DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FIELD AND DEPOT MAINTENANCE MANUAL

SIGNAL GENERATOR SG-336/U

HEADQUARTERS, DEPARTMENT OF THE ARMY
12 MARCH 1962

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 115- or 220-volt ac line connections. Serious injury or death may result from contact with these terminals.

DON'T TAKE CHANCES!

Technical Manual No. 11-6625-406-35

.HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *12 March 1962*

SIGNAL GENERATOR SG-336/U

CHAPTER 1
THEORY

Section I. GENERAL

1. Scope

a. This manual covers field and depot maintenance for Signal Generator SG366/U. It includes instructions appropriate to fourth. and fifth echelons for troubleshooting, testing, aligning, and repairing the equipment, replacing maintenance parts, and repairing specified maintenance parts. It also lists tools, materials, and test equipment for fourth and fifth echelon maintenance. Detailed functions of the equipment are covered in paragraphs 3 through 12.

Note: There are no maintenance functions assigned to third echelon.

b. The complete technical manual for this equipment includes TM 11-6625-40612.

c. Refer to DA Pamphlet 310-4 to determine what Changes to or revisions of this publication are current.

d. Forward comments concerning this manual direct to the Commanding Officer, U. S. Army Signal Materiel Support Agency, ATTN: , SIGMS-PA2d, Fort Monmouth, N. J.

Note: For applicable forms and records, see paragraph 2, TM 11-6625-406-12.

2. Block Diagram

(fig. 1)

The signal generator incorporates a wide-band sweeping oscillator signal source with crystal-controlled, pulse-type frequency markers. It is used for testing, ,aligning, and repairing radar intermediate-frequency (if.) circuits. Signal paths and waveforms are shown in the block diagram (fig. 1) and are described in a through below. For complete circuit details, refer to the overall schematic diagram (fig. 30).

a. Sweep, Generator VI. Sweep generator V1 develops a square-wave output voltage from which a linear sawtooth sweep voltage is derived. The sweep generator is essentially a free-running multivibrator, normally synchronized to the line frequency. The repetition rate maybe varied slightly above or below the line frequency by means of .the front panel SWEEP RATE control. The square-wave output voltage of the sweep generator is applied to a shaping network and to the sweeping oscillator.

b. Shaping Network. The shaping network consists of a resistive-capacitive integrating circuit, which shapes the square-wave voltage applied from sweep generator V1 into a symmetrical, linear sawtooth voltage. The sawtooth output voltage is applied to the SWEEP OUTPUT terminals for connection to the horizontal deflection circuits of an external oscilloscope, and is also applied to sawtooth amplifier V2 and compensating modulator V3.

c. Sawtooth Amplifier V2. Sawtooth amplifier V2 is a single-stage power amplifier, which develops a linear sawtooth current in its plate circuit. The sawtooth current is applied to the control winding of a saturable reactor in the tuned circuit of sweeping oscillator V4, causing the reactance of the saturable reactor and the output frequency of the sweeping oscillator to vary at a linear rate.

d. Sweeping Oscillator V4. Sweeping oscillator V4 consists of a push-pull negative-resistance oscillator circuit that is used to generate a sweeping output in the 20- to 40-megacycle (mc) or the 50- to 70-mc range. The frequency of oscillation depends on the inductance of a saturable reactor in the oscillator tuned circuit. The inductance of the saturable reactor is varied at a linear rate by the sawtooth current applied from sawtooth amplifier V2, and the output frequency of the sweeping oscillator thus varies linearly at the sawtooth rate. During the negative-going portion of the sawtooth, sweeping oscillator V4 is blanked by the square-wave voltage applied to its control grid from sweep generator V1 to provide a clear, zero-voltage reference line on the external oscilloscope during use. The output voltage of sweeping oscillator V4 is maintained at a constant level by a compensating voltage applied from compensating modulator V3. The frequency-swept output voltage of sweeping oscillator V4 is applied to an attenuator network and to a crystal marker circuit.

e. Compensating Modulator V3. Because of the relatively wide frequency deviation in the output of sweeping oscillator V4, the amplitude of the output voltage has a tendency to vary during the sweep cycle.

Compensating modulator V3 is used to amplitude-modulate the sweeping oscillator stage at the sawtooth rate to compensate for this tendency and to maintain the sweeping oscillator output at a relatively constant amplitude. A sawtooth voltage : from the shaping network is applied as the input signal to compensating modulator V3, and the output of the compensating modulator is applied to the plate circuit of sweeping oscillator V4.

f. Attenuator Network. The output voltage of sweeping. oscillator V4 is applied to the 50 Ω SWEEPING OSCILLATOR OUTPUT connector through a resistive attenuator network controlled by the decibel (db) INCREASE control and the attenuator switches. Fixed resistive attenuator sections are inserted into the output circuit by means of the switches. The output voltages can be attenuated over a 0- to 6-db range by use of the db INCREASE control. The switches and the control can be used in any combination.

g. Crystal Marker Circuit. The output voltage of sweeping oscillator V4 is also applied to a crystal marker circuit. If any of the : Front panel CRYSTAL MARKERS switches are set to the on (down) position, the corresponding marker crystals are used in absorption-type marker circuits to produce crystal-controlled frequency markers for the external oscilloscope display. Each of the five crystals supplied is 4 resonant to a single frequency in the 20 to 40-mc range. As the frequency of sweeping oscillator V4 passes through a given crystal frequency, that crystal generates a short train of oscillations which is applied to the detector circuit.

h. Detector Circuit. The detector circuit uses a crystal-diode detector, which rectifies the oscillations developed by the crystal marker circuit, and develops a trigger signal for application to trigger amplifier V5. If an external signal generator is connected to the EXT. OSC.

INPUT connector to provide variable markers, a pulse is developed at the input to the detector circuit each time the output frequency of sweeping oscillator V4 and the frequency of the external signal generator coincide. This pulse of radio frequency (rf) energy is rectified by the detector circuit, and the trigger pulse derived from the rf is applied to trigger amplifier V5.

i. Trigger Amplifiers V5 and V6. Trigger amplifiers V5 and V6 are each a dual triode which together provide four stages of amplification for the trigger voltage applied from the detector circuit. The output trigger voltage of trigger amplifier V6 is applied to pip generator V7.

j. Pip Generator V7. Pip generator V7 is a one-shot multivibrator that generates a sharp positive pip each time a trigger pulse is applied from trigger amplifier V6. The output pips are applied through the pip INCREASE control to the PIP OUTPUT terminals for connection to the vertical deflection circuit of an external oscilloscope.

k. Power Supply Circuits. The power supply circuits, which are mounted on a separate internal chassis, provide 6.3 volts alternating current (ac) and regulated, +250 volts direct current (do) for the tubes of the frequency-generating portion of the signal generator. The input 117-volt-ac line power is rectified by full-wave rectifier V1, and the output of the full-wave rectifier is filtered by a pi-type filter and then applied td an electronic series-type voltage regulator. Tube V3 in the regulator control circuit compares a

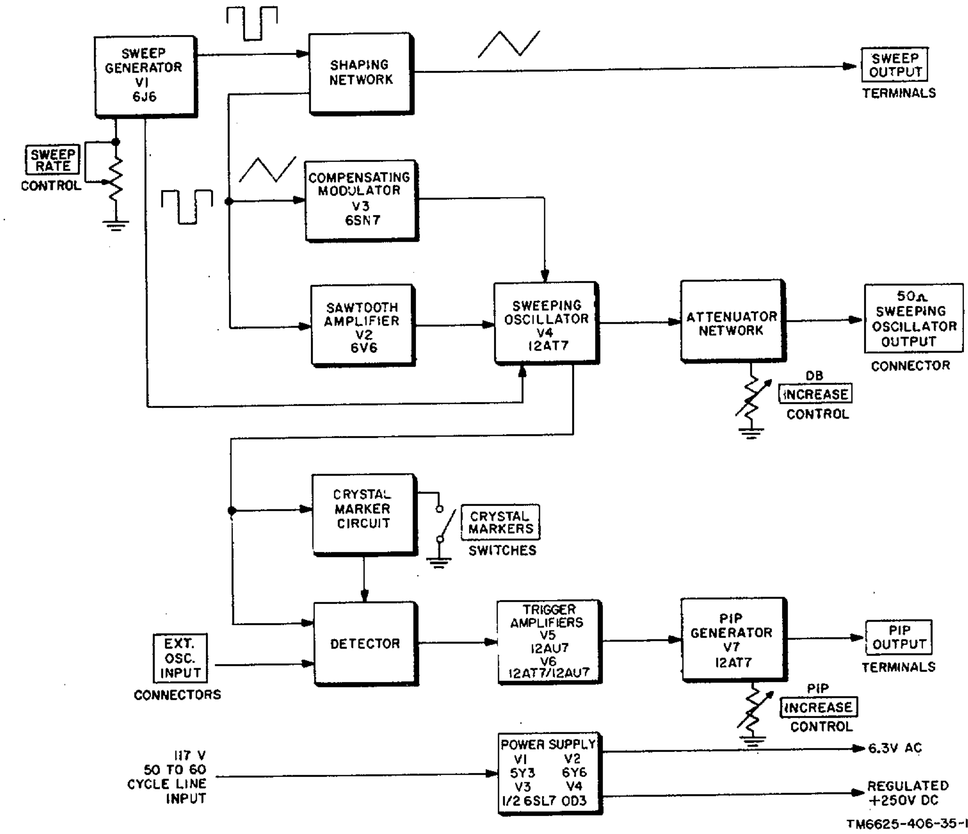


Figure 1. Signal generator, block diagram.

portion of the output voltage of the power supply against a fixed reference voltage provided by tube V4. If the output voltage of the power supply varies, tube V3 supplies a control signal to tube V2. The effective resistance of tube V2, which is connected in series with the output of the power supply, is varied by the control signal to compensate for the change in output voltage.

Section II. CIRCUIT THEORY

3. Sweep Generator V1

(fig. 2)

a. Sweep generator V1 consists of a free-running multivibrator circuit that is normally synchronized to the line frequency. The sweep generator develops a square-wave output voltage from which a linear sawtooth voltage is developed. This linear sawtooth voltage is used to produce a linear change in the output frequency of sweeping oscillator V4 and a linear horizontal deflection on the external oscilloscope.

b. During the production of one complete output cycle, four different conditions exist in the sweep generator circuit: a rapid switchover from a state of conduction in triode V1A to a state of conduction in triode V1B; a relatively long period during which triode V1A is cut off and triode V1B conducts heavily; a second rapid switchover as triode V1A begins to conduct and triode V1B is driven into cutoff; and another relatively long period during which triode V1B is cut off and triode V1A conducts heavily.

c. When power is applied to the circuit, assume that triodeV1B conducts more heavily than triode V1A. Because of the voltage developed across plate resistor

R5 by the. plate current of triodeV1B, the plate voltage of the triode decreases, and this negative-going change is coupled by means of capacitor C1 and resistor R1 to the control grid of triode V1A. The negative-going signal causes a decrease in the conduction of triode V1A, a decrease in the voltage developed across plate resistor R4, and an increase in the plate voltage of triodeV1A. This positive-going change is coupled by capacitor C2 and resistor R8 to the control grid of triode V1B, which further increases the conduction of triode V1B. Because of this cumulative action, triodeV1B is driven abruptly into heavy conduction, and triodeV1A is driven abruptly into cutoff. The voltage at the plate of triode V1B therefore drops sharply from some positive value to a lower value.

d. Because of the time constant of the coupling circuit, a time interval is required for capacitor C1 to discharge to the sharply lower plate potential of triodeV1B. During this interval, the discharge current of capacitor C1 develops a negative voltage across resistor R1, and the negative voltage maintains triodeV1A at cutoff. The plate voltage of triode V1B remains relatively constant for this interval. After a time interval, determined by the time constant of the coupling circuit and the dc control grid potential, the discharge current of capacitor C1 decreases to the point where the voltage developed across resistor R1 is insufficient to maintain triode V1A in tile cutoff condition. At this point triode V1.A begins to conduct, and the circuit operation is abruptly reversed. The flow of plate current through plate resistor R4 causes a reduction in the plate voltage of triode V1A. This negative-going change is coupled to the control grid of triode V1B and reduces the conduction of V1B and increases its plate voltage; this positive-going change in plate voltage is coupled to the control grid of triode V1A, which further increases the conduction of triode V1A. This cumulative action causes a rapid reversal in the state of the two triodes; triode V1A is driven into heavy conduction, and triode V1B is cut off. The voltage at the plate of triode V1B thus increases abruptly and remains relatively constant while triode V1B is maintained at cutoff by the discharge current of capacitor C2. When the discharge current of capacitor C2 decreases to the point where the voltage developed across resistor R8 is insufficient to hold triode V1B at cutoff, the triode begins to conduct, and the cycle is repeated.

e. The free-running frequency of sweep generator V1 is determined by the time constant of the coupling circuits and the dc voltage applied to the control grids.

A voltage divider, composed of resistor R2 and SWEEP RATE potentiometer R3, provides means for slight adjustment of the output frequency. If the SWEEP RATE potentiometer is adjusted to provide a more positive voltage to the control grids, the conduction point of the cutoff triode is reached while the discharge current of the associated coupling circuit is still relatively high. The switching action thus occurs sooner, and the output frequency of the sweep generator is increased. If the SWEEP RATE control is adjusted to provide a less positive voltage, the output frequency is reduced.

f. In normal operation, the free-running frequency is adjusted by means of the SWEEP RATE control to a point slightly lower than the line frequency, and a portion of the 6.3-volt ac filament voltage is applied through a voltage divider and decoupling network, composed of resistors R6 and R7 and capacitor C3, to the control grid of triode V1B. Triode V1B is driven from the cutoff state into conduction on the positive alternation of the ac voltage, and the output frequency of the sweep generator is synchronized to the line frequency. The square-wave output voltage developed in the plate circuit of triode V1B is applied directly to a shaping network and, through capacitor C8, to the control-grid circuit of sweeping oscillator V4.

4. Shaping Network

(fig. 3)

a. The shaping network converts the square-wave output voltage of sweep generator V1 into a linear sawtooth voltage.

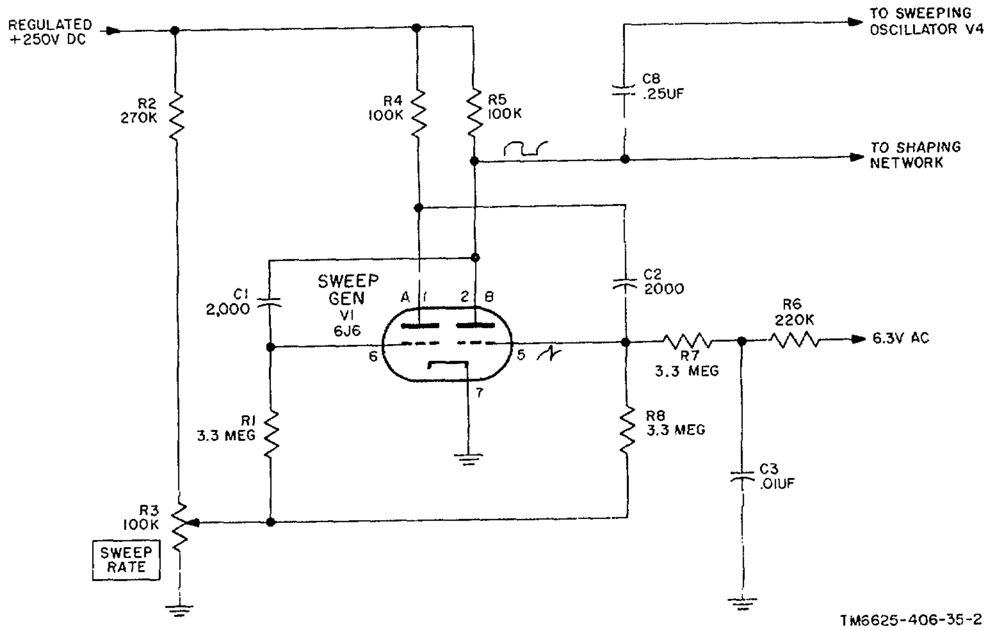


Figure 2. Sweep generator V1, schematic diagram.

This sawtooth voltage is applied to sawtooth amplifier V2, compensating modulator V3, and the SWEEP OUTPUT terminals for connection to the horizontal deflection circuits of an external oscilloscope.

b. The shaping network is essentially a resistive-capacitive integrating circuit composed of resistors R9 and Ri0 and capacitors C4 and C5. Since the input to the integrating circuit is a square-wave voltage, a symmetrical (back-to-back) sawtooth voltage is produced by integration. The sawtooth output voltage is coupled through capacitor C6 to a voltage divider network and to an isolating network.

c. The voltage divider network, composed of resistor R12 and SWEEP WIDTH potentiometer R13, provides means for adjusting the amplitude of the sweep voltage applied to sawtooth amplifier V2 and compensating modulator V3. The amount of frequency sweep in the output of sweeping oscillator V4 is determined by the amplitude of the sawtooth voltage. When SWEEP switch S3A is set to the NAR. position, resistor R12 is included in the voltage divider network, and most of the output sawtooth voltage is dropped across resistor R12. Since only a small portion of the output sawtooth voltage is available at the wiper arm of SWEEP WIDTH potentiometer R13 for application to sawtooth amplifier V2, the output frequency of sweeping oscillator V4 is swept over a narrow (3-mc) range. When SWEEP switch S3A is set to the WIDE position, resistor R12 is shorted out, the sawtooth voltage at the wiper arm of SWEEP WIDTH potentiometer R13 is increased, and the output frequency of sweeping oscillator V4 is swept over a wide (20-mc) range. SWEEP WIDTH potentiometer R13 is screwdriver adjusted to provide the exact sweep range desired. Capacitors C10 and C9 couple the sawtooth voltage to sawtooth amplifier V2 and compensating modulator V3, respectively.

d. The isolating network, composed of resistors R11 and R14 and capacitor C7, prevents feedback of spurious voltages from the external circuits to the shaping network. The sawtooth voltage at the output of the isolating network is applied to the sweep output terminals for application to the horizontal deflection circuits of an external oscilloscope.

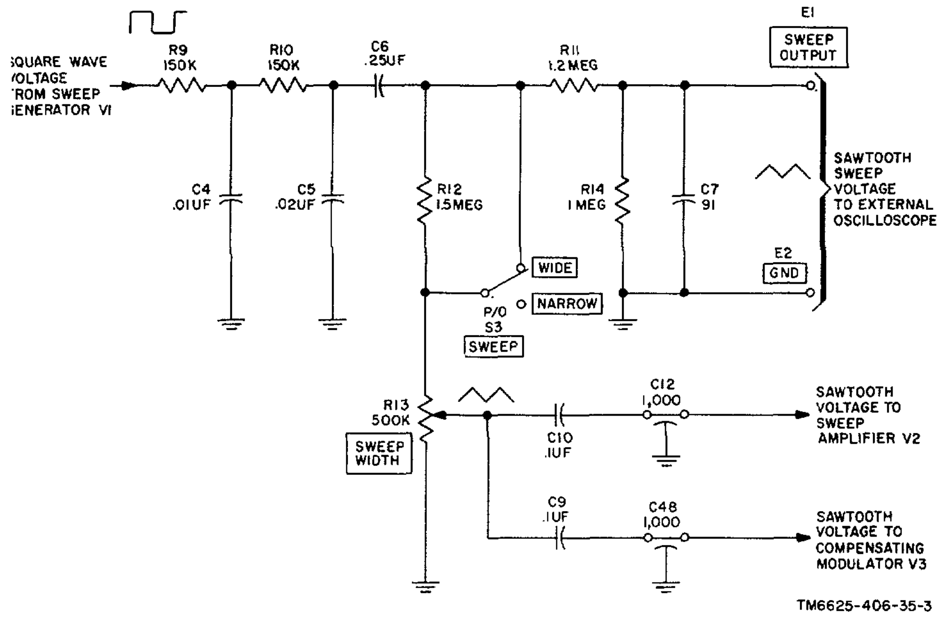


Figure 3. Shaping network, schematic diagram.

5. Sawtooth Amplifier V2

(fig. 4)

a. Sawtooth amplifier V2 is a power amplifier used to supply a sawtooth current to a saturable reactor in the tuned plate circuit of sweeping oscillator V4. The input sawtooth voltage is coupled from the shaping circuits through coupling capacitor C10 and rf bypass feedthrough capacitor C12 to a voltage divider composed of resistor R19 (if a center frequency of 60-mc is selected) or resistor R20 (if a center frequency of 30-mc is selected) and resistor R22. Resistors R19 and R20 are specially selected to insure the proper frequency-sweep limits on the 60-mc and 30-mo bands, respectively. The sawtooth voltage developed across resistor R22 is applied to the control grid of sawtooth amplifier V2.

b. A positive dc voltage is applied to the control grid of sawtooth amplifier V2 through isolating resistor R24 from a voltage divider composed of resistors R23 and R21; a fixed, positive bias voltage is applied to the cathode from a separate voltage. divider to insure a stable operating point for the tube. Screen voltage is applied to the tube through a screen decoupling network composed of screen dropping resistor R25 and screen bypass capacitor C13. The plate load for sawtooth amplifier V2 consists of the control winding of saturable reactor L1.

c. Application of a positive-going sawtooth voltage to the control grid of sawtooth amplifier V2 results in an increase in plate current. Since the plate current flows through the primary control winding of saturable reactor L1, the inductance of the reactor decreases as the sawtooth current increases. Saturable reactor L1 forms part of the tune d circuit of sweeping oscillator V4; therefore, the output frequency of the sweeping oscillator is varied at the sawtooth rate.

d. When SWEEP switch S3 is set to the NAR. position, a sawtooth voltage of relatively low amplitude is applied to sawtooth amplifier V2, and linearity over the small range of input signal can be achieved with no special compensation. Cathode bias voltage for sawtooth amplifier V2 is provided by a voltage divider composed of resistors R26, R27, R28, and R31, FINE TUNE potentiometer R33, and cathode resistor R34. FINE TUNE potentiometer R33 provides means for varying the cathode bias of tube V2, which in turn, varies the initial plate current of V2, the initial inductance of saturable reactor L1, and the center frequency of sweeping oscillator V4 over narrow limits.

e. When SWEEP switch S3 is set to the WIDE position, linear frequency deviation is required with a sawtooth voltage of high amplitude applied to the control grid of sawtooth amplifier V2. The cathode circuit is modified through switch S3B and S3D to compensate for the nonlinear saturation characteristics of the ferrite used in saturable reactor L1 and thus ensure linear frequency deviation of the output of sweeping oscillator V4 throughout the entire sawtooth range. Resistor R32 is inserted into the cathode circuit in place of FINE TUNE potentiometer R33, and a special compensating circuit, composed of resistor R29, LIN ADJ potentiometer R30, and diodes CR2, CR3, and CR4, is connected into the circuit. The diodes are used to decrease the resistance in the cathode circuit as the sawtooth voltage rises to compensate for the nonlinear characteristics of the saturable reactor. The diodes are normally reverse biased by positive v o l tag e s applied to their cathodes by the voltage divider, network between +250-volts dc and ground. At the start of the sawtooth, when the sawtooth voltage is actually negative, none of the diodes conduct, and cathode bias voltage is provided by resistor R34. As the sawtooth voltage rises, the voltage at the cathode also becomes more positive. At different points along the sawtooth, the positive cathode voltage overcomes the reverse bias applied to the diodes, the diodes conduct, and the degenerative feedback produced in the cathode circuit is reduced to provide a more linear frequency deviation. LIN ADJ potentiometer R30 provides for fine adjustments of the linearity.

