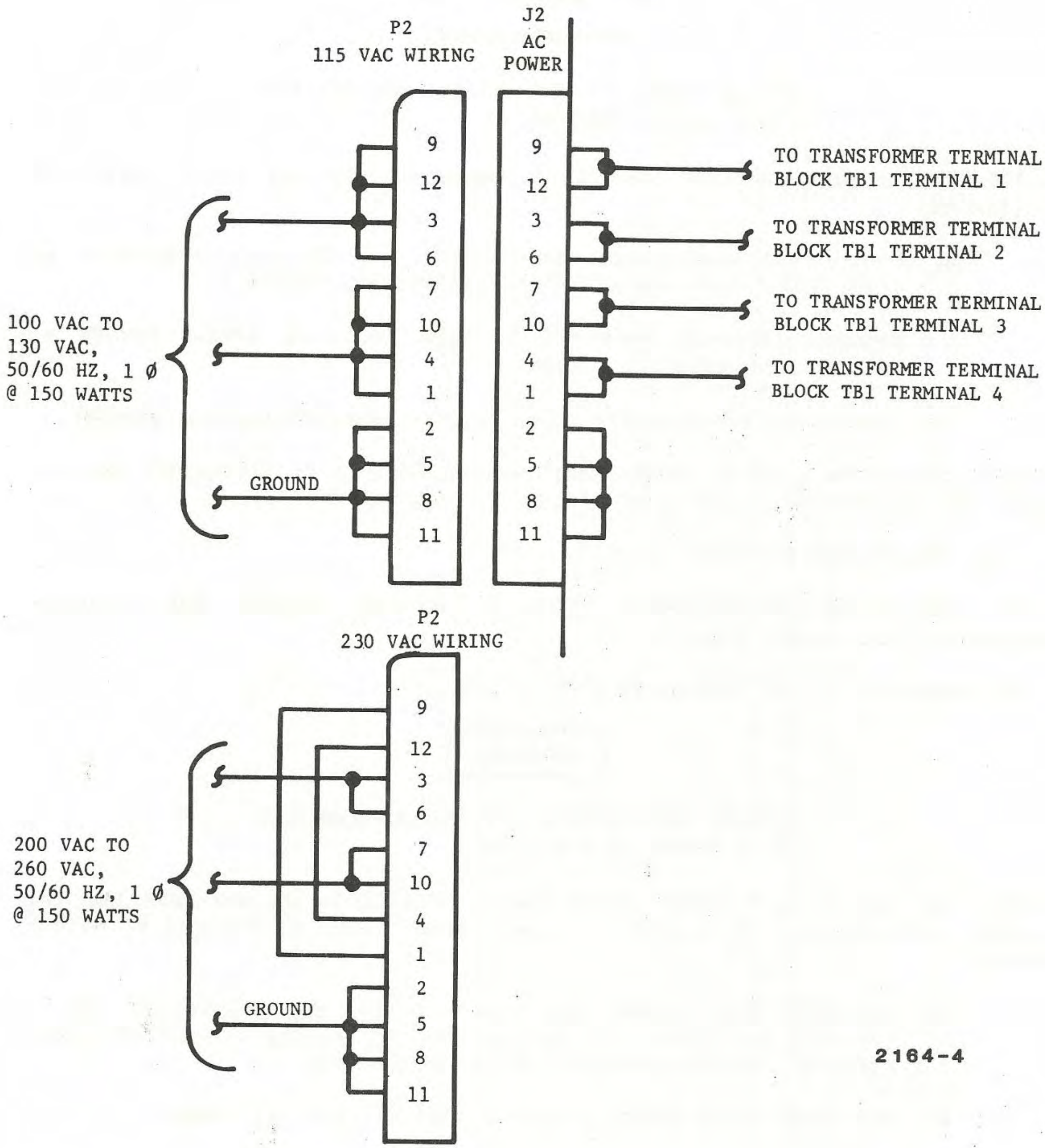


Figure 2-2. Primary AC Wiring

WARNING: Disconnect primary power prior to servicing.

WARNING

ENSURE POWER IS NOT APPLIED TO THE EXCITER BEFORE PROCEEDING.

2-15. The complete exciter should be inspected at this time. Check the following:

a. Ensure all connections at terminal boards and components are tight and secure and all wires are dressed properly.

b. Remove any extra hardware or wire from the area. Ensure all packing materials are removed.

c. Rotate the fan manually to be sure no obstructions are present.

2-16. Ensure the exciter POWER ON/OFF switch (2A1S1) is set to OFF and connect the power cord to the ac source.

2-17. PRELIMINARY CHECKOUT

2-18. Adjust the RF AMP module OUTPUT ADJ control (2A2R13) fully counterclockwise (zero power output).

2-19. Depress the MULTIMETER AC LINE switch.

CAUTION

ENSURE THE EXCITER OUTPUT IS CONNECTED TO A PROPER 50 OHM LOAD.

2-20. Set the exciter POWER ON/OFF switch (2A1S1) to ON and note the following indications. If trouble is experienced, refer to Section V, Maintenance.

a. The MULTIMETER (2A1M1) must indicate 115 Vac ±15 Vac or 230 Vac ±30 Vac, as wired. If the primary ac voltage is out of tolerance, it must be corrected before proceeding.

b. The front panel POWER indicator (3A1DS1) will illuminate.

c. All the module front panel power indicators (+5V, +6V, -6V, +15V, and -15V) will illuminate.

2-21. Adjust the RF AMP module OUTPUT ADJ control (2A2R13) to obtain a three watt rf output. Refer to table 2-3 and check the MULTIMETER (2A1M1) and MODULATION (2A1M2) meter indications listed. If trouble is experienced, refer to Section V, Maintenance.

Table 2-3. Preliminary Meter Indications

MULTIMETER SWITCH POSITION	MULTIMETER INDICATION*
+20V	+22V
-20V	+22V
+5 V	+5 V
AFC	+3V to +12V**
MOD OSC	250 mW ± 100 mW
RF V+	+7.5V
RF CUR	0.9 Amperes
FWD PWR	3W
REF PWR	0.5W

*APPROXIMATE VALUES -- DEPENDENT ON MODULE COMPLEMENT
**DEPENDENT UPON EXCITER FREQUENCY.

2-22. The audio inputs should be checked to ensure correct wiring. Depress the MODULATION switch (2A1A2S1) corresponding to each option purchased with the equipment and check for activity on the MODULATION meter (2A1M2). The monaural audio input may be checked by depressing the MODULATION LEFT or MODULATION RIGHT meter switch and noting activity on the MODULATION meter.

2-23. Set the POWER ON/OFF switch (2A1S1) to OFF.

WARNING: Disconnect primary power prior to servicing.

SECTION III

OPERATION

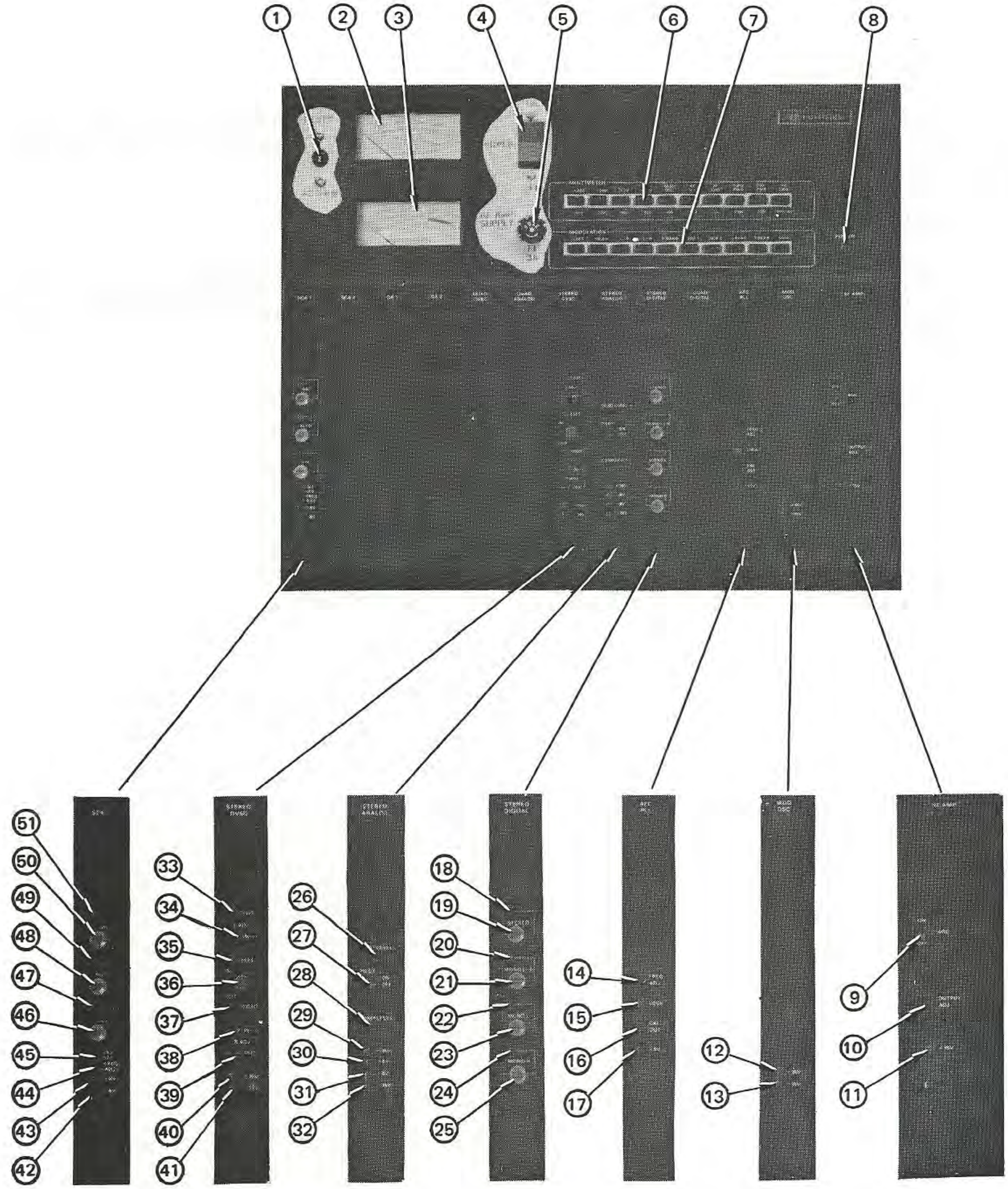
3-1. INTRODUCTION

3-2. This section contains information pertaining to identification, location and function of the controls and indicators of the MX-15 FM EXCITER, setup, and operation procedures.

3-3. CONTROLS AND INDICATORS

3-4. Figure 3-1 shows the location of each control or indicator associated with the MX-15 FM EXCITER and table 3-1 lists each control or indicator with a description of each item listed.

WARNING: Disconnect primary power prior to servicing.



2164-5

Figure 3-1. Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

Table 3-1. Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	AC MAIN RESET circuit breaker (2A1CB1)	Controls primary power and provides overload protection for the exciter power supply.
2	MULTIMETER (2A1M1)	Displays voltage, current or power as selected by the MULTIMETER switch (2A1A1S1).
3	MODULATION meter (2A1M2)	Displays the modulation signals as selected by the MODULATION meter switch (2A1A2S2).
4	POWER ON/OFF switch (2A1S1)	Controls primary power to the exciter power supply.
5	RF AMP SUPPLY fuse (2A1F1)	Provides overload protection for the rf amplifier power supply.
6	MULTIMETER switch (2A1A1S1)	Selects the desired point to monitor exciter voltage, current or power as displayed by the MULTIMETER (2A1M1).
7	MODULATION meter switch (2A1A2S1)	Selects the desired exciter modulation to be monitored on the MODULATION meter (2A1M2).
8	POWER indicator (2A1DS1)	Illuminates to indicate power is applied to the exciter power supply.
	RF AMP MODULE	
9	AGC ON/OFF switch (2A2S1)	Enables the power amplifier automatic output level control.
10	OUTPUT ADJUST control (2A2R13)	Adjusts the power amplifier output level.
11	+15V indicator (2A2CR5)	Illuminates to indicate the RF AMP module +15 volt regulator is operational.

Table 3-1. Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
		MOD OSC MODULE
12	+15V indicator (2A4CR5)	Illuminates to indicate the MOD OSC module +15 volt regulator is operational.
13	-15V indicator (2A4CR6)	Illuminates to indicate the MOD OSC module -15 volt regulator is operational.
		AFC PLL MODULE
14	FREQ ADJ control (2A3R18)	Adjusts the FM carrier frequency.
15	LOCK indicator (2A3CR8)	Illuminates to indicate the exciter is operating within tolerance of the assigned frequency.
16	CAL OUT test point	Provides frequency components at 2.5 MHz, 5.0 MHz, 10.0 MHz, 15.0 MHz, 20.0 MHz, and 25.0 MHz for direct frequency comparisons between the internal frequency standard and broadcast frequency standard such as WWV using a communications receiver.
17	+5V indicator (2A3CR2)	Illuminates to indicate application of the +5 volt supply to the AFC/PLL module.
		STEREO DIGITAL MODULE
18	STEREO indicator (3A2CR6)	Indicates stereo mode of operation is enabled when illuminated.
19	STEREO switch (3A2S4)	Enables stereo mode of operation.

Table 3-1. Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
20	MONO L+R indicator (3A2CR5)	Indicated mono L+R mode of operation is enabled when illuminated.
21	MONO L+R switch (3A2S3)	Enables the mono L+R mode to transmit a mono signal from both stereo channels.
22	MONO L indicator (3A2CR4)	Indicates mono L mode of operation is enabled when illuminated.
23	MONO L switch (3A2S2)	Enables mono L mode to transmit a mono signal from the left stereo channel and mute the right stereo channel.
24	MONO R indicator (3A2CR3)	Indicates the mono R mode of operation is enabled when illuminated.
25	MONO R switch (3A2S1)	Enables the mono R mode to transmit a mono signal from the right stereo channel and mute the left stereo channel.
	STEREO ANALOG MODULE	
26	PILOT LEVEL control (3A1R41)	Adjusts the modulation level of the pilot subcarrier.
27	PILOT ON/OFF switch	Enables or inhibits the pilot subcarrier. For test purposes. Pilot is automatically disabled in any of the three monaural modes.
28	COMP LEVEL control (3A1R27)	Adjusts the composite signal level output from the STEREO ANALOG module.
29	+15V indicator (3A1CR9)	Illuminates to indicate the STEREO ANALOG MODULE +15 volt regulator is operational.
30	+6V indicator (3A1CR10)	Illuminates to indicate the STEREO ANALOG module +6 volt regulator is operational.

WARNING: Disconnect primary power prior to servicing.

Table 3-1. Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
31	-6V indicator (3A1CR11)	Illuminates to indicate the STEREO ANALOG module -6 volt regulator is operational.
32	-15V indicator (3A1CR12)	Illuminates to indicate the STEREO ANALOG module -15 volt regulator is operational.
	STEREO OVSC MODULE	
33	L ADJ OUT control (3A3R87)	Adjusts the left channel output threshold of the STEREO OVSC module.
34	L ADJ IN control (3A3R64)	Adjusts the left channel input threshold of the STEREO OVSC module.
35	LEFT indicator (3A3CR27)	Indicates left channel overshoot control when illuminated.
36	IN/OUT switch (3A3S1)	IN position: Enables operation of the DTR filter. OUT position: Enables the conventional low pass filter.
37	RIGHT indicator (3ACR28)	Indicates right channel overshoot control when illuminated.
38	R ADJ IN control (3A3R10)	Adjusts the right channel input threshold of the STEREO OVSC module.
39	R ADJ OUT control (3A3R33)	Adjusts the right channel output threshold of the STEREO OVSC module.
40	+15V indicator (3A3CR26)	Illuminates to indicate the STEREO OVSC module +15 volt regulator is operational.
41	-15V indicator (3A3CR25)	Illuminates to indicate the STEREO OVSC module -15 volt regulator is operational.

WARNING: Disconnect primary power prior to servicing.

Table 3-1. Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
	SCA 1/SCA 2 MODULE(S)	
42	ON indicator (4A1CR6)	Indicates the presence of SCA subcarrier when illuminated.
43	ON switch (4A1S1)	Enables the SCA carrier.
44	AUTO indicator (4A1CR10)	Indicates the SCA AUTO mode of operation is enabled when illuminated.
45	AUTO switch (4A1S2)	Enables the SCA module automatic muting function.
46	OFF indicator (4A1CR14)	Indicates the SCA channel is muted when illuminated.
47	OFF switch (4A1S3)	Inhibits operation of the SCA channel.
48	INJ LEV control (4A1R16)	Adjusts the injection level of the SCA subcarrier.
49	FREQ ADJ control (4A1R12)	Adjusts the center frequency of the SCA subcarrier.
50	+6V indicator (4A1CR7)	Illuminates to indicate the SCA module +6 volt regulator is operational.
51	-6V indicator (4A1CR8)	Illuminates to indicate the SCA module -6 volt regulator is operational.
	MONO MODULE	
52	-15V indicator (5A1CR6)	Illuminates to indicate the MONO module -15 volt regulator is operational.
53	+15V indicator (5A1CR5)	Illuminates to indicate the MONO module +15 volt regulator is operational.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. AC and DC Metering

DC METERING

MULTIMETER SWITCH POSITION	SIGNAL DISPLAYED
+20V	Pre-regulated +20 volt dc bus to all module power supply regulators.
-20V	Pre-regulated -20 volt dc bus to all module power supply regulators.
+5V	Regulated +5 volt dc supply to TTL circuitry on the AFC/PLL module.
AFC	AFC/PLL module AFC voltage to MOD OSC module.
MOD OSC	MOD OSC module output power.
RF CUR	RF AMP module final amplifier collector current.
FWD PWR	FM exciter output power.
REF PWR	FM exciter reflected power.
AC LINE	AC input to FM exciter.

Table 3-2. AC and DC Metering (Continued)

AC METERING

MODULATION METER SWITCH POSITION	SIGNAL DISPLAYED
LEFT	Pre-emphasized audio input for mono, left channel pre-emphasized audio input for stereo, or left front pre-emphasized audio input for quad transmission.
RIGHT	Pre-emphasized audio input for mono, right channel pre-emphasized audio input for stereo, or right front pre-emphasized audio input for quad transmission.
L+R	Sum of left channel and right channel stereo audio inputs.
L-R	Difference between left channel and right channel stereo audio inputs.
B BAND	Total modulation signal applied to VCO.
SCA 1	SCA channel No. 1 data or pre-emphasized audio input.
SCA 2	SCA channel No. 2 data or pre-emphasized audio input.
L REAR	Left rear pre-emphasized audio input for quad transmission.
R REAR	Right rear pre-emphasized audio input for quad transmission.
OVSC	Overshoot compensation indication.

3-5. OPERATION

3-6. Exciter power on-off is controlled by a single switch accessible from behind the exciter meter panel. As all critical functions in the exciter are stabilized by automatic control circuits and feedback loops, the only adjustments required on a daily basis are the mode controls if the mode of operation must be changed. All mode switching is remoteable from connections on the rear of the exciter.

3-7. MONITORING CAPACITY

3-8. The metering functions are contained within the modular dc and peak reading audio metering circuits. The metering functions are listed in table 3-2.

3-9. MODE SWITCHING

3-10. STEREOPHONIC/MONAURAL SWITCHING. Modes of operation available with the MX-15 FM EXCITER are STEREO, MONO L, MONO R, and MONO L+R which are selected by switches on the STEREO DIGITAL module. Indicators on the module illuminate to indicate the selected mode of operation. MONO L or MONO R allows stations which use stereophonic operation as a standard mode to broadcast in monaural if one audio channel fails during stereophonic operation or if it is desired to broadcast from a separate monaural studio feed. The MONO L+R capability is an exclusive MX-15 feature which allows monaural transmission by both stereophonic channels without changing limiters or studio consoles. Stereophonic programming in the MONO L+R mode is transmitted as monaural by mixing both stereophonic channels.

3-11. SCA SWITCHING

3-12. Either or both of the SCA channels may be operated automatically in the AUTO mode or manually in the ON or OFF modes by switches on each respective SCA module. Indicators on each SCA module illuminate to indicate the selected mode of operation. In the AUTO mode, SCA subcarrier presence is determined by the presence of audio. An adjustable signal threshold from 0 dBm to -30 dBm enables the SCA, and SCA delay time is adjustable from 0.5 to 20 seconds. For manual operation, the SCA ON and SCA OFF switches control the presence of the SCA subcarrier.

3-13. DYNAMIC TRANSIENT RESPONSE FILTER

3-14. The Dynamic Transient Response (DTR) filter is activated by the OVSC module IN/OUT switch when set to the IN position. When the OVSC module IN/-OUT switch is set to the OUT position, filtering is accomplished by a conventional sharp-cutoff low-pass filter which is subject to considerable overshoot. For all programming situations with all types of FM limiters, use of the DTR filter is recommended to eliminate overshoot. This switch is not a normal operating control and is provided to bypass the DTR filter for the following reasons:

WARNING: Disconnect primary power prior to servicing.

a. Allow comparisons between the conventional filter and the DTR filter for exciter setup.

b. Proof of performance measurements. (The DTR filter should be disabled to measure crosstalk. All other measurements may be made with the DTR filter enabled).

c. The DTR filter must be disabled for FM stations which use no peak limiting, or that use a limiter which does not compensate for pre-emphasis characteristics. Thresholds internal to the DTR filter require that the input signal must be peak limited with pre-emphasis protection to prevent audio distortion.

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION

4-2. This section contains principles of operation of the MX-15 FM EXCITER. An overall block diagram and exciter description identifies and describes each modular function and sub-system operation. Additional block diagrams and descriptions are provided in this section for all non-modular components and modules mounted to the mainframe. A detailed description of each plug-in module is provided by each applicable module publication.

4-3. FUNCTIONAL DESCRIPTION

4-4. The electrical functions of the HARRIS MX-15 FM EXCITER can be divided into the following twelve modular sections (see figure 4-1). The description assumes all options have been purchased for use.

4-5. RFI/EMI FILTER (2A1A4)

4-6. The RFI filter ensures electromagnetic compatibility by filtering and bypassing the input and output connections of audio inputs, control lines, status lines, and the ac power input. The SCA auxiliary inputs, the composite signal input, and the exciter rf output lines are shielded coaxial lines and are not routed through the filter.

4-7. Interference by the commercial AM broadcast band to each 600 ohm balanced audio input is rejected by a three pole Butterworth filter (see figure 4-2). The filter RC output section provides loading, padding, and additional rf attenuation through one GHz. The control and status lines are filtered by a low-pass RC filter which prevents external rf interference with the exciter control and status functions. The ac input is RFI filtered by a pi section LC filter. All RFI filter sections provide attenuation between 500 kHz and one GHz. The variable coils in each audio input should be adjusted to obtain the best high frequency crosstalk at 15 kHz.

4-8. POWER SUPPLY (2A1A5)

4-9. Power for each module is provided by individual module monolithic voltage regulators from the power supply pre-regulated ±20 Vdc distribution busses. Additionally, the power supply distributes +34 Vdc to the RF AMP module and positive five volts dc to the logic devices on the AFC/PLL module.

4-10. AC input power is applied through the AC POWER receptacle (J2) and the RFI filter to the AC MAIN RESET circuit breaker and the POWER ON/OFF switch which provide overload protection and power supply control (see figure 4-3). Fan B1 and transformer T1 have dual primary windings which allow operation from either 115 Vac or 230 Vac. The fan and transformer are connected so that the fan will operate whenever primary ac is applied to the power transformer. Connections from the primary of T1 to the dc meter module allow monitoring of the primary ac input voltage.

4-11. POSITIVE FIVE VOLT SUPPLY. Full wave rectifier CR1 provides a positive 13 volt dc potential from one of the secondary windings of transformer T1. This voltage is filtered by capacitor C1 and regulated by monolithic regulator U1 to provide a stable five volt source to operate the logic circuitry on the AFC/PLL module. To ensure adequate heat dissipation, U1 is mounted on the power supply side heat sink assembly in the direct air flow from the fan. Diode CR3 provides reverse current protection for regulator U1 if a fault should occur on the input side of the regulator device.

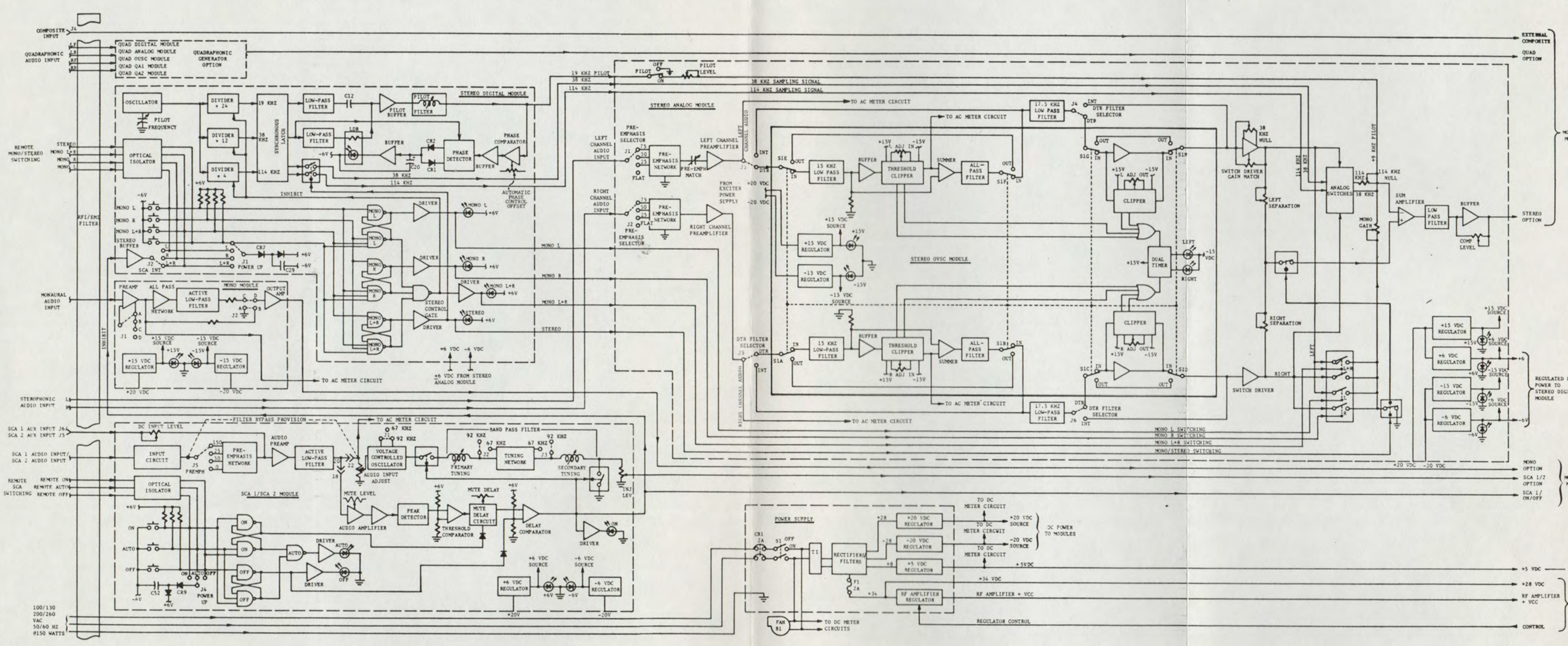
4-12. POSITIVE 34 VOLT SUPPLY. Full wave rectifier CR2 develops a 34 volt dc potential from the second secondary winding of transformer T1. The voltage is filtered by a pi section filter consisting of C2, L1, and C4. Overload protection is provided by the RF AMP SUPPLY fuse (F1). A filtered source of 34 Vdc is applied directly to the RF AMP module to power the internal monolithic +15 volt regulator and an AGC circuit. The output of the RF AMP module AGC circuit is adjusted by the OUTPUT ADJ control (R13) and applied to the base of the power supply +28 Vdc regulator (Q1). Transistor Q1 outputs a positive VCC potential to operate the amplifiers in the RF AMP module. As the RF AMP module OUTPUT ADJ control (R13) is adjusted, the output voltage of transistor Q1 varies which controls the exciter RF output level. Current limiting is provided by circuitry in the RF AMP module which monitors the rf amplifier supply current. Zener diode CR4 provides over voltage protection for the rf output devices. To ensure adequate heat dissipation, Q1 mounts on the power supply rear heatsink assembly in the direct air flow from the fan.

4-13. POSITIVE AND NEGATIVE 20 VOLT SUPPLIES. Positive and negative 34 Vdc is applied to the ±20 Vdc regulator circuits from full wave bridge rectifier CR2. Diodes CR5 and CR6 establish a stable reference to operate the regulators (Q3 and Q4) at the correct positive and negative 20 Vdc output level. Transistors Q5 and Q6 provide foldback current limiting for the regulators by conducting whenever the voltage drop across R4 or R14 reaches a point which causes the respective transistor to turn on. Diodes CR7 and CR8 provide power supply reverse voltage protection for the exciter circuitry. The Darlington output stages (Q3 and Q4) are mounted on the front power supply heatsink assembly in the direct air flow of the fan to ensure adequate cooling. The exciter POWER indicator (2A1DS1) is connected from the negative 20 Vdc supply to ground to indicate power supply operation.

4-14. METERING CIRCUITS

4-15. The metering circuits provide dc, ac, and peak reading audio measurements of selected critical functions. Using built-in metering functions only, peak audio levels may be established without use of external type approved monitors.

4-16. DC METERING CIRCUITS (2A1A1). All inputs are externally connected to each respective circuit for voltage or current measurements as shown in figure 4-4. A ten position pushswitch assembly (S1) selects the specific dc signal to be displayed by the MULTIMETER (M1). All inputs consist of dc



2164-6A

FIGURE 4-1. OVERALL BLOCK DIAGRAM
(SHEET 1 OF 2)

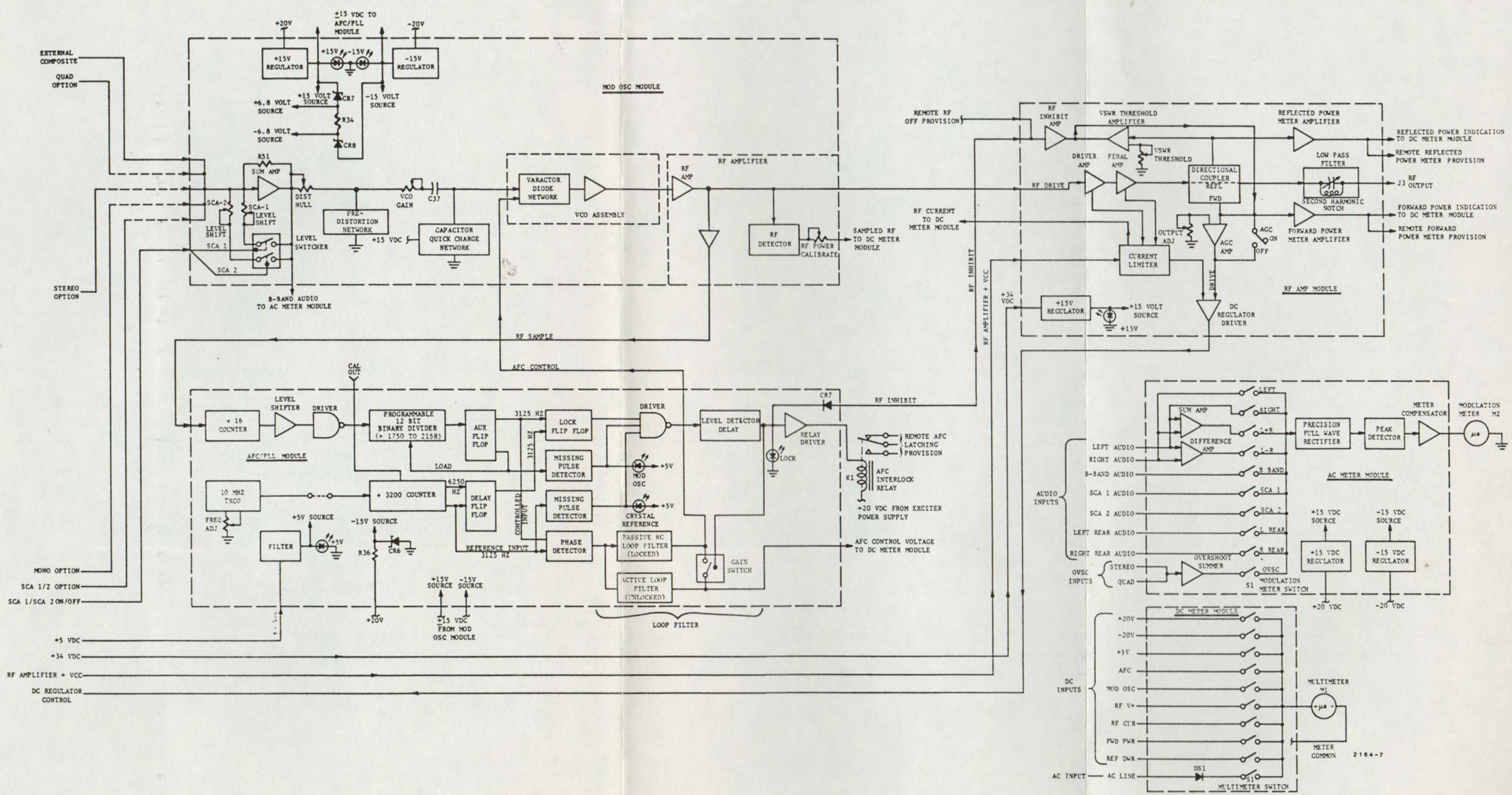


FIGURE 4-1. OVERALL BLOCK DIAGRAM (SHEET 2 OF 2)

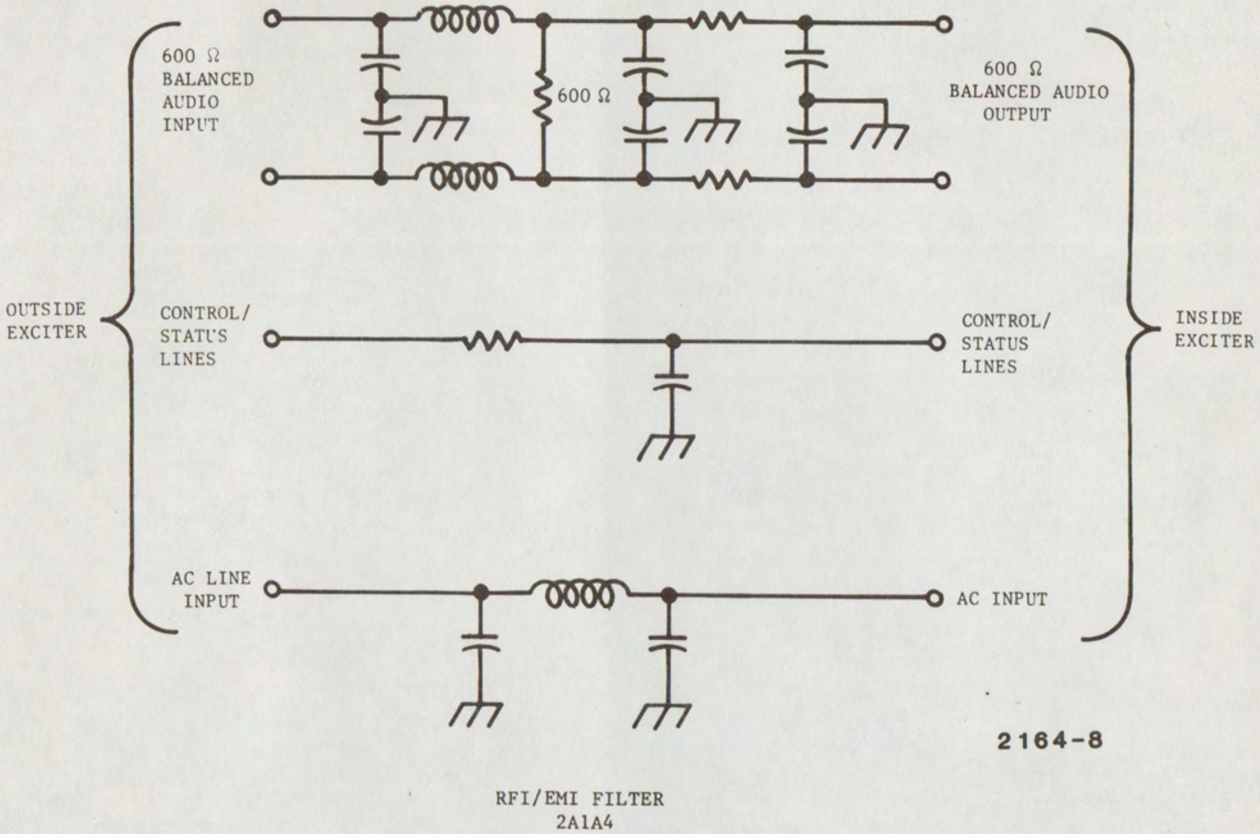


Figure 4-2. RFI Filter Detailed Block Diagram

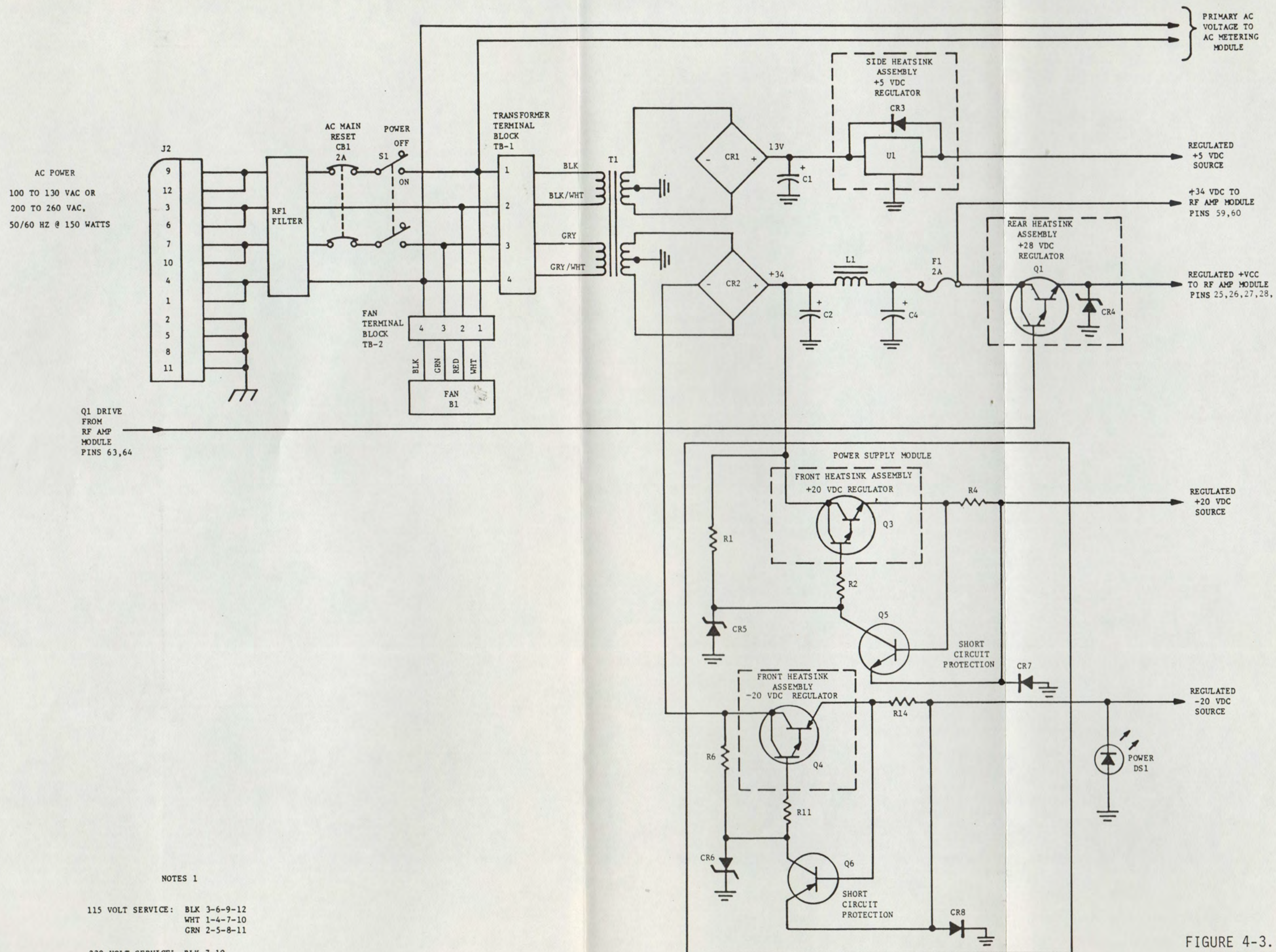


FIGURE 4-3. POWER SUPPLY DETAILED BLOCK DIAGRAM

NOTES 1

115 VOLT SERVICE: BLK 3-6-9-12
WHT 1-4-7-10
GRN 2-5-8-11

230 VOLT SERVICE: BLK 7-10
WHT 3-6
GRN 2-5-8-11
JUMPER 1-9, 4-12

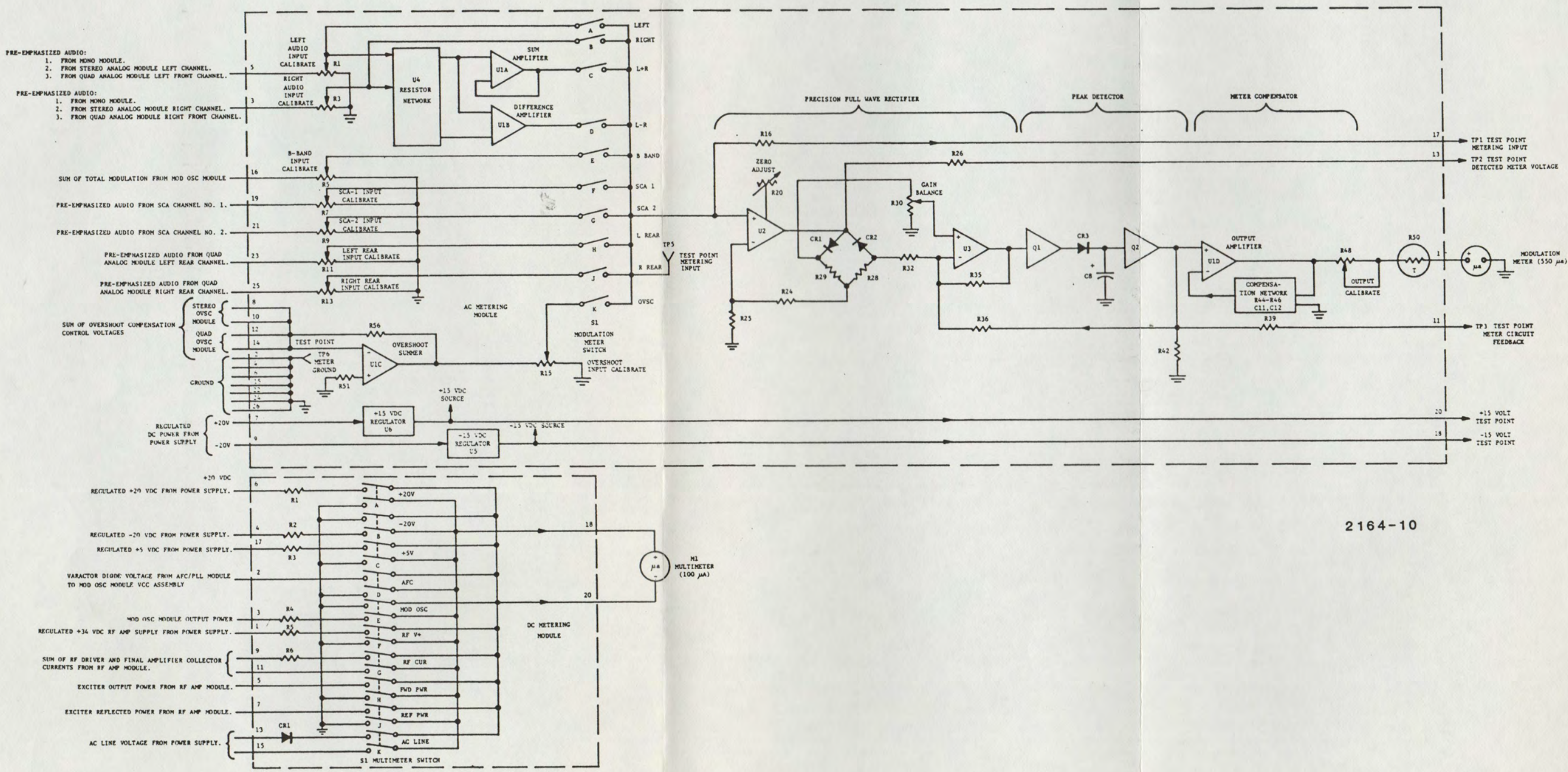


FIGURE 4-4. METERING CIRCUITS
DETAILED BLOCK DIAGRAM

circuits except the ac line voltage from the power supply which is rectified by diode CR1 for application to the meter circuit. A 100 uA meter movement provides high sensitivity and accuracy.

4-17. AC METERING CIRCUITS (2A1A2). All input signals to the ac metering circuits are connected to each respective source as shown in figure 4-4.

4-18. INPUT CIRCUITS. Each input is provided with a potentiometer to calibrate each function. The left front and right front quadraphonic inputs which function as the left channel and right channel inputs are adjusted for level and directed to the MODULATION meter switch (S1) and to the resistor network (U4) which proportions the input signals between the sum amplifier (U1A) and the difference amplifier (U1B). The sum amplifier (U1A) produces the L + R signal and the difference amplifier (U1B) produces the L - R signal. The remaining audio inputs are adjusted for level and applied to the MODULATION meter switch. The OVSC (overshoot compensator) inputs from either the STEREO OVSC or QUAD OVSC module are summed by amplifier U1C, level adjusted, and applied to the MODULATION meter switch.

4-19. SIGNAL PROCESSING. The signal selected by the MODULATION meter switch is applied to a precision full wave rectifier circuit consisting of U2, CR1, CR2, U3, and associated components. As CR1 and CR2 are enclosed in the U2 feedback loop, the forward turn on voltage characteristic of each diode is compensated. The positive going half cycles appear across R28 and the negative going half cycles appear across R29 with no diode thresholds. Control R21 adjusts the offset voltage of U1 to zero. The rectified signal is applied from the anode of CR2 to the inverting input of U3 and from the cathode of CR1 to the noninverting input of U3. Resistor R30 in the inverting input of U3 provides an adjustment to equalize the positive and negative inputs to U3. The signal is peak detected and amplified by a peak detector comprising Q1, CR3, C8, and Q2. Negative dc feedback is obtained from the output of amplifier Q2 and applied to U3. This provides fast and accurate charging of capacitor C8 in response to voltage peaks. The output amplifier (U1D) acts as a meter compensation amplifier to improve the mechanical response characteristics of the meter. Resistor R48 provides a master gain calibration control for the meter and thermistor R50 provides circuit temperature compensation to maintain meter accuracy over the entire range of operating temperatures.

4-20. POWER. Inputs of positive and negative regulated 20 Vdc are re-regulated into positive and negative 15 Vdc sources to operate the ac meter module internal circuitry.

4-21. MOTHER BOARD ASSEMBLY (2A1A3)

4-22. The mother board provides power, signal, and control inputs, interconnections, and outputs for all plug-in modules through strip connectors soldered to the mother board. RF interconnections are provided by 50 ohm micro-strips etched onto the circuit board.

4-23. MONO MODULE (5A1)

4-24. The MONO module accepts an audio input through the RFI filter and provides selectable pre-emphasis and defeatable linear phase low-pass filtering. The resultant signal drives the MOD OSC module.

4-25. INPUT CIRCUIT. A solid state input circuit used in place of a conventional input transformer provides high common mode hum rejection. Pre-emphasis selectable by J1 provides 75 us, 50 us, 25 us, or flat pre-emphasis characteristics. Pre-emphasized monaural audio is applied to the ac meter module and subsequent low-pass filter sections.

4-26. FILTER CIRCUIT. A linear phase low-pass filter comprising an allpass network (phase equalizer) and an eight pole Butterworth low-pass filter are provided following the input preamplifier. The filters can be used to protect the SCA subcarrier and eliminate ultrasonic audio components or the filter may be jumpered out of the circuit with J2 as desired. The all-pass network has a flat frequency response and tailors the phase characteristics so that the algebraic sum of the phase functions of the all-pass network and the low-pass filter will approximate linear phase. The active low-pass filter protects the SCA channels from high frequency interference and the delay compensator minimizes filter overshoot. A unity gain amplifier provides buffering to drive the MOD OSC module.

4-27. POWER. Inputs of positive and negative regulated 20 Vdc are re-regulated to positive and negative 15 Vdc sources to operate the MONO module internal circuitry. Light emitting diodes provide status indications for the positive (+15V) and negative (-15V) power supplies.

4-28. SCA MODULE (4A1)

4-29. The SCA module includes a dual frequency (67 kHz or 92 kHz) FM subcarrier generator. AC and dc coupled inputs allow audio inputs and SSTV or data transmission on the SCA channels without special additional units. Each SCA module includes a seven pole Butterworth active low-pass filter which allows the use of 150 microsecond pre-emphasis without degrading SCA to stereo crosstalk specifications and allows both the 67 kHz and 92 kHz SCA channels to be operated simultaneously without harmonic interference. Variable automatic or manual muting and remote or local mode switching is also provided.

4-30. INPUT CIRCUIT. Two inputs are available for each SCA module. An ac coupled input through the RFI filter is applied through the input circuit to the pre-emphasis selector (J5) which allows selection of 150, 75, 50 microsecond pre-emphasis or flat response. The dc coupled input bypasses the RFI filter and pre-emphasis network and is level adjusted by the DC INPUT LEVEL control. Both audio signals are applied to the audio preamplifier and processed by the low-pass filter. Pre-emphasis audio from the low-pass filter is applied to the ac meter circuit, the audio muting amplifiers, and the voltage controlled oscillator. The filter may be bypassed if desired for special SCA applications.

WARNING: Disconnect primary power prior to servicing.

4-31. FM CIRCUIT. The input signal is level adjusted by the AUDIO INPUT LEVEL control and applied to the voltage controlled oscillator which produces a 67 kHz or 92 kHz frequency modulated rf output as programmed by jumper J1. The FM signal is applied to a doubly tuned band-pass filter in which J2 and J3 determine the filter coupling and center frequency. The INJ LEV control allows adjustment of the module output to the 100 millivolt RMS level required to drive the MOD OSC module. When the SCA is disabled, CMOS switches disconnect the input of the filter and short the filter output to ground.

4-32. MUTE CIRCUIT. Amplification of the low level audio signal from the active low-pass filter to the level required to drive the SCA muting circuit is provided by a two stage high gain amplifier. After amplification, the audio is peak detected and operates a threshold comparator which is referenced to a fixed dc level. As long as the detected peak level of the audio is greater than the comparator dc reference, an output is applied to the mute delay circuit and operates the delay comparator which is also referenced to a fixed dc level. As long as the mute delay circuit outputs a dc level, the delay comparator feeds an SCA ON signal to the MOD OSC module, operates a driver which illuminates the ON indicator, and activates the CMOS control switches. The SCA ON signal from SCA module No. 2 is also applied to the STEREO DIGITAL module to prevent simultaneous 41 kHz SCA (an option that is normally no longer used) and stereophonic operation. The SCA channel is given priority in this situation. For 67 or 92 kHz operation, remove jumper J2 from STEREO DIGITAL board.

4-33. If the audio input level falls below the threshold comparator dc reference or the audio input is interrupted for longer than the time constant for the delay circuit, the delay comparator will inhibit SCA operation and the ON indicator will go out. The SCA threshold is adjusted by the MUTE level control and the SCA delay is adjusted by the MUTE DELAY control.

4-34. MODE SELECTION. Mode selection is performed by two dc flip flops implemented by four cross-coupled NAND gates. The dc flip flops are controlled by levels rather than transitions.

4-35. When mode is selected, either by depressing a mode switch or applying a positive 18 to 24 Vdc potential on the selected remote control input, the respective flip flop will latch and inhibit all other functions. The condition will persist until another mode is selected.

4-36. When the ON mode is selected, a connection from the ON flip flop to the mute delay circuit will inhibit the automatic muting function, illuminate the ON indicator and activate the CMOS switches in the FM circuit. When the OFF function is selected, a connection from the OFF flip flop to the mute delay comparator inhibits SCA operation. In the AUTO mode, both flip flops are reset and the muting delay circuitry will control the module operation. Light emitting diodes provide indications of the ON, AUTO, and OFF modes.

4-37. Power Up Mode Selection. When power is applied, capacitor C52 is initially discharged. Charging current through jumper J4 will produce a LOW condition until the capacitor is charged on the mode selection line selected by the position of J4, initializing the SCA module in the desired mode. Diode CR9 functions as a disconnect diode which allows manual mode switching after capacitor C52 is charged.

4-38. INDICATORS. Light emitting diodes connected to the control gates through drivers illuminate to indicate selection of a specific mode. The ON indicator illuminates to indicate selection of the ON mode and functions as a mute circuit status indicator when the AUTO mode is selected.

4-39. POWER. Inputs of positive and negative regulated 20 Vdc are re-regulated into positive and negative six Vdc sources to operate the SCA generator internal circuitry.

4-40. STEREO DIGITAL MODULE (3A2)

4-41. The STEREO DIGITAL module produces the signals required to generate the digitally synthesized modulated sterephonic signal, generates the phase controlled 19 kHz pilot signal, and provides stereophonic/monaural mode switching.

4-42. SAMPLING SIGNALS. All frequencies used in the STEREO DIGITAL module are derived from a 456 kHz crystal oscillator. The PILOT FREQUENCY control provides an oscillator frequency adjustment. Synchronous dividers divide the oscillator signal by 24, 12, and 4 to respectively produce the 19 kHz pilot signal and the 38 kHz and 114 kHz sampling signals. The correct phase relationship of each signal is ensured by a synchronous latch. The 38 kHz and 114 kHz signals are output from the module through a CMOS switch which is closed by the stereo-on signal from the module control circuitry.

4-43. PILOT SIGNAL. The 19 kHz pilot frequency is differentially applied to two low-pass filters. Outputs are obtained across capacitor C12 and light dependent resistor. The sum of the two voltages produces a constant voltage at the input to the pilot buffer amplifier with the pilot signal phase shift controlled by the resistance of the light dependent resistor. The pilot frequency is buffered and applied to a second low-pass filter to ensure that the pilot frequency output will be pure sinewave. The center frequency of the second low-pass filter is adjusted by the PILOT FILTER control.

4-44. Pilot Phase Control. The pilot frequency output is sampled by a phase comparator in which the dc offset is adjusted by the AUTOMATIC PHASE CONTROL OFFSET adjustment. The phase comparator senses zero voltage crossings of the pilot signal and generates a square wave with the same phase. The signal is amplified and applied to a phase detector. As long as the phase of the generated square wave and the reference obtained from the synchronous latch remains the same, neither CR1 or CR2 will conduct. If the phase of the pilot lags the reference, CR2 will conduct and charge C20. If the pilot leads the reference, CR1 will conduct. The charge on C20 is buffered by an amplifier which drives the light dependent resistor and produces a phase shift at the input to the pilot buffer amplifier. Pulses from CR1 or CR2 will continue to charge C20 and operate the light dependent resistor until the pilot phase is corrected.

4-45. CONTROL CIRCUITS. Stereophonic and monaural switching is controlled by three dc flip flops implemented by six cross coupled NAND gates. The flip flops are controlled by levels rather than transitions. When a monaural or stereophonic mode is selected, either by depressing a mode switch or by applying a positive 18 to 24 Vdc potential on the selected remote control input, the respective flip flop latches and resets all other functions. Mode selection for the STEREO ANALOG module is provided by the STEREO DIGITAL module control circuits.

4-46. If the MONO L switch is depressed, the Mono L flip flop will set and reset the remaining flip flops. The remaining flip flops are controlled in a similar manner and remain reset until another mode is selected. The output of each flip flop is applied to the stereo control gate which outputs a LOW condition that inhibits output of the stereo sampling signals to the STEREO ANALOG module and halts the synchronous divider. When the STEREO switch is depressed all the gates are reset and the inhibit from the stereo control gate is removed. This enables stereophonic operation and stereo sampling signals are output to the STEREO ANALOG module. Individual logic levels output from the STEREO DIGITAL module provide automatic mono/stereo mode switching for the STEREO ANALOG module circuitry.

4-47. SCA-2 Interlock. Operation of 41 kHz SCA during stereophonic programming is not desired as interaction between the stereophonic signal and the 41 kHz SCA channel will produce mutual interference. 41 kHz SCA operation is normally no longer used but this option has been maintained so that if operation of the SCA-2 module on 41 kHz is attempted during stereophonic programming, a positive six volt dc potential from the SCA-2 module applied to the SCA INTERLOCK (J2) circuit of the STEREO DIGITAL module will cause the stereo generator to default to the monaural mode programmed by J2 (for 67 or 92 kHz operation of SCA-2, remove jumper J2 from board). In 41 kHz operation, operation of the module mode selection circuit is inhibited until SCA-2 is switched off. Then the STEREO DIGITAL module may be manually switched to the desired monaural or stereo mode.

4-48. Power Up Mode Selection. When power is applied, capacitor C29 is initially discharged. Charging current through jumper J1 will produce a LOW condition until the capacitor is charged on the mode selection line selected by the position of J1, initializing the SCA module in the desired mode. Diode CR7 functions as a disconnect diode which allows manual mode switching after capacitor C29 is charged.

4-49. INDICATORS. Light emitting diodes connected to the control gates through drivers illuminate to indicate the mode of operation.

4-50. POWER. Inputs of positive and negative six Vdc from regulators in the STEREO ANALOG module function as voltage sources to operate the STEREO DIGITAL module internal circuitry.

4-51. STEREO ANALOG MODULE (3A1)

4-52. The STEREO ANALOG module accepts the stereophonic audio inputs and generates the stereophonic composite signal with switching and pilot signals input from the stereo digital module. Solid state circuits used in place of conventional input transformers provide high common mode hum rejection and selectable pre-emphasis. Dynamic transient response (DTR) low-pass filtering is accomplished by the STEREO OVSC module and the two conventional 17.5 kHz audio low-pass filters in the STEREO ANALOG module. The digitally syn- thesized modulation sampling circuits and the composite filters are also included within the module.

4-53. INPUT CIRCUIT. The two stereo audio signals are input through the RFI filter to individual preamplifiers. A solid state input circuit used in place of conventional input transformer provides high common mode hum rejection. Pre-emphasis of 75 us, 50 us, 25 us, or flat response is selectable by J1 for left channel and by J2 for the right channel. The PRE-EMPH MATCH control in the input to the left channel preamplifier allows adjustment of the left channel pre-emphasis circuit to match the right channel pre-emphasis characteristics for stereo crosstalk adjustments.

4-54. FILTER CIRCUIT. Normally the STEREO ANALOG module will be used with a STEREO OVSC module in which the STEREO ANALOG module filters are used as part of the DTR filtering process. However, the STEREO ANALOG module includes its own audio low-pass filters and can function without the STEREO OVSC module if desired. The pre-emphasized audio from the input preamplifiers is applied to the ac meter circuit and the DTR filter selectors (J3 and J4 for the right channel and J5 and J6 for the left channel). The DTR filter selectors select the OVSC MODULE DTR filter circuitry or allow use of the STEREO ANALOG module 17.5 kHz low-pass filters as desired.

4-55. The pre-emphasized and filtered audio is next applied to the switch driver in each channel. The gain of the left channel driver is adjustable with the GAIN MATCH control. The 38 KHZ NULL control minimizes amplifier dc offset between the left and right channel switch drivers. The LEFT SEPARATION and RIGHT SEPARATION controls allow adjustment to obtain maximum channel separation.

4-56. OUTPUT CIRCUIT. The output of the switch drivers is applied to the analog switches. The 114 kHz and 38 kHz signals from the STEREO DIGITAL module controls the analog switches which generate the DSM sampling function. The 114 KHZ NULL control adjusts the 114 kHz switch output to cancel the third harmonic component of the 38 kHz switch (114 kHz). The 19 kHz pilot signal from the STEREO DIGITAL module is controlled by the PILOT ON/-OFF switch and level adjusted by the PILOT LEVEL control. The DSM sampling signal and the pilot signal are applied to the inverting input of the sum amplifier. A portion of the L + R signal obtained from the separation controls is applied to the non-inverting input of the sum amplifier which in turn drives the composite low-pass filter to eliminate the fifth harmonic and higher ordered harmonics of the 38 kHz signal. The output buffer provides signal amplification and isolation. The COMP LEVEL control adjusts the composite signal level output to suit the input requirements of the MOD OSC module.

4-57. In monaural operation the sampling signals and the pilot signal are inhibited. The mode switching arrangement selects the desired monaural signal. The monaural level is adjusted by the MONO GAIN control.

WARNING: Disconnect primary power prior to servicing.

4-58. MODE SWITCHING. Mode switching is accomplished by CMOS dc flip flops controlled by discrete individual inputs for stereo, mono left, mono right, and mono left plus right.

4-59. Stereophonic Operation. If stereophonic operation is selected, a positive six volt dc level output from the STEREO DIGITAL module closes two CMOS switches between the separation controls which applies a portion of the L + R signal required for stereo operation to the non-inverting input of the sum amplifier. A second CMOS switch pair inhibits monaural operation by grounding the monaural audio line. The 114 kHz and 38 kHz sampling signals and the pilot signal are enabled in the STEREO DIGITAL module.

4-60. Monaural Operation. If a monaural mode is selected, a LOW placed on the stereo line will open the stereo sampling switches. A HIGH output from the STEREO DIGITAL module on the selected monaural mode line will close the appropriate CMOS switch and connect the selected audio source to the sum amplifier input through the MONO GAIN control. The 114 kHz and 38 kHz sampling signals and the pilot signal are automatically inhibited by control circuitry in the STEREO DIGITAL module which prevents stereo sampling.

4-61. POWER. Inputs of positive and negative regulated 20 Vdc are re-regulated into positive and negative fifteen and six Vdc sources to operate the STEREO ANALOG module internal circuitry. Positive and negative six Vdc is applied to the STEREO DIGITAL module internal circuitry. The STEREO DIGITAL module CMOS logic operates between the positive and negative six Vdc potentials and is not referenced to common ground. The +15V, -15V, +6V, -6V light emitting diodes indicate operation of each power supply.

4-62. STEREO OVSC MODULE

4-63. The STEREO OVSC (overshoot compensator) module provides 15 kHz low-pass filtering of the left and right channel audio signals to prevent interference with the 19 kHz pilot signal and eliminates interference between the L + R and L - R signals. A special filtering process limits overshoot to a maximum of two percent to prevent overmodulation. This minimum overshoot allows high levels of modulation to be maintained without degrading signal quality. Indicators on the module front panel and outputs to the ac meter module aid in level setup and provide overshoot limiting indications during operation.

4-64. Normally the STEREO ANALOG module will be used with a STEREO OVSC module in which the STEREO ANALOG module filters are used as part of the DTR filtering process. However, the STEREO ANALOG module includes its own audio low-pass filters and can function without the STEREO OVSC module. The IN/-OUT switch (S1) is provided on the STEREO OVSC module to bypass the overshoot control circuitry and provide conventional low-pass filtering if desired.

4-65. INPUT THRESHOLD. Transformerless input amplifiers on the STEREO ANALOG module drive a dual 15 kHz low-pass filter on the STEREO OVSC module. The low-pass filter output is amplified by a buffer and applied to a threshold clipper which contains an active programmable zener diode. The active zener voltage is adjusted by the L ADJ IN or R ADJ IN controls to the peak voltage level corresponding to 100% modulation. The threshold clipper passes only peaks exceeding 100% modulation (overshoots). The sum amplifier subtracts from the 15 kHz low-pass filter output. The sum is applied to an all-pass filter phase equalizer which is flat in frequency response but produces a phase shift dependent upon frequency.

4-66. OUTPUT THRESHOLD. The output of the all-pass filter is looped out of the STEREO OVSC module, through the STEREO ANALOG module 17.5 kHz low-pass filter, and back to the STEREO OVSC module. The all-pass filter phase characteristic is added to the 17.5 kHz low-pass filter phase characteristic to yield linear phase. The filtered audio drives a clipper circuit containing an active programmable zener diode which is adjusted by the L ADJ OUT and R ADJ OUT controls to pass audio levels corresponding to less than 100% modulation only. The overshoot compensated audio is then output to the STEREO ANALOG module.

4-67. INDICATORS. Outputs from the left and right clipper circuits are applied to wired OR comparators. Whenever an overshoot limiting condition exists, an output from the respective OR circuit will drive half of the dual timer used as a one shot to illuminate the LEFT and RIGHT indicators.

4-68. POWER. Inputs of positive and negative regulated 20 Vdc are re-regulated into positive and negative fifteen volt dc sources to operate the STEREO OVSC module internal circuitry.

4-69. AFC/PLL MODULE

4-70. The AFC/PLL module provides phase locked control of and 50 kHz channel frequency between 87.5 MHz and 108 MHz. All FM channels are synthesized from a stable 10 MHz temperature compensated crystal oscillator (TCXO). As the frequency reference is established at 10.0 MHz, the station frequency may be compared directly with a broadcast frequency standard such as WWV using a communications receiver and the front panel CAL OUT test point. Channel spacing is field programmable in 50 kHz increments to accommodate any domestic or international channel assignment. The AFC/PLL module interfaces with the MOD OSC module for accurate frequency control.

4-71. INTERNAL REFERENCE. A frequency reference is provided by a 10.0 MHz temperature compensated crystal oscillator (TCXO). The unit comprises a sealed modular oscillator with a matched compensation network to ensure accuracy throughout a wide range of ambient temperatures. The TCXO frequency is adjusted by the FREQ ADJ control. A wire jumper allows substitution and isolation of the TCXO for troubleshooting purposes.

4-72. The TCXO drives a divide by 3200 counter. Frequency multiples of 2.5 MHz up to 25.0 MHz are available at the CAL OUT front panel jack to assist in calibration. The divider outputs two 3125 Hz square waves in quadrature. The leading signal is used as a reference for the phase detector and the crystal reference missing pulse detector. The 90° lagging signal is used by the lock detector flip-flop to determine when the carrier is correctly locked on frequency.

4-73. RF FREQUENCY DIVIDERS. An on-frequency rf output from the MOD OSC module is input to the divide by 16 counter which divides the input frequency down to the 6 MHz range. A level shifter couples the emitter-coupled-logic (ECL) signal to transistor-transistor logic (TTL) levels.

4-74. Programmable Divider. A 12 bit programmable binary divider provides division of the 6 MHz signal to 3125 Hz. The counter is programmable with wire jumpers to the flip-flop data inputs to divide the input by a programmable factor between 1750 and 2158. The counter is originally set to the programmed number. When the counter fills to all ONES, a pulse is output to the auxiliary flip-flop. On the next clock pulse, an output from the auxiliary flip-flop resets the counter to the number entered at the data inputs by the wire program jumpers. The counter begins its count again with the succeeding clock pulse.

4-75. LOCK CIRCUIT. Three requirements must be met before the lock detector will recognize a frequency locked condition. The programmable divider chain must be producing a signal, the reference divider chain must be producing a signal, and the two chains must have less the 90° phase difference. After these three conditions are achieved for five seconds, the lock circuit will indicate a locked condition exists.

4-76. Lock Detector. The 90° delay pulse from the delay flip-flop (reference) is input to the lock flip-flop D input and the output of the auxiliary flip-flop (programmable divider) operates as the lock flip-flop clock. As long as the leading 3125 Hz reference and the programmable divider negative transitions are separated $0^\circ \pm 90^\circ$ in phase, the output of the lock flip-flop remains HIGH. If the loop becomes unlocked, the signal from the programmable divider will drift in phase with respect to the reference. If the clock occurs when the delayed 3125 Hz signal is LOW, the lock flip-flop will output a LOW state and signal a frequency unlocked condition.

4-77. Missing Pulse Detectors. A dual retriggerable one-shot used as the missing pulse detectors watches the programmable divider reset line and the crystal reference divider. As long as pulses are present at the inputs to the detectors, the one-shots will remain HIGH. If missing pulses occur in either source, the respective one-shot will not be retriggered and output a LOW condition to signal a frequency unlocked condition. The MOD OSC and the CRYSTAL REFERENCE indicators provide visual indications of the status of the two divider chains.

4-78. Output Circuit. The outputs of the lock flip-flop and the missing pulse detectors are applied to a NAND gate. If all the inputs are present at the NAND gate, the output of the level detector/delay circuit will illuminate the LOCK indicators to signify a frequency locked condition. The output also operates the AFC interlock relay (K1) which provides remote AFC latching. Any missing input to the NAND gate will be detected by the level detector/delay circuit. If a frequency unlocked condition is detected, the level detector delay circuit immediately outputs an inhibit signal which turns off the LOCK indicator, deenergizes the AGC interlock relay, and provides a signal to the RF AMP module which inhibits the exciter rf output.

4-79. PHASE LOCKED LOOP. The phase detector is a flip-flop type with a three state output. If both reference and controlled inputs have zero phase difference, the output is high impedance (open circuit). If the controlled input lags in phase, the phase detector will output zero-volt pulses with the pulse width proportional to the lagging phase angle. If the controlled input leads in phase, the phase detector will generate positive 15 volt pulses with the pulse width proportional to the leading phase angle. The pulses are filtered and applied to the dc meter module and the MOD OSC module VCO assembly varactor diodes which control the exciter rf frequency. A positive voltage to the MOD OSC module will increase the frequency and a negative voltage to the MOD OSC module will decrease the frequency. The phase locked loop is closed by the connection from the MOD OSC module output to the AFC/PLL module divide by 16 counter input.

4-80. Bistable Loop. The phase locked loop used in the module has bistable characteristics which reduce lock-up time to a minimum. When the loop is out of lock, a CMOS switch arrangement operated by the lock detector enables a high rate of correction. When the lock detector senses a locked condition the loop correction characteristic is slowed for optimum transmission of low frequencies.

4-81. POWER. An input of positive five volts dc from the exciter power supply is internally filtered to operate the logic circuitry. The +5V indicator provides an indication of the operation of the five volt source. An additional input of +20 Vdc applied through R36 is stabilized by zener diode CR6 to +15 Vdc. Re-regulated ±15 Vdc inputs from the MOD OSC module provide ±15 Vdc potentials to operate the AFC/PLL module loop filter circuitry.

4-82. MOD OSC MODULE (2A4)

4-83. The MOD OSC module contains the voltage controlled oscillator (VCO) assembly which generates the frequency modulated rf carrier from a composite signal input. The rf output frequency is controlled by a dc control voltage obtained from the AFC/PLL module as part of the phase locked loop. The module also provides automatic level switching for different combinations of SCA, stereophonic, and monaural operation.

4-84. INPUT CIRCUIT. The dc coupled quadraphonic, stereophonic, or monaural composite signals and the ac coupled SCA and external composite signals are input to the module and combined in the summing amplifier to obtain a total modulation signal. Whenever an SCA module is enabled, a corresponding CMOS switch is closed by a positive six volt potential on the appropriate control line from the specific SCA module. The CMOS switches shunt the feedback resistor (R23) with additional resistance to reduce the gain of the amplifier. The gain reduction is adjusted to the injection level of the particular SCA signal to maintain 100% total modulation for all combinations of SCA, stereophonic, or monaural modes.

4-85. PREDISTORTION NETWORK. The modulating signal from the composite amplifier is applied to a diode-resistor predistortion network. The total modulation signal is slightly stretched in the positive direction and slightly compressed in the negative direction. This effect is required to cancel the slightly nonlinear characteristics of the VCO assembly. The amount of predistortion is adjusted by the DIST. NULL control.

4-86. VCO ASSEMBLY (2A4A1). The voltage controlled oscillator comprises a varactor diode tuned oscillator using field effect devices in a shielded subassembly. The unit accepts inputs of predistorted total modulation and an AFC signal from the AFC/PLL module and generates an FM signal on the operating frequency.

4-87. Modulation Input. Predistorted total modulation is applied to the VCO GAIN control which compensates for VCO modulation sensitivity variations and is coupled through capacitor C1 in the VCO subassembly. As the time constant of capacitor C1 is many times the AFC/PLL module lockup time, the capacitor must be quickly charged to ensure a stable locked condition. When power is first applied, C1 is quickly charged to a potential very close to the steady state value by a fast charge circuit. The circuit then decouples itself from the modulation circuit and presents a high impedance input to the varactor diode network.

4-88. AFC Input. The frequency output of the VCO is determined by the AFC voltage to the VCO assembly from the AFC/PLL. If the VCO frequency is lower than the internal reference in the AFC/PLL module, a positive going potential is input to the VCO assembly to increase the output frequency. If the VCO frequency is higher than the internal reference in the AFC/PLL module, a negative going potential is input to the VCO assembly to decrease the output frequency. A steady dc potential on the correction line indicates the VCO frequency and the frequency of the internal reference agree.

4-89. Output Circuit. A frequency modulated rf carrier is output from the oscillator stage, buffered, and applied to rf amplifier hybrid U7.

4-90. OUTPUT. Two rf outputs from the module are provided. One output drives the RF AMP module input circuitry. The remaining output provided by isolation amplifier Q2 drives the AFC/PLL modules divide by 16 counter. An rf detector circuit samples the rf drive voltage to provide an indication of the rf output level. The RF POWER CALIBRATE control provides an adjustment to calibrate the meter indication.

4-91. POWER. Inputs of positive and negative regulated 20 Vdc are re-regulated into ±15 Vdc sources to operate the MOD OSC module and the AFC/PLL module internal circuitry. Light emitting diodes provide a status indication of the operation of the positive (+15V) and negative (-15V) fifteen volt power supplies. Additionally, positive and negative 6 Vdc sources are produced from a series circuit consisting of R7, R34, and R8 from the ±15 volt potentials to operate the CMOS level switching circuits.

WARNING: Disconnect primary power prior to servicing.

4-92. RF AMP MODULE

4-93. The RF AMP module comprises two class C stages which accept an rf input from the MOD OSC module and provide a continuously variable three to fifteen watt rf output. An internal AGC circuit ensures a stable rf output level. Automatic VSWR shutdown, off frequency inhibit provisions, and power supply current limiting provide automatic module operation.

4-94. RF CIRCUIT. Drive is input to the rf amplifier from the MOD OSC module at a level of 250 milliwatts. The rf amplifier provides approximately 20 dB of gain to output a continuously adjustable level from three to fifteen watts. Amplifier tuning is not required as wideband impedance matching is used through the amplifier circuits. The rf is output along a microstrip through a directional coupler and low-pass filter implemented with microstrip techniques. The low-pass filter is tuned by the SECOND HARMONIC NOTCH adjustment to reduce rf harmonics to a minimum level. The rf carrier is output from J3 on the rear of the exciter at an impedance of 50 ohms.

4-95. DIRECTIONAL COUPLER. The rf power amplifier includes a directional coupler produced in printed circuit form using microstrip techniques which samples the forward and reflected power. The power is detected and coupled to the metering circuits. The forward and reflected power indications may be remotely monitored from connections on the rear of the exciter.

4-96. AMPLIFIER INHIBIT. The directional coupler reflected power output is monitored by an adjustable threshold device. Whenever the reflected power exceeds a preset level, the rf amplifier output is limited to prevent overdissipation of the rf amplifier devices. If a frequency unlock condition exists between the AFC/PLL module and the MOD OSC module, an input from the AFC/PLL module will inhibit the rf output until the frequency is again within tolerance. The rf shutdown provision is remoteable from connections on the rear of the exciter.

4-97. RF AMPLIFIER AGC. The directional coupler forward power output applies a dc voltage proportional to forward power output to the AGC amplifier inverting input. The AGC reference applied to the non-inverting input is adjusted by the OUTPUT ADJ control. As the rf output power increases or decreases, the AGC amplifier output to the dc regulator will decrease or increase proportionally. The dc regulator compares the drive from the AGC amplifier with a sample of the rf amplifier collector voltage and drives the transistor in the exciter power supply which in turn lowers or raises the voltage to the rf amplifier. A current limiting stage samples rf amplifier current and initiates limiting at two amperes of supply current. The automatic level control is disabled by the AGC ON/OFF switch which allows manual carrier level control.

4-98. POWER. Filtered positive 34 Vdc obtained from the exciter power supply is regulated into a positive 15 Vdc source to operate the RF AMP module internal circuitry. The +15V indicator provides a status indication of the internal power supply.

SECTION V

MAINTENANCE

5-1. INTRODUCTION

5-2. This section provides preventive maintenance checks, cleaning, corrective maintenance and troubleshooting information.

5-3. PURPOSE

5-4. The information contained in this section is intended to provide guidance to establish a comprehensive maintenance program to promote operational readiness and eliminate downtime. Particular emphasis is placed on preventive maintenance and record keeping functions.

5-5. STATION RECORDS

5-6. The importance of keeping station performance records cannot be overemphasized. Separate logbooks should be maintained by operation and maintenance activities. These records can provide data for predicting potential problem areas and analyzing equipment malfunctions.

5-7. TRANSMITTER LOGBOOK

5-8. As a minimum performance characteristic, the exciter should be monitored (using front panel indicators) and results recorded in the transmitter logbook at each shift change or at least once per day.

5-9. MAINTENANCE LOGBOOK

5-10. The maintenance logbook should contain a complete description of all maintenance activities required to keep the exciter operational. A list of maintenance information to be recorded and analyzed to provide a data base for a failure reporting system is as follows:

DISCREPANCY	Describe the nature of the malfunction. Include all observable symptoms and performance characteristics.
CORRECTIVE ACTION	Describe the repair procedure used to correct the malfunction.
DEFECTIVE PART(S)	List all parts and components replaced or repaired. Include the following details: a. COMPONENT TIME IN USE b. COMPONENT PART NUMBER c. COMPONENT MAJOR ASSEMBLY d. COMPONENT REFERENCE DESIGNATOR

WARNING: Disconnect primary power prior to servicing.

SYSTEM ELAPSED TIME	Total exciter time on.
NAME OF REPAIRMAN	Person who actually made the repair.
STATION ENGINEER	Indicates chief engineer noted and approved the repair.

5-11. SAFETY PRECAUTIONS

5-12. The exciter design provides safety features which ensure that no potentials are accessible to operational personnel from the front panel with the access door closed. Additionally, no high voltage points are readily accessible to personnel unless the exciter case is disassembled. Low voltages are used throughout the module circuitry, however maintenance with power energized is always hazardous and caution should be observed. This is particularly true of the rf amplifier module where high rf potentials exist at high impedance points. It is possible to receive painful but usually not injurious rf burns from the 15 watt output stage. Component or module replacement with power on is not recommended.

5-13. PREVENTIVE MAINTENANCE

5-14. Preventive maintenance is a systematic series of operations performed periodically on equipment. As these procedures cannot be applied indiscriminately, specific instructions are necessary.

a. Visual inspection is the most important preventive maintenance operation because it determines the necessity for the others. Become thoroughly acquainted with normal operating conditions in order to recognize and identify abnormal conditions readily. The remedy for most visible defects is obvious, however care must be taken if heat damaged components are located. Overheating is usually a symptom of trouble. It is essential to determine the actual cause of overheating before the heat damaged component is replaced, otherwise the damage will be repeated.

b. Check parts for overheating, especially mechanical parts such as the fan. The lack of proper ventilation or the existence of some defect can be detected and corrected before serious trouble occurs. Become familiar with operating temperatures in order to recognize deviations from normal temperature.

c. Tighten loose hardware. Do not tighten indiscriminately as fittings may be damaged or broken when they are tightened beyond the pressure for which they are designed.

d. Clean parts when inspection shows that cleaning is required.

e. Make adjustments when inspection shows that adjustments are necessary to maintain normal operation.

f. Lubricate mechanical surfaces to prevent wear and to keep the equipment operating normally. Do not over lubricate.

g. Paint surfaces with the original type of paint (use prime coat if necessary) when inspection shows worn or broken paint film.

5-15. FAN MAINTENANCE

5-16. Inspect the fan and equipment for dust accumulation monthly. Remove dust with a vacuum cleaner and brush. Check the fan for wear. The fan bearings are sealed and fans which are noisy or show wear require replacement of the fan.

5-17. MAINTENANCE OF COMPONENTS

5-18. The following paragraphs provide information for component maintenance.

5-19. SEMICONDUCTORS. The best check of semiconductor performance is actual circuit operation. When semiconductors are replaced, the operation of associated circuits may be affected and should be checked. Replacement semiconductors should be of the original type or a recommended direct replacement. Preventive maintenance of semiconductors is accomplished by performing the following steps:

a. Inspect the semiconductors and surrounding area for accumulations of dirt or dust.

b. Use compressed dry air and a brush to remove dust from the area.

c. Examine all semiconductors for loose connections or corrosion.

5-20. CAPACITORS. Preventive maintenance of capacitors is accomplished as follows:

a. Examine all capacitor terminals for loose connections or corrosion.

b. Ensure that component mountings are tight.

c. Examine the body of each capacitor for swelling, discoloration or other evidence of breakdown.

d. Inspect electrolytic capacitors for signs of leakage.

e. Use compressed dry air and a brush to remove dust from the area.

5-21. FIXED RESISTORS. Preventive maintenance of fixed resistors is accomplished by the following steps:

a. Examine resistors for dirt or signs of overheating. Discolored, cracked or chipped components indicate a possible overload.

b. When replacing a resistor ensure the replacement value corresponds to the original component.

c. Use compressed air and a brush to remove dust from the area.

5-22. VARIABLE RESISTORS. Preventive maintenance of variable resistors follows:

a. Inspect and tighten all loose mountings and connections.

b. If necessary, clean components with a brush and dry compressed air.

5-23. TRANSFORMERS. Preventive maintenance of transformers is accomplished by performing the following:

a. Feel each transformer soon after power removal for signs of overheating.

b. Inspect each transformer for dirt, loose mounting brackets and rivets, loose terminal connections and insecure connecting lugs. Dust, dirt or moisture between terminals may cause flashovers.

c. Tighten loose mounting lugs, terminals or rivets.

d. Use compressed air and a brush to remove dirt from the area.

5-24. FUSES. Preventive maintenance of fuses is accomplished by the following:

a. When a fuse blows determine the cause before installing a replacement.

b. Inspect fuse caps and mounts for charring and corrosion.

c. Examine fuse clips for dirt, improper tension, and loose connections.

d. Dust with a small brush if cleaning is required.

5-25. METERS. Preventive maintenance of meters is accomplished as follows:

a. Inspect meters for loose, dirty or corroded mountings and connections.

b. Check for defective cases and cover glasses.

c. Tighten loose mountings or connections. Since meter cases are made of plastic, exercise care to prevent breakage.

d. Clean meter cases and glass cover with a dry cloth.

e. Remove dirt from mountings and connections with a brush if required.

5-26. RELAYS. Replace hermetically sealed relays if defective. Non-hermetically sealed relays are considered normal if:

a. The relay is mounted securely.

b. Connecting leads are not frayed and the insulation is not damaged.

c. Terminal connections are tight and clean.

d. Moving parts travel freely.

e. Spring tension is correct.

f. Contacts are clean, adjusted properly, and make good contact.

g. The coil shows no signs of overheating.

h. The assembly parts are clean and not corroded.

5-27. SWITCHES. Preventive maintenance of switches is accomplished by checking the following:

a. Inspect switches for defective mechanical action or looseness of mounting and connections.

b. Examine cases for chips or cracks.

c. Operate the switches to determine if each moves freely and is positive in action. In gang and wafer switches, the wiper should make good contact with the stationary member.

d. Tighten all loose connections and mountings.

e. Clean any dirty connection or switch with dry compressed air and a brush as required.

5-28. PRINTED CIRCUIT BOARDS. Preventive maintenance of printed circuit boards is accomplished by checking the following:

a. Inspect the printed circuit boards for cracks or breaks.

b. Inspect the wiring for open circuits or raised foil.

c. Check components for breakage or discoloration due to overheating.

d. Clean off dust and dirt with dry compressed air and a brush as required.

e. Use standard practices to repair solder connections with a low wattage soldering iron.

5-29. CORRECTIVE MAINTENANCE

5-30. The maintenance philosophy of the MX-15 FM EXCITER consists of problem isolation to a specific area or replaceable module and subsequent isolation and replacement of the defective component or module. Further troubleshooting in each applicable module publication provides isolation to specific components.

5-31. Corrective maintenance for the transmitter is limited by the objective of minimum down time. Maintainability and care are considerably simplified for operation and maintenance personnel as the MX-15 FM EXCITER is designed and built with highly reliable and proven elements to minimize down time. All controls are adjustable in view of the meters. Internal components may be accessed through the front panel and the removable top and rear panels. An extender board (HARRIS PN 992 4989 001) is provided with the exciter to assist in troubleshooting.

5-32. TROUBLESHOOTING

5-33. In event of problems, the trouble area must first be isolated to an exciter input, the MX-15 power supply, an exciter module, or the exciter load. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, fuse F1, circuit breaker CB1, and the indicators should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs to indicate the module power supply status. If all LEDs are out or a consistent pattern of dark LEDs exists, a power supply malfunction or distribution bus fault exists. If a single LED is out, either the monolithic voltage regulator on the module has failed in the open condition or short exists on the module and the module regulator is in the current limiting mode.

5-34. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-1 lists typical trouble symptoms pertaining to the overall exciter operation with references to fault isolation diagrams listing probable causes and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem, it only tends to lead the repairman into the area that may be causing the trouble. If a particular MX-15 module is determined faulty, a reference to the individual module maintenance publication will be listed. In event parts are required, refer to Section VI, Parts List.

5-35. COMPONENT REPLACEMENT. The circuit boards used in the MX-15 are of the double-sided plated-through type. This means that there are traces on both sides of the board and the through-holes contain a metallic plating. Because of the plated-through holes, solder creeps up into the hole. This requires a more sophisticated technique for component removal in order to avoid damage to the traces on the board. Excessive heat of any point on the board will cause damage.

WARNING: Disconnect primary power prior to servicing.

5-36. To remove a component from a double-sided board, the leads of the defective component should be cut from the body while the leads are still soldered to the board. The component is then discarded and each lead is heated independently and pulled out of the hole. Each hole may then be cleared of solder by carefully heating with a low wattage iron and removing the residual solder with a solder vacuum tool.

5-37. The new component is installed in the usual way and soldered from the bottom side of the board. If no damage has been done to the plated-through hole, soldering of the top side is not required. However, if the removal procedure did not progress smoothly, each lead should be soldered at the top side to prevent potential intermittent problems.

5-38. After soldering remove residual flux. There are solvents available in electronic supply houses which are useful. The board should then be checked to ensure the defluxing operation has removed the flux and not just smeared it about so that it is less visible. While rosin flux is not normally corrosive, it will absorb moisture and become conductive enough to cause deterioration in specifications over a period of time.

5-39. Prior to starting a troubleshooting procedure check all switches, power cord connections, connecting cables, and power fuses.

5-40. TECHNICAL ASSISTANCE

5-41. HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service during normal business hours (8:00 AM - 5:00 PM Central Time). Emergency service is available 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Group, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

WARNING: Disconnect primary power prior to servicing.

Table 5-1. MX-15 Fault Isolation Index

SYMPTOM	DEFECT/REFERENCE
NO RF CARRIER OUTPUT	Figure 5-1
RF CARRIER LEVEL WILL NOT ADJUST	Defective RF AMP. module. Refer to RF AMP Module Technical Manual.
INADEQUATE CARRIER LEVEL OUTPUT	Figure 5-2
FREQUENCY CONTROL CIRCUIT WILL NOT LOCK (AFC/PLL MODULE LOCK INDICATOR NOT ILLUMINATED).	Figure 5-3
EXCITER OFF FREQUENCY (AFC/PLL MODULE LOCK INDICATOR ILLUMINATED).	Defective AFC/PLL module. Refer to AFC/PLL Module Technical Manual.
HIGH AUDIO DISTORTION IN BOTH STEREO CHANNELS	Figure 5-4
HIGH AUDIO DISTORTION IN ONE STEREO CHANNEL	Defective STEREO ANALOG module. Refer to Stereo Analog Technical Manual.
NOISY AUDIO	Figure 5-5
AM NOISE ON RF CARRIER	Figure 5-6
NO MODULATION	Figure 5-7
CIRCUIT BREAKER CB-1 OPENS	Figure 5-8

WARNING: Disconnect primary power prior to servicing.

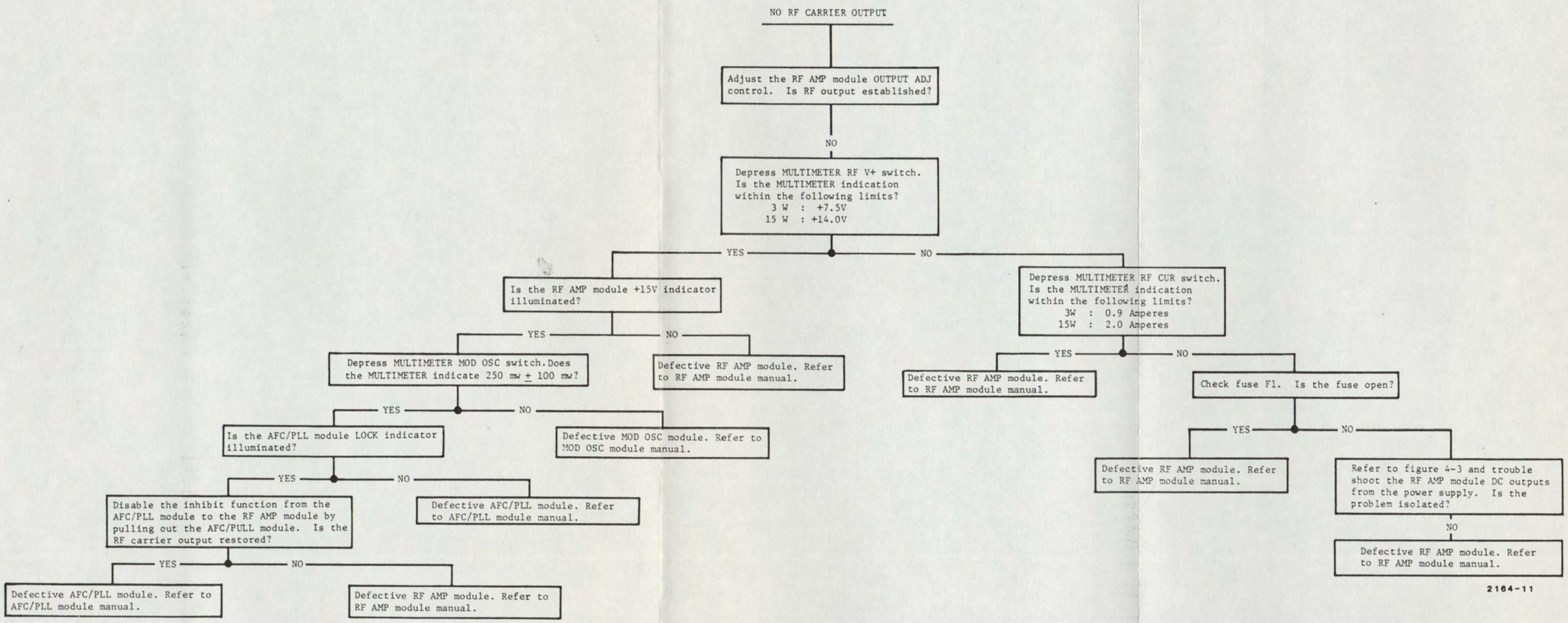


FIGURE 5-1. NO RF CARRIER OUTPUT

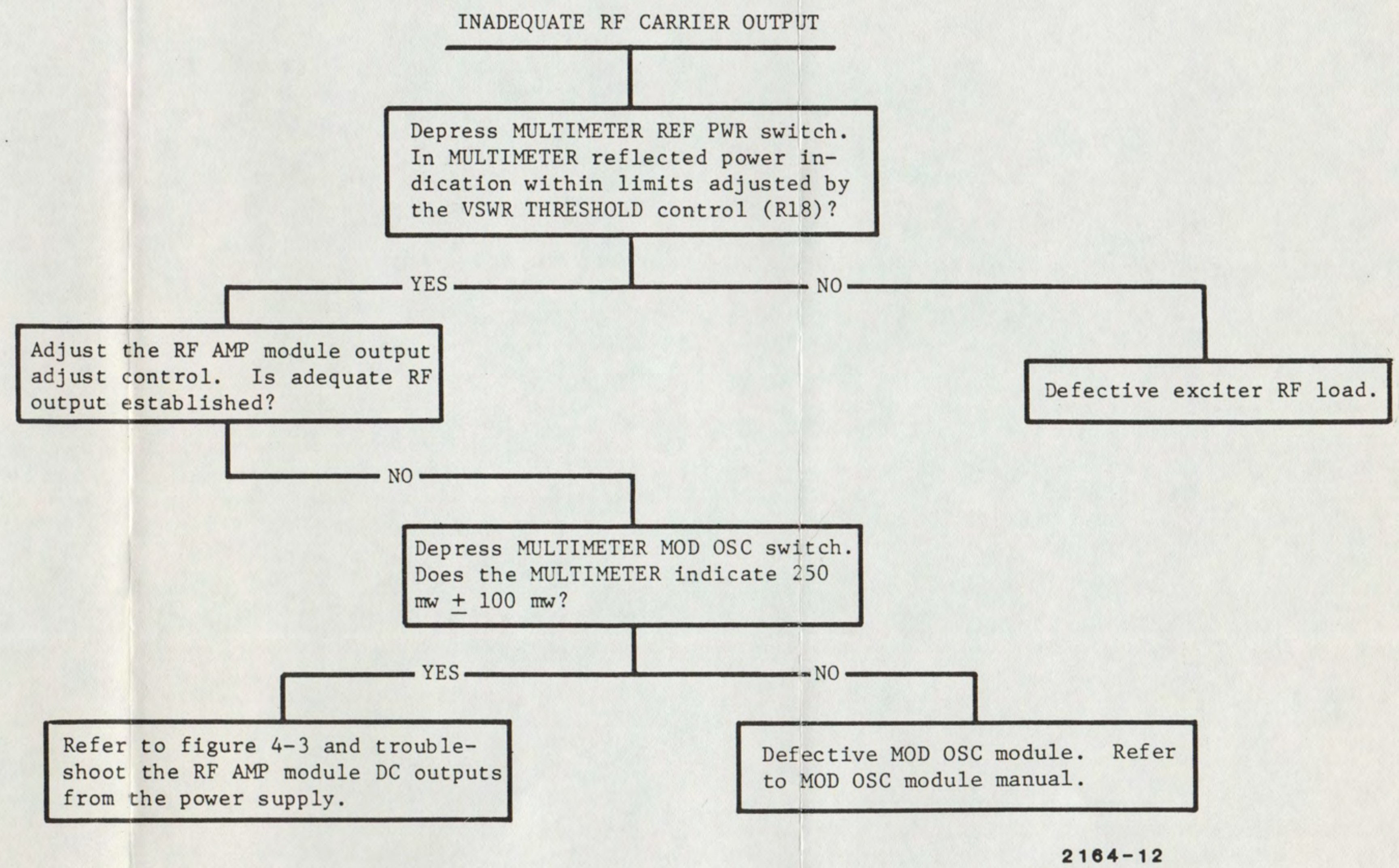


FIGURE 5-2. INADEQUATE RF CARRIER LEVEL OUTPUT

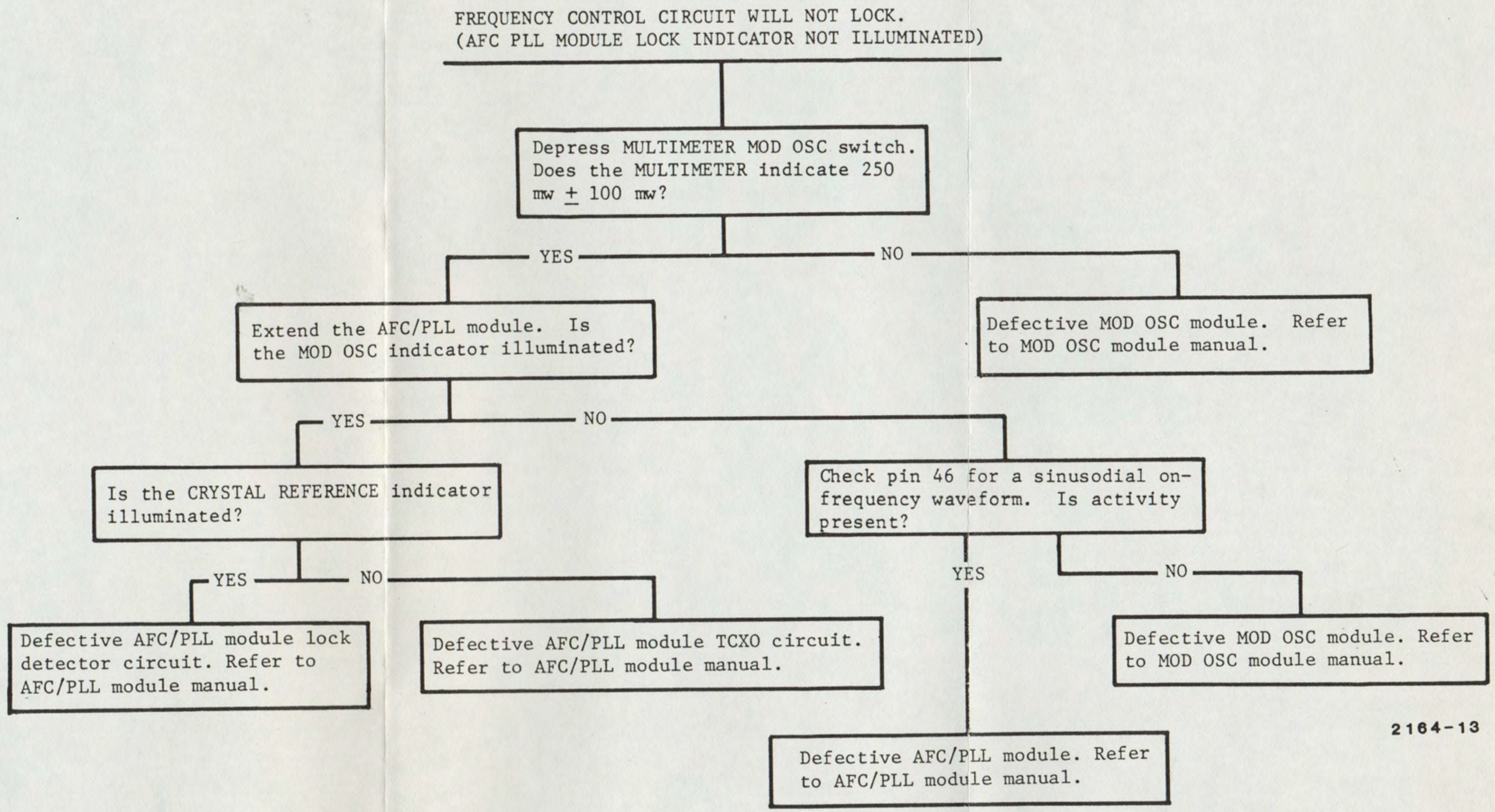


FIGURE 5-3. FREQUENCY CONTROL CIRCUIT WILL NOT LOCK (AFC/PLL MOCULE LOCK INDICATOR NOT ILLUMINATED)

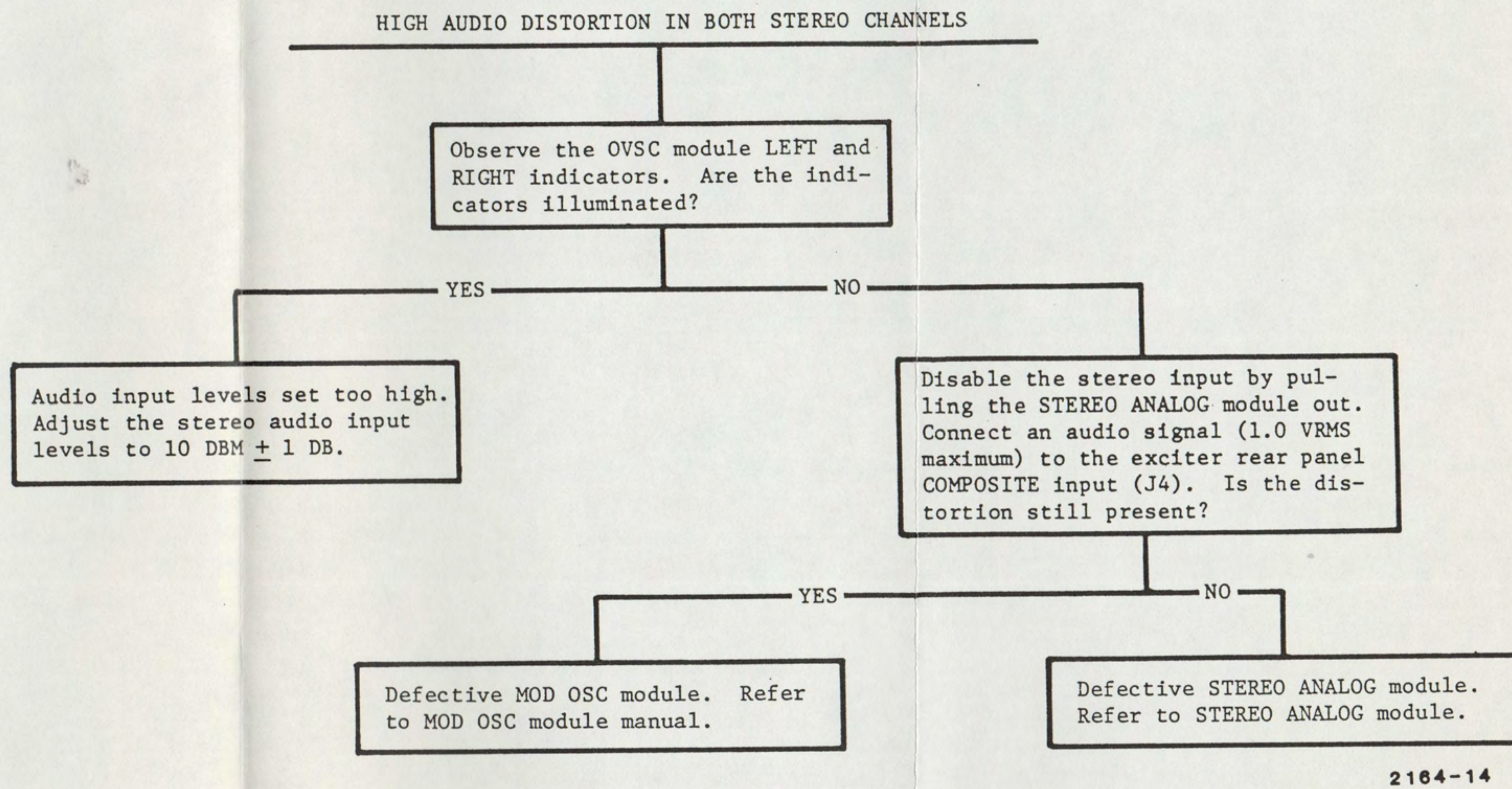
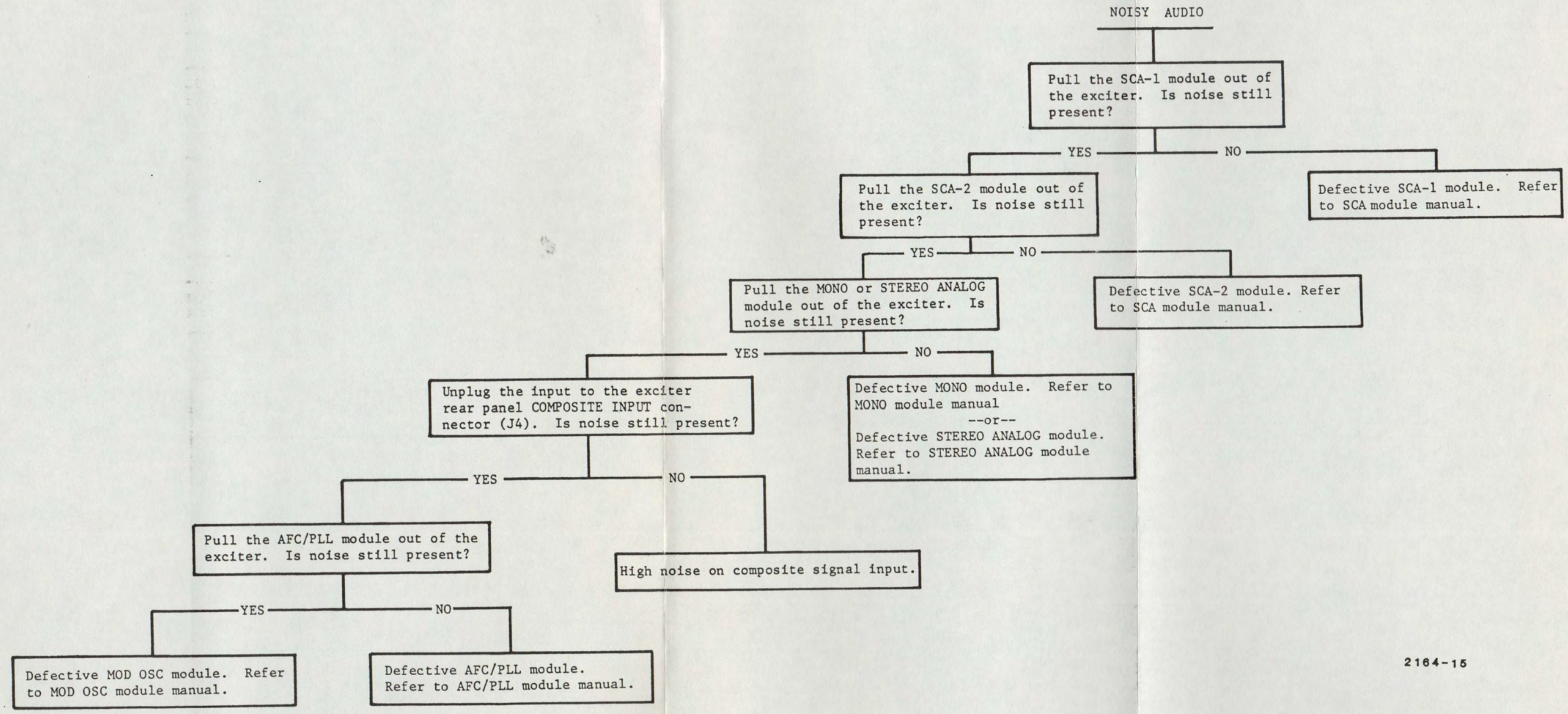


FIGURE 5-4. HIGH AUDIO DISTORTION IN BOTH STEREO CHANNELS



2164-15

FIGURE 5-5. NOISY AUDIO

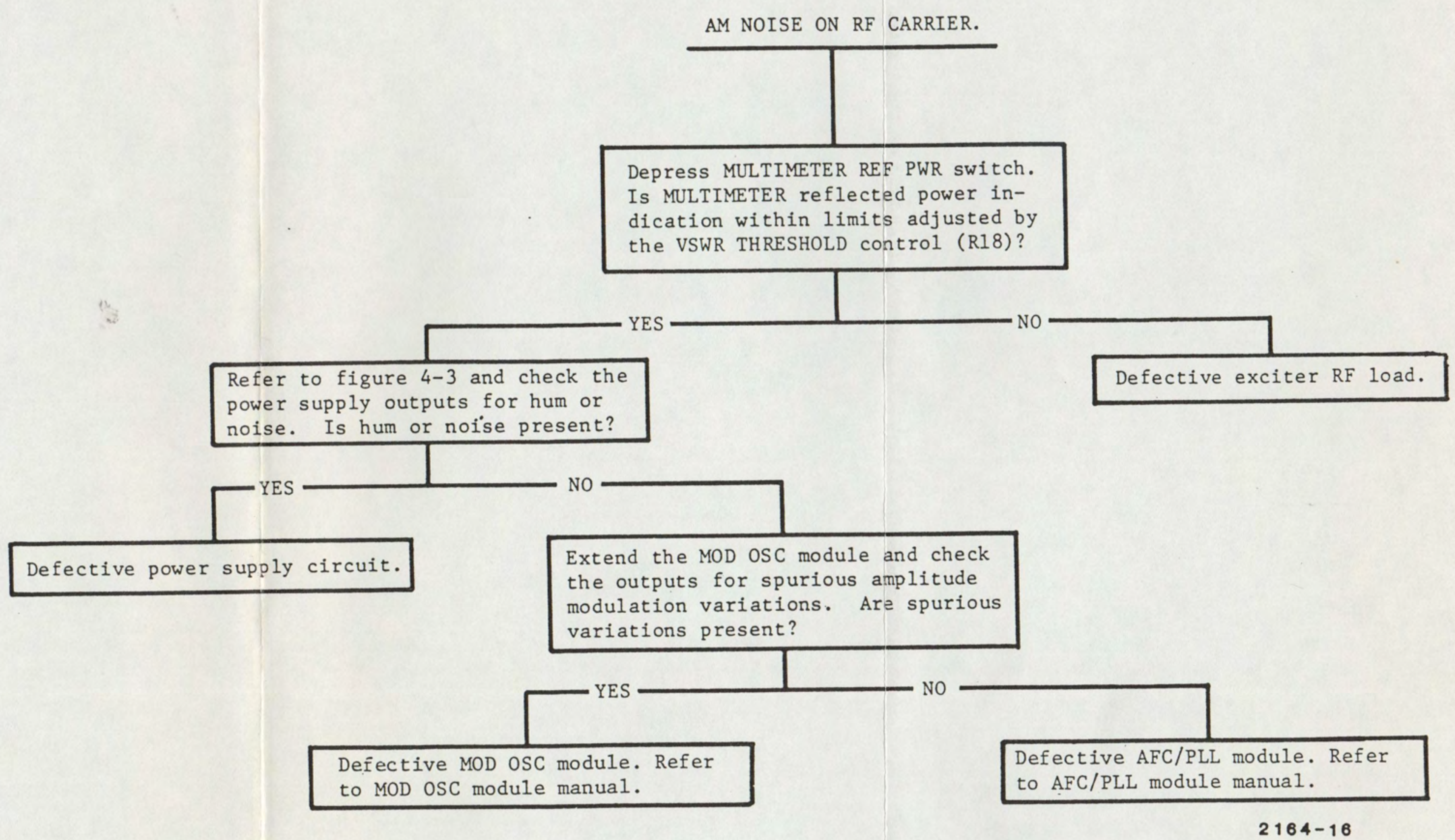
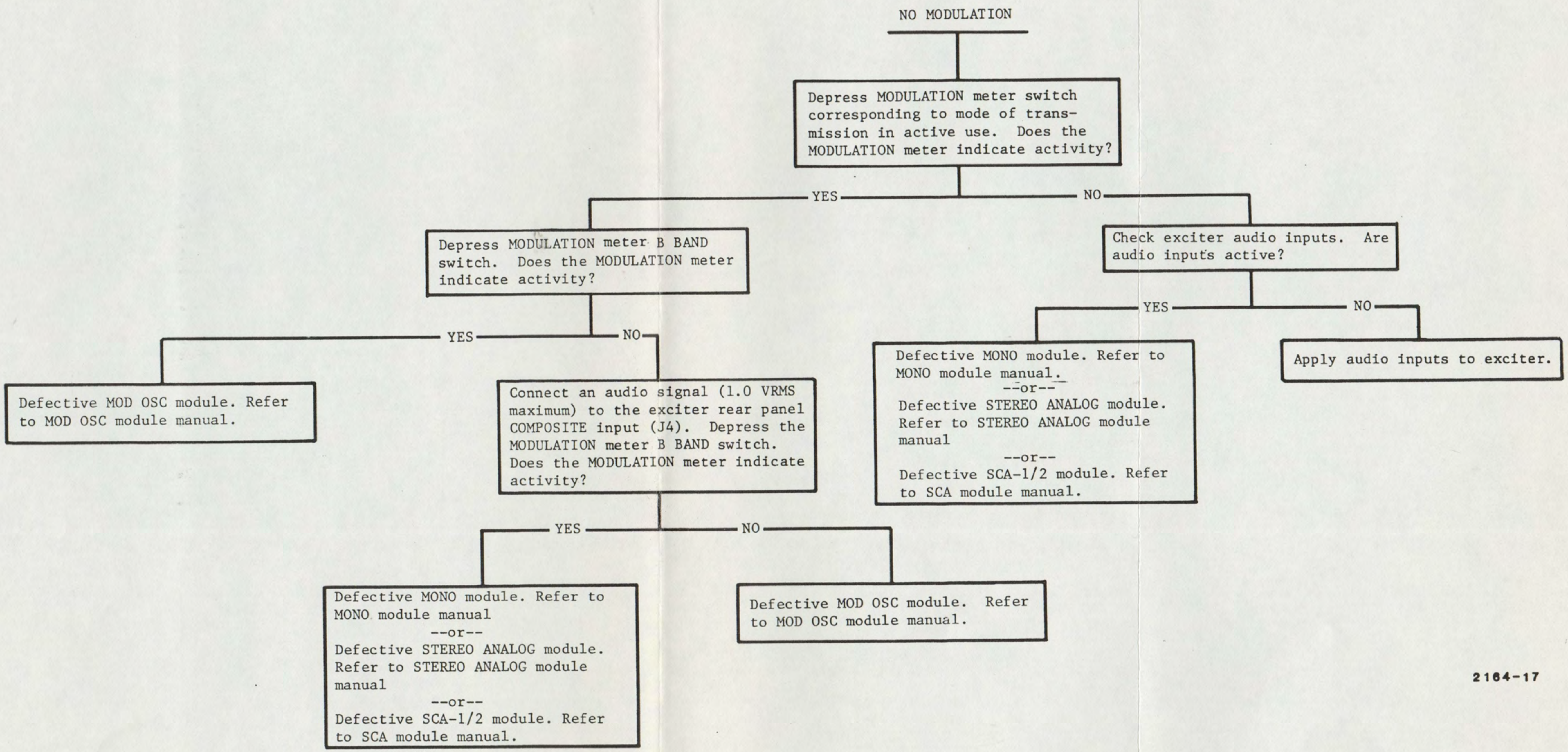


FIGURE 5-6. AM NOISE ON RF CARRIER



2164-17

FIGURE 5-7. NO MODULATION

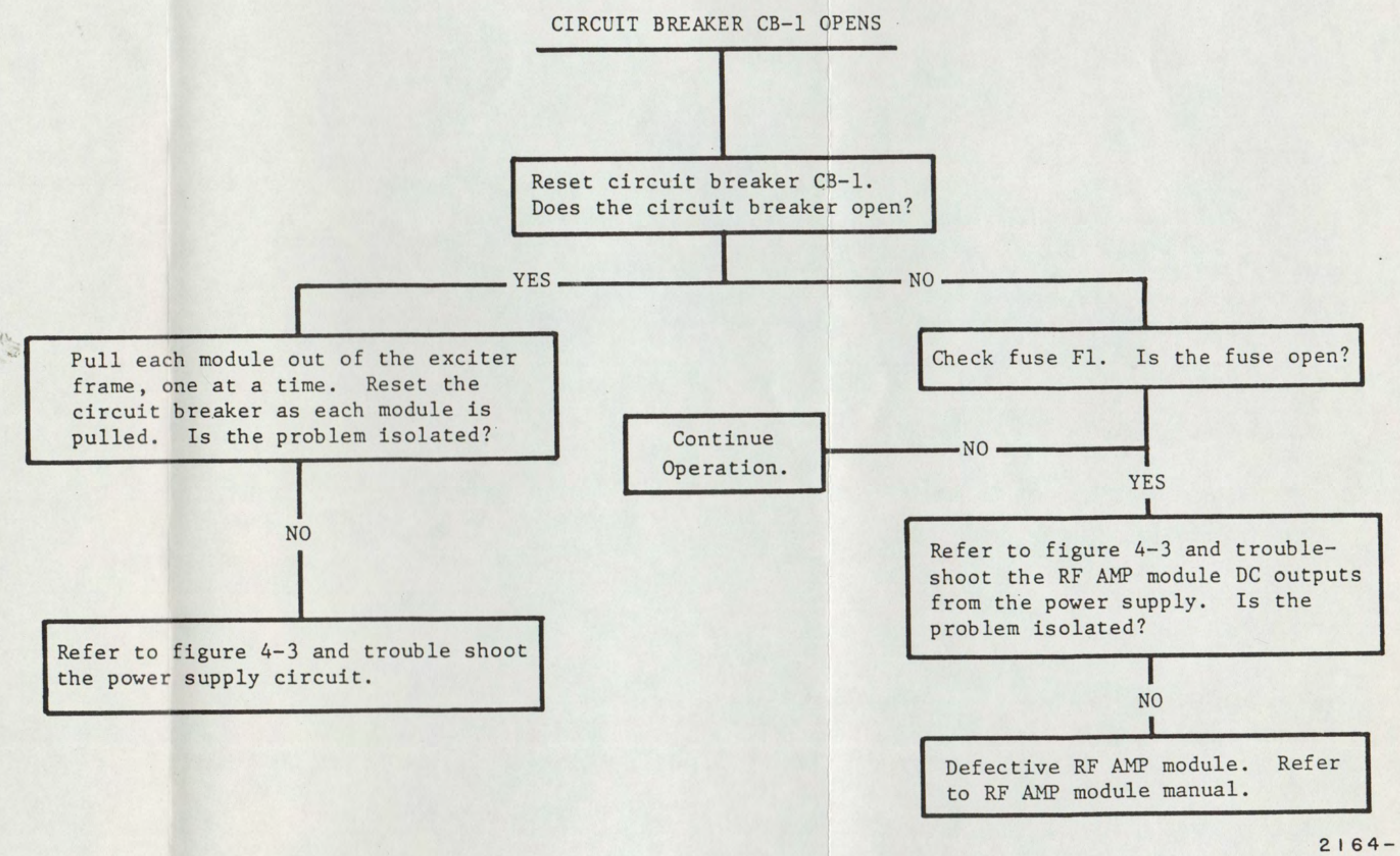


FIGURE 5-8. CIRCUIT BREAKER CB-1 OPENS

SECTION VI

PARTS LIST

6-1. INTRODUCTION

6-2. This section provides a description, reference designator and part number for selected replaceable parts and assemblies required for proper maintenance of the MX-15 FM EXCITER. Table 6-1 lists assemblies having replaceable parts, the table number listing the parts, and the page number on which the table is located. Identity of the assembly nomenclature in table 6-1 signifies the equipment level within the overall equipment configuration.

