COPY 14 OF 65.

L164

OPERATING AND MAINTENANCE MANUAL

FOR

LATCHING RADIO SWITCH SYSTEM LRS-1

L164

COPY 14 OF 65.

LATCHING RADIO SWITCH SYSTEM LRS-1

THIS INSTRUCTION MANUAL DESCRIBES THE LATCHING RADIO SWITCH SYSTEM, MODEL LRS-1, CONSISTING OF THE TRANSMITTER LRST-1 AND THE RECEIVER LRSR-1, (WHITE DOT) AND LRSR-1B (RED DOT). [redacted] 25X1

25X1

THIS MANUAL IS DIVIDED INTO TWO PARTS: PART I DESCRIBES THE TRANSMITTER, AND PART II THE RECEIVER.

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TRANSMITTER LRST-1

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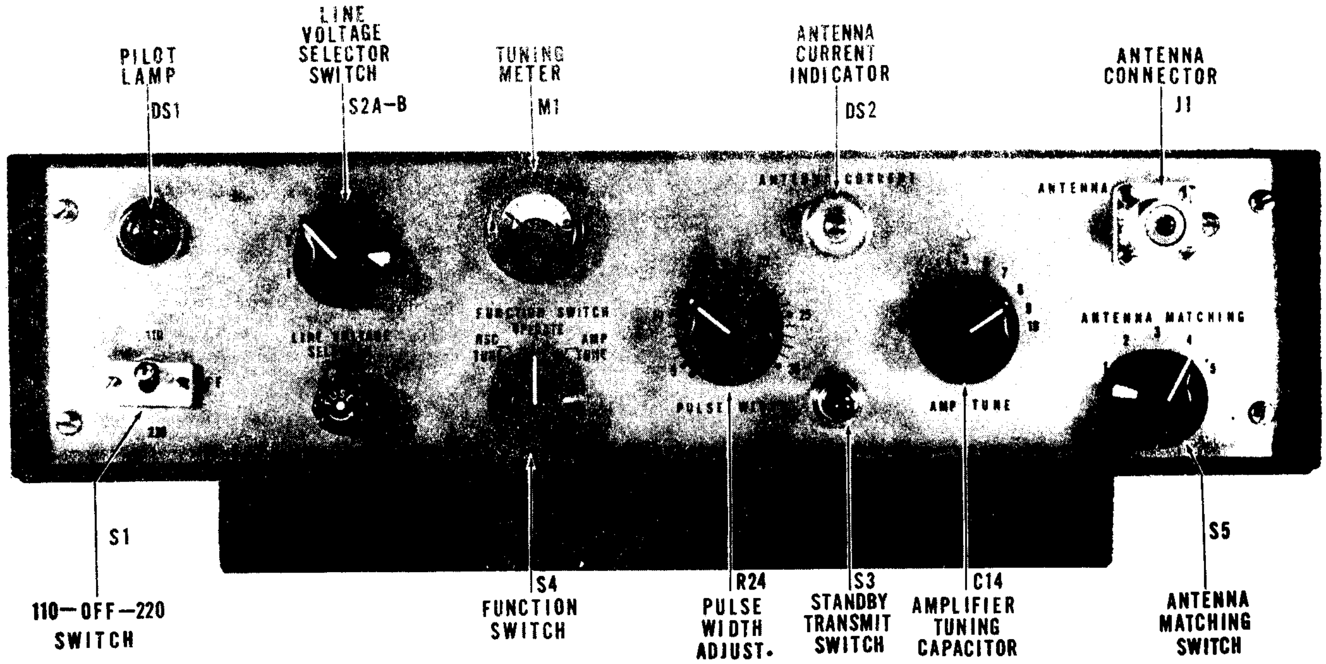

Figure 1-1 Photograph - Transmitter LRST-1. Front View

PART I

TRANSMITTER LRST-1

1. Introduction

1.1 SCOPE

This part of the instruction manual contains information for the operation and maintenance of the Transmitter, Model LRST-1. A photograph of the unit is given in Figure I-1.

1.2 GENERAL DESCRIPTION

The Transmitter LRST-1 is a pulse modulated unit, intended to provide an operating pulse for the Receiver LRSR-1 from a remote location.

The unit may be operated on a line voltage between 70-140 volts or 140-280 volts, 50-60 cps. An adjustable output impedance allows the use of a straight wire antenna from 18 to 30 feet in length.

1.3 GENERAL SPECIFICATIONS

Frequency........................ 6.8 mc, crystal controlled.

Type Modulation.................. Pulse Modulation

Pulse Width...................... Adjustable 5-30 milliseconds

Input Voltage.................... (Adjustable in two ranges) 70-140 v a-c; 140-280 v a-c; 50- 60 cycles

Power Consumption (volt-amps)

Stand by.............. 37 volt-amps.

Transmit.............. 75 volt-amps.

Output Power..................... Approximately 10 watts.

Output Impedance................. Adjustable to match antenna.

Antenna.......................... (Not supplied) 18-30 ft. straight wire.

Dimensions....................... 15 1/16" X 8 7/16" X 3 5/8"(excluding stand).

Weight........................... 16 lbs.

Finish........................... Black wrinkle.

1.4 EQUIPMENT LIST

a. Transmitter LRST-1.

2. OPERATION

2.1 GENERAL

The transmitter LRST-1 is designed to operate directly from a 50-60 cycle a-c power source within either of the two following voltage ranges: 70-140 v a-c or 140-280 v a-c.

CAUTION

Before connecting the equipment to the power source, be sure the power source is 50-60 cycle a-c. Do not attempt to operate the LRST-1 from a d-c or 25 cycle a-c source as serious damage to the equipment will result.

2.2 IDENTIFICATION OF ADJUSTMENTS AND CONTROLS (Figure I-1)

All adjustments and controls with the exception of the meter adjustment, pulse width calibration adjustment, and oscillator tuning adjustment, are located on the front panel.

Identification	Ref. Symbol	Function	Location
110-OFF-220	S1	On-off switch (for 110 v or 220 v range)	Front Panel (lower left)
LINE VOLTAGE SELECTOR	S2	Selects the proper primary tap for line voltage available.	Front Panel (upper left)
STANDBY TRANSMIT	S3	Transmits pulse when depressed.	Front Panel (lower left)
FUNCTION SWITCH	S4	Selects TUNE-OPERATE positions and provides appropriate metering.	Front Panel (center left)
ANTENNA MATCHING	S5	Matches output of transmitter to antenna.	Front Panel (lower right)
PULSE WIDTH	R24	Pulse width adj. of the critical pulse.	Front Panel (center)
AMP. TUN.	C14	Tunes power amplifier.	Front Panel (center right)
Pulse Width Calibration	R8	Sets pulse width range.	Inside unit.
Oscillator Tuning Coil	L1	Tunes the oscillator.	On rear of unit.
Meter Adjustment	R23	Adjusts meter to read 6.3 v directly.	Inside unit.

2.3 OPERATING PROCEDURE

1. Set the LINE VOLTAGE SELECTOR switch to position No. 1, and the 110-OFF-220 switch to the "OFF" position.

CAUTION

Be sure the LINE VOLTAGE SELECTOR switch is in position No. 1 before a-c power is applied, for if it is advanced too far and the line voltage is high, damage to components will result.

2. Plug the line cord into the a-c line, and connect the ground lead (located on the a-c plug) to a ground, e.g., a water pipe or to any metal of a grounded electrical system.

3. Place the FUNCTION SWITCH to OPERATE position.

4. Place the 110-OFF-220 switch to either 110 or 220 position, depending on line voltage. (If the line voltage is between 70-140 v a-c, place switch in 110 v position. If line voltage is between 140-280 v a-c, place switch in 220 v position.) A locking screw is provided on this switch. It should be removed and replaced each time the switch is set for 110 v or 220 v, in order to prevent accidental changeover.

If the line voltage is unknown, place the 110-OFF-220 switch in 220 v position.

5. Rotate the LINE VOLTAGE SELECTOR switch until the meter needle is in the center of the "red" mark (red mark indicates 6.3 v filament voltage). Each position on the LINE VOLTAGE SELECTOR switch represents approximately 10 volts.

If the meter needle does not reach the "red" mark with the LINE VOLTAGE SELECTOR switch fully clockwise and the line voltage is unknown (as stated in Step 4), return the LINE VOLTAGE SELECTOR switch to position No. 1, place the 110-OFF-220 switch in the 110 position, and rotate the LINE VOLTAGE SELECTOR switch until the meter needle is in the center of the "red" mark.

6. Attach a straight wire antenna, 18 to 30 feet long (for optimum loading) to the antenna connector on the front panel, and place the antenna in a vertical position, if possible. The antenna wire should be insulated, in order to prevent accidental grounding.

CAUTION

Do not touch the antenna or antenna connector during tuning or operation; as r.f. burns may result.

7. Set the FUNCTION SWITCH to OSC. TUNE to check oscillator output. If the meter reads .1 ma, or more, the oscillator is operating satisfactorily.

8. Set the FUNCTION SWITCH to AMP. TUNE position.

9. Set the ANTENNA MATCHING adjustment to position No. 1 and tune the AMP. TUNE adjustment for a minimum reading on the meter and/or maximum brightness on the antenna current indicator.

10. Rotate the ANTENNA MATCHING adjustment successively to each of its other positions, tuning the AMP. TUNE adjustment for maximum brightness in each position. Then select the position of greatest brilliance.

NOTE

If the antenna current indicator shows the same brilliance in two positions, use the lower position. (e.g., If positions no. 4 and no. 5 have same brilliance, use no. 4.)

11. Set the FUNCTION SWITCH to the OPERATE position.

12. Adjust the PULSE WIDTH adjustment to correspond to the pulse width setting of the particular receiver to be used with the transmitter.

13. Depress STANDBY-TRANSMIT switch to pulse the transmitter. To check the operation of the system, continue below.

2.4 SYSTEM CHECK

Each transmitter and receiver combination should be operated together in the laboratory before being sent into the field, in order to insure proper operation.

1. Set up and operate the transmitter as outlined above in Section 2.3.

2. Set up and operate the receiver as outlined in Section 2.3, Part II of this manual, attaching the auxiliary device to the receiver.

3. If the auxiliary device is a transmitter, a receiver (tuned to the frequency of the auxiliary device and located with the LRST-1) would be advantageous. If an auxiliary device is not available for testing, a voltmeter placed across one relay contact and the COM terminal of the receiver will suffice.

4. To transmit a switching signal to the LRSR-1, place the FUNCTION SWITCH in the OPERATE position. Depress the STANDBY TRANSMIT switch for approximately 1/2 second and then release. If switching does not occur, try sending one or more additional switching signals.* If switching action still does not occur, rotate the PULSE WIDTH adjustment in 1 msec increments, depressing the STANDBY-TRANSMIT switch two or more times at each setting.* If switching still does not occur, refer to Section 5, Maintenance in both Part I and Part II of this manual.

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*Pause at lease three seconds between pulses.

3. TEST PROCEDURES

3.1 GENERAL

The following checkout procedure is included as a supplement to the Laboratory Data Sheet supplied with each unit. This section describes in detail the measuring techniques used in attaining this data.

3.2 TEST EQUIPMENT REQUIRED

Voltohmmeter - Simpson, Model 260, or equivalent

Oscilloscope - Dumont (long persistent screen) Type 304-A, or equiv.

Variac - General Radio, Model 1001A, or equivalent

Vacuum Tube Voltmeter - Hewlett Packard, Model 410B, or equivalent

Dummy Load - 50 or 200 ohm resistor, 20 watt non-reactive.

Diode Probe

Receiver - LRSR-1

3.3 VOLTAGE CHECKS

a. Filament Voltage

1. Operate the transmitter as outlined in Section 2.3.

2. Connect an a-c voltmeter between the 6.3 v test point (shown in Figure I-4) and ground (chassis).

3. Measure filament voltage. It should be approximately 6.3 v a-c.

b. B+ Voltage

1. Place the transmitter FUNCTION SWITCH in the AMP TUNE position.

2. Attach a 50 ohm dummy load to the transmitter antenna connector.

3. Place a d-c voltmeter between the B+ test point (shown in Figure I-4) and ground, and measure B+. It should be approximately 320 v d-c.

c. Input Voltage Range

In order to check the input voltage range of the transmitter, the following procedure is recommended:

1. Plug the transmitter a-c input into a variac. Be sure the variac "on-off" switch is in the "off" position.

2. Connect an a-c voltmeter to the variac output.

3. Place LINE VOLTAGE SELECTOR switch to position 1.

4. Place 110-OFF-220 switch in 110 position and adjust variac for 70 volts output.

5. Adjust the LINE VOLTAGE SELECTOR switch until the meter needle is in the red mark.

6. Place LINE VOLTAGE SELECTOR switch to position 1.

CAUTION

The LINE VOLTAGE SELECTOR switch should be reset to position 1 before each measurement; then adjusted to the red mark on the meter.

7. Adjust the variac for 140 volts output.

8. Adjust the LINE VOLTAGE SELECTOR switch until the meter needle is in the red mark.

9. Repeat the above steps with the 110-OFF-220 switch in the 220 position, adjusting the variac output to 140 and 280 volts.

3.4 OUTPUT POWER

a. Operate the transmitter as described in Section 2.3.

b. Connect a dummy load of approximately 50 ohms to the antenna connector.

c. Connect an r.f. voltmeter across the dummy load.

d. Tune the transmitter for maximum power out, as described in Section 2.3. Power output may be determined from the following equation:

$$P = \frac{E^2}{R\,(\text{dummy load})}$$

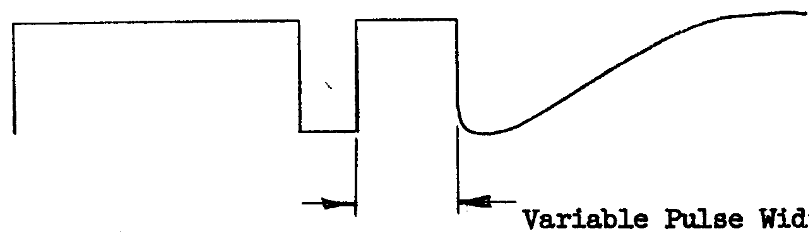
3.5 CHECKING WAVEFORM

a. Operate the transmitter using the dummy load.

b. Connect a diode probe to the oscilloscope and place the high impedance end near the dummy load.

c. Pulse the transmitter.

d. Rotate the PULSE WIDTH adjustment on the transmitter. As this adjustment is rotated, the pulse width of one of the pulses on the scope will vary. This pulse should be similar to the following:



This waveform appears only when the transmitter is pulsed. If the proper waveform does not appear, refer to Section 5, Maintenance.

3.6 PULSE WIDTH RANGE

The following procedure is recommended for measuring pulse width:

a. Set the oscilloscope on driven sweep and push the calibrate button to produce a 60 cycle waveform.

b. Set one 60 cycle wave equal to 16.7 horizontal divisions on the scope.

$t = 1/F$ $\qquad$ $t = 1/60$ $\qquad$ $5 = 16.7$ millisec

c. Use the negative internal trigger on the scope.

d. Using the diode probe connected to the vertical input of the oscilloscope, set pulse to 5 divisions when PULSE WIDTH adjust on transmitter is set at 5. (Do not change sweep amplitude.)

e. Repeat Step d for 20 millisec when PULSE WIDTH adj is set at 20.

f. If the pulse width on the scope does not equal 5 or *20 divisions, when the PULSE WIDTH adjustment is set to 5 or 20, refer to Section 5.8a Setting Pulse Width.

---

* The 20 millisecond setting on the scope may be ±2 milliseconds due to the non-linearity of the potentiometer.

4. THEORY OF OPERATION

4.1 GENERAL

The transmitter circuit consists of a pulse modulator V3, a crystal oscillator V4, a power amplifier V5, a full-wave voltage rectifier V1 and voltage regulator V2. A coded pair of pulses is produced by the pulse modulator V3. These pulses are used to modulate the r.f. output of the crystal oscillator V4. The resultant signal at the output of the oscillator is amplified by the power amplifier V5. The output signal from V5 is applied to the antenna through S5.

4.2 CIRCUIT ANALYSIS

A block diagram is given in Figure I-2, and a circuit diagram in Figure I-7.

