INSTRUCTION MANUAL

TYPE 422
AC-DC
power supply

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

K4XL's  BAMA

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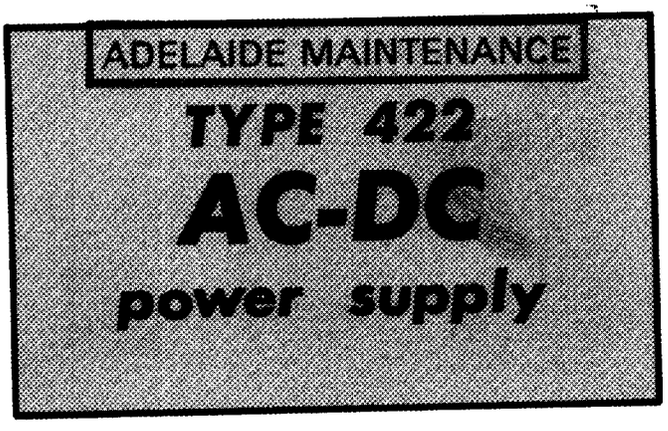
INSTRUCTION MANUAL

Serial Number _____



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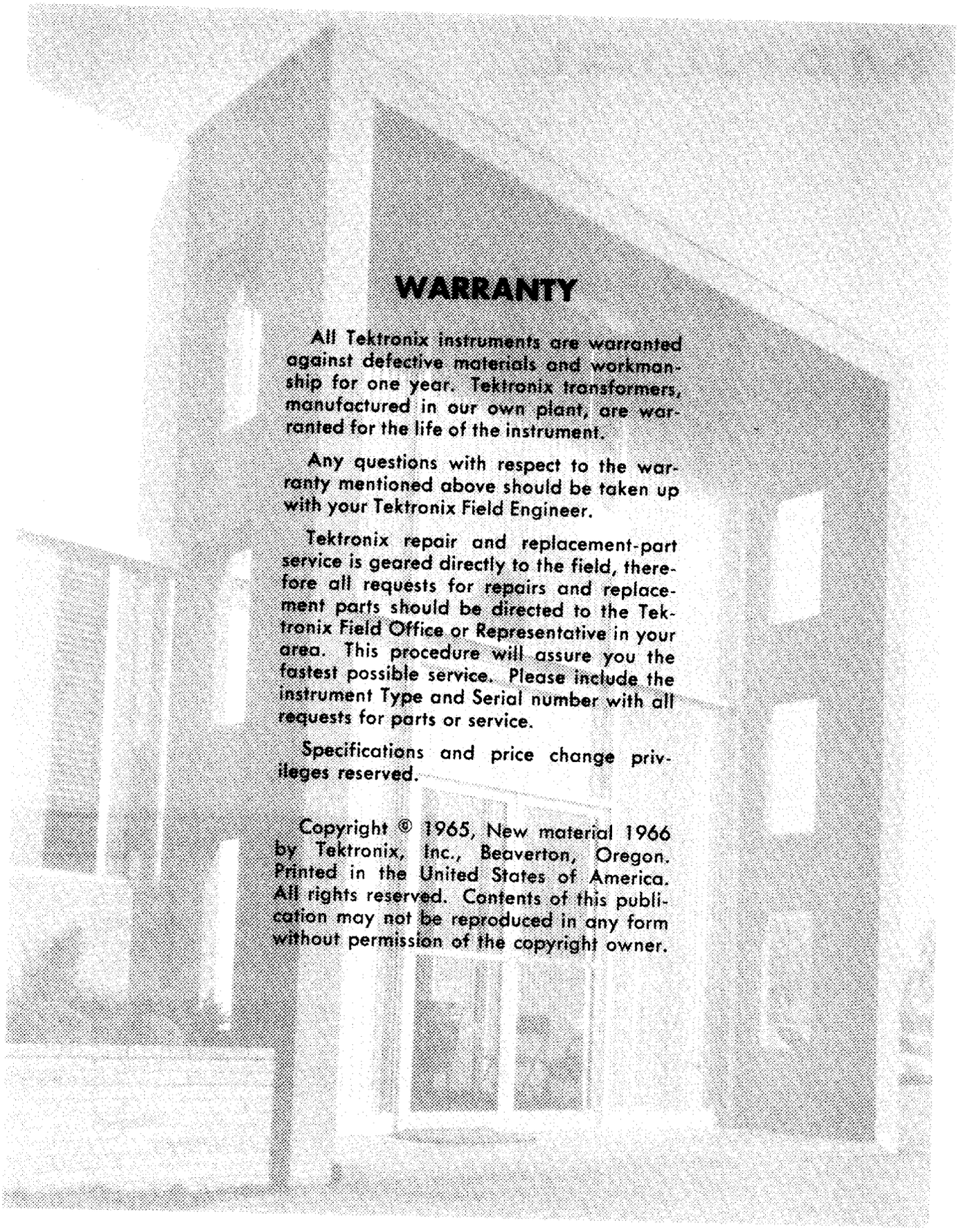

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

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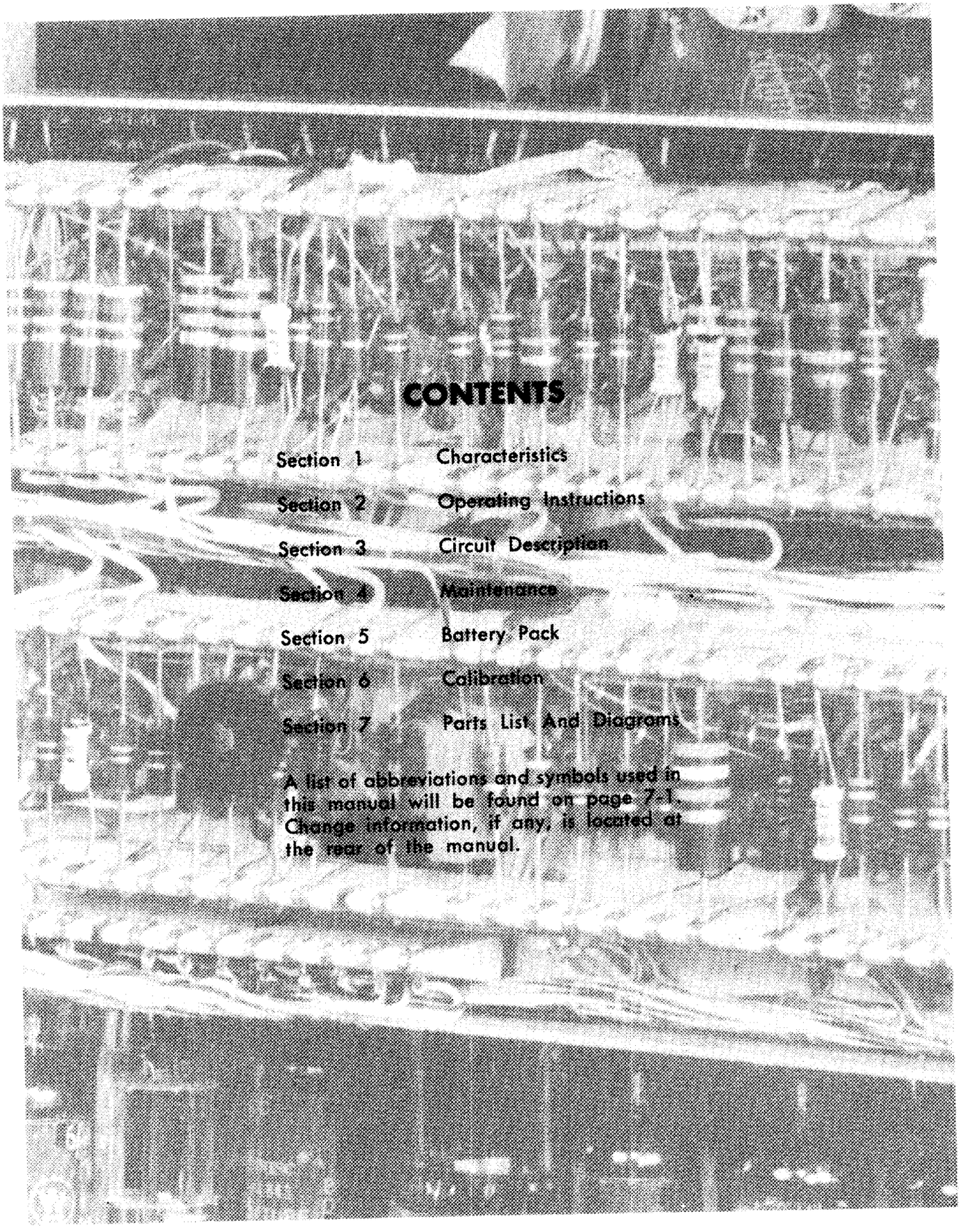

CONTENTS

A list of abbreviations and symbols used in this manual will be found on page 7-1. Change information, if any, is located at the rear of the manual.

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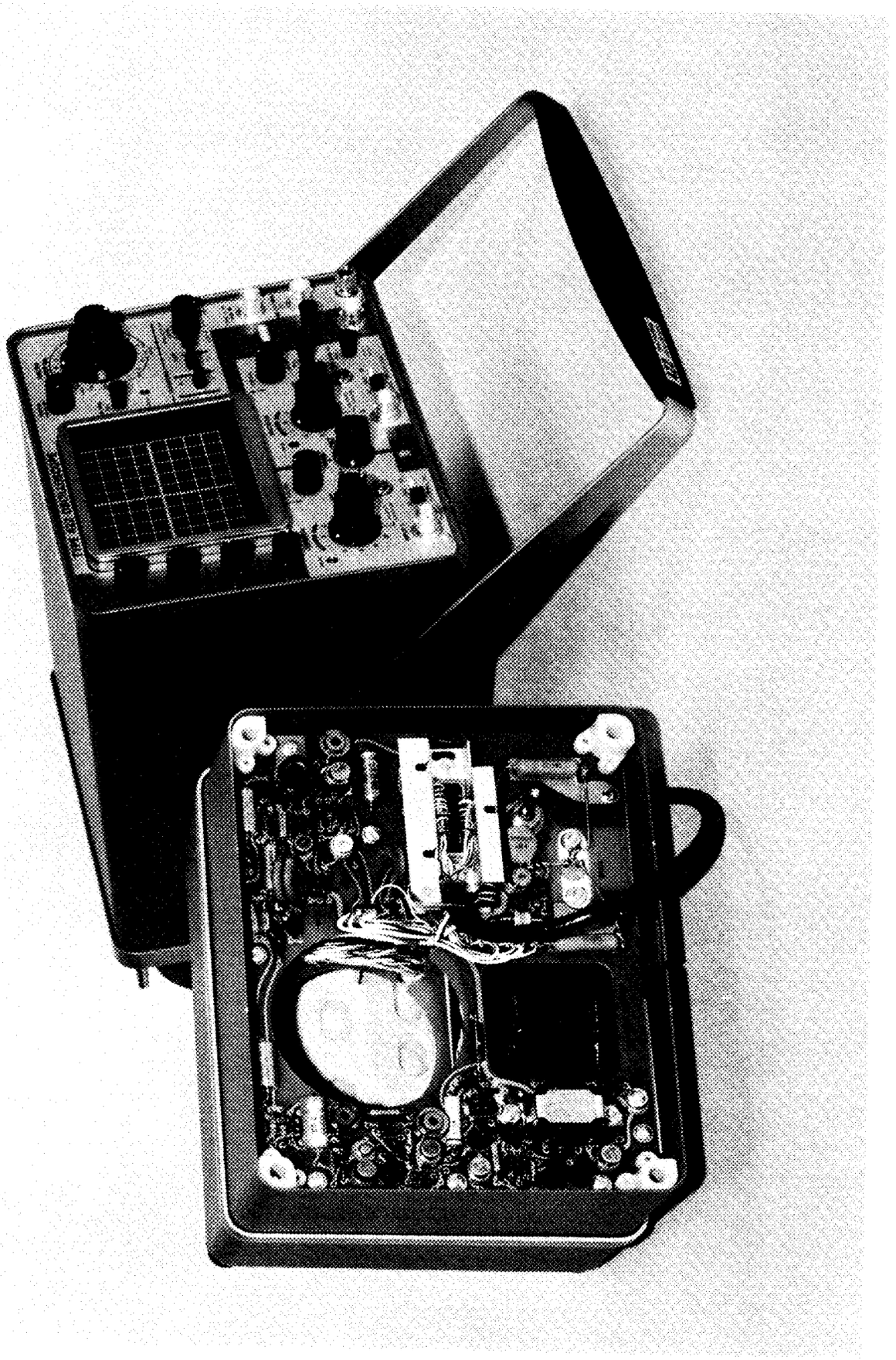


SECTION 1
CHARACTERISTICS

Introduction

The Type 422 AC-DC Power Supply, when supplied with input voltages from either ac, dc external, or dc internal (batteries) sources, will provide all the necessary operating voltages to the Type 422 Indicator.

ELECTRICAL CHARACTERISTICS

Voltage Requirements

AC (Oscilloscope)—115 volts ac ±20%, or 230 volts ac ±20%, 50 to 440 cycles per second. From 50 to 45 cps the line voltage upper limit must be derated linearly to ±10%. The power line total harmonic distortion should not exceed 1% at any frequency. The power supply will function with distortion which exceeds 1%; however, the specified voltage limits will no longer apply.

AC (Battery Charger)—115 volts ac +10%, —20%, or 230 volts ac +10%, —20%, 45 to 440 cps.

DC External—11.5 to 35 volts dc external source voltage supplied to the power supply through furnished dc power cord.

CAUTION

The chassis of the Type 422 must not be elevated more than ±200 volts from the negative power line potential during dc external operation.

DC Internal (Battery Pack)—24 volts dc supplied by 20, 1.2 volt, 3.5 ampere-hour nickel cadmium cells.

Power Consumption

AC—Typically 27 watts at all input voltages.
DC External—Typically 23 watts.
DC Internal (Battery Pack)—Will provide approximately four hours of running time. Battery operation is limited to fifteen minutes after POWER Light starts blinking.

Thermal Protection

Two automatic-resetting thermal cutouts interrupt instrument power on ac operation if the internal temperature of the power supply exceeds a safe operating level. During dc operation one automatic-resetting thermal cutout interrupts the instrument power if the internal temperature exceeds a safe level.

A third automatic-resetting thermal cutout monitors the temperature of the battery pack in the two Charge Battery positions of the POWER MODE switch, and will limit the battery charge current to 30 ma (trickle charge) if the temperature of the batteries exceeds a safe level for the 400 ma charging current.

Battery Charger

The batteries are charged at approximately a 400 ma constant current rate in the CHARGE BATT 115 V AC and CHARGE BATT 230 V AC positions of the POWER MODE switch. Fully discharged batteries when charged at the 400 ma charge rate will reach full charge in approximately 12 hours.

In the OPERATE 115 V AC and 230 V AC positions of the POWER MODE switch, the batteries are trickle-charged at a 30 ma constant current rate.

ENVIRONMENTAL CHARACTERISTICS

NOTE

All environmental characteristics for the Type 422 Indicator apply to the AC-DC Power Supply except as noted below.

Temperature Without Batteries (Category I)

Operating— —15° C to +55° C.
Non-operating— —55° C to +75° C.

Temperature With Batteries (Category I)

Operating— —5° C to +40° C (Battery charging temperature range.)
—15° C to +40° C (Battery discharging temperature range.)
Non-operating— —40° C to +60° C.

MECHANICAL CHARACTERISTICS

Construction

Aluminum-alloy panel and cabinet.
Glass laminate etched-wiring boards.

Finish

Anodized panel, blue-vinyl painted cabinet.

Overall Dimensions (measured at maximum points)

6.75" high, 10.0" wide, 6.84" long (dimensions do not include power cord).

ACCESSORIES

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

ACCESSORIES INCLUDED

	Tektronix Part No.
1—3- to 2-wire power cord adapter.	103-0013-00
1—3-wire ac power cord with male and female connectors.	161-0015-00
1—3-wire dc power cord with female connector.	161-0016-00
2—Instruction manuals	070-0471-00

OPTIONAL ACCESSORIES

1—Battery Pack with 20—1.2 volt 3.5 ampere-hour, nickel-cadmium batteries	016-0066-00

SECTION 2

OPERATING INSTRUCTIONS

General

The Type 422 AC-DC Power Supply will operate the Type 422 Indicator from the ac line, from an 11.5- to 35-volt source of external dc, or from a 24-volt internal dc source comprised of twenty 1.2-volt, 3.5 ampere-hour nickel-cadmium batteries.

This section will describe the different positions of the POWER MODE switch, power supply and remote power supply operation.

Information on front-panel controls, first-time operation, general operating information and basic applications will be found in the manual for the Type 422 Indicator.

REAR-PANEL CONTROL FUSE AND CONNECTOR

Fig. 2-1 shows a rear-panel view of the AC-DC Power Supply with a brief description for each position of the POWER MODE switch, and a brief description of the rear power input connector.

Fig. 2-2 shows the power cord connections for ac or external dc operation. The following table indicates the proper fuse sizes for the different ac or dc voltage ranges of the AC-DC Power Supply.

TABLE 2-1

FUSES

AC F1000		DC F1014	
VOLTAGE	FUSE SIZE	VOLTAGE	FUSE SIZE
115	0.75 a Fast Blow	11.5 to 35	3 a Fast Blow
230	0.75 a Fast Blow	Internal Battery	3 a Fast Blow

GENERAL OPERATING INFORMATION

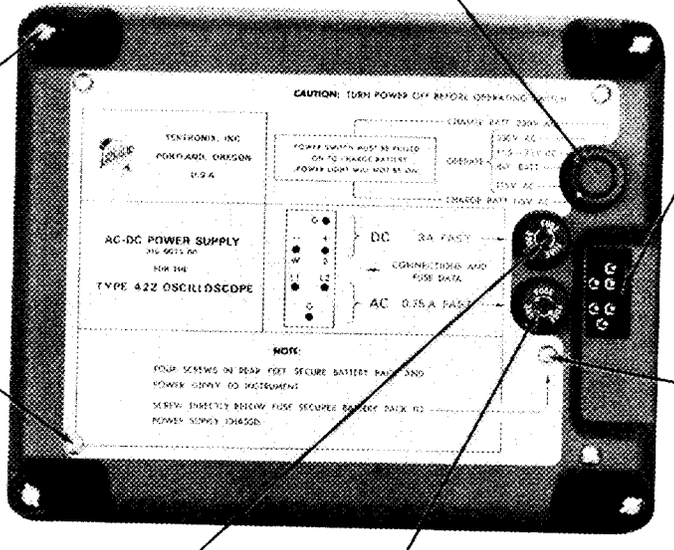
Removing and Attaching the Power Supply

The power supply can be removed from the Type 422 Indicator for maintenance, calibration, or remote operation. Loosen the four power supply securing screws located in the rear feet of the power supply and then separate the units by sliding the power supply to the rear, off the support rods.

To attach the power supply to the Type 422 Indicator reverse the above procedure.

POWER MODE

Switch Position		Function
CHARGE BATT 230 V AC		Used when ac line voltage applied to instrument is 230 volts. Charges batter pack at a 400 ma constant current rate when POWER Switch is on. Indicator does not operate at this switch position.
OPERATE	230 V AC	Used when ac line voltage applied to instrument is 230 volts. Indicator operates and battery pack is charged at a constant current rate of 30 ma when instrument is turned on.
	11. 5—35 V DC	Used when instrument is operated from external dc source. Special dc power cord is used to connect instrument to dc voltage. Only indicator operates. No charging of the battery pack.
	INT BATT	Used when instrument is operated from battery pack that has been installed into power supply. Only indicator operates. No charging of the battery pack.
	115 V AC	Used when ac line voltage applied to instrument is 115 volts. Indicator operates and battery pack is charged at a constant current rate of 30 ma when instrument is turned on.
CHARGE BATT 115 V AC		Used when ac line voltage applied to instrument is 115 volts. Charges battery pack at a 400 ma constant current rate when POWER Switch is on. Indicator does not operate at this switch position.



Power Supply Securing Screws—Secure complete power supply to Type 422 indicator.

Battery Pack Securing Screws—Secure battery pack to battery box. Note if battery pack is not installed. Holes are plugged with screws so instrument will meet environmental characteristics.

Input Connector (P1000)—Connector into which either the ac power cord or the dc power cord for external dc operation is connected.

Battery Box Attaching Screw—Attaches battery box to switch bracket.

Fuse Holder (F1014)—Fuse for dc operation, also protects battery pack during charging.

Fuse Holder (F1000)—Fuse for ac operation.

Fig. 2-1. POWER MODE control, input connector and fuse locations. Also shows POWER MODE switch functions.

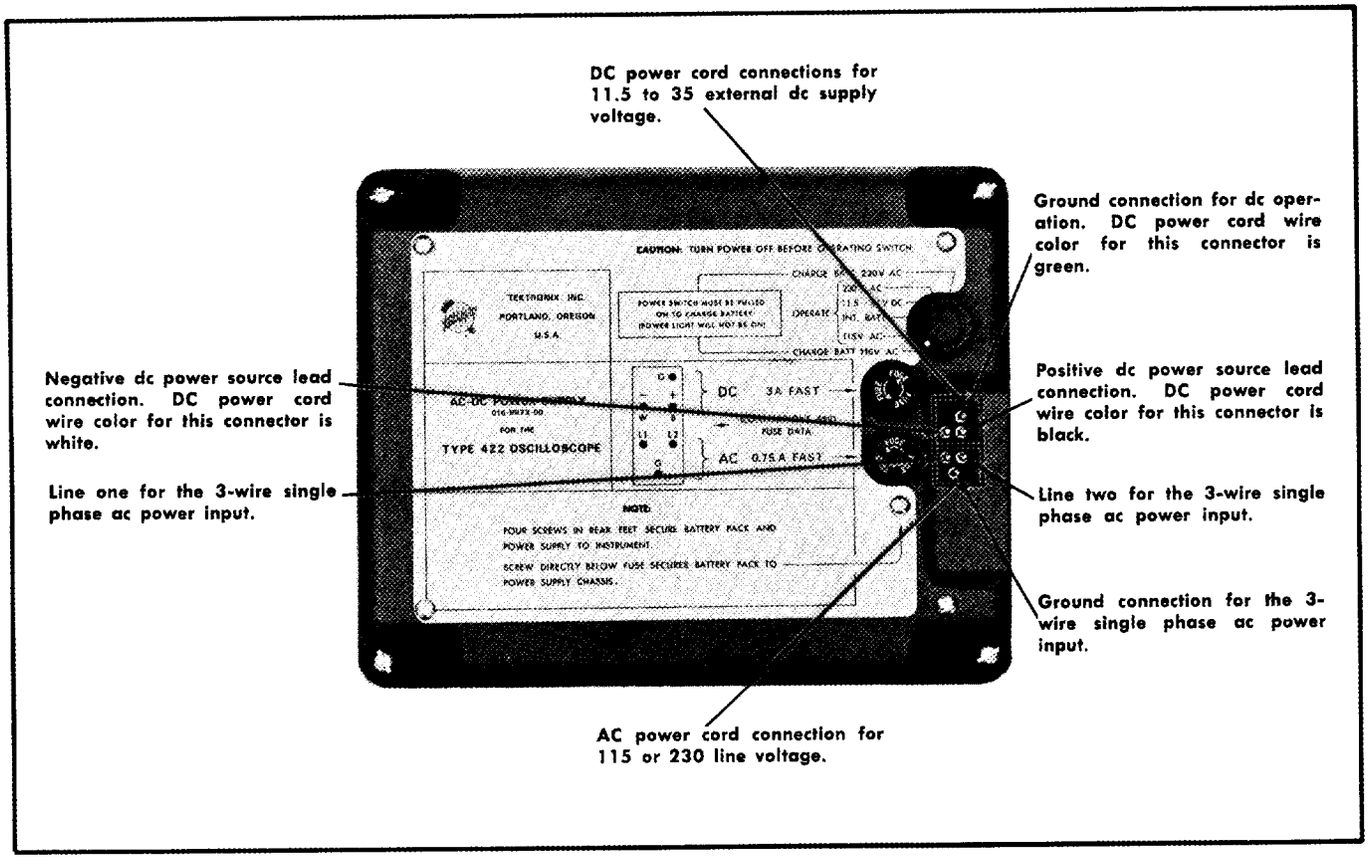


Fig. 2-2. Power cord connections made to P1000 for ac or external dc operation.

