TECHNICAL MANUAL

MS-15R MODULES

HARRIS CORPORATION

Broadcast Products Division

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STEREO ANALOG MODULE

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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 the OVSC module to allow DTR filter provisions or use of the internal low-pass filter as desired. Selectable 75us, 50us, 25us, or FLAT pre-emphasis is also provided.

1-3. TECHNICAL CHARACTERISTICS.

1-4. Table 1-1 lists operating characteristics and parameters of the MS-15R STEREO ANALOG module.

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2-1. GENERAL.

2-2. Refer to 888 1781 001, MS-15R stereo generator, 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 MS-15R 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.

SECTION IV

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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

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 ± 1 DBM for 100% modulation at 400 Hz - 600 ohm balanced resistive input impedance.
Pilot	1.7 V p-p sinusodial 19 kHz Pilot.
CONTROL:	
Stereo Switching	12 V p-p in phase and inverted 38 kHz square waves (CMOS logic level). 12 V 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:	2.8 V p-p Composite Stereo Output.

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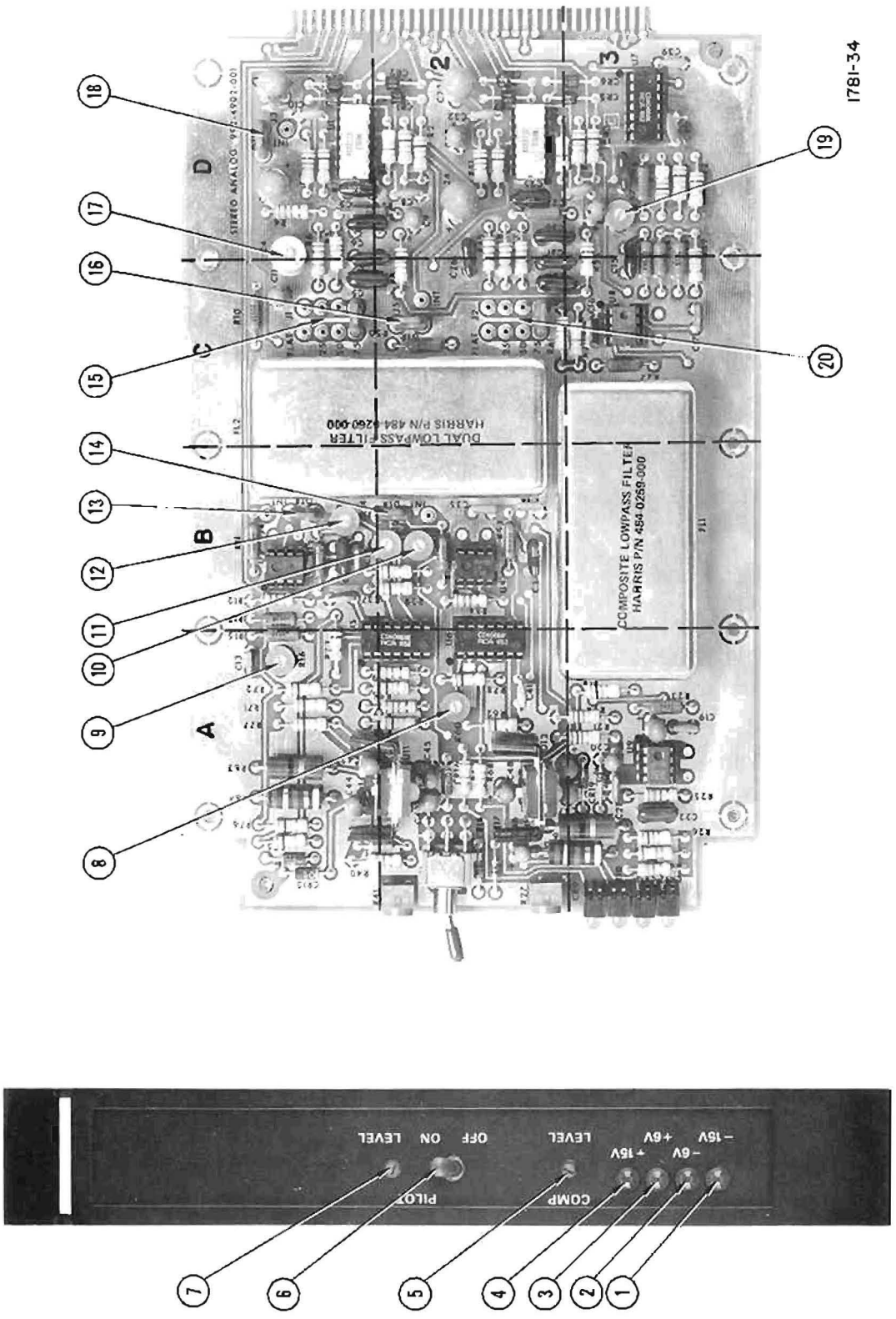

Figure 3-1. STEREO ANALOG Module

WARNING: Disconnect primary power prior to servicing.

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 right into left stereophonic audio separation.
11	LEFT SEPARATION Control (R28)	Adjusts left into right stereophonic audio separation.
12	GAIN MATCH Control (R14)	Adjusts the left channel gain to equal the right channel gain for minimum crosstalk.
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.

Table 3-1. STEREO ANALOG Module Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
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.

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Table 3-2. Control Adjustments

CONTROL	ADJUSTMENT
PILOT LEVEL Control (R41)	1. Operate the stereo generator OUTPUT module meter switch to B-BAND. 2. Adjust R41 to obtain the desired amount of pilot signal (8% to 10%).
COMP LEVEL Control (R27)	1. Disconnect the audio inputs from the LEFT - and + (TP1 pins 7 and 9) and RIGHT - and + (TB1 pins 10 and 12) on the rear of the stereo generator. 2. Apply a 400 Hz sinewave at +10 dBm to both inputs simultaneously. 3. Operate the OUTPUT module meter switch to L. Adjust the 400 Hz signal level until the MODULATION meter indicates 100% (approximately 10 dBm across input). 4. Operate the OUTPUT module meter switch to B-BAND. Adjust R27 until the meter indicates 100%. 5. Remove the 400 Hz test signal and reconnect the audio inputs.
MONO GAIN Control (R60)	1. Disconnect the audio inputs from the LEFT - and + (TB1 pins 7 and 9) and RIGHT - and + (TB1 pins 10 and 12) on the rear of the stereo generator. 2. Apply a 400 Hz sinewave at +10 dBm to both inputs simultaneously. 3. Remove the module. Mount the module in the stereo generator using the extender board provided with the stereo generator. 4. Operate the OUTPUT module meter switch to B-BAND. Adjust the 400 Hz signal level until the meter indicates 100%. 5. Depress the MONO L mode switch on the STEREO DIGITAL module. The MONO L indicator will illuminate. 6. Adjust R60 to obtain an indication of 100% on the meter. 7. Remove the module and extender board and replace the module in the stereo generator. Remove the 400 Hz test signal and reconnect the audio inputs.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
38 KHZ NULL Control (R16)	1. Connect the stereo generator OUTPUT connector (J1) directly to the composite input of a stereo monitor. 2. Adjust the stereo monitor to the 38 kHz position. 3. Disable all modulation to the stereo generator. 4. Remove the module. Mount the module in the stereo generator using the extender board provided with the stereo generator. 5. Depress the STEREO DIGITAL module STEREO switch. The STEREO indicator will illuminate. 6. Set the PILOT ON/OFF switch to OFF. 7. Adjust R16 to obtain a minimum indication on the stereo monitor. (on o'scope 8. Remove the module and extender board and replace the module in the stereo generator. Set the PILOT ON/OFF switch to ON and reconnect the stereo generator output to the load. 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-EMPH MATCH Adjustment (C4) adjustment procedure.
114 KHZ NULL Control (R37)	1. Remove the module. Mount the module in the stereo generator using the extender board provided with the stereo generator. 2. Disconnect the audio inputs from the LEFT - and + (TB1 pins 7 and 9) and IGHT - and + (TB1 pins 10 and 12) on the rear of the stereo generator. 3. Apply a 10 kHz sinewave at +10 dBm to the left channel only.

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Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	4. Connect a spectrum analyzer to module pin 70. 5. Operate the OUTPUT module meter switch to L. Adjust the 10 kHz signal level until the meter indicates 100%. 6. Adjust R37 to obtain a minimum indication of the 114 kHz sidebands on the spectrum analyzer (typical supression >70 dB). 7. Disconnect the spectrum analyzer. 8. Remove the module and extender board and replace the module in the stereo generator. Remove the 10 kHz test signal and reconnect the left channel audio input.
LEFT SEPARATION Control (R28) RIGHT SEPARATION Control (R31) GAIN MATCH Control (R14) PRE-EMPH MATCH Adjustment (C4)	1. Remove the module. Mount the module in the stereo generator using the extender board provided with the stereo generator. 2. Disconnect the audio inputs from the LEFT - and + (TB1 pins 7 and 9) and RIGHT - and + (TB1 pins 10 and 12) on the rear of the stereo generator. 3. Perform the 114 KHZ NULL Control (R37) adjustment procedure, steps 1 through 7. NOTE Correct adjustment of R28 and R31 requires use of a dc coupled oscilloscope with good high frequency amplitude and phase response. A X 1 probe must be used. 4. Connect the oscilloscope to module 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. 7. Remove the 400 Hz test signal from the left channel and connect the signal to the RIGHT - and + (TB1 pins 10 and 12) only.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	8. Operate the OUTPUT module meter switch to R. Adjust the 400 Hz signal level until the meter indicates 100%. 9. Adjust R31 to obtain the flattest composite signal base line indication on the oscilloscope. 10. Set the STEREO OVSC module IN/OUT switch to OUT. 11. Remove the 400 Hz test signal from the right channel. 12. Connect a 100 Hz sinewave to both the LEFT - and + (TB1 pins 7 and 9) and the RIGHT - and + TB1 pins 10 and 12) (both channels strapped together so that L + R). L=R 13. Operate the OUTPUT module meter switch to L. Adjust the 100 Hz signal level until the meter indicates 100%. 14. Adjust C4 to midrange. 15. Using a spectrum analyzer connected to module pin 70 or a stereo modulation monitor on the exciter output adjsuted to the L-R position, adjust R14 for a minimum indication of the L-R signal (typical supression >65 dB). 16. Remove the 100 Hz test signal from the stereo generator audio inputs. 17. Connect a 15 kHz sinewave to both the LEFT - and + (TB1 pins 7 and 9) and the RIGHT - and + (TB1 pins 10 and 12) (both channels strapped together so that L = R). 18. Operate the OUTPUT module meter switch to L. Adjust the 15 kHz signal level until the MODULATION meter indicates 100%. 19. Adjust C4 for a minimum indication of the L-R signal (typical supression >60 dB). Note the audio inputs. 20. Remove the 15 kHz test signal from the audio inputs.

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Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	21. Connect a 400 Hz sinewave to the LEFT - and + (TB1 pins 7 and 9). For test purposes only, cross connect the left and right audio inputs out of phase so that L =-R as follows: TB1 pin 7 to TB1 pin 12 TB1 pin 9 to TB1 pin 10 22. Operate the OUTPUT module meter switch to L. Adjust the 400 Hz signal level until the meter indicates 100%. 23. If a stereo modulation monitor is used, adjust the monitor to the L + R position. 24. If the supression of the L + R signal is not the same as the L - R signal noted in step 19, alternately adjust R28 and R31 slightly equal amounts in the same direction until the L + R supression is equal to the L - R supression noted in step 19. 25. Remove the 400 Hz test signal and straps from the audio inputs. 26. Connect a 400 Hz sinewave to the LEFT - and + (TB1 pins 7 and 9). 27. Operate the OUTPUT module meter switch to L. Adjust the 400 Hz signal level until the meter indicates 100%. 28. Repeat steps 4 through 9. Ensure the separation has not degraded. 29. Perform the PILOT LEVEL Control (R41) adjustment procedure, steps 1 through 7. 30. Perform the COMP LEVEL Control (R27) adjustment procedure, steps 1 through 4. 31. Perform the MONO GAIN Control (R60) adjustment procedure, steps 1 through 6. 32. Disconnect the oscilloscope and spectrum analyzer from the module. Remove the module and extender board and replace the module in the stereo generator. 33. Remove the 400 Hz test signal and reconnect the audio inputs. Reconnect the exciter output to the load.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	34. Set the PILOT ON/OFF switch to ON. Set the STEREO OVSC module IN/OUT switch to ON.

(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.

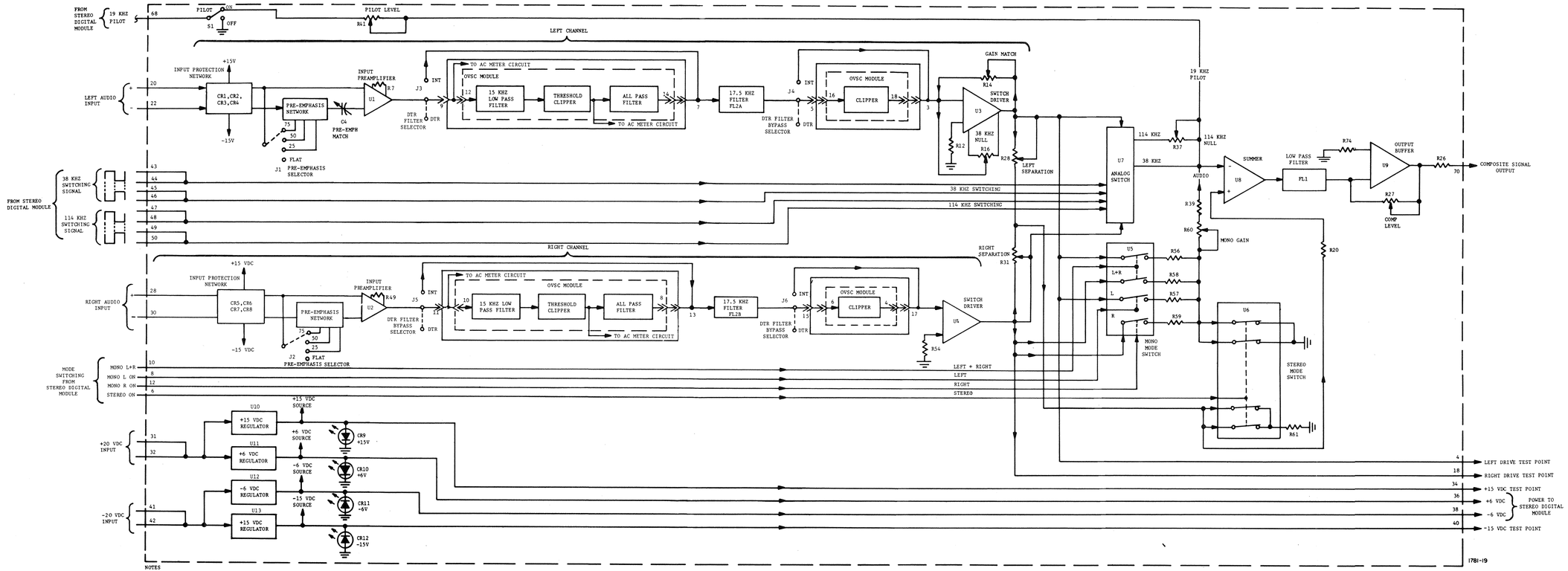
4-6. Pre-emphasized audio from the input preamplifiers is applied to DTR (Dynamic Transient Response) filter selectors J3 in the left channel and J5 in the right channel. Outputs to the AC metering circuits allow monitoring of the left and right pre-emphasized levels.

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 to OUT or the OVSC module must be removed from the stereo generator.

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.



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

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 supression 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 the 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 summer 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 DIGITAL 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 connected 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.

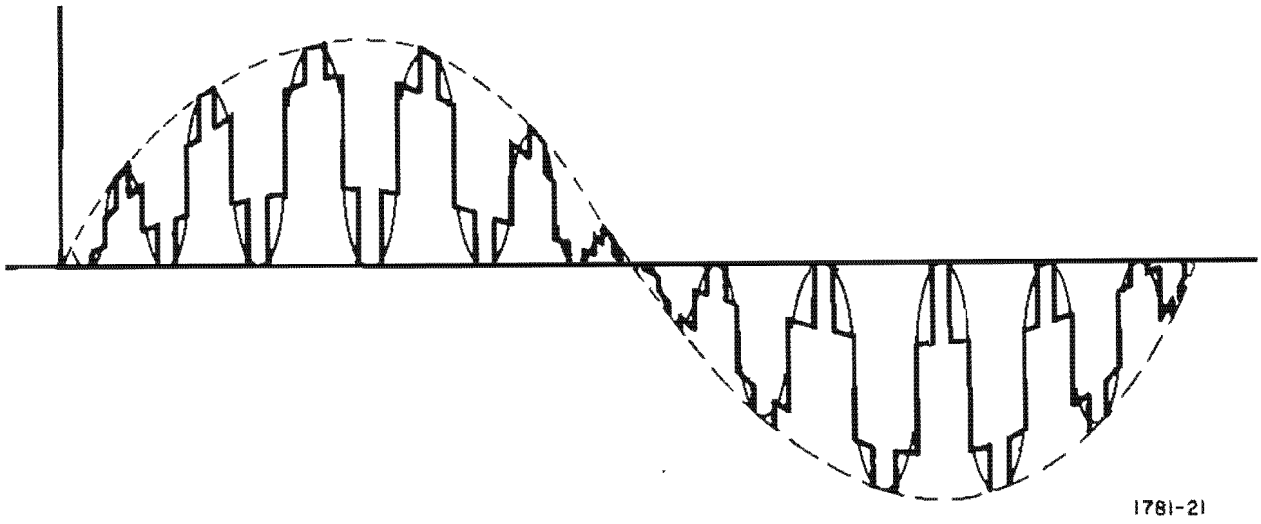


Figure 4-2. DSM Waveform

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 and six volt supplies. Test points are provided to assist in checking regulator outputs. Additionally, ±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 MS-15R stereo generator 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 OUTPUT module meter, fuse F1, 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 a stereo generator 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 5246 001) is provided with the stereo generator 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:

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.

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

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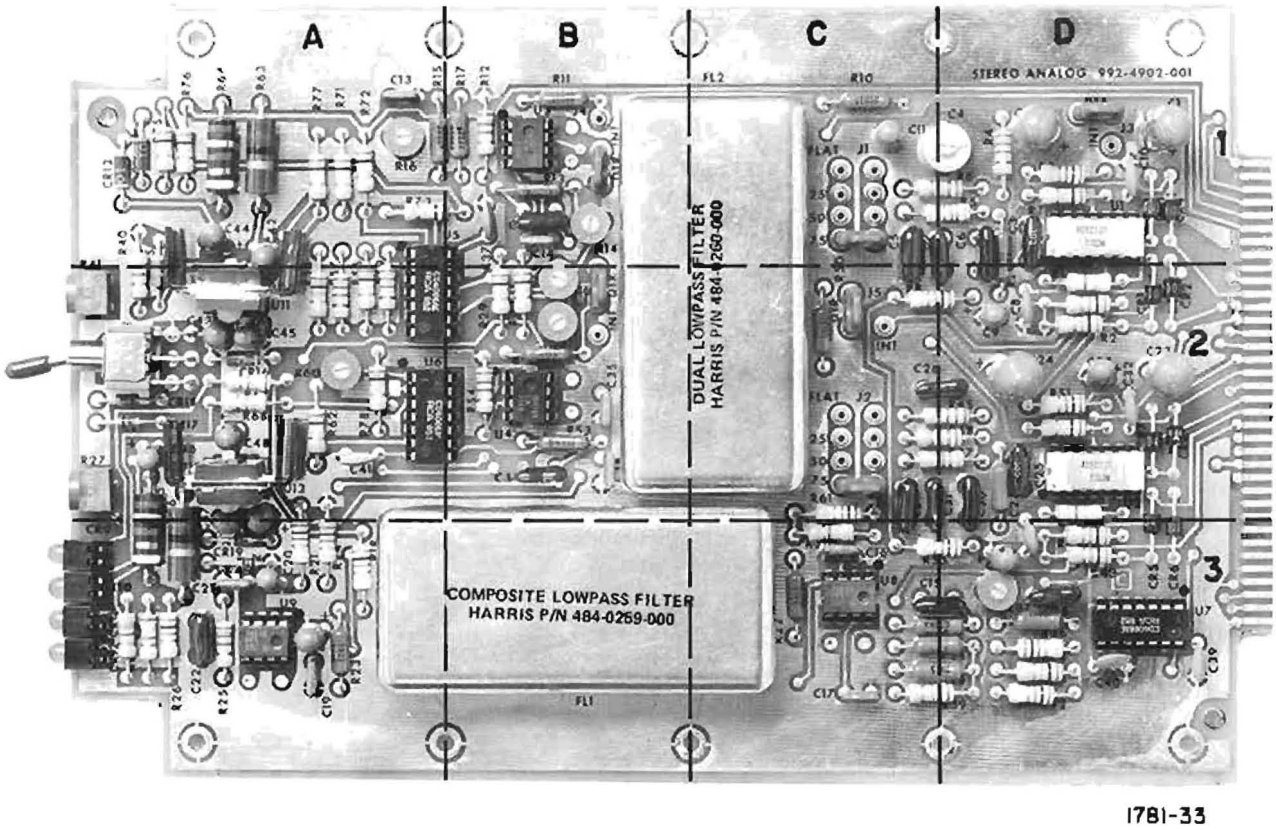


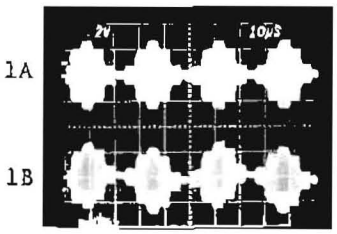
Figure 5-1. STEREO ANALOG Module Parts Layout

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	R1	D2
C11	C1	C39	D3	CR11	A3	R2	D2
C12	B1	C40	D3	CR12	A3	R3	D2
C13	A1	C41	A2	CR13	A1	R4	D1
C14	B1	C42	A1	CR14	A1	R5	D1
C15	C3	C43	A2	CR15	A2	R6	D1
C16	C3	C44	A1	CR16	A2	R7	D1
C17	C3	C45	A2	CR17	A2	R8	C2
C18	A3	C46	A2	CR18	A2	R9	D1
C19	A3	C47	A2	CR19	A3	R10	C1
C20	A3	C48	A2	CR20	A3	R11	B1
C21	A3	C49	A2			R12	B1
C22	A3					R13	B1
C23	D2					R14	B1
C24	D2			FL1	B3	R15	A1
C25	D2			FL2	C1	R16	A1
C26	C2					R17	B1
C27	D2					R18	A3
C28	D3					R19	C3

Table 5-2. STEREO ANALOG Module Parts Index. (Continued)

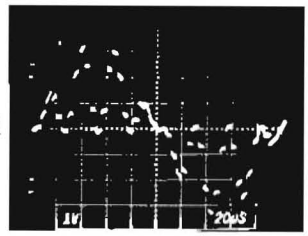
SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
R20	C3	R48	D2	R76	A1		
R21	A3	R49	D2	R77	A1		
R22	C3	R50	C2	R78	A2		
R23	A3	R51	D2				
R24	A3	R52	B2	S1	A2		
R25	A3	R53	B2				
R26	A3	R54	B2	U1	D1		
R27	A2	R55	C3	U2	D2		
R28	B2	R56	A2	U3	B1		
R29	B2	R57	A2	U4	B2		
R30	B2	R58	A2	U5	A2		
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	R67	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				



TEST REQUIREMENTS: A. 1 kHz signal input to left channel.
B. Oscilloscope synchronized to pilot frequency.

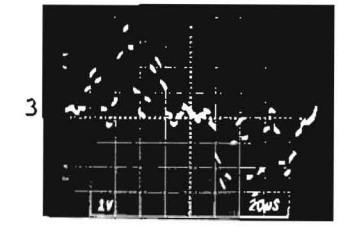
1A DSM sampling waveform at U8 pin 6 with the PILOT ON/OFF switch set to OFF.

1B DSM sampling waveform at U8 pin 6 with the PILOT ON/OFF switch set to ON.



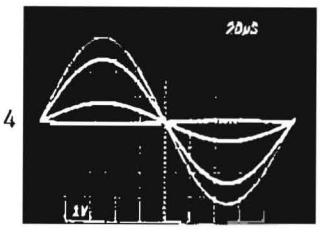
TEST REQUIREMENTS. A. 5 kHz signal input to left channel.
B. Oscilloscope adjusted to single sweep storage mod.
C. PILOT ON/OFF switch set to OFF.

2 DSM sampling waveform at U8 pin 6



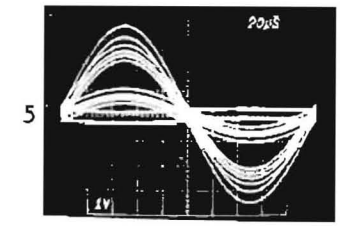
TEST REQUIREMENTS: A. 5 kHz signal input to left channel.
B. Oscilloscope adjusted to single sweep storage mode.
C. PILOT ON/OFF switch set to ON.

3 DSM sampling waveform at U8 pin 6.



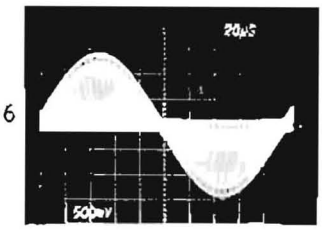
TEST REQUIREMENTS: A. 5 kHz signal input to left channel.
B. Oscilloscope synchronized to audio input.
C. PILOT ON/OFF switch set to OFF.

4 DSM sampling waveform at U8 pin 6



TEST REQUIREMENTS: A. 5 kHz signal input to left channel.
B. Oscilloscope synchronized to audio input.
C. PILOT ON/OFF switch set to ON.

5 DSM sampling waveform at U8 pin 6.



TEST REQUIREMENTS A. 5 kHz signal input to left channel.
B. PILOT ON/OFF switch set to ON.

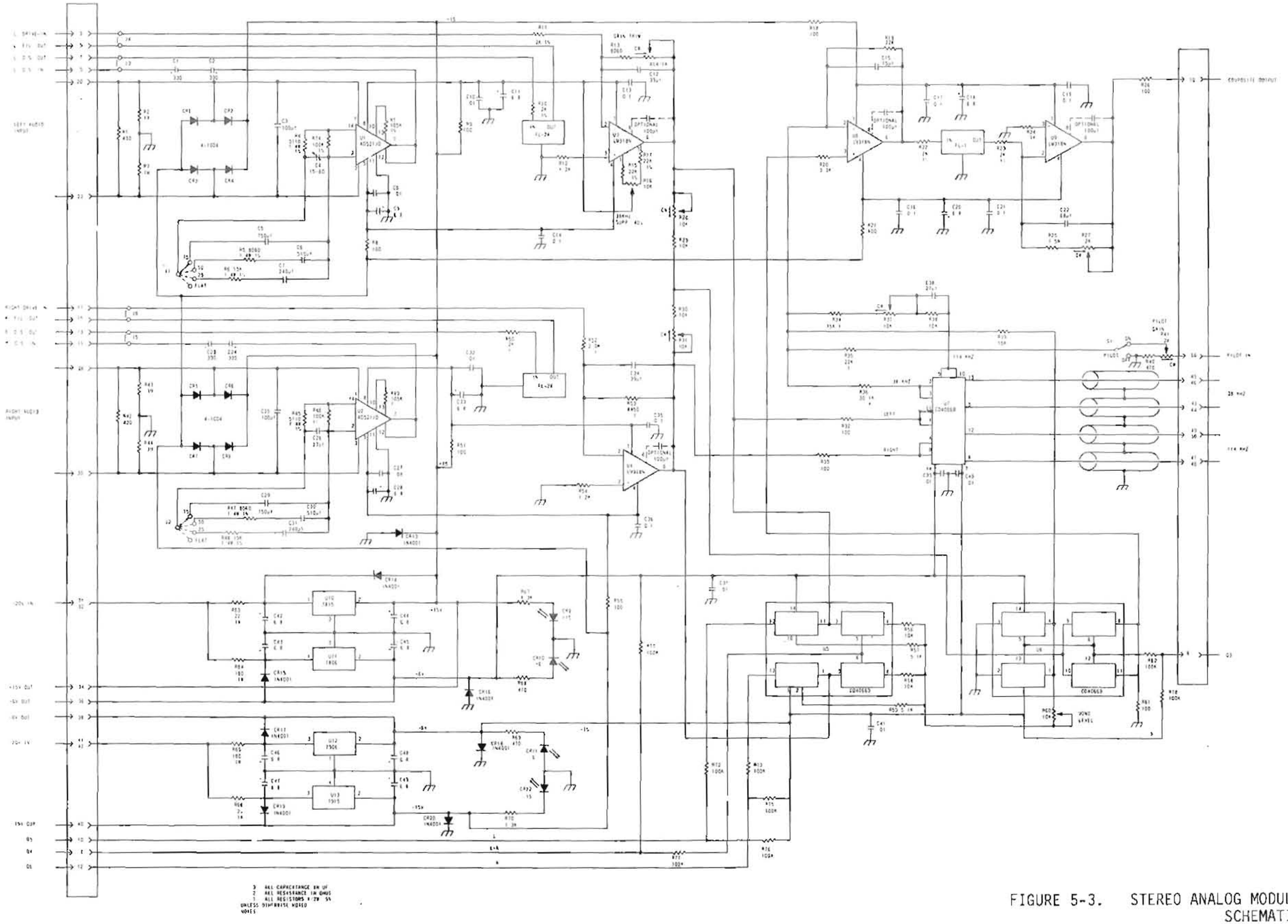
6 DSM stereo generator output at module pin 20

1781-55

1781 007

Figure 5-2. STEREO ANALOG Module Waveforms

WARNING: Disconnect primary power prior to servicing.