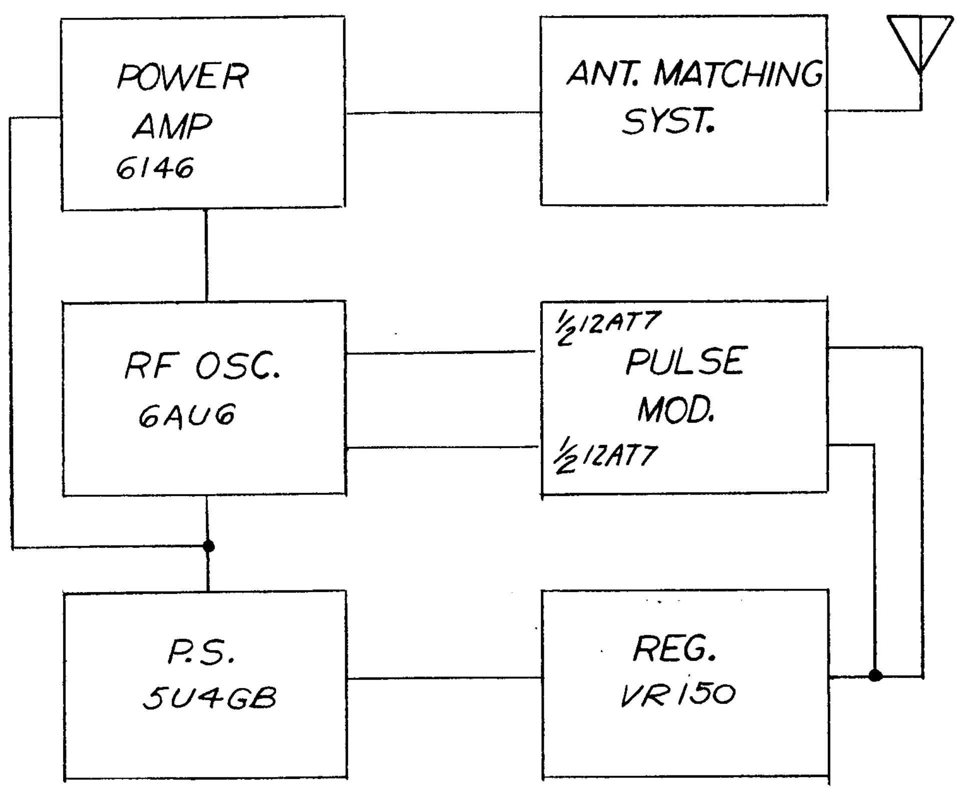


Figure I-2 Block Diagram LRST-1

a. Pulse Modulator

The pulse modulator V3, a type 12AT7 duo-triode, operates two pulses having different widths. These pulses, shown as A and B in Figure I-3, are used to modulate the crystal oscillator V4. Pulse A is produced by V3A and is coupled through C2 to the control grid of the crystal oscillator. Pulse B is produced by V3B and is coupled through C5 to the screen grid of the crystal oscillator.

The negative transition at the end of pulse A drives the control grid of the crystal oscillator sharply negative, thereby cutting off the crystal oscillator for a short period of time. Similarly, the negative transition at the end of pulse B drives the screen grid of the crystal oscillator sharply negative which cuts off the crystal oscillator again for a short period of time at the ends of pulses A and B. The resulting modulation envelope at the plate of the crystal oscillator is shown in C of Figure I-3.

The portion of the signal (shown in C of Figure I-3) which occurs between the start of oscillation and the first notch caused by the end of pulse A forms the protecting pulse. The portion between the first notch and the second notch caused by the end of pulse B forms the operating pulse. The portion which occurs after the second notch and continues until the STANDBY-TRANSMIT switch is released is referred to as the incidental signal since it neither contributes to, nor impairs circuit operation.

The pulse modulator circuit is similar to a pair of monostable multivibrators with the two "normally off" tubes replaced by contacts K1A of relay K1. In the quiescent stage, both halves of V3 are conducting, since the grids at this time are just slightly positive. (Grid current flows through the grid resistors to the +150 volt regulated supply. Since the grid-to-cathode resistance during grid current flow is very small compared to the value of the grid resistors, virtually all of the 150 volts is dropped across the resistors, leaving only a very small positive voltage between grid and cathode.)

Capacitors C3 and C4 are charged to +150 volts, since one terminal of each capacitor connects to a grid which is at zero potential and the other terminals are joined together and returned to the regulated +150 volt supply through R6. When the relay contacts K1A close in response to depressing the STANDBY-TRANSMIT switch, the voltage at the junction of C3 and R5 instantly falls to zero. Since the voltage across the capacitors cannot change instantly, the voltage on the grid sides of the capacitors instantly changes to -150 volts, cutting off both halves of V3. Capacitor C3 then discharges slowly through R5, and C4 discharges through the combination of R24, R8, and R7, until the grid voltages reach values close to zero, at which time the halves of V3 resume conduction. Pulses A and B occur during the cutoff periods, which are approximately 73 percent of the r-c time constants formed by C3 and C4 and their respective grid leak resistances.

The width of pulse A is fixed, while the width of pulse B is adjustable by means of PULSE WIDTH adj. R24 and the pulse width calibration adjustment R8. The width of the operating pulse portion of the complete coded signal is equal to the width of pulse B minus the width of pulse A (neglecting the small notch between the operating pulse and protecting pulse). Therefore, since pulse A is fixed, adjustment of pulse B varies the width of the operating pulse. R8, the pulse width calibration adjustment, provides for initial adjustment to compensate for component tolerances in the radio switch transmitter and radio switch reciever. This control is a screwdriver adjustment located on the chassis. R24, the PULSE WIDTH adjustment, located on the front panel provides selective operation of the receiver.

By coupling the two halves of the pulse modulator to different control elementsof the crystal oscillator (the control grid and the screen grid) the mutual loading effect,which would exist if both were coupled to the same control element, is eliminated. Resistors R4 and R10 are parasitic suppressors. R3 and R9 are the plate load resistors for V3A and V3B, respectively.

b. Crystal Oscillator

The crystal oscillator V4, employs a type 6AU6 pentode in a tri-tet circuit with the screen grid serving as the oscillator plate. Capacitor C7 places the screen grid at r-f ground potential; the suppressor grid is directly grounded. In this type of circuit the low grid to plate capacitance and high plate resistance of the type 6AU6 tube provides isolation between the oscillator section (consisting of the screen grid, control grid, and cathode) and the plate from which oscillator output is taken to drive the power amplifier. The isolation between the oscillator and the plate circuit prevents changes in the power amplifier input impedance from affecting the frequency, operating stability, and modulation capability of the crystal oscillator, thus making a buffer amplifier stage unnecessary. The feedback voltage in the oscillator is developed across choke L3 and is coupled to the grid through the inter-electrode capacitance of the tube.

Choke L2 provides r-f isolation between the oscillator grid and the pulse modulator stage. The choke also provides r-f isolation between grid leak resistor R14 and the crystal to obtain maximum operating Q.

The output voltage for driving the grid of the power amplifier is developed across the oscillator plate tank circuit comprised of L1 and the distributed and wiring capacitance of V4. The choke is slug tuned to provide a tuning adjustment for optimizing the drive to the power amplifier grid.

c. Power Amplifier

Power amplifier V5 employs a type 6146 pentode operating as a class C amplifier. Cathode resistor R19 develops part of the operating bias and limits the plate current in case of oscillator failure. The grid leak resistance is comprised of R17 and meter shunt resistor R18. Capacitor C13 bypasses R18 so that no r-f potential exists on the lead from R18 to the FUNCTION SWITCH S4 and tuning meter M1.

The output coupling circuit consists of a modified pi network having adjustable impedance transformation, which allows optimum impedance matching between the power amplifier plate and a straight wire antenna of any length between 18 and 30 feet. The adjustable impedance transformation is provided by the ANTENNA MATCHING switch S5 and capacitors C15, C16, C17, and C18. The position of switch S5 determines the driving point of the circuit. At resonance, the net reactance (to ground) of the portion of the circuit to the left of the driving point is inductive and equal to the capacitive reactance (to ground) of the portion of the circuit to the right of the driving point. These portions of the circuit are the inductive and capacitive branches, respectively. When the driving point is shifted in the direction toward coil L5, each capacitor to the left of the switch contacts is successfully transferred from the inductance branch to the capacitive branch, increasing the net reactance of both branches; thus increasing the effective inductance and decreasing the effective capacitance. The L/C ratio is thereby increased, increasing the impedance transformation from the antenna terminal to the driving point. The L/C product remains approximately constant so that the circuit is detuned, only slightly when the antenna matching switch is changed. This feature allows matching to a wide range of antenna impedances without requiring variable tuning capacitors at both ends of the coil L5, thereby minimizing the possibility of tuning to a harmonic of the operating frequency. C14 is the output tuning capacitor.

d. Meter and Function Switch Circuit

The meter, located on the front panel indicates filament voltage when the FUNCTION SWITCH is in the OPERATE position; and serves as a tuning indicator in the OSCILLATOR TUNE and AMPLIFIER TUNE positions.

When the FUNCTION SWITCH (S4) is set at OPERATE, R22, R23 (METER ADJ.), CR1, and the tube filaments are placed in series with the meter. The meter indicates filament voltage. With S4 in this position, B+ is applied to the pulse modulator V3, but not to the oscillator V4 or power amplifier V5.

When the FUNCTION SWITCH (S4) is set at OSCILLATOR TUNE, the meter is connected across the meter shunt resistor R21 to read the d-c grid current of the power amplifier as the oscillator plate circuit is being tuned. When the FUNCTION SWITCH (S4) is set at AMPLIFIER TUNE, the meter is switched across meter shunt resistor R18, which is in series with plate supply lead of the power amplifier. The meter reads d-c plate current to the power amplifier to provide an indication during tuning and impedance matching adjustments. With S4 in either the OSC TUNE or AMP TUNE position, B+ is applied to the oscillator V4 and the power amplifier, V5, but not the pulse modulator V3 (continuous carrier is transmitted).

e. Power Supply Circuit

The power supply consists of a full-wave rectifier, utilizing a Type 5U4GB vacuum tube, a power transformer T1, and a filter capacitor and bleeder resistor, C1 and R1, respectively. The LINE VOLTAGE SELECTOR switch S2 is in the primary of T1. S1 is the 110-OFF-220 switch.

f. Voltage Regulator

The voltage regulator V2 (tube type OA2) provides a regulated voltage of +150 volts for the grid timing circuits of the pulse modulator. Resistor R2 in series with V2 limits the current of the regulator tube.

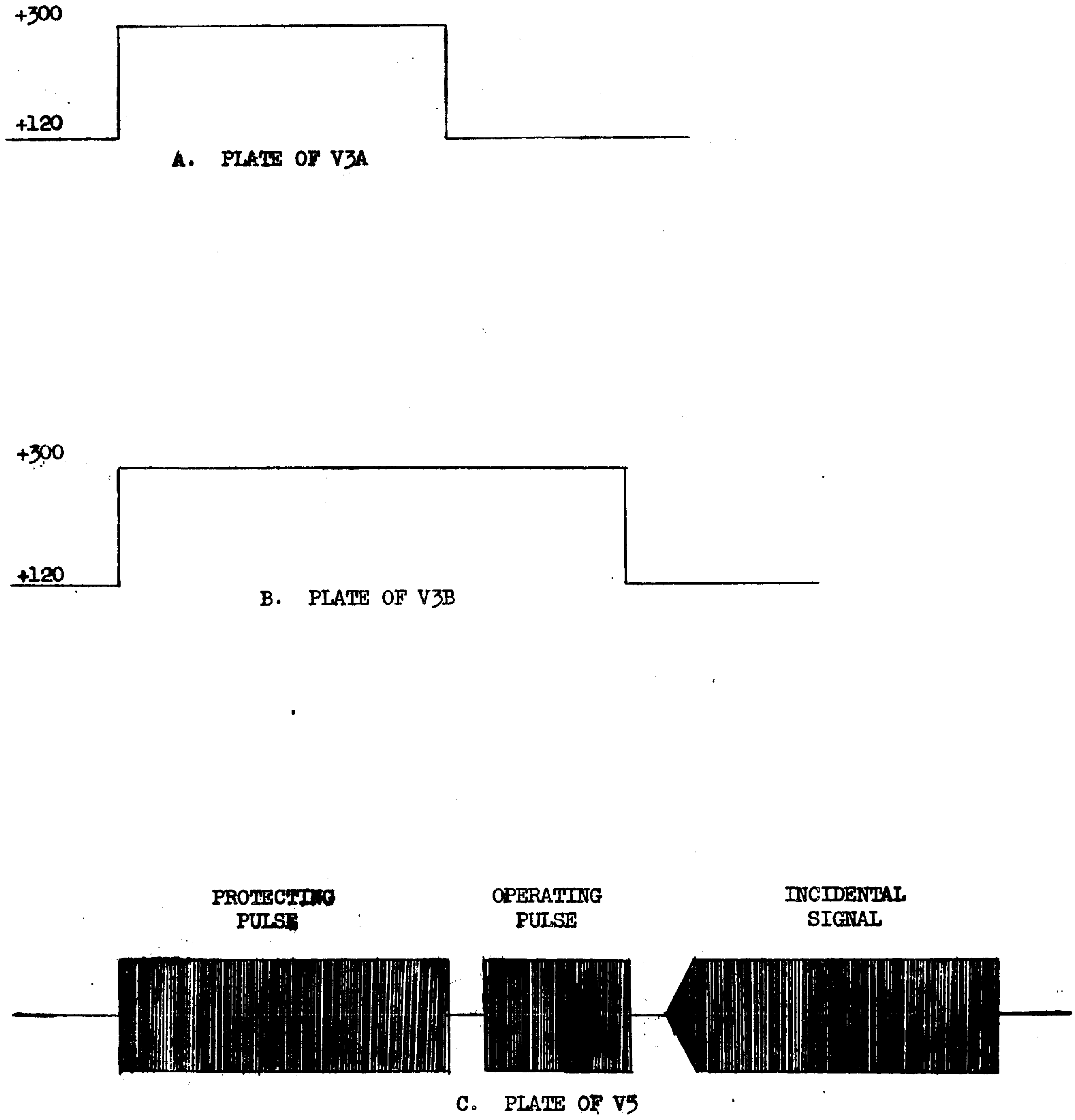


Figure I-3. Pulse Modulator V3 and Power Amplifier V5 Plate Waveforms

5. MAINTENANCE

5.1 GENERAL

The Latching Radio Switch Transmitter is designed to provide reliable operation, and therefore little maintenance is anticipated. All maintenance with the exception of minor repairs, such as broken leads. loose connections, tube replacement, etc., should be conducted in a suitably equipped laboratory, due to the complexity of the pulse circuitry and test equipment required.

5.2 ACCESSIBILITY

All components are easily accessible when the transmitter cover is removed. (There are screws on the bottom rear of the unit, securing the cover to the chassis.) To service the unit, remove these screws and slide the chassis out of its cover.

5.3 TEST EQUIPMENT REQUIRED

Voltohmmeter - Simpson, Model 260, or equivalent.

Audio Oscillator - Hewlett Packard, Model 200AB, or equivalent.

Oscilloscope - Dumont (with long persistent screen) Type 304A, or equivalent.

Variac - General Radio, Model 1001A, or equivalent.

Vacuum Tube Voltmeter - Hewlett Packard, Model 410 B, or equivalent.

Dummy Load - 200 Ohm resistor, 20 watt non-reactive.

Receiver - Model LRSR-1, or equivalent.

5.4 GENERAL PRECAUTIONS

Whenever the unit is serviced, carefully observe the precautions listed below:

a. Before a part (such as a transformer) is unsoldered, note the position of the leads, and tag each lead.

b. Be careful not to damage other connections by pulling or pushing leads out of the way.

c. If soldering is required, try not to allow drops of solder to fall into the set; they may cause a short circuit.

d. Use care in soldering; a poorly soldered joint is one of the most difficult faults to find.

e. Use appropriate ranges on meters and test sets used for trouble-shooting.

5.5 SECTIONALIZING AND LOCALIZING A FAULT

The first step in servicing a defective unit is to sectionalize the fault; i.e., to trace the fault to the stage or circuit by appropriate voltage and/or resistance measurements, as outlined in Section 5.7, Voltage-Resistance Chart. The preliminary tests, listed below, may aid in isolating the source of trouble.

a. Visual Inspection

The purpose of visual inspection is to locate any components which show evidence of mechanical breakdown. Through this inspection, the repairman may frequently discover the fault or determine the stage in which the fault exists. This inspection is valuable in forestalling future failure and in avoiding damage to the unit which might occur through improper servicing methods.

b. Operating Test

It is recommended that the repairman try to operate the equipment, as outlined in Section 2, to determine just what malfunction exists.

c. Intermittents

The possibility of intermittents should not be overlooked. If present, this trouble may often be made to appear by tapping or jarring the unit. It is also possible that the trouble is not in the transmitter unit itself, but in auxiliary apparatus, or connections.

5.6 TROUBLESHOOTING CHART

The following chart is supplied as an aid in locating trouble in the unit. This chart lists the symptoms which the repairman observes, and indicates how to localize trouble quickly in the various sections. Normal voltage and resistance measurements are given in the Voltage-Resistance Chart 5 7, which follows the troubleshooting chart.

Symptom	Probable Cause	Suggestion
Pilot lamp doesn't light when power is applied.	Fuse blown. Line voltage is 220 v, and 110-OFF-220 switch in 110 position, causing fuse to blow.	Be sure 110-OFF-220 switch is in correct position, and replace fuse.
	Power is applied with LINE VOLTAGE SELECTOR switch advanced too far, shorting C1 and blowing the fuse.	Place LINE VOLTAGE SELECTOR switch in correct position, as outlined in Section 2.3, and replace the fuse and C1, if necessary.
No r.f. power out. No meter reading with FUNCTION SWITCH in OSC TUNE position; high meter reading in AMP TUNE position.	Defective oscillator tube (V4) or defective component in oscillator circuit.	Check V4. If V4 is good, measure dc voltages according to Voltage-Resistance Chart, Section 5.7.