NOTE

> Actual component values may vary slightly from component values listed on schematics and parts lists. Due to industry-wide shortages, it is sometimes necessary to use parts other than those specified. In every case, however, a substitute part is selected for conformance to overall design specifications so that equipment performance is not affected. Components that are frequency determined or peculiar to an individual exciter are identified by a HARRIS part number and MX-15 component number on the final test addendum sheets shipped with the equipment.

6-3. REPLACEABLE PARTS SERVICE

6-4. Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Group, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

Table 6-1. REPLACEABLE PARTS LIST INDEX

WARNING: Disconnect primary power prior to servicing

Table 6-1. REPLACEABLE PARTS LIST INDEX (Continued)

TABLE NO.	UNIT NOMENCLATURE	PART NO.	PAGE
6-23	EXTERNAL SCA GENERATOR JUMPER CARD (FOR USE WITH EXTERNALLY MOUNTED SCA GENERATOR)	994 8377 001	6-32

Table 6-2. MX-15 FM EXCITER - 994 7950 003

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
UNIT2	994 7950 004	BASIC - MX-15 FM EXCITER	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. BASIC - MX-15 FM EXCITER - 994 7950 004

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
2A1	992 4980 003	MAIN FRAME	1
2A2	992 6204 001	RF PWR AMP MODULE	1
2A3	992 5981 001	AUTO FREQ CONTROL MOD.	1
2A4	992 5983 002	MODULATED OSCILLATOR MOD.	1
2A5	939 3524 001	EXTENDER BOARD	1
2A6	992 4990 001	ACCESS CABLES	1
	356 0094 000	ADHESIVE CABLE CLIP	1
	410 0232 000	INSULATOR, MICA	3
	464 0026 000	TOOL, ALIGNMENT 5284	1
	992 5988 001	PACKING CHECK LIST	1

Table 6-4. MAIN FRAME - 992 4980 003

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
B1	430 0098 000	FAN, TUBEAXIAL	1
CB1	992 6557 001	CIRCUIT BREAKER INSTALLATION KIT	1
CR1,CR2	384 0764 000	RECT., BRIDGE 15A 600PRV	2
CR3	384 0020 000	RECTIFIER IN4005	1
CR4	386 0391 000	DIODE ZENER 1N2821A	1
CR5	406 0479 000	LIGHT, INDICATOR RED	1
C1	524 0223 000	CAP 4900UF 30V	1
C2	524 0337 000	CAP 5100 UF 50V	1
C3	524 0336 000	CAP 2900 UF 50V	1
C4	524 0337 000	CAP 5100 UF 50V	1
C5,C6,C7,C8	516 0082 000	CAP, DISC .01UF 1KV GMV	4
C9,C14	526 0351 000	CAP 6.8UF 50V 20%	2
C15,C16,C17	516 0082 000	CAP, DISC .01UF 1KV GMV	3
F1	398 0020 000	FUSE 3AG FAST 3A 250	1
L1	476 0399 000	CHOKE, FILTER 5 MH	1
M1	632 0961 000	MULTIMETER	1
M2	632 0962 000	METER, MODULATION	1
Q1,Q3	380 0187 000	TRANSISTOR 2N6055	2
Q4	380 0571 000	TRANSISTOR	1
R7	548 1437 000	RES 665K OHM 1/4W 1%	1
R8,R9	548 0314 000	RES 75K OHM 1/4W 1%	2
R10	548 1437 000	RES 665K OHM 1/4W 1%	1

WARNING: Disconnect primary power prior to servicing.

Table 6-4. MAIN FRAME - 992 4980 003 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
S1	604 0868 000	SW, ROCKER DPDT	1
TB1	614 0004 000	TERM BOARD 4 TERM	1
TB2	614 0786 000	TERM BD, 2C MODULAR 261	1
TB3	614 0147 000	TERM STRIP 6 TERM	1
T1	472 1117 000	XFMR, POWER	1
U1	382 0527 000	IC 340K-5/7805K +5V REG	1
XCR4	404 0661 000	SOCKET, TRANSISTOR	1
XF1	402 0023 000	FUSE HOLDER 342004	1
XQ1,XQ2,XQ3,XQ4	404 0661 000	SOCKET, TRANSISTOR	4
2A1A1	992 4981 001	PC BOARD	1
2A1A2	992 4982 001	PC BOARD	1
2A1A3	992 4983 001	MOTHER BOARD	1
2A1A4	992 4984 001	PC BOARD	1
2A1A5	992 5000 001	POWER SUPPLY BOARD	1
	829 1959 001	HEAT SINK, PWR SUP.	1
	829 1959 002	HEATSINK, PWR. SUP.	1
	829 2901 001	FINGERSTOCK	22
	829 2901 002	FINGERSTOCK	2
	829 3171 001	FILTER, FAN	1
	929 1982 002	PANEL ASSY, METER FRONT	1
	929 2191 001	RIBBON CABLE,20 COND	1
	929 2192 001	RIBBON CABLE ASSY	1

WARNING: Disconnect primary power prior to servicing.

Table 6-4. MAIN FRAME - 992 4980 003 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	929 2193 001	RIBBON CABLE,40 COND	1
	929 2440 001	CABLE, MAIN	1
	938 3828 126	COAX CABLE	3
	938 3828 130	COAX CABLE	1

WARNING: Disconnect primary power prior to servicing

Table 6-5. PC BOARD - 992 4981 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1	384 0321 000	DIODE 5082-2800/1N5711	1
R1,R2	548 0317 000	RES 301K OHM 1/4W 1%	2
R3	548 0932 000	RES 100K OHM 1/4W 1%	1
R4	540 1109 000	RES .5W 33K OHM 5PCT	1
R4	548 0932 000	RES 100K OHM 1/4W 1%	1
R5	548 0317 000	RES 301K OHM 1/4W 1%	1
R6	548 0997 000	RES 20K OHM 1/4W 1%	1
S1	604 0862 000	SWITCH, PB 10 POS	1
	610 0746 000	HEADER ASSY 20 PIN	1
	839 2835 001	SCHEMATIC	1
	839 2836 001	PRINTED BOARD	1

WARNING: Disconnect primary power prior to servicing

Table 6-6. PC BOARD - 992 4982 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1,CR2,CR3	384 0321 000	DIODE 5082-2800/1N5711	3
CR4 thru CR7	384 0431 000	RECT. 1N4001	4
C1	526 0049 000	CAP 6.8UF 35V 20%	1
C2	500 0813 000	CAP MICA 33UUF 500V	1
C3	526 0049 000	CAP 6.8UF 35V 20%	1
C4	500 0817 000	CAP MICA 47UUF 500V	1
C5,C6	526 0049 000	CAP 6.8UF 35V 20%	2
C8	526 0340 000	CAP 1 UF 35V 10%	1
C9,C10	526 0049 000	CAP 6.8UF 35V 20%	2
C11	526 0342 000	CAP 2.7UF 35V 10%	1
C12	526 0106 000	CAP 27UF 35V 10%	1
C13 thru C16	526 0049 000	CAP 6.8UF 35V 20%	4
Q1,Q2	380 0319 000	TRANSISTOR MPS A14	2
R1	550 0913 000	POT, 5K OHM	1
R2	540 1113 000	RES .5W 18K OHM 5PCT	1
R3	550 0913 000	POT, 5K OHM	1
R4	540 1113 000	RES .5W 18K OHM 5PCT	1
R5	550 0398 000	POT 1K OHM 1/2W 10%	1
R6	540 1179 000	RES 1/2W 3600 OHM 5%	1
R7	550 0928 000	POT 20K OHM 1/2W	1
R8	540 1165 000	RES 1/2W 3300 OHM 5%	1
R9	550 0928 000	POT 20K OHM 1/2W	1

WARNING: Disconnect primary power prior to servicing

Table 6-6. PC BOARD - 992 4982 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R10	540 1165 000	RES 1/2W 3300 OHM 5%	1
R11	550 0913 000	POT, 5K OHM	1
R12	540 1113 000	RES .5W 18K OHM 5PCT	1
R13	550 0913 000	POT, 5K OHM	1
R14	540 1113 000	RES .5W 18K OHM 5PCT	1
R15	550 0928 000	POT 20K OHM 1/2W	1
R16	540 1160 000	RES .5W 22K OHM 5%	1
R17	540 1328 000	RES 560K OHM .5W	1
R18	540 1111 000	RES .5W 10K OHM 5PCT	1
R19	540 1151 000	RES .5W 10 OHM 5%	1
R20	540 1144 000	RES .5W 200K OHM 5%	1
R21	550 0930 000	POT 200K OHM 1/2W	1
R22	540 1105 000	RES .5W 5100 OHM 5%	1
R23	540 1151 000	RES .5W 10 OHM 5%	1
R24	540 1251 000	RES 300K OHM .5W 5%	1
R25,R26	540 1159 000	RES .5W 100K OHM 5%	2
R27	540 1129 000	RES .5W 1500 OHM 5%	1
R28,R29	540 1111 000	RES .5W 10K OHM 5PCT	2
R30	550 0935 000	POT 2K OHM 1/2W 10%	1
R31	540 1145 000	RES .5W 6800 OHM 5%	1
R32	540 1111 000	RES .5W 10K OHM 5PCT	1
R33,R34	540 1151 000	RES .5W 10 OHM 5%	2

Table 6-6. PC BOARD - 992 4982 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R35	540 1162 000	RES 1/2W 1 MEGOHM 5%	1
R36	540 1111 000	RES .5W 10K OHM 5PCT	1
R37	540 1134 000	RES .5W 33 OHM 5%	1
R38	540 1160 000	RES .5W 22K OHM 5%	1
R39	540 1159 000	RES .5W 100K OHM 5%	1
R40	540 1337 000	RES 12 MEGOHM 1/2W 5%	1
R41	540 1160 000	RES .5W 22K OHM 5%	1
R42	540 1114 000	RES .5W 4700 OHM 5%	1
R43	540 1165 000	RES 1/2W 3300 OHM 5%	1
R44	540 1210 000	RES 1/2W 150K OHM 5%	1
R45	540 1107 000	RES .5W 20K OHM 5PCT	1
R46	540 1104 000	RES .5W 2000 OHM 5%	1
R47	540 1201 000	RES 1/2W 910 OHM 5%	1
R48	550 0935 000	POT 2K OHM 1/2W 10%	1
R49	540 1129 000	RES .5W 1500 OHM 5%	1
R50	559 0043 000	THERMISTOR 2K OHM	1
R51	540 1107 000	RES .5W 20K OHM 5PCT	1
R52,R53,R54,R55	548 1148 000	RES 100K OHM 1/4W 1%	4
R56,R57,R58	540 1159 000	RES .5W 100K OHM 5%	3
R59	540 1129 000	RES .5W 1500 OHM 5%	1
S1	604 0862 000	SWITCH, PB 10 POS	1
U1	382 0415 000	CKT, INT 324	1

WARNING: Disconnect primary power prior to servicing

Table 6-6. PC BOARD - 992 4982 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
U2,U3	382 0472 000	CKT, INTEGRATED	2
U4	540 1332 000	RES NETWORK 100K OHM	1
U5	382 0360 000	IC, 7915	1
U6	382 0359 000	IC, 7815	1
XU1	404 0674 000	SOCKET, IC 14 CONT	1
XU2,XU3	404 0673 000	SOCKET, IC 8 CONT	2
XU4	404 0675 000	SOCKET, IC 16 CONT	1
	610 0747 000	HEADER ASSY 26 PIN	1
	843 2118 001	SCHEMATIC	1
	939 2851 001	PC BOARD ASSY.	1

WARNING: Disconnect primary power prior to servicing

Table 6-7. MOTHER BOARD - 992 4983 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
P1 thru P13	612 0887 000	CONN, PC BD 72 CONT	13
R1,R2,R3,R4,R5	540 0864 000	RES .25W 10 OHM 5%	5
	610 0746 000	HEADER ASSY 20 PIN	1
	610 0747 000	HEADER ASSY 26 PIN	1
	610 0748 000	HEADER ASSY 40 PIN	1
	620 0515 000	RECP 50-051-0000	4
	852 8415 001	SCHEMATIC	1
	952 8329 001	PRINTED BOARD	1

WARNING: Disconnect primary power prior to servicing.

Table 6-8. PC BOARD - 992 4984 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1	384 0020 000	RECTIFIER IN4005	1
C1,C2	516 0370 000	CAP .005UF 500V 10%	2
C3	500 0756 000	CAP, MICA 330PF 500V 5%	1
C4,C5	516 0370 000	CAP .005UF 500V 10%	2
C6	500 0756 000	CAP, MICA 330PF 500V 5%	1
C7,C8	516 0370 000	CAP .005UF 500V 10%	2
C9	500 0756 000	CAP, MICA 330PF 500V 5%	1
C10,C11	516 0370 000	CAP .005UF 500V 10%	2
C12	500 0756 000	CAP, MICA 330PF 500V 5%	1
C13,C14	516 0370 000	CAP .005UF 500V 10%	2
C15	500 0756 000	CAP, MICA 330PF 500V 5%	1
C16,C17	516 0370 000	CAP .005UF 500V 10%	2
C18	500 0756 000	CAP, MICA 330PF 500V 5%	1
C19,C20	516 0370 000	CAP .005UF 500V 10%	2
C21	500 0756 000	CAP, MICA 330PF 500V 5%	1
C22,C23	516 0370 000	CAP .005UF 500V 10%	2
C24	500 0756 000	CAP, MICA 330PF 500V 5%	1
C25,C26	516 0370 000	CAP .005UF 500V 10%	2
C27	500 0756 000	CAP, MICA 330PF 500V 5%	1
C28,C29	516 0370 000	CAP .005UF 500V 10%	2
C30	500 0756 000	CAP, MICA 330PF 500V 5%	1
C31 thru C46	516 0074 000	CAP, DISC .005UF 1KV 20%	16

Table 6-8. PC BOARD - 992 4984 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C47	516 0084 000	CAP DISC .02UF 600V	1
C48	516 0074 000	CAP, DISC .005UF 1KV 20%	1
C49 thru C52	516 0084 000	CAP DISC .02UF 600V	4
C53 thru C61	516 0074 000	CAP, DISC .005UF 1KV 20%	9
J1	610 0740 000	HEADER, PIN 36CKT	1
J2	610 0748 000	HEADER ASSY 40 PIN	1
J3	610 0739 000	HEADER, PIN 12CKT	1
K1	574 0162 000	RELAY 4PDT 24VDC	1
L1	494 0419 000	CHOKE RF 1000.0UH	1
L2	492 0627 000	INDUCTOR, VARIABLE	1
L3	494 0419 000	CHOKE RF 1000.0UH	1
L4	492 0627 000	INDUCTOR, VARIABLE	1
L5,L6,L7	494 0419 000	CHOKE RF 1000.0UH	3
L8	492 0627 000	INDUCTOR, VARIABLE	1
L9	494 0419 000	CHOKE RF 1000.0UH	1
L10	492 0627 000	INDUCTOR, VARIABLE	1
L11 thru L14	414 0212 000	TOROID, SELECTED	4
R1	540 0900 000	RES .25W 330 OHM 5%	1
R2	540 0915 000	RES .25W 1300 OHM 5%	1
R3,R4	540 0900 000	RES .25W 330 OHM 5%	2
R5	540 0915 000	RES .25W 1300 OHM 5%	1
R6,R7	540 0900 000	RES .25w 330 OHM 5%	2

WARNING: Disconnect primary power prior to servicing

Table 6-8. PC BOARD - 992 4984 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R8	540 0915 000	RES .25W 1300 OHM 5%	1
R9,R10	540 0900 000	RES .25W 330 OHM 5%	2
R11	540 0915 000	RES .25W 1300 OHM 5%	1
R12,R13,R14	540 0900 000	RES .25W 330 OHM 5%	3
R15 thru R24	540 0920 000	RES .25W 2200 OHM 5%	10
R25,R26	548 0263 000	RES 1K OHM 1/8W 1%	2
R27,R28	540 0920 000	RES .25W 2200 OHM 5%	2
R29	540 0912 000	RES .25W 1000 OHM 5%	1
R30	540 0880 000	RES .25W 47 OHM 5PCT	1
R31	540 0017 000	RES .5W 47 OHM 5%	1
R32	540 0912 000	RES .25W 1000 OHM 5%	1
R33	540 0017 000	RES .5W 47 OHM 5%	1
R34	540 0915 000	RES .25W 1300 OHM 5%	1
TB1,TB2	614 0040 000	TERM BOARD 18 TERM	2
XK1	404 0161 000	SOCKET RELAY 9KH2	1
	843 1714 001	SCHEMATIC	1
	943 1715 001	PRINTED BOARD	1

Table 6-9. POWER SUPPLY BOARD - 992 5000 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR5,CR6	386 0077 000	DIODE, ZENER 1N4749A, 24V	2
CR7,CR8	384 0020 000	RECTIFIER IN4005	2
C10 thru C13	522 0548 000	CAP 10UF 50V ELECTROLYTIC	4
Q5	380 0189 000	TRANSISTOR 2N3904	1
Q6	380 0190 000	TRANSISTOR 2N3906	1
R1	540 0339 000	RES 1W 2000 OHM 5%	1
R2	540 1102 000	RES .5W 100 OHM 5PCT	1
R3	540 1216 000	RES 1/2W 330 OHM 5%	1
R4	542 0002 000	RES. 2 OHM 5W	1
R5	540 1137 000	RES .5W 3900 OHM 5%	1
R6	540 0339 000	RES 1W 2000 OHM 5%	1
R11	540 1102 000	RES .5W 100 OHM 5PCT	1
R12	540 1137 000	RES .5W 3900 OHM 5%	1
R13	540 1216 000	RES 1/2W 330 OHM 5%	1
R14	542 0002 000	RES. 2 OHM 5W	1
R15	540 0332 000	RES 1W 1000 OHM 5%	1
	843 2119 001	SCHEMATIC	1
	929 2219 001	PRINTED BOARD	1

WARNING: Disconnect primary power prior to servicing.

Table 6-10. RIBBON CABLE,20 COND - 929 2191 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	250 0268 000	RIBBON CABLE 20 COND	1.5 FT
	612 0895 000	RECP CONN KIT 20 PIN	2

WARNING: Disconnect primary power prior to servicing

Table 6-11. RIBBON CABLE ASSY - 929 2192 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	250 0270 000	RIBBON CABLE 26 COND	1.5 FT
	612 0896 000	RECP CONN KIT 26 PIN	2

WARNING: Disconnect primary power prior to servicing

Table 6-12. RIBBON CABLE,40 COND - 929 2193 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	250 0269 000	RIBBON CABLE 40 COND	.5 FT
	612 0897 000	RECP CONN KIT 40 PIN	2

WARNING: Disconnect primary power prior to servicing

Table 6-13. CABLE, MAIN - 929 2440 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	843 2021 001	CABLE LAYOUT	1
	252 0003 000	WIRE STRD 20AWG WHT	41.9 FT
	253 0074 000	CABLE, 4-C #22AWG	4.1 FT
	253 0093 000	CABLE 4-C 20 AWG	2.2 FT
	253 0059 000	CABLE, AUD 2C 22AWG	2.9 FT
	354 0728 000	TERM, SERIES 110 FEMALE	2
	354 0001 000	TERM LUG RED RING 6	12
	354 0003 000	TERM LUG RED RING 10	13
	354 0669 000	TERM FOR .250 X .032 TAB	2
	296 0253 000	TUBG, SHRINKABLE 3/16	.2 FT
	296 0263 000	TUBG SHRINKABLE .375	.3 FT
	296 0265 000	TUBG SHRINKABLE 1/16	1.9 FT

WARNING: Disconnect primary power prior to servicing

Table 6-14. COAX CABLE - 938 3828 126

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	618 0213 000	COAX CABLE RG188A/U	2.1 FT
	620 0566 000	PLUG, RT ANGLE UG1466/U	3
	620 1510 000	JACK, BULKHEAD, BNC	3

Table 6-15. COAX CABLE - 938 3828 130

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	620 0566 000	PLUG, RT ANGLE UG1466/U	1
	618 0213 000	COAX CABLE RG188A/U	.7 FT
	414 0212 000	TOROID, SELECTED	1
	296 0263 000	TUBG SHRINKABLE .375	.1 FT
	620 1510 000	JACK, BULKHEAD, BNC	1

WARNING: Disconnect primary power prior to servicing

Table 6-16. EXTENDER BOARD - 939 3524 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
J1	612 0916 000	CONN PC BD 72 CONT.	1
	943 2258 001	EXTENDER BOARD ASSY	1
	939 3386 001	PLATE ASSY.	1
	829 2920 001	CATCH, EXTENDER	1
	829 2920 002	CATCH, EXTENDER	1
	456 0082 000	SPRING LC-026C-5	2
	335 0007 000	WASHER NYLON .175 ID	6
	310 0016 000	WASHER FLAT #4	10
	302 0052 000	SCR 4-40 X 1/4	10
	314 0003 000	WASHER SPLIT 4	10
	302 0364 000	SCR 4-40 X 3/16	2
	999 1763 001	HARDWARE LIST	1

WARNING: Disconnect primary power prior to servicing

Table 6-17. EXTENDER BOARD ASSY - 943 2258 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	843 2261 001	EXTENDER	1
	354 0310 000	TERM SLDR 3653-3-01	70

WARNING: Disconnect primary power prior to servicing

Table 6-18. ACCESS CABLES - 992 4990 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	929 2816 001	CORD, AC POWER	1

WARNING: Disconnect primary power prior to servicing

Table 6-19. WIDE BAND OPTION (6) - 994 7983 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	994 7983 001	BLANK MODULE	5

WARNING: Disconnect primary power prior to servicing

Table 6-20. STEREO OPTION (3) - 994 8020 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
3A1	994 7989 001	STEREO ANALOG MODULE	1
3A2	994 7990 001	STEREO DIGITAL MODULE	1
3A3	994 7991 001	STEREO OVERSHOOT MODULE	1

WARNING: Disconnect primary power prior to servicing.

Table 6-21. SCA OPTION (4) - 994 7992 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	992 4977 002	PC BOARD ASSEMBLY	1

WARNING: Disconnect primary power prior to servicing.

Table 6-22. MONO OPTION (5) - 994 8019 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
5A1	994 7988 001	MONAURAL MODULE	1
	994 7983 001	BLANK MODULE	2

WARNING: Disconnect primary power prior to servicing

Table 6-23. EXTERNAL SCA GENERATOR JUMPER CARD - 994 8377 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	843 3292 001	PC BOARD	1
	550 0913 000	POT, 5K OHM	1

WARNING: Disconnect primary power prior to servicing

SECTION VII

DIAGRAMS

7-1. INTRODUCTION

7-2. This section provides schematic, interconnection, and wiring diagrams required for maintenance of the MX-15 FM EXCITER. The following diagrams are contained in this section:

WARNING: Disconnect primary power prior to servicing.

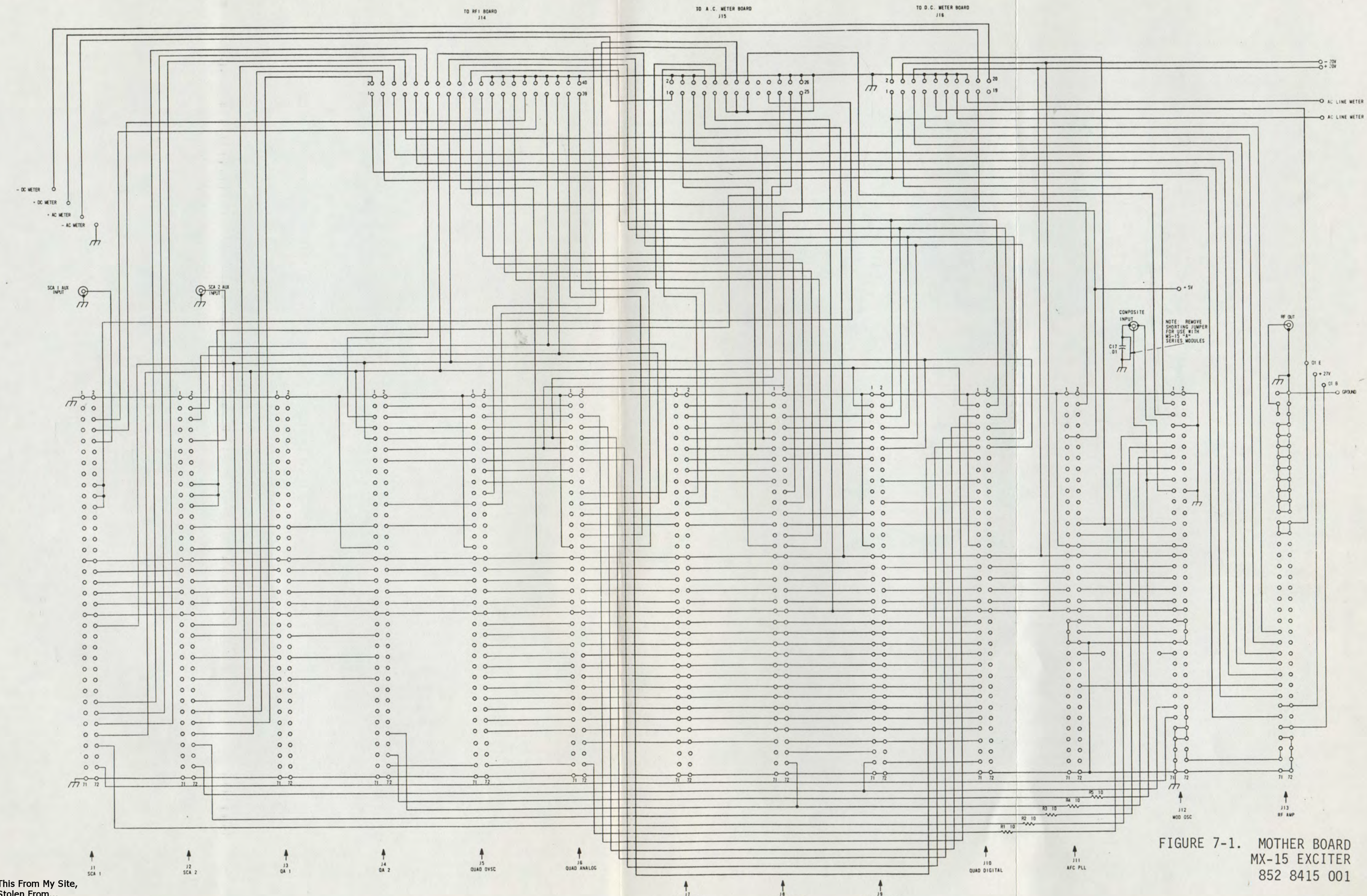
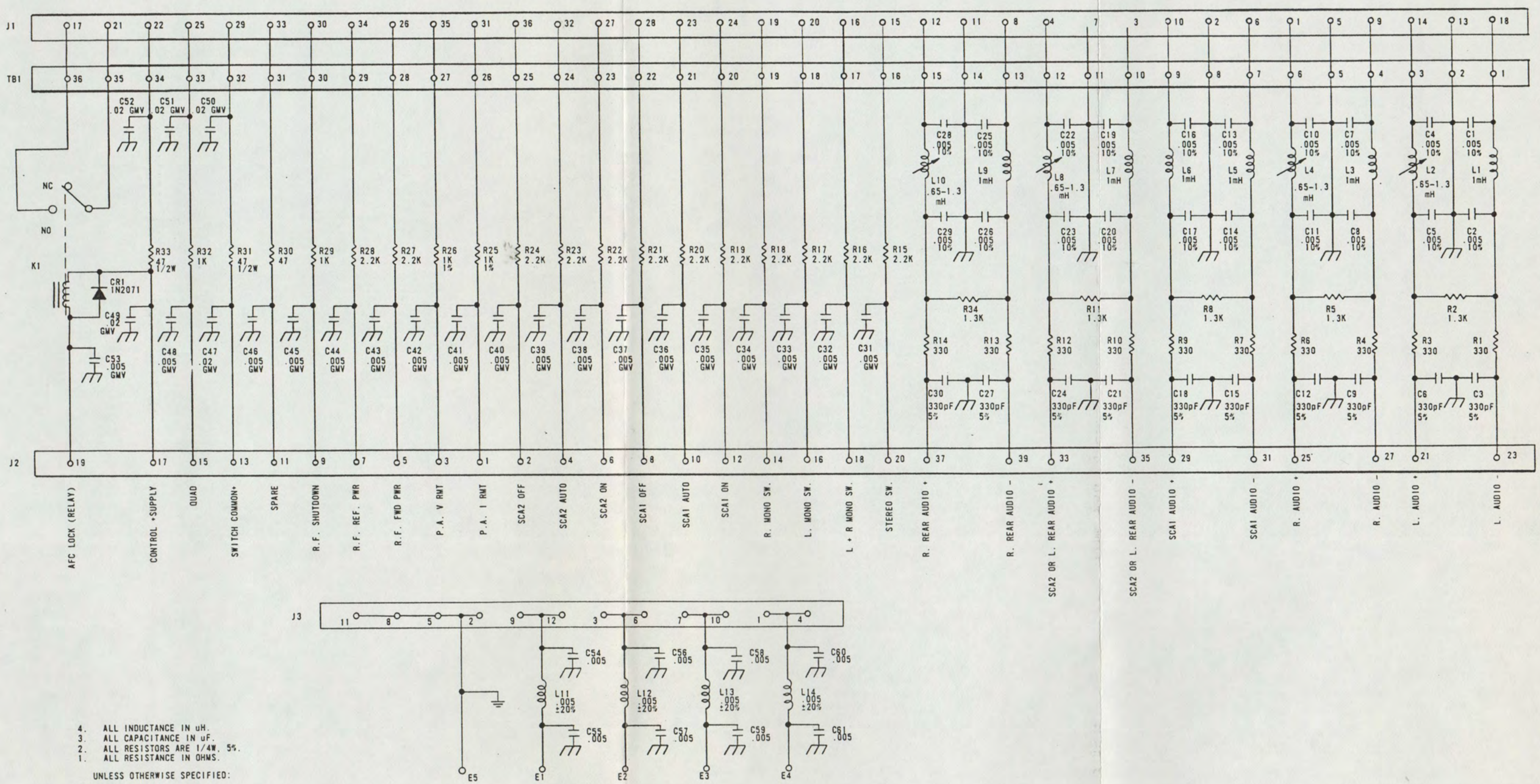


FIGURE 7-1. MOTHER BOARD
MX-15 EXCITER
852 8415 001

NOTES: ALL RESISTOR VALUES IN OHMS

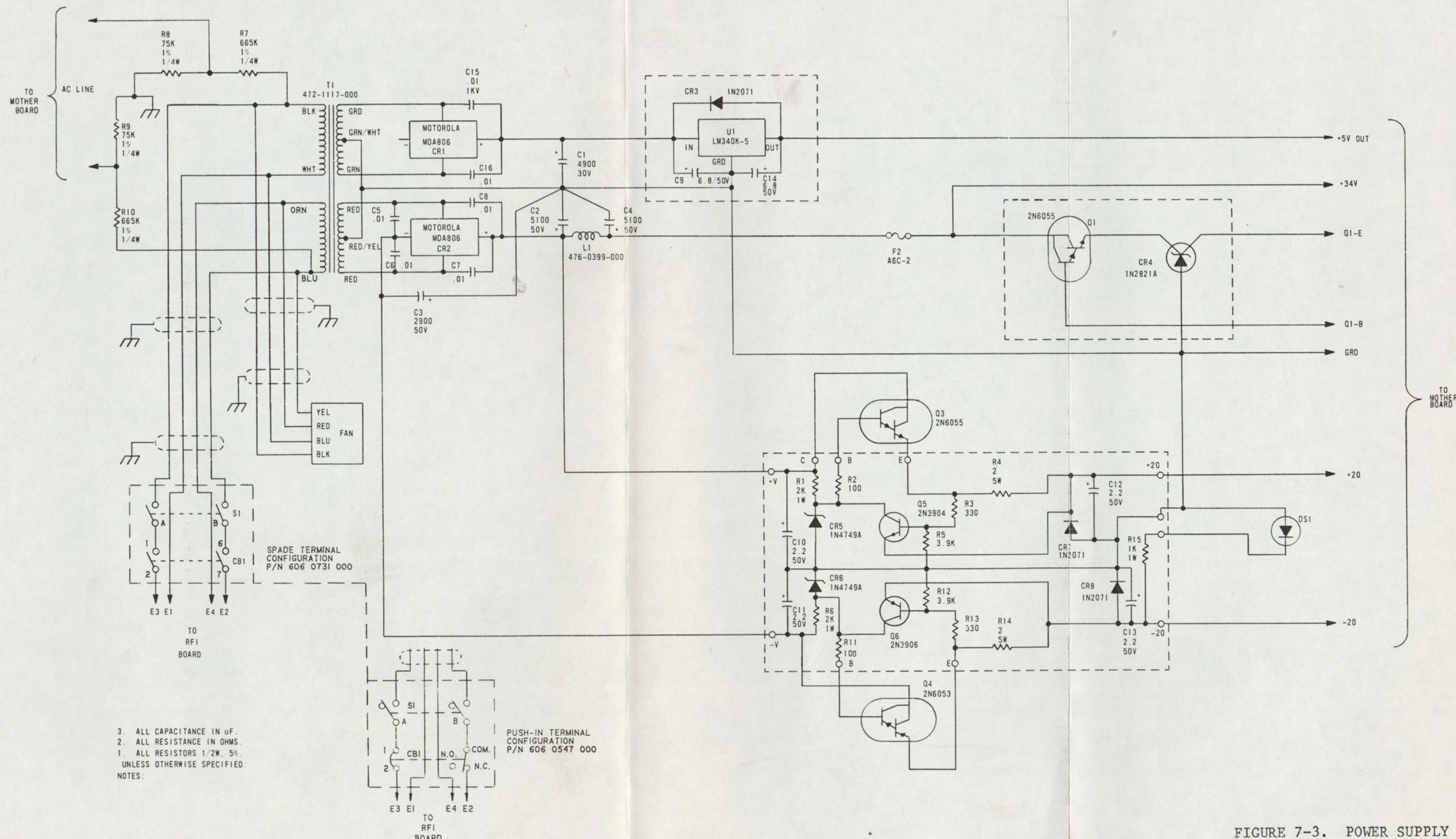


NOTES:

UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS ARE 1/4W, 5%.
3. ALL CAPACITANCE IN uF.
4. ALL INDUCTANCE IN uH.

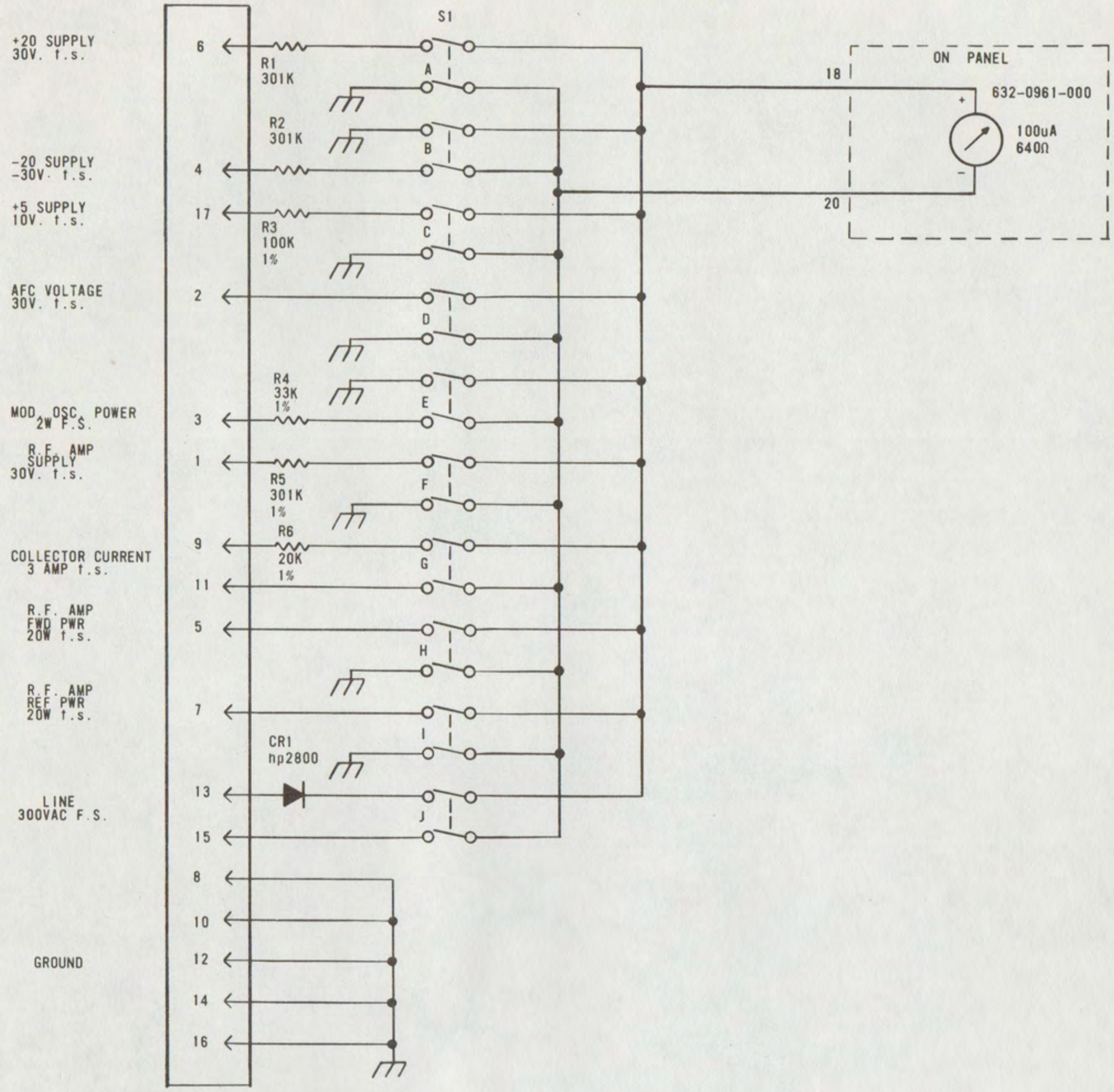
FIGURE 7-2. RFI FILTER
FM EXCITER
843 1714 001



3. ALL CAPACITANCE IN uF.
2. ALL RESISTANCE IN OHMS.
1. ALL RESISTORS 1/2W, 5%.
UNLESS OTHERWISE SPECIFIED
NOTES:

FIGURE 7-3. POWER SUPPLY
FM EXCITER
843 2119 001

888-2164-006
7-7/7-8



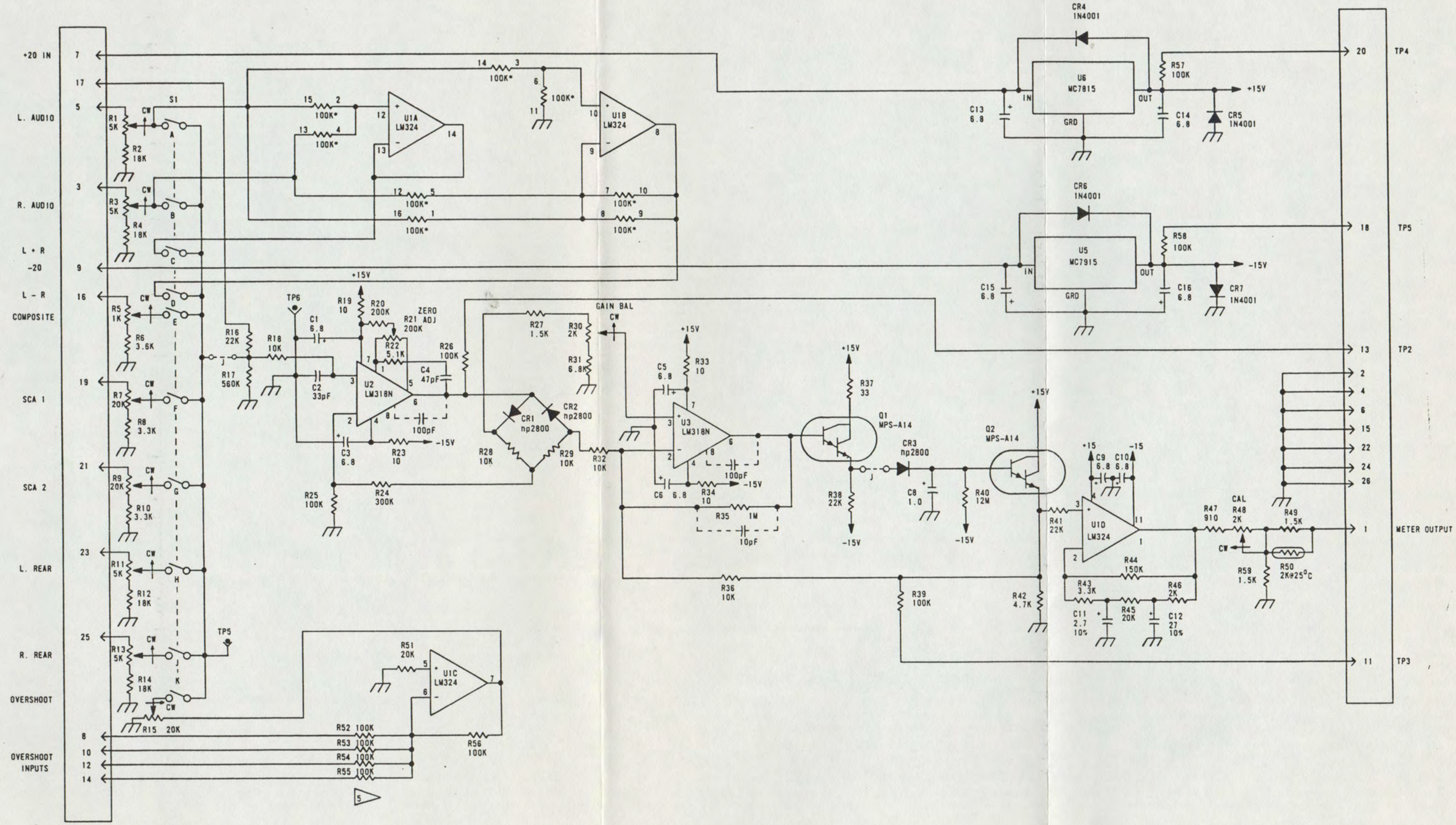
2. RESISTANCE IN OHMS.

1. RESISTORS ARE 1/4W 1%

NOTES:

FIGURE 7-4. DC METER BOARD
FM EXCITER
839 2835 001

WARNING: Disconnect primary power prior to servicing.



5 R52, R53, R54, R55 ARE 1/4W, 1%.
4. * = PART OF U4, RA08-100KN
3. ALL CAPACITANCE IN uF.
2. ALL RESISTANCE IN OHMS.
1. ALL RESISTORS ARE 1/2 W, 5%, LOW NOISE. UNLESS OTHERWISE SPECIFIED:
NOTES:

FIGURE 7-5. MODULATION METER BOARD
FM EXCITER
843 2118 001

APPENDIX A

MANUFACTURERS DATA

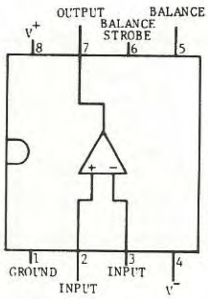
APPENDIX A

MANUFACTURERS DATA

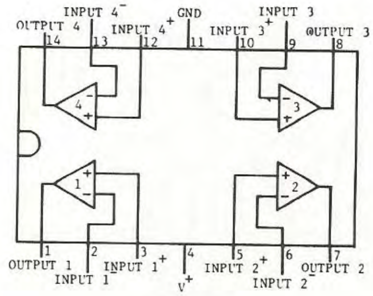
A-1. INTRODUCTION

A-2. This appendix consists of the following technical data which identifies operating characteristics and parameters for various replaceable items used throughout the MX-15 FM EXCITER circuitry.

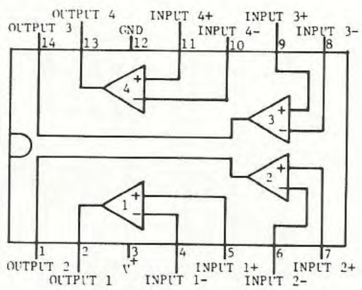
1. Integrated Circuit Connection Diagrams
2. Technical Data Sheet, AD521-JD Instrumentation Amplifier
3. Technical Data Sheet, XR2206 CP Function Generator
4. Technical Data Sheet, HA-4741 Quad Operational Amplifier
5. Technical Data Sheet, ILQ74 Quad Optical Isolator
6. Technical Data Sheet, LM318-N Operational Amplifier
7. Technical Data Sheet, DM-74LS161 Programmable Divider
8. Technical Data Sheet, TL430C Programmable Zener Diode
9. Technical Data Sheet, 74C932N Phase Detector
10. Engineering Report, A New Filtering Process For Optimal Overshoot Control.



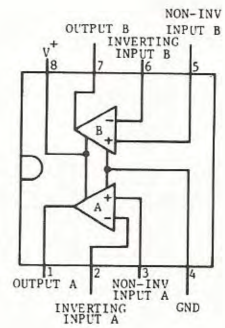
LM311N
VOLTAGE COMPARATOR



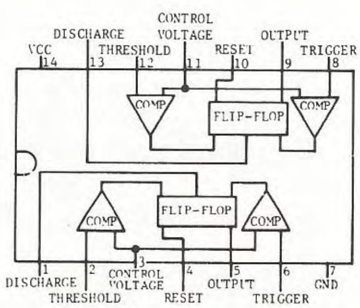
LM324N
QUAD OPERATIONAL AMPLIFIER



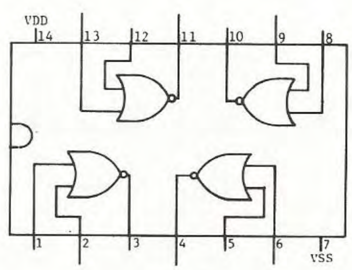
LM339N
QUAD VOLTAGE COMPARATOR



LM358N
DUAL OPERATIONAL AMPLIFIER

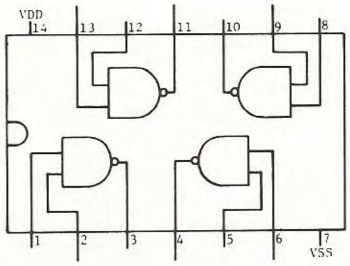


LM556CN
DUAL TIMER

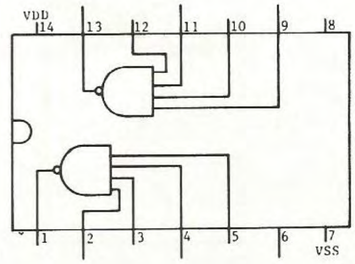


4001B
QUAD 2-INPUT NOR GATE

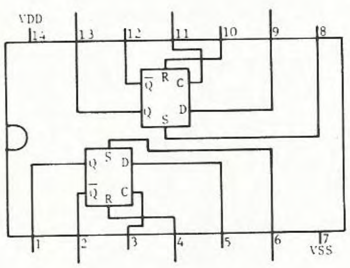
INTEGRATED CIRCUIT CONNECTION DIAGRAMS (SHEET 1 OF 3)



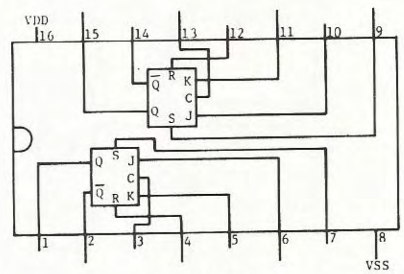
4011B
QUAD 2-INPUT NAND GATE



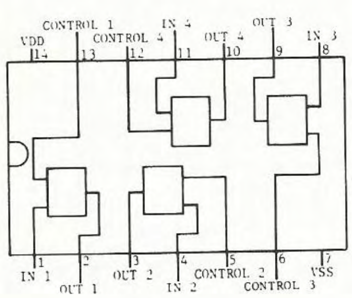
4012B
DUAL 4-INPUT NAND GATE



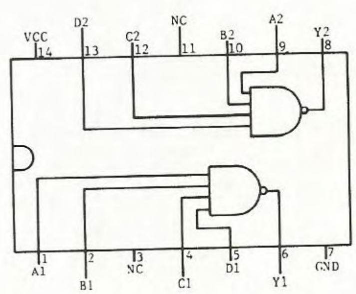
4013B
DUAL D FLIP-FLOP



4027B
DUAL J-K FLIP-FLOP



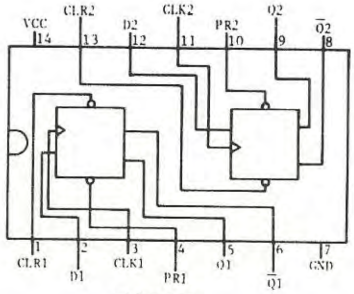
4066B
QUAD ANALOG SWITCH/MULTIPLEXER



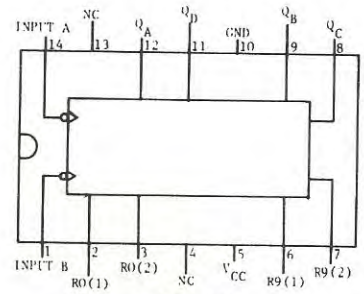
7420N
DUAL 4-INPUT NAND GATE

INTEGRATED CIRCUIT CONNECTION DIAGRAMS (SHEET 2 OF 3)

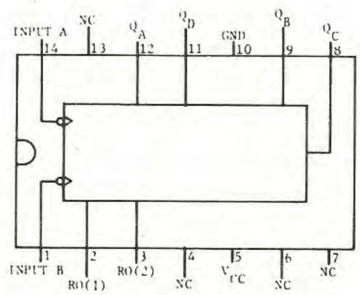
 WARNING: Disconnect primary power prior to servicing.



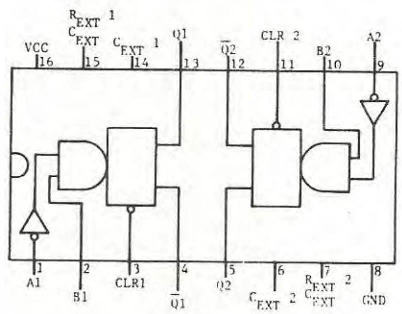
7474N
POSITIVE EDGE TRIGGERED
DUAL D FLIP-FLOP WITH
PRESET AND CLEAR



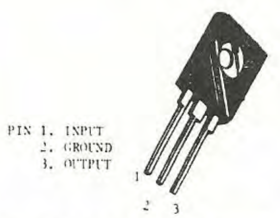
7490AN
DIVIDE BY 10 COUNTER



7493AN
DIVIDE BY 16 COUNTER

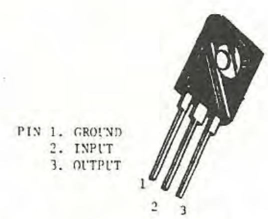


74123N
DUAL RETRIGGERABLE ONE SHOT



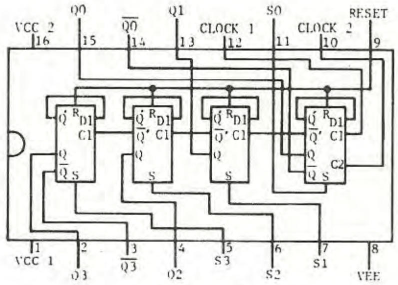
MC7806CT-POSITIVE 6 VOLT FIXED
VOLTAGE REGULATOR

MC7815CT-POSITIVE 15 VOLT FIXED
VOLTAGE REGULATOR



MC7906CT-NEGATIVE 6 VOLT FIXED
VOLTAGE REGULATOR

MC7915CT-NEGATIVE 15 VOLT FIXED
VOLTAGE REGULATOR



MC10178L
DIVIDE BY 16 COUNTER

INTEGRATED CIRCUIT CONNECTION DIAGRAMS (SHEET 3 OF 3)

WARNING: Disconnect primary power prior to servicing.

ANALOG DEVICES

Integrated Circuit Precision Instrumentation Amplifier

AD521

FEATURES

Programmable Gains from 0.1 to 1000
Floating Differential Inputs
High CMRR: 110dB min
Complete Input Protection, Power ON and Power OFF
Functionally Complete with the Addition of Two Resistors
Internally Compensated
Gain Bandwidth Product: 40MHz
Output Current Limited: 25mA
Extremely Low Cost: $8.50 (100's, J)

PRODUCT DESCRIPTION

The AD521 is the second generation, low cost, monolithic I.C. instrumentation amplifier developed by Analog Devices. A true instrumentation amplifier, the AD521 is a controlled gain block with differential inputs and an accurately programmable input/output gain relationship.

The AD521, like its predecessor the AD520, should not be confused with an operational amplifier, even though several manufacturers (including Analog Devices) offer op amps that can be used as building blocks in variable gain instrumentation amplifier circuits. An op amp is merely a high gain component requiring the addition of external feedback to complete the amplification function. Because of the limitations of resistor matching in the external feedback circuit and the relatively low input impedance resulting from the input resistors, an instrumentation amplifier circuit designed around op amps frequently provides less than satisfactory performance. Since the AD521 is a complete amplification circuit which does not depend upon external resistor matching for input/output isolation it maintains its high CMRR (110dB min) in any application. In addition, the high impedance inputs are fully protected against over voltages up to 15V greater than the supply voltage.

The AD521 can be operated at gains from 0.1 to greater than 1000 with the addition of only two programming resistors. Excellent d.c. characteristics are realized through the device's inherently low offset and gain drift and optional one-pot nulling. Dynamic performance is also outstanding with a gain bandwidth product of 40MHz, full peak response of 100kHz and a 10V/µsec slew rate.

The AD521 I.C. instrumentation amplifier is available in three different versions, depending on accuracy and operating temperature range: the economical "J" specified from 0°C to +70°C, the low drift "K", also specified from 0°C to +70°C and the "S", guaranteed over the full MIL-temperature range, -55°C to +125°C. All versions are packaged in a 14 pin DIP.

PRODUCT HIGHLIGHTS

1. The AD521 is a true instrumentation amplifier in integrated circuit form, offering the user performance comparable to many modular instrumentation amplifiers at a fraction of the cost.
2. The AD521 is functionally complete with the addition of two resistors. Gain can be preset from 0.1 to more than 1000.
3. The AD521 is fully protected for input levels up to 15V beyond the supply voltage and 30V differential at the inputs.
4. Internally compensated for all gains, the AD521 also offers the user the provision for limiting bandwidth.
5. Offset nulling can be achieved with an optional trim pot.
6. The AD521 offers superior dynamic performance with a gain bandwidth product of 40MHz, full peak response of 100kHz (independent of gain) and a settling time of 5µsec to 0.1% of a 10V step.
7. Every AD521 is baked for 40 hours at +150°C and temperature cycled ten times from -65°C to +150°C.

Route 1 Industrial Park; P.O. Box 280; Norwood, Mass. 02062
Tel: 617/329-4700 TWX: 710/394-6577
West Coast 213/595-1783
Mid-West 312/894-3300
Texas 214/231-5094

WARNING: Disconnect primary power prior to servicing.

SPECIFICATIONS (typical @ $V_S = \pm15V$, $R_L = 2k\Omega$ and $T_A = 25°C$ unless otherwise specified)

MODEL	AD521J	AD521K	AD521S
GAIN			
Range (For Specified Operation. Note 1.)	1 to 1000	*	*
Equation	$G = R_S/R_G$ V/V	*	*
Error from Equation	(±0.25–0.004G)%	*	*
Nonlinearity (Note 2)			
1≤G≤1000	0.2% max	*	*
Gain Temperature Coefficient	±(3 ±0.05G)ppm/°C	*	±(15 ±0.4G)ppm/°C
OUTPUT CHARACTERISTICS			
Rated Output	±10V, ±10mA min	*	*
Output at Maximum Operating Temperature	±10V @ 5mA min	*	*
Impedance	0.1Ω	*	*
DYNAMIC RESPONSE			
Small Signal Bandwidth (±3dB)			
G = 1	>2MHz	*	*
G = 10	300kHz	*	*
G = 100	200kHz	*	*
G = 1000	40kHz	*	*
Small Signal, ±1.0% Flatness			
G = 1	75kHz	*	*
G = 10	26kHz	*	*
G = 100	24kHz	*	*
G = 1000	6kHz	*	*
Full Peak Response (Note 3)	100kHz	*	*
Slew Rate, 1≤G≤1000	10V/µsec	*	*
Settling Time (any 10V step to within 10mV of Final Value)			
G = 1	7µsec	*	*
G = 10	5µsec	*	*
G = 100	10µsec	*	*
G = 1000	35µsec	*	*
Differential Overload Recovery (±30V Input to within 10mV of Final Value) (Note 4)			
G = 1000	50µsec	*	*
Common Mode Step Recovery (30V Input to within 10mV of Final Value) (Note 5)			
G = 1000	10µsec	*	*
VOLTAGE OFFSET (may be nulled)			
Input Offset Voltage (V_{OS_1})	3mV max (2mV typ)	1.5mV max (0.5mV typ)	**
vs. Temperature	15µV/°C max (7µV/°C typ)	5µV/°C max (1.5µV/°C typ)	**
vs. Supply	3µV/%	*	*
Output Offset Voltage (V_{OS_O})	400mV max (200mV typ)	200mV max (30mV typ)	**
vs. Temperature	400µV/°C max (150µV/°C typ)	150µV/°C max (50µV/°C typ)	**
vs. Supply (Note 6)	0.005V_{OS_O}/%	*	*
INPUT CURRENTS			
Input Bias Current (either input)	80nA max	40nA max	**
vs. Temperature	1nA/°C max	500pA/°C max	**
vs. Supply	2%/V	*	*
Input Offset Current	20nA max	10nA max	**
vs. Temperature	250pA/°C max	125pA/°C max	**
INPUT			
Differential Input Impedance (Note 7)	$3 \times 10^9 \Omega \| 1.8pF$	*	*
Common Mode Input Impedance (Note 8)	$6 \times 10^{10} \Omega \| 3.0pF$	*	*
Input Voltage Range for Specified Performance	±10V	*	*
Maximum Voltage without Damage to Unit, Power ON or OFF Differential Mode (Note 9)	30V	*	*
Voltage at either input (Note 10)	V_S ±15V	*	*
Common Mode Rejection Ratio, DC to 60Hz with 1kΩ source unbalance			
G = 1	70dB min (74dB typ)	74dB min (80dB typ)	**
G = 10	90dB min (94dB typ)	94dB min (100dB typ)	**
G = 1000	100dB min (104dB typ)	104dB min (114dB typ)	**
G = 1000	100dB min (110dB typ)	110dB min (120dB typ)	**
NOISE			
Voltage RTO (p-p) @ 0.1Hz to 10Hz (Note 10)	$\sqrt{(0.5G)^2 + (225)^2}\mu V$	*	*
RMS RTO, 10Hz to 10kHz	$\sqrt{(1.2G)^2 + (50)^2}\mu V$	*	*
Input Current, rms, 10Hz to 10kHz	15pA (rms)	*	*
REFERENCE TERMINAL			
Bias Current	3µA	*	*
Input Resistance	10MΩ	*	*
Voltage Range	±10V	*	*
Gain to Output	1	*	*
POWER SUPPLY			
Operating Voltage Range	±5 to ±18	*	*
Quiescent Supply Current	5mA max	*	*
TEMPERATURE RANGE			
Specified Performance	0 to +70°C	*	-55 to +125°C
Operating	-25 to +85°C	*	-55 to +125°C
Storage	-65 to +150°C	*	*
PRICE			
(1-24)	$12.75	$18.00	$30.00
(25-99)	$10.20	$14.40	$24.00
(100-999)	$8.50	$12.00	$20.00

*Specification same as AD521J.
**Specification same as AD521K.

Specifications and prices subject to change without notice.

NOTES:

1. Gains below 1 and above 1000 are realized by simply adjusting the gain setting resistors. For best results, input voltage should be restricted to ±10V for gains equal to or less than 1.

2. Nonlinearity is defined as the ratio of the deviation from the "best straight line" through a full scale output of ±9 volts to 18 volts. With a combination of high gain and ±10 volt output swing, distortion may increase to as much as 0.3%.

3. Full Peak Response is the typical frequency below which the amplifier will produce full output swing.

4. Differential Overload Recovery is the time it takes the amplifier to recover from a pulsed 30V differential input with 15V of common mode voltage, to within 10mV of final value. The test input is a 30V, 10μsec pulse at a 1kHz rate.(When a differential signal of greater than 11V is applied between the inputs, transistor clamps are activated which drop the excess input voltage across internal input resistors. If a continuous overload is maintained, power dissipated in these resistors causes temperature gradients and a corresponding change in offset voltage, and an added thermal time constant, but will not damage the device.)

5. Common Mode Step Recovery is the time it takes the amplifier to recover from a 30V common mode input with zero volts of differential signal to within 10mV of final value. The test input is a 30V, 10μsec pulse at a 1kHz rate. (When a common mode signal greater than V_S - 0.5V) is applied to the inputs, transistor clamps are activated which drop the excessive input voltage across internal input resistors. Power dissipated in these resistors causes temperature gradients and a corresponding change in offset voltage, and an added thermal time constant, but will not damage the device.)

6. Output Offset Voltage versus Power Supply Change is a constant 0.005 times the unnulled output offset per percent change in either power supply. If the output offset is nulled, the output offset change versus supply change is substantially reduced.

7. Differential Input Impedance is the impedance between the two inputs.

8. Common Mode Input Impedance is the impedance from *either* input to the power supplies.

9. Maximum Input Voltage (differential or at either input) is 30V when using ±15V supplies. A more general specification is that neither input may exceed either supply (even when V_S = 0) by more than 15V and that the difference between the two inputs must not exceed 30V. (See also Notes 4 and 5.)

10. 0.1Hz to 10Hz Peak-to-Peak Voltage Noise is defined as the maximum peak-to-peak voltage noise observed during 2 of 3 separate 10 second periods with the test circuit of Figure 6.

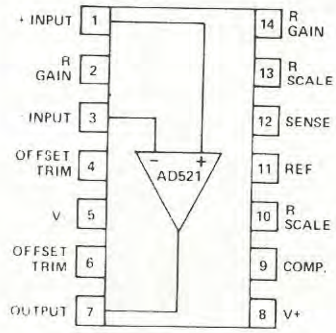


Figure 1. AD521 Pin Configuration

TO-116

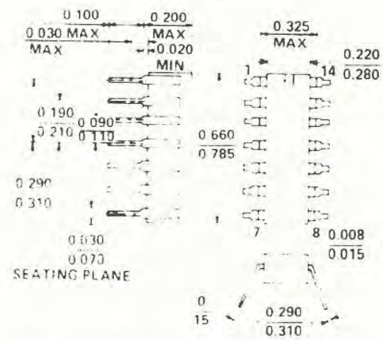
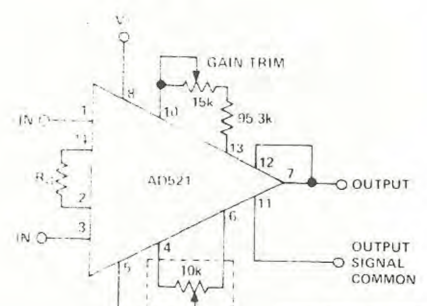


Figure 2. Physical Dimensions



GAIN	VALUE OF R_G
0.1	1MΩ
1	100kΩ
10	10kΩ
100	1kΩ
1000	100Ω

Figure 3. Operating Connections for AD521

INPUT OFFSET AND OUTPUT OFFSET

When specifying offsets and other errors in an operational amplifier, it is often convenient to refer these errors to the inputs. This enables the user to calculate the maximum error he would see at the output under any gain or circuit configuration. An op amp with 1mV of input offset voltage, for example, would produce 1V of offset at the output in a gain of 1000 configuration.

In the case of an instrumentation amplifier, where the gain is controlled in the amplifier, it is more convenient to separate errors into two categories. Those errors which simply add to the output signal and are unaffected by the gain, can be classified as output errors. Those which act as if they are associated with the input signal, such that their effect at the output is proportional to the gain, can be classified as input errors.

As an illustration, a typical AD521 might have a +30mV output offset and a -0.7mV input offset. In a unity gain configuration, the *total* output offset would be +29.3mV or the sum of the two. At a gain of 100, the output offset would be -40mV or: 30mV + 100(-0.7mV) = -40mV.

By separating these errors, one can evaluate the total error independent of the gain settings used, similar to the situation with the input offset specifications on an op amp. In a given gain configuration, both errors can be combined to give a total error with respect to either the input or output by the following formulae:

Total Error R.T.I. = input error + (output error/gain)

Total Error R.T.O. = (Gain x input error) + output error

As shown in Figure 4, the gain range on the AD521 can be extended considerably by adding an attenuator in the sense terminal feedback path (as well as adjusting the ratio, R_S/R_g). Since the sense terminal is the inverting input to the output amplifier, the additional gain to the output is controlled by R_1 and R_2. This gain factor is $1 + R_2/R_1$.

Where offset errors are critical, a resistor equal to the parallel combination of R_1 and R_2 should be placed between pin 11 and V_{REF}. This minimized the offset errors resulting from the input currents at the sense terminal flowing in R_1 and R_2. Note that gain changes introduced by changing the R_1/R_2 attenuator will have a minimum effect on output offset if the offset is carefully nulled at the highest gain setting.

When a predetermined output offset is desired, V_{REF} can be placed in series with pin 11. This offset is then multiplied by the gain factor $1 + R_2/R_1$ as shown in the equation of Figure 4.

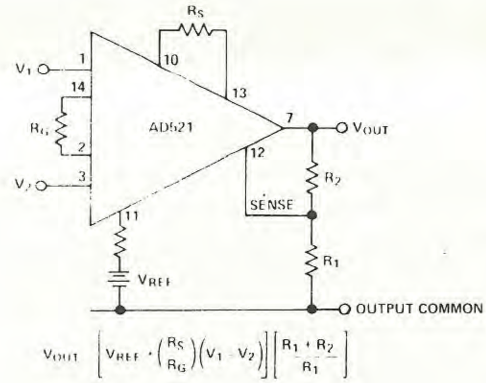


Figure 4. Circuit for utilizing some of the unique features of the AD521. Note that gain changes introduced by changing R_1 and R_2 will have a minimum effect on output offset if the offset is carefully nulled at the highest gain setting.

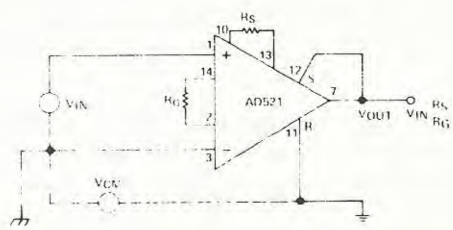


Figure 5. Ground loop elimination. The reference input, Pin 11, allows remote referencing of ground potential. Differences in ground potentials are attenuated by the high CMRR of the 521.

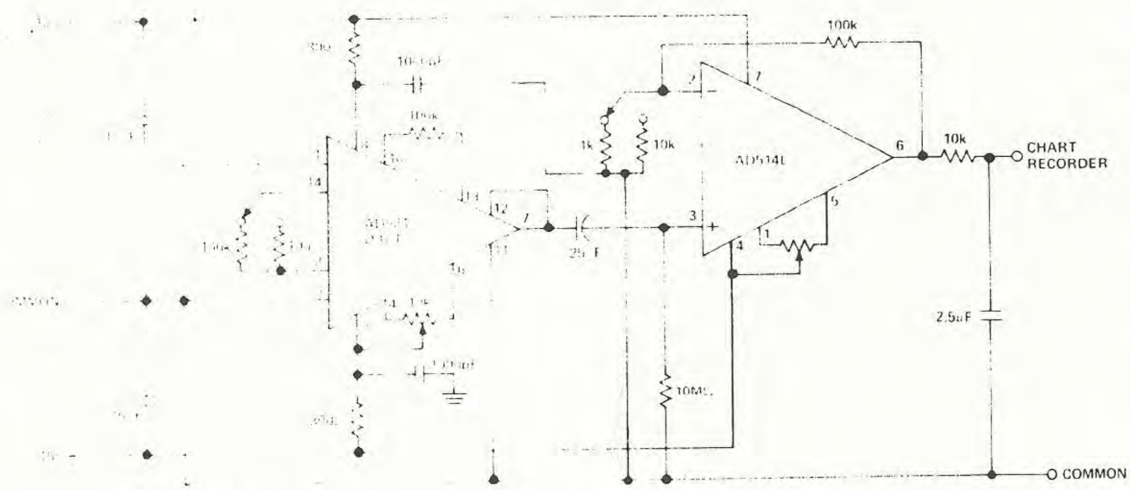


Figure 6. Test circuit for measuring peak to peak noise in the bandwidth 0.1Hz to 10Hz. Typical measurements are found by reading the maximum peak to peak voltage noise of the device under test (D.U.T.) for 3 observation periods of 10 seconds each.

XR-2206

Monolithic Function Generator

The XR-2206 is a monolithic function generator integrated circuit capable of producing high quality sine, square, triangle, ramp and pulse waveforms of high stability and accuracy. The output waveforms can be both amplitude and frequency modulated by an external voltage. Frequency of operation can be selected externally over a range of 0.01 Hz to more than 1 MHz.

The XR-2206 is ideally suited for communications, instrumentation, and function generator applications requiring sinusoidal tone, AM, FM or FSK generation. It has a typical drift specification of 20 ppm/°C. The oscillator frequency can be linearly swept over a 2000: 1 frequency range with an external control voltage with very little affect on distortion.

As shown in Figure 1, the monolithic circuit is comprised of four functional blocks: a voltage-controlled oscillator (VCO); an analog multiplier and sine-shaper; a unity gain buffer amplifier; and a set of current switches. The internal current switches transfer the oscillator current to any one of the two external timing resistors to produce two discrete frequencies selected by the logic level at the FSK input terminal (pin 9).

FEATURES

Low Sinewave Distortion (THD .5%) – insensitive to signal sweep
Excellent Stability (20 ppm/°C, typ)
Wide Sweep Range (2000:1, typ)
Low Supply Sensitivity (0.01%/V, typ)
Linear Amplitude Modulation
Adjustable Duty-Cycle (1% to 99%)
TTL Compatible FSK Controls
Wide Supply Range (10V to 26V)

APPLICATIONS

Waveform Generation
Sine, Square, Triangle, Ramp
Sweep Generation
AM/FM Generation
FSK and PSK Generation
Voltage-to-Frequency Conversion
Tone Generation
Phase-Locked Loops

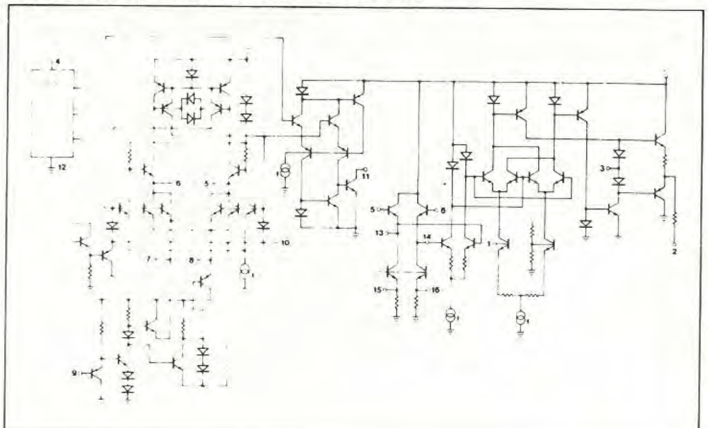
ABSOLUTE MAXIMUM RATINGS

Power Supply	26V
Power Dissipation	750 mW
Derate above 25°C	5 mW/°C
Total Timing Current	6 mA
Storage Temperature	−65°C to +150°C

AVAILABLE TYPES

Part Number	Package Types (16 Pin DIP)	Operating Temperature Range
XR-2206M	Ceramic	−55°C to +125°C
XR-2206N	Ceramic	0°C to +75°C
XR-2206P	Plastic	0°C to +75°C
XR-2206CN	Ceramic	0°C to +75°C
XR-2206CP	Plastic	0°C to +75°C

EQUIVALENT SCHEMATIC DIAGRAM



FUNCTIONAL BLOCK DIAGRAM

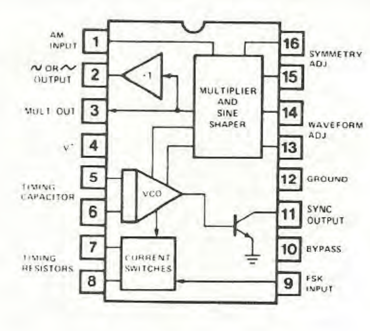


Figure 1.

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., P.O. Box 62229, Sunnyvale, CA 94088
(408) 732-7970 TWX 910-339-9233

10-75 REV 1

WARNING: Disconnect primary power prior to servicing.

ELECTRICAL CHARACTERISTICS

Test Conditions: Test Circuit of Fig. 2, $V^{+} = 12V$, $T_A = 25°C$, $C = 0.01\ \mu F$, $R_1 = 100\ K\Omega$, $R_2 = 10\ K\Omega$ $R_3 = 25\ K\Omega$ unless otherwise specified. S_1 open for triangle, closed for sinewave.

CHARACTERISTICS	XR-2206/XR-2206M MIN.	TYP.	MAX.	XR-2206C MIN.	TYP.	MAX.	UNITS	CONDITIONS
Supply Voltage								
Single Supply	10		26	10		26	V	
Split Supply	±5		±13	±5		±13	V	
Supply Current		12	17		14	20	mA	$R_1 \geq 10\ K\Omega$
Oscillator Section								
Max. Operating Frequency	0.5	1		0.5	1		MHz	$C=1000\ pF$, $R_1=1\ K\Omega$
Lowest Practical Frequency		0.01			0.01		Hz	$C=50\ \mu F$, $R_1=2\ M\Omega$
Frequency Accuracy		±1	±4		±2		% of f_o	$f_o=1/R_1C$
Temperature Stability		±10	±50		±20		ppm/°C	$0°C \leq T_A \leq 75°C$, $R_1=R_2=20\ K\Omega$
Supply Sensitivity		0.01	0.1		0.01		%/V	$V_{LOW} = 10V$, $V_{HIGH} = 20V$, $R_1 = R_2 = 20\ K\Omega$
Sweep Range	1000:1	2000:1			2000:1		$f_H = f_L$	f_H @ $R_1 = 1\ K\Omega$; f_L @ $R_1 = 2\ M\Omega$
Sweep Linearity								
10:1 Sweep		2			2		%	$f_L = 1$ kHz, $f_H = 10$ kHz
1000:1 Sweep		8			8		%	$f_L = 100$ Hz, $f_H = 100$ kHz
FM Distortion		0.1			0.1		%	±10% Deviation
Recommended Timing Components								
Timing Capacitor: C	0.001		100	0.001		100	μF	See Figure 5
Timing Resistors: R_1 & R_2	1		2000	1		2000	$K\Omega$	
Triangle/Sinewave Output								See Note 1, Fig.
Triangle Output		160			160		mV/KΩ	Fig. 2 S_1 Open
Sinewave Output	40	60	80		60		mV/KΩ	Fig. 2 S_1 Closed
Max. Output Swing		6			6		Vpp	
Output Impedance		600			600		Ω	
Triangle Linearity		1			1		%	
Amplitude Stability		0.5			0.5		dB	For 1000:1 Sweep
Sinewave Distortion								$R_1 = 30\ K\Omega$
Without Adjustment		2.5			2.5		%	See Figure 11.
With Adjustment		0.4	1.0		0.5	1.5	%	See Figure 12
Amplitude Modulation								
Input Impedance	50	100		50	100		KΩ	
Modulation Range		100			100		%	
Carrier Suppression		55			55		dB	
Linearity		2			2		%	For 95% modulation
Square Wave Output								Measured at Pin 11
Amplitude		12			12		Vpp	
Rise Time		250			250		nsec	$C_L = 10$ pF
Fall Time		50			50		nsec	$C_L = 10$ pF
Saturation Voltage		0.2	0.4		0.2	0.4	V	$I_L = 2$ mA
Leakage Current		0.1	20		0.1	100	μA	$V_{11}= 26V$
FSK Keying Level (Pin 9)	0.8	1.4	2.4	0.8	1.4	2.4	V	See Section on Circuit Controls
Reference Bypass Voltage	2.9	3.1	3.3	2.5	3	3.5	V	Measured at Pin 10.

Note 1: Output Amplitude is inversely proportional to the resistance R_3 on Pin 3. See Figure 3

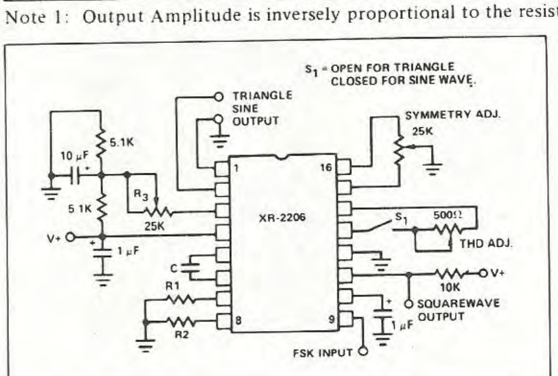


Figure 2. Basic Test Circuit

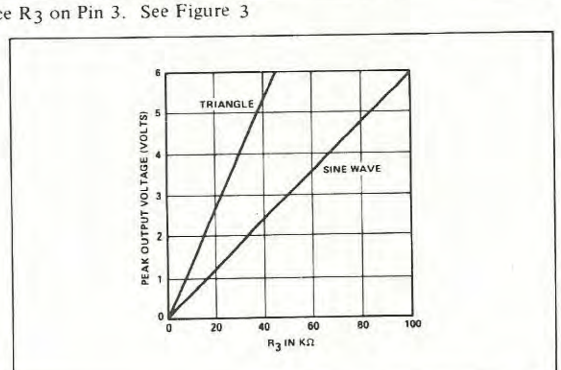


Figure 3. Output Amplitude as a Function of Resistor R_3 at Pin 3.

WARNING: Disconnect primary power prior to servicing.

TYPICAL OPTOELECTRONIC CHARACTERISTIC CURVES FOR EACH CHANNEL

FIGURE 1. RELATIVE OUTPUT VS TEMPERATURE

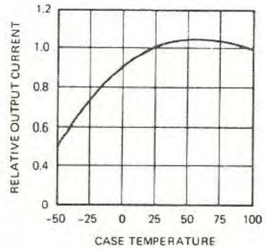


FIGURE 2. DARK CURRENT VS TEMPERATURE

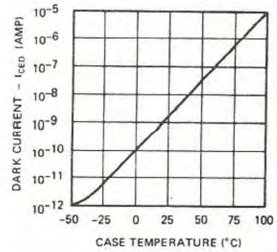


FIGURE 3. TRANSFER CHARACTERISTICS

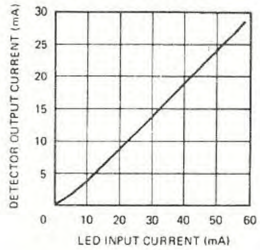


FIGURE 4. DETECTOR OUTPUT CHARACTERISTICS

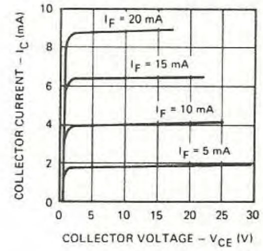
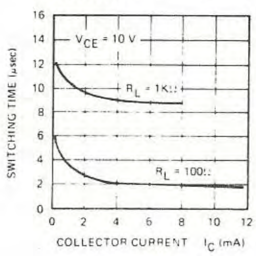


FIGURE 5. SWITCHING TIME VS COLLECTOR CURRENT



WARNING: Disconnect primary power prior to servicing.

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-4741

Quad Operational Amplifier

FEATURES

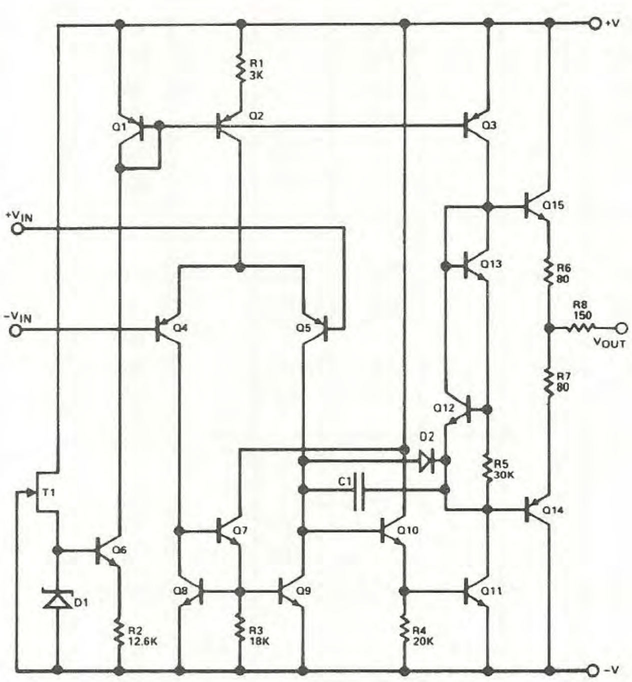
- SLEW RATE — 1.6 V/μS (TYP.)
- BANDWIDTH — 3.5 MHz (TYP.)
- INPUT VOLTAGE NOISE (f = 1KHz) — 9 NV/$\sqrt{Hz}$ (TYP.)
- INPUT OFFSET VOLTAGE — 0.5 mV (TYP.)
- INPUT BIAS CURRENT — 60 nA (TYP.)
- SUPPLY RANGE — ± 2V to ± 20V
- NO CROSSOVER DISTORTION
- STANDARD QUAD PIN–OUT

DESCRIPTION

The HA-4741 contains four general purpose operational amplifiers on a monolithic chip. The performance of each amplifier is equal to or better than the 741 type amplifier in all respects. Its superior bandwidth, slew rate and noise characteristics make it an excellent choice for active filter or audio amplifier applications.

The HA-4741-2 has guaranteed operation over -55°C to +125°C and can be furnished to meet MIL-STD-883 (HA-4741-8). The HA-4741-5 is guaranteed over 0°C to +75°C.

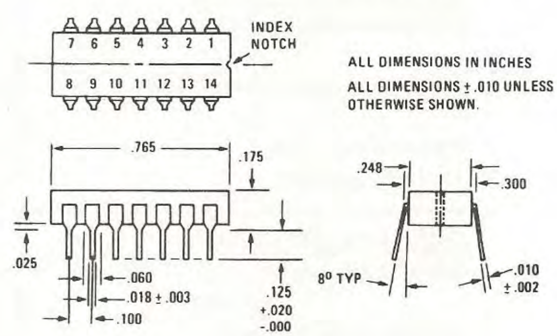
SCHEMATIC DIAGRAM



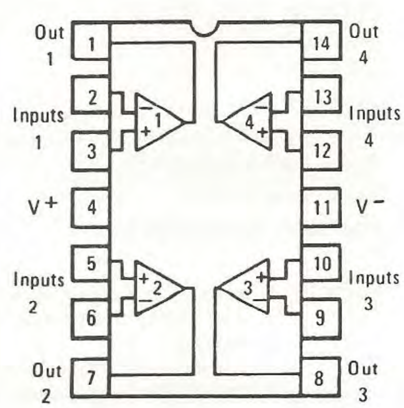
(¼) HA-4741

PACKAGE/PIN OUT

14 LEAD CERAMIC D. I. P. (CERDIP)



PIN OUT



WARNING: Disconnect primary power prior to servicing.

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

T_A = +25°C Unless Otherwise Stated		Power Dissipation (Note 3)	880mW
Voltage Between V+ and V− Terminals	40.0V	Operating Temperature Range	
Differential Input Voltage	±30.0V	HA-4741-2	$-55°C \leq T_A \leq +125°C$
Input Voltage (Note 1)	±15.0V	HA-4741-5	$0°C \leq T_A \leq +75°C$
Output Short Circuit Duration (Note 2)	Indefinite	Storage Temperature Range	$-65°C \leq T_A \leq +150°C$

ELECTRICAL CHARACTERISTICS

V+ = 15V, V− = −15V		HA-4741-2 −55°C to +125°C			HA-4741-5 0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS								
Offset Voltage	+25°C		0.5	3.0		1.0	5.0	mV
	Full		4.0	5.0		5.0	6.5	mV
Av. Offset Voltage Drift	Full		5			5		μV/°C
Bias Current	+25°C		60	200		60	300	nA
	Full			325			400	nA
Offset Current	+25°C		15	30		30	50	nA
	Full			75			100	nA
Common Mode Range	Full	±12			±12			V
Differential Input Resistance	+25°C		5			5		MΩ
Input Noise Voltage (f = 1KHz)	+25°C		9			9		$nV/\sqrt{Hz}$
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Note 4)	+25°C	50K	100K		25K	50K		V/V
	Full	25K			15K			V/V
Common Mode Rejection Ratio (Note 8)	+25°C	80			80			dB
	Full	74			74			dB
Channel Separation (Note 5)	+25°C		−108			−108		dB
Small Signal Bandwidth	+25°C		3.5			3.5		MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (R_L = 10K)	Full	±12	±13.7		±12	±13.7		V
(R_L = 2K)	Full	±10	±12.5		±10	±12.5		V
Full Power Bandwidth (Note 4)	+25°C		25			25		KHz
Output Current (Note 6)	Full	±5	±15		±5	±15		mA
Output Resistance	+25°C		300			300		Ω
TRANSIENT RESPONSE (Note 7)								
Rise Time	+25°C		75			75		ns
Overshoot	+25°C		25			25		%
Slew Rate	+25°C		±1.6			±1.6		V/μs
POWER SUPPLY CHARACTERISTICS								
Supply Current (I^+ or I^-)	+25°C			5.0			7.0	mA
Power Supply Rejection Ratio (Note 8)	Full	80			80			dB

NOTES:
1. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
2. One amplifier may be shorted to ground indefinitely.
3. Derate 5.8mW/°C above T_A = +25°C.
4. V_{OUT} = ±10, R_L = 2K
5. Referred to input; f = 10KHz, R_S = 1K
6. V_{OUT} = ±10
7. See pulse response characteristics
8. ΔV = ±5.0V

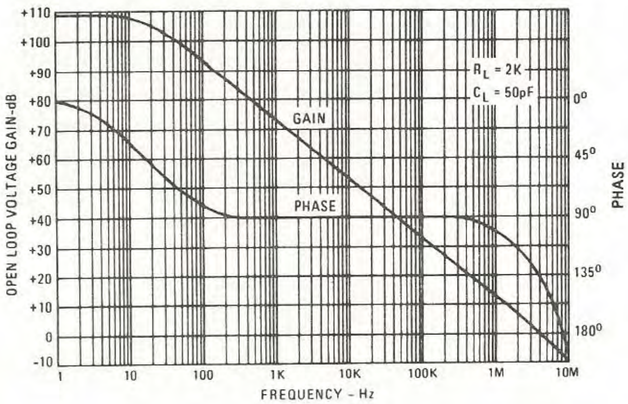
WARNING: Disconnect primary power prior to servicing.

PERFORMANCE CURVES

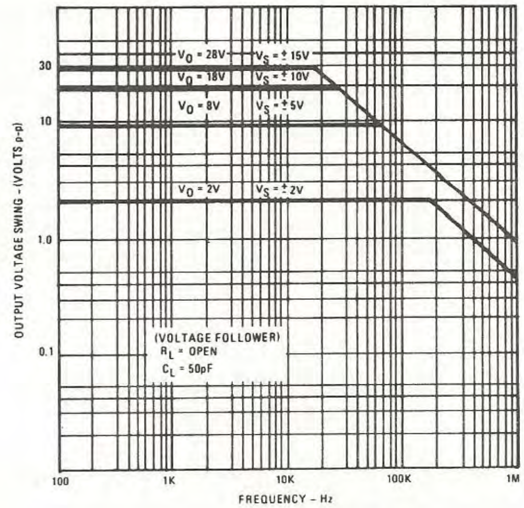
V+ = +15V, V− = −15V, T_A = +25°C

Unless Otherwise Stated.

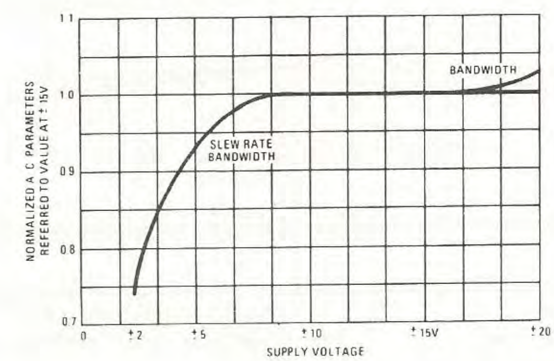
OPEN LOOP FREQUENCY RESPONSE



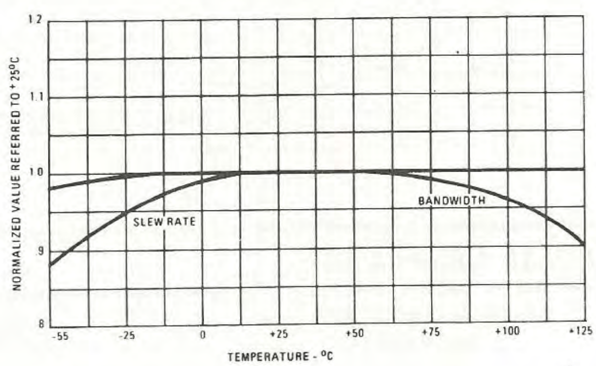
OUTPUT VOLTAGE SWING VS. FREQUENCY



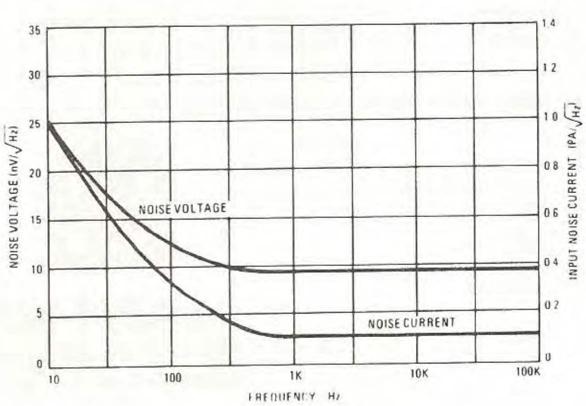
NORMALIZED AC PARAMETERS VS. SUPPLY VOLTAGE



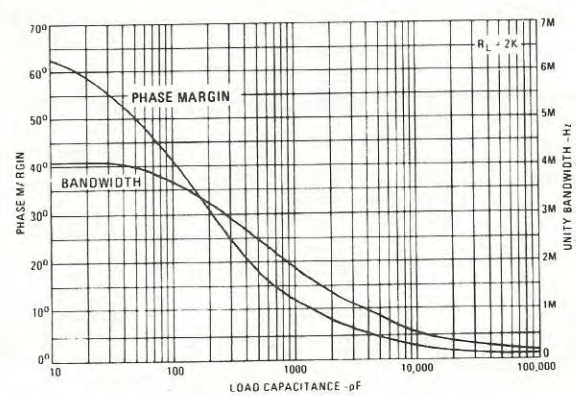
NORMALIZED AC PARAMETERS VS. TEMPERATURE



INPUT NOISE VS. FREQUENCY



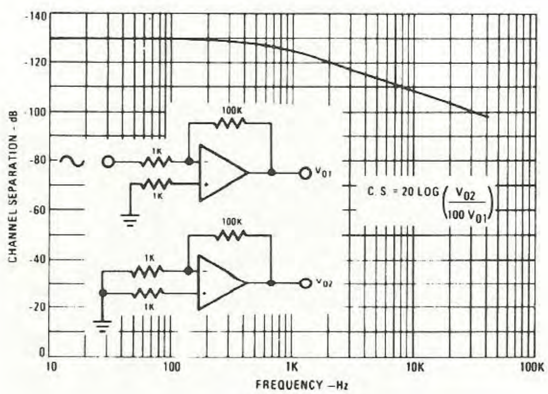
SMALL SIGNAL BANDWIDTH AND PHASE MARGIN VS. LOAD CAPACITANCE



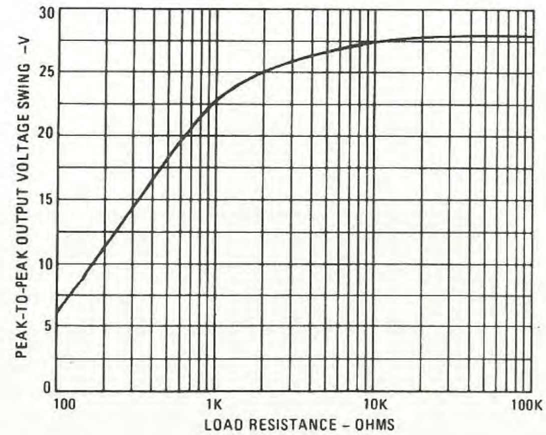
WARNING: Disconnect primary power prior to servicing.

PERFORMANCE CURVES (cont'd.)

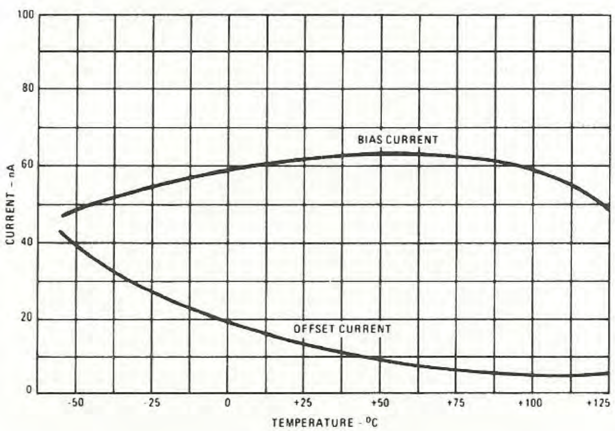
CHANNEL SEPARATION VS. FREQUENCY



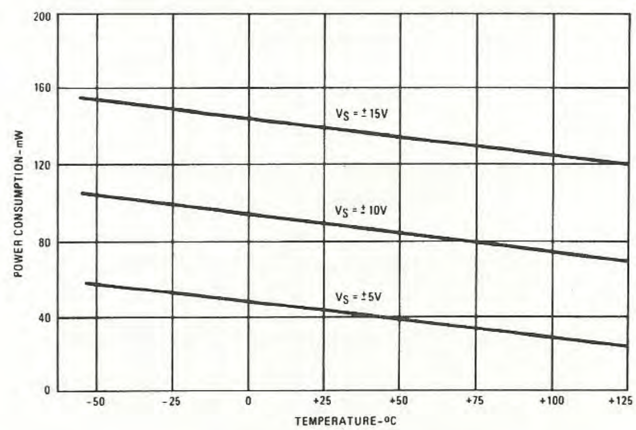
MAXIMUM OUTPUT VOLTAGE SWING VS. LOAD RESISTANCE



INPUT BIAS AND OFFSET CURRENT VS. TEMPERATURE

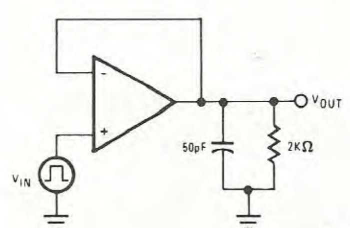


POWER CONSUMPTION VS. TEMPERATURE

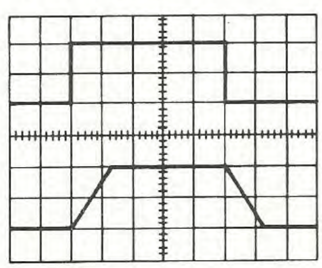


PULSE RESPONSE

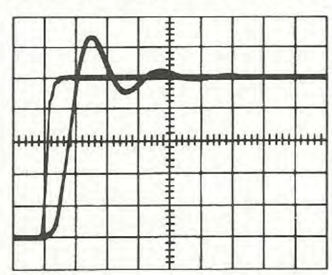
TRANSIENT RESPONSE/SLEW RATE CIRCUIT



SLEW RESPONSE (Volts: 5V/Div, Time: 5 μS/Div)



TRANSIENT RESPONSE (Volts: 10mV/Div , Time: 100ns/Div)



SALES OFFICES-

SUITE 103
4014 LONG BEACH BLVD
LONG BEACH, CALIF. 90807
(213) 426-7687

SUITE 230
1032 ELWELL COURT
PALO ALTO, CALIF. 94303
(415) 964-6443

SUITE 100
15 SPINNING WHEEL ROAD
HINSDALE, ILL. 60521
(312) 325-4242

SUITE 301
177 WORCHESTER STREET
WELLESLEY HILLS, MASS. 02181
(617) 237-5430

SUITE 132
7710 COMPUTER AVENUE
MINNEAPOLIS, MINN. 55435
(612) 835-2505

3215 E. MAIN STREET
ENDWELL, N. Y. 13760
(607) 754-5464

535 BROADHOLLOW ROAD
MELVILLE, L. I., N. Y. 11746
(516) 249-4500

SUITE 220
333 WEST FIRST STREET
DAYTON, OHIO 45402
(513) 226-0636

SUITE 325
650 E. SWEDESFORD ROAD
WAYNE, PENN. 19087
(215) 687-6680

SUITE 7G
777 S. CENTRAL EXPRESSWAY
RICHARDSON, TEXAS 75080
(214) 231-9031

P. O. BOX 883
MELBOURNE, FL. 32901
(305) 724-7430
TWX-510-959-6259

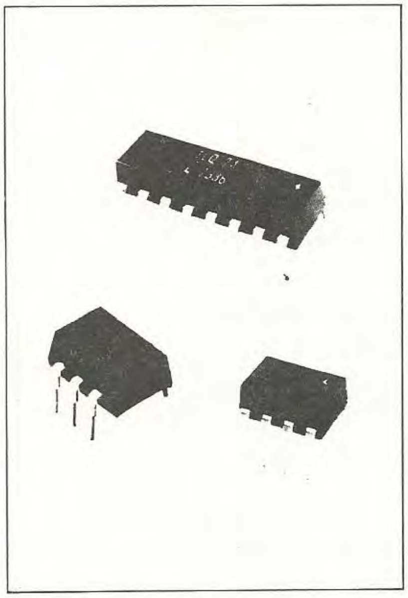
HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

WARNING: Disconnect primary power prior to servicing.

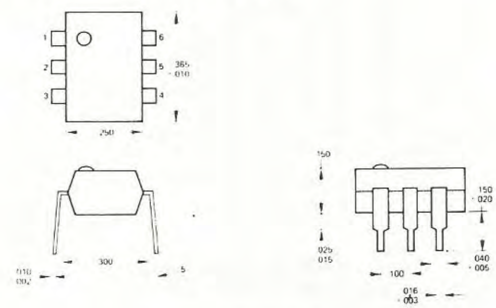
litronix

Iso-Lit 74 Series
IL-74, ILD-74, ILQ-74

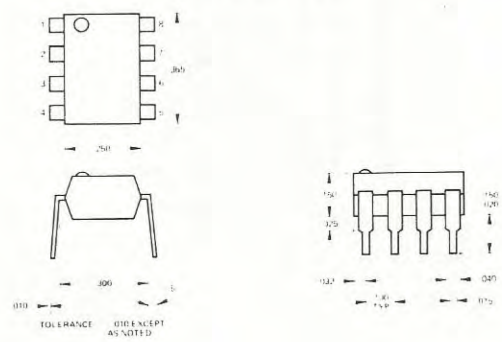
LOGIC-DRIVE OPTO-ISOLATOR



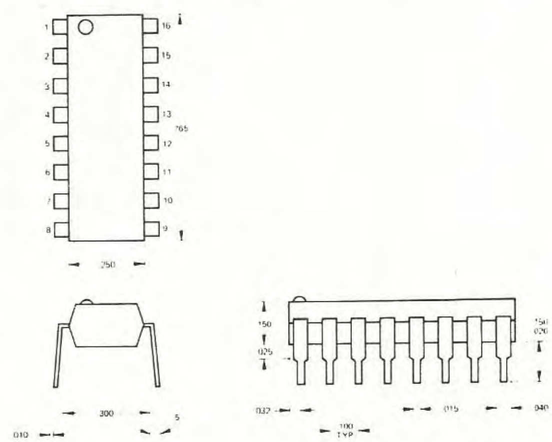
Package Dimensions (in inches)



ISO-LIT 74



ISO-LIT D74



ISO-LIT Q74

FEATURES

- 7400 series T^2L compatible
- 1500 volt breakdown voltage
- 35% typical transfer ratio
- 0.5 pF coupling capacitance
- Industry standard dual-in-line package
- Single channel, dual, and quad configurations

DESCRIPTION

IL-74 is an optically coupled pair employing a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-74 is especially designed for driving medium-speed logic, where it may be used to eliminate troublesome ground loop and noise problems. It can also be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation. The ILD-74 offers two isolated channels in a single DIP package while the ILQ-74 provides four isolated channels per package.

LITRONIX, INC., 19000 HOMESTEAD ROAD / VALLCO PARK / CUPERTINO, CALIF. 95014 / (408) 257-7910 / TWX 910-338-0022

 WARNING: Disconnect primary power prior to servicing.

