

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ORGANIZATIONAL, FIELD
AND DEPOT- MAINTENANCE MANUAL

SIGNAL GENERATORS
AN/USM-44 AND AN/USM-44A

This reprint includes all changes in effect at
the time of publication; change 1.

HEADQUARTERS, DEPARTMENT OF THE ARMY
SEPTEMBER 1962

TECHNICAL MANUAL

Organizational, Field and Depot Maintenance Manual

SIGNAL GENERATORS AN/USM-44 AND AN/USM-44A

TM 11-6625-508-25
CHANGES NO. 1 }
}

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 26. D.C., 6 May 1963

TM 11-6625-508-25, 01 September 1962 is changed as follows

Page 1. Add paragraphs 1-2B and 1-2C after paragraph 1-2A.

1-2B. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes or additional publications pertaining to your equipment. DA Pam is a current index of technical manuals, technical bulletins, supply bulletins, lubrication orders, and modification work orders that are available through publications supply channels. The index lists the individual parts (-10, -20, -35P, etc.) and the latest changes and revisions of each equipment publications.

1-2C. Forward all comments on this publication direct to: Commanding Officer, U. S. Army Electronics Materiel Support Agency, ATTN: SELMS-MP, Fort Monmouth, N.J. DA Form 2028 (Recommended changes to Technical Manual Parts lists or Supply Manuals 7, 8 or 9) will be used.

Page 25. Add paragraphs 5-2.1 through 5-2.4 after paragraph 5-2.

5-2.1. Preventive Maintenance

a. Preventive maintenance is the systematic care, inspection, and servicing of equipment to maintain it in serviceable condition, prevent breakdowns, and assure maximum operational capability. Preventive maintenance is the responsibility of all echelons concerned with the equipment and includes the inspection, testing and repair or replacement of parts, subassemblies, or units that inspection and tests indicate would probably fail before the next scheduled periodic service. Preventive maintenance service and inspections of Signal Generators AN/

USM-44 and AN/USM-44A at the second echelon level are made at monthly intervals unless otherwise directed by the commanding officer.

b. Maintenance forms and records to be used and maintained on this equipment are specified in TM 38-750. Paragraphs 1-5.1 and 1-5.2, TM 11-6625-508-10, contain additional information concerning submission of specific forms.

5-2.2. Monthly Maintenance

a. A month is defined as approximately 30 calendar days of 8-hour-per-day operation. If the equipment is operated 16 hours a day, the monthly maintenance should be performed at 15-day intervals. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition, must have monthly maintenance performed on it.

b. Monthly maintenance on Signal Generators AN/USM-44 and AN/USM-44A will be scheduled in accordance with the requirements of TM 38-750. All deficiencies or shortcomings will be recorded, and those not corrected during the inspection and service will be immediately reported to higher echelon by use of forms and procedures specified by TM 38-750. Equipment which has a deficiency that cannot be corrected by second echelon should be deadlined in accordance with TM 38-750. Perform all the services listed in the monthly maintenance and inspection chart (par. 5-2.3) in the sequence listed. Whenever a *normal condition* or result is not observed, take corrective action in accordance with the paragraph under *References*.

5-2.3. Monthly Maintenance Service and Inspection Chart

Item No.	Procedure		References
	Item	Normal Indication or result	
1	COMPLETENESS: Inspect the equipment for completeness.	Equipment must be complete (table I, TM 11-6625-508-10).	Par. 3.1-6, TM 11-6625-508-10. Par. 5-2.4 b. DA Pam 310-4 for requirements.
2	INSTALLATION: Inspect the equipment for proper installation.	Installation is in accordance with paragraph 2-8, TM 114-625-508-10.	
3	CLEANLINESS: Inspect for cleanliness.	Signal generator must be clean and dry inside and out, and free of grease, dirt, rust, corrosion, and fungus.	
4	PRESERVATION: Inspect for preservation.	Painted surfaces must be free of bare spots, rust, and corrosion.	
5	PUBLICATIONS: Check to see that pertinent publications are available.	a. Operator's manual must be complete and in usable condition, without missing pages. b. All changes pertinent to the equipment are on hand (DA Pam 310-4). c. Organizational, field and depot maintenance manual is complete and in usable condition.	
6	MODIFICATION WORK ORDERS: Check DA PAM 310-4 to determine if new applicable MWO's have been published.	All URGENT MWO's have been applied to the equipment. All ROUTINE MWO's have been scheduled.	
7	SWITCHES, KNOBS, AND DIALS: Inspect for excessive looseness. Check for proper mechanical action by setting each control to each of its possible settings.	Items are firmly attached. Action is positive, without backlash, binding, or scraping.	
8	METERS: Check for broken glass windows.	Windows should not be chipped, broken, or cracked.	
9	CORDS AND CABLES: Inspect for cuts, cracks, strain, and fraying.	Power cord and signal cables should be free from cuts, cracks, strains, and fraying.	
10	HANDLES AND LATCHES: Check for looseness.	Items should be properly fastened to the equipment.	
11	PLUCKOUT ITEMS: Inspect seating of readily accessible items.	Crystals, fuses, lamps, vacuum tubes, and subassemblies should be properly seated, and clamps in proper position and correctly tightened,	
12	RESISTORS AND CAPACITORS: Inspect for cracks, blistering, or other detrimental defects.	Items should show no signs of cracks, blistering, or other detrimental defects.	
13	JACKS AND CONNECTORS: Check for snug fit and good contact.	Jacks and connectors are intact and not loose fitting.	
14	TRANSFORMER: Inspect for corrosion, dirt, and loose connections.	Item should be free from dirt and corrosion. Terminals are properly tightened and secured.	
15	FUSES: Check for proper fuses-	The fuses in use should be of the indicated value and located as follows: Front panel: 2 ea, 3-amp 1 ea, 1/4-amp	
16	PILOT LAMPS: Inspect for burned-out lamps.	Items should light when equipment is turned on.	

5-2.3. Monthly Maintenance Service and Inspection Chart-Continued

Item No.	Procedure		References
	Item	Normal Indication or result	
17	OPERATIONAL CHECK: Refer to sec. III, TM 11-6625-508-10.	Refer to section III, TM 11-6625-508- 10.	Section V.
18	SPARE PARTS: Check all spare for general condition and method of storage.	All spare parts must be in good condition and properly stored. There should be no evidence of overstock, and all shortages will be on valid requisitions.	

5-2.4. Cleaning and Touchup Painting Instructions

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further

corrosion. Refer to the applicable cleaning and refinishing practices specified in TM 9-213. Page 72. Add the following appendix

APPENDIX

REFERENCES

Following is a list of applicable publications available to the maintenance man of Signal Generator AN/USM-44 (*),

DA Pam 310-4

Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.

TM 9-213

TM 11-6625-508-10

SB 38-100

Preservation, Packaging, and Packaging Ma-

TM 38-750

terials, Supplies Equipment Us the Army.

Painting Instructions for Field Use.

Signal Generator USM-44 and USM-44A.

The Army Equ Record System Procedures.

By Order of the Secretary of the Army:

EARLE G. WHEELER,
General, United States Army,
Chief Of Staff

Official:

J. C. LAMBERT,
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The Adjutant General..

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NG: State AG (3) units same as active Army except allowance is one copy each unit.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

HEADQUARTERS,
DEPARTMENT OF THE ARMY
Washington 25, D.C., 21 September 1962

TM 11-6625-508-25 (a reprint of Navy publication NAVWEPS 16-30USM44-502, 1 July 1955) is published for the use of Army personnel.

Note. All folding pages are placed in back of manual.

By Order Of The Secretary Of The Army:

G. H. DECKER
*General, United States Army,
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J. C. LAMBERT,
*Major General, United States Army,
The Adjutant General.*

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NG: State AG (3); units-same as Active Army except allowance is one copy for each unit.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

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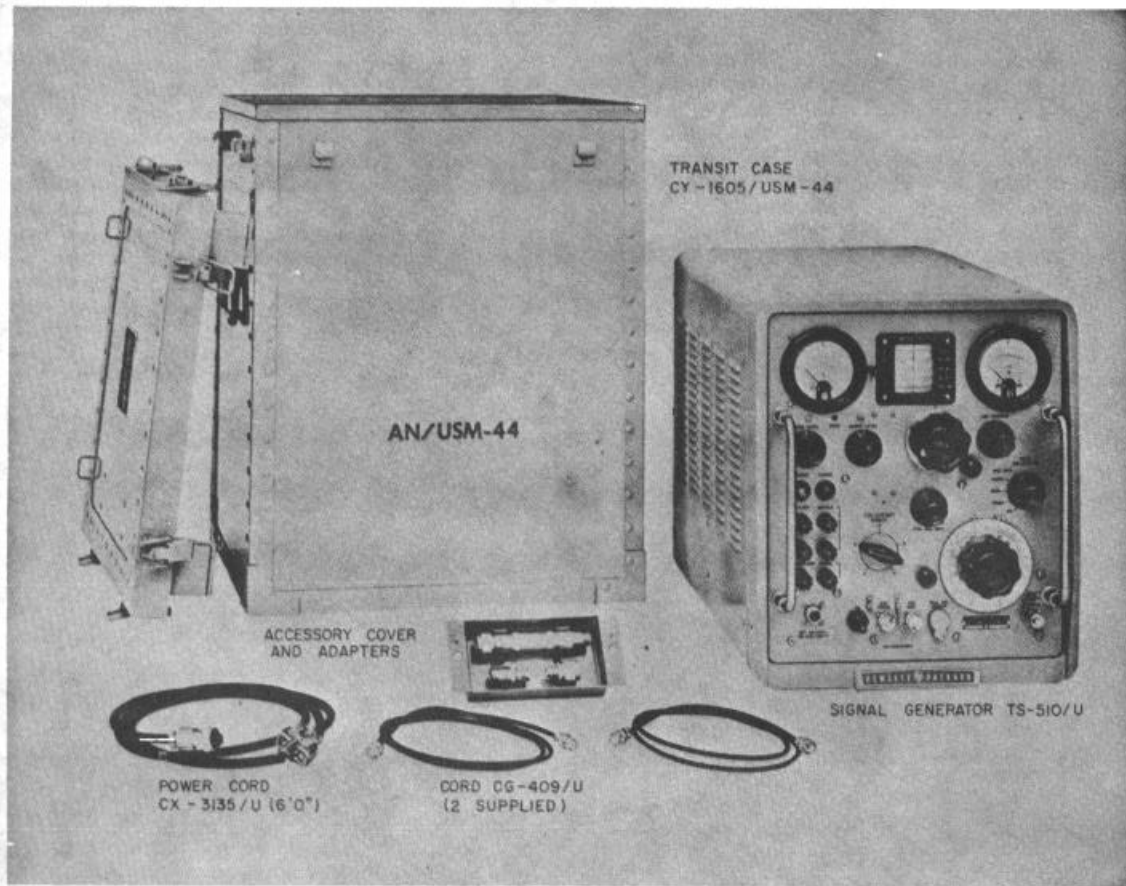


Figure 1-1. Signal Generator AN/USM-44 (Hewlett-Packard), Equipment Supplied

Revised 15 January 1960

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. IDENTIFICATION.

1-2. This publication contains service and maintenance instructions for Signal Generator Test Set AN/USM-44 (figure 1-1), Signal Generator Test Set AN/USM-44A (figure 1-1A) manufactured by Hewlett-Packard Company, Palo Alto, California, and for Signal Generator Test Set AN/USM-44A (figure 1-1B) manufactured by the Nuclear Electronics Corporation, Philadelphia, Pennsylvania. The main component of Signal Generator Test Set AN/USM-44 is Signal Generator TS-510/U. The main component of Signal Generator Test Set AN/USM-44A manufactured by the Hewlett-Packard Company under Orders No. NO. asN383-33733A, N383-36708A, and N383-46471A, and manufactured by the Nuclear Electronics Corporation under Order No. N383-46472 is the Signal Generator

TS-510A/U. This equipment is manufactured in accordance with Specification MIL-G7702 (AER), dated 15 November 1953

1-2A. Throughout this handbook references to Signal Generator TS-510A/U will be construed to mean all models; references to Signal Generator TS-510A/U(*) refer specifically to the Signal Generator TS-510A/U manufactured by the Nuclear Electronics Corporation under Order No. N383-46472; and references to Signal Generator TS-510A/U(**) refer specifically to the Signal Generator TS-510A/U manufactured by the Hewlett-Packard Company under Orders No. NOasN383-33733A, N383-36708A, and N383-47671A. The information contained in this handbook is applicable to Signal Generator TS-510/U and all models of Signal Generator TS-510A/U unless otherwise indicated.

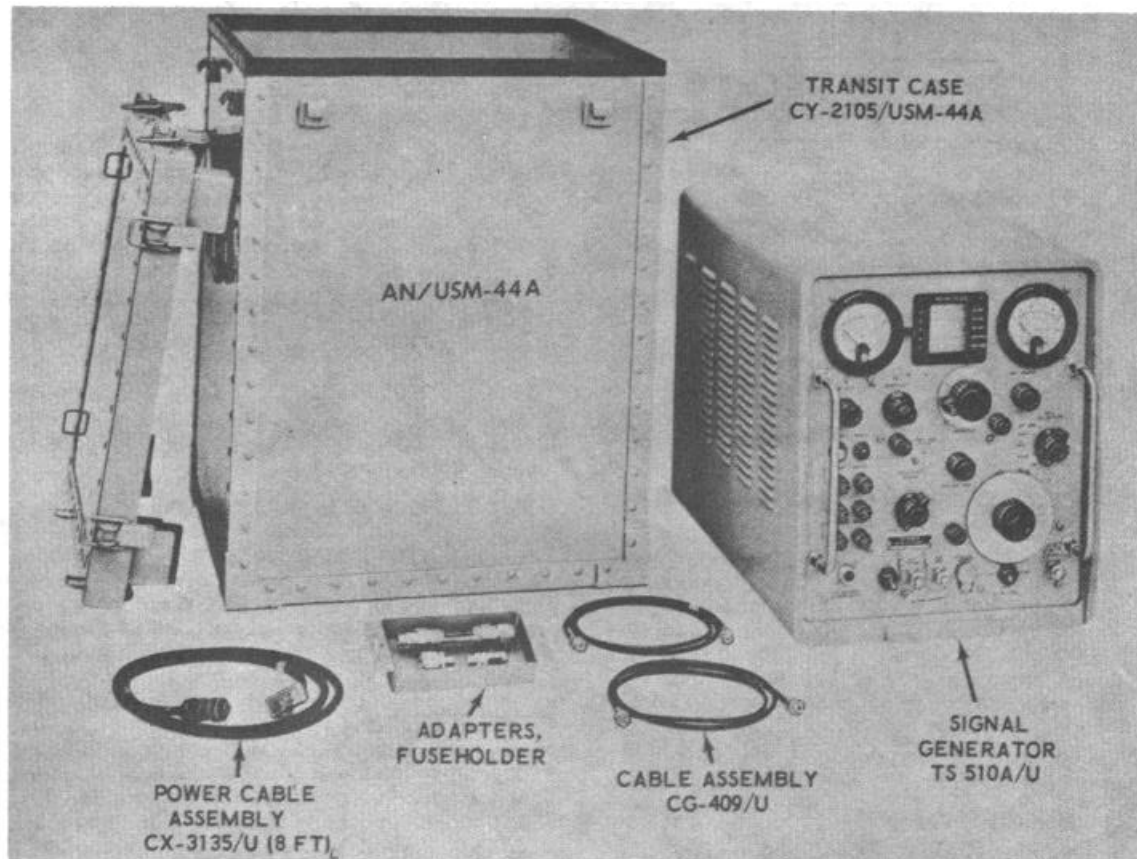


Figure 1-1A. Signal Generator AN/USM-44A (Hewlett-Packard), Equipment Supplied

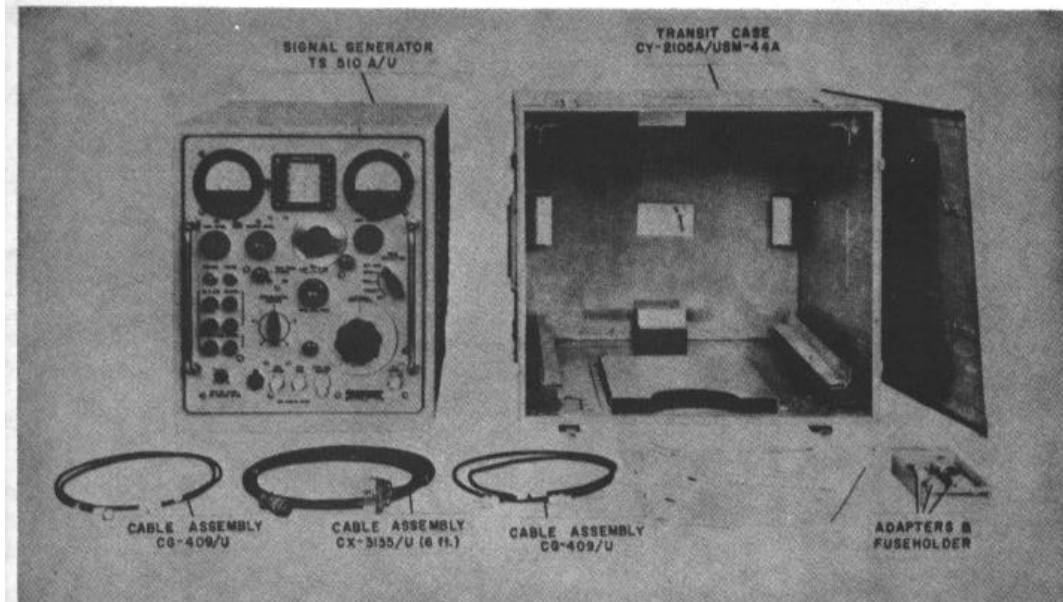


Figure 1-1B. Signal Generator AN/USM-44A (Nuclear Electronics). Equipment Supplied

1-3. LEADING PARTICULARS.

1-4. Signal Generator TS-510A/U is designed to meet the exacting requirements of precision laboratory work and general service work requiring small amounts of r-f power, such as testing and calibrating high frequency radio equipment, measuring standing wave ratios, antenna and transmission line characteristics, receiver sensitivity and similar uses. To be especially useful for accurate calibration of communications equipment such as the AN/ARC-27, the physical construction and circuitry of the r-f generating circuits in the TS-510A/U are designed to produce an output signal that is especially free of spurious amplitude modulation and incidental frequency modulation.

1-5. The frequency range of the signal generator, 10 to 420 megacycles, is covered in five ranges, the range in use being automatically indicated on the five scale frequency dial and each scale providing approximately a 2:1 frequency range. The dial is hand calibrated to an accuracy of 0.5% for each unit and, if necessary, may be removed for equipment service and replaced without loss of accuracy. The output attenuator dial is a pre-calibrated dial which can be removed and replaced with little loss in calibration accuracy.

1-6. The TS-510A/U is 13-3/4 inches wide by 16 inches high by 20 inches long and weighs 62 pounds. The instrument is constructed of aluminum alloy throughout and is designed to have good circuit accessibility. Guardrail handles are provided for protection to the front

panel controls and to assist in removing the instrument from the cabinet. Ventilation for the signal generator is provided by the louvers in the sides and rear of the cabinet. All fuses are replaceable from the front panel by spare fuses located on the front panel. Table 1-4 lists the specifications for the TS-510A/U Signal Generator.

1-7. TUBE COMPLEMENT. Table 1-2 gives the quantity required, type, circuit designation and function of the electron tubes and crystal diodes used in the AN/USM-44 equipment.

1-8. DIFFERENCES IN EQUIPMENTS.

1-9. FINE FREQ. ADJUST CONTROL. Beginning with serial number 510, the TS-510/U Signal Generators are equipped with a short range incremental tuning device for making extremely small changes in the output signal frequency. The FINE FREQ. ADJ. control is operated by an additional knob on the front panel and provides from 0.01 to 0.2% adjustment in the output frequency after selection by the main frequency control dial. The addition of the FINE FREQ. ADJ. control does not alter the circuit, operation, or specifications for the signal generator. The FINE FREQ. ADJ. control is illustrated in figure 2-1 item 28. Several minor changes in the values of electronic parts have been made. These changes do not materially affect the performance of the signal

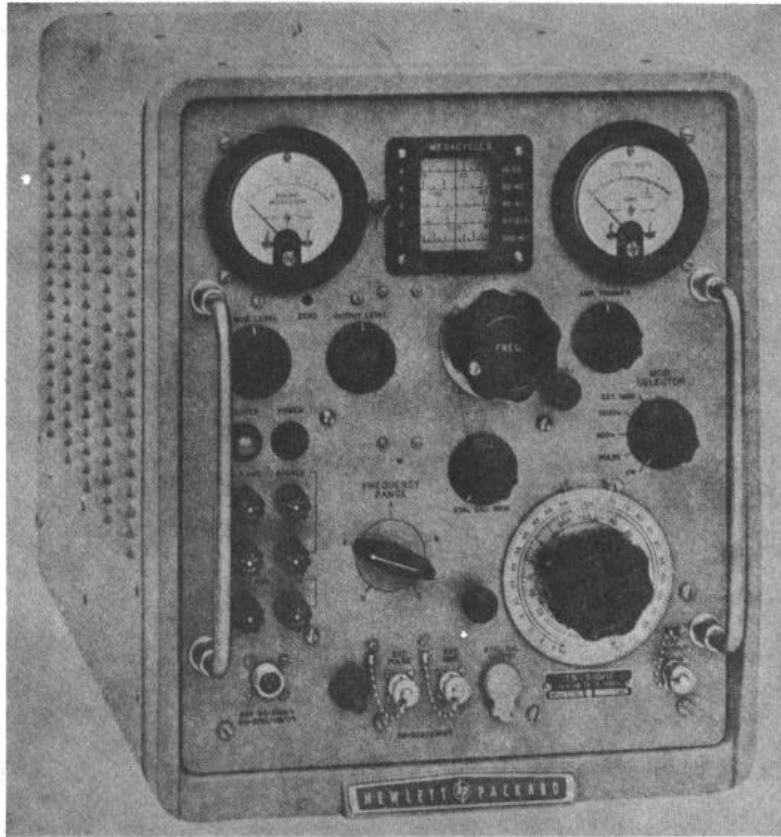


Figure 1-2. Signal Generator TS-510/U

generator, All modifications are listed below with the serial number at which the change took place, the purpose of the modification, and the adjustments required when making the change on early model instruments.

1-9A. CRYSTAL CALIBRATOR, TS-510/U. The calibrator is a 5 megacycle oscillator which is accurate to $\pm 0.01\%$, providing checkpoints every 5 megacycles over the full frequency range of the Signal Generator. It provides an audible beat note of 0.1 milliwatt or better to a 600-ohm headset.

1-9B. CRYSTAL CALIBRATOR, TS-510A/U. The calibrator employs a 6U8 pentode-triode electron tube. The pentode section is a 5 megacycle oscillator which is accurate to $\pm 0.01\%$ and which provides checkpoints every 5 megacycles over the full frequency range of the Signal Generator. The triode section is a 1 megacycle oscillator which is accurate to $\pm 0.01\%$ and which provides checkpoints every megacycle over the frequency range of the Signal Generator. The XTAL

CAL. 1 MC-OFF-5 MC switch provides for selection of calibrator frequency. The crystal calibrator circuit provides an audible beat note of 0.1 milliwatt or better to a 600-ohm headset.

1-9C. OUTPUT ATTENUATOR CONTROL, TS-510/U AND TS-510A/U(*). The accuracy of the attenuator dial is within ± 2 decibels for all conditions of operation at rated load.

1-9D. OUTPUT ATTENUATOR CONTROL, TS-510A/U().** The accuracy of the attenuator dial is within ± 1 decibel for all conditions of operation at rated load.

1-9E. INTERNAL MODULATION, TS-510/U AND TS-510A/U(*). Sine waves are obtainable at frequencies of 400 cps and 1000 cps $\pm 5\%$. Percentage modulation is continuously adjustable from 0 to 95% at output levels up to 0 dbm.

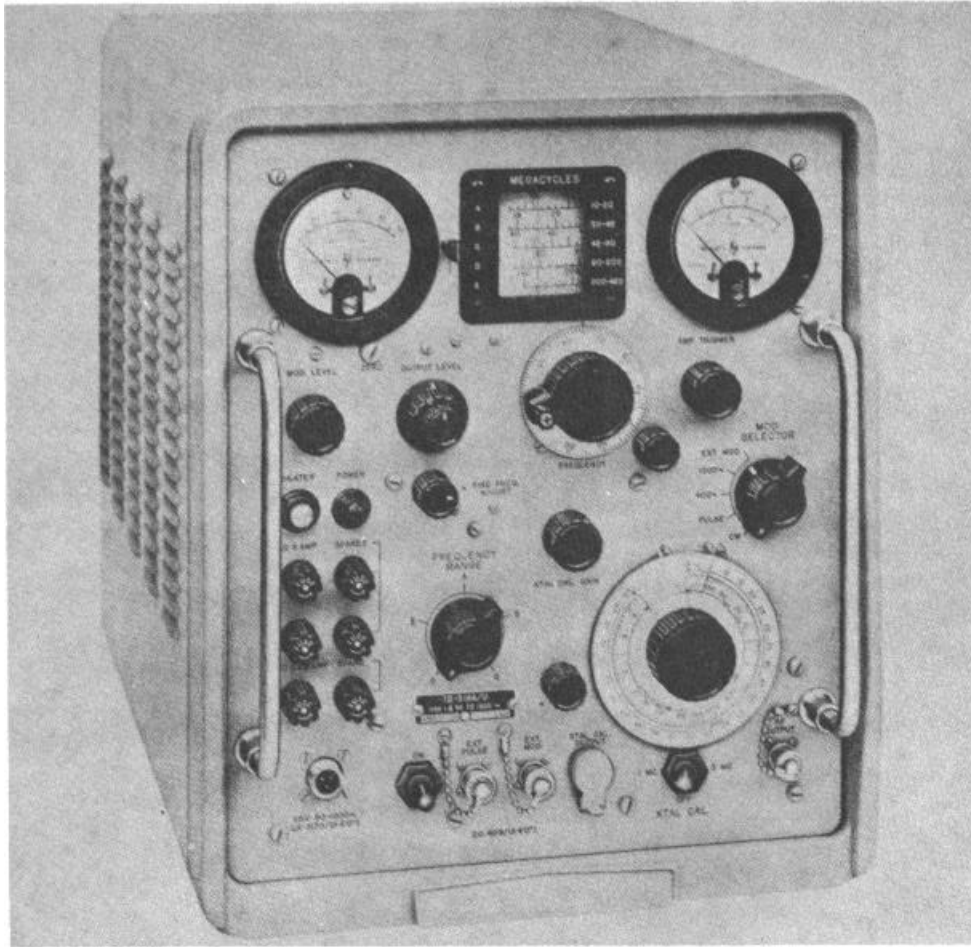


Figure 1-2A. Signal Generator TS-510A/U(**)

1-9F. INTERNAL MODULATION, TS-510A/U().** Sine waves are obtainable at frequencies of 400 cps and 1000 cps $\pm 10\%$. Percentage modulation is continuously adjustable from 0 to 95% at output levels up to 0 dbm.

1-9G. EXTERNAL PULSE MODULATION, TS-510/U AND TS-510A/U(*). Positive 10-volt peak pulse is required. The combined rise and decay time of the r-f output is less than 4 microseconds from 40 to 220 megacycles, and less than 1 microsecond from 220 to 420 megacycles. Residual level must be at least 20 db below 0.5 peak pulse output.

1-9H. EXTERNAL PULSE MODULATION, TS-510A/U().** Positive 5-volt peak pulse is required. The combined rise and decay time of the r-f output is less than 4 microseconds from 40 to 220 megacycles, and less than 1 microsecond from 220 to 420 megacycles. Residual level must be at least 20 db below 0.5 peak pulse output.

1-10. OPERATING CONTROLS, DIALS AND TERMINALS.

1-11. The front panel operating controls, dials and terminals for the TS-510A/U Signal Generator are listed with their functions in Table 1-3 and are shown

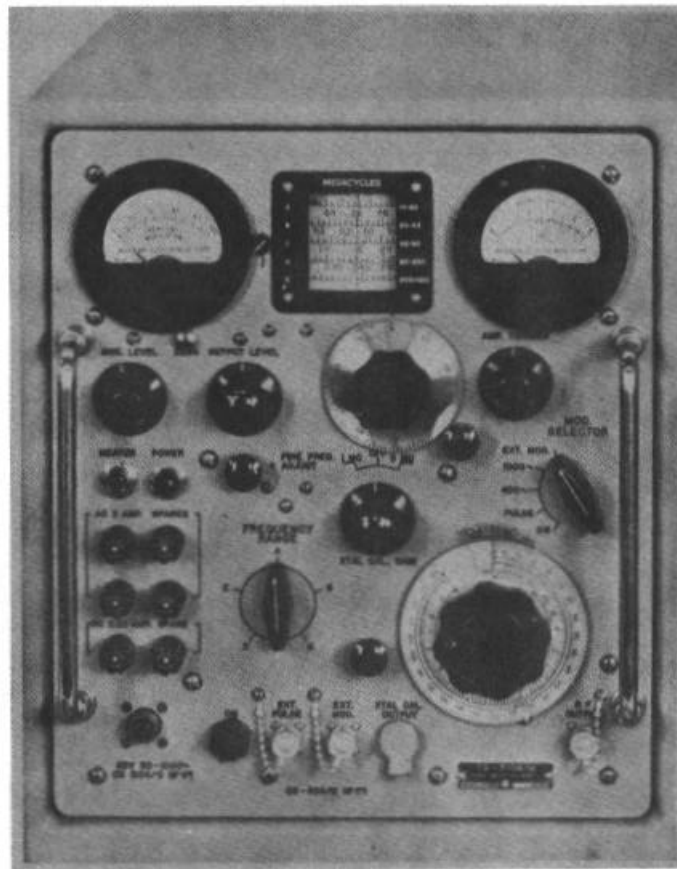


Figure 1-2B. Signal Generator TS-510A/U(*)

in figure 1-3. A simplified block diagram showing which circuits are affected by various front panel controls is shown in figure 1-4.

CAUTION

Do not connect any source of r-f or d-c power to the R-F OUTPUT jack on the TS-510A/U Signal Generator. To do so will burn out the impedance - matching network in the output attenuator and no output will be obtained. Special care must be taken when working with "transceiver" type apparatus, such as the AN/ARC-

27 equipment, to insure that the transmitter remains inoperative while the signal generator is connected to the equipment antenna.

NOTE

For protection to the output attenuator on the TS-510A/U Signal Generator, a special fuse-holder is supplied for connection to the RF OUTPUT cable. When using the signal generator for any application where there is the possibility of voltage being applied to the RF OUTPUT, this fuse must be used between the signal generator and the external equipment.

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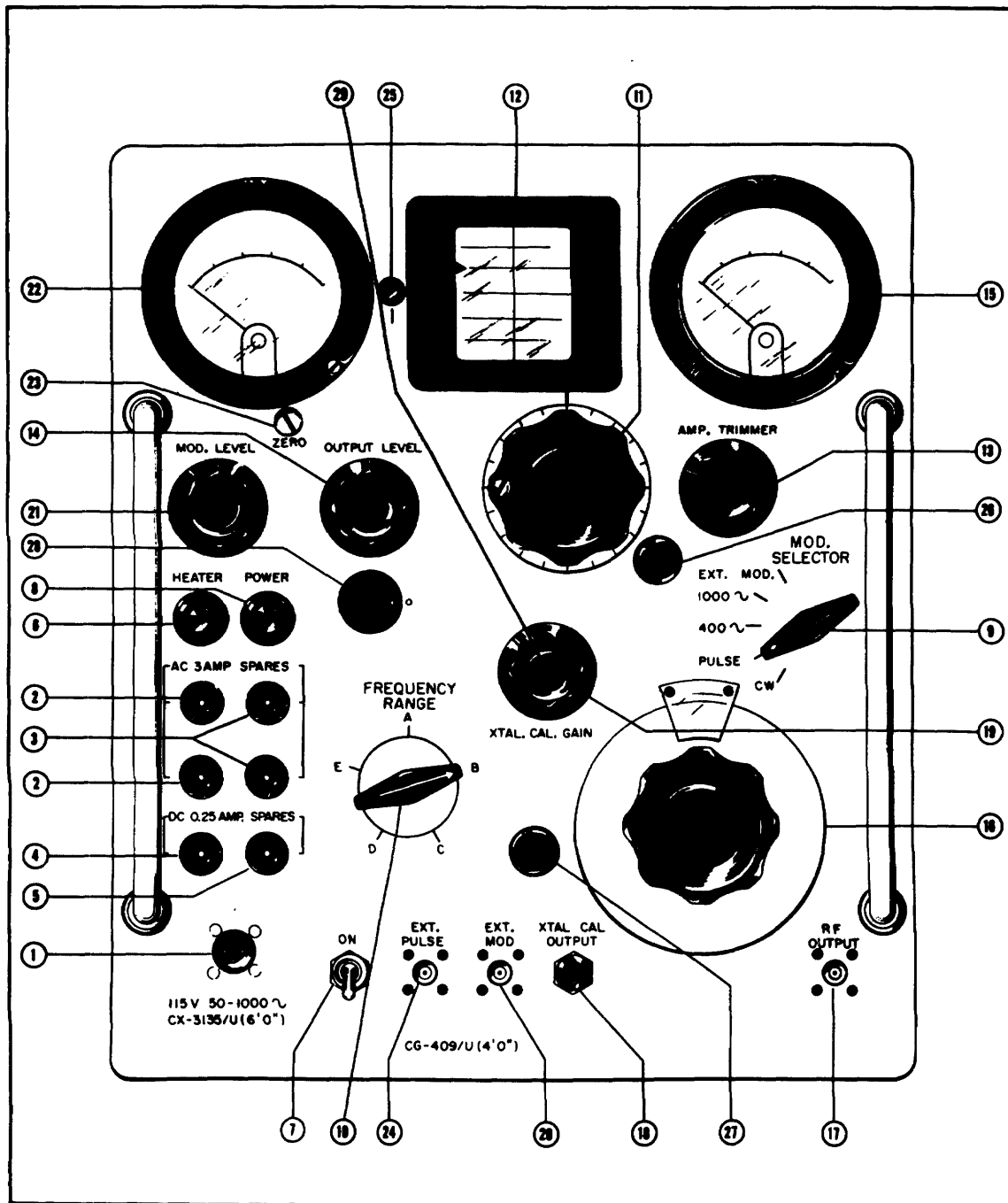


Figure 1-3. Signal Generator TS-510/U, Front Panel Controls

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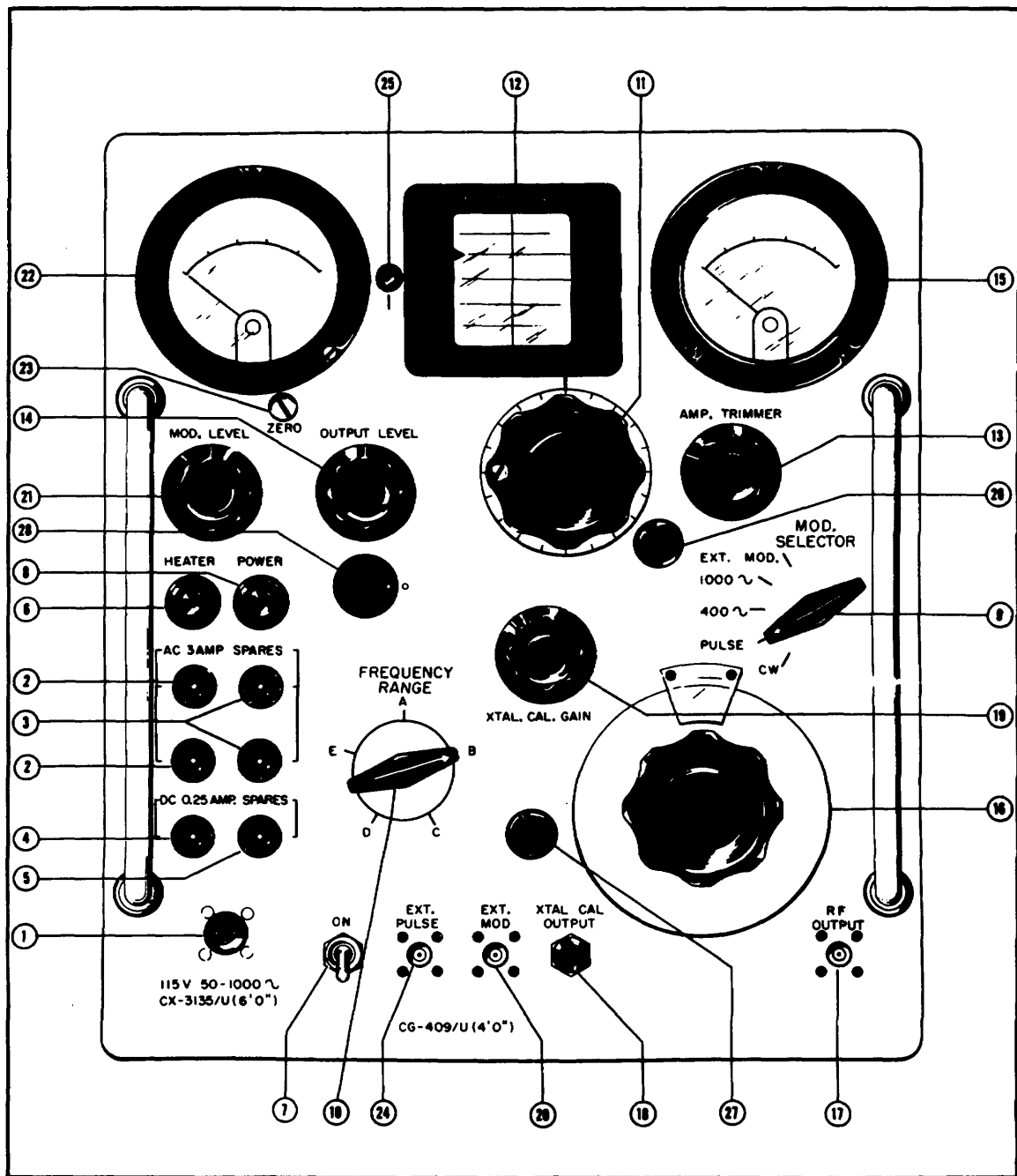


