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CG-273-74 VOLUME 1

1714

TECHNICAL MANUAL

for

LORAN TRANSMITTING SET AN/FPN-42

SECTIONS 1 THROUGH 6
AND APPENDIX I—
TECHNICAL MANUAL FOR
OSCILLOSCOPE OS-103/FPN

PROPERTY OF CFE
TECHNICAL PUBLICATION LOCKER

SPERRY GYROSCOPE COMPANY
DIVISION OF SPERRY RAND CORPORATION
GREAT NECK, NEW YORK

TREASURY DEPARTMENT
U. S. COAST GUARD

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LETTER OF PROMULGATION

1. CG-273-74 is the Technical Manual for Loran Transmitting Set, Type AN/FPN-42 and is effective upon receipt. The four copies furnished with the equipments are parts thereof and shall accompany the basic equipment.

2. Extracts from this publication may be made to facilitate the preparation of other technical manuals and handbooks.

3. Copies of this publication may be obtained by requisition to Commanding Officer, U. S. Coast Guard Supply Center, Brooklyn, New York.

4. Corrections to this publication will be made by serially numbered amendments. They shall be entered promptly by responsible personnel.

J. A. ALGER, JR.
Chief, Office of Engineering

RECORD OF CORRECTIONS MADE

CHANGE NO.	DATE	FIELD CHANGE NO.	SIGNATURE

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The Technical Manual for Loran Transmitting Set AN/FPN-42 is provided in the three volumes listed below:

Volume 1 - Sections 1 through 6, and Technical Manual for Oscilloscope OS-103/FPN

Volume 2 - Section 7, Parts List

Volume 3 - Technical Manual for Power Supply PP-2540/FPN-42

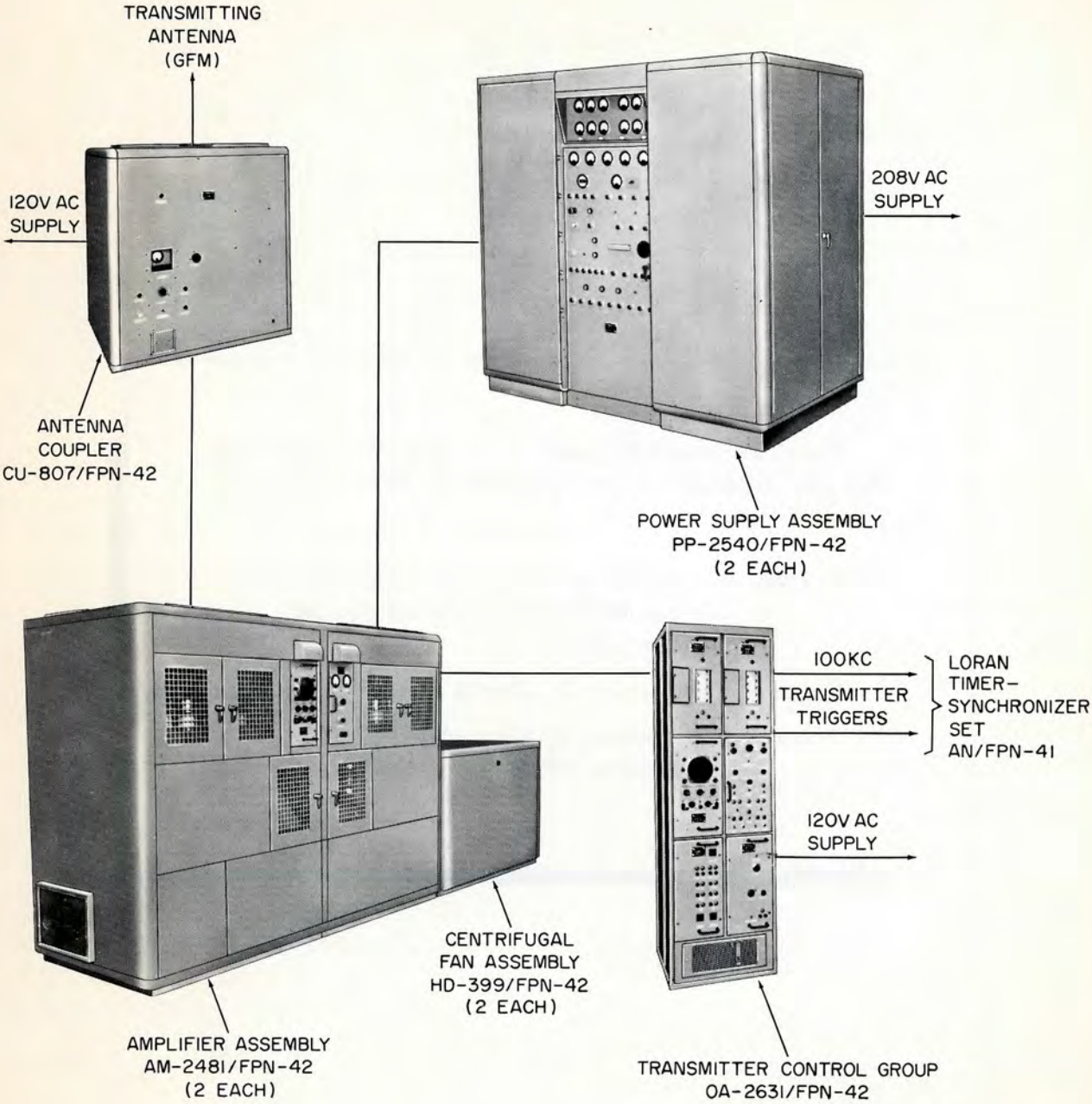


Figure 1-1. Loran Transmitting Set AN/FPN-42, Relationship of Units

SECTION 1

GENERAL INFORMATION

1-1. INTRODUCTION.

a. PURPOSE OF EQUIPMENT. - Loran Transmitting Set AN/FPN-42, figure 1-1, is a permanently-installed land-based equipment supplied as part of a Loran-C transmitting station. Each station generates, shapes, and transmits pulses (bursts of r-f energy) which are used by a remote mobile receiver for position fixing.

b. LORAN-C PRINCIPLES.

(1) A Loran-C system consists of three or four land-based stations, as required to meet the demands of the service area. Station locations and distances apart are accurately known. One station is the master (M) station, the others being slave stations. The master station transmissions are used as the reference for timing and sequencing the transmissions from the other two (x, y) or three (x, y, z) slave stations. Each slave station synchronizes on the master signals.

(2) Loran-C station transmissions are time-shared on a single carrier frequency; that is, each station in a group transmits during an assigned portion of the group repetition interval. During this interval, the master station transmits first, followed in time sequence by the x, y, and z slave stations, each of which transmits after a predetermined coding delay. Because the coding delays are different for each slave station, there is no duplication of time-difference readings from any pair of stations within the service area. Therefore, there is a complete lack of ambiguity in making a position fix.

(3) A Loran-C system differs from Loran-A systems in that it operates at a much lower frequency (100 kc) and employs ground-wave propagated signals exclusively. At 100 kc, ground-wave signals propagate almost equally as well over land or water during both day and night. Elimination of sky-wave signals and the use of ground-wave signals exclusively results in improved accuracy in making time-difference readings.

(4) Loran-C incorporates multipulsing and phase-coding techniques. Instead of a single pulse being transmitted from each station per repetition interval, each station transmits a series of eight pulses spaced 500 or 1000 microseconds apart. This multipulsing technique effectively increases transmitted power by increasing the number of transmitted pulses per second.

(5) Because the transmissions are multipulsed, phase coding of the transmitted pulses from the master and slave stations is possible. Phase coding consists of phase shifting the 100-kc carrier within some pulse envelopes by 180 degrees. Phase coding provides a method of identification of master and slave signals, expedites the automatic search process, simplifies the automatic search apparatus, and permits discrimination against multi-hop sky waves.

(6) The combination of a master station and any of the slave station transmissions produces a unique set of time-difference readings which are plotted as hyperbolas on Loran-C charts.

(7) Signals from all stations are accepted by a receiver located on a craft desiring to determine its position. The time difference of arrival of signals from a pair of transmitting stations is automatically measured and displayed by the receiver. The receiver operator locates the time-difference line for the first station pair on a special Loran chart on which lines of constant time difference are plotted. This establishes a line of position. A second line of position is determined with another time-difference reading from a second station pair. The intersection of these lines of position determines the navigational fix or position.

(8) A Loran-C system employs both pulse-envelope and carrier-cycle matching techniques for obtaining the time-difference readings. This method differs from Loran-A system methods, which matched pulses only. The pulse match of Loran-A systems is comparable to the pulse envelope match used in the Loran-C system. In Loran-C, after the pulse envelopes are matched (within ±5 microseconds), a cycle match is made of the 100-kc sine waves which make up the pulses. Thus, the pulse envelope match produces a coarse time-difference reading and the cycle match produces a fine time-difference reading. This additional fine time-difference reading greatly increases the accuracy of Loran-C systems over Loran-A systems.

1-2. FUNCTIONAL DESCRIPTION.

a. FUNCTION OF LORAN TRANSMITTING SET AN/FPN-42.

(1) Loran Transmitting Set AN/FPN-42 (hereafter referred to as the transmitter group) generates, shapes, and delivers pulses consisting of 100-kc sine waves to a transmitting antenna. It receives 100-kc phase-coded signals and transmitter triggers from Loran Timer-Synchronizer Set AN/FPN-41 (hereafter referred to as the timer-synchronizer). Each pulse generated by the transmitter group is amplitude modulated so that the pulse envelope of the 100-kc signal is of the correct shape. These pulses, or bursts of r-f energy, are approximately 200 microseconds in duration and correspond in time with each transmitter trigger.

(2) The function of the transmitter group is the same at both master and slave stations. Timing, phase coding, and operational modes are controlled by the timer-synchronizer at each station.

b. DESCRIPTION OF COMPONENTS.

(1) GENERAL.

(a) The transmitter group consists of five basic units and an inter-unit cable. Some are duplicated at each station to provide standby in addition to operate transmitter functions. The five basic units and the number required at each station are listed below:

NAME AND DESIGNATION	COLLOQUIAL NAME AND UNIT DESIGNATION	NUMBER REQUIRED PER STATION
Power Supply Assembly PP-2540/FPN-42	High voltage power supply UD 1A	2
Transmitter Control Group OA-2631/FPN-42	Pulse control unit UD 2A	1
Amplifier Assembly AM-2481/FPN-42	Transmitter UD 3A	2
Antenna Coupler CU-807/FPN-42	Coupling and load unit UD 4A	1
Centrifugal Fan Assembly HD-399/FPN-42	Blower assembly UD 5A	2
---	Inter-unit cable UD 8A	1

(b) All units, except the pulse control unit, are located in a transmitter building and are provided with facilities for mounting to the floor or wall. The pulse control unit is located in an operations building which also contains the timer-synchronizer. All units are housed in suitable grey metal cabinets. All operating controls, meters, and indicators are located for the operator's convenience and are identified by appropriate designations.

(2) HIGH VOLTAGE POWER SUPPLY.

(a) The high voltage power supply, figure 1-2, supplies all the power required by the transmitter and blower assembly.

(b) The front panel of the high voltage power supply contains all the meters, switches, indicator lamps, blown fuse indicators, and other operating controls necessary for the application of power to the transmitter. Additional information concerning the high voltage power supply is contained in Volume 3.

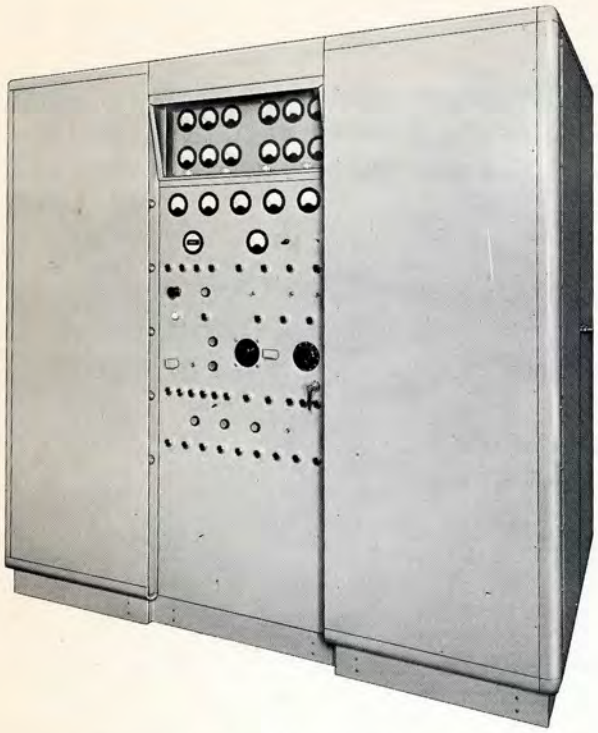


Figure 1-2. Power Supply Assembly PP-2540/FPN-42

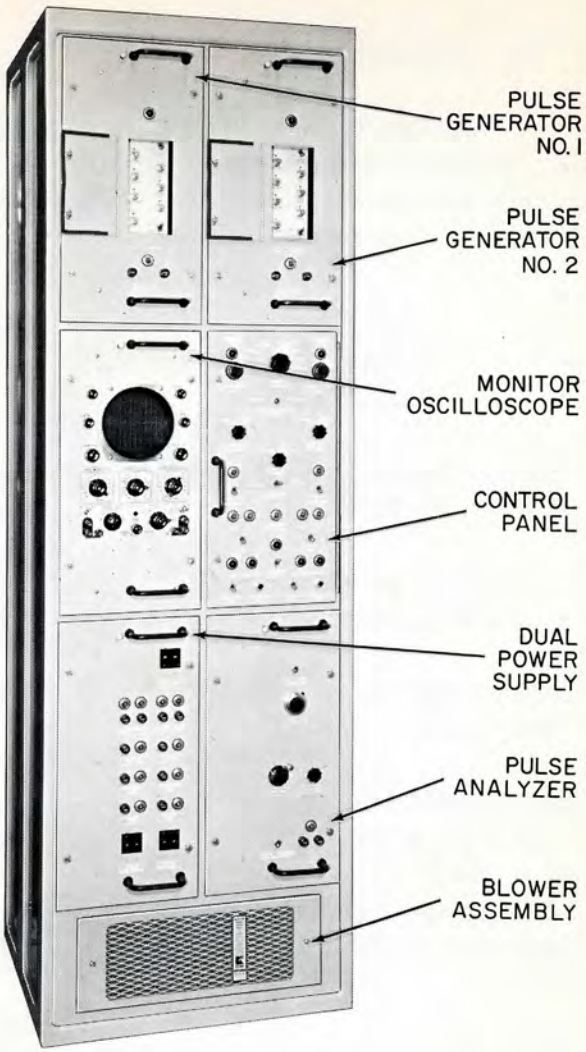


Figure 1-3. Transmitter Control Group OA-2631/FPN-42

(3) PULSE CONTROL UNIT.

(a) The pulse control unit, figure 1-3, provides remote operating and monitoring facilities for the transmitter group. It receives its primary operating power from an auxiliary circuit breaker located in the operations building. The pulse control unit consists of the following subassemblies:

NAME AND DESIGNATION	COLLOQUIAL NAME AND UNIT DESIGNATION	NUMBER PER UNIT
Pulse Generator O-706/FPN-42	Pulse generator UD 2A1 and UD 2A7	2
Oscilloscope OS-103/FPN	Monitor oscilloscope UD 2A2	1

NAME AND DESIGNATION	COLLOQUIAL NAME AND UNIT DESIGNATION	NUMBER PER UNIT
Power Supply Assembly PP-2541/FPN-42	Dual power supply UD 2A3	1
---	Control panel UD 2A5	1
---	Blower assembly UD 2A6	1
Electrical Pulse Analyzer TS-1360/FPN-42	Pulse analyzer UD 2A9	1

(b) The subassemblies perform the following functions:

1. The pulse generators produce 100-kc pulses using triggers and 100-kc signals from the timer-synchronizer. The output of either pulse generator may be used to drive either transmitter.

2. The monitor oscilloscope is used, in conjunction with the SIGNAL SELECTOR switch on the control panel, for observing various waveforms in the pulse generator and the output of the pulse analyzer. It is also used to observe the antenna and dummy load pulses.

3. The dual power supply provides dual internal plate and bias voltages.

4. The control panel contains the necessary switches and indicator lamps for remote operation of the two transmitters.

5. The blower assembly contains a fan for cooling the equipment in the pulse control cabinet.

6. The pulse analyzer enables the operator to check the locally transmitted pulse shape. It provides a means of measuring the relative amplitude of each cycle within the pulse for each of the transmitted pulses.

(4) TRANSMITTER.

(a) The transmitter, figure 1-4, contains four main amplifier stages. The following chart lists the subassemblies contained in the transmitter.

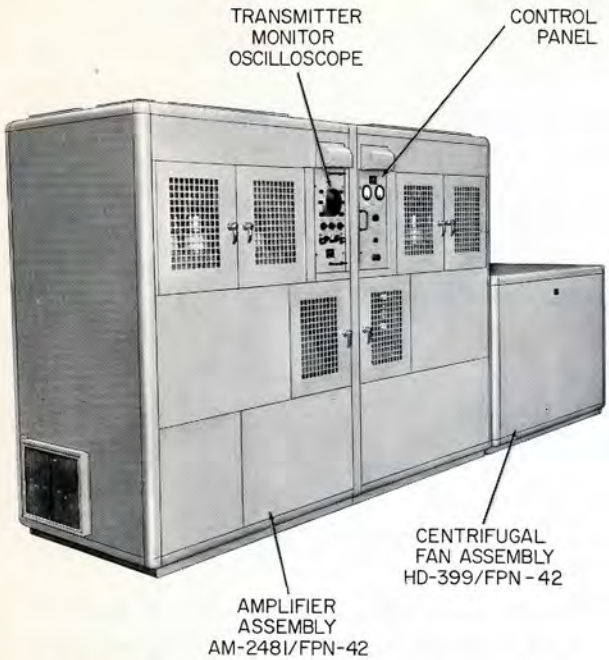


Figure 1-4. Amplifier Assembly AM-2481/FPN-42 and Centrifugal Fan Assembly HD-399/FPN-42

Figure 1-5. Antenna Coupler CU-807/FPN-42

NAME AND DESIGNATION	COLLOQUIAL NAME AND UNIT DESIGNATION	NUMBER PER UNIT
---	Pulse driver UD 3A1	1
Oscilloscope OS-103/FPN	Transmitter monitor oscilloscope UD 3A2	1
---	Cabinet assembly UD 3A4	1

(b) The subassemblies perform the following functions:

1. The four main amplifier stages include the pulse driver, the first intermediate power amplifier (IPA), the second IPA, and the final power amplifier. These stages raise the power level of the 100-kc pulses supplied by the pulse generator and feed them through the coupling and load unit for transmission by the antenna.

2. The transmitter monitor oscilloscope is used, in conjunction with the SIGNAL SELECTOR switch on the control panel of the cabinet assembly (transmitter control panel), for observing various waveforms in the transmitter.

3. The cabinet assembly houses the transmitter control panel and amplifiers.

(5) COUPLING AND LOAD UNIT.

(a) The coupling and load unit, figure 1-5, contains a coil used to tune the antenna and output circuit of the final power amplifier. The coupling and load unit also contains a dummy load.

(b) The dummy load consists of a bank of resistors used for testing the stand-by transmitter. A motor-driven fan forces air over the resistors for cooling purposes. An air switch interlock prevents application of power to the resistors in the event of fan failure.

(c) The coupling and load unit contains relays arranged so that when the operate transmitter is connected to the antenna, the stand-by transmitter is connected to the dummy load. The switching is accomplished at the pulse control unit by a manually-operated switch.

(d) The coupling and load unit provides facilities for reading antenna current and contains a switch which assigns control of the transmitter to either the transmitter building for local operation or to the operations building for remote operation.

(e) The coupling and load unit receives its primary operating power via an auxiliary circuit breaker located in the transmitter building.

(6) BLOWER ASSEMBLY. - The blower assembly, figure 1-4, contains a motor-driven fan which forces air through filters into the transmitter cabinet to cool the high-power tubes in the power amplifier stages.

(7) INTER-UNIT CABLE. - This cable, supplied with suitable connectors, provides the means for interconnecting the units of the transmitter group.

1-3. FACTORY OR FIELD CHANGES.

Table 1-1 lists modifications to Loran Transmitting Set AN/FPN-42 made in the field by means of modification kits. All serial numbers from 1 to 26 inclusive, not specifically mentioned in the table, have been factory fitted.

WARNING

Be sure to observe high voltage safety precautions when inspecting for field change accomplishments.

TABLE 1-1. LORAN TRANSMITTING SET AN/FPN-42, FIELD CHANGES

FIELD CHANGE NUMBER	FIELD CHANGE TITLE AND PURPOSE	SERIAL NUMBERS OF EQUIPMENTS AFFECTED (ALL NUMBERS INCLUSIVE)	FIELD CHANGE ACCOMPLISHED IF:
T1	Spark gap installation	2-11	Mechanical spark gap protection provided.
T2	Plastic frame replacement	1, 3-10	New damping resistor frames installed.
T3	Cancelled		
T4	Cancelled		
T5	Power amplifier plate protection improvement	3-8	Ceramic plate resistors installed in plate circuits of tubes V1 through V8 of transmitter.
T6	Plastic insulating plate change	1-10	High temperature insulating plate installed in transmitter.
T7	Refer to Section 1 in Volume 3		
T8	Refer to Section 1 in Volume 3		
T9	First IPA cooling improvement	1, 3-12	Forced air cooling supplied to 304TH tubes V11 and V12 of transmitter.
T10	7800/7899 tube support change	1-16	Sockets of tubes V1 through V8 of transmitter replaced with ceramic units.

TABLE 1-1. LORAN TRANSMITTING SET AN/FPN-42, FIELD CHANGES (Cont)

FIELD CHANGE NUMBER	FIELD CHANGE TITLE AND PURPOSE	SERIAL NUMBERS OF EQUIPMENTS AFFECTED (ALL NUMBERS INCLUSIVE)	FIELD CHANGE ACCOMPLISHED IF:
T11	Increased breakdown protection for power amplifier plate leads	1-16	Ceramic feed-through insulators provided for plate leads of tubes V1 through V8 of transmitter.
T12	Better protection for pulse control equipment	1-16	Slow-blow fuses installed, as required.
T13	Cancelled		
T14, T16	Refer to Section 1 in Volume 3		
T15	Operation at 2000 feet from Timer-Sync	Applies only to stations with 2000 transmission lines	V19 and V20 added to pulse generator chassis
T17	Increased breakdown protection in second IPA	1-16	Insulator lengths increased in second IPA compartment.
T18	Refer to Section 1 in Volume 3		
T19	Cancelled		
T20	Correct operation of the 3.8 KV overload circuit	1-16	Overload circuit provided with r-f bypass.
T21	Refer to Section 1 in Volume 3		
T22	Increase life of pulse driver amplifier tubes	1-16	Filament voltage limiting resistor inserted into pulse driver.

TABLE 1-1. LORAN TRANSMITTING SET AN/FPN-42, FIELD CHANGES (Cont)

FIELD CHANGE NUMBER	FIELD CHANGE TITLE AND PURPOSE	SERIAL NUMBERS OF EQUIPMENTS AFFECTED (ALL NUMBERS INCLUSIVE)	FIELD CHANGE ACCOMPLISHED IF:
T23	Provide voltage protection for the standby transmitter	1-26	Vacuum switches S22 and S23 installed in outputs of transmitter.
T24	Increase voltage rating of capacitor C83 in transmitter	1-16	Capacitor C83 replaced with higher rated capacitor.

1-4. QUICK REFERENCE DATA.

a. OPERATING CHARACTERISTICS. - Operating characteristics and limitations of the transmitter group are listed below:

CHARACTERISTICS	LIMITATIONS
Transmitter frequency	100-kc (carrier)
Frequency control	Adjustable over a range of three parts in 10^8 with a vernier calibration of 1 part in 10^{10}.
Frequency stability	Maximum change in frequency 0.2 parts in 10^{10} per day and 1 part in 10^{10} per one-half hour period. Maximum rate of change in frequency is 6 parts in 10^{16} per sec^2.
Output signal	Pulsed 100 kc, either single pulsed (groups of one or two pulses) or multipulsed (groups of eight or nine pulses).
Pulse width	Approximately 200 microseconds.
Basic group repetition intervals	30, 40, 50, 60, 80, and 100 milliseconds.
Power output	300 kw peak; 75 kw at the 30-microsecond sampling point, minimum.
Bandwidth and sideband distribution	90 to 100 kc, 99 percent power.

CHARACTERISTICS	LIMITATIONS
Antenna characteristics	An electrically short unipole 625 feet high, top loaded with 24 top loading elements, 600 feet long, anchored 850 feet from the base of the antenna. Antenna impedance is 2.5 - j27 ohms at 100 kc. (With appropriate modifications (to the transmitters and the coupling and load unit) an electrically short unipole 1350 feet high, top loaded with 6 top loading elements (each element 350 feet long), anchored 1900 feet from the base of the unipole (antenna), and having an impedance of 12.8 - j100 ohms at 100 kc may be used.)
Ambient temperature range	0°C. (32°F.) to 50°C. (122°F.).
Non-operating storage temperature range	-62°C. (-80°F.) to 75°C. (167°F.).
Pulse control signal input	Phase-coded 100 kc, 12 to 22.5 volts peak to peak. Triggers, 80 to 180 volts peak.
Transmitter signal input	Approximately 80-microsecond 100-kc pulses, 140 volts peak to peak.

b. INPUT POWER REQUIREMENTS. - The input power requirements for the major components of the transmitter group are listed below:

UNIT	NOMINAL INPUT POWER REQUIREMENTS	CIRCUIT
High voltage power supply	208-volt, 60-cycle, 3-phase, 4-wire, 120 kva, 95-percent power factor	Input
Transmitter	208-volt, 60-cycle, 3-phase, 4-wire, 11 kva regulated	Filament transformers
	120-volt, 60-cycle, single phase 1 kva, unregulated	Controls, relays and indicators
	14 kilovolts dc, 5.5 amperes (maximum)	Power amplifier and second IPA plates
	7 kilovolts dc, 250 milliamperes (maximum)	First IPA plates

UNIT	NOMINAL INPUT POWER REQUIREMENTS	CIRCUIT
	3.5 kilovolts dc, 200 milliamperes (maximum)	Pulse driver plates
	-600 volts dc, 2 amperes (maximum)	First IPA, second IPA and power amplifier bias
	-300 volts dc, 250 milliamperes (maximum)	Pulse driver bias
Blower assembly	208-volt, 60-cycle, 3-phase, 4-wire, 2.5 kva, unregulated	Motor power
Coupling and load unit	120-volt, 60-cycle, single-phase, 0.5 kva	Input
Pulse control unit	120-volt, 60-cycle, single-phase, 2 kva, 90-percent power factor	Input

1-5. EQUIPMENT LISTS.

a. EQUIPMENT SUPPLIED. - Table 1-2 lists the equipment supplied as part of the transmitter group for each station. Duplicate transmitter group components are required to permit operation of one transmitter while the other is in a stand-by condition, undergoing service, or repair. This table lists the quantity, official nomenclature, dimensions, volume, and weight of each article per station.

NOTE

Unless otherwise stated in the table, dimensions are in inches, volume in cubic feet, weight in pounds. All dimensions, volumes, and weights indicated, except total volume and weight, are for single quantities.

TABLE 1-2. LORAN TRANSMITTING SET AN/FPN-42, EQUIPMENT SUPPLIED

QUANT. PER EQUIP.	NOMENCLATURE		OVERALL DIMENSIONS			VOLUME	WEIGHT (APPROX)
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH		
2	Power Supply Assembly	PP-2540/FPN-42	83	86	48	198	7400
1	Transmitter Control Group (includes)	OA-2631/FPN-42	78	24-1/2	26	28.8	500
2	Pulse Generator	O-706/FPN-42	22	10-3/4	22	--	--
1	Oscilloscope	OS-103/FPN	22	10-3/4	22	--	--
1	Power Supply Assembly	PP-2541/FPN-42	22	10-3/4	26	--	--
1	Control Panel	None	22	10-3/4	8	--	--
1	Blower Assembly	None	7	19	10-3/4	--	--
1	Electrical Pulse Analyzer	TS-1360/FPN-42	22	10-3/4	26	--	--
2	Amplifier Assembly (includes)	AM-2481/FPN-42	83	121	44	256	3500
1	Pulse Driver	None	10	29	20	--	--
1	Oscilloscope	OS-103/FPN	22	10-3/4	22	--	--

TABLE 1-2. LORAN TRANSMITTING SET AN/FPN-42, EQUIPMENT SUPPLIED (Cont)

QUANT. PER EQUIP.	NOMENCLATURE		OVERALL DIMENSIONS			VOLUME	WEIGHT (APPROX)
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH		
1	Cabinet Assembly	None	83	121	44	--	--
1	Antenna Coupler	CU-807/FPN-42	55	52-1/2	36	60.2	1000
2	Centrifugal Fan Assembly	HD-399/FPN-42	47	73	44	87.4	700
1	Loran Transmitting Set	AN/FPN-42	--	--	--	1171.8	24700
1	Hewlett-Packard Capacitive Voltage Divider and Instruction Manual	452A	6	3.5	3.5	0.01	3
4	Instruction Manual for Hewlett-Packard Oscilloscope Model 130B	--	--	--	--	--	--
4	Technical Manual for Loran Transmitting Set AN/FPN-42	CG-273-74	--	--	--	--	--

b. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED. - Table 1-3 lists all equipment and handbooks necessary but not supplied for the operation of the transmitter group at the Loran-C station. The use of each item is given in the table.

c. SHIPPING DATA. - Table 1-4 provides transmitter group shipping data. Unless otherwise noted in the table dimensions are in inches, volume in cubic feet, weight in pounds, equipment crated and ready for shipment.

NOTE

All dimensions, volumes, and weights indicated in the table, except complete equipment volume and weight, are for single quantities.

d. EQUIPMENT SIMILARITIES. - The equipment described by this technical manual is discrete, and no equipment of the same or similar series exists.

e. ELECTRON TUBE COMPLEMENT. - Table 1-5 provides the electron tube complement for the transmitter group.

NOTE

Power Supply Assembly PP-2540/FPN-42, Amplifier Assembly AM-2481/FPN-42, and Pulse Generator O-706/FPN-42 are duplicated in one Loran Transmitting Set AN/FPN-42. The number of tubes listed in the table for each of these units is for two units.

TABLE 1-3. LORAN TRANSMITTING SET AN/FPN-42, EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED

QUANT. PER EQUIP.	NOMENCLATURE		REQUIRED USE	REQUIRED CHARACTERISTICS
	NAME	DESIGNATION		
1	Clamp on volt-ammeter	G6625-284-0855	To measure input currents on primary lines	0 to 1000 amperes, 0 to 700 volts, ±3 percent
2	Simpson Multimeter	260	Checking a-c and d-c voltages; checking continuity and resistance	D-c voltage range: 0 to 5000 volts, ±3 percent full scale, 20,000 ohms per volt A-c voltage range: 0 to 5000 volts, ±5 percent full scale, 5000 ohms per volt Resistance range: 0 to 20 megohms, ±3 percent of arc length
1	Vacuum Tube Voltmeter	AN/USM-116	Measure plate voltages	Voltage range: 0-1500 volts ac or dc ±3 percent A-c input impedance: 0.83 megohm and 70 mmf to 1.5 megohms and 60 mmf D-c input resistance: 11 megohms

TABLE 1-3. LORAN TRANSMITTING SET AN/FPN-42, EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED (Cont)

QUANT. PER EQUIP.	NOMENCLATURE		REQUIRED USE	REQUIRED CHARACTERISTICS
	NAME	DESIGNATION		
1	General Radio Frequency Bridge	916-AL	Tuning transmitter upon installation	Resistance range: 0.2 ohms to 1000 megohms Frequency range: 0.005 to 50 mc Reactance: ±11,000 ohms at 100 kc Resistance: 0 to 1000 ohms
1	Instruction Manual for 916-AL	--	Operation of radio frequency bridge	--
1	National Radio Receiver with coils D, E, F, G, H, and J	HRO-60	Bridge detector; spectrum measurements	Frequency range: 0.050 to 0.430 and 0.480 to 4.0 mc
1	Instruction Manual for HRO-60	--	Operation of receiver	--
1	General Radio Signal Generator	Type 1001A	For use with bridge and receiver	Carrier frequency: 0.050 to 50 mc, ±1 percent Output voltage range: 0.1 to 200,000 microvolts

TABLE 1-3. LORAN TRANSMITTING SET AN/FPN-42, EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED (Cont)

QUANT. PER EQUIP.	NOMENCLATURE		REQUIRED USE	REQUIRED CHARACTERISTICS
	NAME	DESIGNATION		
				Output impedance: 10 ohms
1	Instruction Manual for Type 1001A	--	Operation of signal generator	--
1	Hewlett-Packard VTVM	400C	Measure output amplitude of signal generator	Voltage range: 0.001 to 300 volts Frequency range: 10 cps to 4 mc Accuracy: 20 cps to 1 mc ±2 percent full scale
1	Tube Tester	TV-10/U	Checking low voltage tubes in pulse generator, power supply, pulse analyzer, and monitor oscilloscope	Capable of checking all seven, eight, and nine pin tubes in the transmitter group
1	Polaroid Oscilloscope Camera	F-296	Obtaining waveform photographs	Image to object ratio: 0.9 to 1 Lens: 75 mm (f/1.9) Shutter: time, brief, 1/100 to 1 second

TABLE 1-3. LORAN TRANSMITTING SET AN/FPN-42, EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED (Cont)

QUANT. PER EQUIP.	NOMENCLATURE		REQUIRED USE	REQUIRED CHARACTERISTICS
	NAME	DESIGNATION		
1	Tektronix Oscilloscope	531	Troubleshooting individual circuits	Sweep range: 0.1 μsec/cm to 12 sec/cm Sweep calibration: ±3 percent
1	Tektronix Scopemobile	500/53	Movable platform for oscilloscope	Capable of carrying Tektronix oscilloscope Model 531
1	Tektronix Bezel	BE510	Camera adapter for oscilloscope	Capable of accepting Hewlett-Packard oscilloscope camera Model 196A
1	Biddle 500V Megger	601	Checking cabling insulation resistance	0.02 to 20 megohms at 100 volts 0.05 to 50 megohms at 250 volts 0.1 to 100 megohms at 500 volts
1	RCA Receiver	SRR-11	Energy spectrum measurements	Frequency range: 14 to 600 kc Sensitivity: 14 to 18 kc, 8 microvolts or better; 18 to 199 kc, 5 microvolts or better; 100 to

TABLE 1-3. LORAN TRANSMITTING SET AN/FPN-42, EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED (Cont)

QUANT. PER EQUIP.	NOMENCLATURE		REQUIRED USE	REQUIRED CHARACTERISTICS
	NAME	DESIGNATION		
				600kc, 3.5 microvolts or better Threshold control range: 1 to 15,000 microvolts carrier level
1	Hewlett-Packard Amplifier	450A	Energy spectrum measurements	Gain: 40 ± 1/8 db or 20 ± 1/8 db at 1000 cps Frequency response: 10 to 1,000,000 cps ± 0.5 db Distortion: 2 cps to 100 kc, 1 percent
2	Spencer-Kennedy Lab Electronic Filter	300	Energy spectrum measurements	Functions: high-pass or low-pass filter Rate of attenuation: 18 db per octave Cut off frequency range: 20 cps to 200 kc Bandpass limits: 2 cps to 4 mc Input impedance: 2 megohms shunted by 32 μμf

TABLE 1-3. LORAN TRANSMITTING SET AN/FPN-42, EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED (Cont)

QUANT. PER EQUIP.	NOMENCLATURE		REQUIRED USE	REQUIRED CHARACTERISTICS
	NAME	DESIGNATION		
				Output impedance: 300 ohms
1	Transmitting antenna		Radiate Loran-C pulses	An electrically short unipole 625 feet high, top loaded with 24 top loading elements 600 feet long, anchored 850 feet from the base of the antenna. Antenna impedance: 2.5 - j27 ohms at 100 kc (with appropriate modifications (to the transmitters and the coupling and load unit) an electrically short unipole 1350 feet high, top loaded with 6 top loading elements (each element 350 feet long), anchored 1900 feet from the base of the unipole (antenna), and having an impedance of 12.8 - j100 ohms at 100 kc may be used.)

TABLE 1-4. LORAN TRANSMITTING SET AN/FPN-42, SHIPPING DATA

BOX NO.	NOMENCLATURE		OVERALL DIMENSIONS			VOLUME	WEIGHT (APPROX)
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH		
	Power Supply Assembly	PP-2540/FPN-42					
1T, 2T,	left cabinet		92	39	58	120	1400
3T, 4T,	center cabinet		92	39	58	120	1700
5T, 6T,	right cabinet		92	39	58	120	1500
	electron tubes, mounting hardware						
7T, 8T,	plate transformer		69	35	54	75.5	2750
9T, 10T	plate voltage regulator		57	35	41	47.5	2020
	Amplifier Assembly	AM-2481/FPN-42					
11T, 12T	section A-left		95	73	50	201	1725
13T, 14T	section B-right		95	73	50	201	1845
15T	Antenna Coupler	CU-807/FPN-42	65	61	49	112	923
16T, 17T	Centrifugal Fan Assembly	HD-399/FPN-42	58	79	52	137.5	1200
	Transmitter Control Group	OA-2631/FPN-42					
18T	cabinet, control panel, blower assembly		88	37	36	67.8	601
19T	pulse analyzer, power supply, oscilloscope and two pulse generators		33	66	38	47.8	485

TABLE 1-4. LORAN TRANSMITTING SET AN/FPN-42, SHIPPING DATA (Cont)

BOX NO.	NOMENCLATURE		OVERALL DIMENSIONS			VOLUME	WEIGHT (APPROX)
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH		
20TA, 20TB	Oscilloscope Pulse driver	OS-103/FPN None	33	54	36	37	290
21T	Installation equipment	None	15	49	23	9.8	193
22T	Wire and cable Wire duct	None	60	48	48	80	500
23T	Ducting	None	25	61	23	20.3	370
24T, 25T, 26T, 27T	Tuning capacitors (2 per box)	None	25	25	26	9.5	253
28T, 29T, 30T, 31T, 32T, 33T	Filter capacitors (3 per box)	None	23	24	23	7.5	265
34T, 35T	Output transformers	None	33	44	23	19.4	190
37T	Instruction books, special tools, test equipment	None	11	21	11	1.5	100
38T, 39T	Electron tubes	None	41	34	34	27.4	410

TABLE 1-4. LORAN TRANSMITTING SET AN/FPN-42, SHIPPING DATA (Cont)

BOX NO.	NOMENCLATURE		OVERALL DIMENSIONS			VOLUME	WEIGHT (APPROX)
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH		
40T, 41T, 42T, 43T, 44T, 45T, 46T, 47T, 48T, 49T	Filament Transformer	None	15	14	18	2.2	127
	Complete Equipment	AN/FPN-42				2656.8	37104

TABLE 1-5. LORAN TRANSMITTING SET AN/FPN-42, ELECTRON TUBE COMPLEMENT

UNIT	NUMBER OF TUBES OF TYPES INDICATED																									
	5651	5687	5725/6AS6W	5726/6AL5W	5751	5814A	6005/6AQ5W	6080	7800	4PR60	6AU6	6AW8	6BH6	6DJ8/ECC88 or 6BQ7A	6U8	6X4	12AL5	12AT7	12AU7	12AX7	12B4A	0A2WA	3CX100A5	2X3000F	304TH	TOTAL
Power Supply Assembly PP-2540/FPN-42																								24		24
Transmitter Control Group OA-2631/FPN-42 includes:																										
Pulse Generator 0-706/FPN-42		10		4	2	16	4																			36
Oscilloscope OS-103/FPN	5										2	1	2	4	1	1	1	3	4	1	3					28
Power Supply Assembly PP-2541/FPN-42	6				12			8														4				30
Electrical Pulse Analyzer TS-1360/FPN-42			1	4		7																				12
Amplifier Assembly AM-2481/FPN-42	10								20	4	4	2	4	8	2	2	2	6	8	2	6		4		4	88
Total Number of Each Type	21	10	1	8	14	23	4	8	20	4	6	3	6	12	3	3	3	9	12	3	9	4	4	24	4	218

SECTION 2

INSTALLATION

2-1. UNPACKING AND HANDLING.

a. The following general precautions should be observed during unpacking:

(1) Check the outside of the crate or case for signs of external damage.

(2) After the case is opened, check to see that the moisture-vapor barrier is intact.

(3) After the outer wrappings have been removed from the equipment, check the appearance of the equipment for any evidence of damage.

(4) Check tubes or other fragile components that have been packed separately and observe that they are intact and undamaged.

(5) Immediately report any damage or abnormality to the commanding officer.

b. Detailed instructions for unpacking, handling, and assembling the equipment and its parts are contained in paragraph 2-5.

2-2. SITE SELECTION.

Loran-C station sites are selected in advance by the Commandant, U.S. Coast Guard. Construction of the operations and transmitter buildings which house the equipment is performed by the U.S. Coast Guard.

2-3. POWER REQUIREMENTS AND DISTRIBUTION.

a. UNIT POWER REQUIREMENTS.

NOTE

There are two high voltage power supplies; the power requirements listed are for one unit.

(1) HIGH VOLTAGE POWER SUPPLY. - 208-volt, 60-cycle, 3-phase, 4-wire, 120 kva, 95 percent power factor.

(2) PULSE CONTROL CABINET. - 120-volt, 60-cycle, single-phase, 2 kva, 90 percent power factor.

(3) COUPLING AND LOAD. - 120-volt, 60-cycle, single-phase, 0.5 kva.

b. POWER DISTRIBUTION. - See figures 5-12 and 5-13 for primary power distribution information.

2-4. INSTALLATION LAYOUT.

a. The locations of the transmitter group units within the transmitter building have been carefully planned and are shown in figure 2-1. Figure 1-1 shows the functional interconnection of the units.

b. The locations of the transmitter units are arranged so that:

(1) A parallel layout enables the design and use of one cable set with duplicate cable lengths.

(2) Similar output ducts are designed for heat removal.

(3) Output r-f leads of equal length are used so that the transmitter are tuned identically.

(4) Maintenance is simplified by providing adequate space around the equipment for easy access to all panels, service doors, and filters.

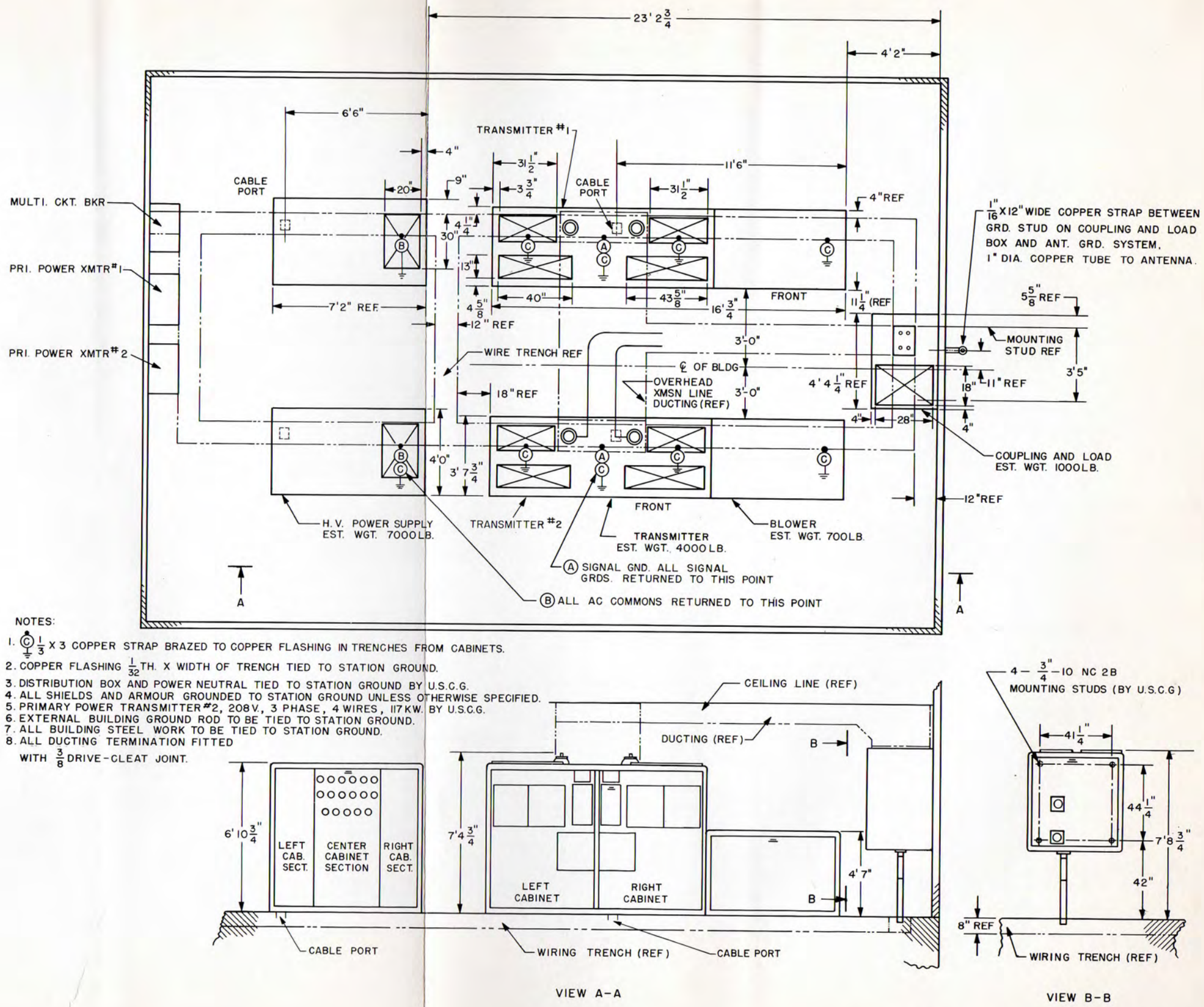
2-5. INSTALLATION REQUIREMENTS.

a. INSTALLATION POINTERS.

(1) To save time and effort, the installation of the equipment should be carefully planned. It is imperative that the dimensions on the layouts be followed to obtain a correct fit to the overhead transmission line and ducting. The locations of the individual units should be noted (see figure 2-1), and marked on the floor of the transmitter building. This will facilitate the final placement of the equipment.

(2) Standby units should be installed concurrently with the operate units. Installation instructions are given for only one unit where duplicate units are to be installed. Kick-plates are provided on the equipment and should be removed during the installation procedure. They are to be reinstalled after the equipment is in its correct location.

(3) Prior to equipment installation, provisions should be made for connecting the units to the station ground system. Copper straps (bands) should be soldered to the copper lining in the cable trench. After the equipment is located properly over the trench, the copper straps should be bolted to the cabinet frame.



NOTES:

1. (C) 1/3 X 3 COPPER STRAP BRAZED TO COPPER FLASHING IN TRENCHES FROM CABINETS.
2. COPPER FLASHING 1/32 TH. X WIDTH OF TRENCH TIED TO STATION GROUND.
3. DISTRIBUTION BOX AND POWER NEUTRAL TIED TO STATION GROUND BY U.S.C.G.
4. ALL SHIELDS AND ARMOUR GROUNDED TO STATION GROUND UNLESS OTHERWISE SPECIFIED.
5. PRIMARY POWER TRANSMITTER #2, 208 V., 3 PHASE, 4 WIRES, 117 KW. BY U.S.C.G.
6. EXTERNAL BUILDING GROUND ROD TO BE TIED TO STATION GROUND.
7. ALL BUILDING STEEL WORK TO BE TIED TO STATION GROUND.
8. ALL DUCTING TERMINATION FITTED WITH 3/8 DRIVE-CLEAT JOINT.

Figure 2-1. Transmitter Building, Installation Layout Diagram

The cabinet finish should be removed at this point so that a solid ground connection is made to bare metal.

NOTE

Copper straps for ground connections are not supplied with the equipment.

(4) It is recommended that the equipment be unpacked and installed in the following order:

(a) Inter-unit cabling

(b) High voltage power supply

(c) Transmitter

(d) Blower assembly

(e) Coupling and load unit

(f) Ducting

(g) Pulse control cabinet

b. DETAILED INSTALLATION PROCEDURE.

NOTE

Table 1-4 lists the contents of the various shipping boxes.

(1) INTER-UNIT CABLING. - Unpack and locate the cabling in the trenches in accordance with figures 2-1 and 2-2. The cabling should be located so that the cable ends will be visible through the access ports of the equipment after the equipment is placed over the trenches. Allow approximately two feet of slack at these terminations so that no undue strain is placed on the cable when drawn up through the floor of the individual pieces of equipment. Observe the reference designation markings on the marker sleeves of the cables for proper terminations.

(2) HIGH VOLTAGE POWER SUPPLY.

(a) The high voltage power supply is composed of three separate cabinet sections which are bolted together to form a complete cabinet assembly. The complete assembly contains the large major subassemblies such as the plate transformer, plate voltage regulator, filament voltage regulator, tube cooling

blower, control panels, and rectifier assembly. All but the plate transformer and the plate voltage regulator are shipped within the cabinet sections.

(b) Unpack the right cabinet section and position it over the previously determined floor location. The plate transformer will be installed in this section.

(c) Unpack and lift the plate transformer into position over a set of large rollers (6 inches in diameter) using a crane and slings (or a fork lift truck) and lower onto the rollers.

CAUTION

Lift the plate transformer by means of the lifting lugs welded to the tank body. Never lift the transformer by its cover or attempt to move it by pushing against the terminals. The weight of the transformer is 2750 pounds; use extreme caution when handling or moving the unit.

(d) Roll the transformer to the edge of the left side of the cabinet section (opposite the double door, see Section 6 of Volume 3). Orientate the transformer so that when it is installed in equipment serial numbers 1 through 16, inclusive, the three delta secondary terminals are adjacent to the double door of the cabinet section; and when it is installed in equipment serial numbers 17 through 26, inclusive, the three primary terminals (least number of insulator rings) are adjacent to the double door.

(e) Place a set of the small wooden rollers (3 inches in diameter) on the cabinet section floor and roll the plate transformer into the cabinet over the mounting holes.

CAUTION

There is not too much clearance between the transformer and the cabinet framework. Use extreme care when rolling the transformer into the cabinet so that the terminals or cooling tubes are not damaged by striking the framework.

(f) Raise the transformer off the rollers, utilizing the lifting lugs welded to the transformer tank near the cover, with offset jacks. Remove the rollers, and lower the transformer gently into place and secure it to the cabinet floor with the hardware provided.

(g) Unpack the center cabinet section and locate it next to the right section on the floor. Make sure that the two sections are properly aligned, and bolt them together with the hardware provided at each of the corresponding bolt holes in the two cabinet section frames.

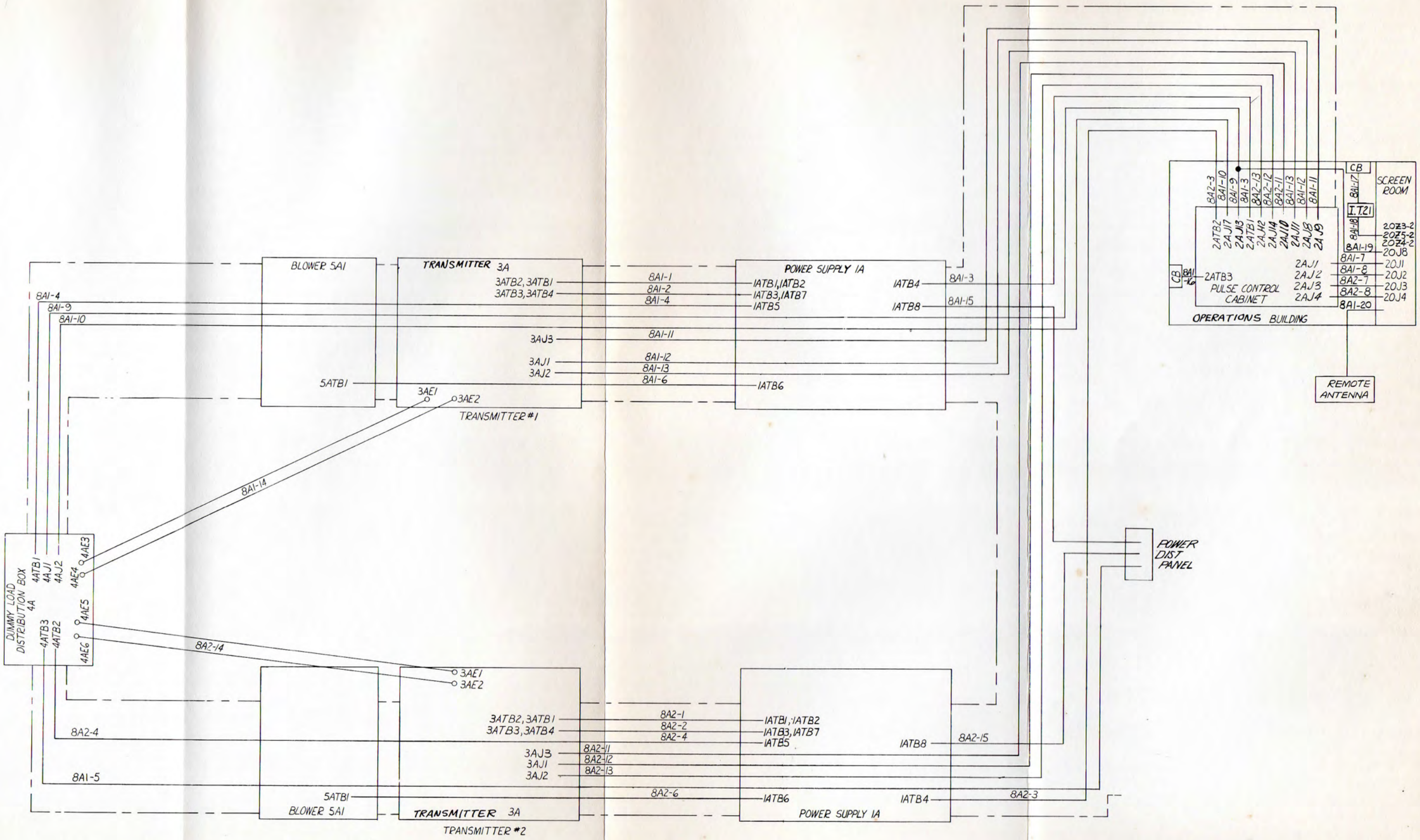


Figure 2-2. Loran Transmitting Set AN/FPN-42, Inter-unit Cabling Diagram

NOTE

The center cabinet section contains the following: tube cooling blower, rectifier section, control panel, and filament voltage regulator.

(h) Unpack and install the rectifier tubes in the tube sockets as shown in Section 6 of Volume 3. Connect the filament leads of each tube to the two sets of filament bus bars above the tubes.

CAUTION

No two filament leads from a tube should be connected to the same bus bar.

(i) Unpack the left cabinet section and place it near (allow enough space for the installation of the plate voltage regulator) its final position next to the center section.

(j) Remove the three mounting bolts on the vertical bracket behind the regulator cooling blower, and completely remove the blower from the cabinet.

(k) Unpack and locate the plate voltage regulator at the rear (opposite the double-door) of the left cabinet section. The regulator should be oriented so that when it is installed, the terminal board section (the many rows of terminal boards) on the regulator can be seen from the front of the cabinet section with the panel removed (see Section 6 of Volume 3).

(l) Locate the plate voltage regulator capacitor bracket (Section 6 of Volume 3) used for mounting capacitors C1 and C2. Remove the two large bolts holding the bracket to the regulator, and swing the capacitor subassembly around so that it rests on the regulator without protruding on the side. Tie it in place temporarily.

(m) Lift the regulator (which weighs 2020 pounds) into its proper position in the cabinet using the two lifting brackets on the top of the regulator frame. Bolt the regulator in place using the hardware provided. Reconnect the blower and capacitor brackets.

(n) Move the cabinet section so that it is next to and aligned with the center section. Bolt the sections together, with the hardware provided, at each of the corresponding bolt holes in the two cabinet section frames.

(o) Relays, switches, and similar parts have been blocked to prevent damage to them during shipment. Remove all such blocks carefully. Remove all ties from resistors, loose cables, and moveable parts which have been secured for shipment. Remove shipping screws from regulating relays of both inductrols.

(p) Connect all cabling between and internal to the cabinet sections to their respective terminations and terminal boards (see Section 2 of Volume 3). Pull the inter-unit cables for the high voltage power supply from the cable trench, through the cable input port, and make connections as indicated by the markings on the cable terminations (see figure 2-3).

CAUTION

All primary power cable connections must be clean and secure in order to prevent overheating. Use a large socket wrench to tighten these connections.

(3) TRANSMITTER.

(a) The transmitter consists of two cabinet sections almost identical in appearance. When bolted together they form one integrated cabinet.

(b) Unpack and position the left cabinet section over the previously determined floor location. This section is closest to the high voltage power supply.

NOTE

This section must be located accurately since the overhead r-f transmission line and protective ducting is fixed in relation to the transmitter and coupling and load unit. Dimensions given in figure 2-1 are from the exterior surface of the cabinet.

(c) Unpack and locate the right cabinet section adjacent to the left cabinet section.

(d) Remove all panels from both cabinet sections. Remove all shipping cartons from both cabinet sections. The cartons contain all loose transmitter parts which were not packed separately.

(e) Carefully move the two halves together, so that the joining ducting sections on the bottom shelf are nested properly. Bolt the cabinet sections in place, with the hardware provided at each of the corresponding bolt holes in the two cabinet section frames.

NOTE

Be sure that the bolts going through the top shelves also pass through the ground plate between the cabinet sections. The ground plate is a 1/2- x 8- x 20-inch aluminum plate.

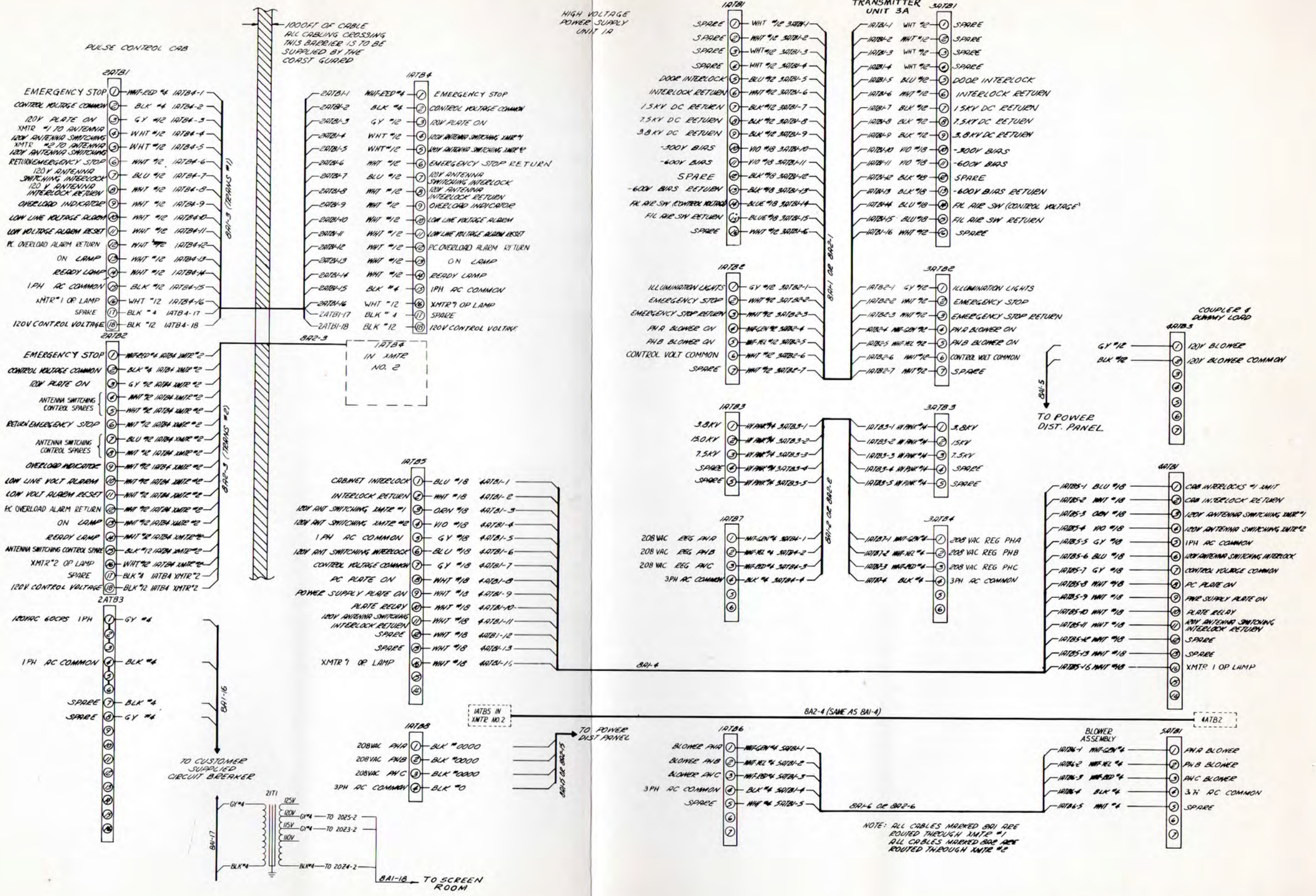
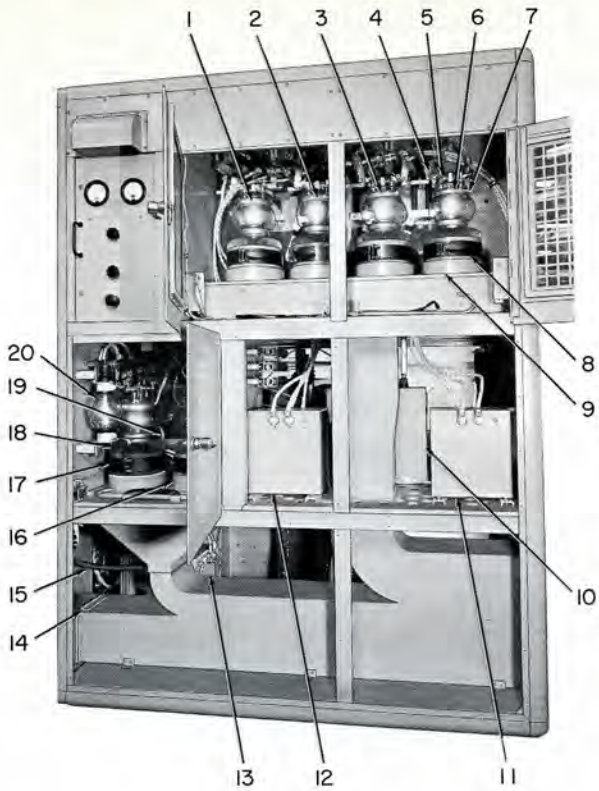


Figure 2-3. Loran Transmitting Set AN/FPN-42, Power and Switching Interconnection Diagram



1 Power amplifier V5
2 Power amplifier V6
3 Power amplifier V7
4 Filament connector
5 Thumb screw
6 Power amplifier V8
7 Grid connector ring
8 Plate strap
9 Tube socket
10 Capacitor C45
11 Transformer T11
12 Transformer T10
13 Transformer T12
14 Drive-cleat joint
15 Flexible cooling tube
16 Power amplifier V10
17 Power amplifier V9
18 Plate lead
19 Plate lead
20 Vacuum capacitor C7

Figure 2-4. Amplifier Assembly AM-2481/FPN-42, Right Cabinet Section, Front View With Panels Removed

(f) Join the two sections of the large blower ducting by inserting the drive cleats provided into the drive-cleat joints (14, figure 2-4).

(g) Fasten the masking panel (12, figure 2-5) to the right cabinet with the hardware provided. This panel is already fastened to the left cabinet section, and is used to cover the joint between the two cabinet sections.

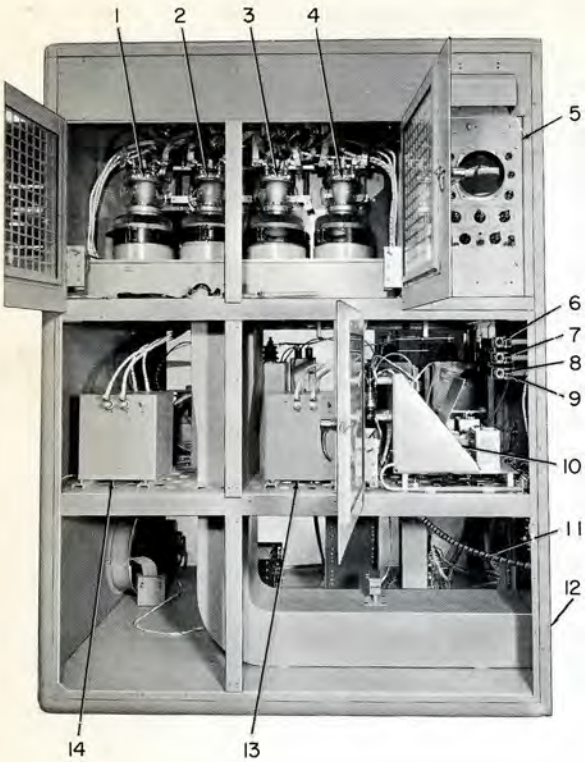
(h) Connect the flexible cooling tube to the nozzles on the right cabinet section cooling air duct and first IPA chassis as shown in figure 2-6.

(i) Unpack the glass output terminals (E21 and E22) and fasten to the top of the cabinets as shown in figure 2-7. Install the plastic cover plate between the two terminals as shown in figure 2-8.

(j) Install the two antenna-disconnect vacuum switches on top of the cabinets as shown in figure 2-9, sheet 2 of 3. Follow the instructions contained in Modification Kit T23.

CAUTION

The antenna disconnect vacuum switches have fragile components, and must be handled with extreme care.



1 Power amplifier V1
2 Power amplifier V2
3 Power amplifier V3
4 Power amplifier V4
5 Transmitter monitor oscilloscope
6 Resistor R122
7 Resistor R123
8 Resistor R124
9 Terminal E91
10 1st IPA assembly
11 Flexible cooling tube
12 Masking panel
13 Transformer T9
14 Transformer T8

Figure 2-5. Amplifier Assembly AM-2481/FPN-42, Left Cabinet Section, Front View With Panels Removed

(k) Unpack the filter capacitors.

WARNING

Unless a wire is connected across the terminals of the filter capacitors, discharge these units cautiously before handling. Remove shorting leads only after the capacitors are mounted in the cabinet sections.

NOTE

Two of the nine capacitors for each transmitter have a notch in the mounting flange (6, figure 2-10). These capacitors must be used only for C10 and C33 (4, 10, figure 2-7).

(l) Install filter capacitors C34, C26, C18, and C10, in that order, as shown in figure 2-10.

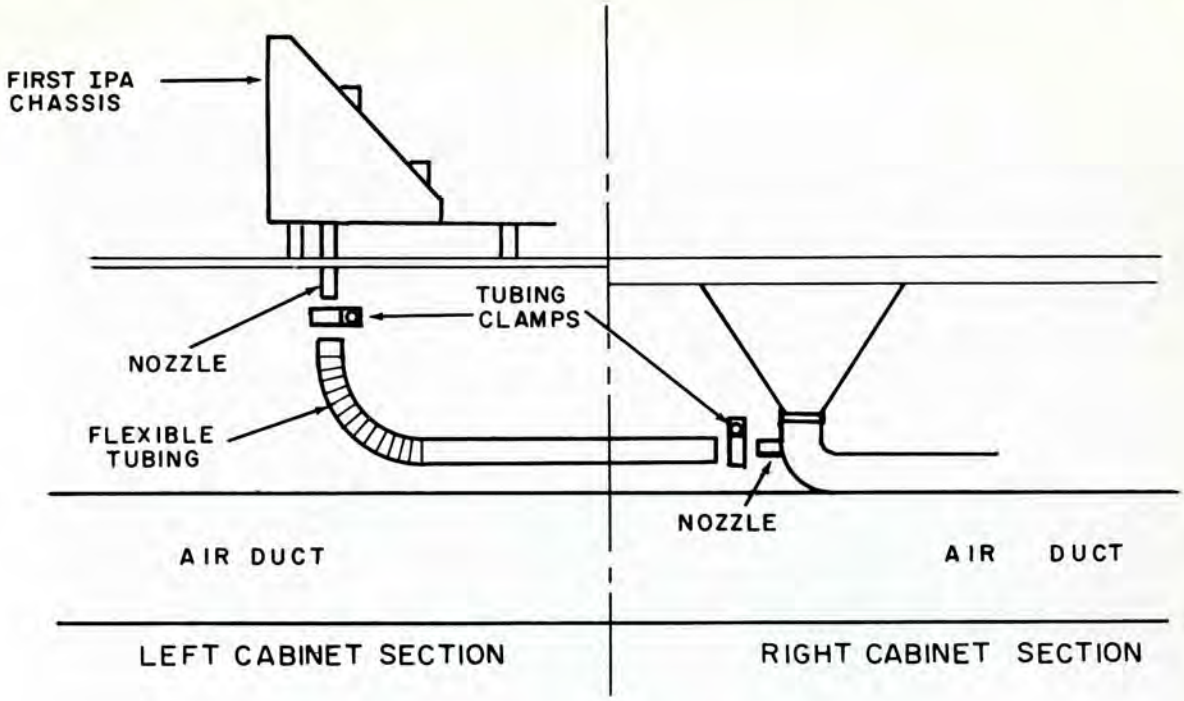


Figure 2-6. Amplifier Assembly AM-2481/FPN-42, Flexible Cooling Tube, Installation Diagram

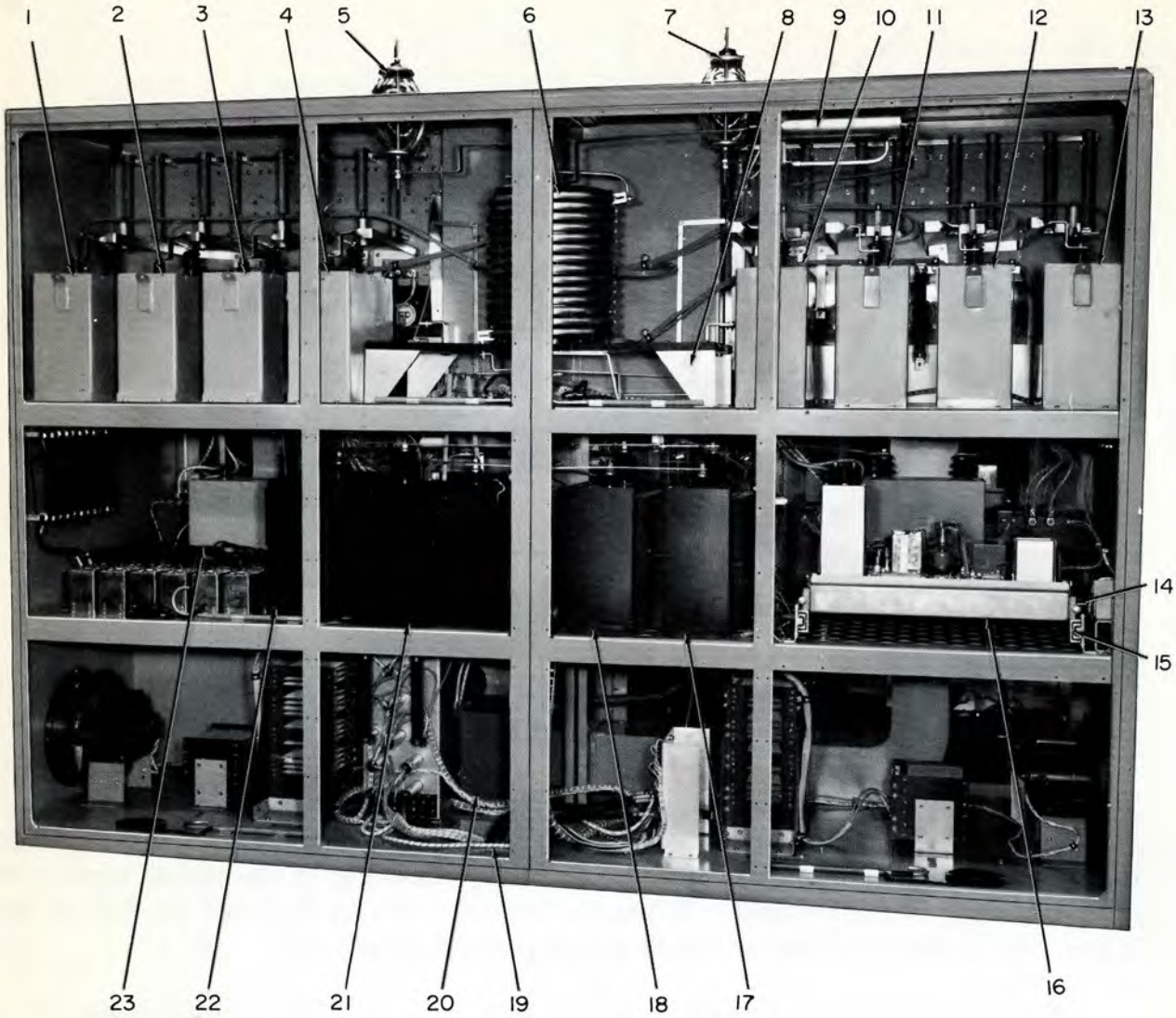
(m) Unpack the large output transformer T5 and its support brackets. Move the transformer, without the support brackets (8, figure 2-7) attached, into position, as shown in figure 2-7, through the large opening in the upper right hand corner of the back of the cabinet. When the transformer is in position, lift it, and install the four support brackets using the hardware supplied.

(n) Install filter capacitors C9, C17, C33, and C25, in that order as shown in figure 2-7. Use precautions mentioned in step (k) when handling these capacitors.

(o) Remove the solid leads for connecting the filter capacitors from one of the cartons shipped with the transmitter. Connect these solid leads from the capacitor to the center partition as shown in figures 2-7 and 2-10. Be sure to maintain adequate voltage clearance (one inch minimum) for the bars on the high voltage terminations of the capacitors.

(p) Install filter capacitor C45 on the middle shelf, as shown in figures 2-4 and 2-7, making sure that the high voltage (large) terminal is facing towards the interior of the cabinet.

(q) Install the solid leads, including the solid lead with filter Z1 attached, to their respective places (see figure 2-8). The solid lead with filter Z1 is mounted between the large capacitor terminal and the large center terminal of the



1 Capacitor C34
2 Capacitor C26
3 Capacitor C18
4 Capacitor C10
5 Output terminal E21
6 Transformer T5
7 Output terminal E22
8 Support bracket
9 Transformer T6
10 Capacitor C33
11 Capacitor C25
12 Capacitor C17
13 Capacitor C9
14 Slide release
15 Slide
16 Pulse driver chassis
17 Capacitor C69
18 Capacitor C41
19 Inter-unit cable
20 Transformer T12
21 Capacitor C42
22 Capacitor C70
23 Capacitor C45

Figure 2-7. Amplifier Assembly AM-2481/FPN-42, Rear Cabinet, View With Panels Removed

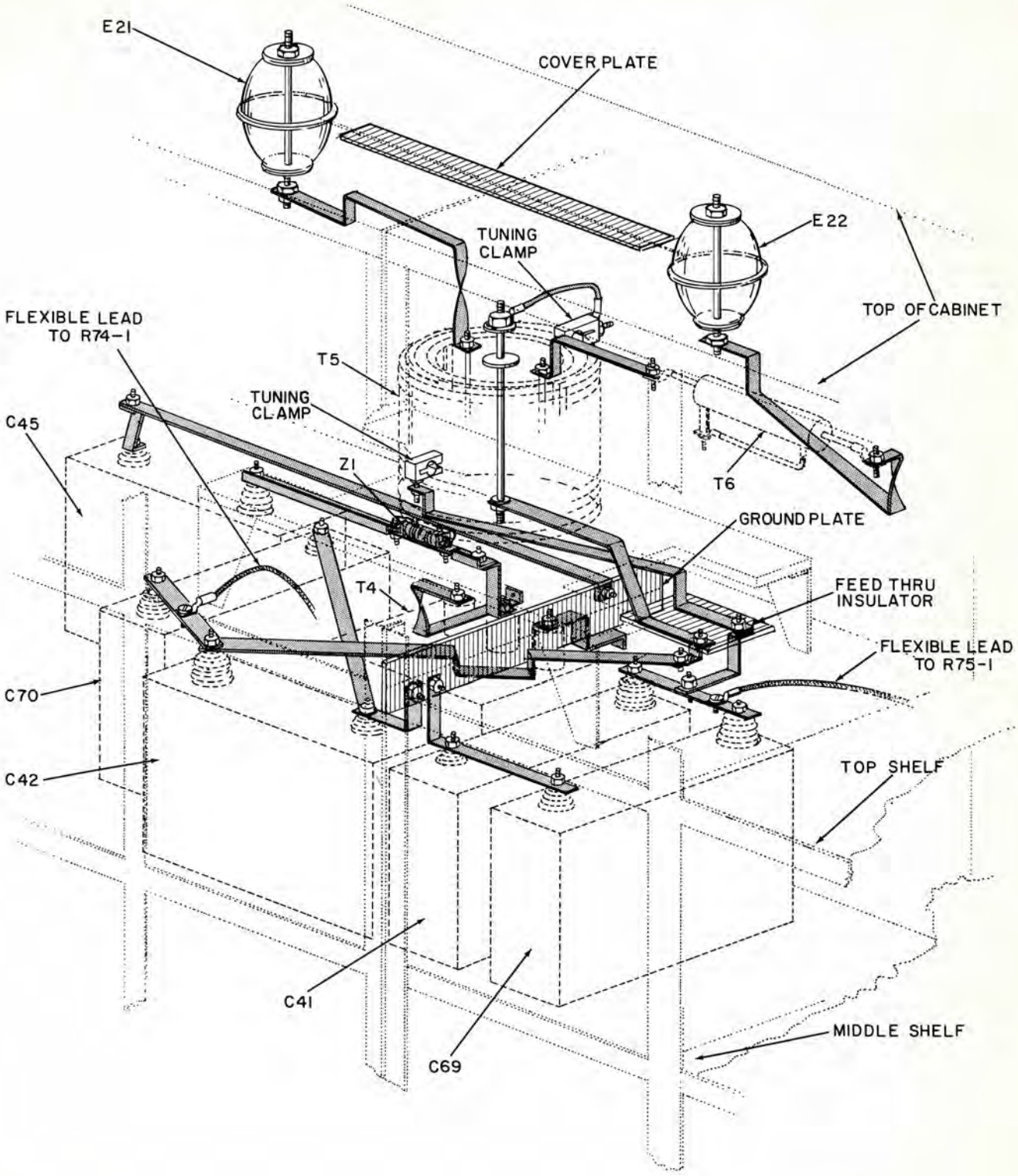


Figure 2-8. Amplifier Assembly AM-2481/FPN-42, Solid Lead Layout Diagram

large interstage transformer T4. The filter is mounted so that it is closest to the capacitor.

(r) Unpack tuning capacitors C70, C42, C41 and C69 and install in that order, on the middle shelf. See figures 2-7 and 2-8 for orientation of the capacitors on the middle shelf. Install all solid leads and the two flexible leads for these capacitors in accordance with figure 2-8.

(s) Connect the remainder of the solid leads within the cabinet to transformer T5 and the output connectors E21 and E22 as shown in figure 2-8.

CAUTION

These leads carry high voltages. Be sure that they are properly connected and oriented to maintain adequate voltage clearance.

(t) Run the four flexible cables from transformer T5 (6, figure 2-7) through the cable clamps (3, figure 2-10) on the center partition and on the filter capacitor high voltage bars and connect the wires to the proper terminals as indicated by the marker at the termination of each wire (see figure 2-10).

NOTE

The flexible leads to the capacitors connect directly to the high voltage bars (1, figure 2-10) rather than to the capacitor terminals.

(u) Unpack the filament transformers and install on the middle and lower shelves (see figures 2-4, 2-5, and 2-7). Connect all leads.

(v) Reconnect resistors R122, R123, and R124 (6, 7, and 8, figure 2-5) to the side panel of the first IPA compartment at terminals E90 and E91. They were removed for shipping and are located on the cabinet shelf. Reconnect the leads to terminals E90 and E91.

(w) Check the following:

1. Blowers for freedom of movement.

2. All solid connections for tightness.

3. All components for signs of damage.

(x) Reconnect the wiring between the two cabinet sections to the proper terminal boards and termination points (see figure 6-20), observing the necessary precautions of routing the cables away from the high voltage stress areas, and matching the lead marker strips with the appropriate termination point.

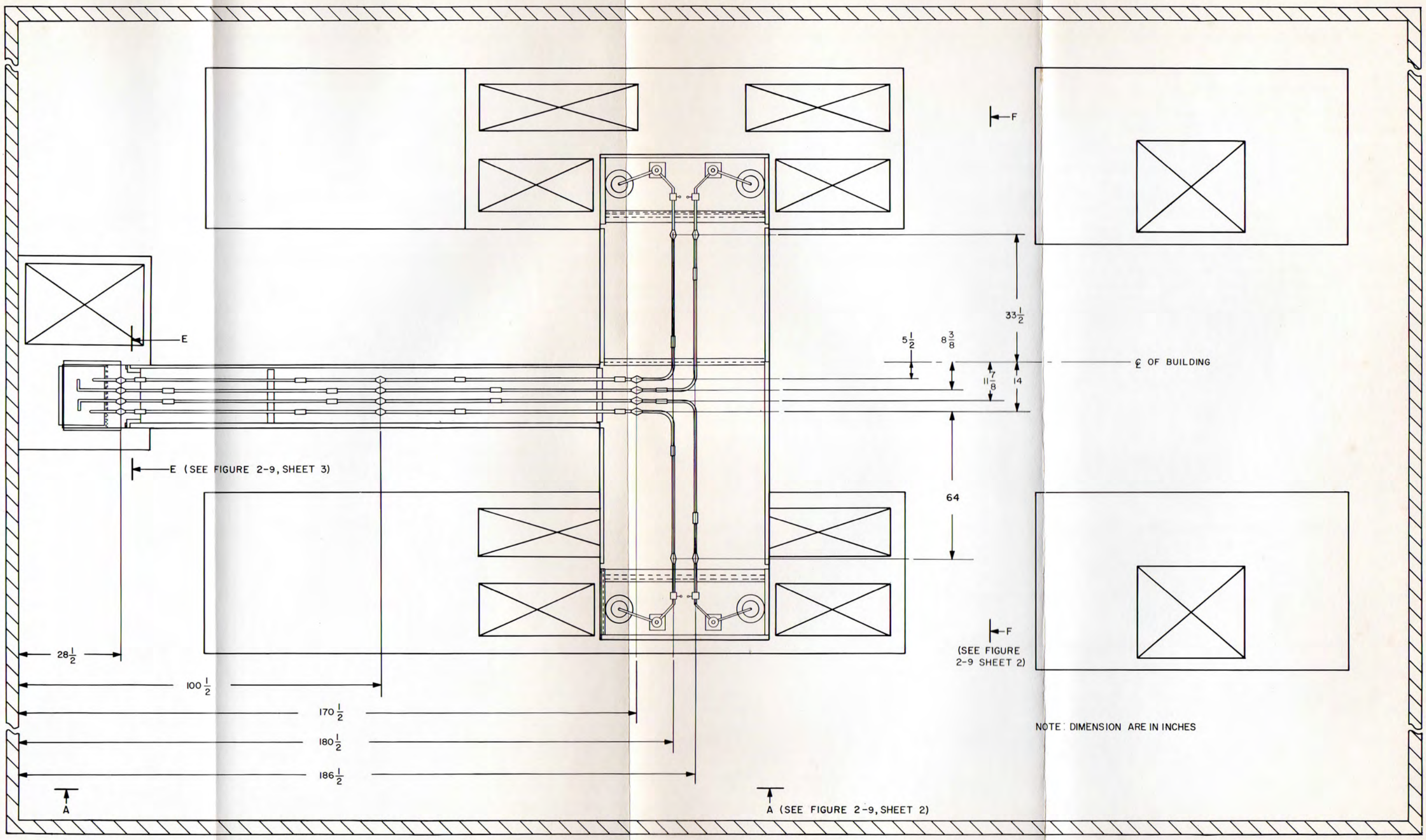
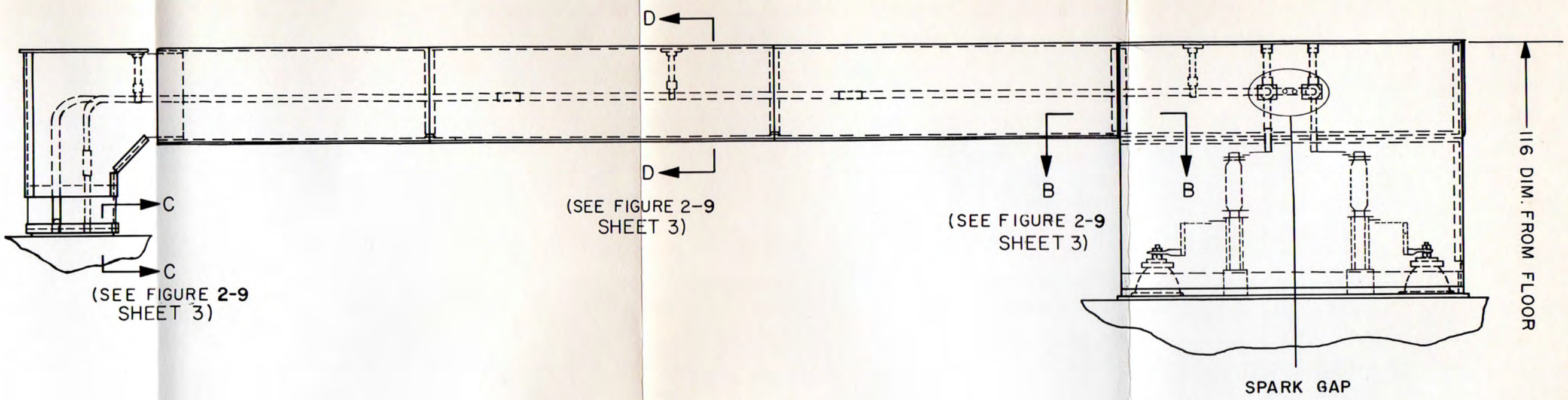
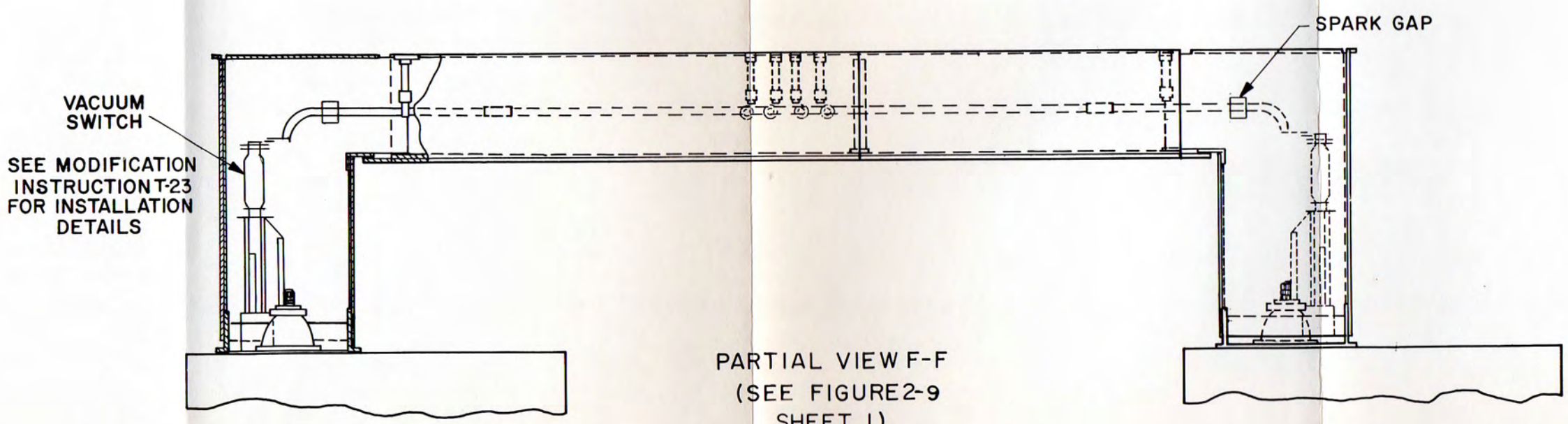


Figure 2-9. Loran Transmitting Set AN/FPN-42, Ducting Layout Diagram (Sheet 1 of 3)



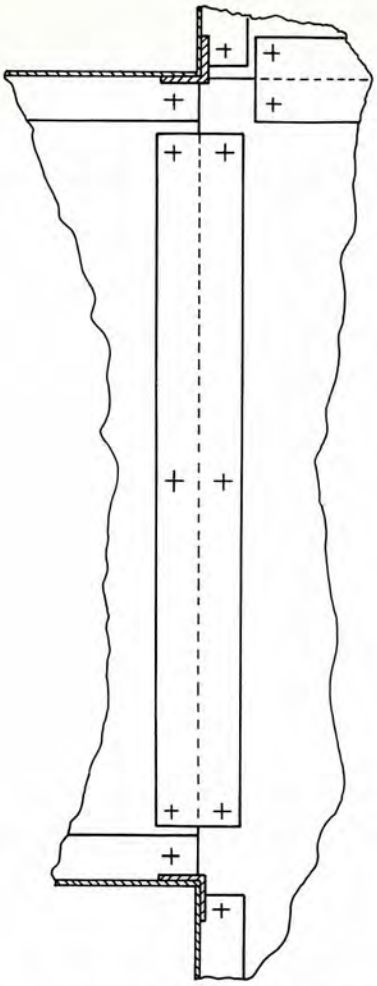
PARTIAL VIEW A-A
(SEE FIGURE 2-9
SHEET 1)

DETAIL "A" (SEE FIGURE 2-9
SHEET 3)

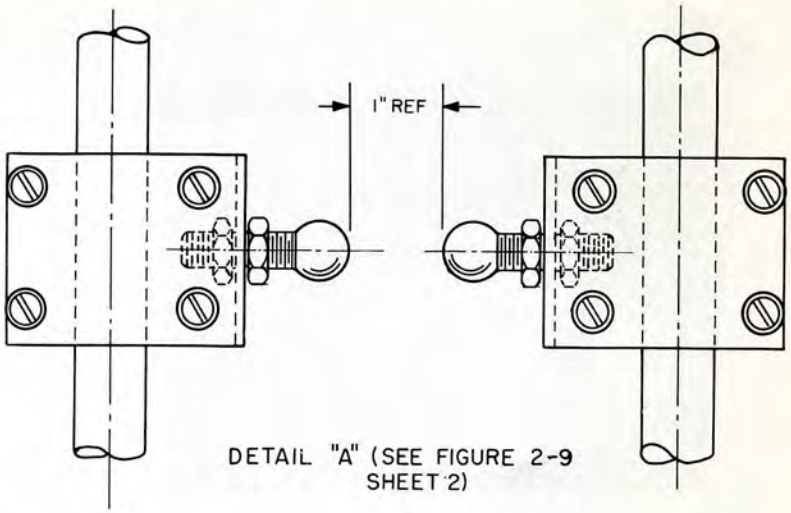


PARTIAL VIEW F-F
(SEE FIGURE 2-9
SHEET 1)

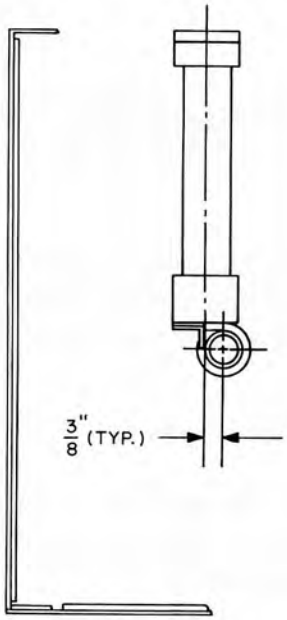
Figure 2-9. Loran Transmitting Set AN/FPN-42, Ducting Layout Diagram (Sheet 2 of 3)



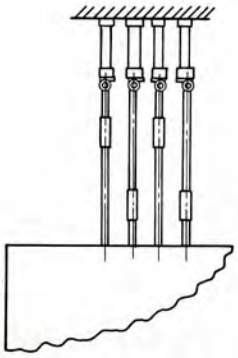
PARTIAL SECTION B-B (SEE FIGURE 2-9, SHEET 2)



DETAIL "A" (SEE FIGURE 2-9 SHEET 2)



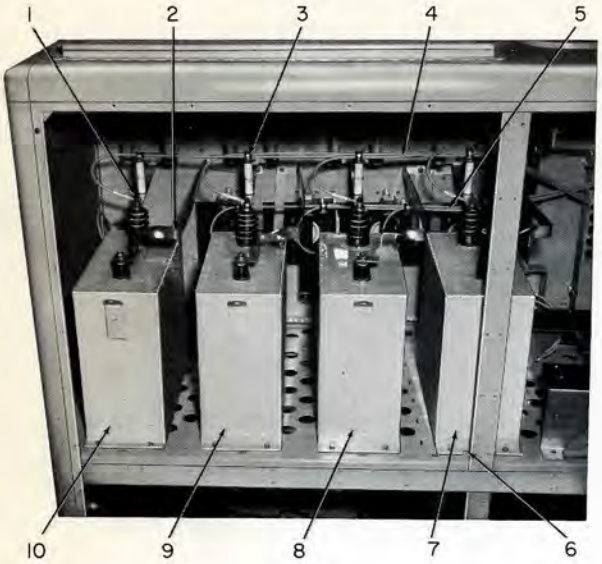
PARTIAL SECTION D-D (SEE FIGURE 2-9 SHEET 2)



VIEW E-E (SEE FIGURE 2-9, SHEET 1)

PARTIAL SECTION C-C (SEE FIGURE 2-9 SHEET 2)

Figure 2-9. Loran Transmitter Set AN/FPN-49, Ducting Layout Diagram (Sheet 3 of 3)



1 Connector on high voltage solid lead

2 Solid lead

3 Clamp

4 Flexible primary lead of transformer T5

5 Flexible primary lead of transformer T5

6 Notch in flange

7 Capacitor C10

8 Capacitor C18

9 Capacitor C26

10 Capacitor C34

Figure 2-10. Amplifier Assembly AM-2461/FPN-42, Right-Rear Cabinet Section, View of Filter Capacitors

(y) Pull the inter-unit cables for the transmitter from the cable trench through the cable input port, and make connections as indicated by the markings on the cable terminations (see figure 2-3).

(4) BLOWER ASSEMBLY.

(a) The blower assembly consists of the high-power tube-cooling blower, its connecting transition pieces, a cover housing for protection of the blower, and filters for the incoming air.

(b) Unpack the blower.

NOTE

This box also contains the cabinet housing and ducting sections.

(c) Remove the cabinet from the shipping skid and place the blower on the floor at the air input side of the transmitter. The blower should be oriented so that the output rectangular opening faces the transmitter (see figure 2-11).

(d) Remove the front, end, and two rear panels of the blower cabinet. Place the blower cabinet frame over the blower and move the cabinet in line with

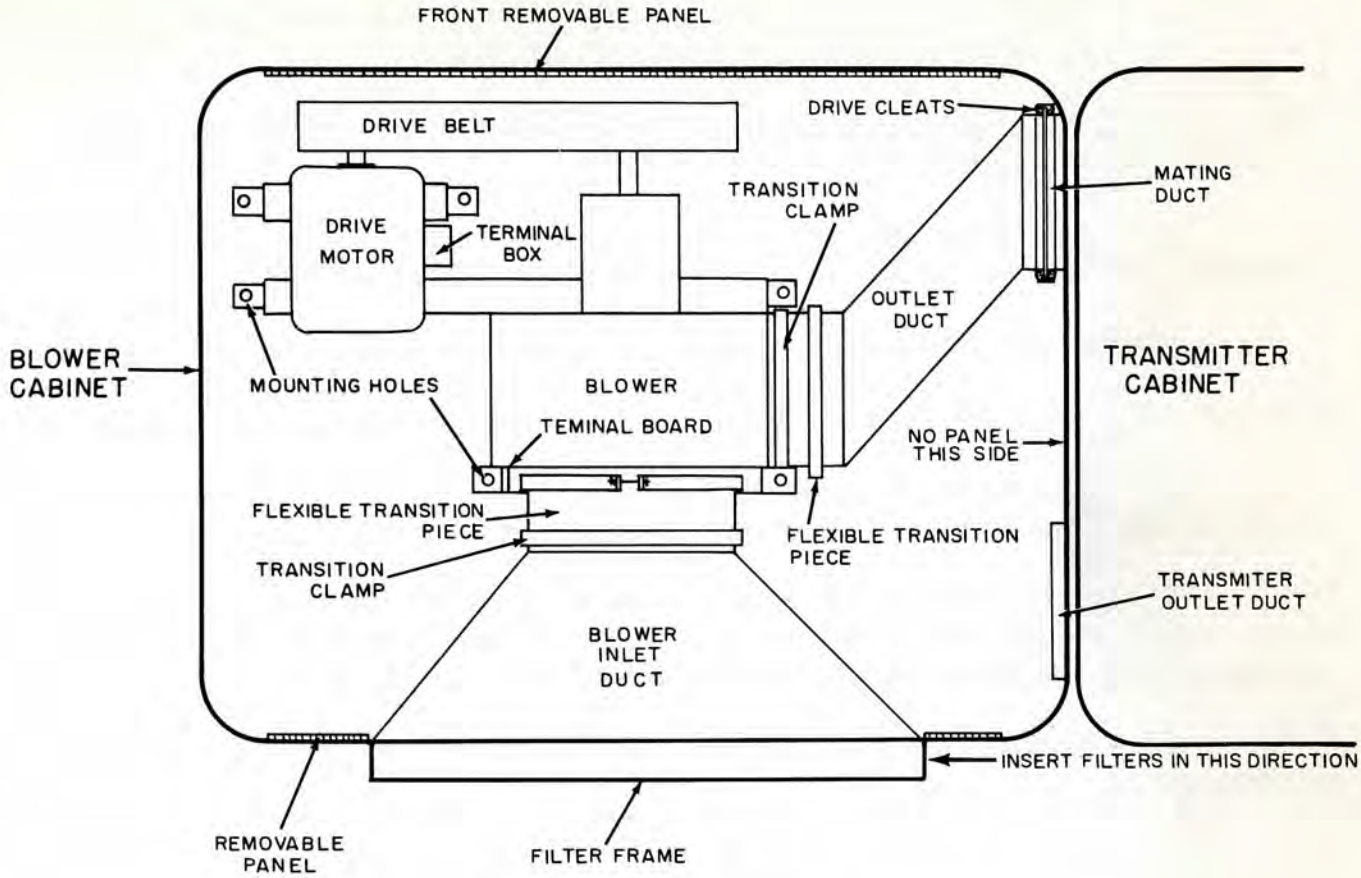


Figure 2-11. Centrifigal Fan Assembly HD-399/FPN-42, Layout Diagram

transmitter cabinet. It may be necessary to tip the blower cabinet so as to clear the drive cleat joints on the transmitter cabinet.

(e) Install the two transition pieces with their flexible connectors from the blower to the transmitter and to the blower cabinet frame. It may be necessary to shift slightly the blower to line up both ducting sections. Fasten in place with clamps, drive cleats, and hardware provided.

(f) Pull the inter-unit cable for the blower assembly from the cable trench, and make connections to the terminal board as indicated by the markings on the cable terminations (see figure 2-3).

(g) Reinstall the blower cabinet panels after checking the blower for freedom of operation, lubricating oil in motor bearings, grease in the grease fittings, proper belt tension, and all cabling properly connected.

(5) COUPLING AND LOAD UNIT.

(a) Unpack the coupling and load unit cabinet.

(b) Locate the four studs which protrude from the building wall at the antenna output terminals.

(c) Remove the two end panels from the cabinet. Mount the cabinet to the four wall studs, securing it in place with the hardware provided.

(d) Connect the terminal discs to the antenna output studs and install the solid wiring to the terminal discs. Check to see that all solid leads are securely fastened, all relays are free to operate, and all shipping braces are removed.

(e) Unpack and install the wiring duct, leading from the bottom of the cabinet to the floor trench, in accordance with figure 2-1.

(f) Pull the inter-unit cable for the coupling and load unit from the cable trench, through the wiring duct, and connect all wires as indicated by the markings at the wire terminations (see figure 2-3).

(g) Check the blower for freedom of movement and replace side panels on the cabinet.

(6) OVERHEAD DUCTING AND TRANSMISSION LINE.

(a) The r-f output of the transmitter exits at the roof of the cabinet from the antenna-disconnect vacuum switches. A transmission line assembly of copper tubing feeds this power to the coupling and load unit where it enters through feed-through studs in the top of the cabinet.

(b) Unpack the transmission line and protective ducting. Assemble in accordance with figure 2-9.

(c) Install the equipment in the following order:

1. Lay out and install on the ceiling the large insulators which support the transmission line.

2. Assemble the tubing sections to the transmitter, coupling and load unit, and to the various insulators in accordance with figure 2-9. Each tubing joint has an associated coupling. The tubing is clamped in place, as shown in figure 2-9, with the clamps and hardware provided so that the complete station line is assembled. There should be a uniform spacing between conductors with the coupling uniformly overlapping the conductor ends.

(d) Lay out ducting sections on the floor in accordance with figure 2-9 for the purpose of familiarization with its final installation. Temporarily

assemble the large elbow sections and side channels in their proper place on the transmitter group cabinets in order to complete the ducting run from the transmitters to the coupling and load unit. Do not install all of the restraining hardware at this time. The ducting sections have areas where dimensional tolerances can be taken up. If the dimensional tolerances do not satisfy the installation, shift the transmitter cabinets until they do. If the installation dimensions are adhered to, no shifting should be necessary.

(e) Remove only the ducting sections necessary to expose tubing joints after satisfying installation problems. Solder all tubing coupling joints with 60-40 solder to insure good electrical contact.

(f) Install the plate spark gap assembly in accordance with figure 2-9. Reassemble the overhead protective ducting and fasten in place.

(7) PULSE CONTROL CABINET.

(a) The pulse control cabinet houses the remote operating equipment. It contains dual pulse generators, a dual power supply, a monitor oscilloscope, a pulse analyzer, cooling equipment and a control panel.

(b) Unpack and locate the cabinet in the operations building in accordance with figure 2-12 (or as necessary to meet the individual station requirements).

(c) Pull the inter-unit cable for the pulse control cabinet from the cable trench, through the cable input port, and make connections as indicated by the markings on the cable terminations (see figure 2-3).

(8) INDIVIDUAL TRANSMITTER UNITS.

(a) Unpack and install the pulse driver chassis (16, figure 2-7) and transmitter monitor oscilloscope (5, figure 2-5) in their proper place in the transmitter, using the hardware provided.

NOTE

Both units are slide mounted. Adjust the chassis and slides so that the chassis moves freely with the slides.

(b) Connect all leads to the respective terminals and terminal boards (see figure 6-15).

(c) Unpack the ceramic tube sockets from their cartons and carefully place the sockets in their receptacles on the tube plenum chambers in the transmitter, as shown in figures 2-4 and 2-5.

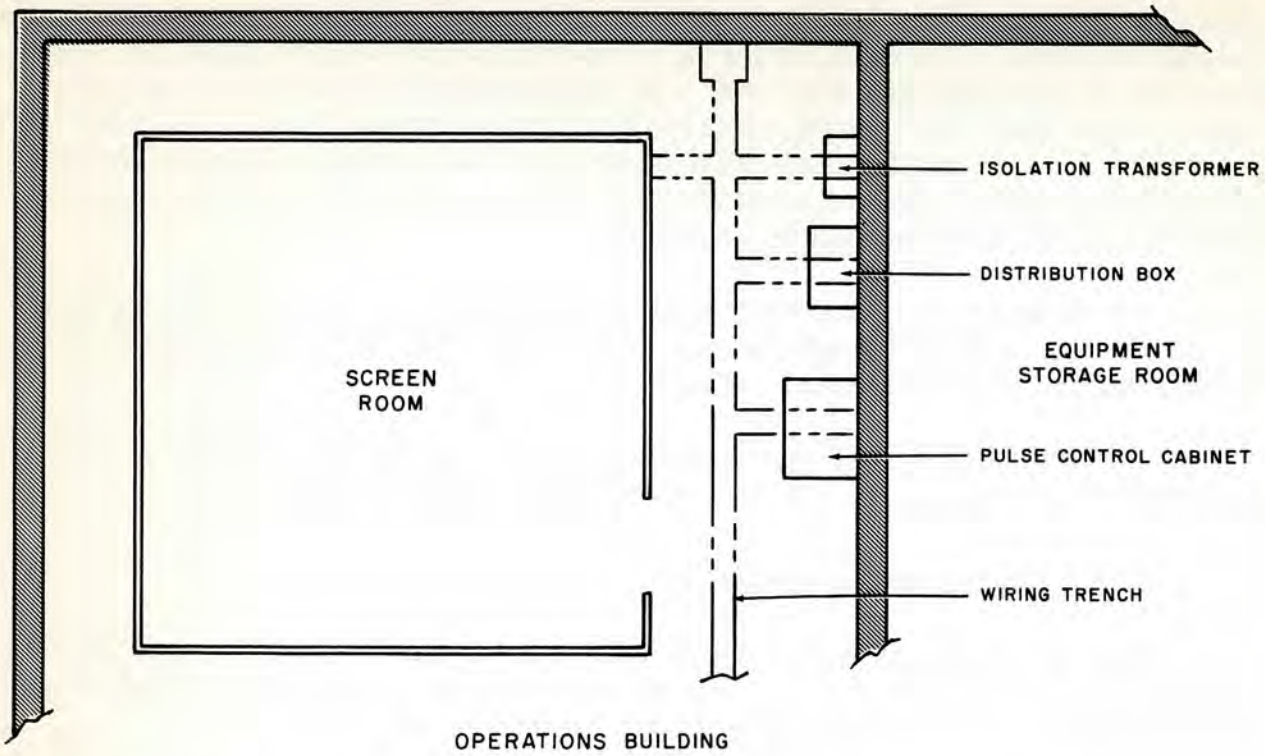


Figure 2-12. Operations Building, Installation Layout Diagram

(d) Unpack and install the electron tubes for each transmitter. Tubes should fit freely in their sockets. The air-cooled tubes should fit snugly without binding.

CAUTION

The ceramic sockets are fragile. Do not force the tubes into the sockets or subject them to undue shock.

(e) Connect the braided plate leads of tubes V1 through V10 from the feed-through terminals behind the tubes to the plate strap at the back of the tubes. The plate strap (8, figure 2-4) is a metallic band, with two handles which is fastened to the cooling fins of the tube. Slip the grid connector ring (7, figure 2-4) over the top of each tube and fasten securely. Connect the clamps on the braided filament leads to the two terminal posts at the top of each tube, and secure with the thumb screws (5, figures 2-4).

(f) Unpack vacuum capacitors C7 and C8 from the transmitter shipping carton and install near tubes V9 and V10 as shown in figure 2-4. Connect a second plate lead from these two tubes to the bottom connector of each capacitor (V9 to C7, and V10 to C8).

(g) Connect the lead from the grid resistors (R6 and R142) of V9 to the top connector of C8 and connect the lead from the grid resistors (R5 and R143) of V10 to the top connector of C7.

(h) Check that all leads in the cabinet have been securely fastened to the proper terminations. Check that all high voltage leads are a safe distance (at least one inch) from any grounded parts. Check that all loose parts supplied have been installed. Replace the panels on the transmitter cabinet.

(9) INDIVIDUAL PULSE CONTROL CABINET UNITS.

(a) Unpack and install the two pulse generators, pulse analyzer, dual power supply, and monitor oscilloscope in the proper place in the pulse control cabinet (see figure 1-3).

NOTE

These units are slide mounted. Adjust the chassis and slides so that the chassis moves freely with the slides.

(b) Connect the internal cables of the pulse control cabinet to the respective chassis terminal boards (see figure 6-10).

c. INTERCONNECTION DIAGRAMS. - Figures 2-2, 2-3, and 2-13 illustrate the inter-unit cables, power and switching interconnections, and r-f interconnections, respectively. Table 2-1 lists the installation cables required including the number of active and spare conductors.

NOTE

Inter-unit cable types and the conductor grouping may vary among installations. Refer to the applicable station plans to determine the correct cabling for any specific installation.

TABLE 2-1. LORAN TRANSMITTING SET AN/FPN-42, INSTALLATION CABLES

CABLE DESIGNATION	CABLE TERMINATIONS		ACTIVE CONDUCTORS	SPARE CONDUCTORS
	FROM	TO		
8A1-1	1ATB1, 2	3ATB1, 2	16	7
8A2-1	1ATB1, 2	3ATB1, 2	16	7
8A1-2	1ATB3, 7	3ATB3, 4	7	2

TABLE 2-1. LORAN TRANSMITTING SET AN/FPN-42, INSTALLATION CABLES (Cont)

CABLE DESIGNATION	CABLE TERMINATIONS		ACTIVE CONDUCTORS	SPARE CONDUCTORS
	FROM	TO		
8A2-2	1ATB3, 7	3ATB3, 4	7	2
8A1-4	1ATB5	4ATB1	14	2
8A2-4	1ATB5	4ATB2	14	2
8A1-5	Auxiliary circuit breaker	4ATB3	2	0
8A1-6	1ATB6	5ATB1	4	1
8A2-6	1ATB6	5ATB1	4	1
8A1-7	20J1	2AJ1	1	0
8A2-7	20J3	2AJ3	1	0
8A1-8	20J2	2AJ2	1	0
8A2-8	20J4	2AJ4	1	0
8A1-19	20J8	2AJ13	1	0
8A1-16	Auxiliary circuit breaker	2ATB3	4	0
8A1-15	Main circuit breaker	1ATB8	4	0
8A2-15	Main circuit breaker	1ATB8	4	0

NOTE

All 8A1 cables are required for operation of a single transmitter. The 8A2 cables are required for operation of the second transmitter.

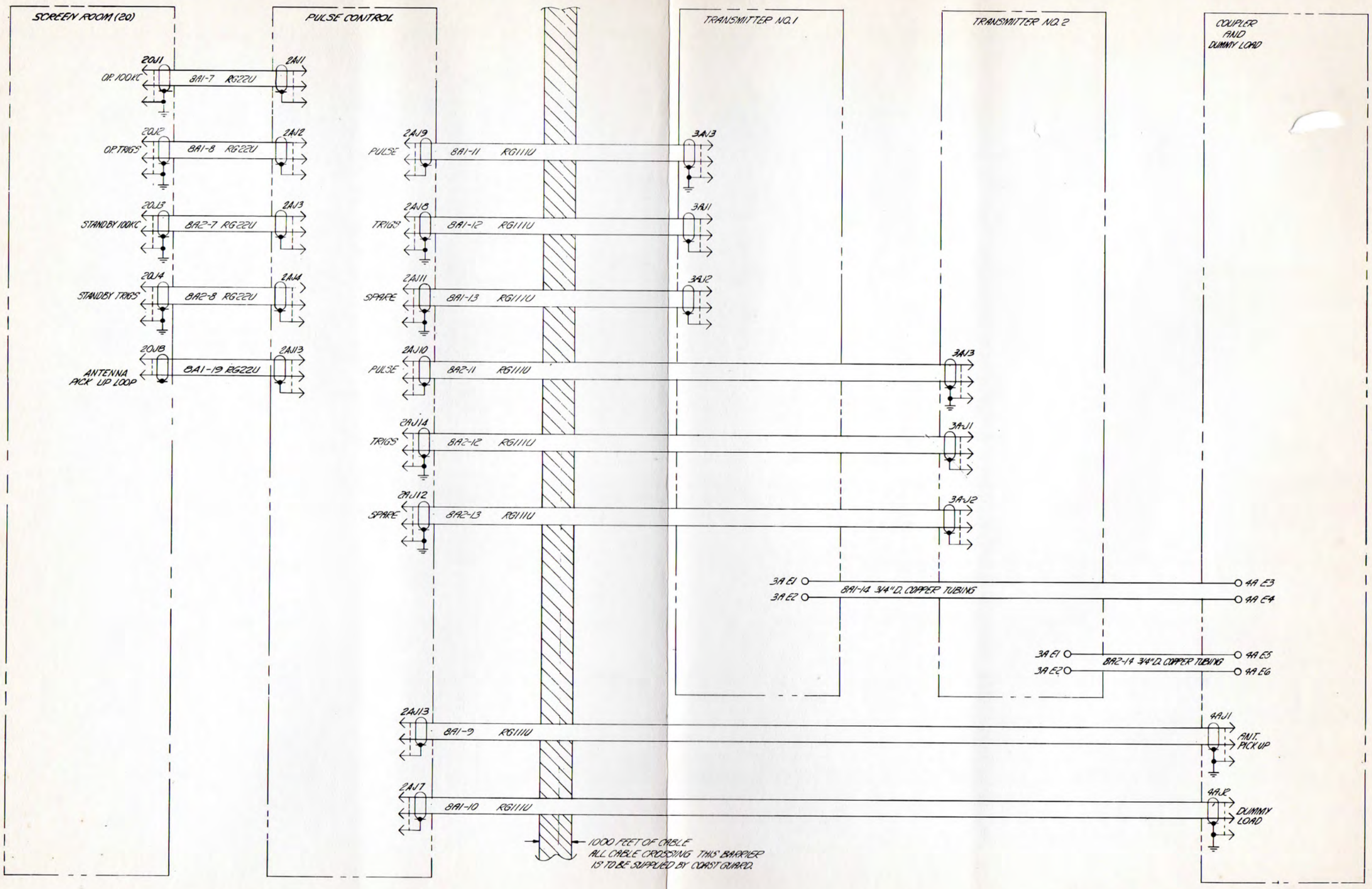


Figure 2-13. Loran Transmitting Set AN/FPN-42, R-F Interconnection Diagram

d. CABLE ASSEMBLY.

(1) ASSEMBLY OF TWINAX CONNECTOR ON RG22/U CABLE.

(a) Cut off end of cable squarely, and slip body (figure 2-14A) of connector over cable.

(b) Cut off jacket 1-5/8 inches from end, being careful not to nick braid (see figure 2-14B).

(c) Cut off external shield 3/8 inch forward of jacket, being careful not to nick internal shield (see figure 2-14B).

(d) Cut off internal shield 5/8 inch from end of cable, and trim dielectric leaving 1/4 inch of insulation on conductors (see figure 2-14B).

(e) Tin exposed conductors and screw sleeve (figure 2-14A) over shielded portion (see figure 2-14C).

(f) Slip contact (figure 2-14A) over end of cable and align the four holes in contact with four holes in sleeve (see figure 2-14D). Apply solder to four holes to make a solid connection between two connector pieces and internal shield. Be careful not to overheat connector so that dielectric will not be damaged. Apply solder to ends of contact pins to make a solid connection to conductors.

(g) Mark one terminal at each end of cable assembly with red paint to indicate polarity after checking cable for continuity (see figure 2-14D).

(h) Screw body of connector over sleeve to complete assembly (see figure 2-14E).

(2) ASSEMBLY OF TWINAX CONNECTOR ON RG22/U CABLE WITH EXTERNAL BRAID. (See figure 2-14F.)

(a) Slip 1/2-inch braid over cable, and cut off cable and braid squarely. Slip body of connector back over braid.

(b) Push braid back over cable, and prepare cable following steps (1) (b) through (1) (e).

(c) Slip braid back toward end of cable until it is flush with end of external shield, and press tightly around shield.

(d) Tin exposed conductors, and screw sleeve back over shielded portion until it reaches end of jacket.

(e) Finish assembly, following steps (1) (f), (g), and (h).

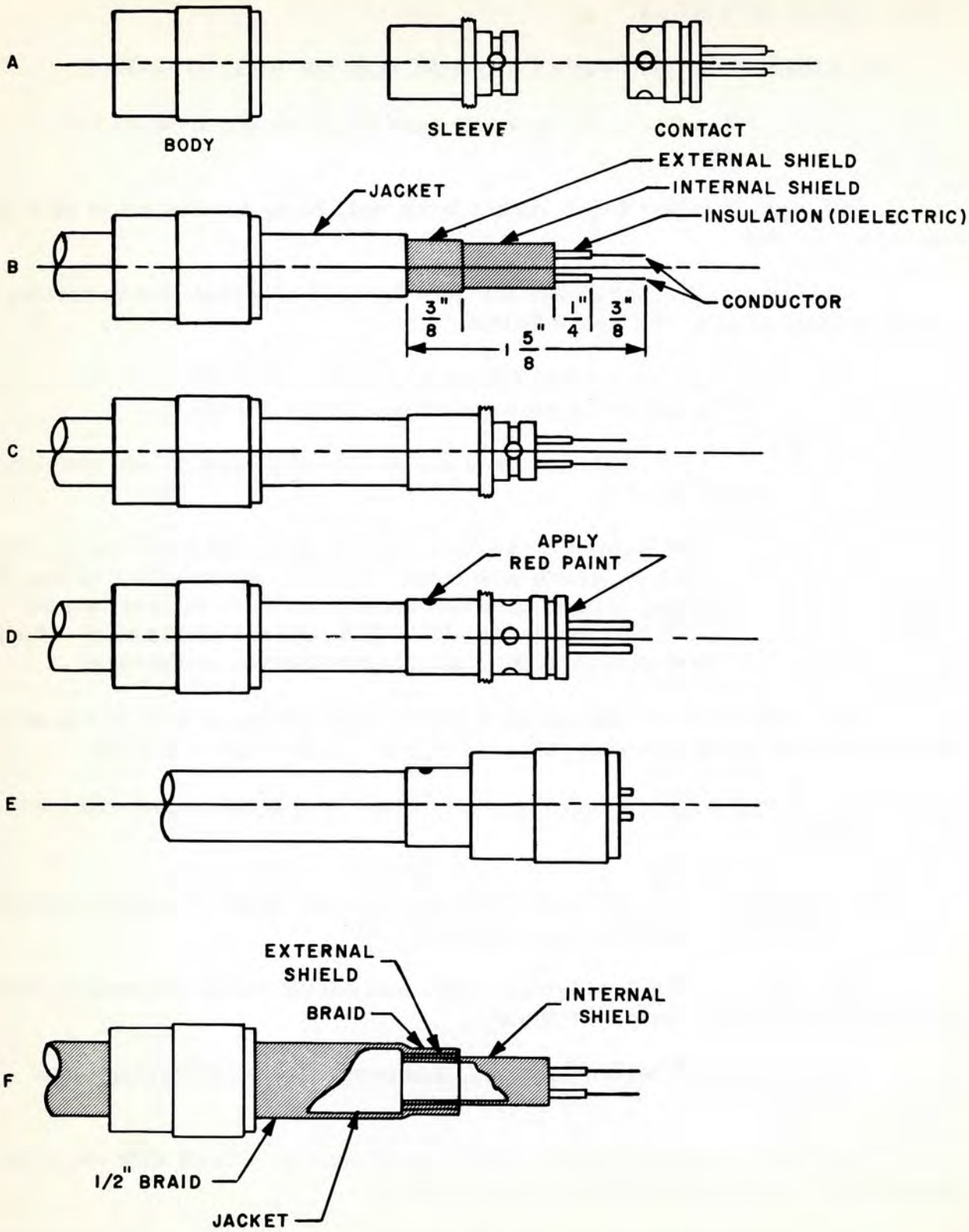


Figure 2-14. Assembly of Twinax Connector on RG 22/U Cable, Layout Diagram

(3) ASSEMBLY OF BNC CABLE CONNECTOR TO RG195/U CABLE.

(a) Slip nut (figure 2-15A) over cable, and cut off end of cable sharply and squarely.

(b) Cut off jacket, squarely, 3/8 inch from end, being careful not to nick braid (see figure 2-15B).

(c) Fan braid out and cut off dielectric and inner conductor under braid 5/16 inch from end of jacket (see figure 2-15C).

(d) Taper braid as shown in figure 2-15D and slide gasket and clamp (figure 2-15A) over tapered braid. Be sure inner shoulder of clamp fits squarely against end of jacket and that it clears all braid wires.

(e) With clamp in place, comb or fan out braid. Trim braid to 1/8 inch from end of clamp. Fold braid back smoothly over end of clamp as shown in figure 2-15E. Make sure no strands of braid reach gasket. Then cut dielectric 3/32 inch from braid. Be sure to cut square and be careful not to nick inner conductor. Cut off inner conductor 1/8 inch from end of dielectric.

(f) Tin inner conductor. Slip contact (figure 2-15A) in place squarely against end of dielectric and solder (see figure 2-15F). Use a pointed soldering iron to prevent distortion of dielectric due to excessive heating. Remove all excessive solder and flux. Examine cable end to make sure inner conductor is in the center of the dielectric.

(g) Push cable assembly into plug body (figure 2-15A) so that dielectric fits squarely against inside of plug insulator. Slide nut into body and screw into place with a wrench until moderately tight, holding cable and body rigidly (see figure 2-15G). When finally assembled, point of the contact should be within ±1/64 inch from end of plug body.

2-6. INSPECTION AND ADJUSTMENT.

NOTE

If correct indications are not obtained, de-energize the equipment, and refer to trouble-shooting (Section 5).

a. ENERGIZING THE EQUIPMENT FOR THE FIRST TIME.

NOTE

The timer-synchronizer should be in the energized condition. Refer to Technical Manual for Loran Timer-Synchronizer Set AN/FPN-41; CG-273-75.

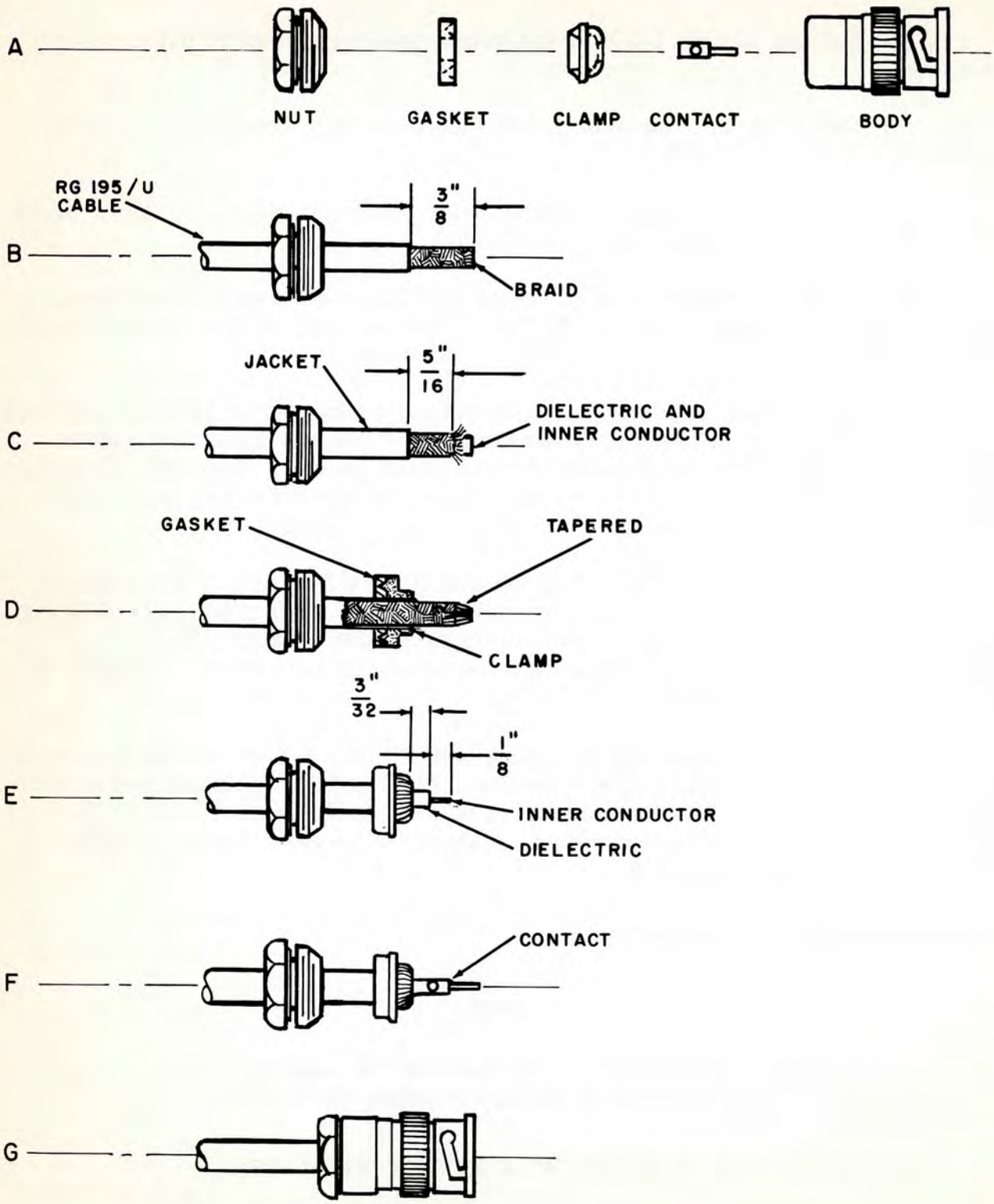


Figure 2-15. Assembly of BNC Cable Connector to RG195/U Cable, Layout Diagram

(1) Place the switches and controls in the positions indicated in table 2-2.

TABLE 2-2. LORAN TRANSMITTING SET AN/FPN-42, INITIAL CONTROL SETTINGS

CONTROL	LOCATION	SETTING
SIGNAL SELECTOR switch S1	Control panel	100 KC
PULSE GEN. SELECTOR SCOPE DISPLAY switch S6	Control panel	PULSE GEN. 1
PULSE GEN. 1 EXCITATION switch S4	Control panel	OPERATE BUS
PULSE GEN. 2 EXCITATION switch S5	Control panel	OPERATE BUS
PULSE GEN. SELECTOR switch S8	Control panel	P. G. 1 TO XMTR 1 - P. G. 2 TO XMTR 2
B+ PULSE GEN. 1 switch S9	Control panel	Off (down)
B+ PULSE GEN. 2 switch S10	Control panel	Off (down)
B+ XMTR 1 switch S11	Control panel	Off (down)
B+ XMTR 2 switch S12	Control panel	Off (down)
INTERLOCK DISABLE switch S13	Control panel	Off (down)
BLOWER MOTOR circuit breaker CB3	Dual power supply	ON
120V LINE POWER SUPPLY 1 circuit breaker CB1-A	Dual power supply	ON
P. S. 1 P. S. 2 PWR. SUPPLY SEL. switch S3	Pulse analyzer	Power supply 1 (left)
PULSE SEL. switch S1	Pulse analyzer	1

TABLE 2-2. LORAN TRANSMITTING SET AN/FPN-42, INITIAL CONTROL SETTINGS (Cont)

CONTROL	LOCATION	SETTING
Refer to table 6-1	Monitor Oscilloscopes	
Auxiliary circuit breaker	Operations building	On
LOCAL & REMOTE SELECTOR switch S7	Coupling and load unit	Local (left)
LOW LINE ALARM switch S12	High voltage power supply	ALARM OPERATIVE
FIL. VOLTAGE switch S4	High voltage power supply	On (up)
BIAS VOLTAGE switch S2	High voltage power supply	Off (down)
PLATE VOLTAGE switch S3	High voltage power supply	Off (down)
Auto-manual switch S16	High voltage power supply	MANUAL
Main circuit breaker	Transmitter building	On
Auxiliary circuit breaker	Transmitter building	On
START switch S8	High voltage power supply	Depress

(2) At the control panel, place the TRANSMITTER SELECTOR switch S7 (27, figure 3-2) in the position which causes the transmitter under test to be operated into the dummy load. Fifteen seconds after depressing high voltage power supply START switch S8 (57, figure 3-6), high voltage power supply FIL. ON lamp DS10 (58) should light. After five minutes have elapsed, FIL. READY lamp DS13 (17) should light. This lamp indicates that the transmitter has had sufficient time to warm up and is now ready for the bias and plate voltages.

NOTE

The low line alarm may sound, due to the sudden load when the transmitter is energized. Reset the alarm by depressing LOW LINE VOLTS RESET switch S11 (36).

(3) Using an accurate 0-10 volt a-c meter, measure and record the filament voltage at the terminals of transmitter tubes V1 through V10. Examine the filament power leads to any tube, more than five percent below the average filament voltage, for tightness and signs of overheating. After all connections have been insured to be electrically and mechanically correct, adjust the average filament voltage to 8.2 volts. This is accomplished by rotating the balance adjustment (Section 6 of Volume 3) of the high voltage power supply filament regulator Z2 until the correct value is achieved. This regulator must be in the auto mode when this adjustment is performed.

NOTE

The filaments will be maintained at the correct value regardless of input line variations.

CAUTION

If new power amplifier tubes have been installed, allow them to "age" under full filament voltage for 72 hours before applying bias and plate voltage.

(4) At the high voltage power supply, place BIAS VOLTAGE switch S2 (19, figure 3-6) in the on (up) position. This applies bias to the pulse driver and power amplifier stages. Adjust -600 BIAS ADJUST transformer T8 (26) and -300 BIAS ADJUST transformer T7 (25) to set the bias voltages as specified in alignment procedures of Section 6. Place PLATE VOLTAGE switch S3 (18) in the on (up) position.

NOTE

The transmitter is now energized.

(5) Operate RAISE MAN. PLATE VOLT ADJ. and LOWER MAN. PLATE VOLT ADJ. switches S23 and S24 (54 and 51) as required to adjust the plate voltage to 15 kv. Observe the equipment for signs of arcing, corona or any other abnormal indication. Note that the current as indicated by transmitter control panel TOTAL CATHODE CURRENT meter M2 (1, figure 3-7) should not exceed 0.1 ampere. Operate under these conditions for at least one hour before attempting to drive the transmitter. At the end of this test, lower the plate voltage to 5 kv and place the high voltage power supply PLATE VOLTAGE and BIAS VOLTAGE switches S3 and S2 (18, 19, figure 3-6) in the off (down) position.

(6) Place the switches and controls in the positions indicated in table 2-3. Check that the waveform presented on the transmitter monitor oscilloscope is as shown in figure 5-1i, and at least 20 volts peak to peak.

(7) At the high voltage power supply, place PLATE VOLTAGE switch S3 (18, figure 3-6) in the on (up) position. Adjust AUTO PLATE VOLT ADJ. potentiometer R40 (53) to set the plate voltage as specified in the alignment procedures in Section 6.

TABLE 2-3. LORAN TRANSMITTING SET AN/FPN-42, CONTROL SETTINGS FOR DISPLAY OF INPUT WAVEFORM

CONTROL	LOCATION	SETTING
AUTO PLATE VOLT ADJUST potentiometer R40	High voltage power supply	Maximum counterclockwise
Auto-manual switch S16	High voltage power supply	AUTO
B+ PULSE GEN. 1 switch S9	Control panel	On (up)
B+ PULSE GEN. 2 switch S10	Control panel	On (up)
BIAS VOLTAGE switch S2	High voltage power supply	On (up)
SIGNAL SELECTOR switch S1	Transmitter control panel	INPUT

(8) The location from which the transmitter plate voltage is controlled is determined by the position of the coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8). Control may only be switched when all transmitter B+ switches are off. To switch control of the transmitter, first place the high voltage power supply PLATE VOLTAGE switch S3 (18, figure 3-6) in the off (down) position, and then place the coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the remote (right) position.

WARNING

Do not attempt any maintenance or repair on the transmitter when coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) is in the remote (left) position. Control of transmitter B+ has been shifted to the control panel in the operations building.

(9) At the control panel, place the B+ switch for the transmitter under test in the on (up) position. At the high voltage power supply, the B+ voltages (as indicated by 3.8 KV DRIVER PLATE VOLTAGE, 7.75 KV DRIVER PLATE VOLTAGE, and 15.5 KV PLATE VOLTAGE meter M17, M16, and M15; 65, 66, and 67, figure 3-6) should rise to the correct level (determined in alignment procedure of Section 6).

(10) Repeat steps (1) through (9) to energize the other transmitter.

b. PRE-OPERATIONAL ADJUSTMENTS.

(1) At the control panel, place TRANSMITTER SELECTOR switch S7 (27, figure 3-2) in the position which causes the transmitter under test to operate into the antenna.

(2) Check the meter readings and the waveforms as specified in table 3-3. If any of the waveforms or meter readings are incorrect, refer to the alignment procedures of Section 6 and perform the adjustments (in the order of occurrence in the alignment procedures) until the incorrect waveform or meter reading has been corrected.

(3) Measure the radiated spectrum and power as specified in the alignment procedures of Section 6. If these measurements indicate that an improper pulse is being radiated, retune the transmitter output circuits as specified in the alignment procedures.

(4) Use the pulse analyzer, refer to paragraph 3-7a (3), to measure the pulse shape of pulses number 1, 3, 5, and 7.

NOTE

Keep a record of these measurements for future reference.

(5) Switch the pulse generator-transmitter combination by placing the control panel PULSE GEN SELECTOR switch S8 (6, figure 3-2) in the opposite position (i.e., P.G. 1 to XMTR 2 - P.G. 2 to XMTR 1). Repeat steps (2), (3), and (4). If the outputs of both pulse generators are identical, the radiated pulses will be correct regardless of which pulse generator is driving the operating transmitter.

(6) Place the switches to the positions indicated in table 2-4. Follow the switching sequence. The position of the TRANSMITTER SELECTOR switch S7 (27, figure 3-2) should be such that the second transmitter operates into the antenna.

TABLE 2-4. LORAN TRANSMITTING SET AN/FPN-42, PRE-OPERATIONAL CONTROL SETTINGS

CONTROL	LOCATION	SETTING
B+ XMTR 1 switch S11	Control panel	Off (down)
B+ XMTR 2 switch S12	Control panel	Off (down)
TRANSMITTER SELECTOR switch S7	Control panel	XMTR 1 TO ANTENNA or XMTR 2 TO ANTENNA, as desired
PULSE GEN. SELECTOR switch S8	Control panel	PG 1 TO XMTR 2 - PG 2 TO XMTR 1
B+ XMTR 1 switch S11	Control panel	On (up)
B+ XMTR 2 switch S12	Control panel	On (up)

(7) Repeat steps (2), (3), and (4). If an adjustment is needed in step (3), tune only the tank circuit in the second transmitter. Do not make any adjustments in the coupling and load unit. These circuits were adjusted when the first transmitter was tuned.

NOTE

The transmitter group is now in operating condition. If it is desired to de-energize the transmitter group before turning control over to the operator, refer to Section 3.

2-7. INTERFERENCE REDUCTION.

The affects of radio interference on the transmitter group have been minimized through the design of the equipment and installation layout, and the adjustments made in paragraph 2-6. Therefore, no interference reduction procedures are provided.

2-8. PREPARATION FOR RESHIPMENT.

The transmitter group is a permanently installed land-based equipment. Therefore, no reshipment instructions are provided.

SECTION 3

OPERATOR'S SECTION

3-1. FUNCTIONAL OPERATION.

a. Loran Transmitting Set AN/FPN-42 generates, shapes, and radiates high-power r-f pulses which are used by a mobile receiver for position fixing. The timing of the pulses is accurately controlled by Loran Timer-Synchronizer Set AN/FPN-41.

b. The transmitter group consists of a pulse control unit, two transmitters, two high voltage power supplies, two blower assemblies, and a coupling and load unit.

(1) The pulse control unit consists functionally of two pulse generators, a dual power supply, a control panel, a monitor oscilloscope, and a pulse analyzer. A pulse generator receives transmitter triggers and a 100-kc reference signal from the timer-synchronizer, and generates properly shaped r-f pulses which drive a transmitter. Each section of the dual power supply provides power for a pulse generator. The control panel provides control of the switching of the transmitters and the pulse generators (either pulse generator can drive either transmitter, and either transmitter may be connected to the antenna). The monitor oscilloscope and the pulse analyzer in conjunction with the control panel provide a means for checking the operation of the transmitter group, by monitoring key waveforms.

(2) A transmitter receives r-f pulses from a pulse generator, and amplifies these pulses to the proper level to drive the antenna. In addition each transmitter contains a control panel and monitor oscilloscope which provide a means of checking the operation of the transmitter by monitoring key waveforms and currents. Transmitter cabinet No. 1 (see figure 2-1) is defined as transmitter 1 and transmitter cabinet No. 2 is defined as transmitter 2.

