

TECHNICAL MANUAL

MS-15R STEREO GENERATOR

994 8140 001



HARRIS CORPORATION

Broadcast Products Division

T.M. No. 888 1781 001

Printed: October 1977

LIST OF EFFECTIVE PAGES

TOTAL NUMBER OF PAGES IS AS FOLLOWS: 64

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List of Effective Pages	Original		
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SAFETY NOTICE

WARNING: THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS AND UNDER CERTAIN CONDITIONS, COULD BE FATAL.

This manual is intended as general guidance for trained and qualified installation, operating, maintenance and service personnel who are familiar with and aware of the dangers inherent to handling potentially hazardous electrical and/or 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 SERVICING OF THIS EQUIPMENT INVOLVES RISKS TO BOTH PERSONNEL AND EQUIPMENT, AND MUST BE PERFORMED ONLY BY PROPERLY TRAINED AND EXPERIENCED PERSONNEL EXERCISING DUE CARE. PERSONNEL MUST FAMILIARIZE THEMSELVES WITH SAFETY REQUIREMENTS, SAFE HANDLING AND OPERATING PRACTICE, AND RELATED FIRST-AID PROCEDURES (E.G., FOR ELECTRICAL BURNS AND ELECTRICAL SHOCK).

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CAUTIONARY NOTICE

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 tired.

Never 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. Proper training of experienced personnel and observing the above guidelines will help assure safe and continued operation of this equipment.

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SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION.

1-2. This technical manual contains information necessary to install, operate, maintain, and service the MS-15R stereo generator. 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.

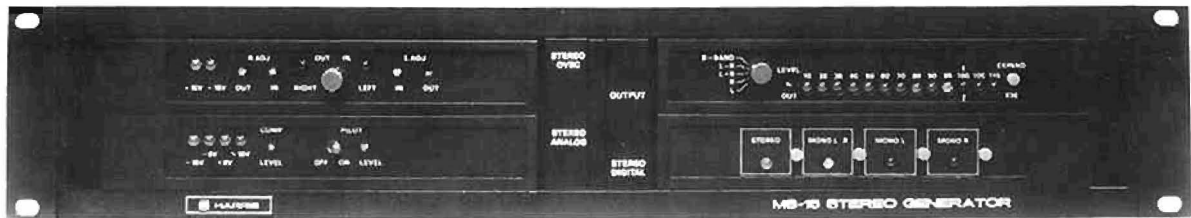
g. SECTION VII, DIAGRAMS, provides block, logic, schematic diagrams, and other drawings required for equipment maintenance.

1-3. EQUIPMENT PURPOSE.

1-4. The Harris MS-15R stereo generator (figure 1-1) produces a composite stereophonic signal from two audio inputs. Operational modes are STEREO, MONO L+R, MONO L, and MONO R. Provisions allow addition of an external monaural modulating signal such as an SCA carrier.

1-5. PHYSICAL DESCRIPTION.

1-6. The MS-15R stereo generator is both electrically and mechanically modular in concept. Each discrete function is implemented by 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. Each module plugs into the mother board which provides electrical interconnections. The non-modular components (power supply and RFI filter) are mounted to the case in the rear of the unit. The stereo generator mounts in 3.5 inches (8.89 cm) of standard 19 inch (48.26 cm) rack space.



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Figure 1-1. MS-15R Stereo Generator

1-7. FUNCTIONAL DESCRIPTION.

1-8. The Harris MS-15R stereo generator accepts two audio inputs at a +10 dBm level and generates a stereophonic, monaural left plus right, monaural left, or monaural right output signal at a low impedance level of 2.5V P-P to 12.0V P-P. An input provision allows summation of an external composite modulation signal such as an SCA signal (see figure 1-2).

1-9. Many design features provide operational characteristics superior to conventional FM equipment. A defeatable phase and amplitude equalizer corrects for deficiencies in the equipment following the MS-15R which might otherwise degrade the performance of the system. True peak-reading metering of the LEFT, RIGHT, L + R, L - R, or B-BAND (total modulation) is implemented by a light emitting diode display. The metering sensitivity can be increased times 10 to allow accurate pilot injection adjustment. Light emitting diodes monitor critical functions on each plug-in module.

1-10. STEREO GENERATOR.

1-11. The stereo generator consists of the STEREO DIGITAL module, the STEREO ANALOG module, and the STEREO OVSC module. Features of these modules are discussed by the following text.

1-12. 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 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 DSM stereo generator produces typically 50 dB of stereophonic channel separation from 30 Hz to 15 kHz with an exceptionally clean baseband signal which promotes minimal interaction between stereo and SCA service. An automatic phase control circuit adjusts the stereophonic pilot phase to maintain separation. Selectable FLAT, 25, 50, or 75 microsecond pre-emphasis is provided.

1-13. 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 transmission to two percent maximum on any input program material processed by any FM limiter. The filter is transparent to audio within its ± 0.5 dB pass-band of 30 Hz to 15 kHz and provides over 60 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.

1-14. OUTPUT.

1-15. The OUTPUT module accepts the stereophonic composite signal from the STEREO ANALOG module and an external modulating signal (if used) from the EXT INPUT provision (J2) on the rear of the unit. The module provides peak-reading metering functions by means of a solid state LED meter, defeatable

phase and amplitude equalization to correct for deficiencies in equipment following the MS-15R, and a low impedance output drive.

1-16. MAIN FRAME.

1-17. RFI FILTER. All stereophonic generator inputs and outputs are filtered by the RFI/EMI filter with the exception of the EXT INPUT (J2) and the OUTPUT (J1) lines which interface via coaxial (shielded) cables.

1-18. POWER SUPPLY. The power supply will operate from either 100 to 130 Vac or 200 to 260 Vac, 50 to 60 Hz. Selection of the 115 or 230 Vac nominal ac source voltage is accomplished internally with wire jumpers. The power supply is bused by F1 at 1 ampere for 115 Vac or 0.5 amperes for 230 Vac. The power supply develops pre-regulated +20 Vdc potentials with foldback current limiting. The dc voltage is distributed by the mother board to each individual module where the supply is re-regulated by individual monolithic voltage regulators.

1-19. EQUIPMENT CHARACTERISTICS.

1-20. ELECTRICAL CHARACTERISTICS.

1-22. Table 1-1 lists electrical operating characteristics and parameters of the MS-15R stereophonic generator.

1-23. MECHANICAL/ENVIRONMENTAL CHARACTERISTICS.

1-24. Table 1-2 lists physical and environmental characteristics of the MS-15R stereophonic generator.

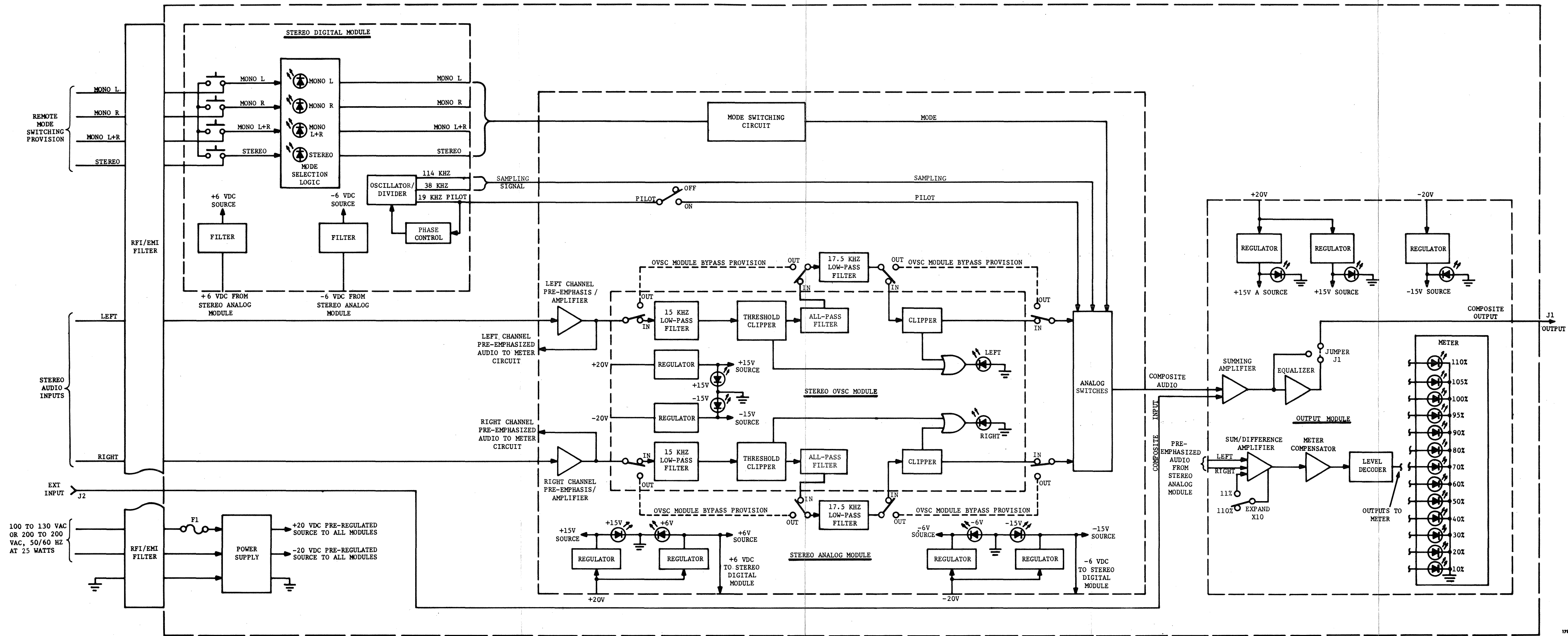


FIGURE 1-2. SIMPLIFIED BLOCK DIAGRAM

Table 1-1. Electrical Characteristics

FUNCTION	CHARACTERISTIC
Primary Power Requirements	100 to 130 Vac or 200 to 260 Vac 50-60 Hz, single phase, 25 watts.
Type of Modulation	Digitally Synthesized Modulation (DSM).
Audio Input Impedance (Left and Right)	600 Ohms balanced resistive, adaptable to other impedances.
Audio Input Level (Left and Right)	+10 dBm \pm 1 dB for 100% modulation at 400 Hz.
Audio Frequency Response	Standard 75 microsecond FCC pre-emphasis curve \pm 0.5 dB from 30 Hz to 15 kHz. Selectable: flat, 25, 50, or 75 microsecond pre-emphasis.
Input Filtering	15 kHz LPF, 50 dB minimum rejection at 19 kHz and above.
Overshoot Protection	Dynamic Transient Response (DTR) filter Defeatable for test purposes.
Audio Transient Response	2% maximum overshoot beyond steady state.
Harmonic Distortion (Left or Right)	0.4% or less from 30 Hz to 15 kHz.
IMD	0.4%, 60/7000 Hz, 4:1 ratio.
Signal-to-Noise Ratio	75 dB below 100% modulation (1.0V RMS Composite Output). Reference 400 Hz, 75 microsecond de-emphasis, measured from 30 Hz to 15 kHz.
Pilot Oscillator	Crystal Controlled.
Pilot Stability	19 kHz \pm 1Hz, 0°C to 50°C.
Pilot Phase	Automatically controlled.
Stereo Separation	45 dB minimum from 30 Hz to 15 kHz.
Dynamic Stereo Separation	40 dB minimum under normal programming conditions.
ELECTRICAL CHARACTERISTICS SUBJECT TO CHANGE WITHOUT NOTICE	

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Table 1-1. Electrical Characteristics (Continued)

FUNCTION	CHARACTERISTIC
Crosstalk (main to stereo subchannel or subchannel to main)	45 dB below 90% modulation.
Subcarrier suppression	60 dB below 100% modulation.
76 kHz suppression	60 dB below 100% modulation.
Modes of operation	Stereo, Mono L + R, Mono L, Mono R.
Composite output impedance	150 ohms unbalanced resistive.
Composite output level	Adjustable from less than 1.0 VRMS to greater than 4.5 VRMS for 100% modulation.
Composite Baseband Equalization	Equalizer provides separate amplitude and phase compensation for studio link or exciter deficiencies (defeatable).
RFI Protection	Filtering provided from 500 kHz through 1 GHz.
Audio/Control Connections	12 terminal barrier strip.
Modulation Meter	5 function, peak reading LED display with X 10 expandable range (adjustable to meet FCC ballistics).
EXTERNAL COMPOSITE INPUT:	
Amplitude response	±0.25 dB from 30 Hz to 15 kHz.
Phase Linearity	±2° from linear phase from 30 Hz to 75 kHz.
Composite Input Impedance	10k ohms unbalanced resistive.
Input Level	1.0V RMS for 100% modulation.

