TECHNICAL MANUAL

GENERAL SUPPORT MAINTENANCE MANUAL

SIGNAL GENERATORS

AN/URM-52

(NSN 6625-00-556-8107)

AN/URM-52A

(NSN 6625-00-592-5742)

AN/URM-52B

(NSN 6625-00-965-1501)

HEADQUARTERS, DEPARTMENT OF THE ARMY

APRIL 1977

WARNING

HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if personnel fail to observe safety precautions
Learn the areas containing high voltage in each piece of equipment.
Be careful not to contact high voltage connections when installing or operating this equipment.
Before working inside the equipment, turn power off and ground points of high potential before touching them.

DON'T TAKE CHANCES!

TECHNICAL MANUAL No. 11-6625-214-40

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 1 April 1977

GENERAL SUPPORT

MAINTENANCE MANUAL

FOR

SIGNAL GENERATORS AN/USM-52 (NSN 6625-00-556-8107)

AN/URM-52A (NSN 6625-00-592-5742) AN/URM-52B (NSN 6625-00-965-1501)

REPORTING OF ERRORS

You can improve this manual by recommending improvements using DA Form 2028-2 (Test) located in the back of the manual. Simply tear out the self-addressed form, fill it out as shown on the sample, fold it where shown, and drop it in the mail.

If there are no blank DA Forms 2028-2 (Test) in the back of your manual, use the standard DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward to the Commander, US Army Electronics Command, ATTN: DRSEL-MA-Q, Fort Monmouth, New Jersey 07703.

In either case a reply will be furnished direct to you.

***This manual supersedes so much of TM 11-6625-214-24, 14 October 1960, including all changes, as pertains to general support.**

List of Illustrations

List of Tables

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual presents a functional description of Signal Generators AN/URM-52, AN/URM-52A, and AN/URM-52B. It gives general support maintenance instructions for the equipment and includes instructions for troubleshooting, testing, and repair. For consistency throughout this manual, Signal Generators AN/URM-52, AN/URM-52A and AN/URM-52B will be referred to as the AN/URM-52(*), except where model differences dictate.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Forms and Records.

a. Reports of Maintenance of Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST4030.29/AFR 71- 13/MCO P4030.29A, and DSAR 4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33A/AFR 75- 18/MCO P4610.19B. and DSAR 4500.15.

1-4. Administrative Storage

Administrative storage of equipment issued to and used by Army activities shall be in accordance with TM 740-90-1.

1-5. Destruction of Army Electronics Materiel

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

1-6. Reporting Equipment Improvement Recommendations (EIR)

EIRs will be prepared using DA Form 2407, Maintenance Request. Instructions for preparing EIRs are provided in TM 38-750, The Army Maintenance Management System. EIRs should be mailed directly to Commander, US Army Electronics Command, ATTN: DRSEL-MA-Q, Fort Monmouth, New Jersey 07703. A reply will be furnished directly to you.

Section II. DESCRIPTION AND DATA

1-7. Purpose and Use

The AN/URM-52(*) is a complete, self-contained signal generator. For a list of accessories applicable to each model of equipment, refer to TM 11-6625-214-12. The equipment is designed for use in testing radar and for other applications requiring small amounts of rf power, such as measuring standing wave ratios, antenna characteristics, transmission line characteristics, conversion gain, alignment and calibration of receivers, and similar uses.

1-8. Description

For a general description of the AN/URM-52(*), refer to TM 11-6625-214-12.

1-9. Tabulated Data

For performance characteristics of the AN/URM- 52(*), refer to tabulated data contained in TM 11- 6625-214-12.

CHAPTER 2

FUNCTIONING OF EQUIPMENT

2-1. Functional Description of Signal Generator AN/URM-52(*)

a. The AN/URM-52(*) is used for testing, calibrating and aligning various types of electronic equipment operating within the frequency range of 3,800 to 7,500 megahertz (MHz). In figure 2-1, the six basic circuits of the AN/URM-52(*) are shown in an overall block diagram.

b. Different modes of modulation are possible by operation of front panel switches. Provisions are incorporated in the generator to disconnect the internal modulation circuits and to employ externally developed modulation voltages when desired. The detail operation of basic circuits, as well as any circuit variations for the different models, will be described in pertinent paragraphs of the manual.

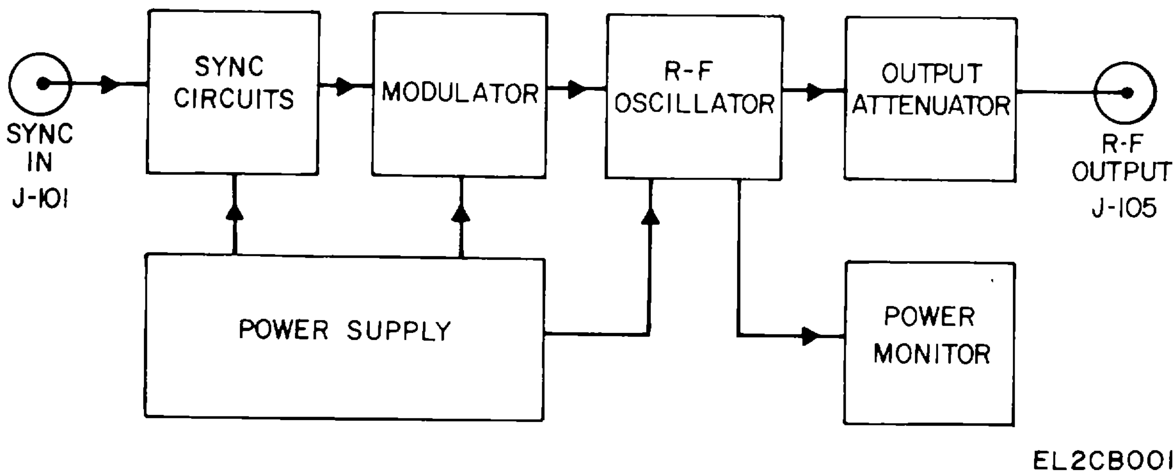


Figure 2-1. Block diagram, Signal Generator AN/URM-52(*).

c. As shown by figure 2-1, the AN/URM-52(*) consists of six basic circuits: the synchronizing circuits, modulator circuits, rf oscillator, output attenuator, power monitor, and power supply circuit.

(1) The synchronizing circuits establish the repetition rate of the modulation pulse applied to the rf oscillator.

(2) The modulator circuits develop a positive pulse, operating bias or cutoff bias, to be applied to the rf oscillator klystron.

(3) The rf oscillator circuit consists of a reflex klystron tube operating at super-high frequencies shf) to produce the rf output signal.

(4) The output attenuator assembly couples he rf energy to the output at the desired level.

(5) The power level existing in the rf oscillator is monitored by the power monitoring system. The system also provides a reference level from which to calibrate the output power level.

(6) The power supply circuit furnishes the operating voltages employed by the electronic circuit elements of the generator.

2-2. Electronic Function, Rf Oscillator

a. Rf Oscillator System.

(1) Klystron construction and operation. The rf oscillator develops the rf output voltage that is applied to the load. The oscillator employs a type 6236 reflex klystron and a tunable parallel plane line section as a resonant tank circuit. The conventional equivalent electrical circuit is shown in figure 2-2. The resonant line circuit is connected between the two resonator grids of the klystron tube. The grid located between the resonator grids and the cathode is the modulator grid. It controls

the flow of electrons from the cathode when a positive modulation pulse is present. The resonator and modulator grids are of open construction so as to present little physical opposition to the passage of electrons through them when electrical conditions are favorable. The electrode at the end of the tube is the repeller, and a voltage is placed upon it that is negative with respect to the resonator grids to repel the electrons back towards the resonator grids.

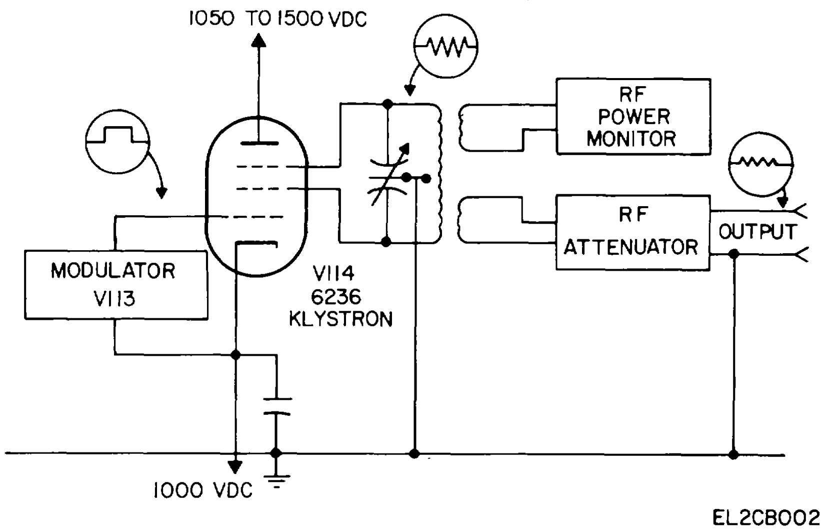


Figure 2-2. Equivalent circuit of rf oscillator.

(2) Oscillation. When the circuit is in oscillation, the potentials at the two resonator grids are continuously changing at a rate equivalent to the frequency of oscillation, which causes some electrons to be accelerated, while others are decelerated during their passage through the grids. The result is that the electron stream is broken up (the electrons bunched) into sections of heavy and light density in the area between the grids and the repeller. The distance that the bunched electron stream will travel beyond the resonator grids and their rate of travel after they have been repelled by the negative repeller electrode is determined by their initial speed and by the value of negative voltage on the repeller. Oscillation is sustained when these factors are adjusted so that the bunches of electrons arrive back at the resonator grids when the oscillating voltage at these grids is such that it opposes the passage of electrons. The electrons supply rf energy to the cavity because they are slowed down by this alternating field between the resonator grids. When the electrons are collected by the resonator grids they become anode current.

(3) Power monitor and attenuator. Two pickup loops are located in the tank circuit to collect rf power. The first is the output attenuator loop which couples the power to be supplied by the generator to the load through an output connector on the panel. The position of this loop is additions are favorable. The electrode at the end of the tube is the repeller, and a voltage is placed upon it that is negative with respect to the resonator grids to repel the electrons back towards the resonator grids. adjustable so that the output power level may be varied as desired. The second is the power monitoring loop that monitors the power level in the oscillating circuit and establishes a reference point to calibrate the output power.

(4) Parallel plane resonator.

(a) Description. The tank circuit employed in the signal generator is known as a parallel plane resonant line. In its physical shape it resembles a rectangular box type cavity with a circular center element and a rectangular plunger to vary the cavity depth. Actually the line is a direct development from a circular coaxial line. The oscillating frequency of such a line with one end shorted is determined by its electrical length in a direction parallel with the center conductor.

(b) Basic operation of resonator. The parallel plane line depends, for its resonant frequency, upon its electrical length and consequently may be tuned by simple mechanical means and can be directly calibrated. This type of cavity provides a resonator in which simple and straightforward methods can be employed to provide broad band suppression of the various parasitic resonance's which occur when other physical dimensions approach the frequency-determining electrical dimensions. Figure 2-3 shows a cutaway view of the resonant line and the other components of the parallel plane oscillator as employed in the signal generator. The type 6236 reflex klystron is mounted so that one of the resonator grids is coupled to the two semilines while the other is coupled to the circular center conductor. The repeller voltage is applied through an insulated filter in the center conductor while the other potentials required to operate the tube are applied through the tube base pins.

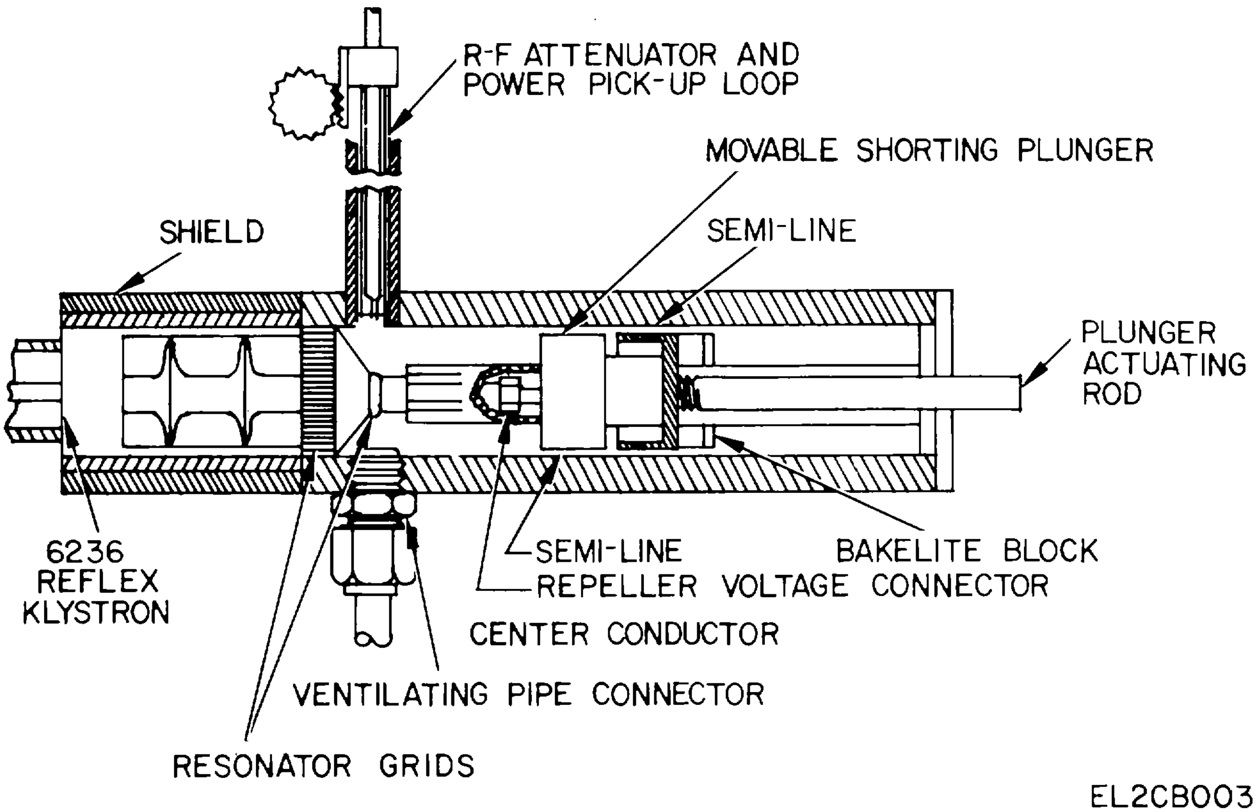


Figure 2-3. Cutaway view of rf oscillator.

(5) Repeller voltage control. The operating characteristics of a reflex klystron are such that an optimum value of repeller voltage exists for each operating frequency. This voltage is the value which will cause the bunched electrons to return to the resonator grids at the proper time. Figure 2-4 shows the repeller voltage characteristics for the type 6236 klystron over the range employed in the signal generator.

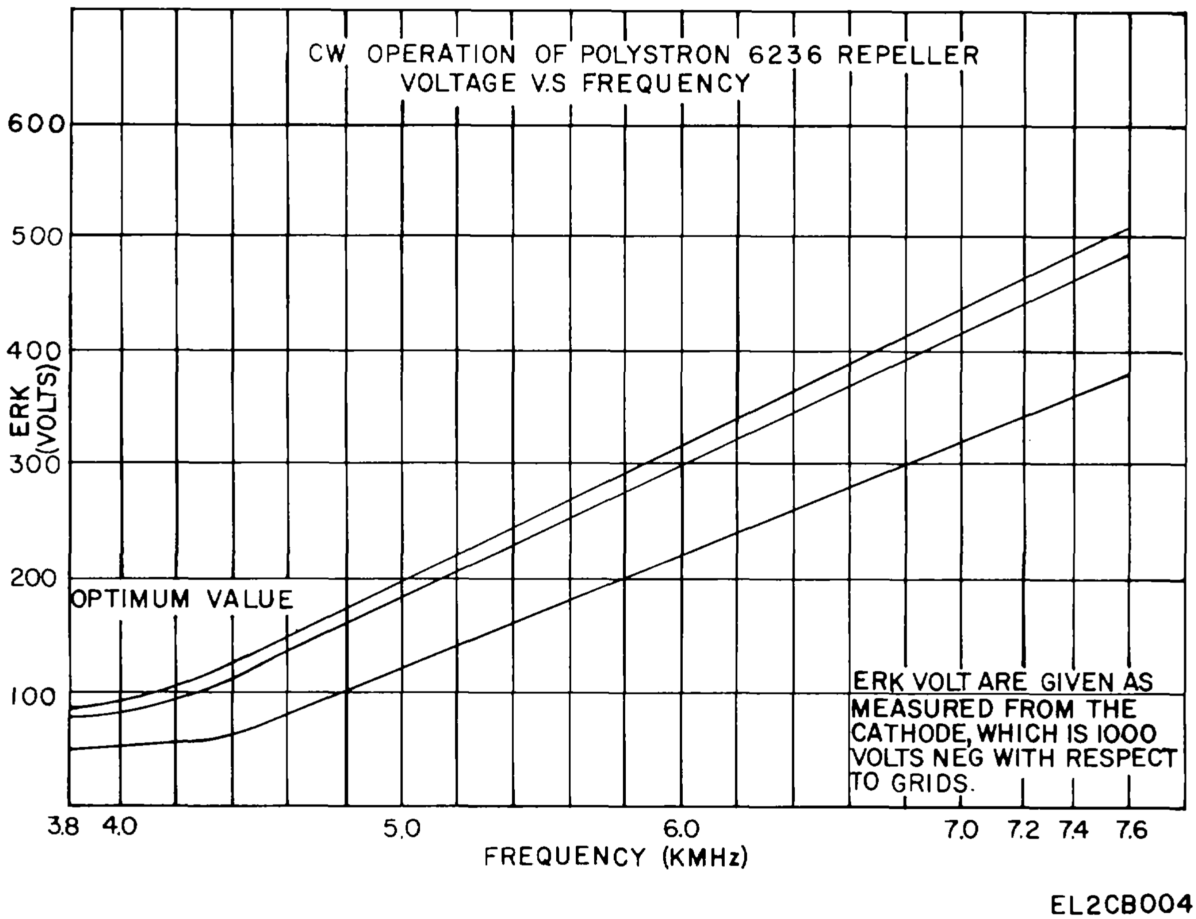


Figure 2-4. Plot of repeller voltage versus frequency.

(a) Repeller voltage characteristics. The repeller voltage characteristics shown in figure 2-4 provide for operation in the 2-3/4 repeller mode. The voltage required for optimum operation varies linearly with frequency for the frequency range above 4400 megahertz. In the frequency range from 3800 to 4400 megahertz the required voltage is not a linear function of frequency but is slightly curved as shown.

(b) Repeller voltage circuit. Figure 2-5 shows the circuit that provides negative voltage to the repeller. Resistor R174 is a 100,00 ohm wirewound potentiometer that is mechanically ganged with the mechanism that tunes the resonant line, providing the proper voltage to the repeller electrode as the frequency is changed. The value of resistors R170, R175, R173, and R178 is adjusted to establish the voltage applied across repeller tracking potentiometer R174.

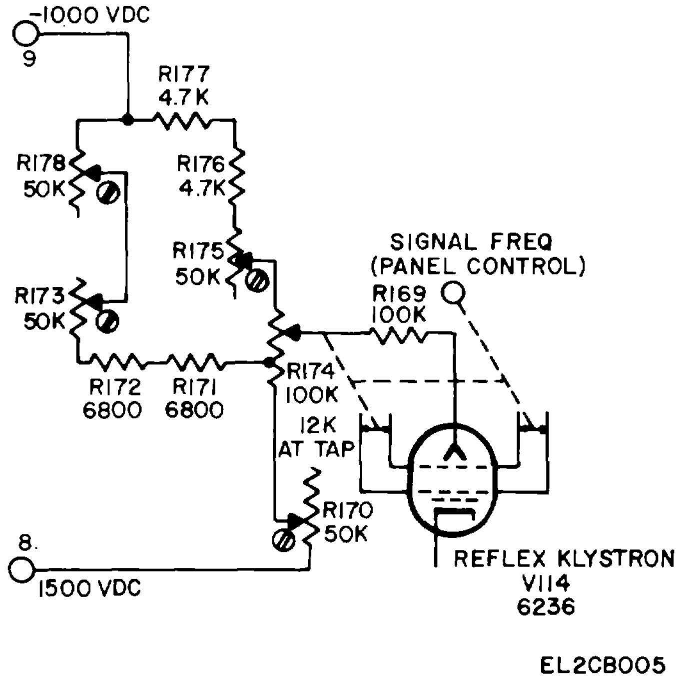


Figure 2-5. Simplified schematic diagram of klystron repeller voltage tracking circuit.

b. Coupling Methods. Power is coupled to the load from the oscillator by a coupling loop located at a high impedance point in the resonant line. This loop slides in a circular waveguide section (fig. 2-3). The cross section of the waveguide is very small in relation to the frequencies of operation, and normal propagation down the waveguide will not take place. However, some limited propagation does take place, and the power level decreases exponentially as the distance from the resonant line increases. Thus, it is possible, by moving a pickup loop linearly in the waveguide to secure an output that varies in decibels in proportion to the linear travel. This type of attenuator is known as an attenuator of the cutoff type and its characteristics are employed so that the pickup probe and indicating dial can be moved by a simple gear train and the dial may be calibrated linearly in decibels.

2-3. Electronic Function, Output Attenuator Assembly and Power Monitoring System

a. Attenuator Assembly. A cross section of the attenuator and rf pickup loop is shown in figure 2-6. The pickup loop couples rf energy from the waveguide section. The assembly consists of an external metal conductor covering a section of RG-55/U cable, replacing the outer shield. A 3-inch section of the center conductor has been removed and is replaced by resistor R203. This resistor is made by plating platinum on a 1/32 inch diameter glass rod, and its value is such that it introduces a 10-db loss in the line. Its dc resistance is approximately 100 ohms and its purpose is to stabilize the source impedance of the signal generator at 52 ohms. The polyiron section on the outside of the probe is designed to absorb power that may leak past the probe in the space between the outer conductor and the waveguide walls.

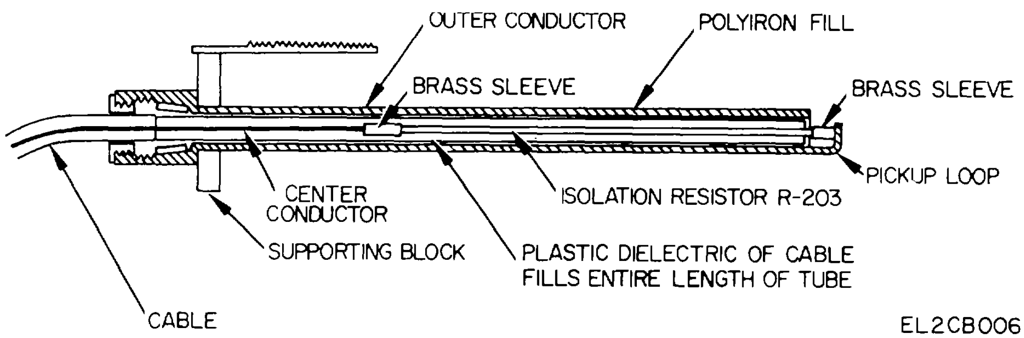


Figure 2-6. Cutaway view of attenuator probe.

b. Power Monitor System The power generated by the oscillator varies with frequency, primarily because of the characteristics of klystrons; therefore, a power monitor circuit is included to indicate the level of the field at the attenuator input.

(1) Power monitoring probe. The power monitor rf probe (fig. 2-7) is constructed similarly to the attenuator probe, except that a bead thermistor R202 is located at the end of the probe, and no resistor is placed in the line. This bead thermistor acts as a power metering bolometer when employed in the bridge circuit. The power monitor probe is moved within its waveguide similar to the power attenuator pickup probe. Its position is controlled by the POWER SET control on the front panel and is indicated by the position of the transparent index scale over the calibrated OUTPUT ATTEN. (attenuator) dial.

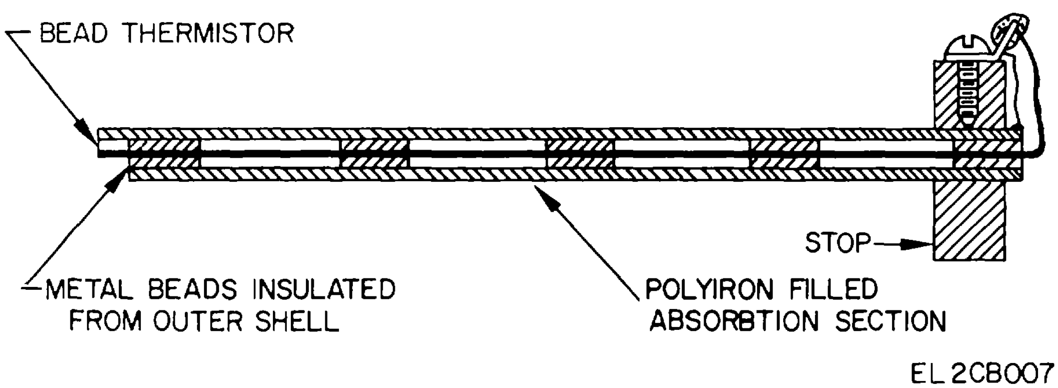


Figure 2-7. Cutaway view of power monitor probe.

(2) Power monitor circuit. The power in the resonator is monitored by the thermistor bridge circuit shown in figure 2-8. Bead type thermistor R202, which is one arm of the bridge, is located at the tip of the piston type probe shown in figure 28. This thermistor absorbs a small amount of power from the resonator. The resistance of the bead is in turn changed by the heat developed within the bead itself. This change unbalances the bridge causing the meter to give an upscale reading. The monitoring circuit also employs two disk type thermistor for temperature and sensitivity compensation.

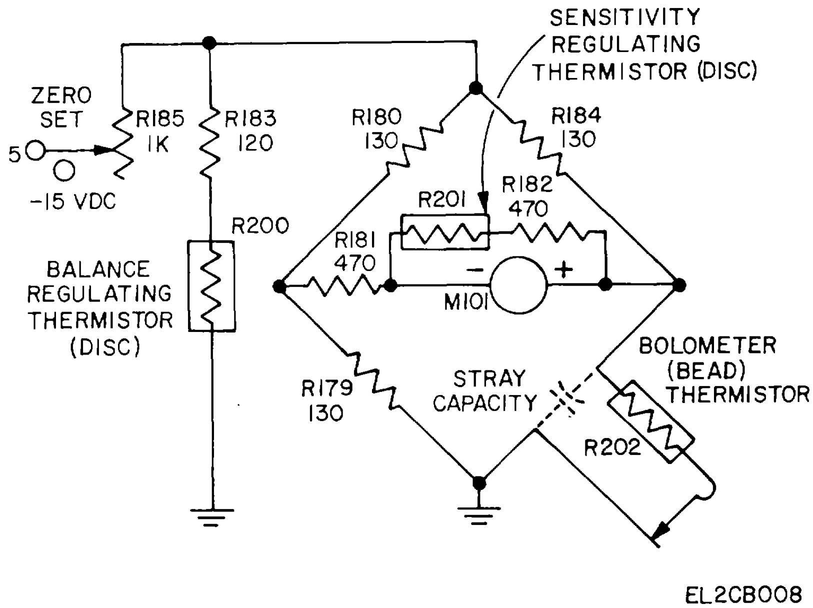


Figure 2-8. Simplified schematic diagram of power monitor circuit.

