INSTRUCTION BOOK

M5693 MODULATION MONITOR

HARRIS INTERTYPE CORPORATION

GATES

WARRANTY

Seller warrants new equipment manufactured by Gates Radio Company against defects in material or workmanship at the time of delivery thereof, that develop under normal use within a period of one year (6 months on moving parts) from the date of shipment, of which Purchaser gives Seller prompt written notice. Other manufacturers' equipment, if any, including electron tubes, and towers, shall carry only such manufacturers' standard warranty.

Seller's sole responsibility for any breach of the foregoing provision of this contract, with respect to any equipment or parts not conforming to the warranty or the description herein contained, is at its option, (a) to repair or replace such equipment or parts upon the return thereof f.o.b. Seller's factory within the period aforesaid, or (b) to accept the return thereof f.o.b. Purchaser's point of installation, whereupon Seller shall either (1) issue a credit to Purchaser's account hereunder in an amount equal to an equitable portion of the total contract price, without interest, or (2) if the total contract price has been paid, refund to Purchaser an equitable portion thereof, without interest.

If the Equipment is described as used, it is sold as is and where is. If the contract covers equipment not owned by Seller at this date it is sold subject to Seller's acquisition of possession and title.

Seller assumes no responsibility for design characteristics of special equipment manufactured to specifications supplied by or on behalf of Purchaser.

Seller shall not be liable for any expense whether for repairs, replacements, material, service or otherwise, incurred by Purchaser or modifications made by Purchaser to the Equipment without prior written consent of Seller.

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RETURNS AND EXCHANGES

Do not return any merchandise without our written approval and Return Authorization. We will provide special shipping instructions and a code number that will assure proper handling and prompt issuance of credit. Please furnish complete details as to circumstances and reasons when requesting return of merchandise. Custom built equipment or merchandise specially ordered for you is not returnable. Where return is at the request of, or for the convenience of the customer, a restocking fee of 15% will be charged. All returned merchandise must be sent freight prepaid and properly insured by the customer. When writing to Gates Radio Company about your order, it will be helpful if you specify the Gates Factory Order Number or Invoice Number.

WARRANTY ADJUSTMENTS

In the event of equipment failure during the warranty period, replacement or repair parts may be provided in accordance with the provisions of the Gates Warranty. In most cases you will be required to return the defective merchandise or part to Gates f.o.b. Quincy, Illinois, for replacement or repair. Cost of repair parts or replacement merchandise will be billed to your account at the time of shipment and compensating credit will be issued to offset the charge when the defective items are returned.

MODIFICATIONS

Gates reserves the right to modify the design and specifications of the equipment shown in this catalog without notice or to withdraw any item from sale provided, however, that any modifications shall not adversely affect the performance of the equipment so modified.

ADDENDA SHEET

M5693 & M5774A MODULATION MONITORS

At times it has been reported that it is impossible to obtain sufficient RF drive to operate an AM Modulation Monitor from the associated transmitter. This situation usually leads to an attempt to modify the RF pickup assembly in the transmitter. Seldom does this method of correction perform to the customer's expectation.

First, this is not a "fault" in any sense of the word. It is simply a function of the transmitter operating frequency, the type and length of the coax connecting the monitor, and a few other things which usually are beyond normal control.

A small (.0005 mf, or so) mica capacitor can be connected across the RF input terminals of the Monitor, and it will "tune" the line to boost the RF voltage tremendously. The exact capacitor value is impossible to predict, and it can only be found by experiment. On rare occasions, the capacitor will need to go in series with the hot lead at the Monitor, and not in parallel (as before explained). Use whichever method produces the desired result. The important thing is that this correction must be made at the Monitor end of the coax, and not at the transmitter end.

This problem, and suggested correction, will apply to any transmitter and to any monitor model - not just Gates alone. It will work, and it is simple and inexpensive.

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ADDENDA SHEET

M5693 & M5774A MODULATION MONITORS

IMPORTANT: NOTE 1 -

Improper monitor readings will result if the monitor is not first calibrated with proper R.F. input levels. Before final adjustment of carrier input is completed, it is mandatory that the 15K ohm resistor on TB1 be replaced by a 1.5K ohm resistor. (See Section IV Pre-Operation, paragraph 5). The modulation meter will read only 20% on the "CARRIER" position of S1 if the 15K ohm resistor has not been replaced. (S1 is "CALIBRATE-READ" switch below percent modulation meter).

After this is done, make certain that sufficient (but not excessive) unmodulated R.F. input is applied to make both the carrier meter and modulation meter calibrate to 100%. Use "CARRIER" control knob on lower left front panel for calibrating modulation meter. Use "CARRIER METER" control knob behind small hinged cover on front panel to calibrate carrier meter. Couple in just enough unmodulated R.F. to do the job.

IMPORTANT: NOTE 2 -

When using this monitor under actual operating conditions, it is standard operating practice to place the "CALIBRATE READ" switch (S1) in the "POS." position even though the modulation meter reads both positive and negative modulation accurately. This gives maximum protection against over-modulation because the meter then shows modulation percentage in the maximum or upward direction while the negative peak flasher warns of excessive over-modulation in the minimum or negative direction.

If the modulation meter is also placed in the "NEG." position of S1, this double protection feature is removed. In addition, certain types of complex programming may be inaccurately indicated.

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M-5693 MODULATION MONITOR

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1. SPECIFICATIONS FOR M5693 MODULATION MONITOR

Frequency Range	540 - 1600 KC
R.F. Input	
Impedance	Approximately 50 to 75 ohms.
Level	Approximately 10 volts.
Modulation Range	
Meter	0% to 100% on negative peaks. 0% to 110% on positive peaks.
Flasher	50% to 100% on negative peaks in steps of 5%.
Response	
Meter	−0.2 db @ 50 cps. 0 db @ 1000 cps. −0.2 db @ 15,000 cps.
Flasher	0 db @ 20 cps. 0 db @ 1000 cps. −0.3 db @ 5000 cps. −0.6 db @ 7500 cps.
Accuracy	
Meter	±2% of full scale at 1000 cps. for any percentage of modulation.
Flasher	±2% of full scale dial calibration at 1000 cps.
Response Time	
Meter	Meter responds to 90% of correct reading with a 50 millisecond pulse of modulation. The meter overshoots 2 to 3% on a step function signal. Needle returns to 10% of reading in 500 to 800 milliseconds after signal is removed.
Flasher	Responds to a 15 ms. pulse of modulation.
Circuits	
Meter	1. Direct coupled amplifier responds correctly to non-symmetrical modulation waveform. 2. High speed meter. 3. Self-calibration.
Flasher	1. Direct coupled flasher shows accurately negative peaks of modulation regardless of waveform. 2. Self-calibration. 3. The flasher also serves as a carrier-failure alarm.
Detector Linearity	Negative peak clipping in the detector diode is very low for frequencies up to 7500 cps. and does not exceed 5% at 10 KC and 100% modulation.
Monitoring Output When feeding a 600 ohm unbalanced load:	Level - −20 DBM at 100% modulation. Response - ±0.2 DB from 50 to 15,000 cycles with 1000 cycle reference. Distortion - less than 0.25% from 20 - 15,000 cycles, (not including detector distortion). Noise - at least 65 DB below maximum output of −20 DBM.

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When feeding an open circuit (grid):	Level - 0.75 V. R.M.S. at 100% modulation. Response - ±0.2 DB from 50 to 15,000 cycles with 1000 cycles reference. Distortion - less than 0.1% from 20 - 15,000 cycles (not including detector distortion). Noise - at least 65 DB below maximum output of 0.75 V. Loading effect of 1000 mmf. (12 ft. of single conductor shielded cable rated at 85 mmfd. per ft.) at 15,000 cycles is about 0.1 DB.
Fidelity Measuring Output	When feeding a load of 100,000 ohms or more, shunted by 500 mmf. or less, the response is ±0.5 DB from 20 to 30,000 cps. Distortion is less than 0.5% and noise is at least 75 DB below maximum output of 4.5 V. R.M.S.
Power Supply	105 to 125 V. (or 115 to 135 V.) 50/60 cycles. Power consumption is 70 watts.
Auxiliary Outputs	Connections at the rear of the instrument for either a local or a remote percentage modulation meter.
Tubes Used	1 - 6X4, 2 - 12B4A, 1 - 5879, 3 - OA2, 1 - OB2, 1 - OC2, 1 - 5687, 1 - 12AU7, 1 - 2D21, 1 - 8-4
Mounting	Rack mounted. 19" X 8-3/4" panel 11-1/2" depth behind panel.
Weight	25 lbs.