(3) A high voltage power supply is associated with each transmitter to provide bias and plate voltages. It contains the controls needed to energize a transmitter, and the monitoring devices necessary to check its power circuits and those of the transmitter.

(4) A blower assembly is associated with each transmitter to provide forced air cooling of the power tubes.

(5) The coupling and load unit contains an antenna coupler and a dummy load (the dummy load dissipates the output power of the transmitter not connected to the antenna). In addition, it provides for the selection of the transmitter group

control point (control panel or individual high voltage power supplies), and the measurement of antenna current.

c. For normal operation, the transmitter group need only consist of one section of the dual power supply, a pulse generator, a transmitter, a high voltage power supply, a blower assembly, the antenna coupler portion of the coupling and load unit, and the portion of the control panel associated with the selected pulse generator and transmitter. However, in order to provide continuous station operation during maintenance, a duplicate dual power supply section, pulse generator, transmitter, high voltage power supply, blower assembly, the dummy load portion of the coupling and load unit, and the portion of the control panel associated with the duplicate pulse generator and transmitter are furnished. During normal operation when no maintenance is being performed, the duplicate pulse generator is kept in the standby condition (B+ voltage removed) and the duplicate transmitter is kept in the ready condition (filament and bias voltages applied; B+ voltage removed), and connected to the dummy load.

d. Each of the transmitters may be energized manually or automatically.

NOTE

Manual or automatic operation of a particular transmitter is selected at its associated high voltage power supply.

(1) Manual operation entails placing the filament and bias switches in the on condition, waiting until the end of a built in time delay, and then manually raising the plate voltage to the proper level.

NOTE

If the plate voltage is turned off during manual operation it must be raised again manually to the proper level when reapplied.

(2) Automatic operation provides mechanical application of the filament, bias and plate voltages.

NOTE

If the plate voltage is turned off during automatic operation it will be raised mechanically to the proper level when reapplied.

e. The transmitter group may be operated locally or remotely.

NOTE

Local or remote control of the transmitter group is selected at the coupling and load unit.

(1) Local operation means that the application of the plate voltage for both transmitters is controlled at the high voltage power supplies in the transmitter building.

(2) Remote operation means that the application of the plate voltage for both transmitters is controlled at the control panel in the operations building.

NOTE

The combination of remote-automatic operation of the transmitter group is preferable, because the operate and standby transmitters may be interchanged rapidly at the control panel.

3-2. PREPARATION FOR USE.

Refer to Section 2 for instruction in the preparation of the transmitter group for use.

3-3. OPERATING PROCEDURES.

a. DESCRIPTION OF CONTROLS. - Table 3-1 describes the controls located on the front panels of the components of the transmitter group. These controls are used during operation, monitoring, and alignment procedures.

TABLE 3-1. LORAN TRANSMITTING SET AN/FPN-42, OPERATING CONTROLS

FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		PULSE GENERATOR		
3-1	1	OPERATE lamp	DS1	When lighted, indicates that the pulse generator is feeding the operate transmitter.
3-1	2	PULSE SPACING switch	S2	Selects proper droop compensation waveform for either 500- or 1000-microsecond pulse space operation.

TABLE 3-1. LORAN TRANSMITTING SET AN/FPN-42, OPERATING CONTROLS (Cont)

FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		PULSE GENERATOR (Cont)		
3-1	3	100 KC BAL potentiometer	R21	Minimizes residual 100 kc between pulses.
3-1	4	PULSE WIDTH potentiometer	R55	Determines the duration of the waveforms fed into the pedestal shaper.
3-1	5	DROOP potentiometer	R75	Adjusts drive to the transmitter to minimize amplitude variation in output.
3-1	6	SCOPE TRIGGER switch	S1	Selects single or multi triggers for controlling the horizontal sweep circuit of the monitor oscilloscope.
3-1	7	Blown fuse lamp	DS2	When out, indicates that fuse F1 or F2 has blown.
3-1	8	1.5A FILAMENT fuse	F2	Protects filament transformer from circuit overload.
3-1	9	1.5A FILAMENT fuse	F1	Protects filament transformer from circuit overload.
3-1	10	GATE WIDTH potentiometer	R42	Controls the time constant of the gate generator, thereby controlling the maximum number of drive cycles.
3-1	11	DECAY TIME potentiometer	R59	Controls the decay time constant, thereby controlling the trailing edge of the transmitter pulses.
3-1	12	RISE TIME potentiometer	R58	Controls the time constant (rise time) for the leading edge of the transmitter pulses.
3-1	13	PULSE AMPL potentiometer	R82	Controls amplitude of driving signal to power amplifier stages in transmitter.

TABLE 3-1. LORAN TRANSMITTING SET
AN/FPN-42, OPERATING CONTROLS (Cont)

FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		CONTROL PANEL		
3-2	1	OPERATE XMTR 2 lamp	DS17	When lighted, indicates transmitter 2 is the operate transmitter
3-2	2	SIGNAL SELECTOR switch	S1	Selects waveform to be displayed on the monitor oscilloscope.
3-2	3	EMERGENCY STOP XMTR 2 switch	S3	Turns off transmitter 2.
3-2	4	PULSE GEN. SELECTOR SCOPE DISPLAY switch	S6	Selects the pulse generator for SIGNAL SELECTOR switch S1.
3-2	5	PULSE GEN. 2 EXCITATION switch	S5	Connects pulse generator 2 to either the operate or standby timer-synchronizer.
3-2	6	PULSE GEN SELECTOR switch	S8	Reverses the connection between pulse generators 1 and 2 and transmitters 1 and 2.
3-2	7	Pulse generator 2 on lamp	DS2	When lighted, indicates that pulse generator 2 is in the on condition.
3-2	8	B+ PULSE GEN. 2 switch	S10	Energizes the rectifiers of power supply 2 (dual power supply).
3-2	9	INTERLOCK INDICATOR lamp	DS3	When lighted, indicates an interlock is open.
3-2	10	Transmitter 2 READY lamp	DS6	When lighted, indicates that bias voltage is applied to transmitter 2.
3-2	11	Transmitter 2 ON lamp	DS7	When lighted, indicates that plate voltage is applied to transmitter 2.

TABLE 3-1. LORAN TRANSMITTING SET AN/FPN-42, OPERATING CONTROLS (Cont)

FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		CONTROL PANEL (Cont)		
3-2	12	B+ XMTR 2 switch	S12	Applies B+ voltage to transmitter 2.
3-2	13	Transmitter 2 LOW V IND lamp	DS11	When lighted, indicates that low line voltage is present at the high voltage power supply for transmitter 2.
3-2	14	Transmitter 2 OVERLOAD IND lamp	DS12	When lighted, indicates an overload in the high voltage power supply for transmitter 2.
3-2	15	LOW VOLT RESET XMTR 2 switch	S15	Resets the control panel low line voltage alarm and lamp for transmitter 2.
3-2	16	OVERLOAD RESET XMTR 2 switch	S17	Resets the control panel overload alarm and lamp for transmitter 2.
3-2	17	LOW VOLT RESET XMTR 1 switch	S14	Resets the control panel low line voltage alarm and lamp for transmitter 1.
3-2	18	OVERLOAD RESET XMTR 1 switch	S16	Resets the control panel overload alarm and lamp for transmitter 1.
3-2	19	Transmitter 1 LOW V IND lamp	DS9	When lighted, indicates that low line voltage is present at the high voltage power supply for transmitter 1.
3-2	20	Transmitter 1 OVERLOAD IND lamp	DS10	When lighted, indicates an overload in the high voltage power supply for transmitter 1.
3-2	21	INTERLOCK DISABLE switch	S13	Disables the interlocks in the pulse control cabinet.
3-2	22	B+ XMTR 1 switch	S11	Applies B+ voltage to transmitter 1.

TABLE 3-1. LORAN TRANSMITTING SET
AN/FPN-42, OPERATING CONTROLS (Cont)

FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		CONTROL PANEL (Cont)		
3-2	23	INTERLOCK DISABLE lamp	DS8	When lighted, indicates that INTERLOCK DISABLE switch S13 is in the on position.
3-2	24	Transmitter 1 READY lamp	DS4	When lighted, indicates that bias voltage is applied to transmitter 1.
3-2	25	Transmitter 1 ON lamp	DS5	When lighted, indicates that plate voltage is applied to transmitter 1.
3-2	26	B+ PULSE GEN. 1 switch	S9	Energizes the rectifiers of power supply 1 (dual power supply).
3-2	27	TRANSMITTER SELECTOR switch	S7	Connects either transmitter 1 or transmitter 2 to the antenna.
3-2	28	Pulse generator 1 on lamp	DS1	When lighted, indicates that pulse generator 1 is in the on condition.
3-2	29	PULSE GEN. 1 EXCITATION switch	S4	Connects pulse generator 1 to either the operate or standby timer-synchronizer.
3-2	30	EMERGENCY STOP XMTR 1 switch	S2	Turns off transmitter 1.
3-2	31	OPERATE XMTR 1 lamp	DS16	When lighted, indicates transmitter 1 is the operate transmitter.
		DUAL POWER SUPPLY		
3-3	1	BLOWER MOTOR circuit breaker	CB3	Turns on the cabinet cooling blower.
3-3	2	Blown fuse lamp	DS4B	When out, indicates fuse F4B has blown.

TABLE 3-1. LORAN TRANSMITTING SET AN/FPN-42, OPERATING CONTROLS (Cont)

FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		DUAL POWER SUPPLY (Cont)		
3-3	3	Blown fuse lamp	DS5B	When out, indicates fuse F5B has blown.
3-3	4	+150 VOLTS 1/4 AMP fuse	F4B	Protects +150 volt supply of power supply 2 from overloads.
3-3	5	-150 VOLTS 1/4 AMP fuse	F5B	Protects -150 volt supply of power supply 2 from overloads.
3-3	6	+300 VOLTS 1/2 AMP fuse	F3B	Protects +300 volt supply of power supply 2 from overloads.
3-3	7	Blown fuse lamp	DS3B	When out, indicates fuse F3B has blown.
3-3	8	P.S. 2 PRIMARY 3 AMP fuse	F2B	Protects power supply 2 transformers from overloads.
3-3	9	Blown fuse lamp	DS2B	When out, indicates fuse F2B has blown.
3-3	10	FILAMENT 2 AMP fuse	F1B	Protects filament transformer for pulse generator 2.
3-3	11	Blown fuse lamp	DS1B	When out, indicates fuse F1B has blown.
3-3	12	120 V LINE POWER SUPPLY 2 circuit breaker	CB1B	Turns on power supply 2.
3-3	13	120 V LINE POWER SUPPLY 1 circuit breaker	CB1A	Turns on power supply 1.
3-3	14	FILAMENT 2 AMP fuse	F1A	Protects filament transformer for pulse generator 1.
3-3	15	Blown fuse lamp	DS1A	When out, indicates fuse F1A has blown.

TABLE 3-1. LORAN TRANSMITTING SET
AN/FPN-42, OPERATING CONTROLS (Cont)

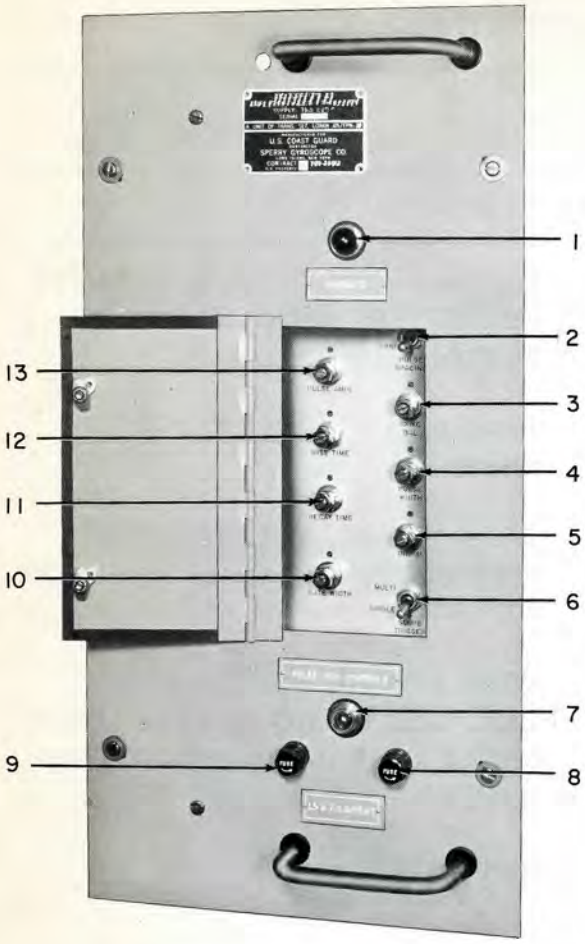
FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		DUAL POWER SUPPLY (Cont)		
3-3	16	P.S. 1 PRIMARY 3 AMP fuse	F2A	Protects power supply 1 transformers from overloads.
3-3	17	Blown fuse lamp	DS2A	When out, indicates fuse F2A has blown.
3-3	18	+300 VOLTS 1/2 AMP fuse	F3A	Protects +300 volt supply of power supply 1 from overloads.
3-3	19	Blown fuse lamp	DS3A	When out, indicates fuse F3A has blown.
3-3	20	+150 VOLTS 1/4 AMP fuse	F4A	Protects +150 volt supply of power supply 1 from overloads.
3-3	21	-150 VOLTS 1/4 AMP fuse	F5A	Protects -150 volt supply of power supply 1 from overloads.
3-3	22	Blown fuse lamp	DS4A	When out, indicates fuse F4A has blown.
3-3	23	Blown fuse lamp	DS5A	When out, indicates fuse F5A has blown.
		PULSE ANALYZER		
3-4	1	P.S.1 P.S.2 PWR. SUPPLY SEL. switch	S3	Selects input power from either of the two power supplies in the pulse control cabinet.
3-4	2	% AMPL. potentiometer	R55	Varies the d-c level that is superimposed on the transmitted signal.
3-4	3	PULSE SEL. switch	S1	Selects one of the eight pulses to be analyzed.
3-4	4	Blown fuse lamp	DS1	When out, indicates that fuse F1 or F2 has blown.

TABLE 3-1. LORAN TRANSMITTING SET AN/FPN-42, OPERATING CONTROLS (Cont)

FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		PULSE ANALYZER (Cont)		
3-4	5	1.5A FILAMENT fuse	F2	Protects filament transformer from overloads.
3-4	6	1.5A FILAMENT fuse	F1	Protects filament transformer from overloads.
3-4	7	SCOPE TRIG. SELECTOR switch	S2	Selects either scope triggers from the pulse analyzer or normal scope triggers.
3-4	8	AMPL. CAL. potentiometer	R52	Calibrates the % AMPL. control to 100-percent at the peak of the pulse.
		MONITOR OSCILLOSCOPE AND TRANSMITTER MONITOR OSCILLOSCOPE		
3-5	Refer to Appendix I, technical manual for Oscilloscope OS-103/FPN.			
		HIGH VOLTAGE POWER SUPPLY		
3-6	Refer to Volume 3			
		TRANSMITTER CONTROL PANEL		
3-7	1	TOTAL CATHODE CURRENT meter	M2	Indicates total cathode current of tubes V1 through V8.
3-7	2	TUBE SELECTOR switch	S17	Selects individual tubes to be monitored on INDIVIDUAL CATHODE CURRENT meter M1.
3-7	3	SIGNAL SELECTOR switch	S18	Selects the waveform to be presented on transmitter monitor oscilloscope.
3-7	4	EMERGENCY STOP switch	S19	Turns off the transmitting equipment
3-7	5	INDIVIDUAL CATHODE CURRENT meter	M1	Indicates cathode current of tube as selected by TUBE SELECTOR switch S17.

TABLE 3-1. LORAN TRANSMITTING SET
AN/FPN-42, OPERATING CONTROLS (Cont)

FIG. NO.	REF. NO.	DESIGNATION	CIRCUIT SYMBOL	FUNCTION
		COUPLING AND LOAD		
3-8	1	WARNING REMOTE OPERATION lamp	DS6	Lights when LOCAL & REMOTE SELECTOR switch S7 is in the remote (right) position.
3-8	2	PUSH TO READ switch	S1	Enables ANTENNA CURRENT meter M1.
3-8	3	TRANSMITTER 2 ON ANTENNA lamp	DS2	When lighted, indicates that transmitter 2 is connected to the antenna.
3-8	4	REMOTE lamp	DS4	When lighted, indicates that LOCAL & REMOTE SELECTOR switch S7 is in the remote (right) position.
3-8	5	BLOWER RESET switch	Part of K1	Resets blower overload.
3-8	6	LOCAL lamp	DS3	When lighted, indicates that LOCAL & REMOTE SELECTOR switch S7 is in the local (left) position.
3-8	7	LOCAL & REMOTE SELECTOR switch	S7	Determines whether the transmitter group is operated locally or remotely.
3-8	8	TRANSMITTER 1 ON ANTENNA lamp	DS1	When lighted, indicates that transmitter 1 is connected to the antenna.
3-8	9	ANTENNA TUNING inductor	L1	Controls antenna tuning.
3-8	10	ANTENNA CURRENT meter	M1	Indicates antenna current.



1 OPERATE lamp DS1
2 PULSE SPACING switch S2
3 100KC BAL potentiometer R21
4 PULSE WIDTH potentiometer R55
5 DROOP potentiometer R75
6 SCOPE TRIGGER switch S1
7 Blown fuse lamp DS2
8 1.5A FILAMENT fuse F2
9 1.5A FILAMENT fuse F1
10 GATE WIDTH potentiometer R42
11 DECAY TIME potentiometer R59
12 RISE TIME potentiometer R58
13 PULSE AMPL potentiometer R82

Figure 3-1. Pulse Generator 0-706/FPN-42, Front Panel Control Locations

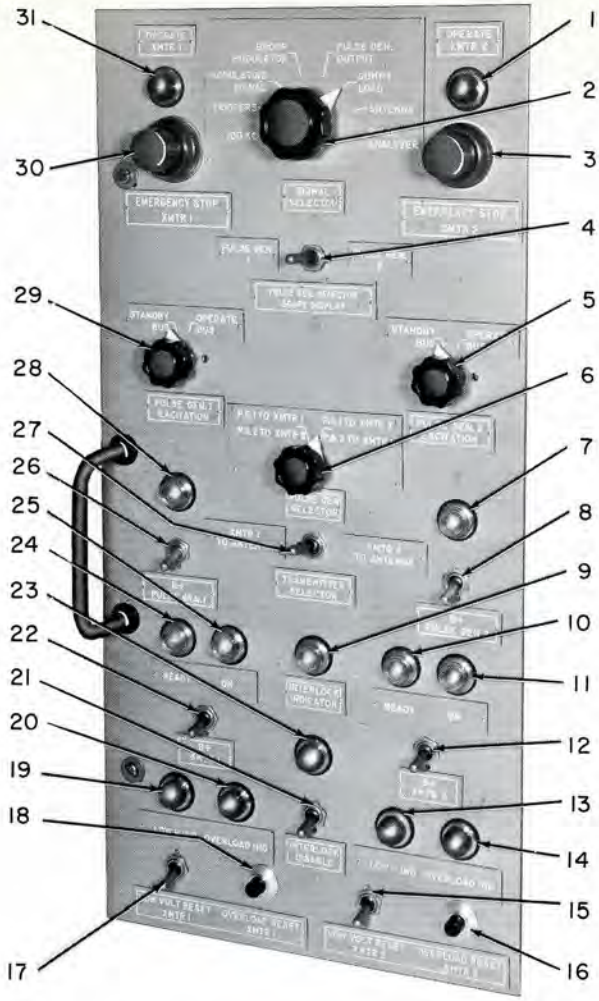
b. SEQUENCE OF OPERATION.

NOTE

All waveforms to be viewed on the monitor oscilloscopes have been amplitude compensated to appear approximately equal in size on the screen. Therefore, the amplitudes as read on the monitor oscilloscopes are not those existing in the circuitry.

(1) TRANSMITTER CONDITIONS. - The following terms are used to describe the various states which may exist in the normal operation of the transmitting equipment.

(a) SHUT-DOWN. - All primary power removed from the equipment.



1 OPERATE XMTR 2 lamp DS17

2 SIGNAL SELECTOR switch S1

3 EMERGENCY STOP XMTR 2 switch S3

4 PULSE GEN. SELECTOR SCOPE DISPLAY switch S6

5 PULSE GEN. 2 EXCITATION switch S5

6 PULSE GEN SELECTOR switch S8

7 Pulse generator 2 on lamp DS2

8 B+ PULSE GEN. 2 switch S10

9 INTERLOCK INDICATOR lamp DS3

10 Transmitter 2 READY lamp DS6

11 Transmitter 2 ON lamp DS7

12 B+ XMTR 2 switch S12

13 Transmitter 2 LOW V IND lamp DS11

14 Transmitter 2 OVERLOAD IND lamp DS12

15 LOW VOLT RESET XMTR 2 switch S15

16 OVERLOAD RESET XMTR 2 switch S17

17 LOW VOLT RESET XMTR 1 switch S14

18 OVERLOAD RESET XMTR 1 switch S16

19 Transmitter 1 LOW V IND lamp DS9

20 Transmitter 1 OVERLOAD IND lamp DS10

21 INTERLOCK DISABLE switch S13

22 B+ XMTR 1 switch S11

23 INTERLOCK DISABLE lamp DS8

24 Transmitter 1 READY lamp DS4

25 Transmitter 1 ON lamp DS5

26 B+ PULSE GEN. 1 switch S9

27 TRANSMITTER SELECTOR switch S7

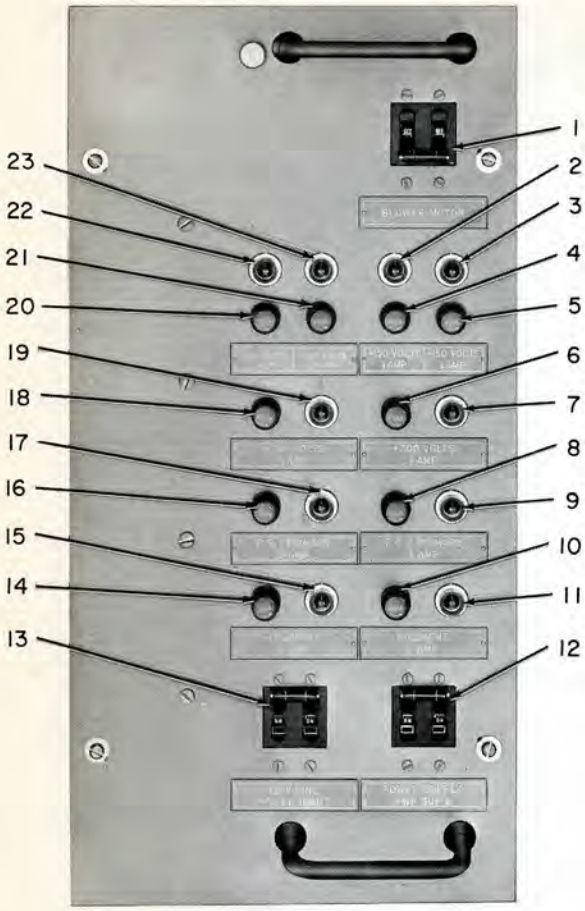
28 Pulse generator 1 on lamp DS1

29 PULSE GEN. 1 EXCITATION switch S4

30 EMERGENCY STOP XMTR 1 switch S2

31 OPERATE XMTR 1 lamp DS16

Figure 3-2. Transmitter Control Group OA-2631/FPN-42, Control Panel, Front Panel Control Locations



1 BLOWER MOTOR circuit breaker CB3
2 Blown fuse lamp DS4B
3 Blown fuse lamp DS5B
4 +150 VOLTS 1/4 AMP fuse F4B
5 -150 VOLTS 1/4 AMP fuse F5B
6 +300 VOLTS 1/2 AMP fuse F3B
7 Blown fuse lamp DS3B
8 P.S. 2 PRIMARY 3 AMP fuse F3B
9 Blown fuse lamp DS2B
10 FILAMENT 2 AMP fuse F1B
11 Blown fuse flamp DS1B
12 120V LINE POWER SUPPLY 2 circuit breaker CB1B
13 120V LINE POWER SUPPLY 1 circuit breaker CB1A
14 FILAMENT 2 AMP fuse F1A
15 Blown fuse lamp DS1A
16 P.S. 1 PRIMARY 3 AMP fuse F2A
17 Blown fuse lamp DS2A
18 +300 VOLTS 1/2 AMP fuse F3A
19 Blown fuse lamp DS3A
20 +150 VOLTS 1/4 AMP fuse F4A
21 -150 VOLTS 1/4 AMP fuse F5A
22 Blown fuse lamp DS4A
23 Blown fuse lamp DS5A

Figure 3-3. Power Supply Assembly PP-2541/FPN-42, Front Panel Control Locations

(b) OFF. - Primary power on, but plate, bias and filament power off.

(c) STANDBY. - Filament power on, but plate and bias power off.

(d) READY. - Filament and bias power on, but plate power off.

(e) ON. - All power on, equipment fully energized.

(2) ENERGIZING THE EQUIPMENT.

(a) STARTING THE PULSE CONTROL UNIT FROM SHUT-DOWN.

NOTE

The timer-synchronizer should be energized. Refer to Technical Manual for Loran Timer-Synchronizer Set AN/FPN-41; CG-273-75.

1. Check that all pulse control unit panels and chassis are in place and secured.

2. At the pulse control unit, place the controls in the positions indicated in table 3-2.

3. At the control panel, select the operate transmitter by placint TRANSMITTER SELECTOR switch S7 (27, figure 3-2) in the XMTR 1 to ANTENNA or XMTR 2 to ANTENNA position.

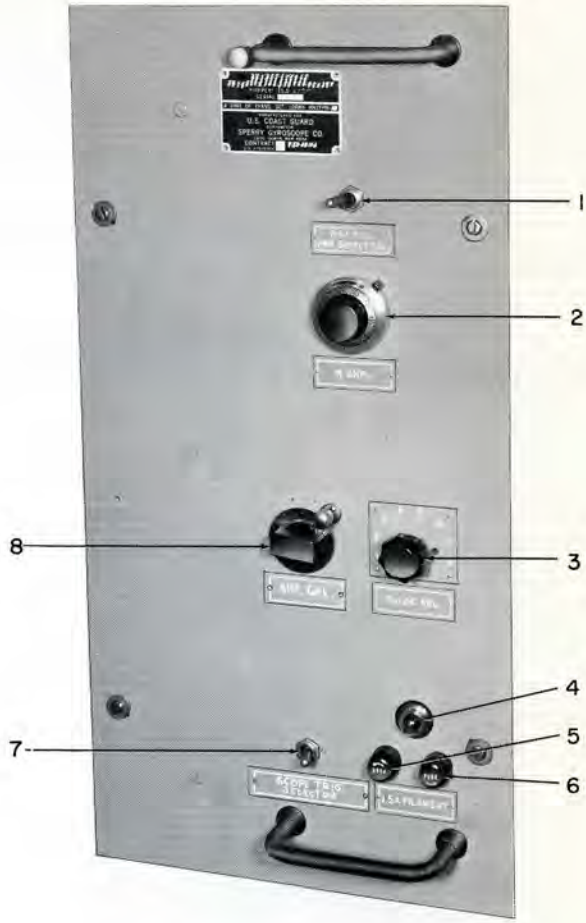
4. At the operations buildings, place the auxiliary circuit breaker, which supplies power to the pulse control cabinet, in the on position. At the coupling and load unit REMOTE and WARNING REMOTE OPERATION lamps DS4 and DS6 (4 and 1, figure 3-8), or LOCAL lamp DS3 (6) may light, depending on the position of LOCAL & REMOTE SELECTOR switch S7 (7).

5. At the dual power supply, place BLOWER MOTOR circuit breaker CB3 (1, figure 3-3) in the ON position.

6. Place 120 V LINE POWER SUPPLY 1 and 120 V LINE POWER SUPPLY 2 circuit breakers CB1A and CB1B (13 and 12, figure 3-3) in the ON position.

7. At the pulse control unit, check that the filament blown fuse lamps on the dual power supply, pulse generators, and pulse analyzer are lighted.

8. At the control panel, place B+ PULSE GEN. 1 and B+ PULSE GEN. 2 switches S9 and S10 (26 and 8, figure 3-2) in the on (up) position.



1 P.S.1 P.S.2 PWR. SUPPLY SEL. switch S3

2 % AMPL. potentiometer R55

3 PULSE SEL. Switch S1

4 Blown fuse lamp DS1

5 1.5A FILAMENT fuse F2

6 1.5A FILAMENT fuse F1

7 SCOPE TRIG. SELECTOR switch S2

8 AMPL. CAL. potentiometer R52

Figure 3-4. Electrical Pulse Analyzer TS-1360/FPN-42, Front Panel Control Locations

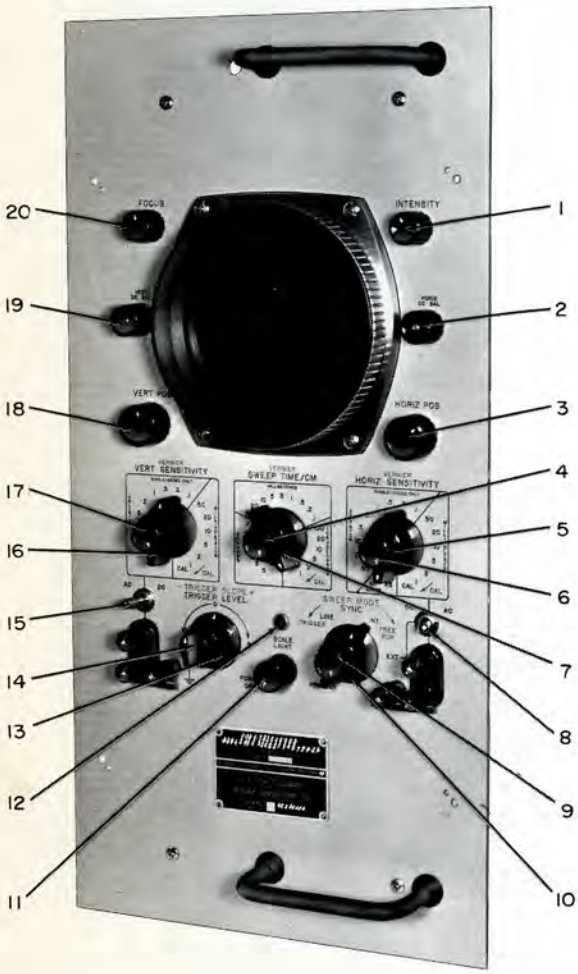
9. Check that the following lamps are lighted:

a. Control panel pulse generator 1 on the pulse generator 2 on lamps DS1 and DS2 (28 and 7, figure 3-2).

b. All dual power supply lamps.

c. Control panel OPERATE XMTR 1 or OPERATE XMTR 2 lamp DS16 or DS17 (31 or), indicating the operate transmitter selected in step 3.

10. At the control panel, place PULSE GEN. SELECTOR SCOPE DISPLAY switch S6 (4) in the PULSE GEN. 1 position.



1 INTENSITY potentiometer
2 HORIZ DC BAL potentiometer
3 HORIZ POS potentiometer
4 SWEEP TIME/CM-VERNIER potentiometer
5 HORIZ SENSITIVITY switch
6 HORIZ SENSITIVITY-VERNIER potentiometer
7 SWEEP TIME/CM switch
8 DC-AC switch
9 SYNC switch
10 SWEEP MODE potentiometer
11 SCALE LIGHT potentiometer
12 Power on lamp
13 TRIGGER LEVEL switch
14 TRIGGER SLOPE switch
15 AC-DC switch
16 VERT SENSITIVITY switch
17 VERT SENSITIVITY-VERNIER potentiometer
18 VERT POS potentiometer
19 VERT DC BAL potentiometer
20 FOCUS potentiometer

Figure 3-5. Oscilloscope OS-103/FPN, Front Panel Control Locations

TABLE 3-2. TRANSMITTER CONTROL GROUP OA-2631/FPN-42, INITIAL CONTROL SETTINGS

CONTROL	LOCATION	SETTING
PULSE GEN. 1 EXCITATION switch S4	Control panel	OPERATE BUS
PULSE GEN. 2 EXCITATION switch S5	Control panel	OPERATE BUS
B+ PULSE GEN. 1 switch S9	Control panel	Off (down)
B+ PULSE GEN. 2 switch S10	Control panel	Off (down)
B+ XMTR 1 switch S11	Control panel	Off (down)
B+ XMTR 2 switch S12	Control panel	Off (down)
INTERLOCK DISABLE switch S13	Control panel	Off (down)
BLOWER MOTOR circuit breaker CB3	Dual power supply	OFF
120 V LINE POWER SUPPLY 2 circuit breaker CB1B	Dual power supply	OFF
120 V LINE POWER SUPPLY 1 circuit breaker CB1A	Dual power supply	OFF

11. Place SIGNAL SELECTOR switch S1 (2) in the 100 KC position.

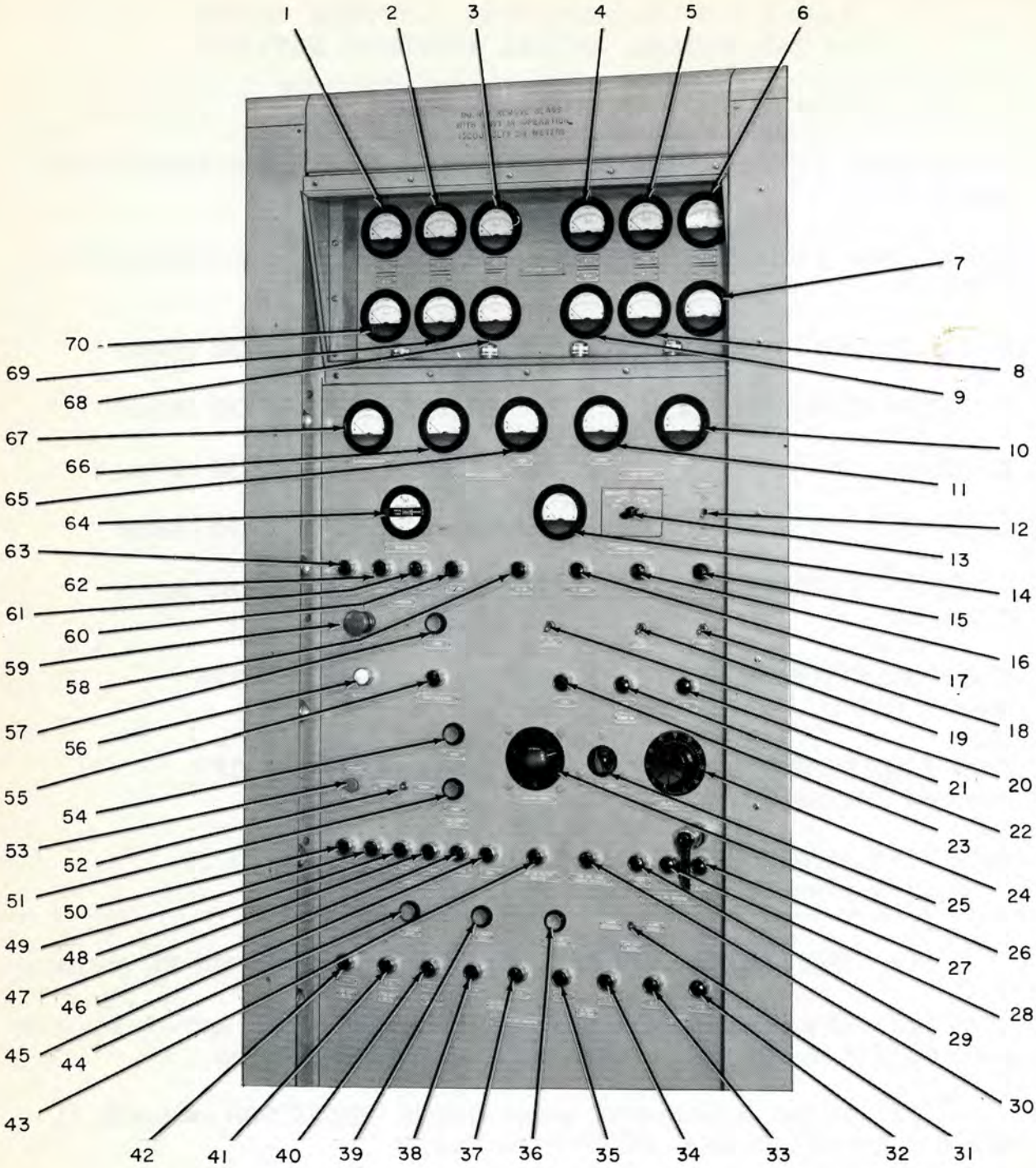
12. At the monitor oscilloscope, the waveform of figure 5-1d, with an amplitude of at least 3 volts peak to peak, should be displayed.

13. At the control panel, place SIGNAL SELECTOR switch S1 (2, figure 3-2) in the PULSE GEN. OUTPUT position.

14. At the monitor oscilloscope, the waveform of figure 5-1e, with an amplitude between 3.6 and 8.0 volts peak to peak, should be displayed.

15. At the control panel, place PULSE GEN. SELECTOR SCOPE DISPLAY switch S6 (4, figure 3-2) in the PULSE GEN. 2 position.

16. Repeat steps 11 through 14.



1 M1 RECTIFIER CURRENT meter
2 M2 RECTIFIER CURRENT meter
3 M3 RECTIFIER CURRENT meter
4 M4 RECTIFIER CURRENT meter
5 M5 RECTIFIER CURRENT meter
6 M6 RECTIFIER CURRENT meter
7 M7 RECTIFIER CURRENT meter
8 M8 RECTIFIER CURRENT meter
9 M9 RECTIFIER CURRENT meter
10 -300V BIAS VOLTAGE meter M13
11 -600V BIAS VOLTAGE meter M14
12 Filament-plate switch S17

Figure 3-6. Power Supply Assembly PP-2540/FPN-42, Front Panel Control Locations

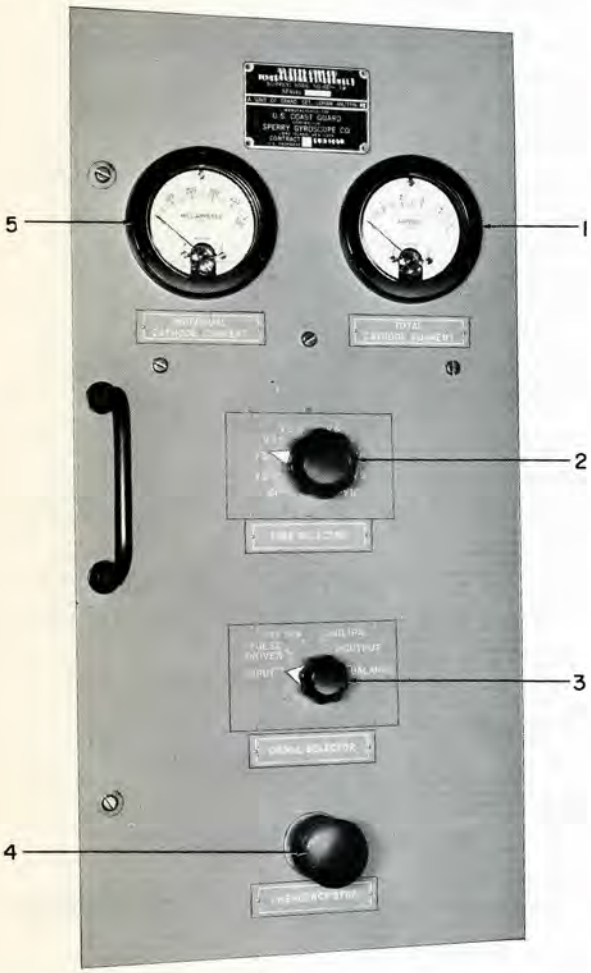
Legend for Figure 3-6 (Cont)

13 PRIMARY VOLTAGE switch S1
14 PRIMARY VOLTAGE meter M18
15 PLATE ON 1 lamp DS14
16 BIAS ON lamp DS15
17 FIL. READY lamp DS13
18 PLATE VOLTAGE switch S3
19 BIAS VOLTAGE switch S2
20 FIL. VOLTAGE switch S4
21 ØC POWER ON lamp DS3
22 ØB POWER ON lamp DS2
23 ØA POWER ON lamp DS1
24 DIMMER CONTROL transformer T9
25 -300 BIAS ADJUST transformer T7
26 -600 BIAS ADJUST transformer T8
27 COUPLING AND LOAD INTERLOCK INDICATOR lamp DS29
28 P.A. INTERLOCK INDICATOR lamp DS28
29 POWER SUPPLY INTERLOCK INDICATOR lamp DS22
30 LOW LINE ALARM DISABLE INDICATOR lamp DS30
31 LOW LINE ALARM switch S12
32 F9 BLOWN FUSE INDICATOR lamp DS33
33 F7 BLOWN FUSE INDICATOR lamp DS27
34 F8 BLOWN FUSE INDICATOR lamp DS32
35 F6 BLOWN FUSE INDICATOR lamp DS26
36 LOW LINE VOLTS RESET switch S11
37 F5 BLOWN FUSE INDICATOR lamp DS12
38 F4 BLOWN FUSE INDICATOR lamp DS11
39 3 STRIKE RESET switch S9
40 F3 BLOWN FUSE INDICATOR lamp DS9
41 F2 BLOWN FUSE INDICATOR lamp DS8
42 F1 BLOWN FUSE INDICATOR lamp DS7
43 LOW LINE VOLTS INDICATOR lamp DS31
44 OVERLOAD RESET switch S10
45 -300V OVERLOAD INDICATOR lamp DS18
46 -600V OVERLOAD INDICATOR lamp DS17
47 3.8KV OVERLOAD INDICATOR lamp DS19
48 7.5KV OVERLOAD INDICATOR lamp DS20
49 15.5KV OVERLOAD INDICATOR lamp DS21
50 BKR. TRIP OVERLOAD INDICATOR lamp DS16
51 LOWER MAN. PLATE VOLT ADJ. switch S24
52 AUTO-MANUAL switch S16
53 AUTO PLATE VOLT ADJ. potentiometer R40
54 RAISE MAN. PLATE VOLT ADJ. switch S23
55 PLATE VOLTS MAX. lamp DS23
56 PLATE VOLTS MIN. lamp DS24
57 START switch S8
58 FIL. ON lamp DS10
59 EMERGENCY STOP switch S7
60 P.A. CAB. BLOWERS ON lamp DS25
61 P.A. TUBE BLOWERS ON lamp DS4
62 POWER SUPPLY CAB. BLOWERS ON lamp DS5
63 POWER SUPPLY TUBE BLOWERS ON lamp DS6
64 ELAPSED TIME meter M19
65 3.8KV DRIVER PLATE VOLTAGE meter M17
66 7.75KV DRIVER PLATE VOLTAGE meter M16
67 15.5KV PLATE VOLTAGE meter M15
68 M9 RECTIFIER CURRENT meter
69 M8 RECTIFIER CURRENT meter
70 M7 RECTIFIER CURRENT meter

NOTE

The pulse control unit should be in this state before a transmitter is energized.

17. At the control panel, connect a pulse generator to the operate transmitter by placing PULSE GEN SELECTOR switch S8 (6, figure 3-2) in the P.G. 1 TO XMTR 1 - P.G. 2 TO XMTR 2 or P.G. 1 TO XMTR 2 - P.G. 2 TO XMTR 1 position. At pulse generator 1 or 2, OPERATE lamp DS1 (1, figure 3-1) should be lighted, depending on which pulse generator is connected to the operate transmitter.



1 TOTAL CATHODE CURRENT meter M2
2 TUBE SELECTOR switch S17
3 SIGNAL SELECTOR switch S18
4 EMERGENCY STOP switch S19
5 INDIVIDUAL CATHODE CURRENT meter M1

Figure 3-7. Amplifier Assembly AM-2481/FPN-42, Control Panel, Front Panel Control Locations

18. At the control panel, place the pulse generator connected to the standby transmitter in the standby condition, by placing B+ PULSE GEN. 1 or B+ PULSE GEN. 2 switch S9 or S10 (26 or 8, figure 3-2) in the off (down) position.

19. Place the operate transmitter B+ switch (B+ XMTR 1 or B+ XMTR 2 switch S11 or S12, 22 or 12) in the on (up) position.

NOTE

B+ voltage cannot be applied until the transmitter is in the ready condition.

(b) PLACING A TRANSMITTER IN THE OFF CONDITION FROM THE SHUT-DOWN CONDITION.

1. Inspect the equipment to insure that all doors and panels are secured and all grounding hooks are secured in the clips provided.

2. Check that high voltage power supply FIL. VOLTAGE, BIAS VOLTAGE, and PLATE VOLTAGE switches S4, S2, and S3 (20, 19 and 18, figure 3-6) are in the off (down) position. Place AUTO-MANUAL switch S16 (52) in the MANUAL position.

3. At the transmitter building, place the auxiliary wall circuit breaker (supplying power to the coupling and load unit) in the on position. At the coupling and load unit, TRANSMITTER 1 ON ANTENNA or TRANSMITTER 2 ON ANTENNA lamp DS1 or DS2 (8,or 3, figure 3-8) should light depending upon the position of control panel TRANSMITTER SELECTOR switch S7 (27, figure 3-2).

4. Place the main wall circuit breaker, supplying power to the high voltage power supply for transmitter 1 or transmitter 2, in the on position. Note that the three high voltage power supply POWER ON lamps DS3, DS2, and DS1 (21, 22, and 23, figure 3-6) are lighted.

NOTE

The transmitter is now in the off condition.

(c) PLACING A TRANSMITTER IN THE STANDBY CONDITION FROM THE OFF CONDITION.

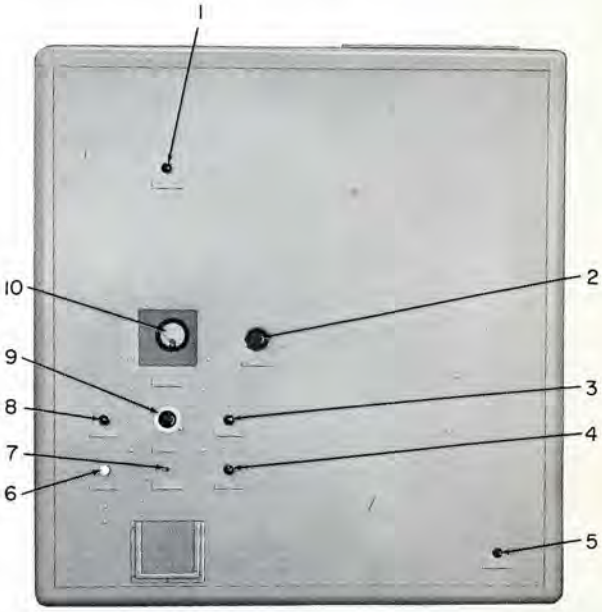
1. At the high voltage power supply place PRIMARY VOLTAGE switch S1 (13, figure 3-6), in turn, in the UNREGULATED ØA, ØB, and ØC positions. Check that PRIMARY VOLTAGE meter M18 (14) indicates between 187 and 229 volts for each position.

2. At the coupling and load unit, place LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the local (left) position. LOCAL lamp DS3 (6) should light.

3. At the high voltage power supply, depress START switch S8 (57, figure 3-6) and check the following:

a. LOW LINE VOLTS INDICATOR lamp DS31 (43) flashes.

b. Low line volts audible alarm sounds. Depress the LOW LINE VOLTS RESET switch S11 (36).



1 WARNING REMOTE OPERATION lamp DS6
2 PUSH TO READ switch S1
3 TRANSMITTER 2 ON ANTENNA lamp DS2
4 REMOTE lamp DS4
5 BLOWER RESET switch (part of K1)
6 LOCAL lamp DS3
7 LOCAL & REMOTE SELECTOR switch S7
8 TRANSMITTER 1 ON ANTENNA lamp DS1
9 ANTENNA TUNING inductor L1
10 ANTENNA CURRENT meter M1

Figure 3-8. Antenna Coupler CU-807/FPN-42, Front Panel Control Locations

NOTE

At the control panel, the low line voltage alarm bell should sound and transmitter 1 or transmitter 2 LOW V IND lamp DS9 or DS11 (19, 13, figure 3-2) should be lighted. The alarm and lamp may be reset by momentarily placing LOW VOLT RESET XMTR 1 or LOW VOLT RESET XMTR 2 switch S14 or S15 (17 or 15) in the up position.

c. Three INTERLOCK INDICATOR lamps DS29, DS28, and DS22 (27, 28, and 29, figure 3-6) are lighted.

d. Six OVERLOAD INDICATOR Lamps DS16 through DS21 (45 through 50) are lighted. If any lamps are not lighted (audible alarm sounds) depress OVERLOAD RESET switch S10 (44).

NOTE

At the control panel, the overload alarm buzzer may sound and transmitter 1 or transmitter 2 OVERLOAD IND lamp DS10 or DS12 (20 or 14, figure 3-2) may light. The alarm and lamp may be reset by depressing OVERLOAD RESET XMTR 1 or OVERLOAD RESET XMTR 2 switch S16 or S17 (18 or 16).

e. At the high voltage power supply, panel lamps are lighted. If not, operate DIMMER CONTROL transformer T9 (24, figure 3-6) for desired illumination.

f. Four BLOWERS ON lamps DS25, DS4, DS5, and DS6 (60 through 63) are lighted.

4. At the high voltage power supply, place FIL. VOLTAGE switch S4 (20, figure 3-6) in the on (up) position. Note that after 15 seconds FIL. ON lamp DS10 (58) lights, and after 5 minutes FIL. READY lamp DS13 (17) lights.

5. At the transmitter, place SIGNAL SELECTOR switch S18 (3, figure 3-7) in the INPUT position. Observe the transmitter monitor oscilloscope pattern. The waveform of figure 5-1i with an amplitude of from 15 to 30 volts peak to peak should be displayed.

NOTE

The transmitter is now in the standby condition.

(d) PLACING A TRANSMITTER IN THE READY CONDITION FROM THE STANDBY CONDITION. - At the high voltage power supply, place BIAS VOLTAGE

switch S2 (19, figure 3-6), in the on (up) position. Note that -600V BIAS VOLTAGE meter M14 (11) reads approximately 540 volts, and that -300 V BIAS VOLTAGE meter M13 (10) reads approximately 270 volts. BIAS ON lamp DS15 (16), and control panel transmitter 1 or 2 READY lamp DS4 or DS6 (24 or 10, figure 3-2) should light.

NOTE

The transmitter is now in the ready condition.

(e) PLACING A TRANSMITTER IN THE ON CONDITION FROM THE READY CONDITION.

1. At the high voltage power supply, place AUTO-MANUAL switch S16 (52, figure 3-6) in the AUTO position.

2. At the coupling and load unit, place LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the remote (right) position WARNING REMOTE OPERATION and REMOTE lamps DS6 and DS4 (1 and 4) should light. At the high voltage power supply; note that PLATE ON lamp DS14 (15, figure 3-6) lights; and 15.5 KV PLATE VOLTAGE meter M15 (67), 7.75 KV DRIVER PLATE VOLTAGE meter M16 (66), and 3.8 KV DRIVER PLATE VOLTAGE meter M17 (65) indications increase smoothly (in less than 15 seconds) to 14 kv, 7 kv and 3.5 kv, respectively. At the control panel, transmitter 1 or 2 ON lamp DS5 or DS7 (25 or 11, figure 3-2) should light.

NOTE

B+ voltage may also be applied manually, and controlled by the high voltage power supply PLATE VOLTAGE, RAISE MAN. PLATE VOLT ADJ. and LOWER MAN. PLATE VOLT ADJ. switches S3, S23, and S24 (18, 54, and 51, figure 3-6).

3. At the transmitter control panel, place SIGNAL SELECTOR switch S18 (3, figure 3-7) in the OUTPUT position. The transmitter monitor oscilloscope should display the waveform of figure 5-1m.

NOTE

The transmitter is now in the on condition.

(f) INTERCHANGING TRANSMITTERS.

1. If the standby transmitter is not in the ready condition, place it in the ready condition in accordance with paragraphs (2) or (3).

2. At the control panel, place the operate transmitter B+ switch (B+ XMTR 1 or B+ XMTR 2 switch S11 or S12, 22, or 12, figure 3-2) in the off (down) position.

3. Place TRANSMITTER SELECTOR switch S7 (27) in the XMTR 1 TO ANTENNA position (if transmitter 2 was the operate transmitter), or in the XMTR 2 TO ANTENNA position (if transmitter 1 was the operate transmitter).

4. Connect the pulse generator which fed the original operate transmitter to the new operate transmitter by placing PULSE GEN SELECTOR switch S8 (6) in the P.G. 1 TO XMTR 1 - P.G. 2 TO XMTR 2 position if it was in the P.G. 1 TO XMTR 2 - P.G. 2 TO XMTR 1 position, or vice versa.

NOTE

The transmitters are now interchanged.

5. Place B+ XMTR 1 switch S11 (22) (if transmitter 2 was the operate transmitter) or B+ XMTR 2 switch S12 (12) (if transmitter 1 was the operate transmitter) in the on (up) position.

NOTE

At the control panel, the audible overload alarm and transmitter 1 or 2 OVERLOAD IND lamp DS10 or DS12 (20 or 14, figure 3-2) may be reset by depressing OVERLOAD RESET XMTR 1 or OVERLOAD RESET XMTR 2 switch S16 or S17 (18 or 16). At the high voltage power supply, the audible overload alarm and the six OVERLOAD INDICATOR lamps DS16 through DS21 (45 through 50, figure 3-6) may be reset by depressing OVERLOAD RESET switch S10 (44).

(g) INTERCHANGING PULSE GENERATORS.

1. At the control panel, place the standby pulse generator in the on condition by placing B+ PULSE GEN. 1 or B+ PULSE GEN. 2 switch S9 or S10 (26 or 8, figure 3-2) in the on (up) position.

2. Select the standby pulse generator for oscilloscope display by placing PULSE GEN. SELECTOR SCOPE DISPLAY switch S6 (4) in the PULSE GEN. 1 or PULSE GEN. 2 position. Repeat steps (a) 11 through (a) 14.

3. Interchange pulse generators by placing PULSE GEN. SELECTOR switch S8 (6) in the P.G. 1 TO XMTR 1 - P.G. 2 TO XMTR 2 position if it was in the P.G. 1 TO XMTR 2 - P.G. 2 TO XMTR 1 position, or vice versa.

NOTE

The pulse generators are now interchanged.

4. Place the new standby pulse generator in the standby condition by placing B+ PULSE GEN. 1 or B+ PULSE GEN. 2 switch S9 or S10 (26 or 8) in the off (down) position.

(h) OPERATING THE STANDBY TRANSMITTER INTO THE DUMMY LOAD.

1. If the standby transmitter is not in the ready condition, place it in the ready condition in accordance with paragraphs (2) or (3).

2. At the high voltage power supply for the operate transmitter, place AUTO-MANUAL switch S16 (52, figure 3-6) in the MANUAL position.

3. Depress LOWER MAN. PLATE VOLT ADJ. switch S24 (51) until PLATE VOLTS MIN. lamp DS24 (56) lights.

4. Place PLATE VOLTAGE switch S3 (18) in the on (up) position.

5. When 15.5 KV PLATE VOLTAGE meter M15 (67) indicates approximately 5 kv, place coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the local (left) position.

NOTE

If an overload indicator lamp on the operate high voltage power supply goes out (audible alarm sounds), indicating an overload due to the switching, reset the overload indicator and audible alarm. The overload indicator and audible alarm at the pulse control unit should also be reset.

6. At the high voltage power supply for the operate transmitter, depress RAISE MAN. PLATE VOLT ADJ. switch S23 (54, figure 3-6) until 15.5 KV PLATE VOLTAGE meter M15 (67) indicates 14 kv.

7. At the control panel, place the standby pulse generator B+ switch (B+ PULSE GEN. 1 or B+ PULSE GEN. 2 switch S9 or S10 26 or 8, figure 3-2) in the on (up) position.

8. At the high voltage power supply for the standby transmitter, place PLATE VOLTAGE switch S3 (18, figure 3-6) in the on (up) position.

NOTE

The standby transmitter is now operating into the dummy load. The standby transmitter can be operated at less than normal B+ voltage, by applying the B+ voltage manually.

(3) DE-ENERGIZING THE EQUIPMENT.

(a) PLACING A TRANSMITTER IN THE READY CONDITION FROM THE ON CONDITION.

NOTE

To place a transmitter in the ready condition from the on condition by remote means, perform steps 1 and 2. To place a transmitter in the ready condition from the on condition by local means, perform steps 3, 4, and 5.

1. At the control panel, place B+ XMTR 1 switch S11 (22, figure 3-2) or B+ XMTR 2 switch S12 (12) (depending on which transmitter is to be placed in the ready condition) in the off (down) position.

2. The audible overload alarm in the pulse control unit may sound, and transmitter 1 or 2 OVERLOAD IND lamp DS10 or DS12 (20 or 14) may light. The alarm and lamp may be reset by depressing OVERLOAD RESET XMTR 1 or OVERLOAD RESET XMTR 2 switch S16 or S17 (18 or 16).

NOTE

The transmitter is now in the ready condition. At the high voltage power supply, the audible overload alarm may sound and one or more OVERLOAD INDICATOR lamps may be out. The alarm and lamps may be reset by depressing OVERLOAD RESET switch S10 (44, figure 3-6).

3. At the high voltage power supply of the transmitter to be placed in the ready condition, place AUTO-MANUAL switch S16 (52, figure 3-6) in the MANUAL position.

4. Depress LOWER MAN. PLATE VOLT ADJ. switch S24 (51) until PLATE VOLTS MIN. lamp DS24 (56) lights.

5. When 15.5 KV PLATE VOLTAGE meter M15 (67) indicates approximately 5 kv, place PLATE VOLTAGE switch S3 (18) in the off (down) position.

NOTE

The transmitter is now in the ready condition.

(b) PLACING A TRANSMITTER IN THE STANDBY CONDITION FROM THE READY CONDITION. - At the high voltage power supply, place BIAS VOLTAGE switch S2 (19, figure 3-6) in the off (down) position.

NOTE

The transmitter is now in the standby condition.

(c) PLACING A TRANSMITTER IN THE OFF CONDITION FROM THE STANDBY CONDITION.

1. At the high voltage power supply, place FIL. VOLTAGE switch S4 (20, figure 3-6) in the off (down) position.

2. After waiting 5 minutes to allow the tubes to cool, depress EMERGENCY STOP switch S7 (59).

NOTE

The transmitter is now in the off condition.

(d) PLACING A TRANSMITTER IN THE SHUT-DOWN CONDITION FROM THE OFF CONDITION. - At the transmitter building, place the main wall circuit breaker, supplying power to the high voltage power supply for transmitter 1 or transmitter 2, in the off position.

NOTE

The transmitter is now in the shut-down condition.

(e) ROUTINE SHUT-DOWN OF THE PULSE CONTROL UNIT.

NOTE

Do not shut down the pulse control unit until both transmitters have been shut down.

1. At the control panel, place B+ PULSE GEN. 1 and B+ PULSE GEN. 2 switches S9 and S10 (26 and 8, figure 3-2) in the off (down) position.

2. At the dual power supply, place 120 V LINE POWER SUPPLY 1 and 120 V LINE POWER SUPPLY 2 circuit breakers CB1A and CB1B (13 and 12, figure 3-3) in the OFF position.

3. Place BLOWER MOTOR circuit breaker CB3 (1) in the OFF position.

4. At the operations building, place the auxiliary circuit breaker, supplying power to the pulse control unit, in the off position.

NOTE

The pulse control unit is now in the shut-down condition.

(f) SECURING THE TRANSMITTER GROUP.

1. De-energize both transmitters and the pulse control unit in accordance with steps (2) (a) through (2) (e).

2. At the transmitter building, place the auxiliary circuit breaker, supplying power to the coupling and load unit, in the off position.

NOTE

The transmitter group is now in the shut-down condition.

(g) EMERGENCY SHUT-DOWN OF A TRANSMITTER.

WARNING

Use this procedure only in the event of an unusual condition in which injury to operating personnel or damage to the equipment might result.

1. Depress control panel EMERGENCY STOP XMTR 1 switch S2 (30, figure 3-2) or EMERGENCY STOP XMTR 2 switch S3 (3); or transmitter EMERGENCY STOP switch S19 (4, figure 3-7); or high voltage power supply EMERGENCY STOP switch S7 (59, figure 3-6).

2. At the transmitter building, place the main wall circuit breaker, supplying power to the high voltage power supply for transmitter 1 or transmitter 2, in the off position.

NOTE

The transmitter is now in the shut-down condition.

(h) EMERGENCY SHUT-DOWN OF THE PULSE CONTROL UNIT.

WARNING

Use this procedure only in the event of an unusal conditions in which injury to operating personnel or damage to the equipment might result.

1. At the control panel, depress EMERGENCY STOP XMTR 1 and EMERGENCY STOP XMTR 2 switches S2 and S3 (30 and 3, figure 3-2).

2. At the operations building, place the auxiliary circuit breaker for the pulse control unit in the off position.

3. Reset overload indicators at the control panel and high voltage power supply.

(i) EMERGENCY SHUT-DOWN OF THE COUPLING AND LOAD UNIT.

WARNING

Use this procedure only in the event of an unusual condition in which injury to operating personnel or damage to the equipment might result.

1. Depress both transmitter EMERGENCY STOP switches S19 (4, figure 3-7), or both high voltage power supply EMERGENCY STOP switches S7 (59, figure 3-6).

2. At the transmitter building, place the auxiliary circuit breaker for the coupling and load unit in the off position.

c. TUNING ADJUSTMENTS. No tuning adjustments should be made by non-technical operating personnel.

d. PRECAUTIONS.

(1) Never operate the equipment with doors open, panels removed, or interlocks disabled, unless trouble-shooting.

(2) Always ground all points within the working area before servicing any part of the transmitting equipment.

(3) Always have at least two persons in the transmitter building when trouble-shooting the transmitting equipment.

(4) Never shut down the transmitting equipment from the on condition using the EMERGENCY STOP switches unless a genuine emergency exists.

(5) Never make any adjustment to the controls behind the access door of a pulse generator; or to AUTO PLATE VOLT ADJ. potentiometer R40 (53, figure 3-6) and -300 BIAS ADJUST and -600 BIAS ADJUST transformers T7, and T8 (25, and 26) of a high voltage power supply.

NOTE

If any adjustment to these controls is necessary, notify a qualified technician.

3-4. SUMMARY OF OPERATING PROCEDURES.

a. ROUTINE STARTING PROCEDURE.

(1) At the operations building, place the auxiliary circuit breaker in the on position.

(2) At the dual power supply, place the three circuit breakers (1, 12, and 13, figure 3-3) in the ON position.

(3) At the control panel, place pulse generator 1 or 2 on the operate bus by placing PULSE GEN. 1 EXCITATION or PULSE GEN. 2 EXCITATION switch S4 or S5 (29 or 5, figure 3-2) in the OPERATE BUS position.

(4) Select the operate transmitter by placing TRANSMITTER SELECTOR switch S7 (27) in the XMTR 1 TO ANTENNA or XMTR 2 TO ANTENNA position.

(5) Place the operate transmitter B+ switch (B+ XMTR 1 or B+ XMTR 2) switch S11 or S12 (22 or 12) in the on (up) position.

(6) Energize the pulse generator as selected in step (3), by placing B+ PULSE GEN. 1 or B+ PULSE GEN. 2 switch S9 or S10 (26 or 8) in the on (up) position.

(7) Connect the pulse generator as selected in step (3) to the monitor oscilloscope by placing PULSE GEN. SELECTOR SCOPE DISPLAY switch S6 (4) in the PULSE GEN. 1 or PULSE GEN. 2 position.

(8) Place SIGNAL SELECTOR switch S1 (2) in the PULSE GEN. OUTPUT position. Check that the monitor oscilloscope display is as shown in figure 5-1e.

(9) Connect the pulse generator selected in step (3) to the operate transmitter selected in step (4), by placing PULSE GEN. SELECTOR switch S8 (6) in the P.G. 1 to XMTR 1 - P.G. 2 to XMTR 2 or P.G. 1 to XMTR 2 - P.G. 2 to XMTR 1 position.

(10) At the transmitter building, place the main and auxiliary circuit breakers in the on position.

(11) At the coupling and load unit, place LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the local (left) position.

(12) At the high voltage power supply for the operate transmitter, depress START switch S8 (57, figure 3-6).

(13) Depress LOW LINE VOLTS RESET and OVERLOAD RESET switches S11 and S10 (36 and 44) as required.

(14) At the control panel, place LOW VOLT RESET XMTR 1 or LOW VOLT RESET XMTR 2 switch S14 or S15 (17 or 15, figure 3-2) in the up position, and depress OVERLOAD RESET XMTR 1 or OVERLOAD RESET XMTR 2 switch S16 or S17 (18 or 16).

(15) At the high voltage power supply, check that AUTO-MANUAL switch S16 (52, figure 3-6) is in the MANUAL position.

(16) Place FIL. VOLTAGE and BIAS VOLTAGE switches S4 and S2 (20 and 19) in the on (up) position.

(17) Place AUTO-MANUAL switch S16 (52) in the AUTO position.

(18) When BIAS ON lamp S15 (16) lights, place coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the remote (right) position.

(19) At the control panel, place SIGNAL SELECTOR switch S1 (2, figure 3-2) in the ANTENNA position. Check that the monitor oscilloscope display is as shown in figure 5-1f.

NOTE

The operate transmitter is now in the on condition.

b. ROUTINE SHUT-DOWN.

NOTE

Steps (1) through (4) place a transmitter in the shut-down condition. If it is desired to place the transmitter group in the shut-down condition perform steps (1) through (9).

(1) At the control panel, place B+ XMTR 1 or B+ XMTR 2 switch S11 or S12 (22 or 12, figure 3-2) in the off (down) position.

(2) At the high voltage power supply, place BIAS VOLTAGE and FIL. VOLTAGE switches S2 and S4 (19 and 20, figure 3-6) in the off (down) position. Wait five minutes before continuing.

(3) Depress EMERGENCY STOP switch S7 (59).

(4) Place the main circuit breaker in the off position.

(5) Repeat steps (1) through (4) for the second transmitter.

(6) At the transmitter building, place the auxiliary circuit breaker in the off position.

(7) At the control panel, place B+ PULSE GEN. 1 and B+ PULSE GEN. 2 switches S9 and S10 (26 and 8, figure 3-2) in the off (down) position.

(8) At the dual power supply, place the three circuit breakers (1, 12, and 13, figure 3-3) in the OFF position.

(9) At the operations building place the auxiliary circuit breaker in the off position.

3-5. EMERGENCY OPERATION

a. OPERATE AND STANDBY EQUIPMENT. - In case of an emergency the operate and standby conditions of the transmitters and/or pulse generators may be interchanged, as described in paragraphs 3-3b (2) (f) and (g).

b. REDUCED POWER OPERATION. - In the event of the failure (indicated by the lack of individual cathode current) of a transmitter power amplifier tube (V1 through V8) when no spares are available, proceed as follows:

NOTE

If the failure occurs in the operate transmitter, first interchange transmitters.

(1) Place the standby transmitter in the off position in accordance with paragraphs 3-3 b (3) (a), (b), and (c).

(2) Ground all points in the area of tubes V1 through V8 (see figures 2-4 and 2-5) with the ground hooks provided.

(3) Remove the tube in which the failure occured, in accordance with paragraph 3-7c (3).

(4) Remove the corresponding tube from the other side of the push-pull circuit

NOTE

Tubes V1 through V4 form one side of the push-pull circuit, the corresponding tubes in the other side of the push-pull circuit are V5 through V8, respectively.

(5) Remove the filament, grid, and plate leads for the removed tubes, in order to eliminate the possibility of a short circuit.

NOTE

If the operate transmitter should fail before a replacement tube is available for the standby transmitter, the standby may be interchanged with the operate transmitter to provide reduced power operation. If necessary, remove appropriate tubes from defective operate transmitter to provide full power operation of the standby transmitter.

3-6. TEST PROCEDURES (FOR TEST EQUIPMENT ONLY)

Although Loran Transmitting Set AN/FPN-42 contains built in test features, it is not itself a piece of test equipment, therefore no test procedures are provided under this heading.

3-7. OPERATOR'S MAINTENANCE

a. ROUTINE OPERATING CHECKS

(1) LAMP CHECKS.

(a) Check all amber and red lamps. In general, all amber lamps should be lighted, and all red lamps should be out. Exceptions to the generality follow:

1. At the control panel, amber transmitter 1 or 2 ON lamp DS5 or DS7 (25 or 11, figure 3-2) should be out if that transmitter is in the ready condition.

2. At the high voltage power supply, red PLATE ON lamp DS14 (15, figure 3-6) should be lighted if the transmitter is in the on condition.

(b) Check all green lamps as follows:

1. At the high voltage power supply, all green lamps should be lighted.

2. At the coupling and load unit, either of the two green lamps may be lighted. If both lamps are either lighted or out simultaneously, the transmitter group is not operating normally.

3. At the control panel, either of the two green lamps may be lighted. If both lamps are either lighted or out simultaneously, the transmitter group is not operating normally.

4. At either pulse generator, the green lamp may be lighted. If both lamps are either lighted or out simultaneously, the transmitter group is not operating normally.

(2) ROUTINE CHECK CHART.

(a) Table 3-3 provides data to be used to establish a permanent record of the equipment condition. The record should indicate when circuits are no longer operating at peak efficiency, and provide a guide for the preventive maintenance program.

(b) Record the data required for the items listed every hour. If certain readings remain within tolerance for several days at a time, record less frequently, but at least every four hours.

NOTE

The recording of waveforms can be performed accurately by using Polaroid Oscilloscope Camera Model F-296.

(3) PROCEDURES FOR USING THE PULSE ANALYZER. - Although the operator during his checks does not normally measure the relative amplitude of each cycle within a transmitted pulse, the following procedure is provided for his use if he is requested to use the pulse analyzer.

NOTE

The transmitter must be on, and operating into the antenna for proper operation of the pulse analyzer.

(a) At the control panel, place SIGNAL SELECTOR switch S1 (2, figure 3-2) in the PULSE ANALYZER position.

(b) At the pulse analyzer, place P.S.1 P.S.2 PWR. SUPPLY SEL. switch S3 (1, figure 3-4) in the power supply 1 (left) or the power supply 2 (right) position depending on which pulse generator is feeding the operate transmitter.

(c) Place SCOPE TRIG. SELECTOR switch S2 (7) in the PULSE ANALYZER position.

(d) Place PULSE SEL. switch S1 (3) in any of eight position (1 through 8), depending on which pulse is to be analyzed.

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
SIGNAL SELECTOR switch S1	Control panel	100KC	Figure 5-1d			3 volts peak to peak (minimum)
SIGNAL SELECTOR switch S1	Control panel	TRIGGERS	Figure 5-1a			5 volts peak (minimum)
SIGNAL SELECTOR switch S1	Control panel	MODULATING SIGNAL	Figure 5-1b			8 volts peak to peak ±10%
SIGNAL SELECTOR switch S1	Control panel	DROOP MODULATOR	Figure 5-1c			1 volt increasing to 2 volts peak to peak ±10%
SIGNAL SELECTOR switch S1	Control panel	PULSE GEN. OUTPUT	Figure 5-1e			3.6 volts increasing to 8 volts peak to peak ±10%
SIGNAL SELECTOR switch S1	Control panel	DUMMY LOAD	Figure 5-1g			5 volts peak to peak ±20%
SIGNAL SELECTOR switch S1	Control panel	ANTENNA	Figure 5-1f			70 volts peak to peak ±20%

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
	High voltage power supply			M1 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M2 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M3 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M4 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M5 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M6 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
	High voltage power supply			M7 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M8 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M9 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M10 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M11 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)
	High voltage power supply			M12 RECTIFIER CURRENT meter	1.3 amps*	2 amps (maximum)

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
	High voltage power supply			15.5KV PLATE VOLTAGE meter M15	14 kv*	±0.3 kv
	High voltage power supply			7.75KV DRIVER PLATE VOLTAGE meter M16	7 kv	±0.2 kv
	High voltage power supply			3.8KV DRIVER PLATE VOLTAGE meter M17	3.5 kv	±0.1 kv
	High voltage power supply			-600V BIAS VOLTAGE meter M14	540 volts	±20 volts
	High voltage power supply			-300V BIAS VOLTAGE meter M13	270 volts	±10 volts
FILAMENT-PLATE switch S17	High voltage power supply	PLATE				

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
PRIMARY VOLTAGE switch S1	High voltage power supply	UNREGU-LATED ØA		PRIMARY VOLTAGE meter M18	208 volts	±21 volts
FILAMENT-PLATE switch S17	High voltage power supply	PLATE				
PRIMARY VOLTAGE switch S1	High voltage power supply	UNREGU-LATED ØB		PRIMARY VOLTAGE meter M18	208 volts	±21 volts
FILAMENT-PLATE switch S17	High voltage power supply	PLATE				
PRIMARY VOLTAGE switch S1	High voltage power supply	UNREGU-LATED ØC		PRIMARY VOLTAGE meter M18	208 volts	±21 volts
FILAMENT-PLATE switch S17	High voltage power supply	PLATE				
PRIMARY VOLTAGE switch S1	High voltage power supply	REGU-LATED ØA		PRIMARY VOLTAGE meter M18	220 volts	±10 volts
FILAMENT-PLATE switch S17	High voltage power supply	PLATE				

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
PRIMARY VOLTAGE switch S1	High voltage power supply	REGULATED ØB		PRIMARY VOLTAGE meter M18	220 volts	±10 volts
FILAMENT PLATE switch S17	High voltage power supply	PLATE				
PRIMARY VOLTAGE switch S1	High voltage power supply	REGULATED ØC		PRIMARY VOLTAGE meter M18	220 volts	±10 volts
TUBE SELECTOR switch S17	Transmitter	V1		INDIVIDUAL CATHODE CURRENT meter M1	350 ma*	+20% -50%
TUBE SELECTOR switch S17	Transmitter	V2		INDIVIDUAL CATHODE CURRENT meter M1	350 ma*	+20% -50%
TUBE SELECTOR switch S17	Transmitter	V3		INDIVIDUAL CATHODE CURRENT meter M1	350 ma*	+20% -50%
TUBE SELECTOR switch S17	Transmitter	V4		INDIVIDUAL CATHODE CURRENT meter M1	350 ma*	+20% -50%

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
TUBE SELECTOR switch S17	Transmitter	V5		INDIVIDUAL CATHODE CURRENT meter M1	350 ma*	+20% -50%
TUBE SELECTOR switch S17	Transmitter	V6		INDIVIDUAL CATHODE CURRENT meter M1	350 ma*	+20% -50%
TUBE SELECTOR switch S17	Transmitter	V7		INDIVIDUAL CATHODE CURRENT meter M1	350 ma*	+20% -50%
TUBE SELECTOR switch S17	Transmitter	V8		INDIVIDUAL CATHODE CURRENT meter M1	350 ma*	+20% -50%
TUBE SELECTOR switch S17	Transmitter	V9		INDIVIDUAL CATHODE CURRENT meter M1	170 ma*	+20% -50%
TUBE SELECTOR switch S17	Transmitter	V10		INDIVIDUAL CATHODE CURRENT meter M1	170 ma*	+20% -50%

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
	Transmitter			TOTAL CATHODE CURRENT meter M2	3.0 amps*	±50%
SIGNAL SELECTOR switch S18	Transmitter	INPUT	Figure 5-1i			18 volts increasing to 30 volts peak to peak ±10%
SIGNAL SELECTOR switch S18	Transmitter	PULSE DRIVER	Figure 5-1j			29 volts increasing to 40 volts peak to peak ±10%
SIGNAL SELECTOR switch S18	Transmitter	1ST IPA	Figure 5-1k			38 volts increasing to 45 volts peak to peak ±10%
SIGNAL SELECTOR switch S18	Transmitter	2ND IPA	Figure 5-1l			36 volts peak to peak ±10%
SIGNAL SELECTOR switch S18	Transmitter	OUTPUT	Figure 5-1m			40 volts peak to peak ±10%

TABLE 3-3. LORAN TRANSMITTING SET AN/FPN-42, ROUTINE CHECK CHART (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	METER	METER READING	LIMITS
SIGNAL SELECTOR switch S18	Transmitter	BALANCE	Figure 5-1n			0.5 volts peak to peak maximum
PUSH TO READ	Coupling and load unit	Depress		ANTENNA CURRENT	30 amps*	±20%

*These meter readings are dependent on the mode of operation (that is: repetition rates and method of pulsing). The readings in the above table correspond to SO repetition rate, multi-pulsing with 1000-microsecond pulse spacing.

(e) Set % AMPL. potentiometer R55 (2) to the 100 position.

(f) Observe the pulse and the reference trace on the monitor oscilloscope. Adjust AMPL. CAL. potentiometer R52 (8) until the peak r-f cycle in the pulse is coincident with the reference trace as shown in figure 5-1h.

NOTE

The pulse analyzer is now calibrated and ready for pulse shape measurements.

(g) The pulse shape measurements are all relative to the peak cycle in the pulse. These relative readings are obtained from % AMPL. potentiometer R55 (2, figure 3-4).

(h) After the pulse analyzer has been calibrated, rotate % AMPL. potentiometer R55 (2) so that the peak of the preceding cycle is coincident with the reference trace. Record the cycle number of the pulse and its corresponding reading.

(i) Repeat step (h) for each r-f cycle in the leading edge of the pulse.

(j) After all measurements have been made, place SCOPE TRIG. SELECTOR switch S2 (7) in the NORMAL position.

b. PREVENTIVE MAINTENANCE

WARNING

No preventive maintenance is to be performed on the coupling and the load unit unless both transmitters are placed in the standby condition.

(1) DAILY MAINTENANCE. - The suggested daily routine is the maintenance of an accurate and complete log containing all oscilloscope displays and meter readings of table 3-3 in tabular form.

(2) WEEKLY MAINTENANCE. - The weekly routine consists of inspecting and cleaning transmitter group components.

WARNING

Observe all high-voltage safety precautions before performing any of these maintenance operations. It is absolutely necessary for the safety of personnel to short circuit all

high-voltage capacitors with the grounding rods provided. Since high-voltage capacitors tend to recharge themselves, their terminals must be kept short circuited during handling or storage.

NOTE

Inspect the following for cracks, chips, blistering, discoloration, leaks, loose connections, dirt, corrosion, and loose grounding leads.

(a) TUBES. - Clean with a lint free cloth. Pay particular attention to glass or ceramic envelopes. This is important because glass etching may cause external flash-over. If the deposits are difficult to remove, moisten with a nonflammable cleaning fluid. Clean exposed terminals with a crocus cloth or No. 0000 sandpaper.

CAUTION

During routine maintenance checks, every cleaning procedure should be followed by inspection since the act of cleaning may inadvertently loosen a connection.

(b) TUBE SOCKETS AND CONNECTORS. - When necessary, clean connectors with a nonflammable cleaning fluid, and brush tube pins and sockets.

(c) CAPACITORS. - Tighten all loose connections.

(d) RESISTORS. - Clean the metal ends of the ferrite type resistors with a brush or cloth dipped in nonflammable cleaning fluid. If necessary, use crocus cloth or No. 0000 sandpaper.

WARNING

Do not touch power resistors immediately after shutdown. They are usually very hot and can cause severe burns.

(e) FUSES AND FUSE CLIPS. - Clean when necessary with No. 0000 sandpaper.

(f) TRANSFORMERS AND FILTER CHOKES. - Clean with dry cloth; clean tarnished and oxidized connectors with No. 0000 sandpaper.

(g) OPEN COIL INDUCTORS. - Cleaning is best accomplished by directing a stream of compressed air at the inductor.

(h) HIGH VOLTAGE BUSHINGS AND INSULATORS. - Tighten connections if loose; examine gaskets and clean with a damp cloth.

(i) ALL OTHER INSULATORS. - Clean with a damp cloth.

(j) AIR FILTERS. - Normally, weekly cleaning is sufficient. Clean more often if necessary. Remove filters from mounting and brush exterior accumulation of dust; wash in trisodium phosphate. After allowing filter to dry thoroughly, spray with SAE-30, -40, or -50 oil. If necessary, check and tighten the flexible sleeving on the blower.

(k) CABINET AND CHASSIS. - Use a compressed air hose to blow out all loose dust from the entire transmitter.

(3) MONTHLY MAINTENANCE.

(a) Check all bolts, nuts and screws and, if necessary, tighten them. Examine the connections to all components where other than a simple soldered joint is used.

(b) Clean the contacts of the following switches by washing with alcohol.

1. SIGNAL SELECTOR switch S18 (3, figure 3-7).

2. TUBE SELECTOR switch S17 (2, figure 3-7).

3. PULSE GEN. 1 EXCITATION switch S4 (29, figure 3-2).

4. PULSE GEN. 2 EXCITATION switch S5 (5, figure 3-2).

5. SIGNAL SELECTOR switch S1 (2, figure 3-2).

6. PULSE GEN SELECTOR switch S8 (6, figure 3-2).

7. PULSE SEL. switch S1 (3, figure 3-4).

(c) Inspect and clean, if necessary, the radiators on the power tubes to be certain there is no foreign material impeding air flow.

(d) Inspect grounding hooks to be certain no conductors are frayed and and that ground connections are secure.

(e) Inspect wiring after each cleaning for loose connections. Particular attention should be directed to the high current carrying points such as bus connections.

(f) Inspect high power capacitors for signs of internal pressure by looking for distortion of containers, such as bulging sides or end caps. Relieve

pressure on defective components before attempting to remove them from the unit. This may be done by melting the solder at one of the seals. Protective safety glasses must be worn during this operation.

(g) Remove one panel from the protective duct on top of the transmitter. Clean the output terminals and roof. Inspect the spark gap for pitting and clean if necessary.

(h) Check the positions of all mechanical interlock cheaters and switch rod positions. Reset if necessary.

(4) LUBRICATION.

(a) TUBE COOLING BLOWER. - The blower assembly contains two grease fittings and two oil reservoirs which require monthly lubrications.

(b) SLIDES. - Grease slides monthly.

(c) GROUNDING SWITCHES. - Grease grounding switches monthly.

(d) HINGES. - Grease door and control panel hinges monthly.

c. EMERGENCY MAINTENANCE. - Most malfunctions may be considered in one of two groups; these are (1) overloads and (2) loss of pulses.

(1) OVERLOADS. - Overloads are indicated by lamps (20 and 14, figure 3-2) and audible alarms on the control panel, and lamps (45 through 50, figure 3-6) and alarms on the high voltage power supply. When overloads occur, the circuit involved is immediately apparent through observation of the six overload indicator lamps on the high voltage power supply. Intermittent and infrequent overload indications, usually caused by humidity, dust accumulation, etc., are quite normal. These overloads do not constitute trouble. However, if the 3-strike relay strikes out immediately after being reset one or two times by depressing 3 STRIKE RESET switch S9 (39), a vacuum tube, insulator, or high voltage lead is probably arcing and a visual inspection should be made to locate the defective component. (If the overload occurs in the operate transmitter, the transmitters should be interchanged in accordance with paragraph 3-3b(2)(f).) Table 3-4 should aid the operator in determining the area to check for the indicated overloads. This visual check should be made with the transmitter energized so that the arc may be seen. To energize the transmitter, depress 3 STRIKE RESET switch S9 (39). When the cause of the overload has been determined, de-energize the transmitter as described in paragraph 3-3b(3) and correct the fault.

WARNING

Personnel should not attempt to get too close to the transmitter during a visual check because of the extremely high voltages (14kv) present. Before working on the equipment, remove power, and ground all points in the working area.

NOTE

When the 3-strike relay strikes out, high voltage power supply PLATE ON and BIAS ON lamps DS14 and DS15 (15 and 16, figure 3-6) should go out and light twice, and then remain out even though PLATE VOLTAGE and BIAS VOLTAGE switches S3 and S2 (18 and 19) are in the on (up) position. At the control panel, the READY and ON lamps for transmitter 1 (DS4 and DS5; 24 and 25, figure 3-2), or for transmitter 2 (DS6 and DS7, 10 and 11), depending on the operate transmitter should go out and light twice, and then remain out.

TABLE 3-4. LORAN TRANSMITTING SET AN/FPN-42, OVERLOAD TRACING

OVERLOAD INDICATOR	INSPECT VICINITY OF:
15.5KV OVERLOAD INDICATOR lamp DS21 and BKR. TRIP OVERLOAD INDICATOR lamp DS16	Transmitter output and driver stages (V1 through V10)
7.75KV OVERLOAD INDICATOR lamp DS20 and BKR. TRIP OVERLOAD INDICATOR lamp DS16	1. First IPA stage (V11 and V12) 2. High voltage power supply
3.5KV OVERLOAD INDICATOR lamp DS19 and BKR. TRIP OVERLOAD INDICATOR lamp DS16	Pulse driver chassis
-600V OVERLOAD INDICATOR lamp DS17 and BKR. TRIP OVERLOAD INDICATOR lamp DS16	1. Transmitter output and driver stages (V1 through V10) 2. First IPA stage (V11 and V12) 3. High voltage power supply
-300V OVERLOAD INDICATOR lamps DS18 and BKR. TRIP OVERLOAD INDICATOR lamp DS16	Pulse driver chassis
BKR. TRIP OVERLOAD INDICATOR lamp DS16	This lamp goes out for all a-c and d-c overloads. When the overload is present in an a-c circuit only, this lamp should be out and all of the d-c overload lamps should be lighted.

(2) LOSS OF PULSES.

NOTE

If the pulses are lost in the operate transmitter, interchange transmitters as described in paragraph 3-3b (2) (f). If the pulses are lost in the operate pulse generator, interchange pulse generators as described in paragraph 3-3b(2) (g).

(a) Check the blown fuse lamps on the dual power supply. If any of these lamps are not lighted, replace the corresponding fuse.

(b) Check the BLOWN FUSE INDICATOR lamps on the high voltage power supply. If any of these lamps are lighted replace the corresponding fuse.

(c) Operate the standby transmitter into the dummy load as described in paragraph 3-3b(2) (h). Place the switches listed in table 3-5 in the position indicated. Compare the waveform on the monitor oscilloscope with that specified in the waveform column. If the waveform is incorrect, remedy the trouble by following the instructions outlined in the correction column.

NOTE

When transmitter control panel SIGNAL SELECTOR switch S1 is placed in the OUTPUT position, as indicated in the last step of table 3-5, the waveform of figure 5-1m and each individual cathode current indication of table 3-3 will not be correct unless the transmitter is operating into the antenna. Therefore, operate the transmitter into the antenna before placing SIGNAL SELECTOR switch S1 in the OUTPUT position.

WARNING

Before making any tube changes in a pulse generator, turn off the B+ in that chassis by placing the appropriate control panel pulse generator B+ switch (26 or 8, figure 3-2) in the off (down) position. Before making any tube changes in a transmitter, completely de-energize the transmitter as described in paragraph 3-3b(3) and ground all points in the working area.

TABLE 3-5. LORAN TRANSMITTING SET AN/FPN-42, LOSS OF PULSE TROUBLE-SHOOTING

CONTROL	LOCATION	SETTING	WAVEFORM	CORRECTION
PULSE CONTROL UNIT				
SIGNAL SELECTOR switch S1	Control panel	100KC	Figure 5-1d	Check the cabling between the screen room and the pulse control unit.
SIGNAL SELECTOR switch S1	Control panel	TRIGGERS	Figure 5-1a	Check the cabling between the screen room and the pulse control unit.
PULSE GENERATOR				
SIGNAL SELECTOR switch S1	Control panel	MODULATING SIGNAL	Figure 5-1b	Replace V8 and V9
SIGNAL SELECTOR switch S1	Control panel	DROOP MODULATOR	Figure 5-1c	1. If the waveform is completely absent, replace V1, V2, and V7. If this does not remedy the trouble, proceed to step 2. 2. Install the original tubes which were removed in step 1. Replace V6. If this does not correct the trouble, proceed to step 3.

TABLE 3-5. LORAN TRANSMITTING SET AN/FPN-42, LOSS OF PULSE TROUBLE-SHOOTING (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	CORRECTION
PULSE GENERATOR (Cont)				
SIGNAL SELECTOR switch S1	Control panel	DROOP MODULATOR	Figure 5-1c	3. Install the original V6. Replace V3, V4, and V5. If this does not correct the trouble, proceed to step 4. 4. Install the original tubes which were removed in step 3. Replace V10, V11, and V12. If this does not correct the trouble, proceed to step 5. 5. Install the original tubes which were removed in step 4. Replace V13 and V14.
SIGNAL SELECTOR switch S1	Control panel	PULSE GEN. OUTPUT	Figure 5-1e	1. Replace V15 and V16. If this does not correct the trouble, proceed to step 2. 2. Install the original tubes which were removed in step 1. Replace V17 and V18.
PULSE DRIVER				
SIGNAL SELECTOR switch S18	Transmitter control panel	INPUT	Figure 5-1i	Check the cable between the operations building and the transmitter building.

TABLE 3-5. LORAN TRANSMITTING SET AN/FPN-42, LOSS OF PULSE TROUBLE-SHOOTING (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	CORRECTION
		PULSE DRIVER (Cont)		
SIGNAL SELECTOR switch S18	Transmitter control panel	PULSE DRIVER	Figure 5-1j	Replace V1, V2, V3, and V4.
		TRANSMITTER		
SIGNAL SELECTOR switch S18	Transmitter control panel	1ST IPA	Figure 5-1k	Replace V11 and V12.
SIGNAL SELECTOR switch S18	Transmitter control panel	2ND IPA	Figure 5-1l	1. Place the TUBE SELECTOR switch to V9. Check the INDIVIDUAL CATHODE CURRENT meter reading. 2. Repeat step 1 for V10. The correct meter reading for either switch position for the S0 rate is found in table 3-3. Replace the tube corresponding to the incorrect meter reading.
SIGNAL SELECTOR switch S1	Transmitter control panel	OUTPUT	Figure 5-1m*	Read the INDIVIDUAL CATHODE CURRENT meter for V1 through V8, by placing the TUBE SELECTOR switch in the corresponding position. The

TABLE 3-5. LORAN TRANSMITTING SET AN/FPN-42, LOSS OF PULSE TROUBLE-SHOOTING (Cont)

CONTROL	LOCATION	SETTING	WAVEFORM	CORRECTION
		TRANSMITTER (Cont)		
SIGNAL SELEC-TOR switch S1	Transmitter control panel	OUTPUT	Figure 5-1m*	correct* meter reading for these switch positions for the S0 rate is found in table 3-3. Replace the tube corre-sponding to the incorrect meter reading.

*The transmitter must be operating into the antenna, otherwise incorrect indications will be obtained.

(3) REPLACEMENT OF TUBES. - Figures 3-9 through 3-12 give the location of the tubes (except for the high voltage power supply, and monitor

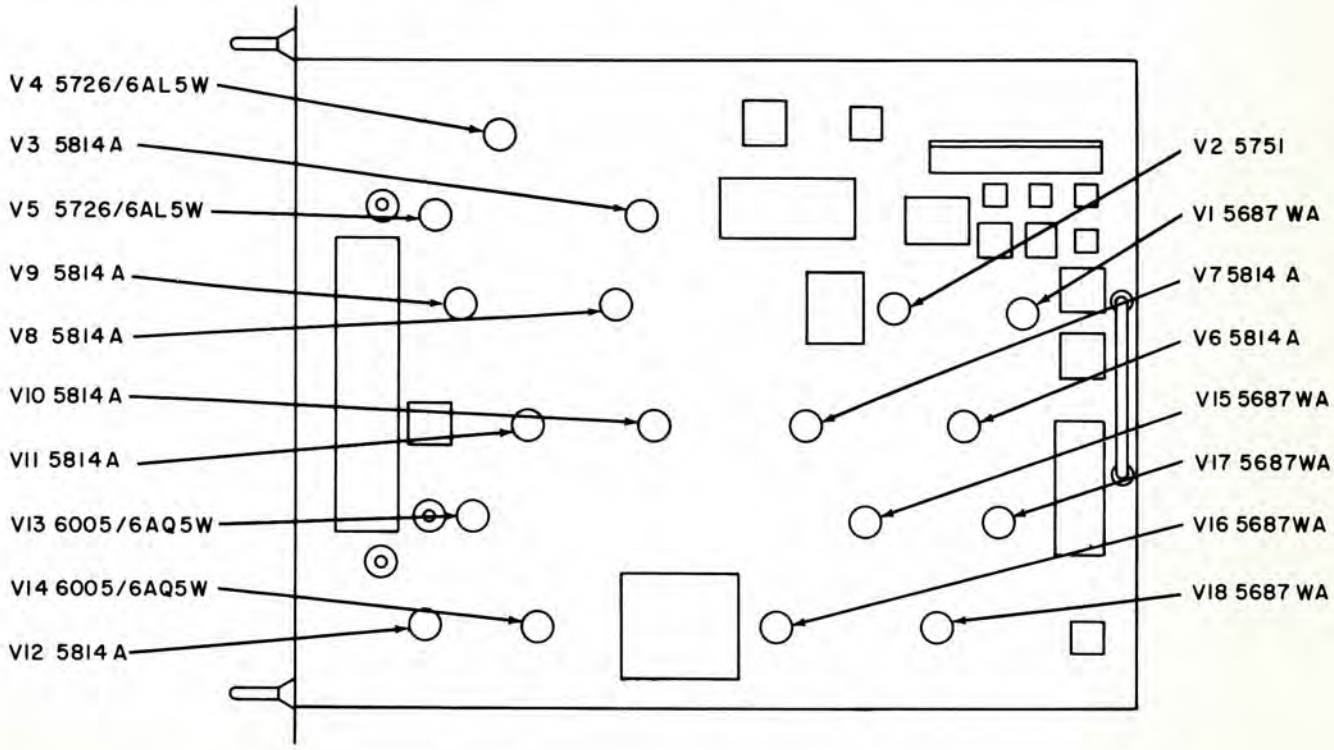


Figure 3-9. Pulse Generator O-706/FPN-42, Tube Locations

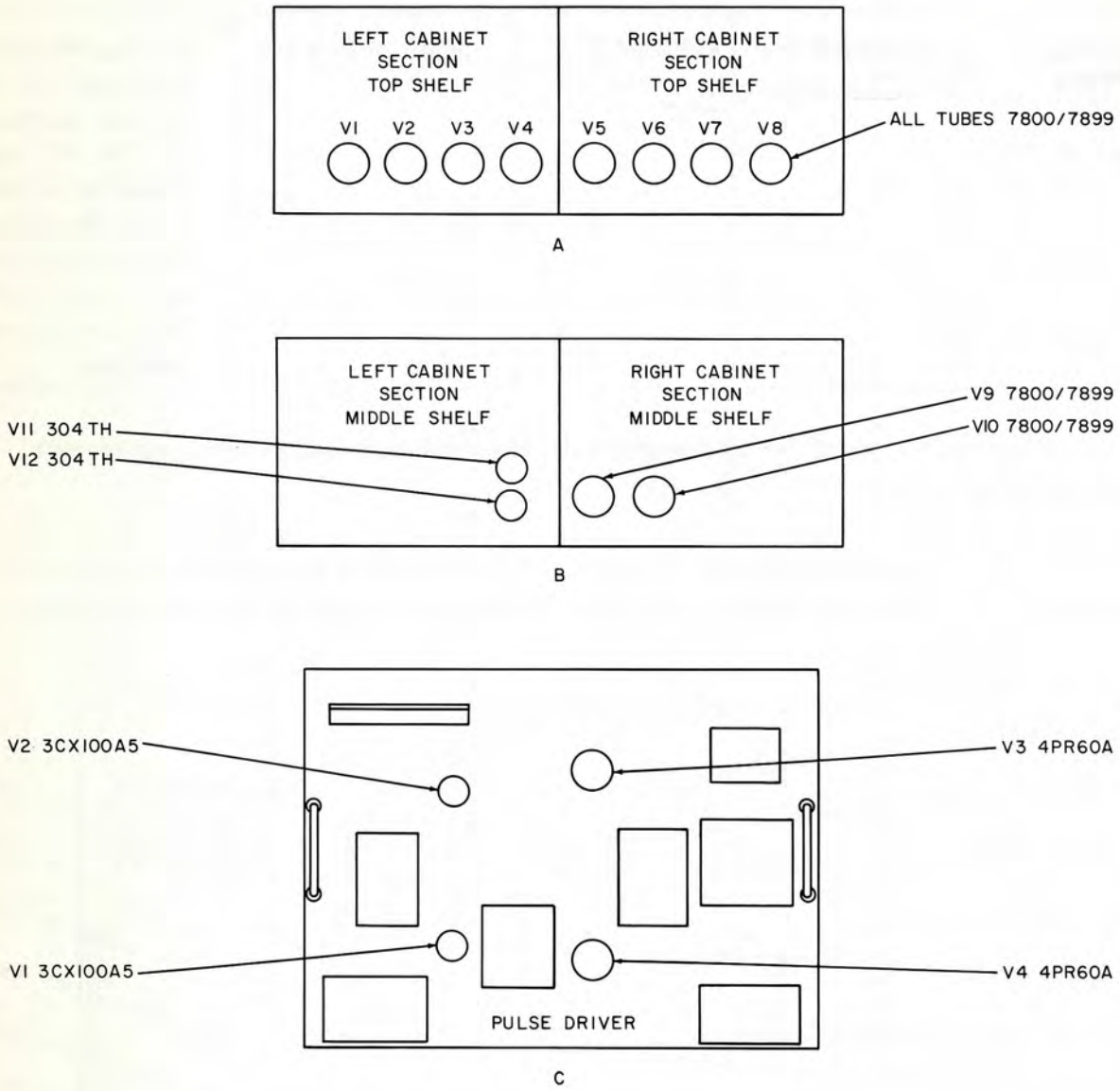


Figure 3-10. Amplifier Assembly AM-2481/FPN-42, Tube Locations

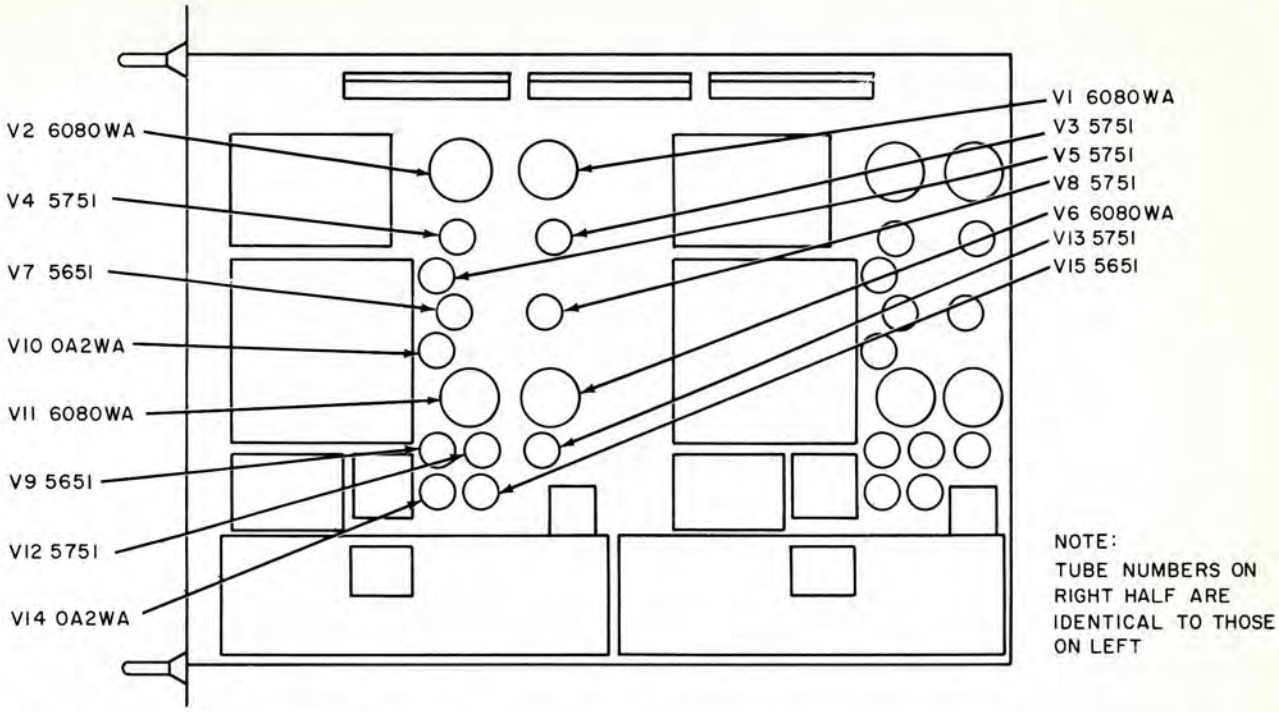


Figure 3-11. Power Supply Assembly PP-2541/FPN-42, Tube Locations

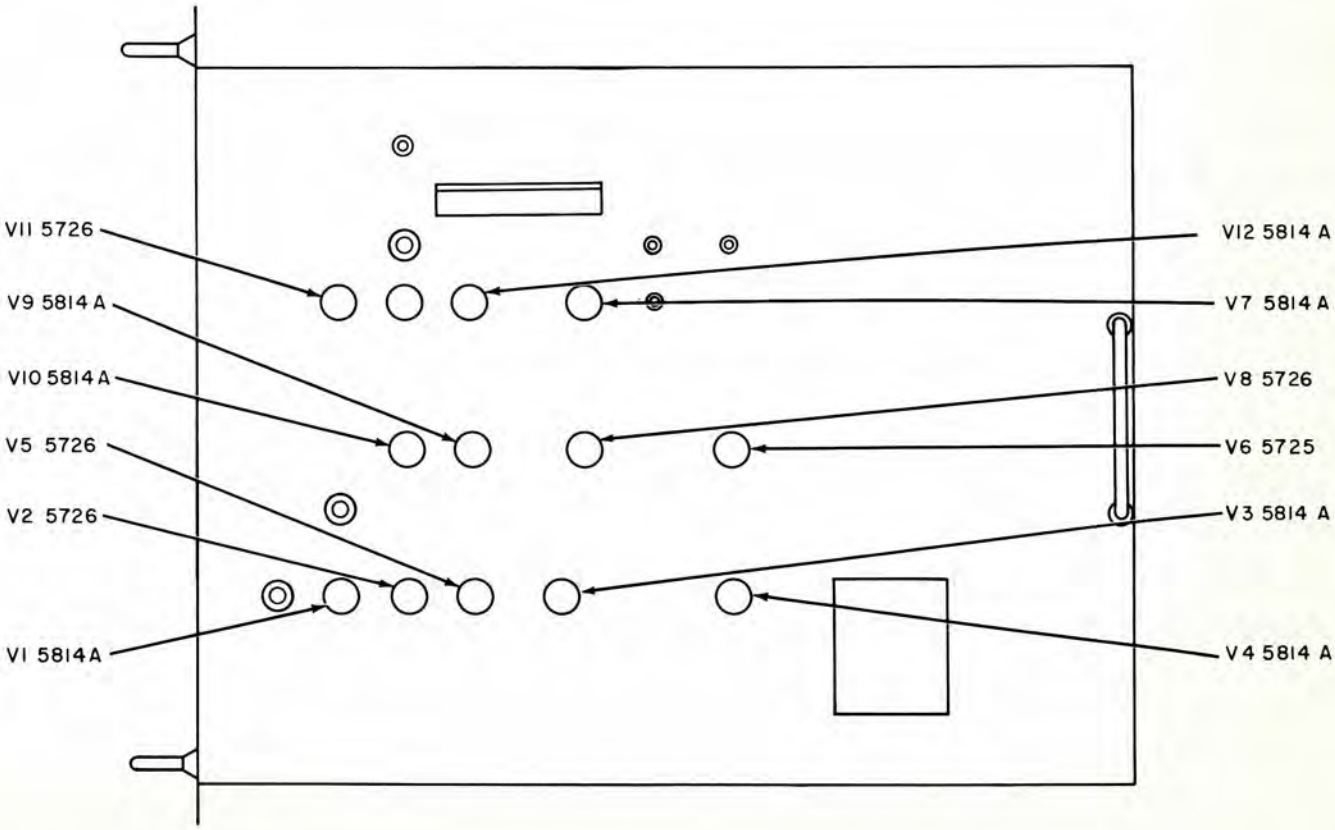


Figure 3-12. Electrical Pulse Analyzer TS-1360/FPN-42, Tube Locations

oscilloscope; refer to Volume 3 and Appendix I, respectively) used in the transmitter group. The following procedures should be used when replacing tubes in a transmitter.

WARNING

Do not attempt to replace any tube in the transmitter until all plate, bias and filament voltages have been removed, and all high voltage points have been carefully grounded with the grounding hooks provided. In addition, B+ voltages should be removed from the dual power supply (power supply 1 or 2), pulse generator, monitor oscilloscope, and pulse analyzer when replacing tubes.

(a) REPLACEMENT OF TYPE 7800/7899 TUBES.

1. Remove the filament leads at the tube terminals by rotating the connector clamp in a counterclockwise direction. Use care to avoid striking the tube envelope with the heavy connector.

2. Loosen the grid clamp from the grid ring and lift clear of the tube.

3. Disconnect the plate lead at the feedthrough terminal using a small wrench.

4. Lift the tube clear of the ceramic socket, keeping a firm grasp on the lifting handles, and remove from the cabinet. Install the plate lead on the new tube.

5. Install the new tube by reversing steps 1 through 3.

(b) REPLACEMENT OF TYPE 304TH TUBES.

1. Using a small screwdriver, loosen the screws holding the grid and plate heat dissipating connectors in place. Carefully remove the connectors from the tube.

2. Carefully lift the tube from the socket using a cloth. Avoid touching the tube envelope which becomes extremely hot during normal operation.

3. Install the new tube by reversing steps 1 and 2.

(c) REPLACEMENT OF TYPE 4PR60A TUBES.

1. Using a small screwdriver, loosen the screw holding the plate heat dissipating connector in place, and remove the connector.

2. Lift the tube from the socket using a cloth. Avoiding touching the tube envelope which becomes extremely hot under normal operation.

3. Install the new tube by reversing steps 1 and 2.

(d) REPLACEMENT OF TYPE 3CX100A5 TUBES.

1. Using a small screwdriver, loosen the screw tightening the plate clamp to the plate heat sink.

2. Lift the tube directly from the socket.

3. Install the new tube by reversing steps 1 and 2.

SECTION 4

PRINCIPLES OF OPERATION

4-1. OVERALL FUNCTIONAL DESCRIPTION.

a. GENERAL.

(1) A Loran-C system consists of three or four Loran-C stations, which transmit high powered, accurately timed groups of pulses, and a receiver which uses the pulses to very accurately determine its navigational position.

(2) A typical Loran-C system consists of a master station designated M and two slave stations designated X and Y, which transmit r-f pulses consisting of short bursts of 100-kc sine-wave signals. The transmissions from the slave stations are timed with respect to those from the master station in order to establish an accurate basis for time measurement, and to assure that the signals arrive at the receiver in sequence and without overlapping.

(3) Each station transmits once during the group repetition interval (GRI) which starts with the transmission of the master pulses. These signals are received by the X and Y stations which insert predetermined coding delays before they transmit their pulses. These delays are of different lengths. The X-station delay is shorter; therefore X transmits before Y.

(4) The stations operate on any one of six basic repetition rates designated H, L, S, SH, SL, and SS which correspond to repetition intervals of 30,000; 40,000; 50,000; 60,000; 80,000; and 100,000 microseconds, respectively. In addition, each of these rates can be modified by any one of eight specific repetition rates which are slight variations of the basic rates.

(5) The stations operate in either a multipulse or single pulse mode. In the multipulse mode, the master station transmits a series of nine pulses and the slave stations each transmit a series of eight pulses, spaced either 1000 or 500 microseconds apart, once each repetition interval. In the single pulse mode, the master station transmits two pulses and each slave station transmits one pulse during each interval.

(6) The signals transmitted by the stations have both ground-wave and sky-wave components. The ground-wave component travels parallel to the earth's surface at an approximate rate of 162,000 nautical miles per second. The sky-wave component travels upward and is reflected off the ionosphere to the receiver in one or more hops. The travel time of the sky wave from the transmitter to the receiver is dependent upon a number of varying factors which limit its usefulness for making accurate time measurements.

(7) Under certain conditions, the first hop sky-wave signal may arrive at the receiver as soon as 30 microseconds after the ground-wave signal. In order to make measurements on the ground wave only, the receiver makes measurements during the first 30 microseconds of the received pulse. The multipulses are phase coded to eliminate the effects of multihop sky-wave trains. To phase code, the 100-kc pulse carrier is phase shifted in steps of 180 degrees so that the contaminating effects of the sky wave on the ground wave are eliminated.

(8) Each Loran-C station consists of a receiving antenna, a timer-synchronizer, a transmitter group, and a transmitting antenna.

(a) The timer-synchronizer is composed of two timers and one switching unit. One timer is chosen to be the operate timer and the second the standby timer. The operate timer at the master station generates timing triggers and a 100-kc reference signal for the transmitter group, and it monitors the signals received from the slave stations. At the slave station, the operate timer-synchronizes with the received master signals and generates timing triggers and 100-kc excitation for the transmitter. The switching unit of the timer-synchronizer set routes the triggers and 100-kc carrier wave from the operate and standby timers to the transmitter group.

(b) The transmitter group generates high power r-f pulses and radiates these pulses from the transmitting antenna. The timing of the generated pulses is accurately controlled by the operate timer triggers. The r-f phase is controlled by the operate 100-kc signal. Circuits within the transmitter control the characteristics of the output pulse, such as rise and decay time, duration, amplitude and pulse shape.

b. TRANSMITTER COMPONENTS.

(1) The transmitter group consists of a pulse control cabinet, two transmitter cabinets, two blower assemblies, two high voltage power supplies, and a coupling and load unit, as functionally illustrated in the overall block diagram, figure 4-1.

(2) The pulse control cabinet consists of a control panel, two pulse generators, a dual power supply, a monitor oscilloscope, a pulse analyzer, and a cabinet blower. The two primary functions of the pulse control cabinet are: the generation of properly shaped r-f pulses which drive the transmitters and the provision of means for remote control of the high powered portion of the transmitter. The secondary function of the circuitry is the monitoring of key waveforms within the transmitter to provide a means for checking the operation of the transmitter circuits. Two identical pulse generators are required, since each transmitter requires its own driving source. The pulse generator-transmitter connection can be interchanged by switching circuits controlled at the control panel.

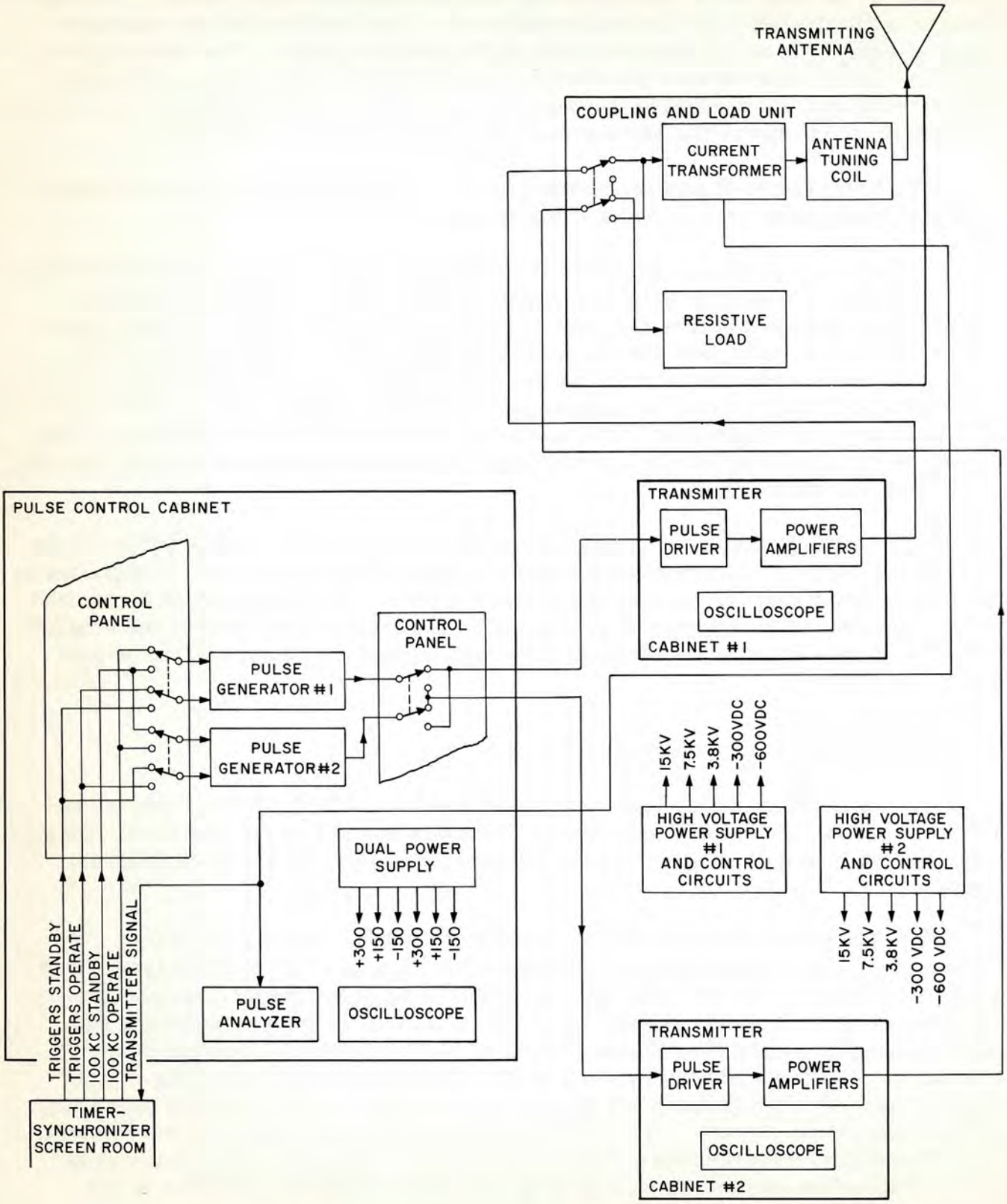


Figure 4-1. Loran Transmitting Set AN/FPN-42, Overall Block Diagram

(3) Each transmitter cabinet contains a pulse driver and power amplifier. This equipment supplies a high powered pulse output for each input pulse from the pulse control cabinet. The output from one transmitter is fed through the antenna tuning coil to the transmitting antenna, while the output from the other transmitter is fed into a resistive dummy load. These connections may be interchanged at the control panel. A blower assembly is attached to each transmitter to provide forced ventilation for cooling the final power amplifier and second IPA tubes.

(4) A high voltage power supply, which provides plate and bias voltages, is associated with each transmitter. Control circuits in the power supply cabinet control the application of output voltages to the load circuits. Under certain conditions, the output plate voltages can also be controlled at the control panel.

(5) The coupling and load cabinet contains the antenna tuning coil and the dummy load. The antenna tuning coil tunes the transmitter output to the transmitting antenna at a frequency of 100 kc. The dummy load dissipates the output power of the transmitter not connected to the transmitting antenna. A switching circuit is provided for interchanging the transmitter and load connections. The switch is controlled from the control panel.

(6) Control circuits located throughout the entire transmitter group control the routing of the transmitter inputs and outputs, the connections between the pulse generators and transmitters, the energizing of all circuits, the application of signals to the monitor oscilloscopes and the action of interlock, overload, and low voltage protection circuits. Since these control circuits are not specifically located in one part of the transmitter group, the discussion of the theory of operation of these circuits is separated from the discussion of individual functional sections.

c. DUPLICATE CIRCUITS. - For normal operation, the transmitting equipment need only consist of a pulse control unit with one pulse generator, a transmitter with its associated blower, a high voltage power supply, and a coupling and load unit. However, in order to provide continuous station operation during maintenance, duplicate pulse generator, transmitter, blower, and high voltage power supply units are provided.

4-2. FUNCTIONAL SECTIONS.

a. PULSE CONTROL UNIT. (See figure 6-12.)

(1) CONTROL PANEL. - Since the control panel circuits operate in conjunction with other control circuits in the equipment, its functional operation is discussed in step e under Control Circuits.

(2) PULSE GENERATOR.

(a) GENERAL. - The pulse generator forms precisely shaped r-f pulses which are fed to the pulse driver chassis in the transmitter. The pulse generator consists of the following circuits: 100-kc squarer, filter, and cathode follower; transmitter trigger circuits and delay line; gate generator and paraphase amplifier; 100-kc gate, amplifier, and paraphase amplifier; pedestal generator and shaper; 100-kc modulator; droop compensation pedestal generator and shaper; droop modulator; and line driver cathode followers. The pulse generator is shown in block form in figure 4-2. Figure 4-3 presents the voltage waveforms occurring in the pulse generator. The schematic diagram of the pulse generator is shown in figure 6-13.

(b) INPUT SIGNALS.

1. The input signals to the pulse generator consist of a gated 100-kc signal and transmitter triggers. The 100-kc signal consists of a block of 100-kc sine-wave signals occurring once during each group repetition interval. The duration of the 100-kc signal and the repetition rate are dependent upon various control settings in the timer-synchronizer. For the multipulse mode of operation with 1000-microsecond pulse spacing, the duration of the 100-kc signal is usually longer than 10,000 microseconds. For 500-microsecond pulse spacing or for single pulse operation, it is possible for the duration to be shorter. For multipulse operation at a slave station, eight transmitter triggers, spaced 1000 microseconds or 500 microseconds apart, are fed to the pulse generator during the interval of the 100-kc signal. For single pulse operation, only one trigger appears during the interval of the 100-kc signal.

2. At a master station, for either multipulse or single pulse operation, an extra transmitter trigger is fed to the pulse generator in addition to the eight triggers or single trigger. At a master station, blink circuits in the timer-synchronizer may cause the extra trigger to blink off and on at various rates. At slave stations, the blink circuits may cause the entire group of eight triggers or the single trigger to jump from 150 to 500 microseconds from its normal position at some fixed rate. Since the transmitter output pulses are synchronized with the transmitter triggers, they also blink when the input triggers are blink-coded. The group repetition interval of the input triggers and 100-kc signal is fixed at certain selectable values within a range of 29,300 to 100,000 microseconds.

(c) DETAILED CIRCUIT OPERATION.

1. 100-KC SQUARER, FILTER AND CATHODE FOLLOWER.

a. The 100-kc reference sine-wave input from the timer-synchronizer is fed to isolation transformer T1 through jack J7. Transformer T1 isolates

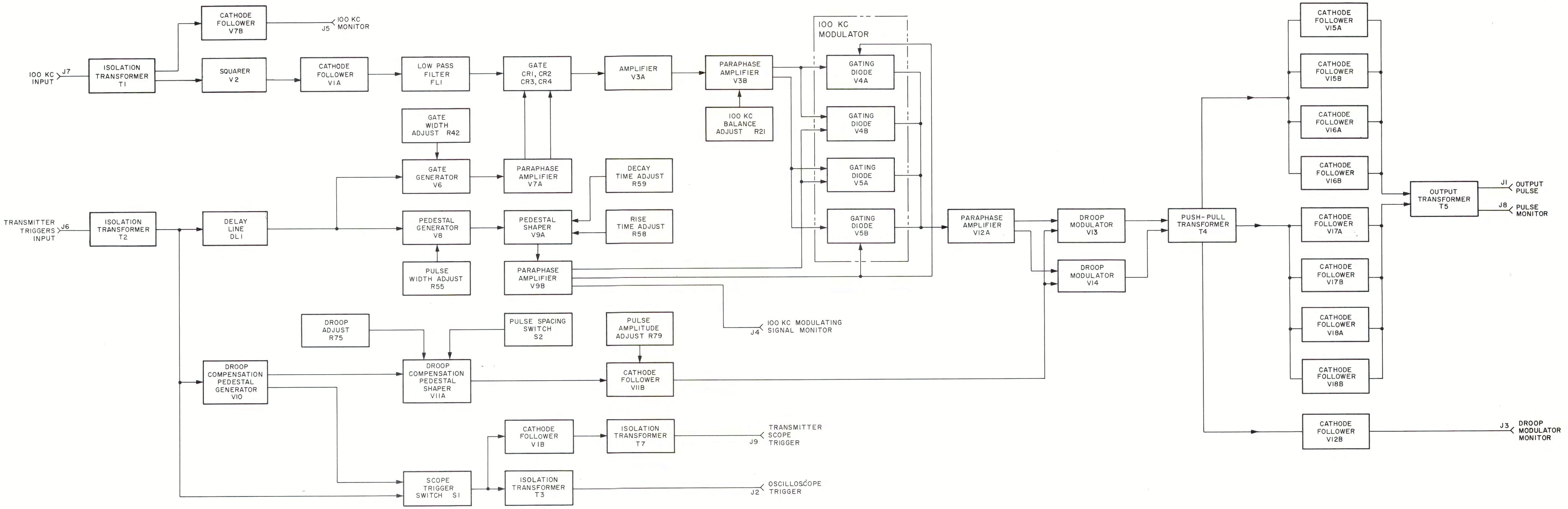


Figure 4-2. Pulse Generator 0-706/FPN-42, Block Diagram

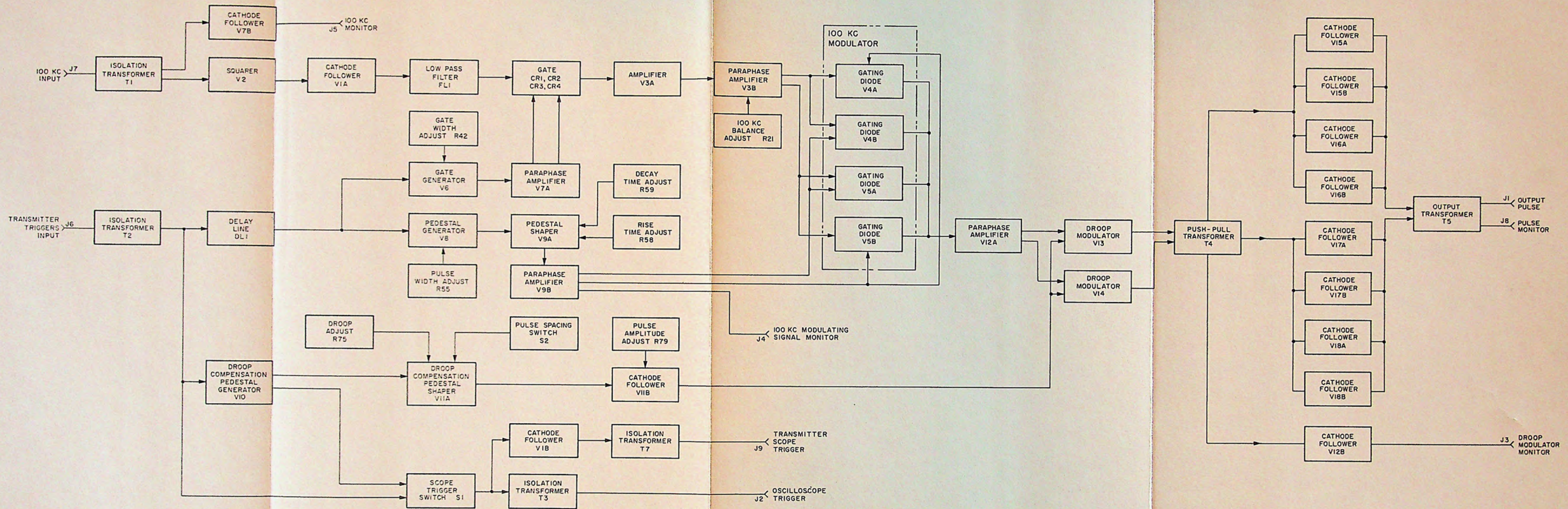


Figure 4-2. Pulse Generator
0-706/FPN-42, Block Diagram

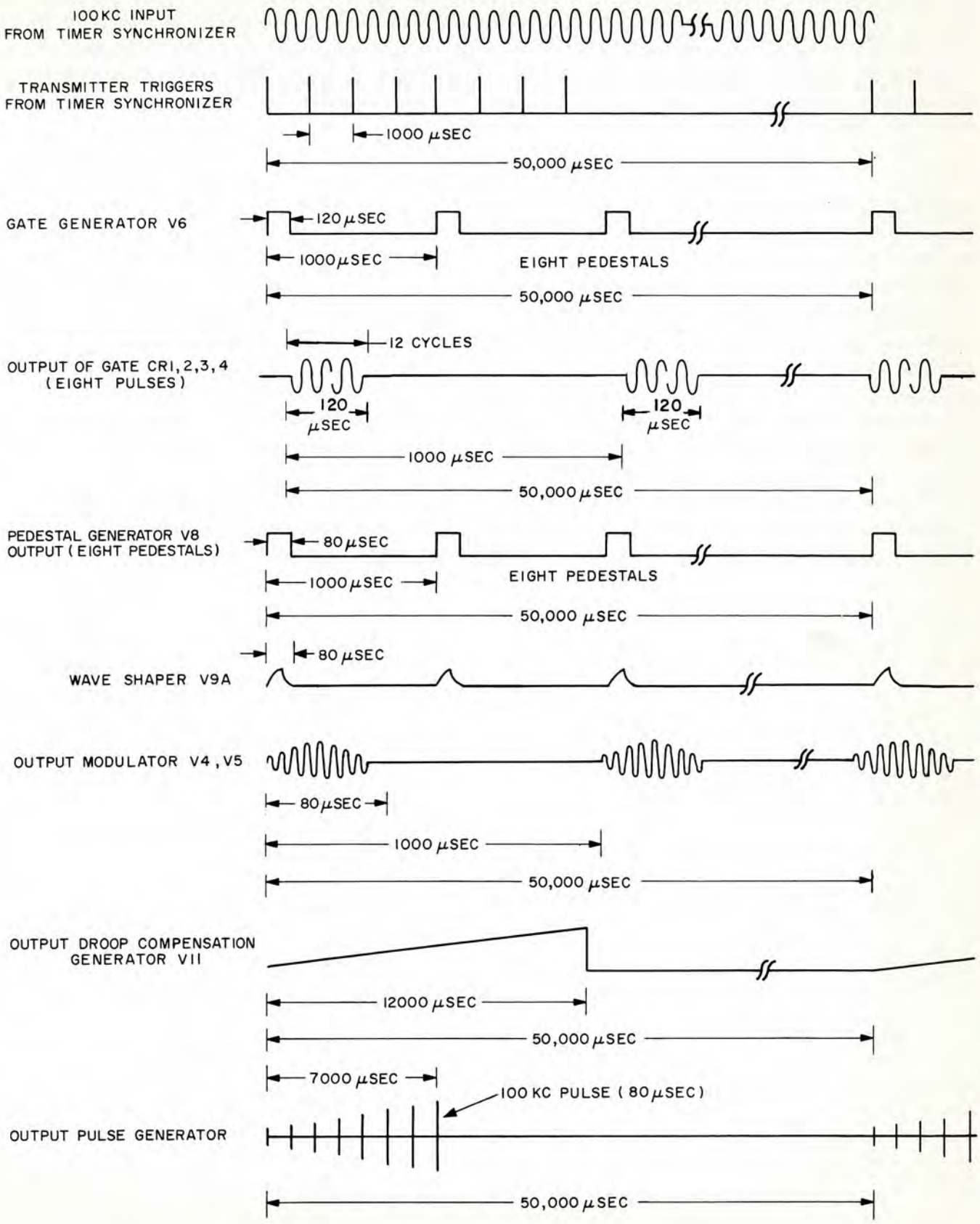


Figure 4-3. Pulse Generator 0-706/FPN-42, Waveform Diagram

the ground circuits of the timer-synchronizer from the pulse generator. The 100 kc from one of the secondaries (terminals 5 and 6) of T1 is direct coupled to the grid (pin 7) of cathode follower V7B. The output of V7B is coupled to jack J5 through capacitor C24 to serve as a 100-kc monitor. The 100 kc from the other secondary (terminals 3 and 4) of T1 is coupled to the grid (pin 2) of squarer V2 through capacitor C1.

b. Squarer V2 limits its sine-wave input to a fixed amplitude square wave, so that later stages will be driven by a constant amplitude signal regardless of amplitude variation in the input waveforms from the timer-synchronizer. (See figure 4-4.) The squarer is a cathode-coupled doubled-ended clipper which clips the positive and negative swings of the 100-kc input, at the same fixed level above and below the zero voltage axis, to provide a symmetrical square wave output. The circuit consists of cathode follower V2A, and amplifier V2B, with a common cathode resistor. The grids (pins 2 and 7) of V2A and V2B are maintained at 70 volts with respect to ground by a voltage divider (R10 and R9) across the plate supply. This bias voltage allows symmetrical clipping around the zero voltage axis. The bias is applied to each grid through an isolation resistor (R5 and R8). The portion of the input signal coupled to pin 7 from pin 2 by R5 and R8 is bypassed to ground by capacitor C3. When no input signal is present both V2A and V2B conduct, and there is a 15-volt drop across resistor R7, so that the plate voltage of V2B is 285 volts. As the input positive half cycle

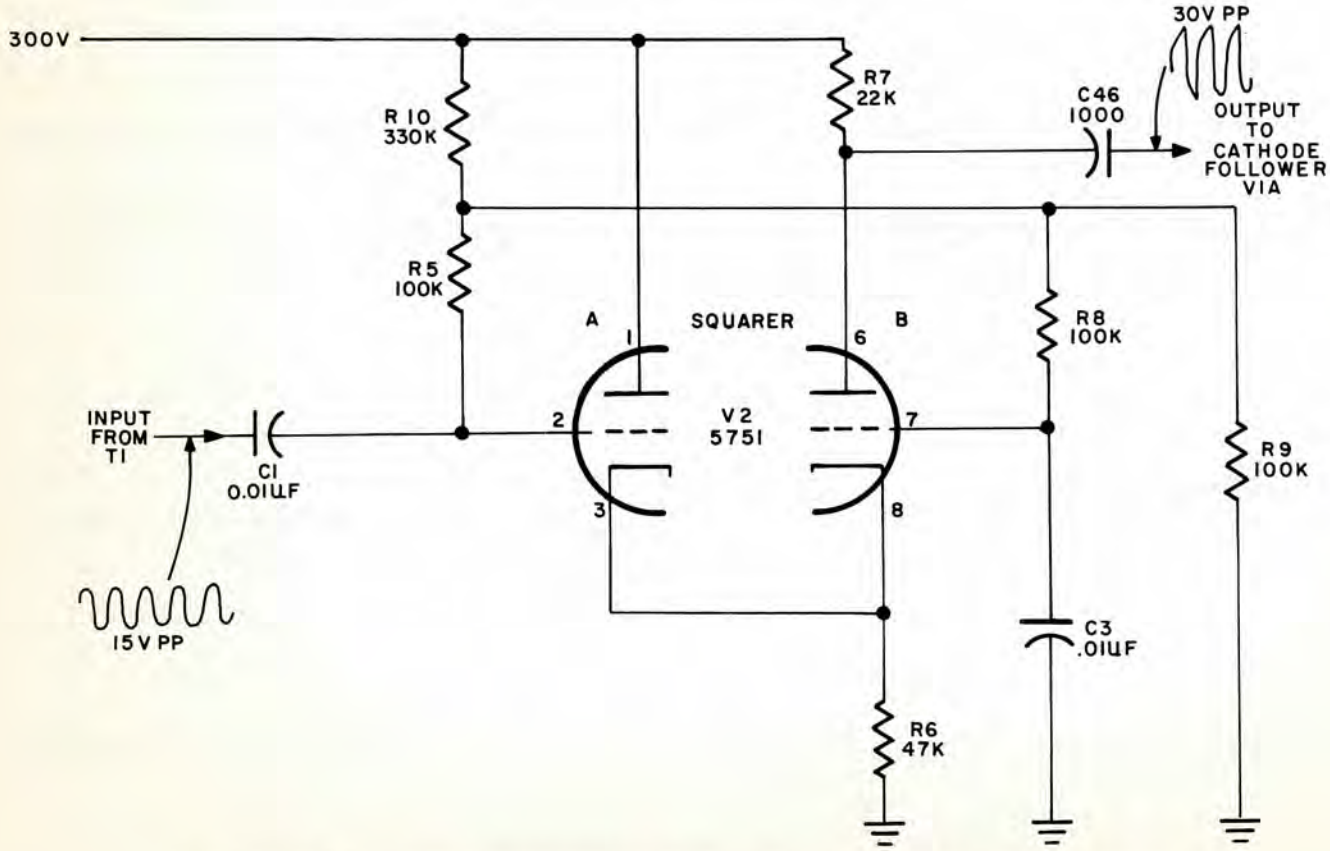


Figure 4-4. Pulse Generator 0-706/FPN-42, 100-kc Squarer, Simplified Schematic Diagram

reaches approximately 3 volts, the increased voltage drop across R6 (due the additional current drawn by V2A), causes V2B to cut off. At cut off, the plate voltage of V2B increases to 300 volts, and remains at this point until V2B starts conducting again. As the input negative half cycle reaches approximately 3 volts, V2A is cut off. As a result, V2B conducts until the bias to cathode voltage relationship limits further conduction. At this point, the voltage at the plate of V2B is 270 volts. The amplifying and clipping action in the circuits produces a 30-volt peak-to-peak square wave output at the plate (pin 6) of V2B.

c. The output of squarer V2 is coupled to the grid (pin 2) of cathode follower V1A through capacitor C46. The low impedance output at the cathode (pin 3) of V1A is coupled to the input (terminal 1) of low pass filter FL1. Filter FL1 removes all harmonics from the 100-kc square wave leaving only the fundamental 100-kc sine wave component with a fixed amplitude characteristic at the output terminal (terminal 3).

2. TRANSMITTER TRIGGER CIRCUITS AND DELAY LINE.

a. The input transmitter triggers from the timer-synchronizer are fed to isolation transformer T2 through jack J6. Transformer T2 isolates the ground circuits of the timer-synchronizer from the pulse generator. Three parallel outputs are taken from the secondary of T2. One output is coupled to SCOPE TRIGGER switch S1 through capacitor C18. When S1 is in the MULTI position, the triggers are fed directly to isolation transformer T3 and to the grid (pin 7) of cathode follower V1B, through capacitor C35. Transformer T3 isolates the ground circuits of the monitor oscilloscope from the pulse generator, and its output is used to trigger the monitor oscilloscope. The low impedance output at the cathode (pin 6) of V1B is fed to isolation transformer T7. Transformer T7 isolates the ground circuits of the transmitter from the pulse generator, and its output is used to trigger the transmitter monitor oscilloscope.

b. A second output of T2 is fed to droop compensation pedestal generator V10 (refer to paragraph 7). A third output of T2 is fed to the input (terminal 1) of delay line DL1 through matching resistor R117. Delay line DL1 delays the transmitter triggers by five microseconds. The delayed triggers at the output (terminal 2) of DL1 are fed to gate generator V8 (refer to paragraph 3 and 5). The delayed triggers are used to trigger the circuits which form the pulse. In this way, the monitor oscilloscopes and the droop compensation pedestal generator are triggered before the start of the pulse.

