

**OPERATING INSTRUCTIONS**



**TYPE 1264-A**

**MODULATING POWER SUPPLY**

**G E N E R A L R A D I O C O M P A N Y**

**B**

# OPERATING INSTRUCTIONS

## TYPE 1264-A

### MODULATING POWER SUPPLY

Form 1264-0100-B  
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West Concord, Massachusetts, USA

GENERAL RADIO COMPANY  
WEST CONCORD, MASSACHUSETTS, USA

## SPECIFICATIONS

### **Regulated DC Output (Unmodulated)**

**Voltage:** Adjustable from 200 to 300 volts.

**Current:** 50 milliamperes maximum.

**Stability:** Output voltage at any rated load will change less than 0.5 volt for  $\pm 10\%$  line-voltage change.

**Ripple:** Less than 1 millivolt, rms, with B- grounded; less than 5 millivolts, rms, with B+ grounded.

### **Heater Power Output (Unregulated)**

**Voltage:** 6.3 volts ac.

**Current:** 2.1 amperes maximum.

### **Square-Wave Output (Internally Generated)**

**Amplitude:** Adjustable from approximately 160 to 210 volts.

**Frequency:** Adjustable from 850 to 1150 cps.

**Stability:** Frequency will change less than 0.5% for  $\pm 10\%$  line-voltage change.

**Duty Ratio:** 0.5, adjustable  $\pm 5\%$ .

### **Square-Wave Output (from External Sine-Wave Generator)**

**Amplitude:** Adjustable from approximately 160 to 210 volts.

**Driver Requirements:** 20 to 50 volts, rms, 20 to 50,000 cps.

### **Pulse Output (Externally Generated)**

**Amplitude:** Adjustable from approximately 160 to 210 volts.

**Duration (between half-amplitude points):** 1.5  $\mu$ sec to square waves; duration determined by external generator.

**Rise and Decay Times (between 10% and 90% of maximum amplitude):** Less than 1.5  $\mu$ sec when driving a load capacitance of 300 pf in shunt with a resistance of 15,000 ohms or less.

**Ramp-off:** None.

**Driver Requirements:** 20 to 50 volts peak, positive polarity, 20 to 100,000 pulses per second.

**Power Requirements:** 105 to 125 (or 210 to 250) volts, 50 to 1000 cps, 85 watts.

**Accessories Supplied:** TYPE CAP-22 Power Cord, connector plug.

**Recommended Oscillators:** TYPE 1361-A (450 to 1050 Mc); TYPES 1215-C (50 to 250 Mc), 1209-C (250 to 920 Mc), 1209-CL (180 to 600 Mc), and 1218-A (900 to 2000 Mc).

**Other Accessories Available:** TYPE 1264-P1 Adaptor Cable to connect to TYPES 1209-C, 1209-CL, and 1215-C Unit Oscillators; TYPE 1264-P2 Adaptor Cable to connect to TYPE 1218-A Unit Oscillator.

**Cabinet:** Convertible bench.

**Dimensions:** Width 8, height 7, depth 9 $\frac{1}{4}$  inches (205 by 180 by 235 mm). Panel adaptor plate sets are available for 19-inch relay-rack mounting, panel height 7 inches.

**Net Weight:** 12 pounds (5.5 kg).

**Shipping Weight:** 26 pounds (12 kg).

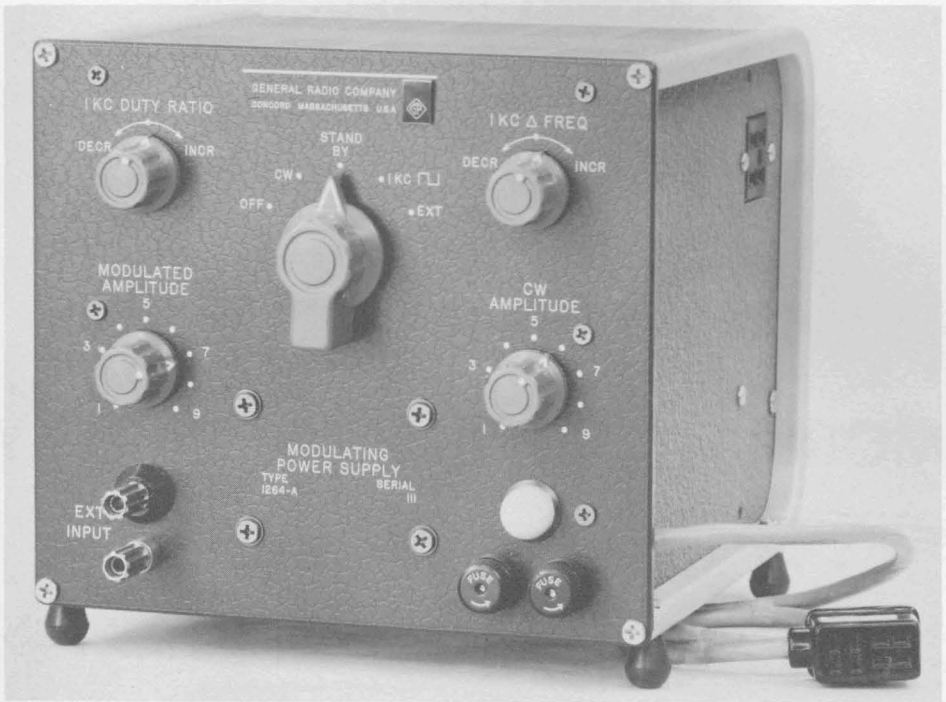


Figure 1. Type 1264-A Modulating Power Supply.



Figure 2. Type 1264-A Attached to Type 1361-A Oscillator.

## Section 1

# INTRODUCTION

### 1.1 PURPOSE.

The Type 1264-A Modulating Power Supply (Figure 1) is designed as a companion instrument to the Type 1361-A Oscillator and similar equipment to permit cw or square-wave-modulated operation of this instrument or pulse-modulated operation using an external pulse source. The Type 1264-A can be bolted directly to the Type 1361-A Oscillator to form a single assembly with all interconnections recessed between the adjacent end frames (see Figure 2). The composite instrument can readily be mounted in a relay rack by means of accessory panel extensions.

With suitable accessory cables, the Type 1264-A can be used with the Type 1209-C, 1209-CL, 1215, or 1218 Unit Oscillator.


### 1.2 DESCRIPTION.

1.2.1 CONTROLS. The following controls are on the panel of the Type 1264-A Modulating Power Supply:

<u>NAME</u>	<u>TYPE</u>	<u>FUNCTION</u>
1-KC DUTY RATIO	Continuous rotary control	Controls duty ratio of internally generated square waves.
1-KC $\Delta$ FREQ	Continuous rotary control	Controls frequency of internally generated square waves.
Function Selector	Rotary Selector Switch	Energizes instrument and selects mode of operation.
MODULATED AMPLITUDE	Continuous rotary control	Controls amplitude of square waves and pulses in 1-KC $\square$ and EXT operation.
CW AMPLITUDE	Continuous rotary control	Controls output voltage in CW operation.

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1.2.2 CONNECTORS. The following connectors are on the panel and sides of the Type 1264-A Modulating Power Supply:

<u>NAME</u>	<u>TYPE</u>	<u>FUNCTION</u>
115/230 volt 50-400 	3-terminal receptacle	Accepts 2- or 3-wire power cable to make connection to power source.
EXT INPUT	Jack-top binding-post pair	Connects external driver for pulse modulation.
	4-terminal receptacle	Accepts power plug from oscillator.
	8-terminal receptacle on end of cable.	Supplies modulation to oscillator.

### 1.3. ACCESSORIES.

1.3.1 DRIVER. The Type 1264-A Modulating Power Supply when used with a suitable rf oscillator provides cw or 1-kc square-wave modulated output. For other modulation characteristics, an external driver is required. The Type 1217 Unit Pulse Generator is recommended for general-purpose pulse or square-wave applications. If square waves only are required, the Type 1210-C Unit RC Oscillator may be used as a driver.

1.3.2 ADAPTORS. When the Type 1264-A is used with certain oscillators, adaptor cables are required. These are as follows:

<u>OSCILLATOR</u>	<u>ADAPTOR CABLE</u>
1209-C, 1209-CL, 1215	1264-P1
1218	1264-P2

When an external driver is required, the interconnection may be made by a Type 274-NP Patch Cord.

1.3.3 RELAY-RACK MOUNTING PANEL EXTENSIONS. The Type 1264-A can be relay-rack mounted either separately or together with the Type 1361-A Oscillator. For mounting of the Type 1264-A alone, one pair of Type 480-P408 Panel Extensions is required. For mounting together with the Type 1361-A Oscillator, one pair of Type 480-P416 Panel Extensions is required.

## Section 2

# INSTALLATION

### 2.1 GENERAL.

The Type 1264-A Modulating Power Supply is intended primarily for use with vhf or uhf oscillators where square-wave or pulse modulation is desired. Installation requires interconnection with the associated oscillator, and with an external driving source if pulse modulation is required. In certain cases relay-rack mounting, attachment to a companion oscillator, or both may be desired.

### 2.2 LINE VOLTAGE REQUIREMENTS.

The nameplate adjacent to the power-input receptacle shows the voltage for which the instrument is connected. Instruments are usually supplied wired for 115-volt operation. However, a simple wiring modification at the power transformer primary is all that is required to convert the instrument for 230-volt use. The wiring modification is described on the schematic diagram, Figure 11.

