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WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

305 DMM OSCILLOSCOPE SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Serial Number _____

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WARRANTY

Tektronix warrants to the original purchaser that this product is free from defects in materials and workmanship, under normal use, for a period of one (1) year from the date of shipment. Tektronix will, at its option, repair or replace the product if Tektronix determines it is defective within the warranty period, and it is returned, freight prepaid, to a Tektronix Service Center.

There is no implied warranty of fitness for a particular purpose. Tektronix is not liable for consequential damages.

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

TERMS

In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER or WARNING—HIGH VOLTAGE indicates a personal injury hazard immediately accessible as one reads the marking.

As Marked on Equipment


DANGER — High voltage.


Protective ground (earth) terminal.

PRECAUTIONS

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

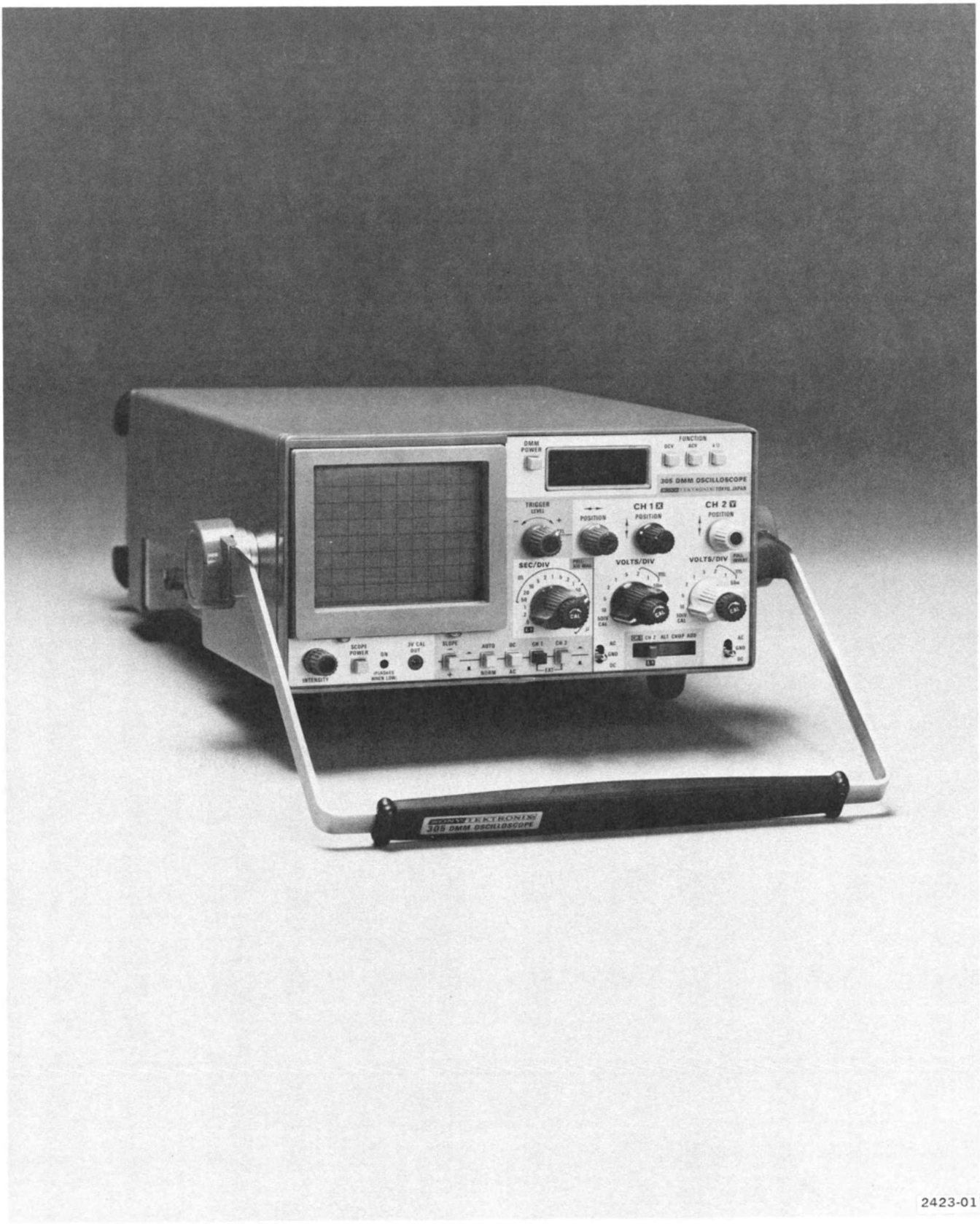
Disconnect power before removing protective panels, soldering, or replacing components.

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for this product and having identical type, voltage rating, and current characteristics.



Sony/Tektronix 305 DMM Oscilloscope

SPECIFICATION

Introduction

The Sony/Tektronix 305 DMM Oscilloscope is a versatile solid-state (except crt) portable instrument that combines small size and light weight with the ability to make precision digital measurements on waveforms associated with industrial, military, computer maintenance, and business machine applications. The 305 is constructed to withstand shock, vibration, and other environmental extremes associated with portability. Operating power for the instrument is provided by external dc, rechargeable batteries, or normal ac power-line voltage. Internal circuitry recharges the batteries when the instrument is connected to power-line voltage. Selection of the DMM or oscilloscope function (or both) is made with front panel push buttons.

The DMM is autoranging and measures resistance, ac and dc voltages. Full-scale ranges are 2 MΩ, 700 Vac, and 1000 Vdc. The front-panel digital readout is a 3 1/2-digit display containing an automatic negative-polarity indicator and decimal-point locator. No polarity indicator is displayed for positive measurements. Input connectors for the multimeter are located on the right side of the instrument cabinet.

The 305 Oscilloscope is dual channel, with a dc-to-five MHz bandpass vertical deflection system. Calibrated deflection factors of 5 mV per division to 10 V per division are available in a 1-2-5 sequence. The horizontal deflection system provides calibrated sweep rates from 0.5 s per division to 1 μs per division. A X10 magnifier increases the indicated sweep rate by a factor of ten, extending the fastest sweep rate to 0.1 μs per division. The trigger input may be internal or external, with triggering effective over the full bandwidth of the vertical deflection system. Calibrated X-Y measurements are made with Channel 2 [Y] providing the vertical deflection signal and Channel 1 [X] providing the horizontal deflection signal. The CH 1 [X] and CH 2 [Y] INPUT connectors are located on the left side of the instrument cabinet. The crt has internal graticule lines with eight vertical divisions and 10 horizontal divisions. (Each division is 0.632 centimeter, approximately 0.25 inch.)

Characteristics

The following characteristics apply over an ambient temperature range of +20° C to +30° C (+68° F to +86° F) unless otherwise stated. Warmup time for the specified accuracies is 5 minutes.

Table 1-1

ELECTRICAL

Characteristic	Performance Requirement	Supplemental Information
	VERTICAL	
Deflection Factor		
Calibrated Range	5 mV/div to 10 V/div.	11 steps in 1-2-5 sequence.
Accuracy		VOLTS/DIV CAL (variable) in detent with gain set at 5 mV/div.
0° C to +40° C	Within 3%.	
−15° C to 0° C	Within 4%.	
+40° C to +55° C	Within 4%.	
Uncalibrated CAL (variable)	Continuously variable between calibrated settings.	Extends deflection factor to at least 25 volts/div.
Low Frequency Linearity		Less than 0.15 division compression or expansion of a 2-division signal at center screen when positioned to the top and bottom of the graticule area.

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
	VERTICAL (cont)	
Frequency Response		
Upper Bandwidth Limit		4-division reference signal vertically centered. VOLTS/DIV CAL (variable) in detent.
5 mV/div to 10 V/div	Dc to at least 5 MHz (−3 dB point).	
Add Mode	Dc to at least 4.5 MHz (−3 dB point).	VOLTS/DIV CAL in detent.
Lower Bandwidth Limit		
Ac Coupled (capacitive)	Approximately 10 Hz for all deflection factors.	
Step Response		
Risetime		4-division positive-going step, vertically centered. VOLTS/DIV CAL in detent.
5 mV/div to 10 V/div	70 ns or less.	
Attenuator Compensation		
5 mV/div to 2 V/div	Within ±3%.	
5 V/div to 10 V/div	Within ±5%.	
Input R and C		
Input Resistance	1 MΩ within 2%.	
Input Capacitance	Approximately 47 pF.	
Maximum Input Voltage		
Dc Coupled (direct)	250 V (dc + peak ac).	
Ac Coupled (capacitively)	250 V (dc + peak ac) or 250 V p-p ac at 1 kHz or less.	
Input Gate Current	500 pA or less at 30° C.	
Noise at 5 mV/div (measured tangentially)		
50 Ω Termination	0.2 division or less.	
10X Probe	0.2 division or less.	
Step Attenuator Balance	1.5 division or less.	
Position Range		At least +8 and −8 divisions from graticule center.
Chopped Mode Repetition Rate	Approximately 50 kHz.	
	CALIBRATOR	
Output Voltage		
+20° C to +30° C	0.3 V p-p within 1%.	
−15° C to +55° C	0.3 V p-p within 2%.	

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
	CALIBRATOR (cont)	
Repetition Rate		Approximately 1 kHz.
Output Resistance		Approximately 2 kΩ.
	TRIGGERING	
Trigger Sensitivity		
Dc Coupled	0.3 division internal or 15 mV external from dc to 0.5 MHz, increasing to 0.75 division internal or 50 mV external from 0.5 MHz to 5 MHz.	
Ac Coupled	0.3 division internal or 15 mV external from 60 Hz to 0.5 MHz, increasing to 0.75 division internal or 50 mV external from 0.5 MHz to 5 MHz. Attenuates all signals below about 60 Hz.	
Trigger Level Range	At least 0.4 V to −0.4 V.	
Display Time Jitter Due to Triggering	20 ns or less.	
External Input		
Resistance	Approximately 1 MΩ.	
Capacitance	Approximately 47 pF.	
TTL Trigger (Trigger Mode: Normal and Dc Coupling) (With 10X probe)		
Threshold Voltage		
Internal	1.4 V within ±0.3 V.	
External	1.4 V within ±0.2 V.	
Minimum Signal Swing for Triggering		
Internal	0.5 division.	
External	500 mV p-p.	
P-P AUTO Operation Sensitivity (Ac or Dc Coupling)		

	Internal	External
500 Hz to 0.5 MHz	0.5 division	35 mV
0.5 MHz to 5 MHz	1.0 division	70 mV
Low Frequency Response (Down to 200 Hz or less)	2.0 divisions	140 mV

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
	TRIGGERING (cont)	
P-P AUTO Level Range		Amplitude trigger point referenced to a 6 division, 1 kHz sine-wave display.
Level **Slope**		**Start of Trace.**
Fully Ccw +		0 to 1 division from bottom of trace.
Fully Cw +		0 to 1 division from top of trace.
Fully Ccw −		0 to 1 division from bottom of trace.
Fully Cw −		0 to 1 division from top of trace.
	HORIZONTAL	
Sweep Time/Div (Unmagnified)		
Calibrated Range	500 ms/div to 1 μs/div.	18 steps in 1-2-5 sequence.
Accuracy		
Unmagnified		Timing set at 1 ms/div or 1 μs/div. Disregard first 0.5 μs of sweep.
0°C to +40°C	Within 3%.	Over center 8 division display.
−15°C to 0°C	Within 4%.	
+40°C to +55°C	Within 4%.	
Linearity		Over any 2 division portion within center 8 divisions. Disregard first 1 μs of total sweep.
0°C to +40°C	Within 4%.	
−15°C to 0°C	Within 5%.	
+40°C to +55°C	Within 5%.	
Magnified X10		
Accuracy		Over center 8 division display. Exclude the first 10 divisions and all past 90 divisions.
0°C to +40°C	Within 5%.	
−15°C to 0°C	Within 6%.	
+40°C to +55°C	Within 6%.	
Linearity		Over any 2 division portion within center 8 divisions. Exclude the first 10 divisions and all past 90 divisions.
0°C to +40°C	Within 6%.	
−15°C to 0°C	Within 7%.	
+40°C to +55°C	Within 7%.	

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
	HORIZONTAL (cont)	
SEC/DIV CAL (variable)	At least 2.5:1.	Extends slowest sweep rate to at least 1.25 s/div.
X-Y Mode		X-Y position of SEC/DIV switch and X-Y (CH 2) position of display mode switch must be selected.
X Sensitivity	Same as vertical.	
Accuracy		
0° C to +40° C	Within 4%.	Over center 8 divisions of display.
Variable Range	Same as vertical.	
X-Axis Bandwidth	Dc to 150 kHz.	8 division reference signal.
Input R and C		
Resistance	Same as vertical.	
Capacitance	Same as vertical.	
Maximum Input Voltage	Same as vertical.	
Phase Difference between X- and Y-Axis Amplifiers		Within 3° from dc to 10 kHz.
	CRT DISPLAY	
Crt		T-3260.
Phosphor	P31, standard.	
Graticule		
Type	Internal black line, nonilluminated.	
Size	8 divisions by 10 divisions (1 division = 0.632 cm or about 0.25 inch).	
Raster Distortion (Geometry)		Within 0.1 division or less total bowing or tilt of a displayed vertical or horizontal line.
Trace Rotation Range		At least 4° on either side of a horizontal graticule line.
Accelerating Potential		Approximately −2 kV.
	POWER SOURCE	
Line Voltage Range		Primary dielectric withstand test. 1500 Vrms, 60 Hz, for 10 seconds minimum (100% test). Ground continuity test (100% test).
115 V	90 V to 132 V.	
230 V	180 V to 250 V.	

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
	POWER SOURCE (cont)	
Line Frequency	48 Hz to 440 Hz.	
External DC Voltage Range	+9 V to +32 V.	
Maximum Power Consumption		
External DC Voltage	9 watts, maximum	12 V power input, 5 MHz, 3-division signal displayed, full intensity, and DMM power on.
AC Power Source	17 watts, maximum	115 Vac power input, 5 MHz, 8-division signal displayed, full intensity, full charge rate, and DMM power on.
	INTERNAL BATTERY SUPPLY	
Battery Pack	C size, 6 cell.	NICAD, 7.5 Vdc at full charge.
Charge Time		
Full Charge	At least 16 hours.	Operating time may be less after 200 charge-discharge cycles. Instrument off during charge cycle.
Operating Time (+20°C to +25°C)		
Oscilloscope		≈2 hours (maximum intensity)
DMM		≈10 hours
Oscilloscope and DMM		≈1.6 hours
	DIGITAL MULTIMETER	
DC Voltmeter		
Range	2 V, 20 V, 200 V, 1000 V.	
Accuracy (+15°C to +35°C)	Within 0.1% of reading, ±2 counts.	
Common Mode Rejection	At least 100 dB at dc, 80 dB at 60 Hz with 1 kΩ unbalance.	
Normal Mode Rejection	At least 30 dB at 60 Hz increasing to 20 dB per decade to 2 kHz.	Valid when input peak voltage is within twice the maximum voltage of the range.
Step Response Time	No more than 1 second plus the range step time (no more than 1 second/step).	
Input Resistance	10 MΩ within 2%.	
AC Voltmeter		
Range	2 V, 20 V, 200 V, 700 V.	
Accuracy (+15°C to +35°C)	Within 0.5% of reading, ±10 counts, 40 Hz to 500 Hz.	

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
	DIGITAL MULTIMETER (cont)	
Response Time	No more than 5 seconds plus the range step time (no more than 1 second/step).	
Input Impedance	10 MΩ within 3% paralleled by at least 70 pF.	
Ohmmeter		
Range	2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ.	
Accuracy (+15°C to +35°C)	Within 0.6% of reading ±3 counts.	
Measurement Current	2 V ÷ range setting.	
Response Time	No more than 5 seconds plus the range step time (no more than 1 second/step).	
Maximum Safe Input Voltage at DMM INPUT Connector		
DCV FUNCTION Setting	±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis.	
ACV FUNCTION Setting	700 Vrms if sinusoidal. ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 V (dc component) between HI and LO inputs.	
kΩ FUNCTION Setting	±100 V (dc + peak ac) between HI and LO inputs.	
LO Floating Voltage	+500 V (dc + peak ac) between LO and chassis.	

Table 1-2

ENVIRONMENTAL

Characteristic	Performance Requirement	Supplemental Information
Temperature		
Operating	−15°C to +55°C (Oscilloscope). 0°C to +55°C (DMM).	
Storage	−25°C to +75°C.	
Altitude		
Operating	To 30,000 feet.	Maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 feet to 30,000 feet.

Table 1-2 (cont)

ENVIRONMENTAL

Characteristic	Performance Requirement	Supplemental Information
Altitude (cont) Storage	To 50,000 feet.	May be tested during nonoperating temperature tests.
Humidity Storage	5 cycles (120 hours) of MIL-E-16400G Method 106B.	Omit freezing and vibration post-test drying period at +25°C, ±5°C at 20% to 80% relative humidity.
Vibration Operating	15 minutes along each of the 3 major axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1-minute cycles. Hold for 3 minutes at 55 Hz. All major resonances must be above 55 Hz.	
Shock Operating and nonoperating	30 g's, 1/2 sinewave, 11 ms duration, 2 nonoperating shocks per axis in each direction for a total of 12 shocks.	
Electromagnetic Interference	Meets the EMC requirements of MIL-STD-461A, when tested in accordance with the following test methods of MIL-STD-462: CE-01, CE-03, CS-01, CS-02, CS-06, RE-02 (limited to 1 GHz), (T) RE-04, RS-01, and RS-03 (limited to 1 GHz).	

Table 1-3

PHYSICAL

Characteristic	Description
Dimensions	See Fig. 1-1.
Weight Without Accessories	4.8 kg (10.56 pounds).

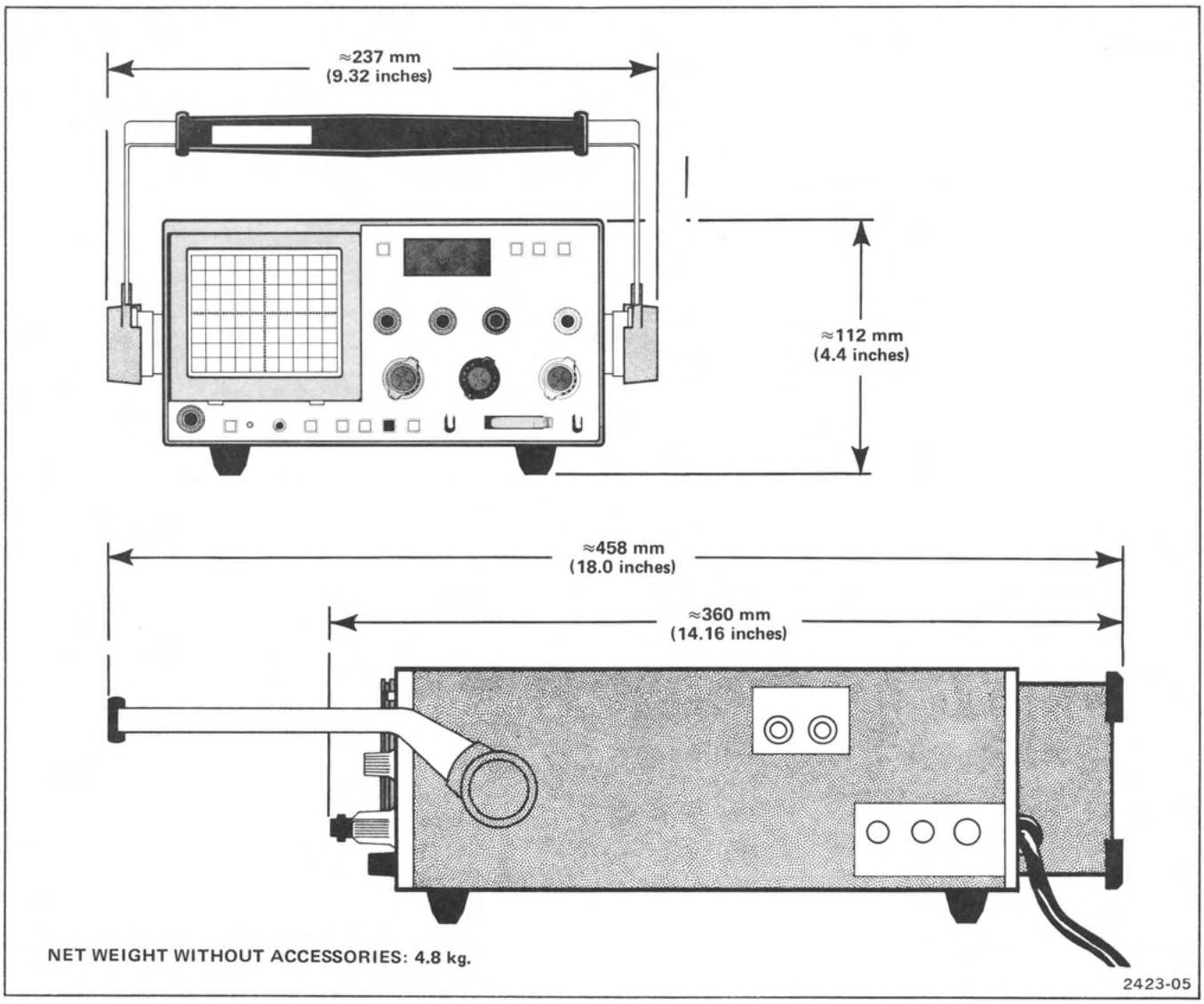


Fig. 1-1. Dimensional drawing.

STANDARD ACCESSORIES

2 10X Probe Packages
1 DMM Probe Package
1 Carrying Case
1 Carrying Case Cover
1 Carrying Strap Assembly
2 Fuses, 0.1 A
1 Fuse, 0.25 A
1 Fuse, 1.5 A
1 Service Manual
1 Operator Manual
1 Clear Crt Filter
1 Blue Crt Filter
1 External DC Cable Assembly

RECOMMENDED OPTIONAL ACCESSORIES

The following optional accessories have been selected from our catalog specifically for your instrument. They are listed as a convenience to help you meet your measurement needs.

Camera Adapter (Extension)
Amber Crt Filter
Viewing Hood
BNC to Binding Post Adapter

NOTE

For part numbers and further information about accessories, refer to the tabbed Accessories page at the back of this manual; for information and prices, refer to a Tektronix Products Catalog or contact your local Field Representative.

OPERATING INSTRUCTIONS

This section of the manual will familiarize the operator with the instrument power requirements, location and operation of external accessible controls, connectors and indicators.

SAFETY INFORMATION

WARNING

High voltage is present inside this instrument. To avoid electric-shock hazard, operating personnel must not remove the protective instrument cover. Component replacement and internal adjustments must be made by qualified service personnel only.

In the ac power source mode, the 305 DMM Oscilloscope operates from a single-phase power source, which has one of its current-carrying conductors at ground (earth) potential.

This instrument has a three-wire power cord with a three-contact plug for connection to the power source and to protective ground. The plug protective-ground contact connects (through the power cord protective grounding conductor) to the accessible metal parts of the instrument. For electric-shock protection, insert this plug into a socket outlet that has a securely grounded protective-ground contact.

Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric-shock hazard. Before making external connections to this instrument, always ground the instrument first by connecting the power cord to a mating power outlet that is known to be properly grounded.

OPERATING VOLTAGE

This instrument may operate from an external dc source, rechargeable batteries (supplied with the instrument), or a 115 or 230 Vac nominal line voltage.

External DC Power

The 305 can operate from an external dc power source of +9 to +32 Vdc. Set the Power Source Selector switch to the EXT DC position (Fig. 2-1). Apply external dc voltage to the two banana jack inputs using the cable assembly supplied with the instrument (Fig. 2-2).