Symptom	Probable Cause	Suggestion
No r.f. power out. No meter reading in either OSC TUNE or AMP TUNE positions.	Defective power supply tube, V1 or V2, or defective component in power supply.	Check V1 and V2. If good, measure voltages in power supply according to Voltage-Resistance Chart, Section 5.7.
Operation normal in OSC TUNE and AMP TUNE positions, but output waveform does not conform to that shown in Fig. II-3.	Defective modulator tube V3, or defective component in modulator circuit.	Check V3. If good, measure dc voltages with function switch in OSC TUNE and OPERATE position.
	Defective relay.	Check relay operation.
Operation normal, r.f. output low.	Oscillator detuned, or low dc voltages in oscillator or amplifier circuit.	Check V4 and V5. If good, tune oscillator tuning coil as explained in Section 5.8. If r.f. output is still low, check dc voltages in osc. and amp. circuits according to Voltage Resistance Chart, Section 5.7
Unable to obtain proper dip in amplifier plate current and maximum brilliance in antenna current indicator at any position of antenna Matching Adjustment.	Antenna system too long, and therefore outside the range of the matching network.	Check antenna length.
	Faulty ground connection.	Check connection to proper ground.
Operation normal, waveform appears proper, but pulse width range incorrect.	Pulse width calibration adjustment not adjusted properly, or in modulator circuit.	Adjust pulse width calibration adjustment as outlined in Section 5.8. Check dc voltage in modulator circuit according to Voltage-Resistance Chart.

5.7 VOLTAGE RESISTANCE CHART

The following voltages and resistances are measured with a Simpson, Model 260 voltohmmeter. All measurements are made to ground.

TEST POINTS	POSITION OF FUNCTION SWITCH	VOLTAGE (volts) 115 v, 60 cycles input. Tol. ±20%	RESISTANCE (ohms) Tol. ±20%
V1			
Pins 1, 3, 5, 7, are not used.			
(Pin 2)	Operate	400	52 K
Pin 2	Osc tune	320	21.5 K
Pin 4	Operate	300 v a-c	213
Pin 4	Osc tune	280 v a-c	213
Pin 6	Operate	300 v a-c	213
Pin 6	Osc tune	280 v a-c	213
Pin 8	Operate	400	52 K
Pin 8	Osc tune	320	21.5 K
V2			
Pins 1, 2, 3, 4, 6 are not used.			
Pin 5	Operate	154	58.8 K
Pin 5	Osc tune		31 K
Pin 7	Operate	0 (gnd)	0 (gnd)
Pin 7	Osc tune		0 (gnd)
V3			
Pin 1	Operate	*98	62.6 K
Pin 1	Osc tune		0
Pin 2	Operate	-.23	551 K
Pin 2	Osc tune		551 K
Pin 3	Operate	0 (gnd)	0 (gnd)
Pin 3	Osc tune		0 (gnd)
Pin 4	Operate	0 (gnd)	0 (gnd)
Pin 4	Osc tune		0 (gnd)
Pin 5	Operate	0 (gnd)	0 (gnd)
Pin 5	Osc tune		0 (gnd)
Pin 6	Operate	*98	62.6 K
Pin 6	Osc tune		0
Pin 7	Operate	-.27	1 meg
Pin 7	Osc tune		1 meg
Pin 8	Operate	0 (gnd)	0 (gnd)
Pin 8	Osc tune		0 (gnd)
Pin 9	Operate	6.3 v a-c	Fil.
Pin 9	Osc tune		Fil.

V4

Pin 1	Operate		22 K
Pin 1	Osc. tune	**-11.2	22 K
Pin 2	Operate		0 (gnd)
Pin 2	Osc tune	0 (gnd)	0 (gnd)
Pin 3	Operate		Fil.
Pin 3	Osc tune	6.3 v a-c	Fil.
Pin 4	Operate		0 (gnd)
Pin 4	Osc tune	0 (gnd)	0 (gnd)
Pin 5	Operate		46.5 K
Pin 5	Osc tune	234	30.8 K
Pin 6	Operate		116.6 K
Pin 6	Osc tune	115	99.3 K
Pin 7	Operate		2.3
Pin 7	Osc tune		2.3

V5

Pins 1, 8
are not used.

Pin 2	Operate		
Pin 2	Osc tune		Fil.
Pin 3	Operate	6.3 v a-c	Fil.
Pin 3	Osc tune		51.5 K
Pin 4	Operate	149	36.1 K
Pin 4	Osc tune		93
Pin 5	Operate	9.1	93
Pin 5	Osc tune		27.3 K
Pin 6	Operate	***-6.5	26.5 K
Pin 6	Osc tune		93
Pin 7	Operate	9.3	93
Pin 7	Osc tune	0 (gnd)	0 (gnd)

K1

Pins 4, 5, 6, 8
are not used.

Pin 1	Operate	0 (gnd)	0 (gnd)
Pin 1	Osc tune	0 (gnd)	0 (gnd)
Pin 2	Operate	0 (gnd)	0 (gnd)
Pin 2	Osc tune	0 (gnd)	0 (gnd)
Pin 3	Operate	153	91 K
Pin 3	Osc tune	0 (gnd)	64.6 K
Pin 7	Operate		9.5 K
Pin 7	Osc tune	86	8.5 K

---

*Transmit Switch <u>ON</u>
**10 K resistor in series with Simpson Meter probe.
***Measured at junction of L2 and R14.

T1 (Power Transformer)

Place ohmmeter leads across a-c line plug (with no power applied).

Position of Line Voltage Selector Switch	Position of 110-OFF-220 Switch	Resistance (Ohms) Tol. ±20%
1	110	4.7
2	110	4.4
3	110	4.0
4	110	3.7
5	110	3.3
6	110	3.1
7	110	2.7
8	110	2.4
1	220	18.1
2	220	16.6
3	220	15.1
4	220	13.8
5	220	12.7
6	220	11.4
7	220	9.9
8	220	8.7

5.8 SPECIAL ADJUSTMENTS

The following adjustments (pulse width calibration adjustment, oscillator tuning adjustment, meter adjustment) are preset and should not have to be changed under normal operating conditions. If, however, a component is changed in one of the circuits effecting the adjustments, mentioned above; or it is desired or necessary to reset these adjustments, the following procedures are recommended.

a. Pulse Width

1. Attach a dummy load to the antenna connector.

2. Operate the transmitter as described in Section 2.3.

3. Loosely couple a diode probe from the vertical input of the scope to the dummy load.

4. Set the scope on driven sweep and push the calibrate button to produce a 60 cycle waveform.

5. Set one 60 cycle wave equal to 16.7 horizontal divisions on the scope.

   t = 1/F   t = 1/60   5 divisions = 16.7 millisec.

6. Use the internal negative trigger on the scope.

7. Pulse the transmitter and adjust the pulse width calibration adjustment (Figure I-4) to equal five divisions on the scope with the PULSE WIDTH adjustment on the transmitter set at 5.

8. Perform step 7 again for a pulse width setting of 20.

b. <u>Oscillator Tuning</u>

1. Operate the transmitter as described in Section 2.3.

2. Place FUNCTION SWITCH in OSC TUNE position.

3. Locate the oscillator tuning adjustment in the rear of the transmitter (Figure I-5) and tune for a maximum reading on the meter.

c. <u>Meter Adjustment</u>

1. Plug the transmitter a-c input into a variac and set the variac to a voltage compatible with the transmitter requirements. (70-280 v a-c, depending on position of 110-OFF-220 switch).