3. GATE GENERATOR AND PARAPHASE AMPLIFIER.

a. The delayed triggers from delay line DL1 are coupled to gate generator V6 through diode CR5 and capacitor C12. Diode CR5 passes only positive triggers to V6. Gate generator V6 (see figure 4-5) is a monostable multivibrator which produces one gate pulse for each trigger input. The gate width is primarily determined by the RC time constant of potentiometer R42, resistor R43, and capacitor C11; and is adjustable from 20 to 130 microseconds

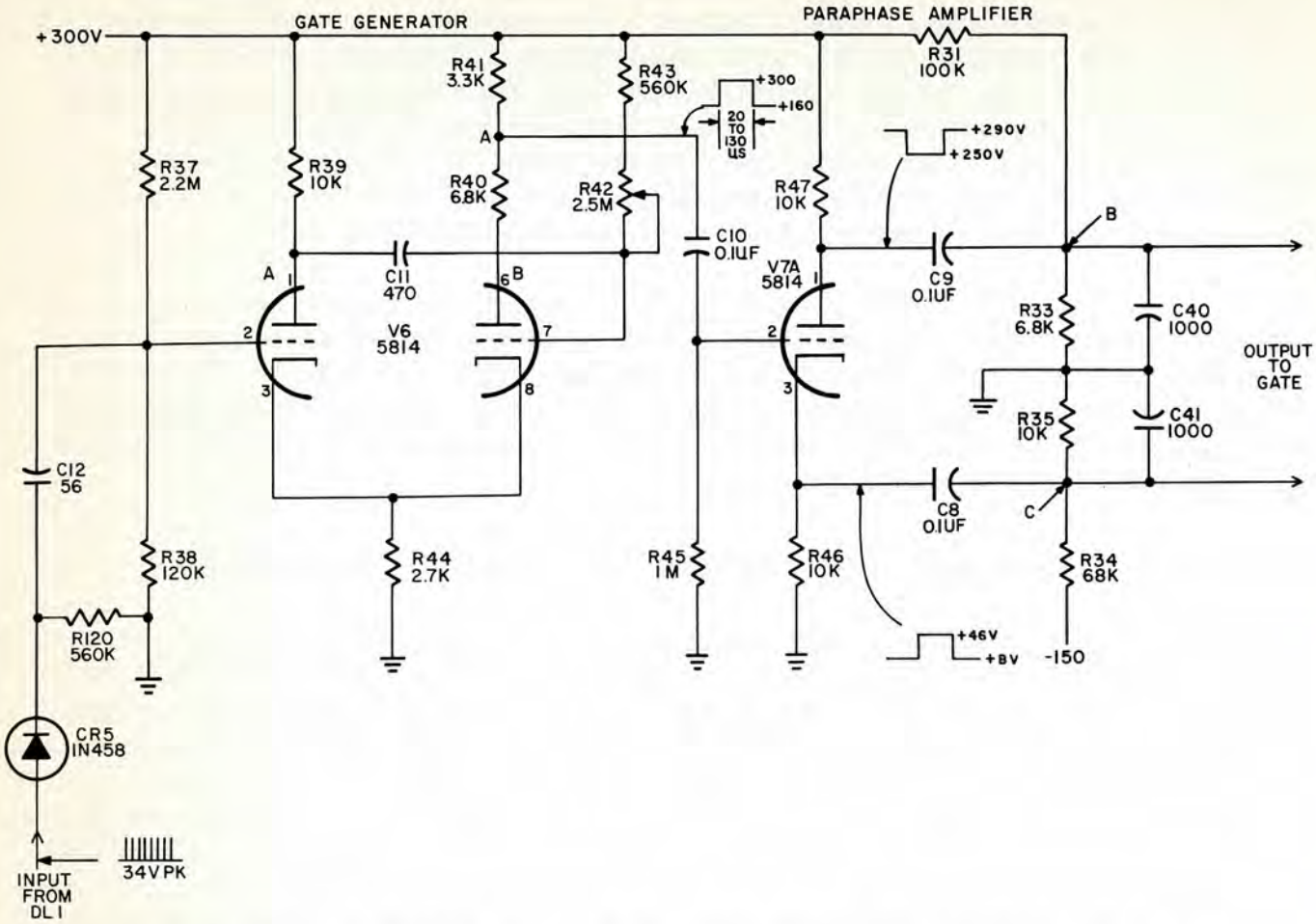


Figure 4-5. Pulse Generator 0-706/FPN-42, Gate Generator and Paraphase Amplifier, Simplified Schematic Diagram

by means of GATE WIDTH potentiometer R42. Tube V6A is normally cut off and V6B is normally conducting due to the biases established by resistors R37 and R38 in the grid circuit of V6A, and R42 and R43 in the grid circuit of V6B. When a positive trigger arrives at the grid (pin 2) of V6A, the grid voltage rises, pulling the tube out of cutoff. When current starts to flow in V6A, the plate (pin 1) voltage falls. The negative going plate swing of V6A is coupled to the grid (pin 7) of V6B through capacitor C11, cutting off the tube and causing the plate (pin 6) voltage to rise. The tube remains in this unstable state until the charge on C11 leaks off through R42 and R43 in series, and the grid voltage of V6B rises sufficiently to allow current to flow once again. The tube then returns to its normally stable state with V6A at cutoff. The gate output is obtained from point A, the junction of resistors R40 and R41 which make up the plate load for V6B.

b. The gate, a positive pulse between 20 and 130 microseconds long, is coupled from point A through capacitor C10 to the grid (pin 2) of paraphase amplifier V7A. Paraphase amplifier V7A has equal plate and cathode

resistors, R47 and R46, respectively. The outputs of V7A, which are obtained at the plate (pin 1) and the cathode (pin 3), are approximately the same peak-to-peak amplitude but of exactly opposite phase. A voltage divider consisting of resistors R31 and R33 establishes a d-c potential of 19 volts at point B. The divider is bypassed by capacitor C40. A similar voltage divider consisting of resistors R34 and R35 establishes a d-c potential of -19 volts at point C. This divider is bypassed by C41. The negative gate output from the plate (pin 1) of V7A is coupled to point B through capacitor C9, and the positive gate output from the cathode (pin 3) of V7A is coupled to point C through capacitor C8. The waveforms at points B and C are then negative and positive gates superimposed on fixed d-c levels. These waveforms are used in the 100-kc gate to control the number of 100-kc cycles in the pulse.

4. 100-KC GATE, AMPLIFIER AND PARAPHASE AMPLIFIER.

a. The 100-kc gate circuits form a train of 100-kc sine waves of the desired length, by gating the c-w signal output (terminal 3) of low pass filter FL1 with the gating signals from paraphase amplifier V7A.

b. See figure 4-6. The input 100 kc is fed to diodes CR1 and CR2 through isolating resistors R12 and R13. During the time when no gating waveform exists, diodes CR3 and CR4 are forward biased, thereby back biasing diodes CR1 and CR2 and preventing any 100 kc from reaching the output. When the gating pulses occur, CR3 and CR4 are back biased, thereby allowing CR1 and CR2 to conduct. Diode CR1 passes the negative half-cycles of the input 100 kc, and CR2 passes the positive half-cycles. The negative and positive half-cycles are recombined at point A, to form a train of 100-kc sine waves during the duration of the gating pulse. Resistor R14 serves as a load for CR1 and CR3, and trimmer capacitors C48 and C49 serve to minimize the amplitude of gating transients.

c. The gated 100-kc output is coupled to the grid (pin 2) of triode amplifier V3A through capacitor C4. The amplified waveform at the plate (pin 1) of V3A is coupled to the grid (pin 7) of paraphase amplifier V3B through capacitor C6. The operation of V3B is similar to that of V7A except that the voltage divider biasing networks are omitted. The 100 KC BAL potentiometer (R21) is included as a part of the cathode resistance to provide a means of balancing the amplitude of the outputs at the plate (pin 6) and the cathode (pin 8).

5. PEDESTAL GENERATOR AND SHAPER.

a. The delayed transmitter triggers at the output terminal of delay line DL1 are coupled to the grid (pin 2) of pedestal generator V8, through diode CR6 and capacitor C13. Diode CR6 passes only positive triggers to V8. See figure 4-7. Pedestal generator V8 is a monostable multivibrator, similar in design to gate generator V6. The output, a positive rectangular pulse, is taken from point A, the junction of resistors R52 and R53 which make up the plate

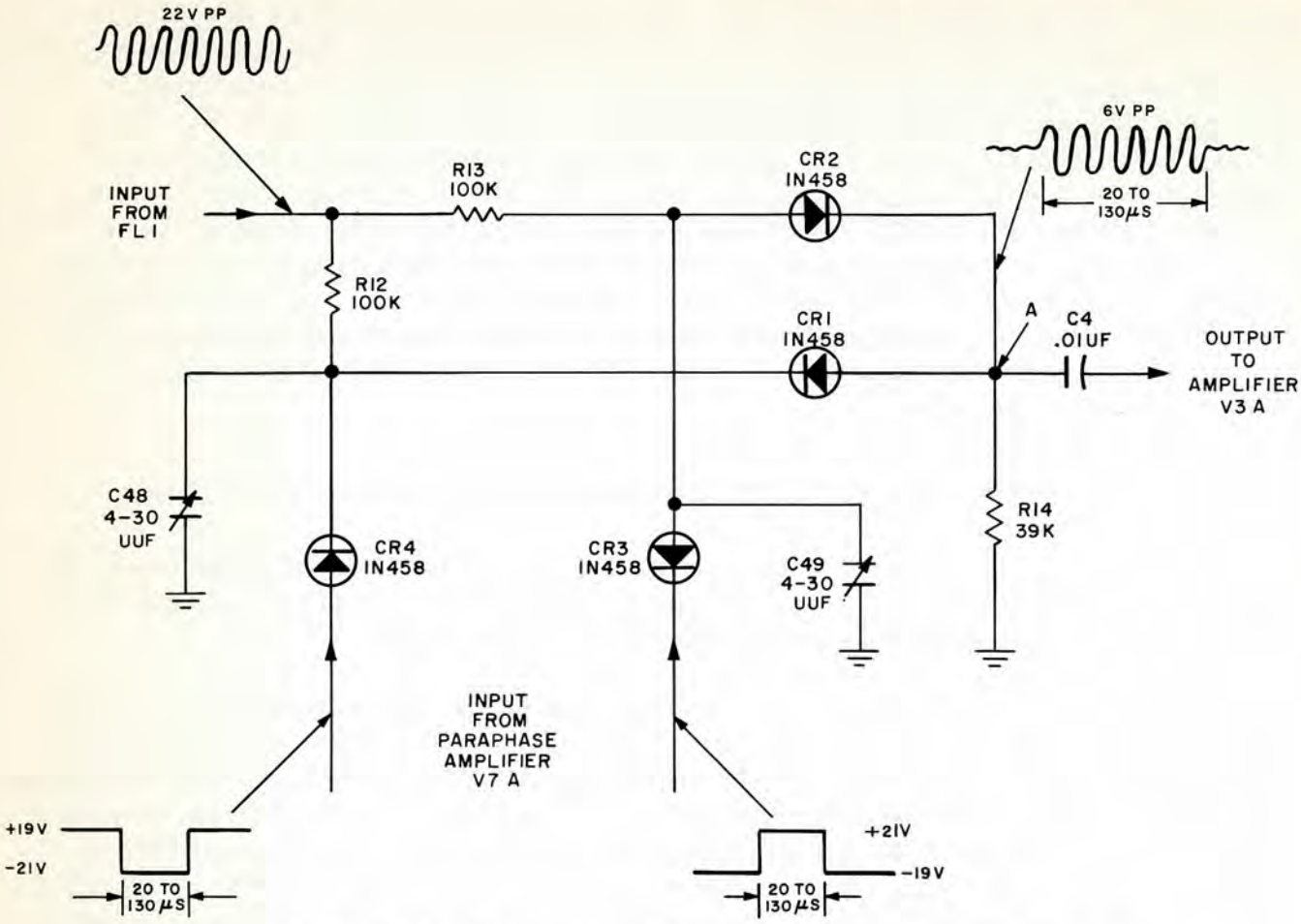


Figure 4-6. Pulse Generator 0-706/FPN-42, 100-KC Gate, Simplified Schematic Diagram

resistance of the second stage (V6B). The pulse width is controlled by PULSE WIDTH potentiometer R55, and the output is fed to the grid (pin 2) of pedestal shaper V9A.

b. Pedestal shaper V9A consists of a cathode follower with RISE TIME and DECAY TIME potentiometers R58 and R59 connected in series for the cathode resistance. The output is taken from point B, the junction of the two controls, where capacitor C26 is connected to ground. The rise time of the output pulse is controlled by the charging time of C26 through R58, and the decay time is controlled by the discharge of C26 through R59. The two controls are normally set for the fastest rise and decay times.

c. The output pulses are fed to the grid (pin 7) of paraphase amplifier V9B, which provides two output signals of opposite polarity for the 100-kc modulator circuit. The operation of V9B is similar to that of V7A except that the voltage divider biasing networks are omitted. A secondary output

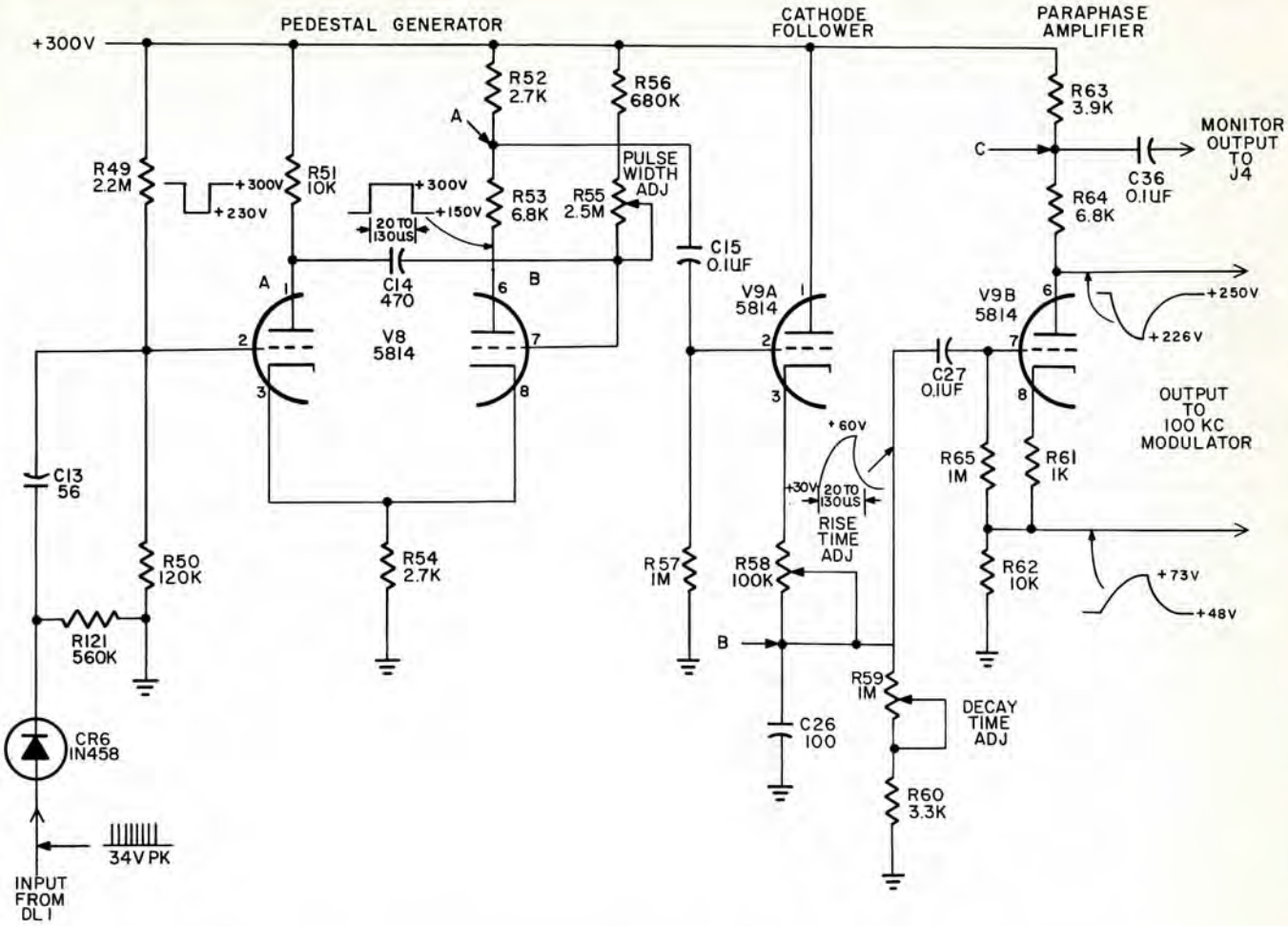


Figure 4-7. Pulse Generator 0-706/FPN-42, Pedestal Generator and Shaper, Simplified Schematic Diagram

is obtained from point C, the junction of resistors R63 and R64 in the plate circuit of V9B. This output is coupled to jack J4 through capacitor C36 as a monitor on the circuit.

6. 100-KC MODULATOR.

a. The 100-kc modulator circuit shapes the envelope of the 100-kc pulse from paraphase amplifier V3B. It also attenuates any 100-kc leakage through the gate, and acts as a secondary safety device to prevent continuous 100-kc signals from reaching the transmitter in the event of a malfunction in the 100-kc gate or gate generator circuits.

b. See figure 4-8. The gated 100-kc signals of opposite phase are coupled to points A and B, from paraphase amplifier V3B, through capacitors C5 and C7. The shaped modulating waveforms of opposite polarity are coupled to

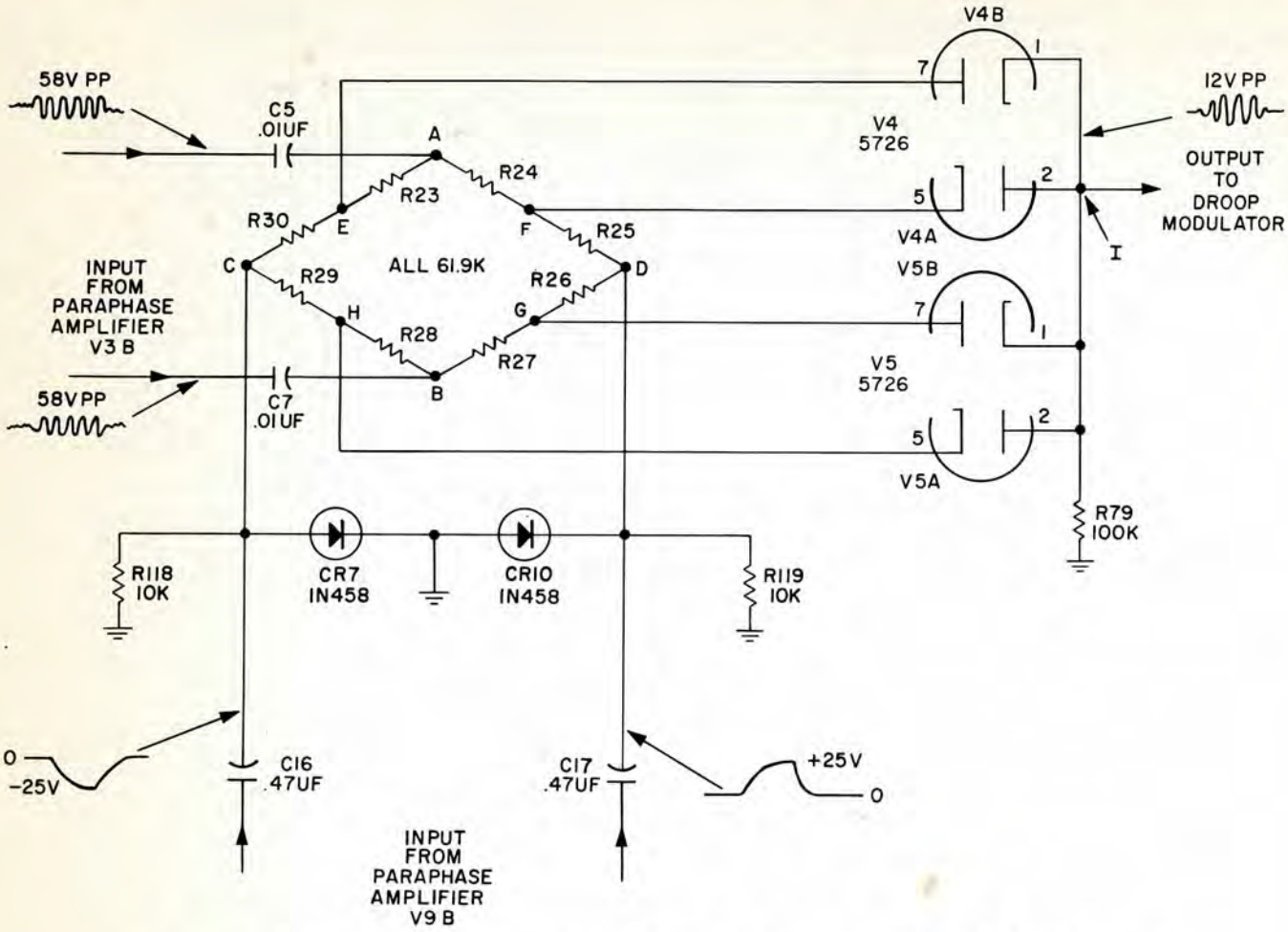


Figure 4-8. Pulse Generator 0-706/FPN-42, 100-KC Modulator, Simplified Schematic Diagram

points C and D, from paraphase amplifier V9B, through capacitors C16 and C17. Diodes CR7 and CR10 act as d-c clamps, preventing points C and D, respectively, from going above and below ground potential. The circuit is a balanced modulator consisting of equal valued resistors R23 through R30, and diodes V4 and V5. If either 100-kc signal or modulating waveform is not present, there is no output.

c. For the signals as shown at points A, B, C and D, circuit operation is as follows: The negative modulating pulse at point C appears (attenuated) at points E and H, thereby forward biasing diode V5A and back biasing diode V4B. The positive modulating pulse at point D appears (attentuated) at points F and G, thereby forward biasing diode V5B and back biasing diode V4A. The positive half-cycles of the input signal at point B pass through V5B, and the negative half-cycles pass through V5A. The positive and negative half-cycles recombine at point I across load resistor R79.

d. If the polarities of the modulating pulses were reversed, the input signal at point A would pass through V4A and V4B, and V5A and V5B would

be back biased. During the time when no modulating pulses exist, points C and D are at ground potential. Positive half-cycles of the input signal at point A pass through V4B to point I, where they combine with and exactly cancel the negative half-cycles of the input signal which pass through V5A from point B.

7. DROOP COMPENSATION PEDESTAL GENERATOR AND SHAPER.

a. Undelayed transmitter triggers from isolation transformer T2 are fed to the grid (pin 2) of droop compensation pedestal generator V10 through diode CR8 and capacitor C19. Diode CR8 passes only positive triggers to V10. See figure 4-9. Tube V10 is a monostable multivibrator which produces a negative rectangular pulse, approximately 12,000 microseconds in duration, from the first trigger in each trigger group. Thus, the output pulse is long enough to encompass an entire group of pulse generator output pulses. The operation of V10 is similar to that of gate generator V6 except that the pulse duration is fixed and primarily determined by capacitor C71 and resistor R71.

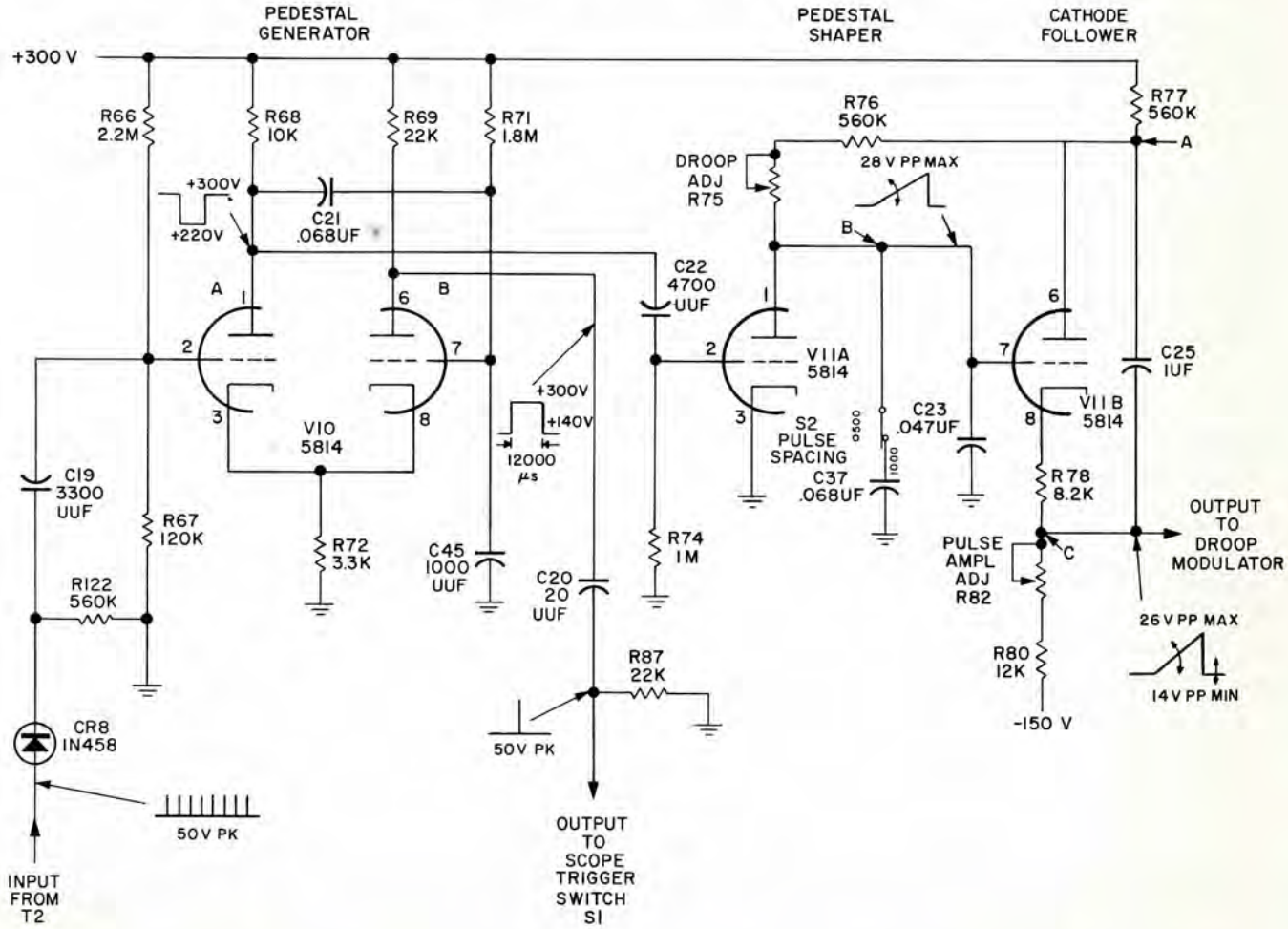


Figure 4-9. Pulse Generator 0-706/FPN-42, Droop Compensation Pedestal Generator and Shaper, Simplified Schematic Diagram

b. The output pulse from the plate (pin 1) of V10 is coupled through capacitor C22, to the grid (pin 2) of droop compensation pedestal shaper V11A. The droop compensation pedestal shaper and cathode follower is a sawtooth generator or bootstrap sweep circuit. Tube V11A functions as a normally closed switch which is opened only by the negative gating voltage from V10. With this switch initially closed, V11A conducts, capacitor C25 is charged to the voltage at point A, capacitor C23 and the grid (pin 7) of V11B are near ground potential, and a constant d-c voltage appears at the cathode (pin 8). When the switch is opened by the negative gating waveform, which cuts off V11A, C23 charges through DROOP ADJ. potentiometer R75 and resistor R76 toward the voltage at point A. (Capacitor C25 is large enough to maintain its initial charge for the duration of the sawtooth.) Thus, the voltage at point B rises, causing the cathode voltage (pin 8) to rise correspondingly.

c. The rise at the cathode (pin 8) is coupled through C25 to point A. Cathode follower V11B has approximately unity gain; thus the voltage change at point A (transmitted through C25) is approximately equal to the voltage change at point B. The voltage across R75 and R76 remains constant, and the current through R75 and R76 (which is the charging current through C23) remains constant. Therefore, C23 is charged by a constant current to develop a linear sawtooth voltage at the circuit output. The sawtooth slope is controlled by DROOP potentiometer R75 which adjusts the charging time of C23.

d. At the end of the sawtooth, the switch is again closed and C25 regains, in a reasonably fast time, the small amount of charge it lost. The output voltage is taken from point C, the junction of cathode resistors R78 and R82. PULSE AMPL potentiometer R82 adjusts the d-c level and the sawtooth amplitude of the output. This is used to control the voltage gain of the droop modulator, so that each successive output pulse has a greater amplitude.

e. With the PULSE SPACING switch S2 in the 1000 position, capacitor C37 shunts C23 producing a longer rise time so that the sawtooth slope is not as steep as before.

f. A second output is obtained from the plate (pin 6) of V10. This output is differentiated by capacitor C20 and resistor R87 and fed to SCOPE TRIGGER switch S1. When S1 is in the SINGLE position, this trigger is coupled to isolation transformer T3. The output of T3 is a single positive trigger at the start of the pulse group which is used to trigger the monitor oscilloscope.

8. DROOP MODULATOR.

a. Droop compensation is necessary since the power supply for the transmitter is unregulated and its voltage decreases from the initial value with each successive transmitted pulse. Therefore, to maintain a constant output (every pulse of the same amplitude), the amount of drive is increased on each group. See figure 4-10.

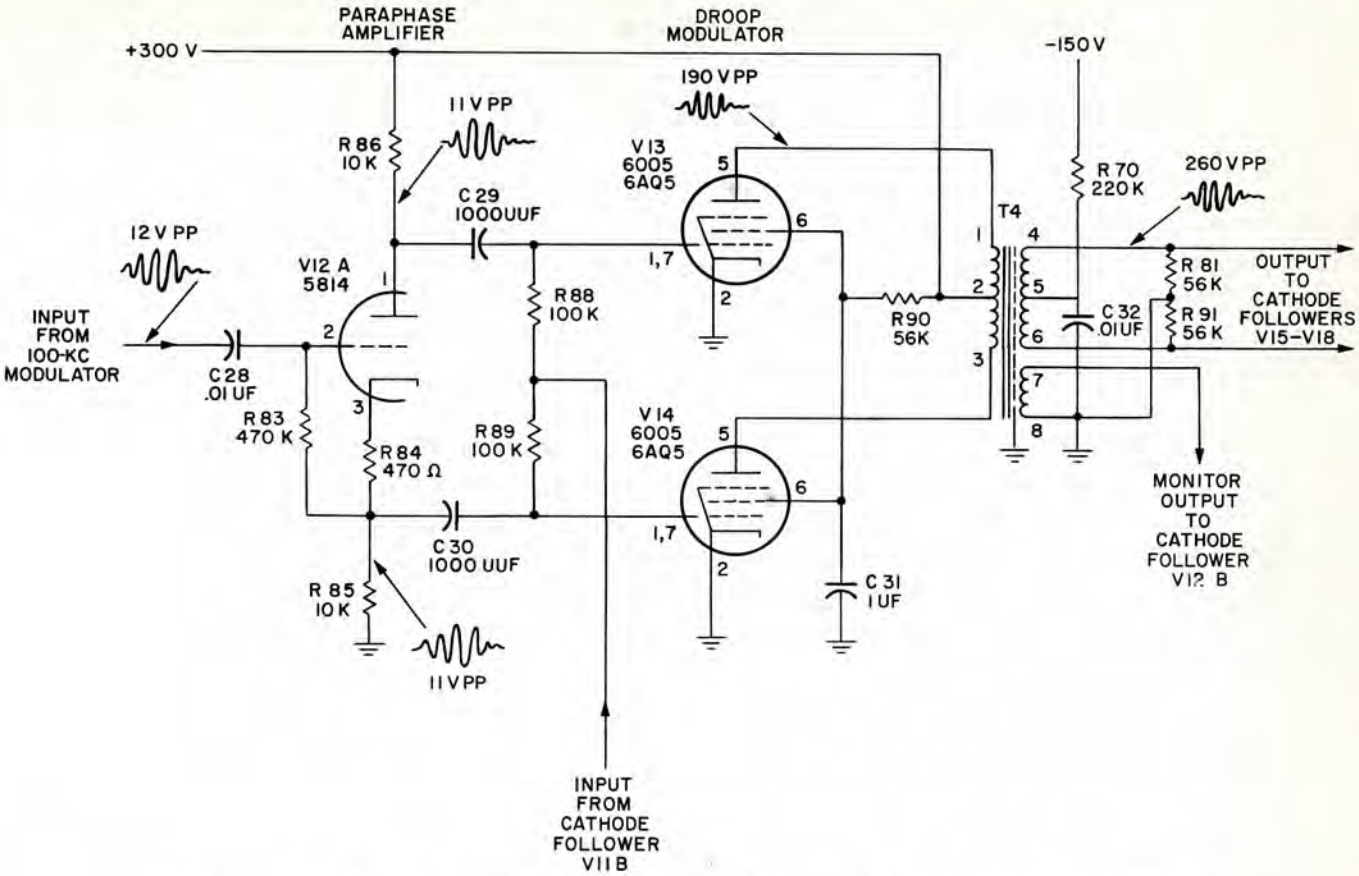


Figure 4-10. Pulse Generator 0-706/FPN-42, Droop Modulator, Simplified Schematic Diagram

b. Shaped, gated 100-kc signals from the 100-kc modulator are coupled to the grid (pin 2) of paraphase amplifier V12A through capacitor C28. The operation of V12A is similar to that of V7A except that the voltage divider biasing networks are omitted. The outputs from the plate (pin 1) and cathode (pin 3) of V12A are coupled to the grids (pin 1) of pentode amplifiers V13 and V14. The droop compensation sawtooth waveform from cathode follower V11B is mixed with the 100-kc signals at the grids of V13 and V14 through isolating resistors R88 and R89. Tubes V13 and V14 are connected in push-pull with transformer T4 serving as the plate transformer. Screen (pin 6) voltage for the two tubes is obtained through dropping resistor R90 which is bypassed by capacitor C31.

c. The gain of V13 and V14 is controlled by the droop compensation sawtooth. As the waveform goes more positive, the gain increases and, therefore, each succeeding output pulse is larger. The output is obtained from the secondary (terminals 4 and 6) of T4. Resistors R70, R81, and R91 establish bias for the line driver cathode followers which are directly coupled to T4. Capacitor C32 bypasses the secondary centertap (terminal 5) to ground.

d. A monitor winding (terminals 7 and 8) is included in T4 to obtain a circuit check. The output of this winding is direct coupled to the grid

(pin 7) of cathode follower V12B through resistor R33. The output at the cathode (pin 8) of V12B is coupled to jack J3 through capacitor C38.

9. LINE DRIVER CATHODE FOLLOWER.

a. The line driver cathode follower consists of eight triode sections (four tube envelopes), V15 through V18, connected as cathode followers to produce the low impedance, high current output required to drive the transmission line between the operations building and the transmitter building. The eight triodes are connected in two groups of four parallel connected cathode followers, and the two groups are connected in push-pull.

b. Input signals from the droop modulator output transformer T4 are coupled to the grids (pins 2 and 7) of V15 through V18 through resistors R100 through R107. These resistors prevent parasitic oscillations in the circuit. Transformer T5 serves as the output transformer for the stage. The secondary (terminals 4 and 6) output is direct coupled to jack J1. A monitor winding (terminals 7 and 8) is included in T5, and its output is coupled to jack J8 through capacitor C43.

(3) DUAL POWER SUPPLY.

(a) GENERAL.

1. The dual power supply consists of two identical power supplies mounted on the same chassis. Each supply delivers regulated 300 volts at 300 milliamperes, 150 volts at 150 milliamperes, and -150 volts at 150 milliamperes. Figure 4-11 is the block diagram of one power supply. The schematic diagram is shown in figure 6-14. The nominal input requirements for each supply are 120 volts, 60 cps, single phase, at 300 watts.

2. The supplies deliver all d-c plate and bias voltages required in the pulse generators and pulse analyzer. The unit contains BLOWER MOTOR circuit breaker CB3 which controls the pulse control unit cooling blower. Complete primary and secondary fusing is also included. Remote control relay K1 is included in each chassis for the purpose of controlling power to the primary of plate transformer T1 when the control panel B+ PULSE GEN. 1 or B+ PULSE GEN. 2 switch is energized.

(b) 300-VOLT POWER SUPPLY. - The 300-volt power supply obtains its a-c plate voltage from the secondary (terminals 5 and 9) of plate transformer T1. The rectifiers for the supply consist of two banks of four series-connected type 1N540 silicon diodes (CR1 through CR8), arranged in a full-wave circuit. The filter for this supply consists of a pi-section network made up of capacitors C1, C2, C3, and C4 and choke L1B. Balancing resistors R73, R74, R75, and R76 are connected across the series filter capacitors to divide the voltage proportionately

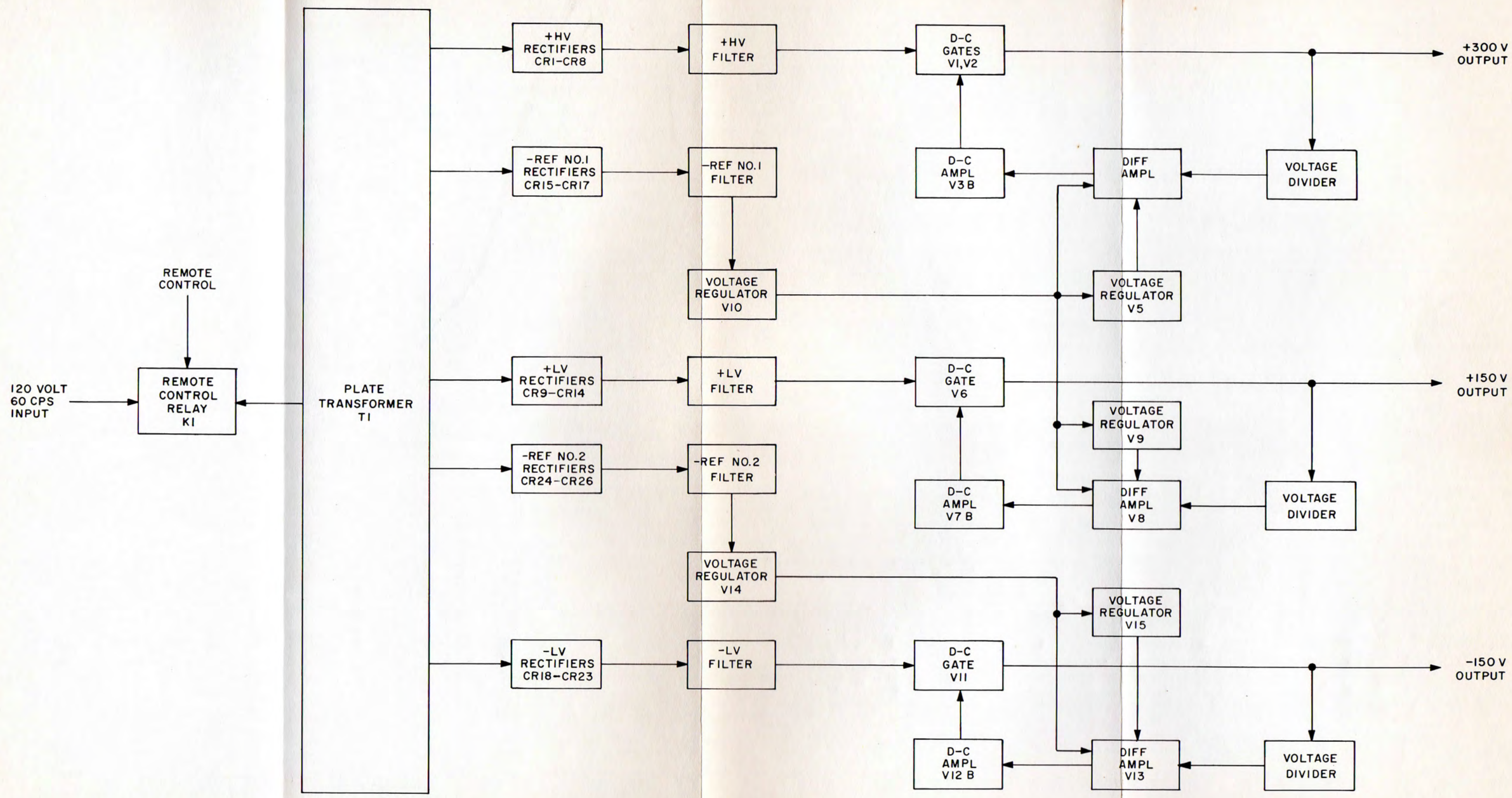


Figure 4-11. Power Supply Assembly PP-2541/FPN-42, Block Diagram

across each. Surge limiting resistor R77 is connected in series with the filter to limit the capacitor charging current and thereby protect the rectifiers. The filtered d-c voltage is then fed to the 300 volt regulator.

(c) 300-VOLT REGULATOR. (see figure 4-12.)

1. D-c gate tubes V1 and V2 pass the power supply current and provide the series impedance necessary to drop the unregulated power supply voltage (450 volts) to the regulated value (300 volts). Regulator amplifier V3 and d-c amplifier V4 serve to amplify small fluctuations in output voltage to the grids of the gate tubes in order to maintain regulation. Voltage regulator tubes V5 and V10 provide stable reference voltage to serve as biases within the amplifier circuit.

2. Understanding the operation of this circuit may be made easier by observing the result of a variation in voltage amplitude. Assume that due to an input line fluctuation, the 450 volt unregulated input momentarily increases. Instantaneously, the 300-volt output rises proportionately at point A. Resistors R20, R21, and R32 make up a voltage divider which adjusts the bias voltage on the grid (pin 7) of regulator amplifier V4B. Any voltage change at point A is reflected proportionately at point B, so this point also becomes instantaneously more positive. The negative end of the cathode resistor R23 (point C) is fixed in voltage by voltage regulator tube V10. The positive increase in bias voltage at the grid of V4B causes more plate current to flow in this tube, causing the common cathode (pins 3 and 8) of V4A and V4B to become instantaneously more positive. The grid (pin 2) of V4A is kept at a constant potential by voltage regulator tube V5, through divider resistor R26 and R9. The positive increase in cathode voltage is thereby reflected as a decrease in positive bias on this tube, causing an instantaneous positive increase in voltage at the plate (pin 1) of V4A. This increase in voltage is coupled to the grid (pin 7) of d-c amplifier V3 as a positive increase in bias, causing more current to flow in the tube, resulting in a decrease in positive voltage at the plate (pin 6). Since the plate of V3B is direct coupled to the grids (pins 1 and 4) of gate tubes V1 and V2, this causes an instantaneous increase in negative bias at this point, raising the impedance of the tubes and making point A instantaneously less positive, thereby maintaining regulation. Operation is identical for changes in load as well as line. The output voltage about which the supply regulates is controlled by +300 potentiometer R21, which adjusts the output level between 285 and 315 volts.

(d) 150-VOLT POWER SUPPLY.

1. The 150-volt power supply obtains its a-c plate voltage from the secondary (terminals 6 and 8) of T1. The rectifiers for this supply consist of two banks of three series-connected type 1N540 silicon diodes (CR9 through CR14) arranged in a full-wave circuit. The filter for this supply consists of a pi-section network made up of capacitors C5 and C6B, and choke L1A. Surge limiting resistor R98 is connected in series with the filter to limit the capacitor charging current, and thereby protect the rectifiers.

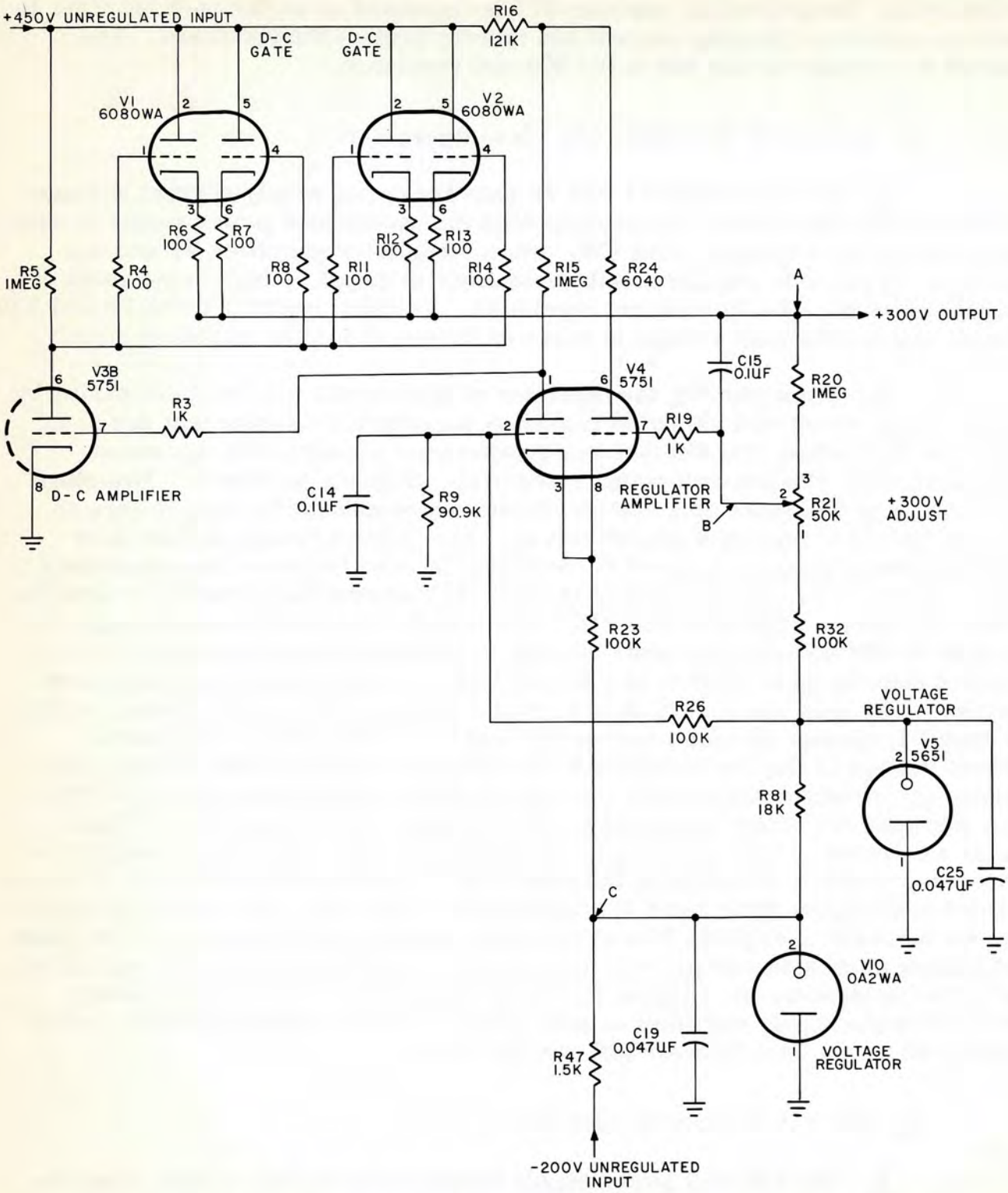


Figure 4-12. Power Supply Assembly PP-2541/FPN-42, 300-Volt Regulator, Simplified Schematic Diagram

2. The 150-volt regulator circuit operates identically with that of the 300-volt regulator as described in paragraph (c). The voltage about which the supply regulates is controlled by +150 potentiometer R44, which adjusts the output level between 142 and 158 volts.

(e) -150-VOLT POWER SUPPLY. - The -150-volt power supply circuit is identical to that of the 150-volt power supply described in paragraph (d). The output level is controlled by the -150 potentiometer R71.

(4) PULSE ANALYZER. - Since the pulse analyzer is primarily a piece of test equipment, its functional operation is discussed in paragraph f under Test Equipment.

b. TRANSMITTER. (See figure 6-17.)

(1) PULSE DRIVER.

(a) GENERAL. - The pulse driver amplifies the r-f pulses from the pulse control cabinet to provide sufficient drive for the power amplifier stages. The pulse driver consists of coupling transformer T1; push-pull power amplifiers V1, V2, V3, and V4; interstage transformer T2 and output transformer T3. The block diagram of the pulse driver is shown in figure 4-13. The schematic diagram of the pulse driver is shown in figure 6-18.

(b) DETAILED CIRCUIT OPERATION.

1. Input coupling transformer T1 serves to isolate the input transmission line from the grid circuit of the first amplifier, and provides a voltage step-up of 1 to 1.7. Loading resistors R1 and R2 serve to properly terminate the transmission line, from the operations building, in 100 ohms under quiescent conditions, and to load T1 sufficiently to provide linear transformer operation when the amplifiers are operated in the grid current region. A monitor winding is included as part of T1 (terminals 7 and 8), the output of which may be observed on the monitor oscilloscope.

2. The two type 3CX100A5 first amplifier tubes (V1 and V2) are connected in push-pull and biased to class B operation. A voltage divider consisting of resistors R3 and R4 provides the required bias to keep this stage at cutoff. Interstage transformer T2 provides an 8 to 1 step-down in output voltage. A monitor winding (terminals 7 and 8) is provided, and its output may be observed on the monitor oscilloscope.

3. The secondary of the interstage transformer T2 is loaded by resistors R9 and R10 to provide linear operation of this transformer when the second amplifier stage is operated in the grid current region. A voltage divider consisting of resistors R12 and R13 supplies bias voltage to the two type 4PR60A

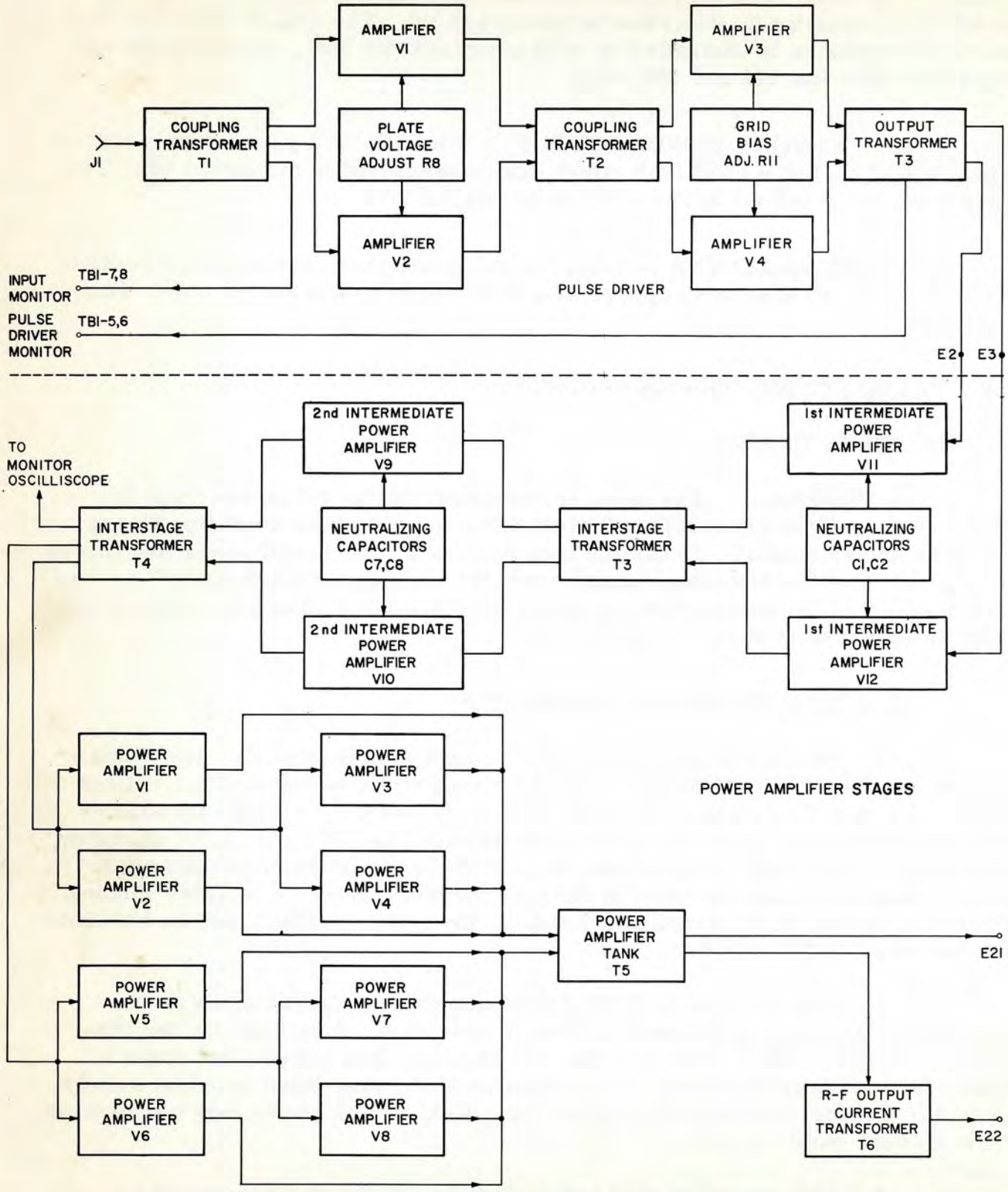


Figure 4-13. Amplifier Assembly AM-2481/FPN-42, Block Diagram

second amplifier tubes (V3 and V4). These tubes are triode connected, and are operated as a push-pull class B amplifier stage. Output transformer T3 for the pulse driver is a 2.5 to 1 step-down unit. This transformer feeds the grids of the first intermediate power amplifier. A monitor winding (terminals 7 and 8) is provided, and its output may be observed on the monitor oscilloscope.

4. The r-f grounds of the pulse driver are insulated from chassis ground, by-passed, and returned separately to the power supply as the 3.8-kv ground return.

(2) POWER AMPLIFIER STAGES.

(a) GENERAL. - The power amplifier stages generate the high power output pulses required to drive the transmitting antenna. The stages consist of two intermediate power amplifier stages and the final power amplifier stage. The block and schematic diagrams of the power amplifier stages are shown in figures 4-13 and 6-17, respectively.

(b) FIRST INTERMEDIATE POWER AMPLIFIER.

1. The first intermediate power amplifier (first IPA) consists of two type 304TH triodes (V11 and V12) operated as a class B push-pull power amplifier. The secondary of the pulse driver output transformer T3 is loaded with resistors R1 and R2 to provide linear operation when the first IPA tubes are operated in the grid current region. To maintain stability, this amplifier is cross-neutralized with adjustable vacuum capacitors C1 and C2, which are adjusted to cancel the grid-to-plate capacity of each amplifier tube.

2. The first IPA output transformer (T3) provides a 2.5:1 step-down to the grids of the following stage. A monitor winding (terminals 7 and 8) is provided and its output may be observed on the monitor oscilloscope.

(c) SECOND INTERMEDIATE POWER AMPLIFIER.

1. The second intermediate power amplifier (second IPA) consists of two type 7800/7899 tubes (V9 and V10) operated as a class B push-pull power amplifier. Neutralizing capacitors C7 and C8 are provided in this stage, as in the first IPA, as described in paragraph (b)1. To provide linear operation of first IPA plate transformer T3 when the second IPA amplifier tubes are operated in the grid current region, the secondary of T3 is loaded with resistors R9 and R10.

2. A filter network consisting of capacitors C3, C4, C5, and C6; chokes L1 and L2; and resistors R138, R139, R140, and R141 is provided in the cathode circuit of each tube to prevent the r-f component of the tube current from flowing in the cathode current metering circuit. Spark gaps E3, E4, E71 and E72 provide protection against an open lead in the ground return circuit.

3. The second IPA output transformer (T4) provides a voltage stepdown of 3.33 to 1. Damping resistors R122, R123, R124, R126, R127 and R128 are connected across the primary (terminals 1 and 3) of T4 to limit inductive overshoot in the pulse. A monitor winding (terminals 9 and 10) is provided to view the output of the second IPA. Current surge limiting network Z1 is included in the circuit to protect T4 from the discharge current of filter capacitor C45 in the event of a tube short in V9 or V10. Bias for these tubes is fed through the secondary center-tap (terminal 5) of T3, and bias filtering is supplied by capacitors C46, C47, C79, C80, C81, and C82.

(d) FINAL POWER AMPLIFIER.

1. The final power amplifier consists of eight type 7800/7899 tubes (V1 through V8) operated as a push-pull parallel class B power amplifier. Bias for this stage is supplied through the secondary centertap (terminal 6) of T4, and is filtered by capacitors C48 through C65 in parallel, as well as r-f bypass capacitor C83. Loading resistors R133 through R137 are connected in parallel with the bias supply to help in maintaining regulation when grid current is fed back into the supply during pulse drive conditions. Loading resistors R16, R17, and R80 through R89 are connected across the secondary of T4 to provide linear transformer operation during grid current conditions.

2. A schematic diagram showing the circuitry of a typical final power amplifier tube V1 is shown in figure 4-14. Plate energy storage capacitor C9 which supplies most of the tube current during the pulse, is charged through surge limiting resistors R19 and R21. This capacitor is charged during the time between transmitted pulses. When plate current is allowed to flow during the pulse, voltage is induced in the primary of multi-filar output transformer T5, one winding of which is connected in series with each tube plate. Each winding, insulated from one another, is run through a common primary where the total current of each tube bank induces voltage into the single secondary. The common primary consists of twelve turns of 3/4-inch copper tubing through which each individual primary is run. Tuning is accomplished by capacitors C41, C42, C69, and C70 connected in series-parallel across the common primary. Damping resistors R74, R75, and R90 through R119 are shunted across the common primary to limit ringing in the tail of the transmitted pulse.

3. Resistor R23 serves to limit tube current in the event of a tube short, and to isolate the plates of the parallel connected tubes from one another. Energy storage capacitor C9 is returned to a-c ground through balancing resistors R29 and R31. R-f bypass capacitors C13 and C15 together with choke L5 serve to protect the d-c cathode current monitoring circuit from r-f currents.

4. The grid circuit includes a parasitic oscillation suppression and isolation network consisting of capacitor C71, resistors R25, R27, R145, and R147, and choke L3. This is essentially a filter network which isolates each grid from high frequency excitation. For monitoring purposes, current transformer

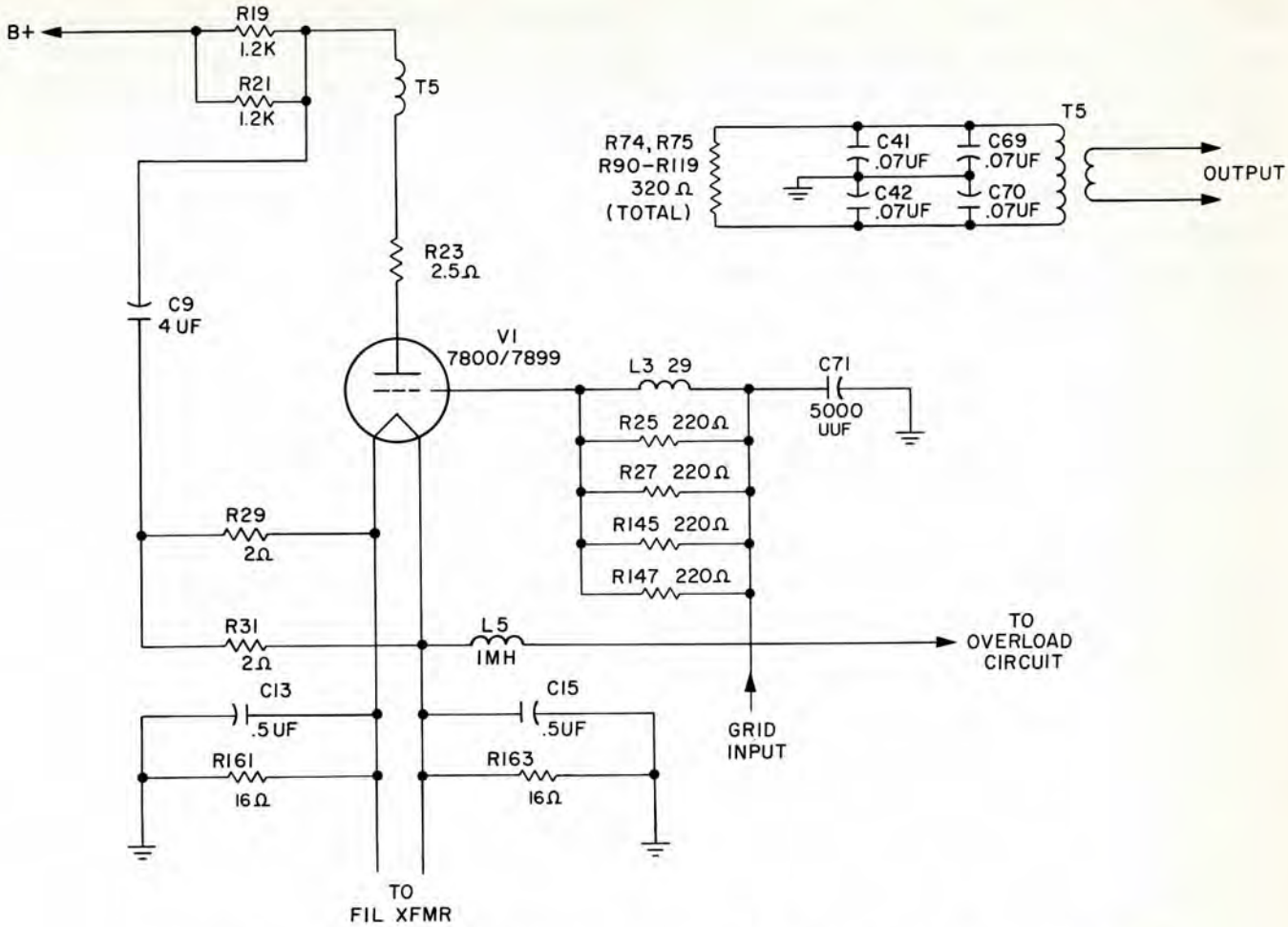


Figure 4-14. Amplifier Assembly AM-2481/FPN-42, Typical Final Power Amplifier Stage, Simplified Schematic Diagram

T6 is connected in series with the secondary of T5. The output of T6 may be observed on the monitor oscilloscope.

c. HIGH VOLTAGE POWER SUPPLY. - The high voltage power supply serves two functions in the transmitter group. First, it generates the high voltages and bias voltages necessary for operation of a transmitter. Second, it provides the automatic controls necessary for proper operation and safeguarding of the operator and a transmitter. A detailed functional description of the high voltage power supply can be found in Volume 3.

d. COUPLING AND LOAD.

(1) GENERAL.

(a) The coupling and load unit contains the antenna coupler, the dummy load, and the switching circuitry for changing the transmitter load (antenna or

dummy load). It also contains LOCAL & REMOTE SELECTOR switch S7 which, when in the remote position, allows the transmitter group to be controlled from the operations building. Figure 4-15 is a block diagram of the coupling and load unit. Figure 6-19 is the schematic diagram of the coupling and load unit.

(b) The inputs to the coupling and load unit are the outputs of each transmitter. These outputs are directly coupled to transmitter 1 load switch S3 and transmitter 2 load switch S4, each of which consists of a solenoid operated single-pole double-throw vacuum switch.

(c) In the operation of the transmitter group, either S3 or S4 is energized. If S3 is energized, then the transmitter 1 output is coupled through antenna tuning coil L1 to the antenna, and the transmitter 2 output is directly coupled to the dummy load. If S4 is energized, the reverse occurs.

(d) PUSH TO READ switch S1, in its normal position, connects the antenna tuning coil L1 directly to the antenna. When S1 is operated, thermocouple TC1 is inserted in series with the antenna. Thermocouple meter M1 then indicates antenna current.

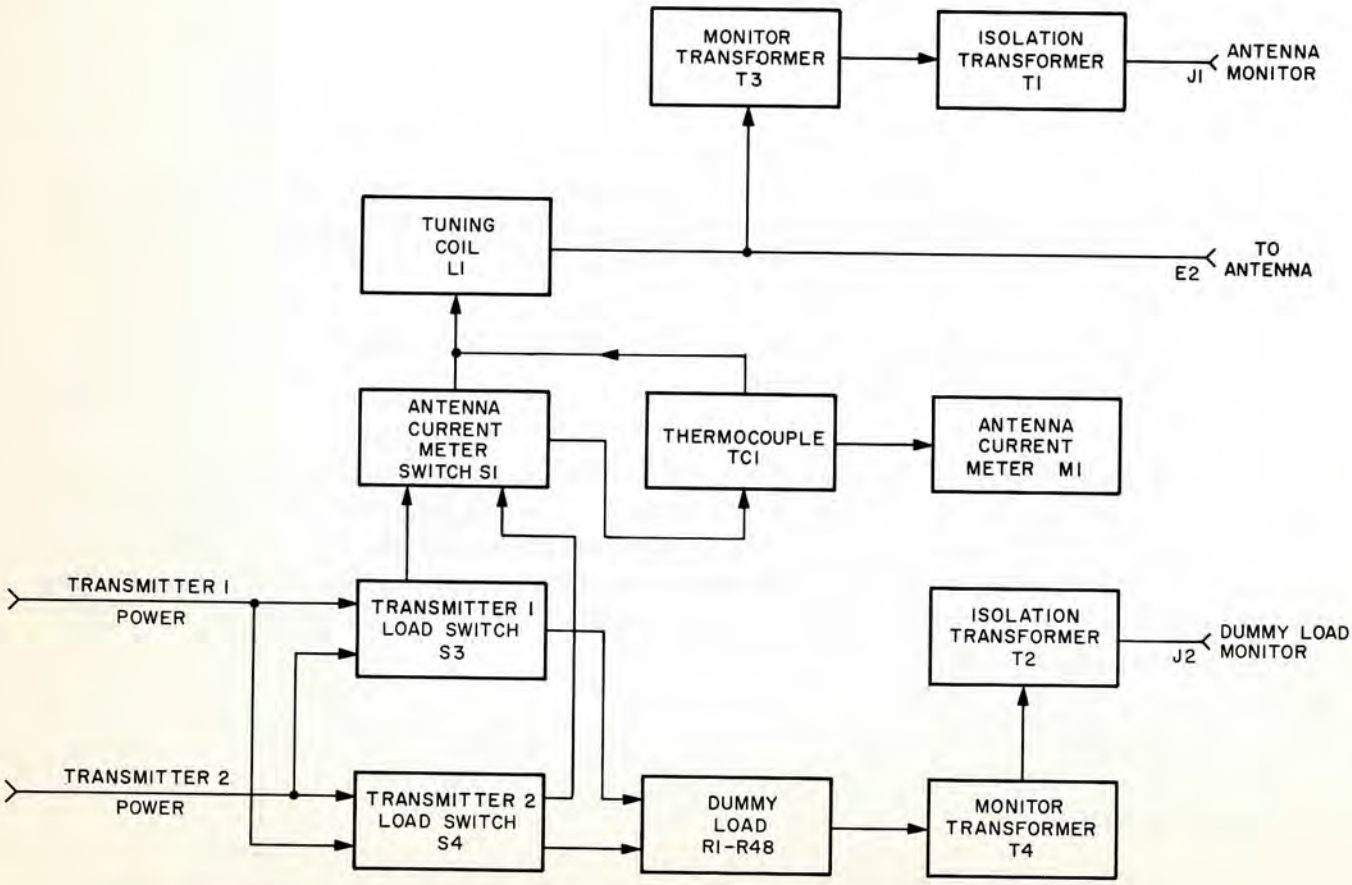


Figure 4-15. Antenna Coupler CU-807/FPN-42, Block Diagram

(2) TRANSMITTER FUNCTION SWITCH S2.

(a) Vacuum switch S3 is energized when transmitter function switch S2 is in the transmitter 1 to antenna position. Vacuum switch S4 is energized when S2 is in the transmitter 2 to antenna position.

(b) The transmitter function switch S2 is a solenoid operated rotary switch consisting of seven non-shorting double wafers, or a total of fourteen non-shorting sections. Thirteen of these sections consist of three single-pole double-throw switches. The fourteenth consists of one single-pole double-throw switch.

(c) The transmitter function switch is controlled by the TRANSMITTER SELECTOR switch S7 located on the control panel. The control voltage from the TRANSMITTER SELECTOR switch S7 passes through the control switch on transmitter function switch S2A, the contacts of 2.5-second time delay relay K2 and bridge rectifier CR1. When the solenoid is energized after 2.5-second delay, control switch S2A moves one position, breaking the control voltage for the solenoid. Therefore, the transmitter function switch, when energized, alternately steps from the transmitter 1 to antenna position to the transmitter 2 to antenna position.

(d) The time delay is necessary to protect the high voltage contacts of switches S3 and S4. The 2.5-second delay allows sufficient time for the capacitors in the final power amplifier stage to discharge before the transmitter loads are switched.

(e) Besides determining which load switch (S3 or S4) is energized, the transmitter function switch also determines the following:

1. Which transmitter control voltage energizes blower motor relay K1. If the transmitter function switch is in transmitter 1 to antenna position, the control voltage from transmitter 2 energizes relay K1.

2. Whether the control voltage for the plate relay passes through the contacts of the air switch of blower B1. If the transmitter function switch is in the transmitter 1 to antenna position, the control voltage for the plate relay of transmitter 2 must pass through the contacts of transmitter 2 air switch S6.

3. Whether the OPERATE XMTR 1 lamp or the OPERATE XMTR 2 lamp (located on the control panel) is lighted. If the transmitter function switch is in the transmitter 1 to antenna position then the OPERATE XMTR 1 lamp is lighted.

(3) MONITOR CIRCUITS. - Transformers T3 and T4 are used to monitor the antenna signal and the dummy load signal, respectively. Each transformer consists of a single turn primary which couples either the antenna or the dummy load current into the secondary. Transformer T3 picks up the antenna current field and T4 picks up the dummy load current field. The signal picked up by each

transformer is then coupled through its associated isolation transformer (T1 and T2) through twinax cable to the monitor oscilloscope, pulse analyzer, and timer-synchronizer (where it may be used in place of the receiving antenna signal).

(4) LOCAL & REMOTE SELECTOR SWITCH S7. - LOCAL & REMOTE SELECTOR switch S7 determines whether the plate relay is energized by control voltage from the high voltage power supply or control voltage from the remotely located control panel. The local position also disables control panel TRANSMITTER SELECTOR switch S7.

(5) BLOWER B1. - Blower B1 is used for cooling the dummy load. It is energized only when the transmitter connected to the dummy load is operated in the on condition (plate voltage applied).

(6) ANTENNA TUNING COIL L1. - Antenna tuning coil L1, which has an inductance range of 14.5 to 25 microhenries, tunes the transmitting antenna to the 100-kc system frequency. Its major effect on the antenna pulse output is that of positioning the center of the spectrum.

(7) DUMMY LOAD. - The dummy load consists of forty-eight 2.5-K, 145-watt resistors (R1 through R48) in parallel. It therefore appears as a 52-ohm, 7-kilowatt average power load as presented to the transmitter.

e. CONTROL CIRCUITS.

(1) HIGH VOLTAGE POWER SUPPLY. - For details of control circuits contained in the high voltage power supply refer to Volume 3.

(2) ANTENNA SWITCHING.

(a) The position of the transmitter function switch (S2, figure 6-19) determines which vacuum switch (S3 and S4) is energized. If S3 is energized, the output of transmitter 1 is connected to the antenna and the output of transmitter 2 is connected to the dummy load. If S4 is energized, the output of transmitter 2 is connected to the antenna, and the output of transmitter 1 is connected to the dummy load.

(b) Transmitter function switch S2 is a solenoid operated rotary switch, the position of which is changed each time the solenoid is energized. A description of the circuit required to actuate this switch follows.

1. The pulse control 120-volt, 60-cycle power leads run through interconnection harness 8A1-4 (figure 2-3) of transmitter 1 to the coupling and load unit. The 120 volts is then connected through interlock switches S12 and S13 to a remote contact (terminal 9) of LOCAL & REMOTE SELECTOR switch S7.

2. If S7 is in the remote position, the 120 volts is connected back through interconnection harness 8A1-4 of transmitter 1 to the high voltage power

supply and then by way of 8A1-3, to the off contacts of control panel B+ XMTR 1 and B+ XMTR 2 switches S12 and S11 (figure 6-15). If S11 and S12 are in the off position, the 120 volts is connected to the pole of TRANSMITTER SELECTOR switch S7. The two contacts of S7 are connected through interconnection harnesses 8A1-3 and 8A1-4 of transmitter 1 to the control wafer of transmitter function switch S2 (figure 6-19).

3. If transmitter function switch S2 is already in the position corresponding to the position of TRANSMITTER SELECTOR switch S7, the 120 volts does not pass through S2. However, if S2 is not already in the position selected by TRANSMITTER SELECTOR switch S7, the 120 volts is connected through S2 to the coil and contact of 2.5-second time delay relay K2 (figure 6-19). After 2.5 seconds the relay contact of K2 closes and connects 120 volts to solenoid rectifier CR1, whereupon the solenoid is energized. The solenoid then advances transmitter function switch S2 one position, whereby the 120 volts connection through S2 is broken and the solenoid becomes de-energized. This new position of S2 now corresponds with the position selected by S7. Switch S2 will then remain in this position until TRANSMITTER SELECTOR switch S7 is placed in the other position, whereby the above process is repeated.

4. To summarize, in order to switch the loads of the transmitters, the door interlocks of the coupling and load cabinet must be closed, LOCAL & REMOTE SELECTOR switch S7 must be in the remote position, and both transmitter B+ switches (S11 and S12) must be in the off position. If these are in the proper positions, then the position of control panel TRANSMITTER SELECTOR switch S7 determines which transmitter is connected to the antenna, and which transmitter is connected to the dummy load.

(3) EMERGENCY STOP.

(a) There are three EMERGENCY STOP switches for each transmitter. They are located on the control panel (S2 for transmitter 1 and S3 for transmitter 2, figure 6-15), on the transmitter (S19, figure 6-17) and on the high voltage power supply (S7, Volume 3, Section 6).

(b) The three EMERGENCY STOP switches are connected in series with the coils of blower starting relays K28, K29, K30 and K31 in the high voltage power supply. When any one of these switches is depressed, the blower starting relays are de-energized, thereby interrupting the power to the remaining relays. This isables all circuits in the transmitter.

(4) PULSE GENERATOR SWITCHING.

(a) There are two pulse generator chassis in the pulse control unit. Each pulse generator may receive its input from either the operate or the standby timer-synchronizer. The outputs of both timer-synchronizers are connected to PULSE GEN. 1 EXCITATION and PULSE GEN. 2 EXCITATION switches S4 and S5 (figure 6-15).

Placing PULSE GEN. 1 EXCITATION switch S4 in the OPERATE BUS position connects the output of the operate timer-synchronizer to the input of pulse generator 1. Placing the same switch in the STANDBY BUS position connects the output of the standby timer-synchronizer to the input of pulse generator 1. PULSE GEN. 2 EXCITATION switch S5 operates similarly.

(b) The connections between the pulse generator output and transmitter input may be interchanged. When PULSE GEN. SELECTOR switch S8 (figure 6-15) is in the PULSE GEN. 1 TO XMTR 1 - PULSE GEN. 2 TO XMTR 2 postion, the output of pulse generator 1 is fed into the input of transmitter 1. When S8 is in the PULSE GEN. 1 TO XMTR 2 - PULSE GEN. 2 TO XMTR 1 position the pulse generator-transmitter connections are interchanged.

(c) When S8 is in the PULSE GEN. 1 TO XMTR 2 - PULSE GEN. 2 TO XMTR 1 position, transmitter oscilloscope trigger control relay K1 (figure 6-12) is energized connecting the input triggers at pulse generator 1 to the transmitter monitor oscilloscope in transmitter 2 for use as oscilloscope synchronization. When switch S8 is in the other position, these connections are interchanged. B+ PULSE GEN. 1 and B+ PULSE GEN. 2 switches S9 and S10 (figure 6-15) energize the B+ relays in power supply 1 and power supply 2, respectively, thereby applying all d-c voltages to the respective pulse generator.

(5) PULSE CONTROL INTERLOCKS.

(a) The pulse control cabinet primary 120-volt, 60-cycle input power is connected to all the chassis in the cabinet through the normally closed contacts of thermostat relay K3 (figure 6-12). If the temperature in the cabinet rises above 70°C. (158°F.), thermostat switch S5 (figure 6-12) closes, energizing thermostat relay K3 and thereby opening the primary power connection to every chassis in the cabinet.

(b) All of the units which connect to the 120-volt, 60-cycle input through an interlock switch are disabled when the interlock switch is open. For example, when the monitor oscilloscope is pulled out of the cabinet, its interlock switch (S3, figure 6-12) is opened, which breaks the 120-volt connection to the oscilloscope. Also, opening any of the interlock switches connects 120 volts through the normally-closed contact of the interlocks to interlock indicator relay K6 (figure 6-12) which, now energized, opens the connection of 120 volts to INTERLOCK INDICATOR lamp DS3 (figure 6-15) located on the control panel.

(c) However, placing INTERLOCK DISABLE switch S13 (figure 6-15) in the on (up) position energizes interlock disable relay K2. This places 120 volts on the poles of K2, which are connected to the normally open contacts of interlock switches S1, S2, S3, and S4 (figure 6-12). Because the normally open contacts of the interlock switches are connected to the different chassis, opening the interlock switch has no effect when INTERLOCK DISABLE switch S13 is in the on (up) position. Also, placing S13 in the on (up) position connects 120 volts to the

normally open contact of interlock indicator relay K6 (figure 6-12); therefore even if one of the individual interlock switches is open, INTERLOCK INDICATOR lamp DS3 (figure 6-15) remains on.

(d) The d-c outputs of power supply 1 and power supply 2 are connected to the contacts of pulse analyzer B+ selector relay K5 (figure 6-12). When K5 is not energized, the d-c outputs of power supply 1 are applied to the pulse analyzer through the normally closed contacts of pulse analyzer B+ interlock relay K4 (figure 6-12). When K5 is energized, the d-c outputs of power supply 2 are applied to the pulse analyzer through the normally open contacts of K4. Whether or not K5 is energized depends upon the position of POWER SUPPLY SELECTOR switch S3 (figure 6-16). When S3 is in the power supply 1 position, K5 is not energized. When S3 is in the power supply 2 position, K5 is energized. Switch S3 also switches the grounds of the pulse analyzer. In the power supply 1 position, the pulse analyzer ground is connected to power supply 1 ground, whereas in the power supply 2 position, the pulse analyzer ground is connected to the power supply 2 ground.

(6) PULSE CONTROL OVERLOAD ALARM AND INTERLOCKS.

(a) One end of the overload relay (K1 for transmitter 1, K2 for transmitter 2, figure 6-15) is connected through interconnecting harness 8A1-3 to the high voltage power supply, where it is returned to control voltage common through the contacts of interlock relays K21, K22, K23 (Section 6, Volume 3). The other end of the overload relay is connected to the 120-volt control voltage through harness 8A1-3 and auxiliary contact c of plate circuit breaker CB1, which is closed when the breaker is in the off or trip position.

(b) Whenever plate circuit breaker CB1 trips open, its auxiliary switch closes, energizing the pulse control overload relay; except if the plate circuit breaker was tripped open because one of the contacts of the high voltage power supply interlock relay opened.

(c) When the pulse control overload relay is energized, it connects 120 volts to overload alarm DS13 (figure 6-15) and control panel overload indicator lamp (DS10 for transmitter 1, DS12 for transmitter 2), and also connects 120 volts to its coil through the overload reset switch (S16 for transmitter 1, S17 for transmitter 2). Thus, when plate circuit breaker CB1 closes again, the pulse control overload relay remains energized until the overload reset switch (S16 or S17) is depressed. However, if the high voltage power supply has three overloads in a period of 90 seconds, then the three strike relay in the high voltage power supply, through the opening of its normally closed contact, prevents plate circuit breaker CB1 from closing. The normally closed auxiliary switch of circuit breaker CB1 then remains closed until 3 STRIKE RESET switch S9 in the high voltage power supply is depressed. Until then, the pulse control overload alarm and overload indicator lamp will remain energized even though the overload reset switch (S16 or S17) is depressed.

(7) TRANSMITTER OUTPUT DISCONNECT VACUUM SWITCHES. - The output of the final power amplifier is fed through insulating terminals E21 and E22, at the top of the transmitter, to vacuum switches S22 and S23. These switches, which are in series with the output lines to the coupling and load unit, are controlled by time delay relay K1 which is, in turn, controlled by BIAS VOLTAGE switch S2 (19, figure 3-6) on the high voltage power supply. When BIAS VOLTAGE switch S2 is first placed in the on position, output switches S22 and S23 close immediately. However, when BIAS VOLTAGE switch S2 is placed in the off position, time delay relay K1 holds the output switches in the closed position for approximately three minutes before the switches open. This time delay allows the final power amplifier circuits to discharge faster because of the full load on the output.

f. TEST EQUIPMENT.

(1) CAPACITIVE VOLTAGE DIVIDER. - The capacitive voltage divider utilizes the principle that an a-c voltage, when applied across a group of capacitors in series, divides inversely proportional to the size of the capacitor. For example, if a high voltage is applied across two series capacitors, one having 1000 times greater capacitance than the other, the voltage across the smaller value capacitor will be 1000 times greater than the voltage across the larger capacitor. The divider is used to extend the voltage range of the oscilloscope to observe high a-c potentials. At 100 kc, the division ratio is approximately 300:1.

(2) PULSE ANALYZER.

(a) GENERAL.

1. The pulse analyzer enables the operator to check the shape of each transmitter pulse. (See figures 4-16, 4-17, 4-18, and 6-16.)

2. The undelayed oscilloscope triggers are fed into the pulse analyzer. The trigger corresponding with the pulse to be analyzed is selected by the position of PULSE SEL. switch S1 and used as an oscilloscope sweep trigger. The transmitter pulses are fed into an accurately calibrated voltage divider used to measure the pulse shape. A relay which switches between ground and the voltage divider output at half the pulse repetition rate (1/2 PRR) provides an output which is fed into the oscilloscope. The oscilloscope waveform is a reference trace and a pulse superimposed on a bias voltage. The bias level for the pulse is adjusted by means of % AMPL potentiometer R55. When R55 has been calibrated and adjusted properly, the dial attached to it provides the relative amplitude of any portion of the pulse with respect to the peak of the pulse.

(b) DETAILED CIRCUIT OPERATION.

1. Undelayed positive oscilloscope triggers from jack J2 in the pulse generator are fed to jack J1 and coupled to the grid (pin 2) of pulse repetition rate

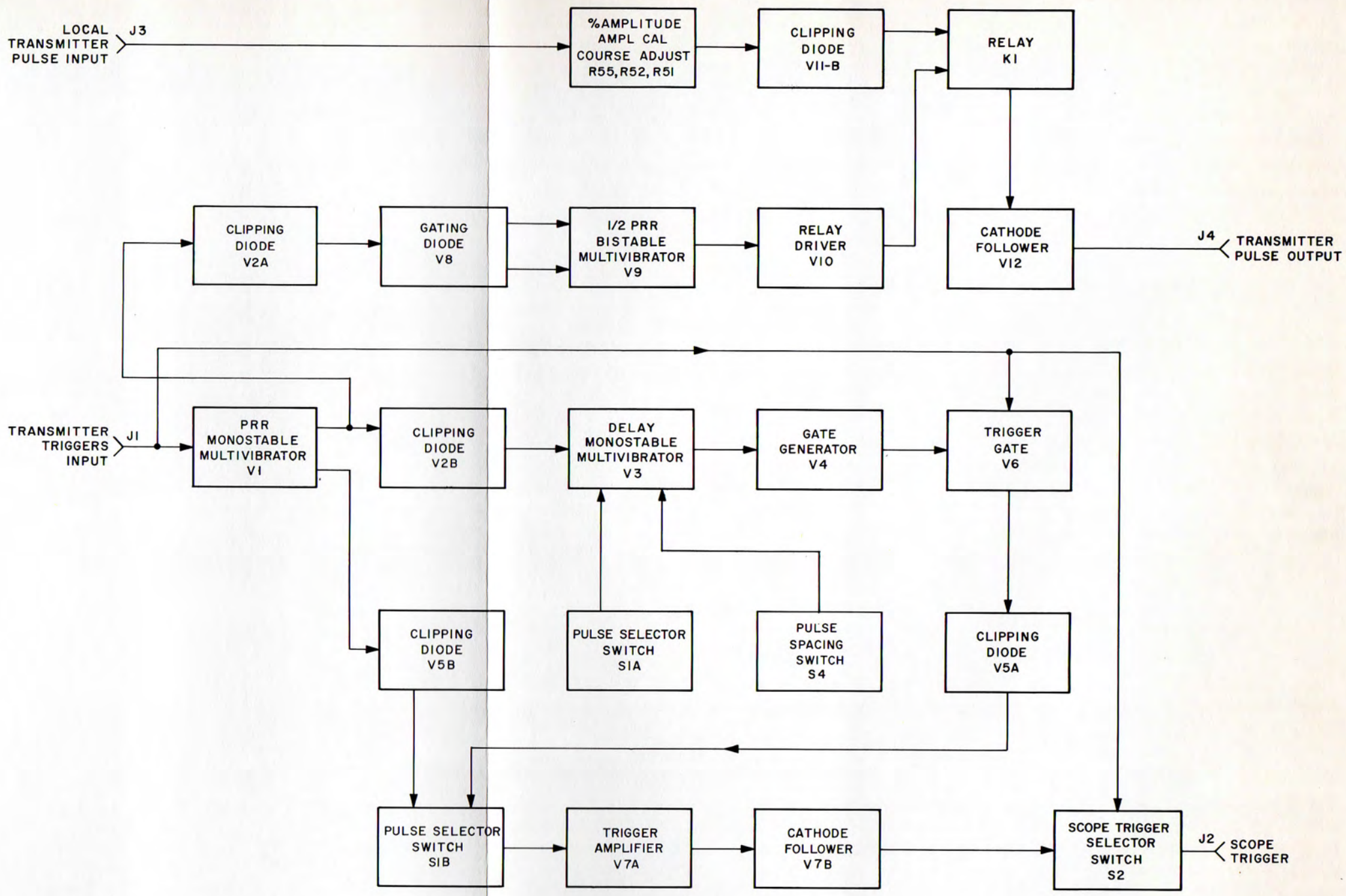


Figure 4-16. Electrical Pulse Analyzer TS-1360/FPN-42, Block Diagram

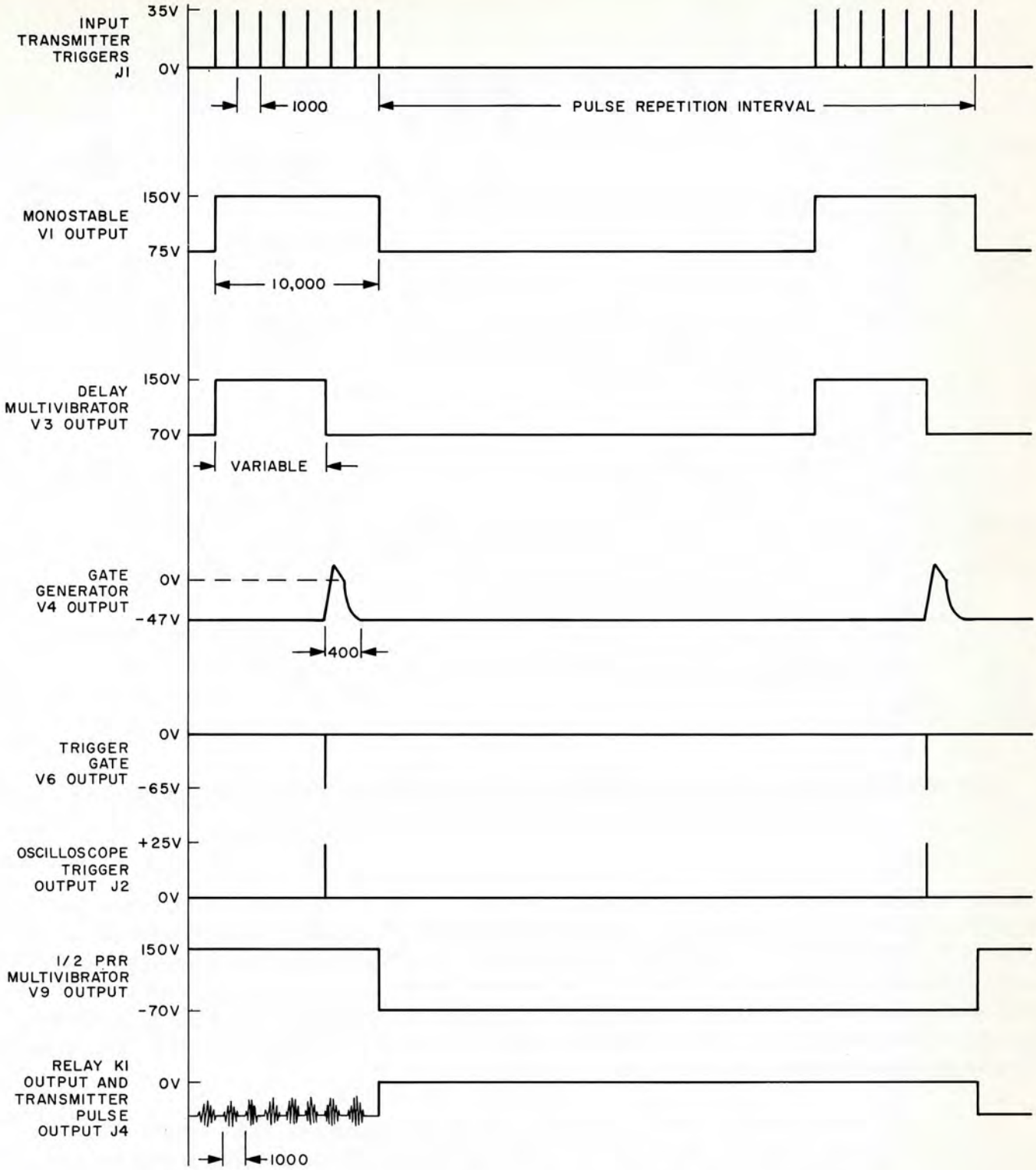


Figure 4-17. Electrical Pulse Analyzer TS-1360/FPN-42, Waveform Diagram

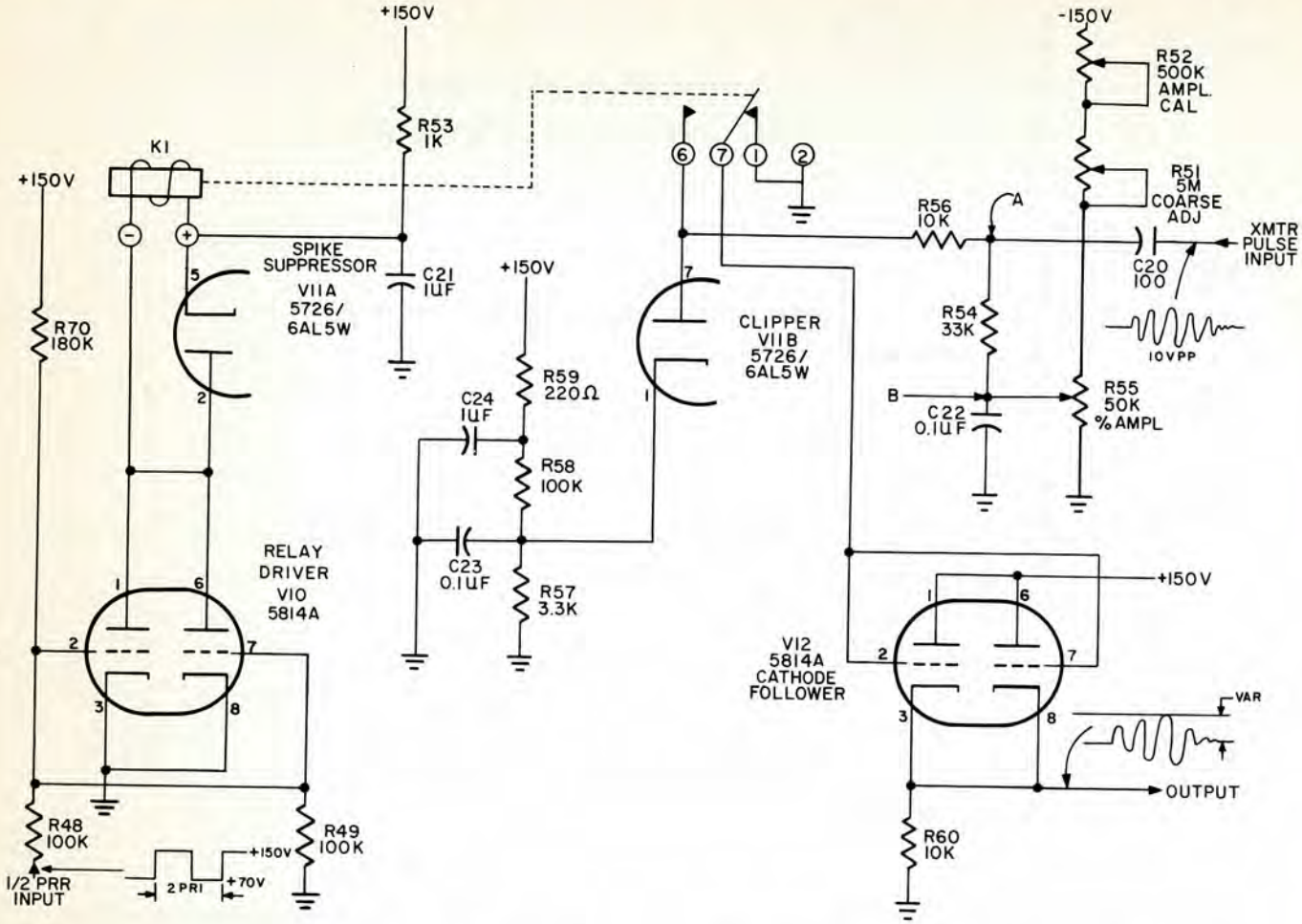


Figure 4-18. Electrical Pulse Analyzer TS-1360/FPN-42, Measuring and Output Circuits, Simplified Schematic Diagram

multivibrator V1 through capacitor C1. Tube V1 is a monostable multivibrator which fires on the first input trigger and generates an output pulse of approximately 10,000 microseconds duration, thus terminating sometime after the last input trigger in each pulse group. Operation of this circuit is similar to that of gate generator V6 in the pulse generator as described in paragraph a (2)(c)3. The period of the pulse is primarily determined by capacitor C3 and resistor R6. The circuit output is obtained at the plate (pin 6) of V1.

2. The output of V1 is differentiated by capacitor C5. Diode V2B clips the negative trigger resulting from the differentiation, leaving a positive trigger coincident with the leading edge of the V1 output waveform. This trigger is fed to the grid (pin 2) of delay multivibrator V3, a monostable multivibrator similar to V1. The time constant of V3 is determined by 500-1000 switch S4 and PULSE SEL. switch S1. Delay adjust potentiometer R12 provides a vernier control on the time constant of V3. The coarse delay is determined by the position of S4. When S4 is in the 1000 position capacitor C27 is connected in parallel with capacitor C6 to lengthen the delay by a factor of two. Switch S1A changes the

time constant of V3 in steps by changing the resistance from the grid (pin 7) to the cathode (pins 3 and 8). When S1 is in the 1 position, V3 does not fire because the grid (pin 7) and the cathodes (pins 3 and 8) are shorted together. As S1 is rotated clockwise, the delay increases by approximately 1000 or 500 microseconds for each succeeding position as determined by the position of S4. Thus, the trailing edge of the output at the plate (pin 6) of V3 always occurs between two successive input triggers.

3. The output of V3 is coupled to the grid (pin 2) of gate generator V4 through capacitor C8. The negative going trailing edge of the V3 output waveform triggers V4, a monostable multivibrator similar to V1 but with a fixed delay of 400 microseconds. The output at the plate (pin 1) of V4 is a 400-microsecond positive gate. This gate is used to select one input trigger and, because of its width, can only select one for all modes of transmission.

4. The output of V4 is coupled to control grid 2 (pin 7) of trigger gate V6 through capacitor C10. Input triggers from jack J1 are coupled to control grid 1 (pin 1) through capacitor C2. Control grid 1 is biased to cutoff by resistors R31, R32, and R33 to eliminate noise output between triggers. When a positive input trigger falls within the gate from V4, a negative output trigger is obtained at the plate (pin 5) of V6.

5. The negative output of V6 is coupled to trigger amplifier V7A through capacitor C26, diode V5A, and switch S1B. When S1 is in any position except the 1 position, the triggers reach V7A. When S1 is in the 1 position, V3 does not fire, therefore V4 does not fire and there is no output from V6. In this case, the output of V1, differentiated by capacitor C7 and resistor R22, is fed to V7A through resistor R64 and S1B. Diode V5B clips the positive trigger resulting from the differentiation. The output of S1B is direct coupled to the grid (pin 2) of V7A which amplifies and inverts the selected trigger. The output at the plate (pin 1) of V7A is coupled to the grid (pin 7) of cathode follower V7B. The low impedance output at the cathode (pin 8) of V7B is coupled to SCOPE TRIG. SELECTOR switch S2. When S2 is in the NORMAL position, input triggers are fed to jack J2 through capacitors C2 and C25. When S2 is in the PULSE ANALYZER position, the output of V7B is fed to J2 through capacitor C16. The triggers from J2 are used to trigger the sweep of the monitor oscilloscope.

6. The output from the plate (pin 6) of V1 is also differentiated by capacitor C4 and resistor R7. Diode V2A clips the positive trigger resulting from the differentiation. The resulting negative trigger, coincident with the trailing edge of the output of V1, is fed to trigger coupler V8 through capacitor C17. The two diode sections of V8 pass the negative triggers to the grids (pins 2 and 7) of 1/2 PRR multivibrator V9. Resistor R69 between the cathodes (pins 3 and 8) of V9 and the cathodes (pins 1 and 5) of V8 biases the diodes in order to obtain maximum trigger transfer. Tube V9 is a conventional bistable multivibrator. Operation of the circuit is similar to that of V1 except that V9 has two stable states and switches back and forth between them with each successive input trigger. The output at the plate (pin 6) of V9 is a 1/2 PRR square wave.

7. The output of V9 is coupled to the grids (pins 2 and 7) of relay driver V10 through isolating resistor R48. (See figure 4-18.) The two triode sections of V10 are connected in parallel, and fast acting relay K1 serves as the plate load for the tube. Tube V10 is biased in and out of conduction by the input 1/2 PRR square wave. When current flows through the tube during the positive portions of the input waveform, K1 is energized and remains in that state until the input waveform goes negative. Resistor R53 and capacitor C21 decouple the circuit from the power supply, and diode V11A acts as a spike suppressor to remove switching transients. Relay K1 is a single-pole double-throw relay, whose contacts are arranged so that when the coil is not energized the grids (pins 2 and 7) of cathode follower V12 are grounded, and when the coil is energized the transmitter pulses are fed to the grids. In this way the output switches between a d-c reference voltage and the transmitter pulse being measured.

8. Transmitter pulses from the pickup loop in the coupling and load unit are fed from jack J3 to point A through capacitor C20. AMPL. CAL. potentiometer R52, COARSE ADJ potentiometer R51, and % AMPL. potentiometer R55 constitute a voltage divider. With the R55 dial set at 100%, R51 and R52 are adjusted so that the largest cycle in the transmitter pulse is coincident with the reference trace as observed on the monitor oscilloscope. This establishes a d-c bias at point B which is added to the input pulse at point A through isolating resistor R54. Point B is bypassed to ground through capacitor C22. Once the equipment is calibrated by adjusting R51 and R52 as described, the amplitude of any other cycle in the pulse may be measured by adjusting R55 until the desired cycle is coincident with the reference trace, and reading the amplitude relative to the peak directly in percent from the % AMPL. dial attached to R55.

9. Diode V11B is included in the circuit to prevent the monitor oscilloscope vertical amplifiers from being overloaded by large signals, when using high oscilloscope gain during measurements on the first few cycles of the pulse. A voltage divider consisting of resistors R57 and R58 establishes a d-c bias of approximately 5 volts at the cathode (pin 1) of V11B. Resistor R59 and capacitor C24 decouple the divider from the power supply. When the signal at the plate (pin 7) of V11B exceeds 5 volts, the 5-volt back bias on V11B is overcome and the tube conducts, presenting a low impedance a-c path to ground through capacitor C23 and thereby clipping the pulse at 5 volts.

10. Output cathode follower V12 consists of two triode sections connected in parallel. The low impedance output at the cathode (pins 3 and 8) is direct coupled to jack J4.

11. Power supply selector switch S3 controls the external relay that controls which section of the dual power supply furnishes B+ voltages to the chassis, and grounds the appropriate power supply ground in the chassis.

SECTION 5

TROUBLE-SHOOTING

5-1. GENERAL

a. This section contains information which enables maintenance personnel to isolate a fault in the overall system to a functional unit, and within the functional unit to a particular part. This information includes preliminary visual checks, waveform, voltage and resistance data, control settings and trouble-shooting charts.

WARNING

High voltages exist inside the equipment which are dangerous to life. While every safety precaution possible has been incorporated into the system, personnel must at all times observe all normal safety regulations. Never service the transmitter group with the high plate voltage on. Dangerous potentials may exist in the high voltage circuits even with the power off due to charges retained by capacitors. To avoid injury always remove power, and discharge and ground circuits before touching them. Never reach within the cabinets for the purpose of servicing or adjusting without the immediate presence or assistance of another person capable of rendering first aid.

b. Major test points, when used in conjunction with the test procedure, are identified by a star-encircled Arabic numeral and designates a point at which trouble may be isolated to a major portion of the unit. Encircled capital letters with an Arabic numeral identify and designate a minor test point, and isolate a trouble within a specific circuit. Figures 5-1 through 5-10 provide the wave shapes and the test point locations used during trouble-shooting, and are grouped at the rear of this section for the convience of the technician.

NOTE

The system from which the waveforms (figures 5-1 and 5-4) were obtained was a slave station operating at the S-0 repetition rate with phase coded input from the timer-synchronizer. The waveforms of figure 5-1 were taken on the monitor oscilloscope (a through h and o) and on the transmitter monitor oscilloscope (i through n). In figure 5-1,

NORMAL triggering means that pulse analyzer SCOPE TRIG. SELECTOR switch S2 (7, figure 3-4) is in the NORMAL position. For figure 5-1h, the monitor oscilloscope was triggered from the pulse analyzer to view the third transmitter pulse. (For a master station this pulse would be 180 degrees out of phase from waveform shown, due to the phase coding.) The waveforms of figure 5-4 were taken on a Tektronix Oscilloscope Model 531 with a type D plug-in unit. The trigger input was obtained from the horizontal input jacks of the monitor oscilloscope with pulse analyzer SCOPE TRIG. SELECTOR switch S2 (7, figure 3-4) set either to the NORMAL or to the PULSE ANAL. position. When SCOPE TRIG. SELECTOR switch S2 was in the PULSE ANAL. position, PULSE SEL. switch S1 (3) was set to position 3 to observe only the third pulse of any multipulse group waveform. (At a master station, the following waveforms would be reversed 180 degrees due to the phase coding: a, c, d, e, f, g, h, i, and l.)

5-2. TEST EQUIPMENT AND SPECIAL TOOLS. - A complete list of test equipment and special tools is given in table 5-1.

TABLE 5-1. LORAN TRANSMITTING SET AN/FPN-42, TEST EQUIPMENT AND SPECIAL TOOLS

NOMENCLATURE	QUANTITY	USE
Simpson Model 260 Multimeter	2	Measures d-c resistance and low plate voltages.
Vacuum Tube Voltmeter AN/USM-116	1	Measures plate voltages.
General Radio RF Bridge 916AL	1	Measure coil impedances.
General Radio Signal Generator 1001A	1	Used with r-f bridge to determine the resonant frequency.
National HRO-60 Receiver with coils D, E, F, G, H, and J	1	Used with signal generator and r-f bridge for impedance measurements.
Hewlett-Packard VTVM 400C	1	Used with signal generator to measure the amplitude of the input signal.

TABLE 5-1. LORAN TRANSMITTING SET AN/FPN-42, TEST EQUIPMENT AND SPECIAL TOOLS (Cont)

NOMENCLATURE	QUANTITY	USE
Tube Tester TV-10/U	1	Tests the low plate voltage tubes in the pulse generator, dual power supply, pulse analyzer and monitor oscilloscope.
Polaroid Oscilloscope Camera Type F-296	1	To obtain waveform photographs.
Tektronix Oscilloscope Model 531	1	To trouble-shoot individual circuits.
Tektronix Scopemobile 500/53	1	Movable platform for oscilloscope.
Tektronix Bezel BE510	1	Camera adapter for oscilloscope.
Biddle Type Megger 500V	1	Checking cabling insulation resistance.
Weston Clamp-on Ammeter Model 633	1	Measures input currents on primary lines.
Hewlett-Packard Voltage Divider 300:1 (Minimum)	1	Measures high a-c plate voltages.

5-3. OVERALL TROUBLE-SHOOTING.

a. PRELIMINARY CHECKS. - Check the transmitter group visually before executing any of the trouble-shooting procedures. A careful check should be made to determine that all front panel controls are in a position consistent with the desired mode of operation. These settings are described in Section 3. The visual inspection should cover such items as the indicator lamps, loose or disconnected exterior cables, physical damage, and an open interlock due to open doors or chassis that are not all the way in, which will activate the interlock switches. All lamps in the transmitter group are lighted during normal operation (refer to table 5-2) with the exception of those lamps noted below.

(1) High voltage power supply BLOWN FUSE INDICATOR lamps DS12, DS26, DS32, DS27, DS33, DS7, DS8, DS9, and DS11 (37, 35, 34, 33, 32, 42, 41, 40, and 38, figure 3-6).

(2) High voltage power supply LOW LINE ALARM DISABLE INDICATOR lamp DS30 (30).

(3) High voltage power supply PLATE VOLTS MIN. and MAX. lamps DS24 and DS23 (56 and 55).

NOTE

The PLATE VOLTS MAX. lamp DS23 will be lighted if the equipment is operating with full plate voltage.

(4) Coupling and load unit TRANSMITTER 2 ON ANTENNA lamp DS2 (3, figure 3-8).

(5) Coupling and load unit LOCAL lamp DS3 (6).

(6) Pulse generator OPERATE lamp DS1 (1, figure 3-1) of pulse generator 2.

(7) Control panel OPERATE XMTR 2 lamp DS17 (1, figure 3-2).

(8) Control panel pulse generator 2 on lamp DS2 (7).

(9) Control panel transmitter 2 READY and ON lamps DS6 and DS7 (10 and 11), if transmitter 2 is in shut down condition.

(10). Control panel transmitter 2 LOW V IND and transmitter 2 OVERLOAD IND lamps DS11 and DS12 (13 and 14).

(11). Control panel INTERLOCK DISABLE lamp DS8 (23).

(12). Control panel INTERLOCK INDICATOR lamp DS3 (9).

b. TEST EQUIPMENT AND SPECIAL TOOLS. - A complete list of test equipment and special tools, required for system trouble-shooting, is given in table 5-1.

c. CONTROL SETTINGS. - Table 5-2 lists the preliminary control settings, for normal operation, assuming that pulse generator 1 excites transmitter 1, transmitter 1 drives the antenna, and the transmitter B+ is controlled remotely. These settings should be made prior to performing the trouble-shooting procedures of tables 5-3 through 5-10. Control settings are to be changed as directed in the trouble-shooting procedures.

NOTE

If trouble occurs in the operating equipment (components which must be in operation for radiation of pulses), the defective unit must be placed in a standby condition and the corresponding standby equipment must be switched into the operate condition. This enables the station to remain operational while the trouble is being corrected. Since there is no standby equipment for the coupling and load unit, it is impossible to remain on the air if the trouble occure in this unit. In all other cases (except for a primary power failure), it is possible to continue station operation while trouble-shooting. Before commencing trouble-shooting, the equipment to be repaired must be placed in the OFF condition as described in Section 3. If station operation is to be continued during trouble-shooting, it is necessary that the standby equipment be placed in the operate condition as described in Section 3.

TABLE 5-2. LORAN TRANSMITTING SET AN/FPN-42, CONTROL SETTINGS UNDER NORMAL OPERATION

CONTROL	LOCATION	SETTING
Main circuit breaker	Transmitter building	On
Auxiliary circuit breaker	Transmitter building	On
Auxiliary circuit breaker	Operations building	On
FIL. VOLTAGE switch S4	High voltage power supply (for both transmitters)	On (up)
BIAS VOLTAGE switch S2	High voltage power supply (for both transmitters)	On (up)
PLATE VOLTAGE switch S3	High voltage power supply (for both transmitters)	Off (down)
AUTO-MANUAL switch S16	High voltage power supply (for both transmitters)	AUTO

TABLE 5-2. LORAN TRANSMITTING SET AN/FPN-42, CONTROL SETTINGS UNDER NORMAL OPERATION (Cont)

CONTROL	LOCATION	SETTING
LOW LINE ALARM switch S12	High voltage power supply (for both transmitters)	ALARM OPERATIVE
LOCAL & REMOTE SELECTOR switch S7	Coupling and load unit	REMOTE
PULSE GEN. 1. EXCITATION switch S4	Control panel	OPERATE BUS
PULSE GEN SELECTOR switch S8	Control panel	P. G. 1 TO XMTR 1, P. G. 2 TO XMTR 2
TRANSMITTER SELECTOR switch S7	Control panel	XMTR 1 TO ANTENNA
B+ XMTR 1 switch S11	Control panel	On (up)
INTERLOCK DISABLE switch S13	Control panel	Off (down)
B+ PULSE GEN. 1 switch S9	Control panel	On (up)
PULSE GEN. 2 EXCITATION switch S5	Control panel	OPERATE BUS
B+ XMTR 2 switch S12	Control panel	Off (down)
B+ PULSE GEN. 2 switch S10	Control panel	Off (down)

d. SYSTEM TROUBLE-SHOOTING CHART. - Table 5-3 is a system trouble-shooting chart which may be used as an aid in isolating a malfunction to a particular unit. It presents to the technician, test points to be used, preliminary actions to be followed, normal indications to be observed, and the succeeding steps to be taken.

NOTE

Table 5-3 does not cover monitor or test equipment circuits. If the monitor oscilloscope acts abnormally, refer to Appendix I, the oscilloscope technical manual, for detailed trouble-shooting

information. If the pulse analyzer acts abnormally, refer to table 5-6. If the alarm circuits operate abnormally, refer to table 5-7.

5-4. FUNCTIONAL SECTION TROUBLE-SHOOTING.

a. GENERAL. - The functional section trouble-shooting procedures are outlined in the charts, tables 5-4 through 5-10, which follow. The paragraphs which introduce the individual charts outline the preliminary checks and control settings which must be made.

WARNING

Before extending any chassis for trouble-shooting, place control panel INTERLOCK DISABLE switch S13, (21, figure 3-2) in the on (up) position. This will prevent the operational units from being shut down due to operation of the cabinet interlock circuits.

b. PULSE CONTROL UNIT FUNCTIONAL SECTIONS.

(1) DUAL POWER SUPPLY.

(a) PRELIMINARY CHECKS.

1. Place all dual power supply circuit breakers, (1, 12, and 13, figure 3-3) in the ON position. Place control panel B+ PULSE GEN. 1 and 2 switches S9 and S10 (26 and 8, figure 3-2) in the on (up) position to energize power supply 1 and power supply 2 of the dual power supply.

2. Observe the filament and d-c voltage fuse indicator lamps. All lamps should be illuminated. If any lamp is out, check the corresponding fuse.

3. Extend the chassis on its slides and inspect the wiring to terminal boards TB1, TB2, and TB3.

WARNING

Terminal board TB3 will have 120 volts, ac at its terminals. Terminal boards TB1 and TB2 may also have 120 volts ac and various d-c voltages at their terminals if the dual power supply circuit breakers are in the ON position. Both power supplies are identical and either one may be completely de-energized by placing the appropriate circuit breaker on the front panel in the OFF position.

4. Check the defective power supply for broken or loose wires and cold solder joints. Also check for burned resistors, charred wire insulation, or any signs of overheating.

NOTE

Both power supply 1 and power supply 2 are identical and the procedure outlined in the trouble-shooting chart is applicable for either supply. In order to properly identify the circuit breaker and remote control switch associated with a power supply, it will be assumed that power supply 1 (located at the rear of the chassis) is defective and is being checked.

(b) DUAL POWER SUPPLY TROUBLE-SHOOTING. - Table 5-4 presents the procedural steps necessary to isolate troubles within the dual power supply.

(2) PULSE GENERATOR.

NOTE

There are two identical pulse generators in the transmitter group and the following procedures are applicable to either pulse generator.

(a) PRELIMINARY CHECKS.

1. Observe pulse generator blown fuse lamp DS2 (7, figure 3-1). The lamp should be illuminated. If the lamp is out, check the associated fuses and replace as required.

2. Extend the chassis on its slides. Inspect the wiring connections at terminal board TB1 for loose or broken connections and check the internal wiring for evidence of excessive heating. Check that all vacuum tubes are firmly seated in their sockets.

3. Place the appropriate control panel B+ PULSE GEN. 1 or 2 switch, S9 or S10 (26 or 8, figure 3-2), in the on (up) position.

4. Check all voltages at terminal board TB1 with a multimeter using the pulse generator schematic diagrams figure 6-13 as a reference for the proper voltage.

(b) PULSE GENERATOR TROUBLE-SHOOTING. - Table 5-5 presents the trouble-shooting procedures to be followed when isolating faults within the pulse generator.

(3) PULSE ANALYZER.

(a) PRELIMINARY CHECKS.

1. Observe pulse analyzer blown fuse lamp DS1 (4, figure 3-4). The lamp should be illuminated. If the lamp is out, check the associated fuses and replace as required.

2. Extend the chassis on its slides and inspect terminal board TB1 for loose or broken connections. Inspect the internal wiring for evidence of excessive heating. Check that all vacuum tubes are firmly seated in their tube sockets.

3. Place pulse analyzer P.S.1 P.S.2 PWR. SUPPLY SEL. switch S3 (1, figure 3-4) in either the P.S.1 or P.S.2 position depending on which of the supplies is energized. Check the position of pulse generator PULSE SPACING switch S2 (2, figure 3-1). The correct position corresponds to the spacing of the transmitter triggers. Using a multimeter, check the a-c and d-c voltages on terminal board TB1 of the pulse analyzer. Refer to the figure 6-16 for the correct voltages.

(b) PULSE ANALYZER TROUBLE-SHOOTING. - Table 5-6 provides the checks required to isolate a fault in the pulse analyzer.

(4) PULSE CONTROL UNIT CABINET AND CONTROL PANEL. - Table 5-7 presents the abnormal indications, probable causes, and corrective measures which will assist the technician in isolating faults in these units.

(5) MONITOR OSCILLOSCOPE. - Functional section trouble-shooting for the monitor oscilloscope is given in Appendix I, the oscilloscope technical manual.

c. TRANSMITTER. - Table 5-8 presents the procedural steps to be followed when isolating troubles occurring in the transmitter. Refer to Section 6 for CAUTION and WARNING notes concerning replacement of parts in this unit.

d. HIGH VOLTAGE POWER SUPPLY. - Refer to the Volume 3 for trouble-shooting procedures on the high voltage power supply.

e. COUPLING AND LOAD UNIT.

(1) PRELIMINARY CHECK.

(a) Make a visual inspection of the coupling and load unit front panel to determine that the proper indicators are illuminated.

(b) If either transmitter is operating into the dummy load, the coupling and load unit blower should be operating. If the blower is not operating, depress coupling and load unit BLOWER RESET switch (5, figure 3-8).

WARNING

Before removing the cabinet panels, place coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the LOCAL position and place high voltage power supply PLATE VOLTAGE switch S3 (18, figure 3-6) on both high voltage power supplies in the off (down) position. After removing the panels, use the ground rod to securely ground both transmitter inputs to the coupling and load unit and leave the ground rod connected to the antenna feed-through E2 during trouble-shooting.

(c) Remove the coupling and load unit panels and check visually to see that:

1. There are no loose connections on terminal boards TB1, TB2, and TB3.

2. There are no broken wires or wafers on the transmitter function switch S2 (9, figure 6-11).

3. The dummy load resistors R1 through R48 (figure 6-18) are all properly seated.

4. The relay switches S3 and S4 (3, figure 6-11) are in place.

5. There are no loose copper tubing connections.

6. All required 120-volt inputs to terminal boards TB1, TB2, and TB3 are present.

7. The connectors to jacks J1 and J2 (17 and 23, figure 6-19) are properly connected.

8. There are no high voltage breakdown burns.

9. There are no broken interlock switches.

(d) Place coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the REMOTE position.

(2) COUPLING AND LOAD UNIT TROUBLE-SHOOTING. - Table 5-9 lists the steps to be followed in isolating troubles located in the coupling and load unit.

f. TRANSMITTER GROUP CONTROL CIRCUITS TROUBLE-SHOOTING. - For controls and indicators peculiar to the pulse control cabinet, high voltage power supply, or coupling and load, refer to the corresponding trouble-shooting chart. Table 5-10 lists transmitter control circuit troubles which are not covered by the other trouble-shooting charts.

g. VOLTAGE AND RESISTANCE READINGS.

(1) The voltage and resistance values for the pulse generator, pulse analyzer, dual power supply, pulse driver, and transmitter are given in table 5-11.

CAUTION

Do not attempt to measure a-c voltages in excess of 600 volts using an external oscilloscope directly. A capacity voltage-divider is supplied for this purpose. When using this instrument for high-voltage measurements, refer to step (2).

(2) The following procedures must be followed when making high-voltage measurements with the capacity voltage-divider.

(a) Place the transmitter in the STANDBY condition as described in Section 3.

WARNING

No measurements are to be made on the transmitter unless it is under local control (the LOCAL & REMOTE SELECTOR switch on the coupling and load unit should be placed in the LOCAL position). Never work on the transmitter without the immediate presence of another person capable of administering first aid.

(b) Ground all points in the working area using the grounding rods provided. All grounding rods should be securely connected to ground before using.

(c) Locate the capacitor voltage-divider near the point to be measured. Connect the output cable to the test oscilloscope input. Connect an insulated lead from the test point to the divider input terminal. Carefully ground the divider

unit case and the oscilloscope chassis to the transmitter cabinet. For additional safety use two ground lines in case one breaks accidentally. Dress the input lead away from the cabinet and other components and wiring.

(d) Place high voltage power supply BIAS VOLTAGE and PLATE VOLTAGE switches S2 and S3 (19 and 18, figure 3-6) in the on (up) position.

(e) Observe the waveform on the test oscilloscope, being careful not to touch the voltage-divider or its input lead.

(f) Place high voltage power supply BIAS VOLTAGE and PLATE VOLTAGE switches S2 and S3 in the off (down) position.

(g) Ground all points in the working area using the grounding rods provided.

(h) Remove the capacity voltage-divider and its connections from the transmitter.

h. POWER INTERLOCK AND DISTRIBUTION. - Figure 5-11 illustrates power interlock and control circuits. Figures 5-12 through 5-13 illustrate the distribution of a-c and d-c power in the transmitter and pulse control units. These diagrams, grouped at the rear of this section, will aid the technician in isolating malfunctions in the various power distribution loops.

5-5. TYPICAL TROUBLES.

The typical troubles which may occur in the transmitter group are given in table 5-12. This table enables maintenance personnel to isolate typical malfunctions of the unit.

5-6. LOCATION OF PARTS.

The locations of transmitter group parts are illustrated in Section 6.

TABLE 5-3. LORAN TRANSMITTING SET AN/FPN-42, SYSTEM TROUBLE-SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	Visual Check	Place dual power supply 120V LINE POWER SUPPLY 1 or 2 circuit breaker CB1A or CB1B (13 or 12, figure 3-3) in the On position.	Blown fuse lamp DS1A or DS1B (15 or 11, figure 3-3) lights. Pulse generator blown fuse lamp DS2 (7, figure 3-1) lights. Blown fuse lamp DS2B or DS2A (9 or 17, figure 3-3) lights.	1. If lamps do not light, check corresponding fuses and lamps. 2. If indication is normal, proceed to step 2.
2	Visual Check	Place control panel B+ PULSE GEN. 1 or 2 switch S9 or S10 (26 or 8, figure 3-2) in the on (up) position.	Dual power supply blown fuse lamps DS3A, DS4A, and DS5A (19, 22, and 23, figure 3-3) lights.	1. If any lamps do not light, check the corresponding fuses and lamps. 2. If indication is normal, proceed to step 3.
3	(1) (2) Figures 5-3 and 6-12	Place control panel INTERLOCK DISABLE switch S13 (21, figure 3-2) in the on (up) position. Measure the d-c voltages at TB1-3 and -4 to ground.	Voltage readings are 300v and -150v, respectively.	1. If readings are incorrect, adjust the dual power supply voltages by varying R21 and R71 (25 and 12, figure 6-1). 2. If voltages cannot be adjusted to the correct values, refer to table 5-4.

TABLE 5-3. LORAN TRANSMITTING SET AN/FPN-42, SYSTEM TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
4	Visual Check	1. Place control panel SIGNAL SELECTOR switch S1 (2, figure 3-2) in the PULSE GEN. OUTPUT position. 2. Place PULSE GEN. SELECTOR SCOPE DISPLAY switch S6 (4) in the PULSE GEN. 1 or 2 position.	See figure 5-1e.	If indication is abnormal, refer to table 5-5.
5	Visual Check	1. Place coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the LOCAL position 2. Place high voltage power supply FIL. VOLTAGE switch S4 (20, figure 3-6) in the on (up) position. 3. Place BIAS VOLTAGE switch S2 (19) and PLATE VOLTAGE switch S3 (18) in the off (down) position.	1. All green and amber indicating lamps on the high voltage power supply light except: a. FIL. ON lamp DS10 (58, figure 3-6) b. FIL. READY lamp DS13 (17) c. BIAS ON lamp DS15 (16)	If indication is abnormal, refer to Section 5 of Volume 3.

TABLE 5-3. LORAN TRANSMITTING SET AN/FPN-42, SYSTEM TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
5 (Cont)		4. Depress START switch S8 (57).	2. All red and white lamps should be out except PLATE VOLTS MIN. DS24 (56). 3. After 15 seconds have elapsed, FIL. ON lamp DS10 (58) lights. 4. After five minutes, FIL. READY lamp DS13 (17) lights.	
6	Visual Check	Place high voltage power supply BIAS VOLTAGE switch S2 (19, figure 3-6) and the PLATE VOLTAGE switch S3 (18) in the on (up) position.	1. All amber and green lamps now light. 2. The PLATE ON lamp DS14 (15, figure 3-6) lights. 3. PLATE VOLTS MIN. lamp DS24 (56) goes out.	If indication is abnormal, refer to Section 5, in Volume 3.
7	Visual Check	Check all meter readings on the high voltage power supply.	Refer to table 3-3.	If indication is abnormal, refer to Section 5, in Volume 3.

TABLE 5-3. LORAN TRANSMITTING SET AN/FPN-42, SYSTEM TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
8	Visual Check	1. Place transmitter control panel SIGNAL SELECTOR switch S18 (3, figure 3-7) in the PULSE DRIVER position. 2. Observe the waveform on the monitor oscilloscope.	See figure 5-1j.	If indication is abnormal, refer to table 5-8, step 2.
9	Visual Check	1. Place transmitter control panel SIGNAL SELECTOR switch S18 (3, figure 3-7) in the 1ST IPA position. 2. Observe the waveform on the monitor oscilloscope.	See figure 5-1k.	If indication is abnormal, refer to table 5-8, step 3.
10	Visual Check	1. Place transmitter control panel SIGNAL SELECTOR switch S18 (3, figure 3-7) in the 2ND IPA position. 2. Observe the waveform on the monitor oscilloscope.	See figure 5-1l.	If indication is abnormal, refer to table 5-8, step 4.

TABLE 5-3. LORAN TRANSMITTING SET AN/FPN-42, SYSTEM TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
11	Visual Check	1. Place transmitter control panel SIGNAL SELECTOR switch S18 (3, figure 3-7) in the OUTPUT position. 2. Observe the waveform on the monitor oscilloscope.	See figure 5-1m.	If indication is abnormal, refer to table 5-8, step 7.

TABLE 5-4. POWER SUPPLY ASSEMBLY PP-2541/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	3 Figures 5-2 and 6-14	Connect a-c voltmeter across TB1-8 and -9.	120 volts ±10%	1. If indication is normal, proceed with step 2. 2. If indication is abnormal, check the wiring from CB1-A. If wiring is correct, replace CB1-A.
2	4 Figures 5-2 and 6-14	Connect a-c voltmeter across T2-3 and -5, and T2-6 and -8.	6.3 volts ±10%	1. If indication is normal, proceed with step 3. 2. If indication is abnormal, check the wiring to T2. If wiring is correct, replace T2.
3	5 Figure 5-2 and 6-14	Connect a-c voltmeter across TB1-10 and TB1-5. Place control panel B+ PULSE GEN. 1 switch S9 in the on (up) position (26, figure 3-2).	120 volts ±10%	1. If indication is normal, proceed with step 4. 2. If indication is abnormal, check the wiring from S9 on the control panel to K1 on the dual power supply. If the wiring is correct, replace S9.
4	6 Figures 5-2 and 6-14	Connect a-c voltmeter across T1-1 and T1-3. Place control panel B+ PULSE GEN. 1 switch S9 (26, figure 3-2) in the on (up) position.	120 volts ±10%	1. If indication is normal, proceed with step 5. 2. If indication is abnormal, check the wiring from T1-1 to K1-2. If wiring is correct, check K1.

TABLE 5-4. POWER SUPPLY ASSEMBLY PP-2541/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
5	A_1 Figures 5-2 and 6-14	Connect d-c voltmeter (+) to V1-2 and (-) to ground.	452 volts ±10%	1. If indication is normal, proceed with step 6. 2. If indication is abnormal, check CR1 through CR8 and the high voltage filter. Replace defective component.
6	A_2 Figures 5-2 and 6-14	Connect d-c voltmeter (+) to V6-2 and (-) to ground.	253 volts ±10%	1. If indication is normal, proceed with step 7. 2. If indication is abnormal, check CR9 through CR14 and the low voltage filter. Replace defective component.
7	A_3 Figures 5-2 and 6-14	Connect d-c voltmeter (+) to V11-2 and (-) to ground.	105 volts ±10%	1. If indication is normal, proceed with step 8. 2. If indication is abnormal, check CR18 through CR23 and the low voltage filter. Replace defective component.
8	A_4 Figures 5-2 and 6-14	Connect d-c voltmeter (-) to junction of R79 and C8 (XC8-2) and (+) to ground.	-200 volts ±10%	1. If indication is normal, proceed with step 9. 2. If indication is abnormal, check CR15 through CR17 and filter. Replace defective component.

TABLE 5-4. POWER SUPPLY ASSEMBLY PP-2541/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
9	A5 Figures 5-2 and 6-14	Connect d-c voltmeter (-) to junction of R86 and C12 (XC12-1) and (+) to ground.	-350 volts ±10%	1. If indication is normal, proceed with step 10. 2. If indication is abnormal, check CR24 through CR26 and filter. Replace defective component.
10	A6 Figures 5-2 and 6-14	Connect d-c voltmeter (+) to TB1-2 and (-) to ground. Vary R21 (25, figure 6-1) through its range.	285 to 315 volts (minimum)	1. If indication is normal, proceed with step 13. 2. If abnormal, adjust R21 so that meter reads as close to 300 volts as possible and proceed with step 11. If this voltage does not exceed 200 volts, replace V1 and V2.
11	A7 Figures 5-2 and 6-14	Connect d-c voltmeter (-) to V5-2 and (+) to ground.	-82 to -92 volts	1. If indication is normal, proceed with step 12. 2. If indication is abnormal, replace V5.
12	Tube check	Remove and check V1, V2, V3, and V4. (See figure 6-1.)	Refer to instruction manual for tube checker.	1. If indication is normal, check the d-c resistance from each tube pin to ground and compare with table 5-11. Replace defective component.

TABLE 5-4. POWER SUPPLY ASSEMBLY PP-2541/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
12 (Cont)				2. If indication is abnormal, replace defective tube and readjust R21 for 300 volts at TB1-2.
13	A8 Figures 5-2 and 6-14	Connect d-c voltmeter (+) to TB1-3 and (-) ground, vary R44 (10, figure 6-1) through its range.	142 to 158 volts (minimum)	1. If indication is normal, proceed with step 17. 2. If indication is abnormal, adjust R44 so that meter reads as close to 150 volts as possible and proceed with step 14.
14	A9 Figures 5-2 and 6-14	Connect d-c voltmeter (-) to V10-2 and (+) to ground.	-150 volts ±1%	1. If indication is normal, proceed with step 15. 2. If indication is abnormal, a) Replace V10 b) Check R47
15	A10 Figures 5-2 and 6-14	Connect d-c voltmeter (-) to V9-2 and (+) to ground.	-82 to -92 volts	1. If indication is normal, proceed with step 16. 2. If indication is abnormal, a) Replace V9 b) Check R46
16	Tube check	Remove and check V6, V7, and V8. (See figure 6-1.)	Refer to instruction manual for tube checker	1. If indication is normal, check the d-c resistance from each tube pin to ground and compare with

TABLE 5-4. POWER SUPPLY ASSEMBLY PP-2541/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
16 (Cont)				table 5-11. Replace defective component. 2. If indication is abnormal, replace defective tube and readjust R44 for 150 volts at TB1-3.
17	A11 Figures 5-2 and 6-14	Connect d-c voltmeter (-) to terminal TB1-4 and (+) to ground. Vary R71 through its range.	-142 to -157 volts (minimum)	If indication is abnormal, adjust R71 so that the meter reads as close to -150 volts as possible and proceed with step 18.
18	A12 Figures 5-2 and 6-14	Connect d-c voltmeter (-) to V14-2 and (+) to ground.	150 volts more negative than the reading in step 17	1. If indication is normal, proceed with step 19. 2. If indication is abnormal: a) Replace V14 b) Check R57
19	A13 Figures 5-2 and 6-14	Connect d-c voltmeter (-) to V15-2 and (+) to ground.	82 to 92 volts more negative than the reading in step 17	1. If indication is normal, proceed with step 20. 2. If indication is abnormal, a) Replace V15 b) Check R67
20	Tube check	Remove and check V11, V12, and V13. (See figure 6-1.)	Refer to instruction manual for tube checker	1. If indication is normal, check the d-c resistance from each tube pin to ground and compare with

TABLE 5-4. POWER SUPPLY ASSEMBLY PP-2541/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
20 (Cont)				table 5-11. Replace defective component. 2. If indication is abnormal, replace defective tube and readjust R71 for -150 volts at TB1-4.

TABLE 5-5. PULSE GENERATOR O-706/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	B1 Figures 5-3 and 6-13	Place oscilloscope probe at V5-1.	See figure 5-4a.	1. If indication is normal, proceed with step 2. 2. If indication is abnormal, proceed with step 7.
2	B2 Figures 5-3 and 6-13	Place oscilloscope probe on the junction of R78 and R82 (E36).	See figure 5-4b.	1. If indication is normal, proceed with step 3. 2. If indication is abnormal, proceed with step 16.
3	B3 B4 Figures 5-3 and 6-13	Place oscilloscope probe at V12-1 and -3.	See figure 5-4c and d.	1. If indication is normal, proceed with step 4. 2. If indication is abnormal: a. Check V12 and replace if defective. b. Check the voltage and resistance of the components associated with V12. Replace defective part.
4	B5 B6 Figures 5-3 and 6-13	Place oscilloscope probe at V13-5 and V14-5.	See figure 5-4e. (●B6 indication is 180 degrees out of phase with that of ●B5.)	1. If indication is normal, proceed with step 5. 2. If indication is abnormal: a. Check V13 and V14 and replace if defective. b. Check the d-c voltage at the pins of V13 and V14.

TABLE 5-5. PULSE GENERATOR O-706/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
4 (Cont)				If any voltages are incorrect, check the defective part.
5	B7 Figures 5-3 and 6-13	1. De-energize the pulse generator. 2. Remove P1 from J1. 3. Connect a 100-ohm dummy load across the secondary of T5. 4. Energize the pulse generator. 5. Place oscilloscope probe at T5-1.	See figure 5-4f.	1. If indication is normal, proceed to step 6. 2. If indication is too low in amplitude: a. Remove and check V15, V16, V17, and V18. b. Check for a short circuit across the primary or secondary of T5. 3. Measure the d-c voltage at T4-4 and T4-6. If the voltage is incorrect, check R70, R81, and R91. 4. If indication is too high in amplitude, check for an open circuit in either the primary or secondary of T5.
6	7 Figures 5-3 and 6-13	Place oscilloscope probe at J1. Ground T5-6 to the chassis. (Do not remove dummy load).	See figure 5-4g.	1. If indication is normal, check the cabling between J1 and S8 on the control panel. If the cabling is intact, refer to the control

TABLE 5-5. PULSE GENERATOR O-706/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6 (Cont)				panel trouble shooting chart. 2. If indication is abnormal, check T5.
7	B8 B9 Figures 5-3 and 6-13	Place oscilloscope probe at V3-6 and V3-8.	See figure 5-4h and i.	1. If indication is normal, proceed with step 8. 2. If indication is abnormal, proceed with step 10.
8	B10 B11 Figures 5-3 and 6-13	Place oscilloscope probe at junction of R29 and R30 (E64) and junction of R25 and R26 (E69).	See figure 5-4j and k.	1. If indication is normal, proceed with step 9. 2. If indication is abnormal, proceed with step 19.
9	B1 Figures 5-3 and 6-13	Place oscilloscope probe at V5-1.	See figure 5-4a.	1. Remove and check V4 and V5. Replace the defective tube. 2. Check the values of R23, R24, R25, R26, R27, R28, R29, and R30. Replace the defective resistor. 3. Replace C5 and C7.
10	B12 Figures 5-3 and 6-13	Place oscilloscope probe at FL1-3.	See figure 5-41.	1. If indication is normal, proceed with step 11. 2. If indication is abnormal, proceed with step 24.

TABLE 5-5 PULSE GENERATOR O-706/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
11	B13 B14 Figures 5-3 and 6-13	Place oscilloscope probe at V7-1 and -3.	See figure 5-4m and n.	1. If indication is normal, proceed with step 12. 2. If indication is abnormal, proceed with step 27.
12	B15 B16 B17 B18 Figures 5-3 and 6-13	Lift one side of CR1, CR2, CR3, and CR4. Measure the forward and backward resistance of CR1, CR2, CR3, and CR4.	Forward resistance should be 14 ohms. Backward resistance should be infinite.	1. If indication is abnormal, replace the defective diode. 2. If indication is normal, proceed with step 13.
13	B19 Figure 5-3 and 6-13	Connect d-c voltmeter (-) to junction of C8 and CR3 (E10) and (+) to ground.	-19 volts	1. If indication is normal, proceed with step 14. 2. If indication is abnormal, check R34 and R35. Replace the defective component.
14	B20 Figures 5-3 and 6-13	Connect d-c voltmeter (+) to junction of C9 and CR4 (E9) and (-) to ground.	19 volts	1. If indication is normal, proceed with step 15. 2. If indication is abnormal, check R31 and R33. Replace defective part.

TABLE 5-5. PULSE GENERATOR O-706/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
15	B8 B9 Figures 5-3 and 6-13	Place oscilloscope probe at V3-6 and -8.	See figure 5-4h and i.	1. If indication is abnormal: a. Remove and check V3. Replace if defective. b. Check values of all components associated with V3. Replace defective part.
16	B21 Figures 5-3 and 6-13	Place oscilloscope probe at V11-1.	See figure 5-4q.	1. If indication is normal: a. Remove and check V11. b. Check the components associated with V11-B. Replace defective part. 2. If indication is abnormal, proceed with step 17.
17	B22 Figures 5-3 and 6-13	Place oscilloscope probe at V10-1.	See figure 5-4r.	1. If indication is normal: a. Remove and check V11. Replace if defective. b. Check the components associated with V11-A. Replace defective part. 2. If indication is abnormal, proceed with step 18.
18	B23 Figures 5-3 and 6-13	Place oscilloscope probe at T3-3.	See figure 5-4s.	1. If indication is normal: a. Remove and check V10. Replace if defective.

TABLE 5-5. PULSE GENERATOR O-706/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
18 (Cont)				b. Check the forward and back resistance of CR8. Replace if defective. c. Check the components associated with V10. Replace defective part.
19	B10 B11 Figures 5-3 and 6-13	Place oscilloscope probe at junction of R29 and R30 (E64) and junction of R25 and R26 (E69).	See figure 5-4j and k.	1. If there is excessive positive overshoot, replace CR7. 2. If there is excessive negative overshoot, replace CR10. 3. If indication is still abnormal, proceed with step 20.
20	B24 Figures 5-3 and 6-13	Place oscilloscope probe at junction of C27 and C26 (E58).	See figure 5-4t.	1. If indication is normal: a. Remove and check V9. Replace if defective. b. Check forward and back resistance of CR7 and CR10. Replace if defective. c. Check the components associated with V9. Replace defective part. 2. If indication is abnormal, proceed with step 21.

TABLE 5-5. PULSE GENERATOR O-706/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
21	B25 Figures 5-3 and 6-13	Place oscilloscope probe at V8-6.	See figure 5-4u.	1. If indication is normal: a. Remove and check V9. Replace if defective. b. Check the components associated with V9. Replace defective part. 2. If indication is abnormal, proceed with step 22.
22	B26 Figures 5-3 and 6-13	Place oscilloscope probe at DL1-2.	See figure 5-4v.	1. If indication is normal: a. Remove and check V8. Replace if defective. b. Check the forward and back resistance of CR6. c. Check the values of components associated with V8. Replace if defective. 2. If indication is abnormal, proceed with step 23.
23	B27 Figures 5-3 and 6-13	Place oscilloscope probe at T2-3.	See figure 5-4w.	1. If indication is normal, replace DL1. 2. If indication is abnormal, check T2.
24	B28 Figures 5-3 and 6-13	Place oscilloscope probe at FL1-1.	See figure 5-4x.	1. If indication is normal, replace FL1. 2. If indication is abnormal, proceed with step 25.