Internal Battery Power

To operate the instrument from the internal battery source, set the Power Source Selector switch to the BATTERY position (Fig. 2-1). Battery voltage is indicated on the DMM digital readout when all DMM FUNCTION push buttons are in the out position.

WARNING

Replacement of internal batteries must be accomplished by qualified service personnel.

AC Power

The 305 can be operated from a 115 or 230 Vac nominal line voltage source with a power line frequency of 48 to 440 Hz (see Fig. 2-1). The AC Input Voltage Selector switch must be set to the range that matches the local ac supply voltage.

WARNING

Changing the AC Input Voltage Selector range must be accomplished by qualified service personnel only. The line voltage fuse must be changed to match the nominal ac voltage range selected.

INTERNAL BATTERY OPERATION

The 305 features battery operation from six rechargeable, nickel-cadmium cells (1.2 V, total nominal voltage of 7.2 Vdc). The operating time of the internal battery depends upon display intensity, state of battery charge, discharge temperature, and the instrument function being used (Oscilloscope, DMM, or both). When the instrument is operated at +20°C to +30°C (+68°F to +86°F) ambient temperature, the typical operating time of a fully-charged battery with both Oscilloscope and DMM in operation is approximately 1.6 hours.

A light-emitting diode (LED), labeled 'ON (FLASHES WHEN LOW)' (Fig. 2-5), is illuminated to indicate that the Oscilloscope function is on and that the battery charge is sufficient for operation. If the battery charge is low, the LED flashes off and on to indicate that the battery requires recharging. An automatic battery over-discharge protection circuit will turn the instrument off to prevent excessive discharge and protect the battery from permanent damage.

AC LINE VOLTAGE RANGE INDICATOR

(A) (B) INDICATES NOMINAL AC INPUT VOLTAGE (115 OR 230 V) FROM WHICH INSTRUMENT MAY BE OPERATED.

POWER SOURCE SELECT SWITCH

(C) OPERATES 305 FROM AC OR EXT DC POWER SOURCE WITH FULL CHG APPLIED TO INTERNAL BATTERIES.

(D) OPERATES FROM AC OR EXT DC POWER SOURCE WITH TRICKLE CHG APPLIED TO BATTERIES.

(E) OPERATES 305 FROM INTERNAL BATTERY POWER SOURCE.

AC POWER SOURCE OPERATION

(F) CHECK THAT THE AC LINE VOLTAGE RANGE INDICATOR DISPLAYS THE NOMINAL AC LINE VOLTAGE AVAILABLE (115 OR 230 V AC).

(G) SET THE POWER SOURCE SELECT SWITCH TO AC, FULL OR TRICKLE CHG.

WARNING

(H) **WHEN OPERATING FROM EXTERNAL DC OR INTERNAL BATTERIES THE INSTRUMENT GROUND CONNECTOR MUST BE CONNECTED TO A PROTECTIVE EARTH GROUND.**

BATTERY POWER SOURCE OPERATION

(I) SET THE POWER SOURCE SELECT SWITCH TO BATTERY POSITION.

EXTERNAL DC POWER SOURCE OPERATION

(J) SET THE POWER SOURCE SELECT SWITCH TO ONE OF THE EXT DC POSITIONS.

(K) APPLY EXTERNAL DC POWER SOURCE (+9 TO +32 V DC) TO THE BANANA JACK INPUT.

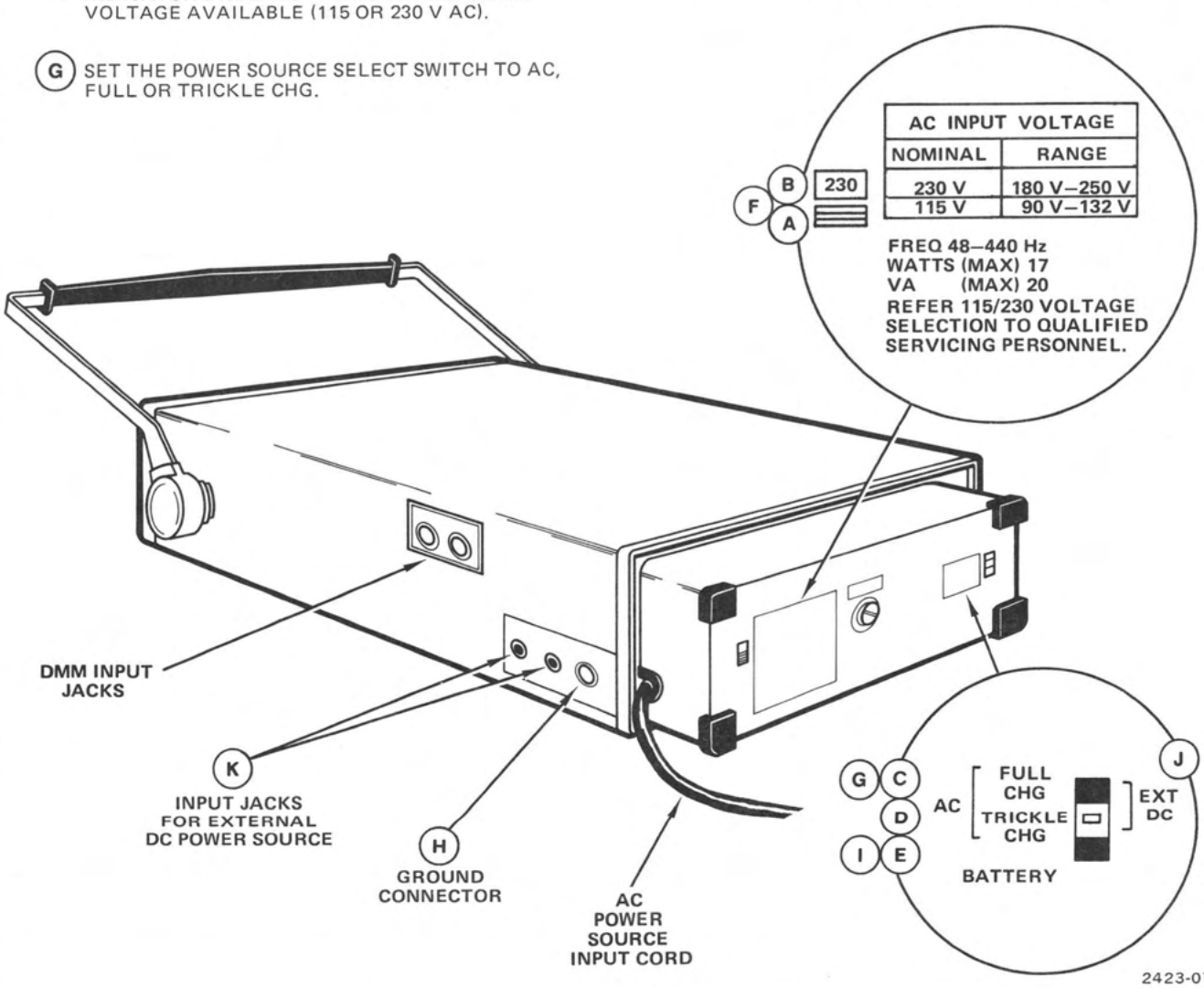


Fig. 2-1. Description of power source operation.

BATTERY CHARGING

To fully charge the battery: turn SCOPE POWER and DMM POWER off, switch the Power Source Selector switch to AC FULL CHG position, connect the instrument to an ac power source, and allow at least 16 hours for the battery to become fully charged. To obtain the longest operating life from the battery, the instrument should be turned on at least once a month and the battery discharged until the Oscilloscope SCOPE POWER LED flashes, then recharged for 24 hours. This procedure balances the charge on the cells and reduces the possibility of any cell becoming reverse charged.

The energy capacity of nickel-cadmium cells varies with the temperature at which they are charged and operated. Table 2-1 shows the percentage of full-charge capacity at various charging and operating temperatures.

Table 2-1

BATTERY CHARGE CAPACITY
CHARGE-DISCHARGE TEMPERATURE REFERENCE

Charging Temperature	Operating Temperature		
	−15°C	+20° to +25°C	+55°C
0°C	40%	60%	50%
+20°C to +25°C	65%	100%	85%
+40°C	40%	65%	55%

BATTERY CARE

Nickel-cadmium cells will self discharge when the instrument is seldom used or stored for extended periods of time. The rate of self discharge is dependent upon temperature and humidity. When the instrument is to be stored for extended periods of time, particularly at high temperatures or humidity, the battery should be charged for at least 16 hours every two weeks. The 305 may be connected to an ac power input source with the Power Selector switch set to AC TRICKLE CHG position to maintain the charge of the battery.

CONTROLS AND CONNECTORS

The major controls and connectors necessary for proper operation of the instrument are located on the front, side, and rear cabinet panels. Some auxiliary adjustments are accessible through the bottom of the cabinet. Figures 2-2 through 2-9 show views of the instrument with the controls and connectors called out. The circled numbers correspond to the discussion about each control and connector. Figure 2-11 shows the location of the auxiliary adjustments and the purpose of the controls. The auxiliary adjustments are made only when necessary and not as a normal routine during operation of the instrument.

Power Source and Signal Input Switches, Connectors, and Indicators

(1) **Power Source Selector switch.** Three-position switch provides operaton selection of ac-source voltage, external dc voltage, or internal battery operation. The AC position, in conjunction with the AC INPUT VOLTAGE Selector switch, allows the 305 to be operated over two ranges of ac-source voltage. The Power Source Selector switch also provides for operator selection of either full-charge rate or trickle-charge rate to the internal battery of the instrument (Fig. 2-2).

(2) **AC Input Voltage Indicator.** Indicates the nominal ac-source voltage (115 V or 230 V) from which the instrument is set to be operated. The 115 V position allows operation from a 90 V to 132 Vac source; the 230 V position allows operation from a 180 V to 250 Vac source.

(3) **+ and −.** Connectors for applying an external dc power source (+9 V to +32 V) (Fig. 2-3).

(4) **Ground Connector.** Connector used for the common ground connection from the power source or associated instruments or devices under test (Fig. 2-3).

(5) **DMM INPUT: HI and LO.** Connectors used to apply external voltages or resistance to be measured by the digital multimeter (Fig. 2-3).

(6) **AC Line Cord.** Connects the instrument to an ac-power source (Fig. 2-3). The cord may be conveniently stored by wrapping it around the feet on the rear cover.

(7) **CH 2 [Y] INPUT.** Connector used to apply an external signal to the Channel 2 vertical deflection system. The Channel 2 input signal provides the Y-axis deflection (vertical) in the X-Y mode of operation (Fig. 2-4).

(8) **EXT TRIG INPUT.** Connector used to apply an external trigger input signal to the trigger generator circuit (Fig. 2-4).

(9) **CH 1 [X] INPUT.** Connector used to apply an external signal either to the input of the Channel 1 vertical deflection system, or (in the X-Y mode of operation) to the X-axis deflection amplifier

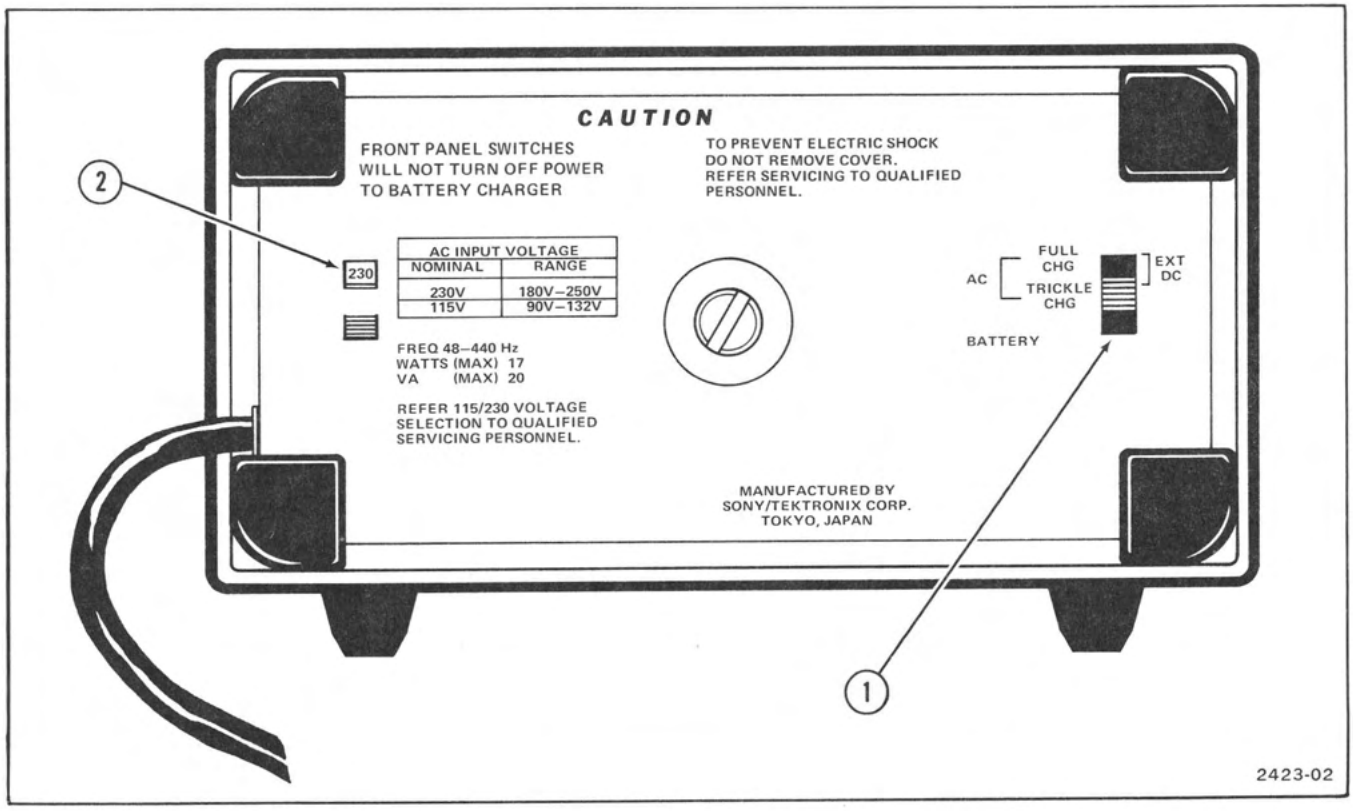


Fig. 2-2. View of rear cover.

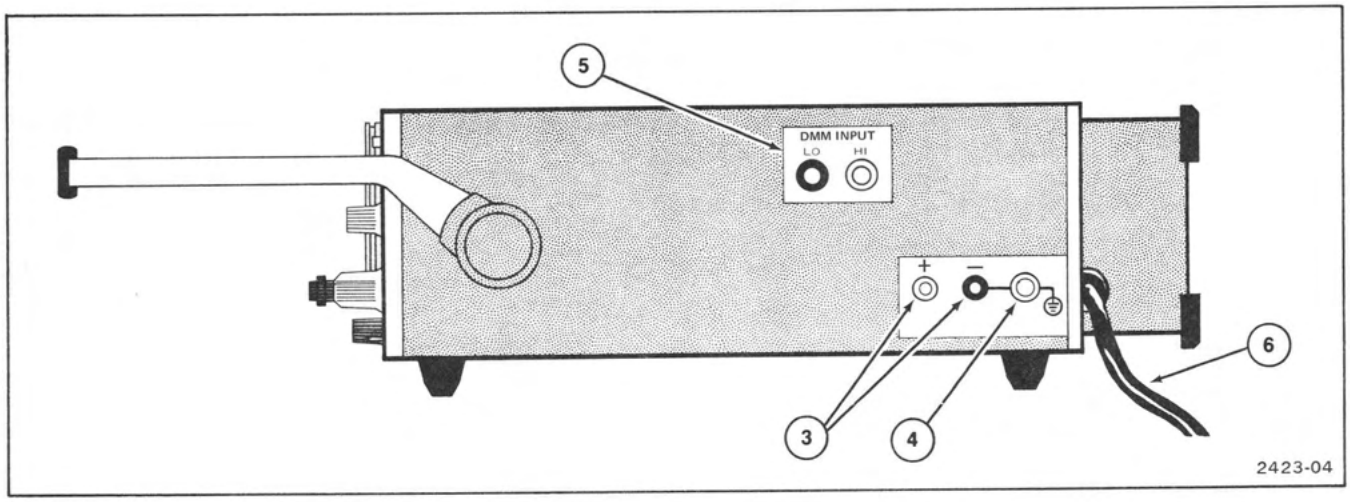


Fig. 2-3. Right side view of instrument cabinet.

(horizontal) (Fig. 2-4). The maximum safe ac or dc voltage coupled to the CH 1 input connector (also applicable for CH 2 or EXT TRIG INPUT) is 250 V (dc + peak ac).

Oscilloscope Cathode-Ray Tube (CRT), Calibrator, and Display Controls (Fig. 2-5)

(10) **SCOPE POWER.** Push-button switch used to turn the Oscilloscope function on (button in) and off (button out). (Oscilloscope section can be operated either independently or simultaneously with DMM section.)

(11) **INTENSITY.** Controls the brightness of the crt display.

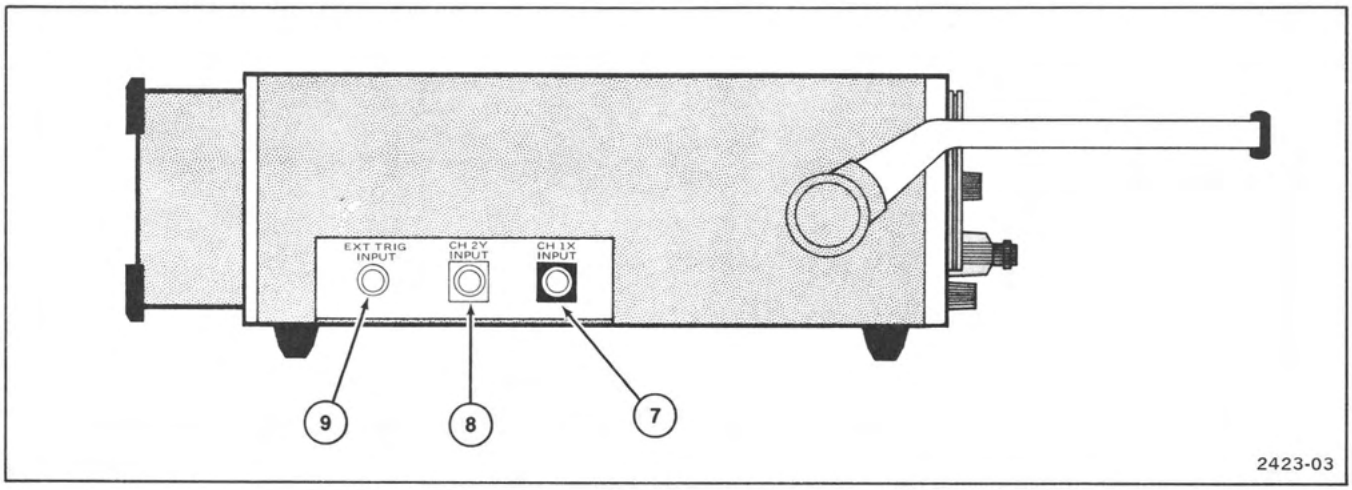


Fig. 2-4. Left side view of instrument cabinet.

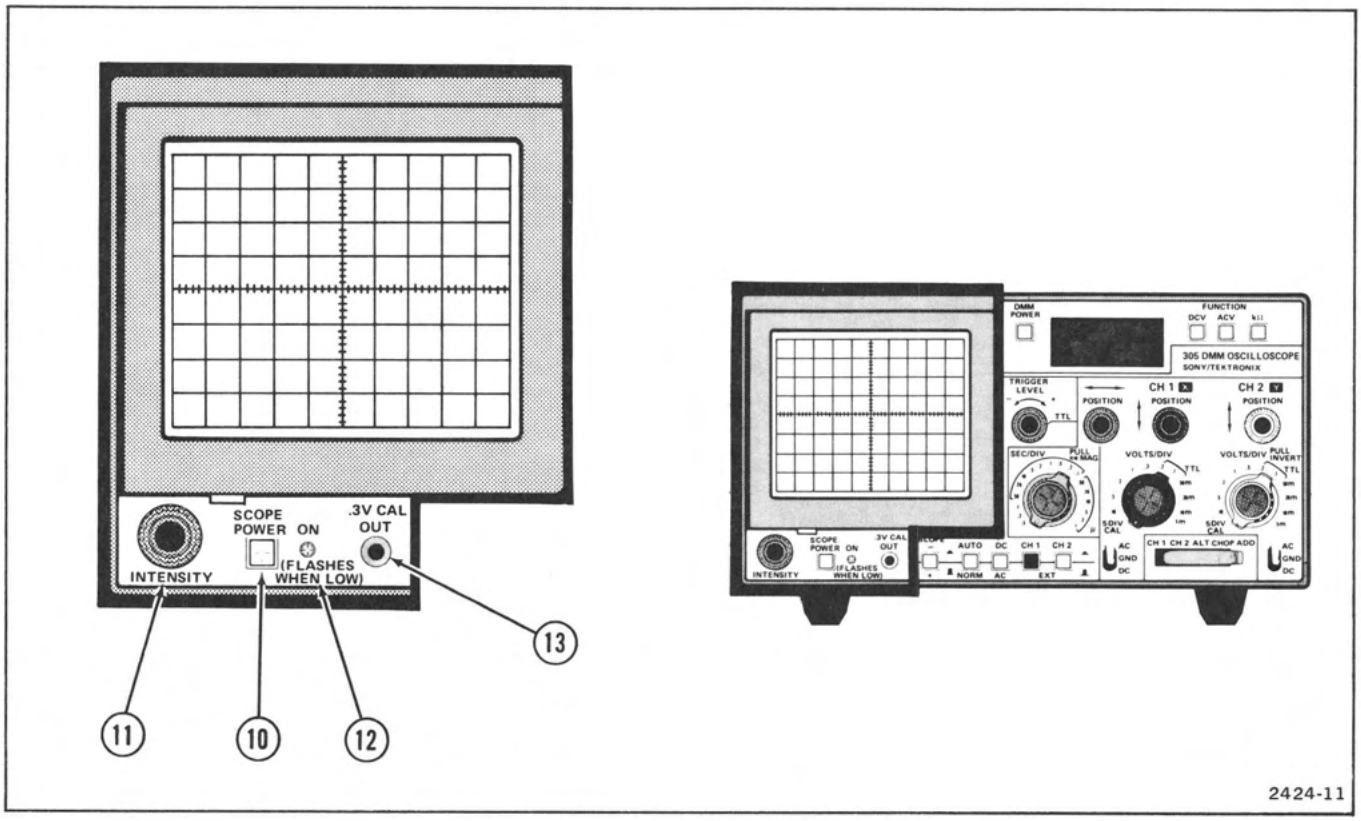


Fig. 2-5. Location of display and calibrator controls.

NOTE

The intensity level should be set to the lowest visible display to prolong the life of the crt and extend the battery life when operating the instrument on the internal battery.

(12) **ON (FLASHES WHEN LOW).** Green LED indicator that is illuminated when SCOPE POWER is on.

