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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL
FIELD AND DEPOT
MAINTENANCE
MANUAL

SIGNAL GENERATORS AN/URM-64 AND AN/URM-64A

This copy is a reprint which includes current pages from Changes 1 and 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY

JANUARY 1959

TECHNICAL MANUAL)
)
No. 11-6625-299-15)

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, 25, D.C., 27 January 1959

SIGNAL GENERATORS AN/URM-64 AND AN/URM-64A

Paragraph		Page
	Table of Contents	i
	List of Illustrations	ii.2
	List of Tables	iv
	Warning	iv
	SECTION I - GENERAL DESCRIPTION	
1.	Purpose of Handbook	1-1
1.1.	Index of Publications	1-1
1.2.	Forms and Records	1-1
2.	Purpose of Equipment	1-1.1
3.	General Principles of Operation	1-1.1
4.	Equipment Supplied	1-1.1
5.	Equipment Required But Not Supplied	1-1.1
6.	General Electrical Characteristics	1-2
	a. Power Requirements	1-2
	b. Operating Range	1-2
	c. Detailed Characteristics	1-2
	d. Standby Heaters	1-2
7.	Description of Equipment Supplied	1-2
	a. Signal Generator TS-419/U	1-2
	b. Accessories	1-2
8.	Quantities and Types of Electron Tubes, Fuses, and Indicator Lamps	1-4
	SECTION II - OPERATION AND ADJUSTMENT	
1.	Unpacking and Inspecting the Equipment	2-1
2.	Function of Equipment	2-1
3.	Pre-installation Tests	2-2
4.	Operating Controls	2-2
5.	Starting the Equipment	2-2
6.	Operating Procedures	2-4
	a. CW Operation	2-4
	b. Pulsed Operation	2-4
	c. Use of Signal Generator TS-419/U to Provide Unsynchronized Pulsed R-F Signals	2-4
	d. Synchronization of the Pulsed R-F Output Signals with an External Signal	2-5
	e. Modulation of the Oscillator with an External Pulse Signal	2-5
	f. Provision of Sync Output for External Use	2-5

*This manual supersedes TM 11-5553, 20 December 1954 and TM 11-6625-299-10P, 14 July 1959, including C1, 19 January 1962, and so much of TM 11-6625-299-20P, 14 July 1959, as pertains to maintenance allocation.

Paragraph Page

7. Use of Signal Frequency Interpolation Scales 2-5
8. Stopping the Equipment 3-0

SECTION III - THEORY OF OPERATION

1. Introduction 3-0
2. Block Diagram 3-0
3. R-F Oscillator 3-0
4. Output System 3-2
   a. R-F Output 3-2
   b. Power Monitor 3-2
5. Modulator and Synchronizer 3-3
   a. General 3-3
   b. Input Amplifier 3-5
   c. Rate Multivibrator 3-6
   d. Delay Multivibrator and Undelayed Sync Output 3-6
   e. Width Multivibrator 3-6
   f. Pulse Amplifier and Delayed Sync Output 3-9
6. Power Supply 3-11

SECTION IV - MAINTENANCE

1. Scope of Maintenance 4-1
2. Preventive Maintenance 4-1
2.1. Preventive Maintenance Checks and Services Periods 4-1
2.2. Daily Preventive Maintenance Checks and Services Charts 4-2
2.3. Weekly Preventive Maintenance Checks and Services Chart 4-2.1
2.4. Cleaning 4-2.2
2.5. Monthly Maintenance 4-2.2
2.6. Monthly Preventive Maintenance Checks and Services Chart 4-2.3
2.7. Touchup Painting Instructions 4-2.4
3. Corrective Maintenance 4-2.4
   a. General 4-2.4
   b. Localizing Trouble 4-2.4
4. Test Equipment Required 4-10
5. Removal and Replacement of Chassis 4-11
   a. Removing the Chassis 4-11
   b. Replacing the Chassis 4-11
6. Replacement of Vacuum Tubes 4-11
   a. General 4-11
   b. Precautions 4-11
   c. Replacement of R-F Oscillator Tube V-111 4-11
7. Initial Electrical Adjustments 4-12
   a. General 4-12
   b. Regulated Voltage Adjustments 4-12
   c. Voltage Checks 4-12
   d. Panel Meter Zero Adjustments 4-12
8. Calibration Adjustments 4-13
   a. General 4-13
   b. Signal Frequency Dial Adjustments 4-14
   c. Output Attenuator Calibrations 4-15

Paragraph		Page
	d. Pulse Width Calibration	4-16
	e. Pulse Delay Calibration	4-17
	f. Pulse Rate Calibration	4-19
9.	Miscellaneous Electrical Tests	4-21
	a. Sine Wave Synchronizing Characteristics	4-21
	b. Pulse Synchronizing Characteristics	4-21
	c. External Modulation Characteristics	4-22
	d. Sync Output Characteristics	4-22
	e. Output Attenuator Impedance	4-23
	f. R-F Leakage Checks	4-24
10.	Maintenance of R-F Assembly	4-25
	a. General	4-26
	b. Thermistors	4-26
	c. R-F Filters	4-29
	d. Reflector Tracking Potentiometer R-185	4-29
	e. Attenuator	4-30
	f. Removal and Replacement of R-F Assembly Complete	4-30
	g. "T" Assembly	4-32
	h. Power Take-off Probe	4-32
	i. Disassembly and Reassembly of Dials and Gears	4-32
	j. Disassembly and Reassembly of Cavity Assembly	4-34
10A.	Removal and Replacement of Selector Switch S-101	4-36
	a. Removal of Selector Switch S-101	4-36
	b. Replacement of Selector Switch S-101	4-36
11.	Voltage Measurements	4-37
12.	Resistance Measurements	4-43
13.	Coil Winding Data	4-43

SECTION V - SUPPLEMENTARY DATA

1.	Functional Tube and Lamp Complement	5-1
2.	Technical Summary	5-1
3.	Signal Generator Considerations	5-2
4.	Interior Illustrations	5-3

SECTION VI - RESISTOR AND CAPACITOR COLOR CODES

SECTION VII - DRAWINGS

APPENDIX	I. REFERENCES	I-1
	II. MAINTENANCE ALLOCATION CHART	II-1
	III. BASIC ISSUE ITEMS LIST	III-1
INDEX		8-1

LIST OF ILLUSTRATIONS

Figure	Title	Page
1-1.	Signal Generator AN/URM-64	1-0
1-2.	Signal Generator TS-419A/U, Right Oblique View	1-2
1-3.	Transit Case CY-686/U and CY-686A/U and Accessories	1-3
1-4.	Signal Generator AN/URM-64A	1-5
2-1.	Signal Generator TS-419A/U, Front Panel View	2-1
2-2.	Signal Generator TS-419/U, Graph of Maximum Allowable Pulse Delay Versus Pulse Repetition Rate	2-5
3-1.	Signal Generator TS-419/U, Block Diagram	3-1
3-2.	Equivalent Circuit for R-F Oscillator and Output System	3-1
3-3.	Signal Generator TS-419/U, Power Monitor Thermistor Bridge, Schematic Diagram	3-3
3-4.	Signal Generator TS-419/U, Modulator and Synchronizer, Block Diagram	3-4
3-5.	Signal Generator TS-419/U, Input Amplifier, Simplified Schematic Diagram	3-5
3-6.	Signal Generator TS-419/U, Rate Multivibrator, Simplified Schematic Diagram	3-7
3-7.	Signal Generator, Delay Multivibrator and Undelayed Sync Output Amplifier, Simplified Schematic Diagram (Contracts NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748, and N383s-77651) and TS-419A/U Equipment	3-7
3-7A.	Signal Generator TS-419/U, Delay Multivibrator and Undelayed Sync Output Amplifier, Simplified Schematic Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)	3-8

LIST OF ILLUSTRATIONS (Cont.)

Figure	Title	Page
3–8.	Signal Generator, Pulse Width Multivibrator, Simplified Schematic Diagram (Contracts NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748, and N383s-77651) and TS-419A/U Equipments	3–8
3–8A.	Signal Generator TS-419/U, Pulse Width Multivibrator, Simplified Schematic Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)	3–9
3–9.	Signal Generator TS-419/U, Pulse Amplifier and Delayed Sync Amplifier, Simplified Schematic Diagram	3–11
3–10.	Signal Generator TS-419/U, Power Supply, Block Diagram	3–12
4–1.	Test Connection Diagram for Measurement of Radio Frequency	4–14
4–2.	Test Connection Diagram for Measurement of R-F Power Output	4–15
4–3.	Test Connection Diagram for Measure ment of Pulse Width	4–16
4–4.	Typical Pattern for Measurement of Two-microsecond Pulse	4–17
4–5.	Test Connection Diagram for Measurement of Pulse Delay	4–18
4–6.	Time Relationships in Delay Measurements	4–19
4–7.	Test Connection Diagram for Measurement of Pulse Repetition Rate and Sine Wave Synchronizing Characteristics	4–20
4–8.	Test Connection Diagram for Measurement of External Modulation Performance	4–23
4–9.	Test Connection Diagram for Measurement of Attenuator VSWR	4–24
4–10.	Test Connection Diagram for Measurement of R-F Leakage	4–25
5–1.	Power Loss Versus Load, Voltage Standing-Wave Ratio	5–3
5–2.	Signal Generator TS-419/U and TS-419A/U, Top View of Chassis	5–4
5–3.	Signal Generator TS-419/U, Bottom of Chassis, Location of Detail Parts (Contract NOa(s)-9748)	5–5
5–3A.	Signal Generator TS-419/U, Bottom of Chassis, Location of Detail Parts (Contracts N383s-5019A, N383s-45741, and N383s-67816)	5–7
5–3B.	Signal Generator TS-419/U, Bottom of Chassis, Location of Detail Parts (Contracts N383s-60879 and N383s-61060)	5–9
5–3C.	Signal Generator TS-419/U, Bottom of Chassis, Location of Detail Parts (Contracts N383s-75748 and N383s-77651)	5–11
5–3D.	Signal Generator TS-419A/U, Bottom of Chassis, Location of Detail Parts (Contracts N383s-16939A, N383-31275A, and N383-46039A)	5–13
6–1.	Resistor Color Codes	6–5
6–2.	Capacitor Color Codes	6–6
7–1.	Signal Generator TS-419/U, Schematic Diagram (Contract No. NOa(s)-9748, N383s-60879, N383s-61060, and NOa (s)-12279)	7–3
7–1A.	Signal Generator TS-419/U, Schematic Diagram (Contracts N383s-5019A, N383s-4541, and N383s-67816)	7–5
7–1B.	Signal Generator TS-419/U, Schematic Diagram (Contract No. N383s-75748 and N383s-77651)	7–7
7–1C.	Signal Generator TS-419A/U, Schematic Diagram (Contracts N383s-16939A, N383-31275A, and N383-46093A)	7–9
7–2.	Signal Generator TS-419/U, Bottom of Chassis, Wiring Diagram (Contract No. NOa(s)-9748 and NOa(s)-12279)	7–11
7–2A.	Signal Generator TS-419/U, Bottom of Chassis, Wiring Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)	7–13
7–2B.	Signal Generator TS-419/U, Bottom of Chassis, Wiring Diagram (Contract No. N383s-60879 and N383s-61060)	7–15
7–2C.	Signal Generator TS-419/U, Bottom of Chassis, Wiring Diagram (Contract No. N383s-75748 and N383s-77651)	7–17
7–2D.	Signal Generator TS-419A/U, Bottom of Chassis, Wiring Diagram (Contracts N383s-16939A, N383-31275A, and N383-46093A)	7–19
7–3.	Signal Generator TS-419/U, Top of Chassis, Wiring Diagram (Contract No. NOa(s)-9748, N383s-60879, N383s-61060, and NOa(s)-12279)	7-21
7–3A.	Signal Generator TS-419/U, Top of Chassis, Wiring Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)	7–23
7–3B.	Signal Generator TS-419/U, Top of Chassis, Wiring Diagram (Contract No. N383s-75748 and N383s-77651)	7–25

LIST OF ILLUSTRATIONS (Cont.)

Figure	Title	Page
7-3C.	Signal Generator TS-419A/U, Top of Chassis, Wiring Diagram (Contracts N383s-16939A, N383-31275A, and N383-46093A)	7-27
7-4.	Signal Generator TS-419/U, Voltage and Resistance Diagram	7-29
7-5.	Signal Generator TS-419/U, Back Plate Assembly, Exploded View	7-31
7-6.	R-F Oscillator, Power Monitor and Output Attenuator, Assembled View	7-33
7-7.	Signal Generator TS-419/U, R-F Oscillator Power Monitor and Output Attenuator, Exploded View	7-35
7-8.	Signal Generator TS-419/U, Outline Dimensions	7-37
7-9.	Attaching UG-88/U Connector to RG-55/U or RG-58/U Cable	7-38

LIST OF TABLES

Table	Title	Page
1-1.	AN/URM-64 Equipment Supplied	1-1
1-2.	Cable Assemblies Supplied with TS-419/U	1-4
1-3.	Quantities and Types of Electron Tubes, Fuses, and Indicator Lamps Supplied with TS-419/U	1-4
1-4.	AN/URM-64A, Equipment Supplied	1-6
1-5.	Cable Assemblies Supplied with TS-419A/U	1-6
1-6.	Quantities and Types of Electron Tubes, Fuses, and Indicator Lamps Supplied with TS-419A/U	1-6
2-1.	Operating Controls, Dials, Connectors, and Indicating Devices	2-2
4-1.	Lubrication Chart	4-2
4-2.	Trouble-Shooting Chart	4-3
4-3.	Test Equipment Required	4-10
4-4.	Voltage Measurements for Initial Electrical Adjustments	4-13
4-5.	Voltage Measurements	4-37
4-6.	Resistance Measurements	4-43
4-7.	Coil Winding Data	4-44
5-1.	Functional Tube and Lamp Complement for Signal Generator TS-419/U	5-1
5-2.	Cable Attenuation	5-2
6-1.	Standard Part Designations	6-2
6-2.	Abbreviations	6-2
6-3.	List of Manufacturers	6-3
6-4.	Table of Replaceable Parts	6-7

WARNING

THIS EQUIPMENT EMPLOYS HIGH VOLTAGES WHICH ARE DANGEROUS AND MAY BE FATAL IF CONTACTED BY OPERATING PERSONNEL. EXTREME CAUTION SHOULD BE EXERCISED WHEN WORKING ON THE EQUIPMENT.

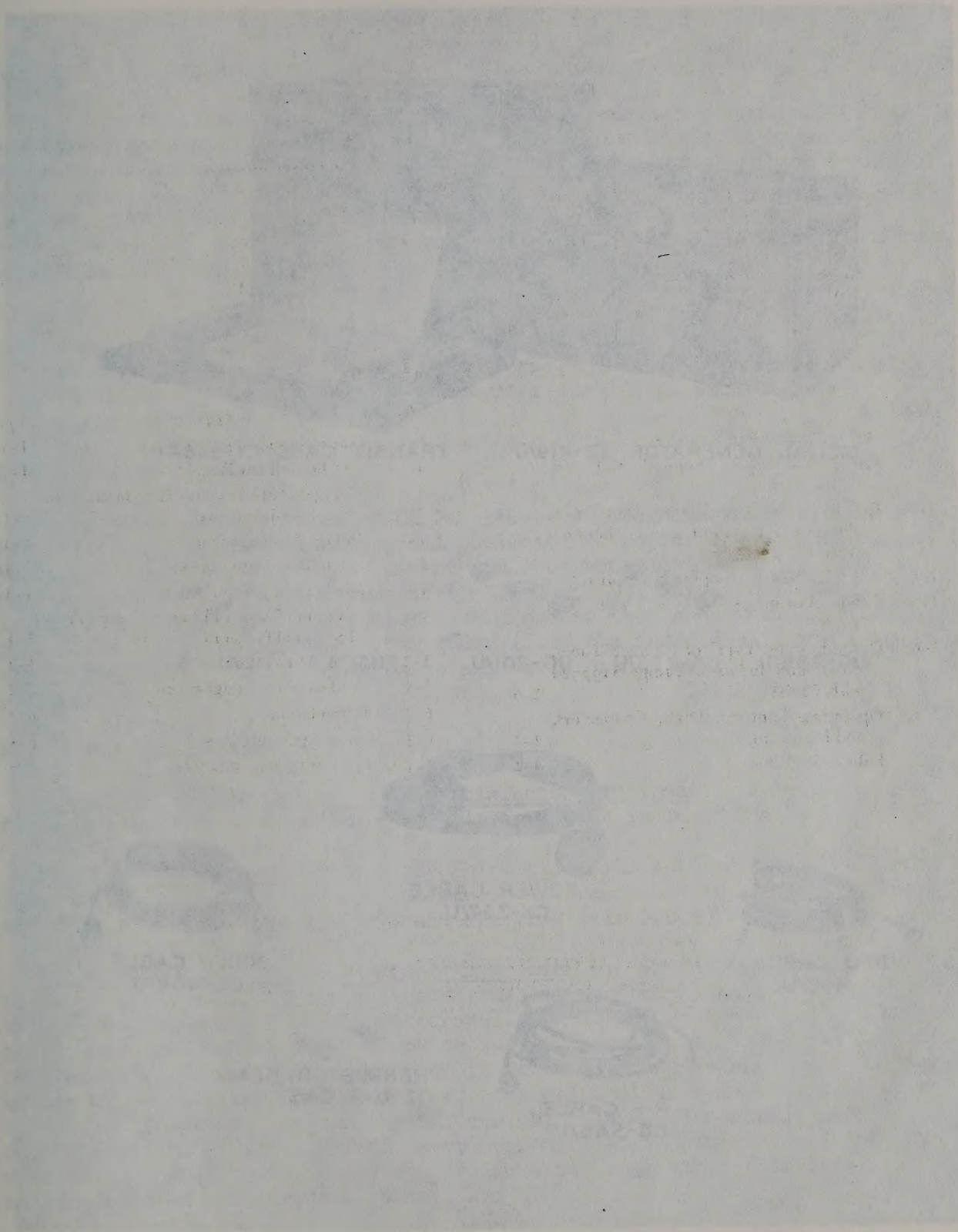




Figure 1-1. Signal Generator AN/URM-64

SECTION I

GENERAL DESCRIPTION

1. PURPOSE OF HANDBOOK.

The purpose of this handbook is to provide complete instructions for the operation, maintenance, and repair of Signal Generator AN/URM-64 and Signal Generator AN/URM-64A. The information contained in this handbook is applicable to all equipments manufactured under various contracts, as listed in section VI. Where essential differences exist between equipments, reference is made to the contract number and (if applicable) to the equipment serial numbers involved.

NOTE

Throughout this handbook, all references to Signal Generator TS-419/U also apply to Signal Generator TS-419A/U, except where specifically noted.

1.1. Index of Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to this equipment. DA Pam 310-4 is a current index of technical manuals, technical bulletins, supply manuals (types 4, 6, 7, 8, and 9), 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 to and revisions of each equipment publication.

1.2. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 ((Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), NAVSANDA Publication 378 (Navy), and AFR 71-4 (Air Force).

c. Reporting of Equipment Manual Improvements. The direct reporting, by the individual user, of errors, omissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended changes to DA technical manual parts lists or supply manual 7, 8, or 9) will be used for reporting these improvements. This form will be completed in triplicate by use of pencil, pen, or typewriter. The original and one copy will be forwarded direct to: Commanding Officer, U. S. Army Electronics Materiel Support Agency, ATTN: SELMS-MP, Fort Monmouth, N. J. One information copy will be furnished to the individual's immediate supervisor (officer, noncommissioned officer, supervisor, etc).

6. GENERAL ELECTRICAL CHARACTERISTICS.

a. POWER REQUIREMENTS. — Signal Generator TS-419/U is designed to operate from an external voltage source of 115 volts, ±10 per cent, a-c, 50 to 1600 cycles per second, single phase, without the need for voltage or frequency range switching. The required volt-amperes do not exceed 300 when the generator is operated within the limits of the line voltage and frequencies given above.

b. OPERATING RANGE. — Signal Generator TS-419/U operates throughout a band of frequencies of 900 to 2100 megacycles per second, producing cw or pulse-modulated rf at a maximum power output level of one milliwatt. An internal pulse generator permits modulation by pulses of repetition rate between 40 and 4000 pulses per second, with delay of 3 to 300 microseconds and width of ½ to 10 microseconds. Provision is made for synchronization with an external pulse or sine wave generator. Modulation by an external pulse generator is also possible.

c. DETAILED CHARACTERISTICS.—A detailed list of electrical characteristics is given in paragraph 2. of section V.

d. STANDBY HEATERS.—Standby heaters are provided. The heaters, which are located on the underside of the chassis, maintain the instrument at approximately six Centigrade degrees (eleven Fahrenheit degrees) above ambient temperature.

7. DESCRIPTION OF EQUIPMENT SUPPLIED.

a. SIGNAL GENERATOR TS-419/U.—Signal Generator TS-419/U (figure 1-2) consists of four major circuits: an r-f oscillator, a modulator and synchronizer, an output system, and a power supply. All of these circuits and their related components are mounted on a common chassis, which is enclosed in a louvered instrument case. All electrical connections are made through the front panel. All controls are directly calibrated and are mounted on the front panel. Two vertically positioned handles, which act as guard rails, are located at the extreme ends of the front panel. The panel is finished a flat grey color and the instrument case is a wrinkle grey. Small vent holes are located in the bottom of the instrument case to permit drainage of any accumulated moisture. A white indicator lamp on the front panel indicates that the space heaters within the instrument are energized and that electronic circuits are unenergized. A red indicator lamp indicates that the electronic circuits are energized and the space heaters are off. Four fuses, two of which are spares, are installed in suitable fuse holders located near the lower left hand corner of the front panel. The weight of Signal Generator TS-419/U, including the instrument case, but not including the transit case and accessories, is 43 pounds. Outline dimensions of Signal Generator TS-419/U removed from the instrument case are shown in figure 7-8. Overall dimensions, including the instrument case, are listed in table 1-1 for Signal Generator TS-419/U, and in table 1-4 for Signal Generator TS-419A/U.

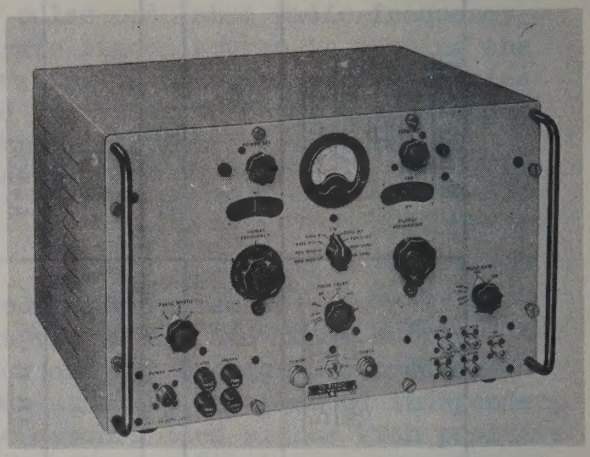


Figure 1-2. Signal Generator TS-419A/U, Right Oblique View

b. ACCESSORIES. *(See figures 1-3 and 1-4.)*

(1) TRANSIT CASE.—Transit Case CY-686/U, CY-686A/U, or CY-686C/U is supplied for transporting the signal generator and protecting it when not in use. All accessories, except the power cable (which is located within the transit case with the TS-419/U), are contained in an aluminum case fastened to the underside of the cover of the transit case. The CY-686/U and CY-686A/U differ with regard to their overall dimensions, total weight (refer to table 1-1), the number of cover latches, and the type of carrying handles. In the CY-686/U, the carrying handles are attached to the external surface at each end. In the CY-686A/U, though located in the same relative position, recessed spring-return handles are used. In the CY-686C/U, the spring-return handles are flush-mounted. All transit cases are constructed of balsa panels, covered on both sides with aluminum sheet and finished in gray enamel. The cover, which is detachable, is equipped with a molded rubber gasket, which presses against the top edges of the transit case when the cover is in position, thus providing a watertight seal. The cover is secured to the body of the CY-686/U by ten trunk-type fasteners. In the CY-686A/U and CY-686C/U, only six fasteners are used.

(2) ADAPTERS.—Three each of adapters UG-201/U, UG-255/U, and UG-273/U are supplied. These adapters provide a means for electrical and mechanical mating of various other common types of radio-frequency connectors with each other. Adapter UG-201/U provides a means for mating a female type "N" connector, such as UG-22B/U, with a male type BNC connector,

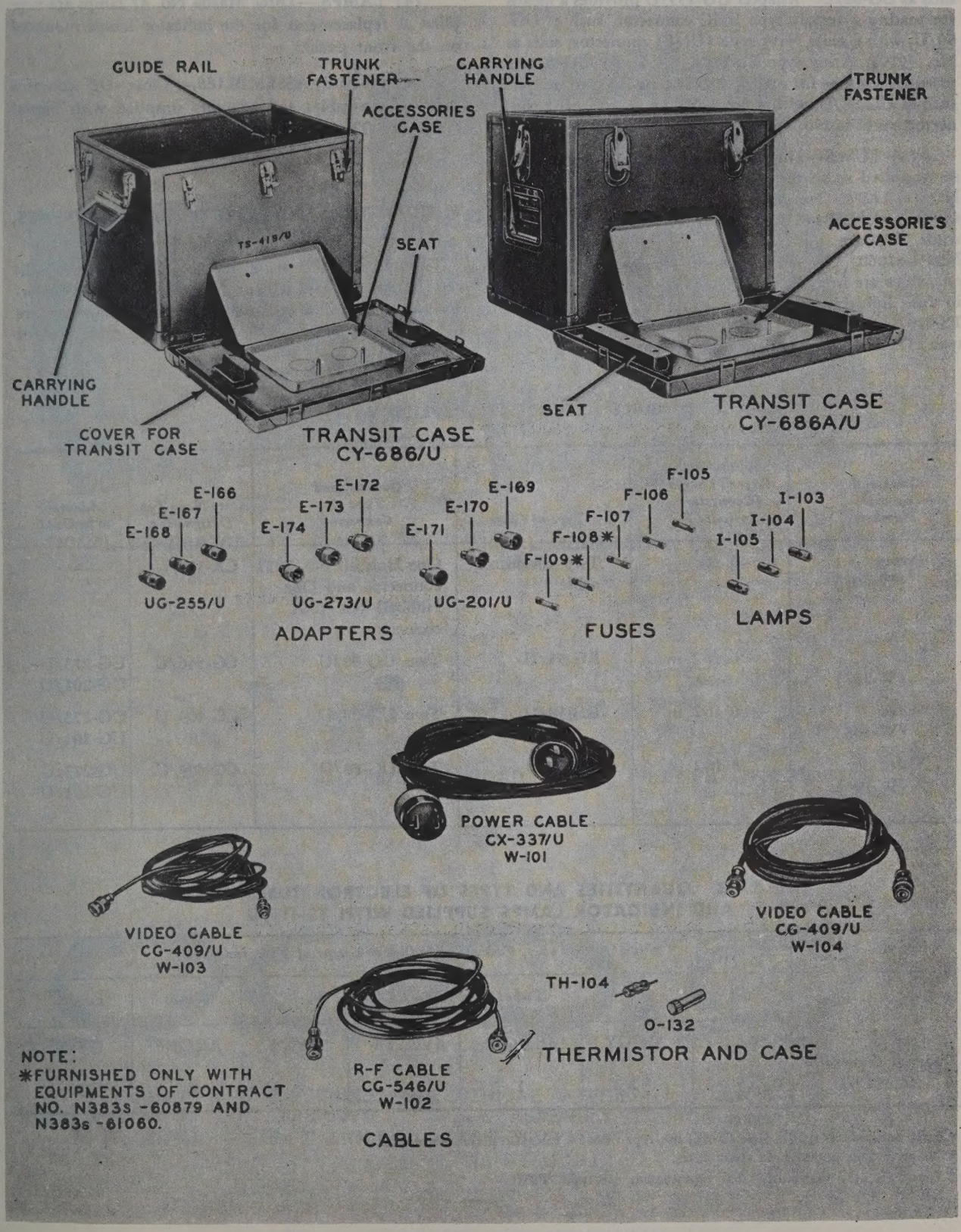


Figure 1-3. Transit Case CY-686/U and CY-686A/U, and Accessories

such as UG-88/U. Adapter UG-255/U provides a means for mating a female type BNC connector, such as UG-90/U, with a male Navy type (UHF) connector, such as No. 49195; Army type PL-259A. Adapter UG-273/U provides a means for mating a male type BNC connector, such as UG-88/U, with a female Navy type (UHF) connector, such as No. 49194; Army type SO-239.

(3) FUSES—Three type 3AG, three-ampere fuses are supplied as spares for Contracts NOa(s)-9748 and NOa(s)-12279. For Contracts N383s-5019A, N383s-45741, and N383s-67816 three type AGC3 are supplied, while five are supplied for Contracts N383s-60879, N383s-61060, N383s-75748, and N383s-77651. These quantities are in addition to the two spare fuses located in fuse holders mounted on the front panel of the TS-419/U. For the TS-419A/U equipment, three MIL type FO2G3R00A 3-ampere fuses are supplied as spares.

(4) LAMPS.—Three Mazda No. 47 lamps are supplied as replacements for the indicator lamps mounted on the front panel.

(5) CABLE ASSEMBLIES.—Table 1-2 contains data on the cables and adapters supplied with Signal Generator TS-419/U.

8. QUANTITIES AND TYPES OF ELECTRON TUBES, FUSES, AND INDICATOR LAMPS.

Twenty-two electron tubes, two fuses, and two indicator lamps are required for operation of Signal Generator TS-419/U. The individual types and quantities are listed in table 1-3 for TS-419/U, and in table 1-6 for TS-419A/U.

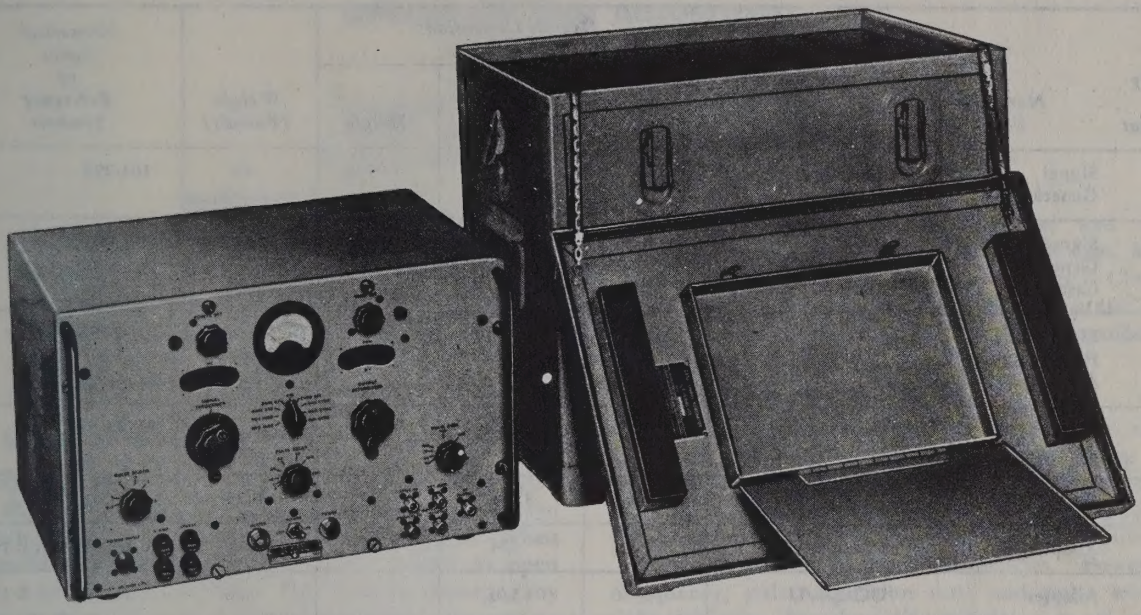
TABLE 1-2. CABLE ASSEMBLIES SUPPLIED WITH TS-419/U

Cable and Symbol Number	*Approximate Overall Length (Connectors Included)*	*Type of Cable*	*Quantity and Type of Connector*	*Army-Navy Type Designation*	*Adapter to be Used*
Power (W-101)	6 ft	Two conductor cable	One Hubbell No. 7057 connector and One Hubbell No. 7084 connector	CX-337/U	——
R-f (W-102)	6 ft-2 in.	RG-55/U	Two UG-88/U	CG-546/U	UG-273/U UG-201/U
Video (W-103)	8 ft-2 in.	RG-58/U	Two UG-88/U	CG-409/U	UG-273/U UG-201/U
Video (W-104)	8 ft-2 in.	RG-58/U	Two UG-88/U	CG-409/U	UG-273/U UG-201/U

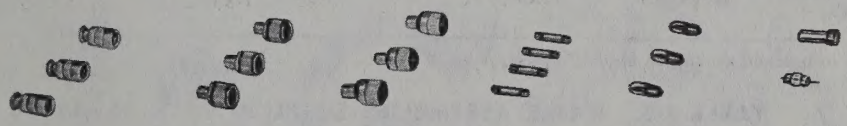
TABLE 1-3. QUANTITIES AND TYPES OF ELECTRON TUBES, FUSES, AND INDICATOR LAMPS SUPPLIED WITH TS-419/U

Unit	*Number of Tubes, Fuses, and Indicator Lamps of Type Indicated*						
	Tubes					*Fuses*	*Lamps*
	0A2	5R4GY	6BM6A*	6V6GTY	7F8W‡	AGC3†	GE47
Signal Generator TS-419/U	5	2	1	8	6	2	2

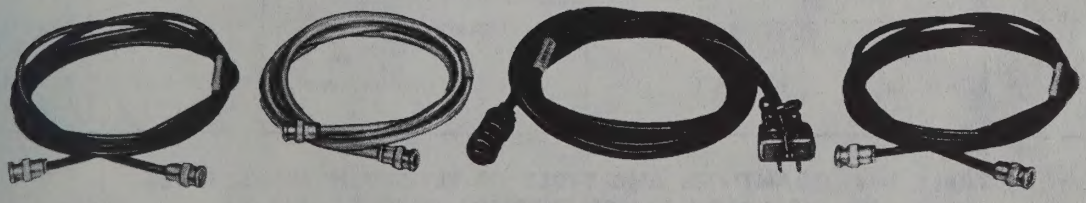
* Early equipments used a type 6BM6; use type 6BM6A for all replacement needs.
† Quantity does not include spare fuses.
‡ Type 7F8 used previously. For replacement use type 7F8W.



SIGNAL GENERATOR TS-419A/U SIGNAL GENERATOR CASE CY-686C/U



UG-255/U UG-273/U UG-201/U FUSES LAMPS THERMISTOR BEAD AND CASE



CORD CG-409A/U (8 FT 2 IN.)

R-F CABLE CG-546/U (6 FT 2 IN.)

ELECTRICAL POWER CABLE ASSEMBLY CX-3135/U (6 FT 0 IN.)

CORD CG-409A/U (8 FT 2 IN.)

Figure 1-4. Signal Generator AN/URM-64A

TABLE 1-4. AN/URM-64A, EQUIPMENT SUPPLIED

Quantity per Equipment	Name of Unit	Army-Navy Type Designation	Overall Dimensions (Inches)			Weight (Pounds)	Numerical Series of Reference Symbols
			Length or Depth	Width or Diameter	Height		
1	Signal Generator	TS-419A/U	14	17-3/8	10-7/8	43	101-299
1	Signal Generator Case	CY-686C/U	13-1/2	20-3/4	16-3/4	25-1/4	A-108
1	Electrical Power Cable Assembly	CX-3135/U	72	1-17/32	23/32	0.75	W-101
1	R-f Cable Assembly	CG-546/U	74	27/64	—	0.25	W-102
2	Cord	CG-409A/U	98	27/64	—	0.25	W-103, W-104
3	Adapter	UG-255/U	1-5/8	3/4	—	0.06	E-166, E-167, E-168
3	Adapter	UG-201/U	1-9/16	3/4	—	0.06	E-169, E-170, E-171
3	Adapter	UG-273/U	1-5/8	3/4	—	0.06	E-172, E-173, E-174
3	Lamp	—	1-3/32	3-3/8	—	0.02	I-103, I-104, I-105
3	Fuse	F02G3ROOA	1-1/4	1/4	—	0.02	F-105, F-106, F-107
1	*Bead Thermistor and Case	—	1-3/8	3/4	—	0.02	TH-104 and O-132

*denotes mounted in bracket, on top of Signal Generator main chassis.

TABLE 1-5. CABLE ASSEMBLIES SUPPLIED WITH TS-419A/U

Cable and Symbol Number	Approximate Overall Length	Type of Cable	Quantity and Type of Connector	Army-Navy Type Designation	Adapter to be Used
Power (W-101)	6 ft	3-conductor No. 18 AWG	One female. AN3106A-10SL-3S and one male UP121M, with reversible grounding blade	CX-3135/U	
R-f (W-102)	6 ft 2 in.	RG-55/U	Two UG-88/U	CG-546/U	UG-273/U, UG-201/U
Video (W-103 and W-104)	8 ft 2 in.	RG-58A/U	Two UG-88/U for each cord	CG-409A/U	UG-273/U, UG-201/U

TABLE 1-6. QUANTITIES AND TYPES OF ELECTRON TUBES, FUSES, AND INDICATOR LAMPS SUPPLIED WITH TS-419A/U

Unit	Number of Tubes, Fuses, and Indicator Lamps of Type Indicated						
	Tubes					Fuses	Lamps
Signal Generator TS-419A/U	0A2WA 5	5R4WGA 2	6BM6A 1	6V6GTY 8	7F8W 6	F02G3ROOA 2	GE47 2

SECTION II

OPERATION AND ADJUSTMENT

Note

Throughout this handbook, all references to TS-419/U also apply to TS-419A/U, except where specifically noted.

WARNING

This equipment employs high voltages which are dangerous and may be fatal if contacted by operating personnel. Operating personnel must not remove the Signal Generator TS-419/U chassis from the instrument case. Observe all safety regulations.

1. UNPACKING AND INSPECTING THE EQUIPMENT.

Signal Generator TS-419/U or TS-419A/U installed in the transit case, is packed in a corrugated carton which, in turn, is packed in a wooden case. When unpacking the equipment, use a nail puller to open the wooden case and take care not to damage any part of the equipment during removal from the carton. After removal of the equipment, remove Signal Generator TS-419/U from the transit case and visually inspect all front panel parts, the transit case, and the instrument case for any apparent damage. Check the equipment received against the packing slip and the list of equipment supplied, table 1-1 of this handbook.

2. FUNCTION OF EQUIPMENT.

Signal Generator TS-419/U is intended for use with airborne radio and radar equipment operating in the band of frequencies from 900 to 2100 megacycles per second for receiver measurements and other applications that require less than one milliwatt of cw or pulsed-type r-f signals in this band of frequencies. Power level, frequency, pulse repetition rate, and pulse width are adjustable by directly calibrated front panel controls. Facilities are provided for synchronizing external equip-

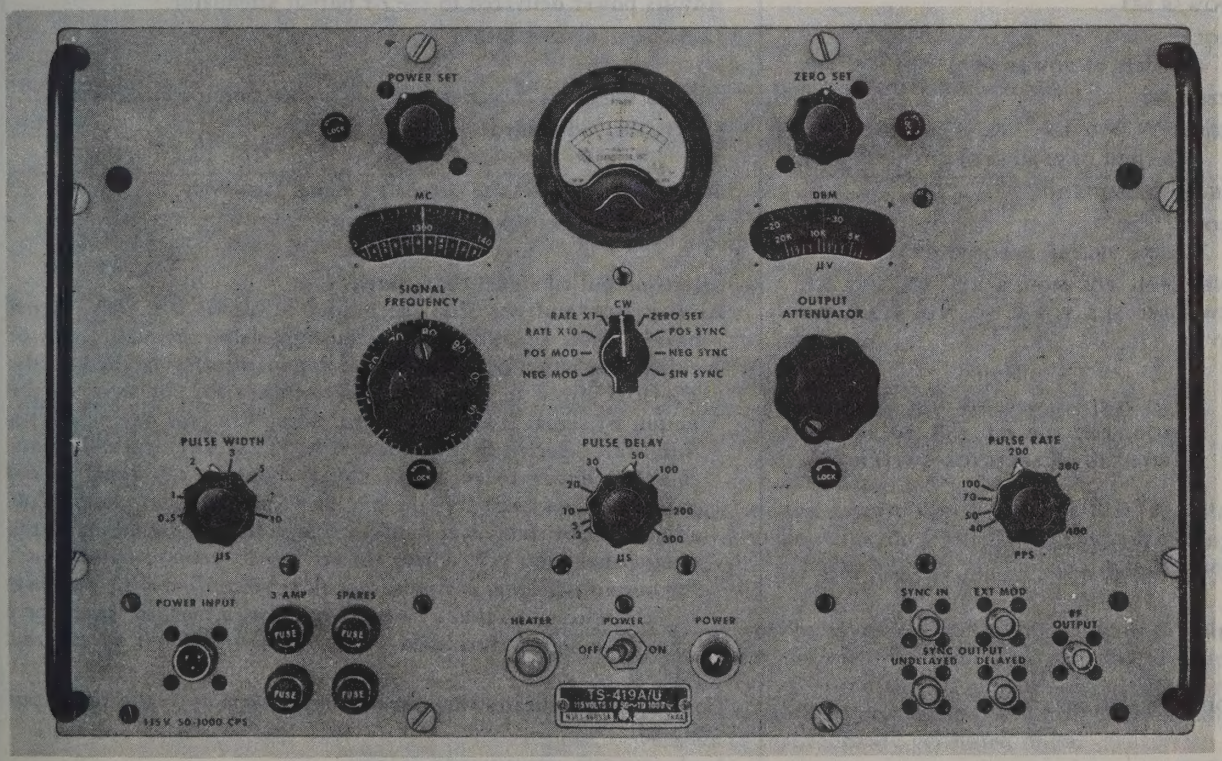


Figure 2-1. Signal Generator TS-419A/U, Front Panel View

ment with pulsed r-f signals, and for synchronizing the TS-419/U or TS-419A/U with sine waves or pulses from external equipment.

3. PRE-INSTALLATION TESTS.

The signal generator requires no pre-installation tests or adjustments previous to use, as described in the operating procedures outlined in this section. A complete list of test equipment required for maintenance tests and adjustments will be found in paragraph 4, section IV.

4. OPERATING CONTROLS.

Before making any measurements with the signal generator, operating personnel must review and become familiar with the function and placement of all controls, connectors, and other detailed parts necessary for the operation and maintenance of the equipment. All operating controls, dials, connectors, and indicating devices are explained briefly by the adjacent panel markings. Table 2-1 lists these components (approximately left to right) according to front panel markings and describes in more detail the function of each.

5. STARTING THE EQUIPMENT.

a. To start the equipment proceed as follows:

(1) Connect Power Cable CX-337/U (for TS-419/U) or CX-3135/U (for TS-419A/U) between the connector marked POWER INPUT and a nominal 115-volt, a-c, 50- to 1600-cps power source. The AN type UP121M three-prong connector of CX-3135/U is designed for mating a power source outlet which has one of its terminals connected to ground potential. In the event that a three-contact power source outlet is not available at the testing location, the ground prong on the UP121M shell may be rotated 180 degrees from its normal contacting position. When operating under this condition, be sure to connect the spade lug terminal (attached to the UP121M shell), to a separate source of earth ground.

Note

With the connection of the power cable, power is supplied to the space heaters used in this equipment and will remain energized until the POWER OFF ON switch is thrown to the ON position or until the power cable is disconnected.

(2) Throw the POWER OFF ON switch to the ON position. Allow a ten-minute warm-up period.

TABLE 2-1. OPERATING CONTROLS, DIALS, CONNECTORS, AND INDICATING DEVICES

Panel Designation	*Function*
	Operating Controls
POWER SET	Adjusts power delivered to the r-f output attenuator.
LOCK (To left of POWER SET)	Locks POWER SET control.
ZERO SET	Adjusts the electrical balance of the power monitor bridge circuit.
LOCK (To right of ZERO SET)	Locks ZERO SET control.
SIGNAL FREQUENCY	Selects and indicates the output r-f signal frequency.
LOCK (Below SIGNAL FREQUENCY)	Locks SIGNAL FREQUENCY control.
NEG MOD, POS MOD, RATE X10, RATE X1, CW, ZERO SET, POS SYNC, NEG SYNC, SIN SYNC **Note** *Hereinafter the* NEG MOD, POS MOD, etc. control will be referred to as SELECTOR SWITCH.	Selects output r-f signal characteristics. At NEG MOD and POS MOD the output r-f signal is a pulse signal having a rate equal to, and an envelope shape similar to, that of either a negative or positive modulation signal furnished to the TS-419/U from an external source. At RATE X10, or RATE X1, the output r-f signal is an unsynchronized pulse signal having a repetition rate selected by the front panel PULSE RATE control multiplied by either 10 or 1. At CW, the output r-f signal is not modulated. At ZERO SET, the output r-f signal is cut off to allow adjustment of the power monitor bridge balance by means of the front panel ZERO SET control. At POS SYNC, NEG SYNC, SIN SYNC, the output r-f signal is a pulse signal, synchronized with, and having a rate equal to that of a positive pulse, a negative pulse, or a sine wave signal, furnished to the TS-419/U from an external source.
OUTPUT ATTENUATOR	Controls and indicates the amount of attenuation of the r-f output signal.
LOCK (Below OUTPUT ATTENUATOR)	Locks OUTPUT ATTENUATOR control.

TABLE 2-1. OPERATING CONTROLS, DIALS, CONNECTORS, AND INDICATING DEVICES (Cont.)

Panel Designation	*Function*
	Operating Controls (Cont.)
PULSE WIDTH	Varies the width of the output pulse from ½ to 10 microseconds between the points which are 50 percent of maximum amplitude of initial rise.
PULSE DELAY	Delays the output pulse relative to internal or external synchronizing voltage over the range of 3 to 300 microseconds.
PULSE RATE	Selects the pulse repetition rate over the range 40 to 4000 pps when the pulse rate is determined internally. Two ranges are used, viz: RATE X10 and RATE X1.
POWER OFF ON	A-c power switch.
	Dials
MC	Direct reading signal frequency dial over the range of frequencies from 900 to 2100 mc/sec without band switching.
DBM-μV	Direct reading output attenuator dial with equivalent microvolt scale beneath.
	Indicating Devices
POWER SET-ZERO SET (METER M-101) **Note** There is no panel marking for this meter, except as marked; however, hereinafter this power output meter will be referred to as METER.	Indicates power delivered to output attenuator.
HEATER	Indicates application of power to space heater only.
POWER	Indicates application of power to all circuits and removal of power from space heater.
	Connectors
POWER INPUT 115 V 50-1600 CPS **Note** Hereinafter this will be referred to as POWER INPUT.	Primary power input connection.
SYNC IN	Connector for incoming external synchronizing signal.
EXT MOD	Connector for incoming external modulation signal for the r-f oscillator.
SYNC OUTPUT UNDELAYED	Connector at which appears a pulse signal of more than 20 volts peak. This pulse coincides with the leading edge of the incoming external synchronizing pulse or with the internally generated pulse.
SYNC OUTPUT DELAYED	Connector at which appears a pulse signal of more than 20 volts peak. This pulse coincides with the leading edge of the pulse appearing at the R-F OUTPUT connector. It may be delayed from 3 to 300 microseconds relative to the incoming external synchronizing pulse, or relative to the internally generated pulse.
R-F OUTPUT	Connector at which appears the r-f output from the variable attenuator.

6. OPERATING PROCEDURES.

CAUTION

If the R-F OUTPUT connector of Signal Generator TS-419/U is connected to a source of power such as a transpondor, suitable attenuators must be used to limit power dissipation in the attenuator termination to 0.5 watt average or 10 watts peak.

a. CW OPERATION.—Most of the functions which can be fulfilled by Signal Generator TS-419/U involve the use of the r-f oscillator. The procedure for placing it into cw operation is as follows:

(1) Set the SIGNAL FREQUENCY control to the desired output frequency.

(2) Set the SELECTOR SWITCH to ZERO SET and adjust the ZERO SET control until the METER reads exactly at the meter dial line marked ZERO SET.

(3) Turn the SELECTOR SWITCH to CW. The positions of the pulse controls during cw operation are not significant.

(4) Adjust the POWER SET control until the METER reads exactly zero dbm (half-scale). This establishes the reference level for the output voltage. Any desired output from —3 dbm (0.16 volt) to —121 dbm (0.2 microvolt) can now be obtained by adjusting the OUTPUT ATTENUATOR. The output power into a 50-ohm resistive load, or the voltage across such a load, may be read directly from the appropriate output attenuator dial scale. For evaluation of errors due to unmatched loads, refer to paragraph 3. of section V.

Note

When measuring small differences in output level, always approach the final OUTPUT ATTENUATOR setting from the same direction, in order to minimize errors from backlash.

(5) When outputs greater than —3 dbm are required, it is necessary to set the METER to some reading between zero and +3 dbm by adjusting the POWER SET control. The recommended reference reading is +3 dbm. Adjustment of the OUTPUT ATTENUATOR will provide an output range from zero to —118 dbm.

Note

Adjustment of the POWER SET control will cause a noticeable change in the frequency of the r-f output. The frequency will be within ±1 percent of the value indicated by the signal frequency (MC) dial for any adjustment of the POWER SET control which produces on-scale meter readings. The dial is calibrated for a zero dbm meter reading and the most accurate frequency indications are obtained at this adjustment.

(6) If the METER is set at a reading other than zero dbm, the reading must be algebraically added to the OUTPUT ATTENUATOR reading in order to know the true r-f output. The following examples show the correct method of determining the power output for power settings other than zero dbm:

OUTPUT ATTENUATOR (—dbm)	—3	—3	—3	—3	—34	—34
METER (±dbm)	0	+1	+2	+3	+3	—5
Actual Power Output (dbm)	—3	—2	—1	0	—31	—39

Note

The output levels as determined above apply only when the RF OUTPUT connector is terminated in a 50-ohm resistive load.

Any deviation of the monitor level from zero dbm or other reference level, such as that caused by adjustment of the OUTPUT ATTENUATOR, should be corrected by using the POWER SET control to restore the reference reading of the METER. This may occur between an attenuator reading of —3 and —10 dbm.

b. PULSED OPERATION.—The operative steps (1) through (6) of paragraph 6.*a.* of this section are required when Signal Generator TS-419/U is to be pulse-modulated, since the amplitude of the pulse is established by reference to the CW amplitude. *The monitor reading will decline to practically zero when pulse modulation is applied, since the average power level will be at a low value.*

c. USE OF SIGNAL GENERATOR TS-419/U TO PROVIDE UNSYNCHRONIZED PULSED R-F SIGNALS.—To use Signal Generator TS-419/U to provide unsynchronized pulsed r-f signals, proceed as follows:

(1) Perform the operative steps listed in paragraph 6.*a.*, this section.

(2) Set the SELECTOR SWITCH to either RATE X10 or RATE X1 and set the PULSE RATE control to give the desired pulse repetition rate. The combined use of these controls permits the selection of any PRR (pulse repetition rate) from 40 to 4000 pulses per second.

(3) Adjust the PULSE WIDTH control to vary the pulse width. The available range is from ½ to 10 microseconds.

(4) If it is desired to delay the timing of the r-f output pulse with respect to the SYNC OUTPUT UNDELAYED, adjust the PULSE DELAY control. This control provides a delay, at the lower repetition rates, from 3 to 300 microseconds. Maximum delay should not be used

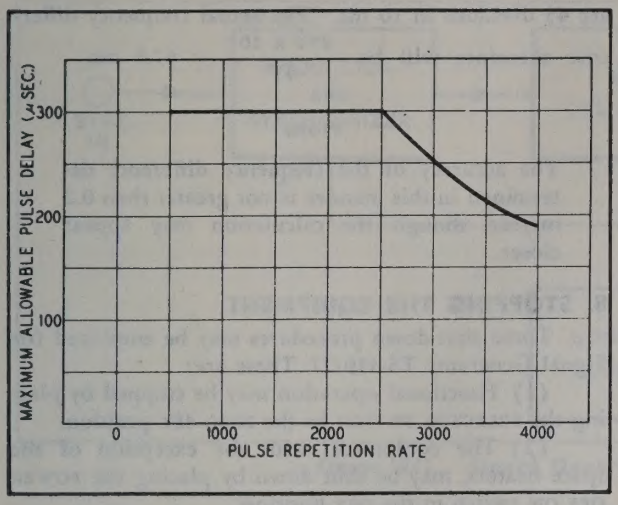


Figure 2-2. Signal Generator TS-419/U, Graph of Maximum Allowable Pulse Delay Versus Pulse Repetition Rate

when PRR is higher than approximately 2500 as the pulsing may become irregular. In addition, as the PRR is increased, less delay must be used until, at the highest PRR, a delay of about 190 microseconds is the maximum that can be used. A graph of the maximum allowable pulse delay for the PRR range is shown in figure 2-2.

(5) Both a delayed and an undelayed video sync pulse are available for external use. To obtain the delayed sync pulse connect Video Cable CG-409/U to the front panel connector marked SYNC OUTPUT DELAYED. To obtain an undelayed sync pulse connect Video Cable CG-409/U to the SYNC OUTPUT UNDELAYED connector. *(Cord CG-409A/U is interchangeable with CG-409/U.)*

d. SYNCHRONIZATION OF THE PULSED R-F OUTPUT SIGNALS WITH AN EXTERNAL SIGNAL. —The pulsed r-f output signals may be synchronized with an external signal having a repetition rate in the range from 40 to 4000 cycles per second. To obtain synchronization, connect Video Cable CG-409/U, carrying the external synchronizing signal, to the front panel connector marked SYNC IN and, depending on the nature of the synchronizing signal, that is, whether it is a positive pulse, a negative pulse, or a sine wave, turn the SELECTOR SWITCH to either the POS SYNC, NEG SYNC, or SIN SYNC position. (Refer to paragraphs 2.*a.*(8) of section V for synchronizing signal requirements.) Refer to paragraphs 6.*c.*(3) through 6.*c.*(5) of this section for control of the pulse width and pulse delay, and the availability of sync output pulses.

e. MODULATION OF THE OSCILLATOR WITH AN EXTERNAL PULSE SIGNAL.—If it is desired to modulate the oscillator with an external pulse signal, that external signal must possess the characteristics enumerated in paragraph 2.*a.*(8) of section V. Connect Video Cable CG-409/U, carrying the external signal, to the EXT MOD connector and, depending on the polarity of the external pulse signal, set the SELECTOR SWITCH to either NEG MOD or POS MOD.

f. PROVISION OF SYNC OUTPUT FOR EXTERNAL USE.

(1) Sync pulses for external use can be obtained when the modulation rate is generated either internally or by synchronization with an external signal. The sync outputs obtained under these conditions are positive video pulses, one of which is delayed and the other undelayed. The delayed pulse occurs simultaneously with the leading edge of the r-f output pulse. The undelayed pulse occurs earlier than the r-f output pulse. This difference in time corresponds to the setting of the PULSE DELAY control. When external pulse synchronization is employed, the undelayed sync output pulse occurs simultaneously with the leading edge of the input sync pulse. The delayed pulse is obtained at the connector marked SYNC OUTPUT DELAYED. The undelayed pulse is obtained at the connector marked SYNC OUTPUT UNDELAYED.

(2) If the oscillator is externally modulated, a sync pulse of positive polarity will appear at the SYNC OUTPUT DELAYED connector. This pulse occurs simultaneously with the leading edge of the r-f output pulse and the leading edge of the external modulating pulse.

(3) Characteristics of the sync output pulses are described in section V, paragraph 2.*a.*(10).

7. USE OF SIGNAL FREQUENCY INTERPOLATION SCALES.

a. Except in serial no. 1-150 manufactured under Contract No. NOa(s)-9748, Signal Generator TS-419/U is equipped with an additional scale on the signal frequency dial, located behind the transparent window, which counts the revolutions of the SIGNAL FREQUENCY control, and with a scaled dial on the SIGNAL FREQUENCY control knob, which is calibrated from 0 to 100. Taken together, these scales permit accurate determination of small increments of frequency, as required in certain types of selectivity and filter characteristic measurements.

b. To determine the frequency difference between two settings of the SIGNAL FREQUENCY control, when these settings are too close to obtain satisfactory accuracy from the direct dial calibrations, proceed as follows:

(1) Note the reading of the signal frequency dial and the reading on the 0 to 100 scale on the SIGNAL FREQUENCY control knob for each frequency setting. Always approach the final SIGNAL FREQUENCY settings from the same direction in order to minimize errors from backlash.

(2) Subtract the smaller of these numbers from the larger.

(3) Determine in the same manner the number of divisions for a 10-megacycle frequency change.

(4) Divide the difference obtained in step (2) by this number and multiply the result by 10 to obtain the frequency difference in megacycles.

Note

When measuring small frequency differences, do not readjust POWER SET control between readings. Use the meter scale as described in paragraph 6.*a.*(6), this section, to correct output attenuator readings for change in power level. Failure to use this procedure may lead to serious error in the measurement of small frequency differences.

c. To illustrate the procedure outlined in paragraph 7.*b.*, this section, the following example is provided. Assume a dial setting of 45 on the lower scale of the signal frequency dial and 73 on the SIGNAL FREQUENCY control. The combination is read as 4573. This corresponds to a frequency of approximately 1431 mc. Similarly, a reading of 4832 corresponds to a frequency of approximately 1488 mc. The difference between these readings equals 259. At a frequency of 1460 mc there are 45 divisions in 10 mc. The actual frequency difference therefore will be $\frac{259 \times 10}{45} = 57.5$ mc.

Note

The accuracy of the frequency difference determined in this manner is not greater than 0.2 mc/sec, though the calculation may appear closer.

8. STOPPING THE EQUIPMENT.

a. Three shut-down procedures may be employed for Signal Generator TS-419/U. These are:

(1) Functional operation may be stopped by placing the SELECTOR SWITCH in the ZERO SET position.

(2) The equipment, with the exception of the space heaters, may be shut down by placing the POWER OFF ON switch in the OFF position.

(3) Complete shutdown of the equipment is accomplished only by removal of Power Cable CX-337/U (on the TS-419/U) or Electrical Power Cable Assembly CX-3135/U (on the TS-419A/U) from the POWER INPUT connector.

SECTION III

THEORY OF OPERATION

1. INTRODUCTION.

a. Signal Generator TS-419/U is a test set that provides r-f signals in the range of 900 to 2100 megacycles per second at amplitudes of 0.16 volt (−3 dbm) to 0.2 microvolt (−121 dbm). The equipment is designed to provide signals to external loads of 50 ohms resistance.

b. Signal Generator TS-419/U provides both continuous-wave and pulse-type radio-frequency output signals. Pulse signals may be derived from either an internal or external source of modulation signal. When pulse signals are derived from the internal modulator, these pulse signals may be synchronized with signals from either an internal or an external source. Provision is included in Signal Generator TS-419/U for delaying the pulse output signal relative to the synchronizing signal.

c. The TS-419/U also generates delayed and undelayed video pulses that can be used by external equipment. The delayed pulse coincides with the leading edge of the r-f output pulse, while the undelayed pulse coincides with the leading edge of the synchronizing pulse.

2. BLOCK DIAGRAM.

The basic circuit of Signal Generator TS-419/U comprises four functional systems as shown in figure 3-1: the r-f oscillator, the output system, the modulator and synchronizer, and the power supply. The r-f oscillator is keyed by the modulator and synchronizer to produce the desired r-f output. The output system determines the amount of r-f power available to the load and provides a direct-reading power output control. The power supply provides plate and filament power to the entire equipment. Complete schematic diagrams of Signal Generator TS-419/U are shown in figures 7-1, 7-1A, 7-1B and 7-1C. Each of the four functional systems is described in detail in the following paragraphs.

3. R-F OSCILLATOR.

a. The r-f oscillator performs the prime function in Signal Generator TS-419/U, generating the r-f power that is delivered to the external load. The oscillator employs a 6BM6A reflex klystron (velocity modulation type) in a coaxial cavity resonator. The tube is called a *reflex* klystron because a single set of grids performs the dual function of bunchers and catchers for the electron stream. An equivalent circuit for the r-f oscillator and associated output system is shown schematically in figure 3-2.

Note

Early equipments used a type 6BM6. The type 6BM6A supersedes the 6BM6 and should be used for all replacement purposes.

b. The resonant circuit L and C in figure 3-2 connects to the resonator grids in klystron tube. Interposed between the resonator grids and the cathode is the focusing grid. On the other side of the resonator grids the reflector electrode, which is at a high negative potential, acts to repel the electrons. All three grids are of relatively open construction and permit the free passage

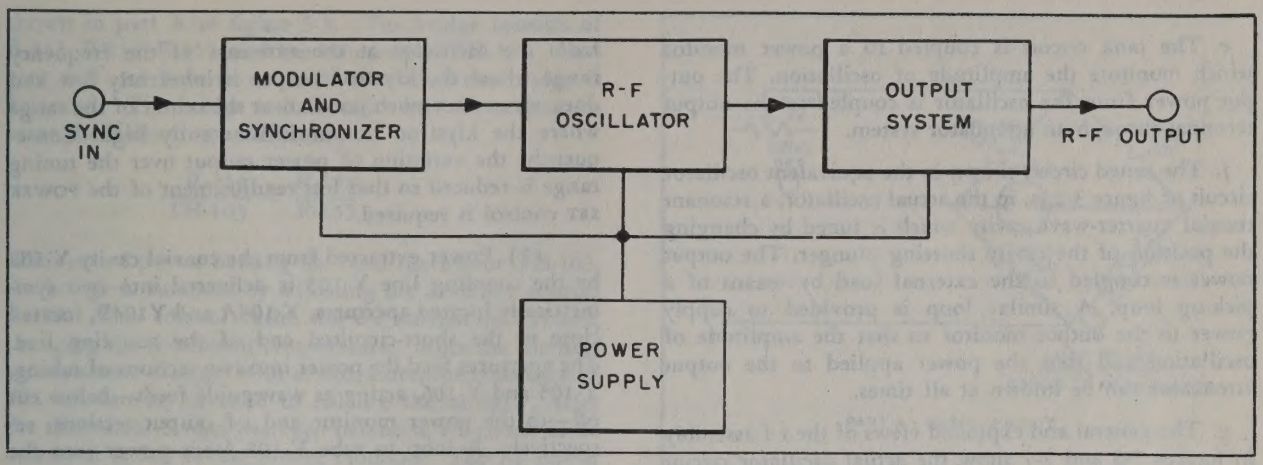


Figure 3-1. Signal Generator TS-419/U, Block Diagram

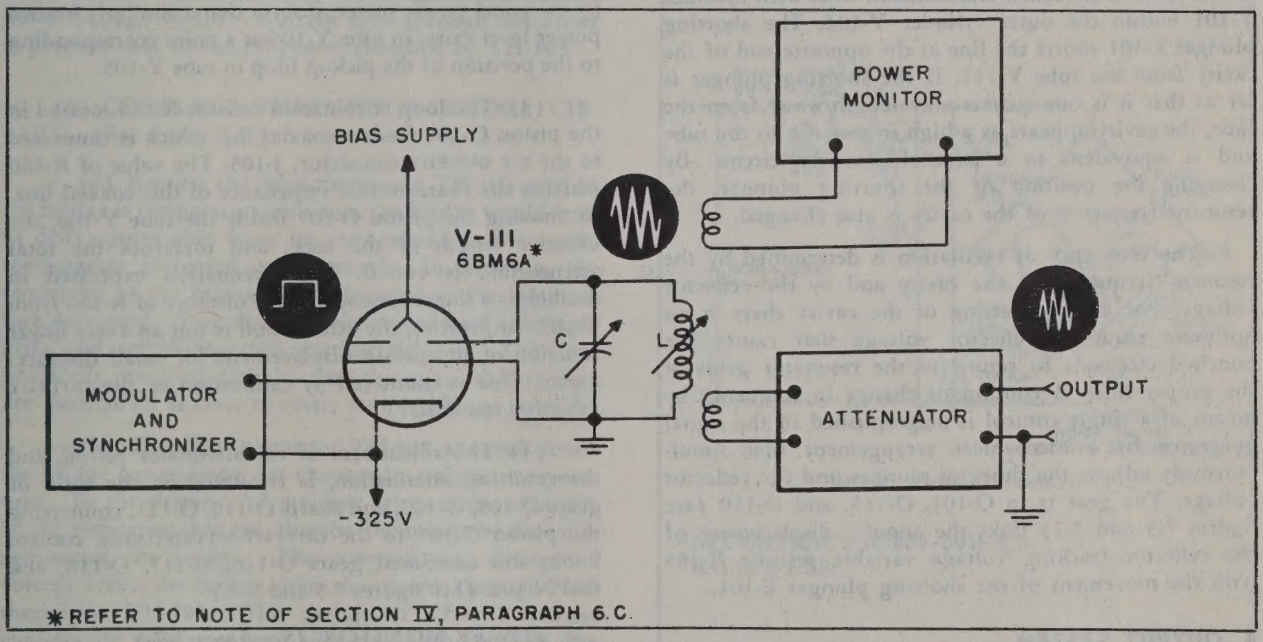


Figure 3-2. Equivalent Circuit for R-F Oscillator and Output System

of electrons when their relative potentials are of the proper magnitude.

c. With the circuit of figure 3-2 in an oscillatory condition, its operation can be explained as follows: The tank circuit L and C, and the resonator grids to which they are connected, are highly positive with respect to the cathode. In addition, the focusing grid has been brought up to the cathode potential by the modulating pulse so that electrons are beamed through the resonator grids.

d. Because the circuit is oscillating, an a-c voltage exists across the tank circuit L and C. This same voltage exists between the resonator grids so that the field between the grids is constantly changing, sometimes aiding the passage of electrons and sometimes opposing the passage of electrons. Thus, as the electrons from the cathode pass through the resonator grids, some are accelerated, while those passing through an instant later are decelerated. The electrons then travel towards the highly negative reflector electrode, some with more velocity than others. The high negative potential of the reflector causes the electrons to reverse their direction of travel and proceed back toward the resonator grids. The electrons which were accelerated travel farther than those which were decelerated, so that both types arrive back at the resonator grids at the same time or in a bunch. The amplitude of the reflector voltage is such that the bunched electrons arrive back at the resonator grids at a time when the field between the resonator grids opposes the passage of electrons. The electrons thus give up energy to the resonator grids and this energy is "stored" in the tank circuit, sustaining the oscillations.

e. The tank circuit is coupled to a power monitor which monitors the amplitude of oscillation. The output power from the oscillator is coupled to the output terminal through an attenuator system.

f. The tuned circuit shown in the equivalent oscillator circuit of figure 3-2 is, in the actual oscillator, a resonant coaxial quarter-wave cavity which is tuned by changing the position of the cavity shorting plunger. The output power is coupled to the external load by means of a pick-up loop. A similar loop is provided to supply power to the output monitor so that the amplitude of oscillation and thus the power applied to the output attenuator can be known at all times.

g. The general and exploded views of the r-f assembly in figures 7-6 and 7-7 show the actual oscillator circuit used in the signal generator. The resonant cavity is built in the form of a coaxial transmission line, with cylinder Y-101 within the outer cylinder Y-102. The shorting plunger E-101 shorts the line at the opposite end of the cavity from the tube V-111. If the shorting plunger is set so that it is one-quarter wavelength away from the tube, the cavity appears as a high impedance to the tube and is equivalent to a parallel resonant circuit. By changing the position of the shorting plunger, the resonant frequency of the cavity is also changed.

h. The frequency of oscillation is determined by the resonant frequency of the cavity and by the reflector voltage. For a given setting of the cavity there is an optimum value of reflector voltage that causes the bunched electrons to return to the resonator grids at the proper time. A continuous change in frequency by means of a single control is accomplished in the signal generator by a mechanical arrangement that simultaneously adjusts the shorting plunger and the reflector voltage. The gear tr. in O-101, O-115, and O-119 (see figures 7-5 and 7-7) links the angular displacement of the reflector tracking voltage variable resistor R-185 with the movement of the shorting plunger E-101.

4. OUTPUT SYSTEM.

a. R-F OUTPUT. (*See figure* 7-7.)

(1) The r-f power output from the oscillator is extracted from the oscillator by means of an adjustable coupling line Y-103. The small capacity provided by the button C-129 on the end of the line Y-103 couples the line to the inner conductor Y-101 of the coaxial cavity Y-102. The amount of pickup is adjusted when the POWER SET knob is rotated. This action, through shaft assembly O-113, moves the inner conductor Y-103 of the coupling line in and out of the cavity Y-102. The load end of the coupling line is short-circuited, giving it the properties of a resonant circuit. Its length is one-quarter wavelength long at a frequency slightly lower than the lowest operating frequency of 900 mc/sec, and three-quarters of a wavelength long at a frequency slightly higher than the highest operating frequency of 2100 mc/sec. This arrangement extracts power efficiently from the oscillator at the extremes of the frequency range where the klystron output is inherently low and does not extract much power near the center of the range where the klystron output is inherently high. Consequently, the variation of power output over the tuning range is reduced so that less readjustment of the POWER SET control is required.