Table 1-2. Mechanical/Environmental Characteristics

FUNCTION	CHARACTERISTIC
Weight	18 pounds (8.16 kg), Net unpacked. 22 pounds (9.98 kg), Net packed.
Size	Width, 19 inches (48.26 cm). Height, 3.5 inches (8.89 cm). Depth, 15 inches (38.1 cm).
Operating Temperature Range	0°C to 50°C. Operational to -20°C.
Maximum Altitude	15,000 feet (4572 meters) above sea level.
Maximum Humidity	Non-condensing. Up to 95% relative.
Required Mounting Space	3.5 inches (8.89 cm) of standard 19 inch (48.26 cm) rack space.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information required to unpack, inspect, and install the MS-15R stereo generator. Preoperational checks and power on checks are provided to 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 MS-15R stereo generator 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 Products 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 a 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 MS-15R stereo generator will be accomplished in five steps: 1) preliminary wiring, 2) stereo generator placement, 3) module installation, 4) stereo generator wiring, and 5) preliminary checkout.

2-8. PRELIMINARY WIRING.

WARNING

ENSURE AC POWER IS NOT APPLIED TO THE STEREO
GENERATOR.

2-9. Remove the top cover of the stereo generator and check the transformer terminal block (TB1) at the rear of the unit. Jumpers on this terminal block determine the primary source voltage. Refer to figure 4-3 and determine which jumpers are required for the installation. Replace the top cover.

2-10. STEREO GENERATOR PLACEMENT.

2-11. The Harris MS-15R stereo generator requires 3.5 vertical inches (8.89 cm) of standard 19 inch (48.26 cm) rack space and should be placed in a location which provides convenient access to the rear panel near power, audio, and control cables. As cooling air enters the equipment through vents in the bottom panel, the stereo generator 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.

2-12. MODULE INSTALLATION.

2-13. Several modules require jumper-plug programming which initializes the module to operate in a predetermined mode at power application. Remove the STEREO DIGITAL, and STEREO ANALOG module covers and refer to table 2-1. Ensure each jumper listed is correctly installed in each respective module to produce the desired mode of operation. After the module programming is completed, replace the module covers and each module should be inserted in its respective slot in the stereo generator.

2-14. STEREO GENERATOR WIRING.

2-15. Refer to table 2-2 and figure 2-1 for information required to connect inputs, remote control lines, and the output to the stereo generator.

2-16. After wiring of the inputs, control lines, and the output is completed, the following additional external connections must be made.

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

b. COMPOSITE INPUT: If an external composite input such as SCA is to be used with the stereo generator, connect the input to the EXT INPUT terminal (J2) on the rear of the stereo generator.

2-17. The complete stereo generator should be inspected at this time. Check the following:

WARNING

ENSURE POWER IS NOT APPLIED TO THE STEREO GENERATOR.

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

Table 2-1. Module Programming

MODULE	JUMPER	NOMENCLATURE	PURPOSE
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 and stereophonic operation is attempted (not used in MS-15R).
STEREO ANALOG	J1	FLAT/25/50/75	Selects stereo input pre-emphasis.
	J2	FLAT/25/50/75	Selects stereo input pre-emphasis.
	J3**	INT/DTR	Selects the internal low-pass filter or enables the DTR filter.
	J4**	INT/DTR	Selects the internal low-pass filter or enables the DTR filter.
	J5**	INT/DTR	Selects the internal low-pass filter or enables the DTR filter.
	J6**	INT/DTR	Selects the internal low-pass filter or enables the DTR filter.
OUTPUT	J1		Energizes or bypasses the amplitude & phase equalizer.
			* Normally set for STEREO. ** Normally set for DTR.

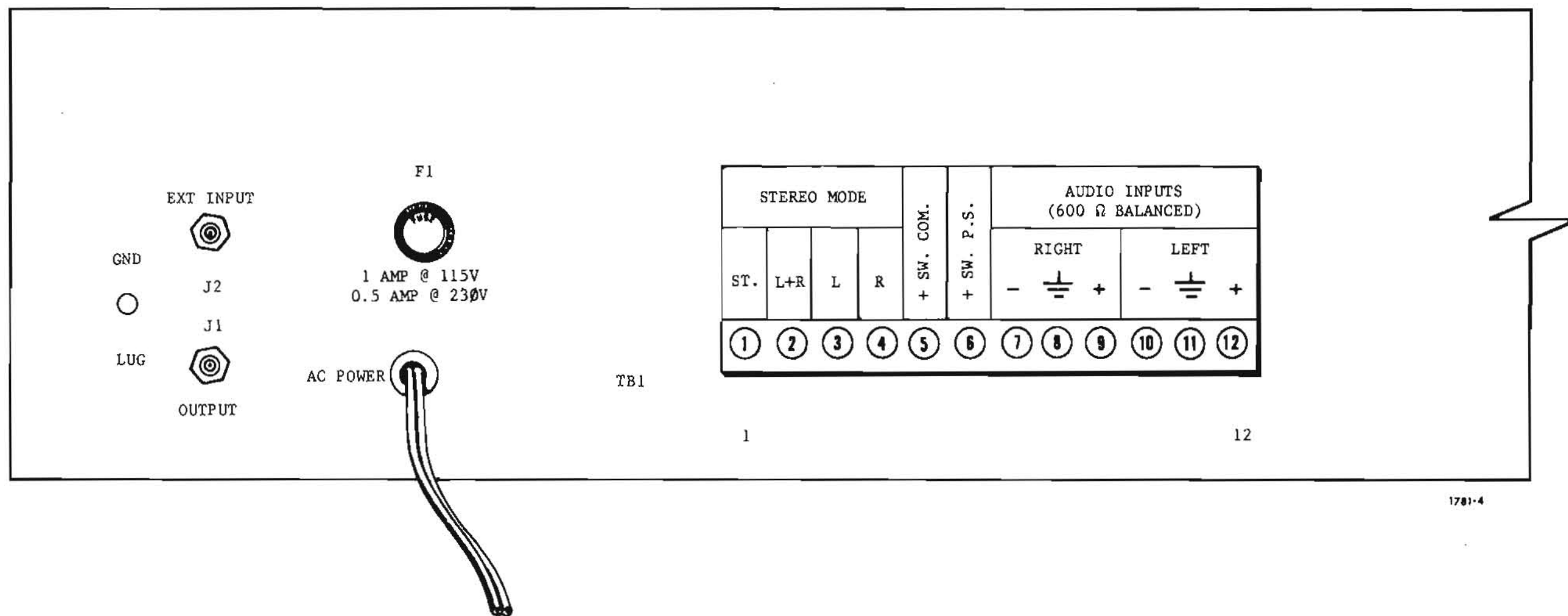
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Table 2-2. Stereo Generator Wiring

TERMINAL	NOMENCLATURE	SIGNAL
TB1 PIN 1	R	(STEREO MODE) A momentary contact to ground will cause the equipment to output a monaural signal from the right stereo channel and mute the left stereo channel.*
2	L	(STEREO MODE) A momentary contact to ground will cause the equipment to output a monaural signal from the left stereo channel and mute the right stereo channel.*
3	L+R	(STEREO MODE) A momentary contact to ground will cause the equipment to output a monaural signal from both stereo channels.*
4	ST.	(STEREO MODE) A momentary contact to ground will cause the equipment to output a stereo signal.
5	+ SW. COM.	A jumper from TB1 pin 6 provides a 20 Vdc potential to operate the remote mode switching circuits (see figure 2-1). If remote mode switching is not desired, the jumper may be removed.
6	+ SW. P.S.	Provides a 20 Vdc potential to operate the remote mode switching circuits through a jumper to TB2 pin 5 (see figure 2-1). If remote mode switching is not desired, the jumper may be removed.
7	LEFT -	(black) 600 ohm balanced audio input (shield) for stereo left channel. (red)
8	LEFT \oplus	
9	LEFT +	
10	RIGHT -	(black) 600 ohm balanced audio input (shield) for stereo right channel. (red)
11	RIGHT \oplus	
12	RIGHT +	

* NOTES:

- Remote control requires that terminal 6 (+S.W. P.S.) be jumpered to terminal 5 (+S.W. COM.) or a positive 12 Vdc to 28 Vdc potential must be jumpered between the desired terminal and terminal 5 (S.W. COM.).



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FIGURE 2-1. GENERATOR EXTERNAL WIRING

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

2-18. PRELIMINARY CHECKOUT.

2-19. Connect the power cord to the ac source. All the module front panel power supply indicators (+15V, -15V, +6V, -6V) will illuminate. If trouble is experienced, refer to Section V, Maintenance.

2-20. The audio inputs should be checked to ensure correct wiring. With programming applied to the LEFT and RIGHT audio inputs at +10 dBm \pm 1 dB, operate the OUTPUT module meter switch through all positions and check for activity on the OUTPUT module meter. All metering positions should yield indications with stereo programming. If the programming is monaural, the L-R meter switch position will yield no indication.

2-21. Disconnect the ac power source.

2-22. Remove the OUTPUT module and remove the side cover. Set jumper J1 in the position closest to U8 (equalizer out). Replace the OUTPUT module in the stereo generator and connect the ac power source.

2-23. Apply programming to the stereo generator and measure the stereo separation and distortion of the system from 30 Hz to 15 kHz at the transmitter site or off the air. If the separation is less than desired and if the separation is not limited by distortion and noise in the composite transmission system, separation may be improved through use of the phase and amplitude equalizer as described by paragraphs 2-25 through 2-20. If adjustment is not desired, proceed to paragraph 2-29.

2-24. Disconnect the ac power source. Remove the OUTPUT module and set jumper J1 in the position furthest from U8 (equalizer in). Adjust the following controls to mid-range: H.F. TURNOVER (R48), L.F. AMP. (R50), L.F. TURNOVER (R51), H.F. AMP. (R49). Adjust the H.F. PHASE control (R45) fully counterclockwise. Mount the OUTPUT module in the stereo generator using the extender board furnished with the unit.