### 2.3 VENTILATION CONSIDERATIONS.

The Type 1264-A Modulating Power Supply dissipates about 80 watts under maximum load conditions. Most of this heat must be carried away by air circulation over and through the unit. It is recommended that at least one rack unit (1-3/4 inches) of blank panel be provided both above and below the Type 1264-A in permanent rack installations. In bench use, other equipment should not be stacked on top of the Type 1264-A.

### 2.4 CONNECTIONS TO AUXILIARY EQUIPMENT.

**2.4.1 CONNECTIONS TO TYPE 1361-A AND SIMILAR OSCILLATORS.**  
The Type 1264-A Modulating Power Supply can be connected to the Type 1361-A and similar Oscillators directly. The four-terminal connector on the end of the cable from the oscillator should be plugged into the receptacle on the right-hand side of the Type 1264-A, and the eight-terminal

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connector on the end of the cable from the Type 1264-A should be mated with the receptacle on the left-hand side of the oscillator after the dummy plug is removed.

**2.4.2 CONNECTIONS TO TYPES 1209-C, 1209-CL, and 1215-C UNIT OSCILLATORS.** The Type 1264-A Modulating Power Supply can be connected to the Type 1209-C, 1209-CL, or 1215-C Oscillators by means of the Type 1264-P1 Adaptor Cable as shown in Figure 3. The four-terminal connector on the adaptor cable is plugged into the mating receptacle on the Type 1264-A, while the four-terminal connector on the cable from the oscillator is plugged into the mating receptacle on the adaptor cable. The eight-terminal connector on the adaptor cable is mated with the matching plug on the cable from the Type 1264-A. The telephone plug on the adaptor cable is plugged into the oscillator modulation jack.

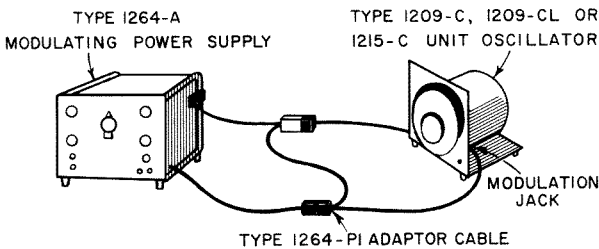


Figure 3. Connection of Type 1264-A to Unit Oscillator by Means of Type 1264-P1 Adaptor Cable.

**2.4.3 CONNECTIONS TO TYPE 1218-A UNIT OSCILLATOR.** The Type 1264-A Modulating Power Supply can be connected to the Type 1218-A Unit Oscillator by means of the Type 1264-P2 Adaptor Cable as shown in Figure 4. The four-terminal connector on the cable from the oscillator is plugged into the mating receptacle on the right-hand side of the Type 1264-A. The eight-terminal connector on the adaptor cable is plugged into the mating connector on the cable from the Type 1264-A. The telephone plug on the adaptor cable is plugged into the oscillator modulation jack, and the terminal lug is attached to terminal No. 3 on the side of the oscillator. The oscillator function switch should be set to PULSE MOD for best results, although no damage will occur if it is inadvertently set to one of the other positions.

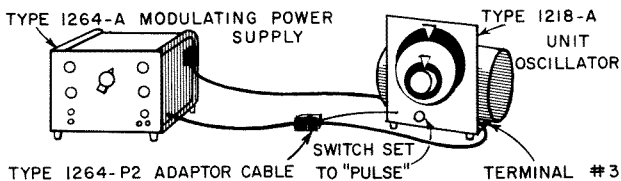


Figure 4. Connection of Type 1264-A to Type 1218-A Unit Oscillator by Means of Type 1264-P2 Adaptor Cable.

**2.4.4 CONNECTIONS TO DRIVER.** Figure 5 illustrates a typical setup of the Type 1264-A using an external driver (refer to paragraph 1.3.1).



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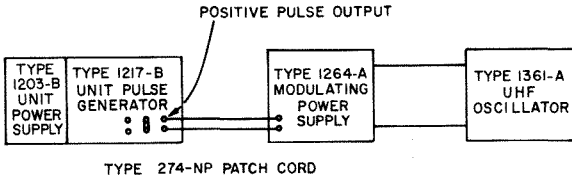


Figure 5. Connections for Pulse Modulation.

### 2.5 ATTACHMENT TO TYPE 1361-A OSCILLATOR.

The Type 1264-A can be rigidly attached to the Type 1361-A Oscillator by means of four 10-32 screws and bolts (supplied with the Type 1264-A) through four mating holes in the left-hand side panel of the Type 1361-A and in the right-hand side panel of the Type 1264-A Modulating Power Supply. The interconnecting cables are coiled up out of sight between the end frames.

To attach the units to each other, proceed as follows:

- a. Remove the dust covers from both instruments by unscrewing the two thumbscrews at the rear of each cover and removing the cover.
- b. Remove the rubber feet from the right-hand side of the Type 1264-A and from the left-hand side of the Type 1361-A.
- c. Remove the dummy plug from the left-hand side of the Type 1361-A and set the instrument down on its right-hand side, with the panel facing away. Locate the dummy plug as shown in Figure 6a.
- d. Place the Type 1264-A down on its left-hand side adjacent to the Type 1361-A as shown in Figure 6a. Coil the cables and mate the matching plugs as shown.
- e. Turn the Type 1264-A over so that its right-hand side lies on top of the left-hand side of the Type 1361-A. The cables should now be as shown in Figure 6b.
- f. Slip the screws through the mating holes from the oscillator side, and engage the nuts on the power-supply side. It will be necessary to raise the Type 1264-A slightly in order to push the screw near the top front corner home. Then lower the Type 1264-A into place. After all screws and nuts are engaged, line up the panels and end frames of the two units, and secure the screws.

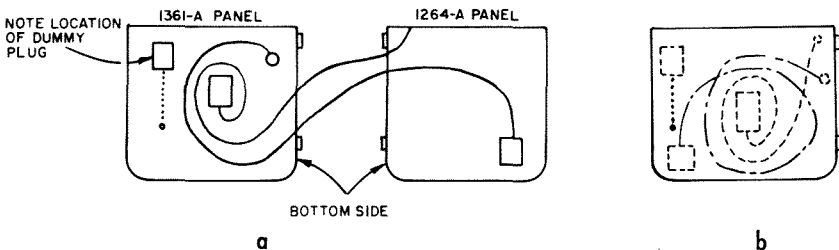


Figure 6a and 6b. Method of Connecting Type 1264-A to Type 1361-A Oscillator. a, above: View looking down on instruments before assembly. b, below: Phantom view showing cable scheme after instruments are attached.

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g. Replace the dust covers, making sure that the solid cover is over the Type 1361-A Oscillator and the perforated cover over the Type 1264-A Modulating Power Supply. Be sure that the front edges of the covers slide into the slots on the rear of the front panels; then secure the covers by tightening the thumbscrews at the rear.

### 2.6 RELAY-RACK MOUNTING.

To mount the Type 1264-A in a relay rack, one pair of Type 480-P408 Adaptor Plates is required. Remove the four screws at the corners of the panel, and use them to secure the adaptor plates to the outside of the panel.

The same procedure is employed to mount the Type 1264-A and the Type 1361-A in a relay rack as one combined unit, except that Type 480-P416 adaptor plates are used.

## Section 3 OPERATING PROCEDURE

### 3.1 PRELIMINARY CONSIDERATIONS.

Before operating the instrument, make sure that the line voltage and frequency are as specified in the nameplate adjacent to the power input connector. Also make sure that the ventilating holes are not obstructed. For details on connecting the Type 1264-A to the Type 1361-A or other oscillators, refer to paragraph 2.4.

### 3.2 NORMAL OPERATING PROCEDURE.

3.2.1 INITIAL SETTINGS. To apply power to the instrument, turn the function switch (the five-position switch in the upper center of the panel) from OFF to the desired mode of operation.

When the function switch is at STANDBY, only heater voltage is applied to the oscillator. The function switch can therefore be used to cut off rf output from the oscillator while leaving the heaters on.

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3.2.2 MAXIMUM OUTPUT SETTINGS. The Type 1264-A will drive the various oscillators close to the maximum allowable output when the CW AMPLITUDE or MODULATED AMPLITUDE control is set fully clockwise. For reduced frequency drift and longer tube life, the AMPLITUDE control should be backed off somewhat from its clockwise limit. For pulsing of the Type 1361-A or 1218-A Oscillator with a duty cycle greater than 0.5, reduce the MODULATED AMPLITUDE setting to prevent excessive tube dissipation.

3.2.3 CW OPERATION. In cw operation the oscillator B+ voltage is adjusted over the range of 200 to 300 volts by means of the CW AMPLITUDE control. Turning this control clockwise increases oscillator output.

3.2.4 1-KC SQUARE-WAVE OPERATION. When the function switch is at 1 KC  $\square$ , the modulator delivers a negative pulse of approximately 0.5 duty ratio to the cathode of the oscillator. The frequency is adjustable from 850 to 1150 cps by means of the 1KC  $\square$  FREQ control. The duty ratio is adjustable over a range of  $\pm 5\%$  by means of the 1 KC DUTY RATIO control. The amplitude is adjustable from approximately 160 to 210 volts by means of the MODULATED AMPLITUDE control. The amplitude is entirely independent of the setting of the CW AMPLITUDE control.