(2) Power extracted from the coaxial cavity Y-102 by the coupling line Y-103 is delivered into two symmetrically located apertures, Y-104A and Y104B, located close to the short-circuited end of the coupling line. The apertures feed the power into two sections of tubing, Y-105 and Y-106, acting as waveguide feeds—below cut off—to the power monitor and r-f output sections, respectively. A loop in tube Y-105 feeds power into the power monitor system. Since the two apertures are symmetrical, a known power in tube Y-105, as indicated by the panel power meter, insures that a similarly known power level exists in tube Y-106 at a point corresponding to the position of the pickup loop in tube Y-105.

(3) The loop termination resistor R-160 located in the piston O-107 feeds a coaxial line which is connected to the R-F OUTPUT connector, J-105. The value of R-160 matches the characteristic impedance of this coaxial line. By moving the piston O-107 inside the tube Y-106, the effective length of the tube, and therefore the total attenuation, is varied. The attenuation expressed in decibels is a linear function of the distance of R-160 from Y-103. In practice, the attenuation is not an exact linear function of the piston displacement for small displacements. This is countered by calibration of the OUTPUT ATTENUATOR dial.

(4) The adjustment of the attenuator piston, and the resulting attenuation, is regulated by the train of gears O-108, O-109, and shafts O-110, O-111, connecting the piston O-107 to the OUTPUT ATTENUATOR control knob, and associated gears O-116, O-117, O-118, and dial N-102. (See figures 7-5 and 7-7.)

b. POWER MONITOR. (*See figure* 7-7.)

(1) GENERAL.—As stated in paragraph 4.*a.*(2), this section, the loop in tube Y-105 feeds power into the power monitor system. The power monitor system is a thermistor bridge circuit that includes the panel meter M-101, used in determining the output power level. Bead and disc thermistors are used in the signal generator. The bead thermistor TH-103 has a small mass and is used for power measurement. It is located in the cavity, and changes in its resistance can be caused by thermal changes in environment, by direct currents flowing through it, or by absorbed r-f power. The two disc thermistors TH-101 and TH-102 have a much larger mass. They are mounted outside the cavity and their resistance is dependent primarily on the ambient temperature.

(2) BASIC THERMISTOR BRIDGE CIRCUIT. (*See figure* 3-3.)—The basic thermistor bridge circuit is

shown in part A of figure 3-3. The bridge consists of R-153, R-154, R-155, and bead thermistor TH-103. Current will not flow in meter M-101 when the bridge is balanced. The bridge is balanced when the resistances meet the following conditions:

$$\frac{\text{R-154}}{\text{TH-103}} = \frac{\text{R-153}}{\text{R-155}}$$

With no r-f power heating the bead thermistor TH-103, the bridge is balanced by adjusting the ZERO SET control R-145. This control varies the d-c current in TH-103, changing the thermistor temperature. Since the thermistor resistance changes with temperature, the resistance of TH-103 can be adjusted to balance the bridge. After the thermistor bridge has been balanced, r-f power to be measured is fed to the power monitor. The r-f power absorbed by TH-103 increases its temperature, decreasing its resistance and unbalancing the bridge so that current flows through M-101. Current flow through the meter is proportional to the r-f power absorbed by TH-103.

(3) COMPLETE THERMISTOR BRIDGE CIRCUIT. (*See figure 3-3.*)

(*a*) Because the bead thermistor TH-103 used in the bridge is temperature-sensitive, the bridge would tend to drift appreciably from its zero setting as the cavity temperature increased or decreased. In addition, the sensitivity of the bridge would increase as the temperature decreased. Two disc thermistors are used as bridge-drift and sensitivity-compensating devices. They are physically mounted directly upon the cavity so that they are maintained as close to cavity temperature as possible.

(*b*) The disc thermistor TH-101 shunted across the bridge compensates for changes in ambient temperature. In the presence of ambient temperature changes, its d-c resistance changes, thereby changing the d-c voltage across the bridge. The compensating change of voltage across the bridge alters the current through bead thermistor TH-103. The change in TH-103 current changes its resistance in a direction that counters the change in its resistance caused by the ambient temperature change. Thermistor TH-101 is incorporated in a network with R-151 and R-152 which is designed to keep the resistance of thermistor TH-103 almost constant over a range of ambient temperatures. Thus, the bridge can be zero-set and will remain in balance to a relatively high degree.

(*c*) Because of the inherent characteristic of thermistor bridges to increase in sensitivity as the ambient temperature decreases, the compensating network of disc thermistor TH-102, R-156, and R-157 has been placed in series with the meter M-101. This network varies the meter resistance in the balance circuit across the bridge so that the sensitivity of the bridge remains constant over the required temperature range.

(*d*) The d-c bridge potential is applied through the series circuit of R-147, R-146, and R-145. ZERO SET

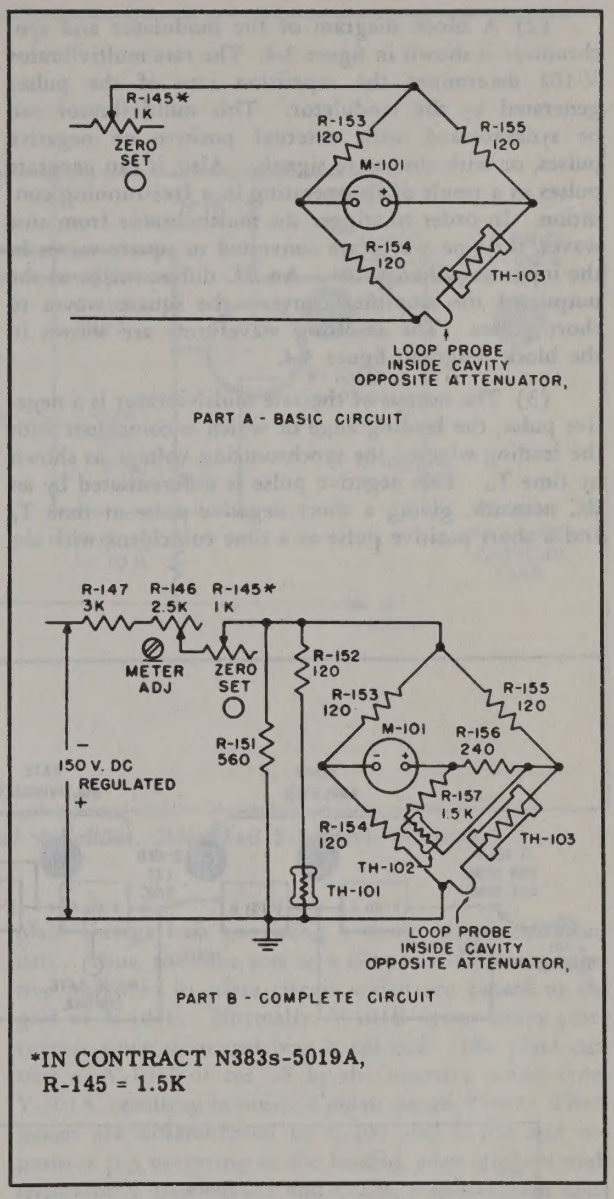


Figure 3-3. Signal Generator TS-419/U, Power Monitor Thermistor Bridge, Schematic Diagram

R-145 is a front panel control that adjusts the electrical balance of the power monitor bridge circuit. ZERO ADJ R-146 is a screw-driver control used to enable R-145 to center on the required adjustment range.

5. MODULATOR AND SYNCHRONIZER.

a. GENERAL.

(1) The modulator and synchronizer includes tubes V-101 and V-110. The basic function of the modulator is to generate a positive video pulse of desired characteristics and to apply that pulse to the focusing grid of the reflex klystron V-111, so that V-111 will oscillate for the duration of the pulse.

(2) A block diagram of the modulator and synchronizer is shown in figure 3-4. The rate multivibrator V-102 determines the repetition rate of the pulses generated by the modulator. This multivibrator can be synchronized with external positive or negative pulses, or with sine-wave signals. Also, it can generate pulses as a result of its operating in a free-running condition. In order to trigger the multivibrator from sine waves, the sine waves are converted to square waves in the input amplifier V-101. An RC differentiator at the output of the amplifier converts the square waves to short pulses. The resulting waveforms are shown in the block diagram, figure 3-4.

(3) The output of the rate multivibrator is a negative pulse, the leading edge of which is coincident with the leading edge of the synchronizing voltage as shown by time T_0. This negative pulse is differentiated by an RC network, giving a short negative pulse at time T_0 and a short positive pulse at a time coincident with the trailing edge of the multivibrator pulse. These short pulses are applied to the clipper V-103A which is designed to pass only the short negative pulse occurring at time T_0. This short negative pulse is then applied to and triggers the delay multivibrator V-104.

(4) The delay multivibrator V-104 is provided as a means for supplying a time delay between the external synchronizing voltage and the video pulse which is eventually applied to the klystron V-111. The positive pulse generated by the delay multivibrator V-104 is adjustable in duration over a range from 3 to 300 microseconds and the length of this pulse determines the amount of delay in the circuit. The delay pulse is differentiated by an RC network, giving a short positive pulse at the leading edge of the pulse (time T_0) and a short negative pulse at the trailing edge of the pulse (time T). The positive pulse at time T_0 is shorted out, however, by the clipper V-103B, leaving only the negative pip at time T. It should be noted that the time

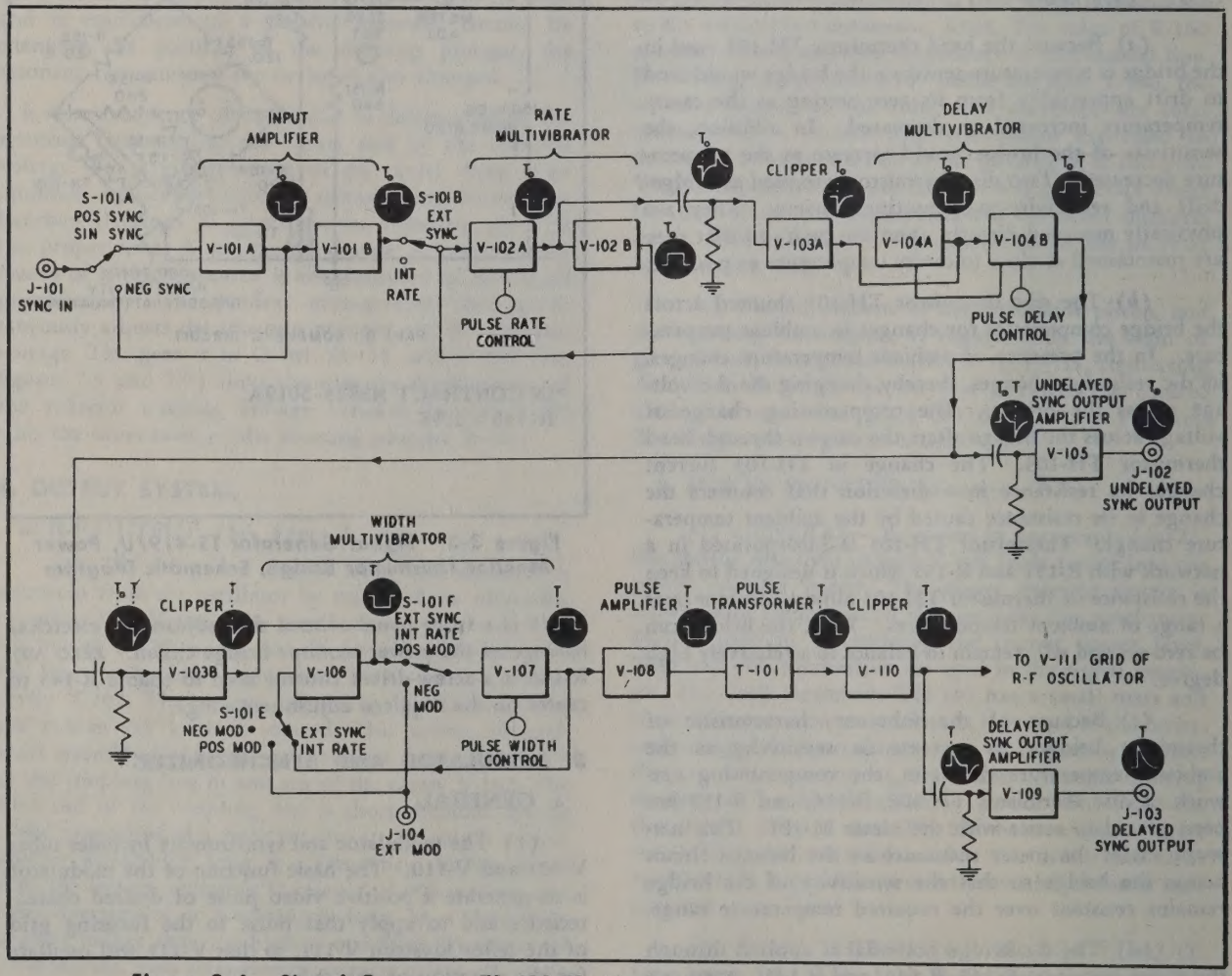


Figure 3-4. Signal Generator TS-419/U, Modulator and Synchronizer, Block Diagram

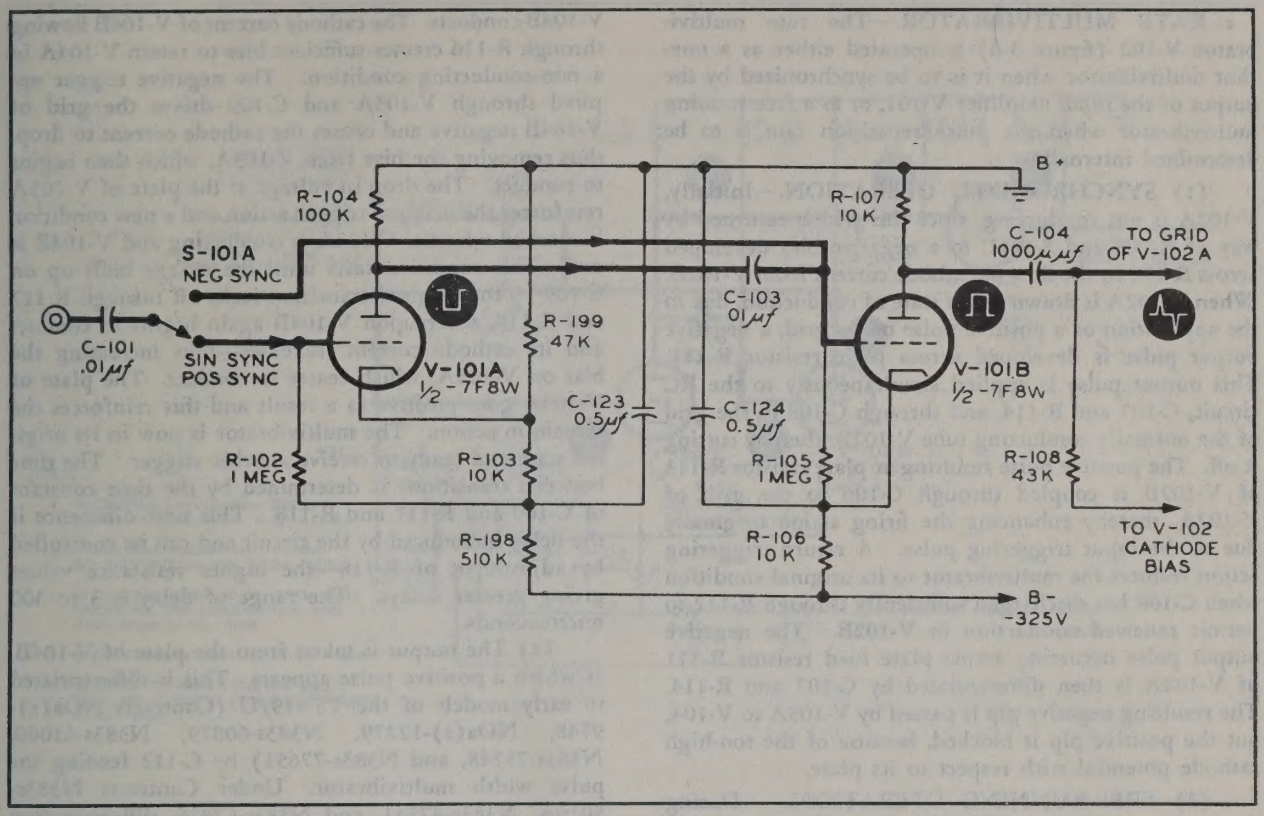


Figure 3-5. Signal Generator TS-419/U, Input Amplifier, Simplified Schematic Diagram

interval between T_n and T is determined by the duration of the pulse generated by the delay multivibrator V-104.

(5) The negative pip occurring at time T is then applied to and triggers the signal width multivibrator, V-106 and V-107, which generates a large positive pulse that is adjustable in duration over a range from 0.5 to 10 microseconds. This positive pulse is applied to the grid of the beam power tube V-108 resulting in a strong negative pulse in the primary of pulse transformer T-101. The stepped-up positive pulse from the secondary of the transformer is limited at a pre-determined level by the clipper V-110 and then applied to the focusing grid of the reflex klystron V-111, allowing oscillation for the duration of the pulse.

b. INPUT AMPLIFIER.—The input amplifier (figure 3-5) is used only when the modulator is to be synchronized to an external source of sine waves or pulses.

(1) SINE WAVE SYNCHRONIZATION.—When the external source provides sine wave signals, they are fed through switch S-101A to the grid of the amplifier tube, V-101A. This tube is nearly cut off by virtue of the bias supplied to its control grid from the voltage divider R-198, R-103, and R-199, which also serves to keep the plate voltage low, providing a sharp cut-off characteristic. Thus, the tube acts as a clipper and creates negative pulses in its plate circuit which are passed to the grid of V-101B. Normally, V-101B draws heavy plate current since zero grid bias is applied. The plate current of V-101B is cut off by the negative pulses from V-101A, resulting in positive pulses across R-107. These pulses are differentiated by C-104 and R-108 and the positive pip occurring at the leading edge triggers multivibrator V-102. C-123 and C-124, together with associated resistors, are decoupling filters to isolate V-101 from power supply fluctuations.

(2) POSITIVE PULSE SYNCHRONIZATION.—Positive pulses follow the same path as sine waves through V-101 and the action is identical with that described for sine waves in paragraph 5.*b.*(1), this section.

(3) NEGATIVE PULSE SYNCHRONIZATION.—Negative pulses are applied to the grid of V-101B without passing through V-101A, since they are already of the proper polarity to cut off V-101B. The remainder of the action is similar to that described for sine waves in paragraph 5.*b.*(1), this section.

c. RATE MULTIVIBRATOR.—The rate multivibrator V-102 (figure 3-6) is operated either as a one-shot multivibrator when it is to be synchronized by the output of the input amplifier V-101, or as a free-running multivibrator when the pulse repetition rate is to be determined internally.

(1) SYNCHRONIZED OPERATION.—Initially, V-102A is not conducting, since the grid is returned by way of R-108 and S-101C to a negative bias developed across R-174 by the flow of cathode current from V-102B. When V-102A is drawn into a state of conduction, due to the application of a positive pulse on its grid, a negative output pulse is developed across plate resistor R-111. This output pulse is applied simultaneously to the RC circuit, C-107 and R-114, and through C-108 to the grid of the normally conducting tube V-102B, thereby cutting it off. The positive pulse resulting at plate resistor R-113 of V-102B is coupled through C-106 to the grid of V-102A, thereby enhancing the firing action originally due to the input triggering pulse. A return triggering action restores the multivibrator to its original condition when C-108 has discharged sufficiently through R-112 to permit renewed conduction in V-102B. The negative output pulse occurring across plate load resistor R-111 of V-102A is then differentiated by C-107 and R-114. The resulting negative pip is passed by V-103A to V-104, but the positive pip is blocked, because of the too-high cathode potential with respect to its plate.

(2) FREE-RUNNING OPERATION. — During free-running operation, the grid of V-102A is returned to the cathode through R-108, S-101C, R-109, and R-110. When power is applied, V-102B tends to draw a heavy plate current, causing a drop across R-113 which is passed to the grid of V-102A through capacitor C-106. V-102A is cut off and its plate voltage rises. This increase is passed back to the grid of V-102B through C-108, thereby enhancing the firing action. When the charge leaks off C-106 through R-108, R-109, and R-110, V-102A begins to conduct, its plate voltage drops, and this charge is passed by C-108 to the grid of V-102B, thereby cutting it off and causing its plate voltage to rise. This rise is passed back to the grid of V-102A through C-106, thereby reinforcing the firing action; however, C-108 is soon discharged by R-112, and V-102B again begins to conduct. The cycle then repeats after a time interval determined by the sum of the time constants due to C-108 and R-112 and C-106 and R-108, R-109, and R-110. The pulse repetition rate is varied by changing R-110 and the range is changed further by connecting C-105 in parallel with C-106 by means of S-101B. The longer the time constant (as by increasing either R or C) the longer the cycle takes and consequently, the fewer the cycles that occur each second and the lower the repetition rate.

d. DELAY MULTIVIBRATOR AND UNDELAYED SYNC OUTPUT. *(See figure 3-7.)*

(1) The pulse delay multivibrator is triggered by the negative pip occurring at time T_0 and passes by V-103A as described in paragraph 5.*c.*(1), this section. The grid of V-104B is returned directly to its cathode through R-117 and R-118 so that zero bias exists and V-104B conducts. The cathode current of V-104B flowing through R-116 creates sufficient bias to retain V-104A in a non-conducting condition. The negative trigger applied through V-103A and C-109 drives the grid of V-104B negative and causes the cathode current to drop, thus removing the bias from V-103A, which then begins to conduct. The drop in voltage at the plate of V-103A reinforces the original trigger action and a new condition is reached wherein V-104A is conducting and V-104B is not. This condition lasts until the charge built up on C-109 by the original transition leaks off through R-117 and R-118, whereupon V-104B again begins to conduct and its cathode current increases—thus increasing the bias on V-104A, which ceases to conduct. The plate of V-104A goes positive as a result and this reinforces the transition action. The multivibrator is now in its original state and ready to receive another trigger. The time between transitions is determined by the time constant of C-109 and R-117 and R-118. This time difference is the delay introduced by the circuit and can be controlled by adjustment of R-118—the higher resistance values giving greater delays. The range of delay is 3 to 300 microseconds.

(2) The output is taken from the plate of V-104B, at which a positive pulse appears. This is differentiated in early models of the TS-419/U (Contracts NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748, and N383s-77651) by C-112 feeding the pulse width multivibrator. Under Contracts N383s-5019A, N383s-47541, and N383s-67816, differentiation is by C-132 feeding R-196. In either case the positive pip occurring at the leading edge is shorted out by clipper V-103B so that only the trailing or delayed edge of the delay pulse is effective in triggering the pulse width multivibrator.

(3) The undelayed sync output amplifier is also fed from the plate of V-104B by way of differentiating network C-110 and R-120. The positive pip appearing at the leading or undelayed edge of the delay pulse occurring as a result of this differentiation is amplified by V-105 and appears as the undelayed sync output pulse at the cathode of V-105. The negative pip occurring at the trailing or delayed edge of the delay pulse is not amplified since V-105 is heavily biased by R-122 and R-197, and as a result a negative input signal produces no effect. Since V-105 is operated as a cathode follower, the output impedance for the undelayed sync output pulse appearing at J-102 is low. Refer to paragraph 2.*a.*(10) of section V for information concerning the characteristics of this pulse.

e. WIDTH MULTIVIBRATOR. *(See figure 3-8.)*—Vacuum tubes V-106 and V-107 are normally connected as a multivibrator to determine the width of the pulses which are to modulate the klystron V-111. These same tubes may also be connected as either a one- or two-stage video amplifier when it is desired to retain the width characteristics of an externally supplied negative or positive modulating pulse. The changeover is made automatically when the SELECTOR SWITCH S-101 is set to NEG MOD or POS MOD. For the characteristics required of external pulses, refer to paragraph 2.*a.*(8) of Section V.

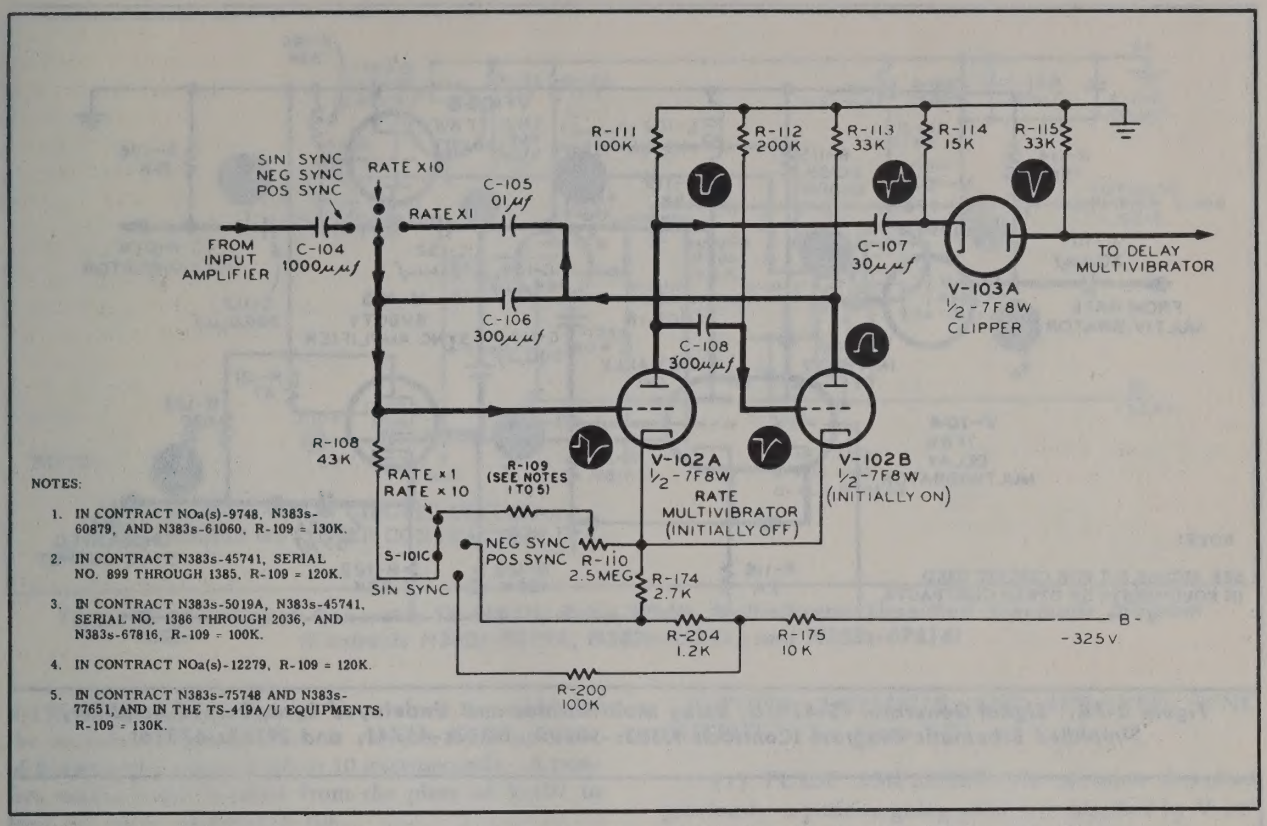


Figure 3-6. Signal Generator TS-419/U, Rate Multivibrator, Simplified Schematic Diagram

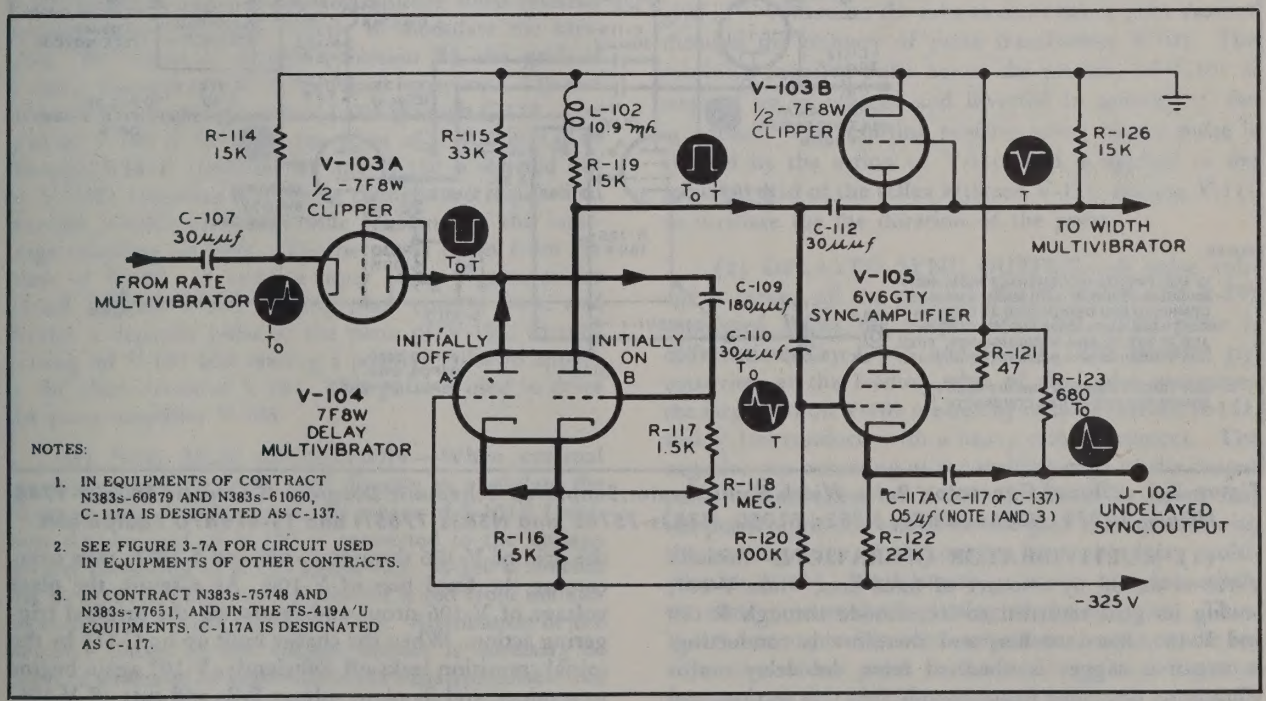


Figure 3-7. Signal Generator, Delay Multivibrator and Undelayed Sync Output Amplifier, Simplified Schematic Diagram (Contracts NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748, and N383s-77651) and TS-419A/U Equipments

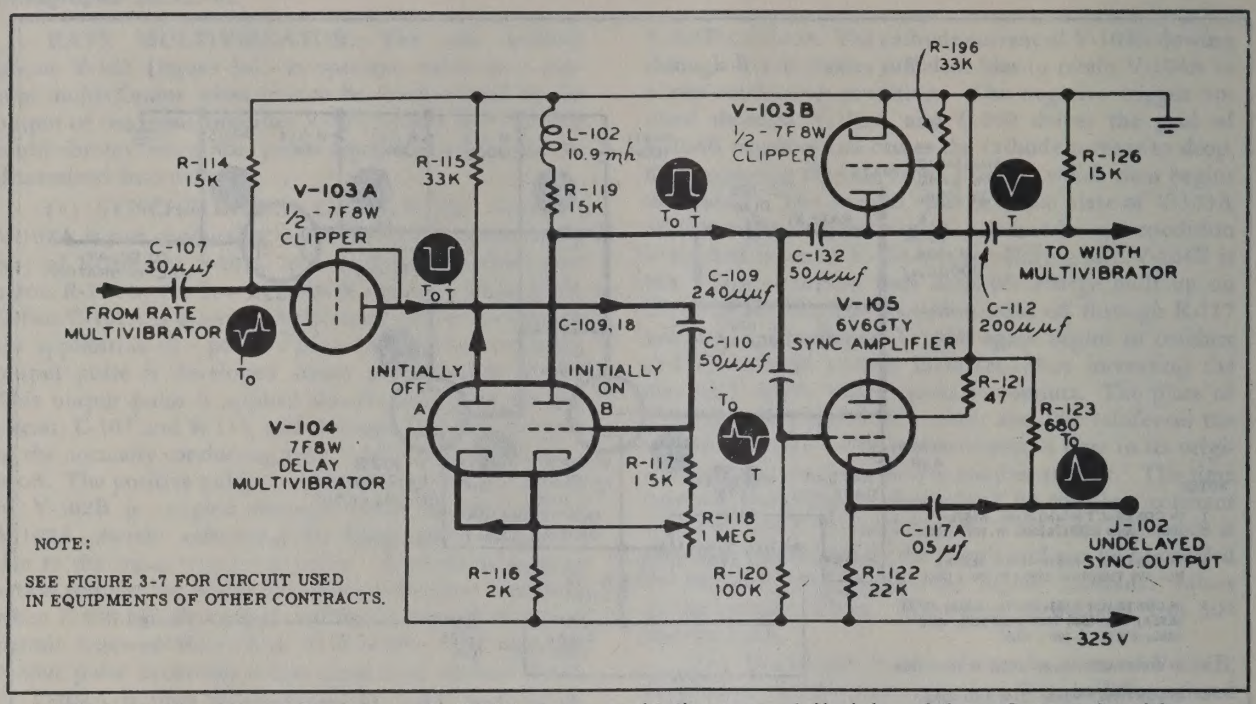


Figure 3-7A. Signal Generator TS-419/U, Delay Multivibrator and Undelayed Sync Output Amplifier, Simplified Schematic Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)

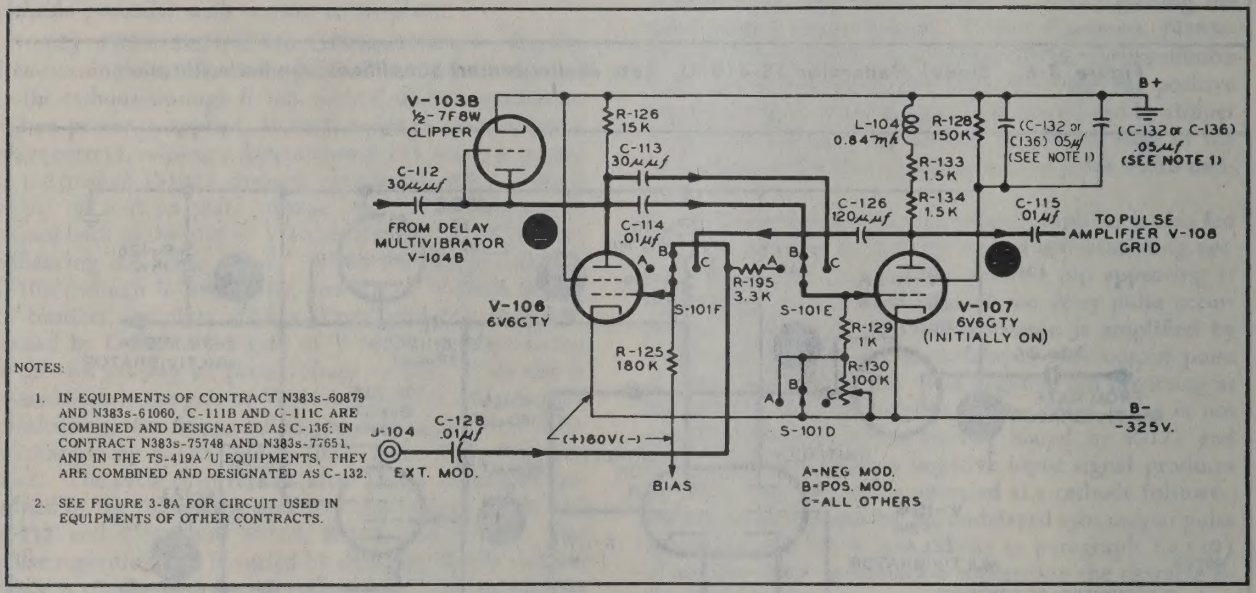


Figure 3-8. Signal Generator, Pulse Width Multivibrator, Simplified Schematic Diagram (Contracts NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748 and N383s-77651) and TS-419A/U Equipments

(1) MULTIVIBRATOR OPERATION.—Initially V-106 is cut off by a source of fixed bias, while V-107, having its grid returned to its cathode through R-129 and R-130, has zero bias and therefore is conducting. A negative trigger is obtained from the delay multivibrator as described in paragraph 5.*d.*, this section, and is conducted through C-113 and S-101E (set to position C) to the grid of V-107, thus cutting it off. The consequent rise in the plate voltage of V-107 is fed back to the grid of V-106 through C-126 and S-101F, thus overcoming the fixed bias of V-106. As a result, the plate voltage of V-106 drops and reinforces the original triggering action. When the charge built up on C-113 by the initial transition leaks off sufficiently, V-107 again begins to conduct, and its plate voltage falls and cuts off V-106, whose plate voltage in turn rises, thus reinforcing the transition action. The time between transitions is determined by the time constant of C-113 and R-129 and

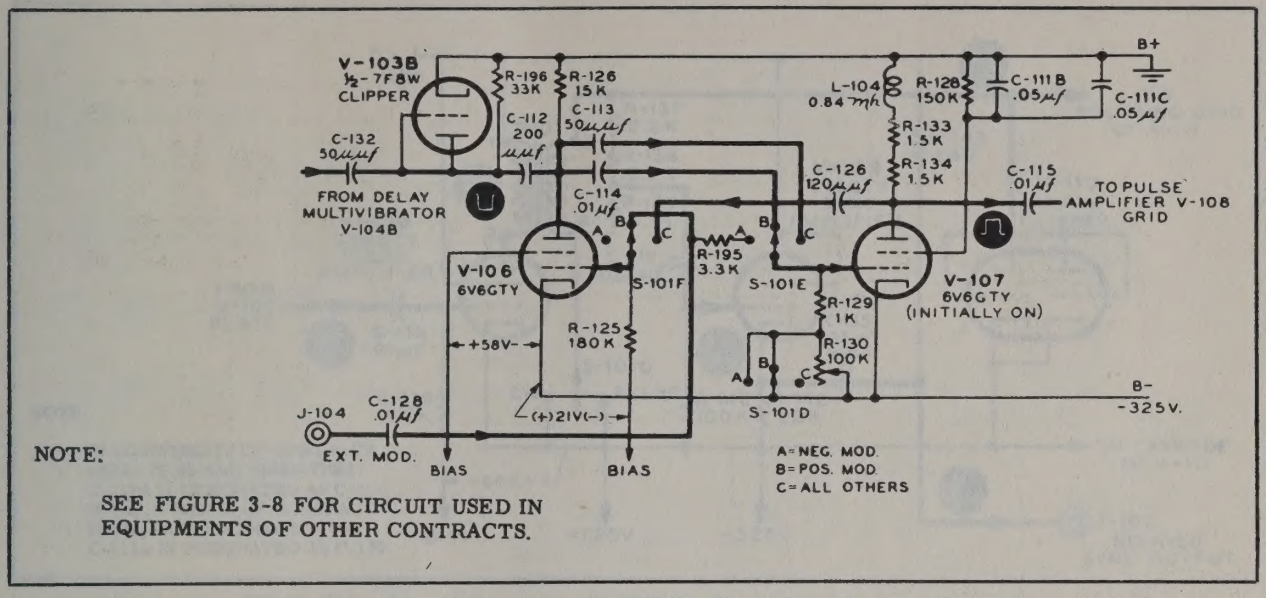


Figure 3-8A. Signal Generator TS-419/U, Pulse Width Multivibrator Simplified Schematic Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)

R-130. This time difference determines the width of the modulating pulse, which is variable by adjustment of R-130 over a range of 0.5 to 10 microseconds. A positive output pulse is taken from the plate of V-107 to feed the pulse amplifier V-108.

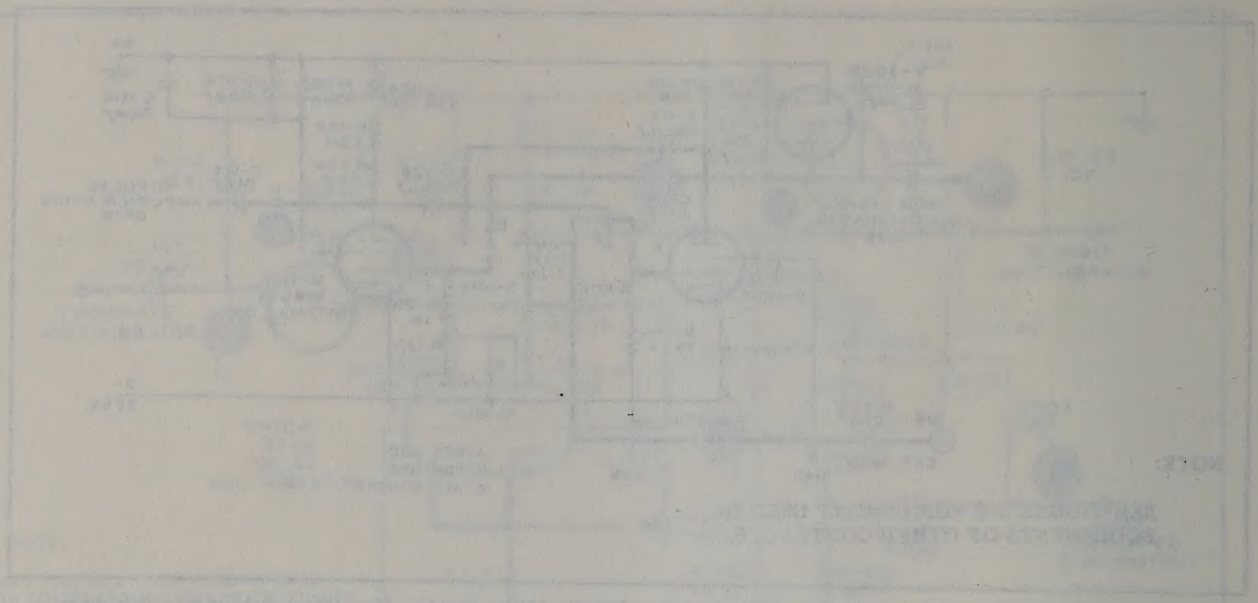
(2) POS MOD OPERATION.—Tubes V-106 and V-107 become a two-stage video amplifier when external positive pulses are used directly to modulate the klystron. By means of S-101F (position B) the grid of V-106 is disconnected from feed back capacitor C-126 and tied to the EXT MOD connector J-104 through C-128. The grid of V-107 is fed from the plate of V-106 by C-114 through S-101E (position B) and R-130 is shorted out by S-101D (position B). These changes are required to provide suitable and fixed time constants in the interstage coupling network. The output is taken from the plate of V-107. A positive input pulse overcomes the cut-off bias on V-106, causing plate current flow, and creates a negative pulse at the plate of V-106, thereby cutting off V-107 and causing a positive pulse to appear in the plate circuit of V-107. This pulse is used to drive the pulse amplifier V-108.

(3) NEG MOD OPERATION.—When external negative pulses are to be used directly to modulate the klystron, only V-107 is used. By means of S-101E (position A) the grid of V-107 is connected to the voltage divider consisting of R-195 and R-129. R-130 is shorted out by S-101D. This voltage divider is fed from the EXT MOD connector J-104 through C-128. Attenuation of the negative pulses by the voltage divider is necessary to prevent widening of high-amplitude negative pulses. An incoming negative pulse cuts off V-107, causing a positive pulse to appear in its plate circuit. This pulse is used to drive pulse amplifier V-108.

f. PULSE AMPLIFIER AND DELAYED SYNC OUTPUT. *(See figure 3-9.)*

(1) PULSE AMPLIFIER.—In all cases described previously, a positive-going pulse was supplied by V-107 to the grid of V-108, which is normally biased beyond cut-off. The positive potential thus impressed on the grid of V-108 causes the tube to draw heavy plate current through the primary of pulse transformer T-101. The resulting negative pulse across the primary of T-101 is stepped up in voltage and inverted in polarity in the secondary. The resulting positive-going output pulse is clipped by the action of V-110, and is applied to the focusing grid of the reflex klystron V-111, causing V-111 to oscillate for the duration of the pulse.

(2) DELAYED SYNC OUTPUT.—A pulse voltage is picked off the network R-137, R-138, and R-139 connected across the output of T-101. This pulse is differentiated by C-116 and R-140. The positive pip occurring at the leading edge of the pulse overcomes the large bias on V-109 created by cathode resistor R-142, and V-109 conducts with a heavy cathode current. The negative pip occurring at the trailing edge of the output pulse has no effect on V-109. It should be noted that the positive pip impressed on the grid corresponds with the trailing edge of the output from the delay multivibrator V-104. Furthermore, it occurs at substantially the same time as the beginning of the r-f pulse. Thus, V-109 acts to provide a low-impedance output source for a positive video pulse at the DELAYED SYNC OUTPUT connector J-103 and also clips any negative portion of the pulse. For output pulse characteristics refer to paragraph 2.*a.*(10) of Section V.



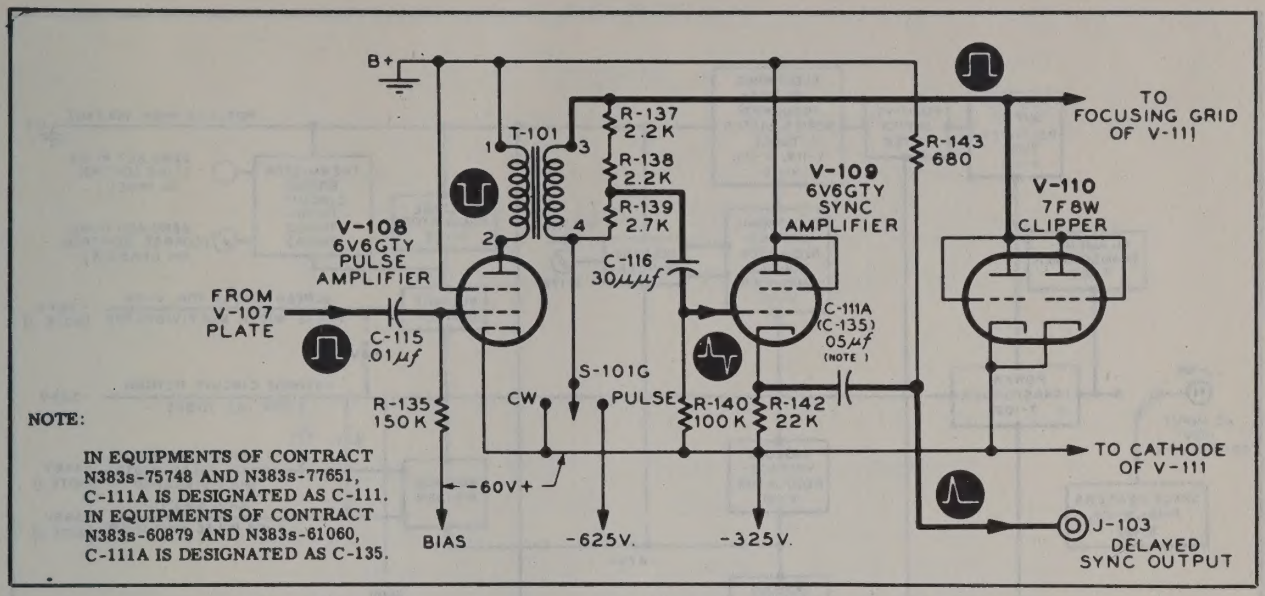


Figure 3-9. Signal Generator TS-419/U, Pulse Amplifier and Delayed Sync Amplifier, Simplified Schematic Diagram

6. POWER SUPPLY. *(See figures 3-10, 7-1, 7-1A, and 7-1B.)*

a. With the power cable connected and POWER OFF ON switch S-102 in the OFF position (white pilot light I-101 on front panel energized), input power is applied to the internal space heaters R-161, R-162, and R-192, to maintain the instrument slightly above ambient temperature. The space heaters are physically located on the underside of the chassis, in three corners. (See figure 5-3.)

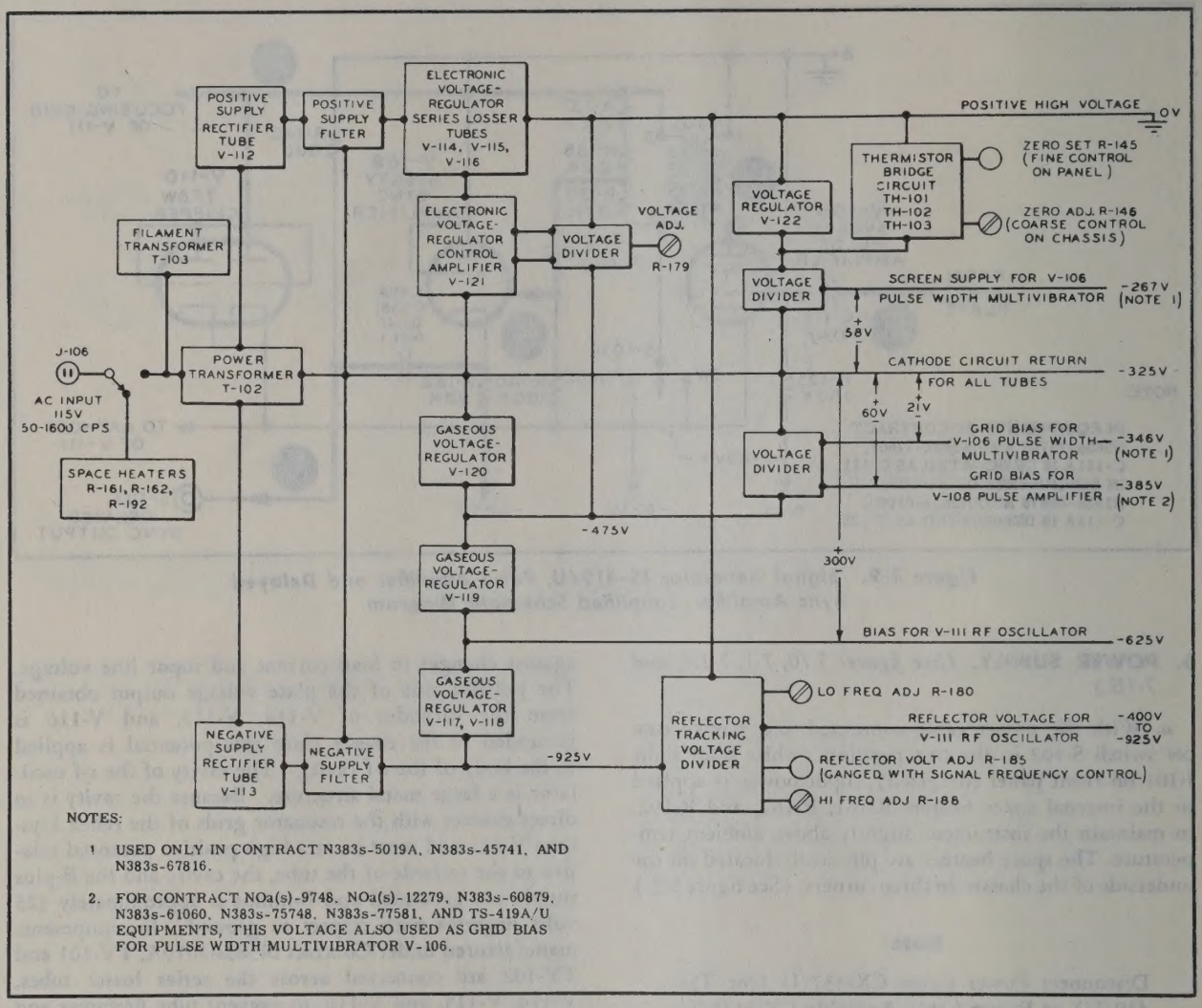
Note

Disconnect Power Cable CX-337/U (for TS-419/U) or Power Cable Assembly CX-3135/U (for TS-419A/U) from the POWER INPUT jack, to make the equipment entirely inactive.

With the power cable connected and POWER OFF ON switch S-102 in the ON position (red pilot light I-102 on the front panel energized) the space heaters are de-energized and power is applied to Signal Generator TS-419/U. Input power is applied to the filament transformer T-103, which supplies filament voltage to all tubes, and to power transformer T-102. High voltage for the plate voltage rectifier V-112 and the bias rectifier V-113 is supplied by power transformer T-102.

b. Positive plate voltage from full-wave rectifier V-112 is filterd by L-101 and C-120 and regulated by a parallel bank of three voltage losser tubes. The losser tubes V-114, V-115, and V-116 are controlled by V-121 operated in a cascode arrangement, that is, an arrangement having the gain of a cascade amplifier and the phase reversal of a single-stage amplifier. This series-losser–cascode control tube combination stabilizes the plate voltage supply against changes in load current and input line voltage. The positive side of the plate voltage output obtained from the cathodes of V-114, V-115, and V-116 is grounded to the chassis since this potential is applied to the body of the r-f cavity. The cavity of the r-f oscillator is a large metal structure. Because the cavity is in direct contact with the resonator grids of the reflex klystron V-111 and must be at a high positive potential relative to the cathode of the tube, the cavity and the B-plus supply are grounded and B-minus is approximately 325 volts negative with respect to ground. In equipments manufactured under Contract N383s-5019A, TY-101 and TY-102 are connected across the series losser tubes, V-114, V-115, and V-116, to prevent tube flashover and consequent breakdown of electrolytic capacitors during initial tube warm-up.

c. Bias voltage from V-113 is filtered by C-121, R-149, R-150, R-171, R-190, R-193, and R-194 and regulated by the group of series voltage regulator tubes V-117 toV-120 inclusive. The positive potential end of this group of regulator tubes is connected to the positive potential return of the bias voltage supply, which is common with the negative potential return of the plate voltage supply. A voltage divider R-172 and R-173 connected across V-120 supplies negative bias to the pulse amplifier V-108 and, in Contracts NOa(s)-9748, -12279, -60879, N383s-61060, -75748, -77651, and in the TS-419A/U equipments, to V-106 of the width multivibrator. Under Contracts N383s-5019A, N383s-45741, and -67816, an additional voltage divider (R-132 and R-203) supplies grid bias to V-106, while screen bias is obtained from the junction of R-148 and R-191. The voltage across V-120 also goes to a voltage divider consisting of R-179, R-178, R-177, and R-176, which connects to the grounded posi-



NOTES:

1. USED ONLY IN CONTRACT N383s-5019A, N383s-45741, AND N383s-67816.
2. FOR CONTRACT NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748, N383s-77581, AND TS-419A/U EQUIPMENTS, THIS VOLTAGE ALSO USED AS GRID BIAS FOR PULSE WIDTH MULTIVIBRATOR V-106.

Figure 3-10. Signal Generator TS-419/U, Power Supply, Block Diagram

tive potential side of the plate supply. This divider supplies control voltage to the grids of the control tube V-121. The plate supply voltage can be adjusted by means of VOLTAGE ADJ R-179, located on top of the chassis. Bias for the r-f oscillator V-111 is obtained from the junction of voltage regulators V-118 and V-119.

d. Reflector voltage for the r-f oscillator V-111 is obtained from a voltage divider connected from the cathode of V-117 to the grounded positive side of the plate voltage supply. This divider is composed of the HI. FREQ. ADJ. variable resistor R-188, reflector tracking voltage variable resistor R-185 (shunted by R-186 and R-187), R-184, R-183, R-182, R-181, and the LO. FREQ. ADJ. variable resistor R-180, all connected in series. Reflector voltage obtained from the junction of R-185 and R-184 is passed through a ripple-frequency filter composed of R-159, C-119B, R-158, and C-119A and through a radio-frequency filter Z-104.

e. Direct current supply for the thermistor bridge in the power monitor is obtained from the cathode of regulator tube V-122 which is connected to the negative potential side of the plate voltage supply through R-148 and R-191. Bridge current from V-122 cathode is drawn through R-147, R-146, and R-145. The functions of R-145 and R-146 are described in paragraph *4.b.*(3) (*d*), this section.

SECTION IV

MAINTENANCE

WARNING

This equipment employs voltages which are dangerous and may be fatal if contacted by personnel. Extreme caution should be exercised when working with the equipment. Observe all safety regulations.

Note

Throughout this handbook, all references to TS-419/U also apply to TS-419A/U, except where specifically noted. In the TS-419A/U, Power Cable Assembly CX-3135/U is used in place of Power Cable CX-337/U.

1. Scope of Maintenance

The maintenance duties assigned to the operator of Signal Generators AN/URM-64 and AN/URM-64A are listed below together with a reference to the paragraphs covering the specific maintenance function. The duties assigned do not require tools or test equipment other than those issued with the signal generator.

a. Daily preventive maintenance checks and services (par. 2.2).

b. Weekly preventive maintenance checks and services (par. 2.3).

c. Cleaning (par. 2.4).

d. Monthly preventive maintenance checks and services (par. 2.6).

e. Touchup painting (par. 2.7).

2. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 2.2 through 2.6 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (pars. 2.2.2.3 and 2.6) outline functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and what the normal conditions are. The References column lists the illustrations, paragraphs, or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by the operator, higher echelon maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

2.1. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of Signal Generators AN/URM-64 and AN/URM-64A are required daily, weekly, and monthly. Paragraphs 2.1, 2.2, and 2.6 specify the items to be checked and serviced. In addition to the routine daily, weekly, and monthly checks and services, the equipment should be rechecked and serviced immediately before going on a mission and as soon after completion of the mission as possible.

2.2. Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Completeness	Be sure the equipment is complete	Appx III.
2	Cleaning	Remove dirt and moisture from exposed surfaces of the case and housing.	Par. 2.4.
3	Meter window	Inspect the meter window for broken glass.	
4	Pilot light	During operation (item 7 below), inspect for a burned-out pilot light.	
5	Meter movement	During operation (item 7 below), check for sticking meter movement.	
6	Knobs, dials, and switches.	While making the operating check (item 7 below), observe that the mechanical action of each knob, dial, and switch is smooth and free of external or internal binding.	
7	Operation	During operation, be alert for any unusual performance or condition.	

2.3. Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Cords and cables	Inspect cords and cables for cuts, cracks, strain, fraying, or deterioration.	
2	Handle and latches ...	Hand-check for looseness of handle and latches.	
3	Preservation	Inspect exposed metal surfaces for rust and corrosion. If present, refer to paragraph 2.7.	

2.4. Cleaning

Inspect the exterior of the signal generator. The exterior surfaces should be free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean soft cloth.

Warning: Cleaning Compound is flammable and its fumes are toxic. Provide adequate ventilation. Do not use near a flame.

b. Remove grease, fungus, and ground-in dirt from the cases; use a cloth dampened (not wet) with Cleaning Compound (Federal stock No. 7930-395-9542).

c. Remove dust or dirt from plugs and jacks with a brush.

Caution: Do not press on the meter face (glass) when cleaning; the meter may be damaged.

d. Clean the front panels, meters, and control knobs; use a soft clean cloth. If dirt is difficult to remove, dampen the cloth with water; mild soap may be used for more effective cleaning.

2.5. Monthly Maintenance

Perform the maintenance functions indicated in the monthly preventive maintenance checks and services chart (par. 2.6) once each month. 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 preventive maintenance checks and services 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 preventive maintenance checks and services. Equipment in limited storage (requires service before operation) does not require monthly preventive maintenance.

2.6. Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Pluckout items	Inspect seating of readily accessible items of a pluckout nature such as fuses, connectors, tubes, and lamps. Do not remove, rock, or twist to inspect. Use only direct pressure to insure item is fully seated.	
2	Resistors and capacitors.	Inspect resistors and capacitors for cracks, blistering, or other detrimental defects.	
3	Publications	See that all publications are complete, serviceable, and current.	DA Pam 310-4.
4	Modifications	Check DA Pamphlet 310-4 to determine if new applicable MWO's have been published. All URGENT MWO's must be applied immediately. All NORMAL MWO's must be scheduled.	DA Pam 310-4 and TM 38-750.

2.7. 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.

3. CORRECTIVE MAINTENANCE.

a. GENERAL. When the equipment fails to function properly, the trouble may be corrected by mechanical or electrical adjustment, or, if necessary, by replacement of one or more defective parts. Care must be exercised during all repair procedures; otherwise, additional troubles may be introduced. Special attention must be paid to physical positioning of wiring and detailed parts since a change in position may affect the operation of the equipment. None of the adjustments or tests described in this section should be undertaken unless the symptoms noted indicate that the particular section of the equipment or the particular series of adjustments requires such attention.

b. LOCALIZING TROUBLE. The first step in correcting any trouble or failure is to isolate the section of the circuit causing the trouble. Such isolation can be best accomplished by considering the circuit as composed of the basic sections shown in figures 3-1 and 3-4. Trouble ordinarily occurs in only one section at a time. After narrowing the trouble down to a specific section, the next step is to determine the tube circuit involved. Check the circuit visually for any obviously defective detailed parts. Localization may be aided through waveform comparison. Figures 7-1, and 7-1A, B, C show waveforms observed at certain points of the circuit during normal operation. In general, if the correct waveform is found to exist at the input of the stage but is incorrect at the output of the same stage, a replacement tube should be installed before attempting further tests. If the trouble is not corrected through tube replacement, always replace the tube originally removed in order to eliminate the need for recalibration of the instrument. If no defective tubes are found, voltage and resistance measurements should be made. Nominal values of voltage and resistance measurements from tube socket terminals to ground are listed in tables 4-5 and 4-6. In addition, normal voltage and resistance readings are shown in figure 7-4. As an aid in servicing the equipment, a troubleshooting chart (table 4-2) is included. Table 4-2 lists the symptoms of possible troubles in the order in which they would probably be observed according to the sequence of operation described in paragraph 6 of Section II.

TABLE 4-1. LUBRICATION CHART

Major Assembly	*Part*	*Type of Lubricant**	*Quantity of Lubricant*	*Lubrication Period*	*Procedure*
R-f assembly	Gears	Light oil	Six drops per gear	2 years	Remove r-f assembly
	Nut, H-105	Grease	Pack balls	2 years	Remove nut
	Hubs, H-116 and H-117	Grease	Light film	2 years	Remove r-f assembly
	Rack and pinion gears, O-108 and O-109	Grease	Light film	2 years	Remove chassis only
	Tumbler Assembly, H-119	Grease	Light film	2 years	Disassemble tumbler assembly
	Shaft bearings	Grease	Light film	2 years	Remove shafts
Cavity	Tuning worm shaft, O-101	Grease	Light film	2 years	Disassemble cavity
	Bearing races, H-157	Grease	Pack balls	2 years	Disassemble cavity
Signal Generator TS-419/U	Instrument case threaded inserts	Grease	Light film	2 years	Remove chasis

**Type of Lubricant*	*Manufacturer's Type*	*AN Specification*
Light oil	Eclipse Pioneer PO-10	AN-O-11
Grease	Esso Beacon #325	AN-G-25

LUBRICATION.—Signal Generator TS-419/U is completely lubricated at the factory and should require additional lubrication at intervals of approximately one year, unless operating terrain is of such nature as to require more frequent lubrication. Lubrication data are given in table 4-1.

TABLE 4-2. TROUBLE-SHOOTING CHART

SYMPTOM	*PROBABLE CAUSE*	*REMEDY*
1. WITH THE POWER CABLE CONNECTED AND "POWER OFF ON" SWITCH "OFF," HEATER LAMP I-101 DOES NOT LIGHT.	No primary a-c power.	Check source of power.
	Power cable defective.	Repair or replace power cable.
	Fuse F-101 and/or F-102 defective.	Replace F-101 and/or F-102.
	Heater lamp I-101 open.	Replace I-101.
2. WITH THE POWER CABLE CONNECTED AND "POWER OFF ON" SWITCH "ON," POWER LAMP I-102 DOES NOT LIGHT.	No primary a-c power.	Check source of power.
	Power cable defective.	Repair or replace power cable.
	Fuse F-101 and/or F-102 defective.	Replace F-101 and/or F-102.
	Power lamp I-102 open.	Replace I-102.
	Filament transformer T-103 defective.	Check continuity and resistance value of windings of T-103 with Multimeter TS-352/U (alternate, Simpson Model 260), with all tubes removed from their sockets. (Refer to table 4-7.) Replace T-103 only after careful tests prove it is defective.
3. SOME FILAMENTS LIGHT, OTHERS DO NOT.	Broken filament lead.	Remove all tubes and check wire continuity with Multimeter TS-352/U (alternate, Simpson Model 260), to determine location of fault.
	T-103 defective.	Replace T-103 only after careful tests prove it is defective. (Refer to trouble No. 2.)
4. FUSES F-101 AND F-102 BLOW REPEATEDLY AS SOON AS POWER IS APPLIED.	V-112, V-113, C-120, C-121, T-102, T-103 defective.	Remove V-112 and check if fuses F-101 and F-102 still blow. If not, check V-112 and C-120. If fuses still blow with V-112 removed, remove V-113 also. **CAUTION** Do not remove V-113 without having previously removed V-112. If, with V-112 and V-113 removed, F-101 and F-102 do not blow, test V-113 in Tube Tester I-177A and check condition of C-121. If trouble still exists, check windings and resistance of T-102 and T-103 with Multimeter TS-352/U (alternate, Simpson Model 260). (Refer to table 4-7.)

TABLE 4-2. TROUBLE-SHOOTING CHART (Cont.)

SYMPTOM	*PROBABLE CAUSE*	*REMEDY*
5. FUSES F-101 AND F-102 BLOW SOON AFTER POWER IS APPLIED.	C-122 shorted.	Replace C-122.
	V-108 defective.	Replace V-108.
	V-111 defective.	Check by removing V-111. If fuses no longer blow, replace V-111. (Refer to paragraph 6.*c.* of this section.)
	Z-101, Z-102, or Z-103 shorted.	Replace Z-101, Z-102, or Z-103.
	Lack of bias on V-108, due to bias supply failure. C-117B (designated C-138A in Contracts N383s-60879, N383s-61060, or C-133B in TS-419A/U) may be shorted.	Check that all voltage regulator tubes V-117, V-118, V-119, and V-120 are glowing. Replace if any are defective. Replace C-117 (C-138 or C-133B); refer to "probable cause."
6. FUSES F-101 AND F-102 BLOW AFTER POWER HAS BEEN APPLIED FOR SEVERAL HOURS OR MORE.	Refer to troubles No. 4 and 5. Also, defective transformer T-102 or T-103 may be probable cause, particularly if fuse blowing is not consistent.	Refer to remedies for troubles No. 4 and 5.
7. FILAMENTS LIGHT, BUT NO EVIDENCE OF PLATE VOLTAGE, i.e., NO METER READING, IRRESPECTIVE OF SETTING OF "ZERO SET" CONTROL.	V-112 defective.	Check d-c voltage, with Multimeter TS-352/U (alternate, Simpson Model 260) on pin 8 of V-112. (See figure 7-4.) If no voltage, replace V-112.
	L-101 open.	Check continuity of L-101 with Multimeter TS-352/U (alternate, Simpson Model 260). (Refer to table 4-7.) Replace if necessary.
	C-120 shorted.	Check C-120. Replace if defective.
	C-122 shorted.	Check C-122. Replace if defective.
	V-122 not seated properly or defective.	Check tube position. Check V-122 for continuity between pins 4 and 7 with Multimeter TS-352/U (alternate, Simpson Model 260) and test in Tube Tester I-177A. If open, replace V-122.
	Defective resistor(s) R-145 through R-148 and R-191.	Check resistance of R-145 through R-148 and R-191 with Multimeter TS-352/U (alternate, Simpson Model 260). (See figures 7-1, 7-1A, and 7-1B.) Replace defective resistor(s).
8. "METER" WILL NOT ZERO SET.	Incorrect plate voltage.	Check voltage from pin 7 of V-110 to ground. (See figure 7-4.) If very high, replace V-121. If very low, check C-131 and if necessary, replace V-111. (Refer to paragraph 6.*c.* of this section.) If no plate voltage, see trouble No. 7. If voltage is within 5 per cent of normal value, reset by means of R-179.

TABLE 4-2. TROUBLE-SHOOTING CHART (Cont.)

SYMPTOM	*PROBABLE CAUSE*	*REMEDY*
8. "METER" WILL NOT ZERO SET (Cont.).	V-122 defective	Check voltage from pin 7 of V-122 to ground. (See figure 7-4.) If incorrect, replace V-122.
	TH-103 open.	Check TH-103 by removing lead from Z-105 and checking continuity between terminal of Z-105 and chassis.
	Open resistor.	Check resistance of R-151 through R-157 with Multimeter TS-352/U (alternate, Simpson Model 260). (See figures 7-1, 7-1A, 7-1B, and 7-1C.) Replace if any are defective. **CAUTION** Short-circuit meter M-101 when checking these resistors.
8A. "METER" WILL NOT ZERO SET AFTER LONG PERIODS OF OPERATION.	Low plate voltage due to defective C-131.	Replace C-131.
9. METER ZERO JUMPS.	If "jump" is about one-quarter inch or less on meter scale and occurs when S-101 is switched, trouble is probably instability of V-120.	Check voltage between pins 1 and 7 of V-120. (See figure 7-4.) If a jump of one or two volts occurs as S-101 is moved or as power is alternately applied, replace V-120.
	If jump is larger than about one-quarter inch as S-101 is switched, voltage regulator is probably defective.	Test V-114, V-115, and V-116 in Tube Tester I-177A. Replace if necessary. Also refer to trouble No. 8.
	If off-scale jumps are observed, tap Z-105. If tapping produces jumps, Z-105, or TH-103, or O-106 is defective.	Check continuity of Z-105 for stability with Wheatstone Bridge. If unstable with tapping, replace. [Refer to paragraphs 10.*c.*(5) and 10.*c.*(6) of this section.] Check TH-103 for stability. If unstable with tapping, replace. [Refer to paragraphs 10.*b.*(1) and 10.*b.*(2) of this section.] Inspect soldering of L-105 to O-106. If open, resolder. Inspect security of connector in O-106 on lead of TH-103. If loose, retighten with small scriber or jeweller's screw driver.
10. NO R-F POWER INDICATED BY "METER" IN "CW" POSITION OF "SELECTOR SWITCH."	Incorrect plate voltage.	Refer to troubles No. 7 and 8.
	Incorrect reflector voltage.	Check adjustment of R-180 and R-188. Check mechanical operation and continuity of R-185; readjust or replace. Refer to paragraph 10.*d.* of this section.