6. Sweeping Oscillator V4

(fig. 5)

a. Sweeping oscillator V4 generates a frequency-swept rf signal in the 20- to 40-mc or the 50- to 70-mc range. Frequency sweep is controlled by the sawtooth current developed by sawtooth amplifier V2. Sweeping oscillator V4 is disabled during the negative-going portion of the sawtooth to provide a clear, 0-volt reference on the external oscilloscope.

b. Sweeping oscillator V4 consists of a push-pull negative-resistance oscillator circuit. This circuit is essentially a plate coupled multivibrator, with a tuned circuit connected between the plates of the two triode sections of V4. The circuit connections are such that the p1 a t-e voltage changes of each triode are connected to the control grid of the other triode. The two triodes conduct alternately in a push-pull manner. Since the plate current of each triode increases at the same time that the plate voltage of that triode decreases, a negative resistance exists between the two plates, and a tuned circuit connected between the two plates will produce sustained oscillations during those periods when the sweeping oscillator stage is not disabled.

c. The square-wave output voltage of sweep generator V1 is coupled through capacitor C8 and applied across a voltage divider composed of resistors R15 and R16. During the negative portions of the square-wave voltage, diode CR1 cannot conduct because of the polarity of the signal voltage, and the negative voltage developed across resistor R16 is applied through rf bypass feedthrough capacitor C11 to the control grids of tube V4. This action disables the sweeping oscillator stage. Since the sawtooth current applied from V2 is derived from the same square-wave voltage, this disabling action occurs during the negative-going portions of the sawtooth cycle.

d. When the square-wave output voltage of sweep generator V1 swings positive, diode CR1 conducts, the control grid circuits of V4 are returned to ground through the low impedance of the conducting diode, and both triode sections of V4 are zero biased. As in a multivibrator, control is assumed by the triode section with the higher initial conduction. Assume that triode section V4B has the larger initial conduction. As the conduction of this triode section increases, its plate voltage decreases because of the voltage developed

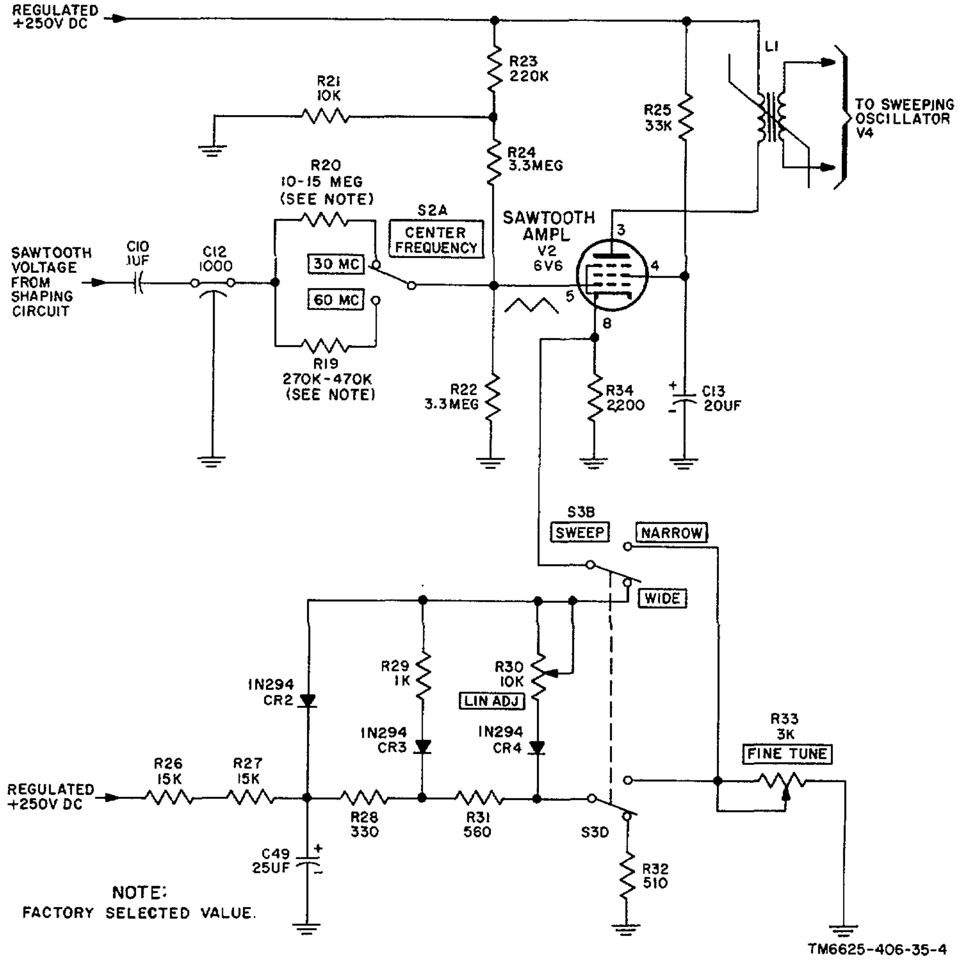


Figure 4. Sawtooth amplifier V2, schematic diagram.

across the tuned circuit by the plate current, and the negative-going change is coupled by means of capacitor C15 and resistor R44 to the control grid of triode V4A. This condition reduces the conduction of triode V4A and increases its plate voltage. This positive-going change in plate voltage is coupled by capacitor C16 and resistor R46 to the control grid of triode V4B, and further increases the conduction of this triode. This cumulative action continues until triode V4A is abruptly driven into cutoff, and triode V4B is driven into heavy conduction. Since the potential difference between the two plates is applied across a tuned circuit, the tuned circuit is excited and oscillates at its resonant frequency. When the rf voltage in the tuned circuit reverses polarity, a positive-going change is coupled from the tuned circuit by capacitor C15 and resistor R44 to the control grid of triode V4A. Triode V4A begins to conduct, and the operation of the circuit is reversed. This action continues, with first one triode section and then the other conducting, as long as the sweeping oscillator circuit is not disabled.

e. The frequency of oscillation is determined by the tuned circuit composed of saturable reactor L1 and capacitor C50 (if the 30-mc center frequency is selected) or capacitor C51 (if the 60-mc center frequency is selected). Since a positive-going sawtooth current is applied to the control winding of saturable reactor L1 from sawtooth amplifier V2, the inductance of the saturable reactor decreases linearly, and the output frequency of sweeping oscillator V4 increases linearly. The frequency band to be used is selected by CENTER FREQUENCY switch S2. When the 30-mc band is selected, the entire inductance is used in the tuned circuit; when the 60-mc band is selected, a portion of the inductance is shorted out by switch S2B and S2C, causing a reduction in inductance and an increase infrequency. Capacitors C50 and C51 are trimmer capacitors for the 30-mc and 60-mc bands, respectively. Resistors R54 and R45 are used to adjust the amplitude of the output voltage of sweeping oscillator V4 by the loading of the tuned circuit. The plate voltage of V4 is varied by compensating modulator V3 to compensate for amplitude variations in the output voltage of sweeping oscillator V4 which tend to occur during the sweeping cycle. The frequency-swept rf output voltage of sweeping oscillator V4 is coupled by means of a pickup winding of saturable reactor L1 to an attenuating network and to the crystal marker circuits.

7. Compensating Modulator V3

(fig. 6)

a. Because of changes in circuit losses and circuit efficiency with changes infrequency, an oscillator stage with a wide frequency deviation and a constant output amplitude is difficult to design. The output amplitude of sweeping oscillator V4 thus has a tendency to vary as the output frequency is varied by the sawtooth current applied to the control winding of saturable reactor L1. To compensate for this tendency, compensating modulator V3 is used.

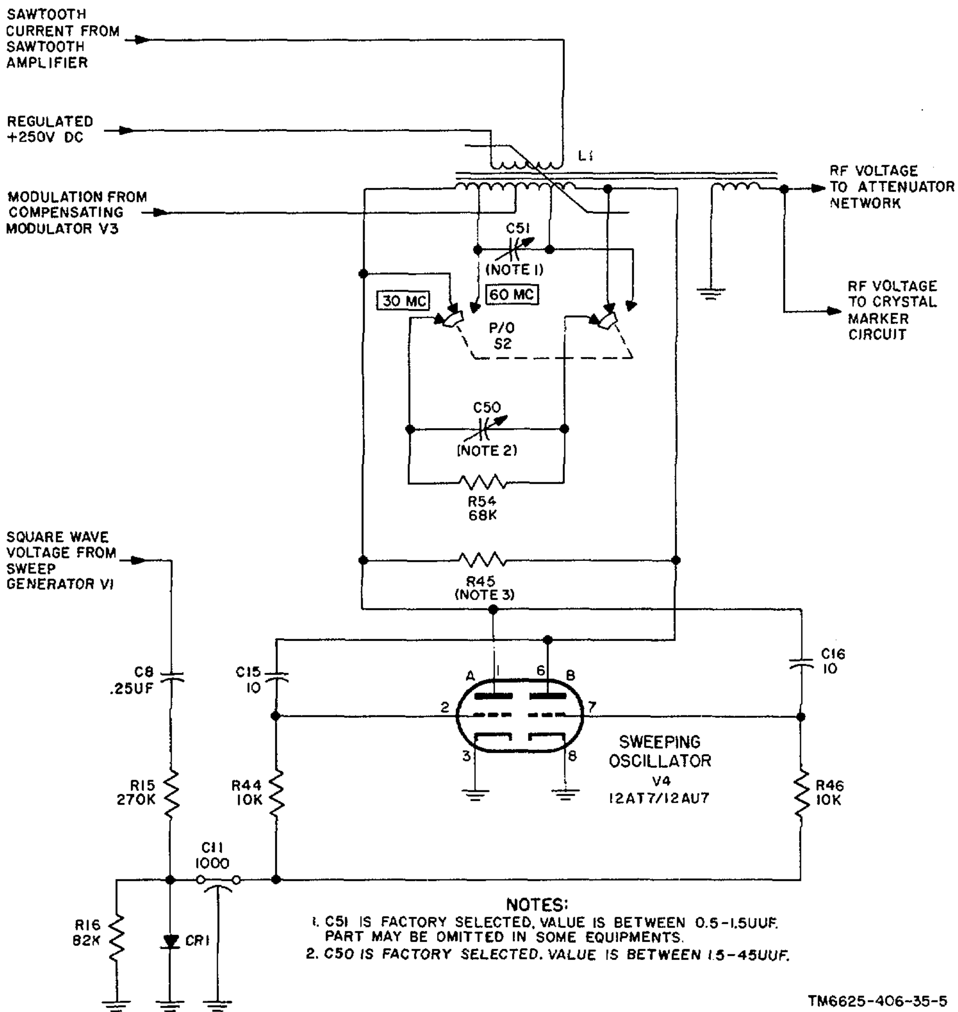


Figure 5. Sweeping oscillator V4, schematic diagram.

b. Depending on the selected center frequency and the characteristics of the circuit parts, either one-half or both halves of compensating modulator V3 are used. Sawtooth voltage is applied from the shaping network through coupling capacitor C9 and rf bypass feedthrough capacitor C48 to compensating modulator V3 through C ENTER FREQUENCY switch S2D. When the switch is set to the 30 MC position, the sawtooth voltage is applied through a voltage divider, composed of resistor R17 and grid resistor R36, to the control grid of triode V3A. The value of resistor R17 is factory selected to provide the proper amplitude of input signal for the required degree of compensation.

c. Triode V3A functions as a voltage amplifier. Bias voltage is provided by cathode resistor R37. The cathode resistor is unbypassed, and the stability of the circuit is improved by the resulting degenerative feedback. The input sawtooth voltage is amplified and inverted by triode V3A, and the sawtooth voltage developed across plate load resistor R38 is coupled by capacitor C14, isolating resistor R41, and grid resistor R42 to the control grid of triode V3B. Resistor R40 provides cathode bias voltage for triode V3B, and resistor R39 is the plate load resistor. The sawtooth voltage developed in the plate circuit of triode V3B is applied to the plate circuit of sweeping oscillator V4. The frequency of sweeping oscillator V4 is varied at the sawtooth rate by the output of sawtooth amplifier V2, and the plate voltage of the sweeping oscillator is varied at the same rate by compensating modulator V3; thus, on the 30-mc band, as the output frequency of the sweeping oscillator increases, the amplitude of the output voltage tends to decrease, but this tendency is compensated for by the increase in plate voltage provided by compensating modulator V3.

d. When the 60-mc range is selected, the ratio of the frequency deviation of sweeping oscillator V4 with respect to the center frequency is smaller; therefore, less compensation is required. The required compensation is also in the opposite direction. If CENTER FREQUENCY switch S2D is set to the 60 MC position, triode V3A is not used, and the input sawtooth voltage is applied to the control grid of triode V3B of resistors R18 and R42. The value of resistor R18 is selected to provide the proper input signal amplitude for the required degree of compensation. Resistor R41 isolates the input signal from the relatively low impedance to ground through resistor R38 and the output impedance of the power supply. Since only one stage is used on the 60-mc band, the output of triode V3B is lower in amplitude and of the opposite polarity which provides proper compensation for this band. Capacitor C52 and resistor R43 decouple the rf plate current of sweeping oscillator V4 from the compensating modulator and the 250-volt dc power supply.

8. Attenuator Network

(fig. 7)

a. The attenuator network adjusts the amplitude of the frequency-swept rf voltage applied from the signal generator to the equipment under test. The frequency-swept rf input signal is applied to the attenuator network through resistor R50 from a pickup winding of saturable reactor L1. The output of the attenuator network is applied to the 50Ω SWEEPING OSCILLATOR OUTPUT connector.

b. Db INCREASE potentiometers R52A and R52B and resistors R51, R53, and R55 form a bridged-T, resistive attenuator network permanently connected into the output circuit. The attenuator network provides attenuation of 0 to 6 db while maintaining a constant output impedance of 50 ohms.

c. Resistors R56 through R64 comprise a resistive, ladder-type attenuator network. The individual pi-sections of the network can be inserted into the output by operation of 20DB switch S4, 20DB switch S5, and 10DB switch S6 to provide attenuation in fixed steps. Any combination of sections can be used. The output from the attenuator network is applied to the 50 Ω SWEEPING OSCILLATOR OUTPUT connector for connection to the equipment under test.

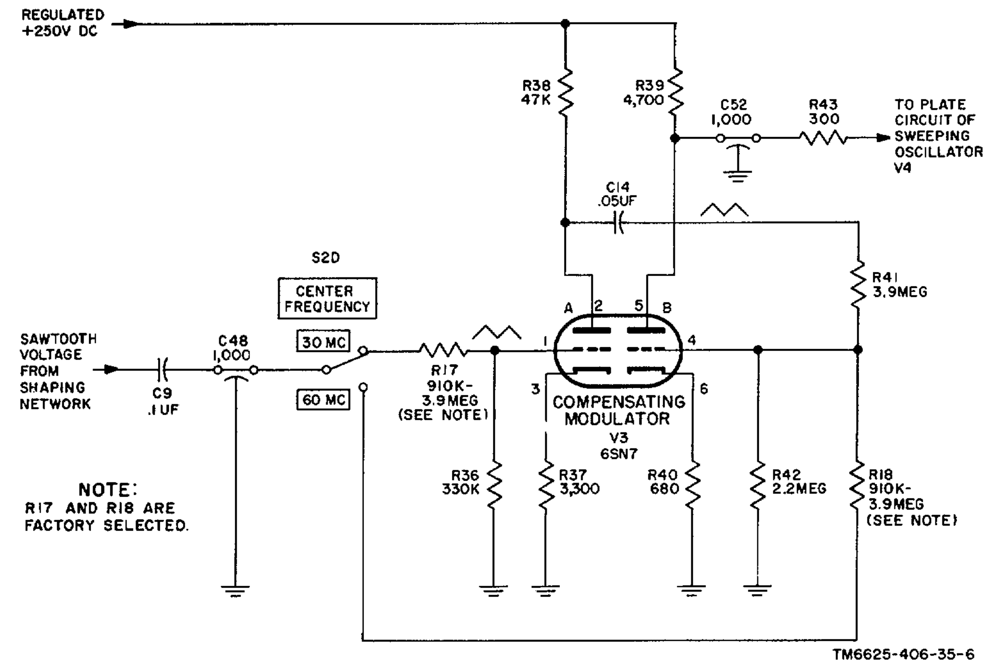


Figure 6. Compensating modulator V3, schematic diagram.

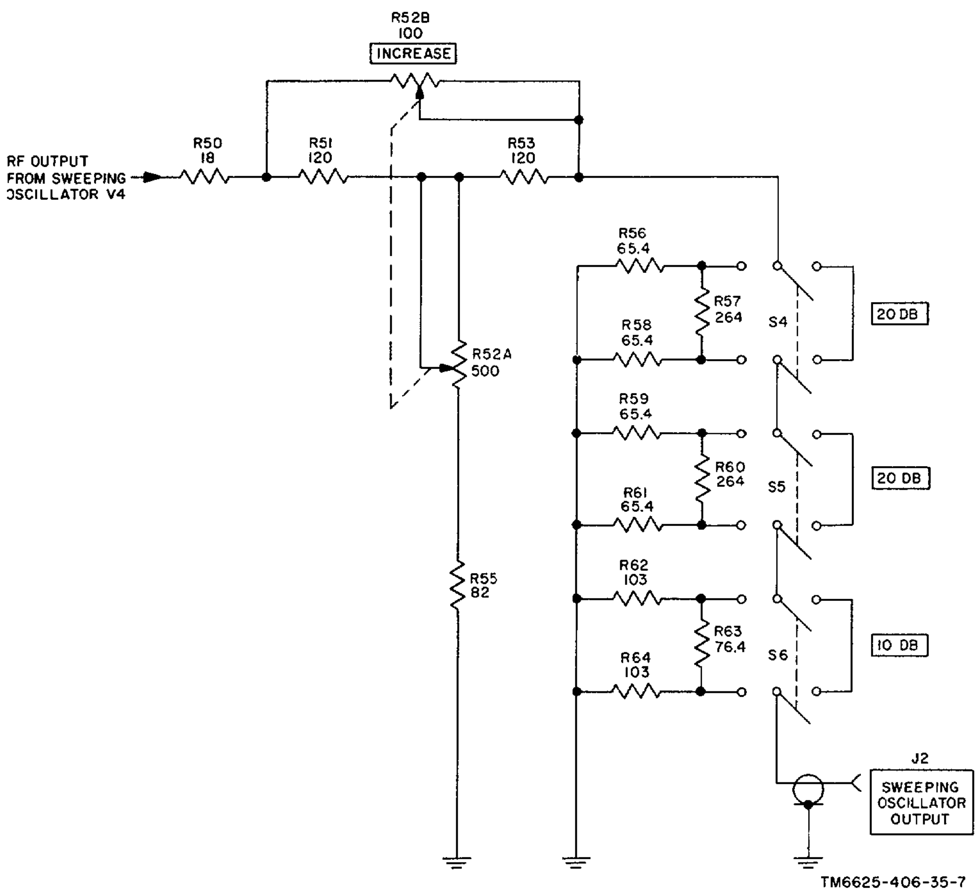


Figure 7. Attenuator network, schematic diagram.

9. Crystal Marker and Detector Circuits
(fig. 8)

a. The crystal marker and detector circuits develop trigger pulses which, after amplification, trigger pip generator V7 to produce frequency-marker signals for application to an external oscilloscope. Up to five crystal markers can be selected by the CRYSTAL MARKERS switches. Facilities for four additional crystal markers are provided; however crystals for these circuits are not supplied. Variable-frequency markers can also be obtained by connection of an external signal generator, adjusted to the desired marker frequency, to the EXT. OSC. INPUT connector.

b. The frequency-swept rf output voltage of sweeping oscillator V4 is applied through resistor R47 and a voltage divider network to the crystal marker circuit. When CENTER FREQUENCY switch S2E is set to the 30 MC position, the amplitude of the rf voltage applied to the crystal marker circuit is determined by the voltage divider composed of resistors R49 and R65. When switch S2E is set to the 60 MC position, resistor R49 is shorted out so that a, larger portion of the rf voltage is applied to the crystal marker circuit to compensate for the reduced activity of crystals at the higher frequencies.

c. The crystals selected by means of the CRYSTAL MARKERS switches are connected into absorption-type marker circuits. Whenever the output frequency of sweeping oscillator V4 passes through the resonant frequency of any selected crystal, that crystal is excited and generates a short train of oscillations. These oscillations are detected by crystal detector CR5, filtered by capacitor C18 and resistor R66, and the resultant negative trigger pulse is applied to trigger amplifier.V5A. For simplicity, only one marker crystal is shown, in figure 8; however nine parallel circuits are provided. When any CRYSTAL MARKERS switch is set to the off position, the switch connects an 8.2-micromicrofarad (uuf) capacitor into the crystal marker circuit. This capacitor simulates the shunt capacitance of the crystal, so that detuning of the crystals in use does not occur as additional crystals are switched in or out of the circuit.

d. When variable-frequency markers are desired, rf voltage at the desired marker frequency is applied from an external signal generator through isolating resistor R35 and combined across resistor R65 with the output of sweeping oscillator V4. When the .output frequency of the sweeping oscillator and the frequency of the external oscillator coincide, a pulse of rf voltage is developed across resistor R65. This rf pulse is detected by crystal detector CR5 and filtered by capacitor C18 and resistor R66, and the resultant negative trigger pulse is applied to trigger amplifier V5A.

10. Trigger Amplifiers V5 and V6
(fig. 27)

a. Trigger amplifiers V5 and V6 amplify the trigger pulses developed in the crystal marker and detector circuits to insure stable triggering of pip generator V7. Trigger amplifiers V5 andV6 provide four stages of cathode-biased, resistance-capacitance coupled voltage amplification.

b. The negative trigger output pulses of the detector circuit are developed across resistor R67 and applied to the control grid of triode V5A through parasitic suppressor R68. Bias voltage for triode V5A is provided by cathode bias resistor R71 and cathode bypass capacitor C19. The applied pulses are amplified and inverted in the first stage, and the positive pulses developed across plate load resistor R69 are coupled to the control grid circuit of triode V5B by capacitor C23 and resistor R74. Except for the addition of capacitor C21, in the circuit of V5B, which filters out spurious rf voltages, the circuits of triodes V5A and V5B are identical. Resistor R72 and capacitor C20 provide cathode bias voltage for triode V5B, resistor R73 is a parasitic suppressor, and resistor R70 is the plate load resistor. The negative trigger pulses developed across plate load resistor R70 are coupled through capacitor C22 to PIP ADJ. W potentiometer R75 and PIP ADJ. N potentiometer

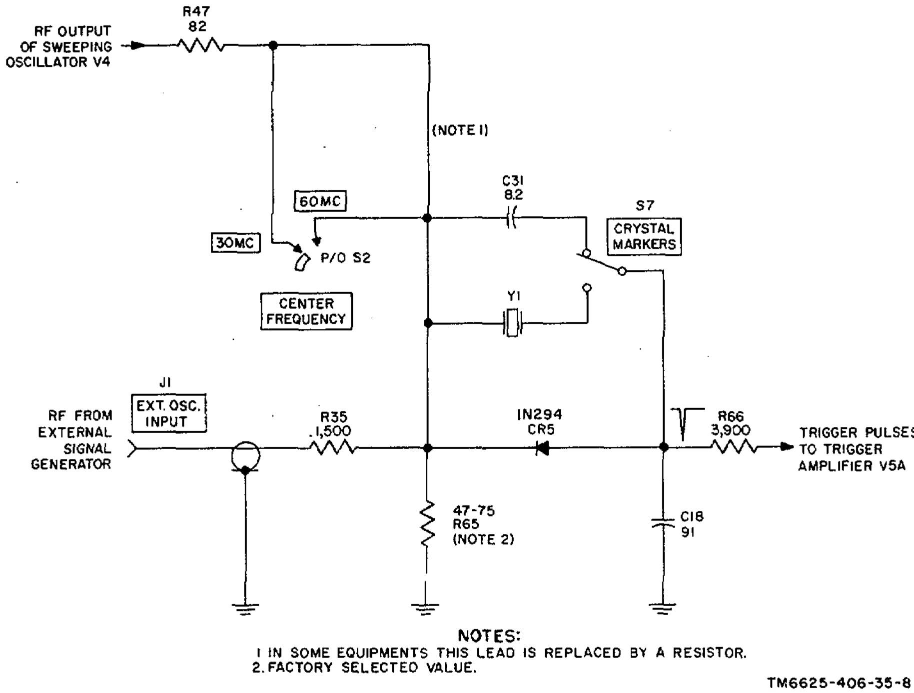


Figure 8. Crystal marker and detector circuits, schematic diagram.

R76, which provide means for adjusting the trigger amplitude in the WIDE and NAR. positions, respectively, of SWEEP switch S3, Capacitor C47 compensates for differences in the trigger pulses due to the slower sweep rate when the narrow sweep is selected.

c. A portion of the trigger voltage, determined by the setting of the potentiometer selected by means of SWEEP switch S3, is coupled to trigger amplifier V6Aby capacitor C24 and resistor R77. Some peaking of the trigger pulses is provided by the coupling circuit. Except for the addition of capacitors C25 and C29, which filter out spurious rf voltages, the third and fourth trigger amplifier circuits are identical with the first. Cathode bias voltage is provided for triodes V6A and V6B by resistor R81 and cathode bypass capacitor C26, and by resistor R82 and cathode bypass capacitor C27, respectively. Resistors R79 and R80 are plate load resistors, and resistors R78 and R83 are parasitic suppressors. The negative trigger pulses developed across plate resistor R80 are coupled through capacitor C30 to pip generator V7. Capacitor C28 and resistor R84 couple the signal to V6B.