TYPICAL OPTOELECTRONIC CHARACTERISTIC CURVES FOR EACH CHANNEL

FIGURE 1. RELATIVE OUTPUT VS TEMPERATURE

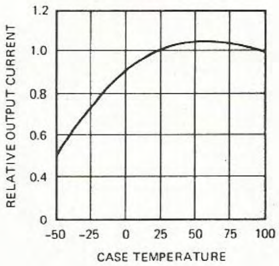


FIGURE 2. DARK CURRENT VS TEMPERATURE

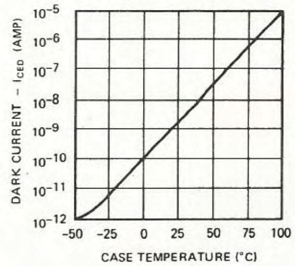


FIGURE 3. TRANSFER CHARACTERISTICS

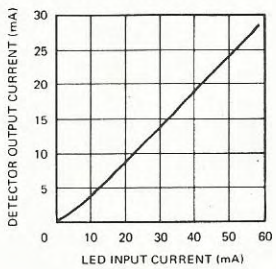


FIGURE 4. DETECTOR OUTPUT CHARACTERISTICS

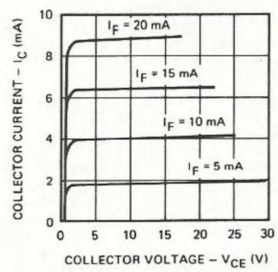
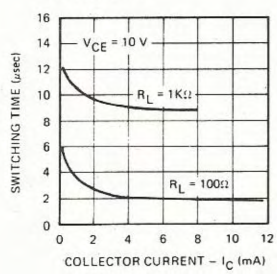


FIGURE 5. SWITCHING TIME VS COLLECTOR CURRENT

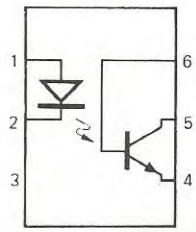


WARNING: Disconnect primary power prior to servicing.

PIN CONFIGURATIONS

ISO-LIT 74

(TOP VIEW)

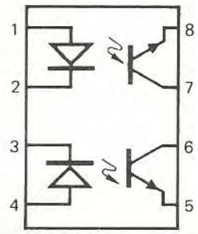


LED CHIP ON PIN 2
PT CHIP ON PIN 5

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	NC
4	EMITTER
5	COLLECTOR
6	BASE

ISO-LIT D74

(TOP VIEW)

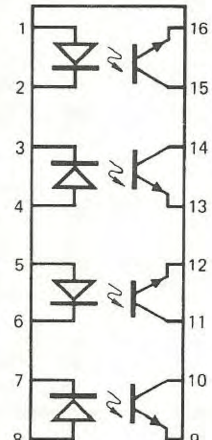


LED CHIPS ON PINS 2 AND 3
PT CHIPS ON PINS 6 AND 7

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	EMITTER
6	COLLECTOR
7	COLLECTOR
8	EMITTER

ISO-LIT Q74

(TOP VIEW)



LED CHIPS ON PINS 2, 3, 6, 7
PT CHIPS ON PINS 10, 11, 14, 15

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	ANODE
6	CATHODE
7	CATHODE
8	ANODE
9	EMITTER
10	COLLECTOR
11	COLLECTOR
12	EMITTER
13	EMITTER
14	COLLECTOR
15	COLLECTOR
16	EMITTER

LITRONIX, INC., 19000 HOMESTEAD ROAD / VALLCO PARK / CUPERTINO, CALIF. 95014 / (408) 257-7910 / TWX 910-338-0022

WARNING: Disconnect primary power prior to servicing.

MAXIMUM RATINGS

Gallium Arsenide LED (each channel)
- Power Dissipation @ 25°C . . . . . 150 mW
- Derate Linearly from 25°C . . . . . 1.33 mW/°C
- Continuous Forward Current . . . . . 100 mA
- Peak Inverse Voltage 3.0V

Detector-Silicon Phototransistor (each channel)
- Power Dissipation @ 25°C . . . . . 150 mW
- Derate Linearly from 25°C . . . . . 2.0 mW/°C
- Collector-Emitter Breakdown Voltage (BV_{CEO}) 20V

Package
- Total Package Dissipation at 25°C Ambient (LED Plus Detector)
  - IL-74 . . . . . 200 mW
  - ILD-74 . . . . . 400 mW
  - ILQ-74 . . . . . 500 mW
- Derate Linearly From 25°C
  - IL-74 . . . . . 3.3 mW/°C
  - ILD-74 . . . . . 5.33 mW/°C
  - ILQ-74 . . . . . 6.67 mW/°C
- Storage Temperature . . . . . −55°C to +150°C
- Operating Temperature . . . . . −55°C to +100°C
- Lead Soldering Time @ 260°C . . . . . 7.0 sec

ELECTRICAL CHARACTERISTICS PER CHANNEL (at 25°C Ambient)

Parameter	Min	Typ	Max	Units	Test Conditions
Gallium Arsenide LED					
Forward Voltage		1.3		V	I_F = 100 mA
Reverse Current		0.1		μA	V_R = 3.0V
Capacitance		100		pF	V_R = 0
Phototransistor Detector					
BV_{CEO}	20			V	I_C = 1 mA
I_{CEO}		5.0	500	nA	V_{CE} = 5V, I_F = 0
Collector-Emitter Capacitance		2.0		pF	V_{CE} = 0
Coupled Characteristics					
DC Current Transfer Ratio	0.125	0.35			I_F = 16 mA, V_{CE} = 5V
Capacitance, Input to Output		0.5		pF	
Breakdown Voltage	1500			V	
Resistance, Input to Output		100		GΩ	
V_{SAT}			0.5	V	I_C = 2 mA, I_F = 16 mA
Propagation Delay					
$t_{D\,ON}$		6.0		μs	R_L = 2.4KΩ, V_{CE} = 5V
$t_{D\,OFF}$		25		μs	I_F = 16 mA

NOTE: IL-74 only, does not apply to the ILD-74 or ILQ-74.

WARNING: Disconnect primary power prior to servicing.

Operational Amplifiers

LM318 operational amplifier general description

The LM318 is a precision high speed operational amplifier designed for applications requiring wide bandwidth and high slew rate. It features a factor of ten increase in speed over general purpose devices without sacrificing DC performance.

features

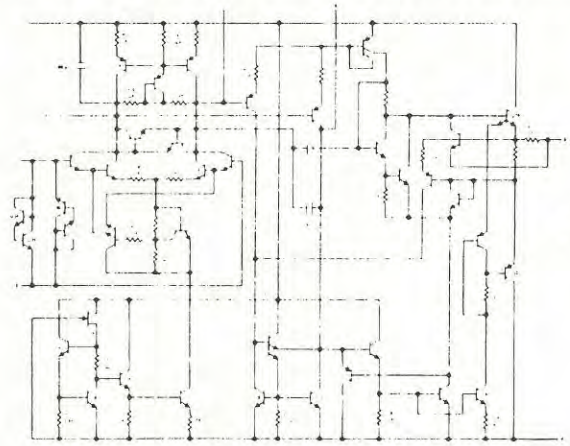
- 15 MHz small signal bandwidth
- Guaranteed 50V/μs slew rate
- Maximum bias current of 500 nA
- Operates from supplies of ±5V to ±20V
- Internal frequency compensation
- Input and output overload protected
- Pin compatible with general purpose op amps

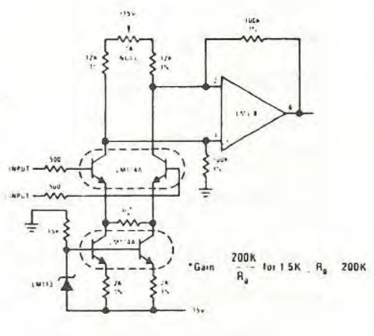
The LM318 has internal unity gain frequency compensation. This considerably simplifies its application since no external components are necessary for operation. However, unlike most internally compensated amplifiers, external frequency compensation may be added for optimum performance. For inverting applications, feedforward compensation will boost the slew rate to over 150V/μs and almost double the bandwidth. Overcompensation can be used with the amplifier for greater stability when maximum bandwidth is not needed. Further, a single capacitor can be added to reduce the 0.1% settling time to under 1 μs.

The high speed and fast settling time of these op amps make them useful in A/D converters, oscillators, active filters, sample and hold circuits, or general purpose amplifiers. These devices are easy to apply and offer an order of magnitude better AC performance than industry standards such as the LM709.

The LM318 is specified for operation over 0°C to 70°C.

schematic diagram and typical application

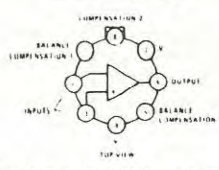




Instrumentation Amplifier

connection diagrams

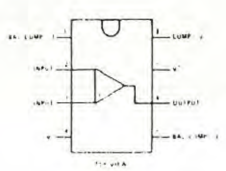
Metal Can Package*



*Pin connections shown on schematic diagram and typical applications are for TO 5 package.

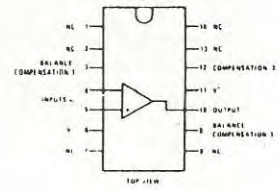
Order Number LM318H
See Package 11

Dual-In-Line Package



Order Number LM318N
See Package 20

Dual-In-Line Package



Order Number LM318D
See Package 1

WARNING: Disconnect primary power prior to servicing.

absolute maximum ratings

Supply Voltage	±20V
Power Dissipation (Note 1)	500 mW
Differential Input Current (Note 2)	±10 mA
Input Voltage (Note 3)	±15V
Output Short-Circuit Duration	Indefinite
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 sec)	300°C

electrical characteristics (Note 4)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$T_A = 25°C$		4	10	mV
Input Offset Current	$T_A = 25°C$		30	200	nA
Input Bias Current	$T_A = 25°C$		150	500	nA
Input Resistance	$T_A = 25°C$	0.5	3		MΩ
Supply Current	$T_A = 25°C$		5	10	mA
Large Signal Voltage Gain	$T_A = 25°C$, $V_S = \pm15V$, $V_{OUT} = \pm10V$, $R_L \geq 2\ k\Omega$	25	200		V/mV
Slew Rate	$T_A = 25°C$, $V_S = \pm15V$, $A_V = 1$	50	70		V/µs
Small Signal Bandwidth	$T_A = 25°C$, $V_S = \pm15V$		15		MHz
Input Offset Voltage				15	mV
Input Offset Current				300	nA
Input Bias Current				750	nA
Large Signal Voltage Gain	$V_S = \pm15V$, $V_{OUT} = \pm10V$, $R_L \geq 2\ k\Omega$	20			V/mV
Output Voltage Swing	$V_S = \pm15V$, $R_L = 2\ k\Omega$	±12	±13		V
Input Voltage Range	$V_S = \pm15V$	±11.5			V
Common Mode Rejection Ratio		70	100		dB
Supply Voltage Rejection Ratio		65	80		dB

Note 1: The maximum junction temperature of the LM318 is 85°C. For operating at elevated temperatures, devices in the TO-5 package must be derated based on a thermal resistance of 150°C/W, junction to ambient, or 45°C/W, junction to case. The thermal resistance of the dual-in-line package is 100°C/W, junction to ambient.

Note 2: The inputs are shunted with back-to-back diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1V is applied between the inputs unless some limiting resistance is used.

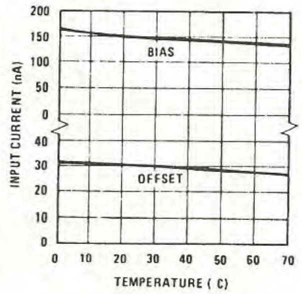
Note 3: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 4: These specifications apply for $\pm5V \leq V_S \leq \pm20V$ and $0°C \leq T_A \leq 70°C$, unless otherwise specified. For proper operation, the power supplies must be bypassed with 0.1 µF disc capacitors.

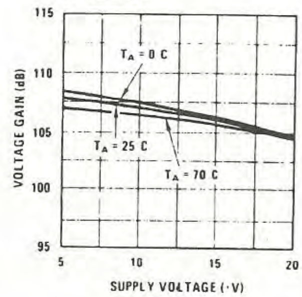
WARNING: Disconnect primary power prior to servicing.

typical performance characteristics

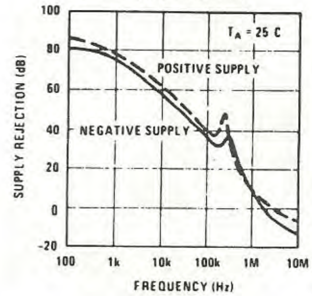
Input Current



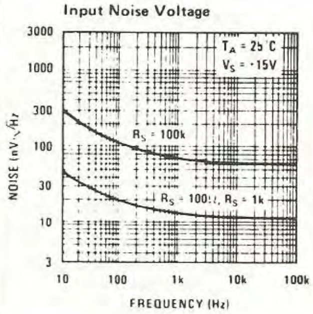
Voltage Gain



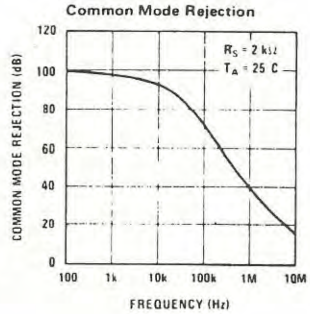
Power Supply Rejection



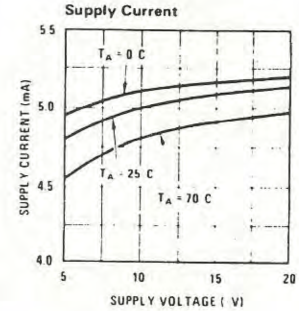
Input Noise Voltage



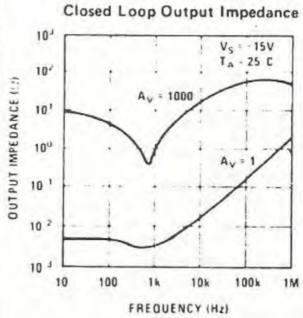
Common Mode Rejection



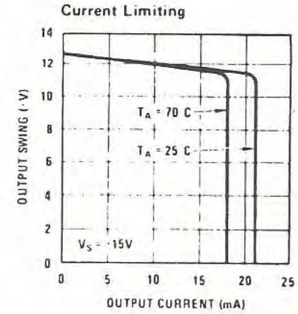
Supply Current



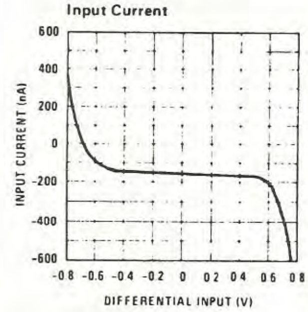
Closed Loop Output Impedance



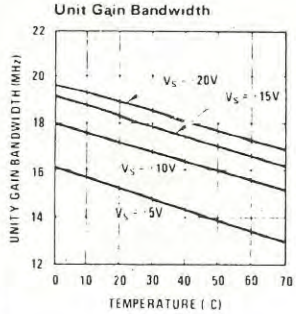
Current Limiting



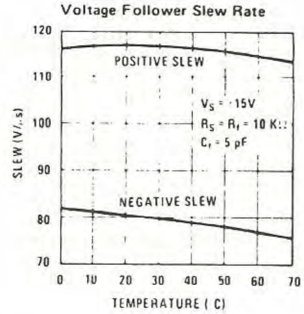
Input Current



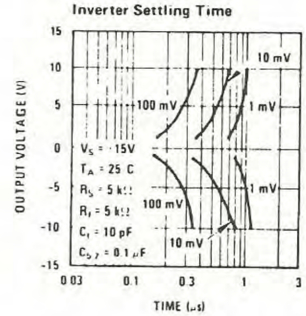
Unit Gain Bandwidth



Voltage Follower Slew Rate



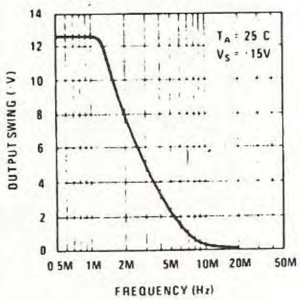
Inverter Settling Time



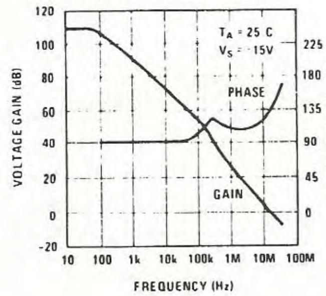
WARNING: Disconnect primary power prior to servicing.

typical performance characteristics (con't)

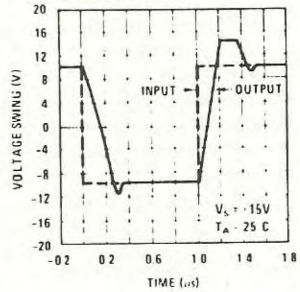
Large Signal Frequency Response



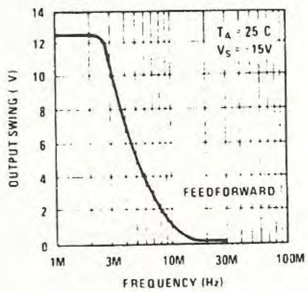
Open Loop Frequency Response



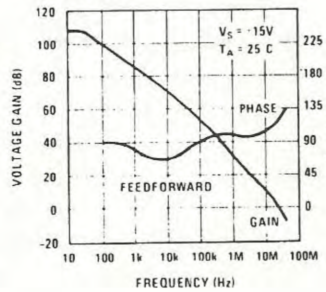
Voltage Follower Pulse Response



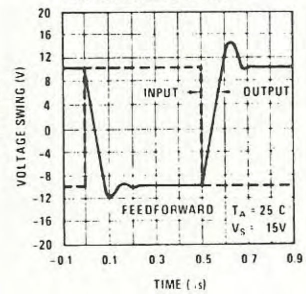
Large Signal Frequency Response



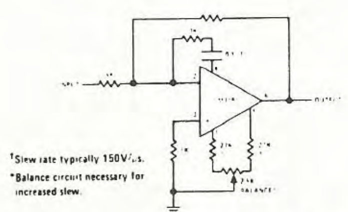
Open Loop Frequency Response



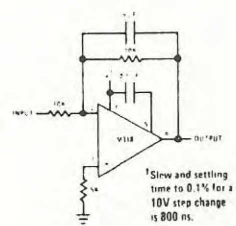
Inverter Pulse Response



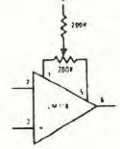
auxiliary circuits



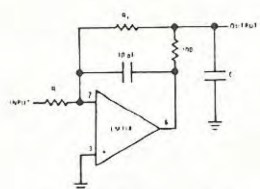
Feedforward Compensation for Greater Inverting Slew Rate†



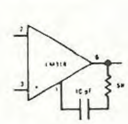
Compensation for Minimum Settling† Time



Offset Balancing



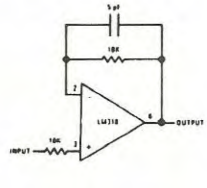
Isolating Large Capacitive Loads



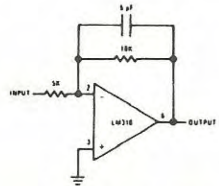
Overcompensation

WARNING: Disconnect primary power prior to servicing.

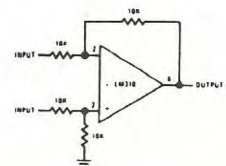
typical applications (con't)



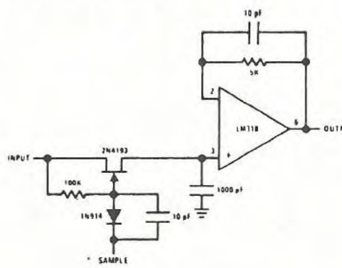
Fast Voltage Follower



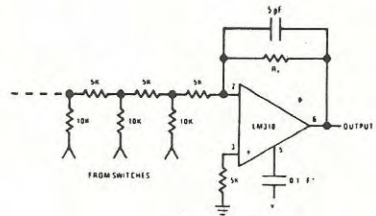
Fast Summing Amplifier



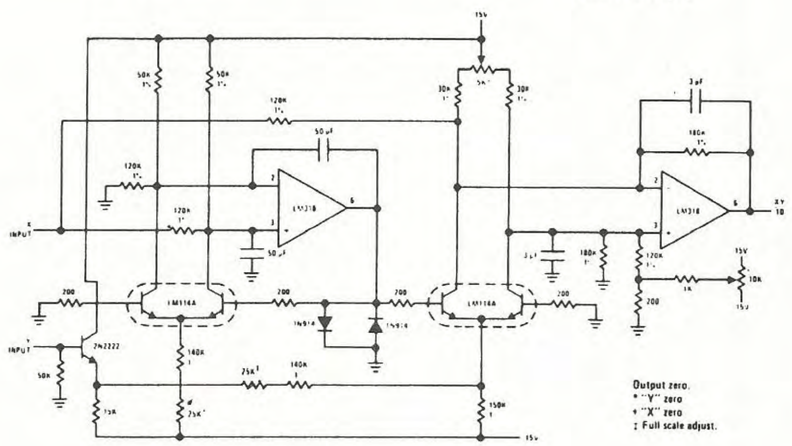
Differential Amplifier



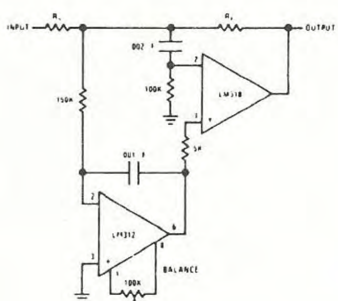
Fast Sample and Hold



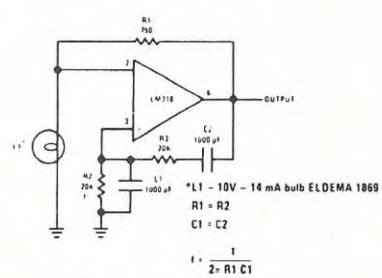
D/A Converter Using Ladder Network



Four Quadrant Multiplier



Fast Summing Amplifer with Low Input Current



Wein Bridge Sine Wave Oscillator

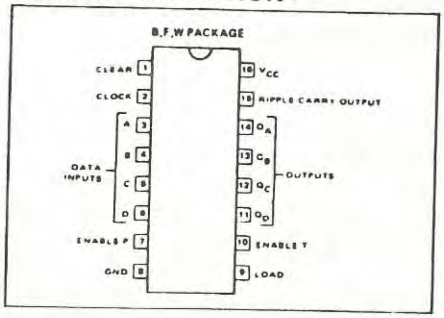
WARNING: Disconnect primary power prior to servicing.

54LS161-F,W • 74LS161-B,F

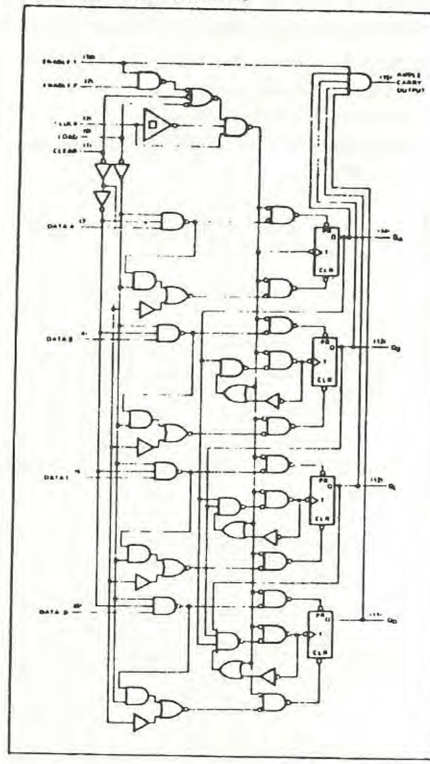
DESCRIPTION

This synchronous presettable binary counter features an internal carry look-ahead for applications in high-speed counting designs. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

PIN CONFIGURATION



BLOCK DIAGRAM



This counter is fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. The clear function for the 54/74LS161 is asynchronous and a low level at the clear input sets all four of the flip-flop outputs low regardless of the levels of clock, load or enable inputs.

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the Q_A output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. Transitions at the enable P or T inputs are allowed regardless of the level of the clock input.

The 54/74LS161 features a fully independent clock circuit. Changes made to control inputs (enable P or T, load or clear) that will modify the operating mode have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading or counting) will be dictated solely by the conditions meeting the stable setup and hold times.

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER*		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Clock}				C_L = 15pF, R_L = 2kΩ, See Figures 1 and 2 and Notes 1 and 2	25	32		MHz
$t_{w (Clock)}$	Width of clock pulse				25			ns
$t_{w (Clear)}$	Width of clear pulse				20			ns
t_{Setup}	Input setup time	A,B,C,D	Q		0↑			
		Enable P or T	Q		20↑			
		Load	Q		20↑			ns
t_{Hold}	Input hold time	A,B,C,D			25↑[2]			ns
		Others			10↑[2]			ns
t_{PLH}		Clock	Ripple carry			23	35	ns
t_{PHL}						23	35	
t_{PLH}		Clock (load input high)	Any Q			16	24	ns
t_{PHL}						18	27	
t_{PLH}		Clock (load input low)	Any Q			17	25	ns
t_{PHL}						19	29	
t_{PLH}		Enable T	Ripple carry			15	23	ns
t_{PHL}						15	23	
t_{PHL}		Clear	Any Q			26	38	ns

* f_{max} - Maximum clock frequency

t_{PLH} - propagation delay time, low-to high-level output

t_{PHL} - propagation delay time, high-to-low level output

NOTES:

1. Propagation delay for clearing is measured from the clear input.
2. The minimum hold time is as specified or as long as the clock input takes to rise from 0.8V to 2.0V., whichever is longer.

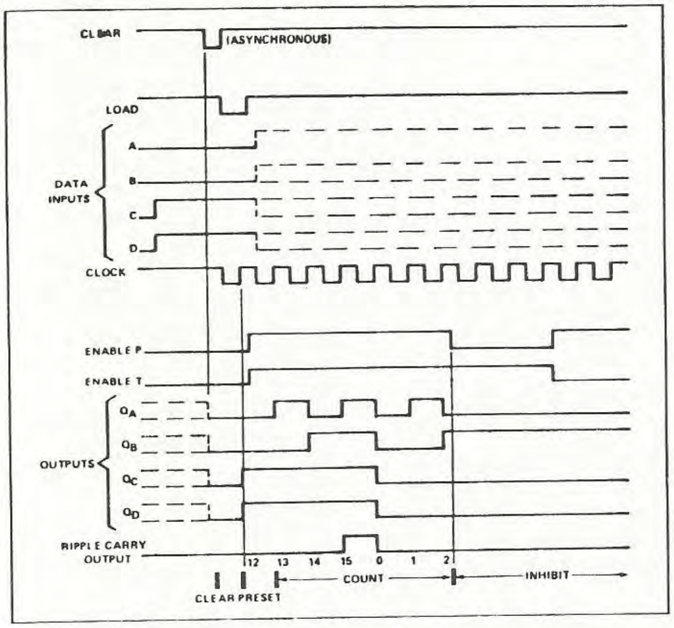
WARNING: Disconnect primary power prior to servicing.

PARAMETER MEASUREMENT INFORMATION

TYPICAL CLEAR, PRESET, COUNT, AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Clear outputs to zero
2. Preset to binary twelve
3. Count to thirteen, fourteen, fifteen, zero, one, and two
4. Inhibit



NOTES

A. The input pulses are supplied by a generator having the following characteristics PRR ≤ 1MHz, Duty Cycle ≤ 50%, $Z_{out} \approx 50\Omega$ $t_r \leq 15ns$, $t_f \leq 6ns$.

B. Outputs Q_D and carry are tested at t_{n+16}, where t_n is the bit time when all outputs are low.

C. $V_{ref} = 1.3V$

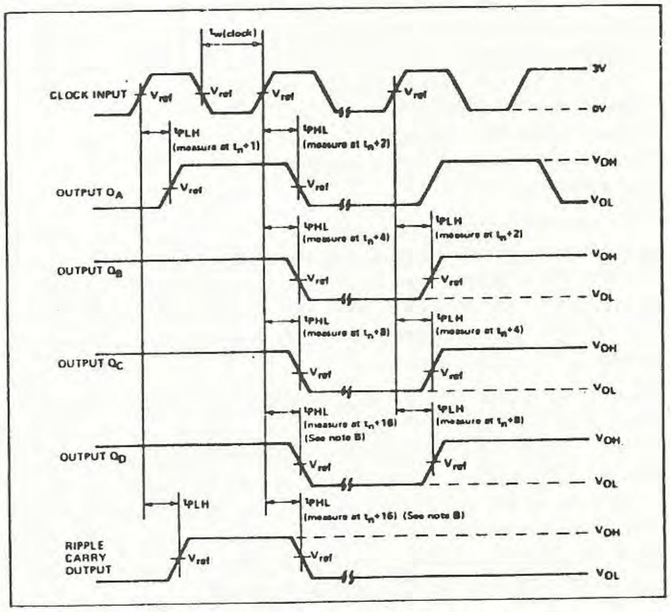


FIGURE 1—VOLTAGE WAVEFORMS

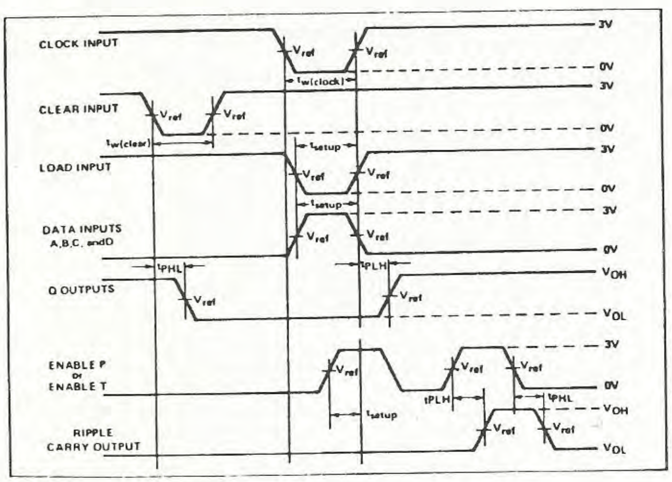


FIGURE 2—VOLTAGE WAVEFORMS

NOTES

A. The input pulses are supplied by generators having the following characteristics PRR ≤ 1MHz, Duty cycle ≤ 50%, $Z_{out} \approx 50\Omega$, $t_r \leq 15ns$, $t_f \leq 6ns$.

B. Enable P and T setup times are measured at t_{n+0}.

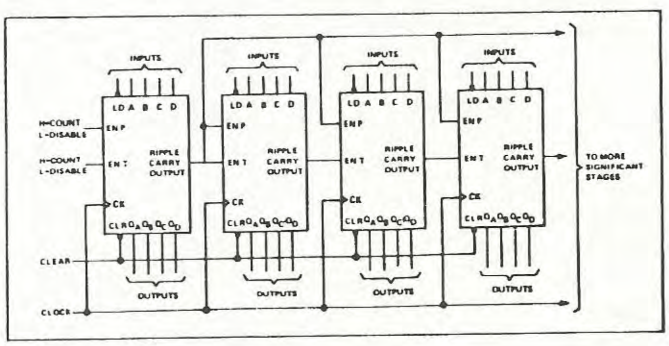
C. $V_{ref} = 1.3V$.

Load circuit is shown at front of book (totem pole output).

TYPICAL APPLICATION DATA

N-BIT SYNCHRONOUS COUNTERS

This application demonstrates how the look-ahead carry circuit can be used to implement a high-speed n-bit counter.The 54/74LS161 will count in binary. Virtually any count mode (modulo-N, N_1-toN_2, N_1-to-maximum) can be used with this fast look-ahead circuit.



signetics

WARNING: Disconnect primary power prior to servicing.

CIRCUIT TYPE TL 430
PROGRAMMABLE SHUNT REGULATOR

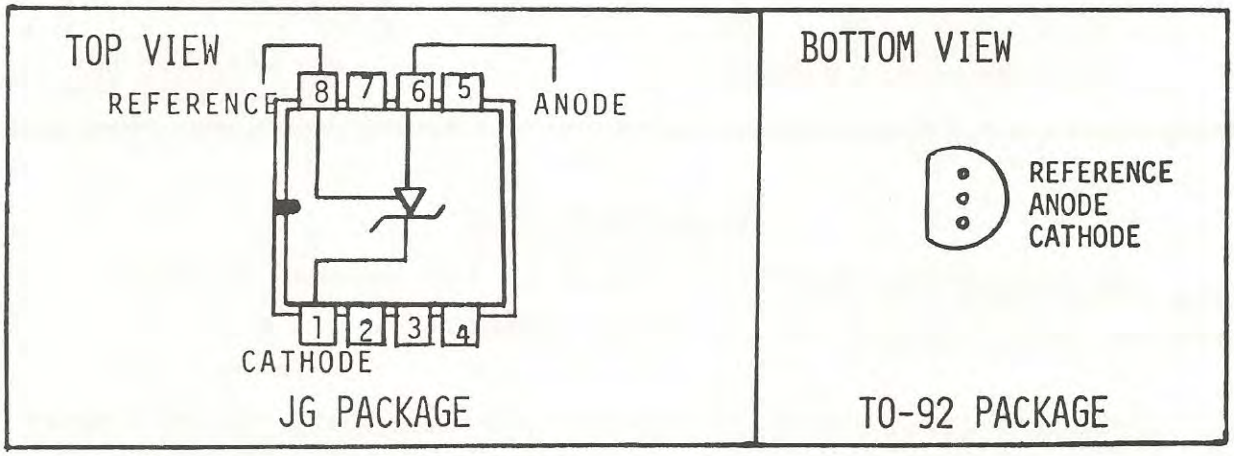
- Temperature Compensated
- Programmable Output Voltage
- Low Output Resistance
- Low Output Noise
- Sink Capability To 100 mA

DESCRIPTION

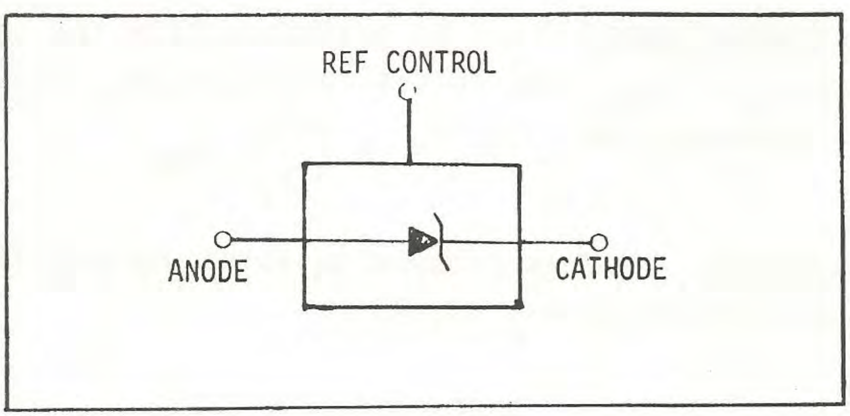
The TL430 is a three terminal "Programmable" shunt regulator featuring excellent stability over temperature, wide operating current range, and low output noise. The output voltage may be set, by two external resistors, to any desired value between 3.0 volts and 30 volts.

The TL430 can replace zener diodes in many applications providing improved performance.

TERMINAL ASSIGNMENTS

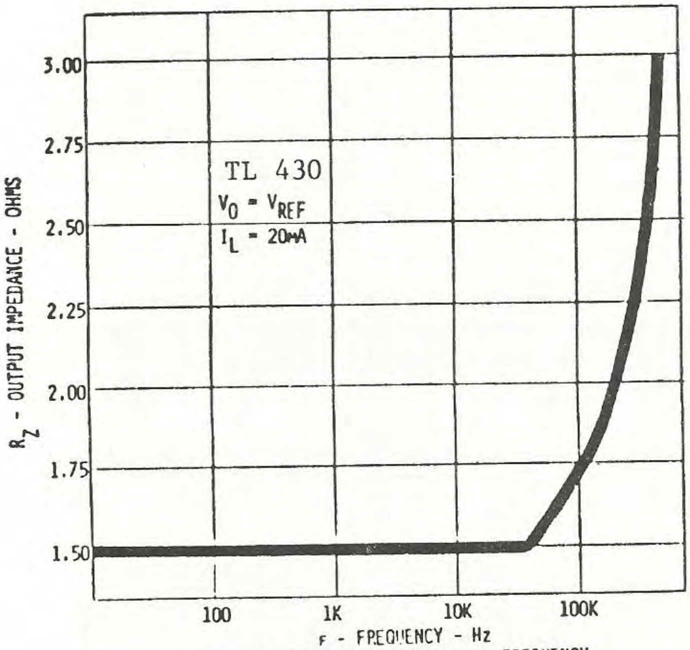


FUNCTIONAL BLOCK DIAGRAM

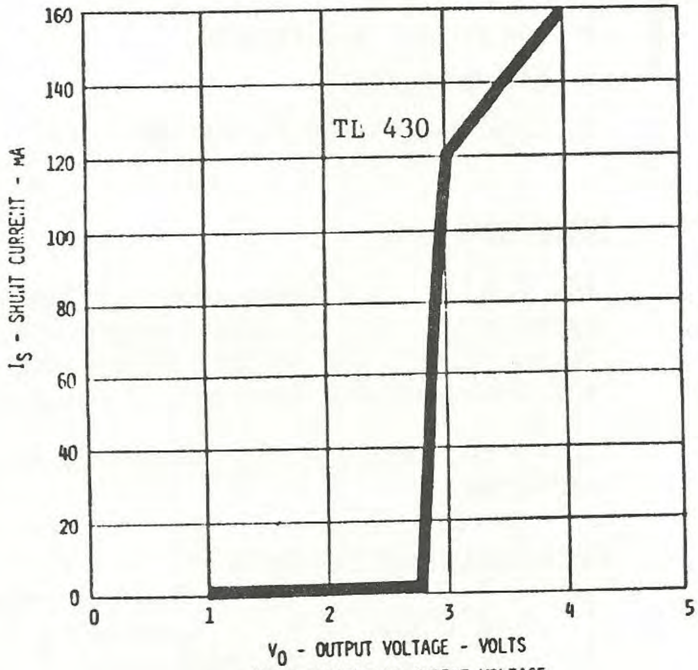


TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 5012 • DALLAS, TEXAS 75222

WARNING: Disconnect primary power prior to servicing.



DYNAMIC OUTPUT IMPEDANCE R_0 VS FREQUENCY



SHUNT CURRENT VS OUTPUT VOLTAGE

DEFINITION OF TERMS

V_{REF} REFERENCE VOLTAGE: The voltage at the reference input terminal with respect to the anode terminal.

I_R REFERENCE INPUT CURRENT: Current required into the reference input, during an on condition, to insure output regulation.

R_{OUT} OUTPUT RESISTANCE: The on resistance from the cathode to anode when $V_0 = V_{REF}$. The output resistance, R_0, for $V_0 > V_{REF}$ is given by the equation:

$$R_0 = 1 + \frac{R_1}{R_2} R_{OUT}$$

I_S SHUNT CURRENT: Minimum cathode to anode current the device can sink and maintain output regulation.

I_B BIAS CURRENT: The shunt current required to insure output regulation.

WARNING: Disconnect primary power prior to servicing.

ABSOLUTE MAXIMUM RATINGS OVER OPERATING FREE-AIR TEMPERATURE RANGE (UNLESS OTHERWISE NOTED)

Peak Operating Voltage 30V
Peak Shunt Current 100mA
Free-Air Power Dissipation 775mW
Storage Temperature Range .... $-65^{o}C$ to $150^{o}C$
Operating Free-Air Temperature .... $0^{o}C$ to $70^{o}C$

RECOMMENDED OPERATING CONDITIONS

	MIN	MAX	UNITS
Output Voltage	V_{REF}	30	V
Output Current	I_B	100	mA

ELECTRICAL CHARACTERISTICS AT $25^{0}C$ UNLESS OTHERWISE NOTED

PARAMETER	TEST FIG	TEST CONDITIONS	TL 430 MIN	TL 430 TYP	TL 430 MAX	UNIT
Reference Voltage	1	$V_0 = V_{REF}$, $I_S = 10mA$	2.5	2.75	3.0	V
Temperature Coefficient of Input Reference $\left(\frac{\Delta V_{REF}}{V_{REF}\ \Delta t}\right)$	1	$V_0 = V_{REF}$, $I_S = 10mA$, $0^{0}C<T_A<70^{0}C$		± 50		ppm/^{0}C
Voltage Reference Input Current, $I_R = \frac{V_0 - V_{REF}}{R_1}$	2	$R_1 = 10K\Omega$, $R_2 = \infty$, $I_S = 10mA$		3	10	µA
Output Resistance, R_{OUT} $R_{OUT} = \Delta V_0/\Delta I_S$	1	$V_0 = V_{REF}$, $\Delta I_S = (52-2)mA = 50mA$		1.5	3	Ω
Bias Current (I_B)	1	See Note 1		0.6	2	mA
Shunt Current I_S	1	$V_{OUT} = V_{REF}$	50			mA
		$5V<V_0<30V$, $P_D < 775mW$	100			mA
Noise "0.1 to 10 Hz"	2	$V_0 = 3V$		50		µV
		$V_0 = 12V$		200		µV
		$V_0 = 30V$		650		µV

NOTE 1: Min. required for regulation

TEXAS INSTRUMENTS
INCORPORATED

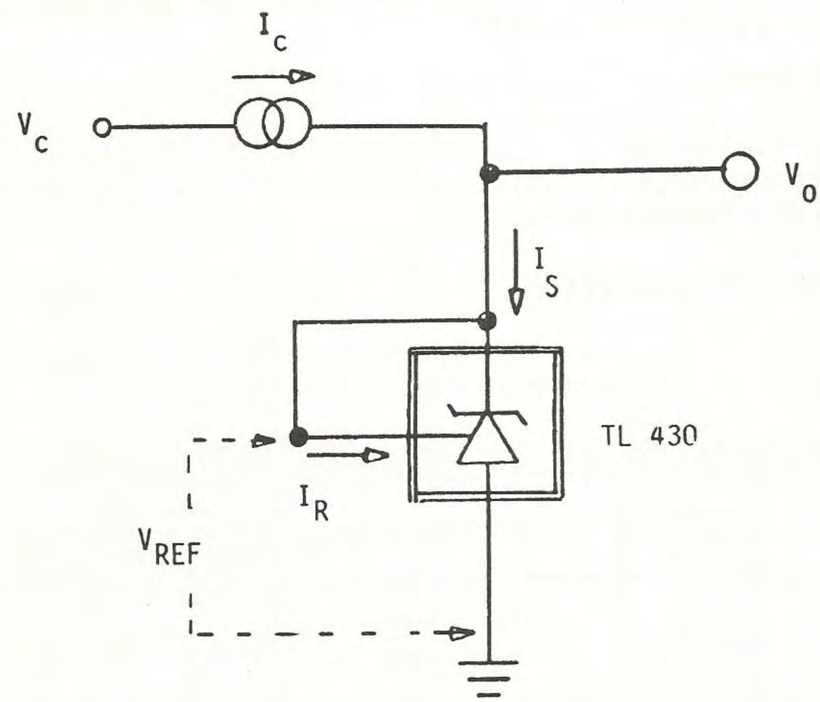
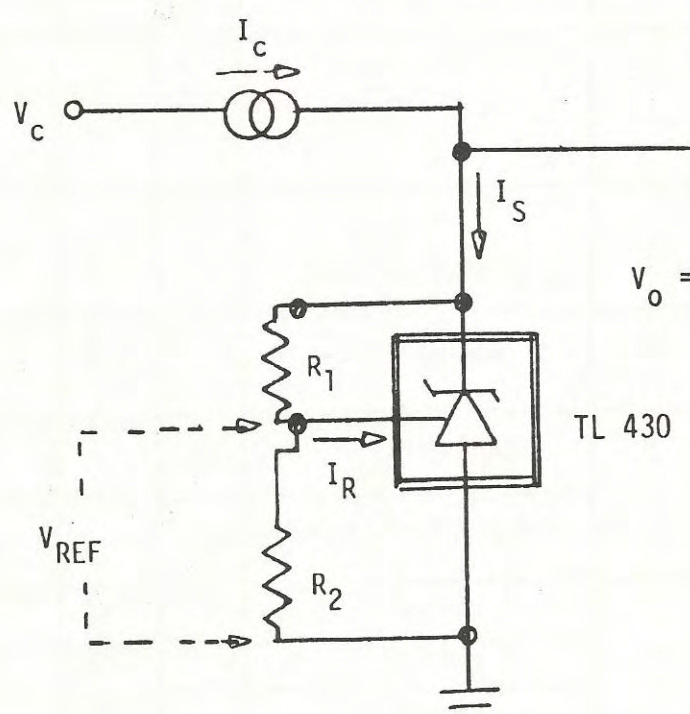


FIGURE 1. $V_O = V_{REF}$ TEST CIRCUIT

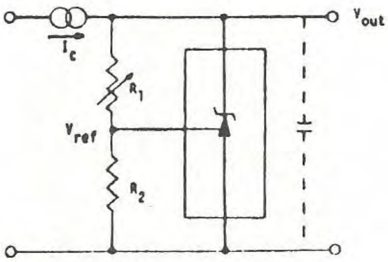


$$V_O = V_{REF}\left(1 + \frac{R_1}{R_2}\right) + I_R R_1$$

FIGURE 2. $V_O > V_{REF}$ TEST CIRCUIT

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 5012 • DALLAS, TEXAS 75222

TYPICAL APPLICATIONS



NOTE: A. $V_{out} = (1 + \frac{R_1}{R_2})\ V_{ref}$

FIGURE 3 - SHUNT REGULATOR

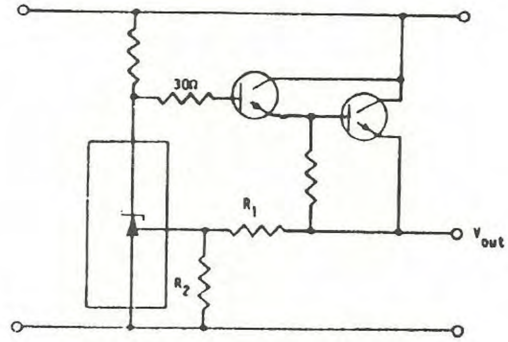
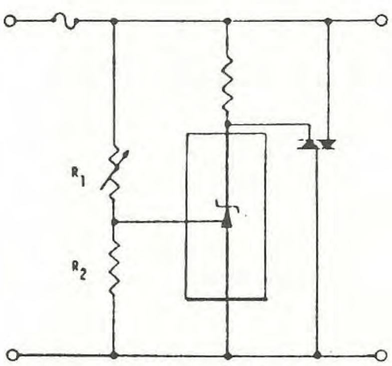


FIGURE 4 - SERIES REGULATOR



NOTE: A. $V_{out\ max} = (1 + \frac{R_1}{R_2})\ V_{ref}$

FIGURE 5 - CROW BAR

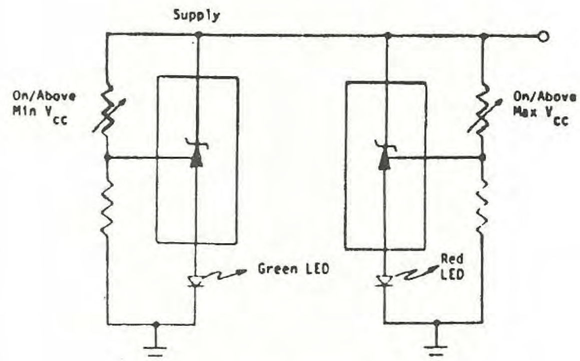
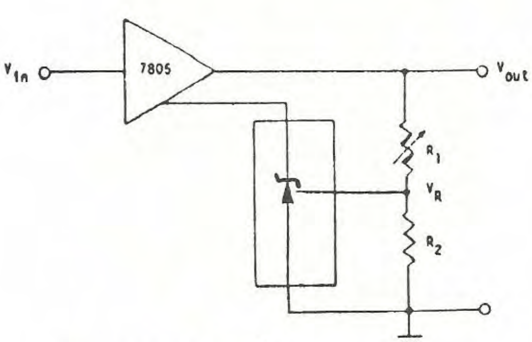


FIGURE 6 - SUPPLY MIN/MAX DETECTOR



NOTES: A. $V_{out} = V_R\ (1 + \frac{R_1}{R_2})$

B. $V_{out\ (min)} = V_R + 5V$

FIGURE 7 - CONTROL OUTPUT VOLTAGE OF FIXED V.R.

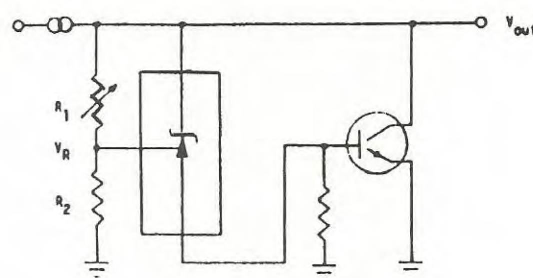


FIGURE 8 - HIGHER CURRENT APPLICATIONS

National Semiconductor

MM54C932/MM74C932 Phase Comparator

General Description

The MM74C932/MM54C932 consists of two independent output phase comparator circuits. The two phase comparators have a common signal input and a common comparator input. The signal input can be directly coupled for a large voltage signal, or capacitively coupled to the self-biasing amplifier at the signal input for a small voltage signal.

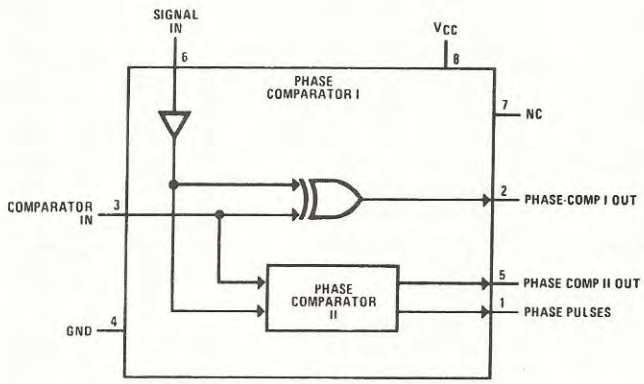
Phase comparator I, an exclusive-OR gate, provides a digital error signal (phase comp. I out) and maintains 90° phase shifts at the VCO center frequency. Between signal input and comparator input (both at 50% duty cycle), it may lock onto the signal input frequencies that are close to harmonics of the VCO center frequency.

Phase comparator II is an edge-controlled digital memory network. It provides a digital error signal (phase comp. II out) and lock in signal (phase pulses) to indicate a locked condition and maintains a 0° phase shift between signal input and comparator input.

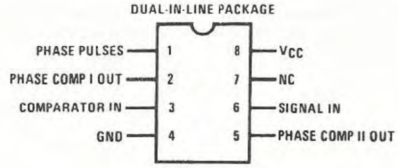
Features

- Wide supply voltage range
- Convenient mini-DIP package
- TRI-STATE® phase-comparator output (comparator II)
- 200 mV input voltage (signal in) sensitivity (typical)

Block Diagram



Connection Diagram



Absolute Maximum Ratings Note 1

Voltage at Any Pin	−0.3V to V_{CC} + 0.3V
Operating Temperature Range	
MM54C932	−55°C to +125°C
MM74C932	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Package Dissipation	500 mW
Operating V_{CC} Range	3V to 15V
Absolute Maximum V_{CC}	18V
Lead Temperature (Soldering, 10 seconds)	300°C

DC Electrical Characteristics

Parameter		Conditions	Min	Typ	Max	Units
I_{CC}	Quiescent Device Current	PIN 5 = V_{CC}, PIN 8 = V_{CC}, PIN 3 = 0_V				
		V_{CC} = 5V		0.005	150	μA
		V_{CC} = 10V		0.01	300	μA
		V_{CC} = 15V		0.015	600	μA
		PIN 5 = V_{CC}, PIN 8 = Open, PIN 3 = 0_V				
		V_{CC} = 5V		5	205	μA
		V_{CC} = 10V		20	710	μA
		V_{CC} = 15V		50	1800	μA
V_{OL}	Low Level Output Voltage	V_{CC} = 5V		0	0.05	V
		V_{CC} = 10V		0	0.05	V
		V_{CC} = 15V		0	0.05	V
V_{OH}	High Level Output Voltage	V_{CC} = 5V	4.95	5		V
		V_{CC} = 10V	9.95	10		V
		V_{CC} = 15V	14.95	15		V
V_{IL}	Low Level Input Voltage Comparator and Signal	V_{CC} = 5V, V_O = 0.5V or 4.5V		2.25	1.5	V
		V_{CC} = 10V, V_O = 1V or 9V		4.5	3.0	V
		V_{CC} = 15V, V_O = 1.5V or 13.5V		6.25	4.0	V
V_{IH}	High Level Input Voltage Comparator and Signal	V_{CC} = 5V, V_O = 0.5V or 4.5V	3.5	2.75		V
		V_{CC} = 10V, V_O = 1V or 9V	7.0	5.5		V
		V_{CC} = 15V, V_O = 1.5V or 13.5V	11.0	8.25		V
I_{OL}	Low Level Output Current	V_{CC} = 5V, V_O = 0.4V	0.36	0.88		mA
		V_{CC} = 10V, V_O = 0.5V	0.9	2.25		mA
		V_{CC} = 15V, V_O = 1.5V	2.4	8.8		mA
I_{OH}	High Level Output Current	V_{CC} = 5V, V_O = 4.6V	−0.36	−0.88		mA
		V_{CC} = 10V, V_O = 9.5V	−0.9	−2.25		mA
		V_{CC} = 15V, V_O = 13.5V	−2.4	−8.8		mA
I_{IN}	Input Current	All Inputs Except Signal Input				
		V_{CC} = 15V, V_{IN} = 0V		-10^{-5}	−1.0	μA
		V_{CC} = 15V, V_{IN} = 15V		10^{-5}	1.0	μA
C_{IN}	Input Capacitance	Any Input, (Note 3)			7.5	pF
P_T	Total Power Dissipation	f_o = 10 kHz, R1 = 1 MΩ, R2 = ∞, VCO_{IN} = $V_{CC}/2$				
		V_{CC} = 5V		0.07		mW
		V_{CC} = 10V		0.6		mW
		V_{CC} = 15V		2.4		mW

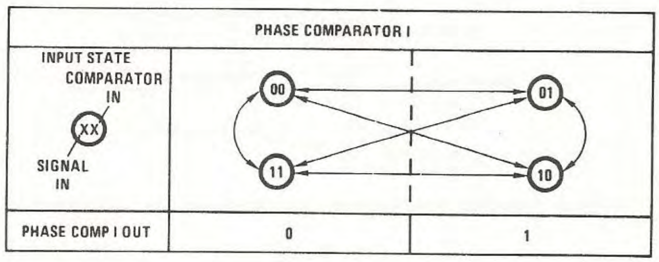
Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

2

Electrical Characteristics

Parameter	Conditions	Min	Typ.	Max	Units
Phase Comparators					
R_{IN} Input Resistance Signal Input	V_{CC} = 5V	1.0	3.0		MΩ
	V_{CC} = 10V	0.2	0.7		MΩ
	V_{CC} = 15V	0.1	0.3		MΩ
Comparator Input	V_{CC} = 5V		10^6		MΩ
	V_{CC} = 10V		10^6		MΩ
	V_{CC} = 15V		10^6		MΩ
AC Coupled Signal Input Voltage Sensitivity	C_{SERIES} = 1000pF, f = 50kHz				
	V_{CC} = 5V		200	400	mV
	V_{CC} = 10V		400	800	mV
	V_{CC} = 15V		700	1400	mV

Phase Comparator State Diagrams



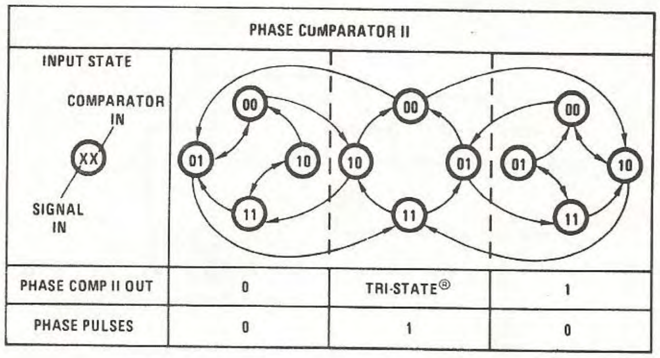


Figure 1.

WARNING: Disconnect primary power prior to servicing.

Typical Waveforms

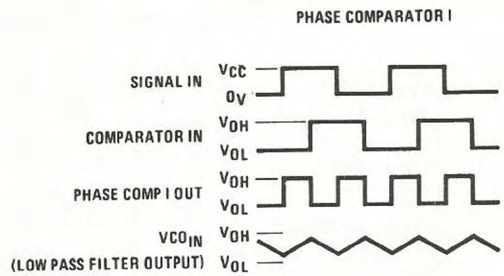


Figure 2. Typical Waveform Employing Phase Comparator I in Locked Condition

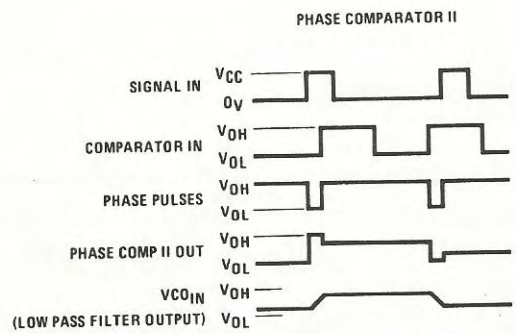
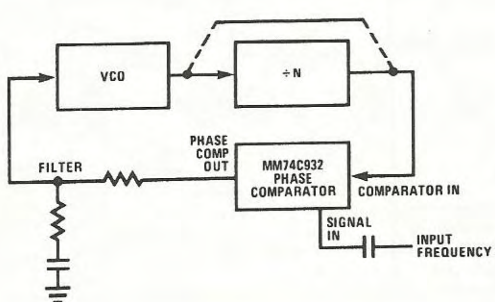


Figure 3. Typical Waveform Employing Phase Comparator II in Locked Condition

Typical Phase Locked Loop



WARNING: Disconnect primary power prior to servicing.

ENGINEERING
REPORT

A NEW FILTERING PROCESS FOR OPTIMAL OVERSHOOT CONTROL

HARRIS
COMMUNICATIONS AND
INFORMATION HANDLING

WARNING: Disconnect primary power prior to servicing.

HARRIS COMMUNICATIONS AND INFORMATION HANDLING

WARNING: Disconnect primary power prior to servicing.

A NEW FILTERING PROCESS FOR OPTIMAL OVERSHOOT CONTROL

By DAVID L. HERSHBERGER
Senior Engineer, FM Radio Transmitters

ABSTRACT

When both peak amplitude (in the time domain) and bandwidth constraints are placed upon a signal as in FM stereo broadcasting, there are conflicts among the requirements for limiting modulation peaks, attenuating components beyond 15 kHz, and maintaining a flat amplitude characteristic to 15 kHz. Previous attempts at overshoot control do not simultaneously satisfy all of the above requirements. Furthermore, some techniques currently in use can cause severe audible distortion under certain programming conditions.

Lowpass filters by design change the frequency distribution of a signal and by consequence change the phase relationships of the same signal. Both changes are causes of overshoot. Elimination of harmonic terms deletes components that serve to reduce the peak amplitude of the signal. Phase distortion rearranges signal components as a function of time to form overmodulating peaks.

Optimal overshoot control must perform all of the following under all programming conditions:

1. Flat frequency response to 15 kHz at all levels up to 100% modulation.
2. High attenuation of frequencies above 15 kHz.
3. Suppress overmodulation due to overshoot to an insignificant level.
4. Insignificant THD and IM distortion at any level up to 100% modulation.
5. No degradation of audio quality.

A new technique that eliminates overmodulation due to overshoot is presented and explained.

I. INTRODUCTION

BACKGROUND: FM stereo radio broadcasting is rapidly becoming a highly competitive medium. This change manifests itself in many ways, including the effort to have a technically superior sound. This objective usually involves a tradeoff between quality and quantity, or fidelity vs. loudness. Most audio processing innovations to date sacrifice some amount of fidelity for some degree of loudness increase. The Harris Dynamic Transient Response (DTR) filter, an integral part of the Harris MS-15 exciter, allows a loudness increase of 2-6 dB (dependent on limiter type) with absolutely no degradation of fidelity.

PRINCIPLES OF STEREO FM: FM stereophonic broadcasting is a frequency domain multiplexed (FDM) system. A left-plus-right (L+R) signal is transmitted in the band 50 Hz-15 kHz. This is the monaural baseband signal. A double sideband suppressed carrier (DSB) signal modulated with left-minus-right information is transmitted at 38 kHz. To properly demodulate the DSB 38 kHz signal, a 19 kHz pilot tone is transmitted with a phase such that when it is frequency-doubled, L-R information can be synchronously detected. The composite stereo signal is shown in Fig. 1.

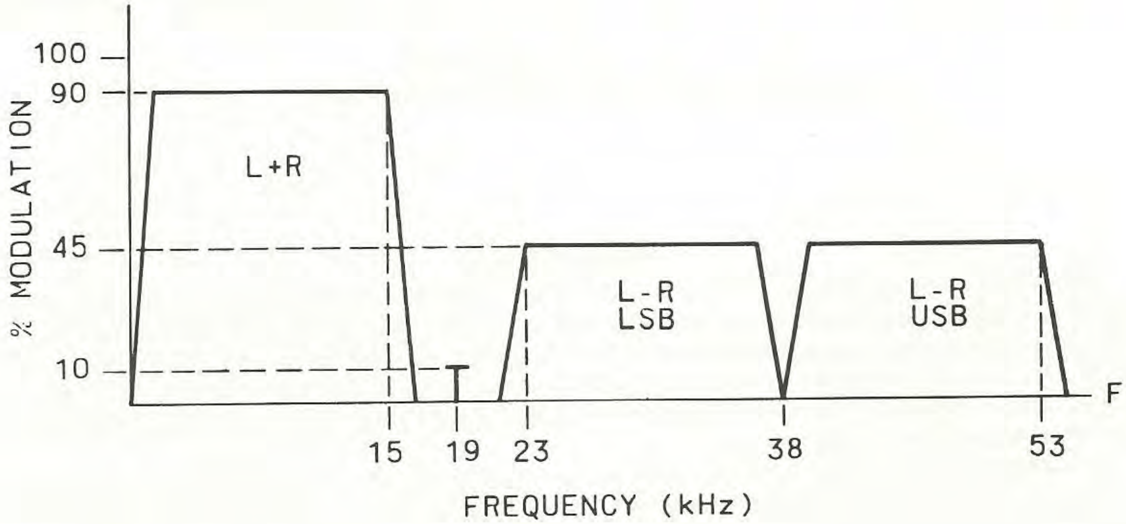


FIGURE 1
FM STEREO MULTIPLEX SIGNAL SPECTRUM

WHY AUDIO LOWPASS FILTERS ARE REQUIRED: There are constraints placed upon the amplitude and bandwidth characteristics of the left- and right-channel audio signals such that the resultant L+R and L-R signals will exceed neither their amplitude bounds nor bandwidth allocations. Otherwise the multiplexed signals would suffer distortion and mutual interference.

To control the amplitude of the L and R channel signals AGC amplifiers, peak limiters, and clipping devices are customarily used. Typically these processors add to the harmonic content of the program, producing a signal which would result in excessive bandwidth. In the better stereo generators, lowpass filters have been included to attenuate harmonics beyond the 15 kHz bandwidth of the system.

Some inexpensive switching type stereo generators omit the audio lowpass filters in an attempt to eliminate overshoot. With no audio filters, the stereo composite lowpass filter will overshoot instead. This is absurd. Not only has the overshoot problem been left unsolved, but the stereo generator is vulnerable to pilot interference and aliasing.

II. CAUSES AND EFFECTS OF OVERSHOOT

MECHANISMS OF OVERSHOOT IN LOWPASS FILTERS: Although the input to a lowpass filter may be accurately amplitude-limited, such is not necessarily the case at the filter's output. Ringing and overshoot of the filter can seriously degrade the accuracy of the limiting action. Lowpass filters may overshoot 6 dB (100%) on some signals which are not uncommon at the output of audio processing equipment.

A lowpass filter changes two independent qualities of its input signal. In addition to the obvious change of the amplitude vs. frequency characteristic the filter also changes phase relationships among different frequencies in the filter's passband. This is equivalent to stating that different frequencies take different lengths of time to propagate through the filter. Associated with these two changes to the signal are two mechanisms causing overshoot.

1. ATTENUATION OF HARMONICS

Consider the ideal case of a lowpass filter with rectangular frequency response and zero time delay. This filter is in fact unrealizable but nevertheless would exhibit overshoot due to elimination of harmonics. The frequency response of this filter is shown in Fig. 2.

WARNING: Disconnect primary power prior to servicing.

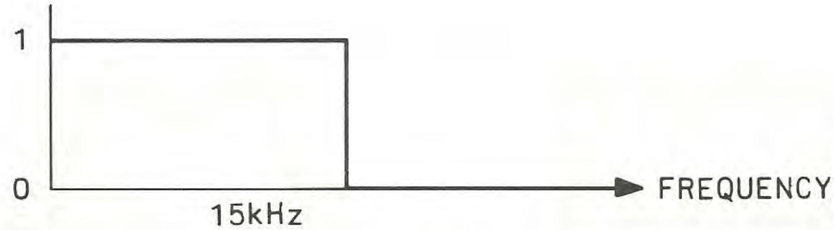


FIGURE 2
IDEAL FILTER FREQUENCY RESPONSE

Assume that the input signal is a 10 kHz squarewave of amplitude A. The Fourier expansion of this signal is:

$$v(t) = A \frac{4}{\pi} \sum_{n=1,3,5,\ldots}^{\infty} \frac{1}{n} \sin(2\pi fnt)$$

where f is frequency.

The squarewave signal has components at the fundamental and odd harmonic frequencies only, i.e., 10, 30, 50, 70, etc. kHz. Since the filter cuts off at 15 kHz only the fundamental (10 kHz) component of the squarewave appears at the filter output. Note that if the squarewave amplitude (A) is one volt, then the peak value of the fundamental component (identically equal to the output signal) is 4/pi or 1.273. This constitutes an overshoot of 27%. The squarewave and its fundamental component are shown superposed in Fig. 3.

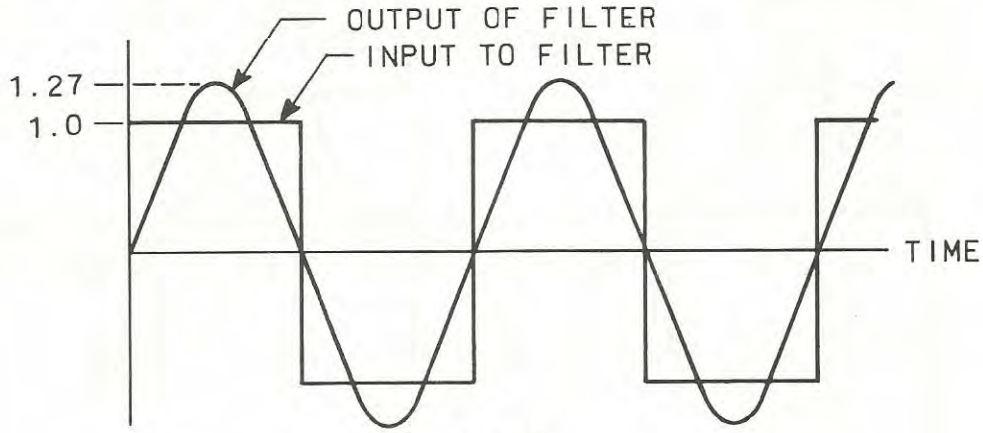


FIGURE 3
SQUAREWAVE AND FUNDAMENTAL COMPONENT

This is only one example of many possible signals that would cause a linear phase lowpass filter to overshoot.

2. NON-UNIFORM TIME DELAY

If different signals propagate through the filter with different time delays, it is possible for input signals separated in time to become coincident at the filter's output. This could result in an overshoot.

Continuing with the example of the squarewave, consider the case where only the fundamental and third harmonic fall within the filter's passband. Squarewaves in the range of 3-5 kHz satisfy this condition. The input and output of the ideal filter discussed in part 1 are shown in Fig. 4.

WARNING: Disconnect primary power prior to servicing.

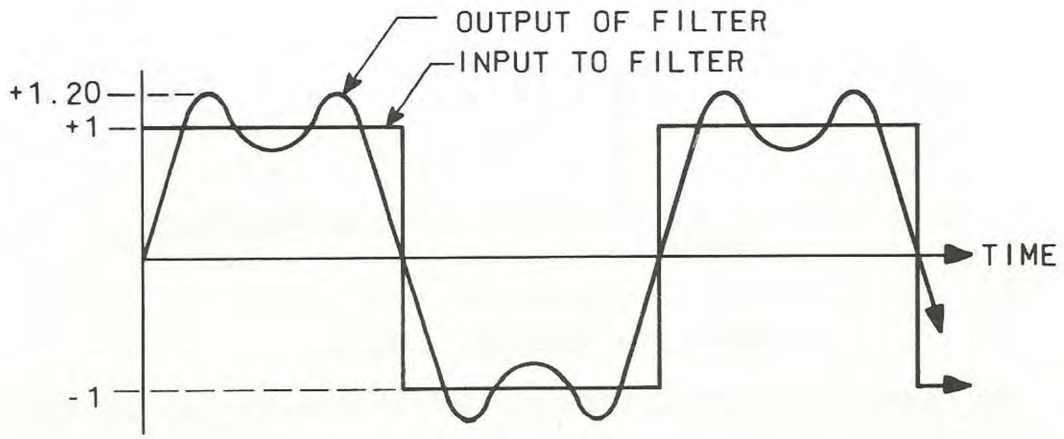


FIGURE 4

3-5kHz SQUAREWAVE RESPONSE: FUNDAMENTAL PLUS 3rd HARMONIC

Overshoot is 20.0%. Since such a filter is impossible to build, the response of Fig. 4 in general cannot be produced. Rather, time delay will vary as a function of frequency, thereby upsetting the phase relationship between the fundamental and third harmonic. If the phase of the third harmonic is shifted 180 degrees relative to the fundamental, the waveform of Fig. 5 results. Overshoot is 70% or 4.6 dB.

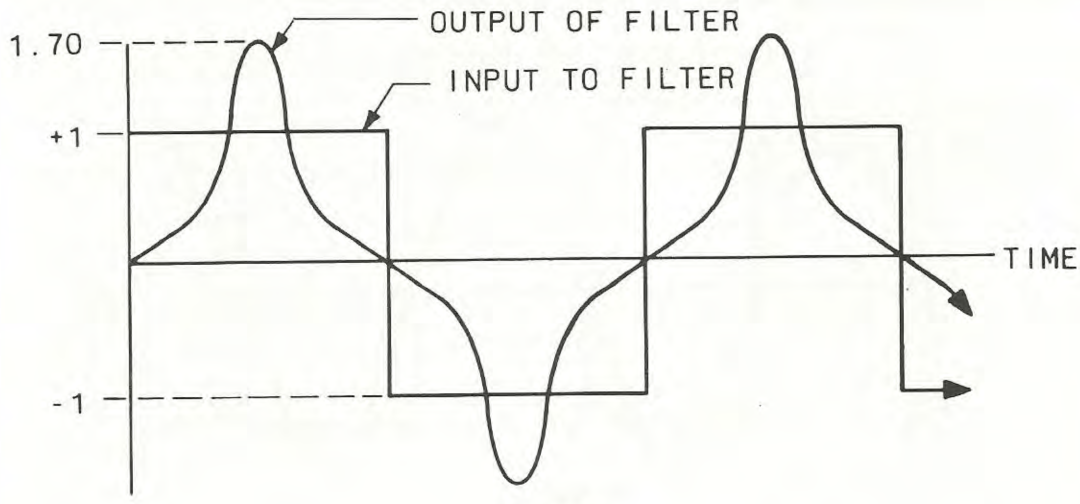


FIGURE 5

EFFECT OF PHASE DISTORTION

EXAMPLES: A typical filter specification may require frequency response to be flat within ±0.1 dB from 0-15 kHz and -50 dB at 19 kHz and above. By far the most practical filter meeting these specifications will be an elliptic function type filter. This filter exhibits a very sharp rate of cutoff and a highly nonuniform time delay characteristic.

A seventh order filter meeting these specifications has group delay (time delay) of approximately 43 microseconds which is uniform from DC to 3.5 kHz, 45 microseconds at 5 kHz, 53 microseconds at 7.5 kHz, 62 usec. at 10 kHz, increasing to 238 microseconds at 15 kHz which corresponds to 1,-285 degrees of phase distortion (3½ rotations). Therefore the squarewave response of Fig. 5 is certainly possible with this filter.

WARNING: Disconnect primary power prior to servicing.

Time delay generally increases with frequency within the passband of an elliptic filter. Minimum time delay is at DC while maximum time delay within the passband occurs at the cutoff frequency. A test signal has been devised which causes filters to overshoot primarily as a function of their time delay distortion. The test signal consists of a sinewave burst immediately followed by a DC step signal. The sinewave will accumulate maximum time delay (238 usec.) while the DC step signal will accumulate a minimal time delay (43 usec.). At the filter's output the sinewave will coincide with the beginning of the DC step signal. This phenomenon is shown in Fig. 6. Note that the overshoot is 100% (6 dB)!

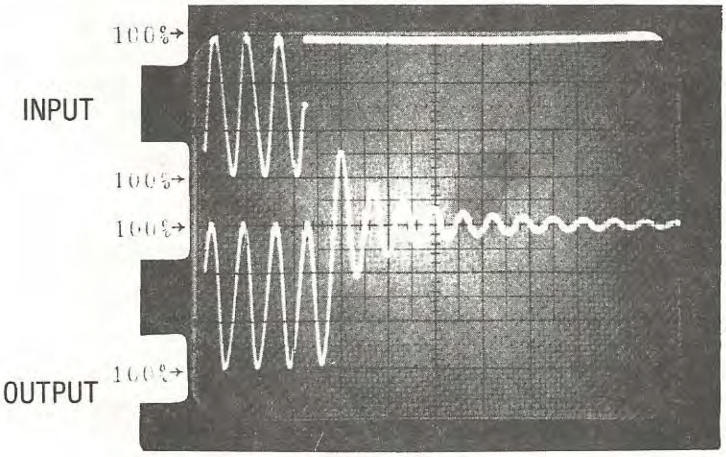


FIGURE 6

SINE/STEP FILTER RESPONSE

Through a combination of effects (both attenuation of harmonics and nonuniform time delay) a myriad of signal types can cause a typical elliptic lowpass filter to overshoot. A low frequency squarewave response is shown in Fig. 7.

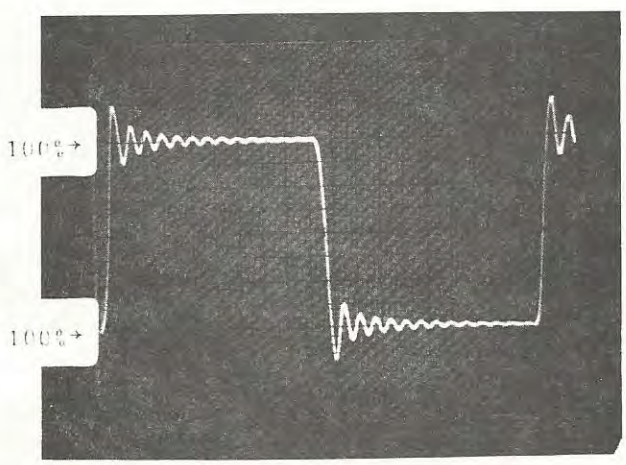


FIGURE 7

TYPICAL FILTER
SQUAREWAVE RESPONSE

The waveforms of Fig. 6 and Fig. 7 are common with certain types of music and/or certain types of FM limiters. To offset overshoot audio levels are simply turned down to a point where overshoots "of frequent recurrence" do not exceed 100% modulation. This can mean a sizeable reduction in modulation effectiveness, usually on the order of 2.5 - 6 dB!

III. DEVELOPMENT OF A SOLUTION

NEED FOR A NEW APPROACH: There have been several previous approaches to the problem. Although existing systems do control overshoot, they also contribute unwanted side effects to the signal.

One method for overshoot control uses a delay line and an AGC stage. This system can cause gain "pumping". Another popular system uses alternate clipping and filtering combined with a complementary high frequency boost and cut. This system suffers from excessive intermodulation distortion and a high frequency rolloff which is dependent upon signal level.

CONSTRAINTS: It is clearly desirable to have a filter which will eliminate harmonics above 15 kHz yet preserve the peak amplitude-limited nature of its input signal. Note that it is not necessary to have a filter that does not overshoot. Ringing and overshoot are completely unobjectionable provided that the overshoots do not exceed the 100% modulation level. From this point on, the term "overshoot" will denote only overshoots above 100% modulation. The filter requirements are:

1. Frequency response flat ±0.5 dB 20 Hz-15 kHz at all levels up to 100% modulation.
2. Attenuation above 19 kHz inclusive: 50 dB minimum.
3. Overshoots not exceeding 102% modulation.
4. Filter shall be transparent to steady state sinewave signals: THD and IM distortion 0.1% or less.
5. Any effect of eliminating overmodulating overshoots shall be inaudible.

BESSEL FILTER UNSATISFACTORY: One filter that does not overshoot is the Bessel type.The Bessel filter has maximally flat time delay for a minimum phase filter. However, its frequency response is inadequate. It has a very gradual rate of cutoff shown in Fig. 8.

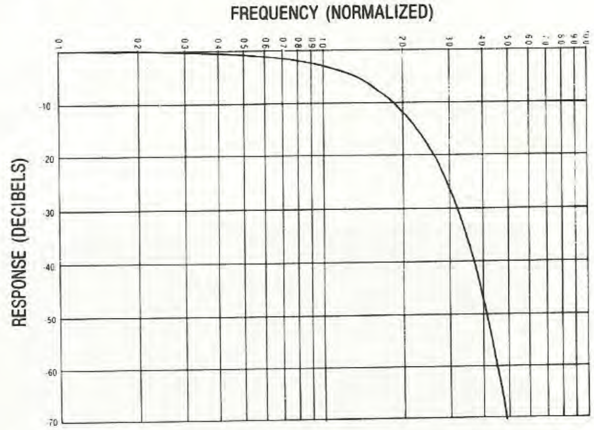


FIGURE 8

IDEAL BESSEL FILTER RESPONSE
(GAUSSIAN FILTER)

NON MINIMUM PHASE FILTER UNSATISFACTORY: If one were to start with a filter with sufficiently sharp cutoff and attempt to find a phase function resulting in minimum overshoot, the result would be a lowpass filter that approximates linear phase, yet still overshoots. Even in the case of the ideal filter discussed under "Causes and Effects of Overshoot", the filter still overshoots.

FILTER MUST BE NONLINEAR: It would appear that there is no filter that satisfies all the above conditions. There is no linear time-invariant filter that satisfies all the above conditions. The statement that we can tolerate overshoots below a certain level implies that a nonlinear filter may work. That is, the filter may have one set of characteristics up to a certain level and other characteristics above that level. The requirements that the action be inaudible and that the filter be transparent to sinewaves (no harmonic or intermodulation distortion) imply that the filter must be perfectly linear up to 100% modulation. It is feasible to have a filter which is linear up to 100% modulation and nonlinear only when an overshoot above 100% is imminent.

IV. SOLUTION: DYNAMIC TRANSIENT RESPONSE FILTER

THEORY, IDEAL CASE: Assume that we have two identical lowpass filters. The filters have a cutoff frequency of 15 kHz with infinite attenuation above and zero attenuation below, and a uniform time delay of 100 microseconds for all frequencies. (Such a filter is of course non-causal and impossible to build.) Consider the situation of Fig. 9 where the filters are cascaded; that is, the output of one filter drives the second.

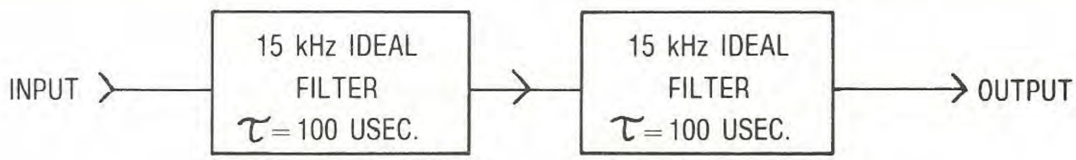


FIGURE 9
CASCADED IDEAL FILTERS

After application of a signal to the first filter, the output appears 100 usec. later with all components above 15 kHz removed. Phase relationships and amplitudes of components below 15 kHz are preserved; the only change to the signal will be the elimination of components above 15 kHz and 100 usec. of time delay. When the first filters's output is applied to the second, the second filter will function only as a 100 usec. delay line. Since there are no components above 15 kHz at the second filter's input, the second filter does not change the signal except for the addition of time delay. Therefore, **the first filter predicts the output of the second filter.** This prediction technique is employed in the Harris DTR filter.

IMPLEMENTATION: The DTR filter is a system which comprises two lowpass filters, an allpass filter (phase equalizer), and nonlinear compensation circuitry. A block diagram is given in Fig. 10.

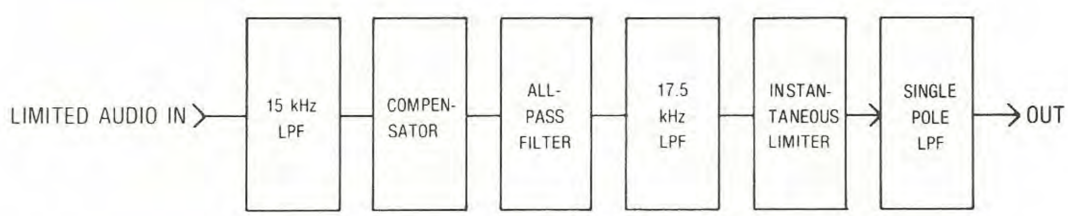


FIGURE 10
DYNAMIC TRANSIENT RESPONSE LOWPASS FILTER

The first filter (at extreme left) in Fig.10 is a seventh order elliptic type with a cutoff frequency of 15 kHz. The second filter is also seventh order elliptic but the cutoff frequency is 17.5 kHz. The second lowpass filter is preceded by an allpass filter which linearizes the lowpass filter's phase from DC to the cutoff frequency of the first filter (15 kHz). The combination of the allpass filter and the second lowpass filter presents an approximately uniform time delay of 100 usec. between DC and 15 kHz.

Since the passband of the first filter is contained within the linear phase passband of the second filter, the second filter changes neither the phase nor amplitude relationships of the first filter's output but only adds time delay. Therefore, the first filter predicts the output of the second filter. If the first filter overshoots, the second filter will overshoot 100 microseconds later. The inverse is also true: if the first filter does not overshoot, the second filter will not overshoot.

The compensator functions only when the first filter overshoots. The compensator is designed to take the appropriate evasive action to stop the second filter's predicted overshoot. This nonlinear action is discussed below.

EVASIVE ACTION: SUBTRACTING OVERSHOOTS: A block diagram of the compensator is shown in Fig. 11.

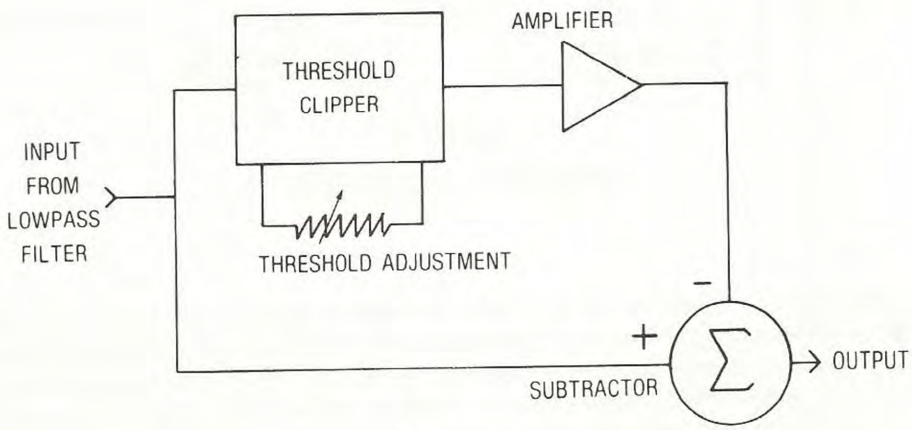
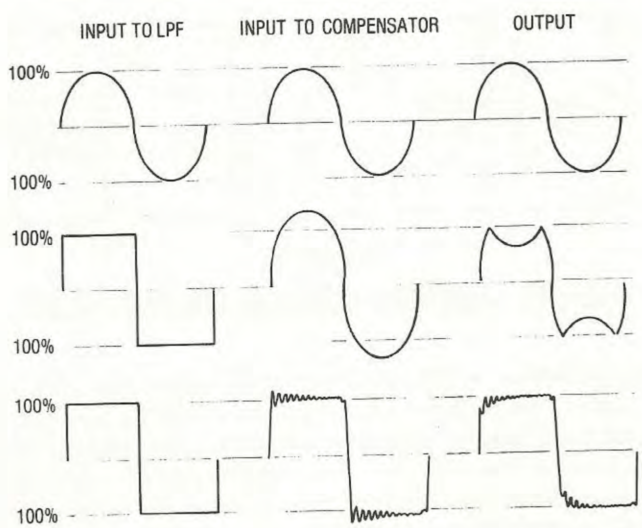


FIGURE 11
COMPENSATOR

Up to the 100% modulation level, the compensator causes no change to the signal. If the first filter overshoots above the 100% modulation level, that part of the signal which exceeds the threshold will be separated from the input and applied to the amplifier. The overshoots, having been separated and amplified, are subtracted from the original signal. Typical inputs and outputs are shown in Fig. 12.



WARNING: Disconnect primary power prior to servicing.

The effect of this action is to subtract a component at the frequency of the offending overshoot.

The output of the compensator contains frequency components above and below 15 kHz. The compensator subtracts signal components below 15 kHz to eliminate overshoot. Incidental extraneous components above 15 kHz are generated in the process. These high frequency products must be removed in such a manner that phase relationships are preserved. For this reason the processed signal is filtered by an allpass/lowpass combination which approximates linear phase to 15 kHz.

INSTANTANEOUS LIMITER/FILTER: Due to several approximations in the process, the second filter may occasionally overshoot several percent. An instantaneous limiter follows the second filter for this reason. Harmonics generated by this device are very low in amplitude since overshoot has been nearly eliminated. The limiter drives a single pole filter which does not overshoot. Even severely processed audio results in harmonic components that are at least 60 dB down.

V. RESULTS

OPERATION: The DTR filter is highly effective in its operation. Overmodulation due to overshoot has been reduced to 2%, approximately the accuracy of a modulation monitor. Operation is possible with **any** limiter and any program material including Dolby® processed audio. Setup is easy. All one does is to apply a signal that is known not to overshoot at 100% peak modulation. This can be a 400 Hz sinewave. Using this signal as a reference the compensation thresholds are set to a level corresponding to 100% modulation. LED indicators are provided to indicate when an overshoot is compensated, thereby facilitating setup.

Extensive listening and A-B tests have shown that on all type of programming the DTR filter produces no audible effect. Unlike other techniques using AGC, delay lines, or conventional clippers, the DTR filter takes action if and only if an overshoot is imminent. Because the energy contained in the overshoots is inappreciable, deletion of that energy is imperceptible to the ear. The modulation monitor, however, does not respond to average energy but rather peak voltage. The perception of the modulation monitor (and the FCC) is unlike that of the ear and **does** respond to low energy, high instantaneous amplitude transients.

The overshoot compensator removes the transients above 100% modulation. It does no more and no less.

WAVEFORMS: When a 600 Hz squarewave is applied to a conventional 15 kHz elliptic function lowpass filter the output rings and overshoots as shown by the top trace of Fig. 13.

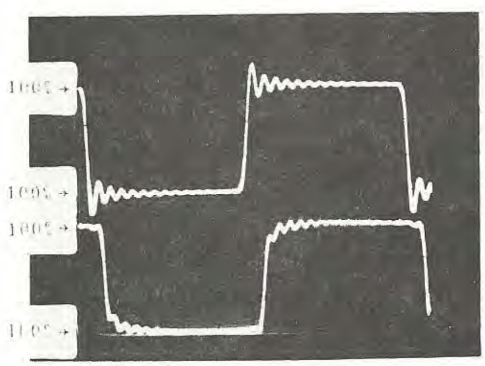


FIGURE 13

SQUAREWAVE RESPONSES

WARNING: Disconnect primary power prior to servicing.

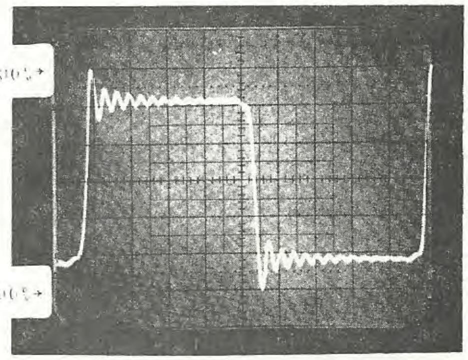
The DTR filter is shown in the bottom trace. There is a small amount of ringing; however, none of this causes overmodulation.

Fig. 14 shows the same squarewave but applied at 65% modulation. The system is completely linear at this level and no compensation is taking place.

FIGURE 14

DTR FILTER RESPONSE:

SQUAREWAVE AT 65% MODULATION

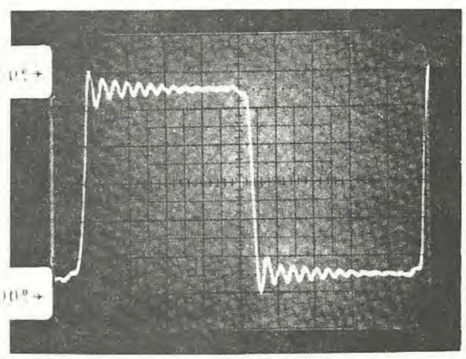


In Fig. 15 the level has been increased to 90% modulation. Here there is some action taking place to limit the first cycle of ringing to 100%.

FIGURE 15

DTR FILTER RESPONSE:

SQUAREWAVE AT 90% MODULATION

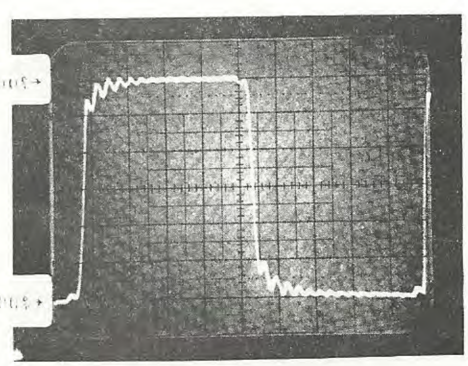


Finally in Fig. 16 the overshoot compensator is completely enabled as the squarewave is applied at 100% modulation.

FIGURE 16

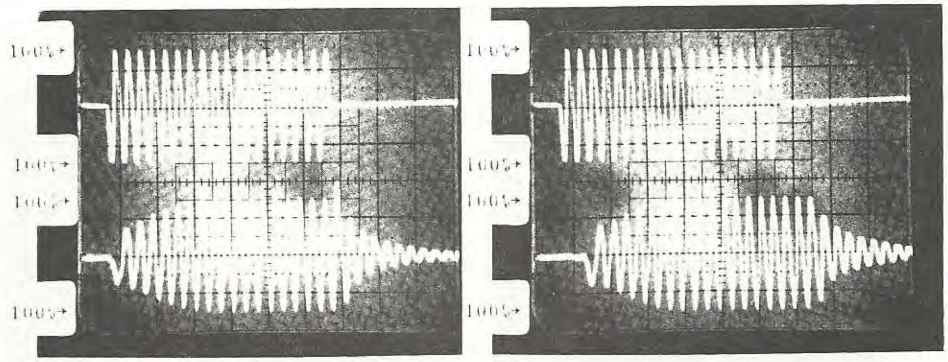
DTR FILTER RESPONSE:

SQUAREWAVE AT 100% MODULATION



WARNING: Disconnect primary power prior to servicing.

Tone bursts also demonstrate the capabilities of the DTR filter. Fig. 17 shows a 15.0 kHz tone burst input signal, the output of a conventional filter, and the output of the DTR filter.

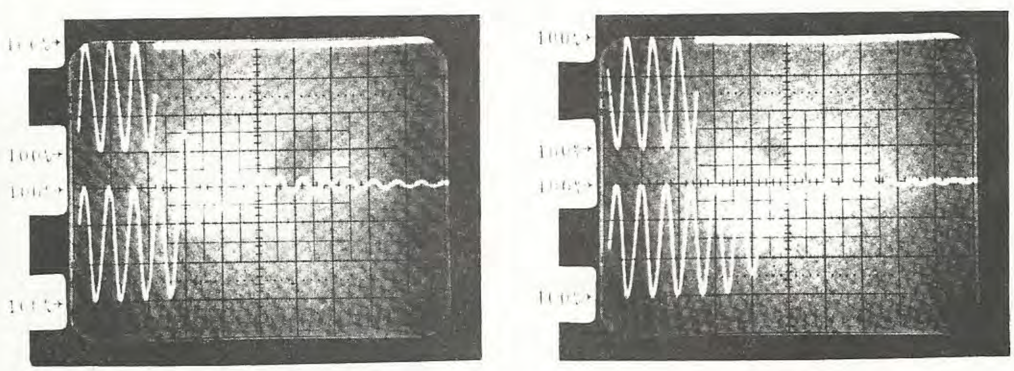


A. CONVENTIONAL FILTER B. DTR FILTER

TOP TRACE: INPUT
BOTTOM TRACE: OUTPUT

TONE BURST TESTS
FIGURE 17

One of the most difficult tests to be contrived for a filter is the signal described under "Examples", Causes and Effects of Overshoot. The signal consists of a sinewave at 100% modulation at a frequency very close to cutoff (15.0 kHz) applied for a time sufficiently long to ensure steady-state filter response, followed immediately by a transition to a step signal. The sinewave signal, being close to cutoff, will accumulate a long time delay with respect to the low-frequency step. At the filter's output, the signals will coincide at the transition. Fig. 18a shows the input and output of a conventional filter. Overshoot is 100%. If the modulation level of the transmitter were to be turned down to accommodate such overshoots without causing overmodulation, a full 6 dB of signal would be lost! The compensated filter response to the same test signal is shown in Fig. 18b. Overshoot is less than 2%. Notice that the DTR filter has no effect on the sinewave.



A. CONVENTIONAL FILTER B. DTR FILTER

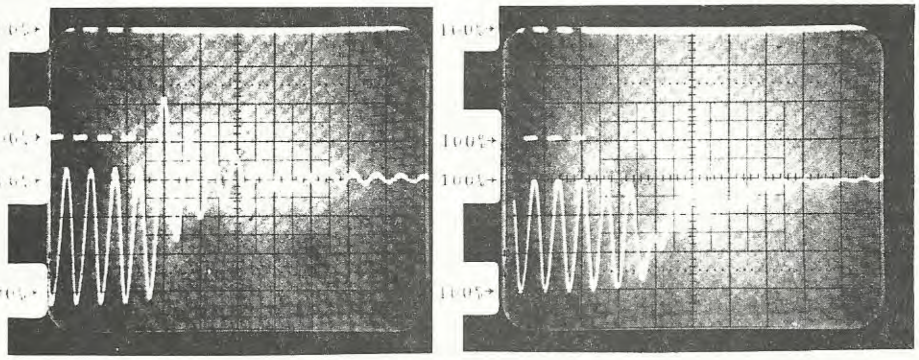
TOP TRACE: INPUT
BOTTOM TRACE: OUTPUT

SINE/STEP TESTS
FIGURE 18

WARNING: Disconnect primary power prior to servicing.

It is possible to cause even more overshoot by substituting a squarewave for the sinewave part of the test signal of Fig. 18. Fig. 19a shows the resultant squarewave/ step test signal applied to a conventional filter which overshoots 150%, or 8 dB!

The response of the DTR filter to the same test signal is shown in Fig. 19b.



A. CONVENTIONAL FILTER　　　B. DTR FILTER

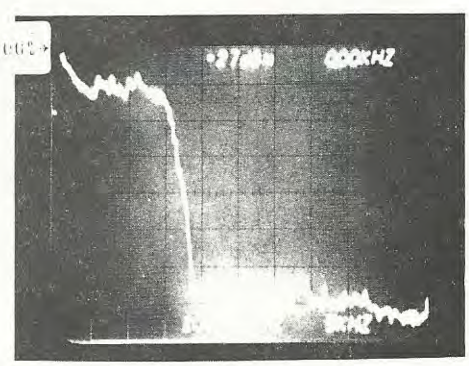
TOP TRACE: INPUT
BOTTOM TRACE: OUTPUT

SQUAREWAVE/STEP TESTS
FIGURE 19

This kind of signal is not uncommon with many types of limiters. Bass note attacks simultaneous with sibilance have been known to cause 100% overshoots when processed by a clipping-type limiter.

DYNAMIC SPECTRUM: Fig. 20 shows the output spectrum of the DTR filter under near "worst case" programming conditions. The input signal had extreme high frequency content, and was processed by several limiters, the last being a hard clipper. The spectrum analyzer, a Tektronix 7L5, is equipped with a microprocessor and memory which was used to produce a miximum-hold display.

FIGURE 20
DYNAMIC SPECTRUM



Over a 3 minute period the output spectrum of the DTR filter was continuously monitored; each time that a frequency contained more energy than previously, the display would be updated. Therefore, the display of Fig. 20 does not represent a typical instantaneous spectrum but rather the maximum spectral amplitude reached over a 3 minute period.

CONCLUSION: It has been shown that the DTR filter is a universally effective method for eliminating overmodulation due to overshoot. Because the compensator takes action **only** when necessary to remove low-energy overshoots, there is no audible distortion under any conditions. Because the compensated filter stands alone, a "systems approach" is not required; any FM limiter may be used.

A typical procedure for setting FM modulation levels has been to apply a sinewave through the program limiter at 100% modulation. A sinewave signal will not cause overshoot. Upon application of programming, the exciter filters will overshoot. With programming the modulation level must be reduced 2.5 to 6 dB to ensure that "peaks of frequent recurrence" do not cause overmodulation. With the Harris MS-15 exciter this last step of turning down the modulation has been eliminated.

The amount of loudness increase is a function of limiter type. The amount of overshoot that a limiter causes in a conventional filter is the amount of overshoot that is eliminated by the DTR filter. This same amount of overshoot is the increase in loudness that can be obtained. Some limiters, due to their excessive rolloff of highs, may only cause overshoots of 35% (2.6 dB). Other limiters, which rely more exclusively on clipping for pre-emphasis protection, can cause 100% overshoots (6 dB). Processors which rely upon a combination of clipping and rolloff will benefit from an intermediate loudness increase.

HARRIS COMMUNICATIONS AND INFORMATION HANDLING

HARRIS CORPORATION Broadcast Products Division
P. O. Box 290, Quincy, Illinois 62301 U.S.A.

JK-2M-877

ADV 513 PTD. IN U.S.A.

WARNING: Disconnect primary power prior to servicing.

MONO MODULE
888-2164-101

TECHNICAL MANUAL

MONO MODULE

994 8019 001

HARRIS

T.M. No. 888-2164-101

Printed: Mar. 5, 1986

MANUAL REVISION HISTORY
MONO MODULE
888-2164-1xx

REV. #	DATE	ECN	PAGES AFFECTED
101	03-05-86	29891	Replaced the following pages: i, ii, 10, 15/16, 21, 24, 25 & 26 Added the Manual Revision History Page

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

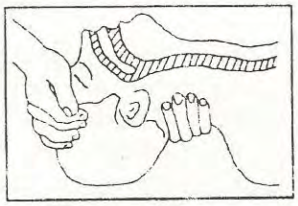
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

(A) AIRWAY

IF UNCONSCIOUS.
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

(B) BREATHING

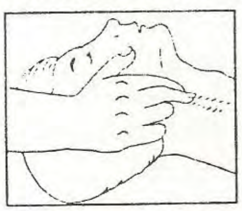
IF NOT BREATHING.
BEGIN ARTIFICIAL BREATHING

TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH RESUSCITATION MUST BE COMMENCED AS SOON AS POSSIBLE

CHECK
CAROTID PULSE



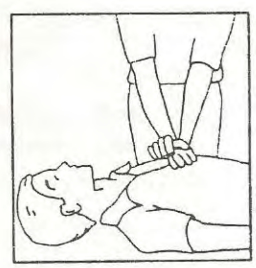
IF PULSE ABSENT.
BEGIN ARTIFICIAL CIRCULATION

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES

APPROX. RATE OF COMPRESSIONS --80 PER MINUTE { ONE RESCUER, 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE { TWO RESCUERS, 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

NOTE

> If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE

1-2. The MONO MODULE accepts a monaural audio signal input and generates a modulating signal to drive the MOD OSC module. Pre-emphasis is selectable and optional linear phase low-pass filtering protects the SCA channels from interference and provides linear overshoot control.

1-3. TECHNICAL CHARACTERISTICS

1-4. Table 1-1 lists operating characteristics and parameters of the FM Exciter MONO MODULE.

SECTION II

INSTALLATION

2-1. GENERAL

2-2. Refer to the MX-15 FM Exciter System Technical Manual, Section II, Installation.

SECTION III

CONTROLS AND INDICATORS

3-1. GENERAL

3-2. Figure 3-1 shows the location of each control or indicator associated with the MX-15 MONO MODULE and table 3-1 lists the controls and indicators with a description of each.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
POWER	+20 Vdc @ 0.075 amperes. -20 Vdc @ 0.080 amperes.
SIGNAL:	
AUDIO	+10 dBm ±1 dB for 100% modulation at 400 Hz. 600 ohm balanced resistive input impedance.
OUTPUTS	
SIGNAL:	
DRIVE	2.8V p-p for 100% modulation.
METERING	2.8V p-p for 100% modulation.

WARNING: Disconnect primary power prior to servicing.

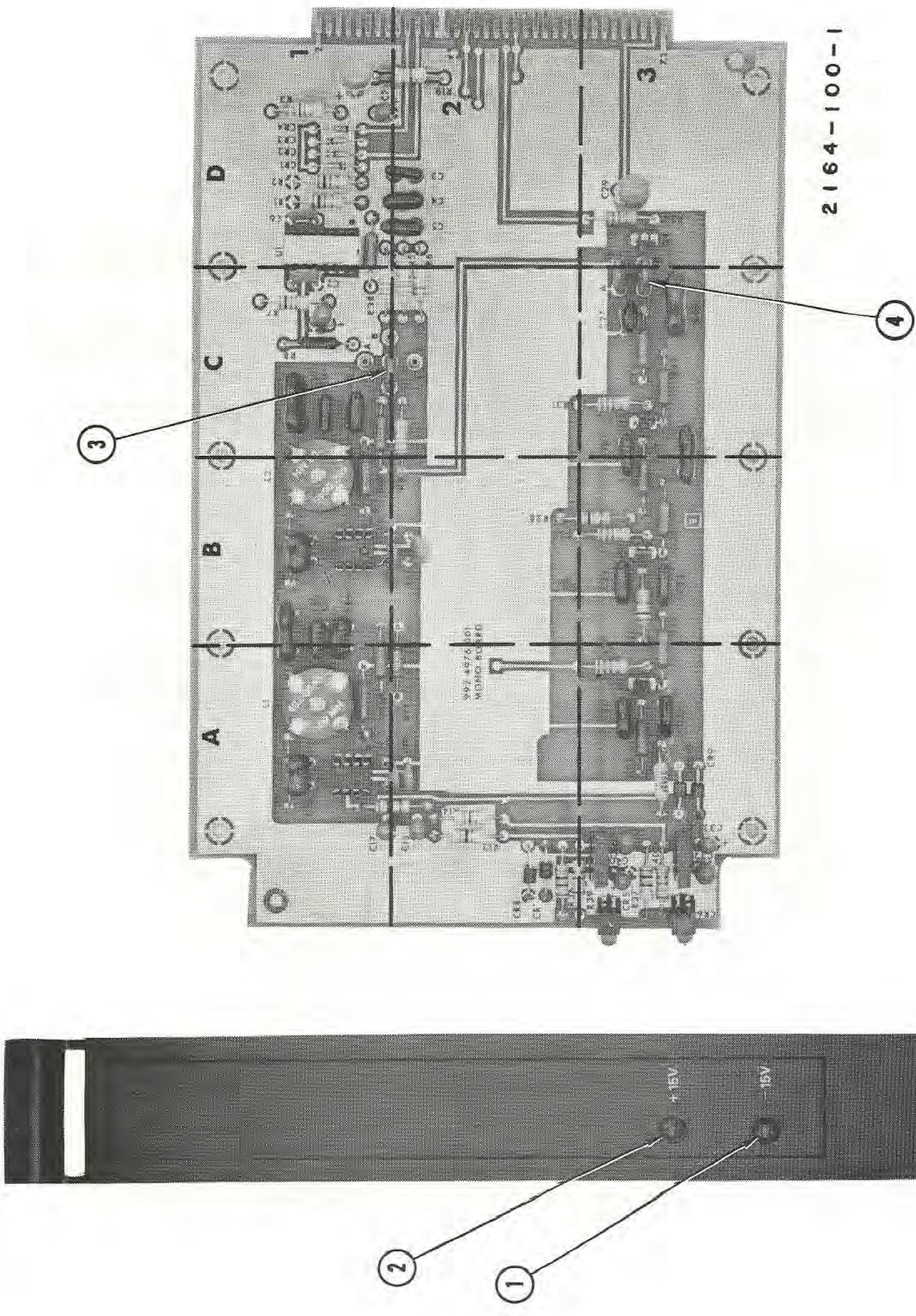


Figure 3-1. MONO MODULE

Table 3-1. MONO MODULE Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	-15V Indicator (CR6)	Illuminates to indicate the MONO MODULE -15 volt regulator is operational.
2	+15V Indicator (CR5)	Illuminates to indicate the MONO module +15 volt regulator is operational.
3	A/B/C/D Program Jumper (J1)	Selects MONO MODULE pre-emphasis A: 75 us B: 50 us C: 25 us D: flat
4	A/B/C/D Program Jumper (J2)	Enables or bypasses the linear phase low-pass filter. Enable: A to B, C to D. Bypass: A to C, B to D.

SECTION IV

PRINCIPLES OF OPERATION

4-1. CIRCUIT DESCRIPTION

4-2. INPUT CIRCUIT

4-3. INPUT PROTECTION NETWORK. Monaural audio input from the RFI filter is applied to a transformerless unity gain instrumentation amplifier (U1) through the input protection network (see figure 4-1). Damage to the preamplifier circuit from an excessive input signal is prevented by a configuration of four diodes connnected to the ±15 Vdc sources. If a signal or transient exceeding the power supply potential appears at the module input, the portion of the input which exceeds the power supply potential will be shunted by the diodes to the ±15 Vdc power supply to limit the signal.

4-4. INPUT PREAMPLIFIER. The input amplifier differs from a standard operational amplifier by the inputs and the methods through which feedback is obtained. The amplifier responds only to the difference in potential between the two inputs. If the same signal is applied to both inputs simultaneously or if only one input is driven and the connection to the second input is opened, the output will be zero. The amplifier therefore behaves as a transformer with response to dc. The amplifier provides the transformer's advantages of isolation and hum rejection without the problems of limited frequency response and phase distortion. A pre-emphasis selector (J1) allows pre-emphasis selection of 75 us, 50 us, 25 us, or flat response. Amplifier gain is determined by resistor R8 and the pre-emphasis network. Pre-emphasized audio is output to the filter section and the ac metering module.

4-5. LINEAR PHASE LOW-PASS FILTER

4-6. ALL-PASS NETWORK. The first section of the filter comprises U2, U3, and associated circuit components as an all-pass network. The frequency response of this section is flat for all frequencies up to the limit of each amplifier. However, the phase characteristic is a non-linear function of frequency. The phase function of the all-pass filter is tailored to the phase of the low-pass filter. When the two phase functions are added, a linear phase results. A test point is provided at the output of the all-pass filter to check for correct operation.

4-7. ACTIVE LOW-PASS FILTER. The active low-pass filter consists of Q1, Q2, Q3, and Q4. Each stage consists of high gain Darlington transistors which are employed as unity gain emitter follower stages. In this application, an active filter is produced through the introduction of positive feedback through capacitors C35, C23, C25, and C28 to each individual stage. Each section of the filter has a different frequency response so that the product of all four sections yields a flat low-pass response which cuts off at 16.9 kHz. The first two stages have a rolled off response at approximately 3.3 kHz and 9.4 kHz respectively. The last two stages have a peaked response at 14.0 kHz and 16.6 kHz respectively.

4-8. The linear phase low-pass filter may be disabled as desired with jumper J2. The module outputs a 1.0 VRMS signal to drive the MOD OSC module.

4-9. POWER

4-10. Positive 20 Vdc enters the module on pins 31 and 32 and negative 20 Vdc enters the module on pins 41 and 42. A regulated potential to operate the module internal circuitry is developed by regulators U4 (+15 Vdc) and U5 (-15 Vdc). Light emitting diode CR5 (+15V) provides an indication of the positive supply and light emitting diode CR6 (-15V) provides an indication of the negative supply. Positive and negative fifteen volt test points are provided to assist in checking the regulator outputs.