NOTES
1. ALL RESISTORS 1/2W 5%
2. ALL RESISTANCE IN OHMS
3. ALL CAPACITANCE IN UF
UNLESS OTHERWISE NOTED

FIGURE 5-3. STEREO ANALOG MODULE SCHEMATIC 852 8408-001

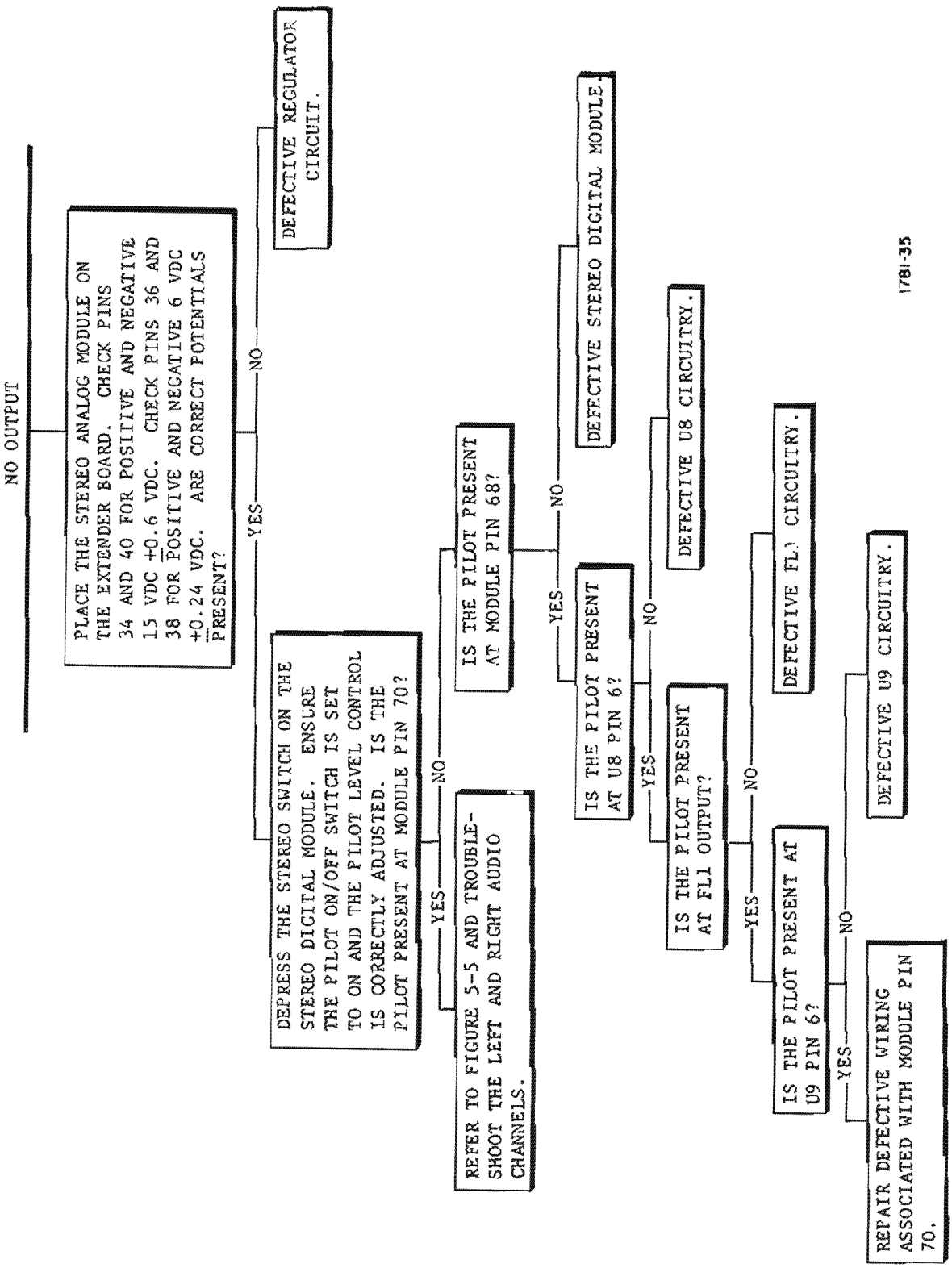


Figure 5-4. No Output

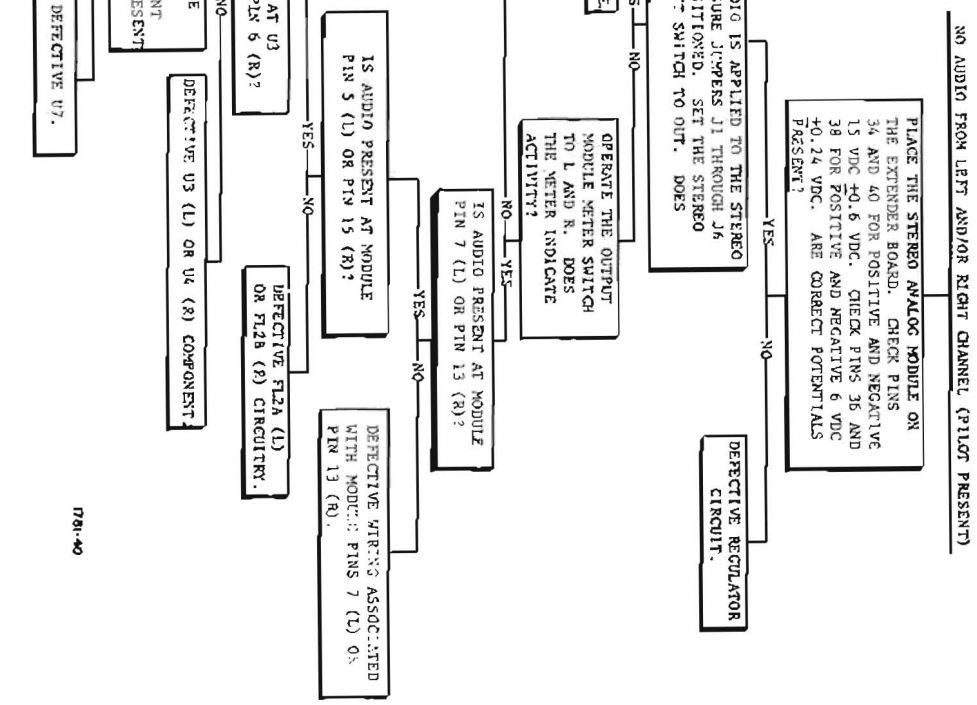


Figure 5-5. No Audio from Left and/or Right Channel (pilot present)

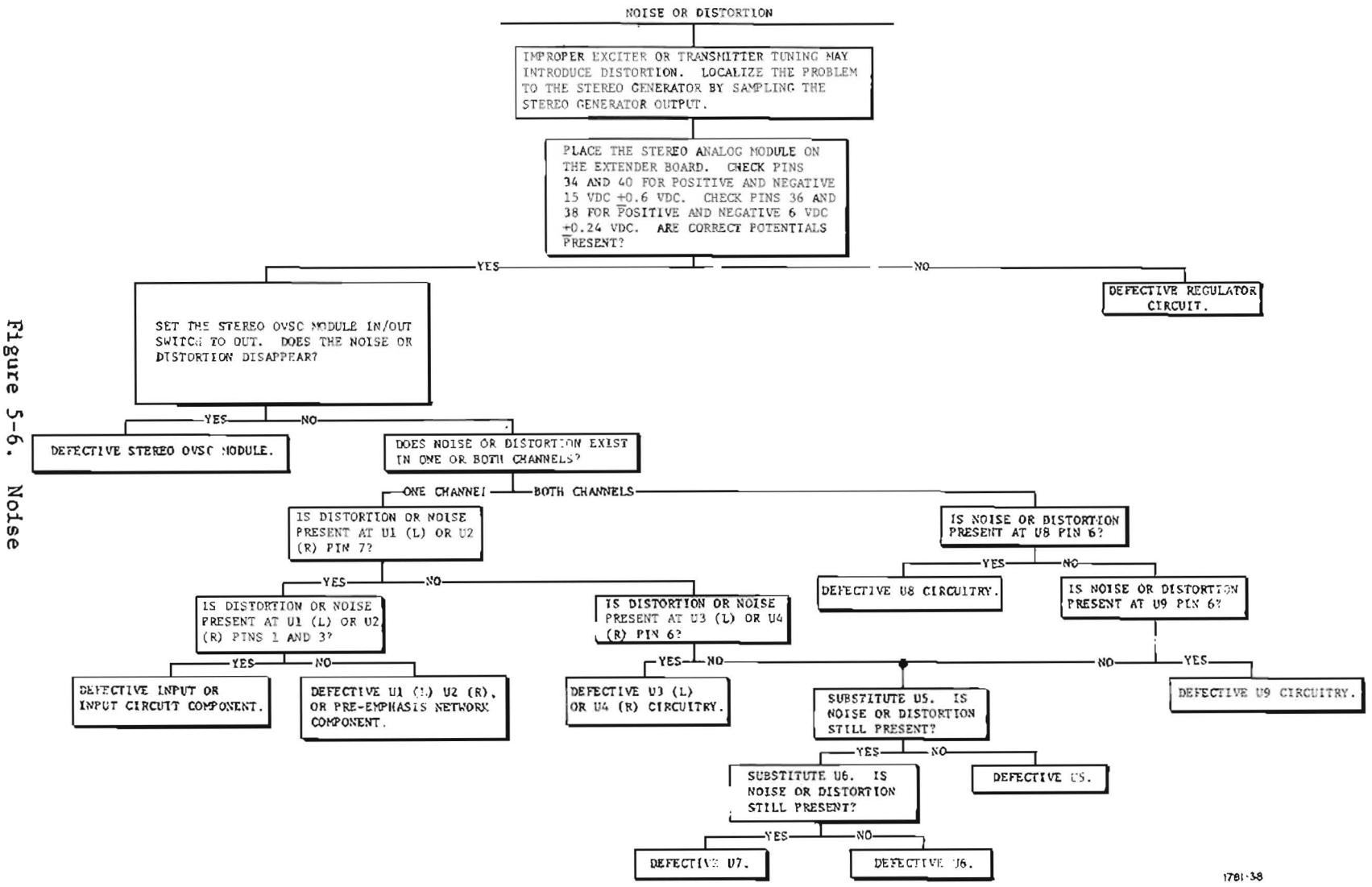


Figure 5-6. Noise

WARNING: Disconnect primary power prior to servicing.

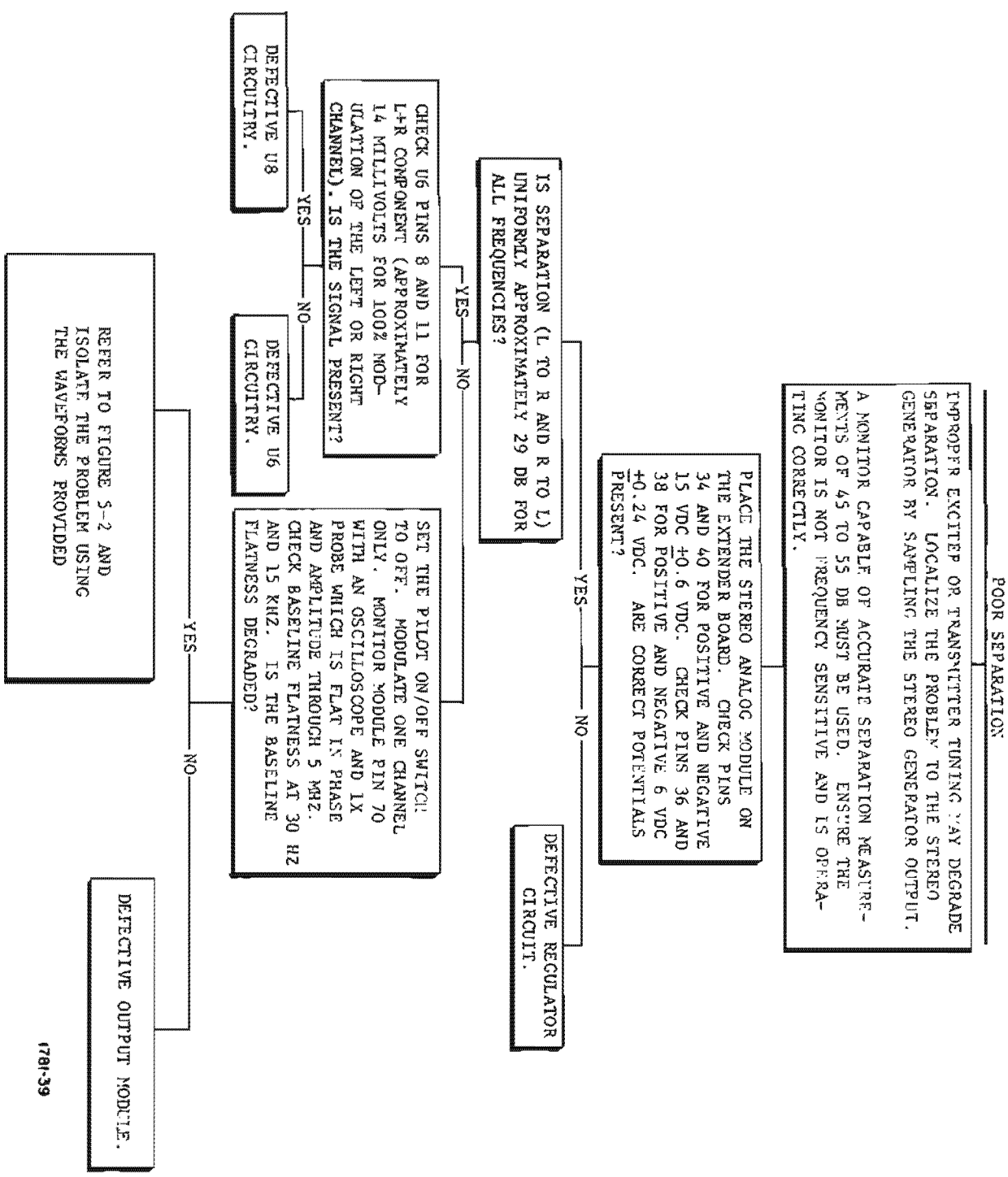


Figure 5-7. Poor Separation

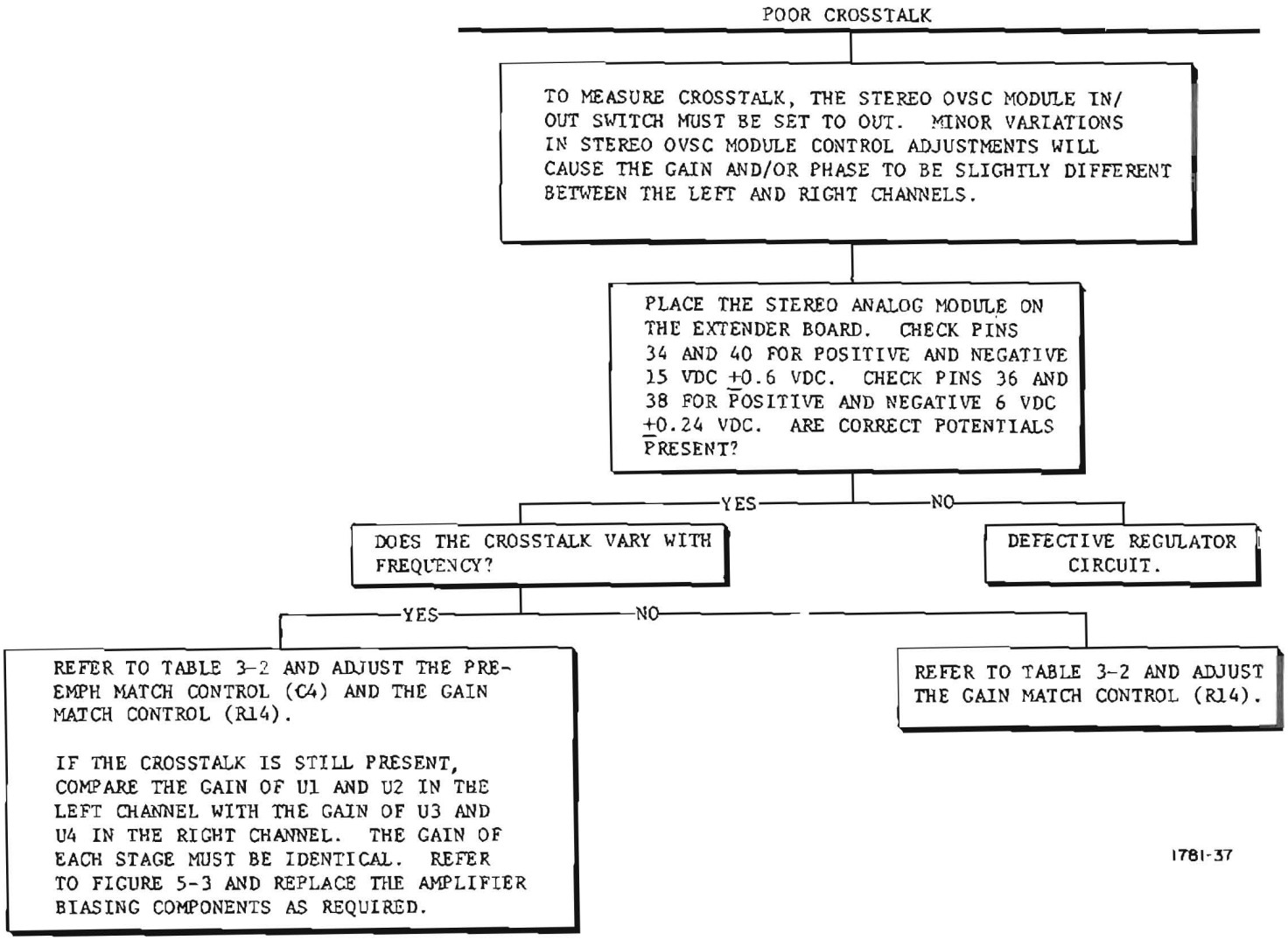


Figure 5-8. Poor Crosstalk

WARNING: Disconnect primary power prior to servicing.

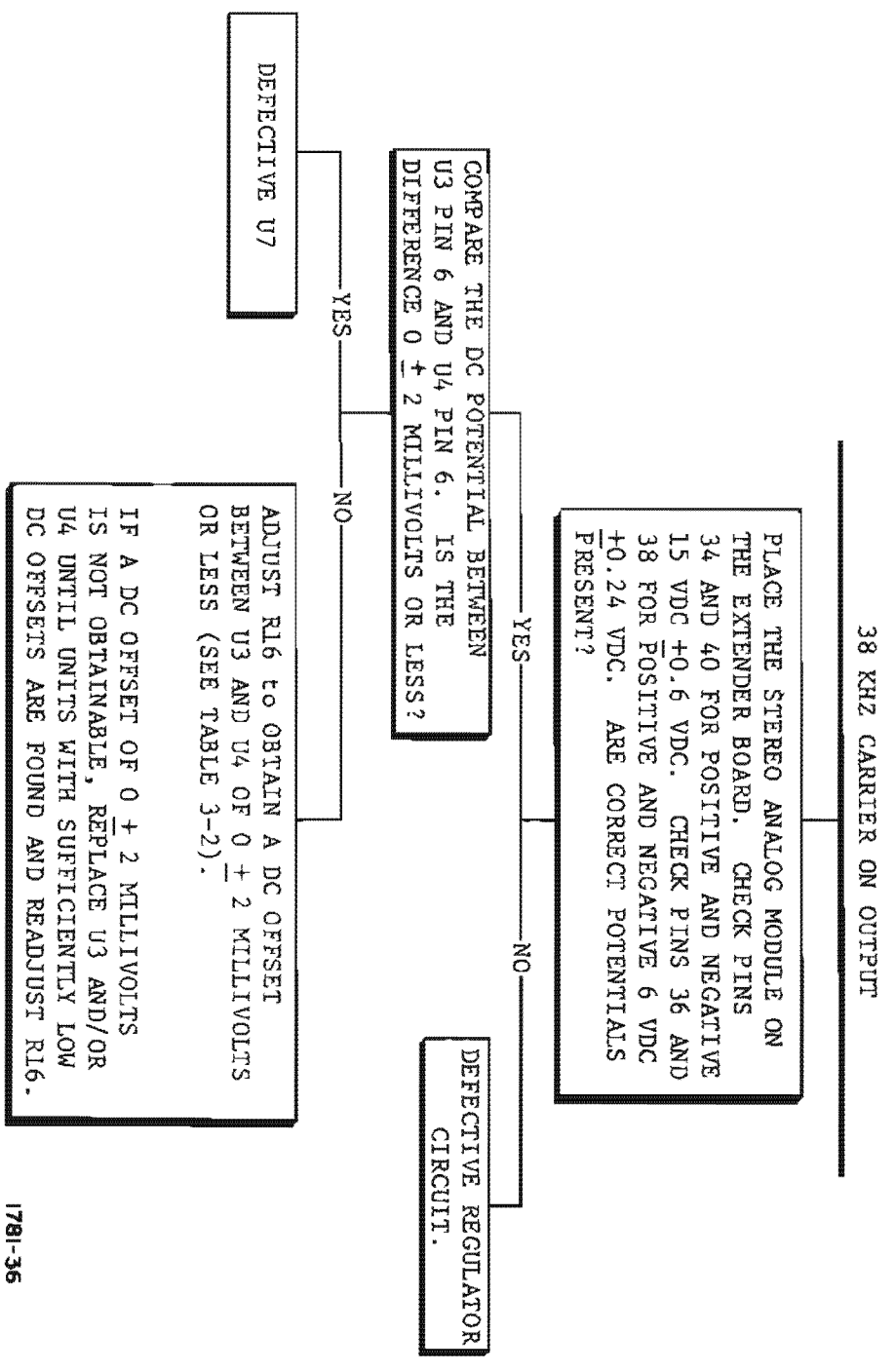


Figure 5-9. 38 kHz Carrier on Output

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 MS-15R STEREO ANALOG module. Table entries are indexed by component reference designator.

1781 002

Table 6-1. STEREO ANALOG Module Front Panel - 994 7989 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
-----	992 4902 001	STEREO ANALOG Module Circuit Board (Refer to figure 6-2).	1

Table 6-2. STEREO ANALOG Module Circuit Board - 992 4902 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C1,C2	526 0045 000	Capacitor, 330 uF, 6V, 10%	2
C3	500 0759 000	Capacitor, 100 pF, Mica	1
C4	518 0054 000	Capacitor, 15-60 pF, Variable	1
C5	500 0841 000	Capacitor, 750 pF, 300V, Mica	1
C6	500 0837 000	Capacitor, 510 pF, 500V, Mica	1
C7	500 0830 000	Capacitor, 240 pF, 500V, Mica	1
C8	516 0375 000	Capacitor, 0.01 uF, 50V	1
C9	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	1
C10	516 0375 000	Capacitor, 0.01 uF, 50V	1
C11	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	1
C12	500 0815 000	Capacitor, 39 pF, 500V, Mica	1
C13,C14	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	2
C15	500 0806 000	Capacitor, 15 pF, 500V, Mica	1
C16,C17	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	2
C18	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	1
C19	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	1
C20	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	1
C21	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	1
C22	500 0821 000	Capacitor, 68 pF, 500V, Mica	1
C23,C24	526 0045 000	Capacitor, 330 uF, 6V, 10%	2
C25	500 0759 000	Capacitor, 100 pF, Mica	1
C26	500 0811 000	Capacitor, 27 pF, 500V, Mica	1
C27	516 0375 000	Capacitor, 0.01 uF, 50V	1
C28	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	1

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Table 6-2. STEREO ANALOG Module Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C29	500 0841 000	Capacitor, 750 pF, 300V, Mica	1
C30	500 0837 000	Capacitor, 510 pF, 500V, Mica	1
C31	500 0830 000	Capacitor, 240 pF, 500V	1
C32	516 0375 000	Capacitor, 0.01 uF, 50V	1
C33	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	1
C34	500 0815 000	Capacitor, 39 pF, 500V	1
C35,C36	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	2
C37	516 0375 000	Capacitor, 0.01 uF, 50V	1
C38	500 0811 000	Capacitor, 27 pF, 500V, Mica	1
C39,C40,C41	516 0375 000	Capacitor, 0.01 uF, 50V	3
C42 thru C49	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	8
CR1 thru CR8	384 0284 000	Diode, 1OD4/1N2070	8
CR9 thru CR12	384 0661 000	LED, Green	4
CR13 thru CR20	384 0431 000	Diode, 1N4001	8
FL1	484 0260 000	Filter, Dual Low Pass	1
FL2	484 0259 000	Filter, Low Pass	1
J1 thru J6	610 0679 000	Plug, Shorting	6
R1	540 1170 000	Resistor, 430 ohm, 1/2W, 5%	1
R2,R3	540 1162 000	Resistor, 1 Megohm, 1/2W, 5%	2
R4	548 0394 000	Resistor, 5110 ohm, 1/4W, 1%	1
R5	548 1396 000	Resistor, 8060 ohm, 1/4W, 1%	1
R6	548 0340 000	Resistor, 15k ohm, 1/4W, 1%	1
R7	548 1370 000	Resistor, 105k ohm, 1/4W, 1%	1

Table 6-2. STEREO ANALOG Module Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R8,R9	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	2
R10,R11	548 0279 000	Resistor, 2000 ohm, 1/4W	2
R12	540 1205 000	Resistor, 1200 ohm, 1/2W, 5%	1
R13	548 1396 000	Resistor, 8.06k ohm, 1/4W	1
R14	550 0398 000	Potentiometer, 1k ohm, 1/2W, 10%	1
R15	548 0366 000	Resistor, 22.1k ohm, 1/4W	1
R16	550 0922 000	Potentiometer, 10k ohm, 1/2W	1
R17	548 0366 000	Resistor, 22.1k ohm, 1/4W	1
R18	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R19	548 0366 000	Resistor, 22.1k ohm, 1/4W	1
R20	540 1165 000	Resistor, 3300 ohm, 1/2W, 5%	1
R21	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R22,R23	548 0279 000	Resistor, 2000 ohm, 1/4W	2
R24	540 1116 000	Resistor, 1000 ohm, 1/2W, 5%	1
R25	540 1129 000	Resistor, 1500 ohm, 1/2W, 5%	1
R26	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R27	550 0927 000	Potentiometer, 2k ohm, 1/2W	1
R28	550 0922 000	Potentiometer, 10k ohm, 1/2W	1
R29,R30	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	2
R31	550 0922 000	Potentiometer, 10k ohm, 1/2W	1
R32,R33	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	2
R34	548 0314 000	Resistor, 75k ohm, 1/4W, 1%	1
R35	548 0366 000	Resistor, 22.1k ohm, 1/4W	1

Table 6-2. STEREO ANALOG Module Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R36	548 0416 000	Resistor, 30.1k ohm, 1/4W	1
R37	550 0922 000	Potentiometer, 10k ohm, 1/2W	1
R38	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1
R39	540 1184 000	Resistor, 15k ohm, 1/2W, 5%	1
R40	540 1115 000	Resistor, 470 ohm, 1/2W, 5%	1
R41	550 0927 000	Potentiometer, 2k ohm, 1/2W	1
R42	540 1170 000	Resistor, 430 ohm, 1/2W, 5%	1
R43,R44	540 1162 000	Resistor, 1 Megohm, 1/2W, 5%	2
R45	548 0394 000	Resistor, 5110 ohm, 1/4W, 1%	1
R46	548 0932 000	Resistor, 100k ohm, 1/4W	1
R47	548 1396 000	Resistor, 8060 ohm, 1/4W, 1%	1
R48	548 0340 000	Resistor, 15k ohm, 1/4W, 1%	1
R49	548 1370 000	Resistor, 105k ohm, 1/4W, 1%	1
R50	548 0279 000	Resistor, 2000 ohm, 1/4W	1
R51	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R52	548 0279 000	Resistor, 2000 ohm, 1/4W	1
R53	548 1360 000	Resistor, 8450 ohm, 1/4W, 1%	1
R54	540 1205 000	Resistor, 1200 ohm, 1/2W, 5%	1
R55	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R56	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1
R57	540 1105 000	Resistor, 5100 ohm, 1/2W, 5%	1
R58	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1
R59	540 1105 000	Resistor, 5100 ohm, 1/2W, 5%	1

Table 6-2. STEREO ANALOG Module Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R60	550 0922 000	Potentiometer, 10k ohm, 1/2W	1
R61	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R62	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	1
R63	540 0292 000	Resistor, 22 ohm, 1W, 5%	1
R64,R65	540 0314 000	Resistor, 180 ohm, 1W, 5%	2
R66	540 0292 000	Resistor, 22 ohm, 1W, 5%	1
R67	540 1187 000	Resistor, 1300 ohm, 1/2W, 5%	1
R68,R69	540 1115 000	Resistor, 470 ohm, 1/2W, 5%	2
R70	540 1187 000	Resistor, 1300 ohm, 1/2W, 5%	1
R71 thru R73	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	3
R74	548 0932 000	Resistor, 100k ohm, 1/4W	1
R75 thru R78	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	4
S1	604 0859 000	Switch, Toggle, DPDT	1
U1,U2	382 0473 000	Integrated Circuit	2
U3,U4	382 0472 000	Integrated Circuit	2
U5,U6,U7	382 0474 000	Integrated Circuit	3
U8,U9	382 0472 000	Integrated Circuit	2
U10	382 0359 000	Integrated Circuit, MC7815CP	1
U11	382 0471 000	Integrated Circuit	1
U12	382 0470 000	Integrated Circuit	1
U13	382 0360 000	Integrated Circuit, MC7915CP	1
XU1,XU2	404 0674 000	Socket, IC, 14 Contact	2
XU3,XU4	404 0673 000	Socket, IC, 8 Contact	2

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Table 6-2. STEREO ANALOG Module Circuit Board - 992 4902 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
XU5 thru XU7	404 0674 000	Socket, IC, 14 Contact	3
XU8,XU9	404 0673 000	Socket, IC, 8 Contact	2
	404 0513 000	Heat Sink, PA1-1CB	2
	410 0344 000	Insulator, Kapton	4
	612 0901 000	Jack, Printed Circuit Mount	28
	843 1603 001	Printed Board	1

1781 002

STEREO DIGITAL MODULE

888 1781 003

TECHNICAL MANUAL

STEREO DIGITAL MODULE

994 7990 002

HARRIS CORPORATION

Broadcast Products Division

T.M. No. 888 1781 003

Printed: November 1977

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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, and interfaces with remote control of mode selection.