3.2.5 EXT OPERATION (PULSE, SQUARE-WAVE, OR SINE-WAVE INPUT). When the function switch is at EXT, the modulator will deliver an output only if a suitable input is applied to the EXT INPUT terminals. This position is most useful when short pulses are required. A positive input pulse of 20-volt peak amplitude is required. Suitable pulses can be obtained from the Type 1217-B Unit Pulse Generator. The video output pulse is of approximately the same duration as the input pulse, but rise and decay times depend on the nature of the load offered by the oscillator. Pulses with duty ratios up to 0.5 (square waves) may be generated without special precautions. The Type 1264-A will accept and deliver pulses of higher duty ratios at all but the highest repetition rates. If a duty ratio greater than 0.5 is used to modulate the Type 1218-A or the Type 1361-A Oscillator, the MODULATED AMPLITUDE control should be backed off in a counterclockwise direction to prevent excessive oscillator tube dissipation. When these oscillators are modulated at a duty ratio of 0.75, the MODULATED AMPLITUDE control should be set at 5 or lower. The Types 1209-C, 1209-CL, and 1215-C Unit Oscillators cannot be overloaded by any setting of the Type 1264-A controls.

Where square waves of approximately 0.5 duty ratio are required at frequencies outside the 850 to 1150-cps internal range, it is possible to generate them in the Type 1264-A by the use of sine waves of at least 20 volts rms applied to the EXT INPUT terminals. The frequency range for such sine-wave drive is 20 cps to 50 kc. Square-wave drive is preferable if the exact duty ratio is important.

### 3.3 OPERATING INSTRUCTIONS.

3.3.1 GENERAL. The character of the modulated rf output obtained from the various oscillators that can be used with the Type 1264-A depends on

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the type of oscillator and the frequency to which it is tuned. The rise and decay times may be either longer or shorter than those of the pulse delivered by the modulator. The characteristics of the modulator when driving a standard load (6000 ohms shunted by 300 pf) are listed in the specifications at the front of this manual.

**3.3.2 TYPE 1361-A OSCILLATOR (450-1050 MC).** The Type 1361-A Oscillator and the Type 1264-A Modulating Power Supply were designed as companion units, and information on the use of the combination is described in the instruction manual for the Type 1361-A. Satisfactory performance is obtained on both square waves and pulses.

**3.3.3 TYPES 1209-C (250-920 MC) AND 1209-CL (180-600 MC) OSCILLATORS.** The Types 1209-C and 1209-CL Unit Oscillators can be modulated by the Type 1264-A Modulating Power Supply when interconnected with the Type 1264-P1 Adaptor Cable as described in paragraph 2.4.2. Owing to the presence of filter capacitors and voltage dividers in the oscillators, the amplitude of the pulses output depends on the duty ratio. For maximum settings of both the CW AMPLITUDE and MODULATED AMPLITUDE controls, the peak pulse amplitude is approximately 3 db greater than the cw amplitude for short pulses, decreasing as the duty ratio increases until it is approximately 1 db lower than cw amplitude for square waves. At 500 Mc a typical rise time is 3  $\mu$ sec and a typical decay time is 4  $\mu$ sec. Some shortening of the input pulse occurs because of delay in starting of the oscillator. At 500 Mc a 10- $\mu$ sec-wide input pulse may typically produce a 9- $\mu$ sec-wide output pulse. At lower frequencies, greater starting delay and appreciable leading-edge jitter may be expected.

**3.3.4 TYPE 1215-C (50-250 MC) UNIT OSCILLATOR.** The Type 1215-C Unit Oscillator can be modulated by the Type 1264-A Modulating Power Supply when interconnected with the Type 1264-P1 Adaptor Cable as described in paragraph 2.4.2. Square-wave operation is satisfactory over the entire tuning range of the oscillator. Pulse performance is satisfactory from 100-250 Mc for pulses that are not too short. With the MODULATED AMPLITUDE control set fully clockwise (maximum output), the following performance is typical at 100 Mc: rise time 2  $\mu$ sec; decay time 2-1/2  $\mu$ sec; for a 10- $\mu$ sec-wide input pulse, an output-pulse width of 8  $\mu$ sec. As the frequency is reduced, the performance is degraded until at 50 Mc a starting delay of 12  $\mu$ sec or more may be expected, accompanied by a rise time of 5  $\mu$ sec and a decay time of 4  $\mu$ sec.

The pulse amplitude is independent of duty ratio for the Type 1215-C Unit Oscillator. At maximum settings of the CW AMPLITUDE and MODULATED AMPLITUDE controls, the cw output is approximately 3 db greater than the peak pulse or square-wave amplitude. The CW AMPLITUDE control may be adjusted counterclockwise to equalize the amplitudes if so desired. This adjustment is independent of both the duty ratio and the oscillator frequency.

**3.3.5 TYPE 1218-A (900-2000 MC) UNIT OSCILLATOR.** The Type 1218-A Unit Oscillator can be modulated by use of the Type 1264-P2 Adaptor Cable

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as described in paragraph 2.4.3. Square-wave operation is satisfactory over the entire tuning range of the oscillator, and pulse modulation is satisfactory for most applications. Pulse performance comparable to that described in the Type 1218-A instruction manual may be expected, with appreciable starting delay at some frequencies.

For maximum oscillator tube life, the MODULATED AMPLITUDE control should be backed off when duty ratios of 0.5 or greater are used. At a duty ratio of 0.75, the MODULATED AMPLITUDE control setting should not be greater than 5.

The circuits of the Type 1218-A are such that the ratio of cw to pulse or square-wave amplitude is a function of oscillator frequency. It may not always be possible to reduce the peak pulse amplitude to the cw amplitude.

If the MODULATED AMPLITUDE control setting is increased suddenly, a transient condition of large cw output may occur. This is a normal condition that does not imply instability, and that will not damage the oscillator. This transient will not occur for usual rates of control adjustment.

## Section 4

# PRINCIPLES OF OPERATION

### 4.1 GENERAL.

The instrument comprises four basic elements: (1) a highly regulated adjustable dc power supply, (2) a modulator, (3) a Schmitt trigger circuit to drive the modulator, and (4) 1-kc multivibrator to drive the trigger circuit for square-wave output at a frequency determined by the internal generator.

### 4.2 POWER SUPPLIES.

**4.2.1 REGULATED POWER SUPPLY.** The regulated power supply uses a full-wave voltage doubler circuit with silicon diode rectifiers and capacitance filtering. R201 limits the peak rectifier current to a safe value. The regulator is of the series lossy type, controlled by comparison of a portion of the output voltage with a reference voltage obtained from gas tube V303. The comparison is performed in a differential cathode-coupled amplifier (V304), and the difference is further amplified by V301. The pentode section V301B is cascode connected to V304B of the comparator to provide a high-gain amplifier. Triode V301A is a cathode follower, which couples the output of the cascode amplifier to the grid of the series lossy tube V302. The series tube is pentode connected, with a 100-volt screen supply provided by a separate half-wave rectifier and filter.

Adjustment of R402 (in cw operation) or R401 (for modulated operation) varies the proportion of the output applied to the comparison circuit, and thereby controls the output voltage. The output voltage can be controlled over the range from 200 to 300 volts with the function switch (S401) set at CW, and over the range 200 to 250 volts for all other operating positions.

**4.2.2 UNREGULATED 1-KC MULTIVIBRATOR POWER SUPPLY.** Half of the dc supply voltage that feeds the regulator is used to supply power to the 1-KC MULTIVIBRATOR (V404).

**4.2.3 UNREGULATED TRIGGER CIRCUIT POWER SUPPLY.** A separate unregulated 300-volt power supply, using silicon diode rectifiers in a voltage doubler circuit with capacitance filtering, provides power to operate the trigger tube (V405). The positive output of this supply is connected to the negative output of the regulated supply. The resulting bus is referred to as COMMON on the schematic diagram (Figure 11). This arrangement permits dc coupling of the trigger to the modulator.

**4.2.4 POWER SUPPLY GROUND.** The COMMON bus is not internally grounded to the instrument case. Either the COMMON bus or the positive

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regulated output bus may be grounded depending on the requirements of the oscillator to be modulated. The necessary grounding is accomplished automatically when the eight-connector cable is plugged into the associated oscillator. This is true whether the connection is direct (as in the case of the Type 1361-A Oscillator) or by way of an adaptor cable (as in the case of the Type 1209-C, 1209-CL, 1215-C or 1218-A Oscillator). The panel of the associated oscillator is also grounded automatically to the case of the Type 1264-A Modulating Power Supply when the units are interconnected.

### 4.3 MODULATOR.

Tubes V402 and V403 constitute the modulator, which delivers a negative pulse to the cathode of the oscillator, thereby turning the oscillator on. The output pulse amplitude can be adjusted from approximately 160 to 210 volts by means of R401, which controls the supply voltage. In the absence of an input signal, V403 is biased beyond cutoff, and its plate and screen are at the supply potential. When the trigger circuit responds to an incoming signal, the grid of V403 rises to +5 volts, drawing current through R406, and causing heavy plate current to flow through the load provided by the oscillator to be modulated. V401A provides a fixed supply voltage for R406, so that operation of the trigger circuit is unaffected by adjustment of the modulator output amplitude. C402 permits additional screen and plate current to flow briefly while charging the load capacitance, thereby providing a short rise time for the modulating pulse. Tube V402 is inactive during the rise of the pulse, because it is cut off by the bias resulting from V403 plate current flowing through R408. When the input signal ends and V403 is again cut off, V402 conducts and discharges the load capacitance rapidly. This action is enhanced by a pulse of screen current supplied by C401, which was charged up to the supply voltage during the time that V403 was turned on. V401B is diode-connected to permit the screen voltage on V402 to rise above the supply potential until C401 is discharged by the resultant screen current.