TABLE 5-5. PULSE GENERATOR O-706/FPN-42
FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
25	B29 Figures 5-3 and 6-13	Place oscilloscope probe at V1-2.	See figure 5-4y.	1. If indication is normal, check V1 and associated circuit. 2. If indication is abnormal, check V2 and associated circuit. If still abnormal, proceed with step 26.
26	B30 Figures 5-3 and 6-13	Place oscilloscope probe at T1-3.	See figure 5-4z.	1. If indication is normal: a. Remove and check V1. Replace if defective. b. Check the values of the components associated with V1. Replace defective part. 2. If indication is abnormal, check T1.
27	B31 Figures 5-3 and 6-13	Place oscilloscope probe at junction of R40 and R41 (E16).	See figure 5-4aa.	1. If indication is normal: a. Remove and check V7. Replace if defective. b. Check the values of the components associated with V7. Replace defective part. 2. If indication is abnormal: a. Remove and check V6. Replace if defective.

TABLE 5-5. PULSE GENERATOR O-706/FPN-42
FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
27 (Cont)				b. Check the forward and back resistance of CR5. Replace if defective. c. Check the values of the components associated with V6. Replace defective part.

TABLE 5-6. ELECTRICAL PULSE ANALYZER TS-1360/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	Visual Check 8 Figures 5-5 and 6-16	1. Place pulse analyzer SCOPE TRIG. SELECTOR switch S2 (7, figure 3-4) in PULSE ANAL position. 2. Synchronize oscilloscope on J1 using + EXT. 3. Place oscilloscope probe at J2. 4. Rotate pulse analyzer PULSE SEL. switch S1 (3) through its range.	The trigger should move in steps of either 500 or 1000 microseconds and should be 10 volts peak minimum. See figure 5-10m.	1. If indication is normal, proceed with step 2. 2. If indication is abnormal, proceed with step 4.
2	C1 Figures 5-5 and 6-16	Place oscilloscope probe at K1-7.	Relay switches between the ground reference and a pulse riding on a negative bias. See figure 5-10a.	1. If indication is normal, proceed with step 3. 2. If indication is abnormal, proceed with step 12.
3	9 Figures 5-5 and 6-16	Place oscilloscope probe at J4.	See figure 5-10n.	1. If indication is normal, the pulse analyzer if functioning properly. 2. If indication is abnormal: a. Check V12 and replace if defective.

TABLE 5-6. ELECTRICAL PULSE ANALYZER TS-1360/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
3 (Cont)				b. Check for an open or short circuit resistors R54 and R56 and potentiometers R51, R52, and R55.
4	C2 Figures 5-5 and 6-16	Place oscilloscope probe at V7-2.	See figure 5-10b.	1. If indication is normal: a. Remove and check V7. Replace if defective. b. Check the components associated with V7. 2. If indication is abnormal, proceed with step 5.
5	C3 Figures 5-5 and 6-16	Place oscilloscope probe at V6-5.	See figure 5-10c.	1. If indication is normal: a. Remove and check V5. Replace if defective. b. Check the wiring and the contacts on wafer switch S1. 2. If indication is abnormal, proceed with step 6.
6	C4 Figures 5-5 and 6-16	Place oscilloscope probe at V6-1.	See figure 5-10d.	1. If indication is normal, proceed with step 7. 2. If indication is abnormal: a. Check C2. b. Check for either a short or open connection between J1 and V6-1 through C2.

TABLE 5-6. ELECTRICAL PULSE ANALYZER TS-1360/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
7	C5 Figures 5-5 and 6-16	Place oscilloscope probe at V6-7.	See figure 5-10e.	1. If indication is normal: a. Remove and check V6. Replace if defective. b. Check the wiring and components associated with V6. 2. If indication is abnormal, proceed with step 8.
8	C6 Figures 5-5 and 6-16	Place oscilloscope probe at V4-2.	See figure 5-10f.	1. If indication is normal: a. Remove and check V4. Replace if defective. b. Check the wiring and components associated with V4. 2. If indication is abnormal, proceed with step 9.
9	C7 Figures 5-5 and 6-16	Place oscilloscope probe at V3-2.	See figure 5-10g.	1. If indication is normal: a. Remove and check V3. Replace if defective. b. Check the components associated with V3. 2. If indication is abnormal, proceed with step 10.

TABLE 5-6. ELECTRICAL PULSE ANALYZER TS-1360/FPN-42, FUNCTION SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
10	C8 Figures 5-5 and 6-16	Place oscilloscope probe at V1-6.	See figure 5-10h.	1. If indication is normal: a. Remove and check V2. Check for short circuit between V2-1 and -7. b. Check C5, R8, and R9. 2. If indication is abnormal, proceed with step 11.
11	C9 Figures 5-5 and 6-16	Place oscilloscope probe at V1-2.	See figure 5-10i.	1. If indication is normal: a. Remove and check V1. Replace if defective. b. Check the components associated with V1. 2. If indication is abnormal, check CR1, C1, R1, R67, and R68.
12	C10 Figures 5-5 and 6-16	Place oscilloscope probe at V8-5	See figure 5-10j.	1. If indication is normal, proceed with step 13. 2. If indication is abnormal: a. Remove and check V2. Replace if defective. b. Check C4 and C17. Replace if defective.
13	C11 Figures 5-5 and 6-16	Place oscilloscope probe at V9-6.	See figure 5-10k.	1. If indication is normal, proceed with step 14.

TABLE 5-6. ELECTRICAL PULSE ANALYZER TS-1360/FPN-42, FUNCTION SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
13 (Cont)				2. If indication is abnormal: a. Remove and check V8. Replace if defective. b. Remove and check V9. Replace if defective. c. Check the components associated with V9.
14	C_{12} Figures 5-5 and 6-16	Place oscilloscope probe at V10-1.	See figure 5-10l.	1. If indication is normal, replace K1. 2. If indication is abnormal: a. Remove and check V10. Replace if defective. b. Remove and check V11. Replace if defective. c. Check R53. d. Check the d-c resistance of the coil of K1 which should be 355 ohms. Replace if defective. e. Check the components associated with V10.

TABLE 5-7. TRANSMITTER CONTROL GROUP OA-2631/FPN-42 AND CONTROL PANEL, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART

ABNORMAL INDICATIONS	PROBABLE CAUSE	CORRECTIVE MEASURES
All power supply voltages and filament voltages absent, and control panel INTERLOCK DISABLE switch S13 (21, figure 3-2) inoperative.	1. Short circuit across cabinet thermostat S5 or thermostat S5 is defective. (See figure 6-12.)	1. Check for a short circuit across the thermostat. If no short is present, replace the thermostat.
	2. Interlock disable relay K2 is defective. (See figure 6-12.)	2. Check K2.
	3. INTERLOCK DISABLE switch S13 is defective. (See figure 6-15.)	3. Check S13.
Control panel INTERLOCK INDICATOR lamp DS3 (9, figure 3-2) inoperative.	1. Defective lamp DS3.	1. Replace DS3.
	2. Interlock indicator relay K6 is defective. (See figure 6-12.)	2. Check K6.
Improper synchronizing triggers fed into transmitter oscilloscope.	1. Transmitter scope trigger control relay K1 malfunctioning. (See figure 6-12.)	1. Check K1.
	2. Defective contacts on PULSE GEN. SELECTOR switch S8. (See figure 6-15.)	2. Repair contact if possible. If not, replace S8.
Improper operation of the interlock or absence of B+ on the pulse analyzer chassis.	1. PWR. SUPPLY SEL. switch S3 on pulse analyzer in improper position. (See figure 6-16.)	1. Check position of S3.
	2. Pulse analyzer B+ select relay K5 defective. (See figure 6-12.)	2. Check K5.
	3. Pulse analyzer B+ interlock relay K4 defective. (See figure 6-12.)	3. Check K4.

TABLE 5-7. TRANSMITTER CONTROL GROUP OA-2631/FPN-42 AND CONTROL PANEL, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

ABNORMAL INDICATIONS	PROBABLE CAUSE	CORRECTIVE MEASURES
Control panel pulse generator 1 on lamp DS1 (28, figure 3-2) inoperative.	1. Defective lamp DS1.	1. Replace DS1.
	2. Either B+ PULSE GEN. 1 switch S9 or its wiring is defective. (See figure 6-15.)	2. Check S9 and associated wiring.
Control panel pulse generator 2 on lamp DS2 (7, figure 3-2) inoperative.	1. Defective lamp DS2.	1. Replace DS2.
	2. Either B+ PULSE GEN. 2 switch S10 or its wiring is defective. (See figure 6-15.)	2. Check S10 and its associated wiring.
Any combination of the following indicators inoperative: control panel transmitter 1 READY and ON and transmitter 2 READY and ON lamps DS4, DS5, DS6, and DS7 (24, 25, 10, and 11, figure 3-2).	1. Defective indicator DS4, DS5, DS6 or DS7. (See figure 6-15.)	1. Replace DS4, DS5, DS6, or DS7.
	2. Defective circuits in high voltage power supply.	2. Refer to Section 5 of Volume 3.
Control panel LOW V IND Lamp DS9 or DS11 (19 or 13, figure 3-2) or low voltage alarm DS14 or DS15 inoperative.	1. Defective indicator DS9, DS11, DS14 or DS15. (See figure 6-15.)	1. Replace DS9, DS11, DS14 or DS15.
	2. Defective circuits in high voltage power supply.	2. Refer to Section 5 of Volume 3.
Control panel transmitter 1 or 2 OVERLOAD IND lamp DS10 or DS12 (20 or 14, figure 3-2) or overload alarm DS13 inoperative.	1. Defective indicators DS10, DS12 or DS13. (See figure 6-15.)	1. Replace DS10, DS12 or DS13.
	2. Overload relay K1 or K2 defective. (See figure 6-15.)	2. Replace K1 or K2.
	3. Defective circuits in high voltage power supply.	3. Refer to Section 5 of Volume 3.

TABLE 5-7. TRANSMITTER CONTROL GROUP OA-2631/FPN-42 AND CONTROL PANEL, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

ABNORMAL INDICATIONS	PROBABLE CAUSE	CORRECTIVE MEASURES
Control panel OPERATE XMTR 1 or 2 lamps DS16 or DS17 (31 or 1, figure 3-2) inoperative.	1. Defective lamp DS16 or DS17. (See figure 6-15.)	1. Replace DS16 or DS17.
	2. Defective circuits in coupling and load unit.	2. Refer to table 5-9.
Control panel XMTR 1 or 2 EMERGENCY STOP switch S2 or S3 (30 or 3, figure 3-2) inoperative.	1. Switch contacts shorted.	1. Check S2 and S3 and replace if defective.
	2. Defective circuits in transmitter or high voltage power supply.	2. Refer to appropriate trouble-shooting charts.
Control panel TRANSMITTER SELECTOR switch S7 (27, figure 3-2) inoperative.	1. Defective switch S7. (See figure 6-15.)	1. Replace S7.
	2. Defective antenna switching circuits in coupling and load unit.	2. Refer to table 5-9.
	3. B+ XMTR 1 switch S11 or B+ XMTR 2 switch 2 improperly positioned or defective. (See figure 6-15.)	3. Check and correct or replace S11 and S12.
Control panel B+ PULSE GEN 1 or 2 switches, S9 and S10, (26 or 8, figure 3-2), inoperative.	Defective remote control relay K1 in dual power supply. (See figure 6-14.)	Refer to table 5-4.
Control panel B+ XMTR 1 or 2 switches S11 and S12 (22, or 12, figure 3-2) inoperative.	1. Coupling and load unit LOCAL & REMOTE SELECTOR switch S7 in LOCAL position. (See figure 6-19.)	1. Place LOCAL & REMOTE SELECTOR switch (7, figure 3-8) in REMOTE position.
	2. Plate voltage relay K27 (Section 6 in Volume 3 of this Technical Manual) in high voltage power supply defective.	2. Check relay K27.

TABLE 5-7. TRANSMITTER CONTROL GROUP OA-2631/FPN-42 AND CONTROL PANEL, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

ABNORMAL INDICATIONS	PROBABLE CAUSE	CORRECTIVE MEASURES
Control panel LOW VOLT RESET XMTR 1 or 2 switches S14 or S15 (17 or 15, figure 3-2) inoperative.	Defective circuits in high voltage power supply.	Refer to Section 5 of Volume 3.

TABLE 5-8. AMPLIFIER ASSEMBLY AM-2481/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	Visual Check	1. Place transmitter control panel SIGNAL SELECTOR switch S18 (3, figure 3-7) in the INPUT position. 2. Observe the monitor oscilloscope.	See figure 5-1i.	1. If indication is normal, proceed with step 2. 2. If indication is abnormal: a. De-energize equipment (B+ and bias) b. Check the output at the pulse control unit. c. Check interconnecting cables 8A1, 8A2, and connectors.
2	Visual Check	Place transmitter control panel SIGNAL SELECTOR switch S18 (3, figure 3-7) in PULSE DRIVER position. Observe the monitor oscilloscope.	See figure 5-1j.	1. If indication is normal, proceed with step 3. 2. If indication is abnormal: a. De-energize the equipment (B+, bias and filaments). b. Remove and check F1 and F2 on pulse driver unit. If either fuse is defective, replace and repeat the check. If fuses are good, but the check is still abnormal, proceed to next step. c. De-energize the equipment (B+ only).

TABLE 5-8. AMPLIFIER ASSEMBLY AM-2481/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
2 (Cont)	E1 E2 E3 E4 Figures 5-6 and 6-18			d. Check the bias at the grid of V1 and V2. Should be -9 volts ±10%. If incorrect, check R3, R4, and T1. Replace component if defective and repeat check. If bias is correct proceed to next step. e. Check the bias at the grids of V3 and V4. Should be -16 volts ±10%. If correct proceed to next step. If incorrect, check R11, R12 and R13 on the pulse driver unit. f. De-energize the equipment (B+, bias and filaments). Replace V1 and V2. Repeat the check. If abnormal, proceed to next step. NOTE Refer to Section 3 for instructions for removing tubes.

TABLE 5-8. AMPLIFIER ASSEMBLY AM-2481/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
2 (Cont)				g. De-energize the equipment (B+, bias and filaments) and replace V3 and V4. Repeat the check. If abnormal, proceed to next step.
	E5 E6 Figures 5-7 and 6-18			h. De-energize the equipment (B+, and bias). Connect d-c voltmeter (using 1000-volt scale) (+) to E5 and (-) to ground. WARNING Do not hold the meter during the measurement. Place the meter on a table or stand.
	Visual Check			i. Energize the equipment and read the meter voltage. Meter should read between 850 and 1000 volts. If abnormal de-energize the equipment and check R130 and R131 and R132 in the transmitter cabinet and R8 in the pulse driver unit. Replace if defective. If normal, check T2 on

TABLE 5-8. AMPLIFIER ASSEMBLY AM-2481/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
2 (Cont)				pulse driver unit for open or shorted windings. If normal, proceed to next step. j. Connect d-c voltmeter (using 5000-volt scale) (+) to T3-2 and (-) to ground. WARNING Use the same precautions as in step h. k. Energize the equipment and read the meter voltage. Meter should read 3.8KV ±10%. If reading is correct, de-energize the equipment and check T3 for open or shorted windings. If reading is incorrect, refer to Section 5 of Volume 3 and troubleshoot the voltage source.
3	Visual Check	Place transmitter control panel SIGNAL SELECTOR switch S18 (3, figure 3-7) in the 1ST IPA position. Observe the monitor oscilloscope.	See figure 5-1k.	NOTE Refer to Section 3 for procedure to use when replacing tubes on the transmitter unit.

TABLE 5-8. AMPLIFIER ASSEMBLY AM-2481/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
3 (Cont)				1. If indication is normal, proceed with step 4. 2. If indication is abnormal: a. De-energize equipment (B+, bias and filaments). b. Replace V11 and V12. c. Energize the equipment and repeat check. 3. If indication is still abnormal: a. De-energize equipment (B+ and bias). b. Check R1, R2, R3, R4, R8, C1, C44, and C2, and replace defective parts. c. Energize equipment and repeat check.
4	Visual Check	Place transmitter control panel SIGNAL SELECTOR switch S18 (3, figure 3-7) in the 2ND I. P. A. position.	See figure 5-11.	1. If indication is normal, proceed with step 7. 2. If indication is abnormal, proceed with step 5.
5	Visual Check	Place transmitter control panel TUBE SELECTOR switch S17 (2, figure 3-7) in the V9 position. Observe the INDIVIDUAL CATHODE CURRENT meter M1(5).	Limits are given in table 3-3.	1. If indication is abnormal, replace V9. (See note in step 3.) 2. If indication is normal, proceed with step 6.

TABLE 5-8. AMPLIFIER ASSEMBLY AM-2481/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6	Visual Check	Place transmitter control panel TUBE SELECTOR switch S17 (2, figure 3-7) in the V10 position. Observe the INDIVIDUAL CATHODE CURRENT meter M1(5).	Limits are given in table 3-3.	1. If indication is normal, proceed with step 7. 2. If indication is abnormal, replace V10 and repeat check. (See note in step 3.) 3. If indication is still abnormal, check R13, R9, R10, R14, C45, C46, C7, C8, C81, C82, C79, C80, and C47. Replace defective parts. 4. Repeat step 4. 5. If indication is still abnormal, check all other components associated with V9 and V10. Replace defective parts.
7	Visual Check	Place SIGNAL SELECTOR switch S18 (3, figure 3-7) in the OUTPUT position. Observe the monitor oscilloscope.	See figure 5-1m.	1. If indication is normal, the unit is functioning properly. 2. If the output amplitude is low, proceed with step 8. 3. If the output is absent, proceed with step 11. 4. If the output is distorted, proceed with step 12.

TABLE 5-8. AMPLIFIER ASSEMBLY AM-2481/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
8	Visual Check	Observe transmitter control panel TOTAL CATHODE CURRENT meter M2 (1, figure 3-7).	Limits are given in table 3-3.	1. If indication is abnormal, proceed with step 9. 2. If indication is normal, proceed to step 10.
9	Visual Check	Place transmitter control panel TUBE SELECTOR switch S17 (2, figure 3-7) in the V1 through V8 positions. Observe INDIVIDUAL CATHODE CURRENT meter M1(5).	Limits are given in table 3-3.	1. If all tube currents are low, check for poor or open output connections and troubleshoot the coupling and load unit. 2. If only some of the tube currents are low; replace tubes operating outside limits, then repeat step 7. (see note in step 3.)
10	Visual Check	De-energize the equipment.		1. Check TUBE SELECTOR switch S17. 2. Check the leads between T4 and the grids of the final amplifiers V1 through V8. 3. Check the continuity of plate voltage lead from TB3-2 to the plate of the tubes. 4. Replace or repair defective parts.

TABLE 5-8. AMPLIFIER ASSEMBLY AM-2481/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
11	Visual Check	De-energize the equipment.		1. Check all components associated with tubes V1 through V8. 2. Replace or repair defective parts.

TABLE 5-9. ANTENNA COUPLER CU-807/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	D1 through D3 Figures 5-8, 5-9, and 6-19	1. Set B+ switch for both transmitters to OFF position, and place control panel TRANSMITTER SELECTOR switch S7 (27, figure 3-2) in the XMTR 1 TO ANTENNA position. 2. Close interlock switches S8 and S9 (figure 6-18). 3. Measure the a-c voltage between S3-1 and -2.	120 volts	If indication is normal, proceed to step 2. If indication is abnormal, open interlock switches S8 and S9 and check continuity through S2 from S3-1 and -2 to S9-2 and TB3-2, respectively. Repair broken or loose connections.
2	10 D4 D27 Figures 5-8 and 6-19	1. Check for continuity between: a. E2 and S3 b. S1-2 and S3 c. S1-1 and S3	0 ohms	If indication is normal: a. Replace S2 (N/O). If indication is abnormal: a. Check connection to L1. b. Replace S1 providing connections are intact to S1.
3	D5 Figures 5-8 and 6-19	1. Close S8 and S9. 2. Measure a-c voltage between S4-1 and -2.	0 volts	If indication is normal, proceed with step 4. If indication is abnormal, open S8 and S9 and check for shorted wafer contacts on S2. Repair or replace defective wafer.

TABLE 5-9. ANTENNA COUPLER CU-807/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
4	11 D6 Figures 5-8 and 6-19	Check for continuity between XMTR 2 power bus and dummy load input.	0 ohms	If indication is normal, check resistance of dummy load. Replace defective resistors. If indication is abnormal, replace S4 (N/C).
5	D7 D8 D9 Figures 5-8 and 6-19	Check for continuity between: a. S7-8 and K1-3 b. TB2-7 and K1-4	0 ohms	If indication is normal, check S7 and if not defective proceed with step 6.
6	D7 D10 Figures 5-8, 5-9 and 6-19	Check for continuity between S7-8 and S6-2.	0 ohms	If indication is normal, check S6 and if not defective proceed with step 7.
7	D11 Figures 5-8 and 6-19	1. Close S8 and S9. 2. Measure voltage between terminal L2 and L1 at K1.	120 volts	If indication is normal, but blower motor does not operate, replace B1. If indication is abnormal, check K1 and replace if defective.
8	D12 D13 Figures 5-8 and 6-19	Check for continuity between S7-6 and terminal TB1-10.	0 ohms	If indication is normal, check S7 and replace if defective.

TABLE 5-9. ANTENNA COUPLER CU-807/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
8 (Cont)				If indication is abnormal, check wiring on wafer I of S2.
9	D5 Figures 5-8 and 6-19	1. Place TRANSMITTER SELECTOR switch S7 (27, figure 3-2) in the XMTR 2 TO ANTENNA position. 2. Close interlock switches S8 and S9. 3. Measure a-c voltage between switch S4-1 and -2.	120 volts	If indication is normal, proceed with step 10. If indication is abnormal, check for open wafer contacts at S2. Repair or replace defective wafer.
10	11 D4 Figures 5-8 and 6-19	1. Check for continuity between XMTR 2 power bus and S1-2. 2. Check for continuity between S1-1 and XMTR 2 power bus.	0 ohms	If both indications are normal, check connections to L1. If only first indication is normal, check S1 and replace if defective. If both indications are abnormal, replace S3 (N/C).
11	D1 Figures 5-8 and 6-19	1. Close S8 and S9. 2. Measure a-c voltage between S3-1 and -2.	0 volts	If indication is normal, proceed with step 12. If indication is abnormal, open S8 and S9 and check for shorted wafer contacts at S2. Replace defective wafer.

TABLE 5-9. ANTENNA COUPLER CU-807/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
12	12 D6 Figures 5-8 and 6-19	Check for continuity between XMTR 1 power bus and dummy load input.	0 ohms	If indication is normal, check resistance of dummy load. If indication is abnormal, replace S4 (N/C). Replace defective resistors.
13	D8 D12 D14 Figures 5-8 and 6-19	Check for continuity between: a. S7-6 and K1-3 b. TB1-7 and K1-4	0 ohms	If indication is normal, check S7 and if not defective proceed with step 14.
14	D12 D15 Figures 5-8 and 6-19	Check for continuity between S7-6 and S5-1.	0 ohms	If indication is normal, check S5 and if not defective proceed with step 7.
15	D7 D16 Figures 5-8 and 6-19	Check for continuity between S7-8 and TB2-10.	0 ohms	If indication is normal, check S7 and replace if defective. If indication is abnormal, check wiring on wafer I of S2.
16	D17 D18 Figures 5-8 and 6-19	Check for continuity between K2-3 and TB1-3.	0 ohms	If indication is abnormal, measure 120 volts ac across TB1-4 and -5. If voltage is present, check K2, CR1 and S2 solenoid. Replace as necessary. If voltage is not

TABLE 5-9. ANTENNA COUPLER CU-807/FPN-42, FUNCTIONAL SECTION TROUBLE-SHOOTING CHART (Cont)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
16 (Cont)				present, check the cabling from the pulse control cabinet.
17	D19 D20 D21 D22 Figures 5-8 and 6-19	Check for continuity between: a. T3 and T1-1 and -3. b. T1-4 and -6 and J1.	0 ohms	If indication is normal, check R49, R50, T1 and T3 and replace defective parts.
18	D23 D24 D25 D26 Figures 5-8 and 6-19	Check for continuity between: a. T4 and T2-1 and -3. b. T2-4 and -6 and J2.	0 ohms	If indication is normal, check R51, R52, T2 and T4 and replace defective parts.

TABLE 5-10. LORAN TRANSMITTING SET AN/FPN-42, CONTROL CIRCUITS TROUBLE-SHOOTING CHART

ABNORMAL INDICATION	PROBABLE CAUSE	CORRECTIVE MEASURES
Inability to switch transmitter loads.	1. No control voltage on coupling and load unit interlock switch S12-1 (figure 6-19).	If high voltage power supply control voltage output exists, replace defective connections from high voltage power supply to the coupling and load unit.
	2. Coupling and load unit interlock switches S12 or S13 either open or defective (figure 6-19).	Close switches if open. Replace if defective.
	3. Coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in LOCAL position or defective.	Place LOCAL & REMOTE SELECTOR switch in the REMOTE position. Replace if defective.
	4. Connection between coupling and load unit LOCAL & REMOTE SELECTOR switch S7 and control panel B+ XMTR 1 switch S11 (figure 6-15) open.	Repair defective interconnection.
	5. Control panel B+ XMTR 1 or 2 switch S11 or S12 (22 or 12, figure 3-2) in on (up) position or defective.	Place B+ XMTR 1 and 2 switches in off (down) position.
	6. Control panel TRANSMITTER SELECTOR switch S7 defective, (27, figure 3-2).	Replace defective switch.
	7. Connection between control panel TRANSMITTER SELECTOR switch S7 and transmitter function switch S2 (figure 6-19) open.	Repair defective interconnection.

TABLE 5-10. LORAN TRANSMITTING SET AN/FPN-42, CONTROL CIRCUITS TROUBLE-SHOOTING CHART (Cont)

ABNORMAL INDICATION	PROBABLE CAUSE	CORRECTIVE MEASURES
	8. Transmitter function switch S2, wafer defective.	Repair or replace defective wafer.
	9. Thermal time delay relay K2 defective.	Replace defective relay.
	10. Rotary solenoid relay rectifier CR1 defective.	Replace defective rectifier.
	11. Transmitter function switch S2, Ledex relay defective.	Replace defective switch.
	12. Proper transmitter load switch S3 or S4 not energized.	Replace if defective. If not defective, refer to table 5-9.
Control panel pulse control EMERGENCY STOP XMTR 1 or 2 switch S3 or S2 (3 or 30, figure 3-2) inoperative.	1. Defective switch S2 or S3 (figure 6-15).	Replace defective switch.
	2. Trouble in high voltage power supply circuits.	Refer to Section 5 of Volume 3.
Transmitter EMERGENCY STOP switch S19, (4, figure 3-7) inoperative.	1. Defective switch S19 (figure 6-17).	Replace defective switch.
	2. Trouble in the high voltage power supply circuits.	Refer to Section 5 of Volume 3.
High voltage power supply EMERGENCY STOP switch, S7 (59, figure 3-6) inoperative.	1. Defective switch S7 (Section 6 of Volume 3).	Replace defective switch.
	2. Trouble in high voltage power supply circuits.	Refer to Section 5 of Volume 3.
Control panel B+ XMTR 1 or 2 switch S12 or S11 (figure 3-2, 12 or 22) inoperative.	1. 120-volt control voltage not present on pole of switch.	Repair defective connection between high voltage power supply and pulse control cabinet.

TABLE 5-10. LORAN TRANSMITTING SET AN/FPN-42, CONTROL CIRCUITS TROUBLE-SHOOTING CHART (Cont)

ABNORMAL INDICATION	PROBABLE CAUSE	CORRECTIVE MEASURES
	2. Defective switch S11 or S12 (figure 6-15).	Replace defective switch.
	3. Connection between control panel B+ XMTR 1 or 2 switch S11 or S12 and coupling and load unit LOCAL & REMOTE SELECTOR switch S7 (figure 6-19) open.	Repair defective connection.
	4. LOCAL & REMOTE SELECTOR switch S7 in LOCAL position or defective.	Place LOCAL & REMOTE SELECTOR switch (7, figure 3-8) in REMOTE position or replace if defective.
	5. Trouble in coupling and load unit transmitter function switch S2 (figure 6-22) or dummy load blower air switch S5 or S6 (if the transmitter is connected to the dummy load).	Replace defective switch.
	6. Interconnection between coupling and load unit TB1-10 or TB2-10 and high voltage power supply TB5-10 open.	Repair defective connection.
	7. Trouble in the high voltage power supply circuits.	Refer to Section 5 of Volume 3.
High voltage power supply PLATE VOLTAGE switch S3 (18, figure 2-6) inoperative.	1. Trouble in high voltage power supply circuits.	Refer to Section 5 of Volume 3.
	2. Interconnection between high voltage power supply TB5-9 and coupling and load unit TB1-9 open.	Repair defective connection.

TABLE 5-10. LORAN TRANSMITTING SET AN/FPN-42, CONTROL CIRCUITS TROUBLE-SHOOTING CHART (Cont)

ABNORMAL INDICATION	PROBABLE CAUSE	CORRECTIVE MEASURES
	3. Coupling and load unit LOCAL & REMOTE SELECTOR switch S7, in the REMOTE position or defective.	Place LOCAL & REMOTE SELECTOR switch (7, figure 3-8) in LOCAL position or replace if defective.
	4. Trouble in coupling and load unit transmitter function switch S2 or dummy load blower air switch S5 or S6 (if transmitter is connected to dummy load).	Refer to table 5-9.
	5. Interconnection between coupling and load unit TB1-10 or TB2-10 and high voltage power supply TB5-10 open.	Repair defective connection.
Pulse control LOW VOLT RESET XMTR 1 or 2 switch S14 or S15 (17 or 15, figure 3-2) inoperative.	1. 120 volt control voltage not present on switch	Repair defective connection between high voltage power supply and pulse control.
	2. LOW VOLT RESET XMTR 1 or 2 switch, S14 or S15 (figure 6-15) is defective.	Replace defective switch.
	3. Connection between pulse control, TB1-11 or TB2-11 and high voltage power supply TB4-11 defective.	Repair defective connection.
	4. Trouble in high voltage power supply circuits.	Refer to Section 5 of Volume 3.

TABLE 5-10. LORAN TRANSMITTING SET AN/FPN-42, CONTROL CIRCUITS TROUBLE-SHOOTING CHART (Cont)

ABNORMAL INDICATION	PROBABLE CAUSE	CORRECTIVE MEASURES
Pulse control OVERLOAD RESET XMTR 2 or 1 switches (16 or 18, figure 3-2), inoperative.	1. Overload reset switches S16 or S17 defective.	Replace defective switch.
	2. Normally closed auxiliary switch of high voltage power supply plate circuit breaker CB1 (figure 6-27, Volume 3) defective.	Replace defective switch.
Pulse control overload alarm DS13 (figure 6-13) and transmitter 1 or 2 OVERLOAD IND lamp DS12 or DS10 (14 or 20, figure 3-2) inoperative.	1. Normally closed auxiliary switch of high voltage power supply plate circuit breaker CB1 defective.	Replace defective auxiliary switch.
	2. Interconnection between high voltage power supply TB4-9 and TB1-9 or pulse control TB2-9 defective.	Repair defective connection.
	3. Pulse control XMTR 1 or 2 overload relay K1 (figure 6-15) defective.	Replace defective relay.
	4. Connection between pulse control TB1-12 or TB2-12 and high voltage power supply TB4-12 defective.	Repair defective connection.
	5. Trouble in the high voltage power supply interlock relay contacts.	Refer to Section 5 of Volume 3.

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS

NOTES:

1. All measurements are made to chassis ground unless otherwise indicated.
2. All resistance measurements made with all tubes in place, all interconnecting cables and wires in place and all voltages removed.
3. All a-c and d-c voltages measured with a multimeter having a resistance of 1000 and 20,000 ohms per volt for a-c and d-c measurements, respectively.
4. All r-f measurements made with test oscilloscope and voltage divider, where necessary.
5. Key to symbols:

   AC indicates RMS

   PP indicates peak-to-peak r-f voltage

   PK indicates peak r-f voltage

   NC indicates no connection

   FIL indicates tube filament terminals.

CIRCUIT POINTS		R (OHMS)	V (VOLTS)	CIRCUIT POINTS		R (OHMS)	V (VOLTS)
FROM	TO			FROM	TO		
PULSE GENERATOR							
DL1-1	D11-2	17	--	T1-1		3	0.3 PP*
DL1-1		40	40 PK*	T1-2		8	15 PP*
DL1-2		38	18 PK*	T1-3		9	15 PP*
FL1-1	FL1-3	190	--	T1-5		8	15 PP*
FL1-1		43K	22 PP	T2-1	T2-2	8	--
FL1-3		43K	20 PP	T2-1		9	-12 PK*
T1-1	T1-2	7	--	T2-2		1	-14 PK*

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)	CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)
PULSE GENERATOR (Cont)							
T2-3		8	-11 PK*	T5-6	∞		50 to 100 PP
T3-1	T3-2	9	--	T5-7		* *	50 to 100 PP
T3-1		10	-23 PK*	T6-1	T6-5	4.7	120 AC
T3-3		9	-23 PK*	T6-6	T6-8	* *	6.3 AC
T4-1	T4-3	80	--	T6-9	T6-11	* *	6.3 AC
T4-1		15K	100 increasing to 200 PP	T7-1	T7-2	6	--
T4-2		15K	300	T7-1		25	6 PK*
T4-3		15K	100 to 200 PP	T7-2		25	-6 PK*
T4-4	T4-6	230	--	T7-3		8.5	20 PK*
T4-4		26K	140 to 250 PP	V1-1		15K	300
T4-5		26K	--	V1-2		56K	30 PP
T4-6		26K	140 to 250 PP	V1-3		1K	24 PP
T4-7		5	20 to 50 PP	V1-4		FIL	FIL
T5-1	T5-3	1.8	--	V1-5		FIL	FIL
T5-1		* *	140 to 260 PP	V1-6		10K	20 PK*
T5-3		1.0	140 to 260 PP	V1-7		18K	50 PK*
T5-4	T5-6	* *	--	V1-8		FIL	FIL
T5-4		∞	50 to 100 PP	V1-9		15K	300
				V2-1		15K	300

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS		R (OHMS)	V (VOLTS)	CIRCUIT POINTS		R (OHMS)	V (VOLTS)
FROM	TO			FROM	TO		
PULSE GENERATOR (Cont)							
V2-2		290K	16 PP*	V4-3		FIL	FIL
V2-3		47K	8 PP	V4-4		FIL	FIL
V2-4		FIL	FIL	V4-5		51K	20 PP
V2-5		FIL	FIL	V4-6		26K	0
V2-6		37K	30 PP	V4-7		51K	20 PP
V2-7		200K	--	V5-1		100K	13 PP
V2-8		47K	8 PP	V5-2		100K	13 PP
V2-9		FIL	FIL	V5-3		FIL	FIL
V3-1		36K	45 PP	V5-4		FIL	FIL
V3-2		470K	4 PP	V5-5		51K	13 PP
V3-3		470	1 PP	V5-6		0	0
V3-4		FIL	FIL	V5-7		51K	13 PP
V3-5		FIL	FIL	V6-1		25K	76 PP
V3-6		25K	300	V6-2		120K	15 PP
V3-7		470K	47 PP	V6-3		2.7K	35 PP
V3-8		12K	42 PP	V6-4		FIL	FIL
V3-9		FIL	FIL	V6-5		FIL	FIL
V4-1		100K	13 PP	V6-6		25K	-32 PK
V4-2		100K	13 PP	V6-7		1.5M	86 PP

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS		R (OHMS)	V (VOLTS)	CIRCUIT POINTS		R (OHMS)	V (VOLTS)
FROM	TO			FROM	TO		
PULSE GENERATOR (Cont)							
V6-8		2.7K	35 PP	V9-1		15K	300
V6-9		FIL	FIL	V9-2		1M	45 PP
V7-1		25K	32 PP	V9-3		3.3K	36 PP
V7-2		1M	55 PP	V9-4		FIL	FIL
V7-3		10K	35 PP	V9-5		FIL	FIL
V7-4		FIL	FIL	V9-6		2.5K	26 PP
V7-5		FIL	FIL	V9-7		1M	35 PP
V7-6		15K	300	V9-8		11K	26 PP
V7-7		3.5K	6 PP	V9-9		FIL	FIL
V7-8		2.2K	4 PP	V10-1		25K	60 PP
V7-9		FIL	FIL	V10-2		120K	56 PP
V8-1		25K	70 PP	V10-3		3.3K	60 PP
V8-2		120K	12 PP	V10-4		FIL	FIL
V8-3		2.7K	30 PP	V10-5		FIL	FIL
V8-4		FIL	FIL	V10-6		37K	200 P
V8-5		FIL	FIL	V10-7		1.8M	64 PP
V8-6		25K	150 PP	V10-8		3.3K	60 PP
V8-7		2M	76 PP	V10-9		FIL	FIL
V8-8		2.7K	30 PP	V11-1		1.5M	20 PP
V8-9		FIL	FIL	V11-2		1M	60 PP

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS		R (OHMS)	V (VOLTS)	CIRCUIT POINTS		R (OHMS)	V (VOLTS)
FROM	TO			FROM	TO		
PULSE GENERATOR (Cont)							
V11-3		0	0	V13-4		FIL	FIL
V11-4		FIL	FIL	V13-5		14K	100 to 200 PP
V11-5		FIL	FIL	V13-6		72K	300
V11-6		15K	300	V13-7		125K	NC
V11-7		1.5M	20 PP	V14-1		125K	18 PP
V11-8		34K	18 PP	V14-2		0	0
V11-9		FIL	FIL	V14-3		FIL	FIL
V12-1		25K	10 PP	V14-4		FIL	FIL
V12-2		470K	12 PP	V14-5		14K	100 to 200 PP
V12-3		11K	11 PP	V14-6		72K	300
V12-4		FIL	FIL	V14-7		125K	NC
V12-5		FIL	FIL	V15-1		14K	+250
V12-6		15K	300	V15-2		27K	140 to 280 PP
V12-7		11K	2 to 4 PP	V15-3		0.9	130 to 260 PP
V12-8		5.6K	1.5 to 3 PP	V15-4		FIL	FIL
V12-9		FIL	FIL	V15-5		FIL	FIL
V13-1		125K	18 PP	V15-6		0.9	130 to 260 PP
V13-2		0	0	V15-7		27K	140 to 280 PP
V13-3		FIL	FIL	V15-8		FIL	FIL

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS		R (OHMS)	V (VOLTS)		CIRCUIT POINTS		R (OHMS)	V (VOLTS)
FROM	TO				FROM	TO		
PULSE GENERATOR (Cont)								
V15-9		14K	250		V18-1		14K	250
V16-1		14K	250		V18-2		27K	140 to 280 PP
V16-2		27K	140 to 280 PP		V18-3		0.9	130 to 260 PP
V16-3		0.9	130 to 260 PP		V18-4		FIL	FIL
V16-4		FIL	FIL		V18-5		FIL	FIL
V16-5		FIL	FIL		V18-6		0.9	130 to 260 PP
V16-6		0.9	130 to 260 PP		V18-7		27K	140 to 280 PP
V16-7		27K	140 to 280 PP		V18-8		FIL	FIL
V16-8		FIL	FIL		V18-9		14K	250
V16-9		14K	250		V19-1		14K	250
V17-1		14K	250		V19-2		27K	140 to 280 PP
V17-2		27K	140 to 280 PP		V19-3		0.9	130 to 260 PP
V17-3		0.9	130 to 260 PP		V19-4		FIL	FIL
V17-4		FIL	FIL		V19-5		FIL	FIL
V17-5		FIL	FIL		V19-6		0.9	130 to 260 PP
V17-6		0.9	130 to 260 PP		V19-7		27K	140 to 280 PP
V17-7		27K	140 to 280 PP		V19-8		FIL	FIL
V17-8		FIL	FIL		V19-9		14K	250
V17-9		14K	250		V20-1		14K	250

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)	CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)
PULSE GENERATOR (Cont)							
V20-2		27K	140 to 280 PP	V20-7		27K	140 to 280 PP
V20-3		0.9	130 to 260 PP	V20-8		FIL	FIL
V20-4		FIL	FIL	V20-9		14K	250
V20-5		FIL	FIL	CR1 FORWARD		13	--
V20-6		0.9	130 to 260 PP	CR1 REVERSE		160K	--
PULSE ANALYZER							
CR1 FORWARD		15	--	V1-6		50K	100 PP
CR1 REVERSE		2.1K	--	V1-7		1.2M	80 PP
K1-	K1+	350	--	V1-8		0	15 PP
K1-		19K	40 PP	V1-9		FIL	FIL
K1+		18.5K	130	V2-1		23K	16 PK
T1-1	T1-3	2.8	120 AC	V2-2		105K	-5 PK
T1-5	T1-6	* *	6.3 AC	V2-3		FIL	FIL
V1-1		140K	80 PP	V2-4		FIL	FIL
V1-2		9K	6 PP	V2-5		0	0
V1-3		0	15 PP	V2-6		NC	NC
V1-4		FIL	FIL	V2-7		0	0
V1-5		FIL	FIL	V3-1		120K	100 PP

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS		R (OHMS)	V (VOLTS)	CIRCUIT POINTS		R (OHMS)	V (VOLTS)
FROM	TO			FROM	TO		
PULSE ANALYZER (Cont)							
V3-2		33K	17 PP	V5-3		FIL	FIL
V3-3		9K	25 PP	V5-4		FIL	FIL
V3-4		FIL	FIL	V5-5		0	0
V3-5		FIL	FIL	V5-6		NC	NC
V3-6		72K	100 PP	V5-7		∞	-38 PK
V3-7		9K	110 PP	V6-1		62K	-40 PK
V3-8		9K	25 PP	V6-2		0	0
V3-9		FIL	FIL	V6-3		FIL	FIL
V4-1		50K	60 PP	V6-4		FIL	FIL
V4-2		80K	100 PP	V6-5		58K	-68 PK
V4-3		10K	40 PP	V6-6		51K	143
V4-4		FIL	FIL	V6-7		86K	64 PP
V4-5		FIL	FIL	V7-1		40K	70 PK
V4-6		74K	100 PP	V7-2		170K	-40 PK
V4-7		105K	4 PP	V7-3		0	0
V4-8		10K	40 PP	V7-4		FIL	FIL
V4-9		FIL	FIL	V7-5		FIL	FIL
V5-1		10K	17 PK	V7-6		18K	150
V5-2		170K	30 PK	V7-7		44K	70 PK

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)	CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)
PULSE ANALYZER (Cont)							
V7-8		5.6K	44 PK	V10-1		20K	40 PP
V7-9		FIL	FIL	V10-2		49K	10 PP
V8-1		500K	7 PK	V10-3		0	0
V8-2		120K	12 PP	V10-4		FIL	FIL
V8-3		FIL	FIL	V10-5		FIL	FIL
V8-4		FIL	FIL	V10-6		20K	38 PP
V8-5		500K	8 PK	V10-7		49K	10 PP
V8-6		NC	NC	V10-8		0	0
V8-7		120K	5 PP	V10-9		FIL	FIL
V9-1		47K	60 PP	V11-1		3.3K	4.6
V9-2		120K	12 PP	V11-2		20K	38 PP
V9-3		18K	2 PP	V11-3		FIL	FIL
V9-4		FIL	FIL	V11-4		FIL	FIL
V9-5		FIL	FIL	V11-5		19K	130
V9-6		38K	50 PP	V11-6		NC	NC
V9-7		120K	5 PP	V11-7		∞	40 PP*
V9-8		18K	2 PP	V12-1		18K	150
V9-9		FIL	FIL	V12-2		0	40 PP*

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)	CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)
PULSE ANALYZER (Cont)							
V12-3		10K	36 PP*	V12-6		18K	150
V12-4		FIL	FIL	V12-7		0	40 PP*
V12-5		FIL	FIL	V12-8		10K	36 PP*
				V12-9		FIL	FIL
DUAL POWER SUPPLY							
CR1 FORWARD		7.5K	--	T1-10	T1-12	31	400 AC
CR1 REVERSE		110K	--	T1-11		7K	-145
K1-3	K1-6	5.4	120 AC	T2-1	T2-2	* *	120 AC
L2-1	L2-2	11	--	T2-3	T2-5	* *	6.3 AC
L2-1		--	120	T2-4		86K	24
L1-1	L1-2	7.8	--	T2-6	T2-8	* *	6.3 AC
L1-1		--	255	T2-7		7K	-145
L1-3	L1-4	11.5	--	V1-1		1.1M	238
L1-3		--	430	V1-2		72K	425
T1-1	T1-3	1.2	120 AC	V1-3		17K	300
T1-5	T1-9	32	700 AC	V1-4		1.1M	238
T1-7		0	0	V1-5		72K	425
T1-6	T1-8	13	400 AC	V1-6		17K	300

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)	CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)
DUAL POWER SUPPLY (Cont)							
V1-7		FIL	FIL	V4-1		1.0M	-3.5
V1-8		FIL	FIL	V4-2		60K	-39
V2-1		1.1M	238	V4-3		140K	-41
V2-2		72K	425	V4-4		FIL	FIL
V2-3		17K	300	V4-5		FIL	FIL
V2-4		1.1M	238	V4-6		14K	300
V2-5		72K	425	V4-7		150K	-44
V2-6		17K	+300	V4-8		140K	-41
V2-7		FIL	FIL	V4-9		FIL	FIL
V2-8		FIL	FIL	V5-1		0	0
V3-1		NC	NC	V5-2		44K	-85
V3-2		NC	NC	V5-3		NC	NC
V3-3		NC	NC	V5-4		44K	-85
V3-4		FIL	FIL	V5-5		0	0
V3-5		FIL	FIL	V5-6		NC	NC
V3-6		1.1M	238	V5-7		44K	-85
V3-7		1.0M	-3.5	V6-1		1.0M	91
V3-8		0	0	V6-2		26K	255
V3-9		FIL	FIL	V6-3		11K	145

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS		R	V	CIRCUIT POINTS		R	V
FROM	TO	(OHMS)	(VOLTS)	FROM	TO	(OHMS)	(VOLTS)
DUAL POWER SUPPLY (Cont)							
V6-4		1.0M	91	V8-6		1.0M	-1.4
V6-5		26K	255	V8-7		60K	-45.5
V6-6		11K	145	V8-8		140K	-47
V6-7		FIL	FIL	V8-9		FIL	FIL
V6-8		FIL	FIL	V9-1		0	0
V7-1		1.0M	91	V9-2		44K	-85
V7-2		1.0M	-1.4	V9-3		NC	NC
V7-3		0	0	V9-4		44K	-85
V7-4		FIL	FIL	V9-5		0	0
V7-5		FIL	FIL	V9-6		NC	NC
V7-6		NC	NC	V9-7		44K	-85
V7-7		NC	NC	V10-1		0	0
V7-8		NC	NC	V10-2		30K	-150
V7-9		FIL	FIL	V10-3		NC	NC
V8-1		9K	150	V10-4		30K	-150
V8-2		190K	-49	V10-5		0	0
V8-3		140K	-47	V10-6		NC	NC
V8-4		FIL	FIL	V10-7		30K	-150
V8-5		FIL	FIL	V11-1		1.0M	-71

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)	CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)
DUAL POWER SUPPLY (Cont)							
V11-2		22K	118	V13-4		FIL	FIL
V11-3		120	0.25	V13-5		FIL	FIL
V11-4		1.0M	-71	V13-6		1.0M	-146
V11-5		22K	118	V13-7		75K	-203
V11-6		120	0.25	V13-8		150K	-193
V11-7		FIL	FIL	V13-9		FIL	FIL
V11-8		FIL	FIL	V14-1		7K	-150
V12-1		1.0M	-71	V14-2		39K	-300
V12-2		1.0M	-146	V14-3		NC	NC
V12-3		7K	-150	V14-4		39K	-300
V12-4		FIL	FIL	V14-5		7K	-150
V12-5		FIL	FIL	V14-6		NC	NC
V12-6		NC	NC	V14-7		39K	-300
V12-7		NC	NC	V15-1		7K	-150
V12-8		NC	NC	V15-2		53K	-234
V12-9		FIL	FIL	V15-3		NC	NC
V13-1		0	0	V15-4		53K	-234
V13-2		210K	-165	V15-5		7K	-150
V13-3		150K	-193	V15-6		NC	NC
				V15-7		53K	-234

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)	CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)
PULSE DRIVER							
JCT, R9,		0.2		T3-1	T3-3	7	--
R10, R12,				T3-1		1K	2000 to 4000 PP
and R13				T3-2		1K	3500
T1-1	T1-2	* *	30 to 65 PP	T3-3		1K	2000 to 4000 PP
				T3-4	T3-6	1	--
T1-1		5.5	--	T3-4		1.4K	800 to 1500 PP
T1-2		6	--	T3-5		1.4K	-440
T1-3	T1-5	* *	--	T3-6		1.4K	800 to 1500 PP
T1-3		40	20 to 40 PP	T3-7	T3-8	* *	50 to 100 PP
T1-4		40	-10V DC	T4-1	T4-2	* *	120 AC
T1-5		40	20 to 40 PP	T4-3	T4-4	* *	26 AC
T1-7	T1-8	* *	15 to 30 PP	T5-1	T5-4	5	120 AC
T2-1	T2-3	2	--	T5-5	T5-6	* *	6.0 AC
T2-1		17K	600 to 1200 PP	V1-P		17K	600 to 1200 PP
T2-2		17K	880	V1-G		42	20 to 40 PP
T2-3		17K	600 to 1200 PP	V1-FA		0	0
T2-4	T2-5	* *	--	V1-FB		FIL	FIL
T2-4		220	80 to 150 PP	V2-P		17K	600 to 1200 PP
T2-5		220	80 to 150 PP	V2-G		42	20 to 40 PP

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)	CIRCUIT POINTS FROM	CIRCUIT POINTS TO	R (OHMS)	V (VOLTS)
PULSE DRIVER (Cont)							
V2-FA		0	0	V3-4		0	0
V2-FB		FIL	FIL	V4-P		1K	2000 to 4000 PP
V3-P		1K	2000 to 4000 PP	V4-1		FIL	FIL
V3-1		FIL	FIL	V4-2		220	80 to 150 PP
V3-2		220	80 to 150 PP	V4-3		220	80 to 150 PP
V3-3		220	80 to 150 PP	V4-4		0	0
TRANSMITTER							
FL1-1	FL1-3	100	--	T3-2		230	6800
FL1-1		90	40 PP	T3-3		230	8000 PP
FL1-3		4	0.2 PP	T3-4	T3-6	1	--
T1-1	T1-4	* *	120 AC	T3-4		1.2K	4000 PP
T1-6	T1-8	* *	10 AC	T3-5		1.2K	-560
T1-7		33	2.5	T3-6		1.2K	4000 PP
T2-1	T2-4	* *	120 AC	T3-7		* *	90 PP
T2-6	T2-8	* *	10 AC	T4-1	T4-3	2	--
T2-7		33	2.5	T4-1		4K	17000 PP
T3-1	T3-3	7	--	T4-2		4K	14000
T3-1		230	8000 PP	T4-3		4K	17000 PP

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS		R (OHMS)	V (VOLTS)		CIRCUIT POINTS		R (OHMS)	V (VOLTS)
FROM	TO				FROM	TO		
TRANSMITTER (Cont)								
T4-4	T4-8	* *	--		T12-1	T12-2	* *	175 AC
T4-4		550	4700 PP		T12-3	T12-4	* *	8.2 AC
T4-6		550	-560		T12-5	T12-6	* *	8.2 AC
T4-8		550	4700 PP		V1-P		4600	22000 PP
T4-9		* *	200 PP		V1-G		525	4700 PP
T7-1	T7-2	10	12 PK		V1-FA		FIL	1.0
T7-5	T7-6	5.5	9 PK		V1-FB		FIL	1.0
T8-1	T8-2	* *	175 AC		V2-P		4.6K	22000 PP
T8-3	T8-4	* *	8.2 AC		V2-6		525	4700 PP
T8-5	T8-6	* *	8.2 AC		V2-FA		FIL	1.0
T9-1	T9-2	* *	175 AC		V2-FB		FIL	1.0
T9-3	T9-4	* *	8.2 AC		V3-P		4.6K	22000 PP
T9-5	T9-6	* *	8.2 AC		V3-G		525	4700 PP
T10-1	T10-2	* *	175 AC		V3-FA		FIL	1.0
T10-3	T10-4	* *	8.2 AC		V3-FB		FIL	1.0
T10-5	T10-6	* *	8.2 AC		V4-P		4.6K	22000 PP
T11-1	T11-2	* *	175 AC		V4-G		525	4700 PP
T11-3	T11-4	* *	8.2 AC		V4-FA		FIL	1.0
T11-5	T11-6	* *	8.2 AC		V4-FB		FIL	1.0

TABLE 5-11. LORAN TRANSMITTING SET AN/FPN-42, VOLTAGE AND RESISTANCE CHARTS (Cont)

CIRCUIT POINTS		R (OHMS)	V (VOLTS)	CIRCUIT POINTS		R (OHMS)	V (VOLTS)
FROM	TO			FROM	TO		
		TRANSMITTER (Cont)					
V5-P		4.6K	22000 PP	V9-P		4.2K	17000 PP
V5-G		525	4700 PP	V9-G		1250	4000 PP
V5-FA		FIL	1.0	V9-FA		FIL	1.0
V5-FB		FIL	1.0	V9-FB		FIL	1.0
V6-P		4.6K	22000 PP	V10-P		4.2K	17000 PP
V6-G		525	4700 PP	V10-G		1250	4000 PP
V6-FA		FIL	1.0	V10-FA		FIL	1.0
V6-FB		FIL	1.0	V10-FB		FIL	1.0
V7-P		4.6K	22000 PP	V11-P		720	8000 PP
V7-G		525	4700 PP	V11-G		1400	800 to 1500 PP
V7-FA		FIL	1.0	V11-FA		FIL	2.5
V7-FB		FIL	1.0	V11-FB		FIL	2.5
V8-P		4.6K	22000 PP	V12-P		720	8000 PP
V8-G		525	4700 PP	V12-G		1400	800 to 1500 PP
V8-FA		FIL	1.0	V12-FA		FIL	2.5
V8-FB		FIL	1.0	V12-FB		FIL	2.5

*Indicates value dependent on input.
**Indicates transformer winding with resistance less than 1.0 ohm.

TABLE 5-12. LORAN TRANSMITTING SET AN/FPN-42, TYPICAL TROUBLES CHART

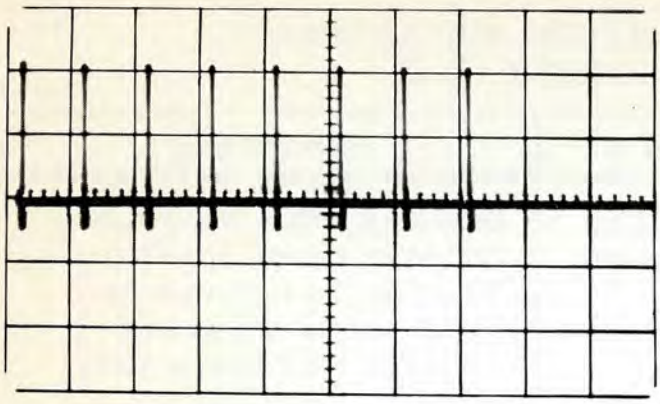
TROUBLE	NATURE OF TROUBLE	SYMPTOMS
Subnormal transmitter operation.	1. Insufficient drive from pulse generator. 2. Low filament voltage in the transmitter. 3. Low plate voltage in the transmitter.	Reduced transmitted output.
Transmitter arcing	Dust, dirt or corrosion on the high voltage lines.	Overload indicator circuits in high voltage power supply are tripped.
Insufficient transmitter output at the sampling point.	1. Transmitter output tank circuit improperly tuned. 2. Rise and decay time controls on the pulse generator improperly positioned.	Sampling point of radiated pulse is less than 50 percent of peak.
Incorrect transmitter oscilloscope triggers.	1. Cathode follower V1 (figure 6-13) on pulse generator defective. 2. Transmitter oscilloscope trigger control relay K1 (figure 6-12) in the pulse control cabinet is defective.	1. Very little or no trigger present at the monitor oscilloscope input. 2. Correct trigger amplitude but the triggers do not synchronize the monitor oscilloscope before the radiated pulse.
Loss of gating waveform.	Either V6 or V7 (figure 6-13) in the pulse generator defective.	Loss of pulse generator output.
Loss of modulating signal in the pulse generator.	Either V8 or V9 (figure 6-13) in the pulse generator defective.	Loss of pulse generator output.
Loss of droop compensation waveform.	Either V10 or V11 (figure 6-13) in the pulse generator defective.	Excessive droop in the radiated pulses.

TABLE 5-12. LORAN TRANSMITTING SET AN/FPN-42, TYPICAL TROUBLES CHART (Cont)

TROUBLE	NATURE OF TROUBLE	SYMPTOMS
Loss of pulse generator cathode follower bias.	Change in component value of either R70, R81, or R91 in the pulse generator.	Resistor R96 in the pulse generator overheating and loss of pulse generator output.
Excessive ambient temperature in the pulse control cabinet.	Cabinet blower is not effective in dissipating heat and thermostat relay S5 (figure 6-12) has closed.	Loss of all 120 volts a-c in the pulse control cabinet except for the blower motor.
Chassis inoperative when extended on its slides.	Interlock disable relay K2 (figure 6-12) in the pulse control cabinet defective.	Loss of B+ and 120 volts ac when a chassis is removed from the cabinet and the INTERLOCK DISABLE switch S13 (21, figure 3-2) is in the on (up) position.
Pulse generator chassis inoperative.	2 Amp filament fuse F1A or F1B (figure 6-14) in the dual power supply is blown.	Loss of all pulse generator filament voltages except for the output cathode followers.
Pulse analyzer inoperative.	Pulse analyzer interlock relay K4 (figure 6-12) in the pulse control cabinet defective.	Loss of pulse analyzer B+ and B- voltages.
Difficulty in selecting proper transmitted pulse for analyzing.	Delay multivibrator V3 (figure 6-16) in the pulse analyzer malfunctioning.	Either no trigger or a trigger improperly positioned in time is obtained from the pulse analyzer as the PULSE SEL switch S1 (3, figure 3-4) is rotated.
Loss of control of transmitter B+ voltage.	LOCAL & REMOTE SELECTOR switch (7, figure 3-2) in the coupling and load unit is in the wrong position.	The indicator lamps associated with the B+ control switches will be unaffected by the B+ control switch position.

TABLE 5-12. LORAN TRANSMITTING SET AN/FPN-42, TYPICAL TROUBLES CHART (Cont)

TROUBLE	NATURE OF TROUBLE	SYMPTOMS
Pulse control overload indicator malfunction.	Overload relay K1 or K2 (figure 6-15) in the pulse control cabinet defective.	Overload indication (determined by an extinguished lamp) on the high voltage power supply but no indication on the pulse control panel.
Abnormal load on either the B+ or B- output of the high voltage power supply.	Overload present in the circuitry indicated by the OVERLOAD INDICATOR lamps on the high voltage power supply.	The 3-strike relay on the high voltage power supply strikes out after being reset.
Loss of radiated power.	Corona existing on a high voltage lead in the transmitter or one of the windings in the output tank coil.	Audible level of the repetition rate in the Transmitter Building above normal.
Improper damping on output tank circuit.	Damping resistors on primary of T5 (figure 6-17) in the transmitter have either become shorted or opened.	Excessive ringing of the transmitted pulse or pulse raising to peak amplitude in less than 70 microseconds.
Loss of radiated power.	Defective type 7800/7899 tube in transmitter.	Low INDIVIDUAL CATHODE CURRENT meter (5, figure 3-7) reading.



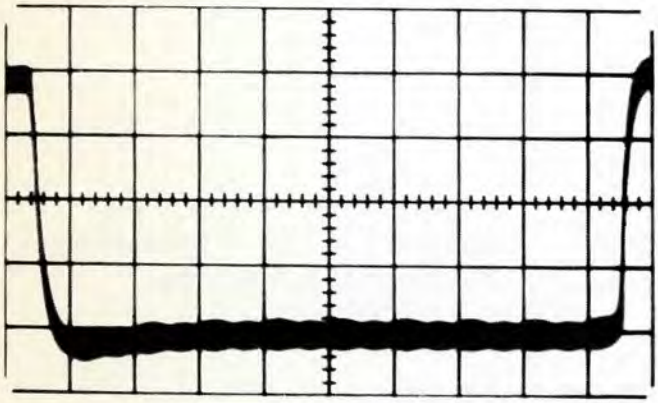
CHECK POINT: Control Panel 2A5

SWEEP TIME: 1 millisec/cm

VERT SENS: 2V/cm

TRIGGER: Normal

a. SIGNAL SELECTOR switch in TRIGGERS position



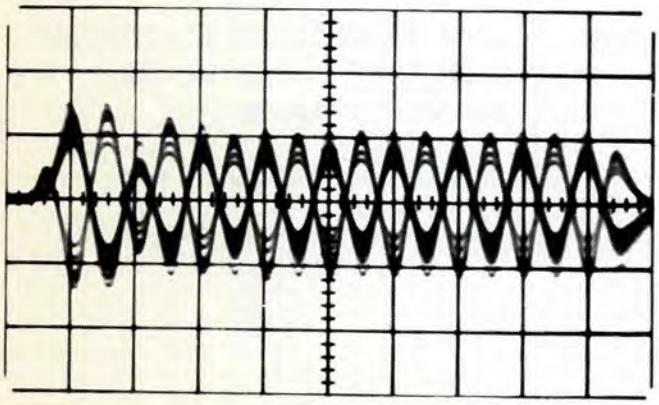
CHECK POINT: Control Panel 2A5

SWEEP TIME: 10 usec/cm

VERT SENS: 2V/cm

TRIGGER: Normal

b. SIGNAL SELECTOR switch in MODULATING SIGNAL position



CHECK POINT: Control Panel 2A5

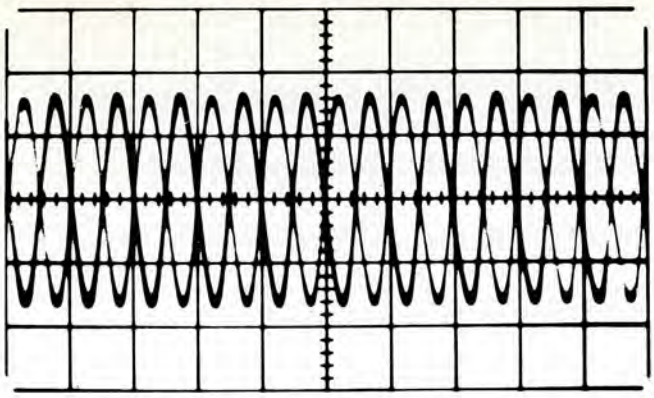
SWEEP TIME: 10 usec/cm

VERT SENS: 0.5V/cm

TRIGGER: Normal

c. SIGNAL SELECTOR switch in DROOP MODULATOR position

Figure 5-1. Oscilloscope OS-103/FPN, Waveforms (Sheet 1 of 5)



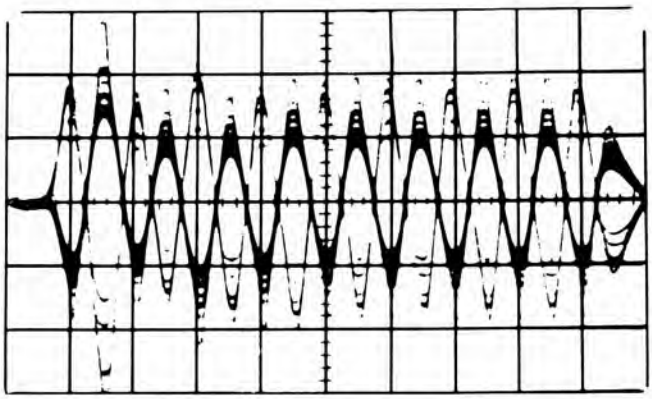
CHECK POINT: Control Panel 2A5

SWEEP TIME: 10 usec/cm

VERT SENS: 1.0 V/cm

TRIGGER: Normal

d. SIGNAL SELECTOR switch in 100 KC position



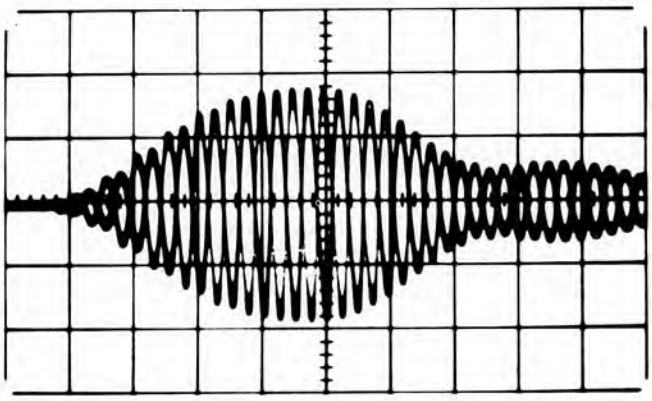
CHECK POINT: Control Panel 2A5

SWEEP TIME: 10 usec/cm

VERT SENS: 2V/cm

TRIGGER: Normal

e. SIGNAL SELECTOR switch in PULSE GEN. OUTPUT position



CHECK POINT: Control Panel 2A5

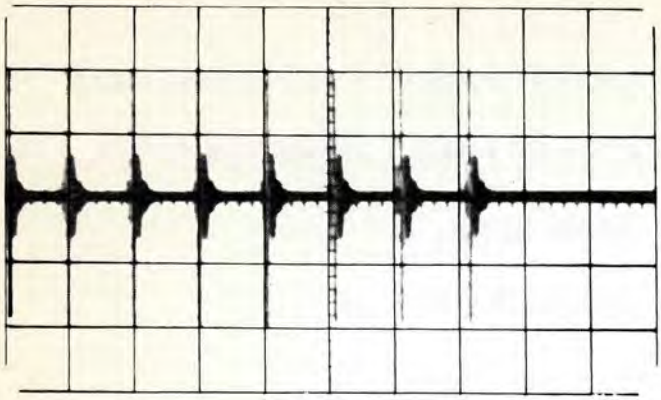
SWEEP TIME: 20 usec/cm

VERT SENS: 20V/cm

TRIGGER: Normal

f. SIGNAL SELECTOR switch in ANTENNA position

Figure 5-1. Oscilloscope OS-103/FPN, Waveforms (Sheet 2 of 5)



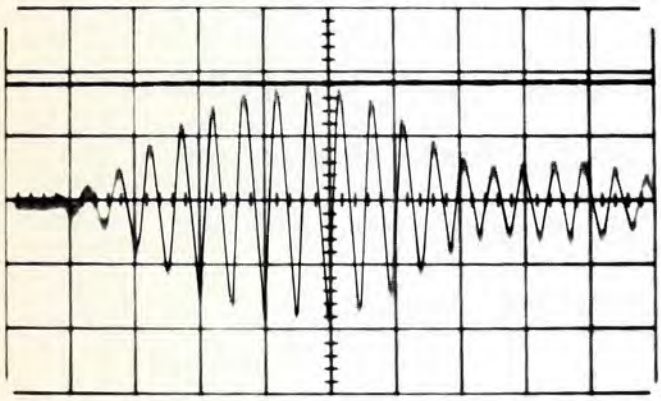
CHECK POINT: Control Panel 2A5

SWEEP TIME: 1 millisec/cm

VERT SENS: 1V/cm

TRIGGER: Normal

g. SIGNAL SELECTOR switch in DUMMY LOAD position



CHECK POINT: Control Panel

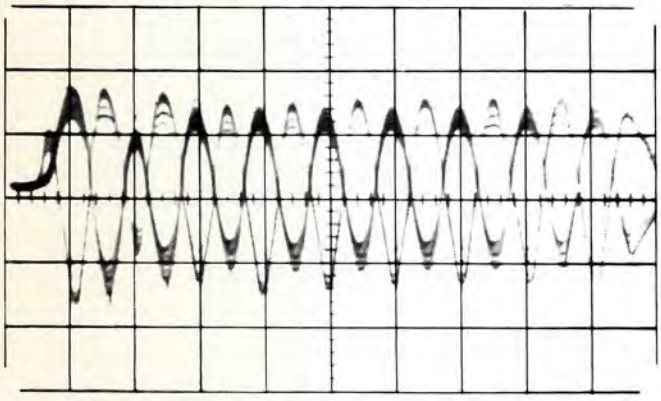
SWEEP TIME: 20 usec/cm

VERT SENS: 10V/cm

SCOPE TRIG. SELECTOR: Pulse Anal.

PULSE SEL: 3

h. SIGNAL SELECTOR switch in PULSE ANALYZER position



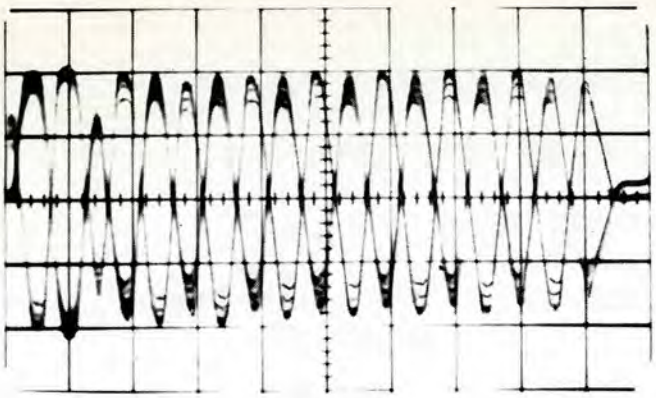
CHECK POINT: Transmitter

SWEEP TIME: 10 usec/cm

VERT SENS: 10V/cm

i. SIGNAL SELECTOR switch in INPUT position

Figure 5-1. Oscilloscope OS-103/FPN, Waveforms (Sheet 3 of 5)

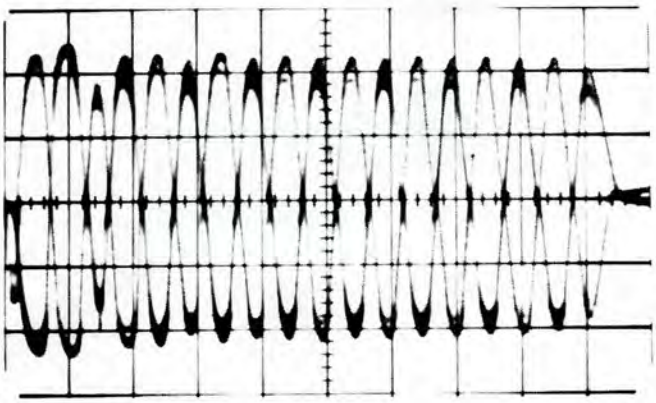


CHECK POINT: Transmitter

SWEEP TIME: 10 usec/cm

VERT SENS: 10V/cm

j. SIGNAL SELECTOR switch in PULSE DRIVER position

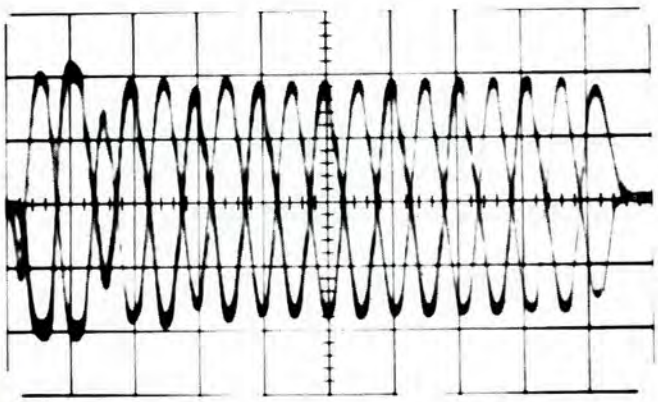


CHECK POINT: Transmitter

SWEEP TIME: 10 usec/cm

VERT SENS: 10V/cm

k. SIGNAL SELECTOR switch in 1ST IPA position



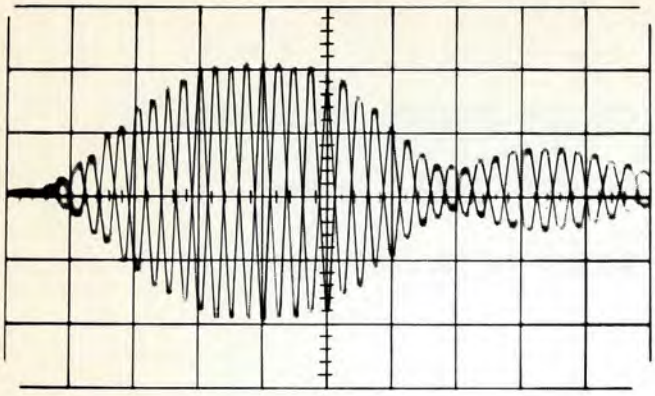
CHECK POINT: Transmitter

SWEEP TIME: 10 usec/cm

VERT SENS: 10V/cm

l. SIGNAL SELECTOR switch in 2ND IPA position

Figure 5-1. Oscilloscope OS-103/FPN, Waveforms (Sheet 4 of 5)



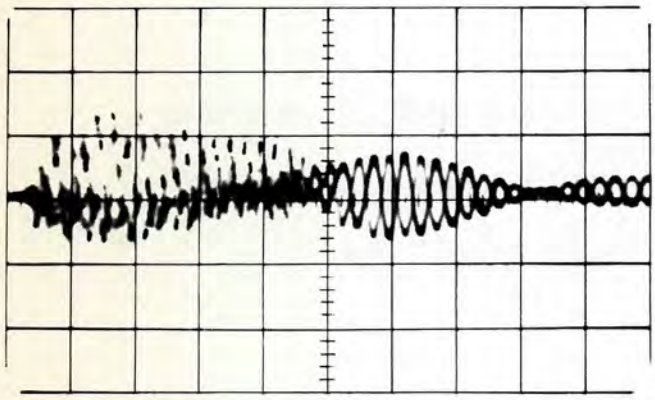
CHECK POINT: Transmitter

SWEEP TIME: 20 usec/cm

VERT SENS: 10V/cm

REMARKS: Transmitter loaded by the antenna.

m. SIGNAL SELECTOR switch in OUTPUT position

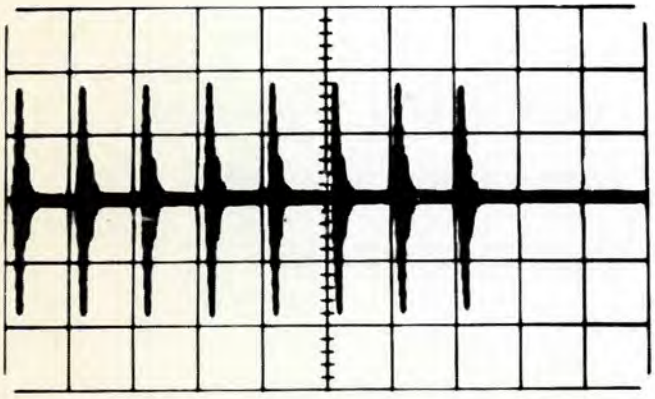


CHECK POINT: Transmitter

SWEEP TIME: 20 usec/cm

VERT SENS: 0.1V/cm

n. SIGNAL SELECTOR switch in BALANCE position



CHECK POINT: Control Panel 2A5

SWEEP TIME: 1 msec/cm

VERT SENS: 20V/cm

o. SIGNAL SELECTOR switch in ANTENNA position

Figure 5-1. Oscilloscope OS-103/FPN, Waveforms (Sheet 5 of 5)

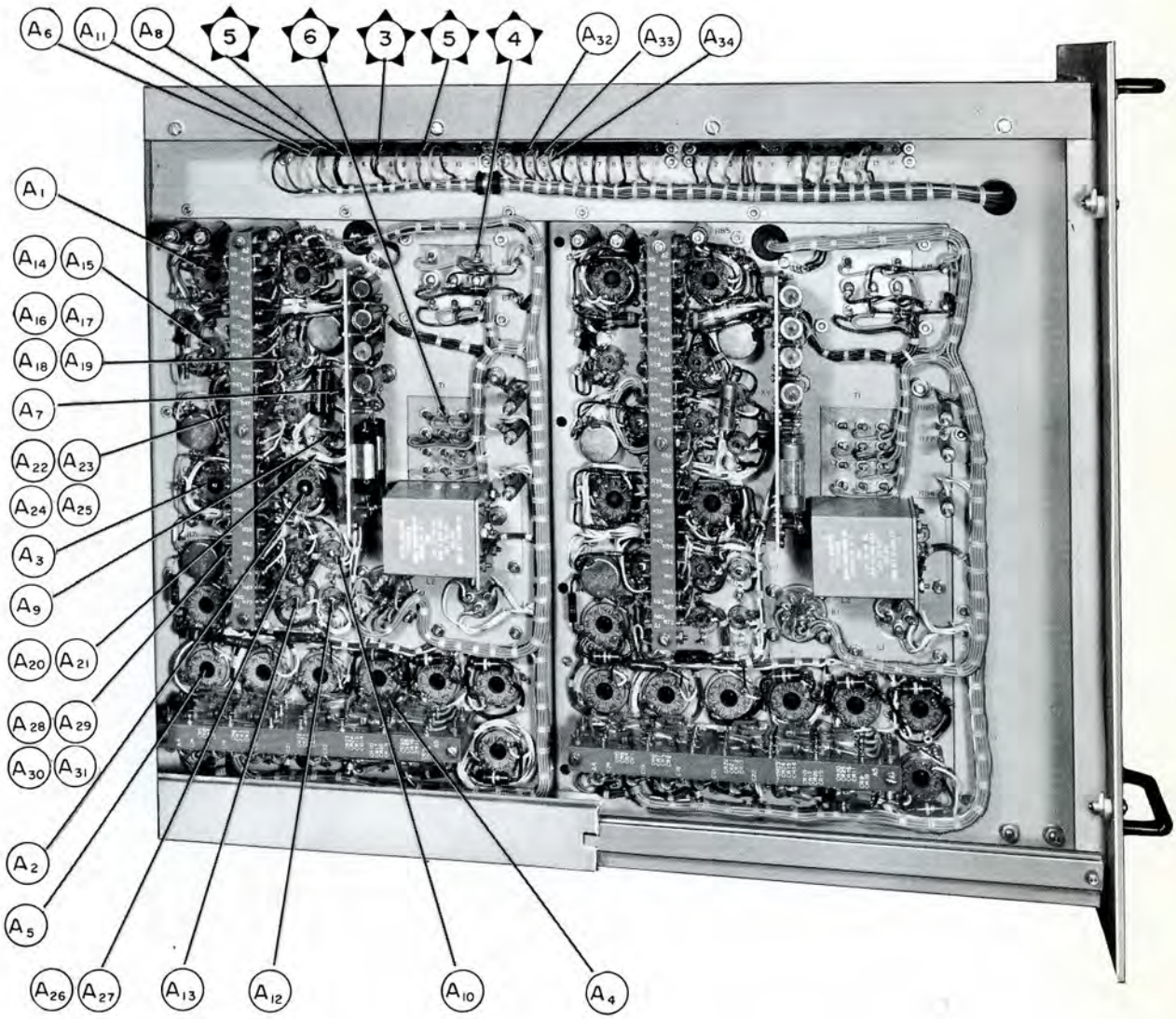


Figure 5-2. Power Supply Assembly PP-2541/FPN-42, Left Chassis View, Location of Test Points

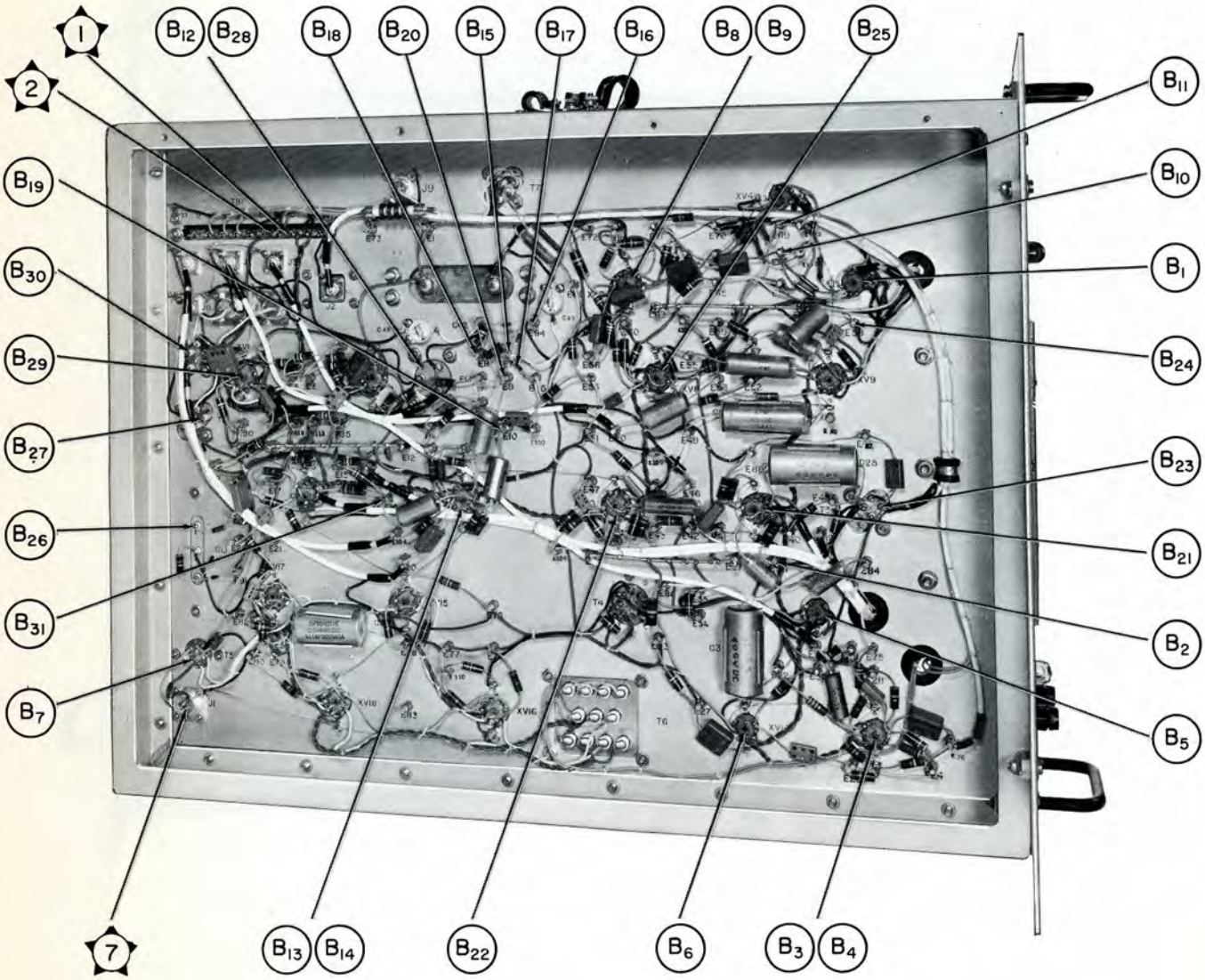
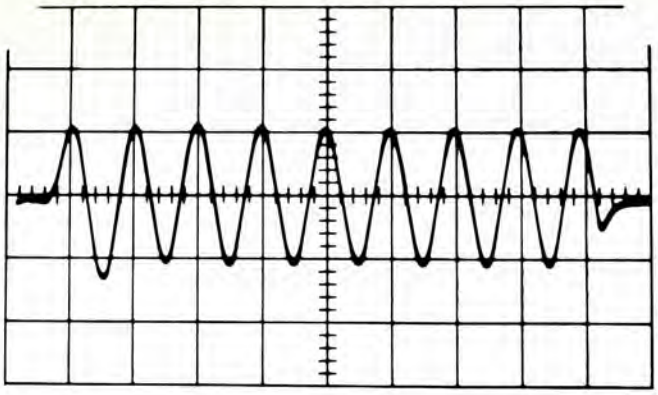


Figure 5-3. Pulse Generator O-706/FPN-42, Left Chassis View, Location of Test Points



TEST POINT: (B1) V5-1

SWEEP TIME: 10 usec/cm

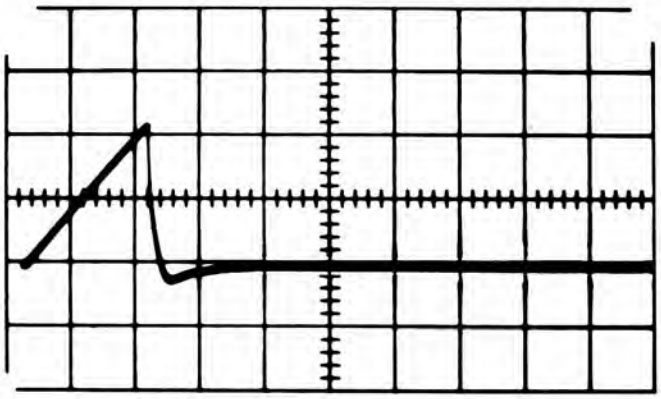
VERT SENS: 5V/cm

TRIGGER: Horizontal jacks on monitor oscilloscope

SCOPE TRIG SELECTOR: Pulse Anal.

PULSE SEL: 3

a. Output 100-kc Modulator



TEST POINT: (B2) E36

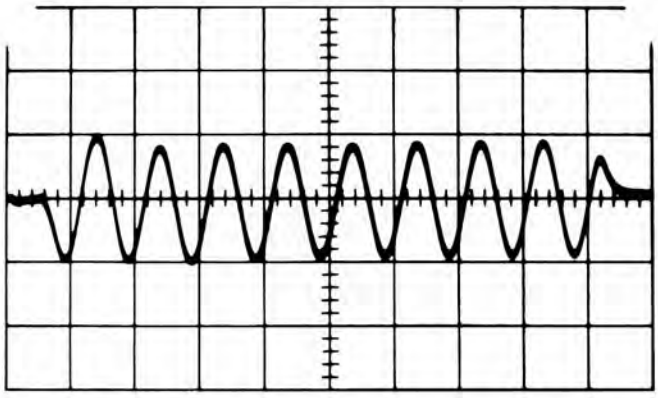
SWEEP TIME: 5 millisec/cm

VERT SENS: 5V/cm

TRIGGER: Horizontal jacks on monitor oscilloscope

SCOPE TRIG SELECTOR: Normal

b. Output Droop Compensation Pedestal Generator



TEST POINT: (B3) V12-1

SWEEP TIME: 10 usec/cm

VERT SENS: 5V/cm

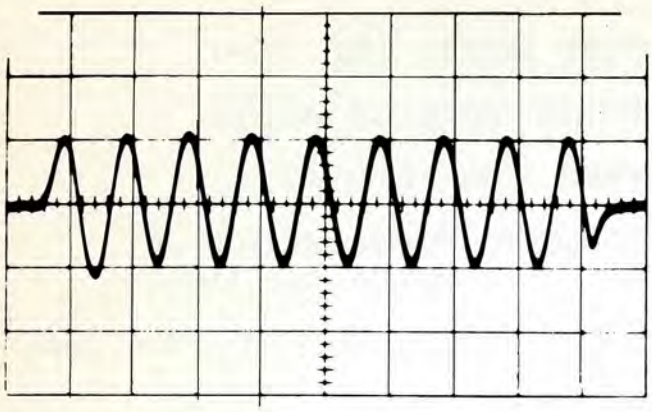
TRIGGER: Horizontal jacks on monitor oscilloscope

SCOPE TRIG SELECTOR: Pulse Anal.

PULSE SEL: 3

c. Droop Modulator

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 1 of 9)



TEST POINT: (B4) V12-3

SWEEP TIME: 10 usec/cm

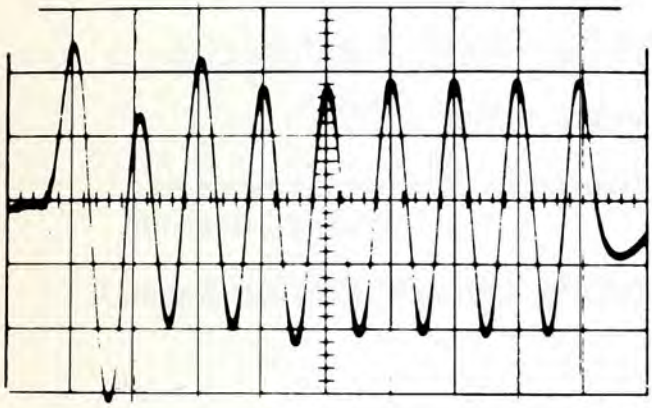
VERT SENS: 5V/cm

TRIGGER: Same as for 5-4a

d. Droop Modulator

TEST POINT: (B5) V13-5

(B6) V14-5



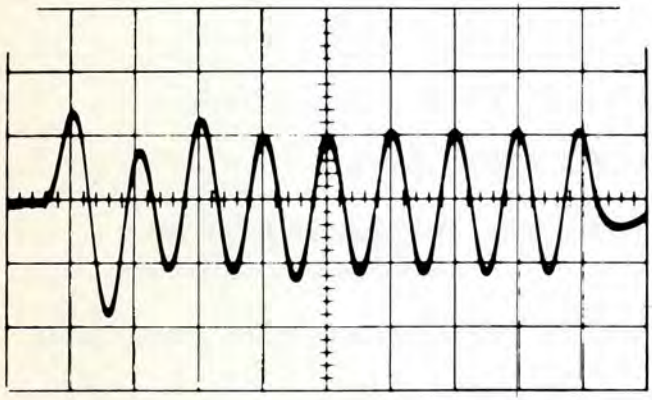
SWEEP TIME: 10 usec/cm

VERT SENS: 20V/cm

NOTE: For any given phase code, ●B5 and ●B6 are 180° degrees out of phase.

TRIGGER: Same as for 5-4a

e. Droop Modulator



TEST POINT: (B7) T5-1

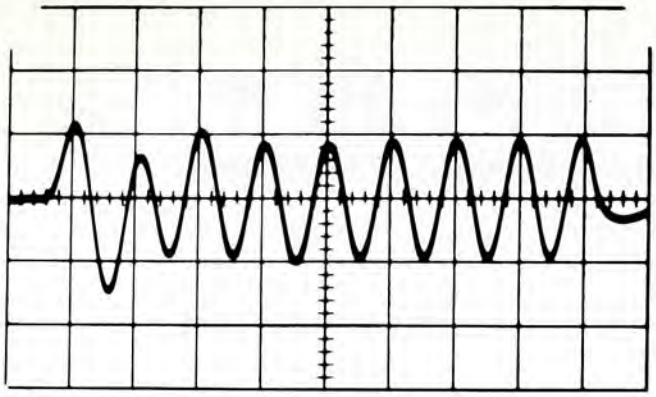
SWEEP TIME: 10 usec/cm

VERT SENS: 50V/cm

TRIGGER: Same as for 5-4a

f. Output Cathode Followers

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 2 of 9)



TEST POINT: 7 T5-4

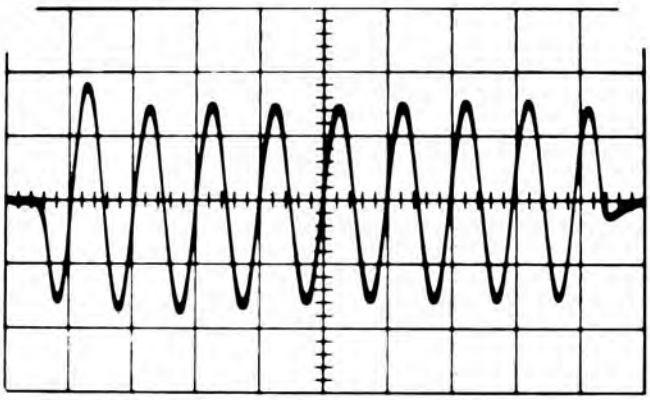
SWEEP TIME: 10 usec/cm

VERT SENS: 20V/cm

REMARKS: Terminal 4, at T5 with terminal 6 grounded

TRIGGER: Same as for 5-4a

g. Output Pulse



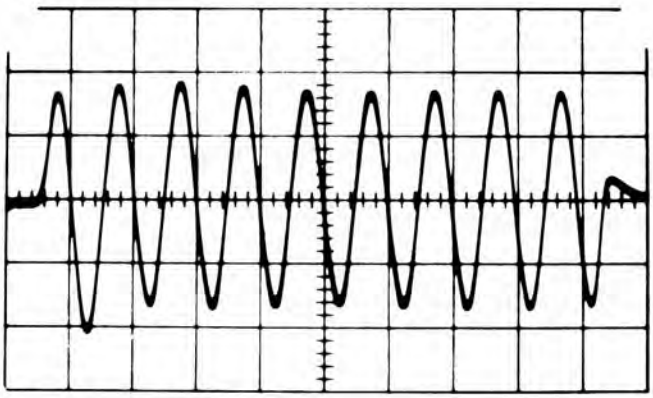
TEST POINT: B8 V3-6

SWEEP TIME: 10 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4a

h. Paraphase Amplifier



TEST POINT: B9 V3-8

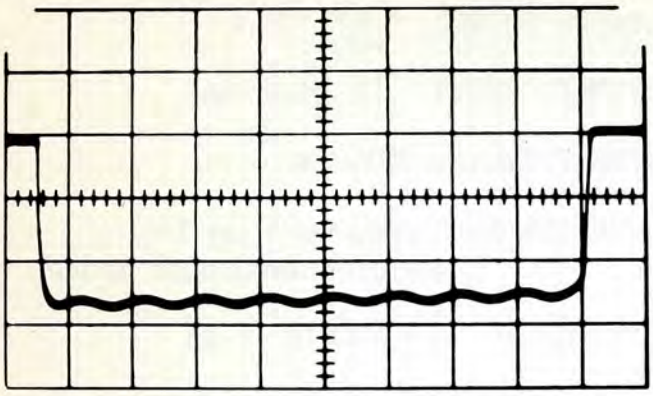
SWEEP TIME: 10 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4a

i. Paraphase Amplifier

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 3 of 9)



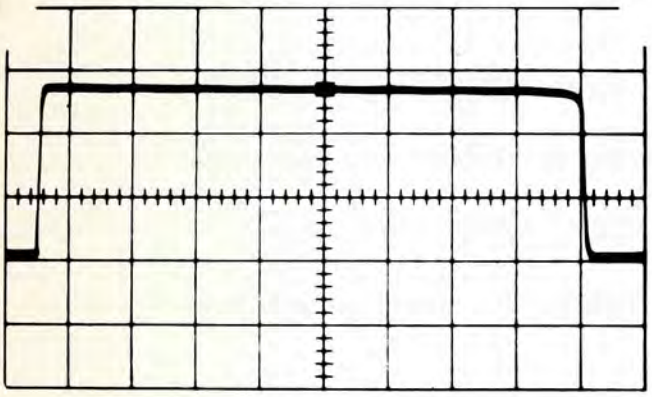
TEST POINT: B10 E64

SWEEP TIME: 10 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4a

j. 100-kc Modulator



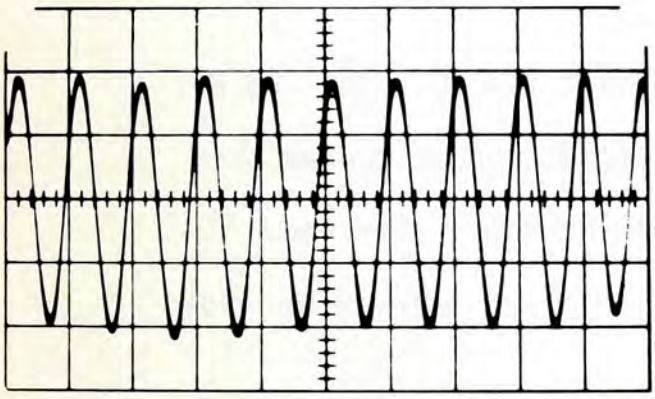
TEST POINT: B11 E69

SWEEP TIME: 10 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4a

k. 100-kc Modulator



TEST POINT: B12 FL1-3

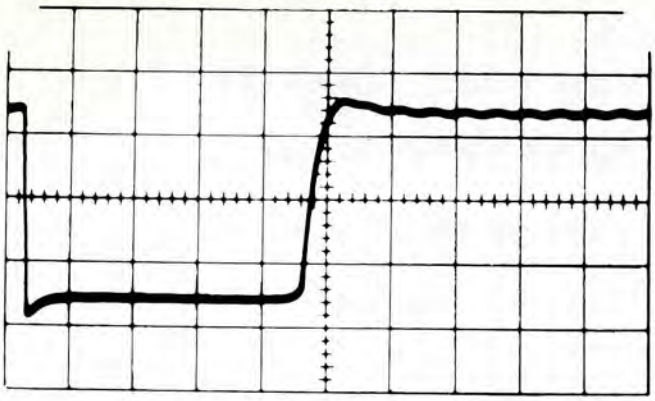
SWEEP TIME: 10 usec/cm

VERT SENS: 5V/cm

TRIGGER: Same as for 5-4a

l. Input to Gate

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 4 of 9)



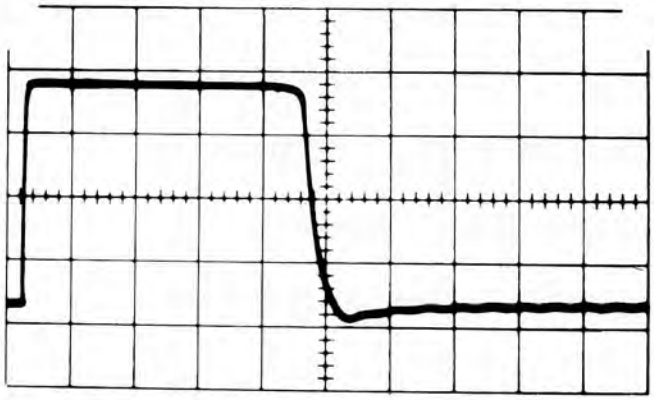
TEST POINT: B13 V7-1

SWEEP TIME: 20 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4a

m. Gate Generator



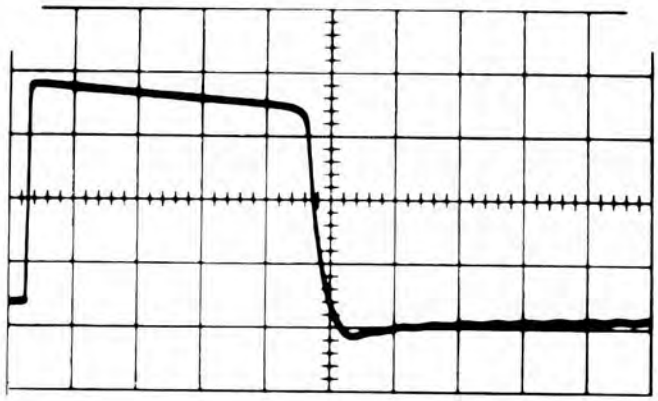
TEST POINT: B14 V7-3

SWEEP TIME: 20 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4a

n. Gate Generator



TEST POINT: B19 E10

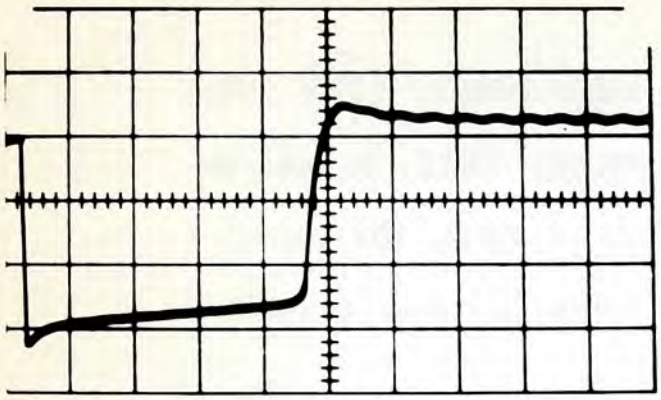
SWEEP TIME: 20 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4a

o. Gate Generator

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 5 of 9)



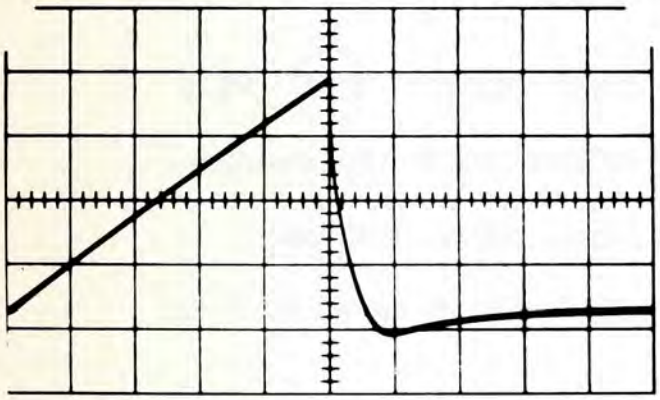
TEST POINT: B20 E9

SWEEP TIME: 20 usec

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4a

p. Gate Generator



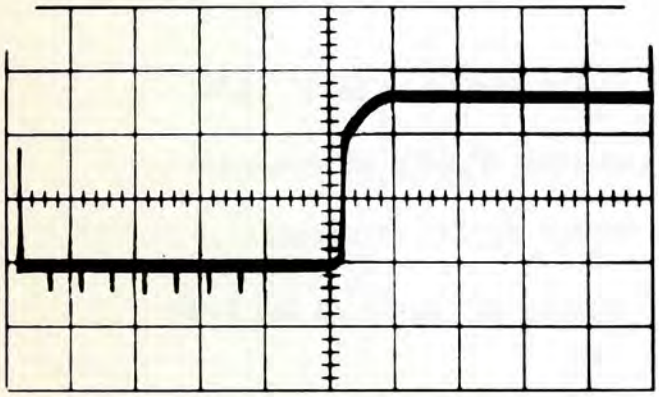
TEST POINT: B21 V11-1

SWEEP TIME: 2 millisec/cm

VERT SENS: 5V/cm

TRIGGER: Same as for 5-4b

q. Droop Compensation Pedestal Shaper



TEST POINT: B22 V10-1

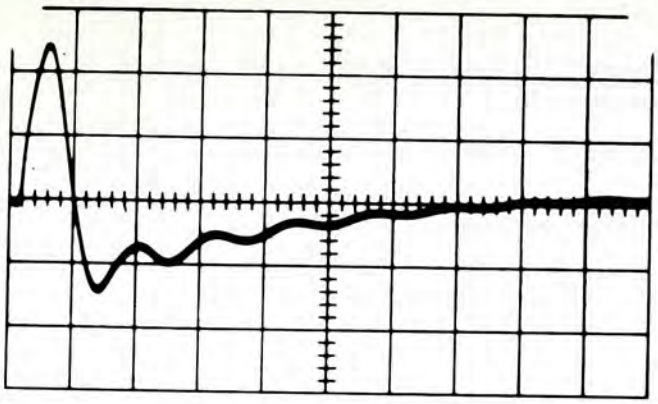
SWEEP TIME: 2 millisec/cm

VERT SENS: 20V/cm

TRIGGER: Same as for 5-4b

r. Droop Compensation Pedestal Generator

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 6 of 9)



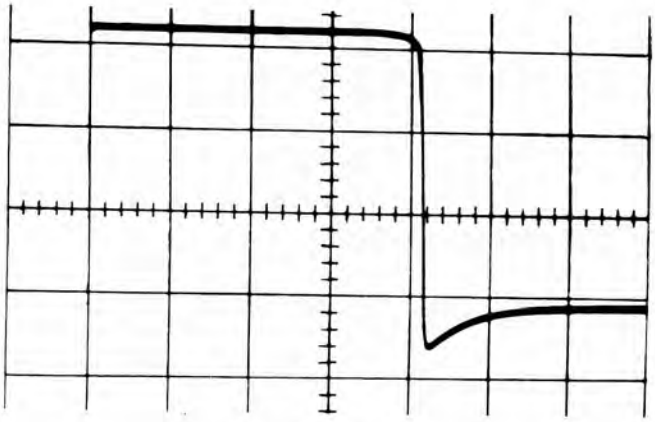
TEST POINT: (B23) T3-3

SWEEP TIME: 1 usec/cm

VERT SENS: 20V/cm

TRIGGER: Same as for 5-4b

s. Oscilloscope Trigger



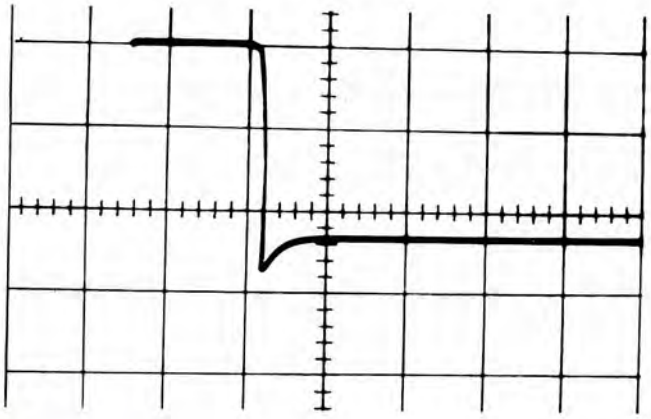
TEST POINT: (B24) E58

SWEEP TIME: 20 millisec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4b

t. Pedestal Shaper



TEST POINT: (B25) V8-6

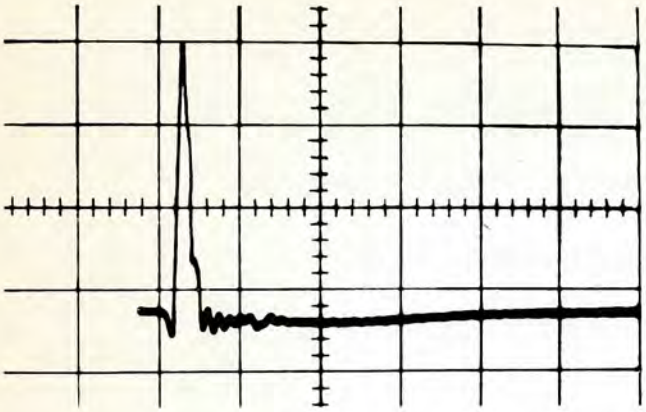
SWEEP TIME: 50 millisec/cm

VERT SENS: 5V/cm

TRIGGER: Same as for 5-4b

u. Pedestal Generator

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 7 of 9)



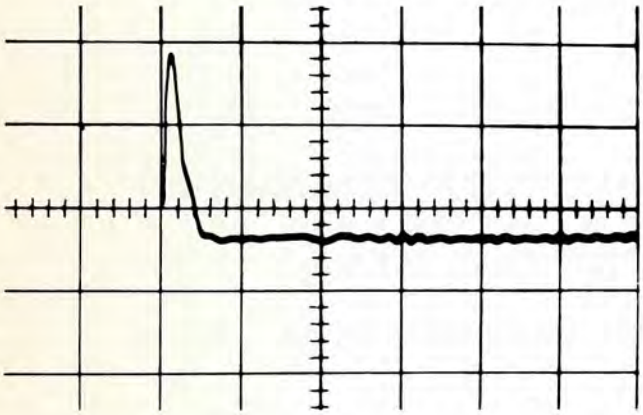
TEST POINT: B26 DL1-2

SWEEP TIME: 2 usec/cm

VERT SENS: 5V/cm

TRIGGER: Same as for 5-4b

v. Delay Line Output



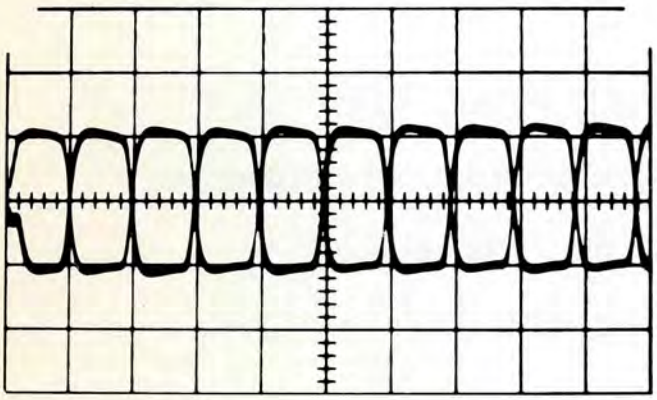
TEST POINT: B27 T2-3

SWEEP TIME: 2 usec/cm

VERT SENS: 20V/cm

TRIGGER: Same as for 5-4b

w. Trigger Input



TEST POINT: B28 FL1-1

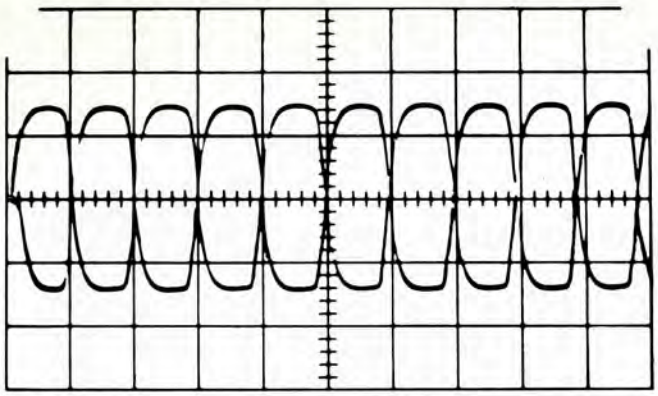
SCOPE TRIGGERS: 5 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4b

x. Squarer Output

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 8 of 9)



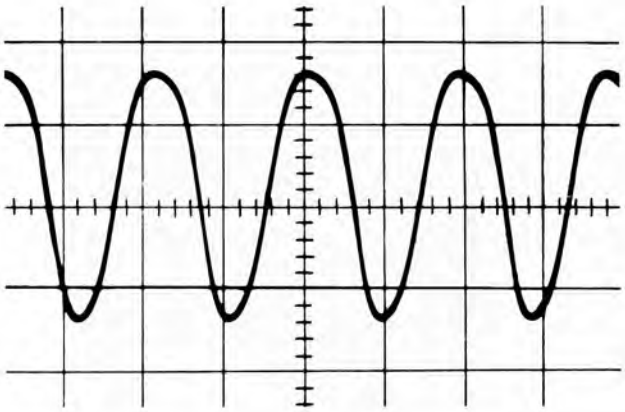
TEST POINT: B29 V1-2

SWEEP TIME: 5 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4b

y. Cathode Follower in Squarer



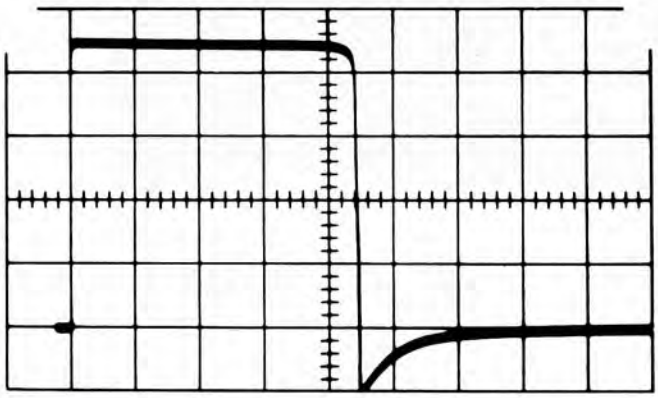
TEST POINT: B30 T1-3

SWEEP TIME: 5 usec/cm

VERT SENS: 5V/cm

TRIGGER: Same as for 5-4b

z. 100 kc input



TEST POINT: B31 E16

SWEEP TIME: 20 usec/cm

VERT SENS: 10V/cm

TRIGGER: Same as for 5-4b

aa. Gate Generator

Figure 5-4. Pulse Generator O-706/FPN-42, Waveforms (Sheet 9 of 9)

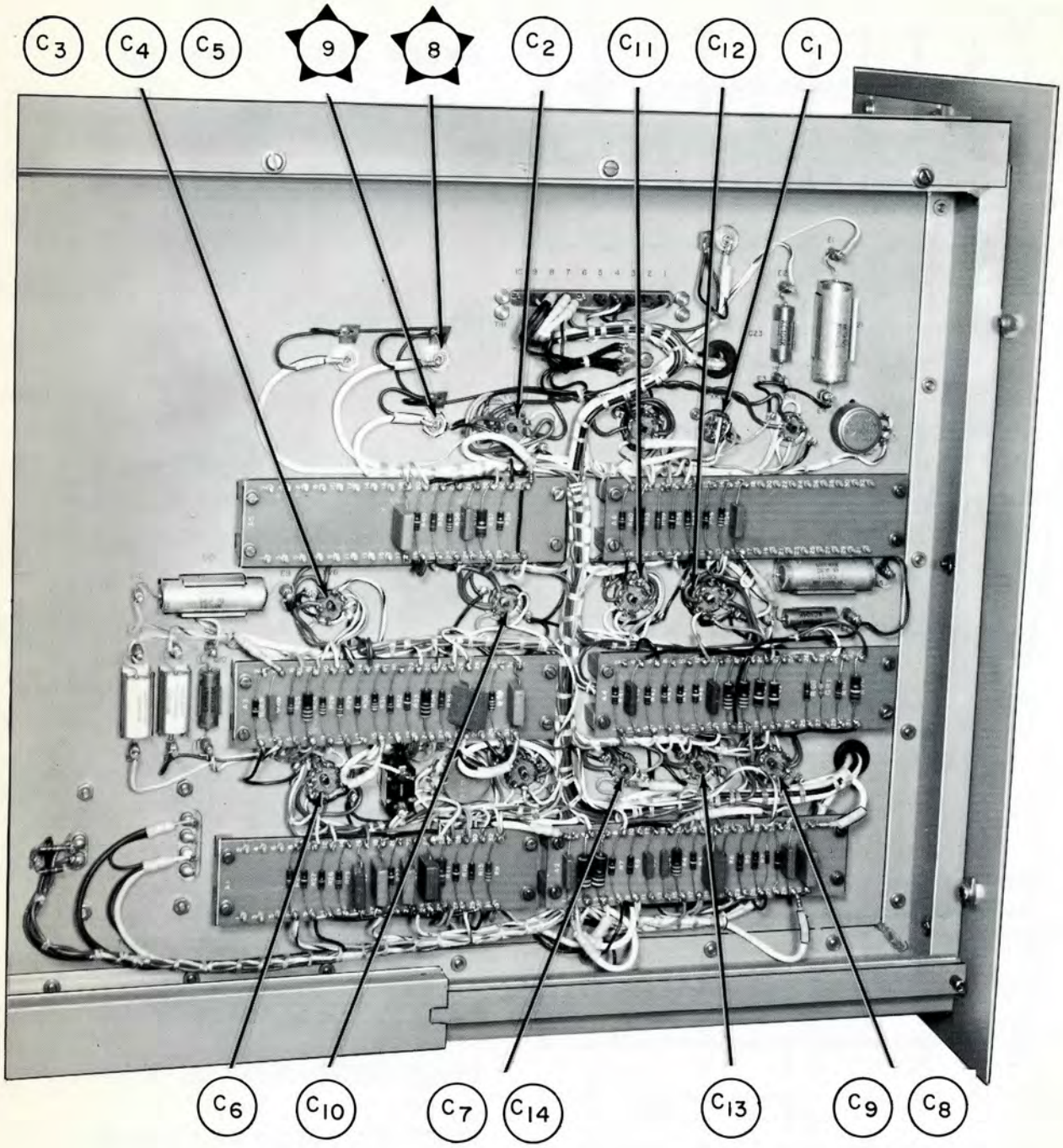


Figure 5-5. Electrical Pulse Analyzer TS-1360/FPN-42, Left Chassis View, Location of Test Points

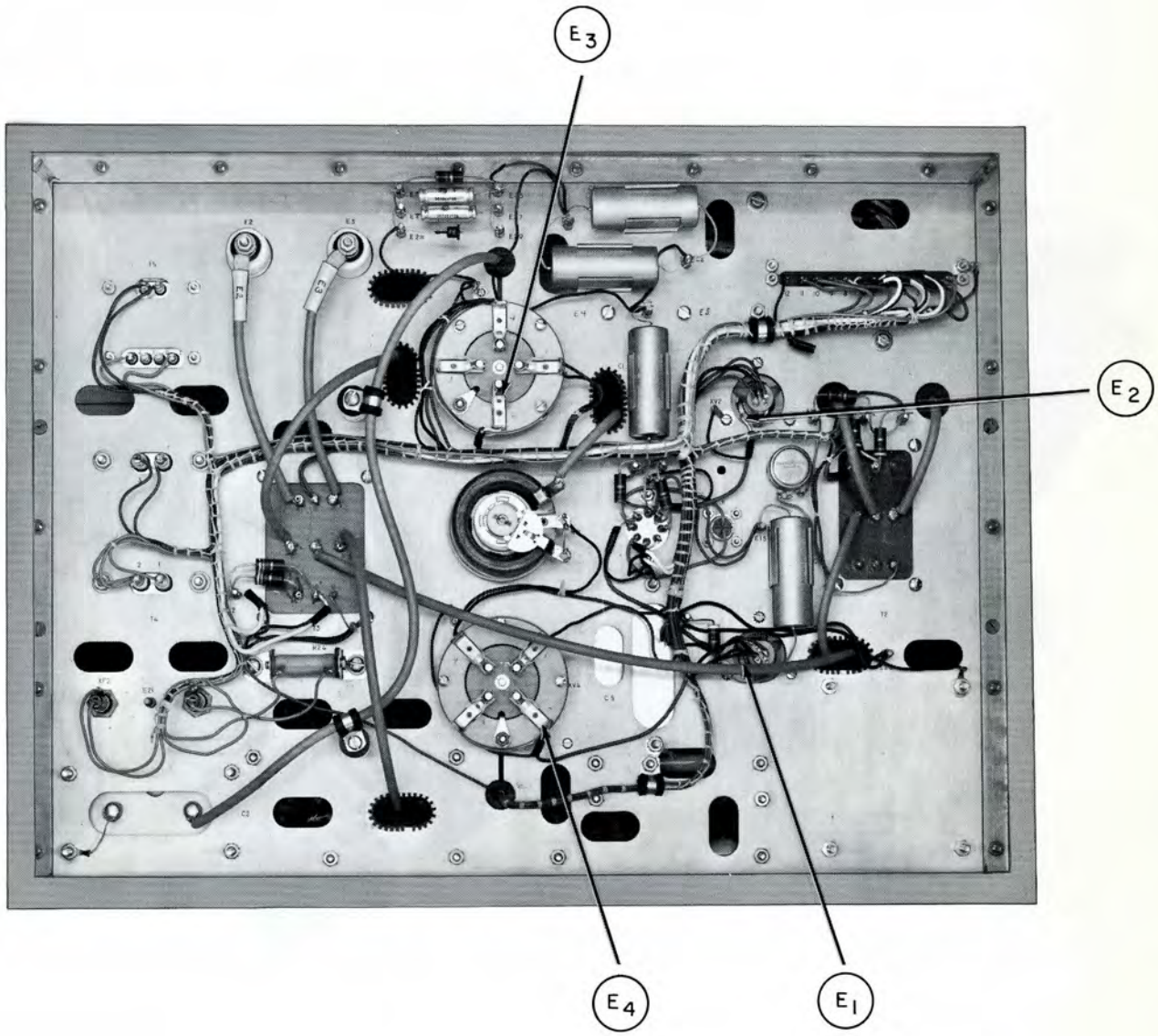


Figure 5-6. Amplifier Assembly AM-2481/FPN-42, Pulse Driver, Bottom Chassis View, Location of Test Points

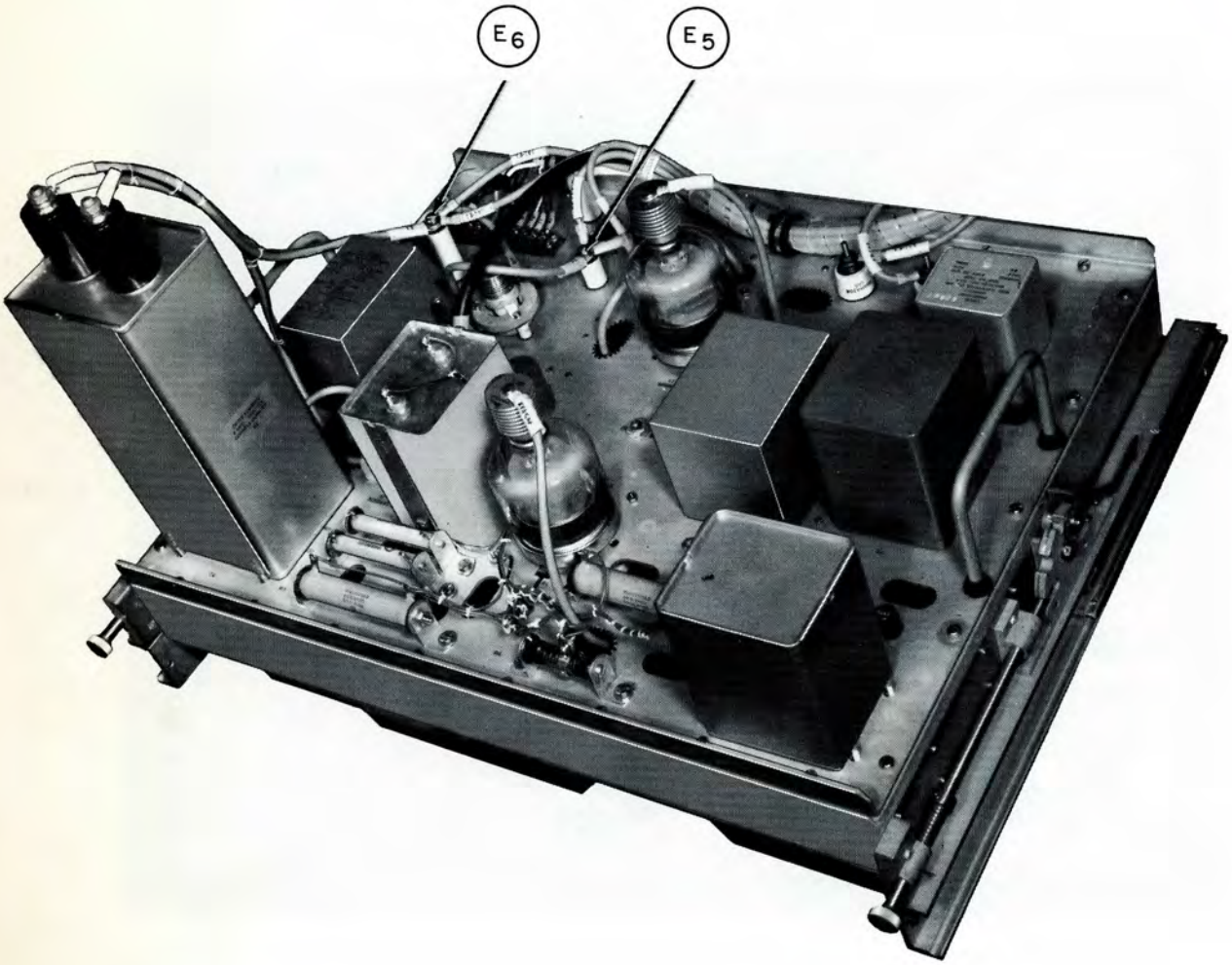


Figure 5-7. Amplifier Assembly AM-2481/FPN-42, Pulse Driver, Top Chassis View, Location of Test Points

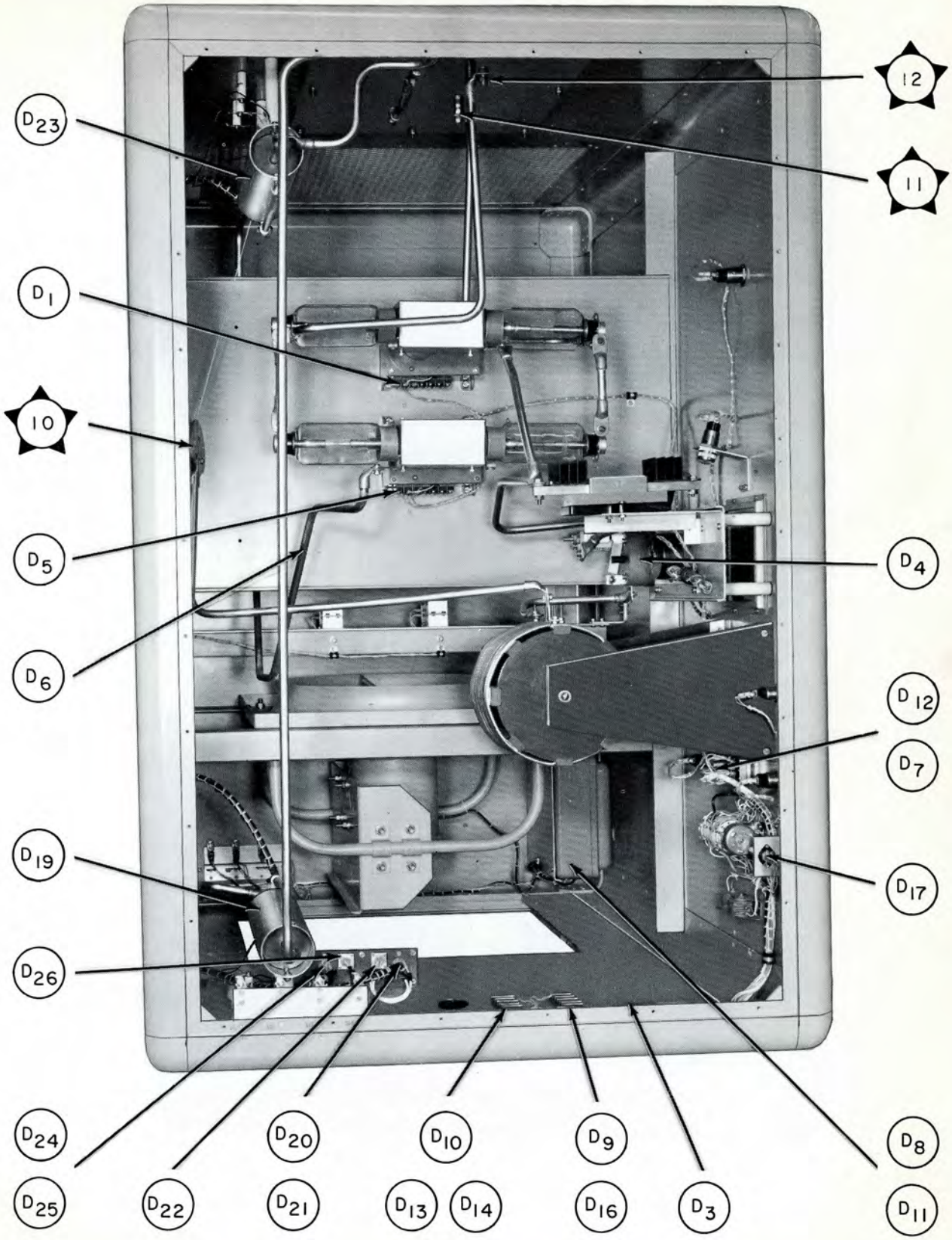


Figure 5-8. Antenna Coupler CU-807/FPN-42, Left Chassis View, Location of Test Points

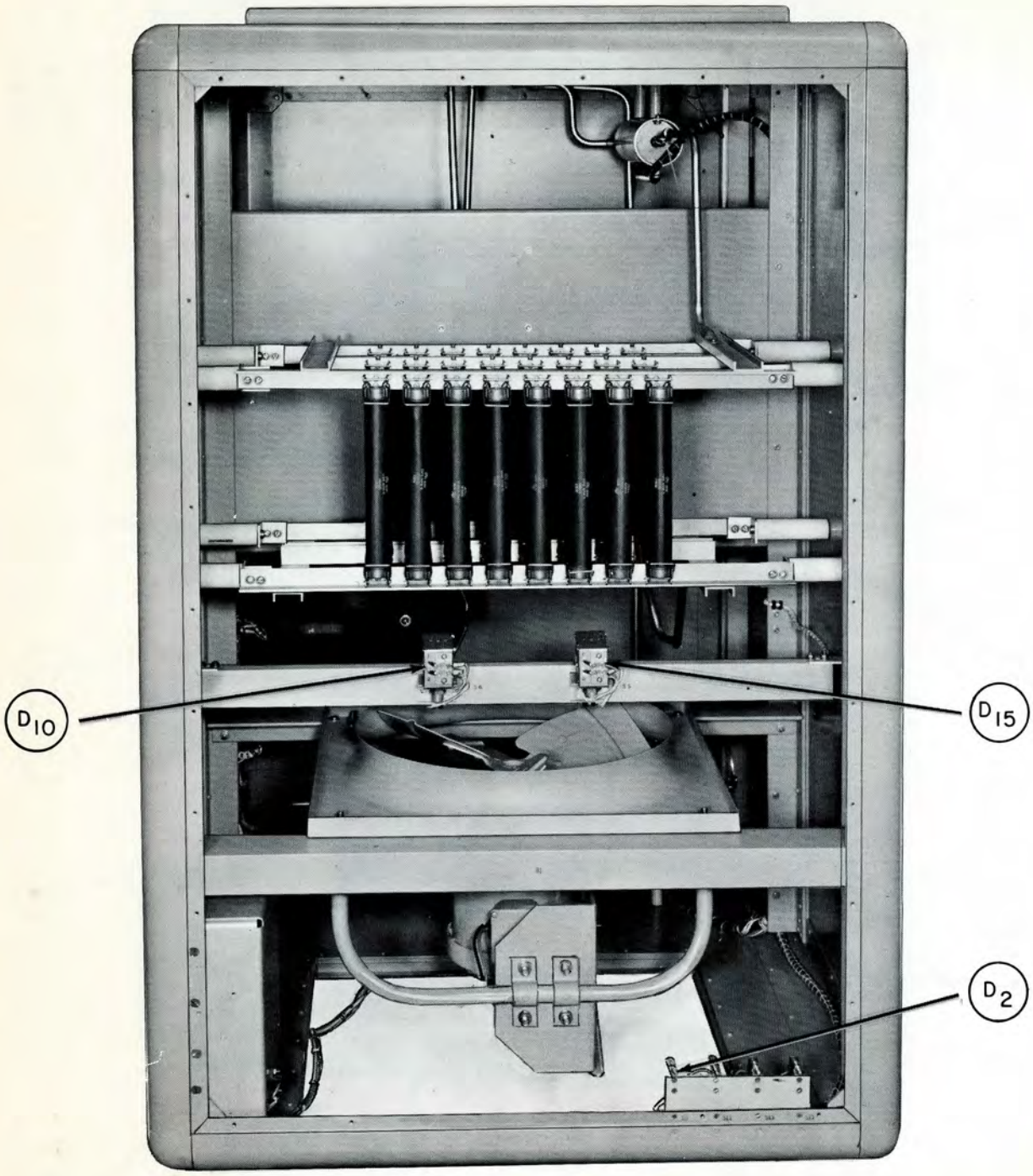
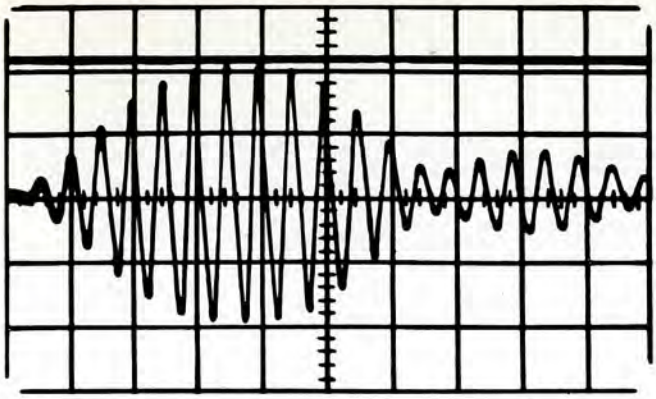


Figure 5-9. Antenna Coupler CU-807/FPN-42, Right Chassis View, Location of Test Points



TEST POINT: (C1) K1-7

SWEEP TIME: 20 usec/cm

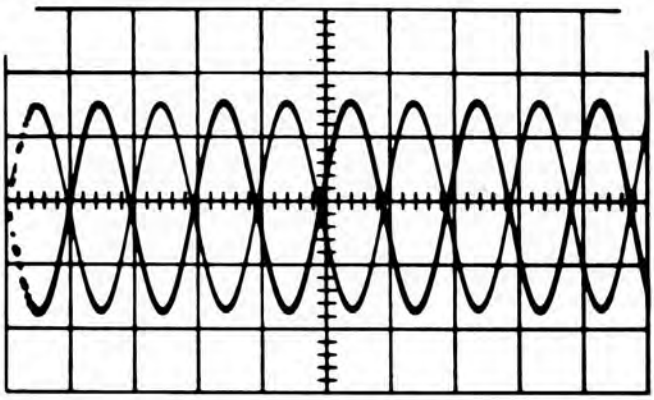
VERT SENS: 10V/cm

TRIGGER: J2 on pulse analyzer

PULSE SEL: 3

REMARKS: Slave station with phase coding on. Master station 3rd pulse would be 180° from that shown.

a. Relay Output

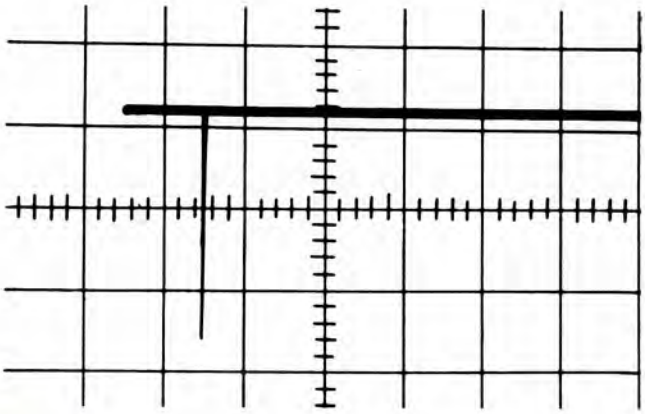


TEST POINT: (C2) V7-2

SWEEP TIME: 1 millisec/cm

VERT SENS: 10V/cm

b. Trigger Amplifier



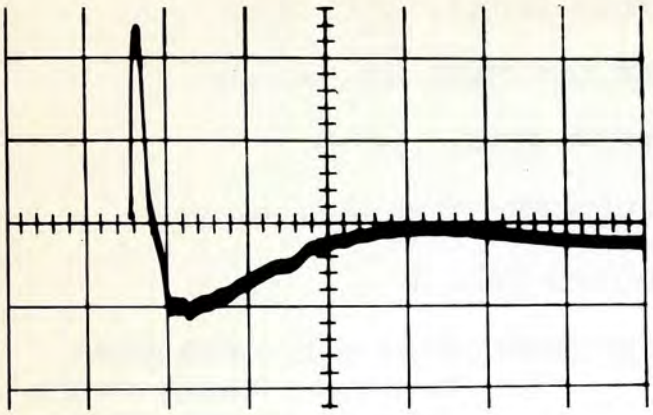
TEST POINT: (C3) V6-5

SWEEP TIME: 1 millisec/cm

VERT SENS: 20V/cm

c. Trigger Gate

Figure 5-10. Electrical Pulse Analyzer TS-1360/FPN-42, Waveforms (Sheet 1 of 5)

