INSTRUCTIONS FOR NO. 90831 MODULATOR

1. GENERAL

The 90831 is a conservatively rated, compact 40 watt modulator designed especially for use with the 90801 Transmitter, but it is adaptable to other transmitters. It contains a 12AX7 double triode speech amplifier, a 6C4 voltage amplifier and class AB1 6146's. The 90831 is suitable for modulating transmitters with power input up to 80 watts. The audio gain is ample for the use of low level high impedance crystal or dynamic phones. The frequency response is adjusted for good communications intelligibly with limited sidebands. The modulator incorporates a switch for complete change-over of modulator, transmitter, and power supplies from CW to 'phone. The modulator is designed to operate into an r.f. load impedance of 4800 ohms.

2. POWER REQUIREMENTS

High Voltage
400 volts d.c. to 750 volts d.c.
at 60 to 150 ma.

Low Voltage
200 volts d.c. to 240 volts d.c.
at 12 to 37 ma.

Heater Voltage
6.3 volts a.c. at 2.95 amperes

Bias Voltage
—45 volts d.c. at zero current

The Millen 90281 High Voltage Power Supply is ideal for supplying the high voltage and the heater voltage. The 90281 supplies 500 to 750 volts d.c. at 235 ma. and 6.3 volts a.c. at 5 amperes. One 90281 Power Supply will handle the high voltage requirements for both the 90801 Transmitter and the 90831 Modulator.

The MILLEN 90201 Low Voltage Power Supply is ideal for supplying the low voltage. It supplies 240 volts d.c. at 115 ma., 105 volts d.c. at 35 ma. regulated, minus 105 volts d.c. at 4 ma. and 6.3 volts a.c. at 4.2 amperes. One low voltage power supply will supply the low voltage for both the 90801 Transmitter and the 90831 Modulator as well as the bias voltage and heater voltage for the modulator. An external divider will be required to reduce the 105 volts bias to 45 volts as required in the modulator.

3. TERMINALS

On the rear panel of the 90831 Modulator are two terminal strips and a high voltage safety terminal.

Safety Terminal This is the modulated d.c. output from the modulator and should be connected to the high voltage terminal on the transmitter.

GND. There are two ground terminals to simplify interconnection between the power supplies, the monitoring oscilloscope, the transmitter and the modulator. To the ground terminals should be connected one side of the heater voltage, the positive side of the bias, the negative side of the high voltage power supply, the negative side of the low voltage power supply and the ground connection to the monitoring oscilloscope.

SCOPE. The audio output of the modulator is isolated from B+ by a coupling capacitor, reduced through a voltage divider and applied to the SCOPE terminal. The audio output at this point is adequate for proper deflection of a 2" or 3" cathode ray tube using no amplifier.

3. This terminal is connected to terminal 4 through the 'phone/CW switch when the switch is in the 'phone position. This is used in switching the screen supply of the transmitter. Terminal 3 on the modulator should be connected to terminal 3 on the 90801 Transmitter.

4. Terminal 4 is connected to terminal 3 through the 'phone/CW switch in the 'phone position and is used in switching the screen supply in the 90801 Transmitter. Terminal 4 on the modulator should be connected to terminal 4 on the 90801 Transmitter.

5. Terminal 5 is connected to terminal 4 through the 'phone/CW switch in the CW position and is used in switching the screen supply on the 90801 transmitter. The normal CW screen supply voltage for the 6146 in the 90801 Transmitter (approximately 240 volts)

should be applied to this terminal rather than directly to terminal 4 on the transmitter.

The end terminal on the top terminal strip is a spare and may be used for interconnecting leads.

C— An external bias supply of minus 45 volts should be connected to this terminal. No current is drawn so this bias voltage may be obtained from any bias source such as the 90201 Low Voltage Power Supply or from a small hearing aid battery.