Figure 1-3A. Signal Generator TS-510/U(*), Front Panel Controls

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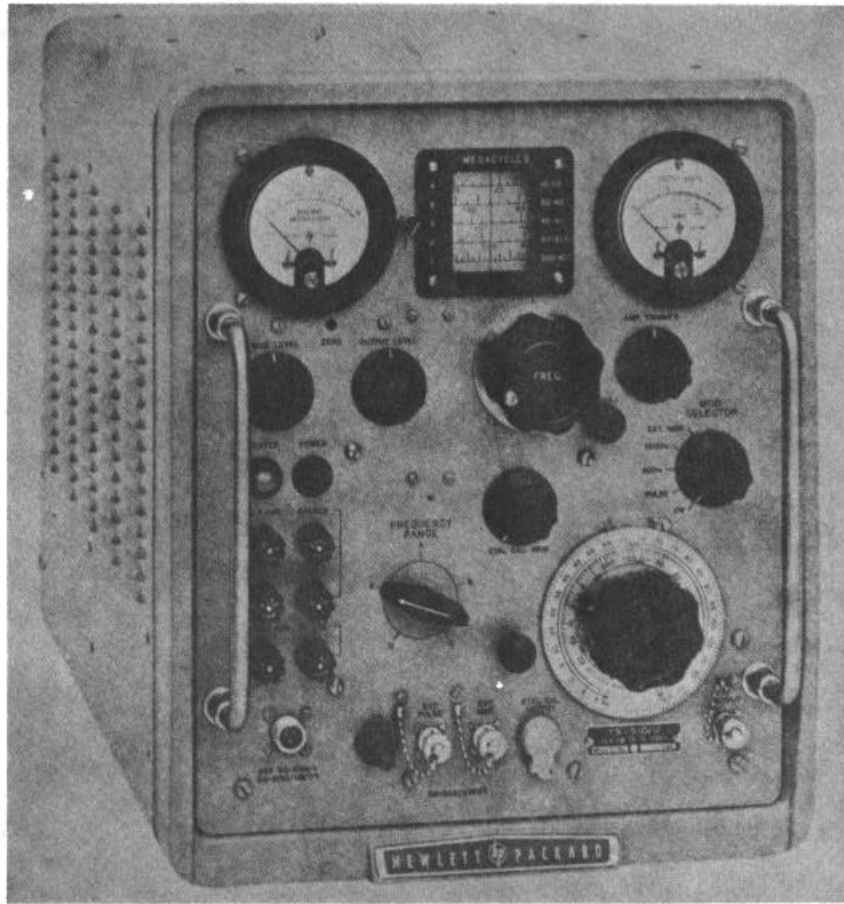
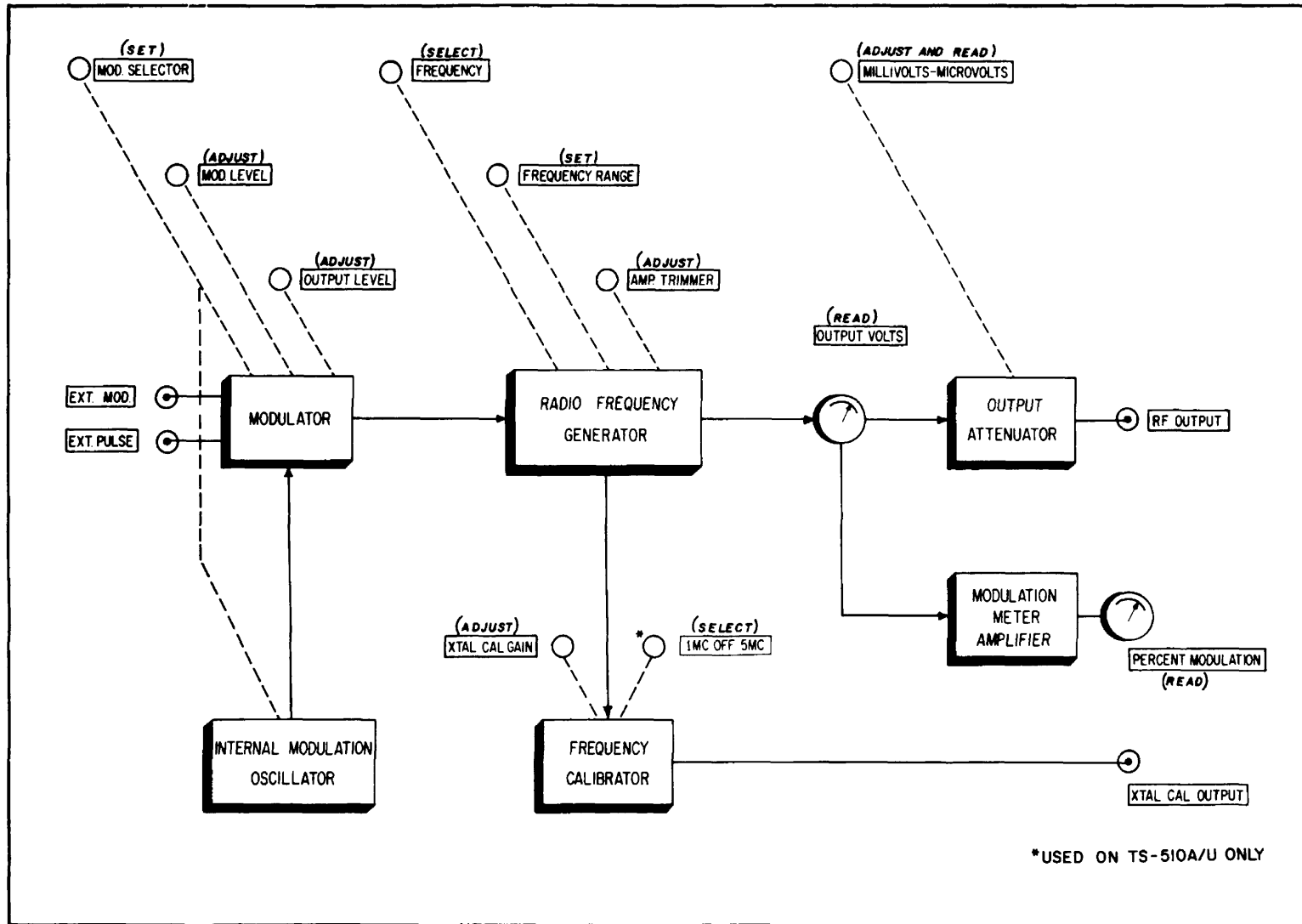


Figure 1-3B. Signal Generator TS-510A/U(**), Front Panel Controls

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Figure 1-4. Diagram Showing Relationship of Front Panel Controls to Major Circuits

Table 1-1. Equipment Supplied

QUANTITY PER EQUIP.	ITEM	AN TYPE DESIG.	OVERALL DIMENSIONS (in.)			WEIGHT (lb)
			HEIGHT or LENGTH	WIDTH	DEPTH	

Signal Generator AN/USM-44 (Hewlett-Packard). (See figure 1-1.)

1	Signal Generator	TS-510/U	16	13-3/4	20	62
1	Transit Case	CY-1605/USM-44	24	20	17-5/8	32
1	Cord	CX-3135/U (6 ft, 0 in.)	72	-	-	0.6
2	Cord	CG-409/U (4 ft, 0 in.)	48	-	-	0.2
1	Connector Adapter	UG-201A/U	-	-	-	-
1	Connector Adapter	UG-349A/U	-	-	-	-
1	R-f Output Fuse Mount	MX-1730/U 4-5/8	4-5/8	3/4 dia	-	0.4
1	R-f Amplifier Tube Wrench (located in chassis clips)		2-7/8	3/4 dia	-	0.2

Signal Generator AN/USM-44A (Hewlett-Packard). (See figure 1-1A.)

1	Signal Generator	TS-510A/U	16	13-3/4	20	62
1	Transit Case	CY-2105/USM-44A	24	20	17-5/8	32
1	Cord	CX-3135/U (8 ft, 0 in.)	96	-	-	0.8
2	Cord	CG-409/U (4 ft, 0 in.)	48	-	-	0.2
1	Connector Adapter	UG-201A/U	-	-	-	-
1	Connector Adapter	UG-349A/U	-	-	-	-
1	R-f Output Fuse Mount	MX-1730/U	4-5/8	3/4 dia	-	0.4
1	R-f Amplifier Tube Wrench (located in chassis clips)	-	2-7/8	3/4 dia	-	0.2

Signal Generator AN/USM-44A (Nuclear Electronics). (See figure 1-1B.)

1	Signal Generator	TS-510A/U	16	13-3/4	20	62
1	Transit Case	CY-2105A/USM-44A	24	20	17-5/8	32
1	Cord	CX-3135/U (6 ft, 0 in.)	72	-	-	0.6
1	Cord	CG-409/U (4 ft, 0 in.)	48	-	-	0.2
2	Connector Adapter	UG-201A/U	-	-	-	-
1	Connector Adapter	UG-349A/U	-	-	-	-
1	R-f Output Fuse Mount	MX- 1730/U	4-5/8	3/4 dia	-	0.4
1	R-f Amplifier Tube Wrench (located in chassis clips)		2-7/8	3/4 dia	-	0.2

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Table 1-2. Electron Tube Complement

QUANTITY	TYPE	NAME AND FUNCTION
1	5651	V15 Gaseous voltage regulator.
1	5670	V1 Modulator limiter.
1	5675	V6 Radio frequency oscillator.
1	5687	V17 Heater supply multivibrator.
2	5814/12AU7	V2 Modulator oscillator. V21 Modulator meter bridge tube.
1	5876	V8 Radio frequency amplifier.
2	6080	V13 Series voltage regulator. V16 Series voltage regulator.
2	6AH6	V18 Modulation indicator amplifier. V19 Modulation indicator amplifier.
*3	6AU6WA	*V9 Xtal calibrator oscillator.
**2		V12 Voltage control amplifier. V14 Voltage control amplifier.
1	6BC4	V7 Radio frequency buffer.
3	6CL6	V3 Modulator amplifier. V4 Modulator cathode follower. V5 Output level control tube.
1	6U8	**V9 Xtal calibrator oscillator.
2	12AT7WA	V10 Xtal calibrator amplifier. V11 Xtal calibrator amplifier.
1	G11A	CR1 Calibrator mixer diode.
1	1N34	CR7 R-f amplifier cathode clamp.
2	1N82	CR2 Power monitor detector. CR3 Power monitor compensator
*Used only on Signal Generator TS-510/U.		
Used only on Signal Generator TS-510A/U(*) and TS-510A/U().		

Table 1-3. Controls and Terminals

REF. NO.	DESIGNATION	FUNCTION
1	Power Receptacle	Receives power from power cord supplied.
2	AC 3 AMP (fuse)	Protects power source and instrument against short circuits.
3	SPARES (fuses)	Replacement 3 amp fuses.
4	DC 0.25 AMP (fuse)	Protects the internal power supply against short circuits.
5	SPARE (fuse)	Replacement 0.25 amp fuse.
6	HEATER (pilot lamp)	Pilot lamp indicates power is applied to generator and space heaters are in operation.
7	Power Switch	In the ON position all circuits of the signal generator are energized. In the off position space heaters are energized
8	POWER (pilot lamp)	Pilot lamp indicates when main circuits are energized.
9	MOD. SELECTOR	Adjusts signal generator circuits for desired type of operation.
10	FREQUENCY RANGE (selector)	Selects frequency range and positions the range pointer on MEGACYCLES dial.
*11	FREQUENCY (control) (see figure 1-3A) or Frequency Control (see figures 1-3 and 1-3B)	Controls the output frequency in combination with the FREQUENCY RANGE switch.
12	MEGACYCLES (indicator)	Indicates frequency of the r-f output signal directly in megacycles.
13	AMP. TRIMMER (control)	Tunes r-f power amplifier for maximum output.
14	OUTPUT LEVEL (control)	Adjusts the r-f power level existing at input to output attenuator.
15	OUTPUT VOLTS-DBM (indicator)	Indicates r-f power level existing at input to output attenuator.
16	Output Attenuator (control)	Selects and indicates the r-f output signal level in microvolts, millivolts, and decibels.
17	RF OUTPUT (jack)	Output connector for r-f output signal (see CAUTION).
18	XTAL CAL. OUTPUT (connector)	Connects headset to crystal calibrator.
19	XTAL CAL. GAIN (control)	Adjusts loudness of beat frequency signal from frequency calibrator.
20	EXT. MOD. (jack)	Receives sine wave from external source for modulation of r-f output signal.
21	MOD. LEVEL (control)	Adjusts modulation percentage to desired value.
22	PERCENT MODULATION (indicator)	Indicates the percentage modulation of the r-f output signal.
23	ZERO (screwdriver adjustment)	Electrically sets the modulation meter to zero with instrument in operation with no modulation applied.
24	EXT. PULSE (jack)	Receives pulses from external source for modulation of the r-f output signal.
25	Frequency Dial Index Adjustment	Adjusts frequency dial index over short range.
26	Frequency Dial Lock	Locks frequency dial.

*Used only on Signal Generator TS-510A/U(**).

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Table 1-3. Controls and Terminals (Cont)

REF. NO.	DESIGNATION	FUNCTION
27	Attenuator Dial Lock	Locks attenuator dial.
28	FINE FREQ. ADJUST	Adjusts RF OUTPUT frequency in very small increments.
*29	1 MC OFF 5 MC	Selects 1 megacycle and 5 megacycle outputs or no output (OFF position).
**29	1 MC OFF 5 MC	Selects 1 megacycle and 5 megacycle outputs or no output (OFF position).

*Used only on Signal Generator TS-510A/U(**).

**Used only on Signal Generator TS-510/U and TS-510A/U(*)

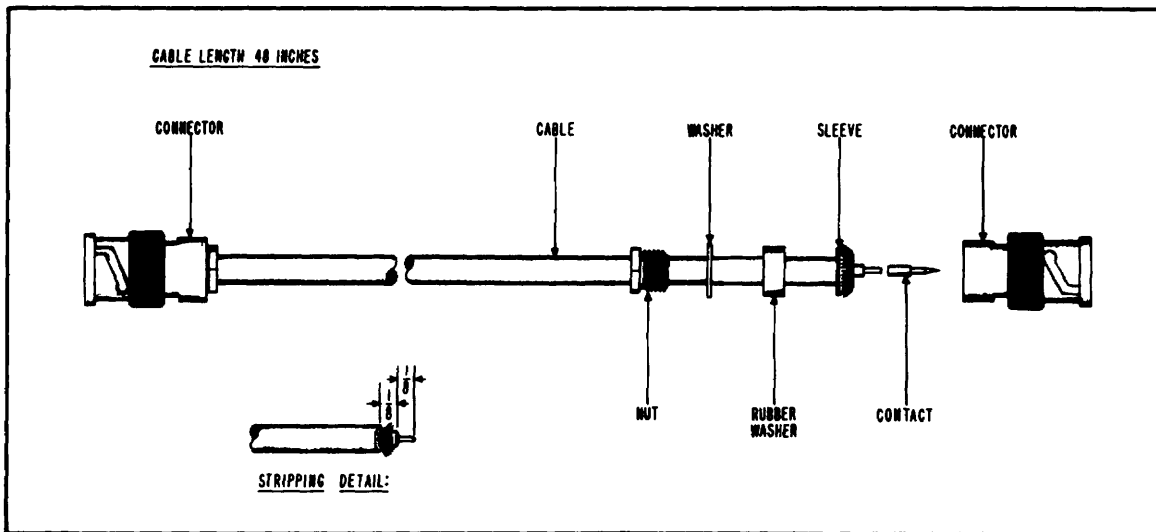


Figure 2-1. Fabrication of Video Cord CG-409/U

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Table 1-4. Specifications for Signal Generators T-510/U and TS-510A/U

TYPES OF OUTPUT:	CW; Internal sine-wave amplitude modulation; External amplitude modulation; External pulse modulation.
FREQUENCY RANGE: ACCURACY OF FREQUENCY CALIBRATION:	10 to 420 megacycles covered in five bands. With crystal calibrator, $\pm 0.05\%$ at checkpoints. Without calibrator, $\pm 0.5\%$ overall.
CRYSTAL CALIBRATOR:	*5 megacycle oscillator accurate to $\pm 0.01\%$ providing checkpoints at each 5 megacycles over full frequency range. Provides 0.1 milliwatt or better to a 600-ohm headset. **5 megacycle oscillator accurate to $\pm 0.01\%$ providing checkpoints at each 1 megacycle and 5 megacycles over the full frequency range. ***1 megacycle oscillator accurate to $\pm 0.01\%$ providing checkpoints at each 1 megacycle over the full frequency range.
OUTPUT VOLTAGE:	Continuously adjustable attenuator provides from 0.1 microvolt minimum to 0.5 volt maximum when operated into rated load of 50 ohms.
OUTPUT LEVEL METER:	Monitors r-f power level fed to output attenuator; calibrated 0 to 7 dbm and 0.1 to 0.5 volt.
OUTPUT LEVEL CALIBRATION ACCURACY:	For all conditions of operation the accuracy of the attenuator dial is within *2 decibels when operated into a rated load. ***The accuracy of the attenuator dial is * 1 db over entire frequency range into a 50-ohm resistive load.
OUTPUT LEVEL AND RATED LOAD:	The VSWR measured at the output connector is less than 1.2 (SWR 1.6 db) when connected to nominal 50-ohm resistive load.
INTERNAL MODULATION:	Sine waves at frequencies of 400 and 1000 cps $\pm 5\%$, ($\pm 10\%$ **). Percent modulation continuously adjustable from zero to 95% at output levels up to 0 dbm.
EXTERNAL MODULATION:	100 to above 20,000 cps. Percent modulation continuously adjustable from zero to 95% at r-f output levels up to 0 dbm with modulating voltages from 4 to 25 volts rms.
PERCENT MODULATION:	Indicated by direct-reading panel meter accurate to $\pm 10\%$.
ENVELOPE DISTORTION FOR SINE WAVE MODULATION:	Less than 5% at 30% modulation for frequencies from 100 to 5000 cps. Less than 10% at 50% modulation.
INPUT IMPEDANCE FOR EXT SINE MODULATION:	20,000 ohms shunted by 50 microfarads.
EXTERNAL PULSE MODULATION:	Positive 10-volt (5-volt***) peak pulse required. Combined rise and decay time of r-f output pulse less than 4 microseconds from 40 to 220 megacycles; less than 1 microsecond from 220 to 420 megacycles. Residual level at least 20 db below 0.5 peak pulse output.
INPUT IMPEDANCE FOR EXT PULSE MODULATION: FREQUENCY STABILITY:	50,000 ohms shunted by 40 micromicrofarads. Frequency drift less than 0.005% per 15-minute period.
INPUT POWER REQUIREMENTS: *Pertains only to TS-510/U **Pertains only to TS-510AAJ(*) ***Pertains only to TS-510A/U(**)	115/230 volts ac, single phase. (**115 volts ac, single phase.)

SECTION II

SPECIAL TEST EQUIPMENT AND SPECIAL TOOLS

2-1. TEST EQUIPMENT REQUIRED.

2-2. No special test equipment has been procured for the maintenance of the TS-510A/U Signal Generator. Table 2-1 lists the test equipment required for making the tests described in this manual. Commercial models of test apparatus are presented when no military counterparts are available

2-3. SPECIAL TOOLS.

2-4. No special tools are required for maintenance of Signal Generator TS-510A/U other than the spanner wrench supplied in the equipment. The spanner wrench is for removing the r-f amplifier tube from inside the r-f generator housing and is located in a spring clip on the instrument chassis adjacent to the generator housing.

2-5. CABLE FABRICATION.

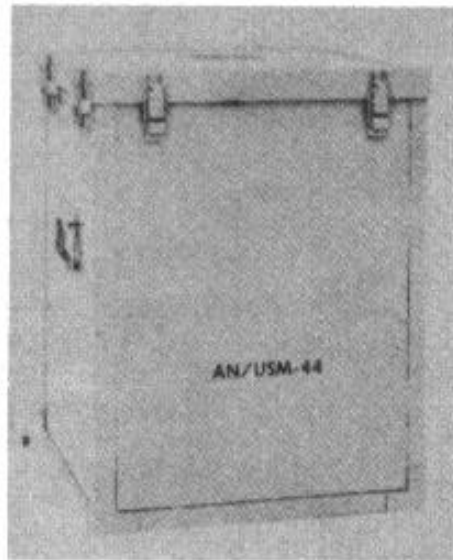
2-6. Two identical test cables are supplied with the AN/USM-44 and AN/USM-44A equipment. These cables are standard 4-foot CG-409/U cables and are the only cables required for use with the signal generator. Additional cables may be constructed, however, care must be used in preparing the ends of the cable for fitting into the connectors,

NOTE

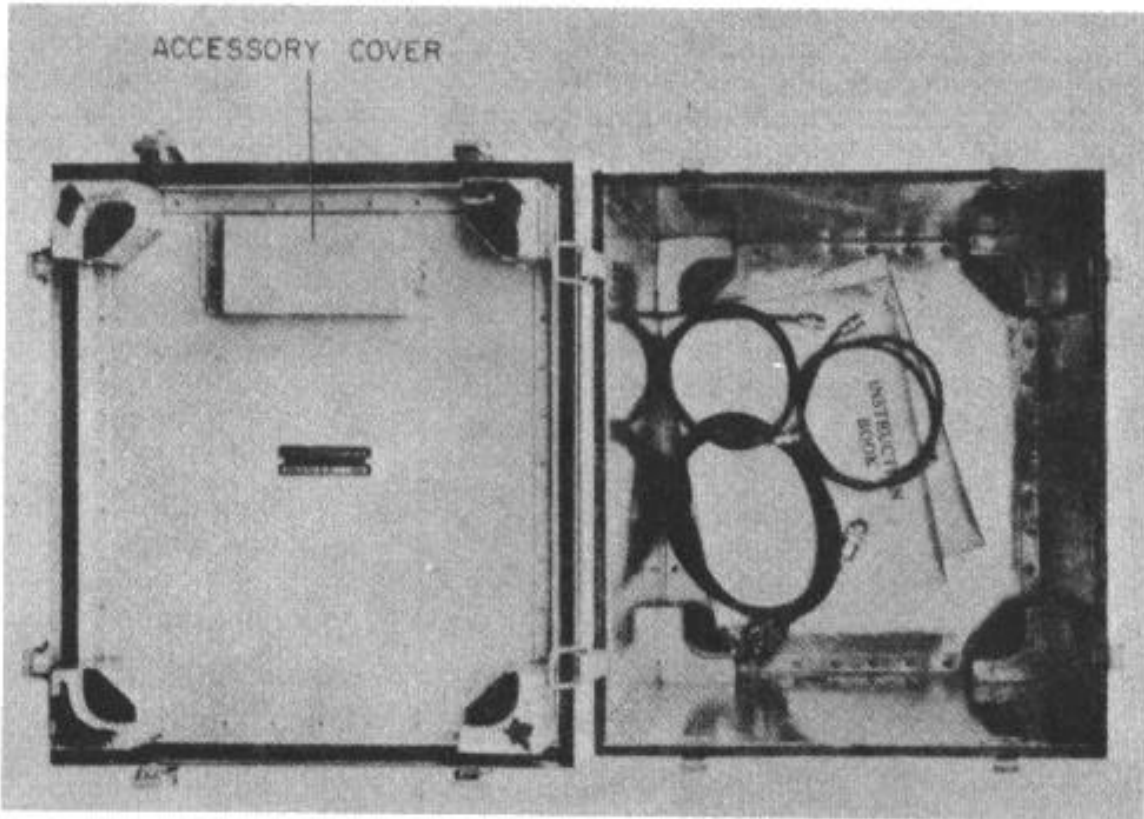
Be neat. Cut squarely, leave no long shield strands, and do not nick the center conductor when cutting through the dielectric. When soldering the center conductor into the connector center pin, do so quickly; do not melt the dielectric. Figure 2-1 shows the cable end prepared for inserting into connector.

Table 2-1. Test Equipment Required for Maintenance

Name	AN Type Desig.	Alternate	Application
Headphone Set	HS-2		Used with internal frequency calibrator.
Non-electronic Multi-meter	AN/PSM-4	TS-352/U	General voltage, current and resistance measurements.
Electronic-Multimeter (ac)	ME-30/U	ME-6/U	High-impedance and/or low level a-c voltage measurements.
Electronic Multimeter (ac and dc)	ME-26A/U		High-impedance ac or dc and/or VHF measurements.
Variable Line Transformer		Variac, 3 amp	Varies input line voltage to detect marginal operation.
Oscilloscope	TS-239/UP		Waveform measurements.
VHF Detector		Hewlett-Packard Co. 420A Wide-Band Crystal Detector	Waveform measurements of modulated VHF carrier.
Test Oscillator	TS-312/FSM-1	TS-382/U	External sine modulation of signal generator.
Pulse Generator	SG-69/FCC		External pulse modulation of signal generator.
Distortion Analyzer	TS-723/U		Modulation distortion measurement.
Frequency Meter	AN/USM-26	LM	Calibration oscillator adjustment.
Power Meter	TS-196/CMP-4	TS-125/AP	VHF output power measurements.
Bolometer Mount		Hewlett-Packard Co. 476A Universal Bolometer Mount	VHF output power measurements.



(a) With cover in place.



(b) Cover removed to show accessory storage.

Figure 3-1. Transit Case CY-1605/USM-44

SECTION III
PREPARATION FOR USE AND RESHIPMENT

3-1. PREPARATION FOR USE.

3-2. Signal Generator Test Set AN/USM-44 and AN/USM-44A are portable, single component, test instruments designed for test bench use. The main component of the Signal Generator Test Set AN/USM44, Signal Generator TS-510/U, is shipped with its accessories in Transit Case CY-1605/USM-44. The main component of the Signal Generator Test Set AN/USM-44A, Signal Generator TS-510A/U(*), is shipped with its accessories in Transit Case CY-2105A/USM-44A; Signal Generator TS-510A/U(**) is shipped with its accessories in Transit Case CY2105/USM-44A. The complete equipment is shown in figures 1-1, 1-1A, and 1-1B. The transit case and accessory stowage is shown in figures 3-1 and 3-2. The construction of Transit Case CY-2105A/USM-44A and CY-2105/USM-44A is similar to that of Transit Case CY-1605/USM-44. The instruction books and accessory cables are stowed in the bottom of the transit case; the r-f connector adapters and an r-f output fuse mount are contained in a snap-on tray, shown in figure 3-2, which fastens to the transit case cover. When unpacking, check the contents of the transit case against the complete equipment shown in figures 1-1, 1-1A and 1-1B.

3-3. To remove the instrument from the transit case, loosen the eight trunk latches on the cover of the case and remove the transit case cover. Pull signal generator from the transit case by the guardrail handles.

Locate the instrument close to a source of 115 volt a-c power and close to the equipment to be tested. The equipment under test and the signal generator should both be within arms' reach of the operator.

3-4. The power cord for the equipment, CX-3135/U, is a 3-conductor cable terminated by a dual purpose male plug which will connect either to a standard 2-conductor a-c outlet or to a special 3-conductor grounded type. The plug is equipped with a removable third contact blade which screws to the body of the plug and is for grounding the chassis of the instrument when used with the appropriate a-c power receptacle. The third blade must be removed if the plug is to be used with the standard 2-conductor a-c outlet.

3-5. Two identical, 4-foot, coaxial connecting cables are provided with the signal generator; one intended for connecting the r-f output signal to external equipment under test, the other for connecting an external source of modulating voltage to the signal generator. These cables are fitted with BNC type terminations at both ends and are used with the signal generator without the need for connecting adapters.

3-6. Two connector adapters are provided so that type N coaxial fittings may be used with the type BNC fittings on the front panel of the signal generator. One is a male BNC to female type N to be used at the front panel r-f output jack; the other, a male type N to female

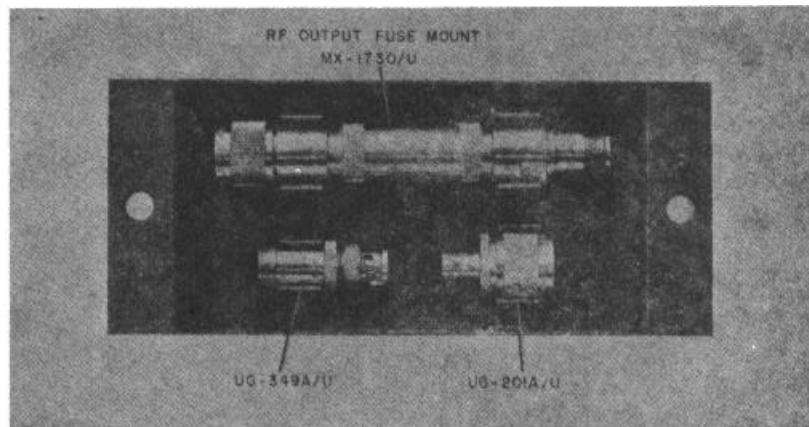


Figure 3-2. Accessory Cover

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BNC to connect the type N output of the r-f fuse mount to a BNC termination. These adapters are required when the r-f output fuseholder, which is designed for use with type N fittings, is to be used with cables equipped with BNC fittings.

3-7. To prevent damage to the precision attenuator resistors, a special r-f fuseholder (with fuse) is supplied for connection between the signal generator and external equipment under test when there is the possibility of an external voltage being applied to r-f output jack on the TS-510A/U. The fuse mount is designed for use with type N fittings but, with the two connector adapters supplied, may also be used with BNC type fittings. It is recommended that the fuse mount be located between the end of a connecting cable and the equipment under test.

3-8. PREPARATION FOR RESHIPMENT.

3-9. No shipping container other than the transit

case for the equipment is required for shipment or transporting Signal Generator AN/USM-44 or AN/USM-44A. The signal generator and all accessories are stored in the transit case (see figure 3-1). To repack the equipment in the transit case, the instruction books are first placed in the bottom of the case with the three accessory cables. The signal generator is then inserted panel up into the case, seating on the rubber bumpers in the bottom of the case. The two connector adapters and the r-f fuse mount are pressed into clamps in the accessory tray which, in turn, fastens to the cover of the transit case by two snap-on fasteners. The cover of the transit case contains rubber bumpers which, when the cover is installed, seat against the front panel of the signal generator and hold it securely in place. No special precautions are required other than to check the completeness of the equipment and to see that the trunk latches holding the cover to the body of the transit case are securely fastened.

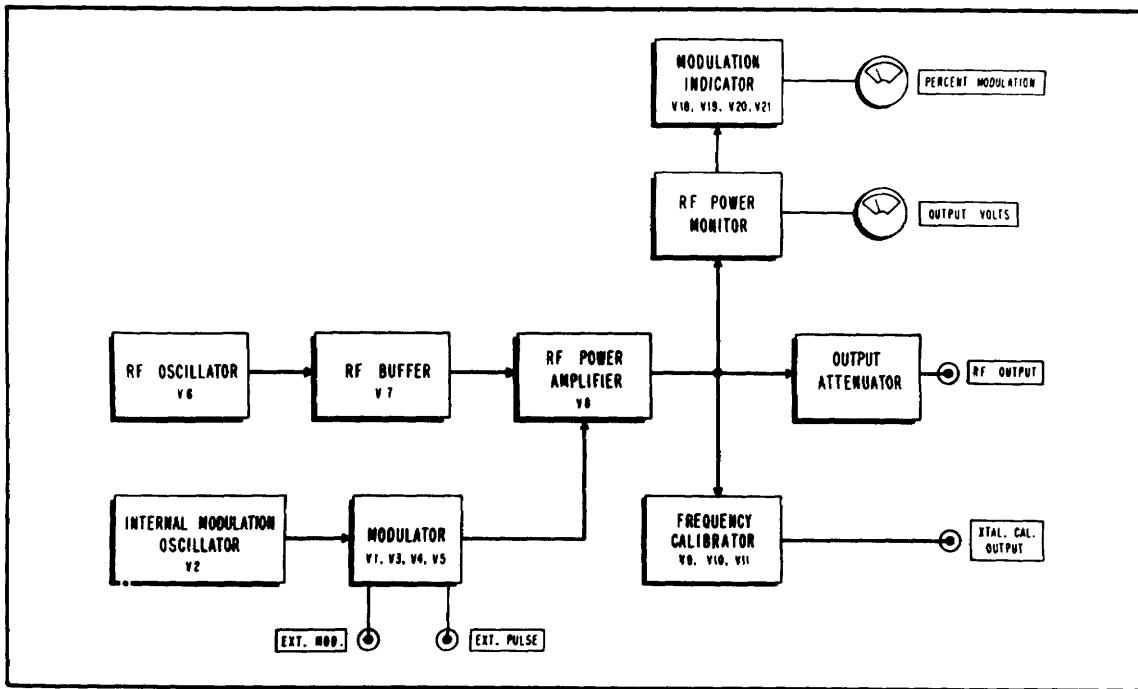


Figure 4-1. Signal Circuit Block Diagram of Signal Generator TS-510A/U

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SECTION IV

THEORY OF OPERATION

4-1. GENERAL SYSTEM OPERATION.

4-2. The electrical circuits of the TS-510A/U Signal Generator consist of the sections shown in the block diagram in Figure 4-1, plus a power supply which is not shown. Briefly, the operation of the various sections is as follows:

a. The radio frequency oscillator generates a variable frequency r-f signal which is fed through a buffer and power amplifier to the output jack of the signal generator. The oscillator is of the Colpitts type carefully designed for very high stability and resetability.

b. The buffer isolates the oscillator from the power amplifier and minimizes interaction between the two circuits.

c. The radio frequency power amplifier receives both the r-f and modulation signals and amplifies the r-f energy for application to the output attenuator. The r-f amplifier also receives variable bias from the modulator which permits adjustment of the power level fed to the output attenuator.

d. The output power monitor samples the r-f energy fed to the output attenuator and indicates the power and voltage level on a front panel meter.

e. The output attenuator obtains monitored r-f energy from the power amplifier, applies the selected degree of attenuation, and conducts the energy to the front panel output jack.

f. The beat frequency calibrator generates harmonics of the 5 mc signal obtained from the crystal, as well as harmonics of the 1 me signal obtained from a tuned circuit and mixes these harmonics with the r-f output signal coupled from the r-f amplifier. The resultant beat frequency signal is amplified and fed through an impedance matching transformer to the front panel headphone jack.

g. The internal modulation oscillator generates either a 400 or 1000 cycle-per-second sine wave for application to the modulator.

h. The modulator receives all modulation signals for application to the r-f power amplifier and also supplies variable bias to the amplifier for control of the r-f output power level.

i. The modulation-measuring circuits receive detected modulation from the r-f power monitor, amplify and rectify it, and indicate the modulation percentage directly on a front panel meter.

4-3. RF GENERATOR ASSEMBLY OPERATION.

4-4. The r-f generator assembly, shown in Figure 4-2 is the heart of the TS-510A/U, generating the r-f energy that is delivered to the external load. The circuit is an MOPA circuit to which a buffer stage has been added to minimize incidental frequency modulation. All of the

radio-frequency circuits in the generator are contained within the generator housing. All electrical connections to the r-f circuits are made through special high-attenuation filters. All removable covers are sealed with replaceable wire braid gaskets.