### 4.4 SCHMITT TRIGGER CIRCUIT.

The Schmitt trigger circuit accepts square waves from the internal multivibrator, or pulses, square waves, or sine waves from an external driver, and converts them to suitable waveforms to drive the modulator. V405 is connected as a bistable trigger, with one coupling provided by the common cathode resistor R426, and the other by plate-to-grid coupling resistors R427 (shunted by C406 to provide fast switching) and R428. The plate of V405B is directly coupled to the grid of modulator tube V403, thereby avoiding any tendency for droop in the output pulse even at long pulse durations.

The input bias on the grid of V405A is set by R420 and R421 at a value that ensures triggering by a positive input pulse of 20 volts peak amplitude. Diode CR401 clamps the negative peak of the driving signal on the grid side of C405 to the predetermined bias voltage. This prevents C405 from charging up in such a way as to permit premature cutoff of the

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trigger tube V405A under conditions of sine wave, square wave, or long repetitive pulse input signals.

### 4.5 1-KC MULTIVIBRATOR.

Tube V404 is a conventional ac-coupled multivibrator with the grids returned to B+ through timing resistors R412, R413, R414, and R415. The use of large plate resistors permits thorough bottoming of the tube plates. The output frequency is virtually independent of tube characteristics and of line voltage, even though the supply voltage is unregulated. Output is obtained from the cathode of V404B across R417. The waveform at this point is more nearly square than that at the grid or plate of either tube section. Resistor R413 permits some adjustment of the duty ratio of the square wave, but has negligible effects on frequency, since the time constant of one of the coupling circuits is increased by the same amount as that of the other coupling is decreased. R412 permits adjustment of the square-wave frequency between 850 and 1150 cps by effectively varying the potential to which the timing circuits are returned.

## Section 5

# SERVICE AND MAINTENANCE

### 5.1 WARRANTY.

We warrant that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, district office, or authorized repair agency personnel, will be repaired, or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

### 5.2 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone



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our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

### 5.3 REMOVAL OF COVER.

#### WARNING

**Always disconnect power before opening the instrument case. The total power-supply potential is 725 volts.**

To remove the dust cover, loosen the two thumb screws on the rear of the instrument and withdraw the cover.

### 5.4 TUBE REPLACEMENT.

Care should be exercised in replacing tubes to be sure that the correct tube type is inserted into each socket. Particular attention is called to the fact that one Type 5963 dual triode is used for the 1-kc multivibrator (V404) at the top center on the modulator circuit board, whereas all other dual triode tubes are Type 5965. Interchange of a 5963 for a 5965, or vice versa, may significantly degrade the performance of the instrument.

### 5.5 TROUBLE-SHOOTING.

5.5.1 GENERAL. Normally, the Type 1264-A is only one unit in a two- or three-unit system that consists of an oscillator, a Type 1264-A, and sometimes an external driver. Most system breakdowns manifest themselves in the oscillator output, but the Type 1264-A or the external driver (if one is used), as well as the oscillator itself, may be the cause of the trouble. Therefore, if a problem does occur, the first step in trouble-shooting is to localize the fault to a single unit.

5.5.2 LOCALIZING TROUBLE TO A UNIT. To determine which unit in the system is faulty, proceed as follows:

Check	Faulty Unit
If oscillator output is faulty in EXT but is normal in 1 KC□ or CW, defective unit is →	EXTERNAL DRIVER
If oscillator output is faulty using the Type 1264-A and is still improper using another power supply, defective unit is →	OSCILLATOR
Refer to paragraph 5.5.3 if another power supply is not available.	

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If oscillator output is faulty using the Type 1264-A but is normal using another power supply, defective unit is  $\longrightarrow$   
 Refer to paragraph 5.5.3 if another power supply is not available.

TYPE 1264-A

If oscillator output is faulty in EXT (using an external driver) or 1 KC  $\square$  but is normal in CW, defective unit is  $\longrightarrow$

TYPE 1264-A  
(modulator or Schmitt circuit)

If oscillator output is faulty in 1 KC  $\square$  but is normal in EXT (using an external driver) and CW, defective unit is  $\longrightarrow$

TYPE 1264-A  
(1-kc multivibrator)

**5.5.3 DETERMINING THE FAULTY CIRCUIT.** If the trouble has been localized to the Type 1264-A, it can be localized further to a specific circuit by a check of output voltages and waveforms according to the listing in Table 5-1. Other waveforms that are important in the analysis of circuit operation are shown on the schematic diagram, Figure 11. The waveforms shown there apply for the 1 KC  $\square$  position of the function switch and provide a check on most aspects of the modular operation. Additional tests are described in paragraph 5.6, Electrical Inspection Procedure.

Test conditions for the measurements listed in Table 5-1 are:

1. Oscillator disconnected from the Type 1264-A.
2. No external drive applied to the EXT INPUT terminals.
3. Pins 2 and 3 of SO102 connected together and to pin 16 of SO101.
4. Line voltage of 115 v (or 230 v if so connected) applied.

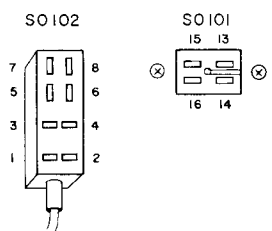


Figure 7. Pin locations on the output connectors of the Type 1264-A.

Voltages can be measured with a volt-ohm-milliammeter, such as the Triplet model 630-A, and waveforms with an oscilloscope such as the Tektronix Type 504 with a 10:1 attenuator probe. Normal variations in voltages in the Type 1264-A combined with the limited accuracy of the simple test equipment recommended can lead to variations of  $\pm 10\%$  in the observed voltages with a normal instrument.

TYPE 1264-A MODULATING POWER SUPPLY

TABLE 5-1. CIRCUIT TESTS

Test Instrument and Range	Connection Points	Function Switch Pos.	Desired Indication	Probable Faulty Circuit			
				Rectifier	Regulator	Modulator	Other
Voltmeter 300 v dc	+ to 15 of SO101 - to 16 of SO101	CW	+300 with CW AMPL fully clock-wise, +200 or less fully ccw	X	X		R402
		STAND BY 1 KC , EXT	0				S401
Voltmeter 300 v dc	+ to 1 of SO102 - to 2 of SO102	CW, STAND BY	0				S401
		1 KC , EXT	+260 with MOD AMPL fully cw, +200 or less fully ccw	X	X		R401 R306
Voltmeter 300 v dc	+ to 7 of SO102 - to 2 of SO102	CW	0				S401
		1 KC	+130 with MOD AMPL fully cw			X	
		STAND BY, EXT	+260 with MOD AMPL fully cw			X	
Voltmeter 12 v ac	13 and 14 of SO101	CW, STAND BY, 1 KC , EXT	6.7 v (varies with line voltage)	X			T201
		1 KC	A 230-v p-p square wave, 1 ms period with MOD AMPL fully cw, decreasing to 165 v p-p fully ccw	X	X	X	S401
Oscillo - scope 20 v/cm + 10:1 attenuator, 0.2 ms/sec sweep rate, ac coupling	Pin 7 of SO102 to ground (pin 3)	CW, STAND BY, EXT	0				S401

5.5.4 TROUBLE-SHOOTING TABLE. The following table outlines the most common symptoms of trouble, probable causes, and remedies.

TABLE 5-2. TROUBLE-SHOOTING

<u>SYMPTOM</u>	<u>PROBABLE CAUSE</u>	<u>REMEDY</u>
1. Pilot lamp extinguished.	Line fuse open. Line fuse blown due to short circuit in power supply or load.	Replace fuse. Check capacitors C201, C202, C203, C204, C205 and replace any defective unit. Check associated oscillator for short circuit.

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Table 5-2. Trouble-Shooting (continued)

<u>SYMPTOM</u>	<u>PROBABLE CAUSE</u>	<u>REMEDY</u>
2. No oscillator output with selector in CW position.	No high voltage applied to oscillator.	<p>Check supply voltage across terminals 15 and 16 of SO101. If voltage is correct, trouble is in oscillator or interconnecting cable.</p> <p>If no supply voltage, check for voltage at cathode of V302. If cathode voltage is present, S401 is probably defective. If voltage is not present, check voltage at plate of V302. If voltage is present, V302 may be defective or there may be a short circuit across C304 or in the associated oscillator. If there is no voltage at the plate of V302, check R201. If open, look for short-circuited capacitor C202 or C203.</p>
3. Excessive oscillator output, cw or modulated	Excessive high voltage due to failure of regulator circuits.	Check V301, V302, V303 and V304; replace any defective tubes.
4. Oscillator delivers cw output when selector is set to 1 kc $\square$ or EXT.	V403 plate current is not cut off due to failure of trigger circuit. Either tube V405 is defective or the 300-volt unregulated supply has failed.	<p>Check V405 and replace if defective.</p> <p>Check supply voltage for V405 across terminals 12 and 13 of modulator board. If low or missing, check C305.</p> <p>Replace if defective. If not, check voltage across terminals 22 and 23 of rectifier board. If no voltage, check C204 and C205 for shorts; check R202 continuity. Replace any defective parts.</p>
5. No square-wave output from oscillator with selector set to 1 kc $\square$ although output at CW is satisfactory.	Defective tube or defective 300-v unregulated supply.	Check V403 and replace if defective. Check 1 kc $\square$ output at terminal 4 of modulator board. If no output, check V404 and replace if defective. If trouble persists, difficulty is probably covered by (4) above.