OPERATING THE POWER SUPPLY REMOTELY

The Type 422 can be operated with the power supply removed. The interconnecting plug on the rear of the indicator can be detached and used as an extension cable. To remove the interconnecting plug, loosen the three screws holding it to the indicator and slide it up slightly; then move it away from the rear of the unit. Unwrap the power cable from the rear of the indicator. The two spring clips (see Fig. 2-3) on the power supply are provided to lock the power cable to the power supply for remote operation. To use the clips, hook one spring clip into the hole provided in the interconnecting plug. (Be sure the POWER switch is set to off.) Slide the plug into place while depressing the other spring clip. To remove the plug, reverse the order in which it was attached.

CAUTION

Do not bend the spring clips so they latch without using the procedure described above. If bent in this manner, they will latch when the power supply is remounted on the indicator and will be difficult to remove without damage to the instrument.

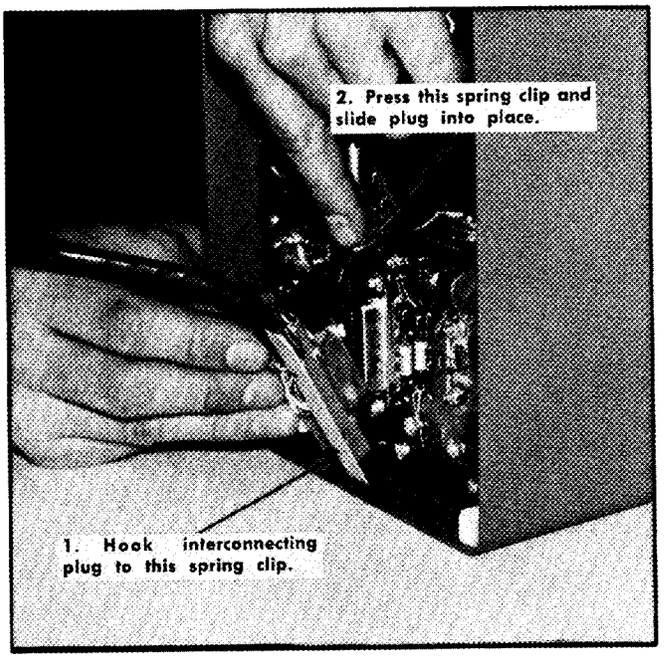


Fig. 2-3. Securing the power cable to the power supply for remote operation.

NOTES

SECTION 3

CIRCUIT DESCRIPTION

Introduction

The Type 422 AC-DC Power Supply accepts power from 115- or 230-volt ac, external dc, or internal Battery Pack, and converts this power to the regulated voltages required to supply the Type 422 Indicator. Provision is made for charging the internal batteries. Fuses, thermal cutouts and diodes protect the circuitry against incorrect usage and adverse environmental conditions.

Dc power, from an external source or an internal battery, is applied directly to the Dc-Dc Regulator. Ac power is transformed and rectified before application to the Dc-Dc Regulator.

The POWER MODE switch, located on the rear of the power supply, determines the mode of operation according to the power source.

Block Diagram

AC Source

115- or 230-volt ac power from power cord jack P1000 is applied to the primary windings of stepdown transformer T1001 via POWER switch SW1001 and voltage selector sections a and b of the POWER MODE switch SW1030. Fuse F1000 and thermal cutout TK1000 protect the unit against shorts and slow overload, respectively.

The center-tapped secondary winding of transformer T1001 supplies a full-wave rectifier circuit which provides dc power for the Dc-Dc Regulator circuitry.

DC Source

External dc power (11.5- to 35-volts) connected to P1000 is supplied via sections c and d of POWER MODE switch SW1030 through fuse F1014, sections e and g of SW1030, thermal cutout TK1039 and POWER switch SW1001 to the Dc-Dc Regulator circuitry.

Diode D1014 protects the unit by causing F1004 to blow, should the external dc source be connected with the wrong polarity.

Internal Battery

In the OPERATE INT BATT mode, the internal 24 V Battery Pack is selected by sections c and d of the POWER MODE switch SW1030 and fed to the Dc-Dc Regulator circuitry by the same path used for external dc power.

The voltage of the internal Battery Pack is monitored by the Low-Voltage Indicator Circuit (Q1045, Q1055 and associated components) which cause the Type 422 front-panel POWER Light indicator to blink when battery voltage falls below 22 volts. Further discharge will impair battery life.

Battery Charger

The Battery Charger is connected to the Battery Pack through section e of SW1030 in all ac positions of the POWER MODE switch. Diode D1016 disconnects the battery from the charge circuit when the ac power is turned off.

When either charge position of the POWER MODE switch is selected, the batteries are charged at approximately a 400-ma rate selected by section f of SW1030. With the POWER MODE switch in either the OPERATE 230 V AC or 115 V AC position, the battery recives a trickle charge at approximately a 30-ma rate.

Thermal cutout TK1033 senses the Battery Pack temperature, and automatically selects the 30-ma charge rate when the Battery Pack temperature rises above 105° F.

DC-DC Regulator

The heart of the Dc-Dc Regulator used in this supply is the "inductive energy pump", shown in simplified form in Fig. 3-1. Its operation is as follows:

Assume there is no current in L1 (SW1 open) but that the storage/filter capacitor C1 is charged to practically the normal load voltage V_L. At the start of a repetition period (time t_0) SW1 is closed, applying the source voltage V_B across the energy storage inductor L1. The charge current increases linearly through L1, storing magnetic energy, until at time t_2 SW1 is opened, and the voltage across L1 swings positive until it exceeds the load voltage V_L. D1 now conducts, discharging the magnetic energy into storage capacitor C1 until, at time t_{11}, current and voltage in L1 drop to zero. C1 is large enough to hold V_L practically constant during the discharge, so that the current decay is also linear. The system is now ready for a new cycle.

The peak current, together with other parameters, determines the load voltage; since the load voltage must be held constant to accommodate variations in source voltage, the "on" time of SW1 may be varied (e.g., by a feedback loop) inversely with the source voltage to insure that the same peak current is always reached.

In practice, a symmetrical double-sided arrangement is used, with the two sides acting alternately. The magnetic energy is stored in the core of T1201, charging through the primary winding and discharging from the secondaries. Dc power from the Power Selector Switch is connected between the primary center tap and ground reference. The two ends of the primary are alternately grounded by saturating switches Q1174, Q1184 through the reverse voltage disconnect diodes D1176 and D1186. The secondary rectifier diodes, filter capacitors and load currents replace D1, C1 and R1 of Fig. 3-1, respectively. Idealized voltage and current waveforms for the circuit are shown in Fig. 3-2 (waveforms 8-11). Filter elements localize large high-speed

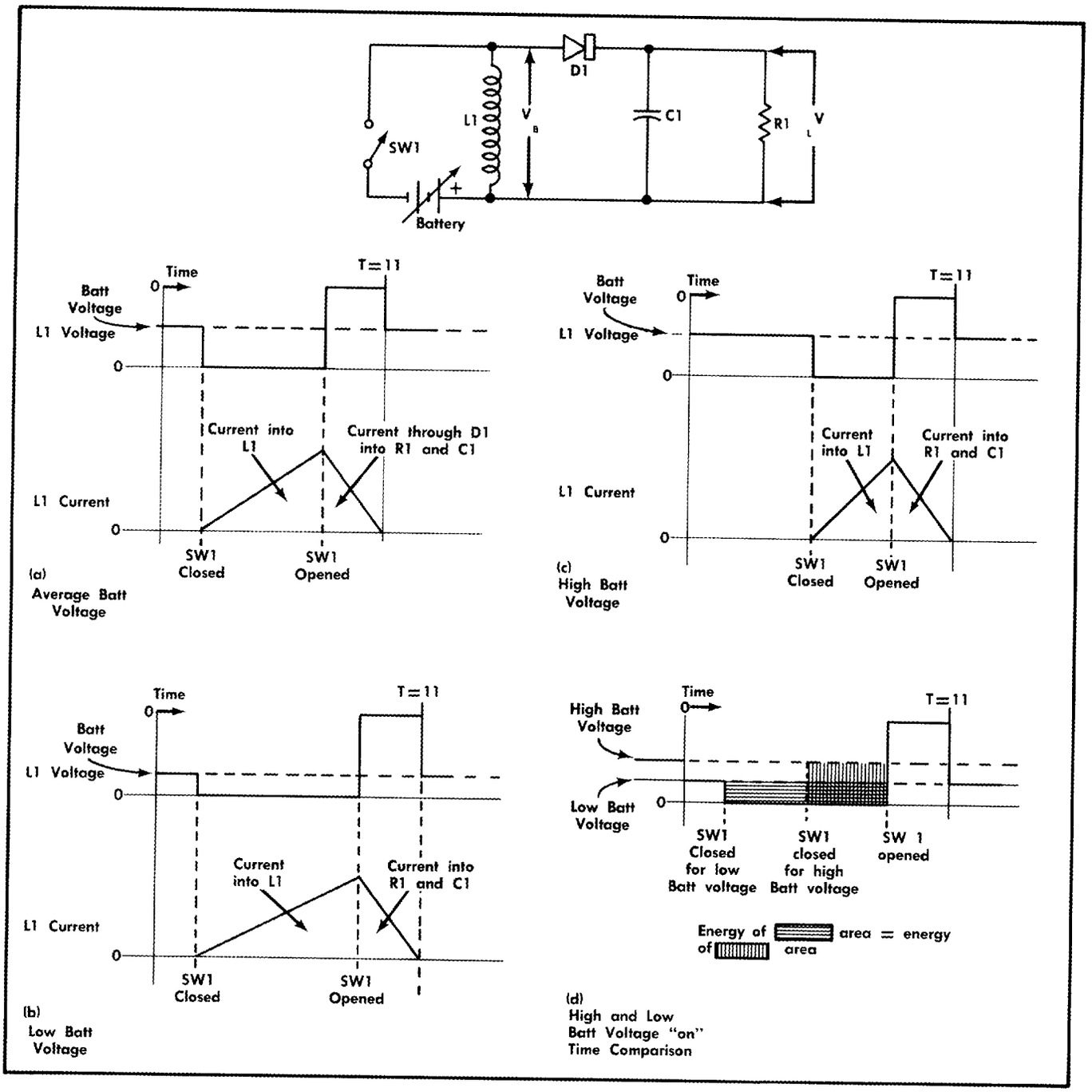


Fig. 3-1. AC-DC Power Supply in an equivalent circuit configuration with associated waveforms. (a) Average Battery voltage. (b) Low Battery voltage. (c) High Battery voltage. (d) Comparing switch "on" time areas for low and high Battery voltages.

current surges and reduce the magnitude of power transients in the switching elements themselves.

Isolated Voltage

In addition to the +95 +55, +12, —12 and 110 volt outputs to the indicator there are several other voltage sources in this power supply which are used only for operation of the regulator circuitry. These sources, +12, —12 volts, and the feedback voltage, are isolated from chassis ground when the instrument is operating from an external dc source. The common for these voltages is also the negative side of the dc input power. Thus the external dc primary power may have either terminal connected to chassis ground or be elevated as much as ±200 volts from the chassis ground.

In the following description the sources used for operation of the regulator circuitry will be called "isolated +12 V" or "isolated —12 V", respectively, to distinguish them from the grounded supplies, even though the isolated supplies are in fact grounded in all modes of operation except external dc.

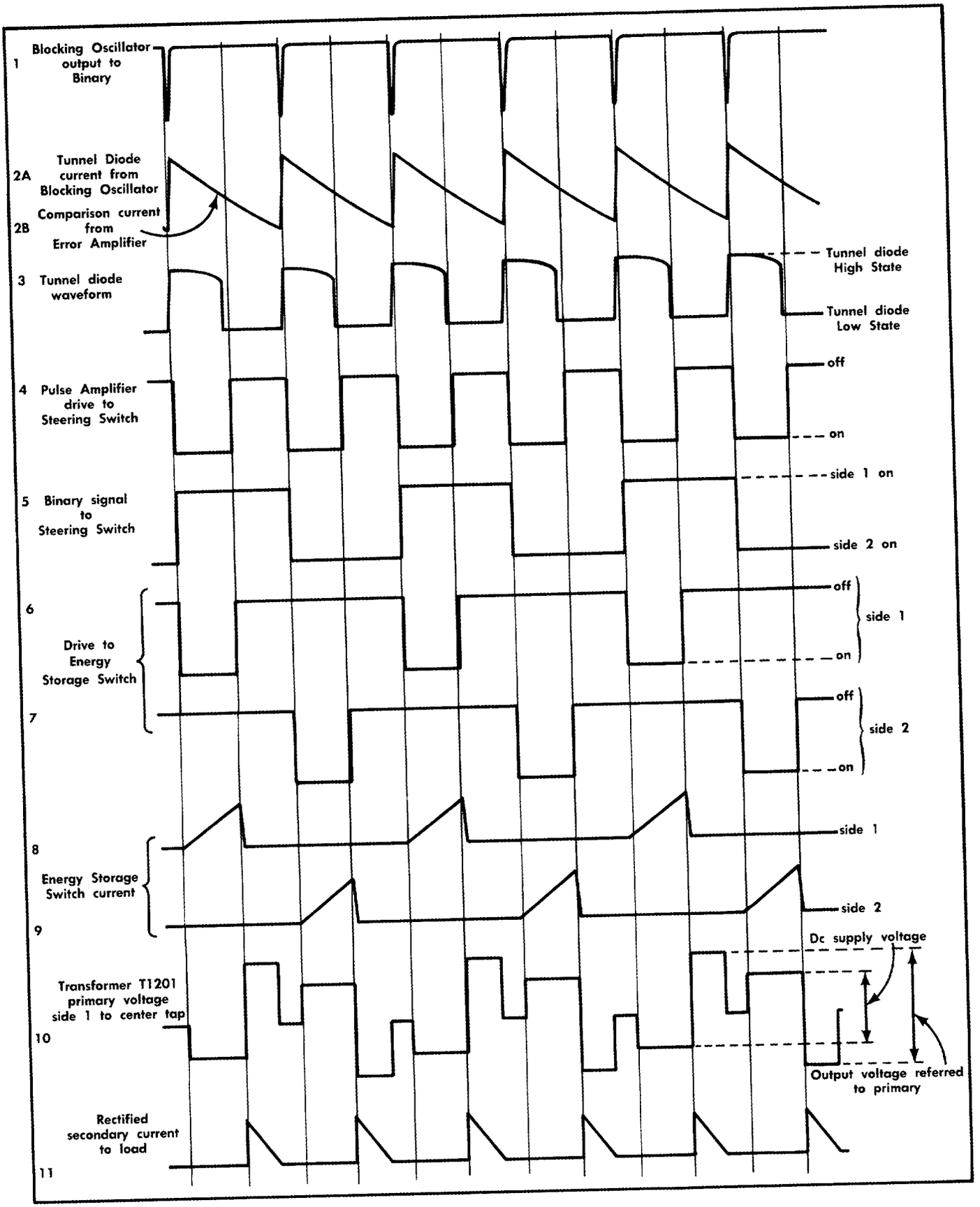


Fig. 3-2. Waveform ladder showing idealized Block Diagram Power Regulator waveform relationships.

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Block Layout. The block layout of the entire Dc-Dc Regulator is shown in the Block Diagram, and its associated idealized waveforms in Fig. 3-2. Timing for the converter is provided by a free-running Blocking Oscillator (Q1120), which generates:

a. A 7-kc train of negative going pulses (waveform 1, Fig. 3-2) which alternately switch the Binary Q1105, Q1115.

b. An approximately sawtooth current (waveform 2A).

The sawtooth current is compared against the output current (waveform 2B) of the Error Amplifier in the Pulse Width Control Tunnel Diode D1155, which then generates pulses (waveform 3) whose width is approximately proportional to the Error Amplifier output current. These pulses are amplified by Pulse Amplifier Q1164, Q1163 (waveform 4) and alternately steered to side 1 (waveform 6) and side 2 (waveform 7) of the symmetrical charging switch by the Steering Switch Q1104, Q1114, according to the state of the control signal (waveform 5) from the Binary.

The Feedback Rectifier/Filter generates a voltage proportional to the rectified and filtered secondary output. This is compared to a reference voltage (Zener Voltage Reference D1135) in Error Amplifier Q1134, Q1144, Q1154 whose output is the pulse width control current to the Pulse Width Control Tunnel Diode D1155, completing the feedback loop. The sense of the loop is such that any rise in the feedback voltage (due, for example, to a rise in dc power source voltage) causes a reduction in the drive pulse width (waveform 4), and so reduces transfer of energy to keep the output voltage constant.

Operating power for the Dc-Dc Regulator circuitry is taken from a winding of T1201. When dc power is first applied, the Start Circuit (Q1193, Q1194) passes enough raw dc power directly to the Blocking Oscillator, Binary, Steering Switch and Pulse Amplifier to allow operation to begin. As the Dc-Dc Regulator output builds up to near normal, the Start Circuit disconnects the raw dc and allows the more efficient Dc-Dc Regulator to supply the operating power to these circuits from the isolated +12 V rectifier/filter.

DETAILED CIRCUIT DESCRIPTION

AC-DC Power Input Circuits

The reader may find it convenient to refer to the Dc-Dc Regulator and Ac-Dc Selector diagrams.

AC Power Input. 115- or 230-volts ac is applied via the ac power cord to P1000. From P1000 the ac power passes through (radio frequency interference) RFI filter T1000 and C1000. One side of the ac line then goes directly to one side of one-half of the primary of T1001. The other side of the ac line goes through one-half of the POWER switch SW1001, ac fuse F1000, and thermal cutout TK1000. It then connects to one end of the other half of T1001 primary. POWER MODE switch SW1030 connects the two primary windings halves to T1001 in series for the CHARGE BATT 230 V AC, and OPERATE 230 V AC switch positions and connects the two primary halves of T1001 in parallel for the OPERATE 115 V AC, and CHARGE BATT 115 V AC switch positions.

The T1001 secondary voltage, typically 35-volts ac, is applied to a rectifier circuit consisting of D1002, D1003, D1004, and D1005. The output of the rectifier circuit is then filtered by C1002, C1003, and C1004. From the filter circuit, 25 volts dc is applied to the dc-dc regulator circuitry via POWER MODE switch SW1030 while the total 50-volt dc output is applied across the Battery Charger and Battery Pack when the POWER MODE switch SW1030 is in any position other than OPERATE 11.5-35 V DC or OPERATE INT BATT.

DC Power Input. 11.5- to 35-volts dc can be applied via the dc power cord to P1000. From P1000 the dc power passes through a RFI filter T1010, C1010, C1011, and C1012. The negative side of the input dc power connects to the zero reference voltage bus in the power supply via POWER MODE switch SW1030 when the switch is set to OPERATE 11.5-35 V DC. The positive side of the input dc power connects to the dc-dc regulator circuitry through dc fuse F1014 via POWER MODE switch SW1030 when SW1030 is set to OPERATE 11.5-35 V DC. Diode D1014 causes F1014 to open if the input dc power polarity is connected incorrectly.

Battery Power. When POWER MODE switch SW1030 is set to OPERATE INT BATT, the negative side of the 24-volt Battery Pack is connected to the zero reference voltage bus, while the positive side of the Battery Pack is connected via dc fuse F1014 to the dc-dc regulator circuitry.

Battery Charger

The Battery Charger provides two constant current charging rates to the Battery Pack. The constant current charging rate depends upon the position of the POWER MODE switch SW1030. When the POWER MODE switch is set to OPERATE 230 V AC or OPERATE 115 V AC, the Battery Pack is trickle charged at a 30-ma rate. When the POWER MODE switch is set to either CHARGE BATT 230 V AC or CHARGE BATT 115 V AC the Battery Pack will be charged at a 400-ma rate. This 400-ma rate will be automatically decreased to the 30-ma rate by TK1033 if Battery Pack temperature goes above 105° F.

The constant current circuit utilizes the Darlington pair Q1023, Q1033 to maintain across R1033 (and R1031 when not shorted by SW1030 and TK1033) a voltage approximately equal to reference diode D1022 voltage. The value of R1033 then determines the charging current, and R1031 and R1033 set the trickle charge rate.

Low-Voltage Indicator Circuit

The Low-Voltage Indicator Circuit causes the Type 422 front-panel POWER Light to blink when the POWER MODE switch is set to OPERATE INT BATT and the Battery Pack voltage drops to 22 volts, the almost fully discharged state. Further discharge is detrimental to battery life.

The Low-Voltage Indicator Circuit monitors the internal battery. When the battery voltage falls to 22 volts, the voltage at the wiper of R1047, LOW VOLTAGE INDICATOR, (part of a voltage divider comprised of R1046, R1047, and R1048) causes Q1045 to turn on.

The emitter of Q1045 is held at a reference voltage of approximately 10.5 volts by Zener diode D1041, and the battery voltage is applied to its base by the adjustable arm of R1047, an element of voltage divider R1046, R1047,

R1048. When the battery voltage falls below the preset threshold, Q1045 conducts, turning on saturated switch Q1055. This completes the switching action by saturating Q1045 via R1054 and D1054; and effectively grounding one end of C1057. This capacitor, together with R1059 and the POWER neon now form a neon relaxation oscillator, the time constants being selected to give a frequency of approximately one-half cycle per second.