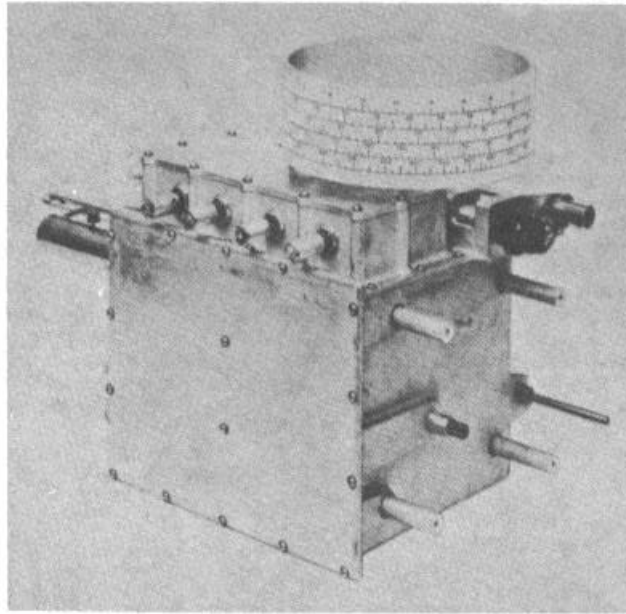
4-5. The generator housing is divided into three compartments. The top compartment houses the three r-f tubes and d-c circuitry. The lower front compartment contains the oscillator tuned circuits; the lower rear compartment contains the power amplifier tuned circuits and the crystal calibrator oscillator. The r-f generator assembly also includes the entire output frequency and attenuator drive mechanisms.

4-6. RADIO FREQUENCY OSCILLATOR. (See Figures 4-2 and 4-3.)

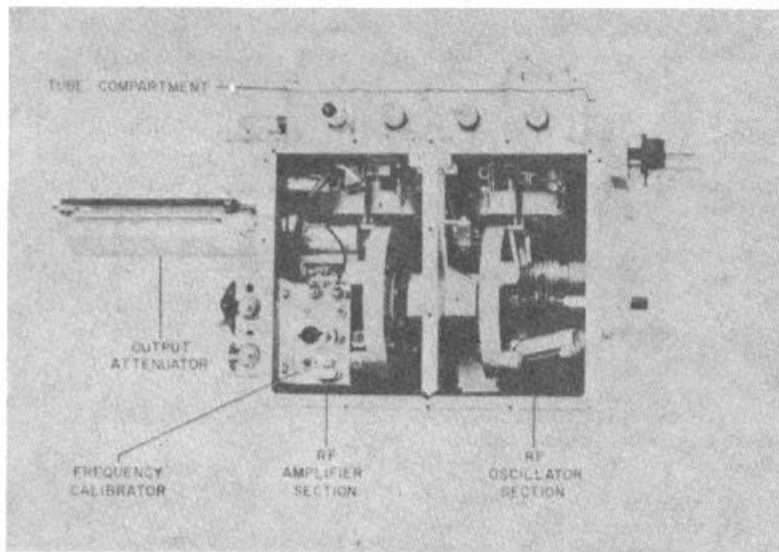
4-7. The radio frequency oscillator generates a sine wave signal from 10 to 420 megacycles in five frequency bands, each band having approximately 2:1 frequency range. A type 5675 "pencil" triode tube is used in a Colpitts circuit tuned by a precision split-stator capacitor (plate meshing type) and five separate r-f transformers, L-1 through L-5. The tuning capacitor, which is specially constructed for high stability and resetability, consists of two stator sections connecting to the grid and plate of the oscillator tube and a floating rotor which meshes equally between the two stators. The tuning capacitor assembly, mounted inside and at the top of the tuning compartment in the r-f generator housing, is driven by a ball-bearing mounted worm drive through the top of the housing casting.

4-8. The oscillator tuning coils are wire-wound under special tension on 5/8-inch diameter ceramic forms on the A, B, and C bands and are silver-plated, Nilvar loops on the D and E bands. Tension-winding provides greater stability with changing temperature. The five inductors are mounted on a revolving turret actuated by the FREQUENCY RANGE selector. As the turret is rotated, the desired coil is positioned in the tuned circuit just below the oscillator tube and tuning capacitor, connections being made through large silverplated contacts mounted directly on the bottoms of the two stators of the tuning capacitor. Both ends of the tuning inductor and capacitor are at r-f and d-c potential, with no part of this circuit grounded.

4-9. The circuit diagram for the oscillator is shown in Figure 4-3. The oscillator tube, V-6, is operated across the -165-volt and +225-volt supplies with considerable series resistance to limit the maximum plate current that can flow. The plate is series-fed through a 3000-ohm resistor, R-45, which also serves to isolate the tuned circuit from r-f ground at C-15, while the cathode is returned to -165-volts through R-42 and R-43. Cathode by-pass capacitor C-25 is actually part of the tube mounting plate and is not visible when the plate is in position. R-42 prevents resonance in the cathode lead; R-43 in conjunction with R-45 limits the maximum plate current that can flow through V-6.



(a) R-F Generator Assembly



(b) With Cover Plate Removed

Figure 4-2. R-F Generator Assembly

4-10. Bias for the control grid is obtained across grid leak resistor R-44, which under usual conditions develops approximately 70 volts at the grid. C-16 couples the tuned circuit to the tube grid, r-f drive being determined by the ratio of grid-plate to grid cathode impedance. These impedances consist partly of inter-electrode capacity, shown as dotted components in the partial schematic diagram, and largely of lumped constants in the tuned circuit. The grid-plate capacity is shunted by the tuned circuit and a small trimmer capacitor C-18, while the grid-cathode capacity is shunted by trimmer capacitor C-59. Trimmer C-18 sets the minimum capacity of the tuned circuit and is used to adjust the high frequency limit of all bands when the oscillator tube is replaced. C-59 is an additional adjustment usually set for minimum capacity and requires no readjustment. This capacitor has minor effect on the grid drive at the high frequency ends of the bands and is usually set for maximum drive. C-68, the FINE FREQ. ADJ. control (included in signal generators with serial numbers 510 and above) adds a very small capacity to the existing capacity in the oscillator tank by rotating a small eccentric aluminum disk closer or farther from the stator of the main tuning capacitor.

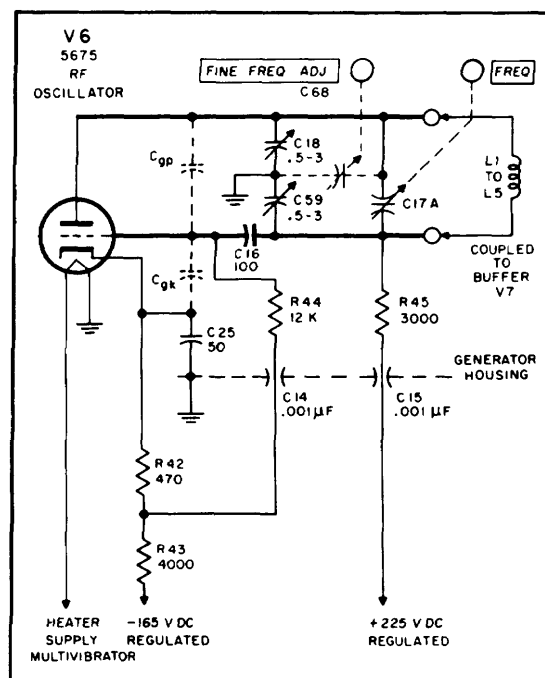


Figure 4-3. Schematic Diagram of Radio Frequency Oscillator

4-11. The inductances of the tuned coils are variable over a small range by adjusting a single shorted turn on each coil for the A, B, C, and D bands and by adjusting the size of the single loop for the E band. In models with serials below 204 the D band coil is adjusted the same as E band. These adjustments are used at the factory to set the low frequency limit of each frequency band.

4-12. Heater voltage for the oscillator tube is obtained from a multivibrator operated on regulated voltage to supply very stable heater power. All power to the oscillator tube is brought through the housing by special filters having very high attenuation of radio frequencies to prevent conduction of the r-f energy outside the instrument. The entire oscillator circuit is contained in the cast aluminum r-f generator assembly shown in Figure 4-2a. The tuned circuits are located in a lower front compartment, the other circuits in a tube compartment above. An inside view of the r-f generator assembly is shown in Figure 4-2b. The oscillator tube is mounted through the top of the tuning compartment so that the grid and plate elements project through the top plate into the tuning compartment, while the heater and cathode elements remain above the top plate. Mounting facilities are contained in the upper compartment, and the tube may be replaced from the upper compartment without entering the tuning compartment.

4-13. RADIO FREQUENCY BUFFER OPERATION.

(See Figure 4-4.)

4-14. A loosely-coupled secondary winding on each of the oscillator coils couples r-f energy from the oscillator to the buffer stage located in the tube compartment in the top of the r-f generator housing. The buffer tube, V-7, is a type 6BC4 miniature triode connected as an untuned, grounded-grid amplifier and serves to isolate the oscillator circuit from the effects of the modulation signal at the cathode of the power amplifier. The use of the buffer reduces incidental frequency modulation to an extremely small value.

4-15. The circuit diagram for the buffer is shown in Figure 4-4. For simplicity, the coupling coil for only the A band is shown in the schematic diagram in Figure 4-4. Although the buffer tube V-7 utilizes a large cathode resistor (R-116, 7500 ohms), it operates with practically zero bias and relatively high plate current. R-116 holds plate current constant for a wide range of tube characteristics and in conjunction with R-47, a dropping resistor in the plate supply lead, serves to limit plate current to safe values. R-117 in conjunction with C-64 and C-65 in the cathode circuit prevents transfer of r-f energy between the oscillator and buffer stages. R-112, mounted on the coil for the A band, damps unwanted resonance in the cathode lead. R-113, shunting the coupling coil, limits the somewhat greater r-f drive from this coil. The plate of the buffer is coupled to the cathode of the r-f amplifier through a wide-band, coupling network consisting of coil L-8 with damping resistor R-13, series coil L-9 with blocking capacitor C-29, and shunt peaking coils L-10 and L-11, shown in Figure 4-5. Resistors shunting the peaking coils are used as the forms for the windings. The resistor values are selected to damp the resonant peaks of the coils. For greatest stability of operation, heater power for the buffer is obtained from the regulated heater supply multivibrator V-17.

4-16. RADIO FREQUENCY POWER AMPLIFIER OPERATION. (See Figure 4-5.)

4-17. The radio frequency power amplifier, V-8, amplifies the r-f energy received from the buffer for application to the r-f output attenuator. The circuit consists of a 5876 "pencil" triode connected as a grounded

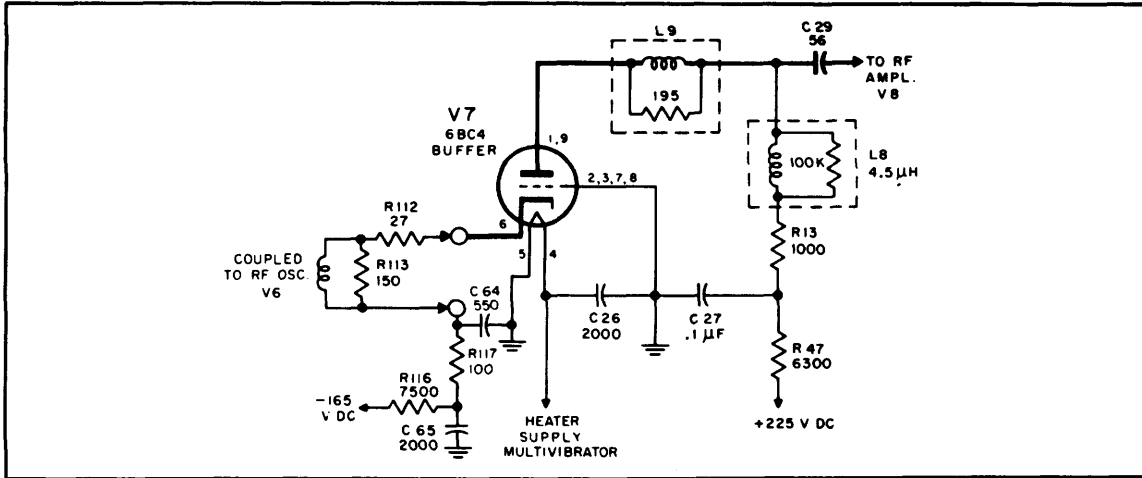


Figure 4-4. Schematic Diagram of Buffer Amplifier

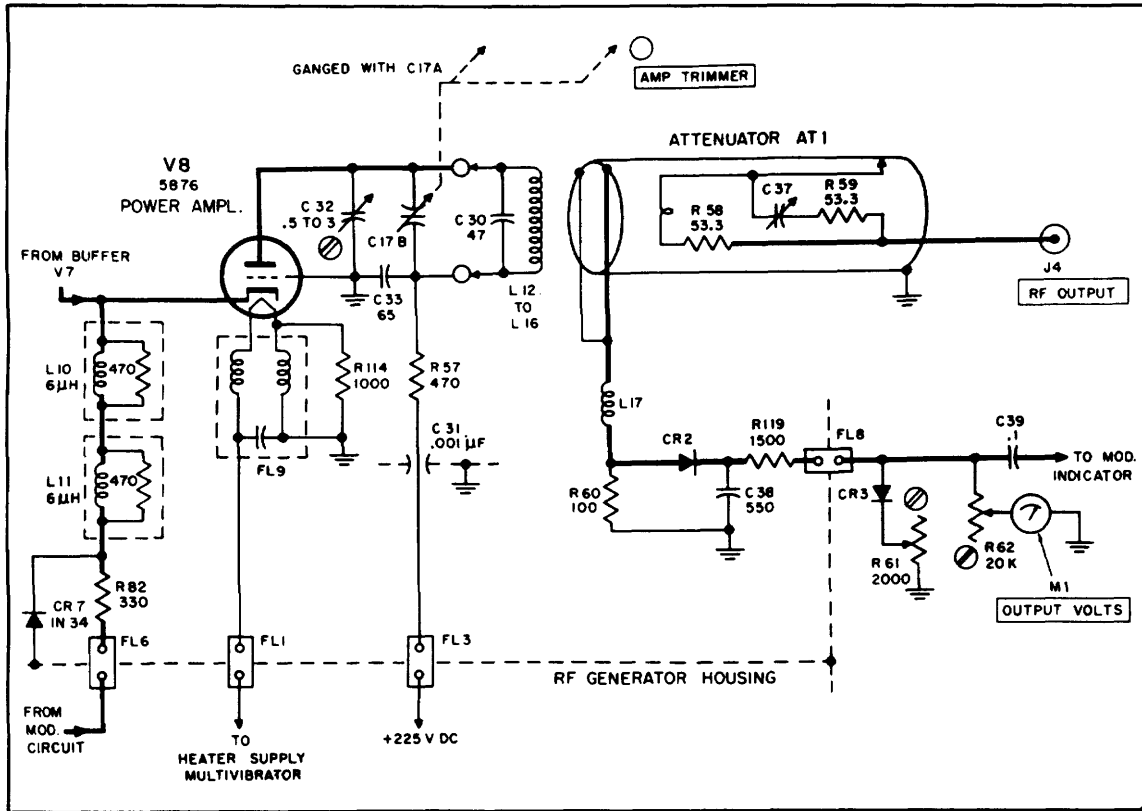


Figure 4-5. Schematic Diagram of Radio Frequency Power Amplifier

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grid, cathode-modulated amplifier. The plate circuit of the amplifier is tuned in the same manner as the oscillator, with a similar split-stator capacitor and five untapped coils mounted on a revolving turret. The amplifier tuning capacitor is ganged with the oscillator capacitor by a double-ended worm drive (see Figure 4-15). The amplifier capacitor is provided with a mechanical linkage, controlled from the front panel, to shift the rotor plates from their normal tracking position. This control allows the amplifier tuning to be separately adjusted for maximum output at all frequencies.

4-18. The coil mounting turret is also ganged with that of the oscillator. The coil in use is so located to be connected directly across the tuning capacitor stators and is inductively coupled to the output attenuator probe. Tuned coils are wound with copper wire on 1/2-inch diameter teflon forms.

4-19. The circuit diagram for the r-f amplifier is shown in Figure 4-5. The power amplifier tube is operated across the -165 and +225-volt supplies. The plate is series-fed from the +225-volt supply through decoupling filter R-57 and C-33. The cathode is returned through a portion of the wide-band coupling filter and resistors R-35 and R-36 to the -165-volt supply. R-36 matches the higher impedance of the cathode circuit of V-5 to the lower impedance of the cathode circuit of V-8, while R-35 is the cathode bias resistor. R-35 is also the cathode load resistor for control tube V-5, and the bias developed across R-35 is largely controlled by the current in V-5. The modulating signal is also developed across R-35 and with the bias voltage is fed to the cathode of V-8. Crystal diode CR-7, connected between the cathode return circuit and ground, limits the lowest potential to which the cathode can be driven. This arrangement protects V-8 from the effects of any negative switching transients which might be applied to its cathode. The plate tank is tuned by C-17B. C-32, a small trimmer capacitor across C-17B, sets the minimum capacity and is provided for adjusting the tracking of the highest frequency band so that minimum operation of the AMP TRIMMER control is required. The inductances of the tuned coils can be adjusted over a small range by means of metal sleeves between the cores and coils on the B, C, and D bands and by altering the winding shape and size on the A and E bands. These adjustments are set at the factory to track the low frequency end of each band with the frequency of the oscillator.

4-20. Heater supply voltage for the r-f amplifier is obtained from the regulated heater supply multivibrator. Filter FL-9 in the heater circuit reduces incidental frequency modulation by preventing leakage of modulating signals between the heaters of the oscillator and amplifier tubes. The tuned circuits of the r-f amplifier are contained in the rear compartment of the r-f generator housing (see Figure 4-2). The d-c circuits for the amplifier are located in the compartment above. The amplifier tube is mounted through the top of the tuning compartment so that the plate element projects through the top plate into the tuning compartment. The heater and cathode elements, and the mounting facilities, are in the upper compartment and the tube may be replaced without entering the tuning compartment.

4-21. OUTPUT ATTENUATOR AND R-F POWER MONITOR OPERATION. (See Figures 4-5 and 4-6.)

4-22. A piston attenuator is used to control the power obtained from the r-f power amplifier (see Figure 4-2b). The housing for the attenuator projects through the rear of the r-f generator housing and terminates, open-ended, close to the r-f amplifier plate circuit inductor. Figure 4-6 shows the front view of the pickup probe removed from the attenuator housing. The nonresonant, single-turn, pickup loop at the end of the attenuator probe couples energy to an impedance matching network, C-37, R-58, and R-59, mounted on the face of the probe and through a section of double shielded coaxial cable to the RF OUTPUT jack. Capacitor C-37 is actually a movable sleeve in the probe body which allows minor adjustment of the internal impedance of the generator so that a minimum standing wave ratio is obtained when the output jack is terminated in a 50-ohm resistive load.

4-23. The attenuator probe is positioned in its housing by a wire cable driven by a ball-bearing mounted pulley system coupled to the front panel attenuator dial. Cable tension is adjustable and is carefully set for minimum back-lash. Friction throughout the system has been reduced to as low a value as possible.

4-24. The r-f power level which is fed to the attenuator is sampled and continuously monitored by an antenna (two parallel wires crossing the open end of the attenuator housing) connected to a small detector assembly mounted under the housing inside the r-f amplifier

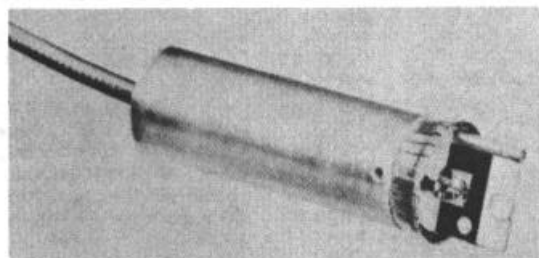


Figure 4-6. R-F Pickup Probe for Output Attenuator

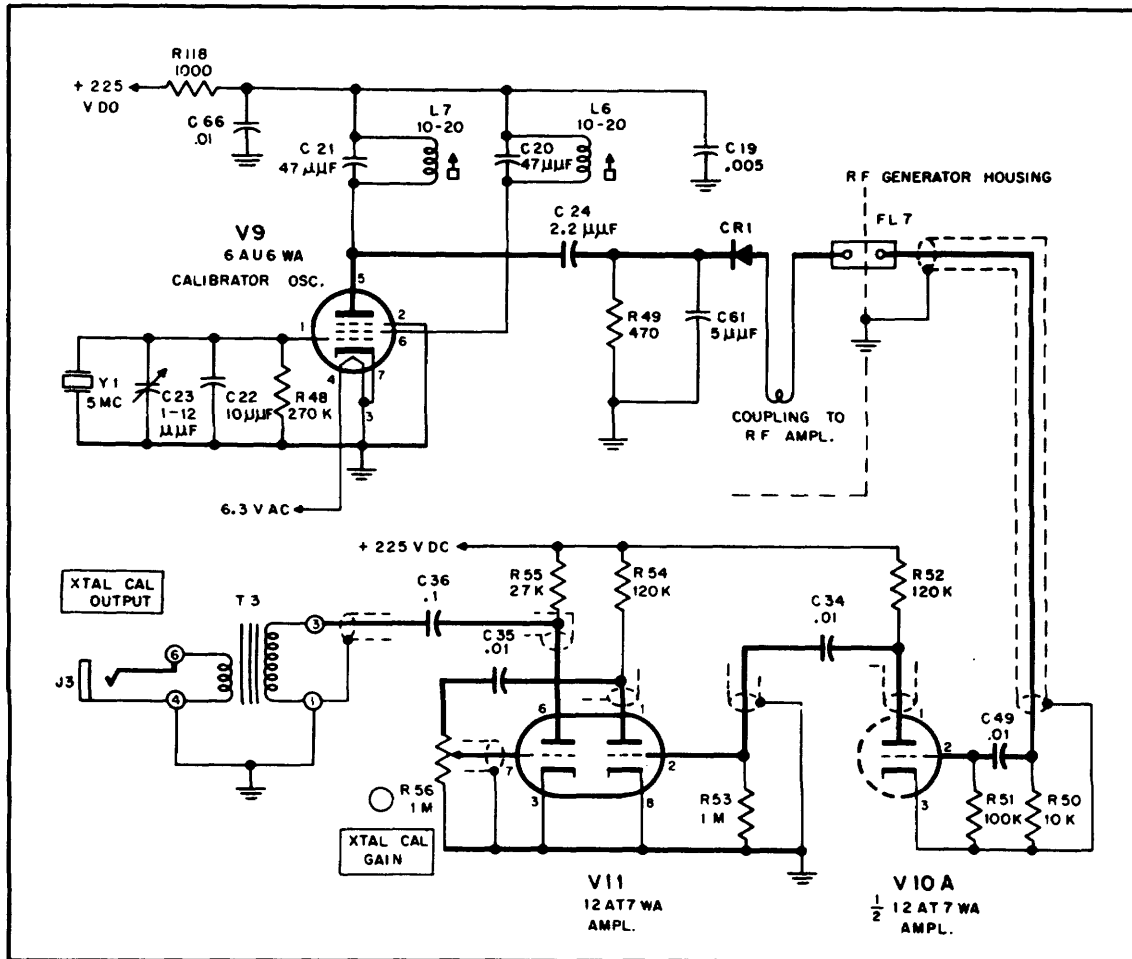


Figure 4-7. Schematic Diagram of Crystal Controlled Frequency Calibrator

tuning compartment (see Figure 4-2b). This power level is indicated in both volts and decibels, over a limited range, on the front panel power level meter. A calibration mark on the meter marked SET LEVEL establishes a predetermined amount of power fed into the attenuator housing for direct reading of the output attenuator dial calibrations.

4-25. Radio frequency energy is coupled from the power monitoring antenna to a crystal detector through L-17, a small coil used to adjust the frequency response of the detector circuit. Crystal diode CR-2 with return resistor R-60 rectifies the radio frequency energy and produces a d-c voltage equal to half the peak-to-peak r-f voltage; R-119 serves to flatten the frequency response of the circuit; C-38 and filter FL-8 remove the remaining r-f component and couple the d-c voltage to a compensating network, CR-3 and R-61. FL-8 is specially designed to attenuate all radio frequencies above approximately 3 megacycles and to pass all frequencies below that frequency with little or no attenuation. CR-3 corrects for non-linearities in detector

CR-2 when the r-f signal level is low and detection takes place in the non-linear region of the diode. The degree of compensation is set by potentiometer R-61 and is adjusted to obtain accurate down-scale readings on the front panel power level meter. M-1 is calibrated to indicate the rms value of the r-f output signal. Potentiometer R-62 adjusts the sensitivity of the meter and is set at the factory with accurate VHF power measuring equipment.

4-26. FREQUENCY CALIBRATOR OPERATION. (See Figures 4-7 and 4-7A.)

4-27. The frequency calibrator consists of a crystal controlled oscillator and mixer located in the r-f amplifier tuning compartment (see Figure 4-2b) and a 75 db resistance-coupled amplifier located on the side chassis of the instrument. The accuracy of the crystal oscillator is within *0.01% of 5 megacycles and allows the frequency dial calibration to be set "on frequency" very accurately at the check points. The calibrator is in continuous operation as long as the

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signal generator is turned on and is designed to operate into an earphone set having 600 ohms or greater impedance.

4-28. The circuit diagram for the complete calibration of Signal Generator TS-510/U is shown in Figure 4-7. For the circuit diagram of the complete calibrator for Signal Generator TS-510A/U refer to Figure 4-7A and paragraph 4-29A. The crystal oscillator uses a type 6AU6WA miniature pentode connected as an electron-coupled oscillator, having both the plate and screen circuits tuned to the crystal frequency of 5 megacycles. Limited adjustment of the crystal frequency is provided by trimmer C-23 connected across the crystal. The calibrator frequency is coupled from the plate of the oscillator through blocking capacitor C-24 to the cathode of mixing diode CR-1. The signal from the r-f power amplifier is inductively coupled to the anode of the mixing diode by running the anode lead of the diode close to the r-f amplifier circuits. Harmonics of the calibrator are generated in the crystal and mixed with the r-f signal to produce beat-frequency signals across R-50.

4-29. Beat-frequency signals from the mixing diode are taken through r-f filter FL-7 in the r-f generator housing to a conventional three-stage resistance coupled amplifier consisting of V-10 and V-11, high- μ twin triodes connected in cascade and located on the lower, right chassis. Only one-half of V-10 is used, the remaining half being grounded. Due to the extremely high gain of the amplifier (approximately 80 db), grounding of the input circuits is extremely critical. It is

important that the load resistor (R-50) for mixer diode CR-1 and the cathode, and the grid return resistor (R-51) for V-10 are not grounded near the tube socket but are connected to the shield of the input cable which, in turn, is grounded at the r-f generator housing, as shown on the schematic diagram. Potentiometer R-56 in the grid circuit of the last amplifier stage controls the volume of the beat frequency output signal. The signal from the output stage is coupled through a 600-ohm line matching transformer T3 to the front panel EXT CAL. OUTPUT jack.

4-29A. The circuit diagram for the complete calibrator of Signal Generator TS-510A/U is shown in Figure 4-7A. The crystal oscillator uses the pentode section of a type 6U8 electron tube connected as an electron-coupled oscillator, having both the plate and screen circuits tuned to the crystal frequency of 5 megacycles. Limited adjustment is provided by trimmer C-23 connected across the crystal. The calibrator frequency is coupled from the plate of the oscillator through blocking capacitor C-24 to the cathode of the mixing diode CR-1. The signal from the r-f power amplifier is inductively coupled to the anode of the mixing diode by running the anode lead of the diode close to the r-f amplifier circuits. Harmonics of the calibrator are generated in the crystal and mixed with the r-f signal to produce beat-frequency signals across R-50.

4-29B. The triode section of the 6U8 supplies an output frequency of 1 megacycle when switch S-2 is in

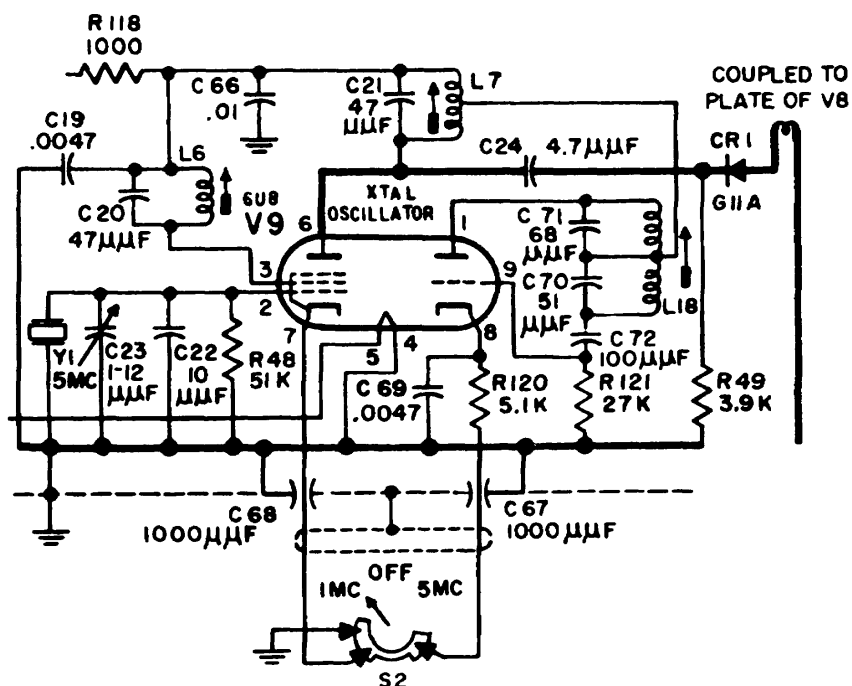


Figure 4-7A. Schematic Diagram of Crystal Controlled Frequency Calibrator TS-510A/U

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the 1 MC position. This output is then coupled to the cathode of the mixing diode CR-1. The plate circuit is tuned to the fifth sub-harmonic of the pentode section by L-18. This results in a 1 megacycle output with an accuracy equal to the accuracy of the pentode section.

4-30. MODULATOR SECTION OPERATION. (See Figures 4-8, 4-9, and 4-10.)

4-31. The purpose of the modulator section is three-fold: To generate 400- and 1000 cycle sine waves for internal modulation of the generator; to amplify the bias on the r-f amplifier tube. The modular consists of a resistance -tuned oscillator, V-2 shown in Figure 4-8, a

limiter and single-stage video amplifier, V-1 and V-3, shown in Figure 4-9; and a cathode follower output stage and output level control tube, V-4 and V-5, shown in Figure 4-1. The modulator circuits are located along the upper portion of the right side chassis; the oscillator on the bottom portion.

4-32. The modulation oscillator is a resistance-tuned sine wave generator of the Wein Bridge type. Basically, the circuit consists of a two-stage resistance-coupled amplifier which is caused to oscillate by the use of a frequency-selective positive feedback circuit. At the resonant frequency there is no phase

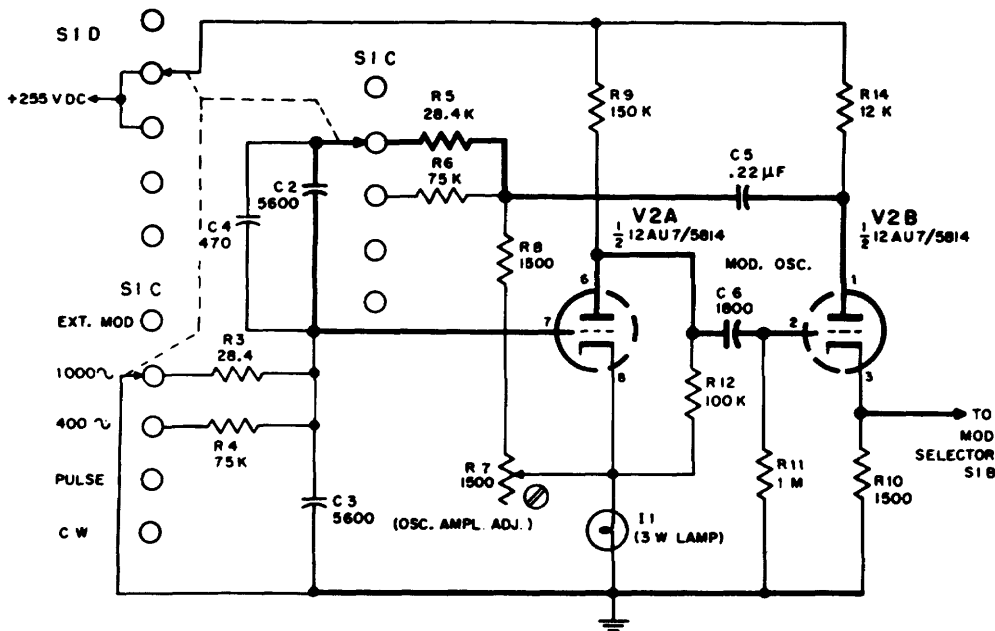


Figure 4-8. Schematic Diagram of Modulation Oscillator

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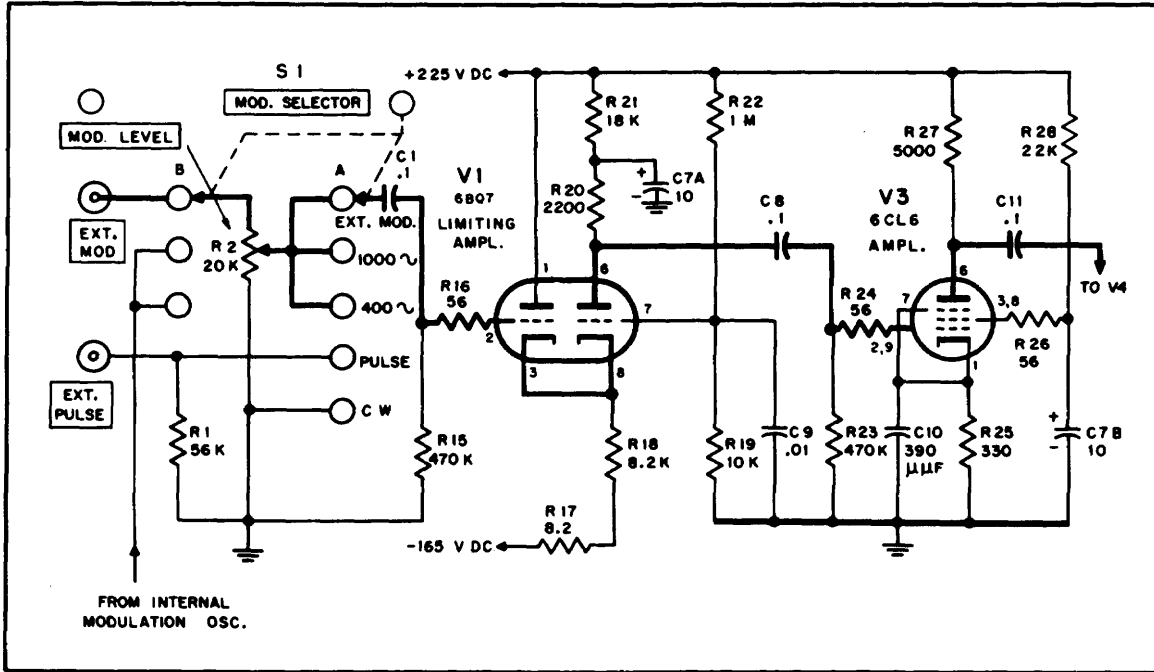


Figure 4-9. Schematic Diagram of Modulation Limiter and Amplifier

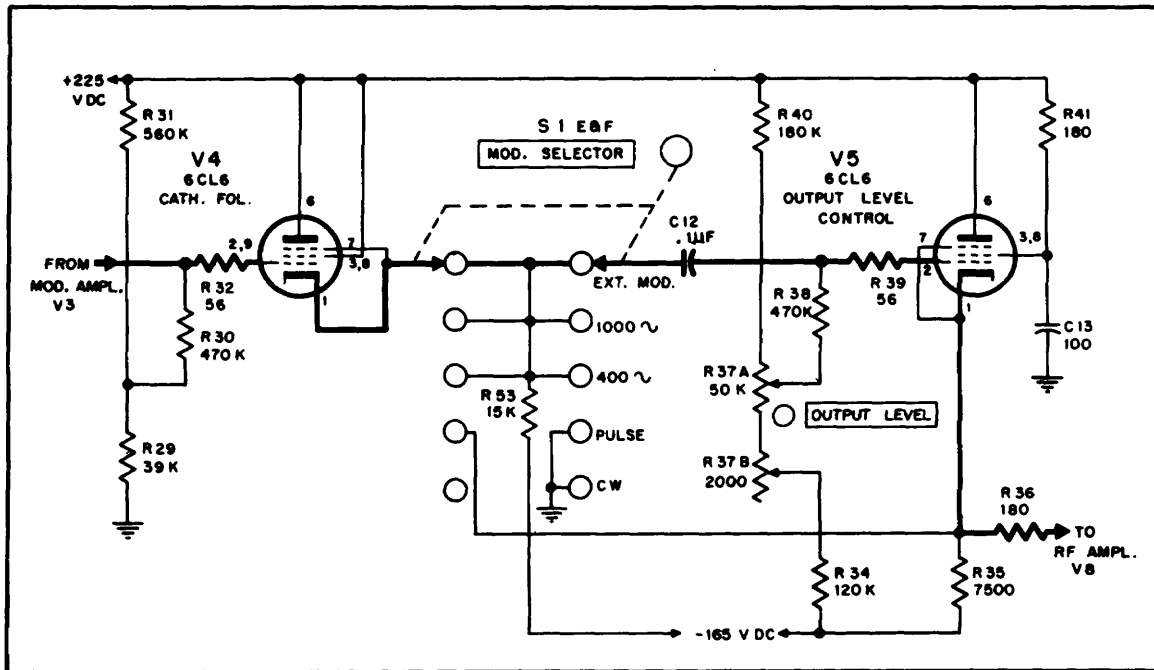


Figure 4-10. Schematic Diagram of Modulation Cathode Follower and Output Level Control Tube

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shift in the positive feedback circuit, so that a voltage of the resonant frequency on the grid of the first tube is reinforced by the output of the second tube and oscillation occurs. The two frequencies of operation are obtained by switching two different sets of resistors, R-3 and R-5 or R-4 and R-6, into the positive feedback network when the MOD. SELECTOR is turned from 400~ to 1000~. Precision resistors having good stability are used in the tuned circuit. Capacitors C-2, C-3, and C-4 comprise the remainder of the tuned circuit. In addition to the positive feedback network, a negative feedback circuit is also used to stabilize the oscillator, reduce distortion, and to maintain a constant output level. This circuit consists of a 3-watt lamp, I-1, used as a thermal resistance element having a positive temperature coefficient, composition resistor R-8 and amplitude adjusting potentiometer R-7. The high positive temperature coefficient of the lamp provides automatic amplitude control of the signal, for if the amplitude of oscillation tends to increase, the current through the lamp tends to increase, thereby increasing the lamp's resistance. Consequently, the negative feedback tends to increase and amplitude of oscillation is maintained constant. The amplifier portion consists of two medium- μ triodes, V-2A and B, in a conventional resistance-coupled circuit with the output voltage being obtained from the cathode of the second stage. Although heater voltage is applied to the oscillator at all times the instrument is in operation, plate voltage is applied to V-2 only when the MOD. SELECTOR switch is in the 400- or 1000-cycle position.