11. Pip Generator V7

(fig. 9)

a. Pip generator V7 generates positive frequency-marker pulses for application to the vertical deflection circuits of an external oscilloscope. The pip generator is essentially a one-shot multivibrator, triggered by negative trigger pulses applied from trigger amplifier V6. A trigger pulse and a corresponding frequency marker pulse are produced each time the frequency of sweeping oscillator V4 passes through the frequency of any crystal selected by the CRYSTAL MARKERS switches, or through the frequency of an external signal generator connected to the EXT. OSC. INPUT connector.

b. In the absence of a trigger pulse, triode section V7B is cut off by a positive voltage applied to the cathode from a voltage divider composed of resistor R90, PIP ADJ potentiometer R88, and resistorR89. Triode section V7A is zero biased, and therefore conducts heavily.

c. When a negative trigger pulse is applied through capacitor C30 to the plate circuit of triode V7B, the negative trigger pulse is coupled by capacitor C44 and resistor R85 to the control grid of triode V7A. This action causes a decrease in plate current, a decrease in the voltage developed across plate resistor R86, and an increase in the plate voltage of triode V7A. This positive-going change in plate voltage is direct-coupled to the control grid of triode V7B and drives the triode into conduction. The flow of plate current through plate resistor R87 causes a negative-going change in the plate voltage of triode V7B; this negative-going change is coupled by means of capacitor C44 and resistor R85 to the control grid of triode V7A, and the plate current of triode V7A is further reduced. This regenerative action causes triode V7A to be driven sharply into cutoff, and triode V7B is driven sharply into a state of heavy conduction. This condition is maintained by the discharge of capacitor C44 through resistor R85. When the voltage developed across resistor R85 by the discharge current drops to a point that is insufficient to hold triode V7A at cutoff, the triode begins to conduct, the action of the circuit is reversed, and triode V7B is driven sharply into cutoff and triode V7A into heavy conduction. This condition is maintained by the bias voltage applied to the cathode of V7B until the next trigger pulse occurs.

d. The positive pulse developed across cathode resistor R89 and PIP ADJ potentiometer R88 each time the pip generator circuit is triggered is coupled by means of capacitor C46, pip INCREASE potentiometer R91, and isolating resistor R92 to the PIP OUTPUT terminals. Pip INCREASE potentiometer R91 provides means for adjusting the amplitude of the output frequency-marker pulses. PIP ADJ potentiometer R88 controls the bias voltage applied to triode V7B, and the setting of the PIP ADJ potentiometer determines the amplitude of trigger pulses required for stable triggering of the pip generator.
Capacitor C45 in the cathode circuit of triode V7B shapes the output pulses to improve the display on the external oscilloscope.

12. Power Supply Circuits

(fig. 28)

a. The power supply circuits supply regulated 250 volts dc for the plate and screen

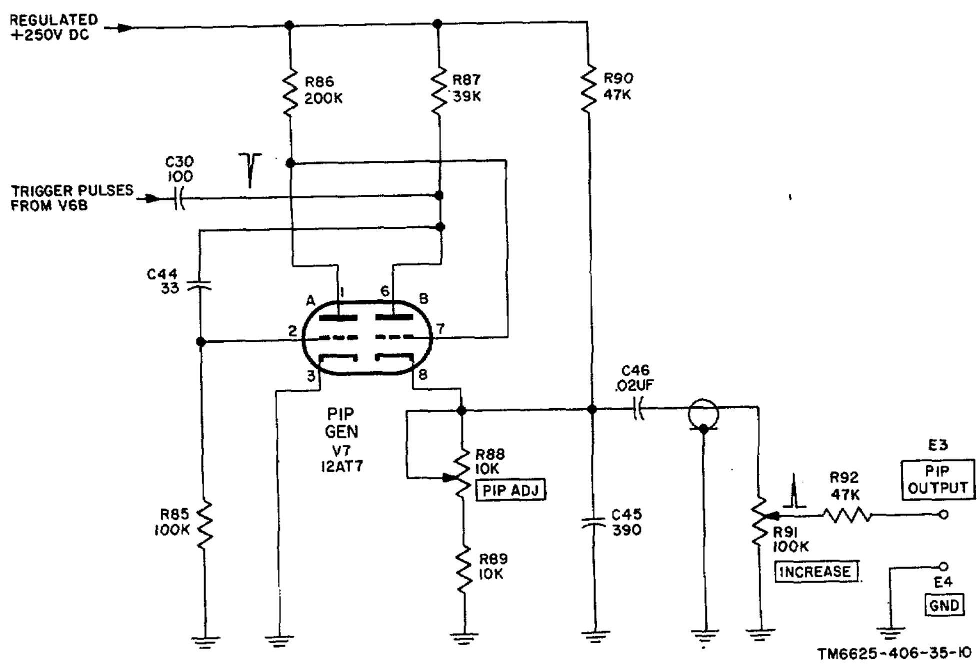


Figure 9. Pip generator V7, schematic diagram.

grid circuits and 6.3 volts ac for the filament circuits of the signal generator. The power supply circuits consist of a full-wave rectifier, a pi-type filter, and an electronic voltage regulator.

b. Input of 117 volts, 50 to 60 cycles ac is applied to the primary winding of power transformer T1 through ac line plug P1, fuse Fl, and ON-OFF switch S1 (on the oscillator chassis). The primary of transformer T1 consists of two windings, normally connected in parallel for 117-volt operation. Power transformer T1 steps up the input voltage to 400 volts for application to the plates of rectifier tube V1. Filament windings on power transformer T1 supply 5 volts and 6.3 volts for tube filaments. The presence of filament voltage is indicated by power indicator lamp I1. The 400-volt output of the power transformer is rectified by full-wave rectifier V1, and the dc output of the rectifier is filtered by a pi-type filter composed of capacitors C1 and C2A and inductor L1. Resistor R1 provides a discharge path for the capacitors when power is turned off. Capacitor C43 in the filament circuit is an rf bypass.

c. The filtered dc output is applied to the voltage regulator circuit. Regulator V2 is connected in series with the regulated dc output circuit of the power supply. By varying the effective internal resistance of regulator V2, the voltage dropped across the tube can be varied, and the output voltage of the power supply will vary. The effective resistance of regulator V2 is controlled by a signal supplied from regulator control V3. A voltage divider circuit (R5, R7, and R8) allows a portion of the regulated dc output voltage, determined by the setting of potentiometer R7, to be applied to the control grid of regulator control V3. The cathode of the tube is held at a constant potential of 150 volts by voltage reference regulator V4 and resistor R6. The conduction of regulator control V3 is determined by its cathode-to-control grid voltage. The voltage developed across plate load resistor R4 by the plate current of regulator control V3 is applied as a control voltage between the cathode and control grid of regulator V2.

d. If the regulated dc output voltage of the power supply circuits tends to increase from the preset level, the voltage applied to the control grid of regulator control V3 from the voltage divider increases proportionally, the conduction of regulator control V3 increases, a more negative voltage is developed across resistor R4, and this voltage is applied to the control grid of regulator V2. With a more negative voltage applied to its control grid, the effective resistance of regulator V2 increases, the voltage drop across the tube increases, and the output voltage of the power supply is reduced. If the output voltage tends to decrease, the operation of the circuit is reversed. The positive voltage applied to the control grid of regulator control V3 decreases, the conduction of the tube decreases, the control voltage developed across plate load resistor R4 becomes less negative, the effective resistance of regulator V2 is decreased, the voltage drop across the tube is reduced, and the output voltage of the power supply is increased to compensate for the original drop.

e. Potentiometer R7 provides means for adjusting the regulated dc output voltage. Capacitor C2B is an output filter capacitor, and capacitor C3 suppresses any oscillations in the voltage regulator circuit. Resistors R2 and R3 are parasitic suppressors. The regulated 250-volt dc output and the 6.3-volt ac output are applied to the oscillator chassis through connectors J1 and P1.

CHAPTER 2
TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

Warning: When servicing the signal generator, be careful when working on the 250-volt plate and power supply circuits, or on the 117-volt ac line circuits.

13. General Instructions

Troubleshooting at field and depot maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field and, depot maintenance procedures are not complete in themselves but supplement the procedures described in TM 11-6625-406-12. The systematic troubleshooting procedure must be completed by means of sectionalizing, localizing, and isolating techniques.

14. Troubleshooting Procedures

a. General. The first step in servicing a defective signal generator is to sectionalize the fault. Sectionalization means tracing the fault to a major assembly or circuit responsible for abnormal operation. The second step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors and arcing and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltages and resistances.

b. Sectionalization. The first step in tracing trouble is to locate the major assembly or circuit at fault by the following methods:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. All indications, particularly on the external oscilloscope used with the signal generator, should be observed, and an attempt made to sectionalize the fault to a major circuit.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. The equipment performance checklist (TM 11-6625-406-12) is a good operational test.

c. Localization. The tests listed below will aid in isolating the trouble. First, localize the trouble to a single stage or circuit, and then isolate the trouble within that circuit by voltage, resistance, and continuity measurements.

(1) *Signal tracing.* Signal tracing (para 21) will help in isolating a trouble to a specific circuit at fault.

(2) *Voltage and resistance measurements.* These measurements will help locate the individual component part at fault. Use the resistor and capacitor color codes (fig. 25 and 26) to find the value of the components. Use the voltage and resistance diagrams (fig. 14, 15, and 29) to find normal readings, and compare them with readings taken.

(3) *Troubleshooting chart.* The trouble symptoms listed in the chart (para 18) will aid in localizing trouble to a component part.

(4) *Intermittent troubles.* In all these 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. Check the wiring and connections to the parts of the signal generator.

15. Test Equipment Required

The following chart lists the test equipment required for troubleshooting the signal generator, and gives the associated technical manuals, and the assigned common names.

Test equipment	Technical manual	Common name
Frequency Meter AN/URM-80	TM 11-5095	Frequency meter
Multimeter TS-352(*)/U[a]	TM 11-5527	Multimeter
Oscilloscope AN/USM-50	TM 11-5129	Oscilloscope
Signal Generator AN/USM-44		CW signal generator
Test Set, Electron Tube TV 7/U	TM 11-6625-274-12	Tube tester
Tool Kit TK-87/U[b]		Toolkit
Tool Kit TK-88/U[b]		Toolkit
Voltmeter, Meter ME-30/U	TM 11-6625-320-12	Voltmeter

[a] Refers to Multimeters TS-352/U, TS352A/U, and TS352B/U.
[b] Use TE-113 until available.

Section II. TROUBLESHOOTING SIGNAL GENERATOR SG-336/U

Caution: Do not attempt removal or replacement of parts before reading the instructions in paragraph 23.

16. Checking Filament and B+ Circuits for Shorts

a. When to Check. When any of the following conditions exist, check for short circuits and clear the trouble before applying power:

(1) When the signal generator is being serviced, and the nature of the abnormal symptoms is not known.

(2) When abnormal symptoms reported from operational tests indicate possible power supply troubles (item 5 of the equipment performance checklist (TM 11-6625-406-12)).

b. Conditions for Tests. Prepare for the short-circuit tests as follows:

(1) Remove the signal generator from its case (para 24).

(2) Remove all tubes and the indicator lamp (para 22).

(3) Disconnect connector J1 (fig. 11) of the power supply chassis from connector P1 (fig. 12) on the oscillator chassis.

(4) Set the SWEEP switch to the WIDE position.

c. Measurements. Make the resistance measurements indicated in the chart below. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit.

Short-circuit tests

Point of measurement	Normal indication	Isolating procedure
Between terminals 8 and 10 of connector P1 (fig. 12).	6 megohms	If resistance reading of approximately 220, 000 ohms is obtained, check for shorted bypass capacitor C3 on oscillator chassis If resistance reading is very low, check for shorted feedthrough capacitor C43, shorted bypass capacitor C17, or for short circuit in indicator lampholder or a short in filament circuit wiring on oscillator chassis.
Between terminals 12 and 7 of connector PI (fig. 12).	18, 000 ohms	If resistance approaches zero, check for shorted feedthrough capacitor C42, or for short circuit in B+ wiring on the oscillator chassis.

Short-circuit tests

Point of measurement	Normal indication	Isolating procedure
		If resistance is lower than normal, but not 0 ohms, check for shorted filter capacitors C25, C29, C45, and C49, for shorted screen bypass capacitor C13, for shorted feedthrough capac - itor C52, or for grounded control winding in saturable reactor L1 on oscillator chassis.
		If resistance is higher than normal, check volt- age divider networks in the control grid circuit of V1, in the control grid and cathode circuits of V2, and in the cathode circuit of V7 for open resistors on the oscillator chassis.
Between terminals 12 and 7 of connector J1 (fig. 11).	130, 000 ohms ----------	If resistance approaches 0 ohms, check for shorted filter capacitor C2B on power supply chassis.
		If resistance is lower than normal, check for leaky filter capacitor C2B, or grounded re- sistance element in potentiometer R7 on power supply chassis.
		If resistance is higher than normal, check re- sistors R5 and R8, and potentiometer R7 on power supply chassis.
Between terminals 8 and 7 of connector J1 (fig. 11).	Infinite resistance reading.	A finite resistance reading indicates a short circuit to ground in the filament wiring be- tween transformer T1 and the measurement points.
Pin 8 of tube socket XV1 on power supply chassis (fig. 14) and chassis ground.	330, 000 ohms ----------	If resistance approaches 0 ohms, check for shorted filter capacitor C1 on power supply chassis.
		If resistance is approximately 200 ohms, check for shorted filter capacitor C2A on power sup ply chassis.
		If resistance is approximately 20, 000 ohms, check for shorted filter capacitor C3 on power supply chassis.
		If resistance is higher than normal, check for open inductor L1 or resistor R1 on power chassis.

17. Test Setup

For dynamic bench tests of the signal generator, remove the unit from its case, be sure that the internal power supply is connected to the oscillator chassis, and connect the line cord to a source of 117 volts, 50 to 60 cycles ac. Use the oscilloscope to check signal output voltages and for internal signal tracing. If variable markers are required for any test, connect an external signal generator, set to the desired marker frequency, to the EXT. OSC. INPUT connector.

18. Localizing Troubles

a. General. In the troubleshooting chart (*d* below), procedures are outlined for sectionalizing troubles to the internal power supply circuits or to the frequency generating circuits, and for localizing troubles to a stage within the signal generator. Parts locations are indicated in figures 10 through 13(2). Voltage and resistance measurements are shown in figures 14, 15, and 29, and waveforms are shown in figure 16. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When trouble has been localized to a particular stage, use voltage and resistance measurements to isolate the trouble to a particular part.

b. Use of Chart. The troubleshooting chart is designed to supplement operational checks detailed in TM 11-6625-40612. If previous operational checks have resulted in reference to a particular item of this chart, go directly to the referenced item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist (TM 11-6625-40612) and proceed until a symptom of trouble appears.

Caution: If operational symptoms are not known, or if they indicate the possibility of short circuits within the signal generator, make the short-circuit checks described in paragraph 16 before applying power to the unit.

c. Conditions for Tests. All checks outlined in the chart are to be conducted with the signal generator-connected to a 117-volt-ac source.

d. Troubleshooting Chart.

Symptom	Probable trouble	Correction
1. Indicator lamp I1 does not light when the ON-OFF switch is set to the ON position. No output available from signal generator.	No ac power is applied to the signal generator.	Check the power cable. Check the source voltage.
	Open fuse F1 in the power supply	Replace the fuse (3 amperes, 250V, type AG (C3). If the replaced fuse blows, check the filament and B+ circuits for shorts (para 16).
	Power supply chassis disconnected from oscillator chassis.	Connect connectorJ1 of the power supply chassis to connector P1 on the oscillator chassis.
	Defective switch S1	Replace ON-OFF switch S1.
	Defective transformer T1	Replace transformer T1 (para 25).
2. Indicator lamp I1 does not light, but all output voltages of the signal generator are normal.	Indicator lamp Ii or indicator lamp socket defective.	Replace indicator lamp I1 (1/2 ampere, 6. 3V type 44) or indicator lamp socket.
3. Indicator lamp I1 lights, but no output voltage, or low output voltage is obtained at SWEEP OUTPUT and PIP OUTPUT, terminals and 50Ω SWEEPING OSCILLATOR OUTPUT connector.	Faulty power supply circuits	Check adjustment of potentiometer R7 (para 34). Check tubes Y1 through V4 on the power supply chassis, and voltages and resistances at the tube sockets (fig. 14).
4. No sawtooth output voltage is available at SWEEP OUTPUT terminals. A signal of constant frequency is available at 50Ω SWEEPING OSCILLATOR OUTPUT connector.	Faulty sweep generator stage	Check tube V1 on the oscillator chassis, and voltages and resistances at the tube socket (fig. 29).
	Faulty shaping circuit	Check capacitors C4 and C5 (on oscillator chassis) for shorts, and capacitor C6 and resistors R9 and R10 for open circuits (fig. 13(1)and 13(2)).
5. Sawtooth output voltage at SWEEP OUTPUT terminals is unstable.	SWEEP RATE control R3 is misadjusted.	Readjust SWEEP RATE control.
	Faulty synchronizing circuit	Check capacitor C3, and resistors R6 and R7 (on oscillator chassis 13(1)and 13(2)).
	Faulty sweep generator stage	Check tube V1 and voltages and resistances at tube socket (on oscillator chassis); (fig. 29).
6. Output voltages at PIP OUTPUT terminals and 50Ω SWEEPING OSCILLATOR OUTPUT connector are normal, but no voltage, or low voltage, is obtained at SWEEP OUTPUT terminals.	Defective resistor R11 or capacitor C7.	Check for shorted capacitor C7, and for open resistor R11 (on oscillator chassis (fig. 12)) Replace if necessary.
7. Sawtooth output voltage at SWEEP OUTPUT terminals is normal, but frequency deviation of output voltage at 50Ω SWEEPING OSCILLATOR OUTPUT connector is incorrect in both the WIDE and NAR. positions of the SWEEP switch.	SWEEP WIDTH potentiometer R13 is misadjusted or defective (fig. 13(1)).	Check adjustment of this control; use the procedure given in paragraph 36. If proper results cannot be obtained, check potentiometer R13. Replace if necessary.
	Faulty sawtooth amplifier stage	Check tube V2 (on oscillator chassis), and voltages and resistances at tube terminals (fig. 29).
	Defective capacitor C10 (fig. 13(2)),, C12, or C48 (fig. 12).	Check for open capacitor C10, and for shorted capacitors C12 and C48 (on oscillator chassis). Replace if necessary.

Symptom	Probable trouble	Correction
8. Frequency deviation of output voltage at 50Ω SWEEPING OSCILLATOR OUTPUT connector is normal in the WIDE position of the SWEEP switch, but is below normal in the NAR. position.	Faulty switching circuit	Check SWEEP switch S3 and resistor R12 (on oscillator chassis), Replace if necessary (para 26).
	Faulty sawtooth amplifier stage	Check tube V2 (on oscillator chassis), and voltages and resistances at the tube socket(fig. 29).
9. Frequency deviation of output voltage at 50Ω SWEEPING OSCILLATOR OUTPUT connector is normal :in the 60 MC position of the CENTER FREQUENCY switch, but is incorrect in the 30 MC position.	Faulty switching circuit	Check CENTER FREQUENCY switch S2A and S2D, and resistors R19 and R20 (on oscillator chassis). Replace if necessary (para 26);
10. No output voltage is available at the 50Ω SWEEPING OSCILLATOR OUTPUT connector. ALL attenuator switches are set to the off position.	Faulty sweeping oscillator	Check tube V4 and voltages and resistances at the tube socket; refer to figure 29.
	Faulty saturable reactor	Check for open pickup coil on saturable reactor L1 (on oscillator chassis). Replace if necessary (para 27).
	Defective attenuator switch	Check for defective switch S4, S5, or S6. Replace if necessary (para 26).
11. No output voltage is available at the 50Ω SWEEPING OSCILLATOR OUTPUT connector when the 30-mc center frequency is selected. Output is normal when 60-mc center frequency is selected.	Defective CENTER FREQUENCY switch.	Replace switch S2 if necessary (para 26).
	Defective capacitor C50	Check for shorted capacitor C50. Replace if necessary.
	Defective saturable reactor L1	Check for open secondary winding in reactor L1 (on oscillator chassis). Replace if necessary (para 27).
12. The amplitude of the output voltage at the 50Ω SWEEPING OSCILLATOR OUTPUT connector varies during the sweeping cycle.	Faulty compensating modulator stage.	Check tube V3 (on oscillator chassis), and voltages and resistances at the tube socket (fig. 2).
13. The frequency deviation of the output voltage at the 50Ω SWEEPING OSCILLATOR OUTPUT connector is nonlinear.	LIN ADJ potentiometer R30 misadjusted.	Readjust this control (para 36).
	Defective crystal diodes	Check crystal diodes CR2, CR3, and CR4. Replace if necessary.
14. The center frequency of the sweeping oscillator output is incorrect.	Trimmer capacitors misadjusted	If trouble appears only on the 30-mc band, readjust the FINE TUNE control. If trouble persists, readjust capacitor C50 (para 36). If trouble appears on both bands, readjust capacitor C51 (para 36).
	Faulty sawtooth amplifier stage	Check tube V2, and voltages and resistances at the tube socket (fig. 29).
15. The amplitude of the output voltage at the 50Ω SWEEPING OSCILLATOR OUTPUT connector is below normal	Faulty sweeping oscillator stage	Check tube V4, and voltages and resistances at the tube socket (fig. 29).
	Faulty output attenuator network	Check resistors R50 through R64. Replace if necessary.
16. Variable markers at the PIP OUTPUT terminals are normal, but one or more of the fixed markers do not appear.	PIP ADJ. W control misadjusted	Readjust the control (para 37).
	Faulty crystal	Check the crystal associated with the missing fixed marker. Replace if necessary.
	Faulty CRYSTAL MARKER switch	Check the switch associated with the missing fixed marker. Replace if necessary (para 26).
	Capacitors C31 through C39 defective.	Check for shorted capacitor C31 through C39. Replace if necessary.

Symptom	Probable trouble	Correction
17. Fixed markers at the PIP OUTPUT terminals are normal, but variable markers do not appear.	Faulty detector circuit	Check resistor R35 and diode CR5 (on oscillator chassis). Replace if necessary.
	External signal generator faulty	Check external signal generator interconnecting cable, and connection to EXT. OSC. INPUT connector.
18. No markers of any type appear at the PIP OUTPUT terminals.	Control misadjusted	Readjust pip INCREASE, PIP ADJ W, and PIP ADJ. N controls. If trouble persists, check adjustment of PIP ADJ potentiometer R88; (para 37).
	Faulty detector, trigger amplifier, or pip generator stage.	Localize trouble to a particular stage by signal tracing; refer to paragraph 18. Check the tube in the affected stage, and voltages and resistances at the tube socket (fig. 29).
	Faulty coupling circuit	Check for defective resistor R47, R49, or R65. Replace if necessary.

19. Isolating Trouble Within a Stage

When trouble has been localized to a stage, use the following techniques to isolate the defective part:

a. Test the tube involved (para 22), either in a tube tester, or by substituting a similar type tube which is known to be operating normally (TM 11-6625-406-12).

b. Take voltage measurements at the tube sockets (fig. 14 and 29) and other points related to the stage in question (fig. 15).

c. If voltage readings are abnormal, take resistance readings (fig. 14, 29, and 15) to isolate open and short circuits. Refer also to the dc resistances of transformers and coils (para 20).

d. Use the schematic diagram (fig. 30) to trace circuits and to isolate the faulty component.

20. Dc Resistances of Transformers and Coils

The dc resistances of the transformer windings and the coils in the signal generator are listed below:

Transformer or coil	Terminals	Ohms
L1 (power supply chassis)		260
T1 (power supply chassis)	Primary (white, white-black leads)	6.2
	Primary (black, black-red leads)	5.6
	Hv secondary (red leads)	320
	Filament windings:	
	Yellow leads	Less than 1
	Brown leads	Less than 1
	Green leads	Less than 1
L1 (oscillator chassis)		4,000

21. Checking Waveforms

(fig. 16)

Certain troubles that do not permit rapid localization to a stage through operational tests can be localized by checking waveforms. Figure 16 shows the waveforms that should exist at the tube sockets. Using Oscilloscope AN/USM-50, compare waveforms at the various points indicated with those shown in the figure. If a difference is noted, make voltage and resistance measurements at that point to isolate the defective part.

