McMartin

INSTRUCTION MANUAL

TBM-3500
FM MODULATION MONITOR

FCC Type Approval #3-119

97.7 MHZ

KSTG FM

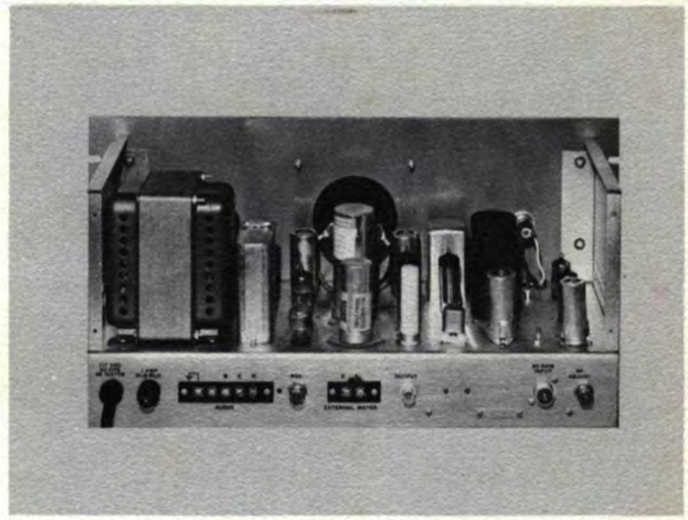
McMartin Industries, Inc.

605 North 13th Street • Omaha 2, Nebr.

Telephone (Area Code 402) 342-2753

McMartin®

TBM 3500 FM MODULATION MONITOR



FEATURES

- Accuracy ±½ db, 20-100 kc cps
- External metering available
- Hi-Speed peak flash indicator
- Measures all FM transmitter modulation including sub channels
- Wideband output provides proof-of-performance
- Can observe composite multiplexed transmission

DESCRIPTION

The McMartin TBM-3500 is a completely self-contained modulation monitor, the first of its kind to follow completely present FCC requirements.

The TBM-3500 is designed to measure the total frequency modulation characteristics of a standard FM transmitter. This monitor will respond to any modulated frequency within a 20-100kc cps spectrum. The TBM-3500 will also operate with any FM transmitter having a center frequency of 88 to 108mc.

The TBM-3500 is equipped with two visual modulation indicating devices; the semi-peak indicating 4.5" meter and the peak indicating neon flasher. The meter is calibrated from "zero" to 133% modulation and the peak flasher being adjustable to a threshold level of between 50% to 120% modulation. One-hundred percent modulation is referenced to a deviation of ±75kc.

The TBM-3500 is designed for standard rack and panel mounting and contains a built-in regulated power supply. The monitor is insensitive to small amounts of RF power and therefore must be connected directly to a sample loop on the transmitter or to an appropriate RF amplifier in the case of remote-operated transmitters.

All performance specifications meet or surpass the requirements outlined by the Federal Communications Commission for monitoring equipment: Type Approval Number 3-119. Remember, the name McMartin assures outstanding performance, quality and reliability.

SPECIFICATIONS

Operating Range:	88 to 108mc fixed
Modulation Range:	Full scale meter deflection indicates deviation of ±100kc or 133% modulation. Scale calibration indicates 100% modulation @ ±75kc.
Meter & Flasher Accuracy::	Within 5% over entire scale (FCC standard for FM)
Meter Characteristics:	Well within FCC requirements. Pointer reaches 90% value of a modulation peak with a duration of approximately 70 milliseconds. Overshoot is less than 3%. Meter delays from full reading to 10% of value in approximately 720 milliseconds.
Peak Flasher Indicator:	Responds to modulation peaks with a duration of 10 milliseconds or less.
Meter Frequency Response:	±½db; 50 cps to 75kc @ 100% modulation
Stability:	Maintained by special inverse feedback.
Output Frequency Response:	High Z FCC de-emphasis curve ±1.0db, 50 to 15,000 cps. Phone Jack ±1.0db, 50 to 15,000 cps. Multiplex 50 to 75,000 cps ±½ db
Distortion:	High Z, 600 ohm, Phone Jack —0.5% max., 50-15,000 cps
Hum & Noise:	Better than —65db below 100% modulation at low audio frequencies.
Output Voltage:	High Z 10 volts for 100% modulation + 6dbm (4mv) @ 100% modulation. Phone Jack 10 volts for 100% modulation 0.2v (P-P) for 10% injection. 2.0v (P-P) for 100% modulation.
RF Input:	1 to 5 volts @ 50 ohm (½ w max.)
Front Panel Indicators:	Modulation meter Modulation Peak Flasher (neon) AC Power (neon)
Front Panel Controls:	AC Power—ON-OFF Function Switch Modulation Polarity Switch Peak Flasher Level Set
Rear Chassis Controls:	RF Attenuator Peak Flasher Level Set
Front Panel Output:	High Z phone jack
Rear Chassis Outputs:	High Z Audio 600 ohm audio Multiplex External Modulation Meter
Tubes:	13 Total Types: 1-6AK5 1-6SN7 1-6AK5/5654 1-6AB4 1-12AT7 1-5696 1-12AT7/6201 2-OA2 1-6BE6 1-3HTF4 1-12AU7 1-6BH6
Diodes:	3-1N3604/SD150
Rectifiers:	4-1N2095
Fuse:	Self-regulating constant-voltage transformer 105-125 VAC, 60 cycles 60 watts with gaseous regulator tubes.
Dimensions:	Standard rack panel 19"x8¾"
Shipping Weight:	25 lbs.

McMartin INDUSTRIES, INCORPORATED

605 N. 13TH STREET OMAHA, NEBRASKA 68102 TELEPHONE (402) 342-2753

PRINTED IN U.S.A.