6.3 V. Heater voltage of 6.3 volts a.c. at 2.95 amperes should be connected to this terminal.

+LV +200 to 240 volts d.c. at 12 to 37 ma. should be connected to this terminal for supplying the plate voltage for the speech amplifiers and screen voltage for the 6146's. The zero signal plate current of the 6146's is determined by the screen voltage supplied to this terminal. Therefore, this voltage should be as near 200 volts as practical. In no case should the voltage applied to +LV be high enough to cause the zero signal plate current to exceed 82 ma.

+H.V. The + 400 to 750 volts d.c. plate voltage for the 6146 modulator tubes should be supplied at this point.

TRANS.

+H.V. The + 600 volts for the transmitter should be connected to this terminal.

4. OPERATION

The MILLEN 90831 Modulator was especially designed for use with the 90801 Transmitter. This modulator has sufficient output for 100% modulation of the transmitter at maximum rated transmitter input. A complete 67 watt phone transmitter consists of (1) 90801 R.F. Transmitter, (1) 90831 Modulator, (1) 90281 High Voltage Power Supply, and (1) 90201 Low Voltage Power Supply. The 90902 2" rack mounted oscilloscope is recommended as the ideal phone monitor.

The 6146 beam tetrode in the 90801 Transmitter should have modulated voltage supplied to the screen grid as well as to the plate to assure linear 100% modulation. Modulated voltage can be applied to the screen by supplying the screen from the modulated high voltage through the series dropping resistors R12 and R13 in the transmitter. The end of this series resistor is connected to terminal 3 on the transmitter thus terminals 3 and 4 should be jumped together by the 'phone/CW switch in the modulator for phone operation. The maximum transmitter input ratings for amplitude modulation are 600 volts d.c. at 113 ma. Under these conditions the screen current is approximately 12 ma. so the r.f. load impedance presented to the modulator is 600 volts divided by 125 ma., or 4800 ohms. In loading the transmitter for 'phone operation the transmitter should be loaded as nearly as possible to 113 ma. plate current so that proper impedance matching is assured and so that the tube ratings are not exceeded.

The performance of the modulated transmitter can best be checked on a cathode ray oscilloscope such as the MILLEN 90900 series of oscilloscopes. The vertical deflection plates of the oscilloscope should be supplied with r.f. voltage obtained by coupling loosely to the transmitter output. The most satisfactory coupling arrangement is a tuned circuit which is loosely link coupled to the amplifier output. The horizontal plates of the oscilloscope should be supplied with audio voltage from the Scope terminal on the modulator. This will give the familiar trapezoidal patterns fully described in the ARRL Handbook.

5. USE WITH OTHER TRANSMITTERS

Although the 90831 Modulator was designed expressly as a companion unit for the 90801 Transmitter, it may be used to modulate any transmitter whose plate input is in the vicinity of 80 watts and which can be loaded so that it presents an r.f. load impedance of approximately 4800 ohms to the modulator. In calculating the r.f. load impedance add the screen current to the plate current in the case the screen as well as the plate. Thus. in the case of the MILLEN 90810 and 90811 VHF Transmitters the plate voltage on the transmitter should be approximately 600 volts and the plate should be loaded so that the total plate and screen current is appriximately 125 ma.

It is also possible to use the 90831 as a cathode modulator for high power amplifiers

6. FREQUENCY RESPONSE

The freqency response of the amplifier is adjusted to put maximum energy in the range where it contributes most to speech intelligibility. That is, the output is highest between 500 and 1200 cycles and drops gradually on either side. The low frequencies are reduced by low values of coupling capacitance at C3 and C4, and high frequencies are attenuated by bypass condensers C6 and C7. Although this limits the sidebands to minimize interference it does not cause speech to sound unnatural or unpleasant.

7. PRECAUTIONS

A. Never apply a signal input to the modulator unless the proper load impedance is applied to the modulator. Should the load impedance be disconnected when an input signal is applied, the modulator output transformer will undoubtedly be damaged.

B. The 90831 Modulator has been designed so that it can produce considerably more power than is required for 100% modulation of the 90801 Transmitter. In general, it will not be necessary to advance the gain control more than approximately half way in order to obtain 100% modulation using normal low level crystal or dynamic microphones.