2-25. If separation is degraded at low frequencies only, the problem may be corrected by adjustment of the L.F. AMP. control (R50) and the L.F. TURNOVER control (R51).

2-26. If separation is degraded at high frequencies only, the problem may be corrected by adjustment of the H.F. AMPL control (R49) and the H.F. TURNOVER control (R48).

2-27. If separation is uniformly degraded, the problem may be corrected by adjustment of the H.F. PHASE control (R45).

2-28. Combinations of control adjustments may be used where the composite transmission system problems are complex.

2-29. Disconnect the ac power source.

2-7/2-8

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 MS-15R stereo generator, 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 MS-15R stereo generator and table 3-1 lists each control or indicator with a description of each item listed.

3-5. OPERATION.

3-6. 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.

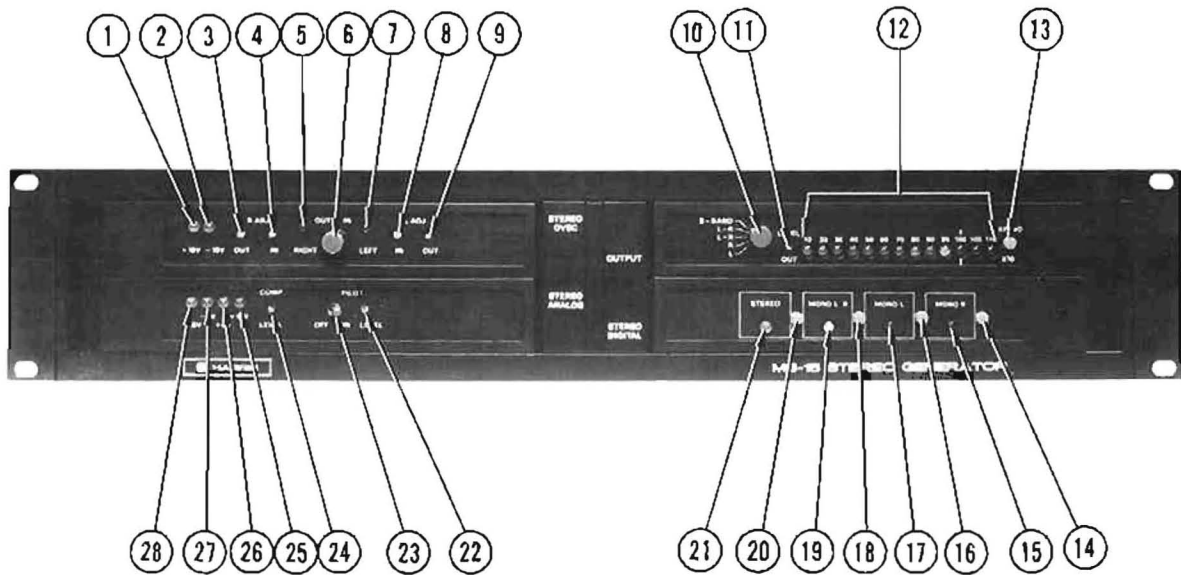
3-8. The metering functions are contained within the peak reading audio metering circuits of the OUTPUT module. The metering functions are listed in table 3-2.

3-9. MODE SWITCHING.

3-10. Modes of operation available with the MS-15R 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 MS-15R 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. DYNAMIC TRANSIENT RESPONSE FILTER.

3-12. The Dynamic Transient Response (DTR) filter is activated when 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:



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Figure 3-1. Controls and Indicators

Table 3-1. Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
<u>STEREO OVSC MODULE</u>		
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 of the STEREO OVSC module.
4	R ADJ IN Control (R10)	Adjusts the right channel input threshold of the STEREO OVSC module.
5	RIGHT Indicator (CR28)	Indicates right channel overshoot control when illuminated.
6	IN/OUT Switch (S1)	IN position: Enables operation of the DTR filter. OUT position: Enables the STEREO ANALOG module conventional low-pass filter.
7	LEFT Indicator (CR27)	Indicates left channel overshoot control when illuminated.
8	L ADJ IN Control (R64)	Adjusts the left channel input threshold of the STEREO OVSC module.
9	L ADJ OUT Control (R87)	Adjusts the left channel output threshold of the STEREO OVSC module.
<u>OUTPUT MODULE</u>		
10	L/R/L+R/L-R/ B BAND Switch (S1)	Selects the desired signal to be monitored by the LED meter.
11	LEVEL OUT Control (R43)	Adjusts the total modulation signal level output by the OUTPUT module from 2.5V P-P to 12.0V P-P.
12	LED Meter (CR13 through CR25)	Displays signals as selected by the B-BAND/L-R/L+R/R/L switch.

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Table 3-1. Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
13	EXPAND X10 Switch (S2)	Changes the meter scale from 110% to 11.0% when depressed to check pilot injection level.
<u>STEREO DIGITAL MODULE</u>		
14	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.
15	MONO R Indicator (CR3)	Indicates the mono R mode of operation is enabled when illuminated.
16	MONO L Switch (S2)	Enables mono L mode to transmit a mono signal from the left stereo channel and mute the right stereo channel.
17	MONO L Indicator (CR4)	Indicates mono L mode of operation is enabled when illuminated.
18	MONO L+R Switch (S3)	Enables the mono L+R mode to transmit a mono signal from both stereo channels.
19	MONO L+R Indicator (CR5)	Indicates mono L+R mode of operation is enabled when illuminated.
20	STEREO Switch (S4)	Enables stereo mode operation.
21	STEREO Indicator (CR6)	Indicates stereo mode of operation is enabled when illuminated.
<u>STEREO ANALOG MODULE</u>		
22	PILOT LEVEL Control (R41)	Adjusts the modulation level of the pilot subcarrier.
23	PILOT ON/OFF Switch (S1)	Enables or inhibits the pilot subcarrier.
24	COMP LEVEL Control (R27)	Adjusts the composite signal level output from the STEREO ANALOG module.
25	+15V Indicator (CR9)	Illuminates to indicate the STEREO ANALOG module +15 volt regulator is operational.

Table 3-1. Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
25	+15V Indicator (CR9)	Illuminates to indicate the STEREO ANALOG module +15 volt regulator is operational.
26	+6V Indicator (CR10)	Illuminates to indicate the STEREO ANALOG module +6 volt regulator is operational.
27	-6V Indicator (CR11)	Illuminates to indicate the STEREO ANALOG module -6 volt regulator is operational.
28	-15V Indicator (CR12)	Illuminates to indicate the STEREO ANALOG module -15 volt regulator is operational.

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Table 3-2. Metering

METERING	
METER SWITCH POSITION	SIGNAL DISPLAYED
L	Left channel pre-emphasized audio input.
R	Right channel pre-emphasized audio input.
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.

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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.

3-13. When the DTR filter is in use, special care must be exercised so that the exciter audio inputs are not even slightly overdriven. Each input is easily checked by monitoring the left and right audio inputs on the meter and adjusting the FM limiter output levels so that the left and right signals do not exceed 100% on the meter.

3-14. Due to the unconventional DTR technique, if it is desired to increase modulation, do not adjust the FM limiter output level. The increase in level will be assumed to be overshoot by the OVSC module and will be corrected. This will result in distortion but no increase in modulation. To increase modulation, adjust the STEREO ANALOG module COMP LEVEL control clockwise. A further explanation of the DTR technique is provided in "A New Filtering Process for Optimal Overshoot Control" in Appendix A of this manual.

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains principles of operation of the MS-15R stereo generator. An overall block diagram and stereo generator 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 circuits mounted in 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 MS-15R stereo generator can be divided into the following six modular sections (see figure 4-1).

4-5. RFI/EMI FILTER.

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

4-7. Interference by the commercial AM broadcast band to each 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 lines are filtered by a low-pass RC filter. 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.

4-9. Power for each module is provided by individual module monolithic voltage regulators from the power supply pre-regulated ± 20 Vdc distribution busses (see figure 4-3).

4-10. AC input power is applied through the RFI filter to power transformer T1. Dual primary windings on transformer T1 allow operation from either 115 Vac or 230 Vac as selected by jumpers on terminal board TB-1.

4-11. POSITIVE AND NEGATIVE 20 VOLT SUPPLIES. Positive and negative 23 Vdc is applied to the ± 20 Vdc regulator circuits from full wave bridge rectifier CR1. 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 increases sufficiently. Diodes CR7 and CR8 provide power supply reverse voltage protection. The Darlington output stages (Q3 and Q4) are mounted on the rear panel to ensure adequate cooling.

4-12. MOTHER BOARD ASSEMBLY.

4-13. The mother board provides power, signal, and control input interconnections, and output wiring for all plug-in modules through strip connectors soldered to the mother board.

4-14. STEREO DIGITAL MODULE.

4-15. The STEREO DIGITAL module produces the signals required to generate the digitally synthesized modulation stereophonic signal, generates the phase controlled 19 kHz pilot signal, and provides stereophonic/monaural mode switching.

4-16. 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.

4-17. PILOT SIGNAL. The 19 kHz pilot frequency is differentially applied to two low-pass filters. Outputs are obtained across capacitor C12 and the 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 the pilot frequency output will be pure sinewave. The center frequency of the second low-pass filter is adjusted by the PILOT FILTER control.

4-18. Automatic Control of Pilot Phase. Pilot frequency 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.

4-19. 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 latch and reset all other functions. Mode selection for the STEREO ANALOG module is provided by the STEREO DIGITAL module control circuits.