(3) Circuit operation. The bridge is balanced for dc conditions. When rf power from the resonator is applied to the thermistor, the bridge becomes unbalanced. The balance indicating device is M101, a 200 microampere meter, connected across the bridge to indicate circuit balance. Resistor R201 is a disk-type thermistor connected in parallel with the meter and it acts as a sensitivity regulator to counteract the tendency of the bridge to decrease in sensitivity as the temperature of the bridge increases. A second disk thermistor, R200, is shunted across the bridge in series with limiting resistor R183. This acts as a balance regulating device to compensate for unbalance due to resistance changes in R202 caused by variations in ambient temperature. An ambient temperature increase will cause the resistance of R202 to decrease, causing more current to flow through its leg of the bridge, increasing the meter reading by unbalancing the bridge. Resistor R200 will also decrease in resistance, causing a drop in the total voltage across the bridge and a decrease in current flow through its various legs, thereby decreasing the meter reading. Since the static resistance of R202 is determined by both the ambient tempeture and the static bridge current flowing through it, the decrease in bridge current caused by the actions of R200 will act to decrease the temperature of R200 and tend to restore the static balance of the bridge. This thermistor is mounted in a recess in the top of the resonator so that it is immediately sensitive to temperature changes. Rf power at the bead thermistor is isolated from the bridge by means of a low pass filter consisting of metal beads spaced along the center conductor within the power monitoring probe. Polyiron fill, embedded in the outer surface of the probe, absorbs any rf energy existing between the probe and its waveguide housing.

c. Operation of Power Monitor and Attenuator Systems. The power level existing at the location of the probes in the resonator varies as the signal generator is tuned over its frequency range. To compensate for this, the penetration of the power monitor probe should be changed by operation of the POWER SET control so that it picks up the amount of power necessary to hold the POWER LEVEL meter at 0 dbm. This establishes the basic reference level for 1 milliwatt and positions the transparent index scale over the attenuator dial.

The OUTPUT ATTEN. control is then adjusted with reference to this index scale to provide the desired attenuation below 1 milliwatt as read on the calibrated dial. The OUTPUT ATTEN. control moves the output attenuator probe mechanically And also moves the calibrated dial. Thus when any calibrated point on the dial is under the index line, the position of the output probe in its waveguide is proportional to that of the power indicating probe (which has been set to the proper reference level) and the power output may be read directly on the dial. Movement of the output probe in its waveguide will cause attenuation. The power indicating dial is calibrated in decibels below 1 milliwatt when coupled to a 52-ohm load.

2-4. Electronic Function, Synchronizing and Modulator Circuits

a. General. The AN/URM-52(*) provides the following types of shf outputs: continuous-wave (cw) unmodulated, internally modulated, and externally modulated rf signals.

(1) Continuous-wave operation. Cw operation is obtained by placing a fixed positive voltage on the klystron rf oscillator accelerator grid.

(2) Internal modulation. Positive pulse, or sawtooth modulating voltages are developed within the modulator circuits for application to the rf oscillator. The internal sawtooth voltage is coupled to the repeller plate of the klystron rf oscillator.

(3) External modulation. Externally applied positive or negative pulses, sine wave, or sawtooth voltages can be used to modulate the rf oscillator. These modulating signals are coupled to the klystron directly or through the synchronizing circuits and modulating circuits to the klystron.

b. Block Diagram Analysis. The synchronizing circuits and modulator circuits are shown in block diagram form in figure 2-9. The synchronizing circuits are utilized when external pulses or sine wave voltages are used for modulation. The modulator circuits establish a modulating pulse (for pulse operation) or a sawtooth voltage (for frequency modulation) and apply it to the rf oscillator to secure the desired type of rf output. Various portions of these circuits are not employed in certain modes of operation such as when external pulse of fm modulation voltages are provided. However, the block diagram shows the condition where all the circuits except the pulse rate multivibrator are employed (delayed pulse output with external synchronization) and the description will cover this mode of operation.

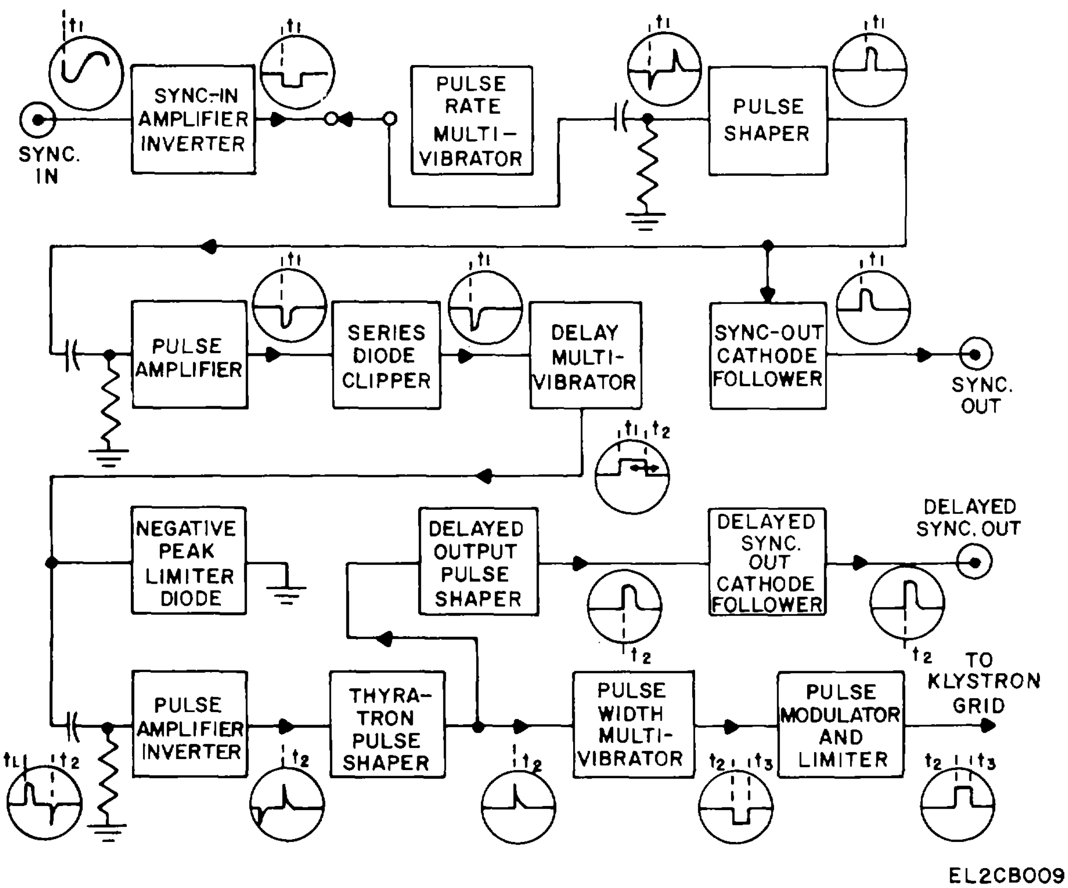


Figure 2-9. Block diagram of modulator circuits.

(1) Sync-in amplifier inverter. The sync-in amplifier will accept either sine waves or positive or negative synchronizing pulses. A sine wave input is converted into a negative waveform with a steep leading edge necessary to trigger the pulse shaper multivibrator. A positive or a negative pulse input will produce a negative square wave output.

(2) Pulse rate multivibrator. The pulse rate multivibrator is not used when external synchronization is employed. When internal timing is desired, the pulse rate multivibrator is free-running with a repetition rate adjustable from 40 to 4,000 Hz per second. Its output is a negative square wave with a very steep leading edge.

(3) Pulse shaper. When external sync signals are employed, the negative signals from the sync-in amplifier and inverter are switched around the pulse rate multivibrator directly to a differentiating network at the input of the pulse shaper. This circuit is a one-shot multivibrator that operates on the differentiated negative voltage pulse and produces a positive pulse of 2 microseconds duration. This pulse is applied to the pulse amplifier and the sync-out cathode follower.

(4) Sync-out cathode follower. The sync-out cathode follower provides the undelayed voltage pulse available at SYNC OUT connector for synchronizing external equipment.

(5) Pulse amplifier. The pulse amplifier produces a negative output pulse of 2 microseconds duration. This pulse is coupled through a series diode clipper to be applied to the delay multivibrator.

(6) Series diode clipper. The series diode clipper removes any positive voltage transients and permits only the negative pulses of sufficient amplitude to be applied to the delay multivibrator.

(7) Delay multivibrator. The delay multivibrator produces a positive rectangular pulse output with the leading edge essentially coincident in time with the synchronizing voltage. The trailing edge appears at a later time (t_2) that is determined' by the adjustment of the PULSE DELAY control on the front panel. From 3 to 300 microseconds delay may be provided between t_1 and t_2

(8) Negative peak limiter diode. The negative peak limiter acts to eliminate negative transients following the trailing edge of the output of the delay multivibrator. This waveform is differentiated into a positive voltage spike at t_1, and a negative spike at t_2

(9) Pulse amplifier-inverter. The differentiated output of the delay multivibrator is applied to the pulse amplifier-inverter which inverts it so that the negative spike appears at t_1 and the positive spike at t_2

(10) Thyratron pulse shaper. The positive spike at $_{t2,}$ will cause the thyratron pulse shaper to ionize and conduct. Its output is used for the delayed sync out pulse and to modulate the klystron rf oscillator.

(11) Delayed output pulse shaper. A positive voltage spike is taken from the thyratron pulse shaper and applied to the delayed output pulse shaper which develops a positive pulse, 2 microseconds in duration.

(12) Delayed sync-out cathode follower. This stage acts as an impedance matching device and its output is a positive 2-microsecond pulse at $_{t2}$ that is available at the delayed sync out connector for synchronizing external equipment.

(13) Pulse width multivibrator. The output of the thyratron pulse shaper, when applied to the pulse width multivibrator, causes this circuit to develop a negative pulse with the leading edge appearing at $_{t2}$ and the trailing edge at $_{t3.}$ The duration of the pulse is adjustable from 0.5 to 10 microseconds by the calibrated PULSE WIDTH control on the front panel.

(14) Pulse modulator and limiter. The negative pulse input is amplified, inverted and a positive pulse is applied to the klystron modulator grid, activating the tube during the period the pulse is present. The positive peaks of pulse are clipped to protect the klystron tube by preventing any voltages more positive than a predetermined value from reaching its grid. Bias voltage on the klystron modulator grid is clamped to a value that establishes proper beam current for the klystron under any condition of modulation.

c. Circuit Description. Refer to figure 2-10 which illustrates the basic sync-input circuit elements of the signal generator.

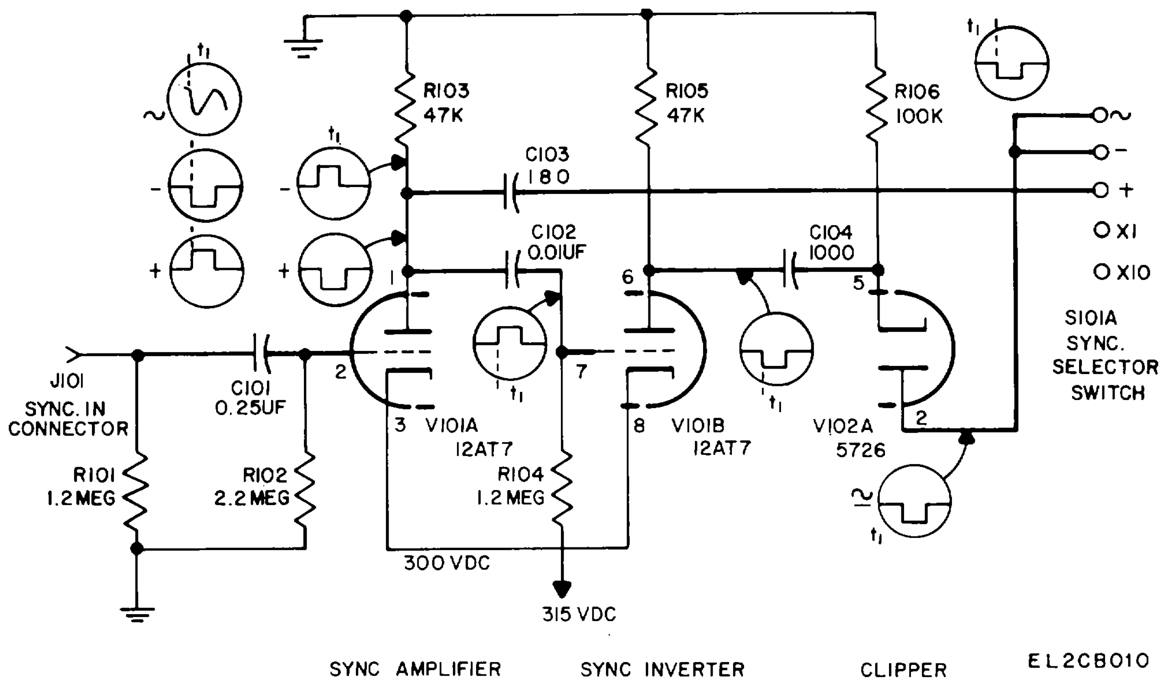


Figure 2-10. Simplified schematic diagram of basic sync-input circuits.

(1) Sync input circuits. These circuits accept the external synchronizing voltage applied at J101, the SYNC. IN connector, and transform it into a negative pulse employed to trigger pulse shaping multivibrator V104. The circuit elements are shown in figure 2-11. Tube V1Ol1A is one-half of a type 12AT7 dual triode. The grid is returned to ground, the cathode to the --300 vdc line. This places the grid at zero bias and the tube is drawing current through plate load resistor R103. The tube responds to both positive and negative signals.

(2) Operation with negative sync-in voltage. The negative-going portion of a sine wave synchronizing voltage, or a negative sync pulse, causes the tube to cut off, developing a positive pulse in its plate circuit. This is applied to the grid of V110B. Tube V101B is normally cutoff with a bias of -15 volts, and the applied positive voltage causes it to draw current through load resistor R105, developing a negative square wave with a steep leading edge. This negative pulse is applied to the and EXT contacts of the SYNC. SELECTOR switch S101A through series diode clipper V102A. Clipper V102A acts to apply only negative voltages to the following circuits.

(3*)* Operation with positive sync-in voltage*.* When a positive external sync voltage is applied to the grid of V1O1A, a negative voltage is developed in its plate circuit and applied to the EXT + contact of S101A by capacitor C103.

(4) Pulse rate multivibrator*, external sync condition.* When external sync signals are employed, the pulse rate multivibrator is switched out of operation as shown in figure 2-11. The negative pulse from diode V102A is switched around the rate multivibrator to differentiating capacitor C112 and shaping multivibrator V104.

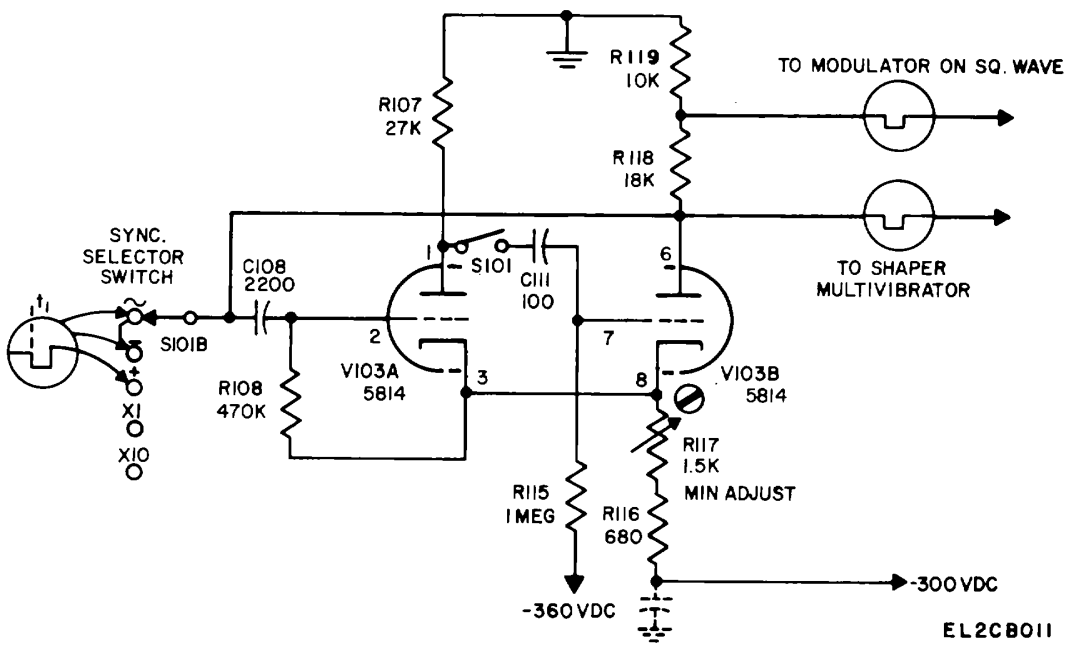


Figure 2-11. Simplified schematic diagram of basic pulse rate multivibrator, external sync-condition.

(5) Pulse rate multivibrator, free-running condition. When SYNC SELECTOR switch S101 is in the X1 or X10, or SQ. WAVE positions, the pulse rate multivibrator is converted to a free running condition (fig. 2-12). Under this condition the sync input circuits are disconnected from the pulse rate multivibrator. The time constants of the multivibrator are balanced so that the circuit generates a voltage wave that is essentially square (50 percent duty cycle at 1,000 pps). This arrangement is used so that internal square wave as well as internal pulse modulation of the rf oscillator can be obtained. The arrangement also provides equally spaced pulses to trigger the sawtooth generator when internal sawtooth frequency modulation is desired. A square wave of full amplitude is taken from the plate of V103B across both R118 and R119 and applied to the sync. out pulse shaping multivibrator. The voltage developed across R119, approximately one-third the full amplitude, is fed to the modulator when the MOD. SELECTOR switch is in the SQ. WAVE position. This output to the modulator is employed only when square wave modulation **is** desired.

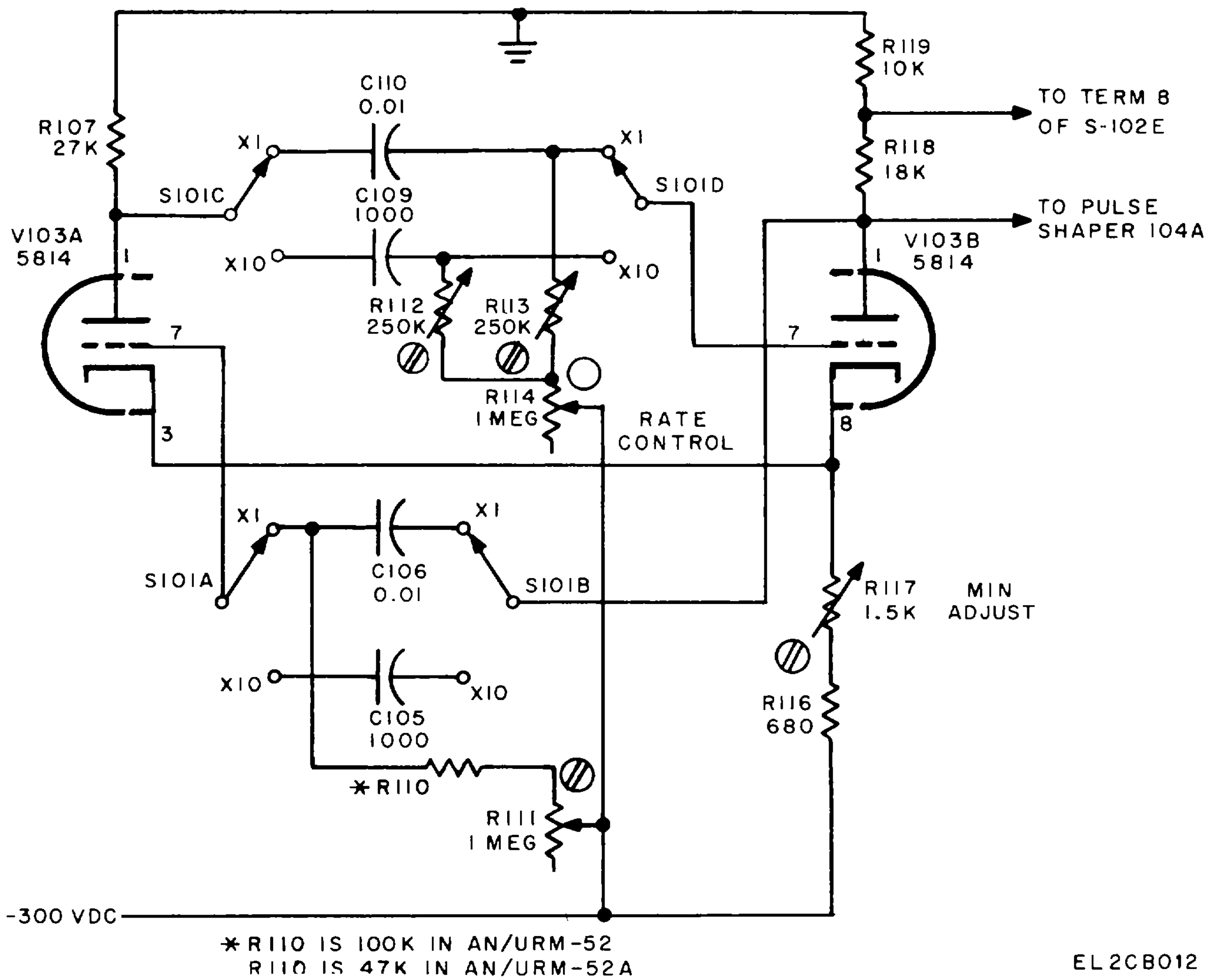
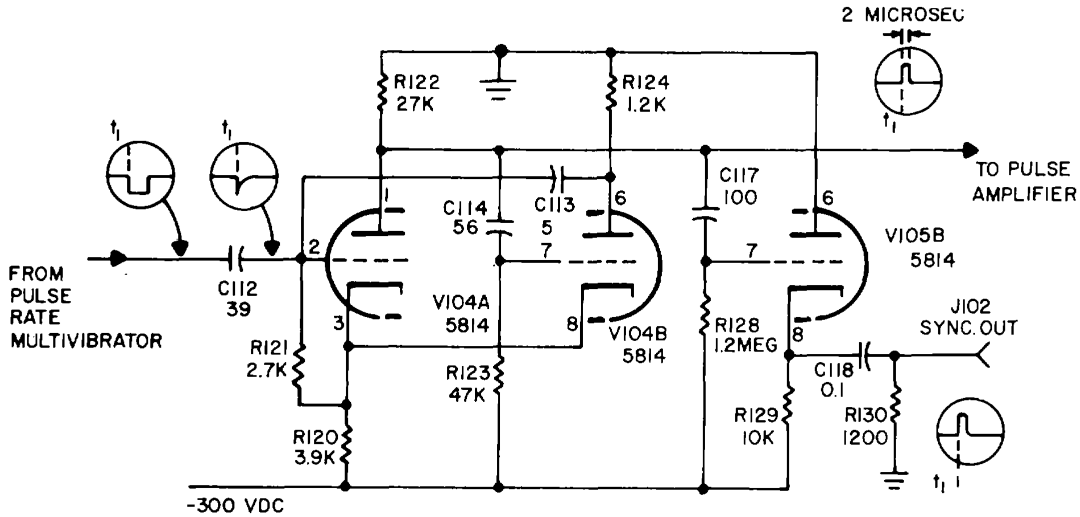


Figure 2-12. Simplified schematic diagram of basic pulse rate multivibrator, free-running condition.

(6) Sync-our pulse shaping multivibrator. The sync-out pulse shaping multivibrator (fig. 2-13) is a one-cycle multivibrator with a 2-microsecond time constant. It consists of V104A and V104B, two halves of a type 5814 dual triode. In the steady state condition V105A is drawing current as its grid is returned to the cathode by resistor R121. Tube V104B is cut off as its grid is returned to -300 vdc, thus placing a bias on the grid developed by the flow of current through V104A and cathode resistor R120. When this multivibrator is triggered by the negative-going leading edge of the voltage generated by the pulse rate multivibrator, a positive voltage pulse appears at the plate, since current flow through R122 stops as the tube cuts off. The width of this positive pulse is determined by the time necessary to discharge C114 through R123. At this point the circuit returns to its resting condition, terminating the pulse. The pulse width is narrow, essentially 2 microseconds.



PULSE SHAPING MULTIVIBRATOR **SYNC.OUT CATHODE FOLLOWER EL2CB013**

Figure 2-13. Simplified schematic diagram of pulse shaping multivibrator and sync-out cathode follower

(7) Sync-out cathode follower. The positive output pulse developed by V104 is applied to pulse amplifier tube V105A, shown in figure 2-14, and to sync-out cathode follower V105B (fig. 2-13). Tube V105B provides the undelayed sync output signal for synchronizing external equipment. It is a standard cathode follower comprised of V105B, one-half of a type 5814 dual triode tube. The output is taken across R129, the cathode resistor, and is capacitively coupled to SYNC OUT connector J102 by C118. Resistor R130 is returned from the center conductor of the connector to ground so that the line is terminated with reference to ground instead of the -300 vdc potential existing at the base of the cathode resistor. The output of the cathode follower is a positive pulse greater than 25 volts when applied to a load having a resistance from 1000 to 100,000 ohms and a shunt capacitance not greater than 500 Picofarad. At no load, the pulse will have an amplitude up to 55 volts.

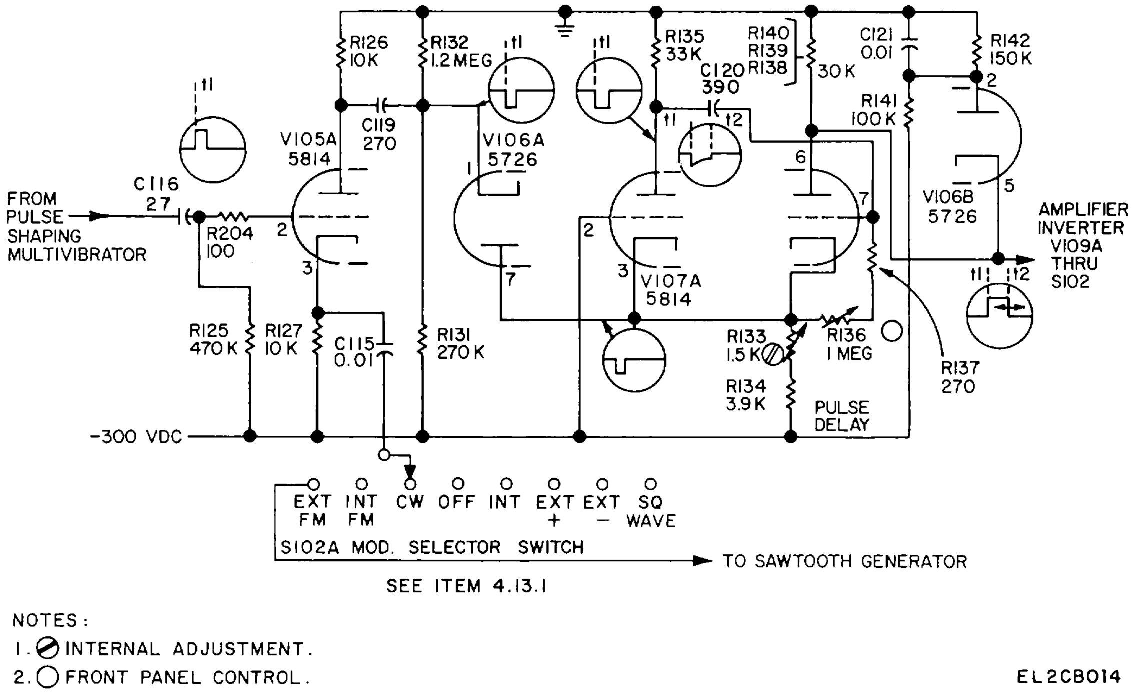


Figure 2-14. Simplified schematic diagram of pulse amplifier and pulse delay multivibrator.

(8) Pulse amplifier. The pulse amplifier is comprised of V105A, one half of a type 5814 tube, as shown in figure 2-14, and its associated circuit elements. It amplifies and inverts the 2microsecond pulse provided by the pulse shaping multivibrator and provides a negative pulse at t1in its plate circuit. It also provides a positive going pulse in its cathode circuit from C115 that is employed to trigger the sawtooth generator when internal frequency modulation is employed. Capacitor 115 is connected as a cathode bypass capacitor when internal pulse modulation is employed.

(9) Pulse delay multivibrator clamp. The negative pulse from the plate of the pulse amplifier is applied to the cathode of the diode limiter V106A shown in figure 2-14. This limiter is connected so that only the negative pulse components with an amplitude greater than the bias on the diode will pass on to the cathode of the pulse delay multivibrator by any positive or low amplitude negative transients that may appear on the output of V105A in addition to the desired trigger pulse.