4-33. The sine wave signal from the modulation oscillator or from an external signal source is coupled through the MOD. LEVEL control to the limiter tube V-1, a 5670 twin triode, then to video amplifier V-3, a type 6CL6 pentode. The purpose of V-1 is to limit the peak amplitude of modulating pulses, since for pulse modulation the input signal is fed directly to the grid of the limiting amplifier without passing through the MOD. LEVEL control. The limiting action of V-1 begins at approximately +2 volts peak which is considerably more than that required for 100% modulation of the output signal. Consequently, signals producing less than 100% modulation pass through the limiter unchanged. Limiting effectively squares the top of an incoming positive waveform above approximately 5 volts without affecting its rise and fall or introducing transients. The uninverted signal from amplitude limiter V-1 is then amplified approximately 18 db by V-3, a resistance-coupled 6CL6 pentode voltage amplifier, and coupled to output cathode follower V-4.

4-34. The modulating signal from the limiter and amplifier, is fed to output cathode follower V-4, a triode-connected type 6CL6 pentode. For sine wave modulation the signal from the cathode of V-4 is coupled through switches S-1E and S-1F to the grid of the output level control tube V-5 and superimposed on the variable bias voltage. The cathodes of both V-5 and the r-f power amplifier V-8 are connected together and returned to the -165-volt supply through resistor R-35. Any signal placed on the grid of V-5 is, therefore, directly coupled from the cathode of V-5 to the cathode of the r-f power amplifier V-8. The d-c voltage level established at the cathodes of the two tubes is

determined largely by the current flowing in V-5. The current in V-5 is controlled by the dual potentiometer voltage divider, R-34, R-37A and B, and R-40, in the grid circuit. The cathode bias for V-8, and consequently the r-f output power, is varied by front panel output level potentiometers, R-37A for coarse adjustment and R-37B for fine adjustment.

4-35. The cathode of V-4 is connected by the MOD. SELECTOR switch directly to the cathode of V-5 for pulse modulation operation. The additional current drawn by V-4 through common cathode resistor R-35 produces a sufficiently high voltage to cut off the r-f amplifier and reduce the r-f output to zero. The modulating pulses are not applied to the grid of V-5, and it now serves only to control the peak level of the r-f output pulse. Negative modulating pulses at the grid of V-4 (the positive input pulse having been inverted in V-3) cut off V-4 and allow the cathode potential to return to the level set by V-5 which establishes an r-f output level equal to the CW level as indicated on the output level meter. A pulse of r-f energy having an envelope shaped like the modulating pulse is then formed.

4-36. MODULATION-MEASURING CIRCUITS OPERATION. (See Figures 4-11 and 4-12.)

4-37. The modulation measuring circuits in the TS510A/U indicate the degree of sine modulation of the r-f output signal directly in percentages between 0 and 100% to an accuracy of 10% or better. These circuits consist of a stabilized wide-band amplifier and a bridgetype meter circuit. The circuit amplifies the detected modulation from the r-f power monitor circuit, rectifies it and applies the resultant d-c voltage to the meter bridge. Being a peak reading circuit, the meter indicates the percent modulation of most waveforms (square-wave, saw-tooth, etc.) that are applied to the EXT. MOD. jack. The meter is calibrated to indicate the percent modulation of a given amount of r-f carrier power, the amount established by SET LEVEL on the output level meter. The percent modulation indication is accurate for all settings of the output attenuator from 0 dbm down.

4-38. The circuit diagram for the stabilized amplifier, shown in Figure 4-11, consists of two conventional resistance-coupled type 6AH6 pentodes, V-18 and V-19. The circuit is stabilized by negative feedback and provides approximately 22 db gain to approximately 2 megacycles. The feedback loop covers both stages, the feedback signal being coupled from the plate of the second stage through dropping resistor R-99 and blocking capacitor C-55 to the cathode of the first stage. The circuit diagram for the bridge circuit is shown in Figure 4-12 and consists of diode rectifier V-20 and twin-triode V-21, the two triodes constituting two legs of the meter bridge. With no modulation signal applied to the amplifier, the steady-state d-c potential at the plate of amplifier V-19 is coupled to the grids of both triodes of V-21. With equal current flowing in the two sides of the bridge, the bridge is balanced and the meter reads zero. Potentiometer R-106 is a front panel zero adjustment of the bridge that provides for variations in tube characteristics in the two sides of the bridge.

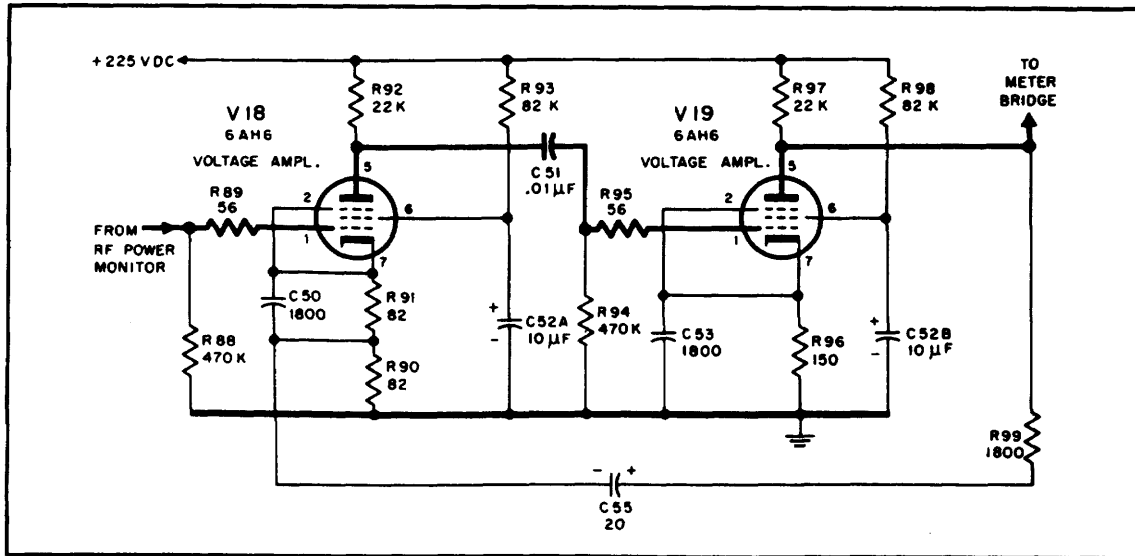


Figure 4-11. Schematic Diagram of Modulation Indicator Amplifier

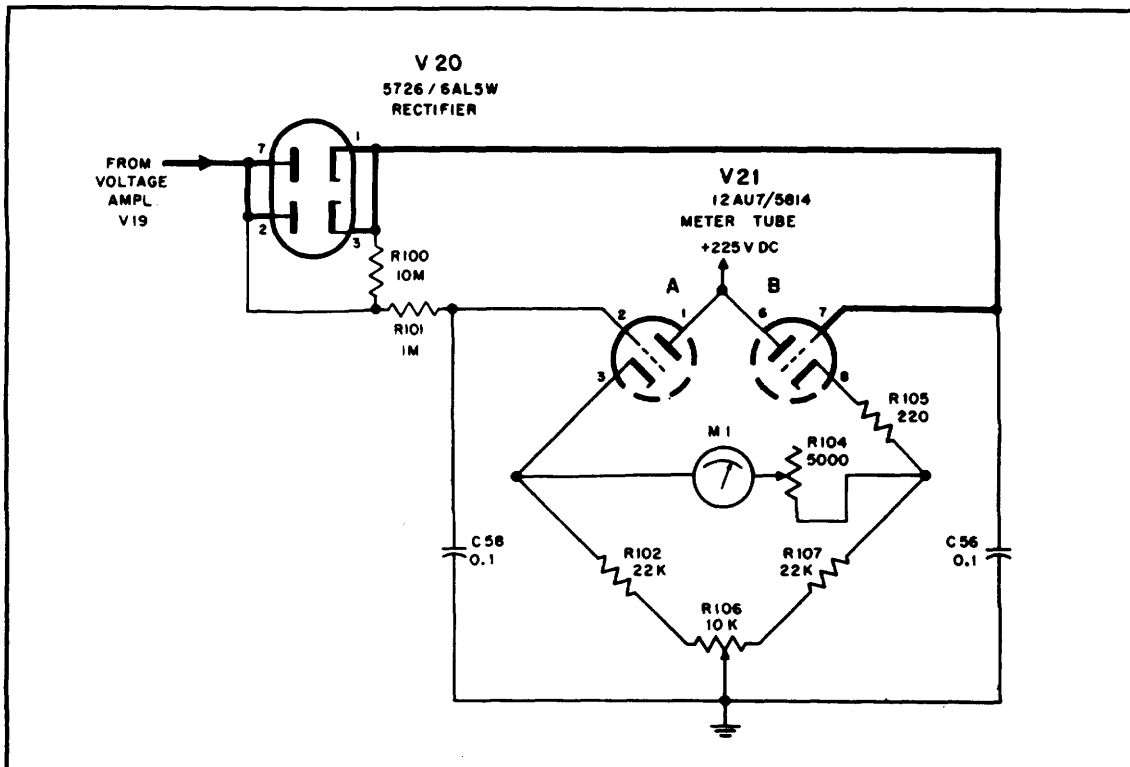


Figure 4-12. Schematic Diagram of Modulation Meter Bridge and Rectifier

4-39. The modulation signal from amplifier V-19 is rectified by diode V-20, and the peak value of the rectified voltage is applied to the triode in one leg of the bridge, unbalancing the bridge and causing the meter to read upscale. The triode in the other leg of the bridge is unaffected by the modulation signal as the signal is filtered out by resistor R-101 and by-pass capacitor C-58. Potentiometer R-104 sets the sensitivity of the meter and is adjusted for correct calibration of the meter.

4-40. POWER SUPPLY. (See Figure 4-13.)

4-41. The power supply for the signal generator consists of two electronically regulated high voltage supplies, one providing -165-volts dc, the other providing +225-volts dc, with the chassis at zero potential. Each regulator is supplied from a full-wave bridge-type selenium rectifier with a separate high voltage winding on the power transformer. The power transformer also supplies a-c voltage for all electron tube heaters except the r-f oscillator and power amplifier. The primary winding of T1 is divided into two parts and may be operated in series for 230-volt lines or

in parallel for 115-volt lines at a frequency of 50-1000 cycles. Transformer T1 of Signal Generator TS-510A/U can be operated only from 115-volt lines at a frequency of 50-420 cycles. The output of each regulated supply is adjusted by screwdriver adjusted potentiometers R-80 and R-71 on the rear instrument chassis. The +225 volt supply uses the -165 supply for a reference voltage; consequently, a change in the -165-volt also affects the output from the +225-volt supply.

4-42. The two regulated power supplies are identical in operation, therefore, only the -165-volt supply will be discussed. Figure 4-13 shows the complete schematic for both supplies. V-14, V-15, and V-16A constitute the voltage regulator circuit for the -165-volt supply. V-15 is a constant-voltage tube which provides a reference bias for voltage amplifier V-14. V-16A, the regulator tube operates as a variable resistor controlled by the voltage at the grid of V-14. If the output from the cathode of V-16A tends to increase, the voltage at the grid of V-14 tends to increase, causing V-14 to draw more current. This lowers the plate

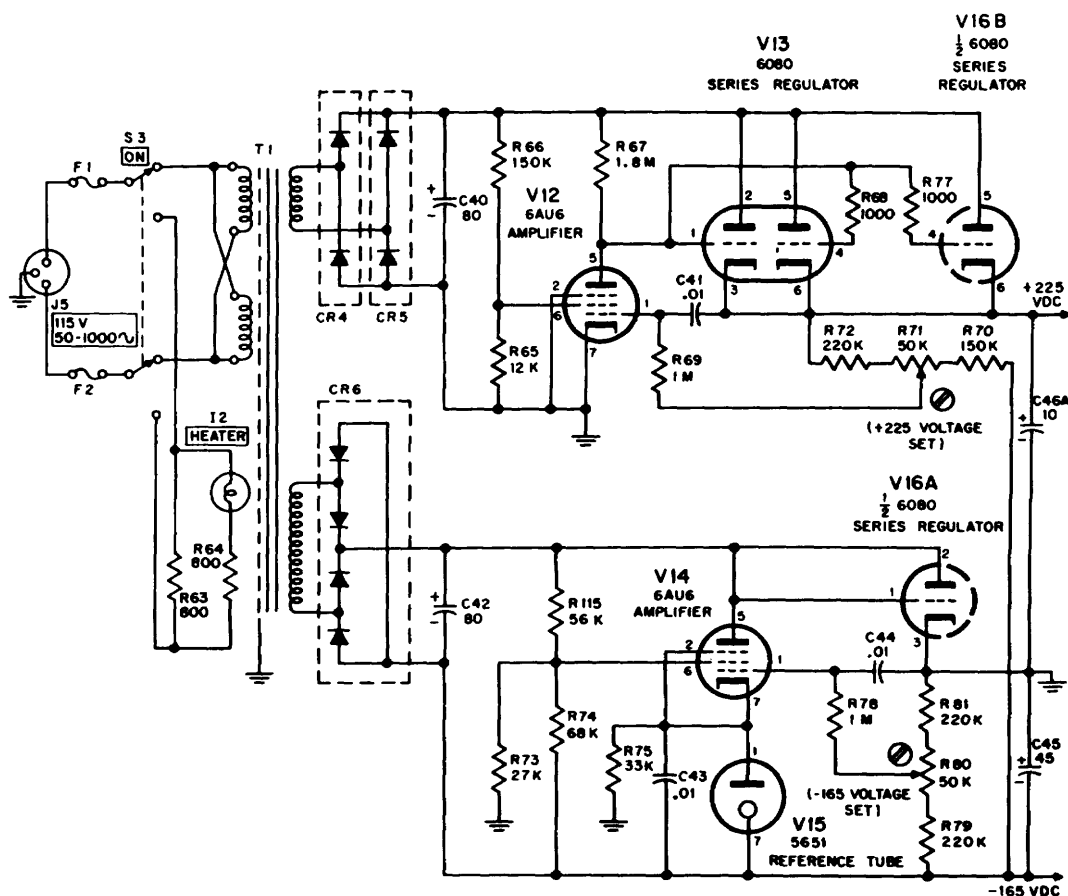


Figure 4-13. Schematic Diagram of Regulated Power Supplies

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voltage of V-14 and, consequently, the grid voltage of V-16A, resulting in a greater plate resistance for V-16A. The greater plate resistance causes a greater voltage drop across V-16A, instantaneously compensating for the increased voltage at its cathode and resulting in a substantially constant voltage output. If the regulated output tends to decrease, the reverse of the above action occurs, also tending to maintain the cathode voltage constant. Ripple in the output voltage is coupled to the grid of V-14 by capacitor C-44, while slower variations in the d-c level are fed to the grid of V-14 through voltage divider R-79, R-80, and R-81. The bias for V-14, and thus the output voltage level from V-16A, is determined by the setting of R-80.

4-43. The operation of the +225-volt supply is identical to the -165-volt supply but due to the greater current required (approximately 150 ma), three regulator tubes (V-13A and B, V-16B) must be used in parallel. The reference voltage for the +225-volt supply is obtained directly from the -165-volt supply.

4-44. HEATER SUPPLY MULTIVIBRATOR (See Figure 4-14.)

4-45. Constant heater voltage is supplied to radio frequency tubes V-6, V-7, and V-8 by a free-running multivibrator operating on the +225-volt regulated supply. The multivibrator develops square waves that are substantially constant in amplitude because the plate voltage excursion is limited by the +225-volt supply and the maximum conductivity of the tube. The type 5687 has sufficient conductivity to cause the plate voltage to fall approximately 25 volts during the negative half cycle. The multivibrator, which operates without bias, is grid-plate coupled and produces symmetrical waves. Transformer T2 couples the output of the multivibrator to heater circuits within the r-f generator housing. Potentiometer R-87 is used to adjust the plate voltage of V-17 and thereby acts to control the applied filament voltage for V-6, V-7, and V-8. Resistors R-84 and R-85, in the grid circuit of the two triodes, prevent grid loading of the opposite plate circuits while the grid is in the positive part of its cycle. R-83 and R-86 are the grid return resistors. The schematic diagram for the heater supply multivibrator is shown in Figure 4-14.

4-46. OPERATION OF MECHANICAL COMPONENTS.

4-47. FREQUENCY DRIVE MECHANISM. The frequency drive mechanism operated by the front panel FREQ. control tunes the r-f oscillator and amplifier plate circuits over the frequency range of the signal generator. The FREQ. knob turns a double-ended worm drive screw which meshes separately to both the oscillator and the power amplifier tuning capacitors in the r-f generator assembly. The drive screw is in two parts. The front part meshes with the oscillator drive, turning only with the FREQ. drive knob, and terminates in a sliding type coupling to the amplifier drive screw. The rear portion of the drive screw turns with the FREQ. drive knob but also can be driven an additional amount on either side of the FREQ. dial setting by the AMP. TRIMMER control. The AMP. TRIMMER control connects only to the back half of the double-ended

worm drive screw and shifts it longitudinally along its axis about 3/8 of an inch. This shifting moves the amplifier capacitor sufficiently to allow the amplifier capacitor to be manually tuned to the oscillator frequency for maximum output across the entire frequency range.

4-48. The frequency drive screw and the drive shafts to both tuning capacitors are full ball-bearing mounted. The "stop" gear for the frequency drive screw is located to the front of the casting and consists of a second gear having one less tooth than its driving gear. The stop gear has one eccentric tooth and the driving gear one solid tooth. As the driving gear turns, the stop gear follows until the eccentric tooth meets the solid tooth and stops. The number of teeth and the number of solid teeth determines the number of turns possible before stopping.

4-49. ATTENUATOR DRIVE SYSTEM. The output attenuator adjusts the level of the signal obtained at the RF OUTPUT jack. The attenuator consists of a piston type pickup probe mounted in a cylindrical waveguide housing which terminates close to the r-f amplifier plate tank. The probe is positioned in the waveguide housing by a flexible cable driven by the front panel attenuator knob. Turning the attenuator control turns a drum at the rear of the r-f generator housing. The flexible cable on the drum feeds around three pulleys and carries the attached attenuator probe along the length of the waveguide housing. All pulleys are ball-bearing mounted and the position of one pulley is adjustable in order to tighten the drive cable. The pulley system as seen from the rear of the r-f generator housing is shown in Figure 5-7 in the following section.

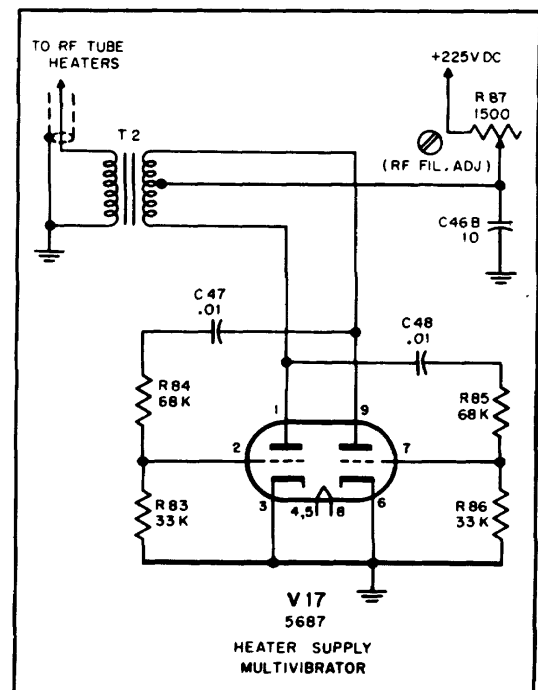


Figure 4-14. Schematic Diagram of Heater Supply Multivibrator

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4-50. The attenuator drive is designed for linear probe travel down the waveguide housing. The waveguide housing is a small diameter operating beyond cut-off over the frequency range of the signal generator. The r-f power level within such a waveguide falls off at an

exponential rate. The combination of linear probe travel and exponential power decrease permits the attenuator dial to be calibrated linearly in decibels and exponentially in voltage. Details of the pickup probe will be found in paragraph 4-22.

SECTION V

ORGANIZATIONAL AND SQUADRON MAINTENANCE

5-1. INTRODUCTION.

5-2. The trouble shooting data in this section will enable an alert and careful operator to locate and service a majority of tube failures and accomplish simple repairs in the TS-510A/U Signal Generator. Paragraph 5-5, Minimum Performance Standards, provides a quick check on the overall performance of the signal generator and, in so doing, isolates troubles to sections of the instrument using only a headphone set and the front panel meters for testing. Paragraph 5-10, Power Supply Trouble Shooting and Adjustments, includes a trouble shooting chart which locates most troubles that may occur in the power supply and indicates the adjustments that are necessary following certain repairs. A chart listing all electron tubes with adjustments required following tube replacement is also included. The servicing in this section requires a reliable 5,000 ohm/volt multimeter or better for voltage measurement and requires only that the signal generator be removed from the cabinet; no further disassembly is necessary. The circuits of the TS510A/U Signal Generator occupy easily defined areas and are immediately accessible. The material in this section is outlined below.

- 5-3 Cabinet Removal.
- 5-5 Minimum Performance Standards.
- 5-10 Power Supply Trouble Shooting and Adjustment.
- 5-14 Replacing Electron Tubes.
- 5-16 Minor Repair and Replacement.
- 5-19 Lubrication.
- 5-21 Inspection Schedule.

5-3. CABINET REMOVAL. (See Figure 5-1.)

5-4. To remove the cabinet from the TS-510A/U Signal Generator, place the instrument face down to rest on the guardrail handles. Loosen the four captive screws on the rear of the cabinet. Lift cabinet off instrument chassis.

5-5. TROUBLESHOOTING THE TS-510A/U.

5-6. The first step in servicing the signal generator is to visually inspect the instrument chassis with the instrument operating. Watch for signs of short circuits, such as excessive heat dissipation, burned or discolored components, etc. Be alert for any signs of damage or misuse. Note condition of tubes, if firmly seated and lighted. A "dead" tube may be quickly spotted if it is not lighted or is cold.

5-7. The test procedure given in Table 5-1 will enable the operator to make a broad, quick check on the overall operation of the TS-510A/U Signal Generator using only front panel meter indications and a headphone set connected to the front panel XTAL CAL. OUTPUT jack. In analyzing any trouble symptom, the power supply voltages should be considered as a possible trouble source and should be checked as described in Paragraph 5-11.

5-8. When troubleshooting the TS-510A/U, isolate the trouble to one of the main sections, the r-f generator assembly, the r-f power monitor, the modulator, the modulation indicator, the calibrator, or the power supply. Analyze the nature of the trouble symptom that is

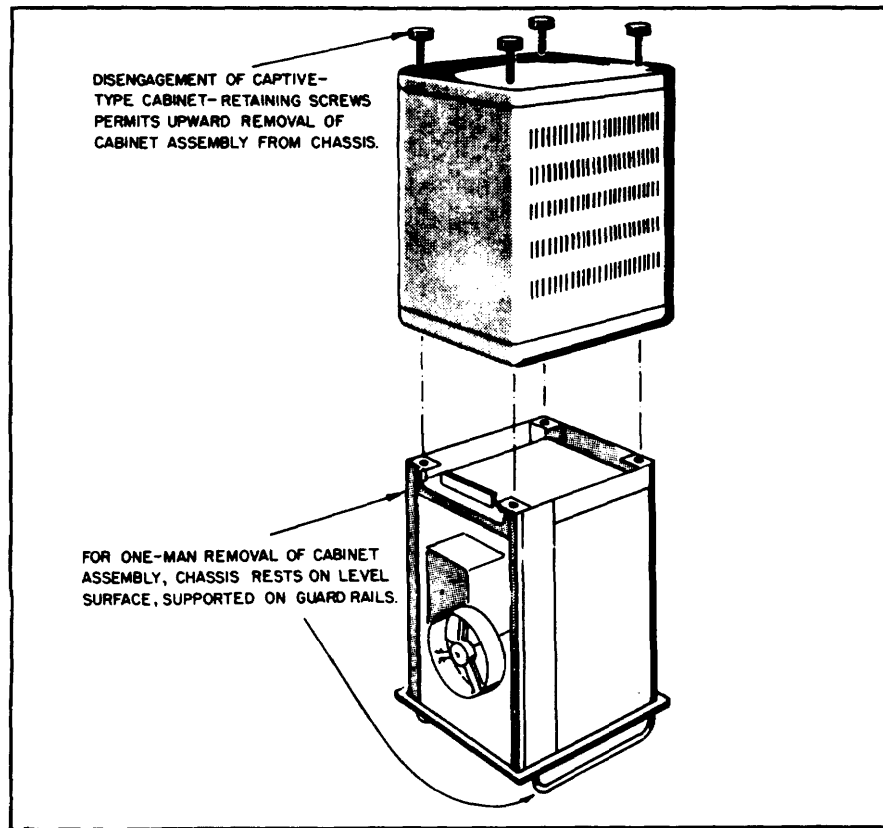


Figure 5-1. Cabinet Removal

observed. In many cases, the symptom will point directly to one section at fault. For example: If no output is obtained on only one band, other bands being normal, it is logical to assume the trouble to be in a coil or switching contacts for that one band. If normal output is obtained but cannot be modulated, the trouble is in the modulator section. If modulation can be obtained but without indication on the percent modulation meter, the modulation indicator section is at fault, etc. The following table will assist with isolating trouble in this manner. To make the tests in Table 5-1, connect the signal generator to a power source, set the front panel controls as follows and proceed with the checks listed in Table 5-1:

Power Switch	ON
MOD. SELECTOR	Begin on CW
FREQUENCY RANGE	Begin on A range
Frequency Control	Begin at low frequency end of frequency dial scale
OUTPUT LEVEL	Begin with mid-range setting
AMP TRIMMER	Tune for maximum reading on OUTPUT VOLTS meter at each frequency tested.
MOD. LEVEL	Begin with minimum setting

XTAL CAL. GAIN
Output Attenuator

Maximum CW position
Not required for this check; however, if signal generator is used with external equipment, set attenuator to obtain convenient indication on external equipment

5-9. An indication of r-f output can be obtained on the OUTPUT VOLTS meter with only the power supply and r-f generator sections operating. Such a reading shows that the oscillator is producing a signal that passes through the buffer and power amplifier to the power monitor; if no reading can be obtained, the fault would logically lie in these circuits.

a. If the power output is limited, V6, V7 or V8 may be suspected of being weak. However, because replacing and readjusting the r-f oscillator and amplifier tubes is complicated, replacement is not recommended for organizational personnel or inexperienced technicians (see Section VI).

b. If the CW output power cannot be reduced to minimum or if control is not possible, the trouble lies in the circuits of the output level control tube V5.

Table 5-1. Minimum Performance Standards Check Chart

Test	Normal Indication	Paragraph Reference
Set controls as indicated in paragraph 5-3 and proceed as follows:		
1. Noting the reading on the OUTPUT VOLTS meter, increase OUTPUT LEVEL control from min to max at various frequencies throughout range of the signal generator. Peak the AMP. TRIMMER for each frequency.	Should be able to obtain a reading from near 0 to full scale at all frequencies.	See paragraphs 5-9 "a" and "b".
2. Using the earphone set and XTAL CAL OUTPUT, note beat frequency check points at various frequencies across range.	Should be able to set frequency dial "on frequency" at all check points using the index shifter control.	See paragraph 5-9 "a". If beat-frequency signals are not obtainable, see paragraph 5-9 "c".
3. Set the MOD. SELECTOR to PULSE.	OUTPUT VOLTS meter should read near zero.	If meter does not read near zero, trouble lies in the circuitry of V4.
4. Set the MOD. SELECTOR to EXT. MOD., then to 400~, then to 1000~.	OUTPUT VOLTS meter should give same indication as for CW operation.	
5. Noting the reading on the PERCENT MODULATION meter, increase the MOD. LEVEL control with the MOD. SELECTOR in both the 400~ and 1000~ positions.	Should be able to obtain 0 to 95% reading with both modulation frequencies. Should also be able to hear the modulation tone in the headset connected to the XTAL CAL. OUTPUT jack.	If necessary, zero set the mod. meter using the front panel zero set control. If modulation is not indicated, see paragraph 5-10.

c. If beat frequency signals are not obtainable from the XTAL CAL. OUTPUT jack, check the output of the calibrator oscillator and mixer circuits by measuring the d-c voltage at the output terminal of F17 (see Figure 6-11). The normal voltage at this point is 1-1/2 to 2-1/2 volts. No voltage or very low voltage indicates a fault in the oscillator circuit, V9. If this voltage is normal, check the calibrator amplifier circuits, V10 and V11.

d. If no signal is available at the RF OUTPUT jack, measure the resistance between the center terminal of the output jack and ground. The resistance should be 53 ohms. If it is not, there is a fault in the output attenuator circuit; however, due to the complexity in repairing the attenuator this operation is not recommended for organizational personnel (see Section VI).

5-10. An indication of modulation obtained on the PERCENT MODULATION meter indicates that the entire signal generator is operating.

a. If, with a satisfactory indication of r-f output on the OUTPUT VOLTS meter, no reading is obtained on the PERCENT MODULATION meter, the fault may lie in three places: The modulation indicator section, the internal modulation oscillator, or the modulator itself.

b. If the PERCENT MODULATION meter gives no indication, but the modulation can be heard in headphones connected to the XTAL CAL. OUTPUT jack, check the modulation meter amplifier and bridge tubes V18 through V21.

c. If neither meter responds to this test, check the internal modulation oscillator V2 by measuring the a-c signal voltage at pin 3 of V2, then pin 3 of V1, with the MOD. SELECTOR in the 400% position and the MOD. LEVEL control set to max. The signal level at both points should be 2 volts rms and may be adjusted by potentiometer R7.

d. If this signal is satisfactory, the trouble lies in the modulator V1, V3 or, to a lesser degree, V4.

5-11. POWER SUPPLY TROUBLE SHOOTING AND ADJUSTMENT.

5-12. Table 5-2 systematically locates troubles in the power supply section using a reliable 5,000 ohm/volt multimeter or better to measure the indicated voltages. The point at which a voltage and resistance is to be measured is listed in column 1 and is illustrated in Figure 5-3. A correct voltage reading obtained from the second column indicates the particular circuit tested to be operating properly and may be passed by. An incorrect or unstable voltage indication

Section V
Paragraphs 5-13 to 5-18

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Table 5-2. Power Supply Trouble Shooting Chart

Measure Voltage at:	Normal Indication	Service Note
1. T1 (Fig. 6-16)	6.3 volts ac rms	This voltage will read between 6.2 and 6.3 volts rms when the line voltage is 115 volts. A noticeably higher or lower voltage indicates that the line voltage is significantly more or less than 115 volts.
2. C45 (Fig. 5-3)	-165 volts dc (regulated)	This is a stable regulated voltage accurately adjusted by R80. If this voltage is significantly high, low, or erratic, check voltage across V15 which should be a steady 150 volts. For excessively high output, check V14; for too low output, check V16A and the voltage applied to V16A shown in Figure 5-3. A weak selenium rectifier CR6 which supplies low voltage to the regulator will cause unstable operation of the regulator.
3. Resistor Board (Fig. 5-3)	+225 volts dc (regulated)	This is a stable regulated voltage accurately adjusted by R71. If this voltage is significantly high, check V12; if too low, check V13 and the voltage applied to V13 shown in Figure 5-3. A weak selenium rectifier CR4 or CR5 which supplies low voltage to the regulator will cause unstable operation of the regulator.
4. T2, Terminal 4 (Fig. 5-3)	7.6 volts as read on average responding meter calibrated in rms volts.	This is a stable square wave voltage that must be measured by an average reading meter calibrated in rms volts and is accurately adjusted by R87. This voltage is applied only to the three r-f tubes within the r-f generator housing. If this voltage is significantly high (8 volts), one of the r-f tube filaments may be open or the heater supply multivibrator is far out of adjustment.

should be corrected as instructed in the service note in the last column. All voltages are measured from chassis ground. When possible, use a variable line transformer to adjust the line voltage between 105 and 125 volts when measuring the power supply voltages. Marginal operation is quickly detected in this manner, as the regulated voltages should remain stable during such line voltage changes.

5-13. The power supply section consists of two electronically regulated supplies and the heater supply multivibrator shown in the block diagram in Figure 5-2. The power supply voltages must be adjusted in the order given in Table 5-2. The output voltage from the heater supply multivibrator depends upon the setting of the + 225-volt supply, which, in turn, depends upon the -165-volt supply; all supplies being dependent upon the stability of the voltage reference tube V15. The heater supply multivibrator must be adjusted as described in the table in order to obtain an adequate and safe filament operating power. The voltage given must be read by an average responding meter, such as the common multimeter test set, and which is calibrated in rms volts. The high voltage of 7.6 volts compensates for an approximate .5 volt drop in the filter which takes filament power into the r-f generator housing.

5-14. REPLACING ELECTRON TUBES.

5-15. When replacing tubes in the TS-510A/U Signal Generator, it is recommended that a check be made on

the operation of the instrument before and after each new tube trial; if no improvement in operation is noticed, the original tube should be returned to the socket. Table 5-3 lists the tubes of the signal generator with a suggested check and paragraph reference if adjustments are necessary following replacement. Figure 5-4 locates the tubes in the signal generator.

5-16. MINOR REPAIR AND ADJUSTMENT.

5-17. The three fuses used in the signal generator are replaceable from the front panel by spare fuses located on the front panel. The two pilot lights are replaceable from the front panel and use standard Mazda No. 47, 6.3 volt, bayonet base lamps. The dial light also uses the No. 47 bulb which is replaceable when the four captive screws in the rear of the instrument are loosened and the chassis pulled from the cabinet sufficiently to gain access to the rear of the front panel.

5-18. The only adjustments in the signal generator which normally would be undertaken by organizational personnel are the power supply voltage adjustments indicated in Table 5-2 and the electrical PERCENT MODULATION meter zero set. The electrical zero set for the PERCENT MODULATION meter is a screwdriver adjustment accessible at the front panel and sets the meter pointer to zero when the signal generator is operating on CW and the MOD. LEVEL control is set to minimum.

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Table 5-3. Tube Replacement Chart

Tube	Function	Check and/or Adjustment Required
V1	Modulation limiter.	None.
V2	Modulation oscillator.	See para. 6-19 in Section VI, Fasron Maintenance.
V3	Modulation amplifier.	None.
V4	Cathode follower.	None.
V5	Output level control tube.	None.
V6	Radio frequency oscillator.	See para. 6-9 in Section VI, Fasron Maintenance.
V7	Radio frequency buffer.	See para. 6-10 in Section VI, Fasron Maintenance.
V8	Radio frequency amplifier.	See para. 6-10 in Section VI, Fasron Maintenance.
V9	XTAL calibrator oscillator.	See para. 6-35 in Section VI, Fasron Maintenance.
*V9	XTAL calibrator oscillator.	See para. 6-36A in Section VI Fasron Maintenance.
V10 and V11	Calibrator amplifier.	None.
V12	Voltage control amplifier.	See Step 3 in Table 5-2.
V-13	Series voltage regulator.	See Step 3 in Table 5-2.
V14	Voltage control amplifier.	See Step 2 in Table 5-2.
V15	Gaseous voltage regulator.	See Step 2 in Table 5-2.
V16	Series voltage regulator.	See Step 2 in Table 5-2.
V17	Heater supply multivibrator.	See Step 4 in Table 5-2.
V18	Modulation indicator amplifier.	None.
V19	Modulation indicator amplifier.	None.
V20	Modulation meter rectifier.	None.
V21	Modulation meter bridge tube.	Set PERCENT MODULATION meter zero set (see para. 5-17).
CR1	Calibrator mixer diode.	None.
CR2	Power monitor detector.	See para. 6-11 in Section VI, Fasron Maintenance.
CR3	Power monitor compensator.	See para. 6-11 in Section VI, Fasron Maintenance.
CR7	R-f amplifier cathode clamp.	See Table 6-2, Item 8.