2. INTRODUCTION

The Gates Modulation Monitor M5693 is designed to continuously monitor the percentage of modulation of a broadcast transmitter. The modulation meter responds correctly to very short peaks of modulation. The modulation meter and over-modulation lamp circuits may be calibrated easily without the use of an oscilloscope. This monitor is approved by the Federal Communications Commission for use in AM broadcast stations.

This instruction book affords valuable information for persons who will install, operate or maintain a Gates M5693 Modulation Monitor. The following should be studied so that the procedures will be well in mind while doing the actual work.

3. INSTALLATION

A. Rack Installation and Transmitter Connections.

Check the packing list for materials.
Check for screws that may have shaken loose during shipment. The Monitor is designed to be installed in a rack cabinet. If the temperature inside the rack cabinet exceeds 130° F, ventilate the cabinet by using an exhaust fan at the top of the cabinet and louvres at the bottom for a cool air inlet. The life of the tubes and the reliability of all the equipment in the rack will be greatly increased if the heat is exhausted from the cabinet. Keep the cabinet from the direct rays of the sun. Install parts which have been removed for shipment. Select and install the RF transformer which covers the transmitter frequency. The transformer plugs into a 4 pin socket behind the front panel.

Turn off power to the rack cabinet, connect the 115V AC line to terminals TB2-1&2 provided on the left side of the monitor just inside the drop-down front panel. If the line voltage is consistently above 120 V. use the 125 V. tap on the power transformer (See schematic of monitor). Turn the monitor POWER switch off. Power to the rack cabinet can now be turned on again. The monitor has been designed to operate from a standard EIA monitor output connection which will provide an output of 10 V. into a load of 75 ohms. Transmitters not provided with a monitor output connection may be fitted with a coil of a few turns close to the power amplifier tank circuit. Use a coaxial cable of approximately 75 ohms impedance, such as RG59/U for connection of the transmitter to the RF input terminals on the monitor. A ground should be applied to only one end of the coaxial cable outer conductor; this connection is made at the monitor by means of the RF input terminals. Ground the top terminal of TB1 to the rack cabinet ground.

If the pickup coil in the transmitter is adjustable, adjust it for minimum coupling before turning RF power into the monitor for the first time.

CAUTION

Excessive RF input levels may damage the carrier level control, or Diodes CR1 and CR2. On initial adjustment, set carrier level control to 3 o'clock and switch S1 to calibrate-carrier. Feed a minimum RF level into the monitor. Immediately adjust the Tune Max control for a maximum reading. If the carrier meter reads much above 100, remove the RF input immediately.

If a reading of 100 cannot be reached by the Tune Max control, increase the RF input level in small steps until the reading is 100 with the carrier level control at 2/3 maximum, or at about 3 o'clock.

If the pickup coil is not adjustable, connect a variable resistor across the coil as a voltage divider as shown in Fig. 1. Adjust the variable resistor for minimum output.

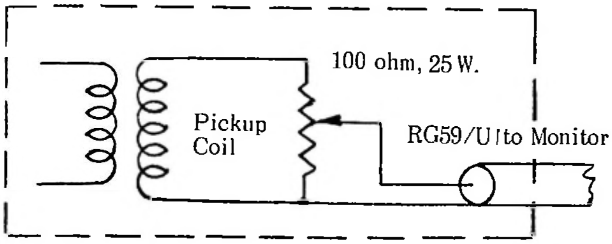


Figure 1. Connections for pickup coil which is not adjustable.

B. Monitor Amplifier Connection

A loudspeaker amplifier may be connected to the terminals at the rear of the instrument marked MON. AMP. The upper terminal is ground. If the input to the amplifier is 600 ohms, leave the 750 ohm resistor connected to the MON AMP terminals. If the amplifier input is a grid or a high resistance volume control remove the 750 ohm resistor.

C. External Meter Connections.

An external meter may be connected after the monitor has been checked with power on and found to be operating properly. First perform the operations found in the "PRE-OPERATION" section. Two types of external meters are available - one to be used in the same building with the monitor; the other, to be used over a telephone line of several miles in conjunction with remote control.

1. Local Meter

If an external meter is to be used in the same building with the monitor, use the remote metering kit M5836A. Remove R23 and connect the meter to these same terminals (marked LOCAL METER). Use a two-conductor shielded cable of less than 50 feet long for the meter connections. Connect the .005 mfd. capacitor across C29 as shown on the schematic. Check monitor calibration. The meter overshoot must now be readjusted. See "Overshoot Adjustment". The external meter may not agree exactly with the meter in the monitor. At any time when the external meter is not connected, the monitor circuits must be restored to normal; put R23 back in place, disconnect the .005 mfd. capacitor from C29, recheck calibration and readjust overshoot.

2. Remote Meter.

If it is desired to use a remote meter over a telephone line connect to the terminals marked "REMOTE METER", using the M5837 remote metering kit. Set the LOCAL-REMOTE switch to LOCAL and the meter switch to CALIBRATE REF. and check calibration of the % MODULATION meter on the monitor (calibrate to 100%). Then turn the LOCAL-REMOTE switch to REMOTE and have someone at the remote point adjust the potentiometer on the remote meter panel so that the remote meter reads 100%. (NOTE: When switched to REMOTE, the local meter will not indicate). REMOTE METER overshoot must now be adjusted. It is done in the same manner as described above for the LOCAL meter, except that C11 is the overshoot adjustment instead of C29.

D. Overshoot Adjustment.

"Overshoot" means that the % MODULATION meter needle does not rise to the steady state value and stop, but goes past it, and then drops back to the steady state value. For checking overshoot, 100% was chosen as the steady-state value because of greatest accuracy and convenience. The overshoot must be adjusted to between 2 and 3%. That is, the needle rises to about 102 or 103%, then drops back to 100%. The easiest and most accurate way to see the overshoot is to hold a card against the face of the % MODULATION meter so that it hides the lower portion of the scale from view. The right hand edge of the card should line up with the meter scale at 102%, as shown in Figure 2. The amount of overshoot can now be easily read. After the monitor has been calibrated carefully, turn the meter switch to CALIBRATE ZERO. Now turn the switch repeatedly from CALIBRATE ZERO to CALIBRATE REF. (each time you switch to CALIBRATE ZERO, allow the needle to return all the way to zero before again switching to CALIBRATE REF.) Without the use of the card, note the approximate amount of overshoot, if any. If there is no overshoot, tighten the adjustment screw of padder C29 about one turn. If there is too much overshoot, loosen the screw. When C29 has been adjusted to give approximately 2 or 3% overshoot, then use the card over the face of the meter in order to read the overshoot exactly.

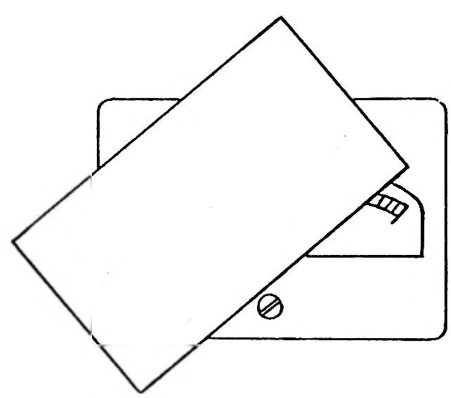


Figure 2.

4. PRE-OPERATION

A. Preliminary Checks

Read these instructions carefully before the monitor is turned on for the first time.

1. With the POWER switch off, check to see that both meters read zero. If they do not, adjust them for zero with a small screwdriver.

2. Set the CARRIER control to about 2/3 clockwise, turn on the transmitter and adjust the TUNE MAX control for maximum deflection of the CARRIER meter. If the CARRIER meter reads much beyond 100, turn off the transmitter immediately and decrease the coupling to the monitor. On the other hand, if the meter reads much below 100, increase coupling. The CARRIER control and diodes CR1 and CR2 may be damaged by feeding too much power into the monitor. See that the monitor is not tuned to a harmonic of the transmitter frequency by tuning for the lowest frequency which will give the greatest indication on the CARRIER meter.