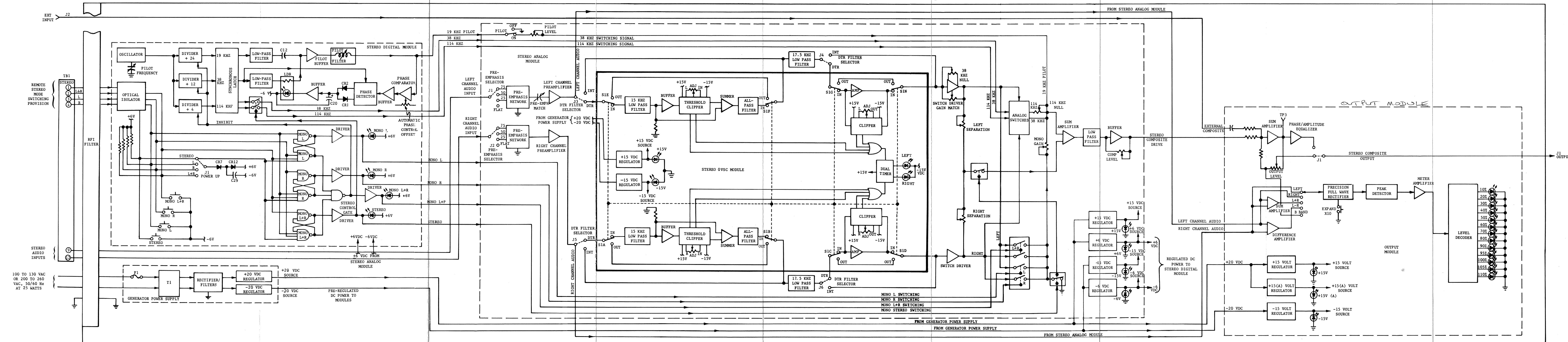


FIGURE 4-1. OVERALL BLOCK DIAGRAM
4-3/4-4

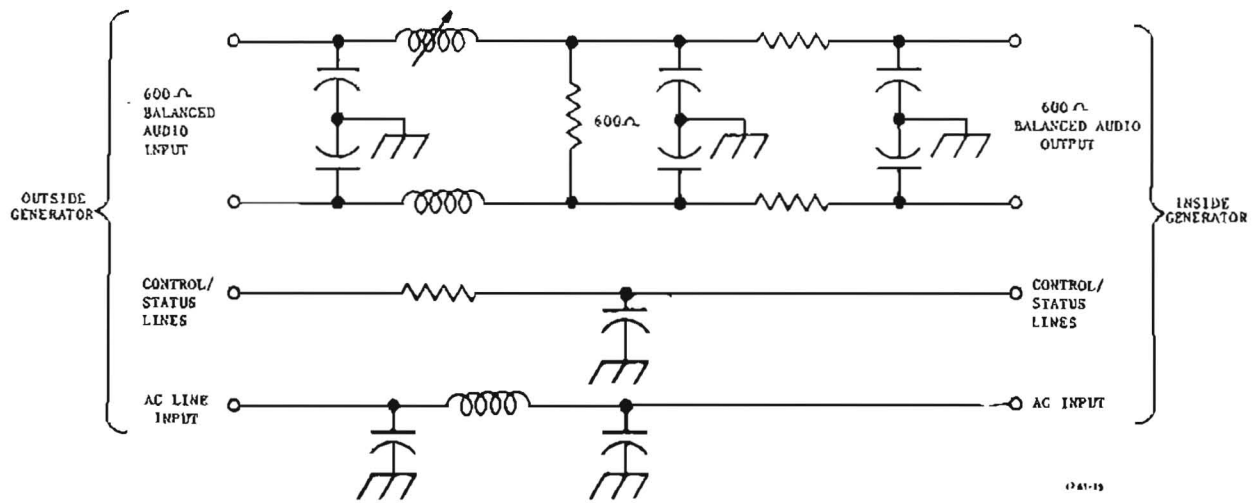


Figure 4-2. RFI Filter Detailed Block Diagram

4-20. Three flip flops control the MONO L+R, MONO L, MONO R, and stereophonic mode switching. When a monaural mode switch is depressed, the associated flip flop is set and the remaining two flip flops are reset. Whenever a monaural mode flip flop is set, the stereo control gate halts the synchronous divider and inhibits the stereo sampling signals. The four logic signals are output to the STEREO ANALOG module to provide audio switching and indicate which of the four operating modes is enabled.

4-21. SCA INTERLOCK. Operation of a 41 kHz SCA channel simultaneously with stereo will result in mutual interference because the 41 kHz SCA and the stereo L-R difference channel occupy the same spectrum. The STEREO DIGITAL module contains circuitry which inhibits stereo operation when it receives a 41 kHz SCA presence signal from an SCA generator. This circuit does not function when used in the MS-15R stereo generator mainframe. It functions only in the MS-15 exciter mainframe when used with a 41 kHz SCA generator.

4-22. 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 STEREO DIGITAL module in the desired mode. Diode CR7 functions as a disconnect diode which allows manual mode switching after capacitor C29 is charged. (POWER UP is normally set to STEREO.)

4-23. INDICATORS. Light emitting diodes connected to the control gates through drivers illuminate to indicate the mode of operation.

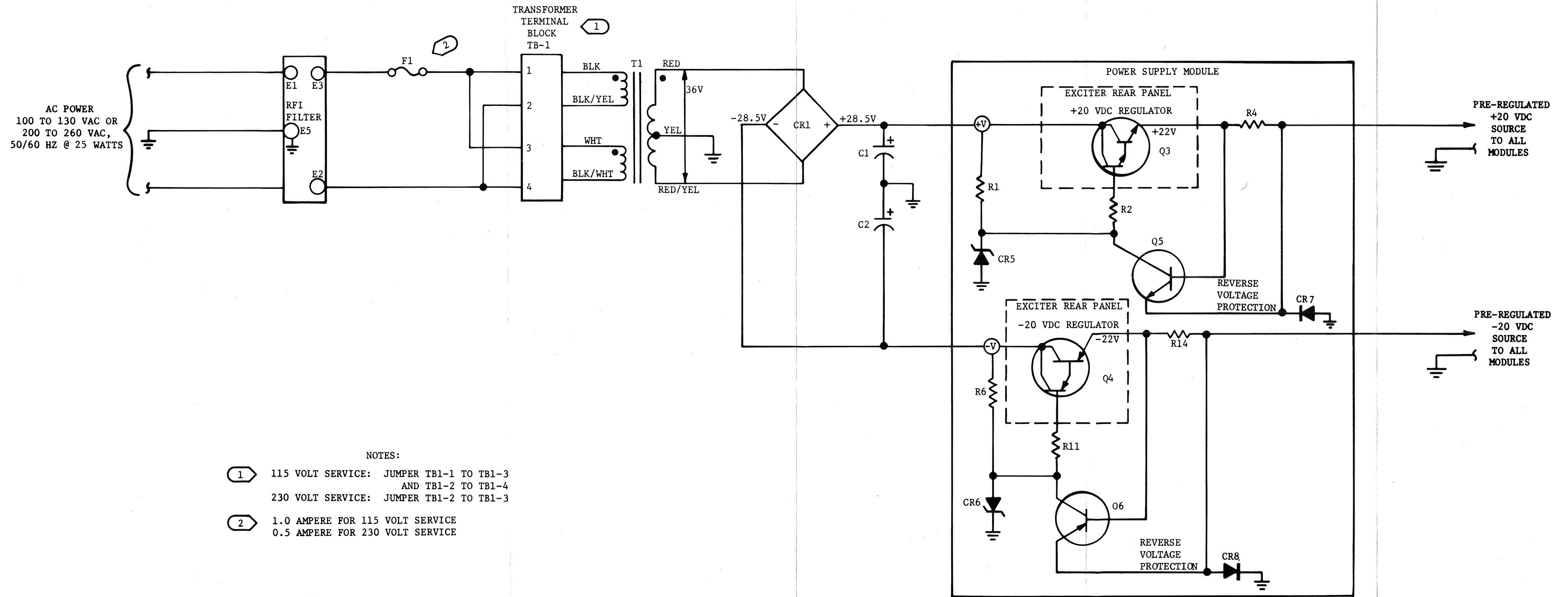
4-24. POWER. Inputs of positive and negative six Vdc from regulators in the STEREO ANALOG module function as voltage sources to operate the STEREO DIGITAL module internal circuitry.

4-25. STEREO ANALOG MODULE (3A1).

4-26. 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 synthesized modulation sampling circuits and the composite filter are also included within the module.

4-27. 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 the 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.

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NOTES:

- ① 115 VOLT SERVICE: JUMPER TB1-1 TO TB1-3
AND TB1-2 TO TB1-4
- 230 VOLT SERVICE: JUMPER TB1-2 TO TB1-3
- ② 1.0 AMPERE FOR 115 VOLT SERVICE
0.5 AMPERE FOR 230 VOLT SERVICE

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FIGURE 4-3. POWER SUPPLY DETAILED BLOCK DIAGRAM

4-28. 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 meter circuit in the OUTPUT module and the DTR filter selectors (J3 and J4 for the right channel and J5 and J6 for the left channel). The DTR filter selectors (normally set to DTR) enable the OVSC module DTR filter circuitry or allow use of the STEREO ANALOG module low-pass filters if desired.

4-29. 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.

4-30. 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 control 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 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 composite metering in the OUTPUT module.

4-31. 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.

4-32. MODE SWITCHING. Mode switching is accomplished by CMOS analog switches controlled by discrete STEREO DIGITAL module inputs for stereo, mono left, mono right, and mono left plus right.

4-33. 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.

4-34. 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.

4-35. 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, and -6V light emitting diodes indicate operation of each power supply.

4-36. STEREO OVSC MODULE.

4-37. 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 aid in level setup and provide overshoot limiting indications during operation.

4-38. 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.

4-39. 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 (overshoots). The sum amplifier subtracts the overshoots 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.

4-40. 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.

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4-41. 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.

4-42. 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.

4-43. OUTPUT MODULE.

4-44. The OUTPUT module provides metering functions from inputs of left and right channel audio, stereo composite drive, and external composite drive. The module also contains a defeatable phase and amplitude equalizer which provides correction for possible deficiencies in associated equipment. Amplifiers in the module provide a low impedance output drive from the stereo generator.

4-45. METERING CIRCUITS. Left and right channel audio from the STEREO ANALOG module preamplifiers is applied to the meter circuits to provide an indication of LEFT or RIGHT audio. The external composite signal from the EXT INPUT connector (J2) and the stereo composite drive from the STEREO ANALOG module are summed in the OUTPUT module to provide a B BAND indication (total modulation). The L+R and L-R signals are generated through the use of sum and difference amplifiers.

4-46. The five meter signals are applied to the meter switch. Which-ever signal is selected by the switch is applied to the precision full wave rectifier. The rectified signal is peak detected in a slow decay circuit and the resultant signal is applied to a solid state LED meter.

4-47. The solid state meter uses 13 LEDs to indicate modulation levels of 10% to 90% in steps of 10% and 90% to 110% in steps of 5%. Each indicator turns on at precisely the indicated percentage level for each respective LED. The meter range may be expanded by 10 by depressing the front panel EXPAND X10 switch to provide a full scale indication of 11.0%. The expanded range allows accurate measurements of pilot or external SCA injection.

4-48. OUTPUT CIRCUITS. The output circuits consist of a summing amplifier and a defeatable phase and amplitude equalizer. The summing amplifier accepts the external composite input from the EXT INPUT connector (J2) and the stereo composite drive from the STEREO ANALOG module. The two signals are mixed and the sum is amplified to a level which is adjustable from 2.5 volts peak-to-peak to 12 volts peak-to-peak. This signal may be used unmodified or the stereo generator output may be obtained from the phase and amplitude equalizer as selected by jumper J1.

4-49. Equalizer Circuit. The phase and amplitude equalizer circuit allows adjustment of the high or low frequency amplitude or adjustment of the high frequency signal phase. When each of the frequency adjustments (TURNOVER and AMP. controls) is adjusted to the center of its range and the H.F. PHASE control is adjusted fully counterclockwise, the equalizer is flat in amplitude and phase. As the controls act on the stereo composite signal, they cannot affect audio frequency response without reducing separation. Each control has a limited range and may be adjusted from the initial adjustment to correct for minor deficiencies found in some transmission systems.

4-50. Output Circuit. The output impedance of the MS-15R is low and can drive capacitive loads including moderately long 50 ohm coaxial lines up to 25 feet and 1000 ohms or greater impedance.

4-51. POWER. Inputs of positive and negative regulated 20 Vdc are re-regulated into positive and negative 15 Vdc sources to operate the OUTPUT module internal circuitry.

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 characteristics, the stereo generator 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 equipment 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

SYSTEM ELAPSED TIME	Total stereo generator 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 stereo generator design provides safety features which ensure that no potentials are accessible to operational personnel from the front panel. 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. 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 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.

5-17. 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. 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.

5-26. 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.

5-27. CORRECTIVE MAINTENANCE.

5-28. The maintenance philosophy of the MS-15R stereo generator 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.

5-29. Corrective maintenance for the equipment is limited by the objective of minimum down time. Maintainability and care are considerably simplified for operation and maintenance personnel as the MS-15R is designed and built with highly reliable and proven elements to minimize down time. All controls are adjustable in view of the indicators. Internal components may be accessed through the removable top and rear panels. An extender board (Harris PN 992 5246 001) is provided with the generator to assist in troubleshooting.