(10) Pulse delay multivibrator. This circuit (fig. 2-14) provides an adjustable time delay in applying the modulation to the rf oscillator. It consists of the two sections of V107, a type 5814 dual trode connected as a one-cycle multivibrator with a time constant adjustable from 3 to 300 microseconds. In the steady state condition, V107A is cut off while V107B is drawing current through its plate load resistors R138, R139, and R140 in parallel with R142 and diode V106B. The multivibrator starts its cycle when a negative pulse drives the cathode of V107A in a negative direction. This is equivalent to placing a positive signal on the grid, and the tube draws current. A negative waveform of voltage appears at the plate of V107A and through capacitor C120 drives the grid of V107B in a negative direction, cutting off this half of the stage. The length of time the circuit will require before returning to its resting condition will be determined by the time constant of C120, R133, R134, R136, and R137. Resistor R136 is the calibrated PULSE DELAY control that adjusts the delay from 3 to 300 microseconds, while R133 is an internal adjustment used to set the maximum delay to 300 microseconds.

(11) Pulse delay multivibrator negative base limiter. Tube V106B serves an additional function during the resting condition by acting as a negative base limiter. It does this by preventing low amplitude negative pulses that may otherwise follow the trailing edge of the main pulse from V107B.

(12) Pulse amplifier-inverter. This stage (fig. 2-15) is comprised of V109A, one half of a type 5814 dual triode. The positive square wave voltage from the pulse delay multivibrator is differentiated by capacitor C122 and resistor R187 to form a sharp position voltage spike at t_1. These are amplified, and arrive inverted in the plate circuit of V109A..

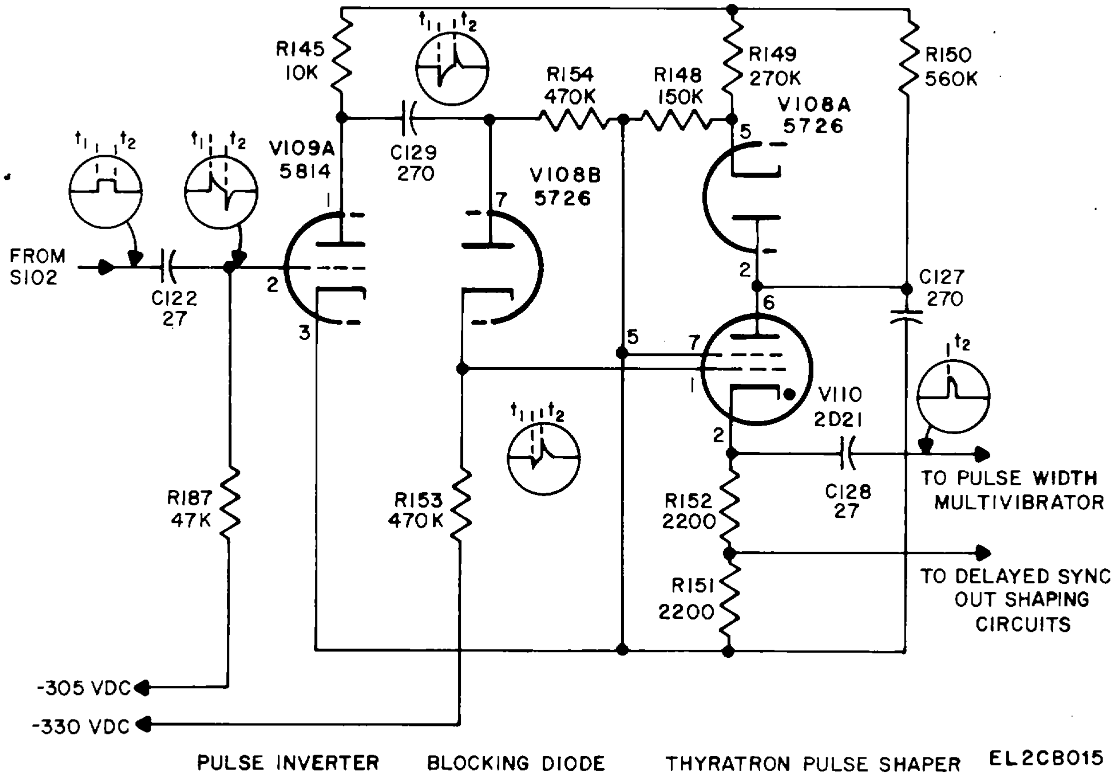


Figure 2-15. Simplified schematic diagram of thyratron pulse shaper circuit

(13) Blocking diode. The output of V109A is applied to the grid of thyratron pulse shaper V110 through blocking diode V108B. The purpose of V108B is to pass the positive output voltage spike at $_{t2}$ from V109A and to block the negative spike at t,. At short delays this insures positive triggering action of thyratron V110.

(14) Thyratron pulse shaper. This stage consists of type 2D21 thyratron tube V110, shown in figure 2-15. Its grid is returned to approximately --330 volts while the cathode is returned to -300 volts, cutting off the tube. Capacitor C127 is charged to approximately 110 volts positive to the cathode, a voltage established by the values of R148 and R149 and V108A. This device for limiting the voltage on C127 is necessary due to wide variation in the pulse repetition frequency of the unit and the fact that the capacitor will charge exponentially with time. This would result in the capacitor charging to a higher potential at the low repetition frequencies than at the higher frequencies. The diode circuit limits the charge to a value that can be reached at the highest repetition frequencies, and prevents it from becoming higher regardless of the charging time available.

(15) Trigger action of thyratron pulse shaper. When the positive pulse from V109A reaches the grid, the gas in the tube ionizes and C127 discharges through the tube, and cathode resistors R151 and R152 in series. This causes a positive pulse to appear across the cathode resistors. When C127 is nearly discharged and the plate voltage is at a very low value the gas in the tube deionizes the tube returns to the resting condition. By this time the pulse on the grid has decayed and the grid bias is again -330 volts. Capacitor C127 is rapidly recharged to its resting voltage of approximately 110 volts and is maintained at this value through the action of the diode circuit explained above. Two positive voltage spikes occurring at $_{t2}$ are taken from the cathode circuit.

One of these is supplied to the pulse width multivibrator, while the other is supplied to the delayed sync pulse output circuits.

(16) Pulse width multivibrator. The pulse width multivibrator shown in figure 2-16 is a onecycle multivibrator employing type 5814 tube Vl11. The circuit employs capacitive cathode to cathode coupling to secure the necessary interstage action. This avoids any feedback connection to the plate of V111A, reducing stray capacitance that would tend to slow down the voltage rise and fall.

Peaking inductance L101 is also employed in the plate circuit from which the output is taken to further steepen the wave front. The section comprised of V111A is cut off since a negative bias of 30 volts is placed on its grid. This places the V111A side of C130 at a potential of -300 volts. The second section is drawing saturation current since its grid is maintained at essentially the cathode voltage by R162. As a result, the other side of C130 is at a relatively higher potential due to the drop across R159 and R158.

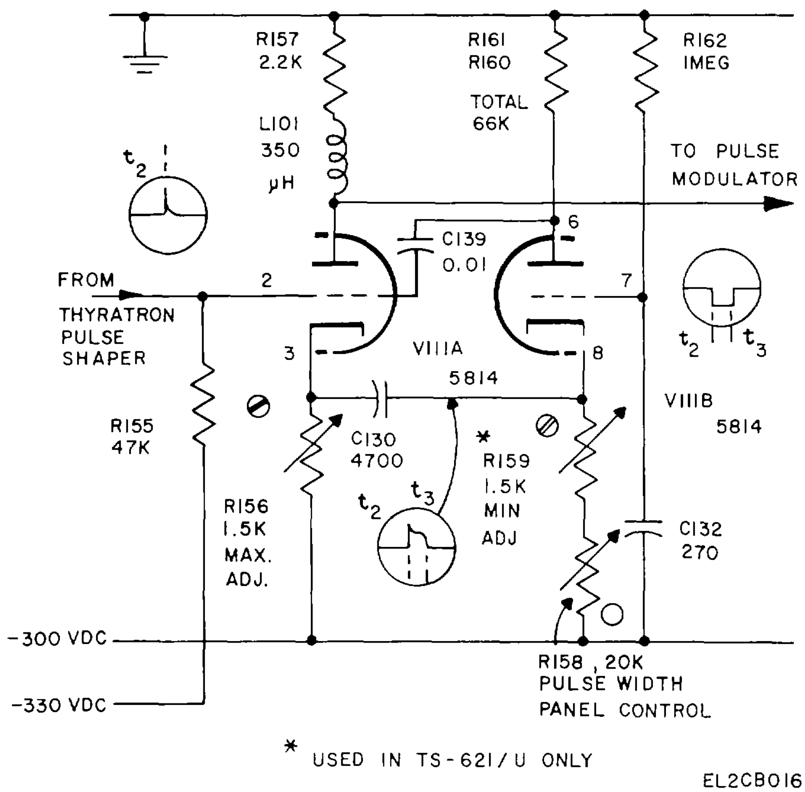


Figure 2-16. Simplified schematic diagram of pulse width multivibrator.

(17) Trigger action of pulse width multivibrator. When the positive pulse at t_2 is applied to the grid of V111A, it immediately draws current, causing the V111A side of C130 to rise instantly an amount equivalent to the potential set up by the current flowing through R156. Resistor R156 is adjustable, and the amount of this rise is determined by the resistance in circuit. Resistor R156 acts as a maximum pulse width adjustment for the circuit. The voltage rise across R156 is applied to the cathode of V111B causing it to become more positive with respect to grid pin 7 This cuts off the tube rapidly since the grid is maintained at essentially the cathode potential due to the time constant of R162 and C132. Capacitor C130 is now charged in a positive direction and commences to discharge through R159 and R158. The time constant of this discharge to the point where V111B will again draw current determines the duration of the negative output pulse taken from the stage. In the AN/URM-52, the minimum width controlled is adjusted by R159, a screwdriver adjustment on the chassis, while the actual pulse width is adjusted by R158, the

calibrated PULSE WIDTH control on the panel. In the AN/URM-52A, pulse width is adjusted only by PULSE WIDTH control R158. This control can be adjusted to provide pulses from 0.5 to 10 microseconds duration. The output of the pulse width multivibrator is a negative pulse starting at t_2 and ending at t_3. This negative pulse is applied to pulse modulator tube V113.

(18) Pulse modulator. The pulse modulator circuits shown in figures 2-17 and 2-18 are comprised of V113, a type 5763 pentode amplifier, and V112A, one half of a type 12AT7 dual triode connected as a diode positive peak clipper on its input grid. Tube V112B, the other half of the type 12AT7 dual triode, diode-connected, provides a fixed operating bias for the modulator grid of klystron rf oscillator tube V114. The negative pulse from the pulse width multivibrator is coupled to the control grid of V113 by C133 and C134 in parallel. Bias for the grid is adjusted by potentiometer R338 in the power supply so that the flow of current in the modulator is sufficient to cut off the klystron. In the AN/URM-52, R341 (fig. 2-17) provides adjustment of the cathode-plate potential applied to diode-connected tube V112B. In the AN/URM-52A, this adjustment is provided by the combination of R341 and R352 (fig. 2-18). Tube V112B functions as a positive clamp in the output circuit of pulse modulator tube V113 which is also the control grid circuit of klystron oscillator V114. The positive excursion of the modulating pulse is clamped at a value determined by the cathodeplate potential applied to tube V112B. In this way, the klystron beam current is maintained at an average value suitable for the modulation duty cycle. The modulation duty cycle during fm, or during continuous output is greater than that for pulse or square wave modulation. The operating characteristics of the klystron, when pulse modulated, improve with increased beam current. In the AN/URM-52A, R352 is provided for adjusting the beam current. Resistor R352 is connected only when MOD SELECTOR switch S102J is positioned at INT, EXT+, EXT-, or SQ WAVE. Under these modulation conditions, R352 enables adjustment of klystron beam current independently from that resulting from adjusting R341 for MOD SELECTOR switch positions CW, INT FM or EXT FM.

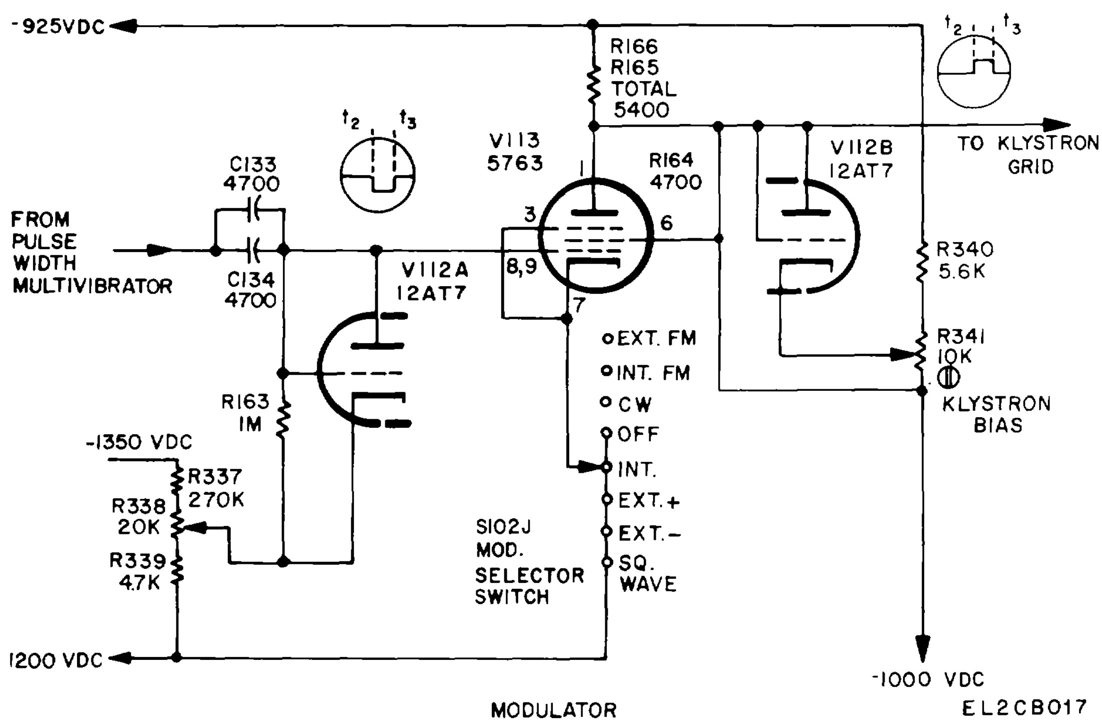


Figure 2-17. Simplified schematic diagram of klystron modulator circuit, AN/URM-52.

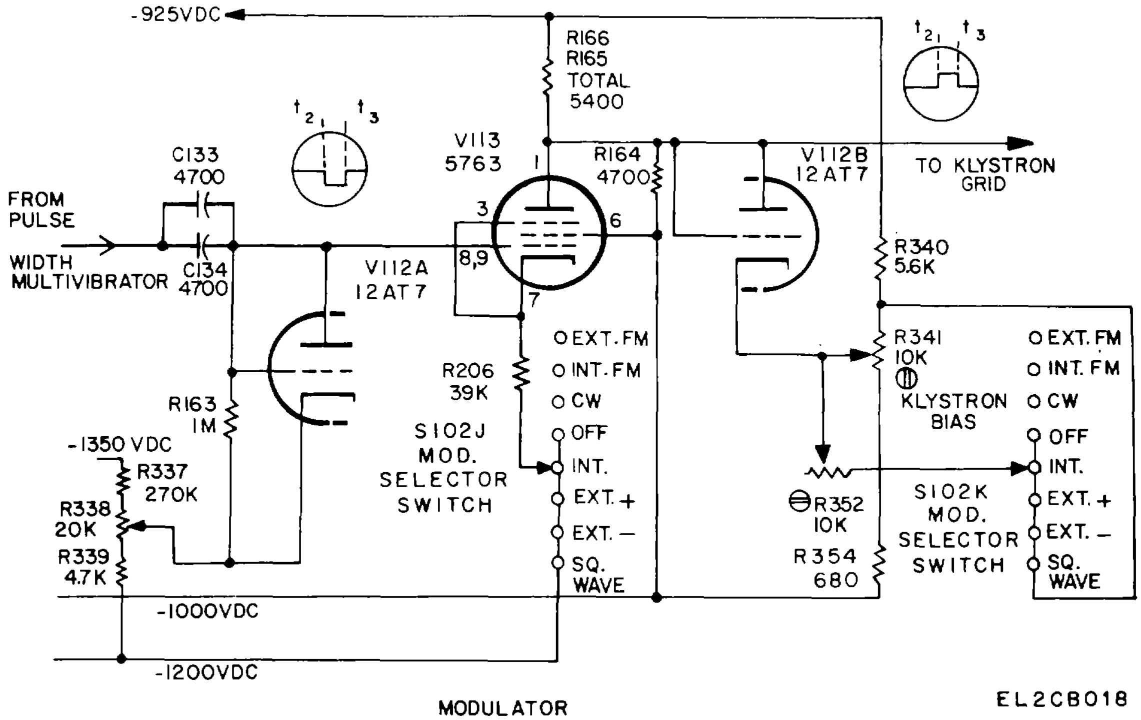


Figure 2-18. Simplified schematic diagram of klystron modulator circuit, AN/URM-52A.

(19) Modulating action. When the negative pulse of voltage starting at t_2 and terminating at t_3 appears on the control grid of V113, the grid is driven to cutoff. The voltage at the plate tends to rise instantly to approximately 965 volts since current flow through its plate resistors is cut off. However, when it crosses the voltage value established by the setting of R341, the diode plate becomes positive with respect to the cathode. Current will then flow through the diode, limiting the positive excursion of the voltage at the grid of the klystron tube to the bias established by the setting of R341. At the termination of the negative pulse at t_3 the voltage at the grid of V113 rises instantly, permitting the tube to again draw current. Any positive transient existing at t_3 will be clipped by diode V112A. At the same time (t_3) the voltage at the plate of V113 will drop, since it will start drawing plate current through its plate resistors. Flow of current through V112B will be blocked at the instant the plate voltage drops below the point established by the adjustment of R341, and the voltage applied to the grid of the klystron will cut off oscillations in the rf oscillator. The modulator tube, as just described, provides an optimum positive output to the modulator grid of the rf oscillator tube to permit it to oscillate during the period between t_2 and t_3.

(20) Delayed sync out pulse shaping vultivibrator (fig. 2-19). The delayed sync out pulse shaping multivibrator is comprised of the two triode sections of type 5814 tube V115. The positive voltage spike developed in the cathode circuit of the thyratron discharge tube is applied to the grid of V115A through capacitor C138 at time t_2. The section of the multivibrator formed by V115A is cut off, its negative bias being established by current of V115B flowing through cathode resistor R195. The section comprised of V115B is drawing current in the resting condition as its grid is returned to the cathode through R194.

(21) Trigger action of V115 stage**.** The positive leading edge of the pulse from V110 causes the multivibrator to switch, cutting off current through V115B and causing the voltage at its plate to rise. The time constant of the circuit is approximately 2 microseconds. At the end of this time, capacitor C139 is charged through R194 and R195 to a point where Vl15 again draws current and completes the cycle. The output at the plate of V115B is a positive voltage pulse of 2 microseconds duration. This is coupled to V109B, the cathode follower.

(22) Delayed sync out cathode follower. Tube V109B is a conventional cathode follower employed as an impedance transformer, receiving the pulse from the high impedance plate of the multivibrator and delivering it to the relatively low impedance

across the delayed sync out connector, J104 located on the panel, for synchronizing external equipment at t_2.

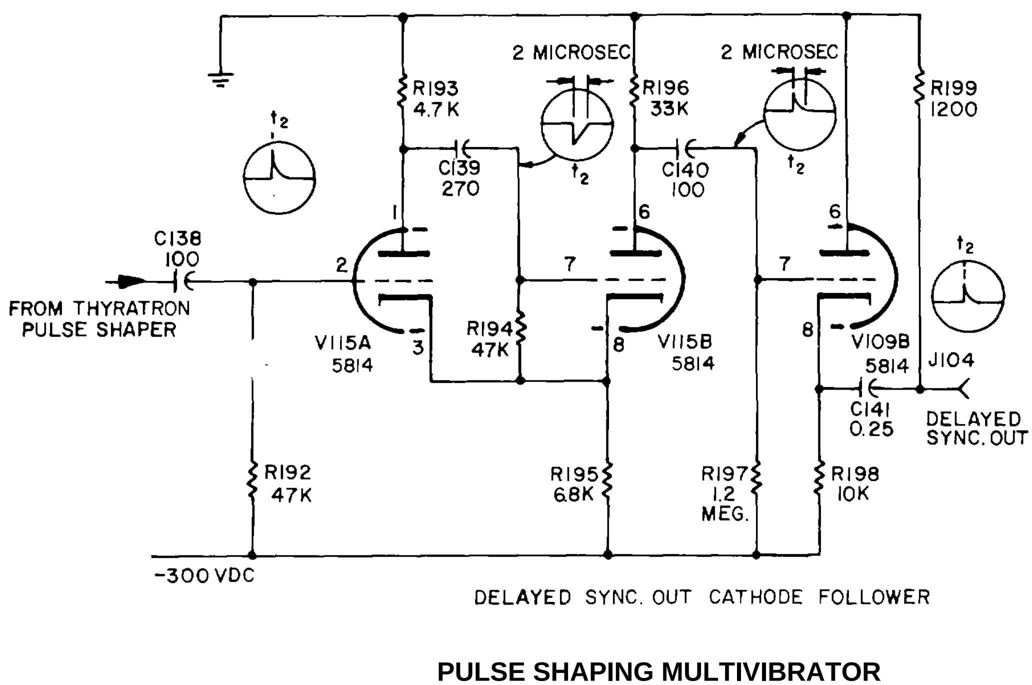


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Figure 2-19. Simplified schematic diagram of delayed sync out pulse shaping multivibrator and cathode follower.

(23) Internal frequency modulation. When MOD SELECTOR switch S102 is in the INT. FM position, thyratron pulse shaper V110 is switched ;o form a conventional relaxation oscillator as ;shown in figure 2-20. This oscillator develops a ;sawtooth voltage wave that is applied to the rf oscillator repeller. Capacitors C124, C124, and p126 with resistors R146 and R147 determine the ,time constant of the sawtooth output for the X1 range while C126. R146, and R147 perform the same function for the X10 range. Resistor R147 is ganged with R111 and R114 and adjusted by the calibrated PULSE RATE control on the panel, so that the fm sweep rate and the internal pulse repetition rate may be adjusted by the same control. The relaxation oscillator is triggered by a positive pulse from the cathode of the pulse shaper and, when activated, delivers a rising sawtooth voltage to the repeller, sweeping the frequency and providing sawtooth frequency modulation.

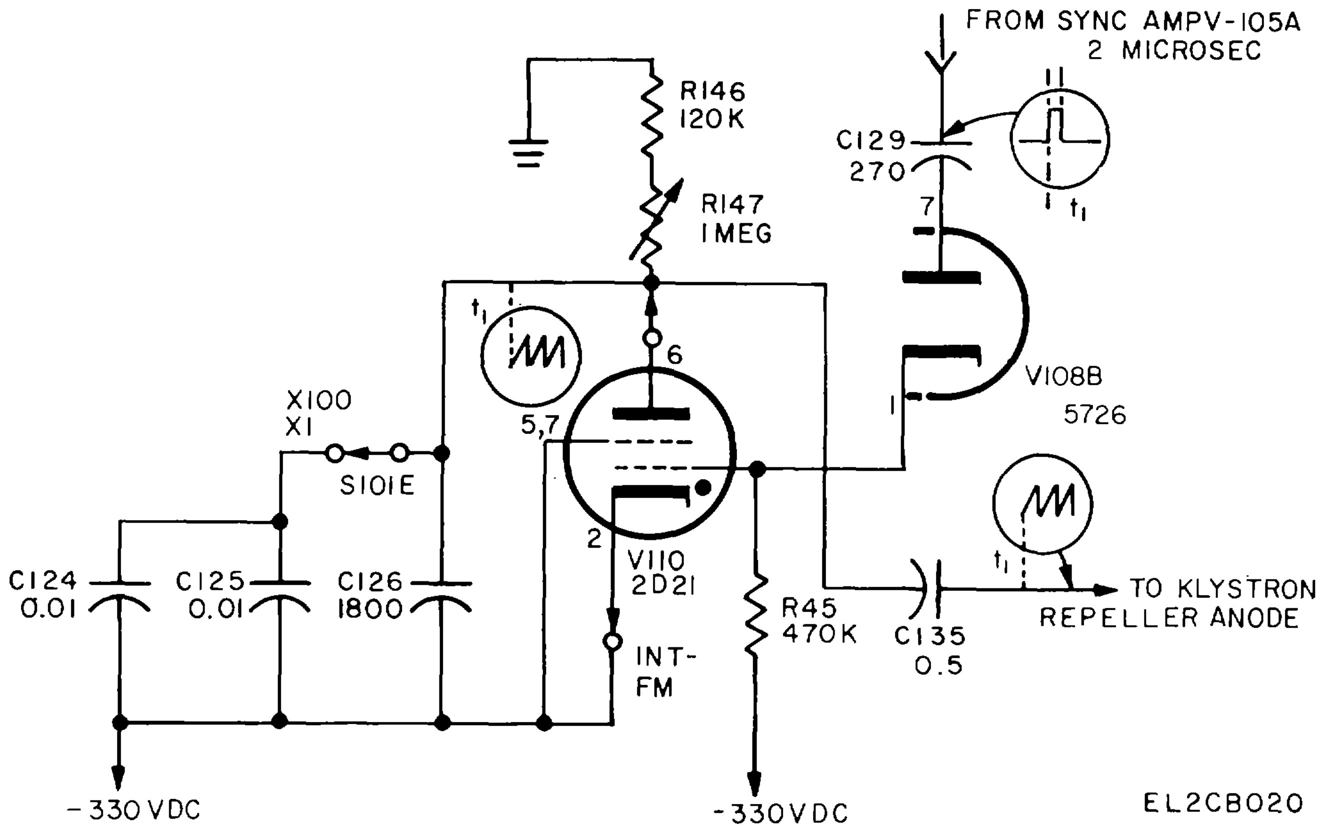


Figure 2-20. Simplified schematic diagram of internal frequency modulation circuits.

CHAPTER 3

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

3-1. Introduction

General support maintenance includes all the techniques outlined for organizational and operator maintenance plus any special or additional techniques required to isolate a defective part. The first step in correcting any trouble or failure which may occur in the AN/URM-52(*) is to isolate the section of the circuit which is causing the trouble. To isolate a defective part or determine the cause of equipment failure will require a complete understanding of the equipment's function. The existence of a malfunction will become apparent in one or more steps of the operating procedures in the preventive maintenance checks and service chart in TM 11-6625-14-12. In addition, general support maintenance personnel will be aided materially be a thorough study of the block diagrams, figures 2-1 and 2-9, in isolating the source of malfunction. The voltage and resistance diagrams, figures FO-10, FO-11, and FO-12, and the waveform diagrams in table 3-3 should be consulted. It should be kept in mind that the source of the trouble ordinarily lies in only one section at a time. However, because of interdependence of the various circuits, symptoms may appear throughout the AN/URM-52(*).

3-2. Tools and Equipment

Tools and test equipment required for general support maintenance are listed in the maintenance allocation chart for AN/URM-52(*).

Section II. TROUBLESHOOTING

3-3. Troubleshooting Procedures

a. General. The first step in servicing a defective AN/URM-52(*) is to localize the fault.

Localization means tracing the fault to a defective circuit responsible for the abnormal condition. The second step is isolation, which means locating the defective part or parts. Some defective parts, such as burned-out resistors, and arcing or shorted switch contacts, can often be located by sight, smell, and hearing; however, most defective parts must by isolated by checking voltages and resistances.

b. Localization. The localization procedures applicable to this equipment are listed in (1) through (5) below, and should be used in localizing the trouble to a circuit in the suspected unit.

(1) Visual inspection. The purpose of the visual inspection is to locate faults without testing or measuring circuits. Perform the visual checks given in TM 11-6625-214-12.

(2) Operational test. The operational check procedure in TM 11-6625-214-12, may localize a trouble to a specific circuit in the AN/URM-52(*).