1-3. TECHNICAL CHARACTERISTICS.

1-4. Table 1-1 lists operating characteristics and parameters of the MS-15R STEREO DIGITAL module.

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. Refer to 888 1781 001, MS-15R stereo generator, 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 MS-15R STEREO DIGITAL module and table 3-1 lists the controls and indicators with a description of each item listed. Control set-up adjustments are listed in table 3-2.

SECTION IV

PRINCIPLES OF OPERATION

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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

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 (used in MS-15 FM Exciter)	+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	+12 V p-p 38 KHZ Square Wave -12 V p-p 38 KHZ Square Wave +12 V p-p 114 KHZ Square Wave -12 V p-p 114 KHZ Square Wave
Mode Switching	+6 VDC for selected mode -6 VDC for inhibit

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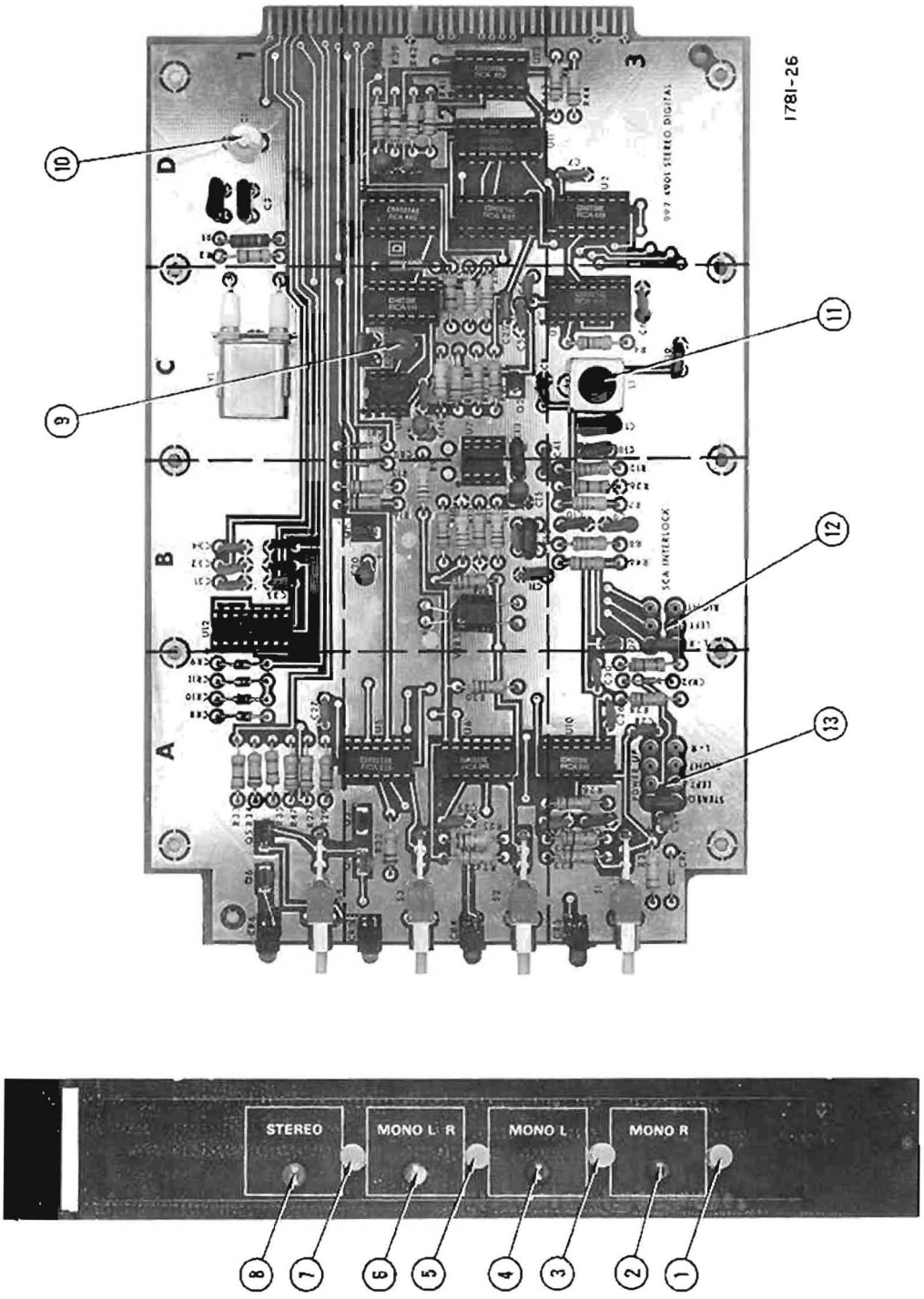


Figure 3-1. STEREO DIGITAL Module

WARNING: Disconnect primary power prior to servicing.

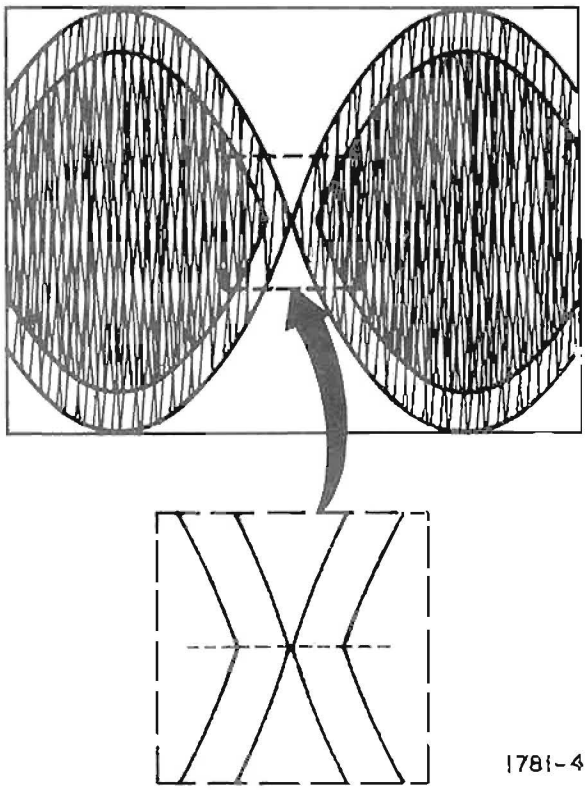
Table 3-1. STEREO DIGITAL Module Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	MONO R Switch (S1)	Enables the mono R mode to output a mono signal from the right channel and mute the left 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 output a mono signal from the left channel and mute the right 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 output 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 offset 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).
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).

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. 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.

Table 3-2. Control Adjsutments (Continued)

CONTROL	ADJUSTMENT
	 1781-41 Figure 3-2. Composite Waveform
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.

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WARNING: Disconnect primary power prior to servicing.

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 a 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. Automatic Control of Pilot Phase. The pilot 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

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PHASE CONTROL OFFSET (R19). As long as the phase of the regenerated square-wave 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 INTERLOCK. Operation of 41 kHz SCA simultaneously with stereo results 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 FM exciter mainframe when used with a 41 kHz SCA generator.

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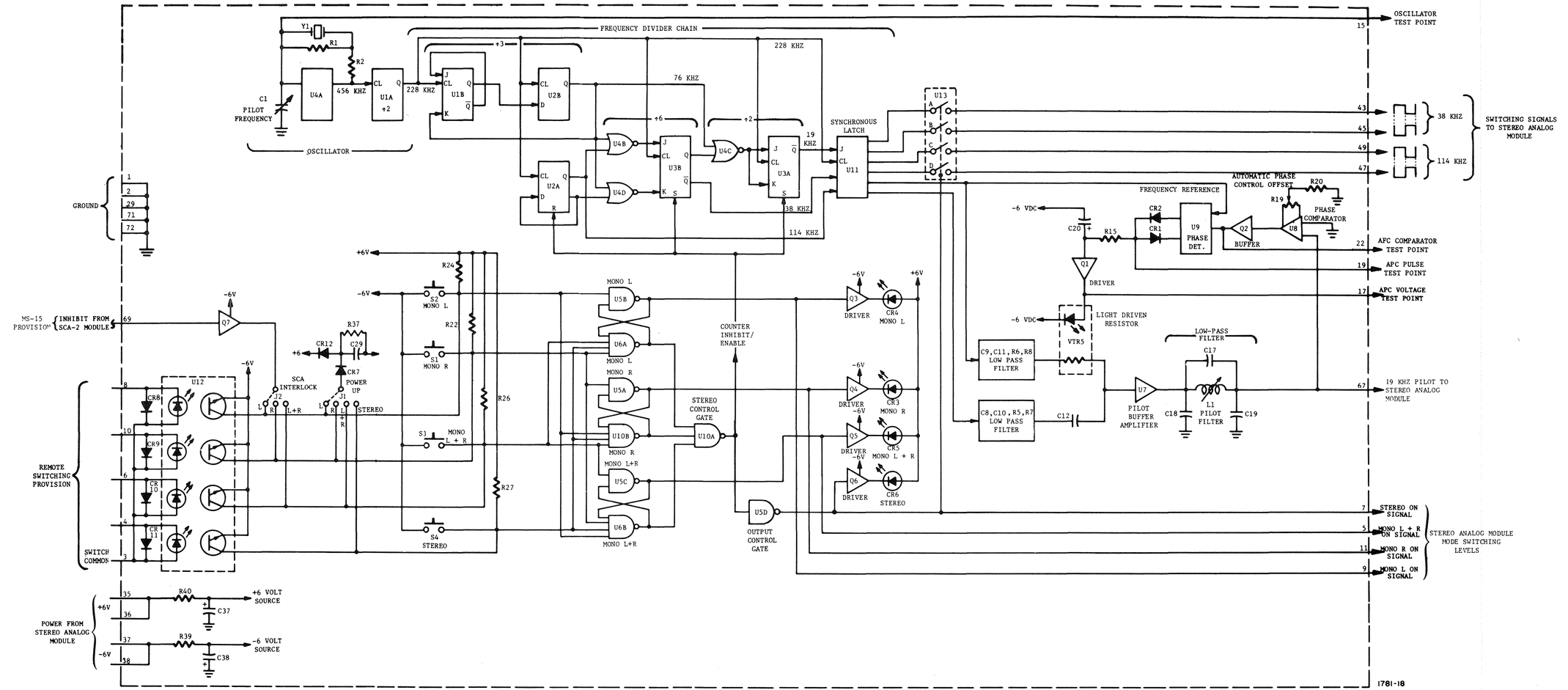

FIGURE 4-1. STEREO DIGITAL MODULE BLOCK DIAGRAM

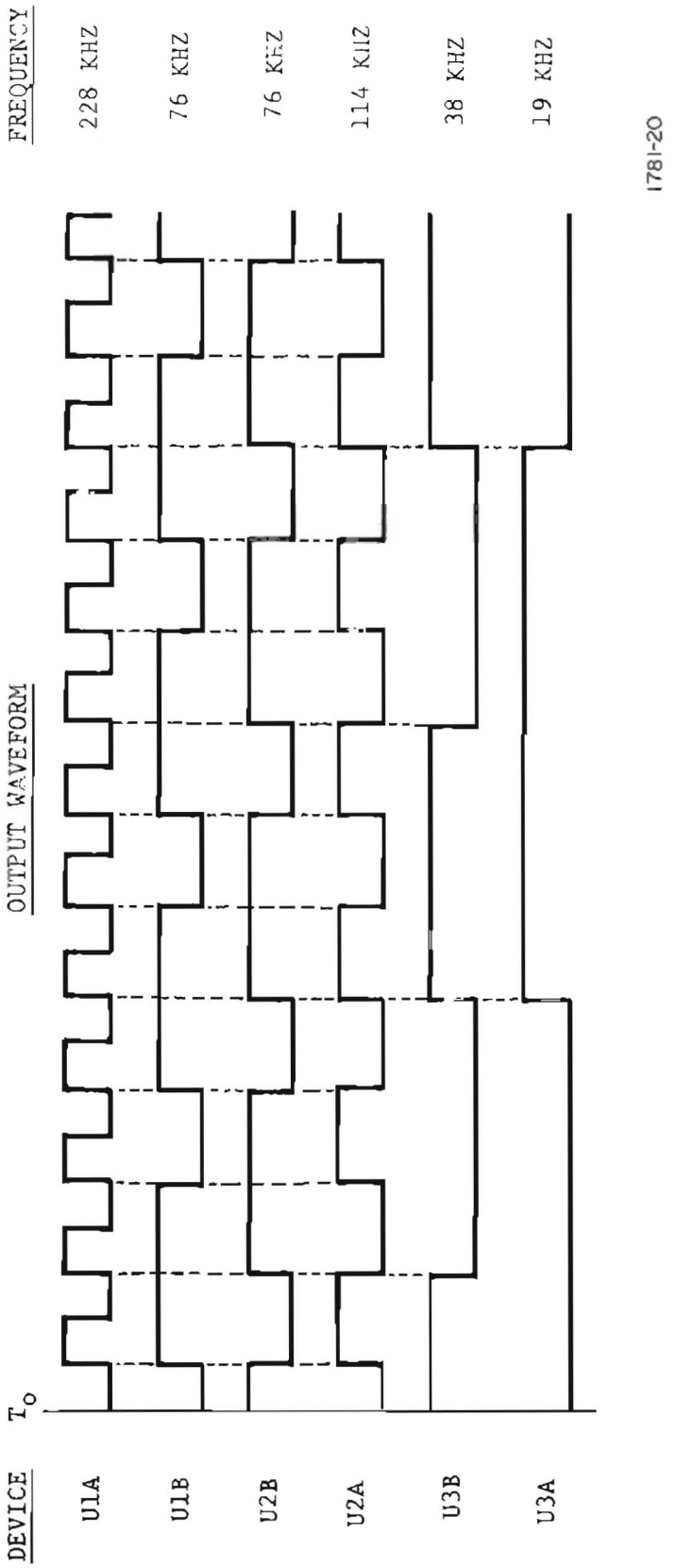

Figure 4-2. Frequency Divider Chain Waveforms

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 initilize 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

5-1. CORRECTIVE MAINTENANCE.

5-2. The MS-15R stereo generator 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 OUTPUT module meter, fuse F1, 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 stereo generator 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 5246 001) is provided with the stereo generator to assist in troubleshooting.

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Table 5-1. STEREO DIGITAL Module Fault Isolation Index

SYMPTON	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.

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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 Module Parts Layout	------
Table 5-2	STEREO DIGITAL Module Parts Index	------
Figure 5-2	STEREO DIGITAL Module Waveforms	------
Figure 5-3	STEREO DIGITAL Module Schematic	852 8407 001

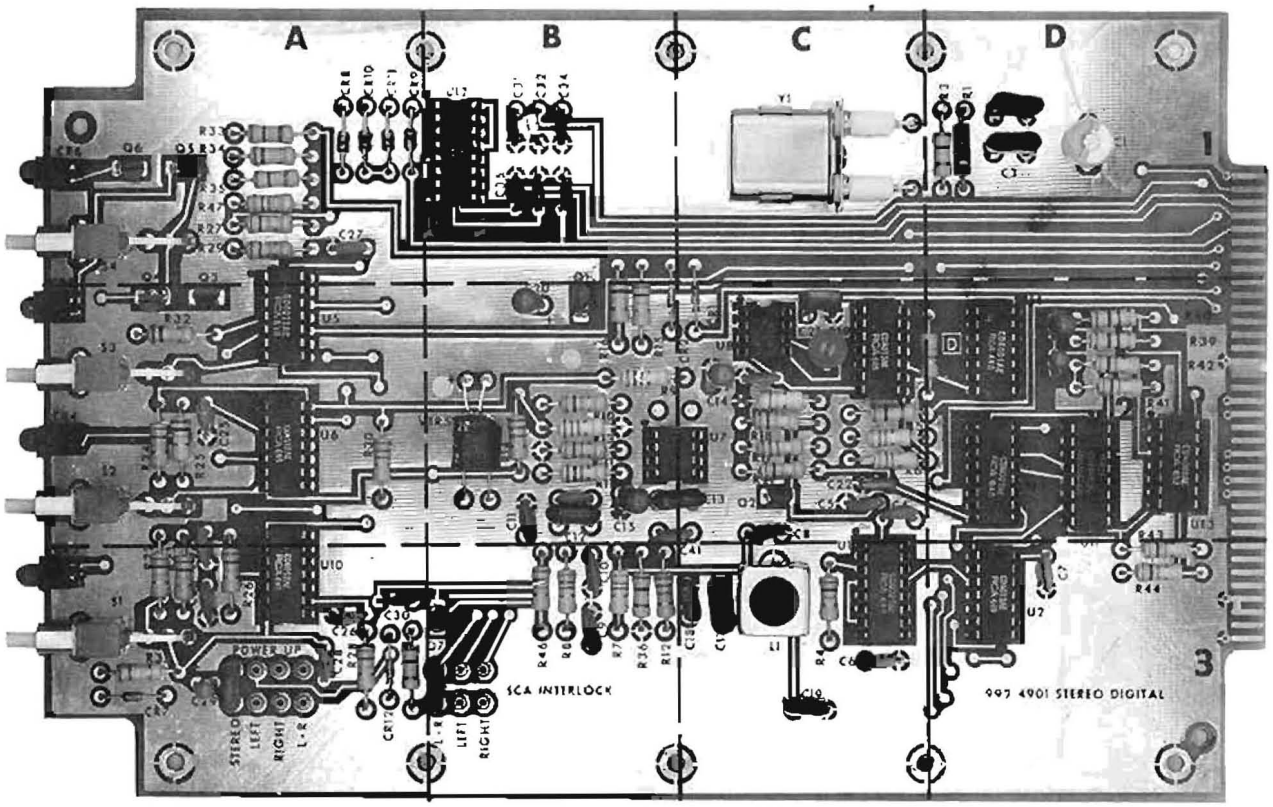

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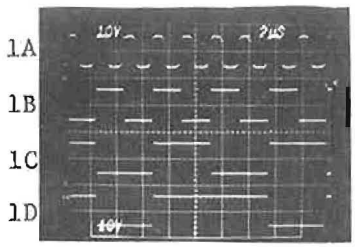
Figure 5-1. STEREO DIGITAL Module Parts Layout

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

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				



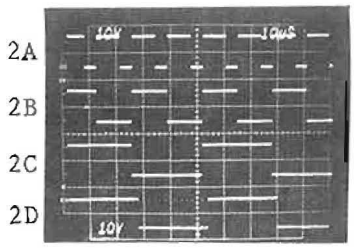
TEST REQUIREMENTS: A. Depress the STEREO switch.

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).



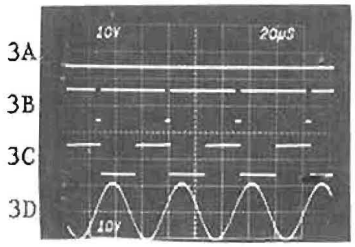
TEST REQUIREMENTS: A. Depress the STEREO switch

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)



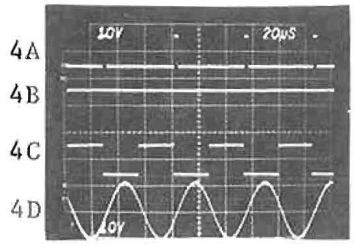
TEST REQUIREMENTS: A. Depress the STEREO switch.

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.



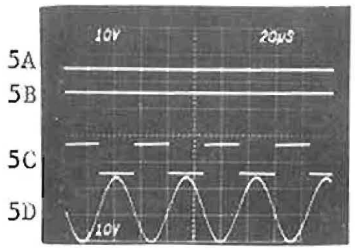
TEST REQUIREMENTS: A. Depress the STEREO switch.

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.



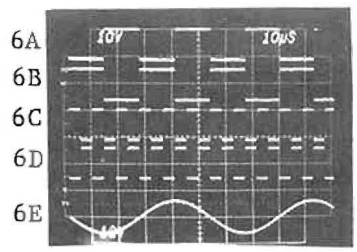
TEST REQUIREMENTS: A. Depress the STEREO switch.

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.



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.

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Figure 5-2. STEREO DIGITAL Module Waveforms

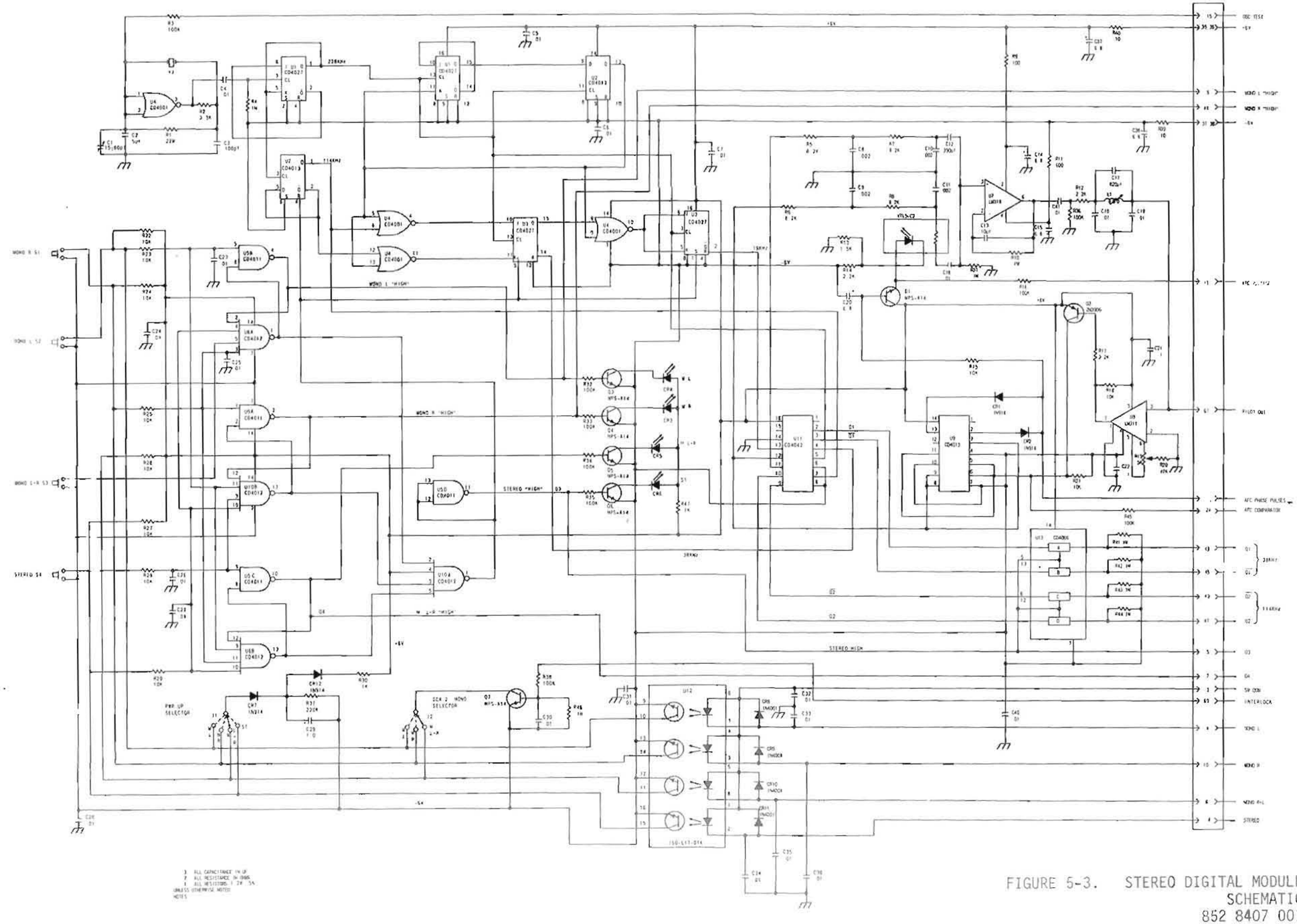

FIGURE 5-3. STEREO DIGITAL MODULE SCHEMATIC 852 8407 001

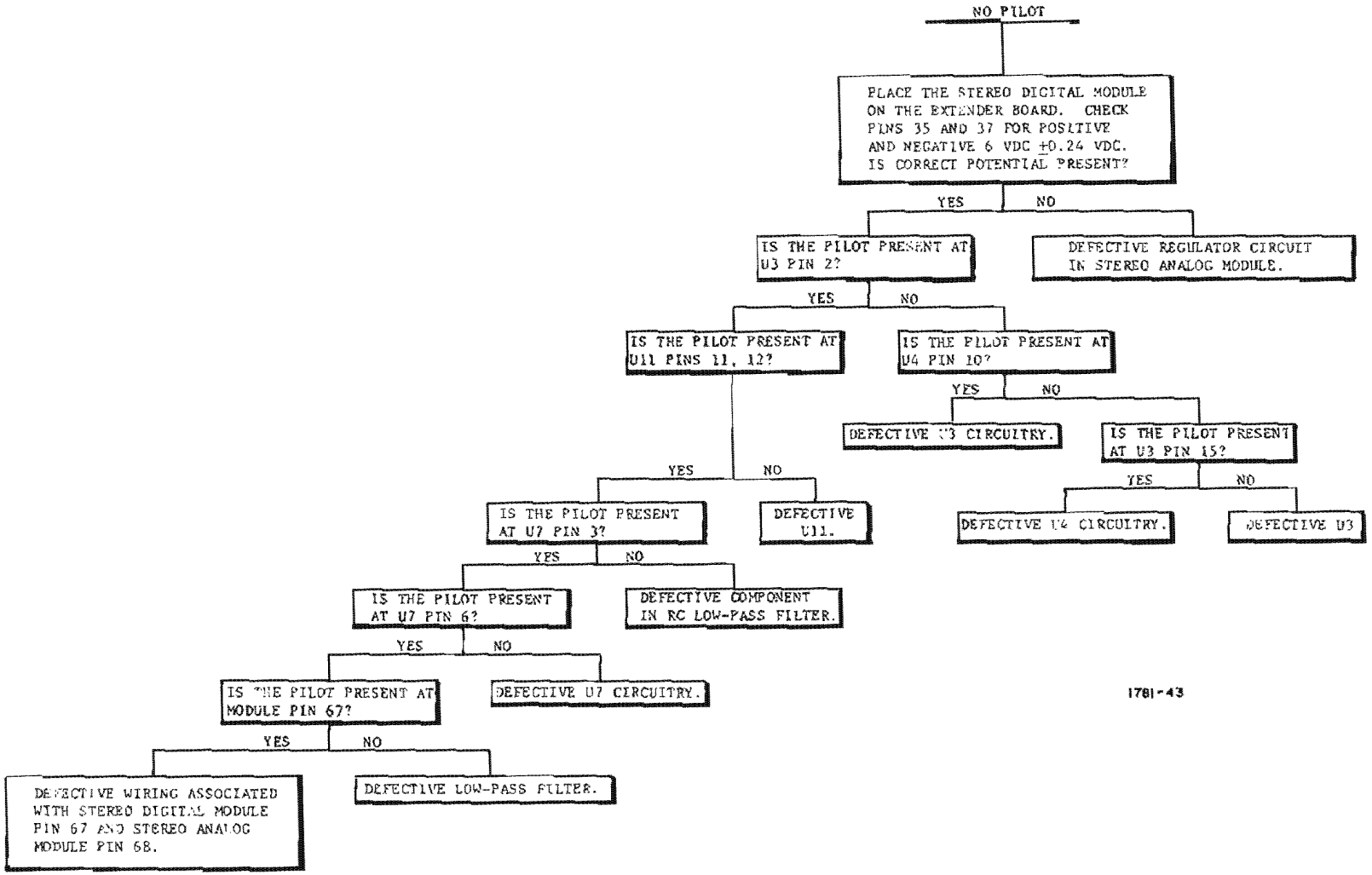

Figure 5-4. No Pilot

WARNING: Disconnect primary power prior to servicing.