3. Check to see that all tubes are in place. Turn the meter switch to CALIBRATE ZERO. Turn the POWER switch on. The % MODULATION meter lamps should light. During warmup the % MODULATION meter needle may go off scale but will return to zero in a couple of seconds.

4. Turn the meter switch through all of its positions noting the readings on each position. The CALIBRATE REF and CALIBRATE CARRIER positions should read about 20. The READ NEG. and READ POS. positions should read about zero. If the readings are much higher than these values, do not proceed to the next step until the trouble has been located, as the meter amplifier has sufficient power to permanently damage the meter.

5. If all is well, turn the POWER switch off. Remove the 15,000 ohm resistor from the two terminals of TB1, marked "Local Meter". This resistor was for meter protection during initial checks. In its place put the 1500 ohm resistor which will be found taped to a nearby electrolytic condenser. Turn the POWER switch on again. The monitor is now ready for calibration. See "Calibration Instructions" in the DAILY OPERATION section.

B. Accessory Meter

After calibration is successfully performed an accessory meter may be connected as described in the INSTALLATION section.

5. DAILY OPERATION

A. Use of Operating Controls

All of the controls for normal operation, except the power switch, are located on the front panel of the modulation monitor. Calibration controls and the POWER switch are located behind the small panel.

1. Turn the POWER switch on. In about 10 seconds the needle of the % MODULATION meter needle may move off scale, but within a few seconds it will return to near zero. A 10 minute warmup is necessary before the monitor is accurate.

2. Check the input tuning by turning the TUNE MAX control to the point where the CARRIER meter reads maximum. Adjust the CARRIER control for a reading of 100 on the CARRIER meter.

3. To read negative modulation peaks on the % MODULATION meter set the meter switch to READ NEG. To read positive modulation peaks set the meter switch to READ POS.

4. Set the % NEG PEAKS switch to the percentage of modulation at which you want the NEG PEAKS lamp to flash. The flasher always operates from the negative peaks of modulation and will agree with the meter if the meter switch is set to READ NEG. If the positive and negative peaks of modulation are unequal as shown by the % MODULATION meter, the flasher will not agree with the meter if the meter switch is set to READ POS. If the transmitter is turned off or fails, the NEG. PEAKS lamp will light, thus serving as a carrier-failure alarm. The lamp may not flash when the switch is in the 100% position as few transmitters are capable of being modulated 100% negative.

B. Calibration Instructions.

1. With the POWER switch and transmitter off, check to see that the meters read zero. If they do not, adjust them for zero with a small screwdriver.

2. Turn the POWER switch and transmitter on. Allow the monitor at least 15 minutes warm-up time before calibration.

3. Turn the meter switch to CALIBRATE ZERO. Adjust the ZERO control located behind the small panel so that the % MODULATION meter reads zero.

4. Turn the meter switch to CALIBRATE REF. Adjust the REF control so that the % MODULATION meter reads 100. Adjust the FLASHER REF. control so that the NEG PEAKS lamp lights.

Approach setting clockwise slowly several times to be sure of the exact setting. Set it at the point where the flasher just lights.

5. Turn the meter switch to CALIBRATE CARRIER. (The transmitter cannot be modulated during this adjustment.) Adjust the TUNE MAX control for maximum deflection of the CARRIER meter. Adjust the CARRIER control so that the % MODULATION meter reads 100. Adjust the CARRIER METER control so that the CARRIER meter reads 100.

6. Close the small panel. Turn the meter switch to either READ NEG or READ POS.

C. Interpretation of the Monitor's Indications.

The accuracy of the monitor may actually cause concern, by showing the presence of various minor transmitter and equipment troubles not readily discernible by other means. In order to avoid confusion and to assure that these things will not be wrongly ascribed to monitor malperformance, some of them are described. All of them can be verified by using an oscilloscope, with carefully calibrated vertical scale, provided the scope is not subject to "base line shift" troubles.

1. Very few, if any transmitters will actually modulate 100% negative. They usually "square off" from 1 to 5% below the theoretical maximum. The % MODULATION meter will show this, on tone, by coming up slightly short of 100% negative, and refusing to advance farther, regardless of any increase in transmitter audio gain. The NEG PEAKS lamp will not light, when the % NEG PEAKS switch is set on 100% with such a transmitter.

Using an R.F. envelope oscilloscope display, this affect can be seen only when the vertical height of the pattern is expanded so as to place the positive modulation peaks well beyond the limits of the screen. Then the "line" normally thought to represent 100% negative modulation will be seen to have appreciable "thickness", showing that 100% has not quite been reached.

This transmitter trouble is generally caused by less-than-perfect neutralization of the modulated R.F. amplifier, or other things which may allow unmoludated R.F. to appear, unwanted, in the output circuits.

2. Very few transmitters are truly symmetrical in their modulating characteristics. Previously available monitors do not give a correct relative indication of positive and negative peaks when measuring an unsymmetrical wave such as a test tone from a transmitter with carrier-shift, because R-C or transformer coupling elements used in them create "base line shift". This tends to cause the meter readings of positive and negative peaks to be more nearly equal than the peaks actually are. The oscilloscope can give the right answer only if the vertical scale is accurately calibrated and carefully read. The THEORY OF OPERATION section may be helpful toward a better understanding of the above difficulties.

The M5693 Modulation Monitor employs direct-coupling, and therefore, will read the true values of positive and negative peaks, regardless of the presence of carrier shift. Note that 1/2 the difference of the two modulation peaks, shown on the % MODULATION meter, is equal to the percentage carrier shift shown by the CARRIER meter, for tone modulation.

CAUTION: For the correct relationships to exist always set the CARRIER control to give a red-line CARRIER meter indication with no modulation. Do not readjust the CARRIER control to get a red-line reference after modulation has been applied.

3. The % MODULATION meter furnishes an indication of peak level that is useful for program monitoring, but it does not give a VU indication. Its readings will not agree with those of a VU meter, which indicates average level.

4. This monitor will give correct peak indications on single program pulses as short as approximately 50 milliseconds. It will measure the true peak amplitude of program or tone, virtually regardless of the waveforms encountered.

6. THEORY OF OPERATION

A. Theory of Amplitude Modulation.

A review of the definitions associated with amplitude modulation is in order before proceeding to the actual theory of this monitor.

Figure 3a shows an unmodulated R.F. carrier wave of a given amplitude as it would appear on an oscilloscope.

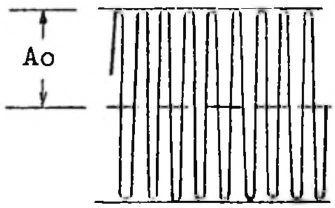


Fig. 3a.

Figure 3b shows a sine wave of audio frequency which will be used to modulate the carrier.

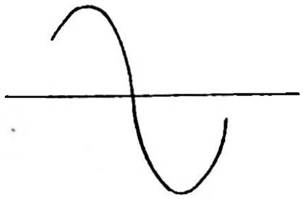


Fig. 3b.

Figure 3c shows a carrier modulated with one cycle of the sine wave audio frequency.

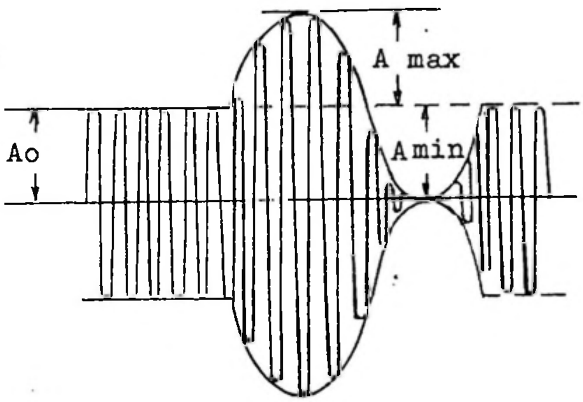


Fig. 3c.

Ao represents the carrier amplitude when unmodulated. A max represents the amount by which the wave exceeds Ao. A min represents the amount that the wave drops below Ao.