2. Operate the transmitter as described in Section 2.3.

3. Place a voltmeter between 6.3 v test point and ground. The meter should read 6.3 v on the ten v a-c scale.

4. Rotate the meter adjustment (Figure I-6) until the meter needle is in the red area (meter on front of transmitter).

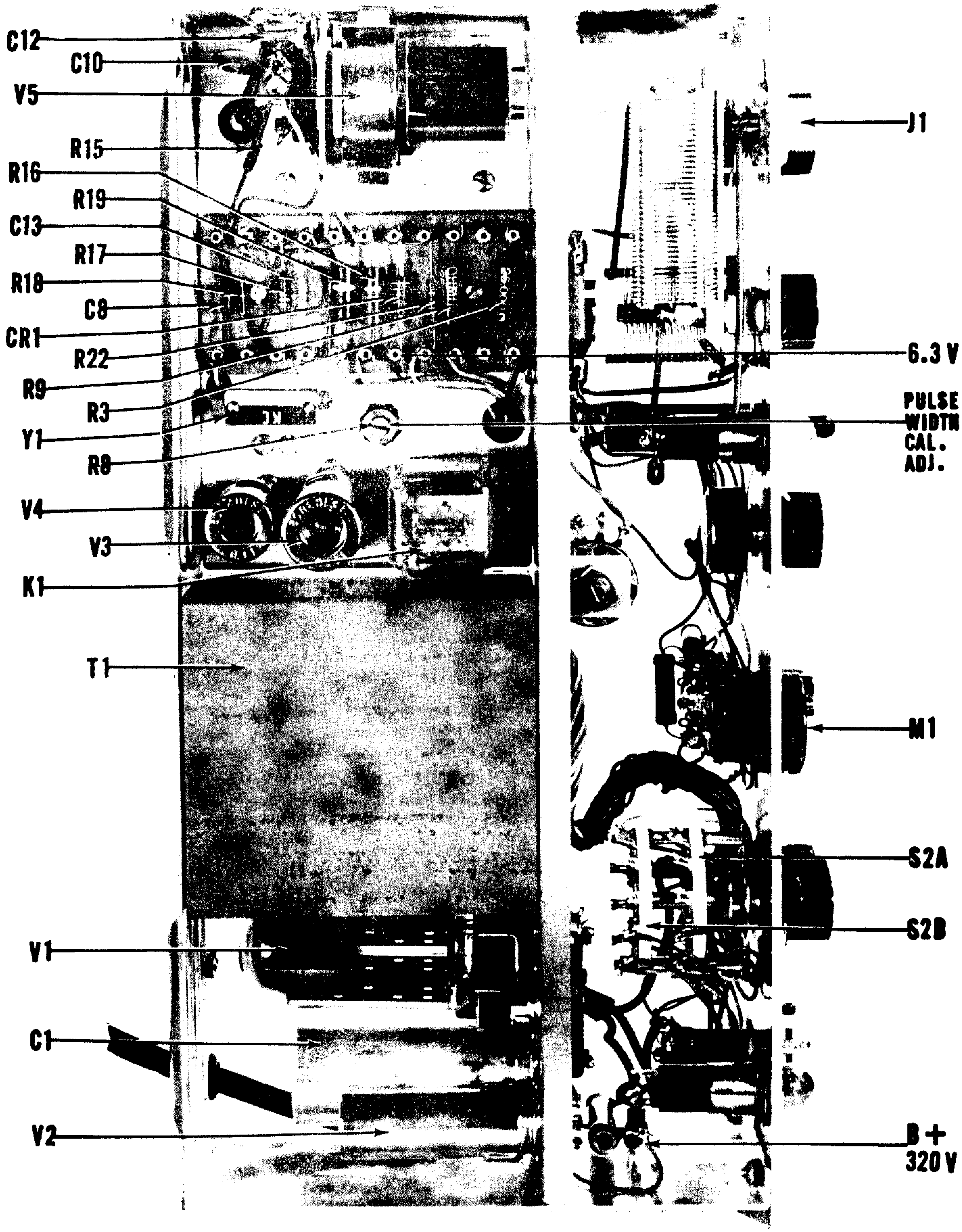


Figure 1-4 Photograph - Component Layout - Top View

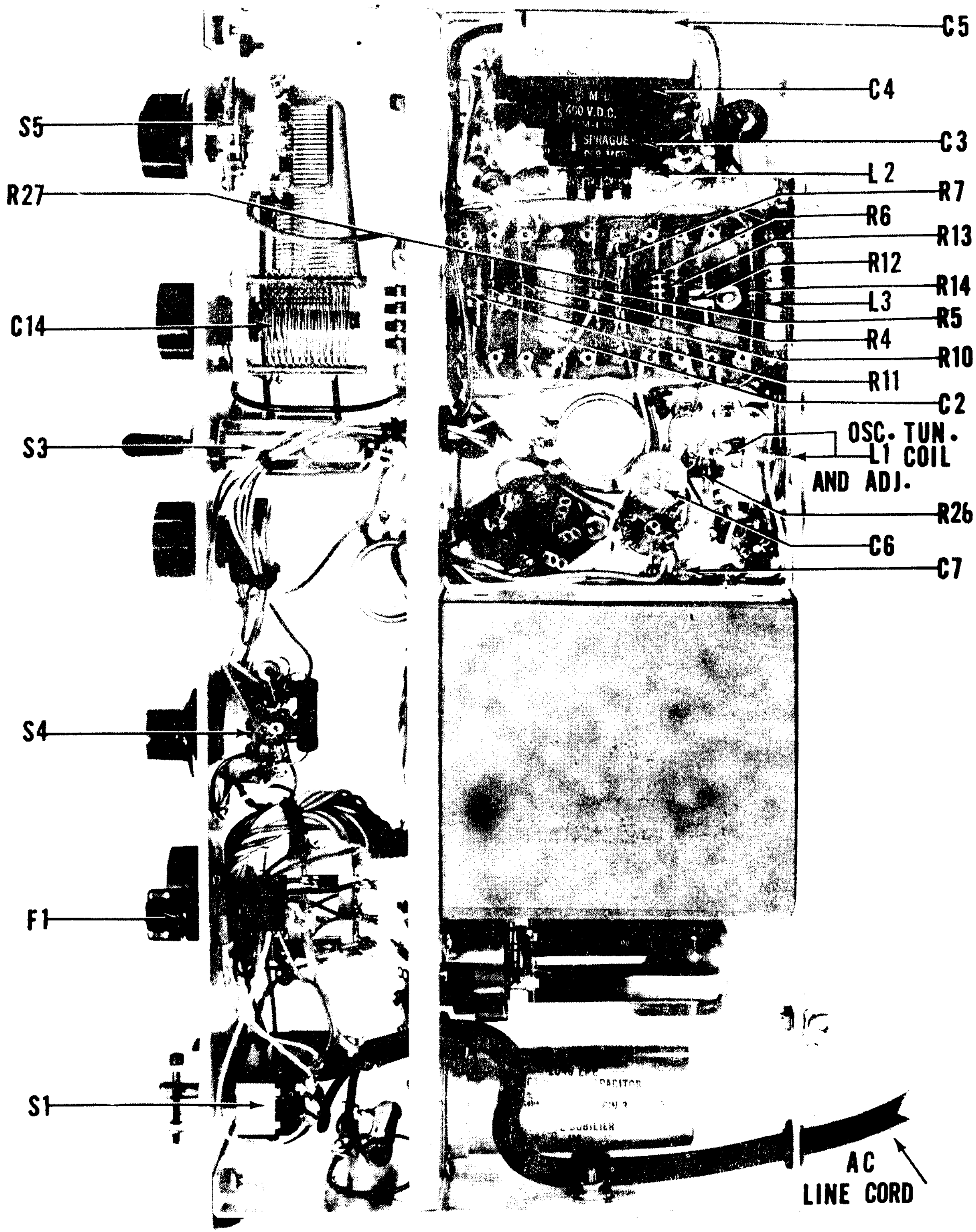


Figure 1-5 Photograph - Component Layout - Bottom View

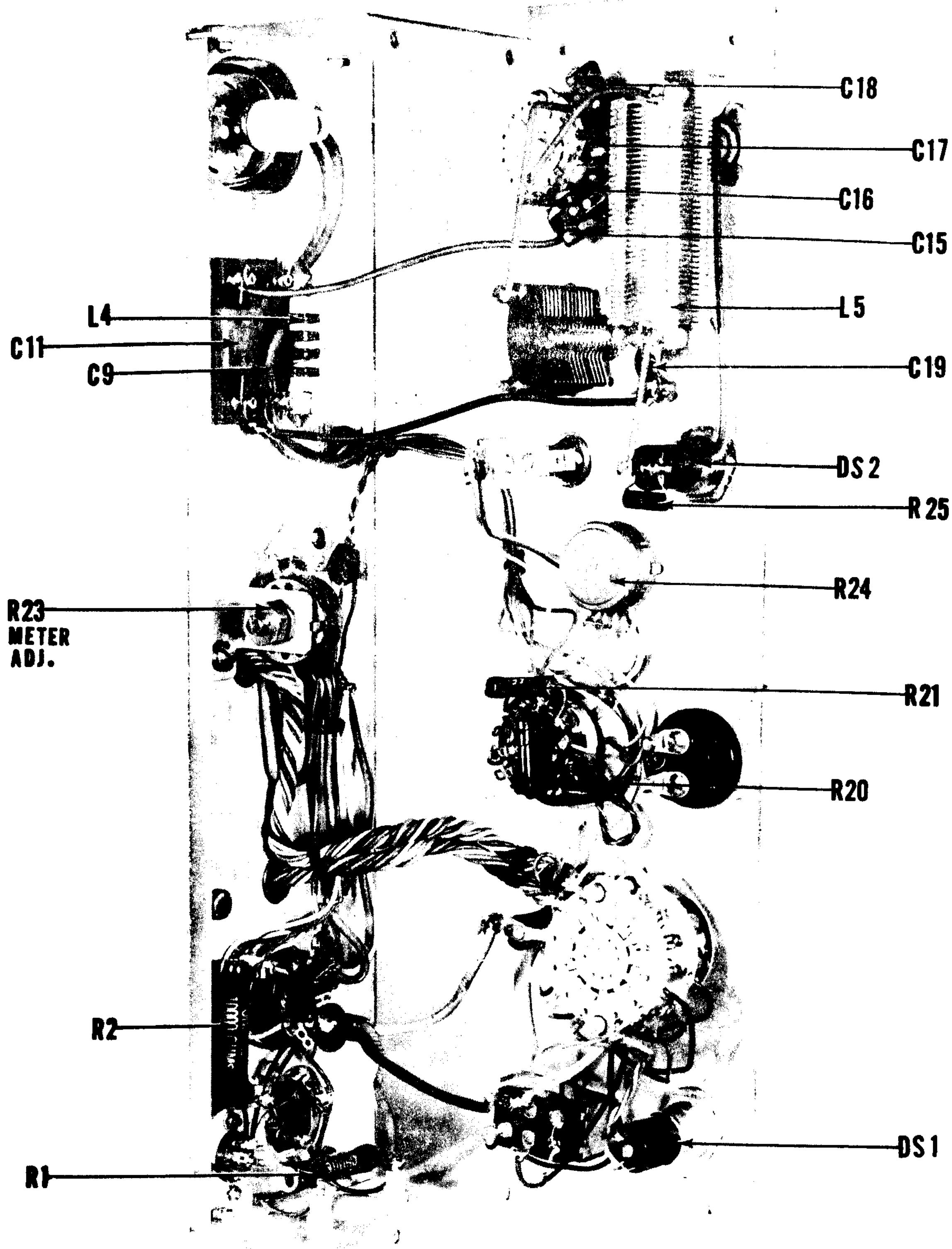


Figure 1-6 Photograph - Component Layout - Behind Front Panel

6. PARTS LIST

Ref. Symbol	Part Name, Description and Function	Manufacturer's Name and Number
C1	Capacitor, Fixed, Electrolytic - 50µfd, 450 v - power supply filter capacitor.	Cornell Dubilier Elec. Corp. Longlife UPB10-HA
C2	Capacitor, Fixed, Paper - .022µfd, 400 v - coupling capacitor between V3A and V4.	Aerovox Corp. P-88N
C3	Capacitor, Fixed, Paper - .068µfd, 400 v - time constant capacitor.	Sprague Prod. Co. 96P68394
C4	Capacitor, Fixed, Paper - .15µfd, 400 v - time constant capacitor.	Sprague Prod. Co. 96P15494
C5	Capacitor, Fixed, Paper - .5µfd, 400 v - coupling capacitor between V3B and V4.	Aerovox Corp. P-88N
C6	Capacitor, Fixed, Ceramic - .004µfd, 1000 v - plate bypass capacitor for V4.	Sprague Prod. Co. 56A-D4
C7	Capacitor, Fixed, Ceramic - .001µfd, 1000 v - screen bypass capacitor for V4.	Sprague Prod. Co. 56A-D1
C8	Capacitor, Fixed, Silver Mica - 30µµfd, 500 v - coupling capacitor between V4 and V5.	Elmenco Prod. Co. DM-15
C9	Capacitor, Fixed, Ceramic - .004µfd, 1000 v - plate bypass capacitor for V5.	Sprague Prod. Co. 56A-D4
C10	Capacitor, Fixed, Ceramic - .004µfd, 1000 v - screen bypass capacitor for V5.	Sprague Prod. Co. 56A-D4
C11	Capacitor, Fixed, Mica - .002µfd, 1500 v - output coupling capacitor for V5.	Arco Prod. Co. VCM-35-202
C12	Capacitor, Fixed, Ceramic - .004µfd, 1000 v - cathode bypass capacitor for V5.	Sprague Prod. Co. 56A-D4
C13	Capacitor, Fixed, Ceramic - .004µfd, 1000 v - R.F. bypass capacitor for grid current metering circuit.	Sprague Prod. Co. 56A-D4
C14	Capacitor, Variable, Air - 6-145µµfd - amplifier tuning capacitor.	Hammarlund Mfg. Co. HFA-140A
C15	Capacitor, Fixed, Silver Mica - 390µµfd, 500 v - antenna matching capacitor.	Sprague Prod. Co. MS-339
C16	Capacitor, Fixed, Silver Mica - 390µµfd, 500 v - antenna matching capacitor.	Sprague Prod. Co. MS-339
C17	Capacitor, Fixed, Silver Mica - 390µµfd, 500 v - antenna matching capacitor.	Sprague Prod. Co. MS-339

Ref. Symbol	Part Name, Description and Function	Manufacturer's Name and Number
C18	Capacitor, Fixed, Silver Mica - 390μμfd, 500 v - antenna matching capacitor.	Sprague Prod. Co. MS-339
C19	Capacitor, Fixed, Silver Mica - 82μμfd, 500 v - antenna matching capacitor.	Arco Prod. Co. DM-15
CR1	Diode, Germanium - rectifier fil-voltage metering circuit.	Transitron Elec. Corp. 1N34A
DS1	Lamp, indicating - pilot light.	General Elec. Co. NE-51
DS2	Lamp, indicating - antenna current indicator.	General Elec. Co. 47
F1	Fuse, line - 1 amp (Slo-blo).	Little Fuse Inc. 313001 3AG
J1	Connector, receptacle, electrical - antenna input connector.	Amphenol Elec. Corp. UHF SO 239
K1	Relay, DPDT, 10K - keys the pulse modulator V3.	Potter-Brumfield KC P11
L1	Coil, r.f. variable - 40 turns, No. 30 wire - oscillator tuning coil.	Special
L2	Coil, r.f. - 2.5 mh., 75 ma - r.f. choke for the grid of V4.	National Co. P-100
L3	Coil, r.f. - 4.7 mh., r.f. inductor for the cathode of V4.	Int. Resistance Co. CL-1
L4	Coil, r.f. - 2.5 mh., 75 ma - r.f. choke for the plate of V5.	National Co. R-100
L5	Coil, r.f. - 40 turns - r.f. amp. inductor.	Illumitronic Eng. Co. Air Dux 816-T
M1	Meter, indicating - 0-1 ma - indicating meter for line voltage, oscillator grid current, amp. current.	Int. Instrument 150
R1	Resistor, Fixed, Wirewound - 50K, 10W, 10% power supply bleeder resistor.	Ohmite Mfg. Co. "Browndevil"
R2	Resistor, Fixed, Wirewound - 10K, 10W, 10% - voltage dropping resistor for V2.	Ohmite Mfg. Co. "Browndevil"
R3	Resistor, Fixed, Wirewound - 25K, 5W, 10% - plate load resistor for V3A.	Ohmite Mfg. Co. "Browndevil"
R4	Resistor, Fixed, Composition - 1K, 1/2W, 10% - parasitic suppressor.	Ohmite Mfg. Co.
R5	Resistor, Fixed, Composition - 1 meg. 1W, 1% grid resistor for V3A - time constant.	Aerovox Corp. CP1

Ref. Symbol	Part Name, Description and Function	Manufacturer's Name and Number
R6	Resistor, Fixed, Composition - 33K, 1W, 10% time constant for V3A and V3B.	Ohmite Mfg. Co.
R7	Resistor, Fixed, Composition - 450K, 1W, ±1% fixed part of V3 time constant.	Aerovox Corp. CP1
R8	Resistor, Variable - 100K, 2W - Pulse width calibration adjustment.	Ohmite Mfg. Co. CU1041
R9	Resistor, Fixed, Wirewound - 25K, 5W, 10% plate load resistor for V3B	Ohmite Mfg. Co. "Browndevil"
R10	Resistor, Fixed, Composition - 1K, 1/2W, 10% parasitic suppressor in plate of V3B.	Ohmite Mfg. Co.
R11	Resistor, Fixed, Composition - 27K, 2W, 10% voltage dropping resistor for K1.	Ohmite Mfg. Co.
R12	Resistor, Fixed, Composition - 10K, 2W, 10% plate dropping resistor for V4.	Ohmite Mfg. Co.
R13	Resistor, Fixed, Composition - 82K, 1/2W, 10% screen dropping resistor for V4.	Ohmite Mfg. Co.
R14	Resistor, Fixed, Composition - 22K, 1/2W, 10% grid leak resistor for V4.	Ohmite Mfg. Co.
R15	Resistor, Fixed, Composition - 100 ohms, 1/2W, 10% parasitic suppressor in grid of V5.	Ohmite Mfg. Co.
R16	Resistor, Fixed, Composition - 15K, 2W, 10% screen dropping resistor for V5.	Ohmite Mfg. Co.
R17	Resistor, Fixed, Composition - 27K, 1/2W, 10% grid leak resistor for V5.	Ohmite Mfg. Co.
R18	Resistor, Fixed, Composition - 1K, 1/2W, 10% shunt resistor for grid current metering circuit.	Ohmite Mfg. Co.
R19	Resistor, Fixed, Composition - 100 ohms, 2W, 10% cathode resistor for V5.	Ohmite Mfg. Co.
R20	Resistor, Fixed, Composition - 1 ohm, 1W, ±1% meter shunt resistor.	Ohmite Mfg. Co.
R21	Resistor, Fixed, Composition - 120, 1W, ±1% meter series resistor.	Ohmite Mfg. Co.
R22	Resistor, Fixed, Composition - 3.3K, 1/2W, 10% limiting resistor for line voltage metering circuit.	Ohmite Mfg. Co.

Ref. Symbol	Part Name, Description and Function	Manufacturer's Name and Number
R23	Resistor, Variable - 2.5K, 2W - calibration adjustment for fil-metering circuit.	Allen-Bradley Co. JLU-2521
R24	Resistor, Variable - 250K, 2W - Pulse width adjustment.	Ohmite Mfg. Co. CLU2541
R25	Resistor, Fixed, Composition - 10 ohms, 1W, 10% shunt resistor for antenna current indicator.	Ohmite Mfg. Co.
R26	Resistor, Fixed, Composition - 10K, 1/2W, 10% parasitic suppressor in plate of V4.	Ohmite Mfg. Co.
R27	Resistor, Fixed, Composition - 10 meg., 1/2W, 10% oscillator plate load resistor.	Ohmite Mfg. Co.
S1	Switch, toggle, DPDT (neutral center) - 110-OFF-220 switch.	Cutler-Hammer Inc. 7563-K4
S2	Switch, Rotary, 2 pole, 11 position - Line voltage selector switch.	Centralab 2513
S3	Switch, Momentary contact, Single pole (spring loaded) - standby - transmit switch.	Switchcraft Inc. 3003
S4	Switch, Rotary, 4 pole, 3 Position - Function Switch.	P.R. Mallory Co. 3243J
S5	Switch, Rotary, 1 Pole, 12 Position - antenna matching switch.	Centralab PA-2000
V1	Tube, Electron - High voltage rectifier (NOTE-must use 5U4GB for size reasons).	R.C.A., or equiv. 5U4GB
V2	Tube, Electron - Gas voltage regulator.	R C.A., or equiv. OA2/VR150
V3	Tube, Electron - Pulse modulator.	R.C.A., or equiv. 12AT7
V4	Tube, R.F. - oscillator.	R.C A., or equiv. 6AU6
V5	Tube, Electron - R.F. power amplifier.	R.C A., or equiv. 6146
Y1	Crystal, Quartz - R.F. oscillator crystal (6.820 mc)	McCoy Elec. Co. M-7

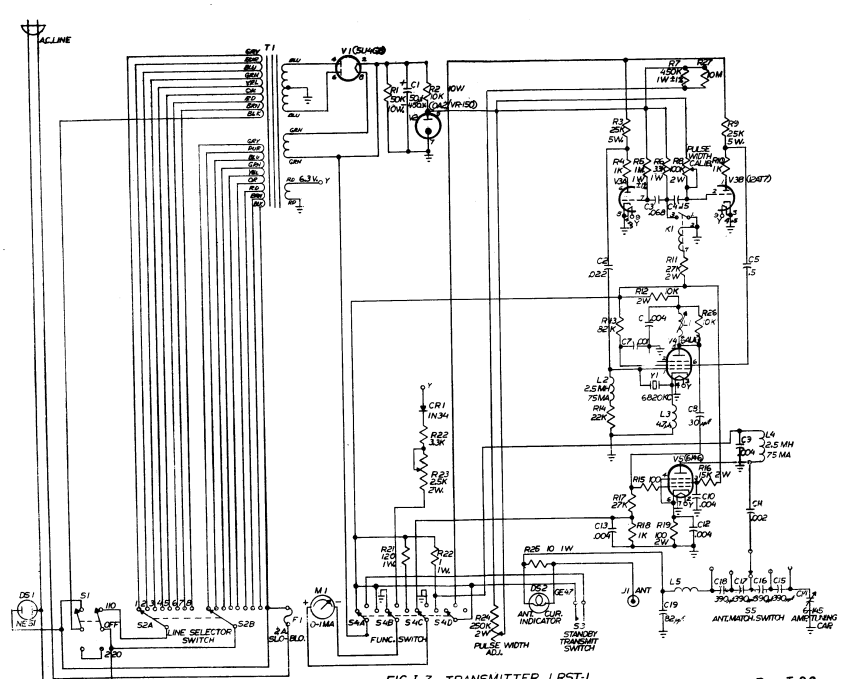


FIG. I-7 TRANSMITTER LRST-1

L164

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PART II

RECEIVER LRSR-1

List of Illustrations

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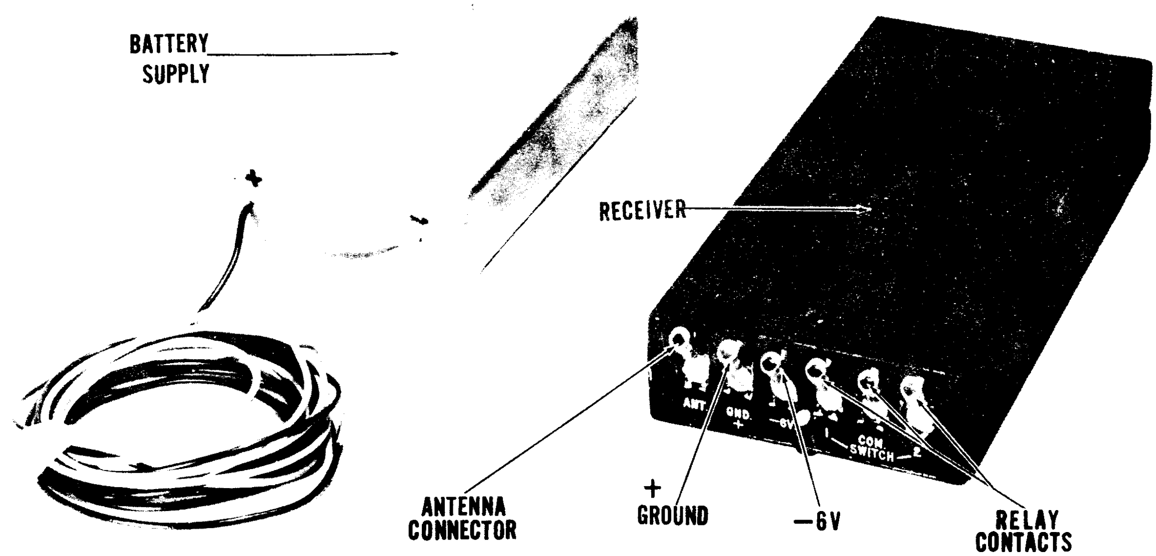


Figure II-1 Receiver LRSR-1

PART II

1. INTRODUCTION

1.1 SCOPE

This part of the instruction manual contains information for the operation and maintenance of the Latching Radio Switch Receiver, Model LRSR-1. A photograph of the unit is given in Figure II-1.

1.2 GENERAL DESCRIPTION

The Receiver LRSR-1 is a pulse-width-modulated receiver, intended primarily as a means of turning "on" or "off" any auxiliary device, requiring 115 v a-c at 1.5 amps, 220 v a-c at .5 amps, or 28 v d-c at 1.5 amps. The LRSR-1 operates from pulses transmitted by the Latching Radio Switch Transmitter, LRST-1.

Transistors and subminiature components have been used to minimize size and reduce power consumption. The unit has been designed to provide reliable, unattended operation under adverse conditions.

1.3 MODEL IDENTIFICATION

There are two models of the LRSR-1, differing only in pulse width setting:

LRSR-1A set for 15 msec ±5 msec - White dot.

LRSR-1B set for 25 msec ±5 msec - Red dot.

The use of different pulse width settings allows the alternate operation of two receivers from one transmitter. The LRSR-1A is identified by a white dot on the front of the case. The LRSR-1B is identified by a red dot on the front of the case.

1.4 GENERAL SPECIFICATIONS

Frequency	Approximately 6.8 mc, crystal controlled
Sensitivity	10 mvolts
Max. Input Signal	Not less than 10 volts
Input Impedance	Approximately 10 K
Bandwidth	Approximately 200 KC
Pulse Width	2 Ranges: 10 to 20 m/sec 20 to 30 m/sec
Voltage	6.5 volts ±.5 v

Current Drain........................	Approximately 3.2 ma (no signal in)
Switching Capacity...................	115 v a-c at 1.5 amps 220 v a-c at .5 amps 28 v d-c at 1.5 amps
Temperature Range....................	0-50° C
Dimensions...........................	5" X 2 3/8" X 15/16"
Weight...............................	Approximately 1/2 lb.
Finish...............................	Black Wrinkle

1.5 EQUIPMENT LIST

Receiver LRSR-1

Battery Supply

Screwdriver

2. OPERATION

2.1 GENERAL

The receiver LRSR-1 is a remotely operated device, having no operating controls. The unit operates (i.e. turns auxiliary equipment "on" or "off") when triggered by the transmitter LRST-1. Therefore, this section is concerned mainly with preparing the unit for operation, which may best be accomplished in a laboratory, prior to final installation.