ALIGNMENT AND CALIBRATION

McMartin TBM-3500 FM Modulation Monitor

Serial Number 30-3198 Checked by RP Date 5-29-68

Customer Collins KMTL

GENERAL

Main Carrier Operating Frequency		97.7		
Intermediate Frequency		21.5		
R.F. Attenuator		OK		
R.F. Level Indicator		OK		
Detector Linearity	+ 100 kc	1.2	v,	-100 kc 1.2 v
VR Current		18	ma	
105-125-VAC regulation		OK		

MAIN CHANNEL

Modulation Meter
calibration @ 50% 50, 100% 100, 133% 133
rise for 70 M.S. pulse 99 %
decay in 720 M.S. delay 10 %
overshoot 2 %

Distortion @ 100% modulation

50 cps	.4 %	5000 cps	.3 %
100 cps	.4 %	10000 cps	.3 %
400 cps	.4 %	15000 cps	.35 %
1000 cps	.3 %	S/N	-67 db

Peak Indicator

tracking @ 50% 50. 70% 70 100% 100
flash speed -- 70 M.S. pulse @ 100% 100 %
18 M.S. pulse @ 100% 98 %

Main Channel Output

Hi impedance	400 cps	0 VU	9.0 V
	10000 cps	-13 db	
600 Ohms	400 cps	0 VU	
	10000 cps	-13 db	

INSTRUCTION MANUAL

TBM-3500
FM MODULATION MONITOR

FCC Type Approval #3-119

TABLE OF CONTENTS

I. General Description 1
II. Technical Specifications. 2-3
III. Installation and Initial Adjustment 4-5

Inspection. 4
Location. 4
Connections, Input. 4
Connections, Output 4-5
Initial Adjustments 5

IV. Operation 5-6

Proof of Performance. 6

V. Circuit Description 7-9
VI. Bessel's Function Modulation Calibration. 10
VII. Table of Audio Frequencies vs. Percentage of Modulation . . 11
VIII. Voltage Table. 12
Callouts. 13-14
Parts List
Schematic

GENERAL DESCRIPTION

The TBM-3500 is designed to measure the total frequency modulation characteristics of a standard FM transmitter. The monitor will respond to any modulating frequency within a spectrum ranging from 50 to 75,000 cps. The monitor will operate with any FM transmitter having a center frequency of 88 to 108 mc.

The TBM-3500 is equipped woth two visual, modulation indicating devices:

1) Semi-peak indicating $4\frac{1}{2}$" meter.
2) Peak indicating neon flasher.

The meter is calibrated from 0 to 133% modulation. The peak flasher is adjustable for a threshold level of between 50% to 120% modulation. Ome hundred percent modulation is referenced to a deviation of ± 75 kc.

The TBM-3500 is designed for standard rack and panel mounting and contains a built-in regulated power supply. The monitor is insensitive to small amounts of RF power and therefore, must be connected directly to a sample loop on the transmitter, or to an appropriate RF amplifier in the case of remote operated transmitters.

All performance specifications meet or surpass the Requirements outlined by the Federal Communications Commiccion for monitoring equipment Type Approval. The FCC Type Approval number for the TBM-3500 is 3-119.

II. TECHNICAL SPECIFICATIONS

Modulation Indicators

Modulation Range	: Full scale meter deflection indicates deviation of ± 100 kc or 133% modulation.
	: Scale calibration indicates 100% modulation @ ±75 kc.
Meter & Flasher Accuracy	: Within 5% over entire scale (FCC standard for FM)
Meter Characteristics	: Well within FCC requirements. Pointer reaches 90% value of a modulation peak with a duration between 50 & 90 milliseconds. Overshoot is less than 3%. Meter decays from full reading to 10% of value within 500 to 900 milliseconds.
Peak Flash Indicator	: Responds to modulation peaks with a duration of 10 milliseconds or less.
Meter Frequency Response	: $\pm\frac{1}{2}$ db; 50 cps to 75 kc @ 100% modulation.
Stability	: Maintained by special inverse feedback.

Audio Outputs

Frequency Range	: High Z - Follows FCC de-emphasis curve. ±1.0db 50 th 15,000 cps.
	: 600 ohm - Follows FCC de-emphasis curve. ±1.0 db 50 to 15,000 cps.
	: Phone jack - ±1.0 db 50 to 15,000 cps.
	: Multiplex - 50 to 75,000 cps $\pm\frac{1}{2}$ db.
Distortion	: High Z, 600 ohm, phone jack - 0.5% max. 50-15,000 cps.
Hum & Noise	: Better than -65 db below 100% modulation at low audio frequencies.
Output Voltage	: High Z - 10v for 100% modulation @ low audio frequencies.
	: 600 ohm - +6 dbm (4 mw) @ 100% modulation.
	: Phone jack - 10v for 100% modulation.
	: Multiplex - 0.2v (P-P) for 10% injection 2.0v (P-P) for 100% modulation.

II. TECHNICAL SPECIFICATIONS (cont'd)

General

RF Input	: 1 to 5 volts @ 50 ohm (½ watt max.)
Front Panel Indicators	: Modulation meter : Modulation peak flasher (neon) : AC power (neon)
Front Panel Controls	: AC power ON-OFF : Function switch : Modulation polarity switch : Peak flasher level set
Rear Chassis Controls	: RF attenuator : Peak flasher calibration
Front Panel Output	: High Z phone jack
Rear Chassis Outputs	: High Z audio : 600 ohm audio : Multiplex : External modulation meter
Tubes	: 13 Types: 1-6AK5, 1-6AK5/5654, 1-12AT7, 1-12AT7/6201, 1-6BE6, 1-12AU7, 1-6SN7, 1-6AB4, 1-5696, 2-OA2, 1-3HTF4, 1-6BH6
Diodes	: 3 - IN3604/SD150
Rectifiers	: 4 - IN2095
Power	: Regulated constant voltage transformer 105-125 volts, 60 cps AC, 60 watts.
Dimensions	: Standard rack panel - 19" x 8¾" Depth behind panel - 8"
Weight	: 25 lbs.
Finish	: Natural gray panel, cadmium plated chassis and cover.

III. INSTALLATION AND INITIAL ADJUSTMENT

Inspection: Upon receipt of your TBM-3500, remove it from the packing material and inspect for any damage caused in transit due to handling or vibration. If damage is found, notify the shipping agency and advise McMartin Industries, Inc. lf such action.

Location: Installation preferrable should be made in a standard equipment rack or cabnet which is well connected electrically to the main station ground and away from strong RF fields created by the transmitter. The monitor should be located near the transmitter in order to take an RF sample directly from the transmitter. It has been designed to be insensitive. If a remote application is desired. RF can be fed from the McMartin TBM-2500, RF amplifier. Remember there are 13 tubes to keep cool. thus ventilation should be given serious consideration. Be sure to consider the source of AC power and connection to the monitoring output of the transmitter.

Connections, Input: Plug the AC line cord into a nominal 117 volt, 60 cps only power source.

Connect a 50 ohm coaxial cable (RG-58 or RG-8) between an RF pick-up loop (or RF amplifier) and the input Ji at the monitor. (Amphenol Type 83-ISP connector is used.)

CAUTION: Do not apply more than 4 watts from the pick-up loop or the monitor may be damaged.