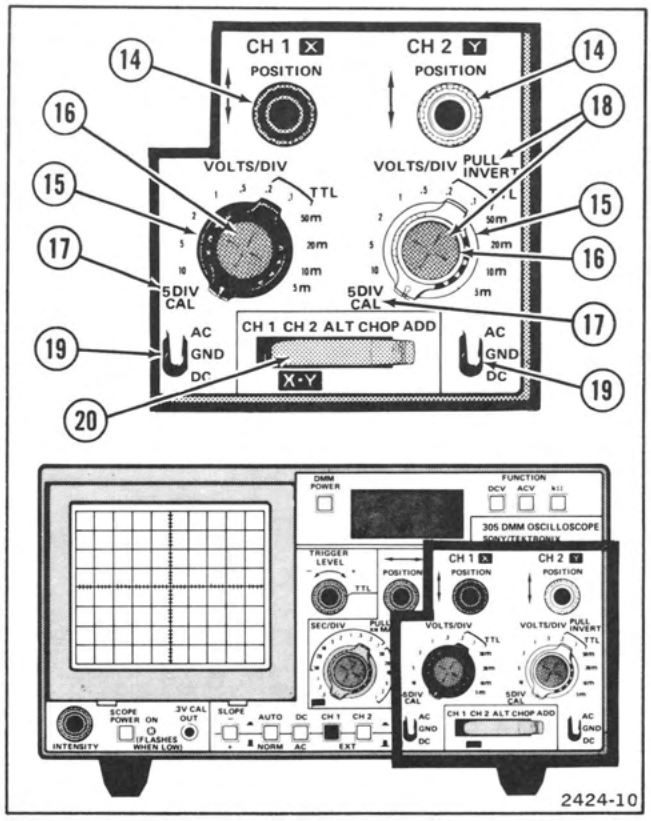


Fig. 2-6. Location of vertical deflection system controls.

NOTE

The LED flashes off and on when the battery requires recharging, and it goes out when the battery charge is low enough to cause the automatic battery over-discharge circuit to turn off the instrument.

(13) **.3V CAL OUT (Calibrator).** Pin-connector output provides an internally generated 0.3 V p-p, 1 kHz square wave. Calibrated voltage is useful for checking vertical deflection factor accuracy and probe compensation.

Vertical Controls (Fig. 2-6)

(14) **POSITION (CH 1 or X, CH 2 or Y).** Controls the vertical position of the crt display for each channel. In the X-Y mode of operation, the CH 1 [X] POSITION control moves the display horizontally, and the CH 2 [Y] POSITION control moves the display vertically.

(15) **VOLTS/DIV (CH 1 and CH 2).** Individual switches for each channel that select the deflection factor for the signal applied to the input connector of the associated channel. CAL control must be in the calibrated detent to obtain the indicated deflection factor. Three positions (0.2, 0.1, and 50 m) of the VOLTS/DIV switches are marked TTL. These positions are the vertical deflection factors that are most useful for viewing TTL logic levels when a 10X probe is being used.

(16) **VOLTS/DIV CAL (CH 1 and CH 2).** Control (concentric with each VOLTS/DIV switch) provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switch. Extends the maximum deflection factor to at least 25 V per division.

(17) **5 DIV CAL.** Position of the VOLTS/DIV switch that internally connects a calibrated signal to the vertical preamplifier circuit. Useful for checking the vertical deflection gain accuracy.

(18) **PULL: INVERT.** Pull the VOLTS/DIV CAL knob to the out position to invert the Channel 2 signal. Used primarily with the ADD Display mode.

(19) **Vertical Coupling.** Three-position switch that selects the method of coupling the input signal to the vertical deflection system.

AC: Input signal is capacitively coupled to the vertical attenuator circuit. Dc component of the input signal is blocked. Lower frequency limit (lower −3 dB point) is approximately 10 Hz.

GND: Connects the attenuator input to ground to provide a ground reference (zero volts) display (does not ground the input signal). The vertical input coupling capacitor is allowed to precharge to the input signal level through a 1 MΩ resistor to ground.

DC: All components of the input signal are directly coupled to the vertical attenuators.

(20) **Display Mode.** Five-position lever switch that selects the operating mode of the vertical deflection system.

CH 1: Displays the signal applied to the CH 1 [X] INPUT connector. In X-Y operation (with CH 2 selected) the Channel 1 signal provides horizontal (X-axis) deflection.

CH 2: Displays the signal applied to the CH 2 [Y] INPUT connector. The CH 2 display mode is selected for X-Y operation and provides the Channel 2 input signal for the vertical (Y-axis deflection).

ALT (Alternate): A dual-trace display that alternately displays signals applied to the CH 1 and CH 2 input connectors. Switching between channels occurs at the end of each sweep. This operating mode is useful when viewing both input signals at sweep rates of 1 ms per division or faster.

CHOP (Chopped): Provides a dual-trace display by switching between Channel 1 and Channel 2 signals at a fixed rate of approximately 50 kHz. This mode is useful when viewing input signals at sweep rates of 0.5 ms per division or slower.

ADD: The crt display is the algebraic sum of the signals applied to the CH 1 and CH 2 input connectors. When the PULL: INVERT control is pulled out to the INVERT position, the Channel 2 signal is inverted, and the crt display is the difference between the signals applied to the CH 1 and CH 2 input connectors.

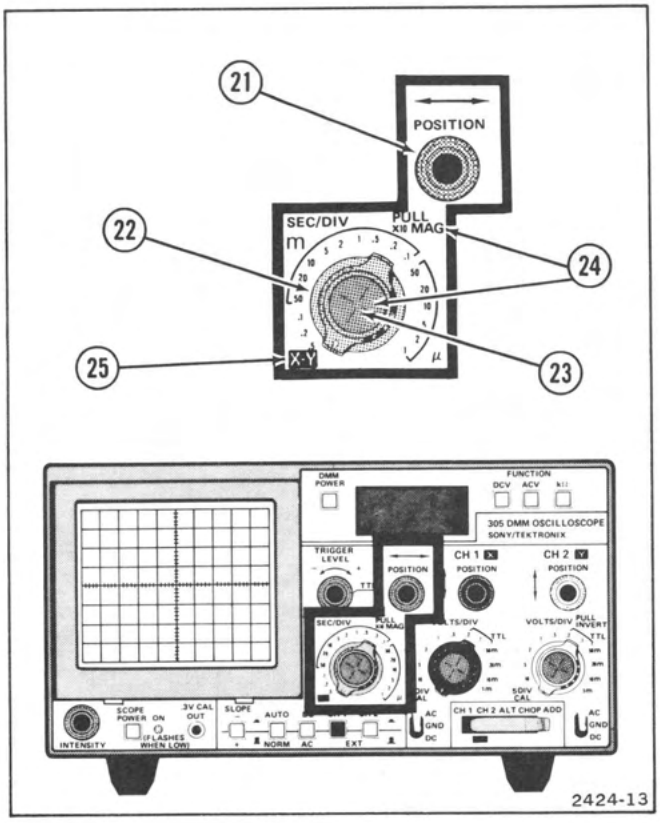


Fig. 2-7. Location of horizontal deflection system controls.

Horizontal Controls (Fig. 2-7)

(21) **POSITION.** Controls the horizontal positioning of the crt display, except in the X-Y mode of operation. In X-Y mode, the CH 1 [X] POSITION control provides the horizontal positioning.

(22) **SEC/DIV.** Selects the calibrated sweep rates of the sweep generator circuit. Variable SEC/DIV CAL control must be in the calibrated detent to obtain the indicated time base sweep rate.

(23) **SEC/DIV CAL.** Control (concentric with the SEC/DIV switch) provides continuously variable uncalibrated sweep rates between the calibrated settings of the SEC/DIV switch. Extends the slowest sweep rate to at least 1.25 s per division.

(24) **PULL: X10 MAG.** Pull the SEC/DIV CAL control to the out position to horizontally magnify the display by a factor of 10. Extends the fastest sweep rate to 0.1 μs per division.

(25) **X-Y.** Fully counterclockwise position of the SEC/DIV switch selects the X-Y display operating mode. X-axis deflection is provided by the signal applied to the CH 1 [X] INPUT connector, and Y-axis deflection is provided by the signal applied to the CH 2 [Y] INPUT connector. The CH 2 [X-Y] display mode must be selected.

Triggering and Sweep Controls (Fig. 2-8)

(26) **Source.** Push-button switches that select the source of the signal applied to the trigger generator circuit for initiating the horizontal sweep.

CH 1 (in): Signal connected to the CH 1 input connector is used as the trigger signal.

CH 2 (in): Signal connected to the CH 2 input connector is used as the trigger signal.

EXT (External Trigger) (CH 1 and CH 2 push buttons both out): Signal connected to the EXT TRIG INPUT connector is used as the trigger signal.

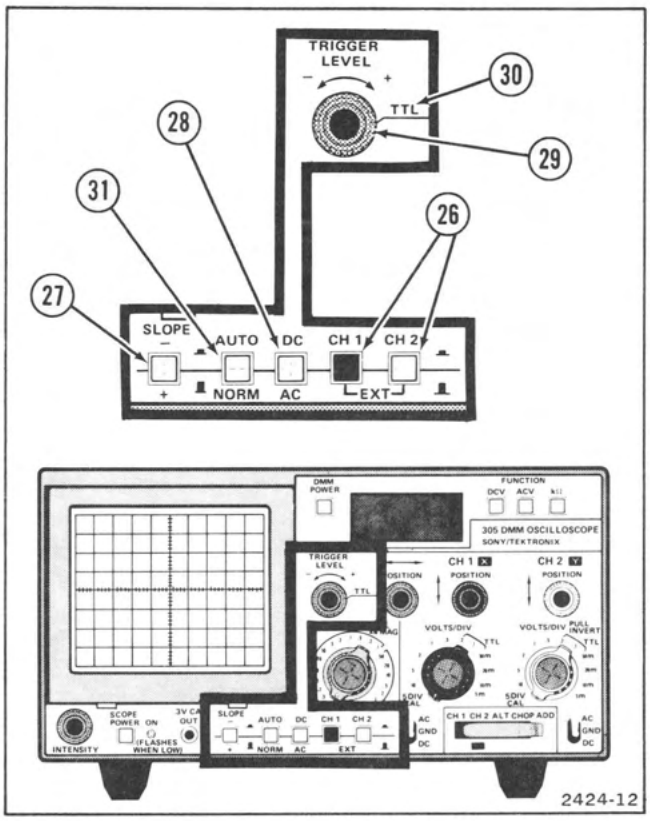


Fig. 2-8. Location of trigger and sweep controls.

(27) **Slope.** Push-button switch that selects either the positive-going or negative-going slope of the trigger signal to initiate the sweep.

+ **(out):** Sweep triggers on the positive-going portion of the trigger signal.

– **(in):** Sweep triggers on the negative-going portion of the trigger signal.

(28) **Trigger Coupling.** Push-button switch that selects the method of coupling a signal to the trigger generator circuit.

AC (out): Rejects dc and attenuates signals below approximately 60 Hz. Accepts signals from approximately 60 Hz to 5 MHz.

DC (in): Provides direct coupling for signals within the instrument vertical bandpass (dc to approximately 5 MHz).

(29) **TRIGGER LEVEL.** Selects the amplitude point on the triggering signal at which the sweep will be triggered. It is usually adjusted after Trigger Source, Coupling, and Slope have been selected.

(30) **TTL.** TRIGGER LEVEL position used in conjunction with the TTL positions of the CH 1 and CH 2 VOLTS/DIV switches. It presets the trigger level for a stable display of an input TTL signal. Trigger Coupling must be in DC; Mode switch in the NORM position.

(31) **Trigger Mode.** Push-button switch that determines the operating mode of the trigger circuit.

AUTO (Automatic) (in): Sweep is triggered when a signal with sufficient amplitude and repetition rate is applied to the vertical system (Channel 1 or Channel 2 signal selected as the trigger signal source) or to the EXT TRIG INPUT connector (external trigger signal is selected as the trigger signal source). In the absence of an adequate trigger signal, the sweep free runs to provide a reference display trace. The sweep will auto trigger if the signal repetition rate is below approximately 200 Hz.

NORM (Normal) (out): Sweep is initiated if the following circuit conditions are met: TRIGGER LEVEL control set correctly; sufficient signal amplitude applied to the vertical system or EXT TRIG INPUT connector; input signal frequency is within the instrument vertical bandpass limits when Trigger Coupling is in the DC position, or signal frequency is between approximately 60 Hz up to 5 MHz in the AC Trigger Coupling mode. In the absence of an adequate trigger signal, or when the trigger controls are misadjusted, a sweep is not generated and a signal or trace is not displayed.

Digital Multimeter Operating Controls (Fig. 2-9)

(32) **DMM POWER.** Push-button switch that turns the digital multimeter on (button in) or off (button out). The digital readout lights when power is applied to the multimeter. (DMM section can be operated either independently or simultaneously with Oscilloscope section.)

(33) **FUNCTION.** Three push-button switches used to select the measurement function of the digital multimeter.

ACV (in): Measures ac voltages connected to the DMM input jacks.

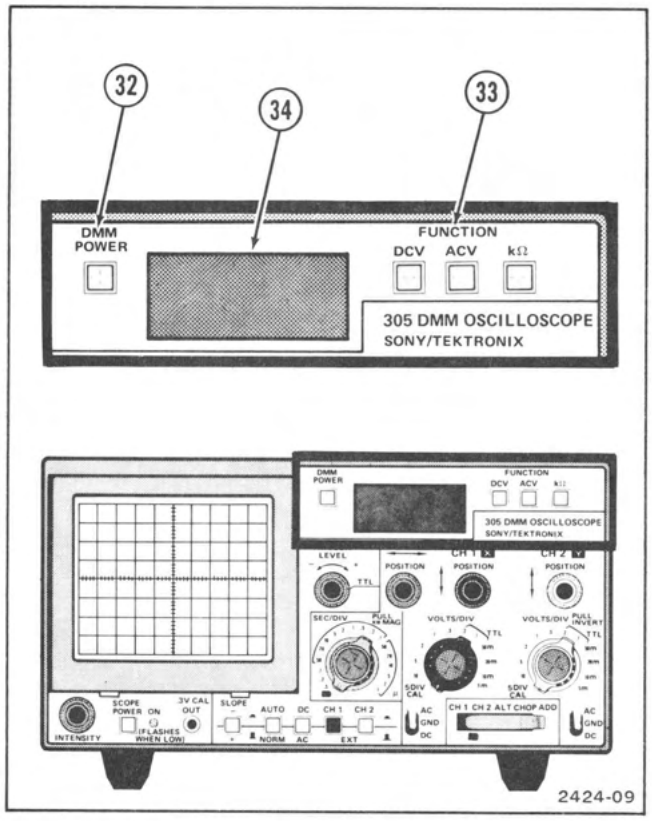


Fig. 2-9. Location of digital multimeter controls.

DCV (in): Measures dc voltages connected to the DMM input jacks.

kΩ (in): Measures resistance connected to the DMM input jacks.

(34) **Digital Readout.** Displays measurement selected by the FUNCTION control switches. Negative polarity indicator is automatic. No polarity indicator is displayed for positive voltage measurements. Decimal point locator is automatic. The readout will alternately display "- . - - -" and the normal display if the voltage of the power source selected is too low for proper DMM operation.

Internal Battery Voltage Indicator. When all the DMM FUNCTION push-button switches are out and power is being supplied by the internal battery source, the digital readout displays the battery voltage level.

BASIC OSCILLOSCOPE DISPLAYS

Normal Sweep Display

1. Preset front panel controls as shown in Table 2-2. Set SCOPE POWER on.

2. Connect an external signal to either the CH 1 input connector or the CH 2 input connector. Adjust the INTENSITY control for the desired display brightness.

3. Set the Display Mode switch for the desired input channel.

4. Adjust the VOLTS/DIV switch to obtain the desired display amplitude. Adjust the selected channel POSITION control to locate the display within the graticule viewing area.

5. Set the SEC/DIV switch and horizontal POSITION control to locate the display within the graticule viewing area.

6. Adjust the TRIGGER LEVEL control for a stable display if necessary.

Magnified Sweep Display

1. Obtain a normal sweep display. (See Normal Sweep Display instructions.)

2. Adjust the INTENSITY control for the desired display brightness.

3. Adjust the horizontal POSITION control to move the display within the graticule viewing area. If necessary, readjust the SEC/DIV control to place the area to be magnified on the center vertical graticule line.

4. Set the PULL: X10 MAG knob to the on (knob out) position. Adjust the horizontal POSITION control for precise positioning of the magnified display. Divide the SEC/DIV setting by 10 to determine the magnified sweep rate.

X-Y Display

1. Preset front panel controls as shown in Table 2-2.

2. Apply the vertical input signal to the CH 2 [Y] INPUT connector, and apply the horizontal signal to the CH 1 [X] INPUT connector.

3. Set the SEC/DIV switch to the X-Y position and the Display Mode switch to CH 2 [X-Y].

4. CH 2 POSITION control determines the vertical positioning, and the CH 1 POSITION control determines the horizontal positioning of the display. Set these controls as necessary.

5. Adjust the CH 1 and CH 2 VOLTS/DIV switches to obtain the desired display.

Alternate or Chopped Display

1. Preset the front panel controls as shown in Table 2-2 for Normal Sweep Display. Set the SCOPE POWER switch to on.

2. Connect two external time-related signals: one to the CH 1 input connector and the other to the CH 2 input connector. Adjust the INTENSITY control for the desired display brightness.

3. With the Display Mode switch set to CH 1, adjust the CH 1 VOLTS/DIV switch to obtain the desired display amplitude. Adjust CH 1 POSITION control to locate the display within the upper half of the graticule viewing area.

4. Set the Display Mode switch to CH 2. Adjust the CH 2 VOLTS/DIV switch to obtain the desired display amplitude and use the CH 2 POSITION control to locate the display within the lower half of the graticule viewing area.

5. Set the Display Mode switch to ALT if the signals to be viewed require a sweep rate of 1 ms per division or faster, or to CHOP if the signals to be viewed require a sweep rate slower than 1 ms per division. Use the CH 1 and CH 2 POSITION controls to obtain the desired trace separation.

6. Set the SEC/DIV switch and horizontal POSITION control to locate the display within the graticule viewing area.

7. Set the Trigger Source switch to select the desired trigger signal (CH 1, CH 2, or EXT).

NOTE

Both signals being viewed must be time related to the trigger or the display will not be stable.

8. Adjust TRIGGER LEVEL for a stable display.

ADD Display

1. Obtain an Alternate or Chopped display. (See Alternate or Chopped Display instructions.)

2. Set the Display Mode switch to ADD to obtain a display of the algebraic sum of Channel 1 and Channel 2 signals (CH 1 plus CH 2).

3. To obtain a display of the difference between Channel 1 and Channel 2 signals, set the CH 2 PULL: INVERT switch to the INVERT position (out).

Table 2-2

CONTROL SELECTOR FOR BASIC OSCILLOSCOPE DISPLAY

Front Panel Controls	Initial Settings	Normal Sweep Display	Magnified Sweep Display	X-Y Display[d]
Display Controls				
SCOPE POWER	On (in)	On (in)	On (in)	On (in)
INTENSITY	Fully CCW[a]	Fully CCW[a]	Fully CCW[a]	Fully CCW[a]
Vertical Controls				
Display Mode	CH 1	CH 1 if applicable	CH 2 if applicable	CH 2 (X-Y)
VOLTS/DIV	10 m	[a]	[a]	[a]
VOLTS/DIV CAL	Detent	Detent	Detent	Detent
POSITION	Midrange	Midrange	Midrange	Midrange
Coupling	GND	AC	AC	AC
PULL : INVERT	Off (in)	Off (in)	Off (in)	Off (in)
Horizontal Controls				
SEC/DIV	.5 m	[b]	[b]	X-Y
SEC/DIV CAL	Detent	Detent	Detent	Detent
PULL : X10 MAG	Off (in)	Off (in)	On (out)	Off (in)
POSITION	Midrange	Midrange	Midrange	Midrange
Trigger Controls				
Source	CH 1 (in)	CH 1 (in) CH 2 if applicable	CH 1 (in) CH 2 if applicable	CH 1 (in)
Coupling	AC (out)	AC (out)	AC (out)	AC (out)
Trigger Mode	AUTO (in)	AUTO (in)	AUTO (in)	AUTO (in)
Slope	+ (out)	+ (out)	+ (out)	+ (out)
Trigger Level	Midrange	Midrange	Midrange	Midrange

[a] Select settings compatible with amplitude of the signal source after INTENSITY is properly set.

[b] Select setting to obtain the desired display.

[c] Input signal applied to the CH 1 or CH 2 input connector located on left side of cabinet panel.

[d] X-signal applied to the CH 1 input connector and Y-signal to the CH 2 input connector.

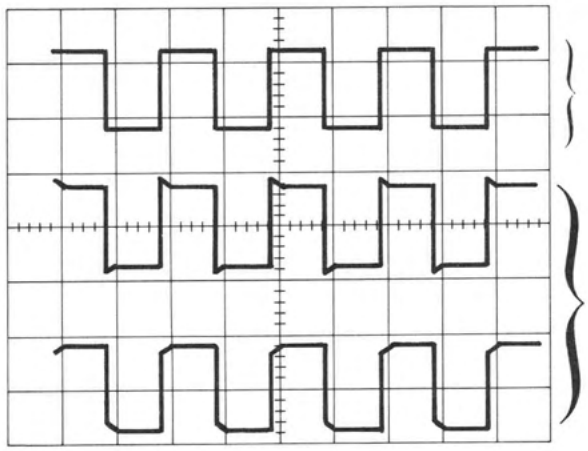


Fig. 2-10. Probe compensation.

OPERATOR OSCILLOSCOPE ADJUSTMENTS AND CHECKS

Probe Compensation

Improper probe compensation is a common source of measurement error. You should check probe compensation when moving the probe from one oscilloscope to another or from one input to the other.

To compensate the 305 Oscilloscope probe:

1. Preset the front panel controls as shown in Table 2-2 for a Normal Sweep Display.

2. Set the CH 1 VOLTS/DIV switch to the 20 m position and touch the Channel 1 probe to the .3 V CAL OUT jack on the front panel.

3. Adjust the TRIGGER LEVEL control for a stable display of the calibrator signal.

4. Adjust the probe compensation for a flat-top waveform as shown in Fig. 2-10. Refer to the probe data sheet, supplied in the probe accessories package, for the adjustment procedure.

Focus and Astigmatism Adjustment

Figure 2-11 shows the location of the operator controls accessed through the bottom of the instrument cabinet.

1. Preset the front panel controls as shown in Table 2-2 for Initial Settings.

2. Set both CH 1 and CH 2 VOLTS/DIV switches to the 5 DIV CAL position.

3. Set the Display Mode switch to ALT and adjust the INTENSITY and both channel POSITION controls for a visible display of both traces.