* Used only on Signal Generator, AN/USM-44A.

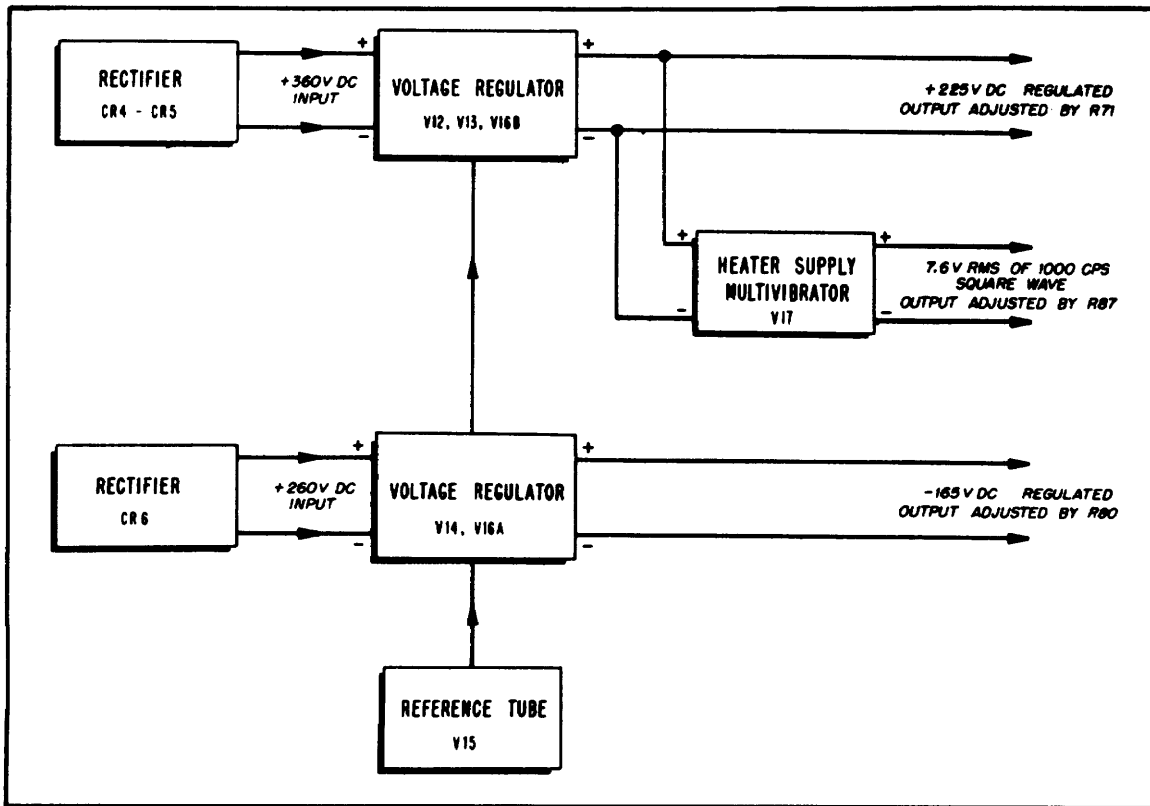


Figure 5-2. Power Supply Block Diagram

5-19. LUBRICATION.

5-20. There are two mechanical operating systems in the TS-510A/U Signal Generator; the frequency drive mechanism shown in Figure 5-5 and the attenuator drive system shown in Figure 5-6. The two systems are thoroughly lubricated at the factory, and it is not expected that subsequent lubrication will be necessary during the first year of use. The gears in the frequency drive system operate at slow speeds and transmit negligible power. Fully shielded ball bearings are used in many applications and require no subsequent attention. Ball bearings that are not fully shielded require only ball bearing lubricant. If cleaning and relubrication are needed after prolonged use of the instrument, excessive dust accumulation, or drying of lubricant, reference to the following chart and Figures 5-5 and 5-6 will assist with renewing the lubricants at various points on the r-f generator assembly. The two worm gears used in the tuning capacitor drive are lubricated with a light-bodied lubricating grease. All remaining sleeve bearing and rubbing surfaces, including the small pulleys used in the attenuator drive system, are lubricated with a low viscosity lubricating oil. The bakelite RANGE SELECTOR drive shaft and the attenuator drive shaft (not shown in the illustration) require light-bodied lubricating grease where they enter the r-f generator housing. In all cases, avoid over-lubrication.

Lubrication Chart
 (See Figures 5-5 and 5-6)

Location	Specification
Oscillator and amplifier worm gears	MIL-G-3278
Amp trimmer stop mechanism	MIL-L-6085
Amp trimmer toggle nut	Same as above
Amp trimmer drive link	Same as above
Amp worm drive shaft	Same as above
Amp sliding coupler	Same as above
Attenuator drive shaft panel bearing	Same as above
Attenuator pulleys unshielded ball bearings)	NAVY 14L3
Attenuator probe guide slot	MIL-G-3378

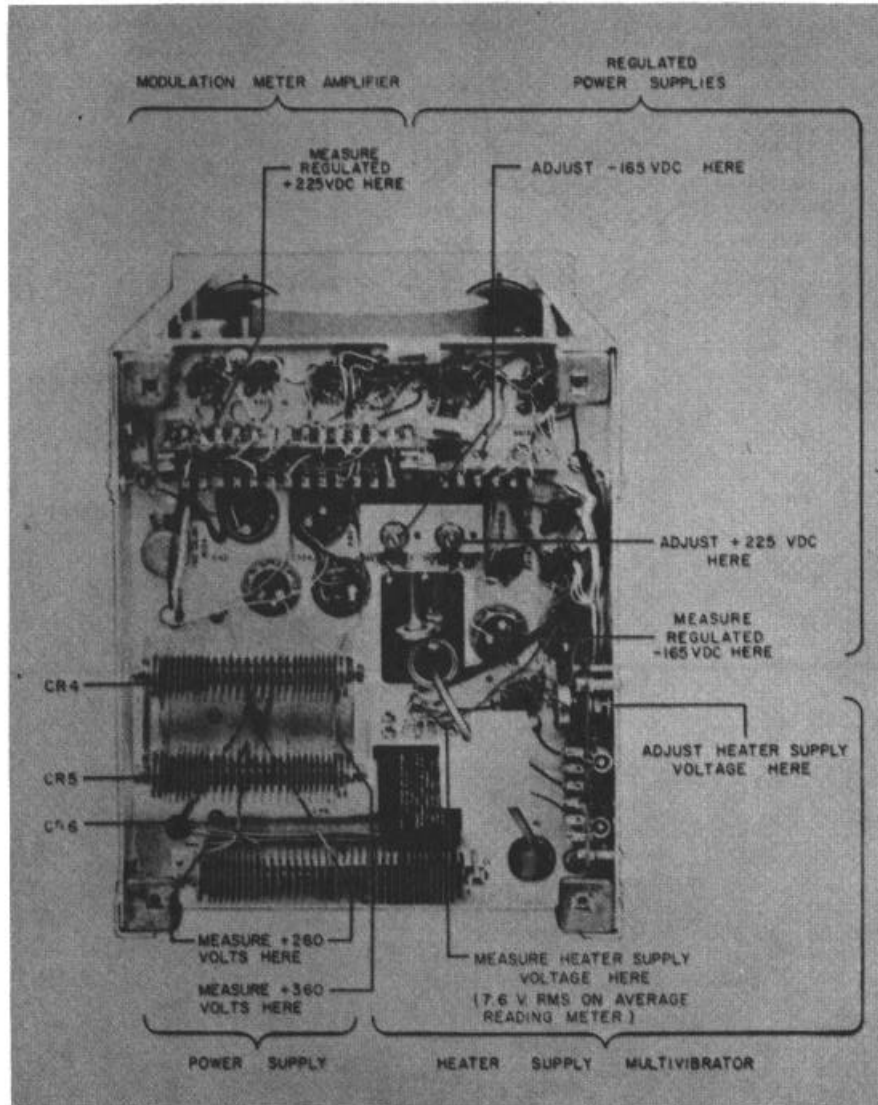


Figure 5-3. Power Supply Section Showing Points of Voltage Measurement and Adjustment

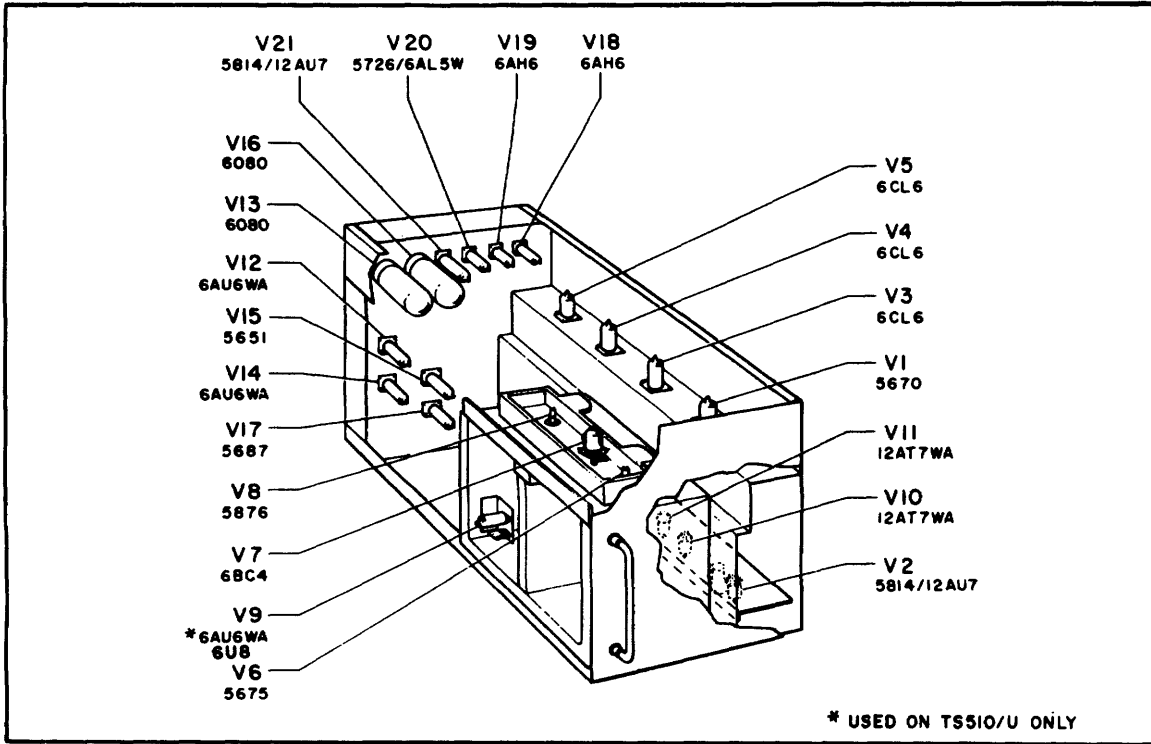


Figure 5-4. Tube Location Diagram

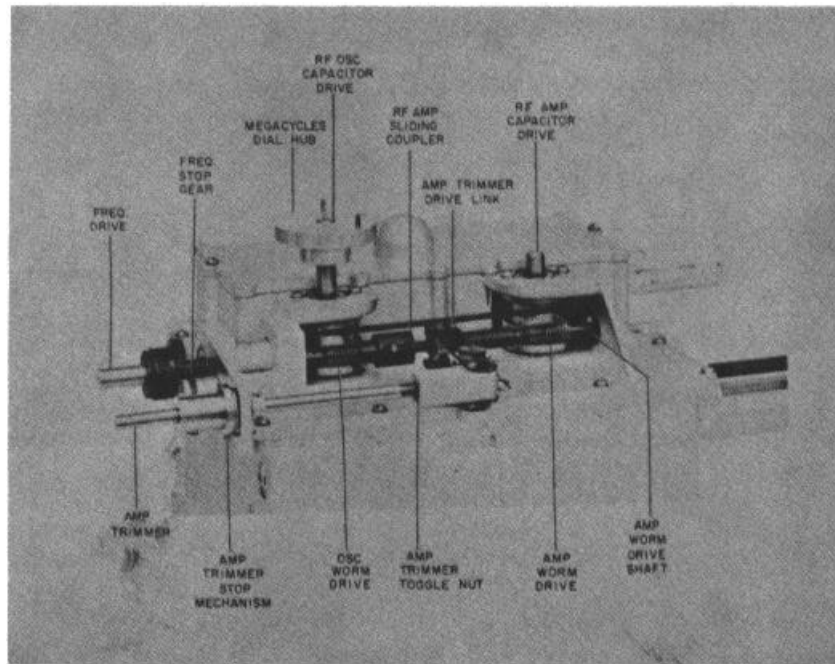


Figure 5-5. Frequency Drive Mechanism Showing Points of Lubrication

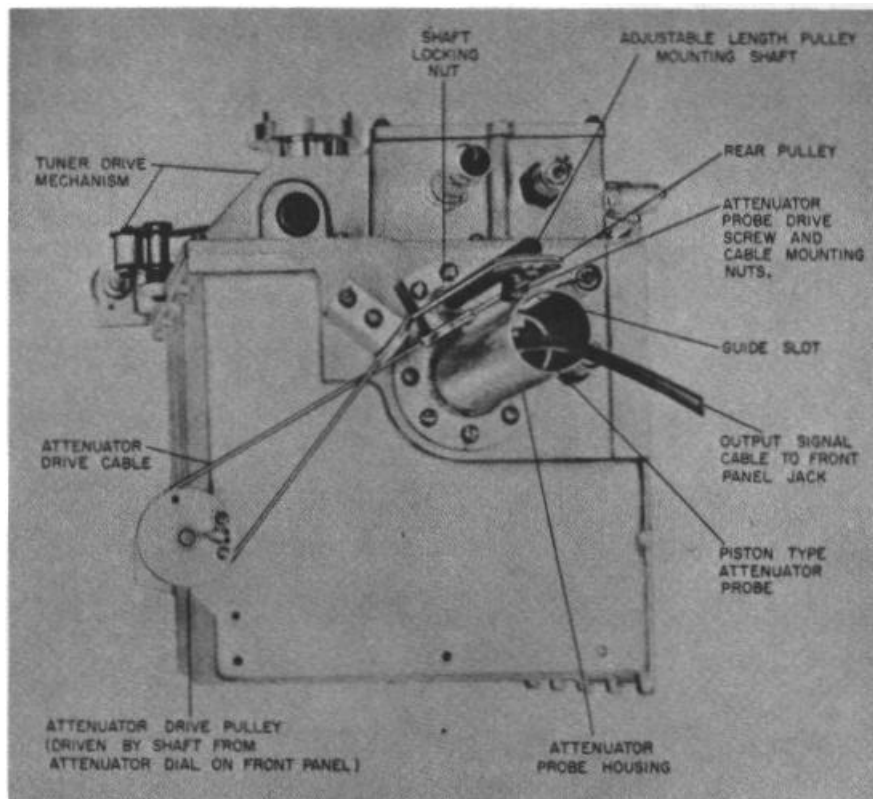


Figure 5-6. R-F Generator Assembly Showing Output Attenuator Drive System, Rear View

5-21. INSPECTION SCHEDULE AND PREVENTIVE MAINTENANCE.

- 5-22. The TS-510A/U Signal Generator requires no special periodic maintenance or checks other than a general alertness for the effects of misuse, loose controls, condition of cables and connectors, and possible damage that may be evident in its general appearance. If the equipment is in normal use, the frequency and attenuator drive mechanisms should be inspected once every six months for drying of the lubrication. Gears of particular importance are the two brass gears which are turned by the worms in the frequency drive mechanism. With proper lubrication and normal use, the lubrication given should last for

over a year of use. Avoid over-lubrication. If the signal generator has been subjected to unusual conditions, excessive moisture, dust, heat, vibration, etc., it is suggested that the instrument be removed from the cabinet and inspected for dirt or moisture accumulation, loosened components, or any possible sign of damage. Forced air under medium pressure is recommended for dusting and drying, although care must be taken not to vary the settings of the adjustment potentiometers. When tightening nuts and screws, various degrees of pressure are required depending on the strength of the material and weight which is supported. Avoid overtightening.

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SECTION VI
FIELD AND FASRON MAINTENANCE

6-1. INTRODUCTION.

6-2. The service instructions in this section are an extension of the instructions in Section V. These instructions include tube replacement, component replacement, calibration procedures and complicated tests which require greater skill and more precise instruments than those described in Section V. Trouble shooting data in this section presume that trouble symptoms have been analyzed and isolated to a section of the signal generator as instructed in Table 5-1 and that the entire power supply is operating properly as determined by the tests in Table 5-2. Replacement procedures are grouped at the beginning of the section followed by recalibration and test procedures toward the end of the section. The material in this section is as follows:

- 6-3 Minimum Performance Standards.
- 6-5 System Analysis Check Chart.
- 6-7 Replacing Tubes in the R-F Generator.
- 6-9 Replacing the Radio Frequency Oscillator Tube.
- 6-10 Replacing the Radio Frequency Amplifier and Buffer Tubes.
- 6-11 Replacing Components in the R-F Power Monitor Circuits.
- 6-13 Replacing/Repairing the R-F Output Attenuator Probe.
- 6-15 Replacing and Repairing the Attenuator Drive Cable.
- 6-17 Repairing the Internal Frequency Calibrator.
- 6-19 Replacing Components in the Modulation Oscillator.

- 6-22 Replacing the R-F Oscillator and Amplifier Tuning Coils.
- 6-24 Replacing Power Transformer T1.
- 6-26 Calibrating the Frequency Dial.
- 6-28 Calibrating the Output Attenuator.
- 6-30 Calibrating the Output Volts Meter.
- 6-32 Calibrating the Percent Modulation Meter.
- 6-35 Calibrating the Frequency-Calibrator Oscillator.
- 6-37 Measuring the Quality of the Pulse Modulated R-F Output Signal.
- 6-39 Measuring the Quality of the Sine Modulated R-F Output Signal.
- 6-41 Maintenance, Overhaul and Inspection Schedule.
- 6-43 Modernization.

6-3. MINIMUM PERFORMANCE STANDARDS.

6-4. To check the overall performance of the signal generator without the use of extensive test equipment, see the minimum performance standards check chart in Section V. The minimum performance check chart in this section lists more extensive tests to determine if each mode of operation is operating satisfactorily. Any one mode of operation may be checked individually, or the entire procedure may be performed in the order given as a systematic trouble locating procedure. Each test is accompanied by a paragraph reference for correction of the problems that can arise during that particular test. The test equipment required for the tests in this section is listed in paragraph 2-1. The illustrated test set-ups are referenced in the chart.

Table 6-1. Minimum Performance Check Chart

Test	Minimum Performance Standard	Paragraph Reference
1. FREQUENCY CALIBRATOR. Check frequency and voltage. See Figure 6-11.	Frequency should be 5 mc \pm 0.01% (500 cycles). D-c output voltage 1-1/2 volts or higher.	See para. 6-35.
2. CW OUTPUT SIGNAL FREQUENCY. Check frequency calibration over full frequency range using the internal frequency calibrator and headset.	All calibrations should be within \pm 0.5% and should be capable of being set "on frequency" using the frequency dial index cursor.	See para. 6-26.
3. CW OUTPUT SIGNAL POWER LEVEL. Check output power level; compare with OUTPUT VOLTS meter and output attenuator dial calibration. See Figure 6-7.	Maximum power level of +4 dbm should be obtainable over full frequency range. 0 dbm power level should be on calibration; other calibration points on attenuator should be within \pm 2 db. OUTPUT VOLTS meter calibration should be "on" at SET LEVEL and \pm 0.5 db at other calibration points.	See paras. 6-28 and 6-30.

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Paragraphs 6-5 to 6-9

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Table 6-1. Minimum Performance Check Chart (Cont.)

Test	Minimum Performance Standard	Paragraph Reference
4. INTERNAL MODULATION. Check modulation capabilities; meter calibration accuracy and distortion in modulated r-f output signal. See Figure 6-10.	Should be able to modulate from 0 to 95% at all r-f output frequencies. Modulation meter calibrations should be within $\pm 10\%$. Distortion on modulated r-f output signal should be less than 5%.	See paras. 6-32 and 6-39.
5. EXTERNAL MODULATION. Check maximum modulation percentage from 100 to 20,000 cps.	Should be able to modulate from 0 to 95% from 100 to 20,000 cps at all r-f output frequencies with 4 volt rms input or less.	See para. 6-39.
6. EXTERNAL PULSE MODULATION. Check waveshape of pulse modulated r-f output signal using pulse rise times and pulse lengths of 1 microsecond at all r-f output frequencies. See Figure 6-12.	Should be able to obtain r-f output pulse rise and decay times as specified in the Table of Specifications for the signal generator.	See para. 6-37.

6-5. SYSTEM ANALYSIS CHECK CHART.

6-6. The schematic diagram at the end of the manual contains a series of test points which are listed below with measurement data taken at each test point. Measurements made at these points provide positive means of isolating a source of trouble to a small circuit area. When a circuit gives a faulty indication at a test point, the measurement may be analyzed to determine the type of failure, for example, insufficient gain through an amplifier normally indicates a weak tube. Distortion may indicate a gassy tube, shorted coupling capacitor, faulty resistor, etc. A faulty resistor is easily located by voltage and/or resistance measurements at the tube socket terminals and by comparing the readings with those given in the tube-socket voltage-resistance diagrams at the rear of the manual. A short circuited capacitor is usually located by measuring zero or low resistance across the capacitor with an ohmmeter. An open capacitor may be isolated by shunting the suspected component with a new one while noting instrument operation and by looking for an improvement in the usual signs of oscillation or instability. Listed with the check points are paragraph references for detailed information regarding a particular measurement. The indicated test point voltages are made to ground with a 20,000 ohm/volt multimeter such as the AN/PSM-4, unless otherwise noted. In some measurements, a higher impedance meter or one having greater sensitivity is required and is so noted. In some measurements in the power supply it is more convenient to measure voltage from the -165 volt supply than from chassis ground and is so indicated. Begin measurements with signal generator set for 0 dbm output level and CW operation (see paragraph 5-8), then shift the controls as instructed in the chart. Follow steps in order given; some steps presume that previous measurements have given satisfactory indications. Set the front panel controls as follows and proceed with the checks in the chart.

Power Switch	ON
MOD. SELECTOR	CW
FREQUENCY RANGE	D band
FREQ. CONTROL	100 megacycles
MOD. LEVEL	Minimum
AMP. TRIMMER	Set for maximum output
OUTPUT LEVEL	Set for SET LEVEL reading on OUTPUT VOLTS meter
Attenuator	0 dbm
XTAL CAL. GAIN	Maximum

6-7. REPLACING TUBES IN THE R-F GENERATOR.

6-8. To replace V6, V7 or V8 in the tube compartment of the r-f generator housing, proceed as follows:

- a. To gain access to the r-f tubes, remove signal generator from cabinet and remove frequency dial and tube compartment top plate as shown in Figure 6-1.
- b. The buffer tube V7 is removed by straight pull.
- c. The oscillator and amplifier tubes V6 and V8 are removed as shown in Figure 6-2.

6-9. REPLACING THE RADIO FREQUENCY OSCILLATOR TUBE. Replacing the radio frequency oscillator tube V6 may affect the calibration of the frequency dial and may affect the maximum power available from the signal generator. In addition, the plate current of new type 5675 pencil triode tubes may differ widely. Following replacement, the plate current must be checked and held between 18 and 27 milliamperes by tube selection and the frequency dial calibration should be checked as follows:

- a. With the new oscillator tube installed and equipment turned off, break the green lead to C15, a feedthrough type capacitor in the r-f generator tube compartment, and insert a 0-50 ma milliammeter.

Table 6-2. System Analysis Check Chart

Step and Test Point	T8-510A/A Control Position	Normal Indication	Possible Cause of Abnormal Indication
1	Operate as described in para. 6-5. Set MOD. SELECTOR to: CW, max output CW, min. output PULSE operation	260V dc, 1.4V ac 90 ma dc 95 ma dc 82 ma dc	excessive ripple, C42. Low voltage, CR6 or excessive current drawn by following circuits.
2	Same as Step 1	-165V dc, 5.5 millivolts ac	See Table 5-2, Item 2.
3	Same as Step 1. Set for: CW, max; output 400 MOD output PULSE operation	+340V dc, 2.7V ac 155 ma dc 175 ma dc 147 ma dc	Excessive ripple, C40. Low voltage, CR4, CR5 or excessive current drawn by following circuits.
4	Same as Step 1 5.5 millivolts ac	+225V dc	See Table 5-2, Item 3.
5	Any position	7.6V ac, square wave	See Table 5-2, Item 4.
6	Set for CW at low freq. end of: "A" band "B" band "C" band "D" band "E" band	103V dc 89V dc 87V dc 82V dc 80V dc	When out of oscillation a voltage of approximately 87 is read on all bands. Check oscillator tube and associated components.
7	Set for CW operation	+110V dc	Higher voltage indicates a weak V7 or open plate circuit.
8	Set for CW operation. Set OUTPUT LEVEL to: Minimum SET LEVEL Maximum	Measure voltage across R82 0V dc +1.4V dc (approx.) +7.0V dc	With output level set to max. and RANGE selector set between ranges, the d-c voltage should not exceed -4.5 volts to ground.
9	Set for CW operation. Set OUTPUT LEVEL to: Minimum SET LEVEL Maximum	+31V dc +6V dc (approx) -7V dc, -26V dc when disconnected from r-f generator	With modulator disconnected from filter FL6, inadequate voltage range indicates poor V5 or control circuit measured in Step 11.
10	Set for 400. Modulation at 10 mc and 100 mc 10% mod. 30% mod. 50% mod. 80% mod.	A-C Volts <u>10 mc</u> <u>100 mc</u> .48 .3 1.3 .75 2.2 1.2 3.7 1.8	Insufficient signal indicates low amplification farther back in the modulator, see Steps 14, 15, and 16.
11	Set for CW operation. Set OUTPUT LEVEL to: Minimum SET LEVEL Maximum	Use electronic voltmeter. +23V dc - 2V dc -30V dc	Rough, insufficient, or excessive voltage check R34, R37, R39, and R40.

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Table 6-2. System Analysis Check Chart (Cont.)

Step and Test Point	TS-510A/U Control Position	Normal Indication	Possible Cause of Abnormal Indication
12	Turn off for this measurement	53 ohms	25 ohms indicates shorted C37, infinite indicates open R58.
13	Set for 400 and 1000 internal modulation operation	2V ac rms +6.4V dc	Adjust R7 to obtain correct voltage; if necessary, change I1.
14	Set for 400 ~ modulation at 10 mc 10% 30% 50% 80%	Use electronic voltmeter .017V ac .048V ac .083V ac .141V ac	Approximate voltages required for modulation of the r-f output signal.
15	Set for 400 ~ modulation at 10 mc 10% 30% 50% 80%	Use electronic voltmeter .068V ac .195V ac .32 V ac .56 V ac	Low output indicates weak V1. Gain should be approximately equal for these signal levels.
16	Set for 400 ~ modulation at 10 mc 10% 30% 50% 80%	.58V ac 1.66V ac 2.8 V ac 4.8 V ac	Low output indicates weak V3, Gain should be approximately equal for these signal levels.
17	Set for 400 ~ modulation at 10 mc 10% 30% 50% 80%	.014V ac .044V ac .174V ac 1.2 V ac	Low output indicates weak CR2 and would be accompanied by low indication on the r-f OUTPUT VOLTS meter. See paragraphs 6-30, 6-32.
18	Set for CW operation. Set OUTPUT VOLTS 4 meter to read: .1 volt Half scale SET LEVEL Full scale	.05V dc .16V dc .23V dc .32V dc	These voltages vary depending upon the forward resistance of CR2 and CR3.
19	Set for 400 ~ modulation at 10 mc 10% 30% 50% 80%	.39V ac 1.0 V ac 1.55V ac 2.50V ac	Low voltage indicates weak V18 or V19.
20	Set for CW operation at any check point	4V dc	If voltage is below 1 volt and beat-frequency signals are not obtainable, check CR1 and V9. See paragraph 6-36.
21	Set for CW operation at any check point	43V ac with J3 connected to 600 ohm load	Low output indicates weak V10 or V 1.

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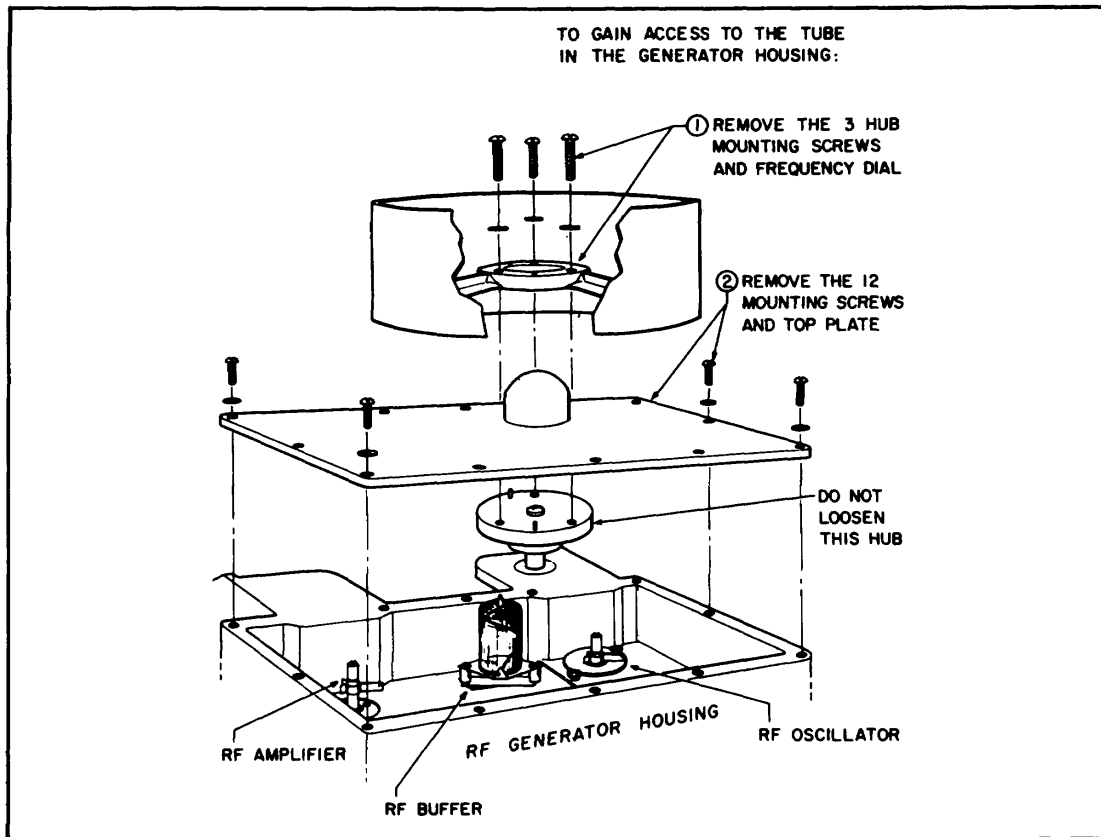


Figure 6-1. Diagram Showing Access to R-F Oscillator, Buffer and Amplifier Tubes

b. Check the heater supply voltage as instructed in Step 4 of Table 5-2.

c. Set the frequency range switch to the E band and turn equipment on. Milliammeter must read between 18 and 27 ma plate current for V6. If it does not, try another replacement tube.

d. Check maximum power output capabilities as instructed in paragraph 6-10.

e. Using the internal heterodyne calibrator, check the frequency calibration throughout the range of the signal generator.

f. To adjust the frequency calibration at the high-frequency end of all bands simultaneously, adjust trimmer capacitor C18, which is accessible in the tube compartment of the r-f generator housing (see Figure 6-17). Capacitor C59 in series with C18 should only be adjusted if the adjustment range of C18 is not great enough. These adjustments have only minor effect at the low frequency ends of the ranges. For further information on frequency calibration, see paragraph 6-26.

6-10. REPLACING RADIO FREQUENCY AMPLIFIER

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AND BUFFER TUBES. Replacing the r-f amplifier and buffer tubes may limit the maximum power output available from the signal generator and should be checked as described below. Proceed as follows:

a. Following replacement of V7 or V8, check the heater supply voltage as instructed in Step 4 of Table 5-2.

b. Check the maximum power output as read on the OUTPUT VOLTS meter throughout the frequency range of the signal generator, setting the AMP. TRIMMER control for maximum output at each frequency tested. A full-scale reading on the OUTPUT VOLTS meter should be obtainable over the entire r-f frequency range of the signal generator.

6-11. REPLACING COMPONENTS IN THE R-F POWER MONITOR CIRCUITS.