Zener diode D1041 provides the Low-Voltage Indicator Circuit reference. C1041 and R1041 comprise a long time-constant circuit which prevents the Low-Voltage Indicator Circuit from responding to the low voltage which will be present on the Dc-Dc Regulator circuitry power bus at the instant when the instrument is first turned on.

Start Circuit

Power to the Start Circuit is supplied only in the "operate" positions of the POWER MODE switch.

The Start Circuit is a series regulator operated from the input voltage to the Dc-Dc Regulator and supplying voltage to the Dc-Dc Regulator circuitry until the first few cycles of output power have been generated. The isolated +12 V Rectifier/Filter and isolated —12 V Rectifier/Filter circuits are then able to supply the operating voltages.

As the input dc voltage to the Start Circuit rises to about ten volts, D1192 will turn on and hold the base of Q1193 at about 8.2 volts. This will in turn cause the isolated +12-volt bus of the isolated +12 V Rectifier/Filter to be at 7.5 volts. The 7.5 volts starts the Blocking Oscillator, Binary, Steering Switch and Energy Storage Switch circuits operating. Once the above circuits are operating, the isolated +12 V Rectifier/Filter is then able to supply the operating voltages, and will turn the Start Circuit off by reverse biasing the emitter-base junction of Q1193.

Blocking Oscillator

The free-running Blocking Oscillator sets the frequency at which the energy storage switching occurs in the power supply.

The frequency of the free-running Blocking Oscillator is determined by C1121, R1123, R1124 and R1125 (OSC FREQ control). Diodes D1117 and D1118 establish a fixed bias of approximately 1.4 volts at the base of Q1120.

When the emitter voltage of Q1120 drops to 0.7 volt, Q1120 turns on and is driven into saturation by the regenerative feedback applied to its base circuit through T1120. When the Blocking Oscillator fires, the base of Q1120 immediately rises 6 volts, and the collector of Q1120 pulls down 6 volts. This 6-volt change developed across the collector winding of T1120 is negatively coupled to the junction of D1105 and D1115 through a third winding of T1120. This pulse aids the conduction; and the resultant cumulative trigger action discharges C1121 (to approximately 6.6 volts) until Q1120 saturates, and no further discharge is possible. The quickly reducing collector current terminates the positive base voltage pulse, cutting off Q1120 and leaving its emitter voltage to fall exponentially toward ground.

When the Blocking Oscillator fires, Pulse Width Control Tunnel Diode D1155 is pulled into its high state.

C1120 and R1120 provides decoupling for the Blocking Oscillator circuit.

Binary

The Binary determines, via the Steering Switch, which transistor of the Energy Storage Switch will be turned on.

The Binary is a collector triggered, emitter comutated multivibrator consisting of Q1105, Q1115 and associated components. Assume Q1105 conducts the tail current through R1117, and Q1115 is practically cut off. Approximate voltages are:

Q1105 collector and Q1115 base	+11.5 volts
Q1105 base and Q1115 collector	+12 volts
Q1105 emitter	+11.4 volts
Q1115 emitter	+11.2 volts

The upper end of C1106 is therefore approximately 0.3 volts negative with respect to its lower end.

When the negative trigger pulse from the blocking oscillator arrives at the junction of D1105, D1115, D1115 conducts first and drives the base and the emitter of Q1105 negative; the emitter of Q1115, tied to it through C1106, goes negative until caught by conduction of Q1115. Q1115 is cut off by the rest of the trigger pulse, which is limited by conduction in both Q1104 and Q1114 bases. When the trigger pulse ends, Q1115 maintains conduction; its base goes to near +12 volts and direct coupling via D1116, R1116, R1106, D1106 to the emitter of Q1105 takes over from C1106 the function of keeping Q1105 cut off, allowing C1106 to charge in the opposite direction, ready for the next trigger pulse.

Pulse Width Control Tunnel Diode and Pulse Amplifier

The Pulse Width Control Tunnel Diode D1155 controls the "on" time of the Energy Storage Switch transistor through the Pulse Amplifier.

The total current in the threshold sensing tunnel diode D1155 is made up of fixed components from R1163, R1161; the control current from the collector of Q1154 (error amplifier); and the exponentially decaying C1121 charge current from R1123 (blocking oscillator). At the start of the blocking oscillator cycle, when Q1120 emitter is near 6.6 volts, the net diode current exceeds the peak current and the diode is in its high state. As C1121 charges, the diode current reduces, until, as some instant determined by the Q1154 collector current, D1155 switches to its low state.

With D1155 in its high state Q1164 saturates, turning Q1163 on hard. With Q1163 turned on, one-half of the primary of T1171 is connected across +12 volts through Q1163 and either Q1104 or Q1114.

Steering Switch

The Steering Switch controls which Energy Storage Switch transistor is turned on. Two inputs must be available to the Steering Switch circuit simultaneously to cause the Steering Switch to turn on one of the Energy Storage Switch transistors.

One input is derived from the Pulse Amplifier Q1163 as explained previously. The input from the Pulse Amplifier is the same no matter which transistor is conducting. Conduction in either Q1114 or Q1104 is determined by the Binary. For example: if Q1115 is conducting it turns Q1114 on and a pulse appears on the primary of T1171 and is coupled to the secondary causing one of the Energy Storage Switch transistors to turn on. Diodes D1104 and D1114 act as disconnect diodes, disconnecting the non-conducting transistor from the primary of T1171.

Energy Storage Switch

When the Energy Storage Switch turns on, it applies the input dc power to one-half of the primary of T1201. The Energy Storage Switch is connected in a push-pull configuration across the primary of T1201, alternately storing energy in the core each half cycle.

A drive current is applied from the secondary of T1171 through the action of the Steering Switch turning on one of the Energy Storage Switch transistors, which will permit the current in one half of the primary of T1201 to build up until the Pulse Width Control Tunnel Diode shuts off.

Zener diodes D1174 and D1184 act as protection devices for Q1174 and Q1184 to prevent any collector-to-emitter transient voltages from exceeding 75 volts.

Diodes D1176 and D1186 act as disconnect diodes disconnecting the non-conducting transistor from the primary of T1201. Diodes D1177 and D1187 connect the charging half of T1201 to de-spiking capacitors C1177 and C1187, respectively.

Feedback Rectifier/Filter, Zener Voltage Reference and Error Amplifier

The Feedback Rectifier/Filter, Zener Voltage Reference and Error Amplifier determine the amount of time needed to store energy in T1201 with a given input source voltage. When the Energy Storage Switch turns off a voltage will be induced into the center-tapped secondary windings of T1201, one of which is the feedback winding connected to the Feedback Rectifier/Filter circuit. The Feedback Rectifier/Filter network consists of rectifiers D1232 and D1233 and filter components C1232, C1233 and R1232. C1232, C1233 and R1232 are chosen to give close tracking between the feedback supply and the other supplies to the Type 422 Indicator. The voltage from the Feedback Rectifier/Filter network is then applied through divider R1131, R1132, and R1130 (—12 VOLTS control) and temperature compensating diode D1132 to the base of comparator transistor Q1134 whose emitter voltage is set by Zener Voltage Reference D1135. Q1134 then sets the conduction levels of Q1144 and Q1154, and hence the bias current for D1155.

The Rectifier and Filter Circuits provide regulated dc voltages to the Type 422 Indicator.

The output voltage from the secondary winding of T1201 is full-wave rectified and then filtered by the different filter networks. From the filter networks regulated dc is supplied to the indicator. An output voltage is also supplied to the Low-Voltage Indicator Circuit in the power supply.

Isolated +12 V Rectifier/Filter and Isolated —12 V Rectifier/Filter

The isolated +12 V Rectifier/Filter and Isolated —12 V Rectifier/Filter furnish the operating voltages for the Power Regulator circuitry after the circuit has been started into operation by the Start Circuit.

Isolated power supplies have been provided to power the regulator circuitry so the input power source (external dc) can be isolated from the chassis potential of the Type 422 Indicator. In external dc operation the negative input to the regulator circuit is floated from chassis ground to allow differences in potential between an external dc source and equipment common of 200 volts maximum.

The output voltage from the T1201 secondary winding is fed to two different full-wave rectifier circuits and filter circuits. The isolated +12 V Rectifier/Filter circuit consists of D1242, D1243, C1195 and C1199, while the isolated —12 V Rectifier/Filter components are D1244, D1245, C1245, C1246 and L1246.

Grounds

C1173, C1181, C1183, C1231 and C1242 provide short high-frequency current paths between ground planes and the zero reference voltage bus.

Due to component location on the etched-wiring board, the collector connection to Q1163 is returned across the board to C1199 in parallel with the +12-volt lead to minimize stray inductance. R1165 damps ringing on Q1163 collector by absorbing reflections along the short-circuited transmission line thus formed.

SECTION 4
MAINTENANCE

General

General maintenance information is given in the Type 422 Indicator manual. The following additional information applies specifically to the AC-DC Power Supply.

CORRECTIVE MAINTENANCE

Component Replacement

Removing the Power Supply Housing. Remove the battery box and the Battery Pack as a unit as per the instructions found in the Operating Instructions section of this manual. Pull the remaining part of the power supply off the indicator support rods and set it down on a flat surface so the interconnecting plug and POWER switch are down.

Remove the four screws located near the corners of the trim casting (see Fig. 4-1). Remove the three screws in the side of the power supply housing near the power supply serial number. After removing the above seven screws, pull the power supply housing off the power supply.

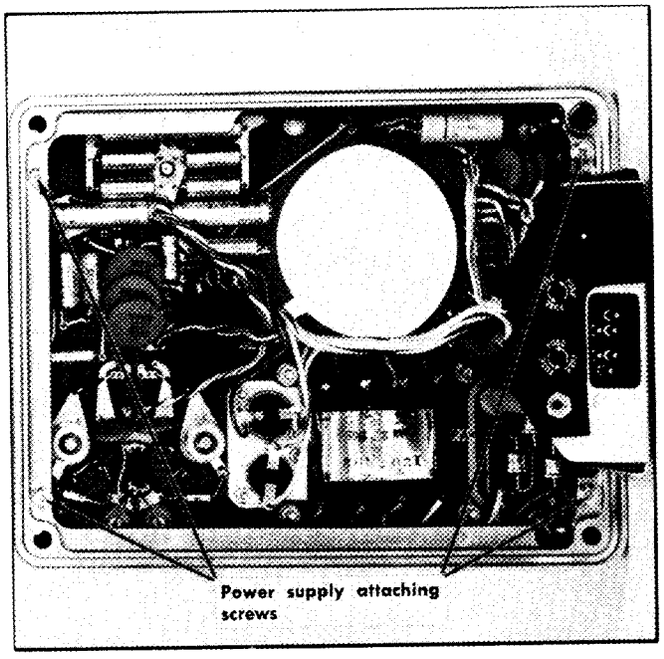


Fig. 4-1. Location of power supply attaching screw in trim casting.

TROUBLESHOOTING

Troubleshooting Aids

Component Numbering. The circuit number of each electrical part is shown on the circuit diagrams. Each main circuit for the Type 422 Indicator is assigned a series of circuit numbers. The series of circuit numbers assigned to the AC-DC Power Supply is numbers 1000 to 1249.

Etched-Wiring Boards. Figs. 4-2 and 4-3 show the etched wiring boards used in the AC-DC Power Supply. Fig. 4-4 shows the location of each board within the power supply. Each electrical component on the boards is identified by its circuit number.

Troubleshooting Techniques

The troubleshooting techniques outlined in the Type 422 Indicator manual can generally be used to troubleshoot the AC-DC Power Supply. Troubleshooting information which applies only to the AC-DC Power Supply is listed below.

NOTE

Table 4-1 gives the resistance readings taken at the interconnecting jack. These readings are typical and may vary between units. All readings were made with the power supply disconnected from the indicator and the power source. The polarity of your ohmmeter will have a definite effect on the resistance values listed in Table 4-1. To avoid confusion, first determine the polarity of your ohmmeter leads by measuring the forward resistance of any good signal diode. The ohmmeter lead connected to the cathode of the diode will be considered the positive ohmmeter lead while the lead connected to the anode of the diode will be considered the negative, or ground ohmmeter lead for the measurements listed in Table 4-1, unless otherwise indicated. All Table 4-1 readings were taken after initial capacitor charge due to ohmmeter voltage. Checking these resistance readings may help to isolate the trouble to the power supply or the circuits in the indicator.

TABLE 4-1

Interconnecting Plug Pin	Ohmmeter Scale	Typical Resistance Reading
1	X 10	0
2	X 10 k	∞
3	X 10	0
4	X 10	0
5	X 10 k	∞
6	X 10	0
7	X 10	*40 Ω
8	X 10 k	100 k
9	X 10	40 Ω
10	X 10 k	∞
11	X 1 k	*8 k
12	X 10 k	∞
13	X 1 k	8 k
14	X 10 k	∞
15	X 10	40 Ω
16	X 10 k	∞
17	X 10	0
18	X 10 k	∞
19	X 10	40 Ω
20	X 10	40 Ω
21	X 10 k	∞
22	X 10	0
23	X 10 k	∞
24	X 10 k	∞

*Reverse ohmmeter leads to obtain the reading.

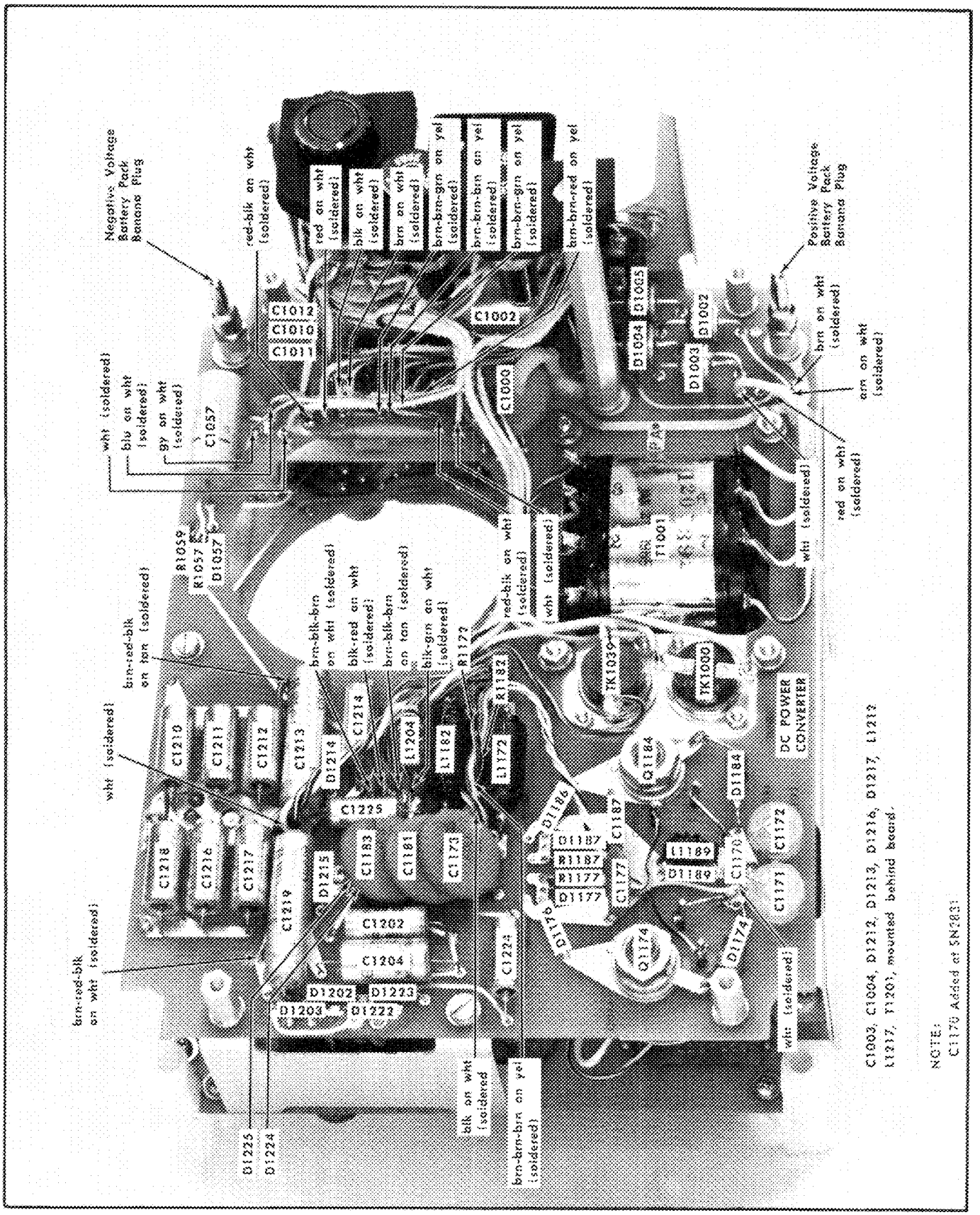


Fig. 4-2. DC Power Converter etched-wiring board

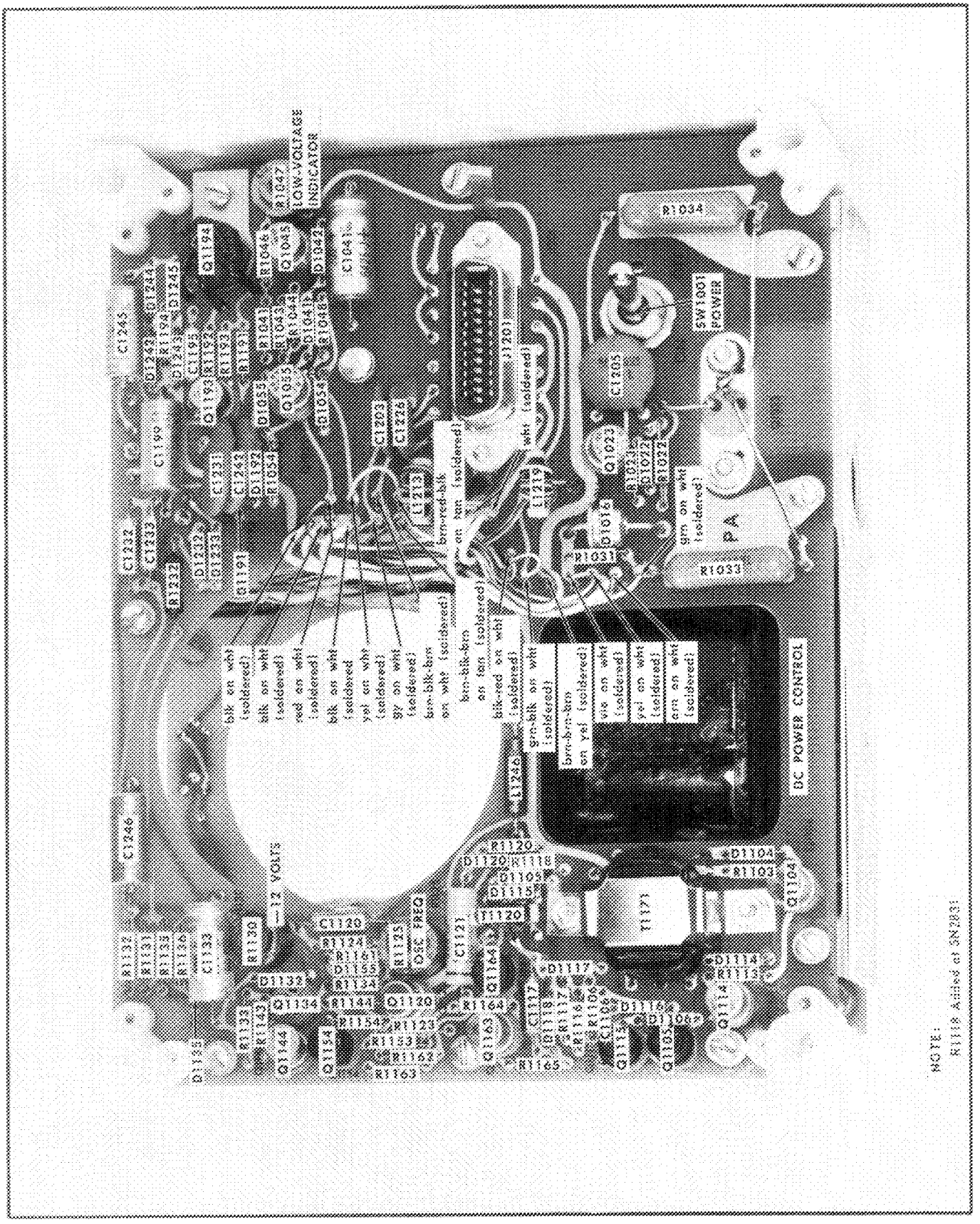


Fig. 4-3. DC Power Control etched-wiring board

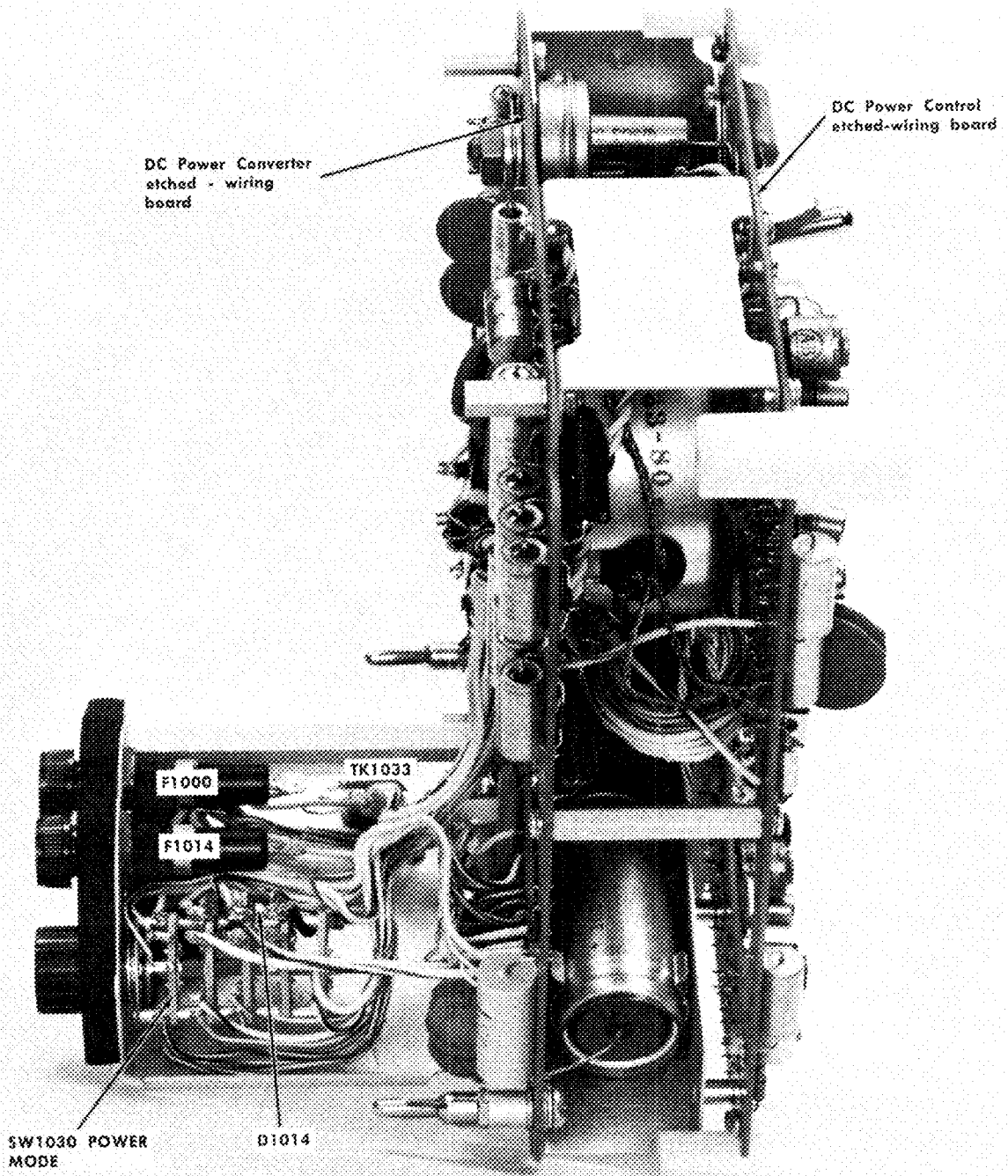


Fig. 4-4. Location of the switch bracket components and of the etched-wiring boards.