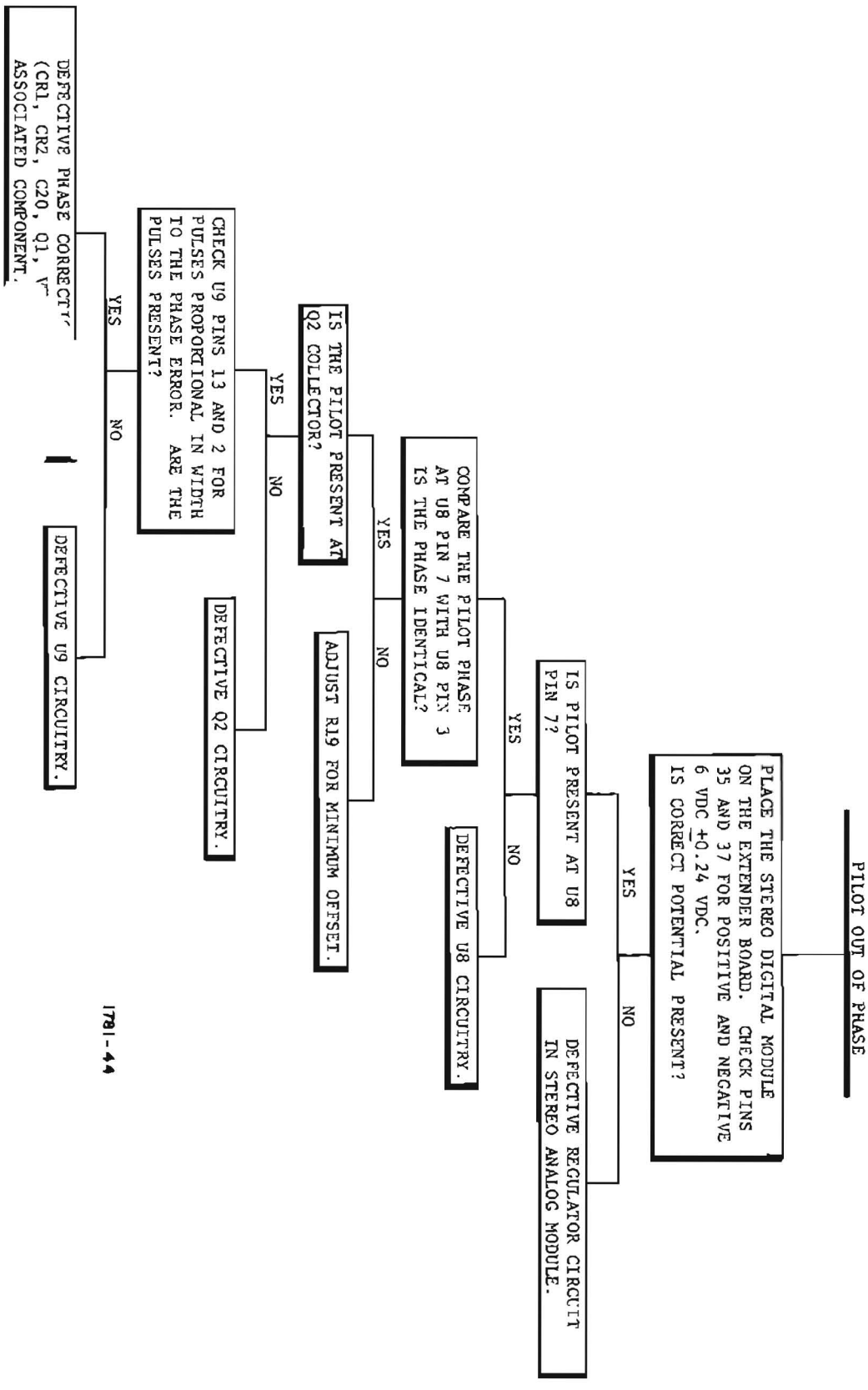

Figure 5-5. Pilot Out of Phase

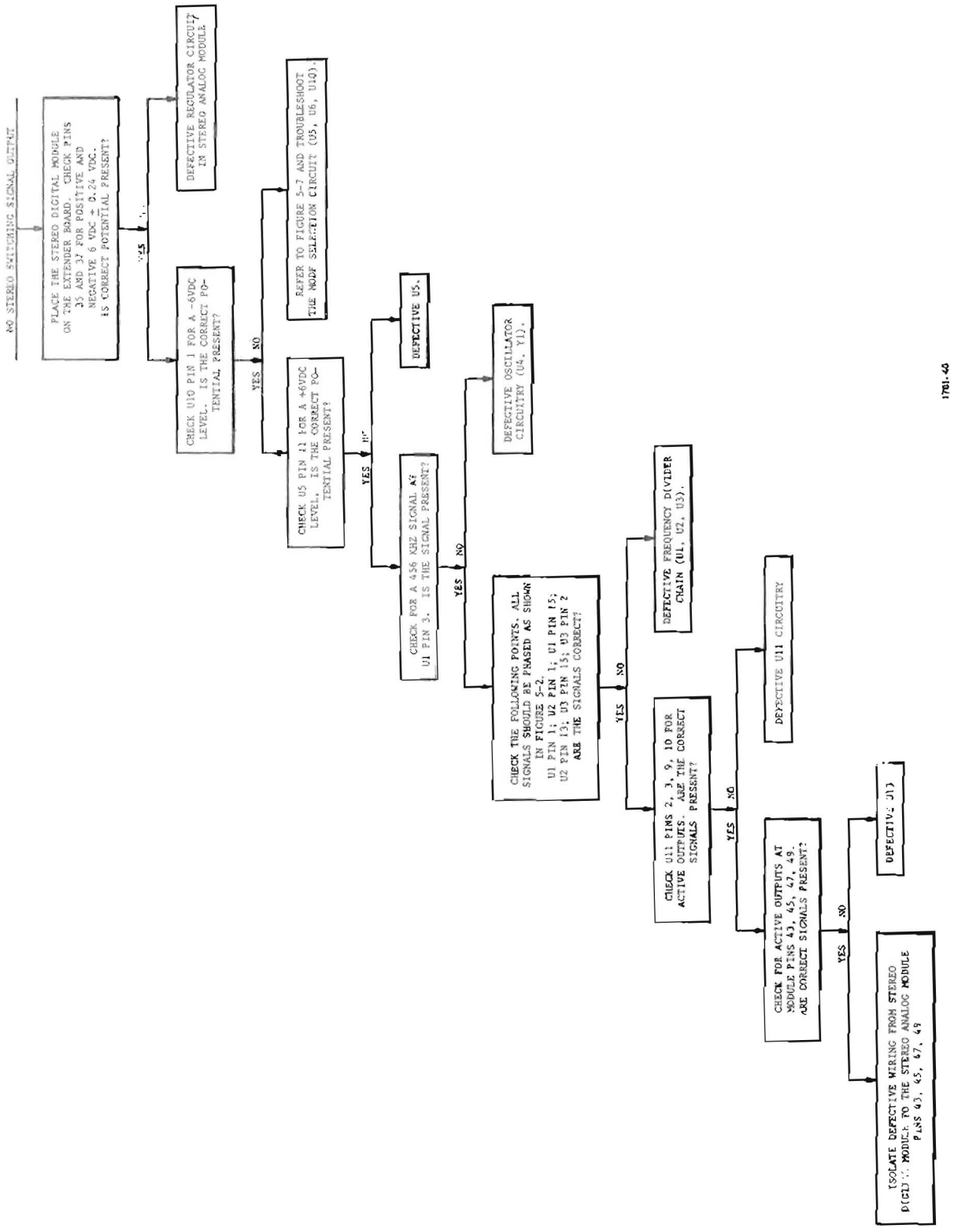

Figure 5-6. No Stereo Switching Signal Output

WARNING: Disconnect primary power prior to servicing.

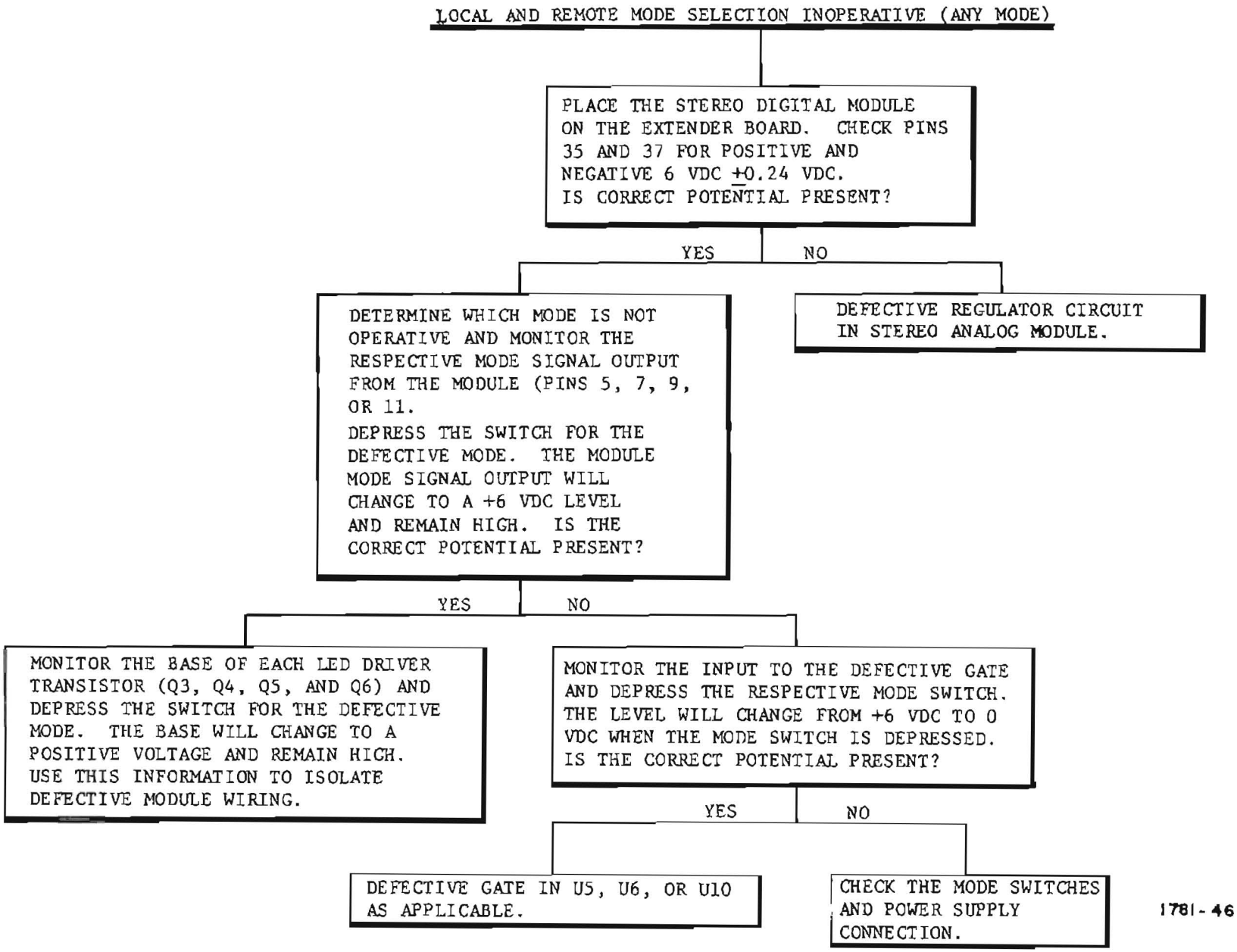

Figure 5-7. Local and Remote Mode Selection Inoperative (any mode)

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 MS-15R STEREO DIGITAL module. Table entries are indexed by component reference designator.

Table 6-1. STEREO DIGITAL Module Front Panel - 994 7990 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
------	992 4901 001	STEREO DIGITAL Module Circuit Board (Refer to figure 6-2).	1

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Table 6-2. STEREO DIGITAL Module Circuit Board - 992 4901 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C1	518 0054 000	Capacitor, 15-60 pF, Variable	1
C2	500 0803 000	Capacitor, 5 pF, 500V, Mica	1
C3	500 0759 000	Capacitor, 100 pF, 500V, Mica	1
C4 thru C7	516 0375 000	Capacitor, 0.01 uF, 50V	4
C8 thru C11	516 0063 000	Capacitor, 0.002 uF, 1kV	4
C12	500 0833 000	Capacitor, 390 pF, 500V, Mica	1
C13	500 0804 000	Capacitor, 10 pF, 500V, Mica	1
C14,C15	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C16	516 0375 000	Capacitor, 0.01 uF, 50V	1
C17	500 0842 000	Capacitor, 820 pF, 300V, Mica	1
C18,C19	508 0414 000	Capacitor, 0.01 uF, 50V, 5%	2
C20	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	1
C21,C22	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	2
C23 thru C28	516 0375 000	Capacitor, 0.01 uF, 50V	6
C29	526 0340 000	Capacitor, 1 uF, 35V, 10%	1
C30 thru C36	516 0375 000	Capacitor, 0.01 uF, 50V	7
C37,C38	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C40,C41	516 0375 000	Capacitor, 0.01 uF, 50V	2
CR1,CR2	384 0205 000	Diode, Silicon, 1N914	2
CR3,CR4	384 0662 000	LED, Red	2
CR5	384 0664 000	LED, Yellow	1
CR6	384 0661 000	LED, Green	1
CR7	384 0205 000	Diode, Silicon, 1N914	1

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Table 6-2. STEREO DIGITAL Module Circuit Board - 992 4901 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR8 thru CR11	384 0431 000	Diode, 1N4001	4
CR12	384 0205 000	Diode, Silicon, 1N914	1
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 thru Q7	380 0319 000	Transistor, MPS A14	5
R1	540 0153 000	Resistor, 22 Megohm, 1/2W, 5%	1
R2	540 1165 000	Resistor, 3300 ohm, 1/2W, 5%	1
R3	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	1
R4	540 1162 000	Resistor, 1 Megohm, 1/2W, 5%	1
R5 thru R8	540 1153 000	Resistor, 8200 ohm, 1/2W, 5%	4
R9	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R10	540 1162 000	Resistor, 1 Megohm, 1/2W, 5%	1
R11	540 1102 000	Resistor, 100 ohm, 1/2W, 5%	1
R12	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R13	540 1129 000	Resistor, 1500 ohm, 1/2W, 5%	1
R14	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R15	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1
R16	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	1
R17	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R18	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1
R19	550 0913 000	Potentiometer, 5k ohm	1

Table 6-2. STEREO DIGITAL Module Circuit Board - 992 4901 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R20	540 1122 000	Resistor, 47k ohm, 1/2W, 5%	1
R21 thru R29	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	9
R30	540 1116 000	Resistor, 1000 ohm, 1/2W, 5%	1
R31	540 1162 000	Resistor, 1 Megohm, 1/2W, 5%	1
R32 thru R36	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	5
R37	540 1212 000	Resistor, 220k ohm, 1/2W, 5%	1
R38	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	1
R39,R40	540 1151 000	Resistor, 10 ohm, 1/2W, 5%	2
R41 thru R44	540 1162 000	Resistor, 1 Megohm, 1/2W, 5%	4
R45	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	1
R46	540 1162 000	Resistor, 1 Megohm, 1/2W, 5%	1
R47	540 1116 000	Resistor, 1000 ohm, 1/2W, 5%	1
S1 thru S4	604 0866 000	Switch, Pushbutton	4
U1	382 0466 000	Integrated Circuit, Digital	1
U2	382 0397 000	Integrated Circuit	1
U3	382 0466 000	Integrated Circuit, Digital	1
U4	382 0287 000	Integrated Circuit	1
U5	382 0288 000	Integrated Circuit	1
U6	382 0396 000	Integrated Circuit	1
U7	382 0472 000	Integrated Circuit	1
U8	382 0452 000	Integrated Circuit, Comparator	1
U9	382 0397 000	Integrated Circuit	1
U10	382 0396 000	Integrated Circuit	1

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Table 6-2. STEREO DIGITAL Module Circuit Board - 992 4901 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
U11	382 0548 000	Integrated Circuit, CD4042CN	1
U12	382 0510 000	Integrated Circuit, ILQ-74	1
U13	382 0474 000	Integrated Circuit	1
VTR5	670 0033 000	Light Dependent Resistor	1
XU1	404 0675 000	Socket, IC, 16 Contact	1
XU2	404 0674 000	Socket, IC, 14 Contact	1
XU3	404 0675 000	Socket, IC, 16 Contact	1
XU4 thru XU6	404 0674 000	Socket, IC, 14 Contact	3
XU7,XU8	404 0673 000	Socket, IC, 8 Contact	2
XU9,XU10	404 0674 000	Socket, IC, 14 Contact	2
XU11,XU12	404 0675 000	Socket, IC, 16 Contact	2
XU13	404 0674 000	Socket, IC, 14 Contact	1
XY1	404 0267 000	Socket, Crystal	1
Y1	444 2534 000	Crystal, 456.00 kHz	1
	612 0901 000	Jack, Printed Circuit Mount	14
	843 1597 001	Printed Board	1

1787 003

STEREO OVSC MODULE

888 1781 004

TECHNICAL MANUAL

STEREO OVSC MODULE

994 7991 002

HARRIS CORPORATION

Broadcast Products Division

T.M. No. 888 1781 004

Printed: November 1977

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WARNING: Disconnect primary power prior to servicing.

LIST OF ILLUSTRATIONS

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SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE.

1-2. The STEREO OVSC module provides a special filtering process which operates independently of limiters to limit the overshoot on FM stereophonic 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 and L-R signals. The filters are transparent to audio within ± 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 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 MS-15R STEREO OVSC module.

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. Refer to 888 1781 001, MS-15R stereo generator, 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 MS-15R 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.

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.

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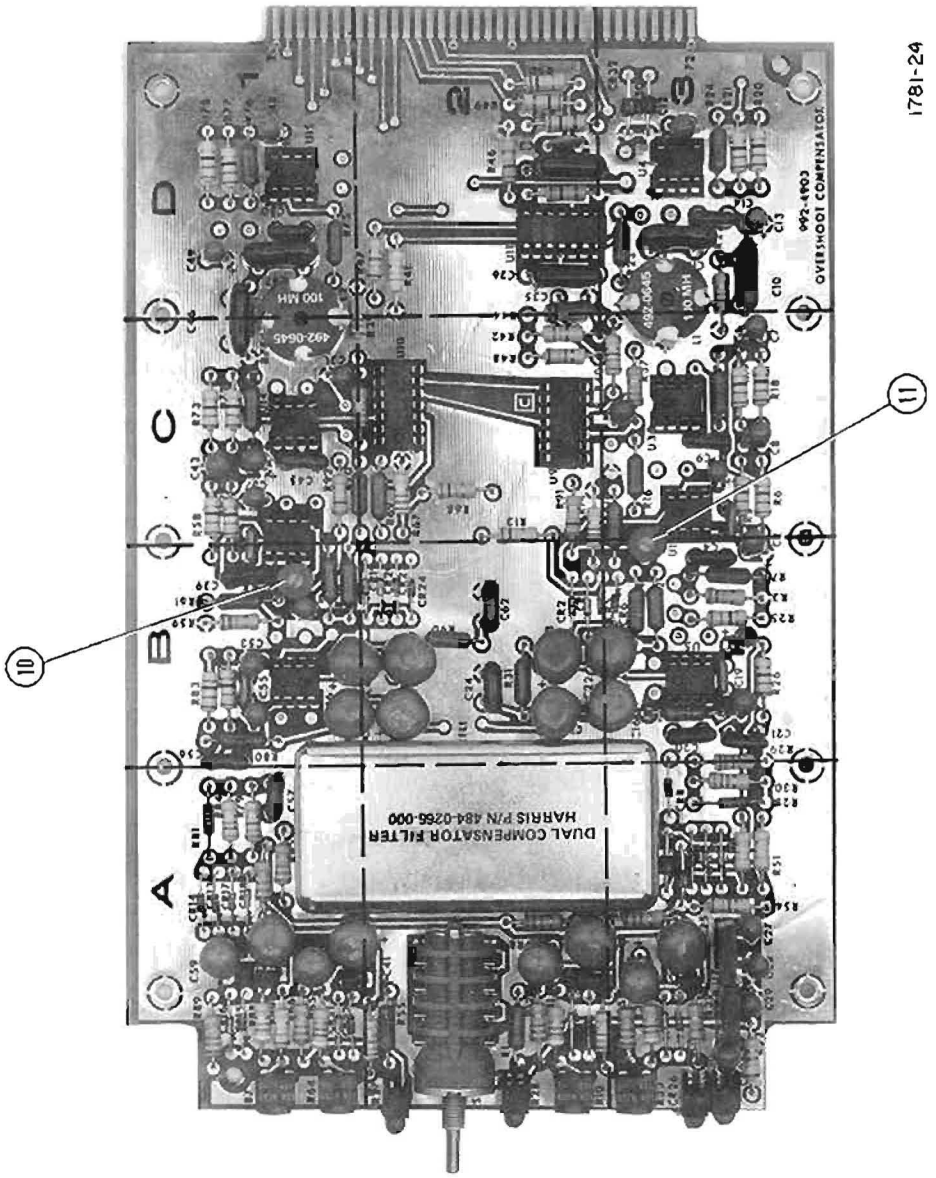

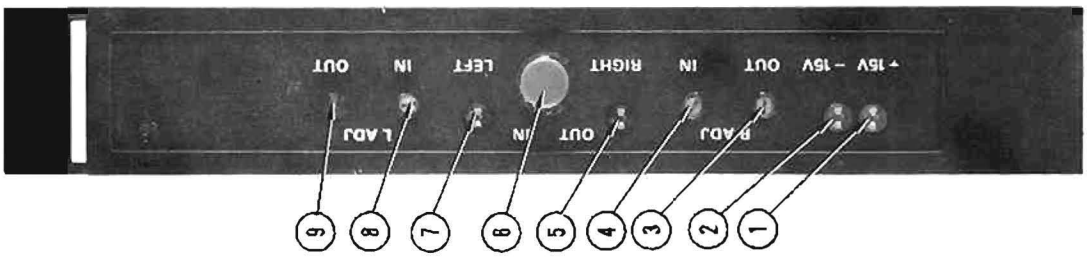

Figure 3-1. STEREO OVSC Module

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 to 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.

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. Disable the SCA input. 5. Disconnect the left and right inputs from the LEFT (-) and (+) and RIGHT (-) and (+) connections on the rear of the stereo generator (TB1 terminals 7 and 9, 10 and 12. 6. Apply a 400 Hz sinusoidal signal at +10 dBm into the left channel only at TB1 terminals 7 and 9. 7. Operate the OUTPUT module meter switch to B-BAND. 8. Adjust the sinusoidal signal level until the meter indicates 97% total modulation. 9. Operate the OUTPUT module meter switch to L. The 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 LEFT indicator illuminates. Adjust the control clockwise until the indicator just goes out. 12. Disconnect the 400 Hz sinusoidal signal from the left channel.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	13. Apply the 400 Hz sinusoidal signal at +10 dBm into the right channel only at TB1, terminals 10 and 12. 14. Operate the OUTPUT module meter switch to B-BAND. 15. Adjust the sinusoidal signal until the meter indicates 97% total modulation. 16. Operate the OUTPUT module meter switch to R. The meter will indicate 100%. The apparent 3% discrepancy is due to the normal phase relationships between the pilot and the 38 kHz DSB signal. 17. Adjust the STEREO OVSC module R ADJ OUT control counterclockwise 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 stereo generator and remove the side cover. 2. Mount the module in the stereo generator using the extender board provided with the stereo generator. 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 $\pm$ 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 stereo generator.

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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 MS-15R 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 stereo generator 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 MS-15R than with conventional stereo generator. If the limiter output is applied to the stereo generator 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 modulation meter will show that 100% modulation is being maintained when in fact it is only overshoots that are reaching 100% program material peaks remaining at 80% modulation.

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On the other hand, if the limiter is driving the stereo generator 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 operating the OUTPUT module meter switch to L or R and noting the level indicated by the meter. The output of the FM limiter should be adjusted to the 100% level on the 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 MS-15R stereo generator 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 only 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 L and R meter switch positions on the OUTPUT module indicate 100% modulation on peaks.

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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 MS-15, 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.

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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 programmable 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 yeild 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 network and each output clipper network are applied to OR circuits which operate the LEFT and RIGHT light emitting diodes to provide a visual indication of the amount of filter overshoot which is being corrected by the 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.