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Table 5-2. Trouble-Shooting (continued)

<u>SYMPTOM</u>	<u>PROBABLE CAUSE</u>	<u>REMEDY</u>
6. No pulse output with selector set to EXT.	Input pulse too short due to oscillator starting delay.	Widen input pulse.
	Incorrect drive polarity or amplitude.	Check for positive input pulse of 20 v or greater peak amplitude.
7. Square-wave synchronization unsatisfactory with selector set to EXT.	Inadequate input amplitude.	Provide 20-volt peak amplitude square-wave input or 20 rms amplitude sine-wave input.
	Defective tube V405. Defective clamp circuit	Replace V405. Check CR401 and associated resistors R418, R419, R420 and R421.
8. Output occurs with no input drive for selector set to EXT.	Defective V405 clamp circuit.	See (7) above.
9. Poor pulse rise time.	Excessive load capacitance.	Check using standard dummy load. If rise time is satisfactory, trouble is not in modulator.
	Defective V403. Inadequate grid drive to V403.	Replace V403. Check cathode voltage on V401A. If incorrect, replace V401. Check R406 and replace if defective.
10. Poor pulse decay time.	Excessive load capacitance	Check using standard dummy load. If decay time is satisfactory, trouble is not in modulator.
	Defective V402. No screen pulse to V402 due to defective clamp tube V401B.	Replace V402. Replace V401.

**5.5.5 VOLTAGE AND RESISTANCE MEASUREMENTS.** Most circuit difficulties in the Type 1264-A Modulating Power Supply will be indicated by incorrect voltages at various tube terminals or by improper values of circuit resistance. Normal values are listed in Table 5-3. They were measured with a GR Type 1806 Electronic Voltmeter under the following test conditions:

1. All voltage measurements are made with 115-v line voltage. The function switch is set to  $1\text{ KC} \square$  and the MODULATED AMPLITUDE con-

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trol set to produce a B+ voltage of 250 volts (pin 1 of SO102 is B+, pin 2 of SO102 is B-).

2. For resistance measurements, set all panel controls fully counterclockwise, and ground terminals 19 through 23 of the rectifier circuit board (the lower vertical board, 1264-70) and terminal 6 of the modulator circuit board (the upper vertical board, 1264-72).

NOTE

Departures of up to 20% from the tabulated values should not be considered abnormal.

TABLE 5-3.  
VOLTAGE AND RESISTANCE MEASUREMENTS

TUBE (TYPE)	PIN	DC VOLTS TO COMMON	OHMS TO GND	TUBE (TYPE)	PIN	DC VOLTS TO COMMON	OHMS TO GND
V301 (6AN8)	1	425	0	V401 (5965)	1	250	300k
	2	235	2.1 M		2	85	510k
	3	240	430k		3	88	∞
	4	100	900k		4	150	180k
	5	100	900k		5	150	180k
	6	235	2.1 M		6	250	300k
	7	250	0		7	250	300k
	8	150	72k		8	250	∞
	9	155	33k		9	150	180k
V302 (6AV5GA)	1	240	430k	V402 (5763)	1	250	300k
	2	100	900k		3	130	∞
	3	250	0		4	150	180k
	5	425	0		5	150	180k
	7	100	900k		6	250	∞
8	350	1k	7		130	∞	
V303 (5651)	1	85	40k		8	120	∞
	4	0	0		9	120	∞
	5	85	40k				
V304 (5965)	1	155	33k	V403 (5763)	1	120	∞
	2	37	500k		3	0	0
	3	39	6.8k		4	-60	110k
	4	100	900k		5	-60	110k
	5	100	900k		6	160	310k
	6	155	33k		7	0	0
	7	37	51k		8	-20	∞
	8	39	6.8k		9	-20	∞
	9	100	900k				

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**Table 5-3. Voltage and Resistance Measurements (continued)**

TUBE (TYPE)	PIN	DC VOLTS TO COMMON	OHMS TO GND	TUBE (TYPE)	PIN	DC VOLTS TO COMMON	OHMS TO GND
V404 (5963)	1	80	180k	V405 (5963)	1	- 50	6.8 k
	2	- 15	1.1 M		2	-190	See Note
	3	18	18k		3	-190	8 k
	4	- 60	110k		4	-60	110k
	5	- 60	110k		5	-60	110k
	6	75	180k		6	- 20	$\infty$
	7	- 36	1M		7	-200	95k
	8	0	0		8	-190	8 k
	9	-60	110k		9	- 60	110k

**NOTE**

Resistance at pin 2 of V405 may be 850 k $\Omega$  or 25 k $\Omega$ , depending on ohmmeter polarity.

**5.6 ELECTRICAL INSPECTION PROCEDURE.**

5.6.1 GENERAL. The following paragraphs describe tests that will establish whether each major portion of the instrument is functioning properly and suggest probable causes for any failures that may occur.

5.6.2 EQUIPMENT REQUIRED. The following equipment is required to inspect the Type 1264-A Modulating Power Supply:

- 1 Type 1210-C Unit R-C Oscillator with a Type 1201-B Unit Power Supply — or a sine-wave generator continuously adjustable from 20 cps to 60 kc with an output of 15 volts into input impedances of 10 kilohms or less.
- 1 Type 1217-B Unit Pulse Generator— or a square-wave generator with a pulse repetition rate of 1 kc, durations continuously adjustable from 1  $\mu$ sec to 600  $\mu$ sec, and an output of 20 volts, peak-to-peak.
- 1 Ballantine Model 310-A sensitive voltmeter — or a device capable of measuring with an accuracy of  $\pm 5\%$  voltages from 1 mv to 20 volts between 20 cps and 60 kc.
- 1 Type W5MT3W Metered Variac<sup>®</sup> Autotransformer— or an autotransformer capable of a continuous output between 0 and 128 volts ac, 90 watts, together with two  $\pm 3\%$  meters: a 0 to 128 v voltmeter and a 0 to 75 w wattmeter.
- 1 Fluke Type 801 differential voltmeter— or a dc voltmeter capable of measuring 190 to 310 volts with an accuracy of  $\pm 1\%$  and a resolution of 0.1 volt.

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- 1 Tektronix Type 541 oscilloscope — or an oscilloscope capable of measuring, within  $\pm 3\%$ , rise times of  $1.3 \mu\text{sec}$ , durations of  $1 \mu\text{sec}$  to  $600 \mu\text{sec}$ , and voltages of 10 to 260 volts.
- 1 Dummy load consisting of a 6-kilohm, 20-watt resistor paralleled by a 300-pf, 500-volt capacitor, and a momentary open switch (refer to paragraph 5.1.3).
- 1 Ohmmeter — Triplett Model 630-A, or a device capable of measuring resistances from 1 ohm to 1 megohm with an accuracy of  $\pm 10\%$ .

**5.6.3 CONNECTIONS REQUIRED.** The following connections (see Figure 8) should be made between output receptacles and to the dummy load for use as called for in subsequent paragraphs.

1. Pins 2 and 3 of SO102 connected together.
2. Pins 4 and 7 of SO102 connected together and to pin 16 of SO101, and by way of a momentary open switch to one side of a dummy load consisting of a 6000-ohm, 20-watt resistor in parallel with a 300-pf, 500-volt capacitor.
3. Pin 1 of SO102 to pin 17 of SO101 and to the other side of the dummy load.

These connections will maintain the common power supply bus at ground (the Type 1264 instrument case) potential for all positions of the function switch S401.

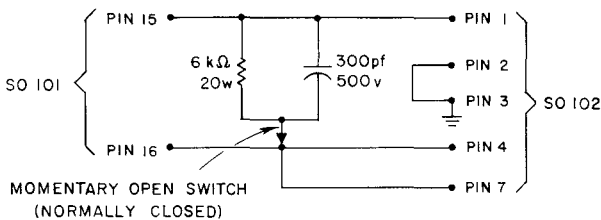


Figure 8. Schematic diagram of dummy load connections.

**5.6.4 MODULATOR OPERATION.** Tests for triggering sensitivity and output pulse characteristics are described in this paragraph.

Make connections described in paragraph 5.6.3. Connect the + OUTPUT PULSE terminals of the Type 1217-B Pulse Generator to the EXT INPUT terminals of the Type 1264-A and to the vertical input terminals of the oscilloscope. Connect the + SYNC output of the Type 1217-B Pulse Generator to the sync input connector of the oscilloscope. Set the oscilloscope for external triggering.

Set the Type 1217-BPRF control to 1 KC and the PULSE DURATION controls to  $600 \mu\text{sec}$ . Set the AMPLITUDE control for 20 volts, as measured on the oscilloscope. Mark this 20-volt level on the AMPLITUDE



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control and then disconnect the +OUTPUT PULSE of the Type 1217-B from the oscilloscope.