TABLE 4-2. TROUBLE-SHOOTING CHART (Cont.)

SYMPTOM	*PROBABLE CAUSE*	*REMEDY*
10. NO R-F POWER INDICATED BY "METER" IN "CW" POSITION OF "SELECTOR SWITCH" (Cont.).	V-111 inoperative.	Replace V-111. Refer to paragraph 6.*c.* of this section.
	Defective thermistor mounting; loop shorted, or center contact loose.	Refer to paragraph 10.*b.* of this section.
	Open choke L-106, L-107, or L-108.*	Replace defective choke.
11. NO R-F OUTPUT AS DETECTED BY RECEIVER OR POWER METER CONNECTED TO "R-F OUTPUT" CONNECTOR, J-105.	Attenuator backed off too far.	Set attenuator at −3 dbm. Be sure drive is not slipping and set screws are tight. Refer to paragraph 8.*c.* of this section.
	Defective attenuator cable assembly.	Replace attenuator cable assembly if resistance across V-105 is not 51 ohms ±20 per cent. Refer to paragraphs 8.*c.* and 10.*e.* of this section.
12. R-F OUTPUT LOW, ERRATIC OR AT WRONG FREQUENCY.	Low plate voltage due to defective C-131.	Replace C-131.
	Reflector voltage incorrect or V-111 defective.	Refer to trouble No. 10.
	If remedies suggested in trouble No. 10 do not remedy the trouble and the output is erratic at the high-frequency end of the tuning range, inner parts of cavity subassembly are probably dirty or corroded.	Tune over any bad spots repeatedly. If trouble is not removed or alleviated after approximately 30 passes, try rotating V-111 slightly. If none of these measures, or replacement of V-111, is of any avail, replace cavity assembly A-106. (Refer to paragraph 10.*j.* of this section.)
13. R-F OUTPUT IN "ZERO SET" POSITION OF S-101.	Choke L-106 open.*	Replace L-106.
	Grid return to V-111 open.	Repair defective wiring. (See figures 7-2, 7-2A, 7-2B, 7-2C and 7-2D.)
	V-111 defective.	Replace V-111.
14. NO R-F PULSE OUTPUT AS DETECTED BY RECEIVER OR CRYSTAL DETECTOR AND OSCILLOSCOPE WITH NEGATIVE "EXT MOD" INPUT.	V-107, V-108, or V-110 defective.	Test V-107, V-108, or V-110 in Tube Tester I-177A. Replace defective tube.
	Defective pulse transformer T-101.	Check resistance of T-101 windings with Multimeter TS-352/U (alternate, Simpson Model 260). (Refer to table 4-7.) If winding is open or shorted to case, replace. Remove leads to terminals No. 1, 3, and 4 before performing this test.
	Incorrect bias on V-108.	Check C-117B (C-138A in Contracts N383s-60879, N383s-61060 or C-133B in TS-419A/U), R-172, R-173. Check voltage between pins 1 and 7 of V-120. Replace any defective component.

* L-106, L-107, and L-108 not used in Contract N383s-5019A.

TABLE 4-2. TROUBLE-SHOOTING CHART (Cont.)

SYMPTOM	*PROBABLE CAUSE*	*REMEDY*
14. NO R-F PULSE OUTPUT AS DETECTED BY RECEIVER OR CRYSTAL DETECTOR AND OSCILLOSCOPE WITH NEGATIVE "EXT MOD" INPUT (Cont.).	S-101E, S-101F, or S-101G defective.	Check continuity of switch *at switch.* Re-form contacts or replace if defective. Check for broken lead to switch.
	L-103 or L-104 open.	Check continuity of L-103 and L-104. (Refer to table 4-7.) Replace if necessary.
	C-115 or C-128 defective.	Check C-115 and C-128. Replace if necessary.
15. NO R-F PULSE OUTPUT AS DETECTED BY RECEIVER OR CRYSTAL DETECTOR AND OSCILLOSCOPE WITH POSITIVE "EXT MOD" INPUT.	Refer to trouble No. 14. If trouble still exists, V-106 is probably defective.	Test V-106 in Tube Tester I-177A and replace if defective.
	Incorrect bias on V-106.	Check voltage across pins 1 and 7 of V-122. Check R-172, R-173, R-203, C-117, 117B, 117C (designated C-138A and C138B in Contracts N383s-60879, -61060, -75748, -77651; designated C-133A and C-133B in TS-419A/U.) In equipments of Contracts N383s-5019A, -45741, and -67816, check R-132, R-148, R-191 and V-122. (See figure 7-1A.) Replace defective parts.
16. NO R-F PULSE OUTPUT AS DETECTED BY RECEIVER OR CRYSTAL DETECTOR AND OSCILLOSCOPE WITH "SELECTOR SWITCH" IN "RATE X1" OR "RATE X10" POSITION.	If dependent on setting of "PULSE WIDTH" control, V-106 is probably defective.	Replace V-106.
	If dependent on setting of "PULSE DELAY" control, V-104 is probably defective.	Replace V-104.
	If dependent on neither "PULSE WIDTH" nor "PULSE DELAY" control settings, V-102 is probably defective.	Replace V-102.
17. NO R-F PULSE OUTPUT AS DETECTED BY RECEIVER OR CRYSTAL DETECTOR AND OSCILLOSCOPE WITH "POS SYNC," "NEG SYNC," OR "SIN SYNC" INPUT.	Refer to troubles No. 14, 15, and 16. If trouble still exists, V-101 or V-102 is probably defective.	Replace V-101 or V-102.
18. NO DELAYED SYNC OUTPUT ALTHOUGH R-F PULSE OUTPUT IS OBTAINED. *(If pulse output is not obtained, refer to troubles No. 14, 15, 16, or 17.)*	V-109 defective.	Replace V-109.
19. NO UNDELAYED SYNC OUTPUT ALTHOUGH DELAYED SYNC OUTPUT AND R-F PULSE OUTPUT ARE OBTAINED.	V-105 defective.	Replace V-105.
20. R-F PULSES 10 MICROSECONDS LONG BEGIN DECAY BEFORE END OF PULSE WHEN PULSES ARE INTERNALLY GENERATED ON RATE X1 RANGE.	V-108 defective.	Replace V-108.
	T-101 defective.	Replace T-101.

TABLE 4-2. TROUBLE-SHOOTING CHART (Cont.)

SYMPTOM	*PROBABLE CAUSE*	*REMEDY*
21. EXCESSIVE NEG MOD SIGNAL REQUIRED TO SECURE FULL MODULATION. *(Also refer to troubles No. 14 and 20.)*	V-107 defective.	Replace V-107.
22. EXCESSIVE POS MOD SIGNAL REQUIRED TO SECURE FULL MODULATION. *(Also refer to troubles No. 15, 20, and 21.)*	V-106 defective.	Replace V-106
23. EXCESSIVE SYNC SIGNAL REQUIRED FOR "SIN SYNC," "POS SYNC," or "NEG SYNC" SETTINGS OF S-101.	V-101 defective.	Replace V-101.
	V-102 defective.	Replace V-102.
	Bias across R-174 excessive.	Check R-174 (in V-102 cathode circuit) and replace if resistance is high.
24. FREE-RUNNING PULSES WHEN UNDESIRED.	If repetition rate depends on "PULSE RATE" control setting, V-102 bias return through S-101C probably defective.	Check V-102 bias return through S-101C (see figure 7-2) and check S-101C. Replace if defective. Check for defective wiring to S-101C.
	If character of pulses depends on settings of "PULSE DELAY" control, V-104 is probably defective.	Replace V-104. Check R-116 (see figures 7-1, 7-1B and 7-1C) and replace if resistance is low.
	If character of pulses depends on setting of "PULSE WIDTH" control, V-106 bias is probably incorrect.	Check voltage from pin 1 to pin 7 of V-120. Check R-172, R-173, R-203, C-117B and C-117C (designated C-138A and C-138B in Contracts N383s-60879, -61060, and -75748; designated C-133A and C-133B in TS-419A/U.) In equipments of Contracts N383s-5019A, -45741, and -67816, check R-132, R-148, R-191, and V-122, figure 7-1A. Replace any defective part. Check —325 volt lead to S-101D.
25. "PULSE WIDTH" CONTROL RANGE INADEQUATE.	If range is almost adequate at either end, either V-106 or V-107 is defective.	Replace V-106 or V-107.
	If only very long pulses are obtained, L-103 may be open.	Check continuity of L-103 (refer to table 4-7) and replace if defective.
	If only very short pulses are obtained, C-113 or lead to it may be open.	Check continuity to C-113. (See figures 7-2, 7-2A, 7-2B, 7-2C, and 7-2D.) Check C-113 and replace if required.
	If maximum width is inadequate, C-126 or C-113 may be defective.	Check C-126 and C-113, and replace if necessary.

TABLE 4-2. TROUBLE-SHOOTING CHART (Cont.)

SYMPTOM	*PROBABLE CAUSE*	*REMEDY*
26. "PULSE DELAY" CONTROL RANGE INADEQUATE.	If range is almost adequate at either end, V-104 is probably defective.	Replace V-104.
	If maximum delay is much too short, C-109 is probably defective.	Check C-109 and replace if necessary.
	If minimum delay cannot quite be reached, either V-102 is excessively biased or V-101 has insufficient gain.	Check bias on V-102. (See figure 7-4.) Test V-101 in Tube Tester I-177A. Replace if necessary.
27. "PULSE RATE" CONTROL RANGE INADEQUATE.	If maximum rate on "RATE X10" range is too low, trouble may be defective V-102 or excess capacity in C-106 or C-108, or excessive resistance in R-108, R-109, or R-112.	Test V-102 in Tube Tester I-177A. Check all detailed parts noted and replace if necessary. Use correct value of R-109. Refer to listing in table 6-4.
	If minimum rate on "RATE X10" is too high, trouble may be inadequate resistance in R-110.	Check value of R-110 with Multimeter TS-352/U and replace if necessary.
28. "PULSE RATE" RANGES DO NOT TRACK.	C-106 value taken in conjunction with C-108 and R-112 sets "RATE X10" range.	Check C-106, C-108, and R-112. (See figures 7-1, 7-1A, and 7-1B.) Replace if necessary.
	C-105 value in conjunction with C-108 and R-112 sets "RATE X1" range.	Check C-105, C-108, and R-112. (See figures 7-1, 7-1A, 7-1B, and 7-1C.) Replace any defective part.
	If "RATE X10" range is nearly correct but "RATE X1" range is incorrect, C-105 or C-108 is defective.	Check C-105 and C-108. Replace if necessary.
29. EXCESSIVE STANDING-WAVE RATIO LOOKING BACK INTO "R-F OUTPUT" CONNECTOR J-105.	Defective output cable W-105.	Replace output cable W-105. Refer to paragraph 10.*e.* of this section.
30. EXCESSIVE R-F LEAKAGE FROM VIDEO RECEPTACLES.	Defective filter Z-101, Z-102, Z-103, Z-104, or Z-105.	Localize defective filter and replace. Refer to paragraphs 9.*f.* and 10.*c.* of this section.
31. EXCESSIVE R-F LEAKAGE NEAR SIGNAL FREQUENCY SHAFT.	Loose screws H-102, H-103, H-104, H-162, H-163, H-164.	Tighten loose screws. (See figure 7-7.)

4. TEST EQUIPMENT REQUIRED.

Test equipment required to perform alignment and adjustment tests on Signal Generator TS-419/U is listed in table 4-3.

TABLE 4-3. TEST EQUIPMENT REQUIRED

Type of Test Equipment	*Preferred Type or Required Characteristics*	*Alternate*
A-c vacuum tube voltmeter	Voltmeter TS-375/U	Hewlett-Packard 410-B General Radio 1800-A
Antenna	Tunable dipole for 900–2100 mc/sec, 50-ohm input impedance	———
Audio oscillator	Audio Oscillator TS-382A/U	Hewlett-Packard 200C Hewlett-Packard 205AG
Crystal rectifier	Rectifier 1N21 in UG-119/UP mount	———
D-c vacuum tube voltmeter	Voltmeter TS-375/U	RCA 165 Hewlett-Packard 410-B
Frequency meter	Frequency Meter TS-186/AP	General Radio Model 720-A and Ferris Calibrator Model 34
Loop	3/8" x 5/8" loop on UG-290/U connector	———
Multimeter for 1,000 ohms-per-volt readings	Multimeter TS-297/U	Simpson 443 Weston 663
Multimeter for 20,000 ohms-per-volt readings	Multimeter TS-352/U	Navy OE Simpson 260 Weston 790
Oscilloscope	Oscilloscope TS-239/UP	———
Plug	CW-159/U	UG-83/U connector with solid cap in place of standard cable clamping nut
Power meter	Hewlett-Packard 430-B with Hewlett-Packard 475-B mount	Power meter capable of measuring 0.25 milliwatt of power (−6 dbm) to an accuracy of ±5 per cent. Input impedance to be 50 ohms at 1600 mc/sec, preferably over range of 900-2100 mc/sec. Thermistor or barretter in suitable mount and associated bridge indicating devices may be used.
Pulse generator	Pulse Generator TS-592/U	Hewlett-Packard 212-A
Receiver	Radio Receiver AN/SPR-1 or AN/APR-1; or Radio Receiver AN/SPR-4 or AN/APR-4 with Tuning Units TN-3 and TN-19	———
Signal generator	Signal Generator TS-419/U	———
Slotted line	Hewlett-Packard 805A	General Radio Type 874-LB with 874D-20 stub and adapters to BNC connectors
Tube tester	Tube Tester, Signal Corps Type I-177A	Hickok 540 Hickok 547

5. REMOVAL AND REPLACEMENT OF CHASSIS.

WARNING

This equipment employs voltages which are dangerous and may be fatal if contacted by operating personnel. Observe all safety regulations.

a. REMOVING THE CHASSIS.—Remove the chassis from the instrument case by loosening the eight captive screws on the front panel and the two on the rear of the instrument case. Grasp the two handles on the front panel and pull the chassis out of the case.

b. REPLACING THE CHASSIS.—When replacing the chassis in the instrument case, stand the instrument case on its back, lift the chassis by the two handles on the front panel and lower the chassis into the instrument case. Start the captive screws on the front panel, then erect the instrument case and start the two captive screws at the rear of the case. Tighten all screws, especially the two rear screws, to provide heat conductivity from the chassis to the instrument case.

6. REPLACEMENT OF VACUUM TUBES.

a. GENERAL.—All tubes supplied with Signal Generator TS-419/U have a life expectancy of 1000 to 1500 hours. No absolute discard data exist for these tubes, and therefore they may be used until proven defective. In general, the troubles that can be attributed to faulty tubes are insufficient power output and faulty pulsing. All tubes except the r-f oscillator tube are accessible for replacement immediately after removal of the chassis from the instrument case.

b. PRECAUTIONS.—Replacement of the following tubes may require that certain circuits of Signal Generator TS-419/U be recalibrated. These tubes and the required recalibration are as follows:

(1) V-102: Recalibrate PULSE RATE control. Refer to paragraph 8.*f.*, this section.

(2) V-104: Recalibrate PULSE DELAY control. Refer to paragraph 8.*e.*, this section.

(3) V-106 or V-107: Recalibrate PULSE WIDTH control. Refer to paragraph 8.*d.*, this section.

(4) V-111: Reset reflector voltage adjustments R-180 and R-188 and reset SIGNAL FREQUENCY dial. Refer to paragraphs 7.*e.* and 8.*b.*, this section.

(5) V-120: Reset the VOLTAGE ADJ. resistor R-179. Refer to paragraph 7.*b.*, this section.

c. REPLACEMENT OF R-F OSCILLATOR TUBE V-111. *(See figure 7-7.)*

Note

Several different identification markings have been employed for the reflex klystron (V-111) used in Signal Generator TS-419/U. In all early models, the klystron was stamped either "6BM6" or "JAN 6BM6." In an intermediate part of the production, tubes marked "PULSE TESTED 6BM6" were supplied; chassis of this production were stamped "USE PULSE TESTED 6BM6 TUBE." In later and present equipment production, tubes stamped JAN-6BM6A are used. The JAN-6BM6A is identical to the 6BM6 and JAN-6BM6 except that it has been tested for pulsed service. It is manufactured to the same specification as the "PULSE TESTED 6BM6." If available, for all replacements of V-111 use tubes marked JAN-6BM6A. Most 6BM6 reflex klystrons with other markings will also perform satisfactorily over most of the tuning range of Signal Generator TS-419/U, but some may have excessive jitter or excessive decay time over part of the tuning range.

The r-f oscillator tube V-111 is plugged into the socket assembly H-106, which in turn plugs into the rear of the cavity where it is secured by a large knurled ring-nut, H-105. To remove V-111 prior to replacement, proceed as follows:

(1) Loosen the nut H-105; then *simultaneously rotate and withdraw* the socket assembly H-106.

WARNING

Removal of the leads from the three projecting terminals is not necessary, but simultaneous rotation and withdrawal is essential to prevent the tube being left within the cavity. Also, if the signal generator has recently been shut down, the metal ring near the base pins of V-111 may be very hot. Avoid contact with this ring.

(2) To remove the tube, grasp it by either of the gold-plated rings and pull.

(3) Inspect the contact fingers. If badly corroded or distorted, replace the r-f assembly. (Refer to paragraph 10.*f.*, this section.)

Note

It is very important that all spring fingers in the cavity make good contact with the tube elements since even a few poor-contacting fingers can prevent the tube from oscillating. Refer to paragraph 10.*j.*(4)(*c*), this section.

(4) Install the replacement tube and replace the socket assembly by inserting the assembly carefully within the cavity and press all the way until it meets a positive stop. Definite resistance will be encountered during this insertion as the internal contact fingers engage the tube.

CAUTION

If the tube does not start its engagement readily, it should be rotated until it finds its center, since excessive force may damage the tube and/or the cavity.

(5) When the tube is properly seated, the beginning of the flared portion of the socket assembly housing H-106 should lie within about 1/8 inch from the rear of the large knurled ring-nut H-105. The socket assembly should be rotated so that the three terminals face away from the high-frequency adjustment R-188. Tighten the nut H-105 hand-tight to secure the socket assembly in place and prevent r-f leakage.

(6) Perform the adjustments described in paragraphs 7.*e.* and 8.*b.* of this section.

7. INITIAL ELECTRICAL ADJUSTMENTS.

a. GENERAL.—The initial electrical adjustments and checks made at the factory prior to calibration of Signal Generator TS-419/U are described here to facilitate the work of maintenance personnel who may be required to repair or recondition the equipment. It is necessary to remove the TS-419/U chassis from its instrument case in order to perform these adjustments. (Refer to paragraph 5.*a.*, this section.)

b. REGULATED VOLTAGE ADJUSTMENTS. (*See figure* 5-2.)—Adjust the B voltage being supplied to Signal Generator TS-419/U as follows:

(1) Remove reflex klystron oscillator tube V-111 from the cavity. (Refer to paragraph 6.*c.*, this section.)

(2) Set VOLTAGE ADJ. potentiometer R-179 fully counterclockwise.

(3) Set SELECTOR SWITCH to ZERO SET.

(4) Connect the power cable between POWER INPUT connector and a nominal 115-volt, a-c, 50-1600 cps power source. Throw POWER OFF ON switch to ON position. Allow a 20-minute warm-up period to insure complete stabilization.

(5) Adjust VOLTAGE ADJ. until the supply voltage as measured from any red lead to chassis is 325 volts ±5 volts.

Note

The meter used for the voltage check should be of such accuracy as to insure compliance with the stated tolerance. In general this will require the use of a meter which has been checked against an accurate standard. The total internal resistance of the meter used may be as low as 50,000 ohms on the scale actually employed.

(6) Secure the locking nut on VOLTAGE ADJ. potentiometer R-179.

c. VOLTAGE CHECKS.—Perform the voltage checks listed in table 4-4, using either Multimeter TS-297/U or, preferably, Multimeter TS-352/U, as follows:

(1) With primary a-c power applied, throw POWER OFF ON switch to ON position.

(2) Set the line voltage to 115±2 volts. Allow a 20-minute warm-up period before making measurements.

d. PANEL METER ZERO ADJUSTMENTS.—To zero-adjust the METER, proceed as follows:

(1) Turn on Signal Generator TS-419/U and allow a minimum warm-up period of 20 minutes to insure complete stabilization.

(2) Set SELECTOR SWITCH to ZERO SET.

(3) Set ZERO SET control to mid-scale (line on knob vertical).

(4) Adjust ZERO ADJ. potentiometer R-146 until METER pointer is on line marked "zero set". (See figure 5-2.)

(5) Secure locking nut on ZERO ADJ. potentiometer R-146. (See figure 5-2.)

e. REFLECTOR VOLTAGE ADJUSTMENTS.—Adjust the reflector voltage as follows:

(1) Disconnect primary power from Signal Generator TS-419/U by disconnecting the power cable from POWER INPUT connector.

(2) If required, install reflex klystron tube V-111. (Refer to paragraph 6.*c.*, this section.)

(3) Tune SIGNAL FREQUENCY control clockwise until the low-frequency stop is reached.

(4) Make a visual check to ascertain that the movable contact on the reflector tracking variable resistor R-185 is located within 1/4-inch of the counterclockwise end of the winding as viewed from the rear of Signal Generator TS-419/U. (See figure 5-2.)

(5) Make circuit connections to required test equipment as shown in figure 4-3.

(6) Turn on Signal Generator TS-419/U and allow a minimum warm-up period of 20 minutes to insure complete stabilization.

(7) Set Signal Generator TS-419/U controls as follows:

SIGNAL FREQUENCY	Refer to paragraphs 7.*e.*-(8) and 7.*e.*(9) of this section.
OUTPUT ATTENUATOR	—3 dbm
POWER SET	Mid-scale (line on knob vertical)
SELECTOR SWITCH	RATE X1
PULSE WIDTH	1

TABLE 4-4. VOLTAGE MEASUREMENTS FOR INITIAL ELECTRICAL ADJUSTMENTS

Negative Meter Lead	*Positive Meter Lead*	*Nominal Voltage*	*Tolerance (±)*	*Selector Switch*	*Notes*
Any red lead	Chassis	325	5	ZERO SET	
V-113, pin No. 4	Any red lead	925	50	ZERO SET	
V-117, pin No. 7	Chassis	925	30	ZERO SET	
V-120, pin No. 7	Any red lead	150	6	ZERO SET	
V-122, pin No. 7	Chassis	150	6	ZERO SET	
V-110, pin No. 3	Any red lead	300	12	NEG MOD	
V-110, pin No. 3	Any red lead	300	12	POS MOD	
V-110, pin No. 3	Any red lead	300	12	RATE X10	
V-110, pin No. 3	Any red lead	300	12	RATE X1	
V-110, pin No. 3	Any red lead	0	1	CW	
V-110, pin No. 3	Any red lead	300	12	ZERO SET	
V-110, pin No. 3	Any red lead	300	12	POS SYNC	
V-110, pin No. 3	Any red lead	300	12	NEG SYNC	
V-110, pin No. 3	Any red lead	300	12	SIN SYNC	
C-117B terminal	C-117 case	62	4	ZERO SET	250 v scale; Multimeter TS-352/U
V-121, pin No. 2	V-121, pin No. 7	6.3	0.4	ZERO SET	10 v a-c scale
V-116, pin No. 2	V-116, pin No. 7	6.3	0.4	ZERO SET	
V-112, pin No. 2	V-112, pin No. 8	5.0	0.3	ZERO SET	
V-113, pin No. 2	V-113, pin No. 8	5.0	0.3	ZERO SET	

PULSE DELAY	3
PULSE RATE	400

(8) Set HI. FREQ. ADJ. potentiometer R-188 to produce the most rectangular pulse as the SIGNAL FREQUENCY control is tuned over the range 1700-2100 mc/sec. Points to be watched for are, in order of importance:

(*a*) Avoid any holes (regions of tuning where the pulse disappears).

(*b*) Minimize any jitter on leading edge of pulse.

(*c*) Produce widest pulse in any region of tuning where the pulse tends to narrow down.

(9) Set LO. FREQ. ADJ. potentiometer R-180 to produce the most rectangular pulse as the SIGNAL FREQUENCY control is tuned over the range 900-1400 mc/sec. Points to be watched for are, in order of importance:

(*a*) Avoid any extra pulse preceding the rise, or following the decay of the main pulse.

(*b*) Avoid any rise in the pulse just before the final decay.

(*c*) Minimize any steps on the pulse decay.

(*d*) Minimize decay time.

(10) Repeat step (8).

(11) Repeat step (9).

Note

The two reflector tracking adjustment steps (8) and (9) are different from those which produce maximum cw output. Adjustment for maximum cw output will not generally produce satisfactory pulsing over the frequency range.

(12) If erratic operation is observed, particularly near the high-frequency end of the tuning range, the cavity assembly probably requires maintenance. Refer to paragraph 10.*j*. of this section.

8. CALIBRATION ADJUSTMENTS.

a. GENERAL.—Calibration adjustments and checks for Signal Generator TS-419/U are described here to

facilitate the work of maintenance personnel responsible for the repair of the equipment. In order to perform these adjustments the signal generator chassis must be removed from its instrument case. Refer to paragraph 5.*a.*, this section.

b. SIGNAL FREQUENCY DIAL ADJUSTMENTS. (*See figure* 7-5.)—To adjust the signal frequency dial proceed as follows:

(1) Connect Signal Generator TS-419/U and required test equipment as shown in part A or B of figure 4-1. The method of connection will depend on the test equipment in use.

(2) Turn on Signal Generator TS-419/U and allow a 20-minute warm-up period to insure complete stabilization.

(3) Turn on Frequency Meter TS-186/AP or alternate General Radio Hetrodyne Frequency Meter Model 720-A and Ferris Calibrator Model 34.

(4) Set the external frequency meter to a frequency that is an exact submultiple of 1800 mc/sec. When Frequency Meter TS-186/AP is used, a convenient value is 900 mc/sec. When General Radio Co. Type 720-A frequency meter is used, a convenient value is 150 mc/sec. In either case the exact frequency setting is determined by obtaining a zero beat in the headset with a suitable harmonic of the crystal calibrator.

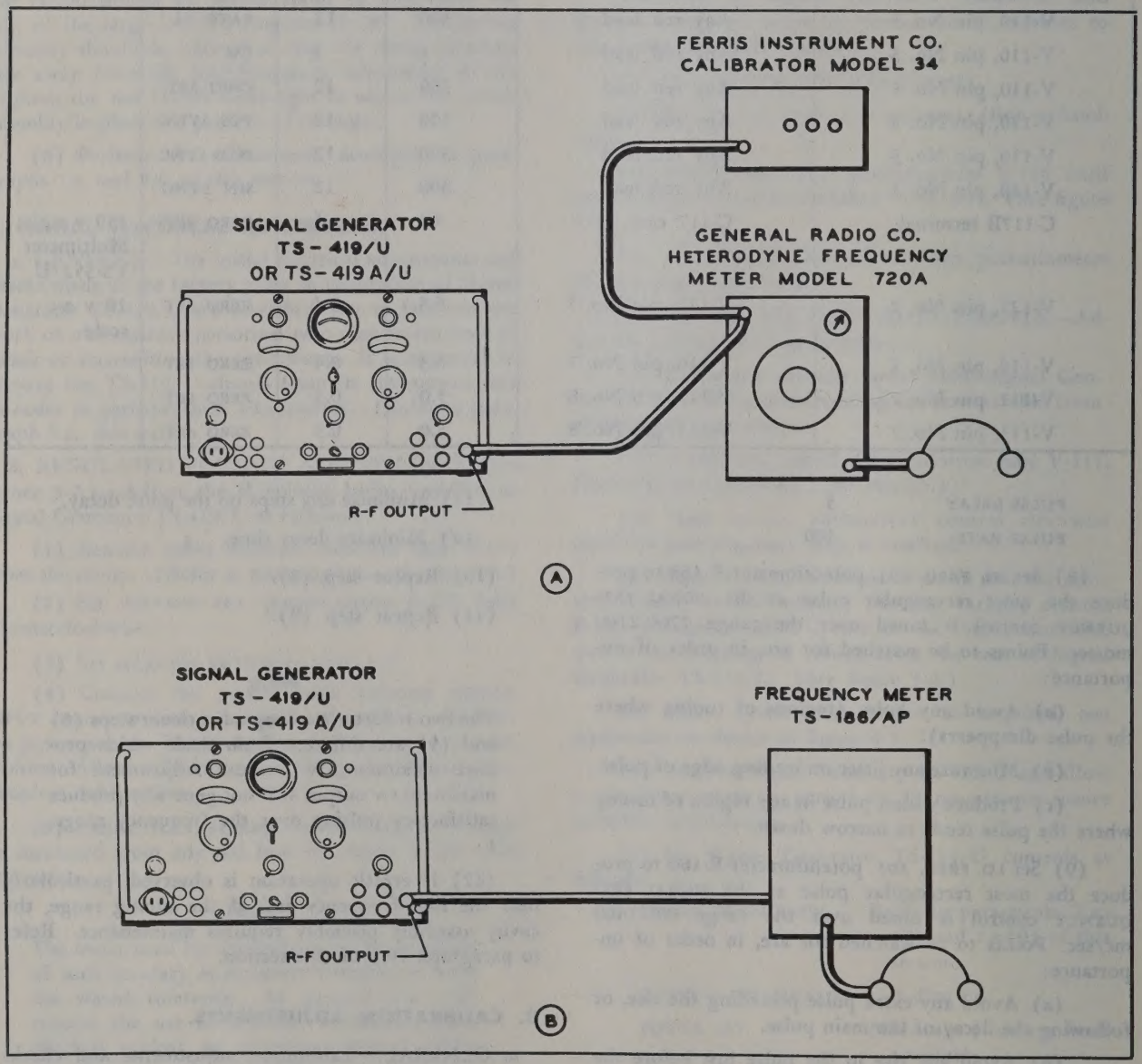


Figure 4-1. Test Connection Diagram for Measurement of Radio Frequency

(5) Once the frequency meter has been set, turn off the crystal calibrator.

(6) Set SELECTOR SWITCH to ZERO SET and adjust ZERO SET control until METER pointer is on line marked ZERO SET.

(7) Set OUTPUT ATTENUATOR to —3 dbm.

(8) Set SELECTOR SWITCH to CW.

(9) Tune SIGNAL FREQUENCY control until an actual measured output frequency of 1800 mc/sec, as determined by observation of a beat in the headset of the frequency meter, is obtained with the POWER SET control adjusted to produce a METER reading of 0 dbm (the mid-scale red line marked "power set"). This output frequency should occur for a signal frequency dial reading between 1700 and 1900 mc/sec.

(10) Turn off Signal Generator TS-419/U.

(11) If the dial reading observed in step (9) is between 1795 and 1805 mc/sec, no further adjustment is required.

(12) Remove power from Signal Generator TS-419/U for the following adjustment: To readjust the signal frequency dial, the dial should be slipped against noticeable frictional resistance by pressing the forefingers against the edge of the dial to rotate until the dial reads 1800 mc/sc. The signal frequency dial is now calibrated to read directly the r-f output frequency obtained at the RF OUTPUT connector J-105.

Note

In equipments of Contract No. N383s-60879, N383s-61060, N383s-75748 and N383s-77651, the signal frequency dial is equipped with a locking screw. This screw is accessible through a hole in the dial, after removing the dial knob and setting the dial to approximately 1750 mc. In equipments of Contract No. NOa(s)-12279, set the dial to approximately 900 mc. Before proceeding with the adjustment described in paragraphs 8.*b*(12) and 8.*b*(13), it will be necessary to unlock the dial by inserting a screw driver through the hole and turning the locking screw a quarter-turn counterclockwise.

(13) Perform additional checks of signal frequency according to above procedure but employing settings as follows:

Signal Generator TS-419/U Nominal	*Signal Frequency Tolerance*	*Frequency Meter TS-186/AP Frequency*	*General Radio Frequency Meter 720-A Frequency*
900	±5	900	150
1500	±8	750	150
2100	±11	1050	150

In the case of Contract No. NOa(s)-12279, the check frequencies are selected as desired throughout the band and are within one percent.

(14) In equipments of Contract No. N383s-60879, N383s-61060, N383s-75748 and N383s-77651, the signal frequency dial was equipped with a locking screw. (Refer to preceding note.) Upon the completion of the adjustments previously described, tighten this locking screw by turning clockwise.

c. OUTPUT ATTENUATOR CALIBRATIONS. (*See figures 7-5, 7-6 and 7-7.*)—To calibrate the output attenuator dial, proceed as follows:

(1) Make circuit connections to required test equipment as shown in figure 4-2.

(2) Check to be sure that the clockwise stop on the OUTPUT ATTENUATOR control is effective at a dial setting of 160 K.

(3) If necessary to reset OUTPUT ATTENUATOR stop, refer to paragraph 10.*i*.(4) (*f*) of this section.

(4) Turn on Signal Generator TS-419/U and Thermistor Bridge Hewlett Packard 430-B, or equivalent. Allow a 20-minute warm-up period to insure complete stabilization.

(5) Tune SIGNAL FREQUENCY control of Signal Generator TS-419/U to 1600 mc/sec.

(6) Set SELECTOR SWITCH to ZERO SET and adjust ZERO SET control until METER pointer is on line marked ZERO SET.

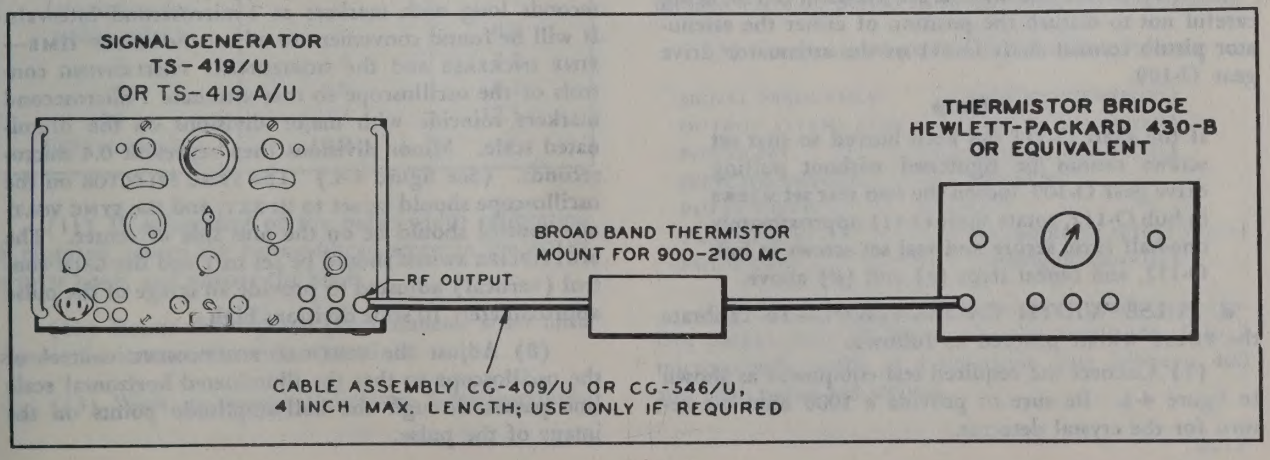


Figure 4-2. Test Connection Diagram for Measurement of R-F Power Output

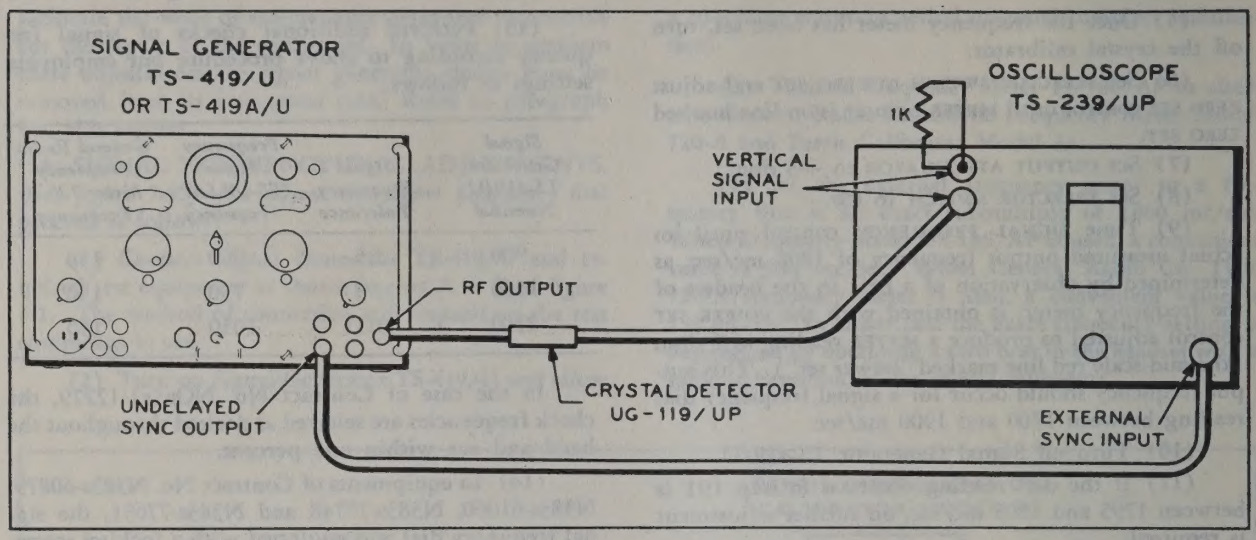


Figure 4-3. Test Connection Diagram for Measurement of Pulse Width

(7) Set SELECTOR SWITCH to CW and adjust POWER SET control to produce a METER reading of 0 dbm. Set OUTPUT ATTENUATOR to —6 dbm.

(8) Observe the power level indicated on power meter. If the indicated power level is between —6.5 and —5.5 dbm, make no further adjustments.

(9) If further adjustment is required, proceed as follows:

(*a*) Lock OUTPUT ATTENUATOR with dial set at —6 dbm.

(*b*) Loosen the two set screws in hub O-110 which carries the attenuator piston rack driving gear O-109.

(*c*) Slide attenuator piston O-107 in or out as required to obtain a reading of —6 dbm on the external power meter.

CAUTION

Make certain that the METER still reads +0 dbm and that the attenuator dial still reads —6 dbm.

(*d*) Secure and seal the set screws in O-110, being careful not to disturb the position of either the attenuator piston control shaft O-111 or the attenuator drive gear O-109.

Note

If the shaft O-111 has been burred so that set screws cannot be tightened without pulling drive gear O-109, loosen the two rear set screws in hub O-112, rotate shaft O-111 approximately one-half turn, secure and seal set screws in hub O-112, and repeat steps (*c*) and (*d*) above.

d. PULSE WIDTH CALIBRATION.—To calibrate the PULSE WIDTH proceed as follows:

(1) Connect the required test equipment as shown in figure 4-3. Be sure to provide a 1000 ohm d-c return for the crystal detector.

(2) Turn on Signal Generator TS-419/U and Oscilloscope TS-239/UP. Allow a 20-minute warm-up period to insure complete stabilization.

(3) Set Signal Generator TS-419/U controls as follows:

SIGNAL FREQUENCY	1500
OUTPUT ATTENUATOR	—3
POWER SET	As required
SELECTOR SWITCH	As required
PULSE RATE	400
PULSE DELAY	3 (refer to text)
PULSE WIDTH	As required

(4) Set SELECTOR SWITCH to ZERO SET and adjust ZERO SET control until METER pointer is on line marked "zero set".

(5) Set SELECTOR SWITCH to CW and adjust POWER SET control to produce a METER reading of +3 dbm.

(6) Set SELECTOR SWITCH to RATE X1.

(7) Make necessary adjustments on Oscilloscope TS-239/UP to obtain a sweep approximately 15 microseconds long with markers at 1-microsecond intervals. It will be found convenient to adjust the SWEEP TIME—FINE INCREASE and the HORIZONTAL POSITIONING controls of the oscilloscope so that alternate 1-microsecond markers coincide with major divisions on the illuminated scale. Minor divisions then represent 0.4 microseconds. (See figure 4-4.) The SYNC SELECTOR on the oscilloscope should be set to HI EXT, and the SYNC VOLTAGE control should be on the plus side of center. The MULTIPLIER switch should be set to 1 and the GAIN control (vertical) adjusted to provide an image of the pulse approximately 10 scale divisions high.

(8) Adjust the VERTICAL POSITIONING control of the oscilloscope so that the illuminated horizontal scale line passes through the half-amplitude points on the image of the pulse.

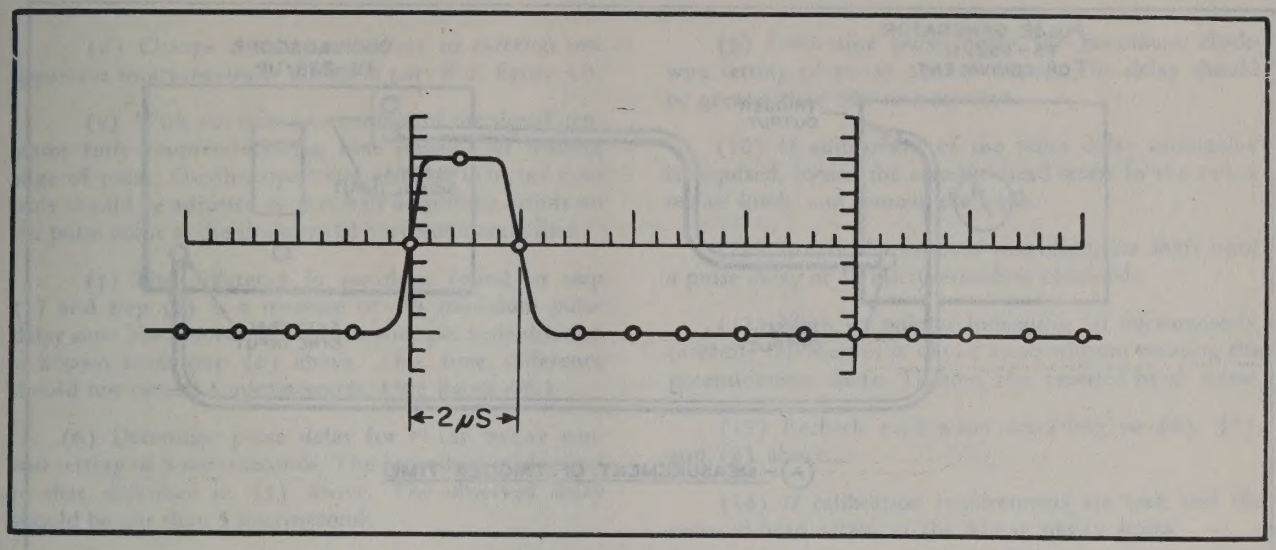


Figure 4-4. Typical Pattern for Measurement of Two-microsecond Pulse

(9) The width of r-f pulses between half-amplitude points may now be read from the horizontal scale since the number of microseconds per scale division is known from the immediately preceding comparison of the scale with the markers.

Note

It will be found convenient to adjust the PULSE DELAY control of the signal generator so that the half-amplitude point of the leading edge coincides with one of the 1-microsecond markers.

(10) Check the range of pulse widths available by operating the PULSE WIDTH control of the signal generator. These should fall between the following limits:

Pulse Width Control Setting	*Pulse Width Must Be*	
	Greater Than	*Less Than*
(minimum for stable pulse)	——	0.8
2	1.5	2.5
5	3.8	6.2
10	7.3	12.5
fully clockwise	10.0	——

(11) If adjustment of the pulse width calibration is required, loosen the recessed-head screw in the PULSE WIDTH knob, and remove the knob.

(12) Rotate the exposed potentiometer shaft until a pulse 5 microseconds wide is obtained.

(13) With its pointer indicating 5 microseconds, carefully replace PULSE WIDTH knob without rotating the potentiometer shaft. Tighten the recessed-head screw.

(14) Recheck calibration according to (9) and (10) above.

(15) If calibration requirements are met, seal the recessed-head screw in the PULSE WIDTH knob.

(16) If calibration does not meet requirements of paragraph (9), it will generally be possible to bring it within tolerance by offsetting the pointer slightly in the required direction when performing step (13).

e. PULSE DELAY CALIBRRATION.—To adjust the PULSE DELAY calibration, proceed as follows:

(1) Connect the required test equipment as shown in figure 4-5.

(2) Turn on the signal generator, Oscilloscope TS-239/UP, and Pulse Generator TS-592/U. Allow a 20-minute warm-up period to insure complete stabilization.

(3) Set the signal generator controls as follows:

SIGNAL FREQUENCY	(setting immaterial)
OUTPUT ATTENUATOR	(setting immaterial)
POWER SET	(setting immaterial)
SELECTOR SWITCH	NEG SYNC
PULSE WIDTH	5
PULSE DELAY	(as required; refer to text)
PULSE RATE	(setting immaterial)

(4) Set pulse generator controls to produce a negative output pulse of 10 to 20 volts amplitude, 1 to 2 microseconds width, at a repetition rate between 400 and 1000 pulses per second.

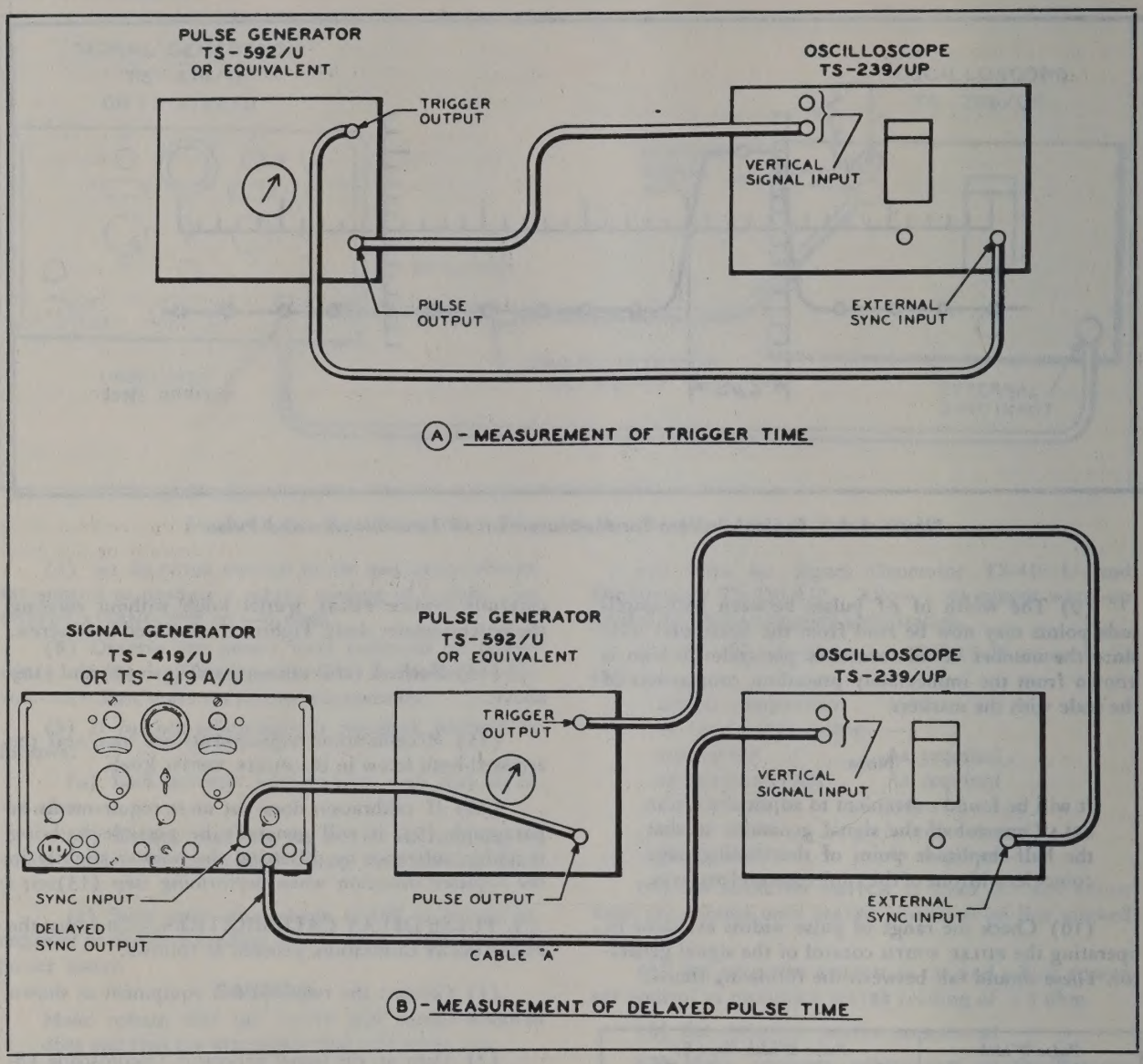


Figure 4-5. Test Connection Diagram for Measurement of Pulse Delay

(5) Determine minimum pulse delay according to the following procedure:

(*a*) Connect the required test equipment as shown in part A of figure 4-5.

(*b*) Make necessary adjustments on Oscilloscope TS-239/UP to obtain a sweep approximately 8 microseconds long with markers at 1-microsecond intervals. It will be found convenient to adjust the SWEEP TIME—FINE INCREASE and the HORIZONTAL POSITIONING controls of the oscilloscope so that successive 1-microsecond markers coincide with major divisions on illuminated scale. Minor divisions then represent 0.2 microsecond. The SYNC SELECTOR on the oscilloscope should be set to HI EXT, and the SYNC VOLTAGE control should be on the plus side of center. The MULTIPLIER switch should be set to 30 and the GAIN control (vertical) adjusted to provide an image of the pulse approximately 10 scale divisions high. Adjust the VERTICAL POSITIONING control of the oscilloscope so that the illuminated horizontal scale line passes through the half-amplitude points on the image of the pulse.

(*c*) Note position of leading edge of pulse on oscilloscope sweep.

CAUTION

Do not disturb HORIZONTAL POSITIONING control or SWEEP TIME controls of Oscilloscope TS-239/UP until remaining steps described in (*d*) and (*e*) below have been completed.

(*d*) Change circuit connections to external test apparatus to arrangement shown in part B of figure 4-5.

(*e*) With PULSE DELAY control of the signal generator fully counterclockwise, note position of leading edge of pulse. Oscilloscope GAIN AND MULTIPLIER controls should be adjusted so that half-amplitude points on the pulse occur at the illuminated horizontal scale line.

(*f*) The difference in positions found in step (*c*) and step (*e*) is a measure of the minimum pulse delay since the number of microseconds per scale division is known from step (*b*) above. This time difference should not exceed 3 microseconds. (See figure 4-6.)

(6) Determine pulse delay for PULSE DELAY control setting of 3 microseconds. The procedure is identical to that described in (5) above. The observed delay should be less than 5 microseconds.

(7) Determine pulse delay for PULSE DELAY control setting of 50 microseconds. The procedure is identical to that described in (5) above except that a sweep length of approximately 80 microseconds with 10-microsecond markers should be employed. The delay should be greater than 40 microseconds and less than 60 microseconds.

(8) Determine pulse delay for PULSE DELAY control setting of 300 microseconds. The procedure is identical to that described in (5) above except that a sweep length of approximately 500 microseconds with 100-microsecond markers should be employed. The delay should be greater than 230 and less than 370 microseconds.

(9) Determine pulse delay for maximum clockwise setting of PULSE DELAY control. The delay should be greater than 300 microseconds.

(10) If adjustment of the pulse delay calibration is required, loosen the recessed head screw in the PULSE DELAY knob, and remove the knob.

(11) Rotate the exposed potentiometer shaft until a pulse delay of 50 microseconds is obtained.

(12) With its pointer indicating 50 microseconds, carefully replace PULSE DELAY knob without rotating the potentiometer shaft. Tighten the recessed-head screw.

(13) Recheck calibration according to (6), (7), and (8) above.

(14) If calibration requirements are met, seal the recessed-head screw in the PULSE DELAY knob.

(15) If calibration does not meet the requirements of (6), (7), and (8) above, it will generally be possible to bring it within tolerance by offsetting the pointer slightly in the required direction when performing step (12).

f. PULSE RATE CALIBRATION.—To adjust the PULSE RATE calibration, proceed as follows:

(1) Connect the required test equipment as shown in Part B of figure 4-7. (A schematic diagram of the phase shift and isolation network referred to in part B of figure 4-7 is shown in part A of figure 4-7.) Turn the equipment on and allow a 20-minute warm-up period to insure complete stabilization.

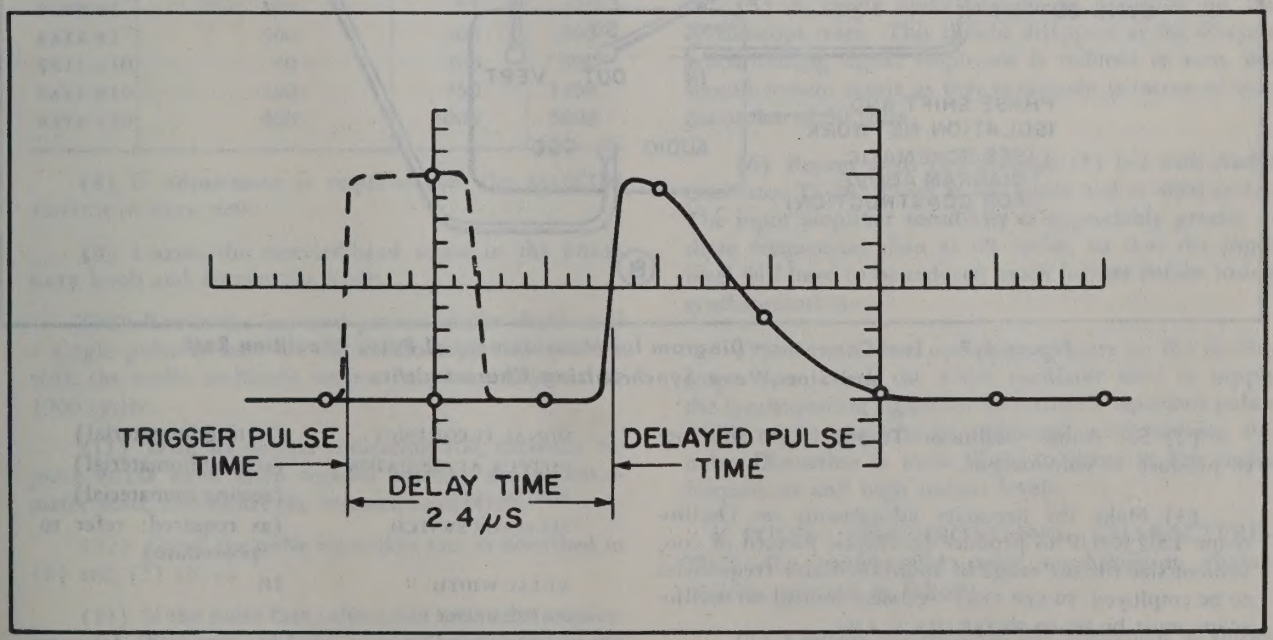


Figure 4-6. Time Relationships in Delay Measurements

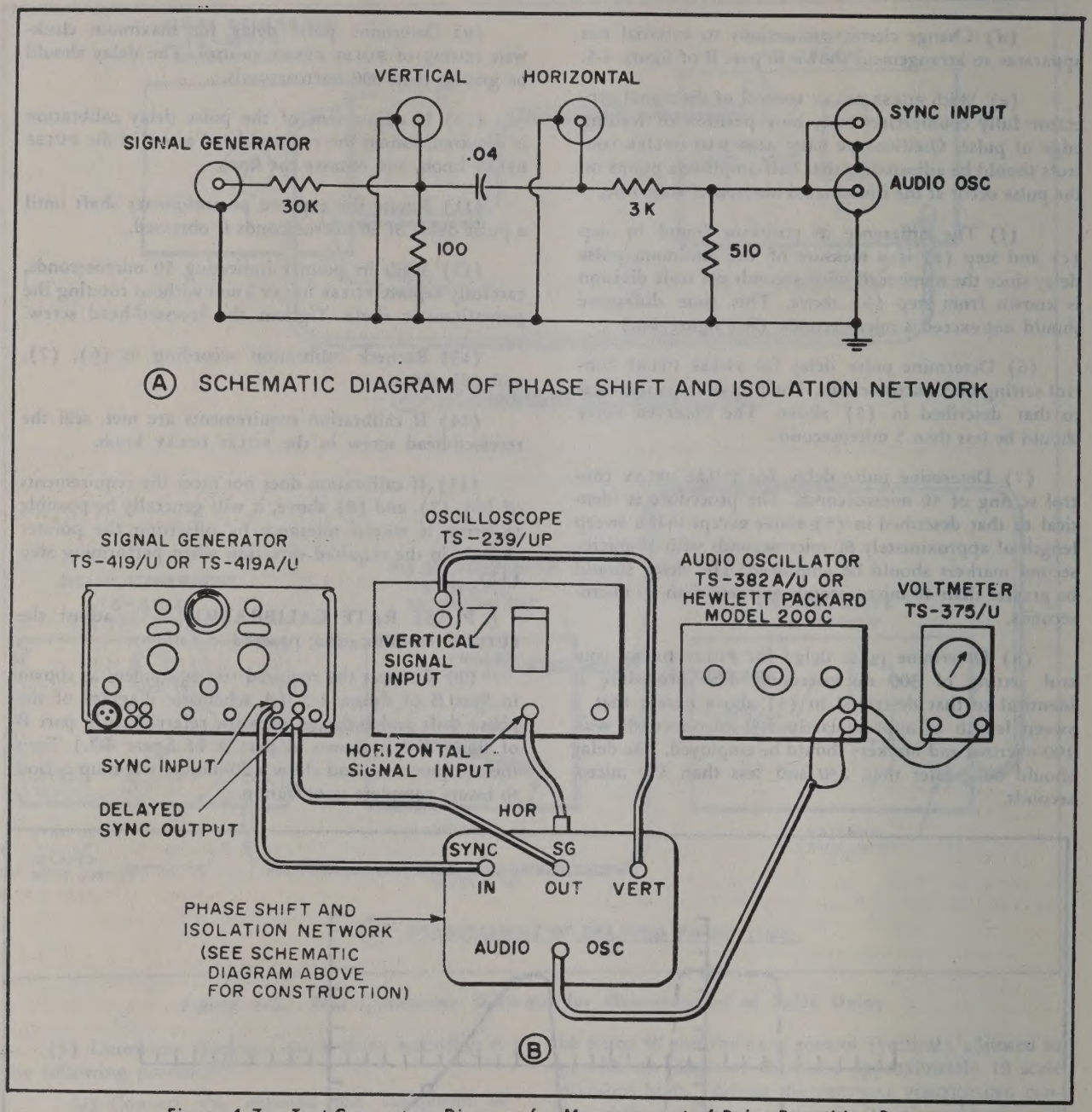


Figure 4-7. Test Connection Diagram for Measurement of Pulse Repetition Rate and Sine Wave Synchronizing Characteristics

(2) Set Audio Oscillator TS-382/U or alternate to produce 10 volts output.

(3) Make the necessary adjustments on Oscilloscope TS-239/UP to produce an elliptic pattern of convenient size for the range of audio oscillator frequencies to be employed. SWEEP TIME—COARSE control on oscilloscope must be set to SWEEP OFF H AMP.

(4) Set the signal generator controls as follows:

SIGNAL FREQUENCY	(setting immaterial)
OUTPUT ATTENUATOR	(setting immaterial)
POWER SET	(setting immaterial)
SELECTOR SWITCH	(as required; refer to procedure)
PULSE WIDTH	10
PULSE DELAY	3
PULSE RATE	(as required; refer to procedure)

(5) Set SELECTOR SWITCH to RATE X10 or RATE X1 and adjust PULSE RATE control to setting for which pulse rate is to be checked.

(6) Sweep the audio oscillator output frequency slowly over the range in which the pulse rate is expected to lie until a single stationary pulse is observed. The lowest audio oscillator frequency setting for which a single pulse is observed gives a correct measure of the pulse repetition rate.

Note

If the audio oscillator is tuned to a multiple of the pulse repetition rate, only a single pulse will be observed, but the base line will not be cleanly broken. If the audio oscillator is tuned to a sub-multiple of the pulse repetition rate, a number of pulses will appear on the trace. Numerous non-integral frequency relationships between the audio oscillator frequency and the pulse repetition rate can give rise to multiple pulses on the trace. Disregard all audio oscillator frequency settings except the lowest one for which a single pulse is observed.

(7) Determine pulse rates according to procedure of step (6) for the following pulse rates:

Selector Switch	*Pulse Rate Control*	*Rate Must Be*	
		Greater Than	*Less Than*
RATE X1	Fully counterclockwise	——	40
RATE X1	Fully clockwise	400	——
RATE X10	Fully counterclockwise	——	400
RATE X10	Fully clockwise	4000	——
RATE X1	40	30	50
RATE X1	100	75	125
RATE X1	400	300	500
RATE X10	40	300	500
RATE X10	100	750	1250
RATE X10	400	3000	5000

(8) If adjustment is required, set the SELECTOR SWITCH to RATE X10.

(9) Loosen the recessed-head screw in the PULSE RATE knob and remove the knob.

(10) Rotate the exposed potentiometer shaft until a single pulse is seen on the oscilloscope tube pattern with the audio oscillator output frequency adjusted to 1000 cycles.

(11) With its pointer indicating 100, carefully replace PULSE RATE knob without rotating the potentiometer shaft, and secure the recessed-head screw.

(12) Check the pulse repetition rate as described in (6) and (7) above.

(13) If the pulse rate calibration meets the requirements of (7) above, seal the recessed-head screw in the PULSE RATE knob.

(14) If calibration does not meet the requirements of (7) above, it will generally be possible to bring it within tolerance by offsetting the pointer slightly in the required direction when performing step (11).

9. MISCELLANEOUS ELECTRICAL TESTS.

a. SINE WAVE SYNCHRONIZING CHARACTERISTICS.—To observe the synchronizing characteristics with sine wave input, proceed as follows:

(1) Connect the required test equipment as shown in part B of figure 4-7. (A schematic diagram of the phase shift and isolation network referred to in part B of figure 4-7 is shown in part A of figure 4-7.) Turn the equipment on. Allow a 20-minute warm-up period to insure complete stabilization.

(2) Set Audio Oscillator TS-382/U, or equivalent, to produce 10 volts output at 40 cycles.

(3) Make the necessary adjustments on Oscilloscope TS-239/UP to produce an elliptical pattern of convenient size. The SWEEP TIME—COARSE control on the oscilloscope should be set to SWEEP OFF H AMP.

(4) Set the Signal Generator TS-419/U controls as follows:

SIGNAL FREQUENCY	(setting immaterial)
OUTPUT ATTENUATOR	(setting immaterial)
POWER SET	(setting immaterial)
SELECTOR SWITCH	SIN SYNC
PULSE WIDTH	10
PULSE DELAY	10
PULSE RATE	(setting immaterial)

(5) A single spike should be observed on the oscilloscope trace. This should disappear as the 40-cycle synchronizing signal amplitude is reduced to zero, but should remain stable as that amplitude is increased to a maximum of 50 volts.

(6) Repeat steps (2) through (5) but with Audio Oscillator TS-382/U set at 400 cycles and at 4000 cycles. The input amplifier sensitivity is appreciably greater at these frequencies than at 40 cycles, so that the input level will have to be reduced much further before losing synchronization.

(7) If more than one pulse appears on the oscilloscope trace, check the audio oscillator used to supply the synchronizing signal for distortion or spurious pulses which might give rise to additional synchronizing signals. Distortion is most likely to occur at low audio frequencies and high output levels.

b. PULSE SYNCHRONIZING CHARACTERISTICS.—To observe the pulse synchronizing characteristics, proceed as follows:

(1) Connect the required test equipment as shown in part B of figure 4-5. Turn the equipment on and

allow a 20 minute warm-up period to insure complete stabilization.

(2) Set the controls of Pulse Generator TS-592/U or equivalent, to produce a negative output pulse of 10 volts amplitude, ½-microsecond width, at any convenient repetition rate between 40 and 4000 pps. A rate between 400 and 1000 pps is adequate to provide a suitably bright trace on Oscilloscope TS-239/UP.

(3) Make the necessary adjustments on the oscilloscope to obtain a sweep approximately 8 microseconds long. The SYNC SELECTOR on the oscilloscope should be set to HI EXT and the SYNC VOLTAGE control on the plus side of center. The MULTIPLIER switch should be set to 30.

(4) Set the signal generator controls as follows:

SIGNAL FREQUENCY	(setting immaterial)
OUTPUT ATTENUATOR	(setting immaterial)
POWER SET	(setting immaterial)
SELECTOR SWITCH	NEG SYNC
PULSE WIDTH	2
PULSE DELAY	5
PULSE RATE	(setting immaterial)

(5) A sync output pulse should be observed on the oscilloscope trace. This pulse should be stable and its characteristics should be essentially independent of the amplitude of the synchronizing pulse up to a maximum of 50 volts, and independent of its width up to a maximum of 30 microseconds.

(6) Repeat steps (2), (3), and (4), but with the pulse generator set to produce positive output pulses and the SELECTOR SWITCH set to POS SYNC. The oscilloscope trace described in step (5) should be the same.

c. EXTERNAL MODULATION CHARACTERISTICS.—To observe the external modulation characteristics, proceed as follows:

(1) Connect the required test equipment as shown in figure 4-8. Turn the equipment on and allow a 20-minute warm-up period to insure complete stabilization.

(2) Set the Pulse Generator TS-592 U, or equivalent, to produce a negative pulse of 40 volts amplitude and 10 microseconds width.

(3) Set the signal generator controls as follows:

SIGNAL FREQUENCY	1500
OUTPUT ATTENUATOR	—3
POWER SET	(to produce 0 dbm meter reading)
SELECTOR SWITCH	NEG MOD
PULSE WIDTH	(setting immaterial)
PULSE DELAY	(setting immaterial)
PULSE RATE	(setting immaterial)

(4) Observe the characteristics of the r-f output pulse on the oscilloscope. The pulse should be of essentially the same width as that supplied by the pulse generator and should be essentially rectangular. The top of the pulse should be flat out to its full length; however, this will not be true for pulses appreciably longer than 10 microseconds.

(5) Vary the pulse generator output pulse width down to ½ microsecond. The r-f output pulse of the signal generator should remain constant in amplitude down to approximately 0.8 microsecond. Below this, the amplitude may decrease and the pulse may even disappear entirely. This is due to the starting time required by the r-f oscillator, which tends to shorten the r-f output pulse slightly as compared with the applied video pulse. Such a condition is normal and does not indicate trouble in the signal generator.

(6) Vary the pulse generator output pulse amplitude up to 70 volts maximum. The output pulse of the signal generator may widen somewhat as the external modulating pulse amplitude is increased. This is due to a slicing action which uses only the bottom part of a pulse when the amplitude of the pulse is larger than that required for full modulation. Because of finite rise and decay times, pulses are generally wider at the base than at the top. This small slicing action may also result in slightly longer rise and decay times on the r-f output pulse, from the signal generator, than are on the video modulating pulse supplied by the external pulse generator.

(7) Repeat steps (2) through (6) but with positive pulse output from the pulse generator and with the SELECTOR SWITCH set to POS MOD. The conditions existing in steps (4), (5), and (6) will be the same.

d. SYNC OUTPUT CHARACTERISTICS.—To observe the sync output characteristics, proceed as follows:

(1) Connect the required test equipment as shown in part B of figure 4-5.

(2) Set the controls of Pulse Generator TS-592 U, or equivalent, to produce a negative output pulse of 10 volts amplitude, ½ microsecond width, at any convenient repetition rate between 40 and 4000 pps. A rate between 400 and 1000 pps is adequate to provide a suitably bright trace on Oscilloscope TS-239 UP.

(3) Make the necessary adjustments on the oscilloscope to obtain a sweep approximately 8 microseconds long. The SYNC SELECTOR on the oscilloscope should be set to HI EXT and the SYNC VOLTAGE control on the plus side of center. The MULTIPLIER switch should be set to 30.