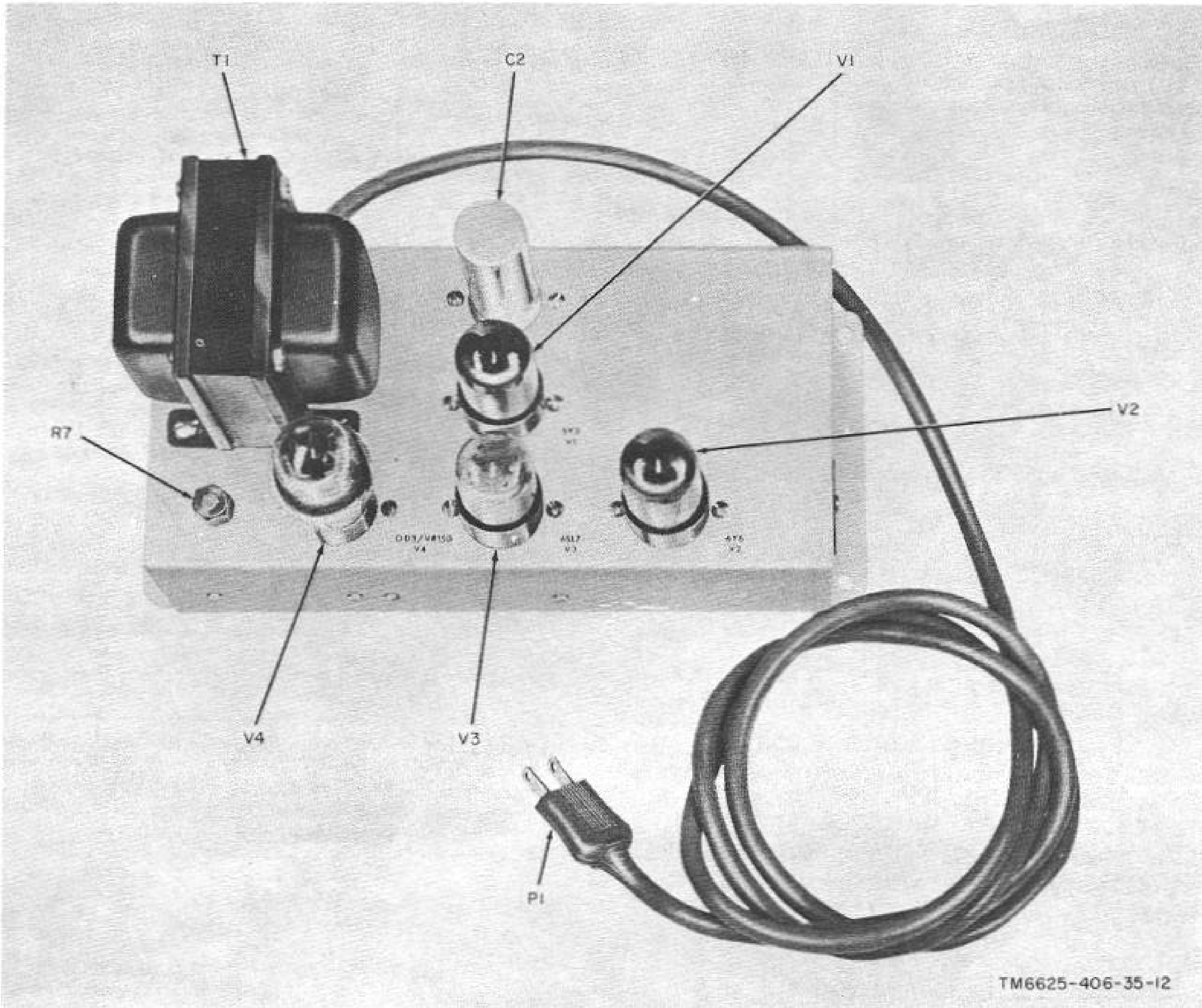


Figure 10. Power supply chassis, top view.

22. Tube Testing Techniques

a. When trouble occurs, check all cabling and connections before removing any tubes. Try to isolate the trouble to a stage. If tube failure is suspected, use the applicable procedure below to check the tubes.

Caution: Do not rock or rotate a tube when removing it from a socket; pull it straight out with a tube puller.

b. Remove and test one tube at a time. Discard the tube only if its defect is obvious or if the tube tester shows it to be defective. Do not discard a tube that tests at or near its minimum test limit on the tube tester. Put back the original tube, or insert a new tube if required, before testing the next one.

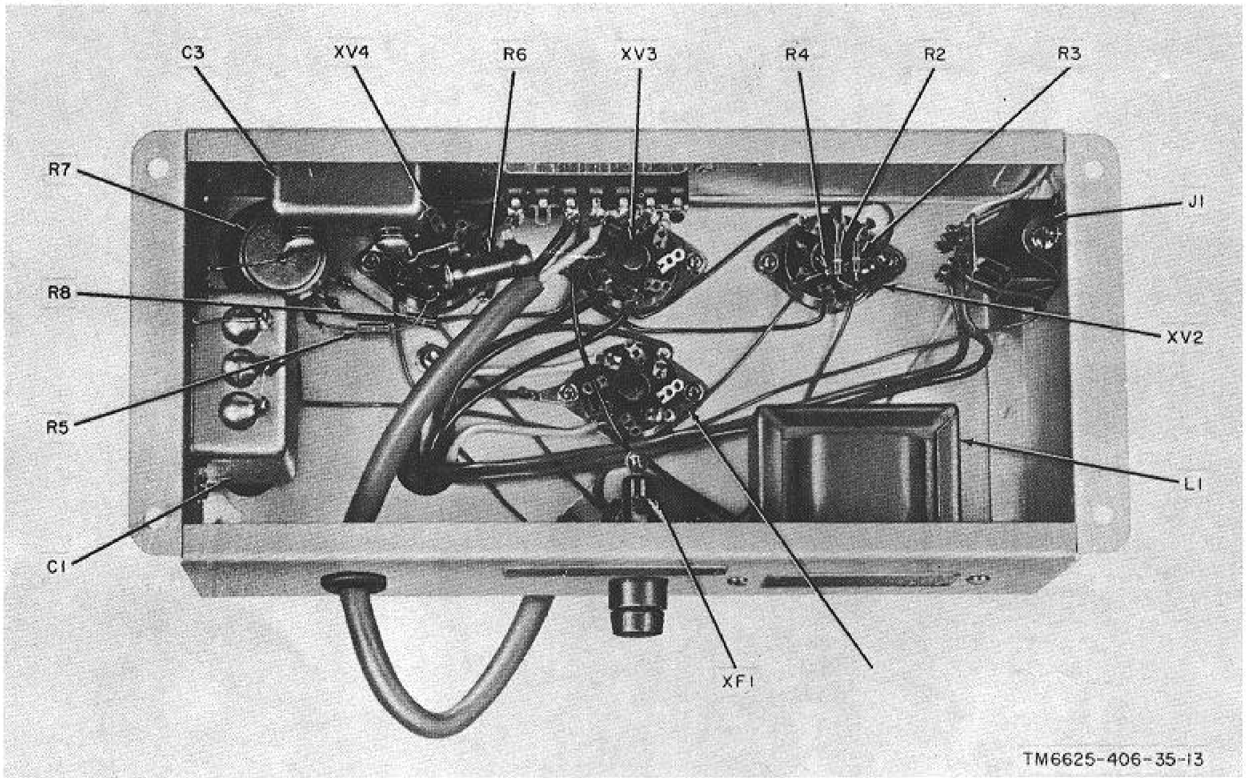


Figure 11. Power supply chassis, bottom view.

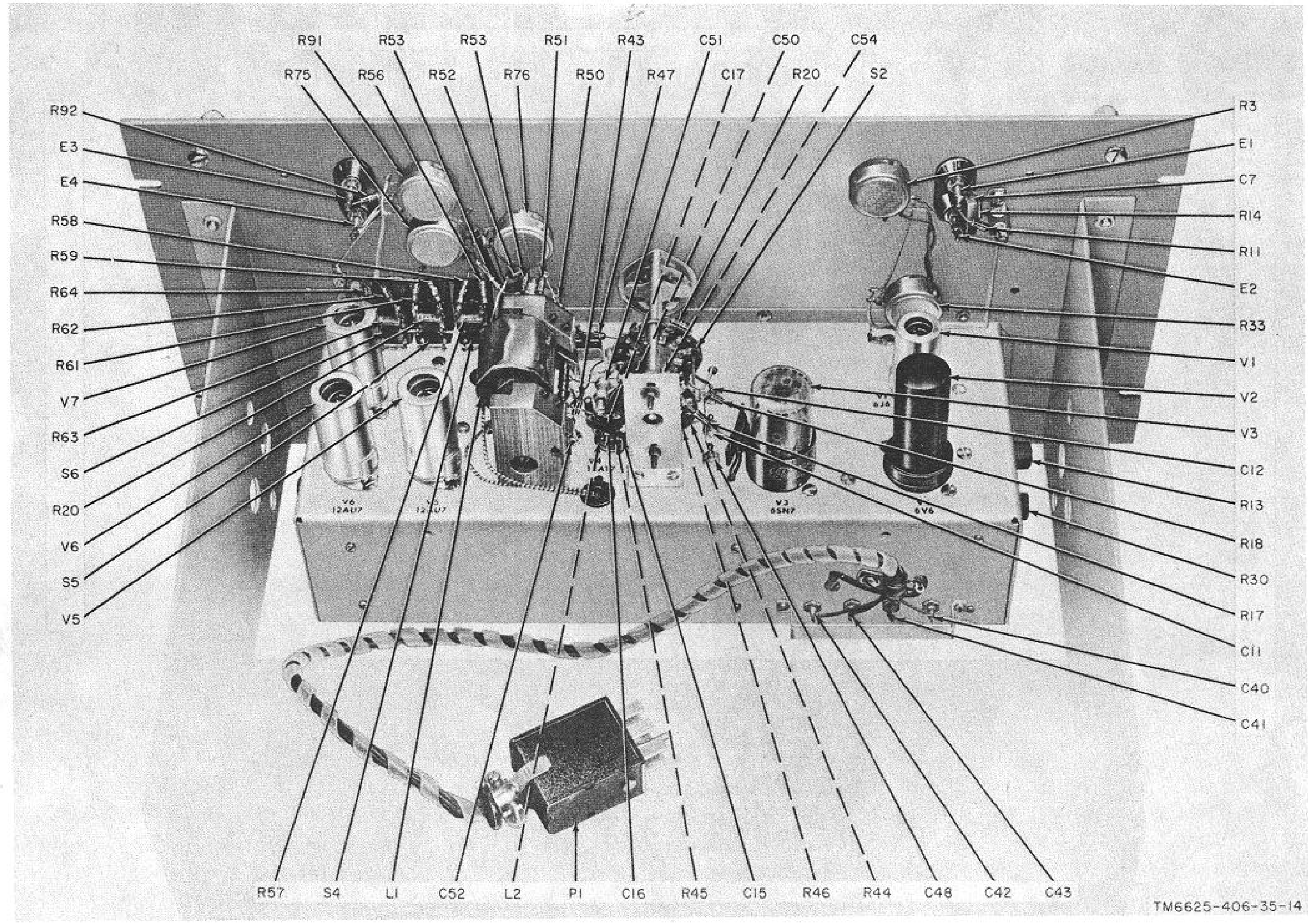


Figure 12. Oscillator chassis, top view.

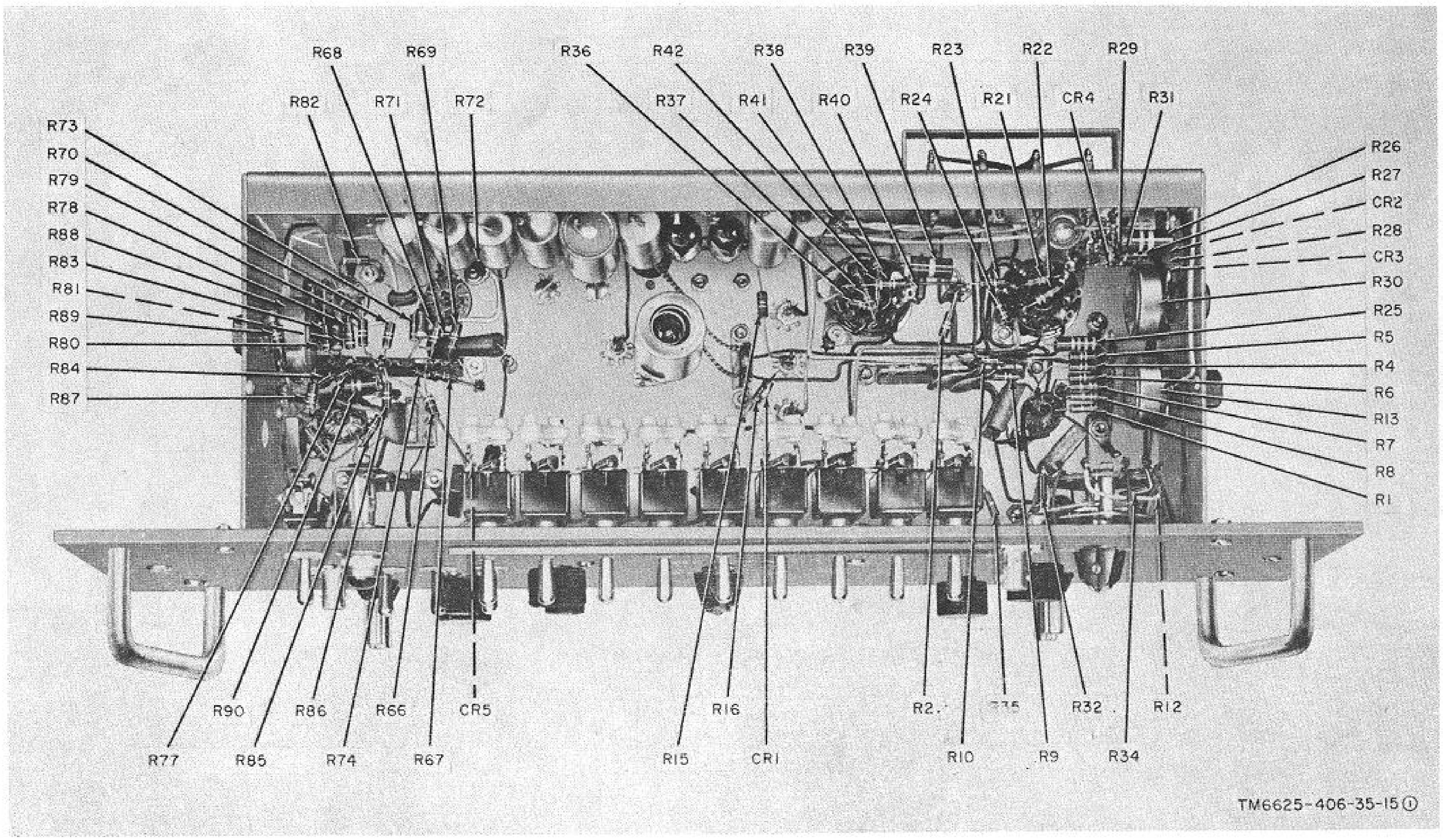


Figure 13(1). Oscillator chassis, bottom view showing location of resistors, capacitors, and other parts (part 1 of 2).

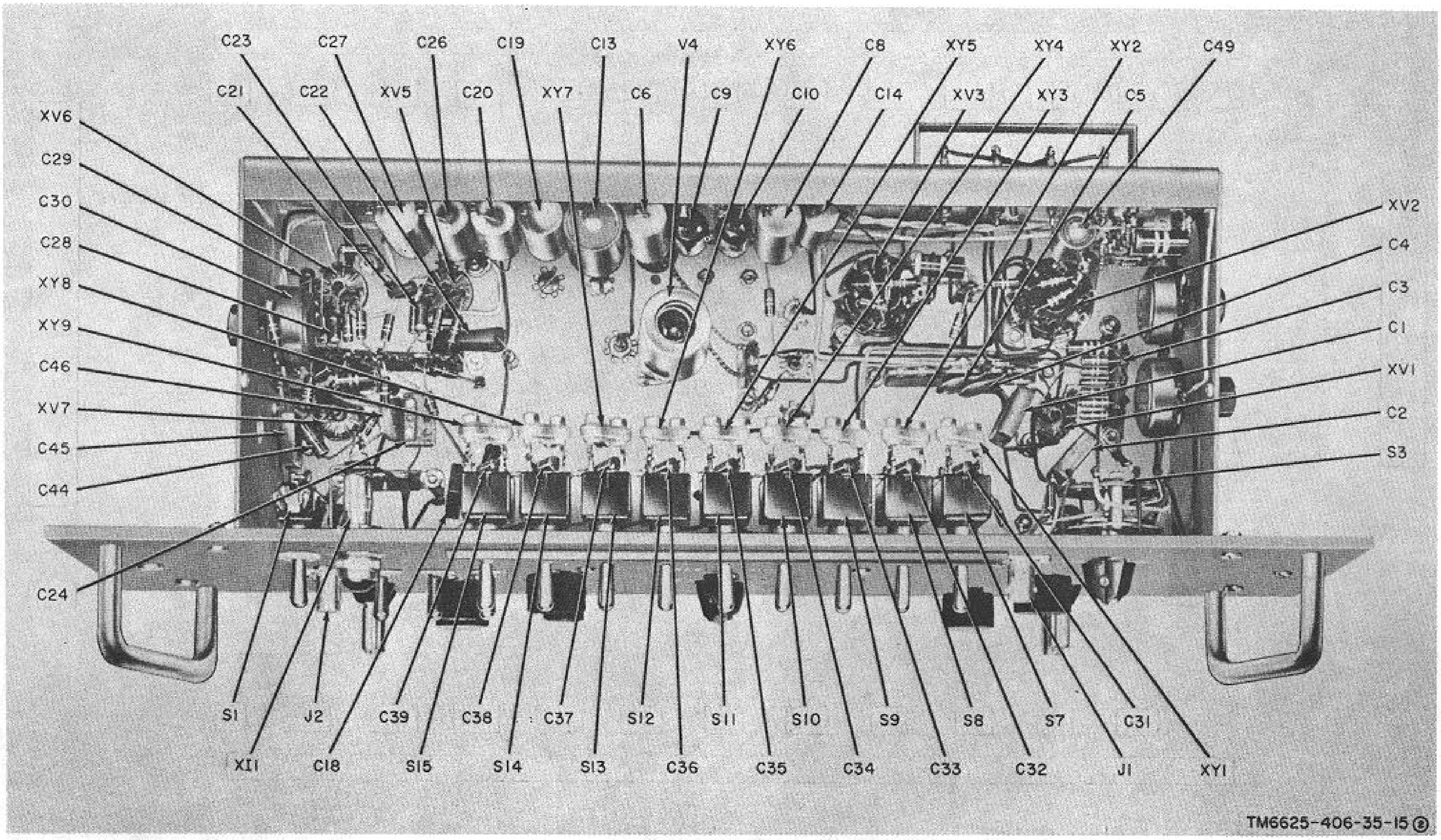
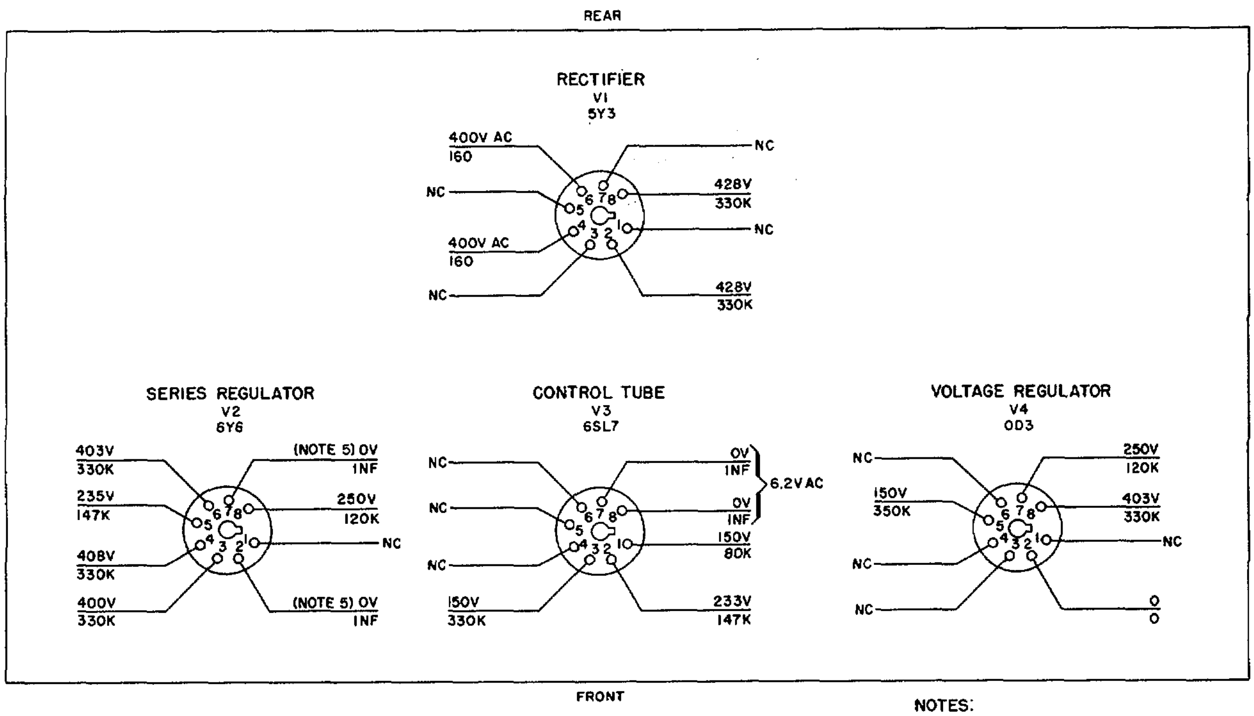


Figure 13(2). Oscillator chassis, bottom view, showing location of resistors, capacitors, and other parts (part 2 of 2).



NOTES:

1. LINE VOLTAGE AT 117V, 50 TO 60 CPS.
2. ALL VOLTAGES TO CHASSIS GROUND ARE DC UNLESS OTHERWISE INDICATED.
3. NC INDICATES NO CONNECTION.
4. ALL VOLTAGES MEASURED WITH VTVM.
5. INF INDICATES INFINITY.
6. * V2, HEATER 2–7 = 6.2 VAC.

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Figure 14. Power supply chassis, tube socket voltage and resistance diagram.

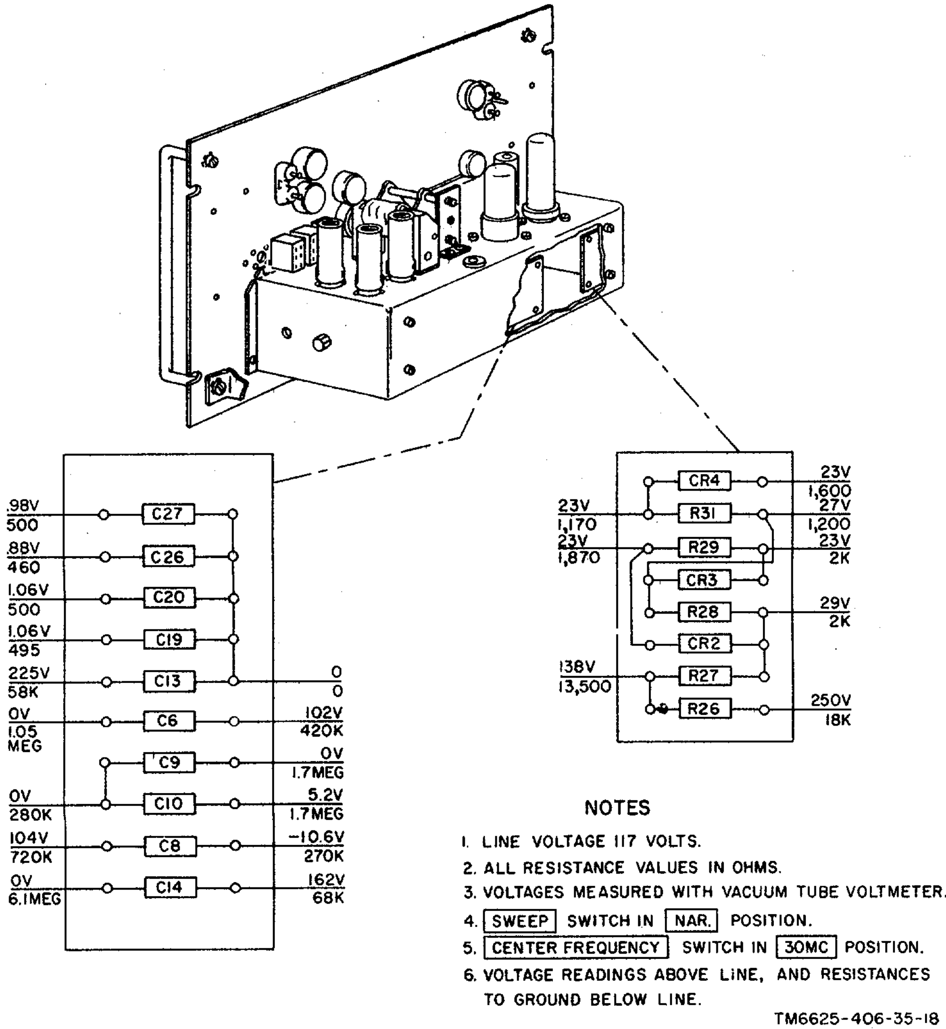


Figure 15. Oscillator chassis resistor-capacitor mounting boards, voltage and resistance diagram.