C. Adjust the +L.V. on the modulator so that the zero-signal plate current does not exceed 82 ma. Preferably, the zero-signal plate current should be in the vicinity of 60 ma. When using the 90201 low voltage power supply this screen voltage may be adjusted conveniently by changing the tap on the power transformer primary.

D. Do not block the free flow of air through the modulator. The 90831 is designed for rack mounting which will allow access of air to the bottom of the modulator. Do not mount the modulator so that no air can flow up past the 6146 tubes.

8. TECHNICAL SUMMARY

Power Supply

High Voltage

400 volts d.c. to 750 volts at 60 to 150 ma.

Low Voltage

200 volts d.c. to 240 volts d.c. at 12 to 37 ma.

Heater Voltage

6.3 volts a.c. to 2.95 amperes.

Bias Voltage

Minus 45 volts d.c. at zero current.

Physical Dimensions

Height—3½ inches

Width—19 inches

Depth—6 inches behind panel (including tubes)

Weight—10 pounds

Tube Complement

Speech Amplifier—12AX7

Driver—6C4

Class AB1 amplifiers—Push-pull 6146's

CATHODE MODULATION OF 90881

The Millen 90831 Modulator may be used to cathode modulate the 90881 R-F Power Amplifier. Since the 90831 is capable of approximately fifty-five watts of undistorted output, the 90881 may be 43% plate modulated, and 57% grid modulated.

The 90881 plate voltage and total plate current must be adjusted to present approximately 4800 ohms load to the modulator. This condition is met when $M(E/I) = 4800$. M is the per cent plate modulation, which in this case is limited to 43% by the modulator output. E is the plate voltage applied to the R-F Power Amplifier, and I is the total R-F Power Amplifier plate current in amperes.

The maximum power input to the 90881, using 812-A tubes, for this type of operation at 43% plate modulation is 226 watts. With this input, the output is approximately 136 watts; equivalent to the output of a 100% plate modulated transmitter with 176 watts input.

For a power input of 226 watts and a modulator load impedance of 4800 ohms, the 90881 plate voltage should be 1040 volts, and the plate current should be 217 milliamperes.