2.2 IDENTIFICATION OF CONNECTIONS (Refer to Figure II-1)

Marking	Function
ANT.	Antenna terminal.
GND. +	Ground terminal - connect positive side of supply to this terminal
-6v	6 volt terminal - connect negative side of supply to this terminal.
COM.	Common terminal - connect one lead of auxiliary device to COM terminal.
1 Switch 2	Relay contact terminals - connect the other lead of auxiliary device to either terminal No. 1 or No. 2.

2.3 OPERATING PROCEDURES

a. LRSR-1 and Auxiliary Device (e.g. RT-3) Using Separate Battery Supplies (Figure II-2a)

1. Connect the battery supply to the receiver attaching the positive (red) lead to the GND terminal and the negative (black) lead to the -6v terminal.

2. Connect the negative lead from the RT-3 battery supply to the COM terminal of the receiver.

3. Connect the positive lead from the RT-3 battery supply to a ground on the RT-3.

4. Place an ohmmeter between COM and relay contacts 1 or 2 on the receiver.

5a. To operate the auxiliary device (RT-3) immediately, (i.e., without triggering the transmitter), attach the "hot" lead from the RT-3 to the closed relay contact (measuring continuity on the ohmmeter).

5b. To leave the auxiliary device (RT-3) in the "off" state until triggered by the transmitter, attach the "hot" lead from the RT-3 to the open relay contact (measuring infinity on the ohmmeter).

6. Attach the antenna to the ANT terminal. The unit should now be operating.

b. LRSR-1 and Auxiliary Device (e.g. RT-3) Using A Common Battery Supply (Figure II-2b)

1. Connect the battery supply to the receiver, attaching the positive (red) lead to the GND terminal and the negative (black) lead to the -6v terminal.

2. Attach a jumper between the COM terminal and the -6v terminal.

3. Attach the ground lead from the auxiliary device (RT-3) to the GND terminal on the LRSR-1.

4. Using a voltmeter, measure the voltage between COM and 1, then between COM and 2.

5a. To operate the auxiliary device immediately, (i.e. without triggering the transmitter), attach the hot lead from the auxiliary device to the closed relay contact (measuring 6.5 v on the voltmeter).

5b. To leave the auxiliary device in the "off" state until triggered by the transmitter, attach the hot lead from the auxiliary device to the open relay contact (measuring 0 v on the voltmeter).

6. Attach the antenna to the ANT terminal. The unit should now be operating.

c. LRSR-1 and Auxiliary Device (e.g. ST-3) Using 110 or 220 v a-c Line (Fig. II-2c

1. Connect the battery supply to the receiver, attaching the positive (red) lead to the GND terminal and the negative (black) lead to the -6v terminal.

2. Connect one lead from the ST-3 to one side of the a-c line.

3. Connect the other side of the a-c line to the COM terminal of the receiver.

4. Place an ohmmeter between COM and relay contacts 1 or 2 on the receiver.

5a. To operate the auxiliary device (ST-3) immediately, (i.e., without triggering the transmitter), attach the other lead from the ST-3 to the closed relay contact (measuring continuity on the ohmmeter).

5b. To leave the auxiliary device (ST-3) in the "off" state until triggered by the transmitter, attach the other lead from the ST-3 to the open relay contact.

6. Attach the antenna to the ANT terminal. The unit should now be operating.

d. LRSR-1 and Auxiliary Device (e.g. RT-3) Using A Common Power Supply (e.g. RT-3PS) (Figure II-2d)

1. Connect the power supply (RT-3PS) to the receiver, attaching the positive lead (outer ring of the connector) to the GND terminal and the negative lead (pin of the connector) to the -6v terminal.

2. Attach a jumper between the COM terminal and the -6v terminal.

3. Attach the ground lead from the auxiliary device (RT-3) to the GND terminal on the LRSR-1.

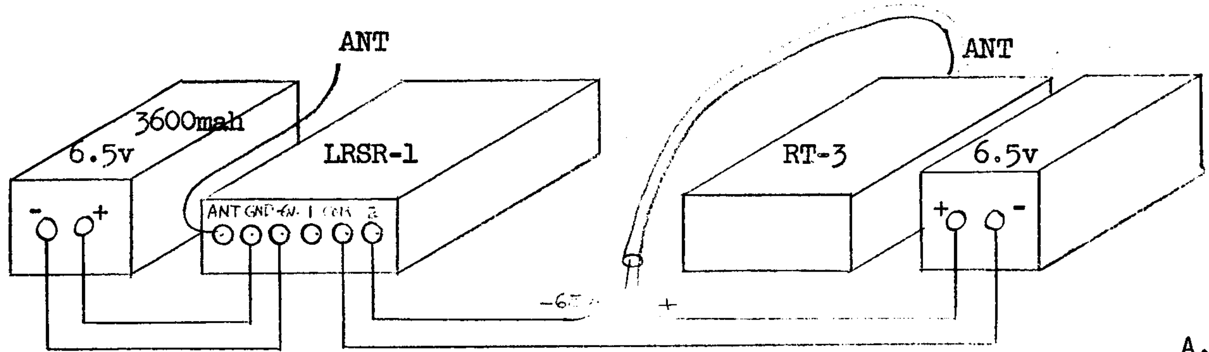
4. Apply a-c power to the power supply (being sure the voltage selector switch on the power supply is in the correct position).

5. Using a voltmeter, measure the voltage between COM and 1, then between COM and 2.

6a. To operate the auxiliary device immediately (i.e., without triggering the transmitter) attach the hot lead from the auxiliary device to the closed relay contact (measuring 6.5 v on the voltmeter).

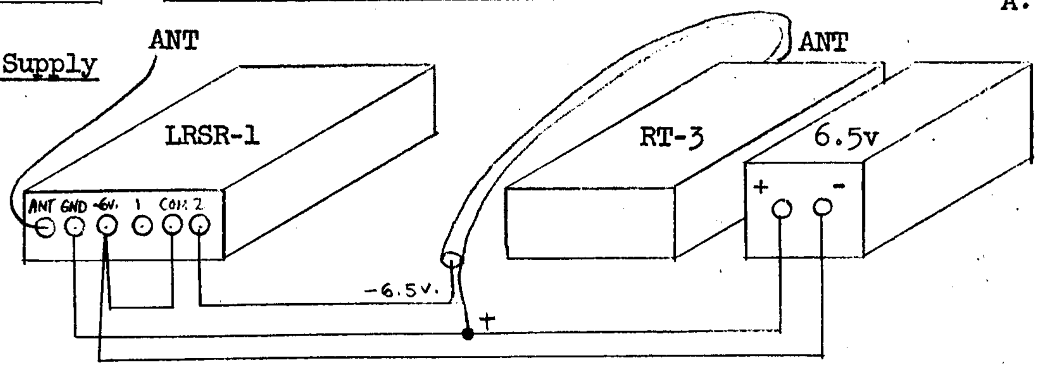
6b. To leave the auxiliary device in the "off" state until triggered by the transmitter, attach the hot lead from the auxiliary device to the open relay contact (measuring 0 v on the voltmeter).

7. Attach the antenna to the ANT terminal. The unit should now be operating.



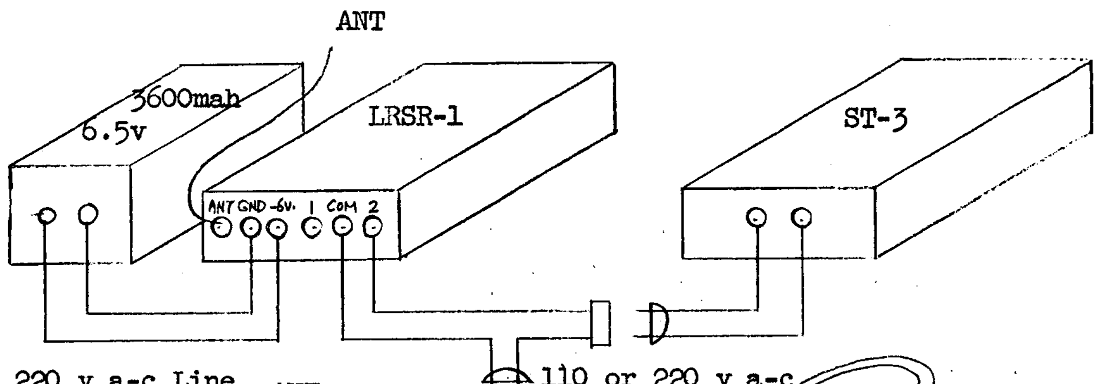
A.

Separate Battery Supply



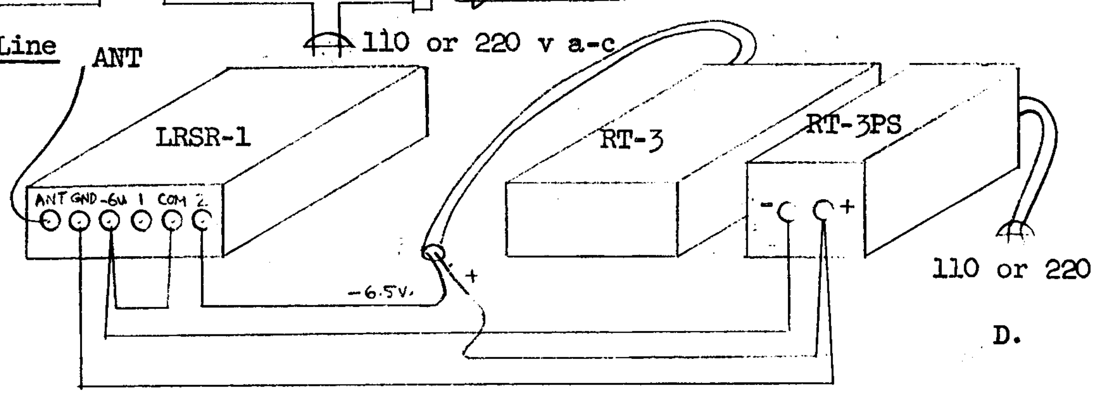
B.

Common Battery Supply



C.

110 or 220 v a-c Line



D.

Common Power Supply

Figure II-2 LRSR-1 AND AUXILIARY DEVICE WITH VARIOUS POWER SUPPLIES

3. TEST PROCEDURES

3.1 GENERAL

This section describes the test procedures used in determining the electrical specifications for the LRSR-1, as outlined in section 1-4. If it is desired or necessary to determine the specifications of a particular unit, the following procedures are recommended. This information should be especially useful in laboratory tests and troubleshooting.

3.2 TEST EQUIPMENT REQUIRED

Signal Generator - General Radio, Model 1001-A, or equivalent

Voltohmmeter - Simpson, Model 260, or equivalent

Oscilloscope - Dumont (long persistent screen) Type 304A, or equivalent

Vacuum Tube Voltmeter - Hewlett Packard, Model 410B, or equivalent

Transmitter LRST-1.

3.3 SUPPLY VOLTAGE AND CURRENT

a. Supply Voltage

1. Operate the receiver as outlined in Section 2.

2. Place a voltmeter between -6v terminal and GND terminal. Supply voltage should be between 6.5 v $\pm$10%.

b. SUPPLY CURRENT (full signal)

1. Operate the receiver as outlined in Section 2.

2. Place an ammeter (Simpson on 10 ma scale) between -6v terminal and GND.

3. Operate the transmitter as outlined in Section 2.3, Part I of this manual, placing the FUNCTION SWITCH in AMP TUNE position.

4. Measure supply current. It should be 5 ma or less.

c. SUPPLY CURRENT (no signal)

1. Perform only steps 1 and 2, as in b, above.

2. Measure supply current. It should be 3.2 ma, or less.

3.4 SENSITIVITY

a. Remove the top cover of the receiver.

b. Place the negative lead of the voltmeter at test point 13 (Figure II-6) and the positive lead at ground.

c. Connect the hot lead of the signal generator to the ANT terminal and the negative lead to GND terminal.

d. Adjust the signal generator output for 6.82 mc (unmodulated).

e. Adjust the attenuator until the voltmeter (at test point 13 reads 1 volt).

The r.f. signal required to produce 1 volt at the limiter output is the sensitivity. This value should be less than 3 millivolts.

3.5 PULSE WIDTH OPERATING RANGE

a. Operate the transmitter LRST-1, as outlined in Section 2.3, Part I of this manual.

b. Set the transmitter PULSE WIDTH adjustment at either 10 or 20, depending on the receiver being tested (10 for LRSR-1A, and 20 for LRSR-1B).

c. Increase the pulse width setting in 2 millisecond increments, pulsing the transmitter three times at each setting (pause at least three seconds between pulses).

Note the setting at which the receiver begins to operate.

d. Continue rotating the PULSE WIDTH adjustment until the receiver stops operating.

The setting at which the receiver starts operating and the setting at which the receiver ceases to operate are the upper and lower limits of the pulse width range.

The pulse width operating range of a model LRSR-1A (white dot) receiver should fall between 10-20 milliseconds.

The pulse width operating range of a model LRSR-1B (red dot) receiver should fall between 20-30 milliseconds.

3.6 OVERALL OPERATION AND/OR HIGH LEVEL OPERATION

a. Operate the transmitter LRST-1, as outlined in Section 2-3, Part I of this manual.

b. Operate the receiver, as outlined in Section 2, Part II of this manual, without connecting an auxiliary device to the unit.

c. Connect an ohmmeter (on the 10,000 ohm scale) between the receiver COM terminal and relay contacts 1 or 2.

d. Pulse the transmitter several times, pausing at least 3 seconds between pulses. The meter should read continuity and infinity with alternate pulses after the first two or three pulses.

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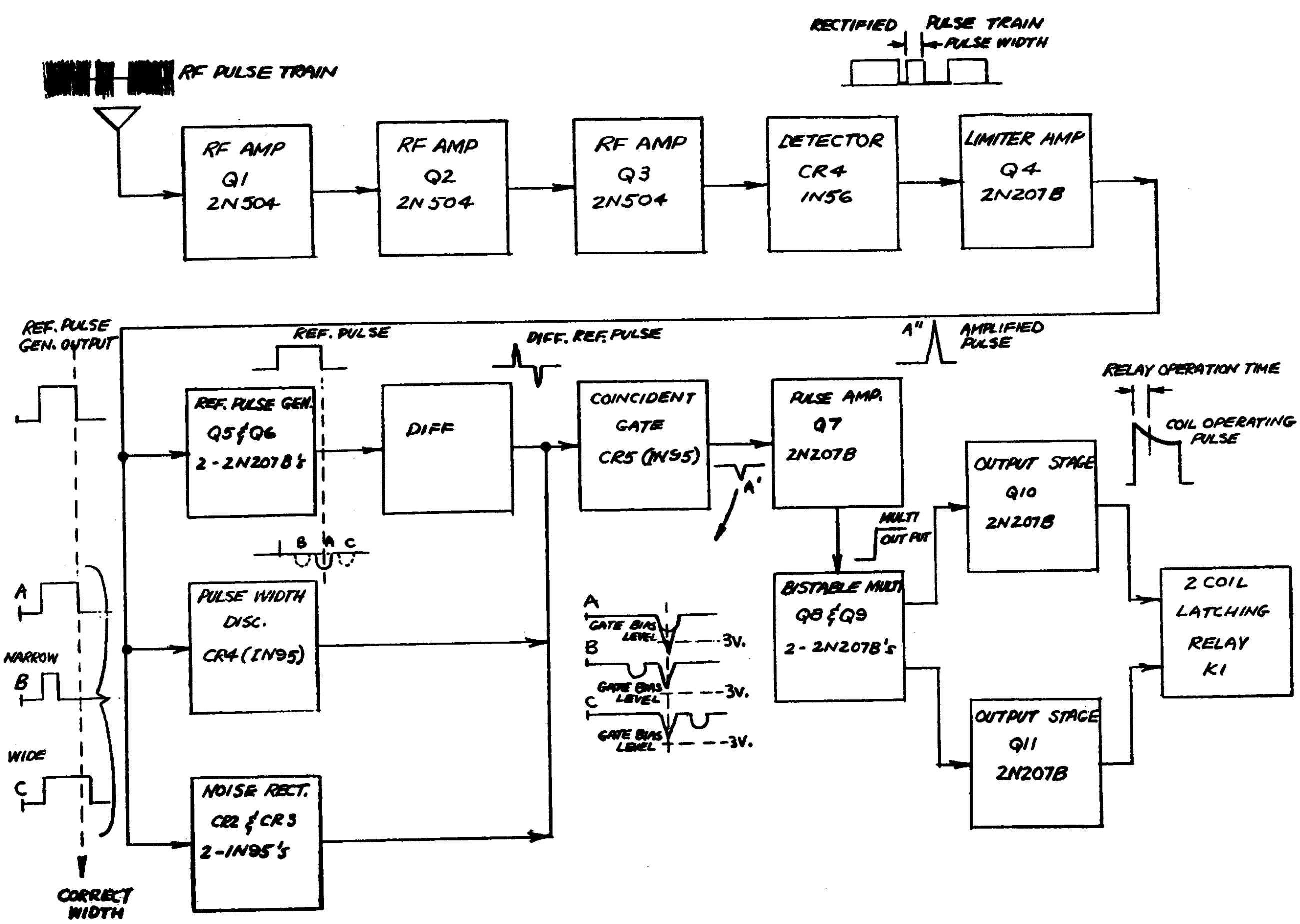
RF PULSE TRAIN
RECTIFIED PULSE TRAIN
PULSE WIDTH
RF AMP Q1 2N504
RF AMP Q2 2N504
RF AMP Q3 2N504
DETECTOR CR4 1N56
LIMITER AMP Q4 2N207B
REF. PULSE GEN. OUTPUT
REF. PULSE
DIFF. REF. PULSE
A" AMPLIFIED PULSE
RELAY OPERATION TIME
COIL OPERATING PULSE
REF. PULSE GEN. Q5 & Q6 2-2N207B's
DIFF
COINCIDENT GATE CR5 (1N95)
PULSE AMP. Q7 2N207B
A'
OUTPUT STAGE Q10 2N207B
MULTI OUTPUT
B A C
A
NARROW
B
WIDE
C
PULSE WIDTH DISC. CR4 (1N95)
GATE BIAS LEVEL
-3V.
BISTABLE MULTI Q8 & Q9 2-2N207B's
2 COIL LATCHING RELAY K1
OUTPUT STAGE Q11 2N207B
NOISE RECT. CR2 & CR3 2-1N95's
CORRECT WIDTH

4. THEORY OF OPERATION

4.1 GENERAL

A coded pulse width modulated r.f. signal is received by the antenna, amplified by the r.f. stages, detected, and further amplified by the limiter stage. The rectified signal is then fed to the decoding circuits. A correctly coded pulse (one having the correct pulse width) will produce a resultant pulse which operates a bi-stable multivibrator. A power output stage is coupled to each side of the multivibrator to operate a two-coil magnetic latching type relay.