6-12. The complete power monitor for the TS-510A/U Signal Generator consists of the detector assembly shown in Figure 6-3 fastened to the bottom of the attenuator tube in the r-f generator housing, an adjustable compensating circuit fastened to the rear of the generator housing and the front panel OUTPUT

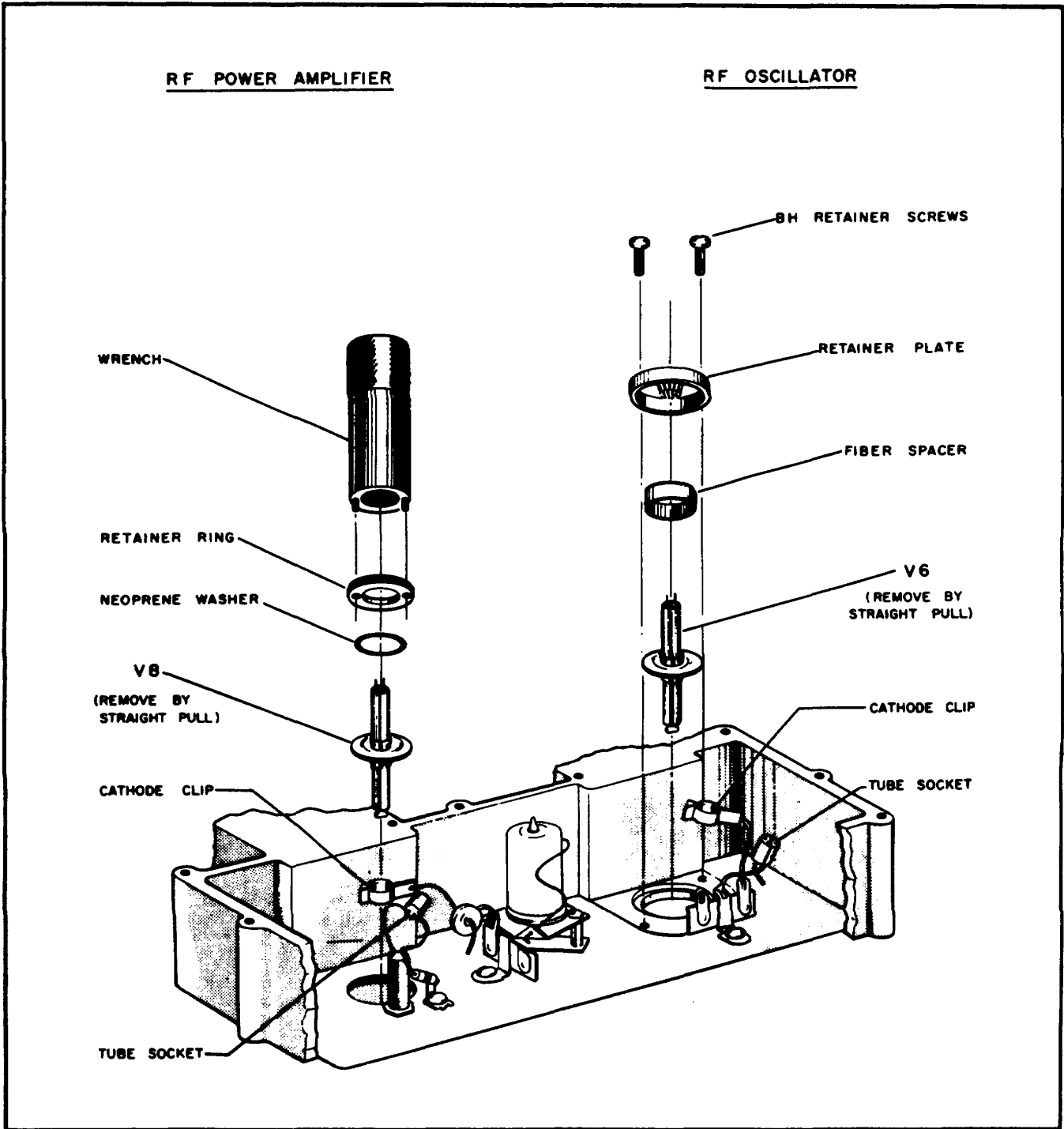


Figure 6-2. Exploded View for Replacement of R-F Oscillator and Amplifier Tubes

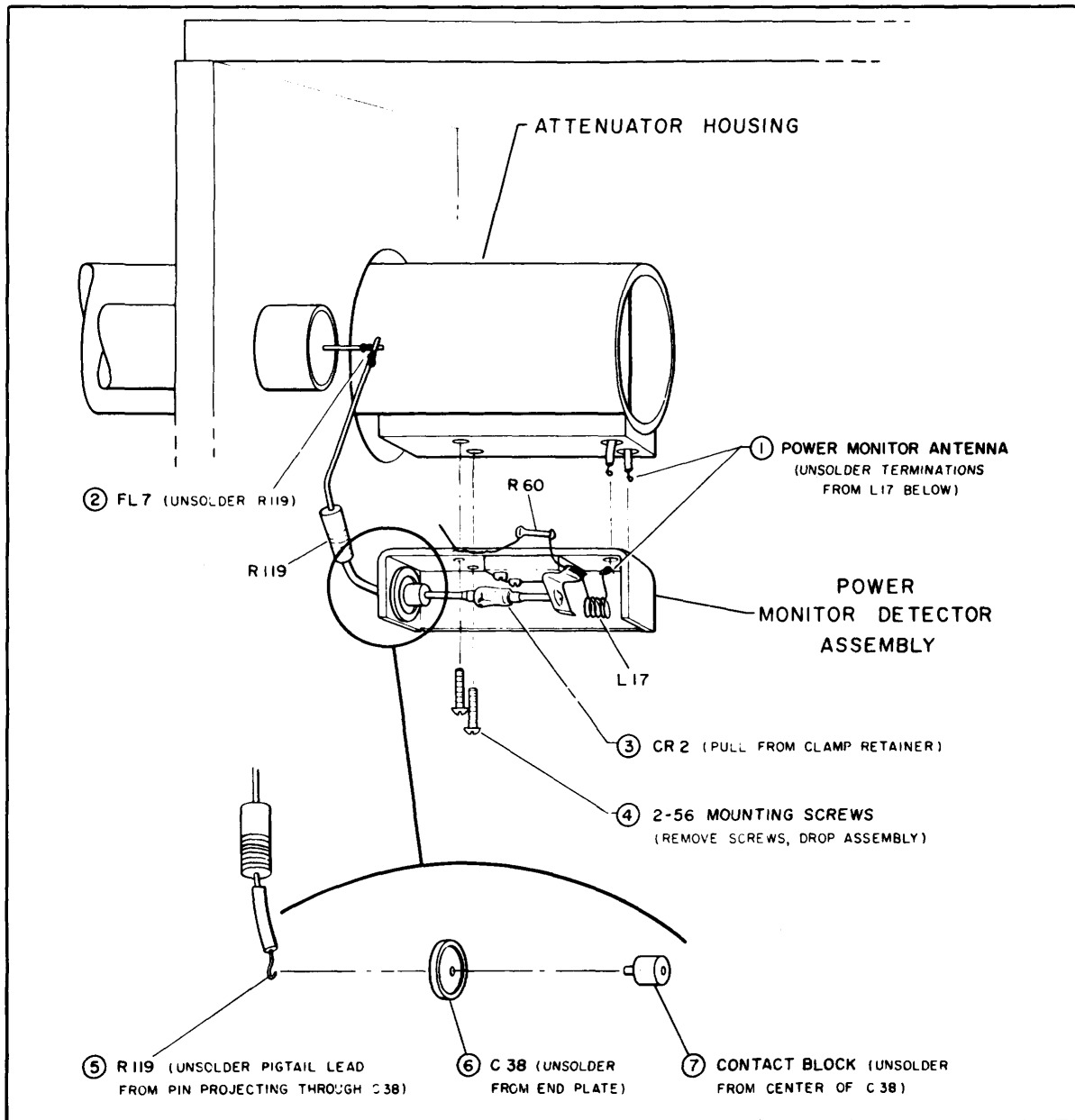
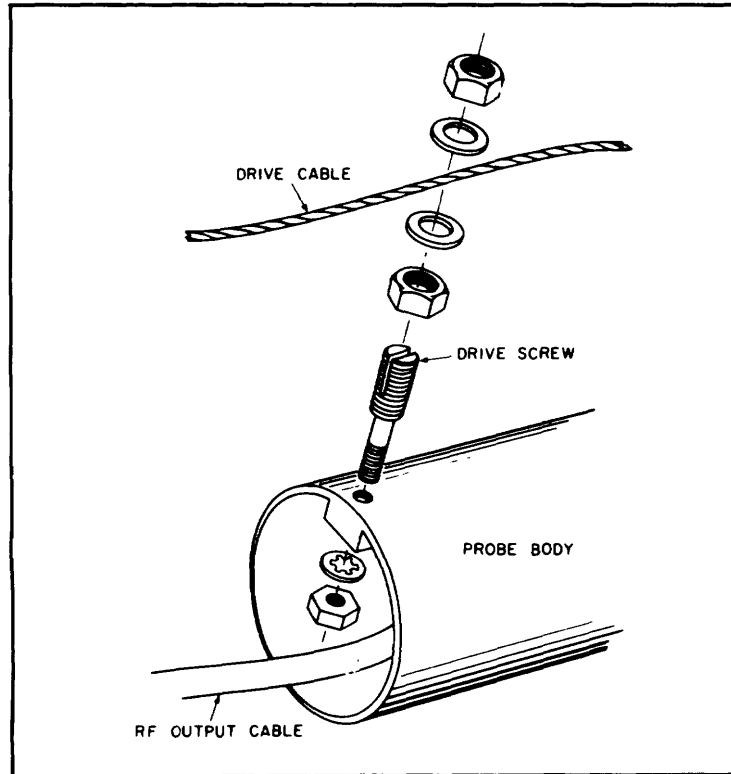


Figure 6-3. Diagram Showing Breakdown of Components in R-F Power Monitor Assembly

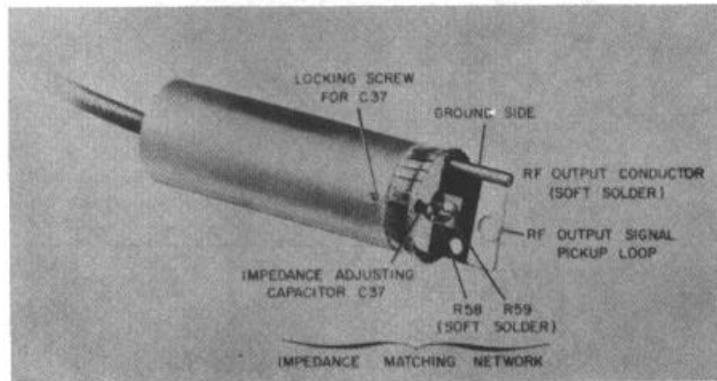
VOLTS meter. All components in these circuits are critical and replacement will affect either or both the calibration and the frequency response of the OUTPUT VOLTS meter. If one of the components in the detector assembly must be replaced, carefully note the exact position of L17 and R60. Do not shift the position of L17 or R60 unnecessarily. The length of L17 and the position of R60 and the length of the one pigtail lead on R60 are used to adjust the frequency response of the circuit. When installing a new component, position the new part exactly as the old one was. The crystal diode

detector is mounted by a single spring clip and is instantly replaced by relieving the spring action and pulling the crystal out. Capacitor C38 is a button type with its periphery soldered against the end plate of the mounting bracket and is replaced as instructed in the numbered steps shown in Figure 6-3. Following replacement of any component in the power monitor circuits, check and, if necessary, adjust the OUTPUT VOLTS meter calibration and frequency response as instructed in paragraph 6-30.

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(a) Probe and Cable Attaching Parts



(b) Front View Showing Impedance Matching Network

Figure 6-4. R-F Output Attenuator Probe

6-13. REPLACING/REPAIRING THE R-F OUTPUT ATTENUATOR PROBE.

6-14. It is not expected that the output attenuator probe will ever require service unless it has been damaged by external voltage applied to the R-F OUTPUT jack. If this is suspected, measure the resistance between the center terminal of the output jack and ground. This resistance should be exactly 53 ohms. If the resistance is not 53 ohms, R58 has been damaged; if the resistance is 0 ohms, C37 may be shorted. If the attenuator probe is electrically damaged, it may be replaced by a completely new probe or the defective resistor or capacitor may be replaced individually (see Step "e" below). In either case, the attenuator probe must be removed from the signal generator as follows:

CAUTION

During removal and replacement of the probe, extreme care must be exercised. The probe consists of a cylindrical metal tube with a series of spring contact fingers around its periphery which can be accidentally bent or twisted. Also, it will be noted that one of the fingers is bent toward the center of the probe slightly. Do not attempt to straighten it since it has been made this way to assure clearance between the probe and the end of the guide slot in the attenuator housing. Make certain that the probe is not subjected to shock. If the probe is subjected to shock, the electrical components attached to the end of the probe can be broken or their position altered with a consequent change in the electrical characteristics of the probe.

a. With the signal generator removed from the cabinet, turn the attenuator control on the front panel until the probe reaches the end of its travel to the rear of the attenuator housing.

b. Referring to Figure 6-4a, remove the nut and washer that hold the drive cable in the probe drive screw in the top of the attenuator probe. Lift the cable out of the screw slot.

c. Remove probe drive screw from probe body by removing inner nut and unscrewing drive screw.

d. Carefully remove the probe by sliding it out of the attenuator housing.

e. If the damage to the attenuator probe is limited to a burned-out resistor, and if a replacement resistor is available, the attenuator may be repaired by carefully unsoldering the old resistor, using a low temperature soldering iron, and replacing the resistor. Soldering must be done quickly and neatly with low temperature solder. Care must be taken to duplicate the original workmanship as closely as possible by positioning the new part exactly as the old one, and by applying as little heat in the soldering process as is possible. Capacitor

C37 need not be adjusted unless it too has been damaged. This capacitor consists of a metal pin with a thin plastic coating acting as the dielectric material, and a metal sleeve. The sleeve is retained by a No. 4 Allen screw in the side of the probe body. If the coating on the pin is pierced, the pin must be replaced. Again, it is important to retain the original positioning. Loosening the set screw shown in Figure 6-4b allows for adjustment of C37 or replacement of the pin or sleeve.

f. If repair is not possible, the probe and cable must be replaced. It will then be necessary to remove the R-F OUTPUT jack from the front panel and release the cable from the clamp holding the cable to the top of the side gusset. The entire probe assembly may then be removed from the instrument. Replacement probes are complete with cable and panel jack and require no adjustment of the impedance-matching network.

g. Insert the new or repaired probe in the attenuator housing. Care must be taken in starting the probe into the housing since the diameter at the probe contact fingers is slightly greater than the inner diameter of the housing. The contact fingers should be depressed slightly while starting the probe into its housing. Under no circumstances should the probe be forced. See CAUTION at beginning of procedure.

h. Replace the split drive screw in the probe, making certain that the screw slot is parallel to the axis of the housing.

i. Set the attenuator drive cable in the screw slot between the two washers and nuts. Do not tighten the upper nut. The cable must move freely through the slot until the maximum probe penetration has been set.

j. Secure the r-f cable to the clamp on the side gusset (see Figure 6-12).

k. Remove the r-f generator side plate to view the inner end of the attenuator housing and the amplifier coils.

l. Set the output attenuator control full ccw against the stop. The dial should read exactly +4 dbm. If it does not, loosen the set screws in knob and correct.

m. Carefully move the attenuator probe toward the amplifier coils until the front edge of the pickup loop is between 1/64 and 1/32-inch back from the open end of the attenuator tube. This distance assures that the pickup loop cannot contact the amplifier coils when set for deepest penetration. Tighten upper nut to hold drive cable.

n. Probe penetration has now been set and the attenuator dial calibration must be checked and adjusted as instructed in paragraph 6-28.

6-15. REPLACING AND REPAIRING THE ATTENUATOR DRIVE CABLE.

6-16. The attenuator drive cable is a special flexible cable consisting of a fine steel wire core covered by bronze braid and a nylon sheath and is expected to last through the life of the signal generator. If slack begins to appear in the drive cable, the cable may be tightened by lengthening the supporting shaft which mounts the

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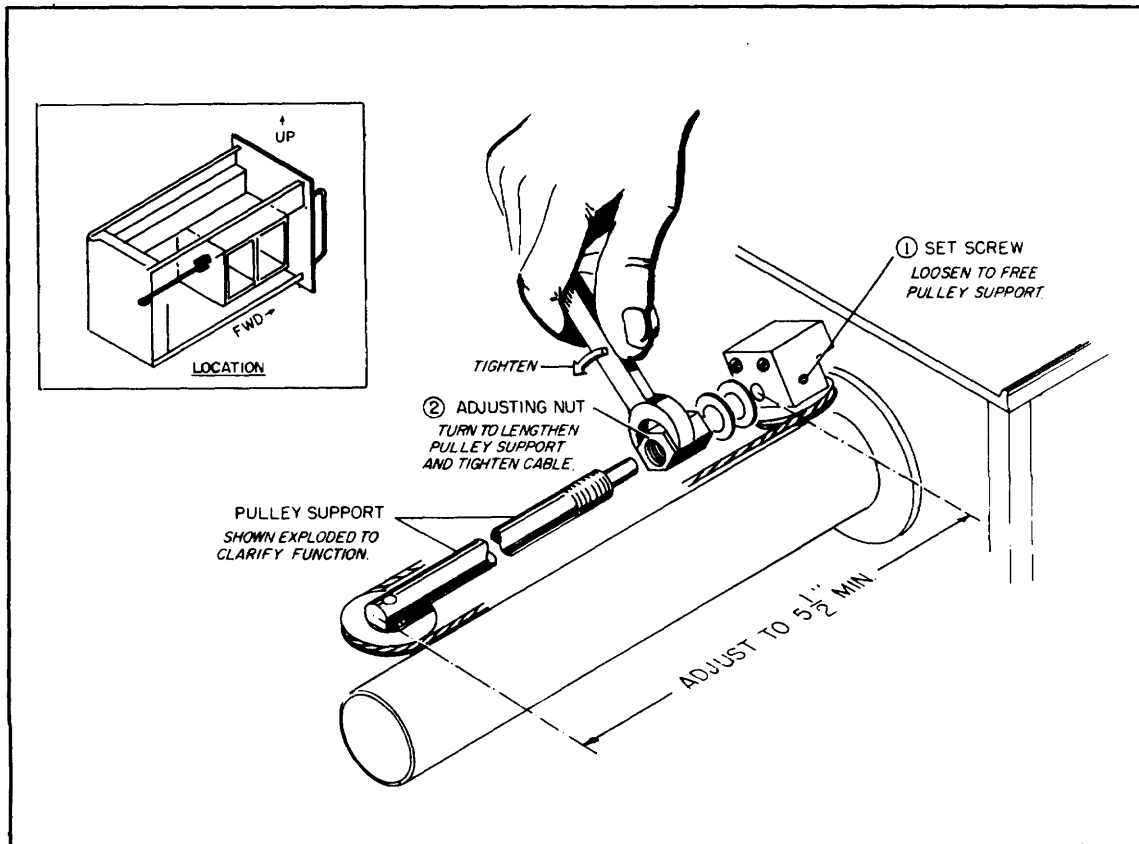


Figure 6-5. Diagram Showing Adjustment of Cable Tension for Output Attenuator Drive System

rear pulley (see Figure 6-5). The shaft is threaded a short distance at the seating end and the depth of seating is determined by the position of the nut on the shaft. The nut is forced against the mounting block face by the tightness of the drive cable and an Allen set screw, when tightened in the mounting block, prevents the shaft from turning. If, due to physical damage or wear, the cable must be replaced, a new cable of the same type should be obtained and installed as instructed below. It is possible with care, to replace the cable so that a minimum of recalibration will be necessary. To replace the attenuator drive cable, proceed as follows:

- a. With signal generator removed from cabinet, remove old drive cable.
- b. Cut replacement cable to 36-inch length.
- c. Referring to Figure 6-5, measure and note the exact distance from face of mounting block to end of rear pulley support shaft.
- d. Loosen set screw holding the rear pulley support shaft in the mounting block and turn adjusting nut

clockwise to bring this distance to approximately 5-3/8 inches prior to installing the new cable.

- e. Viewing the rear of the r-f generator assembly (see Figure 5-6), turn the cable drive drum ccw to the "stop" position.

- f. Insert one end of new cable through the bottom hole in the drum so that 1-1/2 inches protrude and can be looped under the lower attaching screw. Secure end of cable under screw and washer.

- g. Bring drive cable down around the outside of driving drum to the inside of the first pulley. Feed cable around the first pulley and back to the rear pulley, around the rear pulley and forward (over the slot in the attenuator housing) to the third pulley. Feed cable around the third pulley back of the other end of the cable, to the top of the driving drum, once all the way around the drum and through the top terminating hole in the drum. Pull cable tight and secure end under top attaching screw and washer.

- h. Turn adjusting nut for rear pulley shaft clockwise to increase the distance from the end of the rear

pulley support shaft to the face of the mounting block to exactly 5-1/2 inches. This increase in distance should tighten the cable the proper amount and provide the correct length of travel for the attenuator probe.

i. Following replacement of the attenuator drive cable, the attenuator probe penetration must be reset as instructed in paragraph 6-14, steps "k" through "n".

6-17. REPAIRING THE INTERNAL FREQUENCY CALIBRATOR.

6-18. The internal heterodyne frequency calibrator occupies two separate spaces on the signal generator chassis. The 5 mc crystal oscillator and mixer are mounted on a small chassis inside the r-f generator assembly; the calibrator amplifier is located on the lower deck on the right-hand side of the signal generator. The single d-c voltage measurement described in paragraph 6-36, steps "c" and "d", indicates if the calibrator oscillator is functioning. Components in the calibrator amplifiers, V10 and V11, are not critical and may be replaced without special precautions or adjustments. Components below the chassis in the 5 mc crystal oscillator may be replaced by removing the oscillator chassis as described below, followed by adjustments described in paragraph 6-36. To remove the calibrator oscillator chassis from the r-f generator housing, proceed as follows:

a. With the signal generator removed from the cabinet, remove the side plate from the r-f generator housing.

b. Unsolder the shielded heater power (black) lead from the feed-through capacitor in the top of the compartment.

c. Unsolder the shielded plate (white) lead from the tie-point in the top of the compartment.

d. Disconnect wire from standoff insulator to filter FL7.

e. Remove the two 6-32 machine screws attaching the oscillator chassis to the generator housing. Draw calibrator chassis from the compartment carefully feeding power lead and projections.

NOTE

In TS-510A/U Signal Generators with serial numbers 302 and below, four components in the frequency calibrator differed from the value shown in the schematic diagram. See paragraph 6-45 for details of these parts changes.

6-19. REPLACING COMPONENTS IN THE MODULATION OSCILLATOR.

6-20. Other than the resistors and capacitors in the frequency determining network, the tubes and components in the modulation oscillator are not critical and no adjustments are required following their replacement. If it becomes necessary to replace a component in the frequency determining network, it will

be necessary to select the new component so that the specified frequency of oscillation, 400 ~ or 1000 ~, is again obtained. Original components are selected to 1% tolerance and a new part within this tolerance should provide the correct output frequency.

6-21. If lamp I1 is replaced, the output level must be checked and, if necessary, reset to 2 volts. Lamp I1 in the cathode circuit of the oscillator tube provides a thermal resistance having a high positive temperature coefficient and is used to maintain constant output voltage from the oscillator. The type S6 lamps used for this purpose vary from one lamp to another and produce widely varying output voltage from the oscillator. Potentiometer R7 is provided for adjustment of the oscillator output voltage. After the lamp has been replaced, the oscillator voltage as measured at pin 3 of V2 should be adjusted to be 2 volts rms; if it cannot be adjusted to this value, another lamp must be tried.

6-22. REPLACING THE RF OSCILLATOR AND AMPLIFIER TUNING COILS.

6-23. To replace a coil in the r-f amplifier coil turret or to replace the r-f oscillator coil turret, the entire top portion of the r-f generator assembly must be removed as shown in Figure 6-6. It is possible with care in handling, to remove the top portion of the assembly and reinstall it without loss in accuracy of frequency or output level dial calibration. The removed portion must be handled with great care not to bump or shift the position of any of the coils on the turrets. If it becomes necessary to replace an A, B, or C band oscillator coil, the entire turret assembly must be replaced as these coils are mounted on the turret with a permanent cement. The D and E band coils being self-supported wire coils or loops may be replaced separately. The r-f amplifier coils are mounted by axial screws and each coil may be replaced individually. If an amplifier coil is replaced, it is very important that the new coil be installed to be exactly the same distance from the mouth of the attenuator tube as the old one was. The mounting screws allow this distance to be adjusted over a small range and are originally set to obtain an equal amount of power from each coil. If a coil is significantly far from the correct distance, the OUTPUT VOLTS meter calibration for that range may not indicate the power level accurately. To remove the r-f tuning coils from the r-f generator assembly, proceed as follows:

CAUTION

DO NOT bump the tuning coils or frequency drive shaft while servicing this assembly. To do so will complicate the repair and necessitate recalibration when the assembly is replaced.

a. With signal generator removed from cabinet, refer to Figure 6-1 and remove frequency dial assembly.

b. Remove both the FREQ. and AMP. TRIMMER front panel shafts and knobs by loosening the set screws in couplers just behind the front panel.

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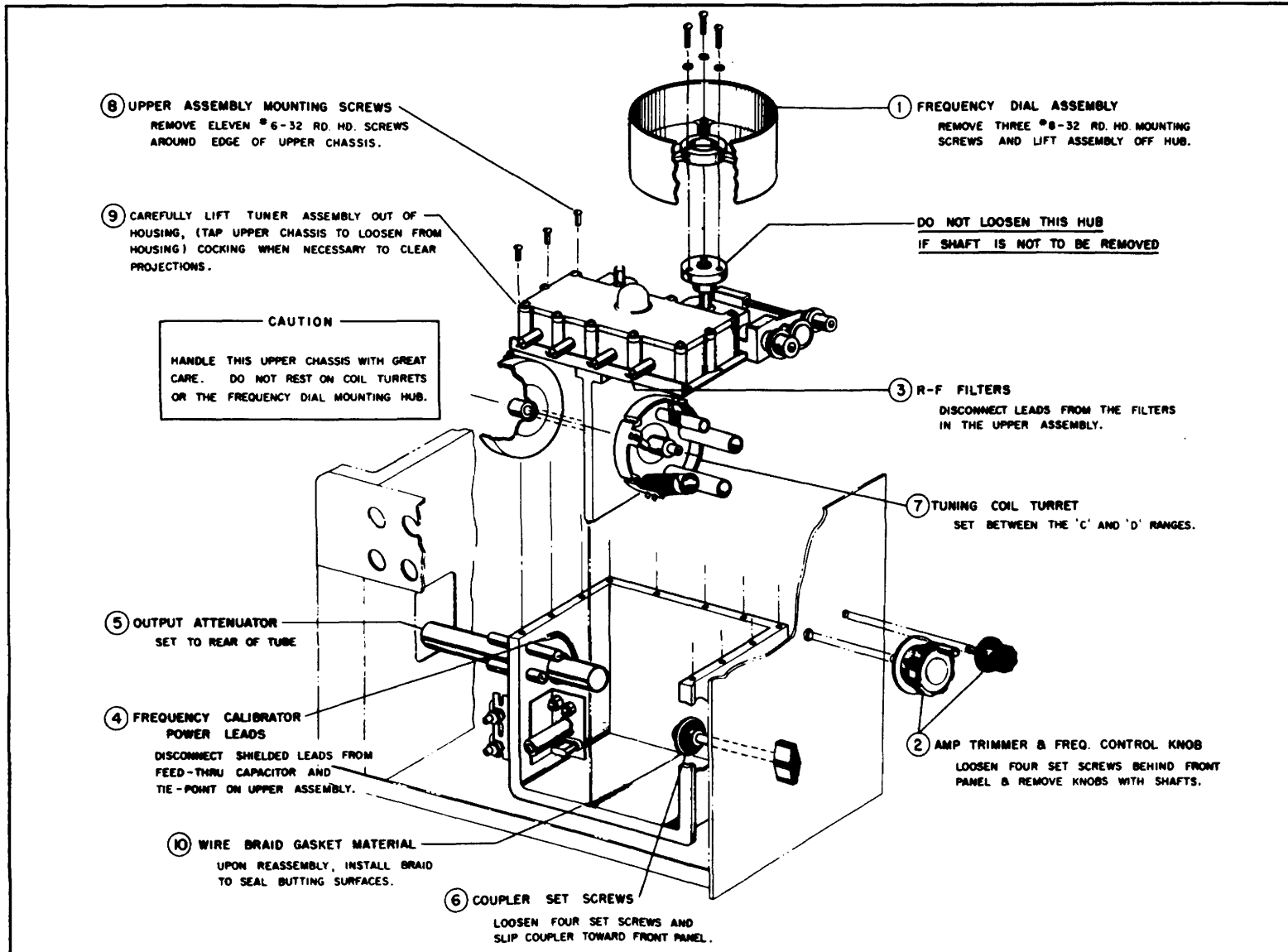


Figure 6-6. Diagram Showing Removal of Frequency Drive Assembly from R-F Generator Housing

c. Identify the wire leads from filters FL1, FL2, FL3, FL4, FL5, and FL6 on the generator housing.

Unsolder these leads.

d. Remove the side plate from the generator housing.

e. Unsolder the shielded black and white leads that connect the frequency calibrator oscillator to the feed through capacitor and tie-point on the top plate of the generator assembly.

f. Loosen the four set screws in the coupler to the oscillator coil turret, slide the coupler toward the turret and pull the FREQUENCY RANGE knob and shaft forward so that the shaft and coupler separate inside the compartment.

g. Rotate coil turrets so that they are between ranges, i.e., so no contacts are meeting.

h. Refer to Figure 6-6 and remove the eleven 6-32 round-head screws that fasten the top assembly to the generator housing. The top plate is indexed by two pins to the bottom portion of the housing. These pins may be tight and a LIGHT tap or pry may be required to separate the top plate from the housing. Do not jar the top assembly as the tuning capacitor alignment may be upset with a loss in frequency dial calibration accuracy and resetability. The index pins may remain attached to either the top plate or the housing when the top assembly is removed.

i. Using great care not to bump the amplifier coils against the attenuator housing, draw the top assembly out the top of the instrument. It will be necessary to juggle the assembly out of the housing to avoid the front and side panel projections.

j. Rest the top assembly on a table such that the weight of the assembly is not borne by either the coil turret assemblies or the frequency drive shaft.

CAUTION

Unless necessary, do not shift the position of the amplifier coil turret on the center shaft.

Both the turret and coils are accurately set to give proper coupling to the output attenuator. If the coil or turret position is changed, the attenuator dial calibration will be upset. If a coil must be replaced, the new coil should be positioned exactly as the old one was. For best accuracy of output level calibration, the output should be checked as described in paragraph 6-28.

k. Noting above CAUTION, remove either coil turret by loosening the two set screws in turret hub and pulling turret off the center shaft.

l. Remove amplifier coils by unsoldering the wire leads to the coil and removing the single axial 6-32 mounting screw.

m. Remove D and E band oscillator coils by unsoldering. A, B, and C band oscillator coils are not

individually replaceable and are replaced by replacing the entire oscillator turret assembly.

6-24. REPLACING POWER TRANSFORMER T1.

6-25. To remove power transformer T1 from the signal generator chassis, space heater R64 with its two mounting feet and adjustment potentiometers R61 and R 62 with their mounting bracket must be loosened from their mounting surfaces, but not removed altogether. Proceed as follows:

a. Remove signal generator from cabinet.

b. Release space heater R64 with mounting feet from bottom plate.

c. Release R61, R62 mounting bracket from the r-f generator housing. Mounting screws thread into housing and may be removed without releasing other parts.

d. Remove tube V17 from socket.

e. Unsolder all leads from terminals of T1, identifying to facilitate replacement.

f. Remove the four large nuts that thread into transformer studs. Remove T1.

g. Replace T1 in reverse order of above.

6-26. CALIBRATING THE FREQUENCY DIAL.

6-27. Two degrees of frequency dial calibration are covered in the following procedures: Simple calibration following replacement of the r-f oscillator tube and the more complicated calibration required if the r-f oscillator coils are replaced. Following replacement of the r-f oscillator tube the MEGACYCLES dial calibration must be checked on each band using the internal frequency calibrator. If it is not possible to bring the frequency dial into calibration with the MEGACYCLES dial index shifter, the high frequency ends of all bands can be adjusted by trimmer C18 inside the tube compartment of the r-f generator housing. It is not expected that a change in the oscillator tube will affect the frequency dial calibration more than at the top of each band. Instructions for this degree of frequency calibration are included in steps "a" through "f" of the following procedure. If a single oscillator coil causes one dial scale to be inaccurate, the inductance of that particular coil must be adjusted to track with the frequency dial calibrations; if the entire oscillator turret is changed, the inductance of each coil must be adjusted individually to track with the frequency dial calibration. Instructions for this degree of frequency dial calibration begin with step "f" in the following procedure. To adjust the frequency dial calibration at the high ends of all frequency bands simultaneously, proceed as follows:

a. With the signal generator removed from the cabinet and operating after a 15 minute warm-up, check the frequency dial calibration at the top of each band and note the nature of a possible discrepancy (is the average calibration too high, or too low?).

b. Remove the frequency dial and tube compartment top plate as shown in Figure 6-1.

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c. Replace the frequency dial with only one mounting screw and recheck calibration of dial as in step "a".

d. Adjust C18 (shown in Figure 6-16) to obtain best overall or desired calibration of the frequency dial. If adjustment of C18 is not sufficient to bring the dial into calibration, C58 may also be adjusted with the same effect; however, C58 is usually not necessary and is set to minimum capacity.

e. Replace tube compartment top plate and re-install frequency dial and recheck calibration. If a single oscillator coil produces poor frequency calibration, or if the entire oscillator coil turret has been replaced and requires complete recalibration, proceed as follows:

f. Before making any adjustments on newly installed coils, first carefully check the calibration obtained with the new coil. Using an accurate wavemeter or frequency meter note the actual frequency coverage of each coil, determine how far, and which way, off frequency each dial scale is. The total amount of each adjustment that is possible is limited, but is generally sufficient for recalibration.

g. Remove the side plate from the r-f generator housing and set the FREQUENCY RANGE selector to gain access to the desired oscillator coil.

h. Adjust the inductance of the desired coil to set the frequency dial calibration "on frequency" at the low end of each band. If the output frequency on a given range is too high, the inductance of the appropriate coil should be increased by moving the shorted turn on the coil (on the A, B, C, and D bands) away from the windings and by lengthening the single loop on the E band. If the frequency is too low, the inductance should be decreased by moving the shorted turn toward the coil winding.

i. Check the high-frequency end of each dial scale to determine which way all upper frequencies must be adjusted for best overall calibration and, if necessary, readjust C18 as instructed in the first part of the procedure.

j. Recheck frequency at the low end of each band and refine the above adjustments for best overall accuracy.

6-28. CALIBRATING THE OUTPUT ATTENUATOR.

6-29. Following repair or replacement of the output attenuator probe, drive cable or dial, the attenuator must be recalibrated. The degree of adjustment will depend on the extent of the repairs. If only the dial has been disturbed, the dial will be the only part requiring adjustment. If the probe or cable has been replaced, the full calibration procedure must be performed and will require the use of a power meter and bolometer mount. The procedure consists of mechanically setting the safe maximum penetration of the probe at the "stop", and adjusting the output volts meter to obtain correct attenuator dial calibration. To calibrate the output attenuator, proceed as follows:

a. Remove signal generator from cabinet. Remove side plate from r-f generator housing.

b. Set attenuator dial to cw "stop". If necessary, loosen attenuator dial and set to read exactly 4 dbm. This is the point of maximum probe penetration.

c. Looking into the inner end of the attenuator probe housing, note the position of the pickup loop relative to the exact end of the tube. The pickup loop must be between 1/64 and 1/32 inch back from the end of the tube. If necessary, loosen the nut which attaches the probe to the drive cable and adjust the maximum penetration to be within the specified amount.

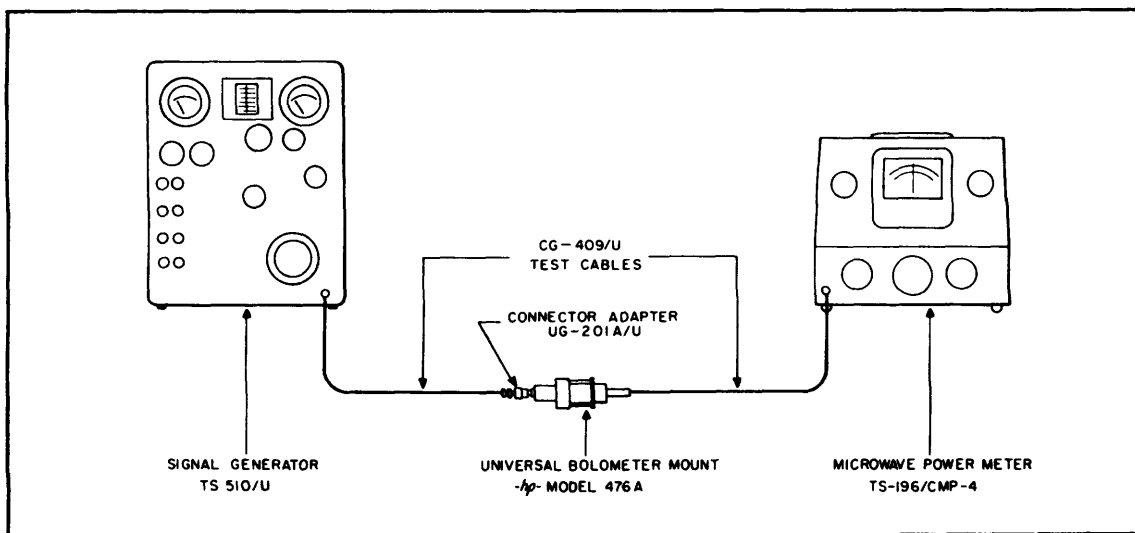


Figure 6-7. Test Set-Up for Calibrating the R-F Output Attenuator Dial

CAUTION

When inserting attenuator probe, or when shifting its position in the housing, do not allow the fingers on the probe body to jam in the guide slot. One finger is designed to slip under this slot if the loop is kept vertical.

d. Connect the signal generator to a power source and allow to warm up for 15 minutes.

e. Set the front panel operating controls as follows:

MOD. SELECTOR	CW
FREQUENCY CONTROL	10 megacycles
FREQUENCY RANGE	A band
AMP. TRIMMER	Adjust for max output
OUTPUT LEVEL	Adjust for max output
MOD. LEVEL	Minimum
XTAL CAL. GAIN	Minimum
Attenuator	+4 dbm ,(max cw position)

f. Connect power meter TS-196/CMP-4 or equivalent through a bolometer mount such as the Hewlett-Packard Co. Model 476A to the RF OUTPUT jack as shown in Figure 6-7.

g. Measure the maximum power obtainable from the signal generator, i.e., with the OUTPUT LEVEL control and the attenuator probe set for maximum penetration. The maximum power available must be between +7 and +9 dbm.

h. If necessary, readjust the maximum penetration of the attenuator to obtain the maximum power level specified in step "g", being careful to not let the probe pickup loop extend beyond the end of the attenuator housing, and preferably to be 1/64 inch back.

i. Set the attenuator dial to 0 dbm or a convenient level just below 0 dbm.

j. Adjust the OUTPUT LEVEL control to obtain the same power reading on the external power meter that is indicated on the attenuator dial.

k. The OUTPUT VOLTS meter pointer should now be at SET LEVEL; if it is not, the OUTPUT VOLTS meter must be adjusted as instructed in paragraph 6-30. If the adjustment of the OUTPUT VOLTS meter amounts to more than one decibel, it will be necessary to retrack the meter and then to recalibrate the PERCENT MODULATION meter circuit as well.

l. Check calibration points between +4 and -10 dbm on the attenuator dial. Calibration at 0 dbm and below should be adjusted for best accuracy.

6-30. CALIBRATING THE OUTPUT VOLTS METER.