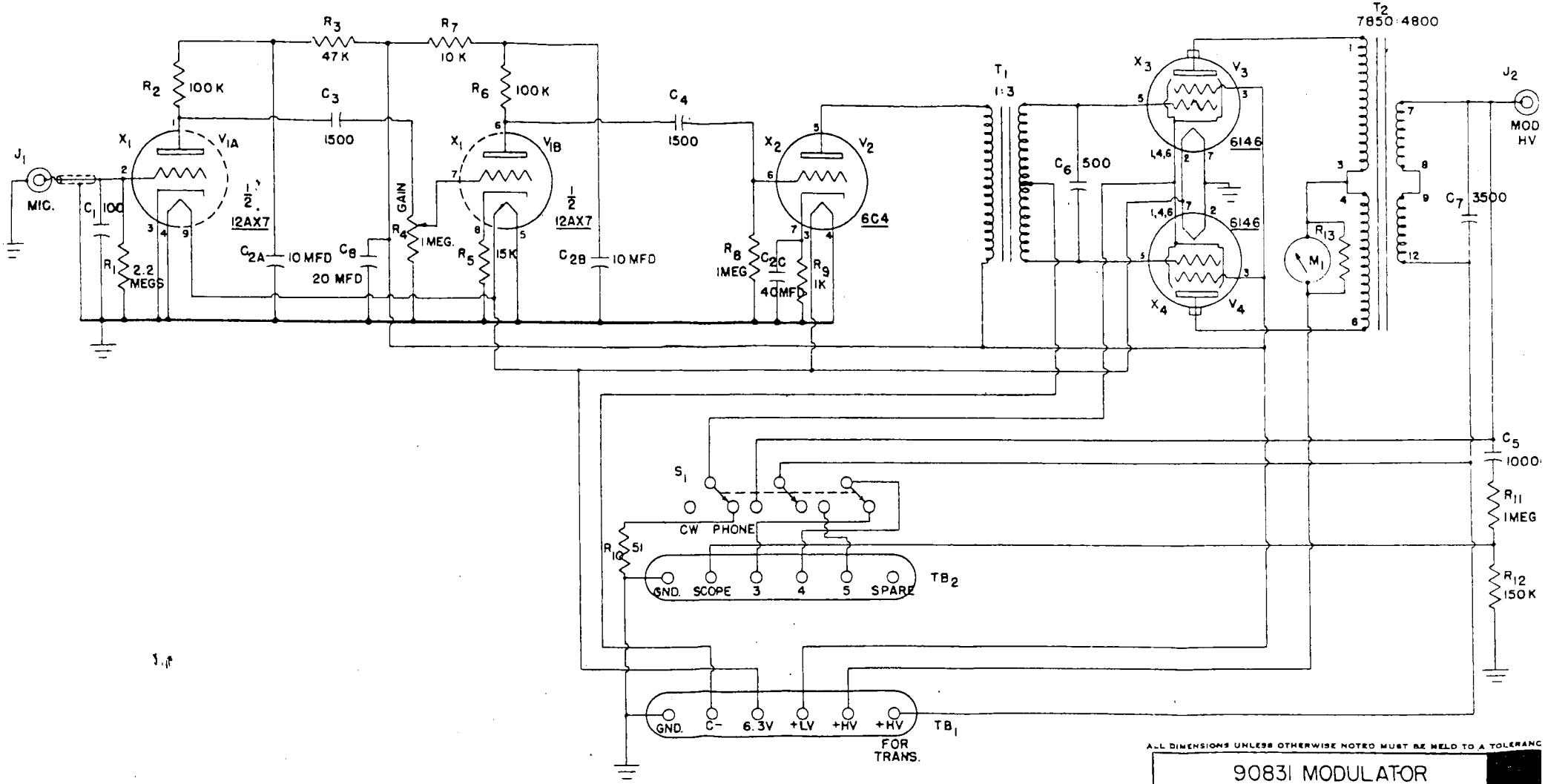
The lower terminal strip on the 90831 Modulator should be connected exactly as described in section 3 of the modulator instruction book, except that the TRANS + H.V. should now be grounded. Terminals 3, 4, and 5 on the upper terminal strip require no connection. The monitoring oscilloscope should be connected to the upper terminal strip as described in section 3. The output from the safety terminal, J2, on the modulator should be connected to the center tap of the amplifier filament transformer. This transformer should be used exclusively for the 812-As in the 90881.

The audio voltage for grid modulation may be obtained by connecting a 500K potentiometer from the SCOPE terminal on the modulator to ground. The arm of the potentiometer should be connected through a 2 mfd. condenser to the C- terminal on the 90881 R-F Power Amplifier. An audio choke should be connected between the amplifier C- terminal and the actual external bias. If more audio voltage is required for grid modulation, it can be obtained from the junction of C5 and R11.

When the 90881 is cathode modulated, it is advisable to change C2 and C3 from 6000 mmf to 1000 mmf and to add a 1000 mmf bypass condenser between the grid coil center-tap and ground.

The audio grid modulating voltage, the bias voltage on the 812-As, and the amplifier plate current should be adjusted for maximum modulation linearity using the trapezoidal pattern on the monitoring oscilloscope.

Terminals 3, 4, and 5 on the Modulator may be used to operate a relay to make the necessary 'Phone-CW changes in the connections for the 90881 R-F Power Amplifier.



ALL DIMENSIONS UNLESS OTHERWISE NOTED MUST BE HELD TO A TOLERANC

	90831 MODULATOR	
	FIRST MADE FOR	
	DESIGNED BY RWC	CHECKED BY R.W.C.
	DRAWN BY V. GUGGER	APPROVED
12-2-53 (1)	V_3 AND V_4 WERE 807'S V_{DG}	JAMES MILLEN MFG. CO., INC. MALDEN, MASS., U.S.A. M90831 DATE 11-4-5

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