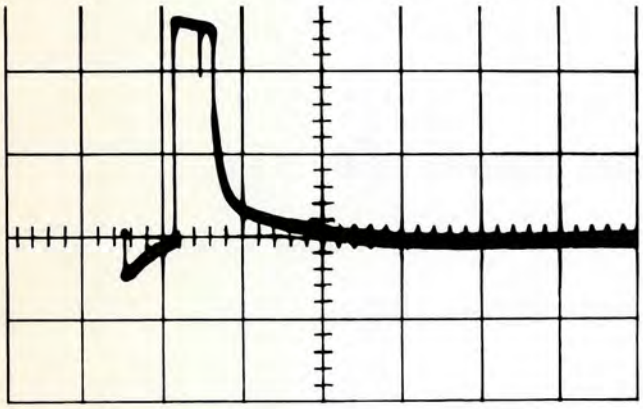


TEST POINT: (C4) V6-1

SWEEP TIME: 5 usec/cm

VERT SENS: 10V/cm

d. Trigger Gate

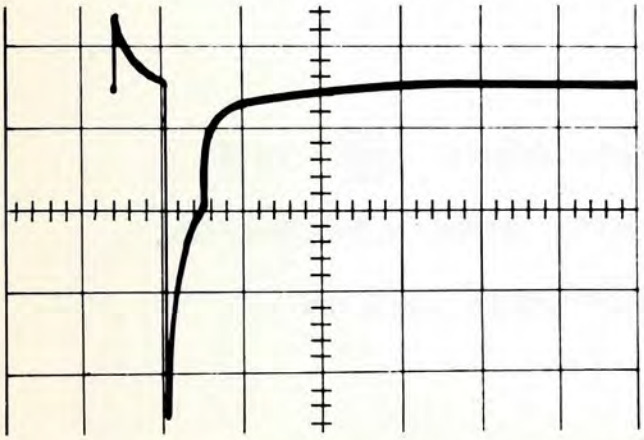


TEST POINT: (C5) V6-7

SWEEP TIME: 1 millisec/cm

VERT SENS: 20V/cm

e. Trigger Gate



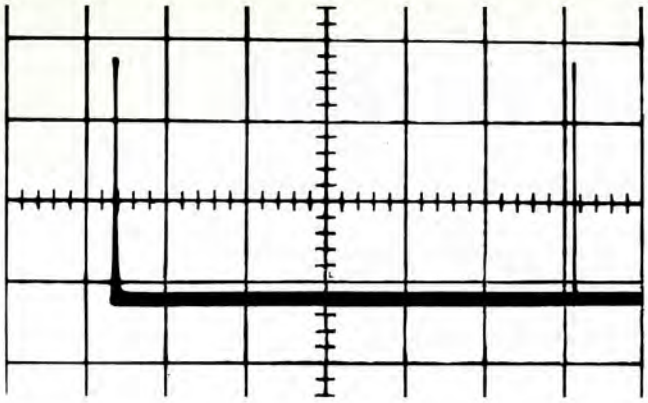
TEST POINT: (C6) V4-2

SWEEP TIME: 1 millisec/cm

VERT SENS: 20V/cm

f. Gate Generator

Figure 5-10. Electrical Pulse Analyzer TS-1360/FPN-42, Waveforms (Sheet 2 of 5)

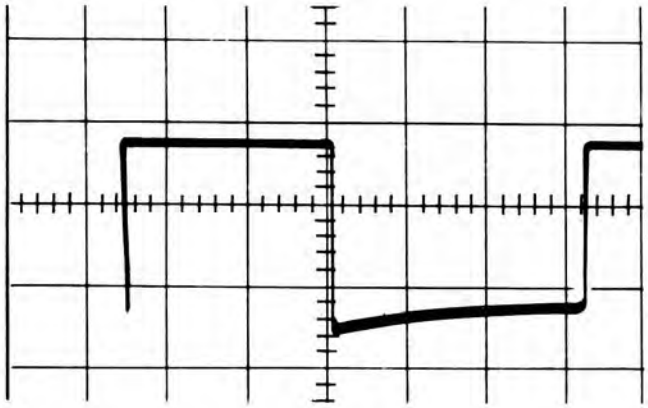


TEST POINT: (C7) V3-2

SWEEP TIME: 5 millisec/cm

VERT SENS: 5V/cm

g. Delay Multivibrator Input

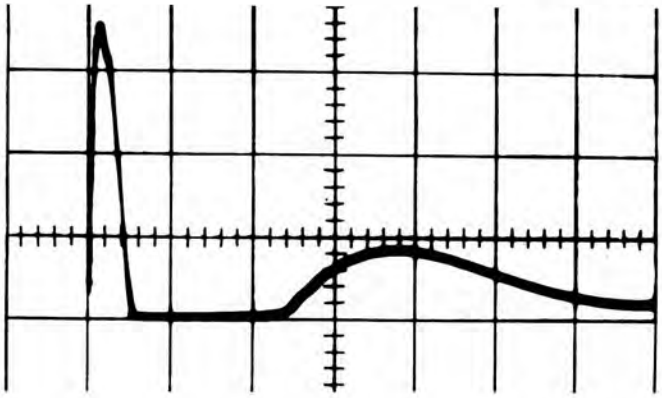


TEST POINT: (C8) V1-6

SWEEP TIME: 5 millisec/cm

VERT SENS: 50V/cm

h. PRR Multivibrator



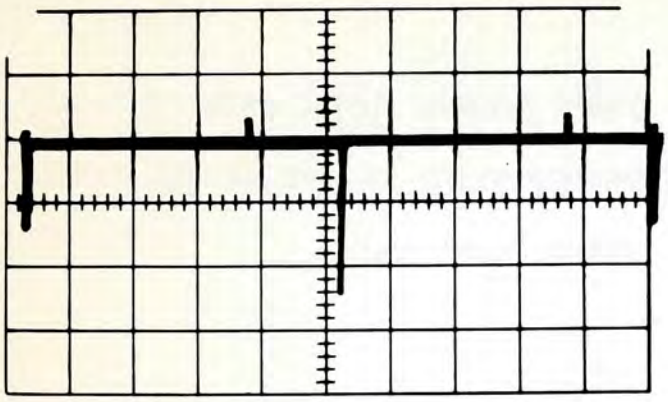
TEST POINT: (C9) V1-2

SWEEP TIME: 5 usec/cm

VERT SENS: 2V/cm

i. PRR Multivibrator Input

Figure 5-10. Electrical Pulse Analyzer TS-1360/FPN-42, Waveforms (Sheet 3 of 5)



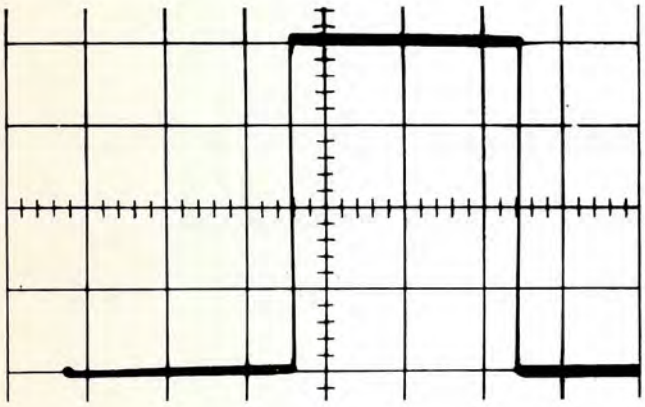
TEST POINT: C10 V8-5

SWEEP TIME: 2 millisec/cm

VERT SENS: 2V/cm

TRIGGER: -INT.

j. Gate

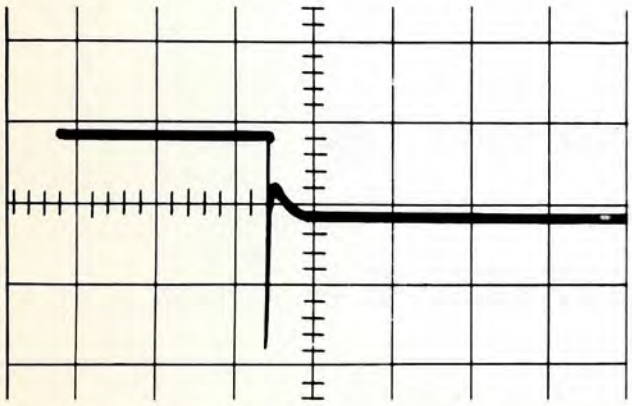


TEST POINT: C11 V9-6

SWEEP TIME: 5 millisec/cm

VERT SENS: 5V/cm

k. 1/2 PRR Multivibrator



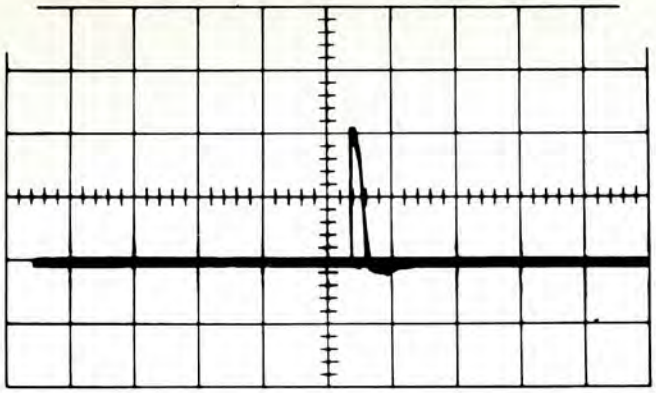
TEST POINT: C12 V10-1

SWEEP TIME: 5 millisec/cm

VERT SENS: 20V/cm

l. Relay Driver

Figure 5-10. Electrical Pulse Analyzer TS-1360/FPN-42, Waveforms (Sheet 4 of 5)



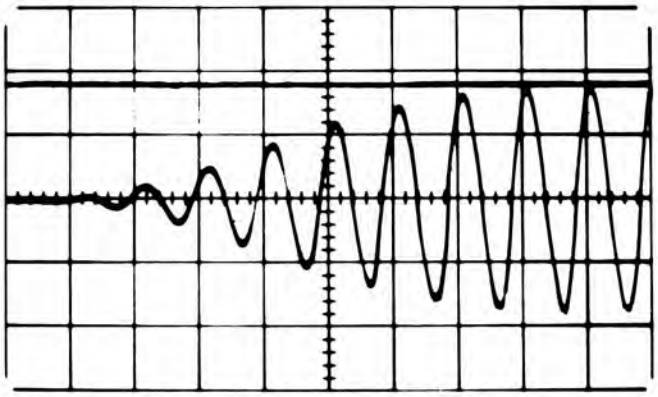
TEST POINT: 8 J2

SWEEP TIME: 200 usec/cm

VERT SENS: 20V/cm

TRIGGER: J1 on pulse analyzer

m. Oscilloscope Trigger Output



TEST POINT: 9 J4

SWEEP TIME: 10 usec/cm

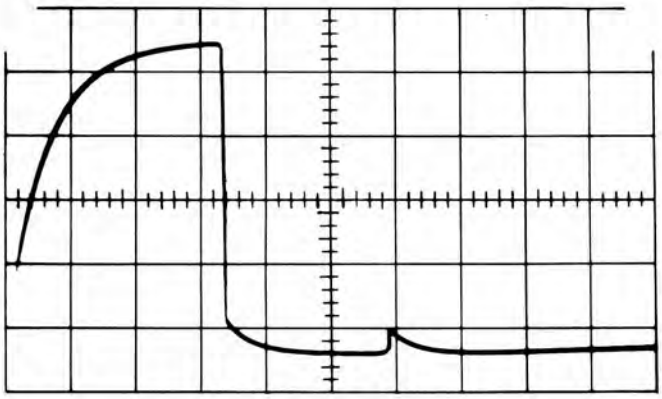
VERT SENS: 10V/cm

TRIGGER: J2 on pulse analyzer

PULSE SEL: 3

REMARKS: Slave station with phase coding on. Master station 3rd pulse would be 180° from that shown.

n. Output



TEST POINT: C14 V3-6

SWEEP TIME: 200 usec/cm

VERT SENS: 20V/cm

TRIGGER: +INT

PULSE SEL: 2

o. Delay Multivibrator

Figure 5-10. Electrical Pulse Analyzer TS-1360/FPN-42, Waveforms (Sheet 5 of 5)

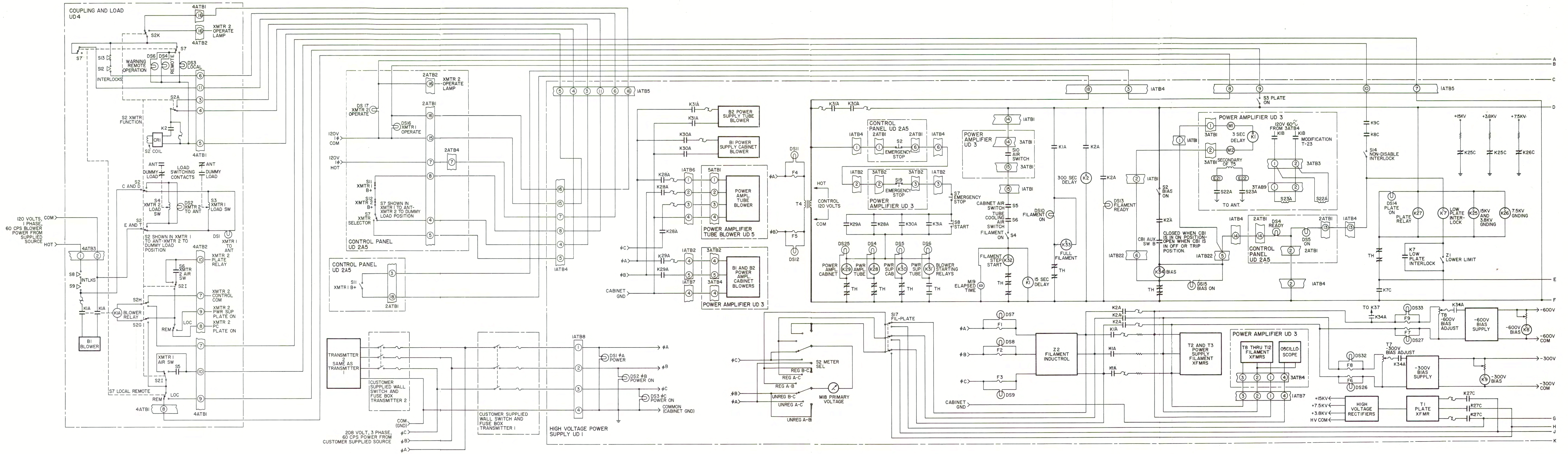


Figure 5-11. Loran Transmitting Set AN/FPN-42, Power Interlock, Schematic Diagram (Sheet 1 of 3)

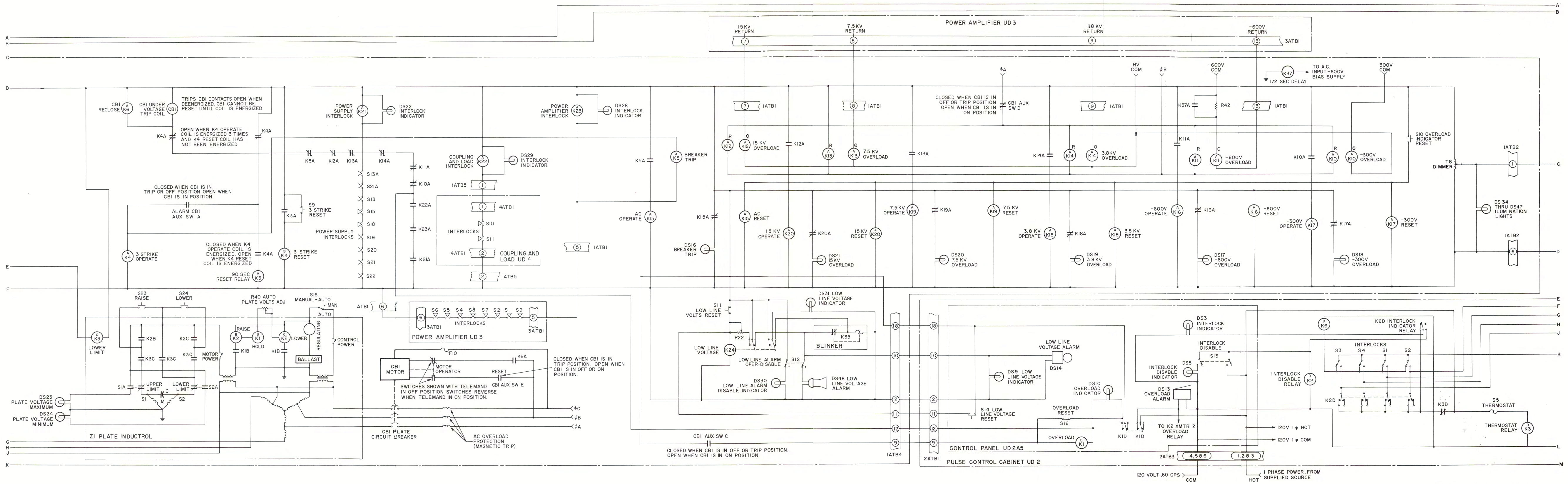


Figure 5-11. Loran Transmitting Set AN/FPN-42, Power Interlock, Schematic Diagram (Sheet 2 of 3)

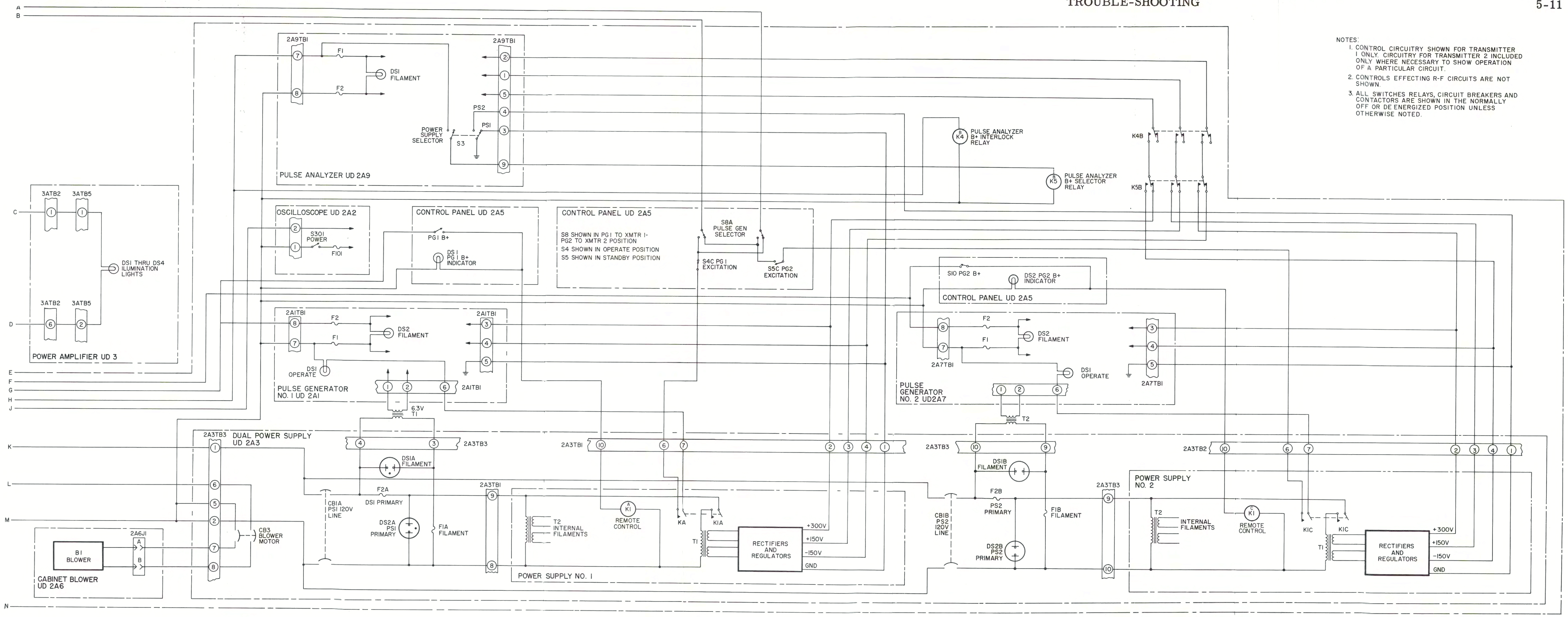


Figure 5-11. Loran Transmitting Set AN/FPN-42, Power Interlock, Schematic Diagram (Sheet 3 of 3)

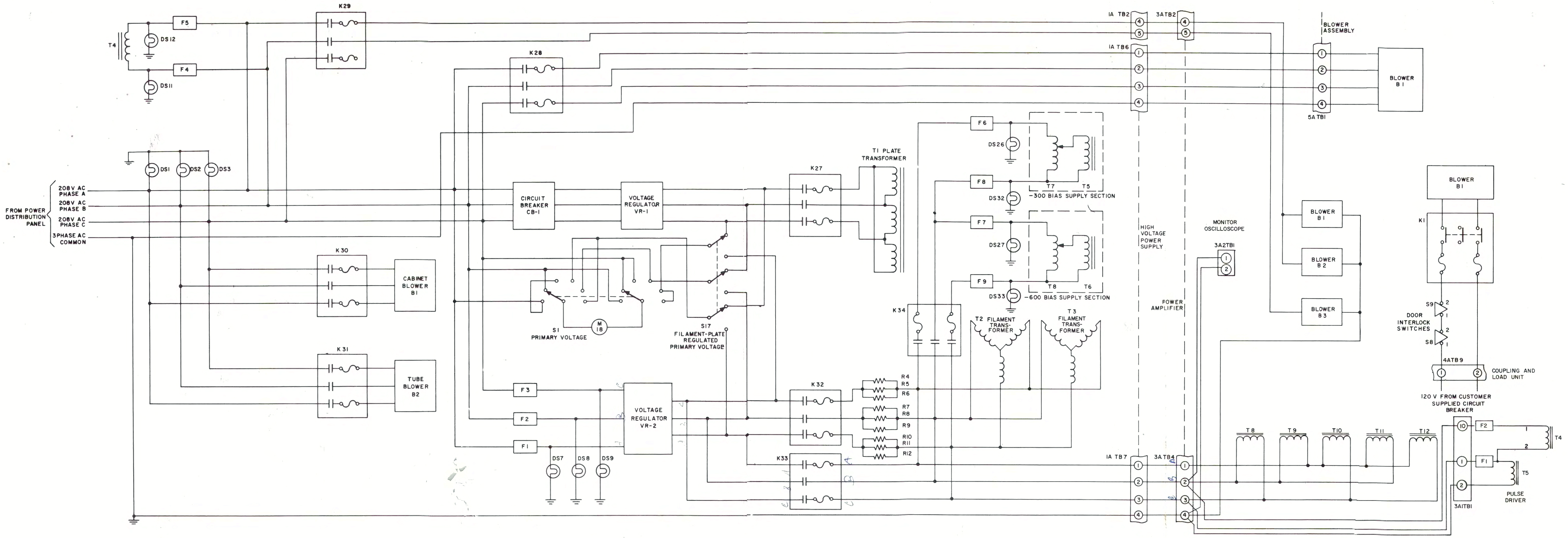


Figure 5-12. Loran Transmitting Set AN/FPN-42, A-C Power Distribution Schematic Diagram (Sheet 1 of 2)

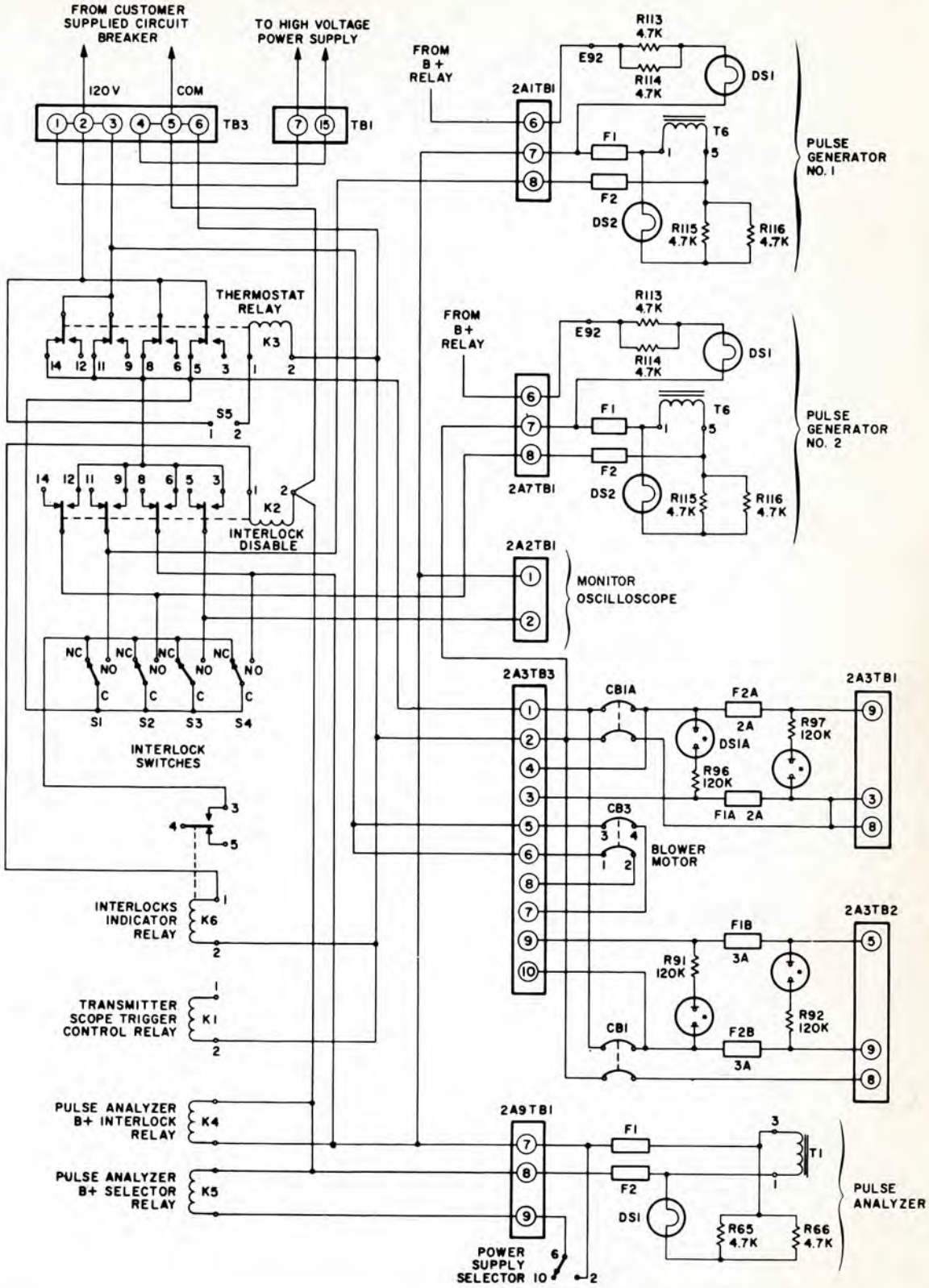


Figure 5-12. Loran Transmitting Set AN/FPN-42, A-C Power Distribution Schematic Diagram (Sheet 2 of 2)

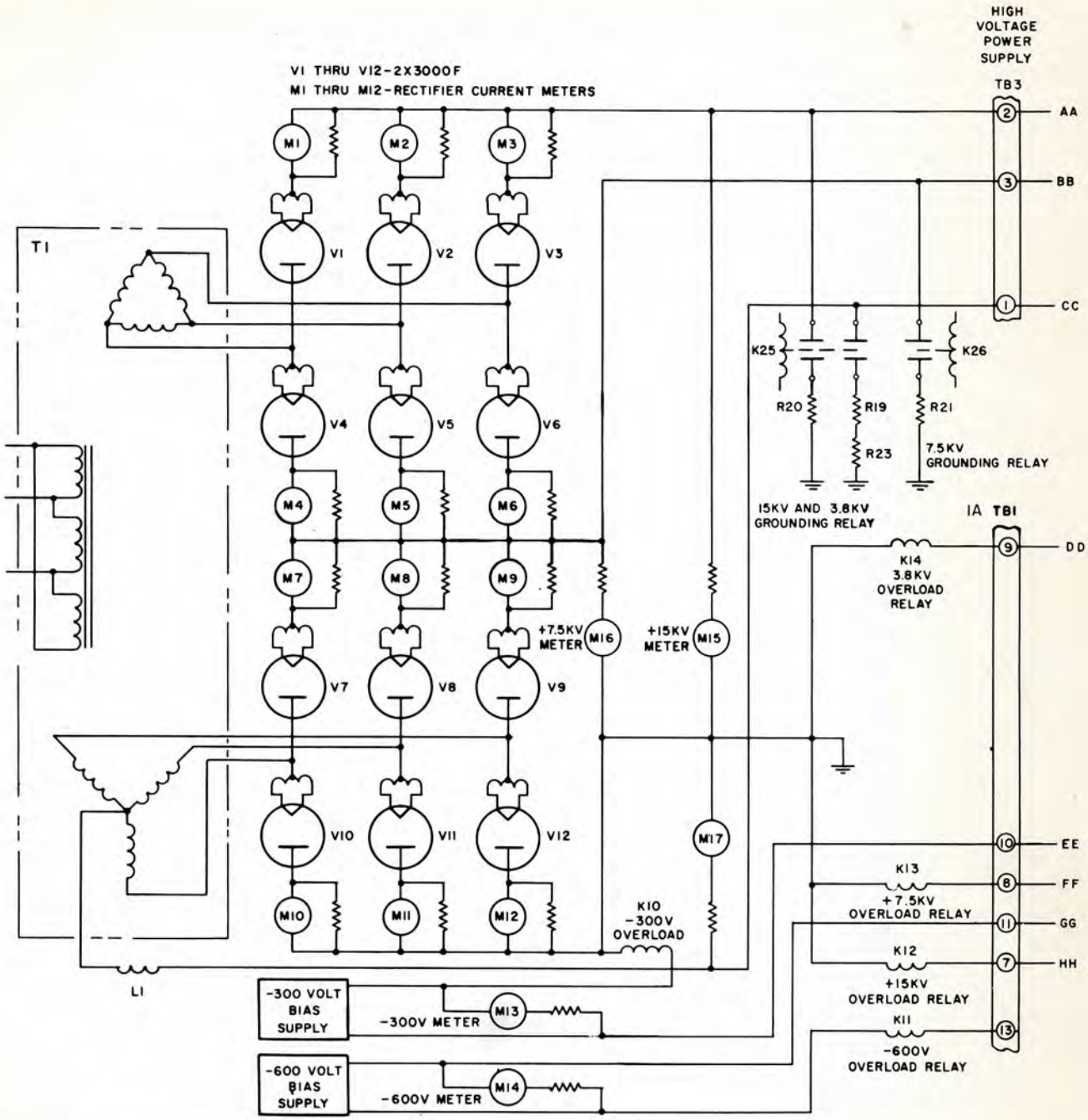


Figure 5-13. Loran Transmitting Set AN/FPN-42, D-C Power Distribution Schematic Diagram (Sheet 1 of 4)

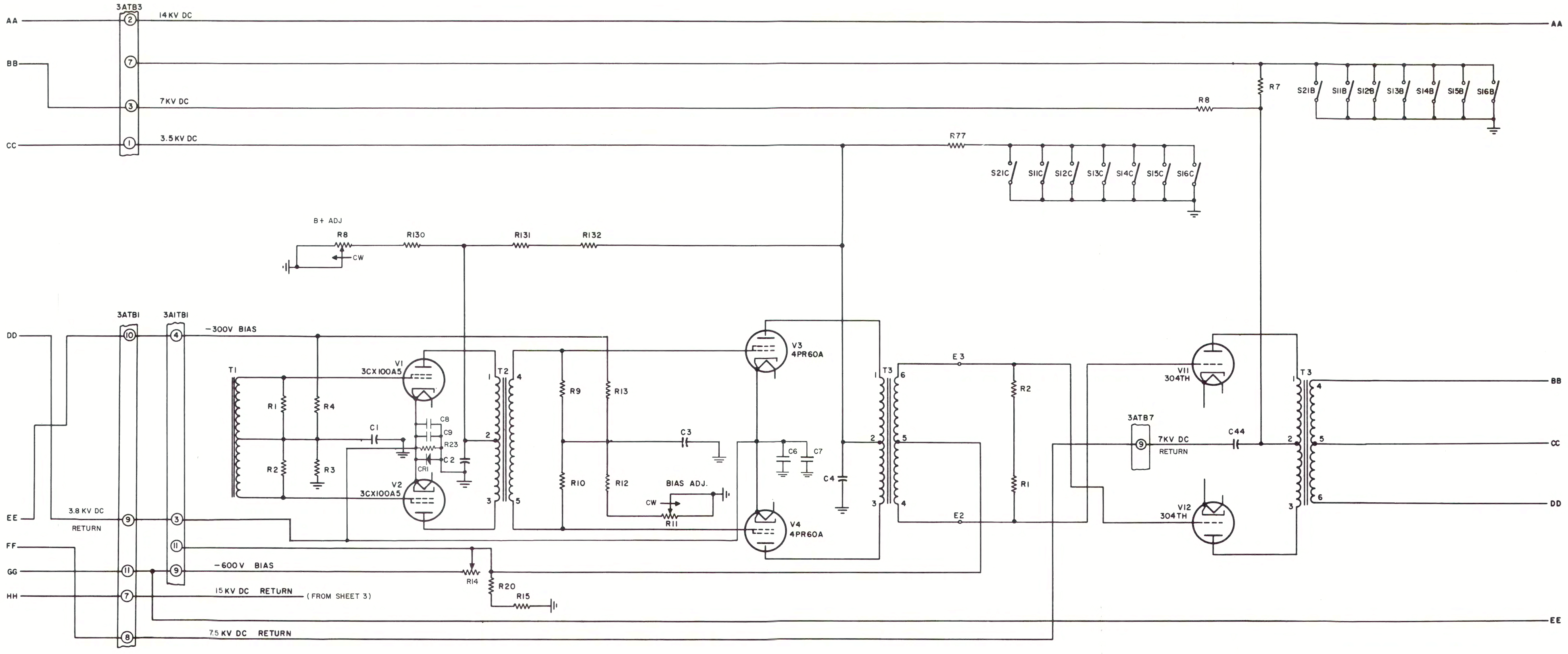


Figure 5-13. Loran Transmitting Set AN/FPN-42, D-C Power Distribution Schematic Diagram (Sheet 2 of 4)

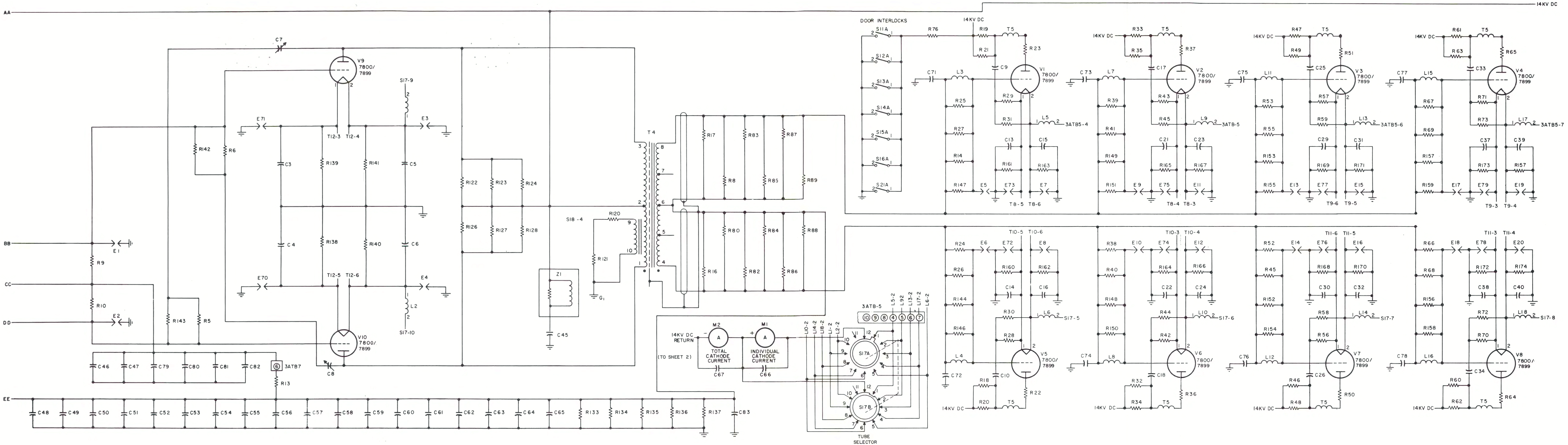


Figure 5-13. Loran Transmitting Set AN/FPN-42, D-C Power Distribution Schematic Diagram (Sheet 3 of 4)

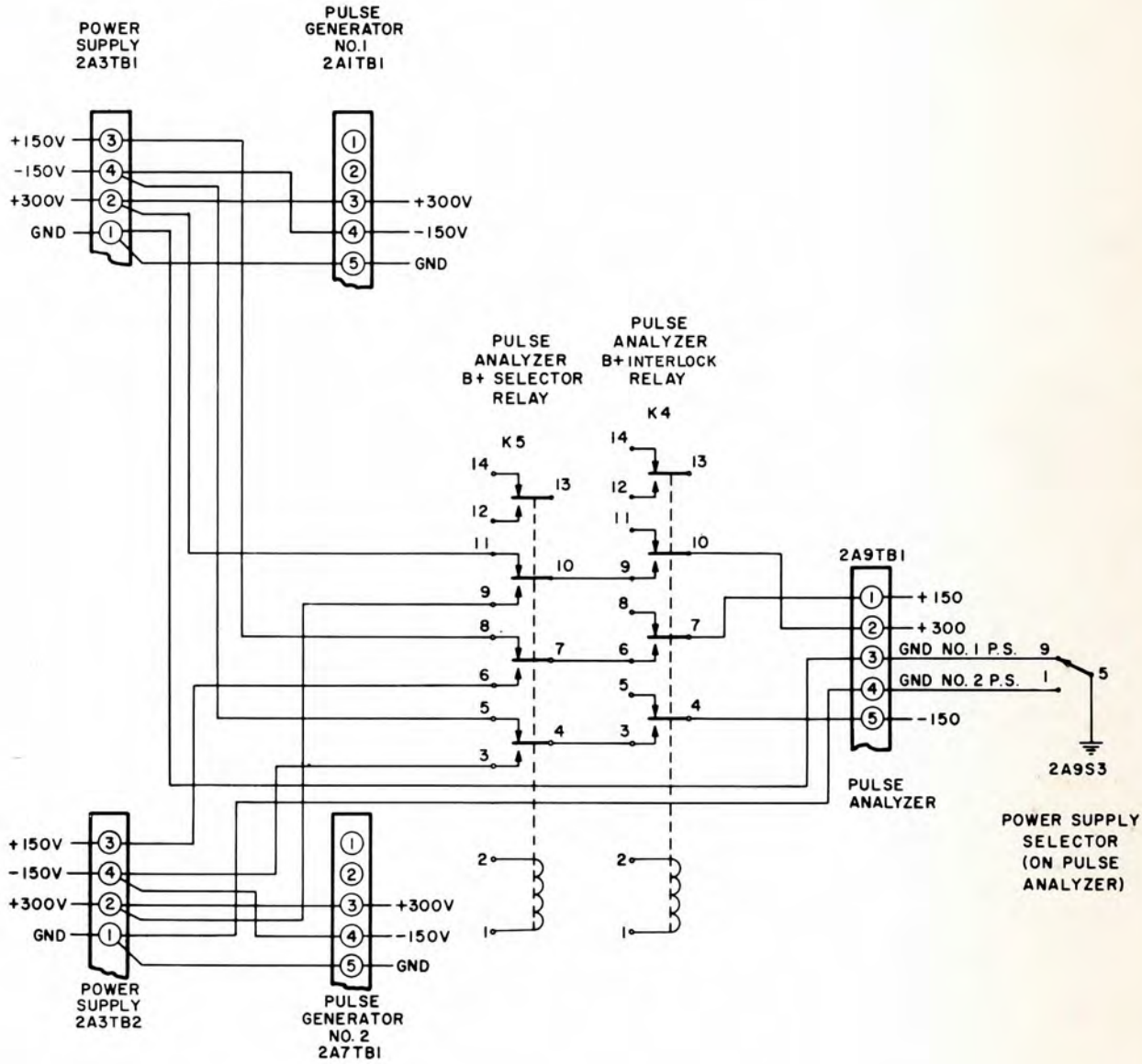


Figure 5-13. Loran Transmitting Set AN/FPN-42, D-C Power Distribution Schematic Diagram (Sheet 4 of 4)

SECTION 6

SERVICE AND REPAIR

6-1. FAILURE REPORT.

Submission of electronic equipment failure reports shall be made in accordance with current instructions contained in the USCG Electronic Maintenance Manual, CG-165, and on the prescribed form indicated therein. The importance of providing complete information cannot be overemphasized. Do not substitute brevity for clarity.

6-2. TUNING AND ADJUSTMENT.

NOTE

For service and repair of the high voltage power supply or the monitor oscilloscope refer to Volume 3 or Appendix I, as required. Figures 6-1 through 6-11 provide the location of parts and test set-up information. Figure 6-12 through 6-19 are the equipment schematic diagrams; these are presented at the rear of the section.

a. TEST EQUIPMENT AND SPECIAL TOOLS. - The test equipment and special tools required for tuning and adjustment are listed in table 5-1. In addition, the following items are used for energy spectrum measurements. (Usually, only one set of these items is required for each Loran-C chain of stations due to the infrequent making of energy spectrum measurements.)

(1) Ungrounded loop antenna of known dimensions. Natural resonant frequency must be at least three times greater than the highest frequency to be measured.

(2) RCA Receiver Model SRR-11, or equivalent.

(3) Hewlett Packard Amplifier Model 450A, or equivalent.

(4) Spencer-Kennedy Lab Electronic Filter Model 300 (2 required), or equivalent.

b. INITIAL CONTROL SETTINGS. - Before starting the alignment procedure place controls in the positions indicated in table 6-1.

NOTE

On the monitor oscilloscopes, jumpers should be connected from the ground binding posts to the bottom binding post on both the vertical and horizontal inputs.

TABLE 6-1. LORAN TRANSMITTING SET AN/FPN-42, CONTROL SETTINGS PRIOR TO ALIGNMENT

CONTROL	LOCATION	SETTING
PULSE AMPL potentiometer R82	PULSE GENERATOR	Mid range
RISE TIME potentiometer R58	PULSE GENERATOR	Maximum counterclockwise (CCW)
DECAY TIME potentiometer R59	PULSE GENERATOR	Maximum CCW
GATE WIDTH potentiometer R42	PULSE GENERATOR	Mid range
PULSE SPACING switch S2	PULSE GENERATOR	1000
100KC BAL potentiometer R21	PULSE GENERATOR	Mid range
PULSE WIDTH potentiometer R55	PULSE GENERATOR	Mid range
DROOP potentiometer R75	PULSE GENERATOR	Maximum CCW
SCOPE TRIGGER switch S1	PULSE GENERATOR	MULTI
FOCUS potentiometer	MONITOR OSCILLOSCOPE*	Center
INTENSITY potentiometer	MONITOR OSCILLOSCOPE*	Center
VERT DC BAL potentiometer	MONITOR OSCILLOSCOPE*	Center
HORIZ DC BAL potentiometer	MONITOR OSCILLOSCOPE*	Center
VERT POS potentiometer	MONITOR OSCILLOSCOPE*	Center
HORIZ POS potentiometer	MONITOR OSCILLOSCOPE*	Center
VERT SENSITIVITY switch	MONITOR OSCILLOSCOPE*	10 VOLTS/CM

*On pulse control unit and each transmitter.

TABLE 6-1. LORAN TRANSMITTING SET AN/FPN-42, CONTROL SETTINGS PRIOR TO ALIGNMENT (Cont)

CONTROL	LOCATION	SETTING
VERT SENSITIVITY-VERNIER potentiometer	MONITOR OSCILLOSCOPE*	CAL
SWEEP TIME/CM switch	MONITOR OSCILLOSCOPE*	1 MILLI-SECOND
SWEEP TIME/CM-VERNIER potentiometer	MONITOR OSCILLOSCOPE*	CAL
HORIZ SENSITIVITY switch	MONITOR OSCILLOSCOPE*	INT SWEEP X1
HORIZ SENSITIVITY-VERNIER potentiometer	MONITOR OSCILLOSCOPE*	CAL
AC-DC switch	MONITOR OSCILLOSCOPE*	AC
DC-AC switch	MONITOR OSCILLOSCOPE*	AC
TRIGGER LEVEL potentiometer	MONITOR OSCILLOSCOPE*	Center
TRIGGER SLOPE switch	MONITOR OSCILLOSCOPE*	+
SCALE LIGHT potentiometer	MONITOR OSCILLOSCOPE*	Maximum CW
SYNC switch	MONITOR OSCILLOSCOPE*	EXT
SWEEP MODE potentiometer	MONITOR OSCILLOSCOPE*	PRE-SET
SIGNAL SELECTOR switch S1	CONTROL PANEL	PULSE GEN. OUTPUT
PULSE GEN. SELECTOR SCOPE DISPLAY switch S6	CONTROL PANEL	PULSE GEN. 1
PULSE GEN. 1 EXCITATION switch S4	CONTROL PANEL	OPERATE BUS
PULSE GEN. 2 EXCITATION switch S5	CONTROL PANEL	OPERATE BUS

*On pulse control unit and each transmitter.

TABLE 6-1. LORAN TRANSMITTING SET AN/FPN-42, CONTROL SETTINGS PRIOR TO ALIGNMENT (Cont)

CONTROL	LOCATION	SETTING
PULSE GEN SELECTOR switch S8	CONTROL PANEL	P.G. 1 TO XMTR 1 P.G. 2 TO XMTR 2
B+ PULSE GEN. 1 switch S9	CONTROL PANEL	On (up)
TRANSMITTER SELECTOR switch S7	CONTROL PANEL	XMTR 1 TO ANTENNA
B+ PULSE GEN. 2 switch S10	CONTROL PANEL	On (up)
B+ XMTR 1 switch S11	CONTROL PANEL	On (up)
B+ XMTR 2 switch S12	CONTROL PANEL	On (up)
INTERLOCK DISABLE switch S13	CONTROL PANEL	On (up)
BLOWER MOTOR circuit breaker CB3	DUAL POWER SUPPLY	ON (up)
120V LINE POWER SUPPLY 1 circuit breaker CB1 A	DUAL POWER SUPPLY	ON (up)
120V LINE POWER SUPPLY 2 circuit breaker CB1 B	DUAL POWER SUPPLY	ON (up)
P.S.1 P.S.2 PWR. SUPPLY SEL. switch S3	PULSE ANALYZER	P.S. 1
% AMPL. potentiometer R55	PULSE ANALYZER	100
AMPL. CAL. potentiometer R52	PULSE ANALYZER	Center
PULSE SEL. switch S1	PULSE ANALYZER	1
SCOPE TRIG. SELECTOR switch S2	PULSE ANALYZER	NORMAL
Pulse Spacing switch S4	PULSE ANALYZER	To correspond to the spacing of the transmitter triggers

TABLE 6-1. LORAN TRANSMITTING SET AN/FPN-42, CONTROL SETTINGS PRIOR TO ALIGNMENT (Cont)

CONTROL	LOCATION	SETTING
LOCAL & REMOTE SELECTOR switch S7	COUPLING AND LOAD UNIT	LOCAL
PRIMARY VOLTAGE switch S1	HIGH VOLTAGE POWER SUPPLY	UNREGU-LATED Ø A
Filament-plate switch S17	HIGH VOLTAGE POWER SUPPLY	PLATE
START switch S8	HIGH VOLTAGE POWER SUPPLY	Depress
FIL. VOLTAGE switch S4	HIGH VOLTAGE POWER SUPPLY	On (up)
BIAS. VOLTAGE switch S2	HIGH VOLTAGE POWER SUPPLY	On (up)
PLATE VOLTAGE switch S3	HIGH VOLTAGE POWER SUPPLY	On (up)
AUTO-MANUAL switch S16	HIGH VOLTAGE POWER SUPPLY	AUTO
DIMMER CONTROL transformer T9	HIGH VOLTAGE POWER SUPPLY	Center
-600 BIAS ADJUST transformer T8	HIGH VOLTAGE POWER SUPPLY	Maximum CW
-300 BIAS ADJUST transformer T9	HIGH VOLTAGE POWER SUPPLY	Maximum CW
AUTO PLATE VOLT ADJ. potentiometer R40	HIGH VOLTAGE POWER SUPPLY	Maximum CCW
LOW LINE ALARM switch S12	HIGH VOLTAGE POWER SUPPLY	ALARM OPERATIVE
-300V overload relay (K10) current adjustment*	HIGH VOLTAGE POWER SUPPLY	Maximum CCW

*NOTE: The method of adjusting overload relays K10 through K14 and overload potentiometer R22 is described in Volume 3.

TABLE 6-1. LORAN TRANSMITTING SET AN/FPN-42, CONTROL SETTINGS PRIOR TO ALIGNMENT (Cont)

CONTROL	LOCATION	SETTING
-600V overload relay (K11) current adjustment*	HIGH VOLTAGE POWER SUPPLY	Maximum CCW
15.5KV overload relay (K12) current adjustment*	HIGH VOLTAGE POWER SUPPLY	Maximum CCW
7.75KV overload relay (K13) current adjustment*	HIGH VOLTAGE POWER SUPPLY	Maximum CCW
3.8KV overload relay (K14) current adjustment*	HIGH VOLTAGE POWER SUPPLY	Maximum CCW
Low Voltage Alarm adjustment potentiometer R22*	HIGH VOLTAGE POWER SUPPLY	Maximum CCW
TUBE SELECTOR switch S17	TRANSMITTER	V1
SIGNAL SELECTOR switch S18	TRANSMITTER	OUTPUT

*NOTE: The method of adjusting overload relays K10 through K14 and overload potentiometer R22 is described in Volume 3.

c. ALIGNMENT PROCEDURE.

(1) DUAL POWER SUPPLY. (See figure 6-1.)

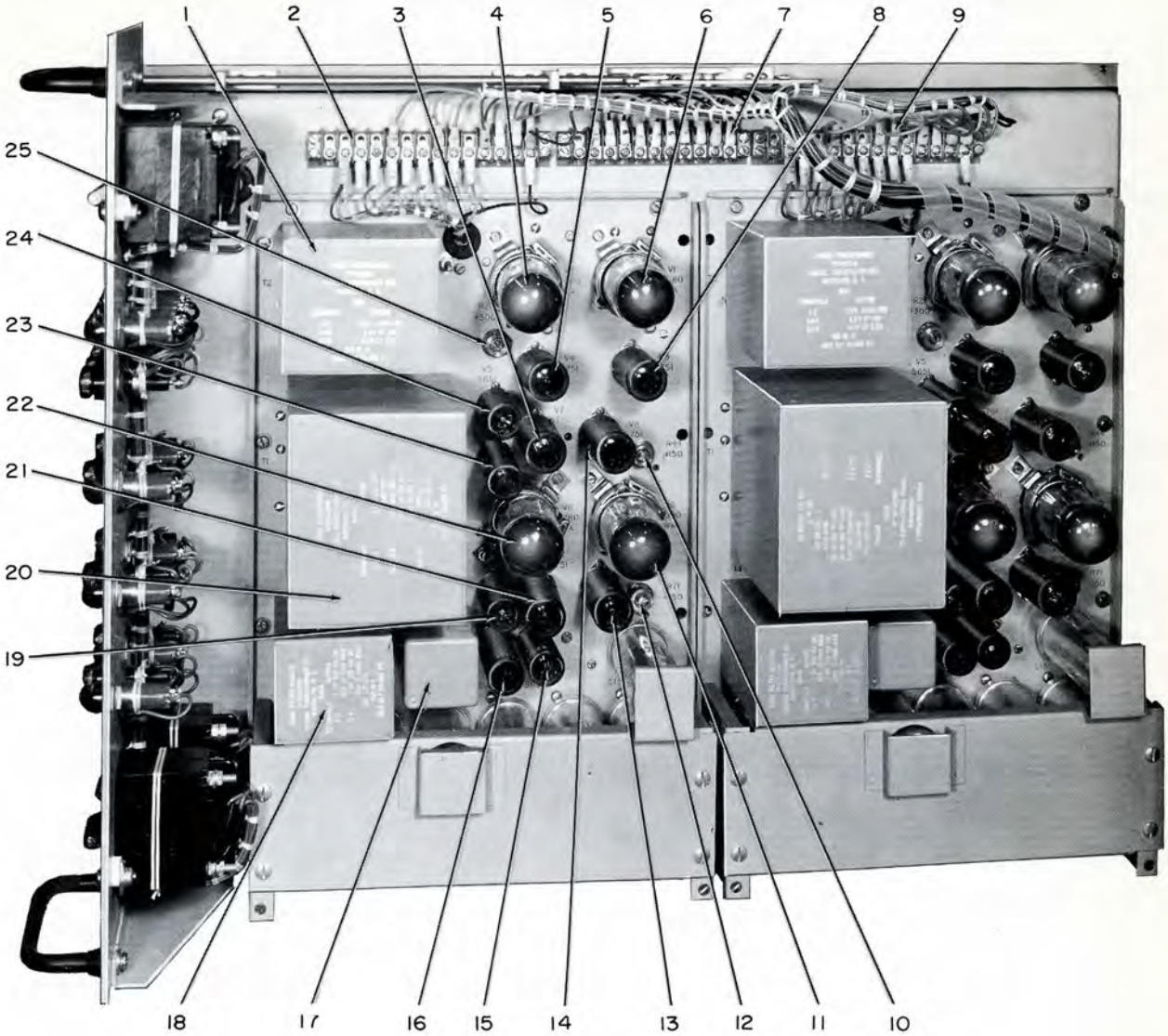
NOTE

Power supply 1 is located at the rear of the chassis and power supply 2 is located adjacent to the front panel; both are identical.

(a) On the dual power supply, measure the d-c voltage at terminal TB1-4 (●A_{11}, figure 5-2). Adjust -150 potentiometer R71 (12, figure 6-1) in power supply 1 for -150 volts.

(b) Measure the d-c voltage at terminal TB2-4 (●A_{34}, figure 5-2). Adjust -150 potentiometer R71 in power supply 2 for -150 volts.

(c) Measure the d-c voltage at terminal TB1-2 (●A_6, figure 5-2). Adjust +300 potentiometer R21 (25, figure 6-1) on power supply 1 for 300 volts.



1 Transformer T2
2 Terminal board TB1
3 D-c amplifier V7
4 D-c gate V2
5 Difference amplifier V4
6 D-c gate V1
7 Terminal board TB3
8 D-c amplifier V3
9 Terminal board TB2
10 +150 potentiometer R44
11 D-c gate V6
12 -150 potentiometer R71
13 Difference amplifier V13
14 Difference amplifier V8
15 Voltage regulator V15
16 Voltage regulator V14
17 Relay K1
18 Inductor L_2
19 Voltage regulator V9
20 Transformer T1
21 D-c amplifier V12
22 D-c gate V11
23 Voltage regulator V10
24 Voltage regulator V5
25 +300 potentiometer R21

Figure 6-1. Power Supply Assembly PP-2541/FPN-42, Right Side View, Parts Location

(d) Measure the d-c voltage at terminal TB2-2 (● A_{32}, figure 5-2). Adjust +300 potentiometer R21 on power supply 2 for 300 volts.

(e) Measure the d-c voltage at terminal TB1-3 (● A_8, figure 5-2). Adjust +150 potentiometer R44 (10, figure 6-1) on power supply 1 for 150 volts.

(f) Measure the d-c voltage at terminal TB2-3 (● A_{33}, figure 5-2). Adjust +150 potentiometer R44 on power supply 2 for 150 volts.

(2) HIGH VOLTAGE POWER SUPPLY.

(a) SUPPLY VOLTAGE ADJUSTMENTS.

1. At the high voltage power supply, monitor -300 VOLT BIAS VOLTAGE meter M13 (10, figure 3-6). Adjust -300 BIAS ADJUST transformer T7 (25) for -270 volts.

2. Monitor -600 VOLT BIAS VOLTAGE meter M14 (11). Adjust -600 BIAS ADJUST transformer T8 (26) for -540 volts.

3. Monitor 15.5KV PLATE VOLTAGE meter M15 (67'). Adjust AUTO PLATE VOLT ADJ potentiometer R40 (53) for 14KV.

(b) OVERLOAD RELAY SENSITIVITY CONTROL ADJUSTMENTS.

NOTE

The following paragraphs describe alignment procedures that involve overload relays in the high voltage power supply. The method of physically adjusting each relay is described in Volume 3.

1. Check that the -300V and -600V overload relay current controls K10 and K11 are in the maximum counterclockwise position.

2. With the transmitter operating normally, (proper repetition rate, pulse spacing, radiated power, etc.) adjust 15.5KV overload relay current control K12 just enough to trip the overload circuits. Back off two turns to desensitize the relay.

3. Repeat step 2 for the remaining overload relay current controls in the order indicated:

7.75KV overload relay current control K13.
-600V overload relay current control K11.
-300V overload relay current control K10.

4. Adjust 3.8KV overload relay current control K14 to its most sensitive position.

(c) LOW VOLTAGE ALARM ADJUSTMENT.

1. Measure and record the voltage between high voltage power supply terminals TB4-1 and TB5-2.

2. Adjust low voltage alarm potentiometer R22 (figure 6-1, Volume 3) just enough to trip the alarm circuits. Read the voltage across the coil of relay K24 (figure 6-1, Volume 3).

3. Compute X using the following formula:

$$X = \frac{(a)\ (b)}{108}$$

where (a) and (b) are the readings obtained in steps 1 and 2, respectively.

4. Adjust potentiometer R22 for a voltage reading across the coil of relay K24 equal to X.

(3) PULSE GENERATOR.

(a) At the pulse generator, check the 100-kc signal input at terminal T1-3 (● B_{30}, figure 5-3). The signal must be at least 3 volts peak to peak and non-phase-coded. (See figure 5-4z.) The coding of the 100-kc input is controlled by Loran Timer-Synchronizer Set AN/FPN-41.

(b) Check the trigger amplitude at terminal T2-3 (● B_{27}, figure 5-3). The triggers must be positive and at least 50 volts peak. (See figure 5-4w.)

(c) Remove the 100-kc input from jack J7 (16, figure 6-2).

(d) Position the wafers of pulse generator capacitors C48 and C49 (figure 6-3) for minimum capacity. (Minimum capacity is obtained when the solder bead on the movable wafer is 180 degrees away from the solder bead on the fixed wafer.)

(e) Monitor the signal at pin V3-8 (● B_9, figure 5-3). Adjust either C48 or C49 to minimize the gating transient at the beginning of the gating waveform. (Note: If the gating transient is positive, adjust C49. If the gating transient is negative, adjust C48.)

(f) Replace the 100-kc input to jack J7 (16, figure 6-2).

(g) On the monitor oscilloscope, note the polarity of the first half cycle of the 100-kc signal. Adjust pulse generator GATE WIDTH potentiometer R42 (10, figure 3-1) for nine full cycles. (See figure 5-4i.)

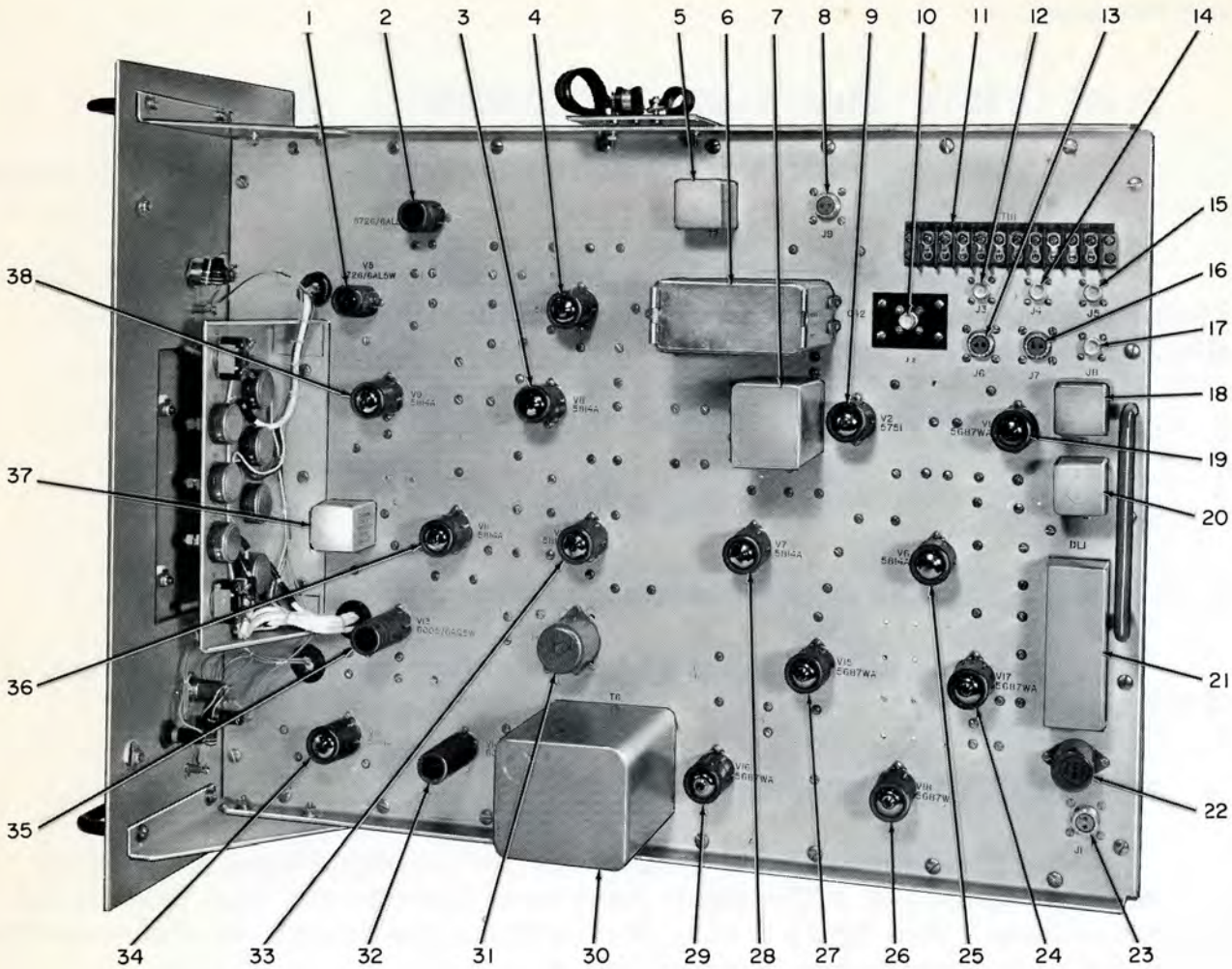


Figure 6-2. Pulse Generator 0-706/FPN-42, Right Side View, Parts Location

NOTE

The first half cycle should begin at the zero crossover point on the 100-kc signal. This is the standard method for initially adjusting the envelope timing control on the transmitter driver chassis in the timer-synchronizer. The only time that it is permissible for the first half cycle to begin at a point other than the zero crossover is when the timer-synchronizer discrepancy readings are being monitored and controlled by a Loran-C receiver. At such times the Loran-C receiver will relay instructions through the master station.

(h) If the pulse generator output is not connected to a transmitter, connect a 100-ohm, 2-watt resistor (dummy load) across the output jack T1

Legend for Figure 6-2.

1 100-kc modulator V5
2 100-kc modulator V4
3 Pedestal generator V8
4 Amplifier and paraphase amplifier V3
5 Transformer T7
6 Capacitor C42
7 Filter FL1
8 Connector J9
9 Squarer V2
10 Connector J2
11 Terminal board TB1
12 Connector J3
13 Connector J6
14 Connector J4
15 Connector J5
16 Connector J7
17 Connector J8
18 Transformer T1
19 Amplifier V1
20 Transformer T2
21 Delay line DL1
22 Transformer T5
23 Connector J1
24 Cathode follower V17
25 Pedestal generator V6
26 Cathode follower V18
27 Cathode follower V15
28 Paraphase amplifier and cathode follower V7
29 Cathode follower V16
30 Transformer T6
31 Transformer T4
32 Paraphase amplifier and droop modulator V14
33 Droop compensation and pedestal generator V10
34 Paraphase amplifier V12
35 Paraphase amplifier and droop modulator V13
36 Droop compensation and pedestal generator V11
37 Transformer T3
38 Pedestal shaper and paraphase amplifier V9

(★7, figure 5-3). Monitor the signal at connector J8 (17, figure 6-2). Adjust pulse generator PULSE WIDTH potentiometer R55 (4, figure 3-1) in a clockwise direction until nine full cycles are observed. (See figure 5-4g.)

NOTE

Additional adjustment of PULSE WIDTH potentiometer R55 will not increase pulse width, but may cause increased leakage amplitude at the pulse generator output. Do not adjust PULSE WIDTH potentiometer R55 beyond the point specified in this procedure.

(i) At the pulse generator, measure (using the test oscilloscope) the amplitude of the output signal at jack J1 (★7, figure 5-3). Adjust PULSE AMPL. potentiometer R82 (13, figure 3-1) until the ninth pulse (eighth pulse at slave stations) of the multipulse group is 100 volts peak to peak.

(j) At the control panel, place SIGNAL SELECTOR switch S1 (2, figure 3-2) in the ANTENNA position. Observe the transmitted pulses on the monitor oscilloscope and on the pulse generator adjust DROOP potentiometer R75 (5, figure 3-1) so that all pulses are of equal magnitude. (See figure 5-1o.)

(k) Readjust PULSE AMPL potentiometer R82 (13, figure 3-1) so that the ninth pulse is 140 volts peak to peak on the monitor oscilloscope. (See figure 5-1o.)

(l) Readjust DROOP potentiometer R75 (5, figure 3-1), if necessary, to equalize the amplitude of all pulses.

(m) At the control panel, place SIGNAL SELECTOR switch S1 (2, figure 3-2) in the PULSE GEN. OUTPUT position.

(n) At the monitor oscilloscope, set VERT SENSITIVITY switch (5, figure 3-5) for 1 VOLTS/CM.

(o) Set SWEEP TIME/CM switch (7, figure 3-5) for approximately 1 MILLISECOND.

(p) Observe the pulse generator output on the monitor oscilloscope and adjust 100KC BAL potentiometer R21 (3, figure 3-1) on the pulse generator for minimum amplitude of 100-kc leakage between individual pulses and also between pulse groups. After balancing, the leakage should be no greater than 1 volt peak to peak.

(q) Pulse generator RISE TIME potentiometer R58 and DECAY TIME potentiometer R59 (12 and 11, figure 3-1) are used for making final trimming adjustments on the radiated pulse. The final settings for these potentiometers are determined by making spectrum and power measurements after the transmitter tank has been tuned. The RISE TIME and DECAY TIME potentiometers are then trimmed to reduce the radiated harmonic power. Spectrum plots must be made after each adjustment to determine the optimum setting. Under normal conditions an acceptable spectrum can be obtained with these two potentiometers set to the maximum counterclockwise position.

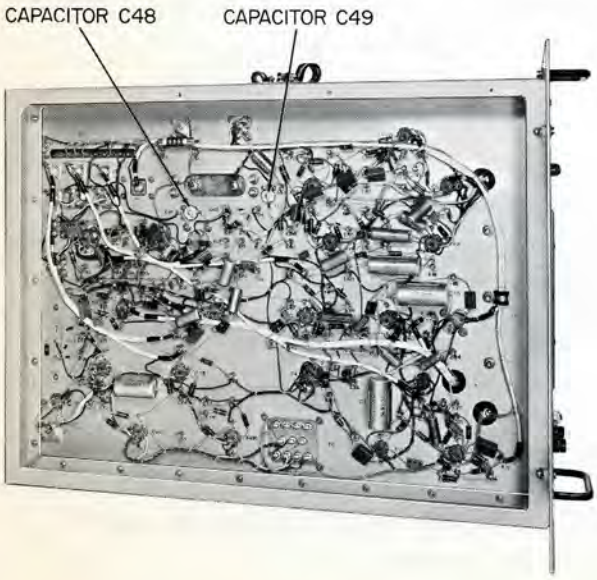


Figure 6-3. Pulse Generator 0-706/FPN-42, Left Side View, Parts Location

(4) PULSE ANALYZER.

(a) Monitor the trigger input at pulse analyzer connector receptacle J1 (5, figure 6-4) with the test oscilloscope. The triggers should be positive and have a minimum amplitude of 35 volts peak.

(b) Synchronize the oscilloscope with triggers from pulse

1 COARSE ADJ potentiometer R51
2 Clipping diode V11
3 Relay driver V10
4 Relay K1
5 Connector J1
6 Cathode follower V12
7 Terminal board TB1
8 Trigger amplifier and cathode follower V7
9 Connector J2
10 Connector J3
11 Trigger gate V6
12 Connector J3
13 Transformer T1
14 Gate generator V4
15 500-1000 switch S4
16 Potentiometer R12
17 Connector J3
18 Delay multivibrator V3
19 Gate V8
20 Clipping diode V5
21 1/2 PRR multivibrator V9
22 Clipping diode V2
23 PRR multivibrator V1

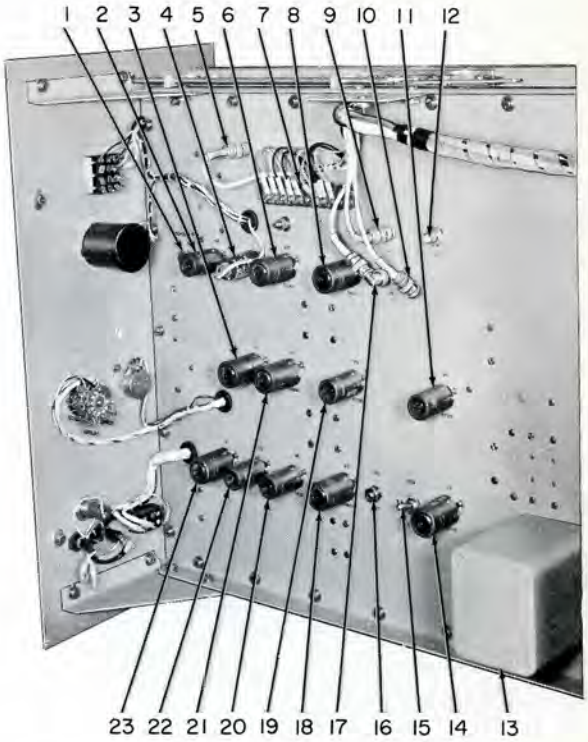


Figure 6-4. Electrical Pulse Analyzer TS-1360/FPN-42, Right Side View, Parts Location

analyzer connector receptacle J. Place the oscilloscope probe on pin V6-7 (● C_5, figure 5-5) and adjust the sweep for 1 millisecond per centimeter.

(c) Place pulse analyzer PULSE SEL. switch S1 (3, figure 3-4) in the 2 position.

(d) Center the negative trigger riding on the positive pedestal by adjusting pulse analyzer potentiometer R12 (16, figure 6-4).

(e) Rotate PULSE SEL. switch S1 (3, figure 3-4) through its range. For each switch position, a transmitter pulse should be present on the oscilloscope. If one or more pulses are absent, readjust potentiometer R12 until pulses are observed for all switch positions.

(f) Set pulse analyzer % AMPL. potentiometer R55 (2, figure 3-4) at 100 and place the test oscilloscope probe on output jack J4 (★9, figure 5-5).

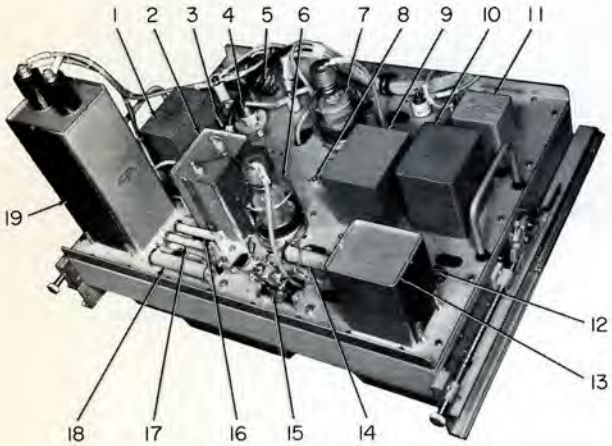
(g) Adjust pulse analyzer COARSE ADJ potentiometer R51 (1, figure 6-4) until the positive peak of the transmitter pulse is near coincidence with the reference trace.

(h) Adjust pulse analyzer AMPL. CAL. potentiometer R52 (8, figure 3-4) until the positive peak of the transmitter pulse is exactly coincident with the reference trace. (See figure 5-10n.)

(5) TRANSMITTER.

When working on the pulse driver and power amplifier stages, always take the following precautions:

(a) At the coupling and load unit, place LOCAL & REMOTE SELECTOR switch S7 (7, figure 3-8) in the LOCAL position



1 Transformer T2
2 Capacitor C5
3 Potentiometer R11
4 Amplifier V2
5 Terminal board TB1
6 Amplifier V4
7 Amplifier V3
8 Potentiometer R8
9 Transformer T3
10 Transformer T4
11 Transformer T5
12 Fuse holder XF2
13 Capacitor C2
14 Resistor R4
15 Potentiometer R14
16 Resistor R15
17 Resistor R20
18 Resistor R13
19 Capacitor C3

Figure 6-5. Pulse Driver, Top Chassis View, Parts Location

(b) At the high voltage power supply, place BIAS VOLTAGE switch S2 (19, figure 3-6) and PLATE VOLTAGE switch S3 (18) in the off (down) position.

(c) Open an interlock by opening either a hinged panel or a door.

(d) At the transmitter, place a grounding bar on the B+ bus and place a grounding bar on the antenna lead.

NOTE

Before making the following adjustments, the high voltage power supply must be adjusted for the proper output voltages. Refer to Volume 3 for this procedure.

(e) Energize the transmitter and measure the voltage (● 5, figure 5-7) at terminal E5 on the pulse driver.

(f) Adjust potentiometer R8 (8, figure 6-5) on pulse driver for 1000 volts at terminal E5.

(g) Measure the bias voltage at pins V3-3 and V4-3 (● E3 and ● E4, figure 5-6) on the pulse driver.

(h) Adjust pulse driver potentiometer R11 (3, figure 6-5) for -16 volts.

(6) TRANSMITTER OUTPUT TUNING.

(a) Open the secondary circuit of the tank coil by removing one of the output solid leads. (See figure 2-8.)

(b) Make the circuit connections shown in figure 6-6.

(c) Vary the frequency and the output amplitude of the oscillator until a reading is obtained on the vtvm.

(d) Peak the vtvm reading by varying the oscillator frequency. The frequency at which the vtvm reading peaks is the resonant frequency of the primary (which should be 100 kc).

(e) If the resonant frequency is above 100 kc, the primary inductance must be increased. If the resonant frequency is below 100 kc, the primary inductance must be decreased.

NOTE

When tuning either the primary or secondary winding of the tank, move both tuning taps on the winding so that the tank remains symmetrical. Using the center point on either the primary or secondary as a reference point, the number of turns in one direction must equal the number of turns in the opposite direction.

(f) Vary the primary inductance by moving both primary taps until the primary is tuned to 100 kc.

(g) Reconnect the secondary winding, and remove all test circuit equipment.

(h) Obtain the data for plotting an energy spectrum curve in the following manner:

1. Make the test circuit connections shown in figure 6-7.

NOTE

No direct connection is made to the transmitter equipment. A six-foot length of wire will normally be sufficient for the trigger antenna.

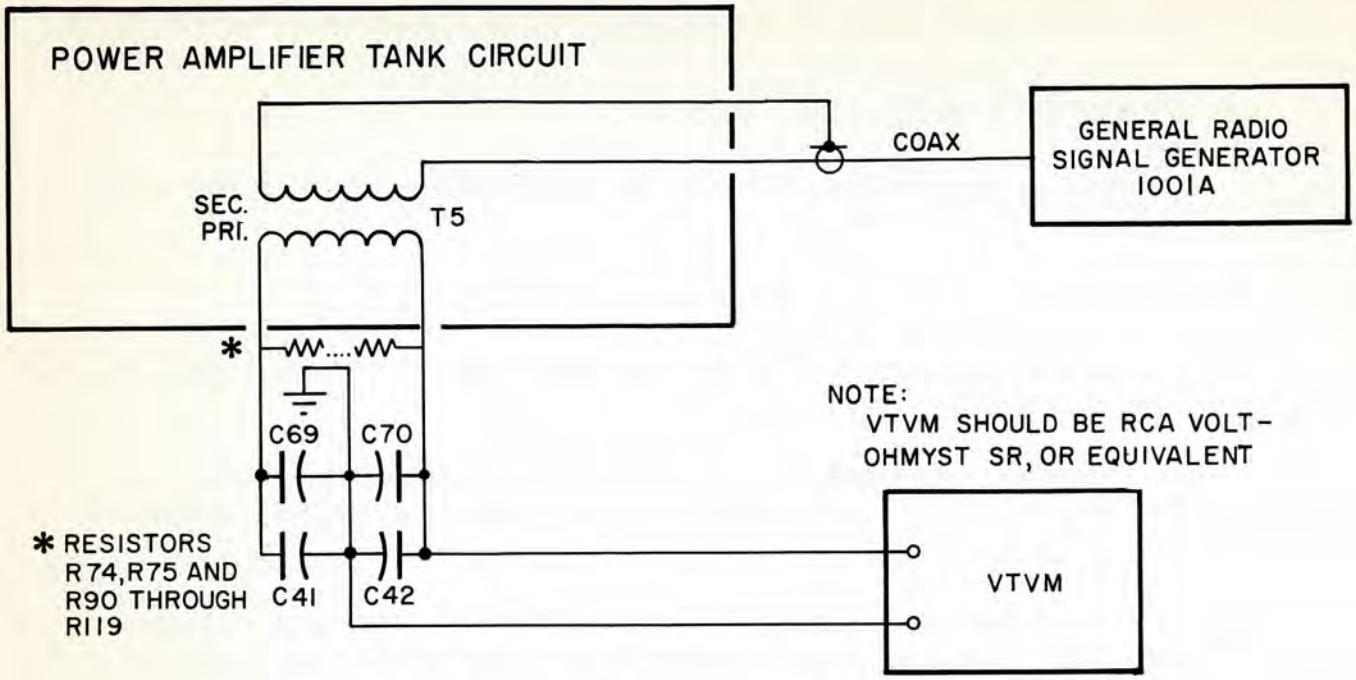


Figure 6-6. Amplifier Assembly AM-2481/FPN-42, Output Tuning Adjustment Circuit

2. Energize the transmitter.

3. Orient the measuring loop with respect to the transmitting antenna for maximum signal on the test oscilloscope with the receiver (RCA model SRR-11 or equivalent) tuned to 100 kc. Orient the trigger circuit antenna for maximum signal amplitude to synchronize the test oscilloscope.

4. Check that the 20-db points of the spectrum curve are equally distant from 100 kc. This is accomplished in the following manner:

a. Tune the receiver to 100 kc.

b. Turn the variable attenuator on the signal generator to 0 (maximum clockwise position), to reduce the c-w output to zero. Set the MODULATION switch to the OFF position.

c. Peak the antenna control on the receiver for maximum signal on the test oscilloscope.

d. Set the SWEEP TIME control for 1 millisecond per centimeter, and adjust the gain controls on the test oscilloscope and receiver for full scale deflection of the received pulses. Check that the receiver is not saturating. If saturation is present, indicated by a limited signal, reduce receiver gain and increase test oscilloscope gain for full scale deflection.

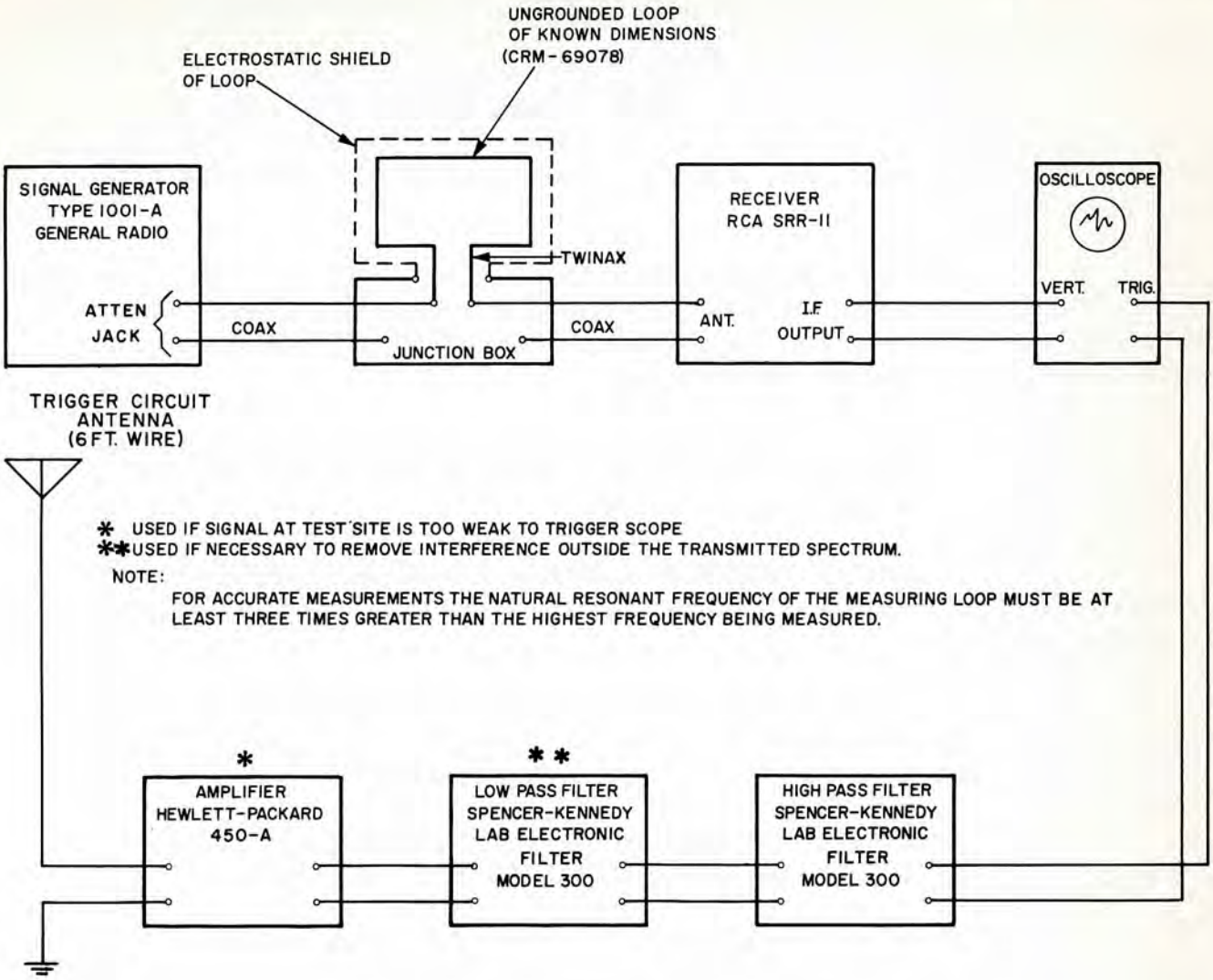


Figure 6-7. Loran Transmitting Set AN/FPN-42, Energy Spectrum Measurement Circuit

e. Vary the receiver tuning and observe the variation of the signal amplitude on the test oscilloscope. When the receiver is tuned to 89 kc and 111 kc, the pulse amplitude should be approximately equal at about one-tenth full scale deflection. If not, adjust coupling and load unit ANTENNA TUNING inductor L1 (9, figure 3-8) to balance the two readings.

5. Measure and record the amplitude of the signal in the following manner:

a. Turn the variable attenuator on the signal generator to 0 (maximum clockwise position). Set the MODULATION switch to the OFF position.

b. Tune the receiver for peak signal on the test oscilloscope (near 100 kc).

c. Peak the antenna control on the receiver for maximum signal on the test oscilloscope.

d. Adjust the gain controls on the receiver and test oscilloscope for full scale deflection. If receiver saturation occurs, reduce receiver gain and increase test oscilloscope gain. Set the oscilloscope SWEEP TIME for 2 milliseconds per centimeter.

e. Set the signal generator frequency controls for a 100-kc output. Adjust the signal generator variable attenuator for a setting of approximately 0.2. Set the MULTIPLIER switch to the highest position which will still provide the entire c-w signal on the test oscilloscope.

f. Adjust the signal generator frequency control for a peak c-w signal on the test oscilloscope. (In this case, the peak will occur near 100 kc since the receiver is tuned to this frequency.)

g. Adjust the CARRIER control on the signal generator so that the needle on the output meter lines up with the SET CARRIER index in the center of the meter scale.

h. Turn the variable attenuator on the signal generator to a maximum clockwise position and recheck the amplitude of the pulse. Readjust the receiver gain control for full scale deflection, if necessary.

i. Adjust the setting of the variable attenuator so that the output of the signal generator is exactly the same amplitude as the pulse.

j. Read and record the signal generator output voltage and frequency. (The output voltage is obtained from the MULTIPLIER setting and the attenuator dial. The frequency is obtained from the receiver dial.)

k. Repeat steps a through j for the frequency range from 80 to 140 kc substituting the measuring frequency for 100 kc in steps e and f. In step b tune the receiver to the measurement frequency, from 80 to 94 kc and 106 to 140 kc; take readings at 2-kc increments. In the range between 94 and 106 kc, read at every 500 cps.

NOTE

At frequencies considerably removed from 100 kc, it may be difficult to obtain full scale deflection. Under these conditions, it is permissible to work with reduced amplitudes.

6. Compensate all voltage readings obtained in step k for variation of the effective height of the loop antenna. The effective height of the loop antenna

is directly proportional to frequency. To calculate the correct amplitudes, divide the measured amplitude by the ratio of the measurement frequency to 100 kc. For example, divide the amplitude measured at 90 kc by 0.90 and divide the amplitude measured at 120 kc by 1.20.

7. Square each of the values obtained in step 6.

(i) Plot frequency versus received voltage squared (frequency along the abscissa) on linear graph paper. The figures to be plotted along the ordinate are those obtained in step (h) 7.

(j) Compute the percentage of total radiated power which is contained in the band between 90 and 110 kc. This is accomplished in the following manner:

1. Measure the area under the curve between 90 and 110 kc. Designate this area as A1. Measure A1 by counting squares under the curve bounded by 90- and 110-kc ordinates.

2. Measure the total area under the curve (A2) by counting the remaining squares under the curve and adding this figure to A1.

3. Percent of radiated energy in the 90 to 110 kc band equals A1/A2 x 100.

(k) If the percentage of total radiated energy in the 90 to 110 kc band is found to be less than 99 percent, change the inductance of the tank secondary by adjusting both the top and bottom taps. Be sure to tune the secondary symmetrically with respect to the midpoint of the winding.

(l) Repeat steps (h) 3, (h) 4, (h) 5, (i), (j), and (k) until at least 99 percent of the total radiated power falls in the 90 to 110 kc band.

(m) Trim ANTENNA TUNING inductor L1 (9, figure 3-8) in very small increments, to minimize phase modulation in the transmitted pulse.

NOTE

The procedure for observing phase modulation is specified in Section 2 of the Technical Manual for Loran Timer-Synchronizer Set AN/FPN-41; CG-273-75

(7) RADIATED SPECTRUM MEASUREMENT.

(a) Repeat the following steps of the transmitter output tuning procedure: steps (6) (h) 1, 2, 3, 5a through j, and 6.

(b) The above measurements should cover the frequency spectrum from 50 to 2500 kc.

(c) Calculate, in decibels, the relative voltage at each measurement frequency using the following formula: (Where, the peak voltage is the highest value obtained in step (6) (h) 6 and the measured voltages are all of the other values obtained in the same step.)

$$\text{Relative voltage (-db)} = -20 \log \left(\frac{\text{Peak voltage}}{\text{Measured voltage}}\right)$$

(d) Plot all readings obtained near the fundamental peak. All peaks should be measured, and their amplitudes compared with the fundamental peak. Any peak less than -60 db (1/1000th) from the fundamental should also be plotted. When plotting a peak, use enough points to describe the curve in the region of the peak. A sample spectrum curve is shown in figure 6-8.

(8) RADIATED POWER MEASUREMENT.

(a) Make circuit connections as shown in figure 6-9.

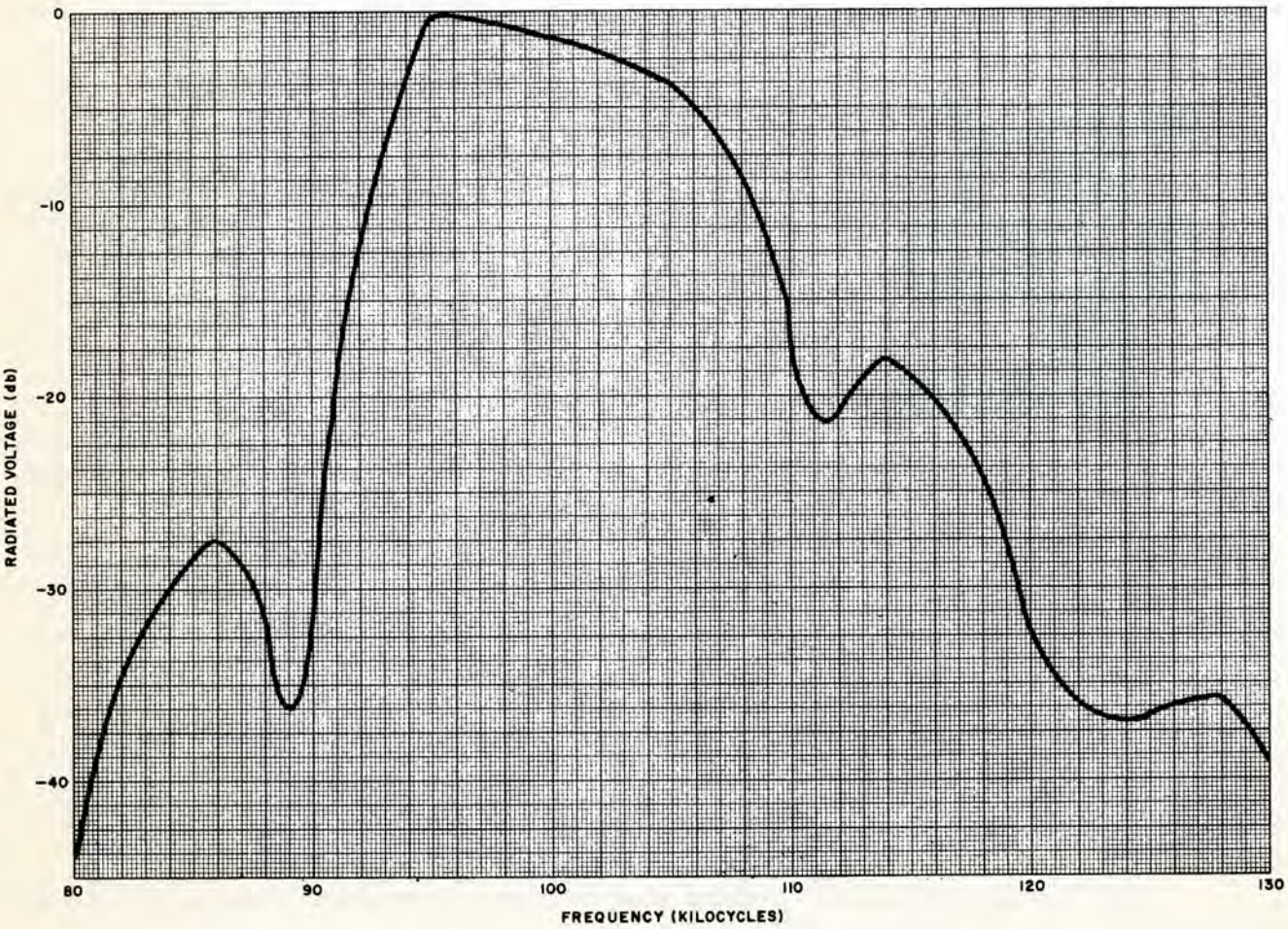


Figure 6-8. Loran Transmitting Set AN/FPN-42, Typical Energy Spectrum Curve

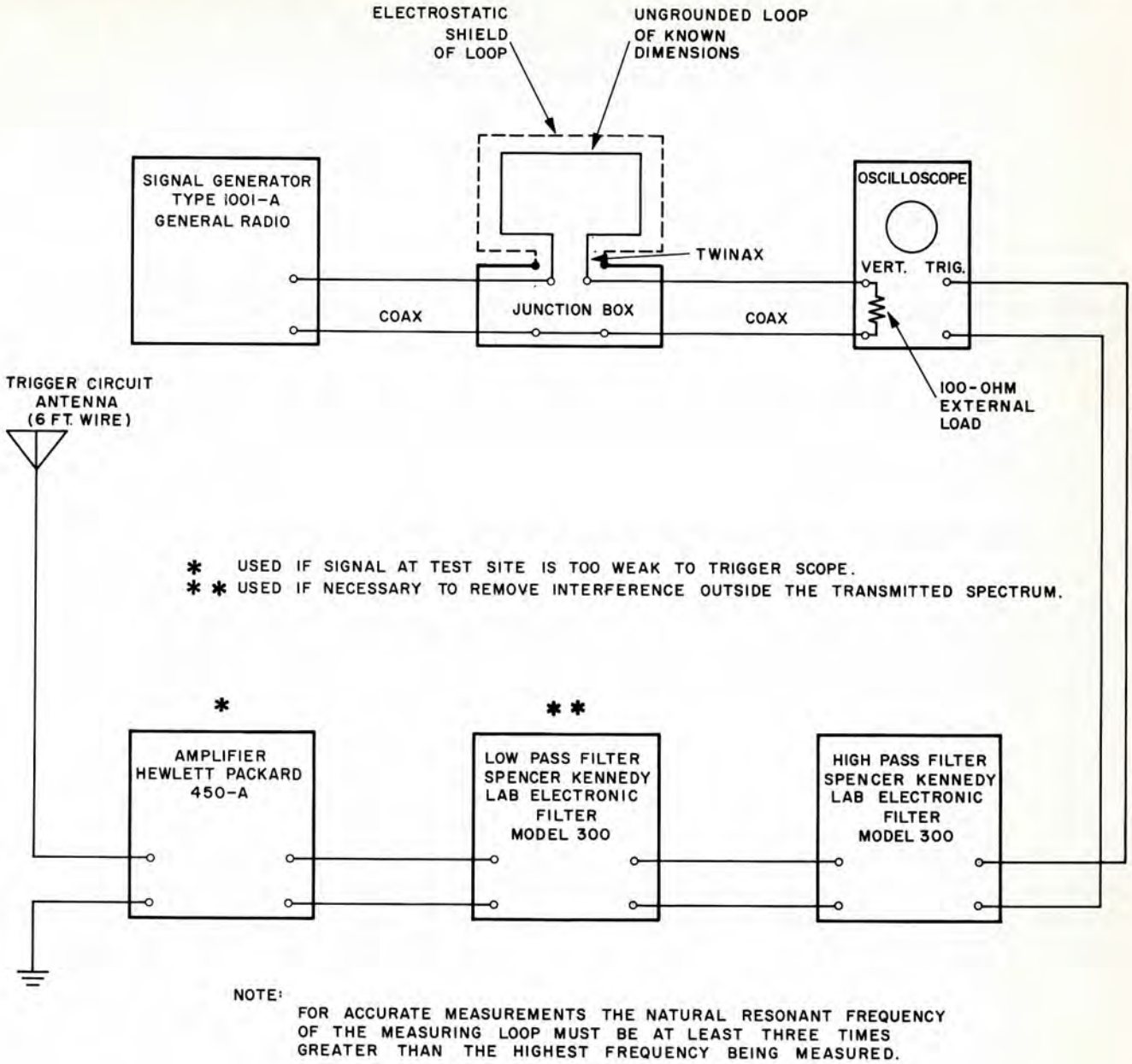


Figure 6-9. Loran Transmitting Set AN/FPN-42, Radiated Power Measurement Circuit

(b) Turn the variable attenuator on the signal generator to zero (maximum clockwise position). Set the MODULATION switch to the OFF position.

(c) Orient the measuring loop for maximum signal on the oscilloscope.

NOTE

The loop antenna used in the test setup shown in figure 6-9 should have a resonant frequency which is at least three

times greater than 100 kc in order to obtain accurate measurements. To calculate the field strength readings, the effective height of the antenna must be known.

(d) Adjust the oscilloscope vertical sensitivity for full scale deflection.

(e) Tune the signal generator to 100 kc.

(f) Adjust the CARRIER Control on the signal generator so that the needle on the output meter lines up with the SET CARRIER index in the center of the meter scale.

(g) Adjust the multiplier and variable attenuator on the signal generator until the amplitude of the signal generator output is equal to the amplitude of the pulse on the oscilloscope.

(h) Read and record the signal generator output.

(i) The peak radiated power is given as (where, FS is field strength in volts per meter at one mile, obtained by dividing the figure obtained in step (h) by the effective height of the loop antenna in meters, and multiplying by the distance from the transmitting antenna in statute miles).

$$P_{PK} = \frac{FS}{0.186}^{2}$$

(j) Repeat steps (a) through (i) at distances along a straight line between ten and fifty miles from the transmitting antenna. Average the values to determine the peak radiated power. Multiply this value by the square of the percentage of the sampling point amplitude to the peak amplitude of the pulse.

NOTE

This is determined by carefully examining the transmitted pulse shape as seen on a monitor oscilloscope connected to a vertical whip. The current pulse shapes as seen on the pulse analyzer are not satisfactory for this purpose. The standard sampling point is a point on the pulse 30.0 ± 0.5 microseconds from the start of the pulse. The amplitude at this point is normally between 55 and 60 percent of the peak amplitude.

(k) The figure for sampling point power as determined by step j should be at least 75 kw. If less power than this is obtained, refer to Section 5.

d. PERFORMANCE STANDARDS. - Performance standards are given in table 6-2. These standards should be met by the transmitter group during normal operation. The controls should be initially set in accordance with table 5-2.

6-3. REMOVAL OF PARTS AND SUBASSEMBLIES.

a. PULSE CONTROL UNIT. (See figures 6-1 through 6-4.)

(1) The chassis of the pulse control unit are designed so that complete removal is unnecessary. Each chassis, including the monitor oscilloscope (but excluding the control panel) is mounted on slides which, in extended position, completely exposes all working components of the chassis. The control panel is hinged to swing away from the cabinet and expose all components.

(2) To slide a chassis out of the rack, rotate the four panel fastener screws 90 degrees counterclockwise, push in the button adjacent to the top handle, and slide the chassis out to the full extent of its travel. A locking device on the slides will automatically lock the chassis in the extended position.

(3) When one or more chassis are extended, the interlock circuit will be broken, and the operating voltages will automatically be removed from the equipment. To have the equipment energized while a chassis is extended, place the control panel INTERLOCK DISABLE switch S13 (21, figure 3-2) in the up (on) position. If this is done before extending the chassis, the drive signal for the transmitter will not be interrupted.

WARNING

When the INTERLOCK DISABLE switch S13 (21) is in the up (on) position, lethal voltages exist on the exposed chassis. Observe high voltage safety precautions at all times.

(4) To slide an extended chassis back into the rack, push in on the slide button to release the slide lock and slide the chassis back into the cabinet. Secure the chassis in the cabinet by rotating the four panel fastener screws 90 degrees clockwise. When all chassis are back in their normal operating positions, the INTERLOCK DISABLE switch S13 (21, figure 3-2) should be placed in the off (down) position. This will protect operating personnel, should another chassis be opened at a later time.

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			PULSE GENERATOR		
1	● B29 figures 5-3 and 6-13	Record amplitude	Connect test oscilloscope probe to V1-2	Test oscilloscope	Figure 5-4y
2	● B12 figures 5-3 and 6-13	Record amplitude	Connect test oscilloscope probe to FL1-3	Test oscilloscope	Figure 5-4l
3	● B28 figures 5-3 and 6-13	Record amplitude	Connect test oscilloscope probe to FL1-1	Test oscilloscope	Figure 5-4x
4	● B13 figures 5-3 and 6-13	Record amplitude	Connect test oscilloscope probe to V7-1	Test oscilloscope	Figure 5-4m
5	● B10 figures 5-3 and 6-13	Record amplitude	Connect test oscilloscope probe to terminal E64	Test oscilloscope	Figure 5-4j
6	● B22 figures 5-3 and 6-13	Record amplitude	Connect test oscilloscope probe to V10-1	Test oscilloscope	Figure 5-4r
7	● B21 figures 5-3 and 6-13	Record amplitude	Connect test oscilloscope probe to V11-1	Test oscilloscope	Figure 5-4q

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			PULSE GENERATOR (Cont)		
8	●B7, ★7 figures 5-3 and 6-13	Record amplitude	Disconnect the cable at J1. Using a clip lead, ground T5-6. Connect test oscilloscope probe to T5-1, then to T5-4.	Test oscilloscope	Figure 5-4f and g
			CONTROL PANEL		
1	Visual check	Record amplitude	At the control panel place PULSE GEN. SELECTOR SCOPE DISPLAY switch S6 (4, figure 3-2) in the PULSE GEN 1 position. Place the SIGNAL SELECTOR switch S1 (2) in the 100 KC position.	Monitor oscilloscope	Figure 5-1d. 3 volts peak to peak minimum
2	Visual check	Record amplitude	Place SIGNAL SELECTOR switch S1 (2) in the TRIGGERS position	Monitor oscilloscope	Figure 5-1a. 4 volts peak minimum
3	Visual check	Record amplitude	Place SIGNAL SELECTOR switch S1 (2) in the MODULATING SIGNAL position	Monitor oscilloscope	Figure 5-1b. 8.0 volts ±10% peak to peak

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			CONTROL PANEL (Cont)		
4	Visual check	Record amplitude of first and eighth pulse	Place SIGNAL SELECTOR switch S1 (2) in the DROOP MODULATOR position	Monitor oscilloscope*	Figure 5-1c. 1.0 volt ±10% peak to peak Figure 5-1c. 2.0 volts ±10% peak to peak
5	Visual check	Record amplitude of first and eighth pulse	Place SIGNAL SELECTOR switch S1 (2) in the PULSE GEN OUTPUT position	Monitor oscilloscope*	Figure 5-1e. 3.6 volts ±10% peak to peak Figure 5-1e. 8.0 volts ±10% peak to peak
6	Visual check	Record amplitude of first and eighth pulse	Place SIGNAL SELECTOR switch S1 (2) in the DUMMY LOAD position	Monitor oscilloscope*	Figure 5-1g. 5.0 volts ±20% peak to peak
7	Visual check	Record amplitude of first and eighth pulse	Place SIGNAL SELECTOR switch S1 (2) in the ANTENNA position	Monitor oscilloscope*	Figure 5-1f and 5-1o. 70 volts ±20% peak to peak

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			DUAL POWER SUPPLY		
1	● A1 figures 5-2 and 6-14	Record amplitude	At dual power supply connect positive side of voltmeter to V1-2	D-c voltmeter	452 volts ±10%
2	● A14 figures 5-2 and 6-14	Record amplitude	Connect positive side of voltmeter to V3-6	D-c voltmeter	238 volts ±5%
3	● A15 figures 5-2 and 6-14	Record amplitude	Connect positive side of voltmeter to V3-7	D-c voltmeter	-3.5±7.0 volts
4	● A16, ● A17 figures 5-2 and 6-14	Record amplitude	Connect positive side of voltmeter to V4-1 and then to V4-6	D-c voltmeter	-3.5±7.0 and +300 ± 5% volts
5	● A18 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V4-7	D-c voltmeter	-44 volts ±5%
6	● A19 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V4-2	D-c voltmeter	-39 volts ±3V

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			DUAL POWER SUPPLY (Cont)		
7	● A6, ● A32 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to TB1-2 and TB2-2	D-c voltmeter	300 volts ±5%
8	● A2 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V6-2	D-c voltmeter	253 volts ±10%
9	● A20 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V7-1	D-c voltmeter	91 volts ±10%
10	● A21 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V7-2	D-c voltmeter	-1.4 ±5.0 volts
11	● A22 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V8-6	D-c	-1.4 ±5.0 volts
12	● A23 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V8-1	D-c voltmeter	150 volts ±5%

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			DUAL POWER SUPPLY (Cont)		
13	● A24, ● A25 figures 5-2 and 6-17	Record amplitude	Connect voltmeter to V8-2 and then V8-7	D-c voltmeter	-51 volts ±10% -47.5 volts ±10%
14	● A10 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V9-2	D-c voltmeter	-85 ±3 volts
15	● A9 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V10-2	D-c voltmeter	-150 ±5 volts
16	● A8, ● A33 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to TB1-3 and at TB2-3	D-c voltmeter	150 volts ±5%
17	● A3 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V11-2	D-c voltmeter	135 volts ±10%
18	● A5 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to junction of C12 and R86	D-c voltmeter	-350 volts ±10%

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			DUAL POWER SUPPLY (Cont)		
19	A26 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V12-1	D-c voltmeter	-71 volts ±10%
20	A27 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V12-3	D-c voltmeter	-150 volts ±5%
21	● A28, ● A29 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V13-6 and then to V13-7	D-c voltmeter	-141 volts ±10% -203 volts ±10%
22	● A30 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V13-2	D-c voltmeter	-165 volts ±10%
23	● A31 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V13-1	D-c voltmeter	-146 volts ±5%
24	● A12 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V14-2	D-c voltmeter	-280 volts ±5%

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			DUAL POWER SUPPLY (Cont)		
25	● A13 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to V15-2	D-c voltmeter	-234 volts ±5%
26	● A11, ● A34 figures 5-2 and 6-14	Record amplitude	Connect voltmeter to TB1-4 and TB2-4	D-c voltmeter	-150 volts ±5%
			PULSE ANALYZER		
1	● C8 figures 5-5 and 6-16	Record amplitude and duration	At the pulse analyzer place test oscilloscope probe on V1-6	Test oscilloscope	Figure 5-10h
2	● C7 figures 5-5 and 6-16	Record amplitude	Place test oscilloscope probe on V3-2	Test oscilloscope	Figure 5-10g
3	● C14 figures 5-5 and 6-16	Record amplitude and duration	Place test oscilloscope probe on V3-6. At the pulse analyzer, place PULSE SEL. switch S1 (3, figure 3-4) in position 2. At the	Test oscilloscope	Figure 5-10o

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			PULSE ANALYZER (Cont)		
3 (Cont)			pulse generator place PULSE SPACING switch S2 (2, figure 3-1) place in 1000 position		
4	● C14 figures 5-5 and 6-16	Record amplitude and duration	At the pulse analyzer place PULSE SEL. switch S1 (3, figure 3-4) in position 3	Test oscilloscope	Figure 5-10-o
5	● C14 figures 5-5 and 6-16	Record amplitude	Place PULSE SEL. switch S1 in position 4	Test	Figure 5-10-o
6	● C14 figures 5-5 and 6-16	Record amplitude and duration	Place PULSE SEL. switch S1 in position 5	Test oscilloscope	Figure 5-10-o
7	● C14 figures 5-5 and 6-16	Record amplitude and duration	Place PULSE SEL. switch S1 in position 6	Test oscilloscope	Figure 5-10-o

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			PULSE ANALYZER (Cont)		
8	● C14 figures 5-5 and 6-16	Record amplitude and duration	Place PULSE SEL. switch S1 in position 7	Test oscilloscope	Figure 5-10-o
9	● C14 figures 5-5 and 6-16	Record amplitude and duration	Place PULSE SEL. switch S1 in position 8	Test oscilloscope	Figure 5-10-o
10	● C3 figures 5-5 and 6-16	Record amplitude	Place test oscilloscope probe on V6-5	Test oscilloscope	Figure 5-10c
11	★8 figures 5-5 and 6-16	Record amplitude	At the pulse analyzer place SCOPE TRIG. SELECTOR switch S2 (7, figure 3-4) in PULSE ANAL. position. Place test oscilloscope probe on J2	Test oscilloscope	Figure 5-10m
12	● C11 figures 5-5 and 6-16	Record amplitude	Place test oscilloscope probe on V9-6	Test oscilloscope	Figure 5-10k

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			PULSE ANALYZER (Cont)		
13	★9 figures 5-5 and 6-16	Record amplitude	Place test oscilloscope probe on J4. Place AMPL. CAL. potentiometer R52 (8, figure 3-4) and % AMPL. potentiometer R55 (2, figure 3-4) in extreme CCW position, then vary COARSE ADJ. potentiometer R51 (9, figure 6-4)	Test oscilloscope	Figure 5-10n
			TRANSMITTER		
1	Visual Check	Record meter reading	At the transmitter control panel, place TUBE SELECTOR switch S17 (2, figure 3-7) in the V1 position	Meter M1	0.13 to 0.40 amp
2	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V2 position	Meter M1	0.13 to 0.40 amp
3	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V3 position	Meter M1	0.13 to 0.40 amp

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			TRANSMITTER (Cont)		
4	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V4 position	Meter M1	0.13 to 0.40 amp
5	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V5 position	Meter M1	0.13 to 0.40 amp
6	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V6 position	Meter M1	0.13 to 0.40 amp
7	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V7 position	Meter M1	0.13 to 0.40 amp
8	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V8 position	Meter M1	0.13 to 0.40 amp
9	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V9 position	Meter M1	0.07 to 0.20 amp

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			TRANSMITTER (Cont)		
10	Visual Check	Record meter reading	Place TUBE SELECTOR switch S17 (2) in the V10 position	Meter M1	0.07 to 0.20 amp
11	Visual Check	Record meter reading	None	Meter M2	1.2 to 4.0 amp
12	Visual Check	Record amplitude	At the transmitter control panel, place SIGNAL SELECTOR switch S18 (3, figure 3-7) in the INPUT position	Transmitter monitor oscilloscope	Figure 5-1i 18 increasing to 30 volts peak to peak
13	Visual Check	Record amplitude	Place SIGNAL SELECTOR switch S18 (3) in the PULSE DRIVER position	Transmitter monitor oscilloscope	Figure 5-1j 29 increasing to 40 volts peak to peak
14	Visual Check	Record amplitude	Place SIGNAL SELECTOR switch S18 (3) in the 1ST IPA position	Transmitter monitor oscilloscope	Figure 5-1k 38 increasing to 45 volts peak to peak

TABLE 6-2. LORAN TRANSMITTING SET AN/FPN-42, PERFORMANCE STANDARD CHART (Cont)

STEP	TEST POINT	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
			TRANSMITTER (Cont)		
15	Visual Check	Record amplitude	Place SIGNAL SELECTOR switch S18 (3) in the 2ND IPA position	Transmitter monitor oscilloscope	Figure 5-1l 36 increasing to 37 volts peak to peak
16	Visual Check	Record amplitude and pulse shape	Place SIGNAL SELECTOR switch S18 (3) in the OUT-PUT position	Transmitter monitor oscilloscope	Figure 5-1m 40 volts peak to peak maximum
17	Visual Check	Record amplitude	Place SIGNAL SELECTOR switch S18 (3) in the BALANCE position	Transmitter monitor oscilloscope	Figure 5-1n 0.5 volts peak to peak maximum
			COUPLING AND LOAD UNIT		
1	Visual Check	Record meter reading	Depress coupling and load unit PUSH TO READ switch S1 (2, figure 3-8)	Meter M1	30 amps** ±20%

*Use slow sweep to observe individual pulses.
**Dependent upon operating rate. Value given is for S-O rate.

b. HIGH VOLTAGE POWER SUPPLY. - Refer to Volume 3.

c. TRANSMITTER. (See figures 2-4, 2-5, 2-7, 2-10, and 6-5.)

(1) The transmitter, in addition to its major individual components, contains some subassemblies and chassis which will require occasional servicing. The pulse driver chassis and monitor oscilloscope are both mounted on slides that enable full extension of the unit for servicing without the necessity for complete removal. In addition, the pulse driver chassis is capable of rotation to expose the underside of the chassis.

(2) The control panel is hinged so that when swung away from the cabinet, it exposes its components.

(3) Removal of the rear panels exposes the tuning capacitors, output transformer, filter capacitors, and various plate, balancing, damping, and bypass resistors. All remaining components are removable from the rear.

(4) The front panels mask the filament transformers for the amplifier tubes. Removal of the panels enables access to the transformers on the middle shelf.

(5) All operating tubes are located behind hinged doors on the front and rear of the cabinet, and are removable from their sockets. The tubes on the pulse driver can be serviced by opening the hinged protective panel at the rear of the cabinet.

(6) To remove any tube from the transmitter cabinet, turn off the plate, bias, and filament voltage and allow the blower to cool the equipment for approximately five minutes. All tubes except those on the pulse driver chassis will be cooled by the blower.

WARNING

Touch all circuits in the working area with a grounding hook to insure that all lethal voltages have been discharged before attempting to service the equipment.

(7) To remove any one of tubes V1 through V10, disconnect the plate lead from the plate of the tube, loosen and remove the filament clamps, and loosen and remove the grid ring. Lift the tube by the two handles on the plate ring to remove the tube from the ceramic socket.

CAUTION

Use extreme care in removing the tube to prevent damage to the ceramic tube socket.

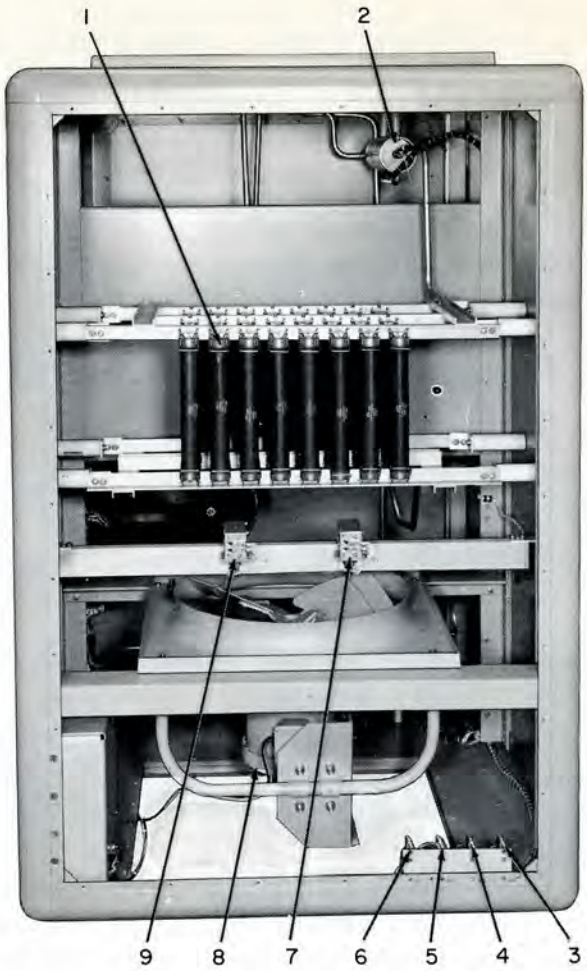
(8) Tubes V11 and V12 and V1 through V4 on the pulse driver chassis are of the conventional type and do not require special procedures for removal.

d. BLOWER. - The blower can be serviced without removal from the blower cabinet. The front panel can be removed for oiling and greasing the motor and blower bearings. The motor can also be removed through the front opening if necessary. Both tension adjustments and replacement of belts or pulleys can be done through the same servicing area.

e. COUPLING AND LOAD UNIT. (See figures 6-10 and 6-11.)

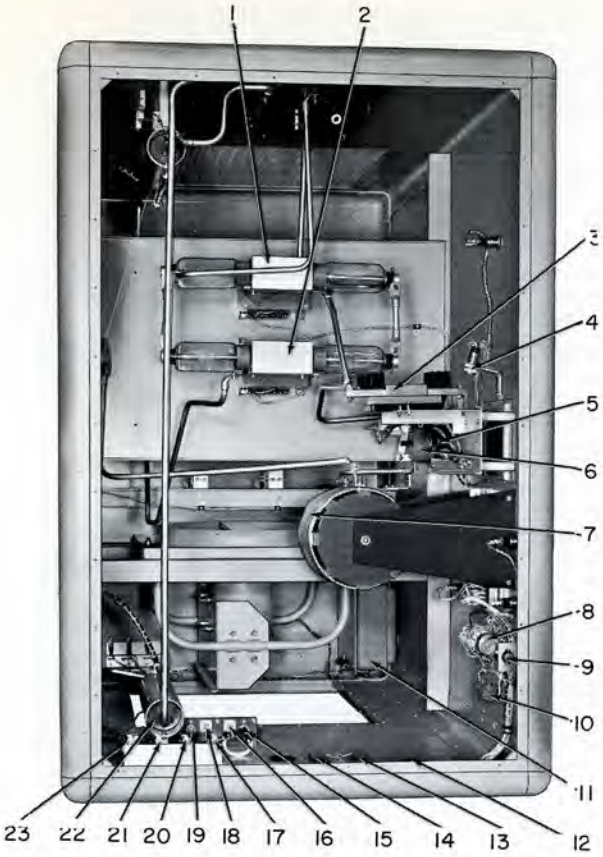
(1) Both side plates of the coupling and load unit are removable for servicing. The removal of the right side plate exposes the components of the dummy load portion of the assembly. Four bolts hold the dummy load blower. The individual resistors of the load are retained by ejector-type clamps for quick removal.

(2) The left side plate, when removed, exposes the portions of the system used for coupling and switching the transmitter to the antenna or dummy load. Major items serviced include the large switching relays, tuning coil, thermocouple metering circuit, and monitoring circuitry. Removal of these components can be accomplished without removal of the coupling and load unit from the wall of the transmitter building.



1 Dummy load resistors R1 through R48
2 Coax pickup assembly
3 Interlock switch S15
4 Interlock switch S13
5 Interlock switch S11
6 Interlock switch S9
7 Transmitter 1 air switch S5
8 Blower B1
9 Transmitter 2 air switch S6

Figure 6-10. Antenna Coupler CU-807/FPN-42, Right Side View, Parts Location



1 Transmitter 1 load switch S3
2 Transmitter 2 load switch S4
3 Thermocouple TC1
4 Meter light DS5
5 Antenna current meter M1
6 Push to read switch S1
7 Timing coil L1
8 Transmitter function switch S2
9 Relay K2
10 Solenoid rectifier CR1
11 Relay K1
12 Terminal board TB3
13 Terminal board TB2
14 Terminal board TB1
15 Transformer T1
16 Jack J1
17 Interlock switch S14
18 Transformer T2
19 Interlock switch S12
20 Interlock switch S10
21 Interlock switch S8
22 Jack J2
23 Transformer T3

Figure 6-11. Antenna Coupler CU-807/FPN-42, Left Side View, Parts Location

6-4. OVERALL SCHEMATIC AND WIRING DIAGRAMS.

a. Individual schematic diagrams for each major unit with the exception of the high voltage power supply appear as figures 6-12 and 6-19. Power and switching interconnections between the major units including the high voltage power supply are shown in figure 2-3. The r-f interconnection between the major units and the units of Loran Timer-Synchronizer Set AN/FPN-41 appears in figure 2-13. Volume 3 contains the schematic diagram of the high voltage power supply.

b. Wiring diagrams typical of each major unit (including the high voltage power supply) appear as figures 6-20 through 6-27. The wiring diagrams will serve as a guide for the technician in locating electrical parts that require removal.

6-5. TESTING OF ELECTRON TUBES.

a. The nature of electron tubes is such that the probability of early failure is greater for a new tube than for one which is operating satisfactorily in a circuit. This is well substantiated by subsequent troubles experienced after tube

replacements have been made during periodic checking based on tube tester indications. There is evidence to show that the life of tubes is shortened by cyclic thermal disturbance occurring when equipment is turned "on and off" frequently.

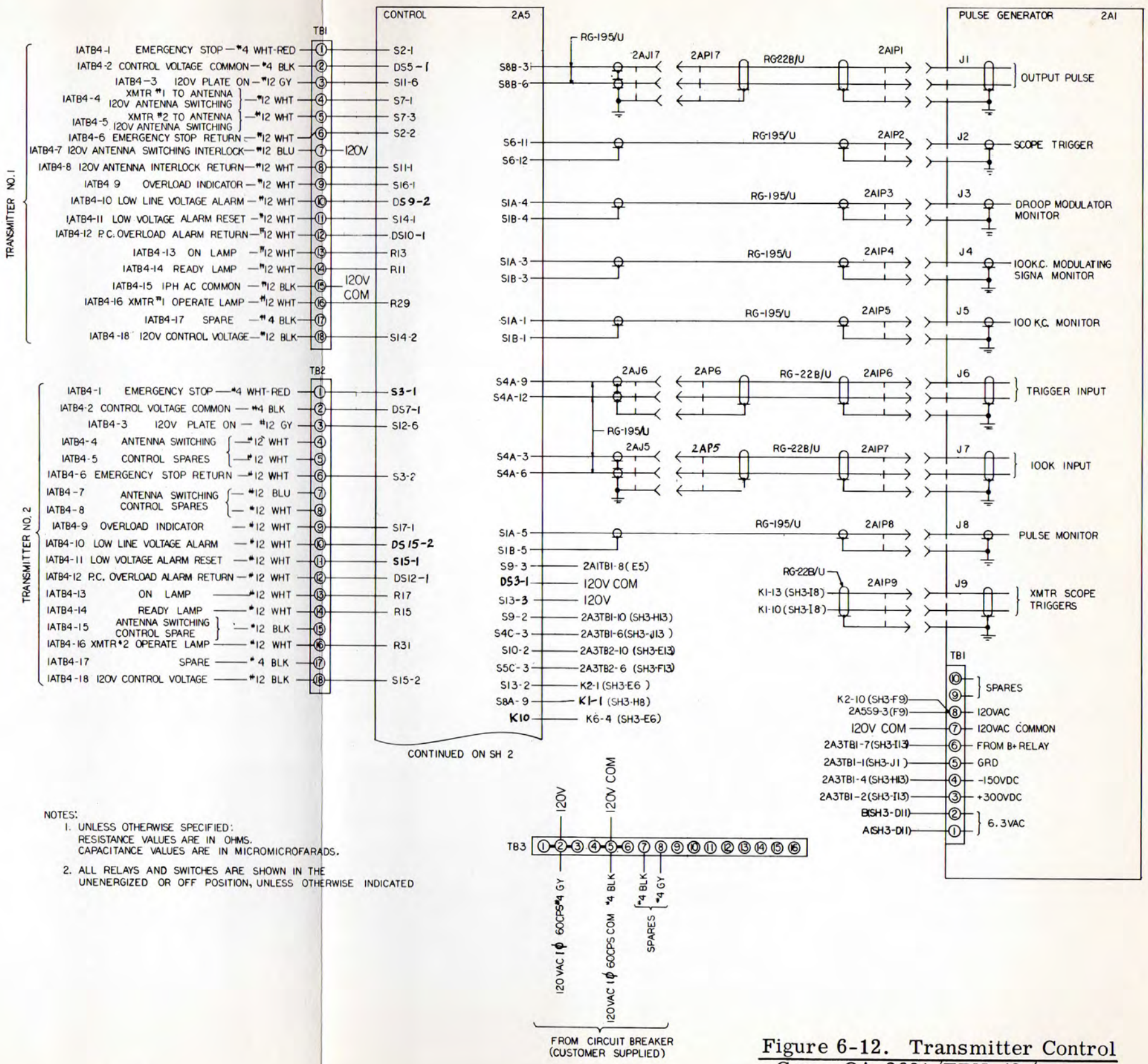
b. In view of the foregoing, the criteria for testing electron tubes shall be as follows:

(1) Never test tubes as a matter of routine. Test tubes only when the equipment shows signs of improper operation and even then, with certain reservations. When a performance deficiency is detected, every attempt should be made to isolate the specific cause.

(2) When trouble has been localized and a tube is suspected, that tube should be removed and tested. If found good, replace in same socket. Do not interchange tubes between sockets. This can lead to detuning of critical circuits or the injection of trouble into a circuit that is normal.

(3) If repair by tube substitution is necessary as a last resort, test a new tube (within the capacity of the tube tester) before placing it in service.

(4) If a new tube tests good but will not work in a particular socket, make a note of this fact and save the tube for use in another application.



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   RESISTANCE VALUES ARE IN OHMS.
   CAPACITANCE VALUES ARE IN MICROMICROFARADS.
2. ALL RELAYS AND SWITCHES ARE SHOWN IN THE UNENERGIZED OR OFF POSITION, UNLESS OTHERWISE INDICATED

Figure 6-12. Transmitter Control Group OA-2631/FPN-42 (Pulse Control Unit, UD2A), Schematic Diagram (Sheet 1 of 3)

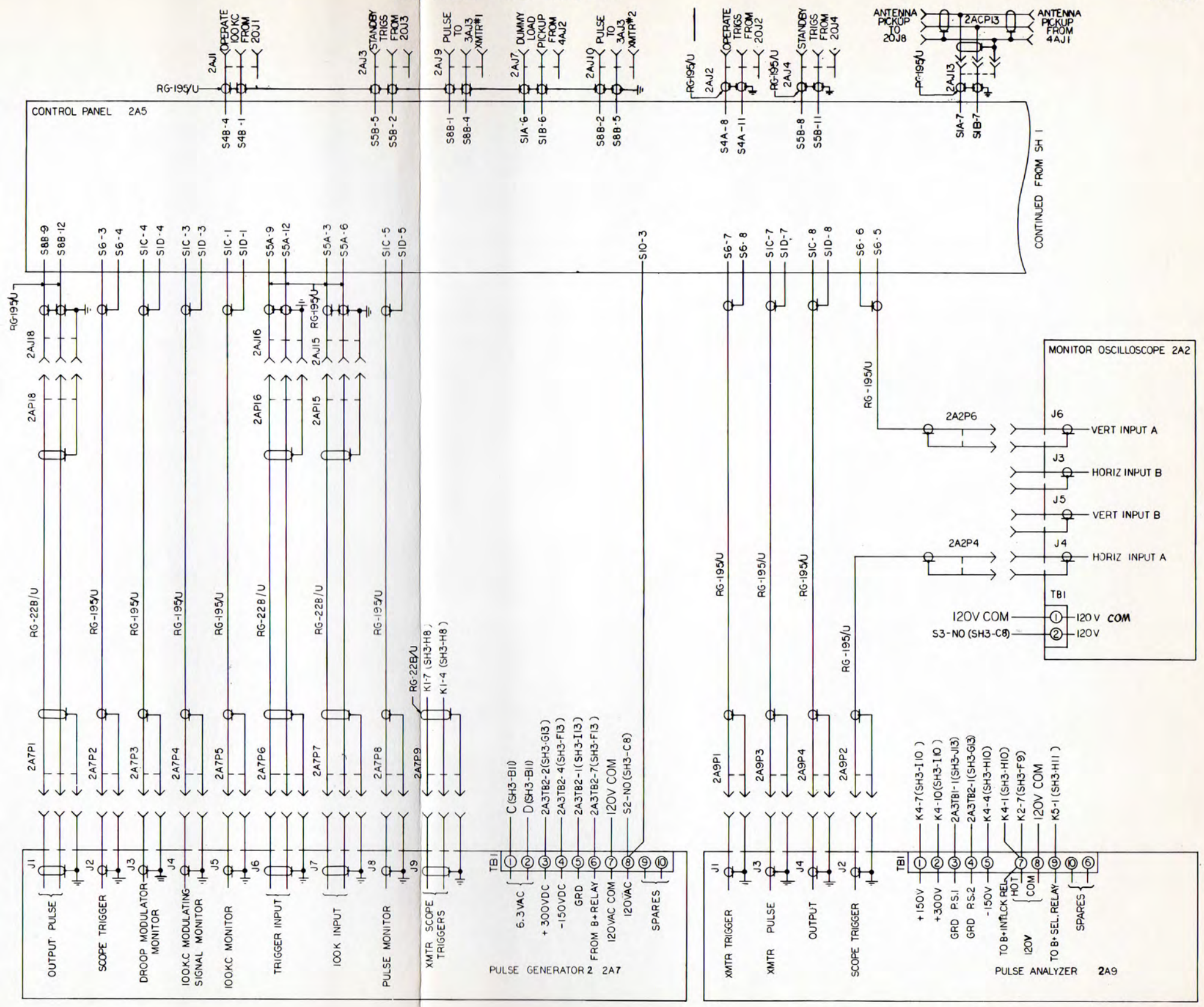
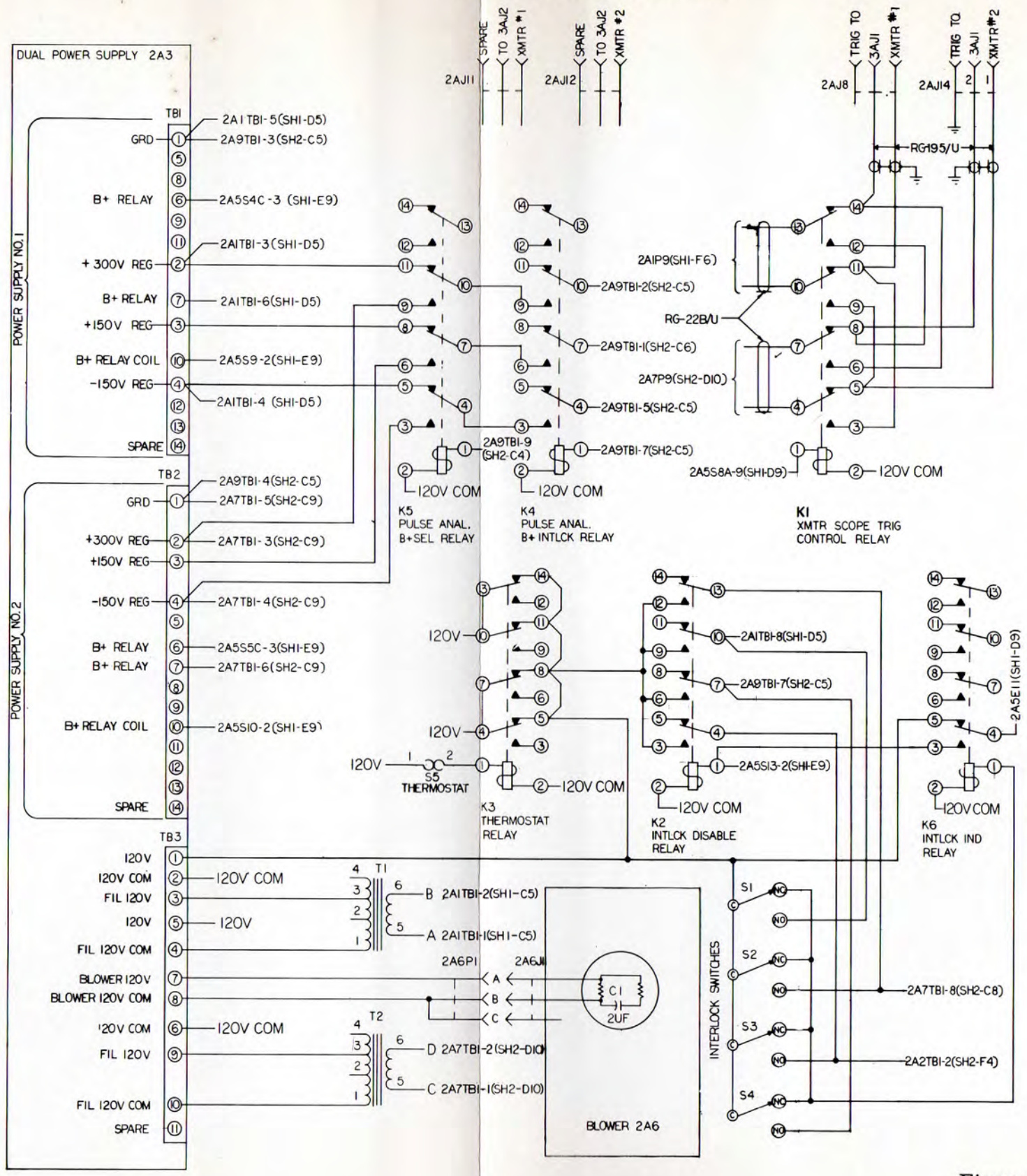
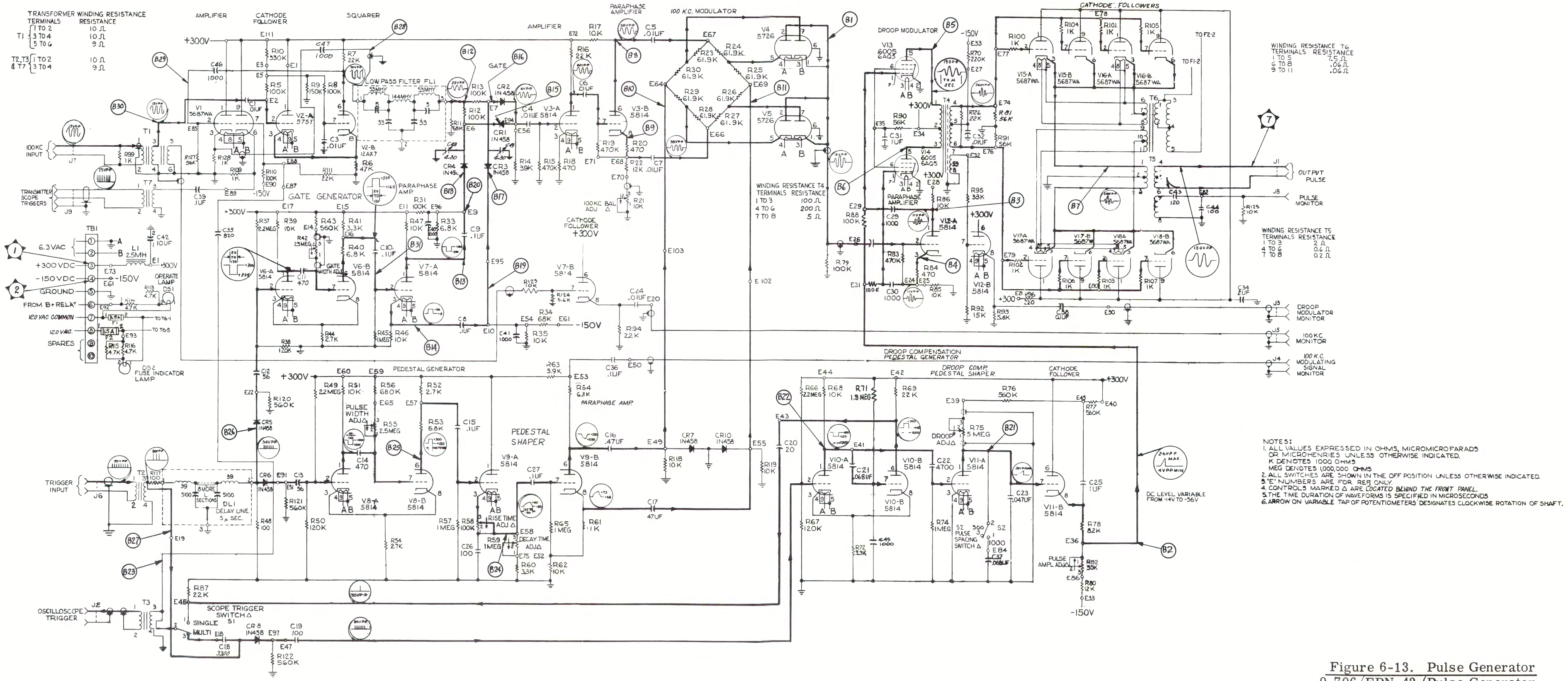


Figure 6-12. Transmitter Control Group OA-2631/FPN-42 (Pulse Control Unit, UD2A), Schematic Diagram (Sheet 2 of 3)



REF DESIG	SPERRY NO FOR REF.	NAME	VALUE	TOL	RATING
C1	4223-09407	CAPACITOR	2UF		
J1	1200138	CONNECTOR			
J2					
J3					
J4					
J5					
J6					
J7					
J8					
J9					
J10					
J11					
J12					
J13					
J14					
J15					
J16					
J17					
J18	1200138	CONNECTOR			
K1	813222	RELAY			
K2					
K3					
K4					
K5					
K6	813222	RELAY			
P1	0658-004	CONNECTOR			
S1	849511	SWITCH			
S2					
S3					
S4	849511	SWITCH			
S5	1381594	THERMOSTAT			
T1	1380805	TRANSFORMER			
T2	1380805	TRANSFORMER			
TB1	618269-18	TERMINAL BOARD			
TB2	618269-18	TERMINAL BOARD			
TB3	618263-16	TERMINAL BOARD			

Figure 6-12. Transmitter Control Group OA-2631/FPN-42 (Pulse Control Unit, UD2A), Schematic Diagram (Sheet 3 of 3)



NOTES:
1. ALL VALUES EXPRESSED IN OHMS, MICROMICROFARADS OR MICROHENRIES UNLESS OTHERWISE INDICATED.
K DENOTES 1000 OHMS
MEG DENOTES 1,000,000 OHMS
2. ALL SWITCHES ARE SHOWN IN THE OFF POSITION UNLESS OTHERWISE INDICATED.
3. "E" NUMBERS ARE FOR REF. ONLY.
4. CONTROLS MARKED Δ ARE LOCATED BEHIND THE FRONT PANEL.
5. THE TIME DURATION OF WAVEFORMS IS SPECIFIED IN MICROSECONDS.
6. ARROW ON VARIABLE TAP OF POTENTIOMETERS DESIGNATES CLOCKWISE ROTATION OF SHAFT.