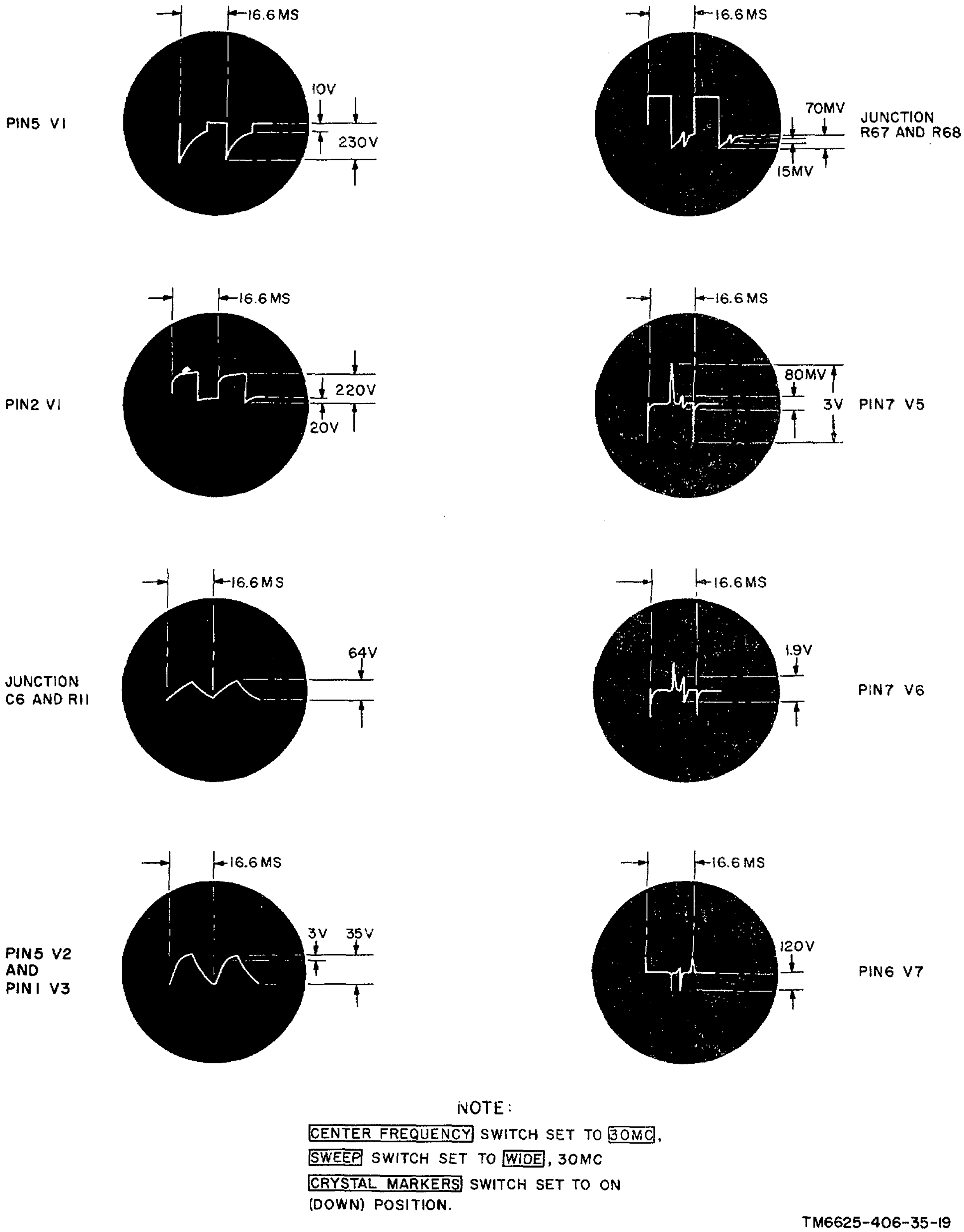


Figure 16. Oscillator chassis, waveforms.

Section I. REPAIRS

23. General Parts Replacement Techniques

After removal of the signal generator from its cabinet (para 24) and the shields from the oscillator chassis, most of the p arts of the signal generator can' be reached and replaced easily without special procedures. The following precautions apply specifically to the signal generator:

a. Do not disturb the setting of the screwdriver-adjustable potentiometers, or capacitors C50 and C51. Any movement of these parts will void the entire alignment of the unit.

b. When soldering crystal diodes, use a pencil-type soldering iron with a 25-watt maximum capacity. Solder quickly. Use a heat sink (such as long-nosed pliers) between the soldered joint and the diode.

c. To reach parts mounted on the tube socket of sweeping oscillator V4, remove the CENTER FREQUENCY switch (para 26).

24. Removal and Replacement of Cabinet and Power Supply Chassis

a. Remove the cabinet and the power supply chassis as follows:

(1) Remove the four recessed-head screws that fasten the front panel to the cabinet.

(2) Slide the signal generator out of the cabinet. Be careful to prevent strain on the power cord. Be sure that the power cord is not tangled and is free to pass through the opening at the rear of the cabinet.

(3) Disconnect connector P1 on the chassis interconnecting cable from connector J1 on the power supply chassis.

(4) Remove the four mounting screws, nuts and lockwashers that attach the power supply chassis to the equipment frame, and remove the power supply chassis.

b. Replace the power supply chassis and the cabinet as follows:

(1) Align the mounting holes in the power supply chassis with the mounting holes in the equipment frame. Fasten the power supply chassis in place; use four mounting screws, lockwashers, and nuts.

(2) Connect connector P1 on the chassis interconnecting cable to connector J1 on the power supply chassis.

(3) Pass the power cord through the cabinet and through the opening at the rear of the cabinet.

(4) Slide the equipment into the cabinet. Align the mounting slots in the front panel with the four threaded mounting holes in the cabinet, and fasten the panel to the cabinet with four recessed-head screws.

25. Removal and Replacement of Power Supply Chassis Parts

a. Power Transformer T1. Remove and replace power transformer T1 as follows:

(1) Remove the cabinet and the power supply chassis (para 24).

(2) Unsolder the 13 leads of the power transformer. Tag each lead as it is disconnected to indicate the proper connection point.

(3) Remove the four mounting, screws, lockwashers, and nuts that fasten the power transformer to the chassis, and remove the power transformer.

(4) Insert the leads of the replacement power transformer through the opening in the chassis. Attach the power transformer to the chassis; use four mounting screws, lockwashers, and nuts.

(5) Using the connection data noted in 1(2) above, route the leads of the power transformer to the proper connection points, cut the leads to the proper length, make the proper connections, and solder the connection.

b. Potentiometer R7. Remove and replace potentiometer R7 as follows:

(1) Remove the cabinet and power supply chassis (para 24).

(2) Unsolder the connections to the three terminal lugs of the potentiometer. Tag the leads to insure]proper connection of the replace: ment potentiometer.

(3) Remove the red fiber mounting nut and lockwasher, and remove the potentiometer.

(4) 'Tighten the hexagonal nut on the shaft of the replacement potentiometer fingertight.

(5) Pass the shaft of the potentiometer through the mounting hole in the chassis.

(6) Position the potentiometer so that the leads that were removed ((2) above) can be connected to the proper terminals.

(7) : Mount the potentiometer on the chassis with the lockwasher and red fiber mounting nut that were removed ((3) above).

(8) Readjust the B+ voltage (para 34).

c. Capacitor C2. Remove and replace capacitor C2 as follows:

(1) Remove the cabinet and power supply chassis (para 24).

(2) Disconnect the connecting leads and resistor R1 from the capacitor terminals.

(3) Remove all solder from the three mounting lugs of the capacitor.

(4) Using pliers, twist each of the three mounting lugs until each is aligned with the slot in the mounting plate, and remove the capacitor.

(5) Insert the three mounting lugs of the replacement capacitor through the slots in the mounting plate. Press the capacitor tightly against the mounting plate, and twist each mounting lug 90° to fasten the capacitor to the mounting plate.

(6) Replace the leads and resistor that were removed ((2) above), and solder them in place.

(7) Solder one of the mounting lugs of the capacitor to the mounting plate to insure a good electrical ground connection.

26. Removal and Replacement of Front Panel Controls

a. Binding Posts. Remove and replace either the PIP OUTPUT or the SWEEP OUTPUT binding posts as follows:

(1) Remove the signal generator from the cabinet, and remove the top shield from the oscillator chassis.

(2) At the rear of the panel, unsolder all connections and remove any parts connected to the binding posts. Remove all excess solder.

(3) Remove the two nuts, lockwashers, and washers at the rear of the binding posts, separate the two halves of the binding post, and remove them from the panel.

(4) Remove the two screws, lockwashers, and washers from the replacement binding posts, separate the two halves, and install the binding posts with the edge of the panel opening clamped between the halves. Install and tighten the two washers, lockwashers, and nuts.

(5) Reconnect and solder the connections and parts that were removed ((2) above).

b. Potentiometers. Remove and replace the front panel potentiometers as follows:

(1) Remove the signal generator from the cabinet, and remove the top shield from the oscillator chassis.

(2) Tag and disconnect the leads from the terminals of the potentiometer to be removed.

(3) Loosen the socket-head setscrews in the knob of the potentiometer, and remove the knob.

(4) Remove the hexagonal mounting nut that fastens the potentiometer

to the panel, and remove the potentiometer. Retain the lockwasher from the potentiometer shaft.

(5) Tighten the hexagonal mounting nut that is supplied on the shaft of the replacement potentiometer.

Place the lockwasher that was removed ((4) above), onto the potentiometer, and insert the shaft of the potentiometer through the opening in the front panel.

(6) Position the potentiometer so that the disconnected leads ((2) above) can reach the proper potentiometer terminals, and fasten the potentiometer to the front panel with a hexagonal mounting nut.

(7) Connect and solder the disconnected leads ((2) above).

(8) Replace the knob on the potentiometer shaft, and tighten the setscrews in the knob.

c. Attenuator Switches. Remove and replace the attenuator switches as follows:

(1) Remove the signal generator from the cabinet, and remove the top shield from the oscillator chassis.

(2) Disconnect all parts and leads from the switch to be removed.

(3) Loosen the hexagonal mounting nut at the rear of the panel; then remove the knurled mounting nut at the front of the panel and remove the switch. Save the lockwasher.

(4) Thread the hexagonal nut onto the replacement switch, install a lockwasher on the threaded portion of the switch, pass the threaded portion through the mounting hole in the panel, place the knurled mounting nut on the part that protrudes through the panel, and tighten the knurled mounting nut until it is flush with the front edge of the threaded portion of the switch.

(5) Tighten the hexagonal mounting nut at the rear of the panel.

(6) Connect and solder all parts and leads that were disconnected ((2) above).

d. CRYSTAL MARKERS Switches. To remove and replace any of the CRYSTAL MARKERS switches, follow the same procedure as in c above. The CRYSTAL MARKERS switches are all connected by bus wires that are looped around two of the switch terminals and soldered. When removing a switch, unsolder the bus wire, open the loop, and slip the opened loop up over the terminal. When the switch is replaced, slip the opened loop down over the switch terminal, tighten the loop, and solder the connection.

e. SWEEP Switch. Remove and replace the SWEEP switch as follows:

(1) Remove the signal generator from the cabinet, and remove the bottom shield from the oscillator chassis.

(2) Loosen the setscrew in the switch knob, and remove the knob.

(3) Remove the lower left mounting screw, lockwasher, and nut from the EXT. OSC. INPUT connector to allow the associated ground lug to be lifted from the panel.

(4) Remove the hexagonal mounting nut at the front of the panel from the switch.

(5) Push the shaft of the switch through the mounting hole, and carefully lift the switch, with all leads attached, clear of the chassis. Sufficient slack has been left in all interconnecting leads to permit this action.

(6) Disconnect all leads and parts attached to the switch terminals; tag each lead or part as it is disconnected.

(7) Connect and solder the leads and parts that were disconnected ((6) above) to the proper terminals of the replacement switch.

(8) Insert the shaft of the replacement switch through the hole in the front panel, and fasten the switch to the panel with the hexagonal nut that was removed ((4) above).

(9) Dress the leads connected to the switch.

(10) Insert the removed screw ((3) above) through the mounting holes in the EXT. OSC. INPUT connector and the front panel, and through the grounding lug on one of the leads from the switch, and fasten it with the lockwasher and nut

that were removed ((3) above).

(11) Place the knob on the shaft of the switch, and tighten the setscrew in the knob.

f. CENTER FREQUENCY Switch. Remove and replace the CENTER FREQUENCY switch as follows:

(1) Remove the signal generator from the cabinet, and remove the top shield from the oscillator chassis.

(2) Loosen the setscrew in the knob, and remove the knob.

(3) Remove the hexagonal mounting nut from the switch shaft.

(4) Disconnect the accessible leads and parts from the switch. Tag each lead as it is removed, and carefully move it out of the way.

(5) Remove the two screws, lockwashers, and nuts that fasten the rear mounting bracket of the switch to the chassis.

(6) Carefully move the switch to reach the bottom terminals, and unsolder the interconnecting leads. Remove the switch, and disconnect all parts connected between terminals of the switch.

(7) Connect and solder the removed parts ((.6) above) between the proper terminals of the replacement switch.

(8) Insert the switch shaft through the hole in the front panel, and carefully connect and solder all leads to the hard-to-reach terminals of the replacement switch.

(9) Fasten the rear mounting bracket of the switch to the chassis; use the two screws, lockwashers, and nuts that were removed ((5) above).

(10) Attach the switch to the front panel with the hexagonal mounting nut.

(11) Connect all remaining leads and parts to the terminals of the switch.

(12) Place the knob on the switch shaft, and tighten the setscrew in the knob.

27. Removal and Replacement of Oscillator Chassis Parts

a. Saturable Reactor L1. Remove and replace saturable reactor L1 as follows:

(1) Remove the signal generator from the cabinet, and remove the top and bottom shields from the oscillator chassis.

(2) Tag and disconnect the control winding leads, the secondary winding leads, and the pickup winding leads of the saturable reactor.

(3) Remove the four mounting screws and lockwashers that fasten the saturable reactor to the chassis, and remove the saturable reactor.

(4) Pass the control winding leads of the replacement saturable reactor through the rubber grommet on the top of the oscillator chassis.

(5) Fasten the saturable reactor to the chassis; use the four screws and lockwashers that were removed ((3) above).

(6) Connect and solder all saturable reactor leads.

(7) Install the top and bottom shields of the oscillator chassis. Realign the signal generator (para 32).

b. Connector P1. Remove and replace connector P1 as follows:

(1) Remove the signal generator from the cabinet.

(2) Disconnect connector P1 from connector J1 on the power supply chassis.

(3) Loosen the two screws that clamp the connector to. the inter connecting cable.

(4) Remove the two screws that fasten the cover of the connector to the connector body. Slide the cover back on the cable.

(5) Disconnect the leads of the interconnecting cable from the terminals of the connector. Remove the connector.

(6) Loosen the two screws in the clamp of the replacement connector. Remove the two screws that fasten the cover of the replacement connector, and remove the cover. Slide the cover onto the interconnecting cable.

(7) Connect and solder the leads of the interconnecting cable to the proper

terminals of the replacement connector. (See color code, fig. 30.)

(8) Slide the cover of the replacement connector down over the body, and install the two screws that were removed ((6) above).

(9) Tighten the two screws in the cable clamp of the connector.

28. Replacement of R45

a. Resistor R45 is used to adjust the sweeping oscillator stage output to 250 millivolts root mean square (rms), as measured at SWEEPING OSCILLATOR OUTPUT jack J1. The value of R45 will be between 50K and 75K ohms.

b. To select the correct value for R45, proceed as follows:

(1) Connect the voltmeter to J1.

(2) Terminate J1 with a 50-ohm resistor.

(3) Connect a wire between the junction of R44 and R46 to ground.

(4) Substitute values between 50K and 75K ohms for R45. When the output voltage read on the voltmeter is 250 millivolts, the correct value has been found.

29. Replacement of R65

a. Resistor R65 is used to match the impedance of the sweeping rf line to the impedance of the crystal bank, which effectively equalizes the amplitude of the trigger pulses. The value of R65 will be between 47 and 75 ohms.

b. To select the correct value for R65, proceed as follows:

(1) Set CENTER FREQUENCY switch S2 in the 60MC position.

(2) Connect the oscilloscope to the junction of C28 and R83.

(3) Substitute values between 47 and 75 ohms for R65. The value that gives the maximum trigger amplitude is the correct value.

30. Replacement of C50

a. Capacitor C50 is the 30-mc centering capacitor. The capacitor may be any variable, capacitor such as a 1.5 to 7, 3 to 12, or 7 to 45 uuf capacitor. The value will be between 1.5 uuf and 45 uuf.

b. To select the value of C50, perform the check given in paragraph 36 and insert the correct value which gives the desired results.

31. Replacement of C47

a. Capacitor C47 is a bypass for the residual' high frequency component of the detected rf applied to the pip circuits. It is effective on narrow variable sweep operation and increases the effective range of PIP ADJ. N potentiometer R76. The value of C47 will be between 1,000 and 2,000 uuf.

b. To determine the value of C47, proceed as follows:

(1) Connect the oscilloscope to the junction of C28 and R83.

(2) Observe the oscilloscope presentation. No more than one marker should appear for each crystal switched in the circuit.

(3) If more than one marker appears for each crystal in the circuit, select a new value for C47.

Section II. ALIGNMENT

32. Test Equipment and Materials Required for Alignment

The following chart lists test equipment required for aligning Signal Generator SG336/U and gives the associated technical manuals, and the assigned common names:

a. Test Equipment.

Test equipment	Technical manuals	Common names
Multimeter TS-352(*)/U[a]	TM 11-5527	Multimeter

Test equipment	Technical manuals	Common names
Voltmeter, Meter ME-30(*)/U	TM 11-6625-320-12	Voltmeter
Signal Generator AN/USM-44		Cw signal generator
Oscilloscope AN/USM-50	TM 11-5129	Oscilloscope
Calibrated detector (para 33)		

[a] Refers to Multimeters TS-352/U, T'352A/U, and T8-352B/U.

b. Materials Required for Construction of Calibrated Detector.

Materials	Federal stock No.
Capacitor, sliver-mica, 390 uuf, 500 volts (C1).	5910-648-7839
Silicon rectifier, type G7C (CR1).	5960-280-6417
Connector, BNC, type UG-185/U (2 required) (J1, J2).	5935-149-4138
Binding post.	5940-680-9734
Resistor, fixed composition, 51-ohms, 1/2-watt, 5-percent tolerance (2 required) (R1, R2).	5905-279-3517
Resistor, fixed composition, 390-ohm, 1/2-watt, 10-percent tolerance (R3).	5905-192-3972
Resistor, fixed composition, 100K, 1/2-watt, 10-percent tolerance (Run).	5905-120-0894
Resistor, fixed composition, 47K, 1/:2-watt, 10-percent tolerance (R5).	5905-539-3210
Insulated terminal post (2 required).	
Screws, 8-32 x 1/2 inch (14 required).	
Sheet aluminum, 1/8 inch (1 square foot).	
Solder lugs (2 required).	
Alligator clips (2 required).	

c. Cables Required for Use With Calibrated Detector.

Equipment	Federal stock No.
Cable assembly (2 required)	MAHB-4935-724-9599
Cable assembly	6625-690-5379

33. Fabrication of Calibrated Detector

(fig. 18)

a. Using sheet aluminum, construct a rectangular chassis of approximately 2-1/4l x 4-1/2 x 1-1/2 inches, and a bottom cover plate for the chassis.

b. Using the type UG-185/U connector and the binding post as a guide, drill mounting holes for these parts.

c. Using the type UG-185/U as a template, drill and tap four holes for the mounting screws of each connector.

d. Drill six holes for mounting screws in the bottom cover plate.

e. Using the bottom cover plate as a template, drill and tap six holes in the bottom lip of the chassis for the six cover plate mounting screws.

f. Mount two insulated terminal posts (5 and 6) over two ground solder lugs (10 and 14) along the longitudinal centerline at the underside of the chassis. Space the two terminal posts approximately 1-3/8 inches apart.

g. Mount two type UG-185/U connectors (1 and 3), and the binding post (8) to the outside of the chassis.

h. Connect, but do not solder, a 390-ohm resistor (4) between the secondary input connector (3) and the nearest insulated terminal post (5).

i. Connect a 51-ohm resistor (2) between the secondary input connector (3) and the nearest ground solder lug (14). Solder all connections at the secondary input connector.

j. Connect a 51-ohm resistor (13) between the insulated terminal post (5) nearest the input connectors and the associated ground solder lug, a length of hookup wire between the primary input connector (1) and the same insulated terminal post, and the silicon rectifier (12) between the two insulated terminal posts. Solder the connections at the primary input connector, the nearest insulated terminal post, and the associated ground solder lug.

k. Connect the 390-uuf capacitor (11) and a 100K-ohm resistor (9) between the second insulated terminal post (6) and its associated ground solder lug; connect a 47K-ohm resistor (7) between the insulated terminal post and one of the terminals of the binding post (8), and connect a length of bus wire between the second terminal of the binding post and the nearest ground solder lug. Solder all connections.

l. Mark the binding post to indicate the high-potential and ground terminals.

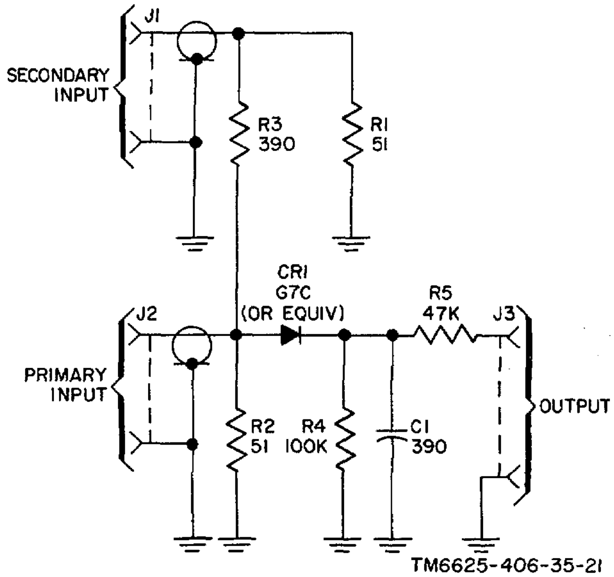


Figure 17. Calibrated detector, schematic diagram.

m. Check the wiring against the schematic diagram (fig. 20).

n. Attach the bottom cover plate to the chassis.

34. B+ Voltage Adjustment

(fig. 19)

Before any other alignment procedures are performed, the B+ voltage of the signal generator must be set to 250 volts. Allow the signal generator and external test equipment to warm up for at least 10 minutes before starting alignment. Adjust the B+ voltage as follows:

a. Set the controls of the multimeter to the proper settings for the measurement of 250 volts dc.

b. Connect the negative lead of the multimeter to chassis ground, and the positive lead to B+ feedthrough capacitor C42 on the rear apron of the oscillator chassis. Capacitor C42 is the feedthrough capacitor to which the red lead of the interconnecting cable is connected.

***Warning:* Be careful when making the multimeter connection to capacitor C42. Serious injury or death may result from bodily contact with the capacitor terminal.**

c. Using a screwdriver, adjust potentiometer R7 (fig. 10) on the power supply chassis until the multimeter indicates 250 volts. Disconnect the voltmeter.