(3) Performance standards. This procedure serves as a further aid in isolating the defective section. The procedure, table 3-1, should be performed before detailed troubleshooting begins.

(4) Voltage and resistance measurements. This method of troubleshooting is detailed in paragraph 3-5 and summarized in table 3-2. Such a table obviously cannot include all the trouble symptoms that may occur. The table should be used as a guide in analyzing symptoms that may not be listed.

(5) Waveform analysis. This consists of a signal-tracing method which requires a thorough knowledge of interpreting waveform patterns. This method is presented in table 3-3.

c. Isolation. Once a trouble has been localized to a basic circuit, further tests and measurements must be made to isolate the trouble to a component part. The most useful tool that a technician has for troubleshooting any circuit is the complete understanding of the circuit operation. When a trouble has been localized to a functional circuit, refer to chapter 2 and review the principles of operation of the circuit. Chapter 2 contains block diagrams and simplified schematic diagrams of the operational basic circuits. These simplified schematic diagrams make the circuit more easily understood than does the overall schematic diagrams. Parts locations are indicated in figures 3-4 through 3-7. Voltage and resistance diagrams (para 3-5) are valuable aids in isolating a defective component. When making resistance measurements, refer to figures FO-10 through FO12 as needed.

d. Techniques. When performing the localization and isolation procedures, the techniques below may be applied. Apply these techniques only as indicated, and observe all cautions.

(1) Substitution. Substitution of the readily replaceable components should be accomplished first to isolate the trouble to either the modulator circuit or the power supply circuit.

(2) Intermittent troubles. In all tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Make a visual inspection of the wiring of the signal generator. Also, minute cracks in terminal boards or tube sockets should not be disregarded as possible sources of intermittent troubles.

3-4. Performance Standards

As a further aid in isolating the section causing the trouble in the AN/URM-52(*), the performance standards procedure in table 3-1 should be accomplished. Unless otherwise specifically stated in the table, all controls should be adjusted and set as follows:

a. Set AN/URM-52(*) power switch to ON. The POWER indicator lamp should light, the HEATER indicator lamp should go out, and the blower should start (except for the SG-577/U model).

b. Adjust signal frequency control to desired frequency and set MOD SELECTOR to OFF.

c. After approximately 30 seconds, adjust ZERO SET control to set the needle of the DBM/POWER SET meter exactly over the ZERO SET line on meter.

d. Set MOD SELECTOR to CW. After approximately 2 minutes, the needle should deflect from the ZERO SET position on the meter.

e. Adjust POWER SET control for 0 DBM (red line) indication on meter.

f. Set MOD SELECTOR to INT.

g. Set SYNC SELECTOR to X10.

h. Set PULSE RATE to 100.

i. Position PULSE DELAY control to extreme counterclockwise setting.

j. Set PULSE WIDTH to 10.

k. Adjust OUTPUT ATTEN control to 0 dbm.

Table 3-1. Performance Standards

STEP	Control positions	Test procedure	Normal indication
1		Connect oscilloscope vertical input to SYNC OUT connector. Set sweep of oscilloscope so that at least two pulses appear on screen	SYNC OUT pulses should appear on oscilloscope at periods of approximately 1000 microseconds and should be steady with a clear trace.
2	Vary setting of PULSE RATE control above and below 100	Same as step 1	Pulses should move closer together and farther apart, indicating effectiveness of PULSE RATE control in X10 position of SYNC SELECTOR switch.
3	Set SYNC SELECTOR switch, to X1 and repeats steps 1 and 2	Same as step 1	SYNC OUT pulses should now have a period of approximately 10,000 microseconds, indicating effectiveness of PULSE RATE control in X1 position of SYNC SELECTOR switch.
4	Initial settings Vary setting of PULSE DELAY control	Connect oscilloscope vertical input to delayed sync out connector. Connect oscilloscope TRIGGER INPUT to SYNC OUT connector	Pulse, or evenly spaced pulses, should move across the screen with variation of PULSE DELAY control, indicating effectiveness of the control.

3-5. Voltage and Resistance Measurements

Normal voltage and resistance measurements taken at the tube sockets are indicated in figures FO-10, FO-11, and FO-12.

WARNING

Be careful when making voltage measurements. High voltages which may be fatal are present in certain portions of the equipment. Be especially careful when making measurements in which neither positive nor negative side of the meter is at chassis potential. In such cases, and in all high voltage measurements, turn the equipment OFF before attaching meter.

After attaching the meter, turn the equipment ON, make the measurement, and turn the equipment OFF before disconnecting the meter.

a. Voltage Measurements. The voltage indication, in figures FO-10 and FO-11 were obtained under the condition as specified in the figures for the model signal generator indicated. Always make voltage measurements under these conditions, or the indications may be inaccurate.

b. Resistance Measurements The resistance indications in diagram FO-12 were obtained under the conditions specified. Always make resistance measurements under these conditions, or indications may be inaccurate.

3-6. Detailed Troubleshooting

a. General. The preventive maintenance procedures and the troubleshooting table in TM 11-6625-214-12 essentially check one function at a time. A given source of trouble may affect several functions of the AN/URM-52(*) simultaneously; therefore, it will usually take a number of steps to isolate the source of trouble. Table 3-4 is designed to aid in such isolation. Parts locations are shown in figures 3-4 through 3-10. Depending on the nature of the operational symptom, it may be necessary to use two or more troubleshooting measurements. The symptoms listed in the operator and organizational troubleshooting table are to be used in conjunction with the general support maintenance troubleshooting table 3-2.

b. Use of Table. When a malfunction has been observed in the equipment, look for a description of the symptoms in the Malfunction column and perform the corrective measures shown in the Corrective action column. If the corrective measures indicated in the table do not fix the trouble, waveform analysis, table 3-3, should be performed.

c. Power Supply Troubleshooting In the AN/URM-52(*), three primary power supplies comprise the power supply circuits. Power for the blower motor is furnished by a solid state full-wave bridge rectifier circuit. In Signal Generator SG557/U, the primary power supply circuits have been modified to use silicon diode type rectifiers in place of the electron tube type rectifiers. All the primary power circuits are electronically regulated and interdependent, each using another as a reference point. The positive side of two of the power supplies are at ground potential and the third is 925 volts negative with respect to ground. A change in the output in the --300 volt supply in turn changes the output voltage of the -1000 volt supply. As indicated in table 3-2, item 4, power supply troubles will usually show up as poor or unstable performance in all positions of the MOD SELECTOR switch. If this malfunction does occur, refer to the voltages in figure FO-10, and measure all output voltages from the power supply. Check the tubes and replace any which appear doubtful, performing those adjustments necessary. If these adjustments do not correct the trouble, measure power supply voltages, and finally, refer to figure FO-12 and perform resistance measurements.

Table 3-2. Troubleshooting

Malfunction	Probable cause	Corrective action
1. Does not sync with external voltages; internal sync satlsfactory	Defective circuit elements in sync in amplifier V101 stage.	a. Check and if necessary replace tube V101 and associated circuit elements. b. Check external connections to SYNC IN connector J101.
2. No sync out pulse; delayed sync out and rf output pulse satisfactory	Defective circuit elements in sync out cathode follower V105B	Check and if necessary replace tube V105 and associated circuit elements.
3. No delayed sync out pulse; sync out pulse and rf output pulse satisfactory	Defective circuit elements in V115 stage or V109B stage	Check and if necessary replace V115 tube and/or tube V109B and associated circuit elements.
4. Poor or unstable performance in all positions of MOD SELECTOR switch and SYNC SELECTOR switch	Defective circuit elements in power supply.	Check and if necessary replace tubes and circuit elements m power supply (Readjust-300V DC regulated supply (para 3-23).
5. No sync out, delayed sync, or rf output pulses; power supply operating properly	Defective circuit elements in pulse rate and/or pulse-forming multi-vibrators, V103 and V104	Check and if necessary replay V103 and/or V104 and associated circuit elements.
6. Rf output continues when MOD SELECTOR switch is OFF	Defective modulator tube V113, or improper setting of klystron bias adjustment/	Check and if necessary replay V113 (para 3-23).
7. Low, erratic, or no rf output pulse, sync pulse output satisfactory	Weak rf oscillator (V114) or improper settings of repeller tracking Potentiometers or beam current control	a. Check klystron beam current, and readjust if necessary (para 3-16). b If a above does not clear the trouble, replace V114 (para 3-14, 3-15, 3-16)

Table 3-2 Troubleshooting-Continued

Malfunction	Probable cause	Corrective action
8. No pulse rf output with MOD SELECTOR switch on INT	a. If pulsed rf output is available with externally developed pulses but not from internally developed pulses, the modulator circuits and klystron, V112 through V114, may be considered operative and the fault lies in preceding circuits	a. Check and replace if necessary tubes preceding V112 and V114 and associated circuit elements
	b If a satisfactory sync out pulse is not obtained when the MOD SELECTOR switch is in the INT position, a fault lies in the circuits of V103, V104, and V105. If this pulse is obtained, these circuits may be considered operative.	b. Check and if necessary replace tubes V103 and V105, and associated circuit elements
	c. If a normal delayed sync out pulse is not obtainable at the connector when a sync out pulse is obtained, the fault lies in the circuits of V106 through V110 or VL15. If thus pulse is present, these circuits may be considered operative.	c. Check and if necessary replace tubes V106 through V110 and V115, and associated circuit elements.
	d. If no rf pulse is obtained when the delayed sync out pulse is satisfactory, the fault lies in the circuits of V111 through V114.	d Check and if necessary replace tubes V111 through V114 and associated circuit elements. Check waveform at grid and plate of modulator tube V113 to determine which of these four circuits and/or tubes is defective.
9. DBM/POWER LEVEL meter needle pins down scale regardless of switch positions	a. Open thermistor R202 in power monitoring probe	a. Check resistance of, and if necessary, replace probe.
	b. Thermistor R201 mounting plate shorted to ground.	b. Check mounting for thermistor R201.
10. DBM/POWER LEVEL meter needle pins up scale regardless of switch positions.	Shorted power monitoring probe	Check resistance of probe and replace if necessary.
11. Poor decay time of rf output pulse	Open choke L101	Measure resistance of L101, if above 10 ohms, replace.
12. Double rf output pulse (normal pulse plus additional poorly shaped pulse) .	Defective capacitor C142 in pulser	Check capacitor by substituting C142; replace if necessary.

WARNING

High voltages which may be fatal are present in certain portions of the equipment. The power supply is wired so that the positive side of two of the developed voltages are at, or near chassis (ground) potential, while in the third, both the positive and negative sides of the voltages are removed from ground potential. Be especially careful when making measurement in which neither the positive nor negative side of the meter is at chassis potential. In such cases, and in all high voltage measurements, turn the equipment OFF before attaching the meter. Turn the equipment ON, then make the measurement and turn the equipment OFF before disconnecting the meter.

3-7. Waveform Analysis

a. In general, this method of troubleshooting (table 3-3) is accomplished by observation of waveforms on an oscilloscope connected, successively, to various points in the signal generator. When a malfunction is observed, further investigation is carried out with a voltmeter and an ohmmeter. Refer to voltage and resistance diagrams, figures FO-10, FO-11, and FO-12. Prior to checking waveforms, the equipment must be allowed to warm up for at least 10 minutes with the control settings as listed in b below. Unless otherwise specifically stated in table 3-3, the controls are adjusted as indicated below for each waveform.

b. Allow the AN/URM-52(*) to warm up for 10 minutes with the control settings indicated below: (1) MOD SELECTOR switch to INT.

(2) SYNC SELECTOR switch to X10.

(3) PULSE RATE control to 100.

(4) PULSE DELAY control maximum counterclockwise (ccw).

(5) PULSE WIDTH control to 10.

(6) Signal frequency control to any desired frequency.

(7) OUTPUT ATTEN dial to 0 dbm.

c. The oscilloscope should be set for 100 microsecond sweep, unless otherwise directed.

d. To view the leading edge of pulses coincident with the sync out pulse, synchronize the AN/URM-52(*) and oscilloscope separately from an outside source such as a pulse generator. The synchronizing pulse to the AN/URM-52(*) should be delayed by a convenient amount.

e. Voltages given for the waveforms are for normal indications, peak-to-peak voltages.

Table 3-3. Waveform Analysis

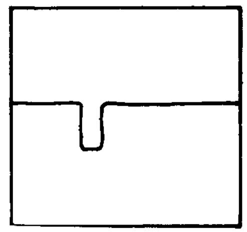
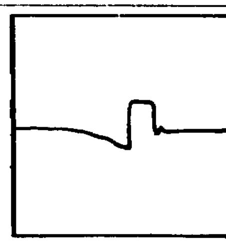
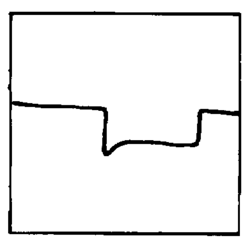
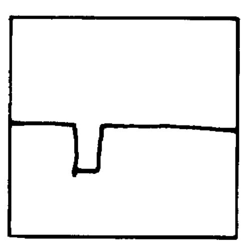
Step	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
1	Refer to Operational Check Procedures, Table 4-1, TM 11-6625-214-12. Advance POWER SET control until reading is obtained on POWER SET meter.	Connect RF OUTPUT through crystal detector to oscilloscope input.	 0.09 volts	Rf oscillator tube V114. If oscilloscope indication is zero, but POWER SET meter indication is satisfaftory; check attenuator resistor R203 by measuring the dc resistance between the center and outer conductors of RF OUTPUT connector. If zero indication is obtained on POWER SET meter as well as on oscilloscope, turn MOD SELECTOR switch to CW position. If indication is normal on CW but 0 on INT the malfunction lies in the pulsing circuits prior to V112 If CW indication is also 0 the malfunction may be with V114 or associated circuits of power supply.
2	Same as step 1.	Connect oscilloscope to pin 1 of tube V113 in series with a 0.01 uf 1000 volt capacitor.	 47 volts	V113, V111, V110 circuits. Proceed with Step 3.
3	Same as step 1, except MOD SELECTOR switch on SQ WAVE.	Same as step 2, but oscilloscope sweep set for 1000 microseconds.	 55 volts	If normal indication is obtained in this type of operation, cause of trouble is not with V113 circuits.
4	Same as step 1, return MOD SELECTOR switch to INT.	Connect oscilloscope to pin 1 of tube V111. Return oscilloscope sweep setting to 100 mircoseconds.	 [illegible]	If indication is normal and abnormal indication was obtained in step 3, check: V113, R163, R164, R165, R166, C142. If indication is abnormal, proceed with step 5.

Table 3-3. Waveform Analysis-Continued

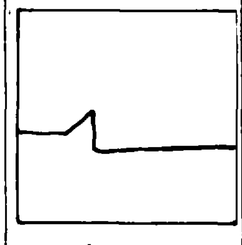
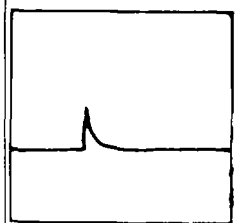
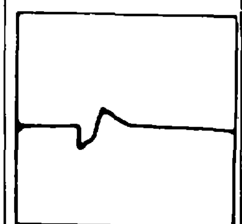
Step	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
5	Same as step 1.	Connect oscilloscope to pin 7 of V111.	 22 volts	Tube V111 or tube V110, or associated circuit elements. Proceed with step 6.
6	Same as step 1.	Connect oscilloscope to pin 2 of V110.	 125 volts	If indication is normal, and indication in step 5 was abnormal, check V111 circuit elements. If indication is abnormal, proceed with step 7. If indication is normal and malfunction appeared at delayed sync out connector, proceed with step 21.
7	Same as step 1.	Connect oscilloscope to pin 1 of V109.	 220 volts.	If indication is normal, and abnormal indication was obtained in step 6, check tube V110 or tube V108, or associated circuit elements. If indication is abnormal, proceed with step 8.
8	Turn MOD SELECTOR switch to EXT. + position.	Connect pulse generator to EXT MOD. connector. Set pulse generator for + pulse output, with an amplitude of at least 15 volts peak, a pulse rate of 1000 pps, and pulse width of 10 mircoseconds. Connect oscilloscope to output of pulse generator, then to pin 1 of V109.	Oscilloscope indication should be the same at pin 1 of V109 as at output of pulse generator, except for inversion of waveform.	If there is an appreciable difference between the waveforms found at pin 1 of V109 and at output of pulse generator, except for inversion, check tube V109 associated circuit elements and voltages. If zero indication is obtained at pin 1 of V109, proceed with step 9. If indication is normal, proceed with step 10.
9	Same as step 8.	Connect oscilloscope to pin 2 of V109.	Oscilloscope indication should be the same at pin 2 of as at output of pulse generator.	If indication is normal, and zero indication was obtained in step 8, check: R145, R146, R147, R189, C124, C125, C126, C129. If indication is zero, check C123.

Table 3-3. Waveform Analysis -Continued

Table 3-3. Waveform Analysis—Continued

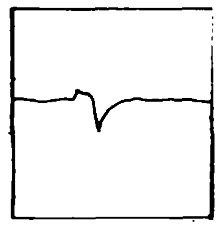
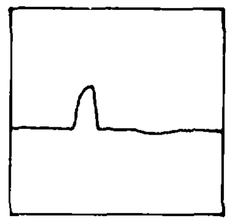
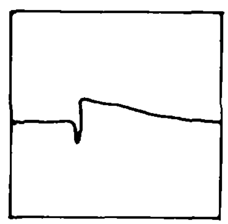
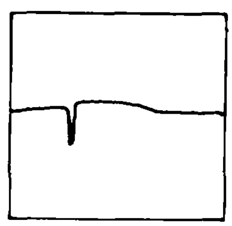
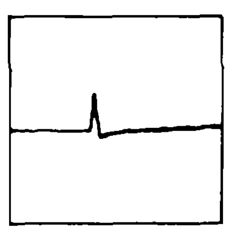
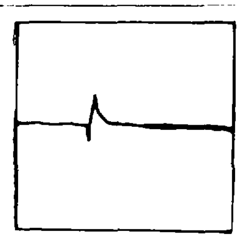
Step	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
10	Same as step 1.	Same as step 9.	 52 volts	Tube V106 or tube V107 or associated circuit elements. Proceed with step 11.
11	Same as step 1.	Connect oscilloscope to pin 6 of V107.	 220 volts	If indication is normal, and abnormal indication was obtained in step 10, check C122. If indication is abnormal, proceed with step 12.
12	Same as step 1.	Connect oscilloscope to pin 1 of V106.	 150 volts	If indication is normal, and abnormal indication was obtained in step 11, check: tubes V107 and V106, R133, R134, R135, R136, R137, R138, R139, R140, C120. If indication is abnormal, proceed with step 13.
13	Same as step 1.	Connect oscilloscope to pin 1 of V105.	 105 volts	If indication is normal, and abnormal indication was obtained in step 12, check C119, C131, and R132. If indication is abnormal, proceed with step 14.
14	Same as step 1.	Connect oscilloscope to pin 1 of V104.		If indication is normal, and abnormal indication was obtained in step 13, check C116, R125, R126. If indication is abnormal, proceed with step 15. If indication is normal, and malfunction appeared at SYNC OUT connector, proceed with step 24.
15	Same as step 1.	Connect oscilloscope to pin 2 of V104.	 52 volts	If indication other than zero is obtained, and abnormal indication was obtained in step 14, check: tube V104, R120, R121, R122, R123, R124, C113, C114. If indication is zero, procmeed with step 16.

Table 3-3. Waveform Analysis -Continued

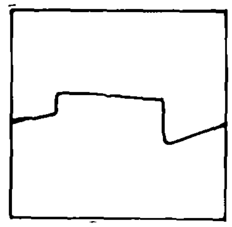
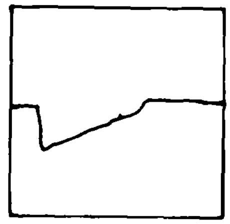
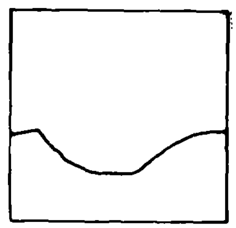
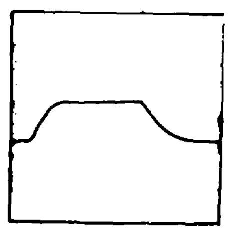
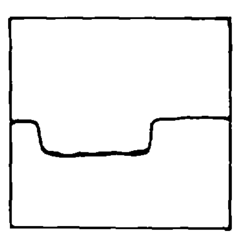
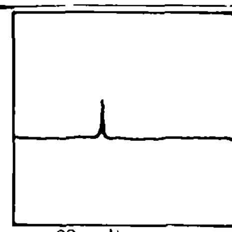
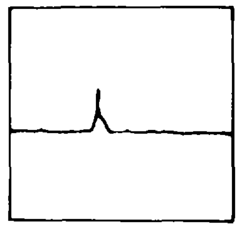
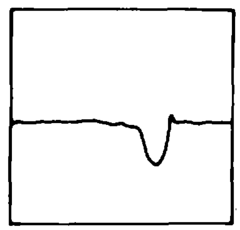
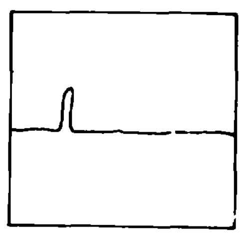
Step	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
16	Same as step 1.	Connect oscilloscope to pin 7 of V103. Adjust oscilloscope sweep for 200 microseconds.	 270 volts	If indication is normal, and abnormal indication was obtained in step 15, check C112. If indication is abnormal, proceed with step 17.
17	Same as step 1.	Connect oscilloscope to pin 2 of V103. Leave oscilloscope sweep on 200 microseconds.	 230 volts	Tube V103, R107, R108, R109, R110, R111, R113, R114, R115, C105, C109. If none of these is defective, and malfunction appeared with SYNC SELECTOR in either of the EXT positions, proceed with step 18.
18	SYNC SELECTOR to EXT.-	Connect pulse generator to SYNC IN connector. Set pulse generator for pulse rate of 1000 pps, pulse width of 5 microseconds, and pulse output to negative with an amplitude of at least 5 volts peak. Adjust oscilloscope sweep for 10 microseconds. Connect oscilloscope to pin 6 of V101.	 270 volts	If indication is normal, check: tube V102, C104, C108, C111, R106, C108. If indication is abnormal, proceed with step 19.
19	Same as step 18.	Same as step 18. Connect oscilloscope to pin 1 of V101.	 65 volts	If indication is normal, check C102. If malfunction appeared with SNYC SELECTOR in EXT. + position check: C103, C107. If indication is abnormal, proceed with step 20.
20	Same as step 18.	Connect oscilloscope to pin 2 of V101.	 14 volts	C101, R101, R102.

Table 3-3. Waveform Analysis -Continued

Table 3-3. Waveform Analysis—Continued

Step	Control Positions	Check Procedure	Normal Indication	Possible Cause of Malfunction
21	Same as step 1.	Connect oscilloscope to pin 8 of V109.	 62 volts	If indication is other than zero, check: tube V109, C141, R198, R199. If none of these is at fault, or indication is zero, proceed with step 22.
22	Same as step 1.	Connect oscilloscope to pin 6 of V115.	 95 volts	If indication is normal, and abnormal indication was obtained in step 21, check C140, R197. If indication is abnormal, proceed with step 23.
23	Same as step 1.	Connect oscilloscope to pin 1 of V115. Oscilloscope sweep set to 10 mircoseconds.	 22 volts	Check: tube V115, C138, C139, R192. R193, R194, R195, R196.
24	Same as step 1.	Connect oscilloscope to pin 8 of V105.	 55 volts	If indication is normal, and abnormal indication appeared at SYNC OUT connector, check: C118, R130. If indication is abnormal, check tube V105, C117, R128, R129.

f. Waveforms should be viewed in sequence until an abnormal pattern is observed. When this occurs, follow the instructions given in the *Possible Cause of Malfunction* column.

3-8. Tube Failures

If tubes are suspected to be the cause of a failure, the defective tube can usually be located by the following procedure:

a. The fit between the cabinet and instrument is intentionally tight, and removing the cabinet is a two-person job. With the line cord removed from the power source, remove the instrument from its cabinet by placing instrument face down on a low surface and loosening captive screws on the rear of the cabinet. The screws will not come out of the cabinet. Lift cabinet from instrument.

b. Plug the line cord into a power source and allow the instrument to warm up for several minutes.

c. Turn off power and carefully touch each tube. Any normal operating tube will feel warm or hot. A cold tube is a good indication of a failure. However, it is well to bear in mind that tubes frequently deteriorate in performance characteristics without completely failing. Such symptoms as low power output, erratic pulsing and synchronization, and generally poor performance can often be traced to changes in tube characteristics.

d. If a tube checker is available, subject each tube to a performance test, short test, and gas or leakage test. Replace any tube about which there is any doubt whatsoever as to its performance.

3-9. Tube Complement

The tubes used in the TS-621/U, TS-621A/U, TS621B/U, and TS-621C/U are listed in table 3-4 and their physical locations shown in figure 3-1. Signal Generator SG-557/U power supply circuits have been modified to use silicon diode type rectifiers in place of 5R4 electron tube type rectifiers. The type and function of the electron tubes and diodes used in the SG-557/U are also listed in table 3-4 and physical location shown in figure 3-2. In table 3-4, replacement of those tubes without asterisks can be made without affecting the performance of the equipment. Replacing the tubes followed by asterisks (e.g., V103*) requires that adjustments of internal controls be made to bring the overall operation and performance of the equipment up to standard. These adjustments are described in paragraph 3-23.

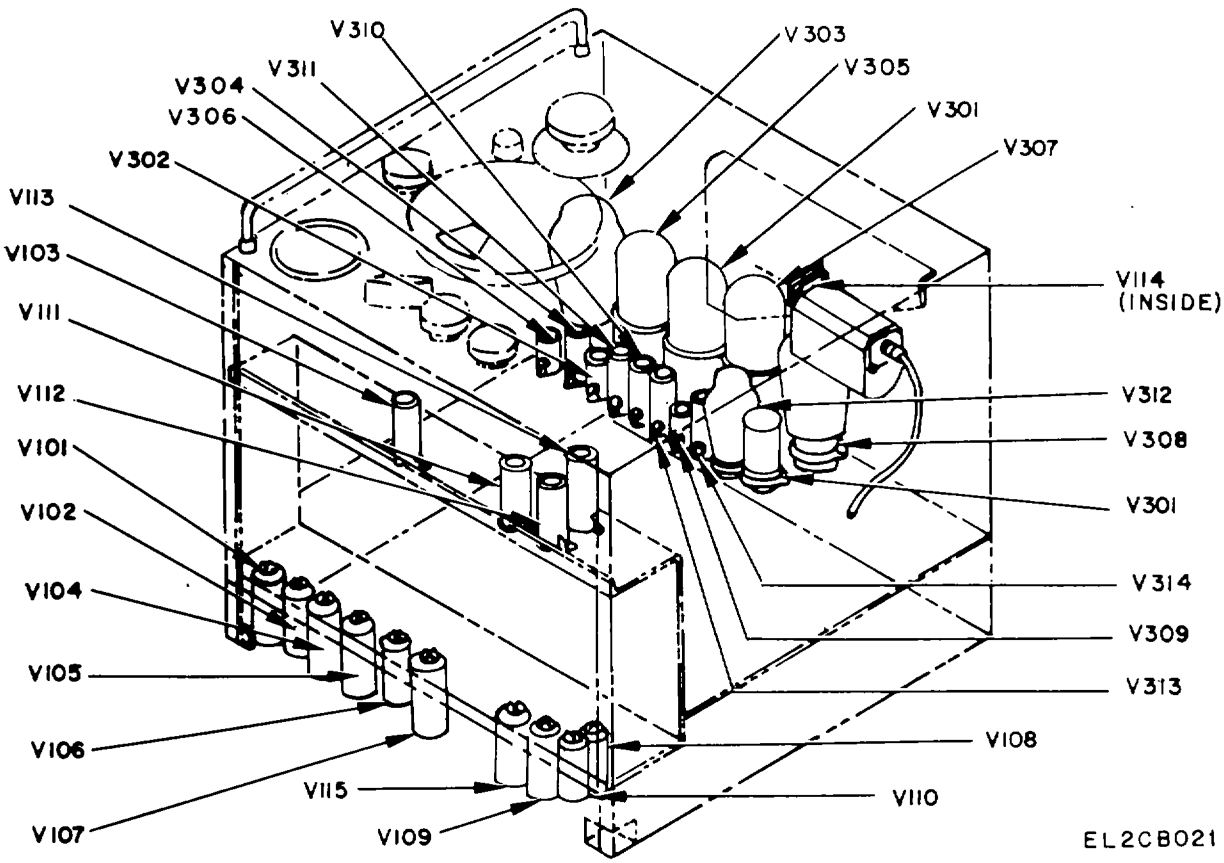


Figure 3-1. Location of tubes, TS-621/U, TS-621A/U, TS-621B/U, and TS-621C/U.