When using the TBM-3500 in conjunction with the TBM-3000 frequency monitor or other existing monitor equipment, simultaneous connection of the RF inputs from the same pick-up loop can be made with the use of a "T" connector such as the Amphenol #83-IT. Where other makes of monitors are in use, it may be necessary to incorporate a resistive pad to achieve the correct RF input level for each unit. It is known that some other manufacturers monitors, found in the field. will create interference detrimental to the accuracy of the TBM-3500 if, they are both connected to the same pick-up loop or RF amplifier. Separate pick-up loops or the McMartin TBM-2500 RF amplifier should eliminate this factor.

Connections, Output: There are provisions on the rear of the monitor for connecting an external modulation meter. This meter should be connected to terminals "E" and "F". The resistor between "E" and "F" must be removed if an external meter is used. Observe meter polarity.

Due to the special characteristics of this meter, it must be ordered from McMartin Industries, Inc. Model number is "M-1M".

* If aural monitoring is desired, refer to the AUDIO terminal board on the rear of the chassis. For high impedance output, connect a shielded cable to terminal "D". The shield should be connected to chassis "C" and "D" and connect to terminals "A" and "B".

III. INSTALLATION AND INITIAL ADJUSTMENT (cont'd)

The BNC connector output on the rear of chassis identified as J2 contains all the modulation from the main channel through subchannels up to 75,000 cycles. This includes all components that the transmitter broadcasts, including stereo and SCA-multiplex. The J2 output is designed with two purposes in mind. First, to serve as the output to feed a stereo monitor. Secondly, to serve as a means to attach specialized measuring equipment such as an oscilloscope for visual observation of the composite modulation. The connected load must have very low input capacity.

Additionally, the J2 output can be used to feed a McMartin TBM-2000 thus enabling aural monitoring of a subcarrier simultaneously and continuously.

The J3 phone jack on the front panel contains the same information as the rear chassis "D" terminal hi-impedance output and can be also used for aural monitoring. This jack can be used for earphone listening and is particularly useful for convenient connection of distortion measuring equipment.

Initial Adjustments: Turn the power on and allow the monitor to warm up ½ hour for temperature stabilization. The red neon pilot light will indicate the power is on.

NOTE: It may be observed that the Sola power transformer operates at a high temperature. This is a completely normal condition since it functions on a core saturation principle and in no way indicates a defect or overload condition.

Place the modulation meter function switch (SW-1) in the RF INPUT position. Set the RF ADJUST control on the rear of the chassis to mid-range - approximately equal distance from either end of its rotation. The pick-up loop in the transmitter should now be adjusted so a reading of about 100% appears on the modulation meter during normal transmitter operation.

Now use the rear chassis RF ADJUST control to set the meter reading to exactly 100%. You now have the proper voltage for operation of the monitor.

IV. OPERATION

It is imperative that the instruction book be read thoroughly befor beginning operations. Particularly note the check-out form attached to the back cover of the instruction manual. This form recaps the readings that were taken on this specific monitor for your specific requirements and should be studied carefully

IV. OPERATION (cont'd)

1) Place the Meter Function switch (SW-1) in RF INPUT position. The meter will read relative RF input voltage from the transmitter. As previously described, this level is controlled by the RF ADJUST control on the rear chassis. The normal meter reading is 100%. This reading should be checked daily and re-adjusted if more than 10% off of 100%.

2) Place the Meter Function switch in TOTAL MOD position. In this position, the entire modulation contained by the transmitter will be read. This is the normal operation position.

3) The PEAK MODULATION control (R-56) can be set at any desired point so that the high speed peak modulation indicator lamp (PL-1) will flash if modulation exceeds the referenced percentage setting.

* Special Note: With normal broadcast program material on the air, it will not be uncommon for the peak flasher to light at a 100% setting while the meter M-1 is averaging about 25 to 40% on peaks. The flasher will catch modulation peaks which are much too short (10 milliseconds and less) for complete meter response. More than occasional lighting of the peak flasher set at 100% indicates an over-modulation condition of the transmitter.

4) The modulation polarity switch SW-2 may be set in either a plus or minus position. In the plus position, positive peaks above the carrier frequency will be observed by the M-1 meter and the peak indicator lamp. In the minus position, negative peaks below the carrier frequency will be read.

Proof of Performance: Proof of performance frequency response and distortion measurements may be readily made for the transmitter. Preferably this is done by connecting a distortion/noise meter with a high impedance input circuit (above 20 K ohms) to the high Z terminal "D" on the rear of the chassis with the other distortion meter input lead grounded to the chassis; or use the phone jack on the front panel. Follow the procedures recommended by the manufacturer of the distortion/noise meter being used. Regardless of which output connection is used THE JUMPER BETWEEN TERMINALS "C" and "D" MUST BE REMOVED for these measurements. Because of the inherent characteristics of the TBM-3500, distortion measurements may be made to less than 0.5% and noise to at least -65 db below 100% modulation.

Special Note: When checking distortion for Proof of Performance tests, remember that the TBM-3500 responds to frequencies up to 75 kc flat. Harmonic Distortion as measured from the TBM-3500 will sometimes be higher than readings taken from alternate monitoring sources. The reason is that other sources do not respond to all audio frequency harmonics.

This same condition may be present with regard to noise measurements. High frequency noise may not be passed by alternate monitoring sources.

V. CIRCUIT DESCRIPTION

A signal will be traced through the TBM-3500 referring to the schematic.

Sampled RF from a pick-up loop is fed through input connector J1 to RF ADJUST which provides a nominal 50 ohm resistive termination. The RF ADJUST control will determine the voltage applied to pin #7 of V-1. V-1 is a pentagrid converter.

V-10B is the local, crystal controlled oscillator with L-1 assembly forming the tank circuit tuned to the crystal frequency. For stable oscillation, L-1 is tuned at a point 15% down from the peak on the slow rise side. The oscillator output is fed to the grid (pin #2) of a frequency doubler tube, V-10A. The doubler tank circuit is made up of L-2 assembly and is tuned to twice the oscillator frequency. The oscillator frequency is selected so that after doubling, the frequency is (IF frequency) mc. less than the transmitter carrier frequency being monitored.

$$\text{Crystal Frequency} = \frac{\text{Carrier Frequency} - (\text{IF freq.})}{2}$$

This signal is then fed to the second control grid of the converter or mixer, pin #1 of V-1.

The IF frequency for the TBM-3500 is as follows: $\frac{97.1 - 21.5}{2} = 37.8$ MH

88-105 mc. operating frequency - 21.5 mc.

105-108 mc. operating frequency - 22.7 mc. $\frac{96.9 - 21.5}{2} = 37.700$ MHz

The plate of the mixer is tuned by L-3 to the heterodyned IF frequency. This signal is subsequently amplified by V-2 and then amplitude limited by V-3 and V-4. L-4, L-5, and L-6 form the tuned circuits for this IF sequence and provide a broadbanded system with extremely low noise. This is essential for the elimination of intermodulation, and linear high frequency audio response.