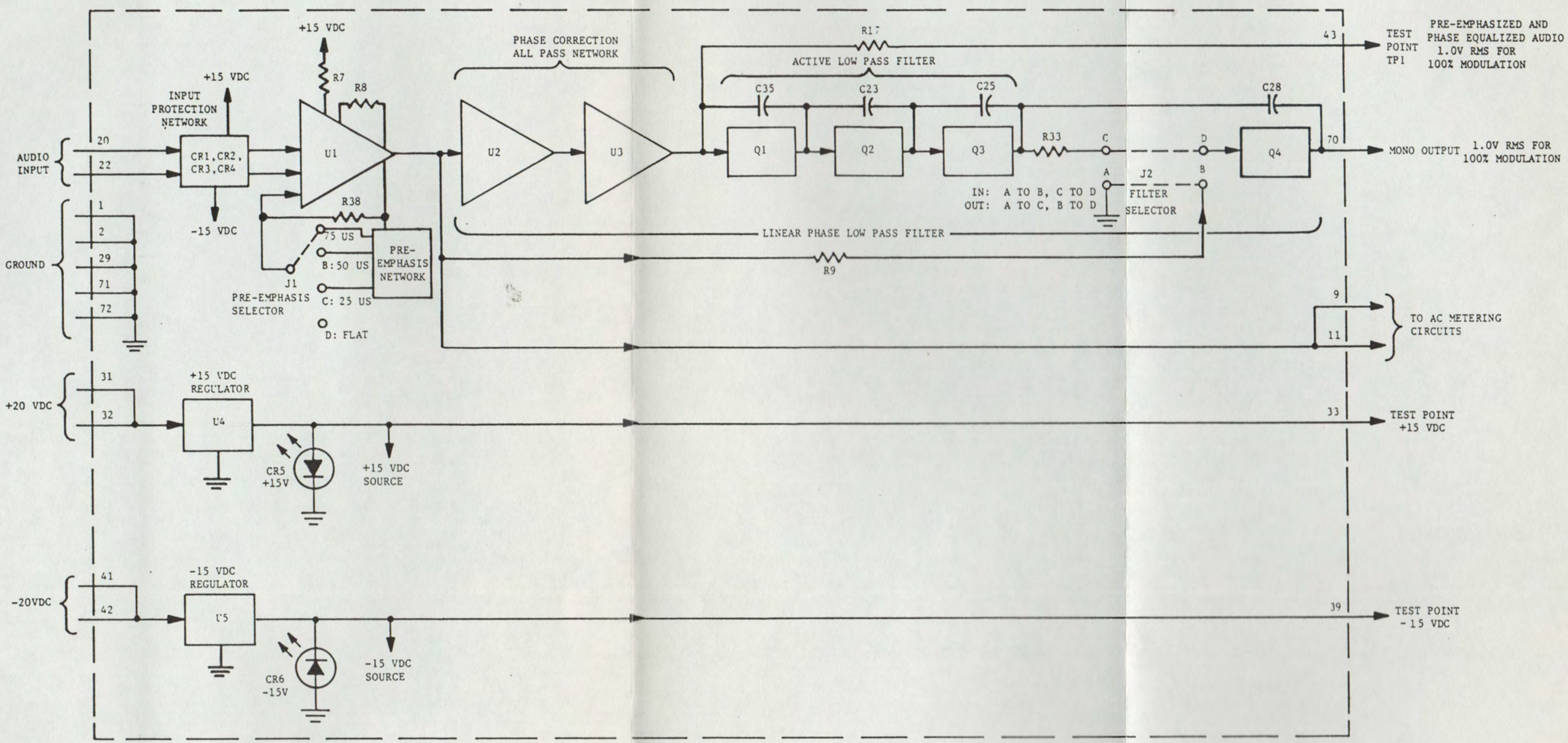


FIGURE 4-1. MONO MODULE BLOCK DIAGRAM

SECTION V

MAINTENANCE

5-1. CORRECTIVE MAINTENANCE

5-2. The MX-15 FM Exciter module maintenance philosophy consists of problem isolation to a specific area or individual component and subsequent isolation and replacement of the defective component.

5-3. TROUBLESHOOTING

5-4. In event of problems, the trouble area must first be isolated to a specific area. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, fuse F1, circuit breaker CB1, and the indicators on each module should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs which indicate the module power supply status. A single dark LED would indicate a problem associated with an individual module monolithic voltage regulator. A consistent pattern of dark LEDs however, would indicate an exciter dc distribution bus fault.

5-5. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-1 lists typical trouble symptoms pertaining to the individual module operation with references to fault isolation diagrams listing probable causes and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem. It only tends to lead the repairman into the area that may be causing the trouble. An extender board (HARRIS PN 992 4989 001) is provided with the exciter to assist in troubleshooting. In event parts are required, refer to Section VI, Parts List. The following information is contained in this section as an aid to maintenance:

REFERENCE	TITLE	NUMBER
Figure 5-1	MONO MODULE Parts Layout	--- ---- ---
Table 5-2	MONO MODULE Parts Index	--- ---- ---
Figure 5-2	MONO MODULE Waveforms	--- ---- ---
Figure 5-3	MONO MODULE Schematic	843 1703 001

WARNING: Disconnect primary power prior to servicing.

5-6. Prior to starting a troubleshooting procedure check all switches, power cord connections, connecting cables, and power fuses.

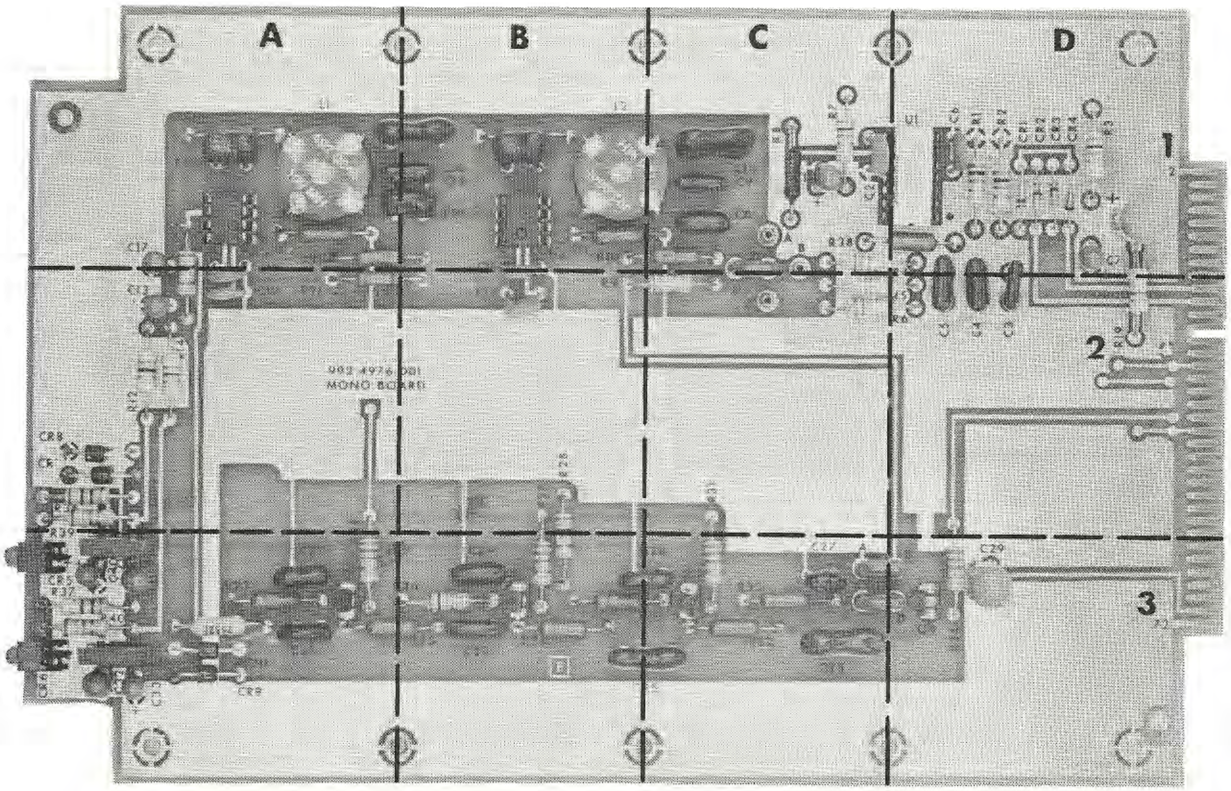
5-7. TECHNICAL ASSISTANCE

5-8. HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service Department 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

Table 5-1. MONO MODULE Fault Isolation Index

SYMPTOM	DEFECT/REFERENCE
NO OUTPUT (modulation meter indicates activity).	Figure 5-4
NO OUTPUT (modulation meter indicates no activity).	Figure 5-5
INCORRECT LOW-PASS FILTERING	Figure 5-6
NOISE OR AUDIO DISTORTION	Figure 5-7

WARNING: Disconnect primary power prior to servicing.



2164-100-3

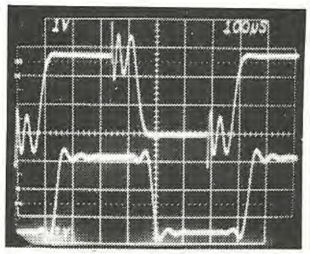
Figure 5-1. MONO MODULE Parts Layout

WARNING: Disconnect primary power prior to servicing.

Table 5-2. MONO MODULE Parts Index

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
C1	C1	C29	D3	Q1	A3	R23	A3
C2	C1	C30	A3	Q2	B3	R24	A3
C3	D2	C31	A3	Q3	C3	R25	B3
C4	D2	C32	A3	Q4	D3	R26	B3
C5	D2	C33	A3			R27	B2
C6	D1	C34	B1			R28	B2
C7	D1	C35	A3	R1	D1	R29	B3
C8	C1			R2	D1	R30	C3
C9	C1			R3	D1	R31	C2
C10	C1	CR1	D1	R4	D2	R32	C3
C11	B1	CR2	D1	R5	D2	R33	C3
C12	B2	CR3	D1	R6	D2	R34	D3
C13	A2	CR4	D1	R7	C1	R35	--
C14	B1	CR5	A3	R8	C1	R36	A2
C15	B1	CR6	A3	R9	B2	R37	A3
C16	B1	CR7	A2	R10	B1	R38	C1
C17	A1	CR8	A2	R11	B1	R39	A2
C18	A1	CR9	A3	R12	A2	R40	A3
C19	A2	CR10	A3	R13	B1		
C20	A1			R14	A2		
C21	--			R15	A1		
C22	A3			R16	A1		
C23	B3			R17	A1	U1	D1
C24	B3	J1	C1-C2	R18	A1	U2	B1
C25	C3	J2	C3-D3	R19	D2	U3	A1
C26	C3			R20	A3	U4	A3
C27	C3	L1	A1	R21	A2	U5	A3
C28	C3	L2	B1	R22	--		

WARNING: Disconnect primary power prior to servicing.

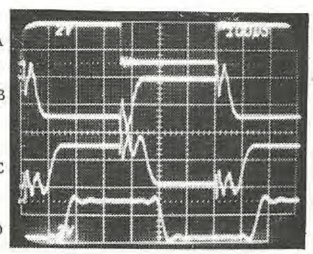


1A

1B

TEST REQUIREMENTS: A. U1 removed.
B. 1500 Hz squarewave applied to XU1 pin 7.

1A	All-pass filter output at U3 pin 6.
1B	Low-pass filter output at Q4 emitter.



2A

2B

2C

2D

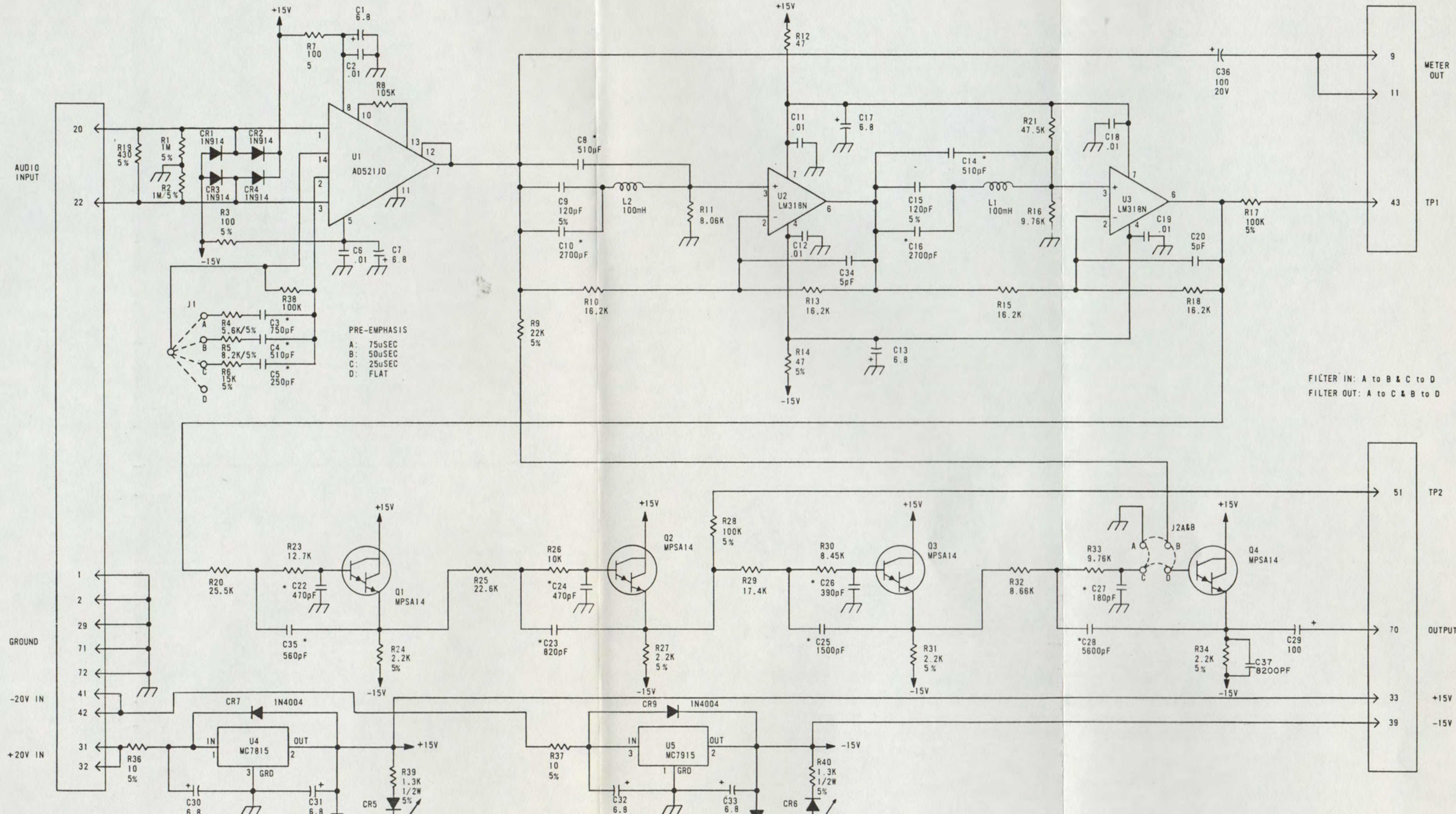
TEST REQUIREMENTS: 1500 Hz squarewave applied to exciter audio input.

2A	U1 pin 7 (ringing due to RFI filter).
2B	U2 pin 6.
2C	U3 pin 6.
2D	Q4 emitter.

2164-100-4

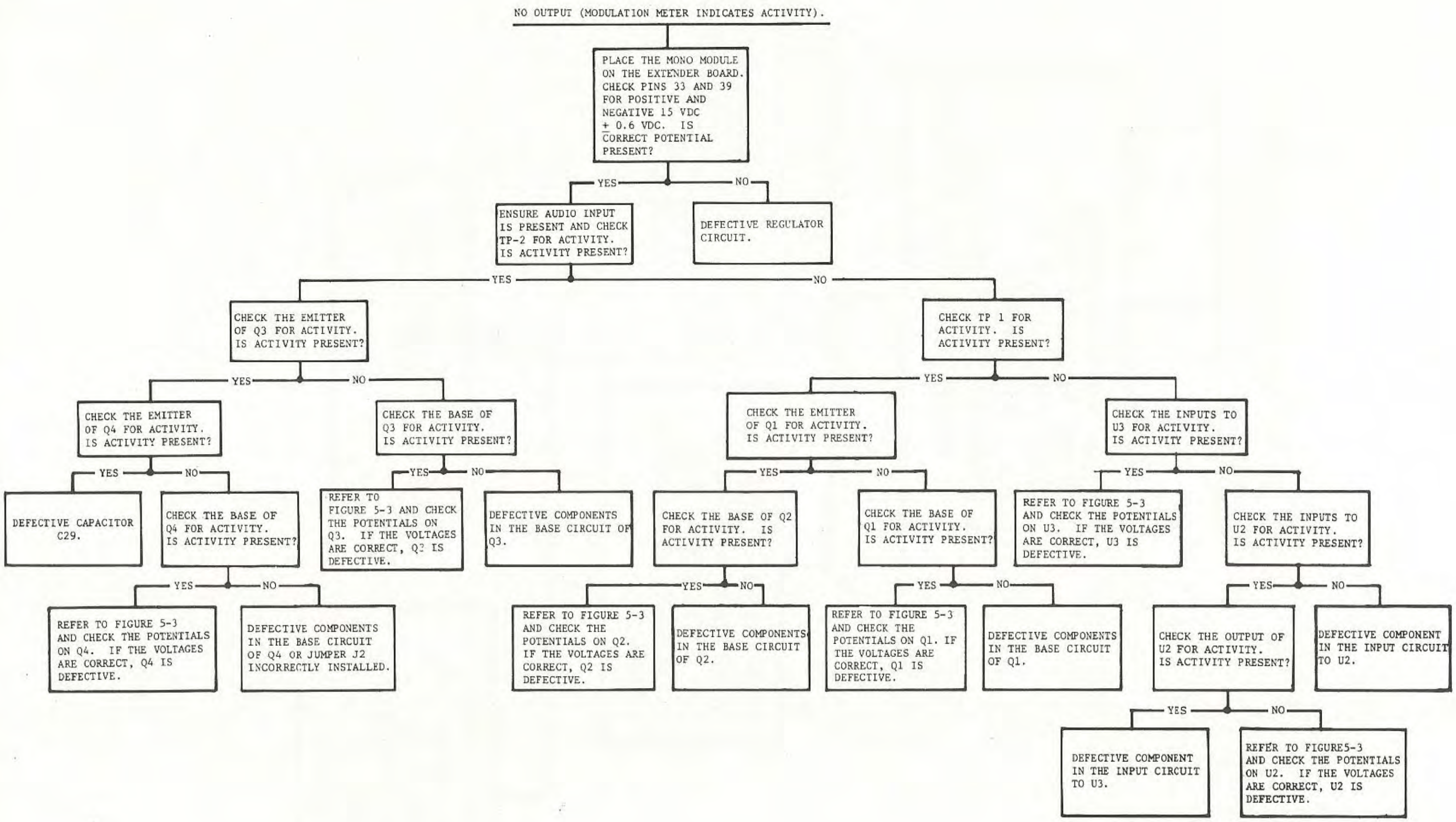
Figure 5-2. MONO MODULE Waveforms

WARNING: Disconnect primary power prior to servicing.



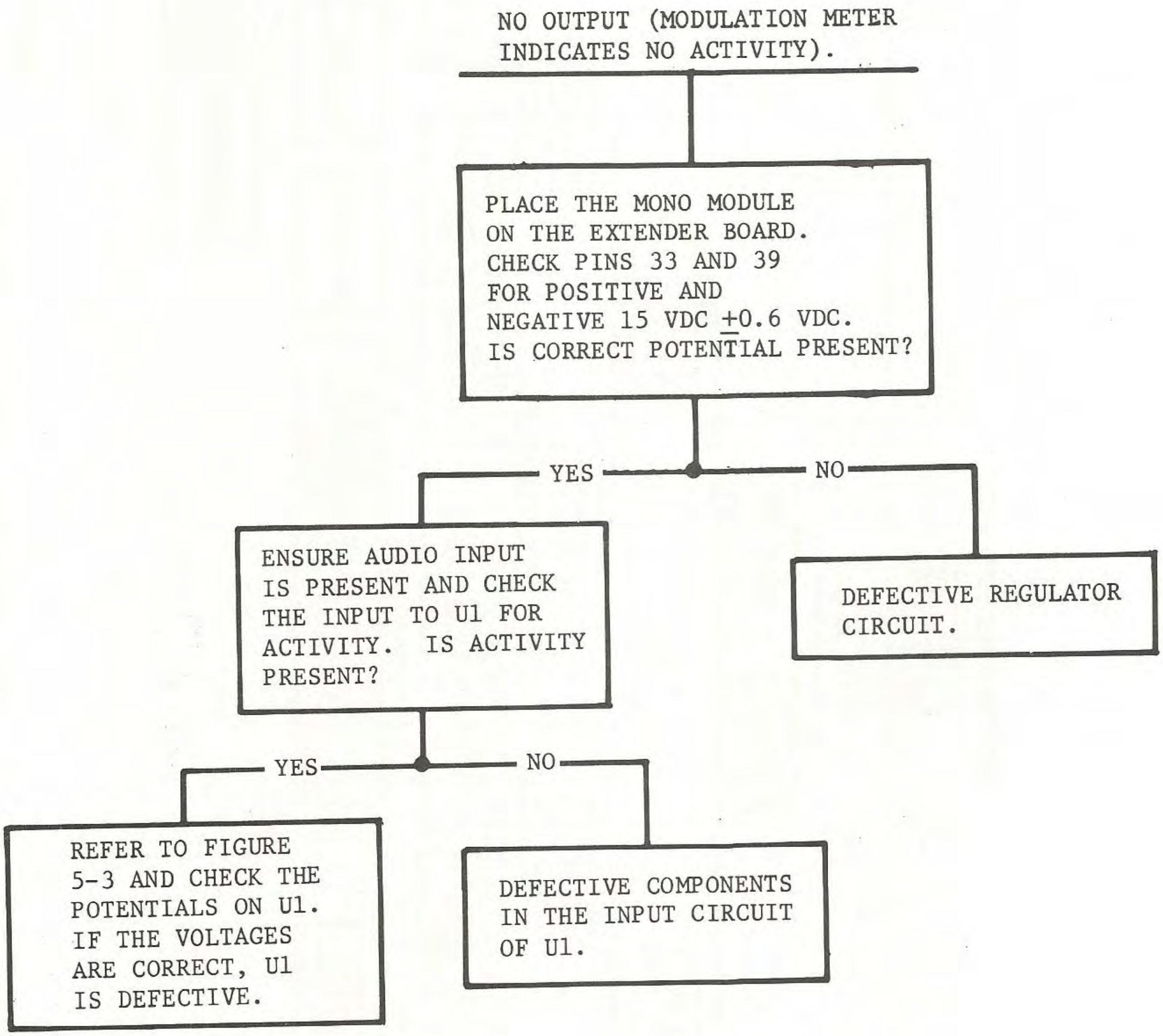
4. * DENOTES ±1% TOLERANCE.
3. ALL CAPACITANCE IN uF.
2. ALL RESISTANCE IN OHMS.
1. ALL RESISTORS ±1%, 1/4W.
UNLESS OTHERWISE SPECIFIED:
NOTES:

FIGURE 5-3. MONO MODULE SCHEMATIC
843 1703 001-D



2164-100-5

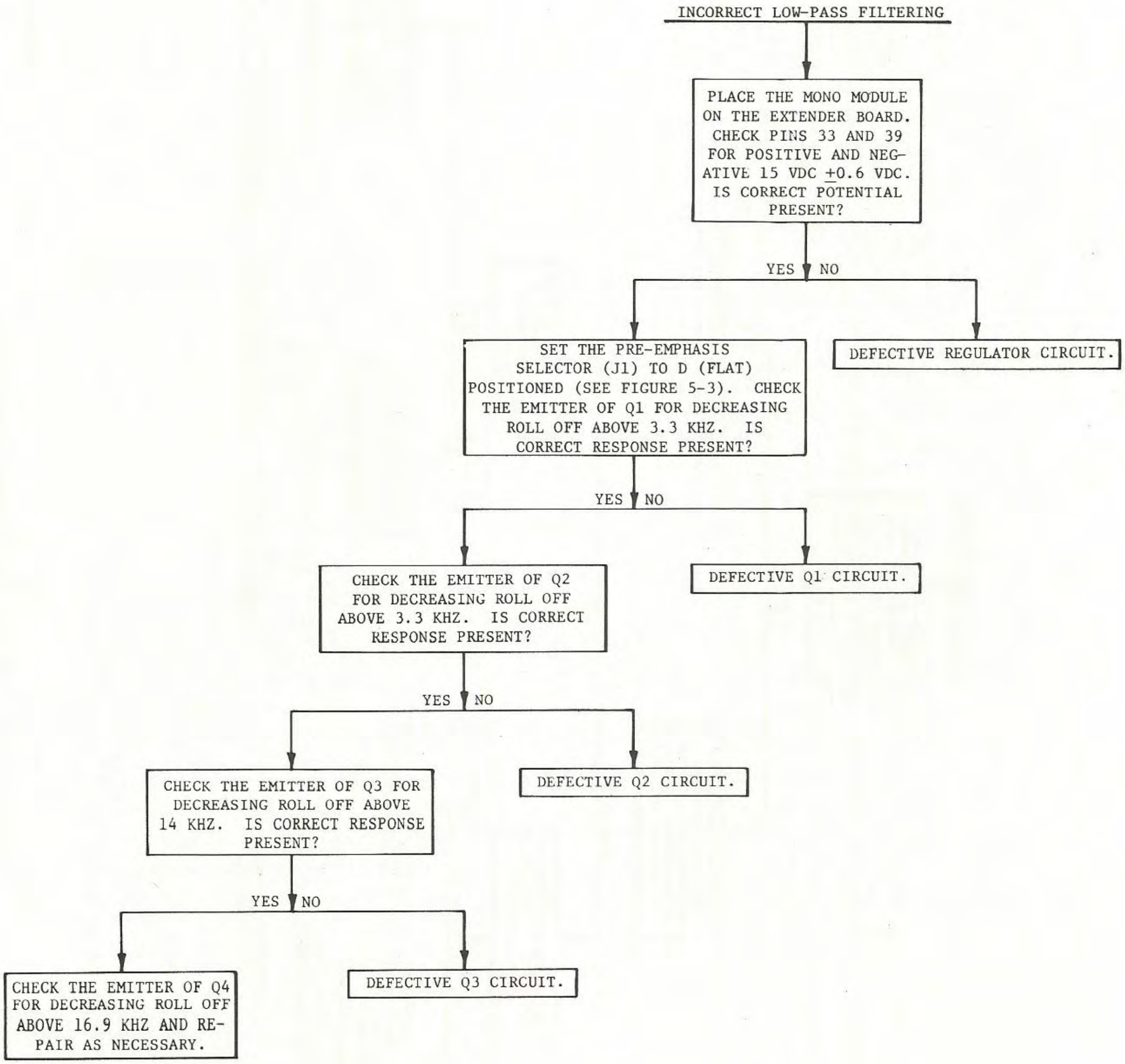
Figure 5-4. No Output (Modulation Meter Indicates Activity)



2164-100-6

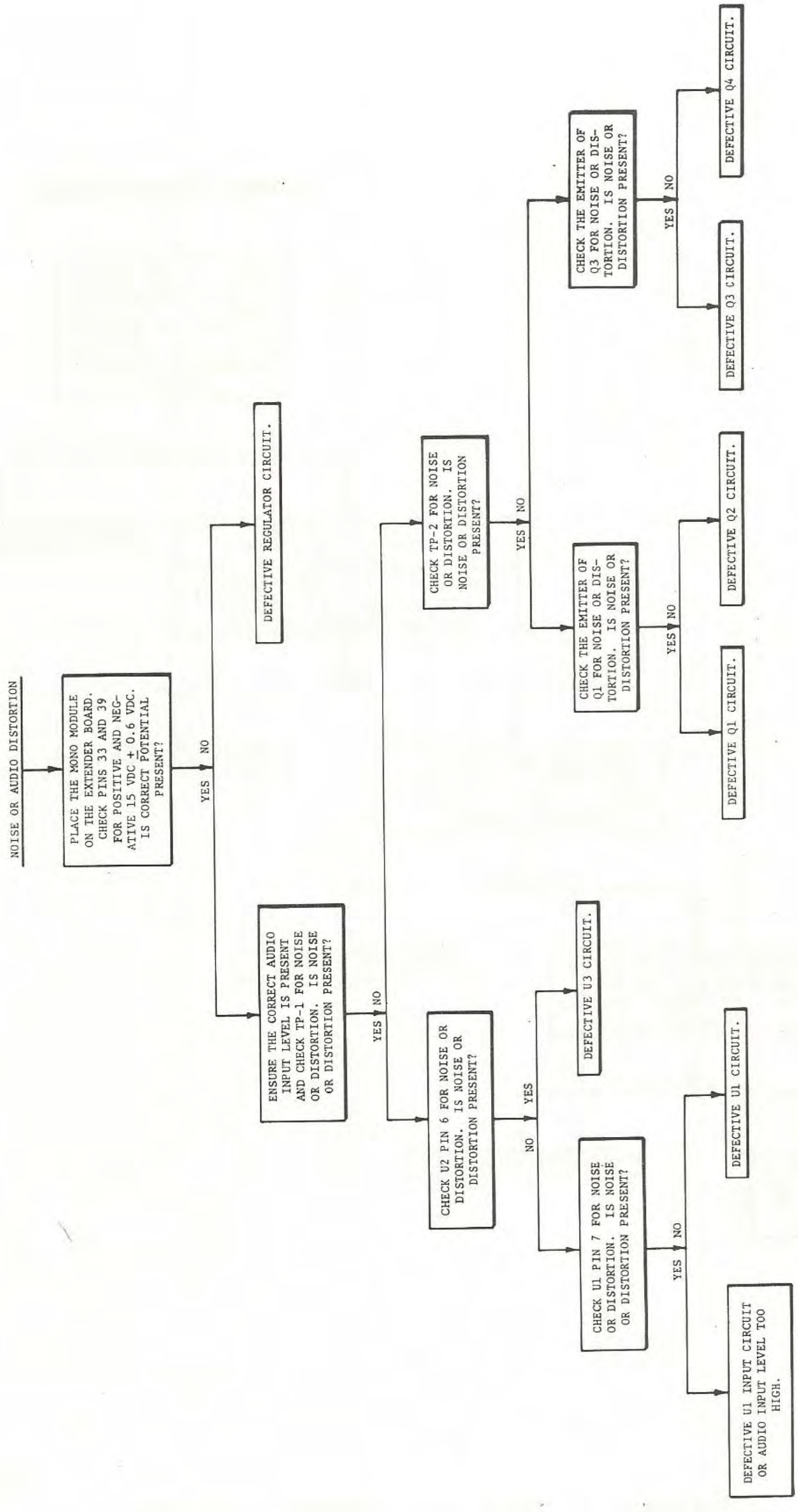
Figure 5-5. No Output (Modulation Meter Indicates No Activity)

WARNING: Disconnect primary power prior to servicing.



2164-100-7

Figure 5-6. Incorrect Low-Pass Filtering



2164-100-8

Figure 5-7. Noise or Audio Distortion

WARNING: Disconnect primary power prior to servicing.

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. Refer to table 6-1 for replaceable parts which are required for proper maintenance of the MX-15 FM Exciter MONO MODULE. Table entries are indexed by component reference designator.

6-3. REPLACEABLE PARTS SERVICE

6-4. Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

 WARNING: Disconnect primary power prior to servicing.

Table 6-1. MONO MODULE Front Panel - 994 8019 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
------	992 4976 001	MONO MODULE Circuit Board (Refer to table 6-2)	1

Table 6-2. MONO MODULE Circuit Board - 992 4976 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1,CR2,CR3,CR4	384 0205 000	DIODE SILICON 1N914	4
CR5,CR6	384 0661 000	L.E.D. GREEN	2
CR7,CR8,CR9 CR10	384 0357 000	RECTIFIER 1N4004	4
C1	526 0049 000	CAP 6.8UF 35V 20%	1
C2	516 0375 000	CAP .01UF 50V	1
C3	500 1217 000	CAP 750PF 500V 1%	1
C4	500 1220 000	CAP 510PF 500V 1%	1
C5	500 1169 000	CAP 240PF 500V 1PCT	1
C6	516 0375 000	CAP .01UF 50V	1
C7	526 0049 000	CAP 6.8UF 35V 20%	1
C8	500 1220 000	CAP 510PF 500V 1%	1
C9	500 0826 000	CAP, MICA 120PF 500V 5%	1
C10	500 1215 000	CAP 2700PF 500V 1%	1
C11,C12	516 0375 000	CAP .01UF 50V	2
C13	526 0049 000	CAP 6.8UF 35V 20%	1
C14	500 1220 000	CAP 510PF 500V 1%	1
C15	500 0826 000	CAP, MICA 120PF 500V 5%	1
C16	500 1215 000	CAP 2700PF 500V 1%	1
C17	526 0049 000	CAP 6.8UF 35V 20%	1
C18,C19	516 0375 000	CAP .01UF 50V	2
C20	500 0803 000	CAP MICA 5UUF 500V	1
C22	500 1221 000	CAP 470PF 500V 1%	1

Table 6-2. MONO MODULE Circuit Board - 992 4976 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C23	500 1218 000	CAP 820PF 500V 1%	1
C24	500 1221 000	CAP 470PF 500V 1%	1
C25	500 1216 000	CAP 1500PF 500V 1%	1
C26	500 1222 000	CAP 390PF 500V 1%	1
C27	500 1224 000	CAP 180PF 500V 1%	1
C28	500 1223 000	CAP 5600PF 300V 1%	1
C29	526 0057 000	CAP 100UF 20V 20%	1
C30,C31,C32,C33	526 0049 000	CAP 6.8UF 35V 20%	4
C34	500 0803 000	CAP MICA 5UUF 500V	1
C35	500 1219 000	CAP 560PF 500V 1%	1
C36	526 0057 000	CAP 100UF 20V 20%	1
C37	500 0846 000	CAP MICA 8200PF 100V 5%	1
J1,J2A,J2B	610 0679 000	PLUG, SHORTING	3
L1,L2	492 0645 000	INDUCTOR 100 MH 2%	2
Q1,Q2,Q3,Q4	380 0319 000	TRANSISTOR MPS-A14	4
R1,R2	540 1162 000	RES 1/2W 1 MEGOHM 5%	2
R3	540 1102 000	RES .5W 100 OHM 5PCT	1
R4	540 1183 000	RES 1/2W 5600 OHM 5%	1
R5	540 1153 000	RES .5W 8200 OHM 5%	1
R6	540 1184 000	RES 1/2W 15K OHM 5%	1
R7	540 1102 000	RES .5W 100 OHM 5PCT	1
R8	548 1370 000	RES 105K OHM 1/4W	1

WARNING: Disconnect primary power prior to servicing.

Table 6-2. MONO MODULE Circuit Board - 992 4976 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R9	540 1160 000	RES .5W 22K OHM 5%	1
R10	548 1364 000	RES 16.2K OHM 1/4W	1
R11	548 1396 000	RES 8.06K OHM 1/4W 1%	1
R12	540 0017 000	RES .5W 47 OHM 5%	1
R13	548 1364 000	RES 16.2K OHM 1/4W	1
R14	540 0017 000	RES .5W 47 OHM 5%	1
R15	548 1364 000	RES 16.2K OHM 1/4W	1
R16	548 1438 000	RES 9.76K OHM 1/4W	1
R17	540 1159 000	RES .5W 100K OHM 5%	1
R18	548 1364 000	RES 16.2K OHM 1/4W	1
R19	540 1170 000	RES 1/2W 430 OHM 5%	1
R20	548 1440 000	RES 25.5K OHM 1/4W 1%	1
R21	548 0569 000	RES 47.5K OHM 1/4W 1%	1
R23	548 0382 000	RES 12.7K OHM 1/4W 1%	1
R24	540 1182 000	RES 1/2W 2200 OHM 5%	1
R25	548 1399 000	RES 22.6K OHM 1/4W 1%	1
R26	540 1111 000	RES .5W 10K OHM 5PCT	1
R27	540 1182 000	RES 1/2W 2200 OHM 5%	1
R28	540 1159 000	RES .5W 100K OHM 5%	1
R29	548 1439 000	RES 17.4K OHM 1/4W 1%	1
R30	548 1360 000	RES 8450 OHM 1/4W 1%	1
R31	540 1182 000	RES 1/2W 2200 OHM 5%	1

WARNING: Disconnect primary power prior to servicing.

Table 6-2. MONO MODULE Circuit Board - 992 4976 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R32	548 0780 000	RES 8.66K OHM 1/4W 1%	1
R33	548 1438 000	RES 9.76K OHM 1/4W	1
R34	540 1182 000	RES 1/2W 2200 OHM 5%	1
R36,R37	540 1151 000	RES .5W 10 OHM 5%	2
R38	548 0932 000	RES 100K OHM 1/4W 1%	1
R39,R40	540 1187 000	RES 1/2W 1300 OHM 5%	2
U1	382 0473 000	CKT, INTEGRATED	1
U2,U3	382 0472 000	IC LM318	2
U4	382 0359 000	IC, 7815	1
U5	382 0360 000	IC, 7915	1
XU1	404 0674 000	SOCKET, IC 14 CONT	1
XU2,XU3	404 0673 000	SOCKET, IC 8 CONT	2
	612 0904 000	JACK, PC MT	9

WARNING: Disconnect primary power prior to servicing.

SCA MODULE
888-2164-251

TECHNICAL MANUAL

SCA MODULE

994 7992 002

T.M. No. 888-2164-251

Printed: June 22, 1984

MANUAL REVISION HISTORY
SCA MODULE
888-2164-25X

REV. #	DATE	ECN	PAGES AFFECTED
251	06-22-84	29006	Replaced the following pages: Title Page, 3, 16, 19/20, 28 thru 32 Added the Manual Revision History Page

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

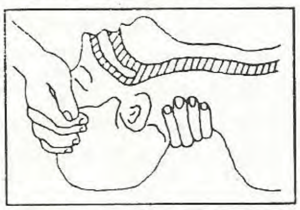
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

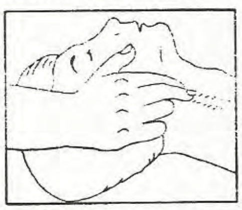
(A) AIRWAY

IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

CHECK
CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

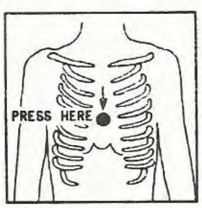
(B) BREATHING

IF NOT BREATHING,
BEGIN ARTIFICIAL BREATHING

TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL
4 QUICK FULL BREATHS
REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

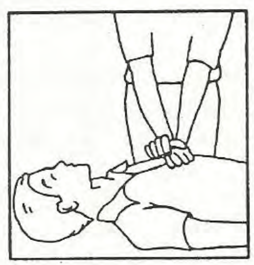
(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES



APPROX. RATE OF COMPRESSIONS --80 PER MINUTE: ONE RESCUER, 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE: TWO RESCUERS, 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

   NOTE

   If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

LIST OF ILLUSTRATIONS

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE

1-2. The SCA MODULE accepts an ac coupled audio or dc coupled input signal such as slow scan television and produces a 92 kHz or 67 kHz frequency modulated SCA subcarrier at the level required to drive the MOD OSC module input circuitry. Selectable manual or automatic muting and programmable pre-emphasis of 150 us, 75 us, 50 us, or flat response are provided. Local and remote switching provisions and module front panel indicators provide convenient SCA operation.

1-3. TECHNICAL CHARACTERISTICS

1-4. Table 1-1 lists operating characteristics and parameters of the MX-15 FM Exciter SCA MODULE.

NOTE

Specifications subject to change without notice.

SECTION II

INSTALLATION

2-1. GENERAL

2-2. Refer to MX-15 FM Exciter System Technical Manual, Section II, Installation.

SECTION III

CONTROLS AND INDICATORS

3-1. GENERAL

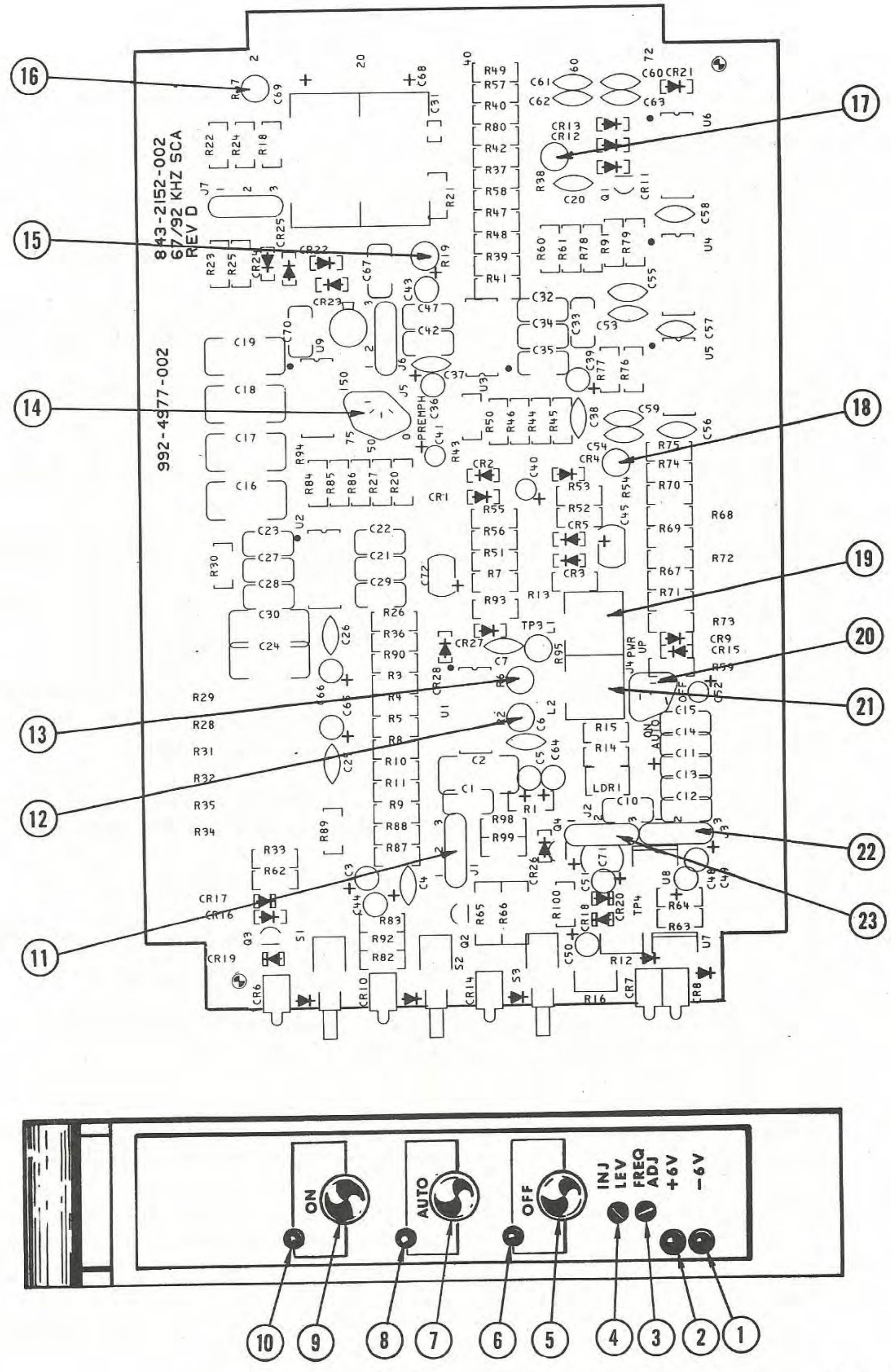
3-2. Figure 3-1 shows the location of each control or indicator associated with the MX-15 FM Exciter SCA MODULE and table 3-1 lists the controls and indicators with a description of each item listed. Control setup adjustments are listed in table 3-2.

WARNING: Disconnect primary power prior to servicing.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
Power:	+20 Vdc @ 0.060 amperes -20 Vdc @ 0.040 amperes
Signal:	
AC	+10 dBm ±1 dB for 100% modulation at 400 Hz @ 600 ohms
DC	1.0V peak for 5 kHz deviation @ 2000 ohms
Control:	
Remote Switching	+18V to +24 Vdc, momentary level
OUTPUTS	
Signal:	100 millivolts RMS composite SCA for 10% injection. (Adjustable from 0 to 30% injection.)
Control:	
SCA-2 inhibit	+6 Vdc for inhibit -6 Vdc for operate

WARNING: Disconnect primary power prior to servicing.



2164-250-1A

Figure 3-1. SCA MODULE

WARNING: Disconnect primary power prior to servicing.

Table 3-1. SCA MODULE Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	-6V Indicator (CR8)	Illuminates to indicate the SCA MODULE -6 volt regulator is operational.
2	+6V Indicator (CR7)	Illuminates to indicate the SCA MODULE +6 volt regulator is operational.
3	FREQ ADJ Control (R2)	Adjusts the center frequency of the SCA subcarrier.
4	INJ LEV Control (R16)	Adjusts the output level of the SCA subcarrier.
5	OFF Switch (S3)	Inhibits operation of the SCA channel.
6	OFF Indicator (CR14)	Indicates operation of the SCA channel is inhibited when illuminated.
7	AUTO Switch (S2)	Enables circuitry on the SCA MODULE to automatically mute the SCA carrier if the SCA audio input mutes.
8	AUTO Indicator (CR10)	Indicates the SCA AUTO mode of operation is enabled when illuminated.
9	ON Switch (S1)	Enables the SCA carrier.
10	ON Indicator (CR6)	Indicates the presence of SCA subcarrier when illuminated.
11	92 KHZ/67 KHZ SCA Frequency Jumper (J1)	Programs SCA channel frequency.
12	Waveform Adjust Control (R2)	Adjusts the SCA oscillator waveform for minimum odd harmonic distortion.
13	Symmetry Adjust Control (R6)	Adjusts the SCA oscillator waveform for symmetry and minimum even harmonic distortion.
14	PREMPH 150/75/50/0 pre-emphasis Jumper (J5)	Selects SCA MODULE input pre-emphasis.

Table 3-1. SCA MODULE Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
15	AUDIO INPUT LEVEL Control (R19)	Adjusts signal level input to the SCA generator circuit.
16	D.C. INPUT LEVEL Control (R17)	Adjusts level of dc coupled input signal.
17	MUTE LEVEL Control (R38)	Adjust threshold level at which SCA subcarrier appears.
18	MUTE DELAY Control (R54)	Adjusts the time delay between the last modulating signal and muting of the SCA subcarrier.
19	Primary Tuning Control (L1)	Tunes primary circuit of doubly tuned SCA bandpass filter.
20	POWER UP OFF/ON/AUTO Jumper (J4)	Determines module operational status at power application (SCA on, SCA auto, SCA off). (Factory set for auto.)
21	Secondary Tuning Control (L2)	Tunes secondary circuit of doubly tuned SCA bandpass filter.
22	92 KHZ/67 KHZ Bandpass Filter Tuning Jumper (J3)	Selects center frequency of bandpass filter output circuit (92 kHz or 67 kHz).
23	92 KHZ/67 KHZ Bandpass Filter Tuning Jumper (J2)	Selects center frequency of bandpass filter input circuit (92 kHz or 67 kHz).

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments

CONTROL	ADJUSTMENT
FREQ ADJ Control (R12)	1. Connect the exciter rf output to a 50 ohm load through a directional coupler or line sampler. 2. Connect a modulation monitor to the line sampler or the forward port of the directional coupler. 3. Connect an SCA monitor to the SCA provision on the modulation monitor. 4. Remove the STEREO ANALOG module from the exciter. 5. Ensure there is no modulation applied to the SCA module. 6. Depress the SCA ON switch. The ON indicator will illuminate. 7. Adjust R12 to the proper SCA frequency (92 kHz or 67 kHz) as indicated by the SCA monitor. 8. Reconnect the exciter output to the load, replace the STEREO ANALOG module in the exciter, and reapply modulation to the SCA module.
INJ LEV Control (R16)	Refer to the MOD OSC module SCA-1 LEVEL SHIFT Control (R54)/SCA-2 LEVEL SHIFT Control (R55) adjustment procedure (888-2164-700).
D.C. INPUT LEVEL Control (R17) AUDIO INPUT LEVEL Control (R19)	1. Connect the exciter rf output to a 50 ohm load through a directional coupler or line sampler. 2. Connect a modulation monitor to the line sampler or the forward port of the directional coupler.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	3. Connect an SCA monitor to the SCA provision on the modulation monitor. 4. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 5. Depress the SCA MODULATION meter switch and ensure the SCA level input to the exciter is correct (see table 1-1). 6. Depress the SCA ON switch. The ON indicator will illuminate. 7. Depress the SCA MODULATION meter switch. If the SCA ac coupled input is used, adjust the audio input level to obtain a 100% MODULATION meter indication and adjust R19 to obtain a SCA monitor indication of 5 kHz deviation. If the SCA dc coupled input is used, adjust R17 to obtain a 100% MODULATION meter indication and adjust R19 to obtain an SCA monitor indication of 5 kHz deviation. * 8. Remove the module and extender board, replace the module in the exciter, and reconnect the exciter to the load.
MUTE LEVEL Control (R38)	1. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 2. Depress the SCA MODULATION meter switch and ensure the SCA level input to the exciter is correct (see table 1-1).

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	3. Adjust R38 fully clockwise. 4. Depress the SCA AUTO switch. The AUTO indicator will illuminate. 5. Adjust R38 counterclockwise until the ON indicator illuminates. 6. Remove the module and extender board and replace the module in the exciter.
MUTE DELAY Control (R54)	1. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 2. Depress the SCA MODULATION meter switch and ensure the SCA audio levels input to the exciter are correct (see table 1-1). 3. Adjust R54 fully counterclockwise. 4. Depress the SCA AUTO switch. The AUTO indicator and the ON indicator will illuminate. 5. Interrupt the SCA audio feed to the exciter. The ON indicator will immediately go out. 6. Apply and remove the SCA audio to the exciter and adjust R54 until the ON indicator remains illuminated for the desired time delay.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	7. Remove the module and extender board and replace the module in the exciter. Ensure the audio feed is connected to the SCA module.
Primary Tuning Control (L1)	1. Connect the exciter rf output to a 50 ohm load through a directional coupler or line sampler.
SECONDARY TUNING Control (L2)	2. Connect a modulation monitor to the line sampler or the forward port of the directional coupler.
	3. Connect an SCA monitor to the SCA provision on the modulation monitor.
	4. Remove the module from the exciter and remove the side cover.
	5. Mount the module in the exciter using the extender board provided with the exciter.
	6. Depress the SCA ON switch. The SCA ON indicator will illuminate.
	7. Adjust L1 or L2 to peak the SCA monitor injection indication.
	8. Remove the extender board, replace the module side cover, and replace the module in the exciter. Reconnect the exciter to the load.
Symmetry Adjust Control (R6)	1. Remove the module from the exciter and remove the side cover.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	2. Mount the module in the exciter using the extender board provided with the exciter.
	3. Connect a low frequency spectrum analyzer between test point TP3 and ground.
	4. Adjust R6 to obtain a minimum second harmonic indication.
	5. Disconnect the spectrum analyzer from the module, remove the extender board, replace the module side cover, and replace the module in the exciter.
Waveform Adjust Control (R2)	1. Remove the module from the exciter and remove the side cover.
	2. Mount the module in the exciter using the extender board provided with the exciter.
	3. Connect a low frequency spectrum analyzer between test point TP3 and ground.
	4. Perform the Symmetry Adjust Control (R6) procedure.
	5. Adjust R2 to obtain a minimum odd harmonic indication.
	6. Disconnect the spectrum analyzer from the module, remove the extender board, replace the module side cover, and replace the module in the exciter.

* SCA modules are normally supplied with 100% modulation equal to ±5 kHz deviation.

WARNING: Disconnect primary power prior to servicing.

SECTION IV

PRINCIPLES OF OPERATION

4-1. CIRCUIT DESCRIPTION

4-2. INPUT CIRCUIT

NOTE

In the following discussion, multiple circuit ICs will have their individual parts designated by the output pin of that circuit (i.e. U2-14 is the reference for the circuit in U2 that has its inputs on pins 13 and 12 and the its output on pin 14).

4-3. AUDIO PREAMPLIFIER. Audio is applied to the SCA MODULE through a pad consisting of R22, R23, R24, and R25 which provides a 600 ohm balanced resistive module input impedance to the input of the unity gain differential amplifier U9. Audio from the differential amplifier is applied to the pre-emphasis network which provides selection of 150 us, 75 us, or flat response as determined by the position of jumper J5. The audio is applied with signal from the dc coupled input to audio preamplifier U2-14. The D.C. INPUT LEVEL control (R17) provides adjustment of the dc input signal level.

4-4. ACTIVE LOW-PASS FILTER. The active low-pass filter comprises U2-14, U2-1, U2-7, and U2-8 which are used as active elements in a seven pole Butterworth low-pass filter. The filter provides 42 dB per octave attenuation above 4.5 kHz. However, the filter cutoff frequency may be moved to 5.0 kHz or 7.5 kHz as desired by changing resistor values as noted on figure 5-3. The entire active low-pass filter may be bypassed for special SCA requirements (see figure 5-3). The output of the active low-pass filter is applied to the ac meter module, the mute circuit audio amplifiers and the voltage controlled oscillator in the rf circuit.

4-5. SCA GENERATION

4-6. VOLTAGE CONTROLLED OSCILLATOR. Input signal to the voltage controlled oscillator is level adjusted by the AUDIO INPUT LEVEL control (R19) and applied to the FM input of the monolithic function generator. The oscillator generates the 92 kHz or 67 kHz SCA subcarrier as programmed by jumper J1. The center frequency of the SCA carrier is adjusted by the FREQ ADJ control (R12). With the symmetry adjust control (R6) and the WAVEFORM ADJUST control (R2) correctly adjusted for minimum distortion, harmonics will be suppressed a minimum of 45 dB below the fundamental frequency.

4-7. OUTPUT CIRCUIT. The SCA signal generated by the voltage controlled oscillator is applied to a doubly tuned bandpass filter in which J2 and J3 determine the coupling and center frequency of the filter for operation on

92 kHz or 67 kHz. This filter attenuates the residual harmonic content in the SCA carrier by more than 70 dB. The primary of the filter is tuned by L1 and the secondary circuit is adjusted by L2. The INJ LEV control (R16) allows adjustment of the SCA module to 100 millivolts for 10% modulation as required to drive the MOD OSC module circuitry. When the SCA module is disabled, Q4 is cutoff, causing LDR1 to open, disconnecting the input to the bandpass filter. Also the VCO (U1) output is inhibited by a low at its pin 1.

4-8. MUTE CIRCUIT

4-9. The SCA mute circuit consists of an audio level detector and a delay timer. If the audio input level falls below a preset threshold or is interrupted for a period longer than an adjustable time delay, the SCA channel output will mute until the audio is reapplied. The SCA threshold sensitivity is adjustable from 0 dBm to -30 dBm by the MUTE LEVEL control (R38) and the SCA delay is adjustable from 0.5 to 20 seconds by the MUTE DELAY control (R54).

4-10. LEVEL DETECTOR. A high gain audio amplifier consisting of U3-7 and U3-1 provides the required amplification to increase the audio level from the active low-pass filter to the level necessary to drive the peak rectifier circuit. After amplification, the audio is applied to a peak detector comprising CR1, CR2, and associated circuitry. The resultant charge is stored in capacitor C41. As long as the potential of the peak detected audio is greater than the dc reference applied to the threshold comparator by R47 and R48, comparator U3-14 applied +6 volts to the delay timer circuit.

4-11. DELAY TIMER. As long as an active +6 Vdc output is applied from the threshold comparator, capacitor C45 will remain fully charged and the delay comparator (U3-8) will output a +6 Vdc level. The output of U3-8 activates LDR1 and enables the VCO (U1) through inverter U4-11, turns on driver Q3 which illuminates the ON indicator, and provides an SCA ON signal to the MOD OSC module. The SCA ON signal from SCA module No. 2 is also applied to the STEREO DIGITAL module to prevent simultaneous SCA and stereophonic operation to prevent mutual interference. The SCA channel is given priority in this situation and the STEREO DIGITAL module is automatically switched to a predetermined monaural mode. Two SCA's can be activated simultaneously by removing the SCA interlock jumper (J2) in the STEREO DIGITAL module.

4-12. If the audio input is interrupted, the charge on capacitor C45 will discharge through the MUTE DELAY control (R54). When the charge on C45 falls below the dc level applied to the delay comparator through R56 and R58, the delay comparator outputs a LOW state and mutes the SCA channel output. Diode CR4 provides isolation to prevent C45 from discharging through U3-14.

4-13. CONTROL CIRCUIT

4-14. Mode selection is performed by two dc flip flops implemented by four cross coupled NAND gates. The dc flip flops are controlled by logic levels rather than transitions. When a mode is selected, either by depressing a mode switch or applying an input on the selected remote control input provision, a momentary LOW (-6) Vdc sets or resets each flip flop. The U4-3/U5-1 flip flop is set (U4-3 HIGH) when the SCA ON mode, the U4-10/U5-13 flip flop is set (U4-10 HIGH) when in the SCA OFF mode, and in the AUTO mode both flip flops are reset and U4-4 outputs a LOW.

4-15. When the SCA ON is selected the positive input to comparator U3-1 is driven HIGH through diode CR5. When SCA OFF is selected, the negative input to comparator U3-8 is forced HIGH through diode CR3. Either action overrides the mute circuit function and manually turns the SCA carrier on or off. In the AUTO mode, diodes CR3 and CR5 are both off which allows the automatic muting function to operate.

4-16. POWER UP MODE SELECTION. When power is applied, capacitor C52 is discharged. Until the capacitor charges through diode CR15, a low condition exists on the mode selection line determined by the position of jumper J4. This will initialize the equipment in the selected mode at power application. Resistor R73 discharges C52 when power is removed.

4-17. REMOTE CONTROL. Remote control mode selection is provided by optical isolator U6. The input side of the optical isolator is protected from reverse bias by diodes CR11, CR12, and CR13. Current limiting resistors for each remote control input are located on the RFI filter. Remote control mode selection consists of application of a positive 18 to 24 Vdc potential on the particular input line.

4-18. MODE INDICATORS. Light emitting diodes connect to the control gates through drivers and illuminate when each mode is selected. The ON indicator illuminates to indicate selection of the ON mode and functions as a mute circuit status indicator when the AUTO mode is selected. The AUTO indicator illuminates when AUTO is selected and the OFF indicator illuminates when module operation is inhibited by selection of the OFF mode.

4-19. POWER

4-20. Positive 20 Vdc enters the module on pins 31 and 32 and negative 20 Vdc enters the module on pins 41 and 42. A regulated potential to operate the module internal circuitry is developed by regulators U7 (+6 Vdc) and U8 (-6 Vdc). Light emitting diodes CR7 (+6V) and CR8 (-6 Vdc) indicate operation of the two regulators. Positive and negative six volt test points are provided to assist in checking the regulator outputs.

SECTION V

MAINTENANCE

5-1. <u>CORRECTIVE MAINTENANCE</u>

5-2. The MX-15 FM Exciter module maintenance philosophy consists of problem isolation to a specific area or individual component and subsequent isolation and replacement of the defective component.

5-3. TROUBLESHOOTING

5-4. In event of problems, the trouble area must first be isolated to a specific area. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, fuse F1, circuit breaker CB1, and the indicators on each module should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs which indicate the module power supply status. A single dark LED would indicate a problem associated with an individual module monolithic voltage regulator. A consistent pattern of dark LEDs however, would indicate an exciter dc distribution bus fault.

5-5. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-1 lists typical trouble symptoms pertaining to the individual module operation with references to fault isolation diagrams listing probable causes and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem. It only tends to lead the repairman into the area that may be causing the trouble. An extender board (HARRIS PN 992 4989 001) is provided with the exciter to assist in troubleshooting. In event parts are required, refer to Section VI, Parts List. The following information is contained in this section as an aid to maintenance:

REFERENCE	TITLE	NUMBER
Figure 5-1	SCA MODULE Parts Layout	--- ---- ---
Figure 5-2	SCA MODULE Waveforms	--- ---- ---
Figure 5-3	SCA MODULE Schematic	839 6583 001

5-6. Prior to starting a troubleshooting procedure check all switches, power cord connections, connecting cables, and power fuses.

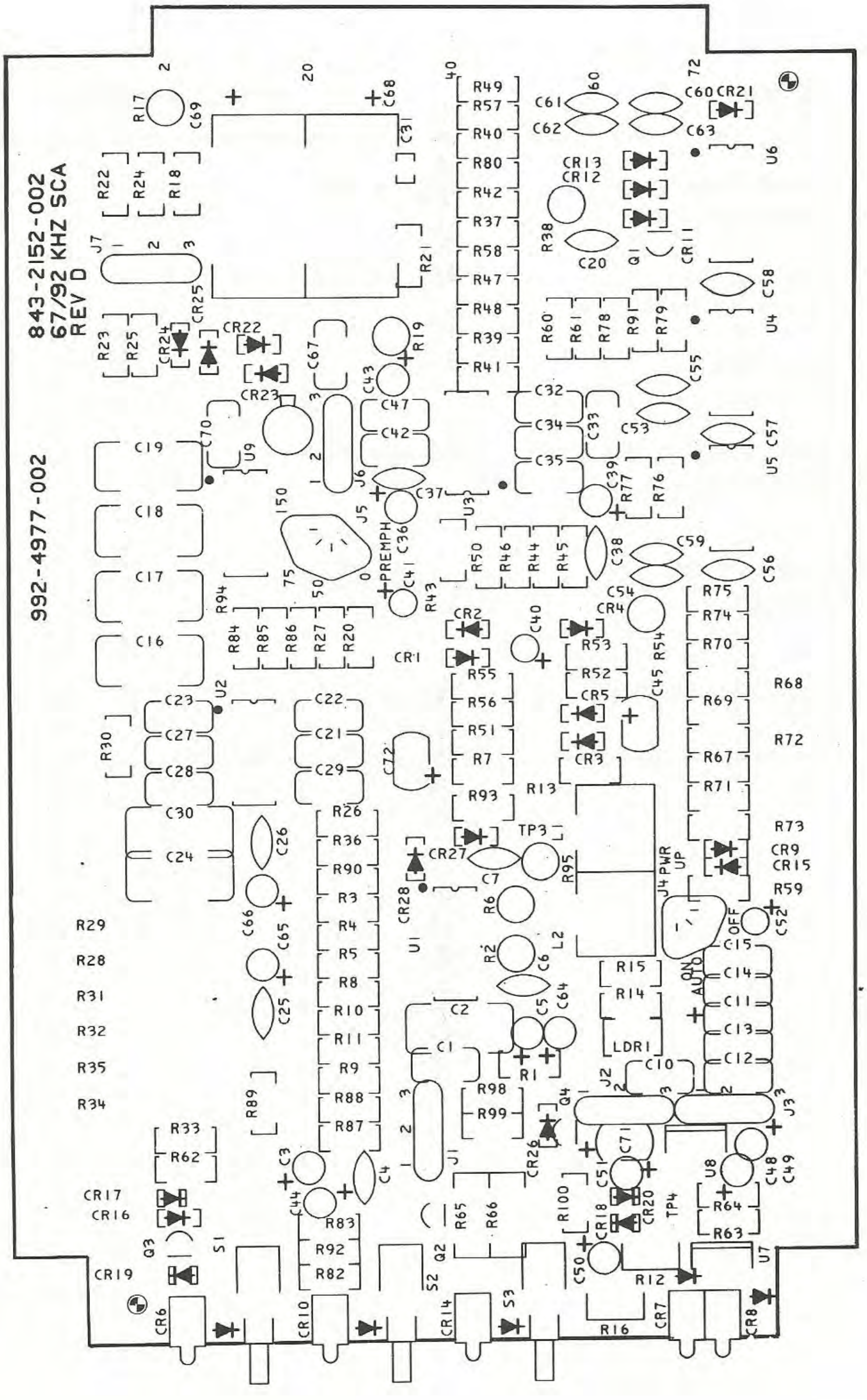
5-7. <u>TECHNICAL ASSISTANCE</u>

5-8. HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service during normal business hours (8:00 a.m - 5:00 p.m. Central Standard Time). Emergency service is available 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Group, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

WARNING: Disconnect primary power prior to servicing.

Table 5-1. SCA MODULE Fault Isolation Index

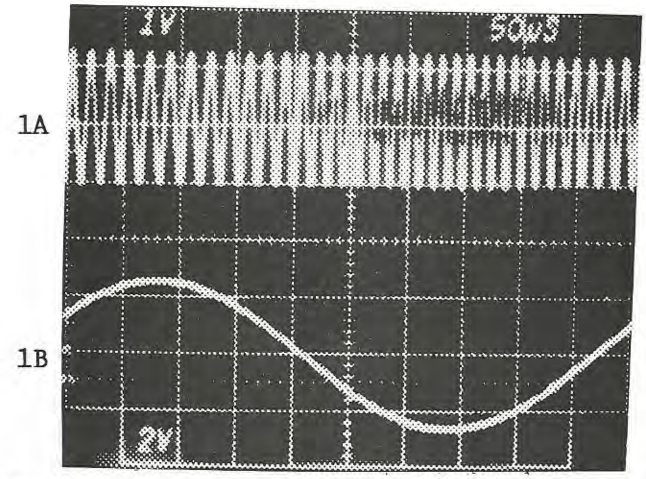
SYMPTOM	DEFECT/REFERENCE
NOT OUTPUT (modulation meter indicates activity	Figure 5-4
NO OUTPUT (modulation meter indicates no activity	Figure 5-5
MUTING INOPERATIVE (ON indicator out).	Figure 5-6
LOCAL AND REMOTE MODE SELECTION INOPERATIVE (any mode).	Figure 5-7
REMOTE MODE SELECTION INOPERATIVE (any mode).	Defective U6
SCA TO STEREO CROSSTALK	Figure 5-8



2164-250-3A

Figure 5-1. SCA MODULE Parts Layout

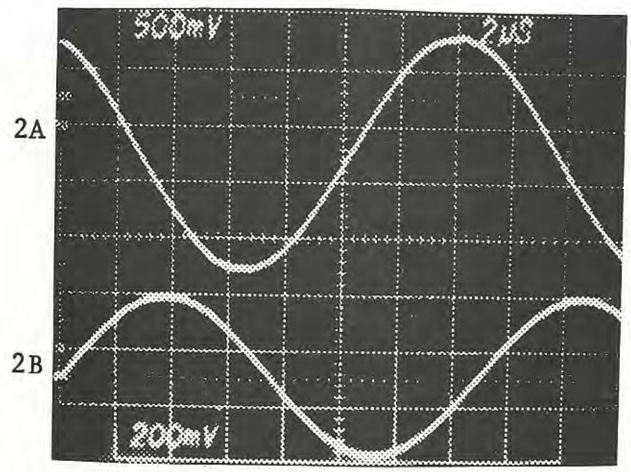
WARNING: Disconnect primary power prior to servicing.



TEST REQUIREMENTS: 2 kHz modulation @±5 kHz deviation

1A Function generator output at TP-3.

1B U2D pin 8.



TEST REQUIREMENTS: A. No signal applied to exciter audio inputs.
B. SCA turned on.

2A Function generator output at TP-3.

2B SCA output at module pin 66.

2164-250-4

Figure 5-2. SCA MODULE Waveforms

WARNING: Disconnect primary power prior to servicing.

TEST CONDITIONS: 1 kHz modulation [illegible] deviation

1A Function generator output at TP-1.

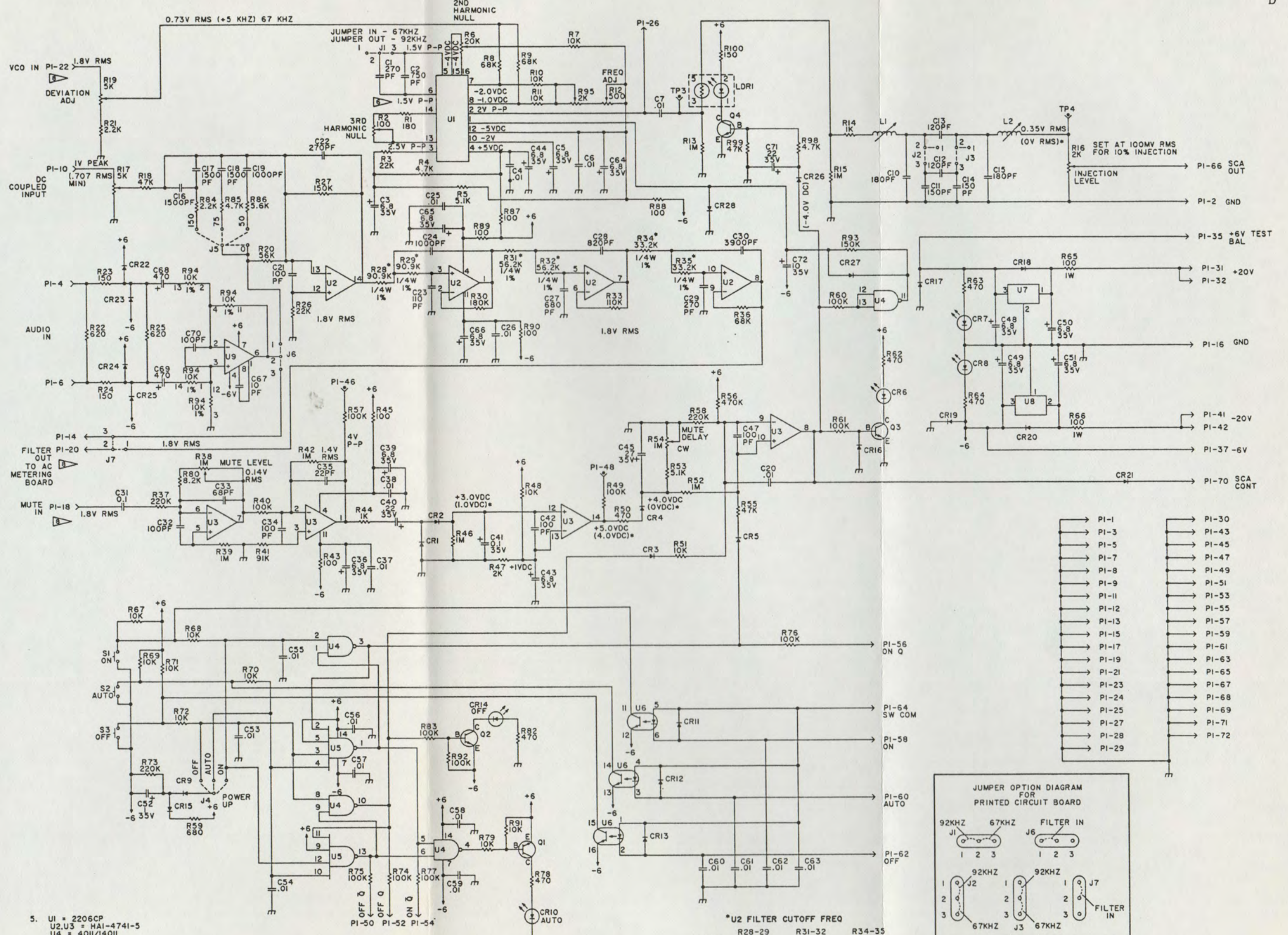
1B U28 pin 8

TEST CONDITIONS: A. No signal applied to external audio inputs.
B. PLs turned on.

2A Function generator output at TP-1.

2B SCA output at [illegible] pin 56.

Figure 3-14. SCA Signal Waveforms 2184-230-4



5. U1 = 2206CP
   U2,U3 = HAI-4741-5
   U4 = 4011/14011
   U5 = 4012
   U6 = OPTO ISOL
   U7 = 7806
   U8 = 7906
   U9 = CA308AT
4. Q4 = 2N4401
3. Q1 = 2N4403
   Q2,Q3 = MPSA14
2. CAPACITANCE IS IN UF
1. RESISTORS ARE IN OHMS, 1/2 WATT, 5% UNLESS OTHERWISE NOTED:

6 ▷ MAY BE SELECTED AT TEST BETWEEN 150-200 OHM

7. CR1-CR5,CR9,CR11-CR13, CR15,CR16,CR21-CR28 = IN914
   CR6-CR8,CR10,CR14 = LED
   CR17-CR20 = IN4001

8 ▷ PI-18,20,22 INTERCONNECTED ON MOTHER BOARD

*U2 FILTER CUTOFF FREQ

	R28-29	R31-32	R34-35	
3KHZ	150K	90.9K	43.2K	
5KHZ	82.5K	47.5K	30.1K	
7.5KHZ	51.1K	23.2K	20.0K	
→ 4.5KHZ	90.9K	56.2K	33.2K	← SUPPLIED STANDARD

ALL 1% METAL FILM, 1/4 WATT RATING.

FIGURE 5-3. SCA MODULE SCHEMATIC
839 6583 001

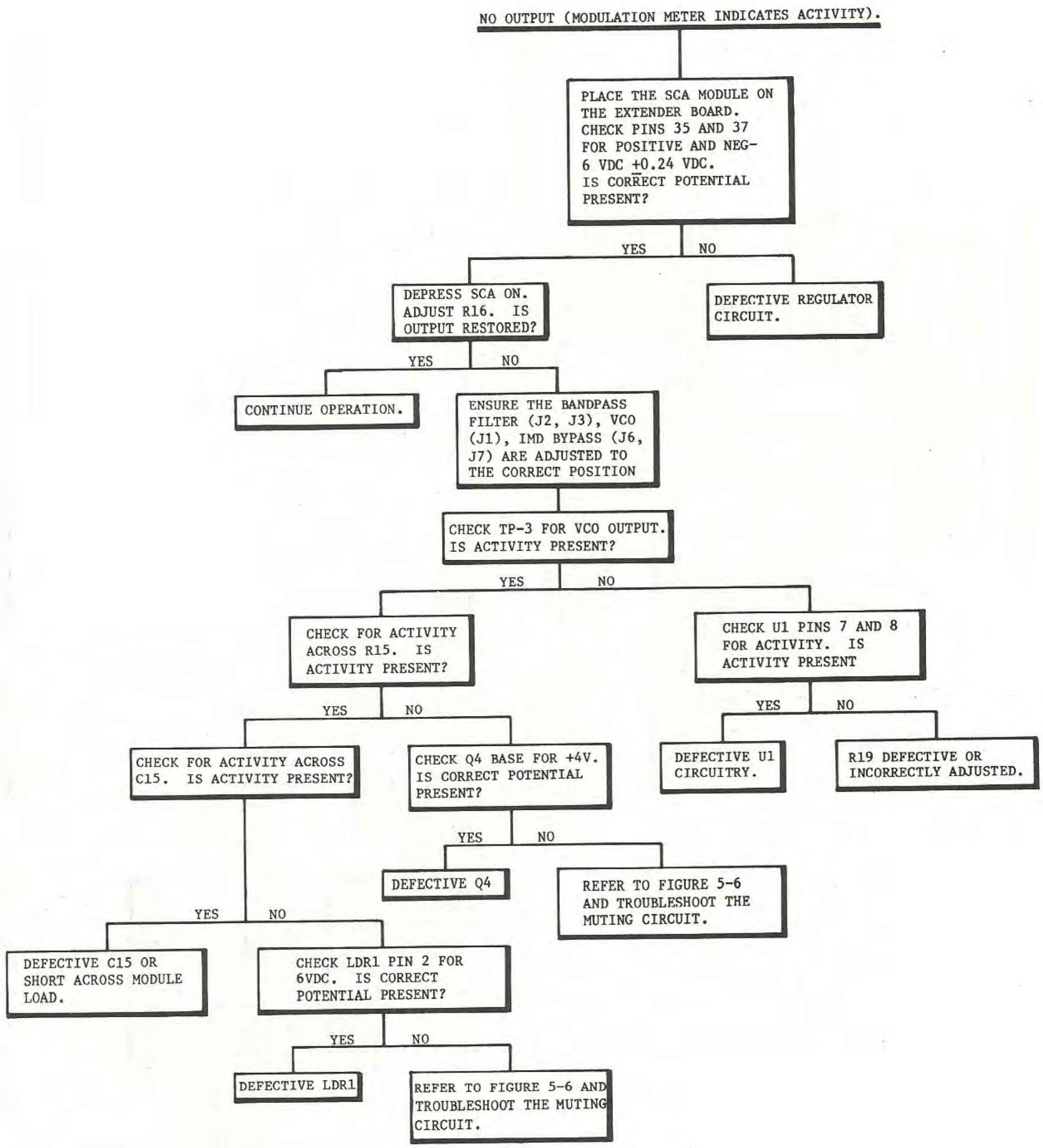
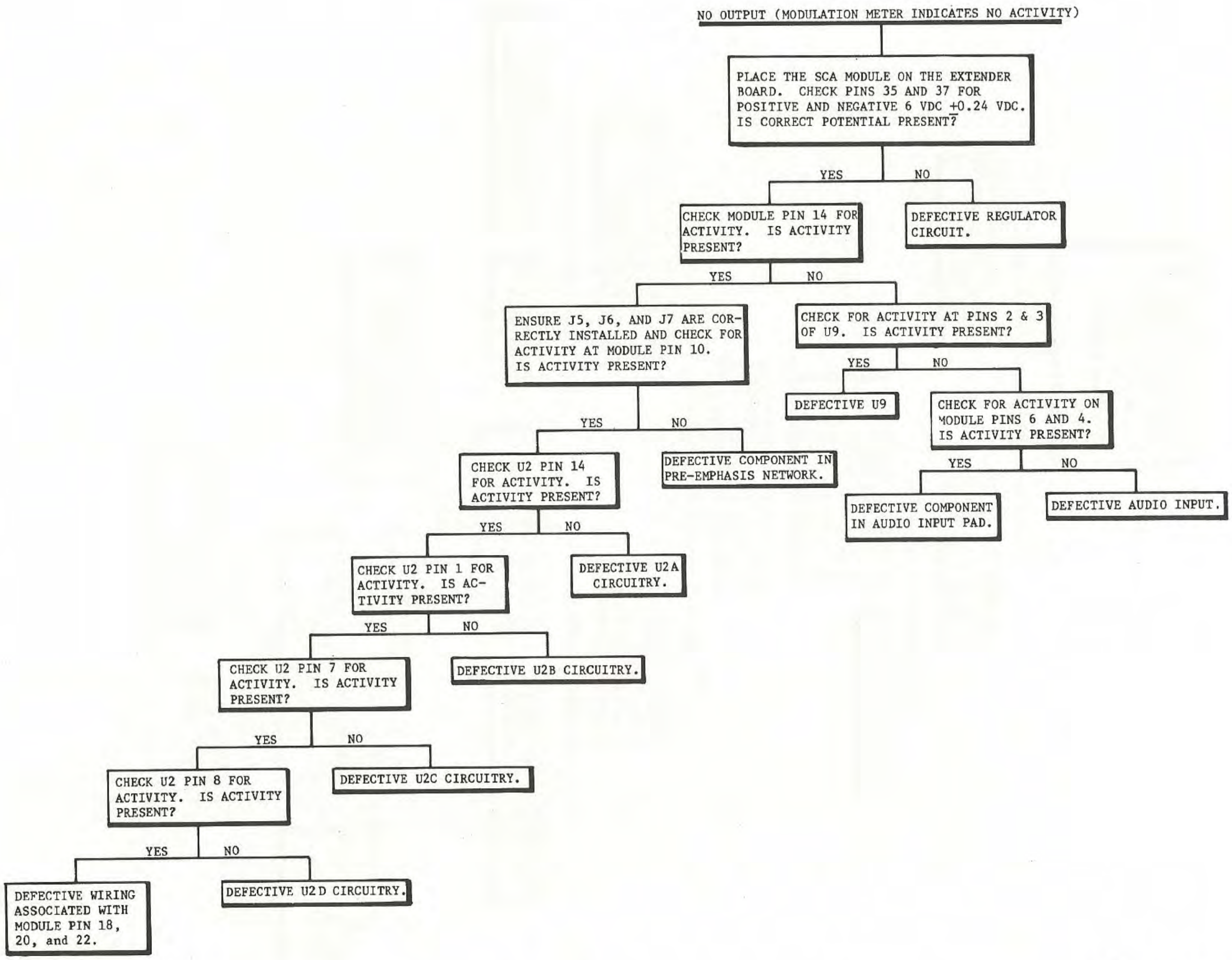


Figure 5-4. No Output (Modulation Meter Indicates Activity)

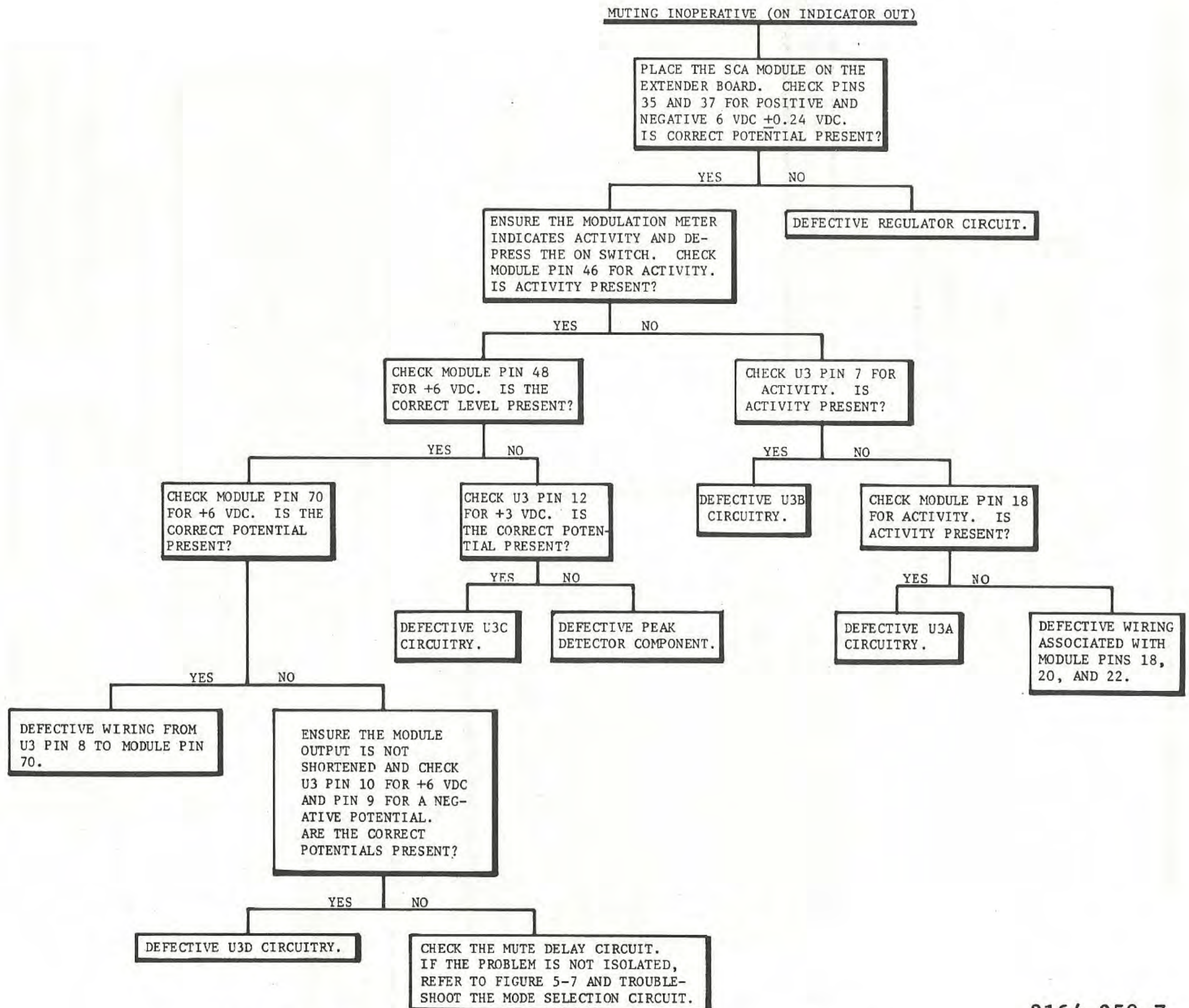
WARNING: Disconnect primary power prior to servicing.



2164-250-6

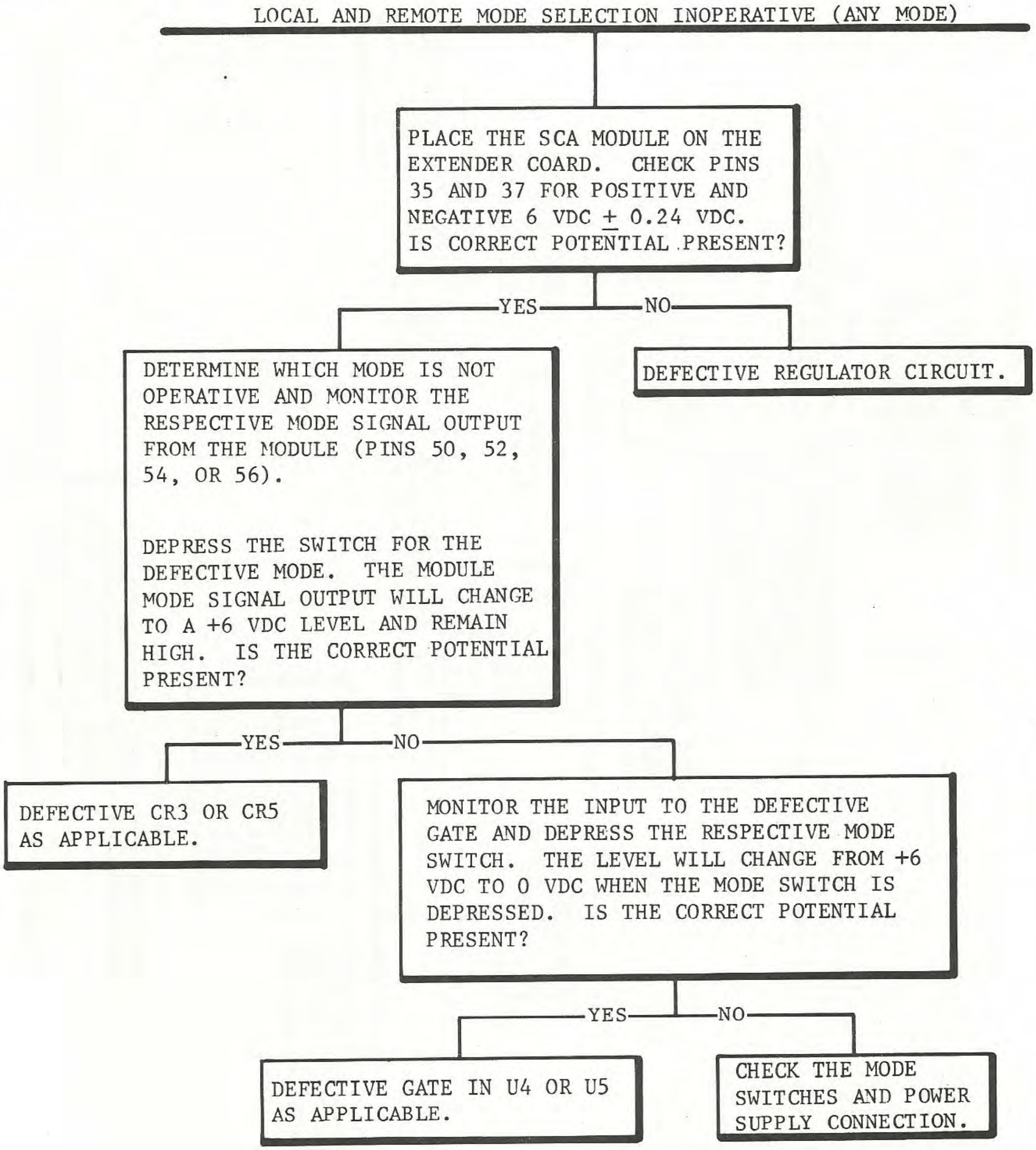
Figure 5-5. No Output (Modulation Meter Indicates No Activity)

WARNING: Disconnect primary power prior to servicing.



2164-250-7

Figure 5-6. Muting Inoperative (On Indicator Out)



2164-250-8

Figure 5-7. Local and Remote Mode Selection Inoperative (Any Mode)

WARNING: Disconnect primary power prior to servicing.

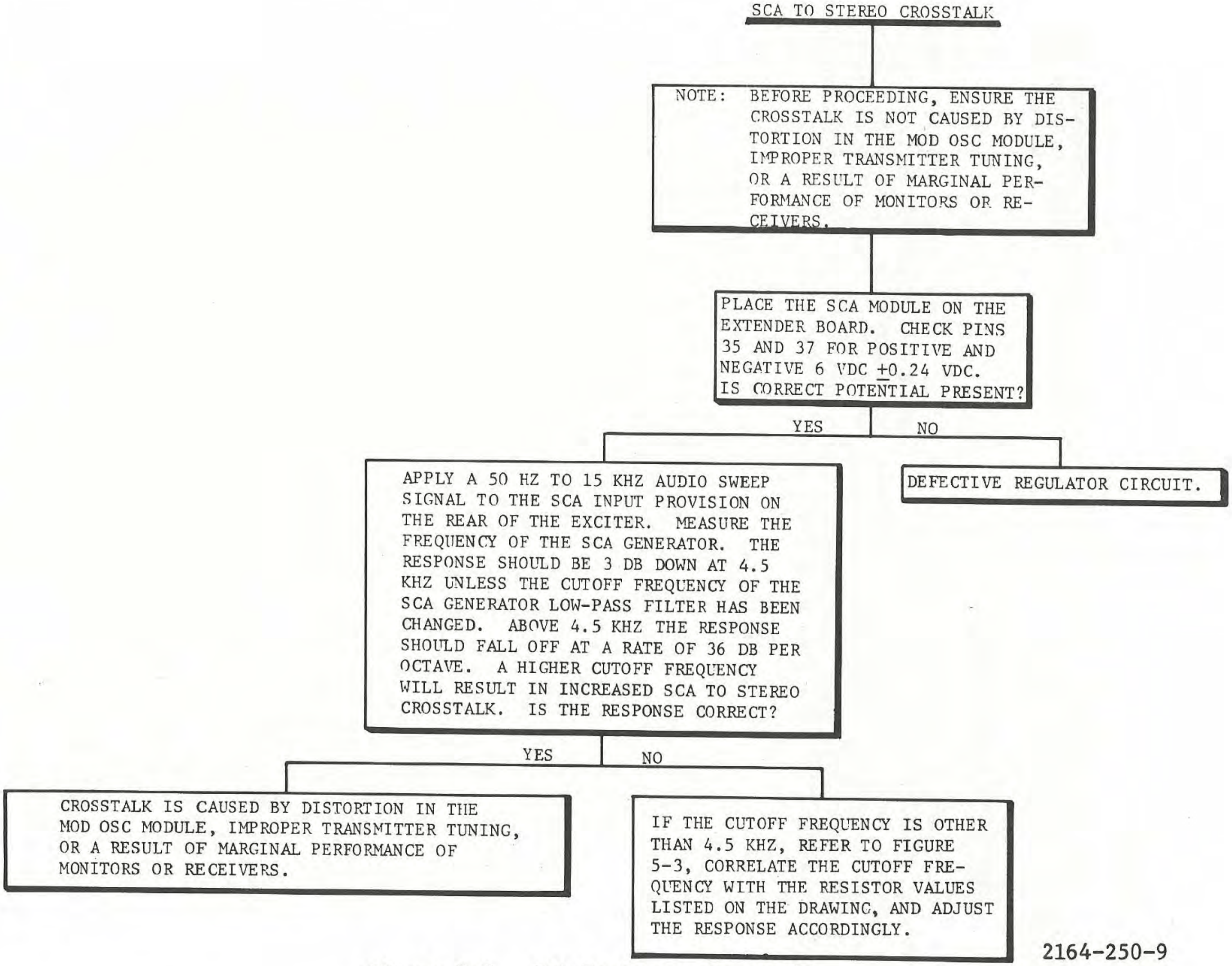


Figure 5-8. SCA To Stereo Crosstalk

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. Refer to table 6-1 for replaceable parts which are required for proper maintenance of the MX-15 FM Exciter SCA MODULE. Table entries are indexed by component number.

6-3. REPLACEABLE PARTS SERVICE

6-4. Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Group, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

Table 6-1. REPLACEABLE PARTS LIST INDEX

WARNING: Disconnect primary power prior to servicing.

Table 6-2. 67/92KHZ SCA GEN MODULE - 994 7992 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
	350 0048 000	RIVET POP .093X.337	2	
	358 2037 000	BALL STUD 6-32X 3/16	1	
	448 0623 000	SPRING CATCH	1	
	813 5007 047	STDOFF 4-40X1.017 .250 H	1	
	813 5092 779	SPACER .25D X .165L	2	
	829 2617 001	BLOCK	1	
	829 2618 001	BLOCK	1	
	839 3254 001	SHIELD	1	
	843 4239 001	COVER 67192KHZ SCA	1	
	939 2389 001	PLATE, CARD MTG	1	
	939 3180 001	EXTRACTOR, SMALL CD.	1	
	939 6634 001	PANEL FRONT SCA	1	
	992 4977 002	PWB,67/92KHZ SCA GEN	1	
	999 1818 001	HARDWARE LIST	1	

WARNING: Disconnect primary power prior to servicing.

Table 6-3. PWB, 67/92KHZ SCA GEN - 992 4977 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
CR001,CR002	384 0205 000	DIODE SILICON 1N914		
CR003,CR004				
CR005			5.0	
CR006,CR007	384 0661 000	L.E.D. GREEN		
CR008			3.0	
CR009	384 0205 000	DIODE SILICON 1N914	1.0	
CR010	384 0664 000	L.E.D. YELLOW	1.0	
CR011,CR012	384 0205 000	DIODE SILICON 1N914		
CR013			3.0	
CR014	384 0662 000	L.E.D. RED	1.0	
CR015,CR016	384 0205 000	DIODE SILICON 1N914	2.0	
CR017,CR018	384 0431 000	RECT. 1N4001		
CR019,CR020			4.0	
CR021,CR022	384 0205 000	DIODE SILICON 1N914		
CR023,CR024				
CR025,CR026				
CR027,CR028			8.0	
C001	500 0755 000	CAP, MICA 270PF 500V 5%	1.0	
C002	500 0911 000	CAP 750PF 500V 5%	1.0	
C003	526 0049 000	CAP 6.8UF 35V 20%	1.0	
C004	516 0375 000	CAP .01UF 50V	1.0	
C005	526 0049 000	CAP 6.8UF 35V 20%	1.0	
C006,C007	516 0375 000	CAP .01UF 50V	2.0	
C010	500 0829 000	CAP, MICA 180PF 500V 5%	1.0	
C011	500 0761 000	CAP, MICA 150PF 500V 5%	1.0	
C012,C013	500 0826 000	CAP, MICA 120PF 500V 5%	2.0	
C014	500 0761 000	CAP, MICA 150PF 500V 5%	1.0	
C015	500 0829 000	CAP, MICA 180PF 500V 5%	1.0	
C016,C017,C018	500 0878 000	CAP 1500 PF 500V 5%	3.0	
C019	500 0852 000	CAP 1000 PF 500V	1.0	
C020	516 0375 000	CAP .01UF 50V	1.0	
C021	500 0759 000	CAP, MICA 100PF 500V 5%	1.0	
C022	500 0916 000	CAP 270PF 500VDC 1%	1.0	
C023	500 0825 000	CAP, MICA 110PF 500V 5%	1.0	
C024	500 0852 000	CAP 1000 PF 500V	1.0	
C025,C026	516 0375 000	CAP .01UF 50V	2.0	
C027	500 0840 000	CAP, MICA 680PF 300V 5%	1.0	
C028	500 0842 000	CAP, MICA 820PF 300V 5%	1.0	
C029	500 0755 000	CAP, MICA 270PF 500V 5%	1.0	
C030	500 0888 000	CAP 3900PF 500V 5%	1.0	
C031	516 0453 000	CAP .1UF 100V 20%	1.0	
C032	500 0759 000	CAP, MICA 100PF 500V 5%	1.0	
C033	500 0821 000	CAP MICA 68UUF 500V	1.0	
C034	500 0759 000	CAP, MICA 100PF 500V 5%	1.0	
C035	500 0809 000	CAP MICA 22UUF 500V	1.0	
C036	526 0049 000	CAP 6.8UF 35V 20%	1.0	
C037,C038	516 0375 000	CAP .01UF 50V	2.0	
C039	526 0049 000	CAP 6.8UF 35V 20%	1.0	

Table 6-3. PWB, 67/92KHZ SCA GEN - 992 4977 002 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
C040	526 0310 000	CAP, .22UF 35V 20%	1.0	
C041	526 0325 000	CAP .1UF 35V 20%	1.0	
C042	500 0759 000	CAP, MICA 100PF 500V 5%	1.0	
C043,C044	526 0049 000	CAP 6.8UF 35V 20%	2.0	
C045	526 0106 000	CAP 27UF 35V 10%	1.0	
C047	500 0759 000	CAP, MICA 100PF 500V 5%	1.0	
C048,C049,C050	526 0049 000	CAP 6.8UF 35V 20%		
C051			4.0	
C052	526 0340 000	CAP 1 UF 35V 10%	1.0	
C053,C054,C055	516 0375 000	CAP .01UF 50V		
C056,C057,C058				
C059,C060,C061				
C062,C063			11.0	
C064,C065,C066	526 0049 000	CAP 6.8UF 35V 20%	3.0	
C067	500 0804 000	CAP, MICA 10PF 500V 5%	1.0	
C068,C069	522 0523 000	CAP 470UF 16V	2.0	
C070	500 0759 000	CAP, MICA 100PF 500V 5%	1.0	
C071	526 0309 000	CAP, 22UF 35V 20%	1.0	
C072	526 0318 000	CAP 10UF 35V 20%	1.0	
J001,J002,J003	610 0679 000	PLUG, SHORTING		
J004,J005,J006				
J007			7.0	
LDR1	670 0033 000	LED, LDR	1.0	
L001,L002	492 0363 000	INDUCTOR, VARIABLE	2.0	
Q001	380 0126 000	XSTR, 2N4403	1.0	
Q002,Q003	380 0319 000	XSTR, MPS-A14	2.0	
Q004	380 0125 000	XSTR, 2N4401	1.0	
R001	540 1177 000	RES 180.0 OHM 1/2W 5%	1.0	
R002	550 0940 000	POT 100 OHM 1/2W 20%	1.0	
R003	540 1160 000	RES 22.0K OHM 1/2W 5%	1.0	
R004	540 1114 000	RES 4.7K OHM 1/2W 5%	1.0	
R005	540 1105 000	RES 5.1K OHM 1/2W 5%	1.0	
R006	550 0928 000	POT 20K OHM 1/2W	1.0	
R007	540 1111 000	RES 10.0K OHM 1/2W 5%	1.0	
R008,R009	540 1249 000	RES 68.0K OHM 1/2W 5%	2.0	
R010,R011	540 1111 000	RES 10.0K OHM 1/2W 5%	2.0	
R012	550 0965 000	POT 500 OHM 1/2W 10%	1.0	
R013	540 1162 000	RES 1.0M OHM 1/2W 5%	1.0	
R014	540 1116 000	RES 1.0K OHM 1/2W 5%	1.0	
R015	540 1162 000	RES 1.0M OHM 1/2W 5%	1.0	
R016	550 0927 000	POT 2K OHM 1/2W	1.0	
R017	550 0913 000	POT, 5K OHM	1.0	
R018	540 0089 000	RES 47.0K OHM 1/2W 5%	1.0	
R019	550 0913 000	POT, 5K OHM	1.0	
R020	540 1172 000	RES 56.0K OHM 1/2W 5%	1.0	
R021	540 1182 000	RES 2.2K OHM 1/2W 5%	1.0	
R022	540 1130 000	RES 620.0 OHM 1/2W 5%	1.0	
R023,R024	540 1117 000	RES 150.0 OHM 1/2W 5%	2.0	

Table 6-3. PWB, 67/92KHZ SCA GEN - 992 4977 002 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
R025	540 1130 000	RES 620.0 OHM 1/2W 5%	1.0	
R026	540 1160 000	RES 22.0K OHM 1/2W 5%	1.0	
R027	540 1210 000	RES 150.0K OHM 1/2W 5%	1.0	
R028,R029	548 0321 000	RES 90.9K OHM 1/4W	2.0	
R030	540 1250 000	RES 180.0K OHM 1/2W 5%	1.0	
R031,R032	548 0866 000	RES 56.2K OHM 1/4W 1%	2.0	
R033	540 1132 000	RES 110.0K OHM 1/2W 5%	1.0	
R034,R035	548 0341 000	RES 33.2K OHM 1/4W 1%	2.0	
R036	540 1249 000	RES 68.0K OHM 1/2W 5%	1.0	
R037	540 1212 000	RES 220.0K OHM 1/2W 5%	1.0	
R038	550 0931 000	POT 1 MEGOHM 1/2W	1.0	
R039	540 1162 000	RES 1.0M OHM 1/2W 5%	1.0	
R040	540 1159 000	RES 100.0K OHM 1/2W 5%	1.0	
R041	540 1317 000	RES 91.0K OHM 1/2W 5%	1.0	
R042	540 1162 000	RES 1.0M OHM 1/2W 5%	1.0	
R043	540 1102 000	RES 100.0 OHM 1/2W 5%	1.0	
R044	540 1116 000	RES 1.0K OHM 1/2W 5%	1.0	
R045	540 1102 000	RES 100.0 OHM 1/2W 5%	1.0	
R046	540 1162 000	RES 1.0M OHM 1/2W 5%	1.0	
R047	540 1104 000	RES 2.0K OHM 1/2W 5%	1.0	
R048	540 1111 000	RES 10.0K OHM 1/2W 5%	1.0	
R049	540 1159 000	RES 100.0K OHM 1/2W 5%	1.0	
R050	540 1115 000	RES 470.0 OHM 1/2W 5%	1.0	
R051	540 1111 000	RES 10.0K OHM 1/2W 5%	1.0	
R052	540 1162 000	RES 1.0M OHM 1/2W 5%	1.0	
R053	540 1105 000	RES 5.1K OHM 1/2W 5%	1.0	
R054	550 0931 000	POT 1 MEGOHM 1/2W	1.0	
R055	540 0089 000	RES 47.0K OHM 1/2W 5%	1.0	
R056	540 1198 000	RES 470.0K OHM 1/2W 5%	1.0	
R057	540 1159 000	RES 100.0K OHM 1/2W 5%	1.0	
R058	540 1212 000	RES 220.0K OHM 1/2W 5%	1.0	
R059	540 1181 000	RES 680.0 OHM 1/2W 5%	1.0	
R060,R061	540 1159 000	RES 100.0K OHM 1/2W 5%	2.0	
R062,R063,R064	540 1115 000	RES 470.0 OHM 1/2W 5%	3.0	
R065,R066	540 0308 000	RES 100.0 OHM 1W 5%	2.0	
R067,R068,R069 R070,R071,R072	540 1111 000	RES 10.0K OHM 1/2W 5%	6.0	
R073	540 1212 000	RES 220.0K OHM 1/2W 5%	1.0	
R074,R075,R076 R077	540 1159 000	RES 100.0K OHM 1/2W 5%	4.0	
R078	540 1115 000	RES 470.0 OHM 1/2W 5%	1.0	
R079	540 1111 000	RES 10.0K OHM 1/2W 5%	1.0	
R080	540 1153 000	RES 8.2K OHM 1/2W 5%	1.0	
R082	540 1115 000	RES 470.0 OHM 1/2W 5%	1.0	
R083	540 1159 000	RES 100.0K OHM 1/2W 5%	1.0	
R084	540 1182 000	RES 2.2K OHM 1/2W 5%	1.0	
R085	540 1114 000	RES 4.7K OHM 1/2W 5%	1.0	
R086	540 1183 000	RES 5.6K OHM 1/2W 5%	1.0	

Table 6-3. PWB, 67/92KHZ SCA GEN - 992 4977 002 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
R087,R088,R089	540 1102 000	RES 100.0 OHM 1/2W 5%		
R090			4.0	
R091	540 1111 000	RES 10.0K OHM 1/2W 5%	1.0	
R092	540 1159 000	RES 100.0K OHM 1/2W 5%	1.0	
R093	540 1210 000	RES 150.0K OHM 1/2W 5%	1.0	
R094	540 1342 000	RES NETWORK 10K OHM	1.0	
R095	550 0935 000	POT 2K OHM 1/2W 10%	1.0	
R098	540 1114 000	RES 4.7K OHM 1/2W 5%	1.0	
R099	540 0089 000	RES 47.0K OHM 1/2W 5%	1.0	
R100	540 1117 000	RES 150.0 OHM 1/2W 5%	1.0	
S001,S002,S003	604 0866 000	SW, PB SPDT	3.0	
U001	382 0538 000	IC, XR2206CP	1.0	
U002,U003	382 0450 000	IC, HA1-4741-5	2.0	
U004	382 0288 000	IC, 4011/14011	1.0	
U005	382 0396 000	IC, 4012/14012	1.0	
U006	382 0510 000	IC, ILQ-74 OPTO ISOL	1.0	
U007	382 0471 000	IC, MC7806CT	1.0	
U008	382 0470 000	IC, MC7906CT	1.0	
U009	382 0460 000	IC, 308A	1.0	
XR94	404 0674 000	SOCKET, IC 14 CONT	1.0	
XU001	404 0675 000	SOCKET, IC 16 CONT	1.0	
XU002,XU003	404 0674 000	SOCKET, IC 14 CONT		
XU004,XU005			4.0	
XU006	404 0675 000	SOCKET, IC 16 CONT	1.0	
XU009	404 0298 000	SOCKET, IC 8 PIN	1.0	
	839 6583 001	SCHEMATIC SCA GENERATOR	0	

WARNING: Disconnect primary power prior to servicing.

STEREO DIG. MOD.
888-2164-300

TECHNICAL MANUAL

STEREO DIGITAL MODULE

994 7990 001

HARRIS

T.M. No. 888-2164-300

Printed: April 1983

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

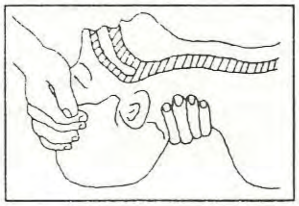
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

(A) AIRWAY

IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

(B) BREATHING

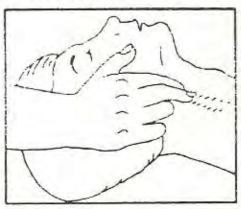
IF NOT BREATHING,
BEGIN ARTIFICIAL BREATHING

TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

CHECK
CAROTID PULSE



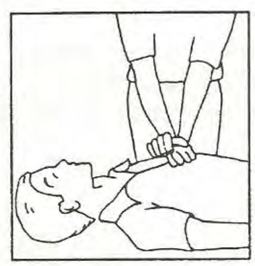
IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES

APPROX. RATE OF COMPRESSIONS --80 PER MINUTE { ONE RESCUER, 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE { TWO RESCUERS, 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

   NOTE

   If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE

1-2. The STEREO DIGITAL MODULE generates the 38 kHz and 114 kHz stereophonic switching signals, the phase controlled 19 kHz pilot signal, and the stereophonic/monaural mode switching signals. The module also allows power up mode selection of any stereophonic or monaural mode, prevents simultaneous stereophonic and 41 kHz SCA operation, and interfaces with remote control of mode selection.

1-3. TECHNICAL CHARACTERISTICS

1-4. Table 1-1 lists operating characteristics and parameters of the MX-15 FM Exciter STEREO DIGITAL MODULE.

SECTION II

INSTALLATION

2-1. GENERAL

2-2. Refer to MX-15 FM Exciter System Technical Manual, Section II, Installation.

SECTION III

CONTROLS AND INDICATORS

3-1. GENERAL

3-2. Figure 3-1 shows the location of each control or indicator associated with the MX-15 FM Exciter STEREO DIGITAL MODULE and table 3-1 lists the controls and indicators with a description of each item listed. Control setup adjustments are listed in table 3-2.

WARNING: Disconnect primary power prior to servicing.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
POWER:	+6 Vdc @ 0.025 amperes. -6 Vdc @ 0.022 amperes.
CONTROL:	
Remote Switching	+18V to +24 Vdc Momentary Level.
SCA-2 Inhibit	+6 Vdc for Stereo Inhibit. -6 or 0 Vdc for Stereo Operate.
OUTPUTS	
SIGNAL:	
Pilot	1.7V p-p Sinusodial 19 kHz Pilot.
CONTROL:	
Stereo Switching	+12V p-p 38 kHz Square Wave -12V p-p 38 kHz Square Wave +12V p-p 114 kHz Square Wave -12V p-p 114 kHz Square Wave
Mode Switching	+6 Vdc for selected mode -6 Vdc for inhibit

 WARNING: Disconnect primary power prior to servicing.

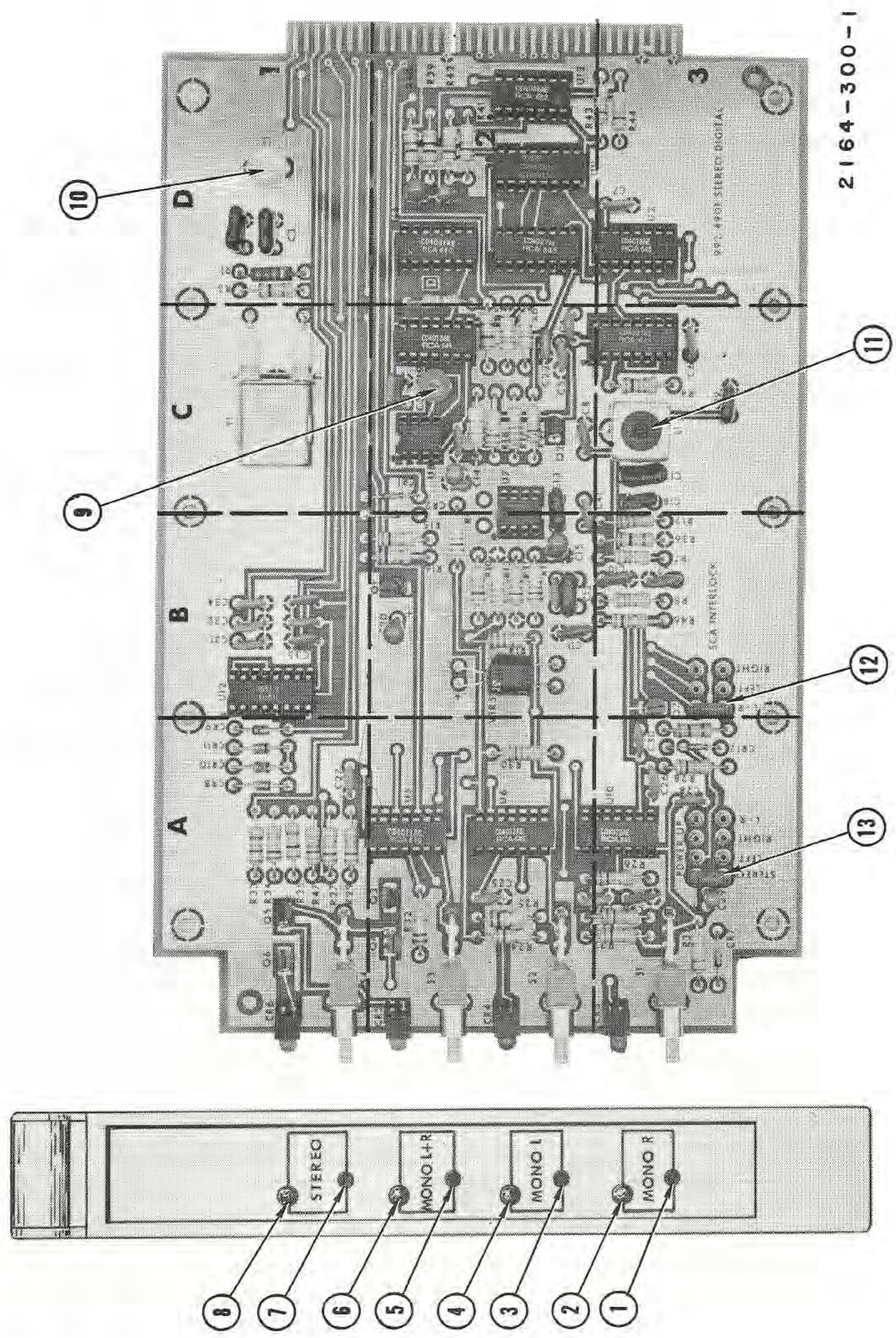


Figure 3-1. STEREO DIGITAL MODULE

Table 3-1. STEREO DIGITAL MODULE Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	MONO R Switch (S1)	Enables the mono R mode to transmit a mono signal from the right stereo channel and mute the left stereo channel.
2	MONO R Indicator (CR3)	Indicates the mono R mode of operation is enabled when illuminated.
3	MONO L Switch (S2)	Enables mono L mode to transmit a mono signal from the left stereo channel and mute the right stereo channel.
4	MONO L Indicator (CR4)	Indicates mono L mode of operation is enabled when illuminated.
5	MONO L+R Switch (S3)	Enables the mono L+R mode to transmit a mono signal from both stereo channels.
6	MONO L+R Indicator (CR5)	Indicates mono L+R mode of operation is enabled when illuminated.
7	STEREO Switch (S4)	Enables stereo mode operation.
8	STEREO Indicator (CR6)	Indicates stereo mode of operation is enabled when illuminated.
9	AUTOMATIC PHASE CONTROL OFFSET Adjustment (R19)	Adjusts phase comparator U8 voltage off-set to zero.
10	PILOT FREQUENCY Control (C1)	Adjusts frequency of pilot signal.
11	PILOT FILTER Adjustment (L1)	Tunes pilot low-pass filter.
12	SCA INTERLOCK L+R/ LEFT/RIGHT Program Jumper (J2)	Selects monaural mode STEREO DIGITAL module will enter if simultaneous 41 kHz SCA and stereophonic operation is attempted. (Factory set for L+R mono.)