Positive modulation is defined by

$$Mp = \frac{A\ Max}{Ao} \times 100\%$$

Negative modulation is defined by

$$Mn = \frac{A\ Min}{Ao} \times 100\%$$

For example, assume that Ao = 10 volts, A max = 10 volts, and A min = 10 volts.

$$Mp = \frac{10}{10} \times 100\% = 100\%$$

$$Mn = \frac{10}{10} \times 100\% = 100\%$$

Hence we have 100% modulation, both positive and negative.

It can readily be seen that negative modulation could never exceed 100%, since A min can never exceed Ao. In actual transmitters, A min never quite reaches the value of Ao due to the fact that the transmitter cannot cut its power completely off at that instant. There is always some carrier power leaking through due to incomplete neutralization or inadequate shielding. Therefore, the % MODULATION meter will never quite reach 100 on negative peaks and the NEG. PEAKS lamp will not flash when the % NEG. PEAKS switch is set to 100.

Another example is shown in Fig. 3d.

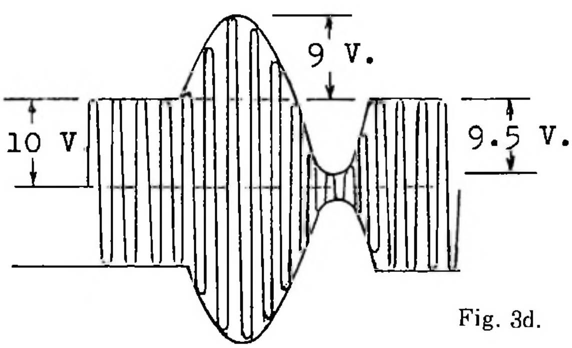


Fig. 3d.

Solving the formula, we get

$$Mp = \frac{9}{10} \times 100\% = 90\%$$

and

$$Mn = \frac{9.5}{10} \times 100\% = 95\%$$

In this case the positive and negative peaks are not equal, which indicates that the modulating wave was not sinusoidal, or that the transmitter is introducing carrier shift. Carrier shift means that the average amplitude of the carrier has changed when modulation was applied.

This same method of measurement applies also to the wave below the centerline. The corresponding parts of the wave above and below the centerline have the same amplitude; that is the lower wave is a mirror image of the upper wave.

B. Theory of the M5693 Monitor.

1. Input and Detector Circuits.

This monitor uses both the upper and lower portions of the modulated carrier wave. The upper portion is used for the audio monitoring and fidelity measuring outputs. The lower half is used for the meter and flasher indications.

The RF input transformer is tuned to resonance with the transmitter by the TUNE MAX variable condenser. The two detectors, CR1 and CR2 rectify the carrier wave and the following filters recover the audio modulation and DC components.

Detector diode CR2 is used only for the audio outputs. When using a noise-distortion meter in conjunction with the monitor, audio is taken from the filter output. However, for monitoring purposes a cathode follower is used as a low impedance source.

Figure 4a represents output of CR1 (if a resistor were substituted for the filter). Figure 4b represents the waveform at the output of the filter. The RF is filtered out, but the audio and DC components pass on through the filter.

The voltage developed by CR1 causes the junction of C5 and L2 to be about 39 volts negative with respect to the + side of the CARRIER meter. R10 applies a bucking voltage of 39 V. positive to the + side of the CARRIER meter with respect to ground. These two voltages, being equal and opposite, cancel each other so the junction of C5 and L2 is at ground potential with unmodulated carrier. See Figure 4b, point #1.

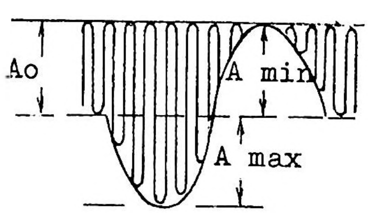


Fig. 4a.

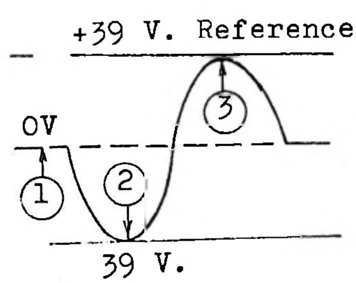


Fig. 4b.

2. Modulation Meter Circuits.

If the meter switch is set to READ POS., the diode CR3 is connected so that it conducts to charge C10 only on peaks which go negative, as in 4 b, point #2. This seeming contradiction arises because we are using the part of the carrier wave below the centerline. Point #2 represents increased transmitter power and is therefore a positive modulation peak. The – 39 volt charge on capacitor C10 is divided by R71, R72, R13, and R14, applied to the meter amplifier, and causes the meter to read 100% (considering a repetitive wave which would keep C10 charged.)

If the meter switch is set to READ NEG. the diode CR3 is turned so that it conducts to charge C10 only on peaks which go positive, as in 4b point #3. Point #3 represents a decrease in transmitter power and is therefore a negative modulation peak. The +39 V. charge on C10 causes the meter to read 100%. The meter connections are reversed by the same switch which reverses CR3, always applying the correct polarity to cause the meter to read up scale.

One thing which contributes to very fast pointer response of the % MODULATION meter is the "spike" voltage formed by the net work consisting of C27, C28, C29, R71, R72, R13, and R14. (With the switch in the REMOTE position, some different components are switched in.) Assume that the transmitter is modulated 100% for one second with a tone from an audio oscillator. The voltage at the top of C10 follows the curve of Fig. 5a. At the instant that 39 volts is applied to C10, the same voltage will appear at the junction of R71 and R72. Then as C27, C28 and C29 charges, the voltage at the junction of R71 and R72 quickly drops to a value determined by the voltage divider ratio, or about 14 V. as shown by Fig. 5b. The lower part of the divider R13 and R14 feeds a grid of V1 with the same wave shape described above, but of smaller amplitude. The other grid of V1 is held at a constant value. The voltage difference developed between the cathodes is applied to the series combination of R23 and the % MODULATION meter. The sharp "spike" voltage overcomes the inertia of the meter movement to start the needle off fast. By the time that the needle reaches 100%, the spike has dropped to a "plateau" level, which holds the meter needle at 100%. At the end of the one second pulse of modulation C10 discharges slowly, causing the needle to slowly return to zero. The very fast upswing of the meter needle gives the monitor the capability of indicating correctly rather short pulses of modulation, and will indicate 90% of the correct reading on a modulation pulse of only 50 milliseconds duration.

C29 is adjusted for a charging rate to suit the individual meter. It is adjusted to give a slight overshoot of the meter needle for a step function signal, as in Fig. 5a.

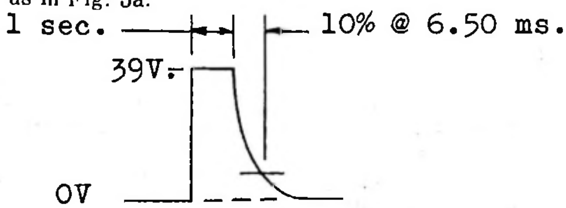


Fig. 5a. - voltage across C10

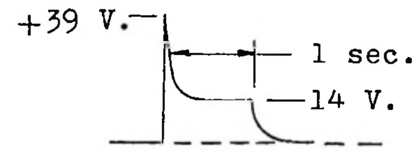


Fig. 5b. - voltage at junction of R71 & R72.

The circuits are D.C. coupled all the way from the detector through the meter. This eliminates the error introduced by resistance-capacity or transformer coupling as in previous monitors when reading a non-symmetrical waveform. If the transmitter is modulated 90% positive and 95% negative, an R-C or transformer coupled monitor will tend to average out the two readings, giving perhaps readings of 92% positive and 93% negative modulation. However with D.C. coupling, the values of modulation are read correctly.

3. Flasher Circuits.

A resistive network made up of R46 through R59 delivers a given percentage of the R.F. detectors D.C. output component to the control grid of thyratron of V12 depending upon the setting of the % NEG PEAKS switch. Capacitor C21 bypassing the % NEG PEAKS switch applies a fixed part of the detector's audio component to the thyratron control grid.