This high quality signal appearing at the plate of V-4 is then demodulated by the newly developed "Hedlund Detector"*. This FM demodulating circuit provides exceptional linearity over an extremely broad range of frequencies and at a comparatively high voltage output, while utilizing only one rectifier.

The detected FM modulation is then distributed to the measuring and output circuits by V-5, both sections of which are paraphase amplifiers with equal voltages produced on the plates and cathodes, but exactly 180 degrees out of phase.

The plate output of V-5A supplies a complete, composite waveform which contains all frequencies from 50 to 75,000 cycles. If stereo multiplex and/or SCA multiplex is being transmitted, a faithful reproduction of the modulation injected at the transmitter will appear at J-2.

*Patent Pending

V. CIRCUIT DESCRIPTION (cont'd.)

If an external modulation meter is utilized, it is connected across the rear chassis terminals marked "E" and "F". This simply connects the two meters in series with each other. R-35 acts as a "dummy load" when an external meter is not used.

Refer back to SW-2. The selected signal polarity at SW-2 is also fed to V-8 through a voltage divider made up by R-47 and R-48. V-8 is a voltage amplifier for driving the thyratron, V-9. The plate load of the V-8 is R-50 which is paralleled by a frequency selective, voltage dividing impedance which feeds the grid of V-9. Due to inherent, high input capacity of the thyratron, high frequency response is compensated by C-38 and R-51. The firing threshold of V-9 is determined by cathode bias as adjusted with front panel control, R-56. R-56 is calibrated in percent of modulation. The calibration of R-59 is set by potentiometer R-54 which is part of the voltage divider across B+. R-58 and R-49 correct the tracking of R-59. C-39 places the cathode at the required AC ground potential. When V-9 fires, current through R-57 develops the necessary voltage to flash the neon lamp, PL-1.

The heart of the power supply is a constant voltage, regulated transformer. The primary is fused and RF filtered. C-42 and the high voltage secondary windings form a resonant circuit at 60 cps. The factor plus the saturated core provide voltage regulation of 3% with line voltage ranging between 105 and 130 VAC. This degree of regulation is also reflected into the filament windings.

The high voltage AC is full-wave rectified and filtered. Further B+ regulation is afforded by the gaseous voltage regulators, V-11 and V-12. DC current passing through these regulators is adjusted by R-65 for 12 to 15 ma. for best regulation. The filament of RF tubes are adequately by-passed for RF. Further filament voltage regulation of V-8 and V-9 is accomplished by the ballast tube, V-13.

VI. Bessel's Function Modulation Calibration

In order to accurately calibrate the M-1 modulation meter, adjust R-40; and for the peak flasher, adjust R-54. These adjustments are made against aural null indications as derived from the following procedure utilizing Bessel's Function:

To start with, the TBM-3500 should be installed and operating normally. Use a good quality, stable communications receiver with a BFO and connect the antenna input to the first limiter tube (V-3) by wrapping a few turns of wire around it. Turn the switch SW-1 to the TOTAL MOD position. Remove all modulation from the transmitter. Tune the communication receiver to the monitor's IF frequency (Max. Indication on S meter). Now adjust the BFO of the receiver to give a beat note of 200-300 cycles at the receiver output. Now take an audio sine wave generator of known accuracy and feed it into the transmitter. Slowly increase sine wave modulation. The amplitude of the transmitter carrier, and in turn the receiver beat note will go through successive amplitude nulls. If you can hear these nulls from the receiver as they occur, you are now ready for calibration.

At this point, refer to the table of Audio Frequencies vs. Percentage of Modulation for Various Nulls. This table illustrates 27 different combinations for arriving at a percentage of modulation calculation. (The first null is impractical because the audio frequency would be too high).

As an example, let us select a frequency of 8,670 cycles which will give us 100% modulation when the third null is reached. Set the audio generator to 8,670 cycles and slowly increase the amplitude until the third null is reached. Stop at that point. The transmitter is now being modulated 100%. If the M-1 modulation meter and peak flasher on the monitor do not read 100% adjust R-40 and R-54 until they do.

If you wish to select a setting other than shown on the table, use the formula:

$$\text{Audio Frequency} = \frac{\text{Frequency Deviation}}{\text{Modulation Index}} \text{ or } \frac{\text{Percentage of Modulation} \times 75{,}000}{\text{Modulation Index}}$$

The frequency deviation at 100% is ± 75 kc, and the modulation index can be selected from the table.

CAUTION: Remember that the accuracy of this calculation is directly related to the accuracy of the audio frequency source which modulates the transmitter. An audio frequency error of 500 cycles will give a modulation error of approximately 2%.

TABLE OF AUDIO FREQUENCIES vs. PERCENTAGE OF MODULATION
FOR VARIOUS NULLS
(Communication Receiver Tuned to IF Frequency)

Null Number	Modulation Index	Frequency Deviation	Percentage of Modulation	Audio Frequency
2	5.520	75,000	100.0%	13,586
2	5.520	55,200	73.6%	10,000
2	5.520	27,600	36.8%	5,000
3	8.654	75,000	100.0%	8,670
3	8.654	86,550	115.4%	10,000
3	8.654	43,275	57.7%	5,000
4	11.792	75,000	100.0%	6,360
4	11.792	58,950	78.6%	5,000
4	11.792	23,550	31.4%	2,000
5	14.931	75,000	100.0%	5,023
5	14.931	74,625	99.5%	5,000
5	14.931	29,850	39.8%	2,000
6	18.071	75,000	100.0%	4,150
6	18.071	90,375	120.5%	5,001
6	18.071	28,630	38.2%	1,585
7	21.212	75,000	100.0%	3,535
7	21.212	63,636	84.8%	3,000
7	21.212	42,424	56.5%	2,000
8	24.353	75,000	100.0%	3,080
8	24.353	97,425	129.9%	4,000
8	24.353	48,675	64.9%	2,000
9	27.494	75,000	100.0%	2,727
9	27.494	82,482	109.9%	3,000
9	27.494	54,988	73.3%	2,000
10	30.635	75,000	100.0%	2,450
10	30.635	61,275	81.7%	2,000
10	30.635	30,600	40.8%	1,000