5-30. The STEREO ANALOG, STEREO DIGITAL, and STEREO OVSC modules are identical to the modules used in the Harris MS-15 FM exciter with the exception that the front panel designations are aligned horizontally rather than vertically. In case of emergency, these three modules only may be interchanged between the MS-15 FM exciter and the MS-15R stereo generator mainframes.

5-31. TROUBLESHOOTING.

5-32. In event of problems, the trouble area must first be isolated to an input, the MS-15R power supply, stereo generator module, or the transmitter and load. Most troubleshooting consists of visual checks. The OUTPUT module meter, fuse F1, 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 a short exists on the module and the module regulator is in the current limiting mode.

5-33. 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 overall 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 MS-15R 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.

5-34. COMPONENT REPLACEMENT. The circuit boards used in the MS-15R 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.

5-35. 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.

5-36. 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.

5-37. After soldering, remove residual flux with a cotton swab moistened with a solvent such as 1, 1, 1-trichloroethane, naphtha, freon TMS, or 99% isopropyl alcohol. Rubbing alcohol is highly diluted with water and is not effective. There are also other 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.

5-38. TECHNICAL ASSISTANCE.

5-39. Technical assistance and troubleshooting recommendations are available from Harris Field Service Department during normal working hours. Emergency technical 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 Products Division, P.O. Box 290, Quincy, Illinois 62301, USA.

Table 5-. MS-15R Fault Isolation Index

SYMPTOM	DEFECT/REFERENCE
NO OUTPUT.	Figure 5-1.
OUTPUT LEVEL WILL NOT ADJUST.	Defective OUTPUT module. Refer to publication 888 1781 005.
INADEQUATE OUTPUT.	Figure 5-2.
HIGH AUDIO DISTORTION IN BOTH STEREO CHANNELS.	Figure 5-3.
HIGH AUDIO DISTORTION IN ONE STEREO CHANNEL.	Defective stereo ANALOG module. Refer to publication 888 1781 002.
NOISY AUDIO.	Figure 5-4.
FUSE F1 OPENS.	Figure 5-5.

1781

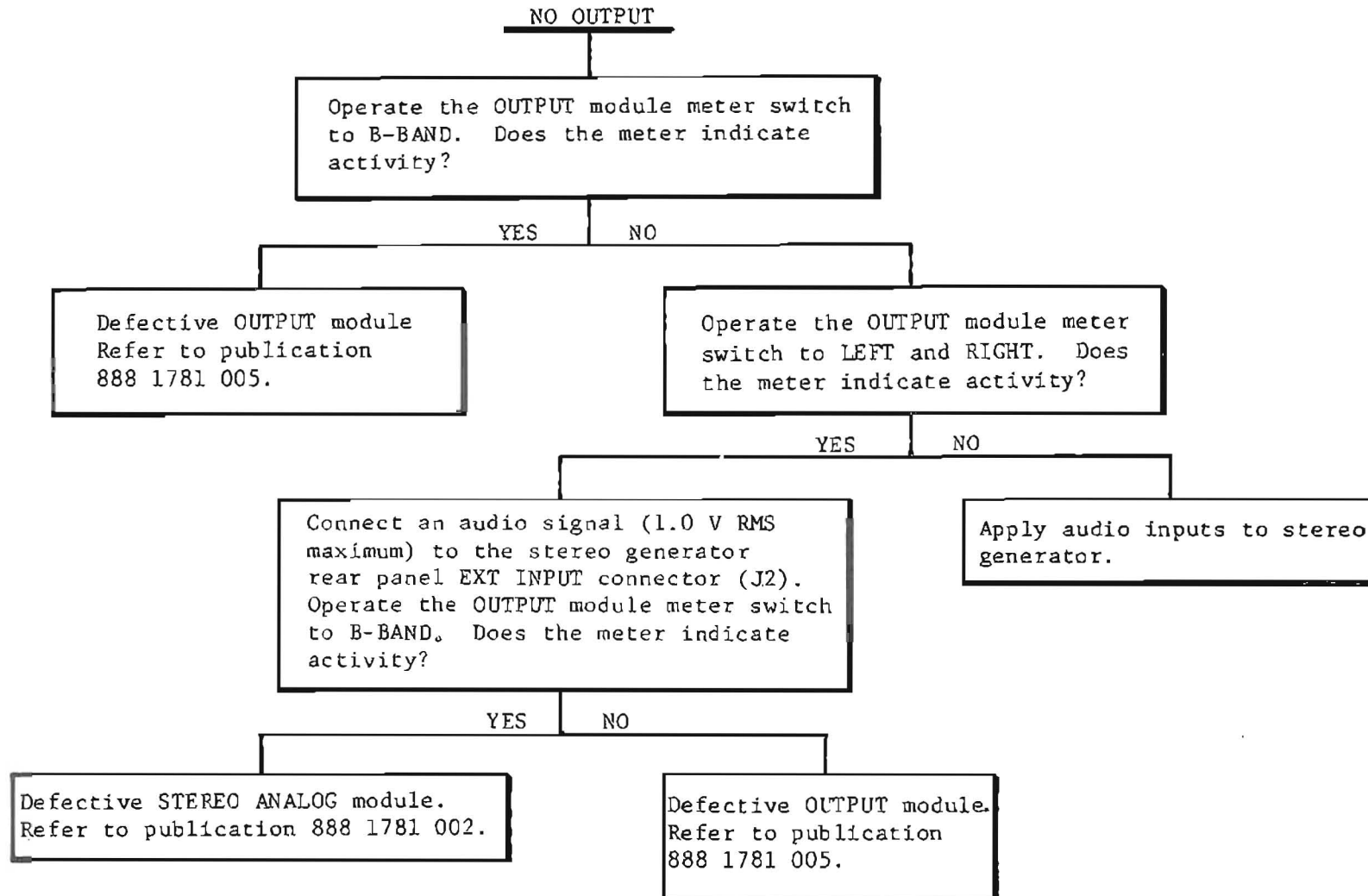
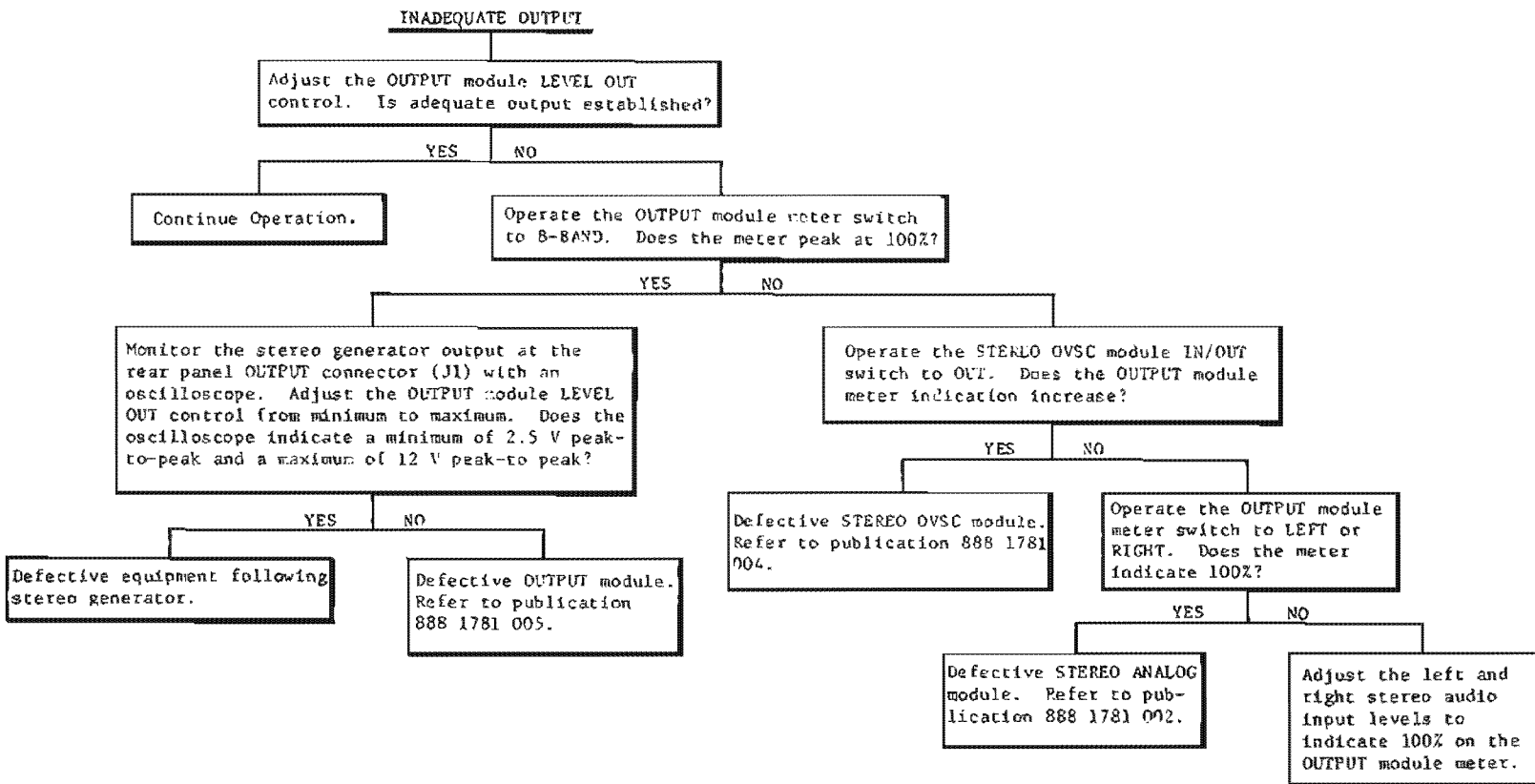