6-31. Following replacement of a component in the r-f power monitor circuit, replacement of the OUTPUT VOLTS meter, or when calibrating the attenuator dial, the OUTPUT VOLTS meter must be adjusted or recalibrated. Changing a component in the power

monitor detector circuit will also affect the frequency response of the power monitor which must then be checked and, if necessary, readjusted. To calibrate the OUTPUT VOLTS meter refer to Figure 6-7 and proceed as follows:

a. Remove the TS-510A/U from its cabinet, connect to a source of power and allow to warm up for 15 minutes with the front panel controls set as follows:

MOD. SELECTOR	CW
FREQUENCY CONTROL	80 megacycles
FREQUENCY RANGE	A band
AMP. TRIMMER	Adjust for max output
OUTPUT LEVEL	Adjust to SET LEVEL
MOD. LEVEL	Extreme counter-clockwise
XTAL CAL. GAIN	Extreme counter-clockwise
Attenuator	0 dbm

b. Connect a power meter and bolometer mount to the RF OUTPUT jack as shown in Figure 6-7.

c. Set the attenuator to exactly 0 dbm and, disregarding the reading on the OUTPUT VOLTS meter, adjust the OUTPUT LEVEL control to obtain exactly 0 dbm reading on the external power meter.

d. Adjust R62 to obtain a reading exactly at SET LEVEL on the self-contained OUTPUT VOLTS meter.

e. Reading the db scale of the OUTPUT VOLTS meter, check the 0 and +7 calibration points with the external power meter (points -4 and +3 decibels from the 0 dbm power level, SET LEVEL calibration on meter). If these points are more than 0.5 db off calibration, proceed with tracking the meter as follows:

f. Adjust the OUTPUT LEVEL control for -4 dbm as read on the external power meter. If necessary, adjust R62 to obtain a reading of 0 db on the self-contained OUTPUT VOLTS meter.

g. Set OUTPUT LEVEL control for +3 dbm as read on the external power meter. If necessary, adjust R61 to obtain a reading of +7 db on the self-contained OUTPUT VOLTS meter.

h. Because the two adjustments R61 and R62 are interactive, steps "f" and "g" must be repeated until best overall accuracy of calibration is obtained.

i. Recheck accuracy of calibration at SET LEVEL (+4 dbm) and, if necessary, adjust R62 to obtain an exact reading at this point.

j. With the attenuator set on 0 dbm and the OUTPUT VOLTS meter set to SET LEVEL, check the r-f output power level at frequencies of 10, 100, 250, and 400 megacycles (use same measuring equipment as used for the calibration procedure above, comparing the higher frequencies with the 20 megacycles calibration frequency). If, at the higher frequencies, the OUTPUT VOLTS meter reading must be made higher to obtain the same power reading on the external power meter, the frequency response of the power monitor circuit is

Section VI

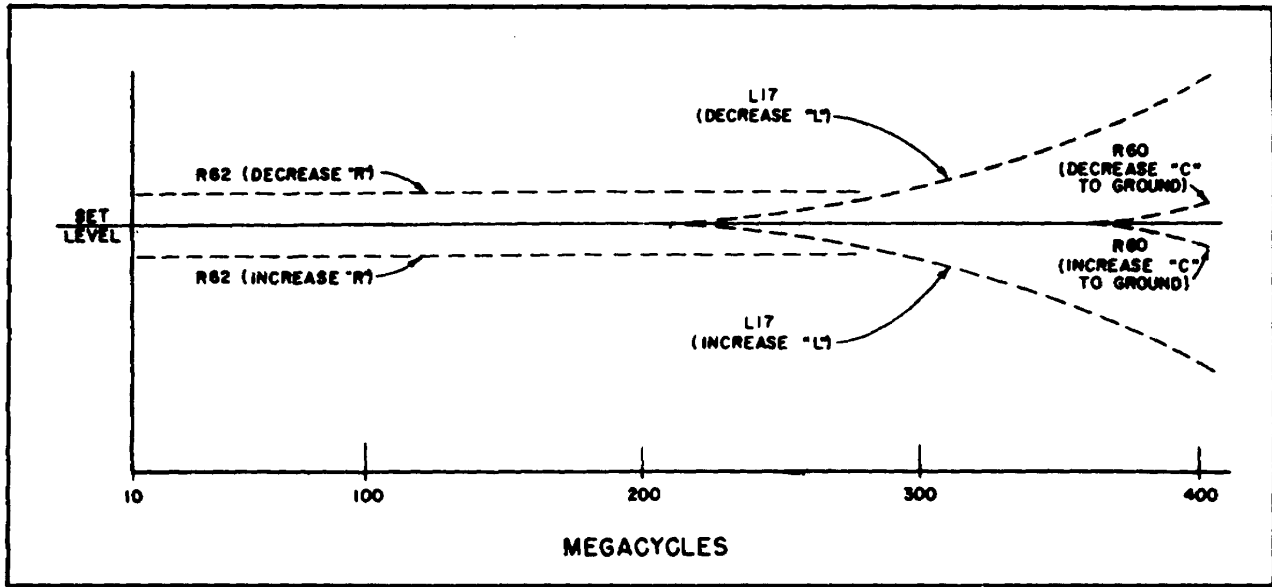


Figure 6-8. Graph Showing Effects of Adjustments on R-F Power Monitor Circuits

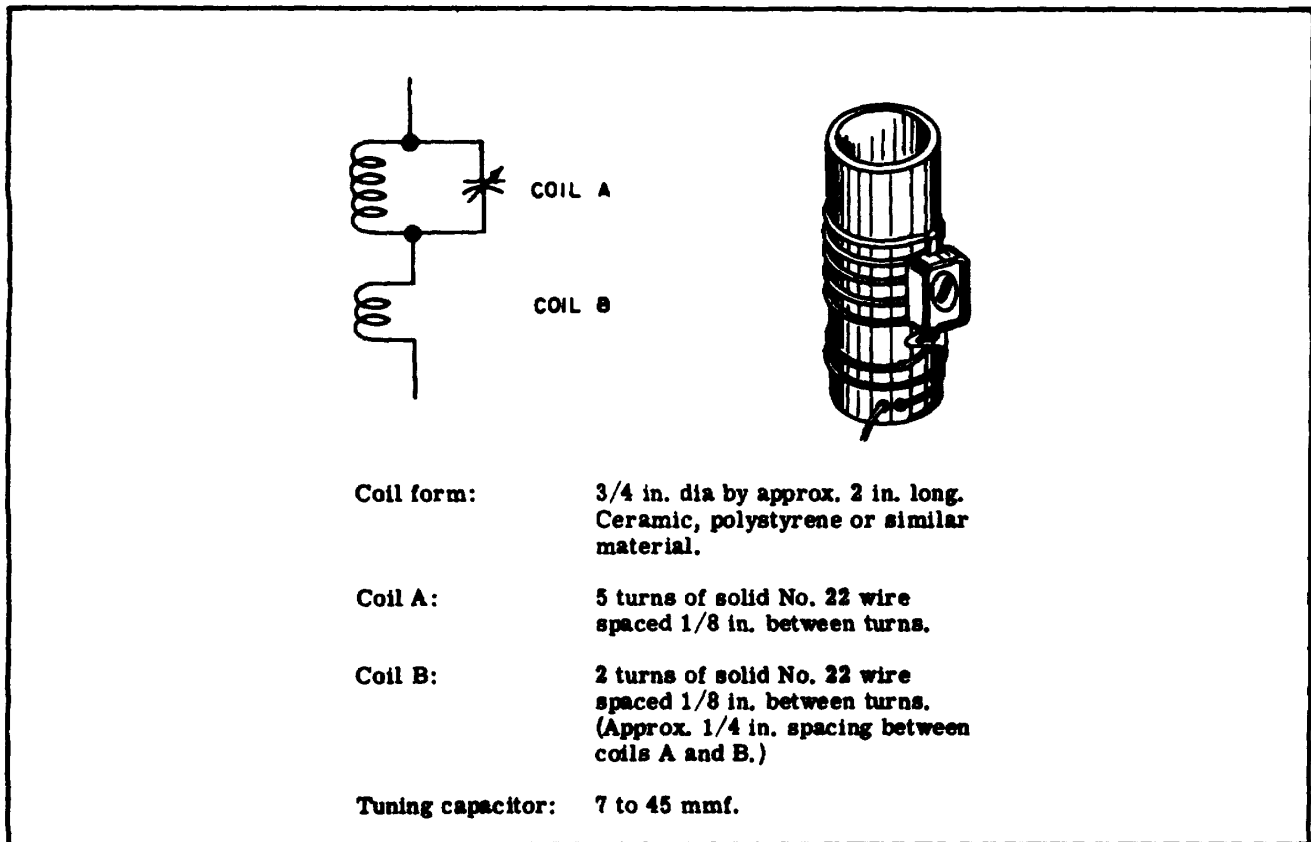


Figure 6-9. Special R-F Transformer Used for Measuring Percentage Modulation

rising. If the OUTPUT VOLTS meter reading must be made lower to obtain the same power output at the higher frequencies, the power monitor response is falling off.

CAUTION

When adjusting the frequency response of the power monitor detector, adjust the position of only one component very slightly at one time or the desired effects of the adjustment will be masked.

k. To adjust the power monitor frequency response at frequencies above approximately 350 megacycles, adjust the distance between R60 and ground to increase or decrease the capacity to ground. (See graph in Figure 6-8 for the effects of this adjustment.)

l. To adjust the power monitor frequency response at frequencies between approximately 250 and 350 megacycles, adjust the inductance of L17 by shortening to increase "L" and lengthening to decrease "L". (See graph in Figure 6-8 for the effects of this adjustment.)

6-32. CALIBRATING THE PERCENT MODULATION METER.

6-33. Following a repair of the modulation measuring circuits or after replacement of the meter itself, it is necessary to recalibrate the PERCENT MODULATION meter. The method of calibration outlined below requires the use of a peak-reading electronic voltmeter capable of measuring a-c voltages to over 400 megacycles, such as the ME-26A/U, and the tuned step-up transformer shown in Figure 6-9 to obtain adequate voltage. Basically, the peak value of the r-f output signal is measured without modulation and then with modulation. A doubling of the peak output voltage indicated on the multimeter represents 100% modulation of the output signal, while lesser percentages of modulation are indicated by proportionally smaller voltage increments.

6-34. The tuned transformer is easily fabricated with conventional tools and parts. Figure 6-9 illustrates such a transformer with all details needed for fabrication. The voltage from the tuned circuit should reach at least two volts with the signal generator OUTPUT VOLTS meter set exactly on SET LEVEL with no modulation present and the attenuator set to 0 dbm. For this procedure, all measurements are made by reading the 0 to 3 volt scale between the 1 and 2 volt calibrations. The 1-volt calibration mark represents 0% modulation; the 2-volt calibration represents 100% modulation; the intermediate graduations indicate each 10% increment of modulation percentage. The accuracy of this method of measurement is expected to be within 5%. To calibrate the PERCENT MODULATION meter, refer to Figure 6-10 and proceed as follows:

a. Remove the signal generator from its cabinet, connect to a power source and allow to warm up for 15 minutes with the front panel operating controls set as follows:

FREQUENCY RANGE	C band
MEGACYCLES DIAL	80 megacycles
MOD. SELECTOR	1000.
AMP. TRIMMER	Adjust for max output
OUTPUT VOLTS meter	Adjust to SET LEVEL
PERCENT MODULATION	Adjust for 0%
Attenuator	0 dbm

b. Connect the signal generator to the test apparatus as shown in Figure 6-10.

c. Set the ME-26A/U voltage range switch to the 10-volt a-c range.

d. Adjust the capacitor on the r-f transformer to obtain highest voltage as read on the 10-volt range on the multimeter.

e. Adjust the output attenuator on the signal generator to obtain a reading of "1" on the 0 to 3-volt scale of the multimeter.

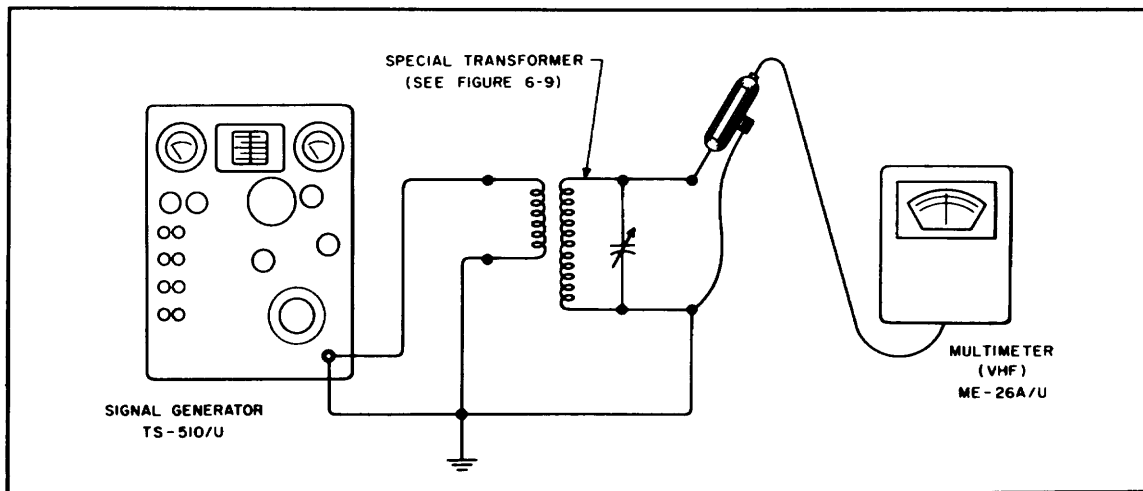


Figure 6-10. Test Set-Up for Measuring Percent Modulation of R-F Carrier

Section VI
Paragraphs 6-35 to 6-36

f. Advance the MOD. LEVEL control to obtain a reading of 1.8 on the 0 to 3-volt scale on the multimeter. If necessary, readjust the OUTPUT LEVEL control to hold the OUTPUT VOLTS meter reading at SET LEVEL. Application of high percentages of modulation may result in a slight rise (1/4 db) in the OUTPUT VOLTS meter indication. The OUTPUT LEVEL control must be set at all times to provide a reading at SET LEVEL on the OUTPUT VOLTS meter.

g. If necessary, adjust R104 to obtain a reading of 80% on the PERCENT MODULATION meter.

h. Check the meter calibration for other modulation

percentages, e.g., 1.1 on the voltmeter corresponds to 10% modulation, 1.2 to 20%, etc. The setting of R104 may be refined to obtain best overall calibration accuracy of the PERCENT MODULATION meter.

6-35. CALIBRATING THE FREQUENCY-CALIBRATOR OSCILLATOR.

6-36. Recalibration of the 5 megacycle crystal-controlled frequency-calibrator oscillator will be necessary following replacement of any of the components

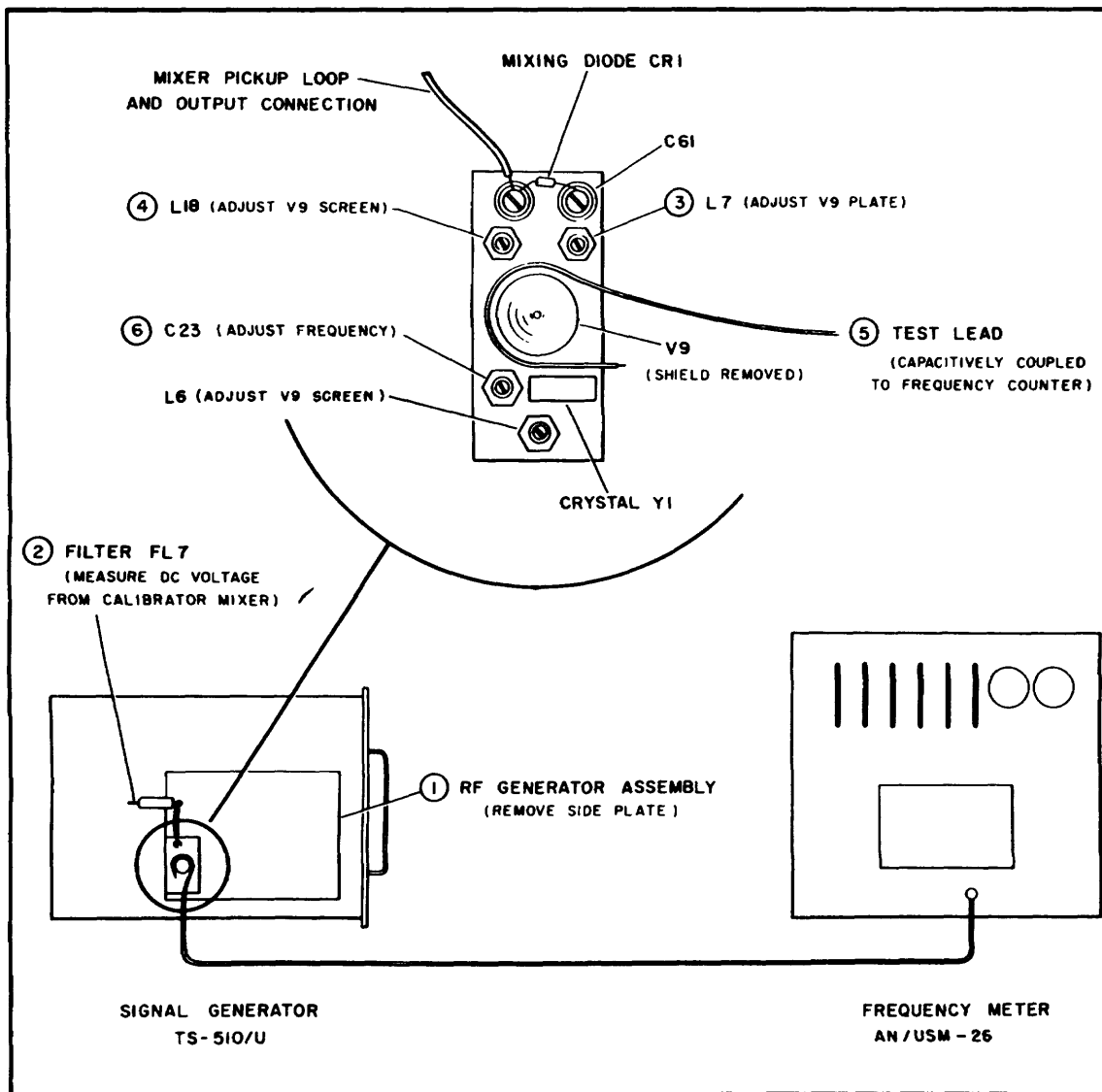


Figure 6-11. Test Set-Up for Calibrating Frequency Calibrator Oscillator

Revised 1 May 1958

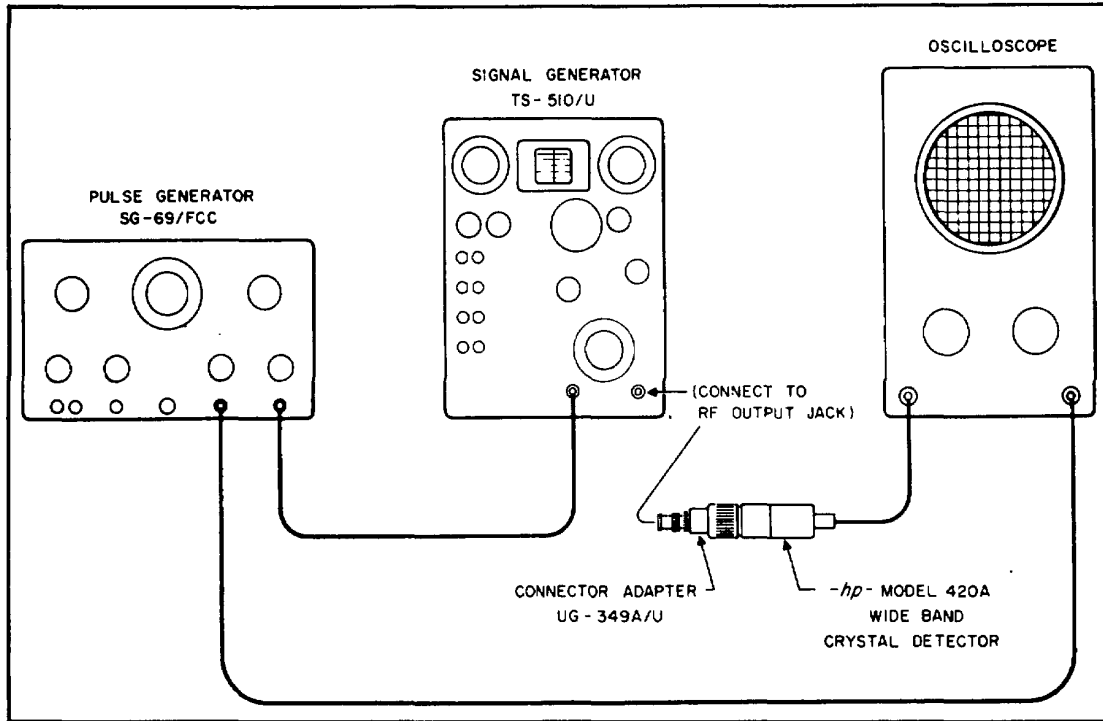


Figure 6-12. Test Set-Up for Measuring R-F Output Pulse.

in the oscillator circuit. Calibration consists of making the very limited frequency adjustment to bring the crystal frequency to exactly 5 megacycles, peaking the tunable oscillator plate tank and minimizing the tunable screen grid tank circuit. To calibrate the calibrator-oscillator, refer to Figure 6-11 and proceed as follows:

- a. Remove signal generator from its cabinet, connect to power source and allow to warm up for 15 minutes.
- b. Remove side plate from the r-f generator housing to gain access to the calibrator oscillator.
- c. Connect a d-c voltmeter to the outside terminal of filter FL7.
- d. Adjust L7 to peak the d-c voltmeter indication. This voltage should be between 1-1/2 and 4 volts.
- e. Adjust L7 (screen adjustment) to dip the dc voltmeter indication. More than one dip is sometimes obtained, any one of which may be used.
- f. Recheck setting of L7. Capacitively couple a lead from V9 to any suitable frequency measuring instrument.
- g. Adjust C23 to obtain exact 5 mc signal as read on the frequency meter. No further adjustment is necessary if the required frequency and output level are obtained.

6-36A. CALIBRATING THE FREQUENCY-CALIBRATOR OSCILLATOR OF SIGNAL GENERATOR, TS-510A/U.

6-38B. For recalibration of the 5 megacycle crystal-controlled frequency-calibrator oscillator refer to paragraph 6-36. To calibrate the 1 megacycle oscillator, refer to figure 6-11 and proceed as follows:

- a. Repeat steps a. through c. of paragraph 6-36.
- b. Adjust L18 to peak the d-c voltmeter. This voltage should be between 1-1/2 and 5 volts.

6-37. MEASURING THE QUALITY OF THE PULSE MODULATED R-F OUTPUT SIGNAL.

6-38. To measure the quality of the r-f output pulse from the TS-510A/U Signal Generator requires an r-f detector such as the Hewlett-Packard Co. Model 420A, a pulse generator supplying high-speed pulses (AN/PPM-1) and a high-speed oscilloscope such as the Tektronix 511 or 514 series, connected as shown in Figure 6-12. The input modulating pulse must have a rise and decay time as fast as a few-tenths microsecond and the oscilloscope must be capable of displaying such a pulse without overshoot or decreased sharpness. Due to the bandwidth limitation in the tuned r-f circuit amplifier the maximum speed of the output pulse from the signal generator improves with increasing frequency (bandwidth being equal to f_0/Q). To measure the quality of the r-f output pulse from the TS-510/U, refer to Figure 6-12 and proceed as follows:

- a. Connect the TS-510A/U to a power source and set controls for external pulse modulation.
- b. Connect the main output pulse from the pulse generator to the EXT. PULSE jack on the TS-510A/U.
- c. Connect the syn output pulse from the pulse generator to the horizontal sweep on the oscilloscope.
- d. Connect the RF OUTPUT jack on the TS-510A/U to the r-f detector and to the vertical amplifier on the oscilloscope.
- e. Set the pulse generator to obtain a 10-volt output pulse of the desired length.
- f. Set the oscilloscope for a 1 microsecond/cm sweep or faster to obtain a convenient pulse picture.
- g. Measure pulse rise and decay time at r-f output frequencies specified under PULSE MODULATION in the table of specifications for the signal generator.

6-39. MEASURING THE QUALITY OF THE SINE MODULATED R-F OUTPUT SIGNAL.

6-40. To measure distortion in the modulated r-f output signal from the TS-510A/U Signal Generator requires an r-f detector such as the Hewlett-Packard Co. Model 420A and a distortion analyzer such as the TS-723/U connected as shown in Figure 6-13. This measurement will be sufficiently accurate to determine if the quality of the modulated output signal is within specifications; however, due to distortion introduced by the detector, the quality of the output signal will always be better than the measurement indicates. If the measurement indicates excessive distortion at more than one r-f output frequency, the r-f amplifier tube may be suspected of being weak and is usually accompanied by lessening of the maximum r-f power available from the signal generator. To measure the quality of the 400 or 1000 cycle sine modulation r-f output signal, refer to Figure 6-13 and proceed as follows:

- a. Connect the TS-510A/U to a power source and set the controls for 400 cycle modulation.
- b. Connect the RF OUTPUT jack on the TS-510A/U to the detector and to the input of the TS-723/U Distortion Analyzer.

c. Adjust the TS-510A/U for 30% modulation of 400 megacycles with output power level set to SET LEVEL and the attenuator set to 0 dbm.

d. Adjust the TS-723/U to obtain a full scale reading when set to .3 volt range and for SET LEVEL operation.

e. Set the TS-723/U for DISTORTION operation and tune out the fundamental frequency. The distortion component that remains is now read directly in percentage from the 0 to 1 scale multiplied by 10 with the range selector on the .03 volt range. Distortion component should be less than 5% of the total signal level at 30% modulation and less than 10% at 50% modulation.

f. Repeat measurements using 1000 cycle modulation if desired.

6-41. MAINTENANCE, OVERHAUL AND INSPECTION SCHEDULE.

6-42. The TS-510A/U Signal Generator requires no periodic overhaul schedule, or maintenance other than that resulting from a part failure. The only preventive maintenance recommended is the lubrication described in paragraph 5-19 and the inspection described in paragraph 5-21.

6-43. MODERNIZATION.

6-44. The schematic and practical wiring diagrams in this manual are for signal generators with serial numbers 303 and above. In instruments with serial numbers below 303, four component values in the 5 megacycle crystal oscillator for the frequency calibrator differed in value (see paragraph 1-8). The new components are directly interchangeable with the original parts; however, if a signal generator is operating satisfactorily, there is no reason to make this modification.

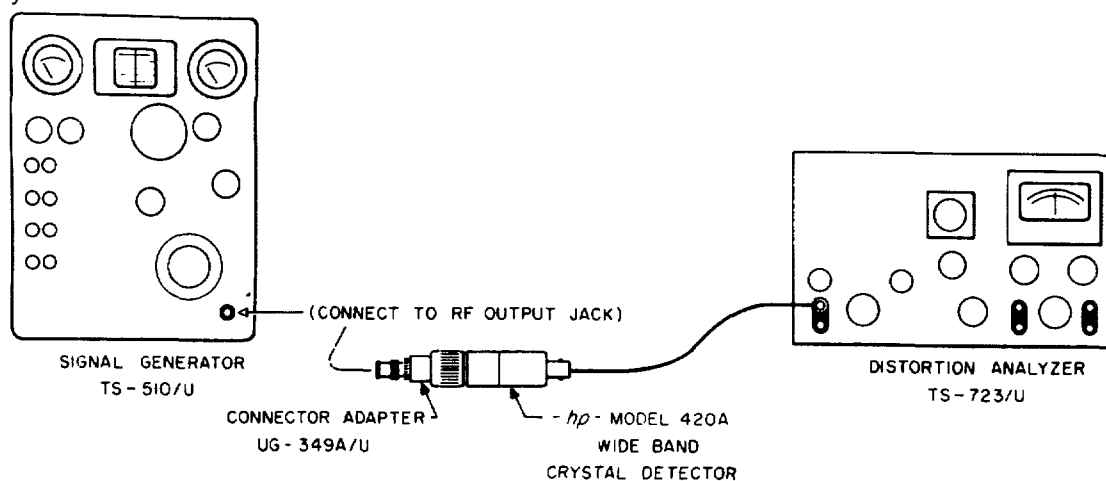


Figure 6-13. Test Set-Up for Measuring the Quality of CW Output Signal.

SECTION VII

DIAGRAMS

7-1. INTRODUCTION.

7-2. This section contains the following illustrations and diagrams for Signal Generator TS-510A/U:

7-1 Signal Generator TS-510A/U Left Side View, Cabinet Removed

7-2 R-F Generator Assembly, Inside View of Tuner Compartments

7-3 R-F Generator Assembly, Inside View of Tube Compartment

7-4 Signal Generator TS-510AYU Right Side View, Cabinet Removed

7-5 Complete Block Diagram for Signal Generator TS-510A/U

7-6 Tube Socket Voltage-Resistance Diagram, Power Supply Section

7-7 Tube Socket Voltage-Resistance Diagram, R-F Generator Section

7-8 Tube Socket Voltage-Resistance Diagram, Modulator Section

7-9 Schematic Diagram for Signal Generator TS-510A/U

7-10 Practical Wiring Diagram for Signal Generator TE-510A/U

7-11 Signal Generator T8S-51A/U Cabinet Dimensions

7-12 Transit Case CY-1605/USM-44 Dimensions

7-13 Resistor and Capacitor Color Code

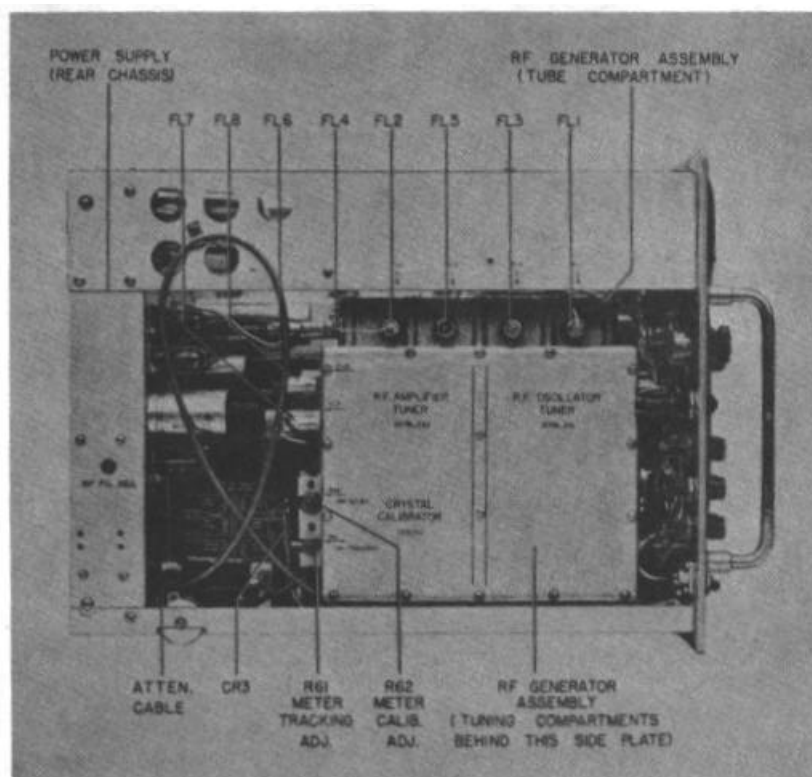


Figure 7-1. Signal Generator TS-510A/U Left Side View, Cover Removed.

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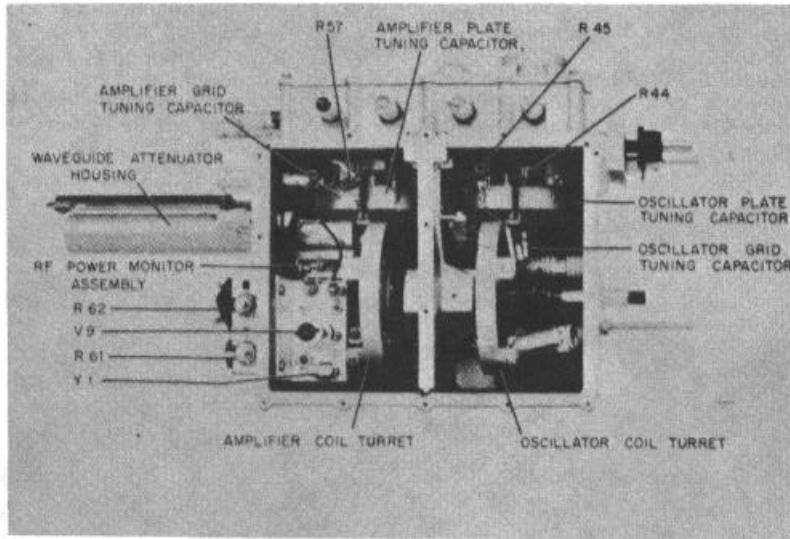


Figure 7-2. R-F Generator Assembly, Inside View of Tuner Compartments.

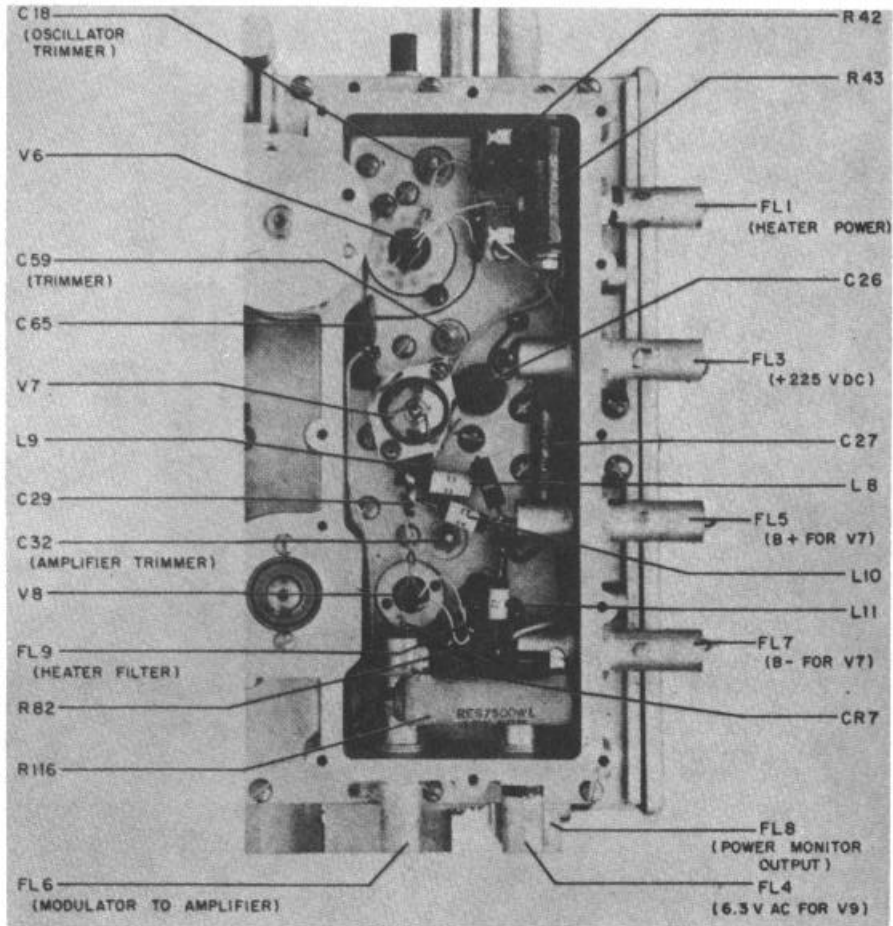


Figure 7-3. R-F Generator Assembly, Inside View of Tube Compartment.

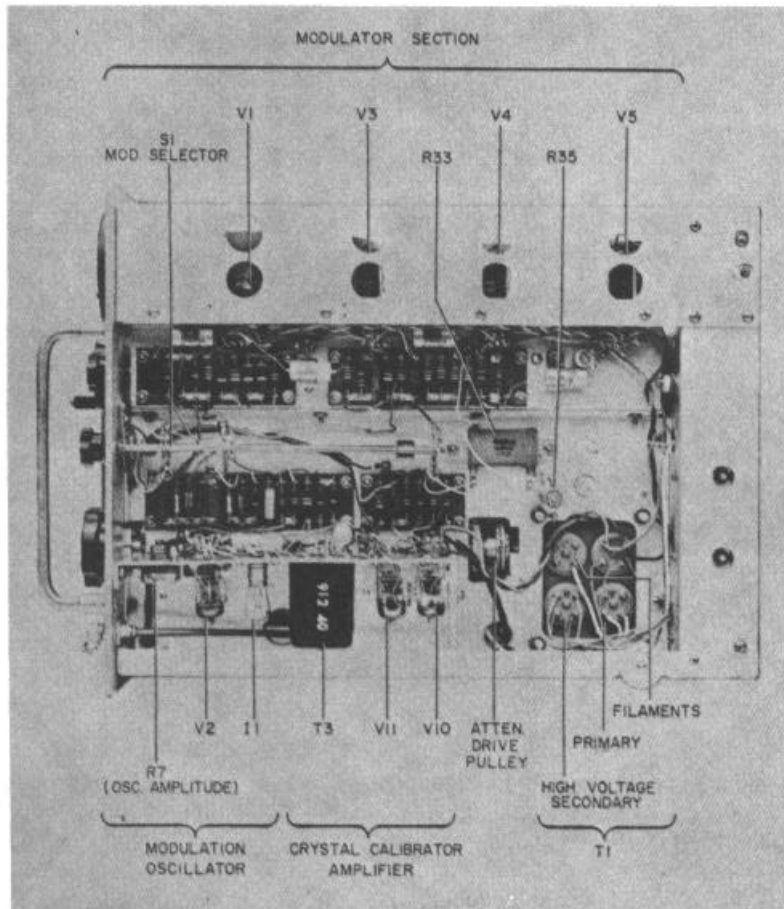


Figure 7-4. Signal Generator TS-510A/U Right Side View, Cover Removed.