TYPICAL VOLTAGES

TBM-3500

		Pin #1	2	3	4	5	6	7	8	9
V1	6BE6	-6.7*	1.1	5.4AC	0	64*	64*	-2.3*		
V2	6BH6	-0.6*	0.3	5.4AC	0	92*	92*	0		
V3	6AK5	-9.6*	0	0	7.0AC	62*	62*	0		
V4	6AK5/5654	-8.7*	0	7.0AC	0	87*	87*	0		
V5	12AT7/6201	250	0	5.5	0	0	250	0	5.5	7.0AC
V6	12AU7	72	0	3.9	0	0	32	0	1.1	7.0AC
V7	6SN7	0	118	2.0	0	200	5.2	7.0AC	0	
V8	6AB4	52	-	6.4AC	6.4AC	-	0	2.1		
V9	5695	0	7.2	6.4AC	6.4AC	7.2	175AC	-		
V-10	12AT7	112	-8.6	0	0	0	98	-5.0	0	7.0AC
V-11	OA2	300	150	-	-	300	-	150		
V-12	OA2	150	0	-	-	150	-	0		
V-13	3HTF4	-	6.0AC	6.0AC	-	-	-	6.0AC	6.0AC	

Note:

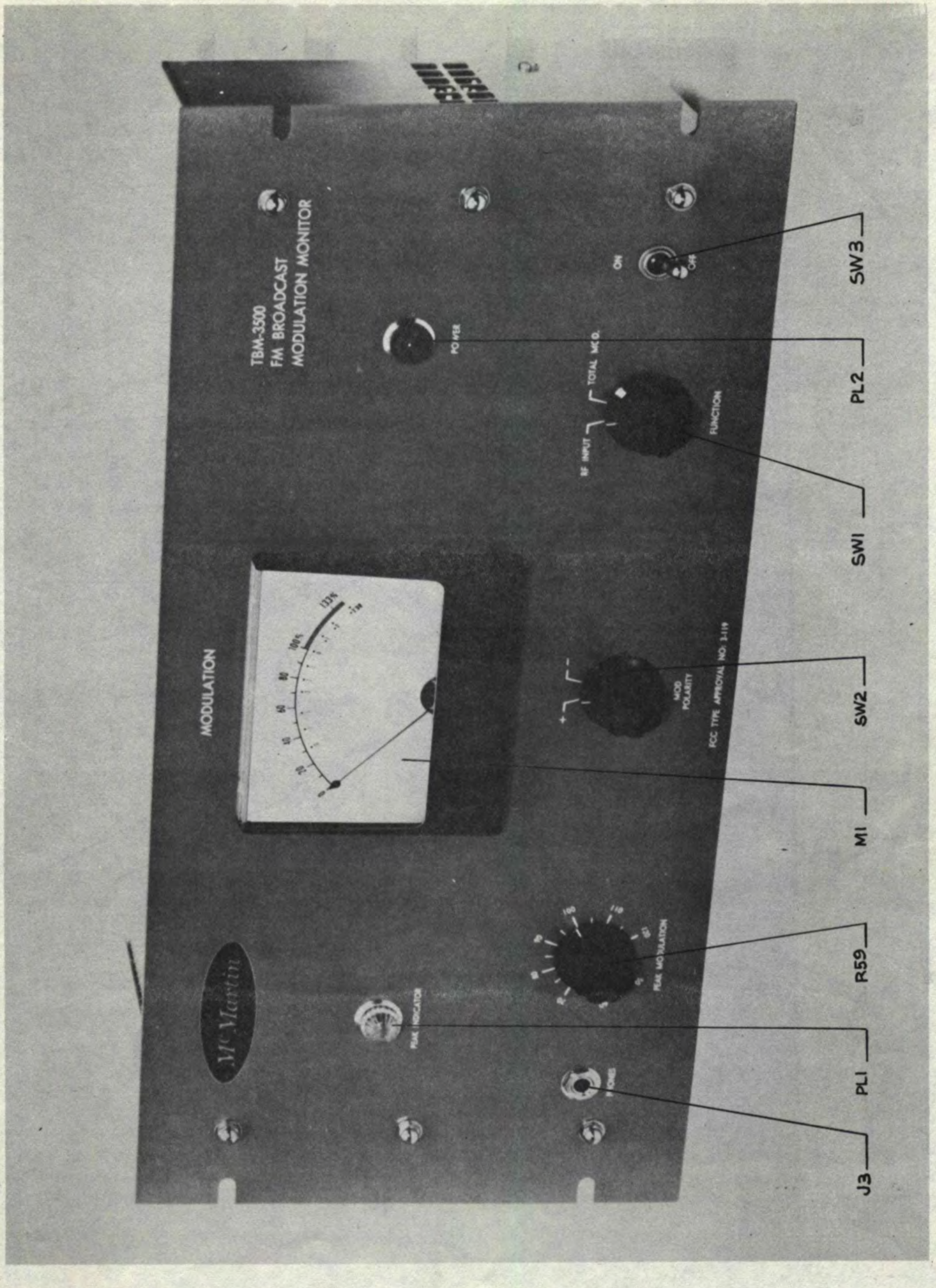
-All DC measurements made with a VTVM (11 megohm input Z)