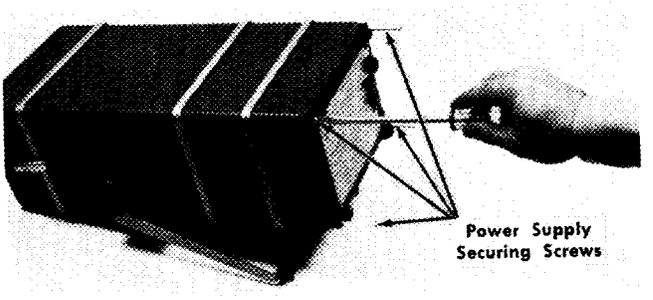
NOTES

SECTION 5
BATTERY PACK

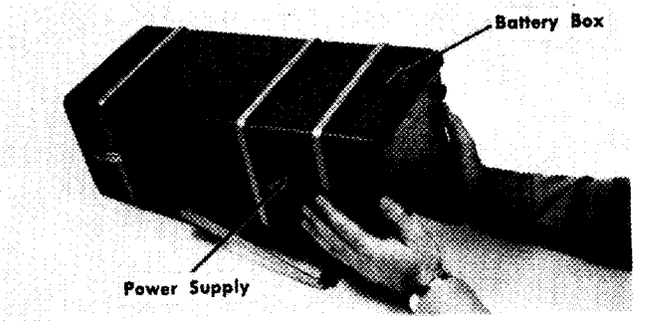
INSTALLATION INSTRUCTIONS
422 BATTERY PACK

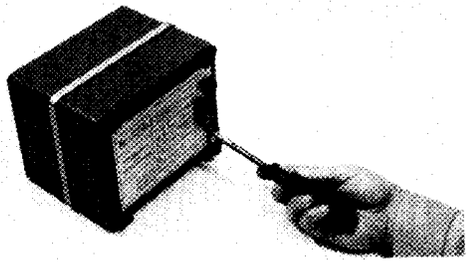
1. Removing the Power Supply and Battery Box

a. Loosen and remove the four power supply securing screws located in the rear feet of the instrument.

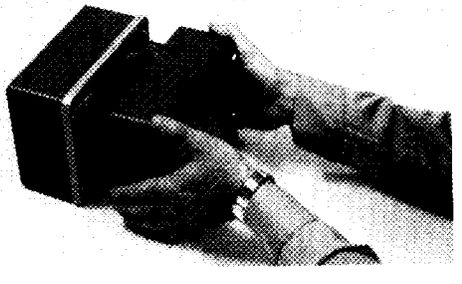


b. Separate the power supply and battery box from the indicator unit by sliding them to the rear and off the support rods.





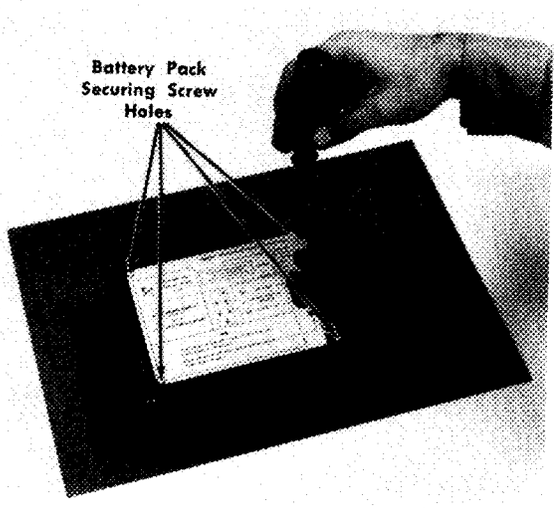
c. Loosen and remove the screw located just below the fuse holders.



d. Detach the battery box from the power supply.

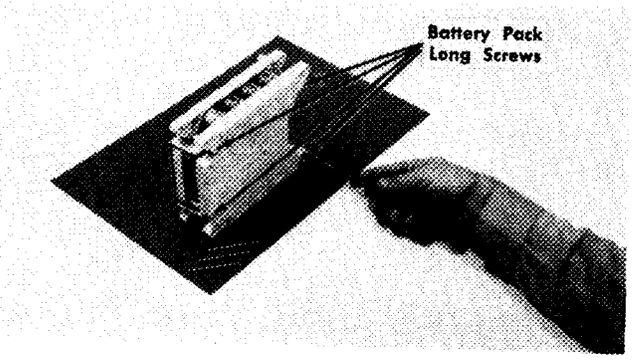
Ⓐ

2. Attaching the Battery Pack

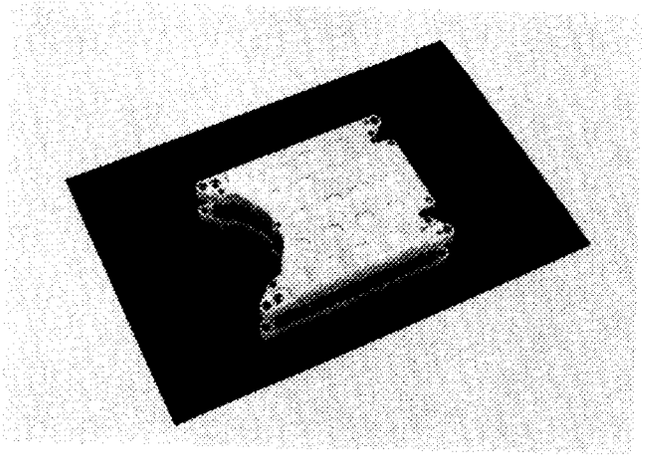


a. Remove and discard the four screws from the Battery Pack securing screw holes.

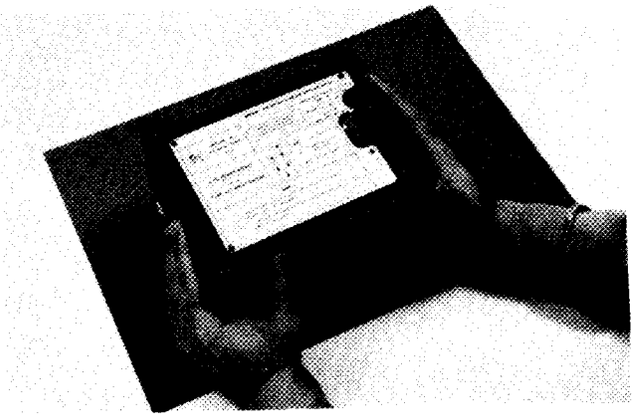
b. Loosen and remove from the Battery Pack the four long screws which go through it near its corners.

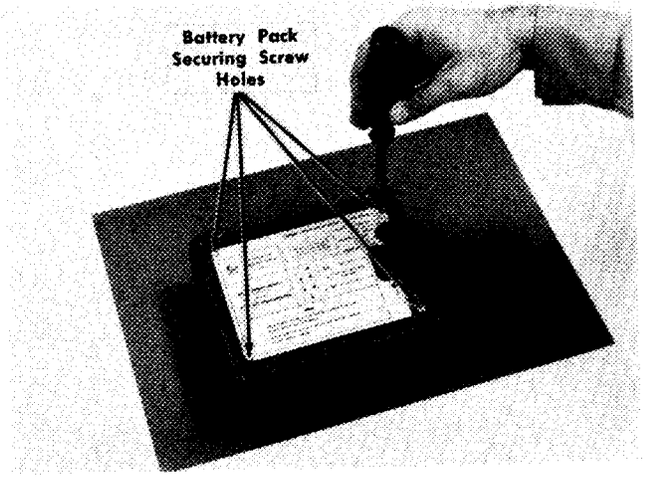


c. Set the Battery Pack on a non-conducting flat surface so it is resting on its interconnecting banana jacks and spring bracket.



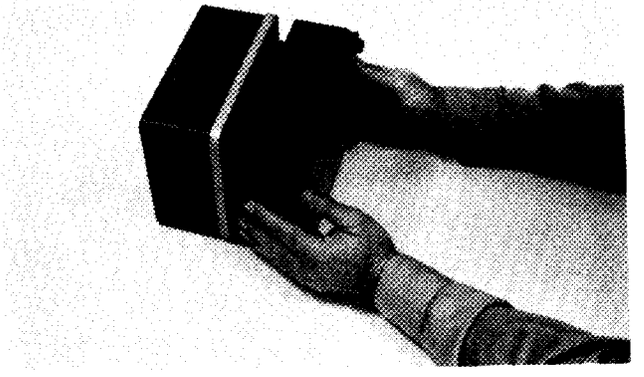
d. Place the battery box over the Battery Pack so that the cutout in the Battery Pack is directly under the knob, fuse and input connector holes in the battery box.

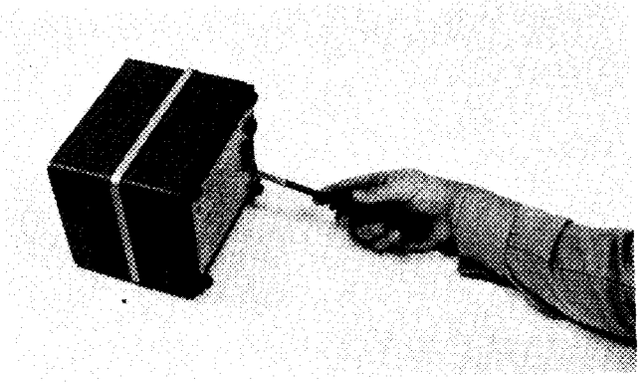




e. Start each of the four long screws, removed from the Battery Pack in step 2b into the four holes indicated, then tighten the four screws securely.

f. Install the battery box/Battery Pack onto the power supply, guiding the interconnecting banana jacks onto the banana plugs of the power supply.



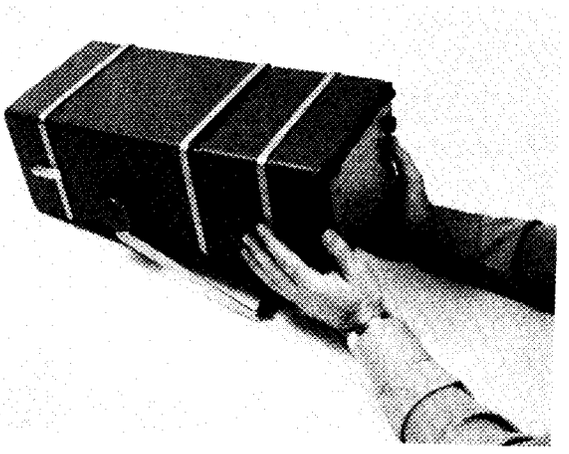


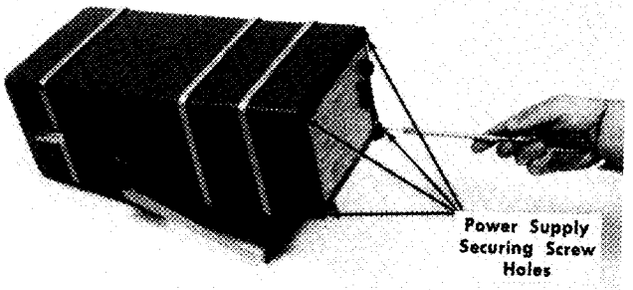
g. Re-install and securely tighten the screw removed in step 1c.

Ⓐ

3. Attaching the Power Supply

a. Slide the power supply onto the four support rods protruding from the indicator unit.





b. Start the four screws removed in step 1a into the holes located in the four rear feet of the power supply; then tighten all four screws securely.

This completes the Battery Pack installation procedure. For more information on the Battery Pack refer to the instruction manual for the Type 422 AC-DC Power Supply.

IMPORTANT INFORMATION ABOUT

THE USE OF NICKEL-CADMIUM BATTERIES

General

The Nickel-Cadmium battery cells supplied have been selected as a result of exhaustive engineering evaluation. Each battery cell has been rigidly inspected, has received an ampere hour test, and has met or exceeded the minimum ampere hour storage requirement.

The battery cells used in the battery pack should provide a useful operating life extending over several hundred charge and discharge cycles, providing the precautions listed below are observed:

Precautions

The life of hermetically sealed Nickel-Cadmium battery cells may be shortened by any of the following abuses:

1. If recommended charge rate is exceeded.

2. If battery charger is operated incorrectly.

3. If discharged to a point where one or more battery cells are reverse polarized.

The following information concerning Nickel-Cadmium battery cells should prove helpful in avoiding the problems mentioned above.

Battery Charging Information

During charging, sealed Nickel-Cadmium battery cells normally contain an internal pressure because gas evolution and chemical recombination is taking place. Therefore, as charging current is increased, gas evolution and internal pressure also increases; charging at rates in excess of those recommended should be avoided. Battery cell cases and seals will withstand these excess pressures, but the pressure relief vents may be punctured. If this occurs a portion of the electrolyte may be expelled with the gas, resulting in shorter overall battery cell life.

Periodic inspection of the battery box is recommended. The battery box should be closely inspected for signs of electrolyte leakage. If any electrolyte residue is found in the battery box, it should be cleaned away with a 2% solution of Boric Acid in water, after which all wetted area should be throughly dried with a soft cloth. For practical purposes, a 2% solution of Boric Acid can be approximated by dissolving 1¼ level teaspoons of the power in one cup of water.

The battery pack used in the Type 422 AC/DC Power Supply should be regarded as a single power storage unit rather than as a set of individual cells, since it is not designed to be readily disassembled for repair or inspection. Any service to the battery pack should be referred to your Tektronix Field Engineer or Representative, especially during the battery warranty period when the guarantee may be altered if the sealed case-retaining screws are removed.

Battery Pack Charging Rates

A battery pack containing 20 specially selected battery cells wired in series is provided for use in the Type 422 AC/DC Power Supply. The battery cells used in the battery pack are special battery cells, having greater ampere hour storage capacity than standard duty battery cells, and having superior high ambient temperature characteristics.

The Type 422 AC/DC Power Supply contains battery charging circuitry that may be operated from either a 115 V AC or 230 V AC power source. In the CHARGE BATT 115 V AC or CHARGE BATT 230 V AC positions of the POWER MODE switch, the battery pack is charged at approximately 400 milliamperes. In the OPERATE 115 V AC or 230 V AC position, the batteries are trickle-charged at a 30 milliampere constant current rate.

The battery pack should be completely discharged each time before recharging, as noted later in paragraphs on Battery Pack Storage And Shelf Life. The battery pack should then be charged 16 hours at 400 milliamperes to insure it is fully charged. During the charging process thermal cutouts in the 422 AC/DC Power Supply provide protection against overheating the battery pack. In the event the battery pack temperature exceeds the maximum temperature point allowable by the thermal monitor, the charge rate is reduced to 30 milliamperes, the trickle-charge rate. When the battery pack temperature drops sufficiently, the thermal cutout resets and the charger resumes the 400 milliampere charge rate. If the thermal switch reduces the charge rate to 30 milliamperes for any length of time during charging, the battery pack will not receive a full charge in 16 hours. For this reason, do not assume battery pack failure because of one instance of short operating time obtained from a battery pack.

Battery Pack Storage and Shelf Life

The battery pack is shipped in a charged condition, and should be fully recharged at 3-6 month intervals. For best retention of storage capacity, the battery pack should be discharged through a 100 ohm resistor to 0 volts, and then recharged. Two complete charge-discharge cycles are recommended. One charge-discharge cycle in this manner at 3-6 month intervals also aids battery pack life, whether the battery pack is in storage or in periodic use in the oscilloscope. An alternative is a continuous 30 milliampere trickle-charge.

WARNING

Fully or partially charged battery packs are capable of delivering a very large current if accidentally short circuited. Care should be exercised to prevent shorting battery terminals with tools, metal work bench or attached wires. A severe burn can be sustained if rings or other jewelry are allowed to short the battery terminals or attached wires.

Charge retention characteristice of Nickel-Cadmium battery cells vary with temperature. They may be stored at any temperature between —40°F and +120°F without damage, but the higher the ambient temperature, the faster will be the self-discharge rate. Battery packs stored at +70°F will lose approximately 50% of their stored charge in 3 months. For this reason an occasional recharge is recommended for battery packs that are in storage. Battery packs stored at

+120°F on the other hand, will be self discharged of all useful energy in 30 days. Due to the greatly accelerated self discharge rate, it is recommended that battery packs in storage at high ambient temperatures be continuously trickle-charged at a 30 milliampere rate.

Nickel-Cadmium Battery Pack Performance Data

The Type 422 oscilloscope may be expected to operate approximately 4 hours on a fully charged battery pack. Derating of this time at extremes of temperature should be expected. Some derating with age and/or after dozens of charge-discharge cycles will also be necessary.

Discharging the battery pack under operating conditions to an excessively low terminal voltage is not recommended, since the likelihood of one or more of the battery cells reversing polarity is greatly increased. The battery pack should never be discharged in use below 22 volts. Below this voltage limit, instrument calibration is not reliable. Care should also be taken to turn the oscilloscope off, or to the charge position when the battery pack is known to be in a low state of charge and the instrument not in use.

If the battery pack is found to fall below the lower voltage limit prematurely, contact your Tektronix Field Engineer or Representative for service immediately.

SECTION 6

CALIBRATION

Introduction

This procedure provides calibration information and a complete operational check for the Type 422 AC-DC Power Supply. The procedure checks the instrument to the performance requirements given in the Characteristics section of this Instruction Manual.

For the quickest and most accurate calibration, specialized calibration equipment is used where applicable. If this equipment is not available, the equipment substituted must equal or exceed the requirements listed under "Equipment Required", which follows. If the equipment does not meet these requirements, the Type 422 AC-DC Power Supply cannot be calibrated to the accuracy given. In such cases, the difference between the accuracy of the equipment used and the specified equipment accuracy must be added to the tolerance listed in the calibration steps.

This procedure may be used as a calibration training aid by following the procedure completely. It can be used to verify instrument operation by checking for the performance requirement or operation listed in each step. It may also be used to make the calibration adjustment by performing only those steps entitled "Adjust . . . ◐". The symbol ◐ is provided to locate the "Adjust" steps.

A verification list is included in this procedure. This list can be used to verify correct calibration and operation of the Type 422. It can also be used as a guide for quick calibration. The step numbers correspond to the steps in the complete calibration procedure.

General Information

Any needed maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the techniques given in Section 4 of this Instruction Manual.

NOTE

In case both the power supply and indicator are to be calibrated, the power supply should be calibrated first.

This procedure is arranged in a sequence which allows the instrument to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed out of sequence or a step may be performed individually. Each step contains complete information for performing that step. However, some adjustments affect the calibration of other circuits within the instrument. In this case, it will be necessary to check the operation of other parts of the instrument. When there is interaction, the calibration steps which need to be checked are noted at the end of the step.

The location of test points and adjustments is shown for each step. Waveforms which are helpful in determining the correct adjustment or operation are also shown.

EQUIPMENT REQUIRED

The following equipment is required for complete calibration of the Type 422 AC-DC Power Supply (Fig. 6-1 in the Type 422 Indicator Manual shows items 1 through 4).

1. Dc voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to 1% at —12 volts, to 2% at +12 volts, +55 volts and +95 volts, and to 3% at +2 volts, +11.5 volts, +22 volts, +35 volts and —110 volts.

2. Test oscilloscope. Risetime, 23 nanoseconds or less; minimum deflection factor, 0.005 volts/division. For example, Tektronix 540-series oscilloscope with Type B plug-in unit, or a calibrated Type 422.

3. Variable autotransformer. Must be capable of supplying at least 75 volt-amperes over a voltage range of 92 to 138 volts (184 to 276 volts for 230-volt nominal line). If autotransformer does not have an ac voltmeter to indicate output voltage, monitor output with an ac voltmeter (rms) with range of at least 138 (or 276) volts.

4. 1X probe with BNC connector. Tektronix P6028.

5. Test oscilloscope to provide proper loading for the power supply. Tektronix Type 422 properly calibrated.

6. Ohmmeter or similar method for checking continuity.

7. Dc power source; must have a variable output voltage from 11.5 to 35 volts and be capable of supplying 2.5 amperes or more of current. For example, Lambda (LH 125 FM), or Trygon (HR 40-3B) dc power supply.

8. Resistor; 50 ohm, 10 watt, 5%, Tektronix Part No. 308-0362-00.

9. Resistor; 680 ohm, 2 watt, 5%, Tektronix Part No. 305-0681-00.

10. Screwdriver, 3" shaft, Tektronix Part No. 003-0192-00. (See Fig. 6-3 in Type 422 Indicator Manual.)

VERIFICATION LIST

This verification list is provided to aid in checking the operation of the Type 422 AC-DC Power Supply. It may also be used as a guide to calibration. The step numbers and titles used here are the same as those used in the Calibration Procedure. Characteristics are those listed in Section 1 of this Instruction Manual.

Type 422 AC-DC Power Supply, Serial No. _____

Calibration Date _____

☐ 1. Adjust —12-Volt Supply ◐
—12-volts ±1% (11.9 to 12.2 volts)

☐ 2. Adjust Blocking Oscillator Frequency ◐
one cycle ≈ 140 μsec.