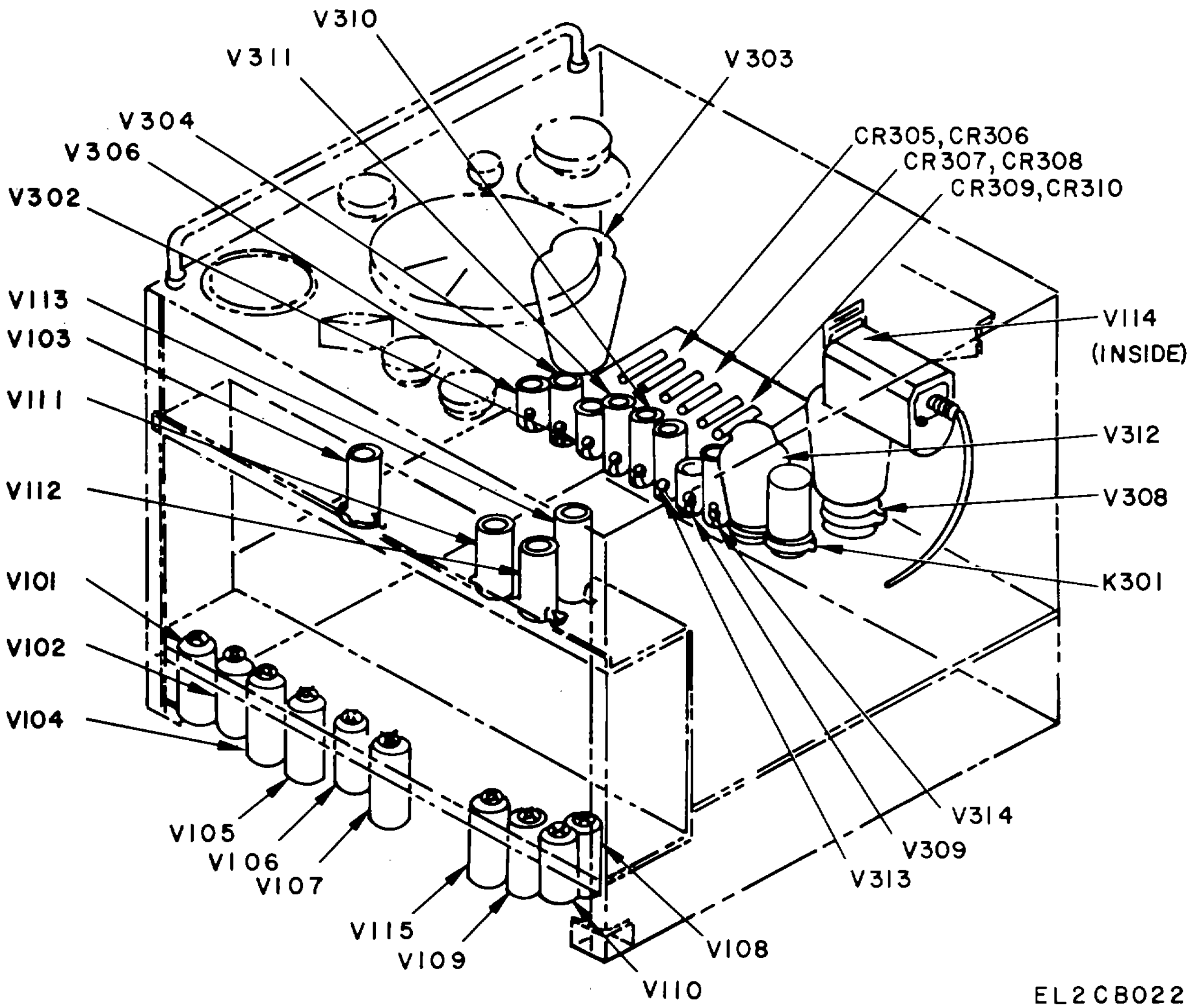


Figure 3-2. Location of tubes and diodes, SG-557/U.

Table 3-4. Tube and Diode Complement

TUBE	JAN TYPE NUMBER TS-621/ U TS-621A/ U	TS-621B/ U	TS-621C/ U	SG-577/ U	FUNCTION
V101	12AT7	12AT7WA	12AT7WA	12AT7WB	Snyc in amplifier and inverter
V102	5726	5726	5726/6AL5W	5726/6AL5W	Coupling diode (½ tube not used)
V103*	5814	5814	5814A	-5814A	Pulse rate multivibrator
V104	5814	5814	5814A	5814A	Sync out pulse shaping multivibrator
V105	5814	5814	5814A	5814A	Pulse amplifier and sync out cathode follow
V106	5726	5726	5726/6AL5W	5726/6AL5W	Base limiter and clamp for pulse delay multivibrator
V107*	5814	5814	5814A	5814A	Pulse delay multivibrator
V108	5726	5726	5726/6AL5W	5726/6AL5W	Clamp and negative pulse clipper
V109	5814	5814	5814A	5814A	Pulse amplifier-inverter and delayed sync out cathode follower
V110	2D21	2D21	5727/2D21W	5727/2D21W	Thyratron pulse shaper
V111*	5814	5814	5814A	5814A	Pulse width multivibrator
V112*	12AT7	12AT7WA	12AT7WA	12AT7WB	Clipper and klystron grid clamp
V113*	5763	5763	5763	5763	Modulator
V114*	6236	6236	6236	6236	Radio frequency oscillator
V115	5814	5814	5814A	5814A	Delayed sync out multivibrator
V301	5R4WGY	5R4WGB	5R4WGA	CR-305 and CR-306 1N1734	Full wave rectifier
V302*	6AU6	6AU6W	6AU6WB		Regulator amplifier
V303*	6AS7	6080WA	6080WB		Series regulator
V304*	OA2	OA2WA	9A2WA		Voltage regulator
V305	5R4WGY	5R4WGB	5R4WGA	CR-307 and CR-308 1N1731	Full wave rectifier

*Required adjustment of internal controls after replacement.

Table 3-4. Tube and Diode Complement-Continued

TUBE	JAN TYPE NUMBER					FUNCTION
	TS 621/ U TS-621A/ U	TS-621B/ U	TS-621C/ U	SG-557/ U		
V306*	6AU6	6AU6WA	6AU6WB		Regulator amplifier	
V307	5R4WGY	5R4WGB	5R4WGA	CR-304 and CR-310 1N1733	Full wave rectifier	
V308*	6AS7	6080WA	6080WA	6080WB	Series regulator	
V309	6AU6	6AU6WA	6AU6WA	6AU6WB	Regulator amplifier	
V310*	OA2	OA2WA	OA2WA	OA2WA	Voltage regulator	
V311*	OA2	OA2WA	OA2WA	OA2WA	Voltage regulator	
V312*	OA3	OA3	OA3	OA3	Voltage regulator	
V313*	OA2	OA2WA	OA2WA	OA2WA	Voltage regulator	
V314*	OA2	OA2WA	OA2WA	OA2WA	Voltage regulator	

*Requires adjustment of internal controls after replacement.

Section III. MAINTENANCE INSTRUCTIONS

3-10. Cleaning

a. Materials. The following materials are required for cleaning the AN/URM-52(*):

(1) Trichloroethane.
(2) Lint-free cloth.
(3) Low-velocity compressed air.
(4) Liquid detergent.
(5) Nylon bristle brush.

b. Methods. Follow the listed procedures for cleaning of the AN/URM-52(*):

(1) Inspect the exterior. The exterior surfaces must be free of dirt, grease, and fungus. Remove dust and dirt with a clean, soft cloth.

(2) Remove grease and oil from cables.

(3) Remove the cabinet by placing the signal generator face down and loosening the knurled captive screws on the back of the cabinet. Lift cabinet from instrument.

(4) Remove and inspect air filter inside cabinet, and replace if necessary. (Does not apply to Signal Generator SG-557/U.)

(5) Remove dust and dirt in the vicinity of blower with low-velocity air; be careful to prevent dirt from falling into resonator ventilating tube.(Does not apply to Signal Generator SG-557/U.)

(6) Circulate low-velocity air through interior to remove dust and dirt.

WARNING

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame or hot metal forms highly toxic phosgene gas.

(7) Remove grease, fungus, and ground-in-dirt from the case with a cloth dampened (not wet) with trichloroethane.

(8) Remove dirt or dust from jacks with a soft brush.

CAUTION

DO NOT clean DBM/POWER SET meter face, MEGACYCLE dial or other plastic parts with trichloroethane. Plastic parts will be damaged.

(9) Clean front panel, control knobs, meter and dial face with a soft, clean, lint-free cloth. Dampen the cloth with water, using liquid detergent if difficulty arises in cleaning.

3-11. Lubrication

The AN/URM-52(*) receives lubrication during manufacture and normally will not require further attention. The gears are designed to run with only their initial lubrication except when the parts are cleaned during rebuild.

3-12. Painting

For instructions relative to painting, refer to TB 43-0118.

3-13. Repairs and Replacement Techniques

a. General. The general support maintenance procedures given in this manual supplement the procedures described in the operator's and organizational maintenance manual. The systematic troubleshooting and repair procedures, which begins with the operational checks that can be performed at organizational maintenance, is carried to a higher category of maintenance in this manual.

b. General Parts Replacement Techniques. To gain access to the interior of the AN/URM-52(*), follow the procedures in paragraph 3-8. Very often, careless replacement of parts creates new faults, therefore the following precautions should be observed:

(1) When replacing a part, be careful not to damage other parts.

(2) Before a part is unsoldered, not the position of the leads so that they may be replaced in their original position.

(3) When replacing a wire, use wire of the same, or larger, gage of the same length.

3-14. Removing V114 Klystron Tube

To remove klystron tube V114, first remove the instrument from its cabinet in accordance with paragraph 3-8; then proceed as follows:

a. Place the signal generator, with the cover removed, in the position shown in figure 3-3, for ease in reaching the tube. The bracket below the resonator is shown removed only to clarify the illustration. It need not be removed when replacing V114.

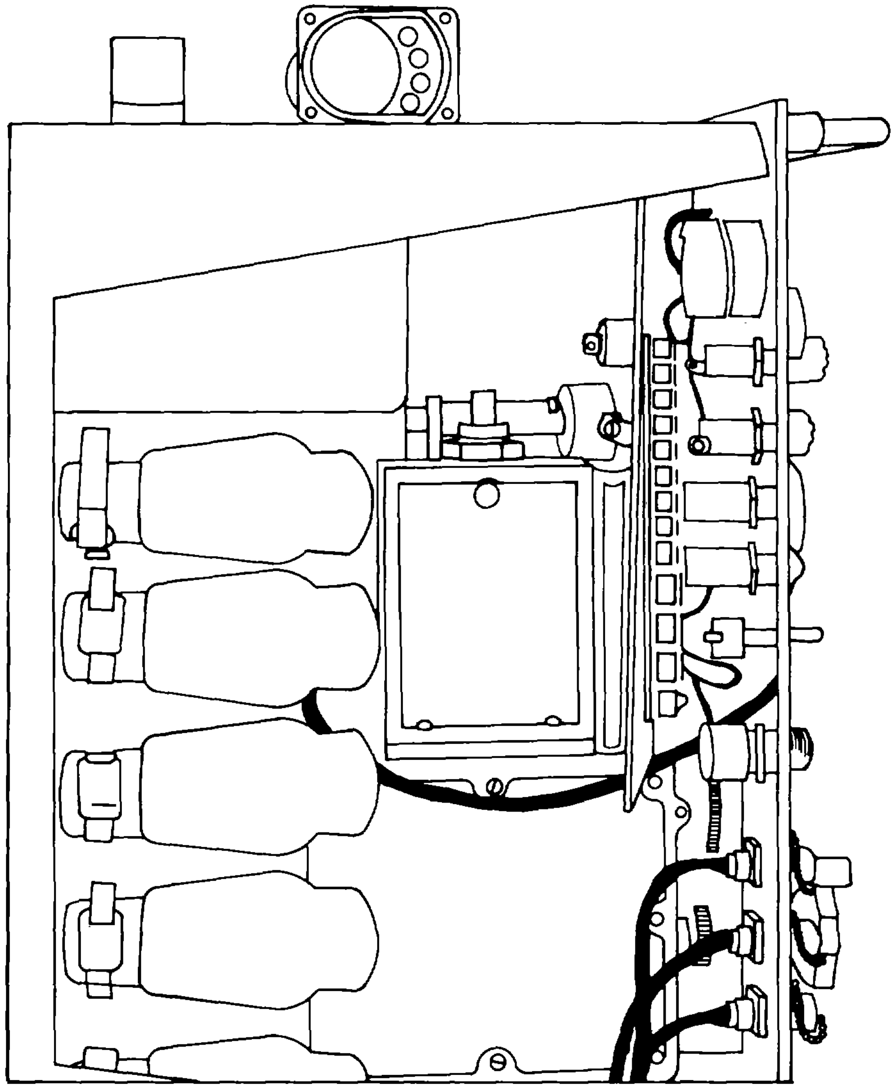


Figure 3-3. Signal Generator AN/URM-52(*)in position for klystron replacement.

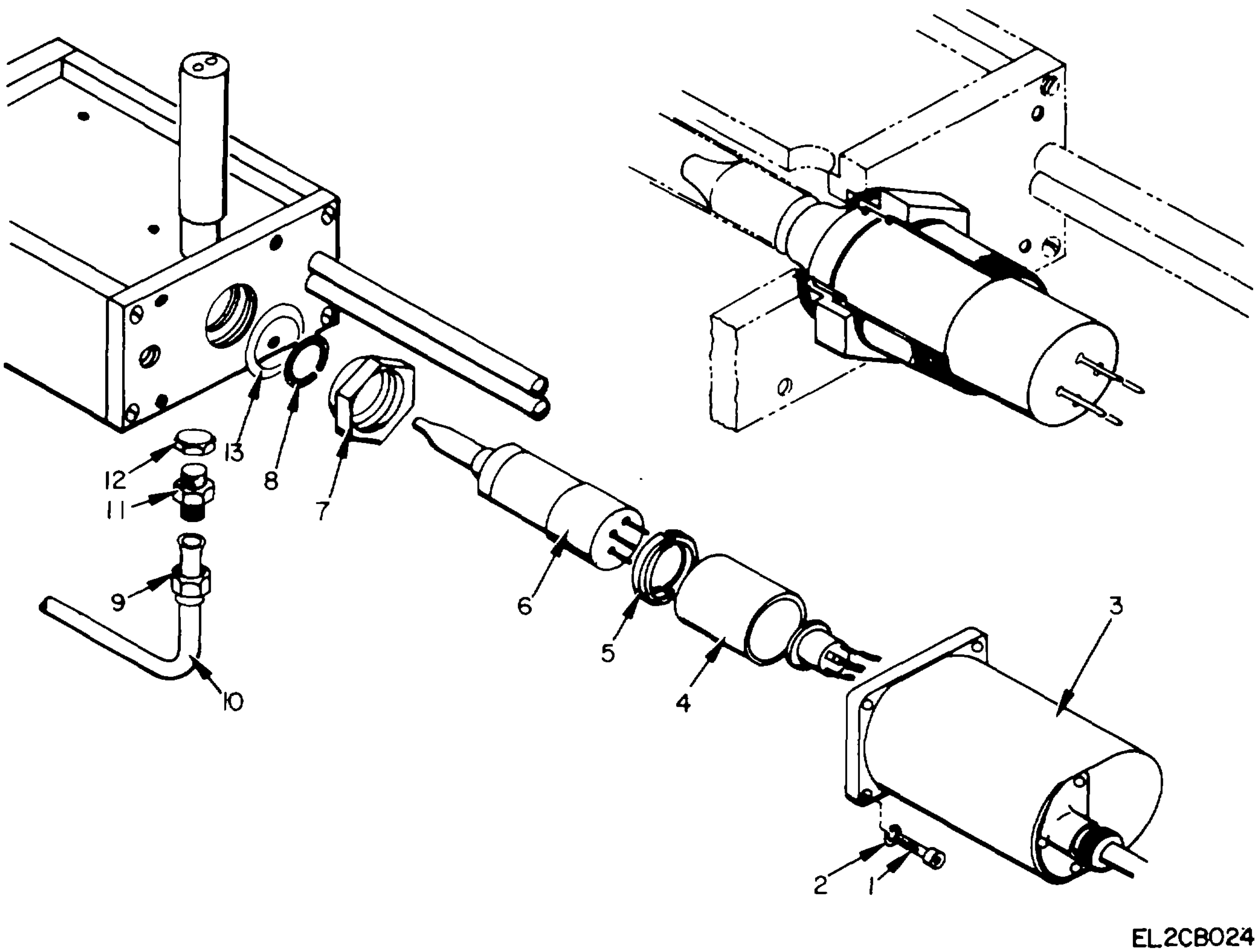


Figure 3-4. Klystron assembly, exploded view.

b. Remove the socket housing cap screws (1, fig. 3-4) and lockwasher (2) with Allen wrench located in the Fahnstock storage clip in the rear of the chassis. Pull the socket housing (3) back until the tube socket is exposed.

c. Pull straight back on the socket until it is free of the tube base.

CAUTION

Be very careful NOT TO APPLY LATERAL PRESSURE when removing the socket.

d. Unscrew the sleeve (4) that covers the body of the klystron tube and remove it. Be careful not to push the klystron sidewavs in the cavity.

e. Turn klystron tube V114 (6) clockwise an pull straight back, removing it from the cavity. Do not attempt to rock the tube or move it sideways. To do so may break the glass seals of the tube.

f. Remove semicircular sections of the clamping ring (5). When the sleeve is removed, one or both of the semicircular sections of the clamping ring (5) may come out. If they do not, do not attempt to pry them out. They will come out automatically when the tube is removed.

g. Unscrew the hex nut (7) at the entrance to the cavity using socket wrench stowed beside tubes on pulser deck. Remove the spring (8) below the hex nut. Do not reuse this same spring except in an emergency. New springs are supplied with the equipment for tube replacement and are located in the plastic envelopes inside the transit case.

NOTE

Replacement springs are not supplied with the TS-621C/U. If required, new springs must be requisitioned.

h. If the cavity ventilating pipe connector (11) protrudes within cavity, remove connector nut (9) and disengage ventilating pipe (10). Loosen set nut (12) and back out the connector until flush with inside face of cavity plate. Tighten set nut (12) lightly, as the connector may be used for tuning when recalibrating the instruments.

3-15. Installing New V114 Klystron Tube

The procedure for installing new klystron V114 follows (fig. 3-4). Before installing a new klystron, personnel should practice by reinstalling the old klystron. The proper thrust and twist required to push the klystron past the spring may then be learned by practice.

CAUTION

When inserting the tube always keep it straight in line with the cavity. Never work it from side to side. To do so will cause possible damage to the glass seals of the tube.

a. Install new spring in entrance to the cavity so that the ends just meet and form a complete circle. (Replacement springs are not supplied with the TS-621C/U.)

b. Thread hex nut into cavity until it is seated very lightly against the spring. Press the spring back under the nut all around so that the spring forms as nearly perfect circle as possible. Tighten the nut very slightly to hold the spring in this position.

c. Observing the above caution, insert the klystron tube into the cavity and push it forward until it engages the spring. Firmly press the tube straight into the cavity, giving it a slight clockwise twist. This will cause the tube to compress the spring slightly, slide by the spring and seat firmly against the cavity proper. Practice with the old klystron, as recommended, will enable the technician to feel when the tube is properly installed.

d. Tighten the hex nut well with the fingers, or very lightly with the wrench.

e. Insert the split clamping ring, making certain that the sections of the ring encircle the grid ring which can be seen just inside the hex nut. When the ring is in the proper position, three or four threads should be visible between the clamping ring and the outside face of the nut.

f. Thread the cover sleeve into the hex nut so that it seats against the clamping ring, causing the ring to grip the klystron grid ring. Tighten by hand, moderately tight.

g. Install the tube socket, pressing it straight onto the tube.

h. Position the socket housing and attach with the four socket head screws originally removed and tighten with the long Allen wrench. Replace all Allen wrenches in the Fahnstock storage clips, and fasten socket wrench in place on pulser deck.

3-16. Adjustments Following Replacement of V114

Following replacement of V114 it is important that two adjustments be made as soon as the instrument is turned on. The following procedure is recommended.

a. With MOD SELECTOR switch on OFF, turn on signal generator with new V114 installed.

b. Check the voltage of the -1000-volt supply.

c. Check the voltage of the 300-volt supply.

d. With MOD SELECTOR switch on CW, adjust the klystron beam current to 20 milliamperes.

e. With MOD SELECTOR switch at OFF, adjust the klystron cutoff bias.

f. With MOD SELECTOR switch at CW, tune signal generator to 7400 mega Hertz.

g. Adjust R170 for peak power output as observed on DBM/POWER SET meter.

h. Reduce peak power output 1 db by readjusting R170. This reduction should be made by turning in the direction in which the power output decreases most slowly.

i. Tune signal generator to 4400 megaHertz.

j. Adjust R173 and/or R178 for the indicatiation described in g and *h* above.

k. Tune signal generator to 3800 megaHertz.

l. Adjust R175 as described in g and h above.

m. Repeat the adjustments described above, as there is some degree of interaction, particularly between the 4400 and 3800 megaHertz adjustments.

n. Connect RF OUTPUT connector to the vertical amplifier of oscillosscope through the crystal detector.

o. Observe square wave operation throughout the entire rf range. If any weak or unstable points are noticed, slightly readjust repeller voltage for best operation.

3-17. Removing Attenuator Probe Assembly
(fig. 3-5)

Power from the resonator is coupled to the RF OUTPUT connector at the front panel through an assembly consisting of the panel connector, a length of RG-55/U cable, and the attenuator probe. Inside the attenuator probe is a special resistor, R202, which consists of a platinum-coated glass rod 0.03 inch in diameter. This resistor should normally last for the life of the equipment even if subjected to shock and vibration. However, if the resistor is broken or otherwise defective, the complete attenuator assembly must be replaced. If the glass rod is broken, the following two symptoms will usually be present. No rf output will be obtained or the dc resistance between the center pin of the RF OUTPUT connector and ground will be very large. If the glass rod is not defective, the resistance will be 85 to 125 ohms. The 8S Generator TS-621C/U attenuator probe us a disk-type probe resistor R203 instead of the platinum-coated glass rod resistor. Normal dc resistance measured between center conductor of RF OUTPUT connector and ground in the attenuator probe using the disk resistor should be between 45 and 60 ohms. Remove the assembly U follows:

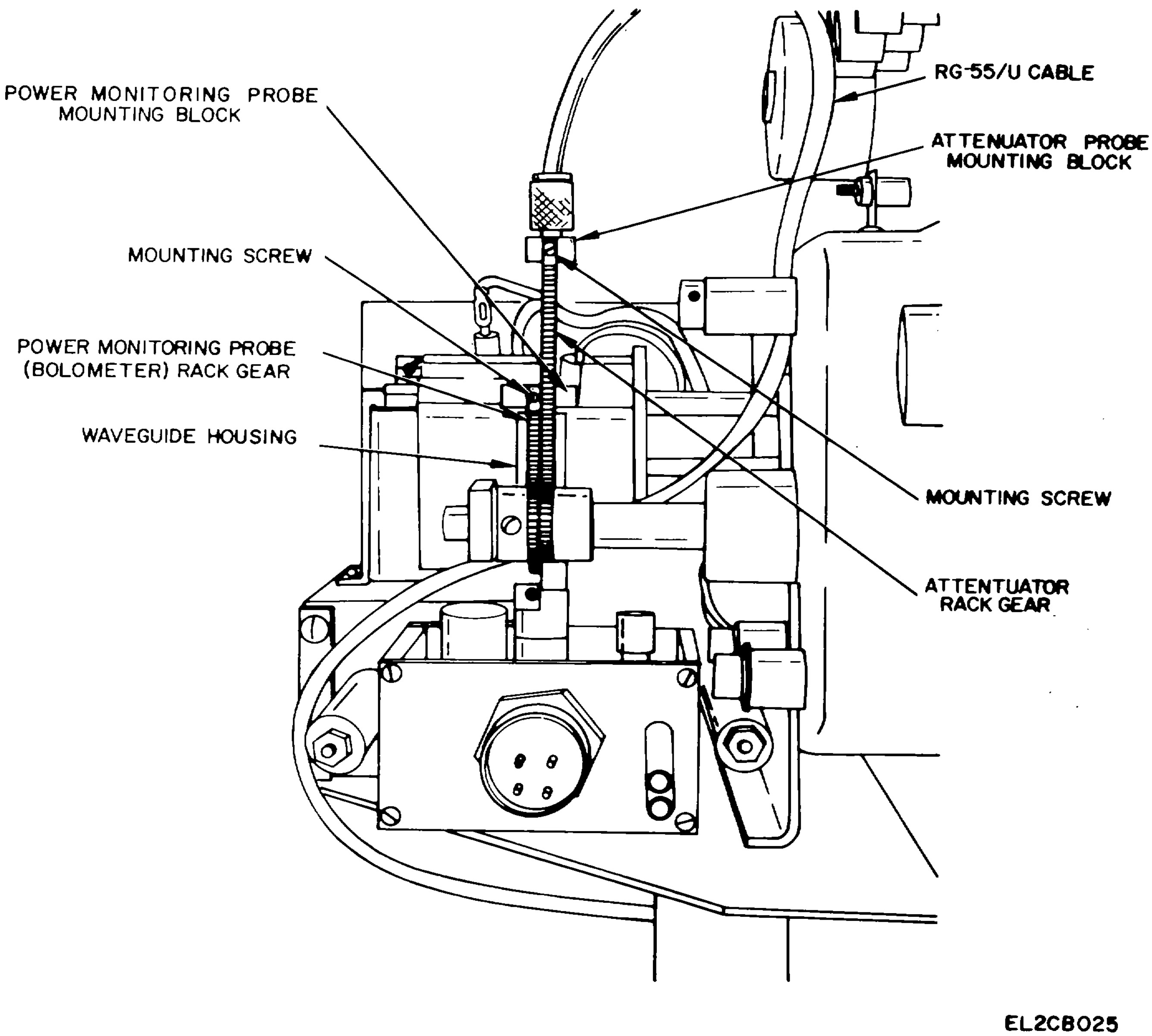


Figure 3-5. Attenuator and power monitoring probe drive assembly.

a. Remove the four screws holding RF OUTPUT

b. Release attenuator cable from under cable connector to front panel. clamp.

c. Remove mounting screw which holds mounting block on attenuator probe to end of attenuator rack gear.

d. Lift mounting block and probe from circular waveguide housing. Be careful when handling attenuator probe. The glass rod resistor can be broken by *twisting* the cable.

3-18. **Replacing Attenuator Probe Assembly**
(fig. 3-5)

The attenuator probe assembly is replaced in accordance with the following procedure:

a. Insert new probe into the waveguide housing only as far as is necessary to match up the mounting holes.

b. Insert mounting screw and tighten.

c. Carefully thread cable under cable clamp and around casting to front panel. Avoid twisting cable more than one-quarter turn.

d. Remount RF OUTPUT connector. Tighten cable clamp.

e. After the assembly is replaced, an error of a few decibels may exist in the calibration of the attenuator dial.

3-19. **Removing Power Monitoring Probe Assembly**
(fig. 3-5)

The power level within the resonator is sampled by an assembly consisting of the power monitoring probe, an open bead type thermistor at its tip, and the probe mounting block and terminals. The assembly will normally last the life of the equipment. However, if replacement becomes necessary, the following procedure should be used:

a. Remove attenuator probe assembly in accordance with the procedure in paragraph 3-17.

b. Disconnect the fine black and white leads that are soldered to the terminals on the power monitoring probe mounting block.

c. Remove the screw holding power monitoring mounting block to end of power monitoring **probe** rack gear.

d. Withdraw probe **from circular waveguide** housing.