A power supply voltage, adjustable by means of the FLASHER REF control applies an initial bias to V12 at its cathode, so as to cause the thyratron just to conduct when its grid-ground voltage is +39 V. When conduction occurs, the NEG PEAKS lamp flashes. V12 plate voltage is supplied from a separate transformer winding. Compensation for voltage variation in this winding due to line voltage variations is furnished by R41 which increases the bias on V12 whenever the AC line voltage increases. The NEG PEAKS lamp will seldom flash when the % NEG PEAKS switch is set to 100% even though the transmitter appears to be modulated 100%. The reason for this is that the flasher reads the negative peaks of modulation and few, if any, transmitters will actually modulate 100% negative. At negative peaks of modulation some RF energy leaks through the modulated stage due to incomplete neutralization or insufficient shielding. When the transmitter is turned off, the NEG PEAKS lamp will flash, serving as a carrier-failure alarm.

4. Power Supplies.

The plate voltage for V1 is supplied by a series regulated power supply. The positive side of the supply is clamped at 180 V. above chassis ground and the voltage at the negative terminal of this supply is adjustable by means of R36 in the vicinity of – 120 V. with respect to ground.

A separate supply uses voltage regulator tubes for shunt regulation. This supply furnishes two reference voltages and V2 plate voltage. The filament voltage of V12 is regulated by ballast RT1.

7. MAINTENANCE

A. Tubes

When replacing tubes, turn off the POWER switch. The meter may be permanently damaged if V1 or tubes in the series-regulated power supply are replaced while power is on.

If any of the tubes V4 through V7 are replaced, check the voltage at the negative side of C17. Adjust R36 for –130 V. at C17. If either V12 or RT1 are replaced, V12 filament voltage must be checked. Connect an A.C. voltmeter between the slider of R63 and pin 7 of RT1. Adjust R63 slider so that the meter reads 6.3 V. Recheck this voltage after about 100 hours of operation. (This also applies to a new monitor).

B. Diodes

If it becomes necessary to replace any of the germanium or silicon diodes CR1 - CR6, do not attempt to unsolder the diode. Clip the leads as close to the terminals as possible and connect the new diode. While the new diode connections are being soldered keep the heat from being conducted to the diode by holding the diode lead with a pair of pliers to carry away the heat.

C. Modulation Meter

If the % MODULATION meter is replaced, the selected resistor across R14 may have to be changed or removed entirely. Need for a change of resistance is indicated when the calibrating controls behind the drop panel do not have sufficient range to calibrate the monitor. The new meter may also require "overshoot" adjustment. See "Overshoot" Adjustment" in the INSTALLATION section.

D. Fidelity Measurements

When making connections to the MEASURE FIDELITY terminals on the back of the monitor, note that the upper terminal of the two is ground. The leads should be shielded and as short as possible.

8. TROUBLE SHOOTING

A. Conditions of Test

The voltage shown on the schematic were taken with normal line voltage, unmodulated RF input and the monitor carefully calibrated. In the following notes, where an abnormal condition is described, it is assumed that all of the other circuits are operating normally.

CAUTION-- Before replacing any tubes, read "Tubes" in MAINTENANCE section.

B. Malfunction and Remedies

1. Monitor completely inoperative; meter lamps and tubes do not light when POWER switch is turned on.

   A. Check fuse F1.
   B. Check for line voltage at TB2.

2. Meter lamps do not light when POWER switch is on. (Carrier meter is not illuminated.)

   A. Remove the two screws from the front of the % MODULATION meter case. Pull off the front cover of the case and check or replace lamps. When replacing the front cover be sure that the zero-set toggle fits into place properly.
   B. Check for voltage at small meter terminals. (Use caution not to short or touch test leads to large meter terminals.)

3. V4 and V5 do not light.

   A. The filament of these two tubes are in series; if one tube is open, neither tube will light.

4. V12 does not light.

   A. Check V12 for open filament.
   B. Check ballast tube RT-1 for open filament

5. All power transformer secondary voltages either too high or too low.

   A. Check AC line voltage. If line voltage is between 105 and 120 V. use 115 V. tap. If line voltage is between 120 and 135 V. use 125 V. tap.

6. Incorrect or no voltages at C17C. (Should be about 300 V. across C17C. The voltage shown on the schematic is referenced to ground.)

   A. Check or replace tubes V3 through V7.
   B. See if V12 glows.
   C. Check voltage across C17A and across C17B. Should be about 370 V. and 355 V. respectively with normal AC line voltage.

7. Incorrect voltage at V8, pin 1 to ground.

   A. See if V8 and V9 both glow.
   B. Check voltage on V1 at pin 3 and at pin 6.
   C. Check or replace V1.

8. Voltage at V10, pin 1 is high.

   A. Replace V10 and V11. Check all voltages back to CR6. Check V2 voltages.

9. Voltage at V10, pin 1 is low.

   A. Determine whether V2 is drawing excessive current by measuring voltage across R30. Should be about 8 or 9 volts.
   B. Check voltages between CR6 and V10.

10. CARRIER meter does not indicate (transmitter on).

   A. See if % MODULATION meter reads 100% when meter switch is set to CALIBRATE CARRIER.
   B. Check voltage from + side of CARRIER meter to L2. Should be about –39 V. at L2.

C. Check voltage from + side of CARRIER meter to L4. Should be about +39 V. at L4. If there is voltage at L4 and not at L2, CR1 may be bad, L1 or L2 may be open, or C3, C4 or C5 may be shorted.
D. Check for metal filings in the plates of the TUNE MAX capacitor.
E. Remove the plug-in RF transformer and check continuity of each winding. Check for open circuit between windings. Remove transmitter cable from RF INPUT terminals. Input terminals should read about 97 ohms. Measure from arm of R1 to ground. Should measure about 97 ohms with CARRIER control full clockwise and 47 ohms with CARRIER control fully counterclockwise.

11. % MODULATION meter does not zero when turning ZERO control with the meter switch in CALIBRATE ZERO position.

A. Check voltages at each end of ZERO control to ground.
B. Check V1 voltages.
C. Check voltage at junction of R21 and R22.
D. Replace V1.

12. % MODULATION meter does not indicate in any position of meter switch.

A. Replace V1.
B. Check meter; turn off POWER switch. Connect a 1-1/2 V. dry cell from pin 3 to pin 6 of V1. Turn meter switch for upscale reading. Should read about 85%.
C. Turn power on again. Check tube and power supply voltages.
D. Set meter switch to CALIBRATE REF. The voltage across R14 should be about 2.2 V. The voltage across C10 should be about 39 V. The voltage from the arm of R10 to ground should be about +39 V.
E. If CR3 was replaced, perhaps it was installed with the wrong polarity.

13. % MODULATION meter reads down-scale in CALIBRATE REF. and CALIBRATE CARRIER positions of meter switch and reads down with modulation in READ NEG. and READ POS. positions.

A. Meter terminals are reversed.

14. % MODULATION meter reads zero in CALIBRATE ZERO position of S1, but reads off scale in CALIBRATE REF position.

A. Check voltage at the arm of the REF control (if meter bangs against stop, insert 15K resistor at LOCAL METER terminals in place of R23 until the trouble is located).

15. % MODULATION meter reads zero in CALIBRATE ZERO position of S1, but reads off scale in both CALIBRATE REF. and CALIBRATE CARRIER positions. (See Item 14 for precaution to protect meter.)

A. Set S1 to CALIBRATE REF. Voltage across R14 should be about +2.2 V. and across C10 about +39 V.

16. % MODULATION meter reads off scale either up or down for any position of S1.

A. Take precaution to protect meter as in Item 14. Perform test shown in item 9.

17. % MODULATION meter needle seems sluggish or swings wide.

A. First calibrate monitor (see Calibration Instructions in PRE-OPERATION section). Check meter overshoot (see "Overshoot Adjustments" in INSTALLATION section).

18. No output from MON. AMP. terminals when transmitter is modulated.

A. Note that normal output into a 600 ohm load is −20 dbm. This is only about .07 V RMS.
B. Replace V2.
C. Check for audio output at MEASURE FIDELITY terminals with a pair of high impedance headphones.
D. Check V2 circuit DC voltages.

19. Output from MON. AMP. terminals seem distorted.

A. Perform steps B and D in 18 above.
B. Check distortion at MEASURE FIDELITY terminals with a Distortion Analyzer.
C. Check distortion at MON. AMP. terminals; disconnect load and 750 ohm resistor if feeding a 600 ohm load. This gives enough voltage to measure distortion on some distortion analyzers.
D. Check distortion of external amplifier by using an audio oscillator and distortion analyzer.