4. Adjust both the FOCUS and ASTIG controls for a well-defined display of both traces.

Trace Rotation

1. Preset the front panel controls as shown in Table 2-2 for Initial Operation.

2. Increase the intensity to obtain a visible display of a single free-running trace.

3. Use the CH 1 POSITION control to move the trace to the center horizontal graticule line.

4. Adjust the TRACE ROTATION control until the trace is parallel to the center horizontal graticule line.

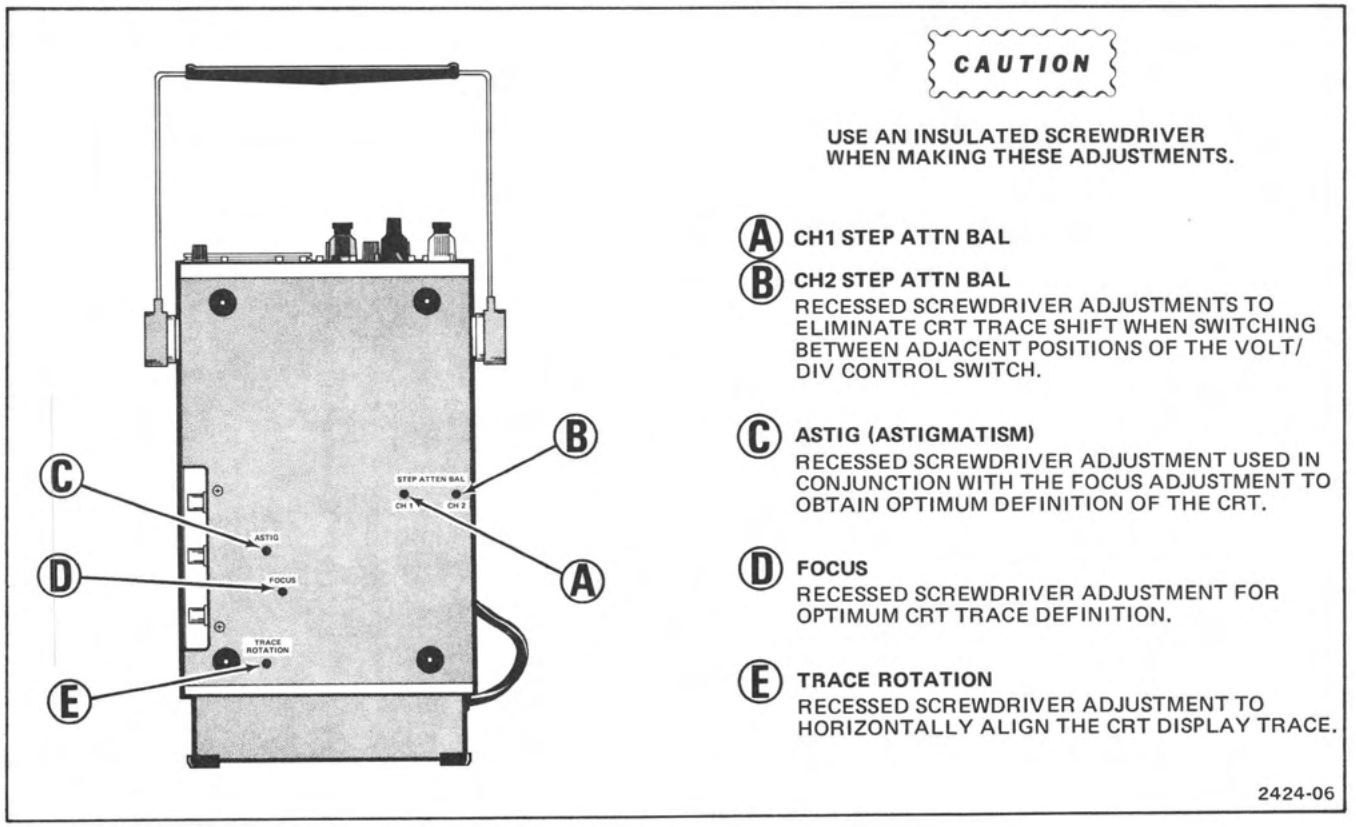


Fig. 2-11. Bottom view of instrument cabinet.

Channel 1 and Channel 2 Step Attenuator Balance

1. Preset the front panel controls as shown in Table 2-2 for Initial Settings.

2. Adjust the intensity to obtain a visible display of a single free-running trace.

3. Switch the CH 1 VOLTS/DIV switch between the 20 m and 5 m positions. Observe the trace and adjust the CH 1 STEP ATTEN BAL for minimum trace shift when switching between the 20 m and 5 m positions of the VOLTS/DIV switch.

4. Set Display Mode switch to CH 2 and repeat Step 3 using CH 2 VOLTS/DIV switch and CH 2 STEP ATTEN BAL adjustment.

Vertical Gain Check

1. Set the CH 1 VOLTS/DIV switch to the 5 DIV CAL position and obtain a normal sweep display (see Normal Sweep Display instructions).

2. CHECK—Display amplitude is within 4.85 to 5.15 vertical divisions.

3. Set the Display Mode switch to CH 2 and set the CH 2 VOLTS/DIV switch to the 5 DIV CAL position.

4. CHECK—Display amplitude is within 4.85 to 5.15 vertical divisions.

NOTE

You may use any signal of known amplitude to confirm the vertical gain.

Basic Timing Check

1. Obtain a normal sweep display of any signal of known frequency.

2. Check that the SEC/DIV CAL is in the calibrated detent, and set the SEC/DIV switch to display one complete cycle of the input signal over approximately two horizontal divisions.

3. Determine the exact number of horizontal divisions occupied by one cycle of the known signal. The time duration of the cycle is equal to the SEC/DIV switch setting times the horizontal divisions. The frequency is calculated using the formula: Frequency = 1/Time Duration.

DIGITAL MULTIMETER DISPLAYS AND OPERATOR CHECKS

CAUTION

The maximum input voltage is ±1000 V (dc + peak ac) between the HI and LO inputs or between the HI input and chassis. The maximum LO floating voltage is ±500 V (dc + peak ac) between LO input and chassis. The DMM may be damaged by attempting to measure voltage if the meter is in the kΩ FUNCTION mode of operation and the applied voltage between HI and LO inputs is in excess of ±100 V (dc + peak ac).

DC Voltage

1. Set the DMM POWER switch on.

2. Push in the DCV FUNCTION push button. The readout should display −.000 ±2 counts with no signal connected to the DMM INPUT.

3. Connect the LO test probe to the reference test point (usually chassis ground) and the HI test probe to the unknown positive dc voltage to be measured.

4. Verify that the display indicates the value of the dc voltage under test.

5. Reverse the HI and LO test probes and verify that the numeric reading is the same as in Step 4, but the negative polarity sign is displayed.

6. Disconnect the test probes from the dc voltage and ground.

AC Voltage

1. Set the DMM POWER switch on.

2. Push in the ACV FUNCTION push button. The readout should display .000 ±10 counts with no signal connected to the DMM INPUT and with the test probe tips shorted together.

3. Connect the LO test probe to the reference test point (usually chassis ground) and the HI test probe to the unknown ac voltage to be measured.

4. Verify that the display indicates the value of the ac voltage under test.

5. Disconnect the DMM test probes from the ac voltage and ground.

Resistance

1. Set the DMM POWER switch on.

2. Push in the kΩ FUNCTION push button. The readout should display a flashing "−1999." overrange condition with no resistance connected to the DMM INPUT.

3. Touch the two DMM test probe tips together. The readout should display .000 ±3 counts.

4. Connect a known resistance to be measured between the DMM test probe tips.

5. Verify that the display indicates the value of the known resistance.

NOTE

The HI test probe is at a negative voltage level with respect to the LO test probe when making resistance measurements.

6. Disconnect the DMM test probes from the resistance under test. Turn off the DMM POWER when measurements are completed.

Battery Voltage

1. Set the Power Source Selector switch (on the instrument rear panel) to BATTERY.

2. Release all the DMM FUNCTION push buttons (all out).

3. Set the DMM POWER switch on.

4. Verify that the display indicates the internal battery voltage level. A typical reading for a fully charged battery is 7.8 volts.

NOTE

In Battery Check mode, the autorange circuitry is inactive, and the display decimal point is set for nominal battery voltage. If power is being supplied from an external dc source or ac power source, an overrange indication will occur if the dc input voltage to the DMM power supply exceeds 20 V. The input voltage may still be within the acceptable range for safe operation of the instrument (+9 V to +32 V).

THEORY OF OPERATION

A complete block diagram of the oscilloscope and DMM circuitry and complete schematics appear in the Diagrams section of this manual. The block diagram shows the relationship between the individual circuits. Refer to the schematic diagrams for electrical values, waveforms, and relationships of the front panel controls to the particular circuits.

OUTLINE FOR THEORY OF OPERATION

OSCILLOSCOPE

DETAILED CIRCUIT DESCRIPTION

OSCILLOSCOPE

BLOCK DIAGRAM

Description

Figure 3-1 shows a simplified block diagram of the 305 Oscilloscope.

The following discussion is provided to aid in understanding the overall concept of the 305 Oscilloscope before the individual circuits are discussed in detail. Only the basic interconnections between the individual blocks appear on the simplified block diagram. Each block represents a major circuit within the oscilloscope. The number on each block corresponds to the number on the complete circuit diagram.

Vertical Amplifier

Signals to be displayed on the crt are connected to the CH 1 [X] or CH 2 [Y] INPUT connectors and applied to the Channel 1 or Channel 2 Attenuator circuits. The output of the Attenuators is applied to the Preamplifier circuits. The Preamplifier circuits in cascade with the Attenuator circuits provide the vertical deflection factor for each channel. Position, gain, and variable attenuation adjustments are provided in the Preamplifier circuits. A trigger-signal pickoff in each Vertical Preamplifier circuit provides a sample of each channel signal to the Trigger Generator circuit.

A signal for horizontal deflection is provided by Channel 1 in the X-Y mode. The Channel 2 Preamplifier contains circuitry to allow the Channel 2 signal to be displayed in an inverted form on the crt. The output of the Preamplifier is connected to the Vertical Switching circuit. Vertical Preamplifier circuitry also provides the signal used for sweep triggering in the CH 1 and CH 2 positions of the Trigger Source switch.

The output of each Vertical Preamplifier circuit connects to the Vertical Switching circuit. The Vertical Switching circuit selects the channel or channels that are to be displayed on the crt. Signals from the Vertical Switching circuit are applied to the Vertical Output Amplifier where the final amplification of the signal is accomplished before it reaches the vertical deflection plates of the crt. An output signal from the switching circuit also connects to the Z-axis Amplifier circuit to blank out the transients that occur when switching between channels in the CHOP Display Mode of Operation.

Calibrator

The Calibrator supplies a 1 kHz square wave to the Channel 1 and Channel 2 Attenuators. In the 5 DIV CAL position of the VOLTS/DIV switch, this signal produces a five-division vertical display on the crt to confirm vertical gain adjustments. The calibrator signal is also present at the 0.3 V CAL OUT jack, and it may be used to check attenuation factor, probe compensation, and vertical gain adjustment.

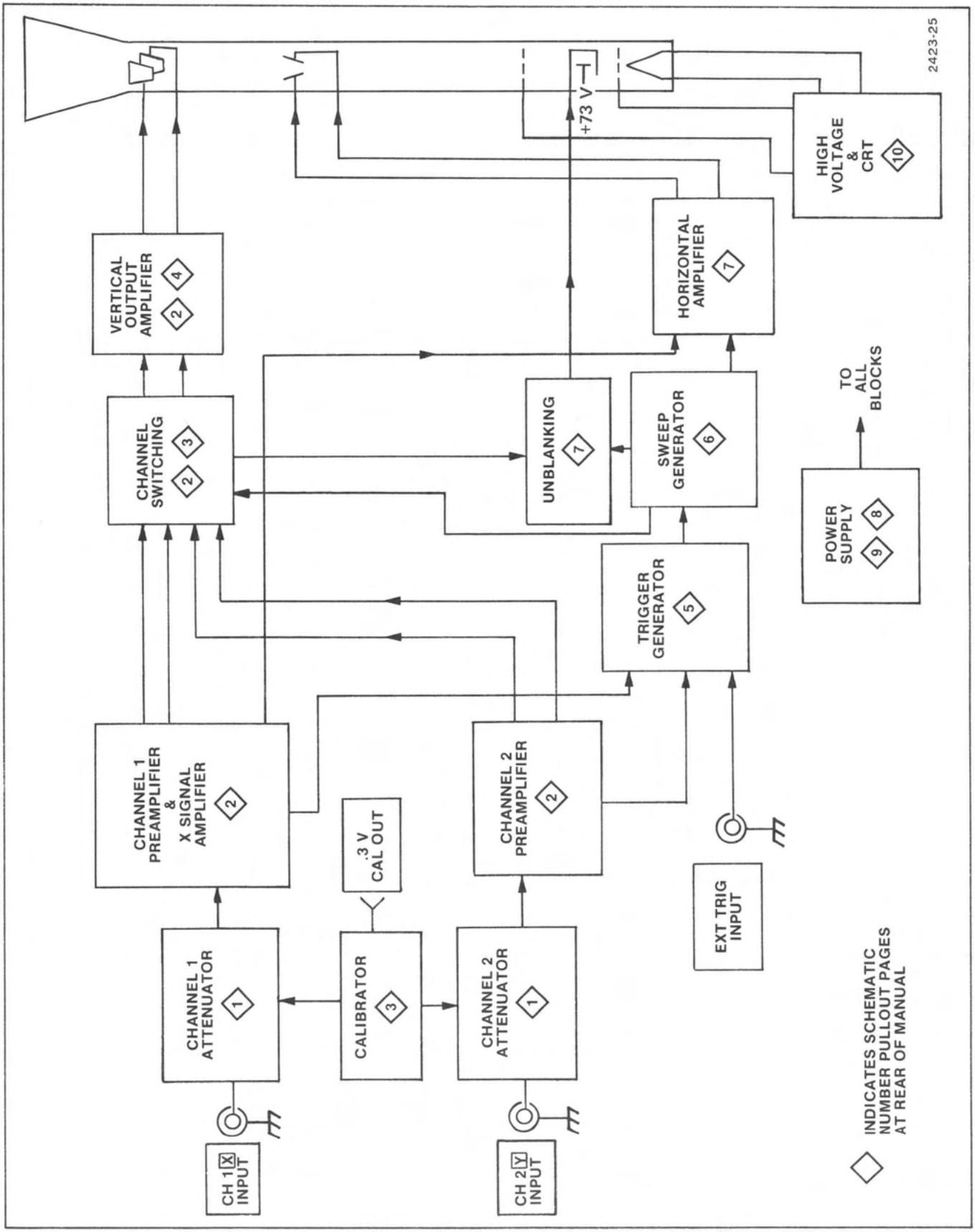


Fig. 3-1. Simplified block diagram of the 305 oscilloscope.

Trigger System

The Trigger Generator circuits produce an output pulse that triggers the Sweep Generator circuits. The input signal to the Trigger Generator circuits can be selected from the Channel 1 signal, the Channel 2 signal, or from a signal applied to the EXT TRIG INPUT connector.

Sweep Generator

The Trigger AUTO-NORM switch controls the mode of operation of the Sweep Generator. In the AUTO position of the switch, absence of an adequate trigger signal causes the sweep to free run. In the NORM position of the switch, a sweep is generated only by an adequate trigger signal.

The output of the Sweep Generator is amplified by the Horizontal Amplifier to produce horizontal deflection for the crt (except in the X-Y position of the SEC/DIV switch). The Horizontal Amplifier contains a X10 Magnifier to increase the sweep rate by a factor of 10 in any position of the SEC/DIV switch. When the SEC/DIV switch is set to the X-Y position, the X-axis signal is connected to the Horizontal Amplifier circuit from the CH 1 Vertical Preamplifier circuit.

The Sweep Generator also produces an unblanking gate that is fed to the Z-axis Amplifier. The gate, coincident with the sweep signal produced by the Sweep Generator, allows the display of a trace on the crt during sweep time. The logic circuitry of the Sweep Generator supplies an alternate trace pulse that is applied to the Vertical Channel Switching circuit. This pulse switches the display between channels at the end of each sweep when ALT Display Mode is selected.

Power Supply and CRT

The Power Supply converts ac power source voltage to dc voltage that is applied to the Battery Charger and Power Source switching circuits. The selected power source is then applied to the oscilloscope Switching Regulator and the DMM DC-to-DC converter where the required operating voltages are produced.

The Battery Charger circuit provides a constant-current source for charging at either a trickle-charge rate or a full-charge rate to charge the internal battery when operating the instrument from an ac power source.

The crt circuitry provides the high voltages necessary to operate the crt. The circuitry includes intensity and focus controls to maintain optimum brightness and focus of the crt display.

DETAILED CIRCUIT DESCRIPTION

CHANNEL 1 PREAMPLIFIER AND CALIBRATOR (Diagrams 1, 2, and 3)

Figure 3-2 shows a simplified block diagram of the Channel 1 Preamplifier circuit.

Input signals enter via the CH 1 [X] INPUT connector. The Channel 1 Preamplifier circuit provides control of input coupling, vertical deflection factor, balance, vertical position, and vertical gain. A sample of the Channel 1 input signal is provided to the Trigger Source and Trigger Preamplifier circuitry to provide internal triggering from the Channel 1 signal only. The signal from the Calibrator is connected to the vertical system through sections of the VOLTS/DIV switch following the input attenuators.

Input Coupling

Input signals applied to the CH 1 [X] INPUT connector can be ac coupled, dc coupled, or internally disconnected. When input coupling switch S2 is in the DC position, the input signal is coupled directly to the Input Attenuator circuit. In the AC position, the input signal passes through coupling capacitor C2. This capacitor prevents the dc component of the signal from passing to the amplifier. In the GND position, S2 opens the direct signal path and connects the input of the amplifier to ground to provide a ground (zero volt) reference. The input signal remains connected to the input circuit and coupling capacitor C2 is allowed to precharge to the signal level through R2, a resistor connected to ground through the coupling switch. With the coupling capacitor precharged, the trace on the crt will remain on screen when the input coupling is switched to the AC position.

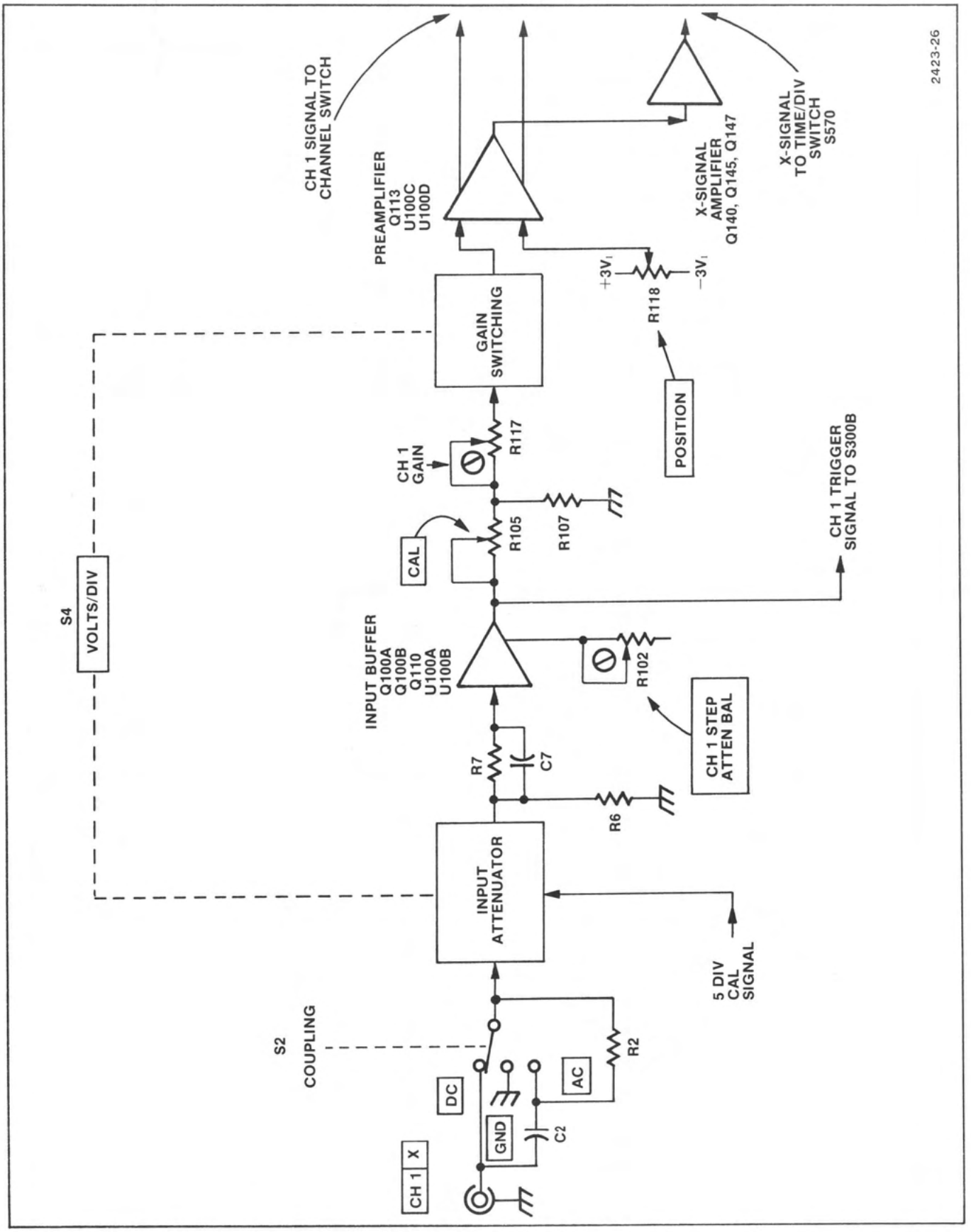


Fig. 3-2. Simplified block diagram of the Channel 1 preamplifier circuitry.

Input Attenuator

The CH 1 [X] deflection factor is determined by the Channel 1 VOLTS/DIV switch. The VOLTS/DIV switch selects the attenaution ratio and preamplifier gain to determine the deflection factor. The basic deflection factor of the vertical deflection system is 5 mV per division. At this setting, no attenuators are switched in, and the gain switching circuit sets the preamplifier gain to maximum. To provide the complete range of deflection factors indicated on the front panel, precision attenuators are switched in and out of the Input Attenuator and Preamplifier gain switching circuits.

The attenuators are frequency-compensated voltage dividers that provide constant attenuation at all frequencies within the bandwidth of the instrument. The input RC characteristic (approximately 1 MΩ times approximately 47 pF) is maintained for each setting of the VOLTS/DIV switch. The attenuator circuit consists of a 10X and a 100X attenuator. Attenuation of 1000X is obtained when the 10X and 100X attenuators are cascaded.

The gain-switching circuit consists of three VOLTS/DIV switch contacts. Attenuators of 1X, 2X, and 4X determine three ranges of Preamplifier gain. Table 3-1 lists the attenuator and gain switching sequence.

Table 3-1

ATTENUATION AND GAIN SWITCHING SEQUENCE

VOLTS/DIV Setting	Input Attenuator	Gain Switch
5 mV	1 X	1 X
10 mV	1 X	2 X
20 mV	1 X	4 X
50 mV	10 X	1 X
.1 V	10 X	2 X
.2 V	10 X	4 X
.5 V	100 X	1 X
1	100 X	2 X
2	100 X	4 X
5	1000 X	1 X
10	1000 X	2 X
5 DIV CAL		1 X

5 Division Calibrator

Switching either Channel VOLTS/DIV switch to the 5 DIV CAL position provides a five-division display on the crt if that channel is selected for display. The calibrator circuit consists of U185B, U185C, and U20A. U185B and U185C form an astable multivibrator; basic frequency of oscillation is determined by R52 and C52. The output of U185B is connected to the clock input of U20A, and U20A divides the oscillator frequency to approximately 1 kHz. A calibration signal also appears at the .3 V CAL OUT jack (on the front panel), where it may be used for compensating probe attenuators.

Input Buffer

Channel 1 signal from the input attenuator is connected to the input buffer stage through R7 and C7. Input resistance for the stage is provided by R6. Current drive to the gate of Q100A is limited by R7 and Q110 in the event excessive amplitude signals are applied to the input connector. Transistor Q100B provides a constant-current source for Q100A; and U100A, in the source lead of Q100B, provides temperature compensation of the input stage.

STEP ATTEN BAL R102 is adjusted for zero-baseline shift of the crt display when switching between the VOLTS/DIV switch positions.

Emitter follower U100B buffers the input preamplifier. The CAL control (R105) permits continuously variable, uncalibrated deflection factors between the calibrated positions of the VOLTS/DIV switch. Overall gain of the Channel 1 vertical deflection system is set by R117.

Preamplifier

The Preamplifier consists of paraphase amplifier U100C and U110D. This amplifier converts the single-ended input signal into two signals, 180° out of phase, to be amplified and used to drive the vertical deflection plates. High-frequency response is optimized by C110 and C111. Transistor Q113 provides a constant-current source for U100C and U100D. Vertical positioning of the Channel 1 signal is done with POSITION control R118. Adjusting R118 changes the dc level on the base of U100D to offset the deflection signal applied to the vertical deflection plates in the crt. In the X-Y mode, R118 is used to position the display horizontally.