3-20. **Replacing Power Monitoring Probe Assembly**
(fig. 3-5)

Replace the power monitoring probe assembly as follows:

a. Insert new probe only as far as is necessary to line up mounting holes. It is important that the replacement probe is not inserted too far into the waveguide housing.

b. Install mounting screw and tighten.

c. Solder black lead to terminal which is connected to shell of probe.

d. Solder white lead to terminal which is connected to the center conductor of the probe.

e. Install attenuator probe assembly in accordance with procedure in paragraph 3-18.

f. Upon installation of a new power monitoring probe, the calibration of the attenuator dial will usually be inaccurate, necessitating recalibration of this dial.

3-21. **Removing Repeller Tracking Potentiometer R174**

To remove repeller tracking potentiometer R174 requires the removal of the front panel assembly. This will require removal of the four type BNC connectors from the front panel, all panel leads connected to the terminal board under the cavity (fig. 3-7 and 3-6), and the klystron housing and socket. The panel assembly can then be safely drawn away from the rest of the instrument. Following removal of the panel assembly, proceed as follows:

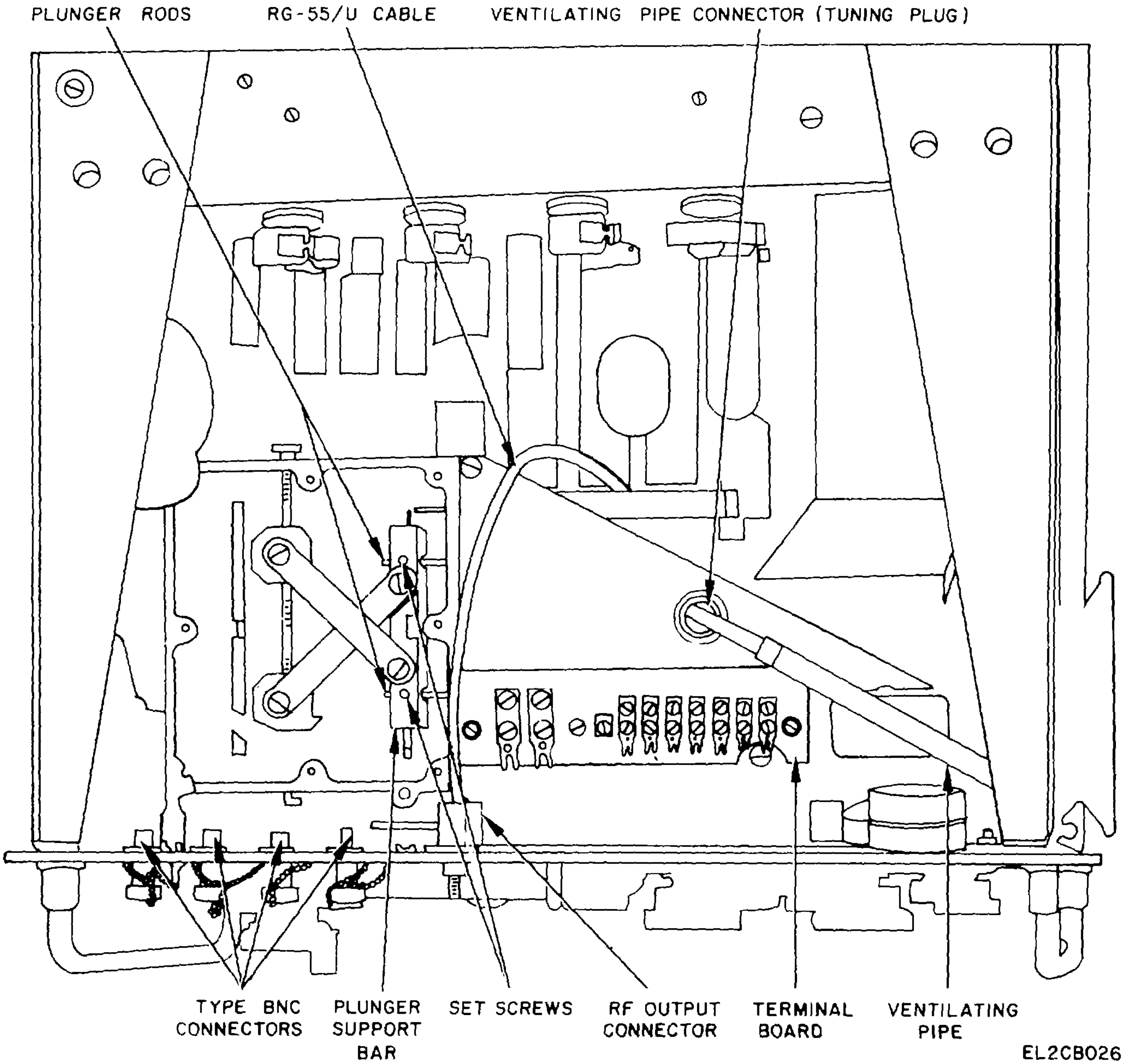


Figure 3-6. Frequency control assembly, Signal Generator AN/URM-52, bottom view.

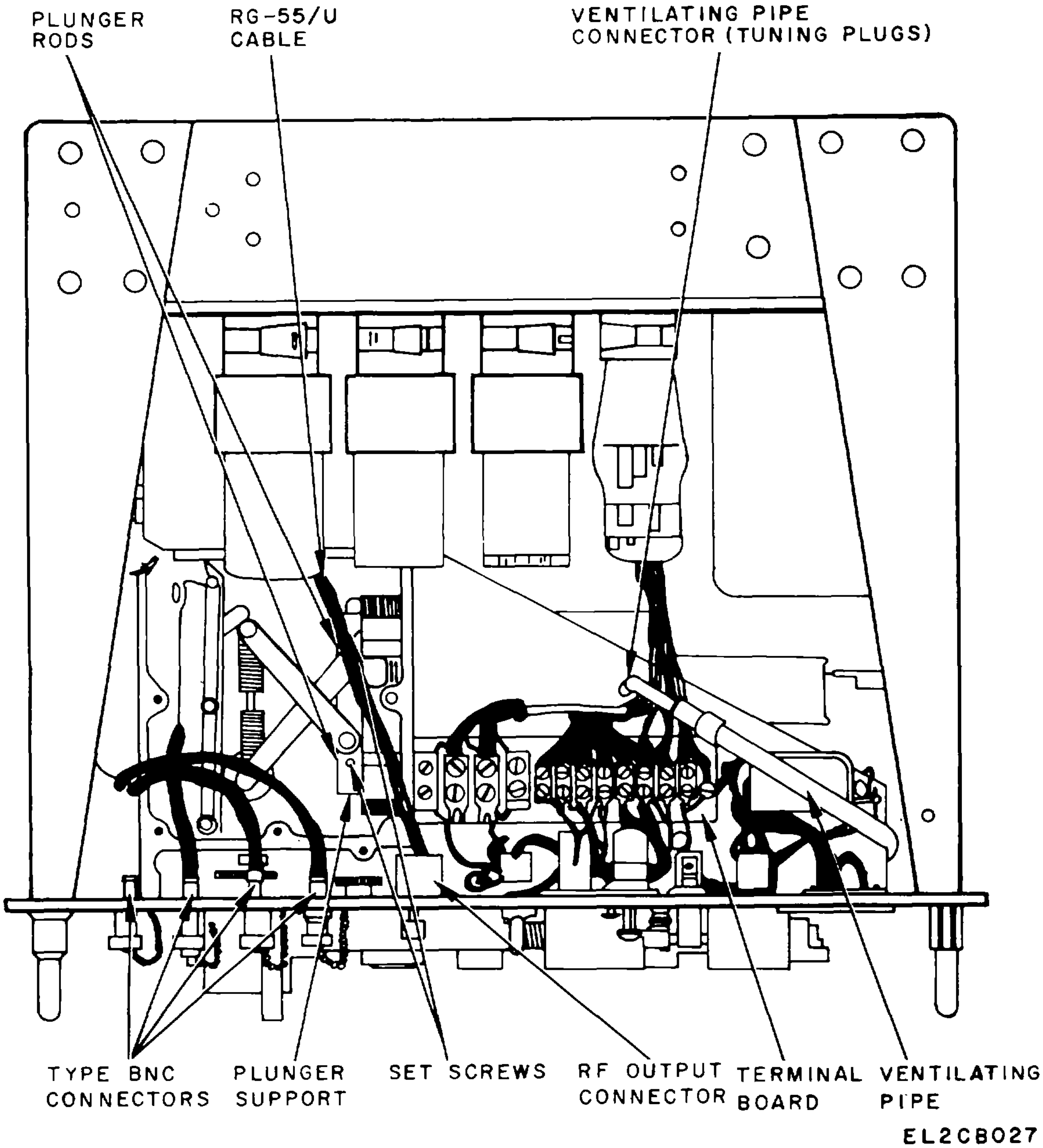


Figure 3-7. Frequency control assembly, Signal Generator AN/URM-52A, bottom view.

a. Loosen the setscrews holding potentiometer R174 shaft in the coupler. Remove leads from potentiometer and tag for easy identification when replaced.

b. Remove the three screws holding the potentiometer to the mounting ring and withdraw potentiometer. (Repeller tracking potentiometer R174 used in the TS-621C/U is mounted Lo the mounting ring by means of two hex nuts and lockwashers on two mounting screws supplied as an integral part of the potentiometer.)

3-22. **Replacing Repeller Tracking Potentiometer R174**

Replace potentiometer R174 as follows:

a. Place the shaft of the new potentiometer in the coupler. Do not tighten the setscrews.

b. Position potentiometer with terminals near the top and replace the three mounting screws. Be careful so that potentiometer shaft does not bind in coupler during any portion of rotation. Tighten mounting screws. Replace leads to respective terminals on the potentiometer.

c. Turn signal frequency control to one-half turn from low frequency end. (For TS-621C/U, connect a multimeter across R174 terminals 1 and 3, as viewed from the front panel, and set meter to read on low-resistance scale.)

d. Adjust potentiometer arm so that it is just at the end of potentiometer resistance wire. (For TS-621C/U, rotate signal frequency control to obtain an indication of 4250 megaHertz on the frequency dial. Rock the signal frequency control in the vicinity of 4250 megaHertz while observing the multimeter for a null indication. Null should be obtained within _20 megahertz of this point. If null is not found within these limits, adjust signal frequency control for 4250 megaHertz indication and lock control in this position. Loosen the two front setscrews on the R174 shaft coupler, turn R174 shaft by hand until a null is obtained and tighten the coupler setscrews.)

e. Tighten setscrews in the coupler.

f. Reset repeller voltage adjustments as described in paragraph 3-16 f through o.

g. Replace panel assembly, including all items removed in paragraph 3-21.

3-23. **Tube Replacement and Necessary Adjustments**

a. Replacing V103. Replacing V103 may lessen accuracy of PULSE RATE control, but will not otherwise affect the performance of the equipment.

b. Replacing V107. Replacing V107 may lessen the accuracy of the PULSE DELAY control.

c. Replacing V111. Replacing Vll may lessen the accuracy of the PULSE WIDTH control, and it may not be possible to reach either the minimum or maximum pulse width indicated on the dial.

d. Replacing V112 or V113. When either V112 or V113 is replaced, check and/or adjust the klystron control grid cutoff voltage and beam current as soon as the instrument is turned on and the klystron is operating. This is done as follows:

(1) Place MOD SELECTOR switch to OFF.

(2) Connect a dc voltmeter, with a sensitivity not less than 1000 ohms per volt between Din 3 of V303 and the chassis, with negative lead or the voltmeter on the chassis.

(3) Adjust R338 until the voltage is a minimum (approximately 0.1 volt). The adjustment should be make only to the point where the voltage no longer decreases. The remaining indication is the result of bleeder current, not klystron amode current. To further the adjustment unnecessarily increases the plate current of the modulator tube V1 1 '

(4) Place MOD SELECTOR switch to CW.

(5) Adjust R341 for exactly 2 volts, indicating a klystron anode current of 20 milliamperes. This value may be varied between 1.8 and 2.2 volts to give best operation of the klystron throughout the radio-frequency range when pulse modulated.

e. Replacing Tubes in Power Supply. When replacing tubes in the power supply section of the signal generator, the three power supplies are all regulated and interdependent, each using another as a reference point, and that the positive sides of two of the supplies are at ground potential and that of the third is 925 volts negative to ground. A change in the output in the -300-volt supply in turn changes the output voltage of the --1000-volt supply. One half of V303 is used in both the -300 and 1000 volt supplies; thus both supplies must be checked following its replacement.

f. Replacing V302, V303, or V304. Following replacement of V302, V303, or V304, proceed as follows:

(1) Connect a dc voltmeter, with a sensitivity not less than 1000 ohms per volt across the terminals of capacitor C304, with the positive lead of the voltmeter on the grounded terminal of capacitor C304.

(2) Adjust R307 until the voltage is **exactly** 300 volts.

(3) Check, and if necessary reset 1000-volt supply as described in g below.

g. Replacing V303 or V306. Following replacement of V303 or V306, proceed as follows:

(1) Connect negative lead of a dc voltmeter, with a sensitivity not less than 1000 ohms per volt to the -1000-volt buss (terminal board under resonator) and the positive lead to ground.

(2) Adjust R320 until voltage is exactly --1000 volts.

h. Replacing V308 through V312. Following replacement of any one of tubes V308 through V312, proceed as follows:

(1) Connect the negative lead of a dc voltmeter, with a sensitivity not less than 1000 ohms per volt to terminal 8 of the terminal board under resonator (-1500 volts) and the positive lead to terminal 9 (--1000 volts).

(2) Adjust R335 until the meter indicates exactly -500 volts.

(3) Following replacement of V312, check klystron operating current as described in d above.

i. Replacing V313 or V314. Following replacement of either of these tubes, proceed as follows:

(1) Connect the negative lead of a dc voltmeter, with sensitivity not less than 1000 ohms per volt to the chassis and positive lead to pin 3 of V303.

(2) Adjust R338 until the meter indicates 0.1 volt (voltage across resistor R31fi (d(3) above).

Section IV. GENERAL SUPPORT TESTING PROCEDURES

3-24. **General**

a. The following paragraphs and tables provide adjustment instructions and performance criteria for the AN/URM-52(*). These adjustments and checks should be performed periodically to assure maximum reliability of the signal generators, as part of troubleshooting procedures, and after repairs and adjustments to assure proper operation before returning the instrument to regular service.

b. Follow the instructions given in each of the paragraphs before those in the corresponding table. Perform each step in sequence. For each step, perform all the actions in the *Control settings* columns; then perform each procedure and verify it against its performance standard.

3-25. **Tools and Test Equipment**

Tools and test equipment required for general support testing procedures are listed in appendix C of TM 11-6625-214-12, and in the preliminary information preceding each performance test.

3-26. **External Pulse Synchronization Check**

a. Test Equipment Required.

(1) Pulse Generator AN/UPM-15.
(2) Oscilloscope AN/USM-281.

b. Test Connections and Conditions. Connect equipment as shown in figure 3-8, with oscilloscope vertical input alternately connected to SYNC OUT and DELAYED SYNC OUT connectors on AN/URM-52(*).

c. Procedure. Follow the procedures outlined in table 3-5.

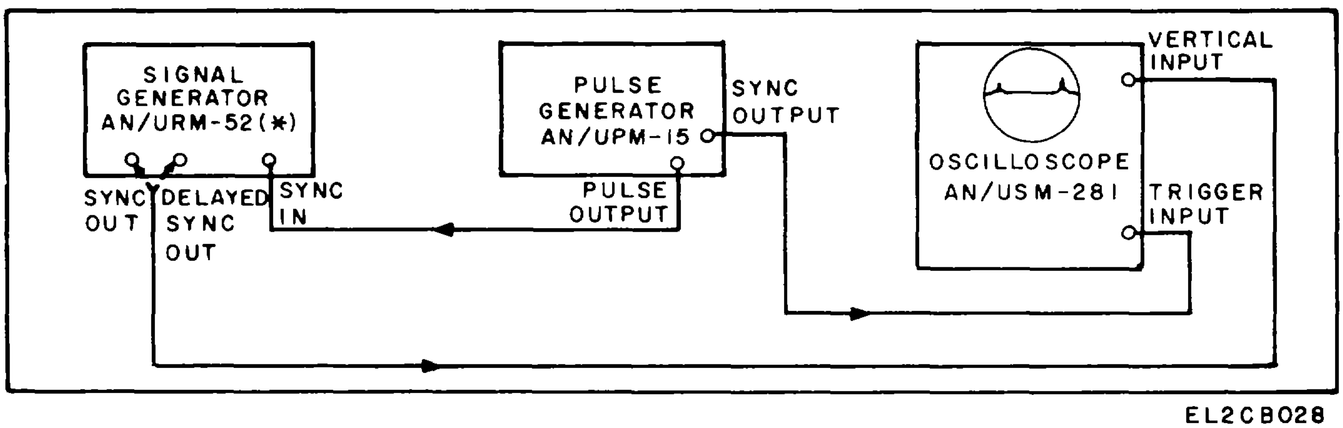


Figure 3-8. External pulse synchronization check, test setup.

Table 3-5. External pulse synchronization check

Step no.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/UPM-15* Pulse width: 0.5 us. Pulse rate: 1000 pps, negative out-put.	Signal frequency: 5 kMHz MOD SELECTOR: INT OUTPUT ATTEN.: -7 db FM AMPLITUDE: full ccw PULSE WIDTH: 5 PULSE DELAY: 25 PULSE RATE: 100 SYNC SELECTOR: EXT.-		
2	Adjust delay of AN/UPM-15 to a value which will permit entire pulse from AN/IJRM-52(*) to be observed on oscilloscope.			
3			a Adjust voltage output of AN/UPM-15 to minimum which will give reliable synchronization. **NOTE** Reliable synchronization is obtained when two or more pulses, separated by a period corresponding to the setting of the pulse rate control, remain on the oscilloscope screen with no sign of instability. b. Measure this voltage.	 5 volts max.
4	Same as step 2 with positive pulse output.	SYNC SELECTOR. EXT. +	Repeat step 3	5 volts max.

3-27. External Sine Wave Synchronization Check

a. Test Equipment Required.

(1) Oscilloscope AN/USM-281.
(2) Signal Generator AN/URM-127.

b. Test Connections and Conditions. Connect equipment as shown in figure 3-9, with oscilloscope vertical input alternately connected to SYNC-OUT and DELAYED SYNC-OUT connectors on AN/URM-52(*).

c. Procedure. Follow the procedures outlined in table 3-6.

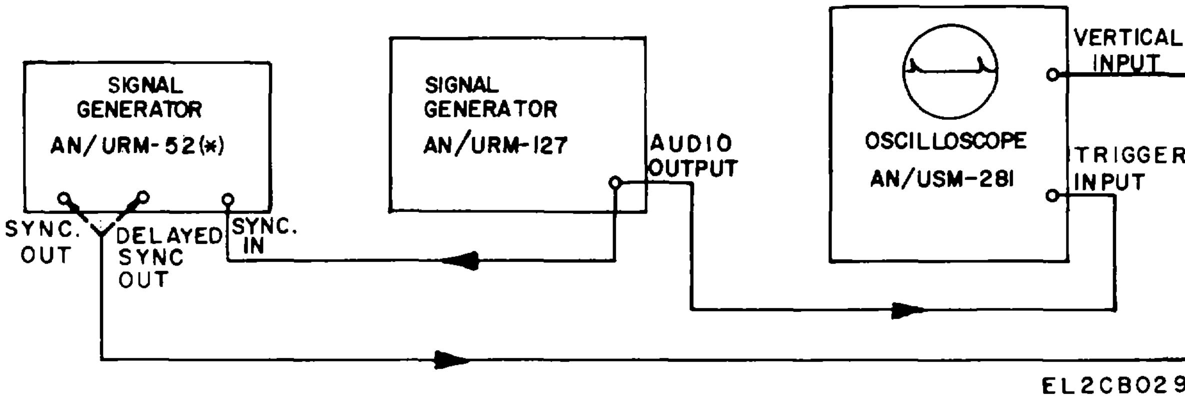


Figure 3-9. External sine wave synchronization check, test setup.

Table 3-6. External Sine Wave Synchronization Check

Step no.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/URM-12*	Signal frequency: 5 kMHz 100 Hz MOD SELECTOR. CW OUTPUT ATTN. -7 db		
	2	FM AMPLITUDE. fully ccw PULSE WIDTH: 5 PULSE DELAY: 25 PULSE RATE: **100** SYNC SELECTOR:	*a.* Adjust output voltage from AN/URM-127 to the minimum required for reliable synchronization. **NOTE** Reliable synchronization is obtained when two or more pulses, separated by a period corresponding to the setting of the pulse rate control, remain on the oscilloscope screen with no sign of instability. *b.* Measure this voltage	Not more than 5 volts rms.

3-28. External Pulse Modulation Check

a. Test Equipment Required.

(1) Oscilloscope AN/USM-281.
(2) Pulse Generator AN/UPM-15.
(3) Detector Mount MX-2569/U.

b. Test Connections and Conditions. Connect equipment as shown in figure 3-13.

c. Procedure. Follow the procedures outlined in table 3-7.

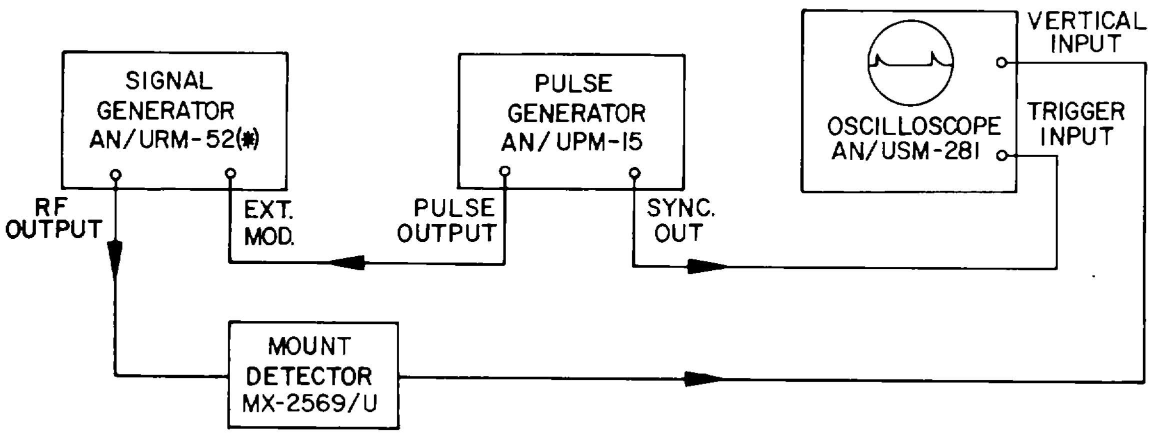


Figure 3-10. External pulse modification check, test setup.

Table 3-7. External Pulse Modulation Check

Step no.	Control settings		Test procedure	Performance standard
	Test equipment	**Equipment under test**		
1	*AN/UPM-15* Pulse rate:1000 pps, negative output. Pulse width: 5 us.	Signal frequency: 5 kMHz MOD. SELECTOR: EXT. - OUTPUT ATTNE: -7 db FM AMPLITUDE: fully ccw PULSE WIDTH: 5 PULSE DELAY: 25 PULSE RATE: 100 SYNC SELECTOR: X10		
2			Adjust voltage output of pulse generator to the minimum which will give a full-size rf output pulse.	Minimum peak amplitude necessary for satisfactory modulation should be more than 15 volts.
3	*AN/UPM-15* Positive pulse output.	MOD SELECTOR: EXT. +	Repeat step 2	Same as step 2.

3-29. External Frequency Modulation Check

a. Test Equipment Required.

(1) Oscilloscope AN/USM-281.
(2) Signal Generator AN/URM-127.
(3) Mount Detector MX-2569/U.

b. Test Connections and Conditions. Connect equipment as indicated in figure 3-11.

c. Procedure. Follow the procedure outlined in table 3-8.

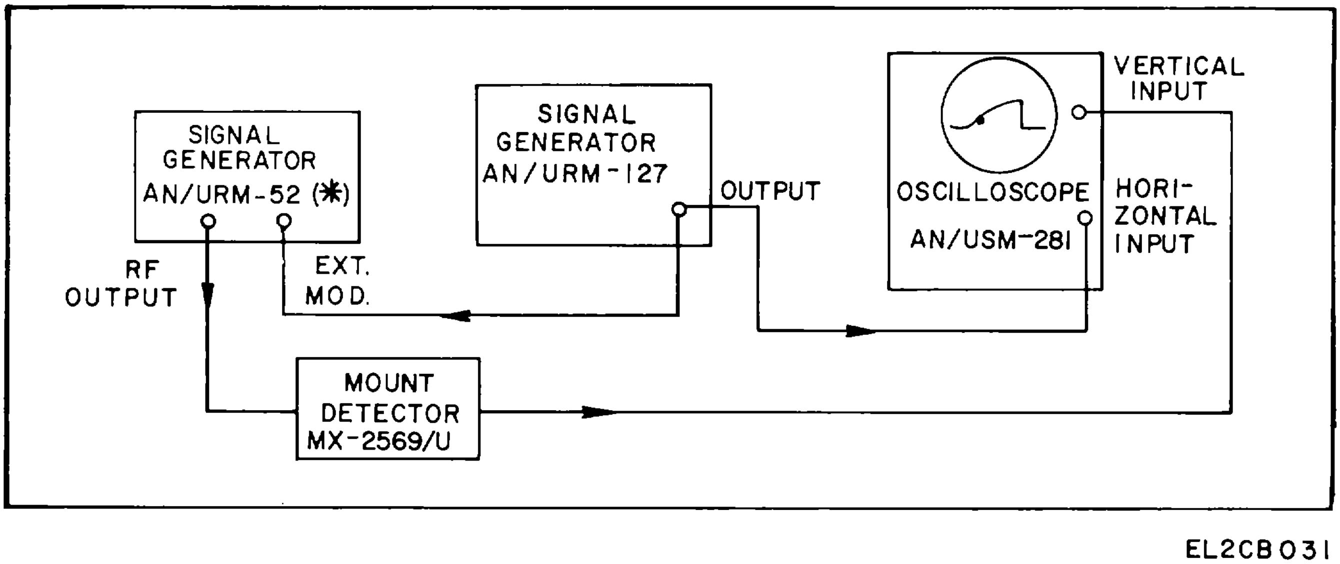


Figure 3-11. External frequency modulation check, test setup.

Table 3-8. External Frequency Modulation Check

Step no.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/URM-127* 10 volts approx 1 kHz	Signal frequency: 5 kMHz MOD SELECTOR: EXT.FM OUTPUT ATTEN: -7 db FM AMPLITUDE: fully ccw PULSE WIDTH' 5 PULSE DELAY: 25 PULSE RATE: 100 SYNC SELECTOR X10		
2			Observe the pattern on the oscilloscope which should represent a portion of the repeller mode.	As the FM AMPLITUDE control is varied, the pattern should change in length.

3-30. **Internal Frequency Modulation Check**

a. Test Equipment Required.

(1) Oscilloscope AN/USM-281.
(2) Mount Detector MX-2569/U.

b. Test Connections and Conditions. Connect equipment as indicated in figure 3-12.

c. Procedure. Follow the procedures outlined in table 3-9.

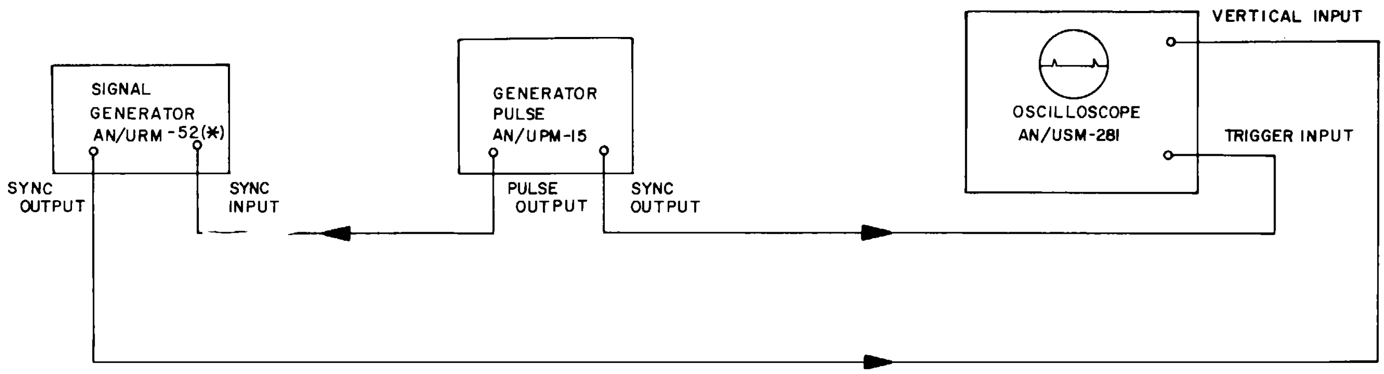


Figure 3-12. Internal frequency modulation check, test setup.