20. NEG. PEAKS lamp will not flash under any conditions.

A. If V12 does not light, remove V12 and RT1 and check their filaments for continuity.
B. Replace NEG. PEAKS lamp, A1.
C. Check voltage at cathode of V12.
D. Check AC voltage between orange wires of power transformer.

21. The NEG. PEAKS lamp does not agree with the % MODULATION meter when the meter switch is set to READ NEG and the % NEG. PEAKS switch is set to 50.

A. Carefully calibrate the monitor (see "Calibration Instructions" in the PRE-OPERATION section). Set the meter switch to READ NEG. and the % NEG. PEAKS switch to 50. Modulate the transmitter with a 1000 cycle tone from an audio oscillator. Gradually increase the oscillator output until the NEG. PEAKS lamp flashes. Note the reading of the % MODULATION meter and decrease the oscillator output. If the reading was below 50%, loosen the locking nut on R46 (hold the base of the locking assembly with a wrench while turning the top nut) and turn the R46 shaft slightly counterclockwise. Again gradually increase the oscillator output until the NEG. PEAKS lamp flashes and note the % MODULATION meter reading. If the meter should read higher than 50% when the lamp flashes, turn R46 shaft clockwise. After final adjustment of R46 is made, carefully tighten the locking nut, holding the base of the locking assembly so that it doesn't turn.

Make a final check at 50% modulation to be sure that tightening of the lock nut has not changed the setting of R46.

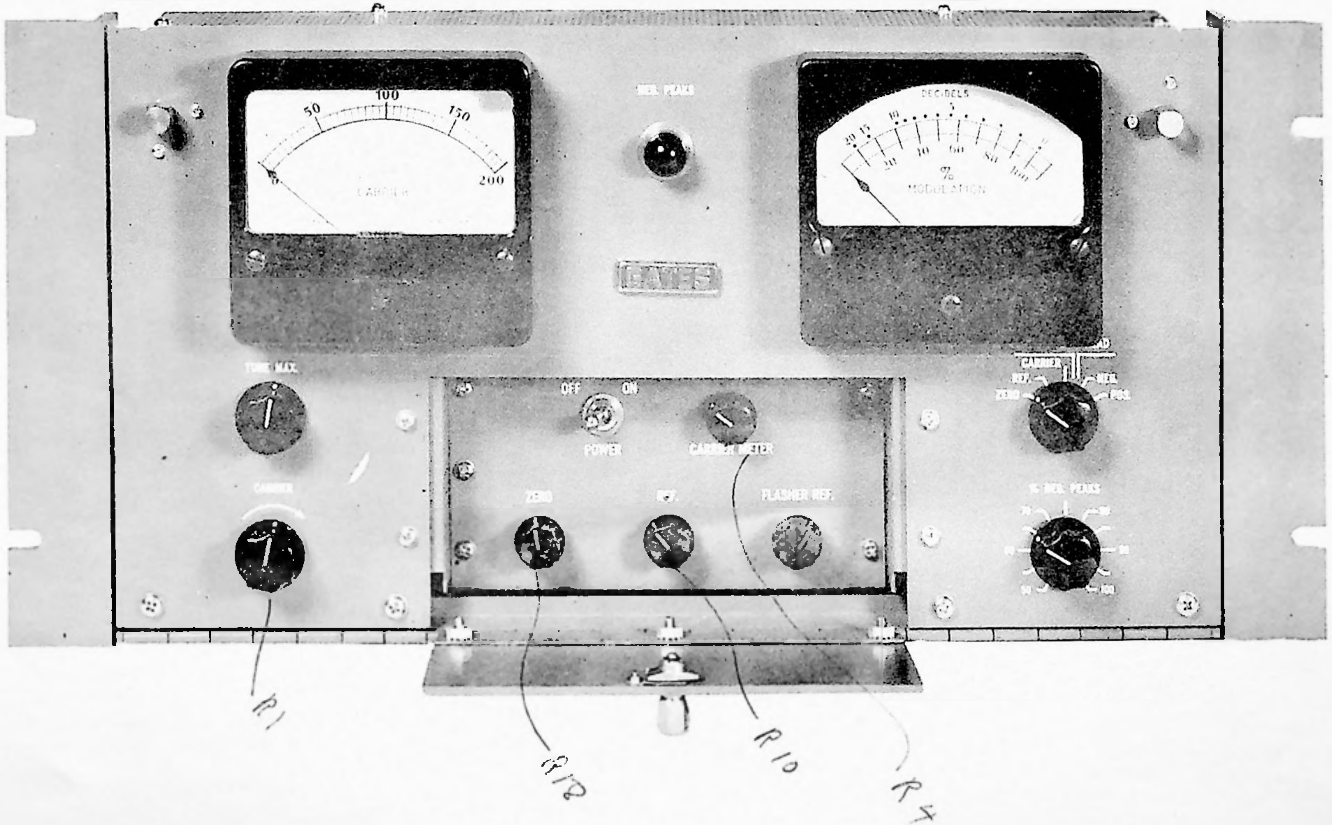
9. PARTS LIST

Symbol No.	Gates Part No.	Description
A1	396 0063 000	Lamp, Neon
C1	516 0115 000	Cap., 24 uuf.
C2	520 0119 000	Cap., Tune Max., 6.7 - 140 uuf.
C3, C6	516 0134 000	Cap., 120 uuf.
C4, C7	516 0141 000	Cap., 240 uuf.
C5	516 0132 000	Cap., 100 uuf.
C8	516 0124 000	Cap., 50 uuf.
C9	522 0077 000	Cap., 10 uf., 50 V.
C10	508 0312 000	Cap., .02 uf., 400 V. ±5%
C11, C29	500 0850 000	Cap., Variable, 1400-3055 uuf.
C12	508 0076 000	Cap., .005 uf., ±10% 100 V.
C13	506 0009 000	Cap., 2 uf., 200 V.
C14	524 0040 000	Cap., 150 uf., 50 V.
C15	506 0008 000	Cap., 1 uf., 200 V.
C16	524 0062 000	Cap., 20-20 uf., 450 V.
C17	524 0079 000	Cap., 15-15-10 uf., 450 V.
C18	506 0010 000	Cap., .01 uf., 400 V.
C20	522 0077 000	Cap., 10 uf., 50 V.
C21	506 0008 000	Cap., 1 uf., 200 V.
C22, C23	508 0011 000	Cap., .01 uf., 400 V.
C24	524 0048 000	Cap., 20 uf., 450 V.
C25	516 0054 000	Cap., .001 uf., 1 KV
C26	506 0004 000	Cap., .05 uf., 200 V.
C27	508 0076 000	Cap., .005 uf., 100 V., ±10%
C28	508 0077 000	Cap., .0033 uf., 600 V.
C30		Cap., (Use with External Meter)
CR1, CR2, CR1A, CR2A	384 0066 000	Germanium Diode, w/std. glass package with metal ends and axial leads
CR3	384 0143 000	Silicon Diode
CR4, CR5, CR6	384 0020 000	Silicon Rectifier
E1	614 0392 000	Binding Post (Red)
E2	614 0393 000	Binding Post (Black)
F1	398 0058 000	Fuse, 2 amp., 250 V.
L1, L2, L3, L4	494 0062 000	Filter Choke, 30 mh
L5	476 0009 000	Choke
M1	632 0257 000	Meter, Carrier
M2	632 0060 000	Meter, % Modulation
R1	552 0288 000	Control, Carrier, 50 ohms
R2	542 0058 000	Res., 50 ohm, 10 W.
R3	540 0076 000	Res., 11K ohm, 1/2 W., 5%
R4	552 0723 000	Control, 5 ohm