☐ 3. Check DC Power Supply Operation Regulation and Ripple

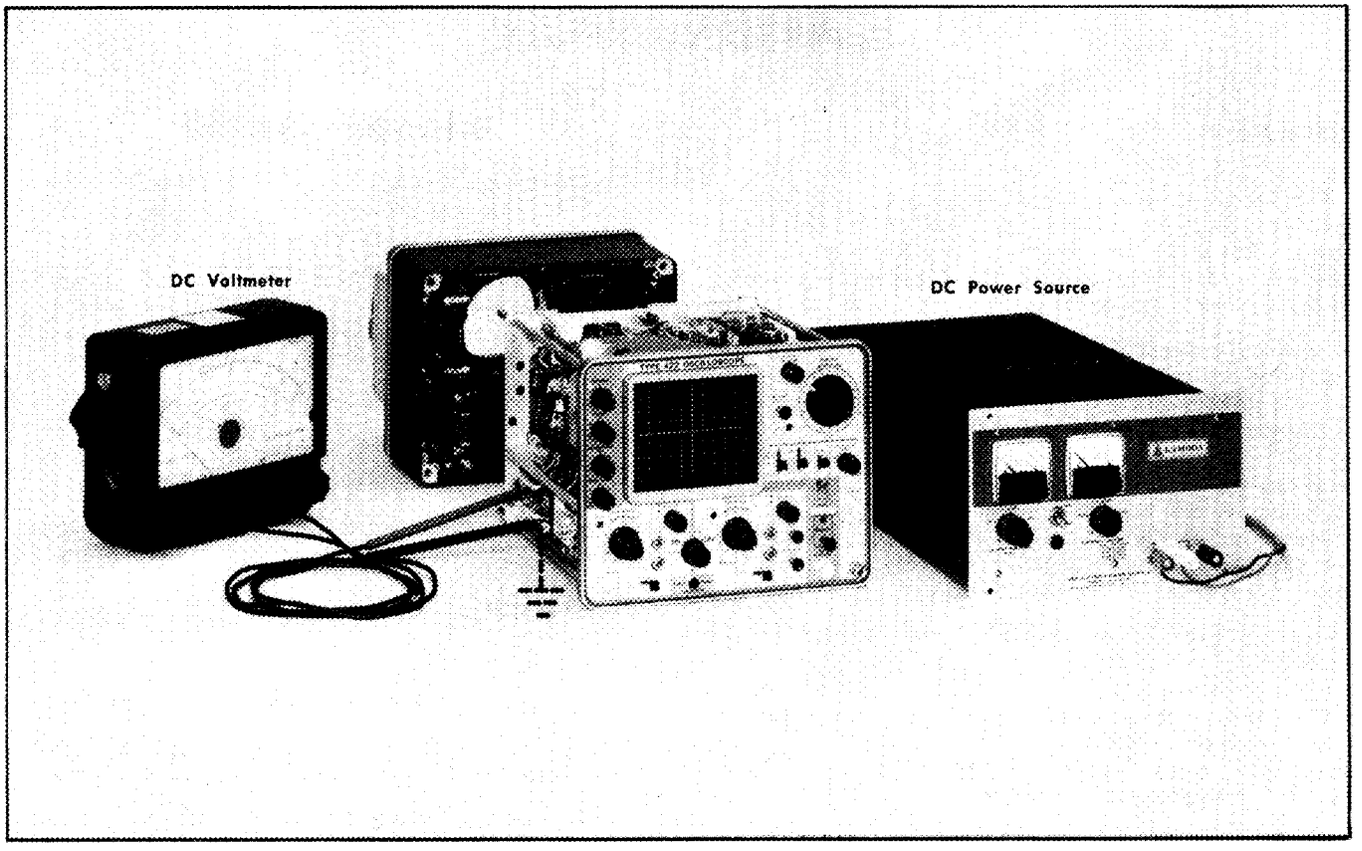


Fig. 6-1. Test equipment setup for —12-volts supply adjustment

Voltage Tolerance		Ripple
—12 volt	±1% (11.9 to 12.2 volts)	20 millivolts
—110 volt	±3% (106.7 to 113.3 volts)	0.5 volt
+12 volt	±2% (11.8 to 12.3 volts)	20 millivolts
+55 volt	±2% (53.9 to 56.1 volts)	0.6 volt
+95 volt	±2% (93.1 to 96.9 volts)	0.8 volt

☐ 4. Adjust Low-Voltage Indicator ◐
POWER Light blinks at 22 volts.

☐ 5. Check AC Power Supply Operation Regulation and Ripple

Voltage Tolerance		Ripple	
		8 kc	120 cycles
—12 volt	±1% (11.9 to 12.2 volts)	20 mv	5 mv
—110 volt	±3% (106.7 to 113.3 volts)	0.5 v	
+12 volt	±2% (11.8 to 12.3 volts)	20 mv	5 mv
+55 volt	±2% (53.9 to 56.1 volts)	0.6 v	
+95 volt	±2% (93.1 to 96.9 volts)	0.8 v	

☐ 6. Check Battery Charger Circuit
400 ma charge current across 50-ohm resistor results in 16 and 23 volts.

40 ma charge current across 680-ohm resistor results in 20 and 34 volts.

PRELIMINARY PROCEDURE

1. Remove the power supply from the indicator.

2. Remove the battery box.

3. Remove the indicator cover.

4. Connect the interconnecting cable for remote operation.

5. Connect the Type 422 AC-DC Power Supply to a variable dc power source which will supply 11.5 to 35 volts at 2.5 amperes, via the 3-wire dc power cord.

6. Set the POWER MODE switch to OPERATE 11.5-35 V DC.

7. Turn on the variable dc power source and adjust it for an output voltage of 22 volts.

8. Switch the Type 422 AC-DC Power Supply POWER switch ON.

NOTE

For checking instrument to accuracy given in the Characteristics section of this Instruction Manual, allow at least 20 minutes warm up.

CALIBRATION PROCEDURE

The calibration procedure which follows shows a test equipment setup picture for each major setup change. Once

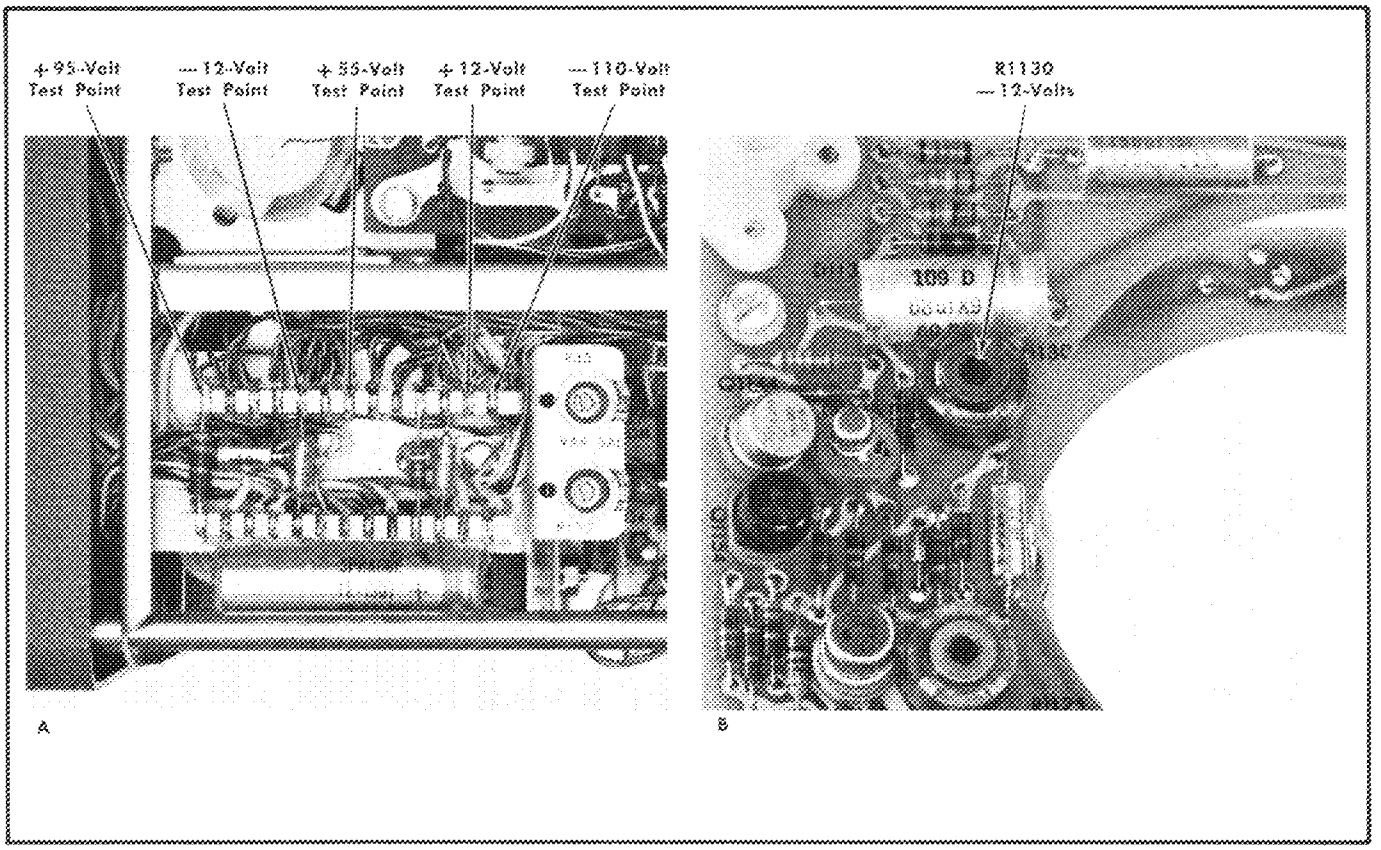


Fig. 6-2. (a) Location of power-supply test points (left side of indicator). (b) Location of —12-volts adjustment (power supply).

the Type 422 Indicator controls indicated below are set to the positions described, it will not again be necessary to set any of the Type 422 Indicator controls.

Type 422 Indicator

Triggering controls	
LEVEL	Adjust so sweep is not triggered.
SCALE ILLUM	Fully clockwise.

1. Adjust —12 Volt Supply

a. Test equipment setup is shown in Fig. 6-1.

b. Connect the dc voltmeter from the —12-volt test point Fig. 6-2a) to chassis ground.

c. Check voltmeter reading for —12 volts ±1% (11.9 to 12.2 volts).

d. Adjust R1130 (see Fig. 6-3b), if necessary, to obtain the voltmeter reading indicated in part (c) of this step.

NOTES

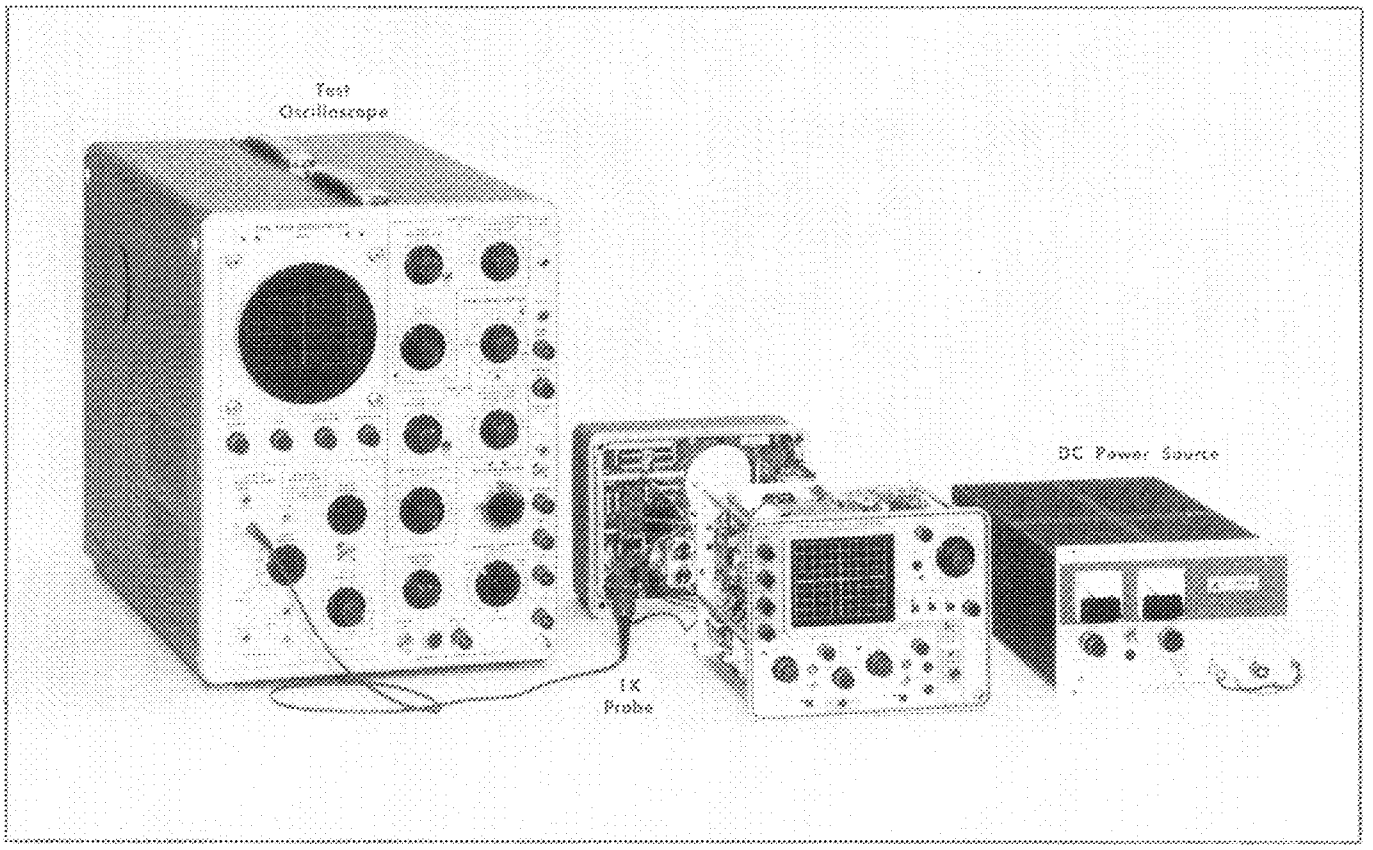


Fig. 6-3. Test equipment setup for Blocking Oscillator Frequency adjustment.

2. Adjust Blocking Oscillator Frequency

a. Test equipment setup is shown in Fig. 6-3.

b. Set the variable dc power source for an output voltage of exactly 13.5 volts.

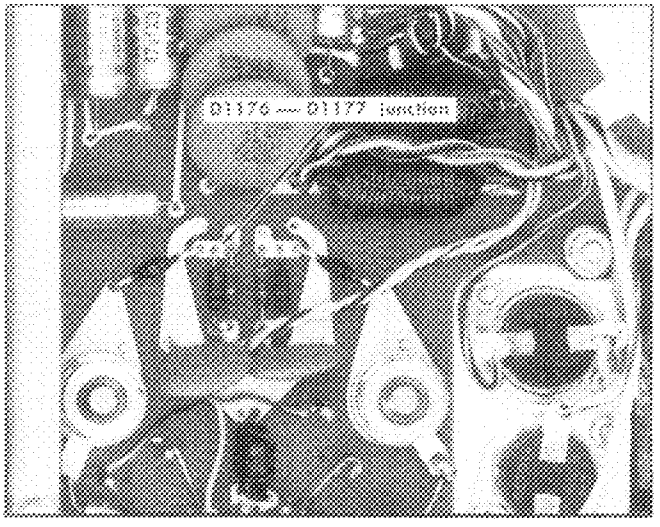


Fig. 6-4. (a) Power supply input voltage measuring test points. (b) Test oscilloscope probe connection.

c. Connect a 1X probe from the test oscilloscope to the junction of D1176 and D1177 (see Fig. 6-4).

d. Set the test oscilloscope Time/CM switch to 20 μSec, Volts/CM control to 20 and adjust the Triggering Level control for a stable display.

e. Adjust OSC FREQ control to obtain a waveform similar to the waveform show in Fig. 6-5.

f. Recheck step 1 "Adjust —12 Volt Supply".

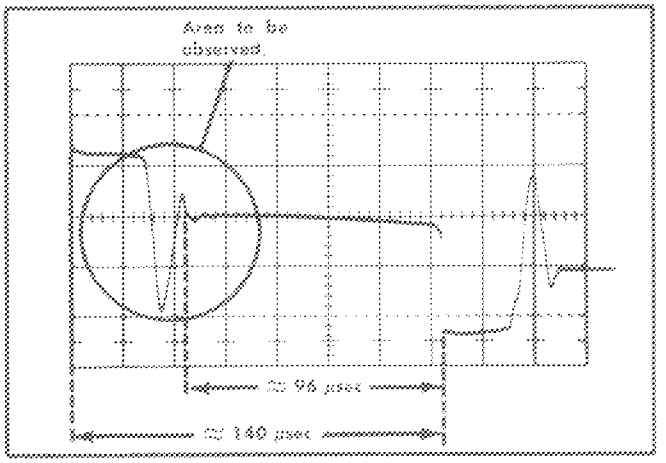


Fig. 6-5. Waveform obtained when OSC FREQ control is correctly adjusted. Oscilloscope controls for waveform were: Time/CM 20-μSec, Volts/CM 20.

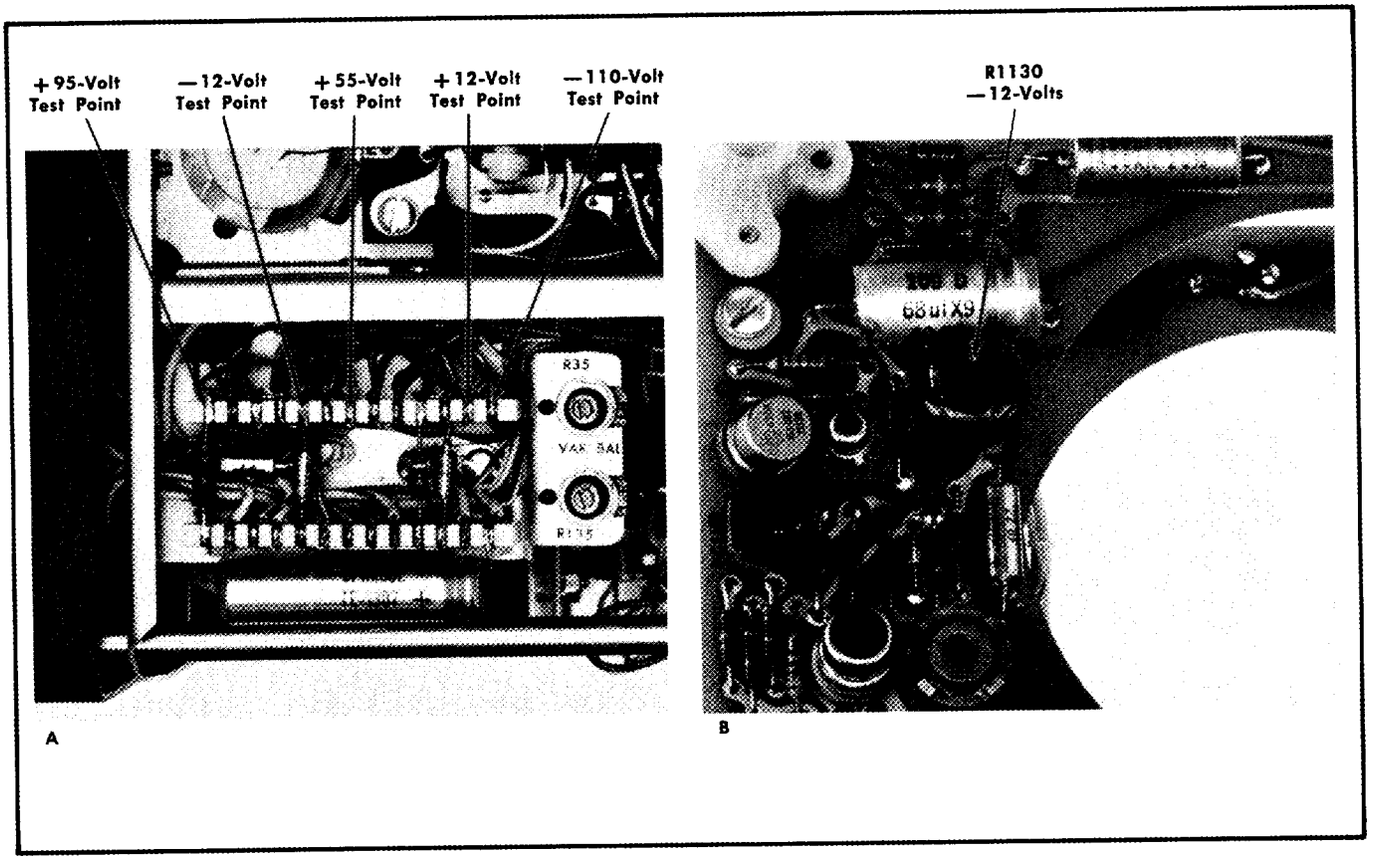


Fig. 6-2. (a) Location of power-supply test points (left side of indicator). (b) Location of —12-volts adjustment (power supply).

the Type 422 Indicator controls indicated below are set to the positions described, it will not again be necessary to set any of the Type 422 Indicator controls.

Type 422 Indicator

Triggering controls	
LEVEL	Adjust so sweep is not triggered.
SCALE ILLUM	Fully clockwise.

1. Adjust —12 Volt Supply

a. Test equipment setup is shown in Fig. 6-1.

b. Connect the dc voltmeter from the —12-volt test point Fig. 6-2a) to chassis ground.

c. Check voltmeter reading for —12 volts ±1% (11.9 to 12.2 volts).

d. Adjust R1130 (see Fig. 6-3b), if necesssary, to obtain the voltmeter reading indicated in part (c) of this step.