X-Signal

The X-Signal Amplifier, which provides the input signal for the Horizontal Amplifier in the X-Y Display Mode,

consist of Q140, Q145, and Q147. X-Signal Amplifier gain is adjusted with R143 (X-Gain). Transistors Q140 and Q145 convert the push-pull Channel 1 signal into a single-ended output signal at the base of Q147. Transistor Q147 amplifies the signal before it is fed to the Horizontal Amplifier.

CHANNEL 2 PREAMPLIFIER (Diagrams 1 and 2)

Figure 3-3 shows a simplified block diagram of the Channel 2 Preamplifier.

The Channel 2 Preamplifier operates the same as the Channel 1 Preamplifier with the following differences. Channel 2 Preamplifier has an inverting switch that reverses the polarity of the Channel 2 signals to the vertical deflection plates. INVERT switch S120 is used to obtain the difference between the Channel 1 signal and Channel 2 signal when ADD Display Mode is selected. Also the Channel 2 Preamplifier does not require a special amplifier for the X-Y Display Mode, because the Channel 2 signal is used directly to provide the vertical deflection in the X-Y Display Mode of operation.

CHANNEL SWITCHING (Diagrams 2 and 3)

Figure 3-4 shows a simplified block diagram of the Channel Switching circuit.

The Channel Switching circuit selects the preamplifier output signal to be connected to the Output Amplifier Driver stage. In the ALT and CHOP Display Modes, the channels are displayed alternately on a shared time basis.

Diode Gates

The Diode Gates, consisting of four diodes each, act as switches that permit either of the vertical preamplifier output signals to reach the Output Amplifier Driver stage. Diodes CR170, CR171, CR172, and CR173 control the Channel 1 Preamplifier output, and CR180, CR181, CR182, and CR183 control the Channel 2 Preamplifier output. These diodes are controlled by flip-flop (FF) U20B, which in turn is controlled by Vertical Mode switch, S20.

Ch 1 Mode

Figure 3-5 shows a simplified diagram of Channel 1 signal path.

In the CH 1 Display Mode, a HI from U185F is applied to the diode gates of Channel 2. This will forward bias CR181 and CR182, and reverse bias CR180 and CR183 to prevent the Channel 2 signal from passing through to the Output Amplifier Driver stage. At the same time, a LO from U185A is applied to the diode gate of Channel 1. This will reverse bias CR171 and CR172, and forward bias CR170 and CR173 to allow the Channel 1 signal to pass to the Output Amplifier Driver stage.

CH 2 Mode

Figure 3-6 shows a simplified diagram of Channel 2 signal path.

In the CH 2 Display Mode, the conditions given for CH 1 Display Mode are reversed, and the Channel 2 signal will pass to the Output Amplifier Driver stage.

ALT

In the ALT Display Mode, the Alt signal is applied to U20B clock input (pin 11) through U180C and U180B at the end of each sweep. Flip-flop U20B pins 12 and 13 will change state on each clock, allowing Channel 1 signal and Channel 2 signal to be alternately displayed on the crt.

CHOP

In the CHOP Display Mode U180C pin 9 is ungrounded; and the multivibrator, composed of U180D and U185D, free runs at about 100 kHz. The output signal from the multivibrator clocks U20B through U180B. Each time the Chop clock causes U20B to change states, the Channel 1 and Channel 2 diode gates switch states. The chopped frequency is approximately 50 kHz.

The Chop Blanking pulse from U180A is applied to the Unblanking circuit. This causes the Unblanking circuit to blank the crt display and prevent the display of switching transients that occur at the time the Vertical Switching circuit is changing the channel display.

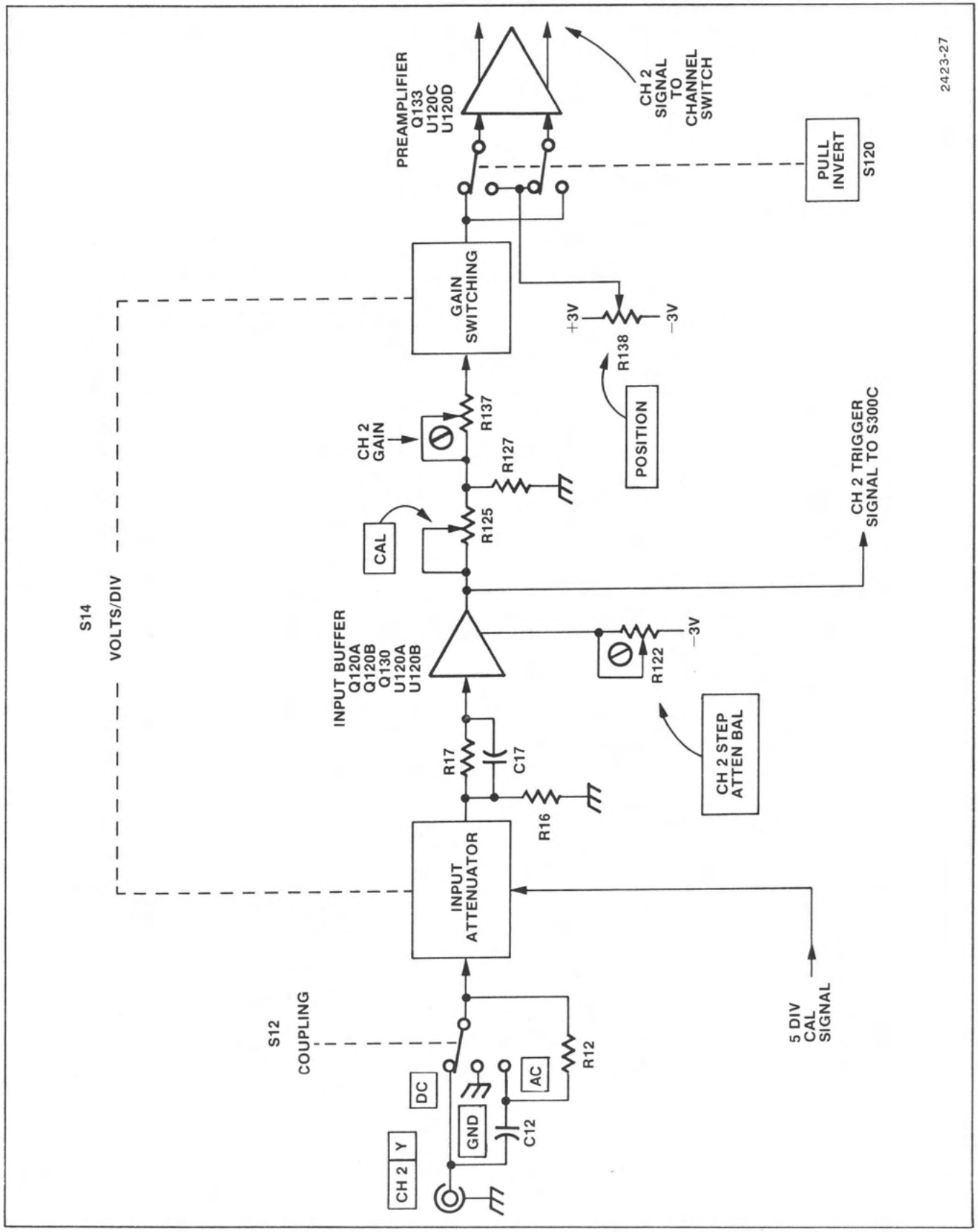


Fig. 3-3. Simplified block diagram of the Channel 2 preamplifier circuitry.

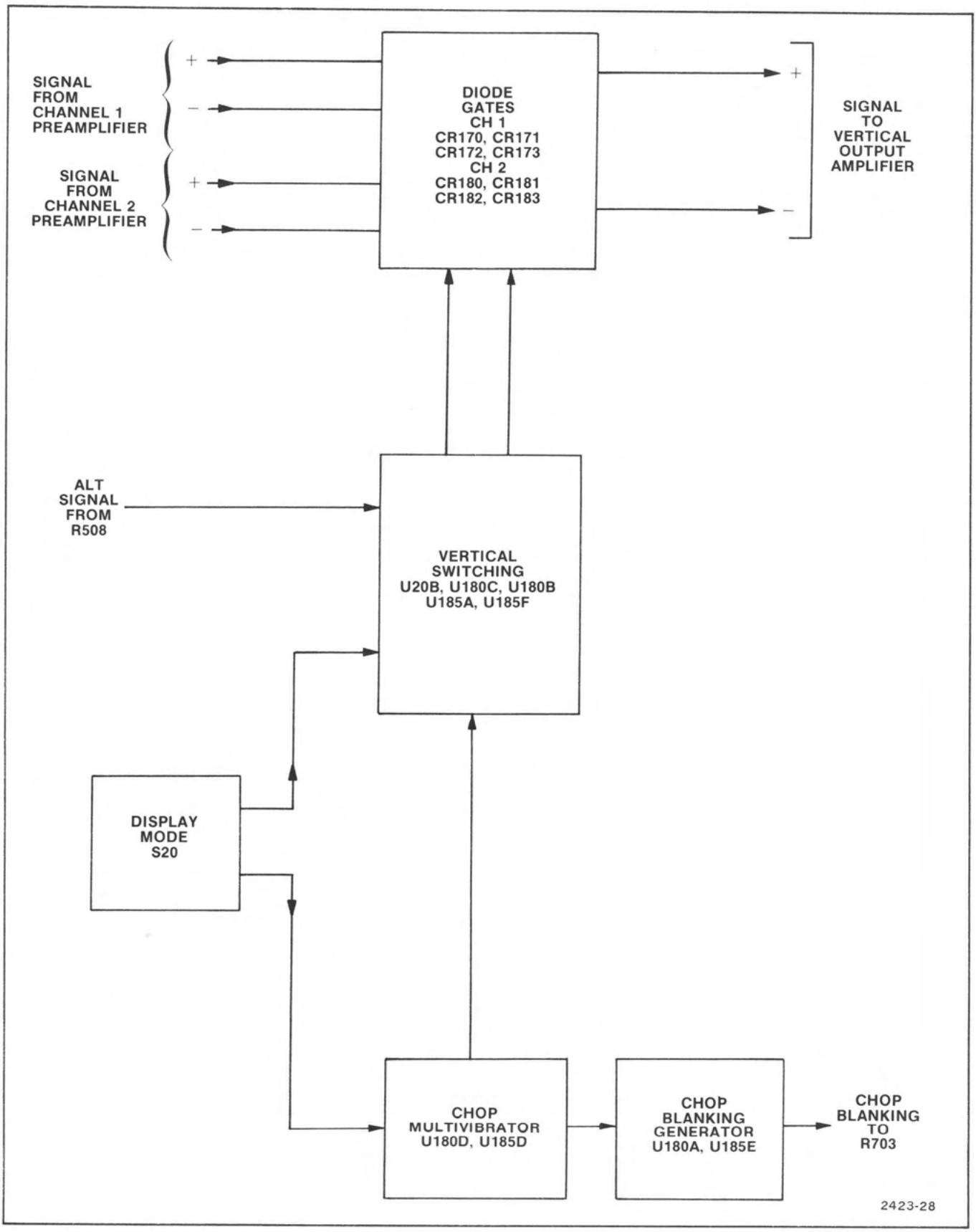


Fig. 3-4. Simplified block diagram of the channel switching circuitry.

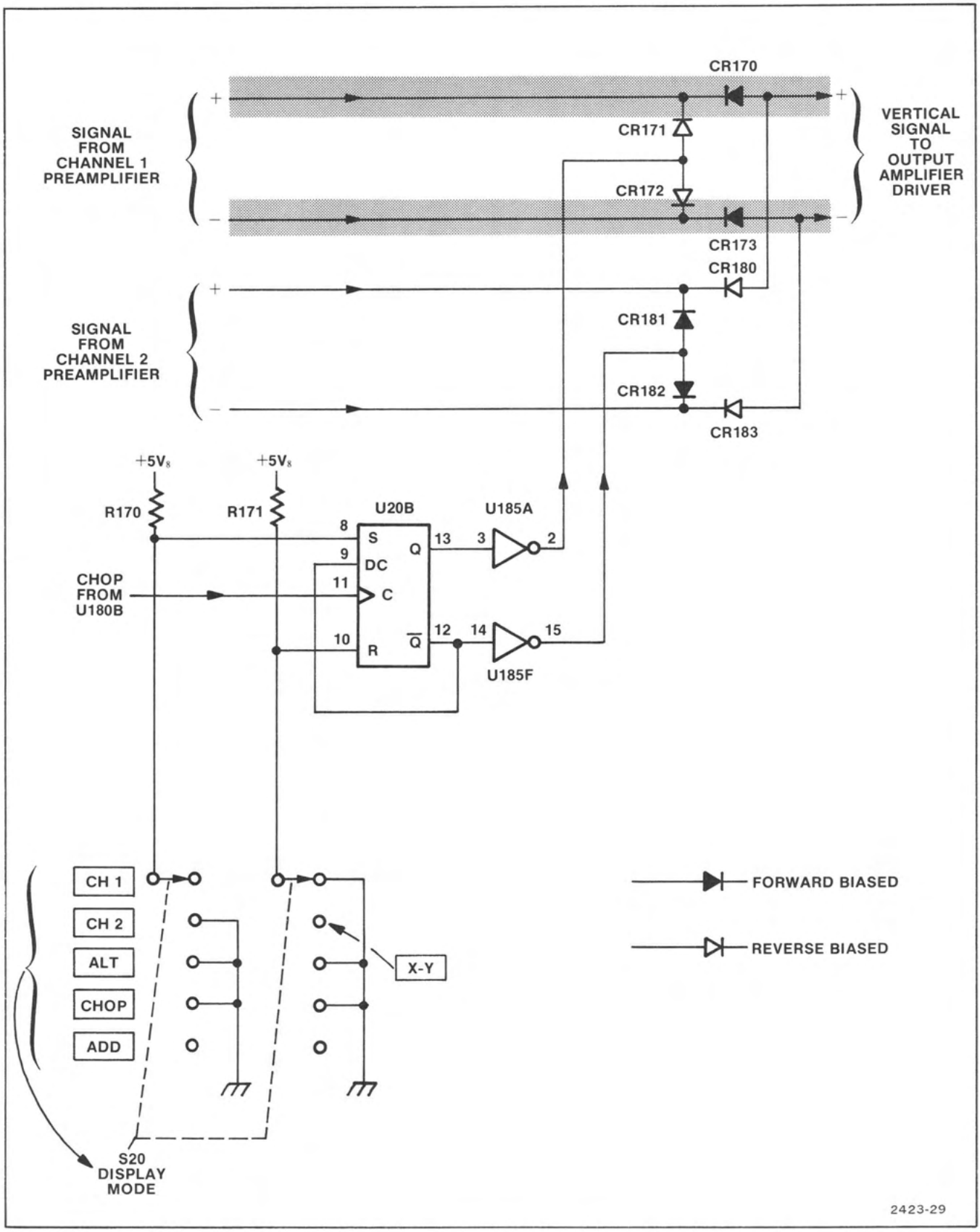


Fig. 3-5. Simplified diagram of the Channel 1 signal path.

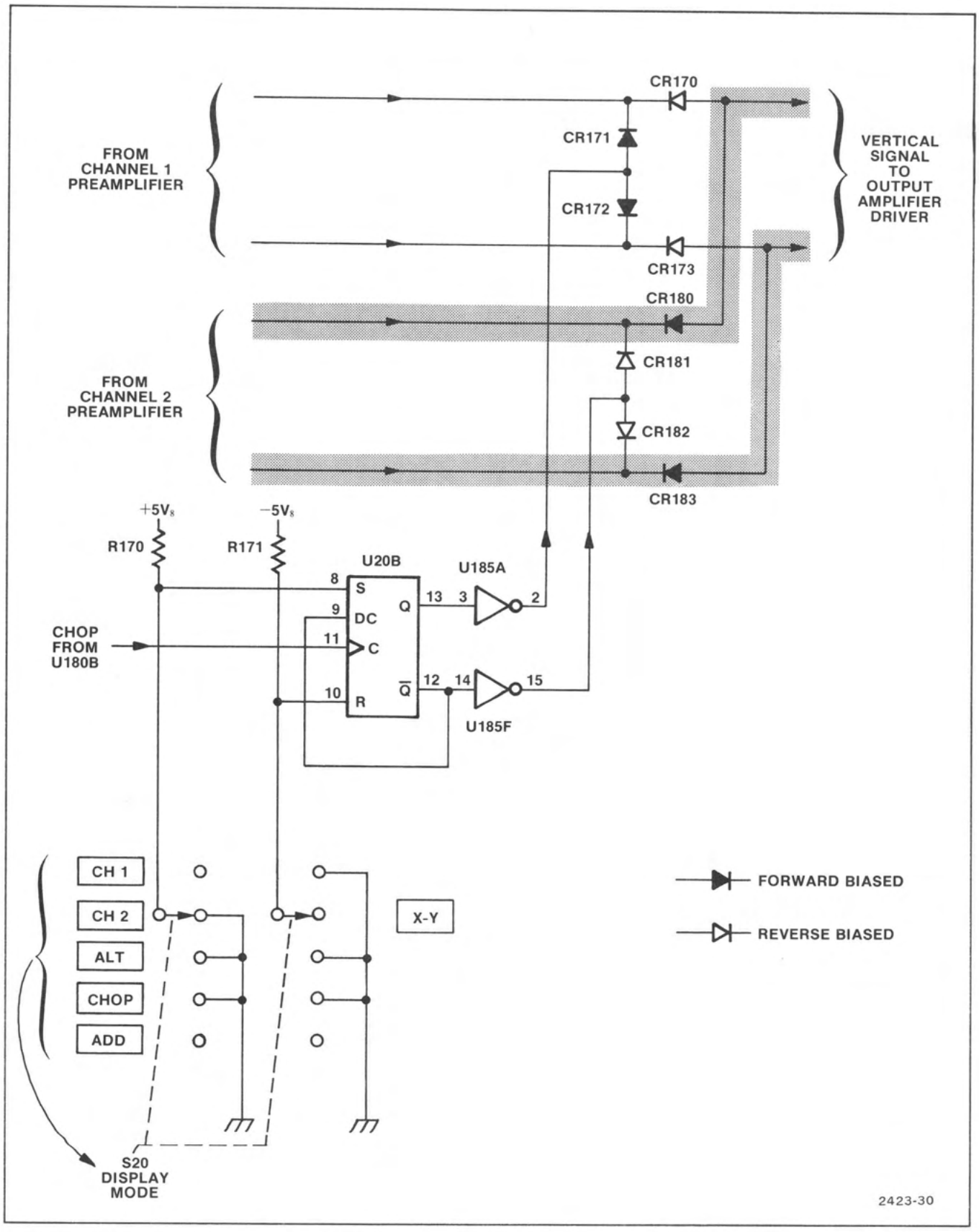


Fig. 3-6. Simplified diagram of the Channel 2 signal path.

ADD

In the ADD Display Mode, S20 removes the ground from both the set and reset inputs of U20B. This allows both inputs to go HI, and on the next clock pulse from U180B both the Q and Q outputs go HI. The HI outputs are inverted by U185A and U185F to a LO, and both Channel Diodes Gates are biased on. Both channel signals are allowed to pass to the Output Amplifier Driver stage, and the output of the Driver is the algebraic sum of the Channel 1 and Channel 2 signals.

VERTICAL OUTPUT AMPLIFIER (Diagrams 2 and 4)

Figure 3-7 shows a simplified diagram of the Vertical Output Amplifier.

The Vertical Output Amplifier has two stages: the Output Amplifier Driver and the Output Amplifier. The Driver circuit provides the necessary amplification of the vertical signal to drive the Output Amplifier and limits the level of the applied signal to prevent the Output Amplifier from saturating. Final amplification of the vertical signal, before it is applied to the crt vertical deflection plates, is accomplished by the Output Amplifier.

Output Amplifier Driver

The vertical signal from the Channel Switching circuit is applied to the Output Amplifier Driver. The Driver is a push-pull circuit with two identical halves. Except as needed for clarity, only the half containing Q200, Q203, Q220, Q222, and Q224 is discussed. The amplification factor of the Driver is approximately 22.

The Driver contains a feedback amplifier and a voltage limiter circuit. Voltage gain is obtained from Q200 and Q220; Q222, in the collector circuit of Q220, acts as a current source. Current is fed back to the emitter circuit of Q200 through common-base stage Q203. Voltage gain of the Driver is proportional to the feedback resistance R222 and the resistance of the gain-setting network in the emitter circuit of Q200 and Q210. Common-mode signals that appear at the base of Q200 and Q210 cause no current change in the emitter resistors, and will not appear in the output. The presence of common-mode signals will not affect the amplifier response to differential signals.

The voltage swing of the Driver is limited to prevent saturation of the Output Amplifier. If the output voltage attempts to go higher than 0 V, Q224 turns on and places R224 in parallel with R222. This increases the feedback current and reduces the amplifier gain by a factor of approximately 25. Components R226, CR226, and C226 prevent oscillation in the feedback circuit with Q224 turned on. If the output voltage drops to −2.6 V, CR221 will become forward biased and R221 will be placed in parallel with R222 to reduce the amplification factor by approximately 25. The output voltage swing is therefore limited to between 0 V and −2.6 V.

Output Amplifier

The Output Amplifier is a push-pull feedback amplifier with two identical halves. The +Vertical signal is amplified by Q260 and U260 to drive the upper deflection plate. The −Vertical signal is amplified by Q280 and U280 to drive the lower deflection plate. Gain of the +Vertical Amplifier is controlled by feedback resistor R251. The +Vertical Amplifier low-frequency gain is controlled by the ratio of the input resistance R250 to the feedback resistance R251. Fast-path amplifier Q260 amplifies the high-frequency components of the +Vertical signal and applies the amplified signal to U260 to increase the frequency response of the +Vertical Amplifier. High-frequency compensation for the +Vertical signal is provided by C250A, C250B, and C251. Comparable components in the −Vertical signal amplifier provide similar circuit actions as described above for the +Vertical signal. The dc output bias for the +Vertical and −Vertical Amplifiers is set with R256 to minimize on-screen distortion.