35. Sweep Output Voltage Check

(fig. 20)

Operation of the rf circuits to be aligned is controlled by the sawtooth sweep voltage of the signal generator. Check the sweep output voltage as follows:

a. Turn on the oscilloscope and signal generator and allow a few minutes warmup.

***Warning:* Be careful when connecting the lead to C43 because the adjacent feed-through capacitors have 250 volts and 115 volts on their exposed terminals.**

b. Connect a coaxial lead from the SWEEP OUTPUT terminals on the signal generator to the SIGNAL INPUT connector on the oscilloscope; connect a coaxial lead from feedthrough capacitor C43 to the SYNCH INPUT connector on the oscilloscope.

c. Set the controls of the oscilloscope as follows:

MULTIPLIER	CAL
CALIBRATION VOLTAGE	70
SYNCH selector switch	HI EXT
SWEEP TIME	10,000
SWEEP DELAY	OUT
TRIGGER RANGE	OFF
MARKER	Z AXIS ON

d. Adjust the other controls to obtain a square wave calibration pattern centered on the oscilloscope screen.

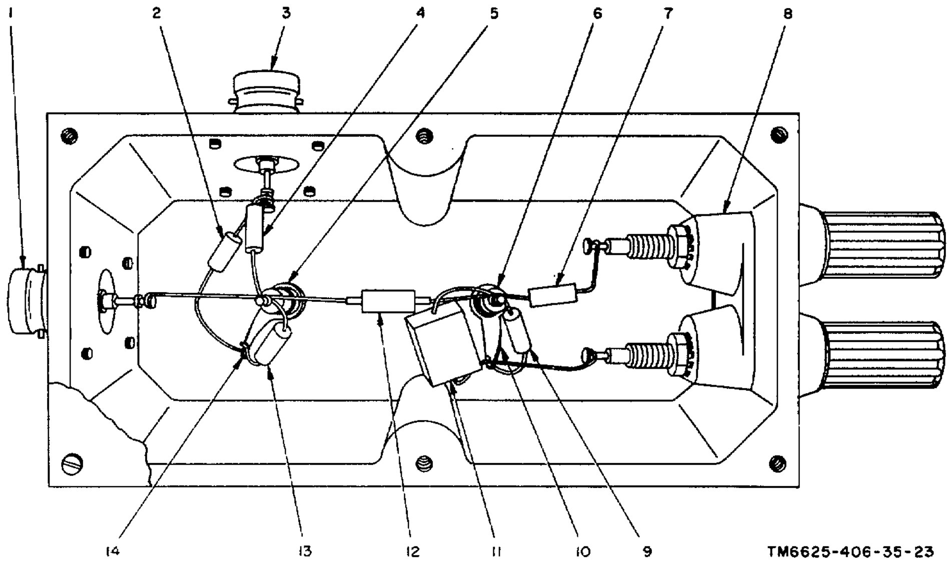
e. Adjust the oscilloscope SCALE ILLUMINATION control until the scale is visible and adjust the VERTICAL GAIN control until the calibration pulse has an amplitude of 10 scale divisions.

f. Set the oscilloscope MULTIPLIER switch to 100.

Note: Do not disturb the setting of the oscilloscope MULTIPLIER, VERTICAL GAIN, and CALIBRATION VOLTAGE controls for the remainder of the procedure.

g. Adjust the oscilloscope SWEEP TIME and SYNCH -/+ controls for a stable oscilloscope pattern. The amplitude of the oscilloscope display must be at least 10 divisions of the oscilloscope scale.

h. Rotate the SWEEP RATE control on the signal generator. The pattern on the oscilloscope should remain stable over a 300 range of SWEEP RATE control.



1 Primary input connector (J2)
2 Resistor, 51-ohm (R1)
3 Secondary input connector (J1)
4 Resistor, 390-ohm (R3)
5 Insulated terminal post
6 Insulated terminal post
7 Resistor, 47K (R5)
8 Binding post
9 Resistor, 100K (R4)
10 Ground solder lug
11 Capacitor, 390-uuf (C1)
12 Silicon rectifier (CR1)
13 Resistor, 51-ohm (R2)
14 Ground solder lug

Figure 18. Fabrication of calibrated detector.

36. Sweeping Oscillator Alignment

a. Center Frequency and Sweep Width Adjustments (fig. 21). Adjust the center frequency and the sweep width of the sweeping oscillator output as follows:

(1) Set the horizontal deflection controls of the oscilloscope for an external signal input. Connect the SWEEP OUTPUT terminal of the signal generator to the horizontal input terminal of the oscilloscope, and the associated GND terminal of the signal generator to the horizontal ground terminal of the oscilloscope.

(2) Connect the 50Ω SWEEPING OSCILLATOR OUTPUT connector of the signal generator to the primary input connector of the calibrated detector (fig. 17). Connect the output of the continuous wave (cw) signal generator to the secondary input of the calibrated detector. Connect the output terminals of the calibrated detector to the vertical input terminals of the oscilloscope.

(3) Set the CENTER FREQUENCY switch on the signal generator to 30MC, the SWEEP switch to WIDE, the db INCREASE control fully clockwise, and the 20DB, and 10DB attenuator s wit c h e s to the out (down) position. Set the SWEEP WIDTH potentiometer (fig. 13(1)) to the center of its range.

(4) Set the frequency of the cw signal generator to 30 mc, and adjust the output voltage until a marker appears on the oscilloscope trace. Adjust trimmer capacitor C50 (fig. 12) until the marker is centered along the oscilloscope trace.

(5) Tune the cw signal generator to move the marker from one extreme of the oscilloscope trace to the other. At one extreme, the cw signal generator frequency should be 20 mc or lower and, at the other extreme, 40 mc or, higher.

(6) If sweep width noted in (5) above is incorrect, adjust the SWEEP WIDTH potentiometer R13 and repeat (4) and (5) above to check the center frequency

and sweep width. Only a slight readjustment of the SWEEP WIDTH potentiometer should be necessary. If the potentiometer must be rotated a considerable amount from the center of its range, adjust the value of resistor R20 (fig. 12) by substitution. If the SWEEP WIDTH potentiometer setting is considerably clockwise from the center setting, decrease the value of resistor R20; if the setting is considerably counterclockwise from the center setting, increase the value of resistor R20. Readjust the SWEEP WIDTH potentiometer and repeat the procedures given in (4) and (5) above to make sure that the center frequency and the sweep width on the 30-mc band are correct.

(7) Set the CENTER FREQUENCY switch on the signal generator to 60 MC.

(8) Set the frequency of the cw signal generator to 60 mc, and adjust the output voltage until a marker appears on the oscilloscope trace. Adjust trimmer capacitor C51 (fig. 12) until the marker is centered along the oscilloscope trace.

(9) Tune the cw signal generator to move the marker from one extreme of the oscilloscope trace to the other. At one extreme, the cw signal generator frequency should be 50 mc or lower and, at the other extreme, 70 me or higher.

(10) If the sweep width noted in (9) above is incorrect, adjust the SWEEP WIDTH potentiometer, and repeat the procedures given in (8) and (9) above to check the center frequency and the sweep width. Only a slight readjustment of the SWEEP WIDTH potentiometer should be required. If extensive changes in : setting are required, disconnect the lead at the top of the chassis that connects feedthrough capacitor C12 (fig. 12) to CENTER FREQUENCY switch S2. Select, by test, a value of resistance (R19) which, when connected between these two points, provides approximately the correct sweep width with the SWEEP WIDTH potentiometer at its center setting. Solder the resistor in place, and repeat the procedures given in (8) and (9) above to make sure that the center frequency and the sweep width on the 60-mc band are correct.

(11) Repeat the procedures given in (3) through (10) above; reset the adjustments as necessary. The center frequencies on the two bands must be 30 mc and 60 mc respectively, and the sweep width on both bands must be a minimum of 20 mc.

(12) Set the CENTER FREQUENCY switch to 30 MC, the SWEEP switch to NAR., and the output frequency of the cw signal generator to 30 mc. Set the FINE TUNE control first to its maximum counterclockwise setting, then to its maximum clockwise setting. At each setting of the control, tune the cw signal generator to center the marker along the oscilloscope trace, and record the center frequency. The center frequency should be variable over the center 50 percent of the 30-mc band (25 to 35).

(13) Set the CENTER FREQUENCY switch to 60 MC, and the output frequency of the cw signal generator to 60'mc. Check the operation of the FINE TUNE control as described in (12) above. The center frequency on the 60-mc band should be variable 55 to 65 mc.

b. Frequency Linearity Adjustment (fig. 21). Adjust the frequency linearity of the sweeping oscillator output as follows:

(1) Set the CENTER FREQUENCY switch to 30 MC, and the SWEEP switch to WIDE. Set the output frequency of the cw signal generator to 30 mc.

(2) Adjust the trace length on the oscilloscope to provide a convenient total horizontal deflection between

the 20- and 40-mc points along the trace.

(3) Tune the cw signal generator successively to 22 mc, 30 mc, and 38 mc, and note the position of the marker along the oscilloscope trace for each frequency. The 30mc point should be within 15 percent of the center of the 22-mc and 38-mc points.

(4) If the linearity specified in (3) above is not obtained, readjust LIN ADJ potentiometer R30 (fig. 13(1), and repeat the procedure given in (3) above until the proper results are obtained. If the setting of LIN ADJ potentiometer R30 is changed, recheck the center frequency and sweep width adjustments given in a above; then recheck the linearity as specified in (3) above.

c. Output Amplitude Check. Check the amplitude of the output of the sweeping oscillator as follows:

(1) Disconnect the 50Ω SWEEPING OSCILLATOR OUTPUT connector of the calibrated detector, the output terminals of the calibrated detector from the oscilloscope, and the cw signal generator output from the secondary input connector of the calibrated detector.

(2) Connect the output of the cw signal generator to the primary input connector of the calibrated detector, and the do leads of the voltmeter to the output terminals of the calibrated detector.

(3) Adjust the output frequency of the cw signal generator to 30 mc, and the output signal amplitude to 250 millivolts. Record the voltmeter indication.

(4) Ground feedthrough capacitor C11 (fig. 12).

(5) Disconnect the cw signal generator, and connect the 50Ω SWEEPING OSCILLATOR OUTPUT connector to the primary input connector of the calibrated detector (B, fig. 22). Observe the indication on the voltmeter. The voltmeter indication should be equal to or greater than that obtained in (3) above.

(6) Set the CENTER FREQUENCY switch to 60 MC, and observe the voltmeter indication. The voltmeter indication should be equal to or greater than that obtained in (3) above.

(7) Disconnect the ground from capacitor C11.

d. Amplitude Linearity Adjustment. Adjust the amplitude linearity of the sweeping oscillator output as follows:

(1) Connect the SWEEP OUTPUT terminal on the signal generator to the HORIZONTAL AMPLIFIER INPUT connector on the oscilloscope with a coaxial lead (fig. 23).

(2) Connect the 50 Ω SWEEPING OSCILLATOR OUTPUT to the PRIMARY INPUT connector on the calibrated detector with a coaxial lead. Connect the OUTPUT TERMINALS of the calibrated detector to the SIGNAL INPUT connector of the oscilloscope using a coaxial lead.

(3) Turn on the signal generator and the oscilloscope and allow a few minutes warmup.

(4) Set the controls of the oscilloscope as follows:

MULTIPLIER	1
SWEEP TIME	HOR AMP ON
MARKER	Z AXIS ON

(5) Set the controls of the signal generator as follows:

CENTER FREQUENCY	30 MC
SWEEP	WIDE
20DB, 20DB, 10DB	down
SWEEP RATE	midrange
Db INCREASE	fully clockwise

(6) Adjust the BRILLIANCE, FOCUS, VERTICAL POSITIONING, and HORIZONTAL POSITIONING controls on the oscilloscope to obtain a horizontal line which is properly centered on the screen. Adjust the HORIZONTAL AMPLIFIER GAIN control to provide a convenient horizontal deflection.

(7) Adjust the VERTICAL GAIN control on the oscilloscope for a convenient height on the oscilloscope. The amplitude of the oscilloscope

pattern should be linear within approximately 10 percent over the entire pattern.

(8) If the linearity specified in (7) above is not obtained, substitute a new value for resistor R17. Repeat the procedure given in (7) above. If the linearity specified is not achieved, try a new value for R17 until the specification is met.

(9) Set the CENTER FREQUENCY control on the signal generator to 60 MC. Repeat the procedure given in (7) above. If the linearity specified is not obtained, repeat the procedure given in (8) above, substituting R18 until the specification is met.

37. Marker Circuit Adjustment

(fig. 21)

Adjust the marker circuits of the signal generator as follows:

a. Connect the SWEEP OUTPUT terminal and the associated GND terminal of the signal generator to the horizontal deflection circuits of the oscilloscope.

b. Set the CENTER FREQUENCY switch to 30 MC, the SWEEP switch to WIDE, the db INCREASE control fully clockwise, and the 20DB, and 10DB attenuator switches to the out (down) position.

c. Set all CRYSTAL MARKERS switches to the down position.

d. Connect the vertical input terminal of the oscilloscope to pin 7 of XV5 (fig. 13(2)). A pulse should appear along the oscilloscope trace at the frequency position that corresponds to the frequency of each marker.

e. Connect the vertical input terminal of the oscilloscope to pin 6 of XV7 (fig. 13). Set the PIP ADJ. W control to midrange. Adjust PIP ADJ potentiometer R88 (fig. 13) until a large negative pulse just appears along the oscilloscope sweep at the position that corresponds to the frequency of each marker crystal.

f. Set the SWEEP switch to NAR. Vary the FINE TUNE control setting while adjusting the PIP ADJ. N control to make sure that a-'negative pulse is obtained for each marker crystal frequency within the narrow sweep range.

g. Set the SWEEP switch to WIDE. Connect the 50Ω SWEEPING OSCILLATOR OUTPUT connector to the primary input connector of the calibrated detector, the output connector of the cw signal generator to the secondary input connector of the calibrated detector, the PIP OUTPUT and associated GND terminals to the vertical input terminals of the oscilloscope, and the output terminals of the calibrated detector to the vertical input terminals of the oscilloscope. Do not disturb the connections between the SWEEP OUTPUT and associated GND terminals and the horizontal input terminals of the oscilloscope.

h. Adjust the PIP ADJ. W control until all crystal markers appear along the oscilloscope trace. Adjust the pip INCREASE control for a convenient marker height.

i. Check the frequency of each crystal marker by tuning the cw signal generator so that the marker produced by the cw signal generator coincides with the crystal marker; note the output frequency of the cw signal generator at this point.

j. Disconnect the input to the vertical input terminals of the oscilloscope. Calibrate the oscilloscope vertical deflection circuits. Reconnect the PIP OUTPUT and associated GND terminals to the vertical input terminals of the oscilloscope. Leave the output terminals of the calibrated detector disconnected.

k. Measure the amplitude of the markers on the oscilloscope. The amplitude of each marker should be greater than 10 volts with the pip INCREASE control set fully clockwise.

CHAPTER 4
FOURTH ECHELON TESTING PROCEDURES AND FINAL TESTING

Section I. FOURTH ECHELON TESTING PROCEDURES

38. General

a. Testing procedures are prepared for use by Signal Field Maintenance Shops and Signal Service Organizations responsible for fourth echelon maintenance of signal equipment to determine the acceptability of repaired signal equipment. These procedures set forth specific requirements that repaired signal equipment must meet before it is returned to the using organization. A summary of the performance standards is given in paragraph 47.

b. Comply with the instructions preceding each chart before proceeding to the chart. Perform each test in sequence. *Do not vary the sequence.* For each step, perform. all the actions required in the *Test equipment control settings and Equipment under test control settings* columns; then perform each specific test procedure and verify it against its performance standard.

39. Test Equipment

All test equipment required to perform the testing procedures given in this section is listed in the following chart and authorized under TA 11-17, and TA 11-100 (1117).

Nomenclature	Federal stock No.	Technical manual
Multimeter TS-352(*)/U[a]	6625-242-5023	TM 11-5527
Oscilloscope AN/USM-50	6625-668-4676	TM 11-5129
Signal Generator AN/USM-44	6625-669-4031	
Calibrated detector		(This manual)

[a] Multimeters TS-352/U, TS-352A/U, and TS-352B/U.

40. Physical Tests and Inspections

a. Test Equipment. None is required.

b. Test Connections and Conditions.

(1) No connections necessary.

(2) Remove signal generator from its case.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	N/A	Controls may be in any position.	*a.* Inspect case and chassis for for damage, missing parts, and condition of paint. *Note:* Touchup painting is recommended in lieu of refinishing whenever practical; screwheads, binding posts, receptacles, and other plated parts will not be painted or polished with abrasives.	*a.* No damage evident or parts missing. External surfaces intended to be painted do not show bare metal. Panel lettering is legible.
			b. Inspect all controls and mechanical assemblies for loose or missing screws, bolts, and nuts.	*b.* Screws, bolts, and nuts are tight. None is missing.
			c. Inspect all connectors, sockets, receptacles, and fuseholders for looseness, damage, or missing parts.	*c.* No loose parts or damage. No missing parts.
2	N/A	Controls may be in any position.	*a.* Rotate all panel controls throughout their limits of	*a.* Controls rotate freely without binding or excessive looseness. travel.
			b. Operate all switches	*b.* Switches operate properly.

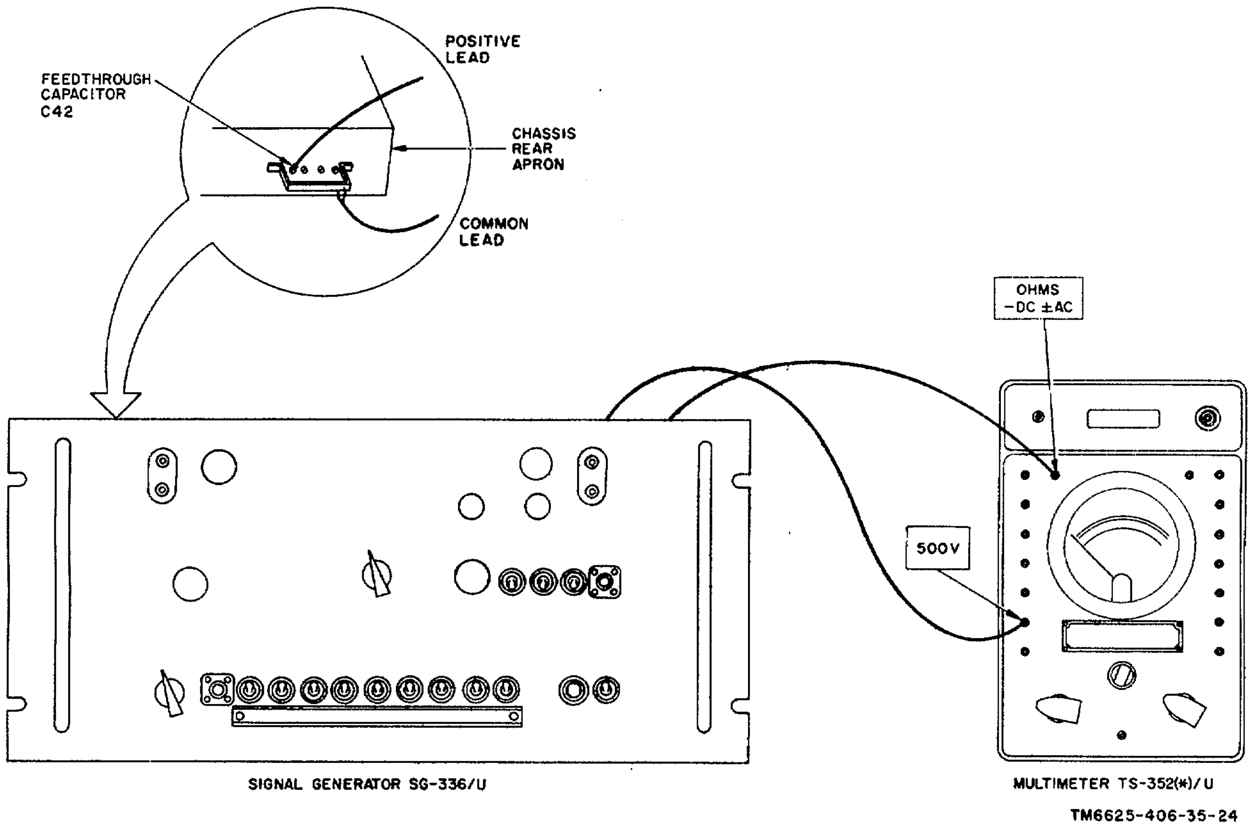


Figure 19. Power supply output voltage test connections.

41. Power Supply Output Voltage Test

a. Test Equipment.

Multimeter TS-352 (*)/U

b. Test Connections and Conditions. Connect the equipment as shown in figure 19.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	TS-352(*)/U: FUNCTION: DIRECT	Power: ON	*a.* Allow a few minutes warmup before proceeding. *b.* Check indication on TS-352(*)/U.	*a.* None. *b.* TS-352(*)/U must indicate 250 volts ±7.5.

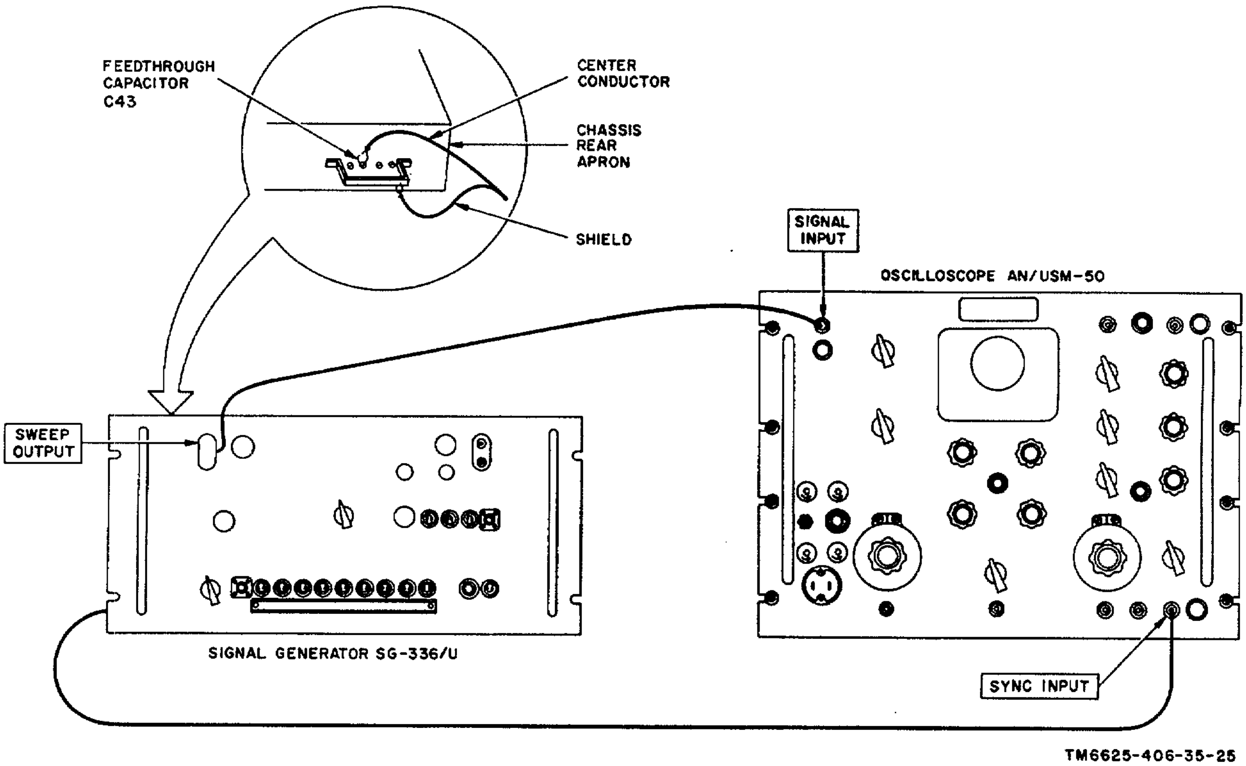


Figure 20. Sweep output voltage test connections.

42. Sweep Output Voltage Test

a. Test Equipment.

