

**TECHNICAL MANUAL**  
**OPERATOR'S, ORGANIZATIONAL,**  
**DIRECT SUPPORT AND GENERAL**  
**SUPPORT MAINTENANCE MANUAL**  
**FOR**  
**PULSE GENERATOR AN/USM-359A**

**(NSN 6625-01-077-4620)**

**(TEKTRONIX MODEL PG 508 WITH TM 503)**

---

**HEADQUARTERS, DEPARTMENT OF THE ARMY**

**27 MARCH 1981**

## SAFETY SUMMARY

This manual contains safety information which the user must follow to ensure safe operation of this instrument. WARNING information is intended to protect the operator; CAUTION information is intended to protect the instrument. The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument.

Warning statements precede potentially dangerous procedures throughout this manual. The instructions contained in the warnings must be followed. The following warning statements are found in this manual.

### WARNING

**Use a proper power source.** This instrument is designed to operate from a power source with its neutral at or near ground potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multi-phase system, or across the legs of a single-phase, three-wire system.

### WARNING

**Avoid live circuits.** Dangerous voltages exist at several points throughout this instrument. When the instrument is operated with the cover removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect power before cleaning the instrument or replacing parts.

### WARNING

**Avoid contact with chemicals.** Handle silicone grease with care. Avoid getting silicon-in grease in eyes. Wash hands thoroughly after use.

### WARNING

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flames; the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided. When necessary, use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician immediately.

### WARNING

Compressed air is dangerous and can cause serious bodily harm if protective means or methods are not observed to prevent a chip or particle (of whatever size) from being blown into the eyes or unbroken skin of the operator or other personnel. Compressed air shall not be used for cleaning purposes except where reduced to less than 30 p.s.i.f. and then only with effective chip guarding and personnel protective equipment. Do not use compressed air to dry parts when Trichlorotrifluoroethane has been used.

### CAUTION

**Avoid power surge damage.** Do not remove or install plug-in unit while power is on as damage may occur to circuitry.

*This manual contains copyright material reproduced by permission of Tektronix, Inc.*

TECHNICAL MANUAL

No. 11-6625-2980-14

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, DC, 27 March 1981

**OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND  
GENERAL SUPPORT MAINTENANCE MANUAL  
FOR  
GENERATOR, PULSE AN/USM-359A  
(TEKTRONIX MODEL PG 508 WITH TM 503)  
(NSN 6625-01-077-4620)**

**REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in back of this manual direct to: Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, New Jersey 07703.

This manual is an authentication of the manufacturer's commercial literature which, through usage, has been found to cover the data required to operate and maintain this equipment. Since the manual was not prepared in accordance with military specifications, the format has not been structured to consider levels of maintenance.

## TABLE OF CONTENTS

		Page			Page
Section 0	INTRODUCTION	0-1	APPENDIX A	TM 503 MAINFRAME	
SECTION 1	OPERATING INSTRUCTIONS		Section I.	INSTALLATION PROCEDURE	A-1
	Instrument Description	1-1	Section II.	TM 503 OPERATING INSTRUCTIONS	A-3
	Installation and Removal	1-1		Introduction	A-3
	BASIC OPERATION	1-2		Powering Up	A-3
	Period and Duration Selection	1-2		Building a System	A-5
	Duty Factors	1-2		Specifications	A-6
	Delayed and Paired Pulse Selection	1-2	Section III.	TM 503 SYSTEM MAINTENANCE	A-7
	Transition Time Selection	1-3		General	A-7
	Transition Time Selection	1-3		Troubleshooting Aids	A-8
	External Triggering and Gating	1-3		Troubleshooting Techniques	A-8
	Trigger Output	1-4		Parts Replacement	A-10
	Manual Trigger	1-4		Diagrams and Circuit Board	
	Control Error Light	1-4		Illustrations	A-14
	Control Error Light	1-4		Power Module Interface Pin	
	OPERATING CONSIDERATIONS	1-4		Assignments	A-15
	Output Termination's and			Detailed Block Diagram	A-16
	Connections	1-4		Parts Location Grid	A-17
	Connections	1-4		Parts Location Grid	A-17
	Rise Time Measurements in Linear			Replaceable Mechanical Parts	A-19
	Systems	1-5	APPENDIX B	REFERENCES	
	Counted Burst Using the DD 501		APPENDIX C	COMPONENTS OF END ITEM AND	
	External Voltage Control	1-5		BASIC ISSUE ITEMS LIST	
	Digital Delay Unit	1-5	Section I.	INTRODUCTION	C-1
	Definitions of Pulse Characteristics	1-8		Scope	C-1
	SPECIFICATIONS	1-9		General	C-1
	Environmental Requirements	1-11		Explanation of Columns	C-1
	Using the Rear Interface		Section II.	COMPONENTS OF END ITEM	C-2
	Connectors	1-12	Section III.	BASIC ISSUE ITEMS	C-3
SECTION 2	THEORY OF OPERATION		APPENDIX D	ADDITIONAL AUTHORIZATION	
	Introduction	2-1		LIST (Not Applicable)	
	Input Circuitry	2-1	APPENDIX E	MAINTENANCE ALLOCATION	
	~ TRIG'D/GATED Light Circuitry	2-1	Section I.	INTRODUCTION	E-1
	Triggered Mode	2-1		General	E-1
	Period Generator	2-2		Maintenance Function	E-1
	Delay Generator	2-2		Column Entries	E-2
	Duration Generator	2-2		Tool and Test Equipment	
	Duration and Delay Control Error			Requirement	E-2
	Light Circuitry	2-3	Section II.	MAINTENANCE ALLOCATION	E-2
	Variable Transition Time Circuitry	2-3		CHART OR PULSE	
	Transition Time Control Error			GENERATOR AN/USM-359A	E-3
	Light Circuitry	2-3	Section III.	TOOL AND TEST EQUIPMENT	
	Level Control Multiplier	2-5		REQUIREMENTS FOR PULSE	
	Output Amplifier	2-6		GENERATOR AN/USM-359A	E-5
	Power Supply	2-6	APPENDIX F	EXPENDABLE SUPPLIES AND	
SECTION 3	SERVICE INFORMATION			MATERIALS LIST	
	Symbols and Reference Designators	3-1	Section I.	INTRODUCTION	F-1
	General Maintenance and			Scope	F-1
	Adjustments	3-2		Explanation of Columns	F-1
	Maintenance	3-2	Section II.	EXPENDABLE SUPPLIES AND	
	Circuit Board Removal	3-2		MATERIALS	F-2
	Circuit Board Removal	3-2			
	Test Equipment	3-2			
	General	3-2			
SECTION 4	CONTROLS AND CONNECTORS				
	AND SCHEMATIC DIAGRAMS	4-1			
SECTION 5	REPLACEABLE MECHANICAL				
	PARTS LIST	5-1			

## LIST OF ILLUSTRATIONS

Fig. No.		Page No.		Page No.	
1-0	Pulse Generator AN/USM-359A.	vi	FO-1	Controls and connectors.	4-1
1-1	PG 508 installation and removal.	1-1	FO-2	Block diagram.	4-3
1-2	Locations of period, delay and duration custom timing capacitors and TRIG/GATE input impedance switch.	1-2	FO-3	Input circuit schematic diagram.	4-5
1-3	Location for transition custom timing capacitor.	1-3	FO-4	Period generator schematic diagram.	4-7
1-4	Equivalent circuit of external input for output voltage control.	1-5	FO-5	Delay generator schematic diagram.	4-9
1-5	Location of trigger jumpers in DD 501 for selecting trigger or delay interval output	1-6	FO-6	Duration generator and control error circuit schematic diagram.	4-11
1-6	PG 508-DD 502 interconnections for counted burst operation.	1-6	FO-7	Transition time generator schematic diagram.	4-13
1-7	Typical propagation delays using PG 508 with DD 501 in counted burst mode at 50 MHz repetition rate.	1-7	FO-8	Level control multiplier schematic diagram.	4-15
1-8	Pulse characteristics.	1-8	FO-9	Output amplifier schematic diagram.	4-17
1-9	Locations for user installed rear interface connections.	1-12	FO-10	Tracking voltage supply schematic diagram.	4-19
2-1	Simplified schematic for control error indicator logic with control settings causing illumination.	2-4	FO-11	PG 508 power supply schematic diagram.	4-21
			FO-12	TM 503 power supply schematic diagram.	4-23
			5-1	A1 board component locations.	5-2
			FO-13	A2 board component locations.	5-3
			FO-14	A3 board component locations.	5-5
			FO-15	A4 board component locations.	5-7
			FO-16	PG 508 exploded view.	5-9

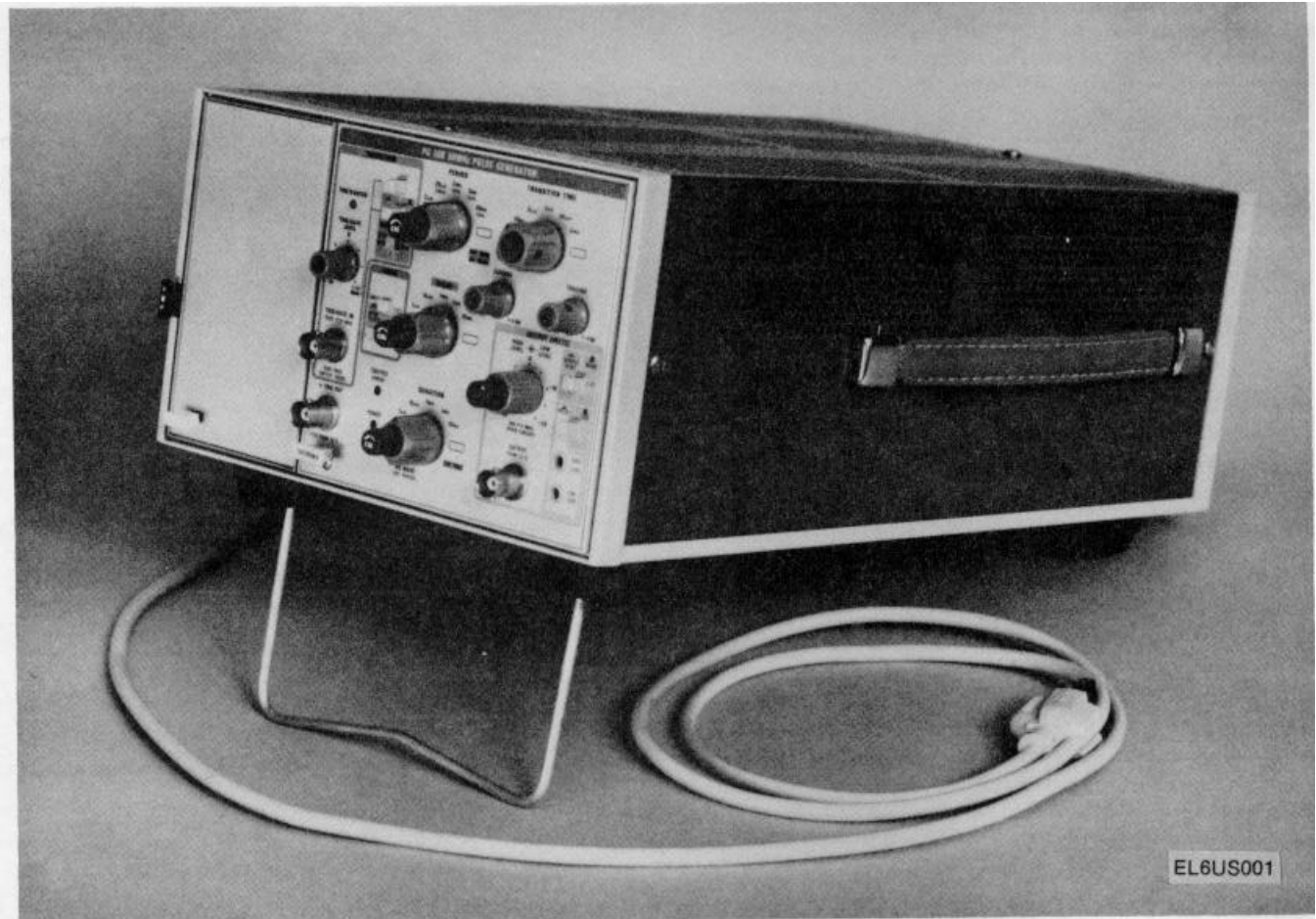


Figure 1-0 . Pulse generator AN/USM-359A

## SECTION O

## INTRODUCTION

**Scope**

This manual describes Pulse Generator AN/USM-359A and provides instructions for operation and maintenance. Throughout this manual, the SG-1178/USM-359A is referred to as Tektronix Model PG 508 and PP-7578/USM 359A is referred to as TM 503.

**Indexes of Publications**

*a. DA Pam 310-4.* Refer to the latest issue of DA Pam 310-4 to determine whether there are New editions, changes, or additional publications pertaining to the equipment.

*b. DA Pam 310-7.* Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

**Maintenance Forms, Records, and Reports**

*Reports of Maintenance and Unsatisfactory Equipment.* Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, The Army Maintenance Management system (Army).

*b. Report of Item and Packaging Discrepancies.* Fill out and forward SF 364 [Report of Discrepancy (ROD)] as prescribed in AR 735-11-2/DLAR 4140.55/NAVMATINS4355.73/AFR 400-54/MCO 4430.3E.

*c. Discrepancy in Shipment Report (DISREP) (SF 361).* Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NA.VSUPI NST 4610.33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

<b>Reporting</b>	<b>Equipment</b>	<b>Improvement</b>
<b>Recommendations (EIR)</b>		

If your AN/USM-359A needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MO, Fort Monmouth, New Jersey 07703. We'll send you a reply.

**Administrative Storage**

To prepare the equipment for administrative storage, ascertain its operability and reliability. In addition, use the proper packing materials.

**Destruction of Army Electronics Materiel**

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

## OPERATING INSTRUCTIONS

### Instrument Description

The PG 508 is a 50 MHz general purpose full function pulse generator usable in all TM 500-series power modules except the TM 501. It is compatible with MOS and other general purpose circuitry. Important features of the instrument include independent period and duration controls with a control error light, independent pulse top and bottom level controls, variable leading and trailing transition time adjustments, and fully adjustable pulse delay capabilities. Front panel controls and connectors provide a trigger or synchronous gate input with level and slope controls, square wave output and complementary pulse output for high duty factors. Delayed and paired pulse and manual trigger or gate capabilities are also provided. All inputs and outputs are internally terminated in 50  $\Omega$  except the TRIG/GATE input which is internally selectable for either 50  $\Omega$  or 1 M $\Omega$ , 20 pF input impedance. Special positions on PERIOD, DURATION, DELAY, and TRANSITION controls permit customized control ranges.

The front panel is color coded for easy reference to controls and their associated functions. Green indicates triggering functions and blue indicates mode functions.

### Installation and Removal

The PG 508 is calibrated and ready for use when received. It operates in any two compartments of the TM 500-series power modules. See Appendix A for line voltage requirements and power module operation. Fig. 1-1 shows the installation and removal procedure. Make certain the power module is off when inserting or removing the PG 508. Check that the PG 508 is fully inserted in the power module. Pull the power switch on the power module. The POWER light on the PG 508 should now be on. Refer to the Controls and Connectors foldout page in Section 4 of this manual for a complete description of the front panel controls and connectors.

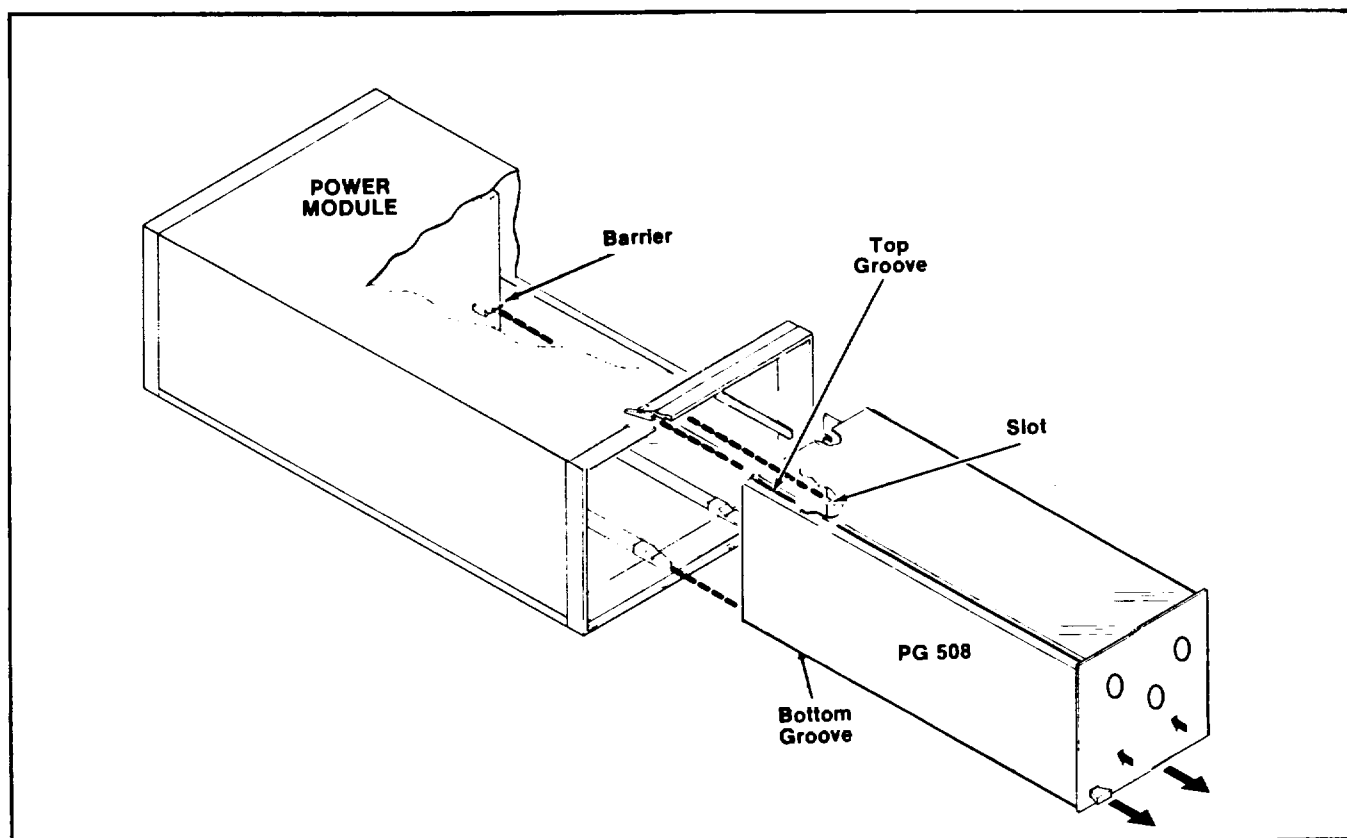


Fig. 1-1. PG 508 installation and removal.



## BASIC OPERATION

### Period and Duration Selection

The period generator operates, in all modes except EXT TRIG or MAN, at a rate set by the PERIOD range switch and variable control. The duration of the output pulse is set by the DURATION range switch and variable control. When the DURATION control is set for a time greater than the PERIOD, the CONTROL ERROR lamp will light. When the DURATION control is set to the SQ WAVE position, the duration time is determined internally at approximately 50% of the period time.

The custom range positions on the PERIOD and DURATION controls permit user-selected period and duration times. To determine the approximate capacitor value for the desired period, multiply the period time in seconds by  $5 \times 10^{-3}$ . The result is the value of the capacitor in Farads. For example, a 50 ms period times  $5 \times 10^{-3}$  equals  $250 \times 10^{-6}$  or 250 HF. This capacitor must be non-polarized and have at least a 6 V rating. Solder this capacitor in the position shown in Fig. 1-2.

To determine the capacitor value for the duration time desired, multiply the duration time by  $1 \times 10^{-2}$ . For example a 50 ms duration time requires 50 ms times  $1 \times 10^{-2}$ .

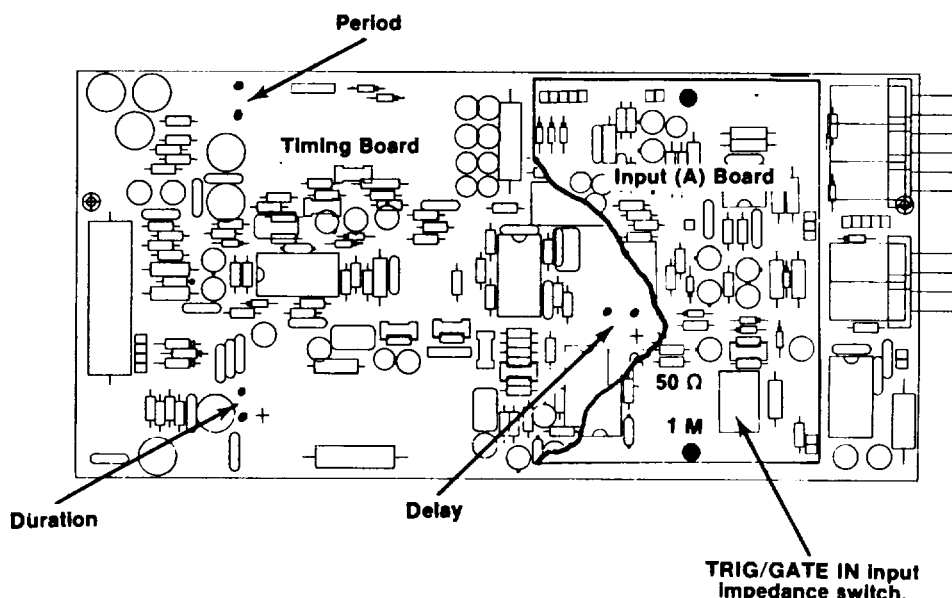
$10^{-2}$  or a 500pF capacitor. If a polarized capacitor is used, observe the correct polarity. Use at least a 6 V rated capacitor. Connect this capacitor as shown in Fig. 1-2.

### Duty Factors

Duty factors greater than those specified are obtainable on several ranges. When the duty factor is increased to the point that internal circuitry prevents completion of the pulse waveform, the CONTROL ERROR light will flash. To further increase the duty factor, switch to the complement mode. Set the DURATION control for a pulse width equal to the desired pulse off time and push the front panel COMPLEMENT (-) pushbutton.

### Delayed and Paired Pulse Selection

In the pulse delay mode, the output pulse is delayed from the +TRIG OUT signal by the DELAY time selected plus a specified fixed delay. In the PAIRED mode of operation, the delay controls the time between the leading edges of the paired pulses. To use this feature push the DELAY button and trigger the external device from the +TRIG OUT jack. Set the DELAY control for the desired delay time from trigger to pulse leading edge. Use the variable control labeled CAL for time adjustments between steps or to increase the delay times beyond the steps.



To determine the custom capacitor value multiply the desired duration or delay time by  $1 \times 10^{-2}$ . See text.

Fig. 1-2. Locations of period, delay and duration custom timing capacitors and TRIG/GATE IN input impedance switch. Remove the Input board to gain access to the delay pads.

Paired pulses are obtained by pushing both the DELAY and UNDLY buttons. An initial pulse now occurs at external trigger time with the second or paired pulse delayed by the selected delay time. The CONTROL ERROR light illuminates if the delay is too short or long for a valid pulse train. A custom delay position is provided on the DELAY switch. To determine the value of the capacitor required, multiply the desired delay time in seconds by  $1 \times 10^{-2}$ . For example, a 50 ms delay time requires a 500 Pf capacitor (50 ms times  $1 \times 10^{-2}$ ). Use either a polarized or non-polarized capacitor with a rating of at least 6 V. If a polarized capacitor is used, observe the polarity markings. Remove the input board and connect the capacitor as shown in Fig. 1-2.

### Transition Time Selection

The leading and trailing times of the pulses may be varied by using the TRANSITION TIME control and the LEADING and TRAILING variable controls. Select the desired transition time range with the TRANSITION TIME control and vary the leading and trailing times independently with the LEADING and TRAILING controls.

A custom range position is also provided on the TRANSITION TIME control. To select the correct capacitor (in Farads) for this range, multiply the desired transition time (in seconds) measured from 10% to 90% points, by  $4.4 \times 10^{-1}$ . For example, a desired transition time of 50 ms requires a capacitor of 220 HF. Connect the capacitor as shown in Fig. 1-3. Use a capacitor with at least a 10 V rating and observe polarity requirements.

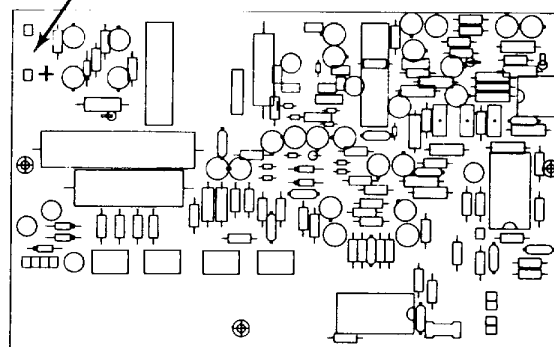
When the transition times become large compared with the duration or period times and the pulse does not reach full amplitude, the CONTROL ERROR light will flash indicating improper control settings.

### Output Levels

The output amplitude and offset are selected by independent pulse LOW LEVEL and HIGH LEVEL controls. Use the front panel voltage calibration marks for an open circuit load and divide the values by two when the PG 508 is operating into a 50  $\Omega$  load. The OUTPUT (VOLTS) controls are interlocked to prevent setting the HIGH LEVEL more negative than the LOW LEVEL. It is also impossible to set the controls for more than about 20 V peak to peak output amplitude into an open circuit or 10 V into 50  $\Omega$ .

Pulse amplitude always equals the pulse high level minus the pulse low level. Offset may be the high level or the low level, whichever is used as the base line reference level. The flexibility of this method is useful in certain applications such as logic testing. Either the high or low level can be varied without disturbing the other.

Transition Time



To determine the custom capacitor value multiply the desired duration or delay time by  $1 \times 10^{-2}$ . See text.

Fig. 1-3. Location for transition custom timing capacitor.

The pulse high and low levels can be preset. Push the PRESET button and adjust the HIGH LEVEL and the LOW LEVEL potentiometers with a screwdriver for the desired output levels.

### External Triggering and Gating

To change the TRIG/GATE IN input impedance remove the plug-in from the mainframe. Remove the left side cover. Set the slide switch, located on the Input board and labeled Input Impedance, to either the 50  $\Omega$  or the 1 MO position. In the 1 MO position the shunt capacitance is approximately 20 pF. A standard oscilloscope probe can be used to acquire the triggering signal from the external circuitry. If a compensated probe is used, calibrate the probe on the input of a 1 M $\Omega$  20 pF oscilloscope first. A 10X probe allows triggering directly from high impedance sources such as MOS digital circuitry with an effective TRIG/GATE LEVEL range of  $\pm 30$  V.

For external gating select the desired period and duration. Press the SYNC GATE pushbutton. Select the desired trigger slope with the + or - SLOPE button. The OUTPUT now consists of pulses, described by the front panel controls, whenever the TRIG/GATE IN input exceeds the TRIG/GATE LEVEL control setting.

To externally trigger the PG 508, connect the triggering signal to the TRIG/GATE IN connector. Select the slope on which triggering is desired with the + or - SLOPE button. Place the PERIOD switch in the EXT TRIG OR MAN position. Now adjust the TRIG/GATE LEVEL control for the desired triggering level. The output waveform commences about 48 ns after the triggering signal.

For external DURATION place the DURATION control in the EXT DUR position, and the PERIOD control in the EXT TRIG OR MAN position. The period and duration of the output waveform are now controlled by the triggering waveform. This is an extremely useful mode of operation for translating logic levels, etc. If the PERIOD is set for internal operation and the DURATION for external, the CONTROL ERROR light illuminates indicating an illegal mode of operation.

The TRIG'D/GATED indicator light functions as a TRIG/GATE level indicator. When the +SLOPE is selected and the external input level exceeds the threshold set by the TRIG/GATE LEVEL control, the light is on continuously. For input voltages below the threshold the light is continuously off. When the input transits through the threshold the light flashes. When the -SLOPE is selected the light behaves as for +SLOPE selection. However, the polarities are reversed.

The TRIG'D/GATED indicator light may be used as a logic level indicator for troubleshooting logic circuitry. Set the TRIG/GATE LEVEL control to a voltage equal to the midrange value of the logic voltage swing. If an attenuator probe is used for signal pickup, remember to consider the attenuation factor when setting the TRIG/GATE LEVEL voltage.

### Trigger Output

The signal appearing at the connector is an approximate square wave. The leading edge (positive-going) precedes the output pulse by a specified fixed

delay plus the delay as set by the DELAY control. In paired pulse operation, the leading edge precedes the first pulse by the fixed delay. The second pulse then appears after the delay as set by the DELAY control. In paired pulse operation, the leading edge) is also available at the front panel by moving a connector on the timing circuit board. See the illustration on the Rear Interface Connector Assignments at the rear of this manual for the location of this connector.

### Manual Trigger

To use this feature place the PERIOD switch in the EXT TRIG OR MAN position. Set the TRIG/GATE LEVEL control fully clockwise. If the +SLOPE is selected, the manual trigger will occur when the MAN button is depressed. If the -SLOPE is selected, the trigger occurs when the button is released. The manual trigger causes one output pulse, or a set of paired pulses if the DELAY and UNDLY buttons are depressed.

### Control Error Light

The CONTROL ERROR light helps to solve setup problems by indicating most control errors. A steady glow indicates static control setting errors while a flashing light indicates dynamic errors. In either case, the control settings do not correctly indicate the output. Check the control settings for compatibility. See Table 1-1. Dynamic functions monitored are period, delay, duration and t transition time.

## OPERATING CONSIDERATIONS

### Output Termination's and Connections

The PG 508 operates as a voltage source in series with an internal 50 n( impedance. Maximum pulse fidelity is obtained when the output operates into an

EXT DUR and DELAY No delay external 50 n impedance. The output circuitry of the PG 508 is fully protected against any voltage transients when operating into passive loads.

Listed below are static control settings that illuminate the CONTROL ERROR light and their corresponding operating modes. Some of these modes may be useful.

If the load has a dc voltage across it, connect a blocking capacitor in series with the OUTPUT connector and the load. Make certain the time constant of the capacitor and load is large enough to maintain pulse top flatness.

Control Settings	Operation
EXT TRIG OR MAN and SYNC GATE	External Trigger Mode
EXT DUR and Internal Period	Square Wave Mode
EXT TRIG OR MAN and SO WAVE (INT PERIOD)	External Duration Mode
SO WAVE (INT PERIOD) and SYNC GATE	Truncated square wave when gate ends
SO WAVE (INT PERIOD) and DELAY	No delay

### Risetime Measurements In Linear Systems

Consider the rise and falltime of associated equipment when measuring the rise or falltime of a linear device. If the risetime of the device under test is at least ten times slower than the combined risetimes of the PG 508, the monitoring oscilloscope, and associated cables, the error introduced will not exceed 1%, and usually may be ignored. If the rise or falltime of the test device is less than ten times slower than the combined risetimes of the testing systems, determine the actual risetime of the device under test by using the following formula:

$$R_s = \sqrt{R_{21}^2 + R_2^2 + R_3^2 + \dots}$$

$R_s$  equals the overall rise or falltime of the entire measurement system and  $R_1$ ,  $R_2$ ,  $R_3$ , etc., are the risetimes or falltimes of the individual components comprising the system.