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

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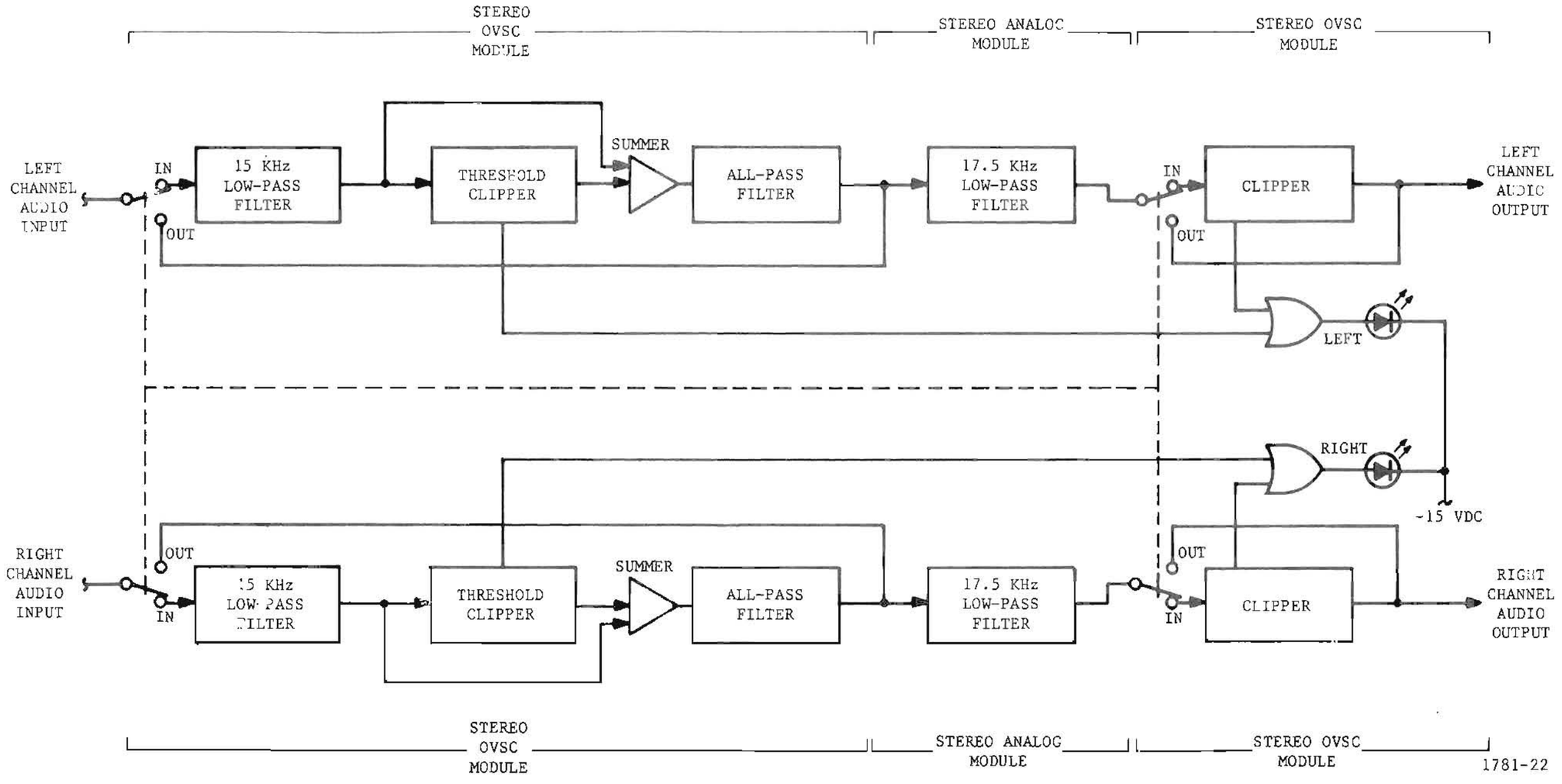

FIGURE 4-1. STEREO OVSC MODULE SIMPLIFIED BLOCK DIAGRAM

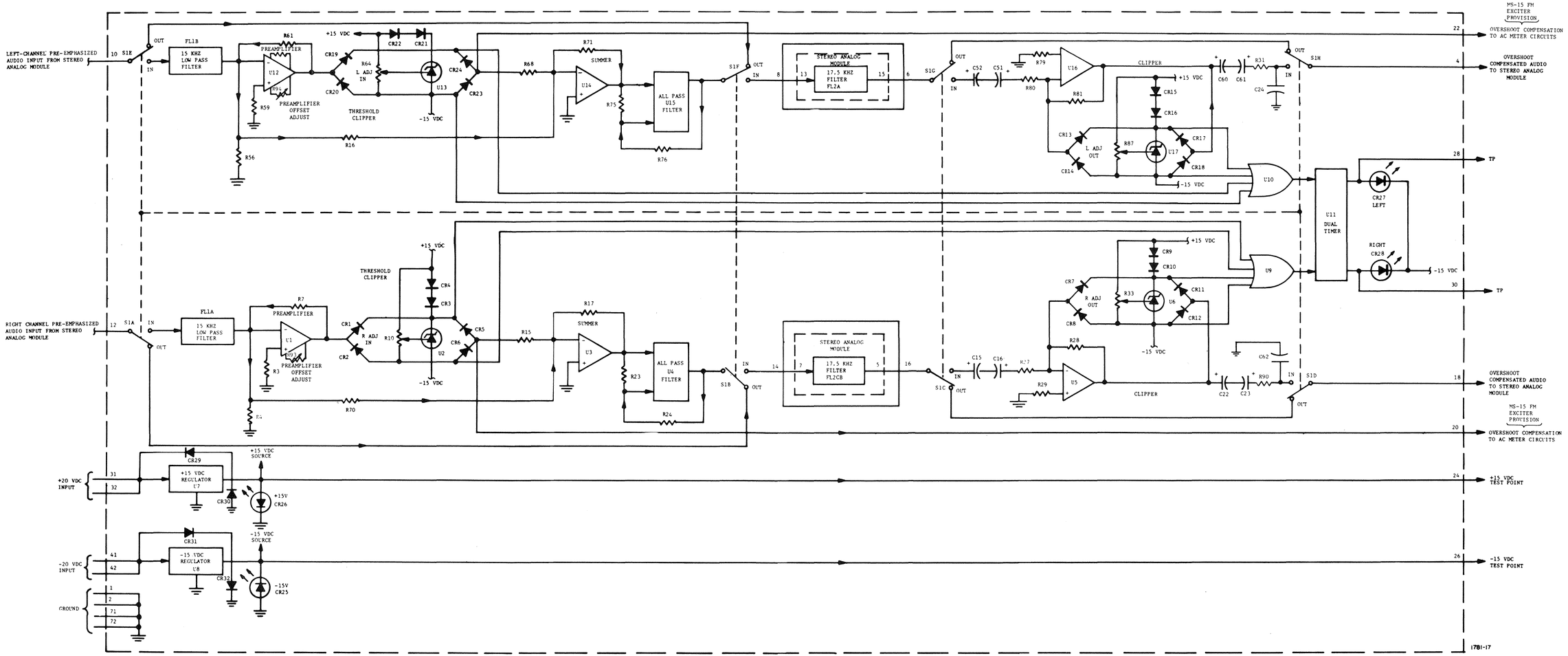

FIGURE 4-2. STEREO OVSC MODULE DETAILED BLOCK DIAGRAM

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 MS-15R stereo generator 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 OUTPUT module meter, fuse F1, 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 a stereo generator 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 5246 001) is provided with the stereo generator 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

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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.

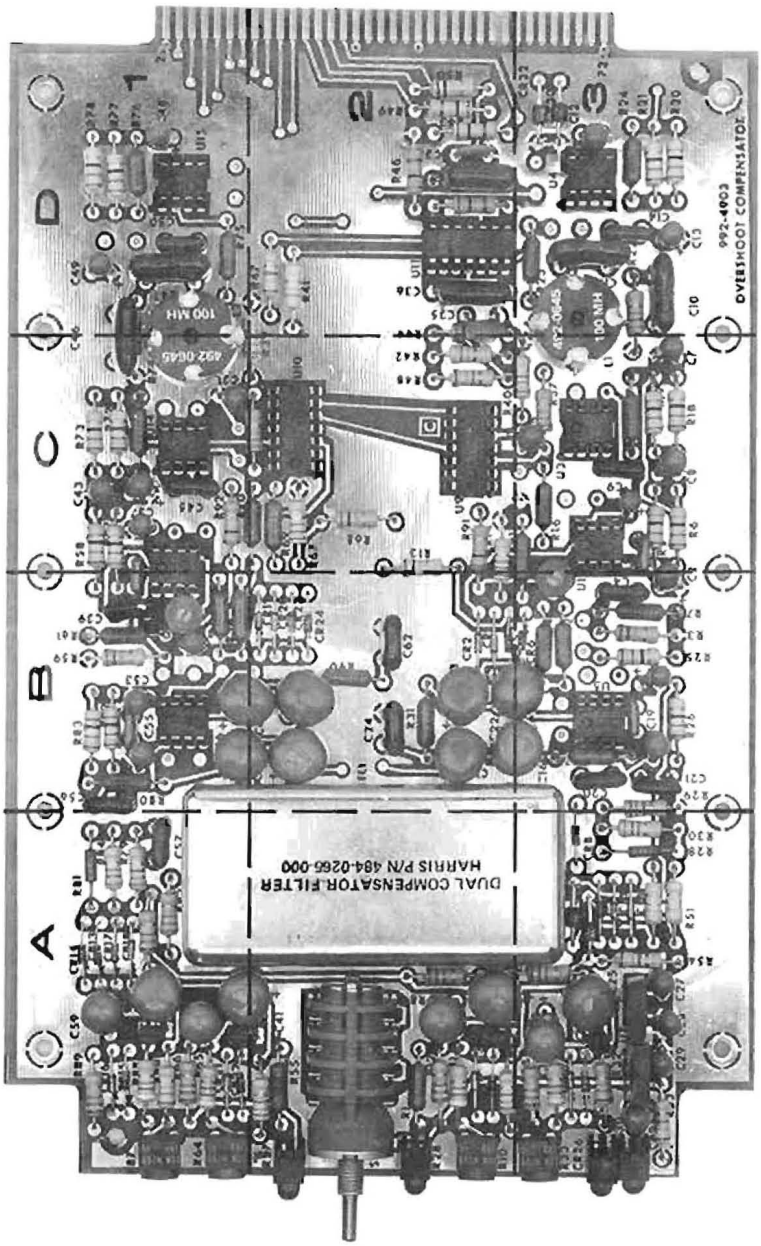

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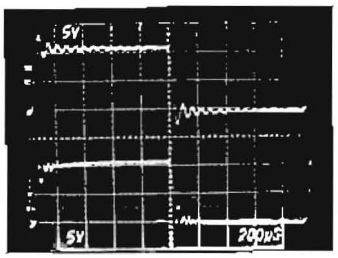
Figure 5-1. STEREO OVSC Module Parts Layout

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

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		

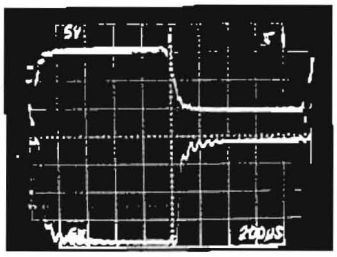


TEST REQUIREMENTS: A. 500 HZ squarewave @ 100% modulation applied to input.

B. STEREO ANALOG module pre-emphasis programmed to FLAT.

1A Filtered audio at U12 pin 6.

1B Overshoot compensator output at U14 pin 6



TEST REQUIREMENTS: A. 500 Hz squarewave @100% modulation applied to input.

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.

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Figure 5-2. STEREO OVSC Module Waveforms

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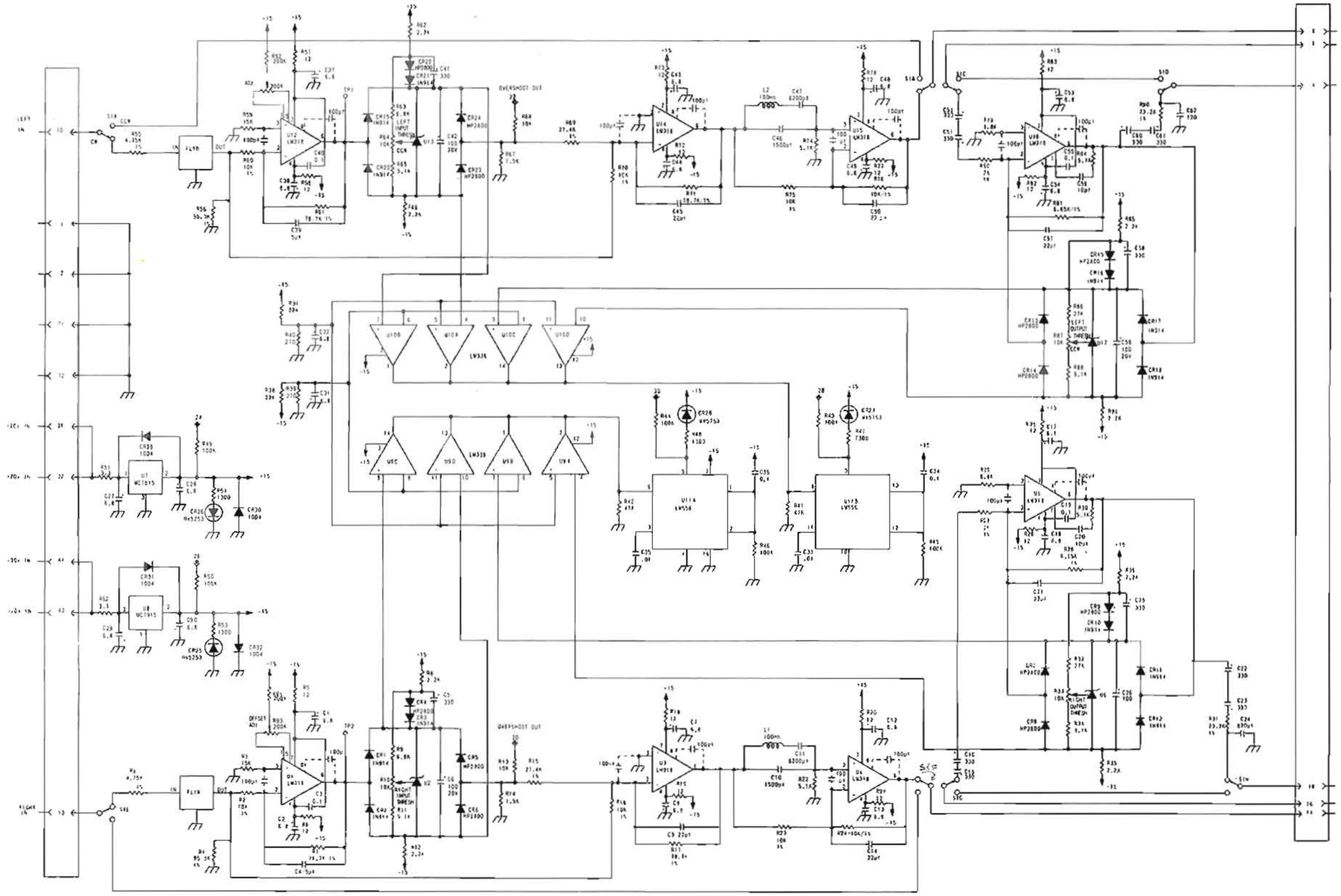

NOTES
UNLESS OTHERWISE NOTED
1 ALL IN RESISTORS 1/4W
2 ALL CAPACITANCE IN UF
3 ALL RESISTANCE IN OHMS
4 ALL RESISTORS 1/2W 1%

FIGURE 5-3. STEREO OVSC MODULE SCHEMATIC 852 8395 001

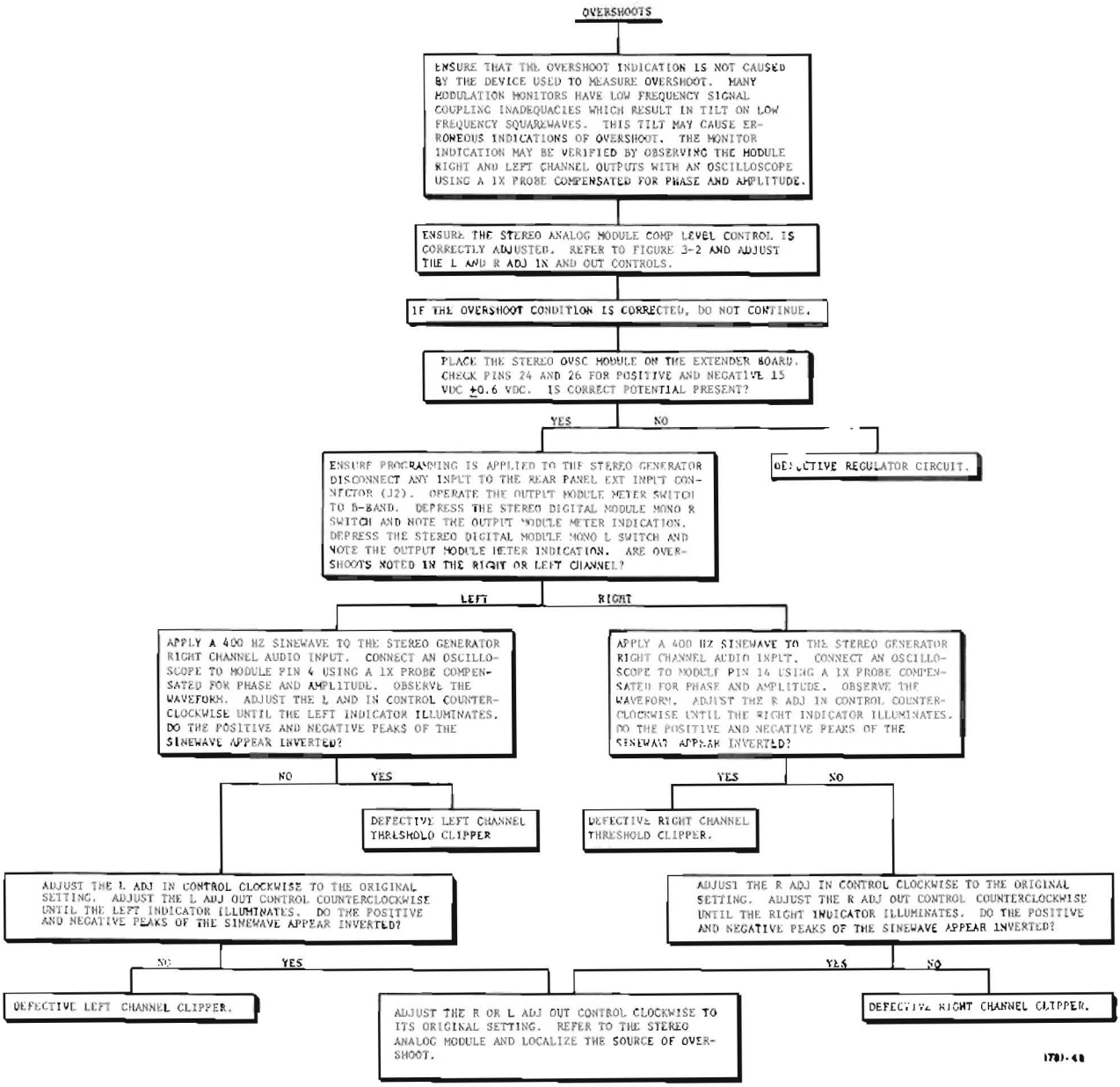

Figure 5-4. Overshoots

WARNING: Disconnect primary power prior to servicing.

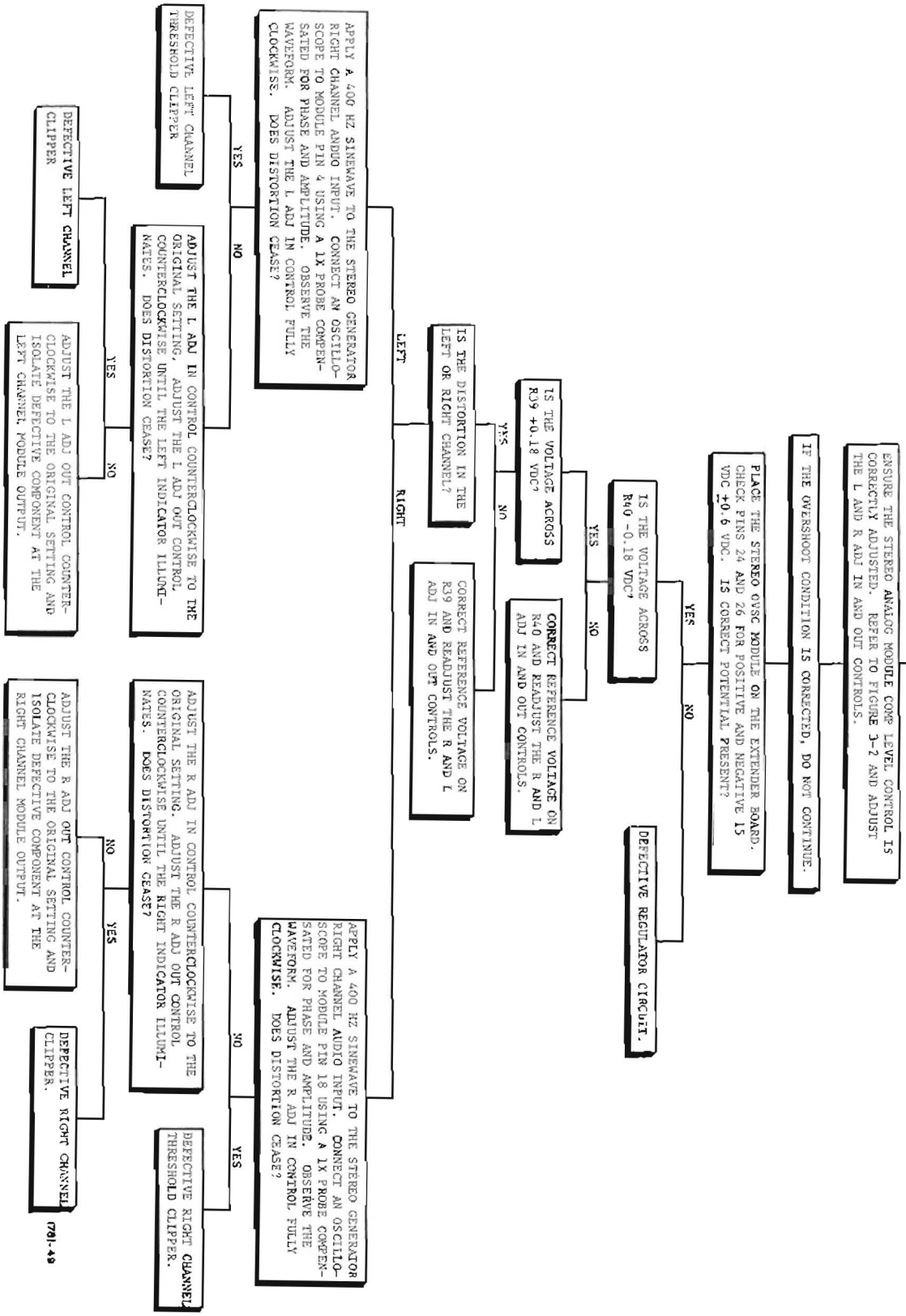

Figure 5-5. Distortion

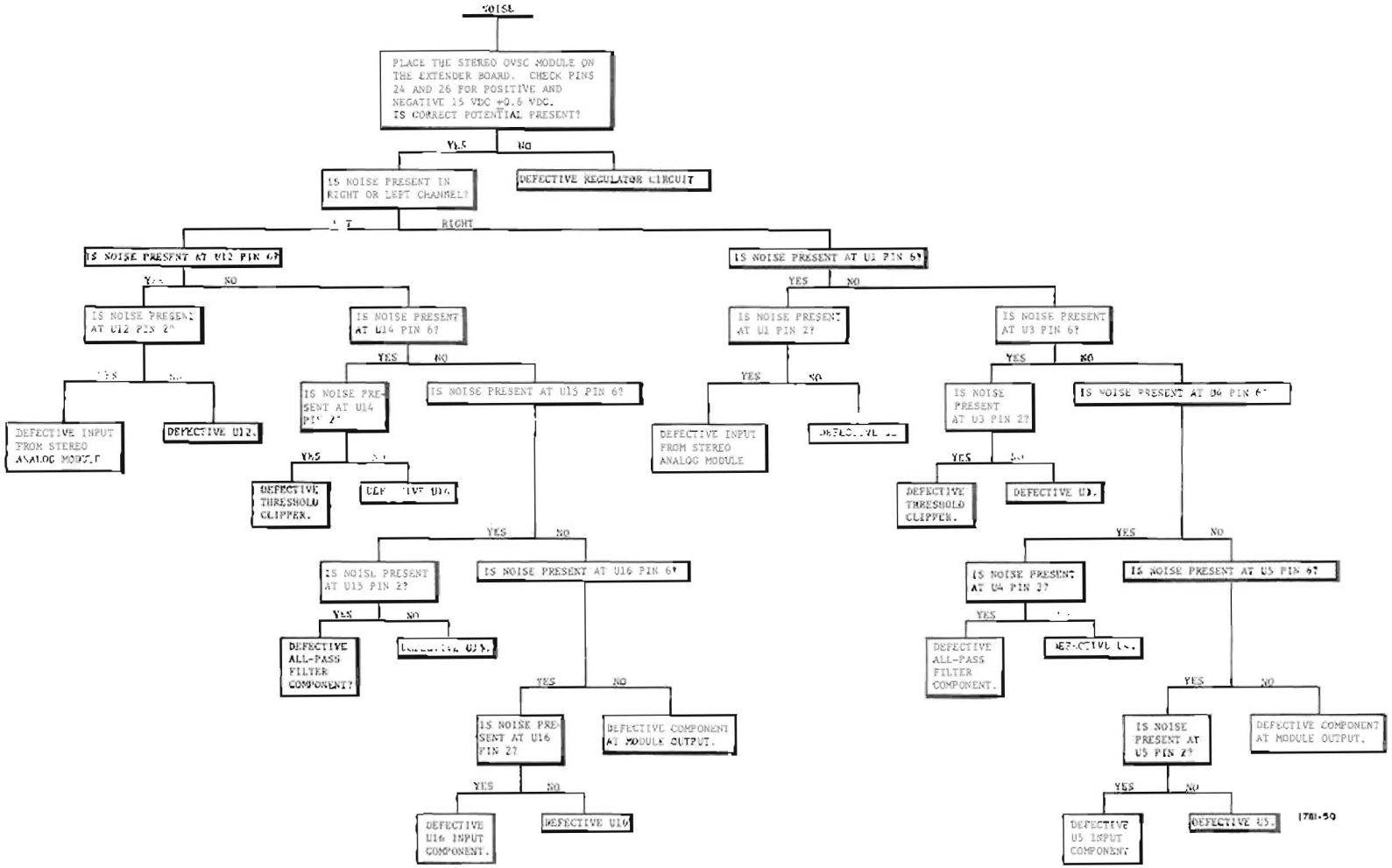

Figure 5-6. Noise

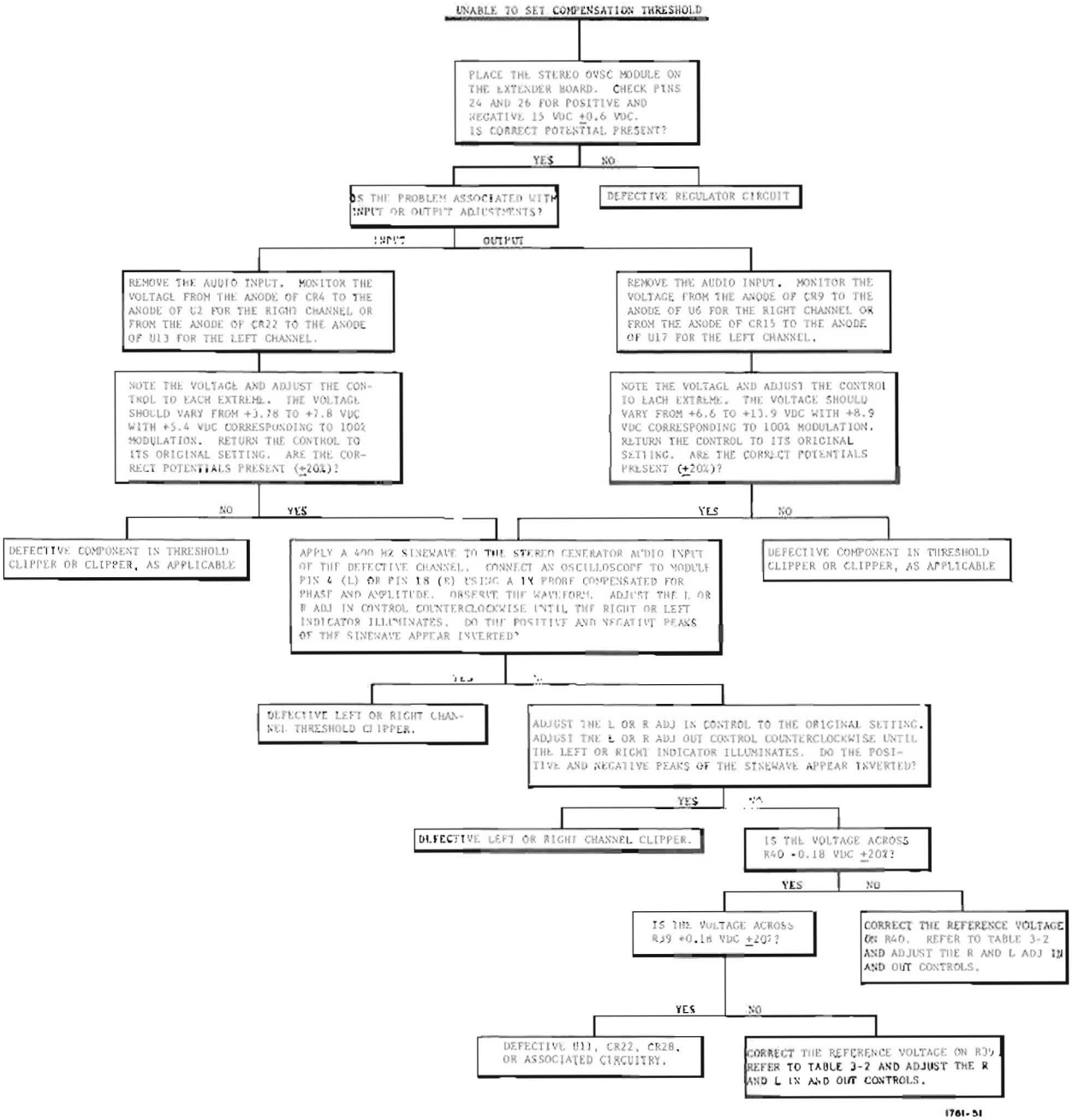

Figure 5-7. Unable to Set Compensation Threshold

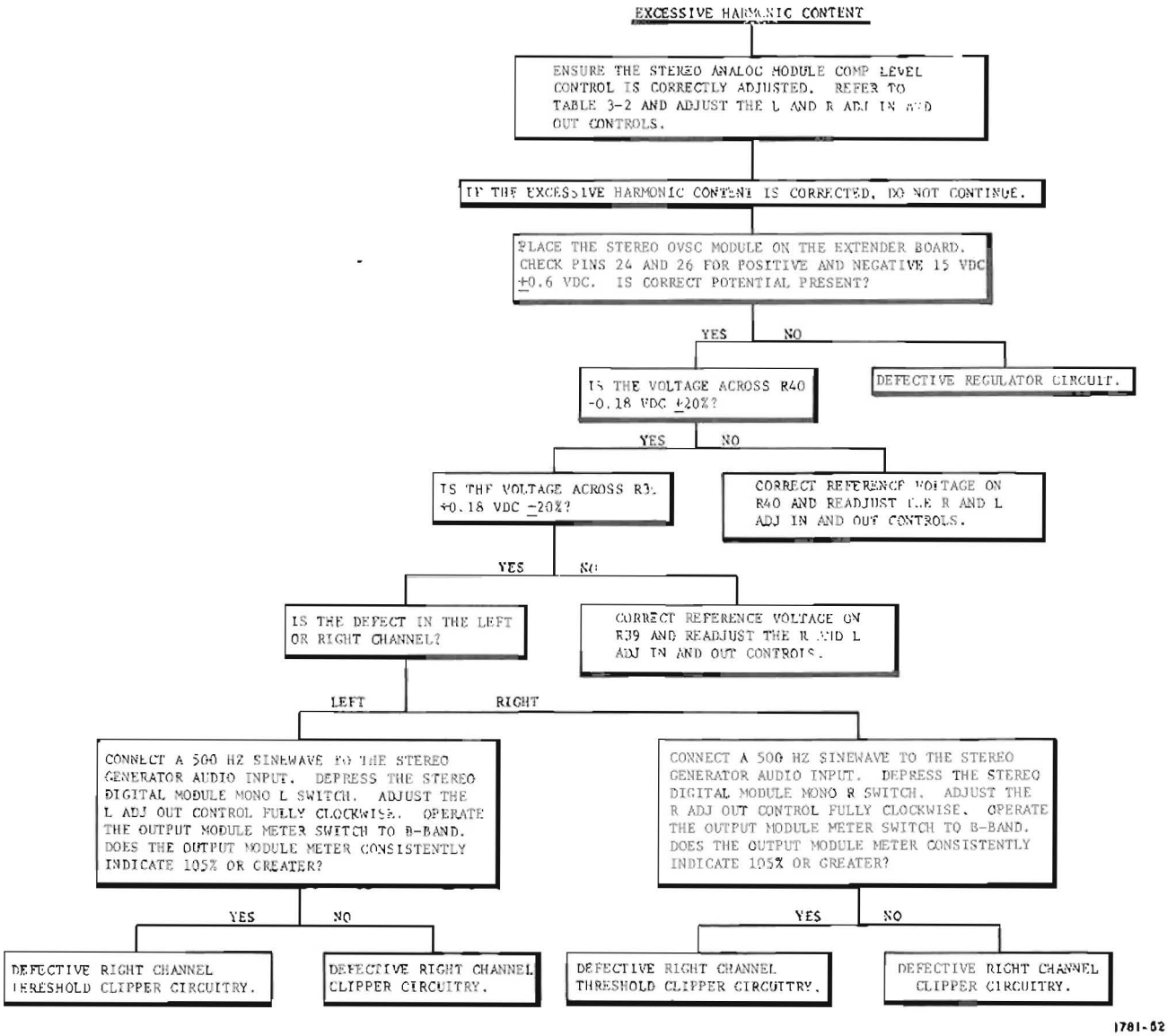

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Figure 5-8. Excessive Harmonic Content