Symbol No.	Gates Part No.	Description
R5	540 0441 000	Res., 5.6 ohm, 1 W., 10%
R6	540 0072 000	Res., 9100 ohm, 1/2 W., 5%
R7, R27	540 0054 000	Res., 1600 ohm, 1/2 W., 5%
R8	540 0039 000	Res., 390 ohm, 1/2 W., 5%
R9	540 0661 000	Res., 120K ohm, 2 W., 5%
R10, R43	552 0728 000	Control, 5K ohm
R11	548 0065 000	Res., 18K ohm, 1 W., 1%
R12	540 0145 000	Res., 10 megohm, 1/2 W., 5%
R13	540 0114 000	Res., 510K ohm, 1/2 W., 5%
R14	540 0116 000	Res., 620K ohm, 1/2 W., 5%
R14A	540 0138 000	Res., 5.1 megohm, 1/2W., 5%
R15, R16	540 0040 000	Res., 430 ohm, 1/2 W., 5%
R17	540 0663 000	Res., 150K ohm, 2 W., 5%
R18	552 0729 000	Control, 10K ohm
R19	540 0659 000	Res., 100K ohm, 2 W., 5%
R20	540 0049 000	Res., 1000 ohm, 1/2 W., 10%
R21, R22, R39	542 1049 000	Res., 10K ohm, 5 W., 5%
R23	540 0053 000	Res., 1500 ohm, 1/2 W., 5%
R23A	540 0077 000	Res., 15K ohm, 1/2 W., 5%
R26	540 0202 000	Res., 100K ohm, 1/2 W., 10%
R28	540 0210 000	Res., 470K ohm, 1/2 W., 10%
R29	540 0062 000	Res., 3600 ohm, 1/2 W., 5%
R30	540 0179 000	Res., 1200 ohm, 1/2 W., 10%
R31	540 0772 000	Res., 470K ohm, 2 W., 10%
R32	540 0118 000	Res., 750K ohm, 1/2 W., 5%
R33	540 0063 000	Res., 3900 ohm, 1/2 W., 5%
R34	540 0642 000	Res., 20K ohm, 2 W., 5%
R35	540 0377 000	Res., 75K ohm, 1 W., 5%
R36	552 0729 000	Control, 10K ohm
R37	540 0375 000	Res., 62K ohm, 1 W., 5%
R38, R45	540 0214 000	Res., 1 megohm, 1/2 W., 10%
R40, R66	542 1059 000	Res., 1500 ohm, 5 W., 5%
R41	540 0728 000	Res., 100 ohm, 2 W., 10%
R42	540 0662 000	Res., 130K ohm, 2 W., 5%
R44	548 0066 000	Res., 20K ohm, 1 W., 1%
R46	550 0208 000	Control, 250K ohm
R47	540 0113 000	Res., 470K ohm, 1/2 W., 5%
R49, R50, R51, R52, R53, R54, R55, R56, R57, R58, R59	540 0091 000	Res., 56K ohm, 1/2 W., 5%
R60	540 0212 000	Res., 680K ohm, 1/2 W., 10%
R61, R62	540 0578 000	Res., 43 ohm, 2 W., 5%
R63	552 0007 000	Res., Adj., 15 ohm, 10 W.
R64	540 0492 000	Res., 100K ohm, 1 W., 10%
R65	540 0197 000	Res., 39K ohm, 1/2 W., 10%
R67, R68	540 0271 000	Res., 3 ohm, 1 W., 5%
R69	540 0057 000	Res., 2200 ohm, 1/2 W., 5%
R70	540 0046 000	Res., 750 ohm, 1/2 W., 5%
R71	540 0142 000	Res., 7.5 megohm, 1/2 W., 5%
R72	540 0132 000	Res., 3 megohm, 1/2 W., 5%
R73	540 0065 000	Res., 4700 ohm, 1/2 W., 5%
RT1	378 0014 000	Tube, Ballast
S1	600 0260 000	Switch, Rotary
S2	604 0005 000	Switch
S3	600 0250 000	Switch, Rotary
S4	602 0007 000	Switch, Lever
T1	472 0270 000	Transformer, Power
T2	913 1850 001	Transformer (540-900 KC)
T2	913 1850 002	Transformer (900-1600 KC)

Symbol No.	Gates Part No.	Description
TB1	614 0075 000	Terminal Board
TB2	614 0092 000	Terminal Board
V1	370 0151 000	Tube, 5687
V2	370 0195 000	Tube, 12AU7A
V3	370 0105 000	Tube, 6X4
V4, V5	370 0119 000	Tube, 12B4A
V6	370 0155 000	Tube, 5879
V7, V10, V11	370 0001 000	Tube, OA2
V8	370 0002 000	Tube, OB2
V9	370 0004 000	Tube, OC2
V12	378 0001 000	Tube, 2D21
XA1	406 0051 000	Pilot Light Assembly (Red)

Symbol No.	Gates Part No.	Description
XF1	402 0022 000	Fuseholder
XRT1	404 0016 000	Socket
XT2	404 0011 000	Socket
XV1	404 0063 000	Socket, Turret
XV2, XV4, XV5	404 0040 000	Socket
XV3, XV7, XV8, XV9, XV10, XV11	404 0033 000	Socket
XV6	404 0044 000	Socket
XV12	404 0038 000	Socket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DECIBELS
% MODULATION
CARRIER
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OFF
ON
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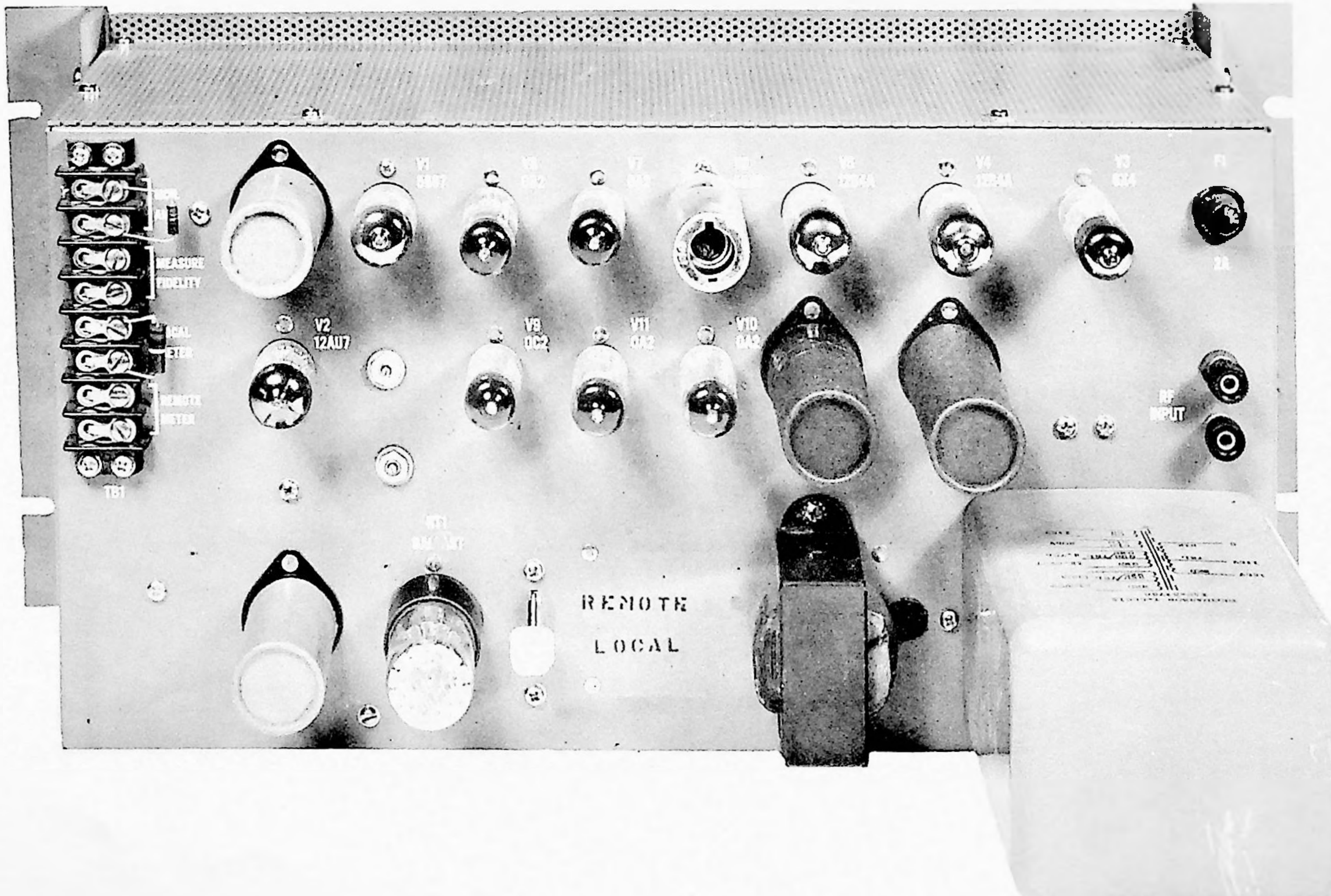
% MOD. PEAKS
GATES
R1
R12
R10
R4