(4) Set the signal generator controls as follows:

SIGNAL FREQUENCY	(setting immaterial)
OUTPUT ATTENUATOR	(setting immaterial)
POWER SET	(setting immaterial)

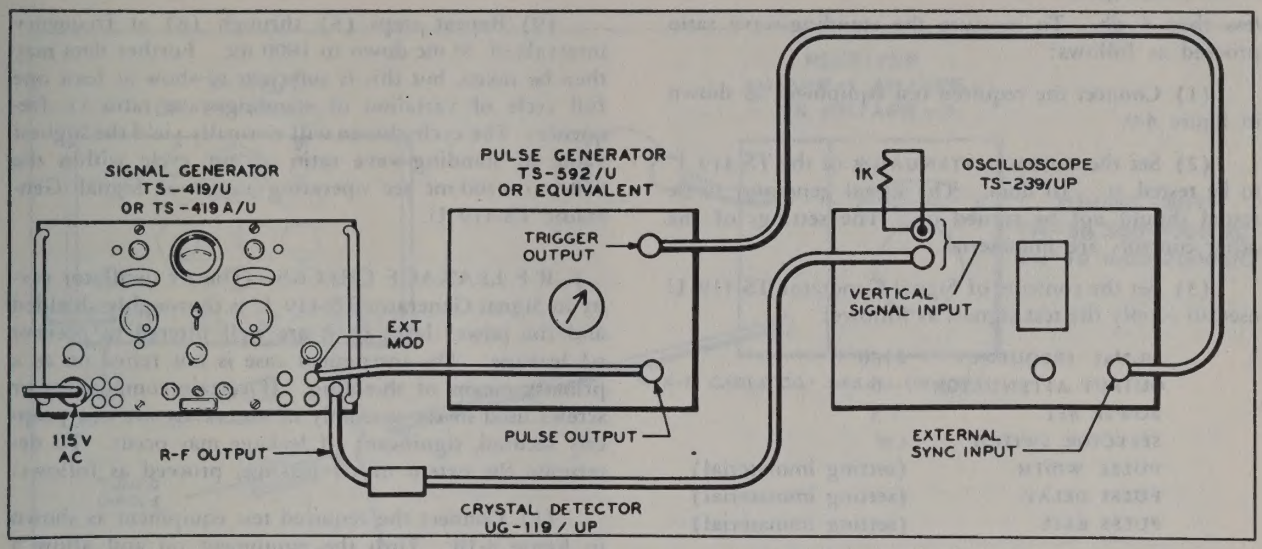


Figure 4-8. Test Connection Diagram for Measurement of External Modulation Performance

SELECTOR SWITCH	NEG SYNC
PULSE WIDTH	2
PULSE DELAY	5
PULSE RATE	(setting immaterial)

(5) A delayed sync output pulse should be observed, with the following characteristics:

(*a*) The rise time should be less than ½ microsecond.

(*b*) The pulse should be less than 5 microseconds wide between half-amplitude points. This width may be measured as described in paragraph 8.*d.* of this section. The width should vary between about 1 and 3 microseconds as the PULSE WIDTH control is varied from minimum to maximum width. The pulse may disappear completely with the control set fully counterclockwise. This is normal and does not indicate trouble.

(*c*) The pulse amplitude may be measured by using the calibrator that is part of Oscilloscope TS-239 UP. It should be between 40 and 50 volts when the DELAYED SYNC OUTPUT connector of Signal Generator TS-419 U is unloaded. It should be greater than 20 volts with any load consisting of resistance in excess of 500 ohms, shunted by capacitance of less than 1500 $\mu\mu$f.

(6) Undelayed sync output pulses may be observed by following the procedure outlined in steps (1) through (4), except that cable A, which feeds the vertical signal input of the oscilloscope, should be connected to the UNDELAYED SYNC OUTPUT connector of the signal generator. A sync output pulse with the following characteristics should be observed:

(*a*) The rise time should be less than 1.5 microseconds.

(*b*) The pulse should be less than 5 microseconds wide between half-amplitude points. This width may be measured by the method described in paragraph 8.*d.* of this section. The width should vary between about 1 and 4 microseconds as the pulse delay control is varied from minimum to maximum delay.

(*c*) The pulse amplitude may be measured using the calibrator which is part of Oscilloscope TS-239/UP. It should be between 40 and 50 volts when the UNDEAYED SYNC OUTPUT connector of Signal Generator TS-419/U is unloaded. It should be greater than 20 volts with any load consisting of resistance in excess of 500 ohms, shunted by capacitance of less than 1500 $\mu\mu$f.

e. OUTPUT ATTENUATOR IMPEDANCE.—The nominal output impedance of Signal Generator TS-419/U is 50 ohms. If power is fed back into the signal generator RF OUTPUT connector through a 50-ohm transmission line, deviation from the nominal 50-ohm output impedance will cause some of the incident power to be reflected. The result of such reflection will be a standing wave pattern on the feed line. Measurement of the ratio of the maximum-amplitude to the minimum-amplitude standing wave gives a measure of the departure of the signal generator output impedance from its nominal value. The standing wave ratio may be expressed in decibels. The larger the decibel value of the standing-wave ratio, the poorer the quality of the output attentuator termination. The actual standing-wave ratio is a function of frequency. In Signal Generator TS-419/U the standing-wave ratio varies cyclically with frequency, minima being spaced about 175 mc apart and maxima approximately half-way between. The greatest standing-wave ratio at any frequency should be

less than 6 db. To measure the standing-wave ratio proceed as follows:

(1) Connect the required test equipment as shown in figure 4-9.

(2) Set the OUTPUT ATTENUATOR of the TS-419 U to be tested at −10 dbm. The signal generator to be tested should *not* be turned on. The settings of the other controls are immaterial.

(3) Set the controls of Signal Generator TS-419 U used to supply the test signals as follows:

SIGNAL FREQUENCY	2100
OUTPUT ATTENUATOR	−6
POWER SET	+3
SELECTOR SWITCH	CW
PULSE WIDTH	(setting immaterial)
PULSE DELAY	(setting immaterial)
PULSE RATE	(setting immaterial)

(4) Tune the stub on the slidable probe of the slotted line to produce maximum deflection of the meter in the detector circuit.

(5) Slide the probe back and forth along the line to locate a minimum and note the meter reading at this point.

(6) Slide the probe back and forth along the line to locate a maximum and leave the probe at this point.

(7) Decrease the OUTPUT ATTENUATOR setting from that in step (3) until the meter reads exactly the value noted in step (5). Note the setting on the DBM scale.

(8) The difference between the attenuator readings of step (3) and step (7) is the standing-wave ratio in decibels.

(9) Repeat steps (3) through (8) at frequency intervals of 20 mc down to 1800 mc. Further data may then be taken, but this is sufficient to show at least one full cycle of variation of standing-wave ratio vs. frequency. The cycle chosen will normally yield the highest value of standing-wave ratio of any cycle within the 900- to 2100-mc sec operating range of Signal Generator TS-419 U.

j. R-F LEAKAGE CHECKS.—The r-f oscillator cavity in Signal Generator TS-419 U is thoroughly shielded and the power leads to it are well filtered to prevent r-f leakage. The instrument case is not relied on as a primary means of shielding. If certain components or screws used in the assembly of the cavity are not properly secured, significant r-f leakage may occur. To determine the extent of r-f leakage, proceed as follows:

(1) Connect the required test equipment as shown in figure 4-10. Turn the equipment on and allow a minimum period of 20 minutes for warm-up to insure complete stabilization.

(2) Set the controls of Signal Generator TS-419 U as follows:

SIGNAL FREQUENCY	900
OUTPUT ATTENUATOR	−70 dbm
POWER SET	0 dbm
SELECTOR SWITCH	CW
PULSE WIDTH	(setting immaterial)
PULSE DELAY	(setting immaterial)
PULSE RATE	(setting immaterial)

(3) Temporarily connect cable CG-546 U between the receiver r-f input connector and the RF OUTPUT connector of Signal Generator TS-419 U. Tune in the TS-419 U on the receiver.

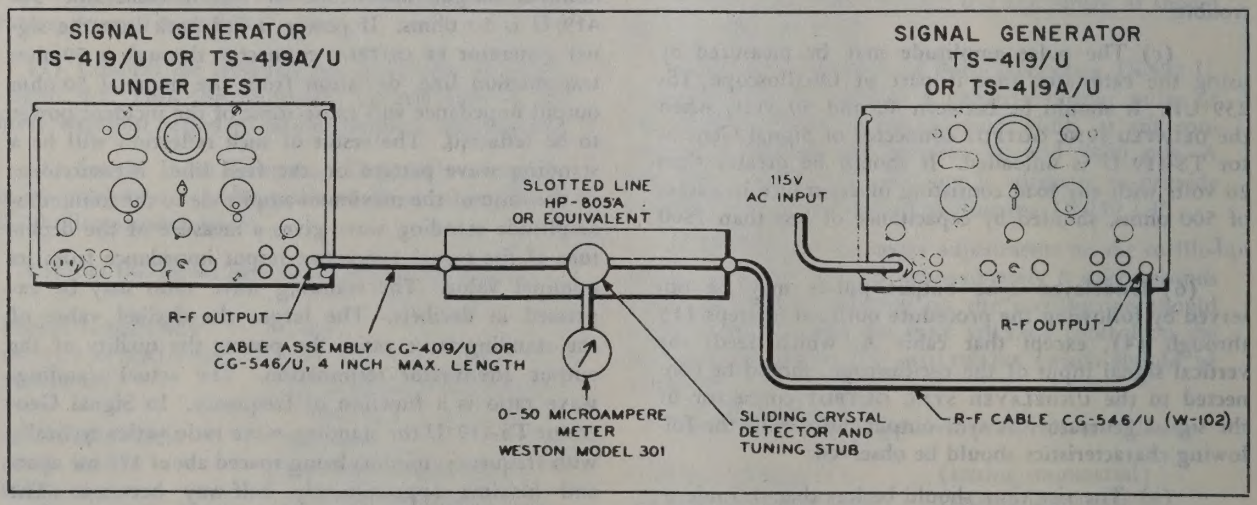


Figure 4-9. Test Connection Diagram for Measurement of Attenuator VSWR

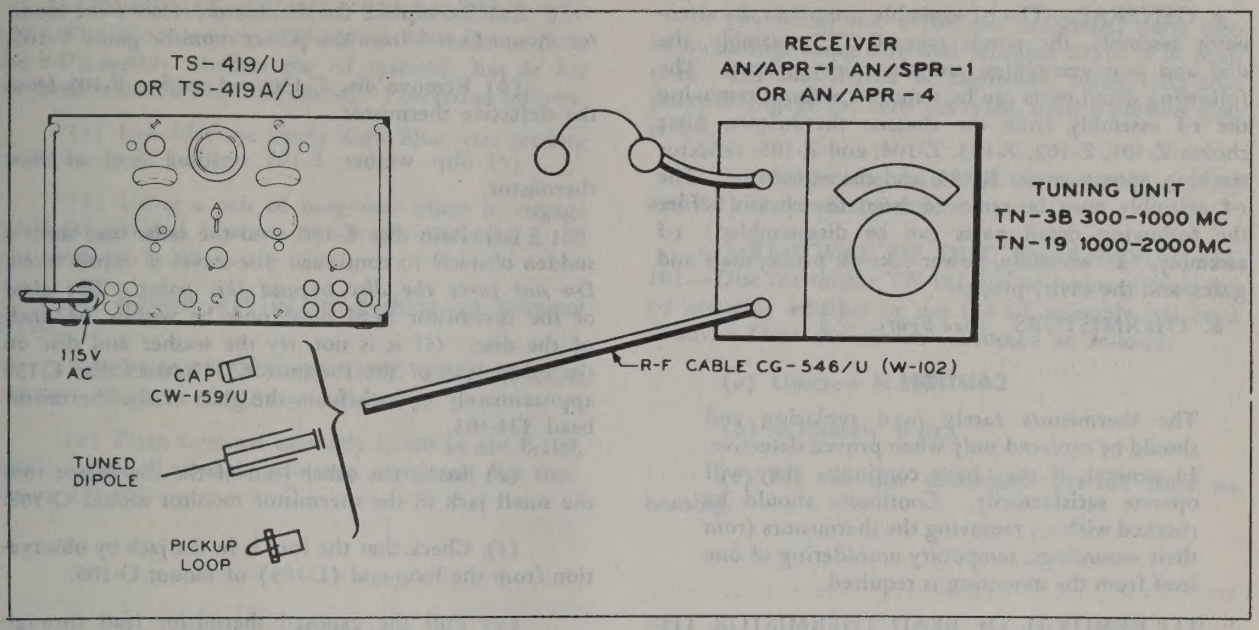


Figure 4-10. Test Connection Diagram for Measurement of R-F Leakage

(4) Disconnect the cable from the RF OUTPUT connector and attach it to the dipole antenna. This antenna should be tuned to the test frequency.

(5) Probe around the vicinity of the TS-419 U with the antenna, keeping the antenna approximately two inches from the instrument case. If leakage is found, note its intensity on the receiver, restore the connections described in step (3), and adjust the OUTPUT ATTENUATOR to give the same receiver output as the leakage value observed with the antenna. The OUTPUT ATTENUATOR reading gives a measure of the leakage observed under the given test conditions.

Note

Upon completion of step (5), check to make sure that the receiver and TS-419/U are still tuned to each other. If retuning of the receiver increases the receiver output, drift has occurred and the measurement should not be relied upon. Such drift is usually the result of inadequate warm-up of the receiver or signal generator.

(6) If leakage from the output attenuator cable is suspected, repeat the foregoing tests with the OUTPUT ATTENUATOR set at —3 dbm and the RF OUTPUT connector capped by a solid cap such as a type CW-159 U. The use of a cap is essential for this test to avoid large radiation directly from the open connector.

(7) If leakage from the video connectors of the signal generator is suspected, repeat step (3) and then connect cable CG-409/U successively to SYNC IN, UNDELAYED SYNC OUT, DELAYED SYNC OUT, and EXT MOD connectors. Leakage from any of these should not exceed 10 microvolts as determined by the substitution method described in step (5). Leakage from these receptacles usually is caused by a defective filter Z-101, or Z-102, or Z-103. It may also be due to inadequate tightening of H-101, H-107, or H-108, or to defective filter Z-104 or Z-105. Trouble should be localized by searching with the pick-up loop in place of the antenna on the receiver. Signal Generator TS-419 U must be removed from its instrument case for this procedure. (Refer to paragraph 5.*a.* of this section.) A little practice in orienting the loop of the cable and in grounding the outer conductor, if required, will make conclusive checks possible.

(8) Repeat steps (2) through (7) at 100-mc frequency intervals in the 900- to 2100-mc sec range.

10. MAINTENANCE OF R-F ASSEMBLY.

(See figures 7-5, 7-6, and 7-7.)

CAUTION

Do not disassemble the equipment any further than necessary to make the inspections, adjustments, or replacements described herein. When disassembly is necessary, follow instructions exactly. Avoid burring nuts and screws; only close-fitting or adjustable wrenches and properly ground screw drivers should be used. Replace all washers and screws on each part as it is removed so that they will be available when reassembling. Replace all lockwashers and tighten and reseal all screws when reassembling.

a. GENERAL.—The r-f assembly comprises the attenuator assembly, the power take-off "T" assembly, the dial and gear assemblies, and the cavity proper. The following detail parts can be removed without removing the r-f assembly from the chassis: thermistors, filter chokes Z-101, Z-102, Z-103, Z-104, and Z-105, reflector tracking potentiometer R-185, and the attenuator. The r-f assembly must be removed from the chassis before the following detail parts can be disassembled: r-f assembly, "T" assembly, power take-off probe, dials and gears, and the cavity proper.

b. THERMISTORS. *(See figure 7-7.)*

CAUTION

The thermistors rarely need replacing and should be replaced only when proven defective. In general, if they have continuity they will operate satisfactorily. Continuity should be checked without removing the thermistors from their mountings; temporary unsoldering of one lead from the mounting is required.

(1) REMOVAL OF BEAD THERMISTOR TH-103.—The entire assembly of L-105 through L-108 can be disassembled from the r-f assembly, whether or not the latter has been removed from the chassis. Proceed as follows:

CAUTION

Since bead thermistor TH-103 and its mounting are quite delicate, exercise care in performing the operations necessary for the removal and replacement of TH-103.

(*a*) Loosen and slip back the knurled nut H-108. Withdraw Z-105 from Y-105. With a small pair of tweezers, engage the projecting contact of the thermistor TH-103, which is inside the housing O-106, and carefully pull out the thermistor and the associated by-pass capacitor C-130.

(*b*) To remove O-106 from Y-105 engage a No. 10-32 screw into the threaded center hole of O-106 and withdraw the monitor mount by pulling it straight out. One of the captive screws in the front panel of the instrument case is suitable for this operation. This operation will also remove tubular spacer E-106 and mica washer E-105.

(2) REPLACEMENT OF BEAD THERMISTOR TH-103.—If the bead thermistor is found to be defective, it may be replaced with the spare thermistor carried in the small capsule located on the top of the chassis at the far left rear corner. (See figure 5-2.)

(*a*) To replace the thermistor, remove the monitor mount O-106 from the power monitor guide Y-105.

(*b*) Remove disc C-130 and washer E-105 from the defective thermistor.

(*c*) Slip washer E-105 on one lead of new thermistor.

(*d*) Push disc C-130 onto the same lead until a sudden obstacle to continued disc-travel is encountered. *Do not force the disc beyond this point.* The glass of the thermistor bead must now be within .047-inch of the disc. (If it is not, try the washer and disc on the other lead of the thermistor.) Retract disc C-130 approximately $\frac{1}{8}$ inch from the glass of the thermistor bead TH-103.

(*e*) Insert the other lead of the thermistor into the small jack in the thermistor monitor mount O-106.

(*f*) Check that the lead is in the jack by observation from the loop-end (L-105) of mount O-106.

(*g*) Pull the exposed thermistor lead through the disc away from the loop-end of the mounting assembly until a sudden obstacle to continued travel is encountered. *Do not force the lead beyond this point.* The disc must be tight on the thermistor lead.

(*h*) Push the disc and bead assembly into mount O-106 until they are seated firmly.

(*i*) Carefully insert the assembly of the disc, thermistor, and mount into the guide Y-105, locating it angularly by means of the locating pin in the guide Y-105 and slot in the mount O-106.

(*j*) Install insulating tubular spacer E-106 so as to center disc C-130.

(*k*) Install choke Z-105 and secure with nut H-108.

(*l*) Apply power to the TS-419/U, and with the SELECTOR SWITCH at ZERO SET, adjust the ZERO SET control until the fiducial line on the knob is vertical. Using a screw driver, reset the chassis-mounted ZERO ADJ. control R-146 to make the meter M-101 indicate to the ZERO SET line.

(*m*) Tap the TS-419/U in the vicinity of the bead thermistor mounting while observing the meter M-101. Jumping of the panel meter indication is evidence of poor or unstable contact in the thermistor circuit or in Z-105.

(3) REMOVAL OF DISC THERMISTOR TH-102.—The disc thermistor TH-102 can be removed from the r-f assembly whether the r-f assembly has or has not been removed from the chassis. Proceed as follows:

(*a*) Unsolder the single dark blue wire leading to the terminal E-108.

(*b*) Using a pair of long-nose pliers to engage the slots provided, unscrew nut E-109. Remove E-109 and terminal E-108.

(*c*) Remove TH-102 by pushing on terminal E-110.

(4) REPLACEMENT OF DISC THERMISTOR TH-102.—Replace TH-102 as follows:

(*a*) Place terminal assembly E-108 in nut E-109, install varnished cambric insulator, and insert disc thermistor TH-102.

(*b*) Screw nut E-109 and associated parts into its mounting, being sure that terminal E-110 is in position. The nut should be tightened, using long-nose pliers to engage the slots provided, until a positive stop is felt.

(*c*) Solder the dark blue wire (see figures 7-3 and 7-7) to terminal E-108.

(5) REMOVAL OF DISC THERMISTOR TH-101.—Disc thermistor TH-101 can be removed from the r-f assembly whether or not the r-f assembly has been removed from the chassis. Proceed as follows:

(*a*) Unscrew H-115.

(*b*) Withdraw E-107.

(*c*) Pry the disc thermistor TH-101 from its housing.

(6) REPLACEMENT OF DISC THERMISTOR TH-101.—Replace TH-101 as follows:

(*a*) Wrap disc thermistor TH-101 in the varnished cambric.

(*b*) Insert the thermistor into the hole. Be certain it is fully seated.

(*c*) Insert E-107.

(*d*) Secure H-115.

c. R-F FILTERS. (*See figure* 7-7.)—The three filters Z-101, Z-102, and Z-103, mounted on the oscillator tube socket assembly H-106, the reflector voltage filter Z-104, and the thermistor choke Z-105 can all be replaced without removing the r-f assembly from the chassis.

(1) REMOVAL OF FILTERS Z-101, Z-102, Z-103.—To remove filter Z-101, Z-102, or Z-103, proceed as follows:

(*a*) Remove socket assembly H-106 from cavity and tube V-111 from socket assembly. (Refer to paragraph 6.*c.* of this section.)

(*b*) Slip off cap O-124, O-125, or O-126 and unsolder lead to external terminal of filter to be removed.

(*c*) Unscrew plug H-123 from rear of socket assembly H-106. Use a screw driver as a lever between the pins projecting from this plug to start it.

(*d*) Unsolder lead from choke L-106 to inner terminal of Z-101, or from choke L-107 to inner terminal of Z-102, or from choke L-108 to inner terminal of Z-103, as required.

Note

Chokes L-106, L-107, and L-108, not used in equipments manufactured under Contract N383s-5019A.

(*e*) Unscrew Z-101, Z-102, or Z-103 from socket assembly H-106.

(2) REPLACEMENT OF FILTERS Z-101, Z-102, Z-103.—To replace filter Z-101, Z-102, or Z-103, proceed as follows: [See note, paragraph 10.*c.*(1).]

(*a*) Screw Z-101, Z-102, or Z-103 into socket assembly H-106 until tight.

(*b*) Replace lead from choke L-106, L-107, or L-108 to inner terminal of filter Z-101, Z-102, or Z-103, respectively.

CAUTION

It is absolutely essential that chokes L-106, L-107, and L-108 be replaced exactly in their original orientation.

(*c*) Replace plug H-123 in rear of socket assembly H-106. Be careful not to cross-thread the fine threads.

(*d*) Solder leads to external terminals of Z-101, Z-102, or Z-103.

(*e*) Slide cap O-124, O-125, or O-126 into place.

(*f*) Replace tube V-111 and socket assembly H-106 into r-f assembly. (Refer to paragraph 6.*c.* of this section.)

(3) REMOVAL OF FILTER Z-104.—To remove filter Z-104, slip off cap O-127, unsolder the lead to the terminal of Z-104, unscrew nut H-101, and withdraw the filter.

(4) REPLACEMENT OF FILTER Z-104.—To replace filter Z-104, proceed as follows:

(*a*) Make certain that hole in conductor E-102 for the pin plug of Z-104 is in a vertical position. If not, it can be re-oriented by inserting a 1/4-inch diameter rod in contact E-102B and rotating the fingers until the desired orientation is obtained. (E-102B is accessible from the tube end of the cavity when the oscillator tube V-111 and its socket assembly H-106 have been removed.)

(*b*) Plug filter Z-104 into place.

(*c*) Secure nut H-101.

(*d*) Resolder lead to terminal of Z-104.

(*e*) Slide cap O-127 into place.

(5) REMOVAL OF FILTER Z-105.—Removal of filter Z-105 is accomplished by unsoldering the lead to its terminal, unscrewing nut H-108, and taking out the filter.

(6) REPLACEMENT OF FILTER Z-105.—Replacement of filter Z-105 is accomplished by putting the filter in place, securing nut H-108, and soldering the lead to its terminal.

d. REFLECTOR TRACKING POTENTIOMETER R-185. (*See figure* 7-5.)—Potentiometer R-185 may be removed and replaced without removing the r-f assembly from the chassis.

(1) REMOVAL OF REFLECTOR TRACKING POTENTIOMETER.—To remove R-185 proceed as follows:

(*a*) Turn signal frequency knob fully clockwise.

(*b*) Unscrew nut H-101 (figure 7-7) and remove Z-104.

(*c*) Remove protective baffle and unsolder leads going to R-185 (figure 7-2).

(*d*) Loosen two set screws in chuck H-120 (figure 7-5).

(*e*) Remove three screws retaining R-185 and withdraw R-185.

(2) REPLACEMENT OF REFLECTOR TRACKING POTENTIOMETER.—To replace R-185, proceed as follows:

(*a*) Turn SIGNAL FREQUENCY knob fully clockwise.

(*b*) Take up two to three teeth on split gears O-115 and engage with pinion of gear assembly O-119. Be sure that gear is oriented so that set screws in chuck H-120 are accessible.

(*c*) Slip R-185 into place, engaging shaft in chuck H-120.

(*d*) Secure R-185 by means of the three mounting screws to the studs provided in back plate A-101.

(*e*) Locate wiper arm of R-185 1/4-inch from the fully counterclockwise end of the winding as viewed from the rear.

CAUTION

Do not force wiper arm up over edge of metal clamping strip.

(*f*) Secure the two recessed-head screws in chuck H-120.

(*g*) Solder leads to center and upper terminals of R-185. (It is immaterial which lead goes to which terminal.)

(*h*) Replace protective baffle on R-185.

(*i*) Replace Z-104.

(*j*) Perform tests described in paragraphs 7.*e*. and 8.*b*. of this section.

e. ATTENUATOR.

Note

If the attenuator is disassembled, recalibration of the power output according to the procedure described in paragraph 8.*c*. of this section is required. Disassembly must not be attempted by activities which do not possess adequate calibration facilities and test equipment.

(1) REMOVAL OF ATTENUATOR.—The attenuator piston O-107 and associated cable W-105 may be removed without removing the r-f assembly from the chassis. Proceed as follows:

(*a*) Remove support bar next to attenuator cable. (See figure 5-2.)

(*b*) Loosen two recessed-head screws in chuck O-110.

(*c*) Remove cable W-105 from chassis and panel as described in paragraph 10.*f*.(1) of this section.

(*d*) Withdraw attenuator piston O-106 and cable W-105 from tube Y-106 of the "T" assembly.

CAUTION

Do not attempt to disassemble the piston O-107 any further. If it is necessary to service the r-f output cable W-105 or the terminating resistor R-160, the entire piston assembly should be replaced; however, if emergency repair of this assembly is necessary, refer to paragraph 10.*e*.(2) of this section.

(2) EMERGENCY REPAIR OF PISTON ASSEMBLY.—Emergency repair of the piston assembly should only be resorted to if a complete replacement assembly is not available, and continued operation of the equipment is required. Proceed as follows:

(*a*) Check the resistance across the terminals of J-105. The resistance should be 51 ohms±20 per cent; if not, check continuity of attenuator output cable W-105. This cable is subject to considerable flexing while the instrument is in use. If either the cable or the resistor requires replacement, a delicate soldering operation is involved.

(*b*) When performing a soldering operation on R-160, prevent the slightest amount of solder from coming in contact with the inside wall of O-107. This can be accomplished by temporarily inserting a piece of wet paper into O-107 at the pick-up end of R-160 where the soldering operation is to take place.

(3) REPLACEMENT OF ATTENUATOR.—Replacement of attenuator piston and associated cable should be carried out as follows:

(*a*) Insert attenuator piston O-107 into tube Y-106 of the "T" assembly.

CAUTION

Be certain the rack gear O-108 slips between the driving gear O-109 and loading spring H-114. This action is necessary to prevent unwanted backlash.

(*b*) Secure cable W-105 to chassis and panel following the procedure described in paragraph 10.*f*.(2) of this section.

(*c*) Replace support bar.

(*d*) Recalibrate power output according to the procedure outlined in paragraph 8.*c*. of this section, being sure to secure and seal the recessed-head set screws in chuck O-110 upon completion of adjustments.

f. REMOVAL AND REPLACEMENT OF R-F ASSEMBLY COMPLETE. (*See figures* 5-2, 5-3, 5-3*A*, 5-3*B*, 5-3*C*, 5-3*D*, 7-3, 7-3*A*, 7-3*B*, 7-3*C*, *and* 7-7.)

(1) REMOVAL OF R-F ASSEMBLY.—To remove the r-f assembly from the chassis, proceed as follows:

(*a*) Stand chassis on its back so that the front panel is facing upwards.

(*b*) Loosen the four screws holding C-120. Slide C-120 toward center of chassis.

(*c*) Unscrew the four small screws on the front panel which secure J-105. Remove J-105, and slip it, together with its cable, free of C-120.

(*d*) Unscrew nut H-111 and carefully slip cable W-105, together with J-105, through the hole in the chassis so that the entire cable assembly is now on the top of the chassis.

(*e*) Remove the two screws H-147 and H-148 holding cavity bracket O-105 to the chassis. They are located between V-113 and V-110.

(*f*) Remove the screw H-149 holding support post H-113 to the chassis. This screw is located between terminal board E-120 and V-114. Retrieve bushing H-165 which is now free.

(*g*) Place the chassis in its normal position with the front panel turned away.

(*h*) Remove protective baffle from R-185.

(*i*) Unsolder the wires leading to the following points: terminal E-107 of thermistor TH-101, terminals, E-108 and E-110 of thermistor TH-102, the terminal of filter Z-104, and the two leads to the reflector variable resistor R-185. (See figures 7-2, 7-2A, B, C, and D.)

(*j*) Remove oscillator tube V-111 and its socket assembly H-106. (Refer to paragraph 6.*c*. of this section.)

(*k*) Disconnect flexible shaft O-113 by loosening the two recessed-head screws in the chuck behind the front panel that connects the POWER SET knob to flexible shaft O-113.

(*l*) Turn the SELECTOR SWITCH to SIN SYNC position. Disconnect the selector switch knob shaft from S-101 by loosening the two set screws in the chuck.

(*m*) Remove the SIGNAL FREQUENCY and OUTPUT ATTENUATOR knobs.

(*n*) Remove the screws H-132 through H-137 that secure the r-f assembly to the front panel.

(*o*) Loosen the three screws retaining meter M-101 until meter can be pulled forward one inch.

(*p*) The r-f assembly is now ready to be withdrawn as a unit from the chassis proper. Slide it back from the panel as far as the tubes will permit.

CAUTION

The wire leads running to the panel meter and ZERO SET potentiometer along the rear of the front panel should be carefully drawn toward the panel and clear of the attenuator dial to prevent possible damage to insulation before proceeding with the following steps.

(*q*) Lift out the r-f assembly by lifting the dial end up first and moving the whole assembly forward and out at about a 45-degree angle. Do not force the unit out. If all obstructions are cleared, it will come freely.

(2) REPLACEMENT OF R-F ASSEMBLY.—To replace the r-f assembly, proceed as follows:

CAUTION

Because of the close fit of electron tubes and wires, and the possibility of defacing dials, care must be exercised in replacing the r-f assembly.

(*a*) Remove socket assembly H-106 and tube V-111 from the r-f assembly. (Refer to paragraph 6.*c*. of this section.)

(*b*) Lift the r-f assembly, tilting the back end of the cavity downward at about a 45-degree angle and slipping it under the rear guard rail. Lower the dial end of the cavity, and slide the assembly into place.

Note

Be sure to get the wire leads to the meter and ZERO SET potentiometer behind the attenuator dial. When bringing the SIGNAL FREQUENCY and OUTPUT ATTENUATOR shafts through the holes in the front panel, make certain that the appropriate locking yokes located on the back of the front panel are properly engaged.

(*c*) Start the screws H-132 through H-137 that secure the r-f assembly to the front panel. After making certain that the hubs on the SIGNAL FREQUENCY and OUTPUT ATTENUATOR shafts are centered in the front panel holes, tighten the screws.

(*d*) Secure the three screws which retain meter M-101.

(*e*) Connect flexible shaft O-113 to the chuck behind the front panel and secure with recessed-head screws.

(*f*) Install and secure SIGNAL FREQUENCY and OUTPUT ATTENUATOR knobs. On signal generators with an interpolation scale on the SIGNAL FREQUENCY knob, this scale must be so oriented that its zero coincides with one of the separating lines on the counting scale of the MC (signal frequency) dial. This orientation can only be made after setting the SIGNAL FREQUENCY dial calibration as described in paragraph 8.*b*. of this section.

(*g*) Secure the knob shaft to the SELECTOR SWITCH shaft by tightening the two recessed-head screws in the chuck on the knob shaft, making certain that both shafts are in the SIN SYNC position (fully clockwise).

(*h*) Solder the two wires leading to the reflector potentiometer R-185, using the center and upper terminals of the resistor. It is immaterial which wire goes to which terminal. Solder the leads going to terminal E-107 of thermistor TH-101, terminals E-108 and E-110 of thermistor TH-102, terminals E-108 and E-110 of thermistor TH-102, and to the terminal of filter Z-104. Slip cap O-127 over the terminal of Z-104.

(*i*) Replace the protective baffle on R-185.

(*j*) Install oscillator tube V-111 and socket assembly H-106. (Refer to paragraph 6.*c*. of this section.)

(*k*) Stand the chassis on its back so that the front panel is facing upward.

(*l*) Secure the cavity mounting bracket O-105 to the chassis with screws H-147 and H-148.

(*m*) Install bushing H-165 between post H-113 and chassis, and secure with screw H-149.

(*n*) Slip W-105 through the hole provided in chassis, and position the anti-turn pin on H-110 in the

locating slot and secure H-111. Insert J-105 into the hole provided on the front panel and secure with the four small screws provided. Give proper slack to W-105 before securing H-109. A rubber insert contained in H-109 squeezes W-105 to prevent "cable walking." (See figure 7-7.)

(*o*) Slide C-120 over W-105 and secure C-120 with the four screws provided. C-120 should clear the side of the chassis by approximately 1/16 inch.

g. "T" ASSEMBLY.

(1) GENERAL.—The "T" assembly A-107 should not ordinarily require servicing. Most troubles associated with the output system of the signal generator are traceable either to the thermistor power monitoring system or to the attenuator, maintenance of which is discussed in paragraphs 10.*b* and 10.*e.*, this section. These operations do not require removal of the "T" assembly. Operation of the drive mechanism for power take-off probe C-129 may be inspected by removing screw plug H-122 without removing the "T" assembly.

(2) REMOVAL OF "T" ASSEMBLY.—If it is desired to remove the entire "T" assembly from the cavity proper, it will be necessary to remove the r-f assembly from the chassis (paragraph 10.*f.*, this section). Proceed as follows:

(*a*) Remove the screw from the front of the back plate A-101 that secures attenuator horizontal support shaft H-112.

(*b*) Loosen the two recessed-head screws in chuck O-110.

(*c*) Unscrew nut H-107.

(*d*) Carefully lift the "T" from the cavity, rotating it slightly about shaft O-111 as an axis, until tube E-104 is free of cavity Y-102, and then pulling away from back plate A-101 until shaft O-111 is free.

CAUTION

After removal be certain to lay the "T" on the bench upside down so that the piston drive gearing O-108 and O-109 faces upward. This action will prevent possible damage to the thermistor terminals and the r-f power take-off C-129.

(3) REPLACEMENT OF "T" ASSEMBLY.—To replace the "T" assembly proceed as follows:

(*a*) If attenuator piston O-107 has been removed, insert it into tube Y-106 of the "T" assembly.

CAUTION

Be certain the rack gear O-108 slips between the driving gear O-109 and loading spring H-114. This action is necessary to prevent unwanted backlash.

(*b*) Engage chuck O-110 and shaft O-111.

(*c*) Carefully insert the "T" assembly into the vertical hole at the tube end of the cavity Y-102.

(*d*) Secure the screw that holds the attenuator horizontal support shaft H-112 to the rear of the back plate A-101.

(*e*) Secure nut H-107.

CAUTION

Before two screws in chuck O-110 can be tightened, it will be necessary to replace the r-f assembly (refer to paragraph 10.*f.*, this section) and perform the output attenuator calibration described in paragraph 8.*c.*, this section.

h. POWER TAKE-OFF PROBE.

CAUTION

Do not dismantle the power take-off probe C-129, or the coupling line attached thereto. This particular assembly has been carefully matched and set at the factory, and should not require servicing. Inspection of the drive mechanism is possible after removal of the metal screw plug H-146. (See figure 7-7.) This mechanism cannot be serviced without special tools.

i. DISASSEMBLY AND REASSEMBLY OF DIALS AND GEARS. (*See figure* 7-5.)—To disassemble the frequency and attenuator dials with attendant gears, it is necessary first to remove the r-f assembly from the chassis proper. (Refer to paragraph 10.*f.*, this section.)

CAUTION

Removal of either dial assembly will necessitate recalibration of the instrument. Disassembly must not be attempted by activities which do not possess adequate calibration facilities and test equipment.

(1) REMOVAL OF SIGNAL FREQUENCY DIAL.—To remove the signal frequency dial N-101 and associated gears, proceed as follows:

(*a*) Crank the signal frequency worm shaft O-101 fully clockwise. It will be necessary to install the signal frequency knob E-151 temporarily in order to do this.

(*b*) Remove hub H-116 and associated washers H-150, H-173, and H-131.

(*c*) Withdraw dial assembly N-101.

Note

If worm shaft O-101 has been burred by the set screws in hub H-116, do not attempt to force N-101 off. Remove burrs with a small file sufficiently to permit easy withdrawal of N-101 dial assembly.

(*d*) Remove washers H-130 and H-172.

(*e*) Remove clip H-121 by first prying bump from its locating hole with a small screw driver and then withdrawing clip radially.

(*f*) Loosen the two recessed-head screws in hub H-120.

(*g*) Withdraw gear assemblies O-115 and O-119 simultaneously.

(2) REASSEMBLY OF SIGNAL FREQUENCY DIAL.—Reassembly of signal frequency dial N-101 and associated gears should be carried out after lubrication as outlined in table 4-1. Proceed as follows:

(*a*) Install the signal frequency knob E-151 temporarily and crank the signal frequency worm shaft fully clockwise.

(*b*) Wind up spring-loaded gears O-115 by two- to three teeth and mesh with pinion on gear assembly O-119.

CAUTION

Chuck H-120 must be so oriented when performing steps (*b*), (*c*), and (*d*) that the recessed-head screws are accessible for tightening.

(*c*) Wind up spring-loaded gears on gear assembly O-119 and mesh with spline on worm shaft O-101.

CAUTION

Do not install spring clip H-121 until called for in step (*g*) below.

(*d*) Slide shaft of gear assembly O-119 into hole provided in mounting plate A-101, and simultaneously slide chuck H-120 over shaft of potentiometer R-185.

(*e*) Locate wiper arm of R-185 in the fully counterclockwise position as viewed from the rear. Do not force wiper arm up over edge of metal clamping strip.

(*f*) Secure the two recessed-head screws in chuck H-120.

(*g*) Install clip H-121, being sure to seat the bump in its locating hole.

(*h*) Install washers H-130 and H-172.

(*i*) Slip dial face counterclockwise relative to the three studs at its center so that the studs are as far clockwise as possible in the slots in the dial face.

(*j*) With the 900 scale mark in a vertical position, slip signal frequency dial N-101 on shaft O-101, take up two to three teeth on split gears, and mesh with pinion of gear assembly O-119.

CAUTION

If for any reason, worm shaft O-101 has been burred so as to prevent N-101 from sliding freely into place, the burrs must be removed before attempting step (*j*). Do not force N-101 onto shaft O-101.

(*k*) Slip dial face clockwise until the three central studs are approximately centered in their slots.

(*l*) Install large flat washer H-131, followed by the two small washers H-173 and H-150.

(*m*) Slip hub H-116 onto worm shaft O-101 until it exerts noticeable pressure on the washer pile-up; then secure the two recessed-head screws.

(3) REMOVAL OF OUTPUT ATTENUATOR DIAL.—Remove attenuator dial N-102 and associated gears as follows:

(*a*) Crank the attenuator pinion shaft O-118 fully clockwise.

(*b*) Remove hub H-117 and associated washers H-129 and H-171.

(*c*) Withdraw dial N-102.

Note

If attenuator pinion shaft O-118 has been burred by the set screws in hub H-117, do not attempt to force N-102 off. Remove burrs with a small file sufficiently to permit easy withdrawal of N-102 dial.

(*d*) Remove washers H-128 and H-170.

(*e*) Gear assembly O-116 may be withdrawn after loosening the two recessed-head screws in chuck O-112 nearest the back plate, A-101. Washers H-151 and H-152 are now free and should be carefully laid aside to prevent loss.

(*f*) Attenuator pinion shaft O-118 may be removed by first loosening the two recessed-head screws in hub H-118 and withdrawing the shaft. This will free tumblers H-119A through H-119K, washers H-126 and H-167, hub H-118, and washers H-127, H-168, and H-169. These parts should be carefully laid aside to prevent loss.

(4) REASSEMBLY OF ATTENUATOR DIAL.—Reassemble attenuator dial N-102 and associated gears as follows:

(*a*) Install washers H-127, H-168, and H-169 on the long end of pinion shaft O-118, slip pinion shaft into its bushing in A-101, install tumblers H-119A through H-119K, install washers H-126 and H-167 with the convex sides toward the end of the shaft, and install hub H-118.

(*b*) Install washer H-151 on shaft of gear assembly O-116, take up two to three teeth on split gears O-116, and slip shaft into its bushing while meshing gears with pinion on O-118. Install washer H-152 on end of shaft O-116, protruding through its bushing. Shaft should engage chuck O-112. Secure the two recessed-head screws on chuck O-112 nearest the plate A-101.

(*c*) Install washers H-128 and H-170 on pinion shaft O-118, slip dial N-102 onto shaft, take up two to three teeth on split gears of dial, and mesh with solid gear of O-116 gear assembly.

Note

If, for any reason, pinion shaft O-118 has been burred so as to prevent N-102 from sliding freely into place, the burrs must be removed before attempting step (*c*). Do not force dial N-102 onto shaft O-118.

(*d*) Install curved washers H-129 and H-171 with their convex sides together.

(*e*) Install hub H-117 with sufficient end pressure to compress curved washers H-129 and H-171. Secure the two recessed-head screws.

(*f*) Set the stop mechanism on the attenuator dial as follows:

1. Temporarily loosen recessed-head screws in hub H-118.

2. Turn shaft O-118 until the −3 dbm scale line on the dial N-102 is exactly vertical.

3. Turn hub H-118 counterclockwise as viewed from the rear until tumblers offer a positive stop.

4. Shaft O-118 should rest firmly against its bushing, hub H-118 should be pushed up so as to compress spring washers H-126A and H-126B, and shaft O-118 may then be secured by means of the two recessed-head screws.

j. DISASSEMBLY AND REASSEMBLY OF CAVITY ASSEMBLY. *(See figure 7-7.)*

CAUTION

Do not attempt to disassemble the cavity proper without proper maintenance facilities. Although the parts can withstand normal handling, careful attention to alignment is required in reassembly.

(1) GENERAL.—Disassembly of the cavity may become necessary if pulsed or cw operation of Signal Generator TS-419/U becomes erratic as the SIGNAL FREQUENCY control is tuned. Trouble of this nature usually occurs near the high-frequency end of the tuning range, and is manifested primarily by erratic pulsing when performing the tests described in paragraph 7.*e*. of this section. Such trouble is usually due to a weak oscillator tube V-111; rotation or replacement of this tube (paragraph 6.*c*. of this section) should be tried prior to more serious measures. If tube replacement does not clear the trouble, it may be necessary to disassemble the cavity in order to clean dirty or corroded parts.

Note

On all components manufactured under Contracts NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748, N383s-77651, and in the TS-419A/U (Contracts N383s-16939A, N383-31275A, and N383-46093A), all cavity parts are silver plated. In equipments of Contracts N383s-5019A, N383s-45741, and N383s-67816, parts E-101A, Y-101A/B, and Y-102 are gold plated. (Gold-plated parts are highly resistant to corrosion and require no protective lacquer.)

(2) DISASSEMBLY OF CAVITY ASSEMBLY.—It is possible to partially disassemble the cavity after the r-f assembly has been removed from the chassis (paragraph 10.*f*. of this section) without removing the dials or gears. Such partial disassembly will permit most cleaning operations to be performed. Proceed as follows:

(*a*) Remove tube V-111 and socket assembly H-106 as described in paragraph 6.*c*. of this section.

(*b*) Turn power set shaft O-131 fully counterclockwise.

(*c*) Remove "T" assembly as described in paragraph 10.*g*.(2) of this section.

(*d*) Unscrew nut H-101 and remove filter Z-104.

(*e*) Remove screws H-102, H-103, H-104, H-162, H-163, and H-164 from the cavity barrel.

(*f*) Withdraw cavity barrel Y-102 from the remainder of the assembly.

CAUTION

Exercise extreme care in handling the exposed parts of the cavity since contact fingers may easily be bent.

(3) INSPECTION OF CAVITY ASSEMBLY.—Inspect the cavity assembly as follows:

(*a*) The inside of barrel Y-102 should show at least one longitudinal mark for each finger on contact ring E-101. Each mark should extend for a distance corresponding to the full travel of E-101. Marks may be slightly irregularly spaced, but none should be missing. If any mark is missing, the associated finger of E-101 should be bent out slightly. Do not bend any finger to produce a permanent set in excess of 0.010 inch. (Refer to paragraph 10.*j*.(4)(*c*) of this section.)

(*b*) Make sure there are no small glass chips inside barrel Y-102.

(*c*) If there are any deep pits or scars inside Y-102, or if it has been bent or dented by accident, it should be replaced.

(*d*) Examine worm shaft O-101 and worm bearing O-102 for looseness. If maintenance beyond cleaning and relubrication is required, complete cavity disassembly is necessary. Clean and lubricate worm O-101, worm bearing O-102, and ball bearings.

(4) CLEANING CAVITY ASSEMBLY.—To clean the cavity assembly detail parts, proceed as follows:

(*a*) The inside of barrel Y-102 should be thoroughly wiped with a *clean* cloth soaked in acetone. Pay particular attention to area between aperture mounting filter Z-104 and contact fingers E-103. Coat inside of barrel *very lightly* with Eclipse Pioneer PO-10 oil (AN Specification AN-O-11).

CAUTION

Avoid contact of cleaning solvents with outside silver surfaces of cavity as these have been lacquered to protect the silver plating from corrosion. (Refer to note of paragraph 10.*j.*(1), this section.)

(*b*) Conductor Y-101A and contact ring Y-101B should be cleaned using a cloth soaked in acetone. If any gum or residue persists, it should be removed by gentle use of crocus cloth. Blow any residue free with a stream of compressed air.

CAUTION

Use crocus cloth with extreme care as this is a cleaning operation only. The plating must not be removed.

(*c*) The outer ring of contact fingers of E-101A may be cleaned with crocus cloth until bright. Do not apply excessive pressure which might deform these delicate fingers. The outside diameter should be 1.530 $\pm$0.010 inches, and should be concentric with conductor Y-101A to within 0.005 inch.

(5) REMOVAL AND REPLACEMENT OF Y-101.—Removal of conductor Y-101 is required if conductor E-102 requires attention or if the inner fingers of E-101 are to be cleaned. These operations are rarely required, and Y-101 should not normally be removed unless either it or conductor E-102 requires replacement due to mechanical damage. If required, proceed as follows:

(*a*) Unscrew the three small screws going radially into support block O-104, and withdraw Y-101 carefully.

(*b*) The inside fingers of contact ring E-101 should be cleaned with crocus cloth until bright. Do not apply excessive pressure which might deform these delicate fingers. Blow any dust free with compressed air.

(*c*) To replace Y-101, insert conductor assembly E-102 in Y-101, and push Y-101 through the inner fingers of contacting ring E-101 into place in support block O-104. Y-101 must be so positioned that the three tapped holes in it line up with those in support block O-104. Orient the assembly so that Y-101 assumes a vertical position with finger Y-101B at the top. This permits E-102 to drop into its proper position. Start the three radial screws through support block O-104 into Y-101.

CAUTION

It is essential that Y-101 be held firmly and squarely seated in O-104 in order to maintain the required alignment while the retaining screws are tightened. When the screws are tight, they should be sealed with enamel. Conductor E-102 should have radial float and endwise play of at least 1/64 inch when properly installed.

(6) REASSEMBLY OF Y-102.—To reassemble barrel Y-102 to cavity, proceed as follows:

(*a*) Start barrel over contact ring fingers E-101. This may be facilitated somewhat by cocking the barrel slightly, starting fingers on one side first, and gradually working the others in, gently compressing the last few with the fingers of one hand if necessary.

(*b*) Slide barrel down into place, depressing the fingers of E-101 as they pass the hole in which filter Z-104 seats. Barrel should be slid until stopped by mounting plate A-101.

CAUTION

Do not under any circumstances force barrel Y-102 past any apparent obstruction. If more than gentle pressure is applied, serious damage to the cavity may result.

(*c*) Orient barrel so that hole for filter Z-104 lines up with hole in support block O-104. Replace filter Z-104 as described in paragraph 10.*c.*(4), this section.

(*d*) Slip stem of "T" assembly into its aperture in barrel Y-102, and secure nut H-107.

(*e*) Install and secure the three screws H-102, H-103, and H-104.

(*f*) Install and secure the three screws H-162, H-163, and H-164.

(7) REMOVAL OF CAVITY ASSEMBLY.—Remove cavity assembly A-106 from r-f assembly A-105 as follows:

(*a*) Remove r-f assembly A-105 from chassis as described in paragraph 10.*f.*(1) of this section.

(*b*) Remove "T" assembly A-107 from r-f assembly A-105 as described in paragraph 10.*g.*(2) of this section.

(*c*) Remove frequency dial N-101 and associated gears from r-f assembly A-105 as described in paragraph 10.*i.*(1) of this section.

(*d*) Remove three flat-head screws retaining cavity assembly A-106 to mounting plate A-101.

(8) REPLACEMENT OF CAVITY ASSEMBLY.—Replace cavity assembly A-106 in r-f assembly A-105 as follows:

(*a*) Put cavity assembly A-106 in place against mounting plate A-101, and secure with three flat-head screws.

(*b*) Replace frequency dial N-101 and associated gears as described in paragraph 10.*i*.(2) of this section.

(*c*) Replace "T" assembly A-107 as described in paragraph 10.*g*.(3) of this section.

(9) COMPLETE DISASSEMBLY OF CAVITY ASSEMBLY.—Complete disassembly of the cavity assembly A-106 is a major operation which should be attempted only if worm shaft O-101 or its bearings have been so damaged as to require maintenance. Disassembly of the tuning mechanism is not recommended since extreme care is required in reassembly to secure satisfactory operation with a minimum of backlash and yet without binding. Certain special shim washers have been added during original assembly by the manufacturer to obtain the required performance. Relative positions and tightness of all parts must be maintained. If disassembly is attempted, mark all parts to insure that they are replaced in *exactly* their original orientation and position. Complete disassembly is possible only after removal of cavity assembly A-106 from r-f assembly A-105 as described in paragraph 10.*j*.(7) of this section.

10A. REMOVAL AND REPLACEMENT OF SELECTOR SWITCH S-101.

Note

Maintenance personnel are cautioned against unnecessary removal of the selector switch S-101. Before removal, check the possibility of defective wire lead connections by making a direct continuity check of all wiring, using Multimeter TS-352/U. It should also be noted that replacement switches supplied under Contracts N383s-60879 and N383s-61060 are furnished with all leads pre-cut and soldered to the switch, while those under Contracts N383s-5019A, NOa(s)-9748, NOa(s)-12279, N383s-45741, N383s-67816 and in the TS-419A/U equipments are supplied without wiring. Under Contracts N383s-75748 and N383s-77651 they may be furnished either way. Follow removal and replacement procedures carefully.

a. REMOVAL OF SELECTOR SWITCH S-101.—To remove the selector switch S-101, proceed as follows:

(1) Remove the switch cover, which is held in place by a front and rear detent, by pulling it up, and remove the insulating cover which is over the switch.

(2) All wires leading to the switch through the holes lettered D, E, F, and G on wiring diagrams, figures 7-2, 7-2A, 7-2B, 7-2C, 7-2D, 7-3. 7-3A, 7-3B, 7-3C, must be unsoldered at their terminal points on the underside of the chassis.

(3) Loosen the two set screws in the shaft coupling behind the front panel, and pull the knob and shaft forward.

(4) Loosen the switch lock nut and remove it and the associated lock washers.

(5) To remove the switch, lift the front ends of the switch up and forward.

b. REPLACEMENT OF SELECTOR SWITCH S-101.—To replace the selector switch S-101, proceed as follows:

(1) If the replacement switch is unwired (refer to preceding note), see figure 7-3, 7-3A, 7-3B or 7-3C, (refer to note which follows), and prewire the switch, using the switch which is being replaced as a model from which lead lengths and wire dressing are copied. Leads must be dressed into four groups corresponding to the holes through which they pass to the underside of the chassis.

Note

In equipments of Contract NOa(s)-9748 (and also N383s-60879, N383s-61060, N383s-75748, and N383s-77651), and in the TS-419A/U, a four-wire group was brought through hole "G" (see figures 7-3, 7-3B and 7-3C). In equipments of Contracts N383s-5019A, N383s-45741, and N383s-67816, a three-wire group was used (see figure 7-3A). These changes involved the "L. GREEN" and "D. BLUE" wires. The contract number of the equipment under repair should be checked and the corresponding wiring diagram used.

(2) If a pre-wired switch is being used for replacement (refer to preceding note), notice that the four-wire groups are individually marked with an alphabetic tag, except on Contracts N383s-75748 and N383s-77651. The letters used correspond to the holes marked and shown on figure 7-3.

(3) Feed the proper wire group through its corresponding chassis hole (see figure 7-3) and set the switch into position on its mount by dropping the rear end in first and then the shaft end.

(4) Resolder the leads to the appropriate points on the underside of the chassis in accordance with the appropriate wiring diagram, figure 7-2, 7-2A, 7-2B, 7-2C, or 7-2D, depending on the contract number of the equipment.

(5) Secure the switch by replacing the lock washers and tightening the lock nut on the shaft.

(6) Insert the selector switch knob and shaft through the front panel hole until the coupling engages the switch shaft. Tighten the two set screws in the coupling.

(7) Place the insulating cover over the switch, and replace the aluminum switch cover, pressing down lightly until the detents are engaged.

(8) Check the operation of the selector switch by following any one of the operating procedures described in paragraph 6. of Section II.

11. VOLTAGE MEASUREMENTS.

Nominal voltage values obtained at tube socket terminals of Signal Generator TS-419/U, under the conditions noted, will be found in table 4-5.

WARNING

When measuring voltages on V-111, V-112, V-113, V-117, V-118, V-119, or V-120 observe all safety regulations. These vacuum tubes have applied potentials which are dangerous and may be fatal if contacted.

TABLE 4-5. VOLTAGE MEASUREMENTS

NOTES:
1. All voltage measurements made with SELECTOR SWITCH in NEG SYNC position.
2. All voltages dc, unless otherwise indicated, tolerance ±10%, and are effective for all equipments unless otherwise specified. (Refer to Note 7.)
3. All measurements made with respect to −325 volt supply line (any red lead), unless followed by asterisk (*); such annotated values are measured with respect to chassis.
4. Multimeter TS-352/U used for 20,000 ohms-per-volt measurements. Alternates: Simpson Model 260, Navy Model OE, or Weston Model 790.
5. Multimeter TS-297/U used for 1000 ohms-per-volt measurements. Alternates: Simpson Model 443 or Weston Model 663.
6. Nominal primary power input, measured with Voltmeter IS-185, 115 volts, 50 to 1600 cps, single phase.
7. Voltage value in parentheses applies to equipments of Contracts N383s-5019A, N383s-45741, and N383s-67816; other value is for equipments of Contracts NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748, and N383s-77651, and the TS-419A/U equipments.

Test Point		*20,000 Ohms-per-Volt Meter*		*1000 Ohms-per-Volt Meter*	
Reference Symbol	*Terminal Number*	*Meter Scale*	*Voltage*	*Meter Scale*	*Voltage*
V-101 (JAN-7F8W)	1	1000	80	——	——
	2	10	6.3 AC	10	6.3 AC
	3	250	—80*	1000	—80*
	4	250	80	1000	80
	5	1000	280	1000	280
	6	250	0*	250	0*
	7	250	0	250	0
	8	1000	275	——	——
V-102 (JAN-7F8W)	1	1000	100	1000	100
	2	10	6.3 AC	10	6.3 AC
	3	250	−185*	1000	−185*
	4	250	100	1000	100
	5	250	100	1000	100
	6	250	0*	250	0*
	7	250	0	250	0
	8	250	85	1000	80
V-103 (JAN-7F8W)	1	250	0*	250	0*
	2	10	6.3* AC	10	6.3* AC
	3	250	0*	250	0*

TABLE 4-5. VOLTAGE MEASUREMENTS (Cont.)

Test Point		*20,000 Ohms-per-Volt Meter*		*1000 Ohms-per-Volt Meter*	
Reference Symbol	*Terminal Number*	*Meter Scale*	*Voltage*	*Meter Scale*	*Voltage*
V-103 (JAN-7F8W) (Cont.)	4	250	0*	250	0*
	5	250	0*	250	0*
	6	250	0*	250	0*
	7	250	0*	250	0*
	8	250	0*	250	0*
V-104 (JAN-7F8W)	1	50	19	——	——
	2	10	6.3 AC	10	6.3 AC
	3	250	−170* (−145*) (Note 7)	250	−170* (−145*) (Note 7)
	4	50	17 (19) (Note 7)	100	17 (19) (Note 7)
	5	50	17 (19) (Note 7)	100	17 (19) (Note 7)
	6	250	0*	250	0*
	7	250	0	250	0
	8	250	0	250	0
V-105 (JAN-6V6GTY)	1	——	——	——	——
	2	10	6.3 AC	10	6.3 AC
	3	250	0*	250	0*
	4	250	0*	250	0*
	5	250	0	250	0
	6	——	——	——	——
	7	250	0	250	0
	8	250	50	250	50
V-106 (JAN-6V6GTY)	1	——	——	——	——
	2	10	6.3 AC	10	6.3 AC
	3	250	0*	250	0*
	4	250	0* (58) (Note 7)	250	0* (58) (Note 7)
	5	1000	−60 (−21) (Note 7)	——	−45 (−19) (Note 7)
	6	—— (250)	—— (58) (Note 7)	—— (250)	—— (58) (Note 7)
	7	250	0	250	0
	8	250	0	250	0
V-107 (JAN-6V6GTY)	1	——	——	——	——
	2	10	6.3 AC	10	6.3 AC
	3	250	−100*	250	−100*
	4	250	90	250	85
	5	250	0	250	0
	6	250	90	250	85
	7	250	0	250	0
	8	250	0	250	0

TABLE 4-5. VOLTAGE MEASUREMENTS (Cont.)

Test Point		*20,000 Ohms-per-Volt Meter*		*1000 Ohms-per-Volt Meter*	
Reference Symbol	*Terminal Number*	*Meter Scale*	*Voltage*	*Meter Scale*	*Voltage*
V-108	1	——	——	——	——
(JAN-6V6GTY)	2	10	6.3 AC	10	6.3 AC
	3	250	0*	250	0*
	4	250	0*	250	0*
	5	1000	−60	1000	−50
	6	——	——	——	——
	7	250	0	250	0
	8	250	0	250	0
V-109	1	——	——	——	——
(JAN-6V6GTY)	2	10	6.3 AC	10	6.3 AC
	3	250	0*	250	0*
	4	250	0*	250	0*
	5	250	0	250	0
	6	250	0	250	0
	7	250	0	250	0
	8	50	37.5	50	36
V-110	1	1000	−300	1000	−300
(JAN-7F8W)	2	10	6.3 AC	10	6.3 AC
	3	1000	−300	1000	−300
	4	250	0	250	0
	5	250	0	250	0
	6	1000	−300	1000	−300
	7	250	0	250	0
	8	1000	−300	1000	−300
V-111	1	1000	−300	1000	−300
(JAN-6BM6A)	2	250	0	250	0
	3	250	0	250	0
	4	10	6.3 AC	10	6.3 AC
V-112	1	——	——	——	——
(JAN-5R4GY	2	10	5.0 AC (to term No. 8)	10	5.0 AC (to term No. 8)
or	3	——	——	——	——
MIL-5R4WGA)	4	1000	680 AC	1000	680 AC
	5	——	——	——	——
	6	1000	680 AC	1000	680 AC
	7	——	——	——	——
	8	1000	240*	1000	240*

TABLE 4-5. VOLTAGE MEASUREMENTS (Cont.)

Test Point		*20,000 Ohms-per-Volt Meter*		*1000 Ohms-per-Volt Meter*	
Reference Symbol	*Terminal Number*	*Meter Scale*	*Voltage*	*Meter Scale*	*Voltage*
V-113	1	——	——	——	——
(JAN-5R4GY	2	10	5.0 AC (to term No. 8)	10	5.0 AC (to term No. 8)
or					
MIL-5R4WGA)	3	——	——	——	——
	4	1000	—925	1000	—925
	5	——	——	——	——
	6	1000	—925	1000	—925
	7	——	——	——	——
	8	1000	680 AC	1000	680 AC
V-114	1	——	——	——	——
(JAN-6V6GTY)	2	10	6.3* AC	10	6.3* AC
	3	1000	225*	1000	225*
	4	1000	225*	1000	225*
	5	50	—15*	100	—14.5*
	6	50	—15*	100	—14.5*
	7	250	0*	250	0*
	8	250	0*	250	0*
V-115	1	——	——	——	——
(JAN-6V6GTY)	2	10	6.3* AC	10	6.3* AC
	3	1000	225*	1000	225*
	4	1000	225*	1000	225*
	5	50	—15*	100	—14.5*
	6	50	—15*	100	—14.5*
	7	250	0*	250	0*
	8	250	0*	250	0*
V-116	1	——	——	——	——
(JAN-6V6GTY)	2	10	6.3* AC	10	6.3* AC
	3	1000	225*	1000	225*
	4	1000	225*	1000	225*
	5	50	—15*	100	—14.5*
	6	50	—15*	100	—14.5*
	7	250	0*	250	0*
	8	250	0*	250	0*
V-117	1	1000	—450	1000	—450
(JAN-0A2	2	1000	—600	1000	—600
or	3	——	——	——	——
MIL-0A2WA)	4	1000	—600	1000	—600

TABLE 4-5. VOLTAGE MEASUREMENTS (Cont.)

Test Point		*20,000 Ohms-per-Volt Meter*		*1000 Ohms-per-Volt Meter*	
Reference Symbol	*Terminal Number*	*Meter Scale*	*Voltage*	*Meter Scale*	*Voltage*
V-117 (JAN-0A2) (Cont.)	5	1000	−450	1000	−450
	6	——	——	——	——
	7	1000	−600	1000	−600
V-118 (JAN-0A2 or MIL-0A2WA)	1	1000	−300	1000	−300
	2	1000	−450	1000	−450
	3	——	——	——	——
	4	1000	−450	1000	−450
	5	1000	−300	1000	−300
	6	——	——	——	——
	7	1000	−450	1000	−450
V-119 (JAN-0A2 or MIL-0A2WA)	1	1000	−150	1000	−150
	2	1000	−300	1000	−300
	3	——	——	——	——
	4	1000	−300	1000	−300
	5	1000	−150	1000	−150
	6	——	——	——	——
	7	1000	−300	1000	−300
V-120 (JAN-0A2 or MIL-0A2WA)	1	1000	0	1000	0
	2	1000	−150	1000	−150
	3	——	——	——	——
	4	1000	−150	1000	−150
	5	1000	0	1000	0
	6	——	——	——	——
	7	1000	−150	1000	−150
V-121 (JAN-7F8W)	1	250	155	1000	155
	2	10	6.3 AC	10	6.3 AC
	3	50	−15*	100	−14*
	4	1000	170	1000	170
	5	250	0	250	0
	6	1000	170	1000	170
	7	250	0	250	0
	8	50	−4.5	1000	0
V-122 (JAN-0A2 or MIL-0A2WA)	1	250	0*	250	0*
	2	250	−150*	250	−150*
	3	——	——	——	——
	4	250	−150*	250	−150*
	5	250	0*	250	0*
	6	——	——	——	——
	7	250	−150*	250	−150*

12. RESISTANCE MEASUREMENTS.

Nominal resistance measurements made at tube socket terminals of Signal Generator TS-419/U, under the conditions noted, will be found in table 4-6.

13. COIL WINDING DATA.

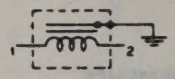
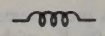
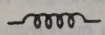
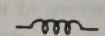
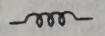
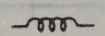
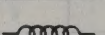
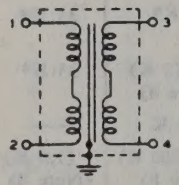
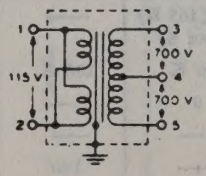
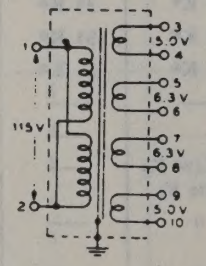
Coil winding data, including resistance values where applicable, are listed in table 4-7. These data will be found useful in testing the coils and transformers used in Signal Generator TS-419/U.

TABLE 4-6. RESISTANCE MEASUREMENTS

NOTES:
1. All resistance measurements made with SELECTOR SWITCH in NEG SYNC position.
2. All resistance values in ohms unless followed by "K"—kilohm (1000 ohms) or "Meg"—megohm (1,000,000 ohms), tolerance ±10%. These values are effective for all equipments unless otherwise specified. (Refer to Note 8.)
3. All measurements made with respect to −325 volt supply line (any red lead), unless followed by asterisk (*); such annotated values are measured with respect to chassis.
4. This measurement varies from 3.0 K to 1 Meg, with respect to −325 volt supply line (any red lead), depending on the setting of the PULSE DELAY control.
5. This measurement varies from approximately 1 K to 100 K, with respect to chassis, depending on the setting of the PULSE WIDTH control.
6. This measurement varies from approximately 100 K to 250 K, with respect to chassis, depending on the setting of the SIGNAL FREQUENCY control.
7. Multimeter TS-352/U used for all resistance measurements. Alternates Simpson Model 260, Navy Model OE, or Weston Model 790.
8. Resistance value in parentheses applies to equipments of Contracts N383s-5019A, N383s-45741, and N383s-67816; other value is for equipments of Contracts NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-75748, and N383s-77651 and the TS-419A/U equipments.

Reference Symbol	*Terminal Number*							
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
V-101	1 Meg	0	10 K*	10 K	47 K*	100 K*	0	1.1 Meg
V-102	200 K*	0	33 K*	14 K	14 K	100 K*	0	54 K
V-103	15 K*(33 K*) (Note 8)	0	15 K*(33 K*) (Note 8)	0*	15 K*	33 K*	0*	33 K*
V-104	Note 4	0	15 K*	1.5 K(2 K) (Note 8)	1.5 K(2 K) (Note 8)	33 K*	0	0
V-105	——	0	0*	47*	100 K	——	0	19 K
V-106	——	0	15 K*	47*(1.5 K) (Note 8)	350 K(200 K) (Note 8)	−(1.5 K) (Note 8)	0	0
V-107	——	0	3 K*	150 K*	Note 5	150 K*	0	0
V-108	——	0	5*	47*	220 K(165 K) (Note 8)	——	0	0
V-109	——	0	0*	47*	100 K	100 K	0	22 K
V-110	——	0	——	0	0	——	0	——
V-111	——	0	0	0	——	——	——	——
V-112	——	——	——	120	——	140	——	——
V-113	——	140	——	Note 6	——	Note 6	——	140
V-114	——	0*	——	——	33 K*	33 K*	0*	0*
V-115	——	0*	——	——	33 K*	33 K*	0*	0*
V-116	——	0*	——	——	33 K*	33 K*	0*	0*
V-117	——	Note 6	——	Note 6	——	——	Note 6	——
V-118	——	——	——	——	——	——	——	——
V-119	130 K(80 K) (Note 8)	——	——	——	130 K(80 K) (Note 8)	——	——	——
V-120	0	130 K(80 K) (Note 8)	——	130 K(80 K) (Note 8)	0	——	130 K(80 K) (Note 8)	——
V-121	110 K*	0	33 K*	——	0	——	0	1.15 Meg*
V-122	0*	4.5 K	——	4.5 K	0*	——	4.5 K	——

TABLE 4-7. COIL WINDING DATA

Symbol Designation	Aircraft Radio Corp Part Number	Diagram	Winding	Wire Size	Turns	Resistance in Ohms: Pin	Resistance in Ohms: At 20° C (68° F)	AC Test Volts RMS	Remarks
L-101	13965		Single	30E	2,856		105-140	1,500	6.0 h at 125 ma d-c with 100 v a-c across coil
L-102	14529		Single	38SSE	1,000		100		10.9 mh ± 5%
L-103	14527		Single	38SSE	150		11		0.205 mh ± 5%
L-104	14528		Single	38SSE	300		24		0.843 mh ± 5%
L-105	13707		Single	——	1		——		Thermistor pick-up loop; part of O-106 ARC-13826
L-106*	14140		Single	28E	13		0.03		0.25 mh
L-107*	14140		Single	28E	13		0.03		0.25 mh
L-108*	14140		Single	28E	13		0.03		0.25 mh
T-101	13791		Pri. Sec.	33 38	160 280	1-2 3-4	4.6 ± 15% 25.4 ± 15%	1,500	Pulse transformer
T-102	13647		Pri. Sec. #1 Sec. #2	23E 29E 29E	310/310 1,887 1,887	1-2 3-4 4-5	1.86-2.34 88.6-111.1 102.6-128.7	1,200 3,000 3,000	Frequency: 50 to 1,600 cps Output: 94 va Secondary current: 135 ma
T-103	13671		Pri. Sec. #1 Sec. #2 Sec. #3 Sec. #4	24E 20E 19E 13E 20E	413/413 19/19 24/24 24 19/19	1-2 3-4 5-6 7-8 9-10	2.75-3.45 0.051-0.063 0.054-0.067 0.031-0.038 0.061-0.076	1,200 2,000 1,500 2,500 3,000	Frequency: 50 to 1,600 cps Output: 70 va Current Sec. #1 2.0 amp Sec. #2 2.4 amp Sec. #3 5.5 amp Sec. #4 2.0 amp

* L-106, L-107, and L-108 not used in Contract N383s-5019A.