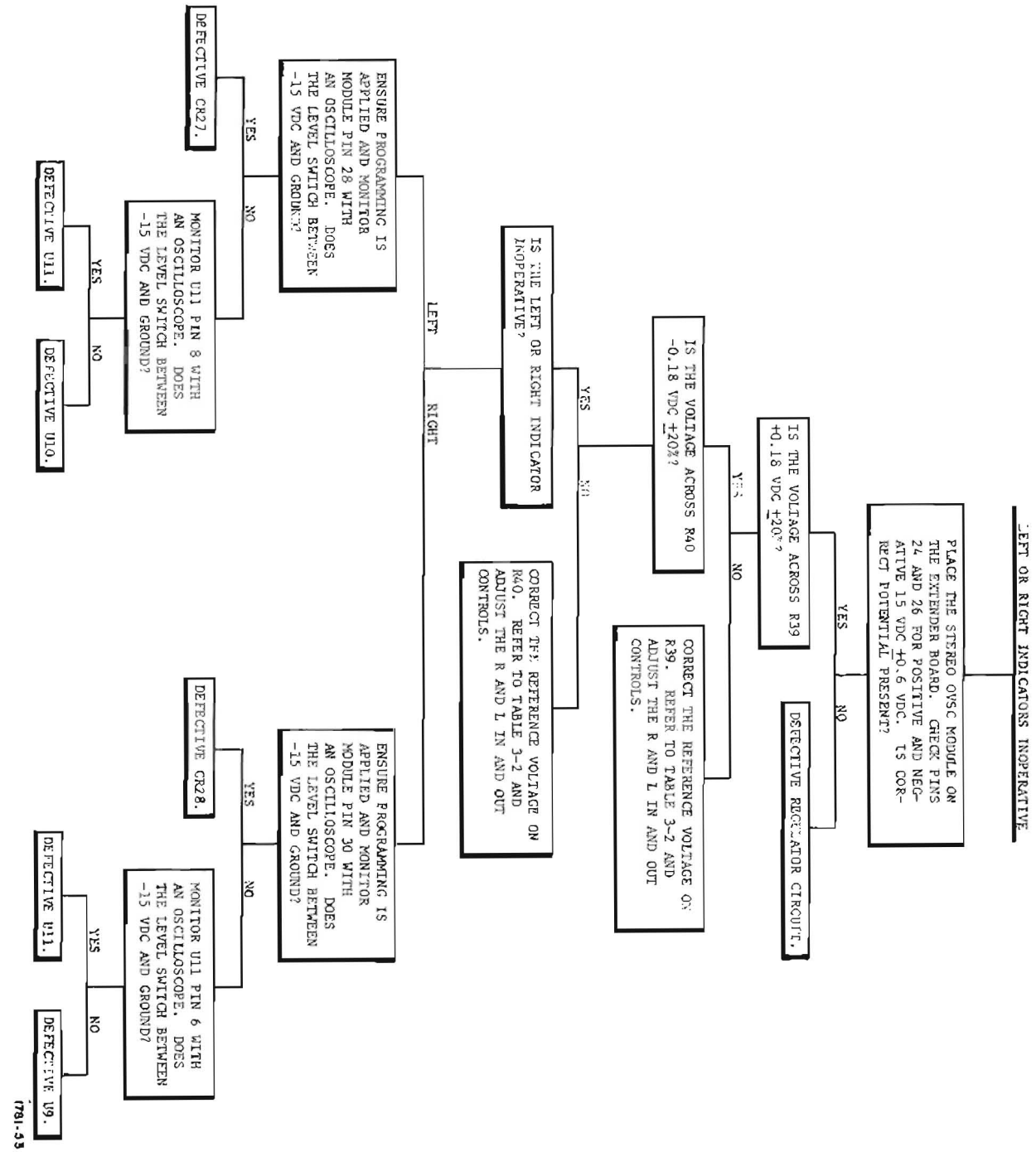

Figure 5-9. Left or Right Indicators Inoperative

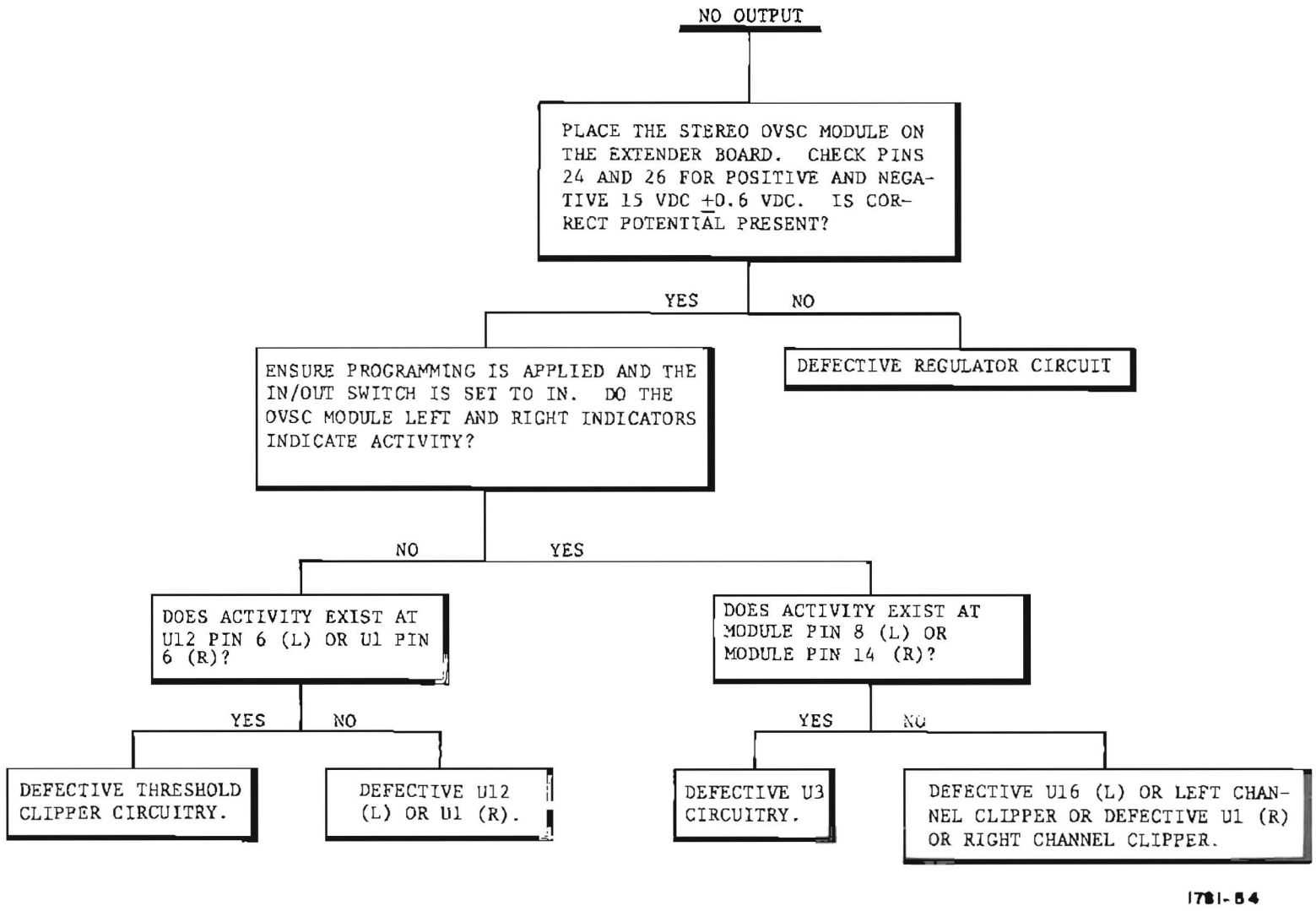

Figure 5-10. No Output

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 MS-15R STEREO OVSC module. Table entries are indexed by component reference designator.

Table 6-1. STEREO OVSC Module Front Panel - 994 7991 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
-------	992 4903 001	STEREO OVSC Module Circuit Board (Refer to table 6-2)	1

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Table 6-2. STEREO OVSC Module Circuit Board - 992 4903 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C1,C2	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C3	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	1
C4	500 0803 000	Capacitor, 5 pF, 500V	1
C5	526 0045 000	Capacitor, 330 uF, 6V, 10%	1
C6	526 0057 000	Capacitor, 100 uF, 20V, 20%	1
C7,C8	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C9	500 0809 000	Capacitor, 22 pF, 500V, Mica	1
C10	500 0878 000	Capacitor, 1500 pF, 500V, 5%	1
C11	500 0910 000	Capacitor, 6200 pF, 300V	1
C12,C13	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C14	500 0809 000	Capacitor, 22 pF, 500V, Mica	1
C15,C16	526 0045 000	Capacitor, 330 uF, 6V, 10%	2
C17,C18	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C19	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	1
C20	500 0804 000	Capacitor, 10 pF, 500V, Mica	1
C21	500 0809 000	Capacitor, 22 pF, 500V, Mica	1
C22	526 0045 000	Capacitor, 330 uF, 6V, 10%	1
C23	526 0045 000	Capacitor, 330 uF, 6V, 10%	1
C24	500 0842 000	Capacitor, 820 pF, 300V	1
C25	526 0045 000	Capacitor, 330 uF, 6V, 10%	1
C26	526 0057 000	Capacitor, 100 uF, 20V, 20%	1
C27 thru C32	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	6
C33	516 0375 000	Capacitor, 0.01 uF, 50V	1

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Table 6-2. STEREO OVSC Module Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C34	508 0408 000	Capacitor, 0.1 uF, 50V, 5%	1
C35	516 0375 000	Capacitor, 0.01 uF, 50V	1
C36	508 0408 000	Capacitor, 0.1 uF, 50V, 5%	1
C37,C38	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C39	500 0803 000	Capacitor, 5 pF, 500V, Mica	1
C40	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	1
C41	526 0045 000	Capacitor, 330 uF, 6V, 10%	1
C42	526 0057 000	Capacitor, 100 uF, 20V, 20%	1
C43,C44	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C45	500 0809 000	Capacitor, 22 pF, 500V, Mica	1
C46	500 0878 000	Capacitor, 1500 pF, 500V, 5%	1
C47	500 0910 000	Capacitor, 6200 pF, 300V	1
C48,C49	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C50	500 0809 000	Capacitor, 22 pF, 500V, Mica	1
C51,C52	526 0045 000	Capacitor, 330 uF, 6V, 10%	2
C53,C54	526 0049 000	Capacitor, 6.8 uF, 35V, 20%	2
C55	516 0453 000	Capacitor, 0.1 uF, 100V, 20%	1
C56	500 0804 000	Capacitor, 10 pF, 500V, Mica	1
C57	500 0809 000	Capacitor, 22 pF, 500V, Mica	1
C58	526 0045 000	Capacitor, 330 uF, 6V, 10%	1
C59	526 0057 000	Capacitor, 100 uF, 20V, 20%	1
C60,C61	526 0045 000	Capacitor, 330 uF, 6V, 10%	2
C62	500 0842 000	Capacitor, 820 pF, 300V, Mica	1

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Table 6-2. STEREO OVSC Module Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR1,CR2,CR3	384 0205 000	Diode, Silicon, 1N914	3
CR4 thru CR9	384 0321 000	Diode, Hot Carrier	6
CR10,CR11,CR12	384 0205 000	Diode, Silicon, 1N914	3
CR13,CR14,CR15	384 0321 000	Diode, Hot Carrier	3
CR16 thru CR21	384 0205 000	Diode, Silicon 1N914	6
CR22,CR23,CR24	384 0321 000	Diode, Hot Carrier	3
CR25,CR26	384 0661 000	LED, Green	2
CR27,CR28	384 0662 000	LED, Red	2
CR29 thru CR32	384 0284 000	Diode, 10D4/1N2070	4
FL1	484 0265 000	Filter, Dual Low-Pass	1
L1,L2	492 0645 000	Inductor, 100 mH, 2%	2
R1	548 0678 000	Resistor, 4750 ohm, 1/4W, 1%	1
R2	548 1361 000	Resistor, 10k ohm, 1/4W, 1%	1
R3	540 1184 000	Resistor, 1/2W, 15k ohm, 5%	1
R4	548 1424 000	Resistor, 95.3k ohm, 1/4W, 1%	1
R5,R6	540 1228 000	Resistor, 12 ohm, 1/2W, 5%	2
R7	548 1431 000	Resistor, 78.7k ohm, 1/4W	1
R8	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R9	540 1145 000	Resistor, 6800 ohm, 1/2W, 5%	1
R10	550 0914 000	Potentiometer, 10k ohm	1
R11	540 1189 000	Resistor, 9100 ohm, 1/2W, 5%	1
R12	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R13	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1

Table 6-2. STEREO OVSC Module Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R14	540 1129 000	Resistor, 1500 ohm, 1/2W, 5%	1
R15	548 1186 000	Resistor, 27.4k ohm, 1/4W, 1%	1
R16	548 1361 000	Resistor, 10k ohm, 1/4W, 1%	1
R17	548 1431 000	Resistor, 78.7k ohm, 1/4W	1
R18 thru R21	540 1228 000	Resistor, 12 ohm, 1/2W, 5%	4
R22	540 1105 000	Resistor, 5100 ohm, 1/2W, 5%	1
R23,R24	548 1361 000	Resistor, 10k ohm, 1/4W, 1%	2
R25,R26	540 1228 000	Resistor, 12 ohm, 1/2W, 5%	2
R27	548 0279 000	Resistor, 2000 ohm, 1/4W	1
R28	548 1358 000	Resistor, 6650 ohm, 1/4W, 1%	1
R29	540 1145 000	Resistor, 6800 ohm, 1/2W, 5%	1
R30	540 1105 000	Resistor, 5100 ohm, 1/2W, 5%	1
R31	548 1430 000	Resistor, 23.2k ohm, 1/4W	1
R32	540 1147 000	Resistor, 27k ohm, 1/2W, 5%	1
R33	550 0914 000	Potentiometer, 10k ohm	1
R34	540 1189 000	Resistor, 9100 ohm, 1/2W, 5%	1
R35,R36	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	2
R37,R38	540 1160 000	Resistor, 22k ohm, 1/2W, 5%	2
R39,R40	540 1188 000	Resistor, 270 ohm, 1/2W, 5%	2
R41,R42	540 1122 000	Resistor, 47k ohm, 1/2W, 5%	2
R43 thru R46	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	4
R47,R48	540 1187 000	Resistor, 1300 ohm, 1/2W, 5%	2
R49,R50	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	2

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Table 6-2. STEREO OVSC Module Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R51,R52	540 1323 000	Resistor, 3.3 ohm, 1/2W, 5%	2
R53,R54	540 1187 000	Resistor, 1300 ohm, 1/2W, 5%	2
R55	548 0678 000	Resistor, 4750 ohm, 1/2W, 1%	1
R56	548 1424 000	Resistor, 95.3k ohm, 1/W	1
R57,R58	540 1228 000	Resistor, 12 ohm, 1/2W, 5%	2
R59	540 1184 000	Resistor, 15k ohm, 1/2W, 5%	1
R60	548 1361 000	Resistor, 10k ohm, 1/4W, 1%	1
R61	548 1431 000	Resistor, 78.7k ohm, 1/4W	1
R62	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R63	540 1145 000	Resistor, 6800 ohm, 1/2W, 5%	1
R64	550 0914 000	Potentiometer, 10k ohm	1
R65	540 1189 000	Resistor, 9100 ohm, 1/2W, 5%	1
R66	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R67	540 1129 000	Resistor, 1500 ohm, 1/2W, 5%	1
R68	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1
R69	548 1186 000	Resistor, 27.4k ohm, 1/4W, 1%	1
R70	548 1361 000	Resistor, 10k ohm, 1/4W, 1%	1
R71	548 1431 000	Resistor, 78.7k ohm, 1/4W	1
R72,R73	540 1228 000	Resistor, 12 ohm, 1/2W, 5%	2
R74	540 1105 000	Resistor, 5100 ohm, 1/2W, 5%	1
R75,R76	548 1361 000	Resistor, 10k ohm, 1/4W, 1%	2
R77,R78	540 1228 000	Resistor, 12 ohm, 1/2W, 5%	2
R79	540 1145 000	Resistor, 6800 ohm, 1/2W, 5%	1

Table 6-2. STEREO OVSC Module Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R80	548 0279 000	Resistor, 2000 ohm, 1/4W	1
R81	548 1358 000	Resistor, 6650 ohm, 1/4W, 1%	1
R82,R83	540 1228 000	Resistor, 12 ohm, 1/2W, 5%	2
R84	540 1105 000	Resistor, 5100 ohm, 1/2W, 5%	1
R85	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R86	540 1147 000	Resistor, 27k ohm, 1/2W, 5%	1
R87	550 0914 000	Potentiometer, 10k ohm	1
R88	540 1189 000	Resistor, 9100 ohm, 1/2W, 5%	1
R89	540 1182 000	Resistor, 2200 ohm, 1/2W, 5%	1
R90	548 1430 000	Resistor, 23.2k ohm, 1/4W	1
R91,R92	540 1144 000	Resistor, 200k ohm, 1/2W, 5%	2
R93,R94	550 0930 000	Potentiometer, 200k ohm, 1/2W	2
S1	600 0581 000	Switch, Rotary, 8PDT	1
U1	382 0472 000	Integrated Circuit	1
U2	382 0520 000	Integrated Circuit, Regulator	1
U3,U4,U5	382 0472 000	Integrated Circuit	3
U6	382 0520 000	Integrated Circuit, Regulator	1
U7	382 0359 000	Integrated Circuit, MC7815CP	1
U8	382 0360 000	Integrated Circuit, MC7915CP	1
U9,U10	382 0521 000	Integrated Circuit	2
U11	382 0381 000	Integrated Circuit, NE556A	1
U12	382 0472 000	Integrated Circuit	1
U13	382 0520 000	Integrated Circuit, Regulator	1

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Table 6-2. STEREO OVSC Module Circuit Board - 992 4903 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
U14,U15,U16	382 0472 000	Integrated Circuit	3
U17	382 0520 000	Integrated Circuit, Regulator	1
XU1 thru XU5	404 0673 000	Socket, IC, 8 Contact	4
XU9,XU10,XU11	404 0674 000	Socket, IC, 14 Contact	3
XU12 thru XU16	404 0673 000	Socket, IC, 8 Contact	4
	939 3564 001	Printed Board	1

1781 004

OUTPUT MODULE
888 1781 005

TECHNICAL MANUAL

OUTPUT MODULE

992 5129 001

HARRIS CORPORATION

Broadcast Products Division

T.M. No. 888 1781 005

Printed: November 1977

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WARNING: Disconnect primary power prior to servicing.

LIST OF ILLUSTRATIONS

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SECTION I

GENERAL DESCRIPTION

1-1. EQUIPMENT PURPOSE.

1-2. The OUTPUT module provides metering functions of the stereo input signals (L and R), the sum and difference signals (L+R and L-R), and total modulation (B-BAND). Additional circuits in the module provide output signal amplification and phase and amplitude equalization to compensate for deficiencies in associated equipment.

1-3. TECHNICAL CHARACTERISTICS.

1-4. Table 1-1 lists operating characteristics and parameters of the MS-15R OUTPUT module.

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. Refer to 888 1781 001, MS-15R stereo generator, 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 MS-15R OUTPUT module and table 3-1 lists the controls and indicators with a description of each item.

SECTION IV

PRINCIPLES OF OPERATION

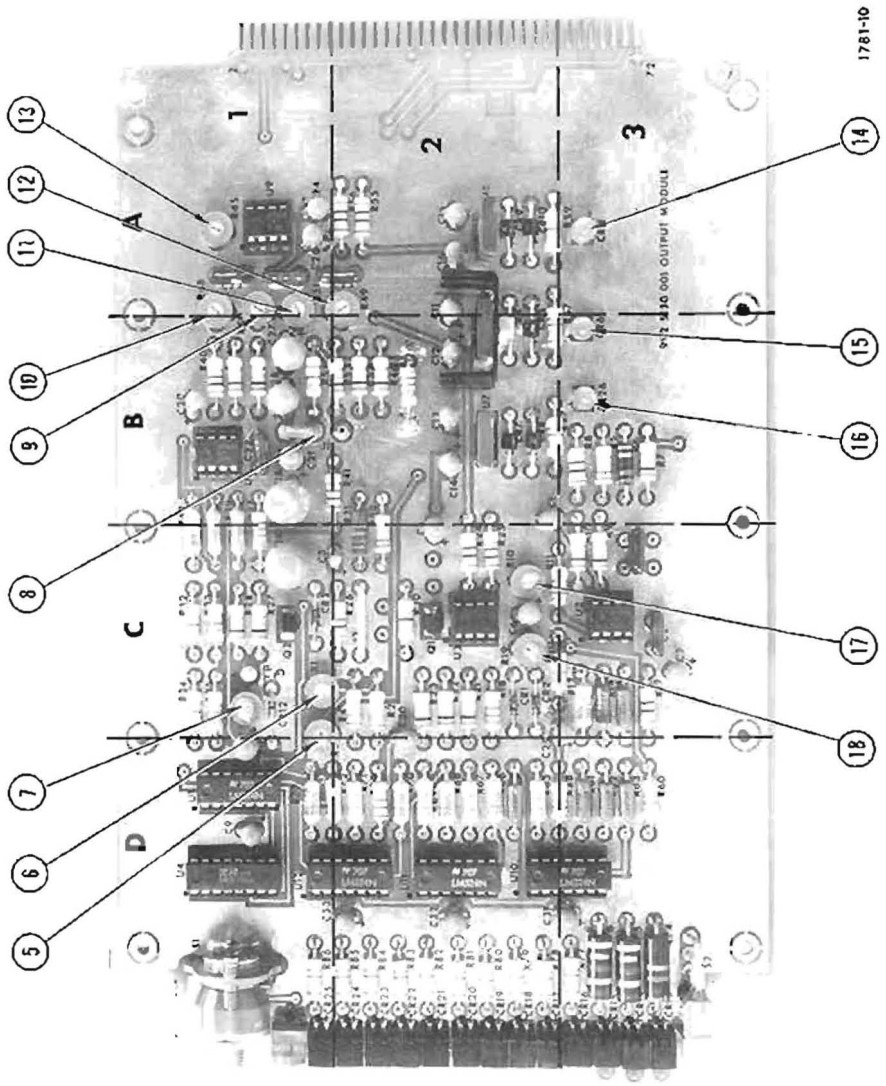
4-1. CIRCUIT DESCRIPTION.

4-2. METERING CIRCUIT.

4-3. INPUT CIRCUIT. The left and right channel audio inputs are applied to the LEFT GAIN (R1) and the RIGHT GAIN (R3) potentiometers which function as meter sensitivity adjustments (see figure 4-1). The resultant signals are applied to sum amplifier U1D and difference amplifier U1C which produce the L+R and L-R signals which are used for metering purposes only. The metering signals (L, R, L+R, L-R, and B-BAND) are all applied to a five position switch which selects the metered function.

Table 1-1. Technical Characteristics

FUNCTION	CHARACTERISTIC
INPUTS	
POWER	+20 VDC @ .054 amperes. -20 VDC @ .042 amperes.
SIGNAL:	
LEFT AND RIGHT CHANNEL PRE-EMPHASIZED AUDIO	+10 DBM ±1 dB for 100% modulation at 400 Hz. 600 ohm balanced resistive input impedance.
STEREO COMPOSITE DRIVE	2.8V P-P. 10k Resistive input impedance.
EXTERNAL COMPOSITE DRIVE	2.8V P-P. 10k Resistive input impedance.
OUTPUTS	
STEREO COMPOSITE DRIVE	2.5 P-P to 12.0V P-P, adjustable.