Oscilloscope AN/USM-50

b. Test Connections and Conditions. Connect the equipment as shown in figure 20.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	AN/USM-50: MULTIPLIER: CAL CALIBRATION VOLTAGE: 70 SYNC selector switch: HI EXT SWEEP TIME: 10, 000 SWEEP DELAY: OUT TRIGGER RANGE: OFF MARKER: Z AXIS ON	Controls may be in any position.	*a.* Turn on the oscilloscope and allow a few minutes warmup period before proceeding. *b.* Adjust oscilloscope BRILLIANCE, FOCUS, VERTICAL POSITIONING, HORIZONTAL POSITIONING, and STABILITY controls until square-Wave calibration pattern, properly centered, is obtained. *c.* Adjust oscilloscope SCALE ILLUMINATION control until the scale is visible, and adjust oscilloscope VERTICAL GAIN control until the calibration pulse has an amplitude of 10 scale divisions. *d.* Set the oscilloscope MULTIPLIER-switch to 100. *Note:* Do not disturb the setting of the oscilloscope MULTIPLIER, VERTICAL GAIN, and CALIBRATION VOLTAGE controls for the remainder of the test.	*a.* None. *b.* None. *c.* None. *d.* None.
2	Leave controls in positions last indicated in step 1.	Power: ON SWEEP RATE: midrange	*a.* Adjust oscilloscope SWEEP TIME and SYNC -/+ controls for stable oscilloscope pattern. *b.* Rotate the SWEEP RATE control.	*a* Amplitude of oscilloscope display must be at least 10 divisions of oscilloscope scale. *b.* Oscilloscope pattern remains stable over 30 -range of rotation of SWEEP RATE control.

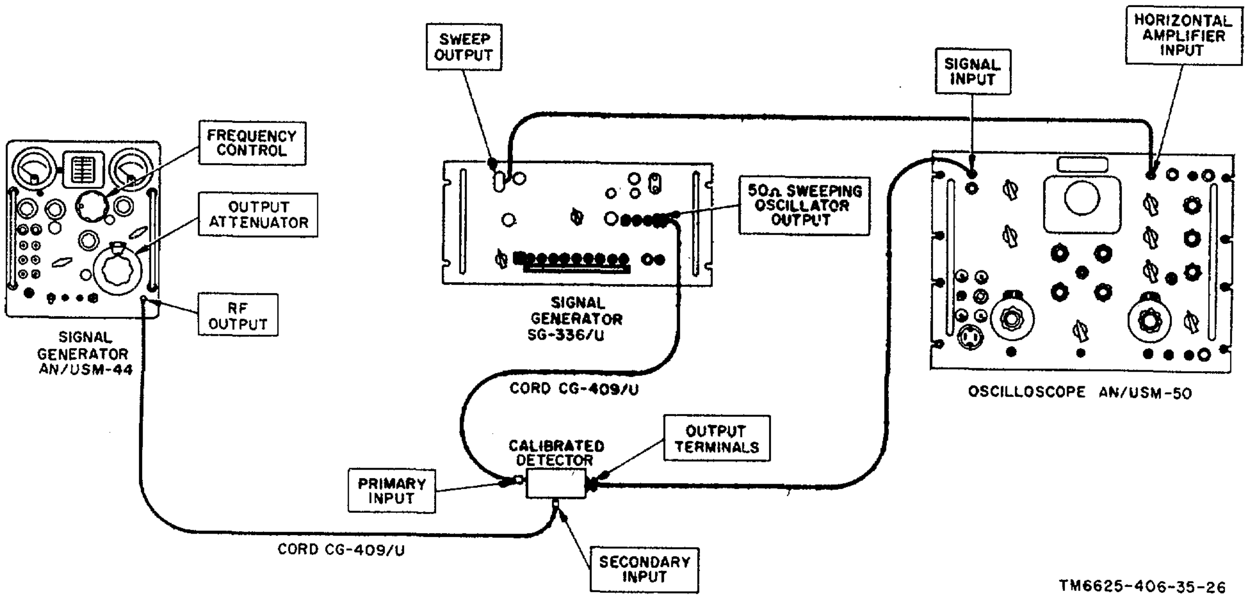


Figure 21. Center frequency and sweep test connections.

43. Center Frequency and Sweep Test

a. Test equipment.

(1) Oscilloscope AN/USM-50.

(2) Signal Generator AN/USM-44.

(3) Calibrated detector.

b. Test Connections and Conditions. Connect the test equipment as shown in figure 21.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	AN/USM-50: MULTIPLIER: 1 SWEEP TIME: HOR AMP ON MARKER: Z AXIS ON AN/USM-44: FREQUENCY RANGE: B MOD. SELECTOR: CW Frequency control: 30 mc on MEGACYCLES dial.	CENTER FREQUENCY: 30 MC SWEEP: WIDE 20DB, 20DB, and 10DB: down SWEEP RATE: midrange Db INCREASE: fully clockwise CRYSTAL MARKERS: up	*a*. Turn on test equipment and equipment under test and allow a 5-minute warmup period before proceeding. *b*. Set the OUTPUT LEVEL on AN/USM-44 to near-maximum, and adjust the AMP. TRIMMER for a maximum indication on the OUTPUT VOLTS meter; then set the OUTPUT LEVEL control to obtain an indication at SET LEVEL on the OUTPUT VOLTS meter. *c*. Adjust oscilloscope BRILLIANCE, FOCUS, VERTICAL POSITIONING, and HORIZONTAL POSITIONING controls to obtain a horizontal line, properly centered, on the oscilloscope. Adjust the HORIZONTAL AMPLIFIER GAIN control to provide a convenient horizontal deflection.	*a*. None. *b*. None. *c*. None.
2	Leave controls in positions last indicated in-step-i.		*a*. Adjust the output attenuator on AN/USM-44 to produce a marker pulse along the oscilloscope trace. *b*. Using the frequency control on AN/USM-44, move the marker to the low frequency end of the oscilloscope trace. *c*. Using the frequency control on AN/USM-44, move the marker to the high frequency end of the oscilloscope trace.	*a*. The marker pulse must be approximately-centered along the oscilloscope trace. *b*. MEGACYCLES dial on AN/USM-44 must indicate 20 mc or lower. *c*. MEGACYCLES dial-on AN/USM-44 must indicate 40 mc or higher.
3	AN/US1M44: FREQUENCY RANGE: C Frequency control: 60 mc on MEGACYCLES dial.	CENTER FREQUENCY: 60 MC	*a*. Adjust output attenuator on AN/USM-44 to produce a marker pulse along the oscilloscope trace. *b*. Using the frequency control on AN/USM-44, move the marker to the low frequency end of the oscilloscope trace. *c*. Using the frequency control on AN/USM-44, move the marker to the high frequency end of the oscilloscope trace.	*a*. The marker pulse must be approximately centered along the oscilloscope trace. *b*. MEGACYCLES dial on AN/USM-44 must indicate 50 mc or lower. *c*. MEGACYCLES dial on AN/USM-44, must indicate 70 mc or higher.
4	AN/USM-44: FREQUENCY RANGE: B Frequency control: 30 mc on MEGACYCLES dial.	CENTER FREQUENCY: 30 MC SWEEP: NAR.	*a*. Set the FINE TUNE control maximum counterclockwise. Using the frequency control on AN/USM-44, center the marker pulse along the oscilloscope trace. *b*. Set the FINE TUNE control maximum clockwise. Using the frequency control on AN/USM-44, center the marker along the oscilloscope trace.	*a*. MEGACYCLES dial on AN/USM-44 must indicate 29.25 mc or lower. *b*. MEGACYCLES dial on AN/USM-44 must indicate 30.75 mc or higher.
5	AN/USM-44: FREQUENCY RANGE: C Frequency control: 60 mc on MEGACYCLES dial.	CENTER FREQUENCY: 60 MC	*a*. Set the FINE TUNE control maximum counterclockwise. Using the frequency control on AN/USM-44, center the marker along the oscilloscope trace. *b*. Set the FINE TUNE control maximum clockwise. Using the frequency control on AN/USM-44, center the marker along the oscilloscope trace.	*a*. MEGACYCLES dial on AN/USM-44 must indicate 59.25 mc or lower *b*. MEGACYCLES dial on AN/USM-44 must indicate 60.75 me or higher.
6	AN/USM-44: FREQUENCY RANGE: B	CENTER FREQUENCY: 30 MC SWEEP: WIDE	Using the frequency control on AN/USM-44, set the MEGACYCLES dial successively to 22, 30, and 38 mc, and note the position of the marker along the oscilloscope trace for each frequency.	The 30-mc marker point must be approximately centered between the 22- and 38-mc marker points.

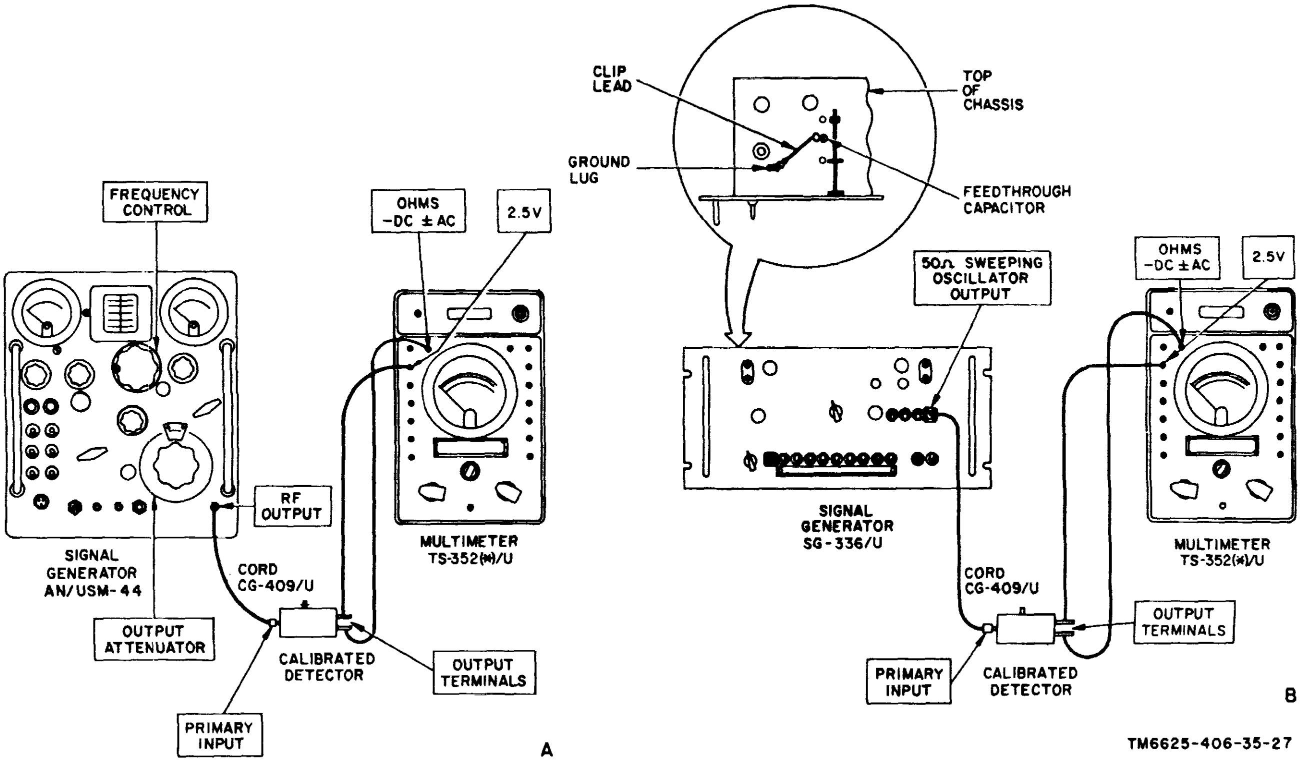


Figure 22. Output amplitude test connections.

44. Output Amplitude Test

a. Test Equipment.

(1) Multimeter TS-352(*)/U.

(2) Signal Generator AN/USM44.

b. Test Connections and Conditions. Connect the test equipment as shown in A, figure 22.

c. Procedure

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	AN/USM A-44: FREQUENCY RANGE: B MOD. SELECTOR: CW Frequency control: 30 mc On MEGACYCLES dial. TS-352(*)/U: FUNCTION: DIRECT	CENTER FREQUENCY: 30MC SWEEP: WIDE 20DB, 20DB, and 10DB: down SWEEP RATE: midrange Db INCREASE: fully clockwise. CRYSTAL MARKERS: up	*a.* Turn on test equipment and equipment under test and allow a 5-minute warmup period before proceeding. *b.* Set the OUTPUT LEVEL control on AN/USM-44 to near maximum, and adjust the AMP. TRIMMER for a maximum-indication on the OUTPUT VOLTS meter; then set the OUTPUT LEVEL control to obtain an indication at SET LEVEL on on the OUTPUT VOLTS meter. *c.* Set the output attenuator on AN/USM-44 to 250 millivolts. Record the indication on TS-352(*)/U.	*a.* None. *b.* None. *c.* None.
2	Leave controls in positions last indicated in step 1.		Connect the equipment as shown in B, figure 25. Observe the performance standard.	Indication on TS-352(*)/U must at least equal that obtained in step 1.
3	Leave controls in positions last indicated in step 2.	CENTER FREQUENCY: 60 MC		Indication on TS-352(*)/U must at least equal that obtained in step 1.

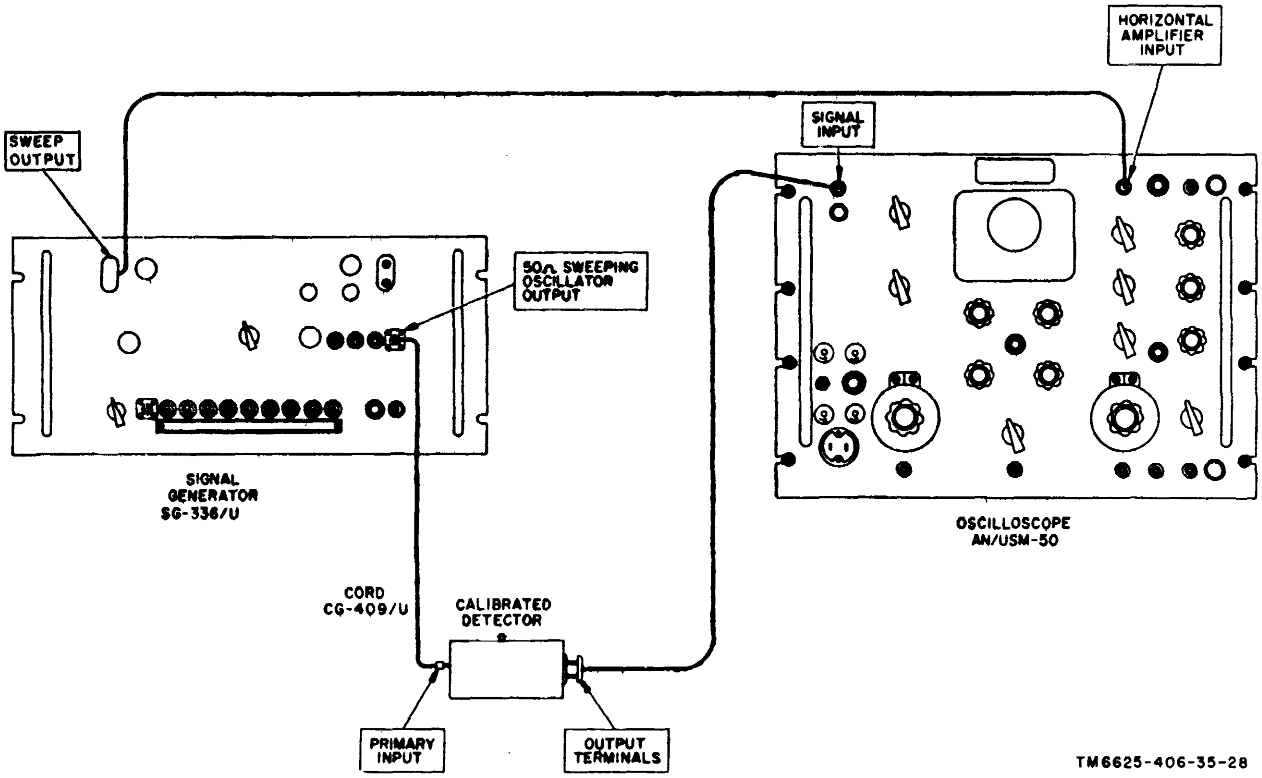


Figure 23. Amplitude linearity test connections.

45. Amplitude Linearity Test

a. Test Equipment.

(1) Oscilloscope AN/USM-50.

(2) Calibrated detector.

b. Test Connections and Conditions. Connect the equipment as shown in figure 23.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	AN/USM-50: MULTIPLIER: 1 SWEEP TIME: HOR AMP ON MARKER: Z AXIS ON	CENTER FREQUENCY: 30MC SWEEP: WIDE 20DB, 20DB, and 10DB: down SWEEP RATE: midrange Db INCREASE: fully clockwise	*a*. Turn on test equipment and equipment under test and allow a 5-minute warmup period before proceeding. *b*. Adjust oscilloscope BRILLIANCE, FOCUS, VERTICAL POSITIONING, and HORIZONTAL POSITIONING controls to obtain a horizontal line, properly centered, on the oscilloscope. Adjust the HORIZONTAL AMPLIFIER GAIN control to provide a convenient horizontal de-deflection.	*a*. None. *b*. None.
2	Leave controls in positions last indicated in step 1.		Adjust the VERTICAL GAIN control on AN/USM-50 for a convenient pattern height on the oscilloscope.	The amplitude of the oscilloscope pattern should be linear within approximately 10 percent over the entire pattern width.
3	Leave controls in positions last indicated in step 2.	CENTER FREQUENCY: 60MC		The amplitude of the oscilloscope pattern should be linear within approximately 10 percent over the entire pattern width.

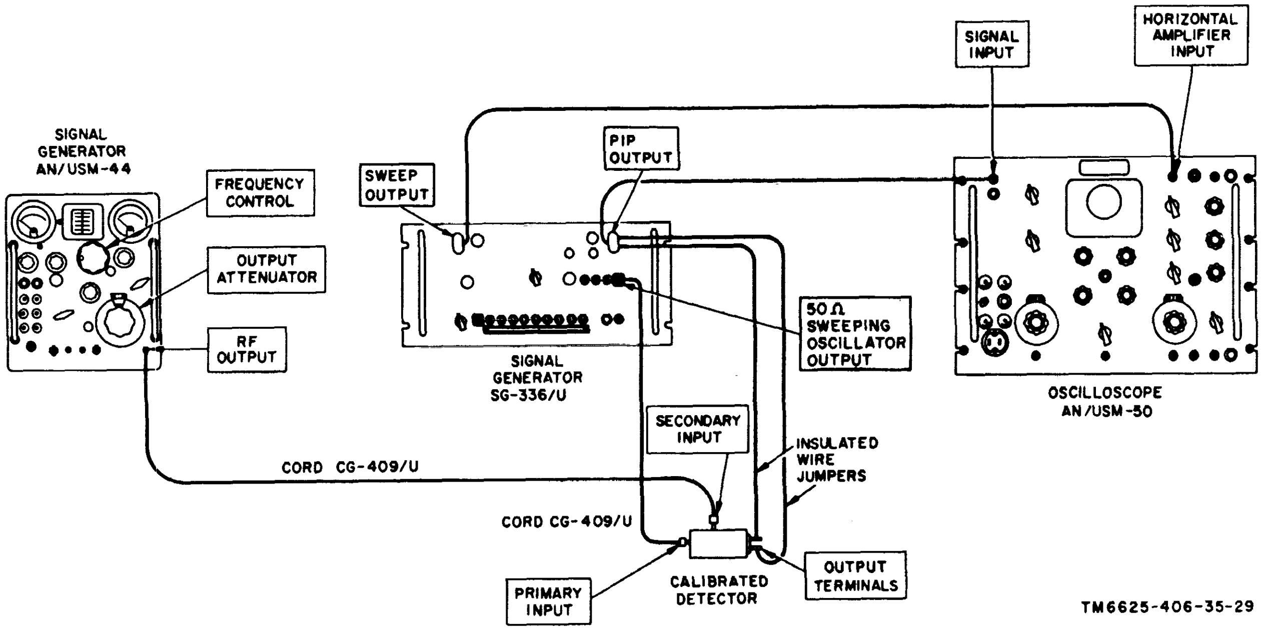


Figure 24. Marker circuit test connections.

46. Marker Circuit Test

a. Test Equipment.

(1) Oscilloscope AN/USM-50.

(2) Signal Generator AN/USM-44.

(3) Calibrated detector.

b. Test Connections and Conditions. Connect the equipment as shown in figure 24.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	AN/USM-50 MULTIPLIER: CAL CALIBRATION VOLTAGE: 100 SYNC selector switch: HI EXT SWEEP TIME: 10,000 SWEEP DELAY: OUT TRIGGER RANGE-OFF MARKER: Z AXIS ON	Controls may be in any position.	*a.* Turn on the oscilloscope and allow a few minutes warmup period before proceeding.	*a.* None.
			b. Adjust oscilloscope BRILLIANCE, FOCUS, VERTICAL POSITIONING, HORIZONTAL POSITIONING, and S-TAILITY controls until square-wave calibration pattern, properly centered, is obtained.	*b.* None.
			c. Adjust oscilloscope SCALE ILLUMINATION control until the scale is visible, and adjust oscilloscope VERTICAL GAIN control until the calibration pulse has an amplitude of 10 scale divisions.	*c.* None.
			d. Set the oscilloscope MULTIPLIER switch to 100. Notes: Do not disturb the setting of the oscilloscop MULLTIPLIER, VERTICAL GAIN, and Calibration VOLTAGE controls for the remainder of the test	*d.* None.
2	AN/USM-50:. SWEEP TIME: HOR AMP ON MULTIPLIER: 1 20DB, AN/USM-44: FREQUENCY RANGE: B MOD SELECTOR: CW Frequency control: 30 me on MEGACYCLES dial.	CENTER FREQUENCY: 30 MC SWEEP: WIDE 20DB, and 10DB: down SWEEP RATE: midrange Db INCREASE: fully clockwise Pip INCREASE: fully clockwise CRYSTAL MARKERS: up	*a.* Turn on test equipment and equipment under test and allow a few minutes warmup period before proceeding.	*a.* None.
			b. Set the OUTPUT LEVEL control on AN/USM-44 to near maximum, and adjust the AMP TRIMMER for a maximum indication on the OUTPUT VOLTS meter; then set the OUTPUT LEVEL control to obtain an indication at SET LEVEL on the OUTPUT VOLTS metqr.	*b.* None.
			c. Set the output attenuator on AN/ USM-44 to obtain a marker along the oscilloscope trace.	*c.* None.
3	Leave controls in position last indicated in step 2.		*a.* Adjust the PIP ADJ. W control	*a.* A marker must appear along the oscilloscope trace for each CRYSTAL MARKERS switch in use.
			b. Adjust the pip INCREASE control for a convenient marker height. Using the frequency control on AN/USM-44, line up the variable marker with each crystal marker in turn. Note the indication on the MEGACYCLES dial on AN/ USM-44 each time the markers are lined up.	*b.* The MEGACYCLES dial indication must agree with the frequency marked on the placard beneath the associated CRYSTAL MARKERS switch for each marker.
4	Leave controls in positions last indicated in step 2.	Pip INCREASE: fully clockwise.	Disconnect the jumpers between the equipment under test and the output terminals of the call-brated detector.	Markers on oscilloscope trace must have an amplitude of at least equal to 10 scale divisions.

47. Test Data Summary

Personnel may find it convenient to arrange the checklist in a manner similar to that shown below:

1. POWER SUPPLY OUTPUT VOLTAGE TEST	250 volts dc ±7. 5
2. SWEEP OUTPUT VOLTAGE TEST	
a. Amplitude	7 volts peak as indicated on calibrated oscilloscope.
b. Frequency	Variable by means of SWEEP RATE control.
3. CENTER FREQUENCY AND SWEEP WIDTH TEST	
a. Center frequency (wide)	
(1) 30-mc range	30 mc
(2) 60-mc range	60 mc
b. Sweep width (wide)	
(1) 30-me range	20 to 40 mc, min.
(2) 60-mc range	50 to 70 mc, min.
c. Center frequency (narrow)	
(1) 30-mc range	Variable by FINE TUNE control over range of 29.25 to 30.75 me, min.
(2) 60-mc range	Variable by FINE TUNE control over range of 59.25 .to 60.75 me min.
d. Sweep linearity	30-mc marker point approximately centered between 22 and 38 mc marker points.
4. OUTPUT AMPLITUDE TEST	250 millivolts
5. AMPLITUDE LINEARITY TEST	Maximum amplitude variation 10 percent as measured over full sweep width on both ranges.
6. MARKER CIRCUIT TEST	
a. Marker frequency..	Agrees with frequency marked on placard beneath associated CRYSTAL MARKERS switch.
b. Marker amplitude..	10 volts min, as measured on calibrated oscilloscope.