### External Voltage Control

The high and low level output voltages can be controlled externally through pins 22B and A at the rear interface connector. Fig. 1-4 shows the equivalent circuit.

Connections must be made from pad K to pad L and pad M to pad N located as shown on the adjustment location illustration in the fold out pages at the rear of this manual. Use ordinary hookup wire of the proper length. Solder the wire to the pads. Also note the location of the Ext Hi and Ext Lo potentiometers on the output board.

To use this feature, set the front panel controls as follows: depress the PRESET button (PRESET), place the PERIOD switch in the EXT TRIG OR MAN position, the DURATION in EXT DUR and the NORM COMPLEMENT switch in the NORM position (out). Use a screwdriver to center the Ext Hi and the preset HIGH LEVEL controls. Supply a voltage to the external high input (pin 22B on the rear interface connector) equal to the lowest external input voltage desired (maximum 20 V).

Now adjust the front panel preset HIGH LEVEL control for an OUTPUT voltage equal to the minimum desired output voltage. It may be necessary to adjust the preset LOW LEVEL control as the OUTPUT voltage is limited to 20 V peak to peak open circuit. The high level OUTPUT voltage is clamped by the low level OUTPUT voltage if this range is exceeded. Now apply a voltage equal to the highest external control voltage desired to the same rear interface connector (pin 22B). Adjust the Ext Hi potentiometer until the highest desired output voltage is obtained. It may be necessary to adjust the preset LOW LEVEL control to obtain the desired output. The high level OUTPUT voltage cannot go below the low level OUTPUT voltage due to the level control voltage clamps. The Ext Hi and the preset HIGH LEVEL controls interact. It may be necessary to repeat the above procedure several times until the desired results are obtained.

Now push the NORM COMPLEMENT switch (COMPLEMENT). Center the Ext Lo and preset LOW LEVEL potentiometers. Supply a voltage to pin 22A of the rear interface connector equal to the lowest external control voltage desired. Adjust the preset LOW LEVEL control for an OUTPUT voltage equal to the lowest OUTPUT voltage desired. Change this voltage to the highest desired external control voltage. Adjust the Ext Lo potentiometer for the highest OUTPUT voltage desired. As these adjustments interact, readjust the preset LOW LEVEL and the Ext Lo potentiometers for the desired results. Do not readjust the preset HIGH LEVEL or the Ext Hi potentiometers. The OUTPUT voltages now vary linearly and independently with the external control voltage.

### Counted Burst Using the DD 501 Digital Delay Unit

This application permits pre-selecting the number of output pulses from the PG 508. The event is initiated by an externally applied signal or pulse, 5 ns or longer. The time duration of this signal or pulse has no effect on the output from the PG 508.

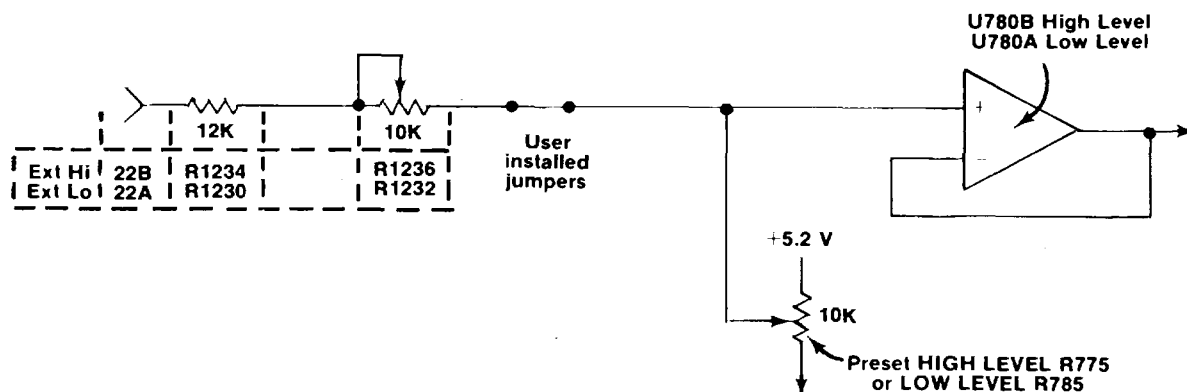


Fig. 1-4. Equivalent circuit of external input for output voltage control.

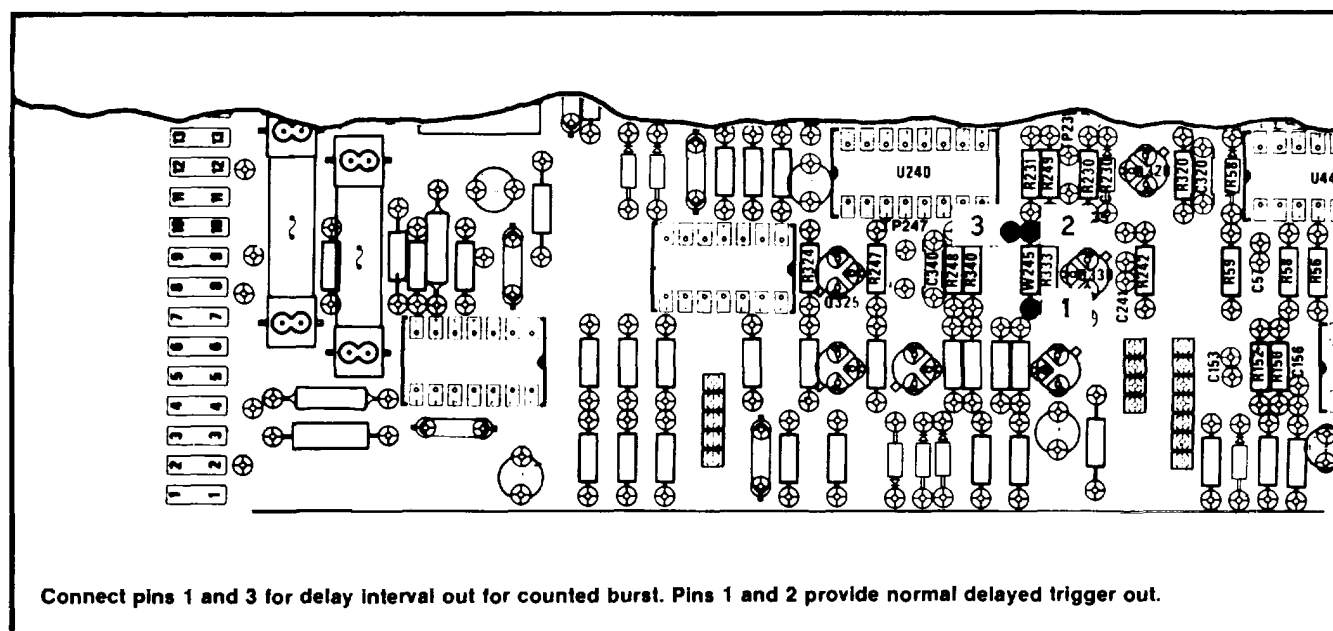


Fig. 1-5. Location of trigger jumpers in DD 501 for selecting trigger or delay interval output.

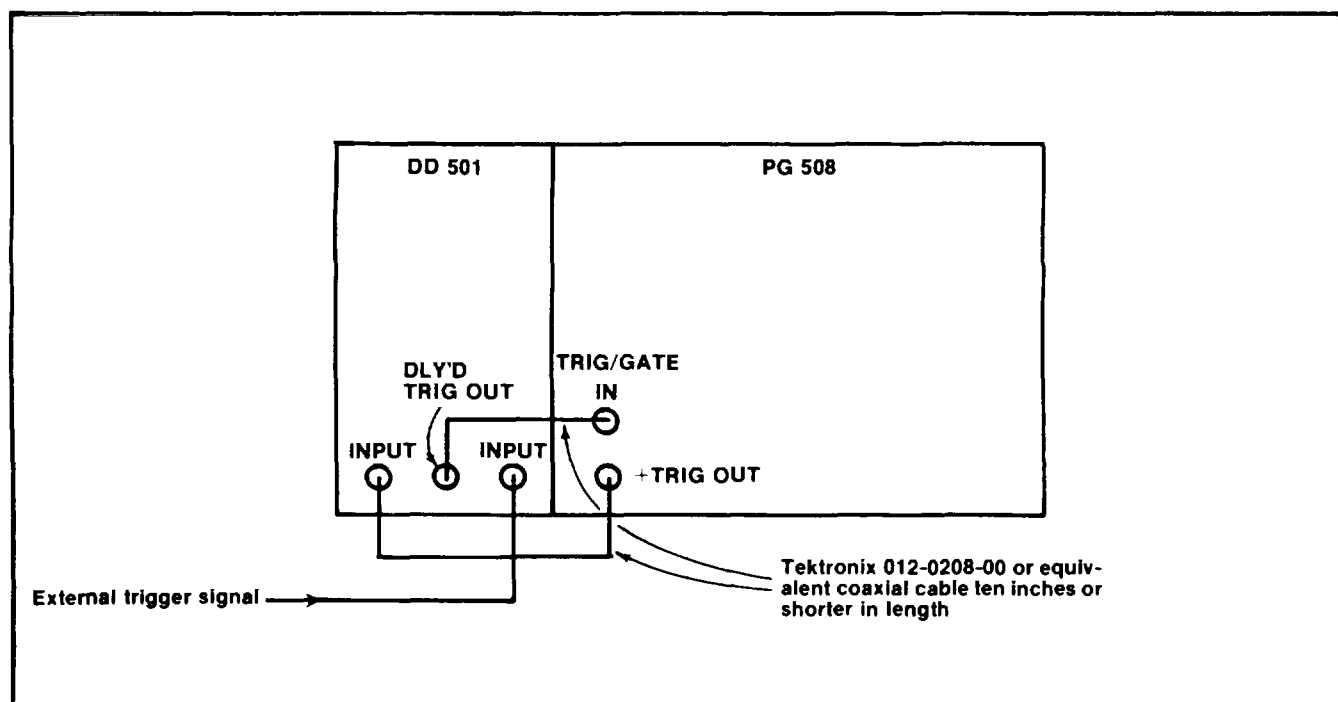


Fig. 1-6. PG 508-DD 501 Interconnections for counted burst operation.

To use this feature, place the DD 501 in the delay interval mode of operation by moving the wire strap as shown in Fig. 1-5 or changing connections, depending on the DD 501 available. Connect the PG 508 and the DD 501 as shown in Fig. 1-6. Use ten inch (Tektronix Part Number 012-0208-00) or shorter cables for interconnecting the two units to reduce delays.

Make certain the PG 508 TRIG/GATE IN input impedance is set for 50  $\Omega$ . (See External Triggering and Gating discussion and Fig. 1-2.) Set the controls of the PG 508 for the desired output waveform with the PG 508 in FREE RUN. Do not use the SQ WAVE mode. Place the PG 508 in the + SLOPE, SYNC GATE mode and set the TRIG/GATE LEVEL control at the 2 o'clock position. Select EVENTS + SLOPE, START + SLOPE and place the EVENTS and START LEVEL controls at the 2 o'clock position on the DD 501. The three TRIG'D lights on the DD 501 and the TRIG'D/GATED light on the PG 508 will be off until the DD 501 is triggered. Upon receipt of a trigger, all lights will illuminate. If not, check the setup and slightly adjust the LEVEL controls as necessary.

Set the EVENTS DELAY COUNT on the DD 501 for one less than the desired number of counts up to PG 508 repetition rates of about 20 MHz. See below for further information. If necessary, a single trigger may be obtained by rotating the DD 501 START LEVEL control through the 0 position, with no external trigger applied. A single trigger may also be obtained by using the TEKTRONIX manual (One Shot) Trigger Generator, Tektronix Part Number 016-0597-00. All other DD 501 and PG 508 operating controls function normally.

Due to propagation delays in the PG 508, DD 501 and the interconnecting cables, one or more pulses in addition to the desired number are generated when the PG 508 repetition rates are set between 20 MHz and 50 MHz. These extra pulses are consistent for any given frequency irrespective of the desired EVENTS DELAY COUNT setting. To determine the number of extra pulses for a given PG 508 period, set the PG 508 and the DD 501 controls as previously described. Now adjust the PG 508 TRIG/GATE LEVEL or the DD 501 EVENTS LEVEL for the same number of extra pulses at DD 501 EVENTS DELAY COUNT setting of zero and nine.

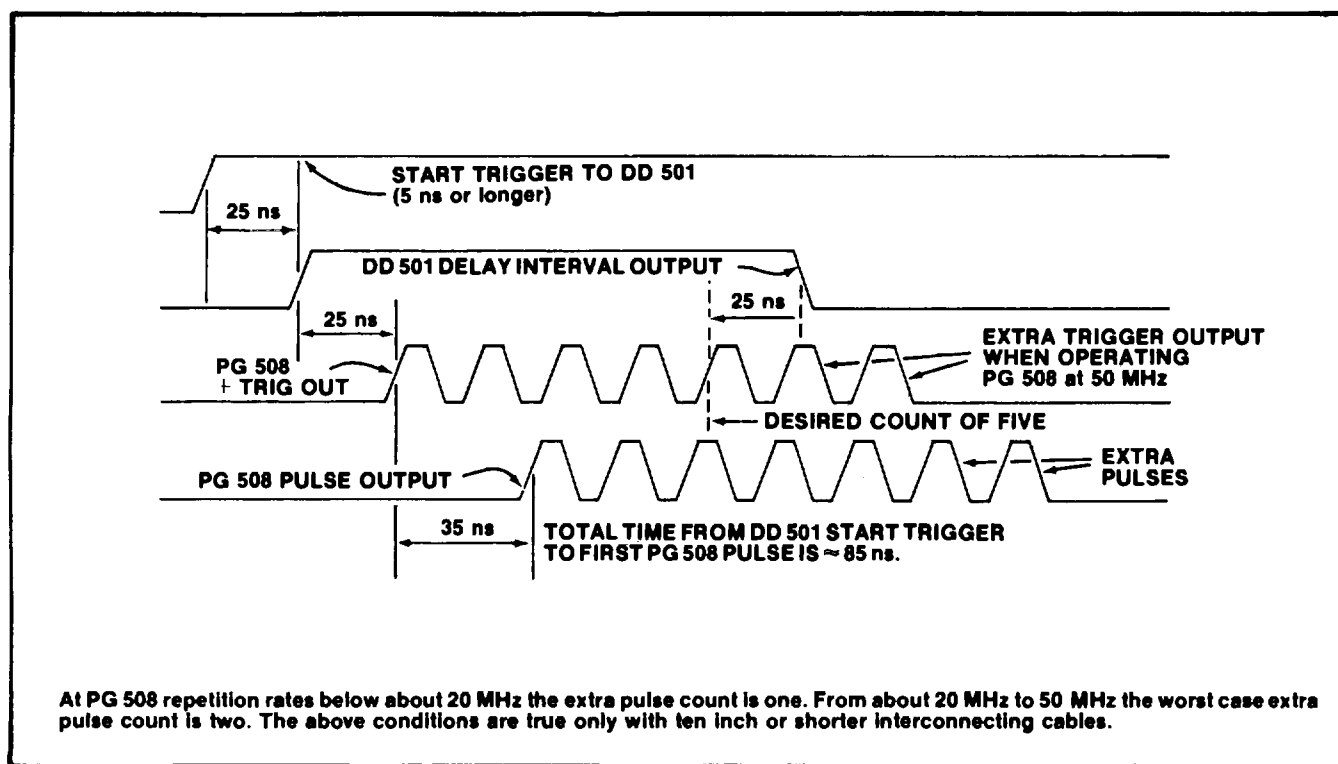


Fig. 1-7. Typical propagation delays using PG 508 with DD 501 in counted burst mode at 50 MHz repetition rate.

**Definitions of Pulse Characteristics** The following is a glossary of common pulse characteristics used in this manual. They are illustrated in Fig. 1-8.

**Amplitude.** The maximum absolute peak value of a pulse measured from the baseline regardless of sign, and excluding unwanted aberrations or overshoot. Measurement points are at 50% of the pulse duration time (pulse high level) and on the baseline (pulse low level) at 50% of the off time (the pulse period minus the pulse duration).

**Aberrations.** Unwanted deviations or excursions in the pulse shape from an ideal square corner and flat top, i.e., overshoot, undershoot or rounding, ringing, and tilt or slope.

**Baseline.** The quiescent dc voltage reference level of the pulse waveform.

**Complementary Pulse.** Normal pulse with high and low levels interchanged. Pulse on-time becomes pulse off time.

**Duty Factor.** Sometimes referred to as duty cycle. The ratio of pulse duration to period, or the product of pulse duration and pulse repetition rate. Duty factor in % =  $\text{Duration/Period} \times 100$ .

**Falltime.** The time interval, at the pulse trailing edge, for the pulse amplitude to fall from the 90% amplitude level to the 10% amplitude level.

**Flatness.** The absence of long term variations to the pulse top; excluding overshoot, ringing or pulse rounding. Sometimes referred to as tilt or slope.

**High Level.** The most positive value of a pulse, regardless of unwanted aberrations or overshoot, measured at a point that is located at 50% of the pulse duration.

**Low Level.** The most negative value of a pulse, regardless of unwanted aberrations or overshoot, measured at a point that is 50% of the off time.

**Offset.** A dc potential of either polarity applied to the waveform to bias the baseline to an amplitude other than zero.

**Overshoot.** The short term pulse excursion (or transient) above the pulse top or below the baseline, which is simultaneous to the leading or trailing edge of the pulse.

**Period.** The time interval for a full pulse cycle, inverse of frequency or repetition rate, or the interval between corresponding pulse amplitudes of two consecutive undelayed or delayed pulses. Generally measured between the 50% amplitude levels of two consecutive pulses.

**Preshoot.** A transient excursion that precedes the step function. It may be of the same or opposite polarity as the pulse.

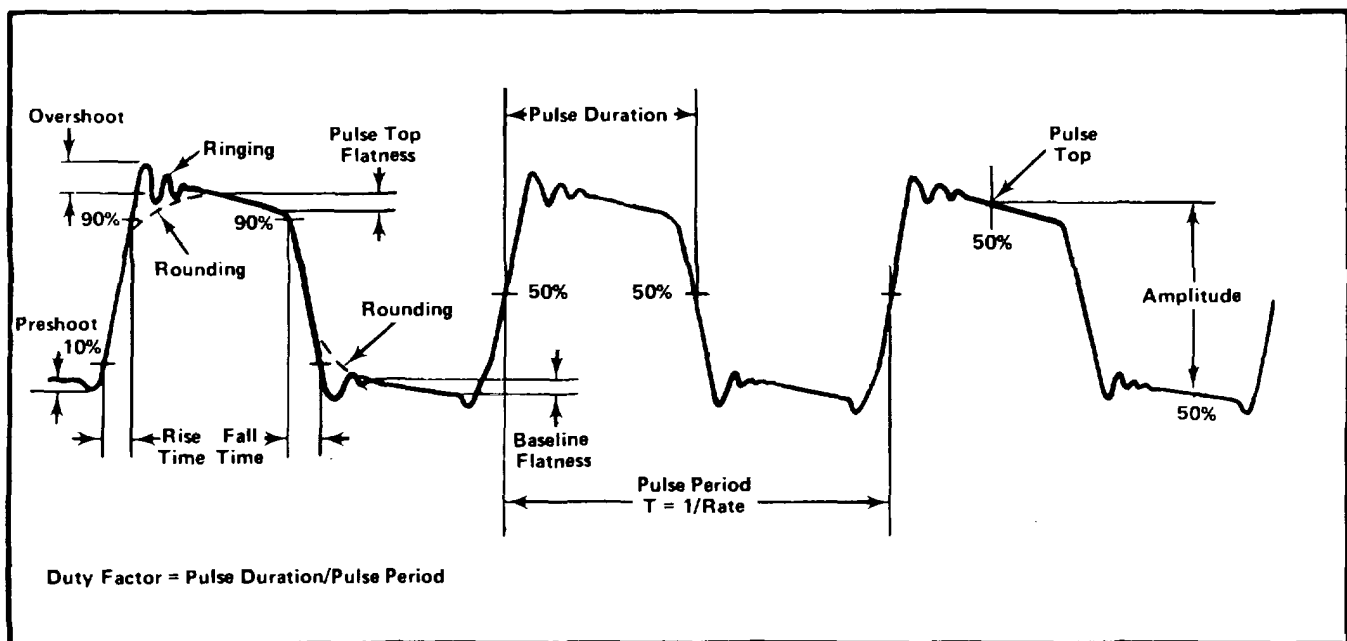


Fig. 1-8. Pulse characteristics.

**Pulse Duration.** The time interval between the leading and trailing edge of a pulse at which the instantaneous amplitude reaches 50% of the peak pulse amplitude.

**Polarity.** The direction from the baseline of the pulse excursion, either positive-going (+) or negative-going (-).

**Ringings.** Periodic aberrations that dampen in time, following the overshoot.

**Risetime.** The time interval, at the step function leading edge, for the pulse to rise from the 10% to 90% amplitude levels.

**Rounding or Undershoot.** The rounding of the pulse corners at the edges of a step function.

**Tilt or Slope.** A distortion of an otherwise flat-topped pulse, characterized by either a decline or a rise of the pulse top (see Flatness).

## SPECIFICATIONS

### PERIOD:

Jitter: <0.1% +50 ps.

Range: <20 ns to >200 ms in seven decade steps plus variable, with overlap on all ranges. Periods longer than 200 ms can be obtained in custom range position.

Jitter: <0.1% +50 ps.

DELAY: (Time between leading transitions in the paired pulse mode)

Range: <10 ns to >100 ms in seven decade steps plus variable, with overlap on all ranges. Delays longer than 100 ms can be obtained in custom range position.

Factor: Delays to at least 70% of pulse periods for periods of 0.2ps to 20 ms, decreasing to at least 50% for a 20 ns period.

Jitter: <0.1% to +50 ps.

### DURATION

Range: <10 ns to >100 ms in seven decade steps plus variable, with overlap on all ranges. Durations longer than 100 ms can be obtained in custom range position. An additional position provides durations of approximately 50% of the period setting for square wave output.

Duty Factor: Pulse durations to at least 70% of pulse periods for periods of 0.2ps to 0 ms, decreasing to at least 50% for a 20 ns period.

### PULSE OUTPUT:

Transition Times: Independently adjustable leading and trailing transition times from <5 ns typical (<7 ns at some offset and amplitude levels) to >50 ms, measured from the 10% point to the 90% point, in six decade steps plus variable. Variable controls with 100:1 range (50:1 on 5 ns) provide overlap on all ranges. Transition times longer than 50 ms are obtainable in the custom range position.

Transition Linearity: Deviation from straight line <5% between the 10% and 90% point for transition times greater than 10 ns.

Amplitude. Pulse high and low levels independently adjustable over a  $\pm 20$  V range from a 50 n low reactance source. Maximum pulse amplitude into a 50 n load is >10.V peak to peak; minimum is <0.5 V peak to peak. Maximum pulse amplitude into an open circuit is >20 V peak to peak; minimum is <1.0 V peak to peak. The preset level controls are adjustable over the same ranges.

Aberrations: <5%, +50 mV into a 50 (n load for pulse levels between  $\pm 5$  V. May increase to <10%, +50 mV for pulse levels outside this range.

### TRIGGER OUTPUT:

Amplitude: >+2 V from 50 n.



Source Impedance: 50  $\Omega$

Duty Cycle: Internal Triggering -50%.

External Triggering Determined by duty cycle of triggering signal.

**TRIGGER/GATE INPUT:**

Sensitivity: 80 mV peak to peak to >10 MHz; 250 mV peak to peak to 50 MHz at 50 n input impedance.

Input Impedance: Internally selected, 50 n or 1 Mn paralleled by -20 pF.

Maximum Input:  $\pm 5$  V peak into 50 n,  $\pm 20$  V peak into 1 Mi.

Minimum Input Pulse Width: 10 ns.

Trigger Level: Polarity: Front panel selectable, + or -slope.

Range:  $\pm 3$  V.

**TRIG'D GATED LIGHT:**

Flashing: Input triggered at greater than approximately a 10 Hz repetition rate or following the input signal at slower repetition rates.

On: (Logic True) TRIG/GATE IN input potential above TRIG/GATE LEVEL setting with + SLOPE selected or below TRIG/GATE LEVEL setting with - SLOPE selected.

Off: (Logic False) TRIG/GATE IN input potential below TRIG/GATE LEVEL with + SLOPE selected or above TRIG/GATE LEVEL with - SLOPE selected.

Synchronous Gate: Rate generator starts synchronously with external gating signal and completes the last output pulse.

**PULSE DELAY MODES:**

Undelayed, delayed and paired. Paired pulse mode limited to 25 MHz. Minimum pulse separation governed by duration duty factor specification.

**FIXED DELAYS:**

Trigger Out to Pulse Out: -23 ns.

Gate Input to Trigger Out: -25 ns.

**CONTROL ERROR LIGHT:**

Steady On: Indicates invalid operating mode. Output is undefined.

Flashing: Timing control settings selected do not properly define the output pulse because valid limits have been exceeded.

Steady Off: Indicates valid operation for most control settings.

**POWER REQUIREMENT:**

Nominal: 40 Watts

Maximum: 45 Watts

**POWER DISSIPATION:**

Nominal: 25 Watts

Maximum: 28 Watts

WEIGHT: 3.5 lbs.

**Environmental Requirements.** The following paragraphs describe the environmental operating conditions for the pulse generator.

The pulse generator can be operated where the ambient temperature is in the range of 0° to +50<sup>0C</sup>, and can be stored where the temperature range is -40° to +750 C. After storage at temperatures outside of the operating range, allow the chassis temperature to stabilize within the operating limits before applying power.

Components that require the most cooling are provided with individual heatsinks. Clearance must be provided on all sides for air flow. Do not block or restrict air flow through any holes in the cabinet by placing objects on or against the pulse generator.

Two thermal cutouts in the pulse generator provide protection by interrupting power to the unit if the internal temperature exceeds a safe operating level. Power is automatically restored when the temperature returns to a safe level. Operation in confined areas or near heat-producing equipment may cause the thermal cutouts to actuate.

The normal operating position of the pulse generator is horizontal, setting on a flat surface, on the four feet provided on the bottom surface, or with the front bail

extended, lifting the front panel for ease in reading or adjusting controls. However, under difficult operating conditions (such as limited space), the pulse generator may be used in other positions without impairment of the electrical characteristics, including setting the cabinet on the four protective bumpers on the rear surface or left side. It is important to remember that, in positions other than normal horizontal position, characteristics such as cooling and resistance to shock and vibration are altered, therefore, operation in other than the normal position should be for short periods only and with more than normal care exercised to protect the pulse generator from damage.

**Power Requirements.** The pulse generator is designed to be operated from either a 115-volt nominal or 230-volt nominal line voltage source. In addition, one of three operating ranges may be selected around each nominal voltage. The voltage selector jumper in the power module allows selection of the operating voltage.

**Space Requirements.** The pulse generator is provided with feet on the bottom surface to provide space for cooling air flow, as well as the front bail. Maintain this clearance by always using the front bail or setting all four feet solidly on a flat surface. In addition, always maintain at least two inches of clearance at both sides, top, and rear of the unit.

## Using the Rear Interface Connectors

See the accompanying chart for rear interface connector assignments. For other functions not detailed here, the small auxiliary board (E) has numerous connectors available. Use the connections to make custom inputs or outputs to the PG 508 through the Power Module.

### Amplitude Monitor

These pins (25A) are connected to the OUTPUT terminal through a 27 k resistor and ground (26A). To use this function, place the PERIOD control in the EXT TRIG OR MAN position and connect an accurate voltmeter to these terminals. Now adjust the TRIG/GATE LEVEL control clockwise for the high steady state output voltage and counter-clockwise for the low steady state output voltage. In this manner, the output pulse amplitude levels may be precisely monitored.

### External Level Control Inputs

See the discussion under the heading External Voltage Control in Section 1 of this manual for use of these terminals.

### Trig/Gate Input

These assignments provide rear interface input capabilities for the front panel TRIG/GATE IN input. The signal lead (24B) must be user installed, but the ground

(25B) is factory wired. To make the proper connections, remove the cable extending from the TRIG/GATE IN connector to the input board by pulling the end from the socket on the board. Install a twelve inch cable with the proper connectors, Tektronix Part No. 175-1827-00, from the connector on the input circuit board labeled Trig/Gate In to the other connector on the output board labeled Trig/Gate In as shown in the illustration.

### Trigger Output

The hot or signal lead (28B) must be user installed, while the ground (27B) is factory wired. To route this function through the rear interface connector, remove the plug on the timing circuit board connected to the cable from the - TRIG OUT front panel connector. This plug is shown on the illustration and is labeled Trig Out. Connect a six inch cable with the proper connectors, Tektronix Part No. 175-1824-00, from the connector labeled Trig Out in the illustration to the connector on the output board labeled - Trig Out in the illustration. To obtain the complement trigger out signal, connect the coaxial cable to the connector labeled Trig Comp in the illustration. The normal trigger output may be used simultaneously with the complement, through the rear connector, without disturbing the operation of either. Figure 9. Locations for user installed rear interface connections.

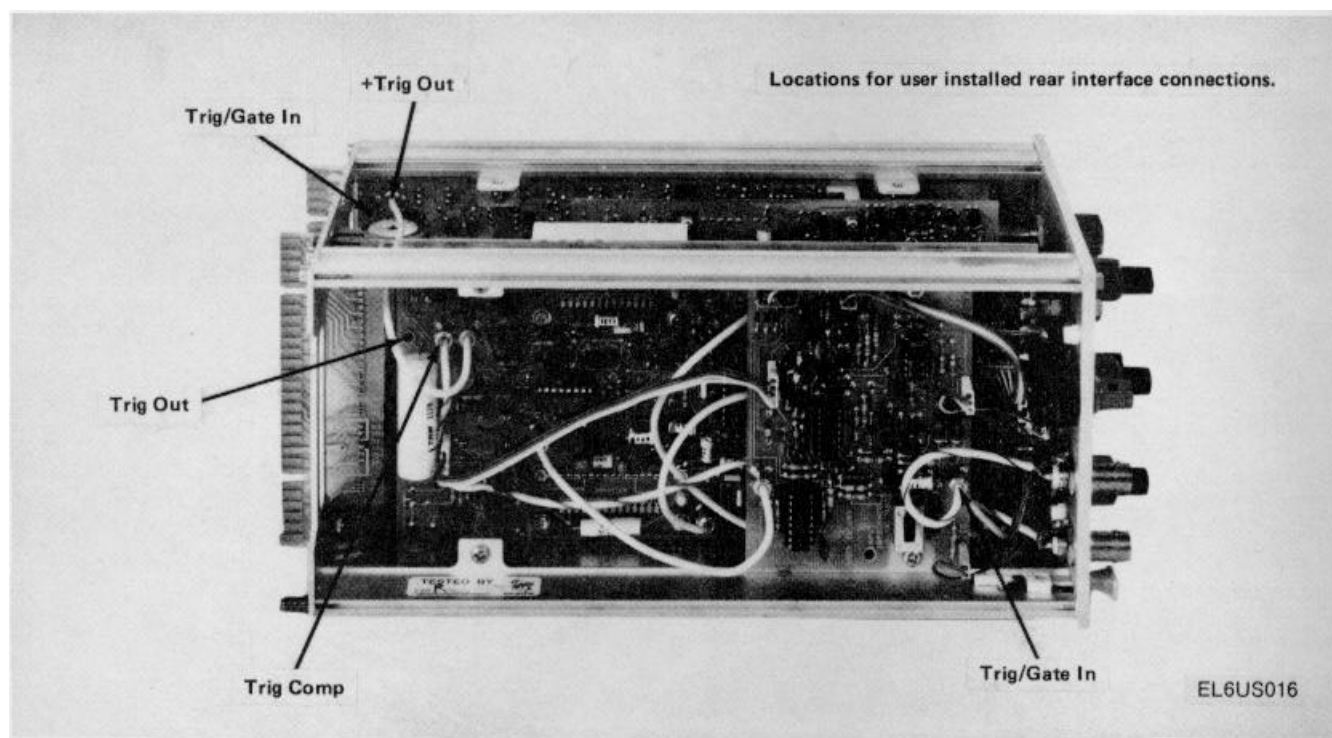


Figure 9. Locations for user installed rear interface connections.