NOTES

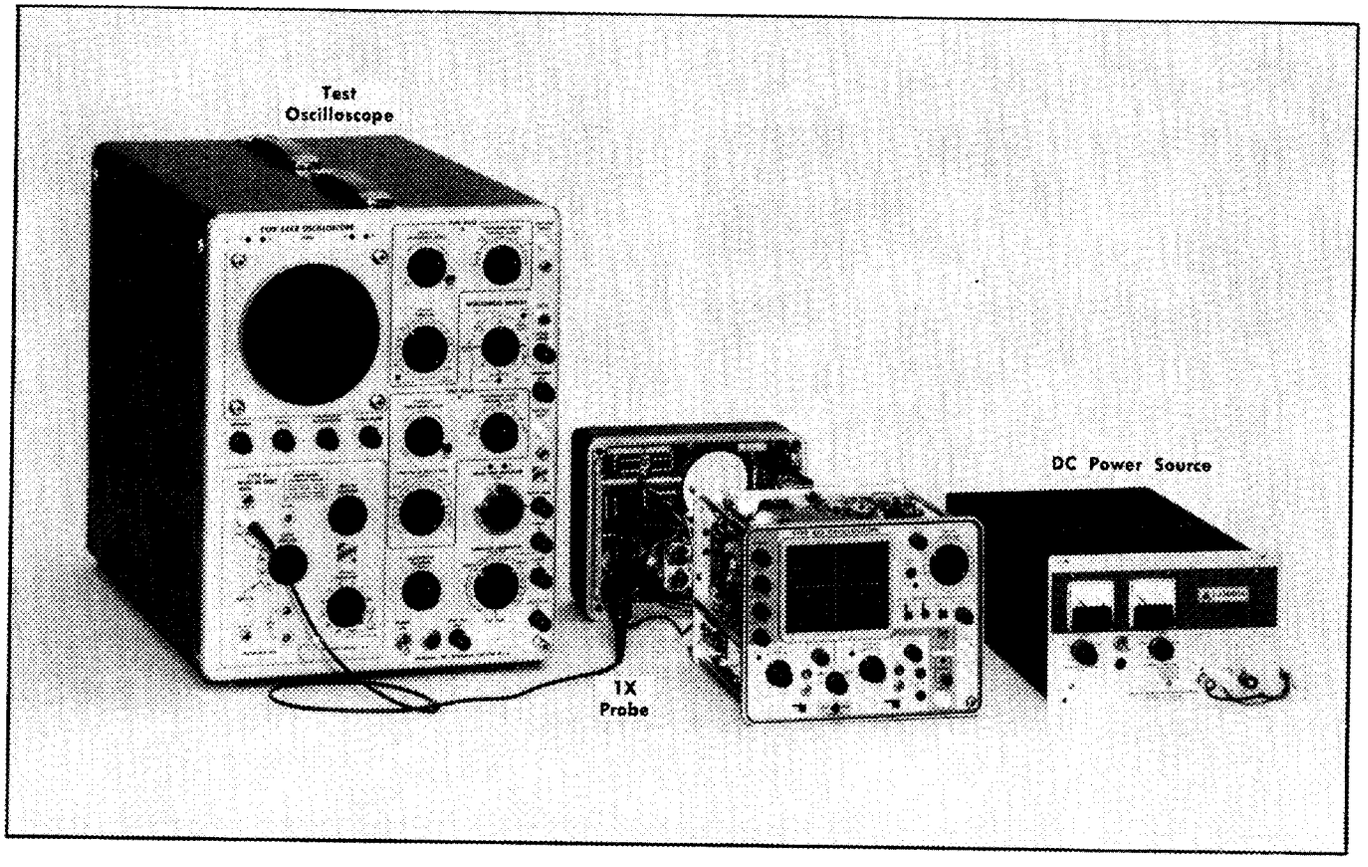


Fig. 6-3. Test equipment setup for Blocking Oscillator Frequency adjustment.

2. Adjust Blocking Oscillator Frequency

a. Test equipment setup is shown in Fig. 6-3.

b. Set the variable dc power source for an output voltage of exactly 11.5 volts.

Fig. 6-4. (a) Power supply input voltage measuring test points. (b) Test oscilloscope probe connection.

c. Connect a 1X probe from the test oscilloscope to the junction of D1176 and D1177 (see Fig. 6-4).

d. Set the test oscilloscope Time/CM switch to 20 μSec, Volts/CM control to 20 and adjust the Triggering Level control for a stable display.

e. Adjust OSC FREQ control to obtain a waveform similar to the waveform show in Fig. 6-5.

f. Recheck step 1 "Adjust —12 Volt Supply".

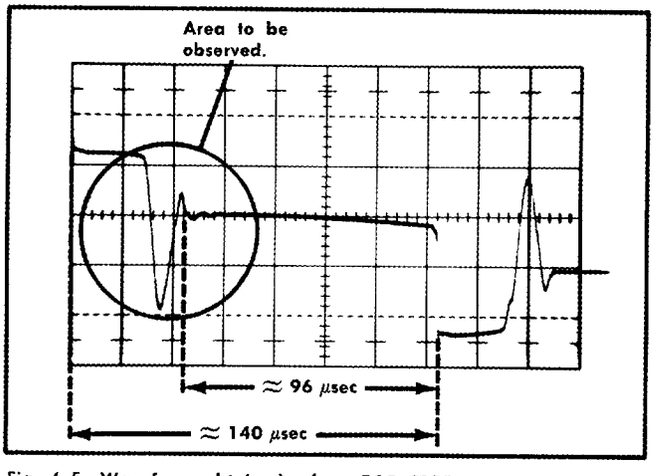


Fig. 6-5. Waveform obtained when OSC FREQ control is correctly adjusted. Oscilloscope controls for waveform were: Time/CM 20-μSec, Volts/CM 20.

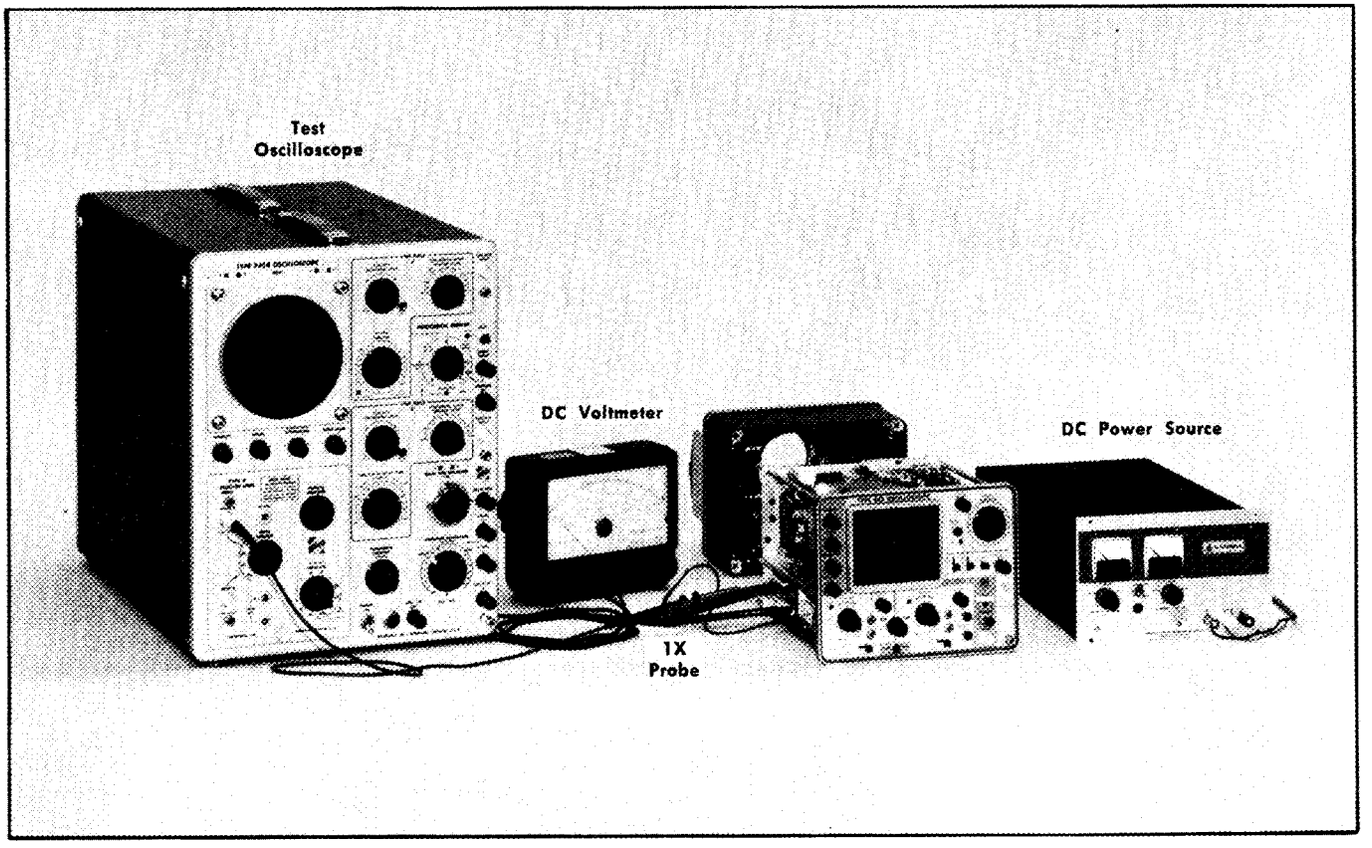


Fig. 6-6. Test equipment setup for checking dc power supply regulation and taking power supply ripple measurements.

3. Check DC Power Supply Operation Regulation and Ripple

a. Test equipment setup is shown in Fig. 6-6.

b. Set the variable dc power source for an output voltage of 11.5 volts.

c. Connect a dc voltmeter to each of the test points shown in Fig. 6-2a and check for the correct voltage as shown in Table 6-1.

TABLE 6-1

Power Supply	Tolerance
—12 volt	±1% (11.9 to 12.2 volts)
—110 volt	±3% (106.7 to 113.3 volts)
+12 volt	±2% (11.8 to 12.3 volts)
+55 volt	±2% (53.9 to 56.1 volts)
+95 volt	±2% (93.1 to 96.9 volts)

d. Set the test oscilloscope Time/CM switch to 0.2 mSec, Volts/CM to 0.005 and vertical input coupling switch to ac.

e. Connect a 1X probe from the test oscilloscope to each of the test points shown in Fig. 6-2a and measure the amplitude of the 8 kc ripple on each supply voltage. Table 6-2 lists the maximum ripple amplitudes for each supply voltage.

TABLE 6-2

Power Supply	Maximum 8 kc Ripple Amplitude
—12 volt	20 millivolts
—110 volt	0.5 volt
+12 volt	20 millivolts
+55 volt	0.6 volt
+95 volt	0.8 volt

f. Set the variable dc power source for an output voltage of 22 volts and repeat parts c, d, and e of this step.

g. Set the variable dc power source for an output voltage of 35 volts and repeat parts c, d, and e of this step.

h. Turn off and disconnect the variable dc power source.

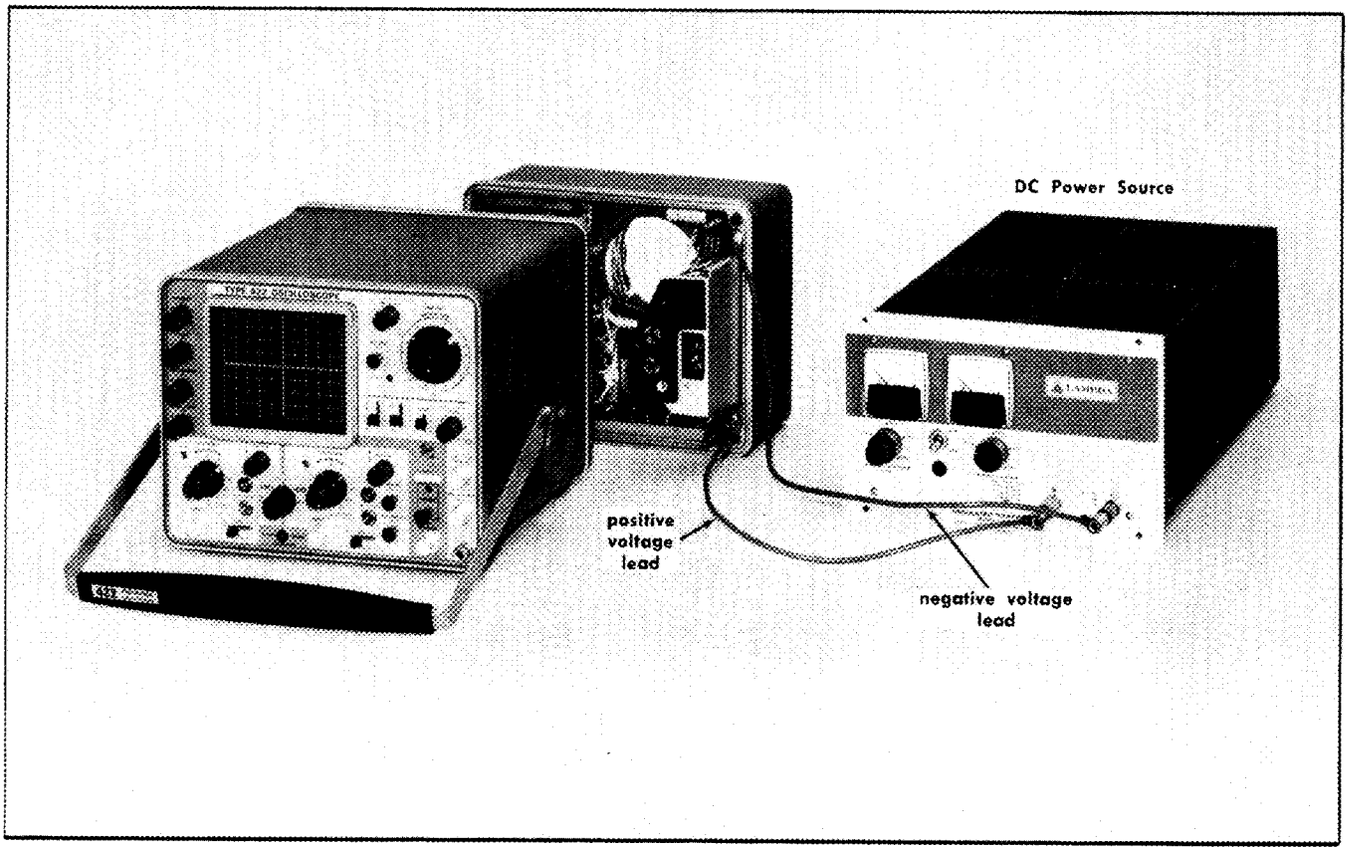


Fig. 6-7. Test equipment setup for Low-Voltage Indicator adjustment.

4. Adjust Low-Voltage Indicator

a. Test equipment setup is shown in Fig. 6-7.

b. Set POWER MODE switch to OPERATE INT BATT.

c. Check that the negative output voltage lead from the variable dc power source is connected to the banana plug near the top of the power supply while the positive voltage lead from the variable dc power source is connected to the lower banana plug.

d. Turn on the variable dc power source and adjust its output voltage for 35 volts.

e. Turn the LOW VOLTAGE INDICATOR control, R1047, fully clockwise (see Fig. 6-8), then check the POWER Light on the Type 422 Indicator for a steady light.

f. Slowly lower the variable dc power source voltage to 22 volts.

g. Turn the LOW VOLTAGE INDICATOR control, R1047, counterclockwise until the POWER Light just starts blinking.

h. Reset the variable dc power source output voltage to 35 volts and check for a steady light from the POWER Light.

i. Slowly decrease the output voltage from the variable dc power source until the POWER Light starts blinking.

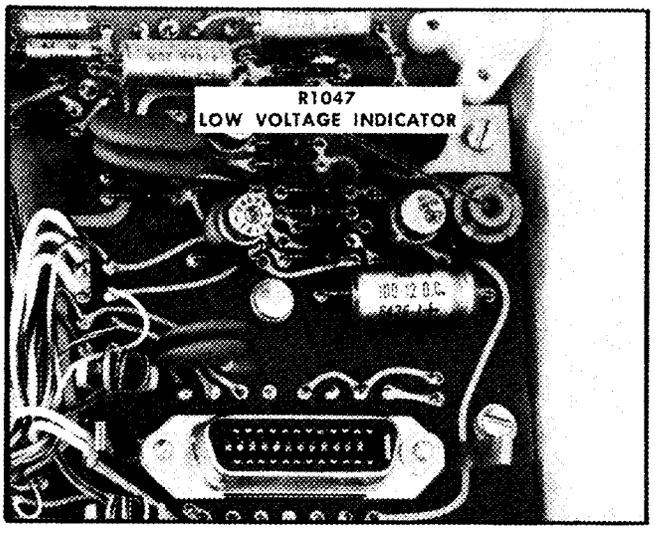


Fig. 6-8. Location of R1047 (LOW VOLTAGE INDICATOR) adjustment.

j. Check the output voltage of the variable dc power source. It should be 22 volts.

k. Turn off and disconnect the variable dc power source.

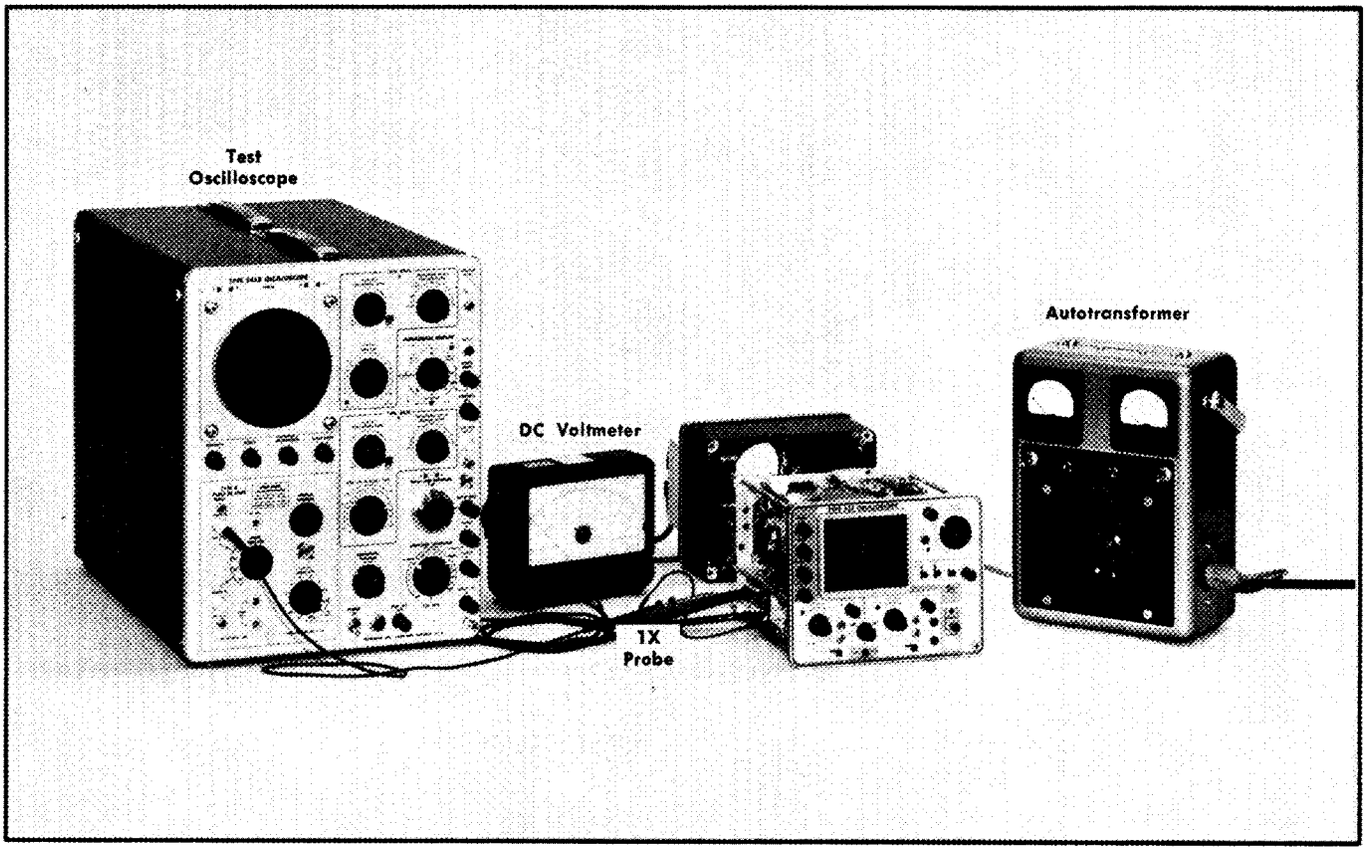


Fig. 6-9 Test equipment setup for checking ac power supply regulation and taking power supply ripple measurements.

5. Check AC Power Supply Operation Regulation and Ripple

a. Test equipment setup is shown in Fig. 6-9.

b. Turn the POWER MODE switch to OPERATE 115 V AC (OPERATE 230 V AC).

c. Turn on the autotransformer and set it for an output voltage of 92 volts (184 volts).

d. Connect a dc voltmeter to each of the test points shown in Fig. 6-2a and check for the correct voltage as shown in Table 6-1.

e. Set the test oscilloscope Time/CM switch to 5 mSec to measure 120-cycle and 8-kc ripple.

f. Set the test oscilloscope Volts/CM switch to 0.005 and the vertical input coupling switch to ac.

g. Connect a 1X probe from the test oscilloscope to each of the test points shown in Fig. 6-2a and measure the ripple amplitudes for each supply voltage. Table 6-3 lists the maximum 8-kc and 120-cycle ripple amplitudes for each supply voltage.

TABLE 6-3

Power Supply	Maximum Ripple	
	8 kc	120 cycles
—12 volt	20 millivolts	5 millivolts
—110 volt	0.5 volt	
+12 volt	20 millivolts	5 millivolts
+55 volt	0.6 volt	
+95 volt	0.8 volt	

h. Set the autotransformer for an output voltage of 115 volts (230 volts) and repeat parts d, e, and f of this step.

i. Set the auto transformer for an output voltage of 138 volts (276 volts) and repeat parts d, e, and f of this step.

j. Turn off the autotransformer.