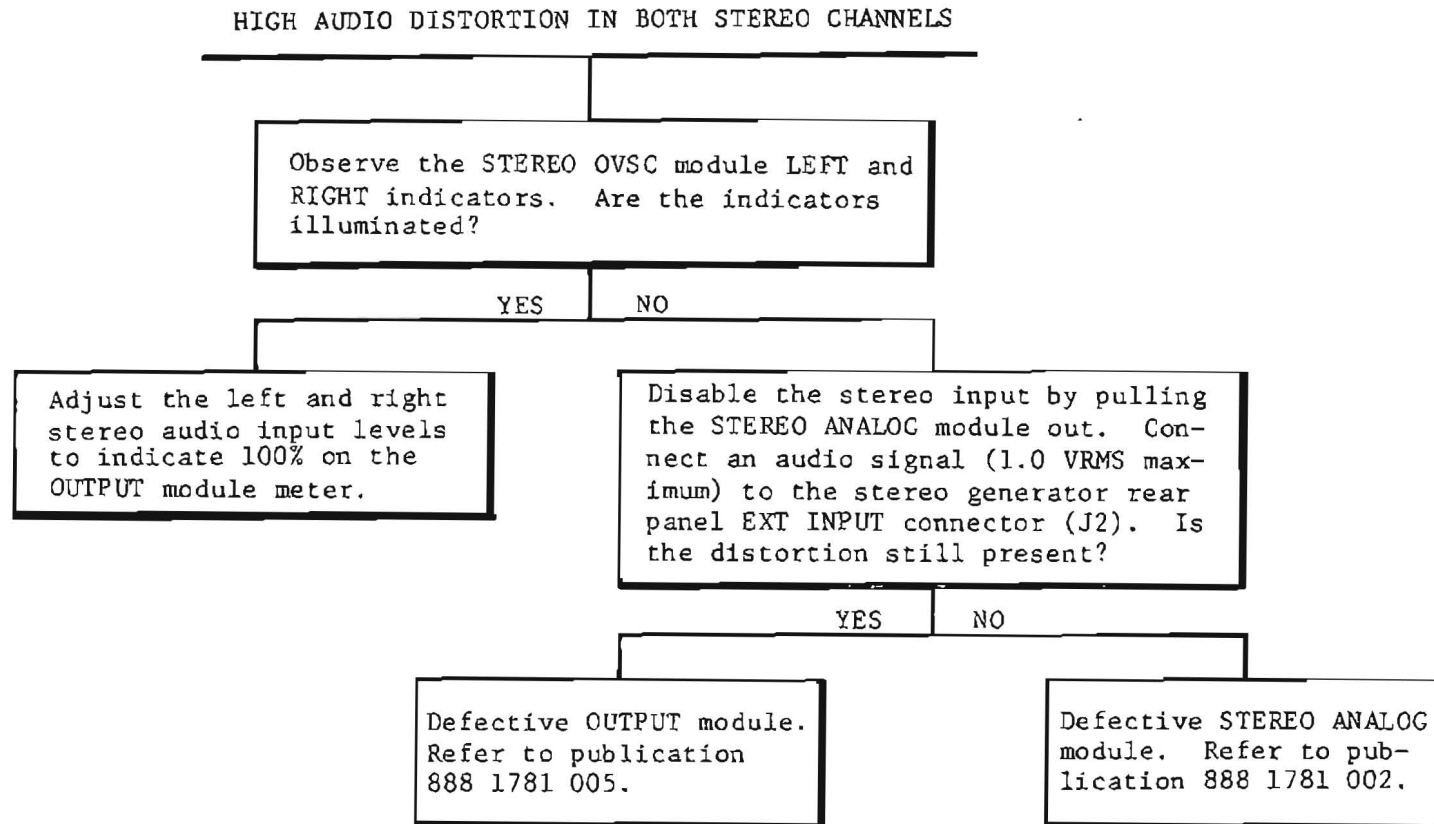
Figure 5-1. No Output

WARNING: Disconnect primary power prior to servicing.

Figure 5-2. Inadequate Output



WARNING: Disconnect primary power prior to servicing.



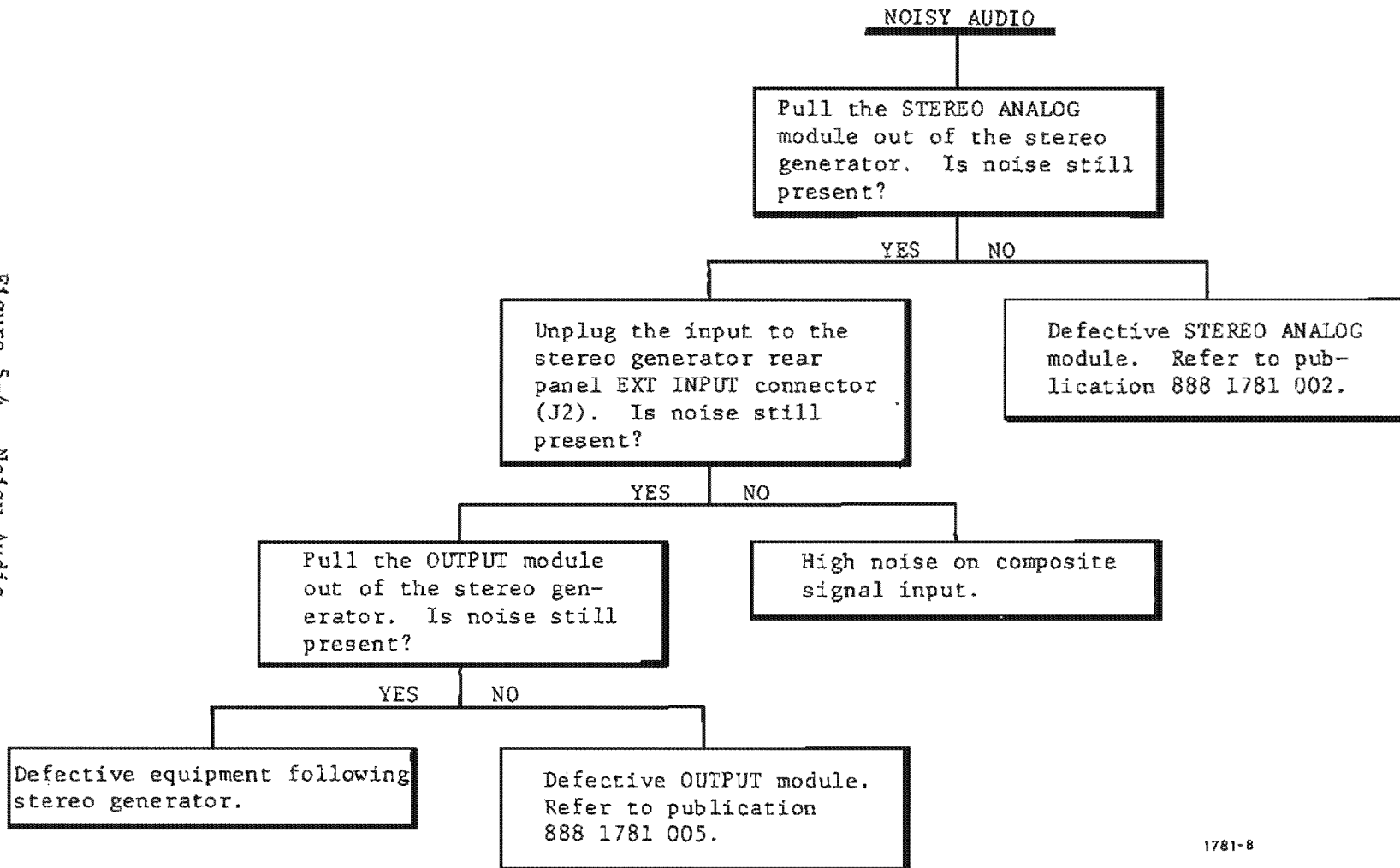
1781-7

Figure 5-3. High Audio Distortion in Both Stereo Channels

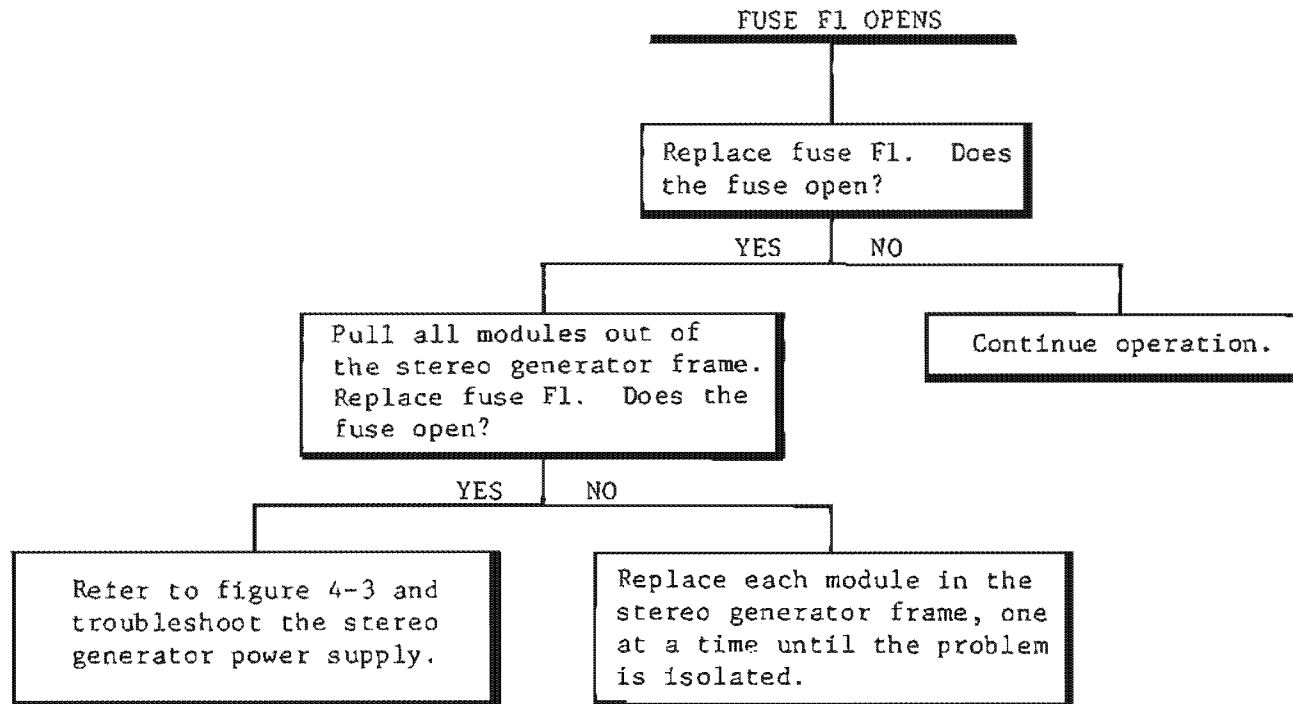
WARNING: Disconnect primary power prior to servicing.

WARNING: Disconnect primary power prior to servicing.

Figure 5-4. Noisy Audio



1781-8



1781-9

Figure 5-5. Fuse F1 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 MS-15R stereo generator. 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 stereo generator are identified by an Harris part number and MS-15R 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 Products Division, P.O. Box 290, Quincy, Illinois 62301, USA.

Table 6-1. Replaceable Parts List Index

TABLE NO.	UNIT NOMENCLATURE	PART NO.	PAGE
6-2	Stereo Generator (2)	992 8140 001	6-3
6-3	Main Frame (2A1)	992 5126 001	6-4
6-4	Ribbon Cable, 20 Conductor	929 2191 002	6-5
6-5	Coaxial Cable	938 3828 126	6-6
6-6	Mother Board (2A1A1)	992 5127 001	6-7
6-7	RFI Filter Module (2A1A2)	992 5128 001	6-8
6-8	Power Supply Module (2A1A3)	992 5000 002	6-9
6-9	Extender Board Assembly (2A7)	992 5246 001	6-10
6-10	Access Cables Extender Pack (2A6)	992 5131 001	6-11
6-11	Stereo Analog Module (2A2)	994 7989 002	6-12
6-12	Stereo Digital Module (2A3)	994 7990 002	6-13
6-13	Stereo Overshoot Compensator Module (2A4)	994 7991 002	6-14
6-14	Output Module (2A5)	992 5129 001	6-15

Table 6-2. Stereo Generator (2) - 994 8140 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
2A1	992 5126 001	Main Frame	1
2A2	994 7989 002	Stereo Analog Module	1
2A3	994 7990 002	Stereo Digital Module	1
2A4	994 7991 002	Stereo Overshoot Compensator Module	1
2A5	992 5129 001	Output Module	1
2A6	992 5131 001	Access Cables Extender Pack	1
2A7	992 5246 001	Extender Board Assembly	1

Table 6-3. Main Frame (2A1) - 992 5126 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
2A1A1	992 5127 001	Printed Circuit , Mother Board	1
2A1A2	992 5128 001	Printed Circuit Board, RFI Filter	1
2A1A3	992 5000 002	Printed Circuit Board, Power Supply	1
	938 3828 126	Cable, Coax	2
	929 2191 002	Cable Assembly, 20 Conductor Ribbon	1
	424 0001 000	Grommet, Cable	1
	358 1772 000	Strain Relief	1
	250 0075 000	Cord, Power	1
C1,C2	524 0323 000	Capacitor, 1800 uF, 40V	2
CR1	384 0314 000	Rectifier, MDA 802	1
F1	398 0054 000	Fuse, MDL, 1 ampere	1
	358 1750 000	Insulator, Nylon, Capacitor	2
	410 0232 000	Insulators, (Q3,Q4)	2
Q3	380 0187 000	Transistor, 2N6055	1
Q4	380 0571 000	Transistor, 2N6053	1
T1	472 0799 000	Transformer	1
TS1	614 0160 000	Terminal Strip	1
XF1	402 0023 000	Fuse Holder	1
XQ3,XQ4	404 0661 000	Transistor Socket	2

Table 6-4. Ribbon Cable, 20 Conductor - 929 2191 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	612 0895 000	Receptacle Connector Kit, 20 Pin	2

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—WARNING: Disconnect primary power prior to servicing.