4.2 CIRCUIT ANALYSIS

A block diagram is given in Figure II-3, and a circuit diagram in Figure II-7

a. R.F. Section

The r.f. amplifier circuit consists of three single-tuned transformer-coupled stages, tuned to 6.8 mc. Three Philco 2N504 transistors, connected in the grounded emitter configuration, are used. Q1 is the first r.f. amplifier transistor. The signal is coupled to the base of Q1 by T1. C1 is a series isolating capacitor for the antenna circuit. C2 is the antenna tuned circuit capacitor. R2 and R3 are base bias resistors for Q1. R2, R3, and the emitter bias resistor R4 provide temperature stable d-c bias for Q1. C3 is an r.f. bypass capacitor for Q1. C4 is an emitter bypass capacitor. R5 and C6 form a decoupling network. C5 is a tuned circuit capacitor in the primary of T2. Q1 is coupled to Q2 by transformer T2. The second and third r.f. stages Q2 and Q3, respectively, function in an identical manner as the first stage. R1, R6, R11, and R16 are transformer load resistors.

b. Detector and Limiter Circuit

The detector (CR1) is a conventional diode detector, using a Sylvania 1N56 germanium diode. C15 is an r.f. bypass capacitor, and the diode load is the base-emitter impedance of the limiter transistor (Q4). The limiter (Q4) is a grounded emitter direct-coupled amplifier, using a Philco 2N207B transistor. Q4 is non-conducting in the absence of a received signal, but conducts fully when a sufficiently strong signal is applied. The voltage at the collector of Q4 swings between the limits of -6 volts (no signal) to -.3 volt (full signal). R20 is the collector load resistor. R18 is an emitter bias resistor. C16 is an r.f. bypass capacitor. R17 is a base return for Q4.

c. Decoding Circuits

The decoding circuits analyze all received pulses, accepting and passing only the operating pulse received from the Latching Radio Switch Transmitter. All pulses referred to in the discussion of decoding circuits pertain to pulses shown in Figure II-4.

d. Switching Circuits

The switching circuits include pulse amplifier Q7, steering diodes CR6 and CR7, bi-stable multivibrator Q8 and Q9, output amplifiers Q10 and Q11, and latching relay K1.

1. Pulse Amplifier

The base-emitter impedance of the pulse amplifier, Q7, is the load resistance of the coincidence gate CR5. The emitter of Q7 is connected to a negative 3 volt bias which is provided by R27 and R50. This is the 3 volt gating bias of CR5. C24 couples the signal to the pulse amplifier. R34 supplies self-bias for Q7 when a signal greater than the bias level is passed. R33 is the load resistor for CR5. When CR5 passes the pulse, Q7 develops a positive trigger pulse at the collector, which is coupled to the steering diodes CR6 and CR7 (in the bi-stable multivibrator circuit) by C26. R36 is an emitter resistor for Q7. C25 is an emitter bypass capacitor. R35 is the collector load resistor for Q7.

2. Bistable Multivibrator

The bistable multivibrator, consisting of transistors Q8 and Q9, has two states of equilibrium. In each state, one of the transistors is cut off, and the other is conducting. The circuit remains in either state (providing power input to the receiver is not interrupted) until a trigger pulse causes it to shift to the other state. The steering diodes, CR6 and CR7, convey the trigger pulse to the proper collector, depending on the state of the circuit, thereby permitting successive triggering by pulses of the same polarity. R43 is a base bias resistor for Q9. R44 and C29 provide a feedback path between Q8 and Q9. R45 is the collector load for Q9. C30 is a bypass capacitor, used for both Q8 and Q9. R42 is a base bias resistor for Q8. R40 and C28 provide a feedback path between Q8 and Q9. R39 is the collector load for Q8.

3. Output Amplifier Circuit

The output current of each multivibrator stage is amplified by the power amplifiers (Q10 and Q11) to a level high enough to operate the relay. Q10 and Q11 idle at approximately 50 μa and conduct only when the multivibrator is triggered. Conduction occurs when the emitter capacitor (C31 or C27) charges. The relay has two coils: one coil (K1A) is connected to the collector of Q10, the other (K1B) is connected to the collector of Q11. R38 is an isolation resistor between Q9 and Q11. R47 is an emitter bias resistor for Q11, and C31 is the emitter bypass capacitor. R37 is an emitter bias resistor for Q10, and C27 is the emitter bypass capacitor.

4.3 PRINCIPLES OF CIRCUIT OPERATION

Some examples of possible received signals are shown at the top of Figure II-4 as A1 through A5. The effect each received signal has on the various decoding circuits is shown directly below the received signal. For example, the effect of signal A1, the operating pulse, on the decoding circuits is shown in B1, C1, D1, E1, F1, and G1.

1. Reference Pulse Generator

The generator is a monostable multivibrator, consisting of Q5 and Q6. The circuit is similar to a plate-coupled multivibrator. Q6 is normally non-conducting. Upon application of the leading edge of any positive pulse from the limiter, coupled through C18 and R28 to the collector of Q6, reference pulse B is generated at the collector of Q6. The duration of pulse B is fixed and is proportional to the r-c product of C17 and R22 (the effect of R22 on pulse width is minor). The differentiating network C20 and R30 produces pulse C, the negative portion of pulse C corresponding to the trailing edge of pulse B. R22 in series with C17 produces the rapid initial drop at the end of pulse B, from which the negative portion of C is formed. The steepness of this portion of pulse B allows the use of a small differentiating capacitor, thus minimizing the loading effect on the pulse width discriminator circuit. R21 is the base bias resistor for Q5. R23 is collector load for Q5. R26 is the emitter bias resistor and C19 the emitter bypass capacitor for Q6. R25 is the collector load for Q6.

2. Pulse Width Discriminator

Pulse width discriminator CR4 receives positive pulses from the limiter (some examples are shown in A of Figure II-4) and delivers short negative pulses having amplitudes dependent on the width of the input pulses. These negative output pulses (D of Figure II-4) occur at the end of the pulses received from the limiter. The circuit is comprised of an r-c differentiating network, consisting of R31 and C21, with the pulse width discriminator diode CR4 in series with the capacitor. R29, across the diode, insures uniform back resistance. When a positive pulse appears at the input of the discriminator, C21 charges slowly through the high back resistance of the diode. At the end of the received pulse A, C21 discharges rapidly through the low forward resistance of the diode and the resistance of R31, producing a short negative pulse across R31, as shown in D. With a wide pulse input, C21 becomes fully charged and produces an output pulse of small amplitude. The lower end of R31 is bypassed to ground by C23, which may be assumed to have negligible impedance as far as the operation of the pulse width discriminator circuit is concerned.

3. Noise Rectifier Circuit

The noise rectifier circuit consists of diodes CR2 and CR3, coupling capacitor C22, and resistor R32. This circuit is similar to a half-wave voltage doubler type rectifier except that the capacitors are of unequal size. The value of C22 is relatively small in order to pass high frequencies and reject low frequencies. This circuit develops a positive d-c voltage across C23 and R32 in response to high frequency components of received noise as shown in E5.

4. Coincidence Gate CR5

Coincidence gate CR5 is a high back resistance diode amplitude selector which passes pulses having peak amplitudes more negative than the gate bias level (-3 volts) and does not pass pulses having amplitudes less negative than the gate bias level. The tips of the pulses passed by this circuit are amplified by the pulse amplifier circuit and used to activate the switching circuit.

The maximum amplitude of any received pulse is held to -6 volts by limiter Q4. The decoding circuits compare the duration of the received pulse with reference pulse B generated within the receiver, and also determine whether the received pulse has the correct shape.

The received pulse A from the output of the limiter is applied to the reference pulse generator circuit and triggers it into operation, forming reference pulse B at its output. The duration of pulse B is fixed, being determined by the r-c time constant of the reference pulse generator.

Pulse B is passed through a differentiating network to form pulse C, the negative pip of pulse C corresponding to the trailing edge of pulse B.

Pulse A is also applied to the pulse width discriminator circuit to produce pulse D, the negative pip of pulse D corresponding to the trailing edge of pulse A.

Pulses C and D are then combined. If the pulse being received is operating pulse A1 (the width of pulse A1 is fixed and is equal to the width of reference pulse B), pulses C and D will occur at the same time as shown in C1 and D1 and their combined output F1 will be sufficient to pass through the coincidence gate circuit and actuate the relay switching circuit. If, however, the pulse being received is too narrow, as in the case of A2, pulse D will occur at an earlier time than pulse C as shown in C2 and D2. Similarly, if the pulse being received is too wide, as in the case of A3, pulse D will occur at later time than pulse C, as shown in C3 and D3. The pulse amplitudes in either case are insufficient to pass through the coincidence gate circuit as shown in F2 and F3, respectively, and consequently no switching takes place.

A4 and A5 are two examples of extraneous received signals which will not be passed by the decoding circuits because, while having the correct overall width, they do not have the correct shape. In the case of A4, the pulse width discriminator will produce output pulses of below normal amplitude as shown in D4, which when combined with pulse C4 are insufficient to pass the coincidence gate circuit as shown in F4.

In the case of A5, the noise rectifier circuit develops a positive d-c voltage as shown in E5. This voltage opposes pulses C5 and D5, the combined voltage of C5, D5, and E5 shown in F5 being insufficient to pass the coincidence gate circuit.

The output signals from the noise rectifier (pulse E), the pulse width discriminator (pulse D), and the reference pulse generator (pulse C) are all combined by the series connection of their respective load resistors R32, R31, and R30. The total voltage is applied to the coincidence gate diode which passes a pulse when the total voltage exceeds the gate bias level (-3 volts).

A received signal having the correct width and shape as shown in A1 will cause operation of the coincidence gate. The waveform at the input of the coincidence gate for this particular case is shown in F1. Since the pulse width is correct, the 2 volt pulse D1 from the pulse width discriminator combines simultaneously with the 2 volt pulse C1 from the reference pulse generator, resulting in a total pulse amplitude greater than the gate bias level. As a result, a pulse will pass through the gate. The noise rectifier develops no voltage at this time because no high frequency noise components were present in the received pulse. If the received pulse is narrower (as shown in A2) or wider (as shown in A3) than the correct width shown in A1, pulses C and D will not occur at the same time and consequently will not combine to exceed the 3 volt bias of the gate as shown in F2 and F3.

Waveform A6 is the same as operating pulse A1 except that a short noise pulse occurs before the operating pulse. Since the noise pulse occurs first, the noise pulse, and not the operating pulse, triggers the reference pulse generator as shown in C6. As a result, the operating pulse is unable to trigger the reference pulse generator. This possibility of noise pulses triggering the reference pulse generator and thus preventing operation is prevented by the use of the coded signal waveform shown in A7. The first portion of A7 is the protecting pulse and the second portion is the operating pulse. The protecting pulse is appreciably longer than the operating pulse to insure that the reference pulse generator will be ready to be triggered after the protecting pulse. The waveform at the input to the coincidence gate in response to the protecting and operating pulses is shown in F7.

A4 and A5 show two types of extraneous signals which are rejected by the decoding circuits. In A4, the spacing between the beginning of the first pulse and the second pulse is equal to the correct width, the output signal D4 from the pulse width discriminator (which is combined with output signal C4 from the reference pulse generator) is too small to allow operation as shown in F4.

A5 is a noise pulse typical of that produced by electric arcs. The high frequency noise components present cause the noise rectifier circuit to develop a positive d-c voltage which opposes the negative output pulses D5 and C5 from the pulse width discriminator and the reference pulse generator, respectively, and the total voltage is thus too small to operate the gate. The time constant of R32 and C23 in the noise rectifier circuit is short enough so that the positive d-c voltage is discharged during reception of a coded signal, in order to prevent blocking when coded signals are received in the presence of noise. Other types of received extraneous signals may be rejected by either the pulse width discriminator, the noise rectifier, or both.

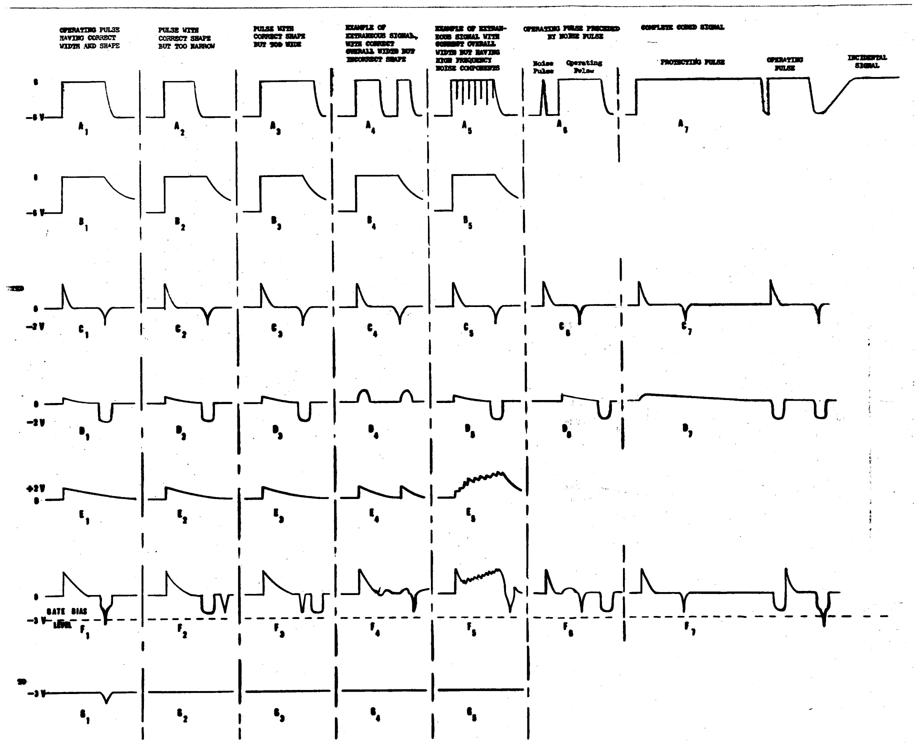

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Figure II-4 Signal Waveforms of Decoding Circuits

5. MAINTENANCE

5.1 GENERAL

The Latching Radio Switch Receiver LRSR-1 is designed to provide reliable operation over long periods of time. Since transistors are soldered in place and subminiature techniques are used in construction, it is recommended that all maintenance (with the exception of minor repairs, such as loose conections, battery replacement, etc.), be conducted in a laboratory.

5.2. BATTERY REPLACEMENT

The battery supply used with the LRSR-1 should be replaced after approximately 1000 hours of operation. A special 3600 hour mercury battery is used. There is no positive method of determining the condition of the battery, i.e., to what extent it has been used or its remaining capacity; therefore, it is recommended that a record of receiver "on" time be kept. When there is any question as to the probable condition of the battery, it should be replaced.

5.3 ACCESSIBILITY

Both sides of the printed circuit board are easily accessible for servicing when the receiver covers are removed. (There are two screws securing each cover to the case.) The printed circuit board may be removed for replacing the relay and other servicing requirements by:

1. Removing the two screws near the front of the board.
2. Unsoldering the long ground strip near the relay. The board will then drop out.

To replace the relay, place a small screwdriver between the relay and the socket and pry gently. The relay may now be replaced.

5.4 TEST EQUIPMENT REQUIRED

Voltohmmeter - Simpson, Model 260, or equivalent

Oscilloscope - Dumont (long persistent screen) Type 304A, or equivalent

Vacuum Tube Voltmeter - Hewlett Packard, Model 410B, or equivalent

Transmitter - LRST-1.