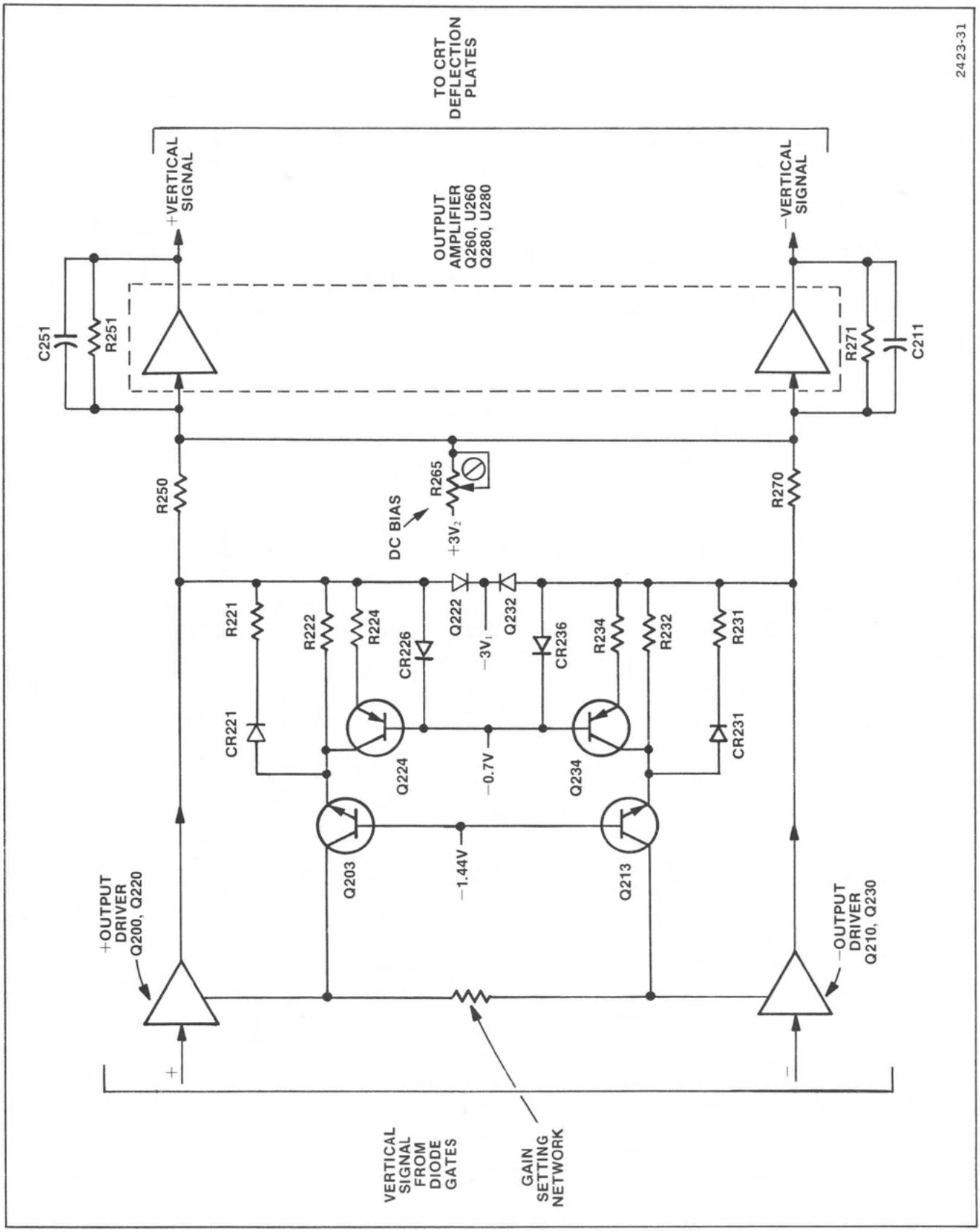


Fig. 3-7. Simplified diagram of the vertical output amplifier.

TRIGGER GENERATOR (Diagram 5)

Figure 3-8 shows a simplified block diagram of the Trigger Generator.

The Trigger Generator circuit produces trigger pulses for application to the Sweep Generator circuit to initiate the sweep signal. These trigger pulses are initiated either by the internal trigger signal from the vertical deflection system or by an external trigger signal applied to the EXT TRIG INPUT connector.

The AC-DC switch, S300A, offers a means of accepting or rejecting certain frequency components of the triggering signal. In AC mode, the dc component of the triggering signal is blocked by coupling capacitors C300 or C328A and C328B.

Internal Trigger Amplifier

The internal trigger signal, from either the Channel 1 Vertical Input Buffer or the Channel 2 Vertical Input Buffer, is connected to the Internal Trigger Amplifier through the trigger Source switch, S300B and S300C. The Internal Trigger Amplifier consists of Q320, Q322, and Q325. These transistors are arranged in a feedback amplifier circuit with a gain that is determined by the ratio of (R325/R324) + 1. Amplifier gain is reduced at the higher frequencies by the series combination of R325A and C326 in parallel with R325.

Trigger DC Level potentiometer R326B is adjusted to balance the dc offset from the internal trigger pickoff in the Vertical Preamplifier.

Ext Input Source Follower

Source follower Q310A is a field-effect transistor (FET) that is used to isolate the Trigger Generator from the EXT TRIG input. A constant-current source is supplied to Q310A by Q310B. In the event that excessively high amplitude signals are applied to the EXT TRIG INPUT connector, the signal will be limited by Q316 and the gate-source junction of Q310A. If the negative-going signal amplitude causes Q316 to become forward biased, Q310A gate will be clamped to approximately −3.6 V. Excessive positive-going signal amplitude will forward bias the gate-source junction of Q310A. As soon as gate current flows, the gate voltage will cease to increase. Gate current is limited to a safe level by the high resistance of R304. The external trigger signal at the output of Q310A is limited to between approximately +1.3 V and −1.3 V by CR314, CR316, CR312, and CR310.

Peak Detectors

The Peak Detectors (U330A and B, Q336, Q350A and B, and U330E) set the voltage range to the trigger comparator in the AUTO trigger mode. The positive peak voltage is applied to one end of the TRIGGER LEVEL potentiometer (R370) and the negative peak level is applied to the opposite end. This allows selection of a trigger level for initiating the sweep that is always within the peak-to-peak limits of the input trigger signal.

Positive peak detection is done by U330A, U330B, and Q336. U330A conducts on the positive peaks of the trigger signal to charge C336 to the positive peak level. On each positive peak, after the initial charging of C336, the charge leaked off between positive-going trigger alternations is replaced when U330A conducts.

The negative Peak Detector is composed of Q350A, Q350B, and U330E. It functions the same as the positive Peak Detector (but on the negative peaks) to keep C356 charged to the negative peak level.

Trigger Generator

Components U330C, U330D, and Q390 form a voltage comparator. The trigger signal is applied to the base of U330D, and a dc level established by R370 (TRIGGER LEVEL) is applied to the base of U330C. When the trigger signal reaches the triggering level established by U330C, U330D turns on and passes the trigger signal to the base of Q390. The trigger signal is amplified by Q390 and applied to a Schmitt trigger circuit (U390A) that shapes the trigger pulse. Slope switch S380 controls the level at U390D pin 13 to determine whether the sweep will be initiated on the negative slope or the positive slope of the trigger.

The TTL Level adjustment R376 presets the Trigger Generator for optimum level control when viewing TTL circuitry signals. Setting the TRIGGER LEVEL control to the TTL position in conjunction with using the TTL positions of the VOLTS/DIV switch will set the 305 for a stable display of TTL signals.

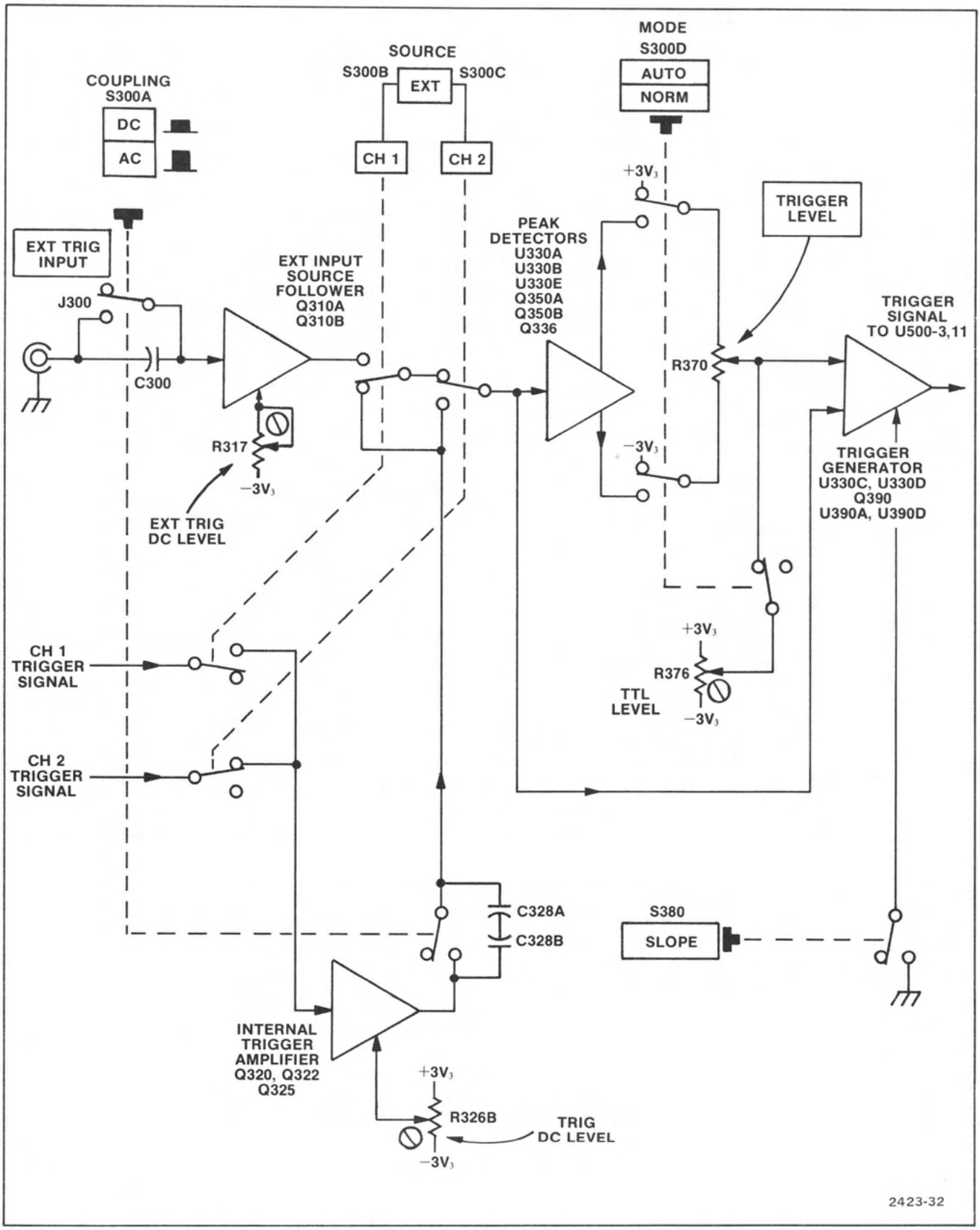


Fig. 3-8. Simplified block diagram of the trigger generator.

SWEEP GENERATOR (Diagram 6)

Figure 3-9 shows a simplified block diagram of the Sweep Generator.

The Sweep Generator produces sawtooth voltage ramps that are amplified by the Horizontal Amplifier circuit to provide horizontal deflection. These sawtooth voltages are produced either on command from the Trigger Generator circuit or automatically initiated by the sweep logic circuitry. The Sweep Generator also produces gate waveforms for the Unblanking and Vertical Switching circuits.

The Sweep Generator logic circuitry consists of U500B and U500A (D flip-flops), U390B and U390C (exclusive-OR circuits), Q500, and diode gating (CR502, CR503, and CR510). Switching transistor Q510 is controlled by the output of U500B.

In the NORM triggering mode, U500B pin 10 is held at a HI by the voltage applied from S300D (AUTO-NORM switch). When a trigger signal is received at U500B pin 11, U500B will be clocked to a HI on pin 9. A HI turns switching transistor Q510 off.

Switching transistor Q510 controls the current into the sweep timing capacitor selected by S570, the SEC/DIV switch. When Q510 is on, the current from FET Q575 is shunted around the timing capacitor, and the timing capacitor will be charged to the emitter-to-collector voltage of Q501. At the moment Q510 is turned off, the selected timing capacitor starts receiving a constant current from Q575 and the selected timing resistor (R570A through R570G). As the capacitor charges, a linear, negative-going ramp is seen at the gate of Q520A. The ramp is fed to the Horizontal Buffer Amplifier through Q520A and Q525. The sweep signal is also applied, via Q526, Q528, and the holdoff timing circuitry (C527A, C527B, C527C, and R527B), to U390B in the sweep logic circuitry.

After the sweep has been initiated, the sweep length is determined by U390B, sweep length adjustment R530B, and the holdoff circuitry. During part of the time that the ramp is going negative, the selected holdoff timing capacitor(s) (C527A through C527C) are charging to a more positive level through R527A, or R527A in parallel with R527B. When the voltage on the emitter of Q526 becomes more positive than the voltage on the base by approximately 0.7 V, Q526 conducts. The remaining portion of the negative-going sweep ramp then causes the holdoff timing capacitors to begin discharging. A negative-going ramp is fed through Q528 to U390B pin 5. When the ramp gets low enough to cross the LO threshold of U390B, U390B changes state to put a LO on pin 6. This LO resets U500B and ends the sweep. At sweep end, the holdoff timing capacitors begin to charge in a positive direction. When the holdoff voltage crosses the threshold level of U390B it switches state again to remove the LO from U500B pin 13. The Sweep Generator is now ready to receive the next trigger signal. The sweep length adjustment R530B sets the switching threshold of U390B thereby setting the sweep length. The holdoff timing circuitry sets the amount of time the holdoff voltage remains below the switching threshold of U390B.

When S300D (AUTO-NORM switch) is set to the AUTO position, U500B pin 10 will be LO in the absence of a trigger signal. With the HI present on U500B pin 13, U500B will be switched to the set condition (Q HI and $\overline{Q}$ LO) to initiate a sweep. The sweep will run as with NORM triggering; and at the end of the sweep U390B will change state, and holdoff time will begin. During holdoff time, U390C pin 9 will have the LO from U390B pin 6 applied. This will switch U390C pin 8 to a HI and U500B pin 10 will be held HI, holding U500B in a reset condition. At the end of holdoff time, U390B and U390C switch states; U500B pin 10 will be LO again, and a sweep will be initiated automatically.

When trigger signals are present, U500A will change state with each positive-going trigger signal. At the state when U500A pin 5 is LO and pin 6 is HI, Q500 will be turned on to charge C502. The charge on C502 will hold U500B pin 10 HI and a sweep will be initiated by the first trigger after holdoff time. Alternate triggers will hold the charge on C502. If the trigger signals are removed, or the time between triggers becomes excessively long, C502 will discharge to a point that U500B pin 10 will see a LO and a sweep will be initiated automatically after holdoff time.

Flip-flop U500B also produces the Alt Sig to the Vertical Switching circuit. When ALT Display Mode is selected, the Alt Sig will cause the display to switch between signals at the end of each trace. Another gate goes to the crt Unblanking circuit (via R700 on diagram 7) to unblank the crt during sweep time and allow the display to be seen.

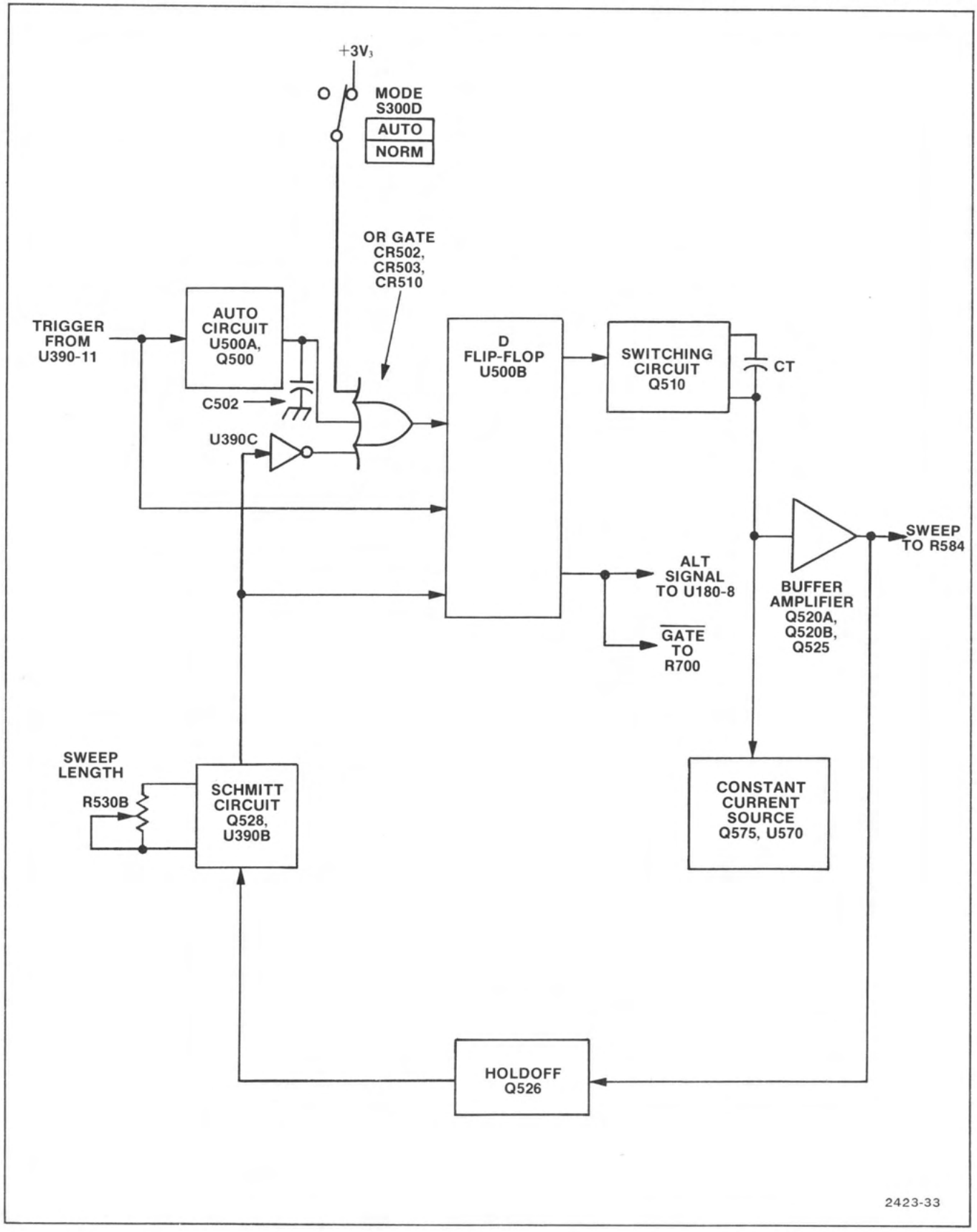


Fig. 3-9. Simplified block diagram of the sweep generator circuity.

HORIZONTAL AMPLIFIER (Diagram 7)

Figure 3-10 shows a simplified block diagram of the Horizontal Amplifier.

The Horizontal Amplifier accepts the sweep signal produced by the Sweep Generator, amplifies it, converts it to a push-pull signal, and applies it to the horizontal deflection plates of the crt. During X-Y operation the signal from the Sweep Generator is disconnected from the Horizontal Amplifier, and the X-signal from Channel 1 is applied. The X-signal is then amplified to provide the horizontal deflection voltage.

Sweep Magnification and Positioning

Magnified sweep and normal sweep are obtained by changing the attenuation factor of the input circuitry. In normal sweep, the signal from the Sweep Generator is attenuated 10 times by the combination of R584 and R586. When S583 (PULL: X10 MAG) is placed in the X10 MAG position, R586 is removed from the input circuit of Q585A, and the attenuation is reduced by a factor of ten. This magnifies the sweep length 10 times, but only one-tenth of the total sweep length is displayed on the crt. When the sweep is magnified, all the sweep rates indicated by the SEC/DIV switch must be divided by a factor of ten to determine the display sweep rate.

POSITION control R581 provides an adjustment to change the collector current of Q580 and supply a dc offset for the input signal. The offset is amplified through the Horizontal Amplifier to shift the deflection of the electron beam in the crt. Positioning range is sufficient to move any portion of a magnified sweep into the graticule area.

X-Y Mode

Setting the SEC/DIV switch to the X-Y position opens the signal path from the Sweep Generator and applies the X-signal (Channel 1) to the Horizontal Amplifier. The Sweep Generator is disabled, and the Unblanking circuit is held in an unblanked condition. The Display Mode switch must be set to the CH 2 [X-Y] position to supply a signal for vertical deflection of the display.

Horizontal Preamplifier

The Preamplifier circuit consists of Q585A, Q585B, and Q594. Either the sweep signal or the X-signal (in X-Y

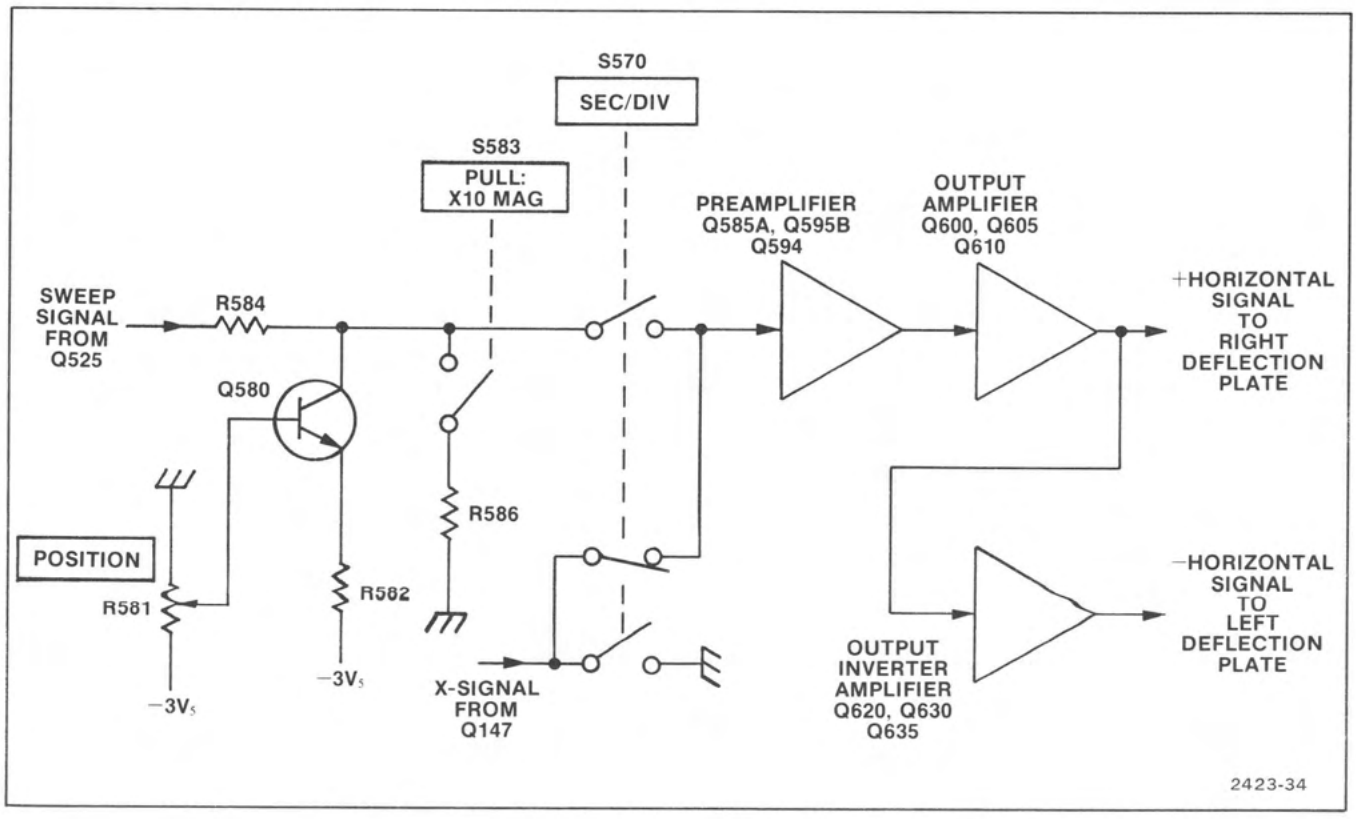


Fig. 3-10. Simplified block diagram of the horizontal amplifier.

mode) is applied to the base of emitter-follower Q585A. This stage provides a high input impedance to prevent loading of the preceding stage. The signal is applied to the Output Amplifier through two common-base amplifier stages, Q585B and Q594. These amplifiers isolate the input circuit from loading and supply the current drive to the Output Amplifier.

Horizontal Output Amplifier and Output Inverting Amplifier

The Output Amplifier is arranged in a feedback amplifier circuit with R612, R614, and C612A as the feedback elements. A negative-going sweep signal is applied to the base of Q610 through emitter-follower Q600. The signal is amplified and inverted by Q610 to provide a positive-going signal for the right deflection plate. High-frequency components of the sweep signal are coupled through C600 and amplified by Q605 to improve the fast sweep rate response of the amplifier. This transistor also improves the retrace response time when the sweep ends.