Table 3-9. Internal Frequency Modulation Check

Step no.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1		Signal frequency: 5 kMHZ MOD SELECTOR: INT OUTPUT ATTEN: -7 db FM AMPLITUDE: fully ccw PULSE WIDTH: 5 PULSE DELAY: 25 PULSE RATE: 100 SYNC SELECTOR: X10		
2			Slowly adjust FM amplitude control and observe change in amplitude of saw tooth pattern on oscilloscope.	This indicates proper operation of the internal frequency modulation circuits.

3-31. **Pulse Shape of Output Synchronizing Pulses-Check**

Pulse shape includes such factors as pulse width, rise and decay time, and flatness. To observe the output synchronizing pulses requires the use of a pulse generator with a variable time delay between the pulse output and the sync output so that the entire pulse of the AN/URM-52(*) will appear on the oscilloscope. To check sync-out pulse, proceed as follows:

a. Test Equipment Required.

(1) Oscilloscope AN/USM-281.
(2) Pulse Generator AN/UPM-15.

b. Test Connections and Conditions. Connect the equipment as shown in figure 3-13.

c. Procedure. Follow the procedures outlined in Label 3-10

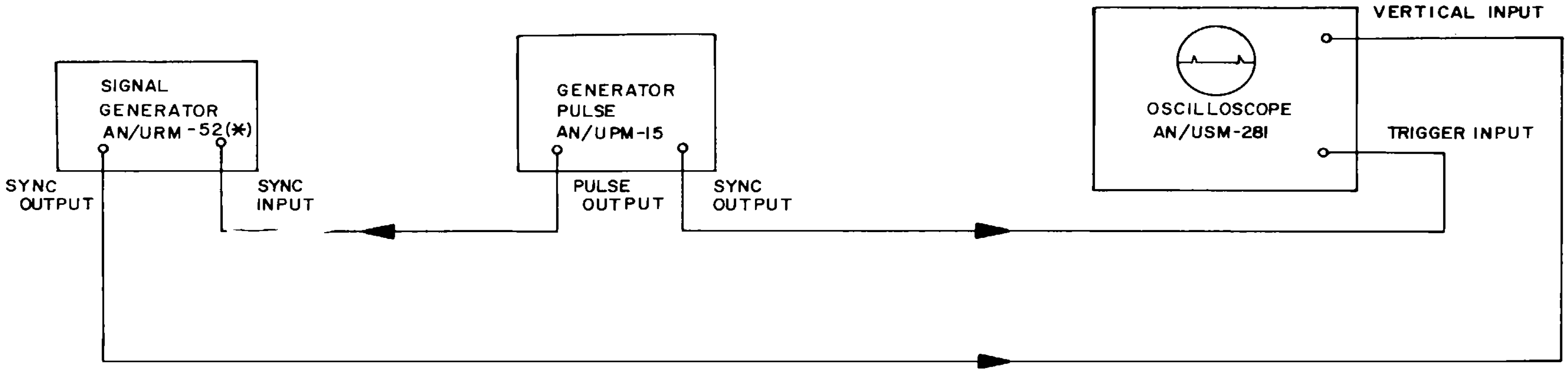


Figure 3-13. Pulse shape of output synchronzing pulses - check, test setup.

Table 3-10. Pulse Shape of Output Synchronizing Pulses Check

Step no.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/UPM-15* 1000 pps, negative output.	Signal frequency: 5 kMHz MOD SELECTOR: CW OUTPUT ATTEN: -7 db FM ALMPOITUDE: fully ccw PULSE WIDTH: 5 PULSE DELAY: 25 FULSE RATE: 100 SYNC SELECTOR: EXT. -		
2	Set delay on AN/UPM-15 to a value which will permit the entire pulse from the signal generator to be observed on oscilloscope.			
3			a. Connect a load, consisting of 1000-ohm resistor in parallel with a 500-uuf capacitor, across the AN/URM-52(*) SYNC OUT connector. b. Measure the peak amplitude and the width of the sync out pulse.	The peak amplitude should be greater than 25 volts and less than 100 volts. The width should be greater.

Table 3-10. Pulse Shape of Output Synchronizing Pulses Check--Continued,

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
				than 05 and less than 5 microseconds.
			c. Measure the rise and decay times.	Observe the flatness of the top of the pulse, and observe the magnitude and direction of any extraneous signals. The rise and decay time should each be less than 1 microsecond when measured between points that are 10 percent and 90 percent of the maximum amplitude of the initial rise. Between points on the initial rise and final decay that are 90 percent of the maximum amplitude of the initial rise, the amplitude should be within 90 to 100 percent of the maximum amplitude of the initial rise. The final' decay should have no rise in excess of 10 percent of the maximum amplitude of the initial rise

APPENDIX A

REFERENCES

DAL Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders. Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters.
TM 11-6625-320-12	Operators and Organizational Maintenance Manual Voltmeter,' Meter ME-30A/U and Voltmeters, Electronic ME-30B/U and ME-30C/U, and ME-30E/U.
TM 11-6625-368-10	Operators Manual: Pulse Generator Sets AN/UPM-15 and AN/UPM-15A.
TMP 11-6625-683-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Signal Generator AN/URM-127.
TMP 11-6625-1703-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tools Lists: Oscilloscope AN/USM-281A.
TM 38-750	The Army Maintenance Management Systems (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use. (Electronics Command.)

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USAES (2)
USAICS (3)
MAAG (1)
USARMIS (1)

Instl (2) except
Fort Gillem (10)
Fort Gordon (10)
Fort Huachuca (10)
Fort Carson (10)
Ft Richardson (ECOM) (2)
LBAD (14)
SAAD (30)
TOAD (14)
SHAD (3)
Sig FLDMS (1)
USAERDAA (1)
USAERDAW (1)
Umts org under fol TOE:
(1 cy each unit)
11-97
11-98
11-117
11-127
11-500 (AA-AC)
29-134
29-136
32-57
32-78
32-500

NG: None
USAR: None
For explanation of abbreviations used, see AR 310-50.

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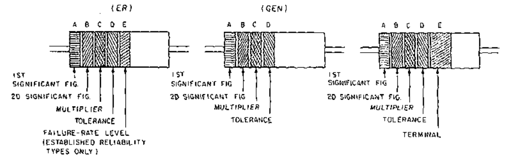


COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS.

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS.

TABLE I
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS.

BAND A		BAND B		BAND C		BAND D		BAND E		
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL	TERM
BLACK ...	0	BLACK	0	BLACK	1			BROWN	M=1.0	
BROWN	1	BROWN	1	BROWN	10			RED	P=0.1	
RED	2	RED	2	RED	100			ORANGE	R=0.01	
ORANGE...	3	ORANGE	3	ORANGE.	1,000			YELLOW..	S=0.001	
YELLOW....	4	YELLOW...	4	YELLOW.	10,000	SILVER	±10 (COMP. TYPE ONLY)	WHITE .	.....	SOLD-ERABLE
GREEN .	5	GREEN.....	5	GREEN ..	100,000	GOLD...	±5			
BLUE	6	BLUE......	6	BLUE. ..	1,000,000	RED....	±2 (NOT APPLICABLE TO ESTABLISHED RELIABILITY).			
PURPLE. (VIOLET)	7	PURPLE. .. (VIOLET)	7							
GRAY...	8	GRAY	8	SILVER	0.01					
WHITE...	9	WHITE...	9	GOLD	0.1					

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE (BANDS A THRU D SHALL BE OF EQUAL WIDTH.)

BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE.

BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE.)

BAND D — THE RESISTANCE TOLERANCE.

BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE - RATE LEVEL (PERCENT FAILURE PER 1,000 HOURS). ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY 1-1/2 TIMES THE WIDTH OF OTHER BANDS, AND INDICATES TYPE OF TERMINAL

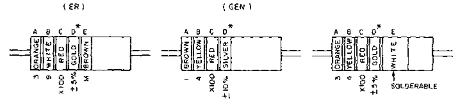
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS
(THESE ARE NOT COLOR CODED)

SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS. THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED. FOR EXAMPLE:

2R7 = 2.7 OHMS 10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS COLOR CODING IS NOT USED. IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS.

EXAMPLES OF COLOR CODING



NOMINAL RESISTANCE 3,900 OHMS
RESISTANCE TOLERANCE ±5%
FAILURE RATE LEVEL M

NOMINAL RESISTANCE 1,400 OHMS
RESISTANCE TOLERANCE ±10%

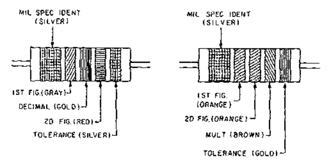
NOMINAL RESISTANCE 3,400 OHMS
RESISTANCE TOLERANCE ±5%
TERMINAL SOLDERABLE

COMPOSITION-TYPE RESISTORS

FILM-TYPE RESISTORS

* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ± 20% AND THE RESISTOR IS NOT MIL-STD.

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS.



(A) 8.2UH ± 10%

(B) 330UH ± 5%

COLOR CODING FOR TUBULAR ENCAPSULATED R.F CHOKES. AT A, AN EXAMPLE OF OF THE CODING FOR AN 8.2UH CHOKE IS GIVEN. AT B, THE COLOR BANDS FOR A 330UH INDUCTOR ARE ILLUSTRATED

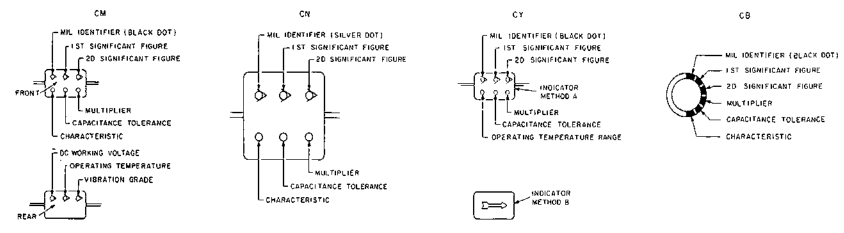
TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	1
RED	2	100	2
ORANGE	3	1,000	3
YELLOW	4		
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE			20
SILVER			10
GOLD	DECIMAL POINT		5

MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL

B. COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS.

CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB.

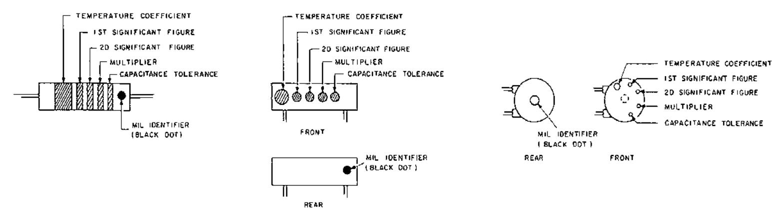


MICA-DIELECTRIC

PAPER-DIELECTRIC

GLASS-DIELECTRIC, GLASS CASE

MICA, BUTTON TYPE



AXIAL LEAD

RADIAL LEAD

DISK-TYPE

TABLE 3 — FOR USE WITH STYLES CM, CN, CY AND CB.

COLOR	MIL ID	1ST SIG FIG.	2D SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]			DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CB	CM	CY, CM	CM
BLACK	CM, CY CB	0	0	1			±20%	±20%		A			-55° TO +70°C	10-55 Hz
BROWN		1	1	10					B	E	B			
RED		2	2	100	±2%		±2%	±2%	C				-55° TO +85°C	
ORANGE		3	3	1,000		±30%			D		D	300		
YELLOW		4	4	10,000					E				-55° TO +125°C	10-2,000Hz
GREEN		5	5		±5%				F			500		
BLUE		6	6										-55° TO +150°C	
PURPLE (VIOLET)		7	7											
GRAY		8	8											
WHITE		9	9											
GOLD				0.1			±5%	±5%						
SILVER	CN			0.01	±10%	±10%	±10%	±10%						

TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC.

COLOR	TEMPERATURE COEFFICIENT[4]	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					CAPACITANCES OVER 10 UUF	CAPACITANCES 10 UUF OR LESS	
BLACK	0	0	0	1		± 2.0 UUF	CC
BROWN	-30	1	1	10	± 1%		
RED	-80	2	2	100	±2 %	± 0.25 UUF	
ORANGE	-150	3	3	1,000			
YELLOW	-220	4	4				
GREEN	-330	5	5		± 5 %	± 0.5 UUF	
BLUE	-470	6	6				
PURPLE (VIOLET)	-750	7	7				
GRAY		8	8	0.01*			
WHITE		9	9	0.1*	± 10%		
GOLD	+100			0.1		± 1.0 UUF	
SILVER				0.01			

1. THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.

2. LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS MIL-C-5, MIL-C-25D, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.

3. LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D

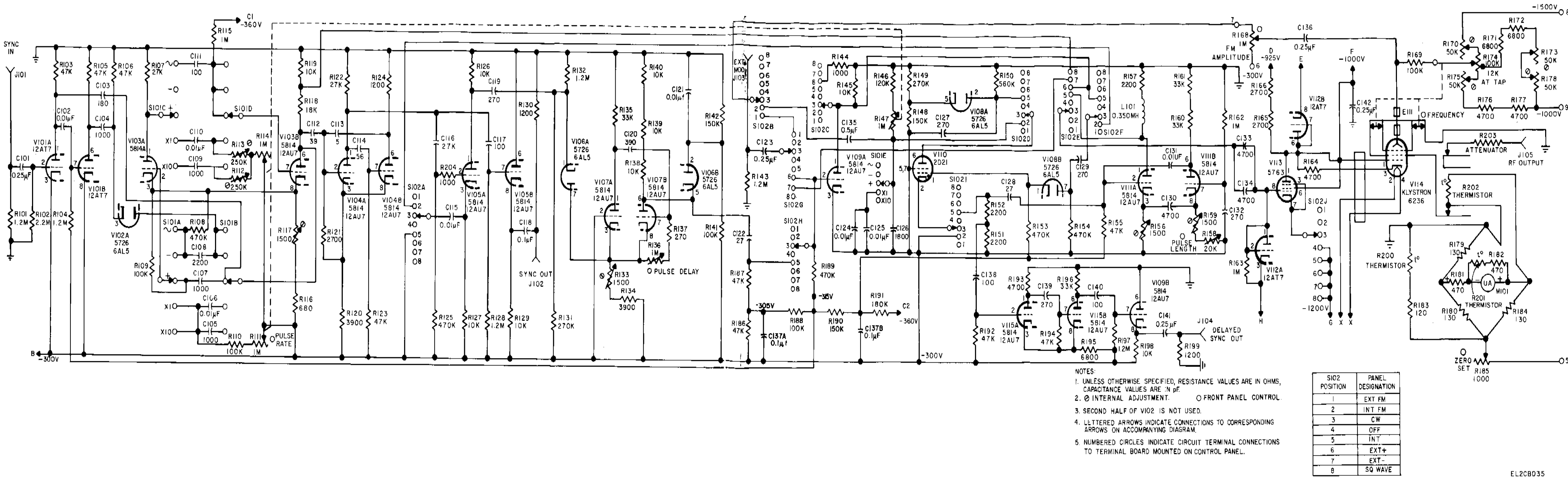
4. TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE.

* OPTIONAL CODING WHERE METALLIC PIGMENTS ARE UNDESIRABLE.

C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS.

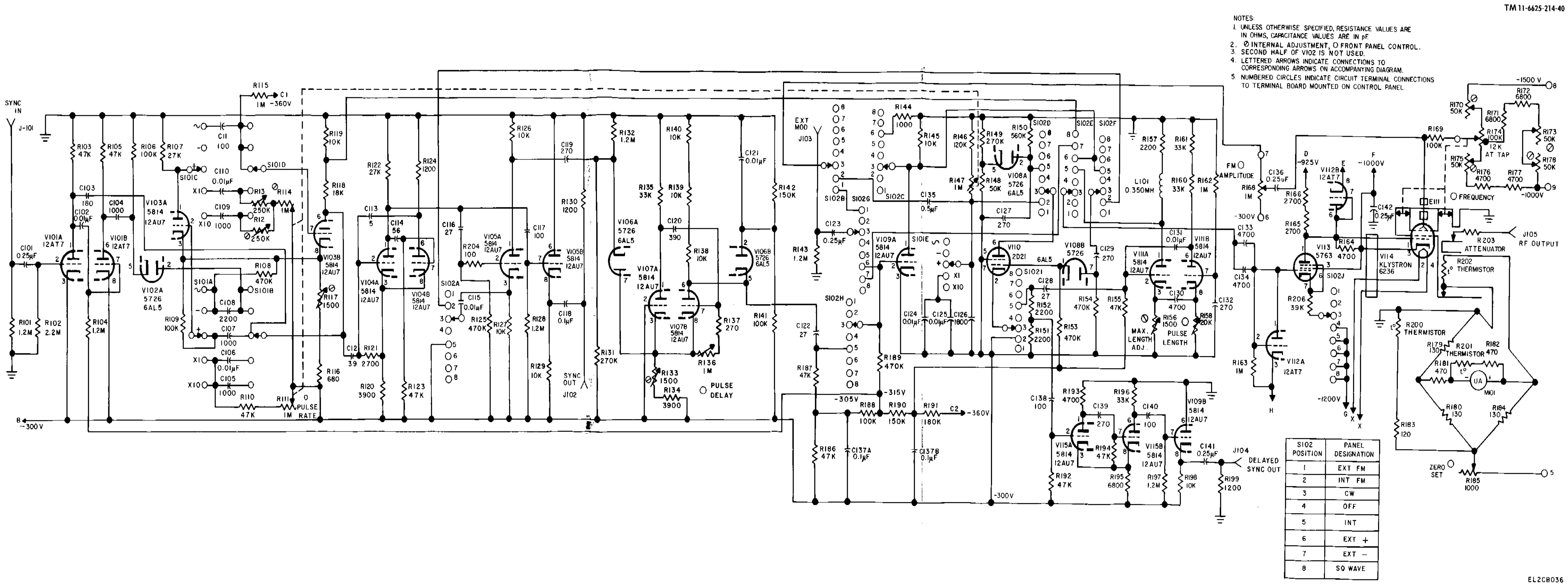
ESC-FM 913-73

Figure FO-1. Color code marking for JIL-STD resistors, indicators, and capacitors.



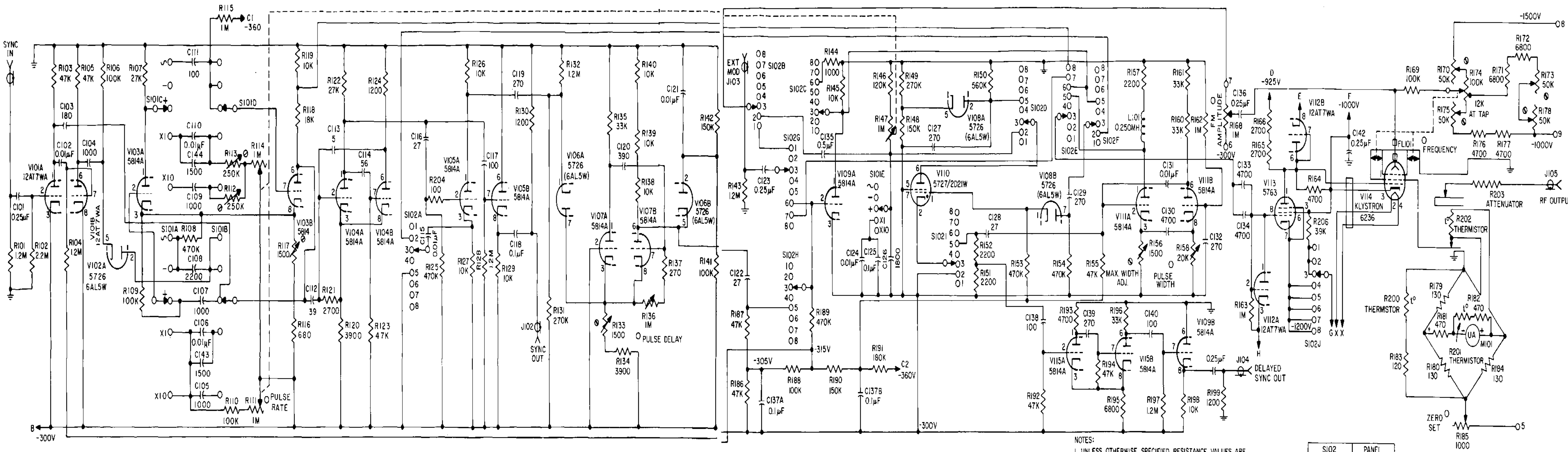
S102 POSITION	PANEL DESIGNATION
1	EXT FM
2	INT FM
3	CW
4	OFF
5	INT
6	EXT+
7	EXT-
8	SQ WAVE

Figure FO-2. Signal Generator TS-621/U pulser and rf oscillator sections, schematic diagram.



S102 POSITION	PANEL DESIGNATION
1	EXT FM
2	INT FM
3	CW
4	OFF
5	INT
6	EXT +
7	EXT –
8	SQ WAVE

Figure FO-3. Signal Generator TS-621A, B/U pulser and rf oscillator sections, schematic diagram



NOTES:

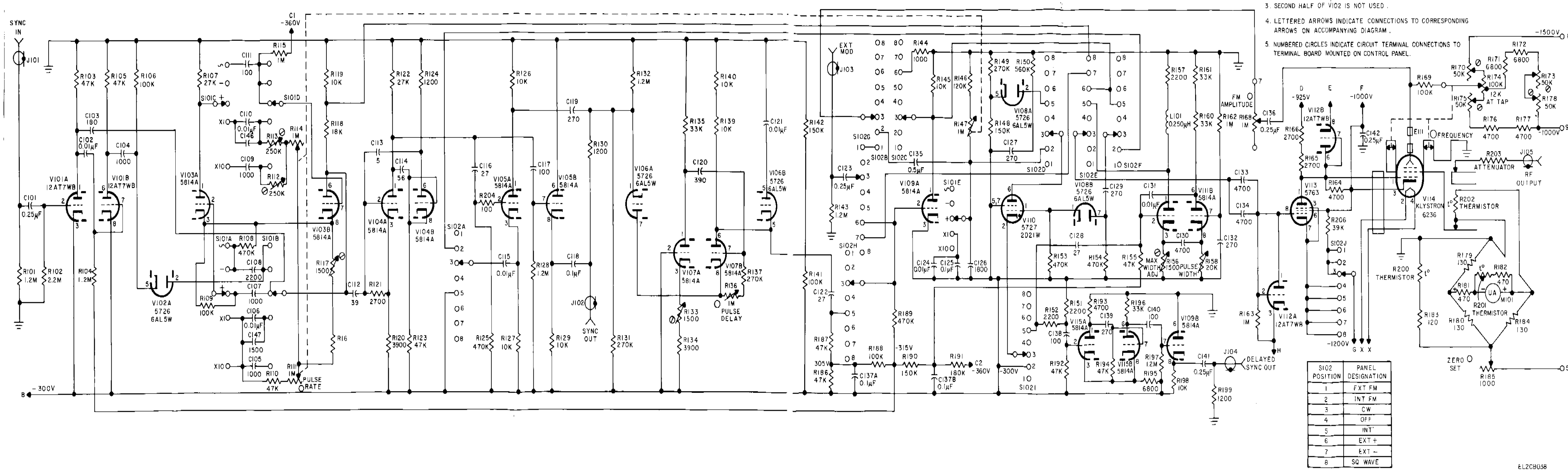
1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN pF
2. ⊘ INTERNAL ADJUSTMENT. O FRONT PANEL CONTROL.
3. SECOND HALF OF V102 IS NOT USED.
4. LETTERED ARROWS INDICATE CONNECTIONS TO CORRESPONDING ARROWS ON ACCOMPANING DIAGRAM.
5. NUMBERED CIRCLES INDICATE CIRCUIT TERMINAL CONNECTIONS TO TERMINAL BOARD MOUNTED ON CONTROL PANEL.