AX 175



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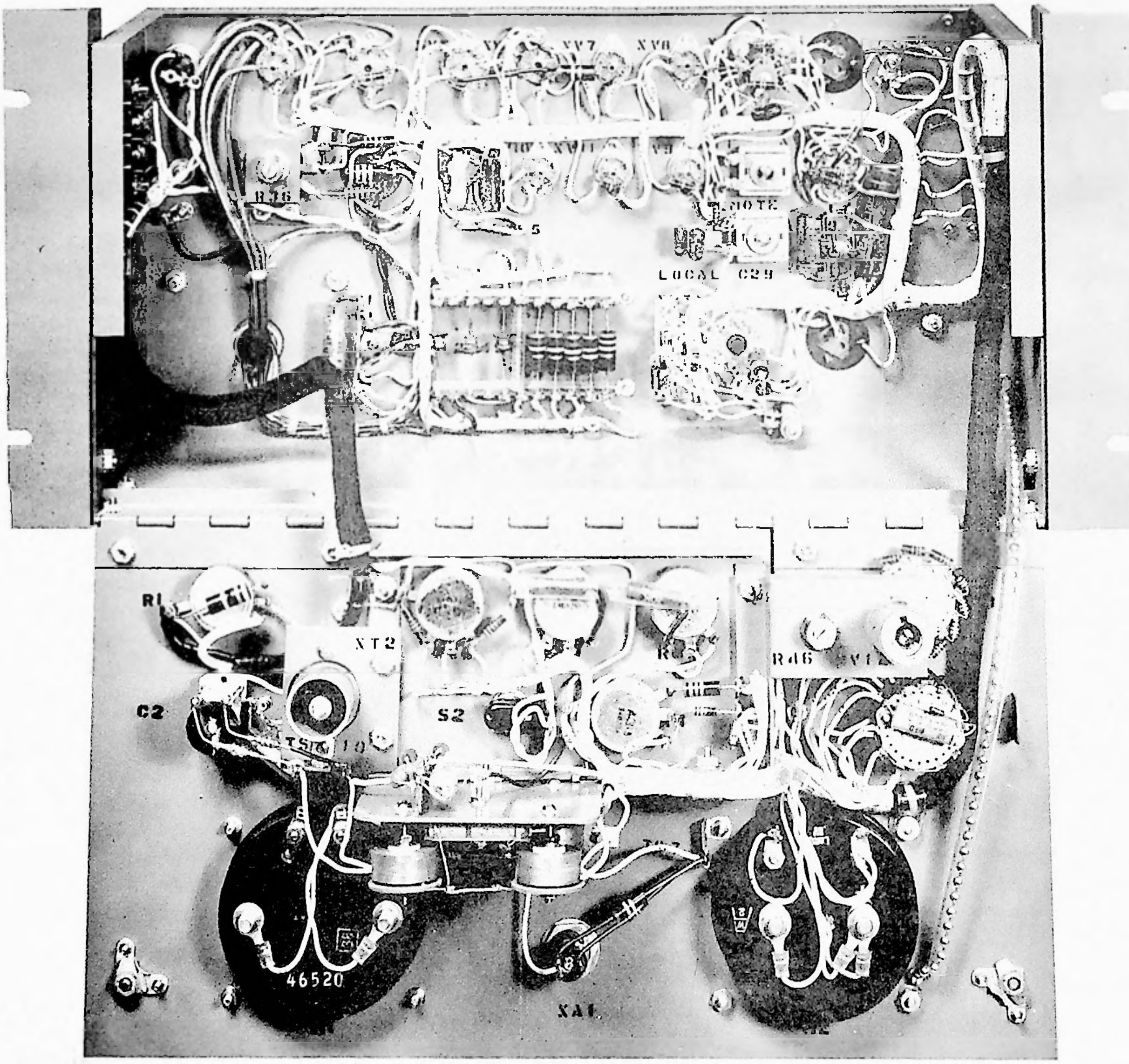
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XT2
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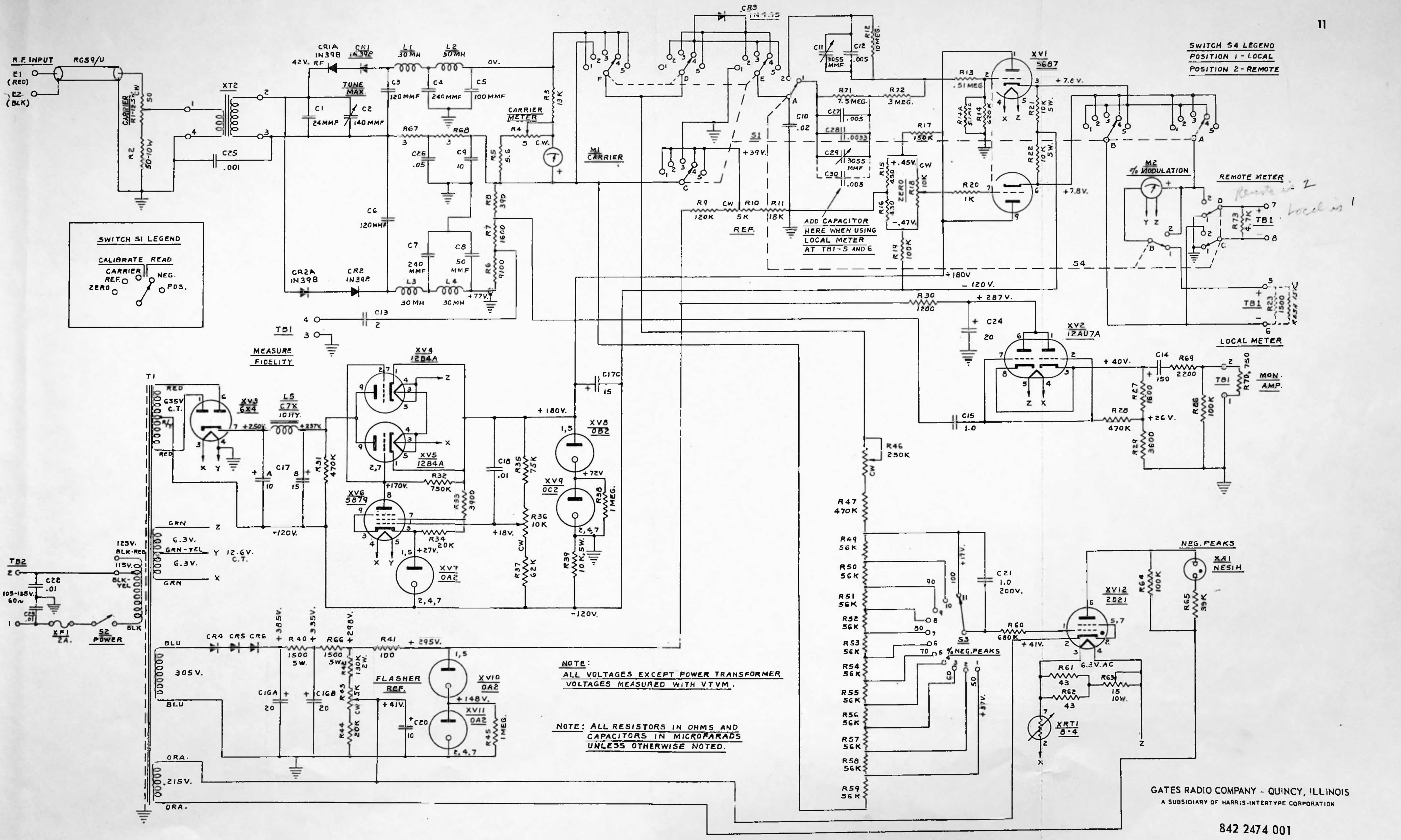
46520
XA1



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SCHEMATIC MODULATION MONITOR M5693

NOTES

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