Table 6-5. Coaxial Cable - 938 3828 126

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	620 1510 000	BNC Connector	1
	620 0566 000	Plug, Right Angle, UG 1466/	1

1781

Table 6-6. Mother Board (2A1A1) - 992 5127 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
J1,J2	620 0515 000	Connector Coax	2
J3 thru J6	612 0887 000	Connector, 72 Pin	4
J7	610 0746 000	Connector, 20 Pin	1
J8	610 0679 000	Plug	1
	404 0523 000	Jacks, Printed Circuit	2
	358 2032 000	Polarizing Insert	4
	939 3464 001	Printed Circuit Board	1

1781

Table 6-7. RFI Filter Module (2A1A2) - 992 5128 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C1,C2,C3,C4	516 0074 000	Capacitor, 0.005 uF, 1 kV	4
C5 thru C16	516 0084 000	Capacitor, 0.02 uF, Disc, +80%, -20%	12
C17,C18,C19	516 0370 000	Capacitor, 0.005 uF, 500V	3
C20	500 0756 000	Capacitor, 330 pF, Mica	1
C21	516 0370 000	Capacitor, 0.005 uF, 500V	1
C22	500 0756 000	Capacitor, 330 pF, Mica	1
C23	516 0370 000	Capacitor, 0.005 uF, 500V	1
C24	500 0756 000	Capacitor, 330 pF, Mica	1
C25,C26	516 0370 000	Capacitor, 0.005 uF, 500V	2
C27	500 0756 000	Capacitor, 330 pF, Mica	1
C28	516 0370 000	Capacitor, 0.005 uF, 500V	1
L1,L2	414 0212 000	Inductor	2
L3,L4,L5,L6	494 0419 000	Inductor, 1 uH	4
R1,R2,R3,R4	540 0920 000	Resistor, 2.2k ohm, 1/4W, 5%	4
R5,R6	540 0880 000	Resistor, 47 ohm, 1/4W, 5%	2
R7	540 0915 000	Resistor, 1.3k ohm, 1/4W, 5%	1
R8,R9,R10	540 0900 000	Resistor, 330 ohm, 1/4W, 5%	3
R11	540 0915 000	Resistor, 1.3k ohm, 1/4W, 5%	1
R12	540 0900 000	Resistor, 330 ohm, 1/4W, 5%	1
TB1	614 0034 000	Terminal Block	1
	610 0746 000	Connector, 20 Pin	1
	939 3481 001	Printed Circuit Board	1

Table 6-8. Power Supply Module (2A1A3) - 992 5000 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C10,C11,C12,C13	526 0349 000	Capacitor, 2.2 uF, 50V	4
CR5,CR6	386 0077 000	Diode, IN4749A	2
CR7,CR8	384 0020 000	Diode, IN2071	2
Q5	380 0189 000	Transistor, 2N3904	1
Q6	380 0190 000	Transistor, 2N3906	1
R1	540 0339 000	Resistor, 2k ohm, 1W	1
R2	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R3	540 1216 000	Resistor, 330 ohm, 1/2W, 5%	1
R4	540 0005 000	Resistor, 5 ohm, 5W	1
R5	540 1137 000	Resistor, 3.9k ohm, 1/2W, 5%	1
R6	540 0339 000	Resistor, 2k ohm, 1W	1
R11	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R12	540 1137 000	Resistor, 3.9k ohm, 1/2 W, 5%	1
R13	540 1216 000	Resistor, 330 ohm, 1/2W, 5%	1
R14	540 0005 000	Resistor, 5 ohm, 5W	1
R15	540 0332 000	Resistor, 1k ohm, 1W, 5%	1
	929 2219 001	Printed Circuit Board	1

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Table 6-9. Extender Board Assembly (2A7) - 992 5246 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
-----	939 3716 001	Printed Circuit Board w/terminals	1
-----	612 0887 000	Connector, 72 Pin	1

1781

Table 6-10. Access Cables Extender Pack (2A6) - 992 5131 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	464 0026 000	J.F.D. Adjustment Tool, P/N 5284	1
	938 3828 019	Cable Assembly, 4 ft.	1
	(620 0502 000)	(Connector, BNC, UG88/U)	2

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Table 6-11. Stereo Analog Module (2A2) - 992 7989 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	992 4902 001	Printed Circuit Board	1

Table 6-12. Stereo Digital Module (2A3) - 994 7990 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	992 4901 001	Printed Circuit Board	1

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WARNING: Disconnect primary power prior to servicing.

Table 6-13. Stereo Overshoot Compensator Module (2A4) - 994 7991 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	992 4903 001	Printed Circuit Board	1
	650 0254 000	Knob, Round B1-123	1
	358 1837 000	Cap, Blue	1

Table 6-14. Output Module (2A5) - 992 5129 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
	992 5130 001	Printed Circuit Board	1
	650 0254 000	Knob, Round BI-123	1
	358 1837 000	Cap, Blue	1

1781

SECTION VII

DIAGRAMS

7-1. INTRODUCTION.

7-2. This section provides schematic, interconnection, and wiring diagrams required for maintenance of the MS-15R stereo generator. The following diagrams are contained in this section:

<u>Figure</u>	<u>Title</u>	<u>Number</u>	<u>Page</u>
7-1	Mother Board, MS-15R Stereo Generator	839 3466 001	7-3
7-2	RFI Filter, MS-15R	839 3598 001	7-5
7-3	Power Supply, MS-15R	839 3599 001	7-7