Section II. FINAL TESTING

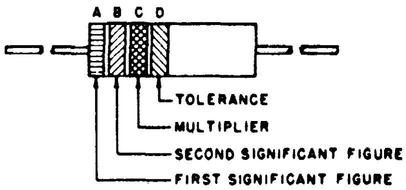
48. Purpose of Final Testing

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that meets the minimum standards stated in the tests will furnish satisfactory operation, equivalent to that of new equipment.

49. Final Tests

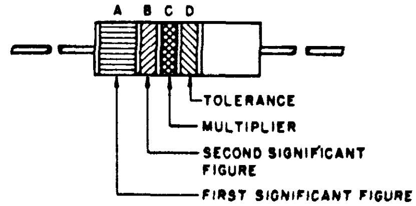
If the results of the tests in paragraphs 38 through 47 are within the limits specified for each test, the equipment will furnish satisfactory operation, equivalent to that of new equipment.

COMPOSITION-TYPE RESISTORS



BAND A— Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS



BAND A— Double Width Signifies Wire-wound Resistor

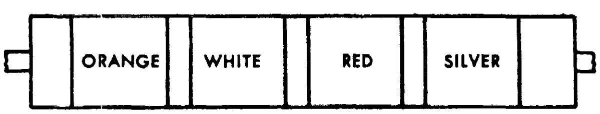
COLOR CODE TABLE

BAND A		BAND B		BAND C		BAND D*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1		
BROWN	1	BROWN	1	BROWN	10		
RED	2	RED	2	RED	100		
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	± 10
GREEN	5	GREEN	5	GREEN	100,000	GOLD	± 5
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	SILVER	0.01		
WHITE	9	WHITE	9	GOLD	0.1		

EXAMPLES OF COLOR CODING

BAND

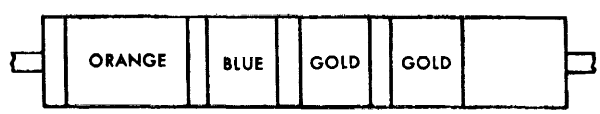
A B C D*



3 9 X100 ± 10%

BAND

A B C D*



3 6 X0.1 ± 5%

NOMINAL RESISTANCE 3,900 Ohms 3.6 Ohms

RESISTANCE TOLERANCE ± 10 percent ± 5 percent

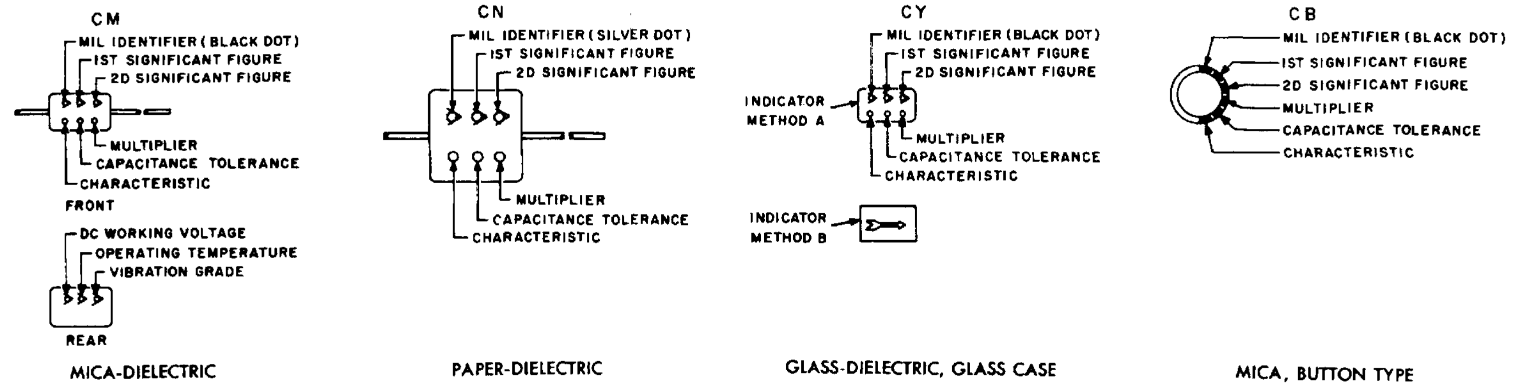
STD-R2

*If Band D is omitted, the resistor tolerance is ±20%, and the resistor is not Mil-Std.

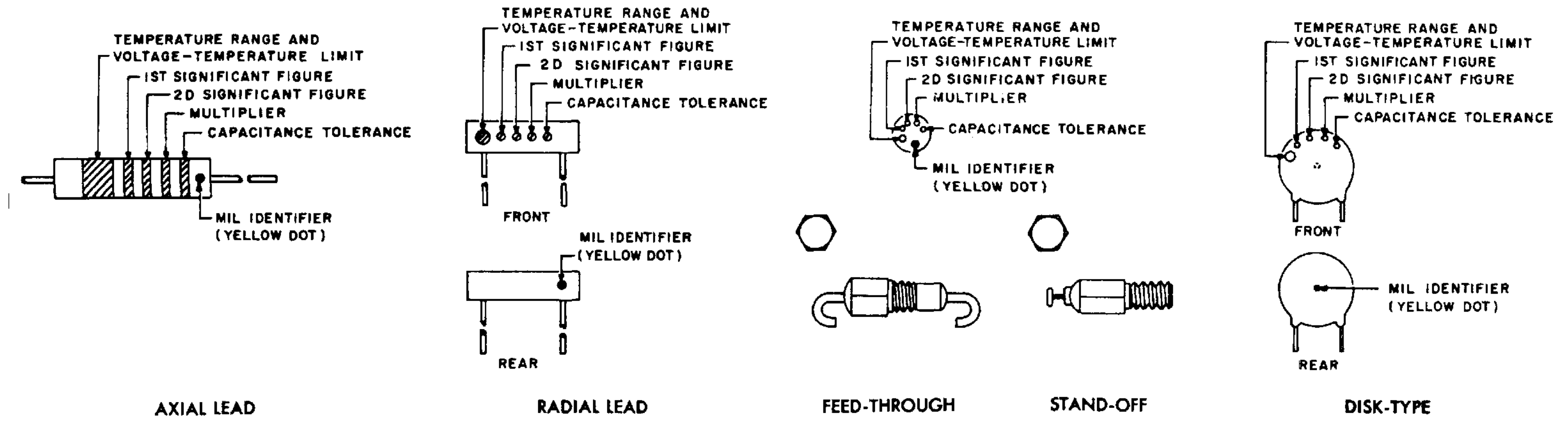
Figure 25. MIL-STD resistor color code markings.

COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

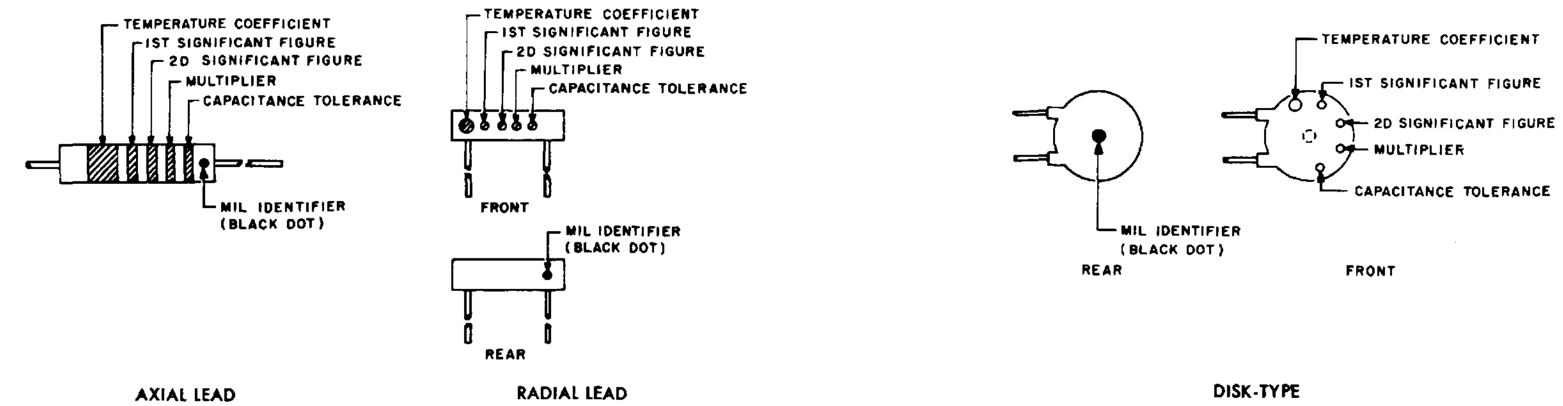
GROUP I Capacitors, Fixed, Various-Dielectrics, Styles CM, CN, CY, and CB



GROUP II Capacitors, Fixed Ceramic-Dielectric (General Purpose) Style CK



GROUP III Capacitors, Fixed, Ceramic-Dieletric (Temperature Compensating) Style CC



COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

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

TABLE II – For use with Group II, General Purpose, Style CK

COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS[3]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AV	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	−30	1	1	10	± 1%		
RED	−80	2	2	100	± 2%	± 0.25uuf	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		± 5%	± 0.5uuf	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	+100					± 1.0uuf	
SILVER							

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–91, MIL–C–11272, and MIL–C–10950 respectively.
3. Letters indicate the temperature range and voltage-temperature limits designated in MIL–C–11015.
4. Temperature coefficient in parts per million per degree centigrade.

STD–C2

Figure 26. MIL-STD capacitor color code markings.

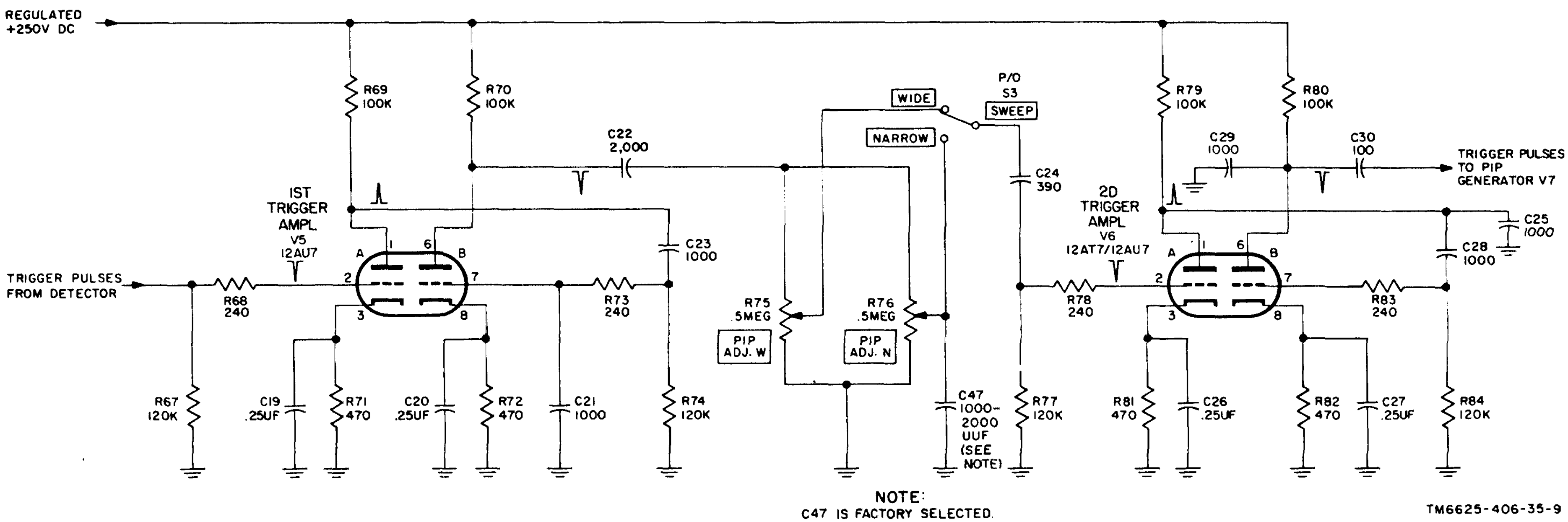


Figure 27. Trigger amplifiers V5 and V6, schematic diagram.

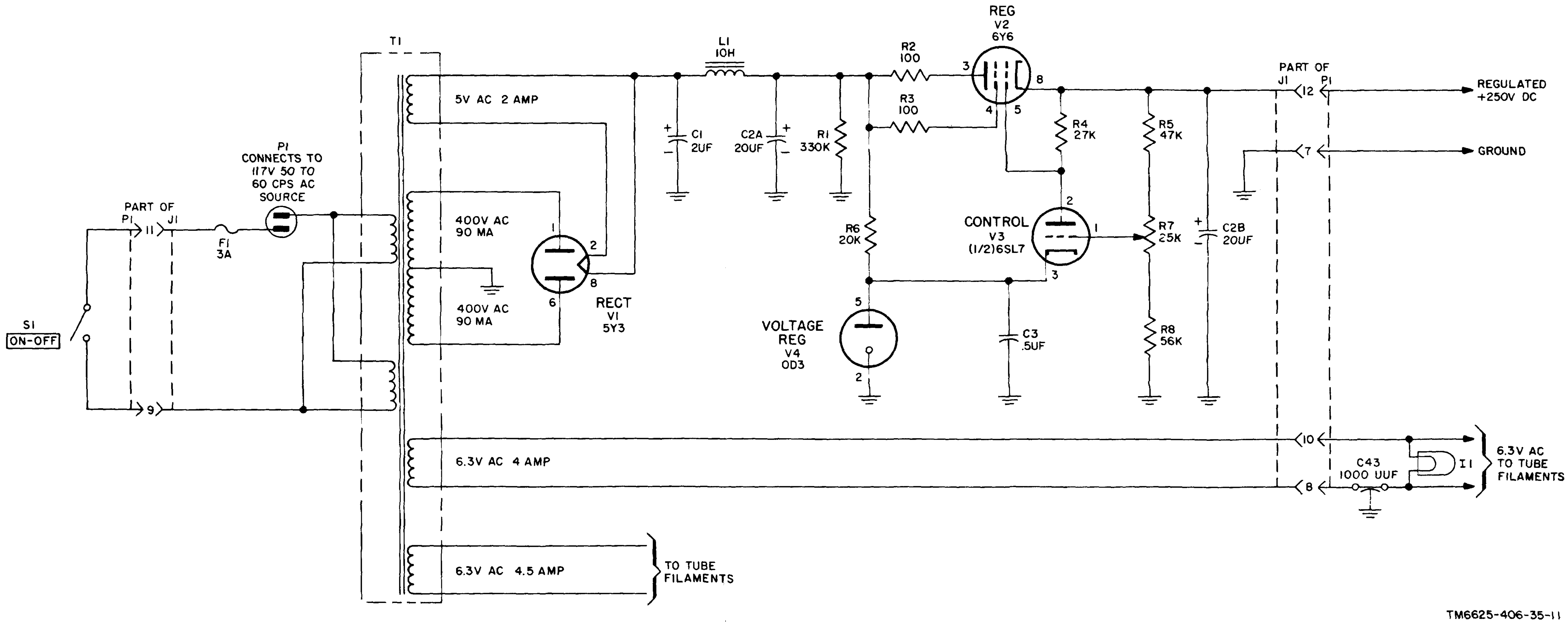
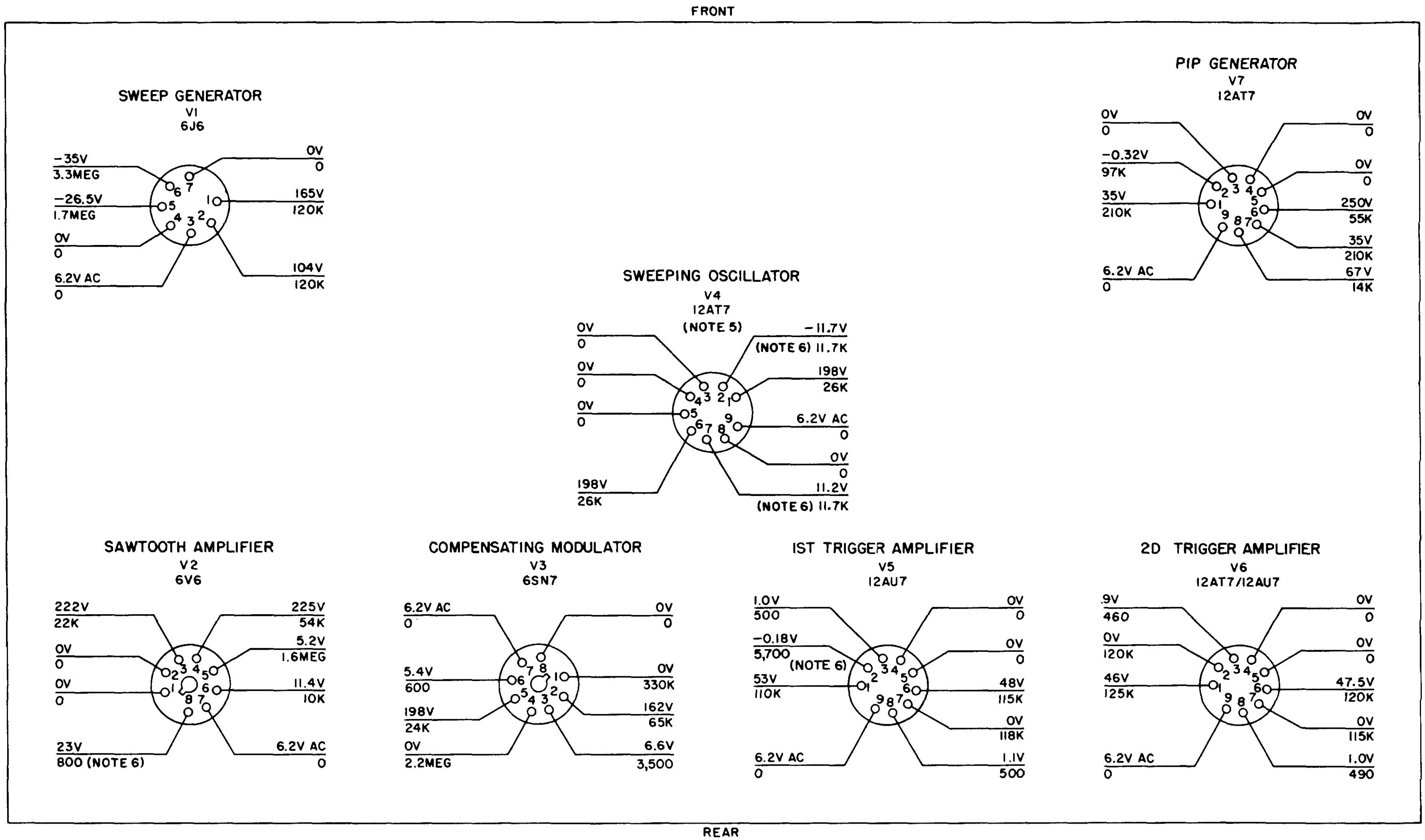


Figure 28. Power supply circuits, schematic diagram.



NOTES:

1. LINE VOLTAGE AT 117 VOLTS, 50 TO 60 CPS.
2. ALL VOLTAGE READINGS TO CHASSIS GROUND ARE DC UNLESS OTHERWISE INDICATED.
3. [SWEEP] SWITCH SET TO [NARROW] POSITION, [CENTER FREQUENCY] SWITCH SET TO [30MC] POSITION.
4. ALL VOLTAGES MEASURED WITH VACUUM TUBE VOLTMETER.
5. V4 MOUNTED ON UNDERSIDE OF CHASSIS.
6. POLARITY OF METER SET TO MEASURE FORWARD RESISTANCE OF CRYSTAL DIODE IN CIRCUIT BEING MEASURED.

TM6625-406-35-17

Figure 29. Oscillator chassis, tube socket voltage and resistance diagram.

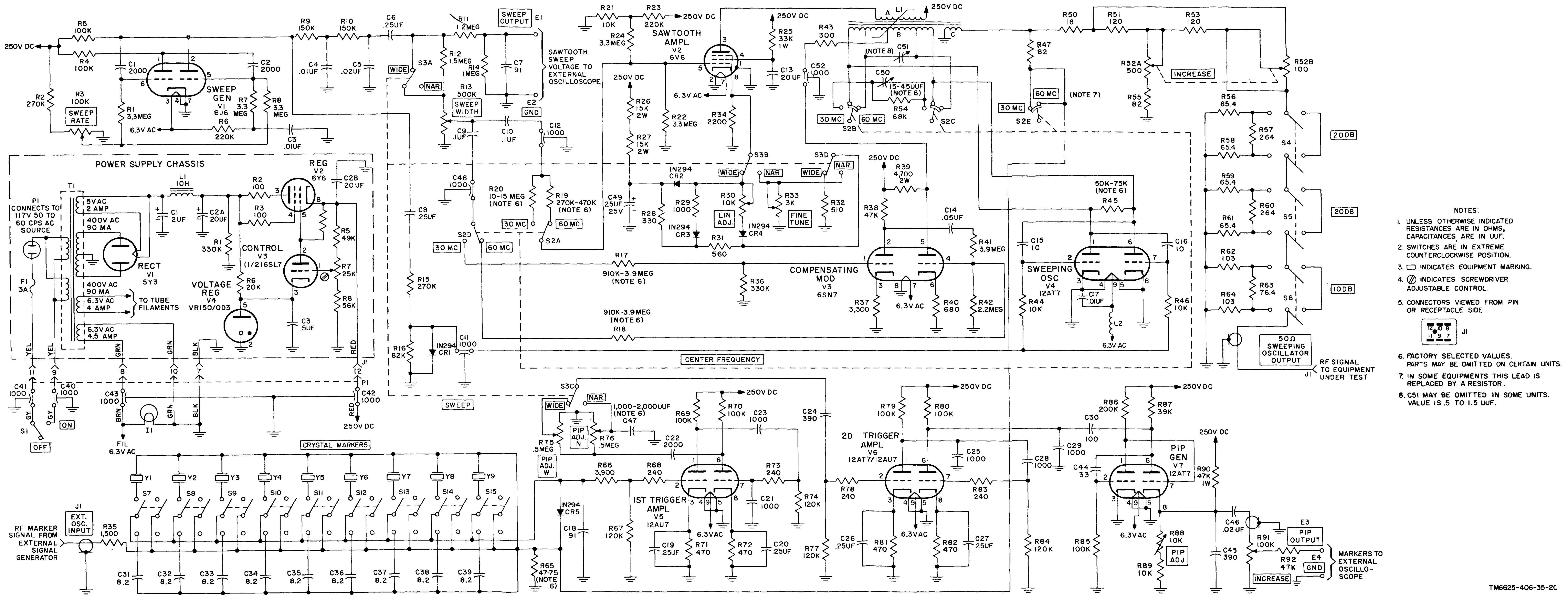


Figure 30. Signal Generator SG-336/U, schematic diagram

APPENDIX
REFERENCES

Following is a list of applicable references available to the field and depot maintenance of Signal Generator SG-336/U.

DA Pamphlet 310-4	Index of Technical Manuals, Technical Bulletins, Supply bulletins, Lubrication Orders, and Modification Work Orders.
TA 11-17	Signal Field Maintenance Shops.
TA 11-100(11-17)	Allowances of Signal Corps Expendable Supplies for Signal Field Maintenance Shops.
TM 11-5095	Frequency Meter AN/URM-80.
TM 11-5129	Oscilloscopes AN/USM-50A, B, and C.
TM 11-5527	Multimeters TS-352/U, TS-352A/U, and TS-352B/U.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV7D/U.
TM 11-6625-320-12	Operator's and Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME30B/U and ME-30C/U.
TM 11-6625-406-12	Operator's and Organizational Maintenance Manual: Signal Generator SG-336/U.

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USATC Inf (2)
USAOMC (8)
SVC Colleges (2)
Br Svc Sch (2)
GENDEP (2) except
Atlanta GENDEP (none)
Sig Sec, GENDEP (5)
Sig Dep (12)
WRAMC (1)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
OSA (1)
USAEPG (2)
AFIP (1)
AMS (1)
Army Pictorial Cen (2)
EMC (1)
Yuma Test Sta (2)
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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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