SECTION V

SUPPLEMENTARY DATA

Note

Throughout this handbook, all references to Signal Generator TS-419/U also apply to Signal Generator TS-419A/U, except where specifically noted.

1. FUNCTIONAL TUBE AND LAMP COMPLEMENT.

The types, descriptions, and functions of the electron tubes and indicator lamps for Signal Generator TS-419/U are listed in table 5-1.

TABLE 5-1. FUNCTIONAL TUBE AND LAMP COMPLEMENT FOR SIGNAL GENERATOR TS-419/U

Reference Symbol	*Type*	*Description*	*Function*
I-101			Space heater indicator
I-102	GE No. 47	Incandescent lamp	Plate and filament power indicator
V-101			Input amplifier
V-102			Rate multivibrator
V-103	7F8W†	Twin triode	Clipper
V-104			Delay multivibrator
V-105			Cathode follower
V-106			Width multivibrator
V-107	6V6GTY	Beam tetrode	Width multivibrator
V-108			Pulse amplifier
V-109			Cathode follower
V-110	7F8W†	Twin triode	Clipper
V-111	6BM6A*	Reflex klystron	R-f oscillator
V-112	5R4GY	Double diode	Rectifier
V-113	or 5R4WGA		Rectifier
V-114			Series losser
V-115	6V6GTY	Beam tetrode	Series losser
V-116			Series losser
V-117			Voltage regulator
V-118	0A2 or	Voltage regulator	Voltage regulator
V-119	0A2WA		Voltage regulator
V-120			Voltage regulator
V-121	7F8W†	Twin triode	Regulator control amplifier
V-122	0A2 or 0A2WA	Voltage regulator	Voltage regulator

* Refer to Note, Section IV, paragraph 6.c.
† Type 7F8 used previously. For replacement use Type 7F8W.

2. TECHNICAL SUMMARY.

a. The following information is a technical summary of the electrical and mechanical characteristics of Signal Generator TS-419/U.

(1) FREQUENCY RANGE.—900 to 2100 mc/sec in one band; single-dial control directly calibrated to ±1 per cent.

(2) FREQUENCY STABILITY.—Warm-up drift less than 0.2 per cent; ambient drift less than 0.005 per cent per °C.

(3) POWER OUTPUT.—Zero dbm to −120 dbm continuously adjustable by a directly calibrated control accurate to ±2 dbm. Power is monitored by a temperature-compensated thermistor bridge operating a panel meter.

(4) OUTPUT IMPEDANCE.—Fifty ohms with maximum voltage standing-wave ratio (VSWR) of 2:1; BNC-type connector.

(5) TYPES OF EMISSION.—CW or pulse amplitude modulated. No provision is made for frequency modulation or for square wave modulation.

(6) SPURIOUS MODULATION.—In cw condition, FM is approximately ±0.01 per cent; AM is less than 0.5 per cent.

(7) R-F PULSE SHAPE.

(*a*) Rise time: less than 0.5 microsecond.

(*b*) Decay time: less than 0.9 microsecond.

(*c*) Flatness: within 10 per cent of amplitude of initial rise.

(8) MODULATION.

(*a*) By external pulses, positive or negative, of peak amplitude 40 to 70 volts, width 0.5 to 10 microseconds, and rate 40 to 4000 pulses per second.

(*b*) By internal pulse generator giving control of

width from 0.5 to 10 microseconds, of delay from 3 to 300 microseconds (but not exceeding 75 per cent of pulse period), and of rate from 40 to 4000 pulses per second.

(*c*) By synchronization to an external pulse generator giving positive or negative pulses of amplitude 10 to 50 volts peak, width 0.5 to 20 microseconds, and rate 40 to 4000 pulses per second. Control of delay and width is as described in (*b*) above.

(*d*) By synchronization to any external sine wave generator giving amplitudes of 10 to 50 volts rms and of frequency between 40 and 4000 cycles per second. Control of delay and width is as described in (*b*) above.

(9) PULSE CONTROLS.

(*a*) PULSE WIDTH—calibrated 0.5 to 10 microseconds ±25 per cent +0.5 microsecond.

(*b*) PULSE DELAY—calibrated 3 to 300 microseconds ±25 per cent.

(*c*) PULSE RATE—calibrated 40 to 4000 pulses per second ±30 per cent.

(10) SYNC OUTPUTS.

(*a*) Undelayed, occurs within 1.5 microseconds of leading edge of sync input or of internally generated rate pulse.

Amplitude: 20 to 50 volts when working into load of greater than 500 ohms shunted by less than 1500 micromicrofarads (mmf).

Rise time: 1.2 microseconds.

Width: 1 to 4 microseconds depending on setting of pulse delay control. (This output is not available when modulating by external pulses.)

(*b*) Delayed, occurs within 1 microsecond of leading edge of r-f pulse.

Amplitude: 20 to 50 volts when working into load of greater than 500 ohms shunted by less than 1500 mmf. Rise time: less than 0.5 microsecond. Width: 1 to 3 microseconds depending on setting of PULSE WIDTH control.

(11) POWER REQUIREMENT.—115 v ± 10 per cent, 50 to 1600 cycles, single phase, 250 watts.

(12) SIZE.—17⅜ inches wide, 10½ inches high, 12 inches deep.

(13) WEIGHT.—43 pounds (less Transit Case).

(14) TUBE COMPLEMENT.—Refer to table 5-1.

3. SIGNAL GENERATOR CONSIDERATIONS.

a. It should be noted that the OUTPUT ATTENUATOR of Signal Generator TS-419 U is calibrated to indicate r-f power delivered at the front panel RF OUTPUT connector, when this connector is terminated by a 50-ohm resistive load. There is some frequency effect in the power monitoring system and this may contribute an inaccuracy up to ±1 db to the knowledge of the output power actually delivered to a resistive load. Over the range of service operating conditions and the life of the instrument, additional errors may be expected so that in general the output power actually delivered to a resistive load is known to within ±2 db. Additional errors in output power measurement may be introduced by mismatched loads or failure to take cable losses into account.

b. The internal impedance of the Signal Generator TS-419/U has been maintained sufficiently close to 50 ohms so that the VSWR, looking into the instrument through the RF OUTPUT connector, is in the worst case less than 2:1 (6 db). For a generator which is a perfect match to the transmission line, any mismatch of the load to the line will result in reduced power transferred to the load. Since the signal generator is not perfectly matched to the line, a mismatch between the load and the nominal 50-ohm resistive impedance of Signal Generator TS-419/U may cause either an increase or a decrease in power delivered to the mismatched load, as compared to that which would be delivered to a 50-ohm resistive load. The loss due to mismatched loads for a perfect signal generator and the range of loss for the maximum allowable VSWR on the actual signal generator are shown in figure 5-1.

c. Power losses in the r-f cable to the load vary with frequency and the length of the cable. These losses are small and are not important in comparative measurements, but must be taken into account for absolute measurements. The data listed in table 5-2 show the approximate attenuation in a six-foot length of RG-55 U or RG-58 U cable for the frequency range from 900 to 2100 mc sec.

TABLE 5-2. CABLE ATTENUATION

Frequency (mc/sec)	*Attenuation (db/6 ft)*
900	0.94
1000	1.00
1100	1.06
1200	1.13
1300	1.19
1400	1.24
1500	1.29
1600	1.34
1700	1.40
1800	1.45
1900	1.50
2000	1.55
2100	1.61

d. Another factor that contributes to losses is improper assembly of coaxial connectors, or deterioration of contacts within the connectors. A standing-wave ratio of several decibels, with attendant error, can often be attributed to this cause. Instructions for attaching a UG-88/U connector to RG-55/U or RG-58/U cable are given and shown in figure 7-9.

4. INTERIOR ILLUSTRATIONS.

Illustrations of the interior (figures 5-2, 5-3, 5-3A 5-3B, 5-3C and 5-3D) of Signal Generator TS-419/U (and TS-419A/U) show the physical location of those replaceable parts discussed in the test and listed in the Table of Replaceable Parts, Table 6-4.

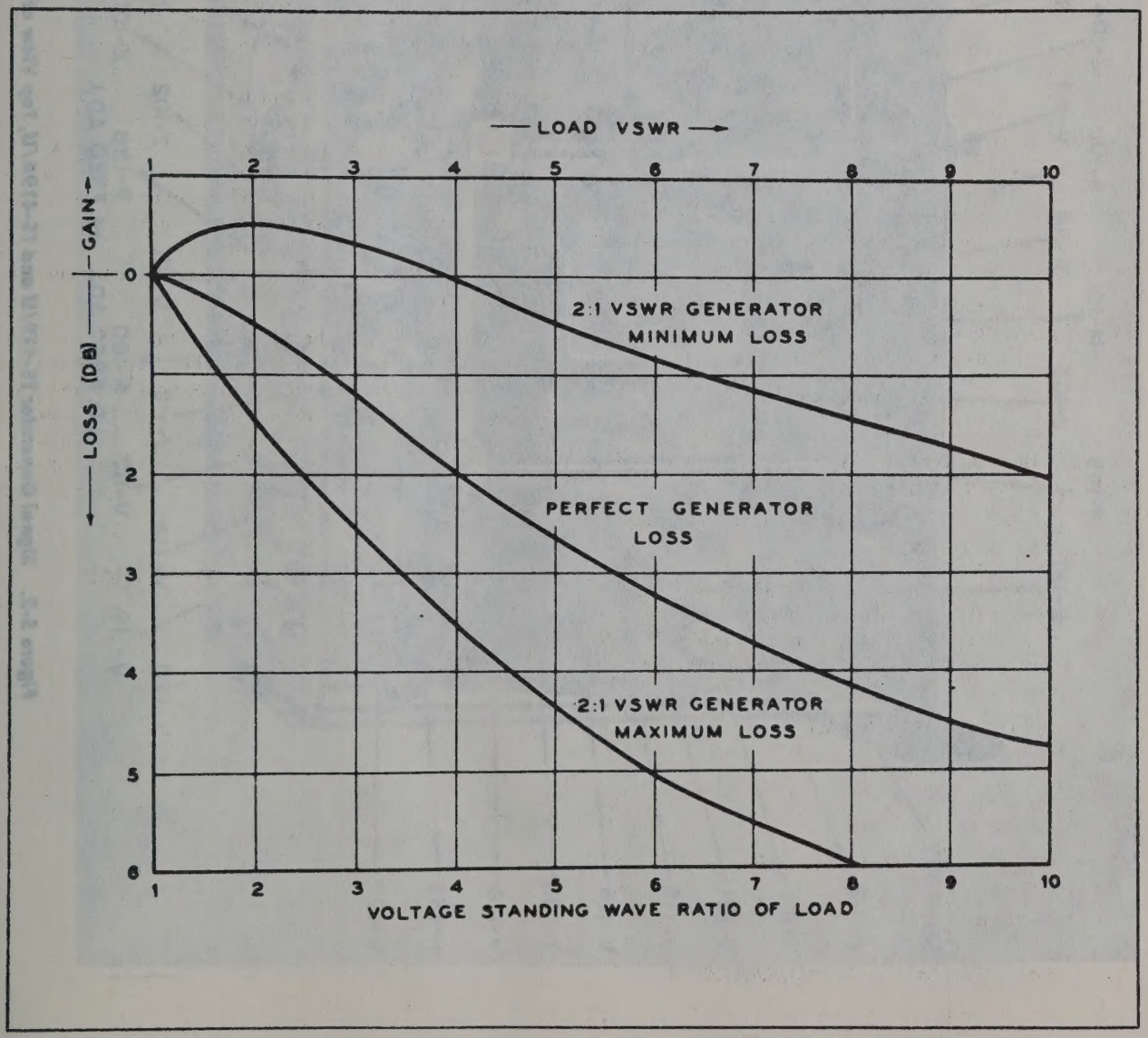


Figure 5-1. Power Loss Versus Load, Voltage Standing-wave Ratio

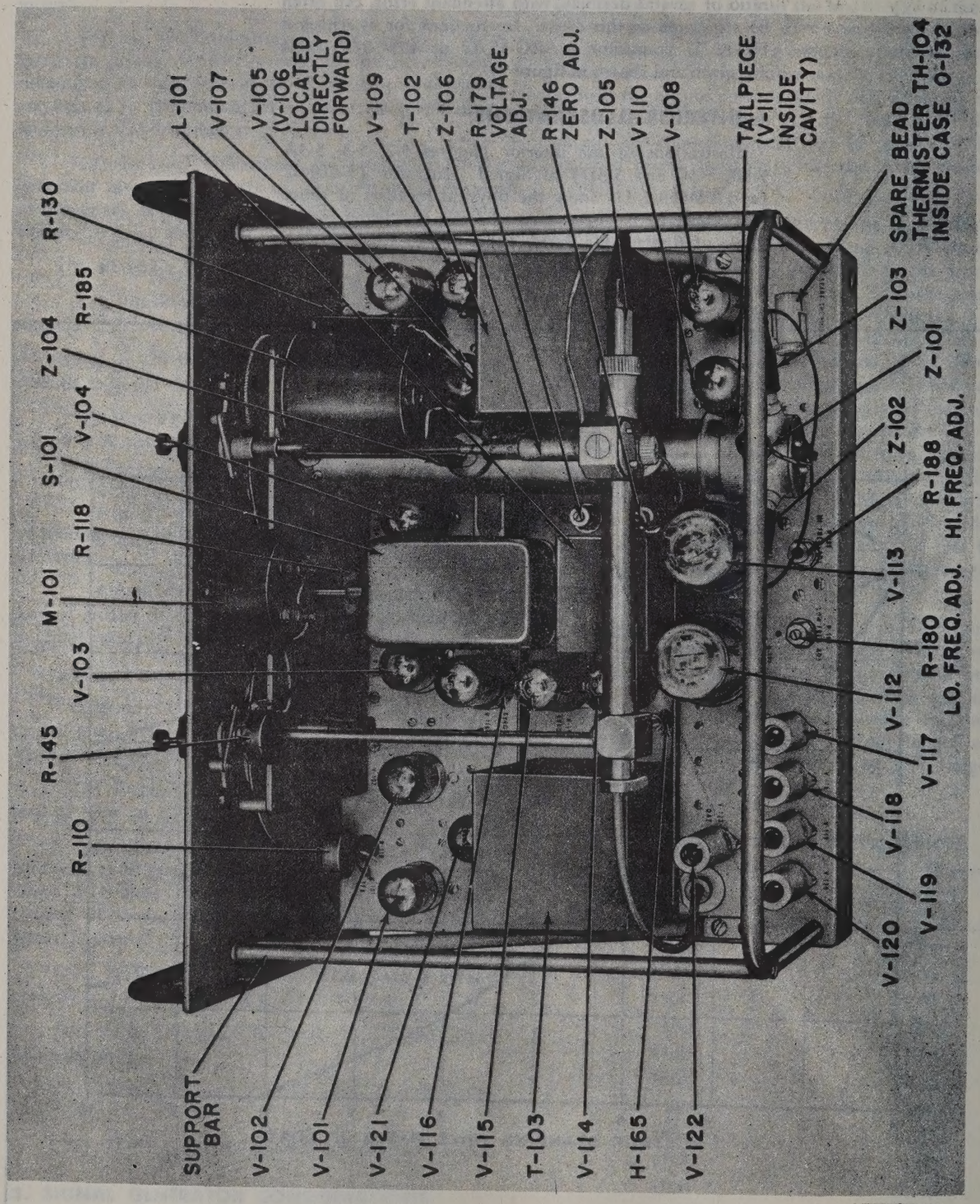


Figure 5-2. Signal Generator TS-419/U and TS-419A/U, Top View of Chassis

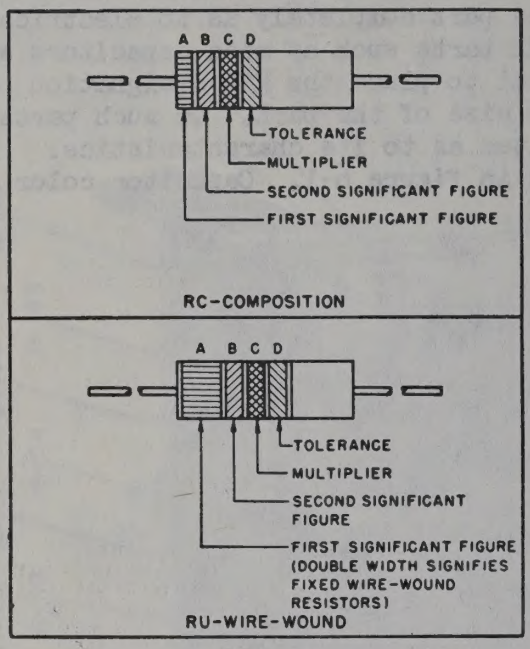
SECTION VI

RESISTOR AND CAPACITOR COLOR CODES

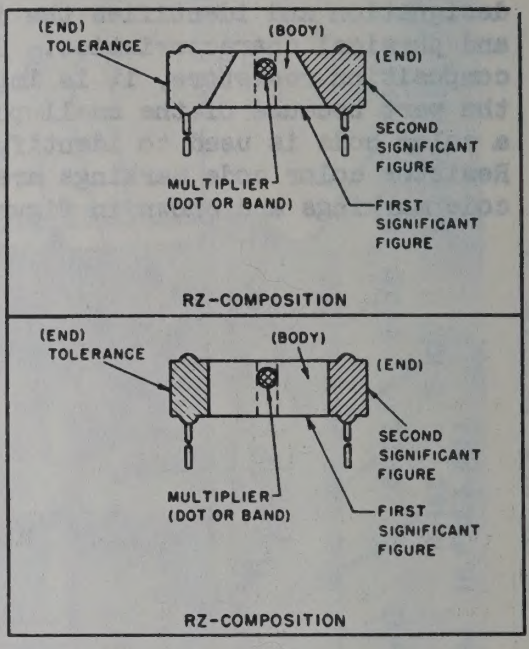
Resistors and capacitors which are manufactured in accordance with military standards are identified by a designation consisting of a combination of letters and numbers. This designation is known as the MIL designation and identifies the detailed part completely as to electrical and physical characteristics. On small parts such as mica capacitors and composition resistors, it is impractical to place the MIL designation on the part because of the small physical size of the part. On such parts a color code is used to identify the item as to its characteristics. Resistor color code markings are shown in figure 6-1. Capacitor color code markings are shown in figure 6-2.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS
(INSULATED)



RADIAL-LEAD RESISTORS
(UNINSULATED)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	±20
BROWN	1	BROWN	1	BROWN	10	SILVER	±10
RED	2	RED	2	RED	100	GOLD	±5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

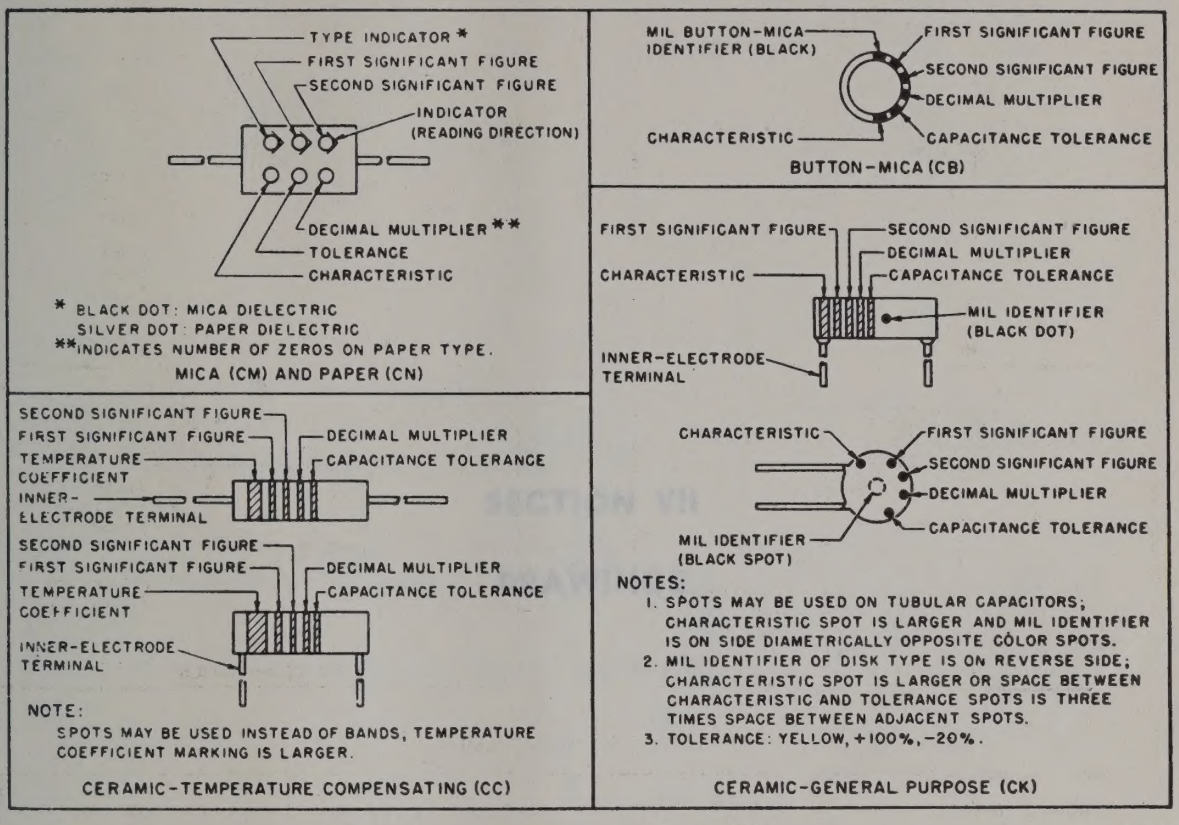
*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

Figure 6-1. Resistor Color Codes

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)

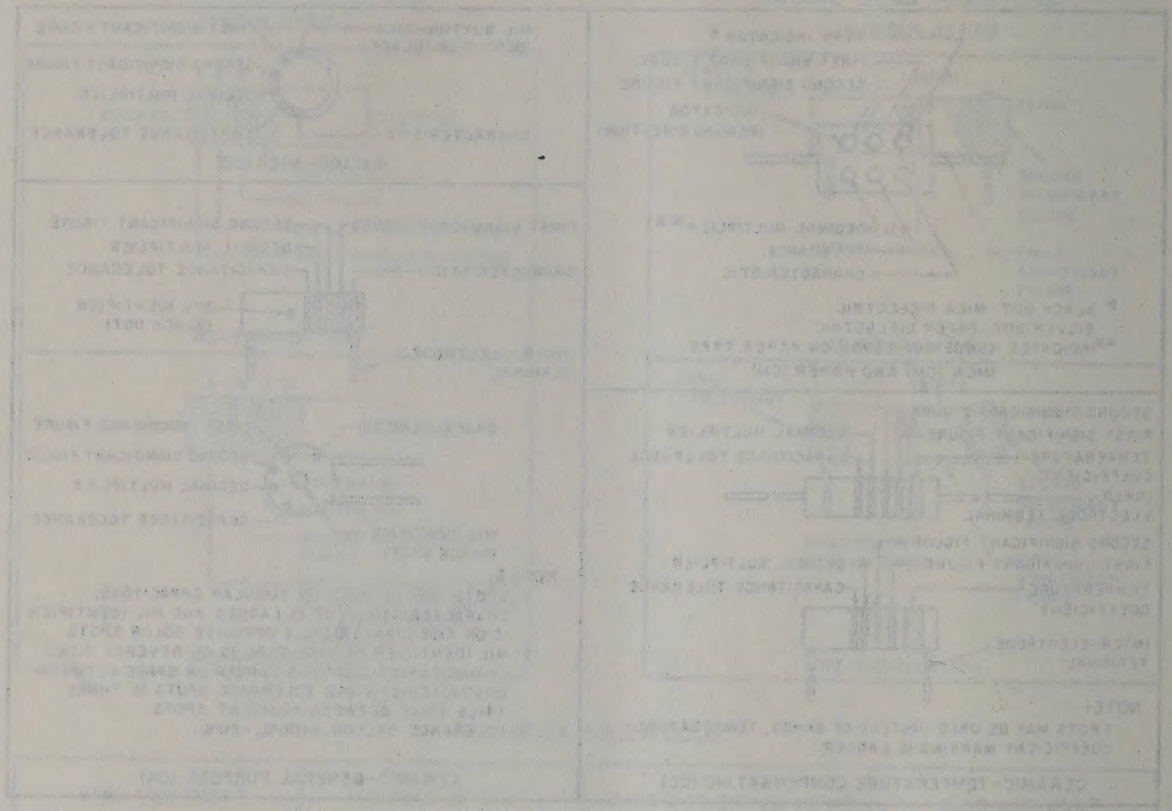


CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1 LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

Figure 6-2. Capacitor Color Codes



SECTION VII

DRAWINGS

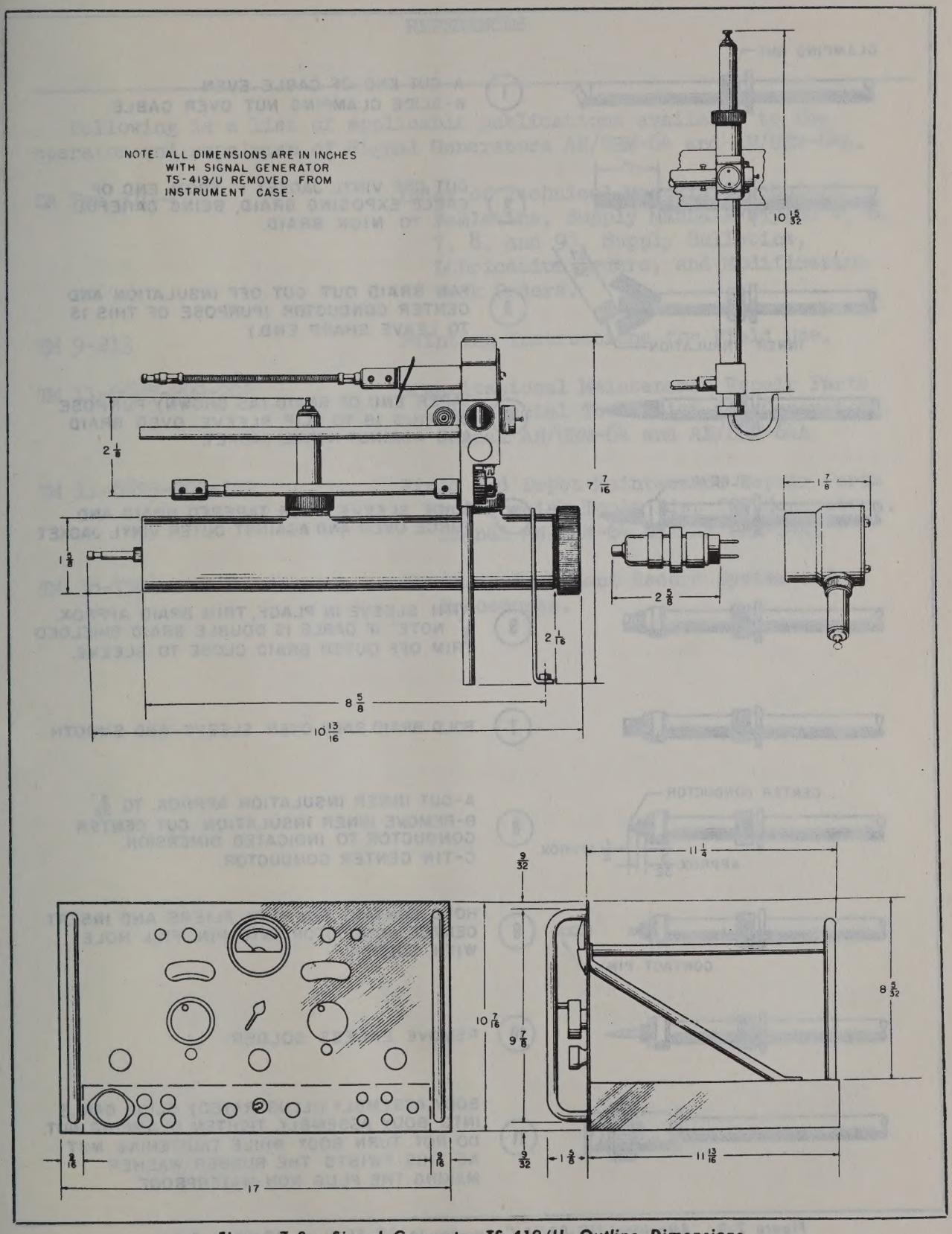
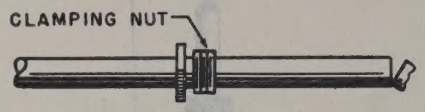
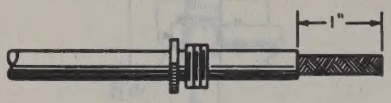


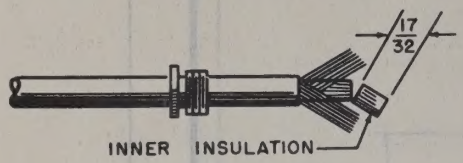
Figure 7-8. Signal Generator TS-419/U, Outline Dimensions



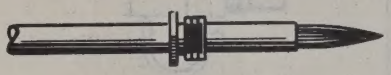
1. A-CUT END OF CABLE EVEN
   B-SLIDE CLAMPING NUT OVER CABLE.



2. CUT OFF VINYL JACKET 1" FROM END OF CABLE EXPOSING BRAID, BEING CAREFUL NOT TO NICK BRAID.



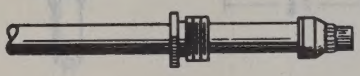
3. FAN BRAID OUT. CUT OFF INSULATION AND CENTER CONDUCTOR (PURPOSE OF THIS IS TO LEAVE SHARP END.)



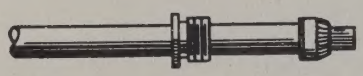
4. TAPER END OF BRAID (AS SHOWN). PURPOSE OF THIS IS TO SLIP SLEEVE OVER BRAID AND AGAINST VINYL JACKET.



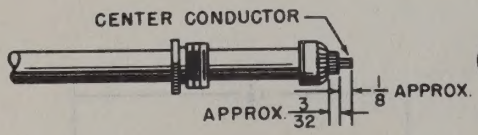
5. SLIDE SLEEVE OVER TAPERED BRAID AND FORCE OVER AND AGAINST OUTER VINYL JACKET.



6. WITH SLEEVE IN PLACE, TRIM BRAID APPROX. 1/8" NOTE: IF CABLE IS DOUBLE BRAID SHIELDED TRIM OFF OUTER BRAID CLOSE TO SLEEVE.



7. FOLD BRAID BACK OVER SLEEVE AND SMOOTH.



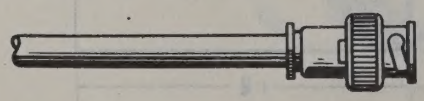
8. A-CUT INNER INSULATION APPROX. TO 3/32"
   B-REMOVE INNER INSULATION. CUT CENTER CONDUCTOR TO INDICATED DIMENSION.
   C-TIN CENTER CONDUCTOR.



9. HOLD CONTACT PIN WITH PLIERS AND INSERT CENTER CONDUCTOR INTO PIN. FILL HOLE WITH SOLDER.



10. REMOVE EXCESS SOLDER.



11. BODY ASSEMBLY (ILLUSTRATED). SLIDE CABLE INTO BODY ASSEMBLY, TIGHTEN CLAMPING NUT. DO NOT TURN BODY WHILE TIGHTENING NUT AS THIS TWISTS THE RUBBER WASHER MAKING THE PLUG NON-WATERPROOF.

Figure 7-9. Attaching UG-88/U Connector to RG-55/U or RG-58/U Cable

APPENDIX I

REFERENCES

Following is a list of applicable publications available to the operator and repairman of Signal Generators AN/URM-64 and AN/URM-64A.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 4, 6, 7, 8, and 9), Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 9-213	Painting Instructions for Field Use.
TM 11-6625-299-20P	Organizational Maintenance Repair Parts and Special Tools List for Generators, Signal AN/URM-64 and AN/URM-64A.
TM 11-6625-299-35P	Field and Depot Maintenance Repair Parts and Special Tools List for Generators, Signal AN/URM-64 and AN/URM-64A.
TM 38-750	The Army Equipment Record System and Procedures.

(g) Align. To adjust two or more components of an electrical system so that their functions are properly synchronized.

(h) Calibrate. To determine, check, or rectify the graduation of an instrument, weapon, or weapons system, or components of a weapons system.

(i) Overhaul. To restore an item to completely serviceable condition as prescribed by serviceability standards developed and published by heads of technical services. This is accomplished through employment of the technique of "Inspect and Repair Only as Necessary" (IROAN). Maximum utilization of diagnostic and test equipment is combined with minimum disassembly of the item during the overhaul process.

(j) Rebuild. To restore an item to a standard as near as possible to original or new condition in appearance, performance, and life expectancy. This is accomplished through the maintenance technique of complete disassembly of the item, inspection of all parts or components, repair or replacement of worn or unserviceable elements using original manufacturing tolerances and/or specifications and subsequent reassembly of the item.

(3) 1st, 2d, 3d, 4th, 5th echelon. The symbol X indicates the echelon responsible for performing that particular maintenance operation, but does not necessarily indicate that repair parts will be stocked at that level. Echelons higher than the echelon marked by X are authorized to perform the indicated operation.

(4) Tools required. This column indicates codes assigned to each individual tool equipment, test equipment, and maintenance equipment referenced. The grouping of codes in this column of the maintenance allocation chart indicates the tool, test, and maintenance equipment required to perform the maintenance function.

(5) Remarks. Entries in this column are used to clarify any of the data cited in the preceding column.

c. Columns in the allocation of tools for maintenance functions chart are as follows:

(1) Tools required for maintenance functions. This column lists tools, test, and maintenance equipment required to perform the maintenance functions.

(2) 1st, 2d, 3d, 4th, 5th echelon. The dagger (†) symbol in these columns indicates the echelons normally allocated the facility.

(3) Tool code. This column lists the tool code assigned.

2. Maintenance by Using Organizations

When this equipment is used by signal services organizations organic to theater headquarters or communication zones to provide theater communications, those maintenance functions allocated up to and including fourth echelon are authorized to the organization operating this equipment.

SECTION II MAINTENANCE ALLOCATION CHART

(1) PART OR COMPONENT	(2) MAINTENANCE FUNCTION	(3) 1ST ECH.	(4) 2ND ECH.	(5) 3RD ECH.	(6) 4TH ECH.	(7) 5TH ECH.	(8) TOOLS REQUIRED	(9) REMARKS
GENERATORS, AN/URM-64; AN/URM-64A	service	X						
	inspect	X						Visual only
	test				X		2,3,4,6,9,10,11	
	repair				X			
	calibrate				X	X	1,5,7,8,9,10	
	rebuild					X		
CABLE ASSEMBLIES, POWER, ELECTRICAL	repair		X					
CABLE ASSEMBLIES, RADIO FREQUENCY	repair				X			
CASE, TRANSIT	replace					X		Fabricate or obtain from salvage
	repair				X			
	rebuild					X		
GENERATOR, SIGNAL TS-419/U; TS-419A/U	repair				X			
	rebuild					X		
CAVITY ASSEMBLY	repair				X			
	rebuild					X		
ATTENUATOR ASSEMBLY: W105	repair				X			
	rebuild					X		
ATTENUATOR AND MONITOR WAVEGUIDE ASSEMBLY: A107	repair				X			
	rebuild					X		
WAVEGUIDE SUB-ASSEMBLY	repair				X			
	rebuild					X		
CAVITY SUB-ASSEMBLY: A106	repair				X			
	rebuild					X		
FILTER ASSEMBLY: Z101, Z102, Z103	repair				X			
	rebuild					X		
FREQUENCY DIAL ASSEMBLY: N101	repair				X			
	rebuild					X		
DIAL ASSEMBLY: N102	repair				X			
	rebuild					X		

(1) TOOLS REQUIRED FOR MAINTENANCE FUNCTIONS	(2) 1ST ECH	(3) 2ND ECH	(4) 3RD ECH	(5) 4TH ECH	(6) 5TH ECH	(7) TOOL CODE	(8) REMARKS
AN/URM-64; AN/URM-64A (continued)							
AUDIO OSCILLATOR TS-382/U				†	†	1	
ELECTRONIC MULTIMETER ME-30A/U				†	†	2	
ELECTRON TUBE TSET SET TV-2/U					†	3	
ELECTRON TUBE TEST SET TV-7/U				†		4	
FREQUENCY METER TS-186/UP				†	†	5	
MULTIMETER TS-352B/U				†	†	6	
OSCILLOSCOPE AN/USM-24				†	†	7	
PULSE GENERATOR AN/UPM-15				†	†	8	
SLOTTED LINE WAVEGUIDE IM-92/U				†	†	9	
STANDING WAVE INDICATOR IM-97/USM-37				†	†	10	
TOOL EQUIPMENT TE-113/U				†	†	11	

APPENDIX III

BASIC ISSUE ITEMS LIST FOR GENERATORS, SIGNAL

AN/URM-64; AN/URM-64A

Section I. INTRODUCTION

1. Scope

This appendix lists items supplied for initial operation and for running spares. The list includes tools, accessories, parts, and material issued as part of the major end item. The list includes all items authorized for basic operator maintenance of the equipment. End items of equipment are issued on the basis of allowances prescribed in equipment authorization tables and other documents that are a basis for requisitioning.

2. Columns

a. Source, Maintenance and Recoverability Code. Not used.

b. Federal Stock Number. This column lists the 11-digit Federal stock number.

c. Designation by Model. The dagger (†) indicates model and/or contract procurement in which the part is used.

d. Description. Nomenclature or the standard item name and brief identifying data for each item are listed in this column. When requisitioning, enter the nomenclature and description.

e. Unit of Issue. The unit of issue is each unless otherwise indicated and is the supply term by which the individual item is counted for procurement, storage, requisitioning, allowances, and issue purposes.

f. Expendability. Nonexpendable items are indicated by NX. Expendable items are not annotated.

g. Quantity Authorized. Under "Items Comprising an Operable Equipment," the column lists the quantity of items supplied for the initial operation of the equipment. Under "Running Spares and Accessory Items," the quantities listed are those issued initially with the equipment as spare parts. The quantities are authorized to be kept on hand by the operator for maintenance of the equipment.

h. Illustrations. Not used.

(1) SOURCE MAINTENANCE AND RECOVERABILITY CODE	(2) FEDERAL STOCK NUMBER	(3) DESIGNATION BY MODEL	(4) DESCRIPTION	(5) UNIT OF ISSUE	(6) EXPENDABILITY	(7) QUANTITY AUTHORIZED	(8) ILLUSTRATIONS FIGURE NO.	(9) ILLUSTRATIONS ITEM NO.
	6625-570-5721	1 2	GENERATORS, SIGNAL AN/URM-64; AN/URM-64A: 900 to 2100 mc, 1 band, ±1%; 0.0 to -120 db ±2 db; 50 ohms out put impedance; alum case; 21-1/4 in x 16-1/2 in x 15-5/8 in		NX			
			NOTE: Model Column 1 refers to AN/URM-64; Column 2 refers to AN/URM-64A					
			ITEMS COMPRISING AN OPERABLE EQUIPMENT					
	Ord thru AGC	† †	TECHNICAL MANUAL TM 11-6625-299-15			2		
	6625-184-4366	†	CABLE ASSEMBLY, POWER, ELECTRICAL CX-337/U: (6 ft)			1		
	6150-560-9519	†	CABLE ASSEMBLY, POWER, ELECTRICAL CX-3277/U: (6 ft)			1		
	6625-295-8241	† †	CABLE ASSEMBLY, RADIO FREQUENCY CG-409A/U: (8-1/2 in)			2		
	6625-545-7933	† †	CABLE ASSEMBLY, RADIO FREQUENCY, CG-546/U: (6 ft)			1		
	6625-257-4817	† †	SIGNAL GENERATOR TS-419/U; TS-419A/U		NX	1		
			RUNNING SPARES AND ACCESSORY ITEMS					
			GENERATOR, SIGNAL AN/URM-64; AN/URM-64A					
	5935-201-3090	† †	ADAPTER, CONNECTOR, UG-201/U			3		
	5935-149-3914	† †	ADAPTER, CONNECTOR, UG-255/U			3		
	5935-149-3534	† †	ADAPTER, CONNECTOR UG-273/U			3		
	6625-372-2077	† †	CASE, TEST SET, CY-686/U; CY-686A/U; CY-686C/U			1		
		1 2 3 4 5	SIGNAL GENERATOR TS-419/U; TS-419A/U					
			NOTE: Model Column 1 refers to TS-419/U procured an Order No. 1241-P-51 (N383S-67816) Column 2 refers to TS-419/U procured on Order No. N383S-91365; Column 3 refers to TS-419/U procured on Order No. N383S-75748; Column 4 refers to TS-419/U procured on Order No. N383S-5019A; Column 5 refers to TS-419A/U					
	5920-189-0846	† † †	FUSE, CARTRIDGE: MIL type F02G3R00A			5		
	5920-131-9821	† †	FUSE, CARTRIDGE: Littlefuse No. 313003			5		
	6240-155-8706	† † † † †	LAMP, INCANDESCENT: GE No. 47			1		

INDEX

	Figure	Page
A		
Abbreviations		6-2
Accessories	1-3, 1-4	1-3, 1-5
Adapters		1-3, 1-5
Adjustments		
calibration of		4-13
initial electrical		4-12
panel meter zero		4-12
regulated voltage		4-12
signal frequency dial		4-14
voltage measurements for		4-13
Amplifier		
delayed sync	3-9	3-9
input	3-5	3-5
pulse	3-9	3-9
undelayed sync	3-7	3-6
Attenuator		
impedance		4-23
removal		4-30
replacement		4-30
Attenuator dial		
removal		4-33
calibration		4-15
Attenuator VSWR, test diagram	4-9	4-24
B		
Back plate assembly, exploded view	7-5	7-31/7-32
Bead thermistor, removal		4-26
Block diagram	3-1	3-1
Bottom view, TS-419/U	5-3, 5-3A, 5-3B, 5-3C 5-3D	5-5/5-6, 5-7/5-8, 5-9/5-10, 5-11/5-12 5-13/5-14
Bottom wiring diagram, TS-419/U	7-2, 7-2A, 7-2B, 7-2C 7-2D	7-11/7-12, 7-13/7-14, 7-15/7-16, 7-17/7-18, 7-19/7-20
C		
Cable assemblies		1-4, 1-6
Cable attenuation		5-2
Calibration		
pulse delay		4-17
pulse width		4-16
of adjustments		4-13
output attenuator dial		4-15
Capacitor		
color code	6-2	6-6
Cavity assembly		
disassembly		4-34
inspection		4-34
removal		4-35
Characteristics		
electrical, summary		5-1
mechanical, summary		5-1
pulse synchronizing		4-21
Chassis, removal and replacement		4-11
Color codes		6-5, 6-6
Conductor Y-101, removal and replacement		4-35
Controls		
operating	2-1	2-2
pulse		5-2
Corrective maintenance		4-2
D		
Delay multivibrator	3-7, 3-7A	3-6, 3-8
Delayed sync output	3-9	3-9
Designations, standard component		6-2
Dial, output attenuator		4-33
Dial, signal frequency		
adjustments		4-14
reassembly		4-33
removal		4-32
Dials and gears, disassembly and reassembly	7-5	4-32
Disc thermistor		4-29
E		
Electrical adjustments, initial		4-12
voltage measurements for		4-13
Electrical characteristics		
general	1-2	1-2
technical summary		5-1
Electrical tests, miscellaneous		4-21
Emission, types of		5-1
Equipment		
function		2-1
purpose		1-1
required, but not supplied		1-1
starting		2-2
supplied	1-1, 1-4	1-1
test, required		4-10
unpacking and inspecting		2-1
External modulation characteristics	4-8	4-22
External pulse signal		2-5
External signal		2-5
F		
Filters, r-f		4-29
removal		4-29
replacement		4-29
Fixed composition resistors		6-5
Fixed mica-dielectric capacitors		6-6
Fixed paper-dielectric capacitors		6-6
Free-running operation		3-6
Frequency range		5-1
Frequency stability		5-1
Front panel view, TS-419A/U	2-1	2-1
Functional tube and lamp complement		5-1
Fuses		1-4, 1-6
G		
Gears		4-32
Graph, pulse delay vs. PRR	2-2	2-5
I		
Illustrations, interior	5-2, 5-3, 5-3A, 5-3B, 5-3C, 5-3D	5-3, 5-4, 5-5/5-6, 5-7/5-8, 5-9/5-10, 5-11/5-12, 5-13/5-14
Impedance, output		5-1
Impedance, output attenuator		4-23
Indicating devices		2-2, 2-3
Indicator lamps		1-4, 1-6
Initial electrical adjustments		4-12
measurements for		4-13
Input amplifier	3-5	3-5
Inspecting the equipment		2-1
Inspection		
cavity assembly		4-34
weekly		4-1
Interpolation scales, signal frequency		2-5

	Figure	Page
L		
Lamps, indicator		1-4, 1-6
Leakage checks, r-f		4-24
Localizing trouble		4-2
Lubrication		4-2
M		
Maintenance		4-1, 4-2
Manufacturers, list of		6-3
Mechanical characteristics, summary		5-1
Measurement, two-microsecond pulse	4-4	4-17
Meter zero adjustments, panel		4-12
Mica-dielectric capacitors, fixed		6-6
Miscellaneous electrical tests		4-21
Modulation		5-1
Modulation, external, characteristics		4-22
Modulator and synchronizer	3-4	3-3
Multivibrator		
delay	3-7, 3-7A	3-6, 3-8
pulse width	3-8, 3-8A	3-6, 3-9
rate	3-6	3-6
Multivibrator operation		3-8
N		
Neg mod operation		3-9
Negative pulse synchronization		3-5
O		
Operating controls	2-1	2-2
Operation range		1-2
Operation		2-1
free-running		3-6
general principles		1-1
Neg mod		3-9
Pos mod		3-9
synchronized		3-6
theory		3-0
Oscillator		
modulation with external pulse signal		2-5
tube, replacement	7-6	4-11
Outline dimensions, TS-419/U	7-8	7-37
Output		
delayed sync		3-8
impedance		5-1
power		5-1
signals, pulsed r-f		2-5
sync		4-22, 5-2
system	3-2	3-0
undelayed sync	3-7, 3-7A	3-6, 3-8
Output attenuator		
assembled view	7-6	7-33/7-34
calibrations		4-15
dial, removal		4-33
exploded view	7-7	7-35/7-36
impedance		4-23
P		
Panel meter zero adjustments		4-12
Paper-dielectric capacitors, fixed		6-6
Parts		
ordering spare		6-2
standard designations		6-2
Piston assembly, emergency repair		4-30
Positive pulse synchronization		3-5
Pos mod operation		3-9
Potentiometer, reflector tracking		4-29
Power		
monitor	7-6	3-2, 7-33/7-34
monitor, exploded view	7-7	7-35/7-36
output		5-1
requirements		1-2, 5-2
supply		3-11
take-off probe		4-32
Power loss vs. load	5-1	5-3
Power supply, block diagram	3-10	3-12
Pre-installation tests		2-2
Preventive maintenance		4-1
Probe, power take-off		4-32
Pulse		
amplifier	3-9	3-9
delay calibration		4-17
delay, test diagram	4-5	4-18
delay vs. PRR, graph	2-2	2-4
repetition rate vs. pulse delay	2-2	2-4
repetition rate, test diagram	4-7	4-20
synchronization		3-5
synchronizing characteristics		4-21
width calibration		4-16
width multivibrator	3-8, 3-8A	3-8, 3-9
width, test diagram	4-3	4-16
voltage, external		2-5
Pulsed r-f signals		2-4, 2-5
R		
Radio frequency, measurement of	4-1	4-14
Rate multivibrator	3-6	3-6
Reference symbols		1-1, 1-6
Reflector tracking potentiometer		4-29
Regulated voltage adjustments		4-12
Replaceable parts, table of		6-7
Resistance measurements	7-4	4-43, 7-29/7-30
Resistors		
color code	6-1	6-5
R-f assembly		
maintenance		4-25
removal and replacement		4-30
R-f filters		4-29
R-f leakage checks	4-10	4-24
R-f oscillator	7-6	7-33/7-34
R-f oscillator, equivalent circuit	3-2	3-1
R-f oscillator, exploded view	7-7	7-35/7-36
R-f oscillator tube		4-11
R-f output		3-2
R-f power output, test diagram	4-2	4-15
Right oblique view, TS-419A/U	1-2	1-2
Routine care		4-1
S		
Selector switch, removal and replacement		4-36
Schematic, TS-419/U, TS-419A/U	7-1, 7-1A, 7-1B, 7-1C	7-3/7-4, 7-5/7-6, 7-7/7-8, 7-9/7-10
Signal frequency dial		
adjustments		4-14
reassembly		4-33
removal		4-32
Signal frequency interpolation scales		2-5
Sine wave synchronization		3-5
Sine wave synchronizing characteristics	4-7	4-20
Spare parts, ordering		6-2
Spurious modulation		5-1
Standard part designations		6-2
Sync output		
characteristics		4-22
delayed	3-9	3-11

	Figure	Page
provision for external use		2-5
undelayed	3-7, 3-7A	3-6, 3-8
Sync outputs		5-2
Sychronization		
negative pulse		3-5
positive pulse		3-5
sine wave		3-5
Synchronized operation		3-6
Synchronizer		3-3
Synchronizing characteristics, sine wave		4-21

T

T assembly		
removal		4-32
replacement		4-32
Table of replaceable parts		6-7
Take-off probe, power		4-32
Test equipment required		4-10
Tests		
miscellaneous electrical		4-21
pre-installation		2-2
Test connection diagram		
attenuator	4-9	4-24
external modulation	4-8	4-23
power output	4-2	4-15
pulse delay	4-5	4-18
pulse repetition rate	4-7	4-20
pulse width	4-3	4-16
radio frequency	4-1	4-14
r-f leakage	4-10	4-24
sine wave characteristics	4-7	4-20
Thermistor TH-103, bead		
removal		4-26
replacement		4-26
Thermistor TH-102, disc		4-27
Thermistor bridge circuit		
basic		3-2
complete		3-3
schematic	3-3	3-3
Time relationship, delay measurement	4-6	4-19
Top view, TS-419/U	5-2	5-4
Top wiring diagram, TS-419/U	7-3, 7-3A, 7-3B, 7-3C	7-21/7-22, 7-23/7-24, 7-25/7-26, 7-27/7-28
Tracking potentiometer, reflector, R-185	7-5	4-29
Transit case CY-686/U	1-1, 1-3, 1-4	1-1, 1-3, 1-5
Trouble, localizing		4-2
Trouble-shooting chart		4-3
Tube and lamp complement		5-1
Tube, r-f oscillator		4-11
Tubes		
electron, quantities and types		1-4, 1-6
vacuum, replacement		4-11

U

UG-88/U connector, attaching		7-38
Unpacking the equipment		2-1
Unsynchronized pulsed r-f signals		2-4
U. S. Air Force		6-1

V

Vacuum tubes, replacement		4-11
Voltage		
adjustments, regulated		4-12
checks		4-12
measurements	7-4	4-37, 7-29/7-30

W

Weekly inspection		4-1
Width multivibrator	3-8, 3-8A	3-6, 3-9
Wiring diagram, TS-419/U	7-2, 7-2A, 7-2B, 7-2C, 7-2D, 7-3, 7-3A, 7-3B, 7-3C	7-11/7-12 through 7-27/7-28

Y

Y-101, removal and replacement		4-35
Y-102, reassembly		4-35

Z

Zero adjustments, panel meter		4-12

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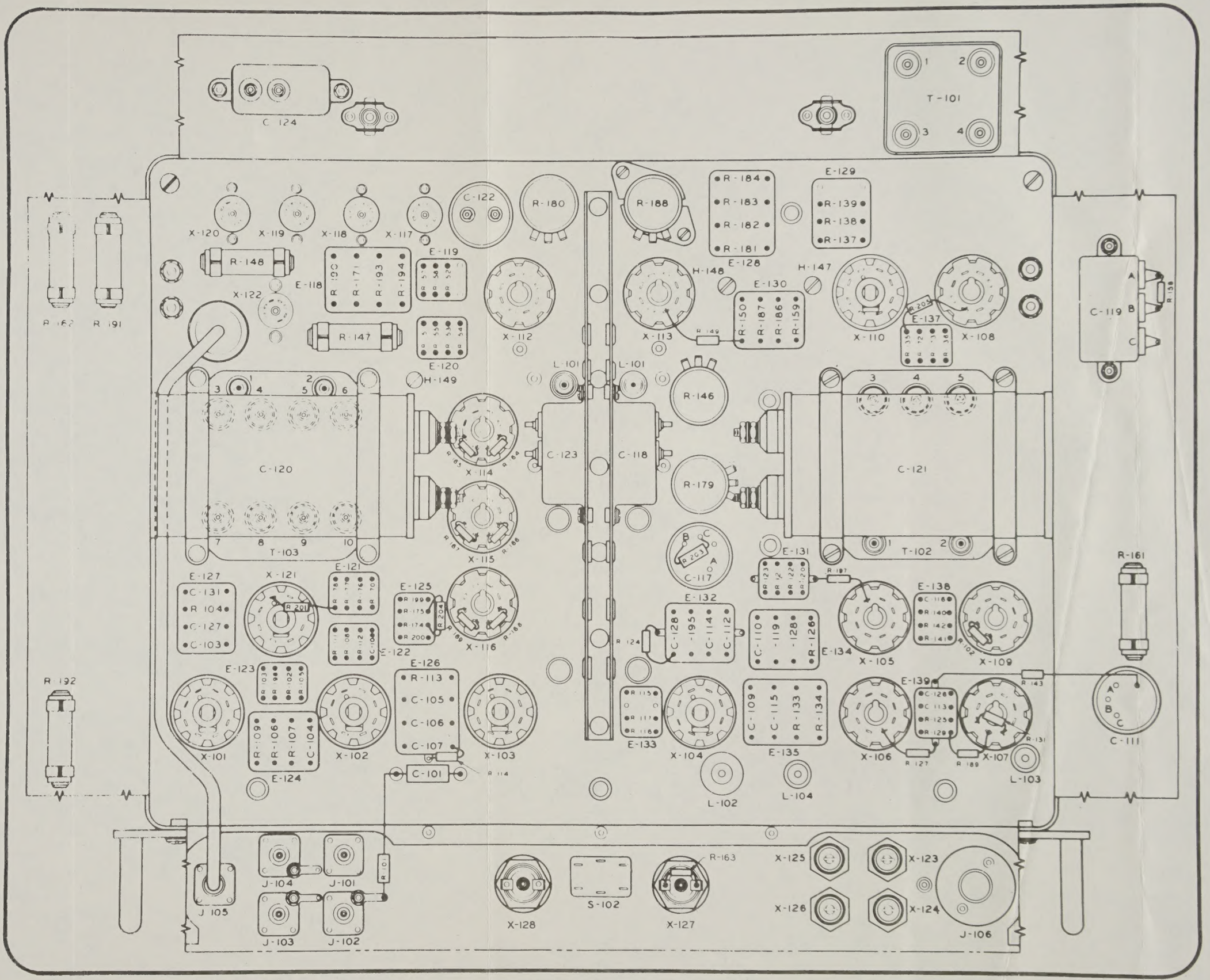
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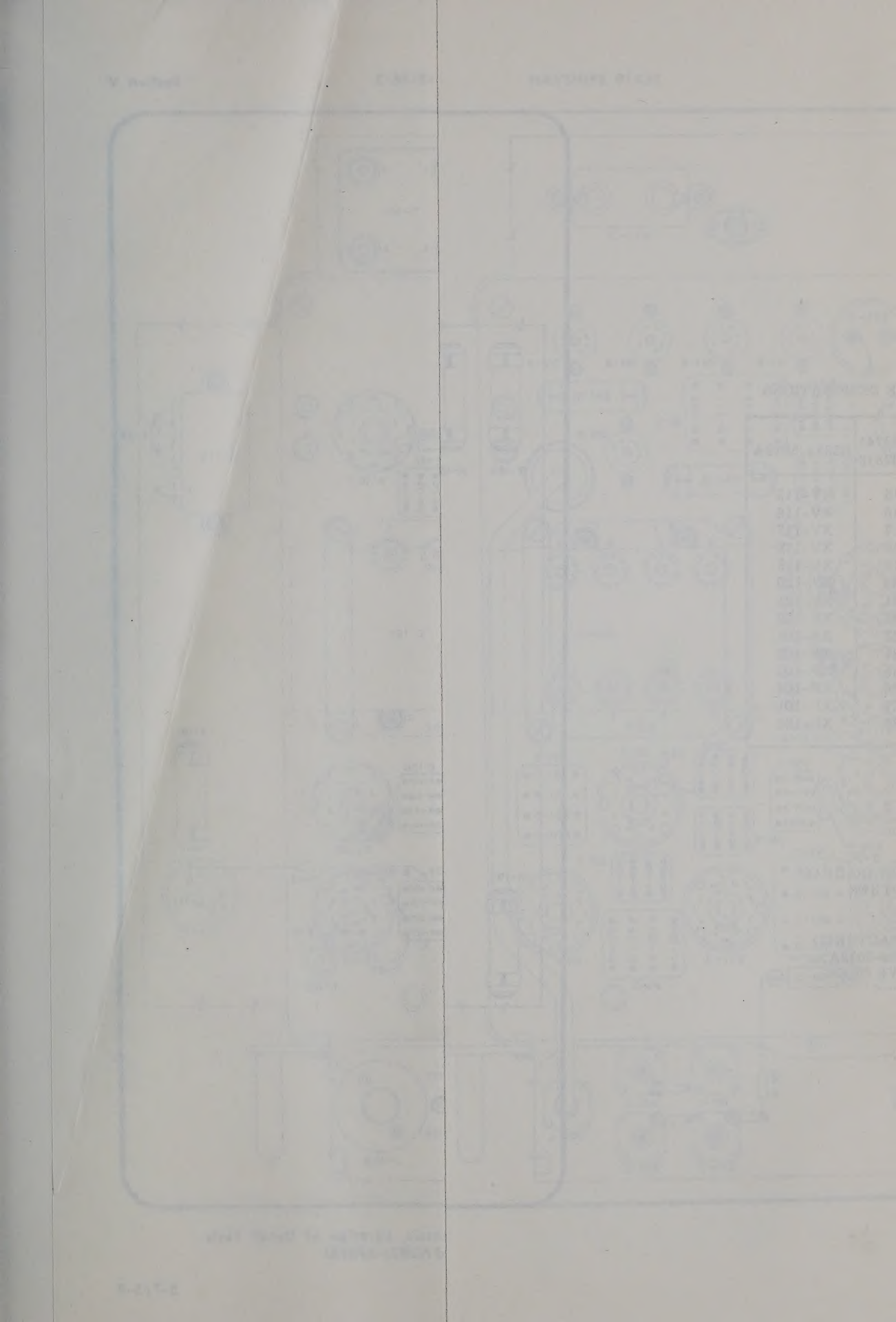


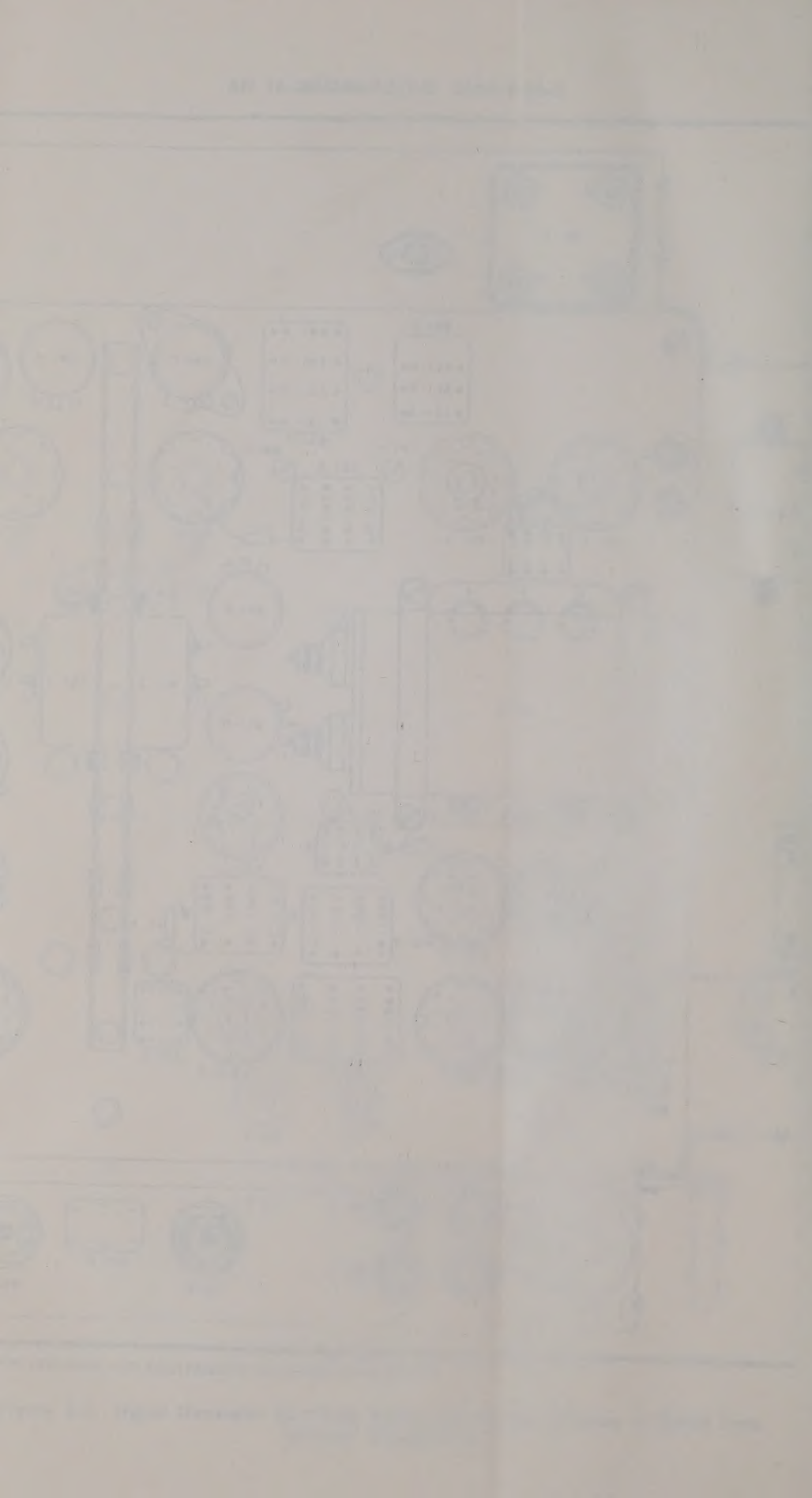


NOTE: SEE FIGURES 5-3A, 5-3B, 5-3C, AND 5-3D FOR LOCATION DIAGRAM FOR EQUIPMENTS OF OTHER CONTRACTS.

Figure 5-3. Signal Generator TS-419/U, Bottom of Chassis, Location of Detail Parts (Contract NOa(s)-9748)







LIST OF COMPARABLE REFERENCE DESIGNATIONS

N383s-45741 N383s-67816	N383s-5019A	N383s-45741 N383s-67816	N383s-5019A
X-101	XV-101	X-115	XV-115
X-102	XV-102	X-116	XV-116
X-103	XV-103	X-117	XV-117
X-104	XV-104	X-118	XV-118
X-105	XV-105	X-119	XV-119
X-106	XV-106	X-120	XV-120
X-107	XV-107	X-121	XV-121
X-108	XV-108	X-122	XV-122
X-109	XV-109	X-123	XF-101
X-110	XV-110	X-124	XF-102
X-111	XV-111	X-125	XF-103
X-112	XV-112	X-126	XF-104
X-113	XV-113	X-127	XI -101
X-114	XV-114	X-128	XI -102

NOTES:

1. SEE FIGURES 5-3, 5-3B, 5-3C, AND 5-3D FOR LOCATION DIAGRAM FOR EQUIPMENTS OF OTHER CONTRACTS.
2. IN EQUIPMENTS MANUFACTURED UNDER CONTRACT N383s-5019A, TY-101 AND TY-102 HAVE BEEN ADDED.