WARNING: Disconnect primary power prior to servicing.

Table 3-1. STEREO DIGITAL MODULE Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
13	POWER UP STEREO/LEFT RIGHT/L+R Program Jumper (J1)	Selects the mode in which the module will initialize when power is applied. (Factory set for stereo.)

 WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments

CONTROL	ADJUSTMENT
AUTOMATIC PHASE CONTROL OFFSET Adjustment (R19)	1. Remove the module from the exciter and mount the module in the exciter using the extender board provided with the unit. 2. Disconnect the stereo audio inputs from the LEFT FRONT + and - (TB1 pins 1 and 3) and the RIGHT FRONT + and - (TB1 pins 4 and 6). 3. Connect a 50 Hz sinewave to the LEFT FRONT + and - (TB1 pins 1 and 3). For test purposes only, cross connect the left and right exciter stereo audio inputs out of phase so that L-R as follows: TB1 pin 1 to TB1 pin 6 TB1 pin 3 to TB1 pin 4 4. Depress the LEFT MODULATION meter switch. Adjust the 50 Hz signal level until the MODULATION meter indicates 100%. NOTE Correct adjustment of R19 requires use of an oscilloscope and X1 probe which are flat in phase and amplitude from dc to 38 kHz. There must be no oscilloscope distortion when the vertical display is expanded. 5. Connect the oscilloscope to module pin 70. Synchronize the oscilloscope to the LEFT FRONT audio.

Table 3-2. Control Adjustments (Continued)

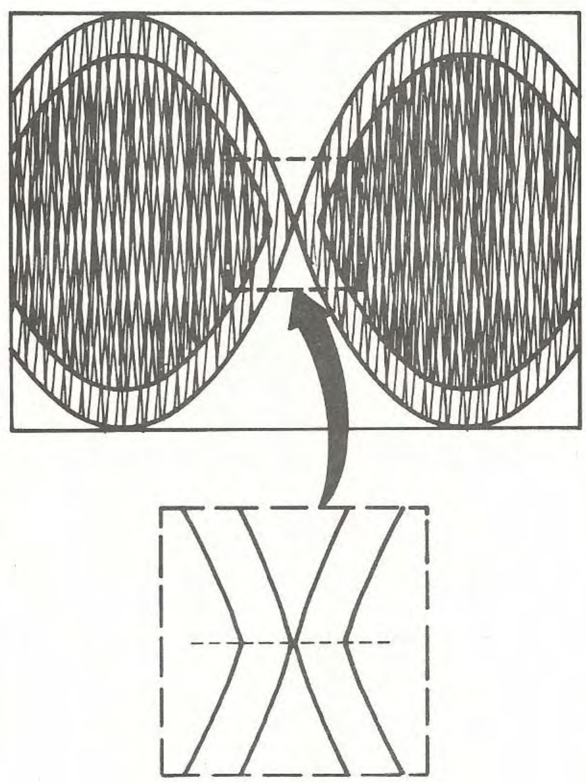
CONTROL	ADJUSTMENT
	6. Expand the vertical display until the zero crossing can be observed in detail. Adjust R19 until the pilot pinchoff points line up as shown in figure 3-2. 7. Disconnect the oscilloscope from the module. Remove the module and extender board and replace the module in the exciter. 8. Remove the 50 Hz test signal and reconnect the stereo audio inputs.  2164-300-2 Figure 3-2. Composite Waveform

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
PILOT FREQUENCY Control (C1)	1. Remove the module. Mount the module in the exciter using extender board provided. 2. Connect a frequency counter to pin 67. 3. Adjust C1 to obtain an indication of 19 kHz ± 1 Hz. 4. Disconnect the frequency counter, remove the module and extender board, and replace the module.
PILOT FILTER Adjustment (L1)	1. Remove the module. Mount the module in the exciter using the extender board provided. 2. Connect an oscilloscope to module pin 67. 3. Adjust L1 to obtain a 1.7V P-P voltage peak. 4. Disconnect the oscilloscope, remove the module and extender board, and replace the module.

WARNING: Disconnect primary power prior to servicing.

SECTION IV

PRINCIPLES OF OPERATION

4-1. CIRCUIT DESCRIPTION

4-2. SIGNAL GENERATION

4-3. OSCILLATOR. A CMOS gate (U4A) used as a crystal oscillator generates a stable 456 kHz reference frequency which is used to produce the 114 kHz and 38 kHz sampling signals and the 19 kHz pilot (see figure 4-1). The PILOT FREQUENCY control (C1) provides an oscillator frequency adjustment and a test point (pin 15) assists in oscillator frequency measurements. A divide-by-two counter (U1A) following the oscillator acts as a buffer and ensures symmetry of the 228 kHz clock pulse.

4-4. FREQUENCY DIVIDER CHAIN. The frequency divider chain divides the input clock frequency from the oscillator buffer into the 114 kHz and 38 kHz stereophonic switching signals and the 19 kHz pilot. The synchronous nature of the counter ensures coincident output transitions and uniform phase relationships among the output signals.

4-5. All flip-flops in the frequency divider chain are clocked by the 228 kHz signal from U1A. Flip-flop U2A divides the 228 kHz clock by two to produce the 114 kHz switching signal (refer to figure 4-2). Flip-flops U1B and U2B form a divide-by-three counter which outputs a 76 kHz signal. The 76 kHz signal and the 114 kHz signal from U2A are input to gates U4B and U4D which comprise a divide-by-six counter with U3B and outputs the 38 kHz switching signal. The 76 kHz signal and the 38 kHz signal from U3B are applied to a divide-by-two counter consisting of U4C and U3A which outputs the 19 kHz pilot frequency. The three signals are simultaneously clocked out of the divider chain by latch U11 which ensures synchronous output, independent of minor differences in IC manufacture.

4-6. SWITCHING SIGNALS. Two 38 kHz and 114 kHz outputs, each output 180 degrees out of phase are obtained from the frequency divider chain. The signals are applied to the STEREO ANALOG module through the transmission gates in U13 which enables the output whenever the output control gate (U5D) outputs a HIGH condition. The switching signals control the generation of the composite stereophonic signal.

4-7. PILOT SIGNAL. The pilot signal is generated by a phase-controlled closed loop which is referenced to the 19 kHz output of U11 in the frequency divider chain. Two 19 kHz outputs from the frequency divider chain, each signal 180 degrees out of phase, are differentially applied to two RC low-pass filters. Outputs from the RC low-pass filters are obtained across capacitor C12 and the light dependent resistor VTR5. The two outputs are summed at the input to the pilot buffer amplifier (U7) and produce a constant voltage with the phase shift variable from 0 to 180 degrees, dependent upon the resistance of VTR5. Amplifier U7 buffers the phase shifted signal and drives the low-pass filter which ensures that the output of the module will be pure sinewave. The PILOT FILTER control (L1) provides an adjustment to peak the low-pass filter. The pilot signal is applied to the STEREO ANALOG module for addition into the composite stereophonic signal.

4-8. Pilot Phase Control. The pilot output signal is sampled by comparator U8 which senses zero voltage crossings of the 19 kHz pilot signal and generates a square wave of the same phase. The output of U8 drives transistor Q2 as a buffer which provides a fast rising edge to trigger phase detector U9. The dc voltage offset of U8 is adjusted to zero by the AUTOMATIC PHASE CONTROL OFFSET (R19). As long as the phase of the regenerated squarewave from Q2 and the frequency reference from U11 coincide exactly, the circuit is considered correctly phased. If the phase of the pilot lags the reference signal, CR2 will conduct. If the pilot phase leads the reference signal, CR1 will conduct. Any discrepancy in pilot phase will cause pulses from the diodes to charge or discharge capacitor C20. The voltage on C20 is buffered by Q1 and acts as the control voltage for light dependent resistor VTR5. This charge determines the current through VTR5 and controls the phase shift at U7. The correction will continue until the phase of the pilot matches the phase reference to U9. Test points are provided at the output of buffer Q2, the output of diodes CR1 and CR2, and at the output of driver Q1.

4-9. CONTROL CIRCUITS

4-10. MODE SELECTION. Stereophonic/monaural mode selection and latching is performed by three dc flip flops. The dc flip flops are implemented by pairs of cross-coupled NAND gates which are controlled by levels rather than transitions. When a mode is selected, either by depressing a mode switch or by applying an input on the selected remote control input, a momentary LOW (-6 Vdc) sets the associated flip flop and resets the remaining flip flops. When all flip flops are reset, the module will enter the stereophonic mode.

4-11. Depressing switch S1 will set the MONO R flip flop (U5B and U6A), depressing switch S2 will set the MONO L flip flop (U5A and U10B), and depressing switch S3 will set the MONO L+R flip flop (U5C and U6B). As each pair of flip flop is set for a particular function, the remaining flip flops are reset. As each mode is selected, the corresponding indicator on the module front panel will illuminate and the respective mode selection line to the STEREO ANALOG module will be driven HIGH.

4-12. Depressing switch S4 (STEREO) resets all flip flops and enables the stereophonic mode. This condition causes the stereo control gate (U10A) to output a LOW condition and enable the frequency divider chain. The signal also causes the output control gate (U5D) to output a HIGH and enable the switching signal output, activate the stereo mode selection line and illuminate the STEREO indicator (CR6) through driver Q6.

4-13. SCA-2 INTERLOCK. Operation of the 41 kHz SCA channel (SCA-2) during stereophonic programming is not possible as the stereo difference channel occupies the same frequencies. If operation of the SCA-2 module (41 kHz) is attempted during stereophonic broadcast, a positive six volt dc potential from the SCA-2 module through driver Q7 will cause the module to enter the

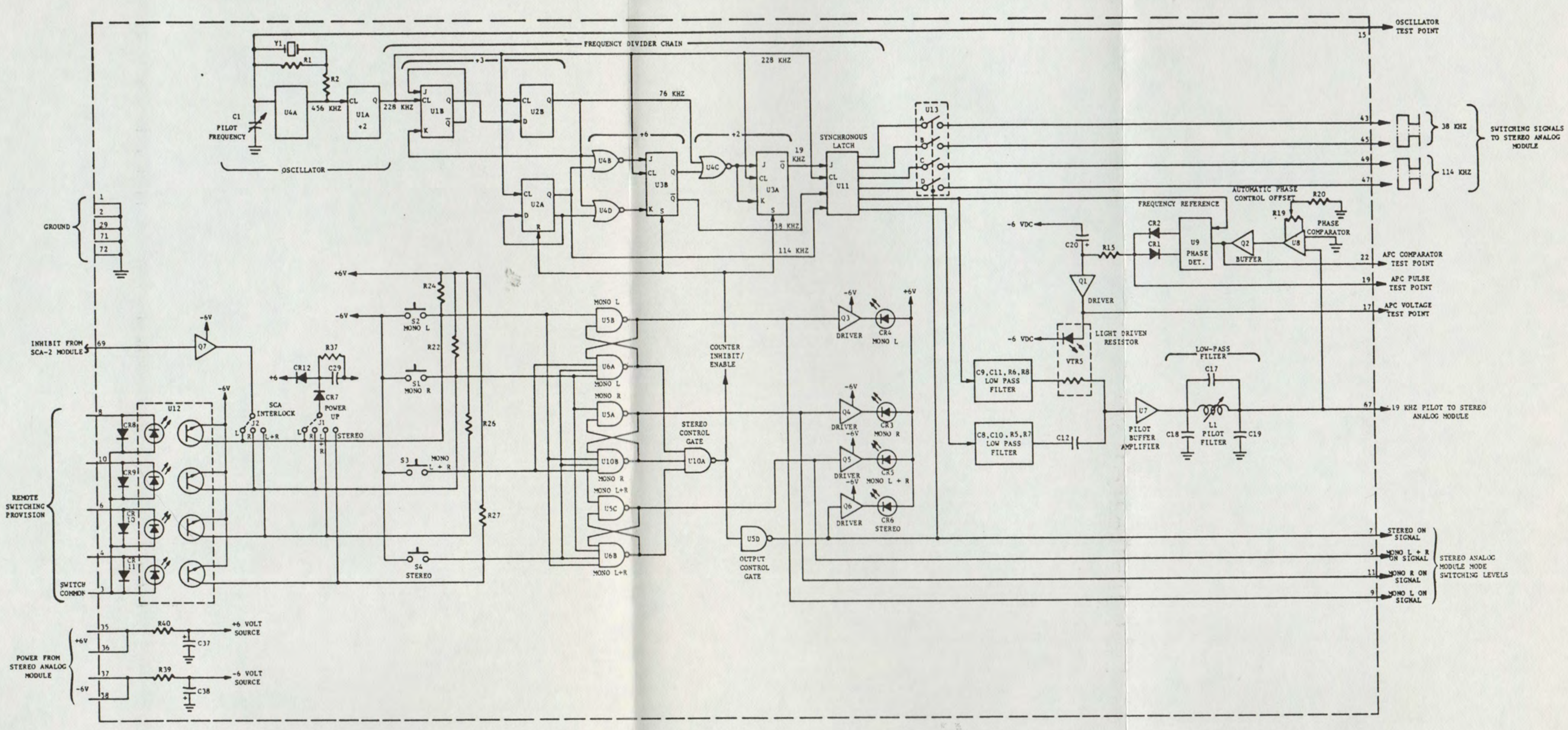
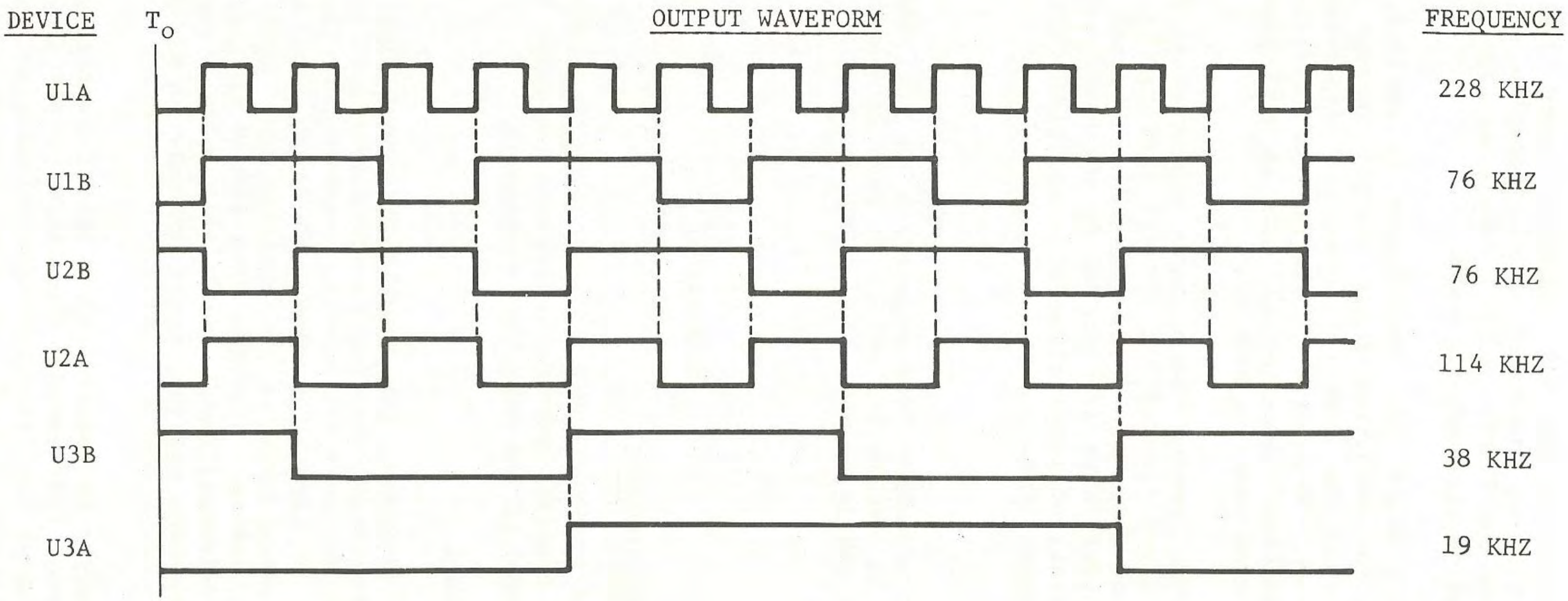


FIGURE 4-1. STEREO DIGITAL MODULE BLOCK DIAGRAM



2164-300-4

Figure 4-2. Frequency Divider Chain Waveforms monaural mode programmed by the SCA INTERLOCK jumper (J2). Operation of the mode selection circuit is inhibited until operation of the SCA-2 channel ceases at which time the STEREO DIGITAL module may be manually switched to the desired monaural or stereophonic mode.

4-14. POWER UP MODE SELECTION. When power is applied, capacitor C29 is discharged. Until the capacitor fully charges through diode CR12, a LOW condition will exist on the mode selection line determined by the position of POWER UP jumper J1. This will initialize the equipment in the selected mode at power application. Resistor R37 acts as a bleeder to ensure capacitor C29 discharges when power is removed.

4-15. REMOTE CONTROL. Remote control mode selection is provided by optical isolator U12. The input side of the optical isolator is protected from reverse bias by diodes CR8, CR9, CR10, and CR11. Current limiting resistors for each remote control input are located on the RFI filter. Remote control mode selection consists of application of a positive 18 to 24 Vdc potential on the particular input line.

4-16. POWER

4-17. DC power is obtained from regulators on the STEREO ANALOG module. Positive six volts dc enters the module on pins 35 and 36 and negative six volts dc enters the module on pins 37 and 38.

SECTION V

MAINTENANCE

5-1. <u>CORRECTIVE MAINTENANCE</u>

5-2. The MX-15 FM Exciter module maintenance philosophy consists of problem isolation to a specific area or individual component and subsequent isolation and replacement of the defective component.

5-3. TROUBLESHOOTING

5-4. In event of problems, the trouble area must first be isolated to a specific area. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, fuse F1, circuit breaker CB1, and the indicators on each module should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs which indicate the module power supply status. A single dark LED would indicate a problem associated with an individual module monolithic voltage regulator. A consistent pattern of dark LEDs however, would indicate an exciter dc distribution bus fault.

5-5. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-2 lists typical trouble symptoms pertaining to the individual module operation with references to fault isolation diagrams listing probable causes

WARNING: Disconnect primary power prior to servicing.

and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem. It only tends to lead the repairman into the area that may be causing the trouble. An extender board (HARRIS PN 992 4989 001) is provided with the exciter to assist in troubleshooting. In event parts are required, refer to Section VI, Parts List. The following information is contained in this section as an aid to maintenance.

REFERENCE	TITLE	NUMBER
Figure 5-1	STEREO DIGITAL Parts Layout	--- ---- ---
Table 5-2	STEREO DIGITAL Parts Index	--- ---- ---
Figure 5-2	STEREO DIGITAL Waveforms	--- ---- ---
Figure 5-3	STEREO DIGITAL Schematic	852 8407 001

5-6. Prior to starting a troubleshooting procedure check all switches, power cord connections, connecting cables, and power fuses.

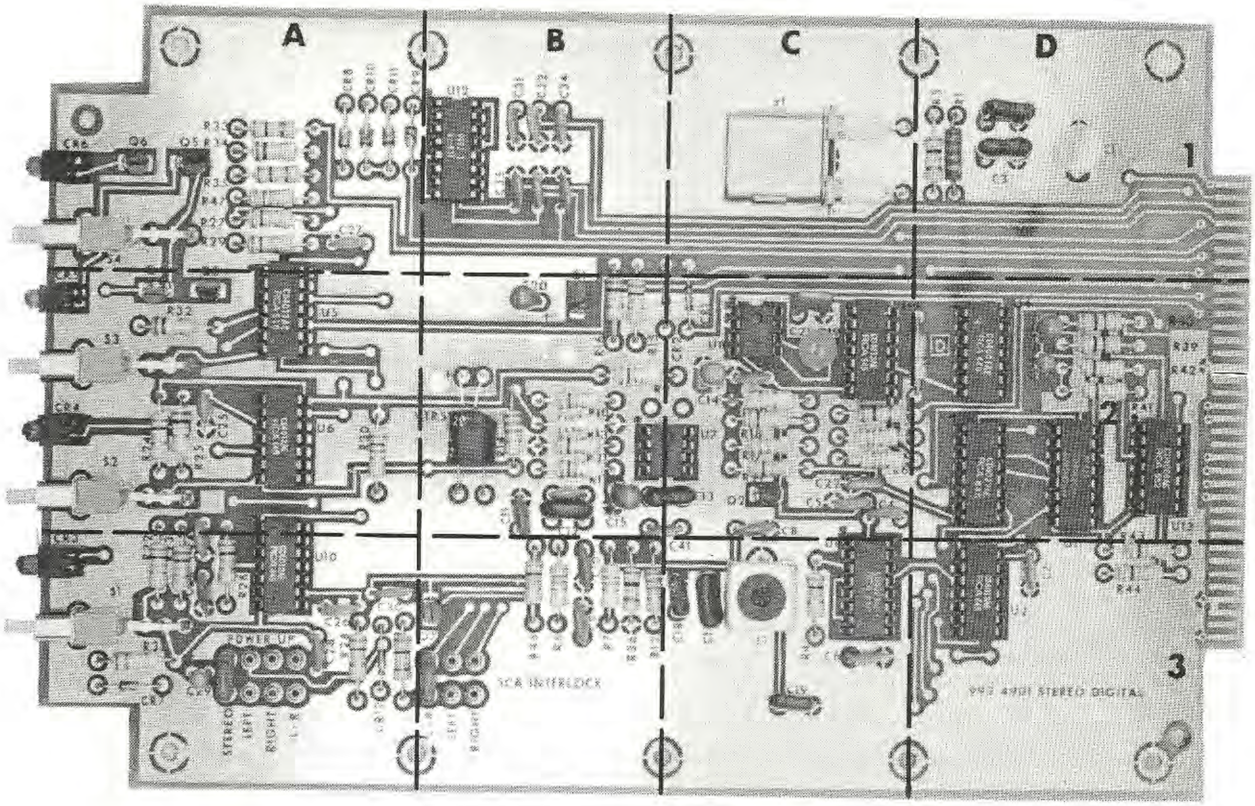
5-7. TECHNICAL ASSISTANCE

5-8. HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service Department 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

Table 5-1. STEREO DIGITAL MODULE Fault Isolation Index

SYMPTOM	DEFECT/REFERENCE
NO PILOT	Figure 5-4
PILOT OUT OF PHASE	Figure 5-5
NO STEREO SWITCHING SIGNAL OUTPUT	Figure 5-6
LOCAL AND REMOTE MODE SELECTION INOPERATIVE (any mode).	Figure 5-7
REMOTE MODE SELECTION INOPERATIVE (any mode)	Defective U12

 WARNING: Disconnect primary power prior to servicing.



2164-300-5

Figure 5-1. STEREO DIGITAL MODULE Parts Layout

WARNING: Disconnect primary power prior to servicing.

Table 5-2. STEREO DIGITAL MODULE Parts Index

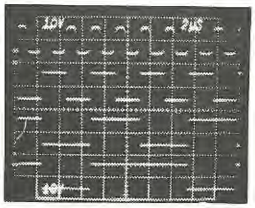
SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
C1	D1	C29	A3	CR10	A1	R1	D1
C2	D1	C30	A3	CR11	A1	R2	C2
C3	D1	C31	B1	CR12	A3	R3	D1
C4	C2	C32	B1			R4	C3
C5	C2	C33	B1			R5	C2
C6	C3	C34	B1			R6	C2
C7	D3	C35	B1			R7	B3
C8	C2	C36	B1			R8	B3
C9	B3	C37	D2	VTR5	B2	R9	B2
C10	B3	C38	D2			R10	B2
C11	B2	C39	--			R11	B2
C12	B2	C40	C2	J1	A3	R12	B3
C13	C2	C41	C3	J2	B3	R13	B2
C14	C2					R14	B2
C15	B2					R15	B2
C16	B2			L1	C3	R16	B2
C17	C3					R17	C2
C18	C3					R18	C2
C19	C3			Q1	B2	R19	C2
C20	B2	CR1	C2	Q2	C2	R20	C2
C21	C2	CR2	C2	Q3	A2	R21	C2
C22	C2	CR3	A3	Q4	A2	R22	A3
C23	A3	CR4	A2	Q5	A1	R23	A3
C24	A3	CR5	A2	Q6	A1	R24	A2
C25	A2	CR6	A1	Q7	B3	R25	A2
C26	A3	CR7	A3			R26	A3
C27	A1	CR8	A1			R27	--
C28	A3	CR9	A1			R28	A3

WARNING: Disconnect primary power prior to servicing.

Table 5-2. STEREO DIGITAL MODULE Parts Index (Continued)

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
R29	A1	S1	A3				
R30	A2	S2	A2				
R31	B2	S3	A2				
R32	A2	S4	A1				
R33	A1						
R34	A1						
R35	A1	U1	C3				
R36	B3	U2	D3				
R37	A3	U3	D2				
R38	A3	U4	D2				
R39	D2	U5	A2				
R40	D2	U6	A2				
R41	D2	U7	C2				
R42	D2	U8	C2				
R43	D3	U9	C2				
R44	D3	U10	A3				
R45	C2	U11	D2				
R46	B3	U12	B1				
R47	A1	U13	D2				
		Y1	C1				

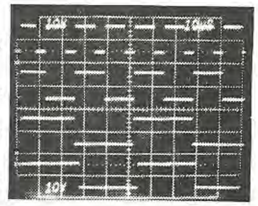
WARNING: Disconnect primary power prior to servicing.



1A 1B 1C 1D

TEST REQUIREMENTS: A. Depress the STEREO switch.

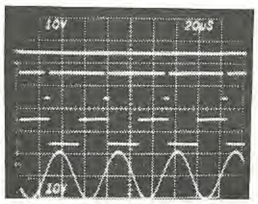
1A Frequency divider chain at U1 pin 3 (456 kHz).
1B Frequency divider chain at U1 pin 1 (228 kHz).
1C Frequency divider chain at U2 pin 1 (114 kHz).
1D Frequency divider chain at U1 pin 15 (76 kHz).



2A 2B 2C 2D

TEST REQUIREMENTS: A. Depress the STEREO switch.

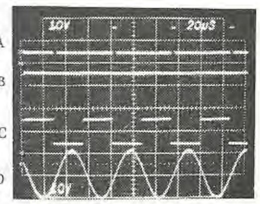
2A Frequency divider chain at U2 pin 13 (76 kHz).
2B Frequency divider chain at U3 pin 15 (38 kHz).
2C Frequency divider chain at U3 pin 2 (19 kHz).
2D Frequency divider chain at U11 pin 11 (19 kHz).



3A 3B 3C 3D

TEST REQUIREMENTS: A. Depress the STEREO switch.

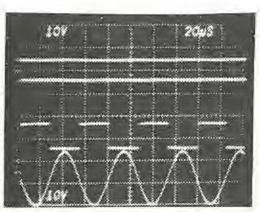
3A Pilot phase control with pilot phase leading at U9 pin 2.
3B Pilot phase control with pilot phase leading at U9 pin 13.
3C Pilot reference with pilot phase leading at U11 pin 11.
3D Pilot output with pilot phase leading at module pin 67.



4A 4B 4C 4D

TEST REQUIREMENTS: A. Depress the STEREO switch.

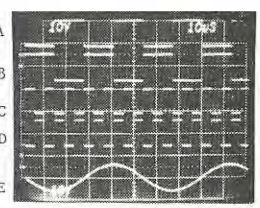
4A Pilot phase control with pilot phase lagging at U9 pin 2.
4B Pilot phase control with pilot phase lagging at U9 pin 13.
4C Pilot reference with pilot phase lagging at U11 pin 11.
4D Pilot output with pilot phase lagging at module pin 67.



5A 5B 5C 5D

TEST REQUIREMENTS: A.Depress the STLREO switch.

5A Pilot phase control with pilot phase correct at U9 pin 2.
5B Pilot phase control with pilot phase correct at U9 pin 13.
5C Pilot reference with pilot phase correct at U11 pin 11.
5D Pilot output with pilot phase correct at module pin 67.



6A 6B 6C 6D 6E

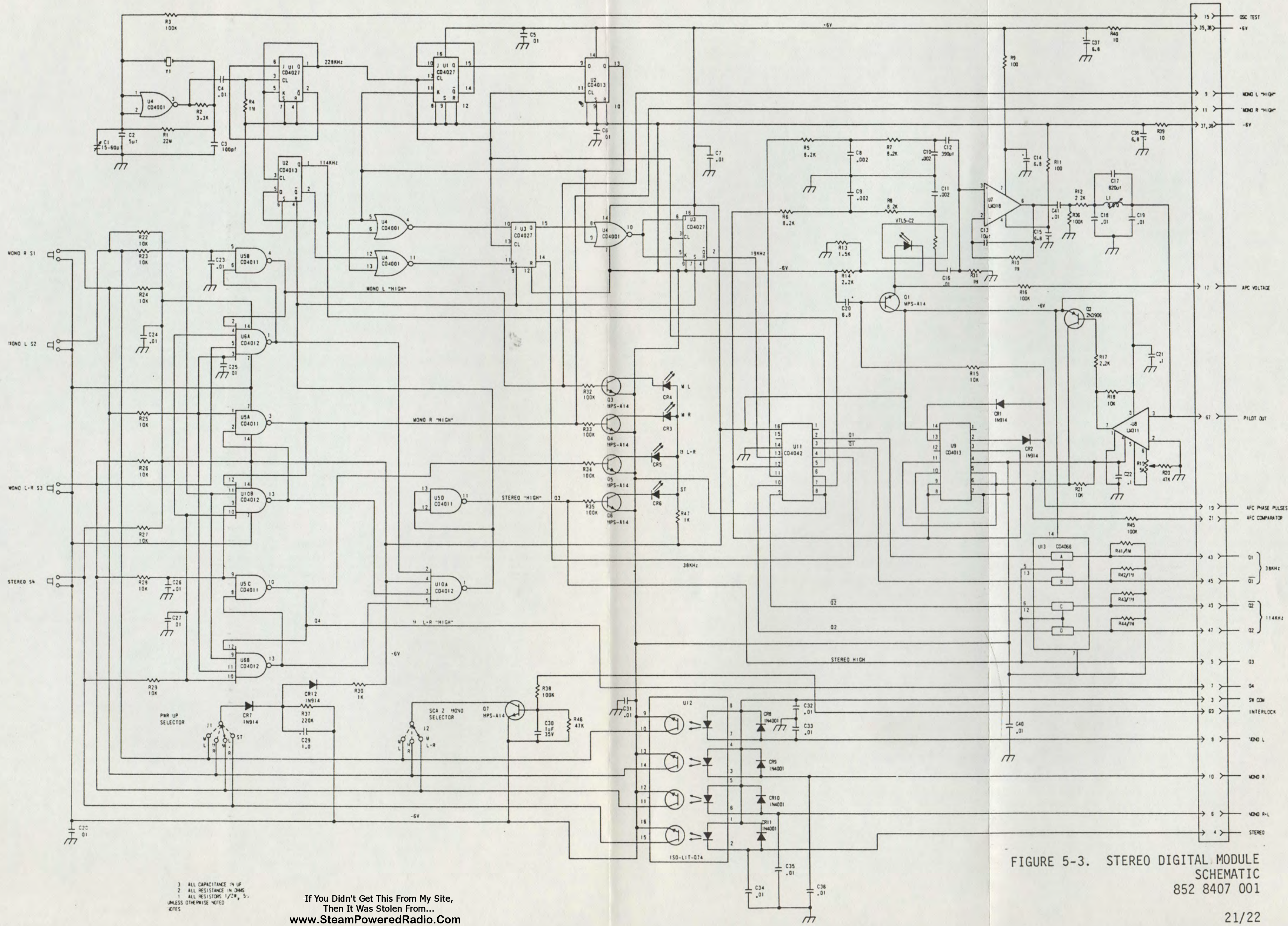
TEST REQUIREMENTS: A. Depress the STEREO switch.

6A 38 kHZ output at module pin 43.
6B Inverted 38 kHz output at module pin 45.
6C 114 kHz output at module pin 47.
6D Inverted 114 kHz output at module pin 49.
6E 19 kHz pilot output at module pin 67.

2164-300-6

Figure 5-2. STEREO DIGITAL MODULE Waveforms

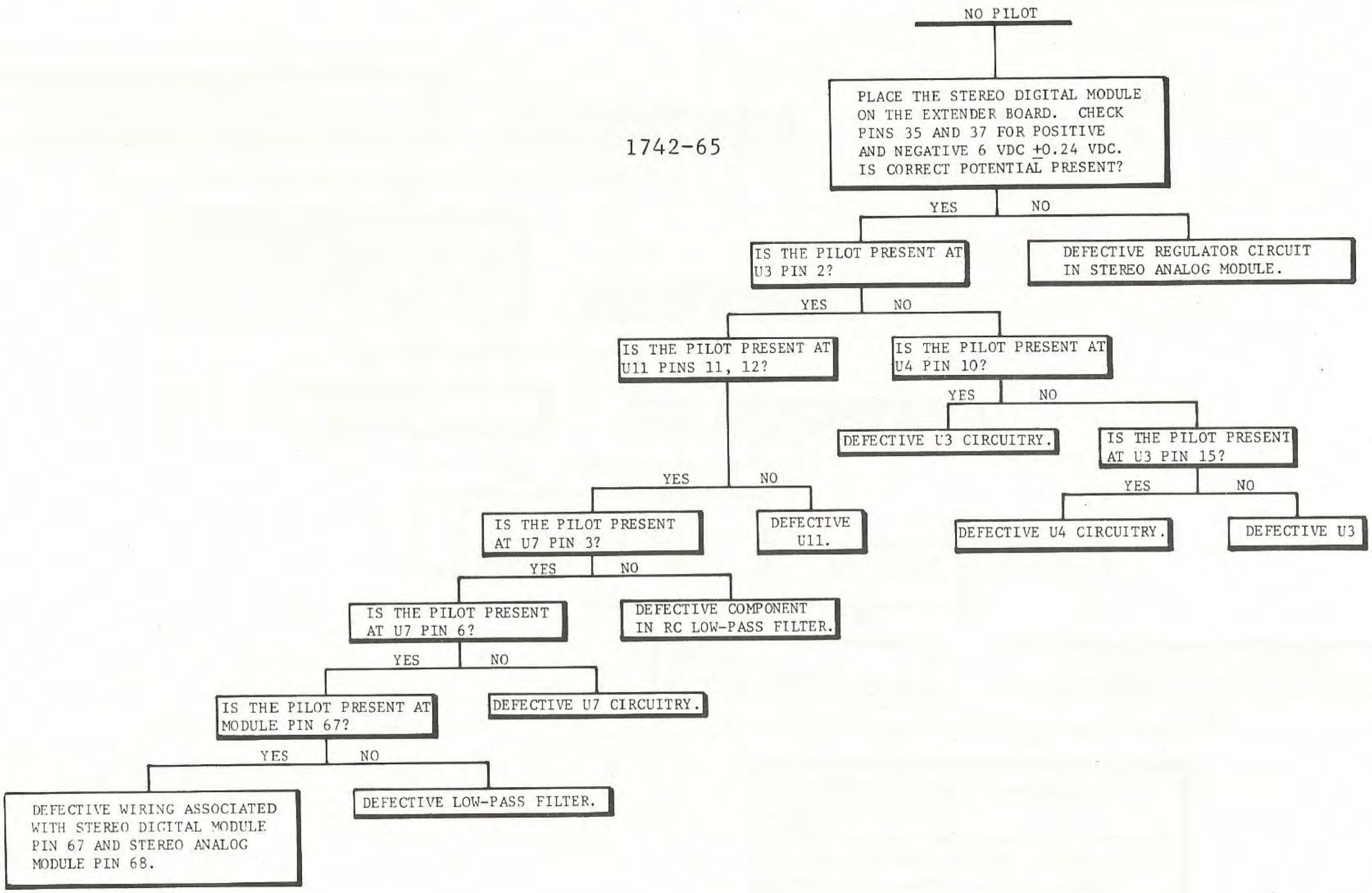
WARNING: Disconnect primary power prior to servicing.



3 ALL CAPACITANCE IN UF
2 ALL RESISTANCE IN OHMS
1 ALL RESISTORS 1/2W, 5%
UNLESS OTHERWISE NOTED
NOTES

FIGURE 5-3. STEREO DIGITAL MODULE SCHEMATIC
852 8407 001

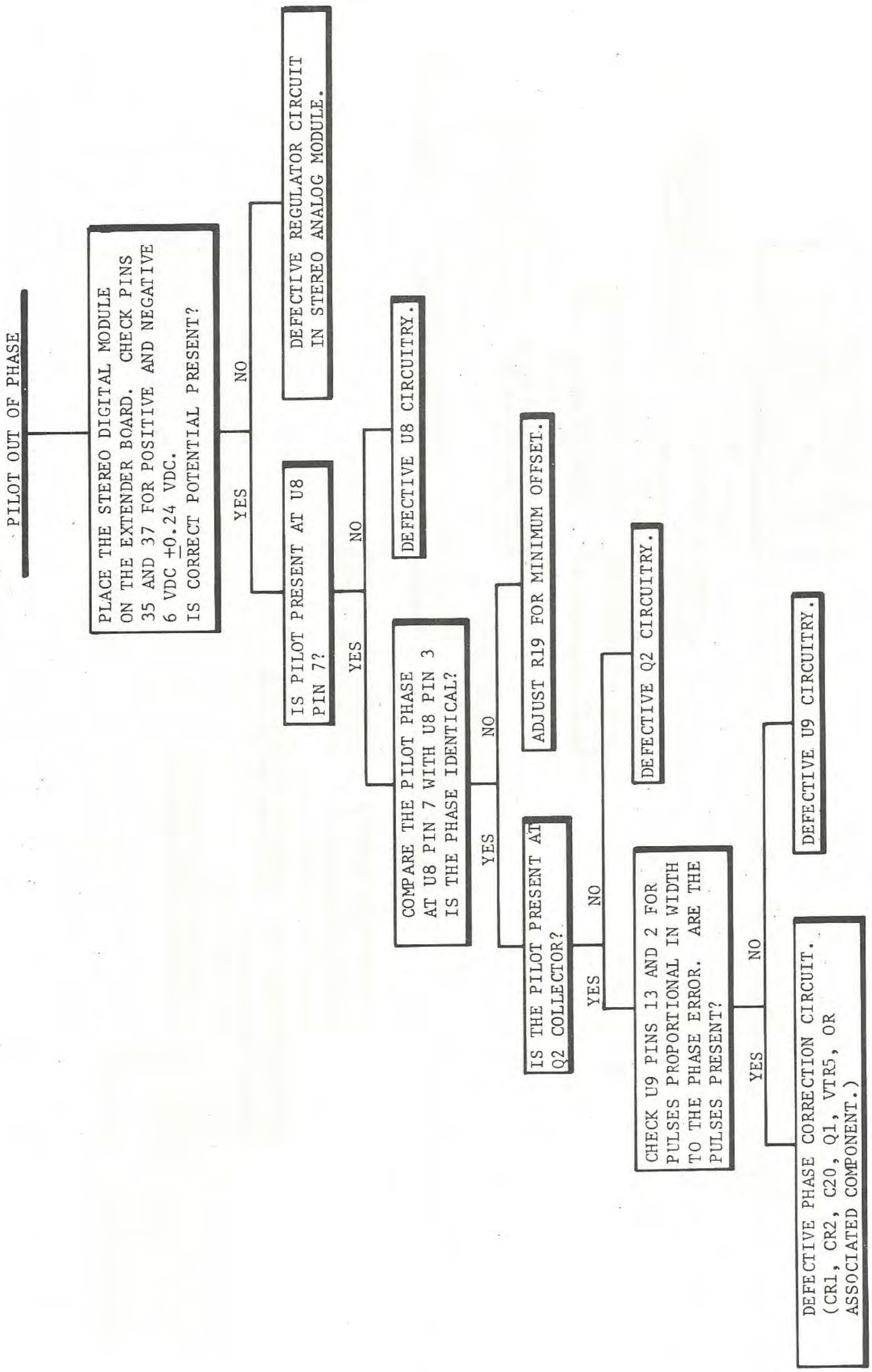
1742-65



2164-300-7

Figure 5-4. No Pilot

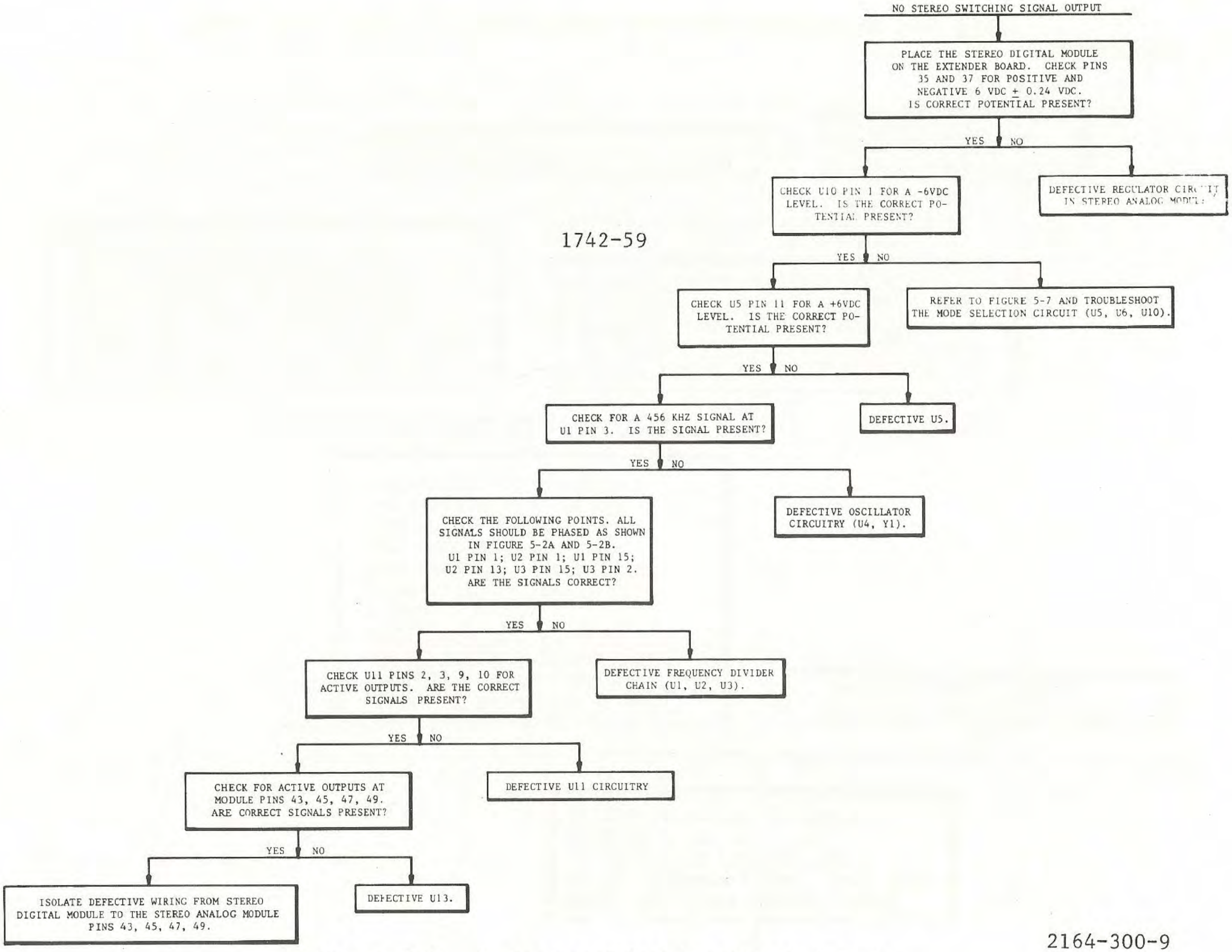
WARNING: Disconnect primary power prior to servicing.



2164-300-8

Figure 5-5. Pilot Out of Phase

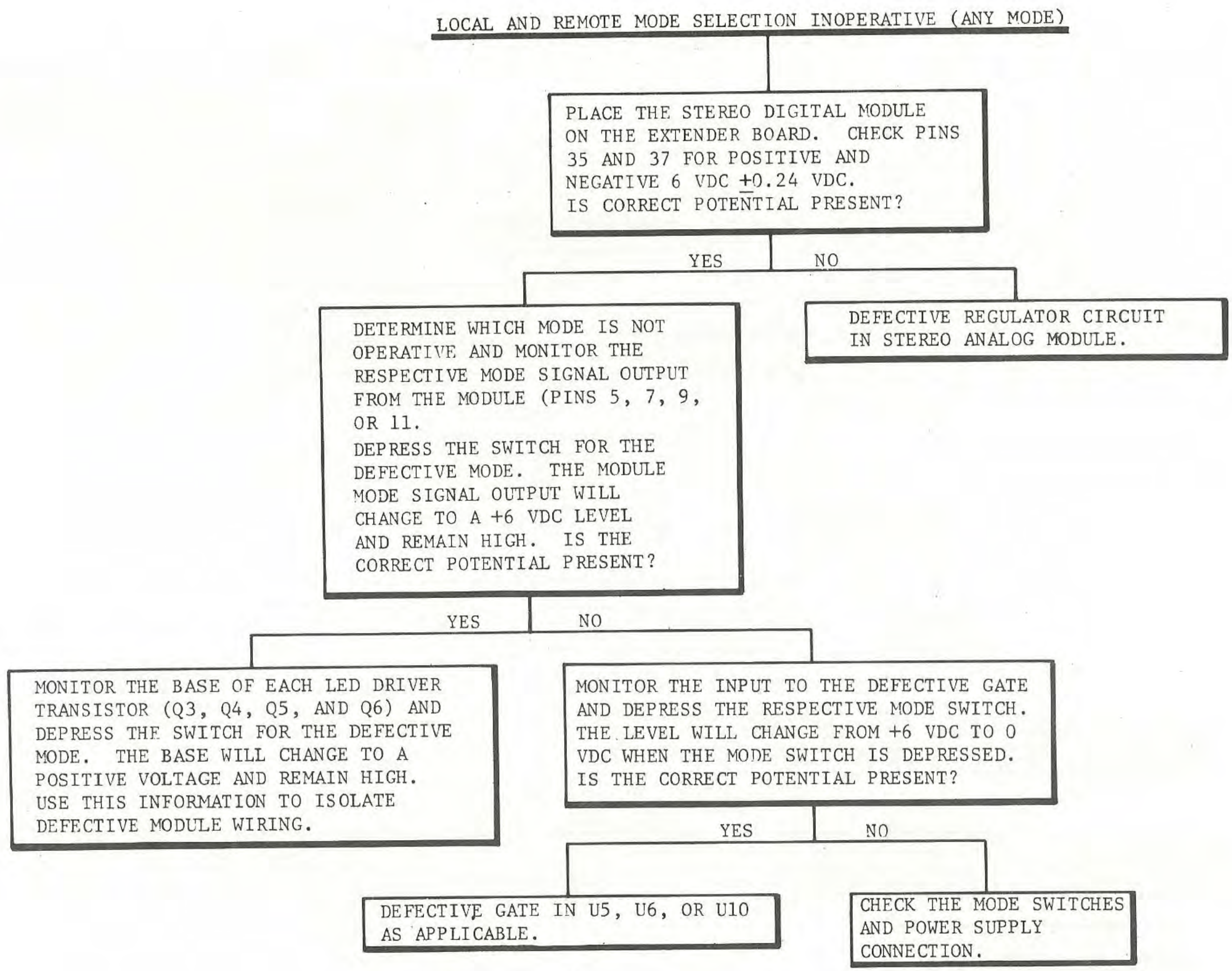
WARNING: Disconnect primary power prior to servicing.



2164-300-9

Figure 5-6. No Stereo Switching Signal Output

WARNING: Disconnect primary power prior to servicing.



2164-300-10

Figure 5-7. Local and Remote Mode Selection Inoperative (Any Mode)

WARNING: Disconnect primary power prior to servicing.

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. Refer to table 6-1 for replaceable parts which are required for proper maintenance of the MX-15 FM Exciter STEREO DIGITAL MODULE. Table entries are indexed by component reference designator.

6-3. REPLACEABLE PARTS SERVICE

6-4. Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

WARNING: Disconnect primary power prior to servicing.

Table 6-1. STEREO DIGITAL MODULE Front Panel - 994 7990 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
-------	992 4901 001	STEREO DIGITAL MODULE Circuit Board (Refer to figure 6-2.)	1

WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO DIGITAL MODULE Circuit Board - 992 4901 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1,CR2	384 0205 000	DIODE SILICON 1N914	2
CR3,CR4	384 0662 000	L.E.D. RED	2
CR5	384 0664 000	L.E.D. YELLOW	1
CR6	384 0661 000	L.E.D. GREEN	1
CR7	384 0205 000	DIODE SILICON 1N914	1
CR8,CR9,CR10	384 0431 000	RECT. 1N4001	
CR11			4
CR12	384 0205 000	DIODE SILICON 1N914	1
C1	518 0054 000	CAP, VAR 15-60PF	1
C2	500 0803 000	CAP MICA 5UUF 500V	1
C3	500 0759 000	CAP, MICA 100PF 500V 5%	1
C4,C5,C6,C7	516 0375 000	CAP .01UF 50V	4
C8,C9,C10,C11	516 0063 000	CAP, DISC .002UF 1KV 20%	4
C12	500 0833 000	CAP, MICA 390PF 500V 5%	1
C13	500 0804 000	CAP, MICA 10PF 500V 5%	1
C14,C15	526 0049 000	CAP 6.8UF 35V 20%	2
C16	516 0375 000	CAP .01UF 50V	1
C17	500 0842 000	CAP, MICA 820PF 300V 5%	1
C18,C19	508 0414 000	CAP .01UF 50V 5%	2
C20	526 0049 000	CAP 6.8UF 35V 20%	1
C21,C22	516 0453 000	CAP .1UF 100V 20%	2
C23,C24,C25,C26 C27,C28	516 0375 000	CAP .01UF 50V	6

 WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO DIGITAL MODULE Circuit Board - 992 4901 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C29	526 0340 000	CAP 1 UF 35V 10%	1
C30	526 0050 000	CAP 1 UF 35V 20%	1
C31,C32,C33,C34 C35,C36	516 0375 000	CAP .01UF 50V	6
C37,C38	526 0049 000	CAP 6.8UF 35V 20%	2
C40,C41	516 0375 000	CAP .01UF 50V	2
J1,J2	610 0679 000	PLUG, SHORTING	2
L1	492 0363 000	INDUCTOR, VARIABLE	1
Q1	380 0319 000	TRANSISTOR MPS-A14	1
Q2	380 0190 000	TRANSISTOR 2N3906	1
Q3,Q4,Q5,Q6,Q7	380 0319 000	TRANSISTOR MPS-A14	5
R1	540 0153 000	RES .5W 22 MEG 5 PCT	1
R2	540 1165 000	RES 1/2W 3300 OHM 5%	1
R3	540 1159 000	RES .5W 100K OHM 5%	1
R4	540 1162 000	RES 1/2W 1 MEGOHM 5%	1
R5,R6,R7,R8	540 1153 000	RES .5W 8200 OHM 5%	4
R9	540 1102 000	RES .5W 100 OHM 5PCT	1
R10	540 1162 000	RES 1/2W 1 MEGOHM 5%	1
R11	540 1102 000	RES .5W 100 OHM 5PCT	1
R12	540 1182 000	RES 1/2W 2200 OHM 5%	1
R13	540 1129 000	RES .5W 1500 OHM 5%	1
R14	540 1182 000	RES 1/2W 2200 OHM 5%	1

 WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO DIGITAL MODULE Circuit Board - 992 4901 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R15	540 1111 000	RES .5W 10K OHM 5PCT	1
R16	540 1159 000	RES .5W 100K OHM 5%	1
R17	540 1182 000	RES 1/2W 2200 OHM 5%	1
R18	540 1111 000	RES .5W 10K OHM 5PCT	1
R19	550 0913 000	POT, 5K OHM	1
R020	540 0089 000	RES .5W 47K OHM 5%	1
R21,R22,R23,R24 R25,R26,R27,R28 R29	540 1111 000	RES .5W 10K OHM 5PCT	9
R30	540 1116 000	RES .5W 1000 OHM 5%	1
R31	540 1162 000	RES 1/2W 1 MEGOHM 5%	1
R32,R33,R34,R35 R36	540 1159 000	RES .5W 100K OHM 5%	5
R37	540 1212 000	RES 1/2W 220K OHM 5%	1
R38	540 1159 000	RES .5W 100K OHM 5%	1
R39,R40	540 1151 000	RES .5W 10 OHM 5%	2
R41,R42,R43,R44	540 1162 000	RES 1/2W 1 MEGOHM 5%	4
R45	540 1159 000	RES .5W 100K OHM 5%	1
R046	540 0089 000	RES .5W 47K OHM 5%	1
R47	540 1116 000	RES .5W 1000 OHM 5%	1
S1,S2,S3,S4	604 0866 000	SW, PUSHBUTTON SPDT	4
U1	382 0466 000	CKT. INT DIGITAL	1
U2	382 0397 000	IC CD4013/MC14013	1

Table 6-2. STEREO DIGITAL MODULE Circuit Board - 992 4901 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
U3	382 0466 000	CKT. INT DIGITAL	1
U4	382 0287 000	IC CD4001/MC14001	1
U5	382 0288 000	IC 4011/14011	1
U6	382 0396 000	CKT, INTEGRATED	1
U7	382 0472 000	IC LM318	1
U8	382 0452 000	IC LM311/CA311	1
U9	382 0397 000	IC CD4013/MC14013	1
U10	382 0396 000	CKT, INTEGRATED	1
U11	382 0548 000	IC, CD4042BCN/MM5642BN	1
U12	382 0510 000	IC ILQ-74 OPTO ISOL	1
U13	382 0523 000	IC, CMOS, MC14066BCPDS	1
XU1	404 0675 000	SOCKET, IC 16 CONT	1
XU2	404 0674 000	SOCKET, IC 14 CONT	1
XU3	404 0675 000	SOCKET, IC 16 CONT	1
XU4,XU5,XU6	404 0674 000	SOCKET, IC 14 CONT	3
XU7,XU8	404 0673 000	SOCKET, IC 8 CONT	2
XU9,XU10	404 0674 000	SOCKET, IC 14 CONT	2
XU11,XU12	404 0675 000	SOCKET, IC 16 CONT	2
XU13	404 0674 000	SOCKET, IC 14 CONT	1
XY1	404 0267 000	SOCKET CRYSTAL	1
Y1	444 2534 000	CRYSTAL 456.00 KHZ	1
	670 0033 000	LED, LDR	1

STEREO ANALOG MOD.
888-2164-403

TECHNICAL MANUAL

STEREO ANALOG MODULE

994 7989 001

HARRIS

T.M. No. 888-2164-403

Printed: Aug. 8, 1986

MANUAL REVISION HISTORY
STEREO ANALOG MODULE
888-2164-4xx

REV. #	DATE	ECN	PAGES AFFECTED
401	03-05-86	29892	Replaced the following pages: Title Page, i, ii, 20, 25/26 & 33 Added Manual Revision History Page
402	05-08-86	30125	Replaced the following pages: Title Page, Manual Revision History Page, 25/26 & 36
403	08-08-86	29989	Replaced the following pages: Title Page, Manual Revision History Page, 25/26, 35 & 36

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

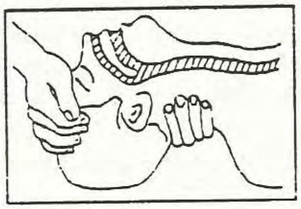
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

(A) AIRWAY

IF UNCONSCIOUS.
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

(B) BREATHING

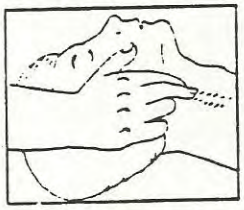
IF NOT BREATHING.
BEGIN ARTIFICIAL BREATHING

TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH RESUSCITATION MUST BE COMMENCED AS SOON AS POSSIBLE

CHECK
CAROTID PULSE



IF PULSE ABSENT.
BEGIN ARTIFICIAL CIRCULATION

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES

APPROX. RATE OF COMPRESSIONS --80 PER MINUTE { ONE RESCUER, 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE { TWO RESCUERS, 5 COMPRESSIONS, 1 BREATH

NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

NOTE

If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE

1-2. The STEREO ANALOG MODULE produces a composite stereophonic signal from the left and right audio inputs. The composite output signal comprises a L+R baseband audio signal from 30 Hz to 15 kHz, a 19 kHz pilot signal at -20 dB for multiplex reference, and a L-R double sideband suppressed carrier signal centered at 38 kHz. The module interfaces with OVSC module to allow DTR filter provisions or use of the internal low-pass filter as desired. Selectable 75us, 50us, or 25us, or FLAT pre-emphasis is also provided.

1-3. TECHNICAL CHARACTERISTICS

1-4. Table 1-1 lists operating characteristics and parameters of the MX-15 FM Exciter STEREO ANALOG MODULE.

SECTION II

INSTALLATION

2-1. GENERAL

2-2. Refer to MX-15 FM Exciter System Technical Manual, Section II, Installation.

SECTION III

CONTROLS AND INDICATORS

3-1. GENERAL

3-2. Figure 3-1 shows the location of each control or indicator associated with the FM Exciter STEREO ANALOG MODULE and table 3-1 lists the controls and indicators with a description of each item listed. Control setup adjustments are listed in table 3-2.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
POWER:	+20 Vdc @ 0.110 amperes -20 Vdc @ 0.105 amperes
SIGNAL:	
Audio (Left and Right Channel)	+10 dBm $\pm$1 dBm for 100% modulation at 400 Hz. 600 ohm balanced resistive input impedance.
Pilot	1.7V p-p sinusodial 19 kHz Pilot.
CONTROL:	
Stereo Switching	12V p-p in phase and inverted 38 kHz square waves (CMOS logic level). 12V p-p in phase and inverted 114 kHz square waves (CMOS logic level).
Mode Switching	+6 Vdc for Selected Mode. -6 Vdc for inhibit (CMOS logic level).
OUTPUTS	
POWER:	+6 Vdc @ 0.025 amperes -6 Vdc @ 0.022 amperes
SIGNAL:	2.8V p-p Composite Stereo Output

WARNING: Disconnect primary power prior to servicing.

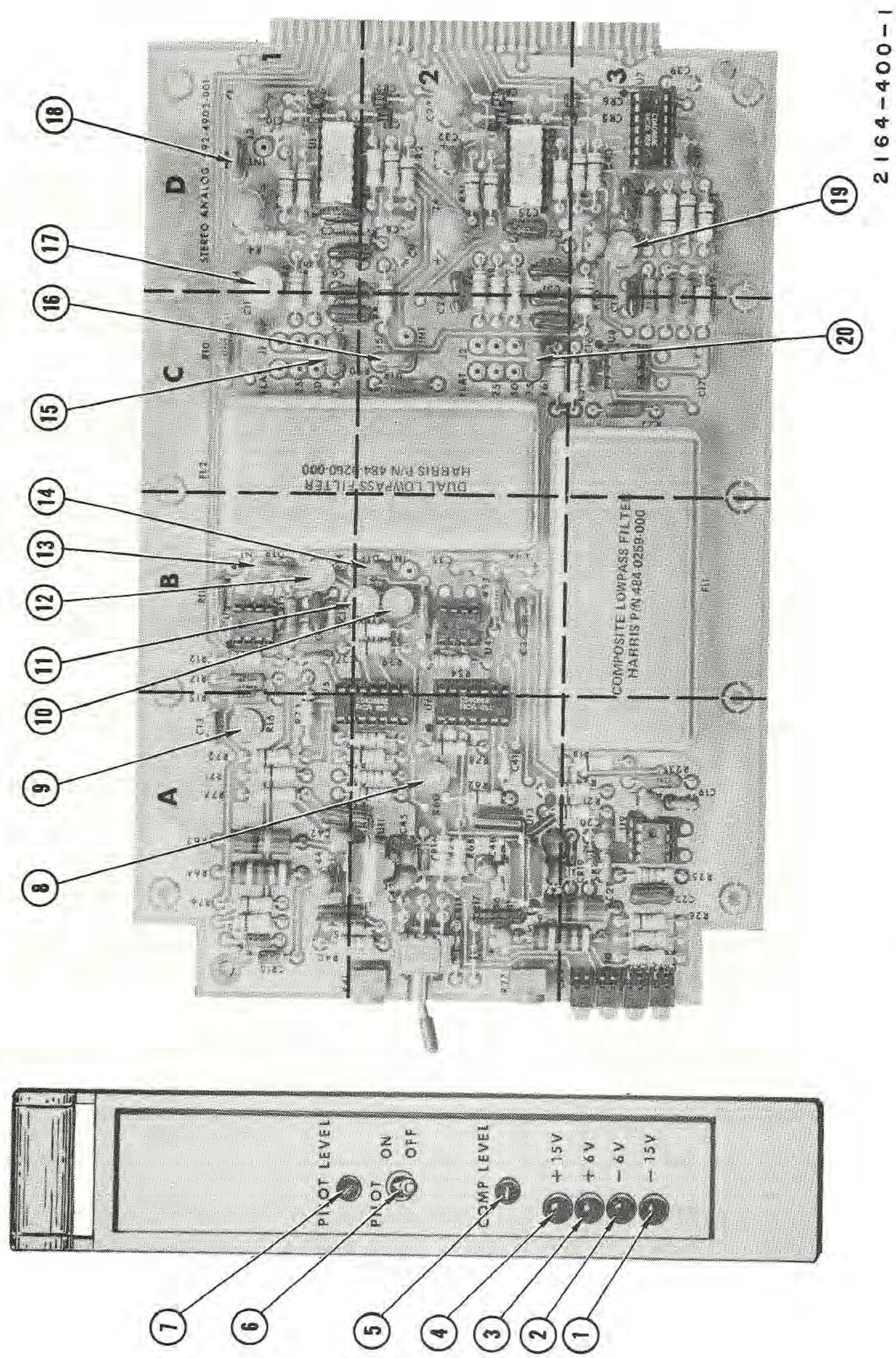


Figure 3-1. STEREO ANALOG MODULE

Table 3-1. STEREO ANALOG MODULE Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	-15V Indicator (CR12)	Illuminates to indicate the STEREO ANALOG MODULE -15 volt regulator is operational.
2	-6V Indicator (CR11)	Illuminates to indicate the STEREO ANALOG MODULE -6 volt regulator is operational.
3	+6V Indicator (CR10)	Illuminates to indicate the STEREO ANALOG MODULE +6 volt regulator is operational.
4	+15V Indicator (CR9)	Illuminates to indicate the STEREO ANALOG MODULE +15 volt regulator is operational.
5	COMP LEVEL Control (R27)	Adjusts the signal level output from the STEREO ANALOG MODULE.
6	PILOT ON/OFF Switch (S1)	Enables or inhibits the pilot subcarrier.
7	PILOT LEVEL Control (R41)	Adjusts the modulation level of the pilot carrier.
8	MONO GAIN Control (R60)	Adjusts monaural audio level in relation to the stereophonic audio level.
9	38 kHz NULL Control (R16)	Adjusts dc offset between left and right switch drivers to null 38 kHz signal.
10	RIGHT SEPARATION Control (R31)	Adjusts left into right stereophonic audio separation.
11	LEFT SEPARATION Control (R28)	Adjusts right into left stereophonic audio separation.
12	GAIN MATCH Control (R14)	Adjusts the left channel gain to equal the right channel gain for minimum crosstalk.

WARNING: Disconnect primary power prior to servicing.

Table 3-1. STEREO ANALOG MODULE Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
13	INT/DTR Filter Selector (J4)	Selects the internal low pass filter or enables the DTR filter.
14	INT/DTR Filter Selector (J6)	Selects the internal low pass filter or enables the DTR filter.
15	75/50/25/FLAT Left Channel Pre-emphasis Selector (J1)	Selects left channel stereophonic input pre-emphasis.
16	INT/DTR Filter Selector (J5)	Selects the internal low pass filter or enables the DTR filter.
17	PRE-EMPH MATCH Adjustment (C4)	Adjusts pre-emphasis characteristics of the left channel to match the right channel pre-emphasis characteristics for minimum crosstalk.
18	INT/DTR Filter Selector (J3)	Selects the internal low pass filter or enables the DTR filter.
19	114 kHz NULL Control Control (R37)	Adjusts the 114 kHz level to cancel the third harmonic of the 38 kHz signal (114 kHz).
20	75/50/25/FLAT Right Channel Pre-emphasis Selector (J2)	Selects right channel stereophonic input pre-emphasis.

Table 3-2. Control Adjustments

CONTROL	ADJUSTMENT
PILOT LEVEL Control (R41)	1. Connect the exciter rf output to a 50 ohm load through a directional coupler or line sampler. 2. Connect a modulation monitor to the line sampler or the forward port of the directional coupler. 3. Connect a stereo monitor to the composite output to the modulation monitor. 4. Depress the SCA 1 and SCA 2 OFF switches. The OFF indicator on each SCA module will illuminate. 5. Adjust R41 to obtain the desired amount of pilot signal (8% to 10%). Note the level. 6. Depress the SCA 1 ON switch. The SCA 1 ON indicator will illuminate. 7. If the pilot signal drops from the level adjusted in step 5, adjust R41 slightly to compensate for the drop. 8. Reconnect the exciter output to the load.
COMP LEVEL Control (R27)	1. Disconnect the stereo audio inputs from LEFT FRONT + and - (TB1 pins 1 and 3) and RIGHT FRONT + and - (TB1 pins 4 and 6) on the rear of the exciter. 2. Apply a 400 Hz sinewave at +10 dBm to both inputs simultaneously. 3. Depress the LEFT MODULATION meter switch. Adjust the 400 Hz signal level until the MODULATION meter indicates 100%.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	4. Depress the B-BAND MODULATION meter switch. Adjust R27 until the MODULATION meter indicates 100%. 5. Remove the 400 Hz test signal and reconnect the stereo audio inputs.
MONO GAIN Control (R60)	1. Disconnect the stereo audio inputs from LEFT FRONT + and - (TB1 pins 1 and 3) and RIGHT FRONT + and - (TB1 pins 4 and 6) on the rear of the exciter. 2. Apply a 400 Hz sinewave at +10 dBm to both inputs simultaneously. 3. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 4. Depress the LEFT MODULATION meter switch. Adjust the 400 Hz signal level until the MODULATION meter indicates 100%. 5. Depress the MONO L mode switch on the STEREO DIGITAL module. The MONO L indicator will illuminate. 6. Depress the LEFT MODULATION meter switch and adjust R60 to obtain an indication of 100% on the MODULATION meter. 7. Remove the module and extender board and replace the module in the exciter. Remove the 400 Hz test signal and reconnect the stereo audio inputs.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
38 KHZ NULL Control (R16)	1. Connect the exciter rf output to a 50 ohm load through a directional coupler or line sampler. 2. Connect a modulation monitor to the line sampler or the forward port of the directional coupler. 3. Connect a stereo monitor to the composite output to the modulation monitor and adjust the stereo monitor to the 38 kHz position. 4. Disable all modulation to the exciter. 5. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 6. Depress the STEREO DIGITAL module STEREO switch. The STEREO indicator will illuminate. 7. Set the PILOT ON/OFF switch to OFF. 8. Adjust R16 to obtain a minimum indication on the stereo monitor. 9. Remove the module and extender board and replace the module in the exciter. Set the PILOT ON/OFF switch to ON and reconnect the exciter output to the load.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	NOTE The 114 KHZ NULL control (R37) is factory preset and should not be adjusted in the field unless the circuit is repaired. Adjustment of R37 affects several parameters and requires subsequent completion of the LEFT SEPARATION Control (R28)/-RIGHT SEPARATION Control (R31)/GAIN MATCH Control (R14)/PRE-EMPHASIS MATCH Adjustment (C4) adjustment procedure.
114 KHZ NULL Control (R37)	1. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 2. Disconnect the stereo audio input from the LEFT FRONT + and - (TB1 pins 1 and 3) on the rear of the exciter. 3. Apply a 400 Hz sinewave at +10 dBm to the left channel only. 4. Connect a spectrum analyzer to pin 70. 5. Depress the LEFT MODULATION meter switch. Adjust the 400 Hz signal level until the MODULATION meter indicates 100%. 6. Adjust R37 to obtain a minimum indication of the 114 kHz signal on the spectrum analyzer (typical suppression 70 dB). 7. Disconnect the spectrum analyzer.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	8. Remove the module and extender board and replace the module in the exciter. Remove the 400 Hz test signal and reconnect the left channel audio input.
LEFT SEPARATION	1. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 2. Disconnect the stereo audio input from the LEFT FRONT + and - (TB1 pins 1 and 3) and the RIGHT FRONT + and - (TB1 pins 4 and 6). 3. Apply a 400 Hz sinewave signal at +10 dBm to the left channel only. NOTE Correct adjustment of R28 and R31 requires use of a dc coupled oscilloscope with good high frequency amplitude and phase response. A X1 probe must be used. 4. Connect the oscilloscope to pin 70. 5. Set the PILOT ON/OFF switch to OFF. 6. Adjust R28 to obtain the flattest composite signal base line indication on the oscilloscope.
RIGHT SEPARATION Control (R31)	1. Remove the 400 Hz test signal from the left channel and connect the signal to the RIGHT FRONT + and - (TB1 pins 4 and 6) only.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	2. Depress the RIGHT MODULATION meter switch. Adjust the 400 Hz signal level until the MODULATION meter indicates 100%.
	3. Adjust R31 to obtain the flattest composite signal base line indication on the oscilloscope.
	4. Set the STEREO OVSC module IN/-OUT switch to OUT.
	5. Remove the 400 Hz test signal from the right channel.
GAIN MATCH Control (R14)	1. Connect a 100 Hz sinewave to both the LEFT FRONT + and - (TB1 pins 1 and 3) and the RIGHT FRONT + and - (TB1 pins 4 and 6) (both channels strapped together so that L = R).
	2. Depress the LEFT MODULATION meter switch. Adjust the 100 Hz signal level until the MODULATION meter indicates 100%.
	3. Adjust C4 to midrange.
	4. Using a spectrum analyzer connected to pin 70 or a stereo modulation monitor on the exciter output adjusted to the L-R position, adjust R14 for a minimum indicator of the L-R signal (typical suppression 65 dB).
	5. Remove the 100 Hz test signal from the exciter stereo audio inputs.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
PRE-EMPHASIS MATCH Adjustment (C4)	1. Connect a 15 kHz sinewave to both the LEFT FRONT + and - (TB1 pins 1 and 3) and the RIGHT FRONT + and - (TB1 pins 4 and 6) (both channels strapped together so that L = R). 2. Depress the LEFT MODULATION meter switch. Adjust the 15 kHz signal level until the MODULATION meter indicates 100%. 3. Adjust C4 for a minimum indication of the L-R signal (typical suppression 60 dB). Note the stereo audio inputs. 4. Remove the 15 kHz test signal from the exciter stereo audio inputs. 5. Connect a 400 Hz sinewave to the LEFT FRONT + and - (TB1 pins and 1 and 3). For test purposes only, cross connect the left and right exciter stereo audio inputs out of phase so that L = -R as follows: TB1 pin 1 to TB1 pin 6 TB3 pin 3 to TB1 pin 4 6. Depress the LEFT MODULATION meter switch. Adjust the 400 Hz signal level until the MODULATION meter indicates 100%. 7. If a stereo modulation monitor is used, adjust the monitor to the L + R signal. If L+R suppression is different in level from L-R indication in step 3, alternately adjust R28 and R41 slightly equal amounts in the same direction until the L + R

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	suppression is equal to the L - R suppression noted in step 3. 8. Remove the 400 Hz test signal and straps from the exciter stereo audio inputs. 9. Connect a 400 Hz sinewave to the LEFT FRONT + and - (TB1 pins 1 and 3). 10. Depress the LEFT MODULATION meter switch. Adjust the 400 Hz signal level until the MODULATION meter indicates 100%. 11. Check LEFT SEPARATION and RIGHT SEPARATION. Ensure the separation has not degraded. 12. Perform the PILOT LEVEL Control (R41) adjustment procedure, steps 1 through 4. 13. Perform the MONO GAIN Control (R27) adjustment procedure, steps 1 through 6. 14. Disconnect the oscilloscope and spectrum analyzer from the module. Remove the module and extender board and replace the module in the exciter. 15. Remove the 400 Hz test signal and reconnect the stereo audio inputs. Reconnect the exciter output to the load. 16. Set the PILOT ON/OFF switch to ON. Set the STEREO OVSC Module IN/OUT switch to ON.

SECTION IV

PRINCIPLES OF OPERATION

4-1. CIRCUIT DESCRIPTION

4-2. INPUT CIRCUIT

4-3. INPUT PROTECTION NETWORK. Two channel audio input from the RFI filter is applied to transformerless unity gain instrumentation amplifiers (U1 and U2) through input protection networks (see figure 4-1). Damage to the preamplifier circuits from an excessive input signal is prevented by a configuration of four diodes connected to the ±15 Vdc sources. If a signal or transient exceeding the power supply potential appears at the module input, the portion of the input which exceeds the power supply potential will be shunted by the diodes to the ±15 Vdc power supply to limit the signal.

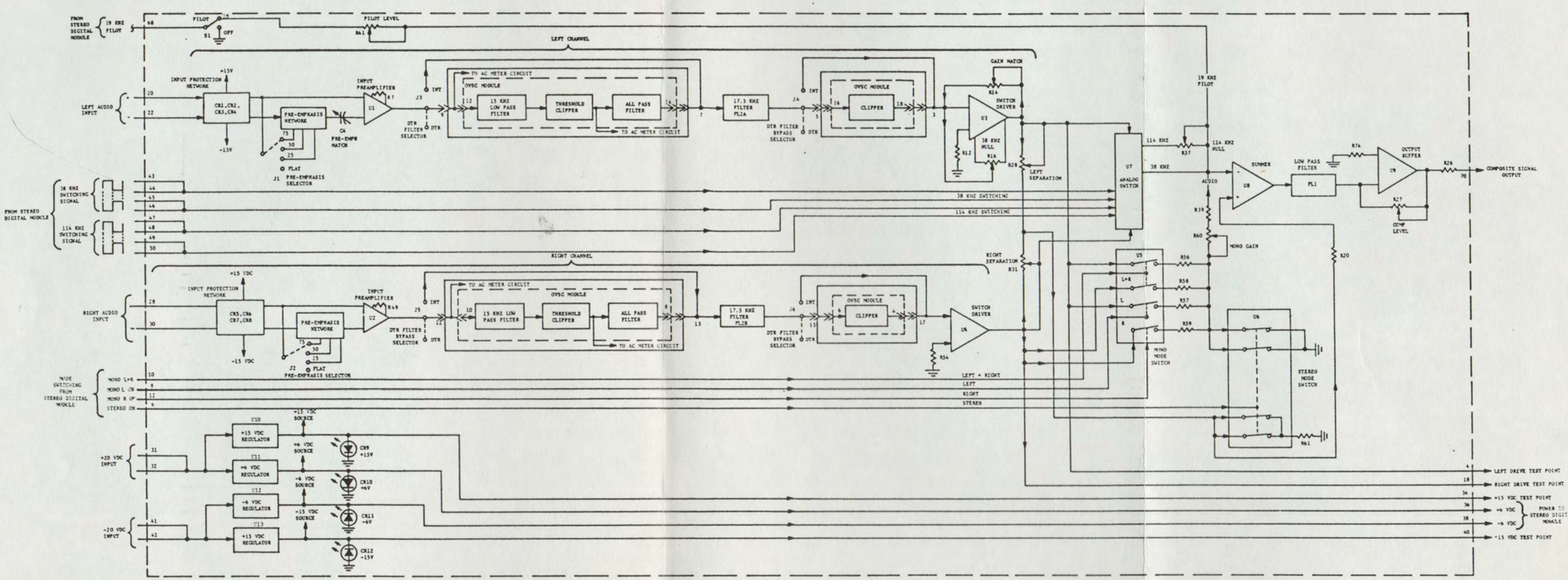
4-4. INPUT PREAMPLIFIER. The input preamplifiers differ from standard operational amplifiers by the inputs and the methods through which feedback is obtained. Each amplifier responds only to the difference in potential between the two inputs. If the same signal is applied to both inputs simultaneously or if only one input is driven and the connection to the second input is opened, the output will be zero. The amplifier therefore behaves as a transformer with response to dc. The amplifiers also provide the transformer's advantages of isolation and hum rejection without the problems of limited frequency response and phase distortion. Pre-emphasis selectors J1 and J2 allow pre-emphasis selection of 75us, 50us, 25us, or FLAT response. Amplifier gain is determined by resistors R7, R49 and the pre-emphasis network. The PRE-EMPH MATCH control (C4) in the left channel preamplifier input allows adjustment of the left channel pre-emphasis circuit to match the right channel pre-emphasis characteristics. The pre-emphasized audio is applied to DTR filter selector J3 in the left channel and DTR filter selector J5 in the right channel.

4-5. FILTER CIRCUIT

4-6. Pre-emphasized audio from the input preamplifiers is applied to DTR (Dynamic Transient Response) filter selectors J3 in the left channel and J5 in the right channel. Outputs to the ac metering circuits allow monitoring of the left and right pre-emphasized levels.

4-7. Normally the STEREO ANALOG MODULE will be used with the STEREO OVSC module in which the STEREO ANALOG MODULE filters are used as part of the DTR filtering process. However, the STEREO ANALOG MODULE includes its own audio low-pass filters and can function without the STEREO OVSC module if desired.

4-8. The DTR filter selectors allow selection of the OVSC module DTR filter circuitry or allow use of the STEREO ANALOG MODULE 17.5 kHz low-pass filters as desired. In any case, all the DTR filter selectors (J3 and J4 in the left channel and J5 and J6 in the right channel) must all be positioned in corresponding locations. If the DTR filter is jumpered out of the circuit (INT position), the OVSC module IN/OUT switch must be placed OUT or the OVSC module must be removed from the exciter.



NOTES

1. PINS 1,2,19,21,23 THROUGH 27,29,67,69,71,72 CONNECT TO GROUND
2. SHOWN IN STEREO OPERATION

FIGURE 4-1. STEREO ANALOG MODULE BLOCK DIAGRAM

4-9. SWITCHING CIRCUIT

4-10. SWITCH DRIVERS. The pre-emphasized and filtered audio is applied to switch driver U3 in the left channel and U4 in the right channel. The gain of the left channel driver is adjusted to match the right channel amplifier gain with the GAIN MATCH control (R14). The 38 kHz NULL control (R16) adjusts 38 kHz suppression by matching the dc offsets between the left and right channel switch drivers. The LEFT SEPARATION (R28) adjusts right into left audio and the RIGHT SEPARATION (R31) adjusts left into right audio to obtain maximum channel separation.

4-11. All waveforms used in the STEREO ANALOG MODULE are generated by the synchronous divider in the STEREO DIGITAL module. This ensures correct phase relationships among the 38 kHz and 114 kHz inverted and non-inverted switching signals and the 19 kHz pilot signal.

4-12. The two sets of square wave switching signals input to the analog switches cause the switches to sample the left and right audio channels at a 38 kHz and 114 kHz rate. The switches output a 38 kHz and 114 kHz sampled audio signal which is summed with the pilot signal at the inverting input to sum amplifier U8. The 114 kHz amplitude is adjusted to the same amplitude as the third harmonic of the 38 kHz signal (114 kHz) by the 114 kHz NULL control (R37). As the two signals are 180 degrees out of phase when summed, the two signals algebraically add to zero and cancel. Therefore the resultant sampling waveform contains no 114 kHz component. The pilot signal amplitude is adjusted with the PILOT LEVEL control (R41) and the PILOT ON/OFF switch (S1) allows the pilot signal to be interrupted for test purposes.

4-13. After low-pass filtering, the 38 kHz double sideband L-R signal peak amplitude must equal L+R audio baseband peak amplitude. This is accomplished by subtracting a small portion of the left and right audio signal fed through R20 from the sampled audio signal at the input of sum amplifier U8. Relative signal amplitudes of the 38 kHz, 114 kHz, and inverted left and right audio components at the summed input are 1.0V P-P, and 0.333 P-P, and 0.03V P-P respectively.

4-14. For monaural operation, the sampling signals and the pilot signal from the STEREO DIGITAL module are inhibited. Switches in U5 select the L+R, L, or R monaural modes. The signal level is controlled by the MONO GAIN control (R60) with the monaural signal applied to U8 through resistor R39.

4-15. MODE SWITCHING

4-16. Mode switching is controlled by CMOS logic inputs for stereo, mono left, mono right, and mono left plus right from the STEREO DIGITAL MODULE.

4-17. MONAURAL OPERATION. If a monaural mode is selected, the stereo mode line is driven LOW which opens the four switches in U6. Operation of the 38 kHz and the 114 kHz sampling signals and the 19 kHz pilot signal is inhibited by control circuitry in the STEREO DIGITIAL module which opens the sampling switches. A positive six volt dc level input from the STEREO DIGITAL module on the selected monaural mode line will close the appropriate mono mode switches in U5 and connect the desired audio source to the sum amplifier input through the MONO GAIN control (R60). Resistors R56, R57, R58, and R59 connnected to the mono mode switch ensure the correct audio level is maintained for each mono mode.

4-18. STEREOPHONIC OPERATION. If stereophonic operation is selected, a positive six volt dc level output from the STEREO DIGITAL module on the stereo mode line activates the stereo mode switches (U6). One portion of the switch connected between the LEFT SEPARATION and RIGHT SEPARATION controls applies a portion of the (L+R) signal required for stereophonic operation to the non-inverting input of the sum amplifier. The second portion of the switch inhibits monaural operation by effectively grounding the monaural audio line. The 38 kHz and 114 kHz sampling signals and the 19 kHz pilot signal output from the STEREO DIGITAL module are enabled during stereophonic operation.

4-19. OUTPUT CIRCUIT

4-20. The output of the sum amplifier feeds the output amplifier through FL-1 which provides the required low-pass filtering. Output buffer U9 amplifies the signal level and provides a low impedance output. The COMP LEVEL control R27 adjusts the composite signal level to 1.0 VRMS for 100% modulation to drive the MOD OSC module circuitry. Several cycles of the digital sampling signal and the 38 kHz fundamental component as would appear at the output of sum amplifier (U8) (pilot off) are shown in figure 4-2.

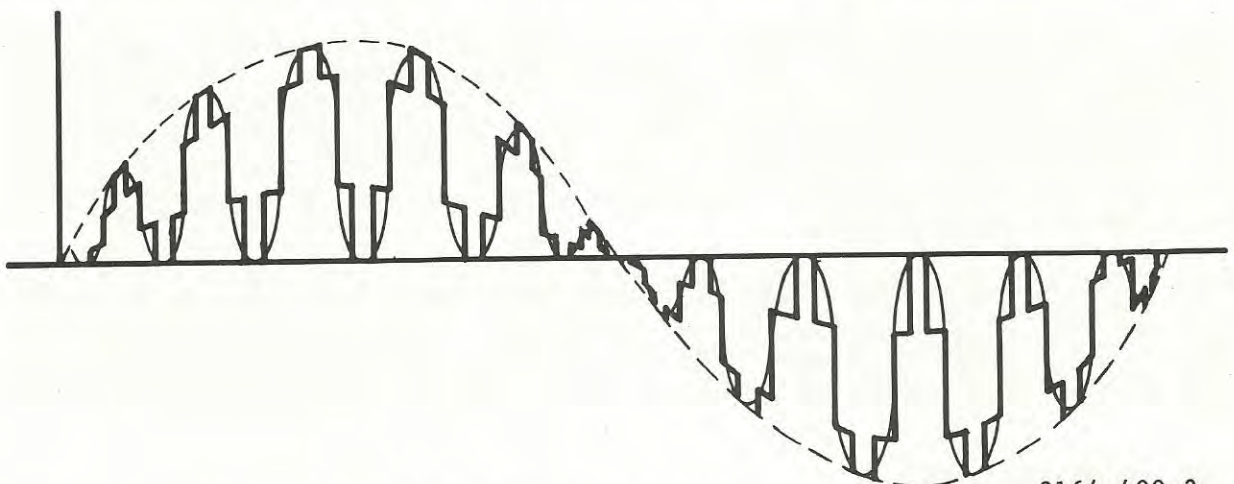


Figure 4-2. DSM Waveform

4-21. POWER

4-22. Positive 20 Vdc enters the module on pins 31 and 32 and negative 20 Vdc enters the module on pins 41 and 42. Regulated potentials to operate the module internal circuitry are developed by regulators U10 (+15 Vdc), U11 (+6 Vdc), U12 (-15 Vdc), and U13 (-6 Vdc). Light emitting diodes CR9 through CR12 provide a visual indication of the positive and negative fifteen

WARNING: Disconnect primary power prior to servicing.

and six volt supplies. Test points are provided to assist in checking regulator outputs. Additionally, $\pm$6 Vdc is output from the STEREO ANALOG MODULE to power the circuitry in the STEREO DIGITAL module.

SECTION V

MAINTENANCE

5-1. CORRECTIVE MAINTENANCE

5-2. The MX-15 FM Exciter module philosophy consists of problem isolation to a specific area or individual component and subsequent isolation and replacement of the defective componet.

5-3. TROUBLESHOOTING

5-4. In event of problems, the trouble area must first be isolated to a specific area. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, fuse F1, circuit breaker CB1, and the indicators on each module should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs which indicate the module power supply status. A single dark LED would indicate a problem associated with an individual module monolithic voltage regulator. A consistent pattern of dark LEDs however, would indicate an exciter dc distribution bus fault.

5-5. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-1 lists typical trouble symptoms pertaining to the individual module operation with references to fault isolation diagrams listing probable causes and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem. It only tends to lead the repairman into the area that may be causing the trouble. An extender board (HARRIS PN 992 4989 001) is provided with the exciter to assist in troubleshooting. In event parts are required, refer to Section VI, Parts List. The following information is contained in this section as an aid to maintenance:

REFERENCE	TITLE	NUMBER
Figure 5-1	STEREO ANALOG MODULE Parts Layout	--- ---- ---
Table 5-2	STEREO ANALOG MODULE Parts Index	--- ---- ---
Figure 5-2	STEREO ANALOG MODULE Waveforms	--- ---- ---
Figure 5-3	STEREO ANALOG MODULE Schematic	852 8408 001

WARNING: Disconnect primary power prior to servicing.

5-6. Prior to starting a troubleshooting procedure check all switches, power cord connections, connecting cables, and power fuses.

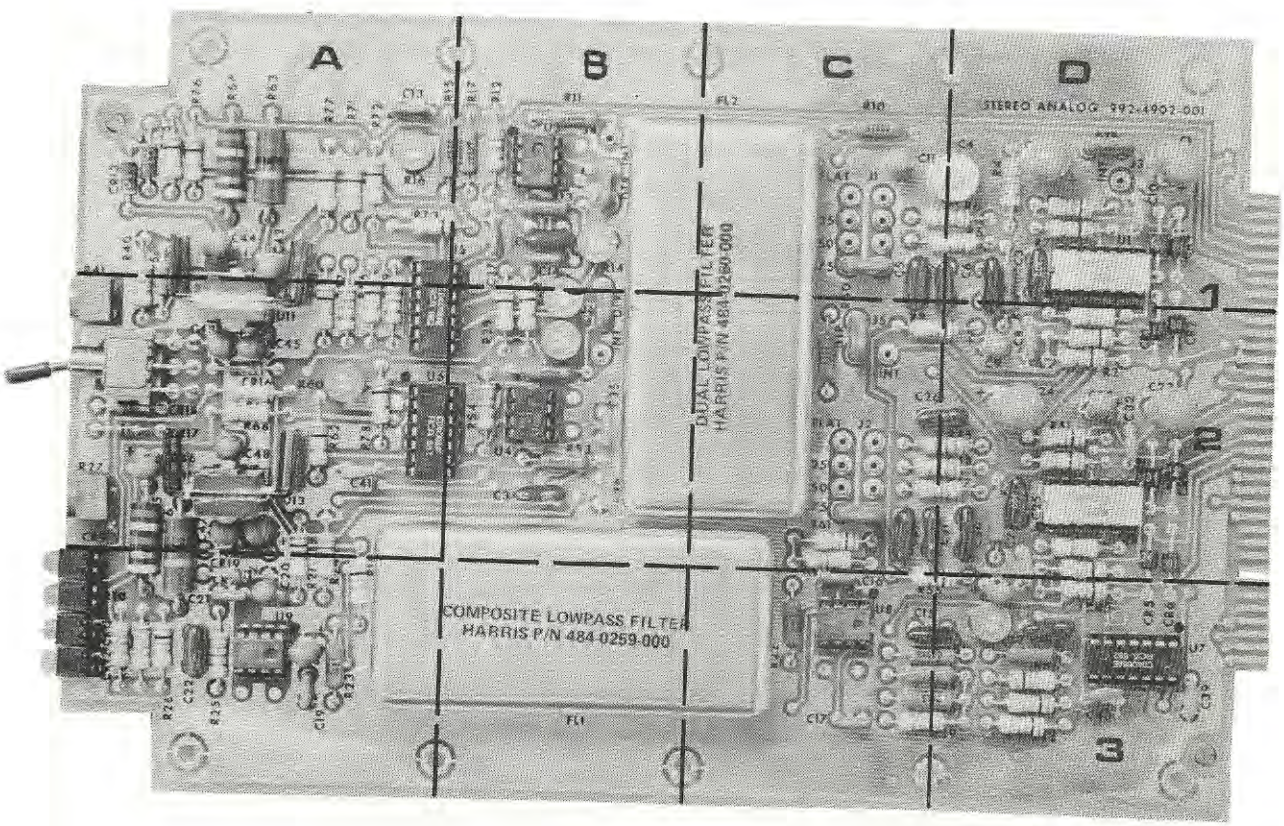
5-7. TECHNICAL ASSISTANCE

5-8. HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service Department 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

Table 5-1. STEREO ANALOG MODULE Fault Isolation Index

SYMPTOM	DEFECT/REFERENCE
NO OUTPUT	Figure 5-4
NO AUDIO FROM LEFT AND/OR RIGHT CHANNEL (pilot present).	Figure 5-5
NOISE	Figure 5-6
POOR SEPARATION	Figure 5-7
POOR CROSSTALK	Figure 5-8
38 KHZ CARRIER ON OUTPUT	Figure 5-9

WARNING: Disconnect primary power prior to servicing.



2164-400-4

Figure 5-1. STEREO ANALOG MODULE Parts Layout

WARNING: Disconnect primary power prior to servicing.

Table 5-2. STEREO ANALOG MODULE Parts Index

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
C1	D1	C29	C2	CR1	D2	J1	C1
C2	D1	C30	D2	CR2	D2	J2	C2
C3	D1	C31	D2	CR3	D1	J3	D1
C4	D1	C32	D2	CR4	D1	J4	B1
C5	C1	C33	D2	CR5	D3	J5	C2
C6	D1	C34	B2	CR6	D3	J6	B2
C7	C1	C35	B2	CR7	D2		
C8	D2	C36	B2	CR8	D2		
C9	D2	C37	B1	CR9	A3		
C10	D1	C38	D3	CR10	A3		
C11	C1	C39	D3	CR11	A3	R1	D2
C12	B1	C40	D3	CR12	A3	R2	D2
C13	A1	C41	A2	CR13	A1	R3	D2
C14	B1	C42	A1	CR14	A1	R4	D1
C15	C3	C43	A2	CR15	A2	R5	D1
C16	C3	C44	A1	CR16	A2	R6	D1
C17	C3	C45	A2	CR17	A2	R7	D1
C18	A3	C46	A2	CR18	A2	R8	C2
C19	A3	C47	A2	CR19	A3	R9	D1
C20	A3	C48	A2	CR20	A3	R10	C1
C21	A3	C49	A2			R11	B1
C22	A3					R12	B1
C23	D2					R13	B1
C24	D2			FL1	B3	R14	B1
C25	D2			FL2	C1	R15	A1
C26	C2					R16	A1
C27	D2					R17	B1
C28	D3					R18	A3
						R19	C3

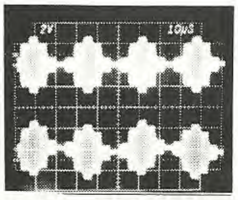
WARNING: Disconnect primary power prior to servicing.

Table 5-2. STEREO ANALOG MODULE Parts Index (Continued)

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
R20	C3	R48	D2	R76	A1		
R21	A3	R39	D2	R77	A1		
R22	C3	R50	C2	R78	A2		
R23	A3	R51	D2				
R24	A3	R52	B2	S1	A2		
R25	A3	R53	B2				
R26	A3	R54	B2	U1	D1		
R27	A2	R55	C3	U2	D2		
R28	B2	R56	A2	U3	B1		
R29	B2	R57	A2	U4	B2		
R30	B2	R47	A2	U5	A2		
R31	B2	R59	A2	U6	A2		
R32	D3	R60	A2	U7	D3		
R33	D3	R61	C2	U8	C3		
R34	C3	R62	A2	U9	A3		
R35	C3	R63	A1	U10	A2		
R36	D3	R64	A1	U11	A2		
R37	D3	R65	A3	U12	A2		
R38	D3	R66	A3	U13	A2		
R39	C3	R56	A2				
R40	A2	R68	A2				
R41	A2	R69	A3				
R42	D2	R70	A3				
R43	D3	R71	A1				
R44	D3	R72	A1				
R45	D2	R73	A1				
R46	D2	R74	D1				
R47	D2	R75	A1				

1A

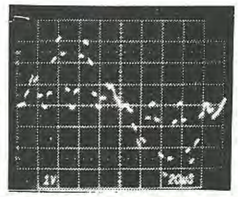
1B



TEST REQUIREMENTS: A. 1 kHz signal input to exciter left channel.
B. Oscilloscope synchronized to pilot frequency

1A DSM sampling waveform at U8 pin 6 with the PILOT ON/OFF switch set to OFF.
1B DSM sampling waveform at U8 pin 6 with the PILOT ON/OFF switch set to ON.

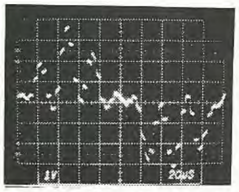
2



TEST REQUIREMENTS: A. 5 kHz signal input to exciter left channel.
B. Oscilloscope adjusted to single sweep storage mode.
C. PILOT ON/OFF switch set to OFF.

2 DSM sampling waveform at U8 pin 6.

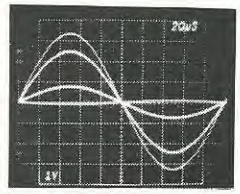
3



TEST REQUIREMENTS: A. 5 kHz signal input to exciter left channel.
B. Oscilloscope adjusted to single sweep storage mode.
C. PILOT ON/OFF switch set to ON.

3 DSM sampling waveform at U8 pin 6.

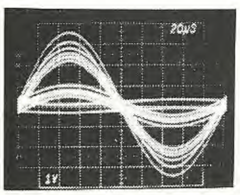
4



TEST REQUIREMENTS: A. 5 kHz signal input to exciter left channel.
B. Oscilloscope synchronized to audio input.
C. PILOT ON/OFF switch set to OFF.

4 DSM sampling waveform at U8 pin 6.

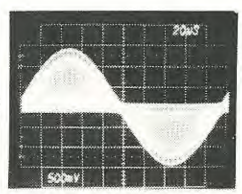
5



TEST REQUIREMENTS: A. 5 kHz signal input to exciter left channel.
B. Oscilloscope synchronized to audio input.
C. PILOT ON/OFF switch set to ON.

5 DSM sampling waveform at U8 pin 6.

6



TEST REQUIREMENTS: A. 5 kHz signal input to exciter left channel.
B. PILOT ON/OFF switch set to ON.

6 DSM stereo generator output at module pin 70.

2164-400-5

Figure 5-2. STEREO ANALOG MODULE Waveforms

WARNING: Disconnect primary power prior to servicing.

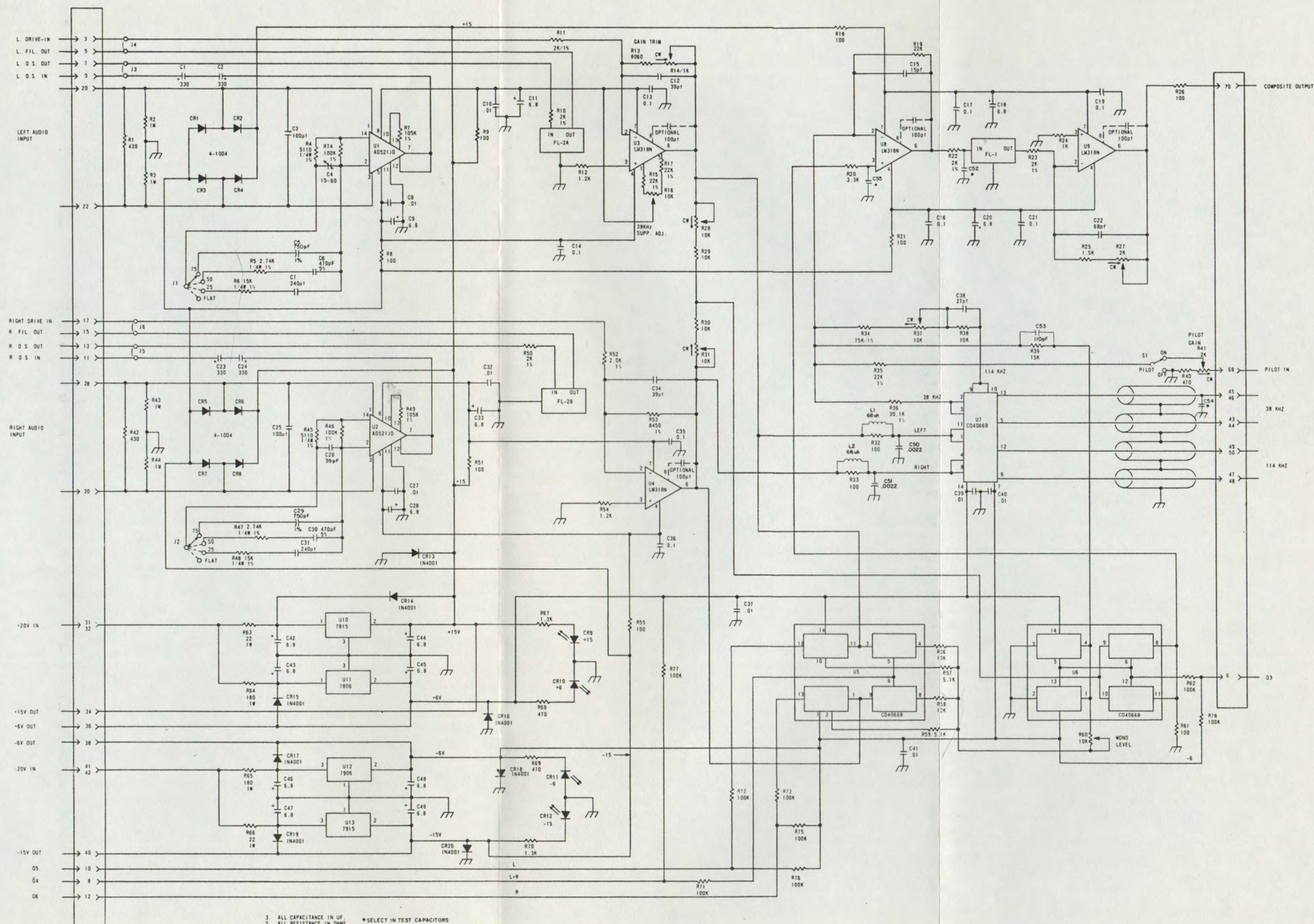
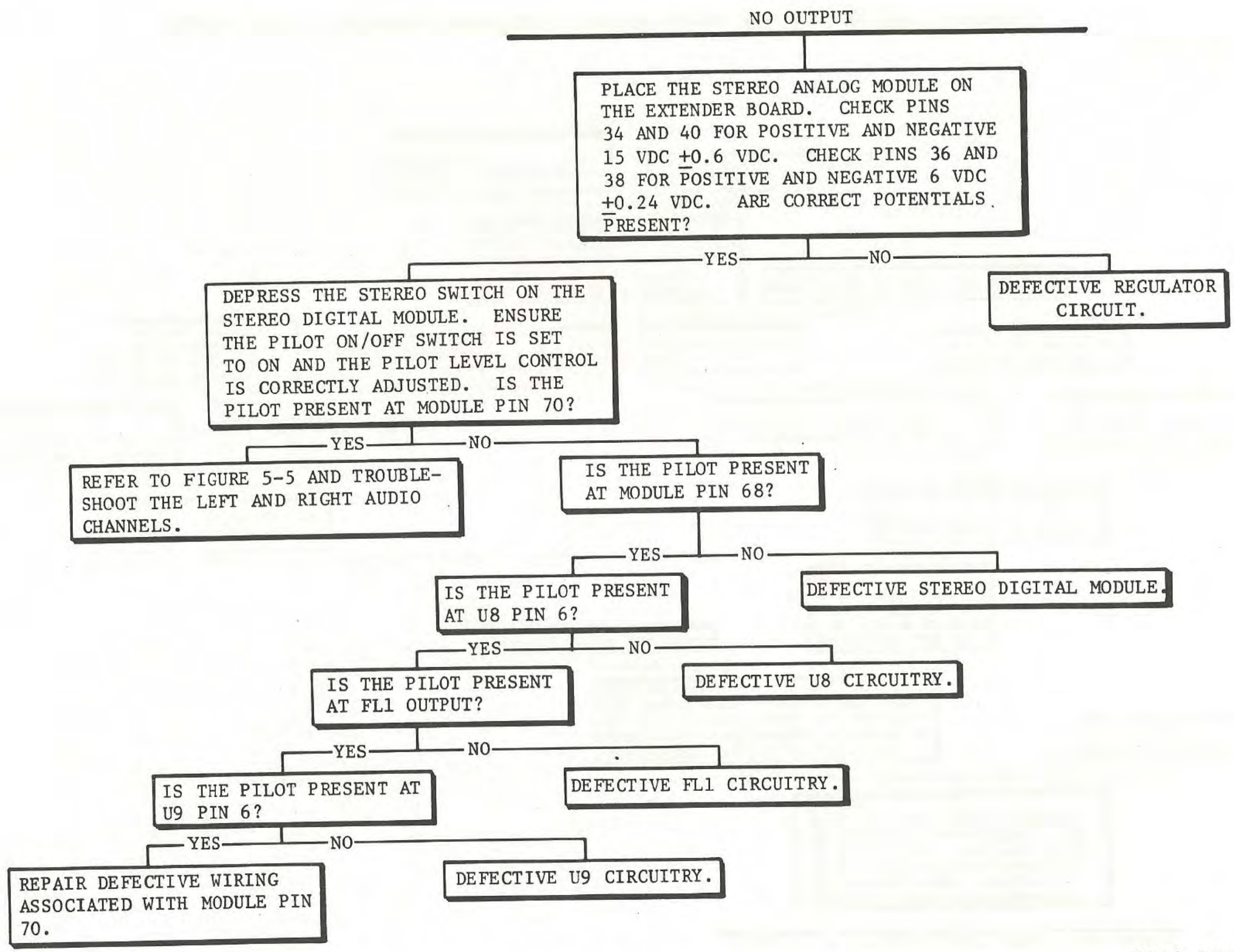


FIGURE 5-3. STEREO ANALOG MODULE SCHEMATIC
852 8408 001-J



2164-400-6

Figure 5-4. No Output

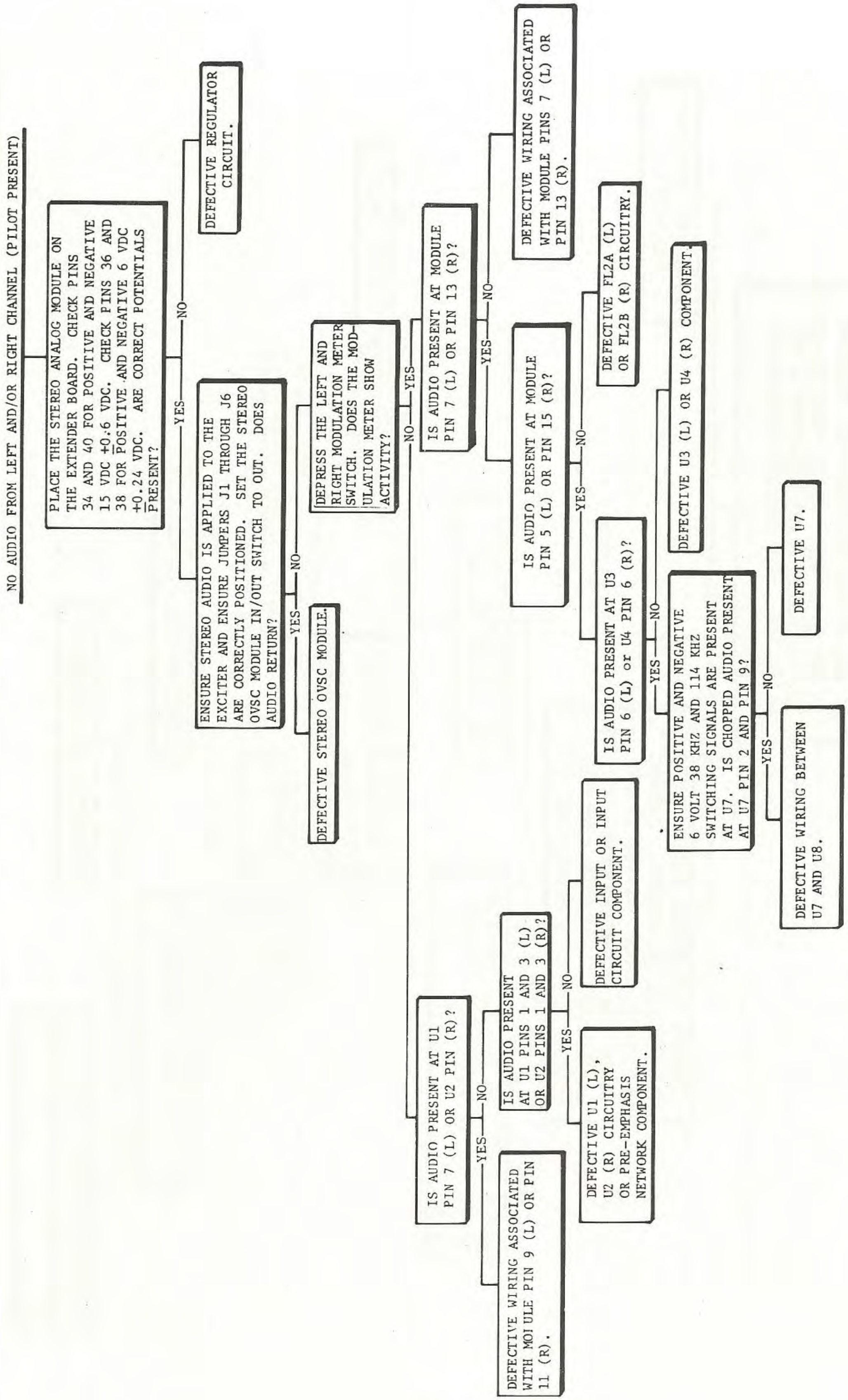


Figure 5-5. No Audio From Left And/Or Right Channel (Pilot Present)

2164-400-7

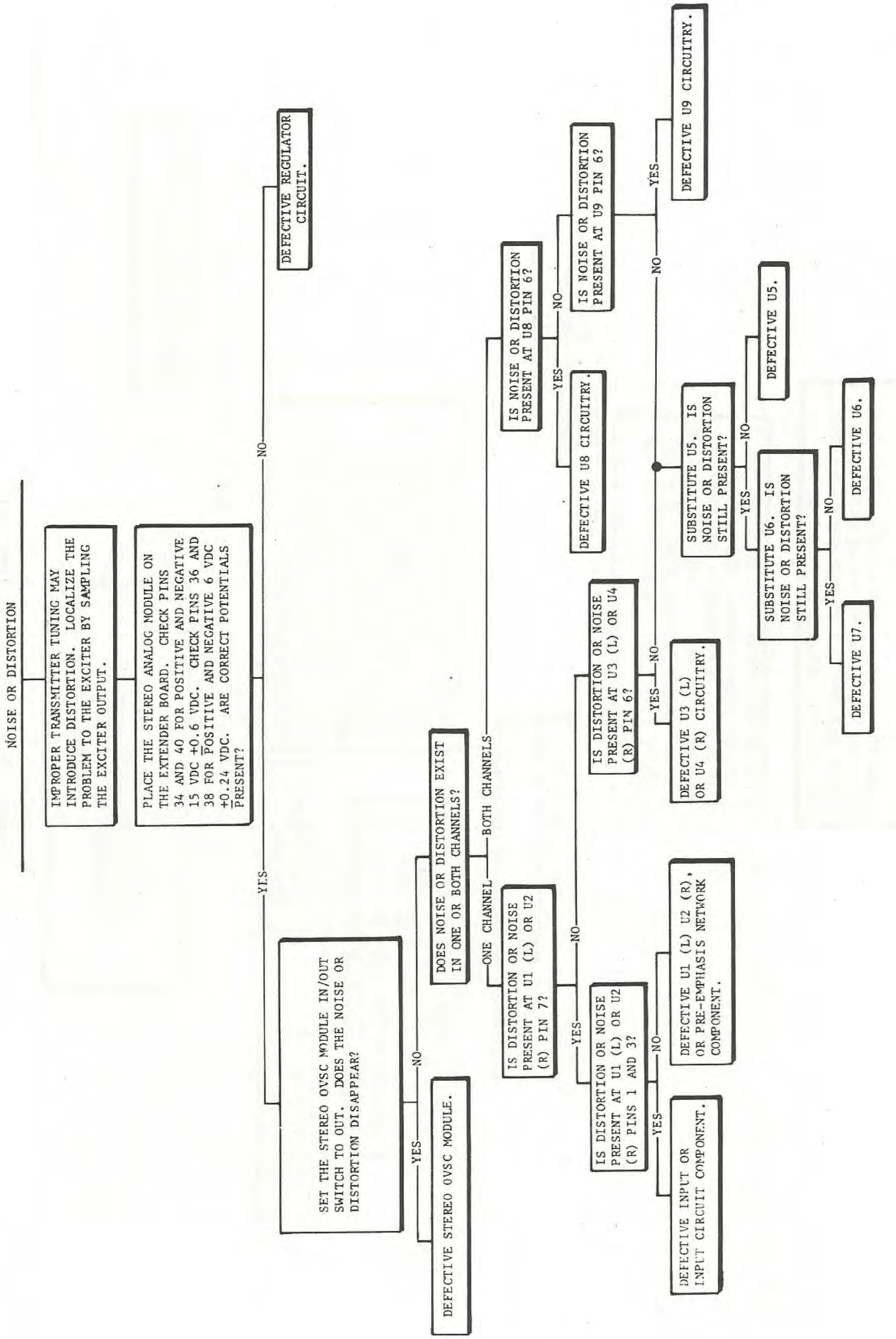


Figure 5-6. Noise or Distortion

WARNING: Disconnect primary power prior to servicing.