Figure 6-13. Pulse Generator 0-706/FPN-42 (Pulse Generator, UD2A1 or UD2A7), Schematic Diagram (Sheet 1 of 2)

REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL	RATING
C1	015-25	CAPACITOR	.01UF	±5%	300VDC
~~C2~~					
C3	015-25	CAPACITOR	.01UF	±5%	300 DC
C4					
C5					
C6					
C7	015-25		.01UF	±5%	300VDC
C8	0328-35		.1UF	±10%	400VDC
C9	0328-35		.1UF	±10%	400VDC
C10	0328-35		1UF	±10%	400VDC
C11	610793-39		470	±5%	300VDC
C12	-17		56		
C13	-17		56		
C14	610793-39		470	±5%	300VDC
C15	0328-35		.1UF	±10%	400VDC
C16	0328-39		.47UF	±10%	400VDC
C17	0328-20		.47UF	±10%	200VDC
C18	015-13		3300	±5%	300VDC
C19	610793-23		100	±5%	300VDC
C20	610793-06		20	±5%	300VDC
C21	0328-34		.068UF	±10%	400VDC
C22	015-17		4700	±10%	500VDC
C23	0328-14		.0471UF	±10%	200VDC
C24	015-25		.01UF	±5%	300VDC
C25	889961		1UF	±10%	400VDC
C26	610793-23		100	±5%	300VDC
C27	0328-35		.1UF	±10%	400VDC
C28	015-25		.01UF	±5%	300VDC
C29	011-55		1000	±5%	300VDC
C30	011-55		1000	±5%	300VDC
C31	889961		1UF	±10%	400VDC
C32	015-25	CAPACITOR	.01UF	±5%	300VDC
~~C33~~	~~0328-35~~		~~1UF~~	~~±10%~~	~~400VDC~~
C34	632313-427	CAPACITOR	2UF	±10%	400VDC
C35	011-53		820	±5%	300VDC
C36	0328-35		.1UF		400VDC
C37	0328-15		.068UF		200VDC
C38	0645-16		.1UF	±5%	200VDC
C39	0328-35	~~CAPACITOR~~	.1UF	±10%	400VDC
C40	011-55		1000	±5%	300VDC
C41	011-55		1000	±5%	300VDC
C42	040-9	CAPACITOR	10UF	±10%	600VDC
C43	610793-25		120	±5%	300VDC
C44	610793-23		100	±5%	300VDC
C45	011-55	CAPACITOR	1000	±5%	300VDC
C46	011-55		1000		
C47	011-55	CAPACITOR	1000		
C48	0282-3	CAPACITOR VAR	4.30		
C49	0282-3	CAPACITOR VAR	4.30		
CR1	619139	DIODE (1N458)			
CR2					
CR3					
CR4					
CR5					
CR6					
CR7					
CR8					
~~CR9~~					
CR10	619139	DIODE (1N458)			
DL1	1200518	DELAY LINE			
DS1	0174-31	LAMP			28V
DS2	0174-31	LAMP			28V

REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL	RATING
F1	632337-10	FUSE	1.5AMP		
F2	632337-10	FUSE	1.5AMP		
FL1	1200520	FILTER			
J1	1200138	CONNECTOR			
J2	603306				
J3					
J4					
J5	603306				
J6	1200138				
J7	1200138				
J8	603306				
J9	1200138	CONNECTOR			
L1	267691	CHOKE	2.5MH	±10%	125MA
~~R1~~	~~813188-33~~	~~RESISTOR~~	~~47K~~	~~±5%~~	~~1W~~
~~R2~~	~~-17~~		~~15K~~		
~~R3~~	~~-89~~		~~33K~~		
~~R4~~	~~-49~~		~~1K~~		
R5	813188-97	RESISTOR	100K	±5%	1W
R6	-89		47K		
R7	-81		22K		
R8	-97		100K		
R9	-101		150K		
R10	-109		330K		
R11	-93		68K		
R12	-97		100K		
R13	-97		100K		
R14	-87		39K		
R15	813188-113		470K		1W
R16	813190-81		22K		2W
R17	813188-73		10K		1W
R18	-41		470		
R19	-113		470K		
R20	813188-41		470	±5%	1W
R21	625713-043	-VAR	10K	±10%	2W
R22	813188-75		12K	±5%	1W
R23	614599-564		61.9K	±1%	1/2W
R24					
R25					
R26					
R27					
R28					
R29					
R30	614899-564		61.9K	±1%	1/2W
R31	813188-97	RESISTOR	100K	±5%	1W
~~R32~~	~~-97~~		~~100K~~		
R33	813188-69	RESISTOR	6.8K	±5%	1W
R34	-93		68K		
R35	813188-73	RESISTOR	10K	±5%	1W
~~R36~~	~~813188-97~~	~~RESISTOR~~	~~100K~~	~~±5%~~	~~1W~~

REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL	RATING
R37	813188-129	RESISTOR	2.2MEG	±5%	1W
R38	813188-99		120K		1W
R39	813188-73		10K		1W
R40	813190-69		6.8K		2W
R41	813188-61		3.3K	±5%	1W
R42	625713-057	-VAR	2.5MEG	±10%	2W
R43	813188-115		560K	±5%	1W
R44	-59		2.7K		
R45	-121		1MEG		
R46	-73		10K		
R47	-73		10K		
R48	-25		100		
R49	-129		2.2MEG		
R50	-99		120K		
R51	-73		10K		
R52	813188-59		2.7K		1W
R53	813190-69		6.8K		2W
R54	813188-59		2.7K	±5%	1W
R55	625713-057	-VAR	2.5MEG	±10%	2W
R56	813188-117		680K	±5%	1W
R57	813188-121		1MEG	±5%	1W
R58	625713-049	-VAR	100K	±10%	2W
R59	625713-055	-VAR	1MEG	±10%	2W
R60	813188-61		3.3K	±5%	1W
R61	-49		1K		
R62	-73		10K		
R63	-63		3.9K		
R64	-69		6.8K		
R65	813188-121		1MEG		
R66	813188-129		2.2MEG		1W
R67	813188-99		120K		1W
R68	813188-73		10K		1W
R69	813188-81		22K		1W
R70	813188-105		220K		1W
R71	813188-127		1.8MEG		1W
R72	813188-61		3.3K		1W
~~R73~~	~~813188-81~~		~~22K~~		~~1W~~
R74	813188-121		1MEG	±5%	1W
R75	625713-059	-VAR	5MEG	±10%	2W
R76	813188-115		560K	±5%	1W
R77	813188-115		560K	±5%	1W
R78	813190-71		8.2K	±5%	2W
R79	813188-97		100K	±5%	1W
R80	813190-75		12K	±5%	2W
R81	813188-91		56K	±5%	1W
R82	625713-047	-VAR	50K	±10%	2W
R83	813188-113		470K	±5%	1W
R84	-41		470		
R85	-73		10K		
R86	-73		10K		
R87	-81		22K		
R88	-97		100K		
R89	-97		100K		
R90	-91		56K		
R91	-91		56K		
R92	-77		15K		
R93	-67		5.6K		
R94	-57		2.2K		
R95	-85		33K		
R96	813188-33		220		1W
~~R97~~	~~813188-91~~		~~56K~~		~~1/2W~~
~~R98~~	~~813188-73~~		~~10K~~		~~1/2W~~
R99	813188-49		1K		1W
R100	813188-49		1K		1W
R101					
R102					
R103					
R104					
R105					
R106					
R107	813188-49	RESISTOR	1K	±5%	1W
~~R108~~	~~-65~~		~~4.7K~~		
R109	813188-49	RESISTOR	1K	±5%	1W
R110	-97		100K		
R111	-81		22K		
~~R112~~	~~813188-73~~		~~10K~~		~~1W~~
R113	813190-65		4.7K		2W
R114	813190-65	RESISTOR	4.7K	±5%	2W

REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL	RATING
R115	813190-65	RESISTOR	4.7K	±5%	2W
R116	813190-65	RESISTOR	4.7K	±5%	2W
R117	813186-25	RESISTOR	100	±5%	1/2W
R118	-73		10K		1/2W
R119	-73		10K		1/2W
R120	813188-115		560K		1W
R121	813188-115		560K		
R122	813188-115	RESISTOR	560K		
R123	-73		10K		
R124	-67		5.6K		
R125	813188-73		10K		1W
R127	813188-91		56K		1W
R128	813190-49	RESISTOR	1K	±5%	2W
S1	0232-4	SWITCH			
S2	0232-4	SWITCH			
T1	606834-2	TRANSFORMER			
T2	606833-2				
T3	606833-2				
T4	1383173				
T5	1381774				
T6	1381573				
T7	606833-2	TRANSFORMER			
TB1	618244-10	TERM. BOARD			
V1	736560-1	TUBE ELECTRON	5687WA		
V2	671114-1		5751		
V3	716841-1		5814A		
V4	716857-1		5726/6AL5W		
V5	716857-1		5726/6AL5W		
V6	716841-1		5814A		
V7					
V8					
V9					
V10					
V11					
V12	716841-1		5814A		
V13	719349-1		6005/6AQ5W		
V14	719349-1		6005/6AQ5W		
V15	736560-1		5687WA		
V16					
V17					
V18	736560-1	TUBE ELECTRON	5687WA		

Figure 6-13. Pulse Generator 0-706/FPN-42 (Pulse Generator, UD2A1 or UD2A7), Schematic Diagram (Sheet 2 of 2)

REF DESIG	SPERRY PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
C1	4223-09545	CAPACITOR	100UF		300 V
C2					
C3					
C4	-09545		100UF		300 V
C5	-09546		60UF		450V
C6A	-09544		45UF		350V
C6B			45UF		350V
C7	-09546		60UF		450V
C8	-				
C9	-				
C10	-				
C11	-				
C12	-09546		60UF		450V
C13A	4223-09544		45UF		350V
C13B			45UF		350V
C14	0645-35		.1UF		400V
C15	-35		.1UF		400V
C16	-35		.1UF		400V
C17	-20		.47UF		200V
C18	-33		.047UF		400V
C19	-33		.047UF		400V
C20	-20		.47UF		200V
C21	-33		.047UF		400V
C22	-33		.047UF		400V
C23	-35		.1UF		400V
C24	-16		.1UF		200V
C25	0645-33	CAPACITOR	.047UF		400V
CB1A	1381787-1	CIRCUIT BREAKER			.5A
CB1B	1381787-1	CIRCUIT BREAKER			.5A
CB3	1381787-4	CIRCUIT BREAKER			1.5A
CR1	631806-1	SEMICONDUCTOR DEVICE IN540			
CR2					
CR3					
CR4					
CR5					
CR6					
CR7					
CR8					
CR9					
CR10					
CR11					
CR12					
CR13					
CR14					
CR15					
CR16					
CR17					
CR18					
CR19					
CR20					
CR21					
CR22					
CR23					
CR24					
CR25					
CR26	631806-1	SEMICONDUCTOR DEVICE IN540			
DS1A	1380726	LAMP			
DS1B					
DS2A					
DS2B					
DS3A					
DS3B					
DS4A					
DS4B					
DS5A					
DS5B	1380726	LAMP			

REF DESIG	SPERRY PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
F1A	632367-11	FUSE	.2A		
F1B	-11		.2A		
F2A	-12		.3A		
F2B	632367-12		.3A		
F3A	632337-7		.5A		
F3B	-7		.5A		
F4A	-4		.25A		
F4B					
F5A					
F5B	632337-4	FUSE	.25A		
K1	4223-09535	RELAY			120VAC
L1	4223-09533	CHOKE	1H		300MA
L2A	4223-09537	CHOKE	1H		150MA
L2B			1H		150MA
R3	813186-49	RESISTOR	1K	±5%	1/2W
R4	813186-25		100	±5%	1/2W
R5	630705-680		1MEG	±1%	1/2W
R6	727241-61		100	±5%	5W
R7	727241-61		100	±5%	5W
R8	813186-25		100	±5%	1/2W
R9	630705-580	RESISTOR	90.9K	±1%	1/2W
R11	813186-25	RESISTOR	100	±5%	1/2W
R12	727241-61				5W
R13	727241-61				5W
R14	813186-25		100	±5%	1/2W
R15	630705-680		1MEG	±1%	1/2W
R16	630705-592	RESISTOR	121K	±1%	1/2W
R19	813186-49	RESISTOR	1K	±5%	1/2W
R20	630705-680	RESISTOR	1MEG	±1%	1/2W
R21	625713-017	RESISTOR-VAR	50K	±10%	2W
R23	630705-584	RESISTOR	100K	±1%	1/2W
R24	630705-215		604Ω	±1%	1/2W
R25	813186-25		100	±5%	1/2W
R26	630705-584		100K	±1%	1/2W
R27	727241-61		100	±5%	5W
R28	727241-61		100	±5%	5W
R29	813186-25		100	±5%	1/2W
R30	607301-326		25K	±1%	1W
R31	607301-459		5K	±1%	1W
R32	630705-584		100K	±1%	1/2W
R33	813186-49		1K	±5%	1/2W
R34	630705-584		100K	±1%	1/2W
R35	630705-576		82.5K	±1%	1/2W
R36	813186-49		1K	±5%	1/2W
R37	630705-680	RESISTOR	1MEG	±1%	1/2W
R39	630705-680	RESISTOR	1MEG	±1%	1/2W
R41	630705-584	RESISTOR	100K	±1%	1/2W
R42	813186-49		1K	±5%	1/2W
R43	630705-680		1MEG	±1%	1/2W
R44	625713-015	-VAR	25K	±10%	2W
R45	630705-608		178K	±1%	1/2W
R46	813190-79		18K	±5%	2W
R47	727241-85		1.5K	±5%	5W
R48	630705-680	RESISTOR	1MEG	±1%	1/2W
R51	813186-25	RESISTOR	100	±5%	1/2W
R52	727241-61				5W
R53	727241-61				5W
R54	813186-25		100	±5%	1/2W
R55	607301-526		25K	±1%	1W
R56	607301-459		5K	±1%	1W
R57	727241-85	RESISTOR	1.5K	±5%	5W
R59	630705-584	RESISTOR	100K	±1%	1/2W
R60	813186-49		1K	±5%	
R61	813186-49		1K	±5%	
R62	630705-576		82.5K	±1%	
R63	630705-680	RESISTOR	1MEG	±1%	1/2W
R66	630705-584	RESISTOR	100K	±1%	1/2W
R67	813190-79	RESISTOR	18K	±5%	2W

REF DESIG	SPERRY PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
R69	813186-49	RESISTOR	1K	±5%	1/2W
R70	630705-680		1MEG	±1%	1/2W
R71	625713-015	-VAR	25K	±10%	2W
R72	630705-608		178K	±1%	1/2W
R73	813190-101		150K	±5%	2W
R74					
R75					
R76	813190-101		150K		2W
R77	727055-35		5		10W
R78	813190-95		82K		2W
R79	727241-90		3K		5W
R80	727055-35		5		10W
R81	813190-79		18K		2W
R82	4223-09583		10K		20W
R83	813186-115		560K		1/2W
R84	813186-97		100K		1/2W
R85	4223-09582		20K		20W
R86	727241-90		3K		5W
R87	813190-95		82K		2W
R88	813188-107		620K		1W
R89	-99		120K		
R90					
R91					
R92	-99		120K		
R93	-107		270K		
R94	-99		120K		
R95					
R96					
R97	813188-99		120K		1W
R98	727055-35		5		10W
R99	4223-09583	RESISTOR	10K	±5%	20W
T1	4223-09534	TRANSFORMER			
T2	4223-09536	TRANSFORMER			
TB1	618223-14	TERMINAL BOARD			
TB2	618223-14	TERMINAL BOARD			
TB3	618223-11	TERMINAL BOARD			
V1	611297	ELECTRON TUBE-6080WA			
V2	611297	-6080WA			
V3	671114	-5751			
V4	671114	-5751			
V5	823668	-5651			
V6	611297	-6080WA			
V7	671114	-5751			
V8	671114	-5751			
V9	823668	-5651			
V10	738627	-0421A			
V11	611297	-6080WA			
V12	671114	-5751			
V13	671114	-5751			
V14	738627	-0421A			
V15	823668	ELECTRON TUBE-5651			

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
RESISTANCE VALUES ARE IN OHMS
CAPACITANCE VALUES ARE IN MICROMICROFARADS
INDUCTANCE VALUES ARE IN MICROHENRIES
2. ALL RELAYS ARE SHOWN IN THE UNENERGIZED POSITION UNLESS OTHERWISE INDICATED.

Figure 6-14. Power Supply Assembly PP-2541/FPN-42 (Dual Power Supply, UD2A3), Schematic Diagram (Sheet 1 of 3)

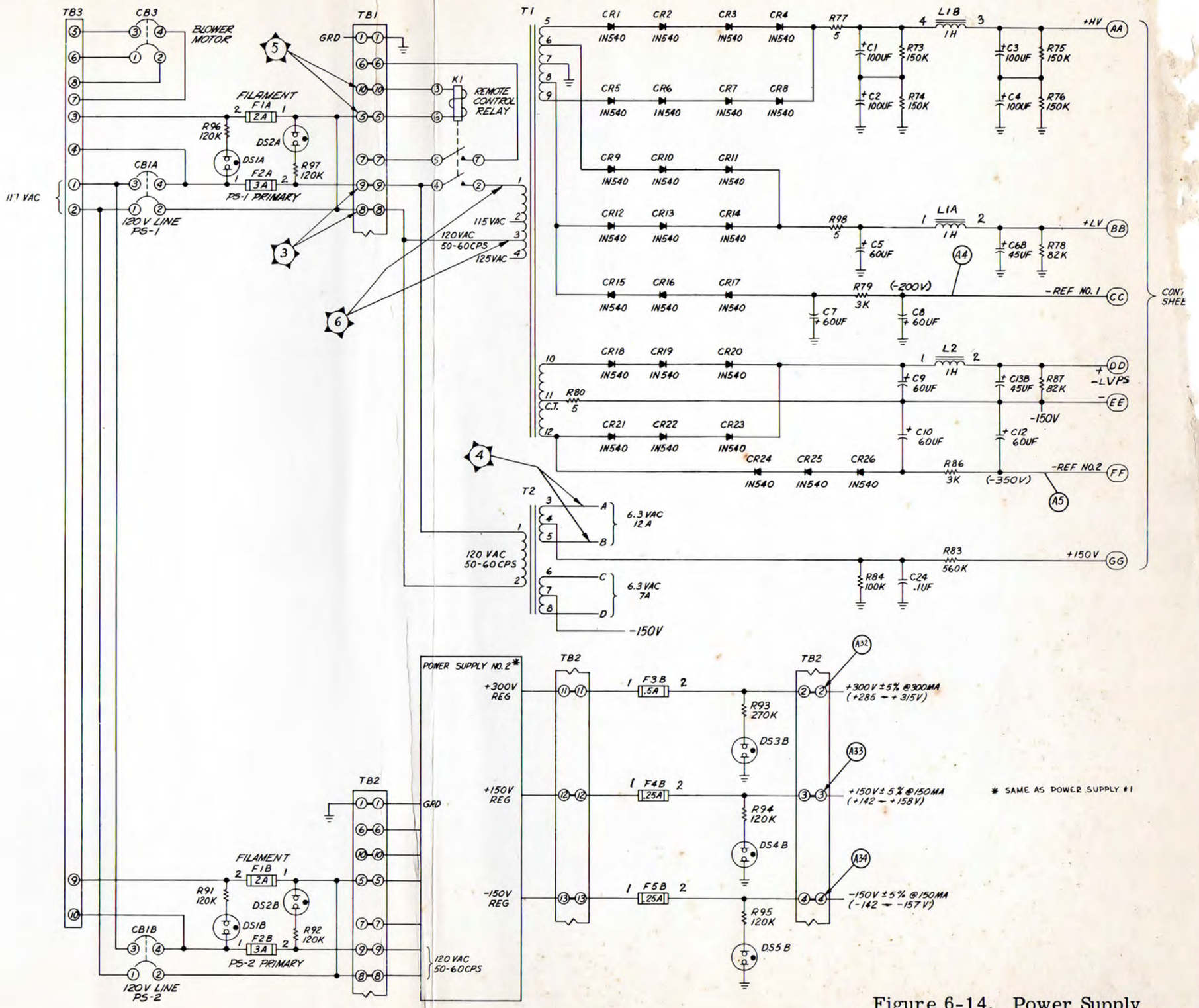


Figure 6-14. Power Supply Assembly PP-2541/FPN-42 (Dual Power Supply, UD2A3), Schematic Diagram (Sheet 2 of 3)

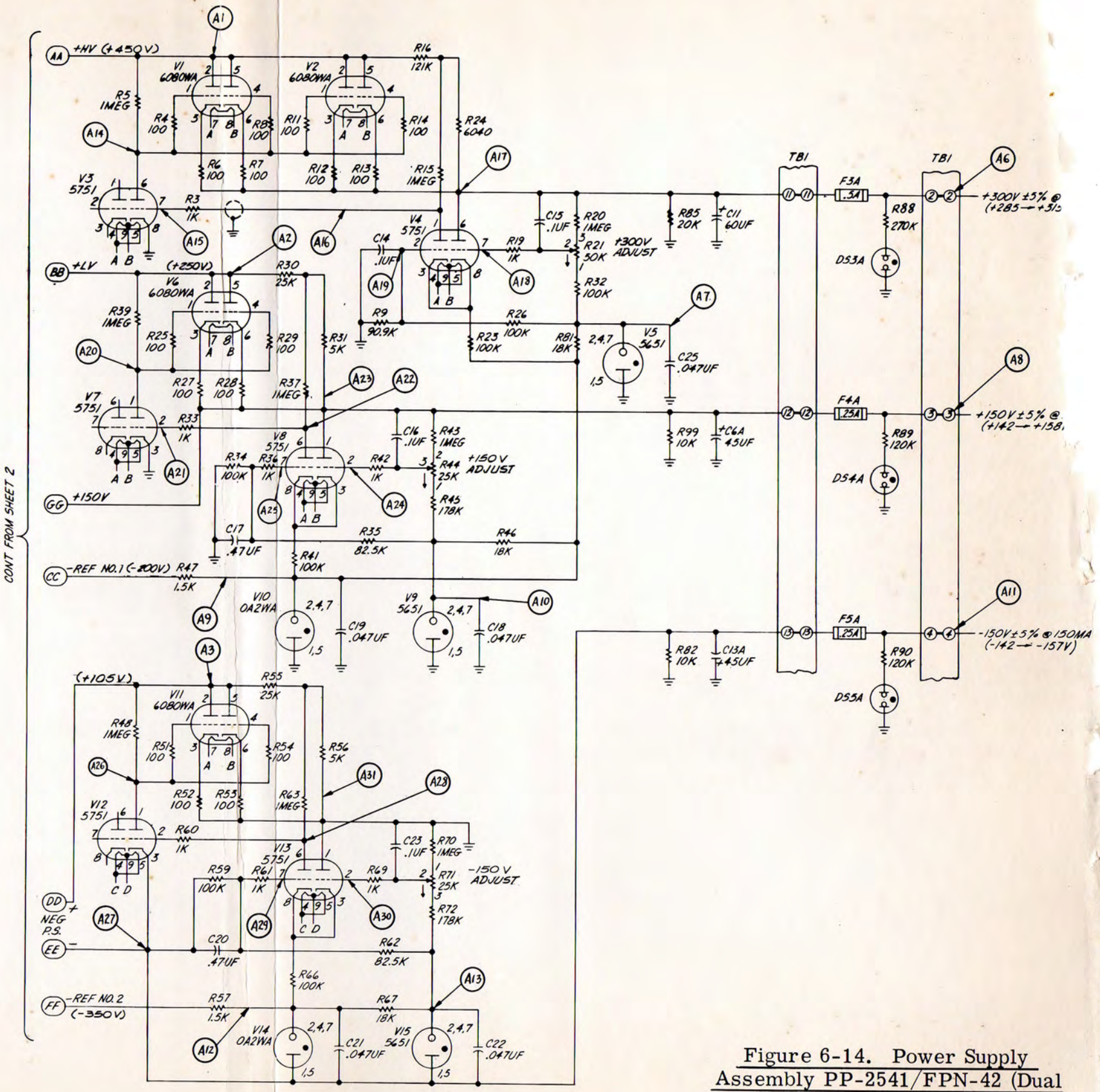
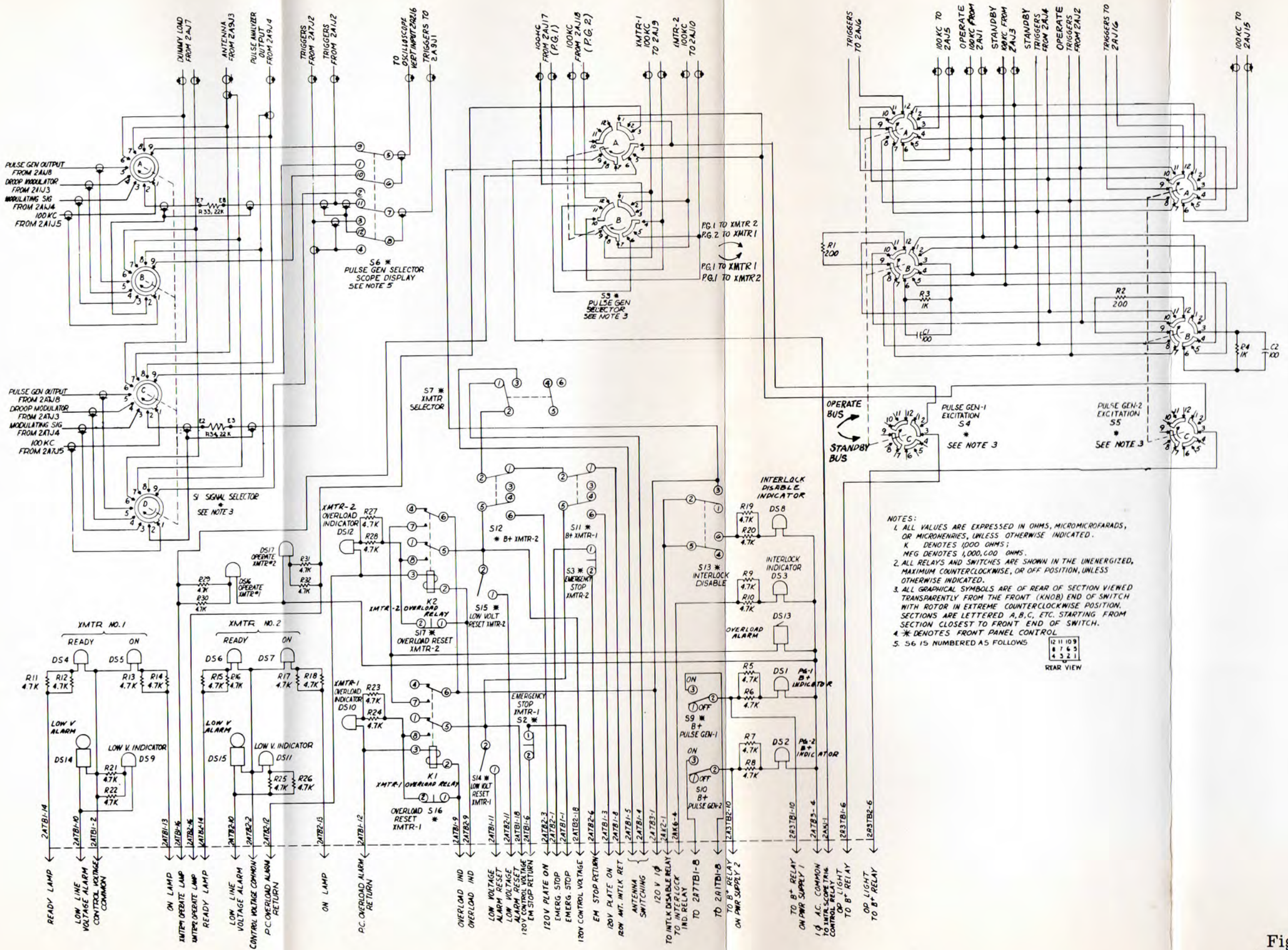


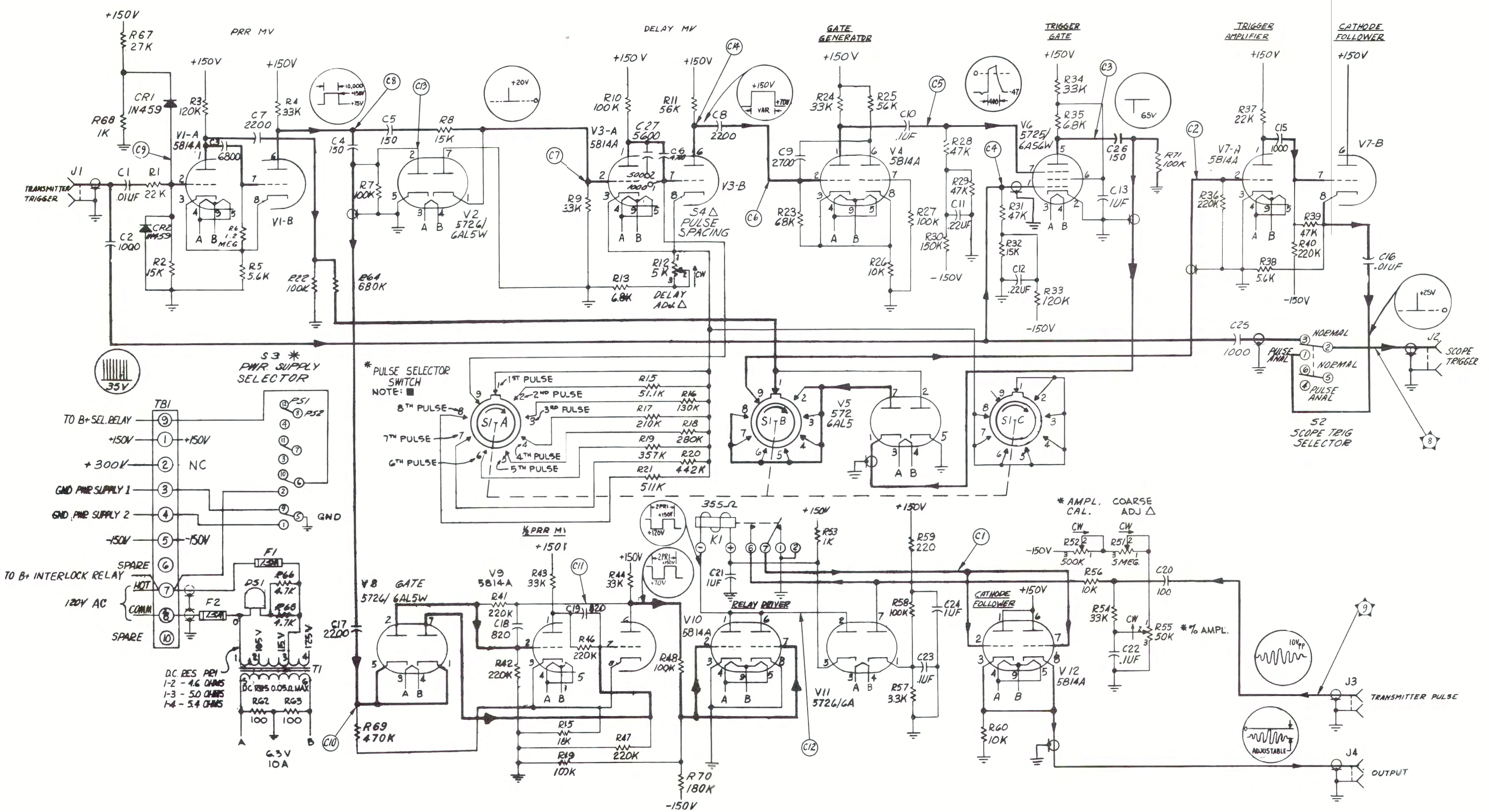
Figure 6-14. Power Supply Assembly PP-2541/FPN-42 (Dual Power Supply, UD2A3), Schematic Diagram (Sheet 3 of 3)



NOTES:
1. ALL VALUES ARE EXPRESSED IN OHMS, MICROMICROFARADS, OR MICROHENRIES, UNLESS OTHERWISE INDICATED.
   K DENOTES 1000 OHMS;
   MEG DENOTES 1,000,000 OHMS.
2. ALL RELAYS AND SWITCHES ARE SHOWN IN THE UNENERGIZED, MAXIMUM COUNTERCLOCKWISE, OR OFF POSITION, UNLESS OTHERWISE INDICATED.
3. ALL GRAPHICAL SYMBOLS ARE OF REAR OF SECTION VIEWED TRANSPARENTLY FROM THE FRONT (KNOB) END OF SWITCH WITH ROTOR IN EXTREME COUNTERCLOCKWISE POSITION. SECTIONS ARE LETTERED A,B,C, ETC. STARTING FROM SECTION CLOSEST TO FRONT END OF SWITCH.
4. * DENOTES FRONT PANEL CONTROL
5. S6 IS NUMBERED AS FOLLOWS

REF DESIG	PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
C1	610793-23	CAPACITOR	100	±5%	300V
C2	610793-23	CAPACITOR	100	±5%	300V
DS1	0174-31	LAMP			
DS2					
DS3					
DS4					
DS5					
DS6					
DS7					
DS8					
DS9					
DS10					
DS11					
DS12	0174-31	LAMP			
DS13	858304	BUZZER			
DS14	1381669	BELL			
DS15	1381669	BELL			
DS16	0174-31	LAMP			
DS17	0174-31	LAMP			
J1	1200138	CONNECTOR			
J2					
J3					
J4					
J5					
J6					
J7					
J8					
J9					
J10					
J11					
J12	1200138	CONNECTOR			
K1	1381669	RELAY			
K2	1381669	RELAY			
R1	813188-32	RESISTOR	200	±5%	1W
R2	813188-32		200		1W
R3	813186-49		1K		1/2W
R4	813186-49		1K		1/2W
R5	813190-65		4.7K		2W
R6					
R7					
R8					
R9					
R10					
R11					
R12					
R13					
R14					
R15					
R16					
R17					
R18					
R19					
R20					
R21					
R22					
R23					
R24					
R25					
R26					
R27					
R28					
R29					
R30					
R31					
R32	813190-65	RESISTOR	4.7K	±5%	2W
S1	6002376-408	SWITCH			
S2	1380766				
S3	1380766				
S4	601190-302				
S5	601190-302				
S6	1034916-2				
S7	0233-4				
S8	601190-202				
S9	0232-4				
S10	0232-4				
S11	0232-4				
S12	0232-4				
S13	0232-4				
S14	0232-3				
S15	0232-3				
S16	721192-11				
S17	721192-11	SWITCH			
R33	813188-81	RESISTOR	22K	5%	1W
R34	813188-81	RESISTOR	22K	5%	1W

Figure 6-15. Control Panel UD2A5, Schematic Diagram



REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL.	RATING
C1	0162-14	CAPACITOR	.01UF	±10%	300VDC
C2	0156-28		1000	±10%	
C3	015-21		6800	±5%	
C4	610793-27		150		
C5	610793-27		150		
C6	015-17		4700	±5%	300VDC
C7	0162-6		2200	±10%	500VDC
C8	0162-6		2200	±10%	
C9	015-11		2700	±5%	500VDC
C10	0645-16		.01UF	±10%	200VDC
C11	-18		.22UF		
C12	-18		.22UF		
C13	0645-22	CAPACITOR	1UF	±10%	200VDC
~~C14~~	~~0162-28~~		~~1000~~		~~300VDC~~
C15	0156-28	CAPACITOR	1000	±10%	300VDC
C16	0162-14		.01UF	±10%	300VDC
C17	0162-6		2200	±10%	500VDC
C18	011-53		820	±5%	300VDC
C19	-53		820	±5%	
C20	011-31		100	±5%	300VDC
C21	0645-22		1UF	±10%	200VDC
C22	-16		.1UF		
C23	-16		.1UF		
C24	0645-22		1UF		200VDC
C25	0156-28		1000	±10%	300VDC
C26	610793-27	CAPACITOR	150	±5%	300VDC
F1	532337-10	FUSE	1.5AMP		
F2	532337-10	FUSE	1.5AMP		
DS1	0174-31	LAMP			
C27	015-19	CAPACITOR	5600	±5%	
CR1	623124-1	DIODE	1N459		
CR2	623124-1	DIODE	1N459		

REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL.	RATING
J1	724102	CONNECTOR			
J2					
J3					
J4	724102	CONNECTOR			
K1	1380737	RELAY			
R1	813186-81	RESISTOR	22K	±5%	½W
R2	-77		15K		
R3	813186-39		120K		½W
R4	813188-85		33K		1W
R5	813186-67		5.6K		½W
R6	-123		1.2MEG		
R7	-97		100K		
R8	-77		15K		
R9	-85		33K		
R10	813186-97		100K		½W
R11	813188-31		56K	±5%	1W
R12	1015763-08	VAR.	5K	±10%	2W
R13	813186-69		6.8K	±5%	½W
~~R14~~	~~813186-127~~		~~1.8MEG~~	~~±5%~~	
R15	614533-556		511K	±1%	
R16	-595		130K		
R17	-615		210K		
R18	-627		280K		
R19	-637		357K		
R20	-646		442K		
R21	614599-452		511K	±1%	
R22	813186-97		100K	±5%	
R23	813186-93		68K		½W
R24	813188-85		33K		1W
R25	813186-91	RESISTOR	56K	±5%	½W

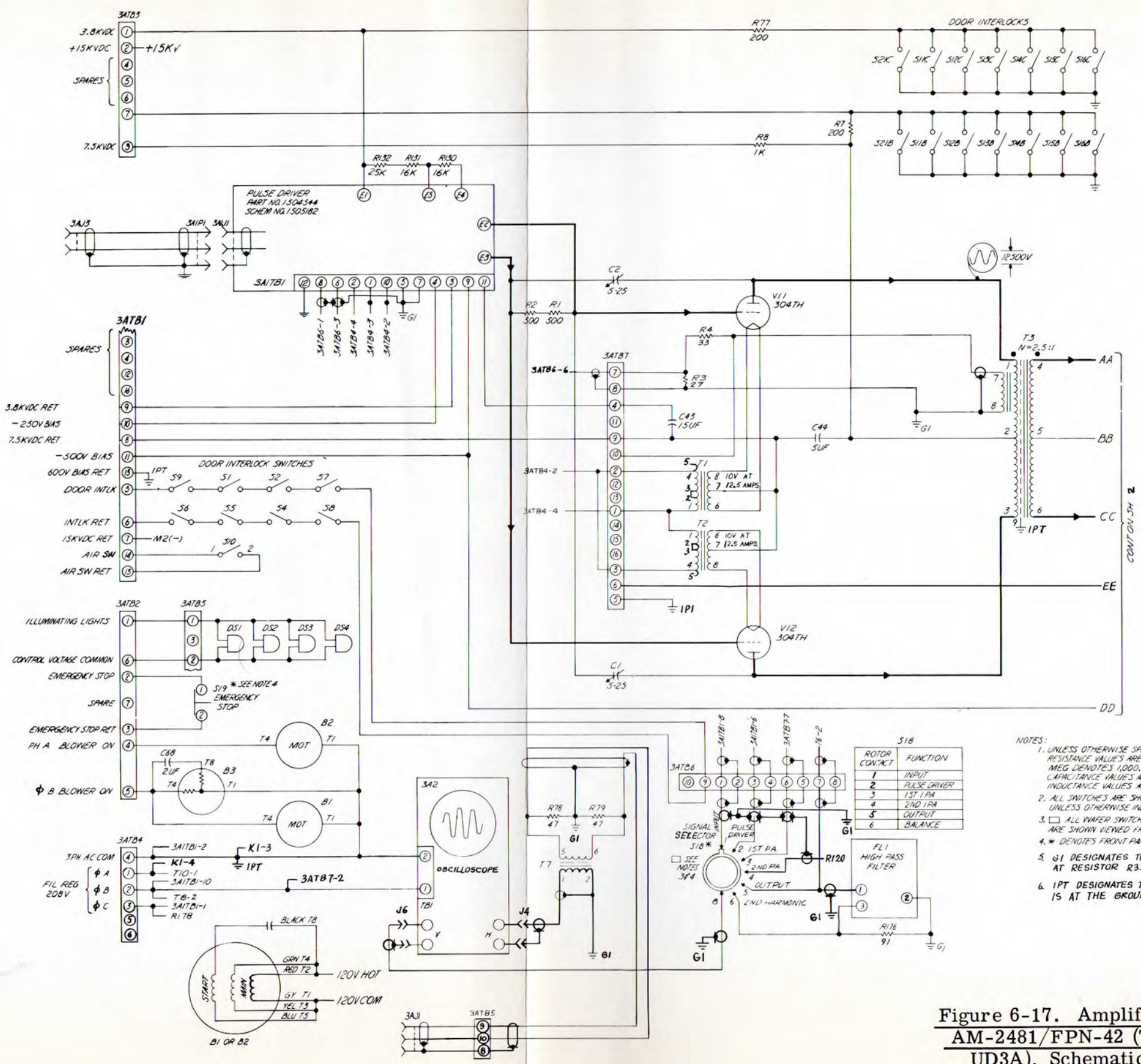
REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL.	RATING
R26	813186-73	RESISTOR	10K	±5%	½W
R27	-97		100K		
R28	-89		47K		
R29	-89		47K		
R30	-101		150K		
R31	-89		47K		
R32	-77		15K		
R33	813186-99		120K		
R34	813188-85		33K		
R35	813186-69		6.8K		
R36	813186-108		220K		½W
R37	813188-81		22K		1W
R38	813186-67		5.6K		½W
R39	-89		47K		
R40	-105		220K		
R41	-105		220K		
R42	813186-105		220K		½W
R43	813188-85		33K		1W
R44	813188-85		33K		1W
R45	813186-79		18K		½W
R46	813186-105		220K		1
R47	813186-105		220K		½W
R48	813188-97		100K		1W
R49	813188-97		100K		1W
~~R50~~	~~813186-87~~		~~33K~~		
R51	1015763-17	VAR.	5MEG		
R52	1015326-053	VAR.	500K		2W
R53	813188-49		1K		1W
R54	813186-85		39K		½W
R55	1200086	VAR.	50K		
R56	813186-73		10K		1/2W
R57	-61		3.3K		
~~R58~~	~~-97~~		~~100K~~		
R59	813186-33	RESISTOR	220	±5%	½W

REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL.	RATING
R60	813186-73	RESISTOR	10K	±5%	½W
~~R61~~	~~-31~~		~~56K~~		
R62	813186-25	RESISTOR	100	±5%	½W
R63	813186-25		100		½W
R64	813186-117		680K		½W
R65	813190-65		4.7K		2W
R66	813190-65		4.7K		2W
R67	813186-53		2.7K		½W
R68	813186-49	RESISTOR	1K	±5%	½W
S1	608876-308	SWITCH			
S2	0235-4	SWITCH			
S3	1034914-2	SWITCH			
T1	1381547	TRANSFORMER	L-54-10A		
S4	0232-1	SWITCH			
TB1	678223-10	TERMINAL BOARD			
V1	716841-1	TUBE, ELECTRON-	5814A		
V2	716857	-5726/6AL5W			
V3	716841-1	-5814A			
V4	716841-1	-5814A			
V5	716857	-5726/6AL5W			
V6	716948-1	-5725/6A6W			
V7	716841-1	-5814A			
V8	716857	-5726/6AL5W			
V9	716841-1	-5814A			
V10	716841-1	-5814A			
V11	716857	-5726/6AL5W			
V12	716841-1	TUBE, ELECTRON-	5814A		
R69	813186-113	RESISTOR	470K	±5%	½W
R70	813188-103	RESISTOR	180K	±5%	1W

REF DESIG	PART NO (FOR REF)	NAME	VALUE	TOL.	RATING
R71	813186-97	RESISTOR	100K	±5%	½W

NOTE:
1. ALL VALUES EXPRESSED IN OHMS, MICROMICROFARADS OR MICROHENRIES, UNLESS OTHERWISE INDICATED; K DENOTES 1,000 OHMS; MEG DENOTES 1,000,000 OHMS.
2. ALL RELAYS AND SWITCHES ARE SHOWN IN THE UNENERGIZED OR OFF POSITION, UNLESS OTHERWISE INDICATED.
3. THE TIME DURATION OF ALL WAVE FORMS IS EXPRESSED IN MICROSECONDS
△ INDICATES CONTROL LOCATED INSIDE
※ FRONT PANEL CONTROL
■ ALL SWITCHES AND SWITCH REFERENCE NUMBERS ARE SHOWN VIEWED FROM THE CONTROL KNOB OR FRONT END

Figure 6-16. Electrical Pulse Analyzer TS-1360/FPN-42 (Pulse Analyzer, UD2A9), Schematic Diagram



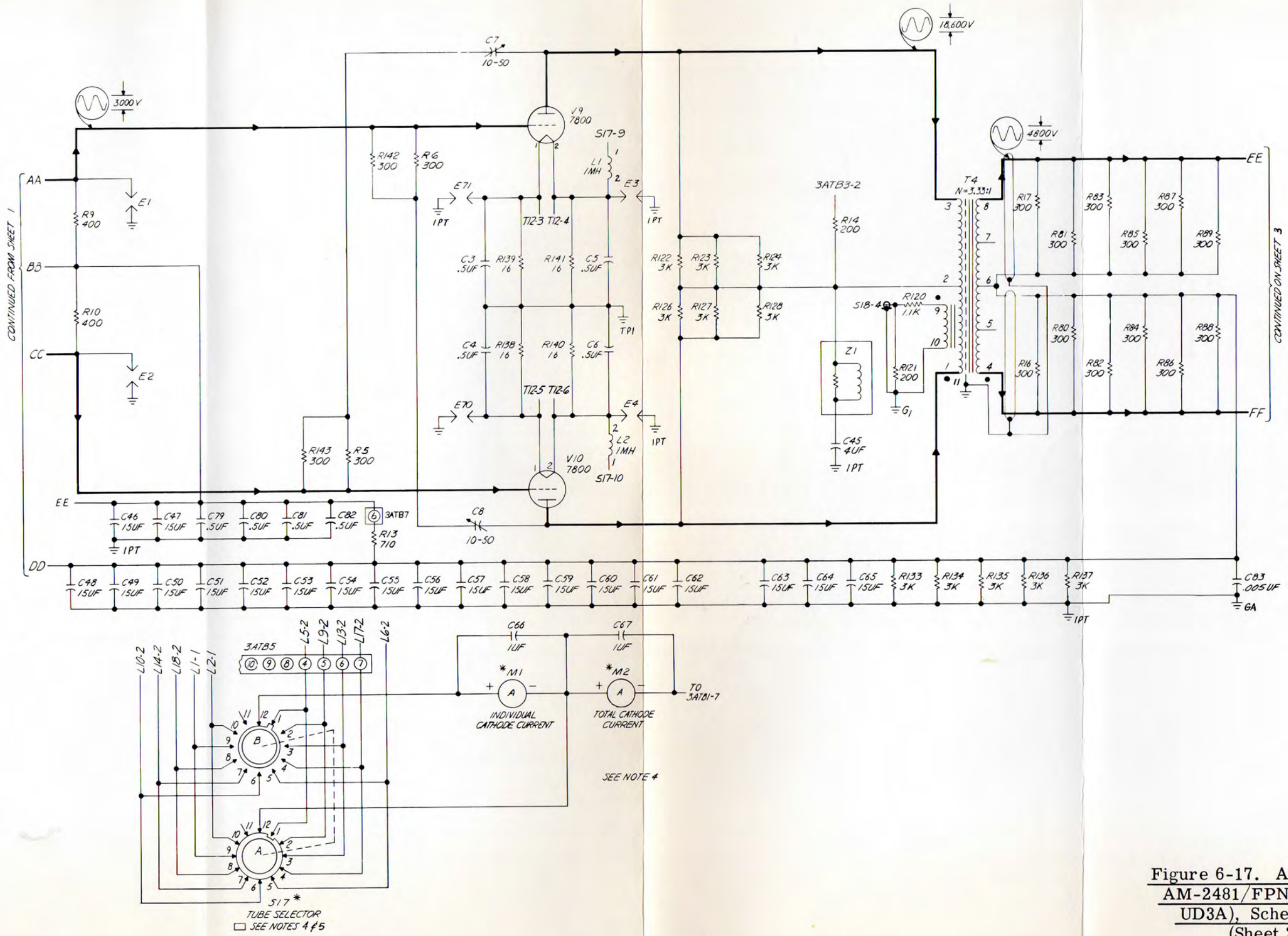
S18

ROTOR CONTACT	FUNCTION
1	INPUT
2	PULSE DRIVER
3	1ST I PA
4	2ND I PA
5	OUTPUT
6	BALANCE

NOTES:

1. UNLESS OTHERWISE SPECIFIED: RESISTANCE VALUES ARE IN OHMS. K DENOTES 1,000 OHMS. MEG DENOTES 1,000,000 OHMS. CAPACITANCE VALUES ARE IN MICROMICROFARADS. INDUCTANCE VALUES ARE IN MICROHENRIES.
2. ALL SWITCHES ARE SHOWN IN THE OFF POSITION, UNLESS OTHERWISE INDICATED.
3. ☐ ALL WAFER SWITCHES AND SWITCH REFERENCE NUMBERS ARE SHOWN VIEWED FROM THE CONTROL KNOB OR FRONT END.
4. * DENOTES FRONT PANEL CONTROL.
5. G1 DESIGNATES THAT THE GROUND POINT IS AT RESISTOR R3.
6. IPT DESIGNATES THAT THE GROUND CONNECTION IS AT THE GROUNDING BAR.

Figure 6-17. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Schematic Diagram (Sheet 1 of 4)



NOTES:

1. G1 DESIGNATES THAT THE GROUND CONNECTION IS AT RESISTOR R3.
2. GA DESIGNATES THAT THE GROUND CONNECTION IS AT TRANSFORMER T4.
3. 1PT DESIGNATES THAT THE GROUND CONNECTION IS AT THE GROUNDING BAR.
4. * DENOTES FRONT PANEL CONTROL.
5. ☐ ALL WAFER SWITCHES AND SWITCH REFERENCE NUMBERS ARE SHOWN VIEWED FROM THE CONTROL KNOB OR FRONT END.

Figure 6-17. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Schematic Diagram (Sheet 2 of 4)

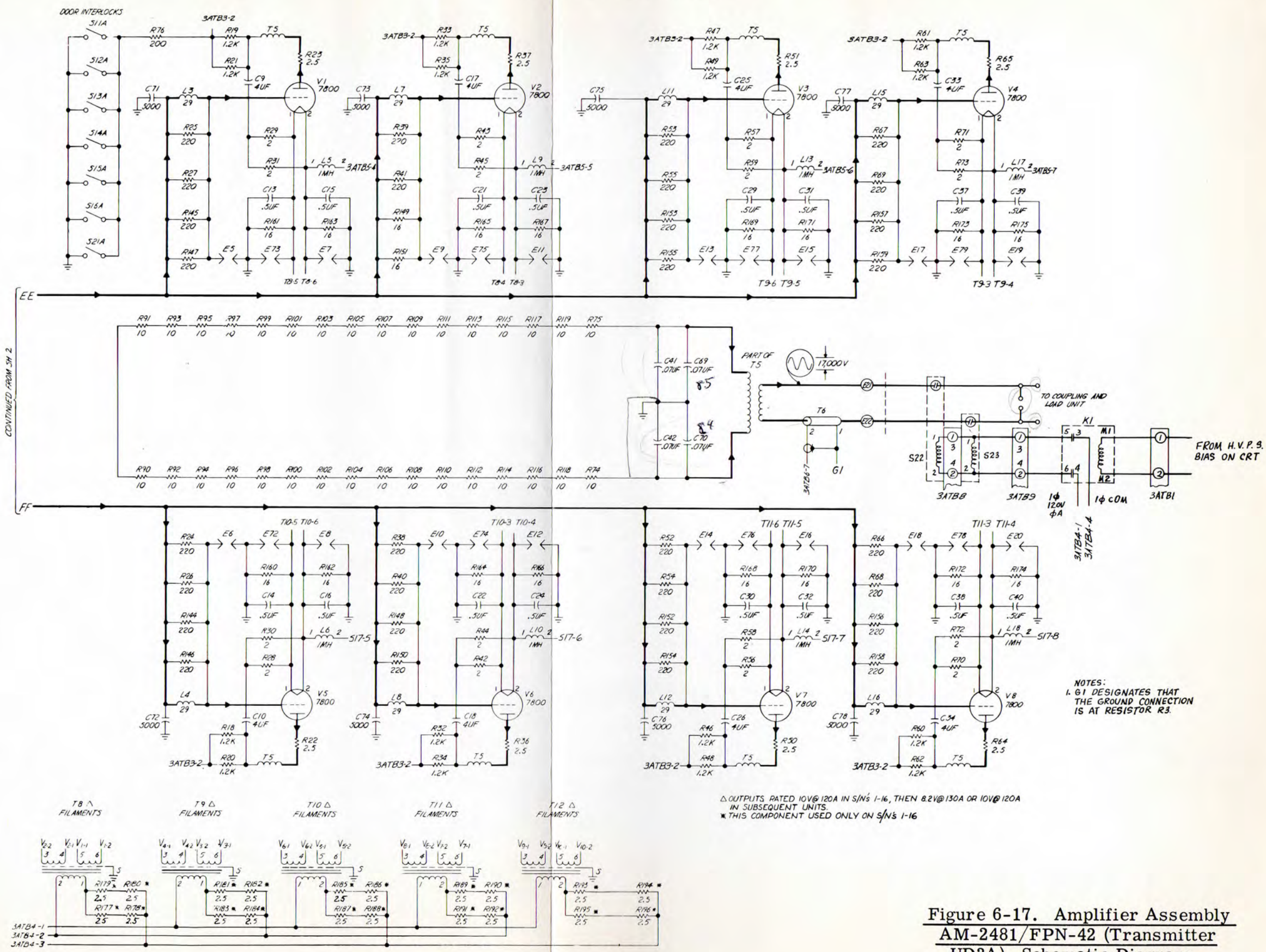


Figure 6-17. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Schematic Diagram (Sheet 3 of 4)

REF DESIG	SPERRY PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
B1		BLOWER	PART OF 1304588		
B2		BLOWER	PART OF 1304588		
B3	1305293	FAN			
C1	1382108	CAPACITOR-VAR	5-25		
C2	1382102	-VAR	5-25		
C3	1382085		.50UF		600V
C4					
C5					
C6	1382085		.50UF		600V
C7	1382082	-VAR	10-50		
C8	1382082	-VAR	10-50		
C9	1380806		4UF		16KV
C10	1380806		4UF		16KV
~~C11~~	~~1241683~~		~~50~~		~~35KV~~
~~C12~~	~~1241683~~		~~50~~		~~35KV~~
C13	1382085		.50UF		600V
C14					
C15					
C16	1382085		.50UF		600V
C17	1380806		4UF		16KV
C18	1380806		4UF		16KV
~~C19~~	~~1241683~~		~~50~~		~~35KV~~
~~C20~~	~~1241683~~		~~50~~		~~35KV~~
C21	1382085		.50UF		600V
C22					
C23					
C24	1382085		.50UF		600V
C25	1380806		4UF		16KV
C26	1380806		4UF		16KV
~~C27~~	~~1241683~~		~~50~~		~~35KV~~
~~C28~~	~~1241683~~		~~50~~		~~35KV~~
C29	1382085		.50UF		600V
C30					
C31					
C32	1382085		.50UF		600V
C33	1380806		4UF		16KV
C34	1380806		4UF		16KV
~~C35~~	~~1241683~~		~~50~~		~~35KV~~
~~C36~~	~~1241683~~		~~50~~		~~35KV~~
C37	1382085		.50UF		600V
C38					
C39					
C40	1382085		.50UF		600V
C41	1505364		.01UF	±5%	10,000VAC
C42	1505364		.01UF	±5%	10,000VAC
C43	040-31		15UF	+20-10%	1KV
C44	1382294		5UF		5KV
C45	1380806		4UF		16KV
C46	040-31		15UF	+20-10%	1KV
C47					
C48					
C49					
C50					
C51					
C52					
C53					
C54					
C55					
C56					
C57					
C58					
C59					
C60					
C61					
C62					
C63					
C64					
C65	040-31		15UF	+20-10%	1KV
C66	0645-22		1UF		100V
C67	0645-22		1UF		100V
C68	632313-427		2UF	±10%	400V
C69	1505364		.01UF	±5%	10,000VAC
C70	1505364		.01UF	±5%	10,000VAC
C71	1383203		3000	±10%	10KV
C72					
C73					
C74					
C75					
C76					
C77					
C78	1383203		3000	±10%	10KV
C79	1382085		.50UF		600V
C80					
C81					
C82	~~1382085~~		~~.50UF~~		~~600V~~
C83	1383203	CAPACITOR	.005UF		10KV

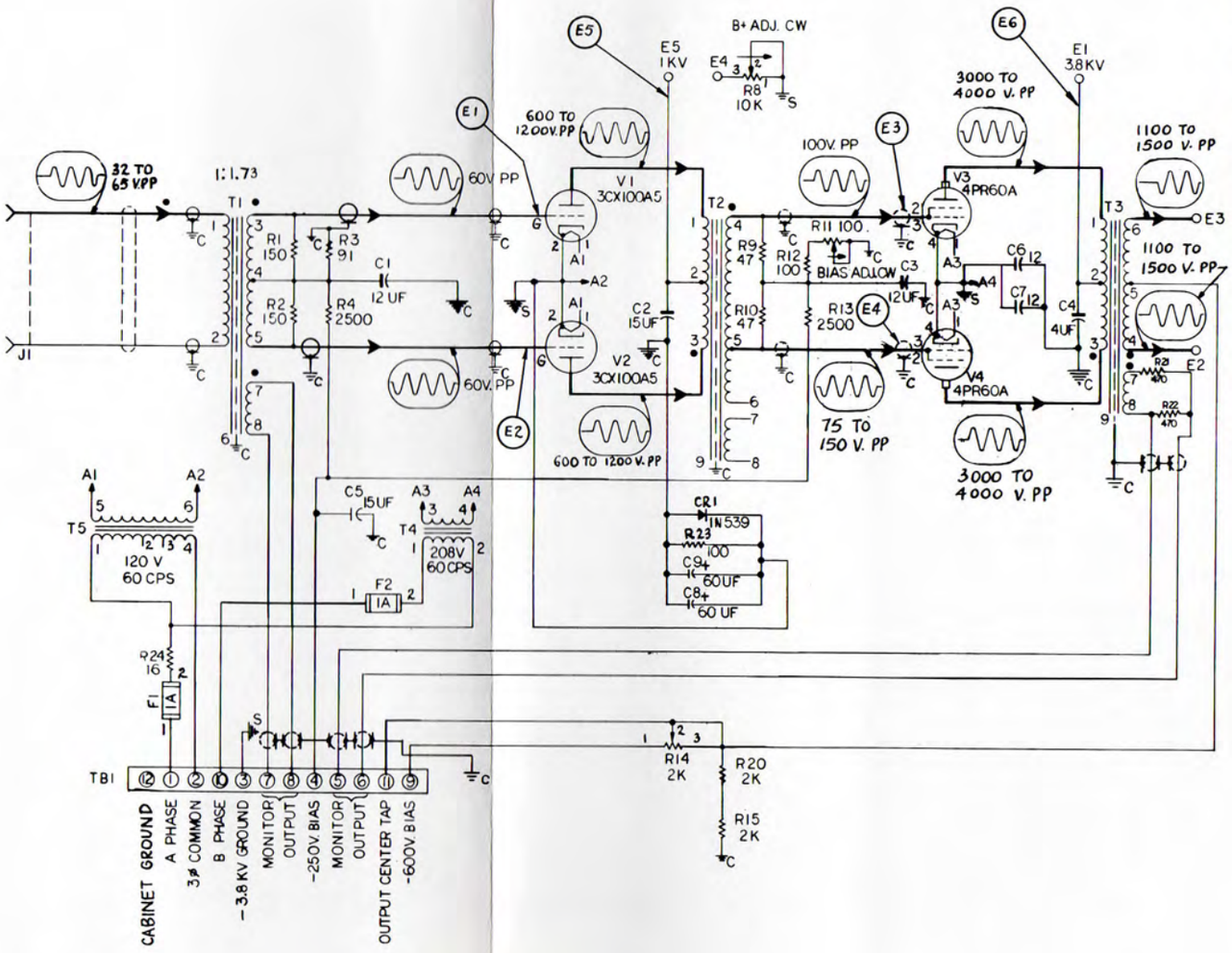
REF DESIG	SPERRY PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
DS1	1200409-7	LAMP			
DS2					
DS3					
DS4	1200409-7	LAMP			
E3	~~1382215-2~~	GAP			
E4	~~1382215-2~~	GAP			
E7	~~1382215-2~~	GAP			
E8	~~1382215-2~~	GAP			
E11	~~1382215-2~~	GAP			
E12	~~1382215-2~~	GAP			
E15	~~1382215-2~~	GAP			
E16	~~1382215-2~~	GAP			
E19	~~1382215-2~~	GAP			
E20	~~1382215-2~~	GAP			
E21	1505307	INDIVIDUAL TERMINAL INSULATOR			
E22	1505307	INDIVIDUAL TERMINAL INSULATOR			
E70	~~1382215-2~~	GAP			
E71					
E72					
E73					
E74					
E75					
E76					
E77					
E78					
E79	~~1382215-2~~	GAP			
FL1	1305700	FILTER			
J1	1200138	CONNECTOR			
J2					
J3					
J4	1200138	CONNECTOR			
L1	1382229	COIL-RF	1MH	±10%	
L2	1382229		1MH		
L3	1382111		29		
L4	1382111		29		
L5	1382229		1MH		
L6	1382229		1MH		
L7	1382111		29		
L8	1382111		29		
L9	1382229		1MH		
L10	1382229		1MH		
L11	1382111		29		
L12	1382111		29		
L13	1382229		1MH		
L14	1382229		1MH		
L15	1382111		29		
L16	1382111		29		
L17	1382229		1MH		
L18	1382229	COIL RF	1MH	±10%	
K1	1508845	RELAY			
M1	720691-27	METER			
M2	739109-05	METER			

REF DESIG	SPERRY PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
R1	0738-75	RESISTOR	500	±10%	26W
R2	0738-75		500	±10%	26W
R3	813190-11		27	±5%	2W
R4	-13		33	±5%	
R5	-36		300	±10%	
R6	813190-36		300		2W
R7	1380789-5		200		145W
R8	-2		1K		
R9	-4		400		
R10	1380789-4	RESISTOR	400	±10%	145W
R11					
R12					
R13					
R14					
R15					
R16					
R17					
R18	1380789-3	RESISTOR	710	±10%	145W
R19	1241691-1	RESISTOR	200	±10%	145W
R20					
R21	1305701-1	RESISTOR	300	±5%	300W
R22	1305701-1		300	±5%	300W
R23	1241712		1.2K	±10%	145W
R24					
R25					
R26					
R27	813190-33		220	±5%	2W
R28	1305361-1		2	±10%	80W
R29					
R30					
R31	1305361-1		2		80W
R32	1241712		1.2K		145W
R33					
R34					
R35	1241712		1.2K		
R36	1380789-6		2.5		
R37	1380789-6		2.5	±10%	145W
R38	813190-33		220	±5%	2W
R39					
R40					
R41	813190-33		220	±5%	2W
R42	1305361-1		2	±10%	80W
R43					
R44					
R45	1305361-1		2		80W
R46	1241712		1.2K		145W
R47					
R48					
R49	1241712		1.2K		
R50	1380789-6		2.5		
R51	1380789-6		2.5	±10%	145W
R52	813190-33		220	±5%	2W
R53					
R54					
R55	813190-33		220	±5%	2W
R56	1305361-1		2	±10%	80W
R57					
R58					
R59	1305361-1		2		80W
R60	1241712		1.2K		145W
R61					
R62					
R63	1241712		1.2K		
R64	1380789-6		2.5		
R65	1380789-6		2.5	±10%	145W
R66	813190-33		220	±5%	2W
R67					
R68					
R69	813190-33		220	±5%	2W
R70	1305361-1		2	±10%	80W
R71					
R72					
R73	1305361-1		2	±10%	80W
R74	1305701-2		10	±5%	300W
R75	1305701-2		10	±5%	300W
R76	1380789-5		200	±10%	145W
R77	1380789-5		200	±10%	145W
R78	813190-17		47	±5%	2W
R79	813190-17		47		2W
R80	1305701-1		300		300W
R81					
R82					
R83					
R84					
R85					
R86					
R87					
R88					
R89	-1		300		
R90	-2		10		
R91					
R92					
R93					
R94					
R95					
R96					
R97					
R98					
R99					
R100	1305701-2	RESISTOR	10	±5%	300W

REF DESIG	SPERRY PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
R101	1305701-2	RESISTOR	10	±5%	300W
R102					
R103					
R104					
R105					
R106					
R107					
R108					
R109					
R110					
R111					
R112					
R113					
R114					
R115					
R116					
R117					
R118					
R119	1305701-2		10		300W
R120	813190-32		11K		2W
R121	813190-32		220	5%	2W
R122	1380789-8		3K	±10%	145W
R123					
R124	1380789-8				
~~R125~~					
R126	1380789-8				
R127					
R128	1380789-8		3K		
~~R129~~					
R130	1200097-2		16K		
R131	-2		16K		
R132	1200097-1		25K		
R133	1380789-8		3K		
R134					
R135					
R136					
R137	1380789-8		3K		145W
R138	0738-45		16		26W
R139					
R140					
R141	0738-45		16	±10%	26W
R142	813190-36		300	±5%	2W
R143	-36		300		
R144	-32		220		
R145					
R146					
R147					
R148					
R149					
R150					
R151					
R152					
R153					
R154					
R155					
R156					
R157					
R158					
R159	813190-33		220	±5%	2W
R160	0738-45		16	±10%	26W
R161					
R162					
R163					
R164					
R165					
R166					
R167					
R168					
R169					
R170					
R171					
R172					
R173					
R174					
R175	0738-45		16	±10%	26W
R176	813190-24		91	±5%	2W
R177	1380789-6		2.5	±10%	145W
R178		RESISTOR	2.5	±10%	145W
R179					
R180	1380789-6	RESISTOR			
R181					
R182					
R183					
R184					
R185					
R186					
R187					
R188					
R189					
R190					
R191					
R192					
R193					
R194					
R195					
R196	1380789-6	RESISTOR	2.5	±10%	145W
R197	1380789-6	RESISTOR	2.5	±10%	145W

REF DESIG	SPERRY PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
S1	842511	SWITCH			
S2	842511	SWITCH			
S3	842511	SWITCH			
S4					
S5					
S6					
S7					
S8					
S9	842511				
S10	1380122				
S11	1305264				
S12					
S13					
S14					
S15					
S16	1305264				
S17	1200286				
S18	600176-207				
S19	1200641	SWITCH			
S21	1305264	SWITCH			
S22					
S23					
T1	1382063	TRANSFORMER			
T2	1382063				
T3	1305086				
T4	1382572				
T5	1305362				
T6	1305360				
T7	6062362				
T8	1382007				
T9					
T10					
T11					
T12	1380807	TRANSFORMER			
TB1	618263-16	TERMINAL BOARD			
TB2	618263-7				
TB3	760612				
TB4	763750-6				
TB5	618263-10				
TB6	618263-10				
TB7	618263-16				
TB8	618263-4				
TB9	618263-4	TERMINAL BOARD			
V1	1383262	TUBE-ELECTRON 7800			
V2					
V3					
V4					
V5					
V6					
V7					
V8					
V9					
V10	1383268	7800			
V11	1383269	3KT0			
V12	1383157	TUBE-ELECTRON 30GTA			
Z1	1382631	SURGE LIMITER			

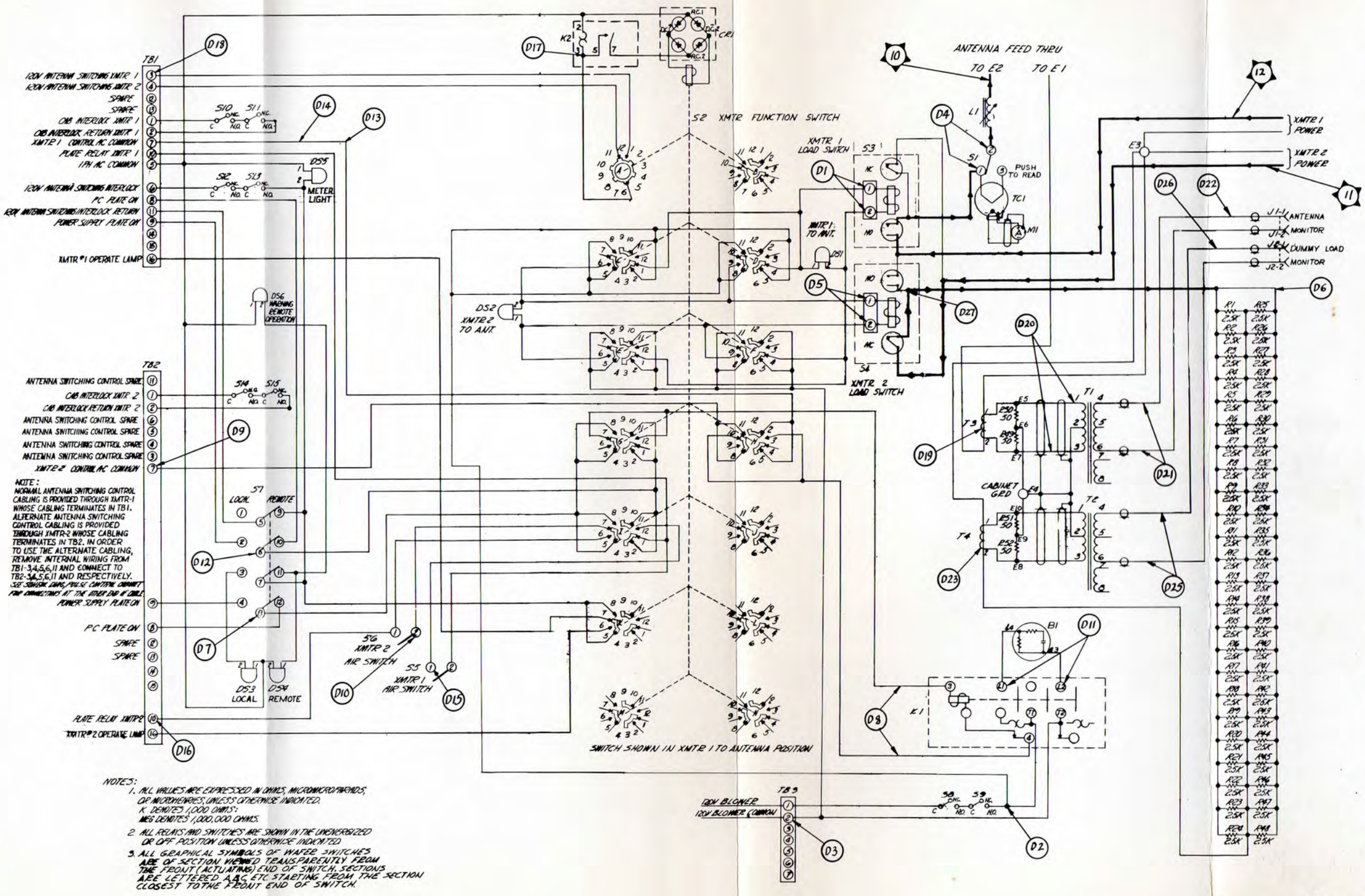
Figure 6-17. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Schematic Diagram (Sheet 4 of 4)



REF DESIG	PART NO. (FOR REF)	NAME	VALUE	TOL.	RATING
C1	626942-234	CAPACITOR	12UF	±10%	200VDC
C2	040-31		15UF	±20%	1KV DC
C3	626942-234		12UF	±10%	200VDC
C4	706711		4UF	±10%	4KV DC
C5	040-31		15UF	±20%	1KV DC
C6	626942-234		12UF	±10%	200VDC
C7	626942-234		12UF	±10%	200VDC
C8	617625-51		60UF	±10%	50VDC
C9	617625-51	CAPACITOR	60UF	±10%	50VDC
J1	1200138	CONNECTOR			
R1	813190-29	RESISTOR	150	±5%	2W
R2	813190-29		150		2W
R3	813190-24		91		2W
R4	0739-89		2000	±5%	55W
R8	601541-028	-VAR	10K	±10%	75W
R9	813190-17		47	±5%	2W
R10	813190-17		47	±5%	
R11	625713-181	-VAR	100	±20%	
R12	813190-25		100	±5%	2W
R13	0739-89		2500		55W
R14	712804-08	-VAR	2K		25W
R15	0738-87		2K		25W
R20	0738-87		2K		25W
R21	813190-41		470		2W
R22	813190-41		470	±5%	2W
R23	813190-25		100	±5%	2W
R24	0737-45	RESISTOR	16	±5%	14W
T1	1380836	TRANSFORMER			
T2	1380337				
T3	1383171				
T4	1380838				
T5	1381546	TRANSFORMER			
TB1	618223-12	TERMINAL BOARD			
V1	632298	TUBE-ELECTRON	3CX100A5		
V2	632298		3CX100A5		
V3	600198-1		4PR60A		
V4	600198-1	TUBE-ELECTRON	4PR60A		
F1	632337-9	FUSE	1A		
F2	632337-9	FUSE	1A		
CR1	1200139	DIODE (IN 539)			

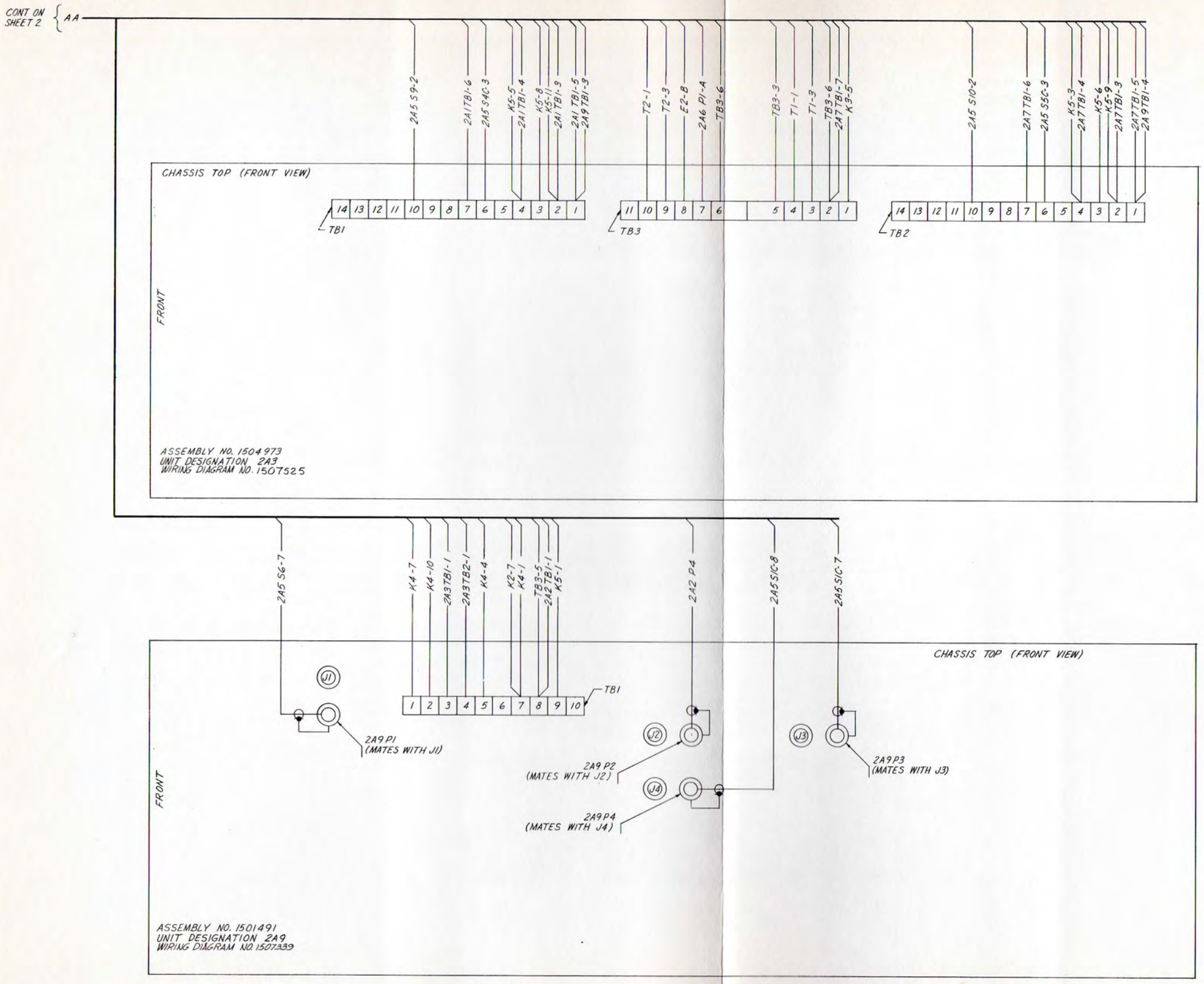
NOTES:
1. ALL VALUES ARE EXPRESSED IN OHMS, MICROMICROFARADS OR MICROHENRIES UNLESS OTHERWISE INDICATED
K DENOTES 1,000 OHMS
MEG DENOTES 1,000,000 OHMS.
2. C DESIGNATES THAT THE GROUND CONNECTIONS ARE COMMON.

Figure 6-18. Pulse Driver UD3A1, Schematic Diagram



REF DESIG	PART NO. (FOR REF)	NAME	VALUE	TOL	RATING
B1	1300800	BLOWER			
CR1	1310801	RECTIFIER			
DS1	1200409-8	LAMP			
DS2	-2				
DS3	-1				
DS4	-3				
DS5	-7				
DS6	1200409-1	LAMP			
C3	0532-25	STAND OFF			
C4	0433-363	SCREW			
J1	1200138	CONNECTOR			
J2	1200136	CONNECTOR			
K1	1200119	RELAY			
K2	1241476	RELAY			
L1	1503363	INDUCTOR			
M1	1304638	METER			
R1	1310789-1	RESISTOR	2.5K	±5%	145W
R2					
R3					
R4					
R5					
R6					
R7					
R8					
R9					
R10					
R11					
R12					
R13					
R14					
R15					
R16					
R17					
R18					
R19					
R20					
R21					
R22					
R23					
R24					
R25					
R26					
R27					
R28					
R29					
R30					
R31					
R32					
R33					
R34					
R35					
R36					
R37					
R38					
R39					
R40					
R41					
R42					
R43					
R44					
R45					
R46					
R47					
R48	1310789-1		2.5K	±5%	145W
R49	727241-55		50	±5%	3W
R50					
R51					
R52	727241-55	RESISTOR	50	±5%	3W
S1	1505323	SWITCH			
S2	1310820				
S3	1310820				
S4	1310820				
S5	1310772				
S6	1310772				
S7	1034516-2				
S8	845311				
S9					
S10					
S11					
S12					
S13					
S14					
S15	845311	SWITCH			
T1	1311774	TRANSFORMER			
T2	1311774				
T3	1310072				
T4	1310072	TRANSFORMER			
TB1	6112063-16	TERMINAL BOARD			
TB2	6112063-18	TERMINAL BOARD			
TB3	6112063-7	TERMINAL BOARD			
TC1	1304638	THERMOCOUPLE			

Figure 6-19. Antenna Coupler CU-807/FPN-42 (Coupling and Load Unit, UD4A), Schematic Diagram



REFERENCE DRAWINGS:
ASSEMBLY OF PULSE CONTROL — DWG NO. 1504535
SCHEMATIC DIAGRAM — DWG NO. 1505210

NOTES:
1. SOLDER ALL CONNECTIONS WITH 60-40 SOLDER AND ROSIN FLUX PER MIL-F-19040B.
2. WIRE PER SPEC MIL-W-5086B.

Figure 6-20. Transmitter Control Group OA-2631/FPN-42 (Pulse Control Unit, UD2A), Wiring Diagram (Sheet 1 of 5)

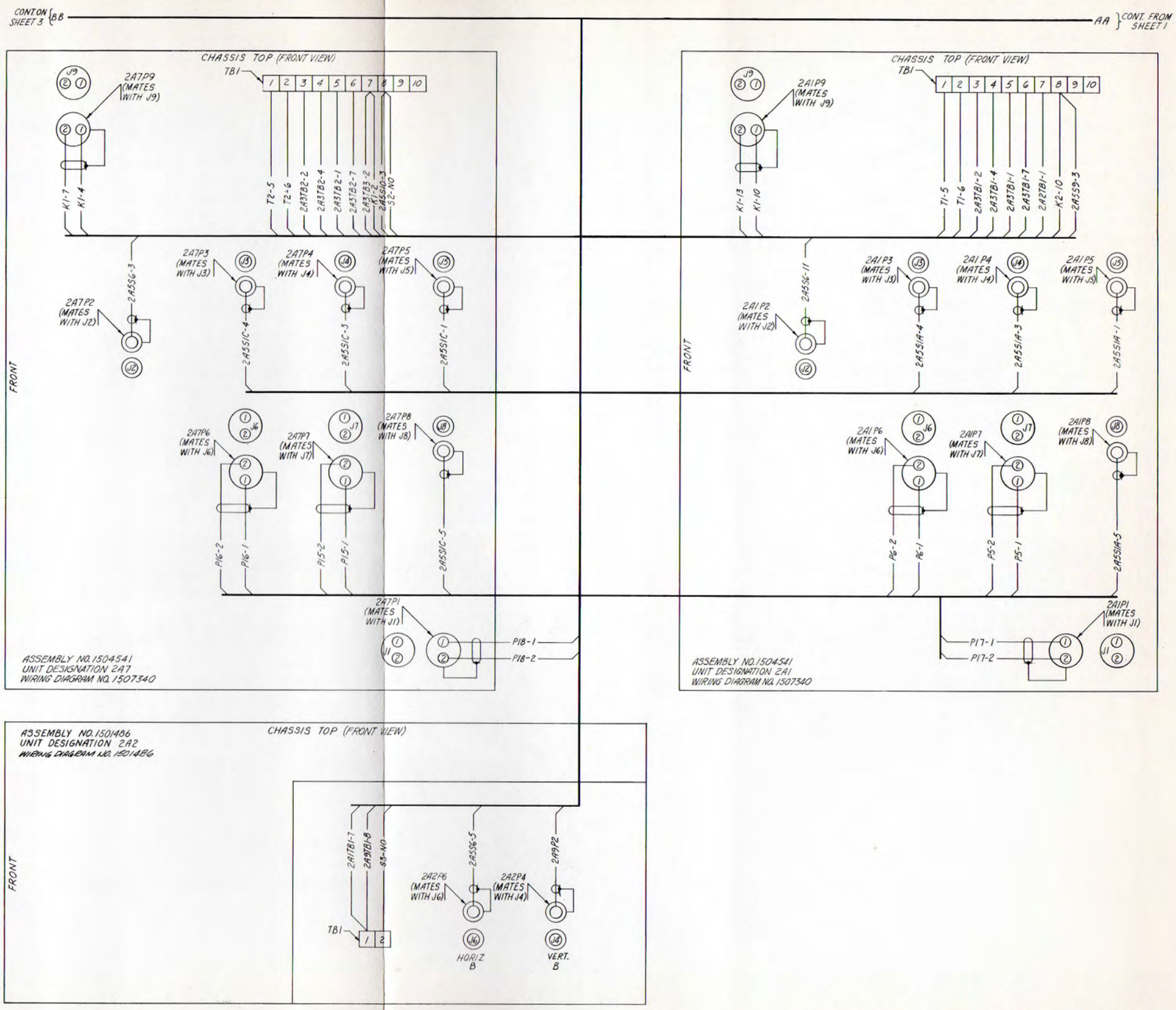


Figure 6-20. Transmitter Control Group OA-2631/FPN-42 (Pulse Control Unit, UD2A), Wiring Diagram (Sheet 2 of 5)

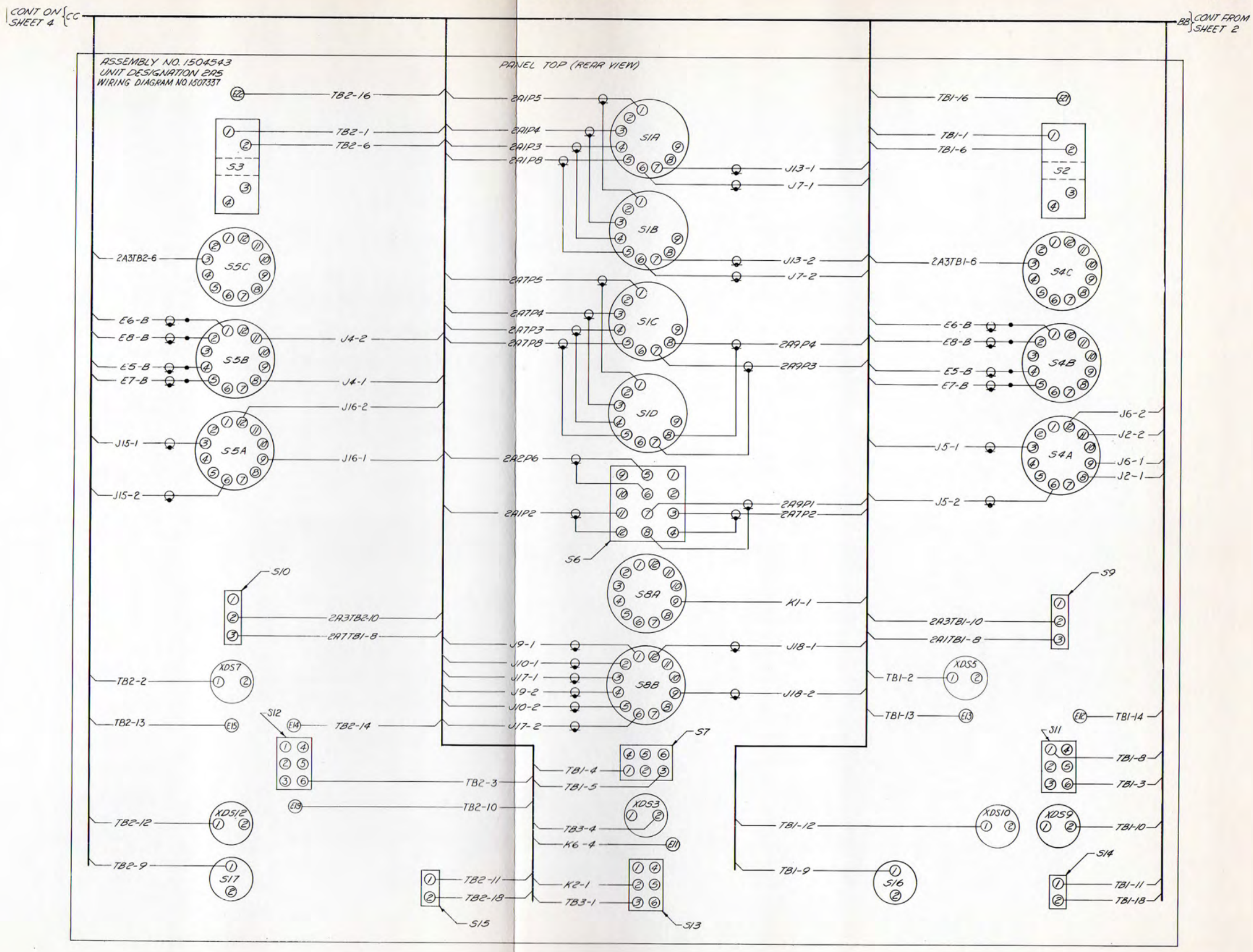


Figure 6-20. Transmitter Control Group OA-2631/FPN-42 (Pulse Control Unit, UD2A), Wiring Diagram (Sheet 3 of 5)

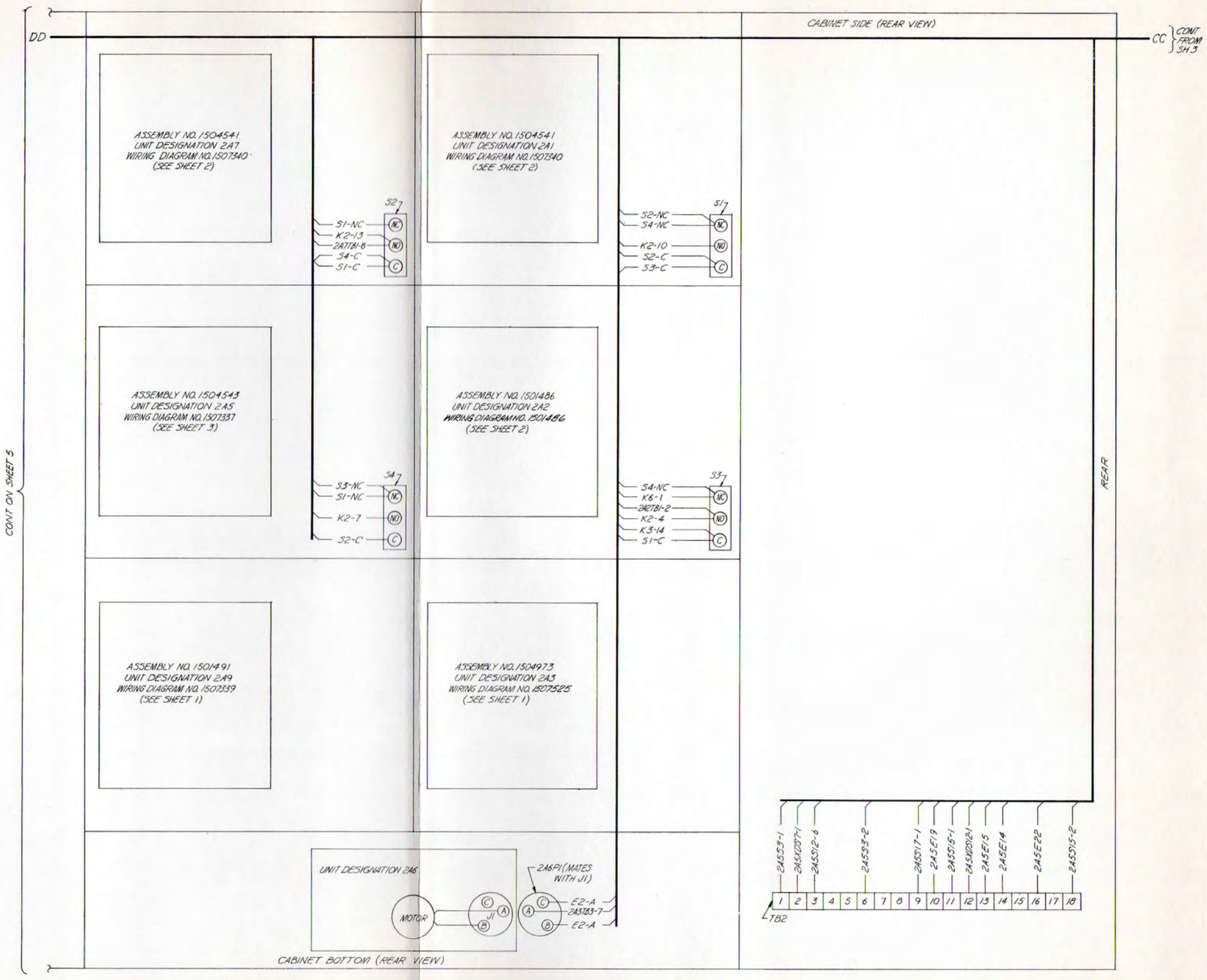


Figure 6-20. Transmitter Control Group OA-2631/FPN-42 (Pulse Control Unit, UD2A), Wiring Diagram (Sheet 4 of 5)

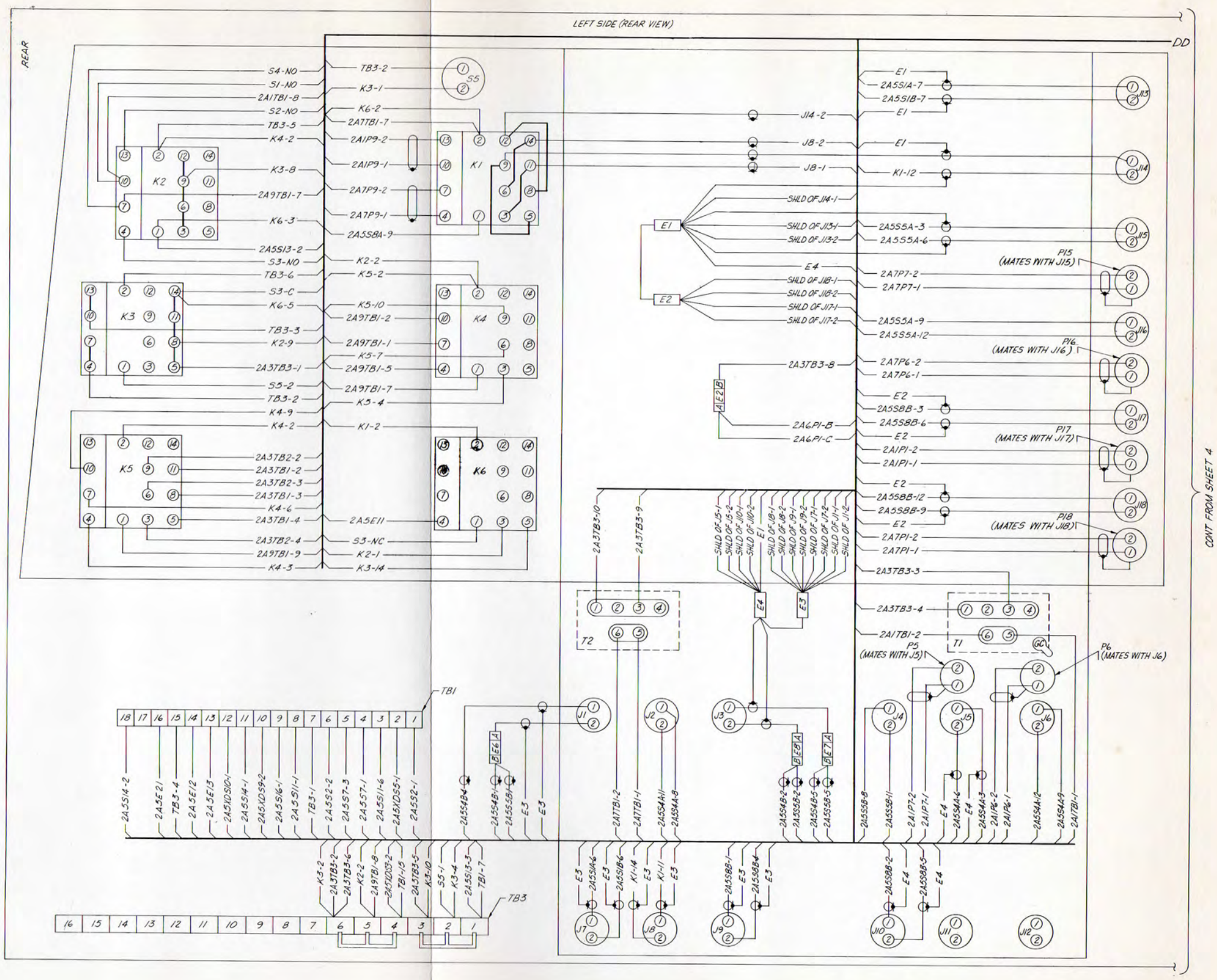
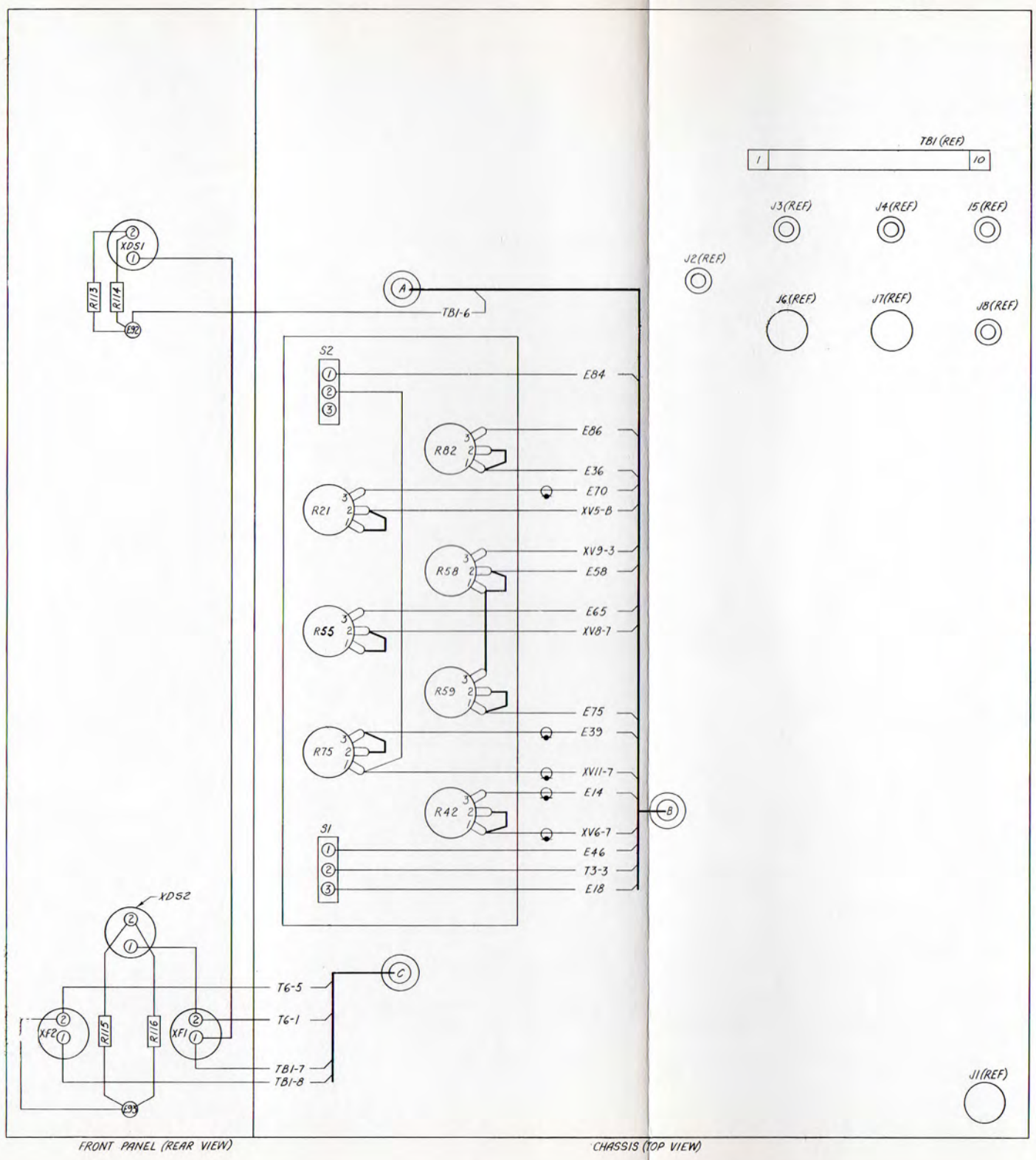


Figure 6-20. Transmitter Control Group OA-2631/FPN-42 (Pulse Control Unit, UD2A), Wiring Diagram (Sheet 5 of 5)



COMPONENT LOCATION	
REF DESIG	ZONE
C1	40I
C3	37H
C4	26H
C5	23I
C6	24I
C7	23I
C8	32F
C9	32F
C10	34E
C11	38E
C12	39E
C13	23G
C14	24G
C15	21H
C16	23F
C17	23G
C18	40E
C19	26F
C20	26G
C21	24F
C22	22E
C23	20D
C24	34E
C25	20F
C26	20H
C27	20H
C28	18C
C29	19C
C30	21C
C31	23D
C32	23B
C34	36D
C35	19F
C36	24F
C37	20D
C38	20C
C39	31J
C40	33G
C41	32F
C42	34I
C43	42C
C44	38D
C45	25F
C46	37F
C47	39G
CR1	32H
CR2	32H
CR3	32G
CR4	32H
CR5	41E
CR6	41D
CR7	24F
CR8	41F
CR10	24H
DL1	42E
E1	34J
E2	39G
E3	38G
E4	39F
E5	38G
E6	33H
E7	32H
E8	33H
E9	32G
E10	32F
E11	34F
E12	35F
E13	39F
E14	36F
E15	37F
E16	36E
E17	38F
E18	40E
E19	40E
E20	35E
E21	39E
E22	40E
E23	39C
E24	17B
E25	19B
E26	17C
E27	24C

COMPONENT LOCATION	
REF DESIG	ZONE
E28	18C
E29	19C
E30	20C
E31	20C
E32	21C
E33	25C
E34	24D
E35	24D
E36	21E
E37	22E
E38	27E
E39	20E
E40	21E
E41	22E
E42	23E
E43	24E
E44	26E
E45	20F
E46	23F
E47	27F
E48	19G
E49	23F
E50	26F
E51	27F
E52	21G
E53	22G
E54	27G
E55	23H
E56	27H
E57	21H
E58	19H
E59	22H
E60	25H
E61	27H
E62	20H
E63	24H
E64	21I
E65	22I
E66	21I
E67	22I
E68	23I
E69	21J
E70	22J
E71	24J
E72	27J
E73	31J
E74	32C
E75	18D
E76	32D
E77	33C
E78	35C
E79	39C
E80	39C
E81	39D
E82	40D
E83	35C
E84	18E
E85	37F
E86	24D
E87	20F
E88	21F
E89	27I
E90	40F
E91	40D
E92	14I
E93	14B
E94	32H
E95	31G
E96	33G
E97	40F
E98	34F
E99	33G
E100	31F
E101	24F
E102	20J
E103	20I
E104	35E
E105	25J
E106	27E
E107	33F
E108	23H
E109	24F
E110	33C
E111	37H
E112	38F
E113	38F
E114	39F
FL1	35G
J1	42C
J2	38J

COMPONENT LOCATION	
REF DESIG	ZONE
J3	39J
J4	40J
J5	42J
J6	39I
J7	40I
J8	42I
J9	36K
L1	35J
R5	38G
R6	36G
R7	37G
R8	38G
R9	37H
R10	38G
R11	35G
R12	35H
R13	32H
R14	26G
R15	26I
R16	26I
R17	25I
R18	25I
R19	24I
R20	23I
R21	12G
R22	23J
R23	21J
R24	21I
R25	21J
R26	20I
R27	20I
R28	20I
R29	20I
R30	21J
R31	33G
R33	34G
R34	27H
R35	27G
R37	39E
R38	37E
R39	39E
R40	36E
R41	36E
R42	11E
R43	36F
R44	38E
R45	33E
R46	33E
R47	34F
R48	42E
R49	25H
R50	24H
R51	25H
R52	21H
R53	23H
R54	24H
R55	12F
R56	23I
R57	19G
R58	11G
R59	11F
R60	18C
R61	21G
R62	23G
R63	23G
R64	21G
R65	21G
R66	27E
R67	26E
R68	27E
R69	24E
R70	24C
R71	25E
R72	25E
R73	24E
R74	22E
R75	12E
R76	20E
R77	20E
R78	21E
R79	18B
R80	24D
R81	33C
R82	11H
R83	18C

COMPONENT LOCATION	
REF DESIG	ZONE
R84	18C
R85	19B
R86	18C
R87	24F
R88	19C
R89	21C
R90	24D
R91	33D
R92	19C
R93	19C
R94	34F
R95	20C
R96	39D
R99	42H
R100	34D
R101	32C
R102	38D
R103	38C
R104	35D
R105	33C
R106	39D
R107	39C
R109	40G
R110	40G
R111	22F
R113	14I
R114	14I
R115	14C
R116	13C
R117	41E
R118	20J
R119	20J
R120	39D
R121	25F
R122	40F
R123	34E
R124	33F
R125	39D
R126	38F
R127	39G
S1	12D
S2	12H
T1	41G
T2	42F
T3	18F
T4	25D
T5	42C
T6	21C
T7	32J
TB1	40J
XDS1	14I
XDS2	14D
XF1	13C
XF2	14C
XV1	40G
XV2	36G
XV3	25I
XV4	21J
XV5	19I
XV6	38E
XV7	34E
XV8	24G
XV9	20G
XV10	26E
XV11	21E
XV12	18C
XV13	20D
XV14	22C
XV15	35D
XV16	32C
XV17	39D
XV18	37C

REFERENCE DRAWINGS:
ASSEMBLY OF PULSE GENERATOR — DWG NO. 1504541
SCHEMATIC DIAGRAM — DWG NO. 1504966

NOTES:
1. SOLDER ALL CONNECTIONS WITH 60-40 SOLDER AND ROSIN FLUX PER M690452.
2. WIRE PER SPEC M695062.

Figure 6-21. Pulse Generator 0-706/FPN-42 (Pulse Generator, UD2A1 or UD2A7), Wiring Diagram (Sheet 1 of 3)

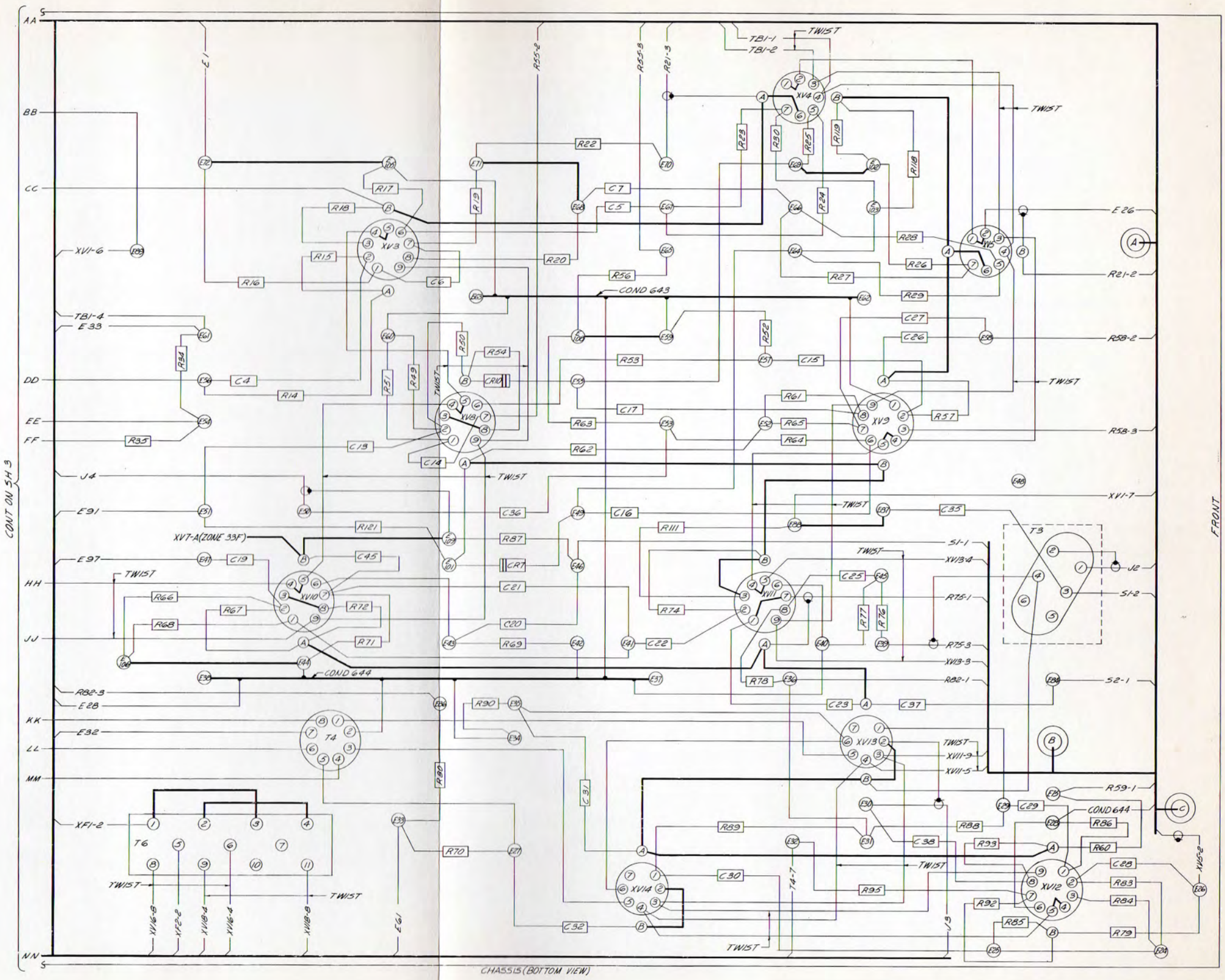


Figure 6-21. Pulse Generator 0-706/FPN-42 (Pulse Generator, UD2A1 or UD2A7), Wiring Diagram (Sheet 2 of 3)

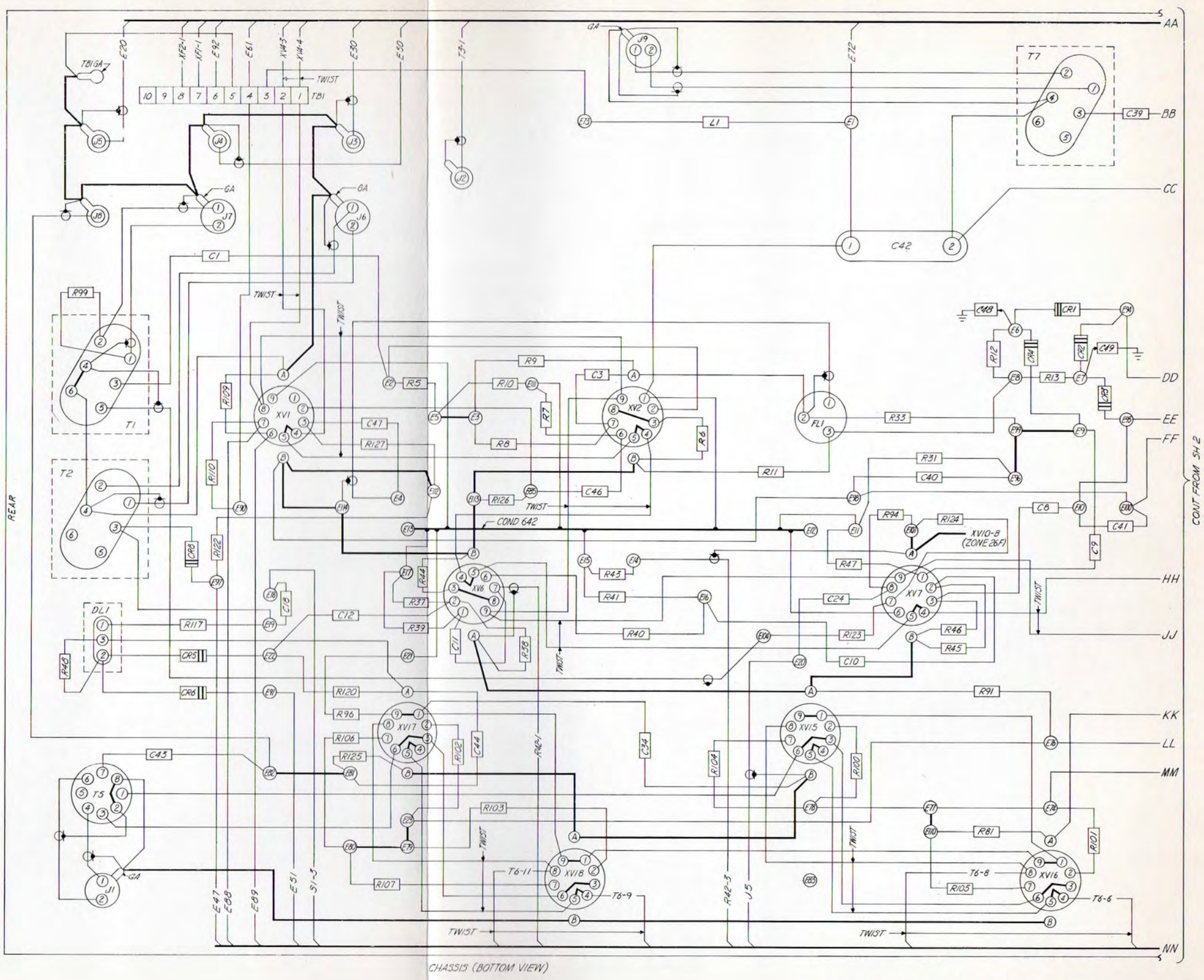


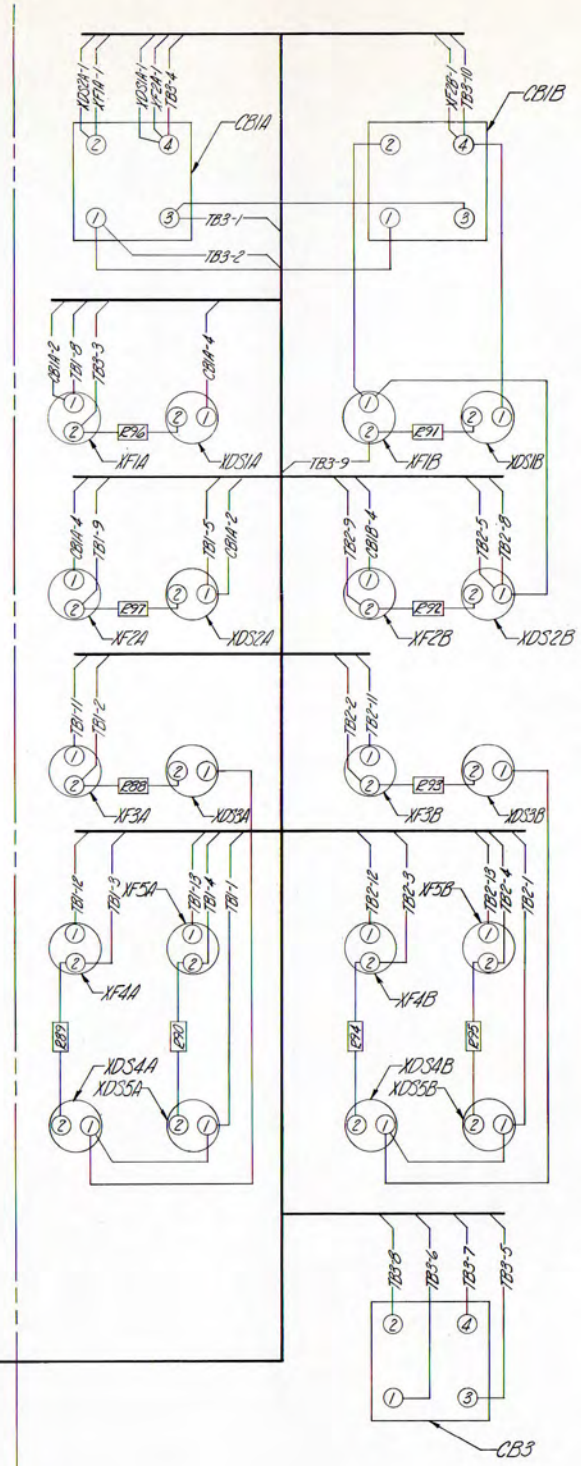
Figure 6-21. Pulse Generator 0-706/FPN-42 (Pulse Generator, UD2A1 or UD2A7), Wiring Diagram (Sheet 3 of 3)

COMPONENT LOCATION	
REF DESIG	ZONE
A1	28K
A2	23E
A3	20H
A4	36D
A5	36F
C14	6I
C15	6I
C16	6H
C17	6H
C18	41E
C19	41E
C20	6H
C21	40E
C22	39E
C23	6H
C24	42E
C25	21F
CB1A	6E
CB1B	6E
CB3	4D
C81	41G
C82	40G
C83	40F
C84	41F
C85	41F
C86	40F
C87	40F
C88	41F
C89	37E
C810	38E
C811	37G
C812	39F
C813	39G
C814	38G
C815	38F
C816	37F
C817	38D
C818	37D
C819	38D
C820	37F
C821	39F
C822	39F
C823	38F
C824	38F
C825	37F
C826	38E

COMPONENT LOCATION	
REF DESIG	ZONE
K1	34J
L1	33J
L2	18C
E8	28H
E4	28J
E5	25K
E6	25K
E7	25J
E8	28I
E9	25J
E11	21J
E12	24K
E13	24K
E14	21J
E15	24J
E16	24J
E19	22I
E20	24J
E21	21I
E23	25I
E24	24I
E25	28D
E26	25J
E27	25I
E28	25I
E29	28D
E30	25H
E31	25H
E32	24I
E33	24I
E34	25F
E35	25F
E36	25E
E37	25G
E39	25F
E41	24H
E42	28E
E43	25H
E44	28E
E45	25E
E46	24H
E47	24H
E48	21D
E51	21D

COMPONENT LOCATION	
REF DESIG	ZONE
E52	24G
E53	24G
E54	22G
E55	24F
E56	24F
E57	24G
E59	24E
E60	25G
E61	24D
E62	24E
E63	25D
E66	24D
E67	24D
E69	27C
E70	28B
E71	28C
E72	24J
E73	32B
E74	32I
E75	32B
E76	39I
E77	18E
E78	34E
E79	37E
E80	18E
E81	28E
E82	27K
E83	18J
E84	18J
E85	23K
E86	40I
E87	42E
E88	6G
E89	6E
E90	5E
E91	6I
E92	4H
E93	4G
E94	4E
E95	4E
E96	6I
E97	6H
E98	18E
E99	28E
T1	15F
T2	18J
TB1	8C
TB2	13C
TB3	11C

COMPONENT LOCATION	
REF DESIG	ZONE
XC1	32B
XC2	32H
XC3	33B
XC4	33H
XC5	33B
XC6	33H
XC7	36B
XC8	36H
XC9	39B
XC10	39H
XC11	42B
XC12	42H
XC13	42J
XDS1A	5I
XDS1B	4I
XDS2A	5H
XDS2B	4H
XDS3A	5G
XDS3B	4G
XDS4A	6E
XDS4B	4E
XDS5A	5E
XDS5B	4E
XF1A	6I
XF1B	4I
XF2A	6H
XF2B	4H
XF3A	6G
XF3B	4G
XF4A	6F
XF4B	4F
XF5A	5F
XF5B	4F
XV1	25J
XV2	22J
XV3	27H
XV4	23H
XV5	21G
XV6	29D
XV7	23F
XV8	27F
XV9	21B
XV10	21E
XV11	22D
XV12	23B
XV13	27B
XV14	35J
XV15	37J



REFERENCE DRAWINGS:
ASSEMBLY OF DUAL POWER SUPPLY DWG NO. 1504973
SCHEMATIC DIAGRAM DWG NO. 1507282

NOTES:
1. SOLDER PER MIL90452
2. WIRE PER MIL25062

POWER SUPPLY #1 (FOR REF)
IDENTICAL TO POWER SUPPLY #2

POWER SUPPLY #2 (FOR REF)
SEE SHEETS 2 AND 3 FOR WIRING

TB2 TOP WIRING IDENTICAL TO TB1

SEE SHEETS 2 AND 3 FOR WIRING

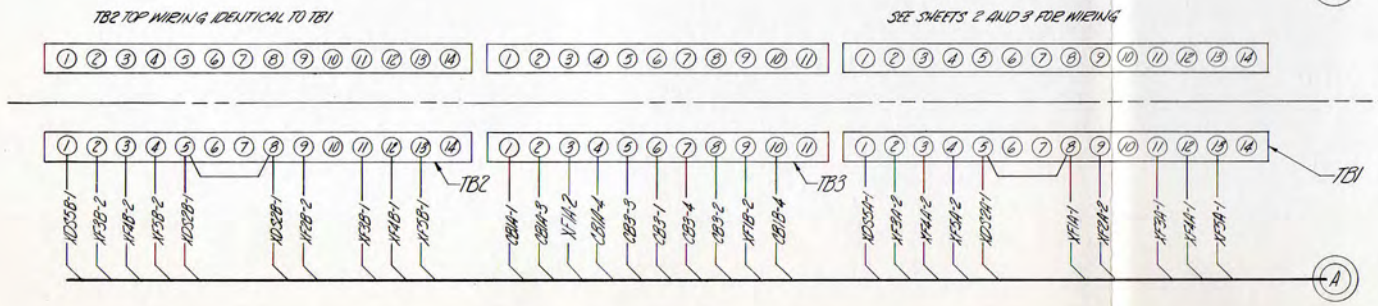


Figure 6-22. Power Supply Assembly PP-2541/FPN-42 (Dual Power Supply, UD2A3), Wiring Diagram (Sheet 1 of 3)

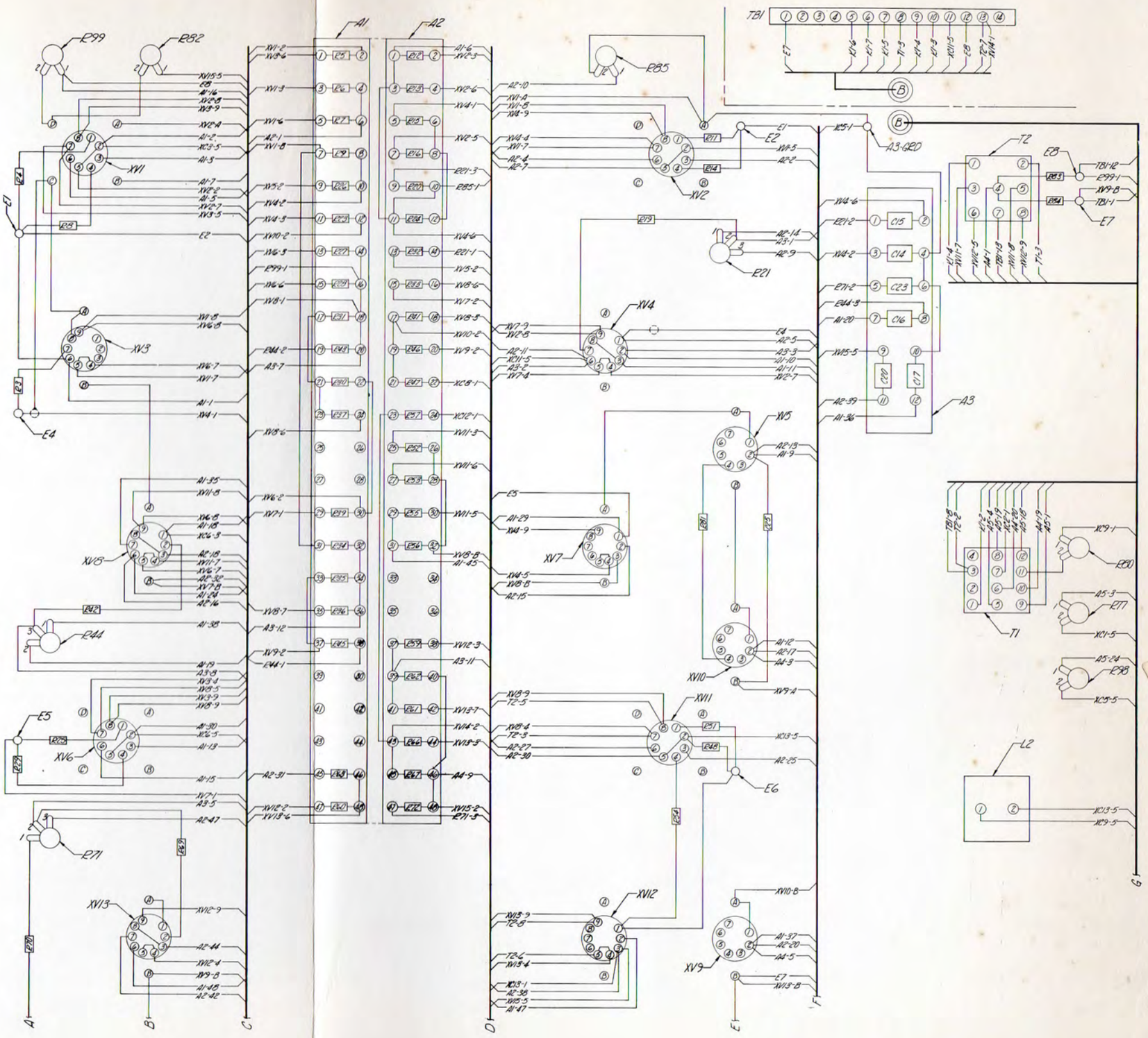


Figure 6-22. Power Supply Assembly PP-2541/FPN-42 (Dual Power Supply, UD2A3), Wiring Diagram (Sheet 2 of 3)

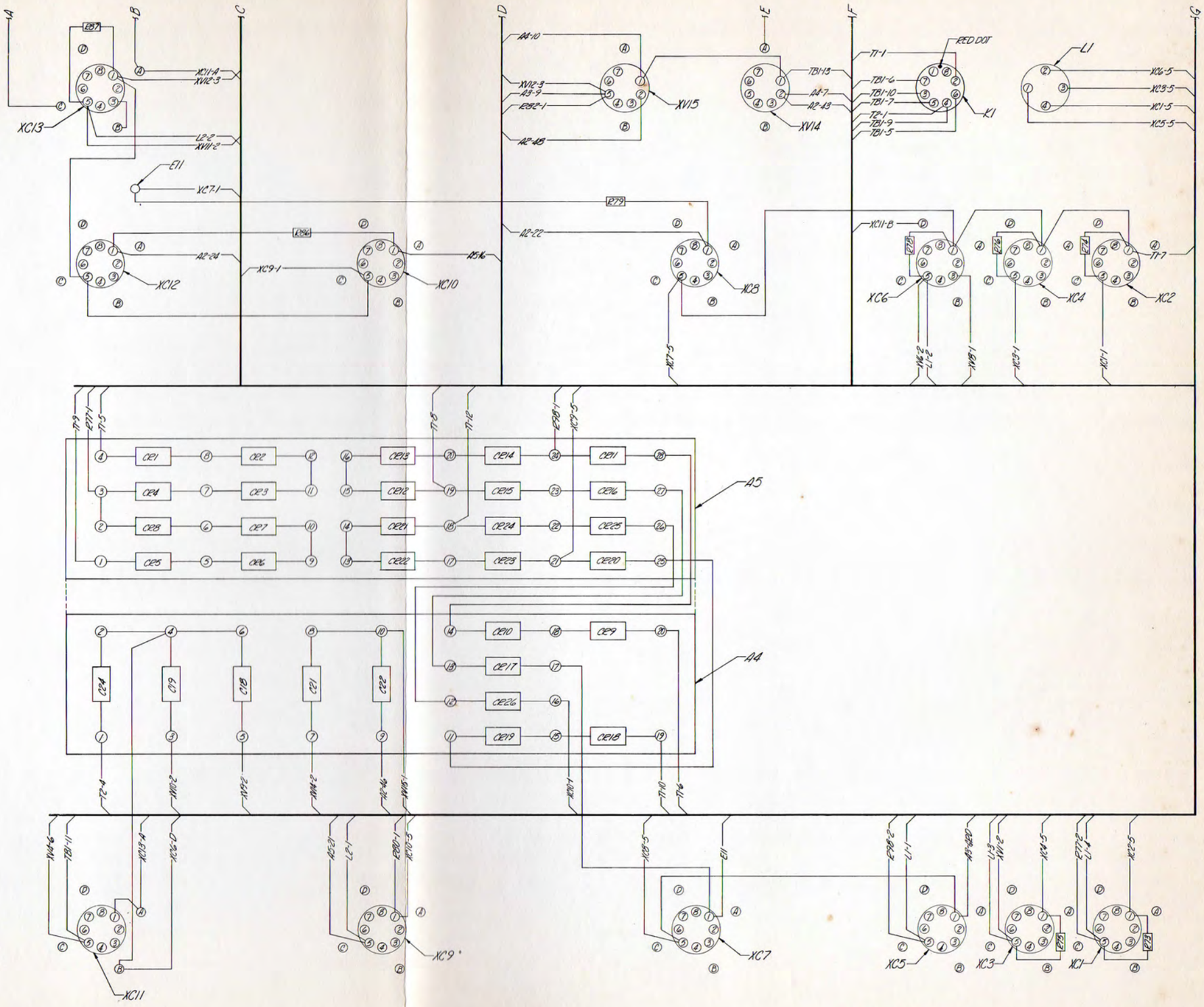


Figure 6-22. Power Supply Assembly PP-2541/FPN-42 (Dual Power Supply, UD2A3), Wiring Diagram (Sheet 3 of 3)

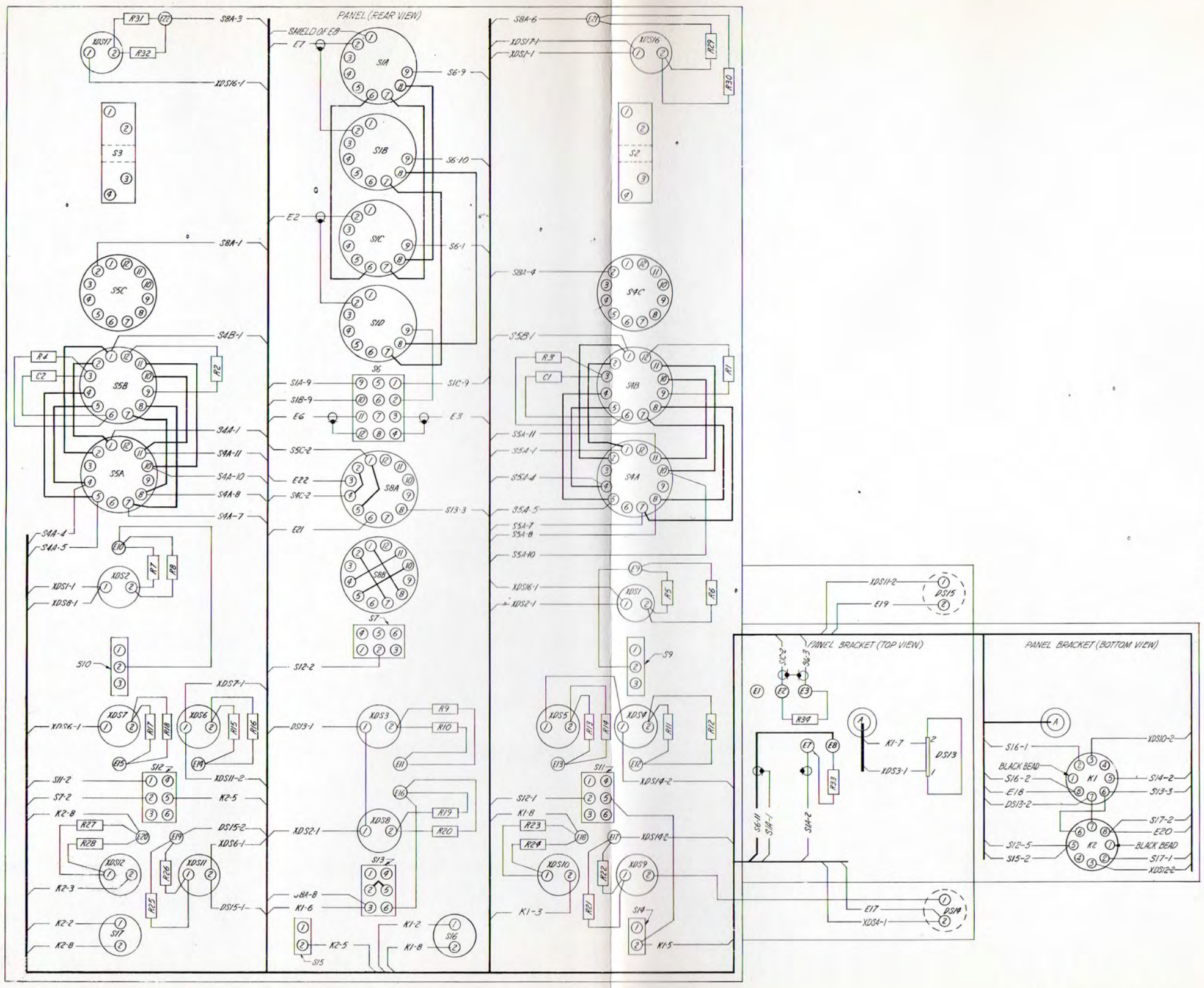


Figure 6-23. Transmitter Control Group OA-2631/FPN-42, Control Panel, Wiring Diagram

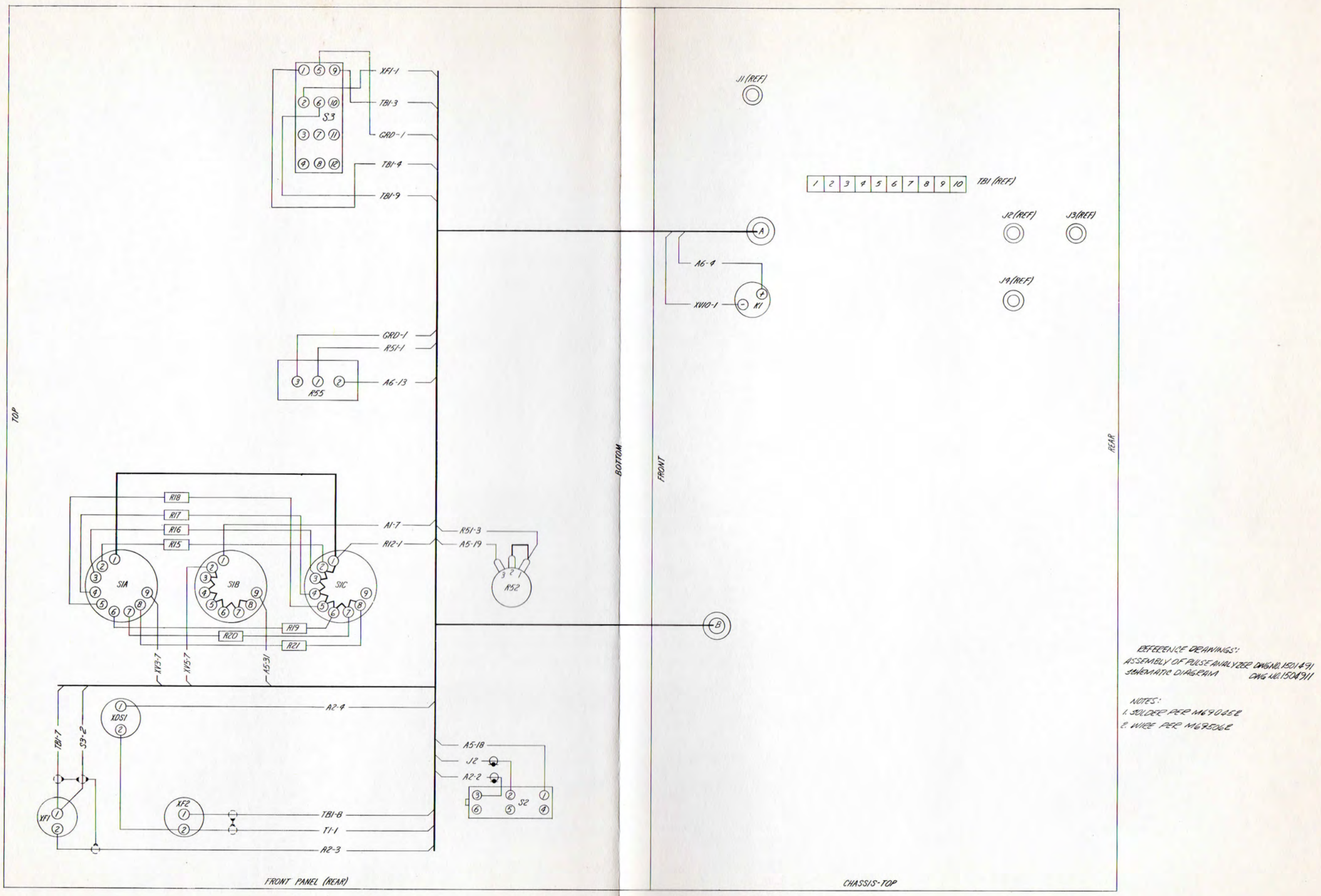


Figure 6-24. Electrical Pulse Analyzer TS-1360/FPN-42 (Pulse Analyzer, UD2A9), Wiring Diagram (Sheet 1 of 3)

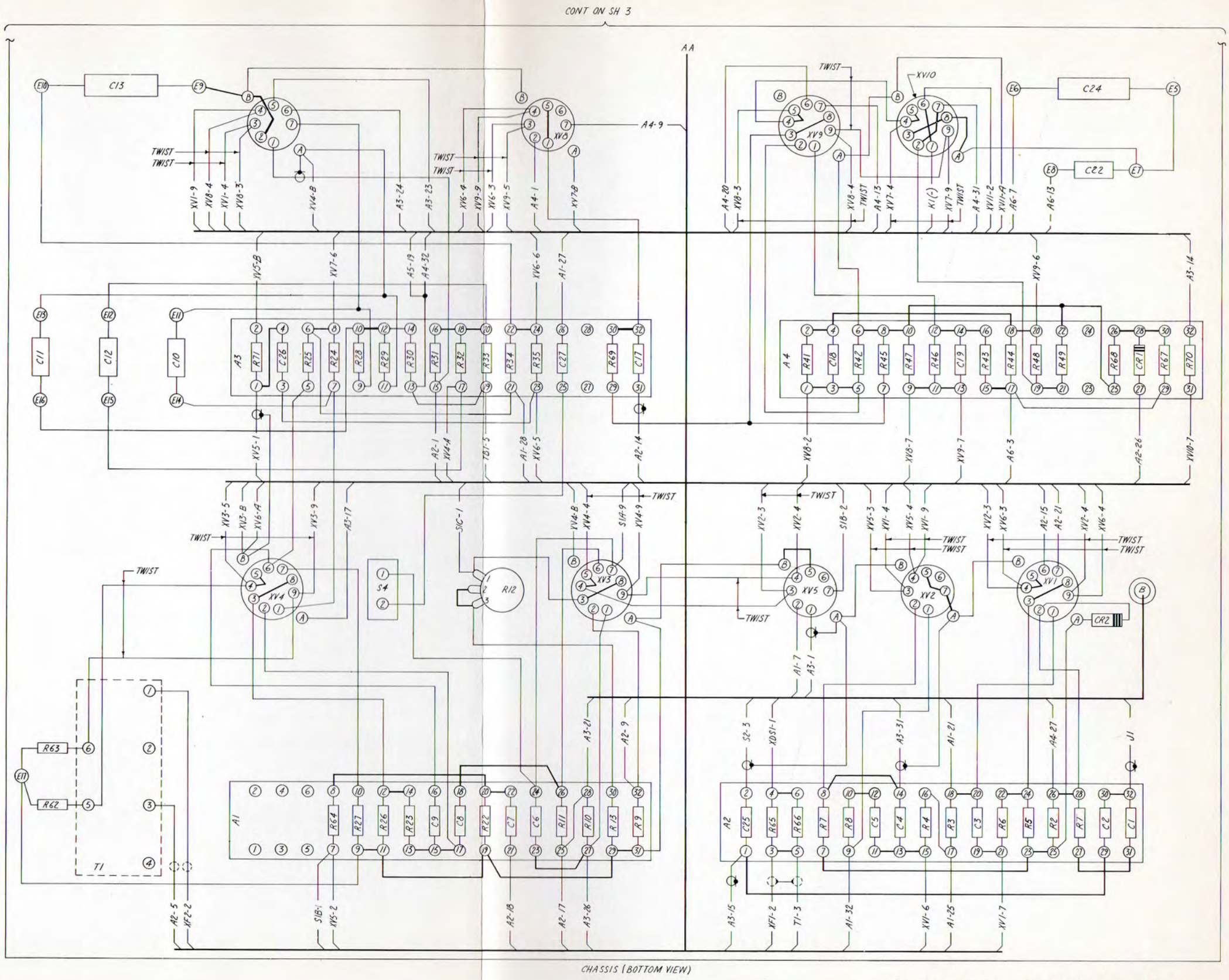


Figure 6-24. Electrical Pulse Analyzer TS-1360/FPN-42 (Pulse Analyzer, UD2A9), Wiring Diagram (Sheet 2 of 3)

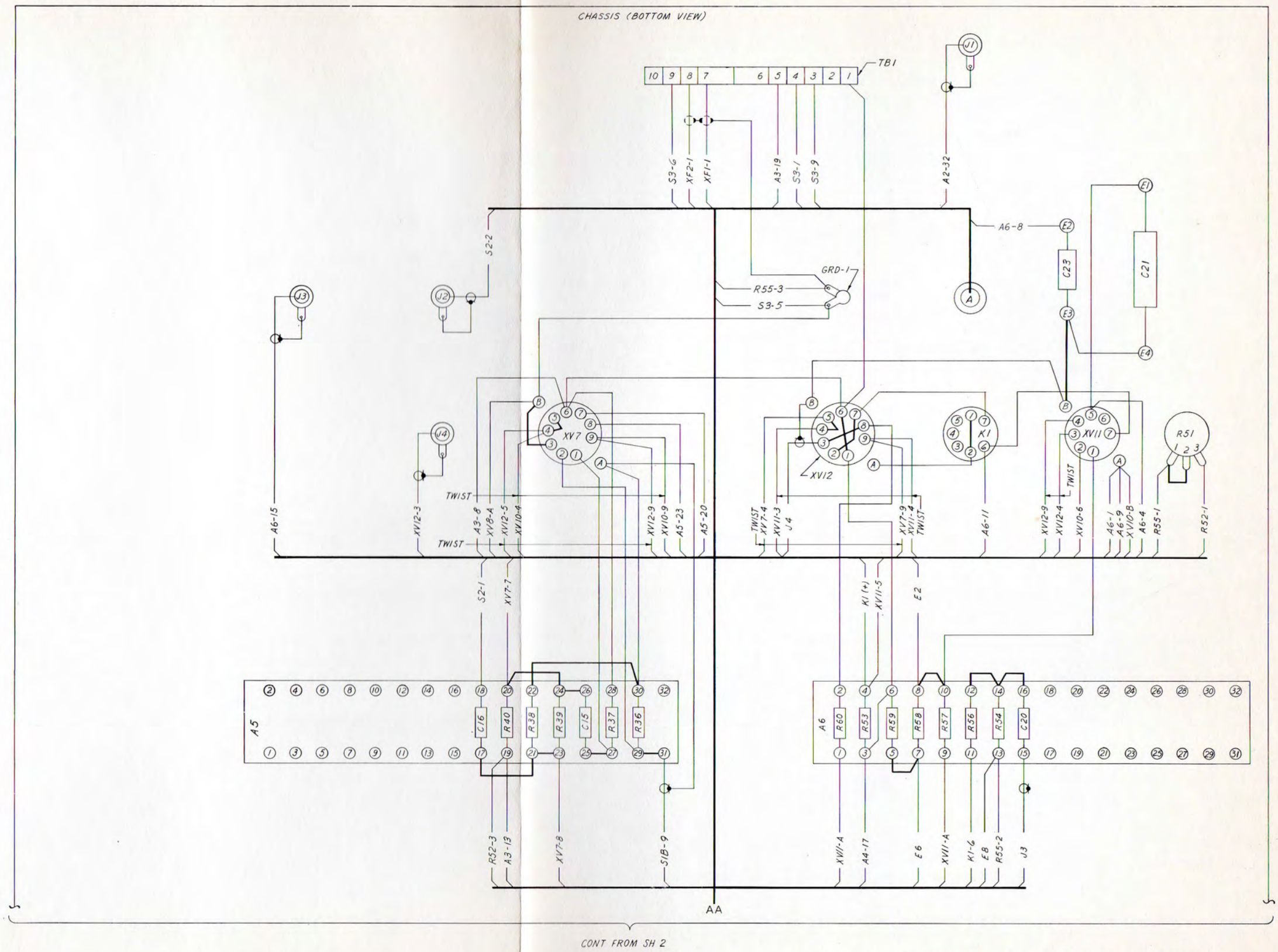
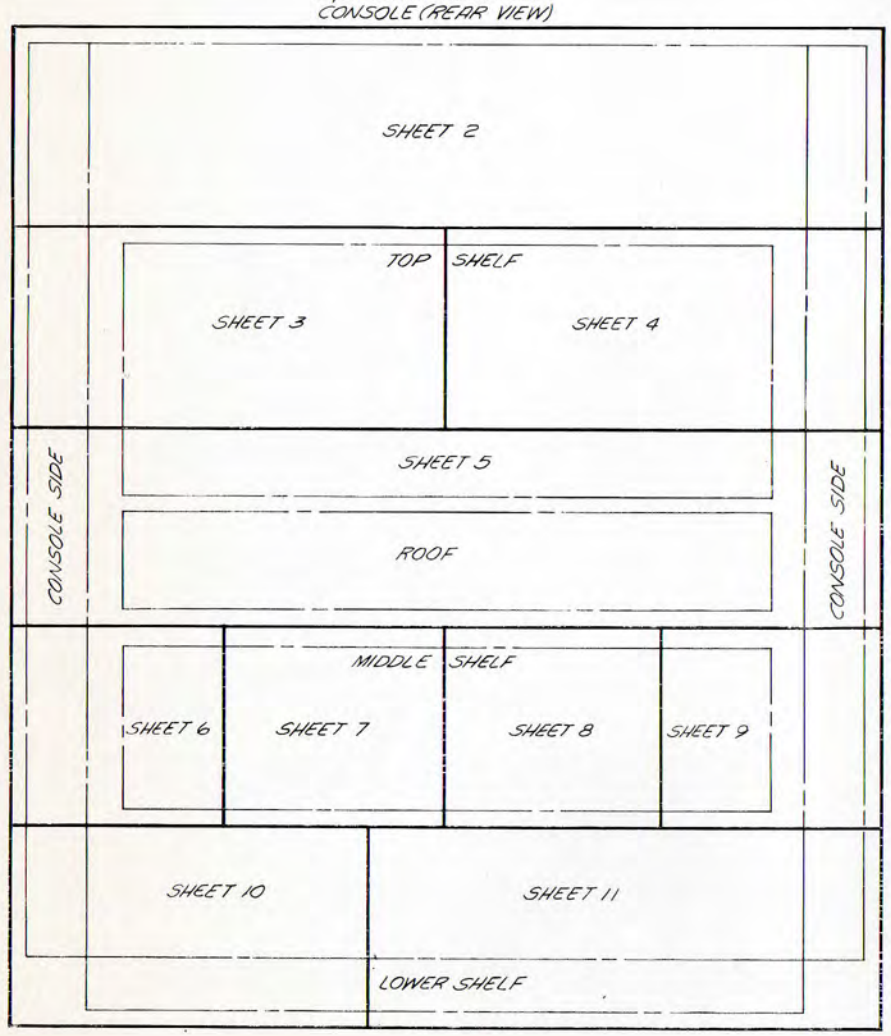


Figure 6-24. Electrical Pulse Analyzer TS-1360/FPN-42 (Pulse Analyzer, UD2A9), Wiring Diagram (Sheet 3 of 3)

EQUIPMENT LOCATION
CONSOLE (REAR VIEW)



COMPONENT LOCATION	
REF DESIG	ZONE
B1	145U
B2	139I
B3	21F
C1	103G
C2	103I
C3	91G
C4	93G
C5	92G
C6	95G
C7	89I
C8	97I
C9	61E
C10	66E
C11	61G
C12	66G
C13	46D
C14	32D
C15	48D
C16	34D
C17	62E
C18	66E
C19	62G
C20	66G
C21	49D
C22	34D
C23	50D
C24	36D
C25	62E
C26	67E
C27	63G
C28	67G
C29	51D
C30	37D
C31	53D
C32	39D
C33	63E
C34	68E
C35	63G
C36	67G
C37	54D
C38	40D
C39	36D
C40	41D
C41	107C
C42	93G
C43	107I
C44	122H
C45	77E
C46	106E
C47	107E
C48	81E
C49	80E
C50	79E
C51	78E
C52	77E
C53	76E
C54	81D
C55	80D
C56	79D
C57	78D
C58	77D
C59	76D
C60	81C
C61	80C
C62	79C
C63	78C
C64	77C
C65	76C
C66	25H
C67	25H
C68	21F
C69	104C
C70	75D
C71	47D
C72	35D
C73	49D
C74	33D
C75	52D
C76	38D
C77	55D
C78	40D
C79	107E
C80	106F
C81	105F

COMPONENT LOCATION	
REF DESIG	ZONE
C82	104F
C83	91D
E1	92H
3A1E1	122E
E2	93H
3A1E2	120F
E3	93G
3A1E3	120F
E4	94G
3A1E4	122F
E5	46F
3A1E5	122F
E6	33F
E7	47D
E8	33D
E9	49F
E10	37F
E11	50D
E12	36D
E13	51F
E14	39F
E15	53D
E16	38D
E17	54F
E18	41F
E19	55D
E20	41D
E21	65B
E22	63B
E31	88I
E32	97I
E33	88I
E34	97I
E35	32D
E36	46D
E37	33D
E38	48D
E39	34D
E40	49D
E41	36D
E42	50D
E43	37D
E44	51D
E45	39D
E46	53D
E47	40D
E48	54D
E49	41D
E50	56D
E51	24H
E52	26H
E53	26G
E54	24G
E55	103E
E56	102E
E57	103E
E58	102E
E59	133E
E60	133D
E61	132E
E62	132D
E63	21F
E64	22F
E65	24F
E66	103G
E67	102G
E68	103I
E69	102I
E70	90J
E71	95J
E72	65J
E73	93F
E74	93E
E75	93E
E76	93E
E77	64J
E78	92H

COMPONENT LOCATION	
REF DESIG	ZONE
E79	54D
E80	33E
E81	47E
E82	35E
E83	49E
E84	38E
E85	52E
E86	40E
E87	55E
E88	84G
E89	84F
E90	88I
E91	87I
E92	97I
E93	98I
E94	116G
E95	116F
E96	115F
FL1	26H
J1	147D
3A1J1	122E
J2	147D
J3	147D
J4	147D
3A2J4	19D
3A2J6	18D
L1	91G
L2	95H
L3	46E
L4	33E
L5	47C
L6	33C
L7	49E
L8	36E
L9	49C
L10	35C
L11	51E
L12	39E
L13	52C
L14	38C
L15	54E
L16	41E
L17	55C
L18	41C
M1	24I
M2	26I
3A1P1	122D
3A2P4	19C
3A2P6	18C
R1	105H
R2	105H
R5	89J
R6	97J
R7	103E
R8	103E
R9	92H
R10	93H
R13	93E
R14	93E
R16	136F
R17	147E
R18	65J

COMPONENT LOCATION	
REF DESIG	ZONE
R19	61J
R20	66J
R21	61J
R22	65H
R23	62H
R24	34F
R25	46F
R26	34F
R27	46F
R28	33F
R29	47F
R30	33F
R31	47F
R32	66J
R33	62J
R34	66J
R35	62J
R36	66H
R37	62H
R38	37F
R39	48F
R40	37F
R41	48F
R42	35F
R43	49F
R44	35F
R45	50F
R46	67J
R47	62J
R48	67J
R49	62J
R50	67H
R51	63H
R52	39F
R53	51F
R54	39F
R55	51F
R56	38F
R57	52F
R58	38F
R59	53F
R60	67J
R61	63J
R62	68J
R63	63J
R64	67H
R65	63H
R66	42F
R67	54F
R68	42F
R69	54F
R70	40F
R71	55F
R72	41F
R73	55F
R74	133F
R75	149E
R76	152E
R77	153E
R78	24G
R79	24G
R80	136F
R81	147E
R82	136F
R83	147E
R84	136F
R85	147E
R86	136F
R87	147E
R88	136F
R89	147E
R90	131E
R91	151E
R92	131E
R93	151E
R94	131E
R95	151E
R96	131E
R97	151E
R98	131E
R99	150E
R100	132F
R101	150E
R102	132F
R103	150E
R104	132F
R105	150E
R106	132F

COMPONENT LOCATION	
REF DESIG	ZONE
R107	150E
R108	132F
R109	149E
R110	132F
R111	149E
R112	133F
R113	149E
R114	133F
R115	149E
R116	133F
R117	149E
R118	133F
R119	149E
R120	95F
R121	95F
R122	88I
R123	88I
R124	88I
R126	97I
R127	98I
R128	98I
R130	116F
R131	116F
R132	115F
R133	84F
R134	84F
R135	84F
R136	83F
R137	83F
R138	93G
R139	91G
R140	95G
R141	93G
R142	97J
R143	89J
R144	34F
R145	46F
R146	34F
R147	46F
R148	37F
R149	48F
R150	37F
R151	48F
R152	39F
R153	51F
R154	39F
R155	51F
R156	42F
R157	53F
R158	42F
R159	53F
R160	31D
R161	46D
R162	34D
R163	48D
R164	34D
R165	48D
R166	37D
R167	51D
R168	37D
R169	51D
R170	39D
R171	54D
R172	39D
R173	54D
R174	41D
R175	56D
R176	26H
R177	59J
R178	59J
R179	59J
R180	60J
R181	60J
R182	60J
R183	60J
R184	61J
R185	70J
R186	70J
R187	70J
R188	69J
R189	69J
R190	69J
R191	69J
R192	68J
R193	140I
R194	140I

COMPONENT LOCATION	
REF DESIG	ZONE
R195	139I
R196	138I
S1	51J
S2	51J
S3	11C
S4	22C
S5	36J
S6	37J
S7	110J
S8	92I
S9	125H
S10	149G
S11	61G
S12	64F
S13	65F
S14	68G
S15	125J
S16	96E
S17	25G
S18	25D
S19	25C
S21	119C
T1	109G
T2	109I
T3	105E
T4	93D
T5	65E
T6	62C
T7	24H
T8	121I
T9	123I
T10	75H
T11	80H
T12	151G
TB1	151B
3A1TB1	124E
3A2TB1	19D
TB2	150D
TB3	152E
TB4	153C
TB5	111G
TB6	111J
TB7	107E
V1	47I
V2	49I
V3	52I
V4	55I
V5	33I
V6	35I
V7	38I
V8	40I
V9	92I
V10	94I
XDS1	21J
XDS2	19J
XDS3	24J
XDS4	26J
XV11	105G
XV12	105I
Z1	77F
1PT GRD	89E

REFERENCE DRAWINGS:
ASSEMBLY OF POWER AMPLIFIER DWG NO. 1504536
SCHEMATIC DIAGRAM DWG NO. 1505235

NOTES:
1. SOLDER ALL CONNECTIONS WITH 60-40 SOLDER AND ROSIN FLUX PER M690452.
2. WIRE PER SPEC M695062.
3. CROSS HATCHING REPRESENTS BUS BARS.

Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 1 of 11)

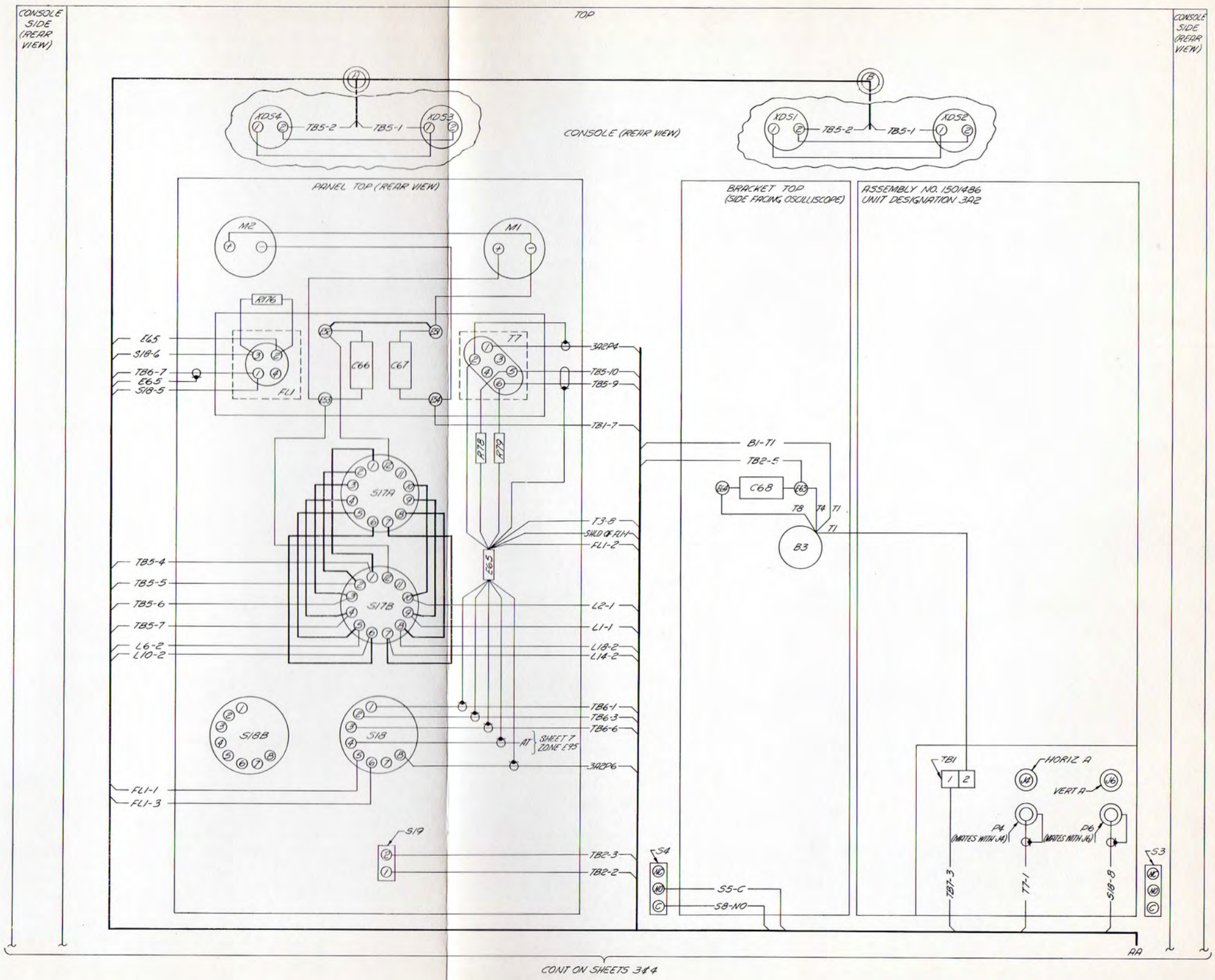


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 2 of 11)

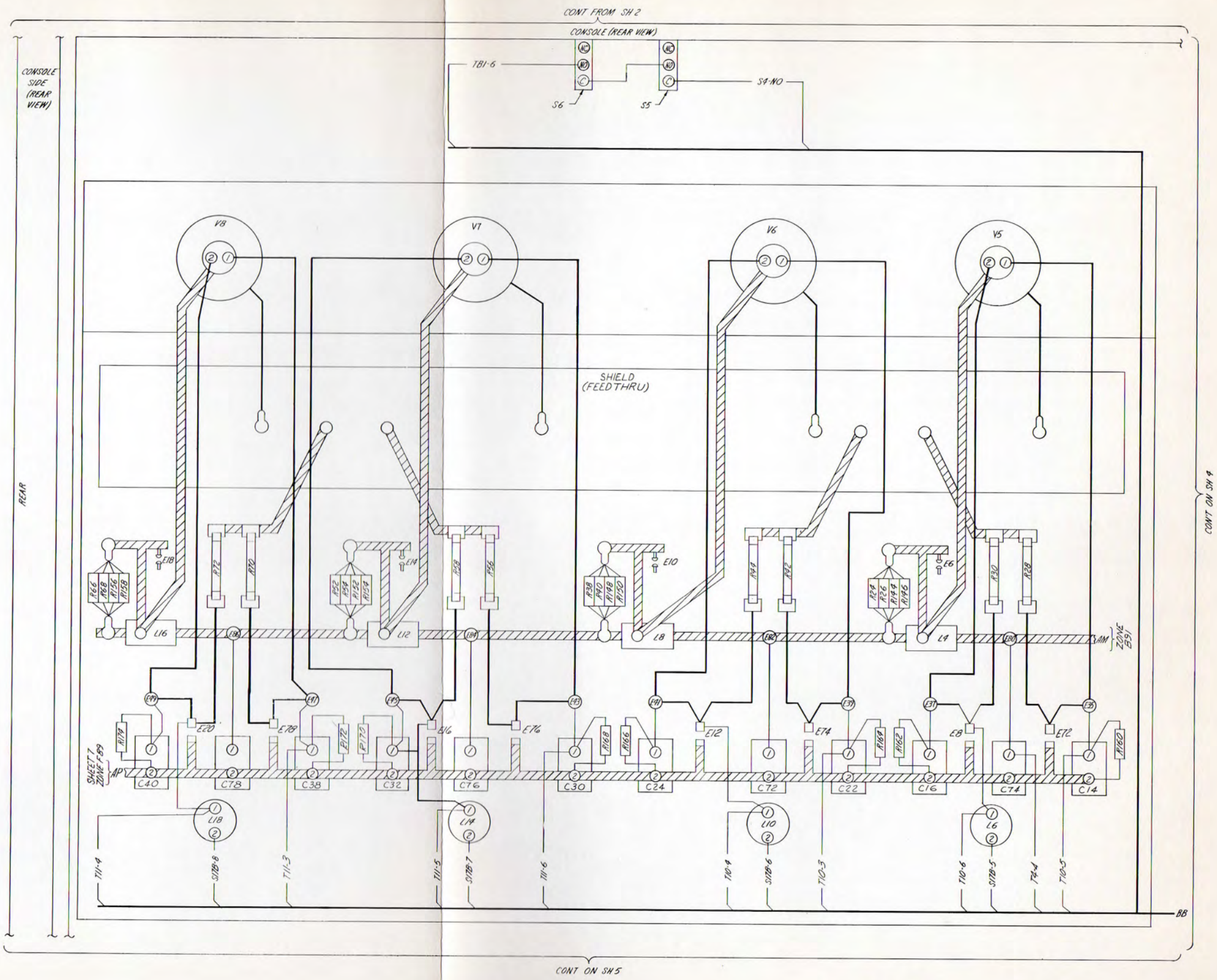


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 3 of 11)

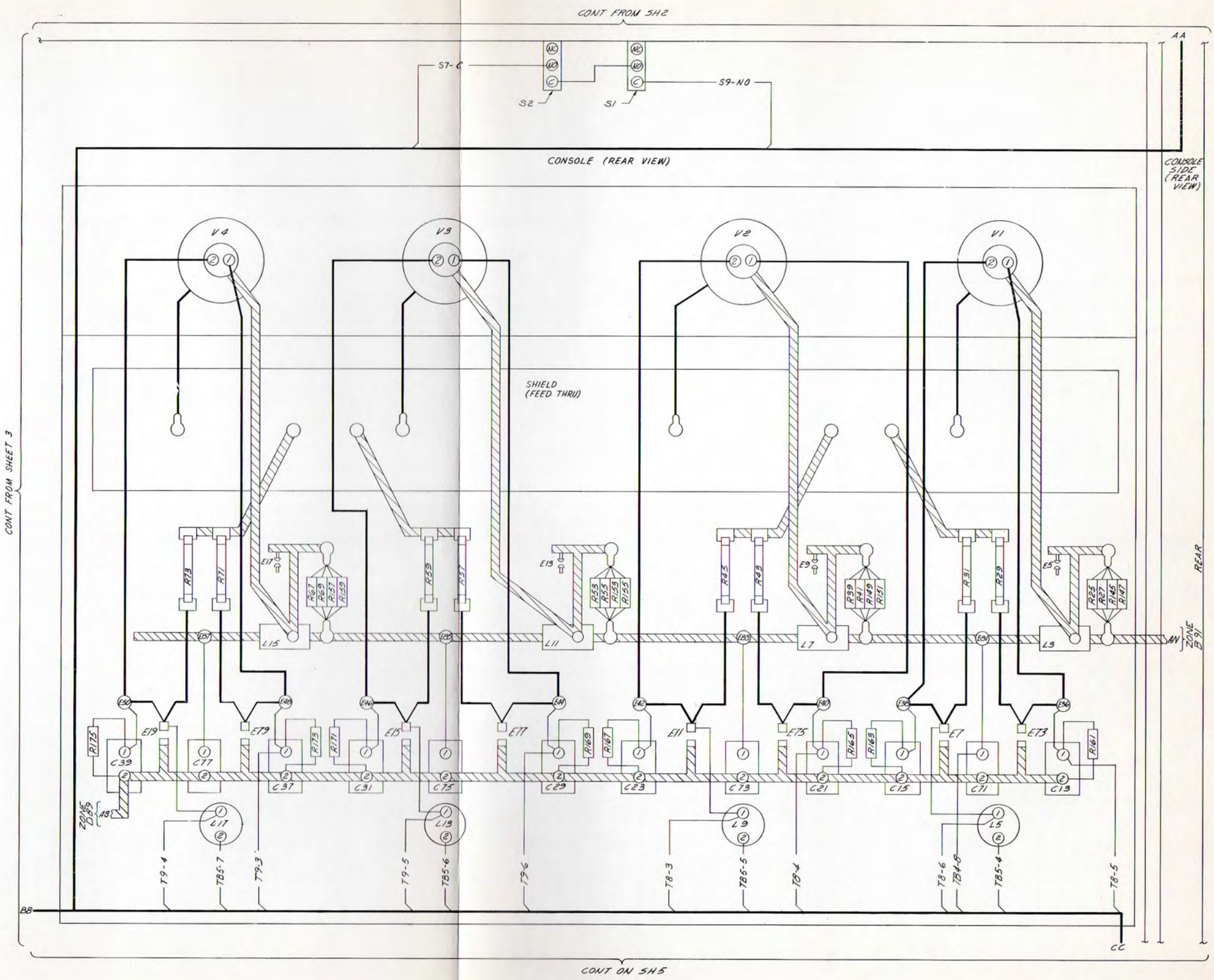


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 4 of 11)

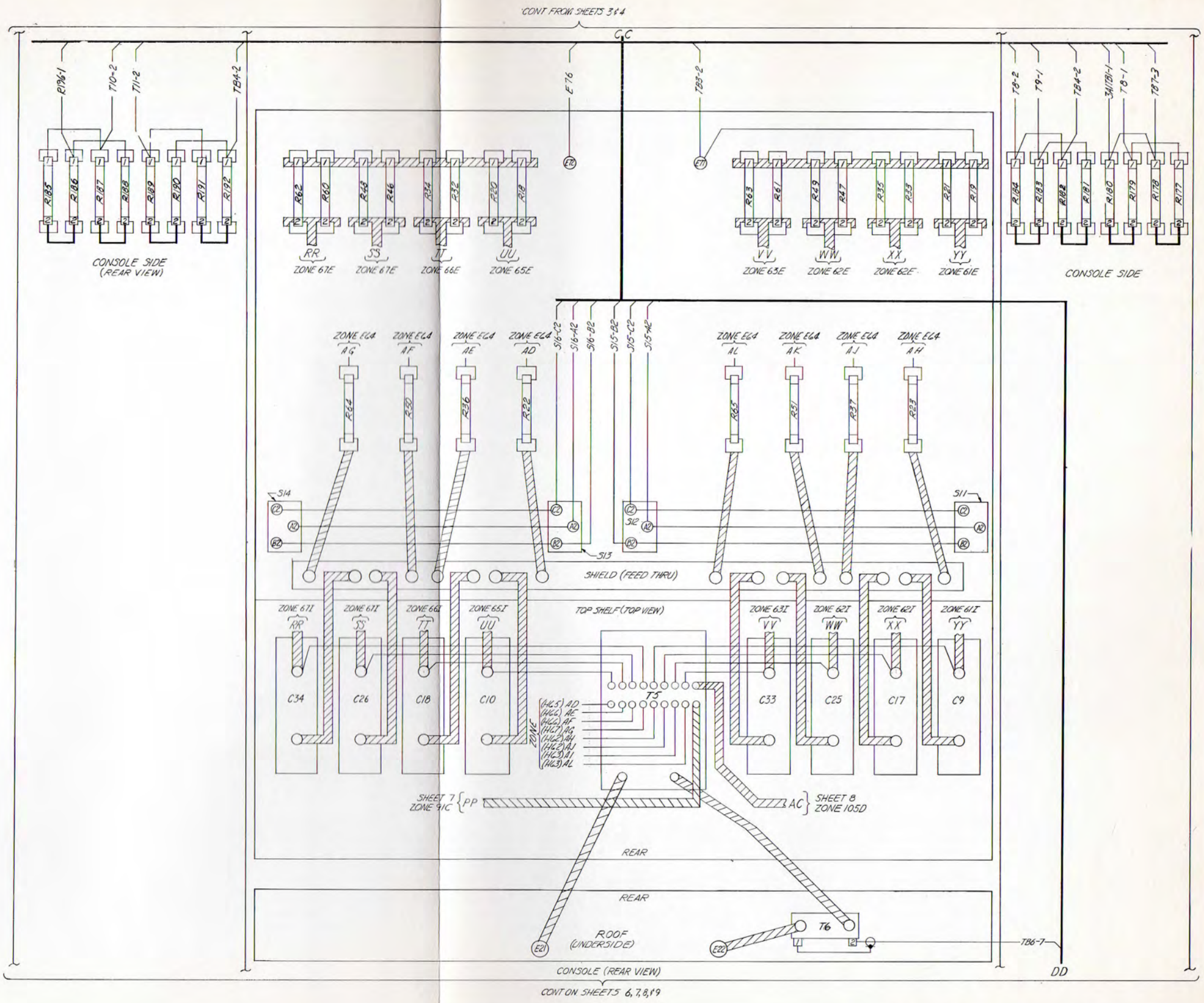


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 5 of 11)

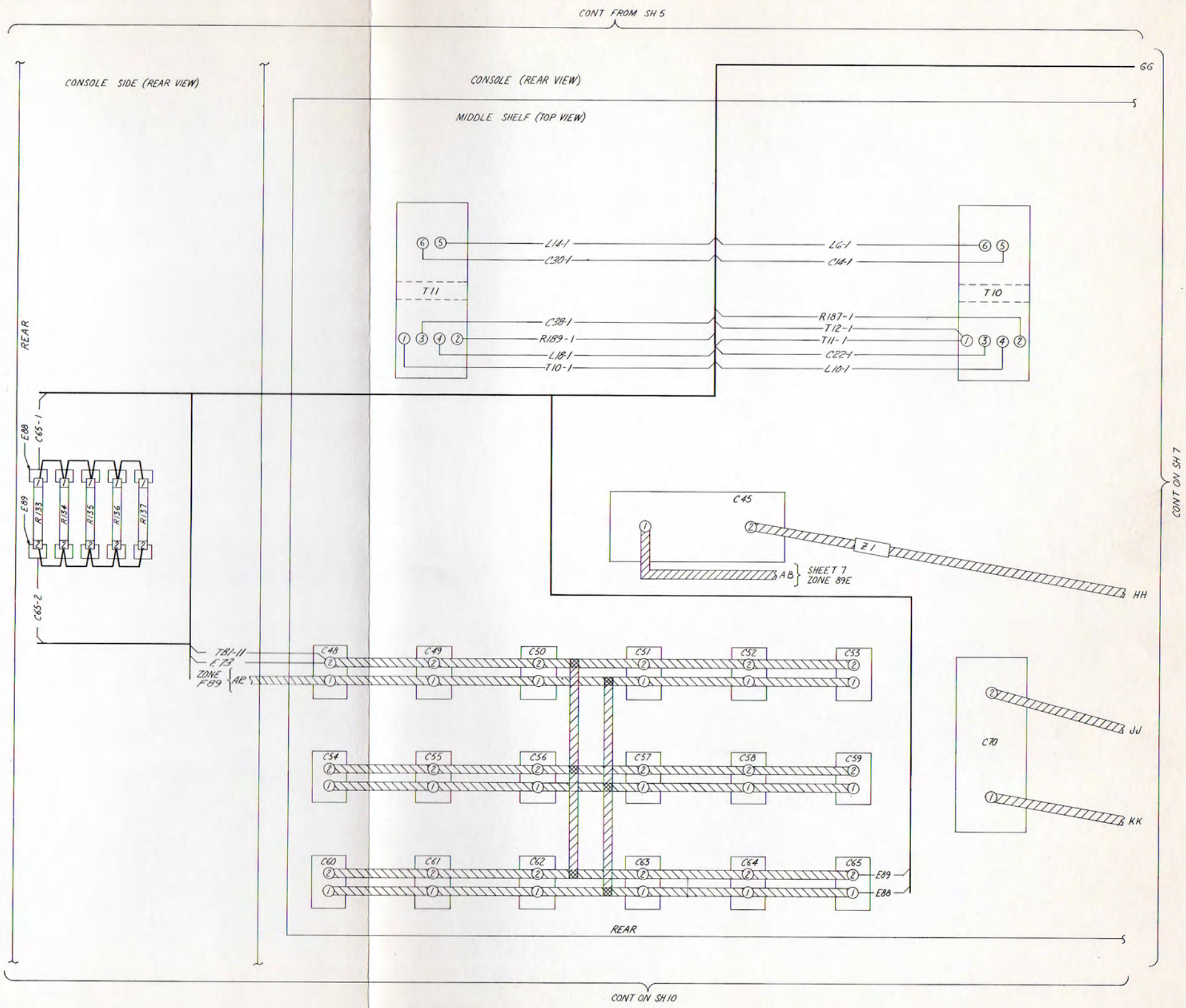


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 6 of 11)

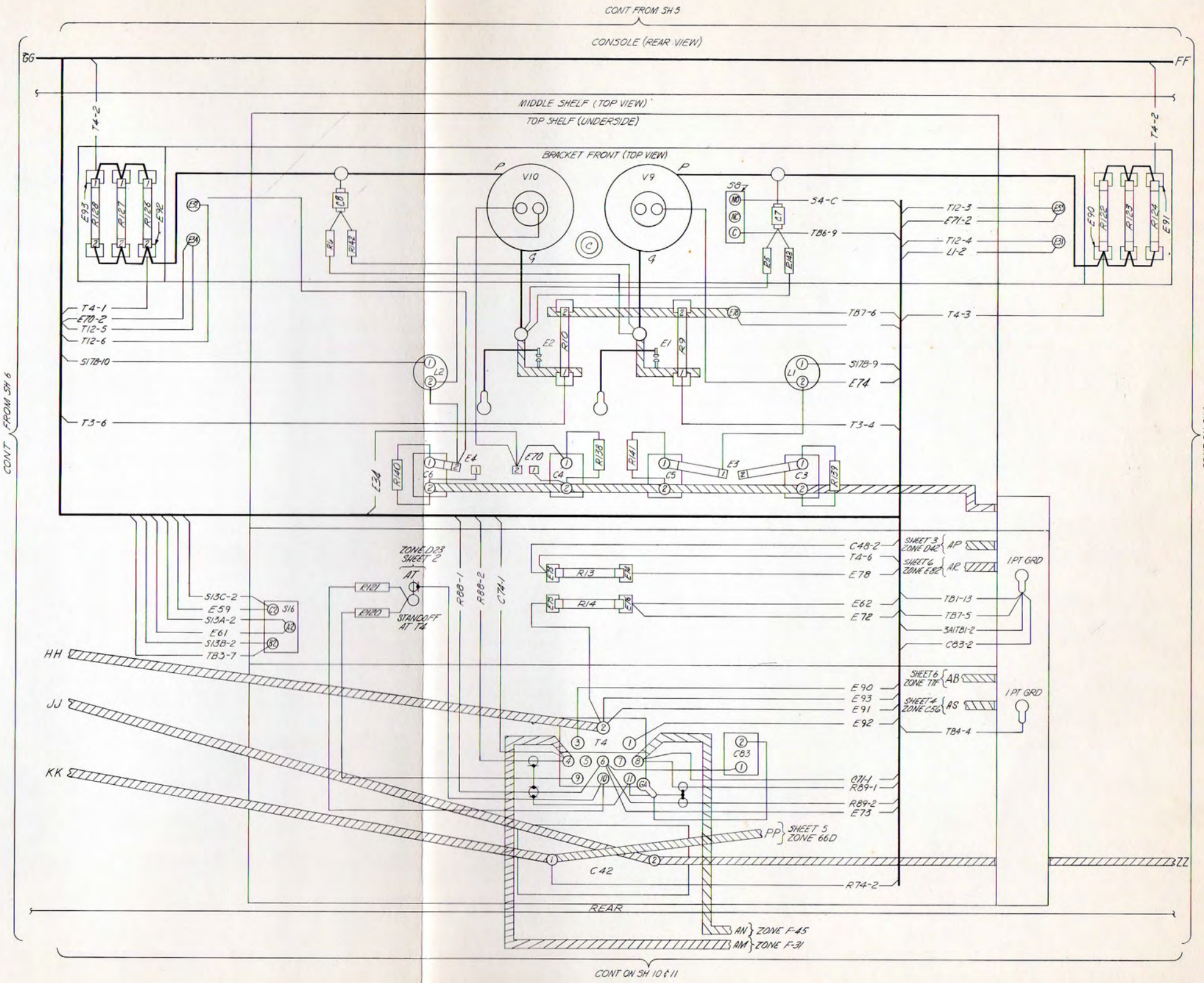


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 7 of 11)

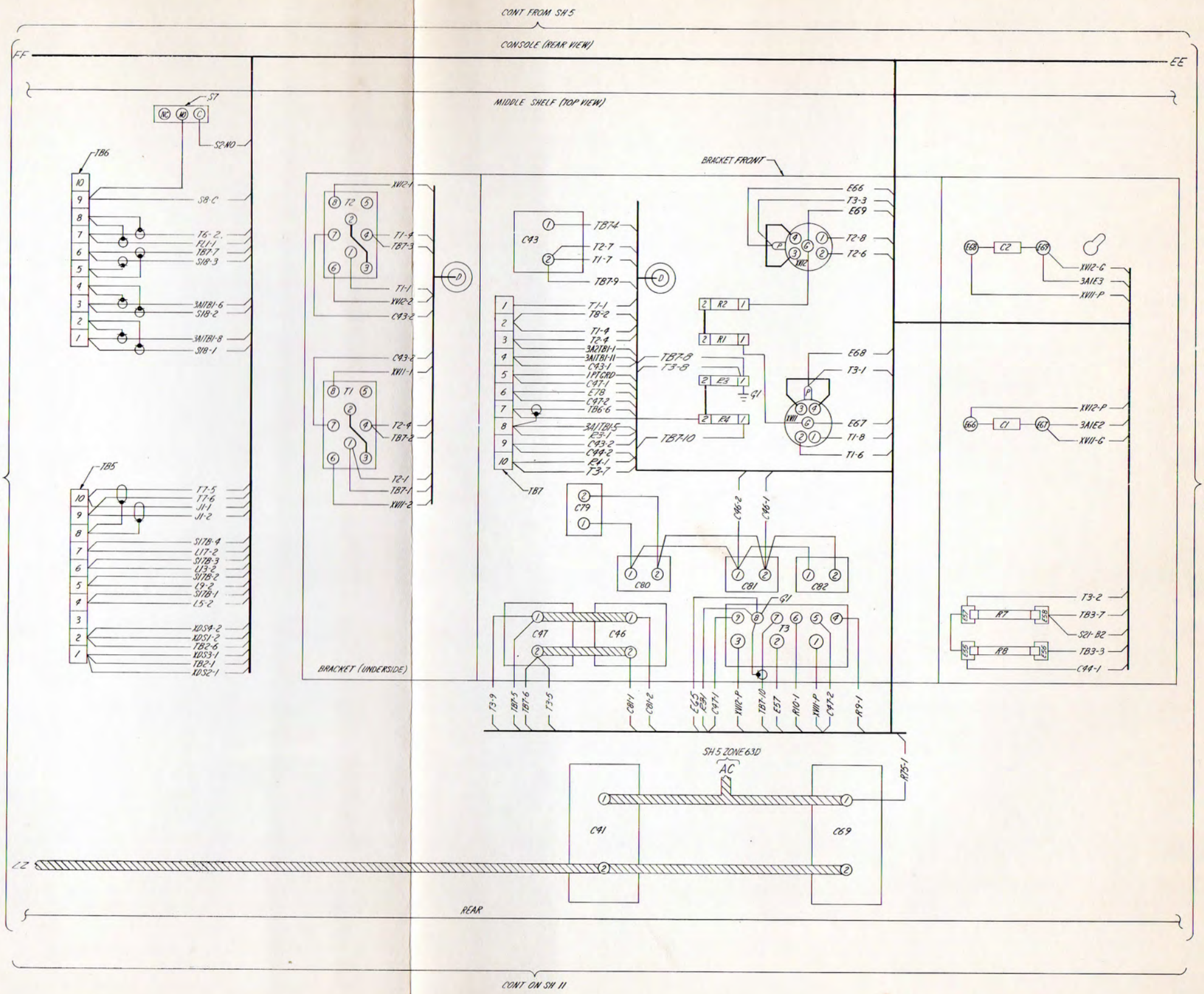


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 8 of 11)

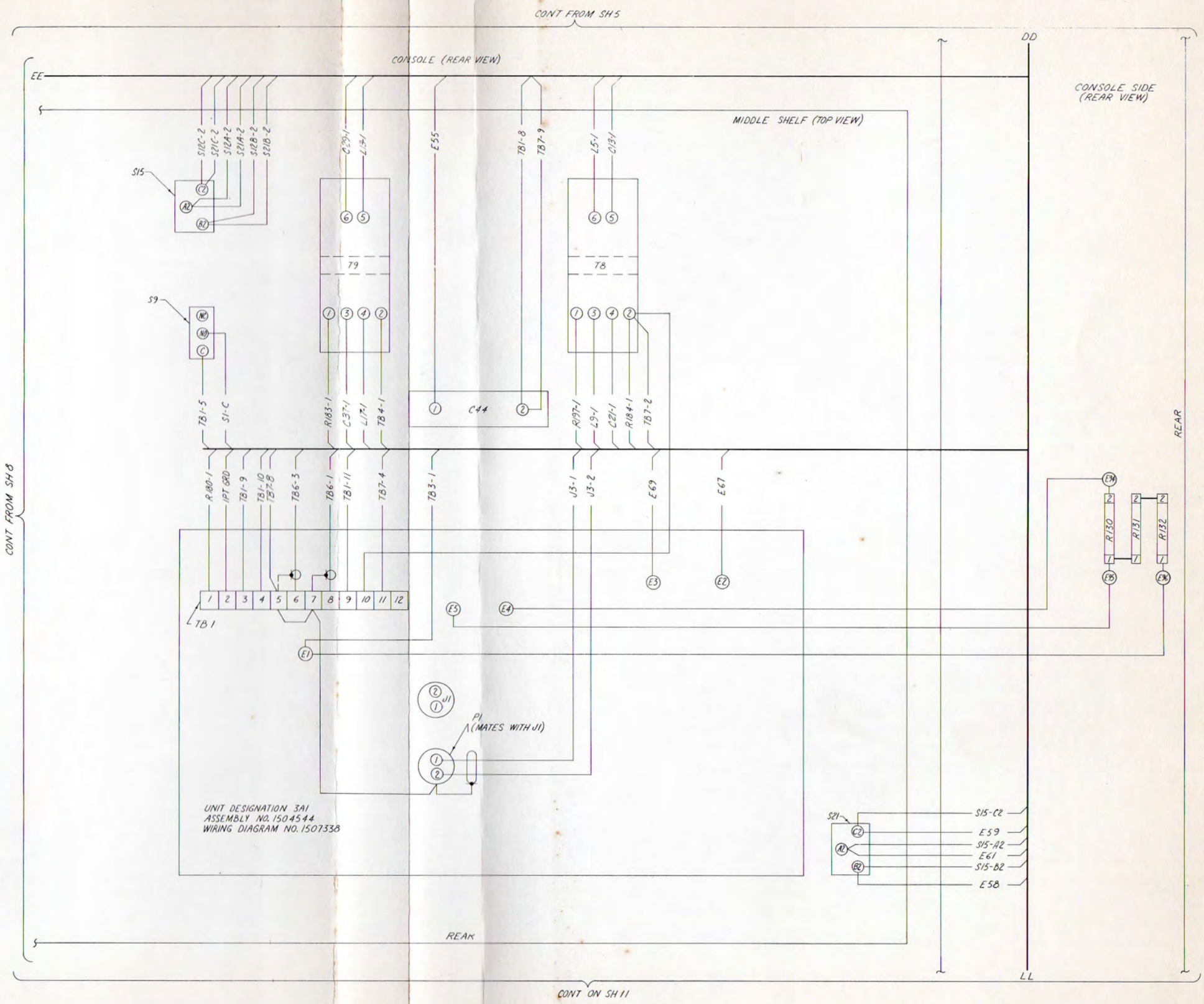


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 9 of 11)

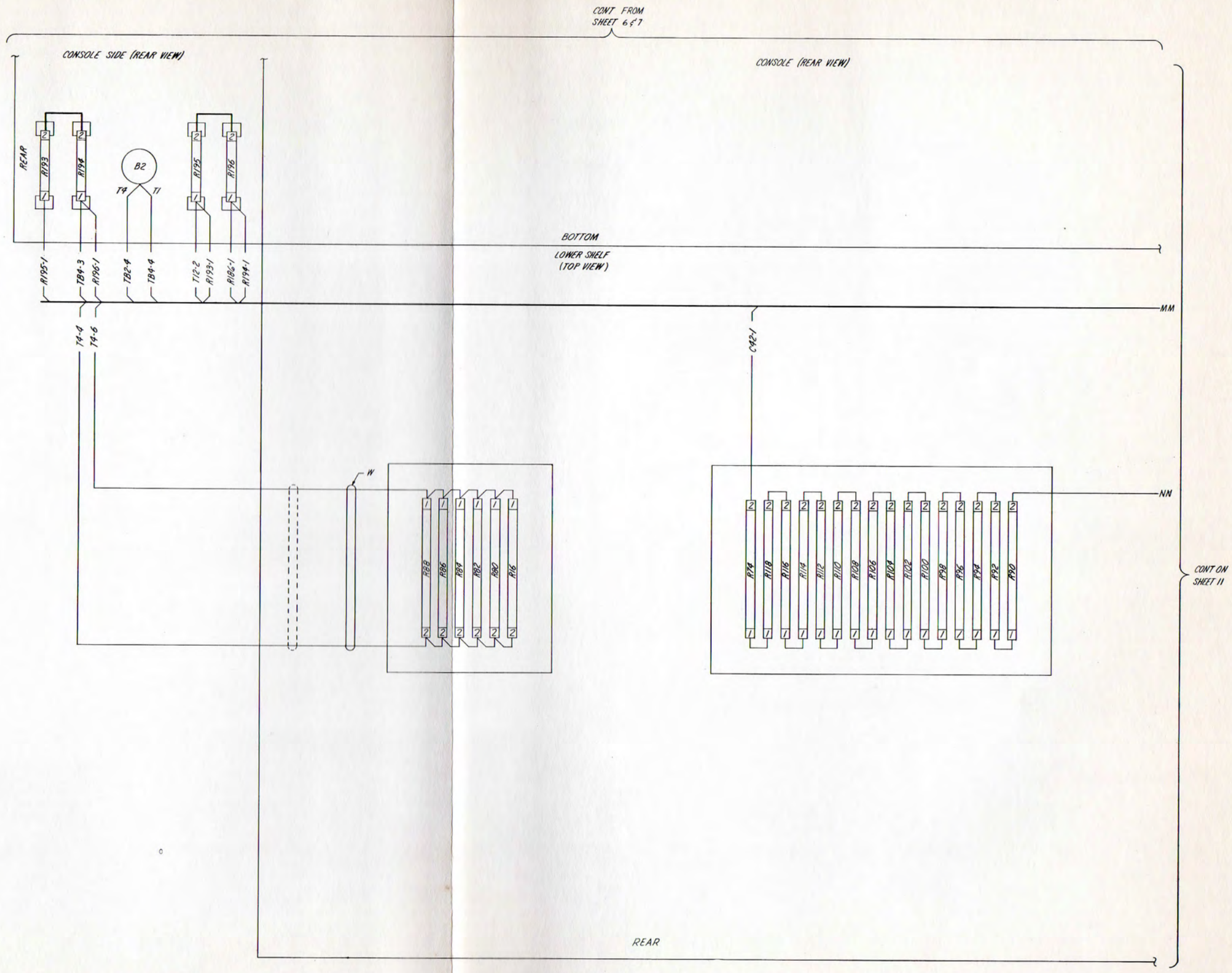


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 10 of 11)

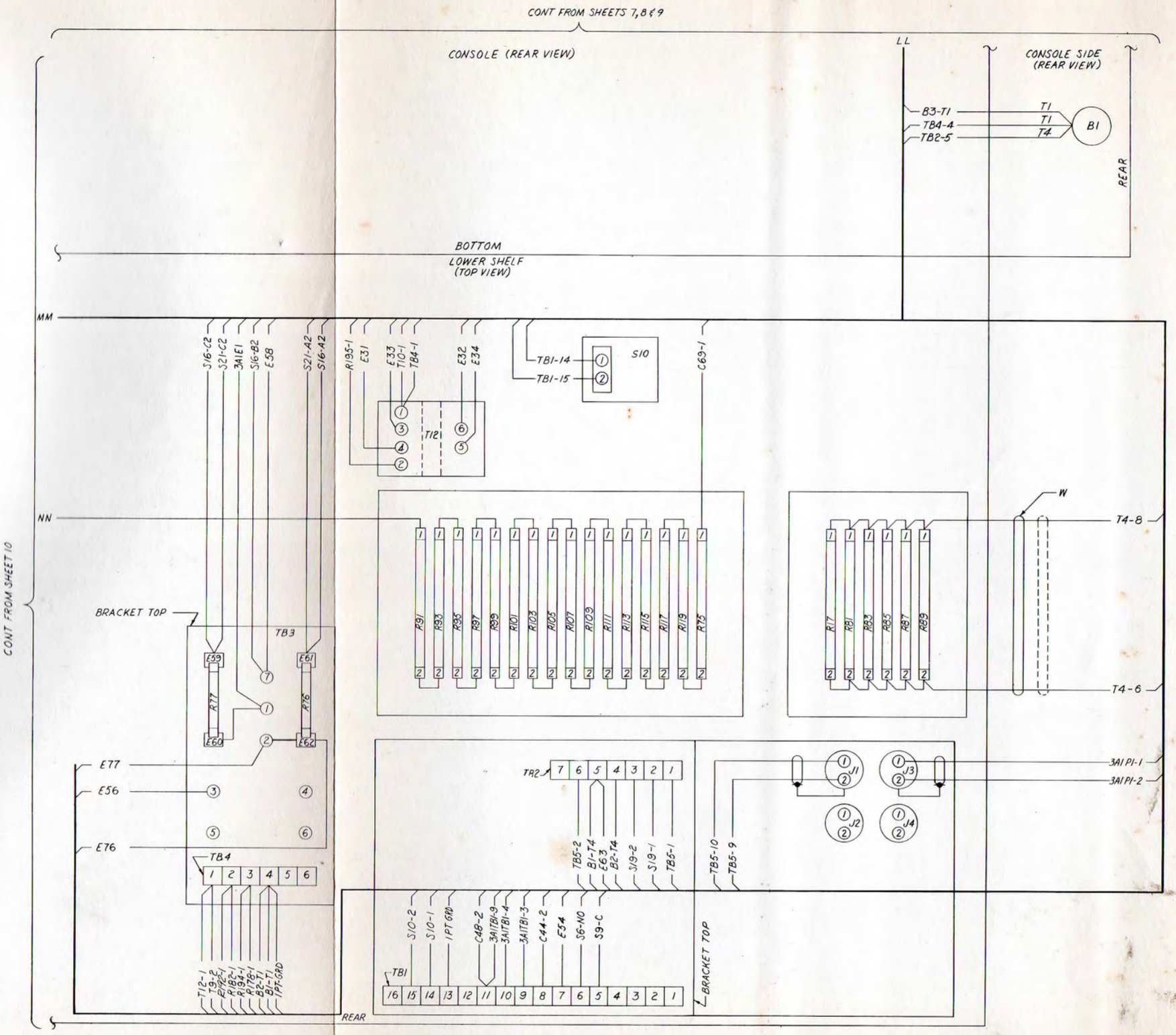


Figure 6-25. Amplifier Assembly AM-2481/FPN-42 (Transmitter UD3A), Wiring Diagram (Sheet 11 of 11)

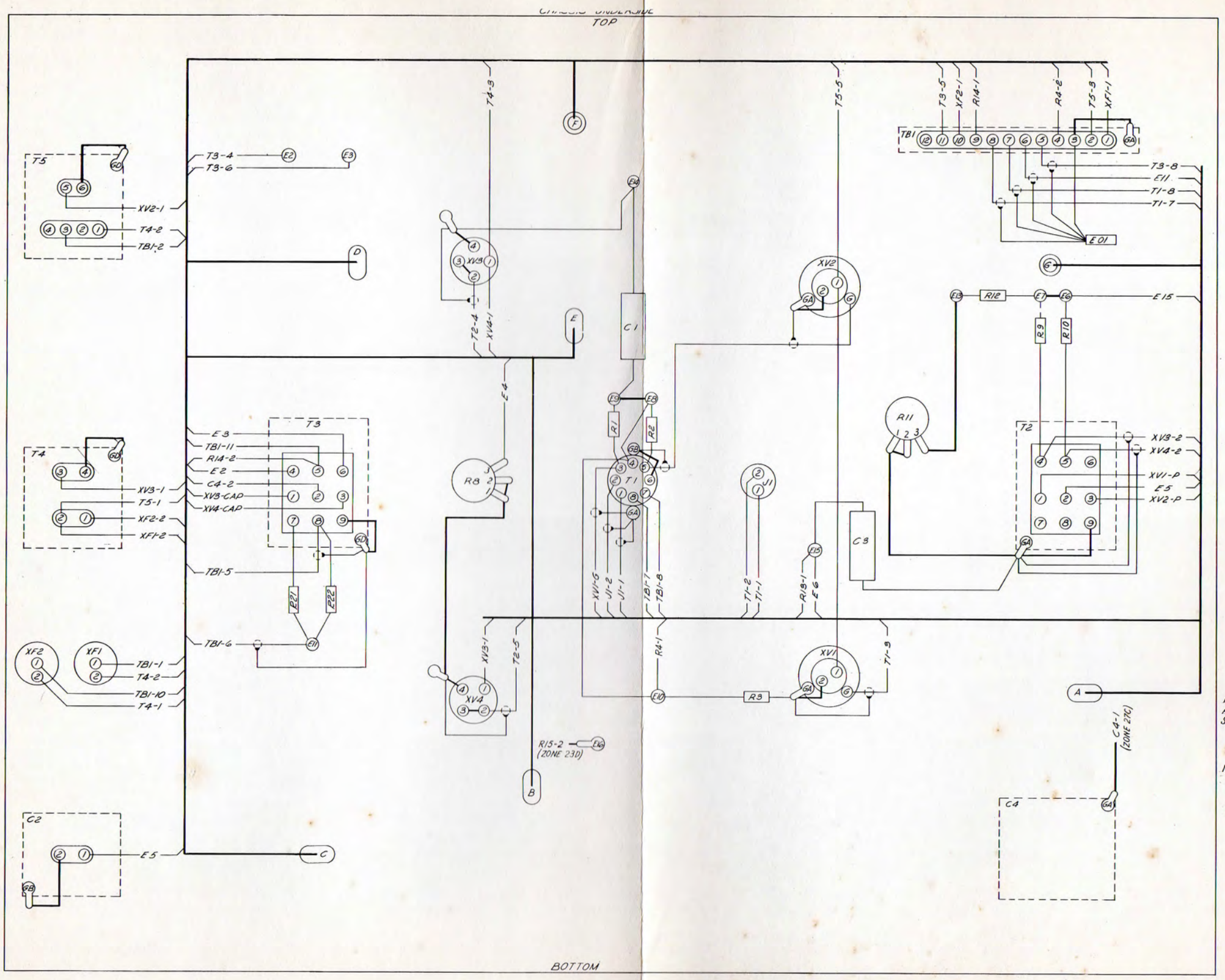


Figure 6-26. Amplifier Assembly AM-2481/FPN-42, Pulse Driver Wiring Diagram (Sheet 1 of 2)

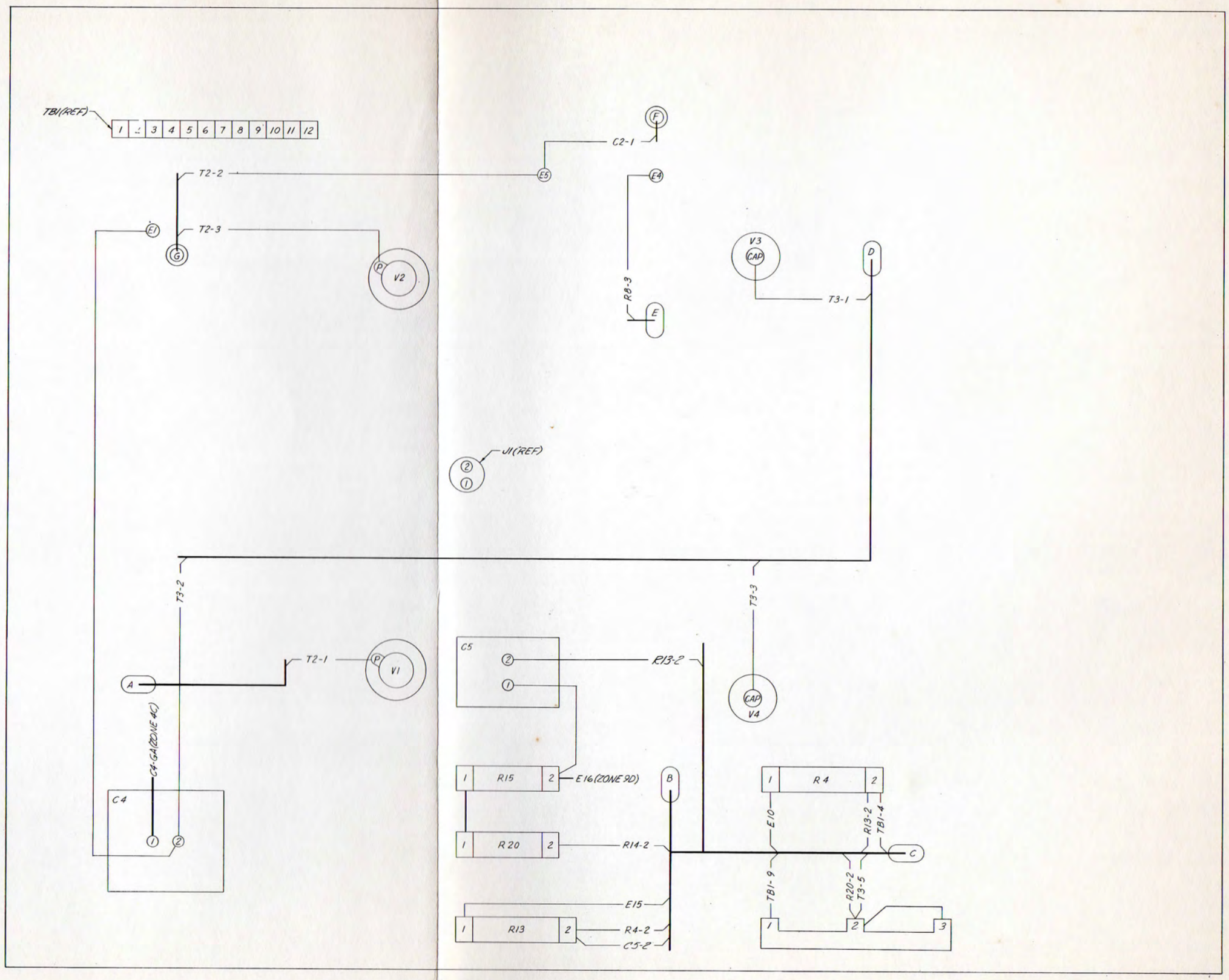


Figure 6-26. Amplifier Assembly AM-2481/FPN-42, Pulse Driver Wiring Diagram (Sheet 2 of 2)

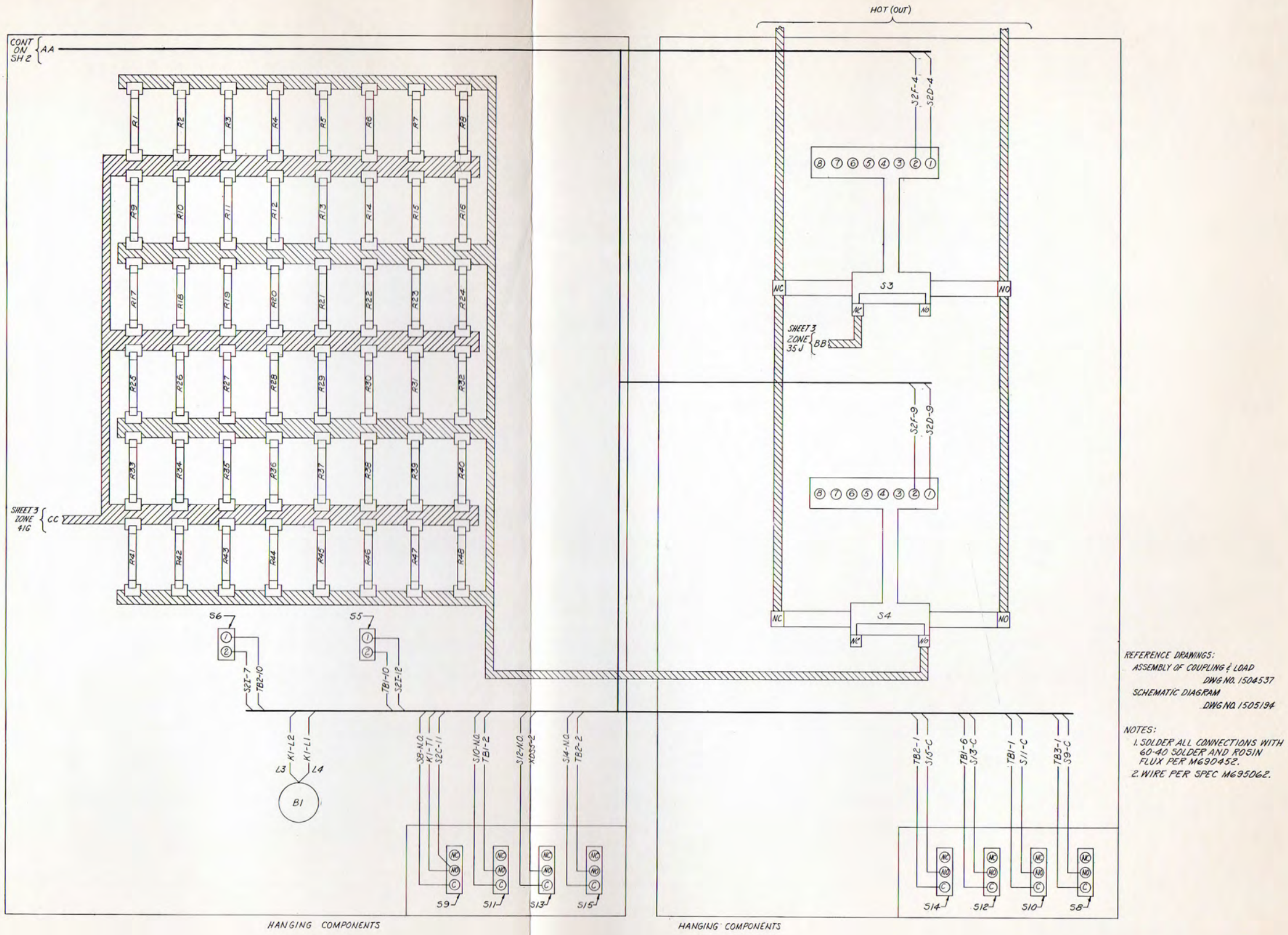


Figure 6-27. Antenna Coupler CU-807/FPN-42 (Coupling and Load Unit, UD4A), Wiring Diagram (Sheet 1 of 3)

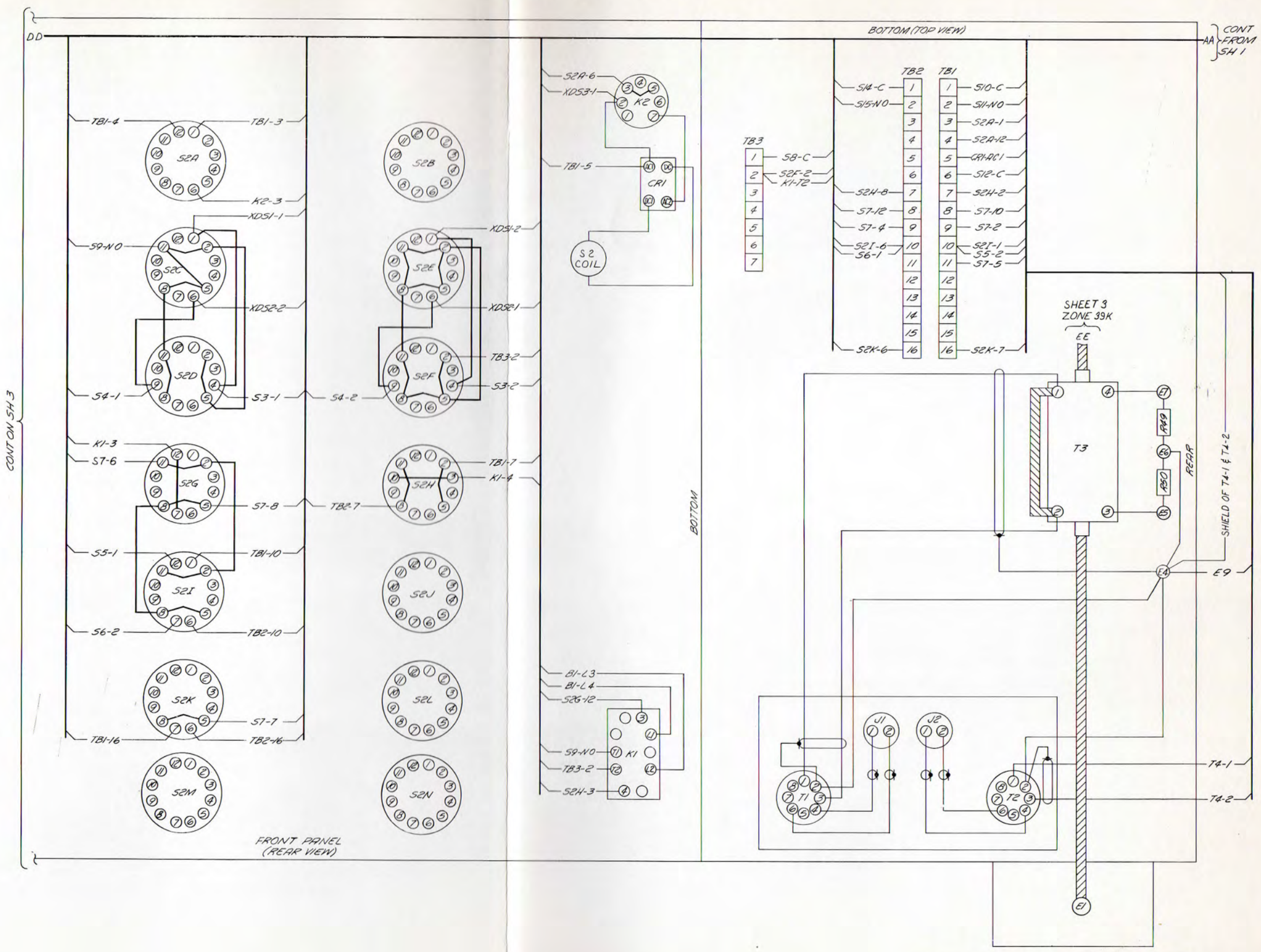


Figure 6-27. Antenna Coupler CU-807/FPN-42 (Coupling and Load Unit, UD4A), Wiring Diagram (Sheet 2 of 3)

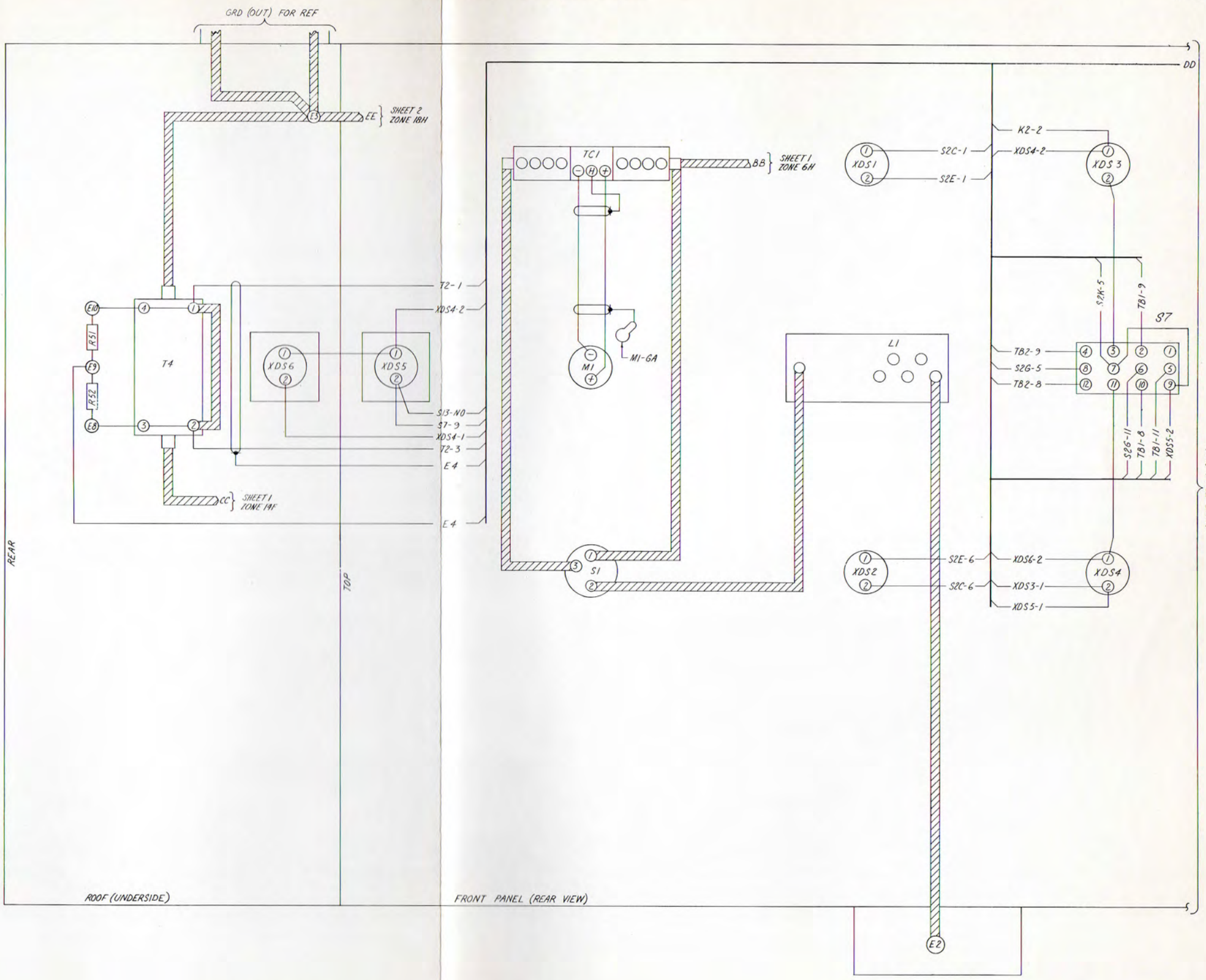


Figure 6-27. Antenna Coupler CU-807/FPN-42 (Coupling and Load Unit, UD4A), Wiring Diagram (Sheet 3 of 3)

APPENDIX I

TECHNICAL MANUAL

for

OSCILLOSCOPE

OS-103/FPN

HEWLETT PACKARD CO.

130B

OSCILLOSCOPE

SERIALS PREFIXED: 001-

OPERATING AND SERVICING MANUAL

PRINTED 1/61
00013-2

OPERATING AND SERVICING MANUAL

MODEL 130B/BR

OSCILLOSCOPE

SERIALS PREFIXED: 001 -

Copyright HEWLETT-PACKARD COMPANY 1959
1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

printed 1/61
00013-2

SPECIFICATIONS

SWEEP

Sweep Range:	0.2 μsec/cm to at least 12.5 sec/cm. 21 calibrated sweeps, accurate within ±5%, in a 1-2-5-10 sequence, 1 μsec/cm to 5 sec/cm. Vernier permits continuous adjustment of sweep time between calibrated steps and extends slowest sweep time to at least 12.5 sec/cm.
Magnifier:	X5 Magnifier may be used on all ranges and expands fastest sweep to 0.2 μ sec/cm. Accuracy within 10%.
Synchronization:	Internally from line voltage or from signals causing 1/2 centimeter or more vertical deflection. Externally from 0.5 volts peak-to-peak or more.
Trigger Point:	Continuously adjustable from -30 to +30 volts on either positive or negative slope of external synchronizing signal, or from any point of the vertical signal presented on the screen.
Preset Triggering:	Switch position on sweep mode control selects optimum setting for automatic triggering.

INPUT AMPLIFIERS

Vertical and horizontal amplifiers have same characteristics.

Sensitivity:	1 mv/cm to at least 125 v/cm. 15 calibrated ranges, accurate within ± 5%, in a 1-2-5-10 sequence, 1 mv/cm to 50 v/cm. Vernier permits continuous adjustment between ranges and decreases sensitivity of 50 v/cm range to at least 125 volts/cm. Input voltage rating 600 volts dc or rms.
Phase Shift:	Within ± 1 ° relative phase shift at frequencies up to 50 kc between vertical and horizontal amplifiers with verniers in cal.
Stability:	1 mv/hr after warmup.
Bandwidth:	DC Coupling: dc to 300 kc. AC Coupling: 2 cps to 300 kc. Specified bandwidth is independent of sensitivity setting.
Balanced Input:	On 1, 2, 5, 10, 20 and 50 mv/cm ranges. Cabinet Mount input impedance: 2 megohms shunted with approximately 25 μμf. Rack Mount input impedance: 2 megohms, approximately 125 μμf shunt capacity. Disconnecting the wires at the front panel which connect to the rear terminals reduces the input capacity to approximately 25 μμf.
Common Signal Rejection (Balanced input only):	Rejection at least 40 db. Common signal must not exceed 1.5 volts.

SPECIFICATIONS (CONT'D.)

Single Ended Input:	Cabinet Mount input impedance: 1 megohm shunted with approximately 50 $\mu\mu$f. Rack Mount input impedance: 1 megohm, approximately 200 $\mu\mu$f shunt capacity. Disconnecting the wires at the front panel connecting to the rear terminals reduces the input capacity to approximately 50 $\mu\mu$f.
Internal Calibrator:	300 millivolts peak-to-peak ±2%, 300 cycles squarewave applied to vertical or horizontal amplifiers by CAL position of input attenuators.

GENERAL

Illuminated Graticule:	Edge lighted graticule with controlled illumination, 10 cm x 10 cm, marked in centimeter squares with 2 mm subdivisions, on major horizontal and vertical axes. Effectively shielded from ambient light.
CRT Plates:	Direct connection to deflection plates via terminals on rear. Sensitivity approximately 20 volts/cm.
Intensity Modulation:	Terminals on rear; 20 volts positive signal blanks CRT at normal intensity.
Cathode Ray Tube:	5 AQP mono-accelerator flat face type with 3000 volt accelerating potential. Available with P1, P2, P7 or P11 screen.
Dimensions:	Cabinet Mount: 9-3/4 in. wide, 15 in. high, 21-1/4 in. deep. Rack Mount: 19 in. wide, 8-3/4 in. high, 22 in. deep, 19-3/4 in. deep behind panel.
Weight:	Cabinet Mount: Net 41 lbs., shipping 54 lbs. Rack Mount: Net 47 lbs, shipping 62 lbs.
Power Supply:	115/230 volts ±10%, 50/1000 cycles, 160 watts.
Filter Supplied:	Color of filter compatible with screen phosphor. Green for P1 and P2, Amber for P7, Blue for P11.
Rack Mount:	Has rear terminals in parallel with front panel connections.
Accessories Furnished:	Supplied with Rack Mount. 130B-12P and Q Mounting Brackets (pr.) Two 125-57 Plugs (mate with rear terminals). Two 125-59 Clamps for 125-57 Plugs.
Accessories Available:	AC-83A Viewing Hood; face-fitting molded rubber. Additional Mounting Brackets. 130B-12P (left) and 130B-12Q (right)

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CATHODE RAY TUBE WARRANTY

The cathode ray tube supplied in your Hewlett-Packard Oscilloscope and replacement cathode ray tubes purchased from hp, are guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. Broken tubes or tubes with burned phosphor are not included in this guarantee.

Your local Hewlett-Packard representative maintains a stock of replacement tubes and will be glad to process your warranty claim for you. Please consult him.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow shipping instructions carefully to insure safe arrival, since no credit can be allowed on broken tubes.

SHIPPING INSTRUCTIONS

1) Carefully wrap the tube in 1/4" thick cotton batting or other soft padding material.

2) Wrap the above in heavy kraft paper.

3) Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.

4) Surround the tube with at least four inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.

5) Tubes returned from outside the continental United States should be packed in a wooden box.

6) Ship prepaid preferably by AIR FREIGHT or RAILWAY EXPRESS. We do not recommend parcel post or air parcel post shipment.

CRT WARRANTY CLAIM

FROM: DATE: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

_____

_____

Person to contact for further information:

NAME: _____

TITLE: _____

COMPANY: _____

ADDRESS: _____

_____

_____

To process your claim quickly please enter the information indicated below:

1) ⓗⓟ INSTRUMENT MODEL _____ SERIAL _____

2) TUBE TYPE _____ SERIAL _____

3) ORIGINAL TUBE _____ REPLACEMENT TUBE _____

4) YOUR PURCHASE ORDER NO. _____

5) DATE PURCHASED _____

6) PURCHASED FROM _____

7) COMPLAINT: (Please describe nature of trouble) _____

_____

_____

_____

8) OPERATING CONDITIONS: (Please describe conditions prior to and at time of failure _____

_____

_____

_____

SIGNATURE _____

_____

SECTION I
GENERAL DESCRIPTION

1-1 GENERAL

The Model 130B dc to 300 kc Oscilloscope is a general purpose oscilloscope. It can be used with either internal or external sweeps which can be either internally or externally synchronized and it can be obtained in either the cabinet or rack type mounting. Because of its high sensitivity and balanced input, the Model 130B may often be used directly with transducers, enabling you to see a direct presentation of phenomena desired without having to resort to preamplifiers.

Some of the special features of this oscilloscope are as follows:

A. LINEAR INTEGRATOR SWEEP GENERATOR

The accurate direct reading sweeps are obtained from a feedback type integrator which insures a high order linearity and stability. This type of sweep generator, is more reliable and independent of tube characteristics than other types of sweep generator.

B. X5 SWEEP EXPANSION

You speed observation and analysis of transients by expanding a two centimeter segment of the trace to 10 centimeters for easy viewing of detail. This X5 sweep expander, may be used on all sweep time settings and expands the fastest sweep time to .2 microsecond/cm.

C. CALIBRATED AMPLIFIERS

Voltage measurements of various waveforms are quickly made with the 130B, accurate within ±5%. A built-in calibrator which is accurate within ±2% permits quick verification and standardization of the amplifier gain.

Phase shift measurements can be made accurately with this oscilloscope over a wide range of input frequencies.

1-2 DAMAGE IN TRANSIT

This instrument should be thoroughly inspected when it is received. If any damage is evident, refer to the "Claim for Damage in Shipment" paragraph on the Warranty sheet in this manual.

1-3 POWER LINE VOLTAGES

The Oscilloscope is shipped from the factory wired for 115 volts ac line operation, unless otherwise specified. However, the instrument may also be operated from a 230 volts ac line source if the proper conversion is made to the power transformer. This conversion is described in the Maintenance Section (Section IV).

1-4 POWER CORD

The three conductor power cable supplied with the instrument is terminated in a polarized three prong male connector recommended by the National Electrical Manufacturers' Association. The third contact is an offset round pin, added to a standard two-blade ac plug, which grounds the instrument chassis when used with the appropriate receptacle. An adapter should be used to connect the NEMA plug to a standard two contact output. When the adapter is used, the ground connection becomes a short lead from the adapter which should be connected to a suitable ground for the protection of operating personnel.

1-5 INSTALLATION OF RACK MOUNT

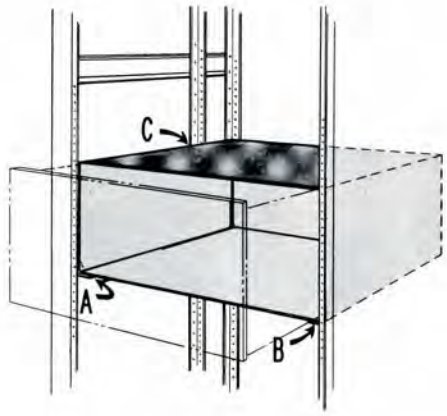
The hp 130BR is designed so that it can be supported in a 19 inch rack by the front panel in the usual manner; or, the dust cover may be rigidly mounted in the rack with brackets as shown in Figure 1-1. In the latter case, the chassis is supported by the dust cover and may be slipped in

or out easily; the screws through the front panel merely holding the chassis in place. To rack mount the 130BR using the brackets:

1) Mount the bracket as shown in Figure 1-1 with screws through the outside holes of the brackets. The length of these screws may be chosen to space the front panel from the panel rails as desired. The brackets at the rear are not necessary in most installations but can be used if added support is required. These brackets are available from the Hewlett-Packard Company as an accessory item.

2) Remove the dust cover from the 130BR and mount it in the brackets with the 10-32 trusshead screws provided.

3) Slip the 130BR into the dust cover and fasten in place with screws through the front panel.



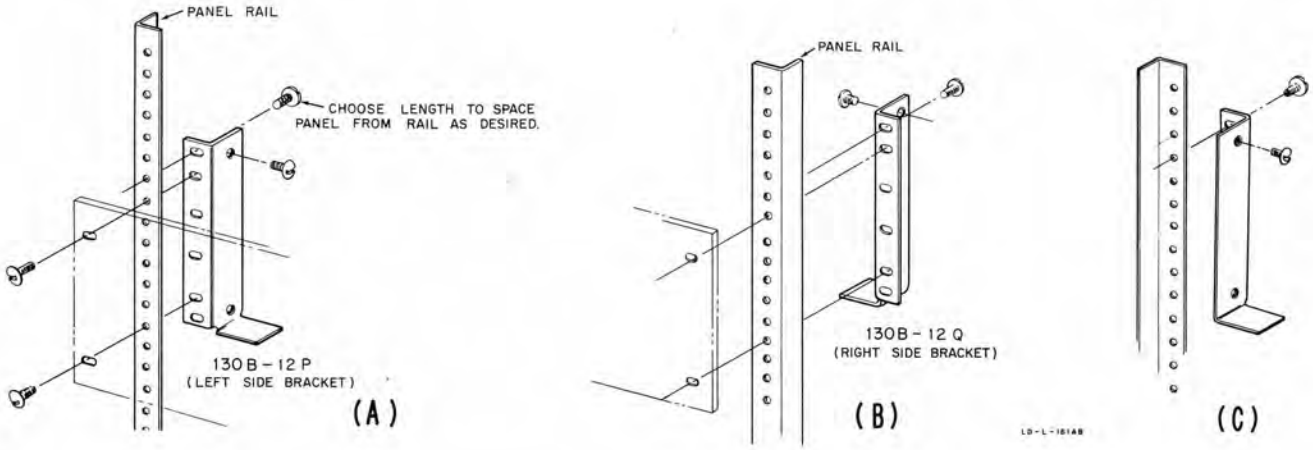


Figure 1-1. Model 130BR Installation

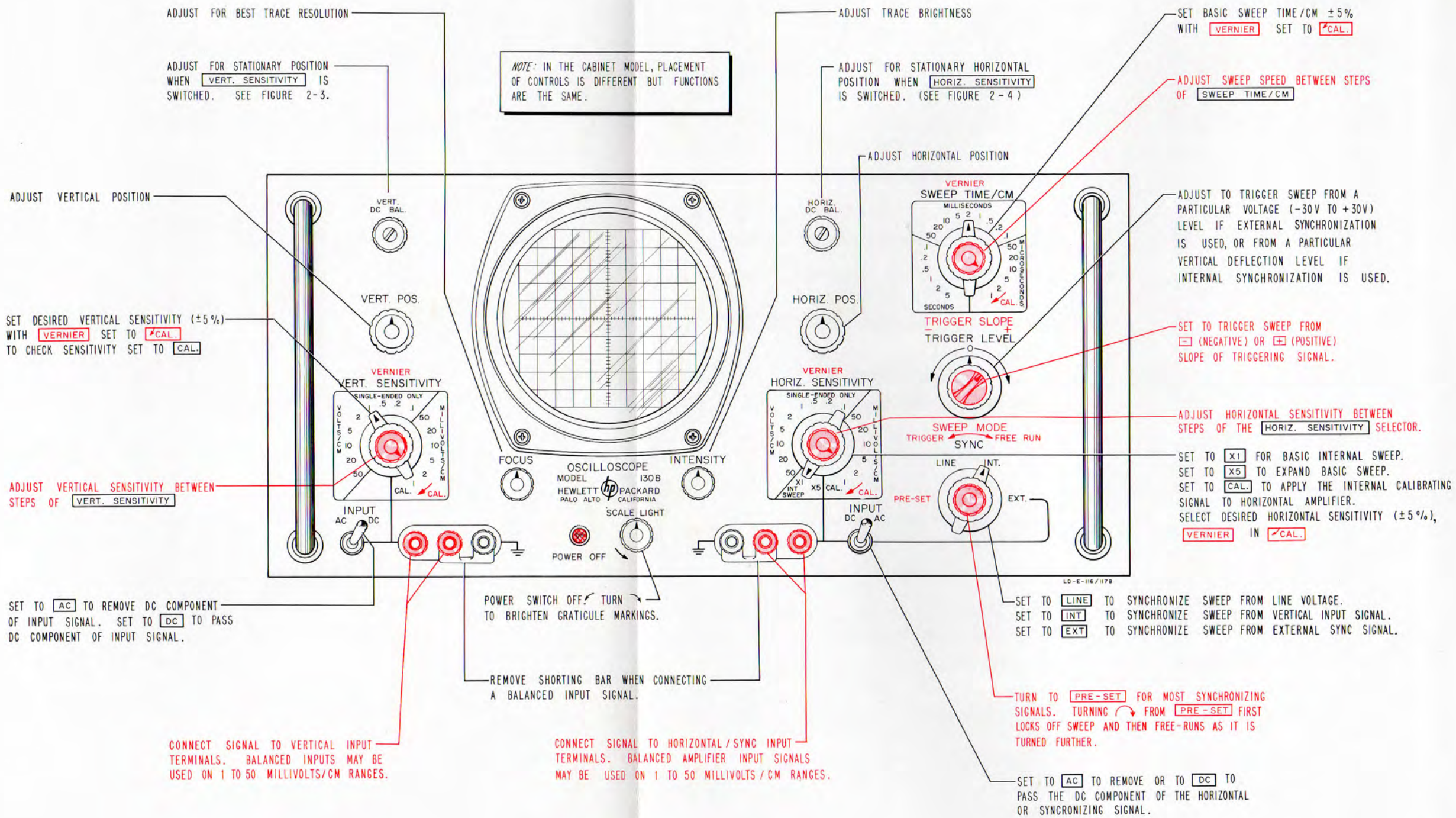
NOTES

FIGURE 2-1
OPERATING CONTROLS
AND TERMINALS

l.

BRATING

%),


ADJUST FOR BEST TRACE RESOLUTION
ADJUST FOR STATIONARY POSITION WHEN VERT. SENSITIVITY IS SWITCHED. SEE FIGURE 2-3.
NOTE: IN THE CABINET MODEL, PLACEMENT OF CONTROLS IS DIFFERENT BUT FUNCTIONS ARE THE SAME.
ADJUST TRACE BRIGHTNESS
ADJUST FOR STATIONARY HORIZONTAL POSITION WHEN HORIZ. SENSITIVITY IS SWITCHED. (SEE FIGURE 2-4)
ADJUST HORIZONTAL POSITION
SET BASIC SWEEP TIME/CM ±5% WITH VERNIER SET TO CAL.
ADJUST SWEEP SPEED BETWEEN STEPS OF SWEEP TIME/CM
ADJUST VERTICAL POSITION
VERT. DC BAL.
VERT. POS.
HORIZ. DC BAL.
HORIZ. POS.
VERNIER
SWEEP TIME/CM
MILLISECONDS
SECONDS
CAL.
TRIGGER SLOPE
TRIGGER LEVEL
ADJUST TO TRIGGER SWEEP FROM A PARTICULAR VOLTAGE (-30V TO +30V) LEVEL IF EXTERNAL SYNCHRONIZATION IS USED, OR FROM A PARTICULAR VERTICAL DEFLECTION LEVEL IF INTERNAL SYNCHRONIZATION IS USED.
SET DESIRED VERTICAL SENSITIVITY (±5%) WITH VERNIER SET TO CAL. TO CHECK SENSITIVITY SET TO CAL.
SET TO TRIGGER SWEEP FROM ⊟ (NEGATIVE) OR ⊞ (POSITIVE) SLOPE OF TRIGGERING SIGNAL.
VERNIER
VERT. SENSITIVITY
SINGLE-ENDED ONLY
VOLTS/CM
MILLIVOLTS/CM
CAL.
VERNIER
HORIZ. SENSITIVITY
SINGLE-ENDED ONLY
INT SWEEP
X1
X5
ADJUST HORIZONTAL SENSITIVITY BETWEEN STEPS OF THE HORIZ. SENSITIVITY SELECTOR.
SWEEP MODE
TRIGGER
FREE RUN
SYNC
LINE
INT.
EXT.
PRE-SET
SET TO X1 FOR BASIC INTERNAL SWEEP.
SET TO X5 TO EXPAND BASIC SWEEP.
SET TO CAL. TO APPLY THE INTERNAL CALIBRATING SIGNAL TO HORIZONTAL AMPLIFIER.
SELECT DESIRED HORIZONTAL SENSITIVITY (±5%), VERNIER IN CAL.
ADJUST VERTICAL SENSITIVITY BETWEEN STEPS OF VERT. SENSITIVITY
FOCUS
OSCILLOSCOPE
MODEL 130B
HEWLETT PACKARD
PALO ALTO CALIFORNIA
INTENSITY
SCALE LIGHT
POWER OFF
INPUT
AC
DC
LD-E-116/1178
SET TO AC TO REMOVE DC COMPONENT OF INPUT SIGNAL. SET TO DC TO PASS DC COMPONENT OF INPUT SIGNAL.
POWER SWITCH OFF. TURN TO BRIGHTEN GRATICULE MARKINGS.
SET TO LINE TO SYNCHRONIZE SWEEP FROM LINE VOLTAGE.
SET TO INT TO SYNCHRONIZE SWEEP FROM VERTICAL INPUT SIGNAL.
SET TO EXT TO SYNCHRONIZE SWEEP FROM EXTERNAL SYNC SIGNAL.
REMOVE SHORTING BAR WHEN CONNECTING A BALANCED INPUT SIGNAL.
TURN TO PRE-SET FOR MOST SYNCHRONIZING SIGNALS. TURNING FROM PRE-SET FIRST LOCKS OFF SWEEP AND THEN FREE-RUNS AS IT IS TURNED FURTHER.
CONNECT SIGNAL TO VERTICAL INPUT TERMINALS. BALANCED INPUTS MAY BE USED ON 1 TO 50 MILLIVOLTS/CM RANGES.
CONNECT SIGNAL TO HORIZONTAL/SYNC INPUT TERMINALS. BALANCED AMPLIFIER INPUT SIGNALS MAY BE USED ON 1 TO 50 MILLIVOLTS/CM RANGES.
SET TO AC TO REMOVE OR TO DC TO PASS THE DC COMPONENT OF THE HORIZONTAL OR SYNCRONIZING SIGNAL.

SECTION II
OPERATING INSTRUCTIONS

2-1 CONTROLS AND TERMINALS

Front panel operation controls are shown in Figure 2-1. This description of the operating controls enables you to operate the instrument if you have a basic knowledge of oscilloscope technique. Detailed operating procedures are given in the operating plates.

INTERNAL SWEEP CONTROLS

SWEEP TIME/CM -
This switch determines the speed at which the crt beam crosses the screen. HORIZ. SENSITIVITY switch must be in an INT. SWEEP position or internal sweeps are not generated. Associated with the SWEEP TIME/CM switch is a concentric VERNIER which provides continuous adjustment of sweep speed between steps. A X5 sweep magnifier operates on all ranges.

SYNC -
This three position switch lets the sweep be triggered either internally or externally. Internal triggering can be accomplished from a line frequency signal or from an applied vertical input signal of sufficient amplitude to produce a one-half centimeter deflection. External triggering can be produced by signals having amplitude greater than 0.5 volt, peak-to-peak.

SWEEP MODE -
As this control is rotated from the extreme clockwise position, the sweep generator will pass from an un-synchronized free-running (FREE RUN) condition through a condition where only triggered operation is possible (TRIGGERED) to a position in which sweeps will not occur. At the extreme counterclockwise position the control switches into a PRESET position. This position provides optimum triggering bias for nearly all waveforms.

TRIGGER LEVEL -
This continuous control selects the level on the sync waveform where triggering is to occur. When the TRIGGER LEVEL control is set to zero, the trigger circuits are the most sensitive.

TRIGGER SLOPE -
This two-position switch, concentric with TRIGGER LEVEL, permits triggering to occur on either the positive or negative slope of internal, external or line voltage sync signals.

Horizontal or Sync INPUT -
A set of three binding posts used for receiving external sync voltages and external generated sweeping voltages. On the rack mount model only, a 3-conductor receptacle J102, mounted at the rear of the instrument, is connected in parallel with the binding posts.

2-2 REAR-ACCESS TERMINALS

------DANGER - HIGH VOLTAGE-----

The following terminals are accessible through the rear access plate of the instrument cabinet: Horizontal and vertical deflection plates, and a terminal for crt intensity (Z-axis) modulation. See Figures 2-8 and 2-10.

2-3 WARM-UP DRIFT

When the oscilloscope is first turned on, drift in the trace will be quite noticeable, particularly at high sensitivities, the trace drift is fastest immediately following turn-on, becoming slower as the instrument warms up. Because of this drift, fine adjustment of amplifier balance should not be attempted until the instrument is thoroughly warm. For most purposes a 5 minute warm-up will be adequate.

2-4 AC OR DC COUPLING

AC coupling permits high gain to be employed without regard for the dc level involved. In the AC position the input signal (vertical or horizontal) is coupled to the amplifier through a capacitor which removes the dc component from the input. This coupling circuit has a low frequency cut-off at 2 cps. To avoid degrading input pulses or square waves below 200 cps it is advisable to use dc coupling. WHEN USING DC COUPLING THE AVERAGE VALUE OF THE DC DETERMINES THE POSITION OF THE SWEEP ON THE OSCILLOSCOPE. IF YOU ARE UNABLE TO FIND THE TRACE WITH THE VERTICAL POSITION CONTROL WHEN USING DC COUPLING, TRY AC COUPLING. When AC coupled the maximum dc that may be applied is 600 volts.

2-5 BALANCED INPUTS

The instrument will accept balanced input signals on the six most sensitive ranges. This arrangement is shown in Figure 2-7.

Driving the instrument from a balanced source can be very effective in removing the unwanted stray pickup that would otherwise obscure the desired information. To take advantage of the noise reduction that is possible with a balanced input, you must be sure that neither terminal of the source is connected to ground, and use double conductor shielded cable between the source and oscilloscope. The input cable shield must be connected to a suitable ground, either at the oscilloscope or some other point. With these precautions in the external input circuit, any stray signals (noise, hum, etc.) will be coupled equally to the two input terminals, and be cancelled by the differential amplifiers. Since the desired information is applied between the two input terminals, it will be amplified and displayed in the normal manner. Since the noise is a problem mainly at low level, the fact that balanced input is available only on the most sensitive ranges is generally not a serious limitation.

The common-mode signal rejection will be at least 40 db (1/100 of the input signal). When using a balanced input certain limitations must be considered. The proper operating levels must be maintained on the input amplifier: The COMMON-MODE SIGNAL VOLTAGE MUST NOT EXCEED 1.5 VOLTS EITHER POSITIVE OR NEGATIVE, ON EITHER INPUT TERMINAL. Note that this is the sum of all voltages (dc plus peak ac).

NOTE

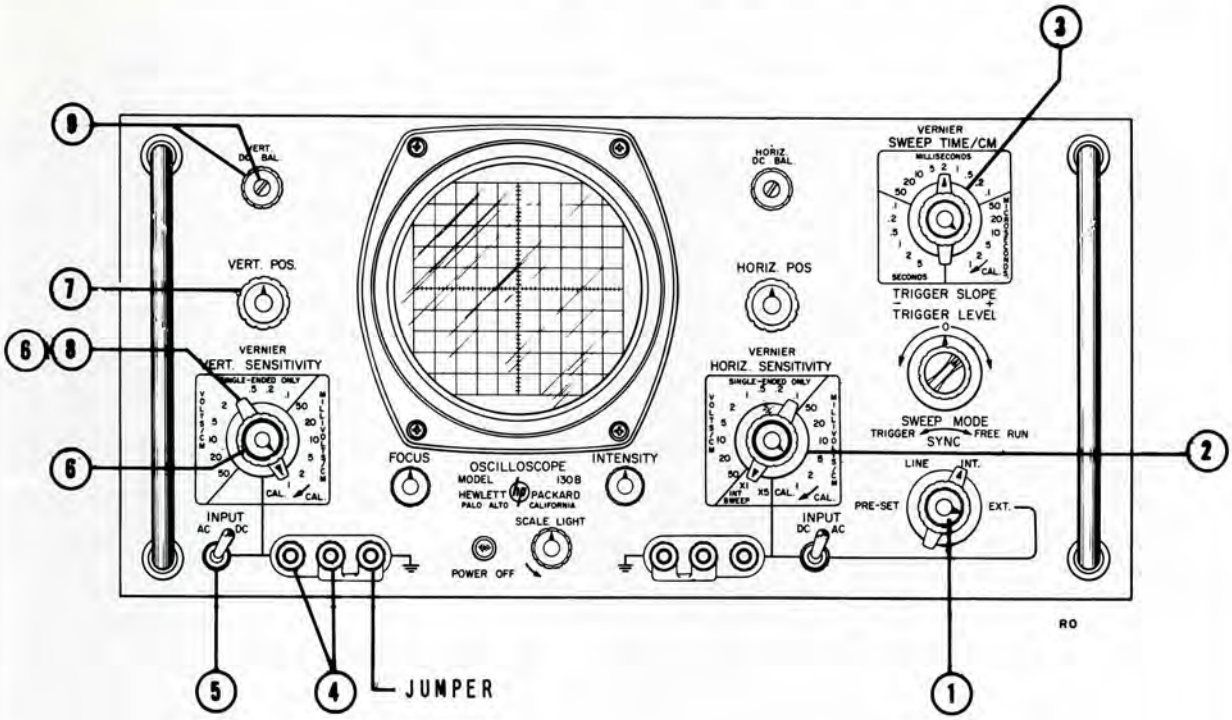
If balanced ac coupling is desired, it is necessary to connect a capacitor in the external signal path to the middle terminal, since a dc voltage on this terminal only unbalances the amplifier. This arrangement is shown in Figure 2-7.

2-6 OPERATING PROCEDURES

Basic operating procedures are described in the following illustrations. Positions of controls are different on the cabinet model but their functions are identical to those of the rack model.

Figure	Description
2-2	VERTICAL BALANCE ADJUSTMENT
2-3	HORIZONTAL BALANCE ADJUSTMENT
2-4	INTERNAL SWEEP-INTERNAL SYNCHRONIZATION
2-5	INTERNAL SWEEP-EXTERNAL SYNCHRONIZATION
2-6	EXTERNAL HORIZONTAL INPUT
2-7	AC COUPLING BALANCED INPUT
2-8	CONNECTION TO CRT DEFLECTION PLATES
2-9	EXTERNAL INTENSITY MODULATION
2-10	ALIGNING SCOPE TRACE WITH GRATICULE

VERTICAL BALANCE ADJUSTMENT



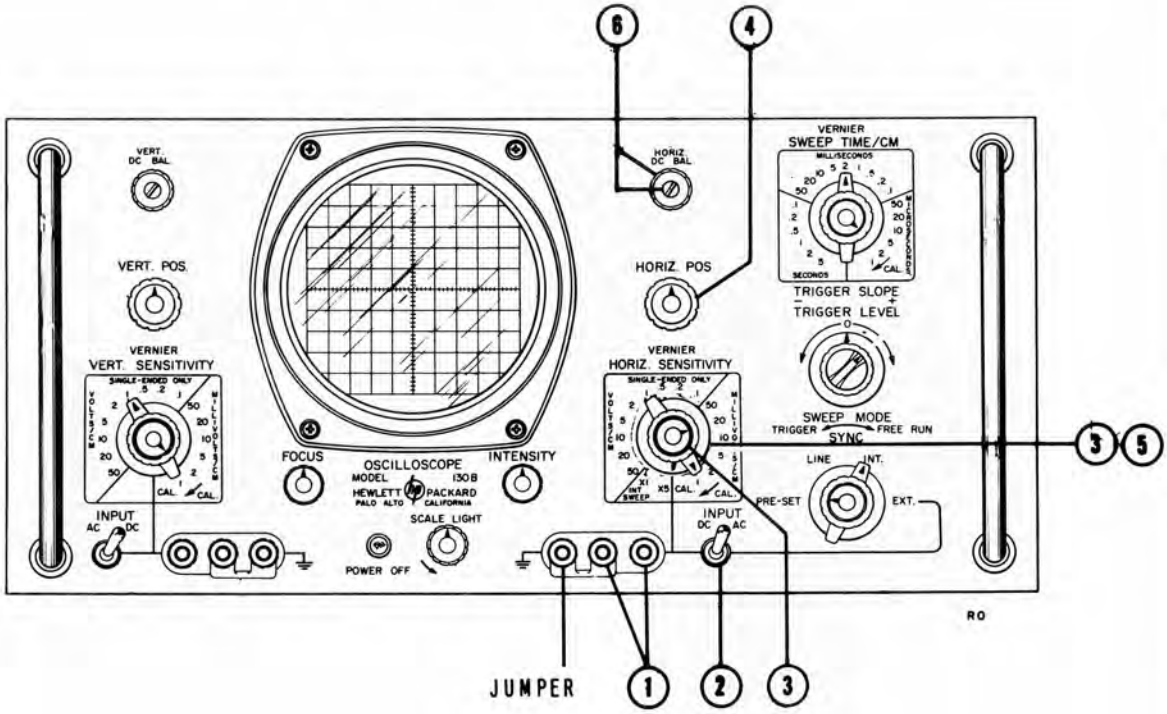
After Warm-up:

1. Turn SWEEP MODE control to FREE RUN.
2. Set HORIZ. SENSITIVITY switch to INT. SWEEP X1.
3. Set SWEEP TIME/CM switch so that a convenient base line is formed. (Any sweep time faster than 50 MILLISECONDS/CM is satisfactory.)
4. Short vertical input terminals together.
5. Set AC-DC switch to DC.
6. Set VERT. SENSITIVITY to CAL. Turn VERNIER to CAL.
7. Center bottom portion of calibration signal trace using VERT. POS. control.
8. Set VERT. SENSITIVITY to 1 MILLIVOLTS/CM.
9. Center trace with coarse (screwdriver) VERT. DC BAL. control or with fine (knob) control if unbalance is slight.
10. Repeat steps 6, 7,8 and 9 if necessary.

NOTE: A separate adjustment (Bal. Adj. on the etched board) is provided to balance the VERNIER.

Figure 2-2

HORIZONTAL BALANCE ADJUSTMENT



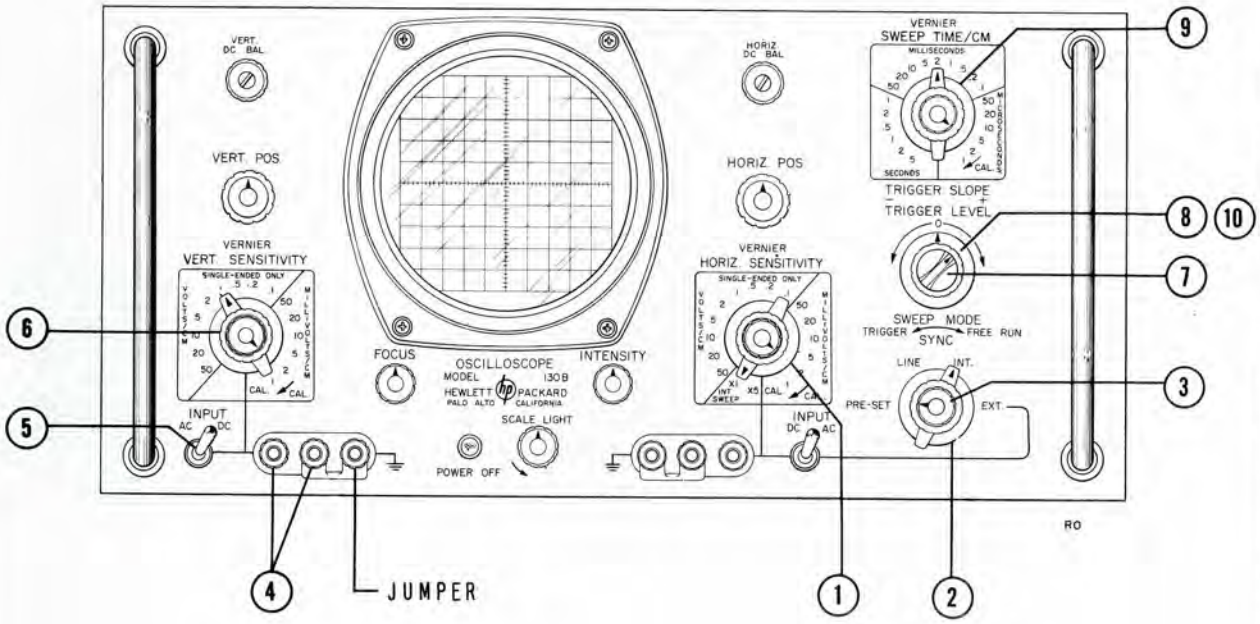
After warm-up:

1. Short together the horizontal INPUT terminals.
2. Set AC-DC switch to DC.
3. Set HORIZ. SENSITIVITY to CAL. Turn VERNIER to CAL.
4. Adjust the HORIZ. POS. control to place the left edge of the calibrating signal trace on the major vertical axis.
5. Set HORIZ. SENSITIVITY to 1 MILLIVOLT/CM.
6. Return the spot to the major vertical axis with the coarse (screwdriver) HORIZ. DC BAL. control or with the fine (knob) control if the unbalance is slight.
7. Repeat steps 2, 3 4, and 5 if necessary.

NOTE: A separate adjustment (Bal. Adj. on the etched board) is provided to balance the VERNIER.

Figure 2-3

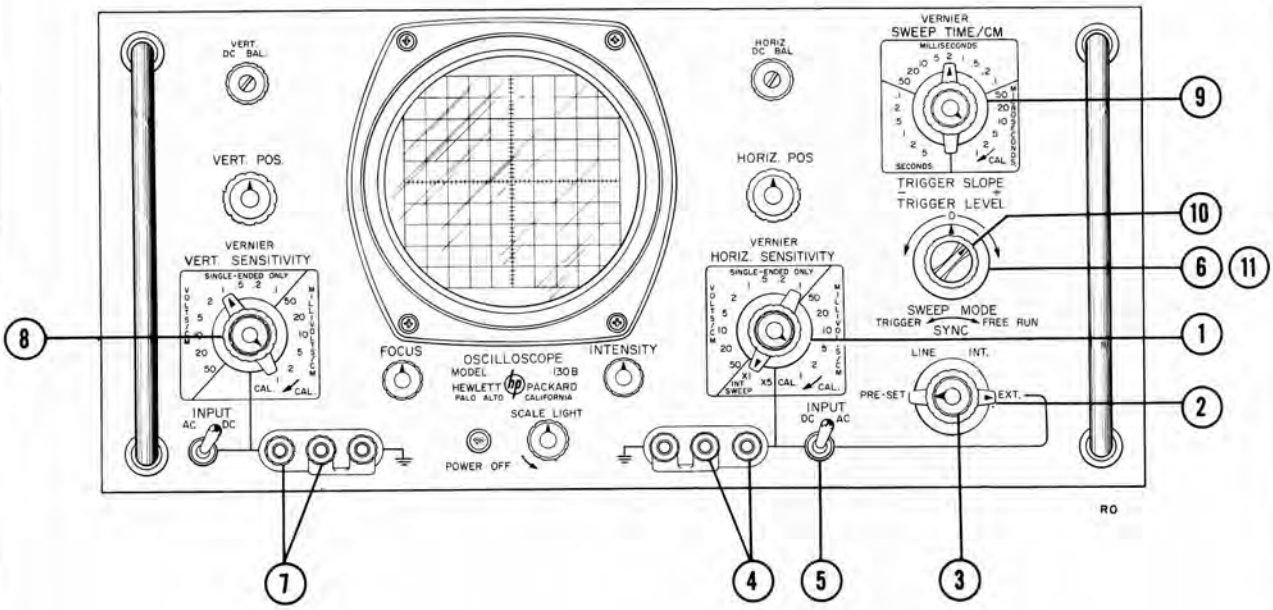
INTERNAL SWEEP - INTERNAL SYNCHRONIZATION



1. Set HORIZ. SENSITIVITY switch to INT. SWEEP X1 (or to X5 for magnified sweeps)
2. Set SYNC switch to INT.
3. Set SWEEP MODE to PRESET.
4. Connect vertical input signal into vertical input terminals.
5. Set AC-DC switch for type coupling desired.
6. Adjust VERT. SENSITIVITY for desired sensitivity.
7. Set TRIGGER SLOPE switch for triggering on positive or negative slope of input signal, as desired.
8. Set TRIGGER LEVEL control to 0.
9. Select desired sweep speed with SWEEP TIME/CM switch.
10. Adjust TRIGGER LEVEL to start trace at desired level. In some cases, it may be necessary to switch SWEEP MODE from PRESET to an individual adjustment for the particular trace being viewed.

Figure 2-4

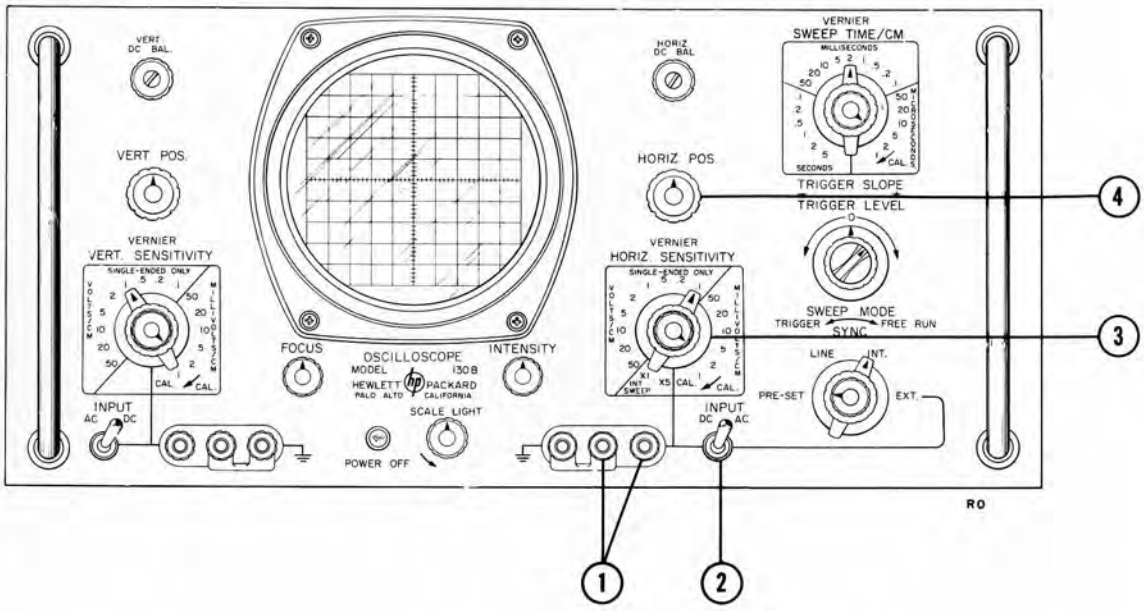
INTERNAL SWEEP - EXTERNAL SYNCHRONIZATION



1. Set HORIZ. SENSITIVITY switch to INT. SWEEP X1 (or to X5 for magnified sweeps).
2. Set SYNC switch to EXT.
3. Set SWEEP MODE to PRESET.
4. Feed synchronizing signal (0.5 volts p-p or more) to the horizontal input terminals.
5. Set AC-DC switch for type coupling desired.
6. Set TRIGGER LEVEL to 0.
7. Feed vertical input signal into vertical input terminals.
8. Adjust VERT. SENSITIVITY for desired sensitivity.
9. Select desired sweep speed with SWEEP TIME/CM switch.
10. Set TRIGGER SLOPE for triggering on positive or negative slope, as desired.
11. Adjust TRIGGER LEVEL to start trace at desired level. In some cases, it may be found necessary to switch SWEEP MODE from PRESET to an individual adjustment for the particular trace being viewed.

Figure 2-5

EXTERNAL HORIZONTAL INPUT

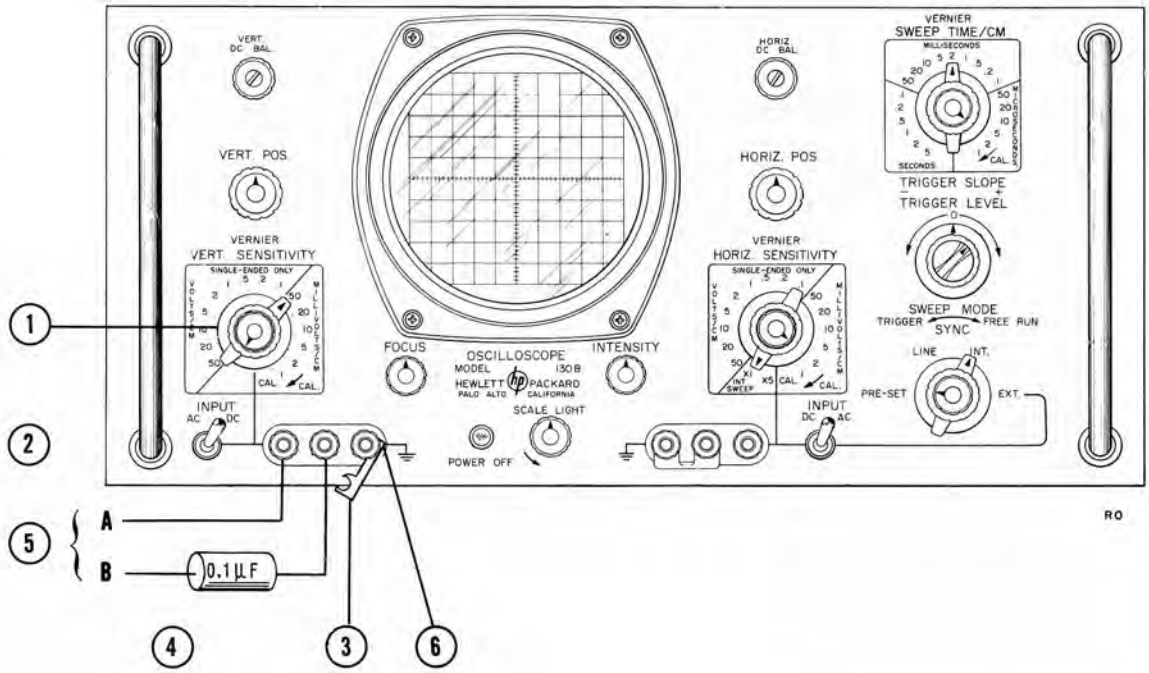


1. Feed horizontal signal to horizontal input terminals.
2. Set AC-DC switch for type of input coupling desired.
3. Set HORIZ. SENSITIVITY switch for desired sensitivity.
4. Adjust horizontal position of pattern with HORIZ. POS. control.

This type of input will be found useful for viewing Lissajous patterns, etc.

Figure 2-6

AC COUPLING BALANCED INPUT



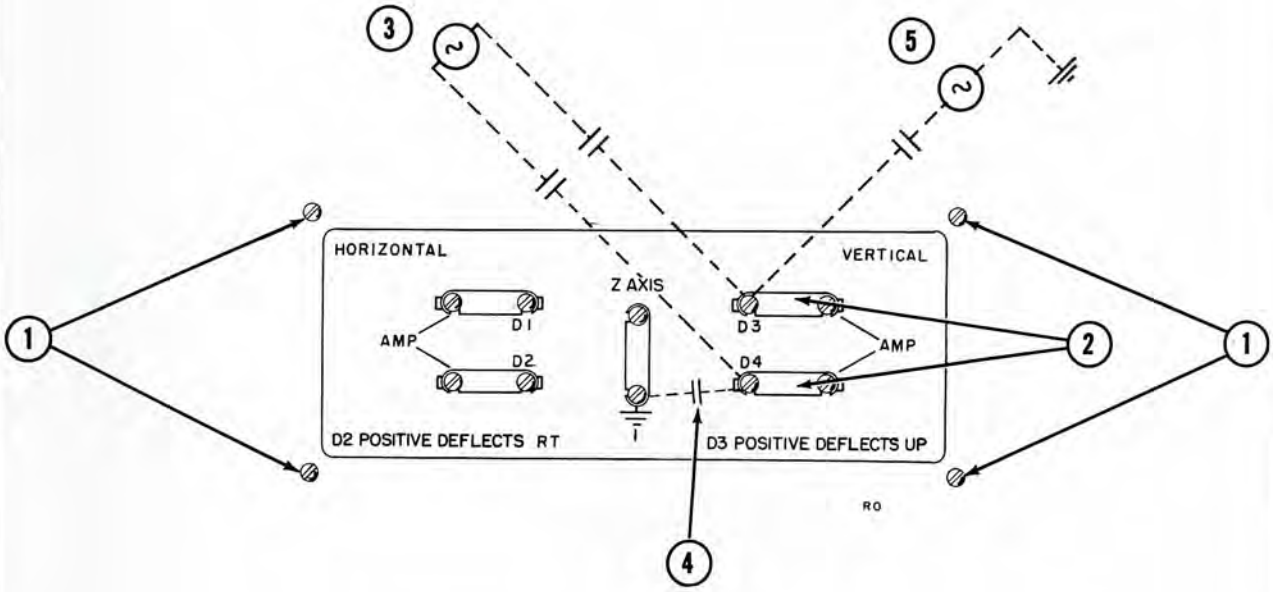
The following procedure is for the vertical input, but is the same for the horizontal input.

1. Set VERT. SENSITIVITY to 50 MILLIVOLTS/CM, input not balanced on higher ranges.
2. Set AC-DC switch to AC.
3. Disconnect shorting strap.
4. Connect 0.1 microfarad capacitor to mid-terminal.
5. Connect input signal to A and B.
6. Ground input at the black terminal.

The capacitor must be used to block any dc.

Figure 2-7

CONNECTION TO CRT DEFLECTION PLATES



The following procedure is for connecting external signals to the vertical deflection plates, but is the same for the horizontal plates.

1. Remove rear access plate fastened by four screws.

2. Remove the shorting bars between the Vertical Amplifier and terminals D3 and D4 and replace them with 1 megohm, 1/2 watt resistor.

For balanced AC coupling:

3. Connect balanced signal through appropriate capacitor to D3 and D4.

For single-ended AC coupling:

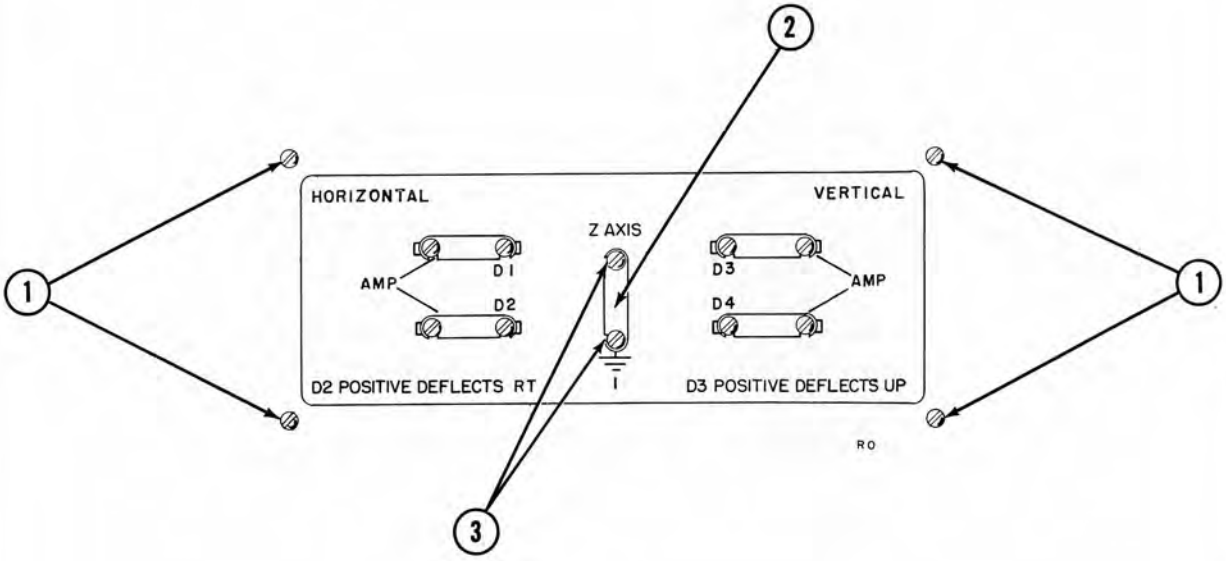
4. Bypass D4 to chassis with an adequate capacity.

5. Connect the signal to D3 through an appropriate capacitor.

NOTE: If it is desired to have positive voltage deflect the beam downward, bypass D3 to chassis and connect the signal to D4.

Figure 2-8

EXTERNAL INTENSITY MODULATION



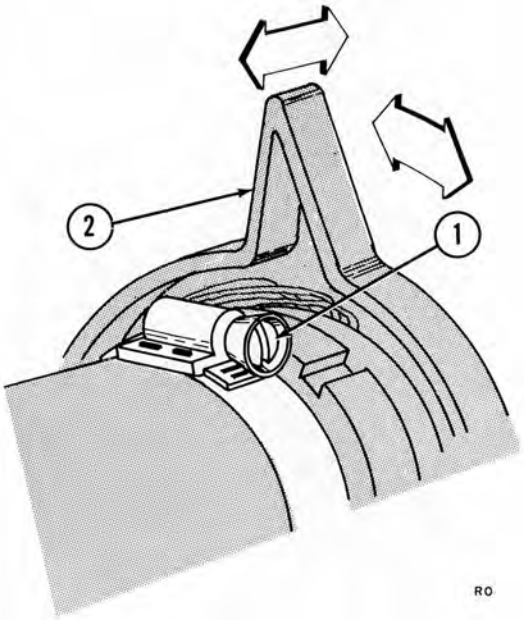
CAUTION: Dangerous Voltages are present on this terminal board. Be sure the instrument is turned off when making this connection.

To intensity modulate the CRT with external signals:

1. Remove rear access plate fastened by four small screws at rear of dust cover.
2. Remove shorting bar.
3. Connect modulating signal to these terminals. A positive voltage of 20 volts peak will blank the CRT trace from normal intensity.

Figure 2-9

ALIGNING SCOPE TRACE WITH GRATICULE



CAUTION: DANGEROUS VOLTAGES ARE PRESENT INSIDE THE INSTRUMENT

Remove two screws at rear of dust cover and slide cover off to rear. Fiber lever (2) controls both radial and longitudinal positioning of CRT and is locked by clamp (1).

To align sweep trace with graticule loosen clamp (1) with a screwdriver. Rotate fiber arm (2) until the trace is parallel to horizontal lines on graticule. Tighten clamp (1) after adjustment has been made.

Figure 2-10

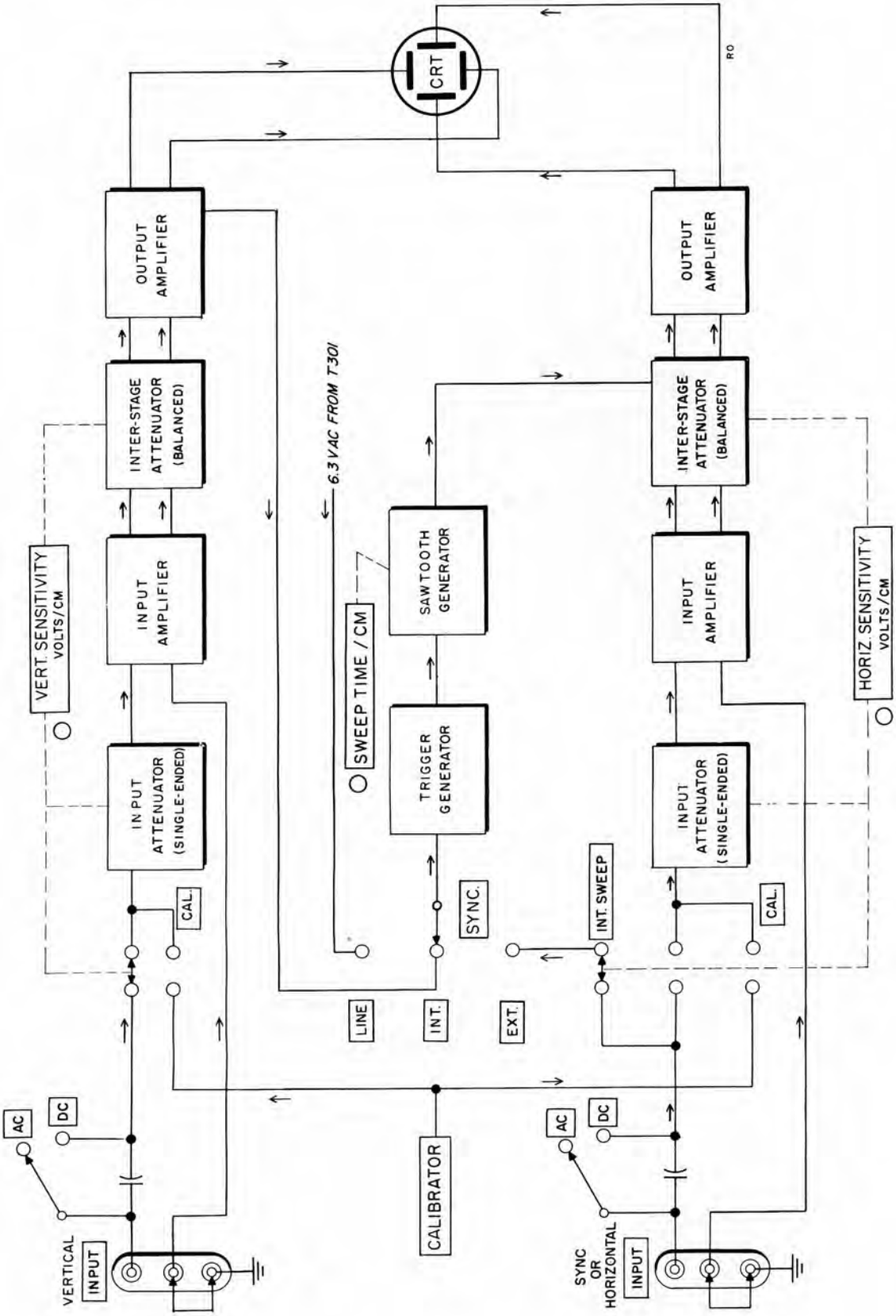


Figure 3-1. Model 130B Block Diagram

SECTION III
THEORY OF OPERATION

3-1 GENERAL CONTENT

This section contains a brief description of the over-all operation of the Model 130B Oscilloscope, description of each major section and detailed description of a Schmitt trigger.

3-2 OVER-ALL OPERATION

The block diagram in Figure 3-1 shows the basic circuits of the Model 130B Oscilloscope.

A. VERTICAL AMPLIFIER

The Vertical Amplifier receives the input signal, amplifies it, and drives the vertical deflection plates of the cathode ray tube. In addition, this amplifier determines the vertical position of the spot on the screen and supplies a signal for synchronizing the sweep with the vertical input signal.

B. HORIZONTAL AMPLIFIER

The Horizontal Amplifier receives its signal either from the horizontal INPUT jack or from the Sweep Generator, amplifies it and drives the horizontal deflection plates of the cathode ray tube. Except for the provisions in the Horizontal Amplifier for amplifying the internally-generated sawtooth voltage, it is essentially the same as the Vertical Amplifier.

C. SWEEP GENERATOR

The Sweep Generator forms a sawtooth voltage to control the horizontal movement of the spot across the face of the cathode ray tube. The Sweep Generator is divided into two parts: 1) a sawtooth generator, 2) a trigger generator, which starts the sawtooth. The trigger generator controls allow the operator to choose the point at which the sawtooth sweep begins.

In addition to forming the internal sweep of the oscilloscope, the Sweep Generator also supplies the required unblanking pulse which brightens the trace during each sweep.

D. CALIBRATOR

An internal square-wave calibrator, with a nominal frequency of 300 cps, is provided for setting the basic gain of the amplifiers. Turning either the VERT. or HORIZ. SENSITIVITY switches to CAL., turns on the calibrator supply voltage and connects its output to the appropriate amplifier.

E. CATHODE RAY TUBE

The cathode ray tube is a 5AQP - mono-accelerator type. It is normally supplied with a P1 phosphor screen but is available in the P7 and P11 phosphors also and P2 upon special order. All are electrically interchangeable and the tube is easily changed. The mono-accelerator anode makes possible a simple astigmatism adjustment which requires no resetting when adjusting the FOCUS or INTENSITY controls. The deflection plate terminals are connected through removable jumpers at the rear of the instrument so that direct connections to the plates can be made easily.

3-3 VERTICAL AMPLIFICATION CHANNEL

The vertical amplification channel consists of three parts: the AC-DC switch, the input attenuator, and the amplifier section proper.

A. AC - DC SWITCH

The signal comes into the input terminals and is fed to the AC-DC switch. For ac coupling, a capacitor is switched into the signal path. In the DC position, the signal goes directly to the input attenuator.

B. INPUT ATTENUATOR

The input attenuator is a sixteen position switch having fifteen calibrated ranges (1 MILLIVOLT/CM to 50 VOLTS/CM) and a calibrate position. When the switch is in the CAL. position, the input of the amplifier is directly connected to the output of the internal calibrator. On ranges less sensitive than 50 MILLIVOLTS/CM, single-ended frequency-compensated attenuators are inserted ahead of the Vertical Amplifier. On the six most sensitive ranges, balanced-type attenuators are inserted between the second differential amplifier (V2) and the third differential amplifier (V3). On the six most sensitive ranges, balanced input signals may be applied to the input terminals after removing the jumper to the ground terminal. The sensitivity may be varied continuously between ranges by means of the VERNIER control.

C. VERTICAL AMPLIFIER

The Vertical Amplifier consists of four stages of balanced differential amplifiers* in cascade. The first stage (V1) has the VERT. DC BAL. adjustment (R10A, B) in its cathode circuit which adjusts the current division between the two halves of the stage. The second stage has a VERNIER control in the cathode circuit which varies the gain of the amplifier between ranges of the VERT. SENSITIVITY switch, and another dc balance adjustment (R20) is also provided. In the last three stages, neutralizing capacitors are used to cancel the coupling effects between the input and output of the amplifier arising from the inter-electrode capacitances. The output of the second stage is fed to the balanced attenuator of the VERT. SENSITIVITY switch. The output of the balanced attenuator is connected to the third balanced differential amplifier (V3). The third stage has two potentiometers in its cathode circuit, one controls the vertical position of the pattern (VERT. POS) and the other adjusts the basic gain of the Vertical Amplifier (R40, Gain Adj.). The fourth balanced differential amplifier (V4) is the output stage. The neon lamps in the grid-cathode circuit of V4 protect the tube when the Model 130B is first turned on. The output of V4 drives the vertical deflection plates of the cathode ray tube. In addition, synchronization signals are coupled from the plates of V4 and coupled into the Sweep Generator to trigger the sweep during either INTERNAL + or INTERNAL - synchronization. As a precaution against drift and hum, a regulated dc supply is used for the heaters of the first three stages.

* Valley and Wallman, "Vacuum Tube Amplifier", Massachusetts Institute of Technology Radiation Series, vol. 18, pp 441-451. McGraw-Hill Book Company, Inc., New York, 1948.

3-4 HORIZONTAL AMPLIFICATION CHANNEL

The Horizontal Amplifier is essentially identical to the Vertical Amplifier, except in the INT. SWEEP X1 and X5 position of the HORIZ. SENSITIVITY switch. In these positions, the sawtooth signal from the Sweep Generator is fed through the sweep attenuator to the grid of V103, the third balanced differential amplifier. In the INT. X5 position, R164, X5 Mag. Adj., in the cathode circuit of V104 sets the gain of the amplifier to obtain sweep magnification of X5. The output of V104 drives the horizontal deflection plates of the cathode ray tube.