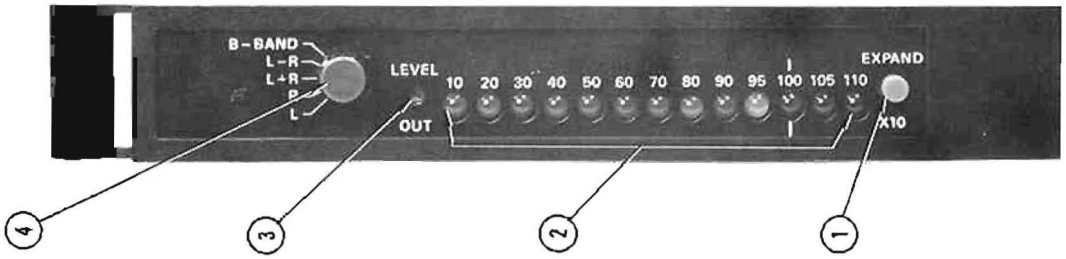


Figure 3-1. OUTPUT Module

Table 3-1. OUTPUT Module Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	EXPAND X10 Switch (S2)	Multiplies the meter sensitivity X 10 when depressed to provide a full scale indication of 11.0%.
2	LED Meter (CR13-CR25)	Displays signals as selected by the B-BAND/L-R/L+R/R/L switch.
3	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.
4	B-BAND/L-R/L+R/R/L Meter Switch (S1)	Selects the desired signal to be monitored by the LED meter.
5	RIGHT GAIN Control (R3)	Adjusts meter right channel sensitivity.
6	LEFT GAIN Control (R1)	Adjusts meter left channel sensitivity.
7	DISPLAY CAL Control (R36)	Adjusts meter calibration.
8	Equalization In/Out Jumper (J1)	Energizes or bypasses the amplitude and phase equalizer.
9	H.F. TURNOVER Control (R48)	Adjusts the frequency at which high frequency cut or boost occurs.
10	L.F. AMP. Control (R50)	Adjusts the amount of low frequency cut or boost.
11	L.F. TURNOVER Control (R51)	Adjusts the frequency at which low frequency cut or boost occurs.
12	H.F. AMP. Control (R49)	Adjust the amount of high frequency cut or boost.
13	H.F. PHASE Control (R45)	Adjust the phase of the high frequency signal without affecting amplitude.
14	-15 Volt Indicator (CR11)	Illuminates to indicate the OUTPUT module -15 volt regulator is operational.
15	+15 Volt Indicator (CR6)	Illuminates to indicate the OUTPUT module +15 volt regulator is operational.

Table 3-1. OUTPUT Module Controls and Indicators (Continued)

REF.	CONTROL/INDICATOR	FUNCTION
16	+15 Volt (A) Indicator (CR26)	Illuminates to indicate the OUTPUT module +15 volt (A) regulator is operational.
17	ZERO ADJ Control (R10)	Adjusts meter null.
18	GAIN BAL Control (R19)	Adjusts for symmetrical meter rectifier operation.

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Table 3-2. Control Adjustments

CONTROL	ADJUSTMENT
H.F. TURNOVER Control (R48) H.F. AMP. Control (R49) L.F. AMP. Control (R50) L.F. TURNOVER Control (R51) H.F. PHASE Control (R45)	1. Disconnect the ac power source. 2. Remove the module and remove the side cover. 3. Set jumper J1 in the position closest to U8 (equalizer out). 4. Replace the module in the stereo generator using the extender board provided with the stereo generator. 5. Connect the ac power source. 6. 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 amplitude equalizer as described in steps 7 through 16. If adjustment is not desired, proceed to step 15. 7. Disconnect the ac power source. 8. Set jumper J1 in the position furthest from U8 (equalizer in). 9. Adjust R48, R49, R50, and R51 to mid-range. 10. Adjust R45 fully counterclockwise. 11. If separation is degraded at low frequencies only, the problem may be corrected by adjustment of R50 and R51. 12. If separation is degraded at high frequencies only, the problem may be corrected by adjustment of R48 and R49. 13. If separation is uniformly degraded, the problem may be corrected by adjustment of R45. 14. Combinaitons of control adjustments may be used where the composite transmission system problems are complex.

Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	15. Disconnect the ac power source. 16. Remove the module and extender board. Replace the module side cover and replace the module in the stereo generator.
LEVEL OUT Control (R43)	1. Adjsut R43 as required to obtain the desired level of stereo composite drive output by the stereo generator (2.5V P-P to 12.0V P-P).
LEFT GAIN Control (R1) RIGHT GAIN Control (R3)	1. Disconnect the audio inputs from the LEFT - and + (TB1 pins 7 and 9) and RIGHT - and + (TB1 pins 10 and 12) on the rear of the stereo generator. 2. Apply a 400 Hz signal at +10 dBm to both inputs simultaneously. 3. Operate the meter switch to L. 4. Adjust R1 until the 100% meter indicator just illuminates. 5. Operate the meter switch to R. 6. Adjust R3 until the 100% meter indicator just illuminates. 7. Remove the 400 Hz test signal and reconnect the audio inputs.
ZERO ADJ Control (R10)	1. Disconnect the audio inputs from the LEFT - and + (TB1 pins 7 and 9) and RIGHT - and + (TB1 pins 10 and 12) on the rear of the stereo generator. 2. Remove the module. Mount the module in the stereo generator using the extender board provided with the stereo generator. 3. Depress the EXPAND X10 switch and adjust R10 until all the meter indicators are out. 4. Remove the module and extender board and replace the module in the stereo generator. Reconnect the audio inputs.
GAIN BAL Control (R19)	1. Remove the STEREO ANALOG module from the stereo generator.

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Table 3-2. Control Adjustments (Continued)

CONTROL	ADJUSTMENT
	2. Remove the module. Mount the module in the stereo generator using the extender board provided with the stereo generator. 3. Apply the positive terminal of a 1 to 1.25 Vdc source to module pin 10. Connect the negative terminal to ground. Note the meter indication. 4. Reverse the polarity of the voltage source so that the negative termianl is connected to module pin 10 and the positive terminal is connected to ground. Note the meter indication. 5. Adjust R19 until the meter indicates the same level for both positive and negative polarities. Repeat steps 3 through 5 as required. 6. Remove the module and extender board and replace the module in the stereo generator. 7. Replace the STEREO ANALOG module in the stereo generator.
DISPLAY CAL Control (R36).	1. Remove the module. Mount the module in the stereo generator using the extender board provided with the stereo generator. 2. Disconnect the audio inputs from the LEFT - and + (TB1 pins 7 and 9) and RIGHT - and + (TB1 pins 10 and 12) on the rear of the stereo generator. 3. Apply a 400 Hz signal at +10 dBm to both inputs simultaneously. 4. Operate the meter switch to B-BAND. 5. Adjust R36 until the 100% meter indicator just illuminates. 6. Remove the module and extender board and replace the module in the stereo generator. Remove the 400 Hz test signal and reconnect the audio inputs.

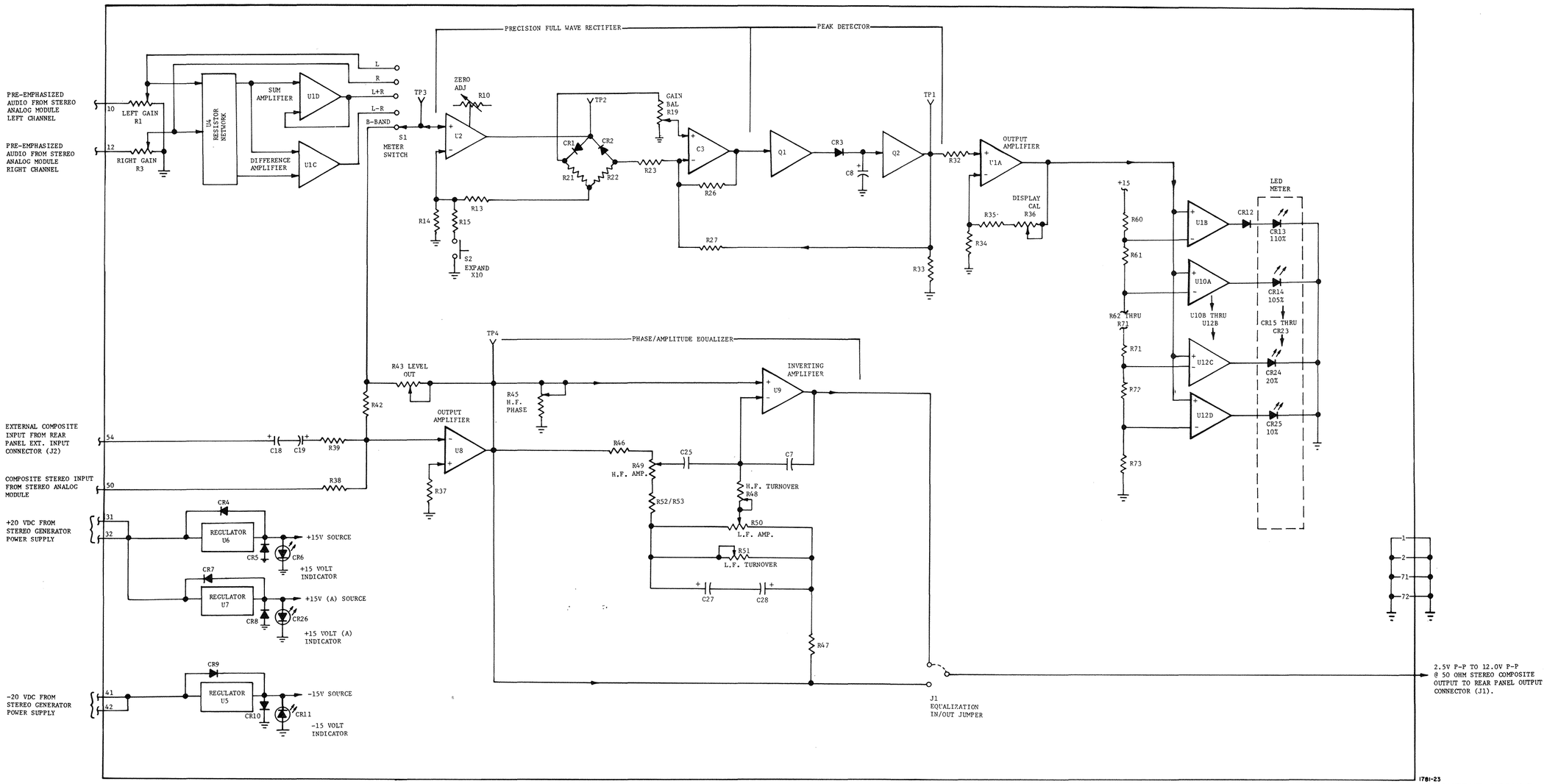

FIGURE 4-1. OUTPUT MODULE BLOCK DIAGRAM

4-4. PRECISION FULL WAVE RECTIFIER. The metered signal is applied to operational amplifier U2 which is used as part of the peak reading meter rectifier. Diodes CR1 and CR2 are enclosed in the feedback path of U2 which allows precision rectification by eliminating the gradual turn on characteristics of the diodes. Due to the high open loop gain of U2, the forward drops of the two diodes appear added to the signal at the output of U2. The positive half cycles of the signal appear at the cathode of CR1 and the negative half cycles appear at the anode of CR2 with neither signal being offset by the forward drop of the diodes. The EXPAND X10 switch (S2) increases the gain of U2 by a factor of 10 which allows the modulation meter to be used to accurately set the pilot injection level. The ZERO ADJ control (R10) adjusts the offset voltage of U2 to zero.

4-5. Positive half cycles are applied to the noninverting input of U3 and the negative half cycles are applied to the inverting input of U3. The resulting output of U3 is a precision full wave rectified version of the signals applied to U2 without the effects of diode turn on voltages. All but a small portion of the feedback for U3 is obtained from the output of the peak detector.

4-6. PEAK DETECTOR. The peak detector consists of Q1, CR3, C8, Q2, and the associated circuit components. Amplifier Q1 boosts the output current capability of U3 to approximately 0.4 amperes as limited by R30. This current provides fast charging of peak detector capacitor C8. Darlington transistor Q2 buffers the input to amplifier U1A and reduces the bias current which discharges C8. Feedback for U3 is obtained from the emitter of Q2 which not only decreases the charging time of C8 but also provides high accuracy independent of the forward turn on voltages of Q1, Q2, and CR3 as these semiconductors are all enclosed within the feedback path of U3.

4-7. METER DISPLAY. The 13 operational amplifiers used as comparators are driven by output amplifier U1A. The gain of U1A is adjusted by the DISPLAY CAL control (R36) which functions as a calibration control for the LED meter display. The 13 operational amplifier inverting inputs are biased by a 1% precision resistor network at levels corresponding to 10%, 20% 30%, 40%, 50%, 60%, 70%, 80%, 90%, 95%, 100%, 105%, and 110% of total modulation. As the output of U1A goes positive, the operational amplifier corresponding to the level of modulation and all additional operational amplifiers below this level are turned on. The resulting display is a row of illuminated LEDs, the number of which is determined by the peak modulating level. Each indicator turns on at the indicated percentage level for each respective LED.

4-8. OUTPUT CIRCUIT.

4-9. OUTPUT AMPLIFIER. The output amplifier and phase and amplitude equalizer comprise U8, U9, and the associated circuitry. Summing amplifier U8 accepts the stereo composite signal from the STEREO ANALOG module, and an external modulating signal (SCA) at a one volt RMS sinewave level which corresponds to 100% modulation. The modulating signal (B-BAND) is amplified by U8 to an adjustable level between 2.5V P-P and 12.0V P-P as determined by the adjustment of the LEVEL OUT control (R43). This signal may be used as the output drive by positioning jumper J1 to defeat the phase and amplitude equalizer circuit.

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4-10. PHASE AND AMPLITUDE EQUALIZER. Amplifier U9 features frequency dependent input and feedback circuits which allow variable amounts of high and low frequency boost or cut. To disable phase equalization, the H.F. PHASE control (R45) is adjusted fully counterclockwise until the wiper of R45 is at ground level and U9 operates as inverting amplifier with the input obtained from U8.

4-11. The H.F. AMP. control (R49) adjusts the amount of high frequency boost or cut and the L.F. AMP. control (R50) adjusts the amount of low frequency boost or cut. The two controls boost or cut the frequency response by changing the ratio of feedback to input impedance at the high and low frequency extremes. The H.F. TURNOVER control (R48) and the L.F. TURNOVER control (R51) control the frequency at which the cut or boost occurs.

4-12. If the amplitude equalizer controls (R49 and R50) are adjusted for flat response, the H.F. PHASE control (R45) approximates an adjustable active all-pass filter circuit which has flat frequecny response independent of phase shift (adjusts high frequency phase without introducing a change in the frequency response). Specifically, adjusting R45 changes the phase lead of the higher frequencies to a maximum of approximately 67 degrees of phase lead at 53 kHz with respect to the low frequencies.

4-13. Usually, no phase correction will be required except for the correction obtained from the amplitude equalization controls (R49 and R50). A simple deficiency in amplitude response due to a transformer, coupling capacitor, or shunt roll off capacitor will cause phase shift in addition to amplitude roll off. If the amplitude response is corrected with the equalizer circuit, the phase shift will also be automatically corrected. Therefore, adjustment of the amplitude equalizer controls (R49 and R50) is usually all that is required to correct for both amplitude and phase problems. If independent control of amplitude and phase is required at the high frequencies due to complex phase and/or amplitude distortion problems, R45 must be adjusted from the phase flat position (fully counterclockwise) to compensate for the distortion.

4-14. POWER.

4-15. 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 U5 (-15V dc), U6 (+15V dc), and U7 (+15V dc A). Light emitting diode CR11 provides an indication of the -15V supply, light emitting diode CR6 provides an indication of the +15V supply, and light emitting diode CR26 provides an indication of the +15V A supply. Two fifteen volt regulators with equal loads are used due to the high current requirements of the LEDs used in the meter circuit. Diodes around each regulator protect the circuit against shorts and reverse polarity.

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SECTION V

MAINTENANCE

5-1. CORRECTIVE MAINTENANCE.

5-2. The MS-15R stereo generator 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 OUTPUT module meter, fuse F1, 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 stereo generator 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 5246 001) is provided with the stereo generator 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.	OUTPUT Module Parts Layout	----
Table 5-2	OUTPUT Module Parts Index	----
Figure 5-2	OUTPUT Module Waveforms	----
Figure 5-3.	OUTPUT Module Schematic	843 2087 001

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Table 5-1. OUTPUT Module Fault Isolation Index

SYMPTOM	DEFECT/REFERENCE
NO OUTPUT.	Figure 5-4.
OUTPUT LEVEL WILL NOT ADJUST.	Defective R43.
INADEQUATE OUTPUT.	Figure 5-5.
DISTORTION OR NOISE.	Figure 5-6.
METER INDICATES FULL SCALE (All Switch Positions).	Figure 5-7.
METER INOPERATIVE.	Figure 5-8.

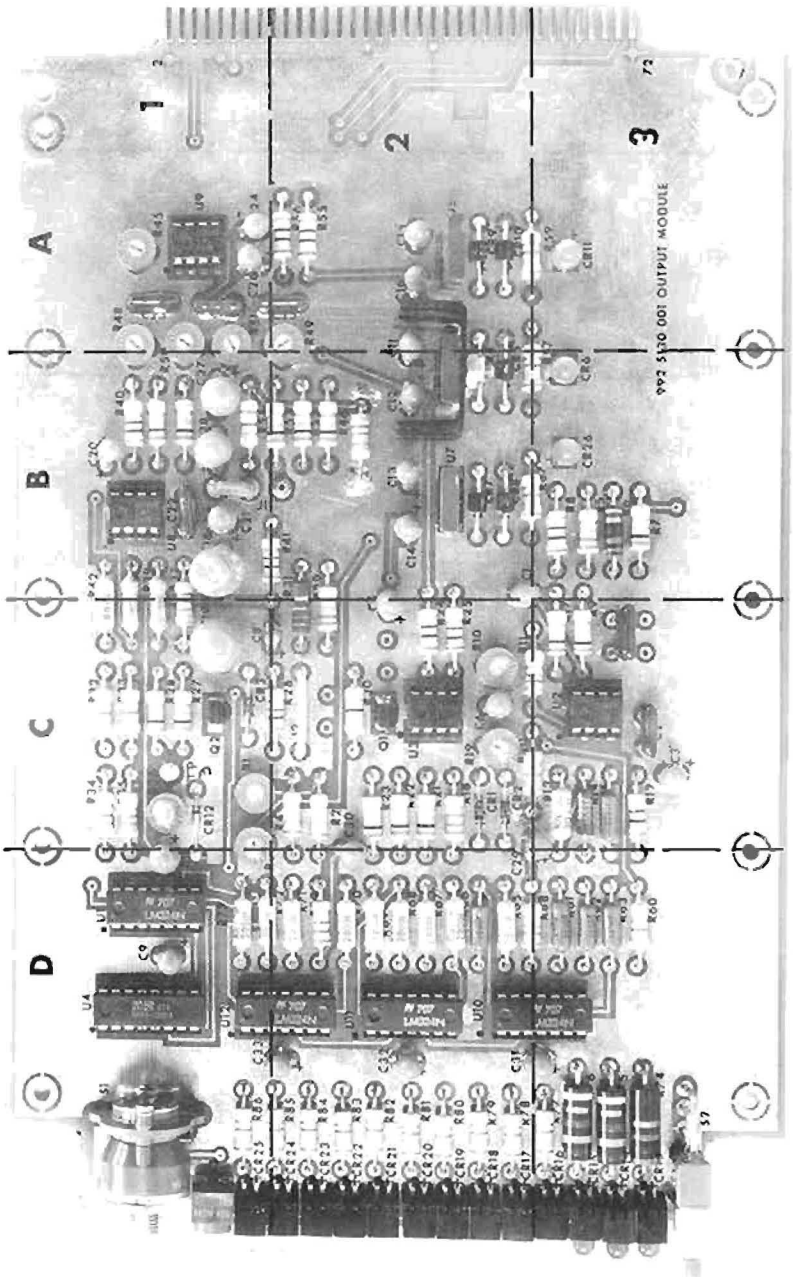


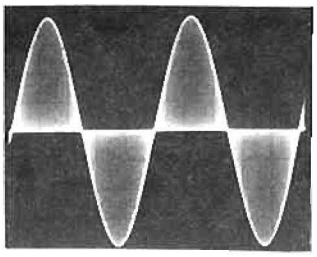
Figure 5-1. OUTPUT Module Parts Layout

Table 5-2. OUTPUT Module Parts Index

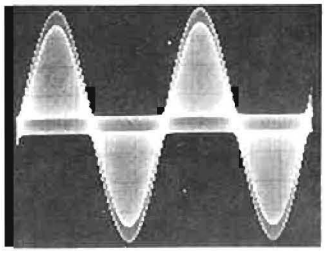
SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
C1	B2	C29	C2	CR22	D2	R14	C3
C2	C3	C30	C2	CR23	D2	R15	C3
C3	C3	C31	D2	CR24	D2	R16	--
C4	C3	C32	D2	CR25	D1	R17	C3
C5	C2	C33	D1	CR26	B3	R18	C2
C6	C2					R19	C2
C7	A1					R20	C2
C8	C1	CR1	C2	J1	C2	R21	C2
C9	D1	CR2	C2	J2	--	R22	C2
C10	C1	CR3	C1			R23	C2
C11	B2	CR4	B2			R24	C2
C12	B2	CR5	B2	Q1	C2	R25	C2
C13	B2	CR6	B3	Q2	C1	R26	C2
C14	B2	CR7	B2			R27	C1
C15	A2	CR8	B2			R28	C1
C16	A2	CR9	A2	R1	C1	R29	B2
C17	--	CR10	A2	R2	C2	R30	C2
C18	B1	CR11	A3	R3	C2	R31	B2
C19	C1	CR12	C1	R4	C2	R32	C1
C20	B1	CR13	D3	R5	B3	R33	C1
C21	B1	CR14	D3	R6	B3	R34	C1
C22	B1	CR15	D3	R7	B3	R35	C1
C23	A1	CR16	D3	R8	B3	R36	C1
C24	A1	CR17	D2	R9	C3	R37	B1
C25	A2	CR18	D2	R10	C2	R38	B1
C26	A1	CR19	D2	R11	C2	R39	B1
C27	B1	CR20	D2	R12	C3	R40	B1
C28	B1	CR21	D2	R13	C3	R41	B2

Table 5-2. OUTPUT Module Parts Index (Continued)

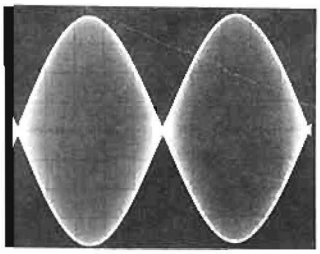
SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
R42	B1	R70	D2	U1	D1		
R43	D1	R71	D2	U2	C3		
R44	B1	R72	D2	U3	C2		
R45	A1	R73	D1	U4	D1		
R46	B2	R74	D3	U5	A2		
R47	B1	R75	D3	U6	B2		
R48	A1	R76	D3	U7	B2		
R49	B2	R77	D3	U8	B1		
R50	B1	R78	D2	U9	A1		
R51	A1	R79	D2	U10	D2		
R52	B2	R80	D2	U11	D2		
R53	B2	R81	D2	U12	D1		
R54	B1	R82	D2				
R55	A2	R83	D2				
R56	A2	R84	D2				
R57	B3	R85	D2				
R58	B2	R86	D1				
R59	A3	R87	B3				
R60	D3	R88	D3				
R61	D3	R89	D2				
R62	D3						
R63	D3						
R64	D2	S1	D1				
R65	D2	S2	D3				
R66	D2						
R67	D2						
R68	D2	TP1	C1				
R69	D2						



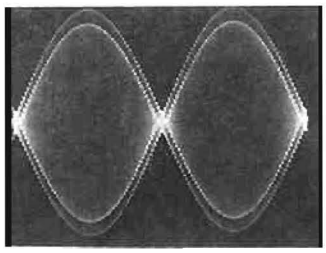
1. Composite stereo waveform without pilot at J1 (OUTPUT connector). Flat baseline indicates correct (L+R) to (L-R) ratio for maximum stereo separation.
   A. Audio input to one channel only.
   B. STEREO ANALOG module PILOT ON/OFF switch set to OFF.



2. Composite stereo waveform with pilot at J1 (OUTPUT connector).
   A. Audio input to one channel only.
   B. STEREO ANALOG module PILOT ON/OFF switch set to ON.



3. Subcarrier (L-R) without pilot at J1 (OUTPUT connector). Zero crossing points indicate good 38 kHz suppression.
   A. Audio input to one channel only.
   B. Audio input strapped so that (L = -R).
   C. STEREO ANALOG module PILOT ON/OFF switch set to OFF.



4. Subcarrier (L-R) with pilot at J1 (OUTPUT connector).
   A. Audio input to one channel only.
   B. Audio input strapped so that (L = -R).
   C. STEREO ANALOG module PILOT ON/OFF switch set to ON.

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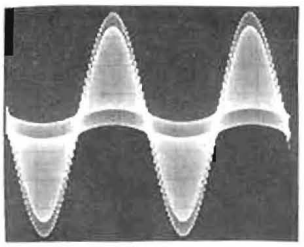
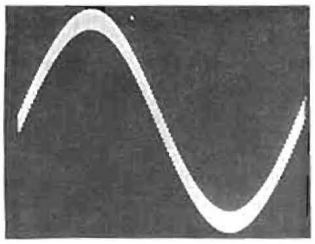
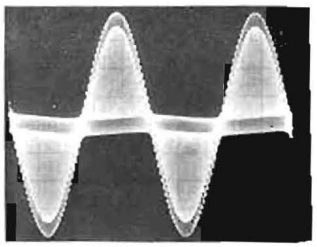
Figure 5-2. OUTPUT Module Waveforms (Sheet 1 of 3)



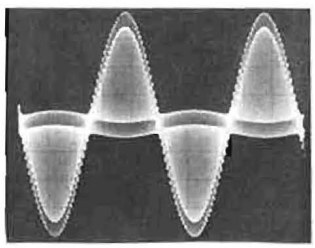
5. Composite stereo waveform with insufficient (L-R) at J1 (OUTPUT connector).
   A. Audio input to one channel only.
   B. STEREO ANALOG module PILOT ON/OFF switch set to ON.



6. Main channel (L+R) with pilot at J1 (OUTPUT connector).
   A. Audio input to one channel only.
   B. Audio input strapped so that (L = R).
   C. STEREO ANALOG module PILOT ON/OFF switch set to ON.



7. Composite stereo waveform with phase error between (L+R) and (L-R) components at J1 (OUTPUT connector).
   A. Audio input to one channel only.
   B. STEREO ANALOG module PILOT ON/OFF switch set to ON.



8. Composite stereo waveform with excessive (L-R) at J1 (OUTPUT connector).
   A. Audio input to one channel only.
   B. STEREO ANALOG module PILOT ON/OFF switch set to ON.

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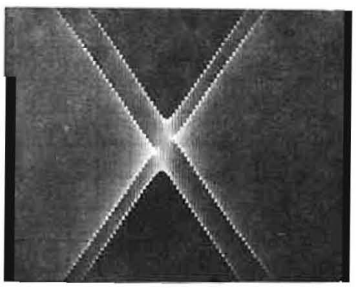
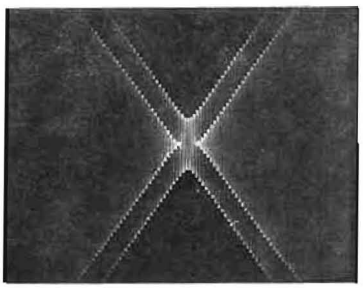
Figure 5-2. OUTPUT Module Waveforms (Sheet 2 of 3)



Subcarrier (L-R) with pilot incorrectly phased at J1 (OUTPUT CONNECTOR).
A. Audio input ot one channel only.
B. Audio Input Strapped so that (L = -R)
C. STEREO ANALOG module PILOT ON/OFF switch set to ON.

10.



Subcarrier (L-R) with pilot correctly phased at J1 (OUTPUT Connector).
A. Audio input to one channel only.
B. Audio input strapped so that (L = -R)
C. STEREO ANALOG module PILOT ON/OFF switch set to ON.