Connect the vertical input of the oscilloscope, using the 10:1 attenuator probe, to observe the modulator output pulse. The oscilloscope ground should be connected to pin 3 of SO102 (Type 1264-A case), and the probe input terminal to pin 7 of SO102. Set the oscilloscope for ac coupling and set the Type 1264-A function switch to EXT.

Vary the output-pulse duration of the Type 1217-B from 600  $\mu$ sec to 1  $\mu$ sec, and check the modulator output pulse by means of the display for the following:

1. Stable waveform, indicating proper operation of the Schmitt trigger in the Type 1264-A.
2. With MODULATED AMPLITUDE control fully clockwise, the output pulse amplitude should be at least 210 volts peak.
3. Overshoot less than 5%.
4. Rise and decay times less than 1.3  $\mu$ sec as measured between the 10 and 90% points.
5. Minimum pulse width, with a 1- $\mu$ sec Type 1217-B input, must be 1.3  $\mu$ sec or less, as measured between the 50% points.

Disconnect the Type 1217-B from the oscilloscope and from the Type 1264-A. Connect the output of the Type 1210-C Unit RC Oscillator to the EXT INPUT of the Type 1264-A. Monitor the output of the Type 1210-C with the sensitive voltmeter and monitor the output of the Type 1264-A with the oscilloscope.

Set the Type 1210-C for a 20-volt, rms, sine-wave output and check the oscilloscope display for a stable waveform on input frequencies from 20 cps to 60 kc.

### Modulator Trouble-Shooting Notes:

Assuming that the supply voltages as determined in paragraph 5.5.3 are correct, absence of an output pulse or poor triggering may be due to one of the following:

1. Signal to EXT INPUT less than 20 volts rms for sine-wave input, or less than 20 volts peak pulse, or pulse input negative instead of positive, or less than 1  $\mu$ sec in duration.
2. V401, V402, V403, V405, or CR401 faulty.
3. Negative supply faulty.

If the triggering is reliable but the output pulse shape is poor or of inadequate amplitude, V401, V402, or V403 is probably defective. V401 and V402 affect the pulse decay characteristics, while V403 controls the rise and amplitude characteristics. Poor rise and decay times may also be caused by excessive capacitance in the dummy load.

Waveforms at various significant points in the circuit are shown on the schematic diagram, Figure 11.

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**5.6.5 MULTIVIBRATOR OPERATION.** Tests for determination of the frequency range and duty ratio of the internal 1 kc  $\square$  modulation are described in this paragraph. Make connections described in paragraph 5.6.3, and connect the vertical input of the oscilloscope, using the 10:1 attenuator probe, to observe the modulator output pulse. The oscilloscope ground should be connected to pin 3 of SO102 (Type 1264-A case), and the probe input terminal to pin 7 of SO102. Set the oscilloscope for an internally triggered display with a sweep rate of 100  $\mu$ sec/cm. Set the oscilloscope for ac coupling, and set the Type 1264-A function switch to 1 KC  $\square$ . Check the center positions of the 1 KC  $\Delta$  FREQ and 1 KC DUTY RATIO controls as follows:

Set the 1 KC  $\Delta$  FREQ and the 1 KC DUTY RATIO controls of the Type 1264-A to produce a total duration of 1 ms for one complete cycle, with each half cycle being 500  $\mu$ sec. The pointers on the knobs should coincide with the dots on the front panel. If they do not, reposition the knobs on their shafts.

Check the range of the 1 KC  $\Delta$  FREQ control by observing the period as the control setting is varied. With the control fully counterclockwise, the period should be at least 1.2 msec, corresponding to a frequency slightly below 850 cps, and with the control fully clockwise, the period should be less than 0.85 msec, corresponding to a frequency slightly above 1150 cps.

Check the range of the 1 KC DUTY RATIO control with the 1 KC  $\Delta$  FREQ control set at the dot. The period of a half cycle should be adjustable over a range of  $\pm 25$   $\mu$ sec.

### 1 Kc Multivibrator Trouble-Shooting Notes:

The 1-kc multivibrator circuit consists of V404 and associated components, the positive supply, and the Y heater bus. The 1-kc multivibrator circuit is unaffected by the negative supply. The typical output waveform is shown on the schematic diagram, Figure 11. If there is no output from the multivibrator, V404 is probably faulty.

If the 1 KC  $\Delta$  FREQ control range is insufficient, or the 1 KC DUTY RATIO control range is insufficient, or the duty ratio improper, V404, R413, R414, R415, C403, or C404 is probably defective.

**5.6.6 RECTIFIER CIRCUIT.** Tests to determine proper functioning of the power transformer T201, rectifiers RX 201-205, and filter capacitors are described in this paragraph. Most troubles in this section of the instrument will either cause the line fuses to blow or will cause excessive power to be drawn from the power line. Check the input power as follows.

Set the Type W5MT3W Metered Variac<sup>®</sup> Autotransformer to zero volts and connect the Type 1264-A to it. Set the Type 1264-A function switch to CW. Slowly increase the line voltage to 115 and check the input power listed in Table 5-4 (to simulate no-load conditions, the dummy load is not connected; to simulate full-load conditions, the dummy load is connected as described in paragraph 5.6.3).

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**TABLE 5-4. INPUT POWER**

Line Voltage	Function Switch Setting	Input Power	
		No-load	Full-load
115	CW	50 watts	70 watts
115	1 KC□□		65 watts

With the input voltage set to 115 volts, output voltages from the rectifier filter circuits should be as listed in Table 5-5. All terminals listed are located on the vertical circuit board supported by the power transformer, and are observed with the dummy load connected, the function switch set to 1 KC□□, and the MODULATED AMPLITUDE control fully clockwise. Measurements may be made with the Triplet Model 630-A volt-ohm-milliammeter.

**TABLE 5-5. RECTIFIER-CIRCUIT VOLTAGES**

Voltmeter Scale	+ Terminal No.	- Terminal No.	Normal Voltage	Possible Cause of Trouble
1200	21	23	425	R201, RX202, RX203, C202, C203
300	20	19	100	RX201, C201
300	23	22	300	R202, RX204, RX205, C204, C205
12, AC	15	16	6.7	T201
12, AC	11	12	6.3	T201
12, AC	7	8	6.1	T201
12, AC	13	14	6.1	T201

Rectifier Circuit Trouble-Shooting Notes:

If there is no output voltage between terminals 21 and 23, and R201 is open, check to be sure that C202 and C203 are not short-circuited, and also that RX202 and RX203 have not been damaged. If there is no output voltage between terminals 23 and 22, and R202 is open, check to be sure that C204 and C205 are not short-circuited, and also that RX204 and RX205 have not been damaged.

If the output voltage from one of the dc supplies is low, it is probable that excessive loading is being applied by the modulator circuits or the external load. If the output voltage is high, a tube in the modulator or regulator circuits is probably defective.

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5.6.7 REGULATOR CIRCUIT. Tests to determine the regulation and filtering performance of the regulator circuit are described in this paragraph. All components of this circuit are located on the horizontal circuit board at the rear of the instrument. Make connections as described in paragraph 5.6.3. Connect the Type 1264-A power cord to the output of the metered Variac®. Use the differential voltmeter to perform the following checks and adjustments of dc voltage, and the sensitive voltmeter to check ripple. The ground or common terminals of the voltmeters should be connected to terminal No. 3 of SO102 (1264-A case), and the high input terminal of the voltmeters to terminal No. 1 of SO102.

**TABLE 5-6. REGULATOR-CIRCUIT TESTS**

Purpose of Test	1264-A Control Settings			Line Voltage Setting	DC Voltage	Ripple Voltage
	Function	MOD AMP	CW AMP			
Adjustment of maximum output voltage	CW	--	CW	115	Adjust R323 for 300.0 volts	---
CW AMP Control Range	CW	--	CCW	115	Less than 200 v	---
MOD AMP Control Range	EXT	CW	--	115	250 to 260 v	---
MOD AMP Control Range	EXT	CCW	--	115	Less than 200 v	---
Line voltage regulation and ripple at low line	CW	--	CW	115	300.0	---
				103	Change less than $\pm 0.2$ v	Less than 1 mv
Load regulation at low line	CW		CW	103	Change less than $\pm 0.2$ v upon removing load	
Line voltage regulation at high line	CW	--	Set for 200.0 v output	115	200.0	
				128	Change less than $\pm 0.2$ v	
Load regulation and ripple at high line	CW	--	Set for 200.0 v output	128	Change less than $\pm 0.2$ v upon removing load	Less than 1 mv

### Regulator Circuit Trouble-Shooting Notes:

The regulator circuit consists of V301 and V304 and associated components. It is not associated in any way with the negative supply, but requires adequate output from the main positive supply and also from the loss tube screen supply. Tests of these supplies are described in paragraph 5.5.6, Rectifier Circuit. If these voltages are adequate, a defective tube V301, V304 is probably responsible for inadequate regulation against line or load changes, as well as for excessive ripple. Apparent excessive