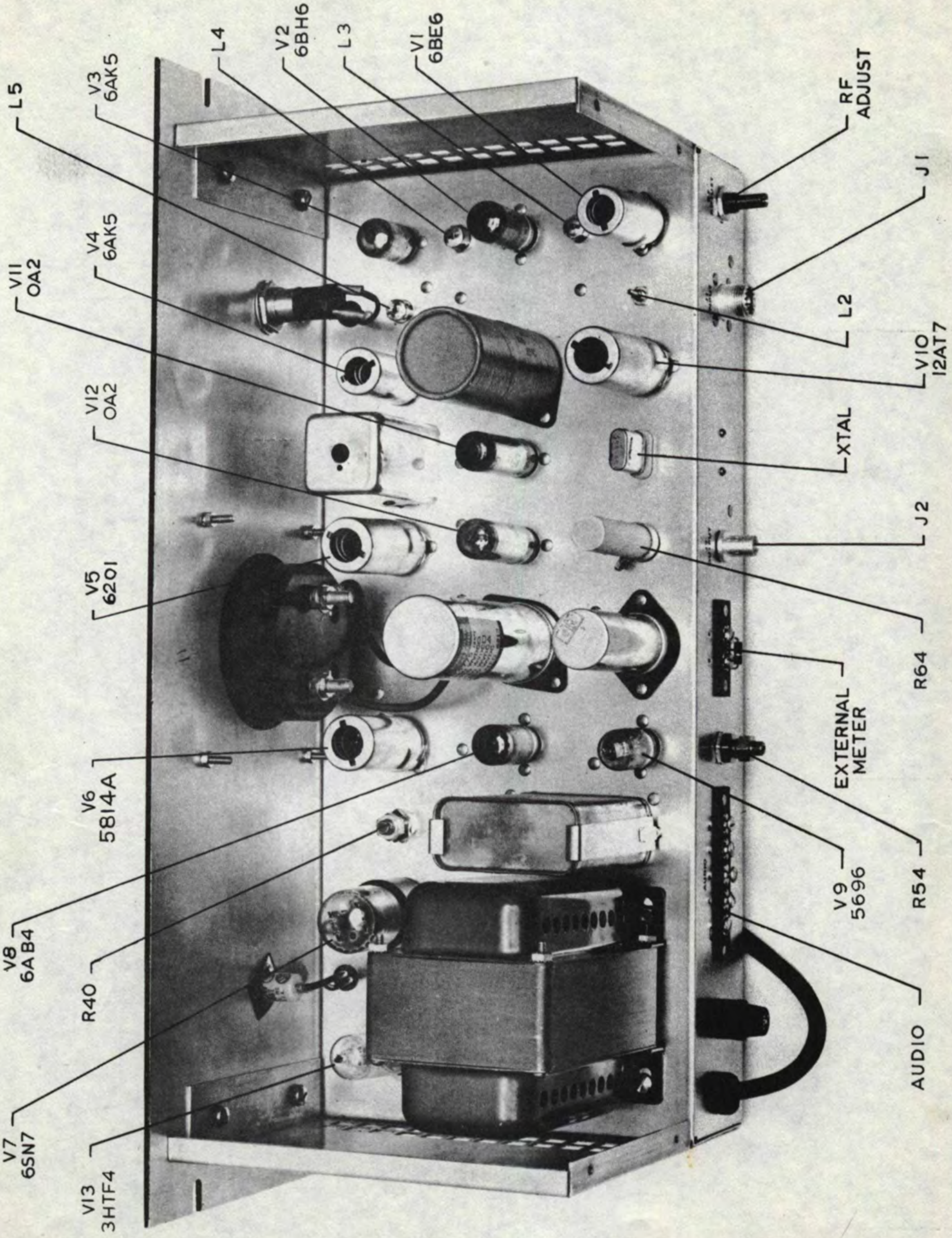
-All AC measurements made with a 5000 ohm/volt meter and specially noted ("AC")

-Chassis ground is common to all DC measurements and AC, except where indicated (--VAC--).

*Indicates a 1 megohm resistor connected in series with the VTVM probe to avoid RF shunting.

-The AC waveform produced by the Sola transformer to supply voltage for the filaments is not a sine wave. There are harmonics present and therefore, the voltage as measured by a typical rms voltmeter will be approximately 7.0 volts. The effective heater voltage remains 6.3VAC.


TBM-3500
FM BROADCAST
MODULATION MONITOR
MODULATION
McMartin
POWER
ON
OFF
RF INPUT
TOTAL MOD.
FUNCTION
MOD POLARITY
FCC TYPE APPROVAL NO. 3-119
PEAK MODULATION
PEAK INDICATOR
PHONES
SW3
PL2
SW1
SW2
M1
R59
PL1
J3


V13 3HTF4
V7 6SN7
R40
V8 6AB4
V6 5814A
V5 6201
V12 OA2
V11 OA2
V4 6AK5
L5
V3 6AK5
L4
V2 6BH6
L3
V1 6BE6
RF ADJUST
J1
L2
V10 12AT7
XTAL
J2
R64
EXTERNAL METER
R54
V9 5696
AUDIO

PARTS LIST

C-1	3000 pf ±5% 500 v	dipped mica capacitor	Cornell Dubilier
C-2	1000 pf ±5% 500 v	" " "	" "
C-3	100 pf ±5% 500 v	" " "	" "
C-4	3000 pf ±5% 500 v	" " "	" "
C-5	100 pf ±10% 500 v	" " "	" "
C-6	100 pf ±10% 500 v	" " "	" "
C-7	.001 mfd +80 -20% 600 v	disc ceramic capacitor	Radio Material
C-8	1000 pf ±5% 500 v	dipped mica capacitor	Cornell Dubilier
C-9	100 pf ±10% 500 v	" " "	" "
C-10	.001 mfd +80 -20% 600 v	disc ceramic capacitor	Radio Material
C-11	3000 pf ±5% 500 v	dipped mica capacitor	Cornell Dubilier
C-12	47 pf ±10% 500 v	" " "	" "
C-13	1000 pf ±5% 500 v	" " "	" "
C-14	1000 pf ±5% 500 v	" " "	" "
C-15a	40 mfd 350 v 4 section	twist prong electrolytic	Mallory
C-15b	40 mfd 350 v " "	" " "	"
C-15c	30 mfd 350 v " "	" " "	"
C-15d	20 mfd 350 v " "	" " "	"
C-16	47 pf ±10% 500 v	dipped mica capacitor	Cornell Dubilier
C-17	3900 pf ±5% 500 v	" " "	" "
C-18	100 pf ±10% 500 v	" " "	" "
C-19	10 pf ±5% 500 v	" " "	" "
C-20	.25 mfd 400 v	metalized paper capacitor	" "
C-21	.25 mfd 400 v	" " "	" "
C-22	1000 pf ±5% 500 v	dipped mica capacitor	" "
C-23	.02 mfd 400 v	metalized paper capacitor	" "
C-24	24 pf ±10%	cipped mica capacitor	" "
C-25	.25 mfd 400 v	metalized paper capacitor	" "

PARTS LIST (cont'd)

C-26	.25 mfd 400 v metalized	paper capacitor	Cornell Dubilier
C-27	100 pf ±5% 500 v	dipped mica capacitor	" "
C-28	.25 mfd 400 v metalized	paper capacitor	" "
C-29	.25 mfd 400 v metalized	" "	" "
C-30a	20 mfd 450 v 2 section	twist prong electrolytic	" "
C-30b	10 mfd 450 v " "	" " "	" "
C-31	.25 mfd 400 v metalized	paper capacitor	" "
C-32	.25 mfd 400 v metalized	" " "	" "
C-33	Adjust at factory, maximum value 500 pf ±5% 500 v	dipped mica capacitor	" "
C-34	10 mfd 450 v	tubular electrolytic	" "
C-35	4 mfd 150 v metalized	paper capacitor (bathtub case)	Aerovox
C-36	4 mfd 150 v metalized	" "	"
C-37	2 mfd 400 v metalized	paper capacitor	Cornell Dubilier
C-39	1 mfd 200 v metalized	" "	" "
C-40	220 pf ±5% v	dipped mica capacitor	" "
C-41	220 pf ±5%	" " "	" "
C-42	85 mfd 600 VAC, aluminum can,	oil filled paper	Aerovox
C-43a	40 mfd 450 v 4 section	twist prong electrolytic	Sprauge
C-43b	40 mfd 450 v	" " "	"
C-43c	40 mfd 450 v	" " "	"
C-43	40 mfd 450 v	" " "	"
C-44	.001 mfd +80 -20% 600 v	disc ceramic capacitor	Radio Material
C-45	.001 mfd +80 -20% 600 v	" " "	" "
C-46	.001 mfd +80 -20% 600 v	" " "	" "
C-47	69 MMFD ±5% 500 v	dipped mica capacitor	Cornell Dubilier