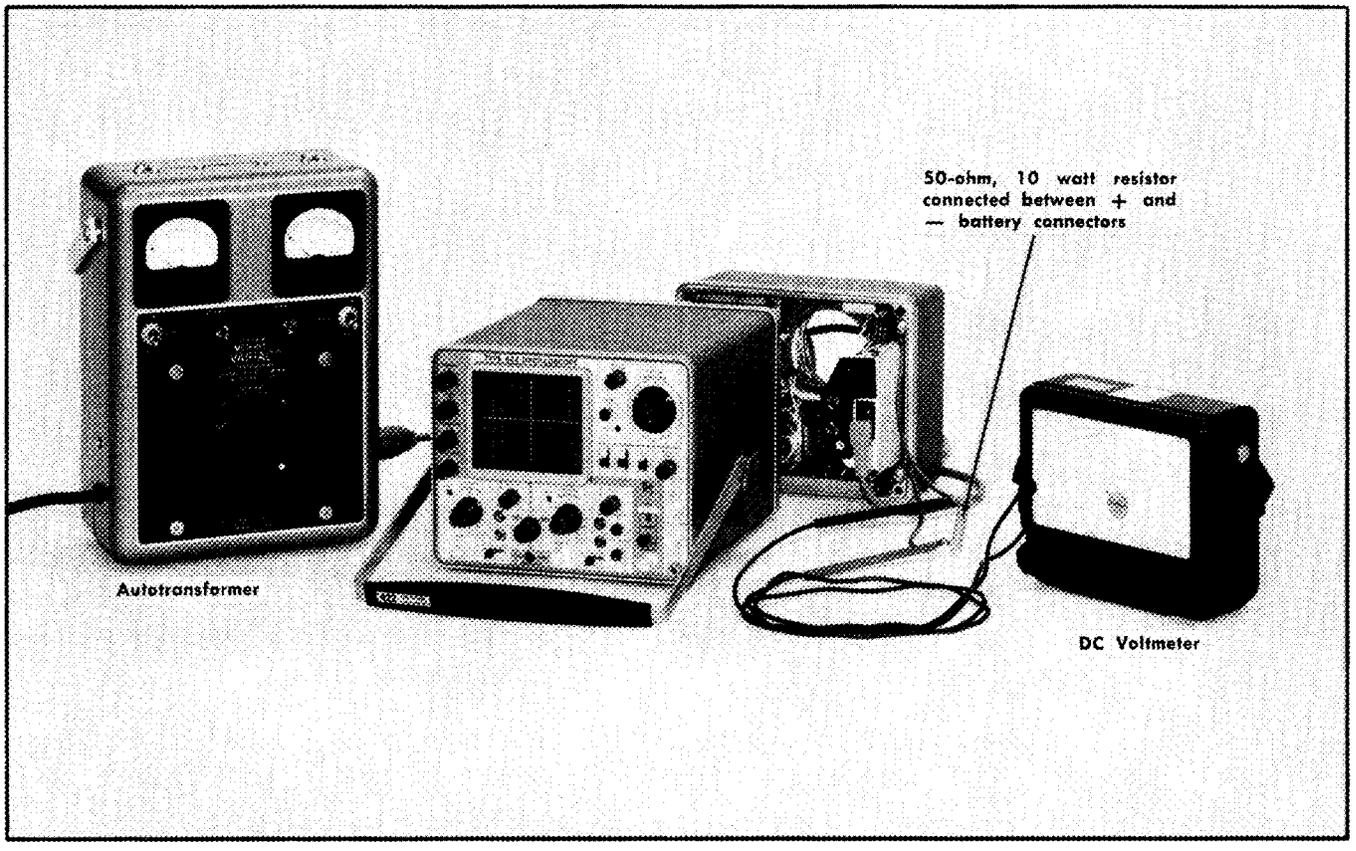


Fig. 6-10. Test equipment setup for checking Battery Charger current.

6. Check Battery Charger Circuit

a. Test equipment setup is shown in Fig. 6-10.

b. Set the POWER MODE switch to CHARGE BATT 115 V AC (CHARGE BATT 230 V AC).

c. Turn on the autotransformer and set it for a 92-volt output.

d. Check that the reading of the dc voltmeter is at least 16 volts.

e. Turn off the autotransformer and allow the 50-ohm resistor to cool.

f. Turn on the autotransformer and set it for a 126.5-volt output.

g. Check that the reading of the dc voltmeter does not exceed 23 volts.

h. Turn off the autotransformer and substitute a 680-ohm 2-watt resistor for the 50-ohm 10-watt resistor.

i. Set the POWER MODE switch to OPERATE 115 V AC (OPERATE 230 V AC).

j. Turn on the autotransformer and set it for a 92-volt output.

k. Check the reading of the dc voltmeter for a reading of at least 20 volts.

l. Set the autotransformer for an output voltage of 126.5 volts.

m. Check the dc voltmeter for a reading of less than 34 volts.

This completes the calibration of the Type 422 AC-DC Power Supply. Disconnect all test equipment and reassemble the power supply. Replace the indicator cover and re-attach the power supply to the indicator.

SECTION 7
PARTS LIST AND DIAGRAMS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

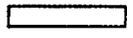
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

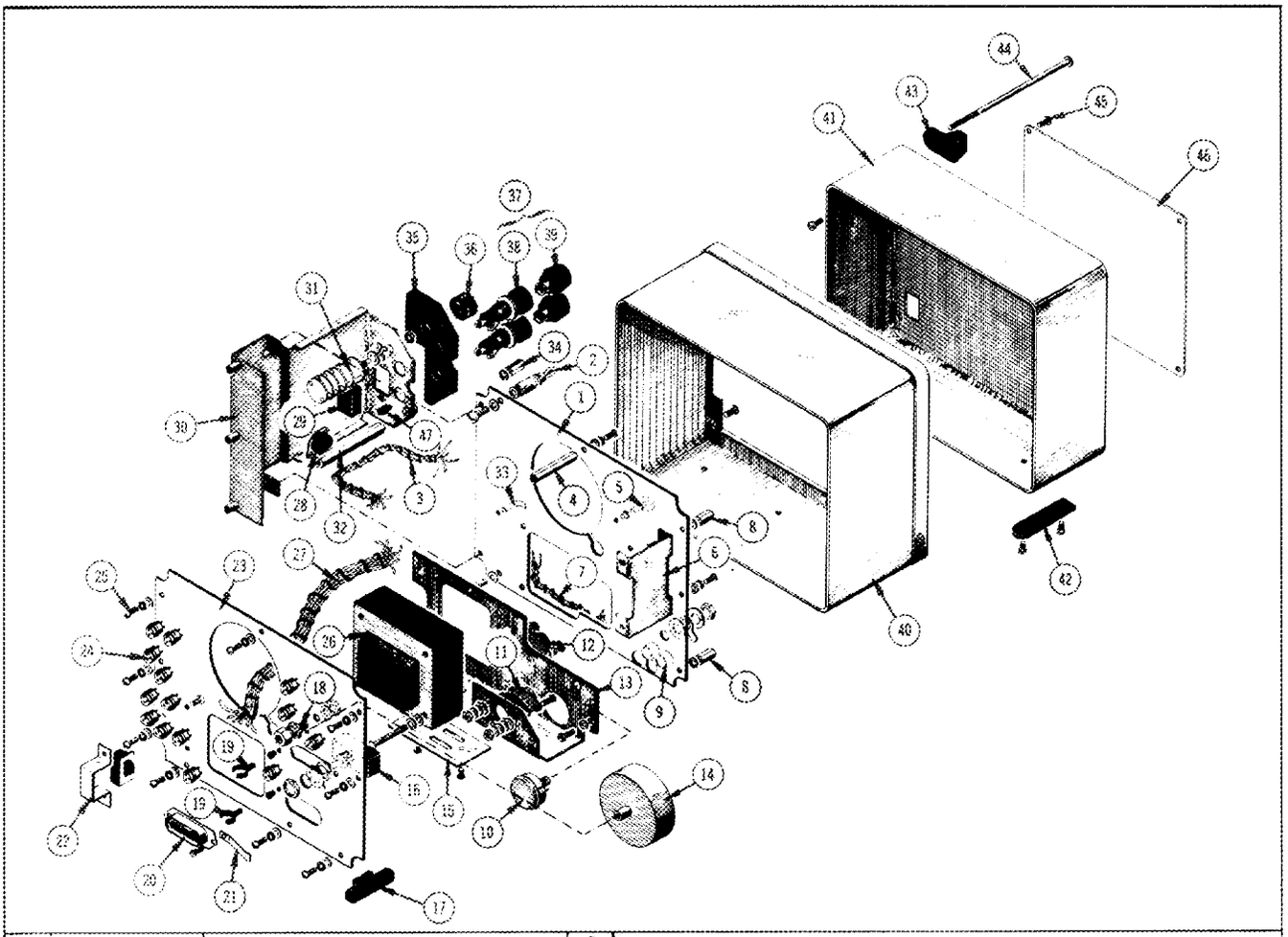
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

EXPLODED VIEW



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	670-0082-00			1	ASSEMBLY, DC POWER CONVERTER
	- - - - - -			-	assembly includes:
	388-0623-00			1	BOARD, etched circuit, rear
2	134-0016-00			2	PLUG, banana, female
	- - - - - -			-	mounting hardware for each: (not included w/plug alone)
	212-0570-00			1	SCREW, 10-32 x 5/8 inch PHS phillips
	210-1003-00	X2540		1	WASHER, flat
	210-0056-00	X2540		1	LOCKWASHER, #10 split
	210-1003-00			1	WASHER, flat
	361-0102-00			1	SPACER, tube
3	179-0978-00	100	3911	1	CABLE HARNESS, AC-DC
	179-0978-01	3912		1	CABLE HARNESS, AC-DC
	179-0977-00	X2550	3911	1	CABLE HARNESS, chassis (see ref. #27)
	179-0977-01	3912		1	CABLE HARNESS, chassis
4	385-0183-00			1	ROD, support
	- - - - - -			-	mounting hardware: (not included w/rod alone)
	211-0097-00	100	579	1	SCREW, 4-40 x 5/16 inch PHS phillips
	211-0116-00	580		1	SCREW, sems, 4-40 x 5/16 inch PHB phillips
	210-0054-00	100	579X	1	LOCKWASHER, #4 split
	210-0994-00	100	579X	1	WASHER, .125 ID x .250 inch OD
5	462-0121-00			1	MOUNT, toroid
	- - - - - -			-	mounting hardware: (not included w/mount alone)
	361-0007-00			1	SPACER, nylon, .063 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
6	407-0125-00			1	BRACKET, side
	- - - - - -			-	mounting hardware: (not included w/bracket alone)
	211-0097-00	100	579	1	SCREW, 4-40 x 5/16 inch PHS phillips
	211-0116-00	580		1	SCREW, sems, 4-40 x 5/16 inch PHB phillips
	210-0054-00	100	579X	1	LOCKWASHER, #4 split
	210-0994-00	100	579X	1	WASHER, .125 ID x .250 inch OD
7	179-0979-00			1	CABLE HARNESS, transformer
8	384-0519-00			2	ROD, spacing
	- - - - - -			-	mounting hardware for each (not included w/rod alone)
	213-0049-00			1	SCREW, 6-32 x 5/16 inch HHS
	210-0055-00			1	LOCKWASHER, #6 split
	210-0802-00			1	WASHER, 6S x 5/16 inch
9	354-0253-00			2	RING, capacitor mounting
10	- - - - - -			2	TRANSISTOR
	- - - - - -			-	mounting hardware for each: (not included w/transistor alone)
	210-0996-00			1	WASHER, shouldered, 3/4 OD x 5/16 inch ID
	210-0807-00	100	2539	1	WASHER, 5/16 ID x 5/8 inch OD
	210-0807-01	2540		1	WASHER, 5/16 ID x 5/8 inch OD
	210-0217-00			1	LUG, solder, 5/16 inch
	210-0057-00			1	LOCKWASHER, 5/16 inch split
	210-0524-00	100	2539	1	NUT, hex, 5/16-24 x 1/2 inch
	210-0524-01	2540		1	NUT, hex, 5/16-24 x 1/2 inch
11	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor alone)
	386-0143-00			1	PLATE, mica insulator
	211-0507-00			2	SCREW, 6-32 x 5/16 inch PHS phillips
	210-0983-00			2	WASHER, shouldered, #6
	210-0261-00			1	LUG, solder, high voltage
	210-0802-00			1	WASHER, 6S x 5/16 inch
	210-0055-00			2	LOCKWASHER, #6 split
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
12	260-0677-00			2	SWITCH, thermal cutout
	- - - - - -			-	mounting hardware for each (not included w/switch alone)
	210-0054-00			2	LOCKWASHER, #4 split
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
13	407-0124-00			1	BRACKET, heat sink
14	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer
	213-0041-00	100	349	2	SCREW, thread cutting, 6-32 x 3/8 inch THS phillips
	211-0537-00	350		2	SCREW, 6-32 x 3/8 inch THS phillips
	210-0802-00			2	WASHER, 6S x 5/16 inch
	210-0055-00			2	LOCKWASHER, #6 split
15	386-0191-00			1	PLATE, support
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0038-00			2	SCREW, 4-40 x 5/16 inch FHS phillips
16	260-0676-00			1	SWITCH, toggle—POWER
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0414-00			1	NUT, hex, 15/32-32 x 9/16 inch
	354-0055-00			1	RING, locking, switch
	210-0473-00			1	NUT, switch, 15/32-32 x 5/64 inch, 12 sided

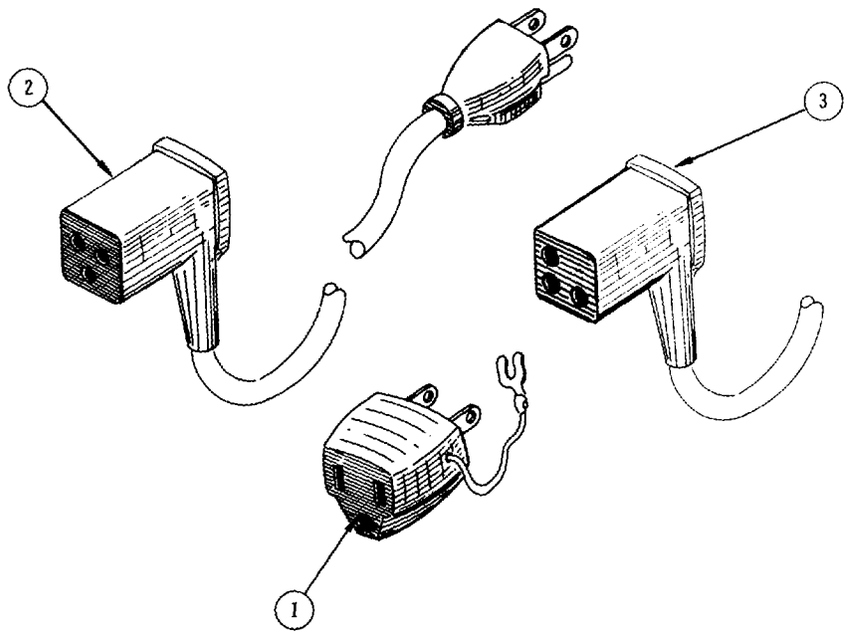
EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
17	351-0090-00			4	GUIDE, corner, power supply
	- - - - - -			-	mounting hardware for each: (not included w/guide)
	213-0034-00			2	SCREW, thread cutting, 4-40 x 5/16 inch PHS phillips
18	214-0289-00			1	HEAT SINK, transistor
	- - - - - -			-	mounting hardware: (not includedw/heat sink)
	210-0909-00	X3195		1	WASHER, mica, 0.196 ID x 0.625 inch OD
	210-0010-00			1	LOCKWASHER, internal, #10
	210-0410-00			1	NUT, hex., 10-32 x 5/16 inch
19	426-0121-00			3	MOUNT, toroid
	- - - - - -			-	mounting hardware for each: (not included w/mount)
	361-0007-00			1	SPACER, nylon, .063 inch
20	131-0346-00			1	CONNECTOR, 24 pin, female
	- - - - - -			-	mounting hardware: (not included w/connector)
	211-0034-00			2	SCREW, 2-56 x 1/2 inch RHS phillips
	210-0864-00			2	WASHER, 3/16 ID x 3/8 inch OD
	210-0053-00			2	LOCKWASHER, #2 split
	210-0405-00			2	NUT, hex, 2-56 x 3/16 inch
21	214-0566-00			2	SPRING, clip
22	407-0126-00			1	BRACKET, transformer mounting
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch PHS phillips
	210-0802-00			2	WASHER, 6S x 5/16 inch
	210-0055-00			2	LOCKWASHER, #6 split
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
23	670-0081-00			1	ASSEMBLY, DC POWER CONTROL (see ref #25)
	- - - - - -			-	assembly includes:
	388-0624-00			1	BOARD, etched circuit, front
24	136-0183-00			14	SOCKET, 3 pin transistor
25	- - - - - -			-	mounting hardware: (not included w/assembly)
	211-0097-00	100	579	9	SCREW, 4-40 x 5/16 inch PHS phillips
	211-0116-00	580		9	SCREW, sems, 4-40 x 5/16 inch PHB phillips
	210-0994-00	100	579X	9	WASHER, .125 ID x .250 inch OD
	210-0054-00	100	579X	9	LOCKWASHER, #4 split
26	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer)
	211-0530-00			2	SCREW, 6-32 x 1 3/4 inches PHS phillips
	210-0802-00	100	3719	8	WASHER, 6S x 5/16 inch
	210-0802-00	3720		4	WASHER, 6S x 5/16 inch
	210-0983-00			4	WASHER, shouldered, #6
	210-0055-00			4	LOCKWASHER, #6 split
	210-0407-00			4	NUT, hex, 6-32 x 1/4 inch
27	179-0977-00	100	2549X	1	CABLE HARNESS, chassis (see ref. #3)
28	260-0678-00			1	SWITCH, thermal cutout
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0054-00			2	LOCKWASHER, #4 split
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
29	131-0384-00			1	CONNECTOR, AC-DC
	- - - - - -			-	mounting hardware: (not included w/connector)
	210-0054-00			2	LOCKWASHER, #4 split
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
30	407-0123-00			1	BRACKET, support
31	260-0679-00			1	SWITCH, unwired—POWER MODE
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
32	385-0185-00			1	ROD, support
	- - - - - -			-	mounting hardware: (not included w/rod)
	210-0056-00			1	LOCKWASHER, #10 split
	220-0434-00			1	NUT, hex, shouldered, .560 inch long
33	343-0089-00			1	CLAMP, cable, size "D"
34	384-0519-00			2	ROD, spacing
	- - - - - -			-	mounting hardware for each: (not included w/rod)
	213-0049-00			1	SCREW, 6-32 x 5/16 inch HHS
	210-0055-00			1	LOCKWASHER, #6 split
	210-0802-00			1	WASHER, 6S x 5/16 inch
35	214-0568-00			1	GASKET, switch bracket
36	366-0326-00			1	KNOB, small charcoal—POWER MODE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
37	352-0002-00			2	ASSEMBLY, fuse holder
	- - - - - -			-	assembly includes:
38	352-0010-00			1	HOLDER, fuse
	210-0873-00			1	WASHER, rubber, 1/2 ID x 11/16 inch OD
	- - - - - -			-	NUT, fuse holder
39	200-0582-00			1	CAP, fuse
40	380-0079-00			1	HOUSING, power supply
	- - - - - -			-	mounting hardware: (not included w/housing)
	211-0507-00			4	SCREW, 6-32 x 5/16 inch PHS phillips
	211-0565-00			3	SCREW, 6-32 x 1/4 inch THS phillips
41	202-0138-00			1	BOX, battery, power supply
	- - - - - -			-	box includes:
42	348-0069-00			2	FOOT, bottom
	- - - - - -			-	mounting hardware for each: (not include w/foot alone)
	211-0501-00			2	SCREW, 6-32 x 1/8 inch PHS phillips
43	348-0068-00			4	FOOT, rear
	- - - - - -			-	mounting hardware for each: (not included w/foot alone)
	213-0034-00			1	SCREW, thread cutting, 4-40 x 5/16 inch RHS phillips
44	212-0572-00			4	SCREW, 10-32 x 5 1/2 inches RHS
45	211-0542-00			4	SCREW, 6-32 x 5/16 inch THS phillips
	210-0803-00			4	WASHER, 6L x 3/8 inch
	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
46	334-0959-00			1	TAG, information
	- - - - - -			-	mounting hardware: (not included w/tag)
	211-0542-00			1	SCREW, 6-32 x 5/16 inch THS phillips
47	210-0201-00			1	LUG, solder, SE4
	- - - - - -			-	mounting hardware (not included w/lug)
	210-0406-00			1	NUT, hex, 4-40 x 3/16 inch

ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
	070-0471-01			2	MANUAL, instruction (not shown)
1	103-0013-00			1	ADAPTER, 3- to 2-wire
2	161-0015-01			1	CORD, power, AC
3	161-0016-01			1	CORD, power, DC

ELECTRICAL PARTS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.		Description		S/N Range
			Capacitors		
Tolerance ±20% unless otherwise indicated.					
C1000	283-0022-00	0.02 μf	Cer	1400 v	
C1001	285-0566-00	0.022 μf	PTM	200 v	10%
C1002	290-0259-00	100 μf	EMT	50 v	
C1003	Use 290-0300-00	1300 μf	Cer	40 v	+75%, —10%
C1004	Use 290-0300-00	1300 μf	Cer	40 v	+75%, —10%
C1010	283-0008-00	0.1 μf	Cer	500 v	
C1011	Use 283-0129-00	0.56 μf	Cer	100 v	
C1012	283-0008-00	0.1 μf	Cer	500 v	
C1041	290-0171-00	100 μf	EMT	12 v	
C1057	285-0623-00	0.47 μf	PTM	100 v	
C1106	290-0267-00	1 μf	EMT	35 v	
C1117	290-0134-00	22 μf	EMT	15 v	
C1120	290-0134-00	22 μf	EMT	15 v	
C1121	285-0686-00	0.068 μf	PTM	100 v	10%
C1133	290-0273-00	68 μf	EMT	60 v	10%
C1170	283-0111-00	0.1 μf	Cer	50 v	X2831-up
C1171	290-0274-00	80 μf	EMT	50 v	+75%, —10%
C1172	290-0274-00	80 μf	EMT	50 v	+75%, —10%
C1173	283-0008-00	0.1 μf	Cer	500 v	
C1177	283-0013-00	0.01 μf	Cer	1000 v	
C1181	283-0008-00	0.1 μf	Cer	500 v	
C1183	283-0008-00	0.1 μf	Cer	500 v	
C1187	283-0013-00	0.01 μf	Cer	1000 v	
C1195	290-0134-00	22 μf	EMT	15 v	
C1199	290-0248-01	150 μf	EMT	15 v	
C1202	290-0272-00	47 μf	EMT	50 v	
C1203	283-0013-00	0.01 μf	Cer	1000 v	
C1204	290-0273-00	68 μf	EMT	60 v	10%
C1205	283-0013-00	0.01 μf	Cer	1000 v	
C1210	290-0248-01	150 μf	EMT	15 v	
C1211	290-0248-01	150 μf	EMT	15 v	
C1212	290-0248-01	150 μf	EMT	15 v	
C1213	290-0266-00	290 μf	EMT	15 v	
C1214	290-0248-01	150 μf	EMT	15 v	
C1216	290-0248-01	150 μf	EMT	15 v	
C1217	290-0248-01	150 μf	EMT	15 v	
C1218	290-0248-01	150 μf	EMT	15 v	
C1219	290-0266-00	290 μf	EMT	15 v	
C1224	290-0270-00	8.2 μf	EMT	60 v	
C1225	290-0271-00	9 μf	EMT	125 v	+20%, —15%
C1226	283-0013-00	0.01 μf	Cer	1000 v	
C1231	283-0008-00	0.1 μf	Cer	500 v	

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description		S/N Range
C1232	290-0187-00	4.7 μf	EMT	35 v	
C1233	290-0187-00	4.7 μf	EMT	35 v	
C1242	283-0008-00	0.1 μf	Cer	500 v	
C1245	290-0248-01	150 μf	EMT	15 v	
C1246	290-0248-01	150 μf	EMT	15 v	