## REAR INTERFACE CONNECTOR ASSIGNMENTS

Remarks	Recommended Loads	Output or Input	Pin B		Pin A	Output or Input	Recommended Loads	Remarks
Factory Wired		Trigger Out Common	28	Barrier Slot	28			
Factory Wired	50 $\Omega$	Trigger Out	27		27			
			26		26	Amplitude Monitor Ground		Factory Wired
Factory Wired		Trig/Gate Input Common	25		25	Amplitude Monitor	>1 M $\Omega$	Factory Wired
User installed		Trig/Gate Input	24		24			
			23	TM 500 Barrier Slot	23			
Factory Wired		External High Level Control Input	22		22	External Low Level Control Input		Factory Wired
			21		21			
			20		20			
			19		19			
			18		18			
			17		17			
			16		16			
			15		15			
			14		14			
25 V ac winding			*13		*13	25 V ac winding		
+33.5 V filtered dc			*12		*12	+33.5 V filtered dc		
Collector lead of pnp series-pass			**11		**11	Base lead of pnp series-pass		
Transformer shield			10		**10	Emitter lead of pnp series-pass		
$\pm 33.5$ V common return			*9		*9	$\pm 33.5$ V common return		
-33.5 V filtered dc			*8		*8	-33.5 V common return		
Collector lead of npn series-pass			**7		**7	Emitter lead of npn series-pass		
No connection			6		**6	Base lead of npn series-pass		
17.5 V ac winding			*5		*5	17.6 V ac winding		
+11.5 V common return			4		4	+11.5 V common return		
+11.5 V common return			*3		*3	+11.5 V common return		
+11.5 V filtered dc			*2		*2	+11.5 V filtered dc		
25 V ac winding			*1		*1	25 V ac winding		
			B		A			

## Rear View of plug-in

Assignments listed for pin 1A - 13A and 1B - 13B are available in all power modules; however only those pins marked with an asterisk (\*) are used by the PG 508. Those connections marked with a double asterisk (\*\*) are the only connections used on the E board.

1-13/(1-14 blank)

## THEORY OF OPERATION

### Introduction

Refer to the block diagram and the schematics in the foldout pages at the rear of this manual as well as the following discussion to understand the operation of the PG 508.

### Input Circuitry

This circuitry processes the external trigger or gating signal providing triggering waveforms for the period circuit. The 50 n input impedance for this circuitry is provided by R12, switched in or out by internal switch S12. When R12 is out of the circuit, the input impedance is 1 M  $\Omega$ , obtained by R14 and R16. Diodes CR16 and CR17 are protective diodes. The proper voltage at the drain of Q20 is set by VR20. The source voltage of Q20 is set by VR22. Impedance transformation, with no voltage shift, is obtained by source follower Q20. Constant current for Q20 is supplied by Q22. A differential comparator is formed by Q25 and Q26. This comparator compares the trigger or gate input level with the level set by the front panel TRIG/GATE control. Constant current for this comparator is provided by Q30. Level control voltage for the differential comparator is provided by operational amplifier U40. The output, pin 6, swings over a range of  $\pm 3$  V. The voltage at TP36 is the triggering level voltage, as set by the TRIG/GATE LEVEL control. If the triggering or gating voltage at the base of Q25 is more positive than TP36, then Q26 is conducting and Q25 is off. This places the collector of Q26 more positive than the collector of Q25. When the gating or triggering waveform level drops below TP36, Q25 conducts and Q26 turns off.

This switching waveform is applied to the bases of U60A and U60B, operating as a differential pair. The collector of U60A drives U60C in a cascade mode of operation. The collector of U60C drives the base of U60D which, as an emitter follower, drives the input of U70B. This gate operates as a dual input Schmitt trigger shaper. When the emitter of U60D goes to about 4.2 V above ground, pin 7 of U70B goes high. When the emitter of U60D drops to about 3.8 V, pin 7 of U70B drops to its low level. The inverting output terminal, pin 6, is always in the opposite state from pin 7. Positive feedback for this portion of the Schmitt is provided by R72. If the unit is manually triggered, pin 10 of U70B is momentarily connected to +5 V. Pin 10 of U70B, along with R75 and R76 now acts as a Schmitt shaper for the manual trigger. This action holds the output, pin 7, high

and the inverting output, pin 6, low as long as the MAN button is depressed.

When the plus slope is selected for triggering or gating, +5 V is applied to pin 4 of U70A. This gate is now inhibited and the signal passes through U70C. As the outputs of U70A and C are connected together, a high on either output overrides the low. Pin 13 of U70C is low as long as the anodes of CR82 and CR84 are low, which occurs when the logic circuitry has enabled the input circuitry. When the control logic is set to disable the input circuitry, the anodes of these diodes are raised to +5 V which disables gates U70A and U70C.

Pin 12 of U70C now shifts between the high and low state corresponding with the input gate or trigger. The output from U70C, pin 14, is passed to the period circuitry. A high at the output of U70C turns the period circuitry off and a low starts the period generator.

### TRIG'D/GATED Light Circuitry

Transistors Q100, Q102, Q110 and their associated components compose the circuitry that operates the front panel TRIG'D/GATE light emitting diode. The pair Q100 and Q102 form a modified stable multivibrator, while Q110 operates as a voltage source. When the output of U70A or U70C is high (period generator off) or the logic circuitry has inhibited the input circuitry, the base of Q100 is high. This causes the base of Q102 to be low through R106. The collector of Q102 is now high and the light emitting diode is off. When the base of Q100 goes low, the base of Q102 goes high, the collector goes low and the light emitting diode illuminates. The light emitting diode circuitry follows the triggering gate up to about a 5 Hz rate, i.e., about 100 ms on and 100 ms off. At faster gating frequencies, C106 inhibits the changing states of this circuitry at about the 5 Hz rate.

### Triggered Mode

In the triggered mode of operation S200-2 is closed. This places a high on pin 10 of U140B locking pin 7 high and pin 6 low irrespective of the level on pin 11. This disables the period generator. Pin 15 of U140C now follows pin 4 of U140A in coincidence with the input triggering signal. Pin 14 of U140C drives Q244 and pin 15 drives Q240. The output from the collector of Q240 is in phase with the trigger or gate input signal providing the trigger output, and the phase of the waveform at the collector of Q244 is inverted.

### Period Generator

This circuitry generates the internal period timing waveform. In this mode, U140B operates as a stable multivibrator. When either input of U140B is high, pin 7 is high and pin 6 is low. The switched timing capacitances are connected from pin 7 to pin 11. These capacitors are switched by the period range switch. The period variable control, R190, varies the resistance in the negative feedback loop.

To start the period cycle, assume pin 7 of U140B goes high and pin 6 low. This positive step, at pin 7, is coupled through the period timing capacitor to pin 11. As the timing capacitor discharges through the resistances connected from pin 11 to pin 6, the voltage at pin 11 decays at a rate determined by the timing capacitor and these resistances. When the switching level (approximately 4 V) is reached, pin 7 goes low and pin 6 goes high. The negative step, at pin 7, is coupled through the timing capacitor, and appears at pin 11. The capacitor now charges through the resistances until the switching level is reached, and the period cycle repeats. The symmetry adjustment compensates for the bias current through pin 11.

When the PERIOD switch is in any position other than EXT TRIG (MAN), switch S200-2 is opened. This lowers pin 10 of U140B and permits the period generator to operate during the external gate on time. During the time of the external gating signal pins 4 and 2 of U 140A are low. Pin 3 is high. As transistors Q150 and Q160 form a comparator, with their bases connected to pins 3 and 1 of U140A respectively, the collector of Q150 is low causing the emitter of Q175 to be low, as well as pin 11 of U140B. This allows the period generator to operate. During the gated off time this action reverses. Pin 11 of U140B rises and inhibits the period generator.

Resistor R170 and R165 adjust the lock up voltage at pin 11 of U140B so that, at turn on, the first period generated is identical in time with subsequent periods. Resistor R 165 is switched into the circuit only on the 20 ns range. Components R177 and C177 form a time constant to help compensate for first period error.

### Delay Generator

This circuitry provides the delay for delayed or paired pulse operation. As the signal from the period generator of the external trigger input goes from high to low at pin 7 of U270B, pin 3 goes high. This causes pin 5 of U270A to go high and pin 2 low. Pin 13 of U270D and pin 9 of U300B go low. Pin 15 of U270D goes high but pin 10 of U300B does not follow until about 10 ns later, due to the delaying action of R275 and C275. When pin 9 of U300B goes low pin 6 goes high, assuming pin 11 is already low. Pin 6 stays high until pin 10 goes high as described above. This action provides the delay

generator with about a 10 ns trigger pulse under all input conditions

The positive-going trigger pulse, at pin 5 of U300A, causes pin 3 to go low and pin 2 high. Positive feedback through R300 and C300 causes pin 4 to go high. The low at the base of Q320 turns Q320 off. The emitter of Q320 goes negative at a rate determined by the timing capacitor and current source Q342, with its variable emitter resistances. As the emitter of Q320 goes negative, it pulls the base of Q294 negative which lowers pin 4 of U300A. When pin 4 reaches the switching threshold ( $\approx 4.0$  V) pin 2 goes low and pin 3 high. The timing capacitor is now discharged through Q320. The monostable delay generator is now reset for the next trigger pulse. Transistor Q290 provides a constant load for the power supplies irrespective of the current flowing through Q294.

Components R304, R306 and C304 provide a delay line for the CONTROL ERROR light. The output from the delay generator is connected to pin 13 of U300C. Pin 15 of U300C is high during the delay time and pin 14 low. Gates U360B and D provide a positive-going trigger at pin 15 of U360D when the delay time ends. Gates U360A and C provide a positive-going trigger at pin 14 when the delay time starts. As the delay time starts, pin 4 of U360A goes low as does pin 11 of U360C. Pin 10 of U360C is low as the anode of CR378 is grounded through the UNDLY switch. The low at pin 11 of U360C allows pin 14 to go high. Pin 14 stays high until the propagation time through gate U360A and the delaying action of R364 and C366 allow the high generated in U360A, from pin 2, to reset U360C through pin 10. This causes pin 14 to return to its low state. The width of the output trigger pulse is about 6 ns.

To obtain the delayed trigger, the anode of CR378 is connected to +5 V disabling gate U360C. The anode of CR382 is grounded through the DLY switch. Gates U360B and U360D now operate in exactly the same manner as U360A and C. A positive trigger pulse appears on pin 15 of U360D when the delay time ends (pin 6 of U360B goes from high to low). In the paired pulse mode both gates operate. Gate U360C provides a positive-going trigger at the start of the delay time and U360D a positive trigger at the end of the delay time.

### Duration Generator

This circuitry generates the duration times. Gate U400B accepts the delayed or undelayed positive triggers from the delay generator. The result is a positive-going pulse at pin 5 of U400A. This triggers the duration generator which operates in the same manner as the delay generator. Refer to the discussion under the heading Delay Generator for a description of the duration generator operation. Gate U400C is an output buffer. Pin

12 goes high during the pulse duration time and if pin 13 is low, pin 15 goes high and pin 14 low. Pin 13 controls U400C in the square wave and external duration modes.

### Duration and Delay Control Error Light Circuitry

This circuitry illuminates the CONTROL ERROR light when the duration or delay times are greater than the periods of their respective triggers. The positive pulse from the duration generator is fed into the D input, pin 10, of U480A. The clock enable line is low. If the duration time is set so that a trigger pulse (connected to the clock in) for the next duration pulse occurs before the output of the duration generator goes low, the high on the D input, pin 10 of U480A, is transferred to the output, pin 1. This high is connected to the set input, pin 5, of U480B which causes the output, pin 2, of U480B to go high illuminating the error light. When the output, pin 2, of U480B goes high, the inputs to U480A and B are disabled through the clock enable line preventing further trigger inputs until both flip flops are reset. When the output, pin 2, of U480B goes and stays high, C487 starts to charge to the voltage on pin 2, through R490. This takes approximately 100 ms. When the reset inputs to U480A and B, pins 13 and 4, reach the high level (about 4.0 V) U480A and B are reset and C487 discharges through R490. When these reset inputs return to the low level both flip flops are ready to accept triggers and the error cycle is ready to repeat. If the delay time is set for a time greater than the period of the delay triggers, the high on pin 7 of U480B transfers to pin 2 directly, and the light is illuminated. Reset takes place in the same manner as described above. Also connected to this circuitry is a line from the transition time board which also lights the CONTROL ERROR light.

The CONTROL ERROR light is also illuminated for certain improper control settings. Fig. 2-1 shows a simplified schematic for the CONTROL ERROR indicator logic and control settings causing illumination.

### Variable Transition Time Circuitry

This circuitry controls the output transition times. Resistors R534 and R536 provide equivalent 50 n termination impedance for the normal (positive-going) input from the duration generator. Also, R520 and R522 provide an identical termination impedance for the complement input (negative-going) from the duration generator. These inputs drive the bases of 0525 and 0530. When the input from the duration generator is high and the complement is low, the collector of 0530 drops from ground to about -1/2 V. This turns Q565 on and Q560 off. The adjustable constant current through 0545, to +15 V, is now passed through R578, from the -15 V supply. Transistor Q560 is turned off as its base is connected to ground. Zener diodes VR620 and VR630 0635 and then through 0630 to charge the particular capacitor determined by the transition time selected. As the capacitor charges through a constant current source, the junction of CR584 and CR600 goes negative at a

linear rate until the diode CR600 turns on. This diode serves as the negative clamp. The voltage at the anode of CR600 is set by R615 through Q608 and 0600. The voltage at the junction of CR584 and CR600 remains low for the pulse duration.

lower the voltage from the bases of 0565 and Q560 to the bases of 0625 and Q630 by about 7.5 V. Transistor Q625 is therefore off and Q630 is conducting. Current flows from -15 V through an adjustable current source

At the end of the pulse duration time, the collector of 0530 goes positive. This action turns 0565 off and Q560 on. Current from the +15 V supply flows through constant current source 0545, then through 0560 raising the junction of CR584 and CR600 at a linear rate determined by the capacitor value and the current available. The junction of CR584 and CR600 goes positive until CR584 turns on. The voltage at the cathode of CR584 is set by R570 through Q575 and 0580. Transistor 0625 is turned on, and Q630 off, passing current from constant current source 0635 through 0625, CR604, and R604 to ground. The leading and trailing transition times are varied independently by varying the amount of current passing through constant current source transistors 0635 and 0545.

The output waveform at the junction of CR584 and CR600 passes to the gate of fet 0680. This fet serves as a source follower for driving 0685 and Q690. These transistors compose a linear differential amplifier. The clamp levels for diodes CR584 and CR600 are set so that Q685 and 0690 are slightly overdriven. This serves to remove any ringing or other signal irregularities at the top and bottom of the waveform. Operational amplifier U665 provides, along with 0660, constant current for 0685 and Q690.

### Transition Time Control Error Light Circuitry

This circuitry illuminates the control error light when the leading transition time is greater than the pulse1 duration time, or when the trailing transition time is greater than the pulse off time. The inverted signal from the leading and trailing generator appears at the base of 0704 through fet follower 0700. A differential amplifier is formed by 0704 and 0706. The output is taken from the collector of Q706. Transistors 0704 and 0706 are overdriven to reduce the window of comparison. During the pulse on time, the base of 0704 is negative with respect to ground. This action causes the collector of 0706 to also go negative, driving the base of Q715, an emitter follower negative. The emitter of Q715 is connected to pins 7 and 10, the D input of flip flops U720A and B.

The waveforms driving the transition time circuitry are also applied to gates U740A and B. Pin 6 of U740B is high during pulse time while pin 4 of U740A is low. The purpose of the four gates in U740 is to delay the signal ap-

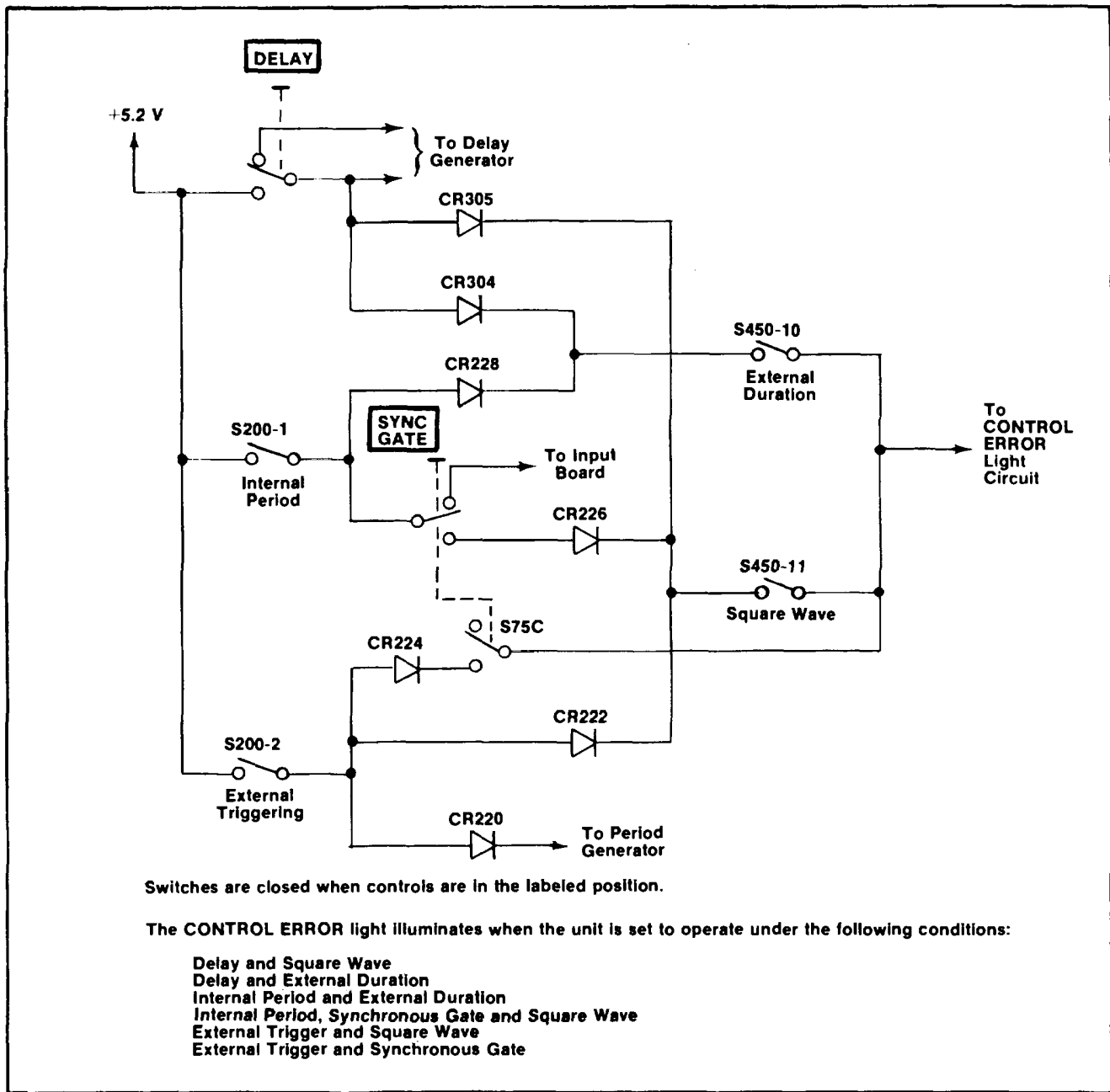


Fig. 2-1. Simplified schematic for CONTROL ERROR Indicator logic with control settings causing Illumination.

proximately the same amount as the circuitry in the variable transition time generator. The positive-going waveform from pin 14 of U740C is fed through pin 6 to the clock input, pin 6, of flip flop U720A. The negative-going output from pin 15 is fed to the clock input pin 11, of flip flop U720B. Flip flop U720A senses the pulse trailing timing error and U720B, the pulse leading timing error. If the leading time from the output of the variable transition time generator is slow enough so that the D input of U720B has not dropped below approximately the 50% point, when the waveform at the clock input of

flip flop U720B (waveform driving the transition time board) goes positive (end of pulse), the high on D input, pin 10, transfers to the output, pin 15, and the CONTROL ERROR lamp is lit.

When pin 15, of flip flop U720B goes high, C734 starts to charge through R728. When the voltage at pin 13 of U720B and pin 5 of U720A reaches the high level (-4.0 V), both flip flops are reset to their initial conditions and the CONTROL ERROR light goes out. If the trailing time of the



pulse is slow enough so that the D input of flip flop U720A has not reached the high level when the pulse at the clock terminal (pin 6) of flip flop U720A goes high (leading portion of the next pulse driving the transition circuitry) the 0 terminal, pin 3, of flip flop U720A goes high. This high is connected to the set terminal, pin 12, of U720B causing the 1 terminal of U720B to go high illuminating the CONTROL ERROR light. The on time and reset for this error indicating mode now proceeds as previously described.

### Level Control Multiplier

This circuitry provides independent top and bottom level control of the output pulse by controlling the amplitude and offset of the drive signal to the linear output amplifier. Also included is circuitry to accomplish the normal complement function and the preset function. Control voltage clamps to ensure the output amplifier is not over driven are also provided.

Amplitude control of the signal occurs in the analog multiplier, U850. The pulse signal provides the X input, and the level control voltages provide the Y input. The X.Y product of these inputs is converted to a drive current for the output amplifier.

Input and complement pulses from the variable transition time generator are applied to the bases of Q825 and 0840. These transistors form a differential amplifier, supplied by constant current source U800B and 0820. A positive-going signal at the base of Q825, with the complementary (negative-going) signal at the base of 0840 causes the signal current at pin 11 of the multiplier to go negative and the signal current at pin 12 to go positive. When the pulse polarity reverses, at the bases of Q825 and 0840, the signal current also reverses polarity at pins 11 and 12. The difference between the currents at pins 11 and 12 corresponds to the X signal input for the multiplier.

The total current flowing from pins 2 and 3 of U850 is essentially equal to the current required by the constant current source, U895A and Q900. However, the difference in currents between these pins corresponds to the Y input signal for the multiplier.

The amplitude difference of these currents is controlled by U895B. This is a dc differential amplifier which amplifies the difference between the high & low level control voltages to produce the Y input signal. Gain adjustment for the Y input signal is provided by R885.

The high and low level control voltages are determined by their respective front panel controls, R770B and R770A. If the preset function is selected, the preset high and preset low potentiometers, R775 and R785, provide the control voltages. These voltages are buffered by unity gain amplifiers U780A and U780B.

Both control voltages range between 0 and +5.2 V. When the control voltages are equal, the Y input is zero and the multiplier signal output (X.Y) equals zero. A difference of +2.6 V between the high and low level control voltages corresponds to maximum output amplitude from the pulse generator.

The normal complement switch inverts the level control voltage inputs to differential amplifier U895B. However, since the difference between the voltages is unchanged, the control voltage input signal has constant amplitude, but reverses polarity. This complements the pulse generator output. The normal complement balance adjustment, R910, ensures that the Y multiplier input responds equally to changes in either the high or low level control voltages.

The signal current at pins 5 and 6 of U850 is the pulse signal. Since 0845, in conjunction with U800B, provides a constant current sink, the current through R954, from the emitter of common base stage Q954, also contains signal current variations. The current driver for the output amplifier is Q954. The signal currents into pins 8 and 9 of U850 also contain the pulse signal. However constant current sink R847, and common base stage 0950 are included only as a balancing thermal load for the multiplier.

To obtain independent control of the output pulse high and low levels, the control voltages are averaged by resistor network R914, R915, R918 and R920. High and Low tracking potentiometers, R915 and R920, are adjustable to provide minimum interaction between pulse levels. The dc voltage from this network, along with the voltage from the offset adjustment R925, is summed and inverted by U930A. U930B provides further gain and level shifting and, in conjunction with 0945, serves as a level controlled offset generator. A dc current source to the collector of Q954 is provided by Q945. The collector of Q954 is the virtual ground input to the output amplifier.

When the high and low level control potentiometers are both at midrange (+2.6 V zero output) 0945 sources all the quiescent bias current required by 0954, which is approximately 15 mA. Therefore, there is no current drive to the output amplifier through R975 or R1055. If the high level control is turned fully cw (maximum output), the low level control voltage remains at +2.6 V. The high level control voltage increases to +5.2 V. This causes the voltage output of U930A to decrease, causing the offset generator U930B and 0945 to source approximately 20 mA. This is an increase of 5 mA. This difference in control voltage settings also causes maximum difference in the control voltage input signal to the multiplier. This action also causes 10 mA peak to peak signal current variations in the collector current of Q954. Since the signal current

variations and dc offset currents are summed at the collectors of Q945 and Q954, the output pulse high level changes to maximum voltage and the low level remains at 0V.

It follows that any positive increase in either the high or low level control voltages causes an increase in the dc offset current. A decrease in either control voltage causes a decrease in offset current. However, signal current variations respond only to differences between these control voltages. The larger the voltage difference, the larger the signal current amplitude into the output amplifier.

Since the dynamic range of the pulse generator output is 4 or - 20 V, and the maximum amplitude is only 20 V peak to peak, clamping circuits are provided to prevent the difference between the high and low level control voltages from exceeding +2.6 V, which corresponds to maximum output. A clamping circuit also prevents the high level from becoming less than the low level control voltage.

The level control unity gain amplifiers U780A and U780B contain a precision diode clamp composed of CR782, CR790, R780, and R782. Since the feedback for U780A is taken from the cathode of CR790, the voltage at the junction of CR782 and CR790 is equal to the low level control voltage plus one diode drop (CR790). If the high level attempts to decrease below the low level or attempts to increase above the high level control voltage, CR782 conducts clamping the high level at the low level voltage. Current limiting for U780B, during clamping, is provided by R780.

U800A is also configured as a precision clamping circuit. The output at pin 1 is equal to the low level control voltage plus 2.6 V plus one diode drop. Therefore, if the high level voltage attempts to exceed the low level plus 2.6 volts, or the low level is decreased more than 2.6V below the high level, CR805 conducts and the high level is clamped at the low level control voltage plus 2.6 volts. The low level control always overrides the high level control. Current limiting for U780B, during clamping, is provided by R780.

### Output Amplifier

The positive and negative dc voltages for this amplifier are provided by dual power supplies which track the high and low level control voltages. These tracking supplies ensure that the positive potential is at least 6 V above the output pulse high level and the negative potential is at least 6 volts below the output pulse low level. This arrangement enables the pulse generator to provide a 40 V dynamic range, with a 20 V peak to peak maximum output pulse, while maintaining minimum power dissipation and voltage requirements for the amplifier transistors. The range of the positive

tracking supply is +6 to +26 V, with a -6 to -26 V range for the negative supply.

The output circuit functions as a linear current driven operational amplifier with a closed loop transresistance gain of 2 V/mA. Negative feedback through R1042 to the input node (collectors of Q945 and Q954) causes a virtual ground at the input. A 10 mA peak to peak input signal creates a 20 V peak to peak output pulse (open circuit).

Since the output amplifier is a complementary circuit, only the operation of one side will be explained.

For a positive-going output pulse, current is driven into the input node. This action causes an increase in base current to Q975 which decreases the base drive to Q980. A cascode circuit is formed by Q980 and Q990, with R985 and L980 serving as a constant current source to the common collector-emitter connection. Therefore, when the base drive to Q980 is decreased, the current in Q990 increases. (The constant current source supplies approximately 60 mA which, with no signal, is equally divided between Q980 and Q990.) Another constant current source, Q1000, causes a 2.0 V drop across R1002. The emitter follower, Q995, buffers this potential and provides a voltage source for the base of the cascode transistor, Q990. An increasing current through Q990 increases the base current from the output parallel emitter followers, Q1010 and Q1015. The emitters of these transistors drive the output positive through a network of resistors and capacitors. Components R1020, R1024, and C1024, in this network, are adjustable to provide an internal resistive 50 n termination for the output. Network C1048 and R1048, with potentiometer R1050, provides transient response peaking for the amplifier.

Equivalent biasing for the complementary output emitter followers is provided by CR990, R990, and CR992. With zero output, the quiescent current in each output follower is approximately 20 mA. The output potential is available at the rear interface connector, pin 25A, for monitoring the output amplitude.

### Power Supply

The +11.5 Vdc from the mainframe provides the raw supply voltage for the series regulated +5.2 Vdc supply. The precision voltage regulator, U1210, includes a temperature compensated voltage reference supply at pin 6. The +5.2 V potentiometer, R1210, with the voltage divider R1209 and R1211 provides the reference input to the non-inverting input, pin 5. The output voltage is applied to the inverting input, pin 4, through R1217. Sensing differences in the two input potentials, the regulator amplifier provides base current drive from pin 10.

to the mainframe transistor used as the series pass element, until the inverting and non-inverting inputs are approximately equal. At this condition, the series pass transistor drops the voltage from the raw supply until the output is +5.2 V. Current limiting is provided by R1215. When the current from the supply exceeds approximately 1.1 A, the regulator provides no further base drive current to the series pass element and current limiting occurs.

The +33.5 Vdc from the mainframe is the raw supply for the regulated +15 Vdc. The 3-terminal voltage regulator, U1205, performs the entire regulating function. Current limiting occurs within U1205.

The -33.5 Vdc from the mainframe is the raw supply for the regulated -15 Vdc. As in the +15 Vdc supply a 3-terminal voltage regulator, U1335, provides the regulating function. However, due to additional load considerations, the raw supply is pre-regulated to decrease power dissipated by the integrated circuit. A shunt current path to the load is furnished by VR1330 and R1330. The zener voltage is also used to maintain base drive to the series pass mainframe transistor. This transistor is used as a pre-regulator to drop the voltage across U1335 to approximately 3.6 V. Current limiting is also provided by the regulator, U1335.

The dual tracking supplies provide the positive and negative voltages required by the output amplifier. The voltage at the base of Q1255 varies from 0 V to +5.2 V depending on the setting of the HIGH LEVEL control. When the voltage at the base of Q1255 varies from 0 V to +2.6 V, the voltage at the collector of the series pass transistor is +6 V. As the voltage at the base of Q1255 varies from +2.6 V to +5.2 V, the voltage at the collector of the series pass transistor varies from +6 V to +26 V.