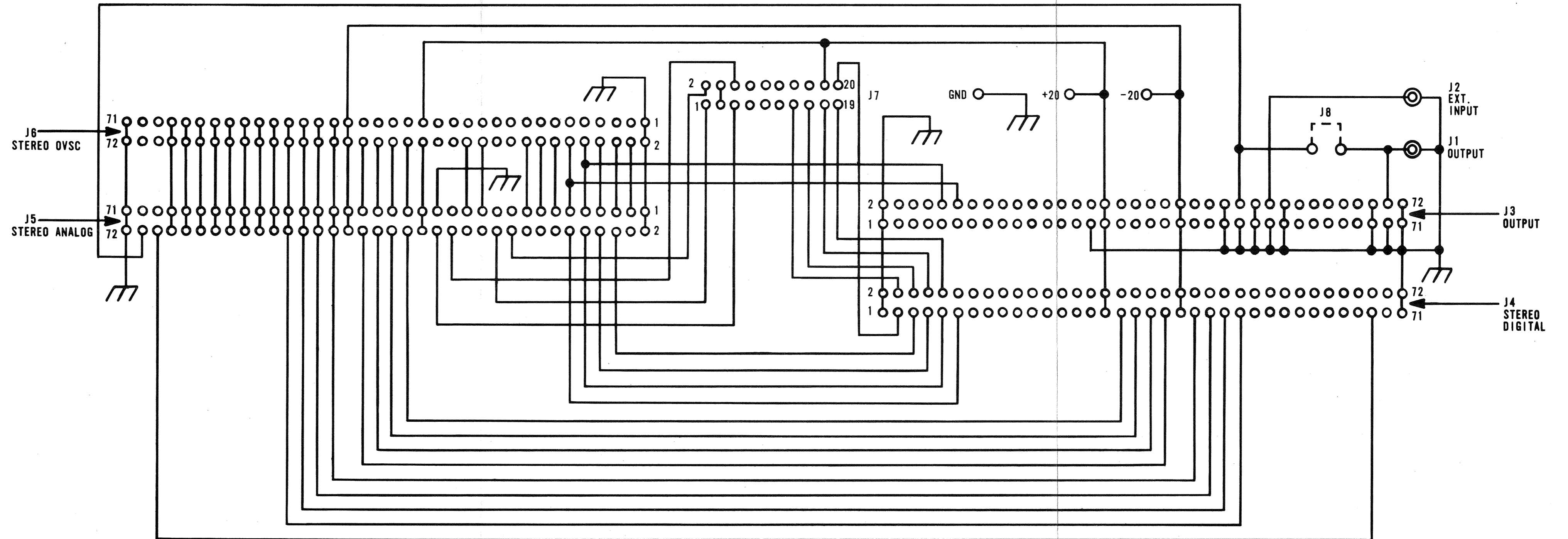
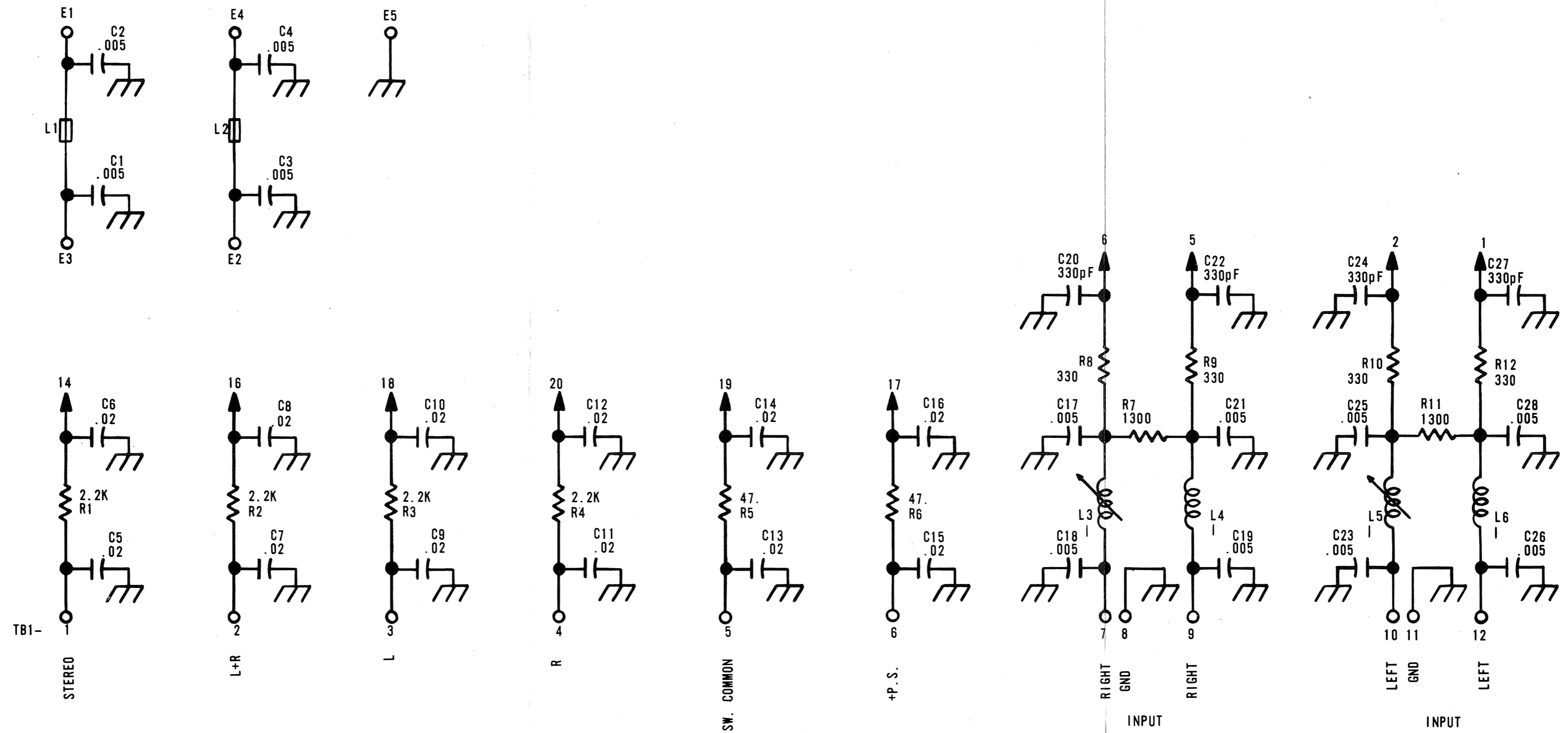
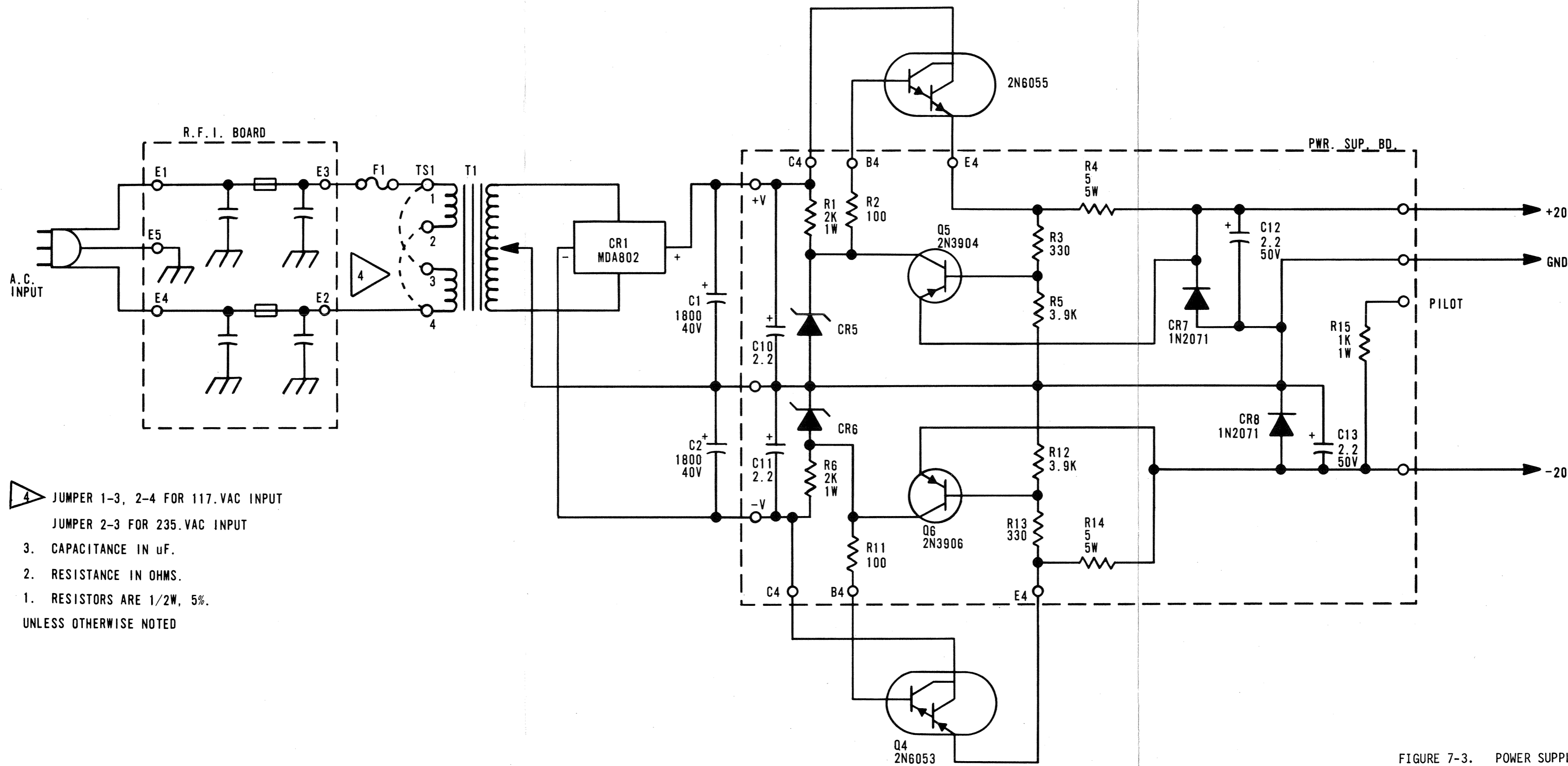


FIGURE 7-1. MOTHER BOARD
MS-15R STEREO GENERATOR



- 4. INDUCTANCE IN uH.
 - 3. CAPACITANCE IN uF.
 - 2. RESISTANCE IN OHMS.
 - 1. RESISTORS ARE 1/4W, 5%.
- UNLESS OTHERWISE NOTED

FIGURE 7-2. RFI FILTER MS-15R



- 4 JUMPER 1-3, 2-4 FOR 117.VAC INPUT
 JUMPER 2-3 FOR 235.VAC INPUT
 3. CAPACITANCE IN μ F.
 2. RESISTANCE IN OHMS.
 1. RESISTORS ARE 1/2W, 5%.
 UNLESS OTHERWISE NOTED

FIGURE 7-3. POWER SUPPLY MS-15R

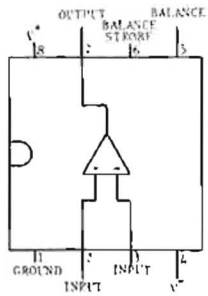
APPENDIX A
MANUFACTURERS DATA

APPENDIX A
MANUFACTURERS DATA

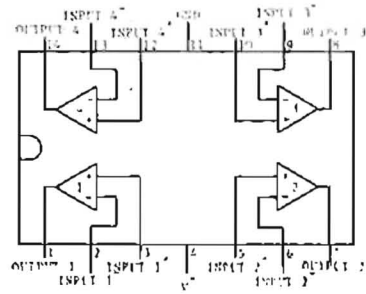
A-1. INTRODUCTION.

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

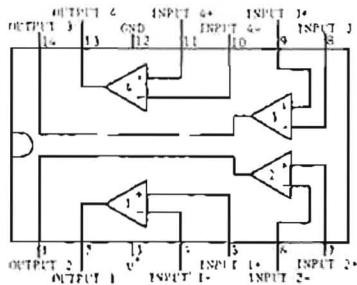
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2. Technical Data Sheet, AD521-JD Instrumentation Amplifier
3. Technical Data Sheet, ILQ74 Quad Optical Isolator
4. Technical Data Sheet, LM318-N Operational Amplifier
5. Technical Data Sheet, TL430C Programmable Zener Diode
6. Engineering Report, A New Filtering Process For Optimal Overshoot Control



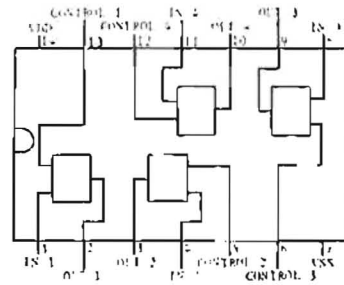
LM311N
VOLTAGE COMPARATOR



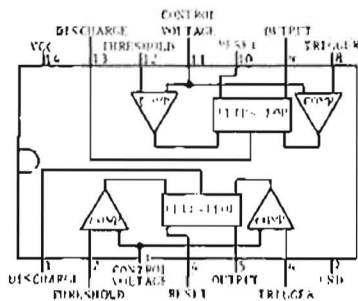
LM324N
QUAD OPERATIONAL AMPLIFIER



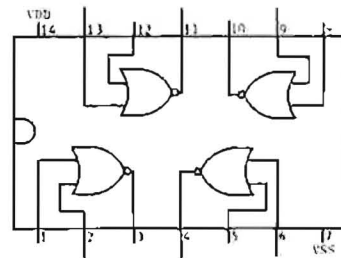
LM339N
QUAD VOLTAGE COMPARATOR



4066B
QUAD ANALOG SWITCH/MULTIPLEXER



LM555CN
DUAL TIMER

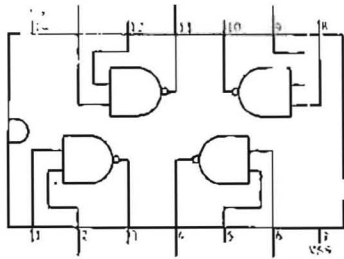


4001B
QUAD 2-INPUT NOR GATE

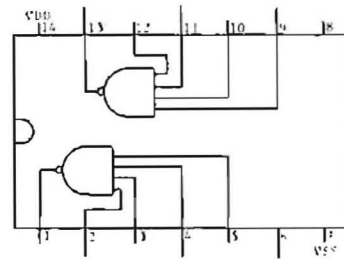
1781-12

INTEGRATED CIRCUIT CONNECTION DIAGRAMS (SHEET 1 OF 2)

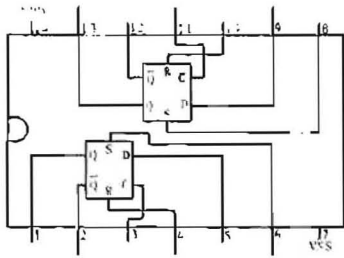
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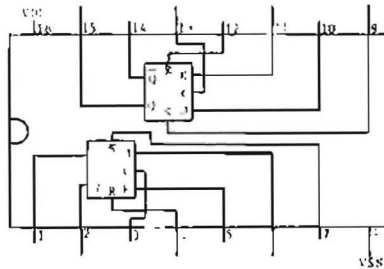
4011B
QUAD 2-INPUT NAND GATE



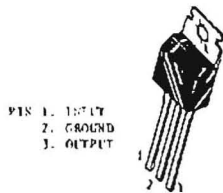
4012B
DUAL 4-INPUT NAND GATE



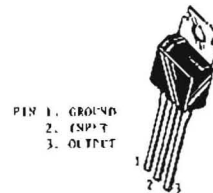
4013B
DUAL D FLIP-FLOP



4027B
DUAL J-K FLIP-FLOP



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