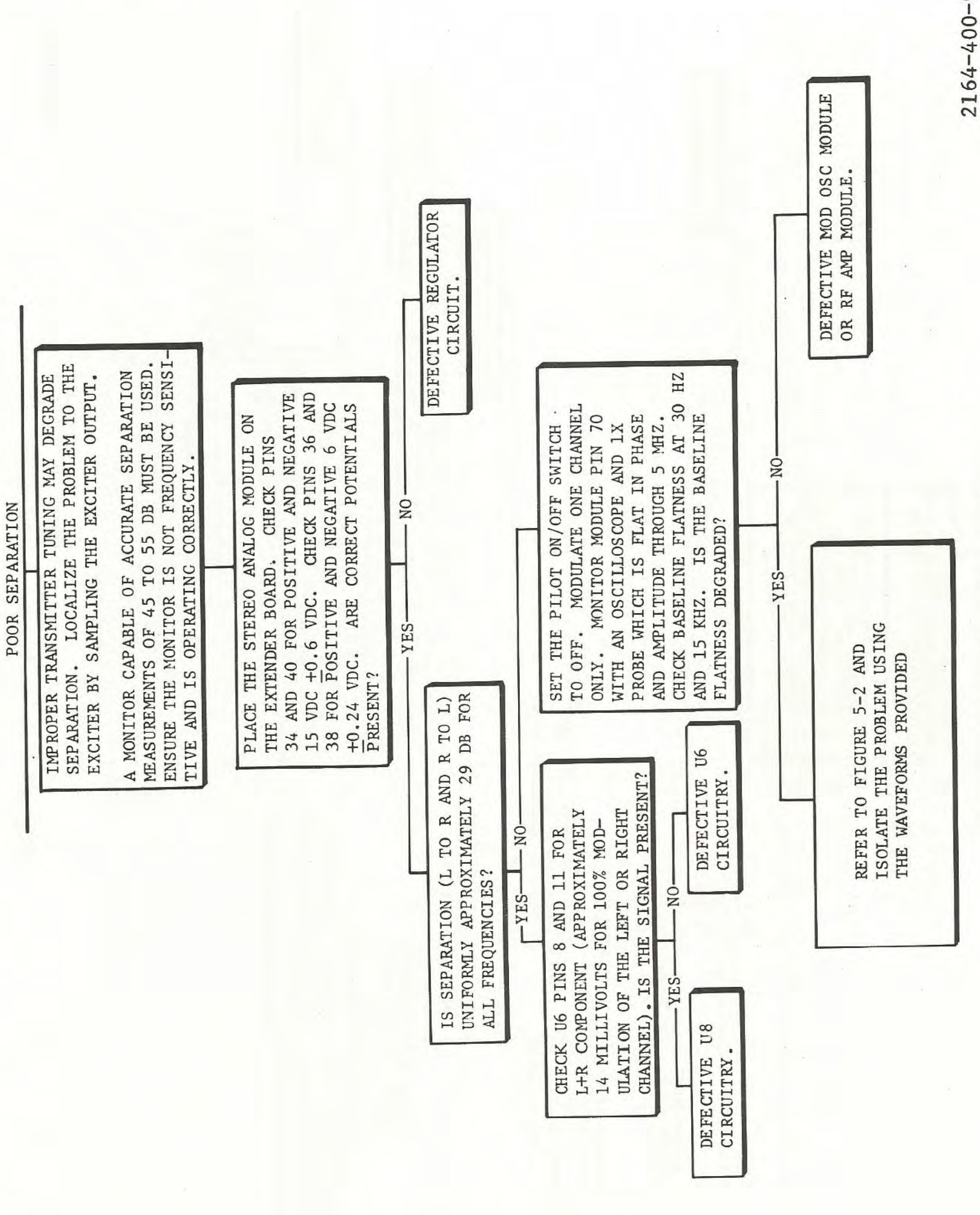
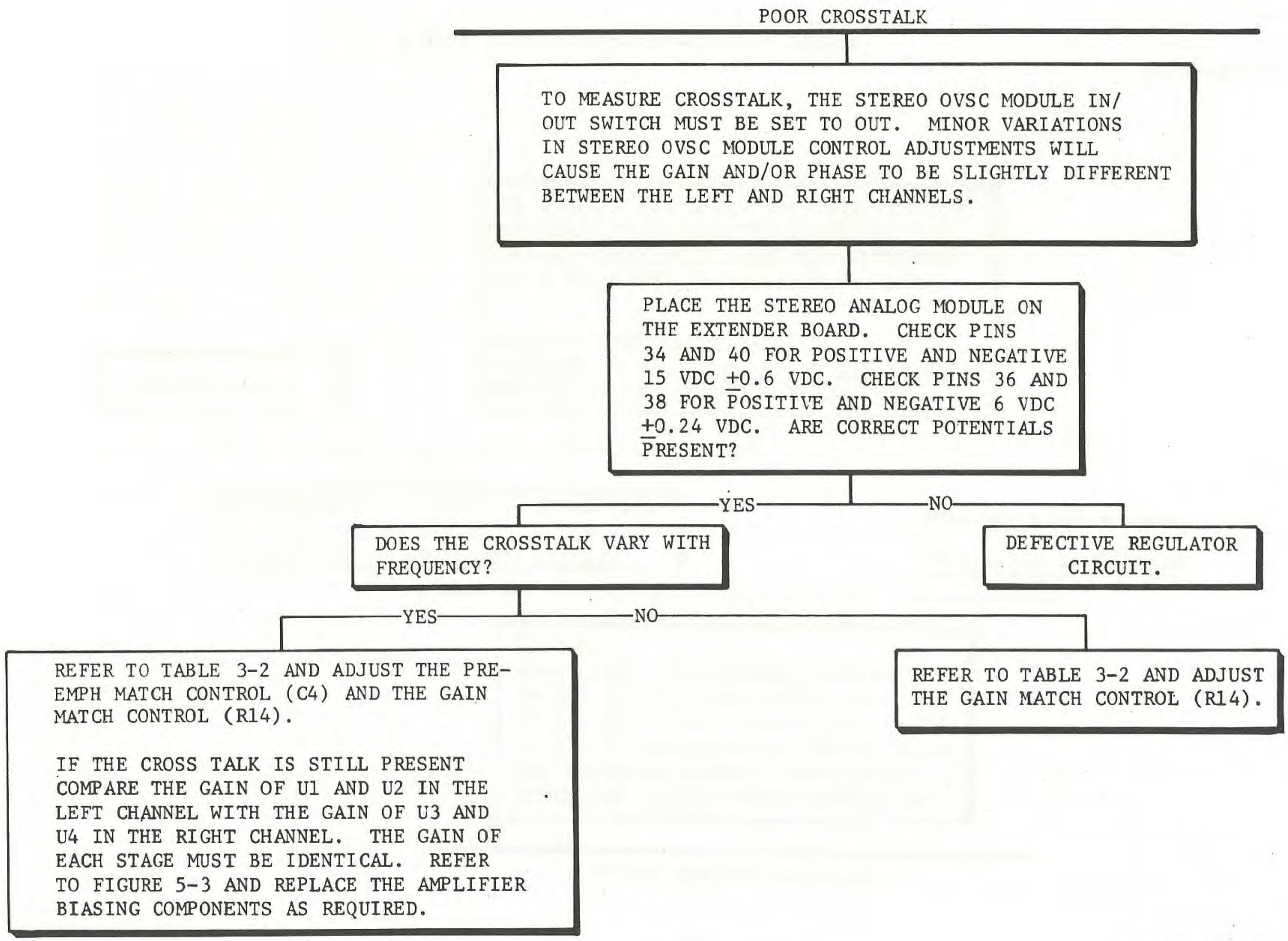


Figure 5-7. Poor Separation



2164-400-10

Figure 5-8. Poor Crosstalk

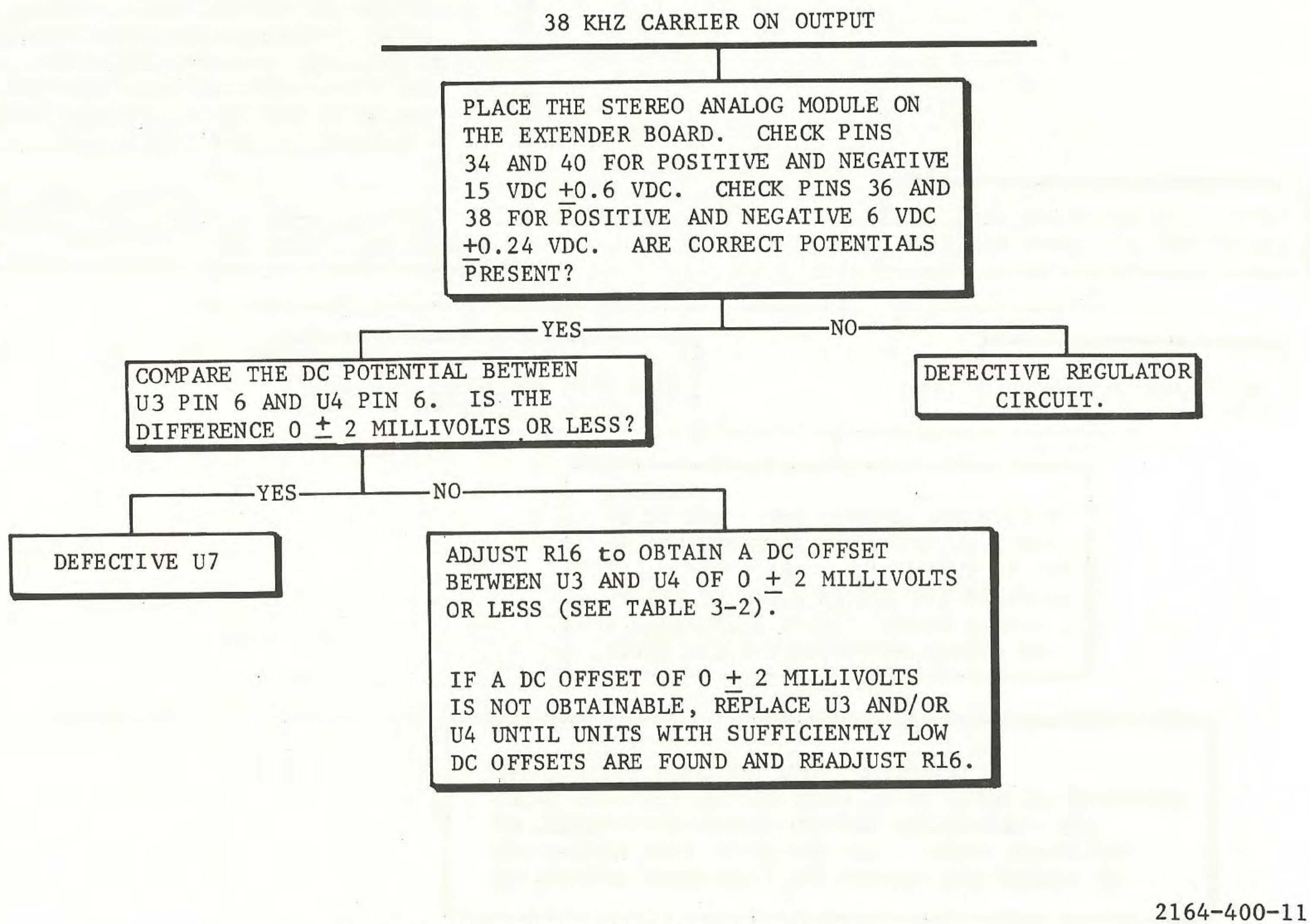


Figure 5-9. 38 kHz Carrier on Output

WARNING: Disconnect primary power prior to servicing.

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. Refer to table 6-2 for replaceable parts which are required for proper maintenance of the MX-15 FM Exciter STEREO ANALOG MODULE. Table entries are indexed by component reference designator.

6-3. REPLACEABLE PARTS SERVICE

6-4. Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

Table 6-1. STEREO ANALOG MODULE Front Panel - 994 7989 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
------	992 4902 001	STEREO ANALOG MODULE Circuit Board (Refer to table 6-2).	1

WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO ANALOG MODULE Circuit Board - 992 4902 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1,CR2,CR3,CR4 CR5,CR6,CR7,CR8	384 0284 000	DIODE 10D4/1N2070	8
CR9,CR10,CR11 CR12	384 0661 000	L.E.D. GREEN	4
CR13,CR14,CR15 CR16,CR17,CR18 CR19,CR20	384 0431 000	RECT. 1N4001	8
C1,C2	526 0045 000	CAP 330UF 6V 10%	2
C3	500 0759 000	CAP, MICA 100PF 500V 5%	1
C4	518 0054 000	CAP, VAR 15-60PF	1
C5	500 1217 000	CAP, MICA 750PF 300V 1%	1
C6	500 0835 000	CAP, MICA 470PF 500V 5%	1
C7	500 0830 000	CAP MICA 240UUF 500V	1
C8	516 0375 000	CAP .01UF 50V	1
C9	526 0049 000	CAP 6.8UF 35V 20%	1
C10	516 0375 000	CAP .01UF 50V	1
C11	526 0049 000	CAP 6.8UF 35V 20%	1
C12	500 0815 000	CAP MICA 39UUF 500V	1
C13,C14	516 0453 000	CAP .1UF 100V 20%	2
C15	500 0806 000	CAP MICA 15UUF 500V	1
C16,C17	516 0453 000	CAP .1UF 100V 20%	2
C18	526 0049 000	CAP 6.8UF 35V 20%	1
C19	516 0453 000	CAP .1UF 100V 20%	1
C20	526 0049 000	CAP 6.8UF 35V 20%	1

Table 6-2. STEREO ANALOG MODULE Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C21	516 0453 000	CAP .1UF 100V 20%	1
C22	500 0821 000	CAP MICA 68UUF 500V	1
C23,C24	526 0045 000	CAP 330UF 6V 10%	2
C25	500 0759 000	CAP, MICA 100PF 500V 5%	1
C26	500 0815 000	CAP MICA 39UUF 500V 5%	1
C27	516 0375 000	CAP .01UF 50V	1
C28	526 0049 000	CAP 6.8UF 35V 20%	1
C29	500 1217 000	CAP, MICA 750PF 300V 1%	1
C30	500 0835 000	CAP, MICA 470PF 500V 5%	1
C31	500 0830 000	CAP MICA 240UUF 500V	1
C32	516 0375 000	CAP .01UF 50V	1
C33	526 0049 000	CAP 6.8UF 35V 20%	1
C34	500 0815 000	CAP MICA 39UUF 500V	1
C35,C36	516 0453 000	CAP .1UF 100V 20%	2
C37	516 0375 000	CAP .01UF 50V	1
C38	500 0811 000	CAP MICA 27UUF 500V	1
C39,C40,C41	516 0375 000	CAP .01UF 50V	3
C42,C43,C44,C45 C46,C47,C48,C49	526 0049 000	CAP 6.8UF 35V 20%	8
C50,C51	506 0234 000	CAP .0022UF 63V 5%	2
C53	500 0825 000	CAP 110PF 500V 5%	1
FL1	484 0260 000	FILTER, DUAL LOWPASS	1
FL2	484 0259 000	FILTER, LOWPASS	1

WARNING: Disconnect primary power prior to servicing.

Table 6-2. STEREO ANALOG MODULE Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
J1,J2,J3,J4,J5 J6	610 0679 000	PLUG, SHORTING	6
L1,L2	494 0406 000	CHOKE RF 68.0UH	2
R1	540 1170 000	RES 1/2W 430 OHM 5%	1
R2,R3	540 1162 000	RES 1/2W 1 MEGOHM 5%	2
R4	548 0394 000	RES 5110 OHM 1/4W 1%	1
R5	548 1389 000	RES 2.74K OHM 1/4W	1
R6	548 0340 000	RES 15K OHM 1/4W 1%	1
R7	548 1370 000	RES 105K OHM 1/4W	1
R8,R9	540 1102 000	RES .5W 100 OHM 5PCT	2
R10,R11	548 0279 000	RES 2000 OHM 1/4W 1%	2
R12	540 1205 000	RES 1/2W 1200 OHM 5%	1
R13	548 1396 000	RES 8.06K OHM 1/4W 1%	1
R14	550 0398 000	POT 1K OHM 1/2W 10%	1
R15	548 0366 000	RES 22.1K OHM 1/4W 1%	1
R16	550 0922 000	POT 10K OHM 1/2W	1
R17	548 0366 000	RES 22.1K OHM 1/4W 1%	1
R18	540 1102 000	RES .5W 100 OHM 5PCT	1
R19	548 0366 000	RES 22.1K OHM 1/4W 1%	1
R20	540 1165 000	RES 1/2W 3300 OHM 5%	1
R21	540 1102 000	RES .5W 100 OHM 5PCT	1
R22,R23	548 0279 000	RES 2000 OHM 1/4W 1%	2
R24	540 1116 000	RES .5W 1000 OHM 5%	1

WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO ANALOG MODULE Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R25	540 1129 000	RES .5W 1500 OHM 5%	1
R26	540 1102 000	RES .5W 100 OHM 5PCT	1
R27	550 0927 000	POT 2K OHM 1/2W	1
R28	550 0922 000	POT 10K OHM 1/2W	1
R29,R30	540 1111 000	RES .5W 10K OHM 5PCT	2
R31	550 0922 000	POT 10K OHM 1/2W	1
R32,R33	540 1102 000	RES .5W 100 OHM 5PCT	2
R34	548 0314 000	RES 75K OHM 1/4W 1%	1
R35	548 0366 000	RES 22.1K OHM 1/4W 1%	1
R36	548 0416 000	RES 30.1K OHM 1/4W 1%	1
R37	550 0922 000	POT 10K OHM 1/2W	1
R38	540 1111 000	RES .5W 10K OHM 5PCT	1
R39	540 1184 000	RES 1/2W 15K OHM 5%	1
R40	540 1115 000	RES .5W 470 OHM 5PCT	1
R41	550 0927 000	POT 2K OHM 1/2W	1
R42	540 1170 000	RES 1/2W 430 OHM 5%	1
R43,R44	540 1162 000	RES 1/2W 1 MEGOHM 5%	2
R45	548 0394 000	RES 5110 OHM 1/4W 1%	1
R46	548 0932 000	RES 100K OHM 1/4W 1%	1
R47	548 1389 000	RES 2.74K OHM 1/4W	1
R48	548 0340 000	RES 15K OHM 1/4W 1%	1
R49	548 1370 000	RES 105K OHM 1/4W	1

WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO ANALOG MODULE Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R50	548 0279 000	RES 2000 OHM 1/4W 1%	1
R51	540 1102 000	RES .5W 100 OHM 5PCT	1
R52	548 0279 000	RES 2000 OHM 1/4W 1%	1
R53	548 1360 000	RES 8450 OHM 1/4W 1%	1
R54	540 1205 000	RES 1/2W 1200 OHM 5%	1
R55	540 1102 000	RES .5W 100 OHM 5PCT	1
R56	540 1111 000	RES .5W 10K OHM 5PCT	1
R57	540 1105 000	RES .5W 5100 OHM 5%	1
R58	540 1111 000	RES .5W 10K OHM 5PCT	1
R59	540 1105 000	RES .5W 5100 OHM 5%	1
R60	550 0922 000	POT 10K OHM 1/2W	1
R61	540 1102 000	RES .5W 100 OHM 5PCT	1
R62	540 1159 000	RES .5W 100K OHM 5%	1
R63	540 0292 000	RES 1W 22 OHM 5PCT	1
R64,R65	540 0314 000	RES 1W 180 OHM 5%	2
R66	540 0292 000	RES 1W 22 OHM 5PCT	1
R67	540 1187 000	RES 1/2W 1300 OHM 5%	1
R68,R69	540 1115 000	RES .5W 470 OHM 5PCT	2
R70	540 1187 000	RES 1/2W 1300 OHM 5%	1
R71,R72,R73	540 1159 000	RES .5W 100K OHM 5%	3
R74	548 0932 000	RES 100K OHM 1/4W 1%	1
R75,R76,R77,R78	540 1159 000	RES .5W 100K OHM 5%	4

WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO ANALOG MODULE Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
S1	604 0859 000	SW, TOGGLE DPDT	1
U1,U2	382 0473 000	CKT, INTEGRATED	2
U3,U4	382 0472 000	IC LM318	2
U5,U6,U7	382 0523 000	IC, CMOS, MC14066BCPDS	3
U8,U9	382 0472 000	IC LM318	2
U10	382 0359 000	IC, 7815	1
U11	382 0471 000	CKT, INTEGRATED	1
U12	382 0470 000	CKT, INTEGRATED	1
U13	382 0360 000	IC, 7915	1
XU1,XU2	404 0674 000	SOCKET, IC 14 CONT	2
XU3,XU4	404 0673 000	SOCKET, IC 8 CONT	2
XU5,XU6,XU7	404 0674 000	SOCKET, IC 14 CONT	3
XU8,XU9	404 0673 000	SOCKET, IC 8 CONT	2
	357 0033 000	SCR 4-40 X .375 BHMS	2
	404 0513 000	HEAT SINK PA1-1CB	2
	410 0344 000	INSULATOR, KAPTON	4
	612 0901 000	JACK, PC MT	2

WARNING: Disconnect primary power prior to servicing

STEREO OVSC MODULE
888-2164-501

TECHNICAL MANUAL

STEREO OVSC MODULE

994 7991 001

HARRIS

T.M. No. 888-2164-501

Printed: Aug. 8, 1986

MANUAL REVISION HISTORY
STEREO OVSC MODULE
888-2164-5xx

REV. #	DATE	ECN	PAGES AFFECTED
001	08-08-86	30519	Replaced the following pages: Title Page, i, ii, 16, 21/22, 31 & 32 Added the Manual Revision History Page

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

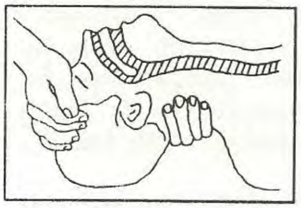
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

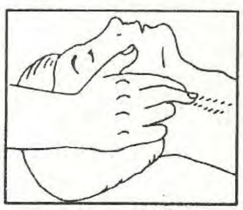
(A) AIRWAY

IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

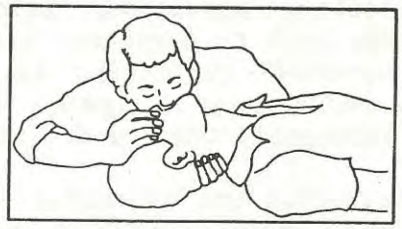
CHECK
CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

(B) BREATHING

IF NOT BREATHING,
BEGIN ARTIFICIAL BREATHING



TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

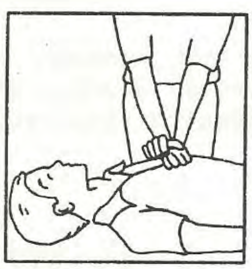
REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES

APPROX. RATE OF COMPRESSIONS --80 PER MINUTE: ONE RESCUER, 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE: TWO RESCUERS, 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

NOTE

> If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

LIST OF ILLUSTRATIONS

WARNING: Disconnect primary power prior to servicing.

SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE

1-2. The STEREO OVSC MODULE provides a special filtering process which operates independently of limiters or sterophonic generators to limit the overshoot on FM sterophonic or future quadraphonic transmission to two percent maximum on any input program material processed by any limiter. Typically, a two to six dB increase in loudness can be achieved due to elimination of overshoot with no other audible effect, which allows high signal levels to be maintained without degrading signal quality. Low-pass filters prevent audio interference with the 19 kHz pilot signal and eliminate interference between the L+R signals. The filters are transparent to audio within $\pm$ 0.5 dB of the passband of 30 Hz to 15 kHz and provide 60 dB of attenuation at 19 kHz and above. Indicators on the module front panel and outputs to the AC meter module aid in level setup and provide overshoot limiting indications during operation.

1-3. TECHNICAL CHARACTERISTICS

1-4. Table 1-1 lists operating characteristics and parameters of the MX-15 FM Exciter STEREO OVSC MODULE.

SECTION II

INSTALLATION

2-1. GENERAL

2-2. Refer to MX-15 FM Exciter System Technical Manual, Section II, Installation.

SECTION III

CONTROLS AND INDICATORS

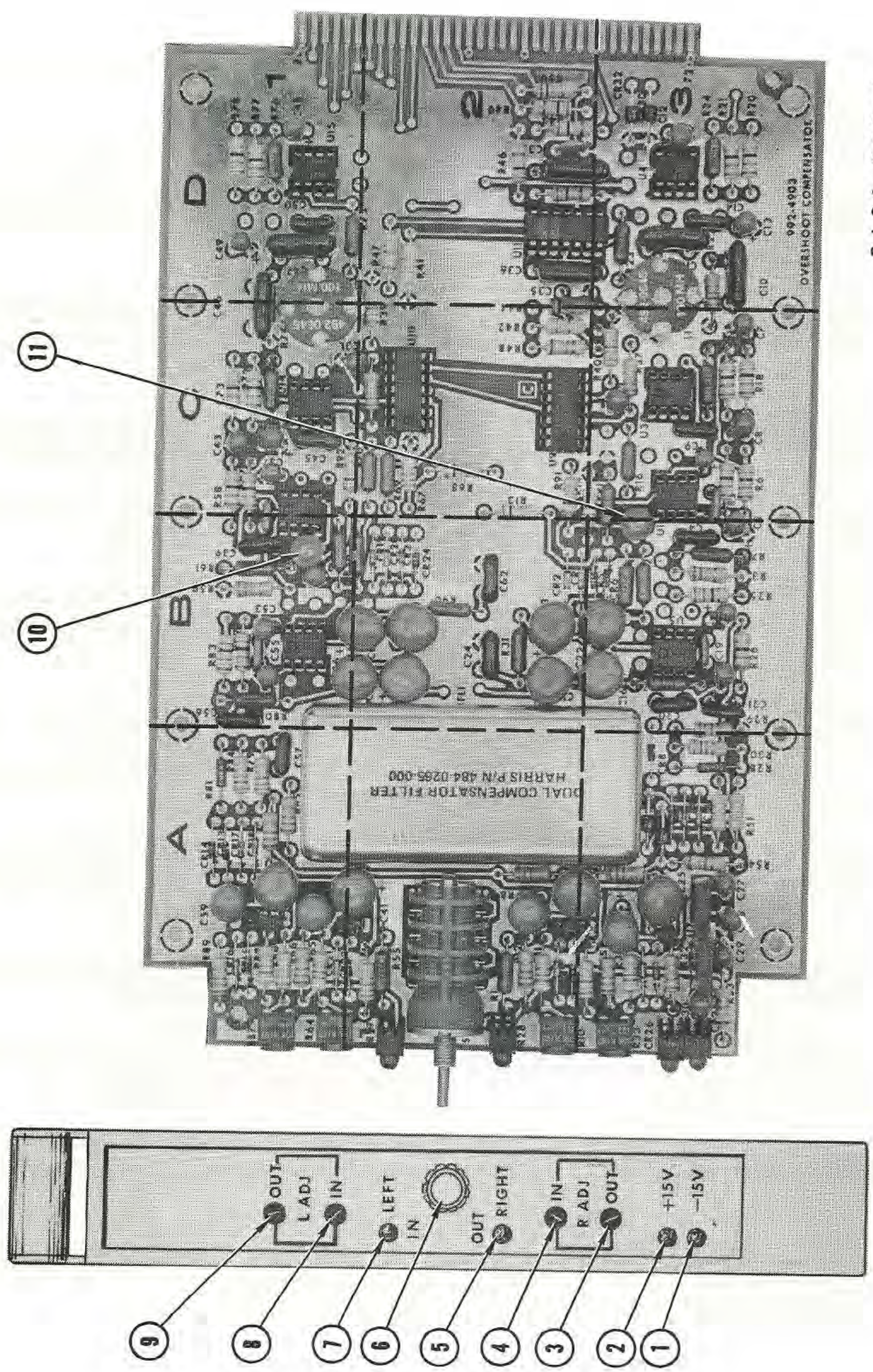
3-1. GENERAL

3-2. Figure 3-1 shows the location of each control or indicator associated with the MX-15 FM Exciter STEREO OVSC MODULE and table 3-1 lists the controls and indicators with a description of each item listed. Control setup adjustments are listed in table 3-2.

WARNING: Disconnect primary power prior to servicing.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
POWER:	+20 Vdc @ 0.100 amperes. -20 Vdc @ 0.120 amperes.
SIGNAL:	
LEFT AND RIGHT CHANNEL AUDIO	Pre-emphasized 1.41 Volts Peak for 100% modulation.
OUTPUTS	
OVERSHOOT COMPENSATION (METERING)	5.36 Volts Peak indicates 100% overshoot.
LEFT AND RIGHT CHANNEL OVERSHOOT COMPENSATED AUDIO	DTR low-pass filtered 0.707 Volts Peak for 100% modulation.



2164-500-1

Figure 3-1. STEREO OVSC MODULE

WARNING: Disconnect primary power prior to servicing.

Table 3-1. STEREO OVSC MODULE Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	-15V Indicator (CR25)	Illuminates to indicate the STEREO OVSC module -15 volt regulator is operational.
2	+15V Indicator (CR26)	Illuminates to indicate the STEREO OVSC module +15 volt regulator is operational.
3	R ADJ OUT Control (R33)	Adjusts the right channel output threshold from the STEREO OVSC MODULE.
4	R ADJ IN Control (R10)	Adjusts the right channel input threshold to the STEREO OVSC MODULE.
5	RIGHT Indicator (CR28)	Indicates operation of the right channel overshoot control circuitry when illuminated.
6	IN/OUT Switch (S1)	IN position: Enables operation of the DTR filter. OUT position: Enables the conventional low-pass filter.
7	LEFT Indicator (CR27)	Indicates operation of the left channel overshoot control circuitry when illuminated.
8	L ADJ IN Control (R64)	Adjusts the left channel input threshold to the STEREO OVSC MODULE.
9	L ADJ OUT Control (R87)	Adjusts the left channel output threshold from the STEREO OVSC MODULE.
10	Left Channel Preamplifier Offset Adjust (R94)	Adjusts DC voltage offset of left channel preamplifier.
11	Right Channel Preamplifier Offset Adjust (R93)	Adjusts DC voltage offset of right channel preamplifier.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments

CONTROL	ADJUSTMENT
L ADJ OUT Control (R87) L ADJ IN Control (R64) R ADJ OUT Control (R33) R ADJ IN Control (R10)	Adjustment of the DTR filter consists of setting internal compensation thresholds to a level corresponding to 100% total modulation as follows: 1. Set the STEREO OVSC MODULE IN/-OUT switch to IN. 2. Adjust all four STEREO OVSC MODULE front panel controls to the maximum clockwise position. These controls are four turn potentiometers without stops at the end of their range. 3. Depress the STEREO DIGITAL module STEREO switch. The STEREO indicator will illuminate. 4. Depress the SCA 1 and SCA 2 module(s) OFF switch(es). Each SCA module OFF indicator will illumminate. 5. Disconnect the left and right stereo inputs from the LEFT FRONT (+) and (-) and RIGHT FRONT (+) and (-) connections on the rear of the exciter (TB1 terminals 1 and 3, 4 and 6). 6. Apply a 400 Hz sinusoidal signal at +10 dBm into the left channel only at TB1 terminals 1 and 3. 7. Depress the B BAND MODULATION meter switch. 8. Adjust the sinusoidal signal level until the MODULATION meter indicates 97% total modulation.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	9. Depress the LEFT MODULATION meter switch. The MODULATION meter will indicate 100%. The apparent 3% discrepancy is due to the normal phase relationships between the pilot and the 38 kHz DSB signal.
	10. Adjust the STEREO OVSC MODULE L ADJ OUT control counterclockwise until the LEFT indicator illuminates. Adjust the control clockwise until the indicator just goes out.
	11. Adjust the STEREO OVSC MODULE L ADJ IN control counterclockwise until the indicator just goes out.
	12. Disconnect the 400 Hz sinusoidal signal from the left channel.
	13. Apply the 400 Hz sinusoidal signal at +10 dBm into the right channel only at TB1, terminals 4 and 6.
	14. Depress the B BAND MODULATION meter switch.
	15. Adjust the sinusoidal signal until the MODULATION METER indicates 97% total modulation.
	16. Depress the RIGHT MODULATION meter switch. The MODULATION meter will indicate 100%. The apparent 3% discrepancy is due to the normal phase relationships between the pilot and the 38 kHz DSB signal.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	17. Adjust the STEREO OVSC MODULE R ADJ OUT control counter-clockwise until the RIGHT indicator illuminates. Adjust the control clockwise until the indicator just goes out.
	18. Adjust the STEREO OVSC MODULE R ADJ IN control counterclockwise until the RIGHT indicator illuminates. Adjust the control clockwise until the indicator just goes out.
	19. Disconnect the 400 Hz sinusoidal signal from the right channel input and reconnect the audio inputs to the left and right channels.
Left Channel Preamplifier Offset Adjust (R94) Right Channel Preamplifier Offset Adjust (R93)	1. Remove the module from the exciter and remove the side cover. 2. Mount the module in the exciter using the extender board provided with the exciter. 3. Connect a DC millivoltmeter to pin 6 of U12 in the left channel or U1 in the right channel. 4. Adjust R94 in the left channel or R93 in the right channel to obtain a DC indication of 0 Vdc ± 0.01 Vdc. 5. Disconnect the millivoltmeter from the module, remove the extender board, replace the module side cover, and replace the module in the exciter.

WARNING: Disconnect primary power prior to servicing.

SECTION IV

PRINCIPLES OF OPERATION

4-1. CIRCUIT DESCRIPTION

4-2. GENERAL INFORMATION

4-3. The STEREO OVSC (overshoot compensator) module provides 15 kHz low-pass filtering of the left and right channel audio signals prior to modulation of the carrier to prevent interference with the 19 kHz pilot and to eliminate interference between the L+R and L-R signals. Low-pass filtering allows high dynamic separation and eliminates the raspy noises characteristic of harmonic interference between L+R and L-R.

4-4. Overshoot is usually caused by the effect of low-pass filtering the audio to remove signals above 15 kHz. A conventional low-pass filter changes two independent characteristics of the input signal. In addition to changing the amplitude response versus frequency, the filter also changes the phase relationships among different frequencies within the filter passband.

4-5. Although the pre-emphasized output of most FM limiters is accurately amplitude-limited, this is not necessarily true after the limiter output has been low-pass filtered. The filter output may ring and overshoot above 100% modulation even though the input is constrained to 100%. The overshoot is due to (1) elimination of harmonics which serve to reduce peak amplitude, and (2) non-uniform time delay (nonlinear phase) which rearranges signal components in time such that new peaks result. The MX-15 FM Exciter Dynamic Transient Response (DTR) filter low-pass filters the limiter output with no more than two percent overshoot, allowing high modulation levels to be maintained with no loss of audio quality.

4-6. MODULE SET UP

4-7. The audio signal input to the exciter should be processed by an FM type peak limiter, that is, a limiter with pre-emphasis protection. Use of an AM limiter or no limiter at all after pre-emphasis will result in the input signals exceeding certain module internal overshoot sensing thresholds. If normal audio exceeds these thresholds, the module will assume the signal to be overshoot and limiting and distortion will result. If the audio input is correctly limited, only overshoots will exceed the internal thresholds producing limiting which will not result in distortion. Refer to "A New Filtering Process for Optimal Overshoot Control" in Appendix A.

4-8. Because the DTR filter presupposes that the input audio signal has been properly amplitude limited to exactly 100% modulation, it is important to ensure that audio levels from the limiter to the exciter are exact. This is considerably more important with the MX-15 FM Exciter than with conventional exciters. If the limiter output is applied to the exciter at 80% modulation, the DTR filter will eliminate overshoots above 100% but will allow overshoots to extend from 80% to 100% modulation. In this case the

WARNING: Disconnect primary power prior to servicing.

modulation meter will show that 100% modulation is being maintained when in fact it is only overshoots that are reaching 100% with program material peaks remaining at 80% modulation. On the other hand, if the limiter is driving the exciter at a level corresponding to 120% modulation, the DTR filter thresholds will assume that normal program peaks are overshoots, and severe distortion will result. For optimum loudness with no degradation of audio quality, the output from the limiter to the exciter audio inputs should be maintained at exactly 100%.

4-9. When the DTR filter is in use, special care must be observed so that the exciter audio inputs are not even slightly overdriven. This may be checked by depressing the LEFT and RIGHT MODULATION switches and noting the level indicated by the MODULATION meter. The output of the FM limiter should be adjusted to the 100% level on the MODULATION meter.

4-10. Due to the unconventional DTR technique, if it is desired to increase modulation, the output level of the FM limiter should not be increased. The STEREO OVSC MODULE will assume the increase is overshoot and limit the signal accordingly. This will result in distortion but no increase in modulation. To increase modulation, the STEREO ANALOG module COMP LEVEL control should be adjusted.

4-11. Normally the STEREO OVSC MODULE and the STEREO ANALOG module will be used together in which case the STEREO ANALOG module low-pass filters are used in the DTR filtering process. The STEREO OVSC MODULE IN/OUT switch is provided to bypass the overshoot control circuits and provide conventional low-pass filtering if desired.

4-12. Some FM limiters contain low-pass filters and/or notch filters at their outputs. When such a limiter is used with the FM exciter there is not only a duplication of circuitry, but the filters in the limiter will overshoot, making the limiter less effective. For maximum modulation without filter overshoot, the internal low-pass filters of these FM limiters should be disabled. In most cases this will be a simple reversible operation.

4-13. The DTR filter must be disabled to measure crosstalk as the gain and phase of the filter is not exactly the same between channels. The difference in gain and phase will affect crosstalk, but not separation. Reasonable crosstalk measurements will be obtained using the DTR filter. However, stated performance will be guaranteed ony in the conventional filter mode with the IN/OUT switch set to OUT.

4-14. Since some FM limiters have finite attack times and/or non-uniform limiting characteristics, it is preferable to set up limiter levels with actual programming rather than with test tones. Steady-state test tones do not take into account attack times. Nor do they check limiting level at any more than one frequency at a time. Therefore, it is advisable to select musical programming with a wide spectral distribution as a test signal. With programming applied to the limiters at a level sufficiently high such that they are in limiting, simply adjust the left and right audio output levels of the limiters such that the LEFT and RIGHT meter positions on the exciter indicate 100% modulation on peaks.

4-15. SIMPLIFIED DESCRIPTION

4-16. The DTR filter comprises two low-pass filters, an all-pass filter, an input threshold clipper, and an output level clipper. A block diagram is provided in figure 4-1.

4-17. The first filter has a cutoff frequency of 15 kHz. The second filter has a cutoff frequency of 17.5 kHz and is preceeded by an all-pass filter which linearizes the signal phase from DC to the cutoff frequency of the first filter (15 kHz). The combination of the all-pass filter and the second low-pass filter presents a uniform time delay of approximately 100 microseconds between DC and 15 kHz. Since the passband of the first filter is contained within the linear phase passband of the second filter, the second filter changes neither the phase nor amplitude relationships of the first output but adds only time delay.

4-18. If the first low-pass filter overshoots, the second low-pass filter will overshoot 100 microseconds later. The inverse is also true: if the first filter does not overshoot, the second filter will not overshoot. The overshoot is controlled by the threshold clipper which passes only peaks which exceed 100% modulation (overshoots). The operation of a threshold clipper is the inverse of a conventional clipper. As a conventional clipper prevents the signal amplitude from exceeding a certain level, a threshold clipper will not pass a signal unless the signal amplitude exceeds a certain level. Then, only the portion of the signal which exceeds the threshold will be output and therefore may be used to separate overshoots from the signal level. In the MX-15 FM Exciter, overshoots from the threshold clipper are algebraically subtracted from the 15 kHz filter output in a sum amplifier to effectively cancel overshoots applied to the all-pass filter.

4-19. The output of the all-pass filter loops out of the STEREO OVSC MODULE through the STEREO ANALOG module 17.5 kHz low-pass filters and back to the STEREO OVSC MODULE. Due to several approximations in the filtering process, the second filter will occasionally overshoot a few percent, however clipping the remaining overshoots will produce negligible harmonic components. The filtered audio is routed through the output clipper which passes levels corresponding to modulation levels of less than 100% only. The filtered overshoot compensated audio is then output to the STEREO ANALOG module.

4-20. Comparators across the clipping diodes sense whenever overshoot correction occurs. The comparator outputs are wire-OR'ed and drive a one shot timer which illuminates the LEFT or RIGHT LEDs to provide a visual indication of overshoot correction.

4-21. DETAILED DESCRIPTION

4-22. As the operation of the left and right channels is identical, only the left channel will be referenced in the detailed description. Refer to the detailed block diagram (figure 4-2) and the schematic diagram (figure 5-3) for the following discussion.

4-23. INPUT CIRCUIT. Audio is input from the STEREO ANALOG module through contacts of the STEREO OVSC MODULE IN/OUT switch (S1). The switch bypasses the overshoot control circuitry and provides conventional low-pass filtering if desired. The audio is fed through a 15 kHz low-pass filter (FL-1B) and drives audio preamplifier (U12). Control R94 provides a preamplifier DC offset adjustment.

4-24. THRESHOLD CLIPPER. The output of preamplifier U12 is applied to a threshold clipper containing an active programming zener diode (U2). The L ADJ IN control (R64) adjusts the zener voltage to the peak voltage level corresponding to 100% modulation minus the voltage drops across temperature compensating diodes CR21 and CR22 so that the threshold clipper will pass only overshoots. The overshoots are output from the junction of diodes CR23 and CR24 to the AC meter circuits and the inverting input of sum amplifier U14. Audio from the low-pass filter (FL-1B) is summed with the audio overshoots from the threshold clipper at the input to amplifier U14. Because U12 inverts the signal, the overshoots are also inverted and are therefore subtracted from the filter output by summing amplifier U14.

4-25. ALL-PASS/LOW-PASS FILTERS. Audio from summer U14 is applied to all-pass filter U15. The all-pass filter (phase equalizer) is flat in frequency response but produces a phase shift dependent upon frequency. The signal is looped out of the STEREO OVSC MODULE, through 17.5 kHz low-pass filter FL-2A in the STEREO Analog module, and back to the STEREO OVSC MODULE. The overall response of the all-pass and low-pass filter characteristics combine to yield a linear phase low-pass characteristic.

4-26. CLIPPER. The output of the 17.5 kHz filter drives amplifier U16 and a threshold clipper which contains an active programmable zener diode (U17). The L ADJ OUT control (R87) adjusts the zener voltage to the peak voltage level corresponding to 100% modulation minus the voltage drop across temperature compensating diodes CR15 and CR16. Because the threshold clipper is in the feed back path of U16, all overshoots exceeding 100% modulation will be clipped. The clipper output level is established by resistor R31, capacitor C24, and a terminating resistance in the STEREO ANALOG module input circuit.

4-27. INDICATORS. Overshoots from each threshold clipper are output to the peak reading meter circuits. The meter provides a visual indication of the amount of filter overshoot which is being corrected within the entire module.

4-28. The LEFT and RIGHT light emitting diodes indicate how often overshoot control is occurring in each channel. Quad comparator U10 monitors the voltage across clipping diodes CR23, CR24, CR13 and CR14 in the left channel. Whenever any of these diodes conduct, the associated comparator turns on and allows dual timer U11 to begin a short (11 millisecond) timing cycle which illuminates CR27 for a sufficiently long time to provide a visual indication of overshoot control. Test points are provided at both outputs from the dual timer to check the indicator drive.

WARNING: Disconnect primary power prior to servicing.

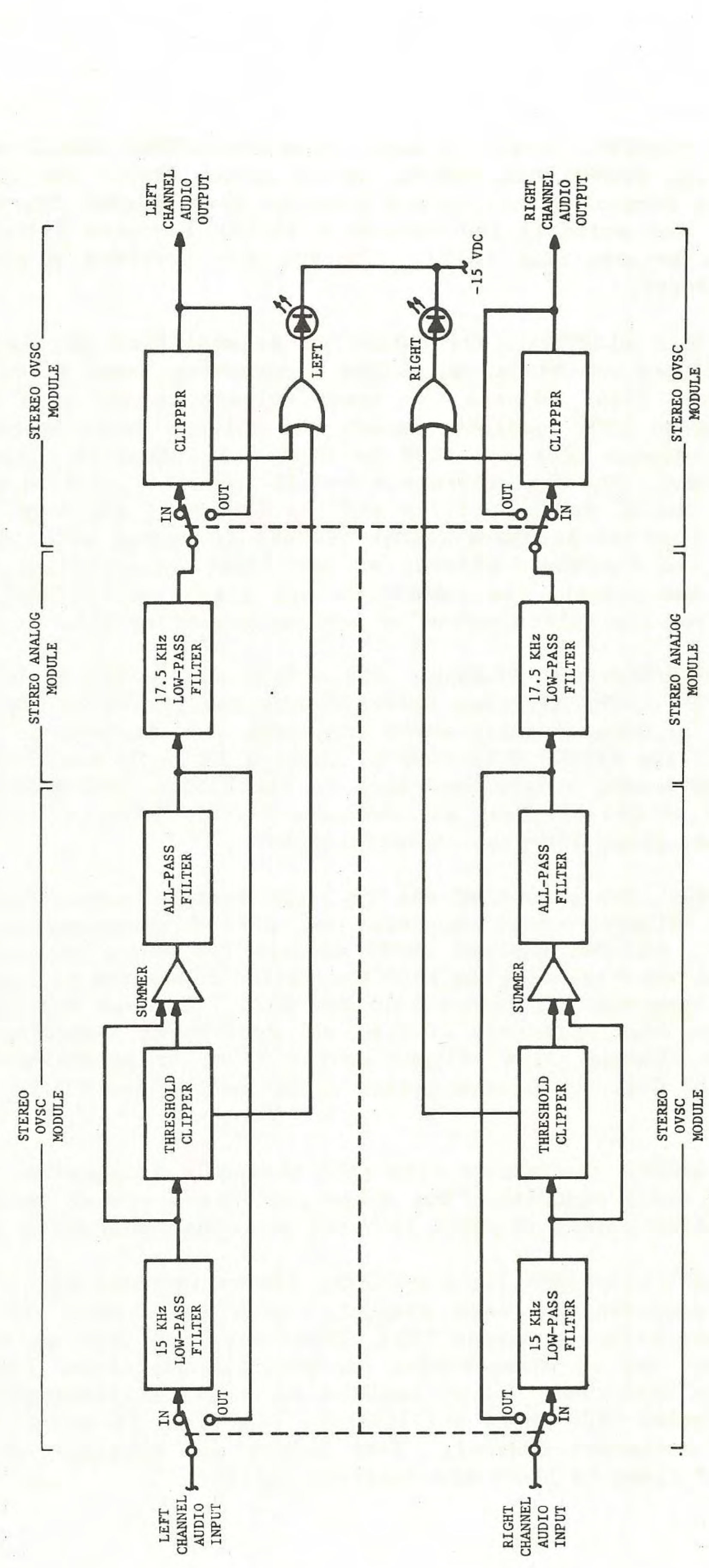


Figure 4-1. STEREO OVSC MODULE Simplified Block Diagram

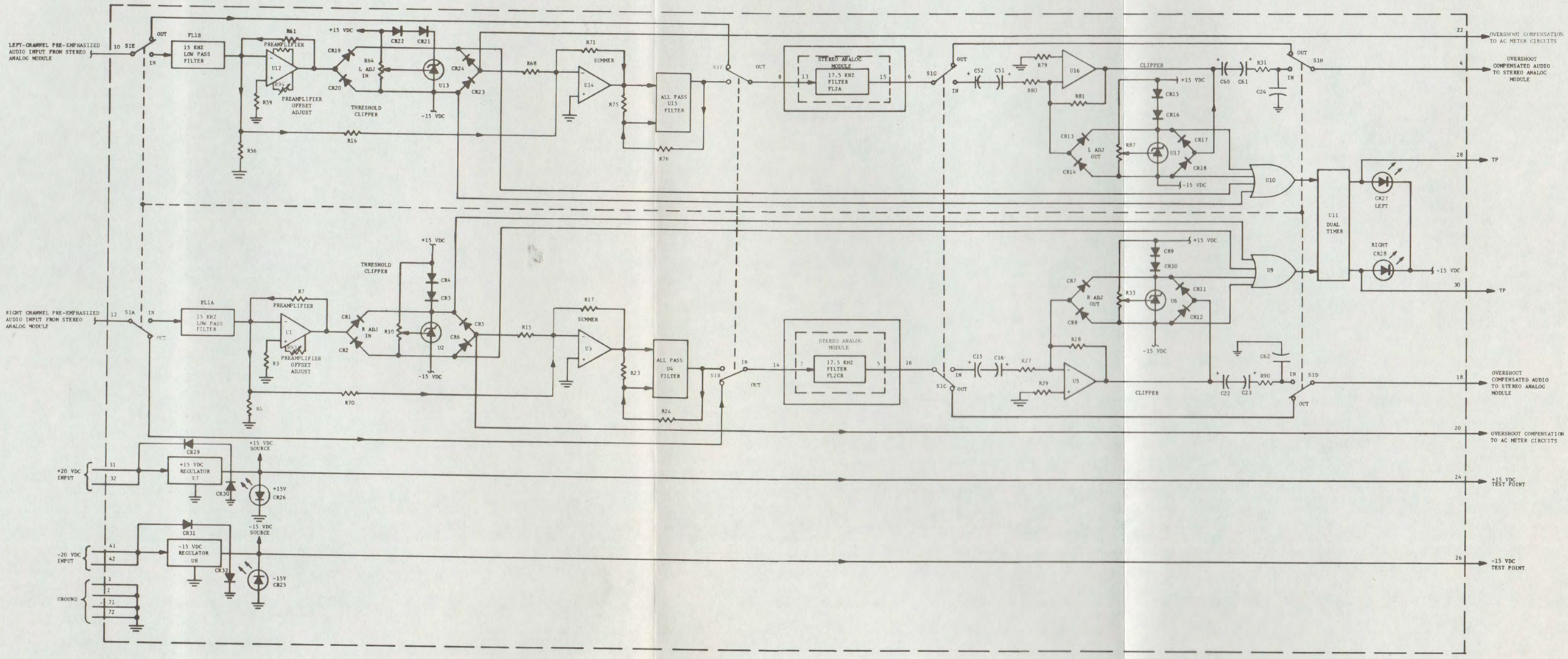


FIGURE 4-2. STEREO OVSC MODULE DETAILED BLOCK DIAGRAM

4-29. POWER. Regulated positive 20 Vdc is input to the module on pins 31 and 32 and regulated negative 20 Vdc is input to the module on pins 41 and 42. The 20 Vdc inputs are re-regulated into ±15 Vdc sources by U7 and U8 as required to operate the module internal circuitry. Diodes CR29, CR30, CR31, and CR32 provide reverse current protection for each regulator and subsequent circuits. The +15V indicator (CR26) and the -15V indicator (CR25) monitor the regulated outputs and pins 24 and 26 are connected as convenient test points to assist in checking the regulator output voltage.

SECTION V

MAINTENANCE

5-1. CORRECTIVE MAINTENANCE

5-2. The MX-15 FM exciter module maintenance philosophy consists of problem isolation to a specific area or individual component and subsequent isolation and replacement of the defective component.

5-3. TROUBLESHOOTING

5-4. In event of problems, the trouble area must first be isolated to a specific area. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, fuse F1, circuit breaker CB1, and the indicators on each module should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs which indicate the module power supply status. A single dark LED would indicate a problem associated with an individual module monolithic voltage regulator. A consistent pattern of dark LEDs however, would indicate an exciter DC distribution bus fault.

5-5. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-1 lists typical trouble symptoms pertaining to the individual module operation with references to fault isolation diagrams listing probable causes and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem. It only tends to lead the repairman into the area that may be causing the trouble. An extender board (HARRIS PN 992-4989-001) is provided with the exciter to assist in troubleshooting. In event parts are required, refer to Section VI, Parts List. The following information is contained in this section as an aid to maintenance:

REFERENCE	TITLE	NUMBER
Figure 5-1	STEREO OVSC MODULE Parts Layout	------
Table 5-2	STEREO OVSC MODULE Parts Index	------
Figure 5-2	STEREO OVSC MODULE Waveforms	------
Figure 5-3	STEREO OVSC MODULE Schematic	852-8395-001

WARNING: Disconnect primary power prior to servicing.

5-6. Prior to starting a troubleshooting procedure check all switches, power cord connections, connecting cables, and power fuses.

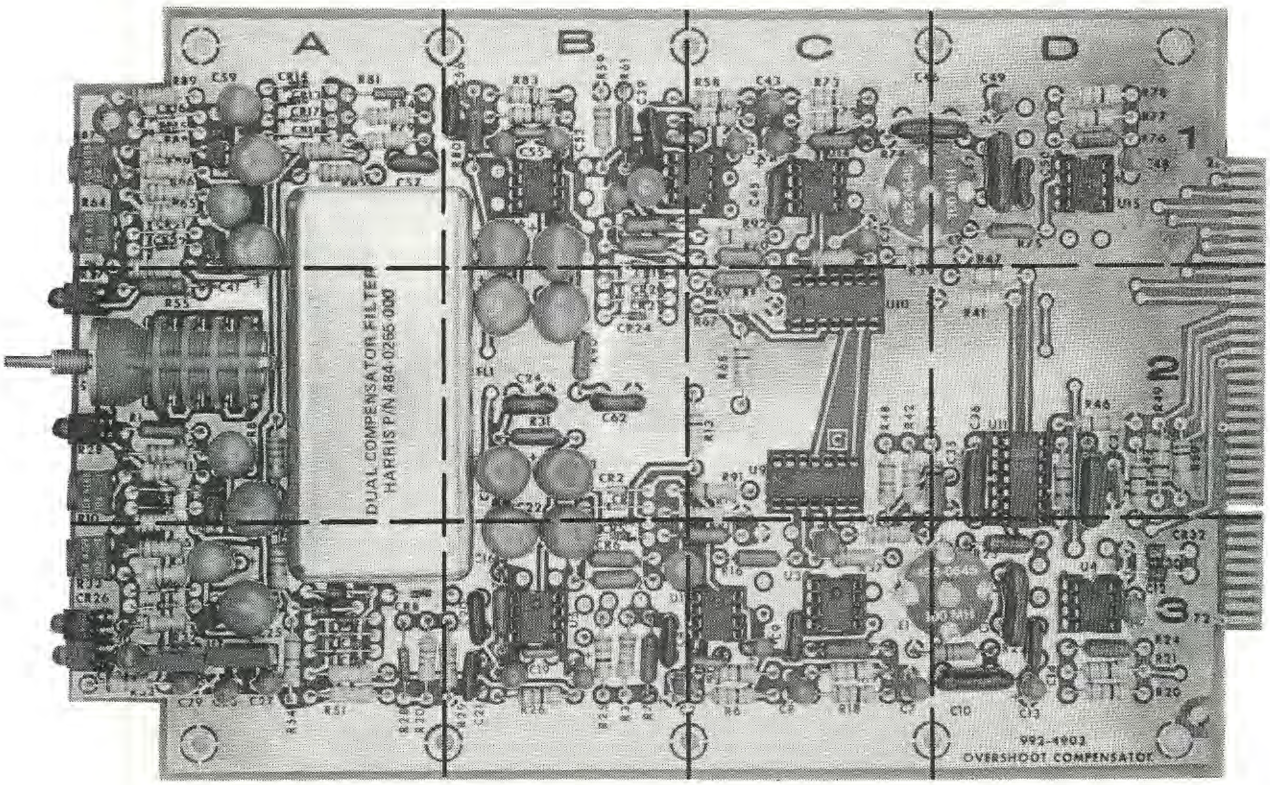
5-7. TECHNICAL ASSISTANCE

5-8. HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service during normal business hours (8:00 AM to 5:00 PM Central Time). Emergency service is available 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

Table 5-1. STEREO OVSC MODULE Fault Isolation Index

SYMPTOM	DEFECT/REFERENCE
OVERSHOOTS	Figure 5-4
DISTORTION	Figure 5-5
NOISE	Figure 5-6
UNABLE TO SET COMPENSATION THRESHOLD	Figure 5-7
EXCESSIVE HARMONIC CONTENT	Figure 5-8
LEFT OR RIGHT INDICATORS INOPERATIVE	Figure 5-9
NO OUTPUT	Figure 5-10

WARNING: Disconnect primary power prior to servicing.



2164-500-4

Figure 5-1. STEREO OVSC MODULE Parts Layout

Table 5-2. STEREO OVSC MODULE Parts Index

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
C1	C3	C29	A3	C57	A1	CR21	A1
C2	C3	C30	A3	C58	A1	CR22	A1
C3	C3	C31	C1	C59	A1	CR23	B2
C4	B3	C32	C3	C60	B1	CR24	B2
C5	A2	C33	D2	C61	B2	CR25	A3
C6	A2	C34	D2	C62	B2	CR26	A3
C7	C3	C35	D2			CR27	A2
C8	C3	C36	D2			CR28	A2
C9	C3	C37	C1	CR1	B2	CR29	A3
C10	D3	C38	B1	CR2	B2	CR30	D3
C11	D3	C39	B1	CR3	A2	CR31	A3
C12	D3	C40	C1	CR4	A2	CR32	D3
C13	D3	C41	A2	CR5	B3		
C14	D3	C42	A1	CR6	B3		
C15	B2	C43	C1	CR7	A3	FL1	A2
C16	B3	C44	C1	CR8	A3		
C17	B3	C45	C1	CR9	A3		
C18	B3	C46	D1	CR10	A3		
C19	B3	C47	D1	CR11	A3	L1	C3
C20	B3	C48	D1	CR12	A3	L2	D1
C21	B3	C49	D1	CR13	A1		
C22	B2	C50	D1	CR14	A1		
C23	B2	C51	B1	CR15	A1	R1	A2
C24	B2	C52	B2	CR16	A1	R2	B3
C25	A3	C53	B1	CR17	A1	R3	B3
C26	A3	C54	B1	CR18	A1	R4	B3
C27	A3	C55	B1	CR19	B2	R5	C3
C28	A3	C56	B1	CR20	B2	R6	C3

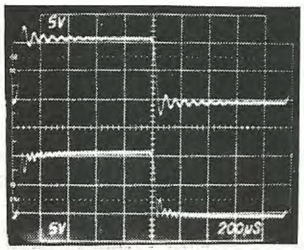
WARNING: Disconnect primary power prior to servicing.

Table 5-2. STEREO OVSC MODULE Parts Index (Continued)

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
R7	B3	R35	A3	R63	A2	R91	C2
R8	A2	R36	A3	R64	A1	R92	C1
R9	A3	R37	C3	R65	A1	R93	C3
R10	A2	R38	C2	R66	A1	R94	B1
R11	A2	R39	C2	R67	C2		
R12	A2	R40	C2	R68	C2		
R13	C2	R41	D2	R69	C2	S1	A2
R14	C2	R42	C2	R70	C1		
R15	C3	R43	D2	R71	C1		
R16	C3	R44	C2	R72	C1	U1	C3
R17	C3	R45	D2	R73	C1	U2	A2
R18	C3	R46	D2	R74	C1	U3	C3
R19	C3	R47	D1	R75	D1	U4	D3
R20	D3	R48	C2	R76	D1	U5	B3
R21	D3	R49	D2	R77	D1	U6	A3
R22	D3	R50	D2	R78	D1	U7	A3
R23	D3	R51	A3	R79	A1	U8	A3
R24	D3	R52	A3	R80	B1	U9	C2
R25	B3	R53	A3	R81	A1	U10	C2
R26	B3	R54	A3	R82	B1	U11	D2
R27	B3	R55	A2	R83	B1	U12	C1
R28	A3	R56	B1	R84	A1	U13	A1
R29	B3	R57	C1	R85	A1	U14	C1
R30	A3	R58	C1	R86	A1	U15	D1
R31	B2	R59	B1	R87	A1	U16	B1
R32	A3	R60	B1	R88	A1	U17	A1
R33	A3	R61	B1	R89	A1		
R34	A3	R62	A1	R90	B2		

WARNING: Disconnect primary power prior to servicing.

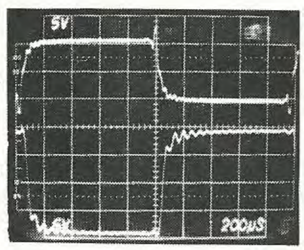
1A
1B




```
TEST REQUIREMENTS: A. 500 Hz squarewave @ 100% modulation
                      applied to exciter.
                   B. STEREO ANALOG module pre-emphasis
                      programmed to FLAT.

1A          Filtered audio at U12 pin 6.
1B          Overshoot compensator output at U14 pin 6.
```

2A
2B



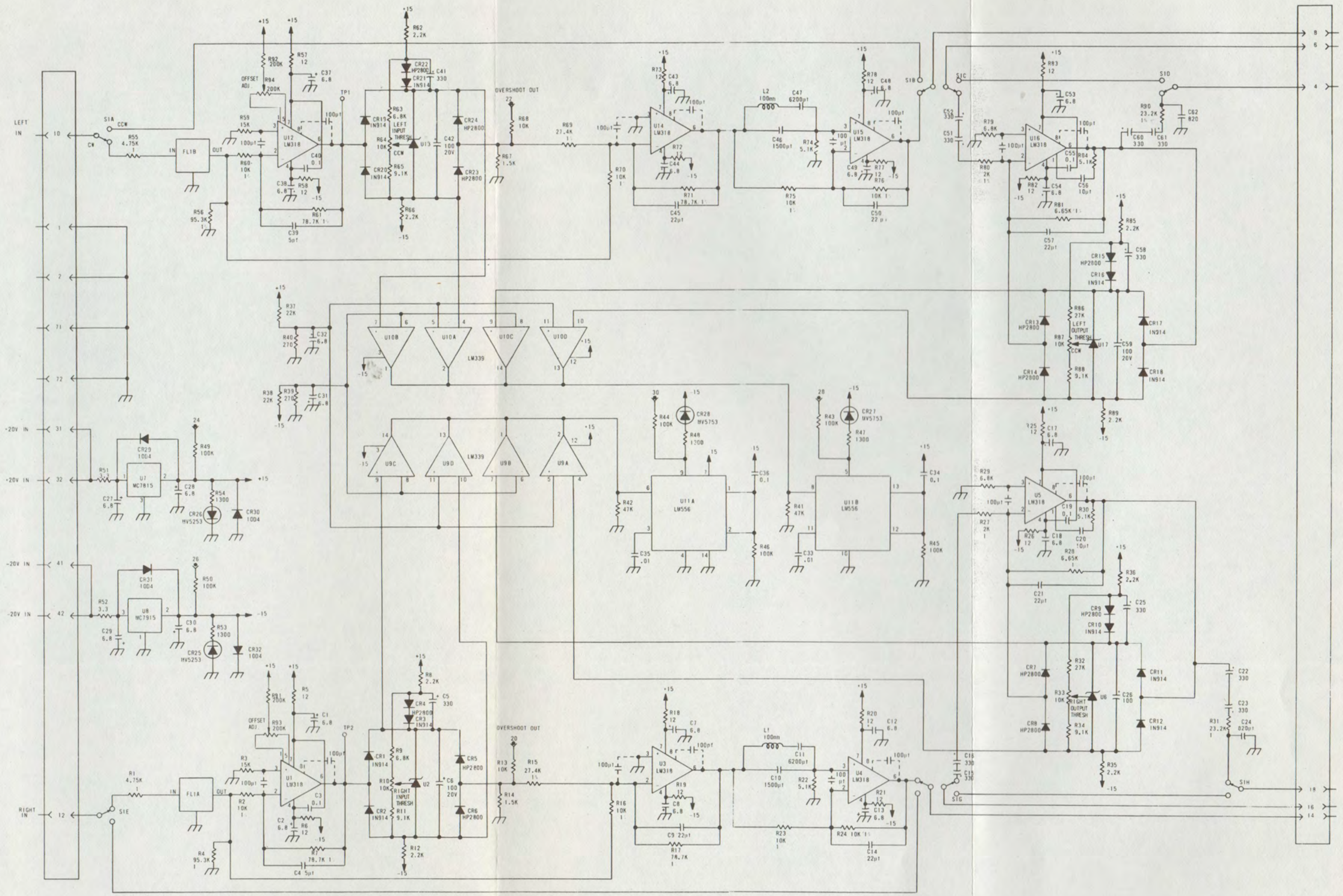

```
TEST REQUIREMENTS: A. 500 Hz squarewave @ 100% modulation
                      applied to exciter.
                   B. STEREO ANALOG module pre-emphasis
                      programmed to FLAT.

2A          All-pass filter output at U15 pin 6.
2B          Clipper output at U16 pin 6.
```

2164-500-5

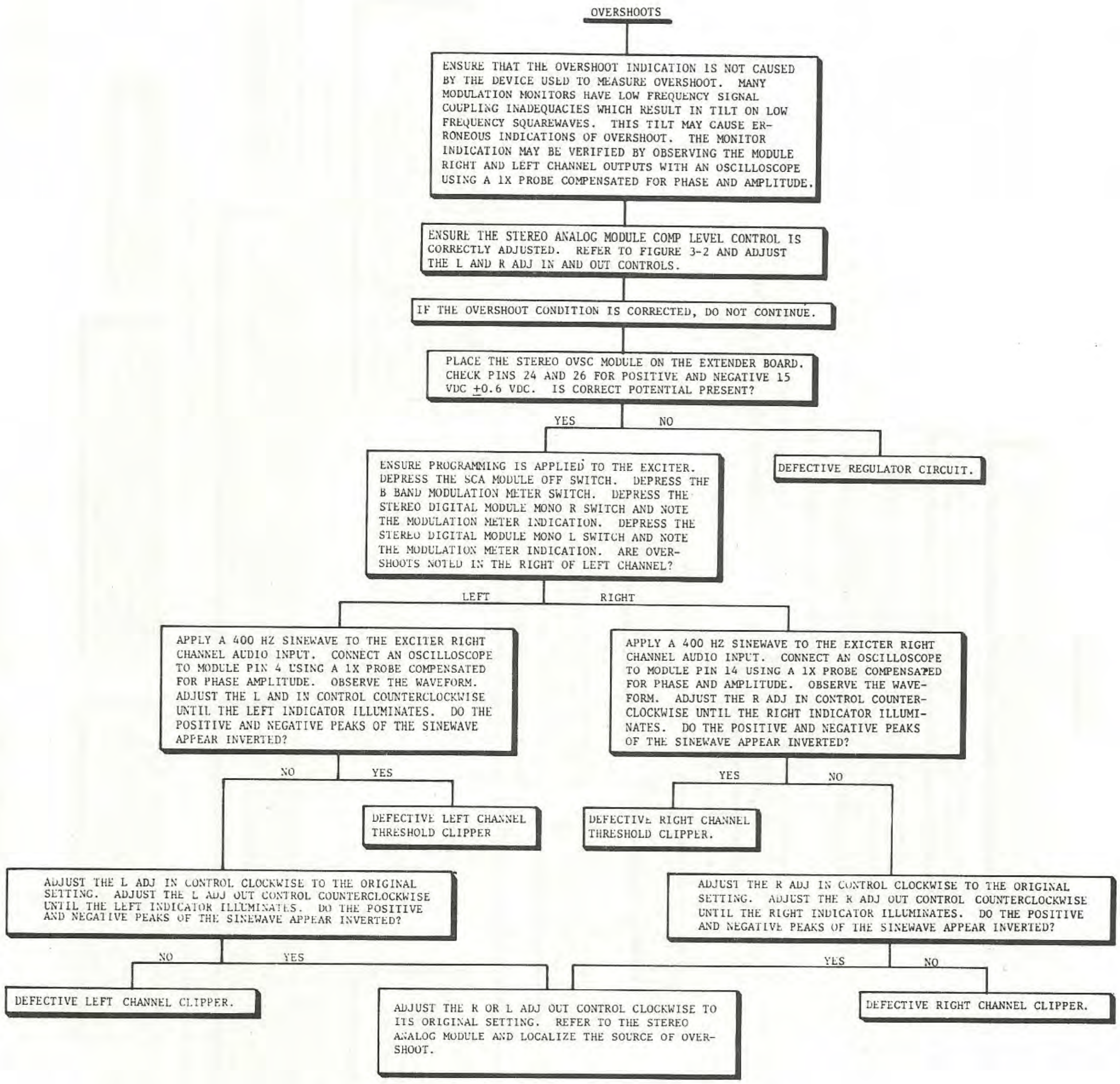
Figure 5-2. STEREO OVSC MODULE Waveforms

WARNING: Disconnect primary power prior to servicing.



4. ALL 1% RESISTORS 1/4W
3. ALL CAPACITANCE IN UF.
2. ALL RESISTANCE IN OHMS.
1. ALL RESISTORS 1/2W, 5%.
UNLESS OTHERWISE NOTED
NOTES

FIGURE 5-3. SCHEMATIC
STEREO OVSC MODULE
852-8395-001-C



2164-500-6

Figure 5-4. Overshoots

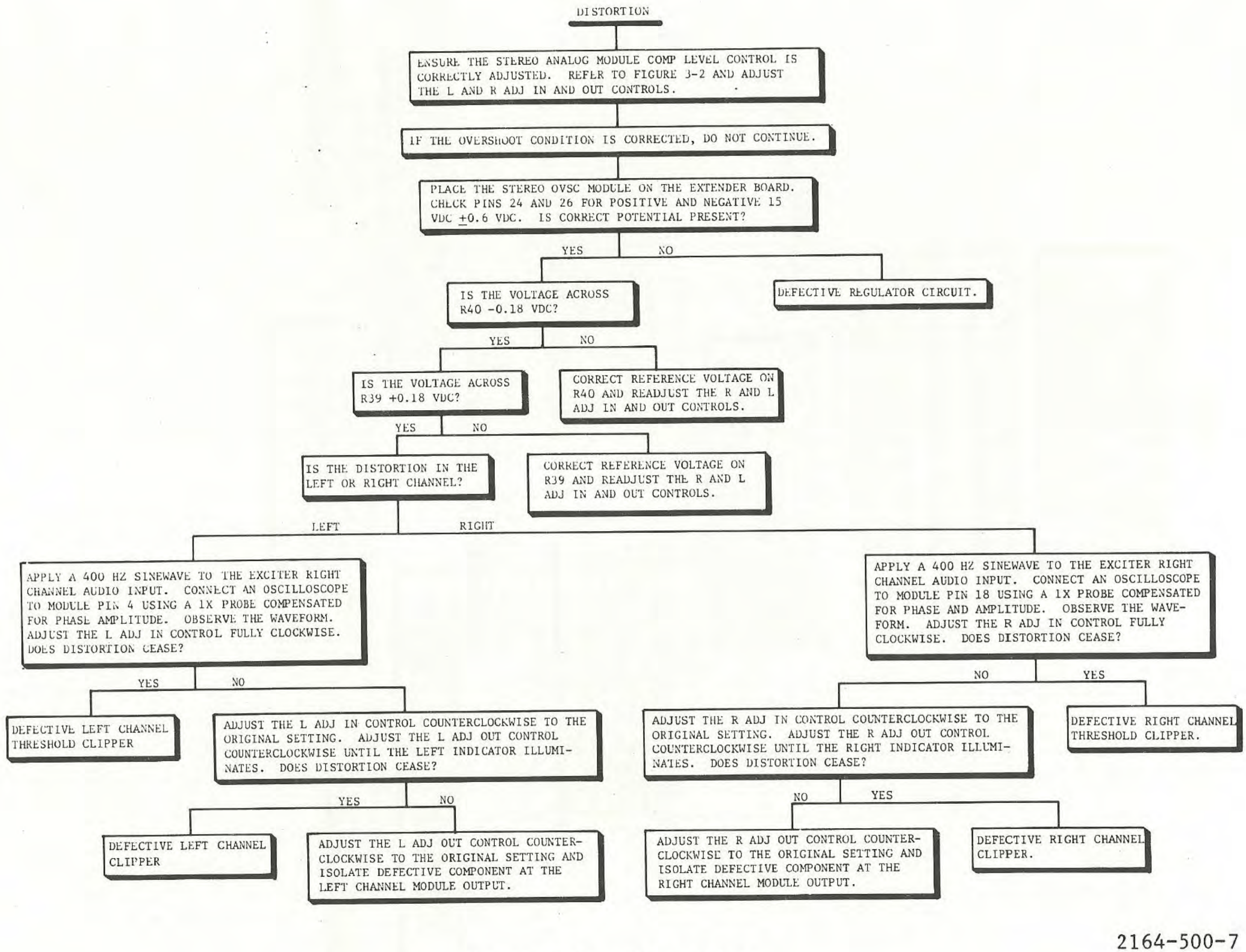


Figure 5-5. Distortion

WARNING: Disconnect primary power prior to servicing.

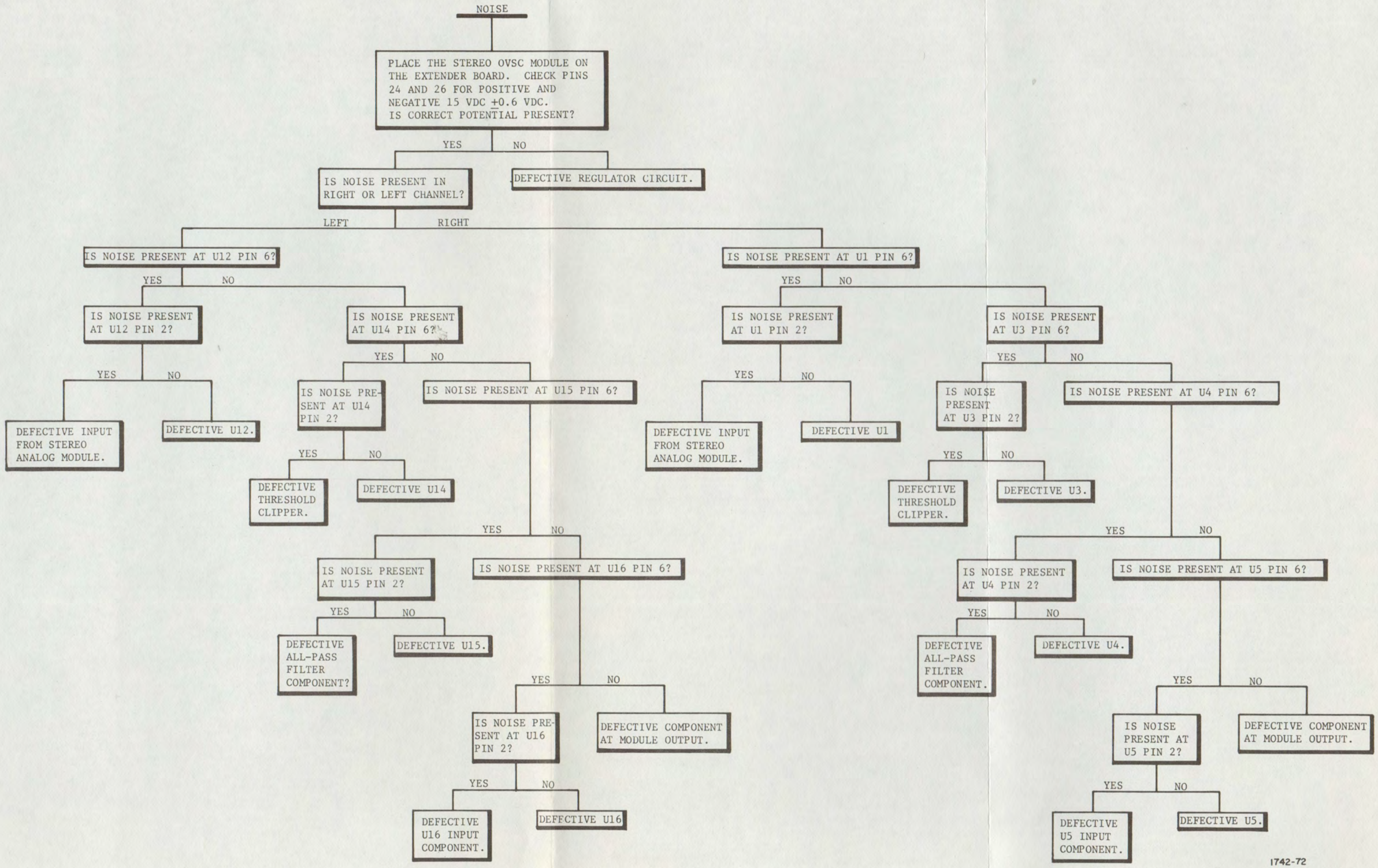
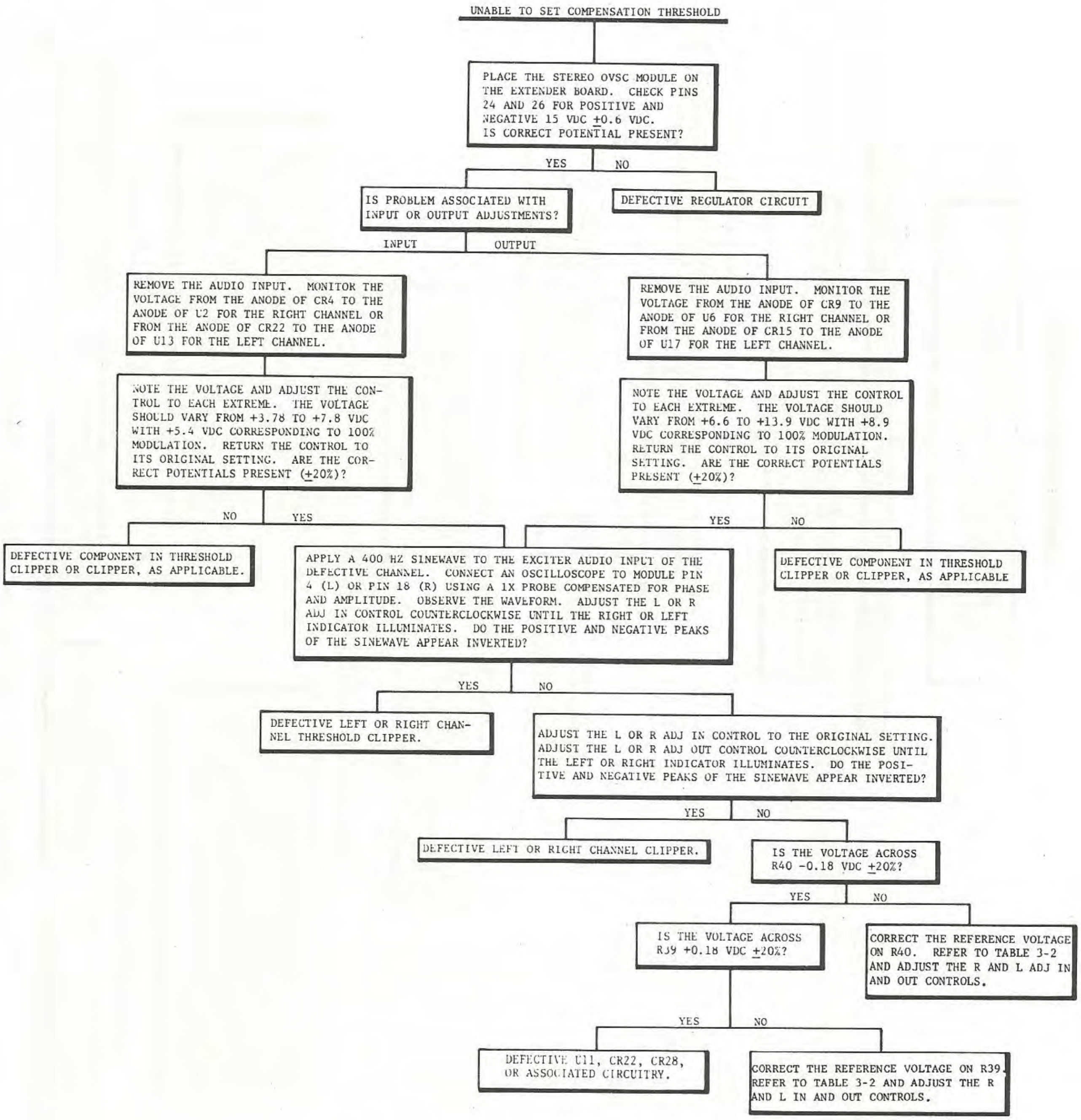


FIGURE 5-6. NOISE



2164-500-9

Figure 5-7. Unable to Set Compensation Threshold

WARNING: Disconnect primary power prior to servicing.

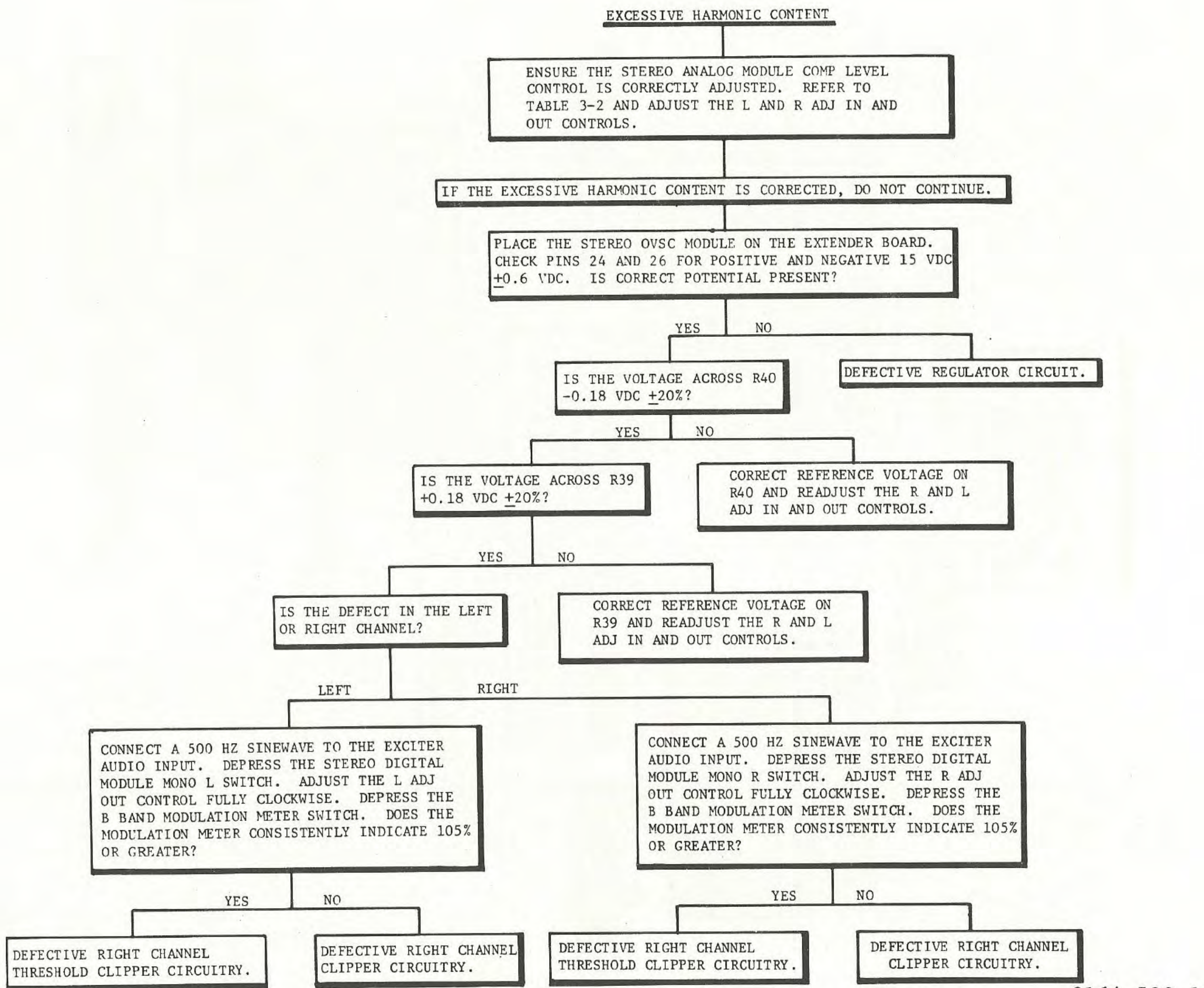


Figure 5-8. Excessive Harmonic Content

WARNING: Disconnect primary power prior to servicing.

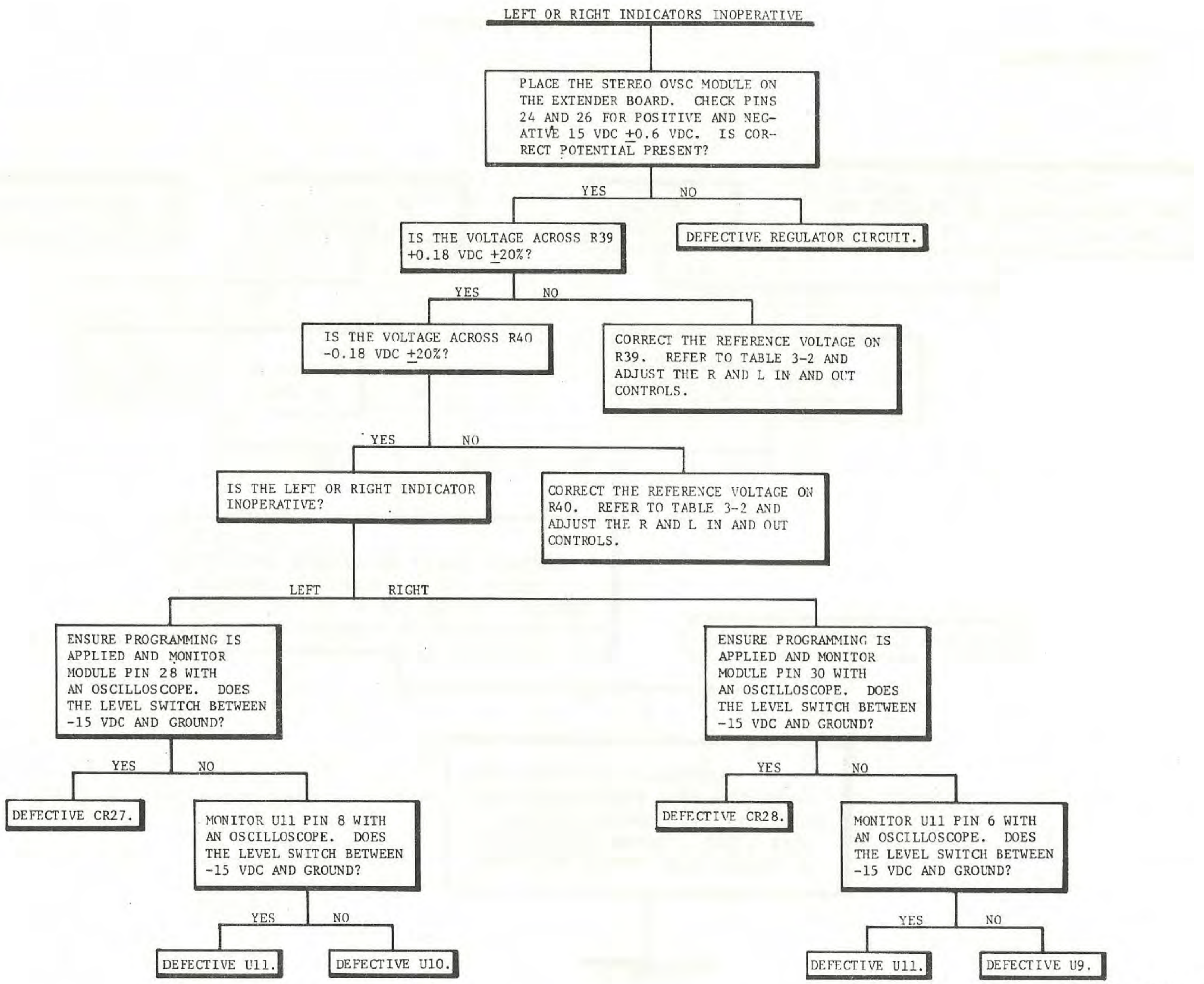
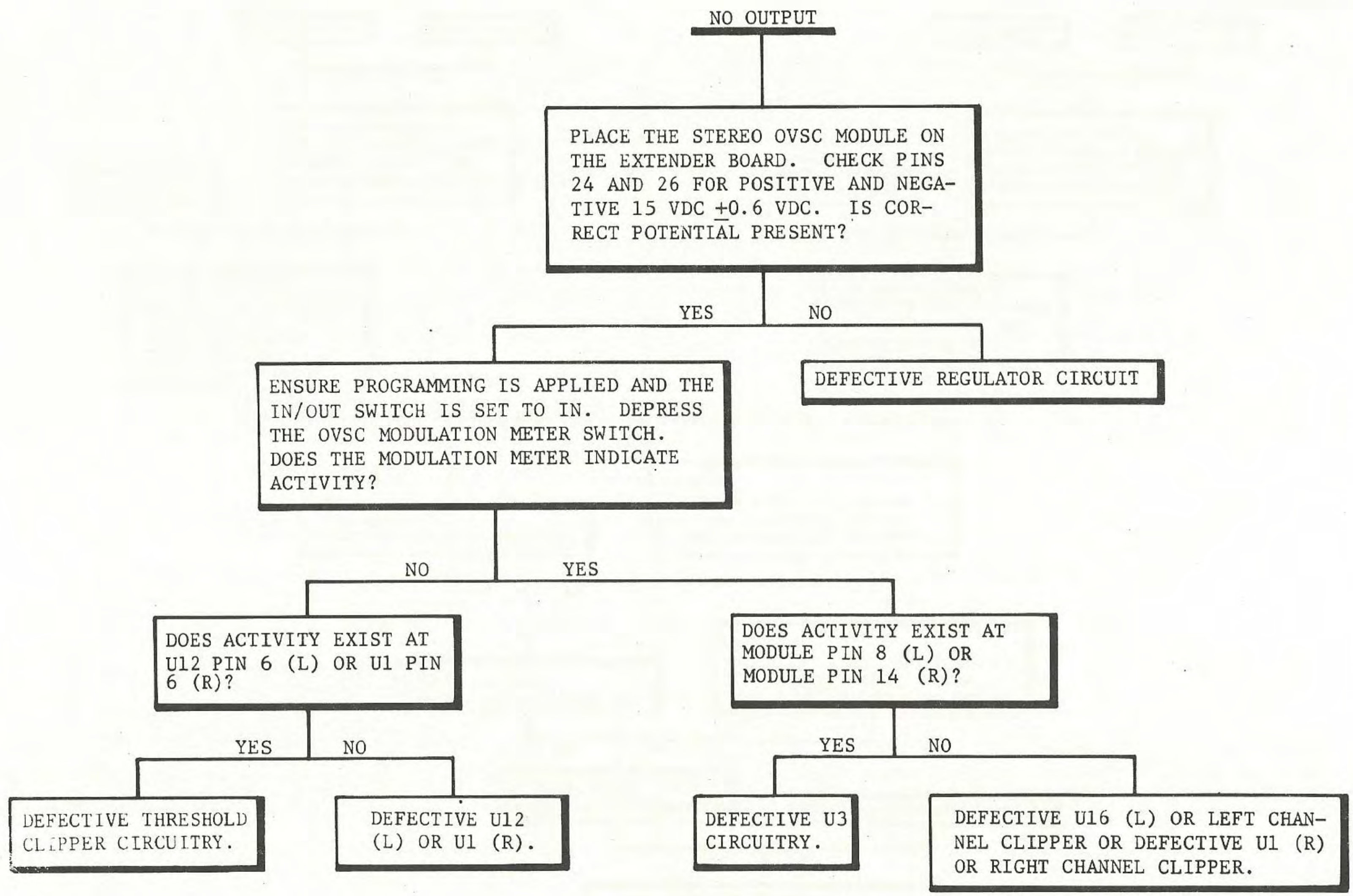


Figure 5-9. Left or Right Indicators Inoperative



2164-500-12

Figure 5-10. No Output

WARNING: Disconnect primary power prior to servicing.

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. Refer to table 6-1 for replaceable parts which are required for proper maintenance of the MX-15 FM Exciter STEREO OVSC MODULE. Table entries are indexed by component reference designator.

6-3. REPLACEABLE PARTS SERVICE

6-4X. Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a TWX facility (910-246-3212) or a TELEX service (247319).

Table 6-1. STEREO OVSC MODULE Front Panel - 994 7991 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY
	992 4903 001	STEREO OVSC MODULE Circuit Board (Refer to table 6-2)	1

WARNING: Disconnect primary power prior to servicing.

Table 6-2. STEREO OVSC MODULE Circuit Board - 992 4903 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1,CR2,CR3	384 0205 000	DIODE SILICON 1N914	3
CR4,CR5,CR6,CR7 CR8,CR9	384 0321 000	DIODE 5082-2800/1N5711	6
CR10,CR11,CR12	384 0205 000	DIODE SILICON 1N914	3
CR13,CR14,CR15	384 0321 000	DIODE 5082-2800/1N5711	3
CR16,CR17,CR18 CR19,CR20,CR21	384 0205 000	DIODE SILICON 1N914	6
CR22,CR23,CR24	384 0321 000	DIODE 5082-2800/1N5711	3
CR25,CR26	384 0661 000	L.E.D. GREEN	2
CR27,CR28	384 0662 000	L.E.D. RED	2
CR29,CR30,CR31 CR32	384 0284 000	DIODE 10D4/1N2070	4
C1,C2	526 0049 000	CAP 6.8UF 35V 20%	2
C3	516 0453 000	CAP .1UF 100V 20%	1
C4	500 0803 000	CAP MICA 5UUF 500V	1
C5	526 0045 000	CAP 330UF 6V 10%	1
C6	526 0057 000	CAP 100UF 20V 20%	1
C7,C8	526 0049 000	CAP 6.8UF 35V 20%	2
C9	500 0809 000	CAP MICA 22UUF 500V	1
C10	500 0878 000	CAP 1500 PF 500V 5%	1
C11	500 0910 000	CAP, 6200PF 300V 5%	1
C12,C13	526 0049 000	CAP 6.8UF 35V 20%	2
C14	500 0809 000	CAP MICA 22UUF 500V	1
C15,C16	526 0045 000	CAP 330UF 6V 10%	2

WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO OVSC MODULE Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C17,C18	526 0049 000	CAP 6.8UF 35V 20%	2
C19	516 0453 000	CAP .1UF 100V 20%	1
C20	500 0804 000	CAP, MICA 10PF 500V 5%	1
C21	500 0809 000	CAP MICA 22UUF 500V	1
C22,C23	526 0045 000	CAP 330UF 6V 10%	2
C24	500 0842 000	CAP, MICA 820PF 300V 5%	1
C25	526 0045 000	CAP 330UF 6V 10%	1
C26	526 0057 000	CAP 100UF 20V 20%	1
C27,C28,C29,C30 C31,C32	526 0049 000	CAP 6.8UF 35V 20%	6
C33	516 0375 000	CAP .01UF 50V	1
C34	508 0408 000	CAP .1 UF 50V 5%	1
C35	516 0375 000	CAP .01UF 50V	1
C36	508 0408 000	CAP .1 UF 50V 5%	1
C37,C38	526 0049 000	CAP 6.8UF 35V 20%	2
C39	500 0803 000	CAP MICA 5UUF 500V	1
C40	516 0453 000	CAP .1UF 100V 20%	1
C41	526 0045 000	CAP 330UF 6V 10%	1
C42	526 0057 000	CAP 100UF 20V 20%	1
C43,C44	526 0049 000	CAP 6.8UF 35V 20%	2
C45	500 0809 000	CAP MICA 22UUF 500V	1
C46	500 0878 000	CAP 1500 PF 500V 5%	1
C47	500 0910 000	CAP, 6200PF 300V 5%	1

Table 6-2. STEREO OVSC MODULE Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C48,C49	526 0049 000	CAP 6.8UF 35V 20%	2
C50	500 0809 000	CAP MICA 22UUF 500V	1
C51,C52	526 0045 000	CAP 330UF 6V 10%	2
C53,C54	526 0049 000	CAP 6.8UF 35V 20%	2
C55	516 0453 000	CAP .1UF 100V 20%	1
C56	500 0804 000	CAP, MICA 10PF 500V 5%	1
C57	500 0809 000	CAP MICA 22UUF 500V	1
C58	526 0045 000	CAP 330UF 6V 10%	1
C59	526 0057 000	CAP 100UF 20V 20%	1
C60,C61	526 0045 000	CAP 330UF 6V 10%	2
C62	500 0842 000	CAP, MICA 820PF 300V 5%	1
FL1	484 0265 000	FILTER, DUAL LOWPASS	1
L1,L2	492 0645 000	INDUCTOR 100 MH 2%	2
R1	548 0678 000	RES 4750 OHM 1/4W 1%	1
R2	548 1361 000	RES 10K OHM 1/4W 1%	1
R3	540 1184 000	RES 1/2W 15K OHM 5%	1
R4	548 1424 000	RES 95.3K OHM 1/4W	1
R5,R6	540 1228 000	RES 1/2W 12 OHM 5%	2
R7	548 1431 000	RES 78.7K OHM 1/4W	1
R8	540 1182 000	RES 1/2W 2200 OHM 5%	1
R9	540 1145 000	RES .5W 6800 OHM 5%	1
R10	550 0914 000	POT, 10K OHM	1

Table 6-2. STEREO OVSC MODULE Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R11	540 1189 000	RES 1/2W 9100 OHM 5%	1
R12	540 1182 000	RES 1/2W 2200 OHM 5%	1
R13	540 1111 000	RES .5W 10K OHM 5PCT	1
R14	540 1129 000	RES .5W 1500 OHM 5%	1
R15	548 1186 000	RES 27.4K OHM 1/4W 1%	1
R16	548 1361 000	RES 10K OHM 1/4W 1%	1
R17	548 1431 000	RES 78.7K OHM 1/4W	1
R18,R19,R20,R21	540 1228 000	RES 1/2W 12 OHM 5%	4
R22	540 1105 000	RES .5W 5100 OHM 5%	1
R23,R24	548 1361 000	RES 10K OHM 1/4W 1%	2
R25,R26	540 1228 000	RES 1/2W 12 OHM 5%	2
R27	548 0279 000	RES 2000 OHM 1/4W 1%	1
R28	548 1358 000	RES 6650 OHM 1/4W 1%	1
R29	540 1145 000	RES .5W 6800 OHM 5%	1
R30	540 1105 000	RES .5W 5100 OHM 5%	1
R31	548 1430 000	RES 23.2K OHM 1/4-1%	1
R32	540 1147 000	RES .5W 27K OHM 5PCT	1
R33	550 0914 000	POT, 10K OHM	1
R34	540 1189 000	RES 1/2W 9100 OHM 5%	1
R35,R36	540 1182 000	RES 1/2W 2200 OHM 5%	2
R37,R38	540 1160 000	RES .5W 22K OHM 5%	2
R39,R40	540 1188 000	RES 1/2W 270 OHM 5%	2

WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO OVSC MODULE Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R041,R042	540 0089 000	RES .5W 47K OHM 5%	2
R43,R44,R45,R46	540 1159 000	RES .5W 100K OHM 5%	4
R47,R48	540 1187 000	RES 1/2W 1300 OHM 5%	2
R49,R50	540 1159 000	RES .5W 100K OHM 5%	2
R51,R52	540 1323 000	RES 3.3 OHM 1/2W 5%	2
R53,R54	540 1187 000	RES 1/2W 1300 OHM 5%	2
R55	548 0678 000	RES 4750 OHM 1/4W 1%	1
R56	548 1424 000	RES 95.3K OHM 1/4W	1
R57,R58	540 1228 000	RES 1/2W 12 OHM 5%	2
R59	540 1184 000	RES 1/2W 15K OHM 5%	1
R60	548 1361 000	RES 10K OHM 1/4W 1%	1
R61	548 1431 000	RES 78.7K OHM 1/4W	1
R62	540 1182 000	RES 1/2W 2200 OHM 5%	1
R63	540 1145 000	RES .5W 6800 OHM 5%	1
R64	550 0914 000	POT, 10K OHM	1
R65	540 1189 000	RES 1/2W 9100 OHM 5%	1
R66	540 1182 000	RES 1/2W 2200 OHM 5%	1
R67	540 1129 000	RES .5W 1500 OHM 5%	1
R68	540 1111 000	RES .5W 10K OHM 5PCT	1
R69	548 1186 000	RES 27.4K OHM 1/4W 1%	1
R70	548 1361 000	RES 10K OHM 1/4W 1%	1
R71	548 1431 000	RES 78.7K OHM 1/4W	1

WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO OVSC MODULE Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R72,R73	540 1228 000	RES 1/2W 12 OHM 5%	2
R74	540 1105 000	RES .5W 5100 OHM 5%	1
R75,R76	548 1361 000	RES 10K OHM 1/4W 1%	2
R77,R78	540 1228 000	RES 1/2W 12 OHM 5%	2
R79	540 1145 000	RES .5W 6800 OHM 5%	1
R80	548 0279 000	RES 2000 OHM 1/4W 1%	1
R81	548 1358 000	RES 6650 OHM 1/4W 1%	1
R82,R83	540 1228 000	RES 1/2W 12 OHM 5%	2
R84	540 1105 000	RES .5W 5100 OHM 5%	1
R85	540 1182 000	RES 1/2W 2200 OHM 5%	1
R86	540 1147 000	RES .5W 27K OHM 5PCT	1
R87	550 0914 000	POT, 10K OHM	1
R88	540 1189 000	RES 1/2W 9100 OHM 5%	1
R89	540 1182 000	RES 1/2W 2200 OHM 5%	1
R90	548 1430 000	RES 23.2K OHM 1/4-1%	1
R91,R92	540 1144 000	RES .5W 200K OHM 5%	2
R93,R94	550 0930 000	POT 200K OHM 1/2W	2
S1	600 0581 000	SW, ROTARY 8PDT	1
U1	382 0472 000	IC LM318	1
U2	382 0520 000	I.C. REGULATOR	1
U3,U4,U5	382 0472 000	IC LM318	3
U6	382 0520 000	I.C. REGULATOR	1

 WARNING: Disconnect primary power prior to servicing

Table 6-2. STEREO OVSC MODULE Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
U7	382 0359 000	IC, 7815	1
U8	382 0360 000	IC, 7915	1
U9,U10	382 0521 000	CKT, INT	2
U11	382 0381 000	CKT, INT NE556N	1
U12	382 0472 000	IC LM318	1
U13	382 0520 000	I.C. REGULATOR	1
U14,U15,U16	382 0472 000	IC LM318	3
U17	382 0520 000	I.C. REGULATOR	1
XU1,XU3,XU4,XU5	404 0673 000	SOCKET, IC 8 CONT	4
XU9,XU10,XU11	404 0674 000	SOCKET, IC 14 CONT	3
XU12,XU14,XU15 XU16	404 0673 000	SOCKET, IC 8 CONT	4
	852 8395 001	SCHEMATIC	1

WARNING: Disconnect primary power prior to servicing

AFC/PLL MODULE
888-2164-602

TECHNICAL MANUAL

AFC/PLL MODULE

992 5981 001

HARRIS

T.M. No. 888-2164-602

Printed: November 14, 1983

MANUAL REVISION HISTORY
AFC/PLL MODULE
888-2164-6xx

REV. #	DATE	ECN	PAGES AFFECTED
002	11-14-83	27835	Replaced the following pages: Title Page and page 15 Added the following page: Manual Revision History Page

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

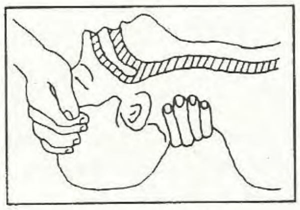
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

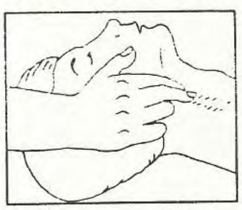
(A) AIRWAY

IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

CHECK
CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

(B) BREATHING

IF NOT BREATHING,
BEGIN ARTIFICIAL BREATHING

TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

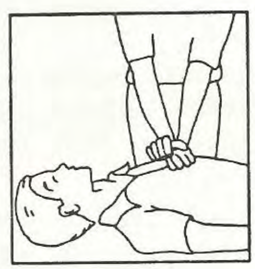
REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES

APPROX. RATE OF COMPRESSIONS --80 PER MINUTE { ONE RESCUER: 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE { TWO RESCUERS: 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

   NOTE

   If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I

GENERAL DESCRIPTION

1-1. <u>EQUIPMENT PURPOSE</u>

1-2. The AFC/PLL MODULE controls the center frequency of any 50 kHz spaced channel within the 87.5 MHz to 108 MHz commercial FM broadcast band. A programmable divider and a temperature compensated crystal oscillator (TCXO) are interfaced with the MOD OSC module to maintain accurate frequency control through use of a phase locked loop. A test point is provided for WWV comparisons of the internal reference frequency for calibration adjustments.

1-3. <u>TECHNICAL CHARACTERISTICS</u>

1-4. Table 1-1 lists operating characteristics and parameters of the AFC/-PLL MODULE.

SECTION II

INSTALLATION

2-1. <u>GENERAL</u>

2-2. Refer to the FM Exciter System Technical Manual, Section II, Installation.

SECTION III

CONTROLS AND INDICATORS

3-1. <u>GENERAL</u>

3-2. Figure 3-1 shows the location of each control or indicator associated with the AFC/PLL and table 3-1 lists the controls and indicators with a description of each item listed. Control setup adjustments are listed in table 3-2.

SECTION IV

PRINCIPLES OF OPERATION

4-1. <u>CIRCUIT DESCRIPTION</u>

4-2. The primary purpose of the AFC/PLL MODULE is to control the FM Exciter rf carrier center frequency. The AFC/PLL module interfaces with the MOD OSC module to form a phase locked loop to accomplish accurate frequency control.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
POWER:	+20 Vdc @ 0.028 amperes. +15 Vdc @ 0.022 amperes. -15 Vdc @ 0.018 amperes. +5 Vdc @ 0.460 amperes.
SIGNAL:	
RF DRIVE	2 milliwatts (300 millivolts rms) on-frequency rf.
OUTPUTS	
CONTROL:	
RF INHIBIT	Ground for inhibit. Open for operate.
RELAY K1 CONTROL	Ground for frequency locked condition; +20 Vdc for frequency unlocked condition.
AFC CONTROL	+1.0 Vdc to +12.0 Vdc, dependent upon exciter operating frequency.
METER VOLTAGE	+1.0 Vdc to +12.0 Vdc, dependent upon exciter operating frequency.

WARNING: Disconnect primary power prior to servicing.