Transistor Q1255 and Q1270 form a differential comparator. The voltage at the base of Q1270 is referenced between the +5.2 V supply, ground and the output voltage. As the HIGH LEVEL control is moved in

the positive direction, the collector of Q1255 goes negative. This increases current flow through Q1280 and therefore the series pass transistor in the mainframe which raises the + tracking supply voltage to the output amplifier. Feedback to the differential comparator is provided by R1275. Transistor Q1265 prevents the +V tracking supply from going lower than about +6 V. The base of Q1265 is set at about 2.6 V. When the base of Q1255 goes more negative than about 2.6 V, Q1265 comes into conduction holding the common emitter circuit at one diode drop from the base of Q1265. If the base of Q1255 is lowered further, Q1255 loses control of the circuit and the supply voltage remains at the level determined by Q1265, 6 V.

Current limiters for this circuit are Q1285, Q1290 and Q1300. A differential comparator is formed by Q1285 and Q1290. If the load on the 4 V supply exceeds the maximum current allowed for the voltage supplied, the voltage drop across R1282 becomes great enough that Q1285 comes into conduction. This action increases conduction in Q1270 reducing the current flow in Q1255. Finally, the conduction through the series pass transistor is limited to a safe value. The current through Q1300 is determined by the actual supply output voltage. Therefore, the current limit varies proportionally with the supply voltage. In most overload conditions, the supply folds back to minimum current. Diode CR1310 conducts should the -V supply go more negative than ground.

The -V supply operates in the same manner as the +V supply. Only the polarities are reversed. Transistors Q1355 and Q1370 are the basic comparator transistors. The base of Q1355 varies between 0 V and +5.2 V. The -V output is prevented from going more positive than about -6 V by Q1365. The series pass transistor is driven by Q1380. The comparator transistors for the current limiting circuitry are Q1385 and Q1395. The current source for the current comparator is Q1400. Diode CR1410 prevents the -V output from going more positive than ground.

## SERVICE INFORMATION

### Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).  
Values less than one are in microfarads (p/F).  
Resistors = Ohms (i).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

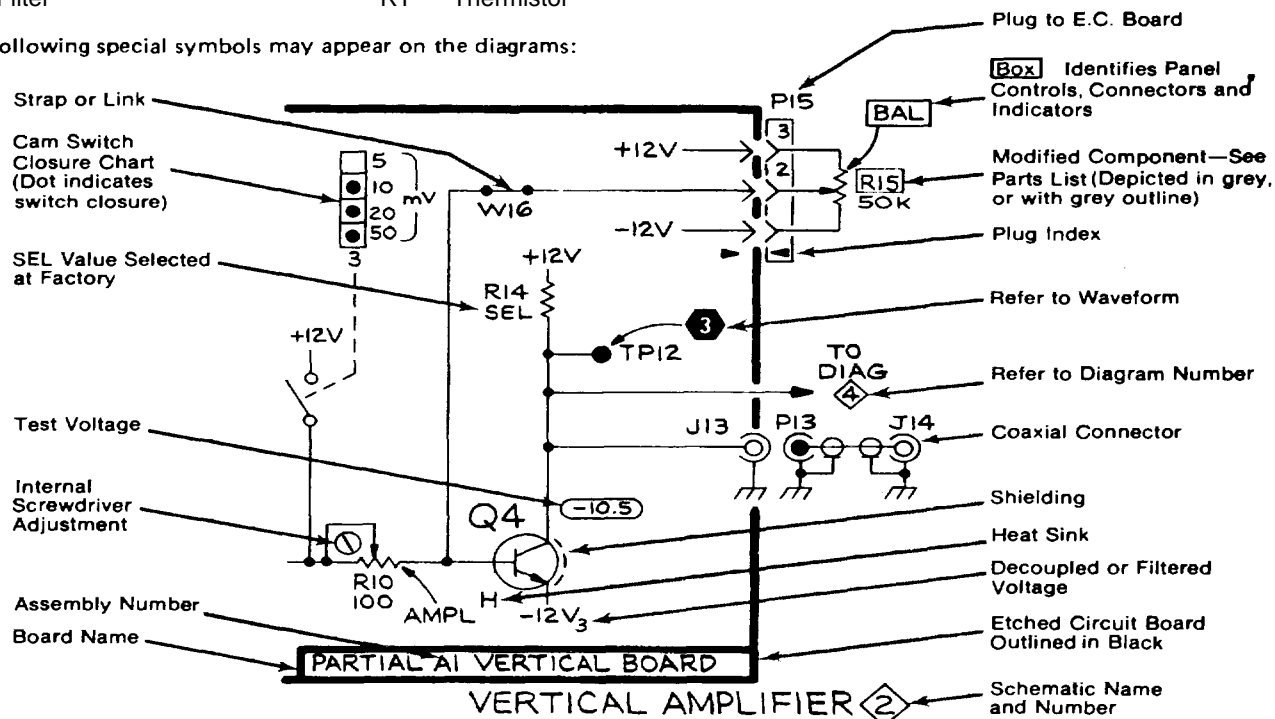
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966 Drafting Practices.  
Y14.2, 1973 Line Conventions and Lettering.  
Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly separable or repairable (circuit board, etc)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contractor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, inseparable or non-repairable (integrated circuit, etc )
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode, signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	O	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

The following special symbols may appear on the diagrams:



## GENERAL MAINTENANCE AND ADJUSTMENTS

### Maintenance

Refer to Appendix A for complete maintenance information.

If trouble exists in the output amplifier, remove the + and - tracking power supply jumpers located as shown in the adjustment location illustration. This completely isolates the tracking power supplies from the output circuitry.

### Circuit Board removal

To remove the output circuit board and gain access to the components on the variable transition timing board, first remove the four screws on the plug-in rear panel and remove the panel. Next remove the TRANSITION TIME knob. Disconnect the coaxial cable plugs and unplug all the wires connected to the output and transition time boards. Finally, remove the four screws holding the output board to the plug-in frame and remove the two boards by sliding toward the rear of the plug-in until the TRANSITION TIME shaft clears the front panel hole. Now lift the boards and remove them from the mainframe. To remove the input board remove the wires and cables to the input board and the two screws holding the board chassis. To remove the timing board, first remove the rear panel, as explained above. Then remove the PERIOD, DELAY, and DURATION knobs from their shafts. Disconnect all wires and cables leading to the timing board. Remove the four screws holding the timing board to the spacers. Slide the timing board toward the rear of the plug-in until the shafts clear the front panel and lift the board out.

### Test Equipment

For adjustment of the PG 508, the following equipment is recommended:

Complete oscilloscope system, capable of faithful reproduction to at least 500 MHz. TEKTRONIX 5440 mainframe, 5A45 real time vertical amplifier, and 5B42 real time delaying sweep plug-in suggested.

50  $\Omega$  42 inch coaxial cable with bnc connectors, Tektronix Part No. 012-0057-01, or equivalent.

### General

Adjustments for the PG 508 are described below. For complete calibration procedures, refer to TB 11-6625 2980-35.

### Output Voltage Control Knob Check or Adjustment

To check or reset the OUTPUT (VOLTS) control knobs, use the following procedure. Connect an oscilloscope to the PG 508 OUTPUT connector. Set the DURATION control to the SQ WAVE position, and the PERIOD control at the 2 ms position. Set the HIGH LEVEL knob for an output level of about +5 V on the oscilloscope, and the LOW LEVEL for 0 V. If the LOW LEVEL knob does not point to 0, loosen the set screw and reset the knob to the 0 mark on the front panel. Now set the LOW LEVEL knob for a reading of about -5 V, and the HIGH LEVEL for 0 V on the oscilloscope. If the HIGH LEVEL knob does not point to 0, loosen the setscrew and readjust.

## REPLACEABLE MECHANICAL PARTS

### PARTS ORDERING INFORMATION

For complete part information, refer to TM 11-6625-2980-24P.

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - \* - - - indicates the end of attaching parts.

### INDEX NUMBERS

Items in this section are referenced by index numbers to FO-16.

### ITEM NAME

### INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item

Name may sometimes appear as incomplete. For further Item Name identification, the U S Federal Cataloging Handbook H6-1 can be utilized where possible.

1 2 3 4 5      *Name & Description*

*Assembly and/or Component*

*Attaching parts for Assembly and/or Component*

*Detail Part of Assembly and/or Component*

*Attaching parts for Detail Part*

*Parts of Detail Part*

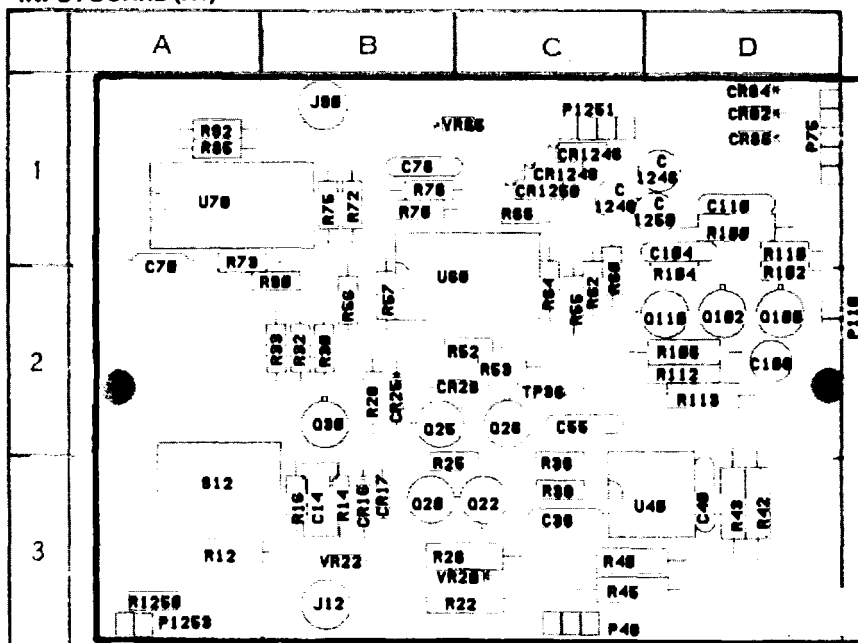
*Attaching parts for Parts of Detail Part*

### ABBREVIATIONS

"	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EOPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVEING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

# PARTS LOCATION GRID

INPUT BOARD (A1)



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C14	B3	P12	B3	R32	B2	R102	D2
C36	C3	P48	C3	R33	B2	R104	D2
C40	D3	P75	D1	R36	C3	R106	D2
C55	C2	P90	B1	R38	C3	R110	D1
C70	A2	P110	D2	R40	C3	R112	D2
C76	B1	P1248	A3	R42	D3	R113	D2
C104	D1	P1251	C1	R43	D3	R1250	A3
C106	D2	P1253	A3	R45	C3		
C110	D1	R52	C2	S12	A3		
C1246	D1	Q20	B3	R53	C2	TP36	C2
C1248	C1	Q22	C3	R55	C2		
C1250	D1	025B2	R56	B2			
026	C2	R57	B2	U40	D3		
CR16	B3	030B2	R60	C2	U60	C2	
CR17	B3	Q100	D2	R62	C2	U70	AI
CR25	B2	0102	D2	R64	C2		
CR26	B2	Q110	D2	R66	C1	VR20	C3
CR82	D1	R70	B1	VR22	B3		
CR84	D1	R12	A3	R72	B1	VR65	C1
CR86	D1	R14	B3	R73	AI		
CR1246 C1	R16	B3	R75	B1			
CR1248 C1	R20	C3	R76	B1			
CR1250 C1	R22	C3	R90	B2			
R25	B3	R92	AI				
J12	B3	R28	B2	R95	AI		
J90	B1	R30	B2	R100	D1		

Figure 5-1 . A1 board component locations .

## FO-16

## Index

No.	Qty	1	2	3	4	5	Name & Description
-1	2						SHIELD,ELEC: SIDE
-2	2						COVER,PLUG-IN:TOP AND BOTTOM (ATTACHING PARTS)
-3	2						SCREW,MACHINE:6-32 X 0.188 INCH,PNH STL ---*---
-4	1						KNOB,LATCH: (ATTACHING PARTS)
-5	1						PIN,KNOB SECRG:0.094 OD X 0.120 INCH LONG ---*---
-6	3						KNOB:GRAY • EACH KNOB INCLUDES:
	-						• SETSCREW:5-40 X 0.125 INCH,HEX SOC STL
-7	3						KNOB:GRAY,0.25 ID X 0.706 OD,0.6H • EACH KNOB INCLUDES:
	-						• SETSCREW:5-40 X 0.125 INCH,HEX SOC STL
-8	1						KNOB:GRAY,0.81 ID X 0.392 OD,0.466 H • SETSCREW:4-40 X 0.125 INCH,HEX SOC STL
-9	1						KNOB:GRAY,0.126 ID X 0.588 OD,0.6H • SETSCREW:5-40 X 0.125 INCH,HEX SOC STL
-10	1						KNOB:0.252 ID X 0.706 OD,0.6H • SETSCREW:5-40 X 0.125 INCH,HEX SOC STL
-11	3						KNOB:GRAY,0.127 ID X 0.5 OD,0.531H • EACH KNOB INCLUDES:
	-						• SETSCREW:5-40 X 0.125 INCH,HEX SOC STL
-12	7						PUSH BUTTON:GRAY
-13	2						CONNECTOR,RCPT, :BNC,FEMALE,W/HARDWARE
-14	2						TERMINAL,LUG:0.391" ID INT TOOTH
-15	1						CONNECTOR,RCPT,:BNC,FEMALE
-16	1						RESISTOR,VAR:(R48) (ATTACHING PARTS)
-17	1						NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS
-18	1						WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL
-19	1						RESISTOR,VAR:(R540 AND R655) (ATTACHING PARTS FOR EACH)
-20	1						NUT,PLAIN,HEX. :0.25-32 X 0.312 INCH,BRS
-21	1						WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL
-22	1						RESISTOR,VAR:(R770A AND B) (ATTACHING PARTS)
-23	1						NUT,PLAIN,HEX. :0.25-32 X 0.312 INCH,BRS
-24	4						BSHG,MACH.THD:HEX,0.375-32 X 0.438"LONG (ATTACHING PARTS)
-25	4						NUT,PLAIN,HEX. :0.375-32 X 0.50 INCH,STL
-26	3						WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL
-27	1						WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL
-28	4						CLIP,ELECTRICAL:CAM SHAFT
-29	2						BUSHING,SLEEVE:PRESS MOUNT
-30	7						FRAME,PUSH BTN:PLASTIC
-31	1						PANEL,FRONT:
-32	1						LATCH,RETAINING:PLUG-IN (ATTACHING PARTS)
-33	1						SCR,TPG,THD FOR:2-32 X 0.312 INCH,PNH STL ---*---
	1						RELEASE,LATCH:
-34	1						SUBPANEL,FRONT: (ATTACHING PARTS)
-35	4						SCR,TPG,THD FOR:6-20 X 0.375"100 DEG,FLH STL



## FO-16

## Index

No.	Qty	1	2	3	4	5	Name & Description
-36	3						BASE,LAMPHOLDER:0.29 OD X 0.19 CASE
-37	3						LAMPHOLDER:WHITE PLASTIC
-38	3						WASHER,FLAT:0.265 ID X 0.375 OD INCH AL
-39	2						LAMP,LED: (DS110 AND DS1250) EPL
-40	1						LAMP,LED: (DS500 )
-41	1						SHIELD,ELEC:REAR SUBPANEL
-42	1						CKT BOARD ASSY:AUXILLARY(A5)
-43	6						• CONTACT,ELEC:0.365L X 0.25 PH BRZ GOLD PL
-44	2						GUIDE,CKT BOARD: (ATTACHING PARTS FOR EACH)
-45	2						SCREW,MACHINE:2-56 X 0.312 INCH,RDH STL
-46	2						NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS
-47	2						WASHER,LOCK:INTL,0.092 ID X 0.175"OD,STL ---*---
-48	FT						PLASTIC CHANNEL:
-49	1						MARKER,IDENT:WARNING
-50	1						PANEL,REAR: (ATTACHING PARTS)
-51	4						SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL ---*---
-52	1						CKT BOARD ASSY:MAIN(A4 ) (ATTACHING PARTS)
-53	4						SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL
-54	4						BRACKET,COVER:TOP AND BOTTOM
-55	4						SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL
-56	1						SCREW,MACHINE:6-32 X 0.250 BDGH,NYL,SLOT
-57	1						SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL
-58	1						NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL ---*---
-							• CKT BOARD ASSY INCLUDES:
-59	1						• MICROCIRCUIT,DI:( U1205)
-60	1						• SWITCH,PUSH:(S785 AND S865)
-61	4						• SPACER,PB SW:0.164 INCH LONG
-62	4						• SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT
-63	4						• HEAT SINK,ELEC:XSTR,0.72 OD X 0.375"H
-64	8						• INSULATOR,DISC:TO-5 TRANSISTOR
-65	4						• HEAT SINK,ELEC:0.422 H X 1.240 INCH OD
-66	3						• CONNECTOR BODY,,:CKT CD MT,3 PRONG
-67	21						• SOCKET,PIN TERM:0.188 INCH LONG
-68	27						• CONTACT,ELEC:0.365L X 0.25 PH BRZ GOLD PL
-69	1						• SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE
-70	4						• TERM.,TEST PT:0.40 INCH LONG
-71	3						• LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L
-72	2						• LINK,TERM.CONNE:2 WIRE BLACK
-73	2						• CLAMP,LOOP:NYLON
-74	1						• HEAT SINK,DIODE:FINGER TYPE (ATTACHING PARTS)
-75	1						• SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL
-76	1						• NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL ---*---
-77	1						• MICROCIRCUIT,LI: (U1335)
-78	3						• CONTACT,ELEC:1.37 INCH LONG
-79	1						• CONN BODY,BPL,EL:3 WIRE RED
-80	3						• CONNECTOR,TERM.:0.48" L,22-26AWG WIRE
-81	1						INS,STANDOFF:0.312 OD X 1.0 INCH LONG (ATTACHING PARTS)
-82	1						SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL ---*---
	1						CKT BOARD ASSY:MAIN W/CAM SW
	1						• CONTACT,ELEC:GROUNDING
	1						• ACTR ASSY CAM S:RANGE(S590 ) (ATTACHING PARTS)
-83	4						• SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL ---*---

## FO-16

## Index

No.	Qty	1	2	3	4	5	Name & Description
-							•• ACTUATOR ASSEMBLY INCLUDES:
-84	1						•• CONTACT,ELEC:GROUNDING
-85	2						•• NUT,PLAIN,HEX.:4-40 X 0.188-INCH,BRS
-86	1						•• SPRING,FLAT:GREEN COLORED
	1						•• SPRING,FLAT:RED COLORED
-87	2						•• ROLLER,DETENT:
-88	1						•• BEARING,CAM SW:FRONT (ATTACHING PARTS)
-89	1						•• RING,RETAINING:0.338 ID X 0.025" THK,STL
-90	1						•• ACTUATOR,CAM SW:RANGE
-91	1						•• SHAFT,CAM SW:
-92	4						•• NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS
-93	1						•• BEARING,CAM SW:CENTER/REAR
-94	1						• CKT BOARD ASSY:RISE AND FALL(A3)
-95	2						•• CONNECTOR BODY,:CKT BD MT,3 PRONG
-96	1						•• SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT
-97	3						•• SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN
-98	1						•• LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L
-99	B						•• CONTACT ASSY,EL:CAM SWITCH,TOP
-100	8						•• RIVET,TUBULAR:0.051 OD X 0.115 INCH LONG
-101	2						•• SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE
-102	9						•• CONTACT,ELEC:0.365L X 0.25 PH BRZ GOLD PL
-103	6						•• SOCKET,PIN TERM:0.188 INCH LONG
-104	1						CKT BOARD ASSY:INPUT(A1) ---*---
-105	2						SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL (ATTACHING PARTS)
-							• CKT BOARD ASSEMBLY INCLUDES:
-106	16						• CONTACT,ELEC:0.365L X 0.25 PH BRZ GOLD PL
-107	1						• SWITCH,SLIDE: (S12 )
-108	1						• SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT
-109	1						• TERM.,TEST PT:0.40 INCH LONG
-110	1						• SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE
-111	1						• SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE
-112	2						• CONNECTOR BODY,:CKT BD MT,3 PRONG
-113	2						• SOCKET,PIN TERM:0.188 INCH LONG
-114	4						SPACER,POST:0.312 OD X 0.812 INCH LONG (ATTACHING PARTS)
-115	2						SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL ---*---
-119	2						CABLE ASSY,RF:50 OHM COAX,8.0 LONG
-							• EACH CABLE ASSY INCLUDES:
							• EYELET,METALLIC:0.126 OD X 0.23 INCH L,BRS
							• EYELET,METALLIC:0.152 OD X 0.245 INCH L,BRS
	1						CKT BOARD ASSY:TIMING W/CAM SW (ATTACHING PARTS)
-120	4						SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL
-							• CKT BOARD ASSY INCLUDES:
-121	2						• EXTENSION SHAFT:8.905 L X 0.125 DIA,AL,CRM
-122	1						• EXTENSION SHAFT:5.58 L X 0.125 DIA,AL,CRM
-123	3						• CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS
	4						• SETSCREW:4-40 X 0.125 INCH,HEX SOC STL
-124	1						• RESISTOR,VAR:(R190)
-125	2						• RESISTOR,VAR:(R335 AND R475)
-126	3						• SPACER,SWITCH:PLASTIC
-127	3						• CONTACT,ELEC:GROUNDING
	1						• ACTR ASSY CAM S:( S200) (ATTACHING PARTS)
-128	4						• SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL ---*---

## FO-16

## Index

No.	Qty	1	2	3	4	5	Name & Description
-							•• ACTR ASSY INCLUDES:
-129	1						•• COVER,CAM SW:1.85 L X 0.876 H,AL (ATTACHING PARTS)
-130	4						•• SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL
-131	4						•• WASHER,LOCK:INTL,0.12 ID X 0.26"OD,STL ----*----
	1						•• CONTACT,ELEC:GROUNDING
-132	2						•• NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS
-133	1						•• SPRING,FLAT:GREEN COLORED
	1						•• SPRING,FLAT:RED COLORED
-134	2						•• ROLLER,DETENT:
-135	1						•• BEARING,CAM SW:FRONT (ATTACHING PARTS)
-136	1						•• RING,RETAINING:0.338 ID X 0.025" THK,STL ----*----
-137	1						•• ACTUATOR,SWITCH:CAM SWITCH
-138	1						•• SHAFT,CAM SW:OUTER CONCENTRIC,W/DRIVER
-139	4						•• NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS
-140	1						•• BEARING,CAM SW:CENTER/REAR
	1						• ACTUATOR ASSY CAM S:(S330A,B) (ATTACHING PARTS)
-141	4						• SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL ----*----
-							•• ACTR ASSY INCLUDES:
-142	1						•• COVER,CAM SW:1.55 L X 0.876 H,AL (ATTACHING PARTS)
-143	4						•• SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL
-144	4						•• SCREW,MACHINE:3-48 X 0.125,PNH,STL ----*----
	1						•• CONTACT,ELEC:GROUNDING
-145	2						•• NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS
-146	1						•• SPRING,FLAT:GREEN COLORED
	1						•• SPRING,FLAT:RED COLORED
-147	2						•• ROLLER,DETENT:
-148	1						•• BEARING,CAM SW:FRONT (ATTACHING PARTS)
-149	1						•• RING,RETAINING:0.338 ID X 0.025" THK,STL ----*----
-150	1						•• ACTUATOR,SWITCH:CAM SWITCH
-151	1						•• SHAFT,CAM SW:W/DRIVER
-152	4						•• NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS
-153	1						•• BEARING,CAM SW:CENTER/REAR
	1						• ACTR ASSY,CAM S: (S450 ) (ATTACHING PARTS)
-154	4						• SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL ----*----
-							•• ACTR ASSY INCLUDES:
-155	1						•• COVER,CAM SW:1.95 L X 0.876 H,AL (ATTACHING PARTS)
-156	4						•• SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL
-157	4						•• WASHER,LOCK:INTL,0.12 ID X 0.26"OD,STL ----*----
	1						•• CONTACT,ELEC:GROUNDING
-158	2						•• NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS
-159	1						•• SPRING,FLAT:GREEN COLORED
	1						•• SPRING,FLAT:RED COLORED
-160	2						•• ROLLER,DETENT:
-161	1						•• BEARING,CAM SW:FRONT (ATTACHING PARTS)
-162	1						•• RING,RETAINING:0.338 ID X 0.025" THK,STL
-163	1						•• ACTUATOR,SWITCH:CAM SWITCH
-164	1						•• SHAFT,CAM SW:OUTER CNCTRC,W/DRIVER

## FO-16

## Index

No.	Qty	1	2	3	4	5	Name & Description
-165	4	••	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS				
-166	1	••	BEARING,CAM SW:CENTER/REAR				
-167	1	•	CKT BOARD ASSY:TIMING( A2)				
-168	1	••	SWITCH,PUSH:(S380A,8)				
-169	1	••	SWITCH,PUSH:(S380A,B,C)				
-170	8	••	SPACER,PB SW:BROWN,0.275 INCH LONG				
-171	4	••	LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L				
-172	6	••	SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE				
-173	37	••	CONTACT,ELEC:CKT CD SW,SPR				
-174	9	••	SOCKET,PIN TERM:0.188 INCH LONG				
-175	9	••	CONNECTOR BODY,;CKT CD MT,3 PRONG				
-176	4	••	CONTACT,ELEC:0.55 INCH LONG				
-177	8	••	CONTACT,ELEC:0.365L X 0.25 PH BRZ GOLD PL				
-178	1		SPRING,GROUND:FLAT				
	2		SUPPORT,PLUG-IN:				
	2		WASHER,FLAT:0.141 ID X .04THK,AL.,21 9 OD				
-179	1		FR SECT,PLUG-IN:LEFT SIDE,TOP AND BOTTOM				
	1		FR SECT,PLUG-IN:TOP LEFT				
-180	1		FR SECT,PLUG-IN:RIGHT SIDE,TOP AND BOTTOM				
-181	1		FR SECT,PLUG-IN:RIGHT SIDE,TOP AND BOTTOM				
-182	FT		WIRE,ELECTRICAL:2 WIRE RIBBON,18.063 FT L				
-183	FT		WIRE,ELECTRICAL:3 WIRE RIBBON,0.250 FT L				
-184	FT		WIRE,ELECTRICAL:4 WIRE RIBBON,12.042 FT L				
-185	FT		WIRE,ELECTRICAL:5 WIRE RIBBON,0.500 FT L				
-186	FT		WIRE,ELECTRICAL:6 WIRE RIBBON,0.625 FT L				
-187	1		EYELET,METALLIC:0.126 OD X 0.23 INCH L,BRS				
-188	1		EYELET,METALLIC:0.152 OD X 0.245 INCH L,BRS				
-189	81		CONNECTOR,TERM.:0.48" L,22-26AWG WIRE				
-190	2		CONN BODY,PL,EL:1 WIRE BROWN				
-191	1		CONN BODY,PL,EL:2 WIRE BLACK				
	2		CONN BODY,PL,EL:2 WIRE RED				
	1		CONN BODY,PL,EL:2 WIRE ORANGE				
-192	1		CONN BODY,PL,EL:3 WIRE YELLOW				
-193	4		CONN BODY,PL,EL:4 WIRE YELLOW				
	2		CONN BODY,PL,EL:4 WIRE GREEN				
-194	2		CONN BODY,PL,EL:5 WIRE GREEN				
-195	3		CONN BODY,PL,EL:6 WIRE BLUE				

## APPENDIX A

### Section I. INSTALLATION PROCEDURE

#### Before you start...

1. Check the rear panel markings. If the factory settings are compatible with the available line voltage and frequency, insert the desired plug-ins. Use the bail to raise the front of the instrument.

...go to Operating Instructions...

2. If a change is needed, follow these steps:

### WARNING

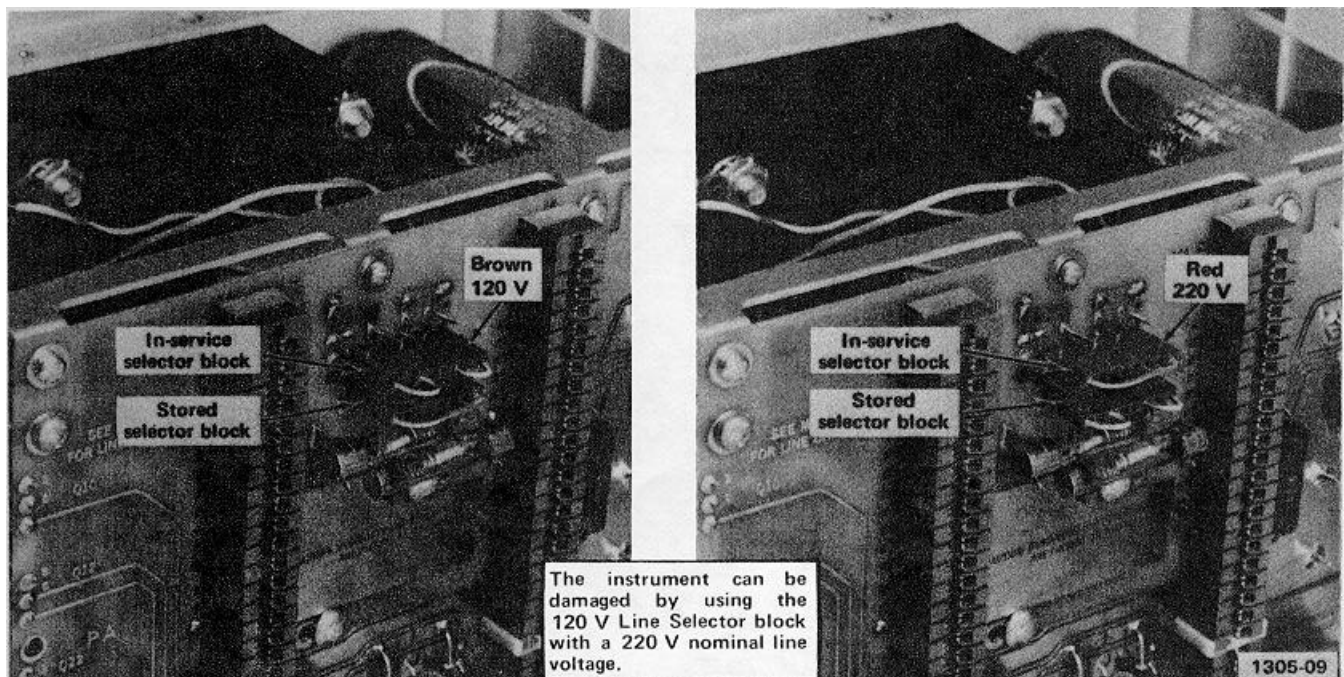
**Use a proper power source.** This instrument is designed to operate from a power source with its neutral at or near ground potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multiphase system, or across the legs of a single-phase, three-wire system.