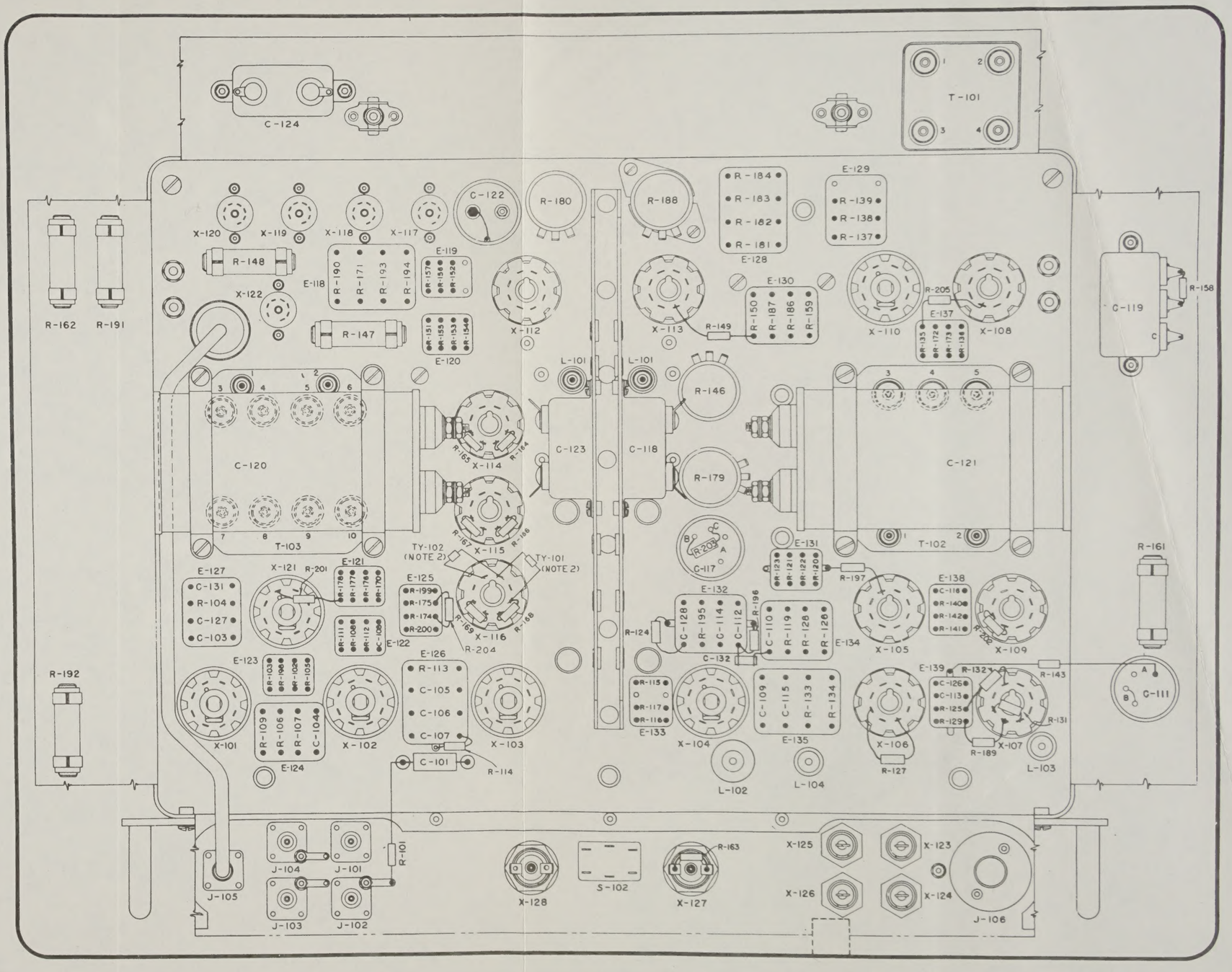
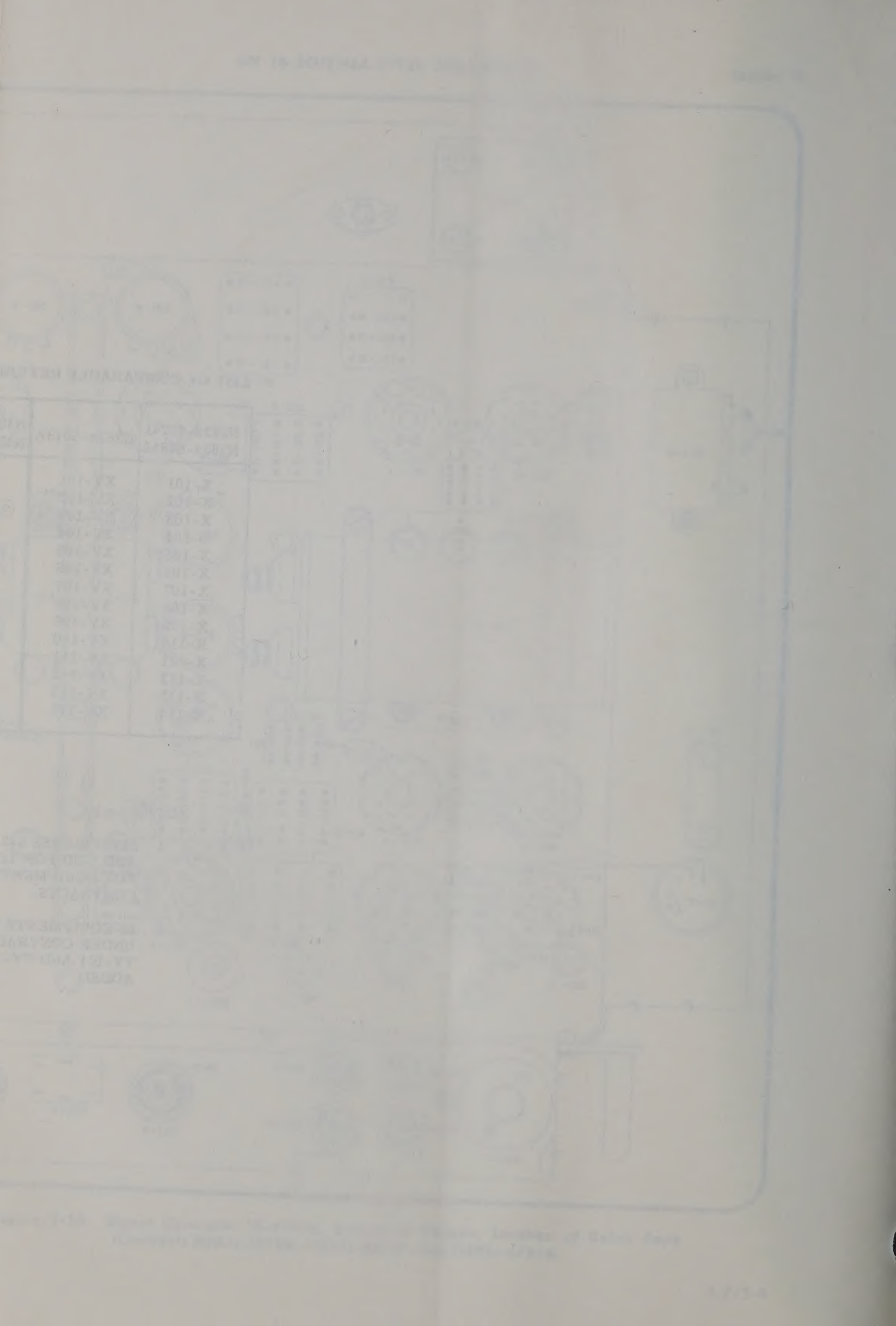
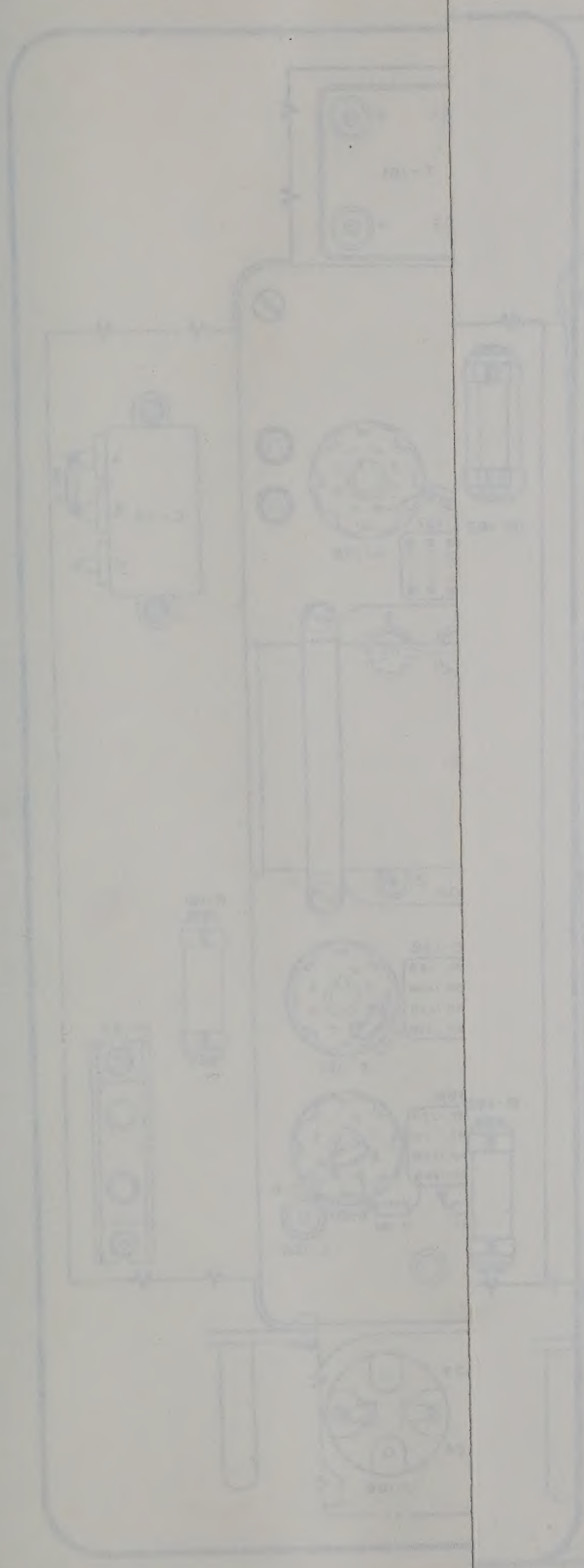
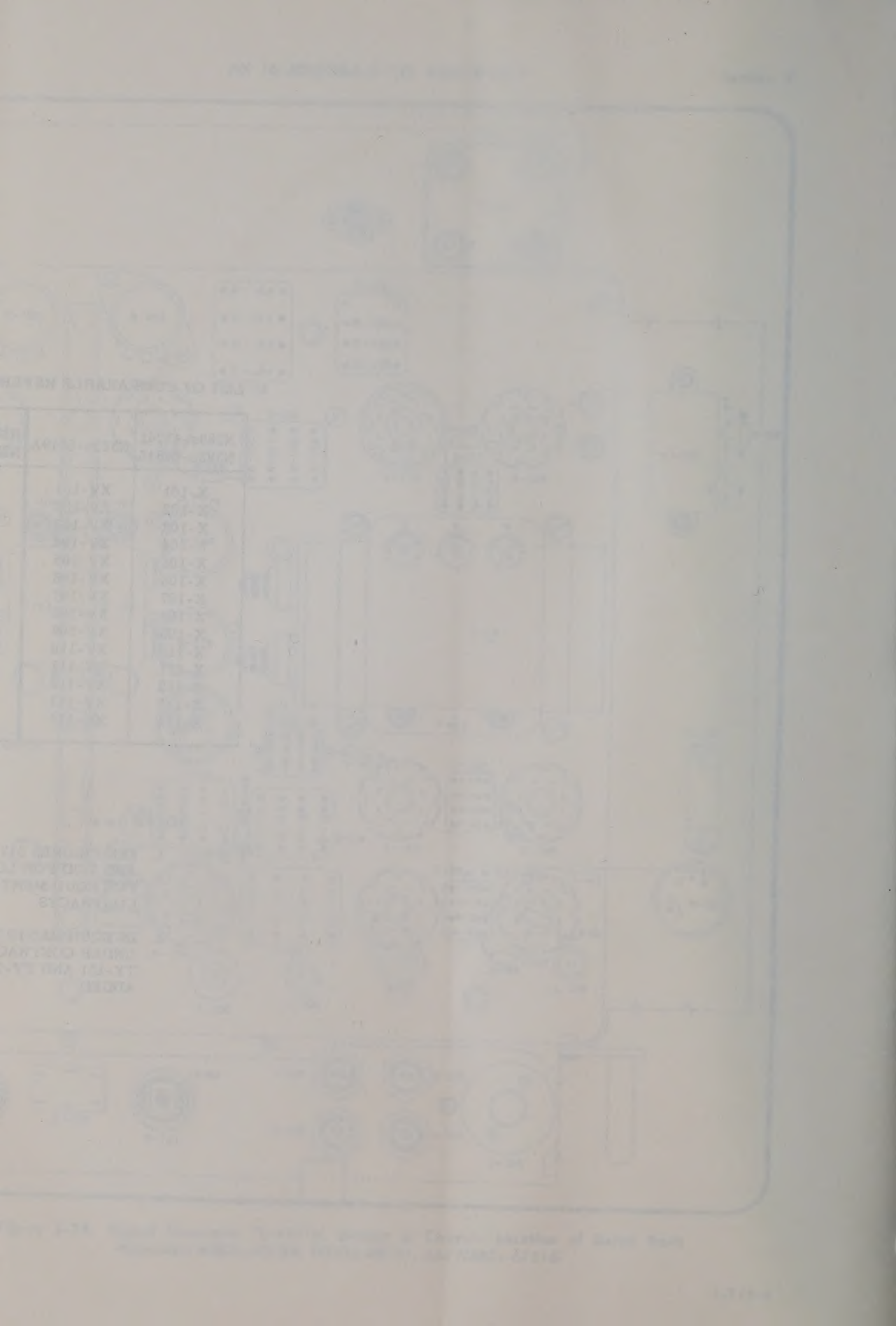
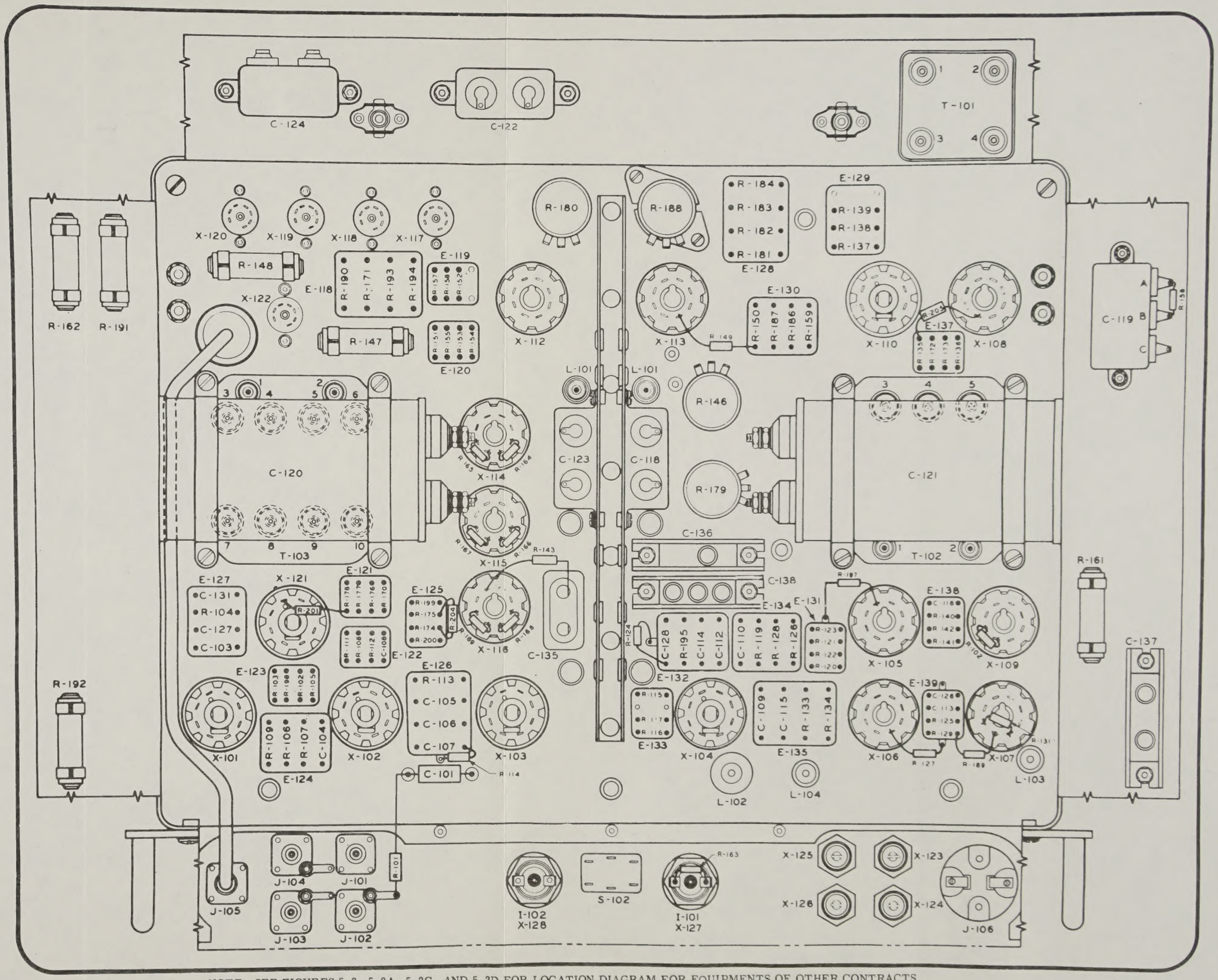


Figure 5-3A. Signal Generator TS-419/U, Bottom of Chassis, Location of Detail Parts (Contracts N383s-5019A, N383s-45741, and N383s-67816)



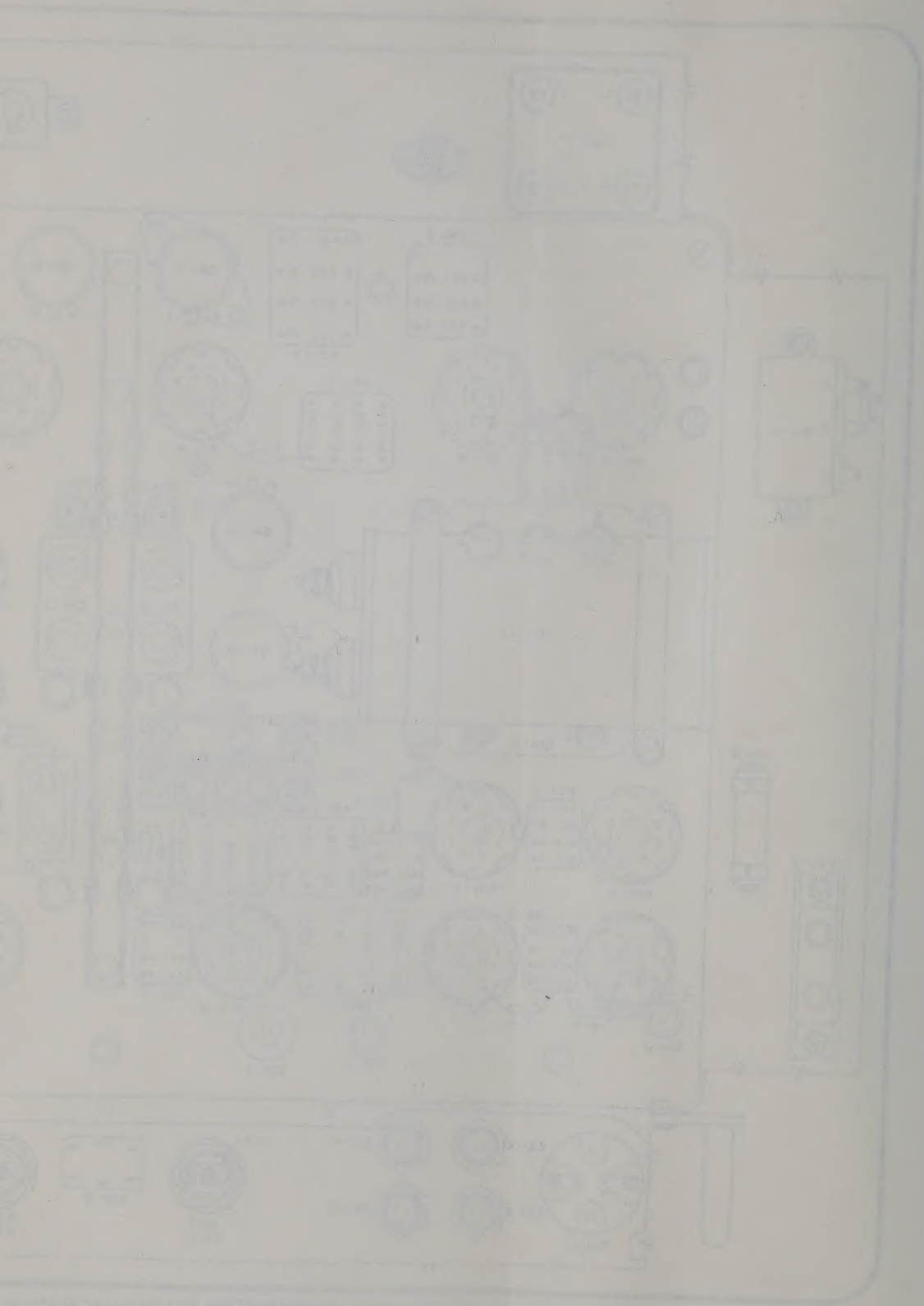


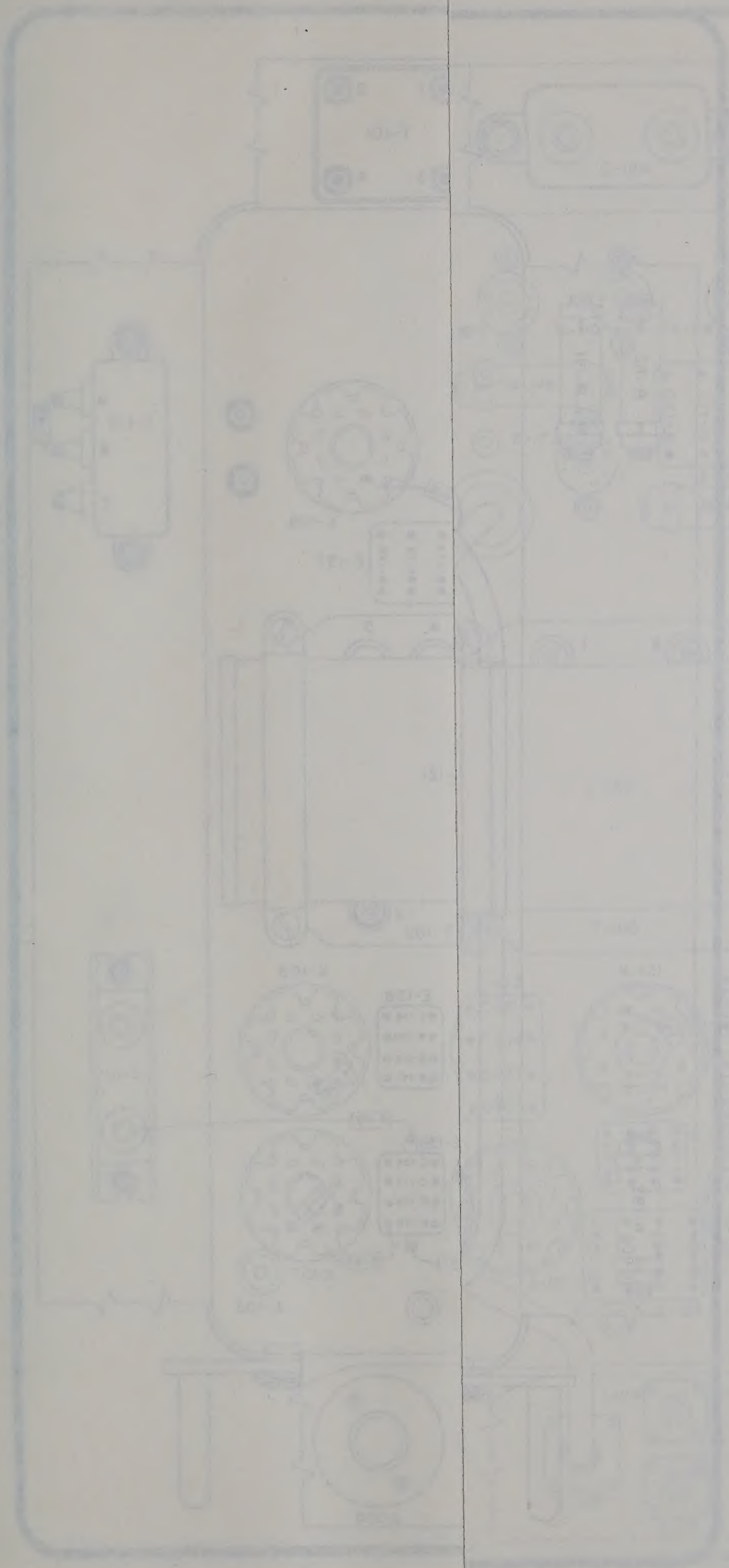


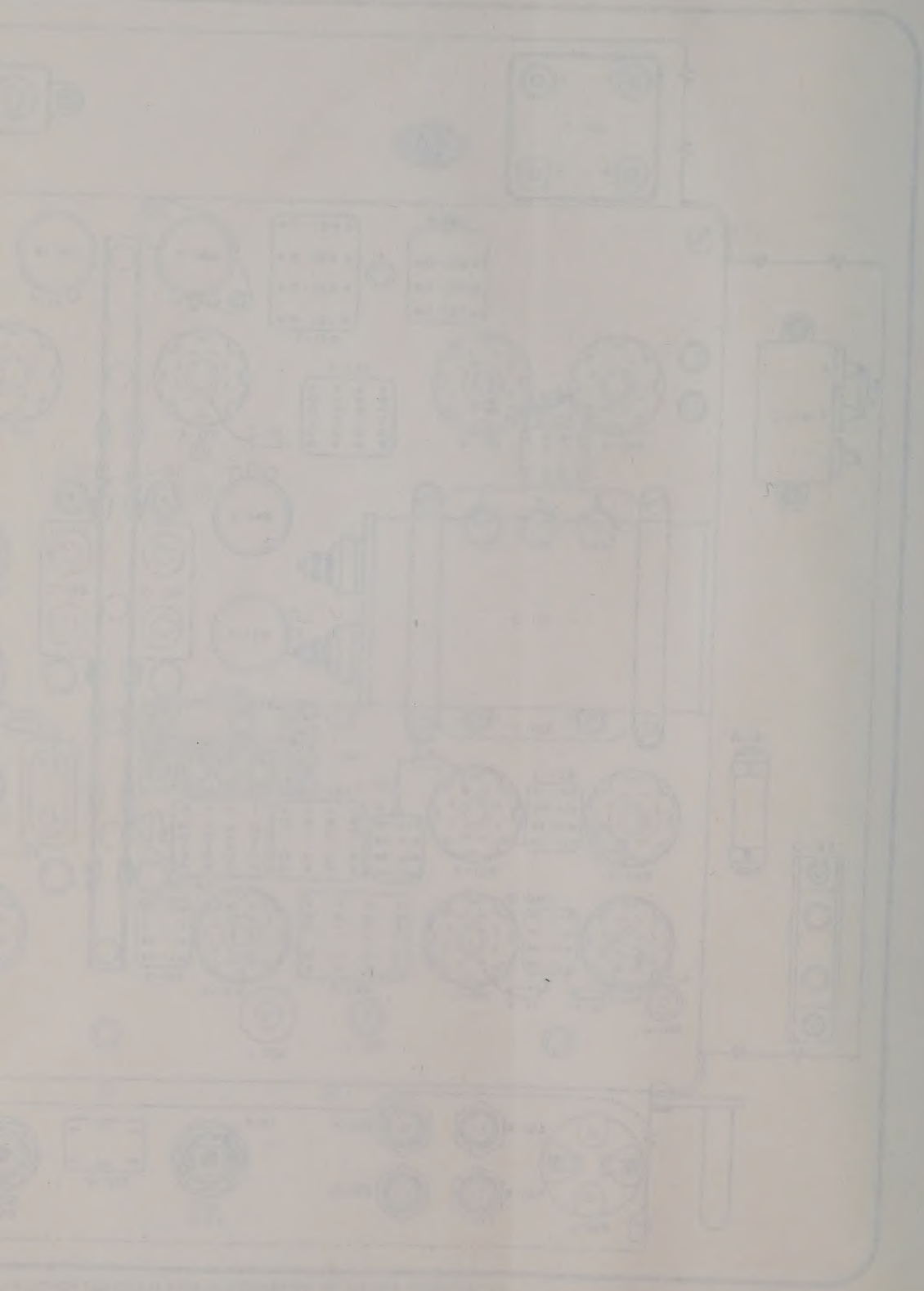


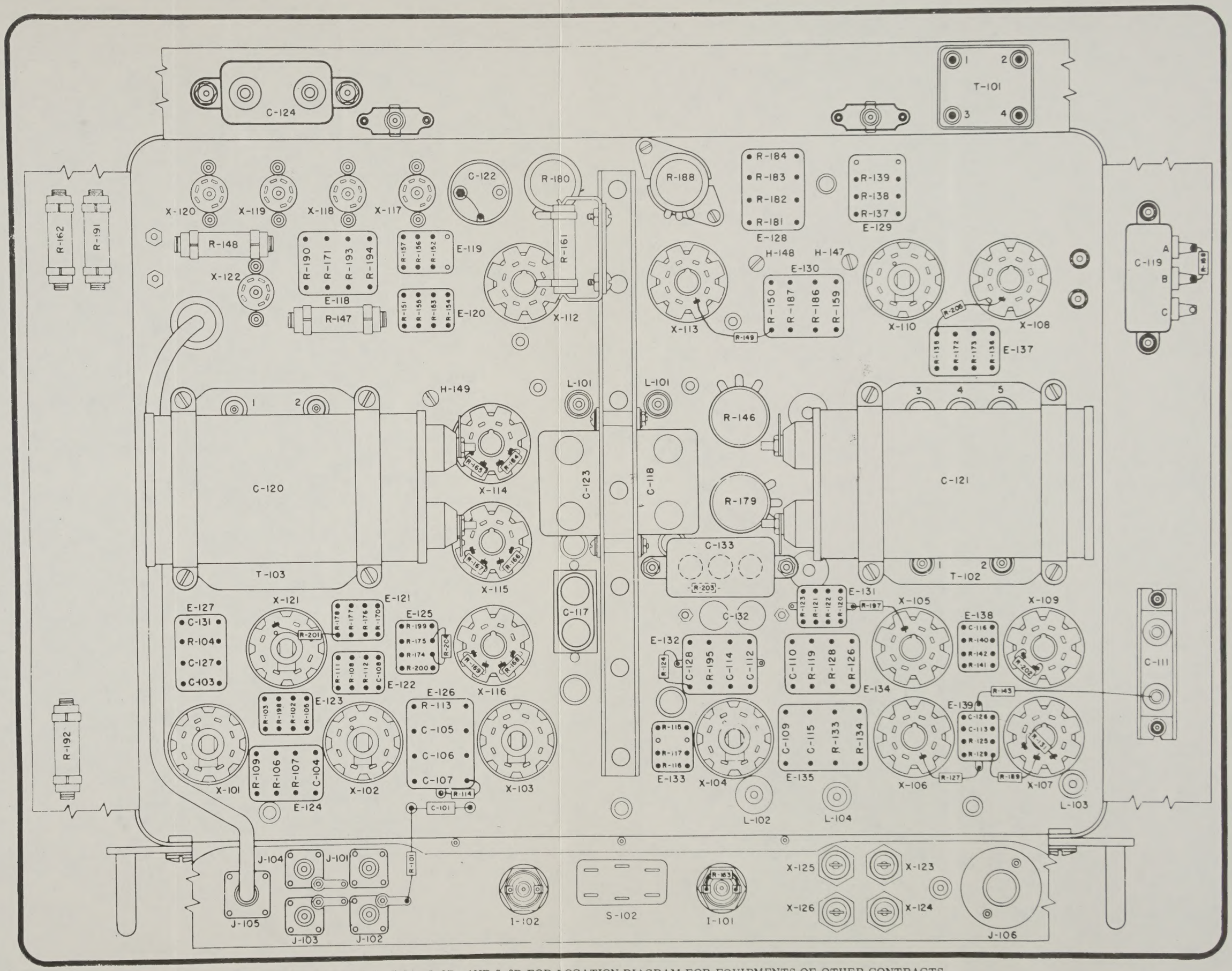
NOTE: SEE FIGURES 5-3, 5-3A, 5-3C, AND 5-3D FOR LOCATION DIAGRAM FOR EQUIPMENTS OF OTHER CONTRACTS.

Figure 5-3B. Signal Generator TS-419/U, Bottom of Chassis, Location of Detail Parts (Contracts N383s-60879 and N383s-61060)



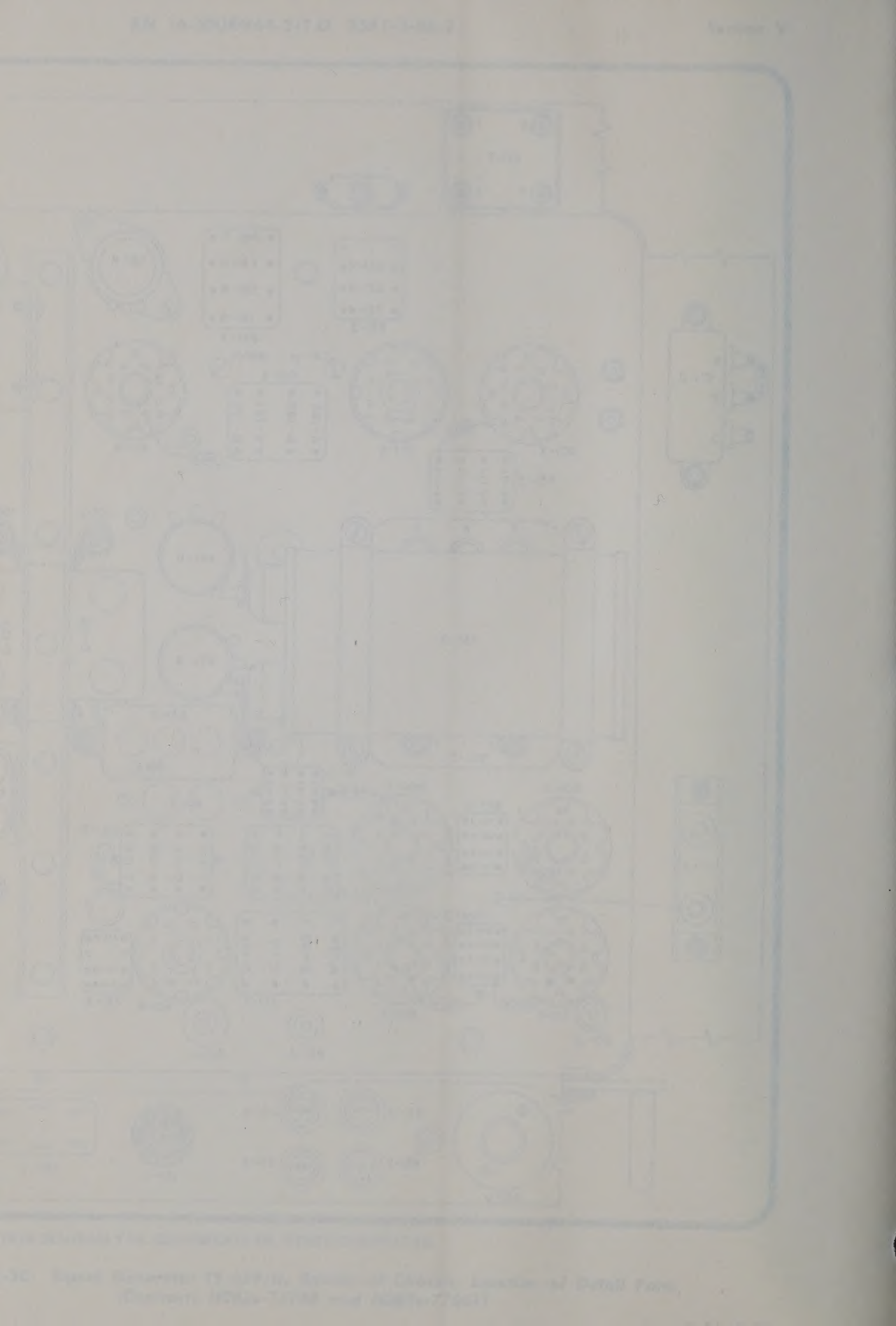


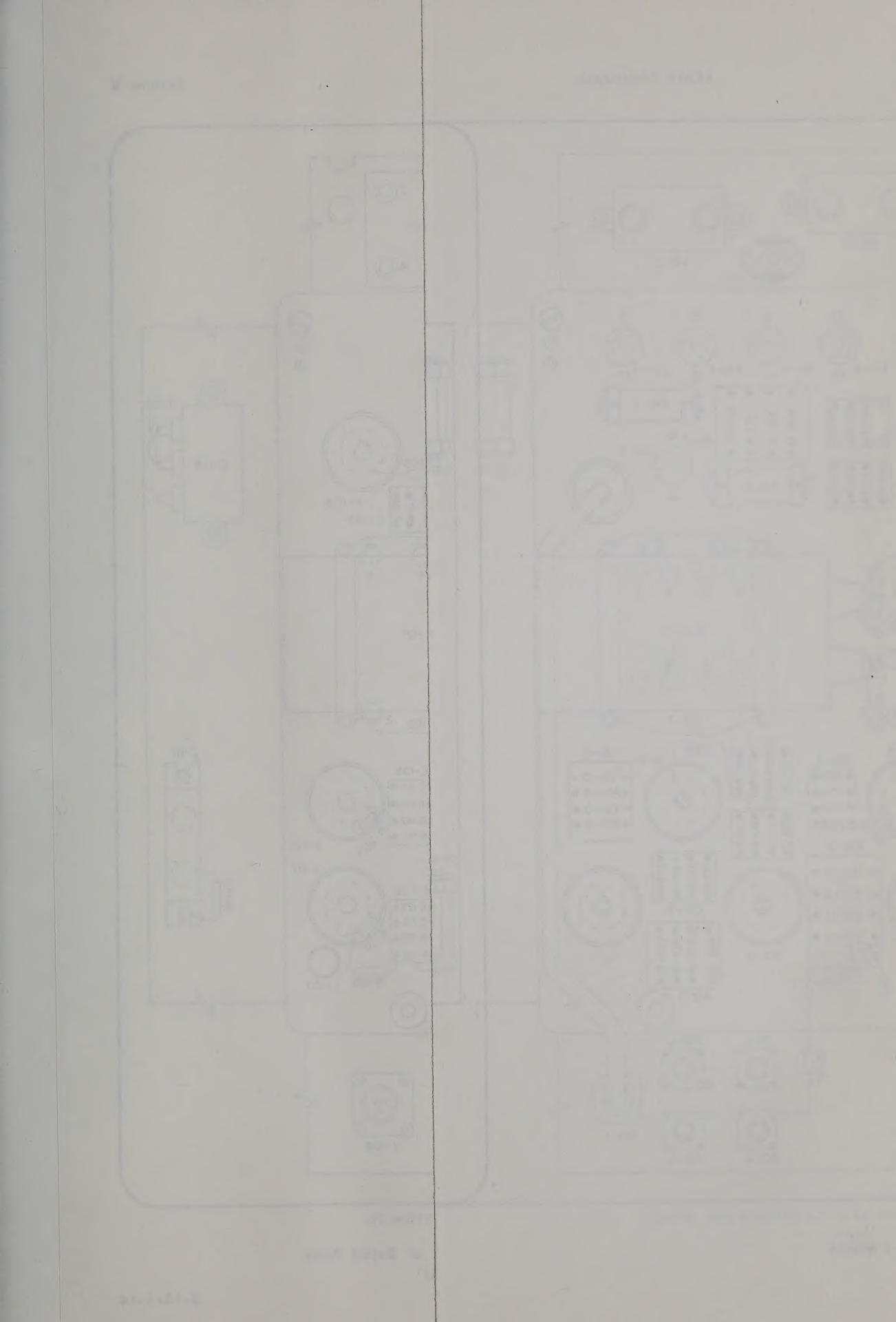


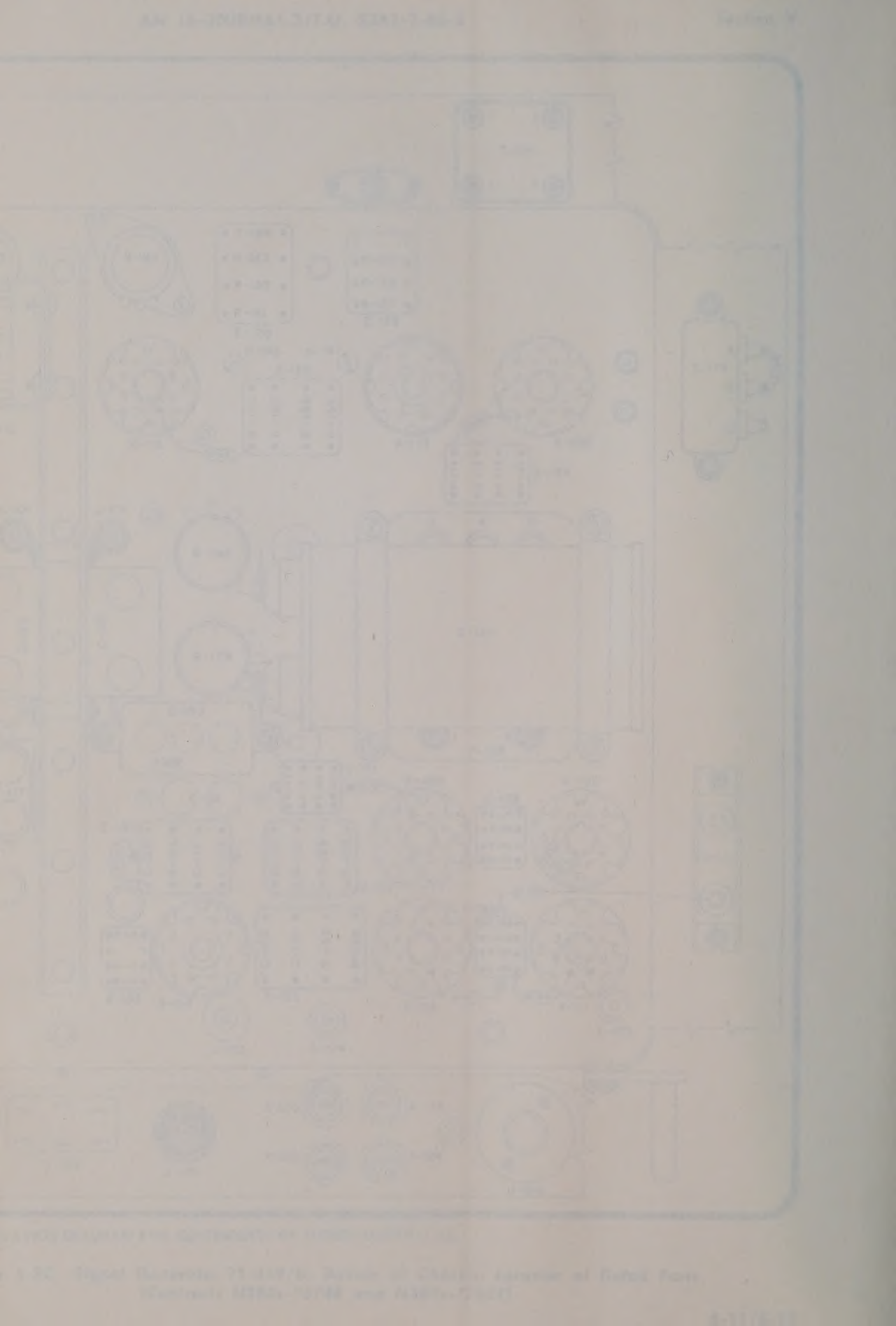


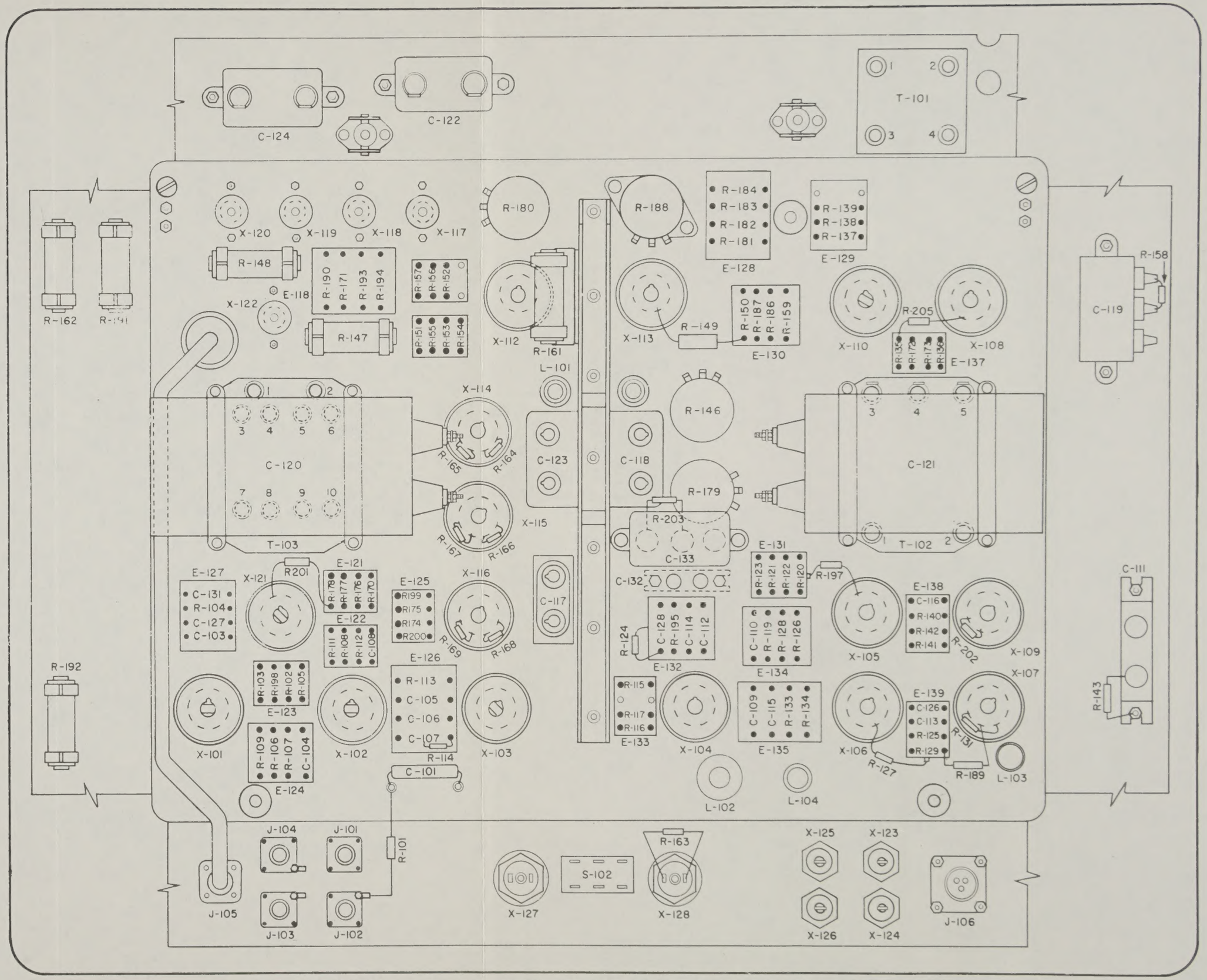
NOTE: SEE FIGURES 5-3, 5-3A, 5-3B, AND 5-3D FOR LOCATION DIAGRAM FOR EQUIPMENTS OF OTHER CONTRACTS.

Figure 5-3C. Signal Generator TS-419/U, Bottom of Chassis, Location of Detail Parts (Contracts N383s-75748 and N383s-77651)



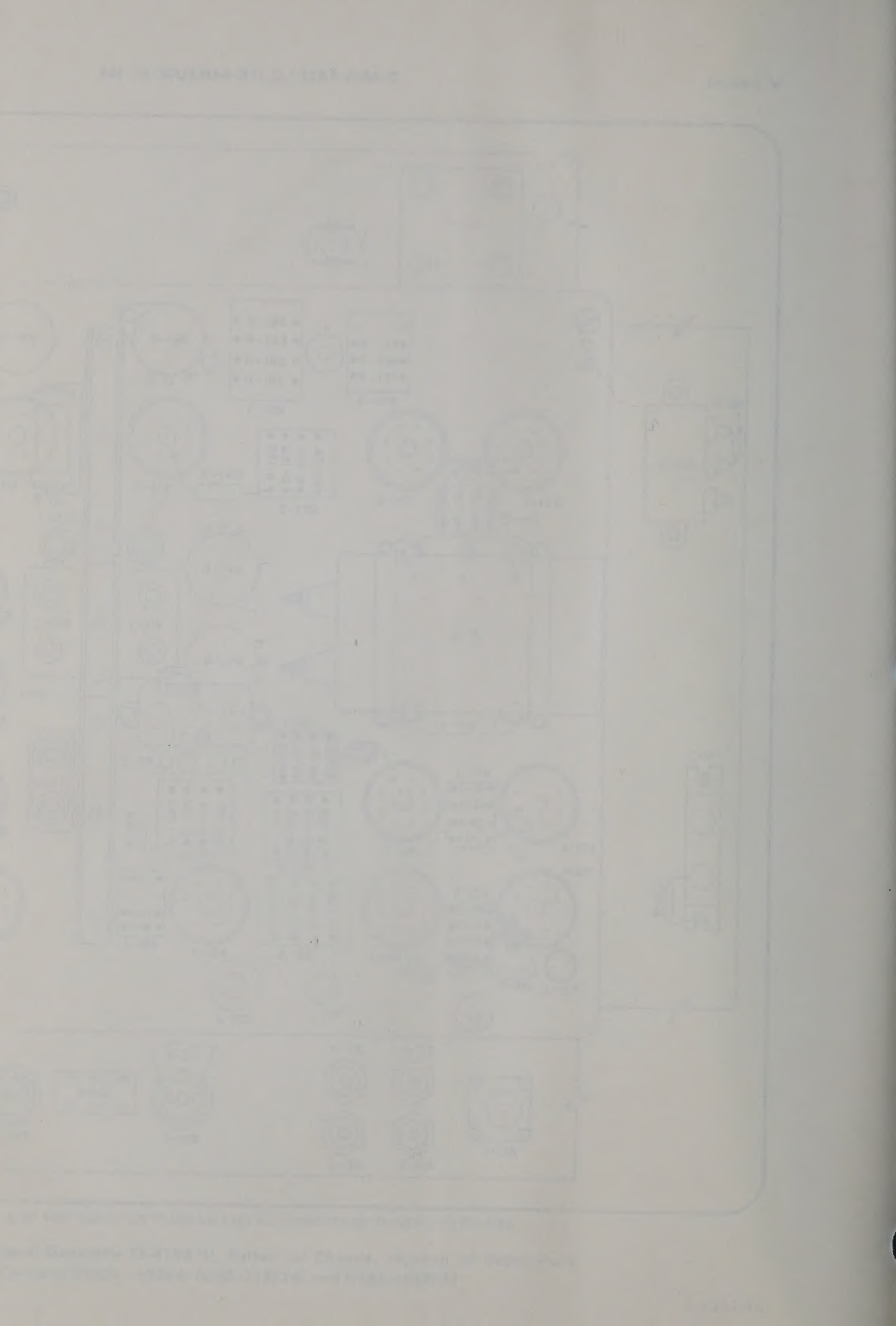




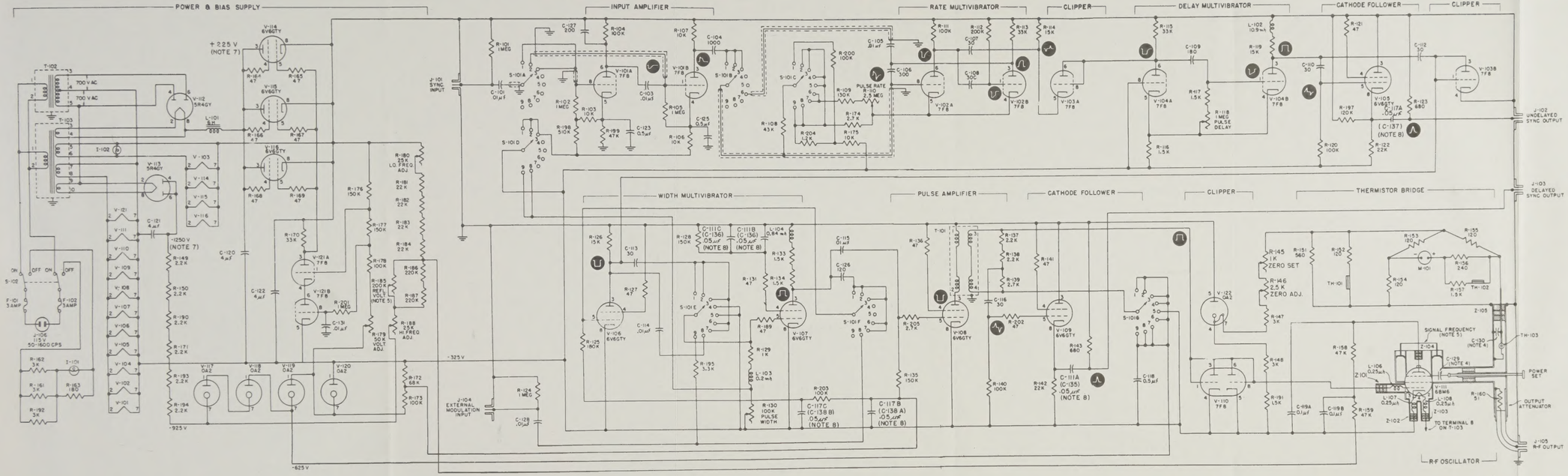


NOTE: SEE FIGURES 5-3, 5-3A, 5-3B, AND 5-3C FOR LOCATION DIAGRAM FOR EQUIPMENTS OF OTHER CONTRACTS.

Figure 5-3D. Signal Generator TS-419A/U, Bottom of Chassis, Location of Detail Parts (Contracts N383s-16939A, N383-31275A, and N383-46039A)







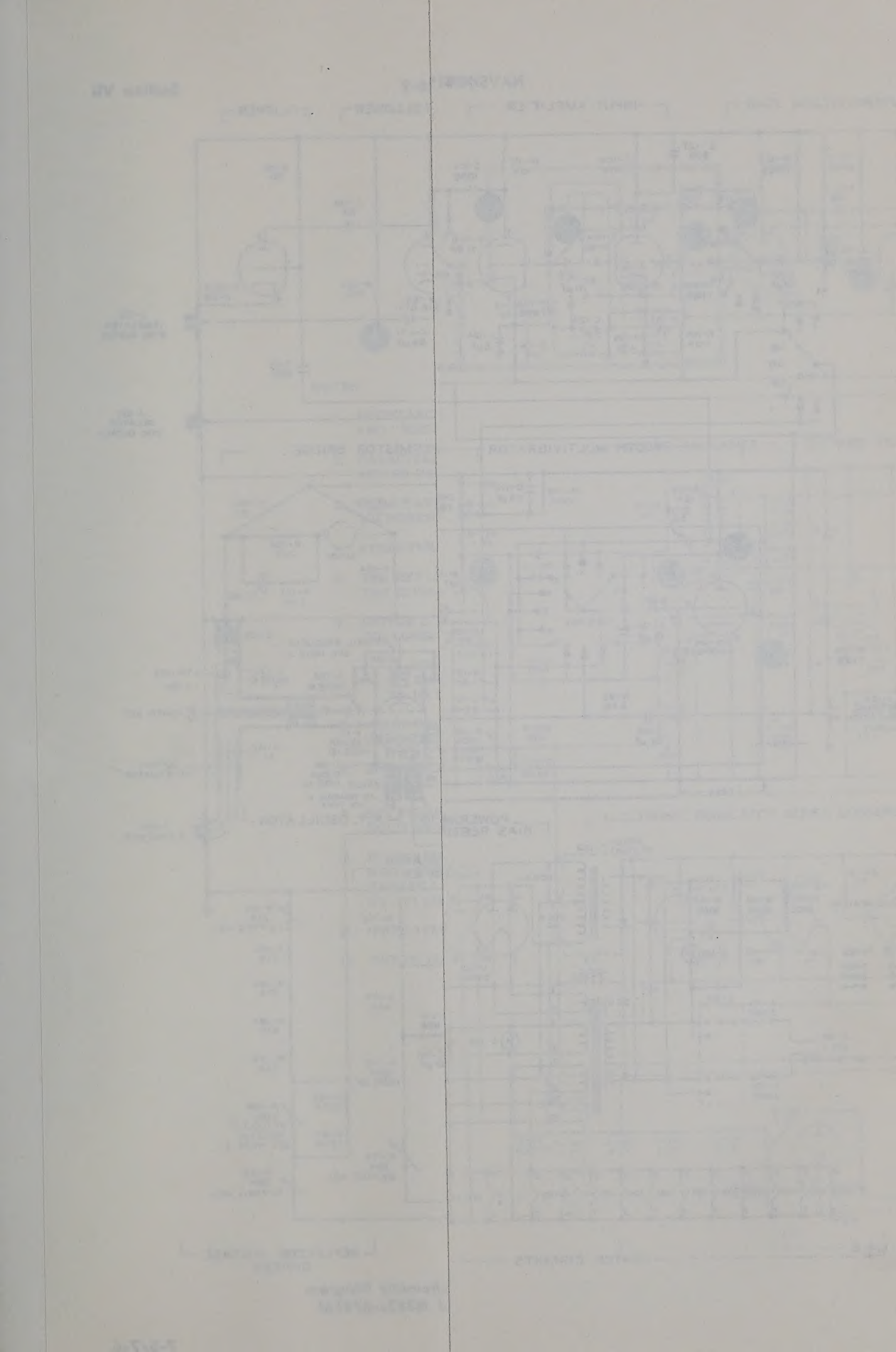
NOTES:

1. RESISTANCE VALUES IN OHMS, MULTIPLIER "K" EQUALS 1,000 AND "MEG" EQUALS 1,000,000.
2. CAPACITANCE VALUES IN MICROMICROFARADS UNLESS FOLLOWED BY "UF" MICROFARAD.
3. INDUCTANCE VALUES IN HENRIES (H), MILLIHENRIES (MH), OR MICROHENRIES (UH).
4. STRUCTURAL PART OF CAVITY.
5. THE REFLECTOR VOLTAGE ADJUSTMENT R-185 IS GANGED TO THE SIGNAL FREQUENCY CONTROL.
6. SWITCH S-101 POSITIONS CORRESPOND WITH FUNCTIONS AS FOLLOWS:

1. SIN SYNC	2. NEG SYNC	3. POS SYNC
4. ZERO SET	5. CW	6. RATE X1
7. RATE X10	8. POS MOD	9. NEG MOD

7. VOLTAGE VALUE WILL VARY WITH PRIMARY VOLTAGE INPUT VOLTAGE INDICATED MEASURED WITH 115-VOLT, 60-CYCLE INPUT.
8. IN EQUIPMENTS OF CONTRACT NO. N383S-61060, C-111A IS DESIGNATED AS C-135, C-111B AND C-111C ARE COMBINED AND DESIGNATED AS C-136, C-117A IS DESIGNATED AS C-137, C-117B AS C-138A, AND C-117C AS C-138B.
9. SEE FIGURES 7-1A, 7-1B, AND 7-1C FOR CIRCUIT USED IN EQUIPMENTS OF OTHER CONTRACTS.

Figure 7-1. Signal Generator TS-419/U, Schematic Diagram (Contract No. NOa(s)-9748, N383s-60879, and N383s-61060)





NOTES:

1. RESISTANCE VALUES IN OHMS. MULTIPLIER "K" EQUALS 1,000 AND "MEG" EQUALS 1,000,000.
2. CAPACITANCE VALUES IN MICROMICROFARADS UNLESS FOLLOWED BY "uf" - MICROFARAD.
3. INDUCTANCE VALUES IN HENRIES (H), MILLIHENRIES (mh), OR MICROHENRIES (uh).
4. STRUCTURAL PART OF CAVITY.
5. THE REFLECTOR VOLTAGE ADJUSTMENT R-185 IS GANGED TO THE SIGNAL FREQUENCY CONTROL.
6. SWITCH S-101 POSITIONS CORRESPOND WITH FUNCTIONS AS FOLLOWS:

1. SIN SYNC	2. NEG SYNC	3. POS SYNC
4. ZERO SET	5. CW	6. RATE X1
7. RATE X10	8. POS MOD	9. NEG MOD

7. VOLTAGE VALUE WILL VARY WITH PRIMARY VOLTAGE INPUT. VOLTAGE INDICATED MEASURED WITH 115-VOLT, 60-CYCLE INPUT.
8. IN SERIAL NO. 899-1385 OF CONTRACT N°43s-45741, R-109 WAS 120K.
9. SEE FIGURES 7-1, 7-1B, AND 7-1C FOR CIRCUIT USED IN EQUIPMENTS OF OTHER CONTRACTS.
10. IN EQUIPMENTS MANUFACTURED UNDER CONTRACT N383s-5019A, R-145 IS 1.5K, R-178 IS 110K. CHOKES L-106, L-107 AND L-108 ARE OMITTED. AND TY-101 AND TY-102 ARE ADDED.
11. TYPE 7F8W REPLACES TYPE 7F8 USED PREVIOUSLY.
12. REFER TO NOTE. SECTION IV. PARAGRAPH 6.c.

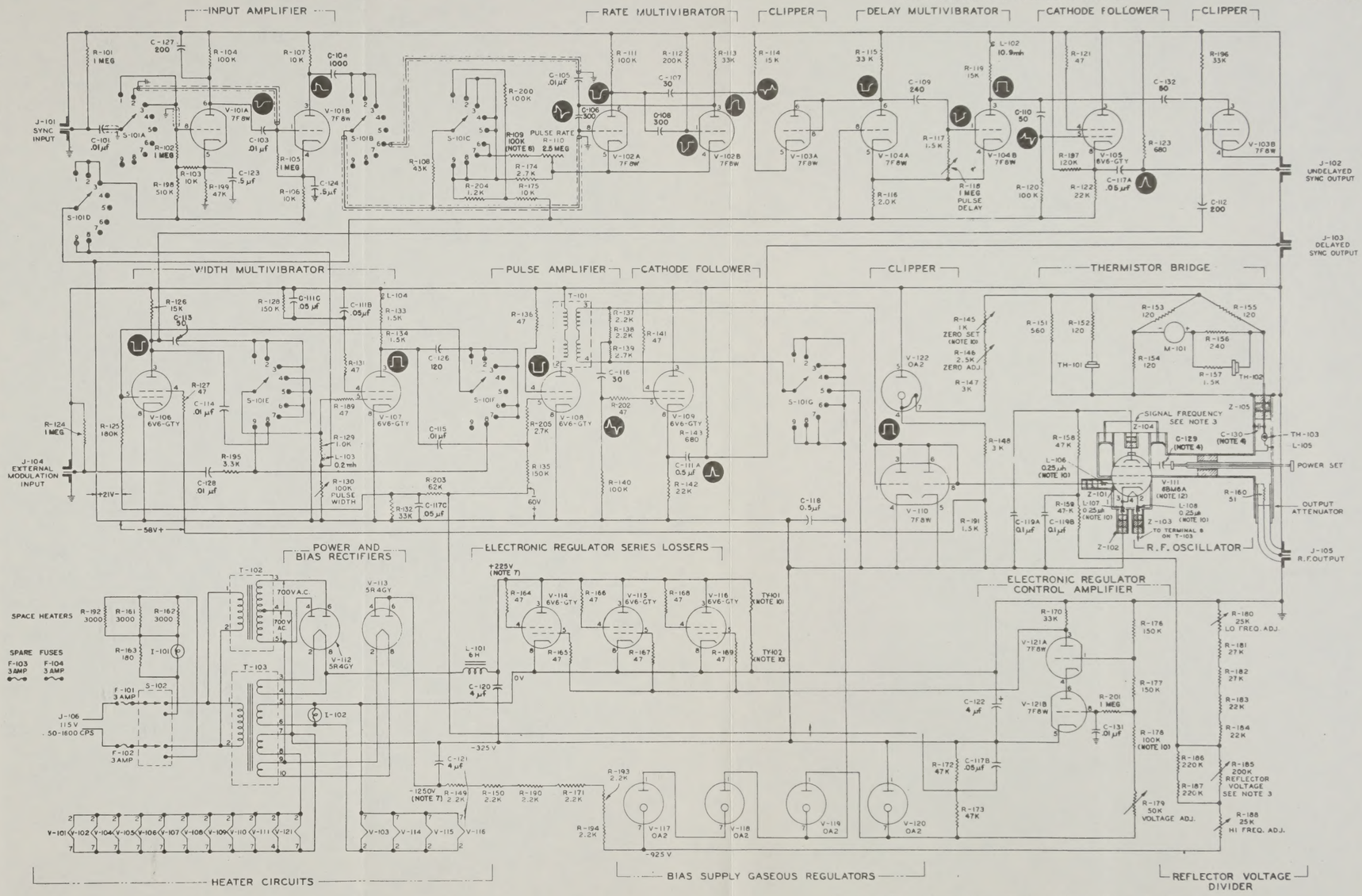
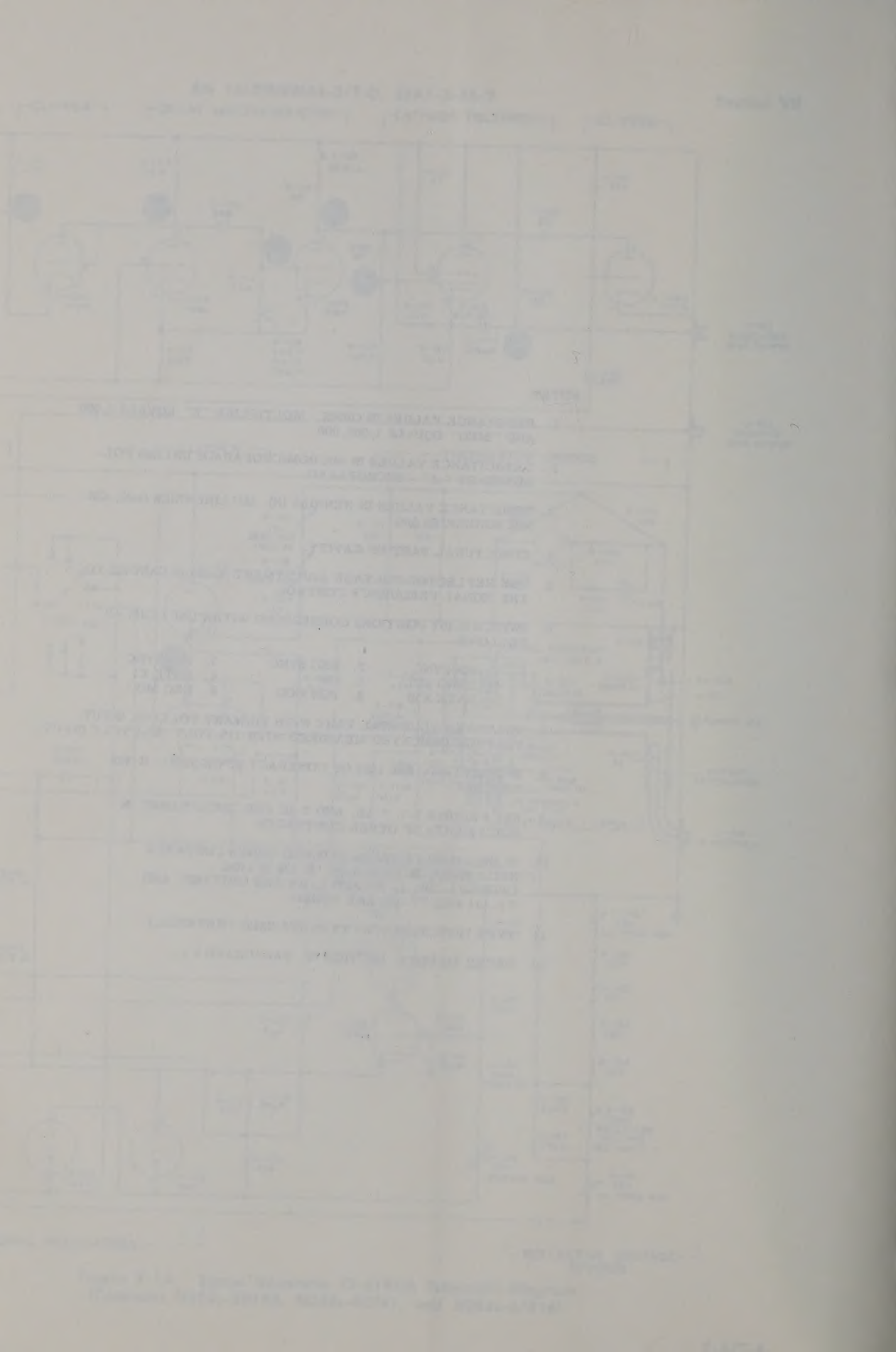
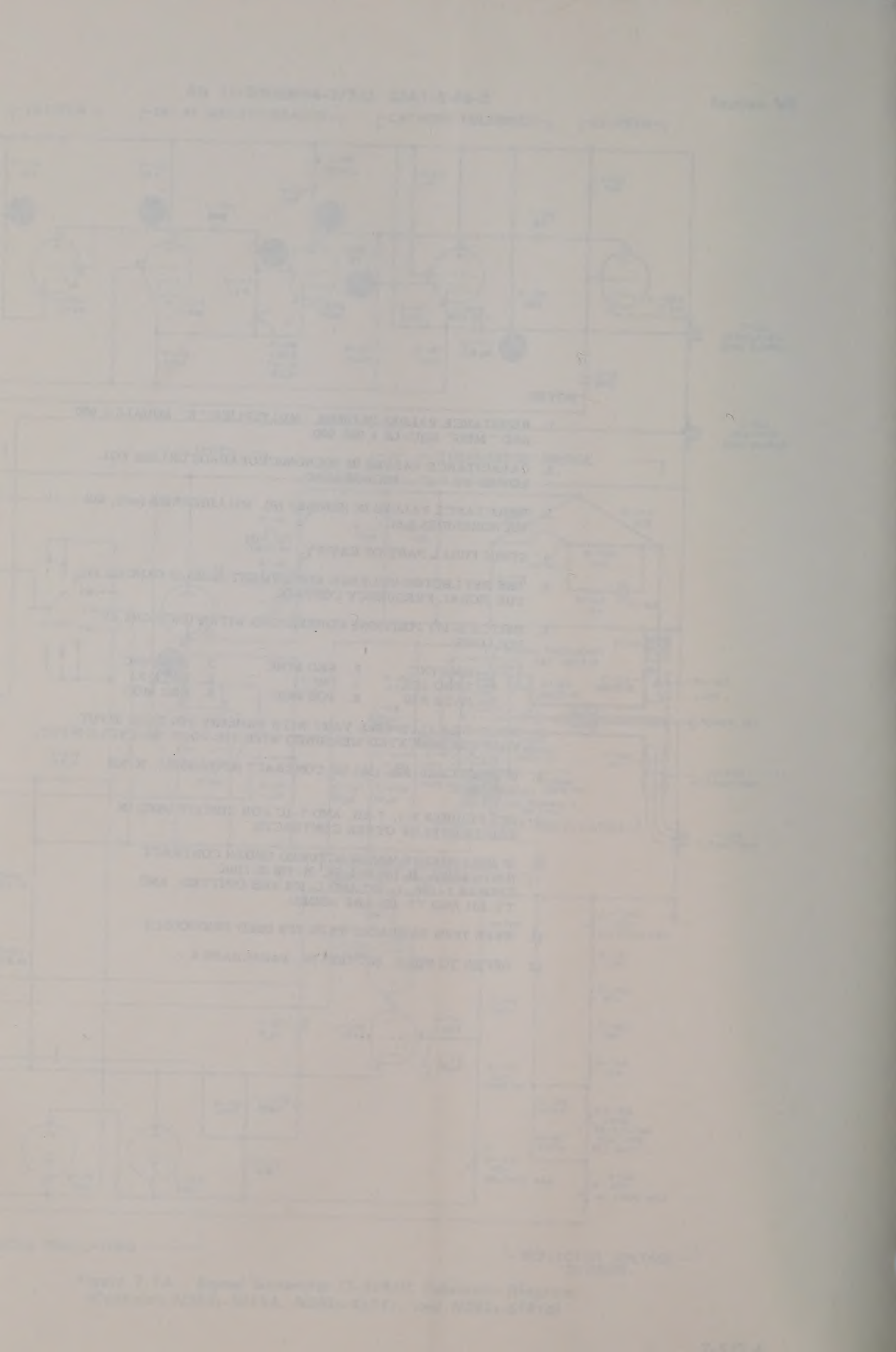
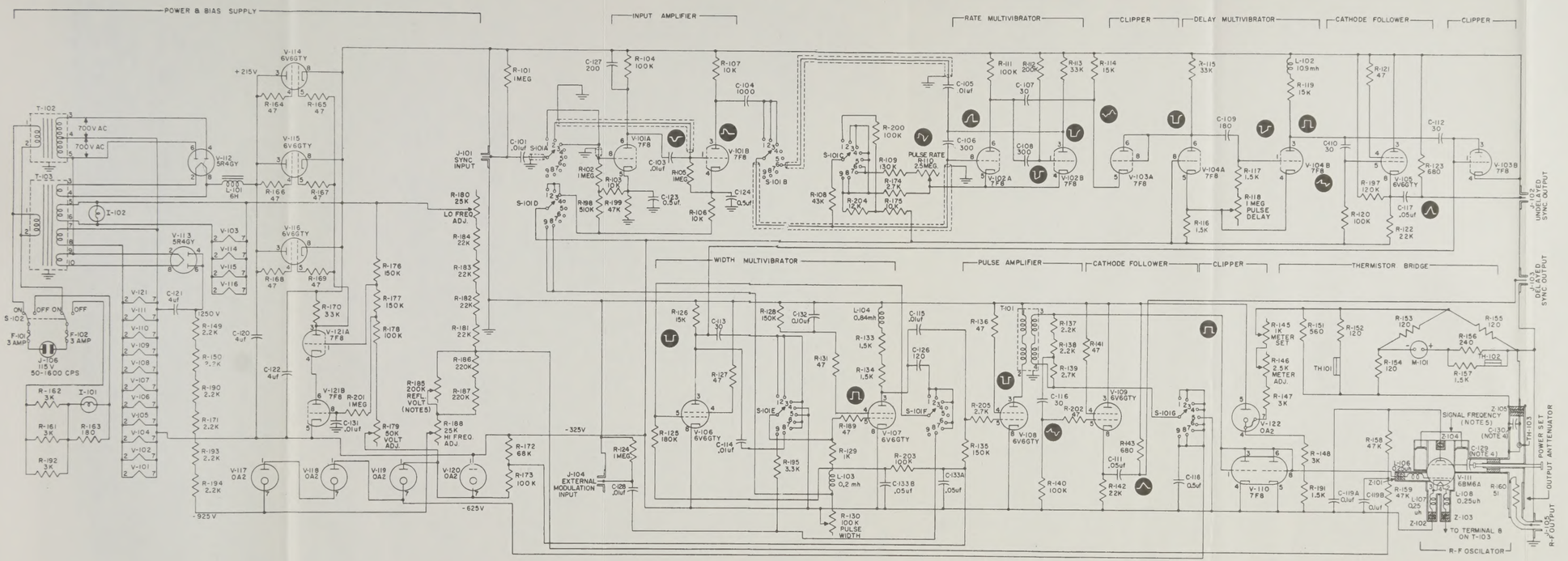