A feedback signal from the collector of Q610 is applied to the base of Q600 through the feedback elements (R612, R614, and C612A). Due to the gain of the Output Amplifier and the amount of feedback, only a very small input voltage appears at the base of Q600.

The Output Inverting Amplifier is similar in operation to the Output Amplifier. Right-deflection-plate voltage is applied to the base of Q635 after attenuation by a voltage divider (R635 and R634). The voltage divider is a high impedance pickoff of the right-deflection-plate signal and reduces the signal to the proper level for input to Q635. Feedback resistance value (R630) is chosen to give the inverter stage an overall gain of one. Transistor Q630 inverts the input signal and Q620 aids the high-frequency signal gain. The signal applied to the left deflection plate is equal in amplitude but opposite in polarity to the right-deflection-plate signal.

POWER SUPPLY (Diagrams 8 and 9)

Figure 3-11 shows a simplified block diagram of the Power Supply circuitry.

The Power Supply consists of input-voltage-source selection, a DC-DC Converter, a Switching Regulator, automatic turn-off circuitry, and a low-line indicator.

AC Power Input

Ac power is applied to the primary of transformer T1001 through Line Fuse F1000 and AC INPUT VOLTAGE Selector switch, S1001. The Selector switch connects the split primaries of T1001 in parallel for 115 V operation or in series for 230 V operation.

NOTE

The Line Fuse, F1000, must be the proper value for each nominal line voltage to properly protect the instrument. Fuses are internally accessible. Procedure for cabinet removal are found in the Maintenance section of this manual. See Replaceable Electrical Parts list for correct fuse values.

The output of the secondary of T1001 is rectified by CR1001 and filtered by C1003.

Power Source Selector

The Power Source Selector switch, S1005, selects one of three sources: EXT DC, BATTERY, or AC; and one of two charge rates: FULL CHG or TRICKLE CHG. Power is applied to the Switching Regulator (via P1009 and P1011) through S1030 SCOPE POWER switch and to the DMM Power Supply through P1303.

Battery Charger

The Battery Charger circuit operates when the instrument is connected to an ac power source. This circuit consists of Q1010 and Q1015, connected as a constant-current source. The amount of the current flow is determined by the resistance value across the base-emitter junction of Q1015. When the Power Source Selector switch is set to FULL CHG, R1006 parallels R1008, and the charging current is approximately 150 mA. When the Power Source Selector switch is set to TRICKLE CHG, only R1008 is across the base-emitter junction of Q1015, and the charging current is approximately 45 mA.

Switching Regulator

The Switching Regulator and DC-DC Converter work together to supply all the low-voltage power for operation of the oscilloscope. Input power in the range of +9 V to +32 V is supplied to the Switching Regulator from the internal battery, an external dc source, or the rectified and filtered ac power source. Output of the Switching Regulator (across C1095) is approximately +5 V for the operation of the DC-DC Converter.

The Switching Regulator consist of two switching transistors (Q1060 and Q1061), a voltage comparator (Q1066 and Q1064), and a turn-off transistor (Q1062). When S1030 contacts are closed and power is applied to the oscilloscope, the base of Q1064 will initially be at zero

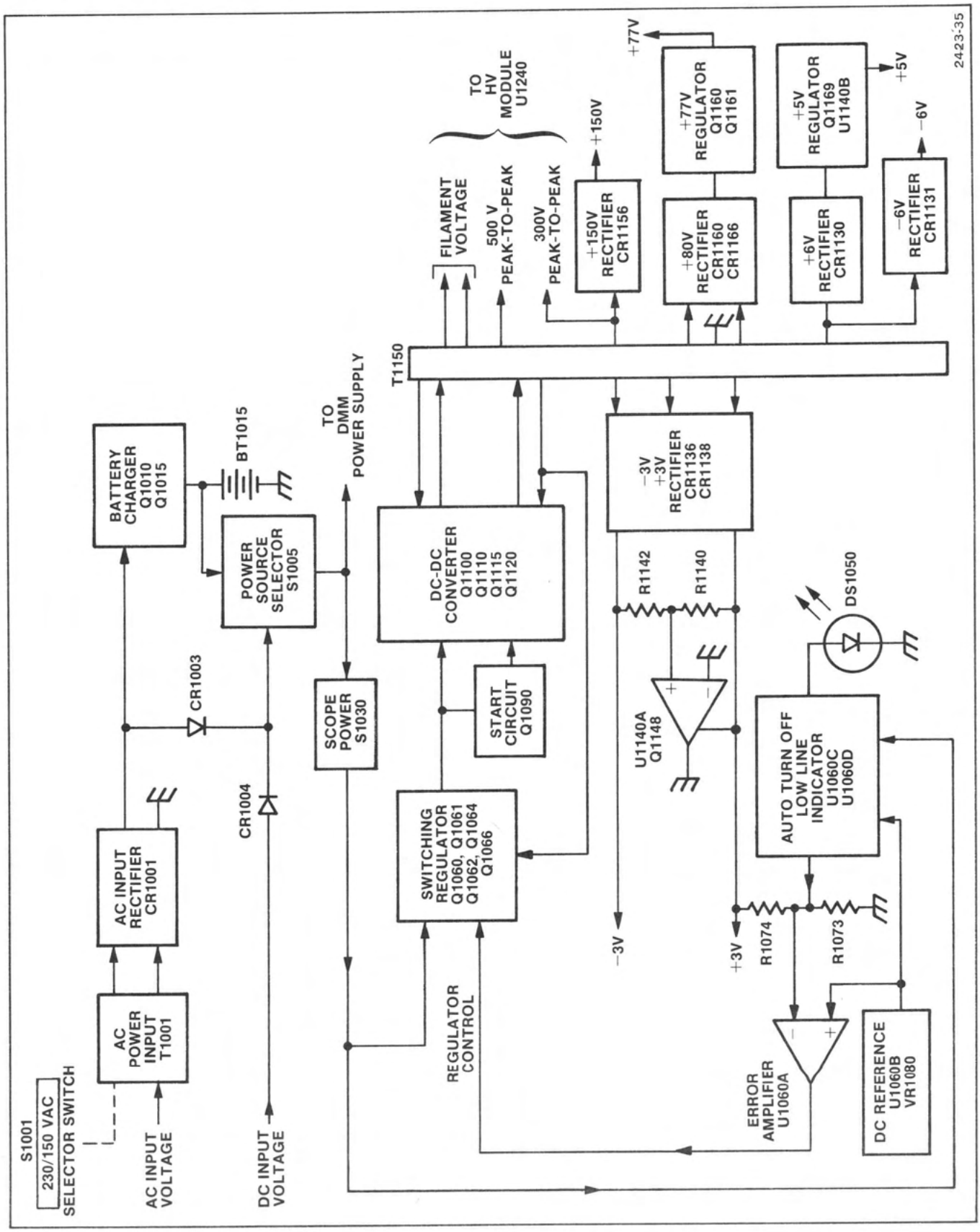


Fig. 3-11. Simplified block diagram of the power supply circuitry.

volts, and the transistor will be off. Voltage from the Regulator Control applied to the base of Q1066 will turn Q1066 on as soon as the level exceeds 0.7 V. When Q1066 turns on, it provides base current to the switching transistors (Q1060 and Q1061), causing them to start conducting. Current is then supplied to the DC-DC converter. Capacitor C1095 is charged up, and a magnetic field builds up around L1060. The current flow also induces a positive feedback voltage in the secondary of T1060 that increases the base current of the switching transistors. The increase in base current to the switching transistors ensures sufficient forward biasing for efficient switching. When the charge on C1095 approaches 5 V, Q1064 will become forward biased and turn on. The emitter voltage on Q1066 rises, and Q1066 becomes reverse biased to turn off. Turn-off transistor Q1062 becomes forward biased and shunts away the base current of the switching transistor to turn them off. When the switching transistors turn off, the field around L1060 collapses and continues to supply current to the DC-DC Converter. When C1095 discharges approximately 0.1 V, Q1064 will turn off, Q1066 will turn on, and the cycle described above is repeated. This switching action maintains an average of approximately 5 V across C1095 as long as the input voltage is within the regulating range (+9 V to +32 V).

DC-DC Converter

The DC-DC Converter changes the direct current supplied by the Switching Regulator into alternating current. The ac is applied to the primary winding of T1150, and the transformer produces the necessary secondary voltages. The current supplied by the secondary windings is rectified and filtered to provide the oscilloscope operating voltages. The DC-DC Converter oscillates at approximately 20 kHz.

When S1030 contacts are closed and power is applied to turn the oscilloscope on, the Switching Regulator supplies +5 V to the center tap of the primary windings of T1150. Because both Q1110 and Q1115 are initially turned off, the converter is started by Q1090. The turn-on transistor (Q1090) supplies base current to both Q1115 and Q1110. Due to circuit imbalances, the collector current of one of the transistors will be higher. If Q1115 has the higher collector current, terminal PC of T1150 will go negative with respect to terminal PA. By transformer action, feedback-winding terminal PD goes positive to supply base current to Q1115, keeping it turned on. Current is also supplied to C1120. When C1120 charges to a voltage of approximately 0.6 V, Q1120 is turned on. Transistor Q1120 shunts the base current of Q1115 to ground, and Q1115 is turned off. Due to the magnetic field collapsing around the windings of T1150 when Q1115 turns off, the voltage induced in the windings reverses polarity. Feedback-winding terminal F becomes positive and Q1110 turns on to supply current to the primary winding. Feedback current is also supplied to C1100 to charge it, and as soon as the voltage across C1100 reaches approximately 0.6 V, Q1100 turns on. The base current of Q1100 is shunted to ground, Q1110 turns off, and the cycle is repeated.

Switching of the regulator and DC-DC Converter are synchronized so that the switching transistors (Q1060 and Q1061) are turned on at the same time as the DC-DC Converter changes state. While the switching transistors are turned off, the voltage across C1095 drops as it discharges. When the voltage level reaches the point where Q1064 turns off, the switching transistors are turned on, recharging C1095 and rebuilding the field around L1060. If Q1110 turns on before C1095 discharges to the Q1064 turn-off voltage level, the downward step in Q1110 collector voltage will be coupled through R1068 and C1068 to the base of Q1064. The additional negative-going pulse will turn off Q1064, and the switching transistors will be turned on at a point when the DC-DC Converter is drawing the least amount of current.

Low Voltage Supply

Secondary windings of T1150 provide the ac voltages to rectifier and filter networks that supply the low-voltage power for the oscilloscope. The low-voltage dc outputs are +6 V, −6 V, +3 V, −3 V, +80 V, and +150 V. The +3 V and −3 V outputs are supplied to the Floating Power Supply (Diagram 9), and the +6 V output is supplied to the +5 V regulator. The +80 V output is supplied to the +77 V regulator (Diagram 10).

+77 Volts

Regulated +77 V is provided by error amplifier Q1161 and series-pass transistor Q1160 (Diagram 10). Input to the regulator is from the +80 V output of the Low Voltage Supply (Diagram 9).

DC Reference Voltage

A reference voltage is generated by U1060B that is applied to U1060A, an error amplifier, for regulation of the +3 V supply. The reference voltage is held constant over a wide variation of $+V_2$, the dc supply voltage.

Initially, when $+V_2$ is applied to U1060B, the current through VR1080, a zener diode, is zero; the dynamic resistance is high, and the output of U1060B pin 7 is near ground potential. The voltage on U1060B pin 5 rises, and the output voltage at pin 7 starts to rise with it. As the current through VR1080 increases, the dynamic resistance of VR1080 decreases. When the dynamic resistance from U1060B pin 5 to ground equals the resistance from pin 6 to ground (CR1084, R1084, and R1086), the positive feedback through R1078 to pin 5 and the negative feedback through R1082 to pin 6 become

equal. At that point the output voltage of U1060B at pin 7 ceases to increase. Variations of current due to different $+V_2$ voltage levels cause the output current from U1060B pin 7 to change. The current changes divide equally between the positive and negative feedback resistors, and the voltage at U1060B pin 7 remains constant.

Potentiometer R1084 (+3 V Adjust) sets the reference level to U1060A which is compared to the +3 V supply level.

Error Amplifier

Error Amplifier U1060A compares the reference voltage level set by R1084 with the +3 V supplied from the secondary winding of T1150. The output of U1060A controls the Switching Regulator to maintain the output level of the DC-DC Converter. If the +3 V supply were to decrease, the output of U1060A would rise. The increase in voltage is fed to the base of Q1066 in the Switching Regulator (via P1008-4 and P1130-4), and it causes the switching transistors (Q1060 and Q1061) to remain on longer. More energy is supplied to L1060 and C1095 to increase the voltage supplied by transformer T1150 secondary windings. Because all the low voltages are supplied by T1150, holding the +3 V supply constant provides regulation of the other secondary voltages.

Auto Turn Off

If the dc power source (either internal battery or external dc source) becomes too low for operation of the oscilloscope, the power is automatically shut off. The source voltage level is compared to the dc reference voltage by U1060D (Diagram 9). When the dc source voltage drops below +6 V, the voltage level on pin 13 of U1060D will drop lower than the voltage on pin 12. The output of U1060D (pin 14) will go HI and override the sample of the +3 V supply on U1060A pin 2. This will cause the output of U1060A pin 1 to go LO. The LO is fed to the base of Q1066 in the Switching Regulator (via P1008-4 and P1130-4) to keep it biased off. Switching transistors Q1060 and Q1061 will remain off, and no power will be supplied to the DC-DC Converter.

Low Line Indicator

To indicate low-line voltage, U1060C is connected as an oscillator that causes the power-on indicator DS1050 to blink. Normally U1060C pin 9 is held near the voltage output of the Error Amplifier U1060A. Pin 10 of U1060C is at a lower potential than pin 9, and U1060C pin 8 is held LO. When the input voltage is less than +6 V, the Switching Regulator and DS1050 will turn off. Pin 1 of U1060A is LO and CR1071 is reverse biased due to the charge on C1048. As C1048 discharges through R1048, the voltage across C1048 will fall to the point where the voltage on pin 9 of U1060C becomes lower than the voltage on pin 10 of U1060C. At that point U1060C pin 8 will go HI and DS1050 will turn on. Capacitor C1048 will now charge through R1048 until U1060C pin 9 goes more positive than pin 10 and U1060C pin 8 will go LO again. The cycle repeats and U1060C will continue to oscillate in this fashion causing DS1050 to blink. The low-line indication will remain until the input voltage rises above +6 V.

Regulated 5 V Supply

Regulation of the +5 V supply is provided by series-pass transistor Q1169 and error amplifier U1140B.

Floating Power Supply

The +3 V and −3 V supplies are generated from a secondary winding of T1150. The secondary floats with respect to ground. Ground reference for the +3 V and −3 V is established by error amplifier U1140A and shunt regulator Q1148. Any change in the difference between the +3 V and −3 V is sensed by U1140A and a correction signal is fed to Q1148 to balance the two voltages.

CRT CIRCUIT (Diagrams 7 and 10)

Figure 3-12 shows a simplified block diagram of the High Voltage and CRT circuit. This circuit provides the high voltage and control circuitry for crt operation.

High Voltage Module

Encapsulated module U1240 contains a high-voltage multiplier, rectifiers and filters, focus-grid dc restorer, control-grid dc restorer, and an isolation filament transformer. The secondary winding of T1150 (Diagram 8) provides crt-filament current, 300 V peak-to-peak to the dc restorers, and 500 V peak-to-peak to the high-voltage multiplier.

High Voltage Regulation

Regulation of the high voltage is provided by U1230 and Q1236. A sense output from the HV module U1240 is supplied to U1230 pin 2 (via P1230-1). If the sense level is not at zero volts, U1230 produces an error signal to Q1236 that changes the amount of Q1236 collector current. This changes the ground reference for the HV multiplier and thereby the HV output from the module.

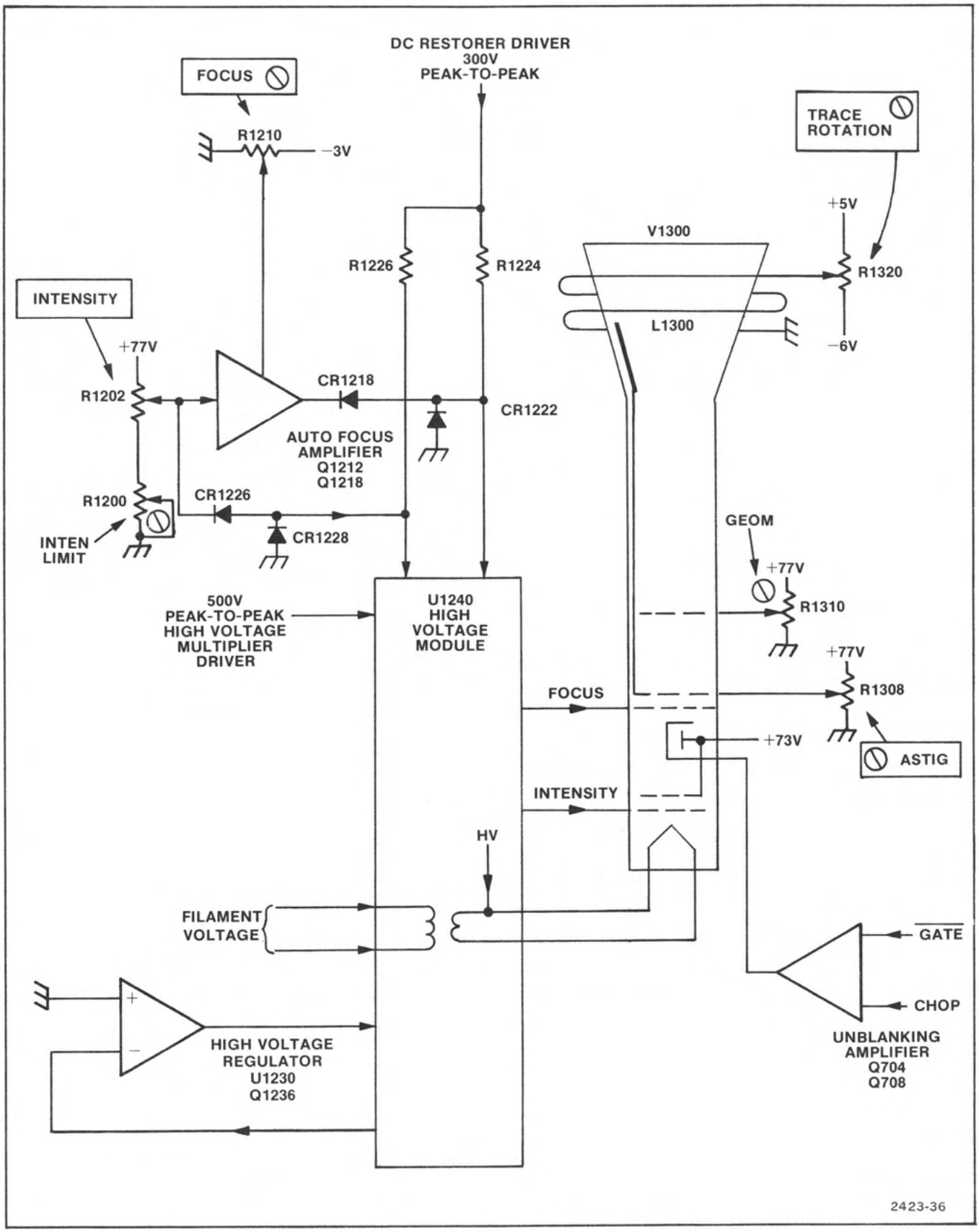


Fig. 3-12. Simplified block diagram of the high voltage and crt circuitry.

Intensity Control

Intensity control is obtained by varying the control-grid voltage with respect to the filament (directly heated cathode) voltage. A dc-restorer circuit within U1240 provides a negative voltage on the control grid with respect to the filament. The 300 V peak-to-peak ac drive is supplied to the intensity input of the HV Module through R1226. Clamping of the lower limit of the voltage occurs when CR1228 becomes forward biased. The positive limit is clamped when CR1226 becomes forward biased. INTENSITY control R1202 establishes the upper clamping level. Clamping the ac-drive voltage produces an approximate square wave with a positive dc-offset level. The square wave is fed to the intensity dc restorer in the HV Module. Intensity control is obtained by changing the positive clamping level of the square wave. Raising the positive clamping level produces larger peak-to-peak voltage to drive the intensity dc restorer, and the control grid becomes more negative with respect to the filament. This reduces the electron beam flow and decreases the display intensity. Lowering the positive clamping level reduces the negative voltage to the control grid, and the display intensity will increase.

Auto Focus

Focus voltage is supplied to the focus grid (pin 13 of V1300) by a dc restorer similar to the intensity dc restorer. For proper focusing, the potential on the focus grid must follow the potential on the control grid.

The Auto-Focus Amplifier produces a control voltage to the focus dc restorer that causes the focus grid potential to track the control grid potential. Transistors Q1212 and Q1281 are arranged in an inverting amplifier circuit. The intensity control voltage is applied to the base of Q1212 through a voltage divider (R1206 and R1208) and a diode CR1208. For low-to-medium display intensities CR1208 is reverse biased, and the focus voltage level is set by FOCUS control R1210. Transistor Q1212 is forward biased and the amount of collector current in Q1218 is limited. The collector voltage of Q1218 sets the positive clamping level of the ac drive to the focus dc restorer in the HV Module. For low-to-medium intensity displays, the positive clamping level is high, and the focus grid voltage is made more negative to track the control-grid voltage.

High intensity displays will cause CR1208 to become forward biased, and the base voltage of Q1212 will follow the voltage level set by the INTENSITY control when it decreases. Collector current of Q1212 will decrease, the base voltage of Q1218 will increase, and the decrease in Q1218 collector voltage that occurs will lower the positive clamping level of CR1218. This reduces the ac drive to the focus dc restorer, and the focus grid will become less negative in order to track the control grid. The negative clamping level of the ac drive is set by CR1222.

Astigmatism, Geometry, and Trace Rotation

Astigmatism adjustment R1308 is used in conjunction with the FOCUS control to provide a well-defined display. Adjustment of the ASTIG potentiometer aids focusing over the entire face of the crt.

Geometry potentiometer is adjusted to eliminate the bowing of horizontal and vertical traces within the graticule area.

The TRACE ROTATION potentiometer R1320 controls the current through L1300. The potentiometer is adjusted to align the trace with the horizontal graticule lines.

Blanking and Unblanking

Signals for unblanking come from either of two sources: unblanking Gate from the Sweep Generator circuit, U500 pin 8, or Chop Blanking from the Vertical Switching circuit U180A pin 3.

The Unblanking Amplifier (Diagram 7) consists of Q704, Q708, and associated circuitry. The output of the amplifier blanks the crt beam during the switching interval in CHOP Display Mode and during retrace time. When the oscilloscope power is turned off, a dc voltage is applied to the base of Q704 (via S1030, Diagram 9) to blank the crt and act as a spot killer.

The crt, V1300, makes use of an extra set of deflection plates for unblanking during sweep time. The undriven blanking plate, connected to pin 5 of the crt, receives a fixed voltage of about +72 V. The other blanking plate (pin 8) is driven by the Unblanking Amplifier (Diagram 7). In a quiescent condition pin 9 is held at a relatively low potential, and the electron beam is deflected to the undriven blanking plate (pin 5). During sweep time the driven blanking plate is approximately the same potential as the undriven blanking plate. Both blanking plates will attract the electron beam equally, and the electron beam will not be deflected by either plate.

BLOCK DIAGRAM

Figure 3-13 shows a simplified block diagram of the DMM.

An ac or dc voltage to be measured is applied to the Input Attenuator. The Input Attenuator is switched by the Autoranging circuit to set the input voltage to the A/D Converter within the correct measurement range. Dc voltage is fed directly to the A/D Converter for measurement. Ac voltage is fed to the AC Converter where it is converted into a dc voltage proportional to the ac rms value. The proportional dc voltage is then applied to the A/D Converter for measurement.