### WARNING

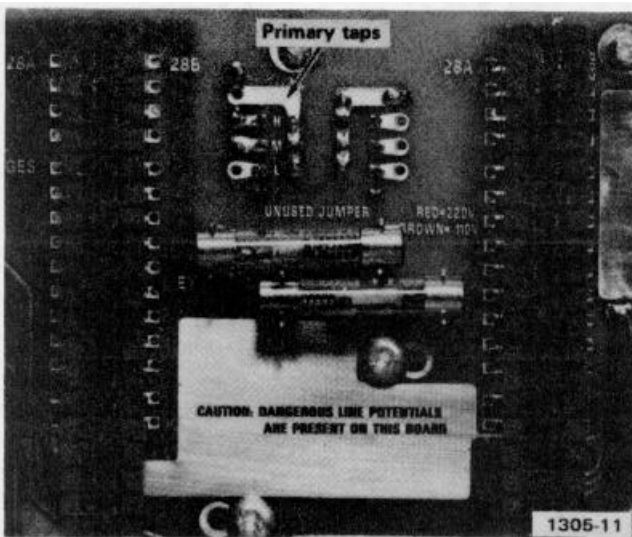
**Avoid live circuits.** Dangerous voltages exist at several points throughout this instrument. When the instrument is operated with the cover removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect power before cleaning the instrument, changing line selector blocks, or replacing parts.

#### a. Line Selector Block(s)

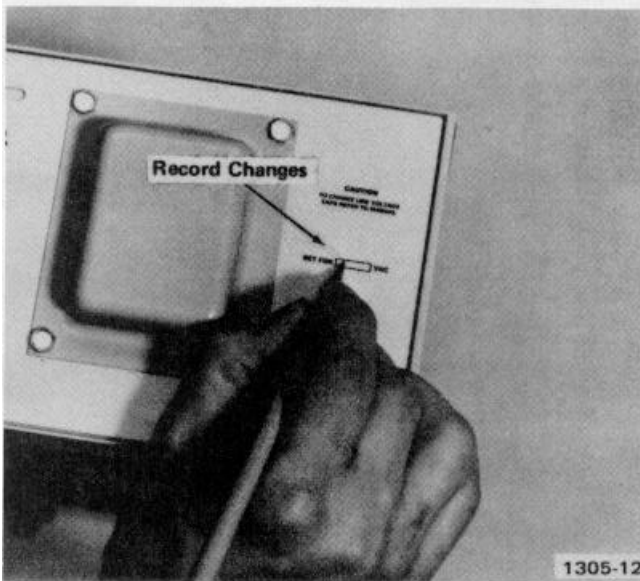
Remove the five hold-down screws on the top of the dust cover cabinet and lift the cabinet off. This gives easy access to the Line Selector blocks located on the main circuit board.



**b. Line Range Taps**



**c. Rear Panel**



Universal Transformer		
Line Selector Block Position	Regulating Ranges	
	120 Volts Nominal	220-Volts Nominal
L	90 VAC to 110 VAC	180 VAC to 220 VAC
M	99 VAC to 121 AC	198 VAC to 242 VAC
H	108 VAC to 132 VAC	216 VAC to 264 VAC
Line Fuse Data	1.6 A slow-blow	0.8 A slow-blow

3. Replace the cabinet.
4. If necessary, change the line cord power plug to match the power source receptacle or use an adapter.
5. Plug the cord into the power source.
6. Insert the desired plug-ins.
7. Use the bail to raise the front of the instrument

**...go to Operating Instructions...**

## TM 503 OPERATING INSTRUCTIONS

### Section II. INTRODUCTION

#### Description

The TEKTRONIX TM 503 Power Module is a three-compartment-wide mainframe for the TM 500 Series of Modular Instrumentation. It accepts up to three independently functional plug-in modules to form a compact, versatile and low cost instrumentation system. The TM 503 is a basic power source and provides an interconnecting scheme for the other members of the TM 500 Series family. Factory options allow customer modification using signal access at the plug-in module/power module interface to provide rear panel inputs and outputs, and interconnections between compartments.

#### Power Source

This instrument is designed to operate from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multiphase system, or across the legs of a single-phase, three-wire system.

#### Power Usage

With three plug-in modules installed, the TM 503 can require up to 120 W of power at the upper limits of the high line voltage ranges. Actual power consumption depends on the particular module combination and operating mode selected at any one time.

#### Operating Temperatures

The TM 503 can be operated in an ambient air temperature of 0°C to +50°C. Thermal cutout devices protect the system by disconnecting the power to the TM 503 Power Module when internal temperatures rise above a safe operating level. These devices automatically return power to the unit when the internal temperatures return to a safe level.

Since the TM 503 can be stored in temperatures between -40°C and +75°C, allow the instrument's chassis to return to within the operating limits before applying power.

## POWERING UP

#### Plug-in Modules

It is not necessary that all the plug-in compartments be utilized in order to operate the Power Module. The only modules needed are those necessary to accomplish the task.

**CAUTION**

*Turn the Power Module off before inserting the plug-in; otherwise, damage may occur to the plug-in circuitry.*

#### Module Installation

1. Check the location of the white plastic barriers on the interconnecting jack to insure that their locations match the slots in the edge of the plug-in module's circuit board.

2. Align the plug-in module chassis with the upper and lower guides of the selected compartment. Push the module in and press firmly to seat the circuit board in the interconnecting jack. (Remove the plug-in module by pulling on the white release latch located in the lower left corner of each module.)

3. Pull the PWR button on the left side of the TM 503. Some plug-in modules have independent power switches, usually labeled OUTPUT, controlling application of mainframe power to the module itself. Push this button to activate the plug-in module.

#### Loading Considerations

With three plug-in modules installed, the TM 503 can require up to 120W of power from the line at high-line

voltage range settings. Actual power consumed, of course, depends on the particular module combination selected at any one time.

This power capability can best be utilized by carefully planning the functional combinations of plug-ins, their external loads, and the resulting power distributions. Optimum conditions would be (1) equal loads in all three compartments, (2) as much power as possible dissipated

In external loads, and (3) operating in an ambient temperature around +250C.

The TM 503 provides each plug-in module with access to a pair of heat-sinked, chassis-mounted transistors, one NPN and one PNP. These Series-Pass transistors allow the plug-in modules to operate in power ranges not possible if the power had to be dissipated in the modules themselves.



## BUILDING A SYSTEM

### Family Compatibility

Mechanically, the plug-in modules are very similar to other TEKTRONIX product families. However, they are not electrically compatible. Therefore, the TM 503 interface has barriers on the mating connectors between pins 6 and 7 to insure that incompatible plug-ins cannot be inserted. See figure below. A compatible module will have a matching slot between pins 6 and 7 of its main circuit board edge connector. This slot and barrier combination is the primary keying assignment.

Another identifier for TM 500-compatible plug-in modules is the white color of the release latch.

### Customizing the Interface

The modularity of this instrumentation system provides for a host of functions to be performed by the plug-in modules. Specific functions are grouped into families or classes, of which there may be several plug-in module members. For instance, some classes are Power Supplies, Signal Sources, Measurement and so forth. Each modular member of a functional family will have a second slot peculiar to its family assignment located in its edge connector. The TM 503 user can "program" one or more compartments to accept only members of that family by installing a second barrier in the interface connector to match the module's slot location. Entire TM 503's could be "programmed" in this manner to set up instrumentation systems for specific work functions.

Jumper wires can be used to further specialize the interface. Compartments can be made to "talk" to each other by connecting jumpers on the back side of the interface board, using pins 14 through 28, A-side and B-side both, of the interconnecting jacks. See the following description of Option 2. Refer to each plug-in module's Manual for the I/O assignments of each pin at the rear interface. Once having made interconnections of a specialized nature, it is recommended that barriers be

installed on the interconnecting jacks to insure module compatibility with the customized wiring.

### Rear Panel

The rear sub-panel is punched for BNC and multi-pin connector mountings. Customer- or factory-installed connectors and wiring (see following description of catalog Option 2) This could provide external access to the interface for external I/O control. This feature makes the TM 500 Series Modular Instrumentation System very flexible in bench-top or rackmounted systems.

**Option 2.** This factory-installed option adds 25-mil squarepin connectors to the rear of the interconnecting jacks at all pin locations from pins 14A and B through pins 28A and B. This will keep the interface flexible by making it easy and fast to change customized wiring using prepared wires with squarepin receptacles and long-nose pliers or tweezers. It also protects the circuit board from damage by repeated soldering and unsoldering of jumper wires. This option also adds three BNC connectors and one 50-pin connector to the rear panel. These connectors are not pre-wired in order to give a system designer as much flexibility as possible. Instead, prepared jumpers, coax cables, and interconnection jack barriers are included in a kit.

### Stacking and Rackmounting

TM 503's with their cabinets and feet in place may be stacked on top of each other. The feet provide clearance for the lower unit's handle and at the same time give adequate spacing for the necessary ventilation.

The TM 503 is designed to be half-rack width. Field conversion kits with slide-out tracks are available to mount one or two TM 503's in a standard 19-inch rack. Vertical space needed is 5 1/4 inches.

## SPECIFICATIONS

### Power Requirements

**Line Voltage Ranges.** Universal Transformer: 100, 110, 200, 220, 240 VAC, all within 10%. Range changing or transformer accomplished with quick-change line-selector block

**Line Frequency Ranges.** Universal Transformer: 48 Hz to 440 Hz.

**Power Consumption.** Maximum primary power approximately 120 W at high line. Actual power consumption depends on plug-in selection and operating modes.

#### Power Cord Conductor Identification

Conductor	Color	Alternate
Color	Color	
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

### Supplies (Unregulated)

Two 25 VAC windings, 500 mA each, supplied to each compartment, independently.

+33.5 V and -33.5 V, 1 A maximum each supply, shared by all compartments.

17.5 VAC and +11.5 V, 3.6 A maximum, shared in any combination between these two supplies and shared among all compartments

#### NOTE

*Current and voltage ratings are for main frame maintenance only. In practice, not all available power may be used at once.*

### Temperature Range

Operating: 0°C to +50°C. Nonoperating: -40°C to +75°C.

### Altitude Range

Operating: To 15,000 feet. Nonoperating: To 50,000 feet.

### Other

Dimensions with Feet and Bail: H 6.0 in., W 8.7 in., L 15.3 in.

Weight without Plug-ins: Approximately 9.5 lb.

## TM 503 SYSTEM MAINTENANCE

### Section III. GENERAL

#### Introduction

This section of the manual is meant to support the entire TM 500 Series family of modules with a general coverage of the most commonly-needed service information pertinent to preventive maintenance, troubleshooting, ordering parts, and replacing components and sub-assemblies.

#### Cabinet Removal

##### **WARNING**

*Dangerous potentials exist at several points throughout the system. When the system must be operated with the cabinet removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect power before cleaning the system or replacing parts.*

Two screws on the top secure the cabinet to the TM 503 frame. Remove them and lift the cabinet straight up. Do not operate the system with the cabinet removed any longer than necessary for troubleshooting and calibration. Re-install the cabinet to protect the interior from dust and to remove personnel shock hazards.

#### Cleaning

##### **WARNING**

*Adequate ventilation should be provided while using TRICHLORO TRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flames; the products of decomposition are toxic and irritating. Since TRICHLORO TRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided. When necessary, use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician immediately.*

Exterior. Loose dust may be removed with a soft cloth or a dry brush. Water and a mild detergent may be

used; however, abrasive cleaners should not be used.

##### **WARNING**

*Compressed air is dangerous and can cause serious bodily harm if protective means or methods are not observed to prevent a chip or particle (of whatever size) from being blown into the eyes or unbroken skin of the operator or other personnel. Compressed air shall not be used for cleaning purposes except where reduced to less than 30 p.s.i.f. and then only with effective chip guarding and personnel protective equipment. Do not use compressed air to dry parts when trichlorotrifluoroethane has been used.*

**Interior.** Cleaning the interior of a unit should precede calibration since the cleaning processes could alter the settings of calibration adjustments. Use low-velocity compressed air to blow off accumulated dust. Hardened dirt can be removed with a soft, dry brush, cotton-tipped swab, or a cloth dampened in a solution of water and mild detergent.

#### Preventive Maintenance

Preventive maintenance steps performed on a regular basis will enhance the reliability of the instrumentation system. However, periodic checks of the semiconductors in the absence of a malfunction are not recommended as preventive maintenance measures. See the semiconductor checking information under Troubleshooting Techniques which follow. A convenient time to perform preventive maintenance is just before instrument calibration.

#### Calibration

To insure accurate signal generation and measurement, the performance of individual units comprising the system should be checked periodically. Refer to TB 11-6625-2980-35 for complete calibration procedures.

## TROUBLESHOOTING AIDS

### Introduction

The following is provided to augment information contained elsewhere in this and other TM 500 Series family manuals when troubleshooting becomes necessary.

### Circuit Descriptions

Each manual has a section devoted to explaining circuit operating theory. Used conjointly with the schematics, this can be a powerful analytic tool.

### Diagrams

Block diagrams and detailed circuit schematics are located on foldout pages in the service section of most of the TM 500 Series family manuals. The schematic diagrams show the component values and assigned circuit reference numbers of each part necessary to the circuit design. Usually the first page of the service sections defines the circuit symbols and reference designators used in that particular instrument. Major circuits are usually identifiable by a series of component numbers. Important wave-forms and voltages may be shown within the diagrams or on adjoining aprons. Those portions of the circuits located on circuit boards are enclosed with a blue tint outline.

### Cam Switch Charts

Cam switches shown on the diagrams are coded on comprehensive charts to locate the cam number of the switch contact in the complete switch assembly, counting from the front, or knob end, toward the rear of the switch. The charts also indicate with a solid dot when each contact is closed.

### Circuit Board Illustrations

Line illustrations showing component locations keyed with a grid scheme for each circuit board are usually placed on the back of a foldout page and sequenced as close as possible to an associated schematic. The GRID LOC column in the Electrical Parts Lists keys each component to the Location illustrations.

### Component and Wiring Color Codes

Colored stripes or dots on electrical components signify electrical values, tolerances, etc., according to EIA standards. Components not color-coded usually have information printed on the body. The wiring coding follows the same EIA standards.

### Testing Equipment

Generally, a wide-band oscilloscope, a probe, and a multimeter are all that is needed to perform basic waveform and voltage checks for diagnostic purposes. The calibration procedures in the manual for each plug-in module list specific test equipment and the features necessary to adequately check out that particular module.

## TROUBLESHOOTING TECHNIQUES

### Introduction

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding to extensive troubleshooting.

### Control Settings

Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instructions section of the manual for the instrument involved.

### System and Associated Equipment

Before proceeding with troubleshooting the TM 500 Series system, check that the instruments in the system are operating correctly. Check for proper interconnection between the power module and the plug-in modules. Check the line voltage at the power source. Check that the signal is properly connected and that the interconnecting cables and the signal source are not defective.

The associated plug-in modules can be checked for proper operation quickly by substituting other like units

known to be operating properly. If the trouble persists after substitution, then the power module is probably at fault. Moving a properly operating plug-in from compartment to compartment will help determine if one or more compartments has a problem.

### Visual Check

Inspect the portion of the system in which the trouble is suspected. Many troubles can be located by visual clues such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

### Instrument Calibration

Check the calibration of the suspected plug-in module or the affected circuit if the trouble is obviously in a certain circuit. The trouble may only be a result of misadjustment or may be corrected by re-calibration. Complete calibration instructions are given in TB 11-6625-2980-35.

### Circuit Isolation

Note the symptom. It often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by making waveform and voltage measurements.

Incorrect operation of all circuits often means trouble in the power supplies. Using a multimeter, check first for correct voltages of the individual regulated supplies according to the plug-in module schematics and calibration procedures. Then check the unregulated supplies of the power modules. Defective components elsewhere in the instruments can appear as power supply problems. In these instances, suspected circuits should be disconnected from apparently bad power supplies one at a time to narrow the search.

### Voltages and Waveforms

Often defective components can be located by using waveform and voltage indications when they appear on the schematic or in the calibration procedures. Such waveforms and voltage labels are typical indications and will vary between instruments. To obtain operating conditions similar to those used to take these readings, refer to the first diagram in the service sections.

### Component Checking

If a component cannot be disconnected from its circuit, then the effects of the associated circuitry must be considered when evaluating the measurement. Except for soldered in transistors and integrated circuits,

most components can be lifted at one end from the circuit board.

**Transistors and IC's.** Turn the power switch off before removing or replacing any semiconductor.

A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a new component for it (or one which has been checked previously). However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended, since they do not check operation under simulated operating conditions. A suction-type desoldering tool must be used to remove soldered-in transistors; see component replacement procedure for details.

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit description is essential to troubleshooting circuits using IC's. Operating waveforms, logic levels, and other operating information for the IC's are given in the circuit description information of the appropriate manual. Use care when checking voltages and waveforms around the IC's so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14- and 16-pin in-line IC's is with an integrated-circuit test clip. This device also doubles as an extraction tool.

**Diodes.** Do not use an ohmmeter that has a high internal current. High currents may damage the diode.

A diode may be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 mV and 3 V, the resistance should be very high in one direction and very low when the leads are reversed.

**Resistors.** Check the resistors with an ohmmeter. Resistor tolerances are given in the Electrical Parts List in every manual. Resistors do not normally need to be replaced unless the measured value varies widely from the specified value.

**Capacitors.** A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter which will not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacity meter, or by checking whether it passes AC signals.

## PARTS REPLACEMENT

### Replacing

The exploded view drawings associated with the Mechanical Parts Lists, located to the rear of most manuals, may be especially helpful when disassembling or reassembling individual components or sub-assemblies.

**Circuit Boards.** If a circuit board is damaged beyond repair, the entire assembly including all soldered-on components, can be replaced. Part numbers are given in the mechanical parts lists for the completely wired (670 prefix) board.

To remove or replace a board, proceed as follows:

1. Disconnect all leads connected to the board (both soldered lead connections and solderless pin connections).

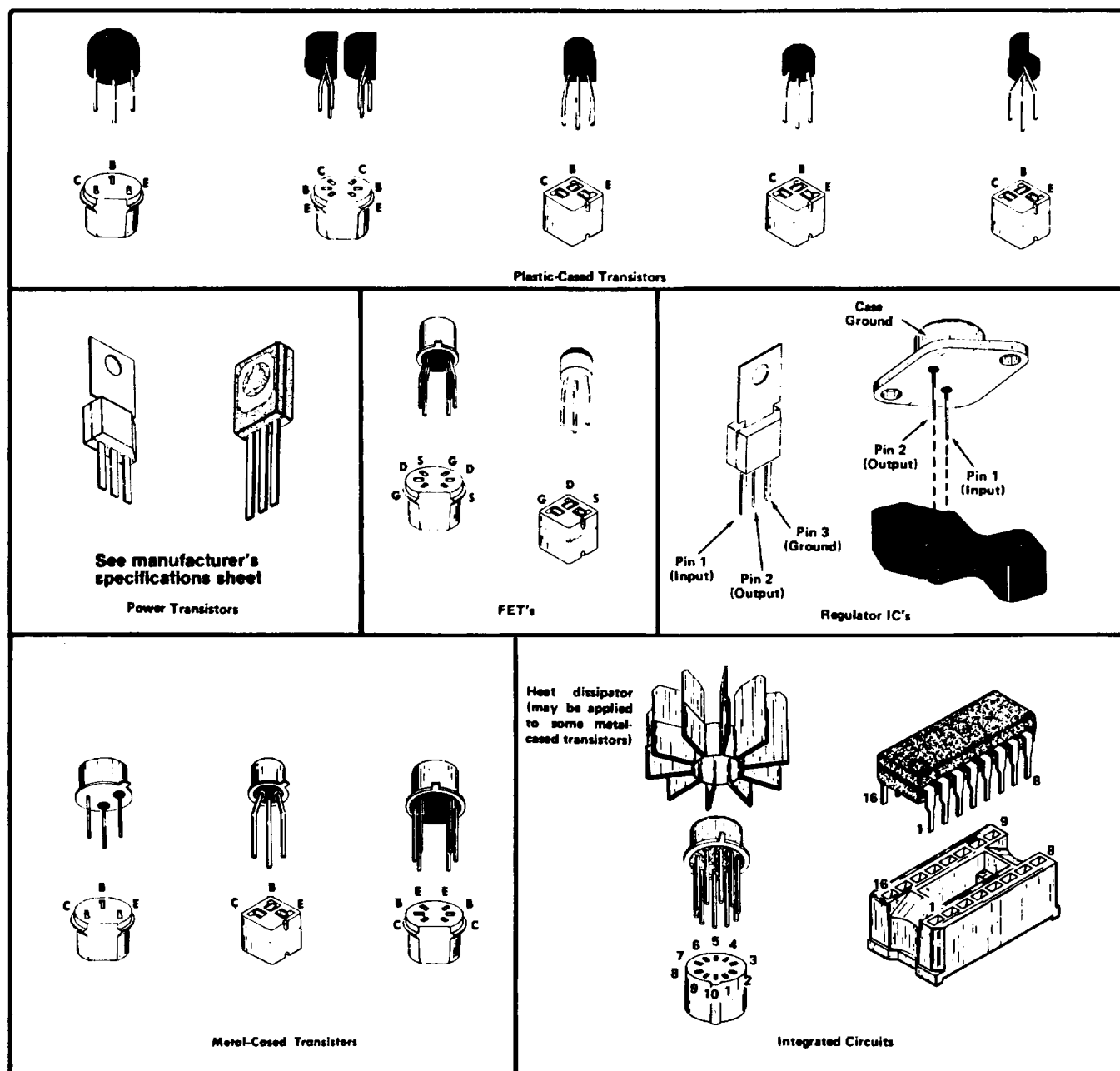
2. Remove all screws holding the board to the chassis or other mounting surface. Some boards may be held fast by plastic mounting clips around the board

edges. For these, push the mounting clips away from the circuit board edges to free the board. Also, remove any knobs, etc., that would prevent the board from being lifted out of the instrument.

3. Lift the circuit board out of the unit. Do not force or bend the board.

4. To replace the board, reverse the order of removal. Use care when replacing pin connectors; if forced into place incorrectly positioned, the pin connectors may be damaged.

**Transistors and IC's.** Transistors and IC's should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the calibration of the instruments. When a transistor is replaced, check the operation of the part of the instrument that may be affected.



Replacement semiconductors should be of the original type or a direct replacement. The above figure shows the lead configuration of the semiconductors used in this instrument system. When removing soldered-in transistors, use a suction-type de-soldering tool to remove the solder from the holes in the circuit board.

An extracting tool should be used to remove the 14- and 16-pin integrated circuits to prevent damage to the pins. If an extracting tool is not available, use care to

avoid damaging the pins. Pull slowly and evenly on both ends of the IC. Try to avoid having one end of the IC disengage from the socket before the other end.

To replace one of the power transistors mounted on the Power Module chassis adjacent to the interface circuit board, first unsolder the leads. Then, loosen the nuts which clamp the transistor to the chassis. Remove the defective transistor. When replacing the transistor, use a mica washer on the metal tab to increase heat transfer from the transistor to the chassis.

**Interconnecting Pins.** To replace a pin which is mounted on a circuit board, first disconnect any pin connectors. Then, unsolder the damaged pin and pull it out of the board with a pair of pliers. Be careful not to damage the wiring on the board with too much heat. Ream out the hole in the circuit board with a 0.031-inch drill. Remove the ferrule from the new interconnecting pin and press the new pin into the hole in the circuit board. Position the pin in the same manner as the old pin. If the old pin was bent at an angle to mate with a connector, bend the new pin to match the associated pins.

**Cam Switches.** Repair of cam type switches should be undertaken only by experienced maintenance personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch.

The cam-type switches consist of rotating cam drums which are turned by front-panel knobs, and sets of spring-leaf contacts mounted on adjacent circuit boards. The contacts are actuated by lobes on the cams. These switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

1. Remove the screws which hold the metal cover on the switch, and lift the cover off the switch. The switch is now open for inspection or cleaning.

2. To completely remove a switch from the circuit board, first remove any knobs or shaft extensions. Loosen the coupling at the potentiometer at the rear of the switch, and pull the long shaft out of the switch assembly.

3. Remove the screws (from the opposite side of the circuit board) which hold the cam drum to the board.

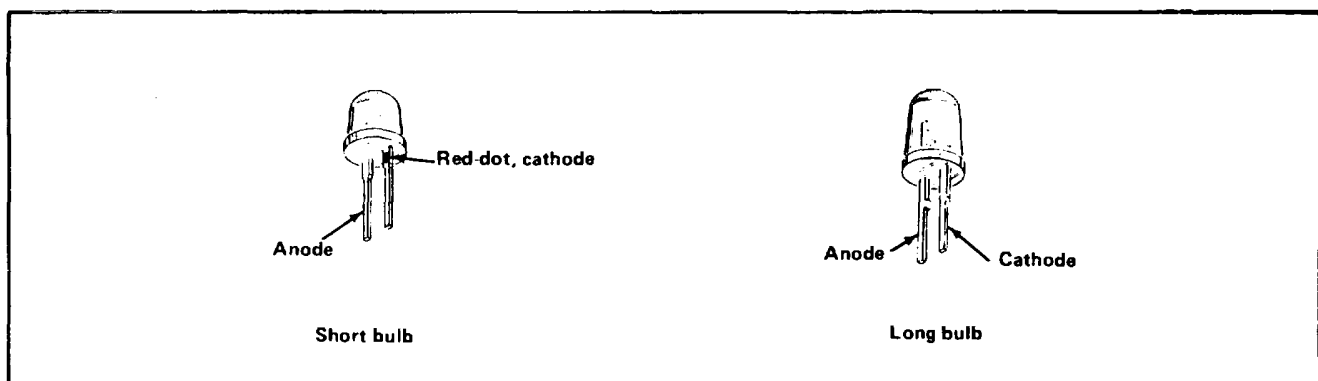
4. To remove the cam drum from the front support block, remove the retaining ring from the shaft on the front of the switch and slide the cam drum out of the support block. Be careful not to lose the small detent roller.

5. To replace defective switch contacts, follow the instructions given in the switch repair kit.

6. To re-install the switch assembly, reverse the above procedure.

**Pushbutton Switches.** The pushbutton switches are not repairable and should be replaced as a unit if defective. Use a suction-type de-soldering tool to remove solder from the circuit board when removing these switches.

**Light-Emitting Diodes.** LED's used as indicators are mounted on the sub-panels with plastic sleeve sockets similar to the incandescent bulb mountings or they are soldered directly to a sub-assembly and so mounted that they protrude through holes in the panel. In these cases, the sub-assembly must be exposed and the anode and cathode lead orientations carefully noted before unsoldering the defective LED. See figure below for LED lead identifying information.





**Power Transformer.** Refer to the exploded view drawing at the rear of the Power Module manuals for disassembly of the rear panel to expose the power transformer. Refer to the schematic diagram color-coding information for correct wiring. After replacement, check out the power supply voltages before installing a plug-in module.

### REPACKAGING FOR SHIPMENT

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Refer to the following table for carton test strength requirements.

2. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.
4. Seal carton with shipping tape or industrial stapler.

### SHIPPING CARTON TEST STRENGTH

Gross Weight (lb.)	Carton Test Strength (lb.)
0-10	200
10-30	275
30-120	375
120-140	500
140-160	600

## DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

### Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).  
Values less than one are in microfarads ( $\mu$ F).  
Resistors = Ohms ( $\Omega$ ).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

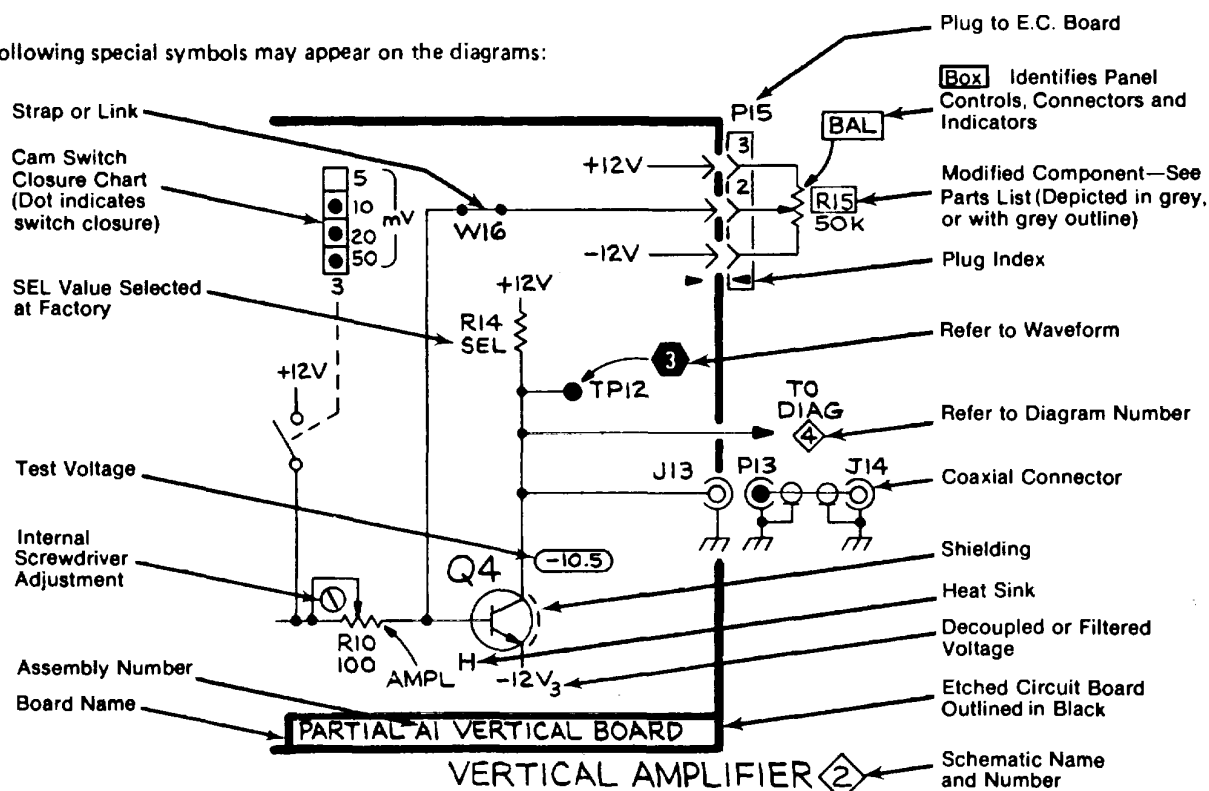
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966 Drafting Practices.  
Y14.2, 1973 Line Conventions and Lettering.  
Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

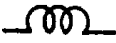

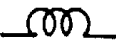
The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board etc.)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, Inseparable or non-repairable (integrated circuit, etc.)
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode, signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc.)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	O	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

The following special symbols may appear on the diagrams:



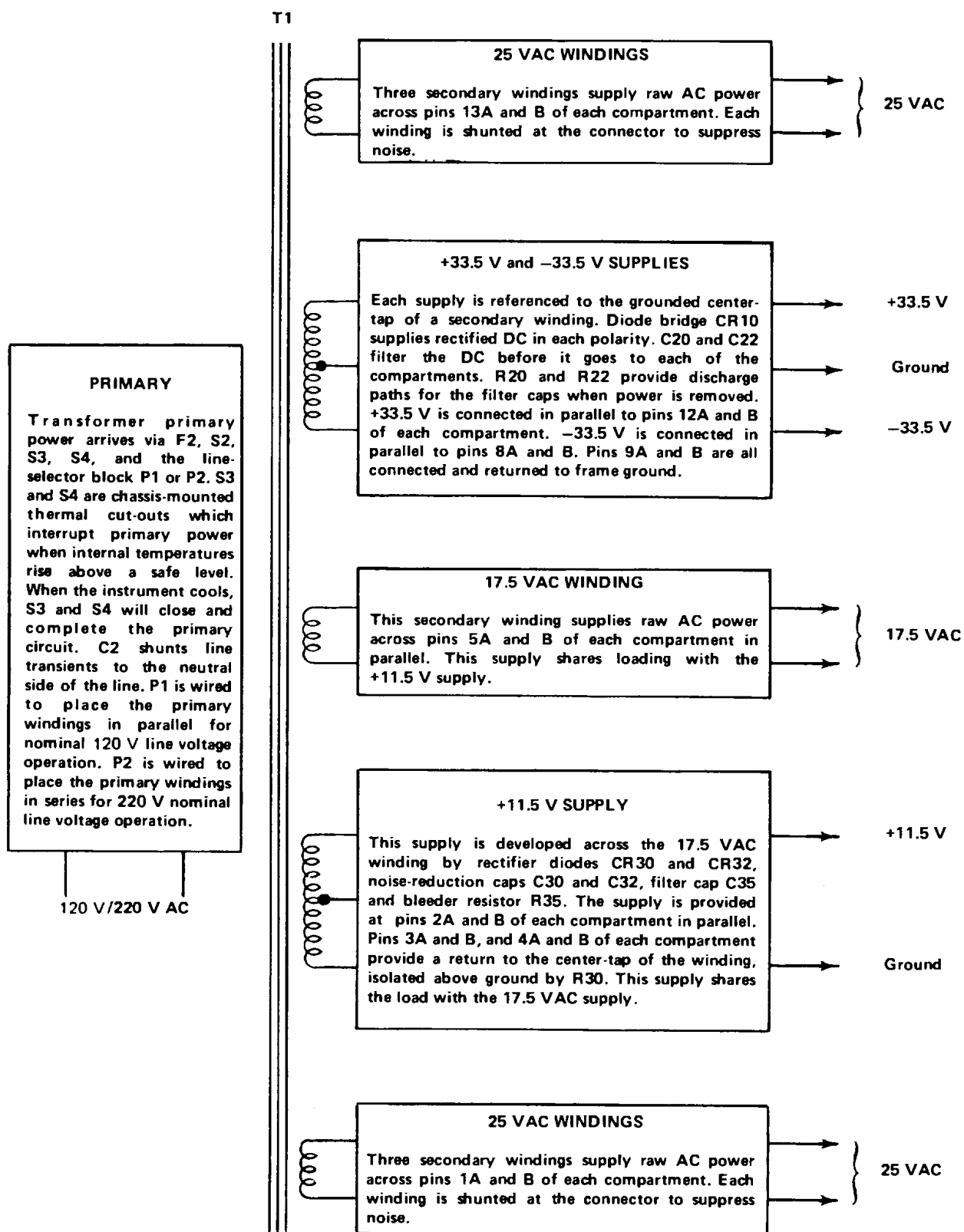
**POWER MODULE INTERFACE  
PIN ASSIGNMENTS  
FRONT VIEW**

	A		B	
	28		28	
	27		27	
	26		26	
	25		25	
	24		24	
	23		23	
	22		22	
	21		21	
	20		20	
	19		19	
	18		18	
	17		17	
	16		16	
	15		15	
	14		14	
	13		13	
25 VAC winding.	12		12	
+33.5 V filtered DC.	11		11	
Base lead of PNP Series-Pass.	10		10	
Emitter lead of PNP Series-Pass.	9		9	
±33.5 V common return.	8		8	
−33.5 V filtered DC.	7		7	
Emitter lead of NPN Series-Pass.	6		6	
Base lead of NPN Series-Pass.	5		5	
17.5 VAC winding.	4		4	
+11.5 V common return.	3		3	
+11.5 V common return.	2		2	
+11.5 V filtered DC.	1		1	
25 VAC winding.				
	A		B	

No permanent I/O assignments. Refer to plug-in module manuals for specific assignments.