5.5 GENERAL PRECAUTIONS

Whenever the unit is serviced, carefully observe the precautions listed below: (careless replacement of parts makes new faults inevitable.)

a. Remove a-c power before servicing the foil side of the unit.

b. Before a part is unsoldered, note the position of the leads, and tag (number) each of the leads.

c. Be careful not to damage other connections by pulling or pushing the leads out of the way.

d. If soldering is performed on the unit, do not allow solder to bridge the foil at any point, it may cause a short circuit.

e. A carelessly soldered connection may create a new fault. It is important to use care in soldering; since a poorly soldered joint is one of the most difficult faults to find.

f. Use appropriate ranges on meters and test sets used for troubleshooting.

g. In replacement of the oscillator transformer, care must be exercised in the orientation of the windings.

h. In replacing transistors, use a soldering iron with a low power rating (22 1/2 watts). Excessive heat applied to a transistor lead may damage the transistor.

5.6 SECTIONALIZING AND LOCALIZING A FAULT

The first step in servicing a defective unit is to sectionalize the fault; i.e., to trace the fault to the stage or circuit by appropriate voltage and/or resistance measurements as outlined in Section 4-8, Voltage-Resistance Chart. The preliminary tests listed below will aid in isolating the source of trouble.

a. Visual Inspection

The purpose of visual inspection is to locate any components which show evidence of mechanical breakdown. Through this inspection, the repairman may frequently discover the fault or determine the stage in which the fault exists. This inspection is valuable in forestalling future failure and in avoiding damage to the unit which might occur through improper servicing methods.

b. Operating and Alignment Test

It is recommended that the repairman try to operate the equipment, as directed in Section 2, to determine just what mal-function exists and to check alignment.

c. Intermittents

In all these tests, the possibilities of intermittents should not be overlooked. If present, this trouble may often be made to appear by tapping or jarring the unit. It is possible that the trouble is not in the receiver itself but in the auxiliary apparatus, or connections.

5.7 TROUBLESHOOTING CHART

The following chart is supplied as an aid in locating trouble in the unit. This chart lists the symptoms which the repairman observes, and indicates how to localize trouble quickly in the various sections. Normal voltage and resistance measurements are given in the Voltage-Resistance Chart 4-6 which follows the Troubleshooting Chart.

TROUBLESHOOTING CHART

(Refer to Figures II-5 and II-6 for test points.)

In servicing a defective unit the following procedure is recommended. Measuring techniques used in obtaining data are outlined in Section 3.

a. Check voltage and waveform at test point 13 (The limiter output).

Symptom	Probable Cause	Suggestion
Voltage at test point 13 is less than 1 volt with 3 mvolts applied. This indicates poor sensitivity.	Transformer detuned or partially open (one or more strands of the litz wire broken.	Retune or replace transformer, if necessary.
	Defective r.f. transistor or defective component in r.f. circuit.	Check r.f. transistors. Check voltages and resistances in r.f. circuits according to Voltage-Resistance Chart, Section 5.8.
	CR1 defective (high forward resistance).	Check and/or replace CR1.
Voltage at test point 13 is .3 volt to 5 volts with no signal applied.	Oscillation in r.f. circuitry.	Open transformer loading resistor R1, R6, R11, and R16. Check and/or replace Q4.
Bandwidth measures less than 100 Kc.	Regeneration in r.f. circuitry.	Check transformer loading resistors R1, R6, R11, R16, and emitter resistor R18, and sensitor R19.
Improper waveshape when pulsed signal is applied (see A7, Figure II-4).	Open base bypass capacitor C3, C7, or C11. Open emitter bypass capacitor C4, C8, or C13.	Check and/or replace C3, C7, or C11. Check and/or replace C4, C8, or C13.
Operation intermittent when near transmitter LRST-1 with antenna wire attached (extraneous vertical pulses at test point 13).	Defective base bypass capacitor C3, Diodes CR8 or CR9 open.	Check and/or replace C3. Check and/or replace CR8 or CR9.

b. If the waveshape and sensitivity appear normal at test point 13, but the unit still does not operate, check the output of the reference pulse generator at test point 19.

Symptom	Probable Cause	Suggestion
No reference pulse at test point 19. See B1, Figure II-4 for correct waveshape.	Q5 or Q6 defective. Defective component in reference pulse circuitry.	Check and/or replace Q5 or Q6. Measure voltages and resistances in reference pulse circuit according to Voltage-Resistance Chart, Section 5.8.
	Open coupling capacitor, C18.	Check and/or replace C18.
Reference pulse too narrow or too wide.	C17 or R22 defective.	Check and/or replace C17 or R22.

c. If the pulse width and shape is correct at test point 19, look at the waveform at the input to the coincidence gate, test point 36. The following pulses may be observed at the input to the coincidence gate:

1. Differentiating pulses.

2. Noise rectification.

3. The addition of two pulses, required for operation.

Symptom	Probable Cause	Suggestion
No differentiation pulses at test point 36. See waveform on Figure II-4.	Open or shorted capacitor C20 and/or open circuit in series resistors R30, R31, R32.	Check and/or replace defective component.
No discriminator pulses, at test point 36. See waveform on Figure II-4.	Open or shorted capacitor C21 and/or diode CR4.	Check and/or replace defective component.
Differentiator pulses alone operating the unit.	CR4 defective.	Check and/or replace CR4.
Addition of pulses normal, but unit still does not operate.	CR4 defective.	Check and/or replace CR4.

d. If the waveforms appear proper up to this point and unit does not operate, check the output of the pulse amplifier, test point 22.

Symptom	Probable Cause	Suggestion
No 6 volt positive spike at test point 22.	CR4 defective.	Check and/or replace CR4.
	-2.6 volt gate bias level beyond ±10% tolerance.	Check and/or replace R27, R33, and R50.
Unit operates without r.f. signal from the transmitter.	Unit in high a-c field. (A C field is being picked up by Q7 and amplified.)	Relocate unit away from a-c field.
	CR2 or CR3 defective.	Check and/or replace defective component.

e. If the 6 volt positive spike appears at the collector of Q7, test point 22, and the unit still does not operate, measure the voltage and check the waveform at test points 25 and 27.

Symptom	Probable Cause	Suggestion
No transfer of voltage from Q8 to Q9, test points 25 and 27.	Defective steering diodes CR6 and CR7.	Check and/or replace CR6 and CR7.
	Defective component in multivibrator circuit.	Measure voltages and resistance in multivibrator circuit according to Voltage-Resistance Chart, Section 5.8
Multivibrator changes state, when pulsed but relay does not operate.	Multivibrator out of phase with amplifier.	Pulse unit with two fast pulses and two normal pulses. Unit should operate on the fourth pulse if the third and fourth pulses have normal delay between them.

f. If unit still does not operate up to this point, check voltages and waveforms at collectors of Q10 and Q11, test points 30 and 33.

Symptom	Probable Cause	Suggestion
Voltage transfers at multivibrator, but relay does not operate.	Q10 or Q11 defective.	Check and/or replace Q10 and Q11.
	C27 or C31 defective.	Check and/or replace C27 or C31.
Waveform less than 15 msec duration.	C27 or C31 defective.	Check and/or replace C27 or C31.
Waveform correct at test point 30 and 31 but unit does not operate.	Relay defective.	Check and/or replace relay as outlined in Section 5.3.

5.8 VOLTAGE-RESISTANCE CHART

DC voltages and resistances were measured with a Simpson, Model 260, voltohmmeter. All measurements are made to ground.

Test Points		DC Voltages (volts) Tol. (±10%)	Resistance (ohms) Pos. meter lead to gnd. Tol(±10%)	Neg. meter lead to gnd. Tol.(±20%)
Q1				
2(e)	to 1 (gnd)	-3.43	10 K	2.9 K
3(b)	1	-3.46	4 K	10 K
4(c)	1	-5.2	6 K	3.5 K
Q2				
5(e)	1	-3.93	8 K	2.4 K
6(b)	1	-3.96	3.4 K	11 K
7(c)	1	-5.4	4.5 K	2.9 K
Q3				
8(e)	1	-2.4	7 K	2.2 K
9(b)	1	-2.5	2.8 K	9.5 K
10(c)	1	-5.6	4.5 K	2.4 K
Q4				
11(e)	1	0	60	24
12(b)	1	0	330	250
13(c)	1	-6.3	6	320
Q5				
14(e)	1	0	0	0
15(b)	1	0	300	95 K
16(c)	1	0	890	12 K
Q6				
17(e)	1	0	1.1 K	900
18(b)	1	0	900	12 K
19(c)	1	-6.2	8.5 K	2.3 K
Q7				
20(e)	1	0	14 K	4.5 K
21(b)	1	0	5 K	15 K
22(c)	1	-6.1	10 K	4.5 K

Test Points	DC Voltages (volts) Tol. (±10%)		Resistance (ohms) Pos. meter lead to gnd. Tol(±10%)	Resistance (ohms) Neg. meter lead to gnd. Tol.(±20%)
Q8				
23(e) to 1 (gnd)	-.6*	-.6**	1 K	900
24(b) 1	-.75*	-.42**	1.1 K	7.5 K
25(c) 1	-.6*	-2.6**	4 K	2.6 K
Q9				
26(e) 1	-.6*	-.6**	1 K	900
27(b) 1	-.42*	-.75**	1.1 K	7.5 K
28(c) 1	-2.6*	-.6**	4 K	2.7 K
Q10				
29(e) 1	-.65*	-2.7**	41 K	2.2 K
30(b) 1	-.57*	-2.6**	3 K	7.5 K
31(c) 1	-6.4*	-6.4**	3.2 K	2 K
Q11				
32(e) 1	-2.7*	-.65**	40 K	2 K
33(b) 1	-2.6*	-.57**	3 K	7.5 K
34(c) 1	-6.4*	6.4**	3.2 K	2 K
OTHER				
Junction R50, R27, R33	-2.5			
Junction R33, C24, CR5	-2.3			

* Q9 Conducting
** Q8 Conducting

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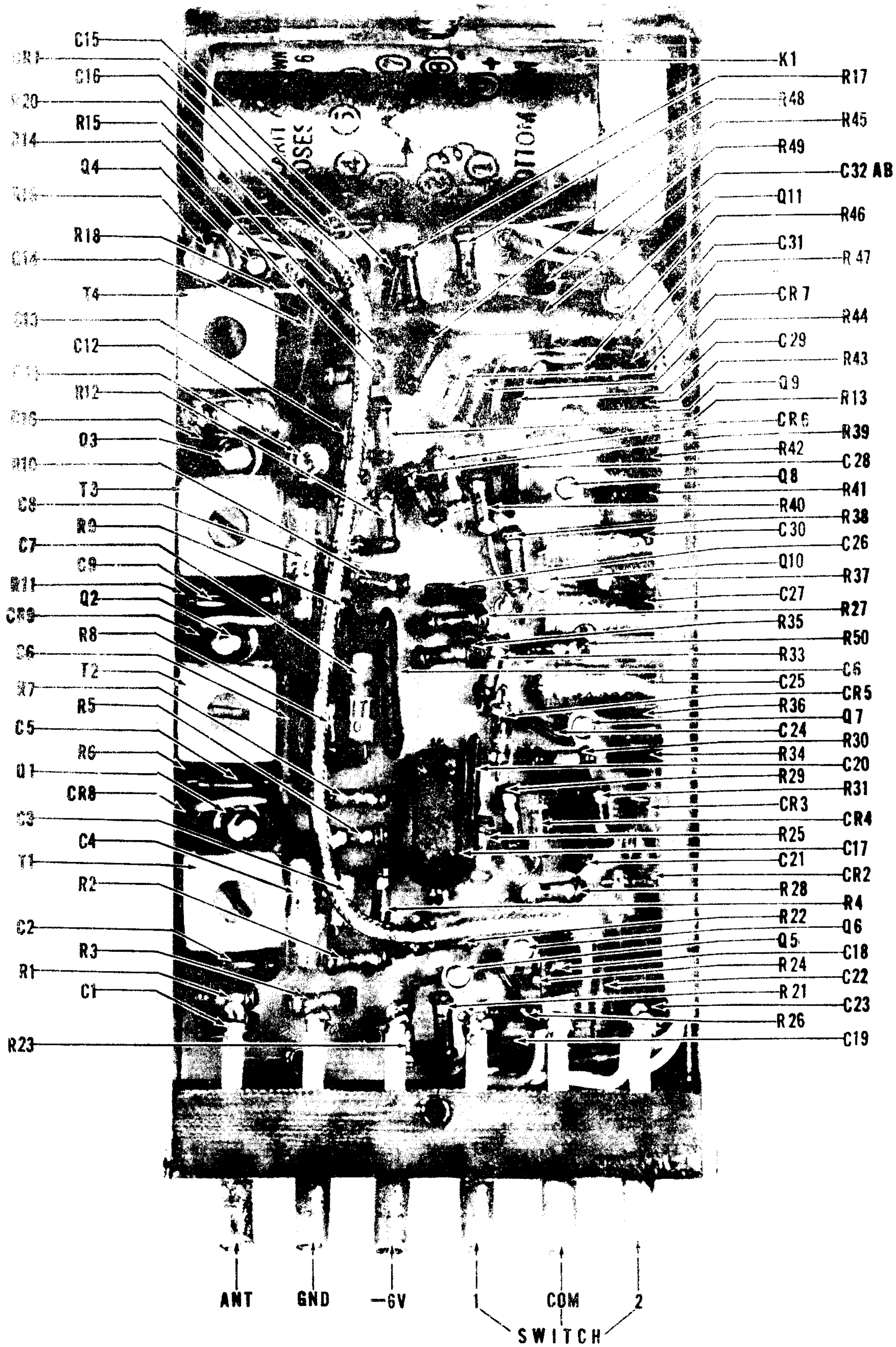