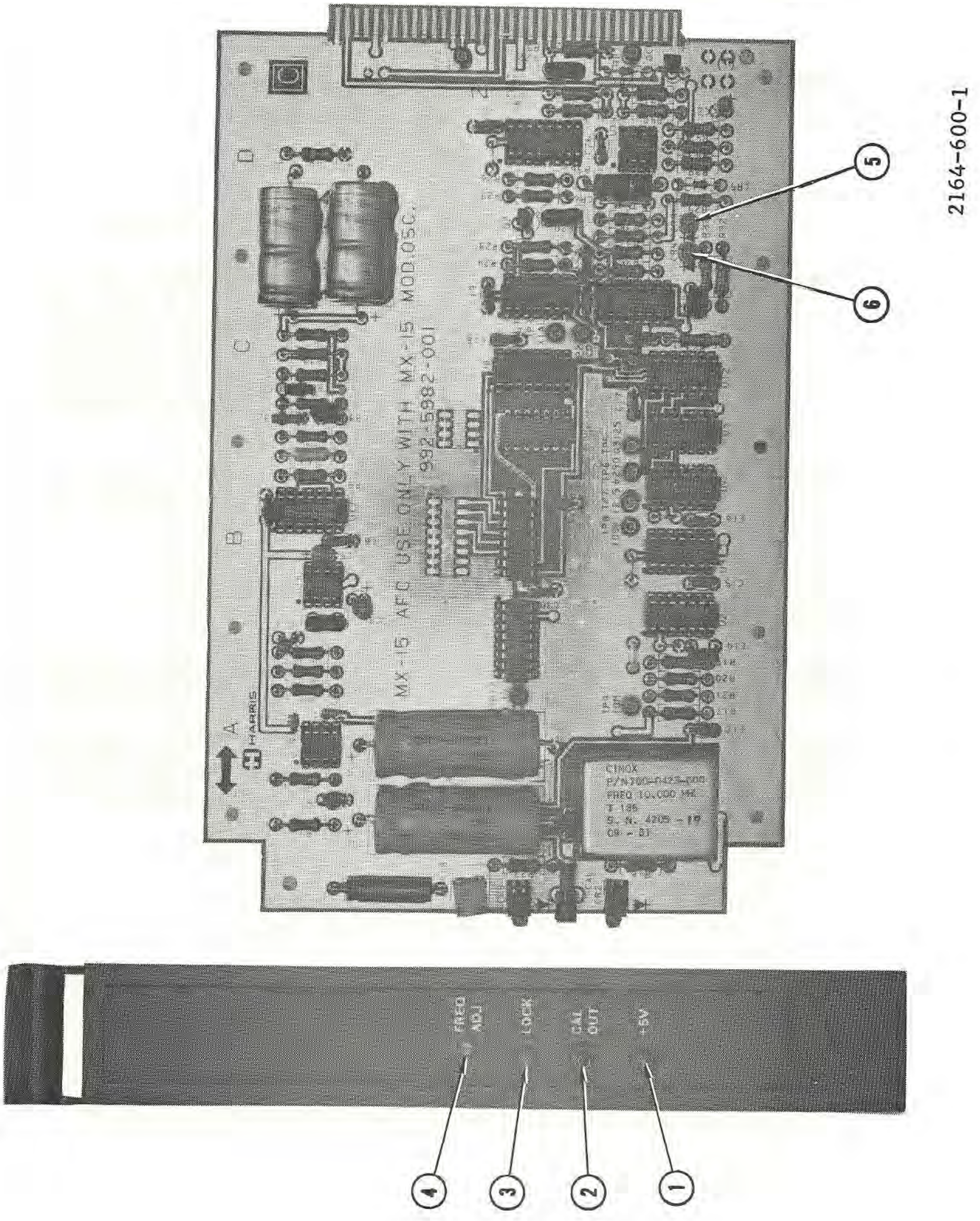


Figure 3-1. AFC/PLL MODULE

WARNING: Disconnect primary power prior to servicing.

Table 3-1. AFC/PLL MODULE Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	+5V Indicator (CR2)	Illuminates to indicate the +5 volt input to AFC/PLL MODULE is present.
2	CAL OUT Test Point	Provides frequency components at 2.5 MHz, 5.0 MHz, 10.0 MHz, 20.0 MHz, and 25.0 MHz for direct frequency comparisons between the internal frequency standard and a broadcast frequency standard such as WWV using a communications receiver.
3	LOCK Indicator (CR8)	Illuminates to indicate the exciter is operating within tolerance of the assigned frequency.
4	FREQ ADJ Control (R18)	Adjusts the FM carrier frequency.
5	MOD OSC Indicator (CR3)	Illuminates to indicate the MOD OSC module rf divider chain is operational.
6	CRYSTAL REFERENCE Indicator (CR4)	Illuminates to indicate the MOD OSC module crystal oscillator and reference divider chain is operational.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments

FREQ ADJ Control (R18)	1. Adjust a communication receiver to receive a broadcast frequency standard such as WWV at one of the following frequencies: 2.5 MHz 5.0 MHz WWV 10.0 MHz 15.0 MHz INTERNATIONAL 20.0 MHz 25.0 MHz 2. Connect a short piece of wire to be used as an antenna to the AFC/PLL MODULE CAL OUT test point. Couple the wire to the receiver antenna as required to obtain a signal. 3. Adjust R18 to obtain a zero beat. 4. Disconnect the wire from the CAL OUT test point.

4-3. PHASE LOCKED LOOP

4-4. A phase locked loop (see figure 4-1) is an automatic frequency control system that develops an error signal which is used as a control voltage to eliminate the system frequency error. The VCO operates as a frequency source whose phase is compared to the phase of a reference oscillator of the same frequency. The phase detector output is applied to a loop filter which determines lockup and modulation characteristics. If used for FM, the loop filter must average out the frequency or phase modulation that is present at the phase detector.

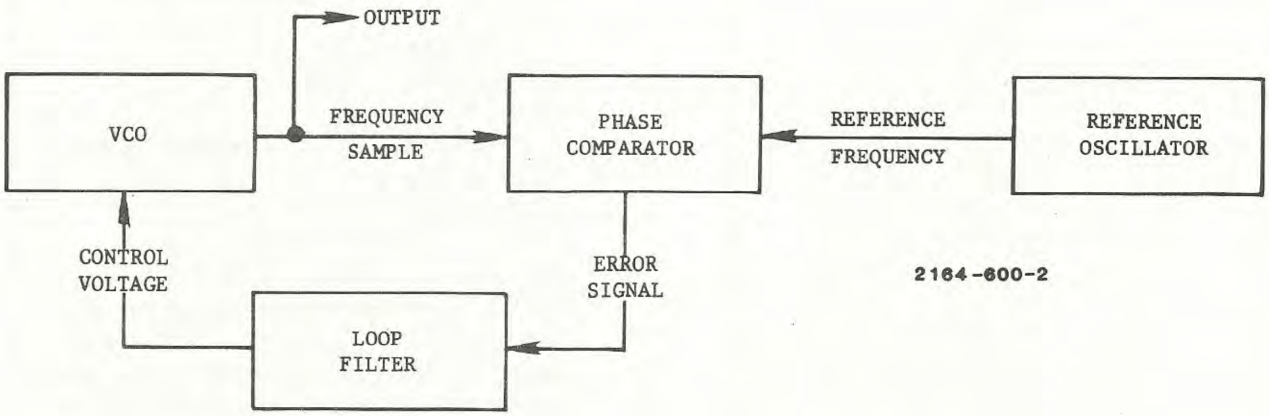


Figure 4-1. Phase Locked Loop

4-5. The directly controlled parameter of a phase locked loop is not frequency, but phase. As frequency is the rate of change of phase, by controlling phase with a finite constant error, frequency is controlled with no error with respect to the reference frequency. Therefore the phase locked loop indirectly controls frequency by accurately controlling phase.

4-6. MODULE GENERAL DESCRIPTION

4-7. VOLTAGE CONTROLLED OSCILLATOR. When power is applied, the MOD OSC module rf amplifiers drive the RF AMP module and provide an rf frequency sample to the AFC/PLL MODULE frequency dividers (see figure 4-2). As the phase locked loop is unlocked at this time, any rf transmission would be off frequency. Therefore, until phase lock is established a ground applied to the RF AMP module by the AFC/PLL MODULE inhibits rf output.

4-8. DIVIDERS. The rf frequency sample is divided to a frequency of 3125 Hz and applied to the lock detector and phase comparator. Frequency changes are accomplished through use of a programmable divider. The reference frequency is established by a highly stable temperature compensated crystal oscillator (TCXO). The CAL OUT test point and the FREQ ADJ control allow calibration of the reference standard. The reference frequency is divided down into two outputs of 3125 Hz, one signal lagging 90 degrees in phase. The 3125 Hz signal is applied to the phase comparator and the lock detector. The 3125 Hz quadrature signal is applied to the lock detector.

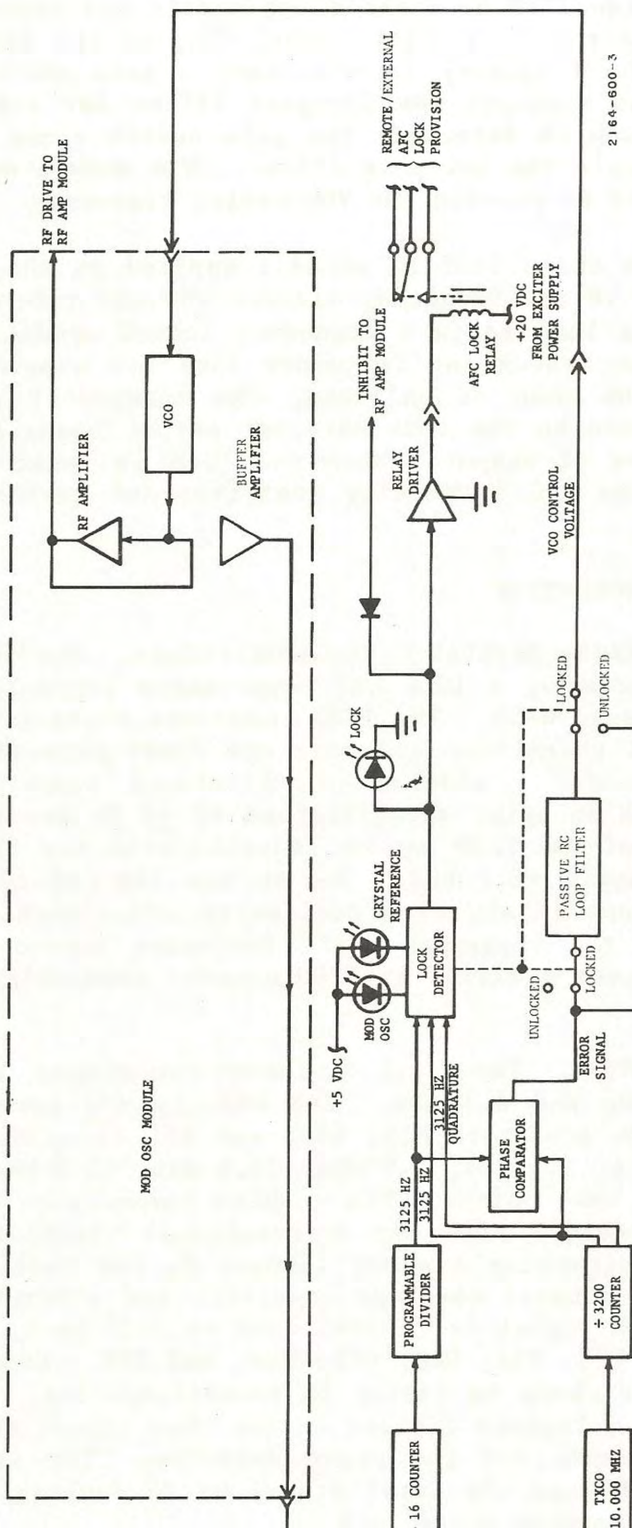


Figure 4-2. AFC/PLL MODULE Simplified Block Diagram

4-9. ERROR SIGNAL. The two 3125 Hz signals applied to the phase comparator provide an error signal to the loop filter consisting of the integrator and low-pass filter. When the frequency is unlocked, a gain switch increases the rate of correction and bypasses the low-pass filter for rapid loop response. When frequency lock is detected, the gain switch opens to slow the rate of correction and enable the low-pass filter. The module output is applied to the MOD OSC module to correct the VCO center frequency.

4-10. LOCK DETECTOR. The three 3125 Hz signals applied to the lock detector are used to determine if the frequency divider and the reference divider are operational and if the loop is in a frequency locked condition. Visual indications of the divider status and frequency lock are provided by light emitting diodes. When the loop is unlocked, the integrator gain is increased and a ground applied to the lock detector output opens the AFC lock relay and inhibits exciter rf output. When the loop is locked, the integrator gain is reduced, the AFC lock relay energizes and exciter rf output is enabled.

4-11. MODULE DETAILED DESCRIPTION

4-12. TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR (TCXO). The internal reference frequency is produced by a 10.0 MHz temperature compensated crystal oscillator (TCXO) (see figure 4-3). The TCXO comprises a sealed modular oscillator with an internal thermistor and varactor diode network matched to the crystal to compensate for a wide range of ambient temperatures. The unit is highly stable with an aging specification of ±2 Hz per year/per MHz (±2 PPM). The frequency of the TCXO may be adjusted with the FREQ ADJ control (R18) over approximately ±1.7 kHz. Due to the limited effect of the FREQ ADJ control, it is not likely that accidental adjustment of the frequency control would put the transmitter off frequency beyond FCC limits. The output of the TCXO drives a divide by 3200 counter consisting of U2, U3, U4, and U5.

4-13. DIVIDE BY 3200 COUNTER. The first divide-by-two stages (U2A and U3A) provide outputs at 5.0 MHz and 2.5 MHz. The signals are summed with the output of the TCXO through resistors R19, R20, and R21 to produce a signal with frequency components at 2.5 MHz, 5.0 MHz, 10.0 MHz, 15.0 MHz, 20.0 MHz, and 25 MHz at the CAL OUT test point. This enables comparisons of the phase locked loop reference frequency with any international broadcast frequency standard such as WWV by attaching a short antenna to the test point, coupling an rf sample into a general coverage receiver, and adjusting FREQ CAL for zero beat. The 2.5 MHz signal is divided down to 3125 Hz by a divide by 800 counter consisting of U2B, U3B, U4B, U5A, U4A, and U5B. Test points are provided along the divider chain to assist in troubleshooting. Two 3125 Hz signals are output by the reference divider chain. One signal obtained from U4A is used as the reference for the phase detector. The second signal which is obtained from U5B lags the first signal by 90 degrees and is used by the lock detector to determine phase lock.

4-14. RF FREQUENCY DIVIDER. On frequency rf from the MOD OSC module is input to the AFC/PLL MODULE at a level of 300 millivolts rms. A divide by 16 counter divides the rf input down to the six MHz range to operate the

WARNING: Disconnect primary power prior to servicing.

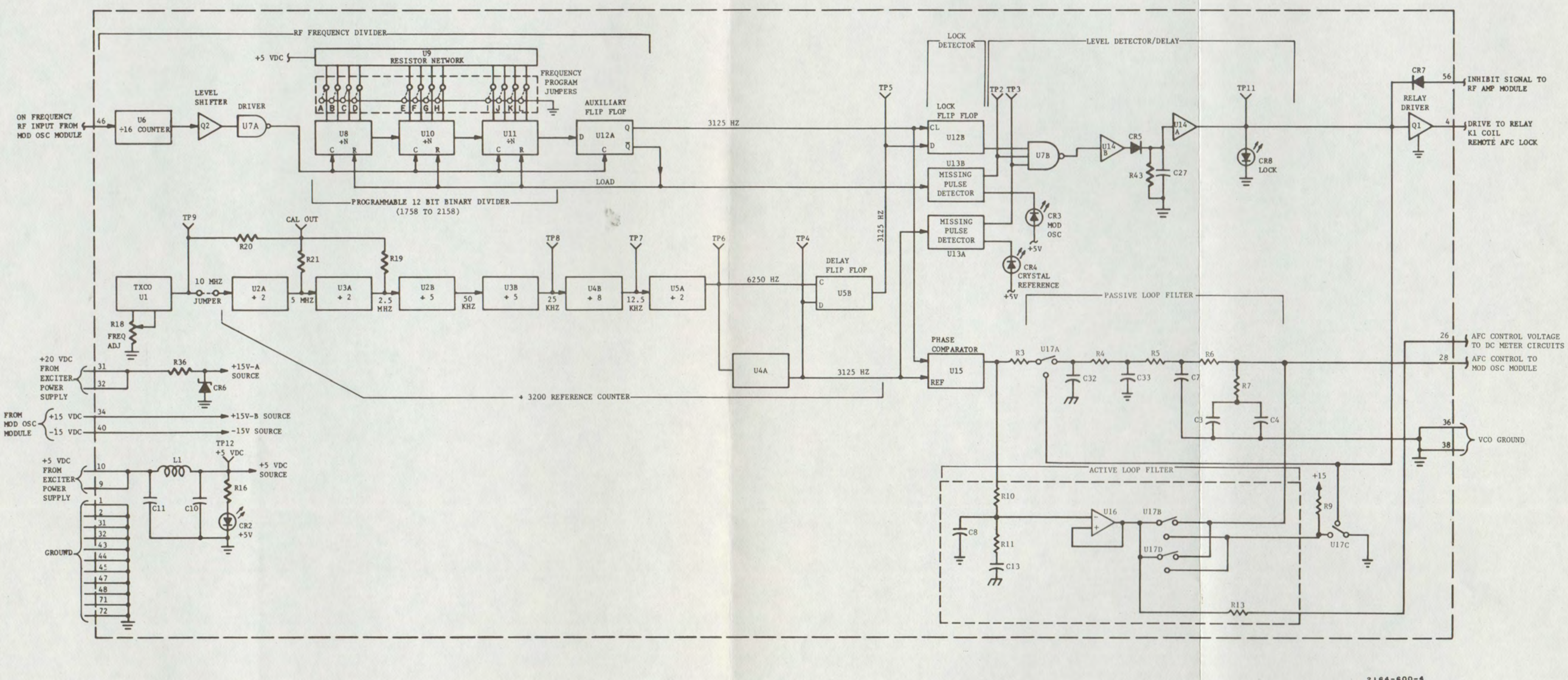


FIGURE 4-3. AFC/PLL MODULE
DETAILED BLOCK DIAGRAM

subsequent TTL logic circuits. The signal is level shifted from ECL levels to TTL logic levels by Q2 and applied through NAND gate U7A which operates as an inverting buffer.

4-15. Programmable Divider. The output of U7A drives a 12 bit programmable divider consisting of U8, U10, and U11. The divider provides division from the approximate six MHz input to 3125 Hz by a programmable divisor from 1748 to 2158. The programmable counter allows use of any exciter rf output frequency from 87.5 MHz to 108.0 MHz in 50 kHz steps without modifying the reference divider chain or adjusting the TCXO. The counter is programmed by wire jumpers which by their absence connect the flip flop data inputs to positive five volts dc (ONE state) or when present short the inputs to ground (ZERO state). A complete list of exciter operating frequencies and divider programming is provided by table 4-1.

4-16. Programmable Divider Operation. When power is applied, the counter is set to the programmed number. When the counter fills to all ONES, the next clock pulse shifts a pulse out of the counter to auxiliary flip flop U12A. The next clock pulse shifts the pulse out of the auxiliary flip flop and resets the programmable counter to the number entered with the wire jumpers. The counter then begins its count again with the following clock pulse. The pulses output by the programmable divider are one clock period long (approximately 150 nanoseconds) at a 3125 Hz rate. The pulses are difficult but not impossible to see on an oscilloscope due to the very low duty cycle of 0.05%.

4-17. MISSING PULSE DETECTORS. The 3125 Hz signal from the rf frequency divider is applied to U13B and the 3125 Hz signal from the reference divider is applied to U13A. As long as each input pulse is repeatedly applied to the respective retriggerable one shot, the output will remain HIGH. If a missing pulse occurs in a divider chain, the one shot monitoring the signal will go LOW and signal a missing pulse. The MOD OSC indicator (CR3) and the CRYSTAL REFERENCE indicator (CR4) (inside the module) provide a visual indication of the status of each divider chain.

4-18. LOCK DETECTOR. The lock detector monitors the output of the two divider chains and indicates phase lock when the following three conditions are met. The reference divider chain must be operating properly, the rf frequency divider chain must be operating properly, and the phase difference between the two chains must be less than 90 degrees. After these three conditions are met for a five second delay, the lock detector will indicate a phase locked condition.

4-19. Lock Flip Flop. The output of the programmable divider clocks a type D flip flop which functions as the lock flip flop. The data input is obtained from the 90 degree delayed 3125 Hz squarewave from the reference divider. As long as the loop is in the locked condition, the narrow pulses from the programmable divider will occur close to the center of the delayed 3125 Hz squarewave as shown by figure 4-4. The phase detector characteristic causes the loop to lock on the negative transitions of the phase detector input signals.

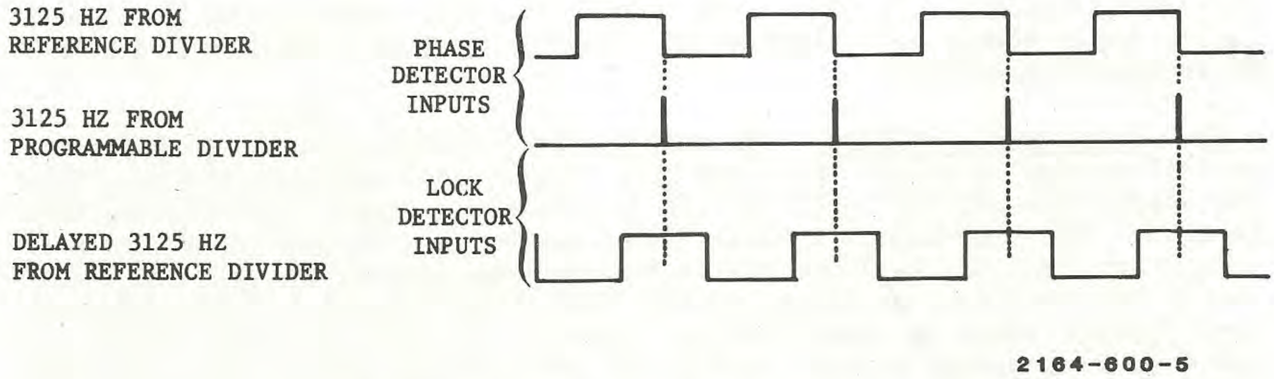


Figure 4-4. Detector Waveforms

4-20. During lock, the lock flip flop outputs a continuous HIGH state. If the loop unlocks, the phase of the programmable divider waveform will drift with respect to the delayed 3125 Hz signal. When the programmable divider signal coincides with the LOW state of the delayed 3125 Hz signal, the lock flip flop will output a LOW state to signal a frequency unlocked condition.

4-21. LEVEL DETECTOR/DELAY. The output of the lock flip and the outputs from the missing pulse detectors are applied to NAND gate U7B. This signal is applied to a quick-charge slow-discharge circuit comprising U14A, U14B, CR5, C27, and R43. If a missing pulse is detected or if the lock detector flip flop output goes LOW, C27 is quickly charged and an out of lock condition is immediately signaled. After lock is achieved, a five second delay is required for capacitor C27 to discharge and allow the lock detector to recover and perceive lock. The output of the circuit controls illumination of the LOCK indicator, applies a ground to the RF AMP module to prevent off frequency transmission when the loop is unlocked, operates the remote AFC lock relay (K1), and operates the CMOS switches associated with the loop filter to control loop correction rates.

4-22. PHASE COMPARATOR. The phase comparator is a flip-flop type which has a three state output. If both the reference and controlled inputs have a zero phase difference between the negative transitions, the output will be a high impedance (open circuit). If the controlled input lags in phase, the phase comparator will output zero-volt pulses with the pulse width proportional to the angle of phase lag. If the controlled input leads in phase, the phase comparator will output positive 15 volt pulses with the pulse width proportional to the angle of phase lead. Additionally, if a frequency difference exists between the two inputs the phase comparator will respond by producing zero volt pulses if the controlled frequency is low and positive 15 volt pulses if the controlled frequency is high. The pulses are converted to an AFC signal by the bistable loop filter.

4-23. <u>Bistable Loop</u>. The PLL filter used in the module has bistable characteristics which reduce loop lock-up time to a minimum. When the loop is unlocked, a CMOS switch arrangement operated by the level detector/delay output enables a high rate of correction by U16 and bypasses the RC low-pass filter formed by R3, C32, R4, C33, R5, C7, R7, C3 and C40. When the lock

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
87.50	1001	0010	1011
87.55	1001	0010	1010
87.60	1001	0010	1001
87.65	1001	0010	1000
87.70	1001	0010	0111
87.75	1001	0010	0110
87.80	1001	0010	0101
87.85	1001	0010	0100
87.90	1001	0010	0011
87.95	1001	0010	0010
88.00	1001	0010	0001
88.05	1001	0010	0000
88.10	1001	0001	1111
88.15	1001	0001	1110
88.20	1001	0001	1101
88.25	1001	0001	1100
88.30	1001	0001	1011
88.35	1001	0001	1010
88.40	1001	0001	1001
88.45	1001	0001	1000
88.50	1001	0001	0111
88.55	1001	0001	0110
88.60	1001	0001	0101
88.65	1001	0001	0100
88.70	1001	0001	0011
88.75	1001	0001	0010
88.80	1001	0001	0001
88.85	1001	0001	0000
88.90	1001	0000	1111
88.95	1001	0000	1110
89.00	1001	0000	1101
89.05	1001	0000	1100
89.10	1001	0000	1011
89.15	1001	0000	1010
89.20	1001	0000	1001
89.25	1001	0000	1000
89.30	1001	0000	0111
89.35	1001	0000	0110
89.40	1001	0000	0101
89.45	1001	0000	0100
89.50	1001	0000	0011
89.55	1001	0000	0010
89.60	1001	0000	0001
89.65	1001	0000	0000
89.70	1000	1111	1111
89.75	1000	1111	1110
89.80	1000	1111	1101
89.85	1000	1111	1100
89.90	1000	1111	1011
89.95	1000	1111	1010
90.00	1000	1111	1001
90.05	1000	1111	1000

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
90.10	1000	1111	0111
90.15	1000	1111	0110
90.20	1000	1111	0101
90.25	1000	1111	0100
90.30	1000	1111	0011
90.35	1000	1111	0010
90.40	1000	1111	0001
90.45	1000	1111	0000
90.50	1000	1110	1111
90.55	1000	1110	1110
90.60	1000	1110	1101
90.65	1000	1110	1100
90.70	1000	1110	1011
90.75	1000	1110	1010
90.80	1000	1110	1001
90.85	1000	1110	1000
90.90	1000	1110	0111
90.95	1000	1110	0110
91.00	1000	1110	0101
91.05	1000	1110	0100
91.10	1000	1110	0011
91.15	1000	1110	0010
91.20	1000	1110	0001
91.25	1000	1110	0000
91.30	1000	1101	1111
91.35	1000	1101	1110
91.40	1000	1101	1101
91.45	1000	1101	1100
91.50	1000	1101	1011
91.55	1000	1101	1010
91.60	1000	1101	1001
91.65	1000	1101	1000
91.70	1000	1101	0111
91.75	1000	1101	0110
91.80	1000	1101	0101
91.85	1000	1101	0100
91.90	1000	1101	0011
91.95	1000	1101	0010
92.00	1000	1101	0001
92.05	1000	1101	0000
92.10	1000	1100	1111
92.15	1000	1100	1110
92.20	1000	1100	1101
92.25	1000	1100	1100
92.30	1000	1100	1011
92.35	1000	1100	1010
92.40	1000	1100	1001
92.45	1000	1100	1000
92.50	1000	1100	0111
92.55	1000	1100	0110
92.60	1000	1100	0101
92.65	1000	1100	0100

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
92.70	1000	1100	0011
92.75	1000	1100	0010
92.80	1000	1100	0001
92.85	1000	1100	0000
92.90	1000	1011	1111
92.95	1000	1011	1110
93.00	1000	1011	1101
93.05	1000	1011	1100
93.10	1000	1011	1011
93.15	1000	1011	1010
93.20	1000	1011	1001
93.25	1000	1011	1000
93.30	1000	1011	0111
93.35	1000	1011	0110
93.40	1000	1011	0101
93.45	1000	1011	0100
93.50	1000	1011	0011
93.55	1000	1011	0010
93.60	1000	1011	0001
93.65	1000	1011	0000
93.70	1000	1010	1111
93.75	1000	1010	1110
93.80	1000	1010	1101
93.85	1000	1010	1100
93.90	1000	1010	1011
93.95	1000	1010	1010
94.00	1000	1010	1001
94.05	1000	1010	1000
94.10	1000	1010	0111
94.15	1000	1010	0110
94.20	1000	1010	0101
94.25	1000	1010	0100
94.30	1000	1010	0011
94.35	1000	1010	0010
94.40	1000	1010	0001
94.45	1000	1010	0000
94.50	1000	1001	1111
94.55	1000	1001	1110
94.60	1000	1001	1101
94.65	1000	1001	1100
94.70	1000	1001	1011
94.75	1000	1001	1010
94.80	1000	1001	1001
94.85	1000	1001	1000
94.90	1000	1001	0111
94.95	1000	1001	0110
95.00	1000	1001	0101
95.05	1000	1001	0100
95.10	1000	1001	0011
95.15	1000	1001	0010
95.20	1000	1001	0001
95.25	1000	1001	0000

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
95.30	1000	1000	1111
95.35	1000	1000	1110
95.40	1000	1000	1101
95.45	1000	1000	1100
95.50	1000	1000	1011
95.55	1000	1000	1010
95.60	1000	1000	1001
95.65	1000	1000	1000
95.70	1000	1000	0111
95.75	1000	1000	0110
95.80	1000	1000	0101
95.85	1000	1000	0100
95.90	1000	1000	0011
95.95	1000	1000	0010
96.00	1000	1000	0001
96.05	1000	1000	0000
96.10	1000	0111	1111
96.15	1000	0111	1110
96.20	1000	0111	1101
96.25	1000	0111	1100
96.30	1000	0111	1011
96.35	1000	0111	1010
96.40	1000	0111	1001
96.45	1000	0111	1000
96.50	1000	0111	0111
96.55	1000	0111	0110
96.60	1000	0111	0101
96.65	1000	0111	0100
96.70	1000	0111	0011
96.75	1000	0111	0010
96.80	1000	0111	0001
96.85	1000	0111	0000
96.90	1000	0110	1111
96.95	1000	0110	1110
97.00	1000	0110	1101
97.05	1000	0110	1100
97.10	1000	0110	1011
97.15	1000	0110	1010
97.20	1000	0110	1001
97.25	1000	0110	1000
97.30	1000	0110	0111
97.35	1000	0110	0110
97.40	1000	0110	0101
97.45	1000	0110	0100
97.50	1000	0110	0011
97.55	1000	0110	0010
97.60	1000	0110	0001
97.65	1000	0110	0000
97.70	1000	0101	1111
97.75	1000	0101	1110
97.80	1000	0101	1101
97.85	1000	0101	1100

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
97.90	1000	0101	1011
97.95	1000	0101	1010
98.00	1000	0101	1001
98.05	1000	0101	1000
98.10	1000	0101	0111
98.15	1000	0101	0110
98.20	1000	0101	0101
98.25	1000	0101	0100
98.30	1000	0101	0011
98.35	1000	0101	0010
98.40	1000	0101	0001
98.45	1000	0101	0000
98.50	1000	0100	1111
98.55	1000	0100	1110
98.60	1000	0100	1101
98.65	1000	0100	1100
98.70	1000	0100	1011
98.75	1000	0100	1010
98.80	1000	0100	1001
98.85	1000	0100	1000
98.90	1000	0100	0111
98.95	1000	0100	0110
99.00	1000	0100	0101
99.05	1000	0100	0100
99.10	1000	0100	0011
99.15	1000	0100	0010
99.20	1000	0100	0001
99.25	1000	0100	0000
99.30	1000	0011	1111
99.35	1000	0011	1110
99.40	1000	0011	1101
99.45	1000	0011	1100
99.50	1000	0011	1011
99.55	1000	0011	1010
99.60	1000	0011	1001
99.65	1000	0011	1000
99.70	1000	0011	0111
99.75	1000	0011	0110
99.80	1000	0011	0101
99.85	1000	0011	0100
99.90	1000	0011	0011
99.95	1000	0011	0010
100.00	1000	0011	0001
100.05	1000	0011	0000
100.10	1000	0010	1111
100.15	1000	0010	1110
100.20	1000	0010	1101
100.25	1000	0010	1100
100.30	1000	0010	1011
100.35	1000	0010	1010
100.40	1000	0010	1001
100.45	1000	0010	1000

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
100.50	1000	0010	0111
100.55	1000	0010	0110
100.60	1000	0010	0101
100.65	1000	0010	0100
100.70	1000	0010	0011
100.75	1000	0010	0010
100.80	1000	0010	0001
100.85	1000	0010	0000
100.90	1000	0001	1111
100.95	1000	0001	1110
101.00	1000	0001	1101
101.05	1000	0001	1100
101.10	1000	0001	1011
101.15	1000	0001	1010
101.20	1000	0001	1001
101.25	1000	0001	1000
101.30	1000	0001	0111
101.35	1000	0001	0110
101.40	1000	0001	0101
101.45	1000	0001	0100
101.50	1000	0001	0011
101.55	1000	0001	0010
101.60	1000	0001	0001
101.65	1000	0001	0000
101.70	1000	0000	1111
101.75	1000	0000	1110
101.80	1000	0000	1101
101.85	1000	0000	1100
101.90	1000	0000	1011
101.95	1000	0000	1010
102.00	1000	0000	1001
102.05	1000	0000	1000
102.10	1000	0000	0111
102.15	1000	0000	0110
102.20	1000	0000	0101
102.25	1000	0000	0100
102.30	1000	0000	0011
102.35	1000	0000	0010
102.40	1000	0000	0001
102.45	1000	0000	0000
102.50	0111	1111	1111
102.55	0111	1111	1110
102.60	0111	1111	1101
102.65	0111	1111	1100
102.70	0111	1111	1011
102.75	0111	1111	1010
102.80	0111	1111	1001
102.85	0111	1111	1000
102.90	0111	1111	0111
102.95	0111	1111	0110
103.00	0111	1111	0101
103.05	0111	1111	0100

FREQ MHZ	JUMPERS LKJI	HGJE	DCBA
103.10	0111	1111	0011
103.15	0111	1111	0010
103.20	0111	1111	0001
103.25	0111	1111	0000
103.30	0111	1110	1111
103.35	0111	1110	1110
103.40	0111	1110	1101
103.45	0111	1110	1100
103.50	0111	1110	1011
103.55	0111	1110	1010
103.60	0111	1110	1001
103.65	0111	1110	1000
103.70	0111	1110	0111
103.75	0111	1110	0110
103.80	0111	1110	0101
103.85	0111	1110	0100
103.90	0111	1110	0011
103.95	0111	1110	0010
104.00	0111	1110	0001
104.05	0111	1110	0000
104.10	0111	1101	1111
104.15	0111	1101	1110
104.20	0111	1101	1101
104.25	0111	1101	1100
104.30	0111	1101	1011
104.35	0111	1101	1010
104.40	0111	1101	1001
104.45	0111	1101	1000
104.50	0111	1101	0111
104.55	0111	1101	0110
104.60	0111	1101	0101
104.65	0111	1101	0100
104.70	0111	1101	0011
104.75	0111	1101	0010
104.80	0111	1101	0001
104.85	0111	1101	0000
104.90	0111	1100	1111
104.95	0111	1100	1110
105.00	0111	1100	1101
105.05	0111	1100	1100
105.10	0111	1100	1011
105.15	0111	1100	1010
105.20	0111	1100	1001
105.25	0111	1100	1000
105.30	0111	1100	0111
105.35	0111	1100	0110
105.40	0111	1100	0101
105.45	0111	1100	0100
105.50	0111	1100	0011
105.55	0111	1100	0010
105.60	0111	1100	0001
105.65	0111	1100	0000

FREQ MHZ	JUMPERS LKJI	HGFE	DCBA
105.70	0111	1011	1111
105.75	0111	1011	1110
105.80	0111	1011	1101
105.85	0111	1011	1100
105.90	0111	1011	1011
105.95	0111	1011	1010
106.00	0111	1011	1001
106.05	0111	1011	1000
106.10	0111	1011	0111
106.15	0111	1011	0110
106.20	0111	1011	0101
106.25	0111	1011	0100
106.30	0111	1011	0011
106.35	0111	1011	0010
106.40	0111	1011	0001
106.45	0111	1011	0000
106.50	0111	1010	1111
106.55	0111	1010	1110
106.60	0111	1010	1101
106.65	0111	1010	1100
106.70	0111	1010	1011
106.75	0111	1010	1010
106.80	0111	1010	1001
106.85	0111	1010	1000
106.90	0111	1010	0111
106.95	0111	1010	0110
107.00	0111	1010	0101
107.05	0111	1010	0100
107.10	0111	1010	0011
107.15	0111	1010	0010
107.20	0111	1010	0001
107.25	0111	1010	0000
107.30	0111	1001	1111
107.35	0111	1001	1110
107.40	0111	1001	1101
107.45	0111	1001	1100
107.50	0111	1001	1011
107.55	0111	1001	1010
107.60	0111	1001	1001
107.65	0111	1001	1000
107.70	0111	1001	0111
107.75	0111	1001	0110
107.80	0111	1001	0101
107.85	0111	1001	0100
107.90	0111	1001	0011
107.95	0111	1001	0010
108.00	0111	1001	0001
108.05	0111	1001	0000

LEGEND: JUMPER IN = 0
JUMPER OUT = 1

2164-600-6

TABLE 4-1. FREQUENCY PROGRAM CHART

detector/delay detects lock, U16 is switched out and the RC low-pass filter is connected in the signal path. The output provides control voltage to the MOD OSC module VCO assembly for frequency correction. An additional output to the dc meter circuit provides an indication of the dc output control voltage which usually ranges from positive one volt to +12 Vdc.

4-24. POWER. An input of positive five volts dc from the exciter power supply is internally filtered to operate the logic circuitry. The +5V indicator provides an indication of the operation of the five volt source. An additional input of +20 Vdc applied through R36 is stabilized by zener diode CR6 to provide +15 volt potential. Re-regulated ±15 Vdc inputs from the MOD OSC module provide ±15 Vdc potentials to operate the AFC/PLL MODULE loop filter circuit.

SECTION V

MAINTENANCE

5-1. CORRECTIVE MAINTENANCE

5-2. The FM Exciter module maintenance philosophy consists of problem isolation to a specific area or individual component and subsequent isolation and replacement of the defective component.

5-3. TROUBLESHOOTING

5-4. In event of problems, the trouble area must first be isolated to a specific area. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, fuse F1, circuit breaker CB1, and the indicators on each module should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs which indicate a problem associated with an individual module monolithic voltage regulator. A consistent pattern of dark LEDs however, would indicate an exciter dc distribution bus fault.

5-5. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-1 lists typical trouble symptoms pertaining to the individual module operation with references to fault isolation diagrams listing probable causes and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem. It only tends to lead the repairman into the area that may be causing the trouble. An extender board (HARRIS PN 992 4989 001) is provided with the exciter to assist in troubleshooting. In event parts are required, refer to Section VI, Parts List. The following information is contained in this section as an aid to maintenance:

REFERENCE	TITLE	NUMBER
Figure 5-1	AFC/PLL MODULE Parts Layout	--- ---- ---
Figure 5-2	AFC/PLL MODULE Waveforms	--- ---- ---
Figure 5-3	AFC/PLL MODULE Schematic	839 6123 002

Table 5-1. AFC/PLL MODULE Fault Isolation Index

LOOP WILL NOT LOCK (LOCK indicator out).	Figure 5-4
LOOP LOCKS ON INCORRECT FREQUENCY (LOCK indicator illuminated).	Figure 5-5
NOISE	Figure 5-6
3125 HZ WHINE	Figure 5-7
SLOW WAVERING OF FREQUENCY (LOCK indicator illuminated).	Figure 5-8
LOOP LOCKS THEN QUICKLY UNLOCKS	Figure 5-9
OUTPUT OFF FREQUENCY	Refer to table 3-2 and adjust the FREQ ADJ Control.

WARNING: Disconnect primary power prior to servicing.

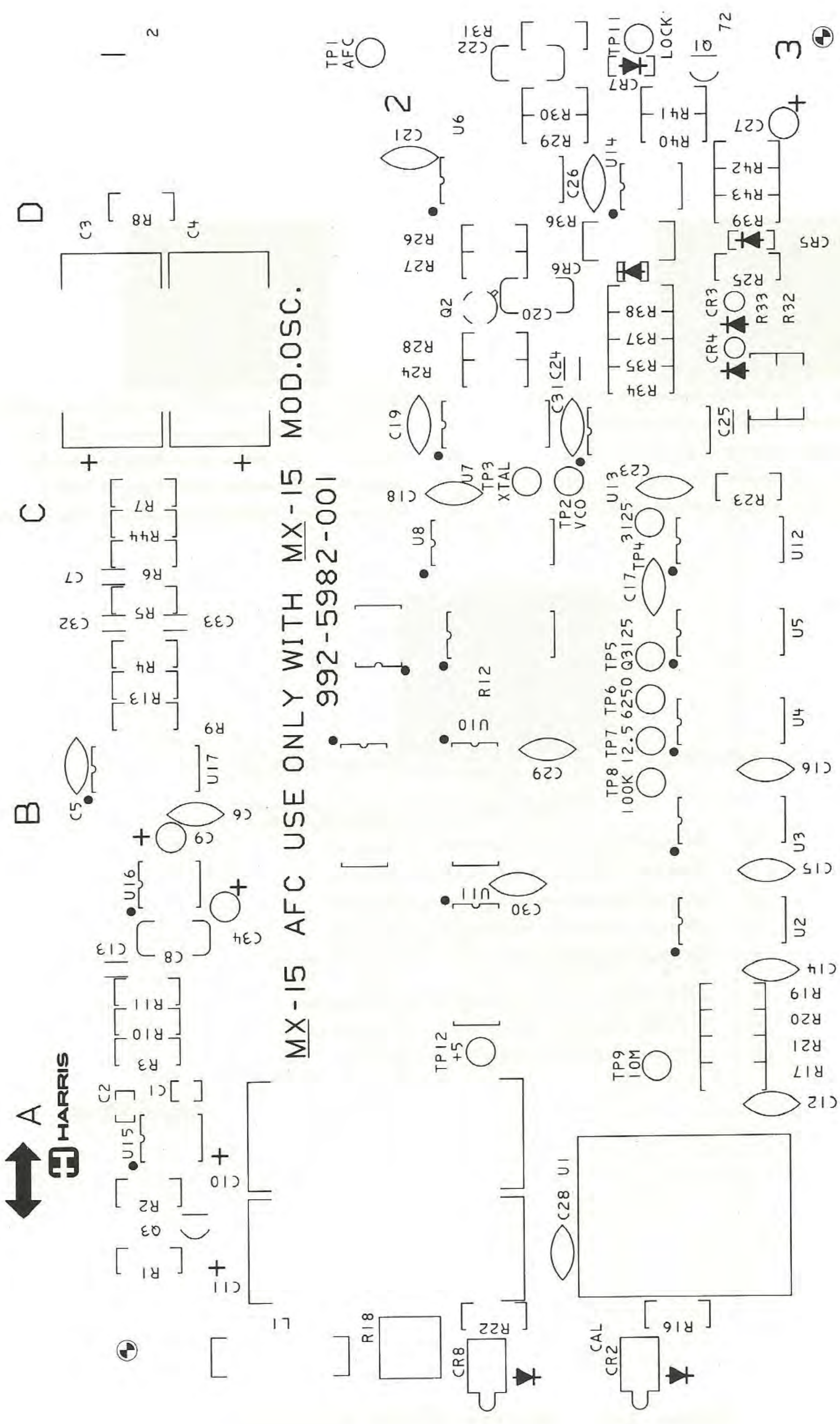
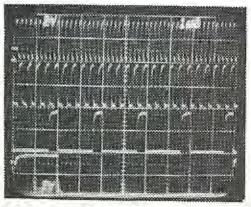


Figure 5-1. AFC/PLL MODULE Parts Layout

1A
1B
1C
1D



TEST REQUIREMENTS: A. Oscilloscope synchronized to U3 pin 11.

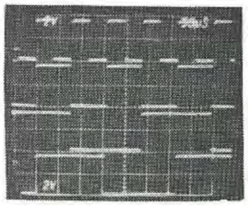
1A Reference counter waveform at U2 pin 12 (5 MHz).

1B Reference counter waveform at U3 pin 13 (2.5 MHz).

1C Reference counter waveform at U2 pin 11 (500 kHz).

1D. Reference counter waveform at U3 pin 11 (100 kHz).

2A
2B
2C
2D



TEST REQUIREMENTS: A. Oscilloscope synchronized to test point TP4.

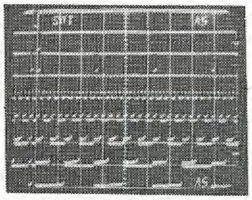
2A Reference counter waveform at test point TP7 (12.5 kHz).

2B Reference counter waveform at test point TP6 (6250 Hz).

2C Reference counter waveform at test point TP4 (3125 Hz).

2D Reference counter waveform at test point TP5 (3125 Hz delayed 90°).

3A
3B
3C
3D
3E
3F
3G
3H



TEST REQUIREMENTS: A. Oscilloscope adjusted for delayed sweep display and synchronized to U12 pin 9.

B. Exciter frequency set to 96.6 MHz. (Other channels will yeild similar, but not identical waveforms.

3A Synchronous programmable divider waveform at U8 pin 13.

3B Synchronous programmable divider waveform at U8 pin 12.

3C Synchronous programmable divider waveform at U8 pin 11.

3D Synchronous programmable divider waveform at U8 pin 10.

3E Synchronous programmable divider clock at U8 pin 2, U10 pin 2, U11 pin 2, or U12 pin 11.

3F Synchronous programmable divider ripple carry at U8 pin 15.

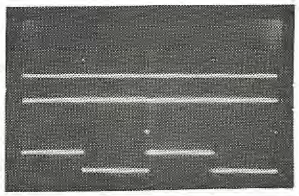
3G Synchronous programmable divider ripple carry at U11 pin 15.

3H Synchronous programmable divider output at U12 pin 9.

2164-600-7

Figure 5-2. AFC/PLL MODULE Waveforms

WARNING: Disconnect primary power prior to servicing.



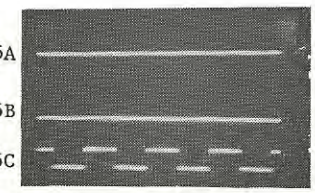
4A
4B
4C

TEST REQUIREMENTS: A. Oscilloscope synchronized to test point TP4.

4A Phase detector waveform at U15 pins 5 and 10 with VCO lagging in phase.

4B Phase detector waveform at U15 pins 5 and 10 with VCO leading in phase.

4C 3125 Hz reference at U15 pin 1.



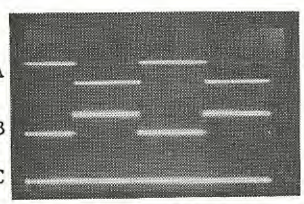
5A
5B
5C

TEST REQUIREMENTS: A. Oscilloscope synchronized to test point TP4.

5A Phase detector waveform at U15 pin 5 with the VCO frequency too high.

5B 3125 Hz reference at U15 pin 3.

5C Phase detector waveform at U15 pin 5 with the VCO frequency too low.



6A
6B
6C

TEST REQUIREMENTS: A. Oscilloscope synchronized to test point TP4.

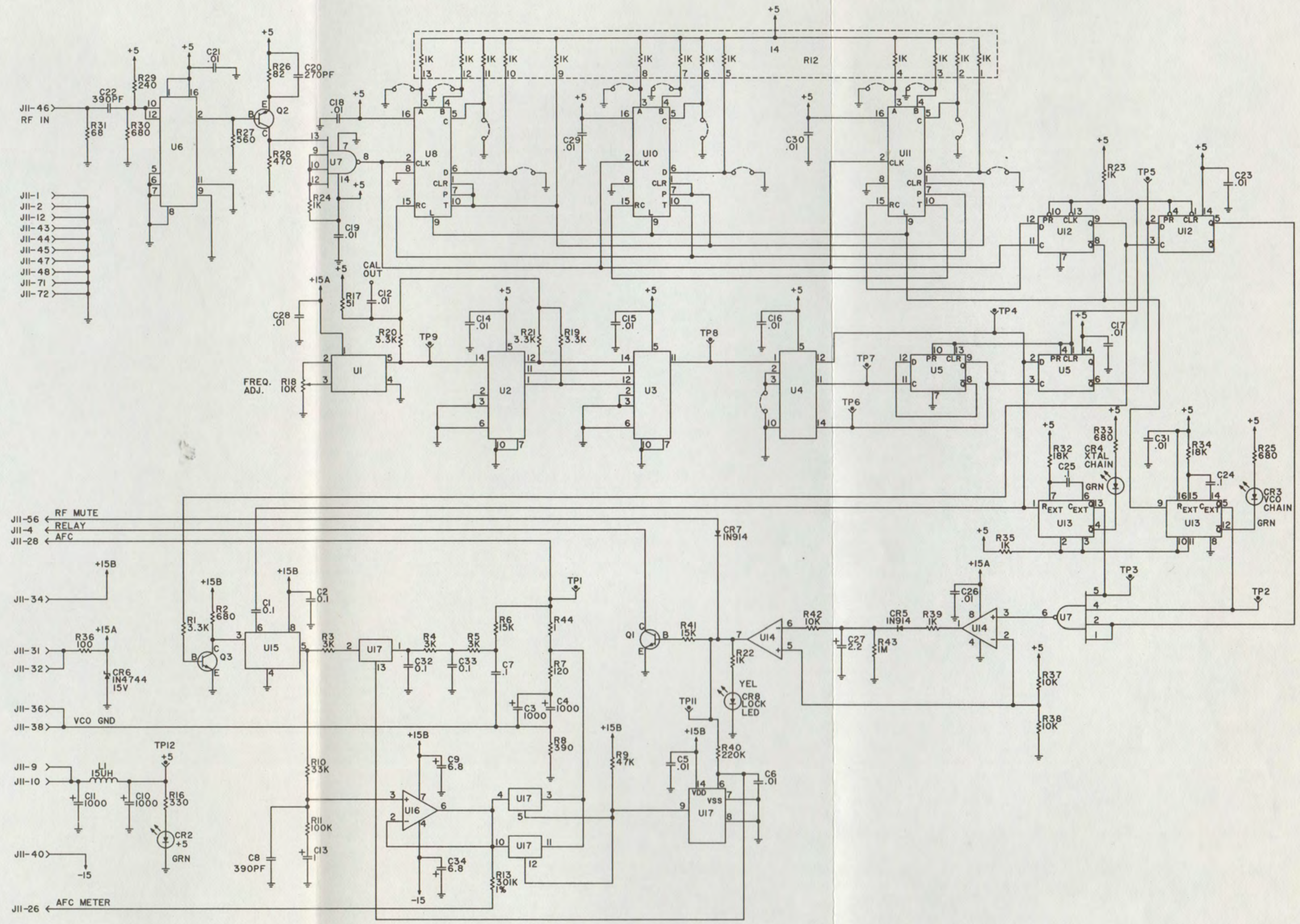
6A Programmable divider output at U12 pin 9.

6B Lock detector waveform at U4 pin 12 (3125 Hz reference).

6C Lock detector waveform at U5 pin 5 (3125 Hz delayed 90°).

2164-600-8

Figure 5-2. AFC/PLL MODULE Waveforms (Continued)



4. U2,U3 = 74LS90 U4 = 74LS93 U5,U12 = 74LS74
U6 = MC10178L U7 = 74LS20N U8,U10,U11 = 74LS161
U13 = SN74123N U14 = LM358P U15 = MM74C932N
U16 = LM318 U17 = CD4066BCN

3. Q1,Q3 = 2N3904 Q2 = 2N4258

2. RESISTORS ARE IN OHMS, 1/2 WATT, 5%

1. CAPACITANCE IN UF

UNLESS OTHERWISE NOTED:

FIGURE 5-3. AFC/PLL MODULE
SCHEMATIC
839 6123 002

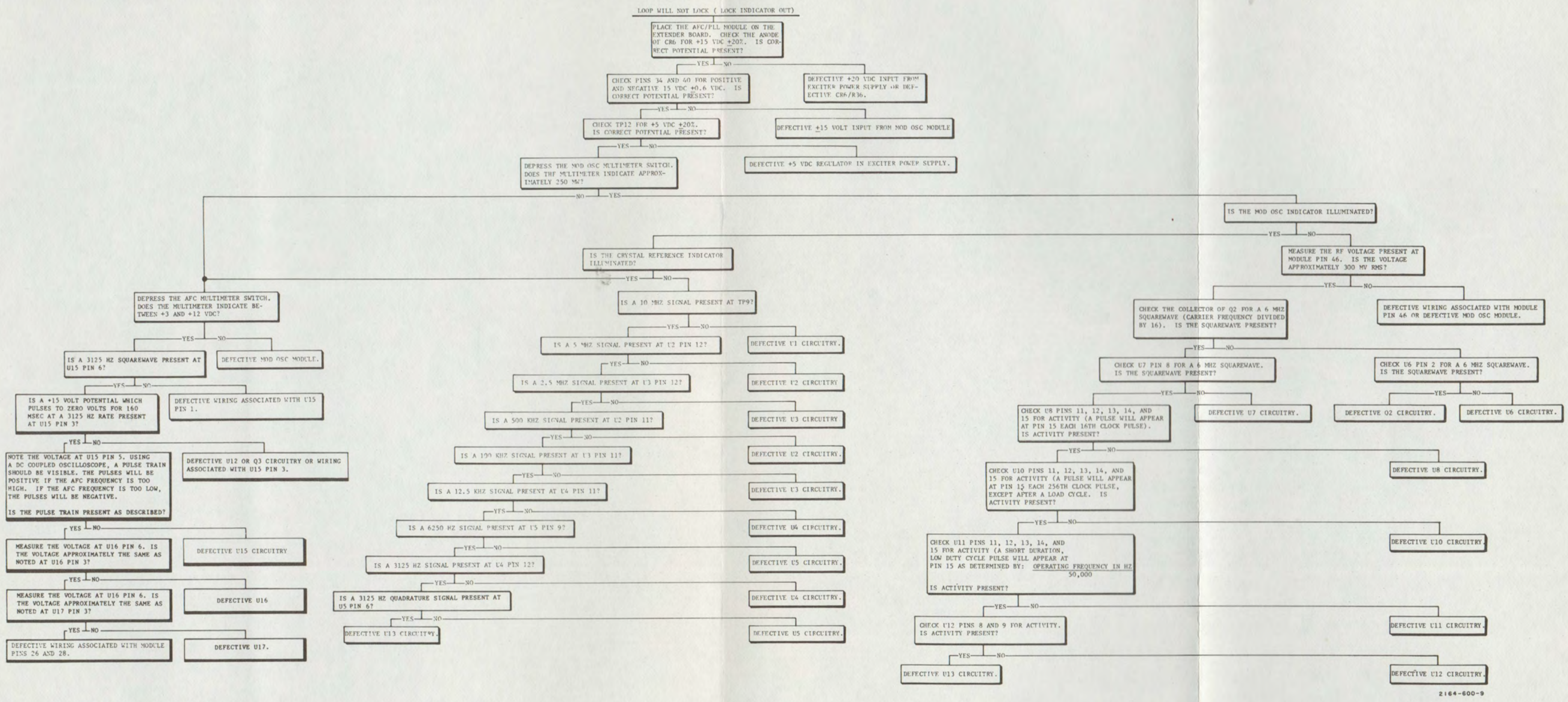


FIGURE 5-4. LOOP WILL NOT LOCK (LOCK INDICATOR OUT)

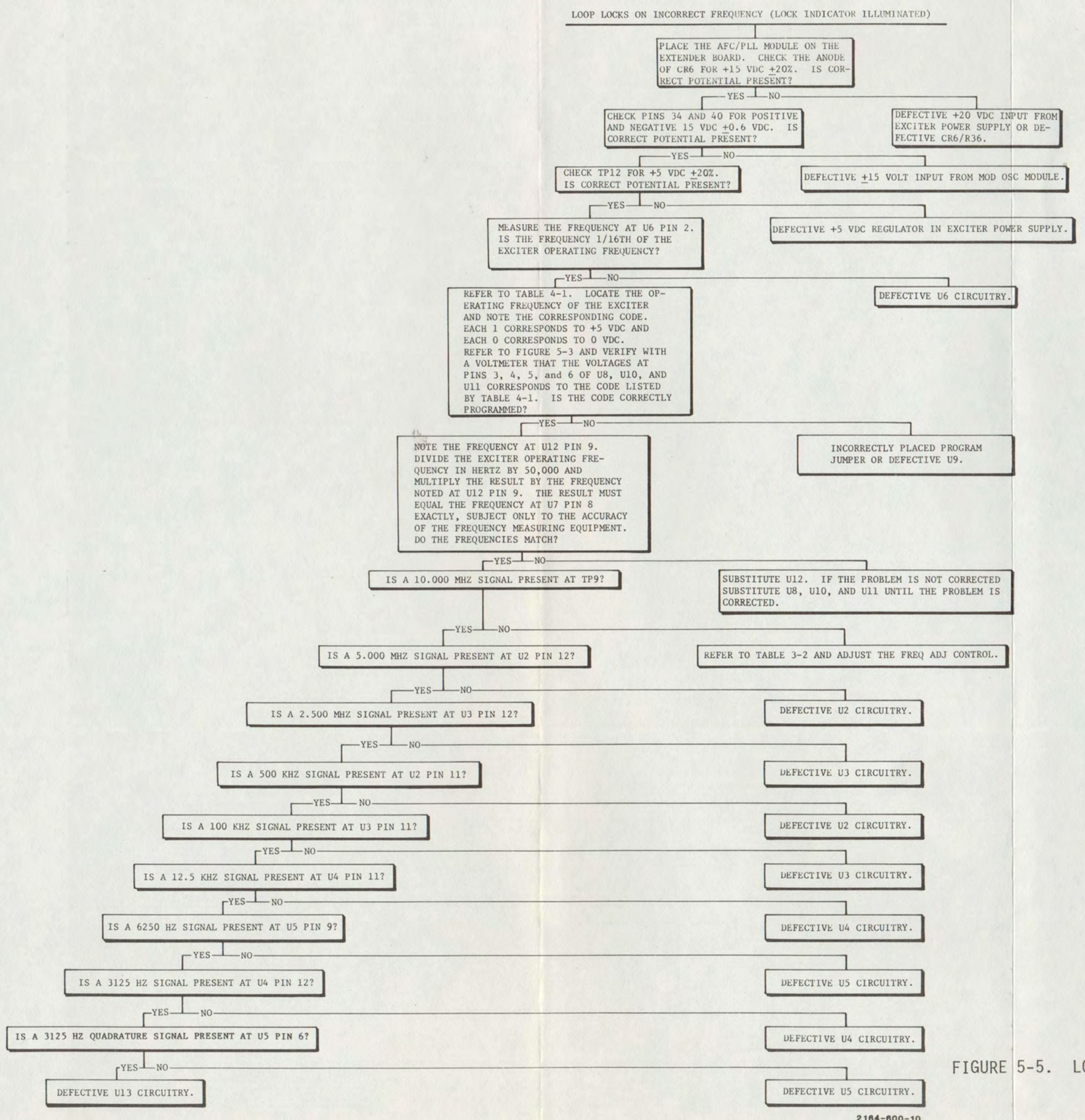


FIGURE 5-5. LOOP LOCKS ON INCORRECT FREQUENCY (LOCK INDICATOR ILLUMINATED)

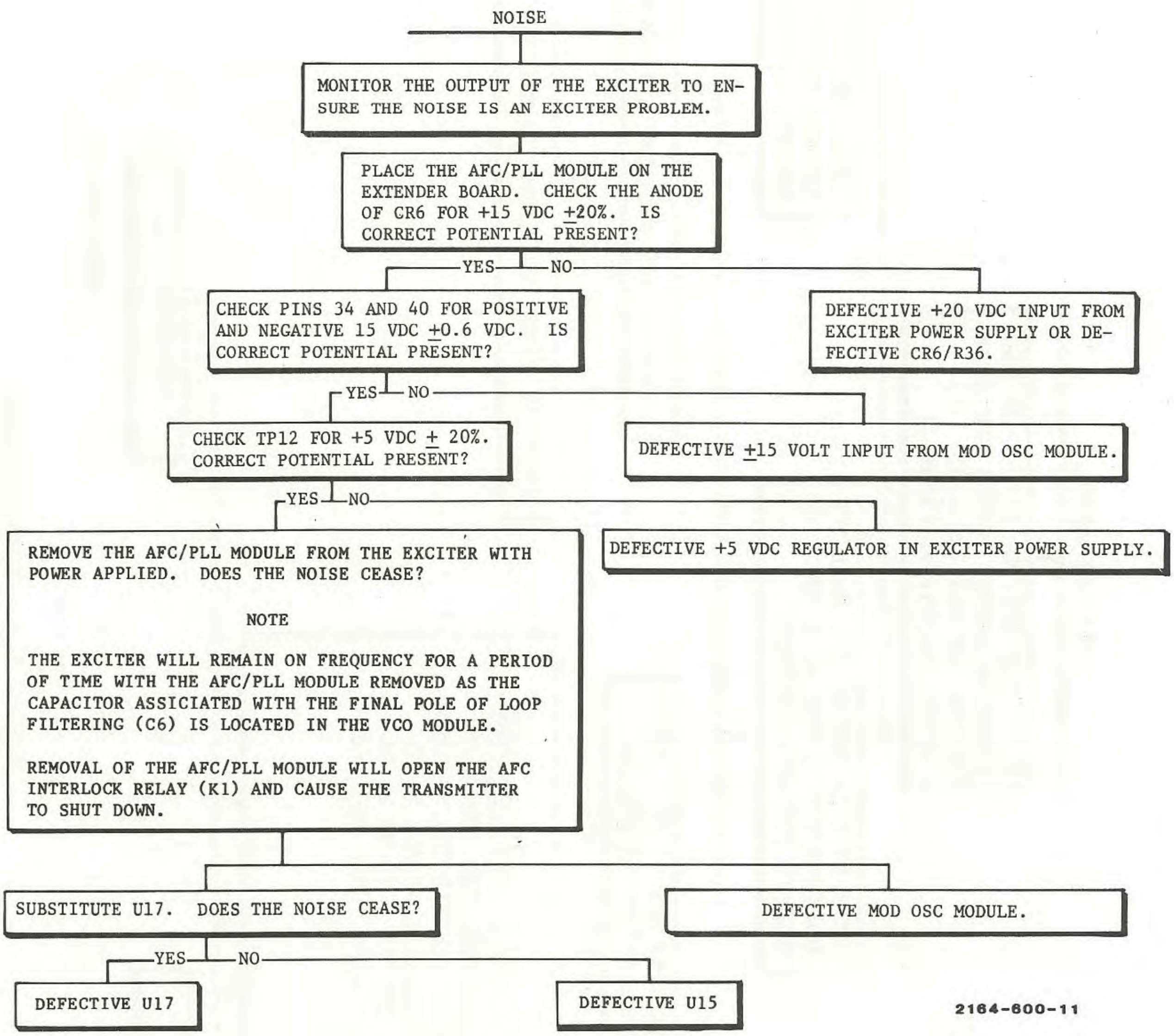
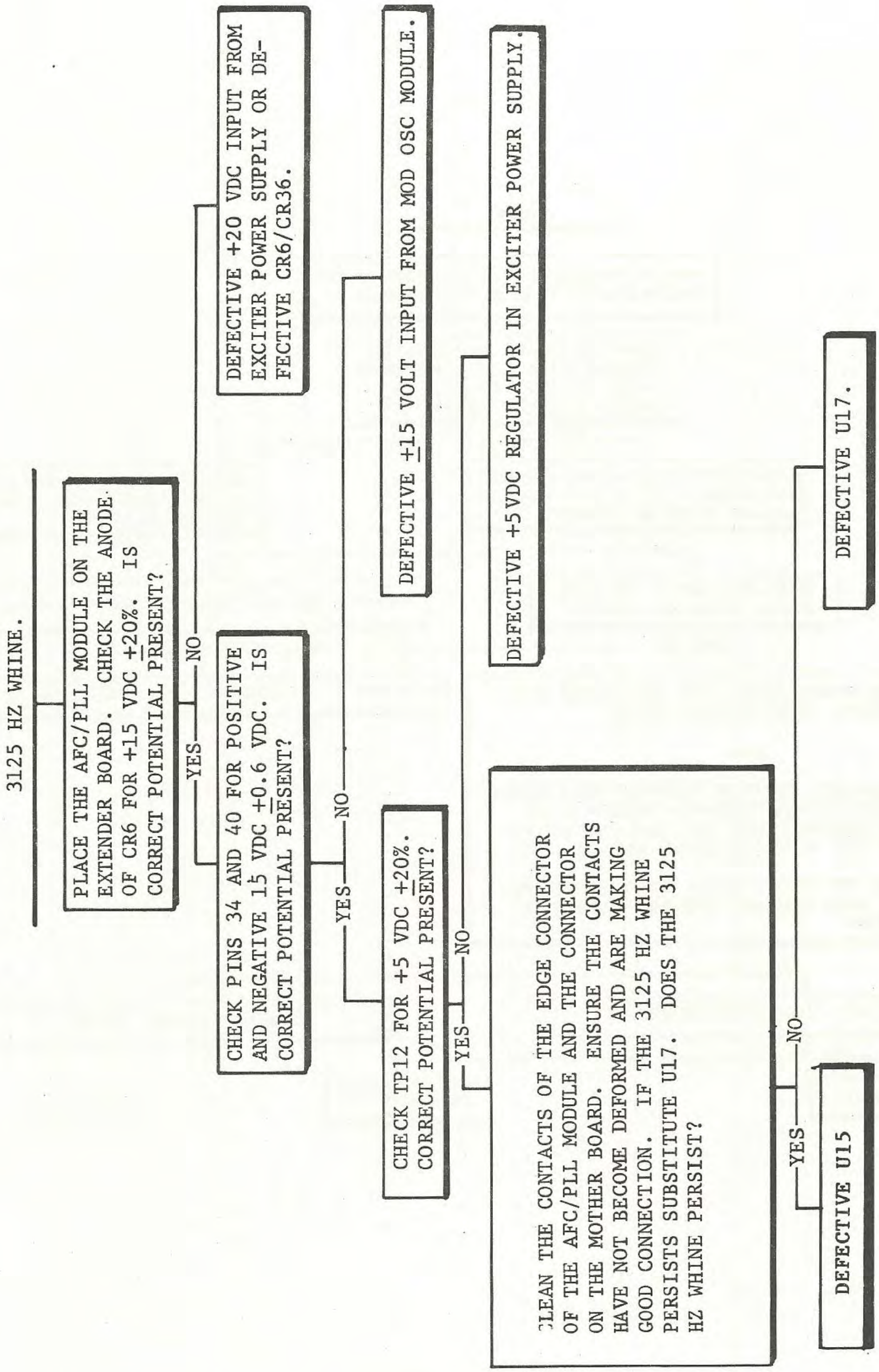


Figure 5-6. Noise

WARNING: Disconnect primary power prior to servicing.



2164-600-12

Figure 5-7. 3125 Hz Whine

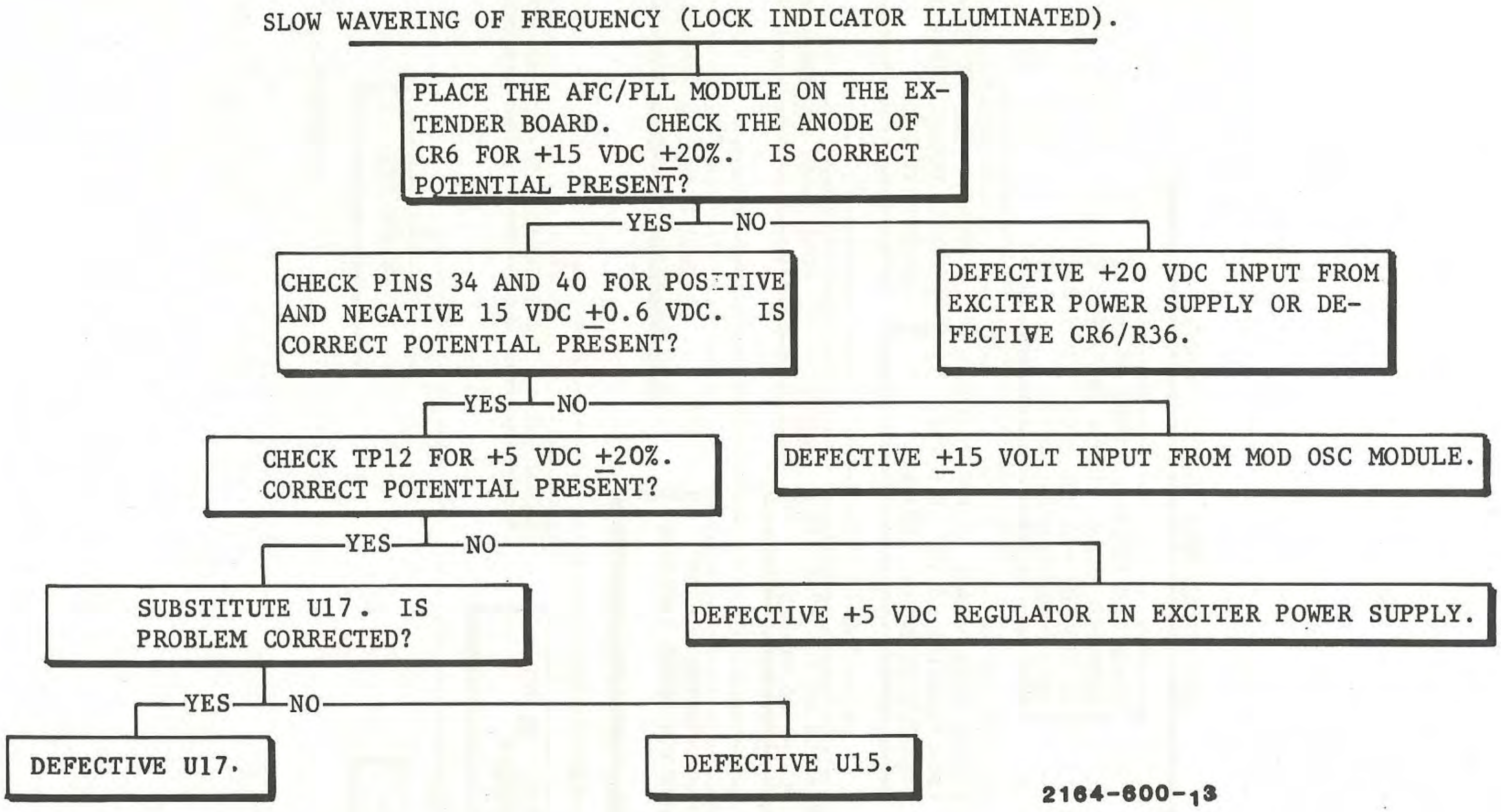
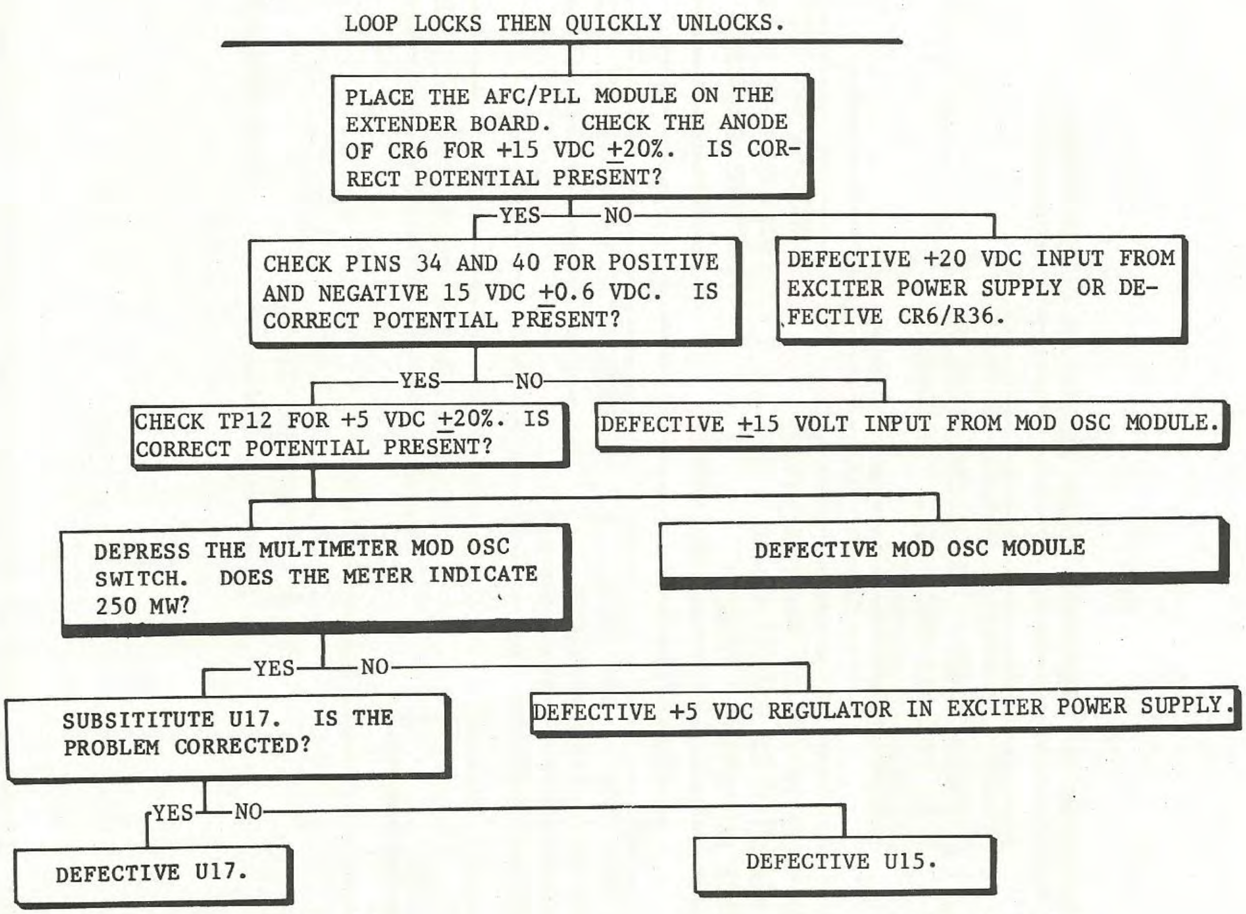


Figure 5-8. Slow Wavering of Frequency (Lock Indicator Illuminated)



2164-600-14

Figure 5-9. Loop Locks Then Quickly Unlocks

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. Refer to table 6-1 for replaceable parts which are required for proper maintenance of the AFC/PLL module. Table entries are indexed by component reference designator.

Table 6-1. Replaceable Parts List Index

TABLE NO.	UNIT NOMENCLATURE	PART NO.	PAGE
6-2	AUTO FREQ CONTROL MOD.	992 5981 001	33
6-3	PWB, AFC	992 5982 001	34

WARNING: Disconnect primary power prior to servicing

Table 6-2. AUTO FREQ CONTROL MOD. - 992 5981 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	350 0048 000	RIVET POP .093X.337	2
	358 2037 000	BALL STUD 6-32X 3/16	1
	448 0623 000	SPRING CATCH	1
	813 5007 047	STANDOFF 1.017 LG	1
	813 5092 779	SPACER .25D X .165L	2
	829 2617 001	BLOCK	1
	829 2618 001	BLOCK	1
	839 3254 001	SHIELD	1
	843 1734 002	COVER	1
	929 2007 001	FRONT PANEL, AFC	1
	939 2389 001	PLATE, CARD MTG	1
	939 3180 001	EXTRACTOR, SMALL CD.	1
	992 5982 001	PWB, AFC	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. PWB, AFC - 992 5982 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR2	384 0661 000	L.E.D. GREEN	1
CR3,CR4	384 0610 000	LED, GREEN	2
CR5	384 0205 000	DIODE SILICON 1N914	1
CR6	386 0092 000	DIODE ZENER 1N4744	1
CR7	384 0205 000	DIODE SILICON 1N914	1
CR8	384 0664 000	L.E.D. YELLOW	1
C1,C2	516 0453 000	CAP .1UF 100V 20%	2
C3,C4	522 0391 000	CAP 1000UF 16V	2
C5,C6	516 0375 000	CAP .01UF 50V	2
C7	516 0484 000	CAP. .1UF 100V 10%	1
C8	500 0833 000	CAP, MICA 390PF 500V 5%	1
C9	526 0049 000	CAP 6.8UF 35V 20%	1
C10,C11	522 0422 000	CAP 1000 UF 10V	2
C12	516 0375 000	CAP .01UF 50V	1
C13	526 0050 000	CAP 1 UF 35V 20%	1
C14 thru C19	516 0375 000	CAP .01UF 50V	6
C20	500 0755 000	CAP, MICA 270PF 500V 5%	1
C21	516 0375 000	CAP .01UF 50V	1
C22	500 0833 000	CAP, MICA 390PF 500V 5%	1
C23	516 0375 000	CAP .01UF 50V	1
C24,C25	516 0484 000	CAP. .1UF 100V 10%	2
C26	516 0375 000	CAP .01UF 50V	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. PWB, AFC - 992 5982 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C27	526 0311 000	CAP 2.2UF 35V 10%	1
C28 thru C31	516 0375 000	CAP .01UF 50V	4
C32,C33	516 0484 000	CAP. .1UF 100V 10%	2
C34	526 0049 000	CAP 6.8UF 35V 20%	1
L1	494 0436 000	CHOKE, RF, 15UH	1
Q1	380 0189 000	TRANSISTOR 2N3904	1
Q2	380 0421 000	TRANSISTOR PN4258-18	1
Q3	380 0189 000	TRANSISTOR 2N3904	1
R1	540 1165 000	RES 1/2W 3300 OHM 5%	1
R2	540 1181 000	RES 1/2W 680 OHM 5%	1
R3,R4,R5	540 1138 000	RES .5W 3000 OHM 5%	3
R6	540 1184 000	RES 1/2W 15K OHM 5%	1
R7	540 1176 000	RES 1/2W 120 OHM 5%	1
R8	540 1164 000	RES 1/2W 390 OHM 5%	1
R9	540 1122 000	RES .5W 47K OHM 5%	1
R10	540 1109 000	RES .5W 33K OHM 5PCT	1
R11	540 1159 000	RES .5W 100K OHM 5%	1
R12	540 1331 000	RES NETWORK 1K OHM	1
R13	548 0317 000	RES 301K OHM 1/4W 1%	1
R16	540 1216 000	RES 1/2W 330 OHM 5%	1
R17	540 1192 000	RES 1/2W 51 OHM 5%	1
R18	550 0914 000	POT, 10K OHM	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. PWB, AFC - 992 5982 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R19,R20,R21	540 1165 000	RES 1/2W 3300 OHM 5%	3
R22,R23,R24	540 1116 000	RES .5W 1000 OHM 5%	3
R25	540 1181 000	RES 1/2W 680 OHM 5%	1
R26	540 1225 000	RES 1/2W 82 OHM 5%	1
R27	540 1191 000	RES 1/2W 560 OHM 5%	1
R28	540 1115 000	RES .5W 470 OHM 5PCT	1
R29	540 1190 000	RES 1/2W 240 OHM 5%	1
R30	540 1181 000	RES 1/2W 680 OHM 5%	1
R31	540 1110 000	RES .5W 68 OHM 5PCT	1
R32	540 1113 000	RES .5W 18K OHM 5PCT	1
R33	540 1181 000	RES 1/2W 680 OHM 5%	1
R34	540 1113 000	RES .5W 18K OHM 5PCT	1
R35	540 1116 000	RES .5W 1000 OHM 5%	1
R36	540 0308 000	RES 1W 100 OHM 5%	1
R37,R38	540 1111 000	RES .5W 10K OHM 5PCT	2
R39	540 1116 000	RES .5W 1000 OHM 5%	1
R40	540 1212 000	RES 1/2W 220K OHM 5%	1
R41	540 1184 000	RES 1/2W 15K OHM 5%	1
R42	540 1111 000	RES .5W 10K OHM 5PCT	1
R43	540 1162 000	RES 1/2W 1 MEGOHM 5%	1
R44	540 1101 000	RES .5W 1 OHM 5%	1
U1	700 0423 000	OSC, CRYSTAL 10MHZ	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. PWB, AFC - 992 5982 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
U2,U3	382 0732 000	IC, 74LS90	2
U4	382 0733 000	IC, 74LS93	1
U5	382 0561 000	IC 74LS74	1
U6	382 0541 000	CKT, INT	1
U7	382 0657 000	IC, 74LS20N, TTL GATE	1
U8,U10,U11	382 0623 000	INT CKT	3
U12	382 0561 000	IC 74LS74	1
U13	382 0148 000	IC SN74123N	1
U14	382 0428 000	IC LM358	1
U15	382 0735 000	IC, MM74C932N	1
U16	382 0472 000	CKT, INTEGRATED	1
U17	382 0523 000	IC, CMOS, MC14066BCPDS	1
XU2,XU3,XU4,XU5	404 0674 000	SOCKET, IC 14 CONT	4
XU6	404 0675 000	SOCKET, IC 16 CONT	1
XU7	404 0674 000	SOCKET, IC 14 CONT	1
XU8,XU10,XU11	404 0675 000	SOCKET, IC 16 CONT	3
XU12	404 0674 000	SOCKET, IC 14 CONT	1
XU13	404 0675 000	SOCKET, IC 16 CONT	1
XU14,XU15,XU16	404 0673 000	SOCKET, IC 8 CONT	3
XU17	404 0674 000	SOCKET, IC 14 CONT	1
	610 0750 000	TEST PROBE, TYPE C	1
	612 0890 000	TEST JACK VERT PC MT	11

WARNING: Disconnect primary power prior to servicing

Table 6-3. PWB, AFC - 992 5982 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	839 6123 002	SCHEMATIC	1
	843 3924 001	PC BOARD	1

WARNING: Disconnect primary power prior to servicing

MOD OSC MODULE
888-2164-704

TECHNICAL MANUAL

MOD OSC MODULE

992 5983 002

HARRIS

T.M. No. 888-2164-704

Printed: April 22, 1985

MANUAL REVISION HISTORY

MOD OSC MODULE

888-2164-7xx

REV. #	DATE	ECN	PAGES AFFECTED
703	11-14-83	27835	Replaced the following pages: Title Page v/vi, 1, 10, 13, 17, 18 Added the following page: Manual Revision History Page
704	04-22-85	29399	Replaced the following pages: Title Page, Manual Revision History Page 25/26 and 34

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

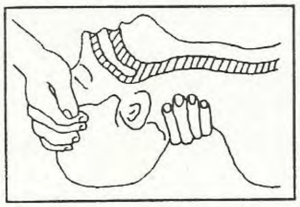
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

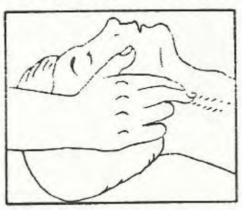
(A) AIRWAY

IF UNCONSCIOUS.
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

CHECK
CAROTID PULSE



IF PULSE ABSENT.
BEGIN ARTIFICIAL
CIRCULATION

(B) BREATHING

IF NOT BREATHING.
BEGIN ARTIFICIAL BREATHING

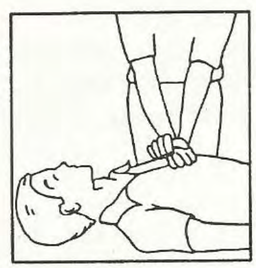
TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL
4 QUICK FULL BREATHS
REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES

APPROX. RATE OF COMPRESSIONS --80 PER MINUTE { ONE RESCUER: 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE { TWO RESCUERS: 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

A. KEEP THEM WARM
B. KEEP THEM AS QUIET AS POSSIBLE
C. LOOSEN THEIR CLOTHING
D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

NOTE

If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

WARNING: Disconnect primary power prior to servicing.

LIST OF TABLES

LIST OF ILLUSTRATIONS

WARNING: Disconnect primary power prior to servicing.

SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE

1-2. The MOD OSC MODULE contains the voltage controlled oscillator (VCO) assembly which generates the frequency modulated rf carrier from a composite modulating signal input. An rf amplifier chain on the module produces an rf output at 300 milliwatts to drive the RF AMP module and an output at two milliwatts is used as a feedback signal to the AFC/PLL module. The rf output frequency is controlled by a dc voltage obtained from the AFC/PLL module as part of phase locked frequency control. Level switching for different combinations of SCA, stereophonic, and monaural operation is also provided by the module.

1-3. TECHNICAL CHARACTERISTICS

1-4. Table 1-1 lists operating characteristics and parameters of the FM Exciter MOD OSC MODULE and VCO assembly.

SECTION II

INSTALLATION

2-1. GENERAL

2-2. Refer to FM Exciter System Technical Manual, Section II, Installation.

SECTION III

CONTROLS AND INDICATORS

3-1. GENERAL

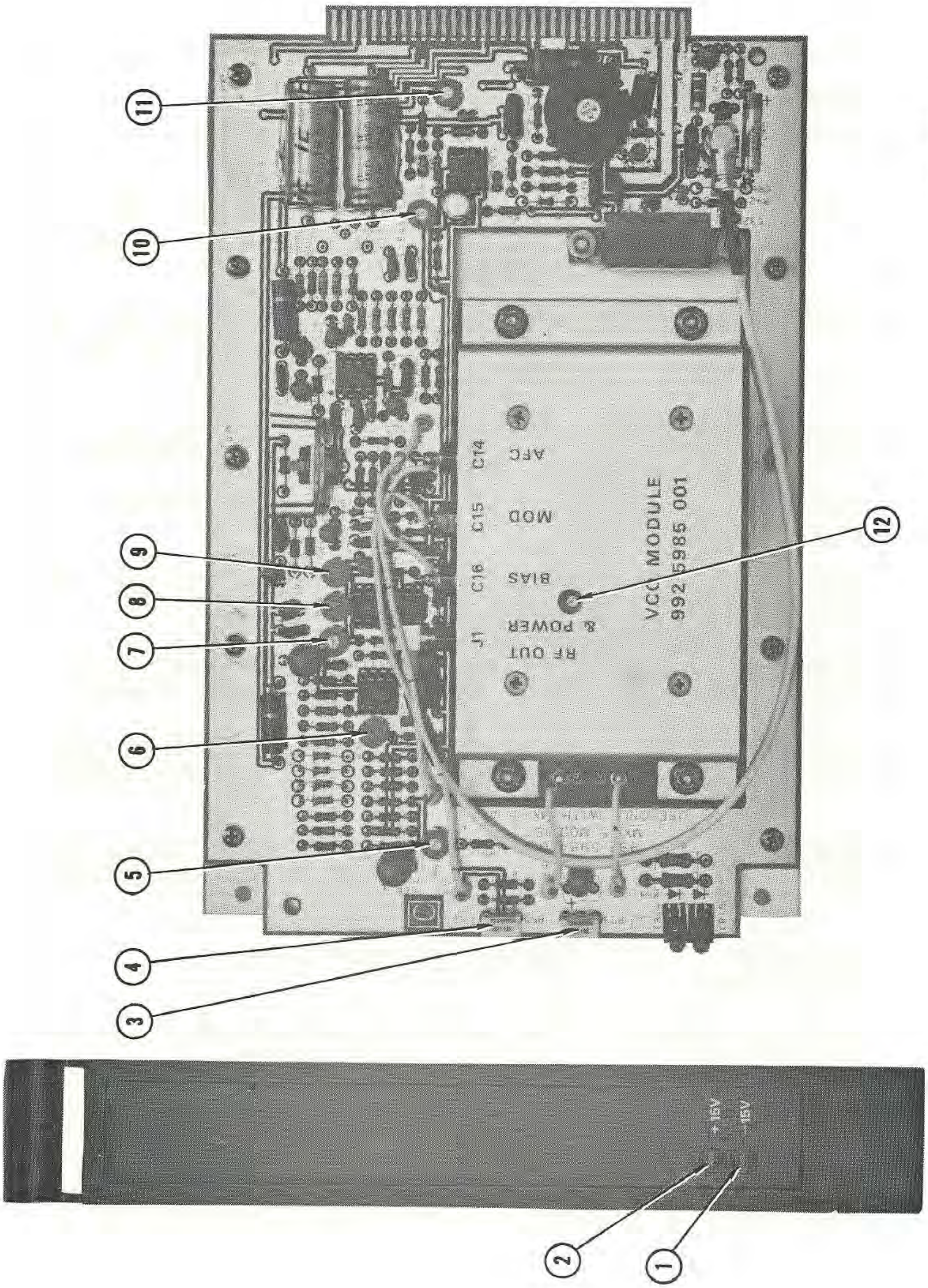
3-2. Figure 3-1 shows the location of each control or indicator associated with the FM Exciter MOD OSC MODULE and table 3-1 lists the controls and indicators with a description of each item listed. Control setup adjustments are listed in table 3-2.

WARNING: Disconnect primary power prior to servicing.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
POWER:	+20 Vdc @ 0.200 amperes -20 Vdc @ 0.025 amperes
SIGNAL:	
QUAD COMPOSITE	1.0 RMS for 100% modulation.
SCA 1/SCA 2 COMPOSITE	100 millivolts RMS for 10% modulation.
STEREO or MONO COMPOSITE	1.0 RMS for 100% modulation.
EXTERNAL COMPOSITE	1.0 RMS for 100% modulation.
CONTROL:	
AFC CONTROL VOLTAGE	+1 Vdc to +12 Vdc, Dependent upon exciter frequency.
SCA 1/2 CONTROL	+6 Vdc with SCA off. -6 Vdc with SCA on.
OUTPUTS	
POWER:	+15 Vdc @ 0.022 amperes -15 Vdc @ 0.018 amperes
SIGNAL:	
RF DRIVE	300 milliwatt on-frequency rf to RF AMP module.
PLL FEEDBACK	2 milliwatt (300 mV rms) on-frequency rf sample to AFC/PLL module.
DETECTED RF	3.5 Vdc to dc meter circuit
B-BAND AUDIO	1.0V RMS to ac meter circuit

WARNING: Disconnect primary power prior to servicing.



2164-700-1

Figure 3-1. MOD OSC MODULE

Table 3-1. MOD OSC MODULE Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	-15V Indicator (CR15)	Illuminates to indicate the MOD OSC MODULE -15 volt regulator is operational.
2	+15V Indicator (CR14)	Illuminates to indicate the MOD OSC MODULE +15 volt regulator is operational.
3 & 4	Humbucker Control R50 & R53	Reduces FM noise caused by ac interference in transmitter installations.
5	VCO GAIN Control (R52)	Adjusts VCO modulation sensitivity.
6	DIST. NULL Control (R70)	Adjusts amount of pre-distortion applied to modulating signal.
7	B-BAND LEVEL Control (R25)	Adjusts total modulation level for correct drive to pre-distortion network.
8	SCA-1 LEVEL SHIFT Control (R26)	Adjusts attenuation of modulating signal to allow SCA-1 injection without overmodulation.
9	SCA-2 LEVEL SHIFT Control (R27)	Adjusts attenuation of modulating signal to allow SCA-2 injection without overmodulation.
10	RF Output Control R33	Adjusts RF output level.
11	RF POWER CALIBRATE Control (R36)	Calibrates exciter MULTIMETER MOD OSC module rf power indication.
12	AFC Voltage Control VCO (C3)	Adjusts AFC voltage.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments

B-BAND LEVEL Control (R25)	1. Remove the STEREO ANALOG module from the exciter. 2. Remove the module from the exciter and remove the side cover. 3. Mount the module in the exciter using the extender board provided with the exciter. 4. Depress the OFF switches on each SCA module. The SCA OFF indicators will illuminate. 5. Disconnect the signal from the COMPOSITE INPUT (J4) on the rear of the exciter and apply a 2.83V P-P ±1% 400 Hz sinewave into J4. 6. Connect an oscilloscope to monitor pin 6 of U1 for a 4.6V P-P signal. 7. Adjust R25 to obtain a 4.6V P-P ±1% indication. 8. Disconnect the oscilloscope, remove the module and extender board, replace the side cover and replace the module in the exciter. Replace the STEREO ANALOG module and reconnect the signal to the COMPOSITE INPUT (J4).
VCO GAIN Control (R52)	1. Remove the STEREO ANALOG module from the exciter. 2. Remove the module. Mount the module in the exciter using the extender board provided with the exciter.

Table 3-2. Control Adjustments (Continued)

	3. Connect the exciter rf output to a 50 ohm load through a directional coupler or line sampler. 4. Connect a modulation monitor to the line sampler or the forward port of the directional coupler. 5. Disconnect the signal from the COMPOSITE INPUT (J4) on the rear of the exciter and apply a 2.83V P-P ±1% 400 Hz sinewave into J4. 6. Adjust R52 to obtain an indication of 10% modulation. 7. Remove the module and extender board, replace the module in the exciter, and reconnect the exciter output to the load. Replace the STEREO ANALOG module and reconnect the signal to the COMPOSITE INPUT (J4).
DIST. NULL Control (R74)	1. Remove the STEREO ANALOG module from the exciter. 2. Remove the module from the exciter and remove the side cover. 3. Mount the module in the exciter using the extender board provided with the exciter. 4. Connect the exciter rf output to a 50 ohm load through a directional coupler or line sampler.

WARNING: Disconnect primary power prior to servicing.

	5. Connect a modulation monitor to the line sampler or the forward port of the directional coupler. 6. Connect an intermodulation distortion analyzer to the modulation monitor composite output or the audio output with the de-emphasis disabled. 7. Disconnect the signal from the COMPOSITE INPUT (J4) on the rear of the exciter and apply a 2.83V P-P ±1% SMPTE intermodulation test signal into J4. 8. Check the voltage at pin 6 of U1 with an oscilloscope for 4.6V P-P ±1%. If the voltage is incorrect, the B-BAND LEVEL Control (R25) adjustment procedure must be accomplished before proceeding. 9. Adjust R74 to obtain a minimum intermodulation distortion. 10. Change the signal input to the COMPOSITE INPUT (J4) to a 2.83V P-P ±1% 400 Hz sinewave. 11. Check the voltage at pin 6 of U1 with an oscilloscope for 4.6V P-P ±1%. If the voltage is incorrect, the B-BAND LEVEL Control (R25) adjustment procedure must be accomplished before proceeding.

	12. Check the modulation monitor for 100% total modulation. If the modulation level is not correct, the VCO GAIN Control (R52) adjustment procedure must be accomplished before proceeding. 13. If R25 was adjusted in step 11 or R52 was adjusted in step 12, repeat steps 4 through 12 until R25 and R52 no longer require adjustment. 14. If R25 was adjusted, depress the MODULATION B-BAND switch and adjust the R5 on the ac meter board until the MODULATION meter indicates 100%. 15. Remove the module and extender board, replace the side cover, replace the module in the exciter, and reconnect the exciter output to the load. Replace the STEREO ANALOG module and reconnect the signal to the COMPOSITE INPUT (J4).
SCA-1 LEVEL SHIFT Control (R26) SCA-2 LEVEL SHIFT Control (R27)	1. Remove the STEREO ANALOG module from the exciter. 2. Depress the OFF switches on each SCA module. The SCA OFF indicators will illuminate. 3. Remove the module. Mount the module in the exciter using extender board provided with the exciter. 4. Depress the B-BAND MODULATION meter switch.

WARNING: Disconnect primary power prior to servicing.

	5. Depress the SCA 1 ON switch. The SCA 1 ON indicator will illuminate. 6. Connect the exciter rf output to a 50 ohm load through a directional coupler or line sampler. 7. Connect a modulation monitor to the line sampler or the forward port of the directional coupler. 8. Connect an SCA monitor to the SCA provision on the modulation monitor. 9. Adjust the INJ LEV control on the SCA 1 module for the desired amount of SCA 1 injection. 10. Apply a 2.83V P-P +1% 400 Hz sinewave to the COMPOSITE INPUT (J4) on the rear of the exciter. 11. Adjust R26 to obtain an indication of 100% total modulation on the MODULATION meter. 12. Disconnect the test signal applied to the COMPOSITE INPUT (J4) on the rear of the exciter. 13. Repeat steps 9 through 12 until 100% total modulation at the desired SCA injection level is obtained. 14. Repeat steps 1 through 14 for the SCA 2 module, adjusting R27.

Table 3-2. Control Adjustments (Continued)

	15. Remove the module and extender board. Replace the module in the exciter and reconnect the exciter output to the load. Replace the STEREO ANALOG module and reconnect the signal to the COMPOSITE INPUT (J4).
RF OUTPUT adjust Control (R33)	1. Remove the module. Mount the module in the exciter using the extender board provided with the exciter.
	2. Attach a 100 MHz oscilloscope or RF voltmeter to J-68 and adjust R33 until it reads 11 volts p-p (3.9 Vrms). Allow 5 seconds for AGC loop to track the change.
	3. Remove the module and extender board and replace the module in the exciter.
R.F. POWER CALIBRATE Control (R36)	1. Remove the module. Mount the module in the exciter using the extender board provided with the exciter.
	2. Depress the MULTIMETER MOD OSC meter switch.
	3. Adjust R36 to obtain a 300 milliwatt indication on the MULTIMETER.
	4. Remove the module and extender board and replace the module in the exciter.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments (Continued)

AFC Voltage Adjust Control VCO (C3)	1. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 2. Depress the Multimeter AFC switch. 3. Adjust C3 in VCO for lowest AFC voltage reading or 2 volts, whichever is higher. 4. Remove the module and the extender and replace the module in the exciter. 5. Check for AFC Lock in 5 seconds or less.
Humbucker Adjust Control R50,R53	1. Remove the Mod/Osc module from the exciter. 2. Remove the front cover from the module. 3. Replace the module in exciter. 4. Connect output of mod monitor to oscilloscope. 5. Adjust R50, R53 separately for lowest noise peaks (probably 120 Hz) on oscilloscope screen. 6. Remove Mod/Osc module from exciter and replace cover. 7. Replace module in exciter.

SECTION IV

PRINCIPLES OF OPERATION

4-1. CIRCUIT DESCRIPTION

4-2. The MOD OSC MODULE contains a VCO sub-module which generates a frequency modulated rf carrier (see figure 4-1). The rf center frequency is controlled by a dc correction voltage from the AFC/PLL module as part of a phase locked loop. The carrier deviation is controlled by a modulation voltage produced from individual audio inputs. The module rf output is amplified into two outputs of approximately 300 milliwatts and two milliwatts to drive the RF AMP and AFC/PLL modules, respectively.

4-3. GENERAL DESCRIPTION

4-4. SUMMING AMPLIFIER/PREDISTORTION. Individual composite inputs from each option are summed at the input to the module summing amplifier. An RC input network ensures each signal is summed in the correct proportion. A true summing node at virtual ground eliminates interaction between inputs. An SCA control input and a level switcher arrangement controls the summing amplifier gain to allow for various combination of SCA channels and maintain a constant peak modulating signal level. The slight distortion in VCO modulation characteristic of other designs is substantially reduced in the MX-15. The modulating signal is applied to a predistortion network which adds a small portion of distortion to cancel distortion generated by the VCO.

4-5. VCO SUB-MODULE. The voltage controlled oscillator accepts the predistorted audio input and a dc frequency correction voltage from the AFC/PLL module and generates the modulated rf carrier. A varactor tuned MOSFET oscillator drives a MOSFET buffer stage for isolation.

4-6. RF AMPLIFIER. The rf amplifier produces two outputs from the 300 millivolt RMS output of the VCO sub-module. One output of 250 milliwatts drives the RF AMP module and the second buffered output of two milliwatts is applied to the AFC/PLL module as the phase locked loop feedback path to control the rf carrier center frequency.

4-7. DETAILED DESCRIPTION

4-8. AUDIO PREAMPLIFIER. Five composite signals are input to the modulated oscillator. The quadraphonic composite and stereophonic or monaural composite inputs are dc coupled and the SCA 1, SCA 2, and the external composite inputs are ac coupled to amplifier U1. All modulation applied to amplifier U1 is summed to a total modulation (B-BAND) signal. The amplifier gain is established by feedback through resistor R23 and the B-BAND LEVEL control (R25) which provides an adjustment to obtain a precise signal level. The B-Band audio is output from the audio preamplifier at the level of 4.6V P-P to the ac meter module which provides an indication of the modulating signal level (see figure 4-2). The external composite signal is buffered by differential amplifier U5, which eliminates hum due to ground loops associated with the external composite input.

4-9. LEVEL SWITCHER. Whenever an SCA subcarrier is enabled, a positive six volt dc level closes a corresponding MOD OSC MODULE CMOS switch pair in U2. This shunts feedback resistor R23 and reduces the gain of the audio preamplifier. The SCA-1 LEVEL SHIFT control (R26) and the SCA-2 LEVEL SHIFT control (R27) provide an adjustment to calibrate the gain reduction to the SCA channel injection level. As a result, 100% peak modulation is maintained for all combinations of SCA, monaural, and stereophonic modes. A negative six volt dc level input from each SCA module to the respective CMOS switch holds the CMOS switches open when the SCA subcarrier is off. To prevent level switcher operation when an SCA module is removed from the exciter, an internal negative six volt source is connected to each control input to U2.

4-10. PREDISTORTION NETWORK. The predistortion network cancels the slight distortion caused by nonlinearity of the VCO to produce lower audio distortion, high stereo separation, and improved SCA performance. The predistortion is accomplished by a diode/resistor network which accepts total modulation from amplifier U1 and acts as a level dependent voltage divider across the DIST. NULL control (R70) and the VCO GAIN control (R52). The signal level at the output of R70 is 4.6V P-P and may be checked at test point TP-2.

4-11. The cathodes of diodes CR10 and CR11 are biased at ±0.57 volts and the cathodes of diodes CR9 and CR12 are biased at ±1.42 volts. When amplifier U1 outputs zero volts (no signal), diodes CR9 and CR10 will conduct and diodes CR11 and CR12 are turned off. As the modulating voltage swings in a positive direction, CR9 and CR10 conduct less and eventually turn off. As the modulating voltage swings in a negative direction, CR11 and CR12 turn on when the modulating voltage exceeds the bias threshold on each diode.

4-12. Whenever any diode is turned on, the modulation signal from amplifier U1 is shunted to ground through resistors in the predistortion network. This effect slightly stretches the positive portion of the modulating signal in the negative direction to cancel the effect of the VCO assembly slight modulation nonlinearity. The DIST. NULL control (R70) provides an adjustment to control the amount of predistortion and the VCO GAIN control (R52) provides an output level adjustment.

4-13. VCO ASSEMBLY. The voltage controlled oscillator submodule comprises a varactor diode tuned Colpitts oscillator using a JFET and a JFET/BJT buffer. The inductive element in the oscillator is formed by a section of shorted coaxial transmission line.

4-14. Modulation Input. Predistorted modulation is applied through the VCO GAIN control (R52) and coupled through capacitor C1 to a back-to-back configuration of varactor diodes in the tank circuit of oscillator Q1.

4-15. As the time constant of coupling capacitor C1 is many times the frequency control phase locked loop lockup time, the capacitor must be quickly charged when power is applied to ensure a stable locked condition.

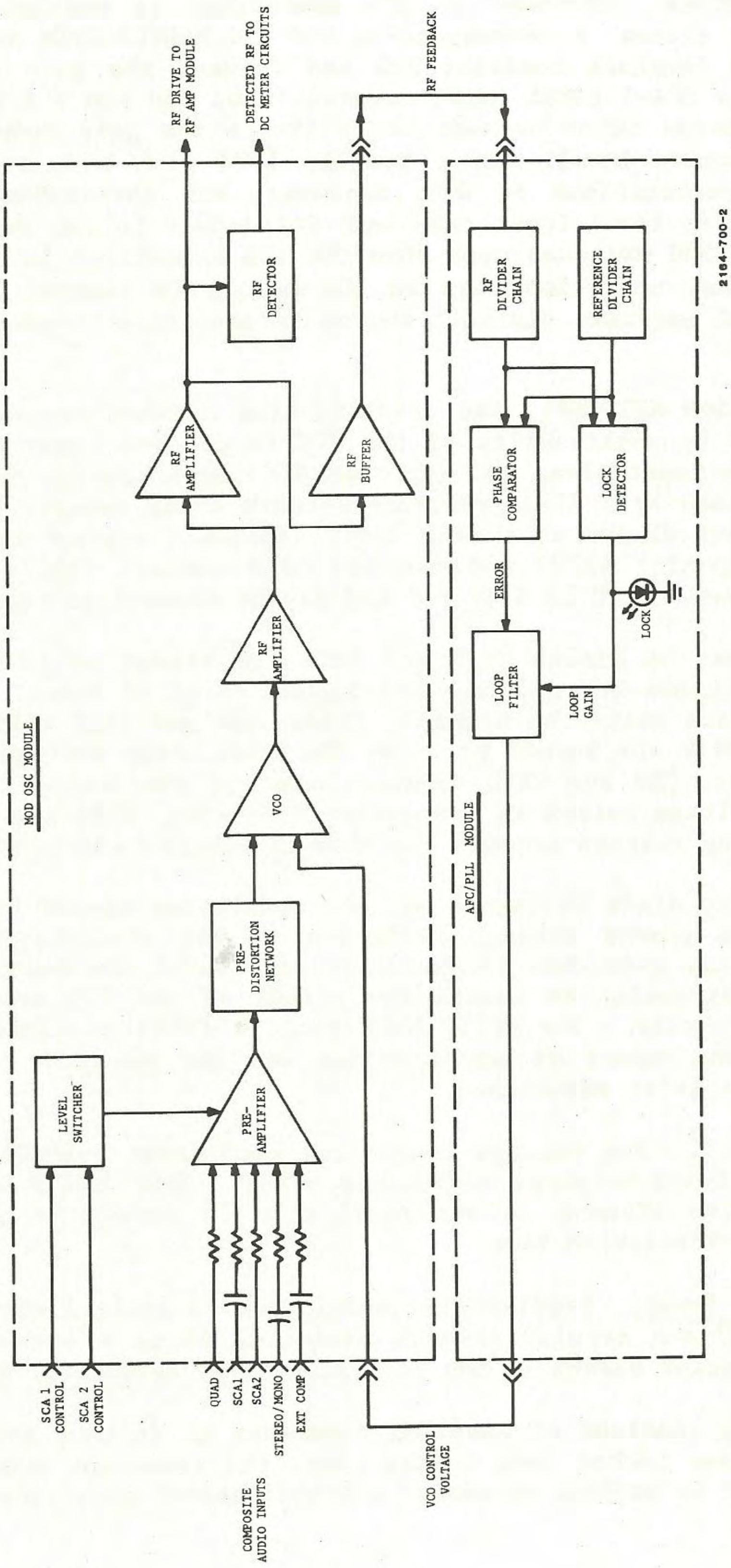
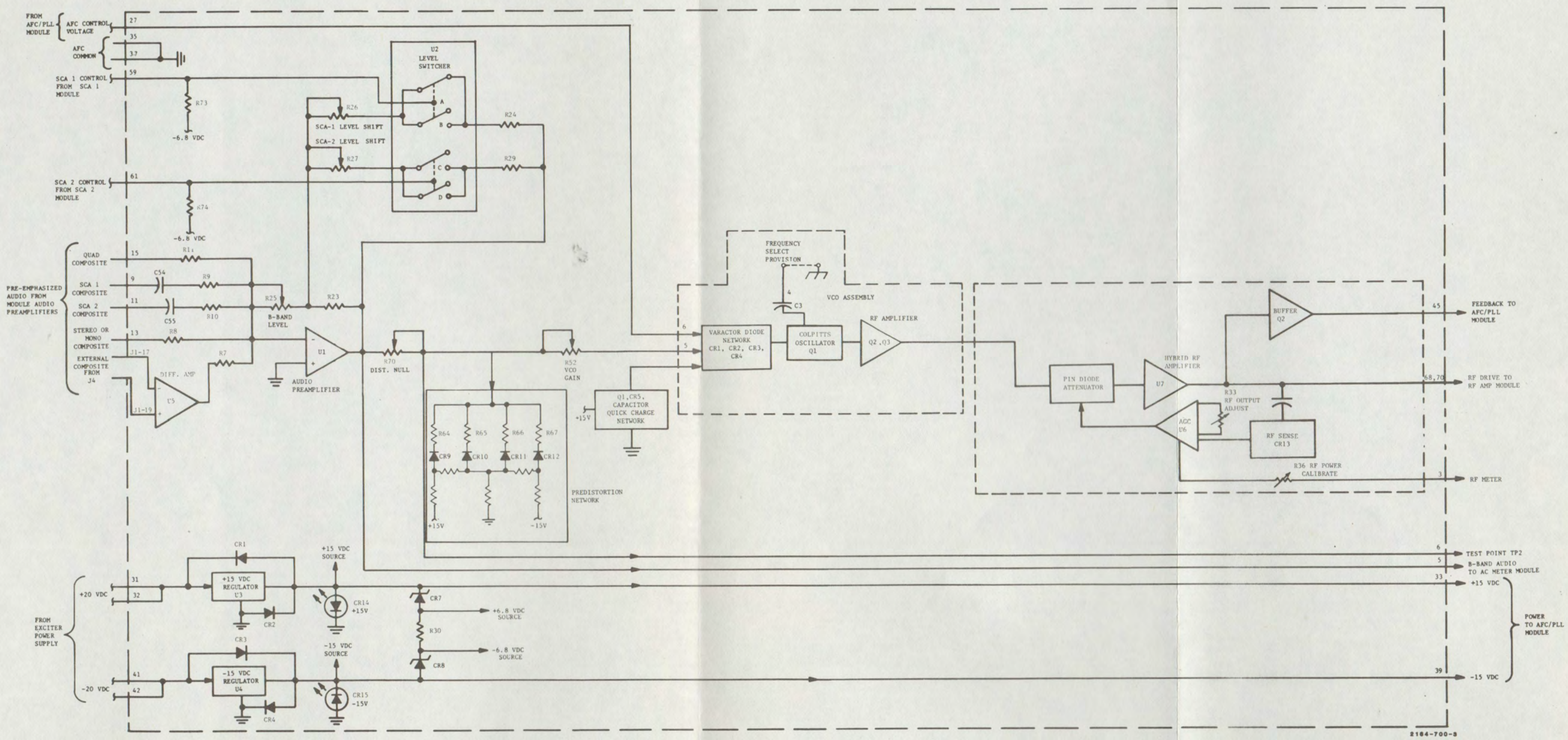


Figure 4-1. MOD OSC MODULE Simplified Block Diagram



NOTES
1. PINS 1,2,7,8,19,20,43,44,46,47,48, 60,62 THROUGH 67,69,71,72 CONNECT TO GROUND

FIGURE 4-2. MOD OSC MODULE DETAILED BLOCK DIAGRAM

The capacitor is charged by a network consisting of Q1 on the MOD OSC board and associated components which charges the capacitor close to the steady state value and decouples itself from the active signal path to present a high impedance input to the varactor diode network. When power is applied, Q1 on the MOD OSC board is turned ON by C59 and C70. C1 is charged through Q1 and a resistive voltage divider. When C49 becomes charged Q1 turns off and C1 continues to charge at a slow rate from the positive source through R49.