Figure 7-1A. Signal Generator TS-419/U, Schematic Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)



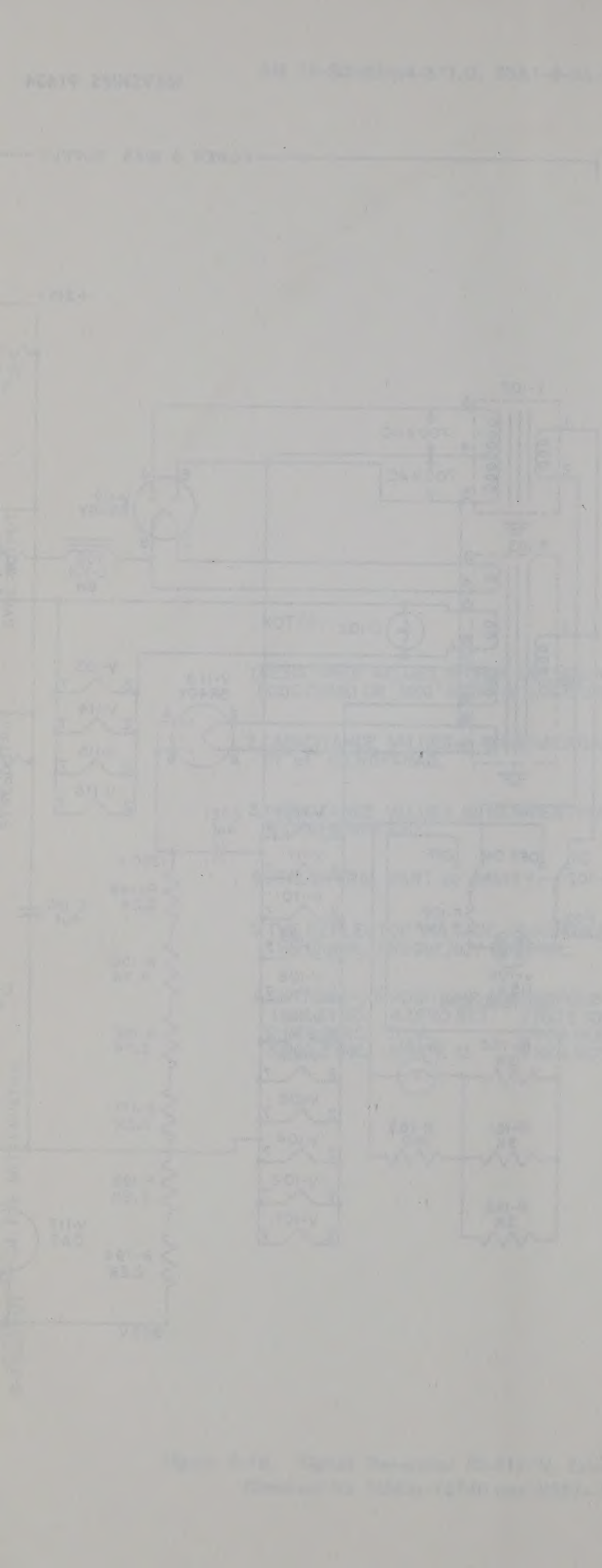


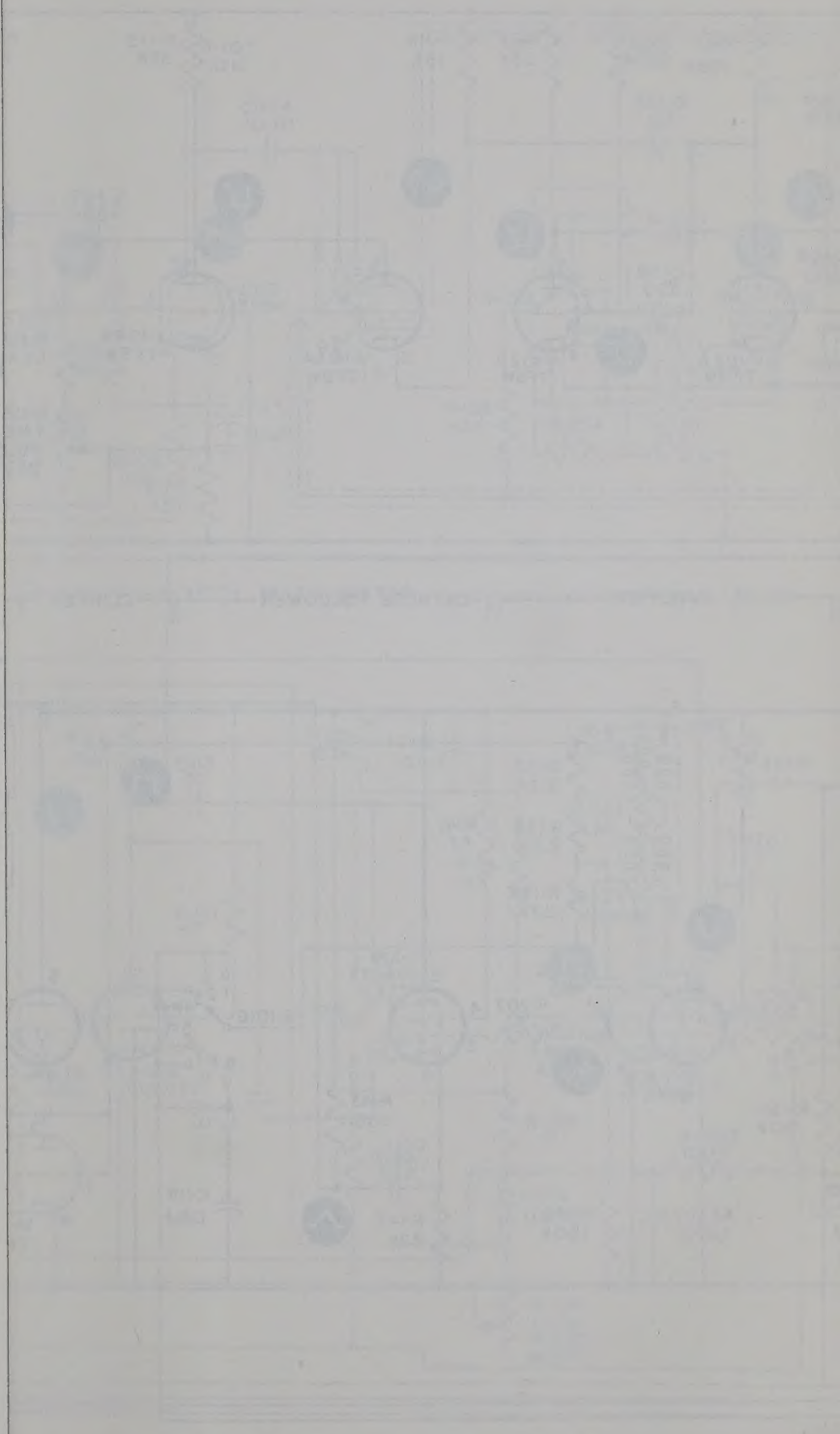


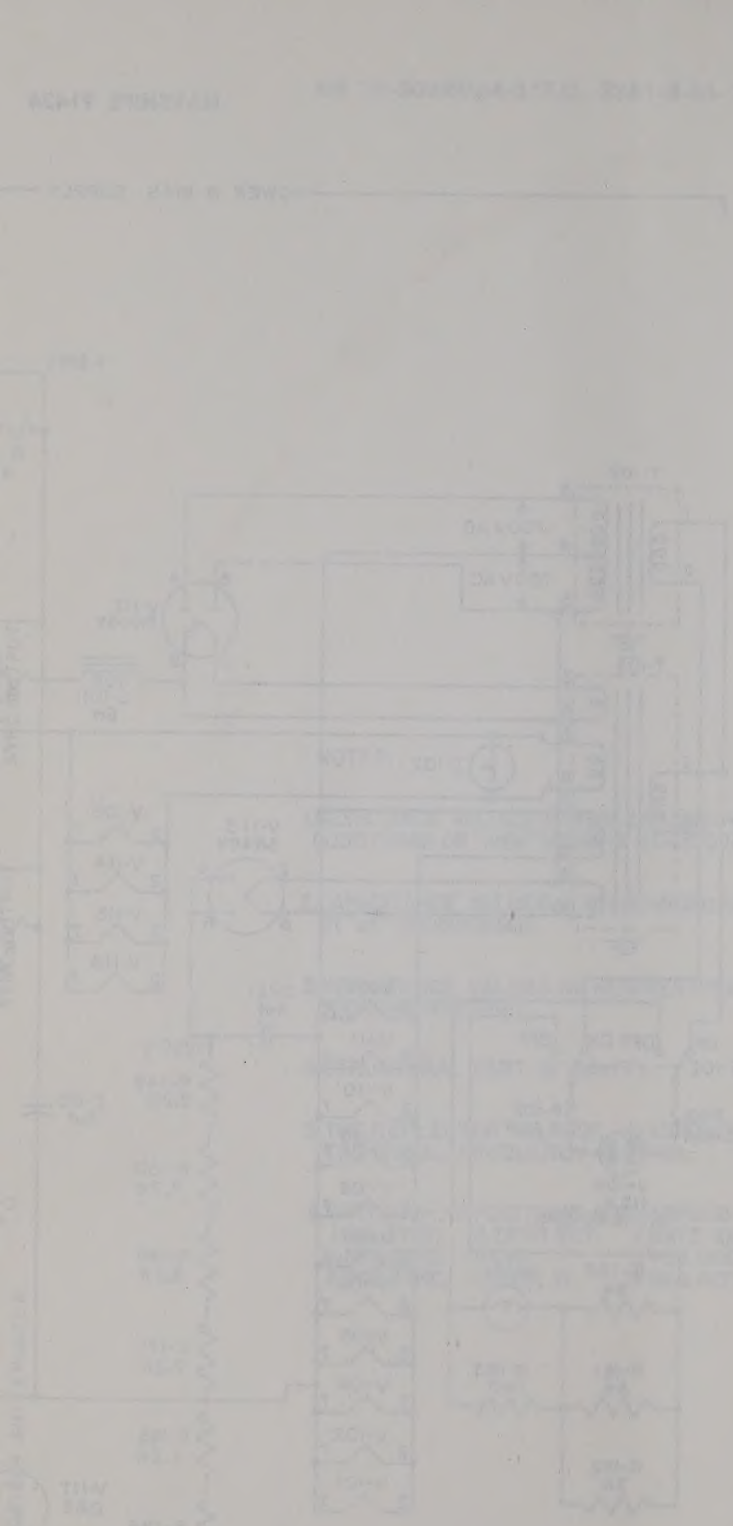
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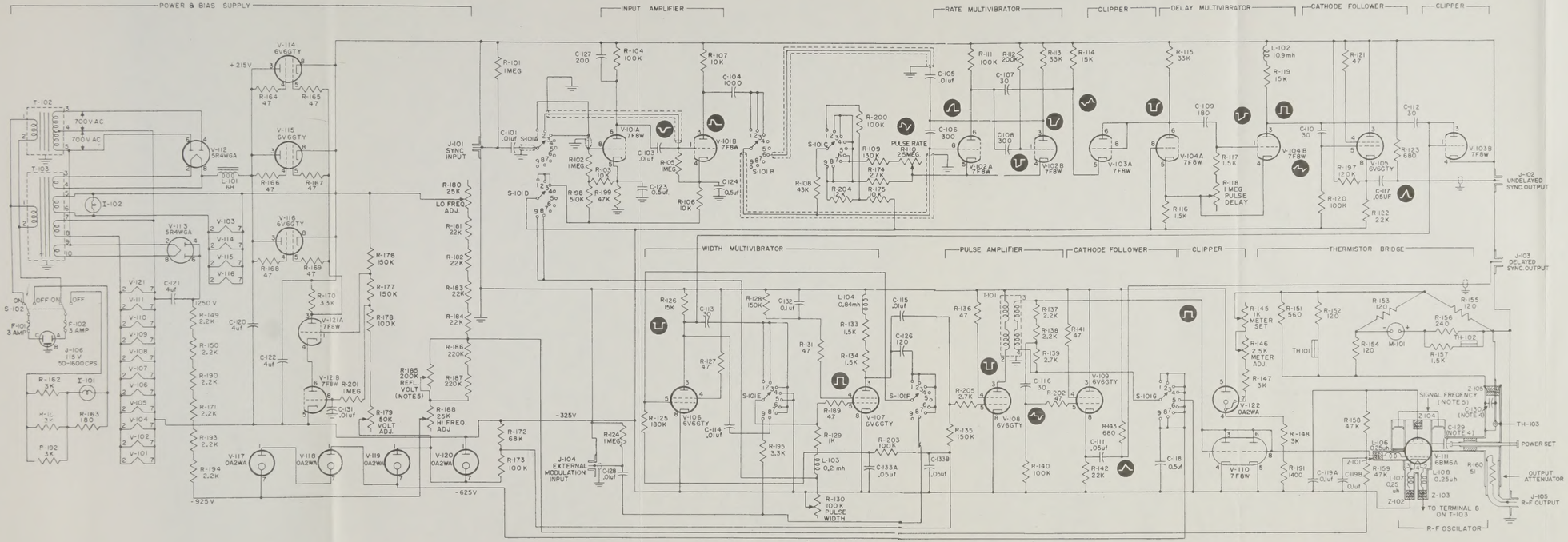
1. RESISTANCE VALUES IN OHMS UNLESS FOLLOWED BY "K" KILOHM (1000 OHMS) OR "MEG" MEGOHM (1,000,000 OHMS).
2. CAPACITANCE VALUES IN MICROMICROFARADS UNLESS FOLLOWED BY "uf" MICROFARAD.
3. INDUCTANCE VALUES IN HENRIES (H) MILLIHENRIES (mh) OR MICROHENRIES (uh).
4. STRUCTURAL PART OF CAVITY.
5. THE REFLECTOR VOLTAGE ADJUSTMENT R-185 IS GANGED TO THE SIGNAL FREQUENCY CONTROL.
6. SWITCH S-101 POSITIONS CORRESPOND WITH FUNCTIONS AS FOLLOWS:
   1. SIN. SYNC. 4. ZERO SET. 7. RATE X10.
   2. NEG. SYNC. 5. CW. 8. POS. MOD.
   3. POS. SYNC. 6. RATE X1. 9. NEG. MOD.

Figure 7-18. Signal Generator TS-419/U, Schematic Diagram (Contract No. N383s-75748 and N383s-77651)







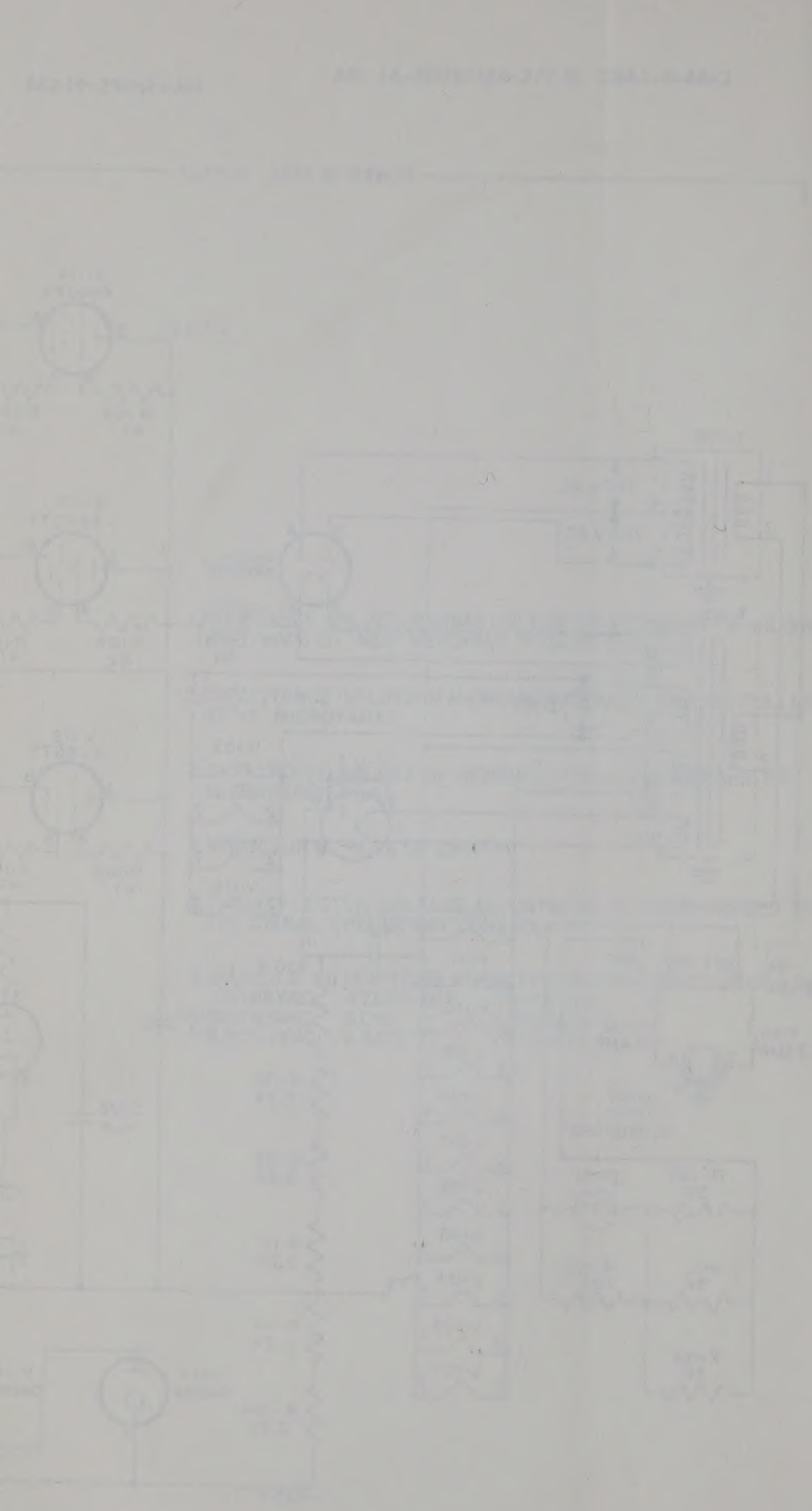


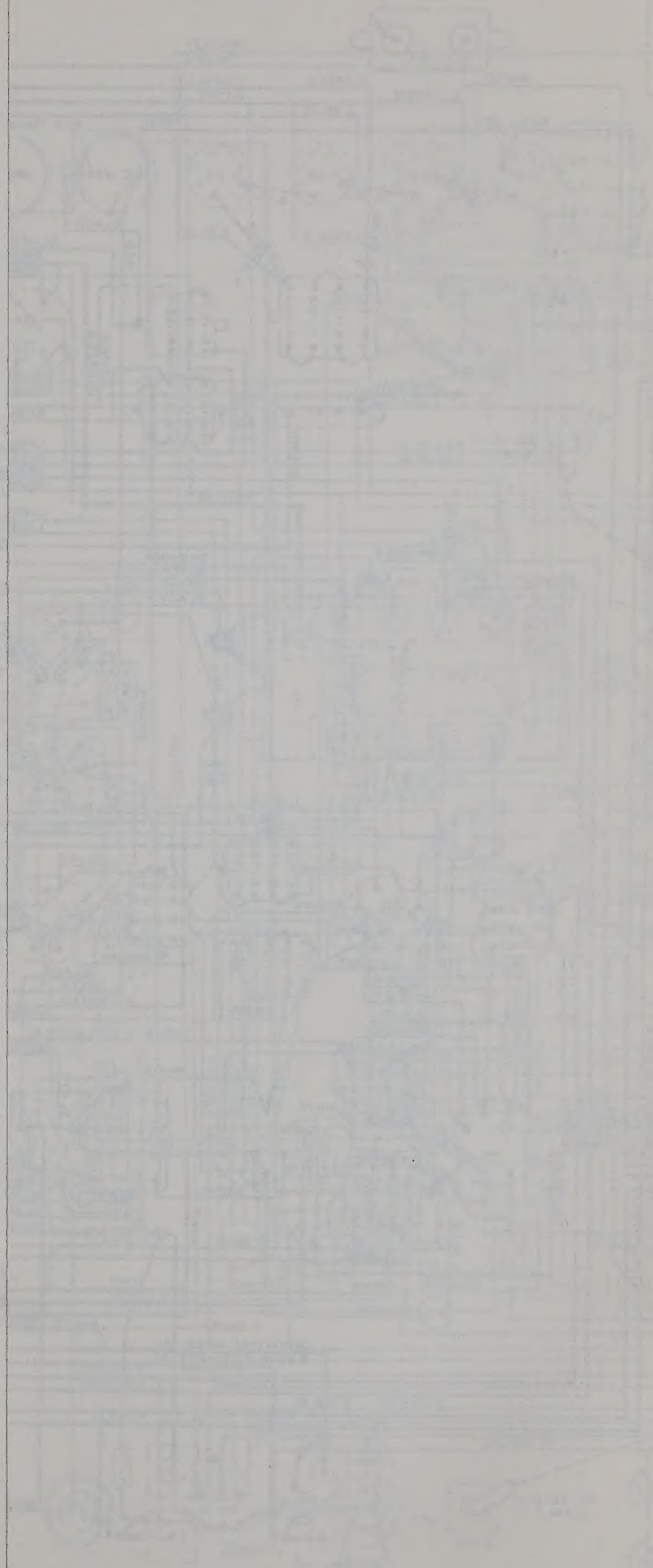
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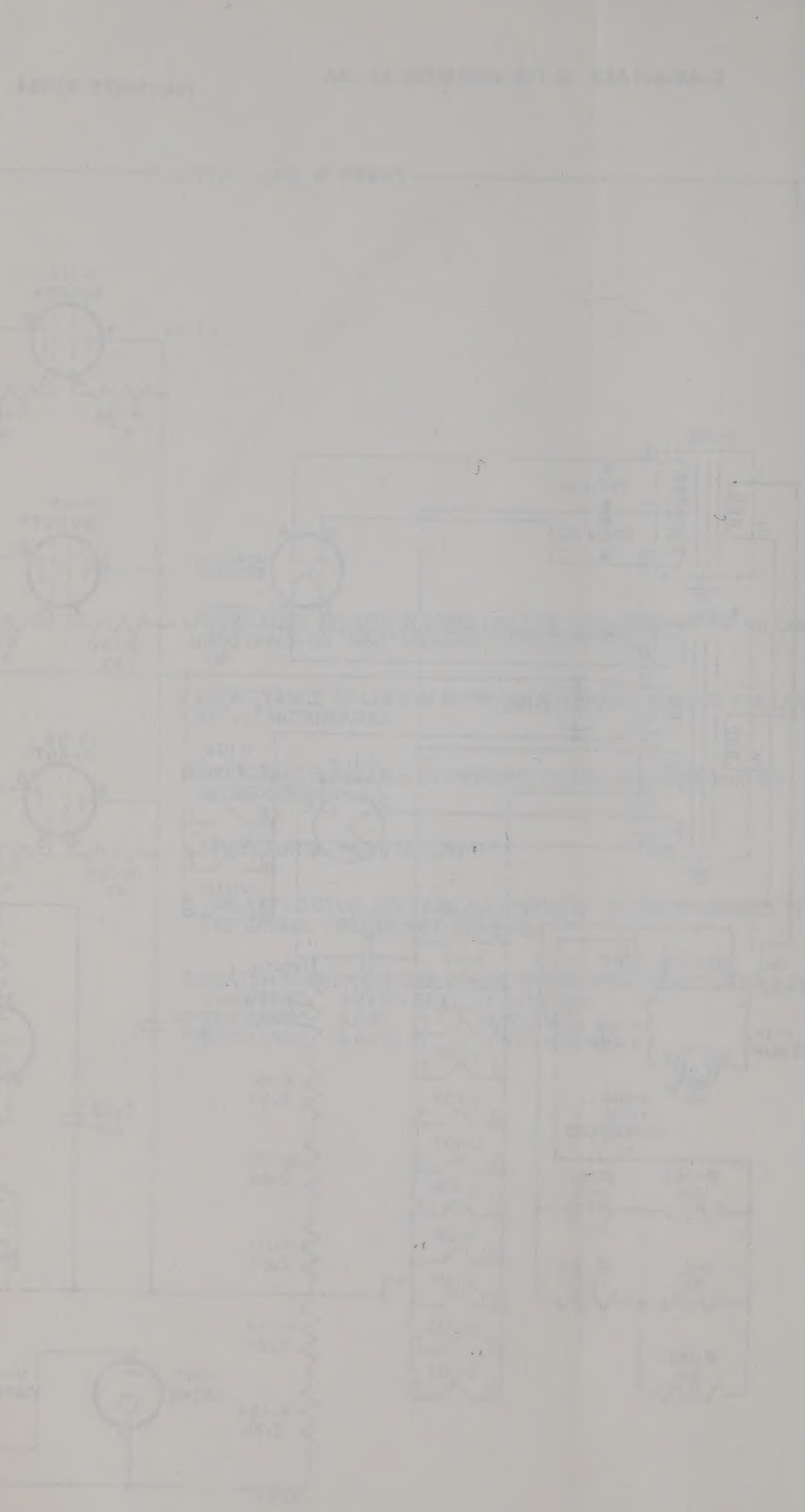
1. RESISTANCE VALUES IN OHMS UNLESS FOLLOWED BY "K" KILOHM (1000 OHMS) OR "MEG" MEGOHM (1,000,000 OHMS).
2. CAPACITANCE VALUES IN MICROMICROFARADS UNLESS FOLLOWED BY "uf" MICROFARAD.
3. INDUCTANCE VALUES IN HENRIES (H) MILLIHENRIES (mh) OR MICROHENRIES (uh).
4. STRUCTURAL PART OF CAVITY.
5. THE REFLECTOR VOLTAGE ADJUSTMENT R-185 IS GANGED TO THE SIGNAL FREQUENCY CONTROL.
6. SWITCH S-101 POSITIONS CORRESPOND WITH FUNCTIONS AS FOLLOWS:

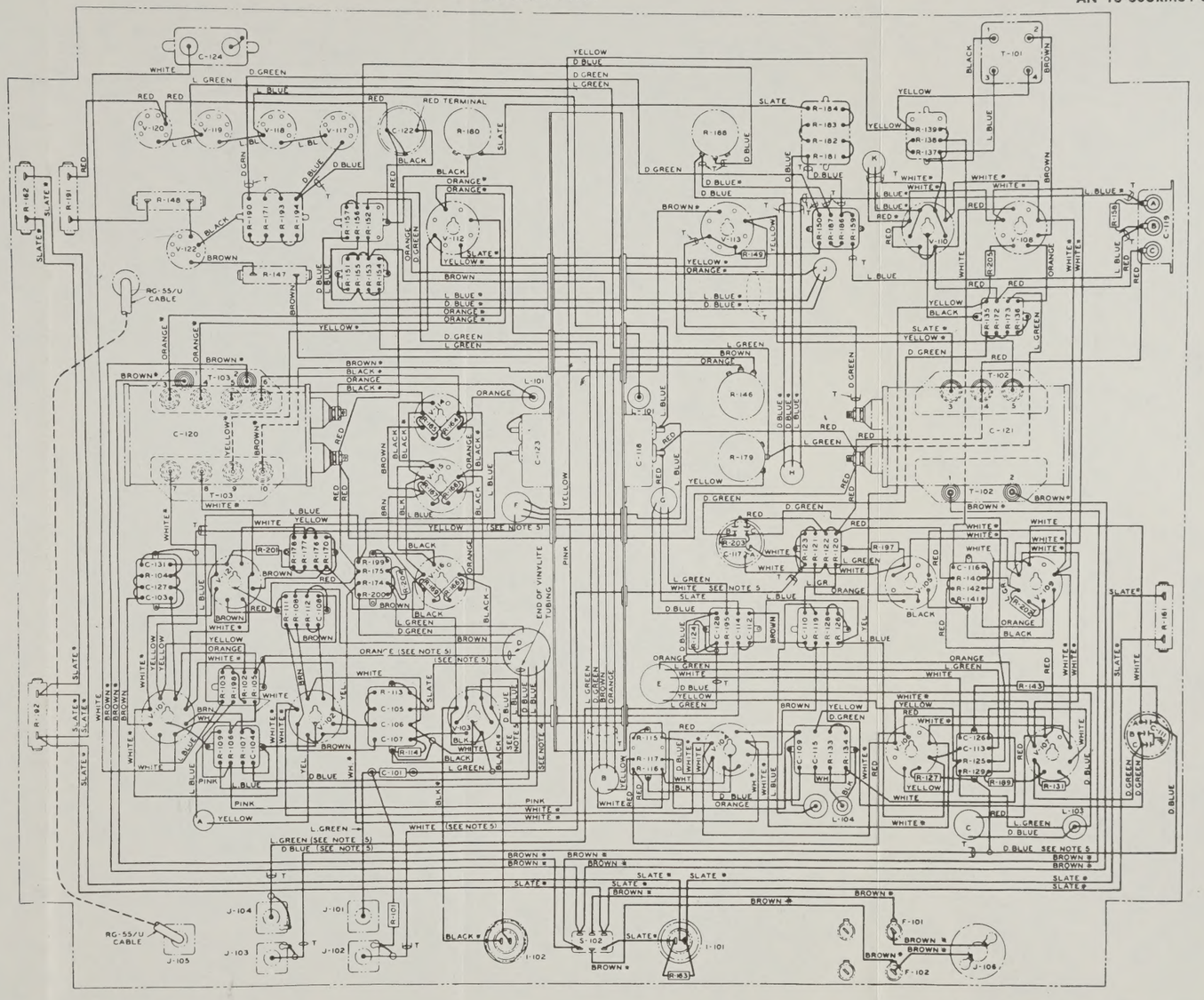
1. SIN. SYNC.	4. ZERO SET.	7. RATE XIO.
2. NEG. SYNC.	5. CW.	8. POS. MOD.
3. POS. SYNC.	6. RATE XI	9. NEG. MOD.

Figure 7-1C. Signal Generator TS-419A/U, Schematic Diagram (Contract No. N383s-16939A, N383-31275A and N383-46093A)









NOTES:

1. ALL WIRES MARKED WITH COLOR NOTE ONLY ARE #22 SOLID COPPER WITH VINYLITE INSULATION.
2. WIRES MARKED WITH COLOR NOTE AND (*) ARE #22 STRANDED COPPER WITH VINYLITE INSULATION.
3. ALL UNMARKED WIRES ARE #22 BARE TINNED SOLID COPPER.
4. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID; BRAID CONNECTED TO GROUND AS SHOWN.
5. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID AND COVERED WITH VINYLITE TUBING. BRAID CONNECTED TO GROUND AS SHOWN.
6. SINGLE WIRES AND GROUPS OF WIRES MARKED "T," COVERED WITH VINYLITE TUBING.
7. ABBREVIATIONS IN COLOR NOTES: L = LIGHT; D = DARK; GR = GREEN; BL = BLUE; WH = WHITE.
8. AVOID SHARP BENDS IN VINYLITE WIRE. SEE DETAIL "A" FOR DRESSING OF LEADS FROM TERMINALS OF TRANSFORMERS AND CAPACITORS. SEE DETAIL "B" FOR DRESSING OF LEADS THROUGH BUSHINGS.
9. FOR COMPLETION OF OVERALL WIRING DIAGRAM SEE FIG. 7-3. CONTINUITY OF WIRING THROUGH BUSHINGS CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS (A)(E)(J) ETC., ON FIGURES 7-2 AND 7-3.
10. SEE FIGURE 7-3 FOR TOP-OF-CHASSIS WIRING DIAGRAM.
11. SEE FIGURE 7-2A, 7-2B, 7-2C, AND 7-2D FOR WIRING USED IN EQUIPMENTS OF OTHER CONTRACTS.

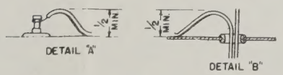
Figure 7-2. Signal Generator TS-419/U, Bottom of Chassis, Wiring Diagram (Contract No. NOa(s)-9748 and NOa(s)-12279)

LIST OF COMPARABLE REFERENCE DESIGNATIONS

N383s-45741 N383s-67816	N383s-5019A	N383s-45741 N383s-67816	N383s-5019A
X-101	XV-101	X-115	XV-115
X-102	XV-102	X-116	XV-116
X-103	XV-103	X-117	XV-117
X-104	XV-104	X-118	XV-118
X-105	XV-105	X-119	XV-119
X-106	XV-106	X-120	XV-120
X-107	XV-107	X-121	XV-121
X-108	XV-108	X-122	XV-122
X-109	XV-109	X-123	XF-101
X-110	XV-110	X-124	XF-102
X-111	XV-111	X-125	XF-103
X-112	XV-112	X-126	XF-104
X-113	XV-113	X-127	XI -101
X-114	XV-114	X-128	XI -102

NOTES:

1. ALL WIRES MARKED WITH COLOR NOTE ONLY ARE #22 SOLID COPPER WITH VINYLITE INSULATION.
2. WIRES MARKED WITH COLOR NOTE AND (*) ARE #22 STRANDED COPPER WITH VINYLITE INSULATION.
3. ALL UNMARKED WIRES ARE #22 BARE TINNED SOLID COPPER.
4. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID; BRAID CONNECTED TO GROUND AS SHOWN.
5. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID AND COVERED WITH VINYLITE TUBING. BRAID CONNECTED TO GROUND AS SHOWN.
6. SINGLE WIRES AND GROUPS OF WIRES MARKED "T" COVERED WITH VINYLITE TUBING.
7. ABBREVIATIONS IN COLOR NOTES: L = LIGHT; D = DARK; GR = GREEN; BL = BLUE; WH = WHITE.
8. AVOID SHARP BENDS IN VINYLITE WIRE. SEE DETAIL "A" FOR DRESSING OF LEADS FROM TERMINALS OF TRANSFORMERS AND CAPACITORS. SEE DETAIL "B" FOR DRESSING OF LEADS THROUGH BUSHINGS.
9. FOR COMPLETION OF OVERALL WIRING DIAGRAM SEE FIG. 7-3A. CONTINUITY OF WIRING THROUGH BUSHINGS CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS (A) (E) (J) ETC., ON FIGURES 7-2A AND 7-3A.
10. SEE FIGURE 7-3A FOR RELATED TOP-OF-CHASSIS WIRING DIAGRAM.
11. SEE FIGURES 7-2, 7-2B, 7-2C AND 7-2D FOR COMPARABLE WIRING USED IN EQUIPMENTS OF OTHER CONTRACTS.
12. IN EQUIPMENTS MANUFACTURED UNDER CONTRACT N383s-5019A, TY-101 AND TY-102 HAVE BEEN ADDED.



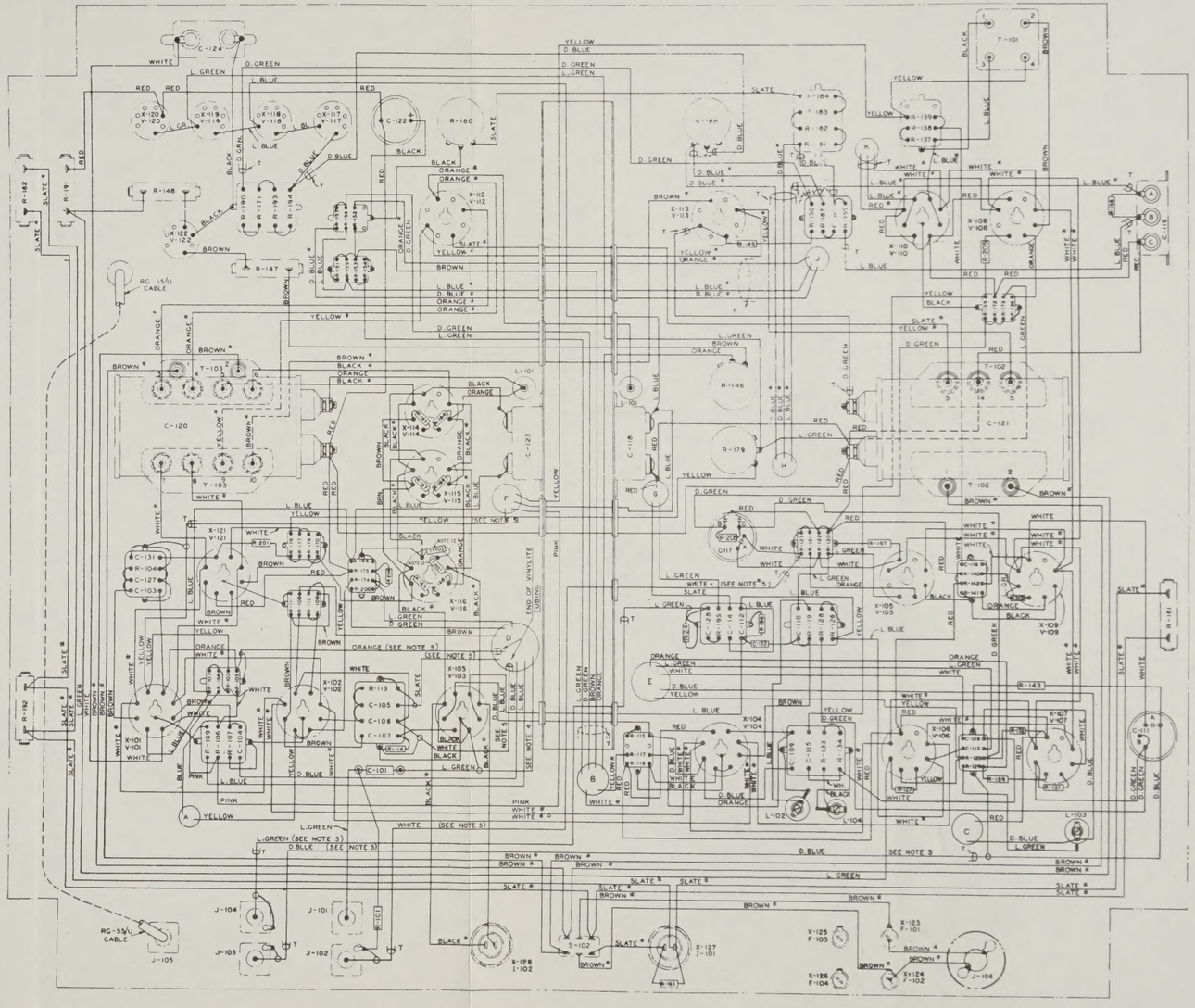
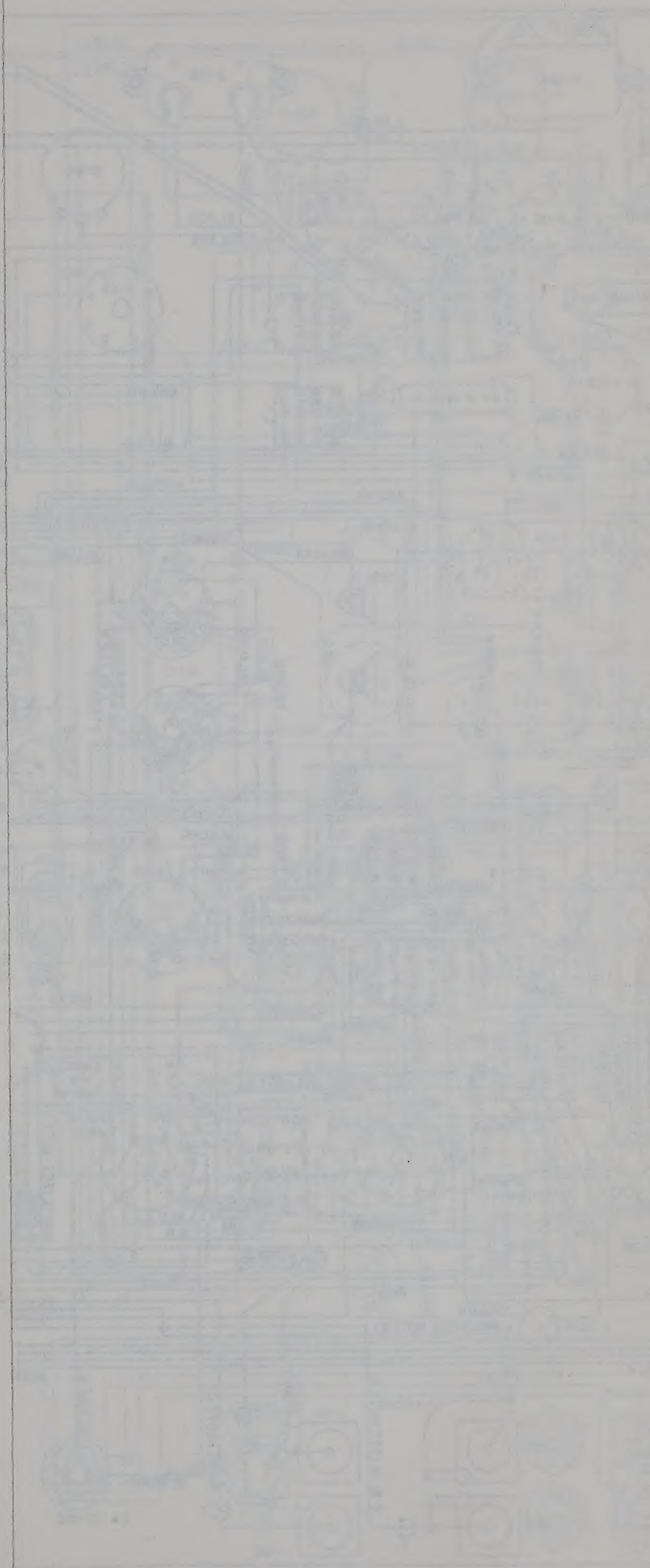
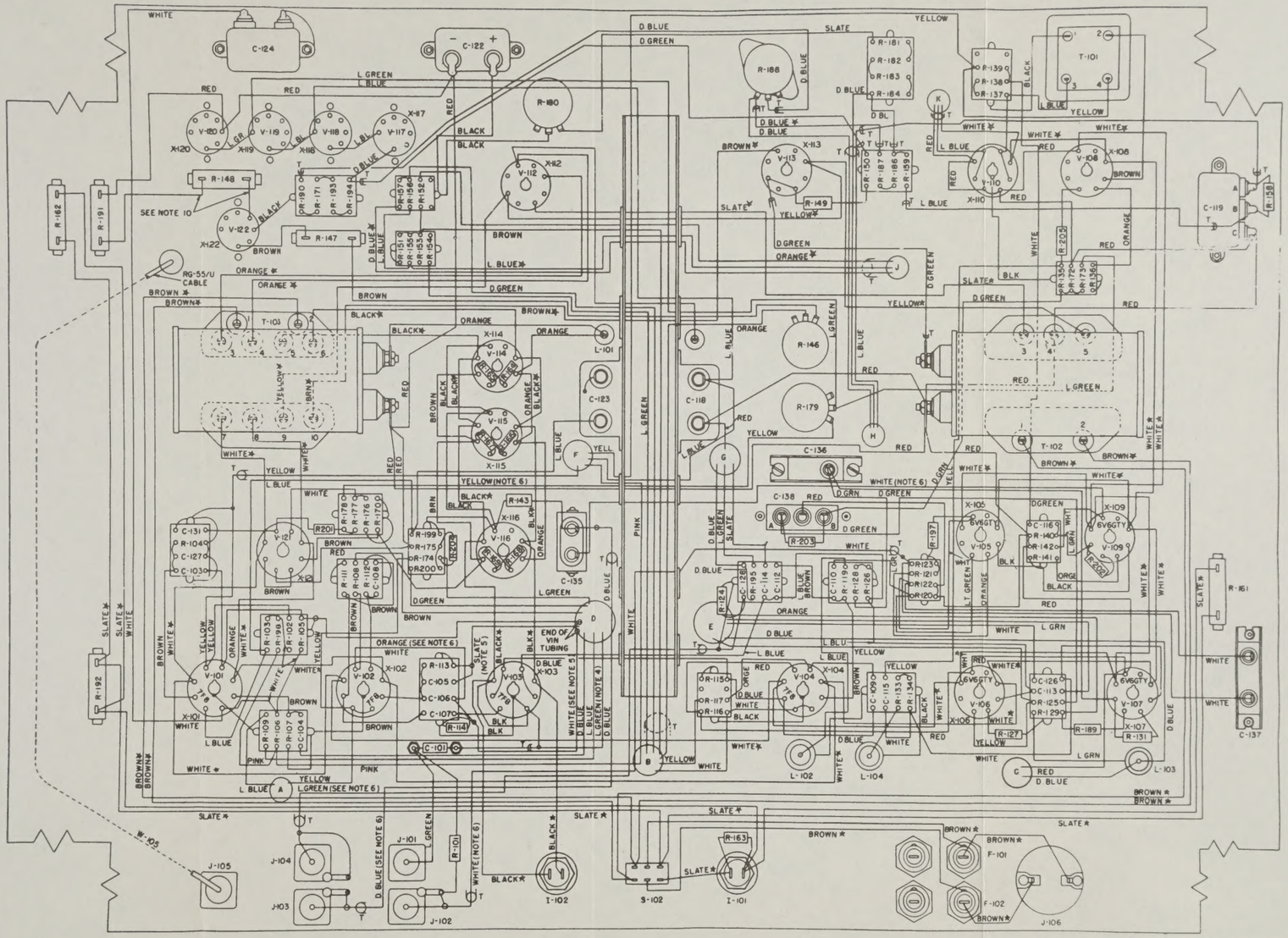


Figure 7-2A. Signal Generator TS-419/U, Bottom of Chassis, Wiring Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)





NOTES:

1. ALL WIRES MARKED WITH COLOR NOTE ONLY ARE #22 SOLID COPPER WITH VINYLITE INSULATION.
2. WIRES MARKED WITH COLOR NOTE AND (*) ARE #22 STRANDED COPPER WITH VINYLITE INSULATION.
3. ALL UNMARKED WIRES ARE #22 BARE TINNED SOLID COPPER.
4. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID; BRAID CONNECTED TO GROUND AS SHOWN.
5. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID AND COVERED WITH VINYLITE TUBING. BRAID CONNECTED TO GROUND AS SHOWN.
6. SINGLE WIRES AND GROUPS OF WIRES MARKED "T," COVERED WITH VINYLITE TUBING.
7. ABBREVIATIONS IN COLOR NOTES: L = LIGHT; D = DARK; GR = GREEN; BL = BLUE; WH = WHITE.
8. AVOID SHARP BENDS IN VINYLITE WIRE. SEE DETAIL "A" FOR DRESSING OF LEADS FROM TERMINALS OF TRANSFORMERS AND CAPACITORS. SEE DETAIL "B" FOR DRESSING OF LEADS THROUGH BUSHINGS.
9. FOR COMPLETION OF OVERALL WIRING DIAGRAM SEE FIG. 7-3B. CONTINUITY OF WIRING THROUGH BUSHINGS CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS (A)(E)(J) ETC., ON FIGURES 7-2B AND 7-3A.
10. SEE FIGURE 7-3A FOR TOP-OF-CHASSIS WIRING DIAGRAM.
11. SEE FIGURES 7-2, 7-2A, 7-2C AND 7-2D FOR COMPARABLE WIRING USED IN EQUIPMENTS OF OTHER CONTRACTS.



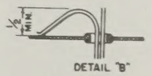
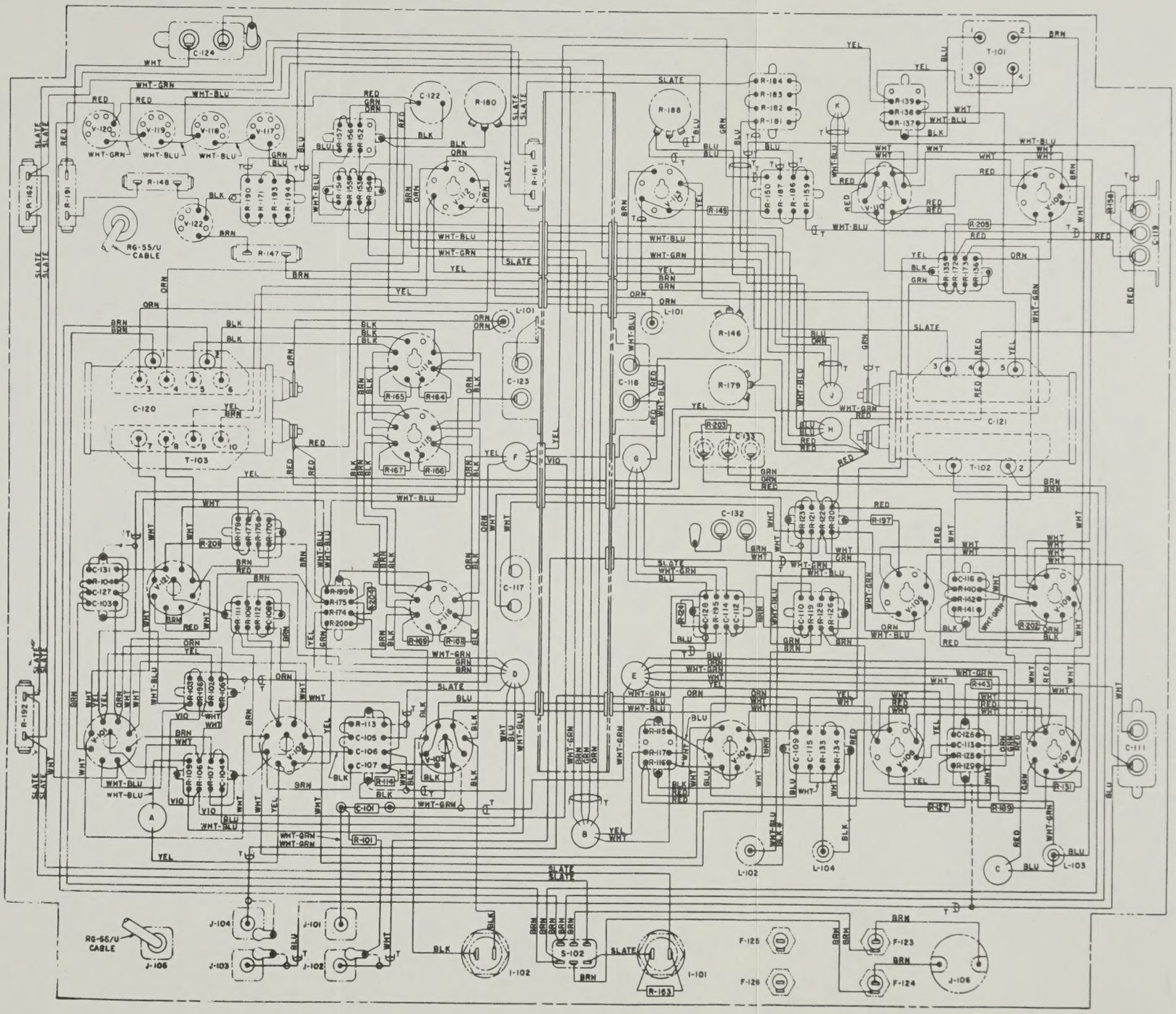


Figure 7-2B. Signal Generator TS-419/U, Bottom of Chassis, Wiring Diagram (Contract No. N383s-60879 and N383s-61060)





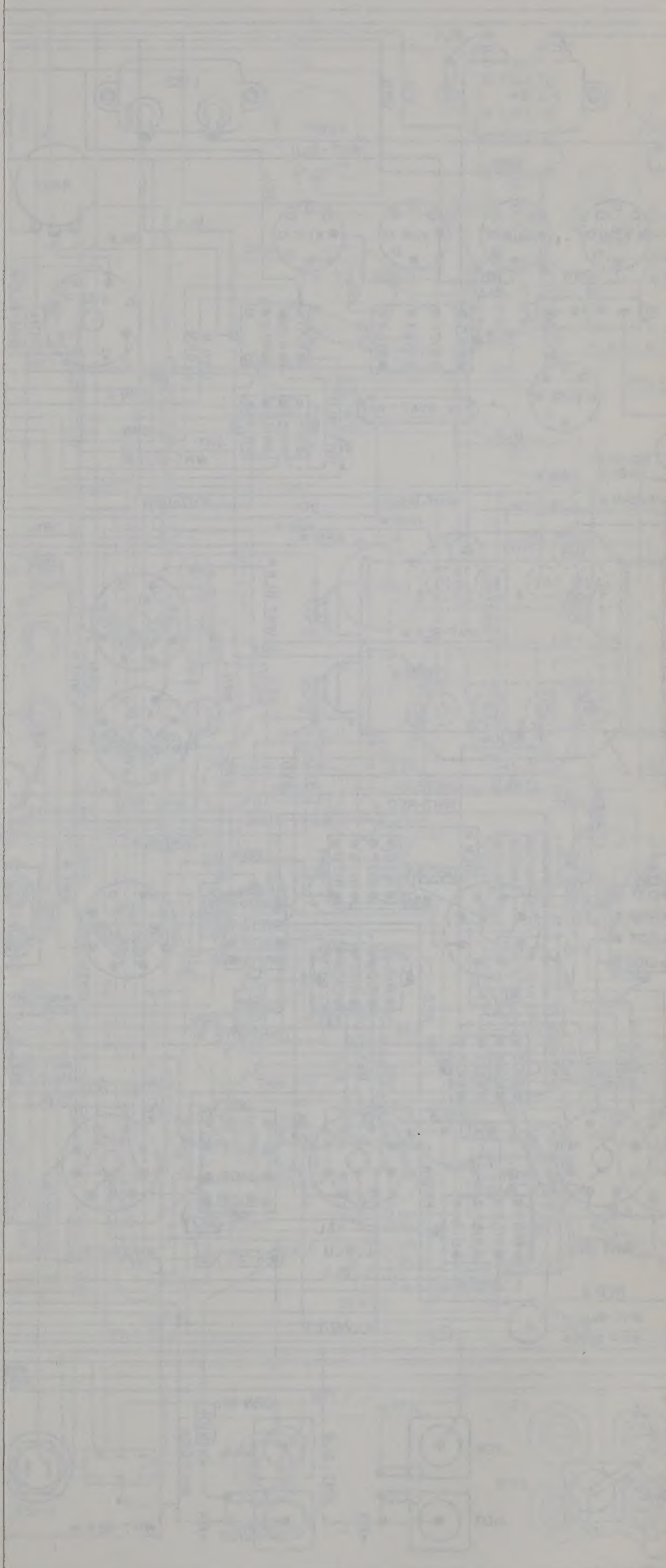


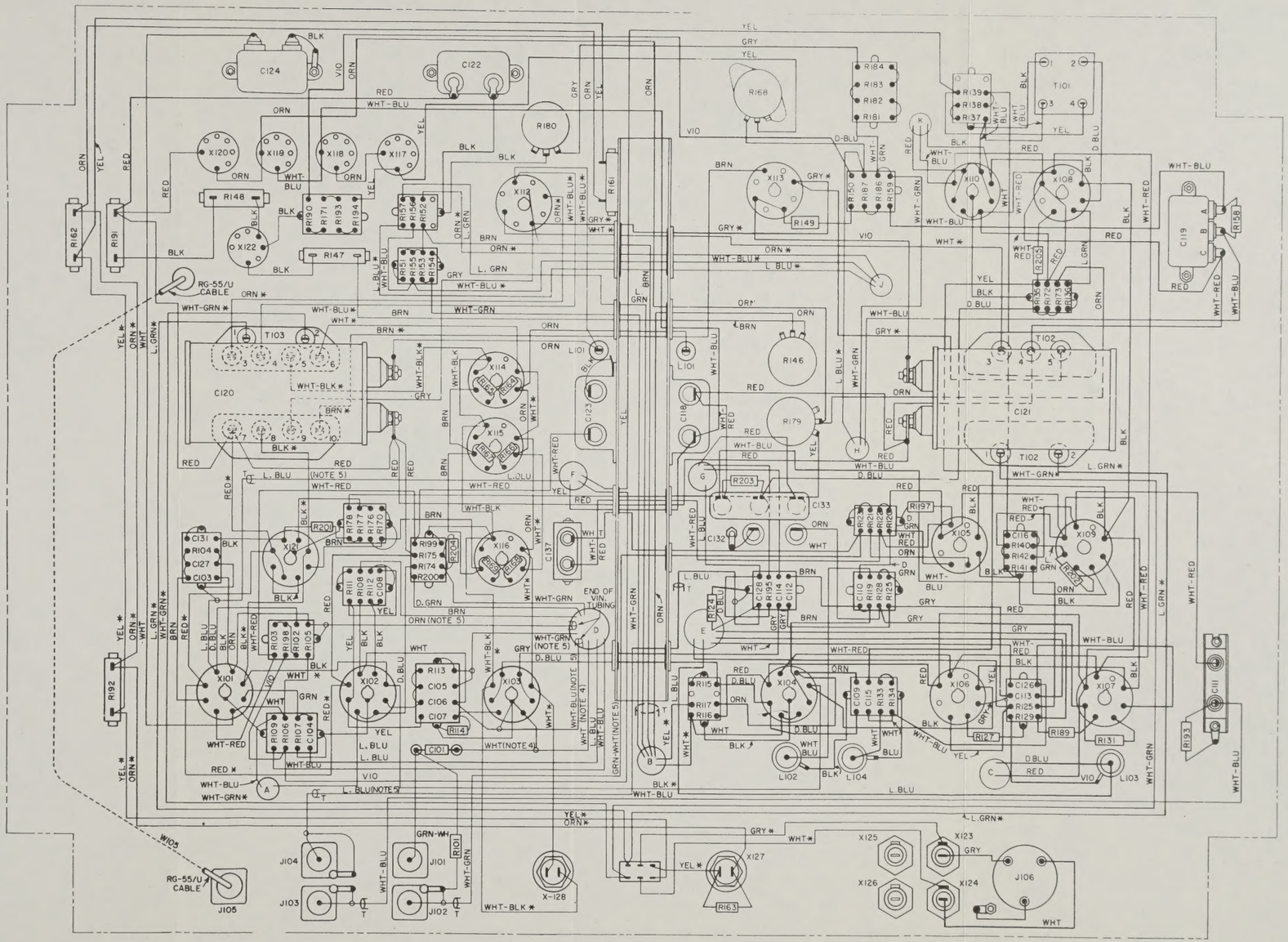


NOTES:

1. ALL WIRES MARKED WITH COLOR NOTE ONLY ARE NO.22 STRANDED COPPER.
2. WIRES MARKED WITH COLOR NOTE AND (*) ARE NO.22 SOLID COPPER.
3. ALL UNMARKED WIRES ARE NO.22 BARE TINNED SOLID COPPER.
4. ---O INDICATES SHIELDED WIRE, SHIELD GROUNDED.
5. COVER SINGLE WIRES AND GROUPS OF WIRES MARKED "T" WITH VINYLITE TUBING.
6. FOR COMPLETION OF OVERALL WIRING DIAGRAM SEE FIG. 7-3B. CONTINUITY OF WIRING THROUGH BUSHING CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS (A), (E), (J), ETC., ON FIGURES 7-2C AND 7-3B.

Figure 7-2C. Signal Generator TS-419/U, Bottom of Chassis, Wiring Diagram (Contract No. N383s-75748 and N383s-77651)

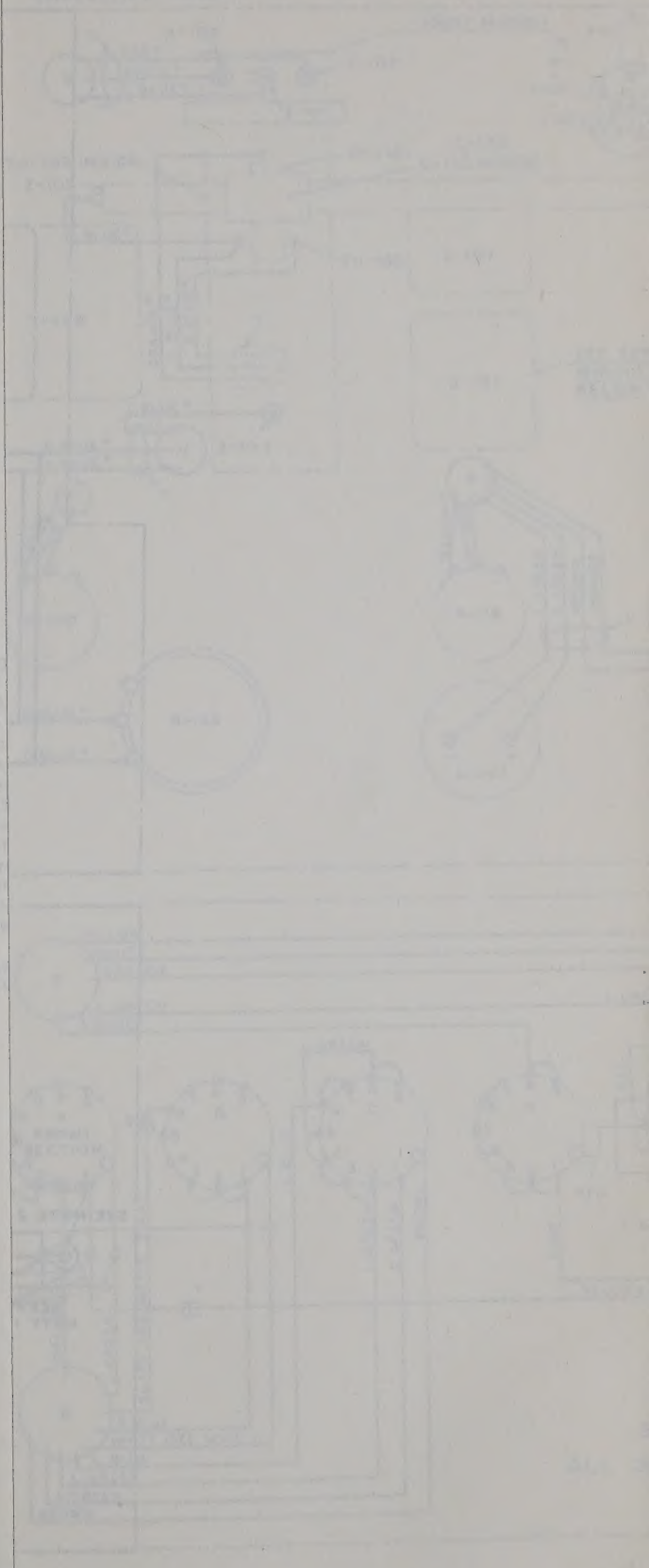


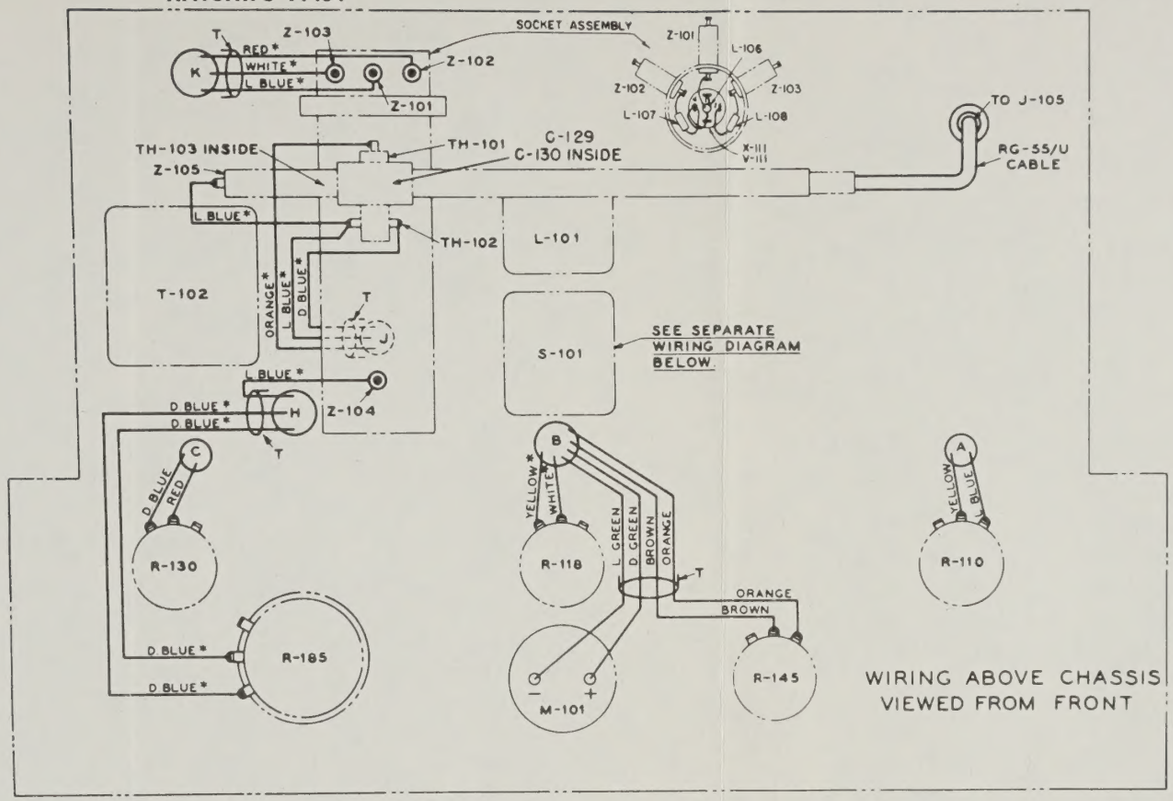


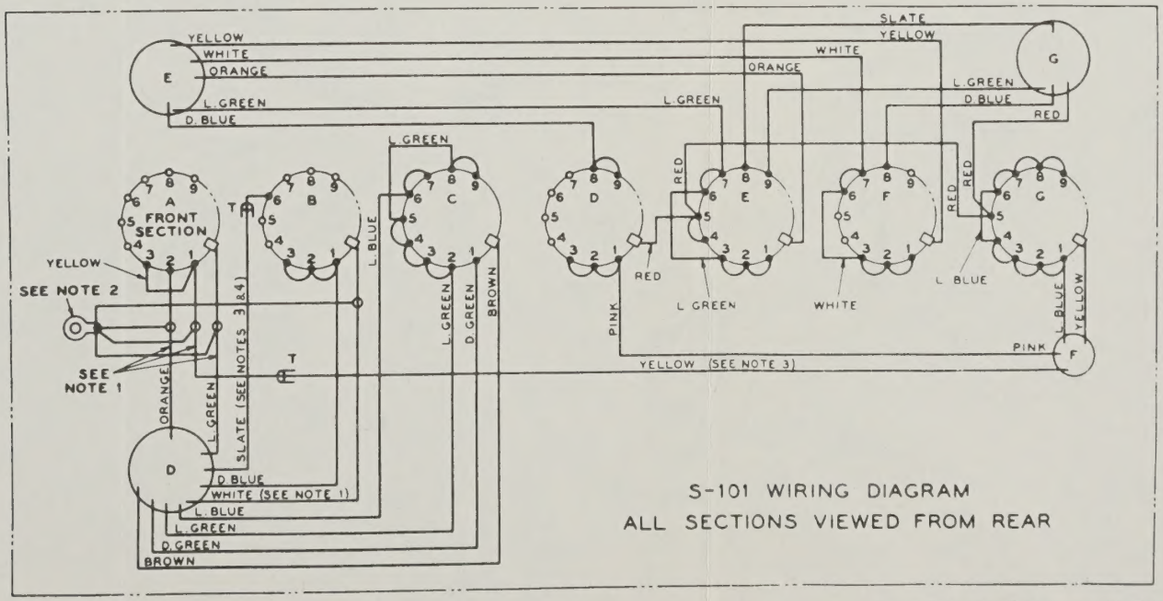
NOTES:

1. ALL WIRES MARKED WITH COLOR NOTE ONLY ARE NO.22 STRANDED COPPER.
2. WIRES MARKED WITH COLOR NOTE AND (*) ARE NO.22 SOLID COPPER.
3. ALL UNMARKED WIRES ARE NO.22 BARE TINNED SOLID COPPER.
4. ---O INDICATES SHIELDED WIRE, SHIELD GROUNDED.
5. COVER SINGLE WIRES AND GROUPS OF WIRES MARKED "T" WITH VINYLITE TUBING.
6. FOR COMPLETION OF TS-419A/U OVERALL WIRING DIAGRAM, SEE FIGURE 7-3C. CONTINUITY OF WIRING THROUGH BUSHINGS CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS Ⓐ, Ⓔ, Ⓙ, ETC, ON FIGURES 7-2D AND 7-3C.