Figure II-5 Receiver LRSR-1, Component Layout

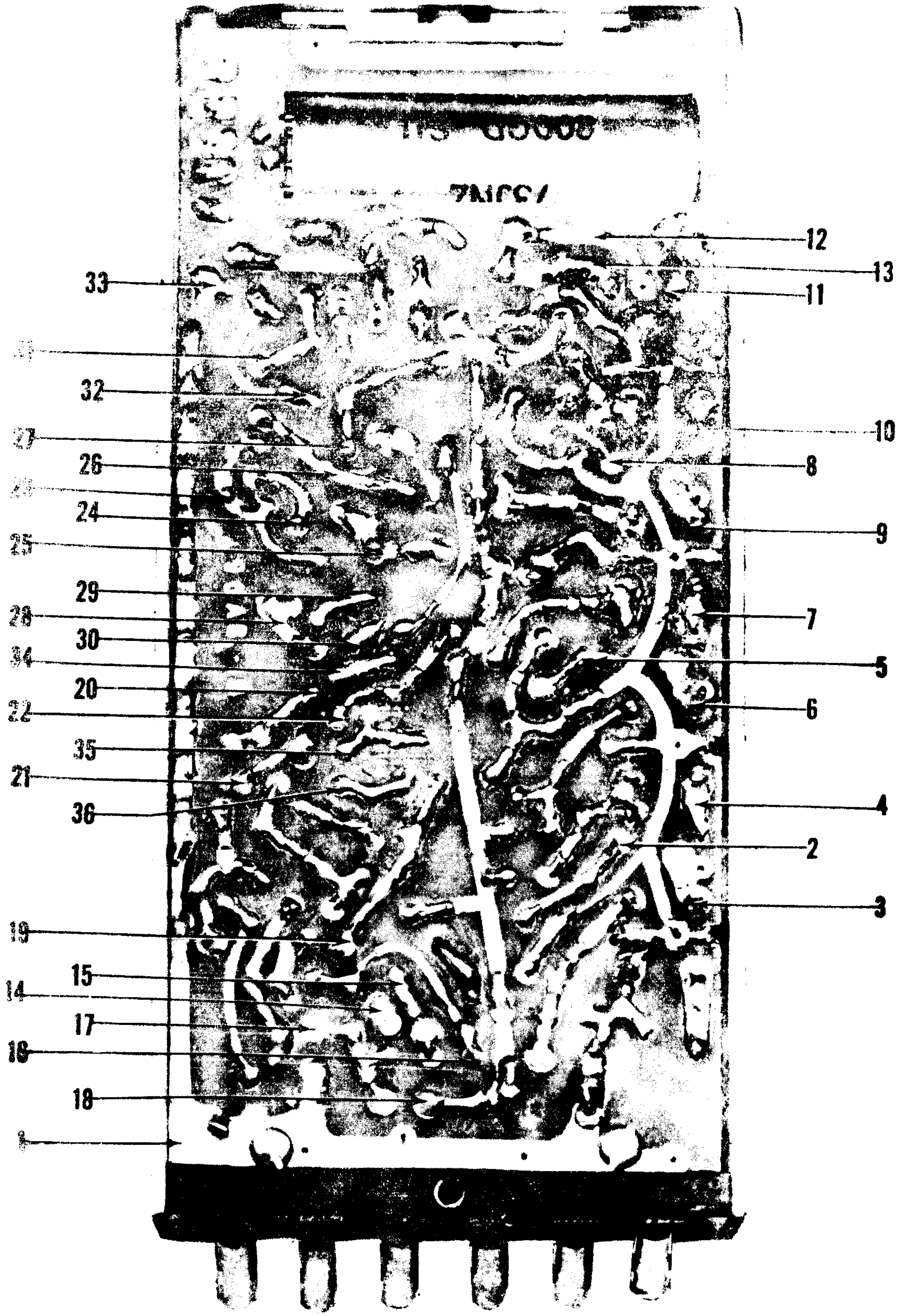


Figure II-6 Receiver LRSR-1, Test Points

6. PARTS LIST

Ref. Symbol	Part Name, Description, Function and Location	Manufacturer's Name and Number
C1	Capacitor, Fixed, Ceramic - 10µµfd - Series limiting capacitor in antenna circuit.	Mucon Corp. Type NPO
C2	Capacitor, Fixed, Ceramic - 91µµfd, Antenna tuned circuit capacitor.	Mucon Corp. Type NPO
C3	Capacitor, Fixed, Ceramic - [illegible] µfd, 4 v - r.f. bypass capacitor for Q1.	[illegible]te Mfg. Co. [illegible]
C4	Capacitor, Fixed, Electrolytic, Tantalum - 25 µfd, 15v - Emitter bypass capacitor for Q1	P.R. Mallory Co. Type TNT
C5	Capacitor, Fixed, Ceramic - 91µµfd, Tuned circuit capacitor in primary of T-2.	Mucon Corp. Type NPO
C6	Capacitor, Fixed, Ceramic - 1µfd, 25 v - Decoupling capacitor in primary of T2.	Mucon Corp. Type T01R
C7	Capacitor, Fixed, Ceramic - [illegible] µfd, 20 v - r.f. bypass capacitor for Q2.	Ohmite Mfg. Co. [illegible]
C8	Capacitor, Fixed, Electrolytic, Tantalum - 25 µfd, 15 v - Emitter bypass capacitor for Q2.	P.R. Mallory Co. Type TNT
C9	Capacitor, Fixed, Ceramic - 91µµfd, Tuned circuit capacitor in primary of T-3.	Mucon Corp. Type NPO
C10	Capacitor, Fixed, Ceramic - .1µfd, 25 v - Decoupling capacitor in primary of T3.	Mucon Corp. Type T01R
C11	Capacitor, Fixed, Ceramic - 4 µfd, 20 v - r.f. bypass capacitor for Q3.	Ohm[illegible] Mfg. Co. [illegible]
C12	Capacitor, Fixed, Ceramic - 91µµfd, Tuned circuit capacitor in primary of T-4.	Mucon Corp. Type NPO
C13	Capacitor, Fixed, Electrolytic, Tantalum - 25 µfd, 15 v - Emitter bypass capacitor for Q3.	P.R. Mallory Co. Type TNT
C14	Capacitor, Fixed, Ceramic - .1µfd, 25 v - Decoupling capacitor in primary of T4.	Mucon Corp. Type
C15	Capacitor, Fixed, Ceramic - .005µfd, 25v - r.f. bypass capacitor for Q4.	Mucon Corp. Type T005R
C16	Capacitor, Fixed, Ceramic - .001µfd, 25 v - r.f. bypass capacitor for Q5.	Mucon Corp. Type T001R

Ref. Symbol	Part Name, Description, Function and Location	Manufacturer's Name and Number
C17	Capacitor, Fixed, Metallized paper - .25 µfd, 200 v (.5 adjusts pulse width of reference generator) Time constant for pulse width.	Hopkins Eng.
C18	Capacitor, Fixed, Ceramic - .01µfd, 25 v - coupling capacitor to reference pulse generator (Q5).	Mucon Corp.
C19	Capacitor. Fixed, Electrolytic, Tantalum - 50 µfd, 6 v - r.f. bypass capacitor for Q5 and Q6.	P.R. Mallory Co. Type TNT
C20	Capacitor, Fixed, Ceramic - .02 µfd, 25 v - Coupling capacitor to coincidence gate circuit (CR 5).	Mucon Corp. Type T05R
C21	Capacitor, Fixed, Ceramic - .05µfd, 25 v - Coupling capacitor to discriminator circuit (CR4).	Mucon Corp. Type T05R
C22	Capacitor, Fixed, Ceramic - .05µfd, 200 v - bypass filter for noise rectifier (CR2).	Hopkins Eng. Type T05R
C23	Capacitor, Fixed, Metallized paper - .25 µfd, 200 v - bypass filter for noise rectifier (CR2).	Hopkins Eng.
C24	Capacitor, Fixed, Ceramic - .01µfd, Coupling to Pulse Amplifier (Q7).	Mucon Corp. Type T01R
C25	Capacitor, Fixed, Electrolytic, Tantalum - 40 µfd, 10 v - Emitter bypass capacitor for Q7.	Sprague Prod. Co. Type 150D
C26	Capacitor, Fixed, Ceramic - .01 µfd, 25 v - Pulse coupling to steering diodes (CR6).	Mucon Corp. Type T01R
C27	Capacitor, Fixed, Electrolytic, Tantalum - 40 µfd, 10 v - Emitter bypass capacitor for Q7.	Sprague Prod. Co. Type 150D
C28	Capacitor, Fixed, Ceramic - .01µfd, 25 v - part of feedback path for 1st section of multivibrator (Q9).	Mucon Corp. Type T01R
C30	Capacitor, Fixed, Electrolytic, Tantalum - 60 µfd, 6 v - common bypass for both sections of multi.	P.R. Mallory Type TNT
C31	Capacitor, Fixed, Electrolytic, Tantalum - 40 µfd, 10 v - Time constant for relay pulse	Sprague Prod. Co. Type 150D
C32a	Capacitor, Fixed, Ceramic - .005 µfd, 600 v - contact spark suppressor.	Centralab Co. DD2-502
C32b	Capacitor, Fixed, Ceramic - .005 µfd, 600 v - contact spark suppressor.	

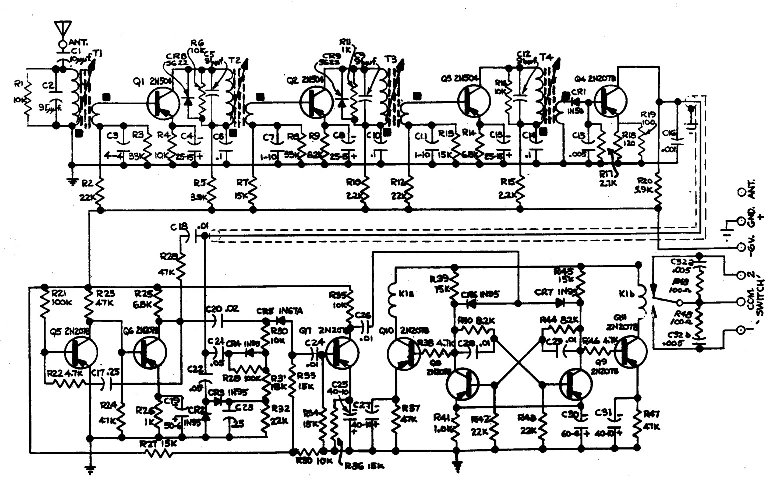
Ref. Symbol	Part Name, Description, Function and Location	Manufacturer's Name and Number
CR1	Semiconductor device, diode - r.f. detector	Sylvania Prod. Co. 1N56
CR2, CR3	Semiconductor device, diode - noise rectification diodes	Hughes Prod. Co. 1N95
CR4	Semiconductor device, diode - pulse width discriminator	Hughes Prod. Co.
CR5	Semiconductor device, diode - coincident gate	Gemco 1N67A
CR6, CR7	Semiconductor device, diode - steering diodes	Hughes Prod. Co. 1N95
K1	Relay, two-coil latching type - 1	Sigma Relay Co. Type 73JNZ-SIL
Q1	Transistor, PNP, Germanium - 1st r.f. stage	Landsdale Tube Co. Philco 2N504
Q2	Transistor, PNP, Germanium - 2nd r.f. stage	Landsdale Tube Co. Philco 2N504
Q3	Transistor, PNP, Germanium - 3rd r.f. stage	Landsdale Tube Co. Philco 2N504
Q4	Transistor, PNP, Germanium - limiter	Landsdale Tube Co. Philco 2N207B
Q5	Transistor, PNP, Germanium - reference pulse generator	Landsdale Tube Co. Philco 2N207B
Q6	Transistor, PNP, Germanium - mono-stable multivibrator	Landsdale Tube Co. Philco 2N207B
Q7	Transistor, PNP, Germanium - pulse amplifier	Landsdale Tube Co. Philco 2N207B
Q8	Transistor, PNP, Germanium - bistable multivibrator	Landsdale Tube Co. Philco 2N207B
Q9	Transistor, PNP, Germanium - bistable multivibrator	Landsdale Tube Co. Philco 2N207B
Q10	Transistor, PNP, Germanium - driver stage for relay	Landsdale Tube Co. Philco 2N207B
Q11	Transistor, PNP, Germanium - driver stage for relay	Landsdale Tube Co. Philco 2N207B

Ref. Symbol	Part Name, Description, Function and Location	Manufacturer's Name and Number
R1	Resistor, Fixed Film - 10 K, 1/20 W, 5% - Loading resistor for T1.	Arnhold Ceramics Stemag Type R
R2	Resistor, Fixed Film - 22 K, 1/20 W, 5% - Base bias resistor for Q1.	Arnhold Ceramics Stemag Type R
R3	Resistor, Fixed Film - 33 K, 1/20 W, 5% - Base bias resistor for Q1.	Arnhold Ceramics Stemag Type R
R4	Resistor, Fixed Film - 10 K, 1/20 W, 5% - Base bias resistor for Q1.	Arnhold Ceramics Stemag Type R
R5	Resistor, Fixed Film - 3.9 K. 1/20 W, 5% - Decoupling resistor.	Arnhold Ceramics Stemag Type R
R6	Resistor, Fixed Film - 10 K, 1/20 W, 5% - Loading resistor for T-2.	Arnhold Ceramics Stemag Type R
R7	Resistor, Fixed Film - 15 K, 1/20 W, 5% - Base bias resistor for Q2.	Arnhold Ceramics Stemag Type R
R8	Resistor, Fixed Film - 33 K, 1/20 W, 5% - Base bias resistor for Q2.	Arnhold Ceramics Stemag Type R
R9	Resistor, Fixed Film - 8.2 K, 1/20 W, 5% - Emitter bias resistor for Q2.	Arnhold Ceramics Stemag Type R
R10	Resistor, Fixed Film - 2.2 K, 1/20 W, 5% - Decoupling resistor in primary of T3.	Arnhold Ceramics Stemag Type R
R11	Resistor, Fixed Film - 2.7 K, 1/20 W, 5% - Loading resistor for T3.	Arnhold Ceramics Stemag Type R
R12	Resistor, Fixed Film - 22K, 1/20 W, 5% - Base bias resistor for Q3.	Arnhold Ceramics Stemag Type R
R13	Resistor, Fixed Film - 15 K, 1/20 W, 5% - Base bias resistor for Q3.	Arnhold Ceramics Stemag Type R
R14	Resistor, Fixed Film - 6.8 K, 1/20 W, 5% - Emitter bias resistor for Q3.	Arnhold Ceramics Stemag Type R
R15	Resistor, Fixed Film - 2.2 K. 1/20 W, 5% - Decoupling resistor in primary of T4.	Arnhold Ceramics Stemag Type R
R16	Resistor, Fixed Film - 10 K, 1/20 W, 5% - Loading resistor for T4.	Arnhold Ceramics Stemag Type R
R17	Resistor, Fixed Film - 2.7 K, 1/20 W, 5% - Base return for Q4.	Arnhold Ceramics Stemag Type R

Ref. Symbol	Part Name, Description, Function and Location	Manufacturer's Name and Number
R18	Resistor, Fixed Film - 120 ohms, 1/20 W, 5% - Emitter bias resistor for Q4.	Arnhold Ceramics Stemag Type R
R19	Resistor, Fixed Film - 100 ohms, (with the positive coefficient of 20%) - Temp. compensation resistor for Q4.	Texas Instruments TM-1/4
R20	Resistor, Fixed Film - 3.9 K, 1/20 W, 5% - Collector load resistor for Q4.	Arnhold Ceramics Stemag Type R
R21	Resistor, Fixed Film - 100 K, 1/20 W, 5% - Base bias resistor for Q5.	Arnhold Ceramics Stemag Type R
R22	Resistor, Fixed Film - 4.7 K, 1/20 W, 5% - Time constant and feedback resistor for Q5.	Arnhold Ceramics Stemag Type R
R23	Resistor, Fixed Film - 4.7K, 1/20 W, 5% - Collector load resistor for Q5.	Arnhold Ceramics Stemag Type R
R24	Resistor, Fixed Film - 4.7K, 1/20 W, 5% - Base bias resistor for Q6.	Arnhold Ceramics Stemag Type R
R25	Resistor, Fixed Film - 6.8 K, 1/20 W, 5% - Collector load resistor for Q6.	Arnhold Ceramics Stemag Type R
R26	Resistor, Fixed Film - 1 K, 1/20 W, 5% - Emitter stabilizing resistor for Q6.	Arnhold Ceramics Stemag Type R
R27	Resistor, Fixed Film - 10 K, 1/20 W, 5% - Voltage divider for 3 volt bias.	Arnhold Ceramics Stemag Type R
R28	Resistor, Fixed Film - 47 K, 1/20 W, 5% - Three (3) volt buss bypass.	Arnhold Ceramics Stemag Type R
R29	Resistor, Fixed Film - 100 K, 1/20 W, 5% - Constant back impedance for CR4.	Arnhold Ceramics Stemag Type R
R30	Resistor, Fixed Film - 10 K, 1/20 W, 5% - Isolation resistor between discriminator and coincident gate.	Arnhold Ceramics Stemag Type R
R31	Resistor, Fixed Film - 18 K, 1/20 W, 5% - part of differentiator circuit load.	Arnhold Ceramics Stemag Type R
R32	Resistor, Fixed Film - 22 K, 1/20 W, 5% - part of differentiator circuit noise rect. load.	Arnhold Ceramics Stemag Type R
R33	Resistor, Fixed Film - 15 K, 1/20 W, 5% - Base bias resistor for Q7.	Arnhold Ceramics Stemag Type R
R34	Resistor, Fixed Film - 15 K, 1/20 W, 5% - Base bias resistor for Q7.	Arnhold Ceramics Stemag Type R

Ref. Symbol	Part Name, Description, Function and Location	Manufacturer's Name and Number
R35	Resistor, Fixed Film - 10 K, 1/20 W, 5% - Collector load resistor for Q7.	Arnhold Ceramics Stemag Type R
R36	Resistor, Fixed Film - 15 K, 1/20 W, 5% - Emitter bias resistor for Q7.	Arnhold Ceramics Stemag Type R
R37	Resistor, Fixed Film - 47 K, 1/20 W, 5% - Together with C27 forms pulse width for relay.	Arnhold Ceramics Stemag Type R
R38	Resistor, Fixed Film - 4.7 K, 1/20 W, 5% - Isolation resistor between Q8 and Q10.	Arnhold Ceramics Stemag Type R
R39	Resistor, Fixed Film - 15 K, 1/20 W, 5% - Collector load resistor for Q8.	Arnhold Ceramics Stemag Type R
R40	Resistor, Fixed Film - 8.2 K, 1/20 W, 5% - Feedback between Q8 and Q9 in the multivibrator.	Arnhold Ceramics Stemag Type R
R41	Resistor, Fixed Film - 1 K, 1/20 W, 5% - Common emitter stabilizing resistor for Q8 and Q9.	Arnhold Ceramics Stemag Type R
R42	Resistor, Fixed Film - 22 K, 1/20 W, 5% - Base bias resistor for Q8.	Arnhold Ceramics Stemag Type R
R43	Resistor, Fixed Film - 22 K, 1/20 W, 5% - Base bias resistor for Q9.	Arnhold Ceramics Stemag Type R
R44	Resistor, Fixed Film -8.2 K, 1/20 W, 5% - Feedback between Q9 and Q8 in the multivibrator.	Arnhold Ceramics Stemag Type R
R45	Resistor, Fixed Film - 15 K, 1/20 W, 5% - Collector load resistor for Q9.	Arnhold Ceramics Stemag Type R
R46	Resistor, Fixed Film -4.7 K, 1/20 W, 5% - Isolation resistor between Q9 and Q11.	Arnhold Ceramics Stemag Type R
R47	Resistor, Fixed Film - 47 K, 1/20 W, 5% - Together with C31 forms pulse width for relay.	Arnhold Ceramics Stemag Type R
R48	Resistor, Fixed Film - 100 ohms, 1/20 W, 5% - Bleeder resistor.	Arnhold Ceramics Stemag Type R
R49	Resistor, Fixed Film - 100 ohms, 1/20 W, 5% - Bleeder resistor.	Arnhold Ceramics Stemag Type R
R50	Resistor, Fixed Film - 10 K, 1/20 W, 5% - Voltage divider for 3 volt bias.	Arnhold Ceramics Stemag Type R

Ref. Symbol	Part Name, Description, Function and Location	Manufacturer's Name and Number
T1	Transformer, r.f. - Coupling transformer between antenna and Q1.	Special
T2	Transformer, r.f. - Coupling transformer between Q1 and Q2.	Special
T3	Transformer, r.f. - Coupling transformer between Q2 and Q3.	Special
T4	Transformer, r.f. - Coupling transformer between Q3 and Q4.	Special
CR8, CR9	Semiconductor device, diode - voltage limiting diode.	Transitron SG22



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