Diodes

D1002	152-0198-00	Silicon	MR 1032A	200 v, 3 Amp	(Motorola)
D1003	152-0198-00	Silicon	MR 1032A	200 v, 3 Amp	(Motorola)
D1004	152-0198-00	Silicon	MR 1032A	200 v, 3 Amp	(Motorola)
D1005	152-0198-00	Silicon	MR 1032A	200 v, 3 Amp	(Motorola)
D1014	152-0198-00	Silicon	MR 1032A	200 v, 3 Amp	(Motorola)
D1016	152-0198-00	Silicon	MR 1032A	200 v, 3 Amp	(Motorola)
D1022	152-0127-00	Zener	1N7552	0.4 w, 7.5 v	5%
D1041	152-0055-00	Zener	1N962A	0.4 w, 11 v	5%
D1042	*152-0061-00	Silicon	Tek Spec		
D1054	*152-0061-00	Silicon	Tek Spec		
D1055	*152-0061-00	Silicon	Tek Spec		
D1057	*152-0061-00	Silicon	Tek Spec		
D1104	*152-0061-00	Silicon	Tek Spec		
D1105	*152-0061-00	Silicon	Tek Spec		
D1106	*152-0061-00	Silicon	Tek Spec		
D1114	*152-0061-00	Silicon	Tek Spec		
D1115	*152-0061-00	Silicon	Tek Spec		
D1116	*152-0061-00	Silicon	Tek Spec		
D1117	*152-0061-00	Silicon	Tek Spec		
D1118	*152-0061-00	Silicon	Tek Spec		
D1120	*152-0061-00	Silicon	Tek Spec		
D1132	*152-0061-00	Silicon	Tek Spec		
D1135	152-0123-00	Zener	1N935A	0.4 w, 9.1 v	5% T. C.
D1155	152-0169-00	Tunnel	1N3712	1 MA	
D1174	152-0101-00	Zener	1N3041B	1 w, 75 v	5%
D1176	152-0180-00	Silicon	Fast switching UTR 1112		(Unitrode)
D1177	*152-0061-00	Silicon	Tek Spec		
D1184	152-0101-00	Zener	1N3041B	1 w, 75 v	5%
D1186	152-0180-00	Silicon	Fast switching UTR 1112		(Unitrode)
D1187	*152-0061-00	Silicon	Tek Spec		
D1189	*152-0061-00	Silicon	Tek Spec		
D1191	*152-0061-00	Silicon	Tek Spec		
D1192	152-0127-00	Zener	1N755A	0.4 w, 7.5 v	5%
D1202	152-0224-00	Silicon	UTR 166		(Unitrode)
D1203	*152-0061-00	Silicon	Tek Spec		

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
D1212	152-0179-00	Silicon Fast switching UTR 02	(Unitrode)
D1213	152-0179-00	Silicon Fast switching UTR 02	(Unitrode)
D1214	*152-0061-00	Silicon Tek Spec	
D1215	*152-0061-00	Silicon Tek Spec	
D1216	152-0179-00	Silicon Fast switching UTR 02	(Unitrode)
D1217	152-0179-00	Silicon Fast switching UTR 02	(Unitrode)
D1222	*152-0061-00	Silicon Tek Spec	
D1223	152-0224-00	Silicon UTR 166	(Unitrode)
D1224	*152-0061-00	Silicon Tek Spec	
D1225	*152-0061-00	Silicon Tek Spec	
D1232	*152-0061-00	Silicon Tek Spec	
D1233	*152-0061-00	Silicon Tek Spec	
D1242	*152-0061-00	Silicon Tek Spec	
D1243	*152-0061-00	Silicon Tek Spec	
D1244	*152-0061-00	Silicon Tek Spec	
D1245	*152-0061-00	Silicon Tek Spec	

Fuses

F1000	159-0042-00	3/4 Amp	3AG	Fast-Blo	115 v-230 v operation
F1014	159-0015-00	3 Amp	3AG	Fast-Blo	11.5 v-35 v operation (internal battery)

Inductors

L1172	*108-0337-00	25 μh
L1182	*108-0337-00	25 μh
L1189	*120-0395-00	Toroid, 3 turns single
L1204	276-0525-00	Core, Ferrite
L1212	*108-0336-00	100 μh
L1213	276-0525-00	Core, Ferrite
L1217	*108-0336-00	100 μh
L1219	276-0525-00	Core, Ferrite
L1246	*120-0415-00	Toroid, 8 turns single

Connectors

P1000	131-0384-00	AC/DC Power
J1201	131-0346-00	Chassis mtd., 24 pin, female

Transistors

Q1023	*151-0136-00	Replaceable by 2N3053
Q1033	*151-0148-00	Selected (RCA 40250)
Q1045	*151-0087-00	Selected from 2N1131
Q1055	*151-0096-00	Selected from 2N1893
Q1104	*151-0087-00	Selected from 2N1131

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q1105	*151-0103-00	Replaceable by 2N2219	
Q1114	*151-0087-00	Selected from 2N1131	
Q1115	*151-0103-00	Replaceable by 2N2219	
Q1120	*151-0103-00	Replaceable by 2N2219	
Q1134	*151-0133-00	Selected from 2N3251	
Q1144	*151-0087-00	Selected from 2N1131	
Q1154	Use *153-0539-00	Selected from 2N2219	
Q1163	*151-0087-00	Selected from 2N1131	
Q1164	*151-0103-00	Replaceable by 2N2219	
Q1174	*151-0163-00	Selected from 2N1899	
Q1184	*151-0163-00	Selected from 2N1899	
Q1193	*151-0103-00	Replaceable by 2N2219	
Q1194	*151-0087-00	Selected from 2N1131	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R1022	301-0362-00	3.6 k	½ w		5%	
R1023	315-0302-00	3 k	¼ w		5%	
R1031	315-0181-00	180 Ω	¼ w		5%	
R1033	308-0166-00	16 Ω	5 w	WW	5%	
R1034	308-0166-00	16 Ω	5 w	WW	5%	
R1041	315-0682-00	6.8 k	¼ w		5%	
R1043	315-0393-00	39 k	¼ w		5%	
R1044	315-0822-00	8.2 k	¼ w		5%	
R1046	315-0113-00	11 k	¼ w		5%	
R1047	311-0496-00	2.5 k		Var		
R1048	315-0822-00	8.2 k	¼ w		5%	
R1054	315-0822-00	8.2 k	¼ w		5%	
R1057	315-0104-00	100 k	¼ w		5%	
R1059	315-0105-00	1 meg	¼ w		5%	
R1103	315-0471-00	470 Ω	¼ w		5%	
R1106	315-0220-00	22 Ω	¼ w		5%	
R1113	315-0471-00	470 Ω	¼ w		5%	
R1116	315-0220-00	22 Ω	¼ w		5%	
R1117	315-0182-00	1.8 k	¼ w		5%	
R1118	315-0821-00	820 Ω	¼ w		5%	X2831-up
R1120	315-0100-00	10 Ω	¼ w		5%	
R1123	321-0193-00	1 k	⅛ w	Prec	1%	
R1124	315-0332-00	3.3 k	¼ w		5%	
R1125	311-0510-00	10 k		Var		
R1130	311-0496-00	2.5 k		Var		
R1131	321-0235-00	2.74 k	⅛ w	Prec	1%	

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.		Description			S/N Range
R1132	321-0314-00	18.2 k	1/8 w	Prec	1%	
R1133	321-0330-00	26.7 k	1/8 w	Prec	1%	
R1134	315-0103-00	10 k	1/4 w		5%	
R1135	321-0139-00	274 Ω	1/8 w	Prec	1%	
R1136	315-0330-00	33 Ω	1/4 w		5%	
R1143	315-0471-00	470 Ω	1/4 w		5%	
R1144	315-0103-00	10 k	1/4 w		5%	
R1153	315-0470-00	47 Ω	1/4 w		5%	
R1154	315-0272-00	2.7 k	1/4 w		5%	
R1161	315-0752-00	7.5 k	1/4 w		5%	
R1162	315-0471-00	470 Ω	1/4 w		5%	
R1163	315-0123-00	12 k	1/4 w		5%	
R1164	315-0223-00	22 k	1/4 w		5%	
R1165	307-0103-00	2.7 Ω	1/4 w		5%	
R1172	315-0470-00	47 Ω	1/4 w		5%	
R1177	315-0471-00	470 Ω	1/4 w		5%	
R1182	315-0470-00	47 Ω	1/4 w		5%	
R1187	315-0471-00	470 Ω	1/4 w		5%	
R1191	315-0432-00	4.3 k	1/4 w		5%	
R1192	315-0101-00	100 Ω	1/4 w		5%	
R1193	315-0222-00	2.2 k	1/4 w		5%	
R1194	315-0330-00	33 Ω	1/4 w		5%	
R1232	309-0060-00	4 Ω	1/2 w	Prec	1%	

Switches

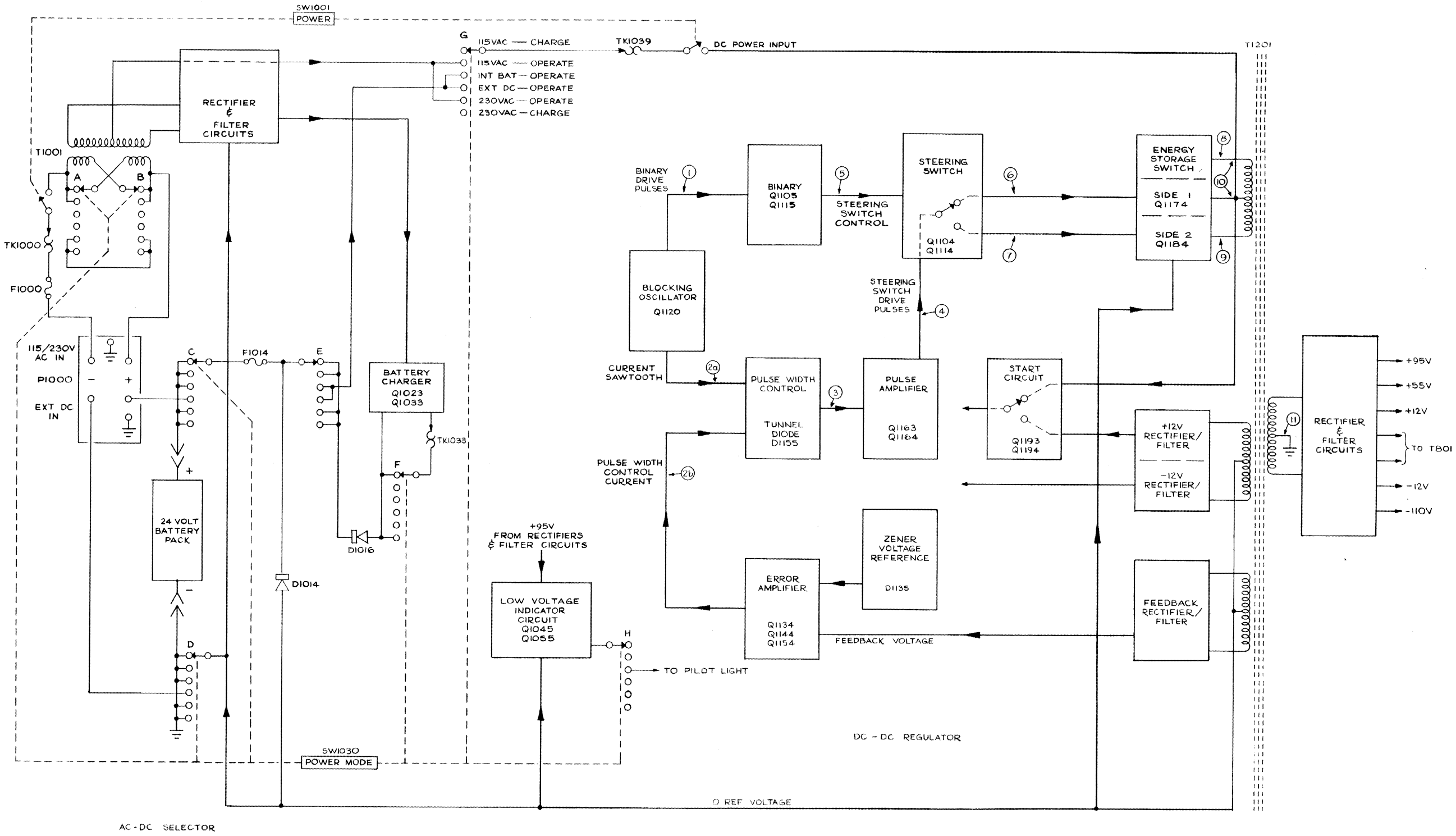
	Unwired	Wired		
SW1001	260-0676-00		Toggle	POWER
SW1030	260-0679-00		Rotary	POWER MODE

Thermal Cutouts

TK1000	260-0677-00	158° F
TK1033	260-0678-00	105° F
TK1039	260-0677-00	158° F

Transformers

T1000	*120-0397-00	Toroid, 10 turns bifilar
T1001	*120-0392-00	Power
T1010	*120-0397-00	Toroid, 10 turns bifilar
T1120	*120-0396-00	Toroid, 6 turns trifilar
T1171	*120-0393-00	Driver
T1201	*120-0394-00	Toroid, Pre-Regulator



TYPE 422 AC-DC POWER SUPPLY

A

GIN 665

BLOCK DIAGRAM

IMPORTANT

VOLTAGE AND WAVEFORM CONDITIONS

Circuit voltages measured with 20,000 Ω/volt VOM. All readings in volts.

Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Test oscilloscope was dc coupled (except where noted) using a 10X probe.

Voltage and waveform measurements given on the schematics are not absolute and may vary between instruments. Apparent differences between voltage levels measured with the voltmeter and those shown on the waveform are due to circuit loading.

Voltages and waveforms are indicated on the schematics in blue.

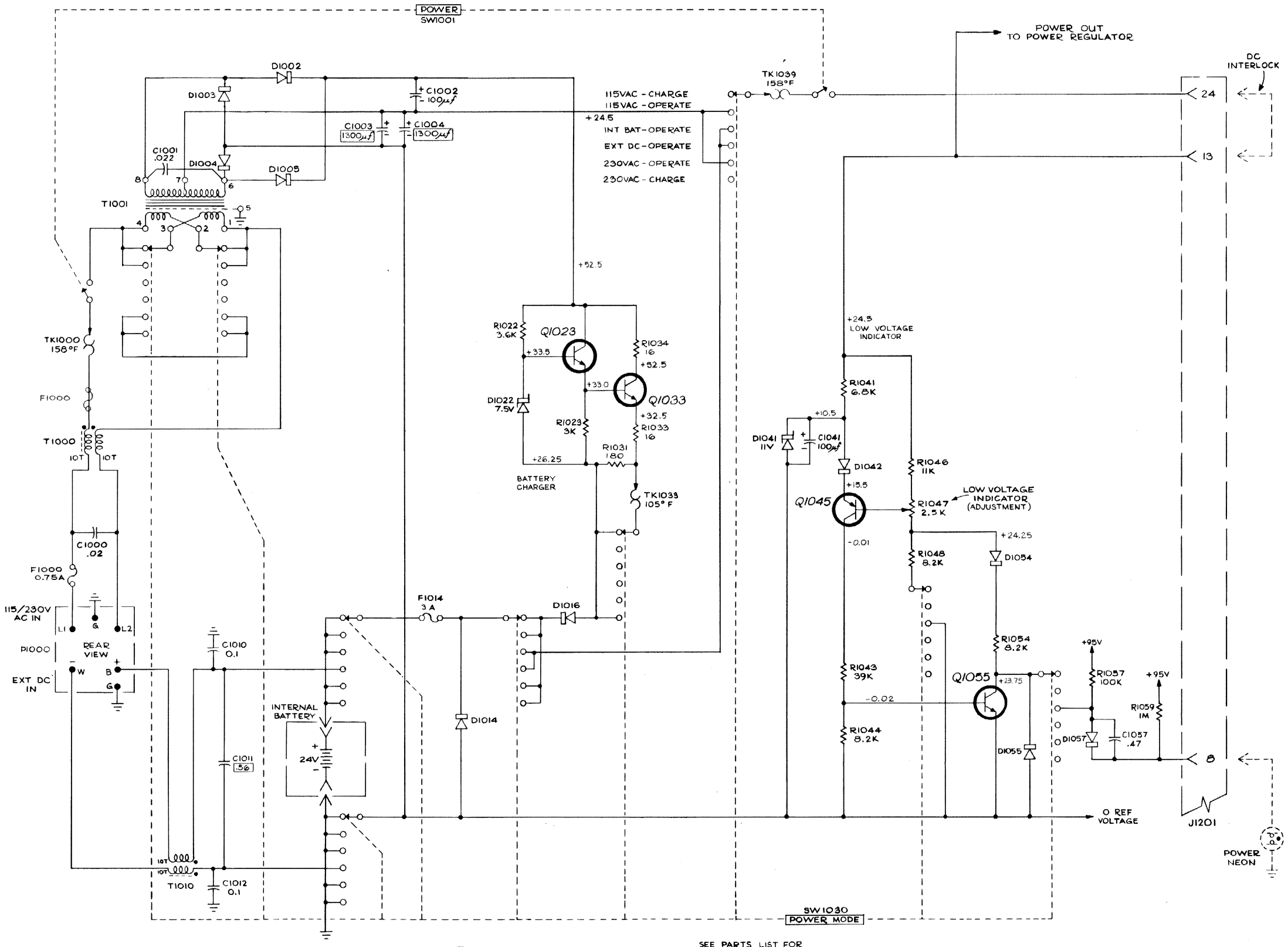
Voltage readings and waveforms were obtained under the following conditions using a calibrated Type 422 Indicator.

AC-DC Power Supply

1. Power supply remotely connected to indicator.
2. Battery Pack connected to power supply for Battery Charger voltages only.
3. Power switch ON.
4. POWER MODE switch set to OPERATE 115 V AC.
5. Input power—115-volts ac, 60 cycle.

Type 422 Indicator

1. SCALE ILLUM control set fully clockwise.
2. LEVEL control adjusted so sweep is not triggered.
3. Remaining controls set as desired.



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

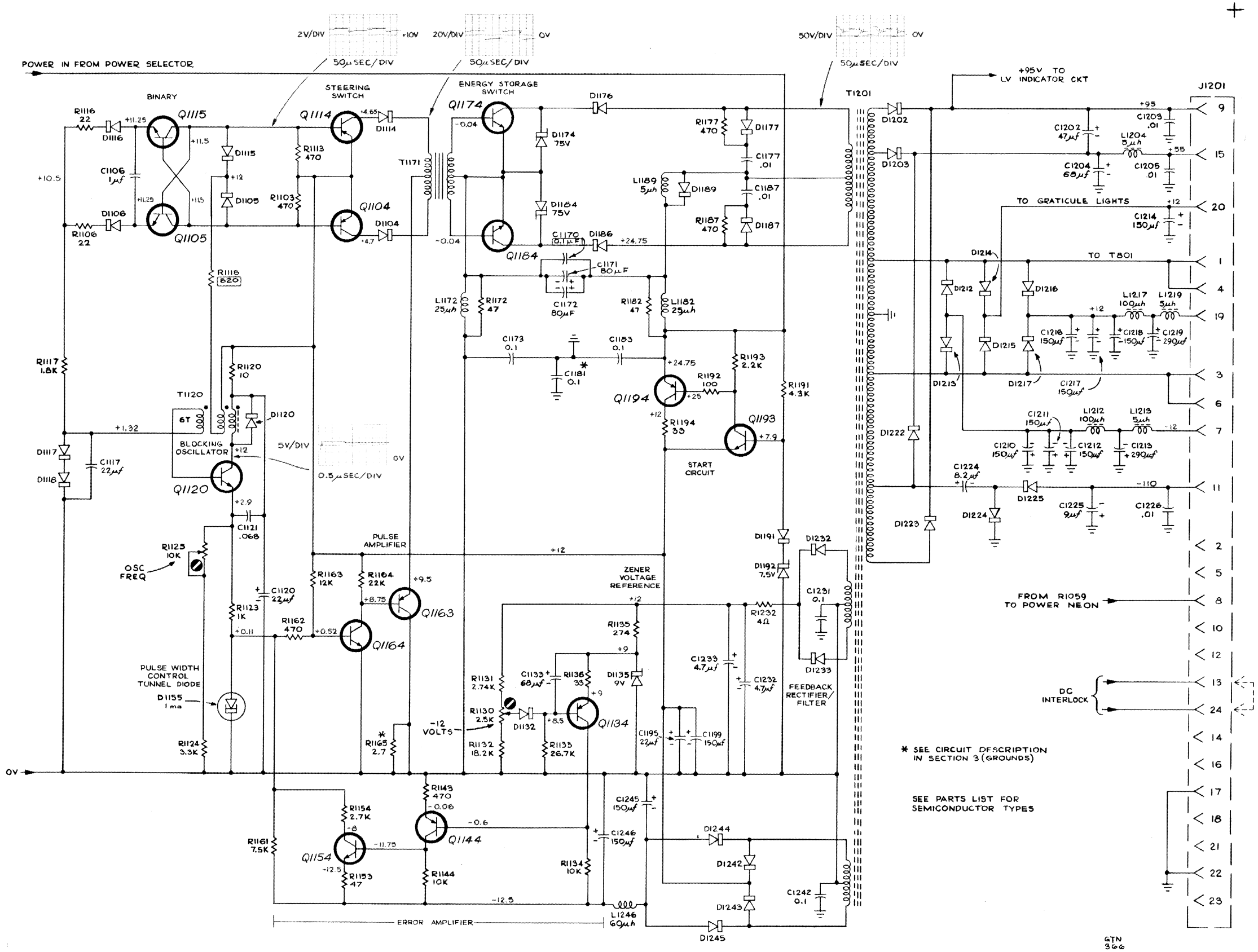
TYPE 422 AC-DC POWER SUPPLY

D

GTN 666

POWER SELECTOR

AC-DC Selector



TYPE 422 AC-DC POWER SUPPLY

B

POWER REGULATOR

DC-DC Regulator

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TEXT CORRECTION

Section 3 - - - Circuit Description

Page 3-5, First column, Start Circuit.

Change 3rd paragraph to read as follows:

As the input dc voltage to the Start Circuit rises to about ten volts, D1192 will turn on and hold the base of Q1193 at about 8.9 volts. This will in turn cause the isolated +12-volt bus of the isolated +12V Rectifier/Filter to be at 8.2 volts. The 8.2 volts starts the Blocking Oscillator, Binary, Steering Switch and Energy Storage Switch circuits operating. Once the above circuits are operating, the isolated +12V Rectifier/Filter is then able to supply the operating voltages, and will turn the Start Circuit off by reverse biasing the emitter-base junction of Q1193.

PARTS LIST CORRECTION

CHANGE TO:

D1192	152-0217-00	Zener	0.4w, 8.2v 5%