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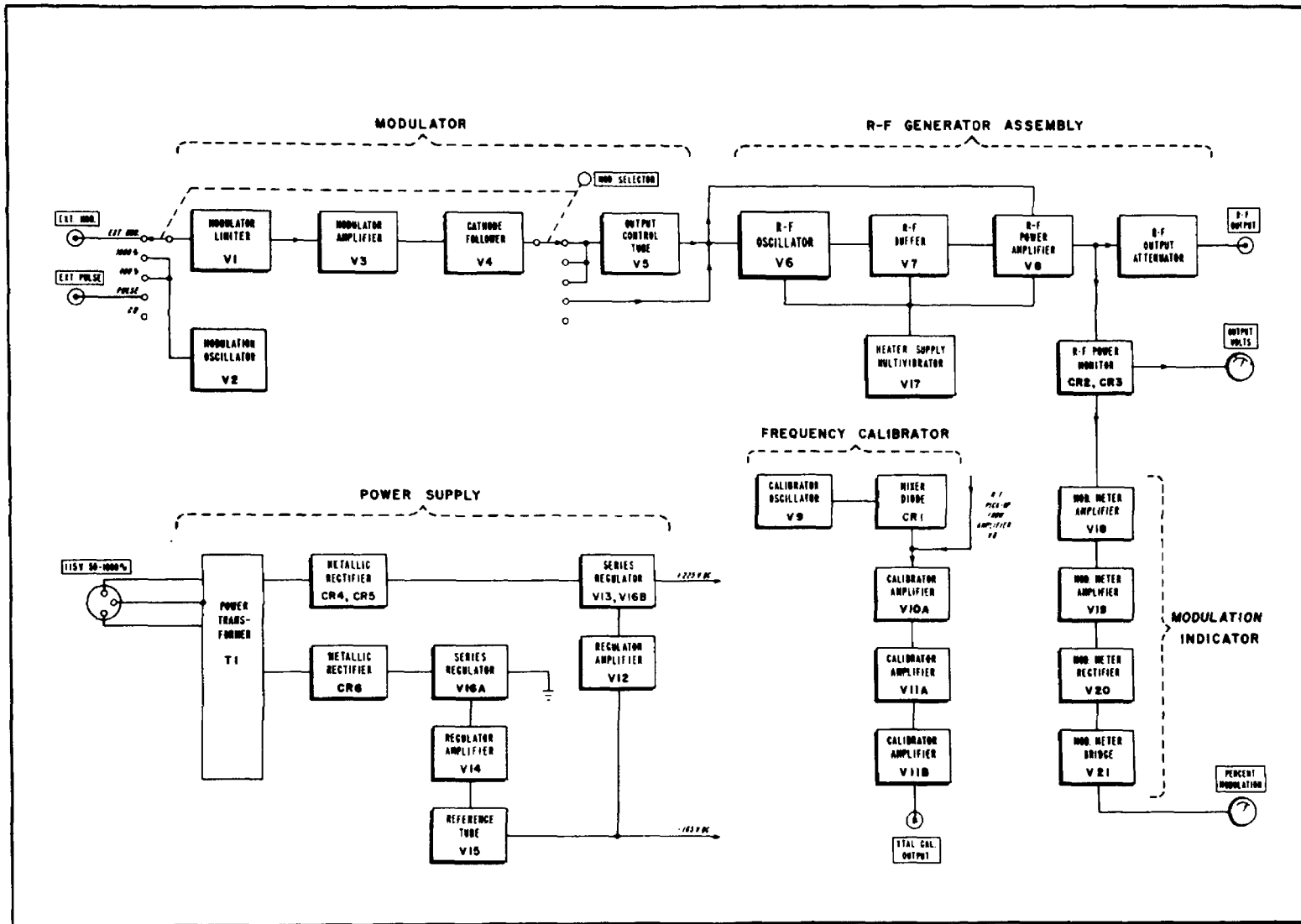


Figure 7-5. Complete Block Diagram for Signal Generator TS-510A/U.

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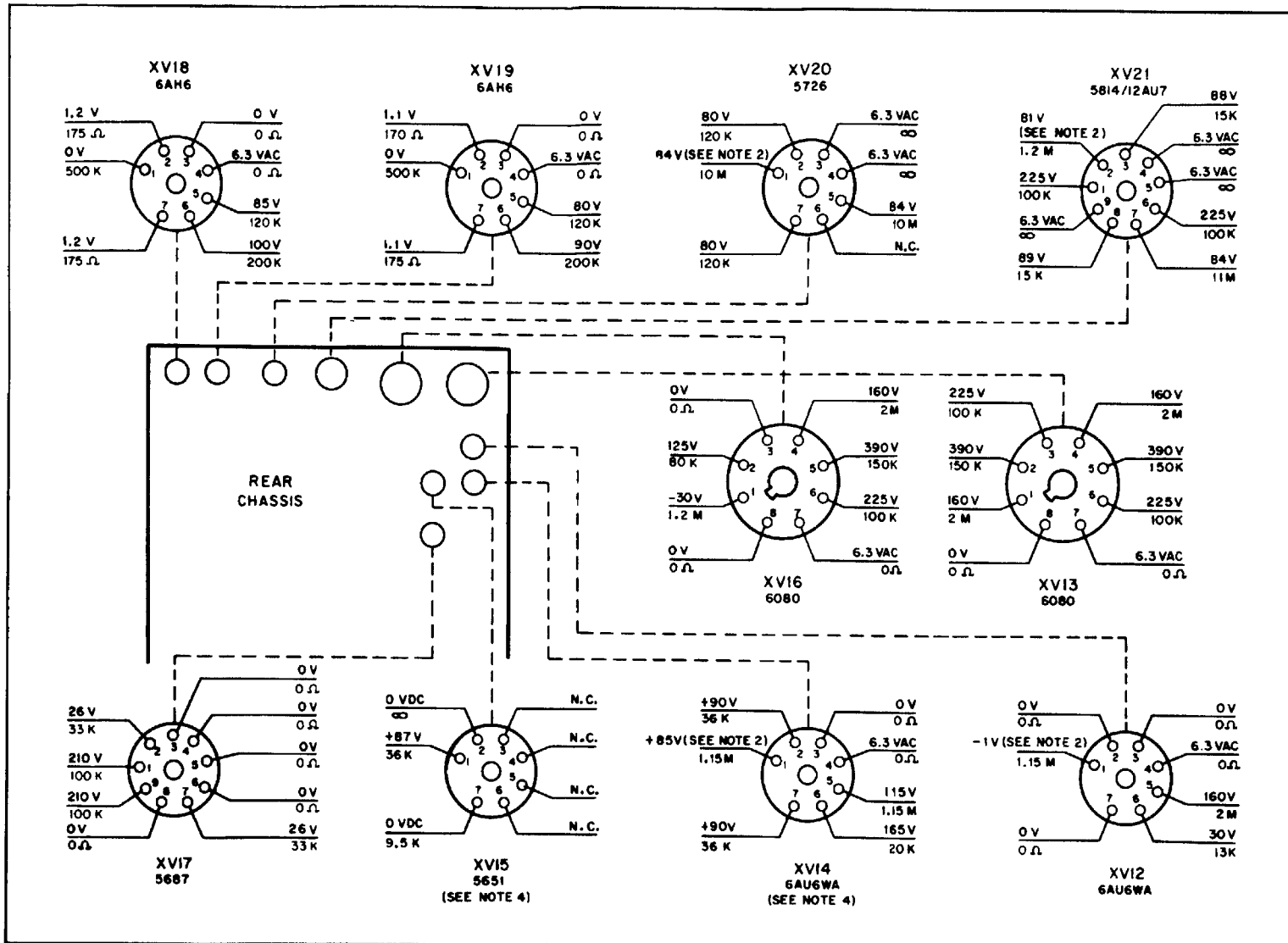


Figure 7-6. Tube Socket Voltage-Resistance Diagram, Power Supply Section.

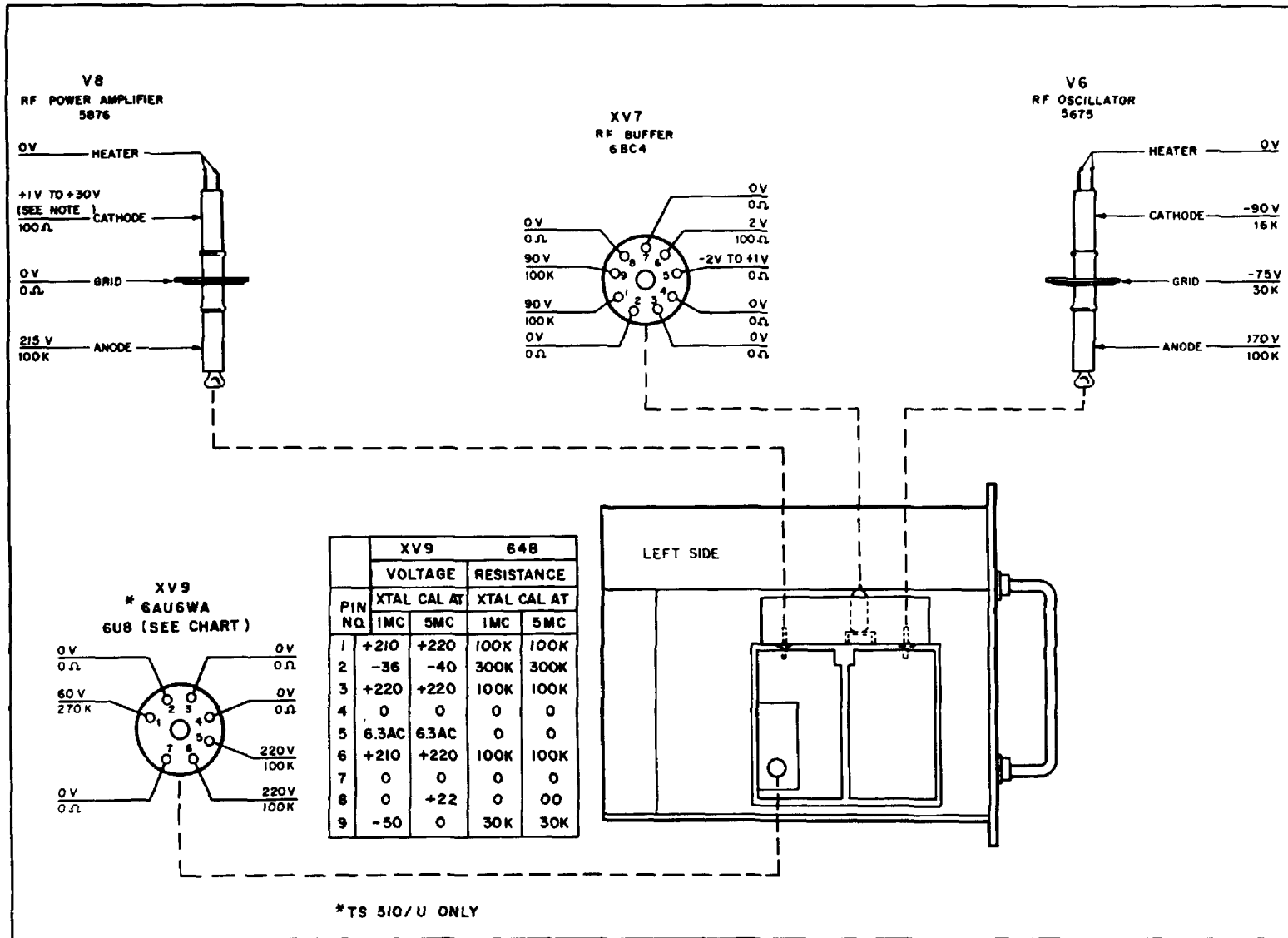


Figure 7-7. Tube Socket Voltage-Resistance Diagram, R-F Generator Section.

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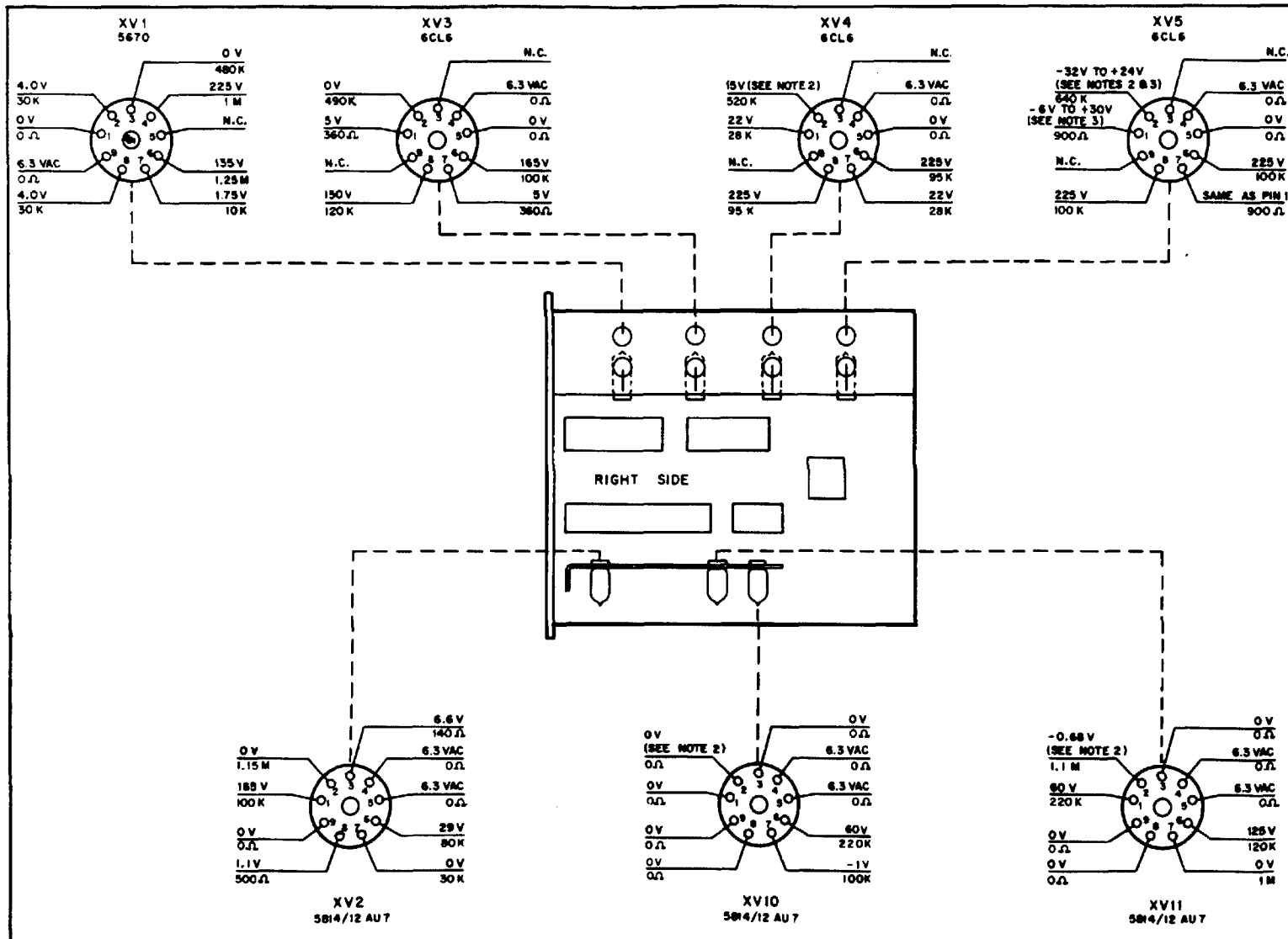


Figure 7-8. Tube Socket Voltage-Resistance Diagram, Modulator Section.

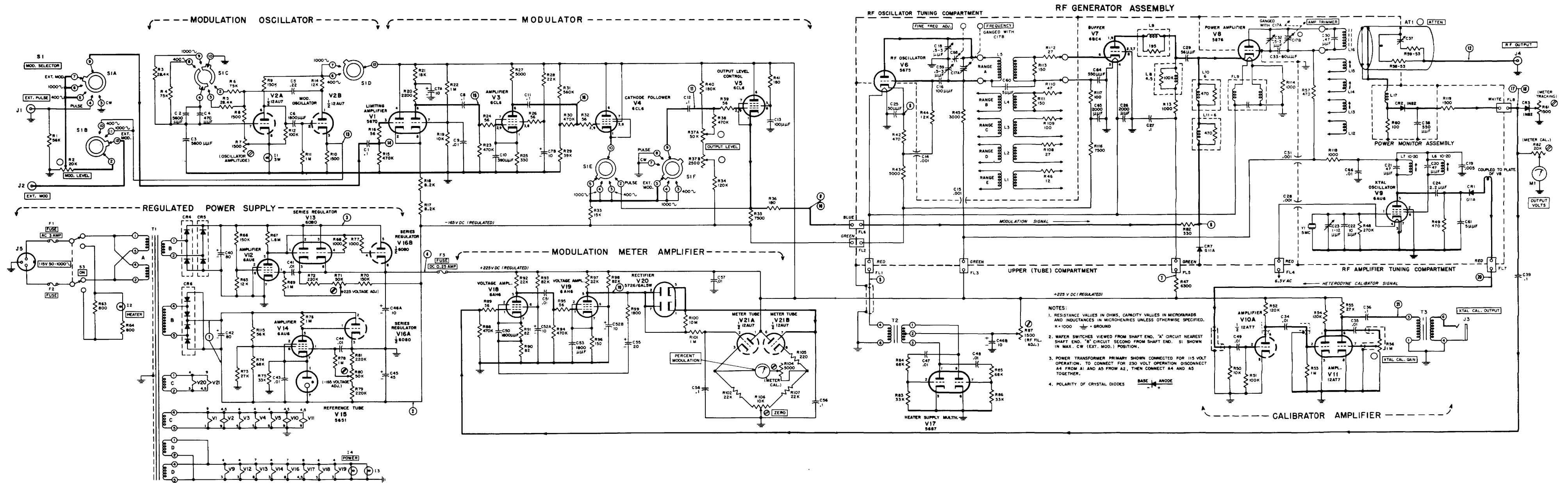


Figure 7-9. Schematic Diagram for Signal Generator TS-510/U.

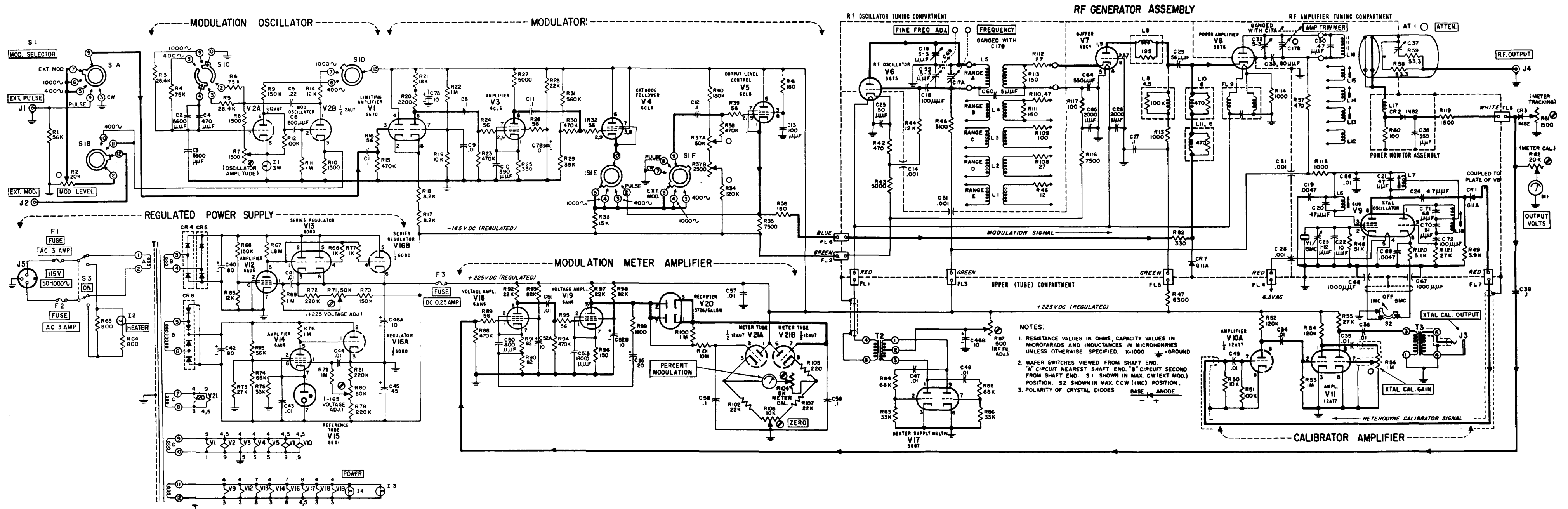


Figure 7-9A. Schematic Diagram for Signal Generator TS-510A/U(*)

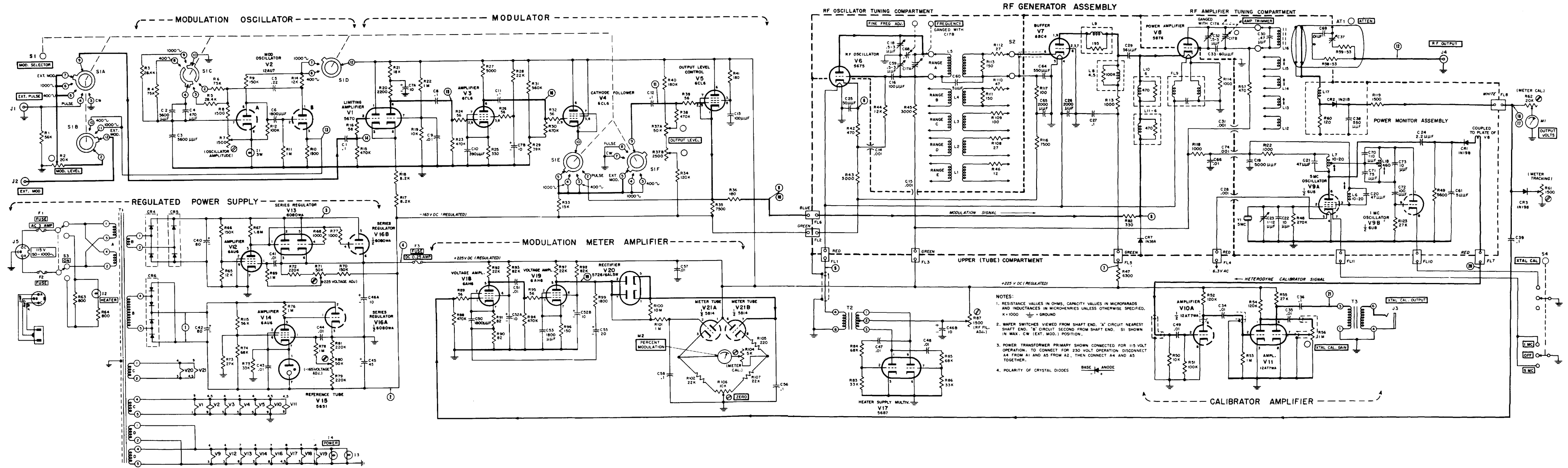


Figure 7-9B. Schematic Diagram for Signal Generator TS-510A/U(**).

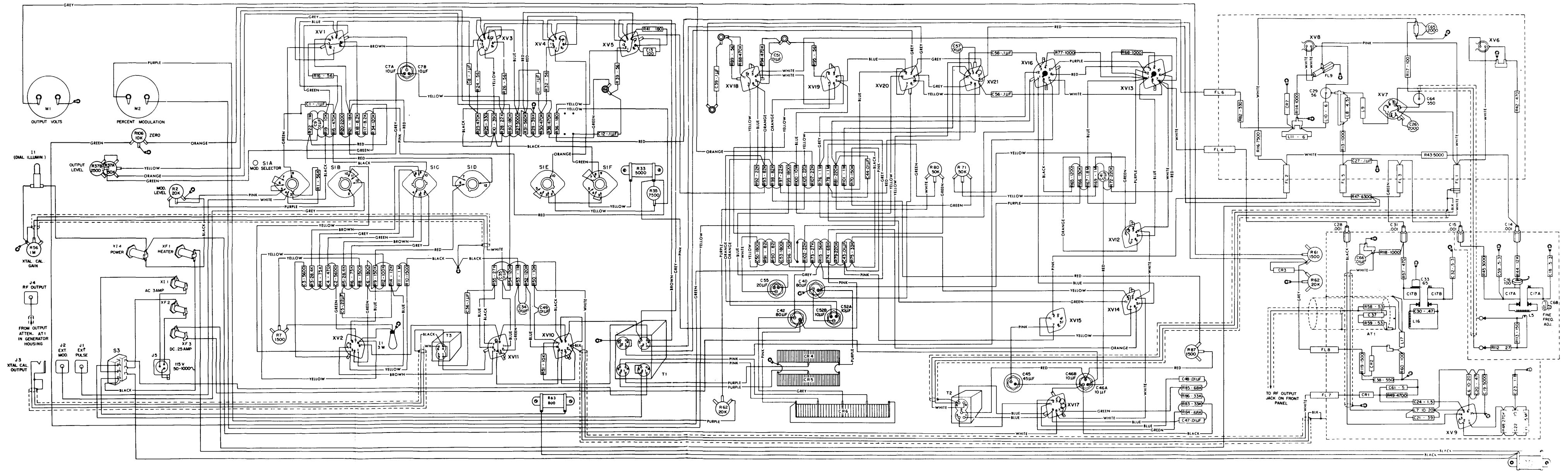


Figure 7-10. Practical Wiring Diagram for Signal Generator TS-510/U

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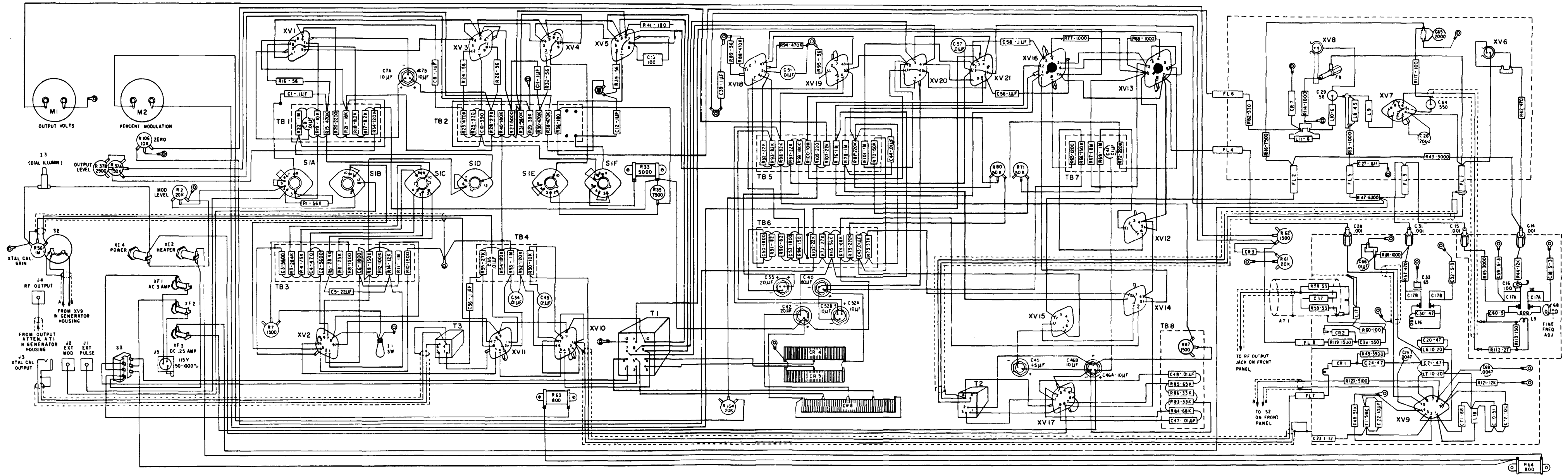


Figure 7-10A. Practical Wiring Diagram for Signal Generator TS-510A/U(*)

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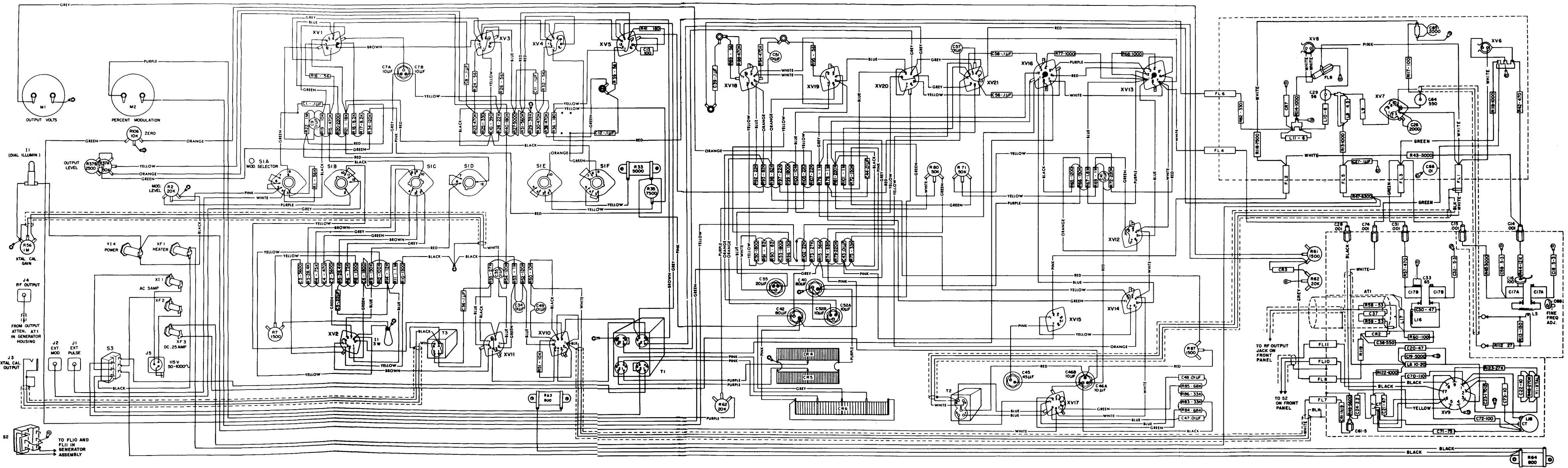


Figure 7-10B. Practical Wiring Diagram for Signal Generator TS-510A/U(*)

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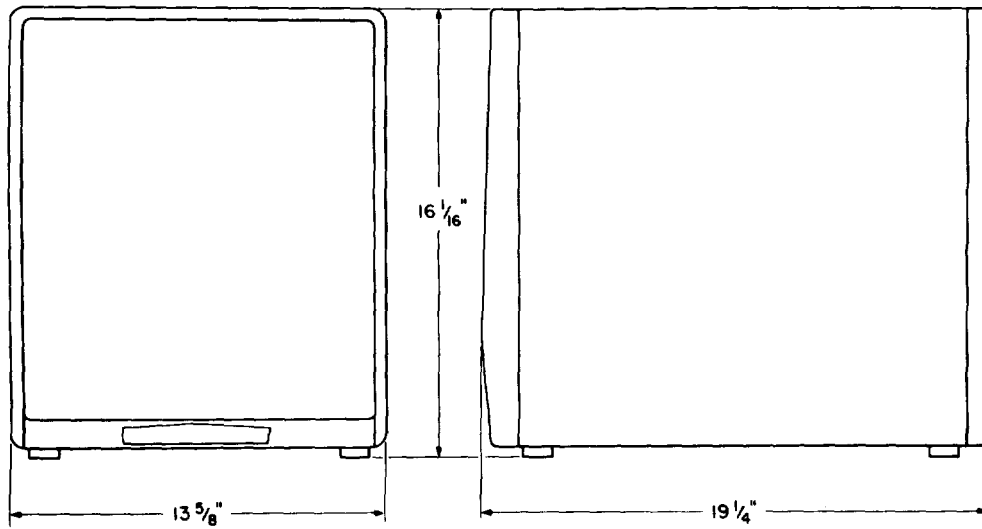


Figure 7-11. Signal Generator TS-510A/U Cabinet Dimensions.

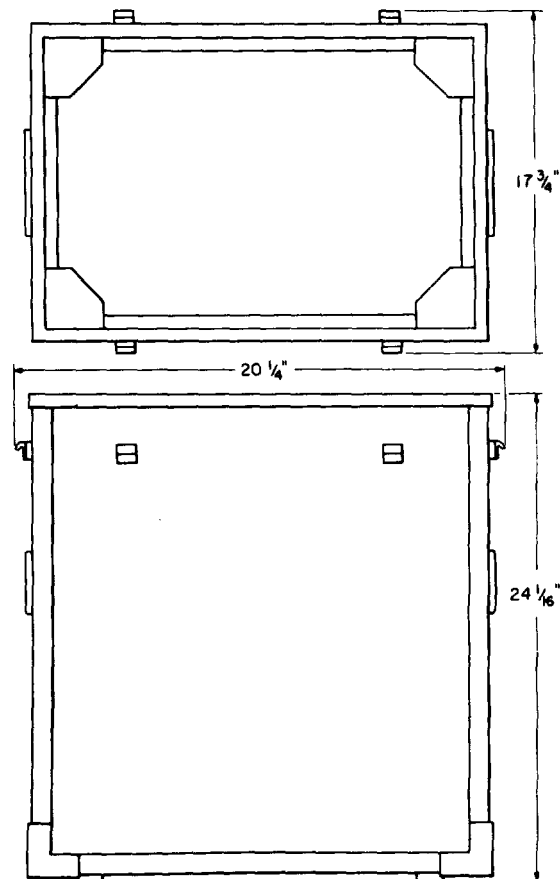
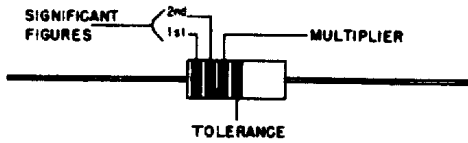


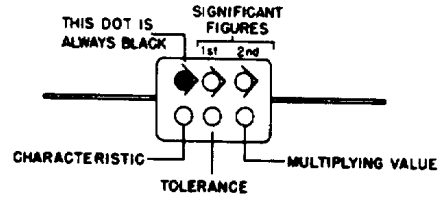
Figure 7-12. Transit Case CY-1605/USM-44 Dimensions.

JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS



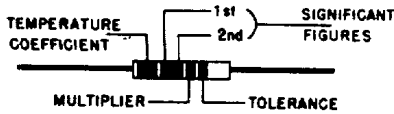
Color	Sig. Fig.	Multiplier	Tolerance
Black	0	1	-
Brown	1	10	±1%
Red	2	100	±2%
Orange	3	1000	±3%
Yellow	4	10000	±4%
Green	5	100000	±5%
Blue	6	1000000	±6%
Violet	7	10000000	±7%
Gray	8	100000000	±8%
White	9	1000000000	±9%
Gold			±5%
Silver			±10%
No color			±20%

JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



Color	CAPACITANCE		Tolerance	Char. Desig.
	Sig. Fig.	Multiplier		
Black	0	1	±20%	A
Brown	1	10		B
Red	2	100	±2%	C
Orange	3	1000		D
Yellow	4	10000		E
Green	5			F
Blue	6			G
Violet	7			
Gray	8			
White	9			
Gold			±5%	
Silver			±10%	
No color				

JAN COLOR CODE FOR CERAMIC DIELECTRIC CAPACITORS (TEMPERATURE COMPENSATING)



Color	CAPACITANCE		TOLERANCE		Char. Desig.
	Sig. Fig.	Multiplier	In % (Cap. More than 10 µf)	In µf (Cap. Less than 10 µf)	
Black	0	1	±20	±2	C
Brown	1	10	±1		H
Red	2	100	±2		L
Orange	3	1000			P
Yellow	4				R
Green	5		±5	±0.5	S
Blue	6				T
Violet	7				U
Gray	8			±0.25	B
White	9		±10	±1	SL
Gold					A

COLOR CODE FOR MINIATURE CAPACITORS



Color Code	Value
Green & White	0.5 µf
Violet & White	0.68 µf
Brown (one band only)	1.0 µf
Brown & Green	1.5 µf
Red (one band only)	2.2 µf
Orange (one band only)	3.3 µf
Green (one band only)	4.7 µf

Figure 7-13. Resistor and Capacitor Color Code.

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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 decigrams = .035 ounce
 1 dekagram = 10 grams = .35 ounce
 1 hectogram = 10 dekagrams = 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 milliliters = .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

<i>To change</i>	<i>To</i>	<i>Multiply by</i>	<i>To change</i>	<i>To</i>	<i>Multiply by</i>
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	1.365	metric tons	short tons	1.102
pound-inches	newton-meters	.11375			

Temperature (Exact)

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

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