4-16. AFC Input. The VCO assembly frequency output is determined by the AFC voltage input from the AFC/PLL module, a positive going potential applied to the VCO assembly increases the oscillator frequency. If the VCO frequency is higher than the internal reference in the AFC/PLL module, a negative going potential applied to the VCO assembly decreases the oscillator frequency. A steady dc potential on the AFC line indicates the VCO frequency and the internal reference frequency in the AFC/PLL module agree. The AFC voltage is applied to a back-to-back configuration of varactor diodes to control oscillator Q1.

4-17. Oscillator/Amplifier. The frequency control voltage and predistorted modulation are combined by the varactor diode network and applied to a common drain Colpitts JFET oscillator (Q1). Capacitor C3 adjusts the bias voltage on the varactors for a region of reduced sensitivity to noise voltage. The AFC will lock within a range of 1-12v. A JFET/BJT cascode amplifier follows the oscillator as a buffer stage which outputs the carrier signal. Additional isolation is provided by a "Tee" attenuator formed by R3, R7, and R8.

4-18. RF OUTPUT CIRCUIT. The RF amplifier is a hybrid gain block powered by the +20 volt supply. One output is used to drive the RF AMP module. A second buffered output provides a feedback path for the frequency control phase locked loop circuit in the AFC/PLL module. This provides isolation between the RF amplifier drive and the AFC/PLL module frequency dividers which tend to generate switching products and cause mutual interference. The output of 300 milliwatts is applied by microstrip transmission line to drive the RF AMP module. The RF AMP module drive is sampled by an rf detector and fed to the dc meter circuit which provides an indication of the rf output level. The RF POWER CALIBRATE control (R36) allows calibration of the meter indication. The power output is controlled by the Power Adjust control (R33) in the AGC loop formed around dual operational amplifier U6.

4-19. POWER. Inputs of positive and negative regulated 20 Vdc are re-regulated by U3 and U4 into ±15 Vdc sources to operate the MOD OSC MODULE. Outputs of positive and negative 15 Vdc are applied to the AFC/PLL module to operate the loop filter circuitry. Diodes CR13, CR14, CR15, and CR16 provide reverse voltage protection for the regulator and module circuitry. Light emitting diodes provide a status indication of the operation of the positive (+15V) and negative (-15V) fifteen volt power supplies. Additionally, positive and negative eight Vdc sources are produced from a series circuit consisting of CR7, R34, and CR8 from the ±15 volt potentials to control the CMOS level switching circuits. Additional filtering for the VCO supply is supplied by capacitance multiplier Q3, C42.

SECTION V

MAINTENANCE

5-1. CORRECTIVE MAINTENANCE

5-2. The FM exciter module maintenance philosophy consists of problem isolation to a specific area or individual component and subsequent isolation and replacement of the defective component.

5-3. TROUBLESHOOTING

5-4. In event of problems, the trouble area must first be isolated to a specific area. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, fuse F1, circuit breaker CB1, and the indicators on each module should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs which indicate the module power supply status. A single dark LED would indicate a problem associated with an individual module monolithic voltage regulator. A consistent pattern of dark LEDs however, would indicate an exciter dc distribution bus fault.

5-5. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-1 lists typical trouble symptoms pertaining to the individual module operation with references to fault isolation diagrams listing probable causes and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem. It only tends to lead the repairman into the area that may be causing the trouble. An extender board is provided with the exciter to assist in troubleshooting. In event parts are required, refer to Section VI, Parts List. The following information is contained in this section as an aid to maintenance:

REFERENCE	TITLE	NUMBER
Figure 5-1	MOD OSC MODULE Parts Layout	--- ---- ---
Figure 5-2	MOD OSC MODULE Schematic	839 6123 001
Figure 5-3	VCO Parts Layout	--- ---- ---
Figure 5-4	VCO ASSEMBLY Schematic	839 6123 004

Table 5-1. MOD OSC Module Fault Isolation Index

NO RF OUTPUT (AFC/PLL module LOCK indicator illuminated).	Figure 5-5
NO RF OUTPUT (AFC/PLL module LOCK indicator out).	Figure 5-6
NOISE	Figure 5-7
DISTORTION	Figure 5-8
NO MODULATION	Figure 5-9

WARNING: Disconnect primary power prior to servicing.

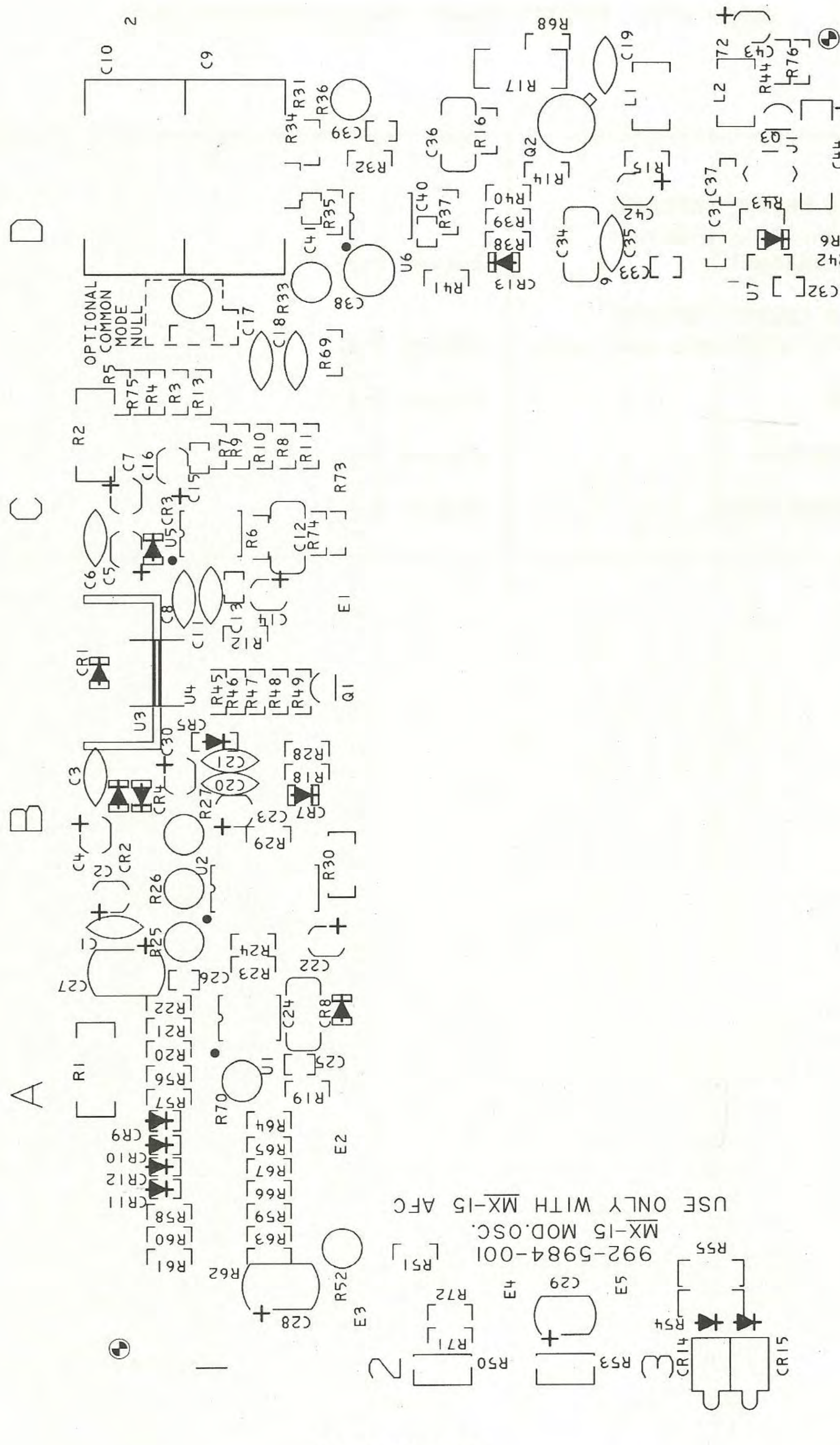
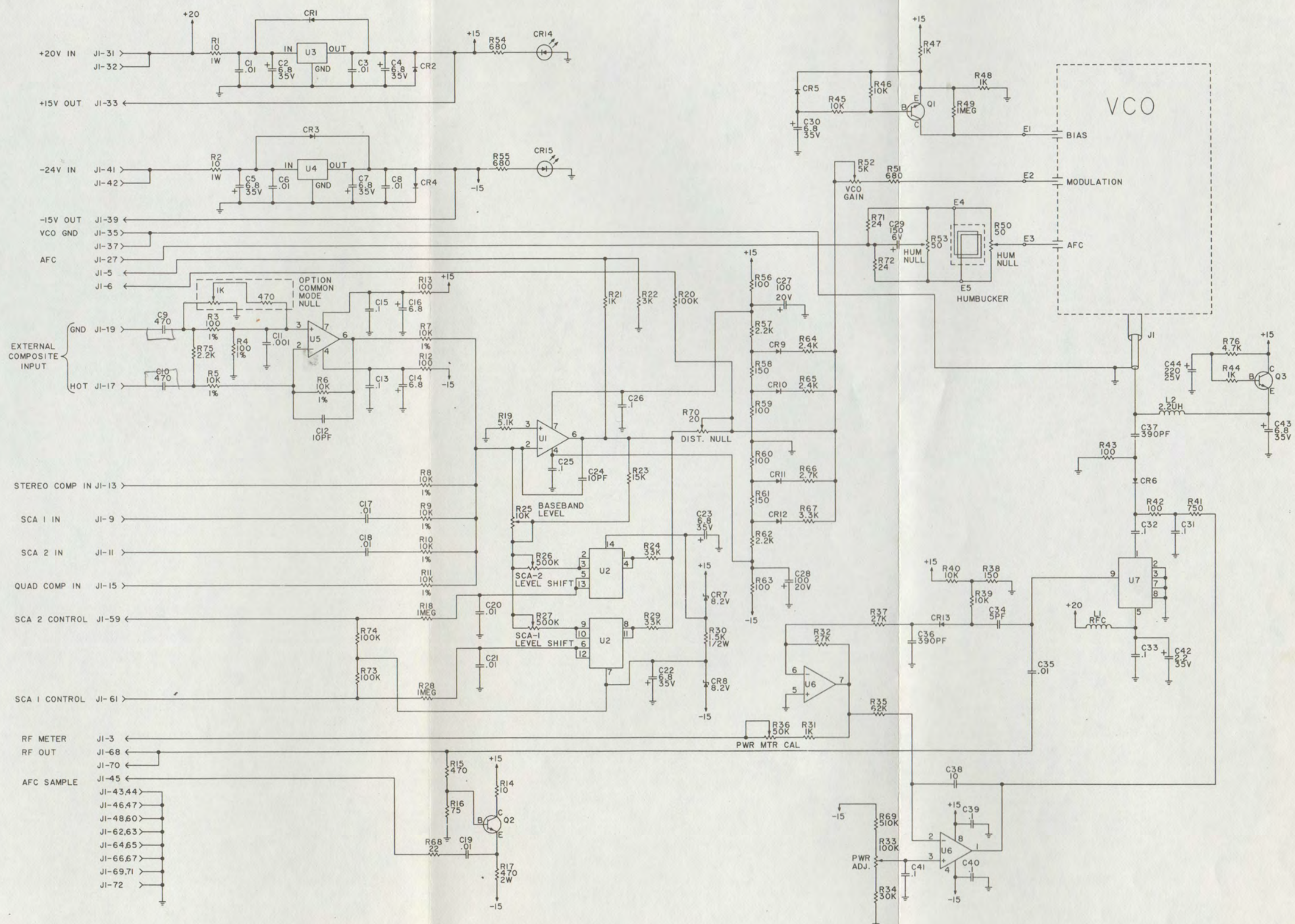


Figure 5-1. MOD OSC MODULE Parts Layout

WARNING: Disconnect primary power prior to servicing.



5. Q1 = 2N4403   Q2 = 2N3866   Q3 = 2N3904
4. CR1,CR2,CR3,CR4 = 1N4001   CR5 = 1N914   CR6 = HP5082-3081
   CR7,CR8 = 1N4738   CR9,CR10,CR11,CR12,CR13 = HOT CARRIER HP2800
3. U1,U5 = LM318N   U2 = 4066B   U3 = 7815
   U4 = 7915   U6 = LM358N   U7 = MHW592
2. CAPACITANCE IS IN UF
1. RESISTORS ARE IN OHMS, 1/4 WATT, 5%
UNLESS OTHERWISE NOTED:

FIGURE 5-2. MOD OSC MODULE SCHEMATIC
839 6123 001

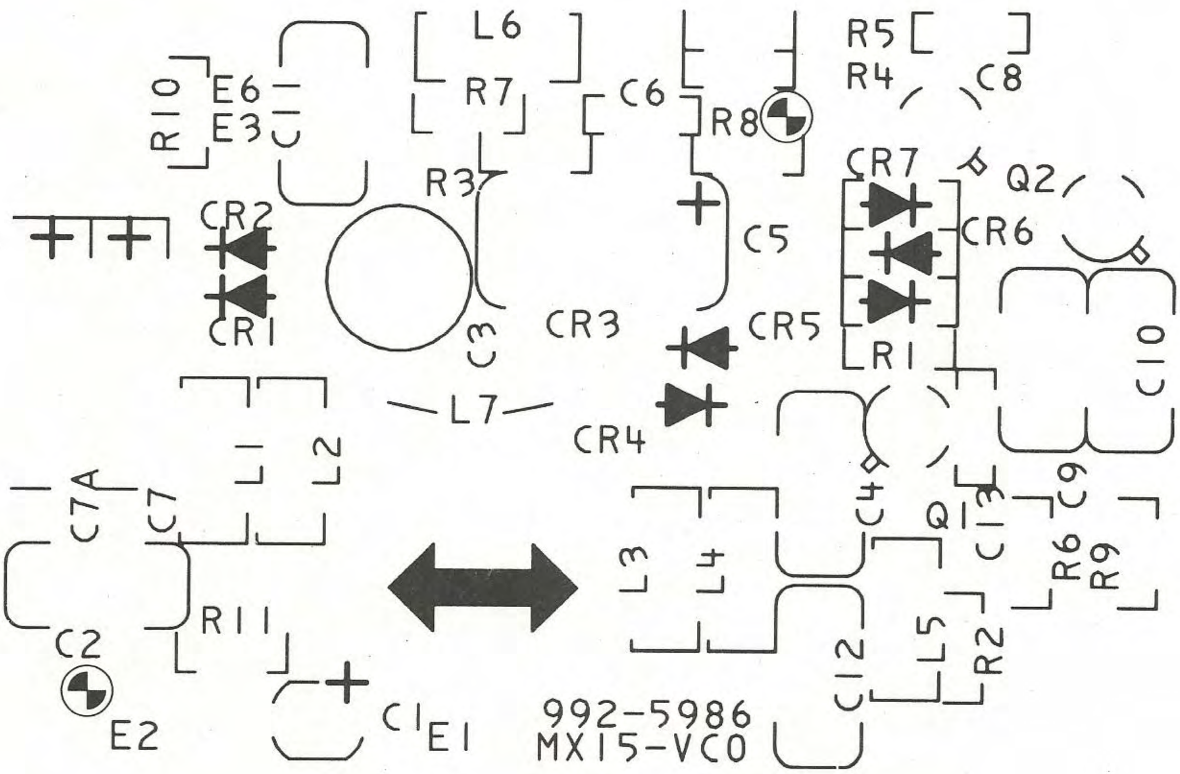
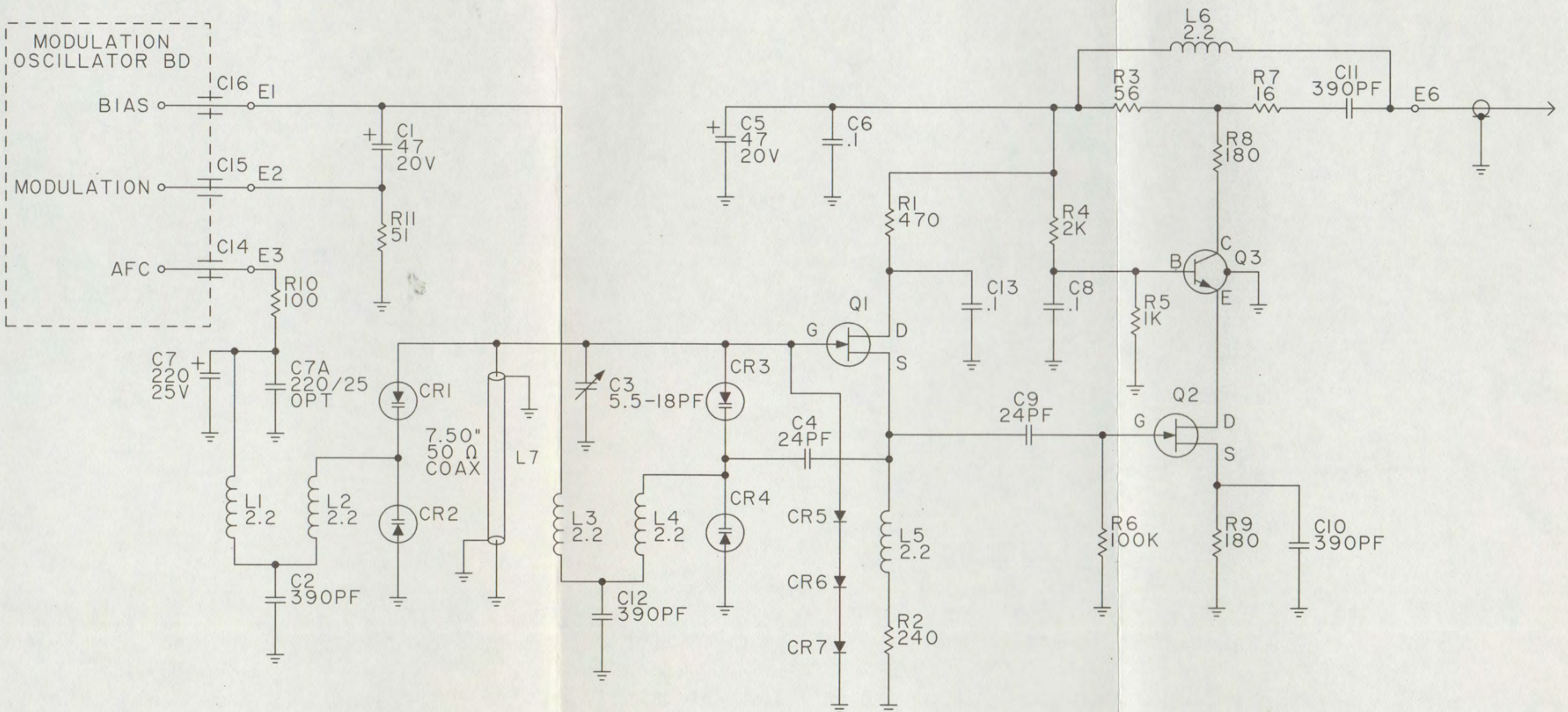


Figure 5-3. VCO Parts Layout

WARNING: Disconnect primary power prior to servicing.



7. CR5,CR6,CR7 = IN914
6. Q1,Q2 = U310 Q3 = 2N5179
5. CR1,CR2,CR3,CR4 = MV109
4. INDUCTANCE IS IN UH
3. CAPACITANCE IS IN UF
2. RESISTORS ARE 1/4 W 5%
1. RESISTANCE IS IN OHMS

UNLESS OTHERWISE NOTED:

FIGURE 5-4. VCO ASSEMBLY SCHEMATIC
839 6123 004-B

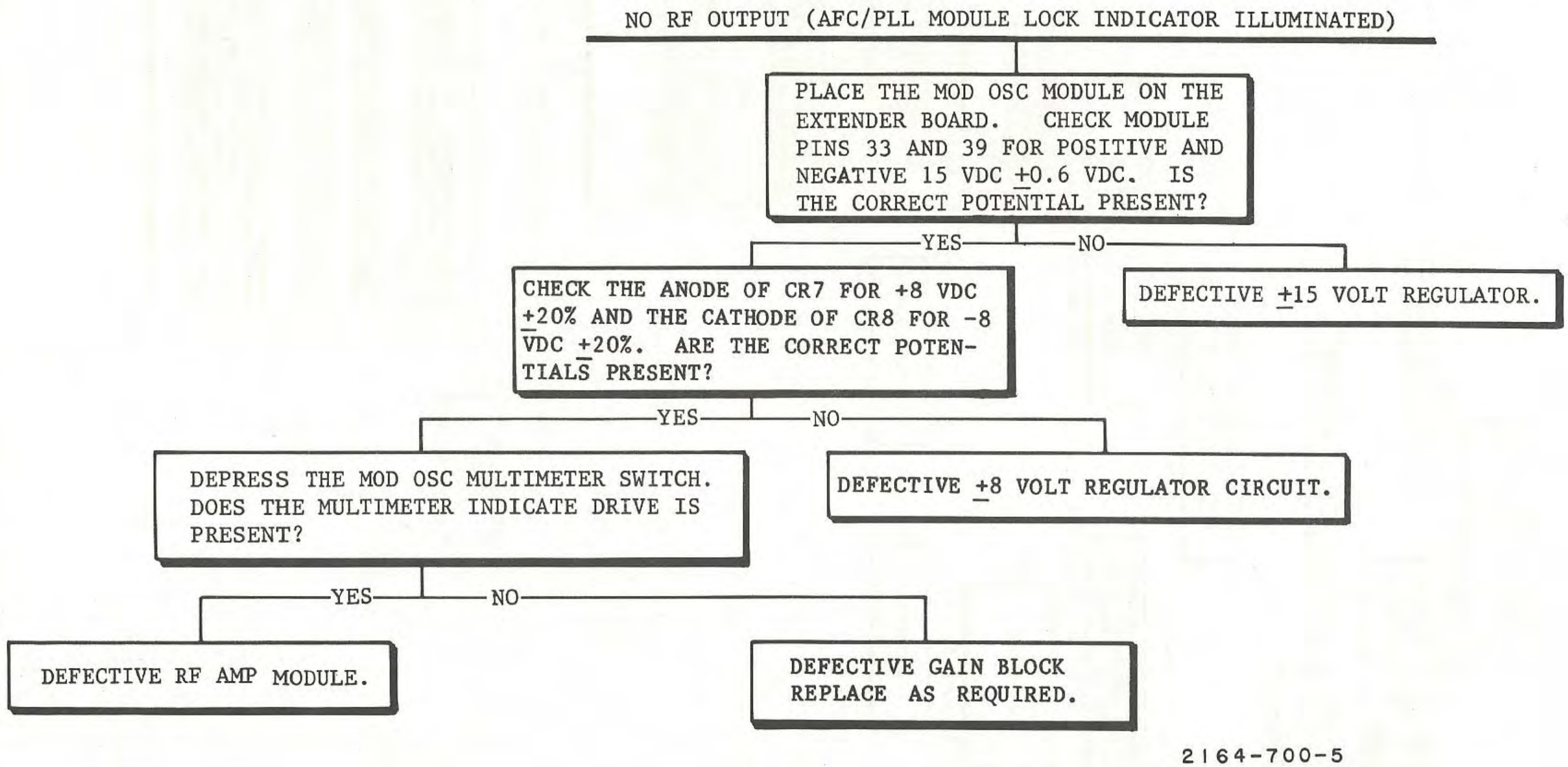


Figure 5-5. No RF Output (AFC/PLL Module Lock Indicator Illuminated)

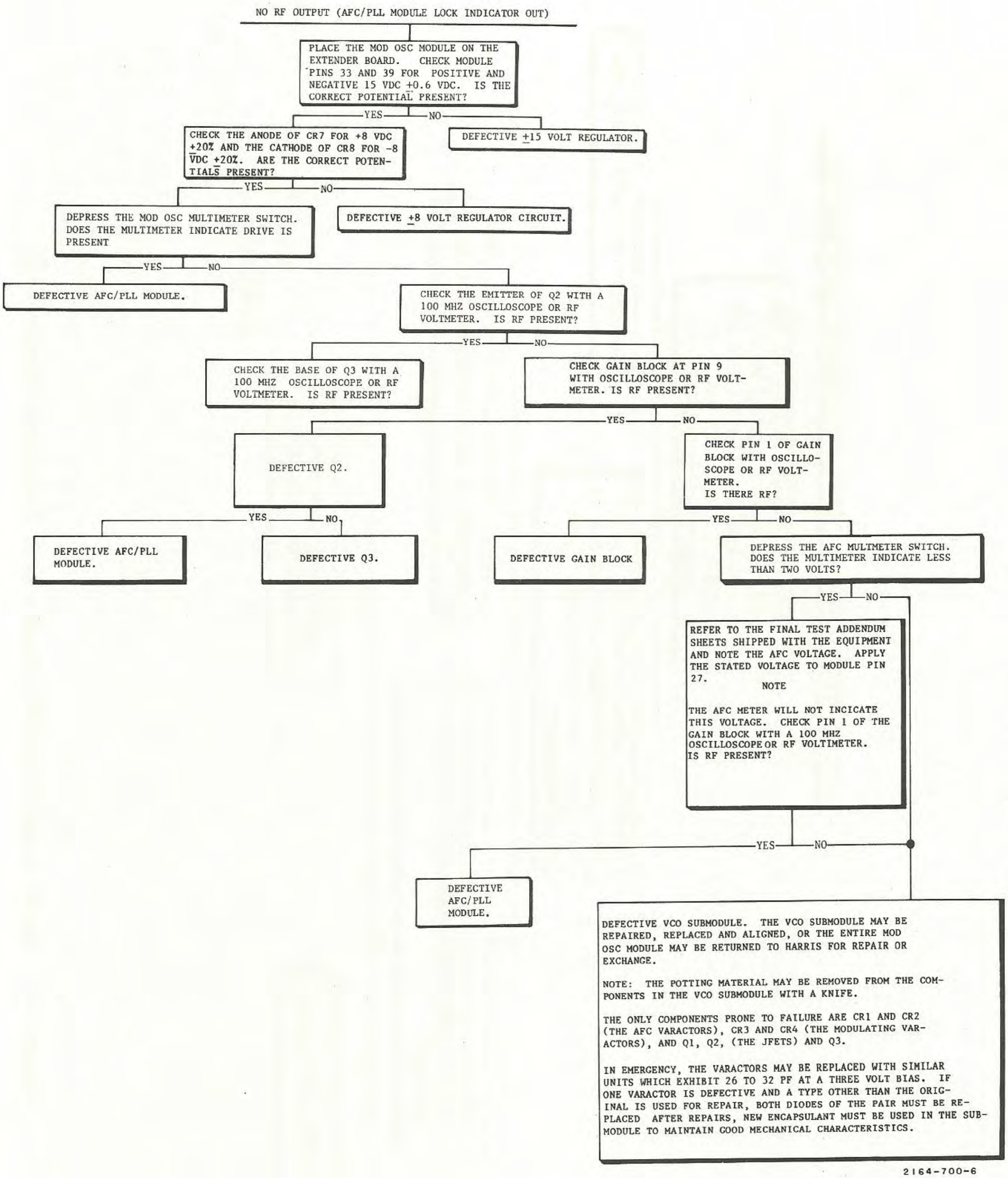


Figure 5-6. No RF Output (AFC/PLL Module Lock Indication Out)

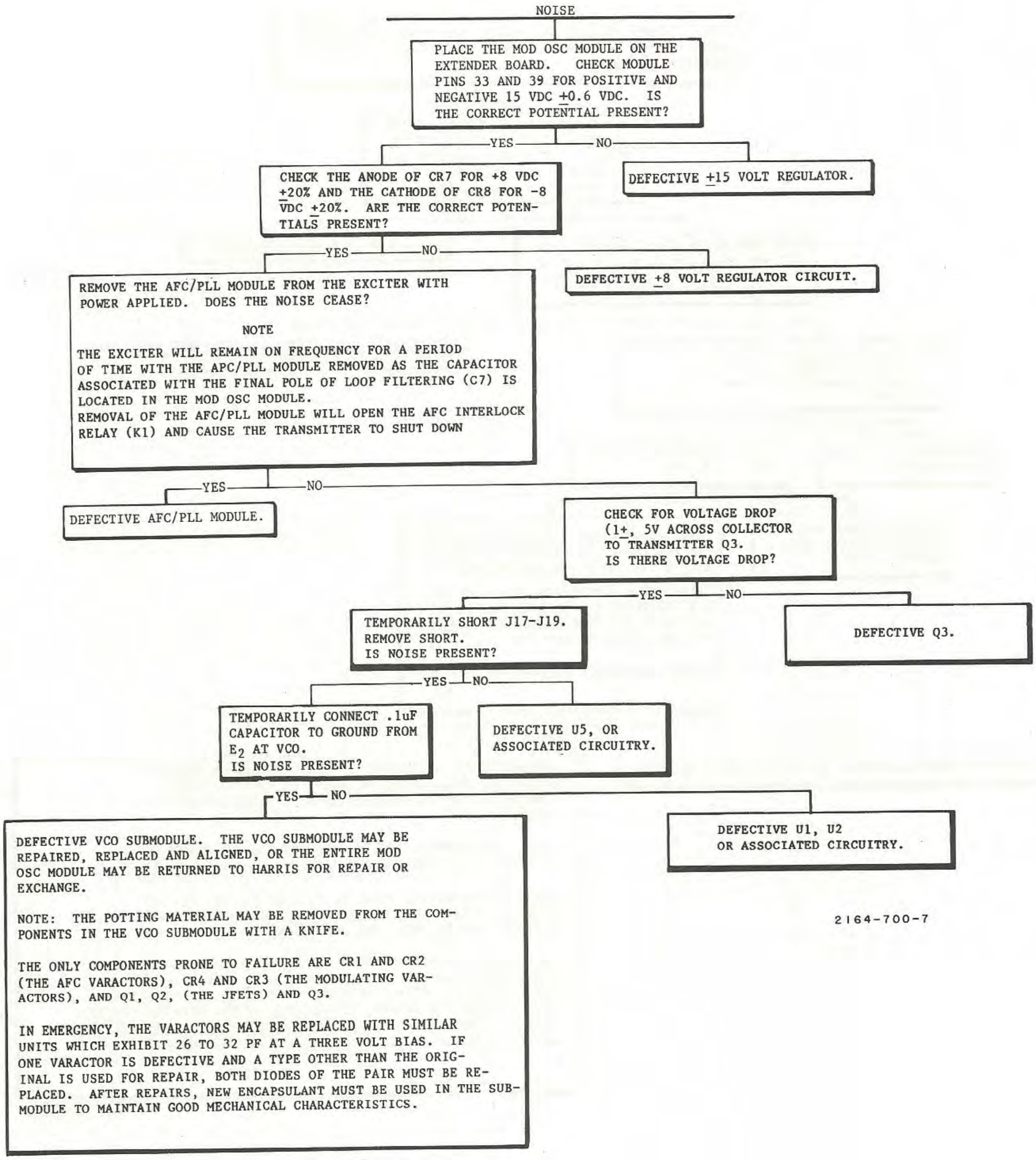
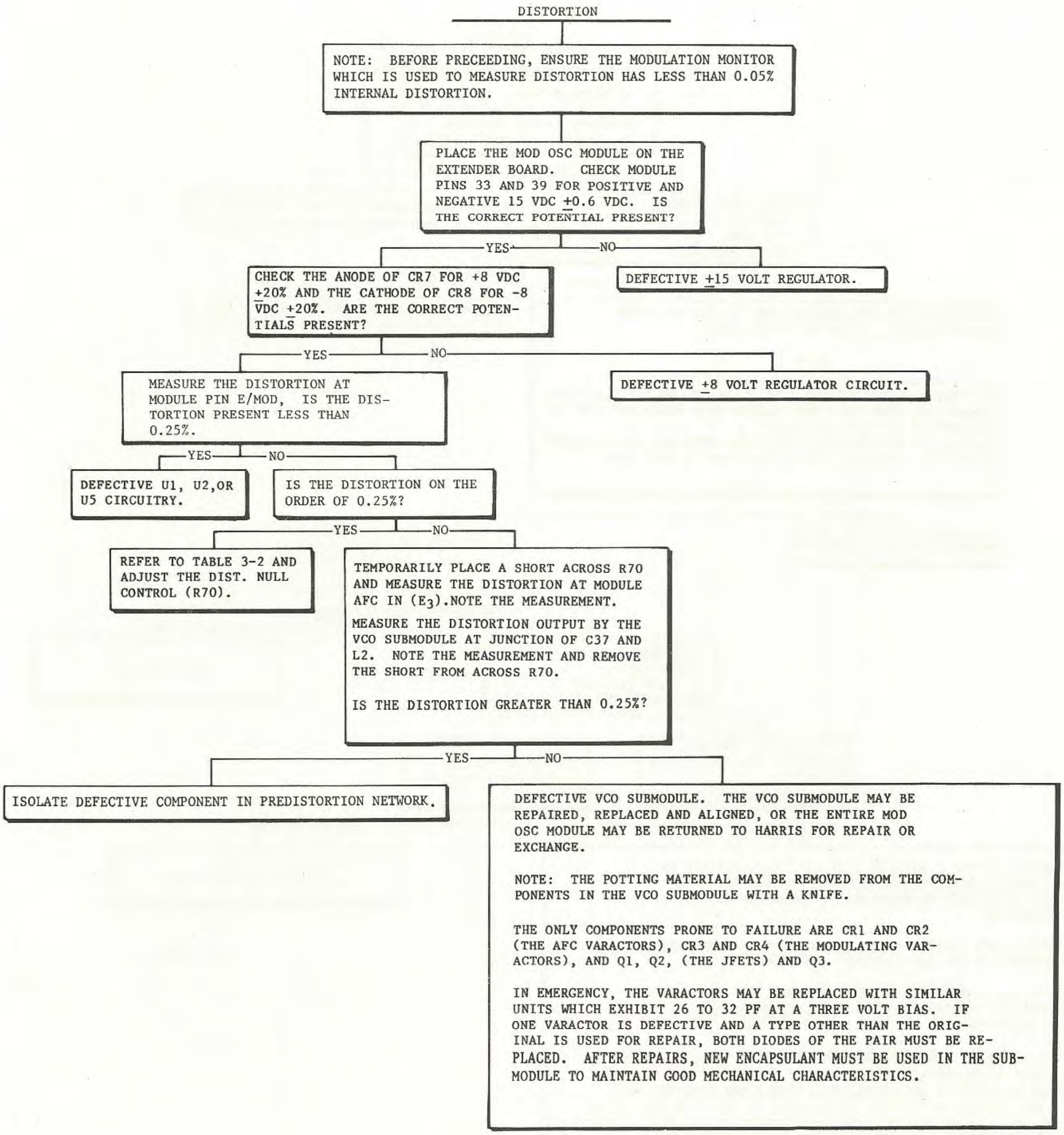


Figure 5-7. Noise

WARNING: Disconnect primary power prior to servicing.



2164-700-8

Figure 5-8. Distortion

WARNING: Disconnect primary power prior to servicing.

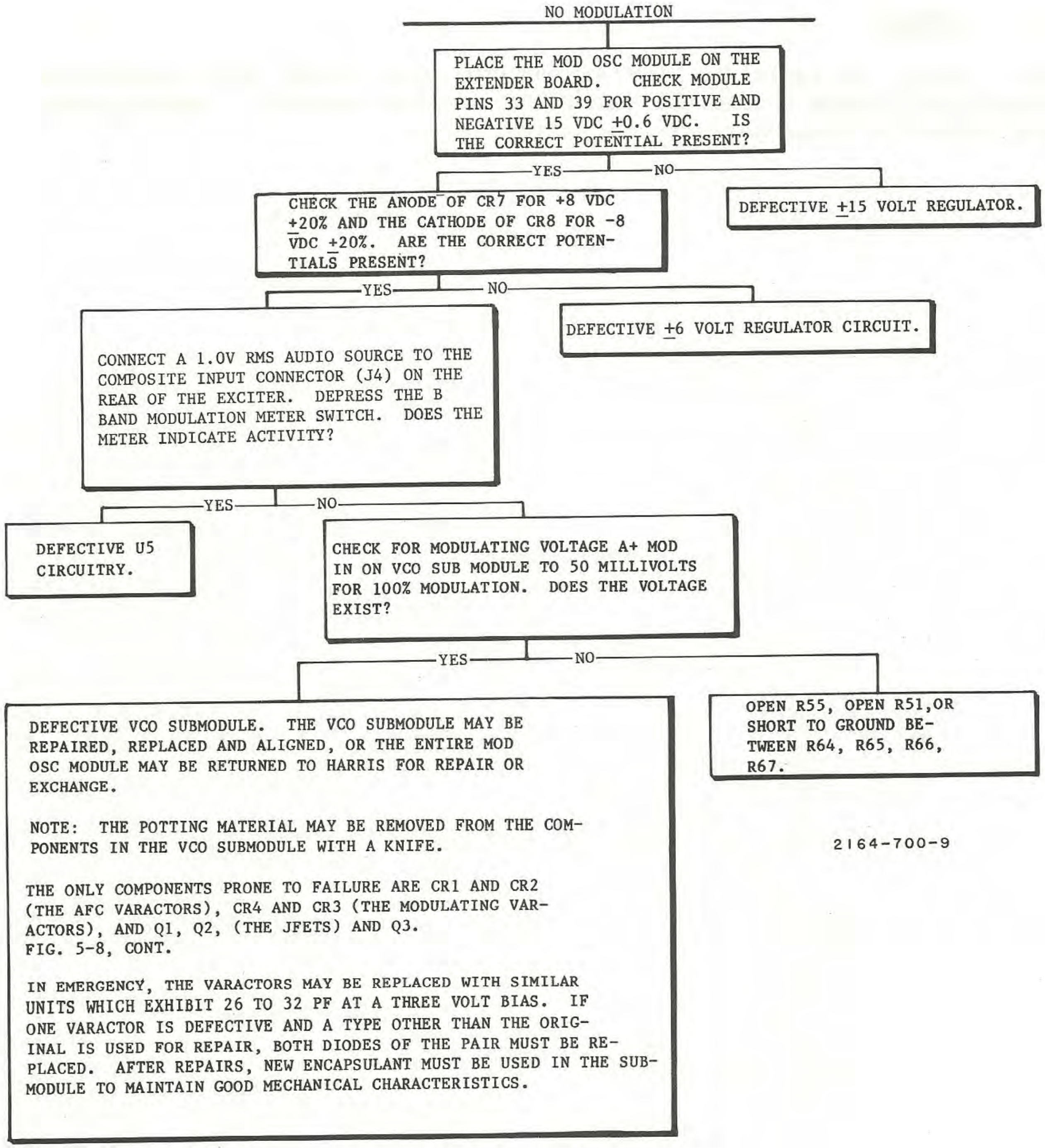


Figure 5-9. No Modulation

WARNING: Disconnect primary power prior to servicing.

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. Refer to table 6-1 for replaceable parts which are required for proper maintenance of the MOD OSC MODULE and VCO assembly. Tables entries are indexed by component reference designator.

Table 6-1. REPLACEABLE PARTS LIST INDEX

WARNING: Disconnect primary power prior to servicing.

Table 6-2. MODULATED OSC MODULE 992 5983 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
A1	992 5985 002	VCO MODULE ASSY	1.0	
	939 6124 001	PC BOARD HUMBUCKER	1	
	992 5984 001	PWB, MOD. OSC.	1	

Table 6-3. VCO MODULE ASSY 992 5985 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
C014,C015,C016	516 0450 000	CAP 1000PF 500V 20%	3.0	
J001	620 0445 000	RECP 50 OHM 27-9	1.0	
	829 8745 002	COVER, VCO BOX	1	
	839 6018 001	BOX	1	
	992 5986 002	PWB, VCO	1	

Table 6-4. PWB, VCO 992 5986 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
CR1,CR2,CR3,CR4	528 0030 000	DIODE, VARACTOR	4.0	
CR5,CR6,CR7	384 0205 000	DIODE SILICON 1N914	3.0	
C1	526 0359 000	CAP 47UF 20/25V 10%	1.0	
C02	500 0833 000	CAP, MICA 390PF 500V 5%	1.0	
C3	518 0104 000	CAP, VAR 5.5-18PF	1.0	
C4	500 0810 000	CAP MICA 24UUF 500V	1.0	
C5	526 0359 000	CAP 47UF 20/25V 10%	1.0	
C06	516 0453 000	CAP .1UF 100V 20%	1.0	
C7	526 0360 000	CAP 220 UF 15V 10%	1.0	
C08	516 0453 000	CAP .1UF 100V 20%	1.0	
C9	500 0810 000	CAP MICA 24UUF 500V	1.0	
C10,C11,C12	500 0833 000	CAP, MICA 390PF 500V 5%	3.0	
C13	516 0453 000	CAP .1UF 100V 20%	1.0	
L1,L2,L3,L4,L5	494 0388 000	CHOKE RF 2.20 UH		
L6			6.0	
L7	929 8906 001	COAX SHORTED LINE 50 OHM	1.0	
Q1,Q2	380 0622 000	TRANSISTOR U310	2.0	
Q3	380 0536 000	TRANSISTOR 2N5179	1.0	
R1	540 0904 000	RES .25W 470 OHM 5%	1.0	
R2	540 0897 000	RES .25W 240 OHM 5%	1.0	
R3	540 0882 000	RES .25W 56 OHM 5PCT	1.0	
R4	540 0919 000	RES .25W 2000 OHM 5%	1.0	
R5	540 0912 000	RES .25W 1000 OHM 5%	1.0	
R6	540 0960 000	RES .25W 100K OHM 5%	1.0	
R7	540 0869 000	RES .25W 16 OHM 5PCT	1.0	
R8,R9	540 0894 000	RES .25W 180 OHM 5%	2.0	
R10	540 0888 000	RES .25W 100 OHM 5%	1.0	
R11	540 0881 000	RES .25W 51 OHM 5PCT	1.0	
	839 6123 004	SCHEM, VCO	0	
	939 5998 010	PWB, VCO MOD	1	

WARNING: Disconnect primary power prior to servicing.

Table 6-5. COAX SHORTED LINE 50 OHM 929 8906 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
	618 0207 000	COAX CABLE RG178B U	.65	FT

Table 6-6. CADS, JUMPERS 929 8942 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
	252 0003 000	WIRE STRD 20AWG WHT	1.3	FT
	618 0213 000	COAX CABLE RG188A/U	1.0	FT
	620 0566 000	PLUG, RT ANGLE UG1466/U	2.0	

Table 6-7. PWB, MOD. OSC. 992 5984 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
CR1,CR2,CR3,CR4	384 0431 000	RECT. 1N4001	4.0	
CR5	384 0205 000	DIODE SILICON 1N914	1.0	
CR6	384 0355 000	DIODE, HP5082-3081	1.0	
CR7,CR8	386 0091 000	DIODE ZENER 1N4738	2.0	
CR9,CR10,CR11	384 0321 000	DIODE 5082-2800/1N5711		
CR12,CR13			5.0	
CR14,CR15	384 0661 000	L.E.D. GREEN	2.0	
C1	516 0375 000	CAP .01UF 50V	1.0	
C2	526 0049 000	CAP 6.8UF 35V 20%	1.0	
C3	516 0375 000	CAP .01UF 50V	1.0	
C4,C5	526 0049 000	CAP 6.8UF 35V 20%	2.0	
C6	516 0375 000	CAP .01UF 50V	1.0	
C7	526 0049 000	CAP 6.8UF 35V 20%	1.0	
C8	516 0375 000	CAP .01UF 50V	1.0	
C9,C10	522 0523 000	CAP 470UF 16V	2.0	
C11	516 0054 000	CAP, DISC .001UF 1KV 10%	1.0	
C12	500 0804 000	CAP, MICA 10PF 500V 5%	1.0	
C13	516 0453 000	CAP .1UF 100V 20%	1.0	
C14	526 0049 000	CAP 6.8UF 35V 20%	1.0	
C15	516 0453 000	CAP .1UF 100V 20%	1.0	
C16	526 0049 000	CAP 6.8UF 35V 20%	1.0	
C17,C18,C19,C20	516 0375 000	CAP .01UF 50V		
C21			5.0	
C22,C23	526 0049 000	CAP 6.8UF 35V 20%	2.0	
C24	500 0804 000	CAP, MICA 10PF 500V 5%	1.0	
C25,C26	516 0453 000	CAP .1UF 100V 20%	2.0	
C27,C28	526 0057 000	CAP 100UF 20V 20%	2.0	
C29	526 0102 000	CAP 150UF 6V	1.0	
C30	526 0049 000	CAP 6.8UF 35V 20%	1.0	
C31,C32,C33	516 0453 000	CAP .1UF 100V 20%	3.0	
C34	500 0803 000	CAP MICA 5UUF 500V	1.0	
C35	516 0375 000	CAP .01UF 50V	1.0	
C36,C37	500 0833 000	CAP, MICA 390PF 500V 5%	2.0	
C38	522 0524 000	CAP 10 UF 25V	1.0	
C39,C40,C41	516 0453 000	CAP .1UF 100V 20%	3.0	
C42	526 0311 000	CAP 2.2UF 35V 10%	1.0	
C43	526 0049 000	CAP 6.8UF 35V 20%	1.0	

WARNING: Disconnect primary power prior to servicing.

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
C44	526 0243 000	CAP 220 UF 25VDC	1.0	
J001	620 0515 000	RECP 50-051-0000	1.0	
L1	494 0218 000	CHOKE WIDE BAND	1.0	
L2	494 0388 000	CHOKE RF 2.20 UH	1.0	
Q1	380 0126 000	TRANSISTOR 2N4403	1.0	
Q2	380 0116 000	TRANSISTOR 2N3866	1.0	
Q3	380 0189 000	TRANSISTOR 2N3904	1.0	
R1,R2	540 0284 000	RES 1WAT 10 OHM 5PCT	2.0	
R3,R4	548 1098 000	RES 100 OHM 1/4W 1%	2.0	
R5,R6,R7,R8,R9	548 1121 000	RES 10K OHM 1/4W 1%		
R10,R11			7.0	
R12,R13	540 0888 000	RES .25W 100 OHM 5%	2.0	
R14	540 0864 000	RES .25W 10 OHM 5%	1.0	
R15	540 0904 000	RES .25W 470 OHM 5%	1.0	
R16	540 0885 000	RES .25W 75 OHM 5PCT	1.0	
R17	540 0603 000	RES 2W 470 OHM 5PCT	1.0	
R18	540 0984 000	RES .25W 1.0M OHM 5%	1.0	
R19	540 0929 000	RES .25W 5100 OHM 5%	1.0	
R20	540 0960 000	RES .25W 100K OHM 5%	1.0	
R21	540 0912 000	RES .25W 1000 OHM 5%	1.0	
R22	540 0923 000	RES .25W 3000 OHM 5%	1.0	
R23	540 0940 000	RES .25W 15K OHM 5%	1.0	
R24	540 0948 000	RES .25W 33K OHM 5%	1.0	
R25	550 0922 000	POT 10K OHM 1/2W	1.0	
R26,R27	550 0936 000	POT 500K OHM 1/2W	2.0	
R28	540 0984 000	RES .25W 1.0M OHM 5%	1.0	
R29	540 0948 000	RES .25W 33K OHM 5%	1.0	
R30	540 1129 000	RES .5W 1500 OHM 5%	1.0	
R31	540 0912 000	RES .25W 1000 OHM 5%	1.0	
R32	540 0946 000	RES .25W 27K OHM 5%	1.0	
R33	550 0921 000	POT 100K OHM 1/2W	1.0	
R34	540 0947 000	RES .25W 30K OHM 5%	1.0	
R35	540 0955 000	RES .25W 62K OHM 5%	1.0	
R36	550 0929 000	POT 50K OHM 1/2 W	1.0	
R37	540 0946 000	RES .25W 27K OHM 5%	1.0	
R38	540 0892 000	RES .25W 150 OHM 5%	1.0	
R39,R40	540 0936 000	RES .25W 10K OHM 5%	2.0	
R41	540 0909 000	RES .25W 750 OHM 5%	1.0	
R42,R43	540 0888 000	RES .25W 100 OHM 5%	2.0	
R44	540 0912 000	RES .25W 1000 OHM 5%	1.0	
R45,R46	540 0936 000	RES .25W 10K OHM 5%	2.0	
R47,R48	540 0912 000	RES .25W 1000 OHM 5%	2.0	
R49	540 0984 000	RES .25W 1.0M OHM 5%	1.0	
R50	550 0841 000	POT 50 OHM 1/2W 10%	1.0	
R51	540 0908 000	RES .25W 680 OHM 5%	1.0	
R52	550 0913 000	POT, 5K OHM	1.0	
R53	550 0841 000	POT 50 OHM 1/2W 10%	1.0	
R54,R55	540 1181 000	RES 1/2W 680 OHM 5%	2.0	
R56	540 0888 000	RES .25W 100 OHM 5%	1.0	

Table 6-7. PWB, MOD. OSC. 992 5984 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY	UM
R57	540 0920 000	RES .25W 2200 OHM 5%	1.0	
R58	540 0892 000	RES .25W 150 OHM 5%	1.0	
R59,R60	540 0888 000	RES .25W 100 OHM 5%	2.0	
R61	540 0892 000	RES .25W 150 OHM 5%	1.0	
R62	540 0920 000	RES .25W 2200 OHM 5%	1.0	
R63	540 0888 000	RES .25W 100 OHM 5%	1.0	
R64,R65	540 0921 000	RES .25W 2400 OHM 5%	2.0	
R66	540 0922 000	RES .25W 2700 OHM 5%	1.0	
R67	540 0924 000	RES .25W 3300 OHM 5%	1.0	
R68	540 0872 000	RES .25W 22 OHM 5PCT	1.0	
R69	540 0977 000	RES .25W 510K OHM 5%	1.0	
R70	550 1028 000	POT 20 OHM 1/2W 10%	1.0	
R71,R72	540 0873 000	RES .25W 24 OHM 5PCT	2.0	
R73,R74	540 0960 000	RES .25W 100K OHM 5%	2.0	
R75	540 0920 000	RES .25W 2200 OHM 5%	1.0	
R76	540 0928 000	RES .25W 4700 OHM 5%	1.0	
U1	382 0472 000	IC LM318	1.0	
U2	382 0523 000	IC MC14066BCPDS	1.0	
U3	382 0359 000	IC, 7815	1.0	
U4	382 0360 000	IC, 7915	1.0	
U5	382 0472 000	IC LM318	1.0	
U6	382 0428 000	IC LM358	1.0	
U7	382 0734 000	IC, MHW592/CA2830	1.0	
XU1	404 0673 000	SOCKET, IC 8 CONT	1.0	
XU2	404 0674 000	SOCKET, IC 14 CONT	1.0	
XU5,XU6	404 0673 000	SOCKET, IC 8 CONT	2.0	
	404 0198 000	TRANSIPAD 10020 DAP	1	
	404 0513 000	HEAT SINK PA1-1CB	1	
	404 0528 000	HEAT SINK 2228B	1	
	410 0344 000	INSULATOR, KAPTON	2	
	839 6123 001	SCHEMATIC	1.0	

WARNING: Disconnect primary power prior to servicing.

RF AMP MODULE
888-2164-800

TECHNICAL MANUAL

RF AMP MODULE

992 6204 001

HARRIS

T.M. No. 888-2164-800

Printed: November 1982

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

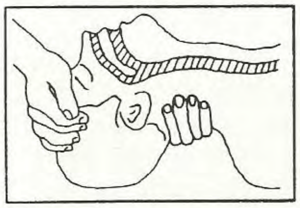
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

(A) AIRWAY

IF UNCONSCIOUS.
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

(B) BREATHING

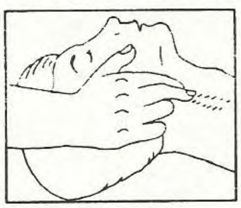
IF NOT BREATHING.
BEGIN ARTIFICIAL BREATHING

TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

CHECK
CAROTID PULSE



IF PULSE ABSENT.
BEGIN ARTIFICIAL
CIRCULATION

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES

APPROX. RATE OF COMPRESSIONS --80 PER MINUTE — ONE RESCUER: 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE — TWO RESCUERS: 5 COMPRESSIONS, 1 BREATH

NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

NOTE

> If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE

1-2. The RF AMP MODULE comprises two class C operated amplifier stages which accept a 300 milliwatt RF input from the MOD OSC module and provide a continuously variable three to fifteen watt RF output. An internal AGC circuit ensures a stable RF output level. Automatic VSWR shutdown, off frequency inhibit control, and power supply current limiting allow automatic module operation. Forward and reflected power sensed by the directional coupler and outputs of amplifier voltage and current provide indications of the module status. RF shutdown, as well as forward and reflected (VSWR) levels are remoteable from provisions on the rear of the exciter.

1-3. TECHNICAL CHARACTERISTICS

1-4. Table 1-1 lists operating characteristics and parameters of the RF AMP MODULE.

SECTION II

INSTALLATION

2-1. GENERAL

2-2. Refer to FM Exciter System Technical Manual, Section II, Installation.

SECTION III

CONTROLS AND INDICATORS

3-1. GENERAL

3-2. Figure 3-1 shows the location of each control or indicator associated with the RF AMP MODULE and table 3-1 lists the controls and indicators with a description of each item listed. Control setup adjustments are listed in table 3-2.

WARNING: Disconnect primary power prior to servicing.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
POWER:	Filtered +34 Vdc @ 3.0 amperes maximum. 0 to +24 Vdc, Regulated by external pass transistor.
SIGNAL:	
RF Drive	87.5 MHz to 108 MHz @ 250 milliwatts.
CONTROL:	
RF Inhibit	Open for Operate Ground for Inhibit
External RF Inhibit	Open for Operate Ground for Inhibit
OUTPUTS	
POWER:	
Regulator Drive	0 to +24 Vdc @ 0.020 amperes.
SIGNAL:	
RF Carrier	88 MHz to 108 MHz FM @ 3 to 15 watts, adjustable. 50 ohms impedance for full specification performance.
METERING:	
Amplifier Voltage	0 to +30 Vdc, full scale
Amplifier Current	0 to 3.0 amperes, full scale

WARNING: Disconnect primary power prior to servicing.

Table 1-1. Technical Characteristics (Continued)

FUNCTION	CHARACTERISTIC
Forward Power - Local	0 - 4 Vdc into open circuit.
Remote	0 - 4 Vdc into open circuit.
Reflected Power - Local	0 - 4 Vdc into open circuit.
Remote	0 - 4 Vdc into open circuit.

WARNING: Disconnect primary power prior to servicing.

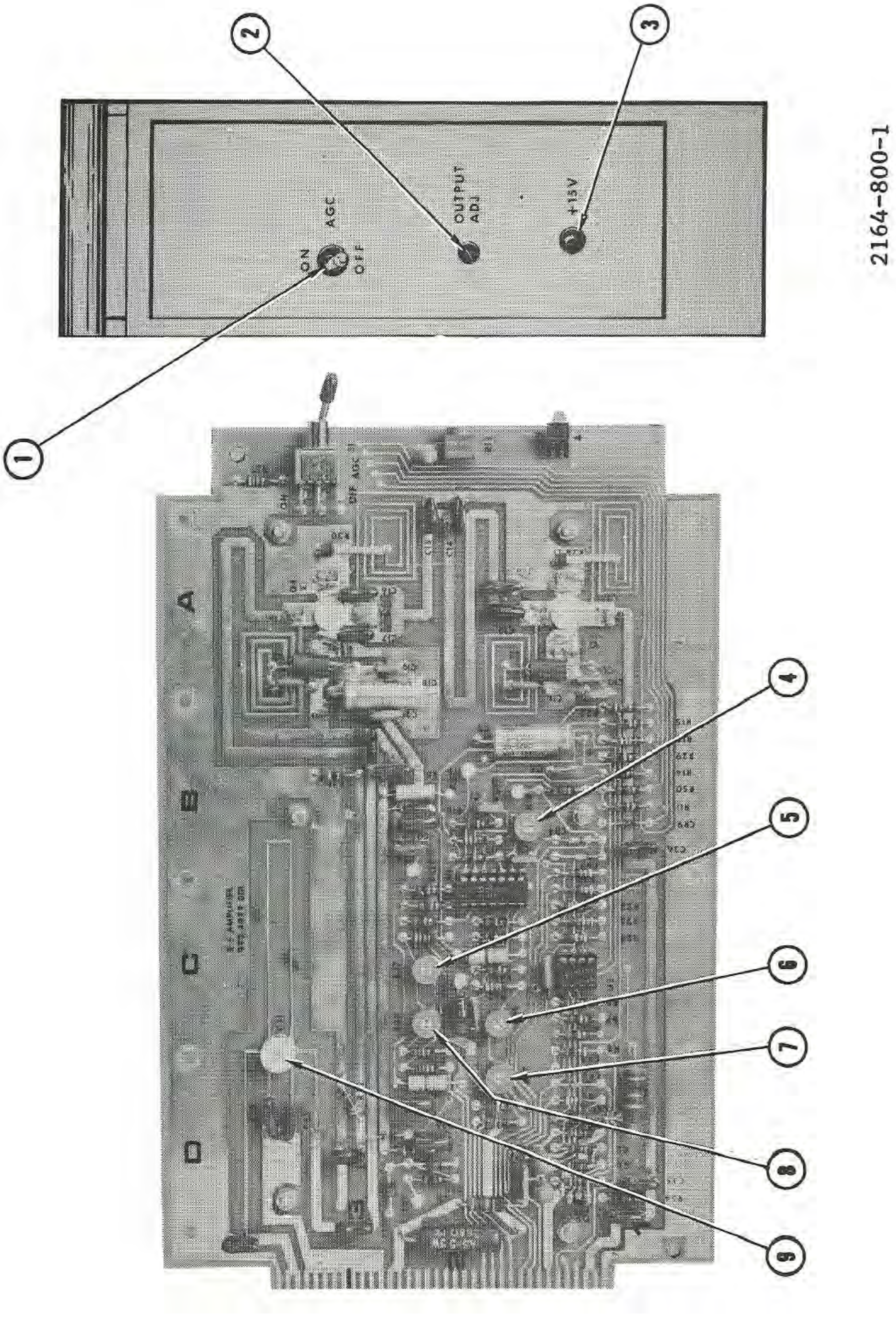


Figure 3-1. RF AMP MODULE

 WARNING: Disconnect primary power prior to servicing.

Table 3-1. RF AMP MODULE Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	AGC ON/OFF Switch (2A2S1)	Enables the power amplifier automatic output level control.
2	OUTPUT ADJUST Control	Adjusts the power amplifier output level.
3	+15V Indicator (CR5)	Illuminates to indicate the RF AMP MODULE +15 volt regulator is operational.
4	VSWR THRESHOLD Control (R18)	Adjusts the reflected power level at which the module limites rf output.
5	REMOTE POWER REFLECTED LEVEL Control (R37)	Calibrates remote reflected power meter indication.
6	REMOTE POWER FORWARD LEVEL Control (R46)	Calibrates remote forward power meter indication.
7	POWER REF Control (R47)	Calibrates exciter MULTIMETER reflected power indication.
8	POWER FWD Control (R38)	Calibrates exciter MULTIMETER forward power indication.
9	SECOND HARMONIC NOTCH Adjustment (C31)	Adjusts notch filter to second harmonic. Allows use of exciter as a ten watt transmitter - adjustment not required when used as exciter.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments

OUTPUT ADJUST Control (R13)	1. Depress the MULTIMETER FWD PWR switch. NOTE Due to finite coupler directivity and detector diode forward voltage drop, the range and accuracy of the forward and reflected power indications is limited to ±10% full scale. 2. If used as an exciter, adjust R19 to obtain the required drive to the transmitter as indicated by the MULTIMETER. 3. If used as a ten watt transmitter, adjust R19 to obtain the licensed power output as indicated by the MULTIMETER.
VSWR THRESHOLD Control (R18)	1. Depress the MULTIMETER FWD PWR Switch. Note the MULTIMETER indication. 2. Depress the MULTIMETER REF PWR Switch. If the MULTIMETER indication is approximately 50% or more of the forward power indication (3.1 VSWR) adjust the exciter load before proceeding. Note the MULTIMETER indication. 3. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 4. Disconnect the RF cable from J3 on the rear of the exciter. 5. Adjust R18 fully counterclockwise.

WARNING: Disconnect primary power prior to servicing.

	6. Adjust R18 clockwise to increase the MULTIMETER reflected power indication over the indication noted in step 2 as desired. 7. Remove the module and extender board, replace the module in the exciter, and reconnect the RF cable to J3 on the rear of the exciter.
SECOND HARMONIC NOTCH Adjustment (C31)	NOTE This adjustment is only required when using the MX-15 as a ten watt transmitter. 1. Connect the exciter RF output to a 50 ohm load through a directional coupler or line sampler. 2. Connect a spectrum analyzer to the line sampler or directional coupler forward port. 3. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 4. Note the spectrum analyzer display and adjust C31 for minimum amplitude of the second harmonic. 5. Remove the module and extender board, replace the module in the exciter, and reconnect the exciter output to the load.
POWER FWD Control (R38) REMOTE POWER FORWARD LEVEL Control (R46)	NOTE This procedure affects meter calibration only and should not be adjusted unless the meter circuit is repaired.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments (Continued)

POWER REF Control (R47) REMOTE POWER REFLECTED LEVEL Control (R37)	1. Connect the exciter RF output to a 50 ohm load through an accurately calibrated wattmeter capable of measuring forward and reflected power. 2. Remove the module. Mount the module in the exciter using the extender board provided with the exciter. 3. Adjust the wattmeter to measure forward power and adjust the OUTPUT ADJ control to obtain a mid-range indication on the external wattmeter. 4. Depress the MULTIMETER FWD PWR switch and adjust R38 until the MULTIMETER indication matches the external wattmeter indication. 5. If an external forward power meter is used, adjust R46 until the indication matches the external wattmeter indication. 6. Adjust the external wattmeter to measure reflected power. Replace the 50 ohm load with a 2:1 to 3:1 mismatch. 7. Depress the MULTIMETER REF PWR switch and adjust R47 until the MULTIMETER indication matches the external wattmeter indication. 8. If an external reflected power meter is used, adjust R37 until the indication matches the external wattmeter indication.

WARNING: Disconnect primary power prior to servicing.

Table 3-2. Control Adjustments (Continued)

	9. Remove the module and extender board, replace the module in the the exciter, and reconnect the exciter output to the load.

SECTION IV

PRINCIPLES OF OPERATION

4-1. CIRCUIT DESCRIPTION

4-2. RF CIRCUIT

4-3. RF AMPLIFIER. Drive is input to the RF AMP MODULE from the MOD OSC module at a level of 300 milliwatts (see figure 4-1). Chebyshev wideband impedance matching networks allow full 88 MHz to 108 MHz coverage with no amplifier tuning. The RF input is matched to the base impedance of Q3 by capacitors C35, C36, and a series section of microstrip. The RF driver (Q3) amplifies the signal to approximately a two watt maximum level. A matching network consisting of capacitors C13 through C17 and the associated series sections of microstrip match the collector impedance of Q3 to the base impedance of the RF final amplifier (Q4) over the entire FM broadcast band. The fifteen watt maximum output is transformed to a 50 ohm impedance by capacitor C22 and the output section of series microstrip. DC blocking is provided by capacitor C23.

4-4. OUTPUT CIRCUIT. The RF is output through a directional coupler and a low-pass filter implemented with microstrip techniques. The shunt leg at the input to the filter consisting of the series combination of a section of microstrip and capacitor C32 traps the third harmonic. In a similar manner, the output shunt leg consisting of the series combination of a section of microstrip and capacitor C33, traps the second harmonic. The series leg consisting of a parallel combination of microstrip and the SECOND HARMONIC NOTCH control (C31) provides additional suppression of the second harmonic. This control should be adjusted as required to reduce the second harmonic to a minimum level when the exciter is used as a low power transmitter. This adjustment is not required when using the unit as an exciter. The remaining series microstrip and shunt capacitor C37 attenuate harmonics above the third harmonic. The RF carrier is output from J3 on the rear of the exciter at an impedance of 50 ohms.

4-5. DIRECTIONAL COUPLER

4-6. The RF AMP MODULE includes a directional coupler produced in printed circuit form with microstrip techniques using the principle that adjacent sections of microstrip transmission line share common inductive and capacitive coupling. Due to basic microstrip principles, perfect directivity cannot be achieved. This limits the "zeroing" of the reflected power directional coupler.

4-7. FORWARD POWER SENSOR. The forward port of the directional coupler is broadbanded over the entire commercial FM broadcast band by capacitor C27 and L5. Resistor R41 terminates diode CR8 which rectifies the RF present at the unterminated end of the sensing line. The voltage is filtered by C28, C30, and L6 and applied to the AGC amplifier (U1D) and to the forward power meter amplifier (U1B). The PINC test point (TP1) provides a convenient

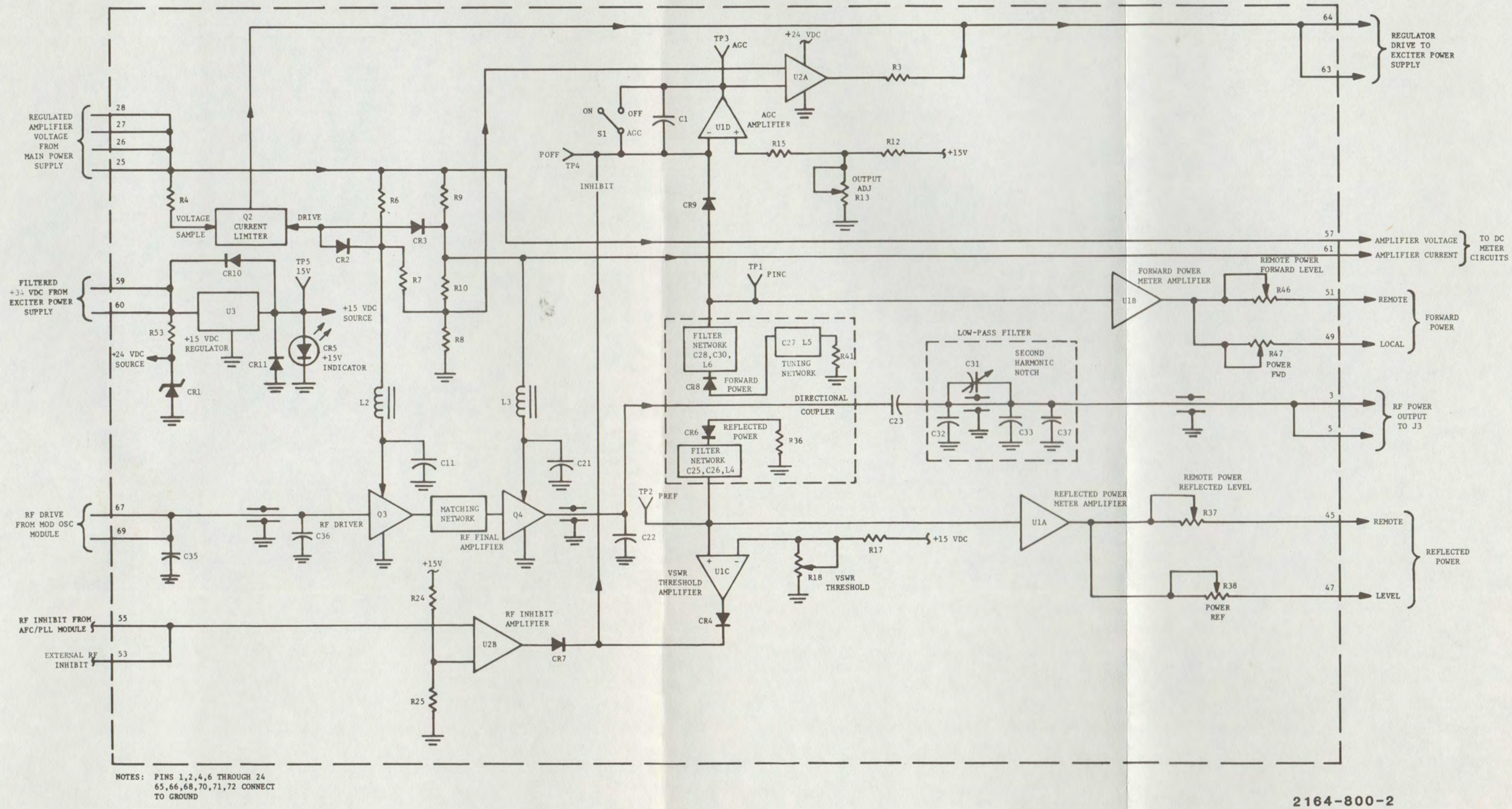


FIGURE 4-1. RF AMP MODULE BLOCK DIAGRAM

location to monitor the potential developed by the forward port of the directional coupler.

4-8. REFLECTED POWER SENSOR. The reflected port of the directional coupler similiarly develops a rectified RF voltage through CR6 produced along the sensing line which is terminated by resistor R36. The voltage is filtered by C25, C26, and L4 and applied to the VSWR threshold amplifier (U1C) and the reflected power meter amplifier (U1A). The PREF test point (TP2) provides a convenient location to monitor the potential developed by the reflected port of the directional coupler.

4-9. VSWR METERING. The forward power indication is applied to the forward power meter amplifier (U1B) which isolates the local and remote power meters from the directional coupler. In a similar manner, the reflected power indication is applied to the reflected power meter amplifier (U1B). One output from each meter amplifier is applied to the DC meter circuits to provide a local indication of the forward and reflected power. The local indications are calibrated by the POWER FWD control (R47) and the POWER REF control (R38). Provisions on the rear of the exciter allow both the forward and reflected power indications to be remoted. The REMOTE POWER FORWARD LEVEL control (R37) allows calibration of both potentials to match external metering.

4-10. CONTROL CIRCUITS

4-11. VSWR POWER LIMITING. The VSWR power limiting circuit automatically limits the RF power output to prevent over-dissipation of the RF amplifier devices. It does not totally inhibit RF power output. Under high VSWR conditions, the amplifier could become unstable and the foldback current limiting circuit could create spurious outputs. Thus, the RF AMP MODULE should not be operated into high VSWR conditions for maximum performance. No damage can be expected under short or open load conditions if the factory adjustment of the VSWR THRESHOLD control (R18) is maintained.

4-12. The directional coupler reflected power output is monitored by adjustable threshold amplifier U1C. Whenever the reflected power exceeds the level preset by the VSWR THRESHOLD control (R18), a bias is applied through CR4 to the AGC amplifier (U1D) which limits the voltage applied to the RF amplifier devices and thereby protects the output stages. The POFF test point (TP4) provides a convenient location to monitor the control bias to the AGC amplifier (U1D).

4-13. AMPLIFIER INHIBIT. During power applicaton or whenever a frequency unlocked condition exists between the AFC/PLL module and the MOD OSC module, a ground is automatically applied from the AFC/PLL module to the input of the RF inhibit amplifier (U2B) which inhibits RF output. The ground causes amplifier U2B to output a bias through CR7 to the AGC amplifier (U1D) which removes the voltage applied to the RF amplifier stages. When the AFC/PLL module signals a frequency locked condition, RF output is again enabled. The RF shutdown provision is remoteable from connections on the rear of the exciter. The POFF test point (TP4) provides a convenient location to monitor the control bias to the AGC amplifier (U1D).

4-14. RF AMPLIFIER AGC. RF amplifier output power is controlled by regulating the RF amplifier collector voltage. This allows simplified AGC circuitry and high RF power transistor effeciency at all power levels. As less thermal stress on the RF power transistors will produce more reliable operation, heat generated by the controlling process is dissipated by the DC regulator in the power supply. To ensure adequate heat dissipation, the RF transistors and the DC regulator transistor are mounted on large heat sinks in the direct air flow from the fan.

4-15. AGC Operation. High gain negative AGC feedback determines the supply potential applied to the RF output transistors. A DC voltage proportional to the forward power output is produced by the directional coupler and applied to the inverting input of AGC amplifier U1D. A reference voltage which is adjusted by the OUTPUT ADJ control (R13) is applied to the noninverting input of the AGC amplifier. If the RF output power decreases beyond the value adjusted by R13, the inverting input of the AGC amplifier will be driven increasingly negative. This causes the output of U1D to increase in a positive direction which in turn drives regulator driver U2A in a positive direction. U2A compares a sample of the RF collector voltage and drives regulator transistor Q1 in the exciter power supply to increase the RF amplifier collector voltage. If the RF output power increases beyond the AGC value, the opposite sequence limits the power applied to the RF amplifier collector circuit. The only DC feedback path for U1D in the AGC mode is through the entire AGC control loop. The AGC circuit is disabled to allow manual control by adding negative feedback directly to the AGC amplifier (U1D) through the AGC ON/OFF switch (S1).

4-16. Current Limiting. RF amplifier collector current through resistors R6 and R9 is monitored by current limiter Q2. If the collector of Q3 exceeds 0.5 amperes or if the collector current of Q4 exceeds two amperes, the AGC control loop action will be overridden by the current limiter stage which prevents any increase in drive to power supply regulator transistor Q1. During normal operation, the current through resistors R6 and R9 cuts off current limiter Q2.

4-17. POWER

4-18. Filtered positive 34 VDC obtained from the exciter power supply enters the module on pins 59 and 60. The potential is regulated into a positive 15 Vdc source by U3 to operate the RF AMP MODULE internal circuitry. Diodes CR10 and CR11 protect the regulator circuit from damage due to shorts and reverse potentials. The +15V indicator provides an indication of the internal power supply status. Additionally a stabilized source of positive 24 Vdc is developed by R53 and CR1 to operate the regulator driver (U2A).

WARNING: Disconnect primary power prior to servicing.

SECTION V

MAINTENANCE

5-1. CORRECTIVE MAINTENANCE

5-2. The MX-15 FM exciter module maintenance philosophy consists of problem isolation to a specific area or individual component and subsequent isolation and replacement of the defective component.

5-3. TROUBLESHOOTING

5-4. In event of problems, the trouble area must first be isolated to a specific area. Most troubleshooting consists of visual checks. The MODULATION meter, MULTIMETER, FUSE F1, circuit breaker CB1, and the indicators on each module should be used to determine in which area the malfunction exists. All module power supplies are equipped with LEDs which indicate the module power supply status. A single dark LED would indicate a problem associated with an individual module monolithic voltage regulator. A consistent pattern of dark LEDs however, would indicate an exciter DC distribution bus fault.

5-5. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. Table 5-1 lists typical trouble symptoms pertaining to the individual module operation with references to fault isolation diagrams listing probable causes and corrective actions. A corrective action given for a trouble symptom is not necessarily the only answer to a problem. It only tends to lead the repairman into the area that may be causing the trouble. An extender board (HARRIS PN 992 4989 001) is provided with the exicter to assist in troubleshooting. In event parts are required, refer to Section VI, Parts List. The following information is contained in this section as an aid to maintenance:

WARNING

LOW VOLTAGES ARE USED THROUGHOUT THE MODULE CIRCUITRY, HOWEVER MAINTENANCE WITH POWER ENERGIZED IS ALWAYS HAZARDOUS AND CAUTION SHOULD BE OBSERVED. THIS IS PARTICULARLY TRUE OF THE RF AMP MODULE WHERE HIGH RF POTENTIALS EXIST AT HIGH IMPEDANCE POINTS. IT IS POSSIBLE TO RECEIVE PAINFUL BUT USUALLY NOT INJURIOUS RF BURNS FROM THE 15 WATT OUTPUT STAGE. COMPONENT OR MODULE REPLACEMENT WITH POWER ON IS NOT RECOMMENDED.

REFERENCE	TITLE	NUMBER
Figure 5-1	RF AMP MODULE Parts Layout	------
Figure 5-2	RF AMP MODULE Schematic	852 8997 001

Table 5-1. RF AMP MODULE Fault Isolation Index

NO RF OUTPUT	Figure 5-3.
INADEQUATE RF OUTPUT	Figure 5-4.
CANNOT REDUCE OUTPUT POWER	Figure 5-5.
AM NOISE ON OUTPUT	Figure 5-6.
FUSE F1 OPENS	Figure 5-7.

WARNING: Disconnect primary power prior to servicing.

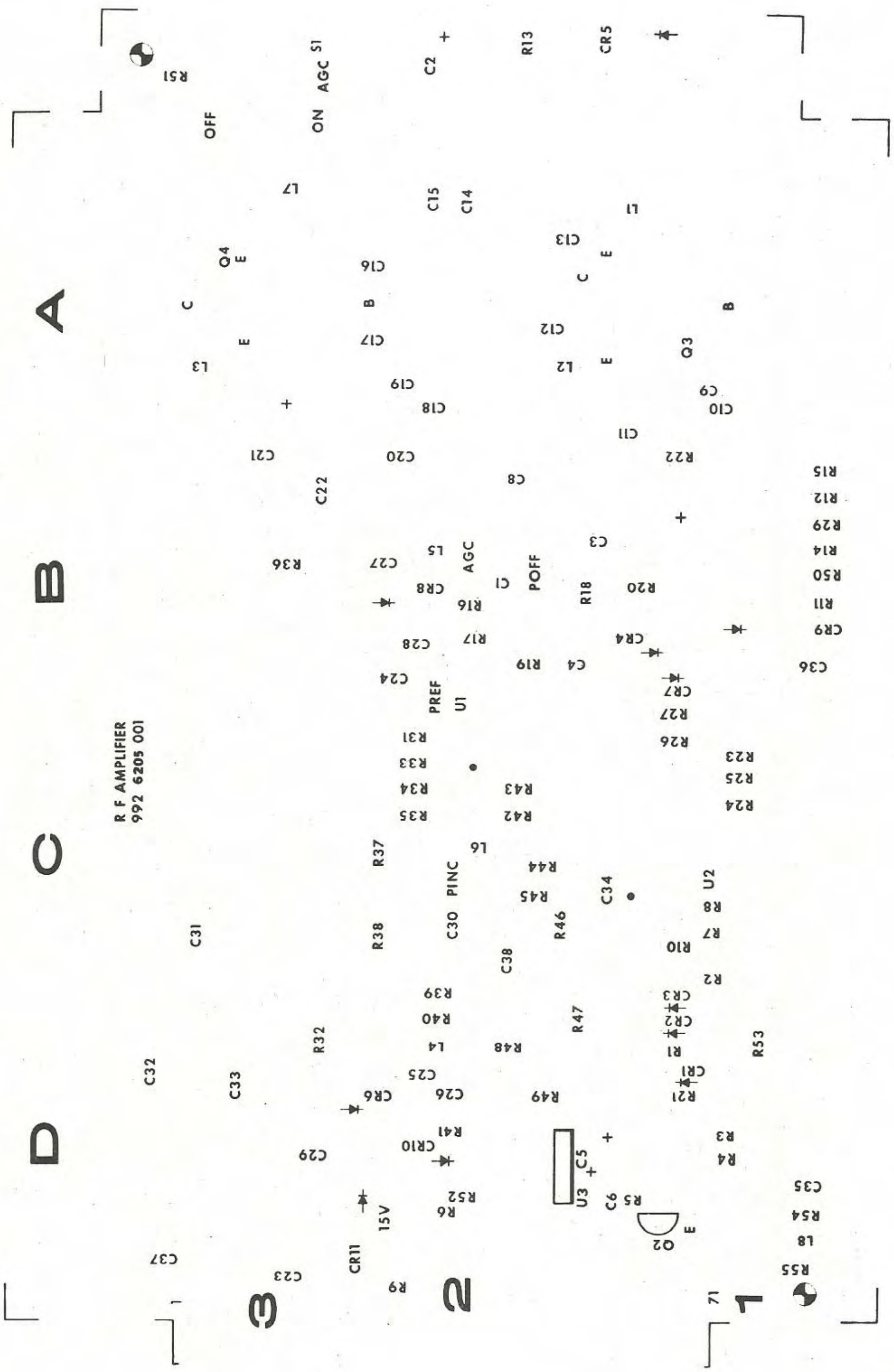


Figure 5-1. RF AMP MODULE Parts Layout

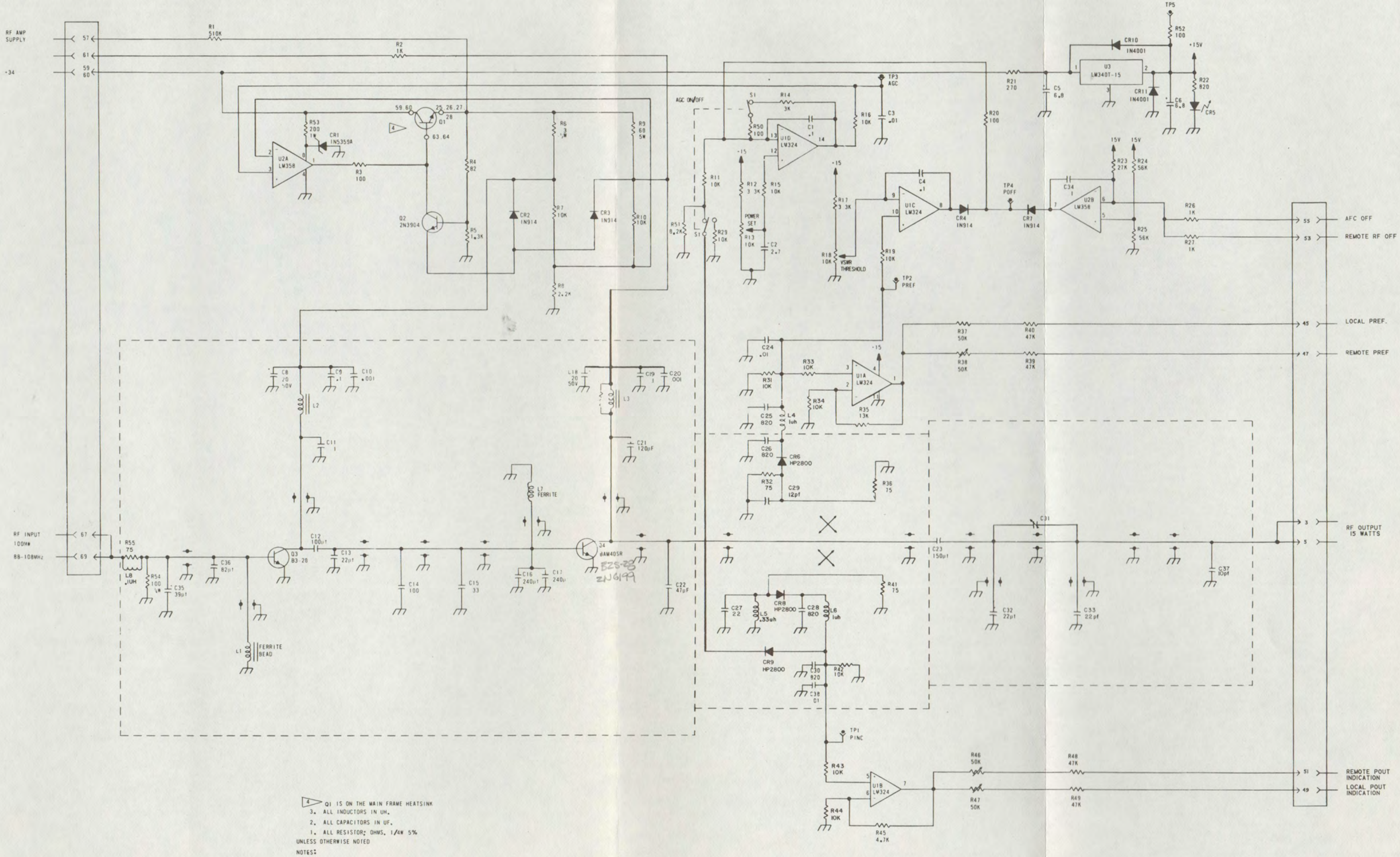


FIGURE 5-2. RF AMP MODULE SCHEMATIC
852 8997 001

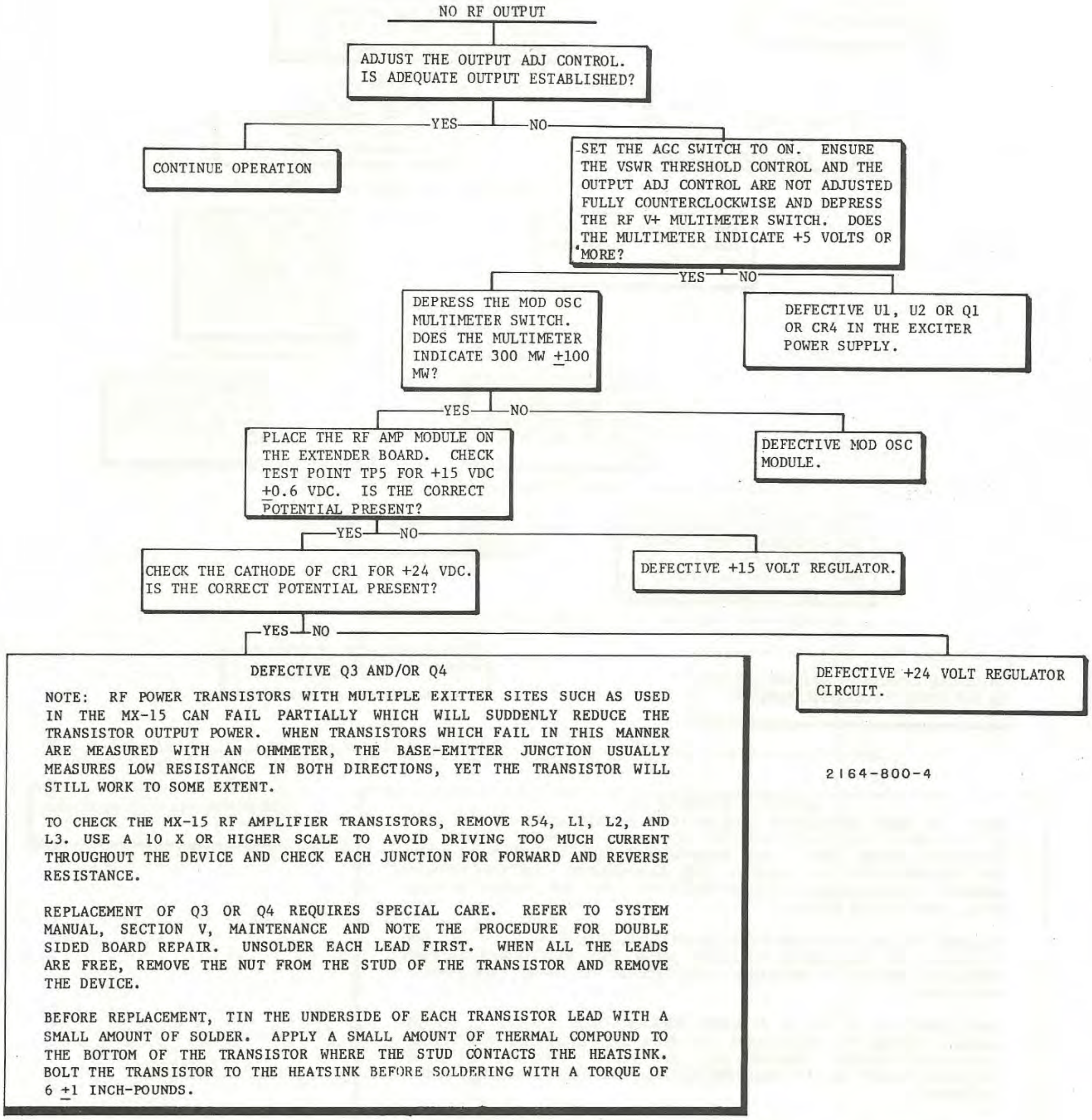


Figure 5-3. No RF Output

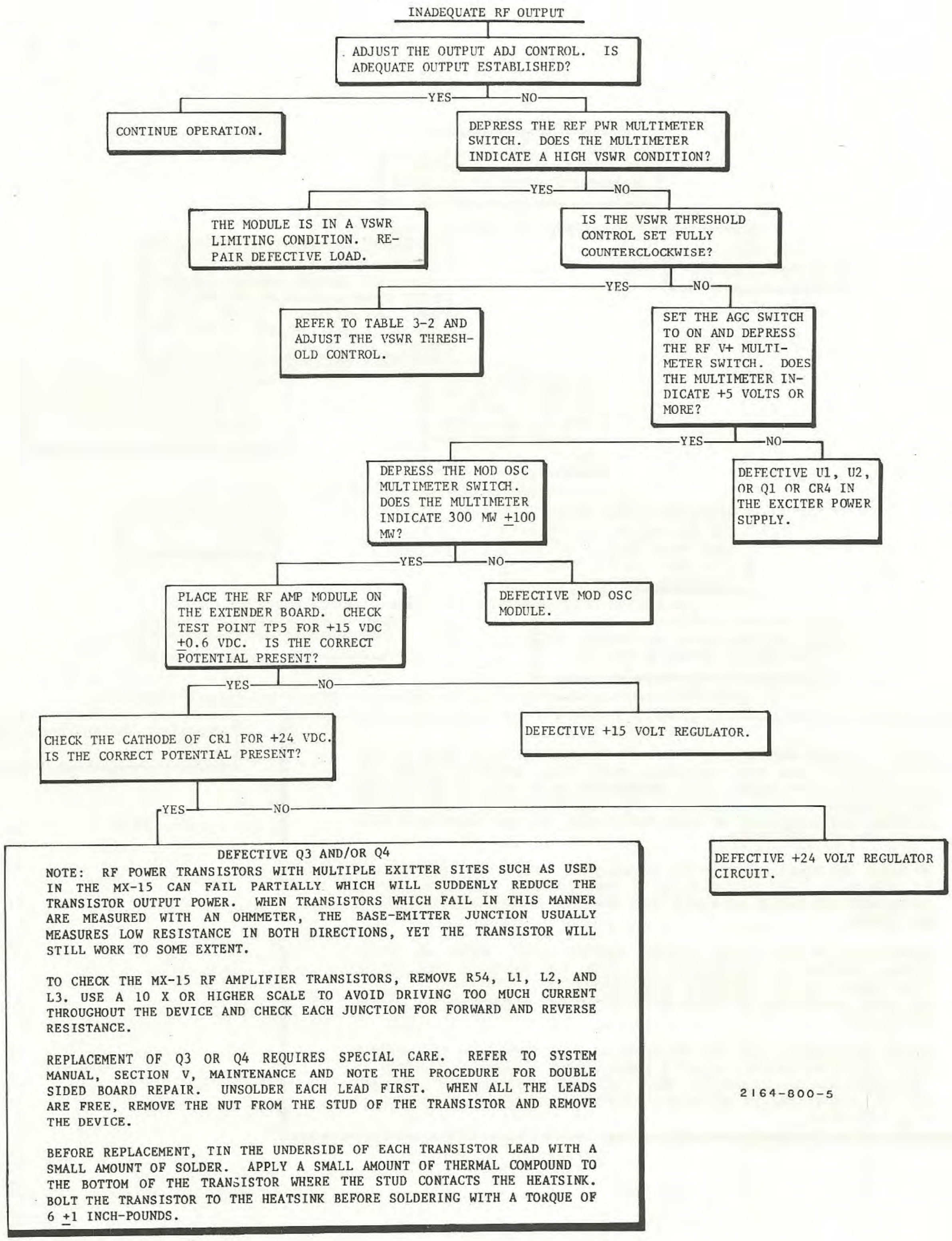
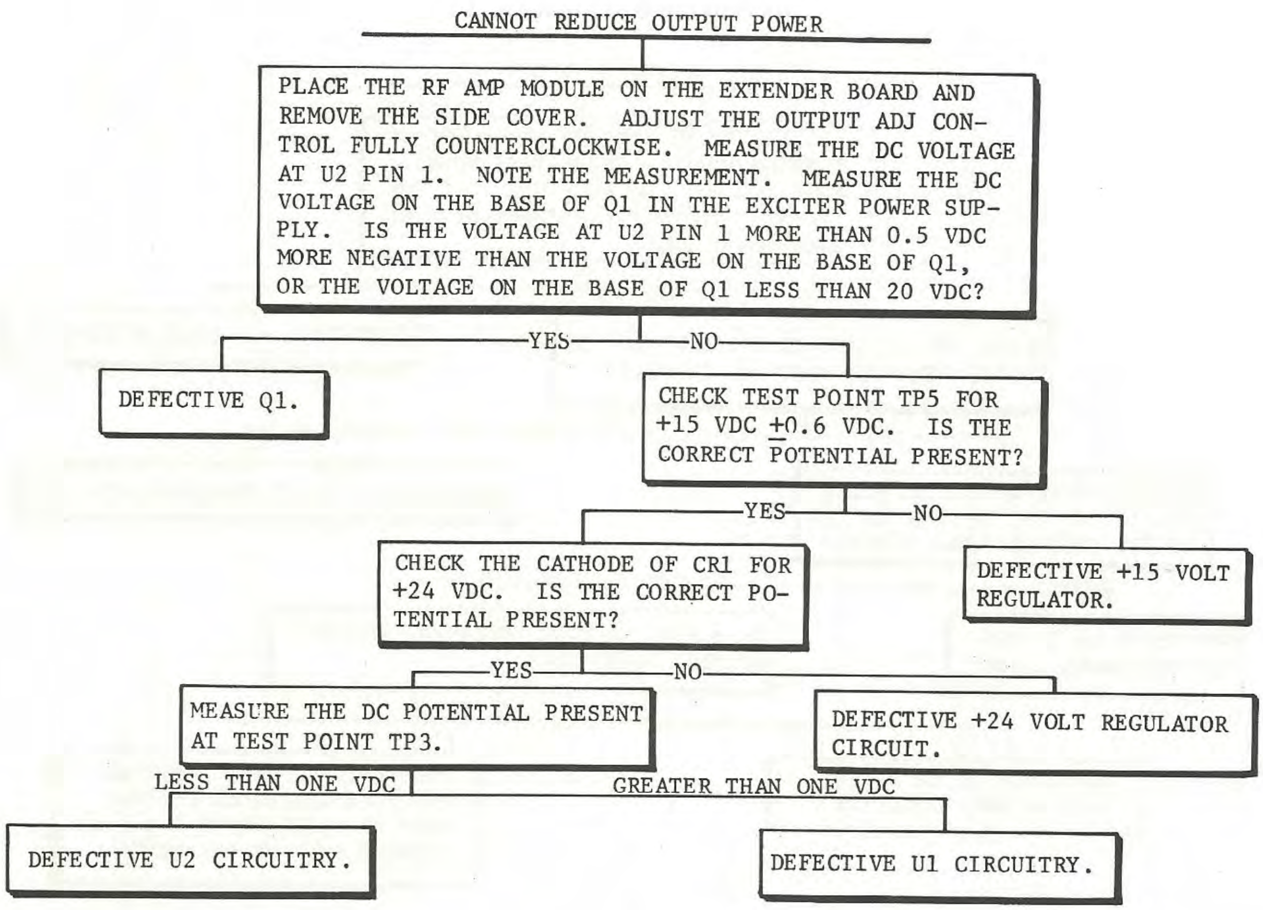


Figure 5-4. Inadequate RF Output

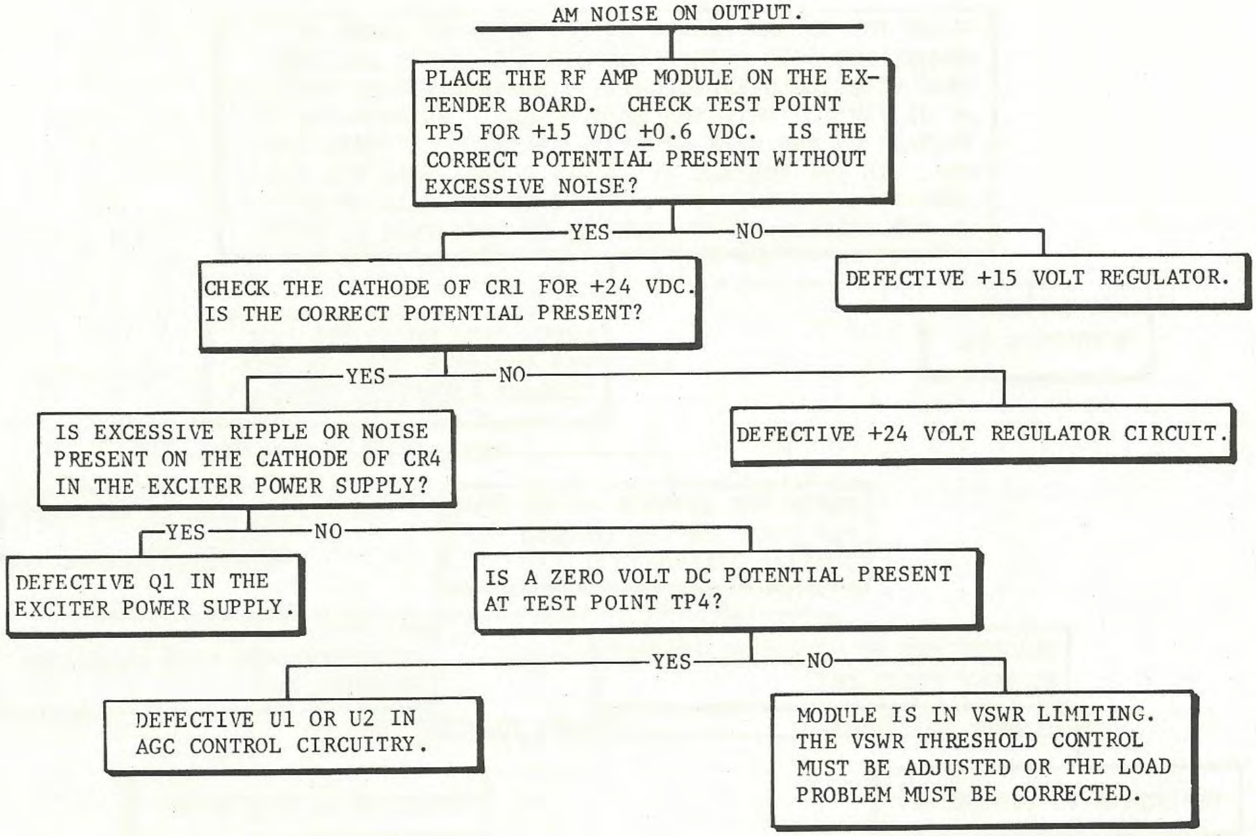
WARNING: Disconnect primary power prior to servicing.



2164-800-6

Figure 5-5. Cannot Reduce Output Power

 WARNING: Disconnect primary power prior to servicing.



2164-800-7

Figure 5-6. AM Noise On Output

WARNING: Disconnect primary power prior to servicing.

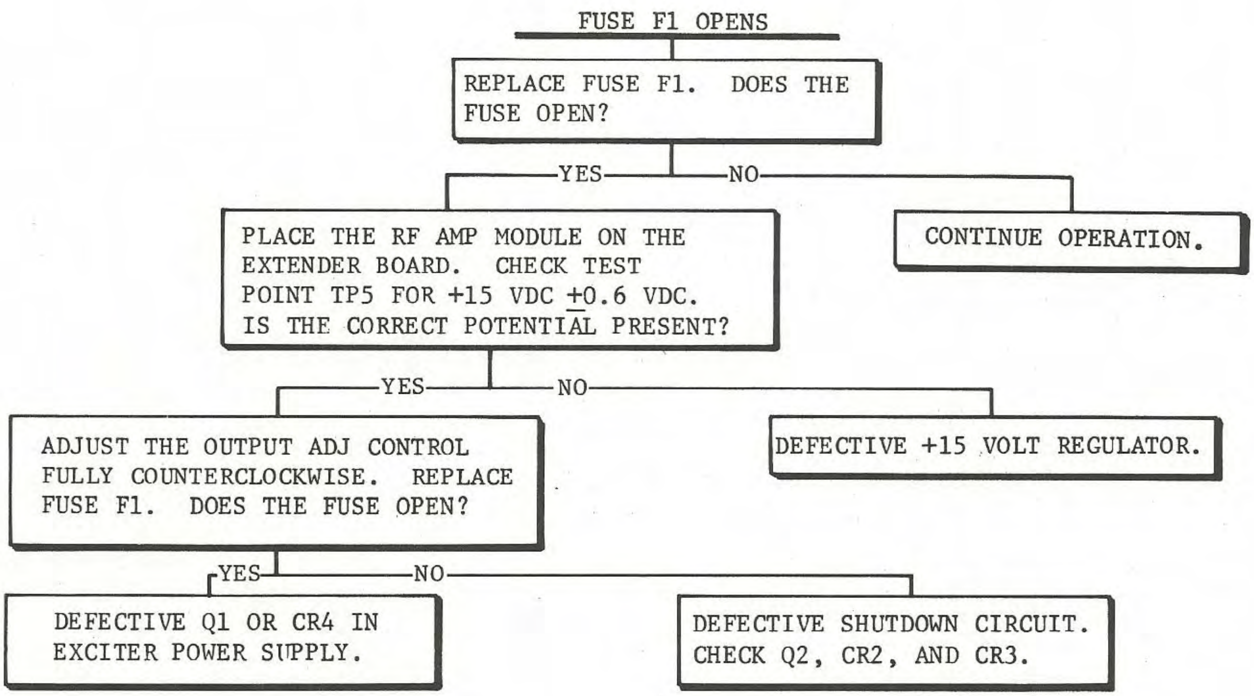


Figure 5-7. Fuse F1 Opens

WARNING: Disconnect primary power prior to servicing.

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. Refer to table 6-1 for replaceable parts which are required for proper maintenance of the MX-15 RF AMP MODULE. Table entries are indexed by component reference designator.

Table 6-1. Replaceable Parts List Index

WARNING: Disconnect primary power prior to servicing

Table 6-2. RF PWR AMP MODULE - 992 6204 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	350 0048 000	RIVET POP .093X.337	2
	358 2037 000	BALL STUD 6-32X 3/16	1
	448 0623 000	SPRING CATCH	1
	813 5006 047	STANDOFF-HEX	8
	813 5007 048	STANDOFF 2.217 LG	1
	813 5092 779	SPACER .25D X .165L	2
	816 9688 001	STANDOFF	2
	829 2617 001	BLOCK	1
	829 2618 001	BLOCK	1
	839 2740 001	PLATE, CARD MTG	1
	839 3420 001	SHIELD, BACK PLT.	1
	843 4152 001	COVER, RF AMP	1
	929 2195 001	FRONT PANEL, RFAMP	1
	939 3181 001	EXTRACTOR, LARGE CD.	1
	992 6205 001	PC BD, RF PWR AMP	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. PC BD, RF PWR AMP - 992 6205 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1	386 0366 000	DIODE, ZENER 1N5359A	1
CR2,CR3,CR4	384 0205 000	DIODE SILICON 1N914	3
CR5	384 0661 000	L.E.D. GREEN	1
CR6	384 0321 000	DIODE 5082-2800/1N5711	1
CR7	384 0205 000	DIODE SILICON 1N914	1
CR8,CR9	384 0321 000	DIODE 5082-2800/1N5711	2
CR10,CR11	384 0284 000	DIODE 10D4/1N2070	2
C1	516 0453 000	CAP .1UF 100V 20%	1
C2	526 0342 000	CAP 2.7UF 35V 10%	1
C3	516 0375 000	CAP .01UF 50V	1
C4	516 0453 000	CAP .1UF 100V 20%	1
C5,C6	526 0049 000	CAP 6.8UF 35V 20%	2
C8	522 0256 000	CAP 20 UF 50V	1
C9	516 0453 000	CAP .1UF 100V 20%	1
C10	516 0054 000	CAP, DISC .001UF 1KV 10%	1
C11	516 0453 000	CAP .1UF 100V 20%	1
C12	500 0759 000	CAP, MICA 100PF 500V 5%	1
C13	500 0809 000	CAP MICA 22UUF 500V	1
C14	500 0759 000	CAP, MICA 100PF 500V 5%	1
C15	500 0813 000	CAP MICA 33UUF 500V	1
C16,C17	500 0830 000	CAP MICA 240UUF 500V	2
C18	522 0256 000	CAP 20 UF 50V	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. PC BD, RF PWR AMP - 992 6205 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C19	516 0453 000	CAP .1UF 100V 20%	1
C20	516 0054 000	CAP, DISC .001UF 1KV 10%	1
C21	500 0826 000	CAP, MICA 120PF 500V 5%	1
C22	500 0817 000	CAP MICA 47UUF 500V	1
C23	500 0761 000	CAP, MICA 150PF 500V 5%	1
C24	516 0375 000	CAP .01UF 50V	1
C25,C26	500 0842 000	CAP, MICA 820PF 300V 5%	2
C27	500 0809 000	CAP MICA 22UUF 500V	1
C28	500 0842 000	CAP, MICA 820PF 300V 5%	1
C29	500 0805 000	CAP MICA 12UUF 500V	1
C30	500 0842 000	CAP, MICA 820PF 300V 5%	1
C31	518 0058 000	CAP, VAR 5.5-18PF	1
C32,C33	500 0809 000	CAP MICA 22UUF 500V	2
C34	516 0453 000	CAP .1UF 100V 20%	1
C35	500 0815 000	CAP MICA 39UUF 500V	1
C36	500 0823 000	CAP, MICA 82PF 500V 5%	1
C37	500 0804 000	CAP, MICA 10PF 500V 5%	1
C38	516 0375 000	CAP .01UF 50V	1
L1	414 0087 000	BEAD. FERRITE SHIELD	1
L2	494 0218 000	CHOKE WIDE BAND	1
L4	494 0384 000	CHOKE, RF 1.00 UH	1
L5	494 0378 000	CHOKE, RF 0.33 UH	1

Table 6-3. PC BD, RF PWR AMP - 992 6205 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
L6	494 0384 000	CHOKE, RF 1.00 UH	1
L7	414 0087 000	BEAD. FERRITE SHIELD	1
L8	494 0372 000	CHOKE, RF 0.10UH	1
Q2	380 0189 000	TRANSISTOR 2N3904	1
Q3	380 0556 000	TRANSISTOR B-3-28	1
Q4	380 0610 000	TRANSISTOR BAM40SR B25-28 2N6199	1
R1	540 0977 000	RES .25W 510K OHM 5%	1
R2	540 0912 000	RES .25W 1000 OHM 5%	1
R3	540 0888 000	RES .25W 100 OHM 5%	1
R4	540 0886 000	RES .25W 82 OHM 5PCT	1
R005	540 0915 000	RES .25W 1300 OHM 5%	1
R6	540 0846 000	RES .5W 3 OHM 5 PCT	1
R7	540 0936 000	RES .25W 10K OHM 5%	1
R8	540 0920 000	RES .25W 2200 OHM 5%	1
R9	548 1425 000	RES .68 OHM 5W 1%	1
R10,R11	540 0936 000	RES .25W 10K OHM 5%	2
R12	540 0924 000	RES .25W 3300 OHM 5%	1
R13	550 0914 000	POT, 10K OHM	1
R14	540 0923 000	RES .25W 3000 OHM 5%	1
R15,R16	540 0936 000	RES .25W 10K OHM 5%	2
R17	540 0924 000	RES .25W 3300 OHM 5%	1
R18	550 0922 000	POT 10K OHM 1/2W	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. PC BD, RF PWR AMP - 992 6205 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R19	540 0936 000	RES .25W 10K OHM 5%	1
R20	540 0888 000	RES .25W 100 OHM 5%	1
R21	540 0898 000	RES .25W 270 OHM 5%	1
R22	540 0910 000	RES .25W 820 OHM 5%	1
R23	540 0946 000	RES .25W 27K OHM 5%	1
R24,R25	540 0954 000	RES .25W 56K OHM 5%	2
R26,R27	540 0912 000	RES .25W 1000 OHM 5%	2
R29,R31	540 0936 000	RES .25W 10K OHM 5%	2
R032	548 0885 000	RES 33.2K 1/2W 1%	1
R33,R34	540 0936 000	RES .25W 10K OHM 5%	2
R35	540 0939 000	RES .25W 13K OHM 5%	1
R036	548 0885 000	RES 33.2K 1/2W 1%	1
R37,R38	550 0929 000	POT 50K OHM 1/2 W	2
R39,R40	540 0952 000	RES .25W 47K OHM 5%	2
R42,R43,R44	540 0936 000	RES .25W 10K OHM 5%	3
R45	540 0928 000	RES .25W 4700 OHM 5%	1
R46,R47	550 0929 000	POT 50K OHM 1/2 W	2
R48,R49	540 0952 000	RES .25W 47K OHM 5%	2
R50	540 0888 000	RES .25W 100 OHM 5%	1
R51	540 0934 000	RES .25W 8200 OHM 5%	1
R52	540 0888 000	RES .25W 100 OHM 5%	1
R53	540 0315 000	RES 1W 200 OHM 5%	1

WARNING: Disconnect primary power prior to servicing

Table 6-3. PC BD, RF PWR AMP - 992 6205 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R54	540 0888 000	RES .25W 100 OHM 5%	1
R055	540 0875 000	RES .25W 30 OHM 5PCT	1
S1	604 0859 000	SW, TOGGLE DPDT	1
U1	382 0415 000	CKT, INT 324	1
U2	382 0428 000	IC LM358	1
U3	382 0359 000	IC, 7815	1
XU1	404 0674 000	SOCKET, IC 14 CONT	1
XU2	404 0673 000	SOCKET, IC 8 CONT	1
	839 2919 001	HEAT SINK, RF PWR AM	1
	852 8997 001	SCHEMATIC, RF AMP	0
	929 7155 001	RESISTOR ASSY	1
	943 4150 001	PC BOARD RF AMP	1

WARNING: Disconnect primary power prior to servicing

Table 6-4. RESISTOR ASSY - 929 7155 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	540 0571 000	RES 2W 22 OHM 5PCT	1
	251 0087 000	WIRE MAGNET 24 AWG	30 LB

WARNING: Disconnect primary power prior to servicing