No permanent I/O assignments. Refer to plug-in module manuals for specific assignments.

## DETAILED BLOCK DIAGRAM



## REPLACEABLE MECHANICAL PARTS

### SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number

OOX Part removed after this serial number

### INDEX NUMBERS

Items in this section are referenced by index numbers to **the figure on page A-23**.

### INDICATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5                      *Name & Description*

*Assembly and/or Component*

*Attaching parts for Assembly and/or Component*

- - - \* - - -

*Detail Part of Assembly and/or Component*

*Attaching parts for Detail Part*

- - - \* - - -

*Parts of Detail Part*

*Attaching parts for Parts of Detail Part*

- - - \* - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - - - indicates the end of

**Attaching parts must be purchased separately, unless otherwise specified.**

### ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

### ABBREVIATIONS

"	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICON	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
1ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
.ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTIONS	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

Index No.	Qty	1	2	3	4	5	Name & Description
-1	1	COVER,CAL FXTR:W/HANDLE (ATTACHING PARTS)					
-2	2	SCREW,MACHINE:6-32 X 0.188 INCH,PNH STL					
	1	SCREW,MIACHINE:8-32 X 0.188,TRH,SST --- * ---					
	-	• COVER INCLUDES:					
	1	• COVER,CAL FXTR:W/O HANDLE					
-3	1	• HANDLE,CARRYING: (ATTACHING PARTS)					
-4							
-5							
-6	2	• RIVET,BLIND:0.125 OD X 0.357 L,DOMED HEAD					
	2	• WSHR,SHOULDERED:O.143" ID X 0.75" OD,BRS --- * ---					
-7	1	EXTENSION SHAFT:13.612 L X 0.048 STL W/PB (ATTACHING PARTS)					
-8	2	SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL --- * ---					
-9	1	ADAPTER,SW ACTR:					
-10	1	SWITCH,PUSH-PUL:10A,250VAC					
-11	1	BRACKET,ANGLE:CKT CARD SPRT,LEFT (ATTACHING PARTS)					
-12	2	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL					
-13	4	NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL					
-14	2	SCREW,MACHINE:6-32 X 0.312"100 DEG,FLH STL --- * ---					
-15	2	SWITCH,THERMO:(S3,S4) (ATTACHING PARTS FOR EACH)					
-16	2	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL					
-17	2	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL --- * ---					
-18	1	TERMINAL,LUG:0.146 INCH DIA DE,45 DEG BEND (ATTACHING PARTS)					
-19	1	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL --- * ---					
-20	1	TRANSFORMER: (T1) (ATTACHING PARTS)					
-21	4	SCREW,MACHINE:10-32 X 2.250" HEX.HD STL					
-22	4	NUT,EXTENDED WA:10-32 X 0.375 INCH,STL					
-23	4	INS SLV,ELEC:0.187 ID X 1.50 INCH LONG					
	4	WASHER,LOCK:INT,0.20 ID X0.376" OD,STL					
	1	TERMINAL,LUG:SE #10 --- * ---					
	1	TERMINAL,LUG:SE #8 (ATTACHING PARTS)					
	1	NUT,PLAIN,EXT W:8-32 X 0.344 INCH,STL --- * ---					
-24	1	COVER,ELEC XFMR:					
-25	1	CKT BOARD ASSY:INTERFACE(A1)					
-26	14	CONTACT,ELEC:0.365 L X 0.25 PH BRZ GOLD PL					
-27	3	CONNECTOR,RCPT,:28/56 CONTACT					
-28	3	KEY,CONN PLZN:					
-29	4	CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE					
-30	1	RETAINER,CAP: (ATTACHING PARTS)					
-31	2	SCR,ASSEM,WSHR:6-32 X 0.312 INCH,PNH STL					
-32	2	NUT,PLAIN,HEX. :6-32 X 0.25 INCH,BRS --- * ---					

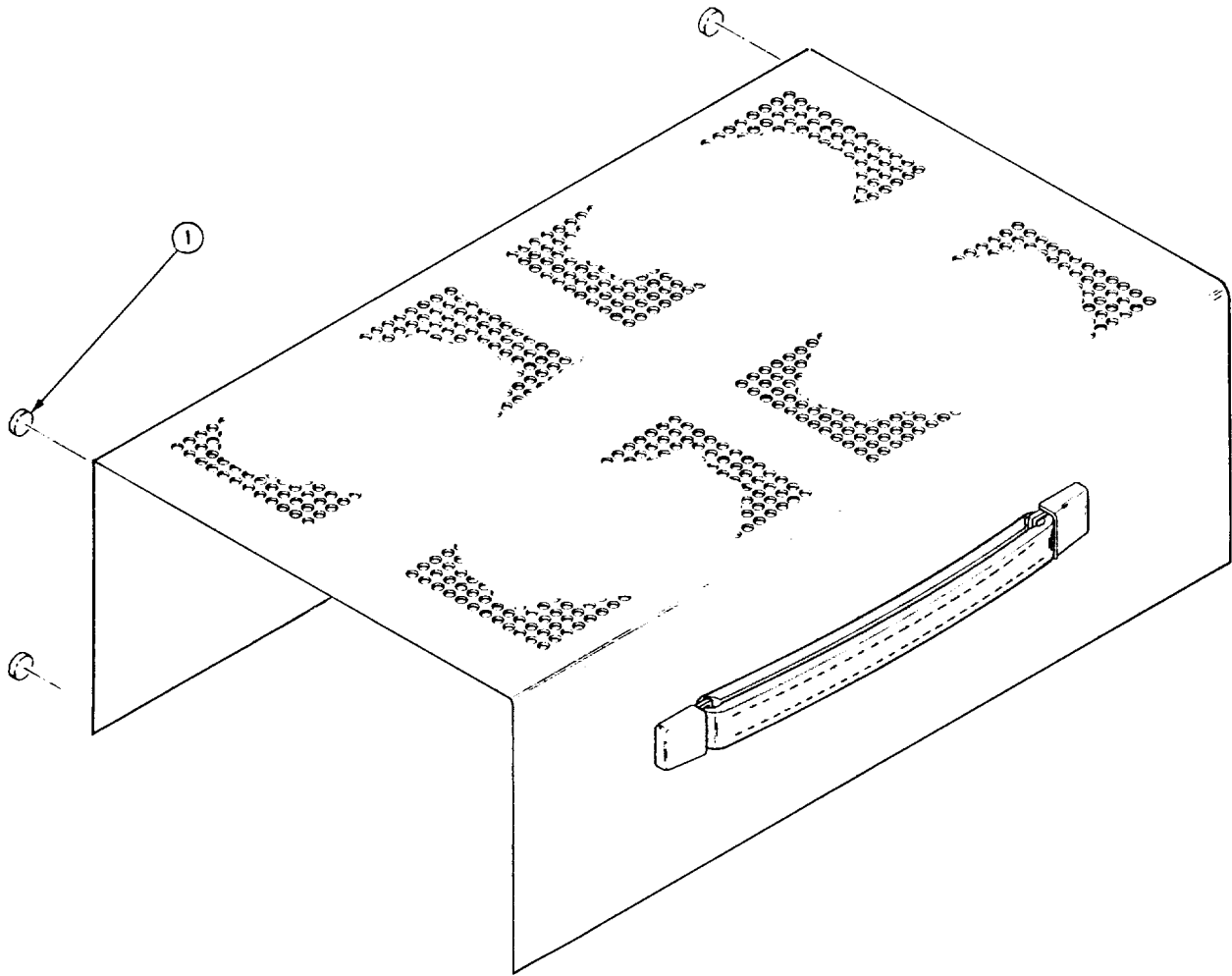
Index					
No.	Qty	1	2	3	4 5 Name & Description
-33	1				LINK,TERM. CONN:8,22 AWG,1.5 L
-34	1				LINK,TERM. CONN:8,22 AWG,1.5 L
-35	1				• BRACKET,REIF-F: (ATTACHING PARTS)
-36					• DELETED
-37	4				• RIVET,BLIND:0.125 DIA GRIP,AL ---*---
					(ATTACHING PARTS FOR CKT BD ASSY)
-38	2				SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL
-39	2				NUT,CHASSIS MTG:
-40	6				NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL
-41	6				INSULATOR,WSHR:0.812 OD X 0.0025 INCH THK
	6				WASHER,FLAT:0.15 ID X 0.375 INCH OD,STL ---*---
-42	1				HEAT SINK,XSTR:
-43	1				HEAT SINK,XSTR:
-44	1				BRACKET,ANGLE:CKT CARD SPRT,RIGHT (ATTACHING PARTS)
-45	2				SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL
-46	4				NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL
-47	2				SCREW,HACHINE:6-32 X 0.312"100 DEG,FLH STL ---*---
-48	4				LEG,ELEC EQUIP.:PLASTIC (ATTACHING PARTS FOR EACH)
-49	1				SCREW,MACHINE:8-32 X 1.5 INCH,PNH,STL
-50	1				NUT,PLAIN,EXT W:8-32 X 0.344 INCH,STL ---*---
-51	1				PANEL,REAR:OPTION 2 (ATTACHING PARTS)
	2				NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL
	2				SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL ---*---
-52	1				BSHG,STRAIN RLF:
-53	1				CABLE ASSY,PWR:
-54	1				FUSEHOLDER: W/MOUNTING HARDWARE
-55	1				WASHER,NONMETAL:0.5 ID X 0.688 INCH OD,NPRN
-56	3				GUIDE,PL-IN:UPPER (ATTACHING PARTS FOR EACH)
-57	1				SCREW,MACHINE:2-56 X 0.188" 82 DEG,FLH,STL ---*---
	2				HINGE BLOCK,STA:LEFT
	2				HINGE BLOCK,STA:RIGHT
	1				STAND,ELEC EQPT:
-58	1				FLIPSTAND,CAB.: COVER,PWR SPLY:BOTTOM
	1				COVER,PWR SPLY:BOTTOM
	1				CAB.BOT,PWR SUP: (ATTACHING PARTS)
-59	4				SCREW,MACHINE:4-40 X 0.188"100 DEG,FLH STL ---*---

## Index

No	Qty	1	2	3	4	5	Name & Description
-	-						• CABINET BOTTOM ASSEMBLY INCLUDES:
-60	1						• CAB.BOT,PWR SUP:
-61	2						• FOOT,CABINET:LEFT FRONT AND RIGHT REAR
-62	2						• SPT PIVOT,FLIP:LEFT FRONT AND RIGHT REAR (ATTACHING PARTS FOR EACH)
-63	2						• SCREW,IMACHINE:6-32 X 0.75 INCH,FILH STL
-64	2						• NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL --- * ---
-65	2						• FOOT,CABINET:RIGHT FRONT AND LEFT REAR
-66	2						• SPT PIVOT,FLIP:RIGHT FRONT AND LEFT REAR (ATTACHING PARTS FOR EACH)
-67	2						• SCREW,MACHINE:6-32 X 0.75 INCH,FILH STL
-68	2						• NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL --- * ---
-69	3						GUIDE,SLIDE:BLACK (ATTACHING PARTS)
-70	2						SCREW,MACHINE:4-40 X 0.312"100 DEG,FLH STL
-71	1						SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL --- * ---
		1					MARKER,IDENT:MARKED "CAUTION"
		2					PLATE,IDENT:WARNING,TRANSISTORS
-72	1						FRAME ASSY,CAB:
-73	3						CONTACT,ELECTRICAL: (ATTACHING PARTS)
-74	3						EYELET,METALLIC:0.089 OD X 0.125" L,BRASS --- * ---



# STANDARD ACCESSORIES



Index No	Qty	1	2	3	4	5	Nome & Description
-1	4						BUMPER,PLASTIC:0.45 DIA X 0.195 GRAY POLY
	1						MANUAL, TECH: INSTRUCTION

## TM 503 POWER MODULE

A-25/(A-26 blank)

**APPENDIX B****REFERENCES**

---

DA Pam 310-4	Index of Technical Publications: Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrications Orders.
DA Pam 310-7	US Army Index of Modification Work Orders.
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies, and Equipment Used by the Army.
TB 43-0118	Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters.
TB 43-180	Calibration Requirements for the Maintenance of Army Materiel.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).
TM 11-6625-2980-24P	Organizational, Direct Support and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) Pulse Generator AN/USM-359A. (To be published)

## APPENDIX C

## COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS

## Section I. INTRODUCTION

**B-1. SCOPE**

This appendix lists components of end item and basic issue items for the pulse generator to help you inventory items required for safe and efficient operation.

**B-2. GENERAL**

The Components of End Item and Basic Issue Items Lists are divided into the following sections:

*a. Section II. Components of End Item.* This listing is for informational purposes only, and is not authority to requisition replacements. These items are part of the end item, but are removed and separately packaged for transportation or shipment. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Illustrations are furnished to assist you in identifying the items.

*b. Section III. Basic Issue Items.* These are the minimum essential items required to place the pulse generator in operation, to operate it, and to perform emergency repairs. Although shipped separately packaged, BII must be with the pulse generator during operation and whenever it is transferred between property accounts. The illustrations will assist you with hard-to-identify items. This manual is your authority to request/requisition replacement BII, based on

TOE/MTOE authorization of the end item.

**B-3. EXPLANATION OF COLUMNS**

The following provides an explanation of columns found in the tabular listings:

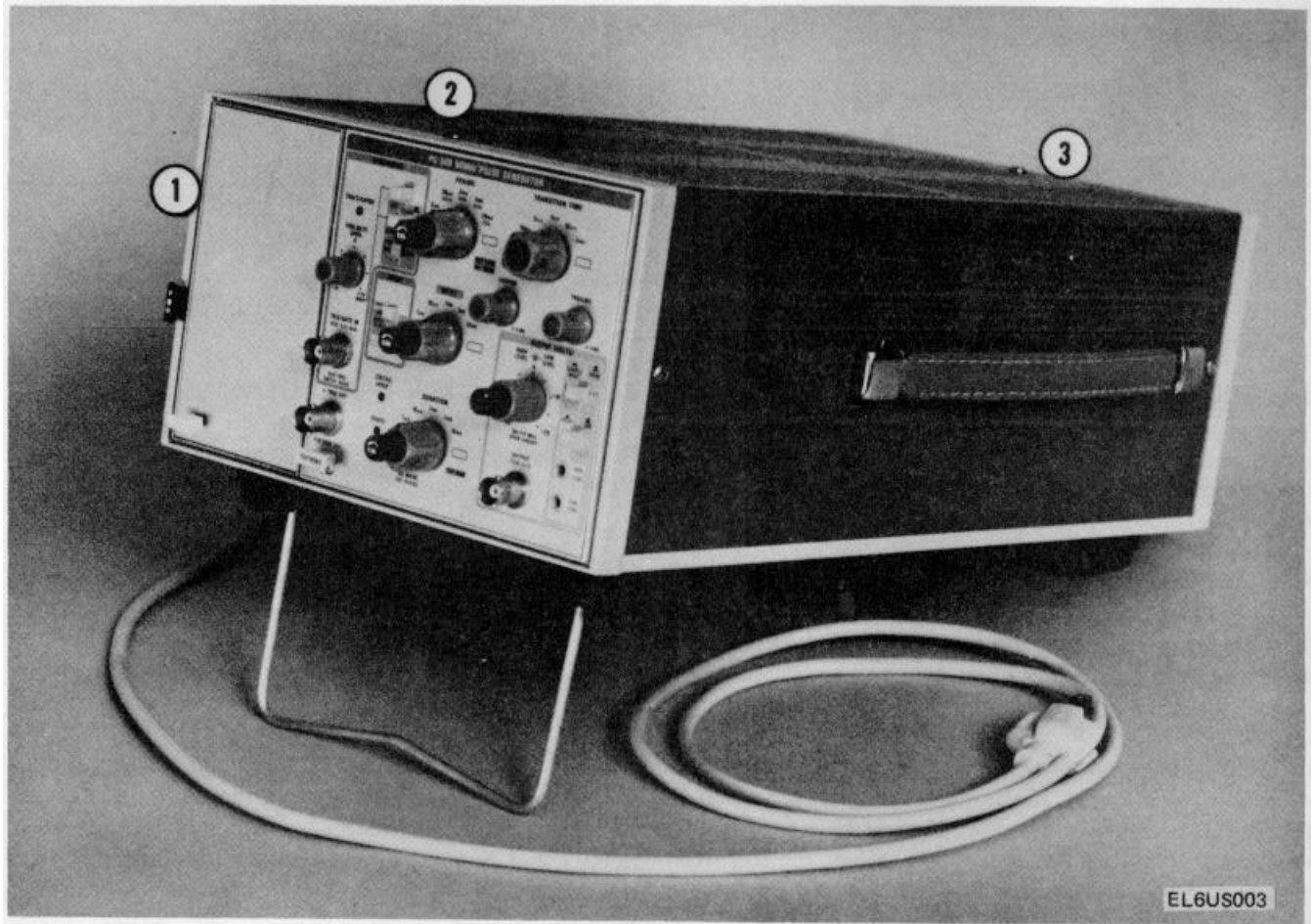
*a. Column (1) - Illustration Number (Illus Number).* This column indicates the number of the illustration in which the item is shown.

*b. Column (2) - National Stock Number.* Indicates the National stock number assigned to the item and will be used for requisitioning purposes.

*c. Column (3) - Description.* Indicates the Federal item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the FSCM (in parentheses) followed by the part number.

*d. Column (4) - Unit of Measure (U/M).* Indicates the measure used in performing the actual operational/maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr).

*e. Column (5) - Quantity required (Qty rqr).* Indicates the quantity of the item authorized to be used with/on the equipment.



Pulse generator AN/USM-395A.

## SECTION II. COMPONENTS OF END ITEM

(1) Illus Number	(2) National Stock Number	(3) Description FSCM and Part Number	Usable On Code	(4) U/M	(5) Qty rqr
1		PANEL, BLANK: (80009) 016-0195-03		EA	1
2	6625-01-051-6639	PLUG-IN UNIT, ELECTRONIC TEST EQUIPMENT. SG-1178/USM-359A (80009) PG-508		EA	1
3	6625-00-373-7528	POWER SUPPLY. PP-7578/USM-359A (80009) TM-503		EA	1

### SECTION III. BASIC ISSUE ITEMS

(1) Illus Number	(2) National Stock Number	(3) Description FSCM and Part Number	Usable On Code	(4) U/M	(5) Qty rqr
		MANUAL, TECHNICAL: TM 11-6625-2980-14		EA	1

## APPENDIX E

## MAINTENANCE ALLOCATION

## Section I. INTRODUCTION

**E-1. General**

This appendix provides a summary of the maintenance operations for the Pulse Generator AN/USM-359A. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

*g. Install.* The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

**E-2. Maintenance Function**

Maintenance functions will be limited to and defined as follows:

*h. Replace.* The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

*a. Inspect.* To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

*i. Repair.* The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

*b. Test.* To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

*j. Overhaul.* That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

*c. Service.* Operations required periodically to keep an item in proper operating conditions, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

*d. Adjust.* To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

*k. Rebuild.* Consists of those services actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/components.

*e. Align.* To adjust specified variable elements of an item to bring about optimum or desired performance.

*f. Calibrate.* To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement.

**E-3. Column Entries (Section II)**

*a. Column 1, Group Number.* Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

*b. Column 2, Component/Assembly.* Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

*c. Column 3, Maintenance Functions.* Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

*d. Column 4, Maintenance Category.* Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of task-hours specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

**C** - Operator/Crew  
**O** - Organizational  
**F** - Direct Support  
**H** - General Support  
**D** - Depot

*e. Column 5, Tools and Equipment.* Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

*f. Column 6, Remarks.* Column 6 contains an alphabetic code which leads to the remark in section IV, Remarks, which is pertinent to the item opposite the particular code.

**E-4. TOOL and Test Equipment Requirement (Section III)**

*a. Tool or Test Equipment Reference Code.* The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

*b. Maintenance Category.* The codes in this column indicate the maintenance category allocated the tool or test equipment.

*c. Nomenclature.* This column lists the noun name and nonmenclature of the tools and test equipment required to perform the maintenance functions.

*d. National/NATO Stock Number.* This column lists the National/NATO stock number of the specified tool or test equipment.

*e. Tool Number.* This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

**E-5. Remarks (Section IV)**

*a. Reference Code.* This code refers to the appropriate item in section II, column 6.

*b. Remarks.* This column provides the required explanatory information necessary to clarify items appearing in section II.

**SECTION II. MAINTENANCE ALLOCATION CHART  
FOR  
PULSE GENERATOR AN/USM-359A  
TEKTRONIX PG-508T NSN 6625-01-077-4620**

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS	
			UNIT		INTERMEDIATE	DEPOT				
			C	O	F	H	D			
00	PULSE GENERATOR AN/USM-359A	Inspect		0.1					Visual External Simple Operational	
		Test		0.2					1 thru 15	
		Calibrate					2.0		1 thru 15	
		Repair				1.0			1 thru 15	
		Overhaul					10.0		1 thru 15	
01	PLUG-IN UNIT, ELECTRONIC TEST EQUIPMENT SG-1178/USM-359A	Inspect					0.2		15	
		Test					0.5		1 thru 15	
		Replace					0.1		12	
		Repair					1.0		1 thru 15	
0101	CIRCUIT CARD ASSY (A1) INPUT 670-4273-01	Inspect					0.1		12	
		Test					0.2		7,9,12,15	
		Replace					0.1		12	
		Repair						0.2	1 thru 15	
0102	CIRCUIT CARD ASSY (A2) TIMING 670-4274-02	Inspect					0.1		12	
		Test					0.5		7,9,12,15	
		Replace					0.1		12	
		Repair						0.2	1 thru 15	
0103	CIRCUIT ASSY (A3) TRANSITION TIMING 670-4275-02	Inspect					0.2		12	
		Test					0.5		1,7,9,12,15	
		Replace					0.1		12	
		Repair						0.2	1 thru 15	
0104	CIRCUIT ASSY (A4) OUTPUT 670-4276-01	Inspect					0.1		12	
		Test					0.5		7,9,13,15	
		Replace					0.1		12	
		Repair						0.2	1 thru 15	
0105	CIRCUIT CARD ASSY (A5) AUXILIARY 670-4272-00	Inspect					0.1		12	
		Test					0.2		7,9, 12	
		Replace					0.1		12	
		Repair						0.2	1 thru 15	
0106	CIRCUIT CARD ASSY (A6) + CAM SWITCH 672-0557-001	Inspect					0.1		12	
		Test					0.5		1,7,9,12,15	
		Replace					0.1		12	
		Repair						0.2	1 thru 15	
0107	CIRCUIT ASSY (A7) + CAM SWITCH 672-0558-01	Inspect					0.2		12	
		Test					0.5		1,7,9,12,15	
		Replace					0.1		12	
		Repair						0.2	1 thru 15	
02	POWER SUPPLY PP-7578/USM-359A	Inspect					0.2		12	
		Test					0.5		1,7,9,12,15	
		Replace					0.1		12	
		Repair						0.2	1 thru 15	
E-3										



**SECTION II. MAINTENANCE ALLOCATION CHART  
FOR  
PULSE GENERATOR AN/USM-359A  
TEKTRONIX PG-508T NSN 6625-01-077-4620**

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT		INTERMEDIATE		DEPOT		
			C	O	F	H	D		
0201	CIRCUIT CARD ASSY (AI) 670-2024-00 POWER MODULE TM-503 INTERFACE	Inspect Test Replace Repair				0.1 0.5 0.1		12 1,7,9,12,15 12 1 thru 15	
03	BLANK PLUG-IN PANEL PN 016-0195-03	Inspect Replace Repair				0.1 0.1 0.1		12 12 12	
		<b>E-4</b>							

**SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS  
FOR  
PULSE GENERATOR AN/USM-359A/TEKTRONIX PG-508T**

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	H,D	Oscilloscope, OS-262 (P)/U, Equivalent to TEKTRONIX Type 7623A	6625-01.007-9416	
2	H,O	Amplifier, Dual Trace AM-6785/U, equivalent to TEKTRONIX Type 7A26	6625-00-361-5318	
3	H,D	Time Base, TD-1159/U, equivalent to TEKTRONIX Type 7B53A	6625-00-261-5139	
4	H,D	Digital Delay 7DII	6625-00-506-1132	
5	H,D	Generator, Square-Wave, equivalent to TEKTRONIX Type PG 501	6625-00-520-5179	
6	H,D	Counter-Timer, equivalent to TEKTRONIX Type DC 504	6625-01-022-3254	
7	H,D	Multimeter, ANIUSM-451, equivalent to Ballantine Type 9632M	6625-00-060-6804	
8	H,D	Power Module, PP-7578/USM-359A, equivalent to TEKTRONIX Type TM 503	6625-00-373-7528	
9	H,D	Extender, Plugin, equivalent to TEKTRONIX Part No. 067-0645-02	4931-01.0394036	
10	H,D	Cable, 2 ea, 50 Ohms, RG-58/U, 41 In., equivalent to TEKTRONIX Part No. 012-0057-01	6625-00-4954831	
11	H,D	Termination, equivalent to TEKTRONIX Part No. 011-0049-01	5985-00-087-4954	
12	H,D	Tool, Kit, Electronic Equipment TK-100/G	5180-00-605-0079	
13	H,D	Auto Transformer, Variable, TF 510/U, equivalent to General Radio W1OMT3VM	6210-00-054-7794	
14	H,D	Test Set, Semiconductor, TS-1836D/U	6625-00-138-7320	
15	H,D	Cable, 20 in. (Two Pin-to-Pin BNC) TEKTRONIX Part No. 175-1178-00		
<b>E-5/(E-6 blank)</b>				

**APPENDIX F**  
**EXPENDABLE SUPPLIES AND MATERIALS LIST**

---

**Section I. INTRODUCTION**

**F-1. SCOPE**

This appendix lists expendable supplies and materials you will need to operate and maintain the pulse generator. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

**F-2. EXPLANATION OF COLUMNS**

- a. Column(10)- Item number. Not used.
- b. Column(2)- Level. This column identifies the lowest level of maintenance that requires the listed item.