3-5 SWEEP GENERATOR

The sweep generator provides a sawtooth voltage to produce linear horizontal movement of the spot across the face of the cathode ray tube when the HORIZ. SENSITIVITY switch is set to INT. SWEEP (X1 or X5). In addition, the sweep generator furnishes the pulse required to unblank the cathode ray tube during each sweep.

The sweep generator consists of a Trigger Generator, a Sawtooth Generator, and a Gate Out Cathode Follower.

A. TRIGGER GENERATOR

The purpose of the Trigger Generator is to receive a synchronizing signal and convert it into a fast, constant-amplitude pulse to start the Sawtooth Generator.

The Trigger Generator consists of a SYNC selector switch (S201), a Trigger Amplifier (V201), and a Trigger Generator (V202). The SYNC selector switch accepts a signal from:

1) the Vertical Amplifier (internal synchronization, + or -),
2) an internal 6.3 volt source (line-frequency synchronization), or
3) the horizontal INPUT terminals (external synchronization).

The synchronizing signal is fed to V201 which amplifies the signal and delivers it in the proper phase, as selected by the TRIGGER SLOPE switch, to the Trigger Generator. Adjustment of the TRIGGER LEVEL control sets the output level of V201, determining the point on the input waveform that will trigger the Trigger Generator (V202). Trigger Generator (V202) is a Schmitt trigger circuit; a discussion of the Schmitt trigger follows:

A Schmitt trigger consists of two amplifiers, A and B, having both plate-to-grid and cathode-to-cathode coupling. The circuit has two stable states: A side conducting, B side cut off; B side conducting, A side cut off. Due to regenerative action the change-over from one state to the other is very rapid, producing fast rise and decay times in the square-wave output. The levels at which the change-over takes place (hysteresis limits) can be adjusted to be close together as in the Trigger Generator (V202) or widely spaced as in the Start-Stop Trigger (V203). To trigger the circuit, the A side grid voltage must cross a particular hysteresis limit to change the state of the circuit. For example, if the A side is conducting, driving the grid voltage positive through the upper hysteresis limit will have no effect, but driving the grid voltage negative through the lower hysteresis limit will put the A side out of conduction and B side into conduction.

B. SAWTOOTH GENERATOR

The Sawtooth Generator consists of Start-Stop Trigger (V203), and Integrator Switch (V205), a Feedback Integrator (V206B), and Integrator Cathode Follower (V206A), and a Retriggering Hold-Off Cathode Follower (V207B).

Start-Stop Trigger (V203), a Schmitt trigger circuit, is fed by Trigger Generator (V202). The square wave output of V203 is fed directly to the Integrator Switch (V205), which in turn controls the action of Feedback Integrator (V206B). When V203 produces a negative pulse,it causes V205 to cut off permitting V206B to commence operation.

Feedback Integrator (V206B), a Miller integrator circuit*, generates essentially a positive linearly rising waveform, which is applied to the Horizontal Amplifier to sweep the trace across the face of the cathode ray tube. The rate at which this sweep takes place is determined by the values of the RC network in the grid circuit of V206B. These values are varied by the SWEEP TIME switch. The output of V206B is fed through a neon lamp (I203) to the Integrator Cathode Follower (V206A). Neon lamps (I204 to I206) are used to drop the voltage to the proper level and at the same time furnish a direct-coupled path for the signal. The neon lamps are shunted with a capacitor to improve the high-frequency response of the circuit, and a series resistor is used to eliminate any tendency toward oscillation.

The output of the Integrator Cathode Follower (V206A) is fed to two circuits: 1) through the sweep attenuator to the Horizontal Amplifier and 2) to the Retriggering Hold-Off Cathode Follower (V207B) in the Sawtooth Generator feedback circuit. During the Sweep, V207B conducts and the capacitor in its cathode circuit charges. However, at the termination of the sweep, V207B is cut off and the cathode capacitor discharges, maintaining a positive bias on the grid of V203A. This hold-off bias allows sufficient time between sweeps for the Sweep Generator to recover. The bias which determines the triggering level of the Start-Stop Trigger (V203A) is supplied by the Retriggering Bias Control (V207A). The bias is adjusted by the SWEEP MODE control, R218, in the grid circuit of V207A.

C. GATE OUT CATHODE FOLLOWER

Another function of the Start-Stop Trigger is to furnish a pulse to unblank the cathode ray tube. The Gate Out Cathode Follower (V204), couples the required positive unblanking pulse from the Start-Stop Trigger to the grid of the crt for the duration of the sweep.

3-6 LOW VOLTAGE POWER SUPPLY

The low-voltage power supply consists of four regulated voltage supplies, three positive (+585V, +300V, +100V) and one negative (-150V), furnishing the plate voltages and dc filament voltages required for the instrument.

The operation of each of the four regulators is similar; only the -150 volt supply will be discussed. V306, V307 and V308 constitute the voltage regulator circuit for the -150 volt supply. V308, a glow discharge tube, probides a reference voltage for the cathode of V307, the

* Millman and Taub, "Pulse and Digital Circuits" pp 216-228, McGraw-Hill Book Company, Inc., New York, 1956.

Control Tube. V306, a Series Regulator, is controlled by the voltage at the plate of V307. If the output voltage from the rectifier increases, the bias of V307 decreases, causing V307 to draw more current. This lowers the plate voltage of V307 and the grid voltage of V306, resulting in greater plate resistance for V306. Increased plate resistance causes a greater voltage drop across V306, compensating for the increased output voltage from the rectifier and resulting in substantially constant output.

If the output voltage from the rectifier decreases, the reverse of the above action occurs. Changes in supply voltage due to changes in load current are minimized in the same manner. Thus, the output voltage is held essentially constant. The output of the -150 volt supply serves as the reference voltage for the three positive-voltage supplies.

3-7 HIGH-VOLTAGE POWER SUPPLY

The high-voltage power supply provides regulated dc voltage to the cathode and control grid of the cathode ray tube. The high-voltage power supply consists of an RF Oscillator tube (V313), a high-voltage transformer (T302), high-voltage rectifiers (V310,311) and a High-Voltage Control Tube (V312). The RF Oscillator, a Hartley circuit, oscillates at a frequency of approximately 100 kc. The high-voltage transformer has two separate secondaries which feed the High-Voltage Rectifiers.

The output of V310 is connected to the cathode of the cathode ray tube. A fraction of this voltage is fed to the High-Voltage Control Tube V312, a dc-coupled amplifier. The output of V312 is fed back to the screen of RF Oscillator tube (V313) in proper phase to oppose any change in the high-voltage output. The INTENSITY control in the output of this supply determines the voltage on the cathode of the cathode ray tube.

The output of V311 is connected to the control grid of the cathode ray tube, and normally the crt beam is cut off. During the sweep operation, a positive pulse from the Gate Out Cathode Follower (V204) in the Sweep Generator circuit overrides the negative crt grid cutoff voltage and unblanks the cathode ray tube. The brilliance of the trace may be adjusted with the Intensity Adjust potentiometer (R343), in series with grid-voltage supply.

3-8 CALIBRATOR

The Calibrator, a square-wave oscillator, produces an accurate voltage across R244 for application to either amplifier for setting the basic gain. Turning either the VERT. or HORIZ. SENSITIVITY switches to CAL. turns on the Calibrator and connects its output to the appropriate amplifier.

The Calibrator consists of two neon lamps (I 207 and I 208) in a relaxation oscillator circuit. Operation of the Calibrator is as follows:

When the +300 volt supply is applied to the Calibrator, I 207 will ionize first due to higher potential across it compared to the potential across I 208. When I 207 fires it will draw current through R243. However, the voltage at the junction of R242, C213 and R243 will build up slowly because the voltage across a capacitor cannot change instantaneously. As C213 allows this voltage to change, the voltage at the common junction of I 207 and I 208 will also change, since the voltage drop across the ionized neon lamp is constant (approximately 60 volts). As the voltage at the common junction of I 207 and I 208 reaches approximately +70 volts, I 208 will fire. This additional current through R240 and R241 will reduce the voltage across I 207 and it will de-ionize. I 208 remains lit until the voltage across C213 charges through R243 to a voltage approximately 70 volts below the voltage that appears at the common junction of I 207 and I 208. I 207 will now fire and the action will repeat itself.

I 208 is thus alternately turned off and on at a rate of approximately 300 cps. The output of the Calibrator is taken from the current passing through R244 and I 208. The output is approximately a square wave which can be set with R240 to obtain 300 millivolts in amplitude.

SECTION IV
MAINTENANCE

4-1 INTRODUCTION

This section contains instructions for testing, adjusting, and trouble shooting the Model 130B Oscilloscope.

Standard, readily available components are used for manufacture of hp instruments whenever possible. Special components are available through your local hp Representative who maintains a part stock for your convenience.

When ordering parts, specify instrument model and serial number plus the component description and stock number appearing in the Table of Replaceable Parts.

Your local hp Representative maintains complete facilities and specially trained personnel to assist you with any problems you may have with hp instruments.

The material in this section is divided according to circuit functions, each section having a complete set of adjustment instructions. The material in this section is as follows:

4-2 Simple Check Procedure
4-3 Isolating Troubles to Major Sections
4-4 Removing the Cabinet
4-5 Connecting for 230 Volt Operation
4-6 Tube Replacement
4-7 Condensed Test and Adjustment Procedure
4-8 Adjustment Procedure
4-9 Turn On
4-10 Power Supplies
4-11 Replacing and Adjusting the CRT
4-12 Checking and Adjusting the Calibrator
4-13 Adjusting the Vertical Amplifier
4-14 Adjusting the Horizontal Amplifier
4-15 Phase Shift Adjust
4-16 Adjusting Preset
4-17 Adjusting the Sawtooth Generator and Sweep Amplifier

The following test equipment is used for testing and adjusting the Model 130B Oscilloscope during manufacture. Equivalent test equipment may be used.

1) A high impedance dc vacuum tube voltmeter, such as an hp Model 410B with an hp Model 459A DC Voltage Multiplier.

2) A high impedance ac vacuum tube voltmeter, such as an hp Model 400D/H/L.

3) A variable power line transformer with a minimum rating of 3 amps.

4) A square-wave generator such as an hp Model 211A.

5) A sine-wave oscillator with a maximum frequency of at least 500,000 cycles, such as an hp Model 200CD.

6) An accurate time mark generator suitable for sweep speed calibration.

4-2 SIMPLE CHECK PROCEDURE

This check should be performed first whenever instrument malfunction is suspected. It is not necessary to remove the instrument from the cabinet.

Set both VERT. and HORIZ. SENSITIVITY switches on CAL. The pattern should be a straight line tilted at 45 degrees. In addition, the deflection should be a total of six centimeters in the horizontal and vertical directions.

If the proper pattern is obtained, it is likely that both the Vertical and Horizontal Amplifier, the Power Supplies and the Calibrator are functioning properly. To check the Sweep Generator proceed as follows:

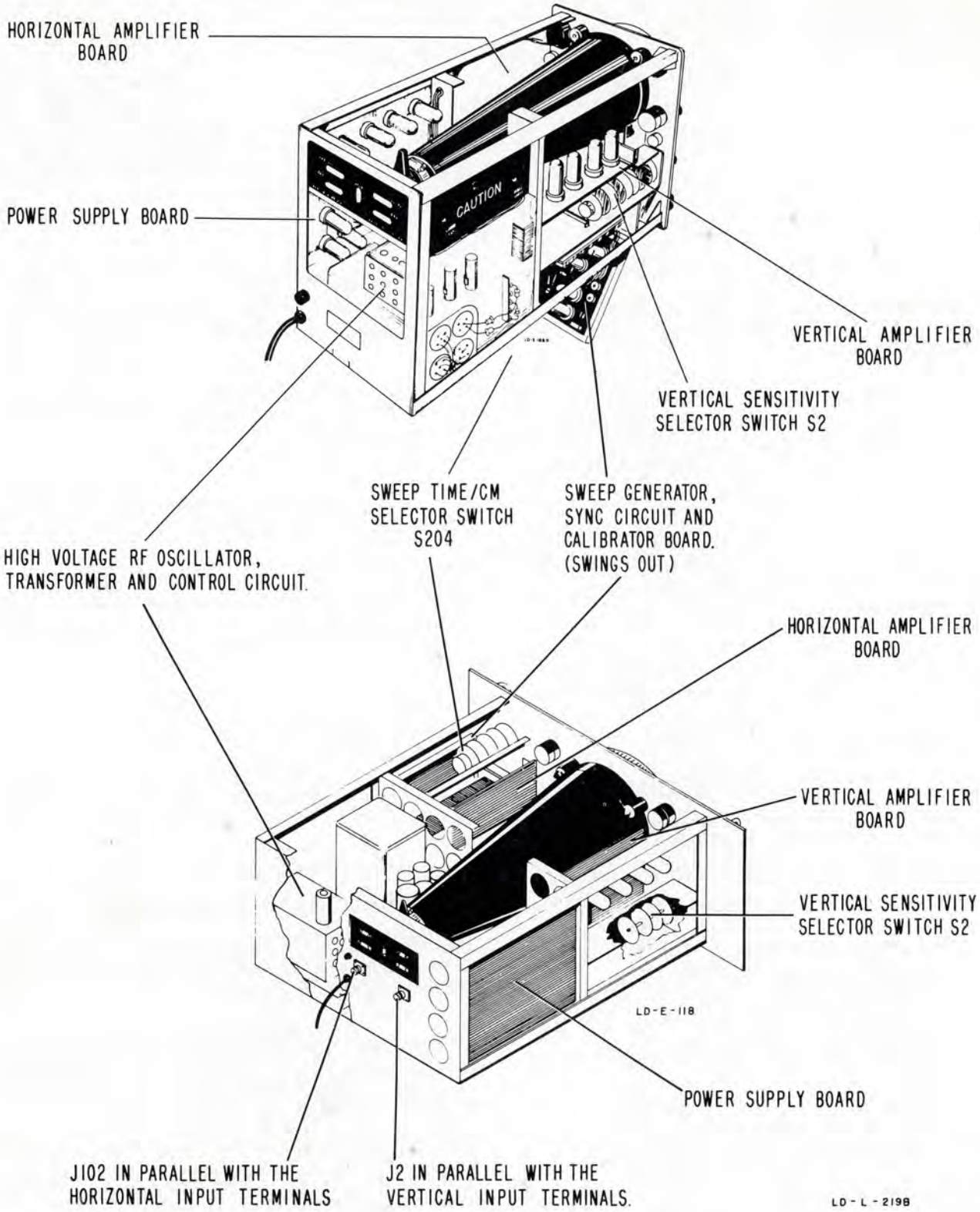


Figure 4-1. Location Diagram for Major Circuits

1) Leaving the VERT. SENSITIVITY switch in CAL, switch HORIZ. SENSITIVITY switch to INT. SWEEP X1.

2) Switch SWEEP TIME/CM switch to 1 MILLISECOND. A six centimeter square-wave pattern should appear on the screen. If no pattern is obtained be sure SWEEP MODE is in PRESET, SYNC switch is in INT., and adjust TRIGGER LEVEL to trigger. If a pattern cannot be obtained, the malfunction is most likely in the Sweep Generator.

4-3 ISOLATING TROUBLES TO MAJOR SECTIONS

Determining which major section contains a malfunction is usually not a difficult process, if the following general rules are remembered.

1) A failure affecting all major sections can usually be traced to the power supply.

2) A failure occurring in the last two stages of the Horizontal Amplifier also will affect internally generated sweeps, while a failure in the first two stages affects only the Horizontal Amplifier.

3) A sweep Generator failure affects internally generated sweeps only, and does not affect the Horizontal Amplifier.

4) If following the Simple Check Procedure does not produce a trace or spot on the screen, measure the voltages on the deflection plates of the Cathode-Ray Tube (deflection plate terminal board is a convenient place to measure). If, with both VERT. and HORIZ. SENSITIVITY switches set to 50 MILLIVOLTS/CM, these voltages can be set to approximately 480 vdc using the position controls, look for trouble in the high voltage section of the power supplies. If one set of deflection plates has unbalanced voltages, or if the position control must be turned far from its mechanical center to balance these voltages, look for trouble in that amplifier. If both sets of deflection plates have unusual voltages, look for trouble in the power supply.

5) If the series heater string should open, all major sections will be inoperative.

6) The two sides of the direct-coupled differential amplifier, such as are used in the Vertical and Horizontal Amplifiers on the 130B, are balanced and, unless a signal is present, the spot will be motionless in the center of the screen. Any signal, whether this signal is applied to the input terminals or is supplied by an internal source, such as a positioning or balance control, causes the spot to move from the center of the screen. As the instrument ages it is to be expected that a drift will occur which must be compensated by internal adjustments. However, should there be a component failure in either amplifier the spot will be thrown off the screen and usually out of range of adjustment of the balance and positioning controls. To isolate the trouble, begin by shorting together the grids of the amplifier closest to the output. If the trace (spot) returns to the screen, the fault is ahead of this stage. Proceed towards the front of the amplifier. If shorting the grids of one stage does not return the spot to the screen, the fault is in this stage, or if there is a balancing control in this stage, it may be out of adjustment.

7) To check the Sweep Generator quickly, set the SWEEP TIME/CM switch to 5 or 10 MILLISECONDS/CM, turn the SWEEP MODE control to FREE RUN, and observe I201, I202 and I203. These are the three neon lamps near V206 (6AW8) on the Sweep Cenerator etched circuit board. If these lamps flicker regularly, the Sweep Generator is sweeping. Turning the SWEEP MODE into the TRIGGER region should stop the generation of sweeps and, hence, the flickering of the neon lamps.

4-4 REMOVING THE CABINET

In the cabinet model, remove the two screws at the rear of the cabinet, and push the instrument forward.

If the 130BR has been rack-mounted with brackets as described in Figure 1-1, remove the screws which pass through the front panel, and withdraw the chassis. If the instrument is out of the rack, turn it on its face (handles will protect the controls), remove the two screws at the rear, and lift off the dust cover.

4-5 CONNECTING FOR 230 VOLT OPERATION

Unless otherwise requested by the customer, ⓗⓟ instruments are shipped with their power transformer primaries connected in parallel for operation on 115 volt (nominal) power lines.

To convert to 230 volt supply, remove the instrument from its cabinet or dust cover by removing the two screws at the rear of the chassis, and

push the chassis forward. At the primary of the power transformer (marked A), remove the wires connecting terminals 2 and 5, and 1 and 4. Then connect 1 to 2 as shown in Figure 4-2, and replace the 2 amp slow-blow fuse (F301) with a 1-1/4 amp slow-blow fuse. The instrument may now be connected to the 230 volt line.

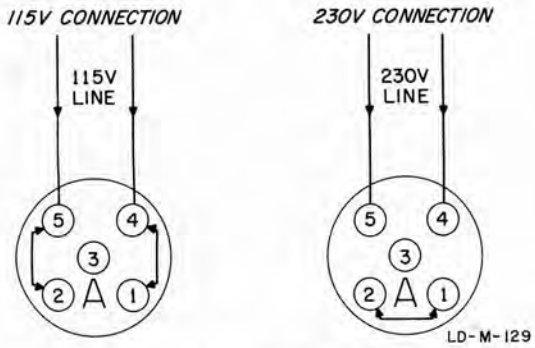


Figure 4-2. Line Voltage Connection

-6 TUBE REPLACEMENT

In many cases instrument malfunction can be corrected by replacing a weak or defective tube. Before changing the setting of any internal adjustment, check the tubes. Adjustments made in an attempt to compensate for a defective tube will often complicate the repair problem.

It is a good practice to check tubes by substitution rather than by using a "tube checker". The results obtained from the "tube checker" can be misleading. Before removing a tube, mark it so that if the tube is good it can be returned to the same socket. Replace only tubes proved to be weak or defective.

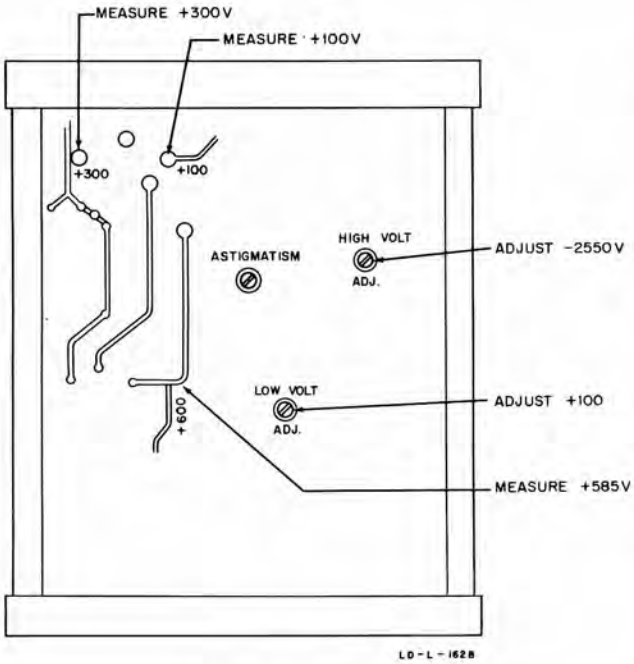
Any tube with corresponding standard EIA (JEDEC) characteristics can be used as a replacement. Where variation in tube characteristics will affect circuit performance, an adjustment is provided. The following table lists the tests and adjustments which should be performed if such tubes are replaced.

The chart in Table 4-2 lists all tubes in the 130B with their functions and adjustments required when replacing tubes. The heaters of some tubes are operated in series from a regulated dc voltage obtained from the Low-Voltage Power Supply. These tubes are identified in the chart with an asterisk and their heaters are shown in the Filament and Primary Detail Schematic. If a tube in the dc string is pulled or burned out, all tubes in the string will be turned off.

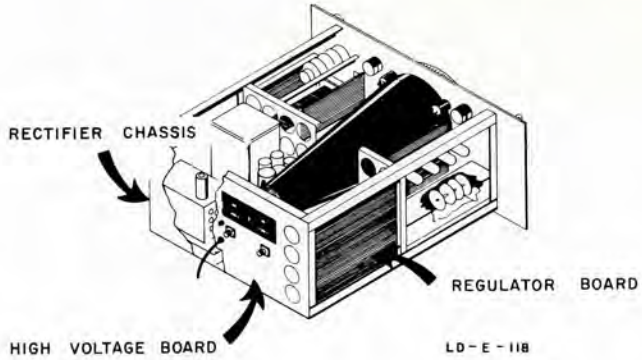
TABLE 4-1.
CONDENSED TEST AND ADJUSTMENT PROCEDURE

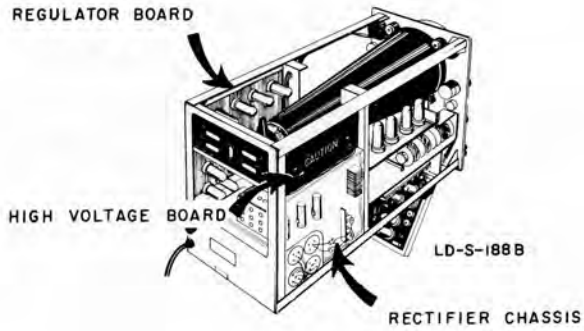
TABLE 4-1. CONDENSED TEST AND ADJUSTMENT PROCEDURE

Test	External Equipment Required	Procedure	Adjust	Notes
1. Low Voltage Power Supply	DC vtvm with 1% accuracy	Measure all low voltage power supply outputs should be within the following limits: -150 ± 6 volts +100 ± 4 volts +300 ±12 volts +585 ±25 volts	If voltages are outside limits, adjust R332 for -150 volts.	Check sweep calibration if -150V is adjusted.
2. Vertical amplifier balance	NONE	HOR.SENS. to INT.SWEEP X1, SWEEP MODE to free-run, SYNC to INT., SWEEP TIME to 1.0 ms/cm, short-circuit input terminals and set INPUT for DC. VERT. SENS. and Vernier to Cal.	Center bottom of calibrating signal with VERT.POS. control	Repeat as required.
		VERT.SENS. to 1 mv/cm, Center VERT.DC.BAL control (knob).	Center trace with coarse balance control. (Screw adjustment in center of DC BAL control.)	
3. Vertical VERNIER balance	NONE	Short circuit input terminals and set INPUT for DC. VERT.SENS. to 1 mv/cm, VERNIER to Cal.	Center spot (or trace) with VERT. POS. control.	Repeat as required.
		VERNIER fully CCW	Return spot to center with R20	
4. Vertical amplifier gain	400 cycle Voltage Calibration Generator	VERT.SENS. to 50 mv/cm. VERNIER to Cal. Connect 300 mv p-p from Calibration Generator to vertical input.	Adjust R40 for 6 cm deflection.	
	Square Wave Generator	Connect 50 kc square wave to Vert. Input. Adjust square wave generator for 6 cm deflection. SYNC to INT, Adjust SWEEP MODE and TRIGGER LEVEL for stable picture.	Adjust C12 for best square wave.	
5. Calibrator	NONE	VERT.SENS. and VERNIER to CAL, SWEEP MODE to free-run; SWEEP TIME to 1 ms/cm.	Adjust R240 for 6 cm deflection.	
6. Horizontal amplifier balance	NONE	Short-circuit input terminals and set INPUT for DC. VERT.SENS. to 50 mv/cm, with no input. HOR.SENS. and VERNIER to CAL.	Center the left spot with the HOR.POS. control.	Repeat as required.
		HOR.SENS. to 1 mv/cm, Center the HOR.DC BAL control (knob).	Center the spot with the coarse balance control (screw driver adjustment in center of DC BAL control).	
7. Horizontal VERNIER balance	NONE	Short-circuit input terminals and set INPUT for DC. HOR.SENS. to 1 mv/cm, VERNIER to CAL.	Center spot with POS. control HORIZ.	Repeat as required.
		VERNIER fully CCW.	Return spot to center with R120.	
8. Horizontal amplifier gain	NONE	HOR.SENS. and VERNIER to CAL.	Adjust R144 for 6 cm between spots.	
	Square wave generator	HOR.SENS. to 50 mv/cm, Connect 50 kc square wave to Hor. input and adjust for 6 cm deflection.	Adjust C114 for best defined spots.	
9. Sweep gain	Time Marker Generator	HOR.SENS. to INT.SWEEP X1 SWEEP TIME to 1 ms/cm, VERNIER to CAL; 1 kc markers from generator to VERT. input. SYNC to INT. Adjust SWEEP MODE and TRIG.LEVEL for stable pattern.	Adjust R134 for one marker/cm	
		HOR.SENS. to INT.SWEEP X5.	Adjust R164 for markers 5 cm apart.	
10. Sweep preset	DC VTVM	HOR.SENS. to INT.SWEEP X1. SWEEP TIME to 1 ms/cm, SWEEP MODE to PRE-SET, SYNC to EXT. with no input. Connect VTVM 30 volt range between center arm of Preset pot (R220) and ground.	Slowly adjust R220 and note voltage just prior to sweep start. Adjust pre-set for 2 volts more positive than voltage noted.	
11. Sweep length	Sine Wave Oscillator	HOR.SENS. to INT.SWEEP X1. SWEEP TIME to 1 ms/cm. SYNC to INT. Connect 500 kc sine wave to vertical input. Adjust level and VERT SENS. to produce 6 cm vertical deflection.	Adjust R229 for a trace about 10.5 cm long.	

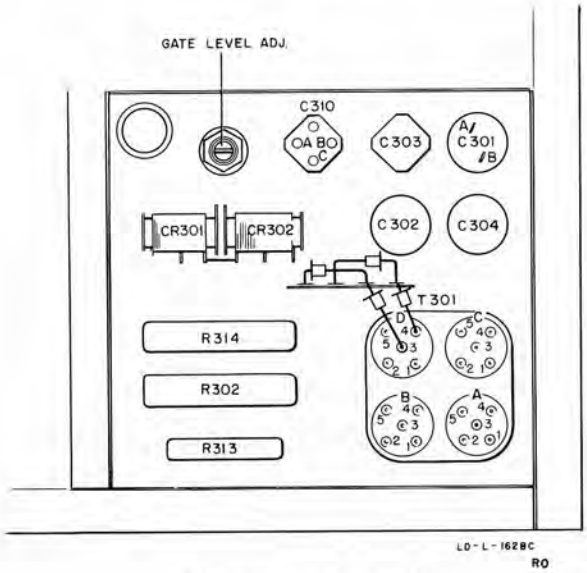


REGULATOR BOARD





POWER SUPPLY LOCATION DIAGRAM



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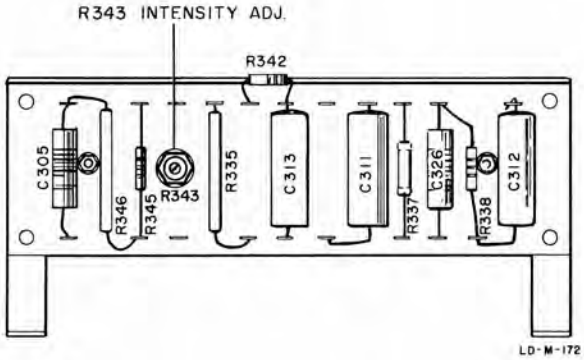


HIGH VOLTAGE BOARD

Figure 4-3. Power Supply Location Diagram

4-8 ADJUSTMENT PROCEDURE

Usually a particular oscilloscope will not need complete testing and calibration. Only one or two tests will be needed and they can be done without completing the entire test procedure.

The following procedures are listed in a recommended sequence for a complete test and calibration operation. In general, tubes are the main cause of trouble and new ones should be tried before making adjustments or other component replacements.

Specifications for the hp Model 130B Oscilloscope are given in the front of this manual. The following test procedures contain extra checks to help you analyze a particular instrument. These extra checks and the data they contain can not be considered as specifications.

A fifteen minute warm-up and power supply output voltage measurements are always recommended before making any other test or adjustment.

4-9 TURN ON

When turning the oscilloscope on for the first time after repair in any circuit, measure resistance from power supplies to ground. They usually will be within 25% of the following:

+100 volt supply	110 ohms
-150	50,000 ohms
+300	9,000 ohms
+585	85,000 ohms

CAUTION

When first turning an oscilloscope on after power supply repairs, turn the intensity and both positioning controls full counterclockwise before applying power. Failure to follow this precaution can cause permanent cathode-ray tube damage.

4-10 POWER SUPPLIES

The power supplies in the oscilloscope are extremely stable and will require infrequent adjustment. The output voltages should be measured at regular intervals but unnecessary adjustments should be avoided.

Power supply voltages may be measured at the points indicated in Figure 4-3.

To adjust the power supply section, refer to Figure 4-3, and proceed as follows:

A. LOW VOLTAGE SUPPLY

1) Turn sweep generator off by turning the HOR. SENS. switch to 50 volt/cm position.

2) Permit the 130B to warm up for at least five minutes at a line voltage of 115/230 volts.

3) Measure power supply voltages with line volts set to 115 volts. The voltages will normally be within the limits given in Table 4-3. Control R332 can be adjusted if necessary to set the +100 volt supply within limits.

If adjustment of the +100 volt supply was necessary, all sweep timing, calibrator and gain adjustments must be checked.

If poor low voltage supply regulation is suspected, the following check may be made:

-- Check the regulation of each power supply voltage as the power line voltage is varied between 103 and 127 volts. All regulated voltages should remain within ±1% over this range of line voltage.

-- Measure the ac ripple on each supply voltage. This ac voltage should not exceed the amount specified in Table 4-3.

TABLE 4-3. REGULATED POWER SUPPLY TOLERANCES

Supply	Tolerance (115/230 volt line)	Variation ±10% line voltage change	Nominal Ripple at 115/230V
+100 V	±4%	±1%	5 mv
-150 V	±4%	±1%	5 mv
+300 V	±4%	±1%	5 mv
+585 V	±4%	±1%	60 mv

If any output does not regulate or has excessive ripple, replace the Series Regulator Tube or the Control Tube of that supply. It must be kept in mind, however, that loss of regulation of the -150 volts will cause the other supplies to lose regulation, and that loss of regulation of the +100 volts will cause the +585 volt and +300 volt supplies to lose regulation also.

SERVICING ETCHED CIRCUIT BOARDS

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

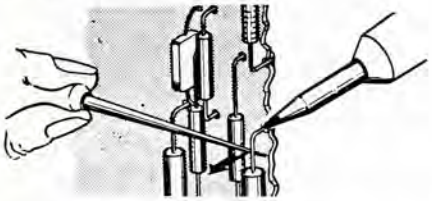
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

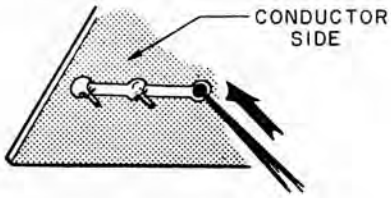
When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

WARNING: If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

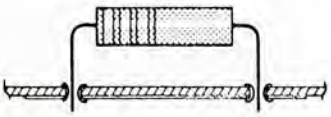
1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.



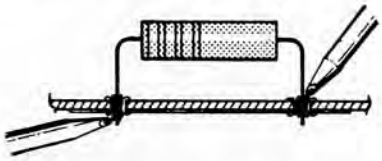
2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.



3. Bend clean tinned leads on new part and carefully insert through eyelets or holes in board.

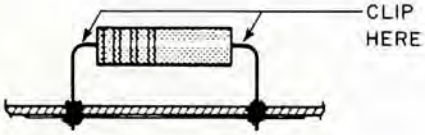


4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

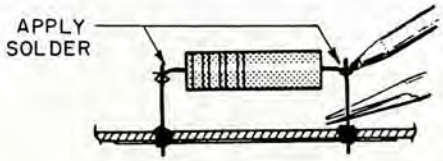


In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.



2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.



This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

Figure 4-4. Servicing Etched Circuit Boards

B. HIGH VOLTAGE SUPPLY

1) The -2550 volt output is measured on the resistor board under the base of the crt. Connect an appropriate dc voltmeter (such as an ⓗⓟ Model 410B VTVM with an ⓗⓟ Model 459A DC Resistive Voltage Multiplier) to the Junction of R338, C312 (marked -2550 CATH. on cover).

2) With the line at 115/230 volts the high voltage should measure -2550 ±4%. Control R334 can be adjusted if necessary to set the -2550 volt supply within limits.

If poor -2550 voltage supply regulation is suspected the following check may be made:

-- Check the regulation by varying the line voltage between 103 and 127 volts. The -2550 should remain within ±1% over this range of line voltage. If the -2550 supply does not regulate check the control tube V312.

3) Set SWEEP TIME/CM to 5 MILLISECONDS.

4) Set HOR. SENS. to INT. SWEEP X1.

5) Set SWEEP MODE fully clockwise to FREE RUN.

6) Set INTENSITY control to 10 o'clock.

7) Set Int. Adj., R343, until the trace is just visible.

8) Set SWEEP MODE fully counterclockwise to PRESET.

9) Set INTENSITY control for a low intensity spot.

10) Center spot and adjust FOCUS control and ASTIGMATISM (R303) to obtain a small round and sharply focused spot.

4-11 REPLACING AND ADJUSTING THE CRT

To replace the cathode-ray tube, refer to Figure 2-10, and proceed as follows:

1) Turn off and remove the 130B from the cabinet.

2) Loosen the clamp on the crt socket. (Cabinet model; remove cover from High Voltage terminal board to get access for screwdriver through board).

3) Remove the front-panel bezel.

4) With a screwdriver loosen the crt base from socket. Free the crt from the socket by pressing on the center of the tube base with one hand while supporting the front of the crt with the other.

DANGER - Do not apply force on neck of tube.

5) Remove the crt through the front panel.

CAUTION - HANDLE THE CATHODE RAY TUBE CAREFULLY.

6) Insert the replacement crt through the front panel and seat in socket.

7) Replace front-panel bezel.

8) Adjust the socket assembly so that the face of the crt just misses the bezel assembly. Tighten the clamp just enough to hold the crt in place loosely.

NOTE

Turn the INTENSITY control to minimum when first applying power to a crt. The phosphor can be damaged quickly by too much brightness.

---

9) Set the INTENSITY control fully counterclockwise. Turn the 130B on and allow to warm up.

10) Set the SWEEP MODE control to FREE RUN.

11) Adjust the INTENSITY control to obtain a weak trace; adjust the FOCUS control for a sharp trace, and with the vertical position control, center the trace vertically.

12) Align trace with graticule using the alignment handle at rear of crt.

CAUTION - Do not over-tighten crt clamp or tube damage may result.

13) Making certain the crt face is close to but not touching the bezel assembly, tighten the clamp on the crt socket only enough to hold the crt from turning. If the face of the tube touches the bezel assembly, Newton rings may be visible.

14) Readjust the astigmatism; see paragraph 4-10B.

15) Check the gain calibration of the Vertical and Horizontal Amplifiers by setting the VERTICAL and HORIZONTAL SENSITIVITY selectors to CAL, and if necessary, adjusting R40 (Figure 4-5) to obtain 6 cm vertical deflection and R144 (Figure 4-6) to obtain 6 cm horizontal deflection on the trace; see paragraph 4-13B and 4-14B.

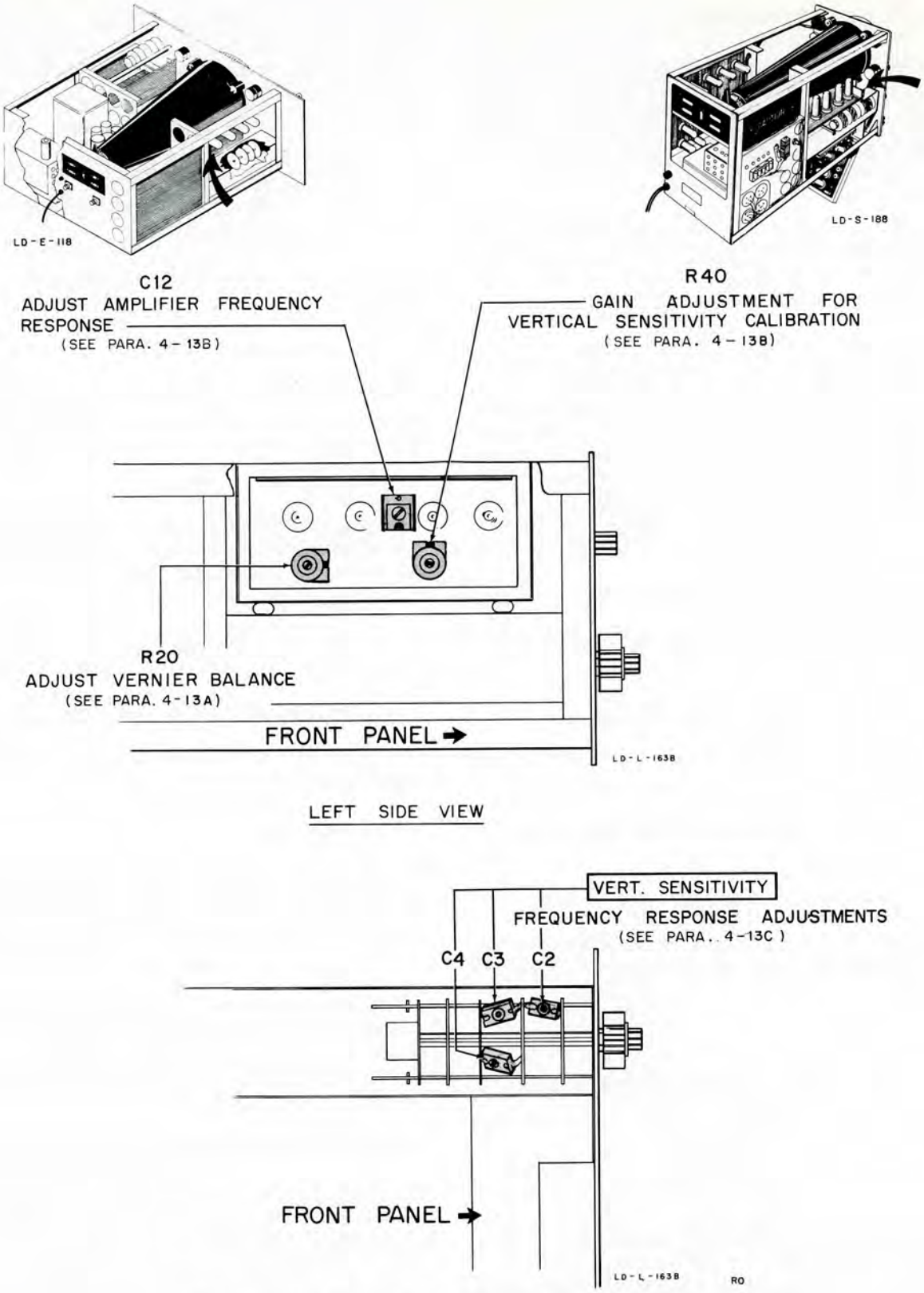


Figure 4-5. Vertical Amplifier Adjustment Location

4-12 CHECKING AND ADJUSTING THE CALIBRATOR

1) Set HORIZ. SENSITIVITY to INT. SWEEP X1; SWEEP TIME/CM to 1 MILLISECOND; SWEEP MODE to PRESET; SYNC. to INT.; and TRIGGER LEVEL to "0".

NOTE

If PRESET (SWEEP MODE) is maladjusted, you may not obtain a trace. See paragraph 4-16.

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2) Set the VERT. SENSITIVITY switch to 50 MILLIVOLTS/CM. Place the VERNIER control in CAL.

3) Connect the signal source to the vertical INPUT terminals and set its rms output voltage, read on the vtvm, to 106 millivolts (300 mv/ $2\sqrt{2}$) and its output frequency to 1000 cps.

4) Adjust R40 (see Figure 4-5) to obtain exactly 6 centimeters deflection.

5) Set the VERT. SENSITIVITY switch to CAL.

6) Adjust the R240 (see Figure 4-7) for exactly 6 centimeters deflection.

4-13 ADJUSTING THE VERTICAL AMPLIFIER

The following adjustments are located in the vicinity of the Vertical Amplifier or the VERT. SENSITIVITY switch as shown in Figure 4-5.

A. VERNIER BALANCE ADJUSTMENT

To adjust VERNIER balance, allow the instrument to warm up 15 minutes and adjust Vertical balance as shown by Figure 2-2. Then refer to Figure 4-5 and proceed as follows:

1) Short the INPUT terminals and set the INPUT switch to DC.

2) Set VERT. SENSITIVITY to 1 MILLIVOLT/CM, and VERNIER to CAL.

3) Center spot (or trace) with VERT. POS. control.

4) Turn VERNIER fully counterclockwise and return spot to center with R20, the Bal. Adj.

The trace should now be stationary as the VERNIER is rotated.

B. VERT. AMPL. GAIN AND FREQ. RESP. ADJUSTMENTS

To adjust the Vertical Amplifier gain and frequency response refer to Figure 4-5 and proceed as follows:

1) Adjust Vertical and VERNIER balance as indicated by Figure 2-2 and paragraph 4-13A.

2) Set HORIZ. SENSITIVITY to INT. SWEEP X1 and set the SWEEP TIME/CM switch to 2 MILLISECONDS, SWEEP MODE to PRESET and TRIGGER LEVEL to "0".

3) Place VERTICAL SENSITIVITY switch and its VERNIER in CAL.

4) Adjust R40 for exactly 6 centimeters deflection.

5) Set VERT. SENSITIVITY to 50 MILLIVOLTS/CM. Set SYNC to INT.

6) Set SWEEP TIME/CM switch to 5 MICROSECONDS.

7) Connect a 50 kc square wave to the Vertical INPUT and adjust the square-wave amplitude for 6 to 8 centimeters deflection.

8) Adjust C12 for best square wave. To give C12 a range of adjustment sufficient to compensate for variations of tube characteristics, C13 may be connected in parallel with C12 to increase the maximum capacity to 1340 $\mu\mu$f.

C. INPUT ATTENUATOR FREQUENCY RESPONSE ADJUSTMENTS

To adjust frequency response of the input attenuator refer to Figure 4-5 and proceed as follows:

1) Connect a 5 kc square wave to the Vertical INPUT.

2) Set SWEEP TIME/CM to obtain 3 or 4 cycles of the square wave.

3) Make the indicated adjustment for best square-wave presentation on the following ranges:

VOLT/CM	ADJUST
10	C2
1	C4
.1	C3

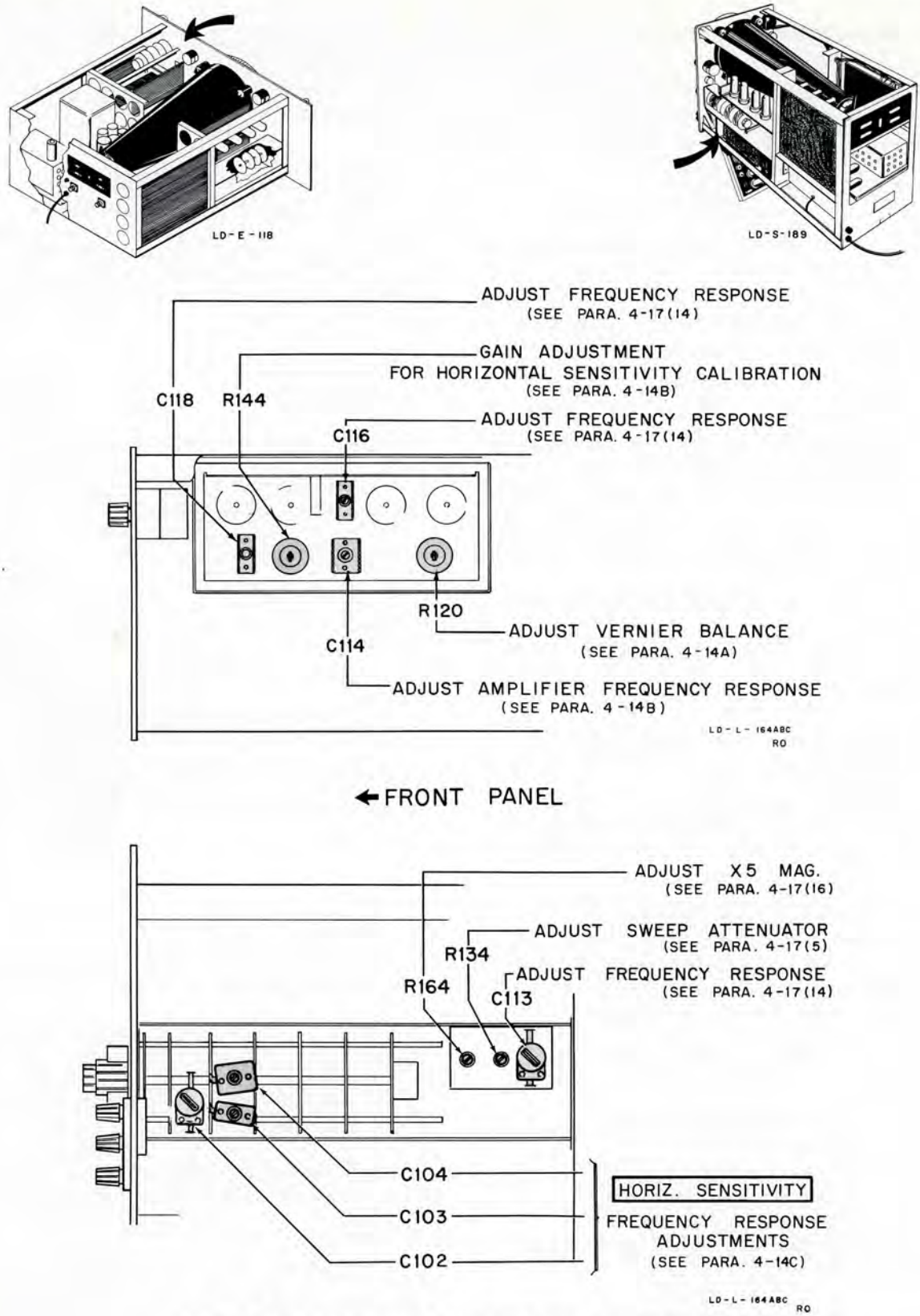


Figure 4-6. Horizontal Amplifier Adjustment Locations

4-14 ADJUSTING HORIZONTAL AMPLIFIER

To adjust the Horizontal Amplifier, refer to Figure 4-6 and proceed as follows:

A. VERNIER BALANCE ADJUSTMENT

To adjust the VERNIER balance allow the instrument to warm up thoroughly and adjust Horizontal balance as shown by Figure 2-3; then refer to Figure 4-6 and:

1) Short the INPUT terminals and set the INPUT switch to DC.

2) Set the HORIZ. SENSITIVITY to 1 MILLIVOLT/CM and the VERNIER to CAL.

3) Center the spot with the HORIZ. POS. control.

4) Turn the VERNIER completely counterclockwise and return the spot to the center with R120, Bal. Adj. The spot will now be stationary as the VERNIER is rotated.

B. AMPLIFIER GAIN AND FREQUENCY RESPONSE ADJUSTMENTS

To adjust the gain and frequency response, refer to Figure 4-6 and proceed as follows:

1) Set HORIZ. SENSITIVITY switch to CAL. and the VERNIER to CAL.

2) Adjust R144 for exactly 6 centimeters deflection.

3) Set VERT. SENSITIVITY to 2 VOLTS/CM.

4) Connect an 8 kc (approximately) sine wave to the Vertical INPUT of the oscilloscope and to the SYNC. IN terminal of the 211A square wave generator; adjust the sine wave for 10 cm deflection.

5) Set HORIZ. SENSITIVITY to 50 MILLIVOLTS/CM.

6) Connect a 50 kc square wave to the Horizontal INPUT, and adjust the square wave amplitude for 6 to 8 cm deflection.

7) Adjust C114 for best square wave response.

NOTE

Some vacuum tubes require more capacity for compensation than the maximum value of C114. Capacitor C115 may be connected in parallel with C114 to increase the maximum capacity to 1340 $\mu\mu$f, permitting a greater percentage of vacuum tubes to be used.

C. INPUT ATTENUATOR FREQUENCY RESPONSE ADJUSTMENTS

To adjust the frequency response at the input attenuator, refer to Figure 4-6 and proceed as follows:

1) Set VERT. SENSITIVITY to 2 VOLTS/CM.

2) Connect an 800 cps (approximately) sine wave to the Vertical INPUT of the oscilloscope and to the Sync-In terminal of the 211A square wave generator; adjust the sine wave for 10 centimeter deflection.

3) Set HORIZ. SENSITIVITY to 10 VOLTS/CM (VERNIER in CAL.).

4) Connect a 5 kc square wave to the Horizontal INPUT and adjust its amplitude for 6 centimeter deflection.

5) Make the following adjustments on the ranges indicated for the best square wave response, adjusting the square-wave amplitude to 6 centimeters on each range.

VOLTS/CM	ADJUST (see Fig. 4-6)
10	C102
1	C104
.1	C103

4-15 PHASE SHIFT ADJUST

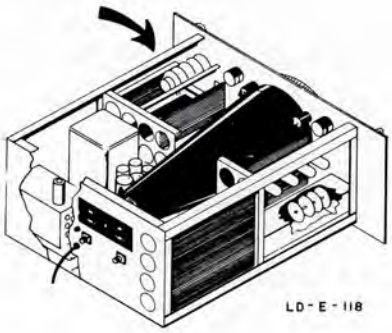
Phase shift between Vertical and Horizontal Amplifiers.

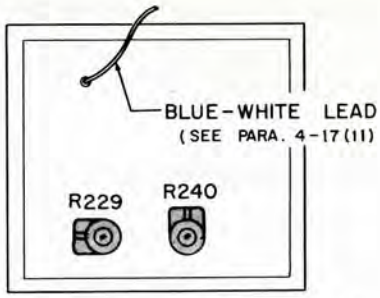
If the square wave response of the Vertical and Horizontal Amplifier was carefully set, the relative phase shift between the two amplifiers should not exceed one degree at frequencies below 50 kc.

To check Phase Balance:

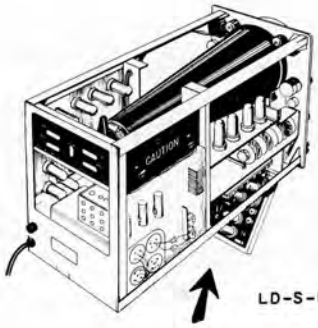
1) Set VERT. and HORIZ. SENSITIVITY to 50 MILLIVOLTS/CM and VERNIER to CAL.

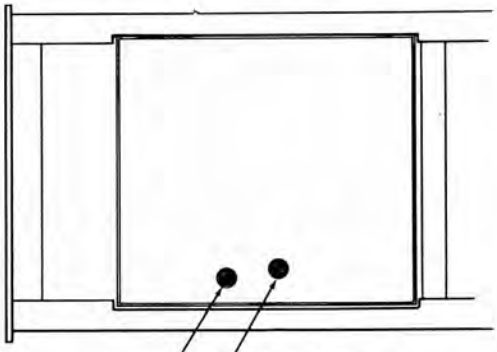
2) Apply a 50 kc sine-wave signal to the HORIZ. INPUT and VERT. INPUT. Center pattern and adjust signal amplitude for 6 cm vertical and 6 cm horizontal deflection.





TUBE SIDE OF BOARD (DOOR OPEN)





R240
ADJUST CALIBRATOR
(SEE PARA. 4-12)

R229
ADJUST SWEEP LENGTH
(SEE PARA. 4-17(17)

BOTTOM VIEW
(CABINET MODEL)

RIGHT SIDE VIEW
(RACK MOUNT MODEL)

SWEEP TIME/CM ADJUSTMENTS
(SEE PARA. 4-17)

C227
ADJUST 1 MICROSECOND

C225
ADJUST 10 MICROSECONDS

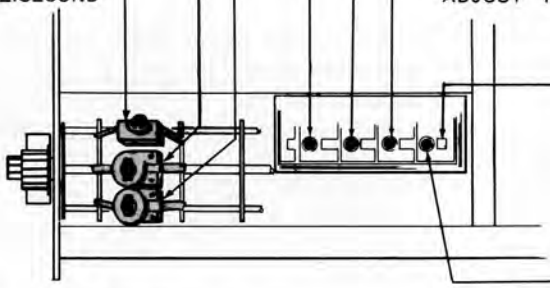
C223
ADJUST .1 MILLISECOND

R259
ADJUST .1 SECOND

R260
ADJUST 10 MILLISECONDS

R261
ADJUST 1 MILLISECOND

RACK MOUNT MODEL ONLY. LOCATED BELOW THE HORIZONTAL SENSITIVITY SWITCH ON CABINET MODEL.



R220
ADJUST PRESET
(SEE PARA. 4-16)

TOP VIEW (RACK MOUNT MODEL)
BOTTOM VIEW (CABINET MODEL WITH SWEEP DECK OPEN)

LD-L-165
RO

Figure 4-7. Sweep Generator Adjustment Locations

The opening of the pattern, if any, should not exceed a tenth of a centimeter. If necessary to correct phase difference, adjust C114 for closure of the pattern (Figure 4-6).

4-16 ADJUSTING PRESET

To adjust Preset refer to Figure 4-7 and proceed as follows:

1) Set VERT. SENSITIVITY to OFF, SWEEP TIME/CM switch to .1 MILLISECOND and SWEEP MODE control maximum counterclockwise to PRESET. Set SYNC selector to INT.

2) Connect a dc voltmeter between ground (+) and the center tap of R220 the PRESET adjust control.

3) Turn R220 fully counterclockwise. Then slowly adjust R220 clockwise until the sweep generator begins to free fun. Turn R220 counterclockwise until the sweep just stops and record this voltage which should be about -26 volts.

4) Set R220 to give a voltmeter indication exactly 2 volts less negative than the voltage noted.

4-17 ADJUSTING THE SAWTOOTH GENERATOR AND SWEEP AMPLIFIER

To adjust the Sawtooth Generator and Sweep Amplifier refer to Figures 4-6 and 4-7 and proceed as follows:

1) Set SYNC to INT., SWEEP MODE to PRESET and TRIGGER LEVEL to "0".

2) Set HORIZ. SENSITIVITY to INT. SWEEP X1, SWEEP TIME/CM to 1 MILLISECOND, and its VERNIER to CAL.

3) Connect 1 kc (1000 μ sec) time markers to the Vertical INPUT.

4) Set R261, 1 Millisecond Adj., on the potentiometer board, to its mechanical center.

5) Adjust R134, Sweep Attenuator, (Figure 4-6) and HORIZ. POS. for approximately 1 time marker/cm. This is a rather coarse adjustment. Set it as close as is practical. Then make the final adjustment with R261.

6) Set SWEEP TIME/CM to 10 MILLISECONDS and connect 100 cycle (10,000μ sec) time markers to the Vertical INPUT.

7) Adjust R260 (Figure 4-7) for 1 marker per centimeter.

8) Set SWEEP TIME/CM to .1 SECOND and connect 10 cycle (100,000 μsec) time markers to the Vertical INPUT.

9) Adjust R259 (Figure 4-7) for 1 marker per centimeter.

10) Disconnect the time mark generator from the Vertical INPUT, set VERT. SENSITIVITY switch to 10 VOLTS/CM, the Vertical and Horizontal input switches to AC, and SWEEP TIME/CM to 5 MICROSECONDS.

11) Disconnect the blue-white lead (Figure 4-7) from the Sweep Generator board and connect it through a 1 microfarad capacitor to the Horizontal INPUT. Set SYNC to EXT.

12) Connect a wire between V206 pin 1 (6AW8) and the Vertical INPUT.

13) Connect a 50 kc square wave from the 600 ohm output of the hp Model 211A to the Horizontal INPUT and adjust its amplitude for about 6 centimeter deflection.

14) Adjust C113 near the HORIZ. SENSITIVITY switch, and C116 and C118 on the Horizontal Amplifier board (Figures 4-6 and 4-7), for best square wave presentation. Remove the wire between V206 pin 1 and the Vertical INPUT.

15) Reconnect the blue-white lead to the Sweep Generator board, and connect the time marker generator to the Vertical INPUT. Make the following adjustment as indicated for 1 time marker per centimeter.

Time Marker	SWEEP TIME/CM	(Fig. 4-7) Adjust
1 μsec (1 mc)	1 MICROSEC.	C227
10 μsec (100 kc)	10 MICROSEC.	C225
.1 msec(10 kc)	.1 MILLISEC.	C223

16) Set HORIZ. SENSITIVITY to INT. SWEEP X5, and adjust R164 (Figure 4-6), for markers 5 centimeters apart.

17) Connect a 500 kc signal to the Horizontal INPUT, set SWEEP TIME/CM to 1 MILLISECOND, set SYNC to EXT, and adjust R229, Sweep Length, (Figure 4-7) for a trace about 10.5 centimeters long.

NOTES

SCHEMATIC DIAGRAM NOTES

1. Heavy solid line shows main signal path; heavy dashed line shows control, secondary signal, or feedback path.

2. Heavy box indicates front-panel engraving; light box indicates chassis marking.

3. Arrows on potentiometers indicate clockwise rotation as viewed from the round shaft end, counter-clockwise from the rectangular shaft end.

4. Resistance values in ohms, inductance in microhenries, and capacitance in micromicrofarads unless otherwise specified.

5. Rotary switch schematics are electrical representations; for exact switching details refer to the switch assembly drawings.

6. Relays shown in condition prevailing during normal instrument operation.

7. ‡ indicates a selected part. See parts list.

8. Interconnecting parts and assemblies are shown on cable diagram.

9. * indicated value adjusted at factory. Part may be omitted.

VOLTAGE AND RESISTANCE DIAGRAM NOTES

1. Each tube socket terminal is numbered and lettered to indicate the tube element and pin number, as follows:

*	=	no tube element	P	=	plate
H	=	heater	T	=	target (plate)
K	=	cathode	R	=	reflector or repeller
G	=	control grid	A	=	anode (plate)
Sc	=	screen grid	S	=	spade
Sp	=	suppressor grid	Sh	=	shield
Hm	=	heater mid-tap	NC	=	no external connection to socket
IS	=	internal shield	Δ	=	indefinite reading due to circuit (see 2.)

The numerical subscript to tube-element designators indicates the section of a multiple-section tube; the letter subscript to tube-element designators indicates the functional difference between like elements in the same tube section, such as t for triode and p for pentode.

A socket terminal with an asterisk may be used as a tie point and may have a voltage and resistance shown.

2. Voltages values shown are for guidance; values may vary from those shown due to tube aging or normal differences between instruments. Resistance values may vary considerably from those shown when the circuit contains potentiometers, crystal diodes, or electrolytic capacitors.

3. Voltage measured at the terminal is shown above the line, resistance below the line; measurements made with an electronic multimeter, from terminal to chassis ground unless otherwise noted.

4. A solid line between socket terminals indicates a connection external to the tube between the terminals; a dotted line between terminals indicates a connection inside the tube. Voltage and resistance are given at only one of the two joined terminals.

VERTICAL AMPLIFIER
VOLTAGE - RESISTANCE DIAGRAM
(VIEWED FROM ETCHED SIDE)

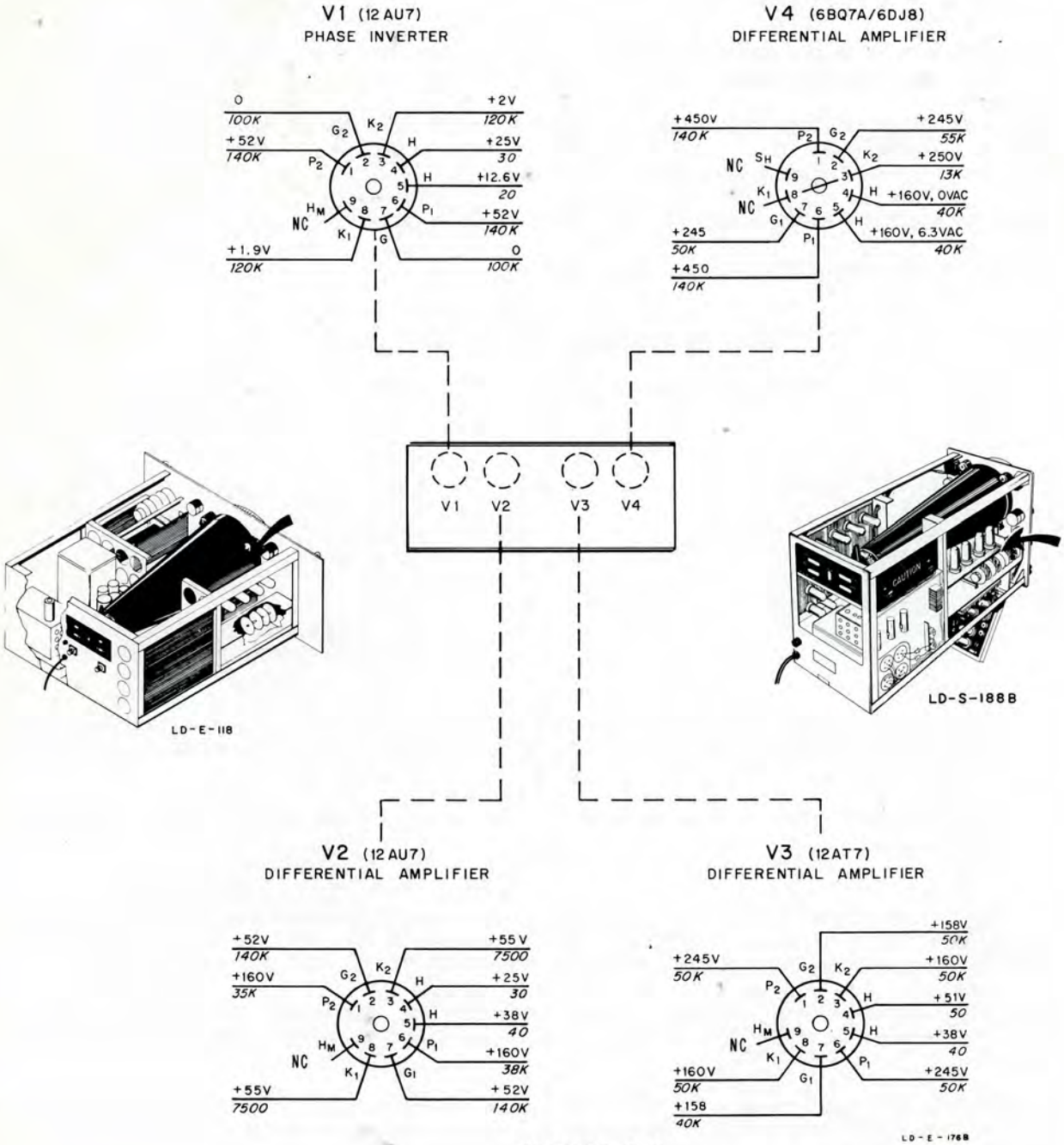
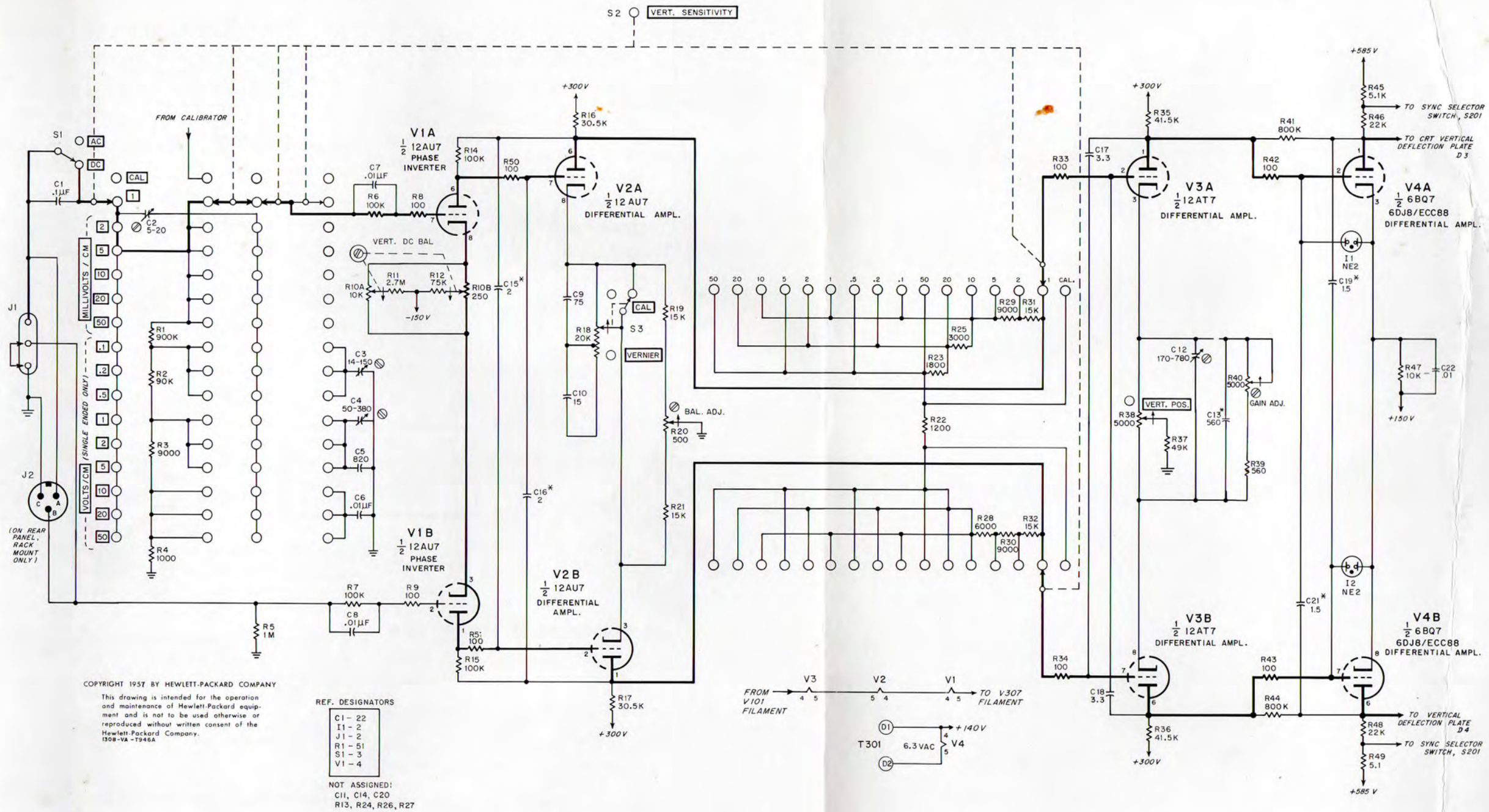


FIGURE 4-8

FIGURE 4-9
VERTICAL AMPLIFIER



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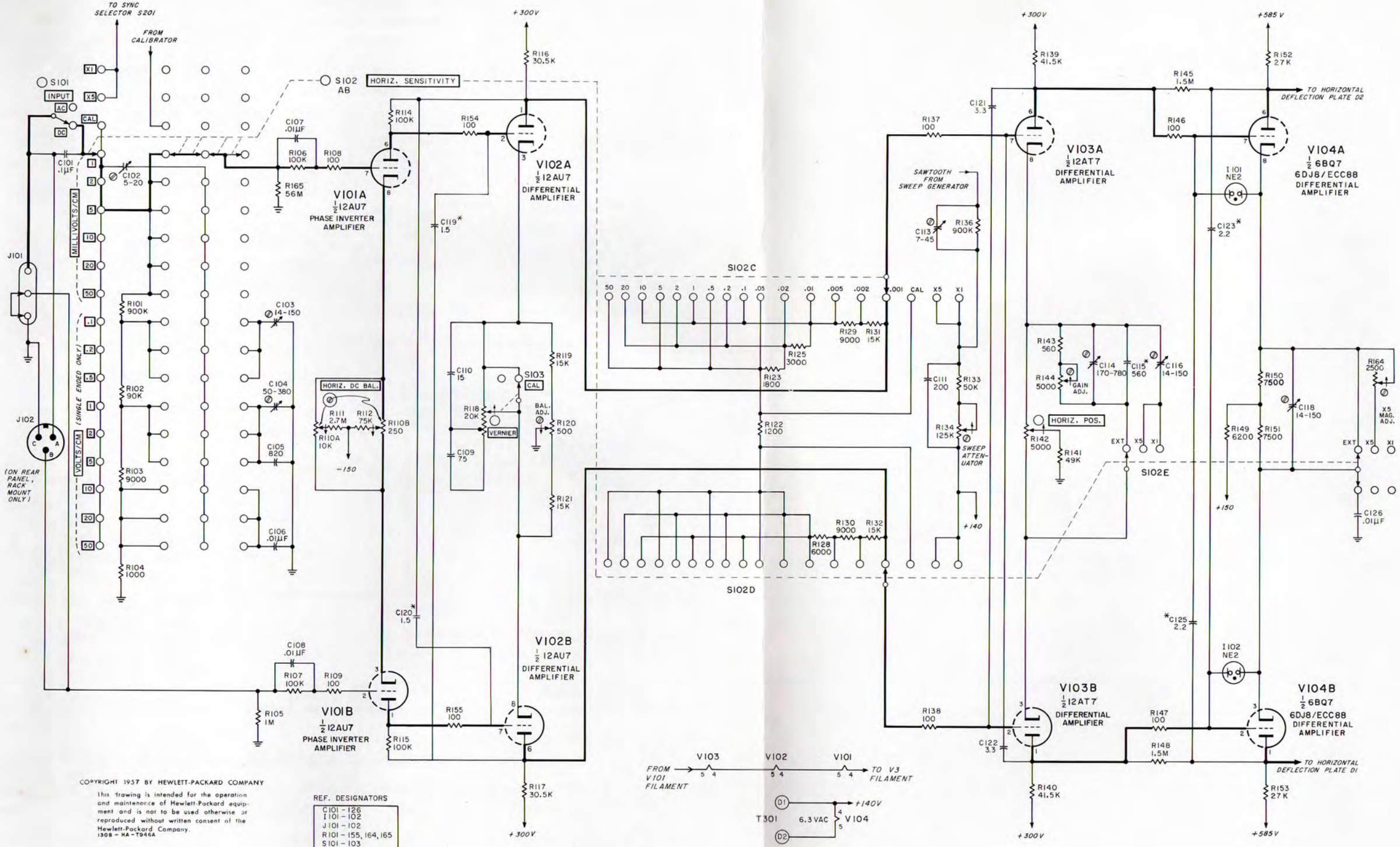
1308-VA-T946A

REF. DESIGNATORS

C1 - 22
I1 - 2
J1 - 2
R1 - 51
S1 - 3
V1 - 4

NOT ASSIGNED:
C11, C14, C20
R13, R24, R26, R27

FIGURE 4-11
HORIZONTAL AMPLIFIER



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1308 - HA - T946A

REF. DESIGNATORS

C101 - 126
I101 - 102
J101 - 102
R101 - 155, 164, 165
S101 - 103
V101 - 104

NOT ASSIGNED:
C112, C117, C124
R113, R124, R126, R127, R135, R156 - 163

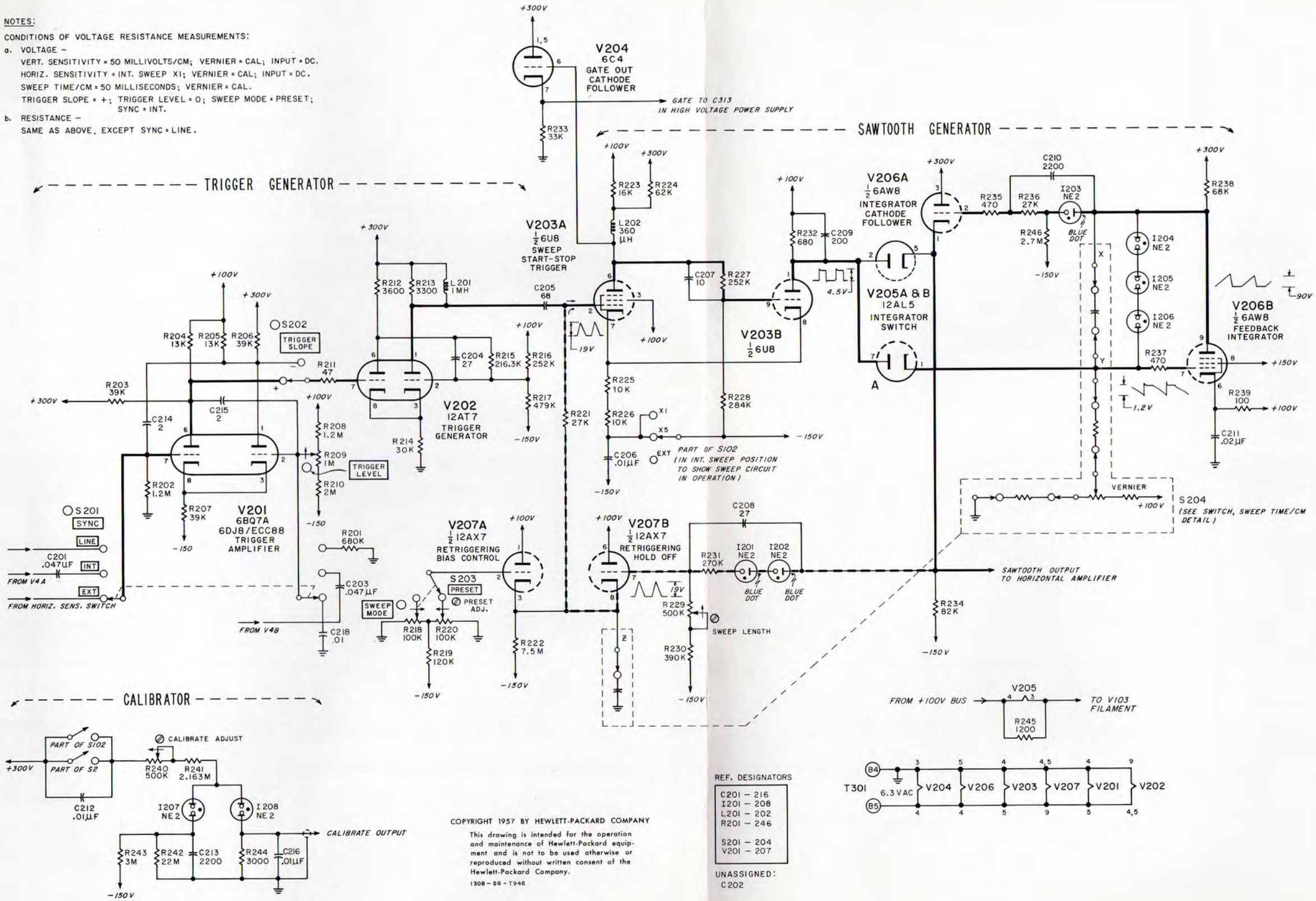
FIGURE 4-13
SWEEP GENERATOR

NOTES:

CONDITIONS OF VOLTAGE RESISTANCE MEASUREMENTS:

a. VOLTAGE –
VERT. SENSITIVITY = 50 MILLIVOLTS/CM; VERNIER = CAL; INPUT = DC.
HORIZ. SENSITIVITY = INT. SWEEP X1; VERNIER = CAL; INPUT = DC.
SWEEP TIME/CM = 50 MILLISECONDS; VERNIER = CAL.
TRIGGER SLOPE = +; TRIGGER LEVEL = 0; SWEEP MODE = PRESET; SYNC = INT.

b. RESISTANCE –
SAME AS ABOVE, EXCEPT SYNC = LINE.



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1308 – SG – T946

REF. DESIGNATORS

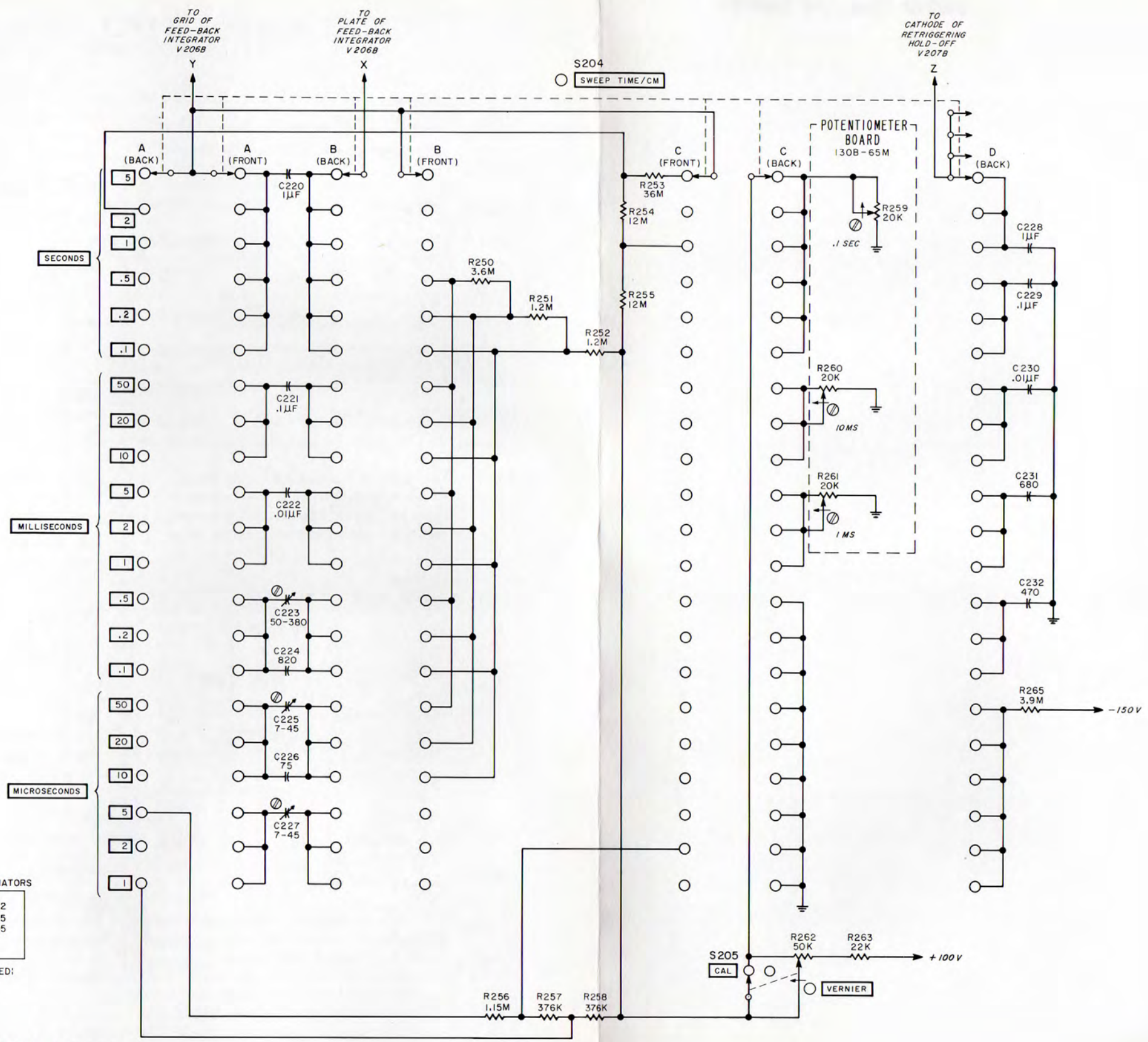
C201 – 216
I201 – 208
L201 – 202
R201 – 246

S201 – 204
V201 – 207

UNASSIGNED:
C202

FIGURE 4-14

SWEEP TIME/CM SWITCH



REF. DESIGNATORS

C220 — 232
R250 — 265
S204 — 205

NOT ASSIGNED:
R264

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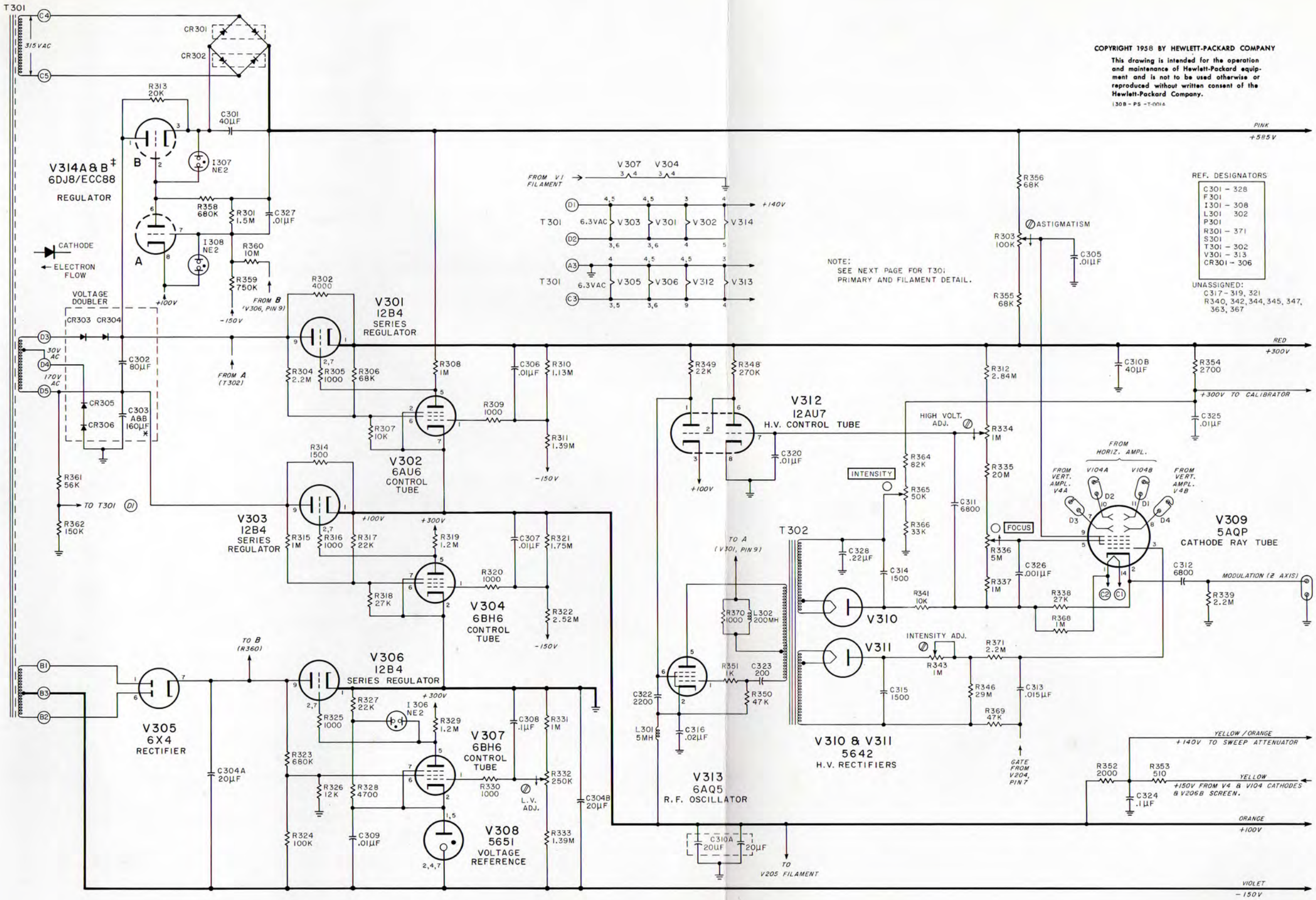
130B - ST/CM SWITCH - T946A

FIGURE 4-16
POWER SUPPLY



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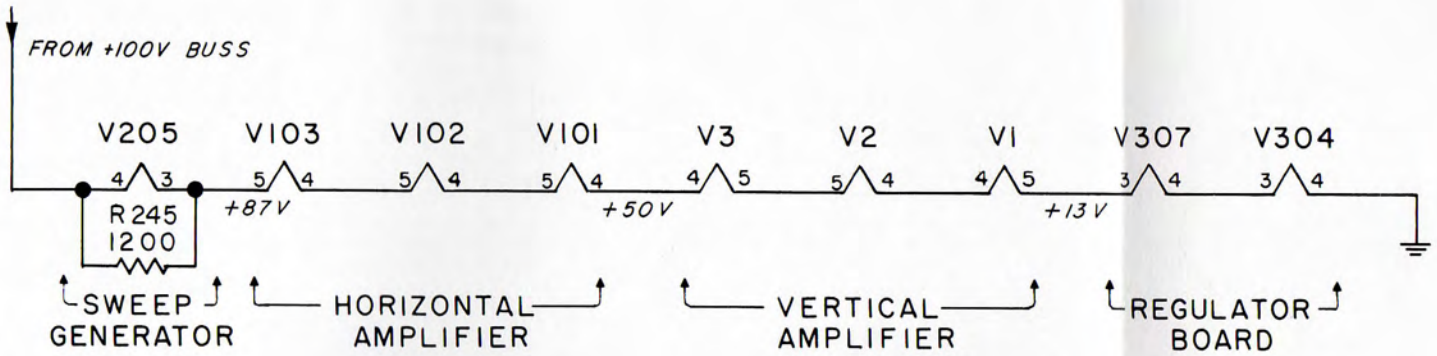
130B - PS - T-0014

FIGURE 4-17
FILAMENT AND PRIMARY DETAIL



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130B — FIL. DETAIL — T001

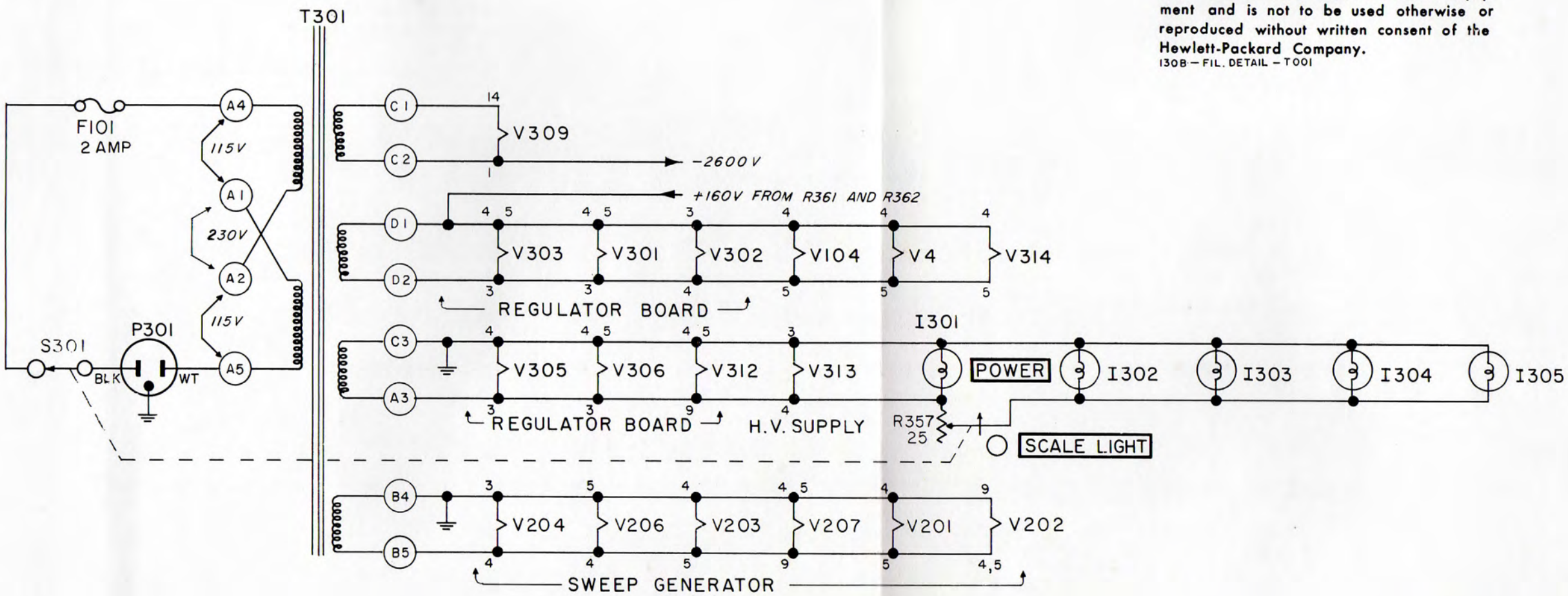
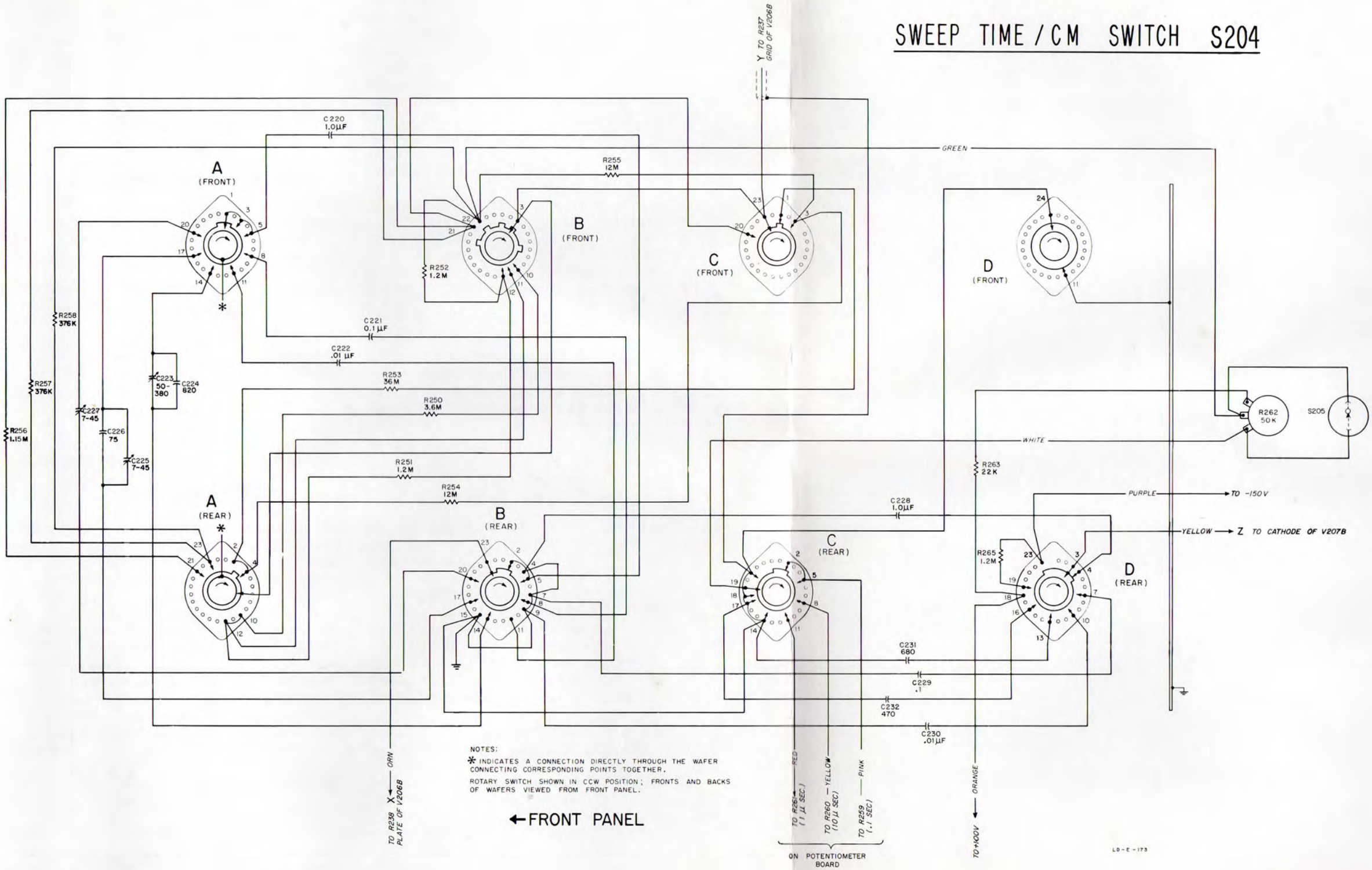


FIGURE 4-18
SWEEP TIME/CM SWITCH ASSEMBLY DIAGRAM

SWEEP TIME / CM SWITCH S204



NOTES:

* INDICATES A CONNECTION DIRECTLY THROUGH THE WAFER CONNECTING CORRESPONDING POINTS TOGETHER.

ROTARY SWITCH SHOWN IN CCW POSITION; FRONTS AND BACKS OF WAFERS VIEWED FROM FRONT PANEL.

← FRONT PANEL

CATHODE RAY TUBE WARRANTY

The cathode ray tube supplied in your Hewlett-Packard Oscilloscope and replacement cathode ray tubes purchased from hp, are guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. Broken tubes or tubes with burned phosphor are not included in this guarantee.

Your local Hewlett-Packard representative maintains a stock of replacement tubes and will be glad to process your warranty claim for you. Please consult him.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow shipping instructions carefully to insure safe arrival, since no credit can be allowed on broken tubes.

SHIPPING INSTRUCTIONS

1) Carefully wrap the tube in 1/4" thick cotton batting or other soft padding material.

2) Wrap the above in heavy kraft paper.

3) Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.

4) Surround the tube with at least four inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.

5) Tubes returned from outside the continental United States should be packed in a wooden box.

6) Ship prepaid preferably by AIR FREIGHT or RAILWAY EXPRESS. We do not recommend parcel post or air parcel post shipment.

CRT WARRANTY CLAIM

FROM: DATE: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

_____

_____

Person to contact for further information:

NAME: _____

TITLE: _____

COMPANY: _____

ADDRESS: _____

_____

_____

To process your claim quickly please enter the information indicated below:

1) ⓗⓟ INSTRUMENT MODEL _____ SERIAL _____

2) TUBE TYPE _____ SERIAL _____

3) ORIGINAL TUBE _____ REPLACEMENT TUBE _____

4) YOUR PURCHASE ORDER NO. _____

5) DATE PURCHASED _____

6) PURCHASED FROM _____

7) COMPLAINT: (Please describe nature of trouble) _____

_____

_____

_____

8) OPERATING CONDITIONS: (Please describe conditions prior to and at time of failure _____

_____

_____

_____

SIGNATURE _____

_____

SECTION V
TABLE OF REPLACEABLE PARTS

NOTE

Standard components have been used in this instrument, whenever possible. Special components may be obtained from your local Hewlett-Packard representative or from the factory.

When ordering parts always include:

1. hp Stock Number.
2. Complete description of part including circuit reference.
3. Model number and serial number of instrument.
4. If part is not listed, give complete description, function and location of part.

Corrections to the Table of Replaceable Parts are listed on an Instruction Manual Change sheet at the front of this manual.

RECOMMENDED SPARE PARTS LIST

Column RS in the Table lists the recommended spare parts quantities to maintain one instrument for one year of isolated service. Order complete spare parts kits from the Factory Parts Sales Department. ALWAYS MENTION THE MODEL AND SERIAL NUMBERS OF INSTRUMENTS INVOLVED.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	hp STOCK NO.	TQ	RS		
C1	Capacitor: fixed, mylar, 0.1 μf ±20%, 600 vdcw Texas Capacitor Co.	0170-0022	2	1		
C2	Capacitor: variable, ceramic, 5-20 pf 500 vdcw L*	0130-0006	2	1		
C3	Capacitor: variable, mica, 14 - 50 pf 500 vdcw Electromotive Mfg. Co.	0131-0004	4	1		
C4	Capacitor: variable, mica, 50-380 pf 175 vdcw Electromotive Mfg. Co.	0131-0001	3	1		
C5	Capacitor: fixed, silver mica, 820 pf ±5%, 500 vdcw Z*	0140-0091	3	1		
C6	Capacitor: fixed, mica .01 μf ±5%, 300 vdcw Z*	0140-0009	2	1		
C7, 8	Capacitor: fixed, ceramic, .01 μf ±20%, 1000 vdcw CC*	0150-0012	8	2		
C9	Capacitor: fixed, mica, 75 pf ±5%, 300 vdcw V*	0140-0040	3	1		
C10	Capacitor: fixed, mica, 15 pf ±10%, 500 vdcw V*	0140-0004	2	1		
C11	This circuit reference not assigned					
C12	Capacitor: variable, mica 170-780 pf 175 vdcw Electromotive Mfg. Co.	0131-0003	2	1		
C13	Capacitor: fixed, mica, 560 pf ±10%, 500 vdcw Optimum value selected at factory Average value shown Z*	0140-0044	2	1		
C14	This circuit reference not assigned					
C15, 16	Capacitor: fixed, titanium dioxide, 2 pf ±5%, 500 vdcw Optimum value selected at factory Average value shown DD*	0150-0031	4	1		
C17, 18	Capacitor: fixed, titanium dioxide, 3.3 pf ±10%, 500 vdcw DD*	0150-0022	4	1		
C19	Capacitor: fixed, titanium dioxide, 1.5 pf ±20%, 500 vdcw DD*	0150-0011	3	1		
C20	This circuit reference not assigned					

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
TQ - Total quantity used in the instrument.
RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	hp STOCK NO.	TQ	RS		
C21	Same as C19 Optimum value selected at factory Average value shown					
C22	Same as C7					
C23 thru C100	These circuit references not assigned					
C101	Same as C1					
C102	Same as C2					
C103	Same as C3					
C104	Same as C4					
C105	Same as C5					
C106	Same as C6					
C107, 108	Same as C7					
C109	Same as C9					
C110	Same as C10					
C111	Capacitor: fixed, mica, 200 pf ±10%, 500 vdcw V*	0140-0056	2	1		
C112	This circuit reference not assigned					
C113	Capacitor: variable, ceramic, 7-45 pf 500 vdcw L*	0130-0001	3	1		
C114	Same as C12					
C115	Same as C13					
C116	Same as C3					
C117	This circuit reference not assigned					
C118	Same as C3					
C119, 120	Same as C19 Optimum value selected at factory Average value shown					
C121, 122	Same as C17					

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**

TQ - **Total quantity used in the instrument.**

RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
C123	Capacitor: fixed, titanium dioxide, 2.2 pf ±10%, 500 vdcw Optimum value selected at factory DD* Average value shown	0150-0015	2	1		
C124	This circuit reference not assigned					
C125	Same as C123 Optimum value selected at factory Average value shown					
C126	Capacitor: fixed, paper, .01 μf ±10%, 600 vdcw CC*	0160-0002	2	1		
C127 thru C200	These circuit references not assigned					
C201	Capacitor: fixed, paper, .047 μf ±10%, 1000 vdcw CC*	0160-0056	2	1		
C202	This circuit reference not assigned					
C203	Same as C201					
C204	Capacitor: fixed, mica, 27 pf ±10%, 500 vdcw Z*	0140-0005	2	1		
C205	Capacitor: fixed, mica, 68 pf ±10%, 500 vdcw V*	0140-0025	1	1		
C206	Same as C7					
C207	Capacitor: fixed, ceramic, 10 pf ±0.5 pf 500 vdcw K*	0150-0009	1	1		
C208	Same as C204					
C209	Capacitor: fixed, silver mica, 200 μf ±5%, 500 vdcw Z*	0140-0090	1	1		
C210	Capacitor: fixed, paper, 2200 pf ±10%, 600 vdcw CC*	0160-0007	2	1		
C211	Capacitor: fixed, ceramic, .02 μf ±10%, 600 vdcw G*	0150-0024	2	1		
C212	Same as C7					
C213	Same as C210					
C214, 215	Same as C15					

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**

TQ - **Total quantity used in the instrument.**

RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
C216	Capacitor: fixed, ceramic, .01 μf ±20%, 1000 vdcw CW*	0150-0012	1	1		
C217	This circuit reference not assigned					
C218	Same as C7					
C219	This circuit reference not assigned					
C220	Capacitor: fixed, mylar, 1.0 μf ±5%, 200 vdcw CW*	0170-0018	2	1		
C221	Capacitor: fixed, mylar, 0.1 μf ±5%, 200 vdcw CW*	0170-0019	1	1		
C222	Capacitor: fixed, mylar, .01 μf ±5%, 400 vdcw CW*	0170-0017	1	1		
C223	Same as C4					
C224	Same as C5					
C225	Same as C113					
C226	Same as C9					
C227	Same as C113					
C228	Same as C220					
C229	Capacitor: fixed, paper, 0.1 μf ±10%, 400 vdcw CC*	0160-0013	3	1		
C230	Same as C126					
C231	Capacitor: fixed, mica, 680 pf ±10%, 500 vdcw Z*	0140-0007	1	1		
C232	Capacitor: fixed, mica, 470 pf ±10%, 500 vdcw V*	0140-0027	1	1		
C233 thru C300	These circuit references not assigned					
C301	Capacitor: fixed, electrolytic, 2 section, 20 μf/sect., 450 vdcw CC*	0180-0012	2	1		
C302	Capacitor: fixed, electrolytic, 80 μf, 300 vdcw X*	0180-0044	1	1		
C303	Capacitor: fixed, electrolytic, 160 μf, 450 vdcw Optimum value selected at factory Average value shown CC*	0180-0030	1	1		

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**

TQ - **Total quantity used in the instrument.**

RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
C304A, B	Same as C301					
C305	Capacitor: fixed, paper, 0.1 μf ±10%, 1000 vdcw J*	0160-0040	1	1		
C306, 307	Capacitor: fixed, tubular, .01 μf ±20%, 400 vdcw CC*	0160-0054	5	2		
C308	Same as C229					
C309	Same as C306					
C310A, B	Capacitor: fixed, electrolytic, 4 sections, 20 μf/sect., 450 vdcw CC*	0180-0025	1	1		
C311, 312	Capacitor: fixed, paper, 6800 pf ±10%, 5000 vdcw CC*	0160-0045	2	1		
C313	Capacitor: fixed, paper, .015 μf ±10%, 3000 vdcw CC*	0160-0062	1	1		
C314, 315	Capacitor: fixed, paper, 1500 pf ±20%, 500 vdcw CC*	0160-0061	2			
C316	Same as C211					
C317 thru C319	These circuit references not assigned					
C320	Same as C306					
C321	This circuit reference not assigned					
C322	Capacitor: fixed, ceramic, 2000 pf ±20%, 1000 vdcw Radio Mat. Corp.	0150-0023	1	1		
C323	Same as C111					
C324	Same as C229					
C325	Same as C306					
C326	Capacitor: fixed, paper, .001 μf ±10%, 600 vdcw CC*	0160-0006	1	1		
C327	Same as C7					
C328	Capacitor: fixed, paper, .22 μf 400 vdcw CC*	0160-0018	1	1		

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	TQ	RS		
CR301, 302	Diode, selenium	CN*	1883-0005	2	2		
CR303 thru CR306	Diode, silicon: 500 ma, 400 PIV	BV*	1901-0007	4	4		
F301	Fuse, cartridge: 2 amp, slow blow for 115 V		2110-0006	1	10		
	1/2 amp, slow blow, for 230 V operation	E*	2110-0008	1	0		
I1, 2	Lamp, neon: 1/25 W, 90 vdcw, 65 VAC, NE2	O*	2140-0008	6	6		
I3 thru I100	These circuit references not assigned						
I101, 102	Same as I1						
I103 thru I200	These circuit references not assigned						
I201 thru I208	Lamp, neon: aged and selected, blue code	HP*	G-84B	9	9		
I209 thru I300	These circuit references not assigned						
I301	Lamp, incandescent: 6-8V, 2 pin base, #12	D*	2140-0012	1	1		
I302 thru I305	Lamp, incandescent: 6-8V, .15 amp, #47	O*	2140-0009	4	4		
I306	Same as I201						
I307, 308	Same as I1						
J1	Binding Post Assembly: red	HP*	AC-10D	4	1		
	Insulator, binding post (rack model)	HP*	AC-54A	4	0		
	Insulator, binding post (cabinet model)	HP*	AC-54B	2	0		
	Connector Assembly	HP*	G-76J	1	1		
J2	Connector, receptacle: male, 3 contact (on rear panel, rack mount only)	HP*	1251-0039	2	1		
J3 thru J100	These circuit references not assigned						

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	TQ	RS		
J101	Binding Post Assembly: red	HP*	AC-10D	(2)	See	J1	
	Insulator, binding post (rack model)	HP*	AC-54A	(2)	See	J1	
	Insulator, binding post (cabinet model)	HP*	AC-54B	(1)	See	J1	
	Connector Assembly	HP*	G-76K	1	1		
J102	Same as J2						
L201	Inductor: 1 μh	CG*	9140-0053	1	1		
L202	Inductor: 360 μh	CG*	9140-0038	1	1		
L203 thru L300	These circuit references not assigned						
L301	Coil, r.f.: 5 mh	CG*	9140-0037	1	1		
L302	Coil, r.f.: 200 μh	CG*	9140-0019	1	1		
P1	Cord, power	Cornish Wire Co.	8120-0050	1	1		
R1	Resistor: fixed, deposited carbon, 900,000 ohms ±1%, 1/2 W	NN*	0727-0259	3	1		
R2	Resistor: fixed, deposited carbon, 90,000 ohms ±1%, 1/2 W	NN*	0727-0203	2	1		
R3	Resistor: fixed, deposited carbon, 9000 ohms ±1%, 1/2 W	NN*	0727-0152	6	2		
R4	Resistor: fixed, deposited carbon, 1000 ohms ±1%, 1/2 W	NN*	0727-0100	2	1		
R5	Resistor: fixed, deposited carbon, 1 megohm ±1%, 1/2 W	NN*	0727-0274	4	1		
R6, 7	Resistor: fixed, composition, 100,000 ohms ±10%, 1/2 W	B*	0687-1041	4	1		
R8, 9	Resistor: fixed, composition, 100 ohms ±10%, 1/2 W	B*	0687-1011	17	4		

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
R10A, B	Resistor: variable, dual concentric, linear taper, Rear section: 250 ohms ±10% Front section: 10,000 ohms ±10%, 2 W BO*	2100-0147	2	1		
R11	Resistor: fixed, composition, 2.7 megohms ±10%, 1/2 W B*	0687-2751	3	1		
R12	Resistor: fixed, deposited carbon, 75,000 ohms ±1%, 1 W NN*	0730-0058	2	1		
R13	This circuit reference not assigned					
R14, 15	Resistor: fixed, metal film, 100,000 ohms ±1%, 1/2 W The Daven Co.	0757-0011	4	1		
R16, 17	Resistor: fixed, deposited carbon, 30,500 ohms ±1%, 1 W NN*	0730-0045	4	1		
R18	Resistor: variable, composition, 20,000 ohms ±20%, 1/3 W BO*	2100-0145	2	1		
R19	Resistor: fixed, deposited carbon, 15,000 ohms ±1%, 1/2 W NN*	0727-0168	8	2		
R20	Resistor: variable, composition, linear taper, 500 ohms ±20%, 2/10 W BO*	2100-0151	2	1		
R21	Same as R19					
R22	Resistor: fixed, deposited carbon, 1200 ohms ±1%, 1/2 W NN*	0727-0105	2	1		
R23	Resistor: fixed, deposited carbon, 1800 ohms ±1%, 1/2 W NN*	0727-0112	2	1		
R24	This circuit reference not assigned					
R25	Resistor: fixed, deposited carbon, 3000 ohms ±1%, 1/2 W NN*	0727-0124	3	1		
R26, 27	These circuit references not assigned					
R28	Resistor: fixed, deposited carbon, 6000 ohms ±1%, 1/2 W NN*	0727-0140	2	1		
R29, 30	Same as R3					
R31, 32	Same as R19					

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
R33, 34	Same as R8					
R35, 36	Resistor: fixed, deposited carbon, 41,500 ohms ±1%, 1 W NN*	0730-0050	4	1		
R37	Resistor: fixed, deposited carbon, 49,000 ohms ±1%, 1 W NN*	0730-0051	2	1		
R38	Resistor: variable, composition, linear taper, 5000 ohms ±20%, 1/2 W G*	2100-0011	2	1		
R39	Resistor: fixed, composition, 560 ohms ±10%, 1/2 W B*	0687-5611	2	1		
R40	Resistor: variable, composition, 5000 ohms ±30%, 1/3 W, linear taper BO*	2100-0091	2	1		
R41	Resistor: fixed, deposited carbon, 800,000 ohms ±1%, 1/2 W NN*	0727-0255	2	1		
R42, 43	Same as R8					
R44	Same as R41					
R45	Resistor: fixed, composition, 5100 ohms ±5%, 1 W B*	0689-5125	2	1		
R46	Resistor: fixed, composition, 22,000 ohms ±10%, 2 W B*	0693-2231	2	1		
R47	Resistor: fixed, composition, 10,000 ohms ±10%, 2 W B*	0693-1031	1	1		
R48	Same as R46					
R49	Same as R45					
R50, 51	Same as R8					
R52 thru R100	These circuit references not assigned					
R101	Same as R1					
R102	Same as R2					
R103	Same as R3					

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	hp STOCK NO.	TQ	RS		
R104	Same as R4					
R105	Same as R5					
R106, 107	Same as R6					
R108, 109	Same as R8					
R110A,B	Same as R10					
R111	Same as R11					
R112	Same as R12					
R113	This circuit reference not assigned					
R114, 115	Same as R14					
R116, 117	Same as R16					
R118	Same as R18					
R119	Same as R19					
R120	Same as R20					
R121	Same as R19					
R122	Same as R22					
R123	Same as R23					
R124	This circuit reference not assigned					
R125	Same as R25					
R126, 127	These circuit references not assigned					
R128	Same as R28					
R129, 130	Same as R3					
R131, 132	Same as R19					
R133	Resistor: fixed, deposited carbon, 50,000 ohms ±1%, 1/2 W NN*	0727-0195	1	1		
R134	Resistor: variable, composition, linear taper, 125,000 ohms ±20%, 1/4 W BO*	2100-0073	1	1		

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
R135	This circuit reference not assigned					
R136	Same as R1					
R137, 138	Same as R8					
R139, 140	Same as R35					
R141	Same as R37					
R142	Same as R38					
R143	Same as R39					
R144	Same as R40					
R145	Resistor: fixed, deposited carbon, 1.5 megohms ±1%, 1/2 W NN*	0727-0282	3	1		
R146, 147	Same as R8					
R148	Same as R145					
R149	Resistor: fixed, composition, 6200 ohms ±5%, 2 W B*	0692-6225	1	1		
R150, 151	Resistor: fixed, composition, 7500 ohms ±5%, 1 W B*	0689-7525	2	1		
R152, 153	Resistor: fixed, composition, 27,000 ohms ±10%, 2 W B*	0693-2731	2	1		
R154, 155	Same as R8					
R156 thru R163	These circuit references not assigned					
R164	Resistor: variable, composition, linear taper, 2500 ohms ±10%, 1/2 W G*	2100-0067	1	1		
R165	Resistor: fixed, composition, 56 megohms ±10%, 1/2 W B*	0687-5661	1	1		
R166 thru R200	These circuit references not assigned					

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
R201	Resistor: fixed, composition, 680,000 ohms ±10%, 1/2 W B*	0687-6841	1	1		
R202	Resistor: fixed, composition, 1.2 megohms ±10%, 1/2 W B*	0687-1251	2	1		
R203	Resistor: fixed, composition, 39,000 ohms ±5%, 2 W B*	0692-3935	3	1		
R204, 205	Resistor: fixed, composition, 13,000 ohms ±5%, 1 W B*	0689-1335	2	1		
R206, 207	Same as R203					
R208	Same as R202					
R209	Part of S202: not separately replaceable					
R210	Resistor: fixed, deposited carbon, 2 megohms ±1%, 1/2 W NN*	0727-0287	1	1		
R211	Resistor: fixed, composition, 47 ohms ±10%, 1/2 W B*	0687-4701	1	1		
R212	Resistor: fixed, composition, 3600 ohms ±5%, 1/2 W B*	0686-3625	1	1		
R213	Resistor: fixed, composition, 3300 ohms ±10%, 1/2 W B*	0687-3321	1	1		
R214	Resistor: fixed, composition, 30,000 ohms ±5%, 2 W B*	0692-3035	1	1		
R215	Resistor: fixed, deposited carbon, 216,300 ohms ±1%, 1/2 W NN*	0727-0223	1	1		
R216	Resistor: fixed, deposited carbon, 252,000 ohms ±1%, 1/2 W NN*	0727-0228	2	1		
R217	Resistor: fixed, deposited carbon, 479,000 ohms ±1%, 1 W NN*	0730-0091	1	1		
R218	Part of S201: not separately replaceable					
R219	Resistor: fixed, composition, 120,000 ohms ±10%, 1/2 W B*	0687-1241	1	1		
R220	Resistor: variable, composition, linear taper, 100,000 ohms ±30%, 1/4 W BO*	2100-0095	2	1		

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
R221	Resistor: fixed, composition, 27,000 ohms ±10%, 1/2 W B*	0687-2731	4	1		
R22	Resistor: fixed, composition, 7.5 megohms ±5%, 1/2 W B*	0686-7555	1	1		
R223	Resistor: fixed, composition, 16,000 ohms ±5%, 1 W B*	0689-1635	1	1		
R224	Resistor: fixed, composition, 62,000 ohms, ±5%, 2 W B*	0692-6235	1	1		
R225	Resistor: fixed, metal film 20,000 ohms ±10%, 4 W AB*	0771-0004	1	1		
R226	This circuit reference not assigned					
R227	Same as R216					
R228	Resistor: fixed, deposited carbon, 284,000 ohms ±1%, 1/2 W NN*	0727-0230	1	1		
R229	Resistor: variable, composition, linear taper 500,000 ohms ±30%, 1/4 W BO*	2100-0102	2	1		
R230	Resistor: fixed, composition, 390,000 ohms ±10%, 1/2 W B*	0687-3941	1	1		
R231	Resistor: fixed, composition, 270,000 ohms ±10%, 1/2 W B*	0687-2741	1	1		
R232	Resistor: fixed, composition, 1000 ohms ±5%, 1/2 W B*	0686-1025	1	1		
R233	Resistor: fixed, composition, 33,000 ohms ±10%, 1 W B*	0690-3331	1	1		
R234	Resistor: fixed, composition, 82,000 ohms ±10%, 2 W B*	0693-8231	1	1		
R235	Resistor: fixed, composition, 470 ohms ±10%, 1/2 W B*	0687-4711	2	1		
R236	Same as R221					
R237	Same as R235					
R238	Resistor: fixed, composition, 68,000 ohms ±10%, 2 W B*	0693-6831	1	1		
R239	Same as R8					
R240	Same as R229					

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	hp STOCK NO.	TQ	RS		
R241	Resistor: fixed, deposited carbon, 2.163 megohms ±1%, 1 W NN*	0730-0113	1	1		
R242	Resistor: fixed, composition, 22 megohms ±10%, 1/2 W B*	0687-2261	1	1		
R243	Resistor: fixed, composition, 3 megohms ±5%, 1/2 W B*	0686-3055	1	1		
R244	Same as R25					
R245	Resistor: fixed, composition, 1200 ohms ±10%, 1/2 W B*	0687-1221	1	1		
R246	Same as R11					
R247 thru R249	These circuit references not assigned					
R250	Resistor: fixed, deposited carbon, 3.6 megohms ±1%, 1/2 W NN*	0727-0294	1	1		
R251, 252	Resistor: fixed, deposited carbon, 1.2 megohms ±1%, 1/2 W NN*	0727-0280	2	1		
R253	Resistor: fixed, deposited carbon, 36 megohms ±1%, 2 W NN*	0733-0009	1	1		
R254, 255	Resistor: fixed, deposited carbon, 12 megohms ±1%, 1 W NN*	0730-0145	2	1		
R256	Resistor: fixed, deposited carbon, 1.15 megohms ±1%, 1/2 W NN*	0727-0279	1	1		
R257, 258	Resistor: fixed, deposited carbon, 376,000 ohms ±1%, 1/2 W NN*	0727-0237	2	1		
R259 thru R261	Resistor: variable, composition, linear taper, 20,000 ohms ±20%, 1/4 W BO*	2100-0093	3	1		
R262	Resistor: variable, composition, linear taper, 50,000 ohms ±30%, 1/3 W BO*	2100-0107	1	1		
R263	Resistor: fixed, composition, 22,000 ohms ±10%, 1/2 W B*	0687-2231	2	1		
R264	This circuit reference not assigned					

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
R265	Resistor: fixed, composition, 3.9 megohms ±10%, 1/2 W B*	0687-3951	1	1		
R266 thru R300	These circuit references not assigned					
R301	Same as R145					
R302	Resistor: fixed, wirewound, 4000 ohms ±5%, 20 W S*	0818-0001	1	1		
R303	Same as R220					
R304	Resistor: fixed, composition, 2.2 megohms ±10%, 1 W B*	0690-2251	2	1		
R305	Resistor: fixed, composition, 1000 ohms ±10%, 1/2 W B*	0687-1021	8	2		
R306	Resistor: fixed, composition, 68,000 ohms ±10%, 1 W B*	0690-6831	1	1		
R307	Resistor: fixed, composition, 10,000 ohms ±10%, 1/2 W B*	0687-1031	2	1		
R308	Resistor: fixed, composition, 1 megohm ±10%, 1 W B*	0690-1051	2	1		
R309	Same as R305					
R310	Resistor: fixed, deposited carbon, 1.13 megohms ±1%, 1/2 W NN*	0727-0278	1	1		
R311	Resistor: fixed, deposited carbon, 1.39 megohms ±1%, 1/2 W NN*	0727-0281	2	1		
R312	Resistor: fixed, deposited carbon, 2.84 megohms ±1%, 1 W NN*	0730-0116	1	1		
R313	Resistor: fixed, wirewound, 20,000 ohms ±10%, 10 W S*	0816-0018	1	1		
R314	Resistor: fixed, wirewound, 1500 ohms ±10%, 20 W S*	0819-0016	1	1		
R315	Same as R308					
R316	Same as R305					

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
R317	Resistor: fixed, composition, 22,000 ohms ±10%, 1 W B*	0690-2231	1	1		
R318	Same as R221					
R319	Resistor: fixed, composition, 1.2 megohms ±10%, 1 W B*	0690-1251	2	1		
R320	Same as R305					
R321	Resistor: fixed, deposited carbon, 1.75 megohms ±1%, 1/2 W NN*	0727-0284	1	1		
R322	Resistor: fixed, deposited carbon, 2.52 megohms ±1%, 1/2 W NN*	0727-0289	1	1		
R323	Resistor: fixed, composition, 680,000 ohms ±10%, 1 W B*	0690-6841	2	1		
R324	Resistor: fixed, composition, 100,000 ohms ±10%, 1 W B*	0690-1041	1	1		
R325	Same as R305					
R326	Resistor: fixed, composition, 12,000 ohms ±10%, 1 W B*	0690-1231	1	1		
R327	Same as R263					
R328	Resistor: fixed, composition, 4700 ohms ±10%, 1/2 W B*	0687-4721	1	1		
R329	Same as R319					
R330	Same as R305					
R331	Same as R5					
R332	Resistor: variable, composition, linear taper, 250,000 ohms ±30%, 1/4 W BO*	2100-0144	1	1		
R333	Same as R311					
R334	Resistor: variable, composition, linear taper, 1 megohm ±30%, 1/4 W BO*	2100-0096	1	1		
R335	Resistor: fixed, deposited carbon, 20 megohms ±10%, 1 W AV*	0813-0014	1	1		

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	TQ	RS		
R336	Resistor: variable, composition, linear taper, 5 megohms ±30%, 1/2 W I*	2100-0112	1	1		
R337	Same as R5					
R338	Same as R221					
R339	Same as R304					
R340	This circuit reference not assigned					
R341	Same as R307					
R342	This circuit reference not assigned					
R343	Resistor: variable, composition, linear taper, 1 megohm ±30%, 1/4 W BO*	2100-0080	1	1		
R344, 345	These circuit references not assigned					
R346	Resistor: fixed, deposited carbon, 29 megohms ±10%, 1 W AV*	0813-0015	1	1		
R347	This circuit reference not assigned					
R348	Resistor: fixed, composition, 270,000 ohms ±10%, 1 W B*	0690-2741	1	1		
R349	Same as R46					
R350	Resistor: fixed, composition, 47,000 ohms ±10%, 1/2 W B*	0687-4731	2	1		
R351	Same as R305					
R352	Resistor: fixed, composition, 2000 ohms ±5%, 1/2 W B*	0686-2025	1	1		
R353	Resistor: fixed, composition, 510 ohms ±5%, 1 W B*	0689-5115	1	1		
R354	Resistor: fixed, composition, 2700 ohms ±10%, 1/2 W B*	0687-2721	1	1		
R355, 356	Resistor: fixed, composition, 68,000 ohms ±10%, 1/2 W B*	0687-6831	2	1		

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	hp STOCK NO.	TQ	RS		
R357	Resistor: variable, wirewound, 25 ohms ±10%, 2 W, linear taper BO*	2100-0140	1	1		
R358	Same as R323					
R359	Resistor: fixed, deposited carbon, 750,000 ohms ±1%, 1/2 W NN*	0727-0253	1	1		
R360	Resistor: fixed, composition, 10 megohms ±10%, 1/2 W B*	0687-1061	1	1		
R361	Resistor: fixed, composition, 56,000 ohms ±10%, 1 W B*	0690-5631	1	1		
R362	Resistor: fixed, composition, 150,000 ohms ±10%, 1 W B*	0690-1541	1	1		
R363	This circuit reference not assigned					
R364	Resistor: fixed, composition, 82,000 ohms ±10%, 1/2 W B*	0687-8231	1	1		
R365	Resistor: variable, composition, linear taper, 50,000 ohms ±20%, 1/2 W G*	2100-0013	1	1		
R366	Resistor: fixed, composition, 33,000 ohms ±10%, 1/2 W B*	0687-3331	1	1		
R367	This circuit reference not assigned					
R368	Resistor: fixed, composition, 1 megohm ±10%, 1/2 W B*	0687-1051	1	1		
R369	Same as R350					
R370	Same as R305					
R371	Resistor: fixed, composition, 2.2 megohms ±10%, 1/2 W B*	0687-2251	1	1		
S1	Switch, toggle: SPST Vertical AC-DC Switch D*	3101-0001	1	1		
S2	Vertical Sensitivity Switch Assembly HP*	130B-95A	1	1		
S3	Part of R18: not separately replaceable					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
TQ - Total quantity used in the instrument.
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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	TQ	RS		
S4 thru S100	These circuit references not assigned						
S101	Switch, rotary: 5 section, 16 pos.	W*	3100-0243	1	1		
S102	Horizontal Sensitivity Switch Assembly	HP*	130B-95B	1	1		
S103	Part of R118: not separately replaceable						
S104 thru S200	These circuit references not assigned						
S201	Sync Switch Assembly	HP*	130B-19H	1	1		
S202	Trigger Level Switch Assembly	HP*	130B-19G	1	1		
S203	Part of R218: not separately replaceable						
S204	Sweep Time/CM Switch Assembly	HP*	130B-19J	1	1		
S205	Part of R262: not separately replaceable						
S206 thru S300	These circuit references not assigned						
S301	Part of R357: not separately replaceable						
T1 thru T300	These circuit references not assigned						
T301	Transformer, power	HP*	9100-0091	1	1		
T302	Transformer, rf, high voltage	HP*	130B-11B-1	1	1		
V1	Tube, electron: 12AU7, selected	HP*	G-73R	2	2		
V2	Tube, electron: 12AU7	ZZ*	1932-0029	3	3		
V3	Tube, electron: 12AT7	ZZ*	1932-0027	3	3		
V4	Tube, electron: 6DJ8	ZZ*	1932-0022	4	4		
V5 thru V100	These circuit references not assigned						
V101	Same as V1						
V102	Same as V2						
V103	Same as V3						
V104	Same as V4						

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	TQ	RS		
V105 thru V200	These circuit references not assigned						
V201	Same as V4						
V202	Same as V3						
V203	Tube, electron: 6U8	ZZ*	1933-0004	1	1		
V204	Tube, electron: 6C4	ZZ*	1921-0005	1	1		
V205	Tube, electron: 12AL5	ZZ*	1930-0019	1	1		
V206	Tube, electron: 6AW8A	ZZ*	1933-0002	1	1		
V207	Tube, electron: 12AX7	ZZ*	1932-0030	1	1		
V208 thru V300	These circuit references not assigned						
V301	Tube, electron: 12B4A	ZZ*	1921-0010	3	3		
V302	Tube, electron: 6AU6	ZZ*	1923-0021	1	1		
V303	Same as V301						
V304	Tube, electron: 6BH6	ZZ*	1923-0027	2	2		
V305	Tube, electron: 6X4	ZZ*	1930-0016	1	1		
V306	Same as V301						
V307	Same as V304						
V308	Tube, electron: 5651	ZZ*	1940-0001	1	1		
V309	Tube, electron, cathode-ray type (Normally supplied with P1 phosphor. Also available are P2, P5 and P7.)	ZZ*	2090-0007	1	1		
V310, 311	Tube, electron: 5642	ZZ*	1920-0001	2	2		
V312	Same as V2						
V313	Tube, electron: 6AQ5	ZZ*	1923-0018	1	1		
V314	Same as V4						

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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	TQ	RS		
	MISCELLANEOUS						
	CRT bezel	HP*	120A-20A	1	0		
	Filter, light: amber	HP*	120A-83A	1	0		
	Filter, light: blue	HP*	120A-83B	1	0		
	Filter, light: green	HP*	120A-83G	1	0		
	Fuseholder	T*	1400-0007	1	1		
	Graticule	HP*	120A-83C	1	0		
	High voltage oscillator and rectifier assembly	HP*	130B-11B	1	0		
	Holder, rectifier	T*	1400-0056	2	1		
	Jewel, for pilot lamp	HP*	1450-0020	1	0		
	Knob: FOCUS, INTENSITY, SCALE LIGHT	HP*	G-74D	3	0		
	Knob: VERT. POS., HORIZ. POS.	HP*	G-74G	2	0		
	Knob: TRIGGER LEVEL	HP*	G-74L	1	0		
	Knob: VERT. SENSITIVITY, HORIZ. SENSITIVITY, SYNC TIME, SWEEP TIME	HP*	G-74Q	4	0		
	Knob: TRIGGER SLOPE	HP*	G-74AT	1	0		
	Knob: VERNIER, VERT. SENSITIVITY, HORIZ. SENSITIVITY, SYNC TIME, SWEEP TIME	HP*	G-74AU	4	0		
	Knob: VERT. and HORIZ. DC BAL	HP*	G-74BJ	2	0		
	Socket assembly, pilot lamp	AD*	1450-0022	1	0		

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LIST OF CODE LETTERS USED IN TABLE OF REPLACEABLE PARTS TO DESIGNATE THE MANUFACTURERS

CODE LETTER	MANUFACTURER	ADDRESS
A	Aerovox Corp.	New Bedford, Mass.
B	Allen-Bradley Co.	Milwaukee 4, Wis.
C	Amperite Co.	New York, N. Y.
D	Arrow, Hart & Hegeman	Hartford, Conn.
E	Bussman Manufacturing Co.	St. Louis, Mo.
F	Carborundum Co.	Niagara Falls, N. Y.
G	Centralab	Milwaukee 1, Wis.
H	Cinch-Jones Mfg. Co.	Chicago 24, Ill.
HP	Hewlett-Packard Co.	Palo Alto, Calif.
I	Clarostat Mfg. Co.	Dover, N. H.
J	Cornell Dubilier Elec. Co.	South Plainfield, N. J.
K	Hi-Q Division of Aerovox	Olean, N. Y.
L	Erie Resistor Corp.	Erie 6, Pa.
M	Fed. Telephone & Radio Corp.	Clifton, N. J.
N	General Electric Co.	Schenectady 5, N. Y.
O	General Electric Supply Corp.	San Francisco, Calif.
P	Girard-Hopkins	Oakland, Calif.
Q	Industrial Products Co.	Danbury, Conn.
R	International Resistance Co.	Philadelphia 8, Pa.
S	Lectrohm Inc.	Chicago 20, Ill.
T	Littlefuse Inc.	Des Plaines, Ill.
U	Maguire Industries Inc.	Greenwich, Conn.
V	Micamold Radio Corp.	Brooklyn 37, N. Y.
W	Oak Manufacturing Co.	Chicago 10, Ill.
X	P. R. Mallory Co., Inc.	Indianapolis, Ind.
Y	Radio Corp. of America	Harrison, N. J.
Z	Sangamo Electric Co.	Marion, Ill.
AA	Sarkes Tarzian	Bloomington, Ind.
BB	Signal Indicator Co.	Brooklyn 37, N. Y.
CC	Sprague Electric Co.	North Adams, Mass.
DD	Stackpole Carbon Co.	St. Marys, Pa.
EE	Sylvania Electric Products Co.	Warren, Pa.
FF	Western Electric Co.	New York 5, N. Y.
GG	Wilkor Products, Inc.	Cleveland, Ohio
HH	Amphenol	Chicago 50, Ill.
II	Dial Light Co. of America	Brooklyn 37, N. Y.
JJ	Leecraft Manufacturing Co.	New York, N. Y.
KK	Switchcraft, Inc.	Chicago 22, Ill.
LL	Gremar Manufacturing Co.	Wakefield, Mass.
MM	Carad Corp.	Redwood City, Calif.
NN	Electra Manufacturing Co.	Kansas City, Mo.
OO	Acro Manufacturing Co.	Columbus 16, Ohio
PP	Alliance Manufacturing Co.	Alliance, Ohio
QQ	Arco Electronics, Inc.	New York 13, N. Y.
RR	Astron Corp.	East Newark, N. J.
SS	Axel Brothers Inc.	Long Island City, N. Y.
TT	Belden Manufacturing Co.	Chicago 44, Ill.
UU	Bird Electronics Corp.	Cleveland 14, Ohio
VV	Barber Colman Co.	Rockford, Ill.
WW	Bud Radio Inc.	Cleveland 3, Ohio
XX	Allen D. Cardwell Mfg. Co.	Plainville, Conn.
YY	Cinema Engineering Co.	Burbank, Calif.
ZZ	Any brand tube meeting RETMA standards.	
AB	Corning Glass Works	Corning, N. Y.
AC	Dale Products, Inc.	Columbus, Neb.
AD	The Drake Mfg. Co.	Chicago 22, Ill.
AE	Elco Corp.	Philadelphia 24, Pa.
AF	Hugh H. Eby Co.	Philadelphia 44, Pa.
AG	Thomas A. Edison, Inc.	West Orange, N. J.
AH	Fansteel Metallurgical Corp.	North Chicago, Ill.
AI	General Ceramics & Steatite Corp.	Keasbey, N. J.
AJ	The Gudeman Co.	Sunnyvale, Calif.
AK	Hammerlund Mfg. Co., Inc.	New York 1, N. Y.
AL	Industrial Condenser Corp.	Chicago 18, Ill.
AM	Insuline Corp. of America	Manchester, N. H.
AN	Jennings Radio Mfg. Corp.	San Jose, Calif.
AO	E. F. Johnson Co.	Waseca, Minn.
AP	Lenz Electric Mfg. Co.	Chicago 47, Ill.
AQ	Micro-Switch	Freeport, Ill.
AR	Mechanical Industries Prod. Co.	Akron 8, Ohio
AS	Model Eng. & Mfg., Inc.	Huntington, Ind.
AT	The Muter Co.	Chicago 5, Ill.
AU	Ohmite Mfg. Co.	Skokie, Ill.
AV	Resistance Products Co.	Harrisburg, Pa.
AW	Radio Condenser Co.	Camden 3, N. J.
AX	Shallcross Manufacturing Co.	Collingdale, Pa.
AY	Solar Manufacturing Co.	Los Angeles 58, Calif.
AZ	Sealectro Corp.	New Rochelle, N. Y.
BA	Spencer Thermostat	Attleboro, Mass.
BC	Stevens Manufacturing Co.	Mansfield, Ohio
BD	Torrington Manufacturing Co.	Van Nuys, Calif.
BE	Vector Electronic Co.	Los Angeles 65, Calif.
BF	Weston Electrical Inst. Corp.	Newark 5, N. J.
BG	Advance Electric & Relay Co.	Burbank, Calif.
BH	E. I. DuPont	San Francisco, Calif.
BI	Electronics Tube Corp.	Philadelphia 18, Pa.
BJ	Aircraft Radio Corp.	Boonton, N. J.
BK	Allied Control Co., Inc.	New York 21, N. Y.
BL	Augat Brothers, Inc.	Attleboro, Mass.
BM	Carter Radio Division	Chicago, Ill.
BN	CBS Hytron Radio & Electric	Danvers, Mass.
BO	Chicago Telephone Supply	Elkhart, Ind.
BP	Henry L. Crowley Co., Inc.	West Orange, N. J.
BQ	Curtiss-Wright Corp.	Carlstadt, N. J.
BR	Allen B. DuMont Labs	Clifton, N. J.
BS	Excel Transformer Co.	Oakland, Calif.
BT	General Radio Co.	Cambridge 39, Mass.
BU	Hughes Aircraft Co.	Culver City, Calif.
BV	International Rectifier Corp.	El Segundo, Calif.
BW	James Knights Co.	Sandwich, Ill.
BX	Mueller Electric Co.	Cleveland, Ohio
BY	Precision Thermometer & Inst. Co.	Philadelphia 30, Pa.
BZ	Radio Essentials Inc.	Mt. Vernon, N. Y.
CA	Raytheon Manufacturing Co.	Newton, Mass.
CB	Tung-Sol Lamp Works, Inc.	Newark 4, N. J.
CD	Varian Associates	Palo Alto, Calif.
CE	Victory Engineering Corp.	Union, N. J.
CF	Weckesser Co.	Chicago 30, Ill.
CG	Wilco Corporation	Indianapolis, Ind.
CH	Winchester Electronics, Inc.	Santa Monica, Calif.
CI	Malco Tool & Die	Los Angeles 42, Calif.
CJ	Oxford Electric Corp.	Chicago 15, Ill.
CK	Camloc-Fastener Corp.	Paramus, N. J.
CL	George K. Garrett	Philadelphia 34, Pa.
CM	Union Switch & Signal	Swissvale, Pa.
CN	Radio Receptor	New York 11, N. Y.
CO	Automatic & Precision Mfg. Co.	Yonkers, N. Y.
CP	Bassick Co.	Bridgeport 2, Conn.
CQ	Birnbach Radio Co.	New York 13, N. Y.
CR	Fischer Specialties	Cincinnati 6, Ohio
CS	Telefunken (c/o MVM, Inc.)	New York, N. Y.
CT	Potter-Brumfield Co.	Princeton, Ind.
CU	Cannon Electric Co.	Los Angeles, Calif.
CV	Dynac, Inc.	Palo Alto, Calif.
CW	Good-All Electric Mfg. Co.	Ogallala, Nebr.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Hewlett-Packard Company warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Klystron tubes as well as other electron tubes, fuses and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

All shipments of Hewlett-Packard instruments should be made via Truck or Railway Express. The instruments should be packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock-absorbing material.

DO NOT HESITATE TO CALL ON US

HEWLETT-PACKARD COMPANY

Laboratory Instruments for Speed and Accuracy

1501 Page Mill Road Palo Alto, California

CABLE "HEWPACK"

hp