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Figure 5-2. OUTPUT Module Waveforms (Sheet 3 of 3)

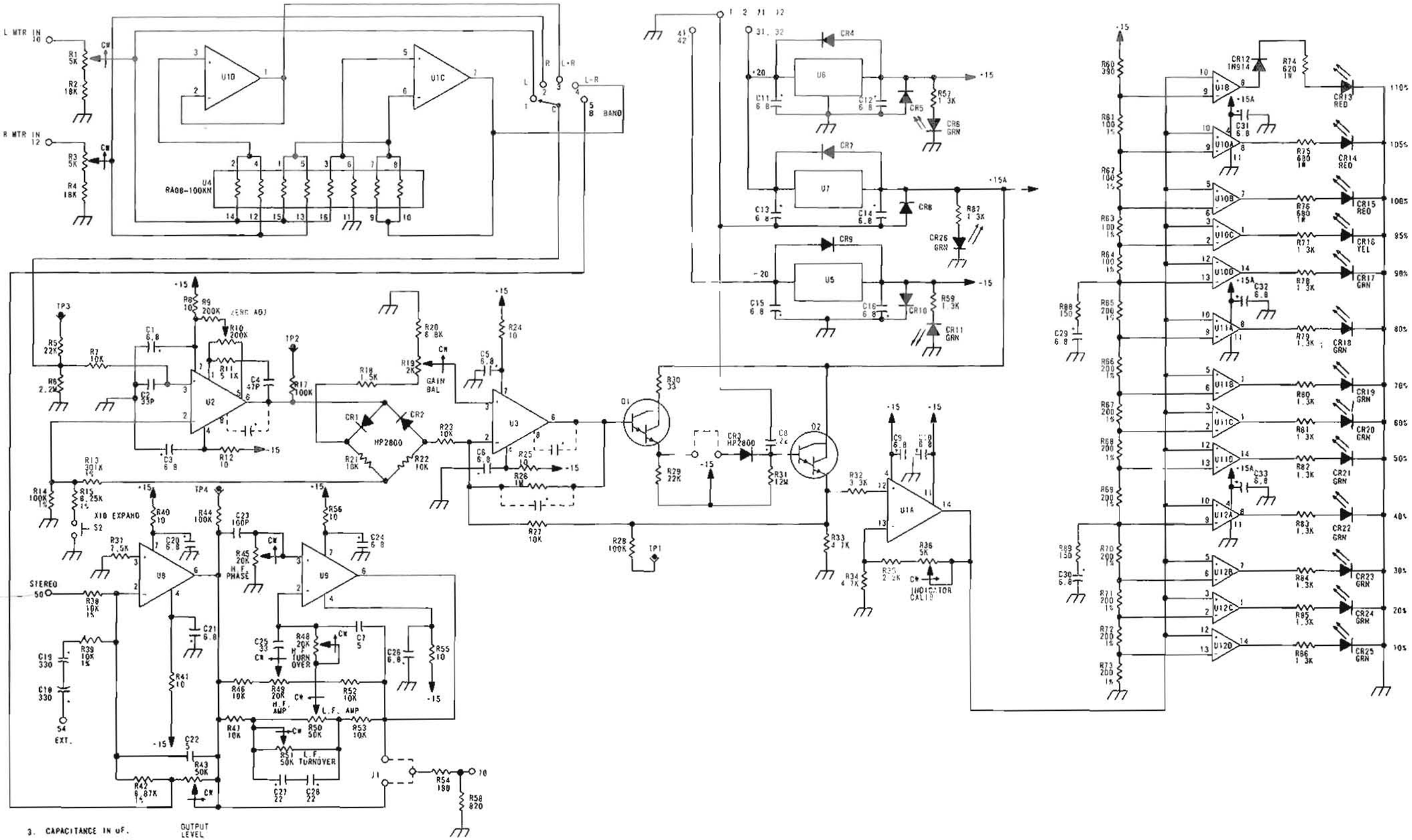

FIGURE 5-3. OUTPUT MODULE SCHEMATIC 843 2087 001

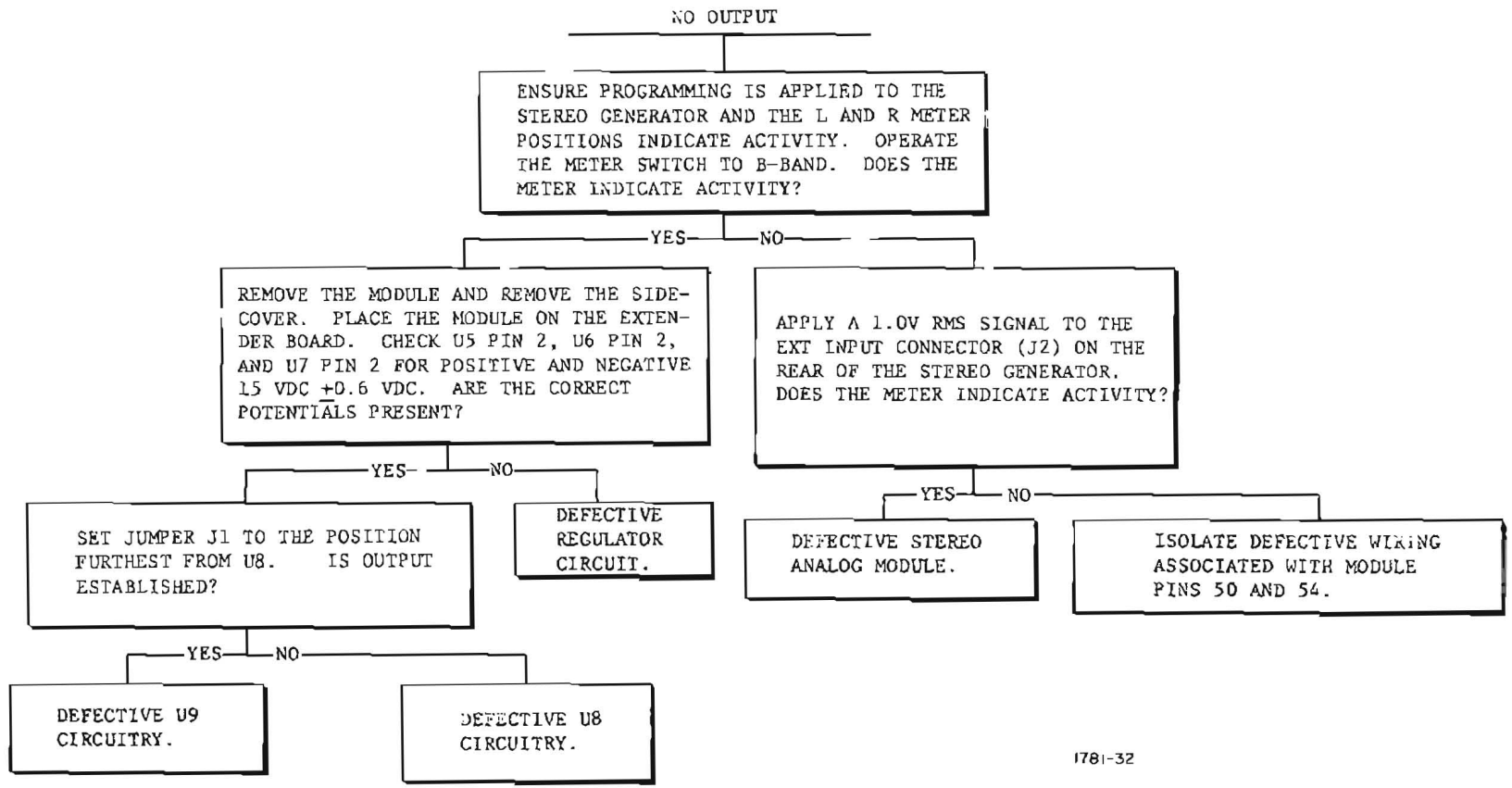

Figure 5-4. No Output

WARNING: Disconnect primary power prior to servicing.

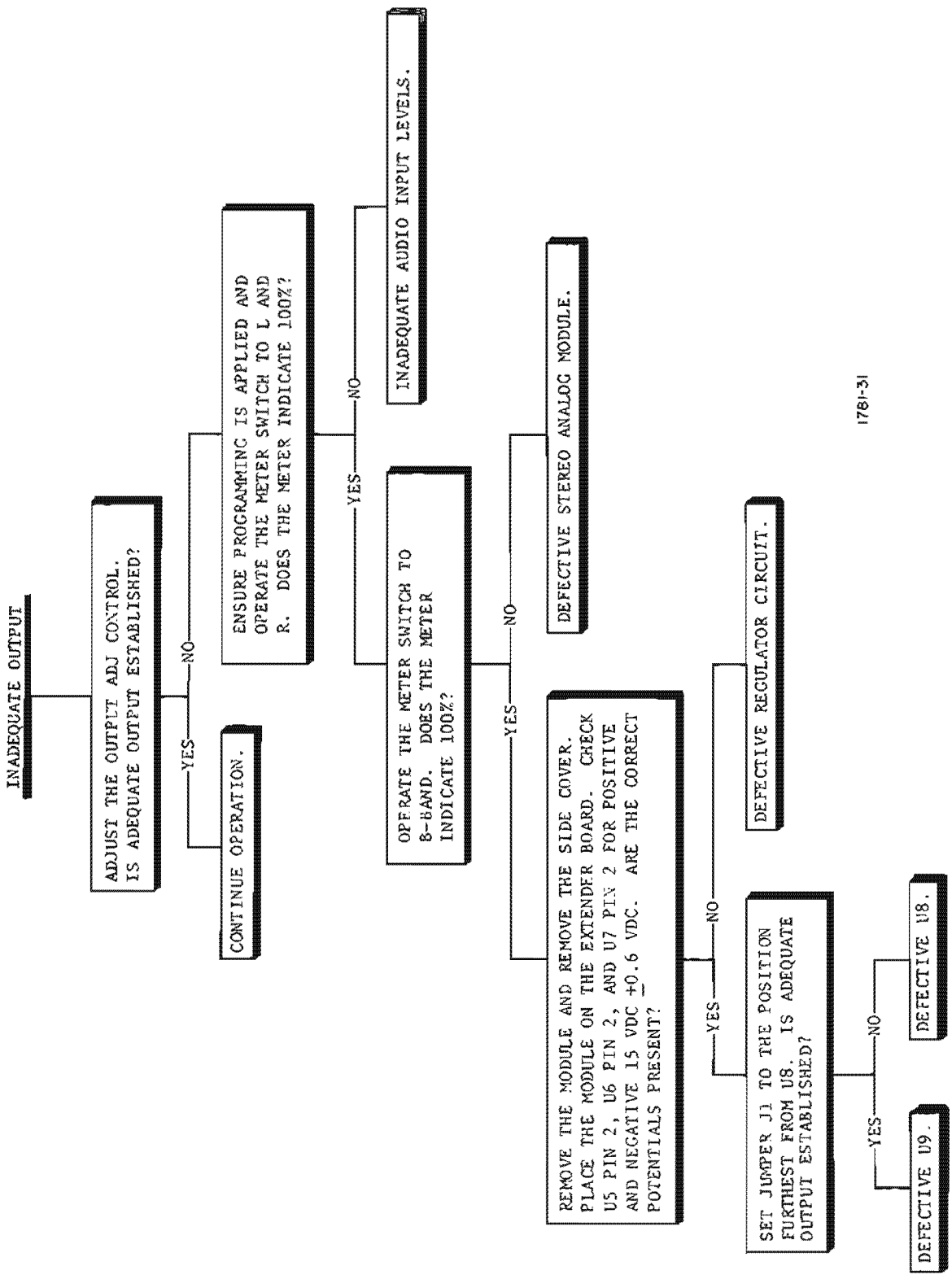

Figure 5-5. Inadequate Output

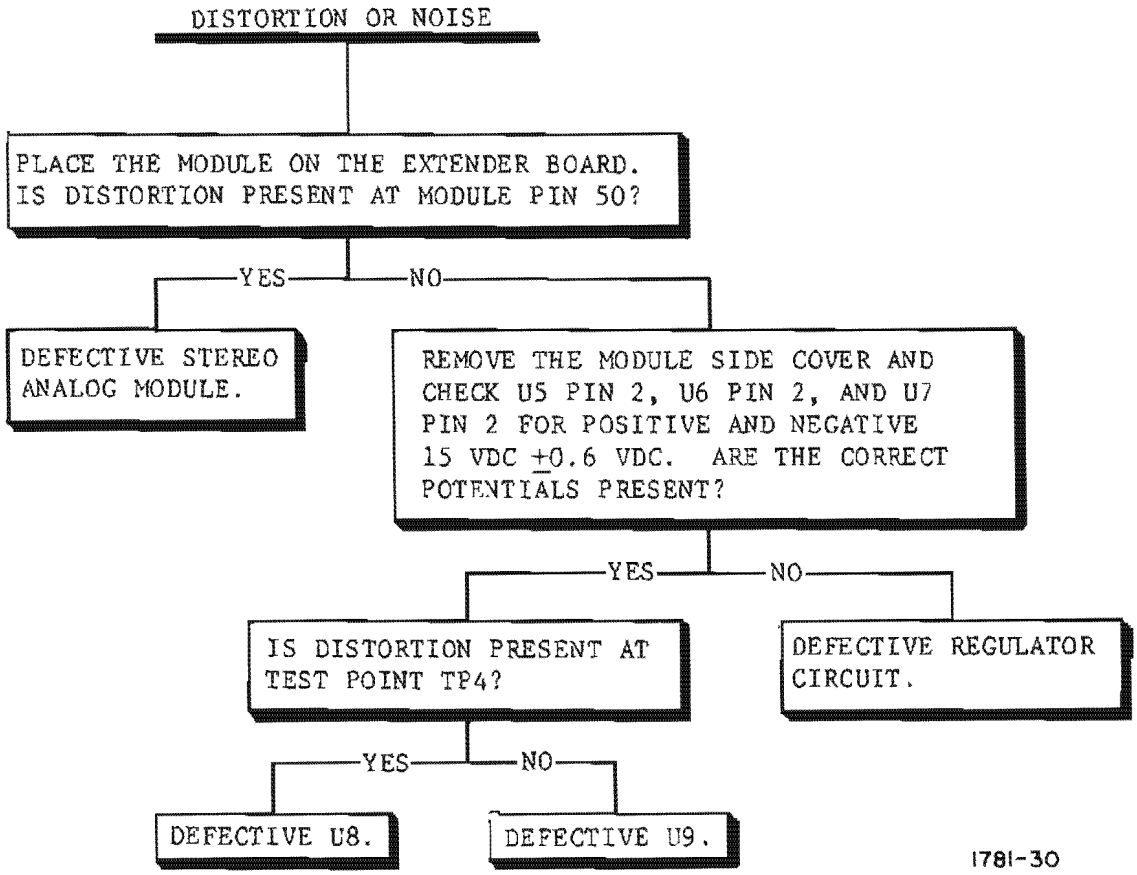

Figure 5-6. Distortion or Noise

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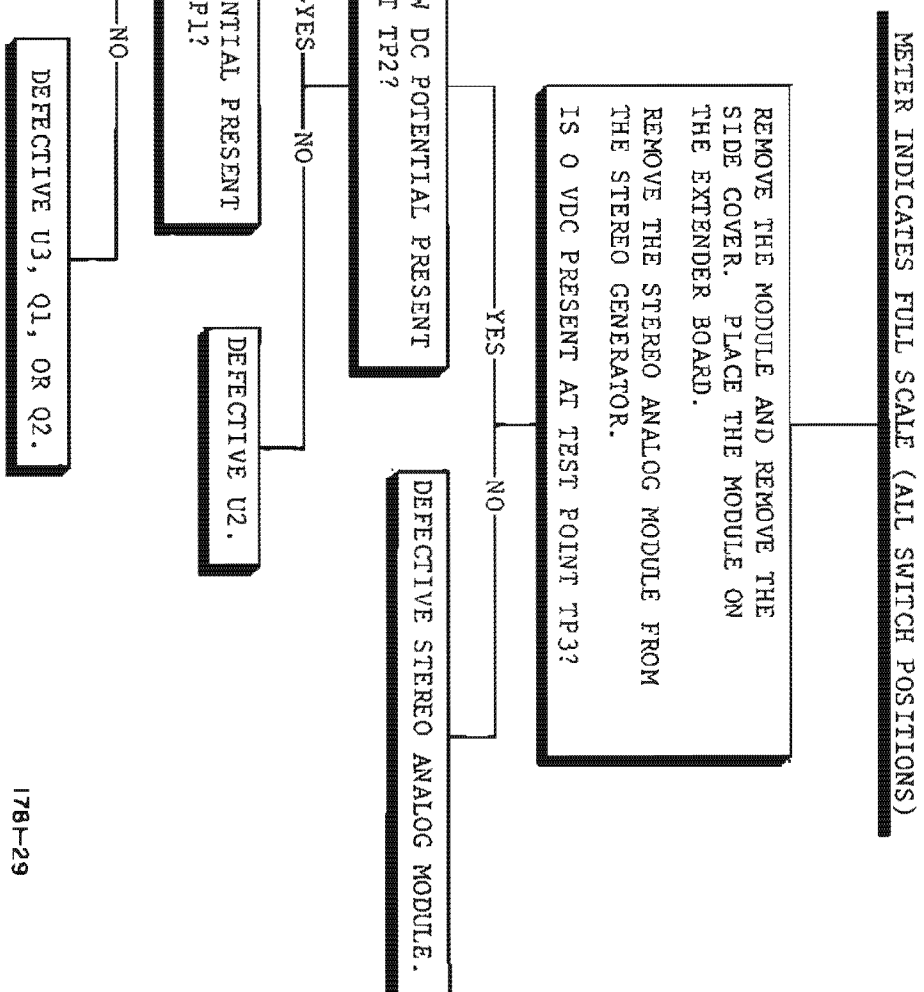

Figure 5-7. Meter Indicates Full Scale (All Switch Positions)

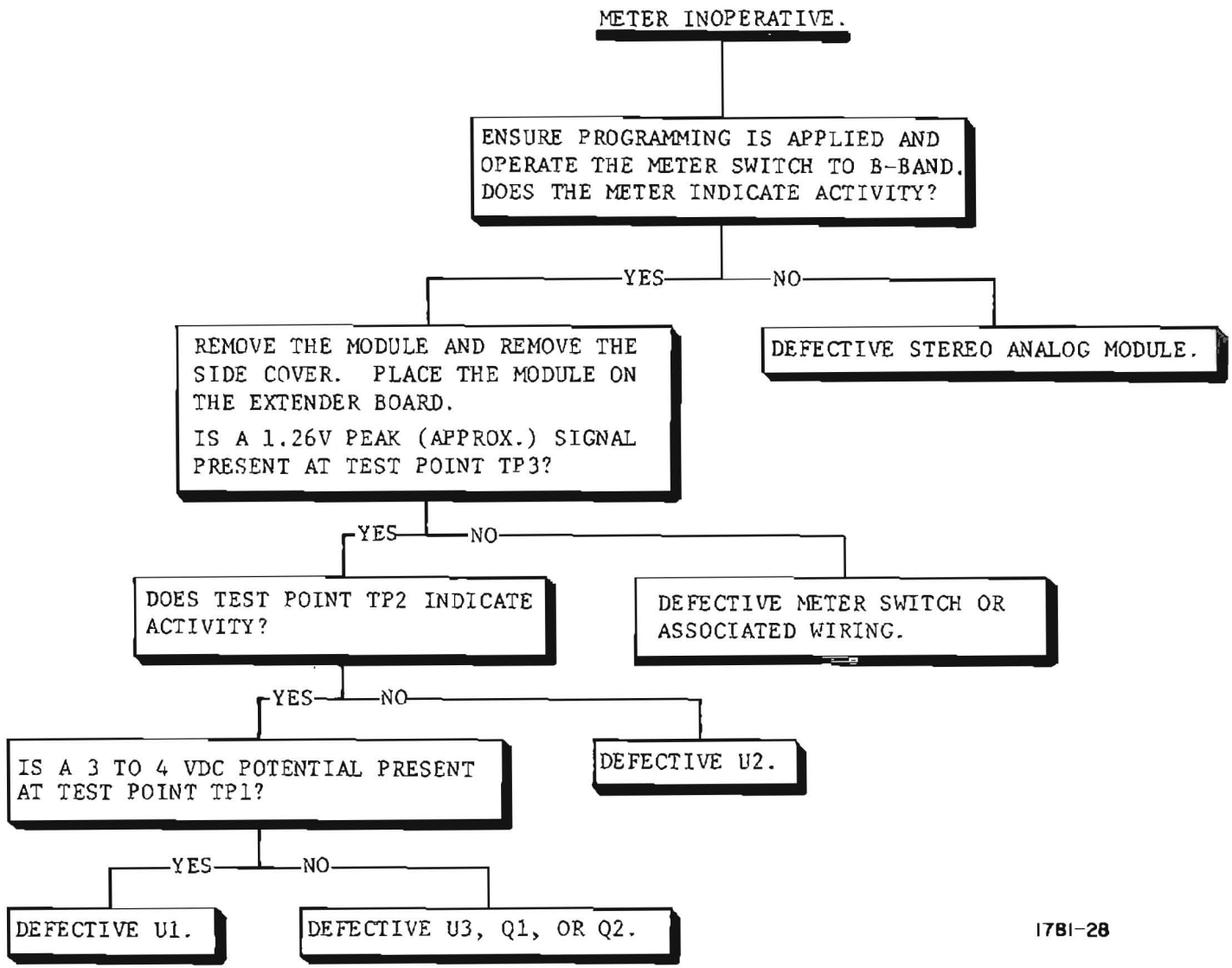

Figure 5-8. Meter Inoperative

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 MS-15R OUTPUT module. Table entries are indexed by component reference designator.

Table 6-1. OUTPUT Module Front Panel - 992 5129 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
------	992 5130 001	OUTPUT Module Circuit Board (Refer to table 6-2)	1

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Table 6-2. OUTPUT Module Circuit Board - 992 5130 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C1	526 0049 000	Capacitor, 6.8 uF, 35V	1
C2	500 0813 000	Capacitor, 33 pF, Mica	1
C3	526 0049 000	Capacitor, 6.8 uF, 35V	1
C4	500 0817 000	Capacitor, 47 pF, Mica	1
C5,C6	526 0049 000	Capacitor, 6.8 uF, 35V	2
C7	500 0803 000	Capacitor, 5 pF, Mica	1
C8	526 0310 000	Capacitor, 0.22 uF, Tantalum	1
C9 thru C16	526 0049 000	Capacitor, 6.8 uF, 35V	8
C18,C19	526 0045 000	Capacitor, 330 uF, Tantalum	2
C20,C21	526 0049 000	Capacitor, 6.8 uF, 35V	2
C22	500 0803 000	Capacitor, 5 pF, Mica	1
C23	500 0759 000	Capacitor, 100 pF, Mica	1
C24	526 0049 000	Capacitor, 6.8 uF, 35V	1
C25	500 0813 000	Capacitor, 33 pF, Mica	1
C26	526 0049 000	Capacitor, 6.8 uF, 35V	1
C27,C28	526 0309 000	Capacitor, 22 uF, Tantalum	2
C29 thru C33	526 0049 000	Capacitor, 6.8 uF, 35V	5
CR1,CR2,CR3	384 0321 000	Diode, HP2800	3
CR4,CR5	384 0284 000	Diode, 10D4	2
CR6	384 0610 000	Diode, LED, Green	1
CR7,CR8,CR9,CR10	384 0284 000	Diode, 10D4	4
CR11	384 0610 000	Diode, LED, Green	1

Table 6-2. OUTPUT Module Circuit Board - 992 5130 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
CR12	384 0205 000	Diode, IN914	1
CR13,CR14,CR15	384 0662 000	Diode, LED, Red	3
CR16	384 0664 000	Diode, LED, Yellow	1
CR17 thru CR25	384 0661 000	Diode, LED, Green	9
CR26	384 0610 000	Diode, LED, Green	1
J1	610 0679 000	Plug	1
Q1,Q2	380 0319 000	Transistor, MPS-A14	2
R1	550 0913 000	Potentiometer, 5k ohm, 4 Turn, 1/2W, 10%	1
R2	540 1113 000	Resistor, 18k ohm, 1/2W, 5%	1
R3	550 0913 000	Potentiometer, 5k ohm, 4 Turn, 1/2W, 10%	1
R4	540 1113 000	Resistor, 18k ohm, 1/2W, 5%	1
R5	540 1160 000	Resistor, 22k ohm, 1/2W, 5%	1
R6	540 1150 000	Resistor, 2.2 Megohm, 1/2W, 5%	1
R7	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1
R8	540 1151 000	Resistor, 10 ohm, 1/2W, 5%	1
R9	540 1144 000	Resistor, 200k ohm, 1/2W, 5%	1
R10	550 0930 000	Potentiometer, 200k ohm, 4 Turn, 1/2W, 10%	1
R11	540 1105 000	Resistor, 5.1k ohm, 1/2W, 5%	1
R12	540 1151 000	Resistor, 10 ohm, 1/2W, 5%	1
R13	548 0317 000	Resistor, 301k ohm, 1/4W, 1%	1
R14	548 0932 000	Resistor, 100k ohm, 1/4W, 1%	1

Table 6-2. OUTPUT Module Circuit Board - 992 5130 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R15	548 1397 000	Resistor, 8.25k ohm, 1/4W, 1%	1
R17	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	1
R18	540 1129 000	Resistor, 1.5k ohm, 1/2W, 5%	1
R19	550 0935 000	Potentiometer, 2k ohm, 4 Turn, 1/2W, 10%	1
R20	540 1145 000	Resistor, 6.8k ohm, 1/2W, 5%	1
R21,R22,R23	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	3
R24,R25	540 1151 000	Resistor, 10 ohm, 1/2W, 5%	2
R26	540 1162 000	Resistor, 1 Megohm, 1/2W, 5%	1
R27	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	1
R28	540 1159 000	Resistor, 100k ohm, 1/2W, 5%	1
R29	540 1160 000	Resistor, 22k ohm, 1/2W, 5%	1
R30	540 1134 000	Resistor, 33 ohm, 1/2W, 5%	1
R31	540 1337 000	Resistor, 12 Megohm, 1/2W, 5%	1
R32	540 1165 000	Resistor, 3.3k ohm, 1/2W, 5%	1
R33,R34	540 1114 000	Resistor, 4.7k ohm, 1/2W, 5%	2
R35	540 1153 000	Resistor, 8.2k ohm, 1/2W, 5%	1
R36	550 0913 000	Potentiometer, 5k ohm, 4 Turn, 1/2W, 10%	1
R37	540 1154 000	Resistor, 7.5k ohm, 1/2W, 5%	1
R38,R39	548 1361 000	Resistor, 10k ohm, 1/4W, 1%	2
R40,R41	540 1151 000	Resistor, 10 ohm, 1/2W, 5%	2
R42	548 0414 000	Resistor, 8.87k ohm, 1/4W, 1%	1

Table 6-2. OUTPUT Module Circuit Board - 992 5130 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R43	550 0941 000	Potentiometer, 50k ohm, 4 Turn, 1/2W, 10%	1
R44	540 1159 000	Resistor, 100k, 1/2W, 5%	1
R45	550 0928 000	Potentiometer, 20k ohm, 4 Turn, 1/2W, 10%	1
R46,R47	540 1111 000	Resistor, 10k, 1/2W, 5%	2
R48,R49	550 0928 000	Potentiometer, 20k ohm, 4 Turn, 1/2W, 10%	2
R50,R51	550 0929 000	Potentiometer, 50k ohm, 4 Turn, 1/2W, 10%	2
R52,R53	540 1111 000	Resistor, 10k ohm, 1/2W, 5%	2
R54	540 1192 000	Resistor, 51 ohm, 1/2W, 5%	1
R55,R56	540 1151 000	Resistor, 10 ohm, 1/2W, 5%	2
R57,R59	540 1187 000	Resistor, 1.3k ohm, 1/2W, 5%	2
R60	540 1164 000	Resistor, 390 ohm, 1/2W, 5%	1
R61 thru R64	548 0363 000	Resistor, 100 ohm, 1/4W, 1%	4
R65 thru R73	548 0278 000	Resistor, 200 ohm, 1/4W, 1%	9
R74	540 0327 000	Resistor, 620 ohm, 1W, 5%	1
R75,R76	540 0328 000	Resistor, 680 ohm, 1W, 5%	2
R77 thru R87	540 1187 000	Resistor, 1.3k ohm, 1/2W, 5%	11
R88,R89	540 1117 000	Resistor, 150 ohm, 1/2W, 5%	2
S1	600 0584 000	Switch	1
S2	604 0866 000	Switch, Pushbutton	1
U1	382 0415 000	Integrated Circuit, LM324N	1

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Table 6-2. OUTPUT Module Circuit Board - 992 5130 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
U2,U3	382 0472 000	Integrated Circuit, LM318N	2
U4	540 1332 000	Integrated Circuit, RA08-100KN	1
U5	382 0360 000	Integrated Circuit, MC7915	1
U6,U7	382 0359 000	Integrated Circuit, MC7815	2
U8,U9	382 0472 000	Integrated Circuit, LM318N	2
U10,U11,U12	382 0415 000	Integrated Circuit, LM324N	3
XU1	404 0674 000	Socket, IC, 14 Pin	1
XU2,XU3	404 0673 000	Socket, IC, 8 Pin	2
XU4	404 0675 000	Socket, IC, 16 Pin	1
XU8,XU9	404 0673 000	Socket, IC, 8 Pin	2
XU10,XU11,XU12	404 0674 000	Socket, IC, 14 Pin	3
	404 0523 000	Jacks, PC	3
	943 2088 001	Printed Circuit Board	1
	404 0513 000	Heat Sink	1

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