(enter as applicable)

C - Operator/Crew  
O - Organizational Maintenance  
F - Direct Support Maintenance  
H - General Support Maintenance

c. Column(3)- National Stock Number. This is the National stock number assigned to the item; use it to request or requisition the item.

d. Column(4)- Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) in parentheses followed by the part number.

e. Column(5)- Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

## SECTION II. EXPENDABLE SUPPLIES AND MATERIALS

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
	0	8020-00-721-9657	Brush, paint	ea
	0	7920-00-862-6710	Cloth, lint-free	yd
	0		Paint	oz
	0		Sandpaper	sh
	0		Detergent	oz
	0	6850-00-105-3084	Trichlorotrifluoroethane	qt

Official:

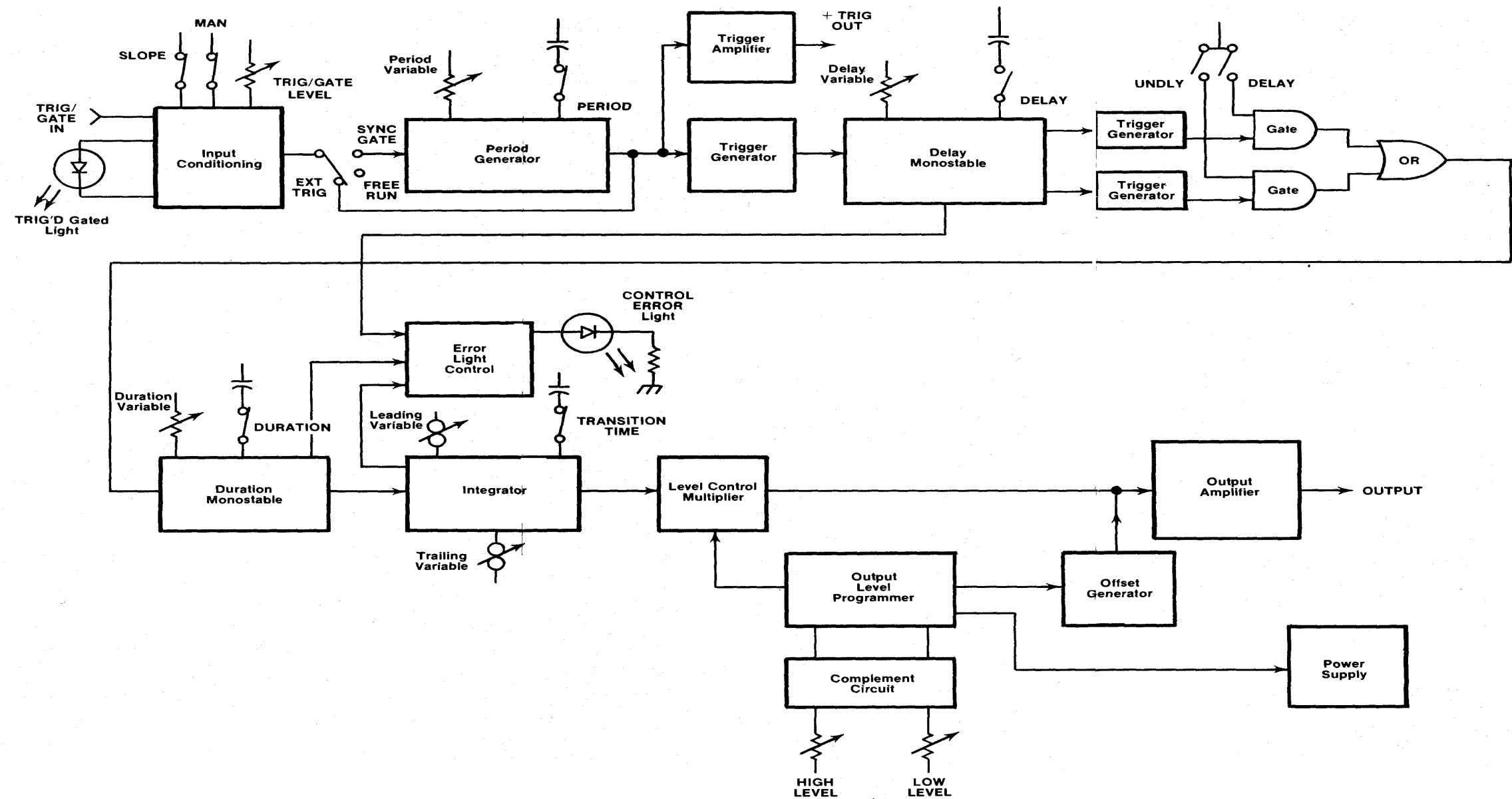
J. C. PENNINGTON  
*Major General, United States Army*  
*The Adjutant General*

E. C. MEYER  
*General, United States Army*  
*Chief of Staff*

DISTRIBUTION:

To be distributed in accordance with DA Form 12-34B, Requirements for TMDE/Calbr & Repair.





FO-2. Block Diagram

4-3/(4-4 blank)

VOLTAGE AND WAVEFORM CONDITIONS

WARNING

DANGEROUS POTENTIALS EXIST AT SEVERAL POINTS THROUGHOUT THIS INSTRUMENT. WHEN THE INSTRUMENT IS OPERATED WITH THE COVERS REMOVED, DO NOT TOUCH EXPOSED CONNECTIONS OR COMPONENTS. SOME TRANSISTORS HAVE VOLTAGES PRESENT ON THEIR CASES. DISCONNECT THE POWER SOURCE BEFORE REPLACING PARTS.

RECOMMENDED TEST EQUIPMENT

ITEM	RECOMMENDED TYPE
OSCILLOSCOPE SYSTEM	TEKTRONIX SC 504. USE A TEKTRONIX P6006 OR P6054 10X PROBE.
VOLTMETER (NON-LOADING DIGITAL MULTIMETER)	TEKTRONIX DM 501 DIGITAL MULTIMETER.

VOLTAGE MEASUREMENTS:

VOLTAGE MEASUREMENTS ON THIS DIAGRAM WERE MADE UNDER THE FOLLOWING CONDITIONS:

TRIG/GATE IN	SIGNAL GENERATOR OUTPUT OF 500 Hz AT 150 mV p-p.		
TRIG/GATE LEVEL	SET FOR TRIG'D/GATED INDICATOR FLASHING.		
SLOPE -/+	-	SYNC GATE/FREE RUN	FREE RUN
MODE	UNDLY	TRANSITION TIME	5 ns
PERIOD	EXT TRIG	LEADING, TRAILING	FULLY CCW
DURATION	EXT DUR	ALL CAL CONTROLS	FULLY CCW
		DELAY	ANY
		HIGH LEVEL	+5 V
		LOW LEVEL	-5 V

VOLTMETER SETTINGS:

VOLTMETER SET FOR CLOSEST TO MID-SCALE READING WITH COMMON TERMINAL ATTACHED TO CHASSIS GROUND.

WAVEFORMS:

WAVEFORM CONDITIONS ARE THE SAME AS VOLTAGE CONDITIONS WITH THE FOLLOWING EXCEPTIONS:

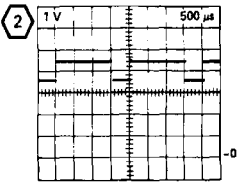
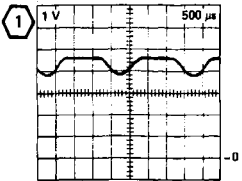
SLOPE -/+	+	SYNC GATE/FREE RUN	SYNC GATE
MODE	PULSE PAIR	DURATION	10 $\mu$ s
PERIOD	.2 ms	DELAY	.1 ms
		TRANSITION TIME	5 $\mu$ s

OSCILLOSCOPE SETTINGS:

USE TEE CONNECTOR ON SIGNAL GENERATOR OUTPUT TO EXTERNALLY TRIGGER BOTH THE PULSE GENERATOR AND THE OSCILLOSCOPE. SET FOR AC COUPLE, AUTO MODE AT + LEVEL. USE A 10X PROBE.

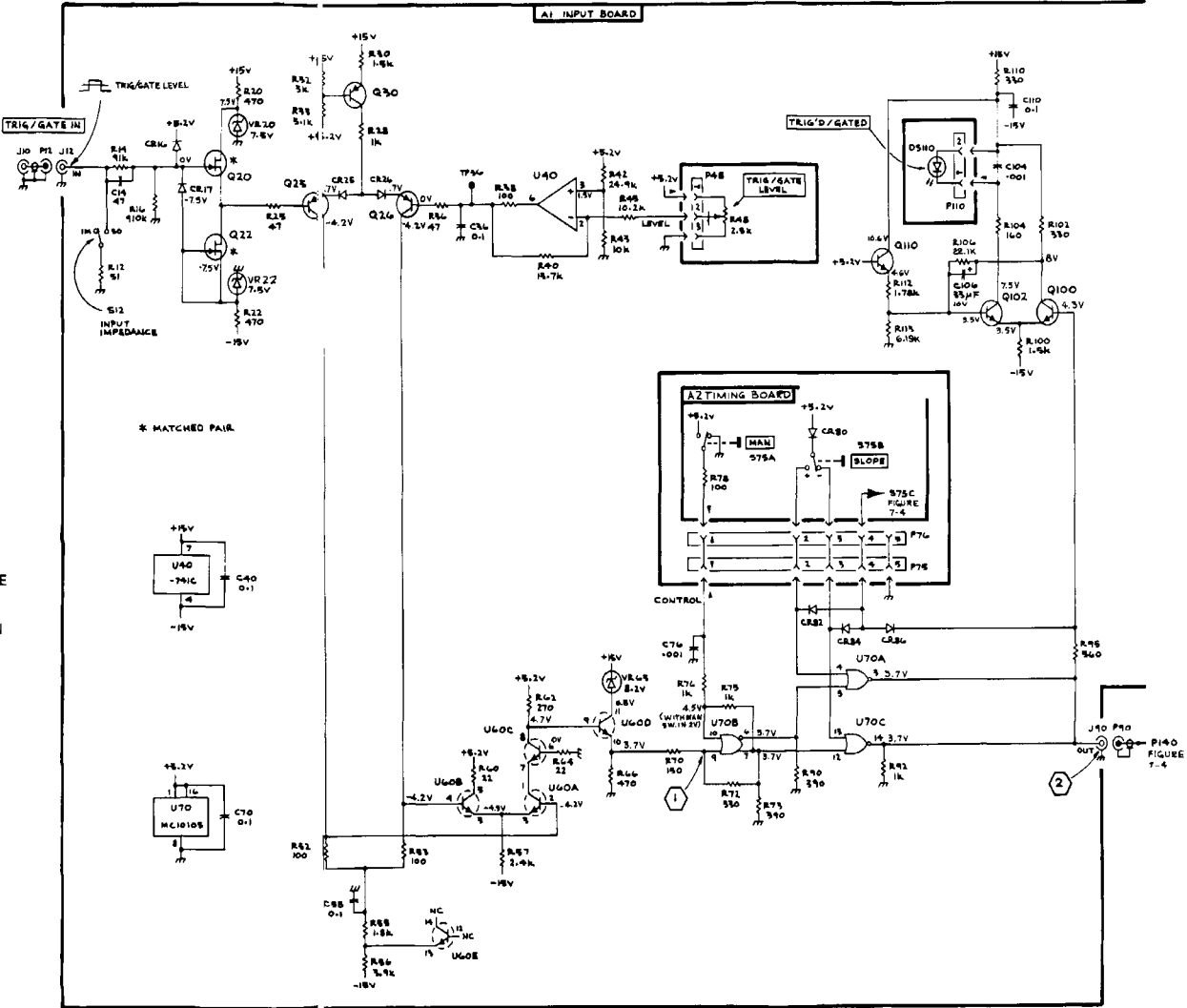
NOTE

VOLTAGES AND WAVEFORMS MAY VARY BETWEEN INSTRUMENTS.



NOTES

1. ALL VOLTAGES ARE POSITIVE EXCEPT WHERE NEGATIVE POLARITIES ARE SHOWN.
2. ALL RESISTANCE VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE SPECIFIED.
3. CAPACITANCE VALUES OF ONE OR GREATER ARE EXPRESSED IN PICOFARADS (pF). CAPACITANCE VALUES OF LESS THAN ONE ARE EXPRESSED IN MICROFARADS ( $\mu$ F).



FO-3. Input circuit schematic diagram.









VOLTAGE AND WAVEFORM CONDITIONS

WARNING

DANGEROUS POTENTIALS EXIST AT SEVERAL POINTS THROUGHOUT THIS INSTRUMENT. WHEN THE INSTRUMENT IS OPERATED WITH THE COVERS REMOVED, DO NOT TOUCH EXPOSED CONNECTIONS OR COMPONENTS. SOME TRANSISTORS HAVE VOLTAGES PRESENT ON THEIR CASES. DISCONNECT THE POWER SOURCE BEFORE REPLACING PARTS.

RECOMMENDED TEST EQUIPMENT	
ITEM	RECOMMENDED TYPE
OSCILLOSCOPE SYSTEM	TEKTRONIX SC 504. USE A TEKTRONIX P6006 OR P6054 10X PROBE.
VOLTMETER (NON-LOADING DIGITAL MULTIMETER)	TEKTRONIX DM 501 DIGITAL MULTIMETER.

VOLTAGE MEASUREMENTS:  
VOLTAGE MEASUREMENTS ON THIS DIAGRAM WERE MADE UNDER THE FOLLOWING CONDITIONS:

SLOPE -/+	-	SYNC GATE/FREE RUN	FREE RUN
MODE	DELAY	TRANSITION TIME	5 ns
PERIOD	2 ms	LEADING, TRAILING	FULLY CCW
DURATION	10 $\mu$ s	ALL CAL CONTROLS	FULLY CCW
DELAY	.1 ms	HIGH LEVEL	+5 V
		LOW LEVEL	-5 V

VOLTMETER SETTINGS:  
VOLTMETER SET FOR CLOSEST TO MID-SCALE READING WITH COMMON TERMINAL ATTACHED TO CHASSIS GROUND.

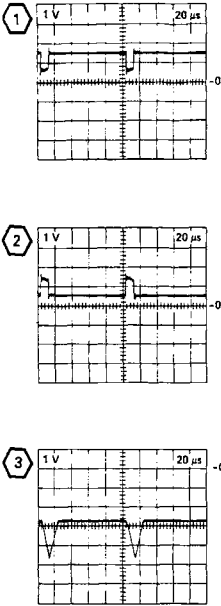
WAVEFORMS:  
WAVEFORM CONDITIONS ARE THE SAME AS VOLTAGE CONDITIONS WITH THE FOLLOWING EXCEPTIONS:

TRIG/GATE IN	SIGNAL GENERATOR OUTPUT OF 500 Hz AT 150 mV p.p.
TRIG/GATE LEVEL	SET FOR TRIG'D/GATED INDICATOR FLASHING.
SLOPE -/+	+
MODE	PULSE PAIR
SYNC GATE/FREE RUN	SYNC GATE
TRANSITION TIME	5 $\mu$ s

OSCILLOSCOPE SETTINGS:  
USE TEE CONNECTOR ON SIGNAL GENERATOR OUTPUT TO EXTERNALLY TRIGGER BOTH THE PULSE GENERATOR AND THE OSCILLOSCOPE. SET FOR AC COUPLE, AUTO MODE AT + LEVEL.

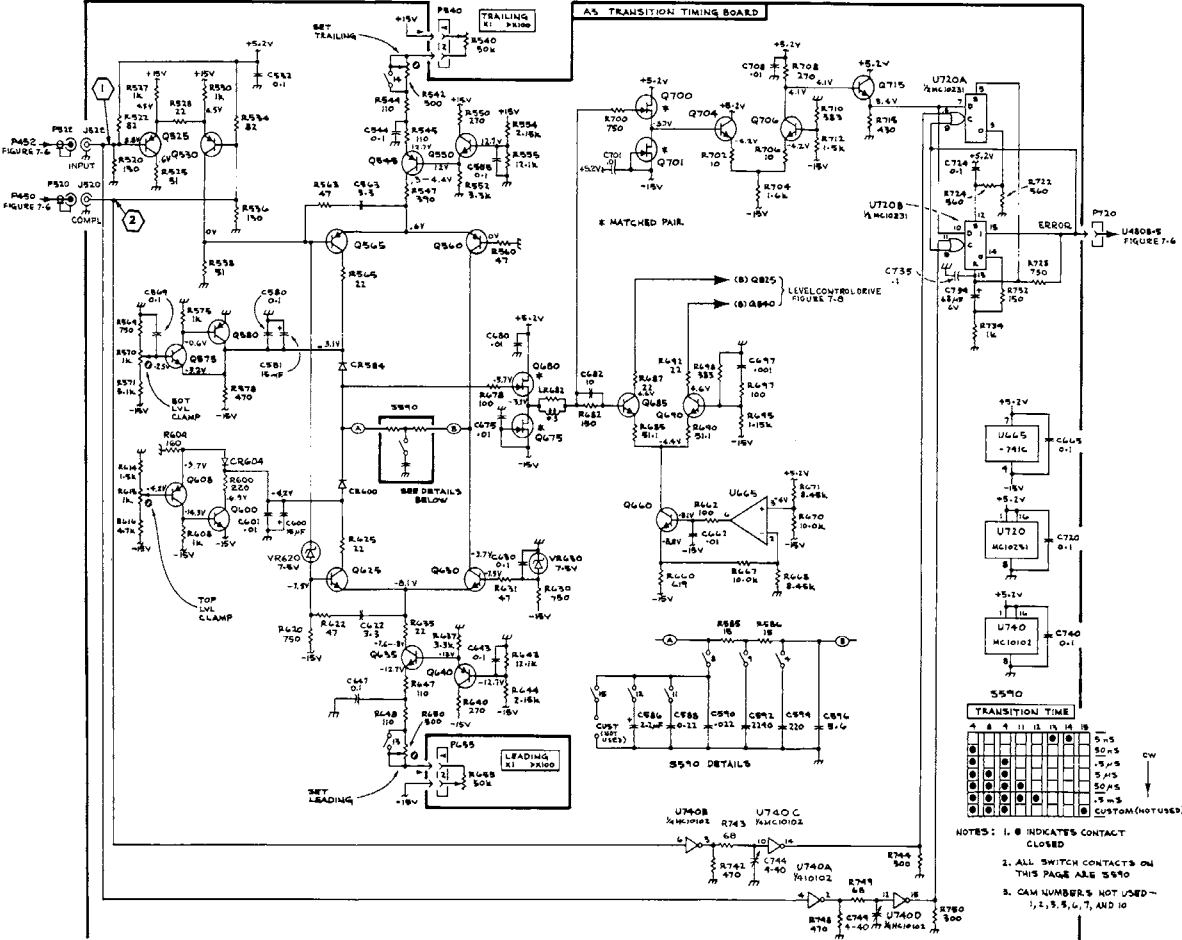
NOTE

VOLTAGES AND WAVEFORMS MAY VARY BETWEEN INSTRUMENTS.



NOTES

- INDICATES CONTACT CLOSED.
- ALL SWITCH CONTACTS ON THIS PAGE ARE S590.
- CAM NUMBERS NOT USED - 1, 2, 3, 5, 6, 7, AND 10.
- ALL VOLTAGES ARE POSITIVE EXCEPT WHERE NEGATIVE POLARITIES ARE SHOWN.
- ALL RESISTANCE VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE SPECIFIED.
- CAPACITANCE VALUES OF ONE OR GREATER ARE EXPRESSED IN PICOFARADS (pF). CAPACITANCE VALUES OF LESS THAN ONE ARE EXPRESSED IN MICROFARADS (μF).
- INDUCTANCE VALUES ARE EXPRESSED IN MICROHENRYS (μH).



FO 7. Transition time generator schematic diagram

VOLTAGE AND WAVEFORM CONDITIONS

WARNING

DANGEROUS POTENTIALS EXIST AT SEVERAL POINTS THROUGHOUT THIS INSTRUMENT. WHEN THE INSTRUMENT IS OPERATED WITH THE COVERS REMOVED, DO NOT TOUCH EXPOSED CONNECTIONS OR COMPONENTS. SOME TRANSISTORS HAVE VOLTAGES PRESENT ON THEIR CASES. DISCONNECT THE POWER SOURCE BEFORE REPLACING PARTS.

RECOMMENDED TEST EQUIPMENT

ITEM	RECOMMENDED TYPE
OSCILLOSCOPE SYSTEM	TEKTRONIX SC 504. USE A TEKTRONIX P6006 OR P6054 10X PROBE.
VOLTMETER (NON-LOADING DIGITAL MULTIMETER)	TEKTRONIX DM 501 DIGITAL MULTIMETER.

VOLTAGE MEASUREMENTS:

VOLTAGE MEASUREMENTS ON THIS DIAGRAM WERE MADE UNDER THE FOLLOWING CONDITIONS:

SLOPE -/+	-	SYNC GATE/FREE RUN	FREE RUN
MODE	DELAY	TRANSITION TIME	5 ns
PERIOD	.2 ms	LEADING, TRAILING	FULLY CCW
DURATION	10 $\mu$ s	ALL CAL CONTROLS	FULLY CCW
DELAY	.1 ms	HIGH LEVEL	+5 V
		LOW LEVEL	-5 V

VOLTMETER SETTINGS:

VOLTMETER SET FOR CLOSEST TO MID-SCALE READING WITH COMMON TERMINAL ATTACHED TO CHASSIS GROUND.

WAVEFORMS:

WAVEFORM CONDITIONS ARE THE SAME AS VOLTAGE CONDITIONS WITH THE FOLLOWING EXCEPTIONS:

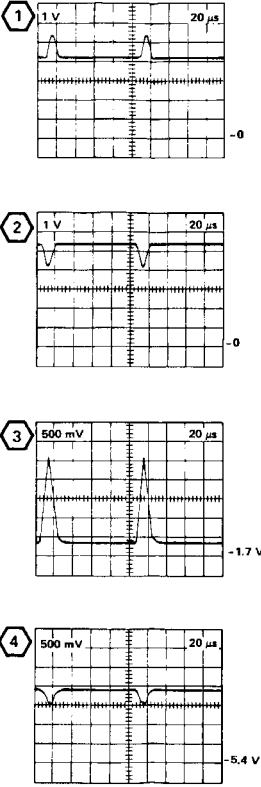
TRIG/GATE IN	SIGNAL GENERATOR OUTPUT OF 500 Hz AT 150 mV p-p.
TRIG/GATE LEVEL	SET FOR TRIG'D/GATED INDICATOR FLASHING.
SLOPE -/+	+
MODE	PULSE PAIR
SYNC GATE/FREE RUN	SYNC GATE
TRANSITION TIME	5 $\mu$ s

OSCILLOSCOPE SETTINGS:

USE TEE CONNECTOR ON SIGNAL GENERATOR OUTPUT TO EXTERNALLY TRIGGER BOTH THE PULSE GENERATOR AND THE OSCILLOSCOPE. SET FOR AC COUPLE, AUTO MODE AT + LEVEL.

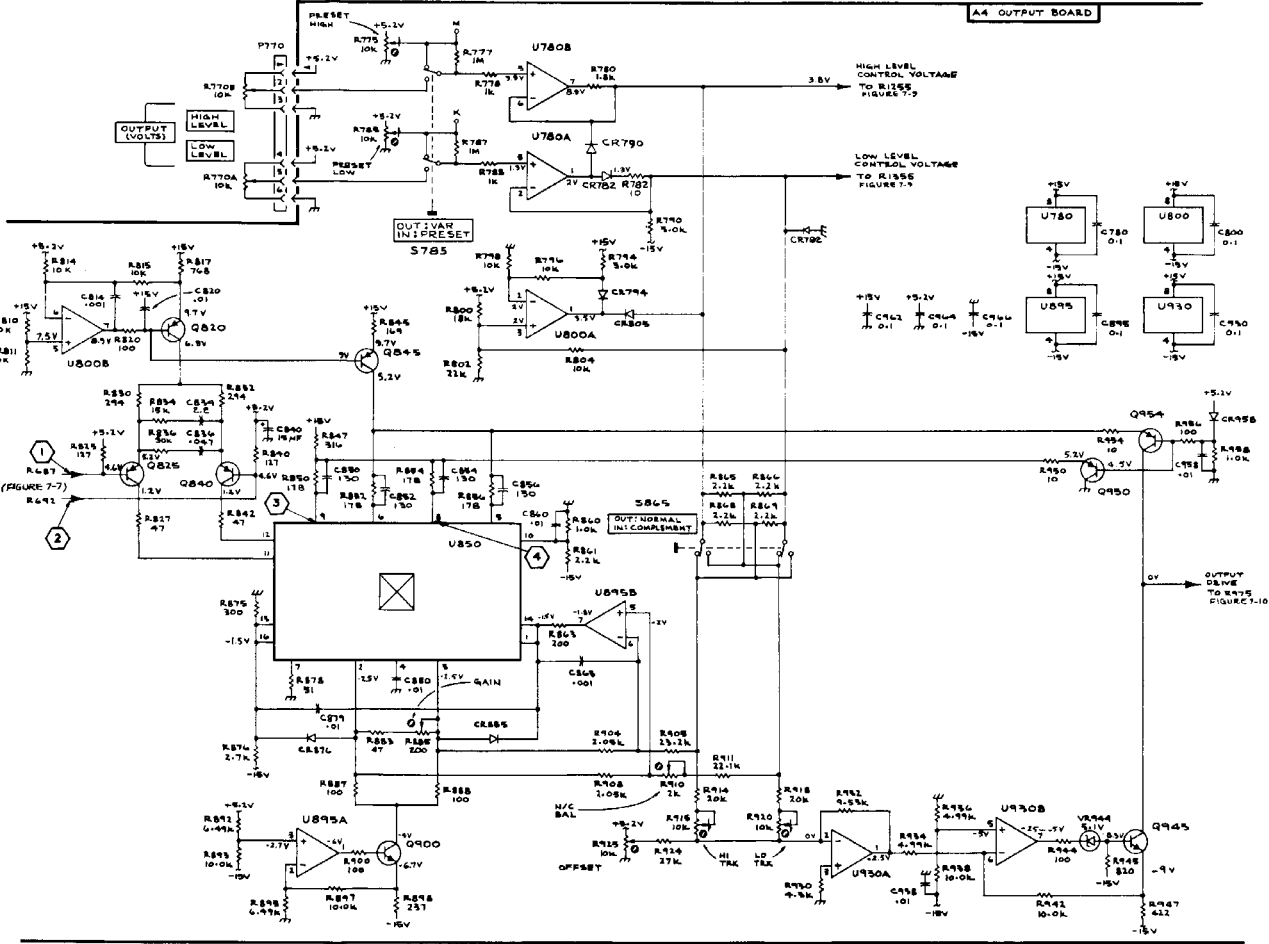
NOTE

VOLTAGES AND WAVEFORMS MAY VARY BETWEEN INSTRUMENTS.



NOTES

1. ALL VOLTAGES ARE POSITIVE EXCEPT WHERE NEGATIVE POLARITIES ARE SHOWN.
2. ALL RESISTANCE VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE SPECIFIED.
3. CAPACITANCE VALUES OF ONE OR GREATER ARE EXPRESSED IN PICO FARADS (pF). CAPACITANCE VALUES OF LESS THAN ONE ARE EXPRESSED IN MICRO FARADS ( $\mu$ F).



FO -8. Level control multiplier schematic diagram.



VOLTAGE AND WAVEFORM CONDITIONS

WARNING

DANGEROUS POTENTIALS EXIST AT SEVERAL POINTS THROUGHOUT THIS INSTRUMENT. WHEN THE INSTRUMENT IS OPERATED WITH THE COVERS REMOVED, DO NOT TOUCH EXPOSED CONNECTIONS OR COMPONENTS. SOME TRANSISTORS HAVE VOLTAGES PRESENT ON THEIR CASES. DISCONNECT THE POWER SOURCE BEFORE REPLACING PARTS.

RECOMMENDED TEST EQUIPMENT

ITEM	RECOMMENDED TYPE
VOLTMETER (NON-LOADING DIGITAL MULTIMETER)	TEKTRONIX DM 501 DIGITAL MULTIMETER.

VOLTAGE MEASUREMENTS:

VOLTAGE MEASUREMENTS ON THIS DIAGRAM WERE MADE UNDER THE FOLLOWING CONDITIONS:

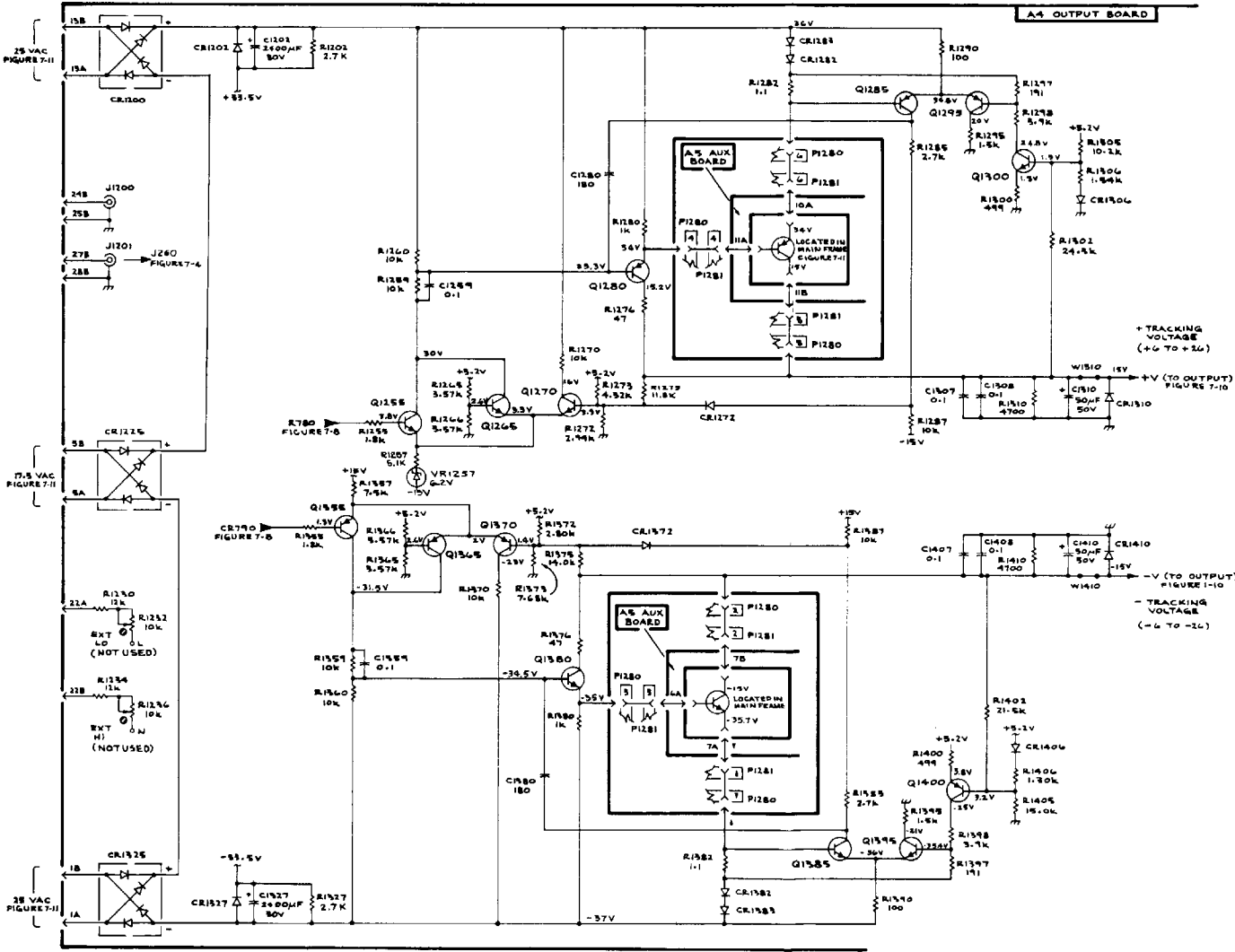
SLOPE -/+	-	SYNC GATE/FREE RUN	FREE RUN
MODE	DELAY	TRANSITION TIME	5 ns
PERIOD	2 ms	LEADING, TRAILING	FULLY CCW
DURATION	10 $\mu$ s	ALL CAL CONTROLS	FULLY CCW
DELAY	.1 ms		

VOLTMETER SETTINGS:

VOLTMETER SET FOR CLOSEST TO MID-SCALE READING WITH COMMON TERMINAL ATTACHED TO CHASSIS GROUND.