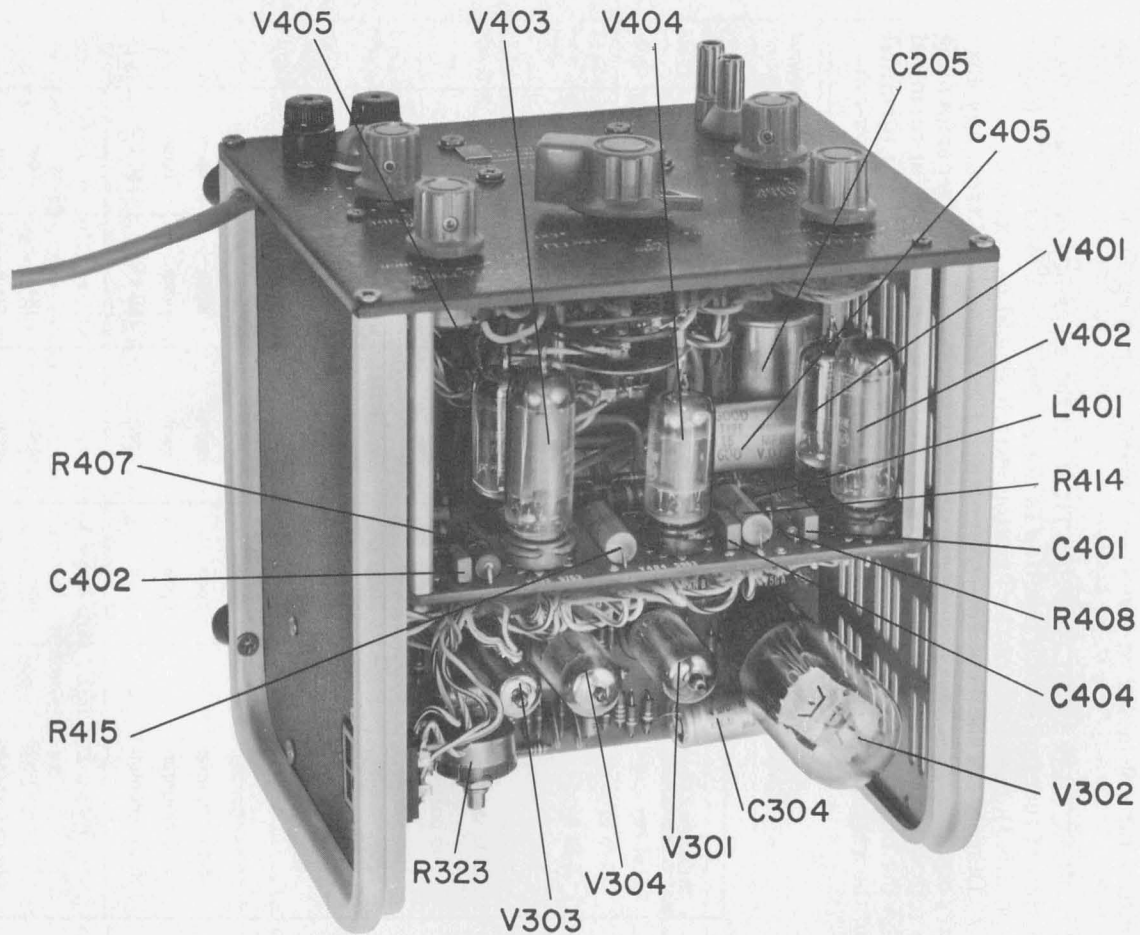


Figure 9. Top Interior View.

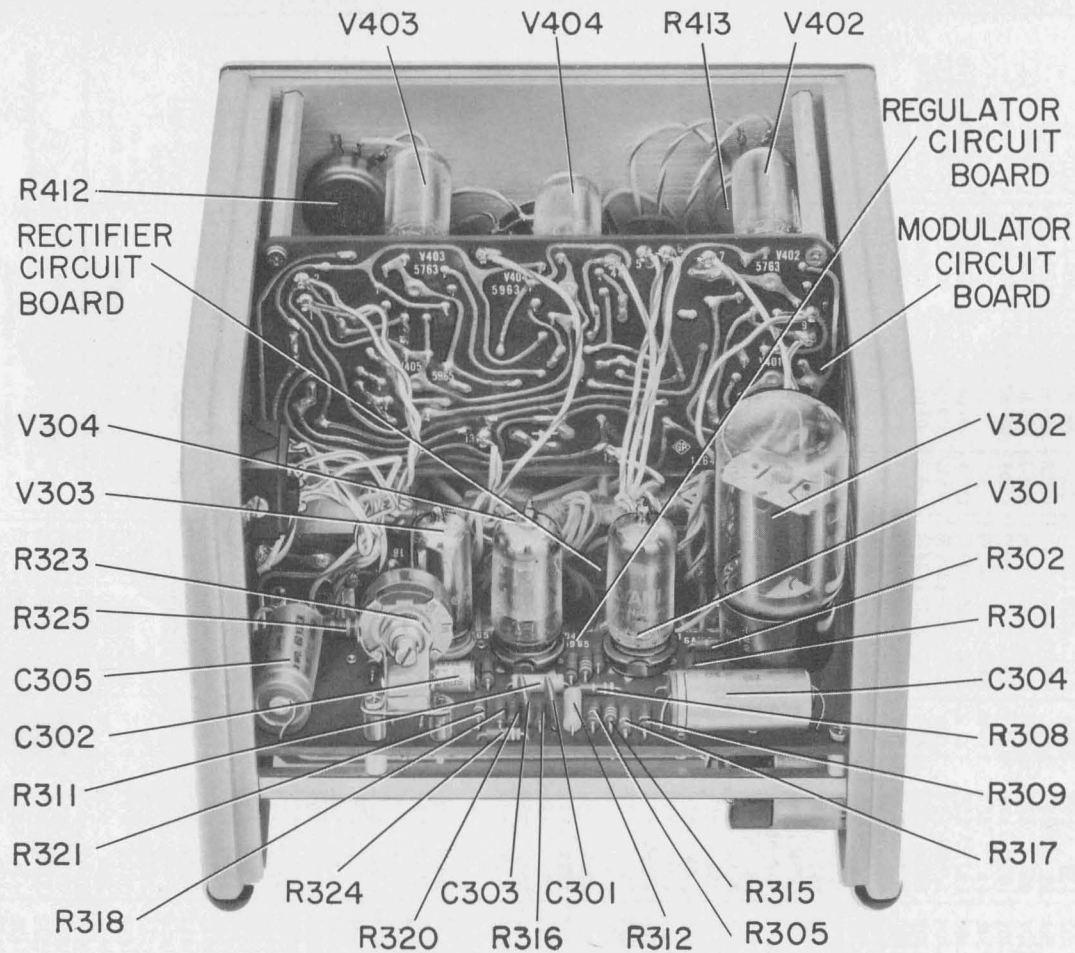


Figure 10. Rear Interior View.