PARTS LIST (cont'd)

R-1	100 K ±10% ½ W	composition carbon,	fixed resistor	Allen-Bradley
R-2	10 K ±10% 1 W	" "	" "	" "
R-3	220 K ±10% ½ W	" "	" "	" "
R-4	1000 ±10% 1 W	" "	" "	" "
R-5	100 K ±10% ½ W	" "	" "	" "
R-6	100 K ±10% ½ W	" "	" "	" "
R-7	220 K ±10% ½ W	" "	" "	" "
R-8	10 K ±10% 1 W	" "	" "	" "
R-9	10 K ±10% ½ W	" "	" "	" "
R-10	68 K ±10% ½ W	" "	" "	" "
R-11	220 K ±10% ½ W	" "	" "	" "
R-12	4700 ±10% ½ W	" "	" "	" "
R-13	33 K ±10% ½ W	" "	" "	" "
R-14	4700 ±10% ½ W	" "	" "	" "
R-15	10 K ±10% 1 W	" "	" "	" "
R-16	33 K ±10% ½ W	" "	" "	" "
R-17	4700 ±10% 1 W	" "	" "	" "
R-18	4700 ±10% ½ W	" "	" "	" "
R-19	130 K ±10% ½ W	" "	" "	" "
R-20	470 K ±10% ½ W	" "	" "	" "
R-21	10 K ±10% 1 W	" "	" "	" "
R-22	10 K ±10% 1 W	" "	" "	" "
R-23	10 K ±5% 1 W	" "	" "	" "
R-24	10 K ±1% 1 W	" "	" "	" "
R-25	100 K ±10% ½ W	" "	" "	" "
R-26	Adjust at factory nominal value (75 K ±5% ½ W)	" "	" "	" "

PARTS LIST (cont'd)

R-27	470 K ±10% ½ W	Composition carbon,	fixed resistor	Allen-Bradley
R-28	2200 ±10% 1 W	" "	" "	" "
R-29	15 K ±10% 2 W	" "	" "	" "
R-30	68 K ±10% ½ W	" "	" "	" "
R-31	100 K ±5% ½ W	" "	" "	" "
R-32	100 K ±10% ½ W	" "	" "	" "
R-33	270 ±10% 2 W	" "	" "	" "
R-34	15 K ±10% 2 W	" "	" "	" "
R-35	1500 ±5% ½ W	" "	" "	" "
R-36	100 K ±5% 1 W	" "	" "	" "
R-37	100 K ±5% 1 W	" "	" "	" "
R-38	100 K ±5% ½ W	" "	" "	" "
R-39	33 K ±10% ½ W	" "	" "	" "
R-40	1500 ±10% 2 W	" "	Control Type AB	Ohmite
R-41	100 K ±10% ½ W	" "	fixed resistor	Allen-Bradley
R-42	680 ±10% 1 W	" "	" "	" "
R-43	3300 ±10% ½ W	" "	" "	" "
R-44	Adjust at factory, nominal value, (27 K ½ W ±10%)	" "	" "	" "
R-45	5600 ±10% 2 W	" "	" "	" "
R-46	33 K ±10% 1 W	" "	" "	" "
R-47	47 K ±10% ½ W	" "	" "	" "
R-48	470 K ±10% ½ W	" "	" "	" "
R-49	Adjust at factory, nominal value, (1000 ±10% ½ W)	" "	" "	" "
R-50	27 K ±10% 2 W	" "	" "	" "

PARTS LIST (cont'd)