S102 POSITION	PANEL DESIGNATION
1	EXT FM
2	INTR FM
3	CW
4	OFF
5	INTR
6	EXT+
7	EXT-
8	SQ WAVE

EL2CB037

Figure FO-4. Signal Generator TS-621C/U pulser and rf oscillator sections, schematic diagram

TM 11-6625-214-40



S102 POSITION	PANEL DESIGNATION
1	EXT FM
2	INT FM
3	CW
4	OFF
5	INT
6	EXT +
7	EXT –
8	SQ WAVE

Figure FO-5. Signal Generator SG-557/U pulser and rf oscillator sections, schematic diagram

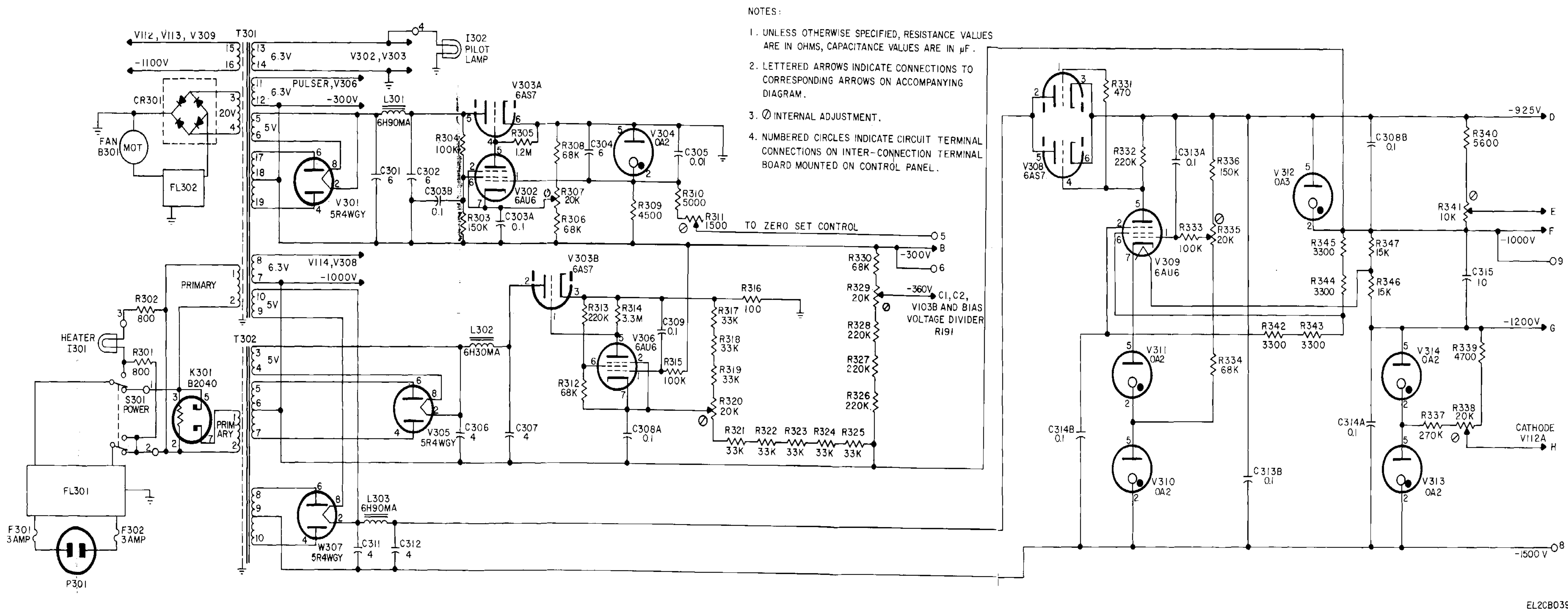


Figure FO-6. Signal Generator TS-621/U pulser and rf oscillator sections, schematic diagram

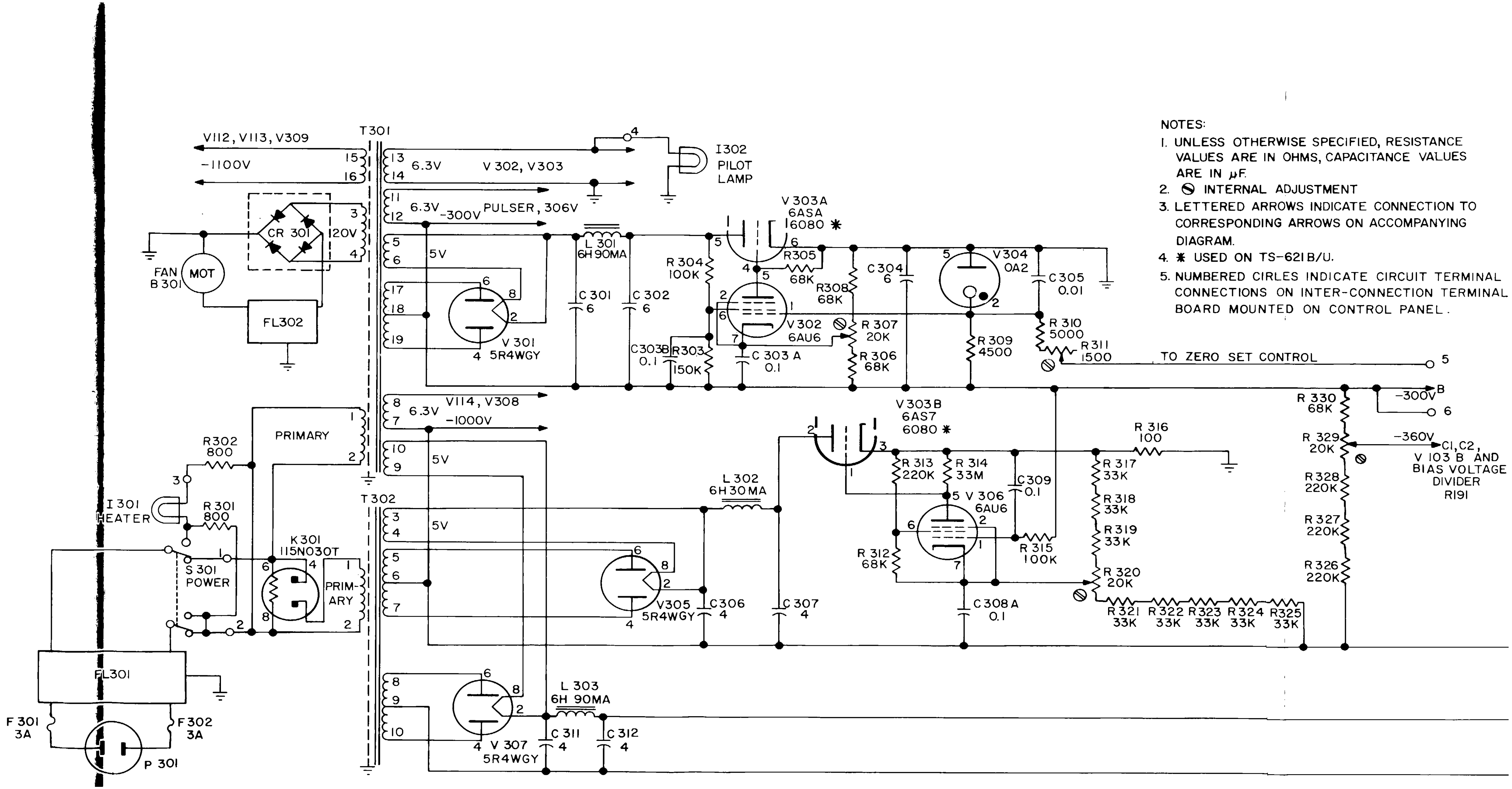


Figure FO-7. Signal generator TS-621A,B/U power supply section, schematic diagram.

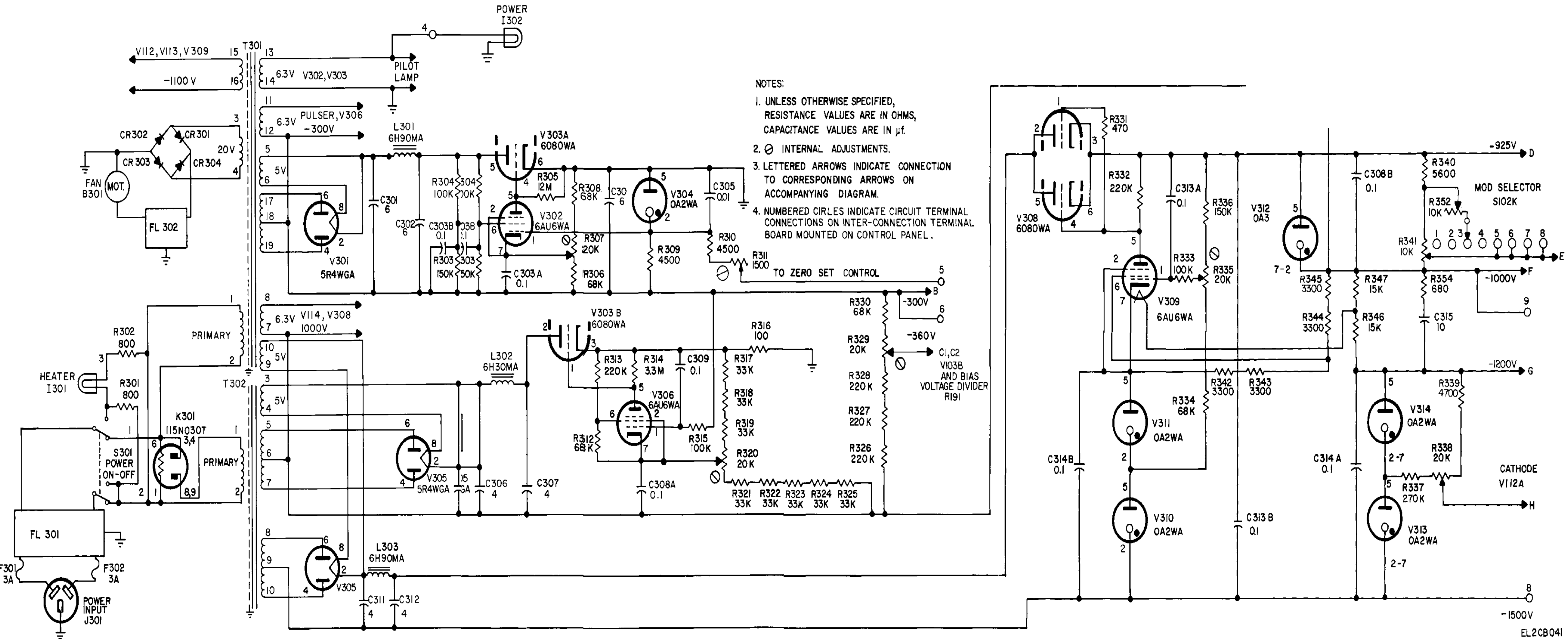


Figure FO-8. Signal Generator TS/621C/U power supply section, schematic diagram.

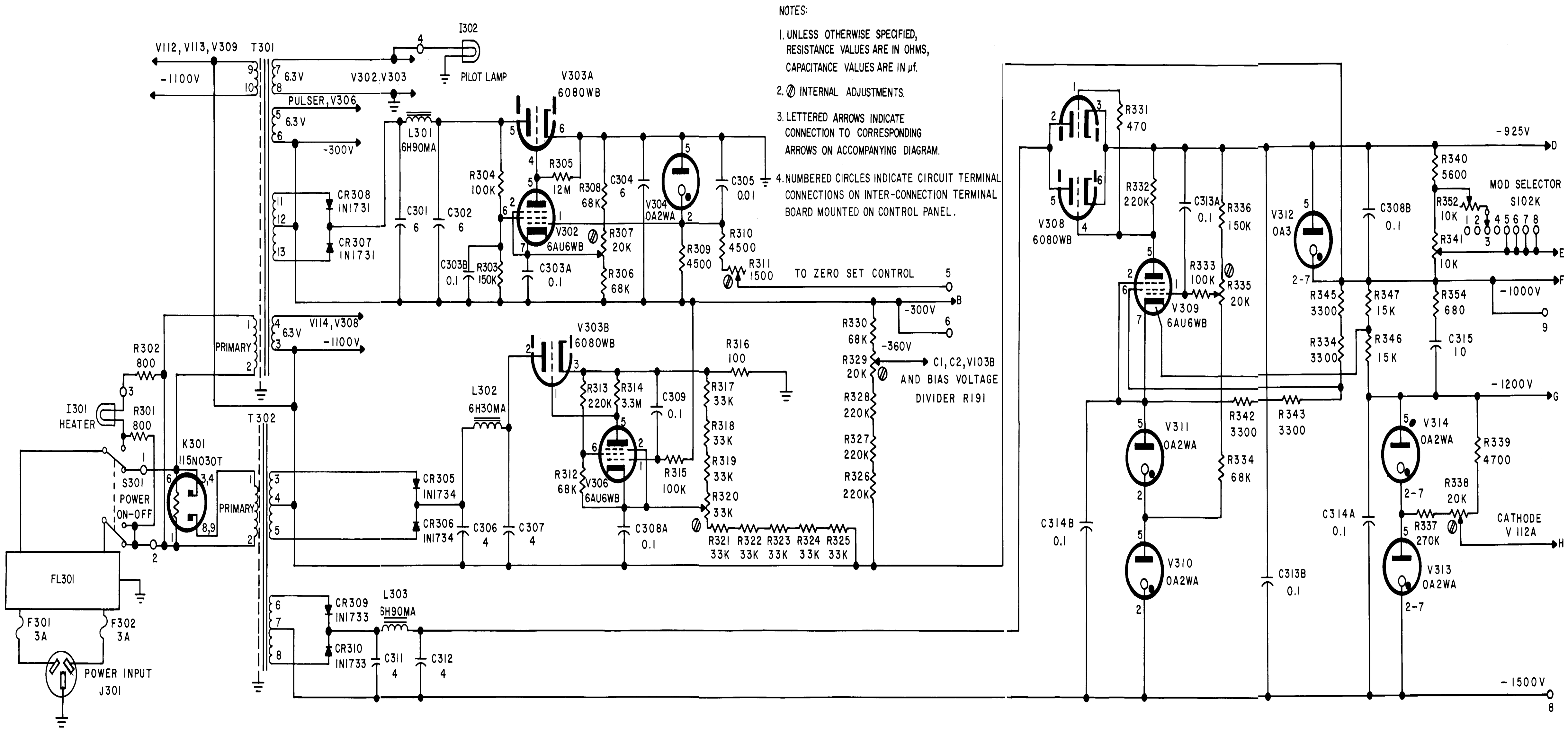
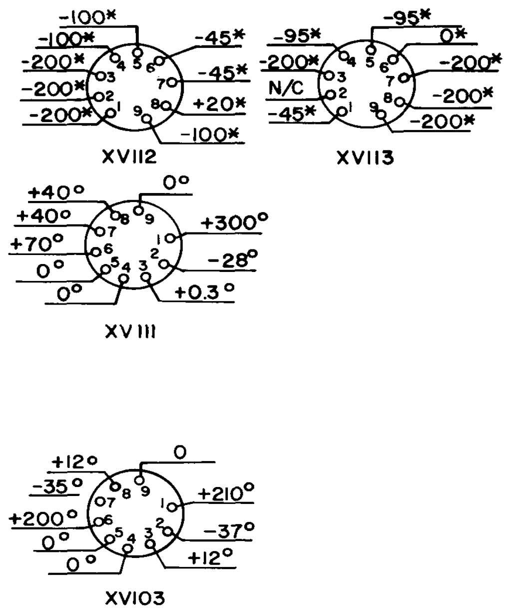
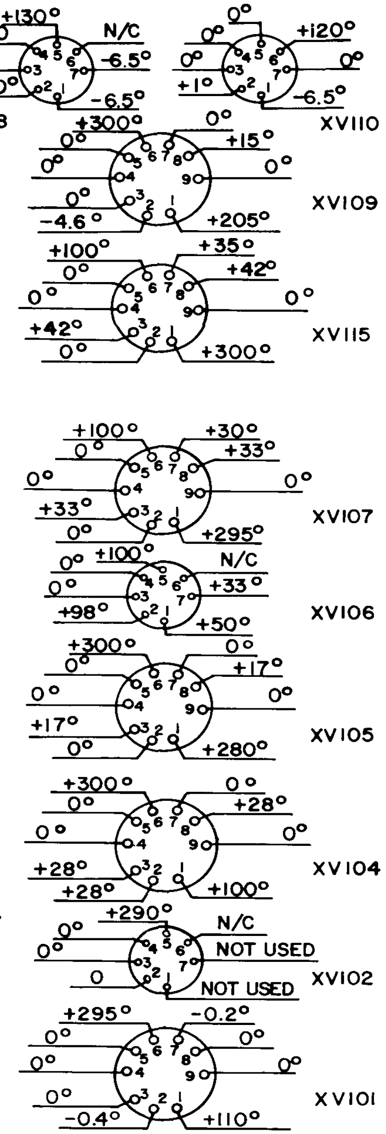
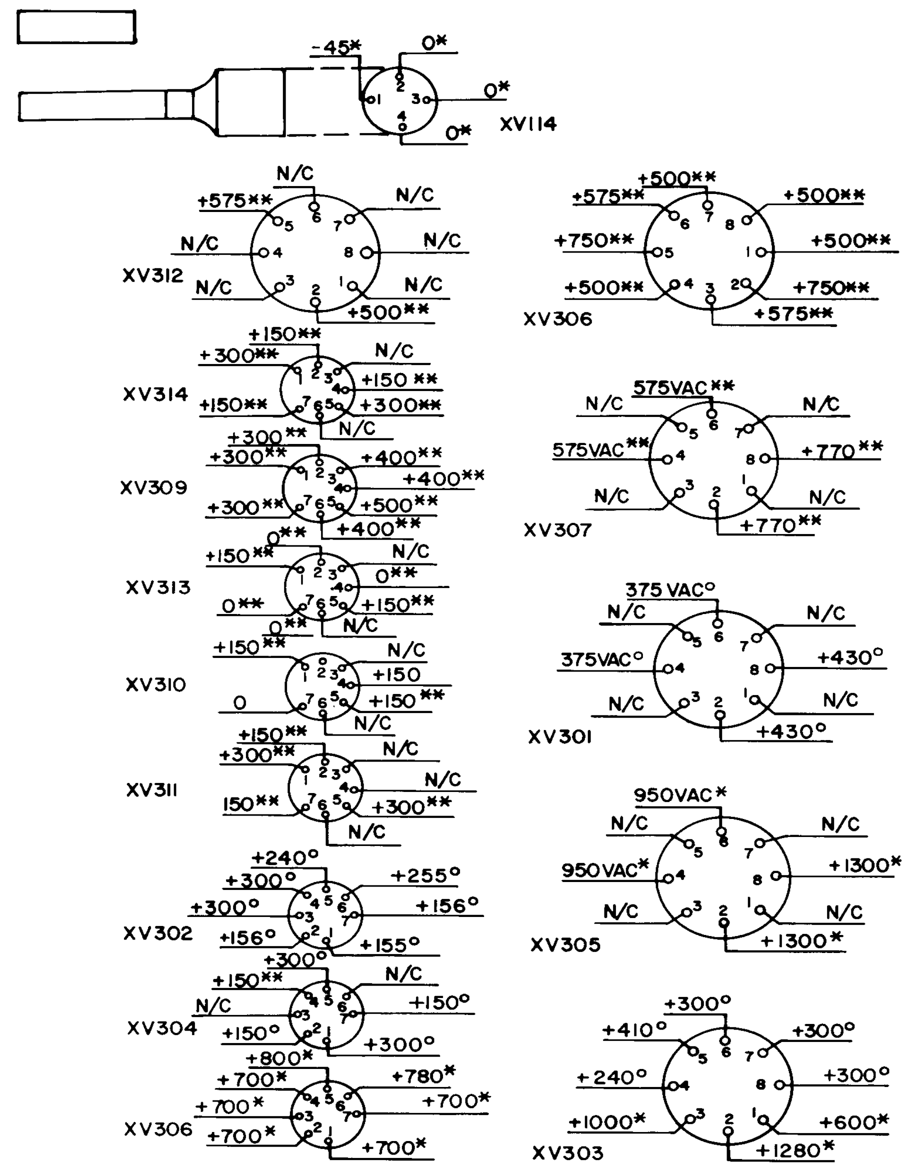


Figure FO-9. Signal Generator GS-557/U power supply section, schematic diagram.



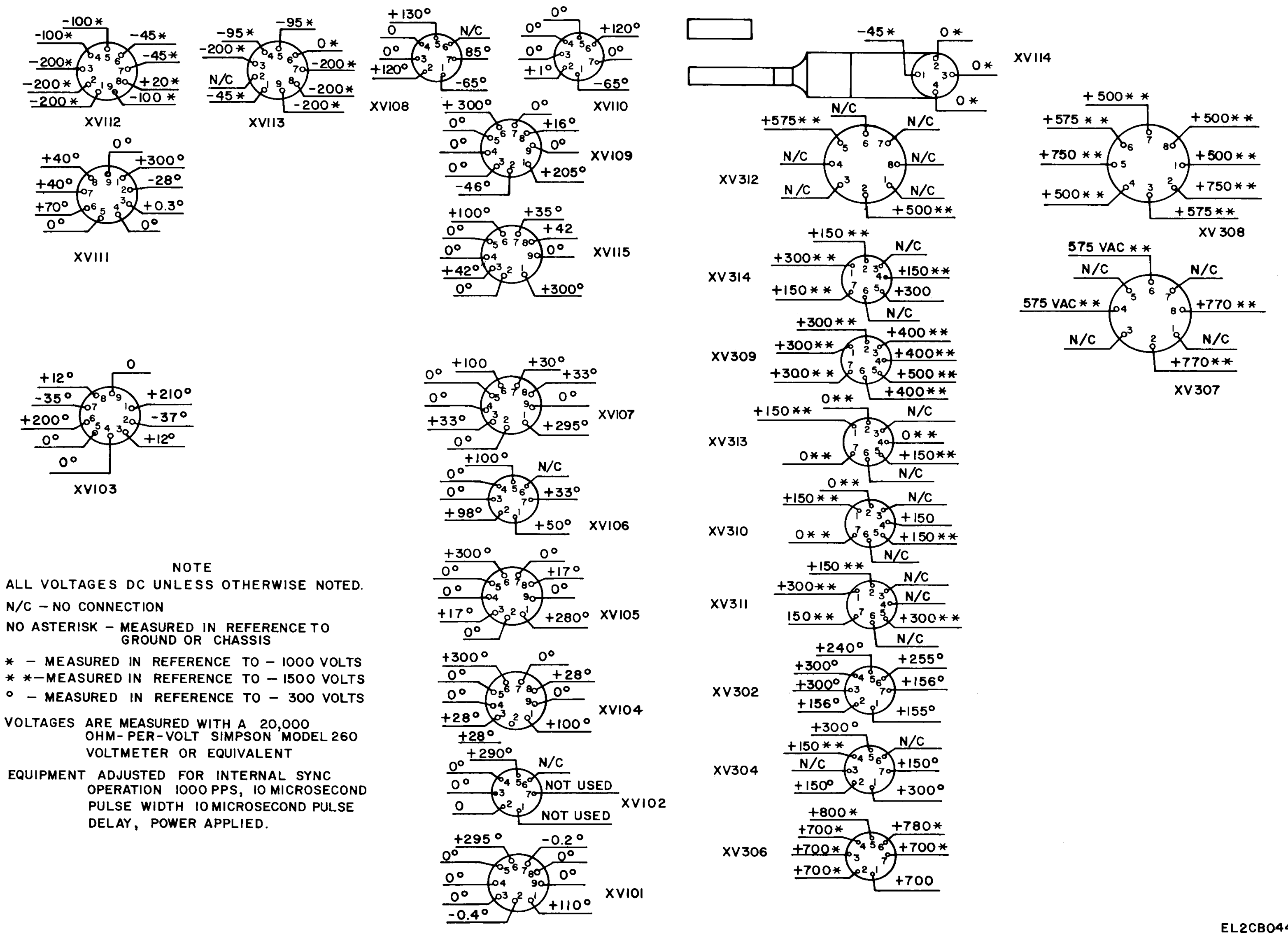




NOTES:

1. ALL VOLTAGES DC UNLESS OTHERWISE NOTED.
2. N/C—NO CONNECTION
3. NO ASTERISK—MEASURED IN REFERENCE TO GROUND OR CHASSIS.
4. * —MEASURED IN REFERENCE TO -1000 VOLTS.
5. ** —MEASURED IN REFERENCE TO -1500 VOLTS.
6. ° — MEASURED IN REFERENCE TO —300 VOLTS.
7. VOLTAGES ARE MEASURED WITH A 20,000 OHM-PER-VOLT SIMPSON MODEL 260 VOLTMETER OR EQUIVALENT.
8. EQUIPMENT ADJUSTED FOR INTERNAL SYNC OPERATION, 100PPS, 10 MICROSECOND PULSE WIDTH, 10 MICROSECOND PULSE DELAY, POWER APPLIED.

Figure FO-10. Tube socket voltage measurement for Signal Generators TS-621, A, B/U.



NOTE

ALL VOLTAGES DC UNLESS OTHERWISE NOTED.

N/C – NO CONNECTION

NO ASTERISK – MEASURED IN REFERENCE TO GROUND OR CHASSIS

* – MEASURED IN REFERENCE TO – 1000 VOLTS

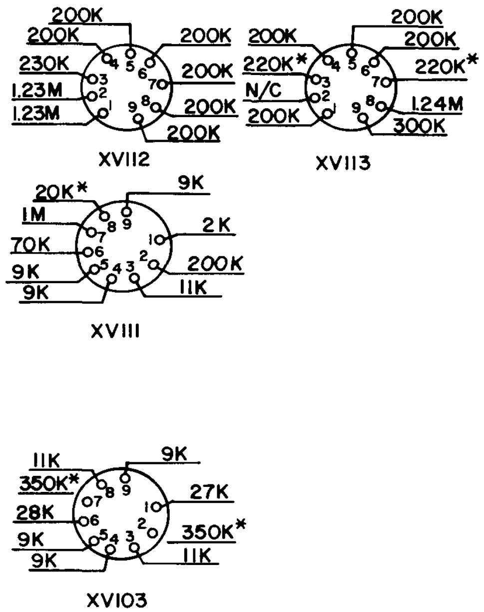
** – MEASURED IN REFERENCE TO – 1500 VOLTS

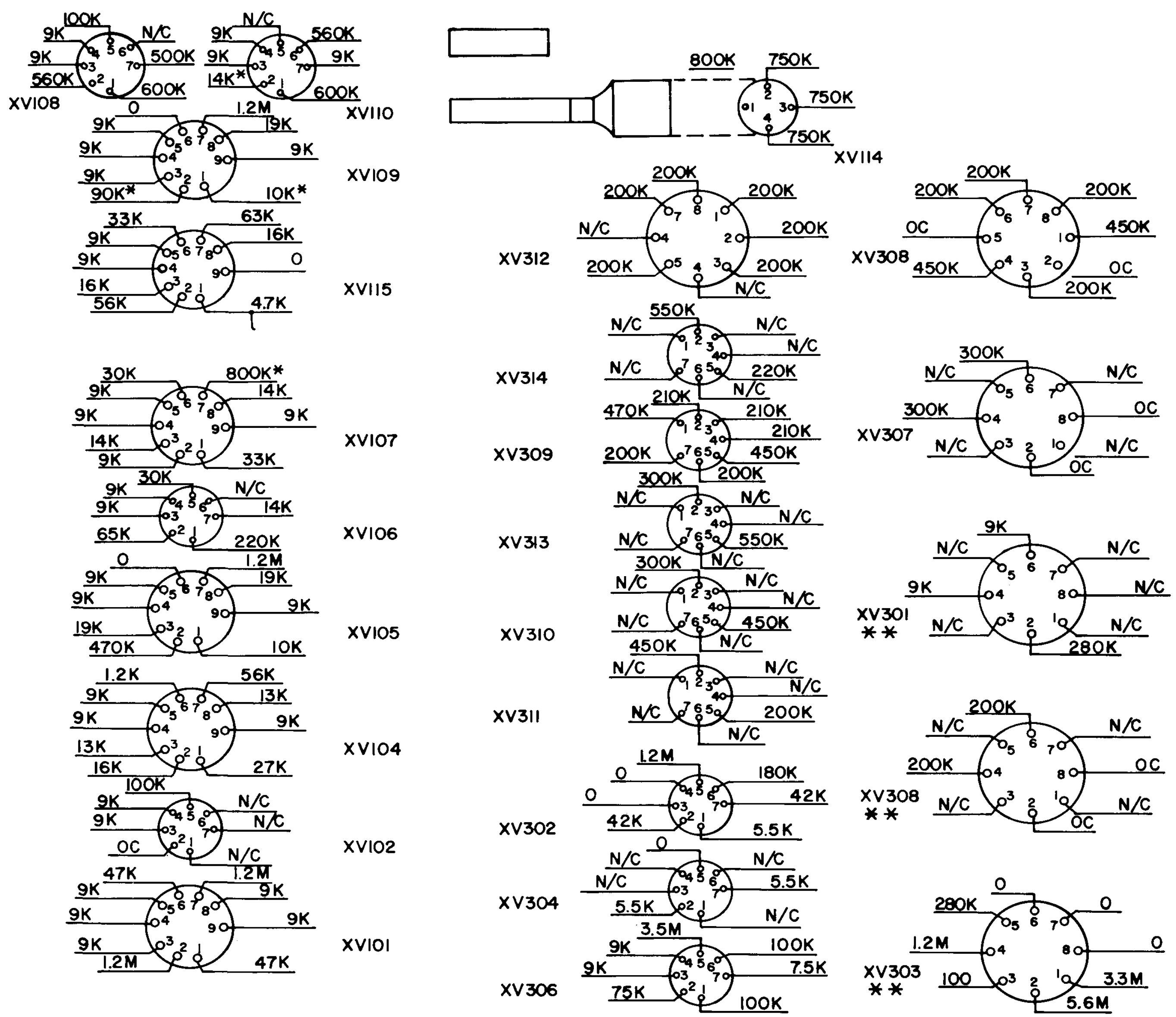
° – MEASURED IN REFERENCE TO – 300 VOLTS

VOLTAGES ARE MEASURED WITH A 20,000 OHM-PER-VOLT SIMPSON MODEL 260 VOLTMETER OR EQUIVALENT

EQUIPMENT ADJUSTED FOR INTERNAL SYNC OPERATION 1000 PPS, 10 MICROSECOND PULSE WIDTH 10 MICROSECOND PULSE DELAY, POWER APPLIED.

Figure FO-11. Tube socket voltage measurement for Signal Generators GS-557/U.





NOTES

1. EQUIPMENT DISCONNECTED FROM AC SOURCE
2. K–1000 OHMS
3. M–MEGOHMS
4. MEASUREMENTS MADE WITH SIMPSON MODEL 260 VOLT–OHM METER OR EQUIVALENT, USING SCALE THAT GIVES READING CLOSEST TO CENTER OF SCALE, REFERENCE TO GROUND OR CHASSIS.

* THESE VALUES WILL VARY WITH THE SETTING OF THE FRONT PANEL CONTROLS.

** V301, V305 AND V303 REPLACED BY CR305 THROUGH CR310 IN SG-557/O.

EL2CB045

*Figure FO-12. Tube socket voltage measurement for Signal Generators AN/URM-52(**

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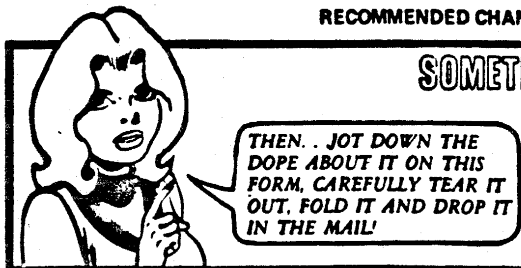

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