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PARTS LIST

RESISTORS				CAPACITORS						
R101	15	±10%	1/2w	REW-3C (150 C)	C201	16µf	150 dcwv	COE-4		
R102	1 M	±5%	1/2w	REC-20BF (105 B)	C202	90-30-30µf	300 dcwv	COE-52		
R201	82	±5%	10w	REPO-44 (820 B)	C203	90-30-30µf	300 dcwv	COE-52		
R202	47	±5%	1/2w	REC-20BF (470 B)	C204	90-30-30µf	300 dcwv	COE-52		
R301	10 M	±5%	1/2w	REC-20BF (106 B)	C205	90-30-30µf	300 dcwv	COE-52		
R302	1 k	±5%	1/2w	REC-20BF (102 B)	C301	.01µf ±20%	500 dcwv	COC-62 (103 D)		
R303	1 k	±5%	1/2w	REC-20BF (102 B)	C302	.047µf ±10%	400 dcwv	COW-25 (473 C)		
R304	2.7 M	±5%	1/2w	REC-20BF (275 B)	C303	.01µf ±20%	500 dcwv	COC-62 (103 D)		
R305	120 k	±5%	1/2w	REC-20BF (124 B)	C304	4µf	450 dcwv	COE-32		
R306	100 k	±5%	1/2w	REC-20BF (104 B)	C305	4µf	450 dcwv	COE-32		
R307	390 k	±5%	1/2w	REC-20BF (394 B)	C401	180 pf ±10%	500 dcwv	COM-22 B (181 C)		
R308	4.3 M	±5%	1/2w	REC-20BF (435 B)	C402	.001µf ±10%	500 dcwv	COM-22 B (102 C)		
R309	100 k	±5%	1/2w	REC-20BF (104 B)	C403	.001µf ±1%	500 dcwv	COM-22 F (102 A)		
R310	56 k	±5%	1w	REC-30BF (563 B)	C404	.001µf ±1%	500 dcwv	COM-22 F (102 A)		
R311	100 k	±1%	1/4w	REF-65 (104 A)	C405	0.15µf ±10%	600 dcwv	COP-25 (154 C)		
R312	75 k	±1%	1/4w	REF-65 (753 A)	C406	10 pf ±10%	500 dcwv	COC-21NPO (100 C)		
R313	1 k	±5%	1/2w	REC-20BF (102 B)						
R314	33 k	±5%	1/2w	REC-20BF (333 B)	TUBES					
R315	33 k	±5%	1/2w	REC-20BF (333 B)	V301	6AN8	V304	5965	V403	5763
R316	6.8 k	±5%	1/2w	REC-20BF (682 B)	V302	6AV5GA	V401	5965	V404	5963
R317	180 k	±5%	1/2w	REC-20BF (184 B)	V303	5651	V402	5763	V405	5965
R318	2.2 M	±5%	1/2w	REC-20BF (225 B)						
R319	1 k	±5%	1/2w	REC-20BF (102 B)	MISCELLANEOUS					
R320	1.5 M	±5%	1/2w	REC-20BF (155 B)	CR401	DIODE		2RED-1008		
R321	470 k	±5%	1/2w	REC-20BF (474 B)	F101	FUSE, 115v: 0.8 amp		FUF-1		
R322	164 k	±1%	1/2w	REF-65 (1643 A)	F102	FUSE, 115v: 0.8 amp		FUF-1		
R323	10 k	±10%		POSC-11 (103 C)	J101	JACK		BP-5		
R324	36 k	±5%	1/2w	REC-20BF (363 B)	J102	JACK		BP-10, 11/16		
R325	3.3 k	±10%	1w	REC-30BF (332 C)	L401	INDUCTOR, 100 µh		CHA-3-3		
R401	100 k	±10%		POSC-7 (104 C)	P101	LAMP, 6.3v No. 44		2LAP-939		
R402	250 k	±10%		POSC-7 (254 C)	PL101	PLUG		CDPP-2-2		
R403	120 k	±5%	1/2w	REC-20BF (124 B)	RX201	RECTIFIER (200v PIV)		2RE-1001		
R404	180 k	±5%	1/2w	REC-20BF (184 B)	RX202	RECTIFIER (600v PIV)		2RE-1003		
R405	470 k	±5%	1/2w	REC-20BF (474 B)	RX203	RECTIFIER (600v PIV)		2RE-1003		
R406	12 k	±5%	2w	REC-41BF (123 B)	RX204	RECTIFIER (400v PIV)		2RE-1002		
R407	10 k	±5%	2w	REC-41BF (103 B)	RX205	RECTIFIER (400v PIV)		2RE-1002		
R408	330	±5%	1/2w	REC-20BF (331 B)	S401	SWITCH		SWRW-204		
R409	240 k	±5%	1/2w	REC-20BF (244 B)	S402	SWITCH		SWRW-204		
R410	360 k	±5%	1/2w	REC-20BF (364 B)	SO101	SOCKET		CDMS-11-4		
R411	180 k	±5%	1/2w	REC-20BF (184 B)	SO102	SOCKET		1264-40		
R412	250 k	±10%		POSC-7 (254 C)	T201	TRANSFORMER		365-495		
R413	100 k	±10%		POSC-7 (104 C)						
R414	787 k	±1%	1w	REF-75 (7870 A)	NOTES:					
R415	787 k	±1%	1w	REF-75 (7870 A)	All resistances are in ohms, except as otherwise indicated					
R416	180 k	±5%	1/2w	REC-20BF (184 B)	by k (kilohms) or M (megohms).					
R417	18 k	±5%	1/2w	REC-20BF (183 B)	Type designations for resistors and capacitors are as					
R418	150 k	±5%	1/2w	REC-20BF (154 B)	follows:					
R419	27 k	±5%	1/2w	REC-20BF (273 B)	COC - Capacitor, ceramic		REC - Resistor, composition			
R420	5.6 M	±5%	1/2w	REC-20BF (565 B)	COE - Capacitor, electrolytic		REF - Resistor, film			
R421	1 M	±5%	1/2w	REC-20BF (105 B)	COM - Capacitor, mica		REPO - Resistor, power			
R422	100	±5%	1/2w	REC-20BF (101 B)	COP - Capacitor, plastic		REW - Resistor, wire-wound			
R423	150 k	±5%	1/2w	REC-20BF (154 B)	POSC - Potentiometer, composition					
R424	470 k	±5%	1/2w	REC-20BF (474 B)						
R425	6.8 k	±5%	2w	REC-41BF (682 B)						
R426	4.7 k	±5%	2w	REC-41BF (472 B)						
R427	470 k	±5%	1/2w	REC-20BF (474 B)						
R428	120 k	±5%	1/2w	REC-20BF (124 B)						
R429	100	±5%	1/2w	REC-20BF (101 B)						

NOTES:

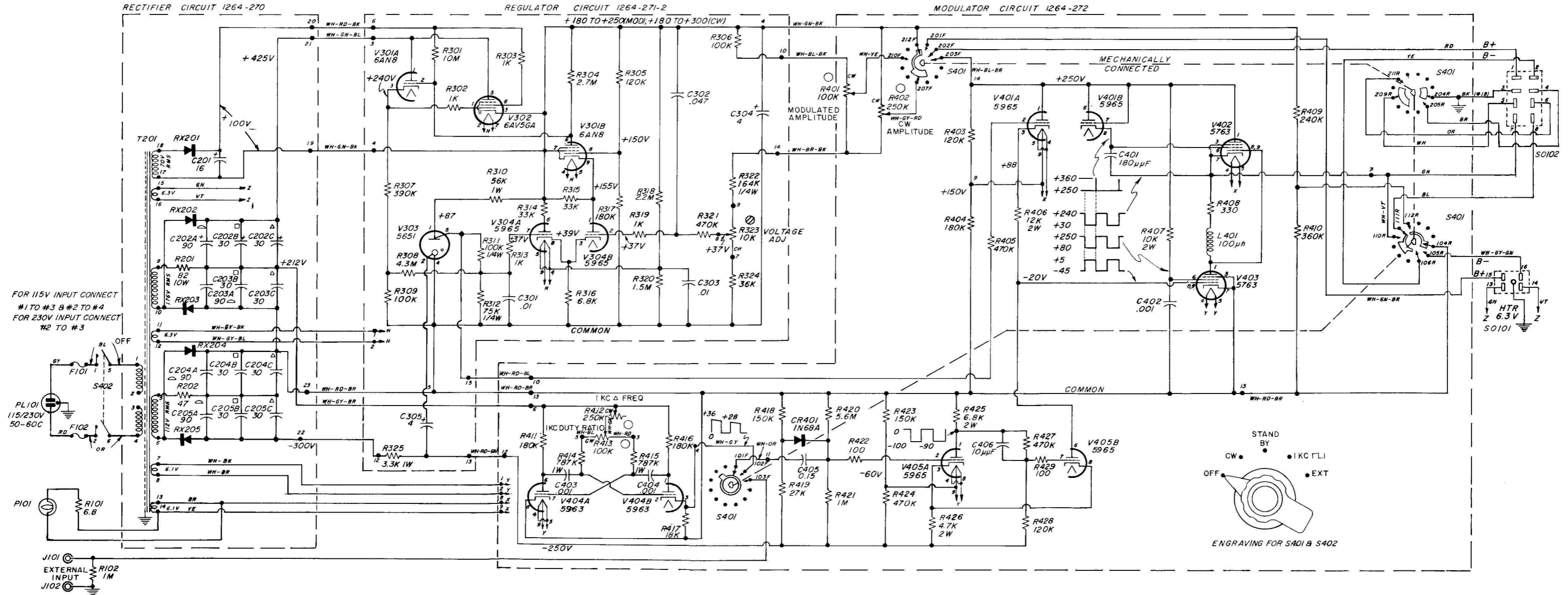
RESISTORS 1/2 WATT, UNLESS OTHERWISE SPECIFIED  
 RESISTANCE IN OHMS, UNLESS OTHERWISE SPECIFIED  
 K = 1000 OHMS M = 1 MEGOHM

CAPACITANCE VALUES IN MICROFARADS UNLESS  
 OTHERWISE SPECIFIED

VOLTAGES ARE REFERRED TO COMMON LEAD UNLESS OTHERWISE SPECIFIED  
 VOLTAGES ARE MEASURED AT 115V INPUT WITH AMPLITUDE CONTROLS SET TO  
 PRODUCE 250V REGULATED SUPPLY VOLTAGE AND WITH S401 SET TO 1 Kc □

⊗ SCREWDRIVER ADJUSTMENT  
 ○ KNOB CONTROL

Figure 11. Schematic Diagram of the Type 1264-A.  
 (For Elementary Schematic, see next page.)





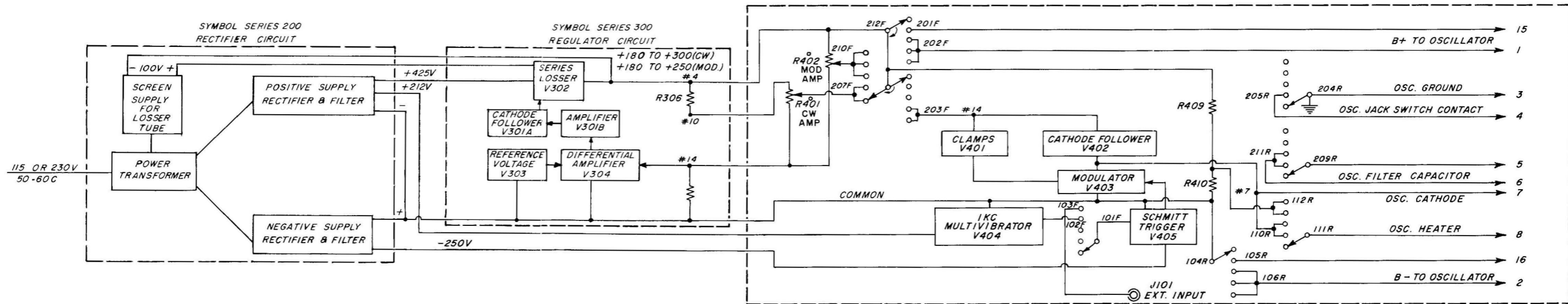


Figure 12. Elementary Schematic Diagram of the Type 1264-A.

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