Figure 7-2D. Signal Generator TS-419A/U, Bottom of Chassis, Wiring Diagram (Contract No. N383s-16939A, N383-31275A, and N383-46093A)







NOTES:

1. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID; BRAID CONNECTED TO GROUND AS SHOWN.
2. MOUNT GROUND LUG UNDER NUT ON FRONT PLATE OF SWITCH WHICH IS LOCATED BETWEEN CONTACTS #1 AND #2.
3. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID AND COVERED WITH VINYLITE TUBING.
4. BRAID MUST COME WITHIN 1/8" OF CONTACT. VINYLITE TUBING MUST EXTEND AT LEAST 1/16" BEYOND END OF BRAID.
5. COVER SINGLE WIRES AND GROUPS OF WIRES MARKED "T" WITH VINYLITE TUBING.
6. CONTINUITY OF WIRING THROUGH BUSHINGS CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS (A) (E) (J) ETC., ON FIGURES 7-2, 7-2B, AND 7-3.
7. SEE FIGURES 7-2 AND 7-2B FOR UNDER-CHASSIS WIRING DIAGRAMS
8. SEE FIGURES 7-3, 7-3A, 7-3B, AND 7-3C FOR WIRING USED IN EQUIPMENTS OF OTHER CONTRACTS.

Figure 7-3. Signal Generator TS-419/U, Top of Chassis, Wiring Diagram (Contract No. NOa(s)-9748, N383s-60879, N383s-61060 and NOa(s)-12279)

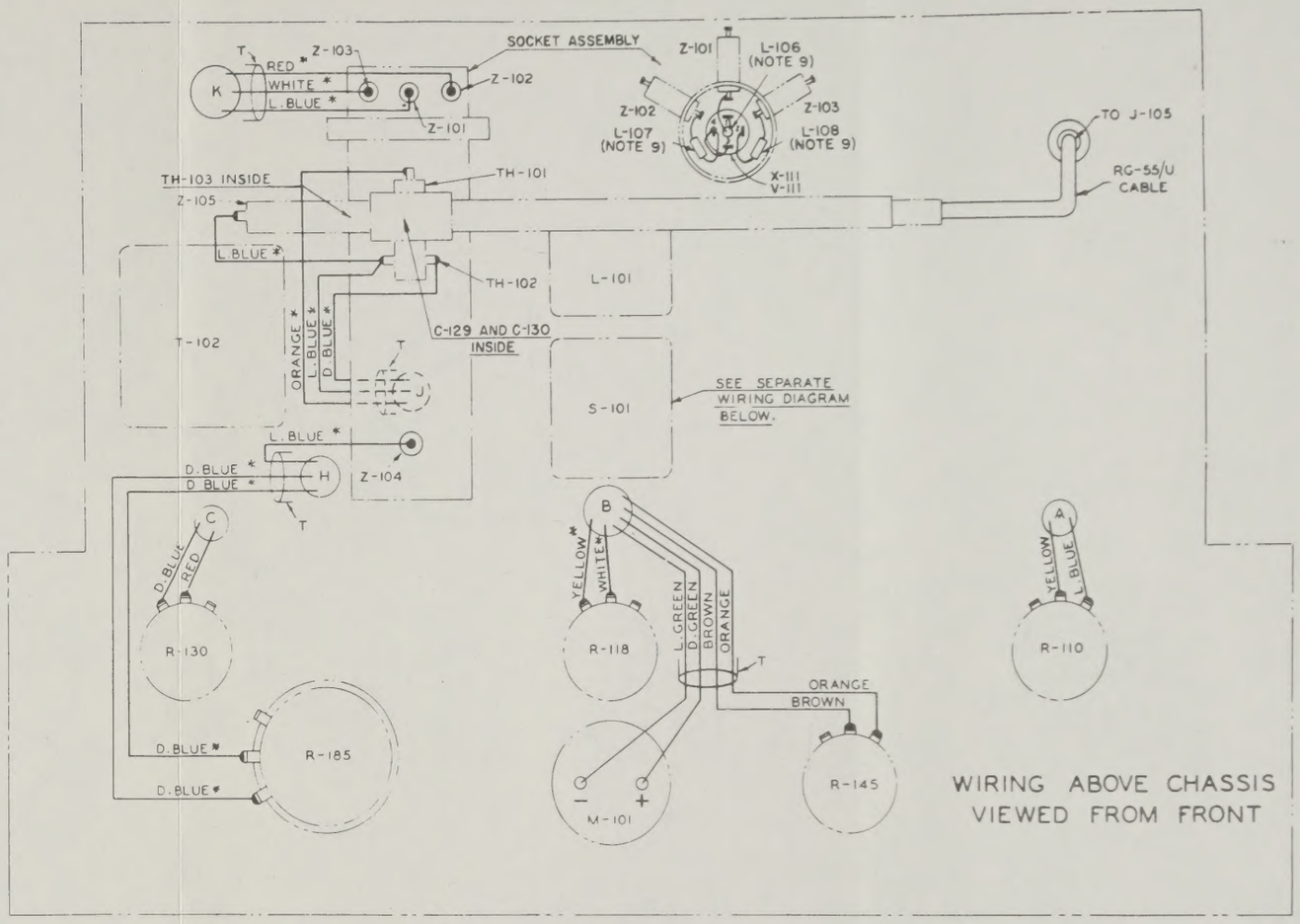






NOTES:

1. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID; BRAID CONNECTED TO GROUND AS SHOWN.
2. MOUNT GROUND LUG UNDER NUT ON FRONT PLATE OF SWITCH WHICH IS LOCATED BETWEEN CONTACTS #1 AND #2.
3. #22 SOLID COPPER WIRE WITH VINYLITE INSULATION ENCLOSED IN BRAID AND COVERED WITH VINYLITE TUBING.
4. BRAID MUST COME WITHIN 3/8" OF CONTACT. VINYLITE TUBING MUST EXTEND AT LEAST 1/16" BEYOND END OF BRAID.
5. COVER SINGLE WIRES AND GROUPS OF WIRES MARKED "T" WITH VINYLITE TUBING.
6. CONTINUITY OF WIRING THROUGH BUSHINGS CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS A, E, J, ETC., ON FIGURES 7-2A AND 7-3A.
7. SEE FIGURE 7-2A FOR RELATED UNDER-CHASSIS WIRING DIAGRAM.
8. SEE FIGURES 7-2, 7-2B, 7-2C, 7-2D AND 7-3, 7-3B, 7-3C FOR COMPARABLE WIRING USED IN EQUIPMENTS OF OTHER CONTRACTS.
9. IN EQUIPMENTS MANUFACTURED UNDER CONTRACT N383s-5019A, CHOKES L-106, L-107 AND L-108 ARE OMITTED.



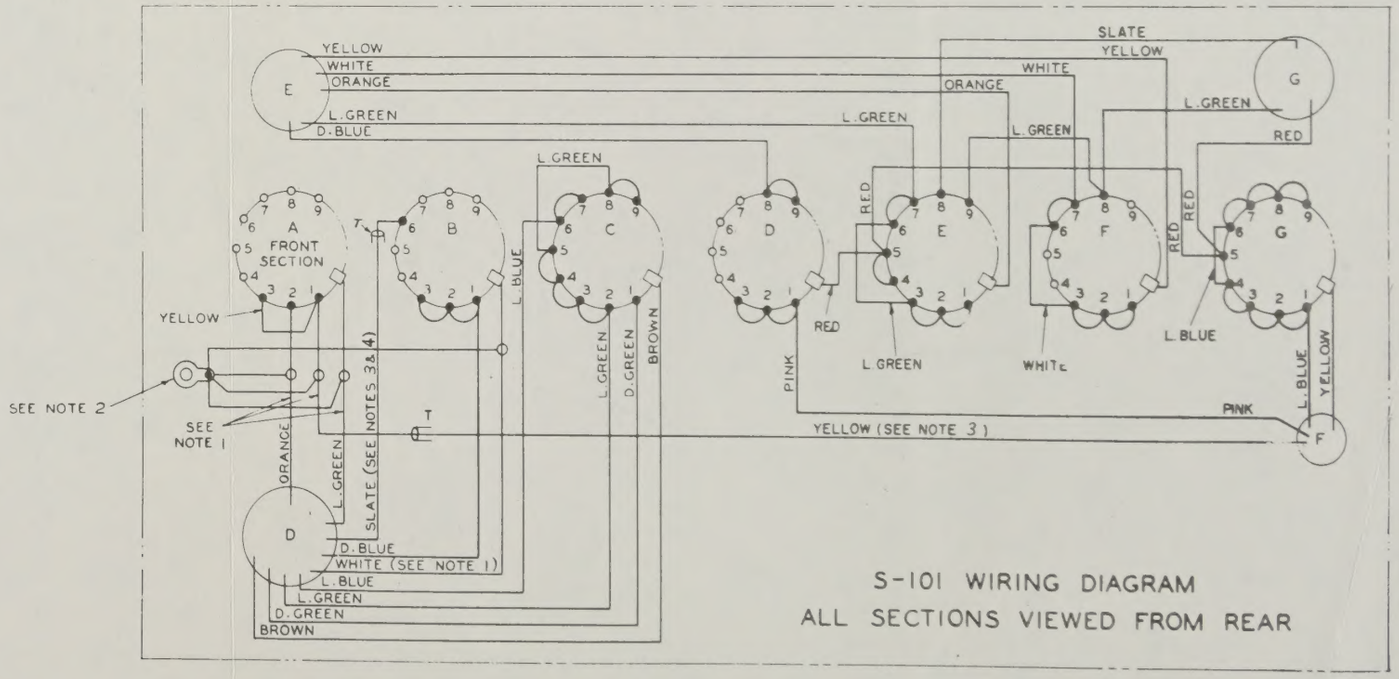
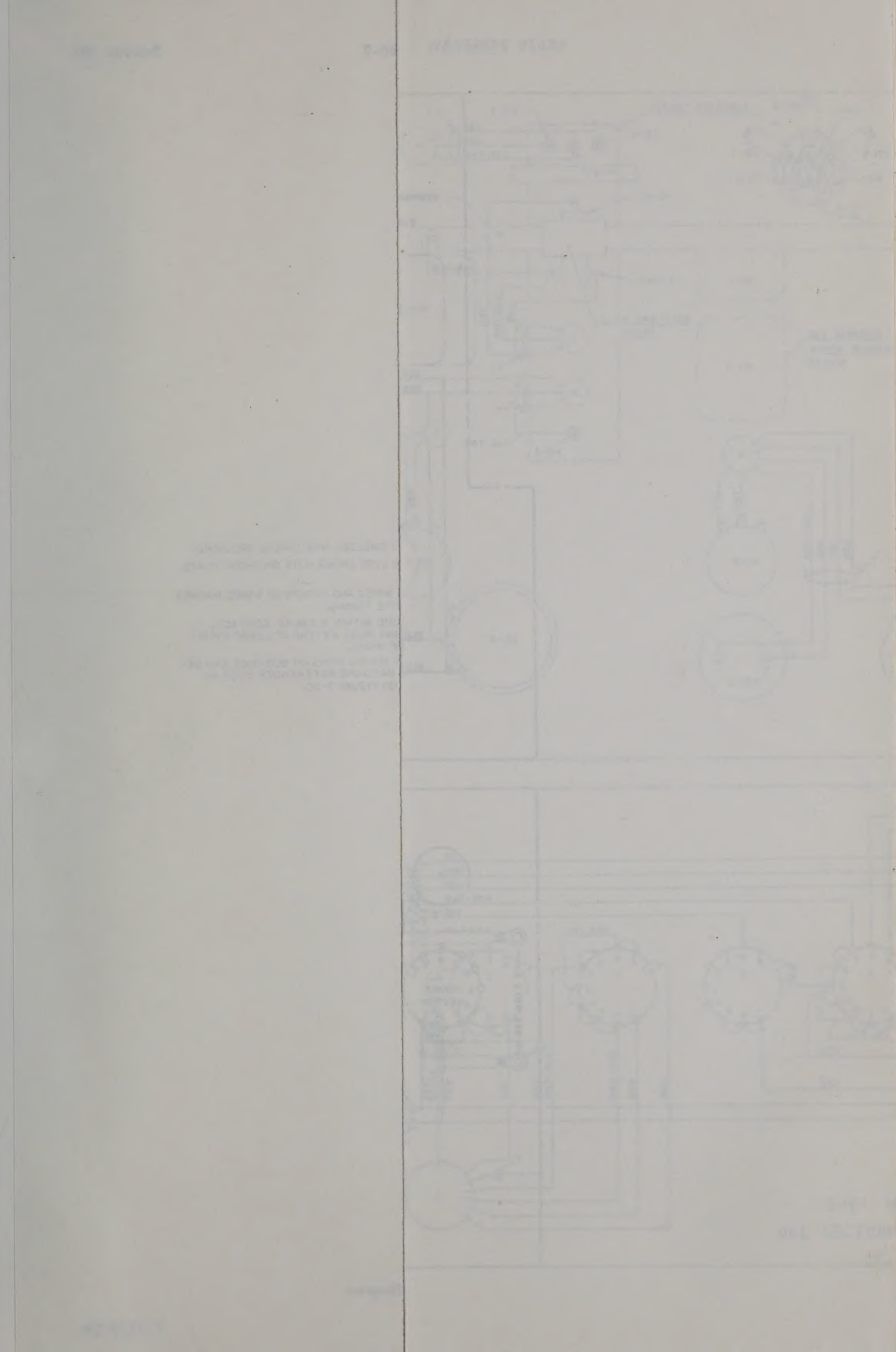
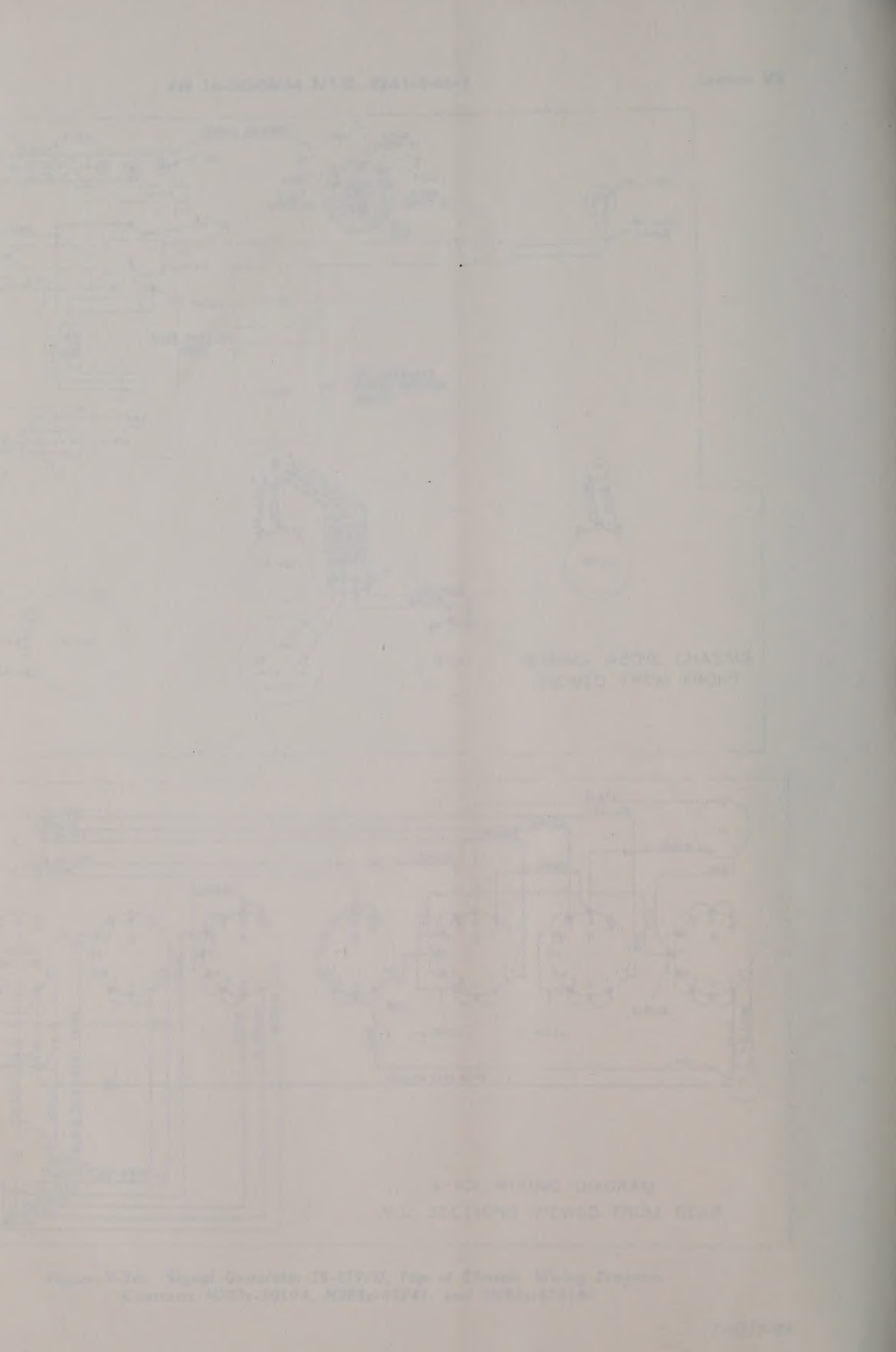
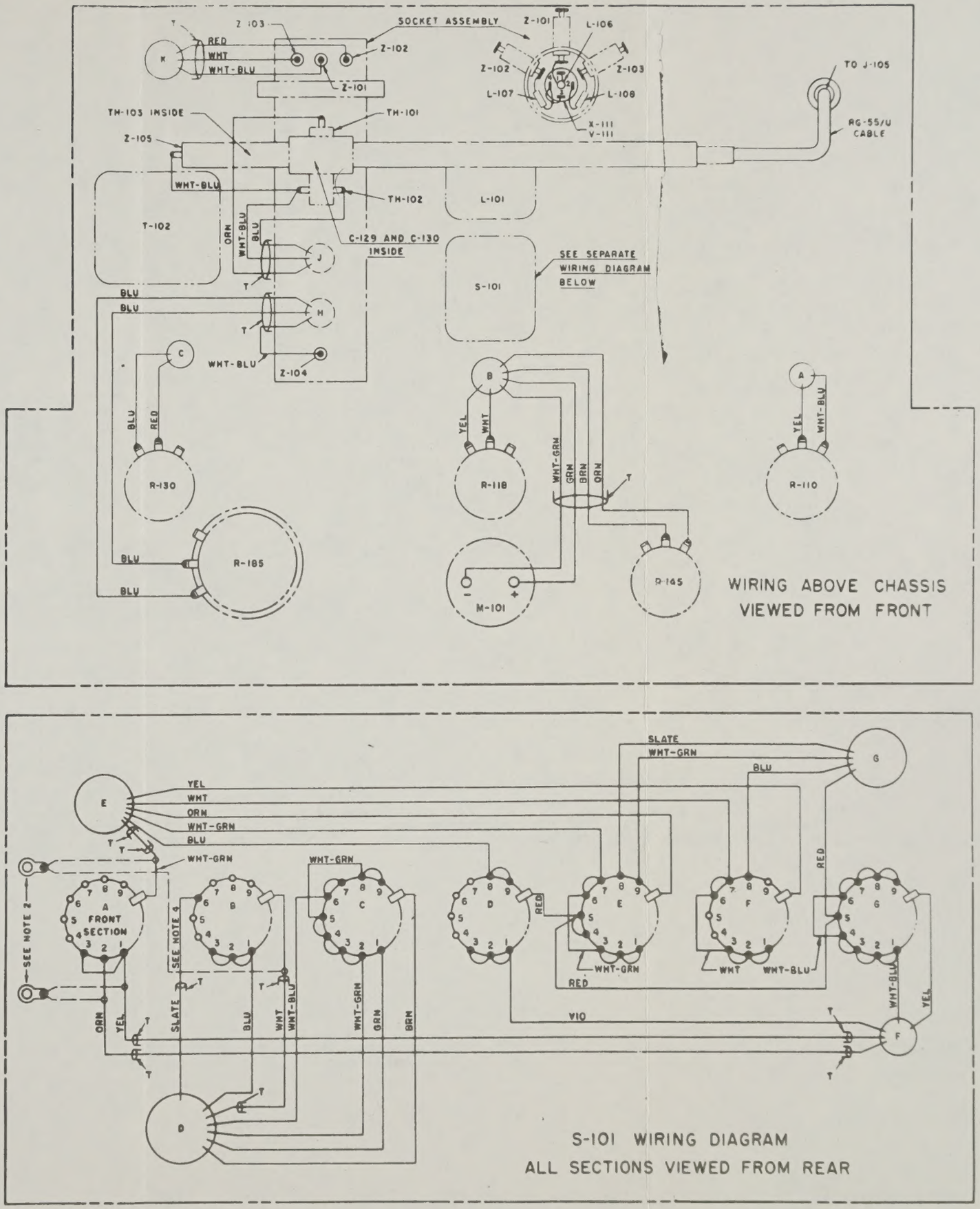


Figure 7-3A. Signal Generator TS-419/U, Top of Chassis, Wiring Diagram (Contracts N383s-5019A, N383s-45741, and N383s-67816)





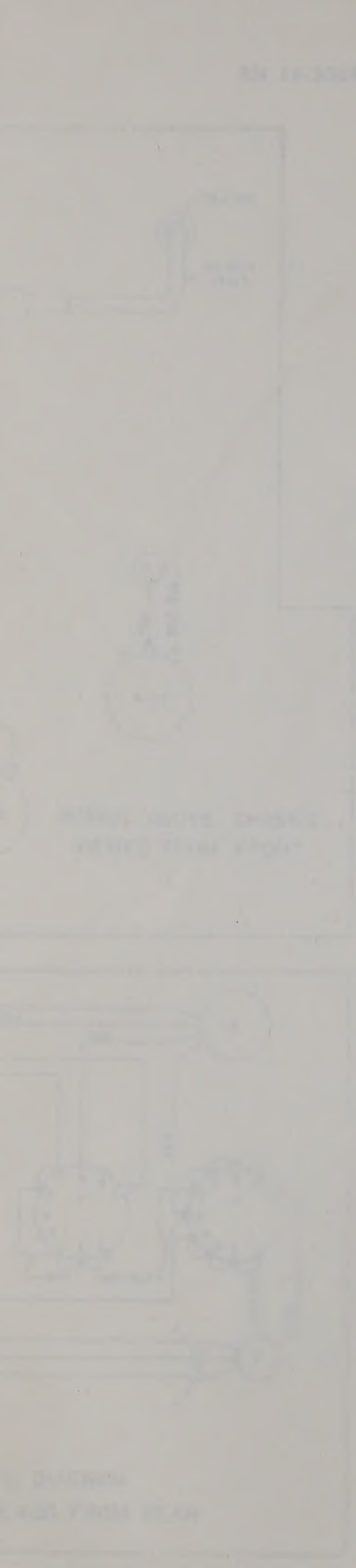


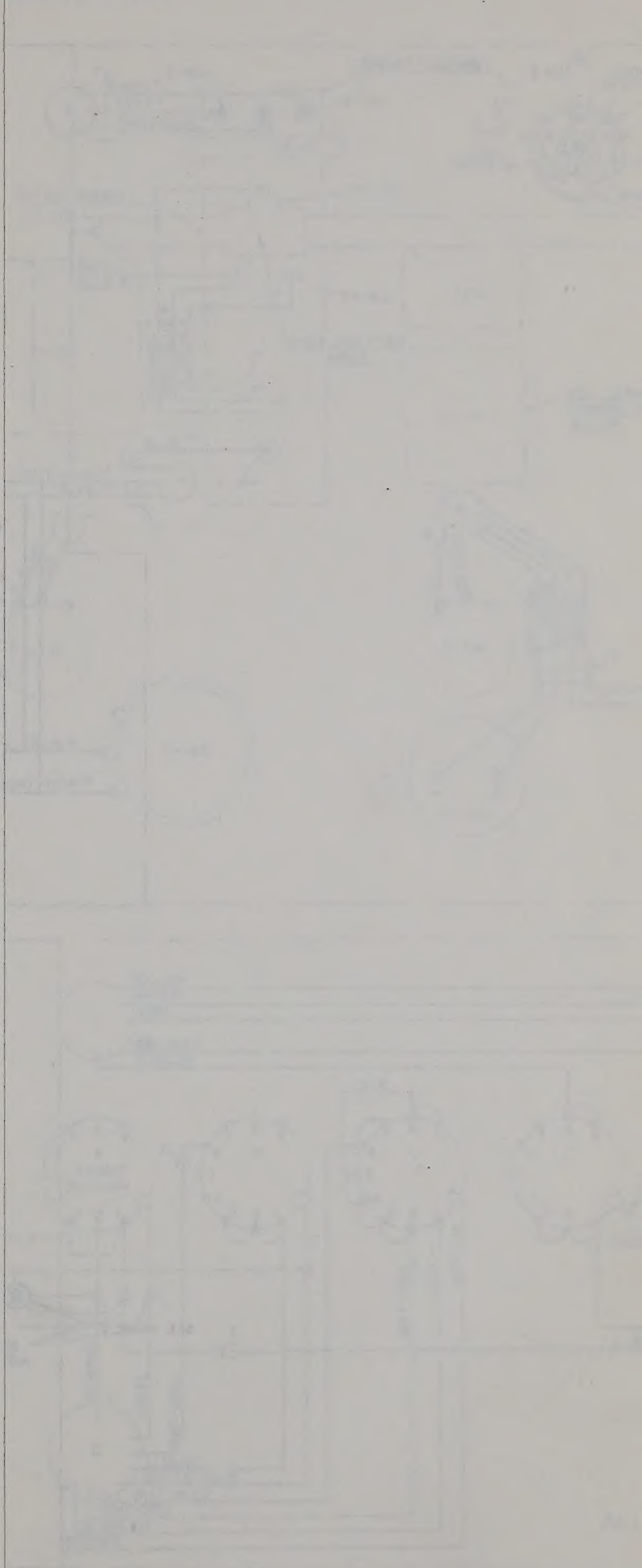


NOTES:

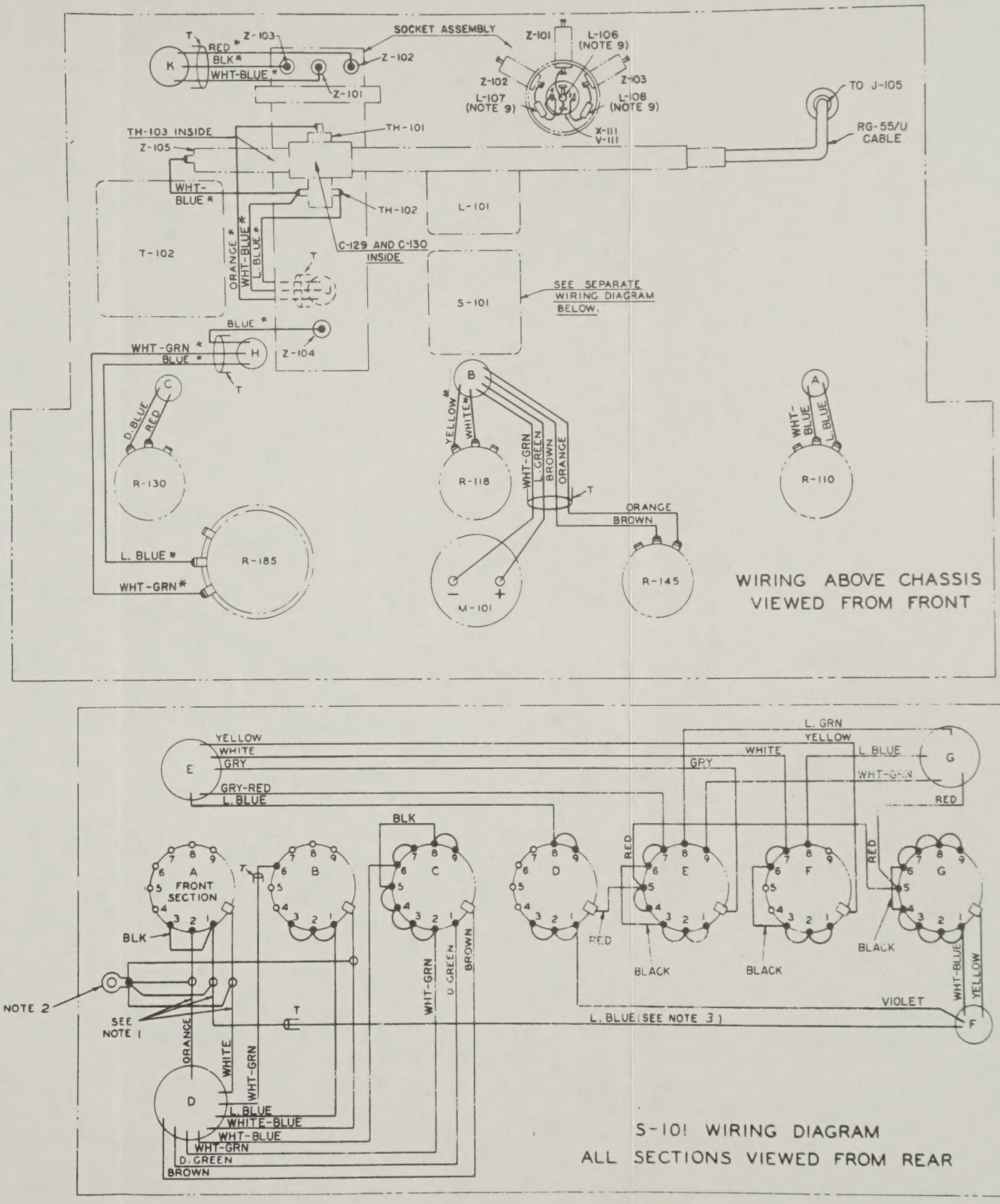
1. ---O INDICATES SHIELDED WIRE, SHIELD GROUNDED.
2. MOUNT GROUND LUGS UNDER NUTS ON FRONT PLATE OF SWITCH.
3. COVER SINGLE WIRES AND GROUPS OF WIRES MARKED "T" WITH VINYLITE TUBING.
4. BRAID MUST COME WITHIN 3/8 IN. OF CONTACT. VINYLITE TUBING MUST EXTEND AT LEAST 1/16 IN. BEYOND END OF BRAID.
5. CONTINUITY OF WIRING THROUGH BUSHINGS CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS (A)(E)(J) ETC., ON FIGURE 7-2C.

Figure 7-3B. Signal Generator TS-419/U, Top of Chassis, Wiring Diagram (Contract No. N383s-75748 and N383s-77651)





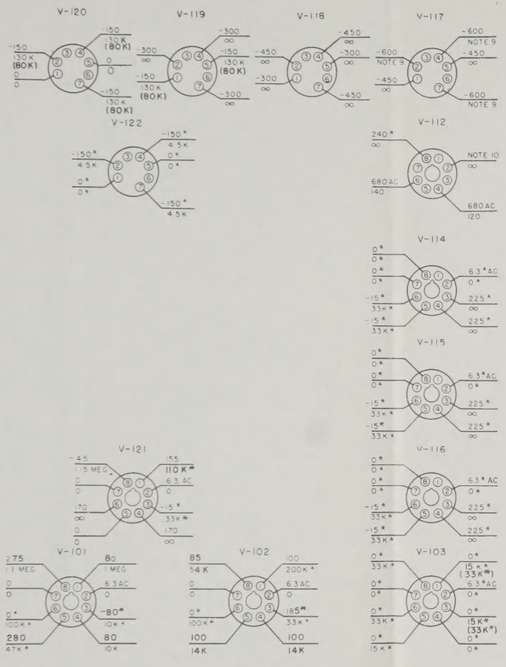




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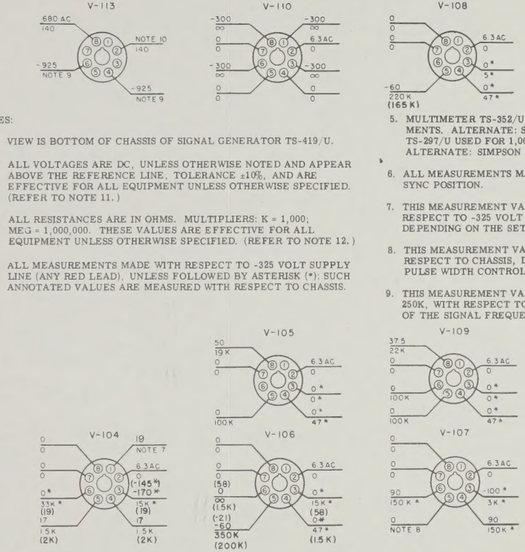
1. ---O INDICATES SHIELDED WIRE, SHIELD GROUNDED.
2. MOUNT GROUND LUGS UNDER NUTS ON FRONT PLATE OF SWITCH.
3. COVER SINGLE WIRES AND GROUPS OF WIRES MARKED "T" WITH VINYLITE TUBING.
4. BRAID MUST COME WITHIN 3/8 IN. OF CONTACT. VINYLITE TUBING MUST EXTEND AT LEAST 1/16 IN. BEYOND END OF BRAID.
5. CONTINUITY OF WIRING THROUGH BUSHINGS CAN BE FOLLOWED BY MATCHING REFERENCES SUCH AS Ⓐ, Ⓔ, Ⓙ, ETC., ON FIGURE 7-2D

Figure 7-3C. Signal Generator TS-419A/U, Top of Chassis, Wiring Diagram (Contract No. N383s-16939A, N31275A, and N383-46093A)



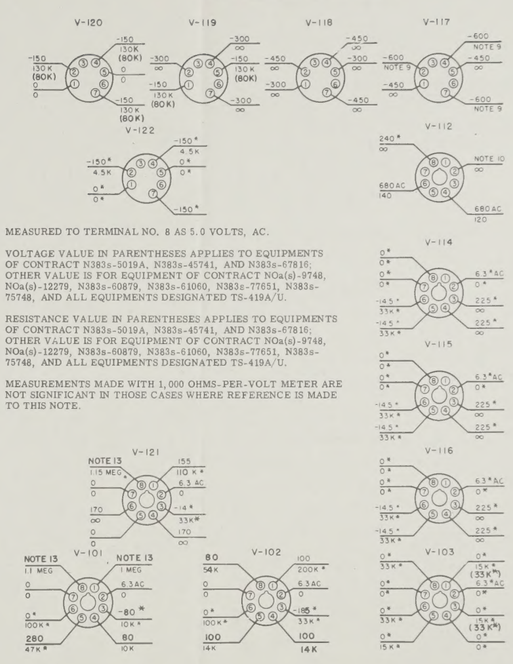
NOTES:

1. VIEW IS BOTTOM OF CHASSIS OF SIGNAL GENERATOR TS-419/U.
2. ALL VOLTAGES ARE DC, UNLESS OTHERWISE NOTED AND APPEAR ABOVE THE REFERENCE LINE, TOLERANCE ±10%, AND ARE EFFECTIVE FOR ALL EQUIPMENT UNLESS OTHERWISE SPECIFIED. (REFER TO NOTE 11.)
3. ALL RESISTANCES ARE IN OHMS. MULTIPLIERS: K = 1,000; MEG = 1,000,000. THESE VALUES ARE EFFECTIVE FOR ALL EQUIPMENT UNLESS OTHERWISE SPECIFIED. (REFER TO NOTE 12.)
4. ALL MEASUREMENTS MADE WITH RESPECT TO -325 VOLT SUPPLY LINE (ANY RED LEAD), UNLESS FOLLOWED BY ASTERISK (*): SUCH ANNOTATED VALUES ARE MEASURED WITH RESPECT TO CHASSIS.



5. MULTIMETER TS-352/U USED FOR 20,000-OHM-VOLT MEASUREMENTS. ALTERNATE: SIMPSON MODEL 260. MULTIMETER TS-297/U USED FOR 1,000-OHM-VOLT MEASUREMENTS. ALTERNATE: SIMPSON MODEL 443.
6. ALL MEASUREMENTS MADE WITH SELECTOR SWITCH IN NEG SYNC POSITION.
7. THIS MEASUREMENT VARIES FROM 3.0K TO 1 MEG, WITH RESPECT TO -325 VOLT SUPPLY LINE (ANY RED LEAD), DEPENDING ON THE SETTING OF THE PULSE DELAY CONTROL.
8. THIS MEASUREMENT VARIES FROM 1.0K TO 100K, WITH RESPECT TO CHASSIS, DEPENDING ON THE SETTING OF THE PULSE WIDTH CONTROL.
9. THIS MEASUREMENT VARIES FROM APPROXIMATELY 100K TO 250K, WITH RESPECT TO CHASSIS, DEPENDING ON THE SETTING OF THE SIGNAL FREQUENCY CONTROL.

AN 16-30URM64-3/T.O. 33A1-8-86-2



10. MEASURED TO TERMINAL NO. 8 AS 5.0 VOLTS, AC.
11. VOLTAGE VALUE IN PARENTHESES APPLIES TO EQUIPMENTS OF CONTRACT N383s-5019A, N383s-45741, AND N383s-67816; OTHER VALUE IS FOR EQUIPMENT OF CONTRACT NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-77651, N383s-75748, AND ALL EQUIPMENTS DESIGNATED TS-419A/U.
12. RESISTANCE VALUE IN PARENTHESES APPLIES TO EQUIPMENTS OF CONTRACT N383s-5019A, N383s-45741, AND N383s-67816; OTHER VALUE IS FOR EQUIPMENT OF CONTRACT NOa(s)-9748, NOa(s)-12279, N383s-60879, N383s-61060, N383s-77651, N383s-75748, AND ALL EQUIPMENTS DESIGNATED TS-419A/U.
13. MEASUREMENTS MADE WITH 1,000 OHMS-PER-VOLT METER ARE NOT SIGNIFICANT IN THOSE CASES WHERE REFERENCE IS MADE TO THIS NOTE.

AN 16-30URM64-3/T.O. 33A1-8-86-2

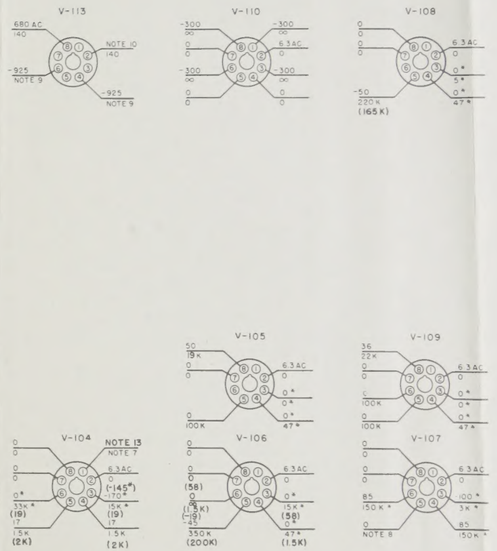
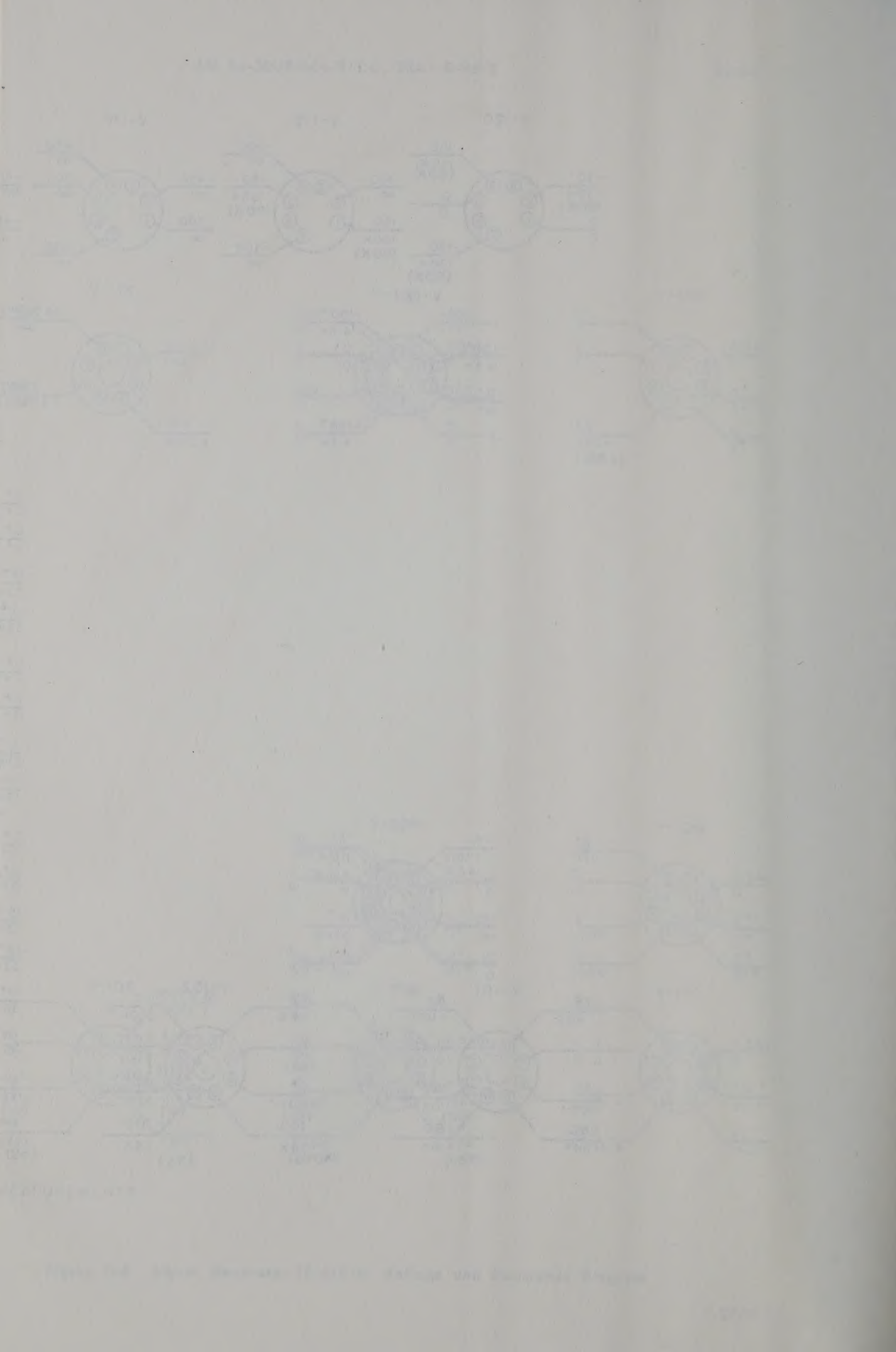


Figure 7-4. Signal Generator TS-419/U, Voltage and Resistance Diagram





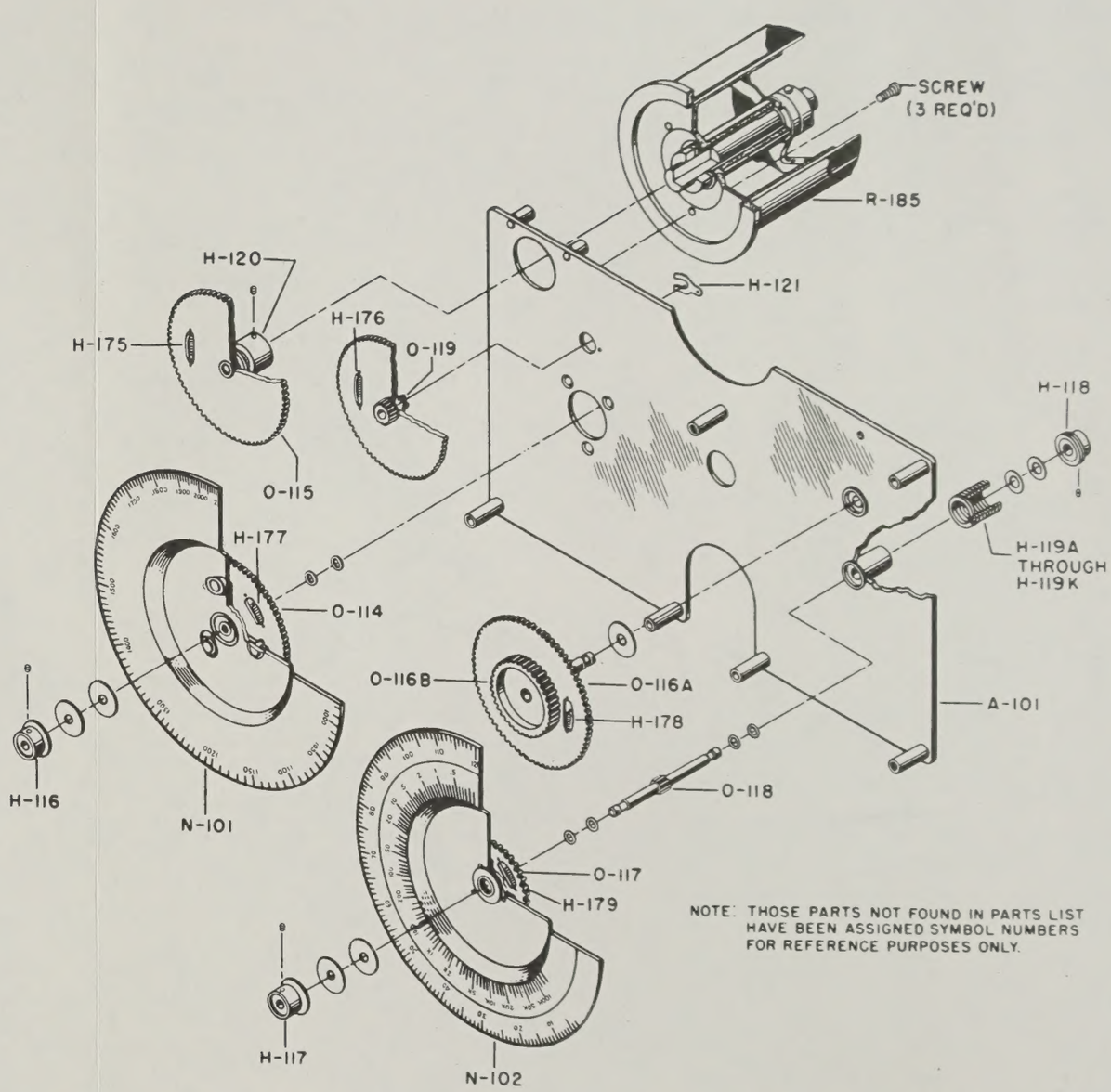
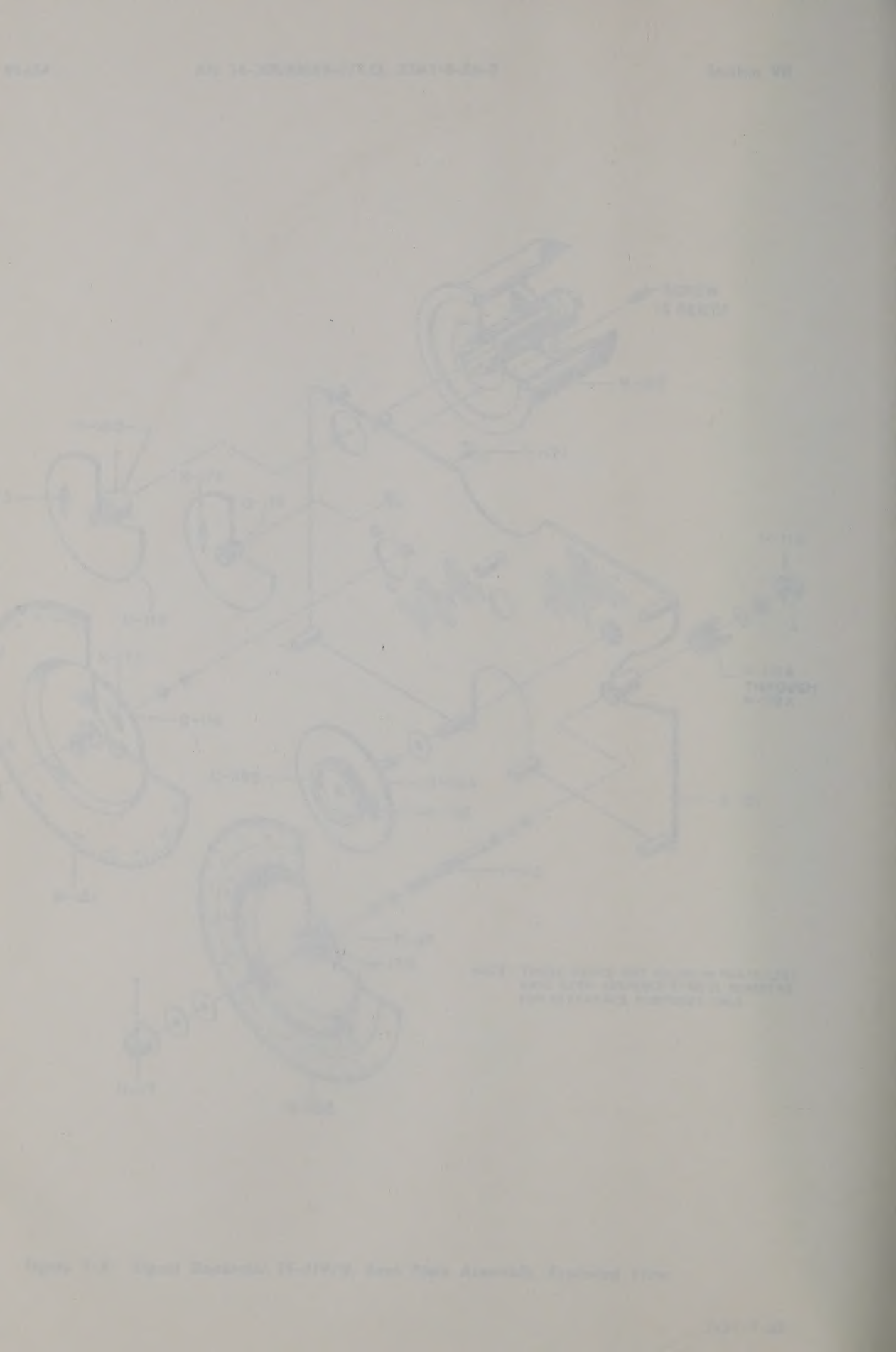
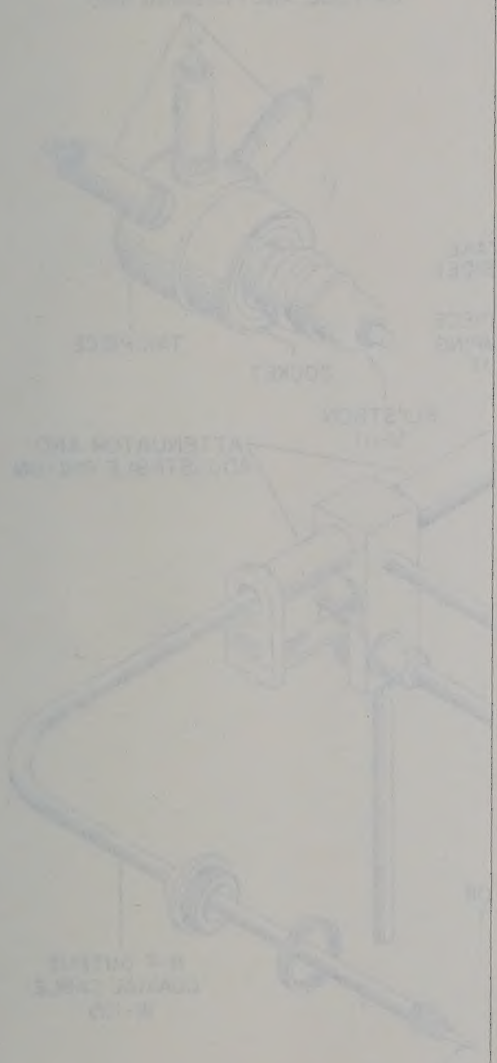
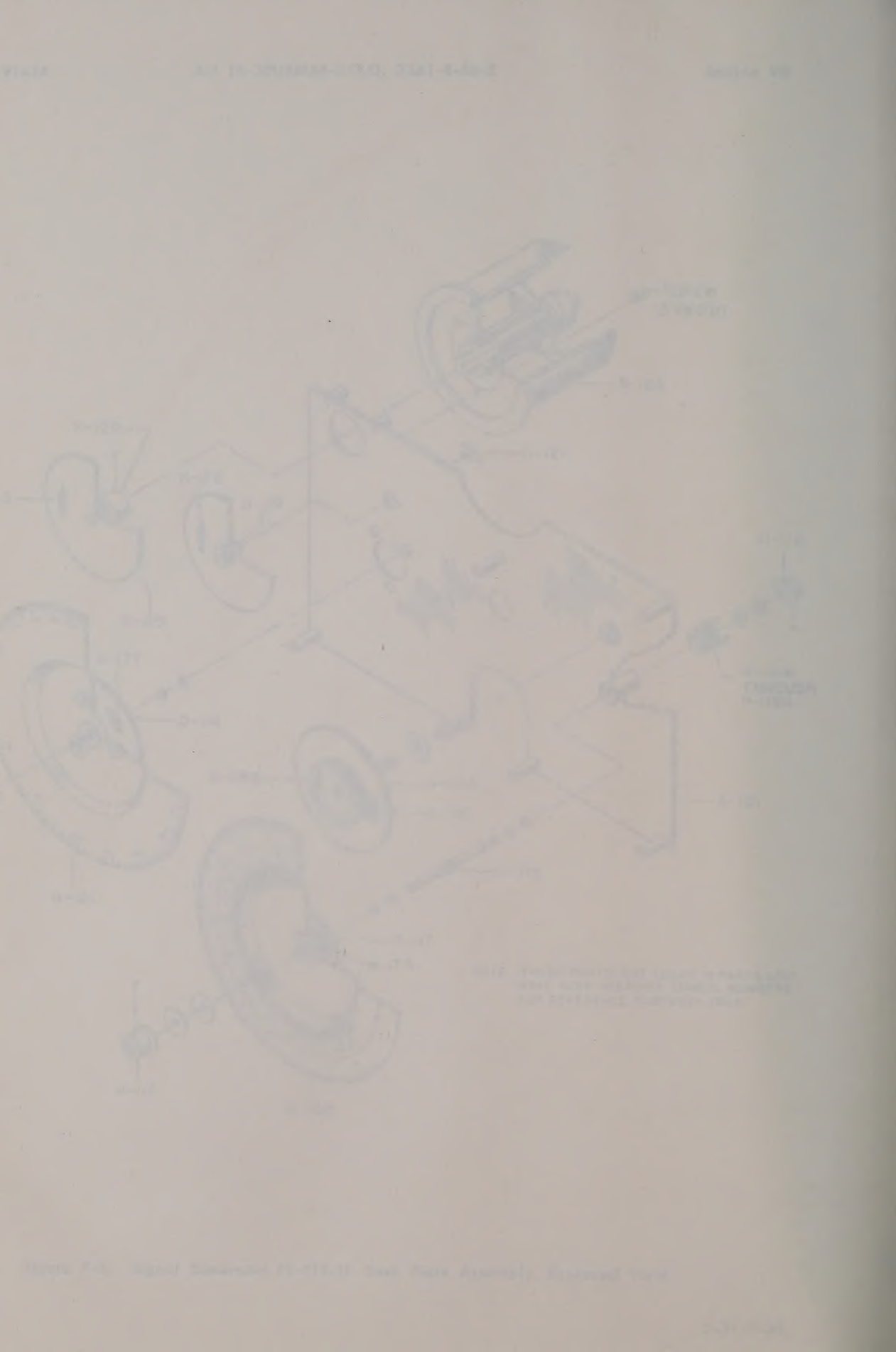


Figure 7-5. Signal Generator TS-419/U, Back Plate Assembly, Exploded View







NAVSHIPS 91434 AN 16-30URM64-3/T.O 33A1-8-86-2

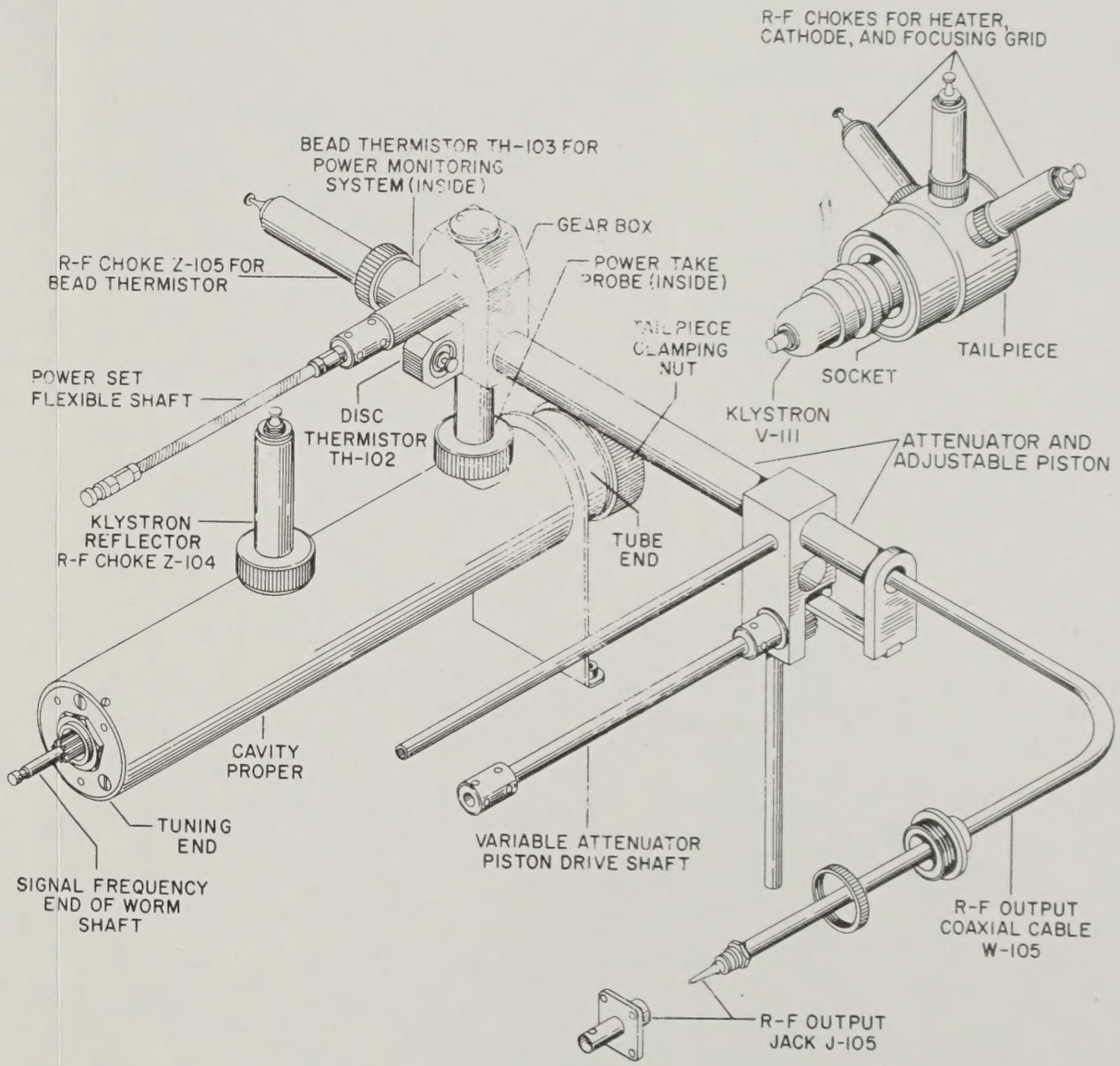
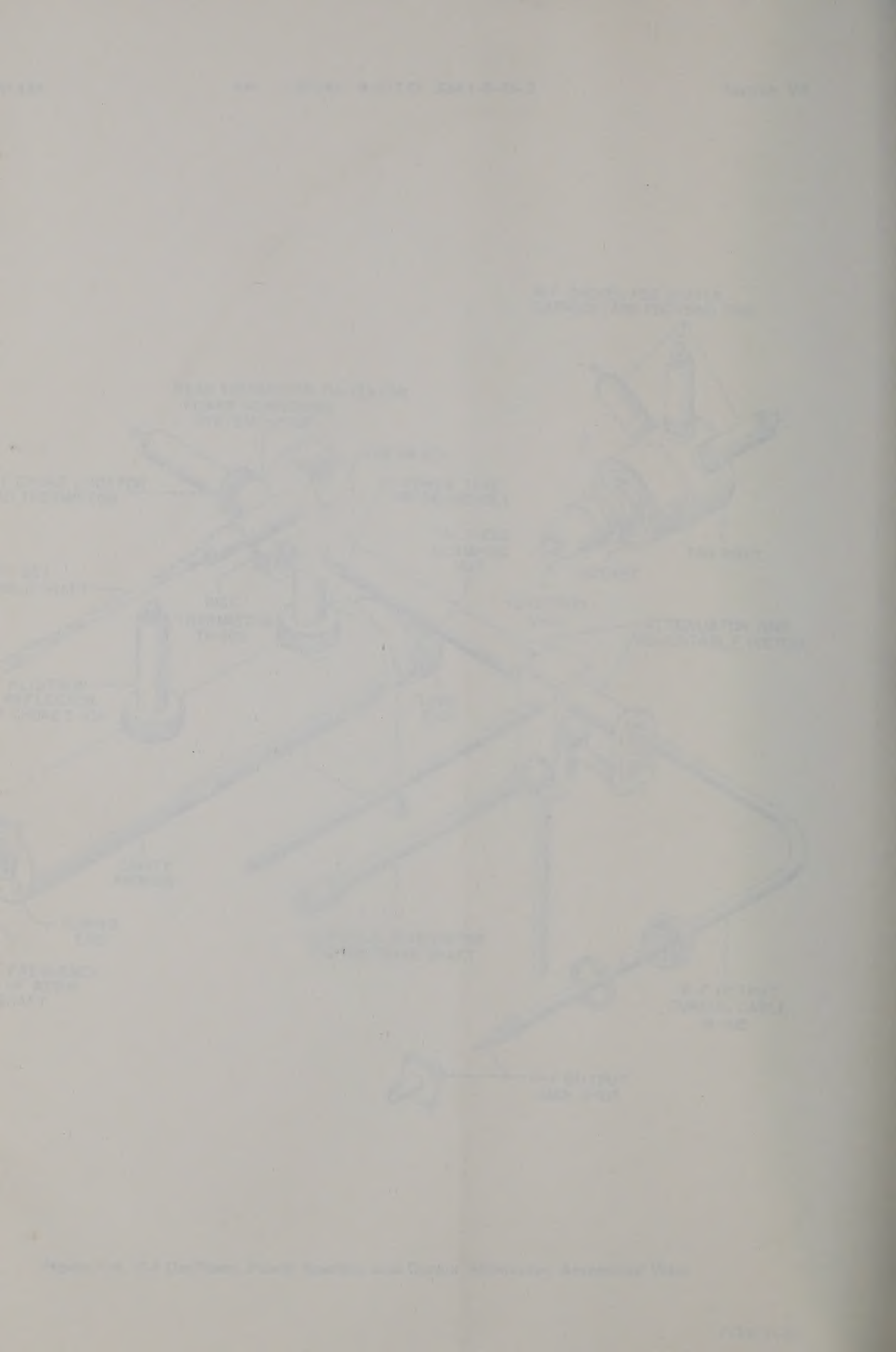


Figure 7-6. R-f Oscillator, Power Monitor, and Output Attenuator, Assembled View







NOTES:

1. THOSE PARTS NOT FOUND IN PARTS LIST HAVE BEEN ASSIGNED SYMBOL NUMBERS FOR REFERENCE PURPOSES ONLY.
2. IN EQUIPMENTS MANUFACTURED UNDER CONTRACT N383s-5019A, CHOKES L-106, L-107, AND L-108 ARE OMITTED.

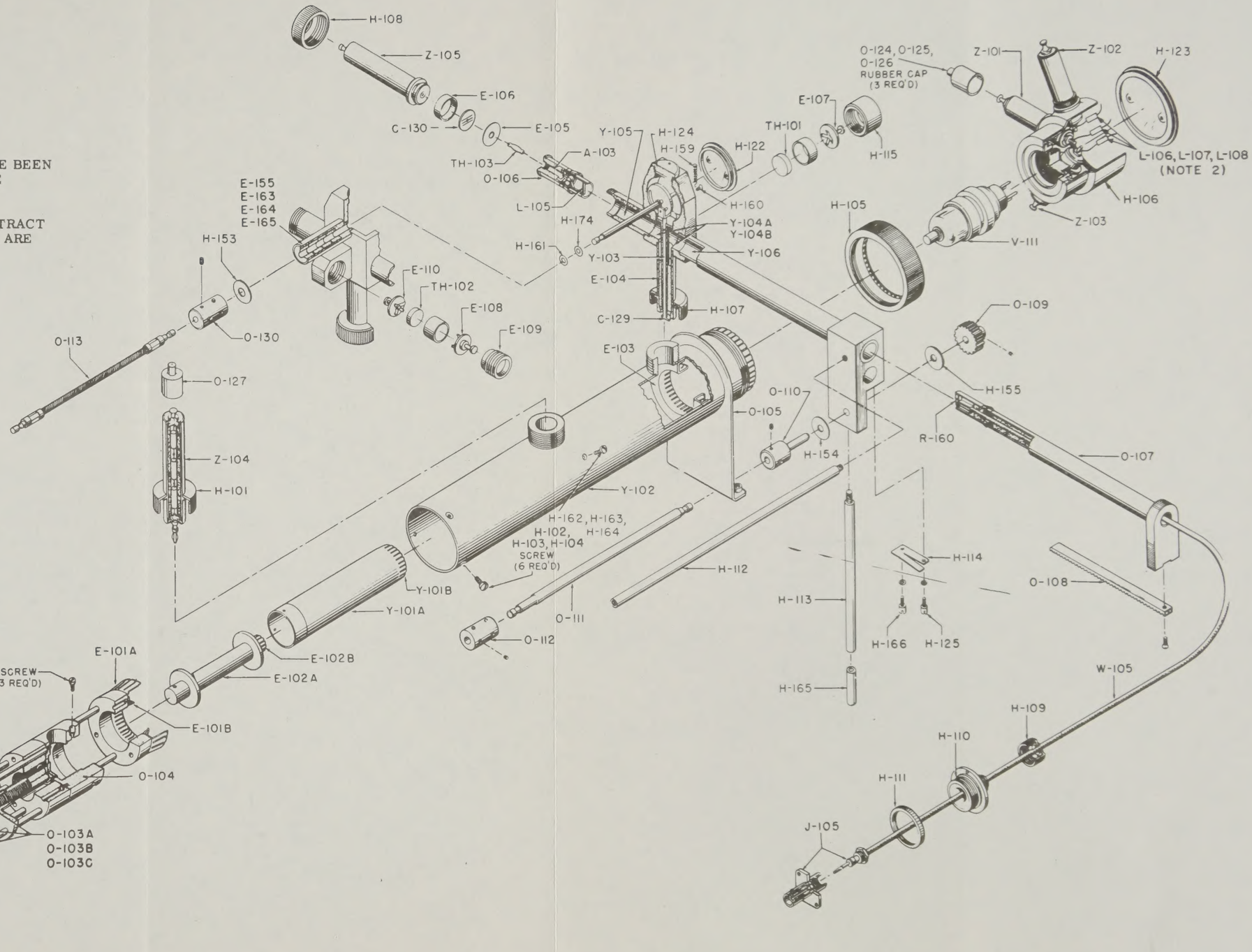


Figure 7-7. Signal Generator TS-419/U, R-F Oscillator, Power Monitor, and Output Attenuator, Exploded View