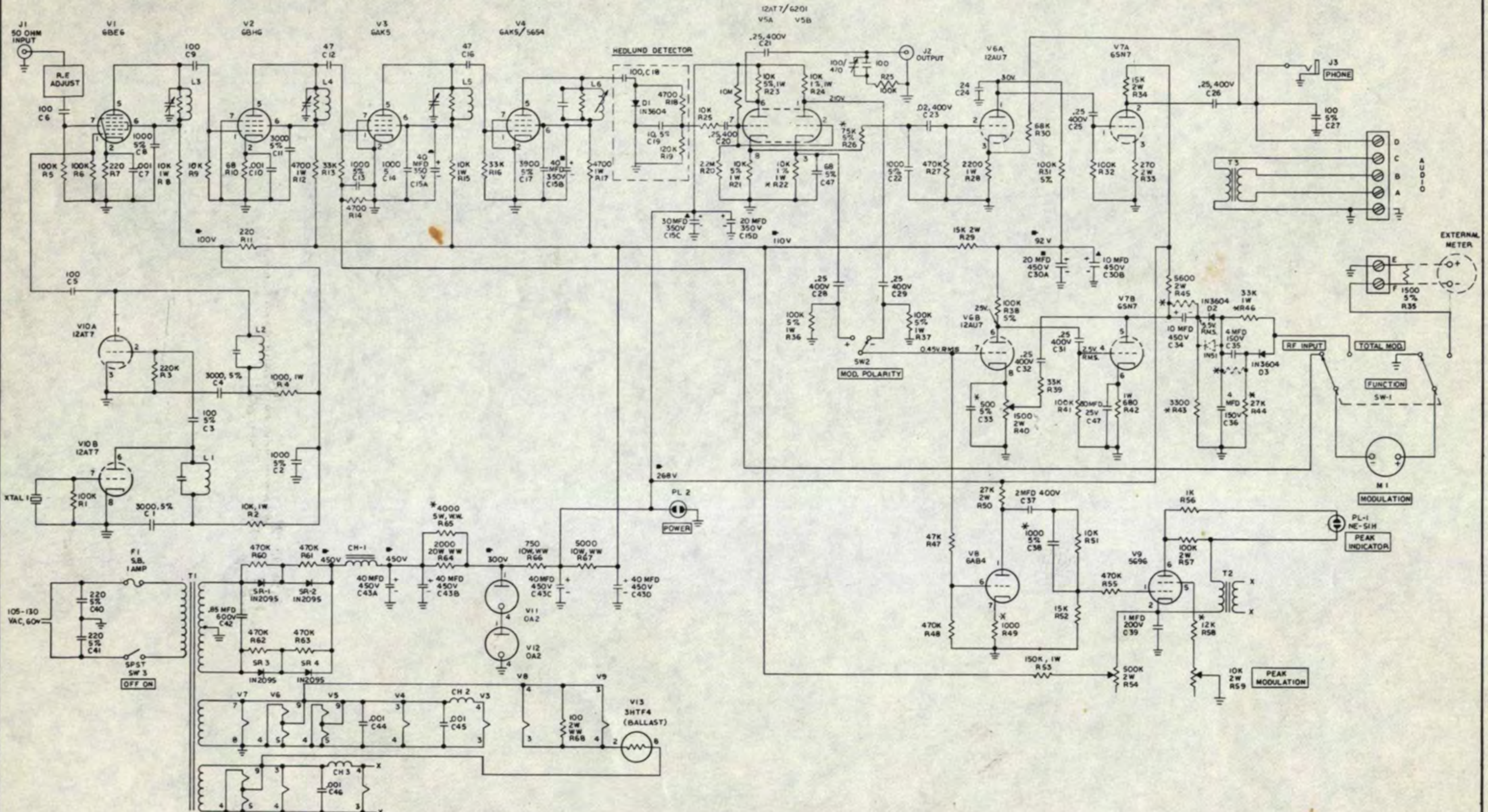
R-51	10 K ±10% ½ W	Composition carbon,	fixed resistor	Allen-Bradley
R-52	15 K ±10% ½ W	" "	" "	" "
R-53	150 K ±10% 1 W	" "	" "	" "
R-54	300 K ±10% 2 W	" "	control type AB	Ohmite
R-55	470 K ±10% ½ W	" "	fixed resistor	Allen-Bradley
R-56	10 K ±10% ½ W	" "	" "	" "
R-57	100 K ±10% 2 W	" "	" "	" "
R-58	Adjust at factory, nominal value, (12 K ±10% ½ W)	" "	" "	" "
R-59	10 K ±10% 2 W	" "	control type J	" "
R-60	470 K ±10% ½ W	" "	fixed resistor	" "
R-61	470 K ±10% ½ W	" "	" "	" "
R-62	470 K ±10% ½ W	" "	" "	" "
R-63	470 K ±10% ½ W	" "	" "	" "
R-64	2000 ±10% 20 W	top mount ceramic,	wirewound fixed resistor	Milwaukee
R-65	Adjust at factory, nominal value, (4000 ±10% 5 W)	vitreous enamel	wirewound fixed resistor	Ohmite
R-66	750 ±10% 10 W	vitreous enamel	wirewound fixed resistor	Ohmite
R-67	5000 ±10% 10 W	" "	" "	"
R-68	100 ±10% 2 W	sandstone	" "	Milwaukee
T-1	Power transformer,	105-130 VAC (regulated plate filament)		Sole Electric
T-2	Transformer, 6 v primary,	150 v @ 10 ma. secondary		McMartin Industries
T-3	Audio output 15 K primary,	600 ohm secondary shielded		McMartin Industries

PARTS LIST (cont'd)

SR-1	1N2095 Silicon rectifier 600 piv @ 700 ma.	P.R. Mallory
SR-2	1N2095 Silicon rectifier 600 piv @ 700 ma.	" "
SR-3	1N2095 Silicon rectifier 600 piv @ 700 ma.	" "
SR-4	1N2095 Silicon rectifier 600 piv @ 700 ma.	" "
D-1	1N3604/SD 150 Silicon diode	General Electric
D-2	1N3604/SD " "	" "
D-3	1N3604/SD " "	" "
SW-1	2 pole, 2 position wafer switch	Centralab
SW-2	2 pole, 2 position wafer switch	"
SW-3	SPST bat handle toggle switch	Cutler Hammer
L-1	Osc. coil assembly with nominal value capacitor (5 pf $\pm$10% 500 v)	McMartin Industries
L-2	Doubler coil assembly with nominal value capacitor (5 pf $\pm$10% 500 v)	McMartin Industries
L-3	IF coil assembly with 3.5 pf - 12 pf adjustable capacitor and nominal value resistor (10 K $\pm$10% ½ w)	" "
L-4	IF coil assembly with 3.5 pf - 12 pf adjustable capacitor and nominal value resistor (10 K $\pm$10% ½ w)	" "
L-5	IF coil assembly with 3.5 pf - 12 pf adjustable capacitor and nominal value resistor (2200 $\pm$10% ½ w)	" "
L-6	Slug tuned IF coil assembly with nominal value resistor (27 K +10% ½ w) and nominal value capacitor (24 pf $\pm$10% 500 v)	" "

PARTS LIST (cont'd)

PL-1	Main peak indicator NE-51H	General Electric
PL-2	Pilot Light assembly (neon)	Leecraft
CH-1	Filter choke, 6R @ 150 ma. dc	Quality Transformer
CH-2	2.5 uh RF choke	McMartin Industries
CH-3	2.5 uh RF choke	McMartin Industries
XTAL-1	Main channel crystal, frequency specified by customer	McMartin Industries
M-1	Meter, 300 uh main channel modulation	McMartin Industries
F-1	Fuse, 1 amp 3 AG Slo-Blo	Littlefuse
V-1	Tube - 6BE6	General Electric
V-2	Tube - 6BH6	" "
V-3	Tube - 6AK5	" "
V-4	Tube - 6AK5/5654	" "
V-5	Tube - 12AT7/6201	" "
V-6	Tube - 12AU7	" "
V-7	Tube - 6SN7	" "
V-8	Tube - 6AB4	" "
V-9	Tube - 5696	" "
V-10	Tube - 12AT7	" "
V-11	Tube - OA2	Amperex
V-12	Tube - OA2	"
V-13	Tube - 3HTF4 (ballast)	Amperite



NOTES
1. ALL RESISTORS ±10% 1/2 W UNLESS OTHERWISE SPEC.
2. CAPACITORS: WHOLE NO'S IN MMFD UNLESS OTHERWISE SPEC.
DECIMALS IN MFD UNLESS OTHERWISE SPEC.
TOL. 10% UNLESS OTHERWISE SPEC.
3. ▭ REPRESENTS FRONT PANEL FUNCTION
4. * REPRESENTS NOMINAL VALUE SELECTED IN PRODUCTION.
5. ► REPRESENTS B+ VOLTAGES TAKEN FROM GROUND

McMARTIN INDUSTRIES, INC. OMAHA NEBRASKA	
TITLE SCHEMATIC, TBM-3500 FM MODULATION MONITOR	
DR. BY: BOOMSMA	DATE: 4-23-63
CHK. BY:	SCALE: —

D-1037