NOTE

VOLTAGES MAY VARY BETWEEN INSTRUMENTS.



FO-10. Tracking voltage supply schematic diagram

VOLTAGE AND WAVEFORM CONDITIONS

WARNING

DANGEROUS POTENTIALS EXIST AT SEVERAL POINTS THROUGHOUT THIS INSTRUMENT. WHEN THE INSTRUMENT IS OPERATED WITH THE COVERS REMOVED, DO NOT TOUCH EXPOSED CONNECTIONS OR COMPONENTS. SOME TRANSISTORS HAVE VOLTAGES PRESENT ON THEIR CASES. DISCONNECT THE POWER SOURCE BEFORE REPLACING PARTS.

RECOMMENDED TEST EQUIPMENT

ITEM	RECOMMENDED TYPE
VOLTMETER (NON-LOADING DIGITAL MULTIMETER)	TEKTRONIX DM 501 DIGITAL MULTIMETER.

VOLTAGE MEASUREMENTS:

VOLTAGE MEASUREMENTS ON THIS DIAGRAM WERE MADE UNDER THE FOLLOWING CONDITIONS:

SLOPE -/+	-	SYNC GATE/FREE RUN	FREE RUN
MODE	DELAY	TRANSITION TIME	5 ns
PERIOD	.2 ms	LEADING, TRAILING	FULLY CCW
DURATION	10 $\mu$ s	ALL CAL CONTROLS	FULLY CCW
DELAY	.1 ms	HIGH LEVEL	+5 V
		LOW LEVEL	-5 V

ALL VOLTAGES POSITIVE EXCEPT WHERE NEGATIVE POLARITIES ARE SHOWN.

VOLTMETER SETTINGS:

VOLTMETER SET FOR CLOSEST TO MID-SCALE READING WITH COMMON TERMINAL ATTACHED TO CHASSIS GROUND. ALL RESISTANCE VALUES ARE EXPRESSED IN OHMS. CAPACITANCE VALUES OF ONE OR GREATER ARE EXPRESSED IN PICO FARADS (pF). CAPACITANCE VALUES OF LESS THAN ONE ARE EXPRESSED IN MICRO FARADS ( $\mu$ F).

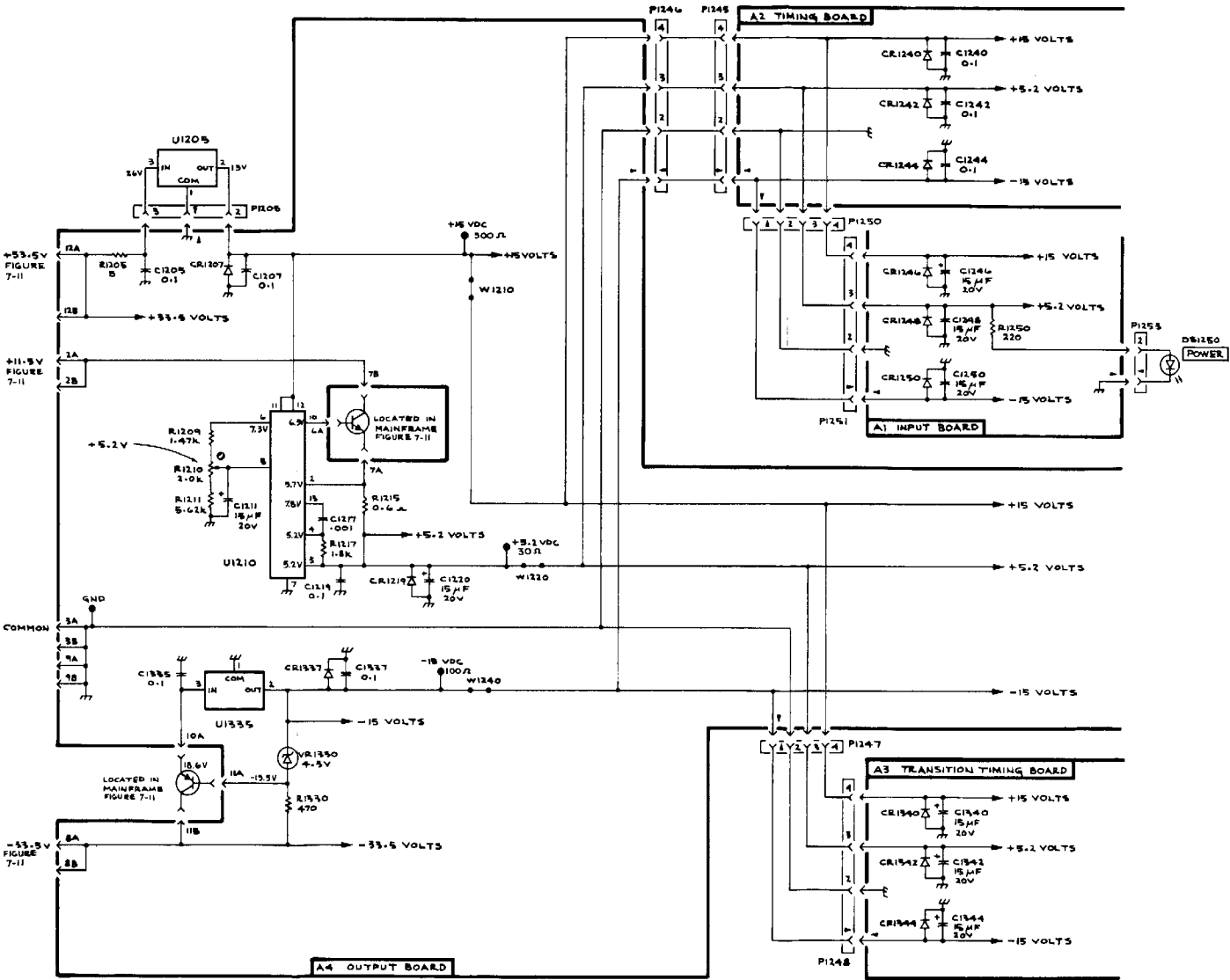
RESISTANCE MEASUREMENTS:

RESISTANCE MEASUREMENTS ON THIS DIAGRAM WERE MADE UNDER THE FOLLOWING CONDITIONS:

ALL SETTINGS THE SAME AS ABOVE. POWER SWITCH TO OFF. OHMMETER SETTINGS. OHMMETER SET TO CLOSEST TO MID-SCALE READING WITH COMMON TERMINAL ATTACHED TO CHASSIS GROUND.

NOTE

VOLTAGES AND RESISTANCES MAY VARY BETWEEN INSTRUMENTS.



FO-11. PG 508 power supply schematic diagram.



VOLTAGE AND WAVEFORM CONDITIONS

WARNING

DANGEROUS POTENTIALS EXIST AT SEVERAL POINTS THROUGHOUT THIS INSTRUMENT. WHEN THE INSTRUMENT IS OPERATED WITH THE COVERS REMOVED, DO NOT TOUCH EXPOSED CONNECTIONS OR COMPONENTS. SOME TRANSISTORS HAVE VOLTAGES PRESENT ON THEIR CASES. DISCONNECT THE POWER SOURCE BEFORE REPLACING PARTS.

RECOMMENDED TEST EQUIPMENT

ITEM	RECOMMENDED TYPE
VOLTMETER (NON-LOADING DIGITAL MULTIMETER)	TEKTRONIX DM 501 DIGITAL MULTIMETER.

VOLTAGE MEASUREMENTS:

VOLTAGE MEASUREMENTS ON THIS DIAGRAM WERE MADE UNDER THE FOLLOWING CONDITIONS:  
WITH PLUG-IN UNIT REMOVED.

VOLTMETER SETTINGS:

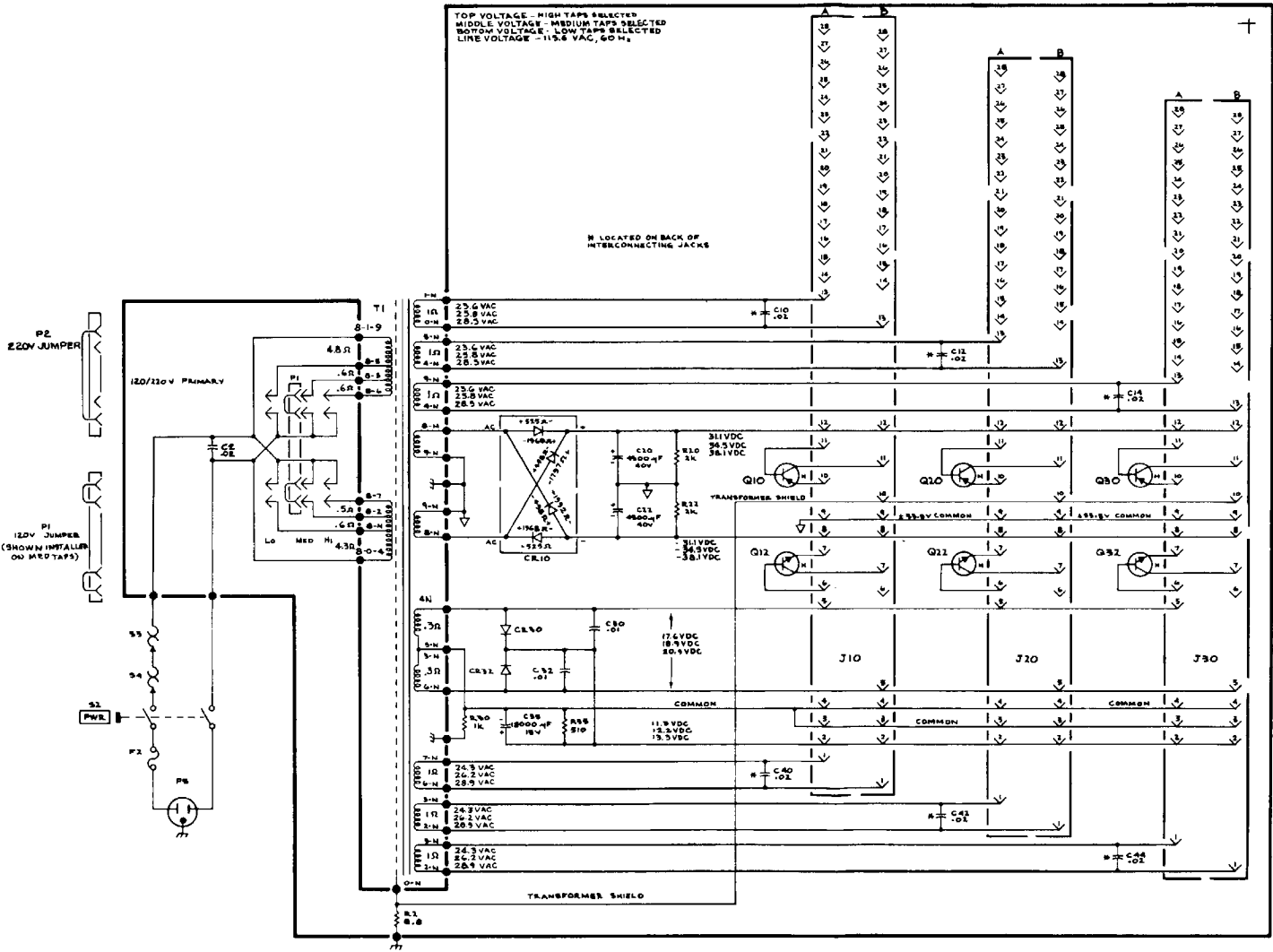
VOLTMETER SET FOR CLOSEST TO MID-SCALE READING WITH COMMON TERMINAL ATTACHED TO CHASSIS GROUND.

RESISTANCE MEASUREMENTS:

RESISTANCE MEASUREMENTS MADE WITH POWER SWITCH OFF AND PLUG-IN UNIT REMOVED. TRANSFORMER INPUT WINDING MEASUREMENTS MADE WITH INPUT JUMPER REMOVED. OHMMETER SET FOR CLOSEST TO MID-SCALE READING WITH COMMON TERMINAL ATTACHED TO CHASSIS GROUND.

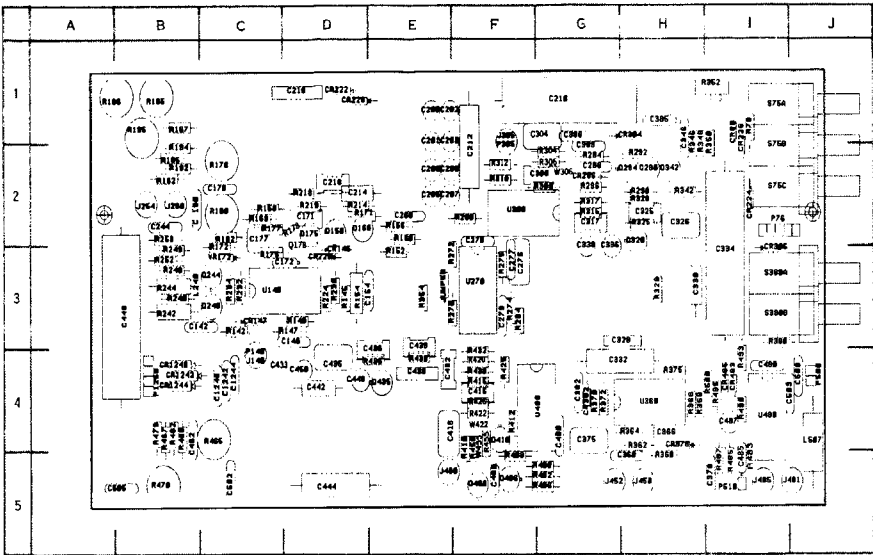
NOTE

VOLTAGES MAY VARY BETWEEN INSTRUMENTS.



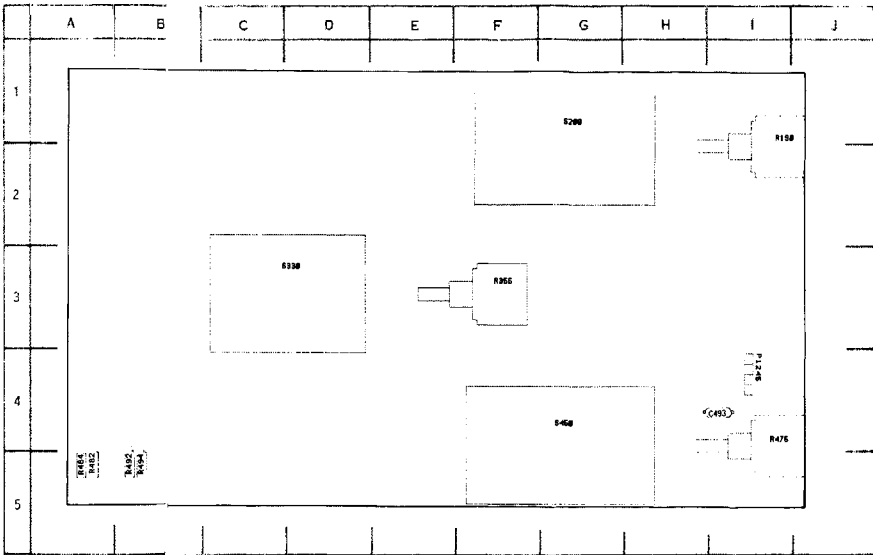
FO-12. TM 503 power supply schematic diagram.

### TIMING BOARD (A2)

[illegible]

REV. B APR 1978

(BACKSIDE) TIMING BOARD ( A2 )



\*On back of board

†San Parts List for

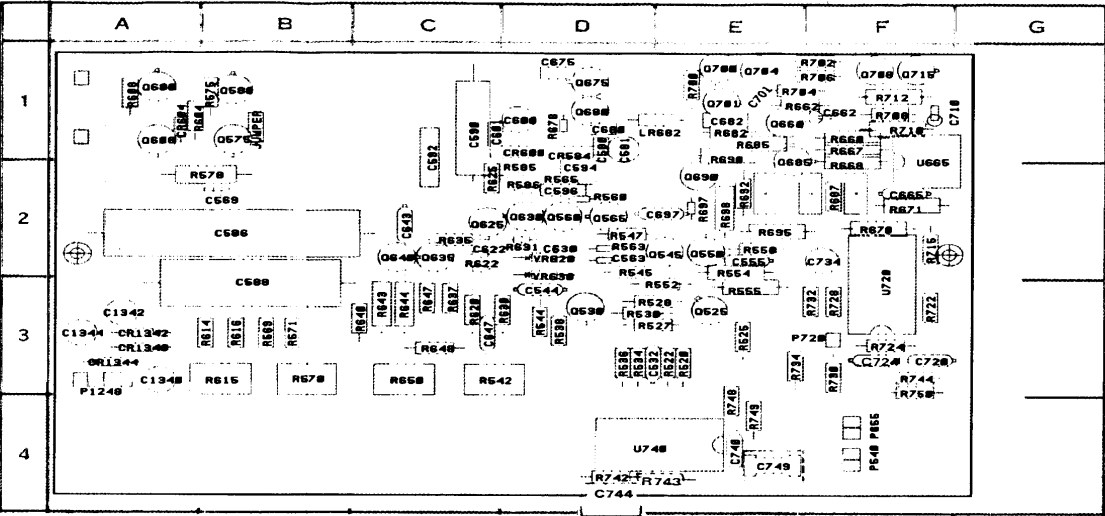
††R482 & R492  
moved to back of  
board effective SN  
B020245.

FO-13. A2 board component locations.

**5-3/(5-4 blank)**

## PARTS LOCATION GRID

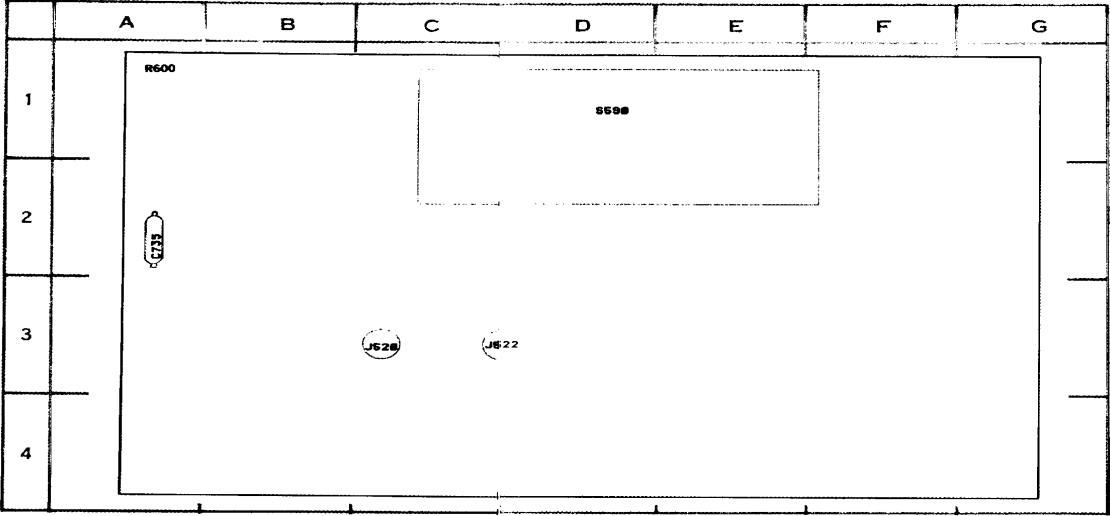
### TRANSITION TIMING BOARD (A3)

[illegible]

†See Parts List for serial number ranges.

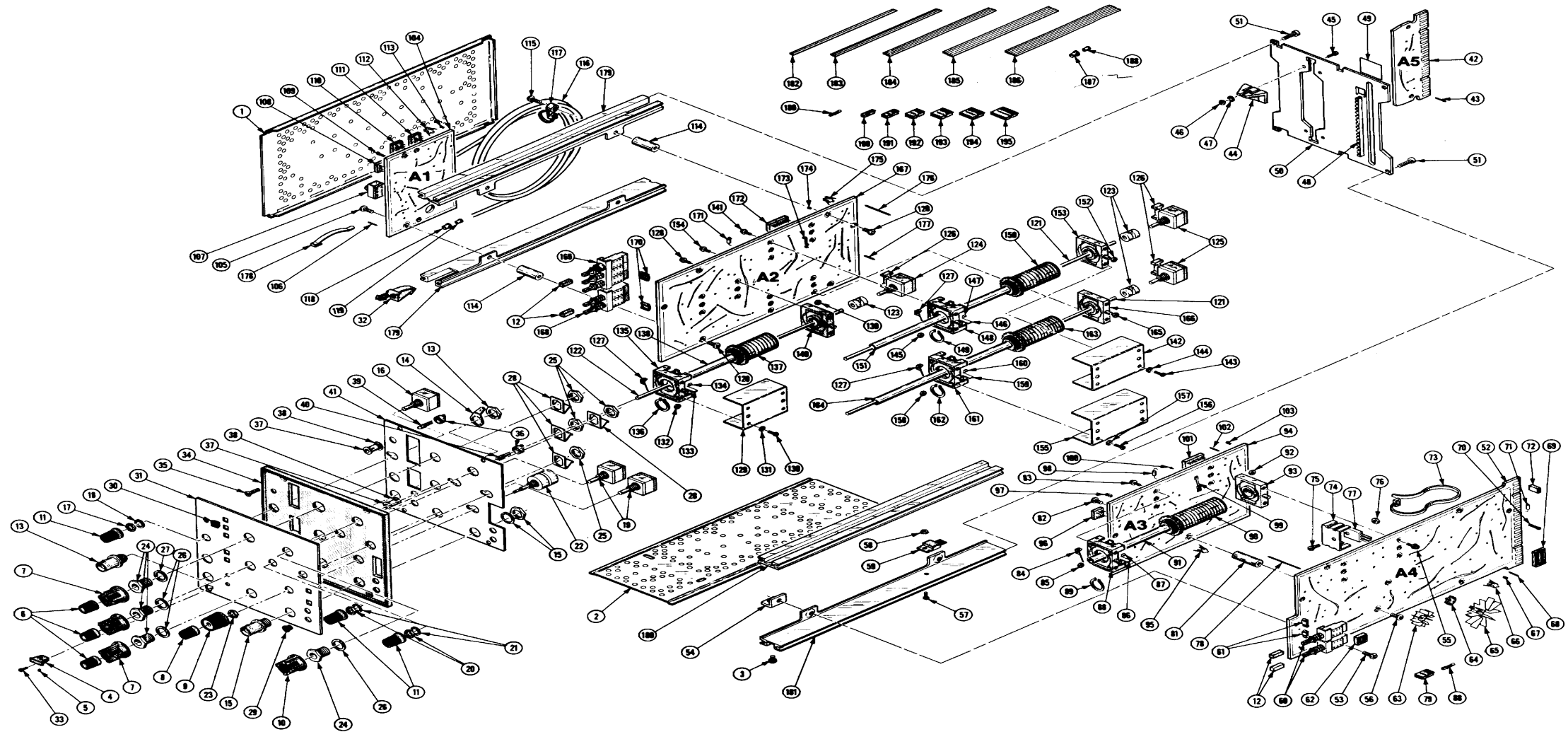
**\*On/back of board.**

**(BACKSIDE) TRANSITION TIMING BOARD (A3)**



*FO-14. A3 board component locations.*

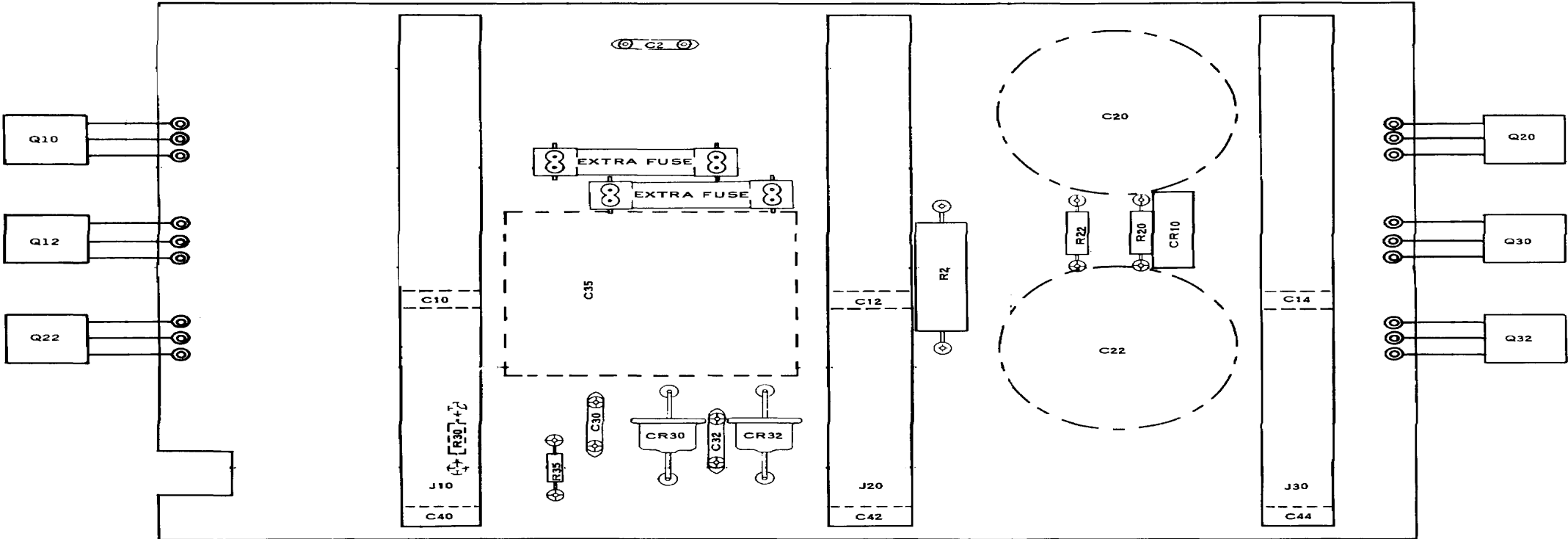
**5-7/(5-8 blank)**



FO-16. PG 508 exploded view.

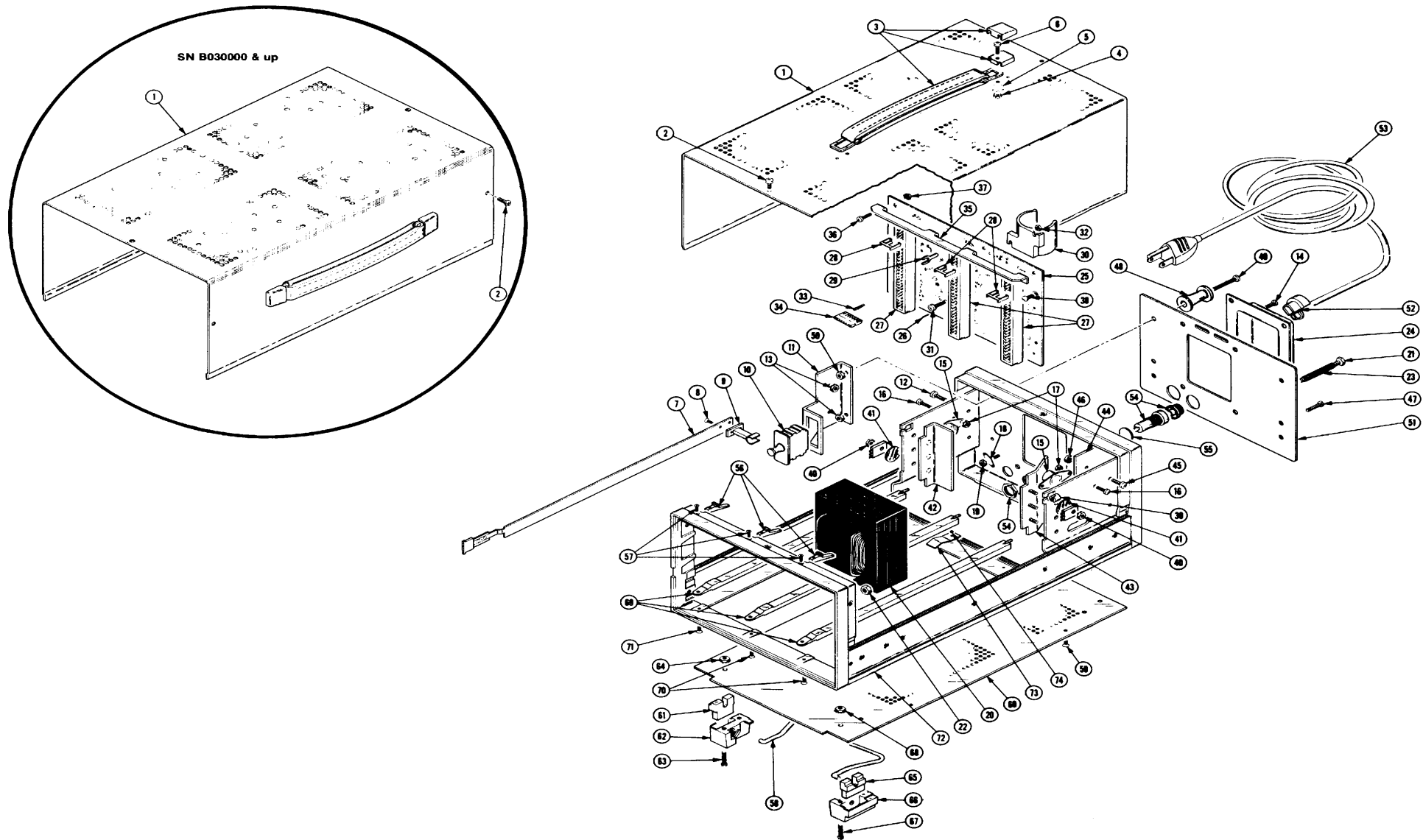
5-9/(5-10 blank)

PARTS LOCATION GRID



NOTE: COMPONENTS SHOWN WITH DASHED LINES ARE LOCATED ON BACK SIDE OF BOARD.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C2	E1	CR10	I3	Q22	A4
C10	D4	CR30	E5	Q30	K3
C12	G4	CR32	F5	Q32	K4
C14	I4	CR32	F5		
C20	H2			R2	G4
C22	H4	J10	D6	R20	H3
C30	E5	J20	G6	R22	H3
C32	E5	J30	I6	R30	D5
C35	E4			R35	D6
C40	D6	Q10	A2		
C42	F6	Q12	A3		
C44	I6	Q20	K2		



TM 503 POWER MODULE

A-23/(A-24 blank)







This fine document...

Was brought to you by me:



### [Liberated Manuals -- free army and government manuals](#)

Why do I do it? I am tired of sleazy CD-ROM sellers, who take publicly available information, slap “watermarks” and other junk on it, and sell it. Those masters of search engine manipulation make sure that their sites that sell free information, come up first in search engines. They did not create it... They did not even scan it... Why should they get your money? Why are not letting you give those free manuals to your friends?

I am setting this document FREE. This document was made by the US Government and is NOT protected by Copyright. Feel free to share, republish, sell and so on.

I am not asking you for donations, fees or handouts. If you can, please provide a link to [liberatedmanuals.com](http://liberatedmanuals.com), so that free manuals come up first in search engines:

<A HREF=<http://www.liberatedmanuals.com/>>Free Military and Government Manuals</A>

- Sincerely  
Igor Chudov  
<http://igor.chudov.com/>
- [Chicago Machinery Movers](#)