A resistance value to be measured is placed across the input of the Ohms Converter. The Ohms Converter supplies a reference current to the unknown resistance. The voltage developed across the resistance by the reference current is proportional to the resistance value, and it is applied to the A/D Converter for measurement.

The Function Selector switches the DMM circuitry to perform the measurement selected by the FUNCTION push buttons on the DMM front panel.

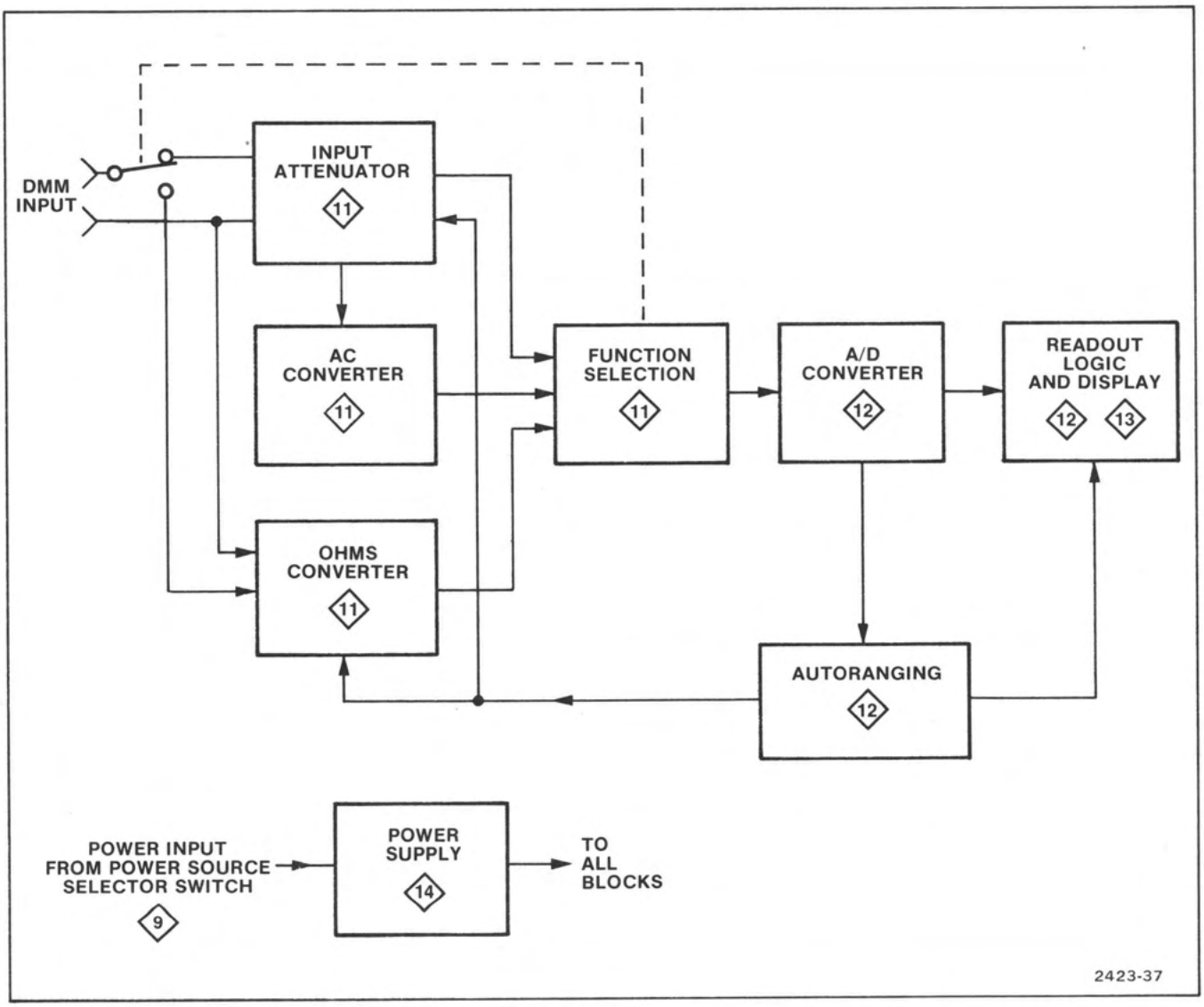


Fig. 3-13. Simplified block diagram of the DMM.

Voltages applied to the A/D Converter are digitized and applied to the Readout Logic for display. If the voltage is overrange or underrange (out of the measurement limits of the A/D Converter), signals are applied to the Autoranging circuitry that cause it to switch the Input Attenuator or the Ohms Converter to a different range. The Autoranging circuit will continue switching until either the voltage to the A/D Converter is within range or the highest or lowest range has been selected. The Autoranging circuit also selects the decimal point in the LED indicators.

The Readout Logic and Display uses the digital output from the A/D Converter to drive four, seven-segment LED indicators for display of the measured value.

A Power Supply, separate from the Oscilloscope Power Supply, is used to supply all the DMM operating voltages. The DMM may be operated independently of the oscilloscope.

DETAILED CIRCUIT DESCRIPTION

FUNCTION SELECTION (Diagram 11)

Figure 3-14 shows a simplified diagram of the Function switch.

The FUNCTION switch S800 selects one of the four modes: DCV, ACV, kΩ, or Battery Check. In DCV mode the input signal is directly coupled to the Input Attenuator. In ACV mode the input signal is coupled through C800 and R801 to the Input Attenuator. In kΩ mode the unknown resistance is applied to the Ohms Converter to generate a voltage proportional to the resistance value. In Battery Check mode, all FUNCTION switch push buttons are in the out position. A control voltage from S800 is applied to U870 pin 1 (preset enable) to set the Autoranging for nominal battery range, and the Battery Check voltage is applied to the A/D Converter U850 via U830D from the DMM Power Supply circuitry.

Dcv Cal adjustment R855 sets the reference voltage level to the A/D Converter when the FUNCTION switch is in the DCV or kΩ mode, and R853, the Acv Cal adjustment, sets the reference voltage level when the ACV mode is selected.

INPUT ATTENUATOR (Diagram 11)

Figure 3-15 shows a simplified diagram of the Input Attenuator circuit with the Function switch shown in the DCV mode.

The function of the Input Attenuator circuit is to limit the input signal to the A/D Converter to a level that is within the measurement range of the converter. The circuit consists of feedback amplifier U800, analog switch U805, and feedback resistors R802A through R802D. The feedback resistors are selected by the analog switch as determined by controlling signals from the autoranging circuit. The output voltage from the attenuator is applied to analog switch U840A where it is routed to either the AC Converter (ACV mode) or the A/D Converter (DCV mode).

Zero Adjust R803 is adjusted to set the DMM for a 0 V display in the DCV mode with the test probes shorted together.

Feedback amplifier U800 is protected from excessive negative or positive voltages that may be applied to the INPUT jacks by diodes CR800 and CR801.

AC CONVERTER (Diagram 11)

Figure 3-16 shows a simplified diagram of the AC Converter circuit with the FUNCTION switch shown in the ACV mode.

The ac input voltage is converted to a negative dc voltage proportional to the rms value of a sine-wave input voltage. The ac input voltage is half-wave rectified and integrated. This provides a dc voltage proportional to the average value of the rectified waveform.

Ac input voltage is applied via U800, U805, and U840A to comparator U810A, where it is compared to 0 V. The output of the comparator is a square-wave that is capacitively coupled to U880A. U880A inverts the square wave and makes it 180° out of phase with the input ac waveform. The positive half cycle of the ac input waveform will cause a negative-going square wave at the output of U880A and analog switch U830B will open. The positive half cycle will not be seen at the output of the switch. On the negative half cycle of the ac input signal, the positive-going square wave at the output of U880A will close analog switch U830B and the negative half cycle of the input will pass to the integrating circuit composed of C814 and R816. C814 will charge at a rate determined by the time constant of C814 and R816. When the analog switch opens on the positive half cycle of the input waveform, C814 discharges at a rate determined by the time constant of R816, R815, and C814. Since R815 is small compared to R816, the discharge time constant is nearly equal to the charging time constant. Therefore C814 is charged up to the average value of the half-wave-rectified ac voltage at the input.

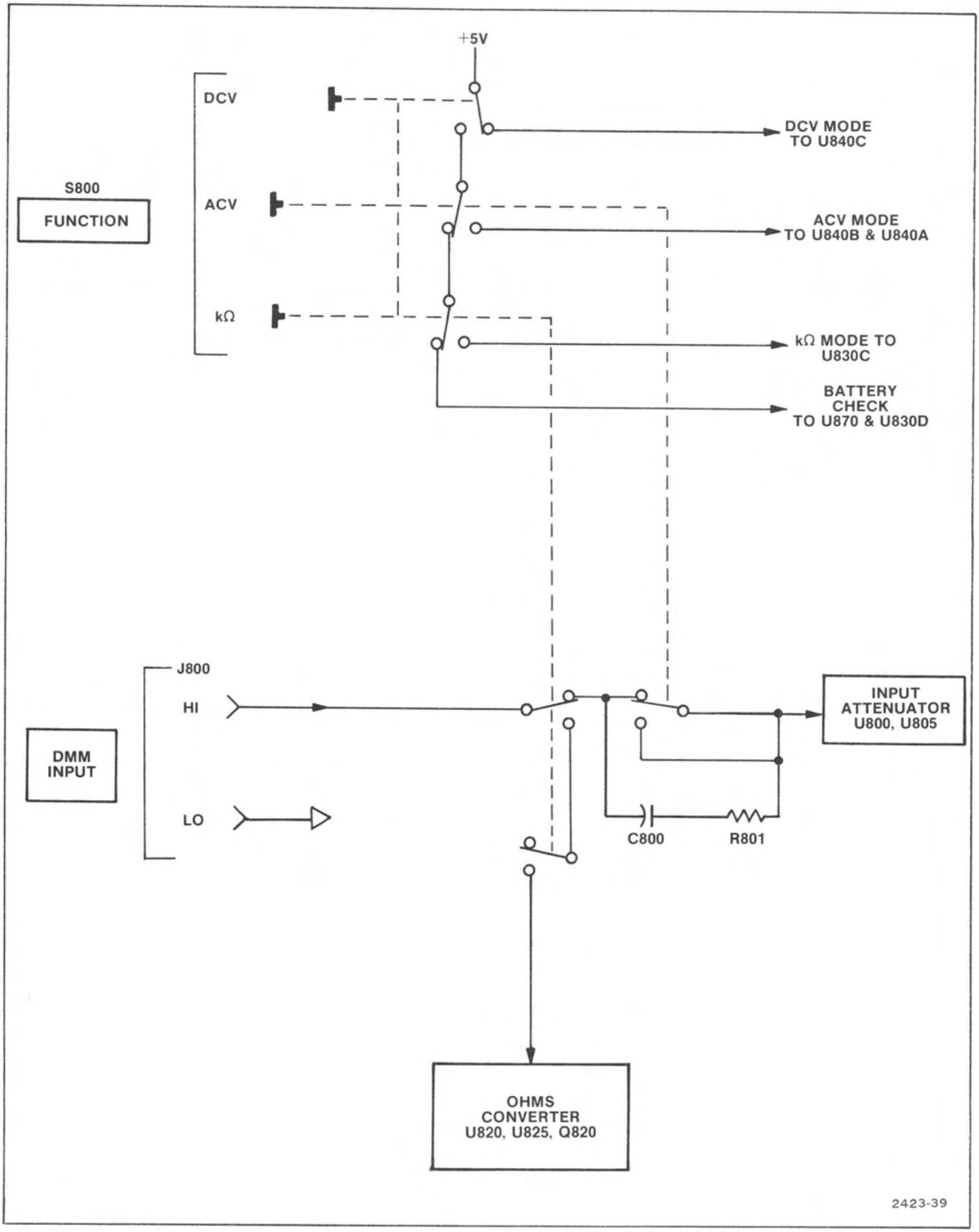


Fig. 3-14. Simplified diagram of the function switch.

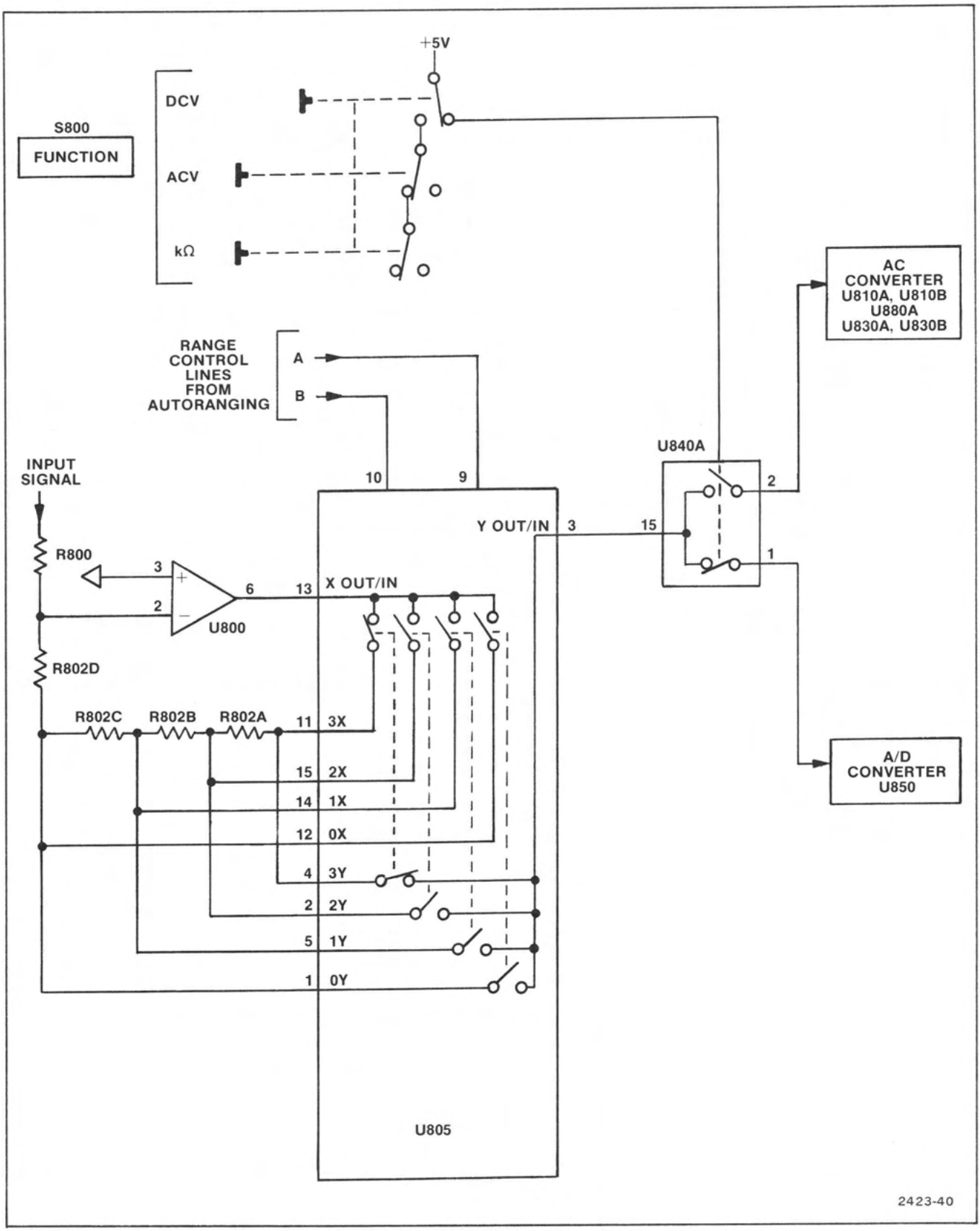


Fig. 3-15. Simplified diagram of the input attenuator circuitry.

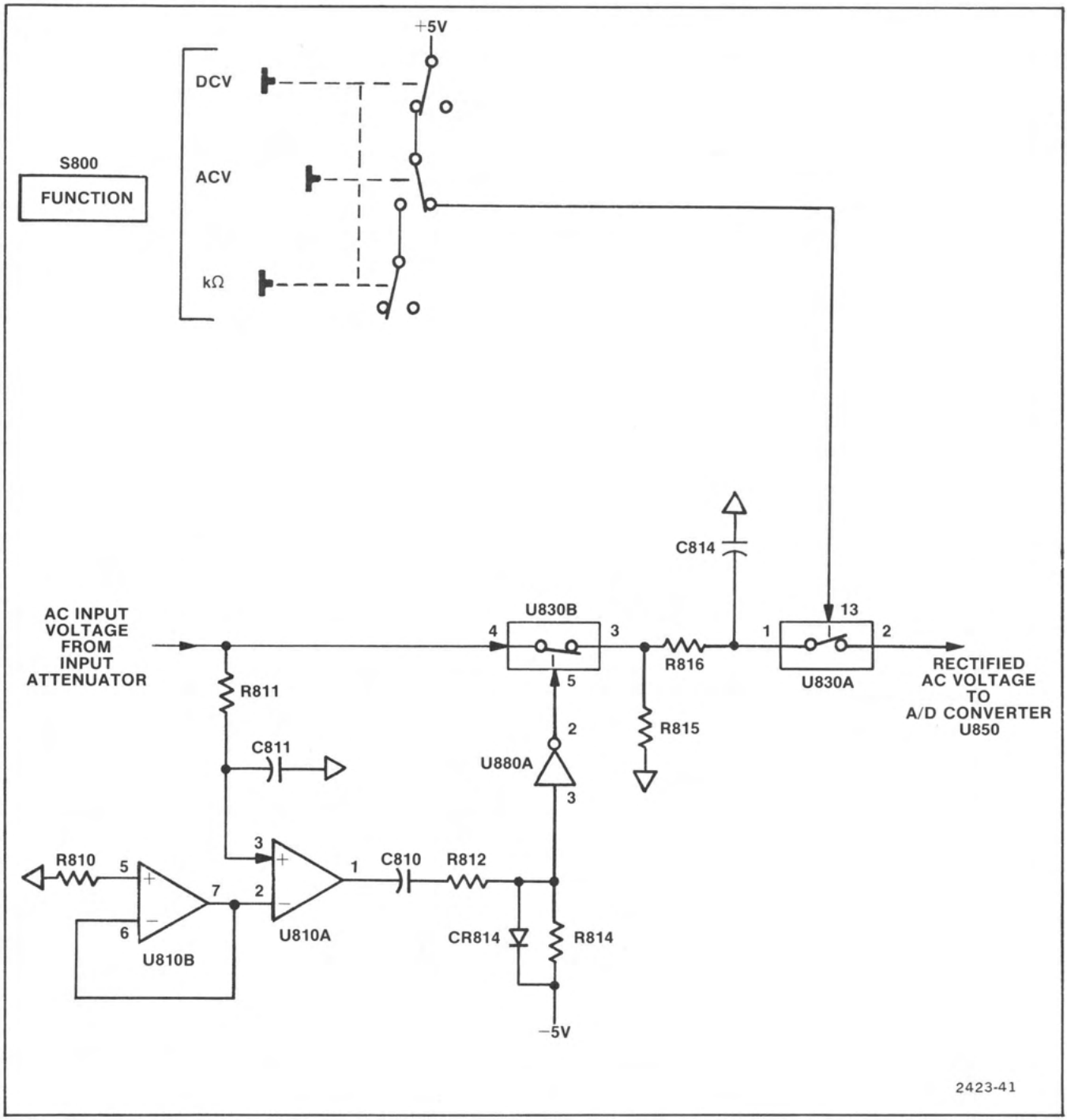


Fig. 3-16. Simplified diagram of the ac converter circuitry.

The rectified ac voltage is applied to the A/D Converter through analog switch U830A.

The Acv Cal adjustment R853 sets the ac reference voltage of the A/D Converter so that the LED display reads out the rms value of a sine-wave input voltage.

OHMS CONVERTER (Diagram 11)

Figure 3-17 shows a simplified diagram of the Ohms Converter circuit with the FUNCTION switch shown in the kΩ mode.

The Ohms Converter circuit performs resistance-to-voltage conversion when the DMM is in the kΩ mode. The reference-current generator consisting of U820, Q820, and selectable source resistors, supplies a constant reference current to the unknown resistor under test. The voltage that is developed across the resistor is proportional to its resistance value. Autoranging circuitry selects the proper source resistor for Q820 through analog switch U825. This sets the current that flows through the resistor under test. U820 senses any voltage change across the Q820 source resistor and produces a correction signal to Q820 that will maintain a constant current through the selected source resistor and the resistor under test. The negative voltage developed across the unknown resistance by the reference current is fed to the A/D Converter through analog switch U830C.

Components DS800, VR827, CR820, and CR821 provide input protection to the Ohms Converter in case the probe leads are accidentally connected to a voltage source when the DMM is in the kΩ mode. KΩ adjust R825 is adjusted to set the DMM for a display of 1000 with a 1 MΩ precision resistor across the DMM INPUT jacks.

A/D CONVERTER (Diagram 11)

The A/D Converter U850 is a 3 1/2-digit, dual-ramp analog-to-digital converter. The analog input voltage at pin 3 is converted to a binary-coded-decimal (bcd) digital output at the Q_0 through Q_3 outputs (pins 20, 21, 22, and 23). Pins 16, 17, 18, and 19 drive the digit select transistors (Q886 through Q889) that enable the correct LED indicator for the display. The LED indicators are enabled in sequence to match the digit being multiplexed out of the A/D Converter to U860.

Out-of-range signals are supplied to the Autoranging circuit from pin 15 ($\overline{OR}$) and from pin 20 (Q_0) during the first 1/2 digit display time. The output of pin 22 (Q_2) is the minus (−) polarity indicator during the first 1/2 digit display time. A reference voltage is supplied to pin 2 (V_{ref}) that is compared to the input voltage. The reference level is switched by analog switch U840 between ac and dc reference levels.

AUTORANGING (Diagram 12)

Figure 3-18 shows a simplified block diagram of the Autoranging circuit.

The Autoranging circuit controls the Input Attenuator and the Ohms converter to ensure proper voltage to the A/D Converter for the different measurement ranges available. It also determines the position of the decimal point in the readout display.

When the seven-segment readout reads less than 0180 or more than 1999, the Autoranging circuit is activated.

Underrange Condition

When an underrange condition exists, pin 15 of U850 is at a HI. Upon reaching the end of conversion point (EOC), the Q_0 through Q_3 outputs of U850 will have the most significant digit (MSD) information present. The readout of the MSD requires only the Q_3 output to display a 1, so this is the time period that the overrange, underrange, and minus (−) polarity information is presented to the autoranging and display circuitry.

In underrange, at the leading edge of the EOC pulse, U850 Q_0 output pin 20 goes HI. The EOC pulse is inverted by U880F and the pulse trailing edge clocks U895A and U870. With the HI from U850 pin 20, applied to U895A pin 5, the $\overline{Q}$ output of U895A pin 2 goes LO when U895A is clocked. This LO is applied to U890B pin 6 along with the HI from $\overline{OR}$ (U850 pin 15) at U890B pin 5, and HI is placed on U890B pin 4. This will cause a LO on U890A pin 3 unless U870 has reached its highest count.

The HI present on U870 pin 10 from $\overline{OR}$ (U850 pin 15) causes U870 to count up (increment) with each clock pulse (EOC). Each increment of the output from Q_2 and Q_3 (pins 11 and 14) causes the Input Attenuator or Ohms Converter to decrease the attenuation of the voltage to the A/D Converter by one range step. When U870 reaches its highest count, the 3X switch (U885 pin 11) closes and a LO from U880E is applied to U890A pin 1. The LO is inverted by U890A, driving U870 pin 5 HI and inhibiting U870 from further counting. In the case just described, an underrange condition may still exist if the voltage applied to the A/D Converter is lower than the instruments lowest range.

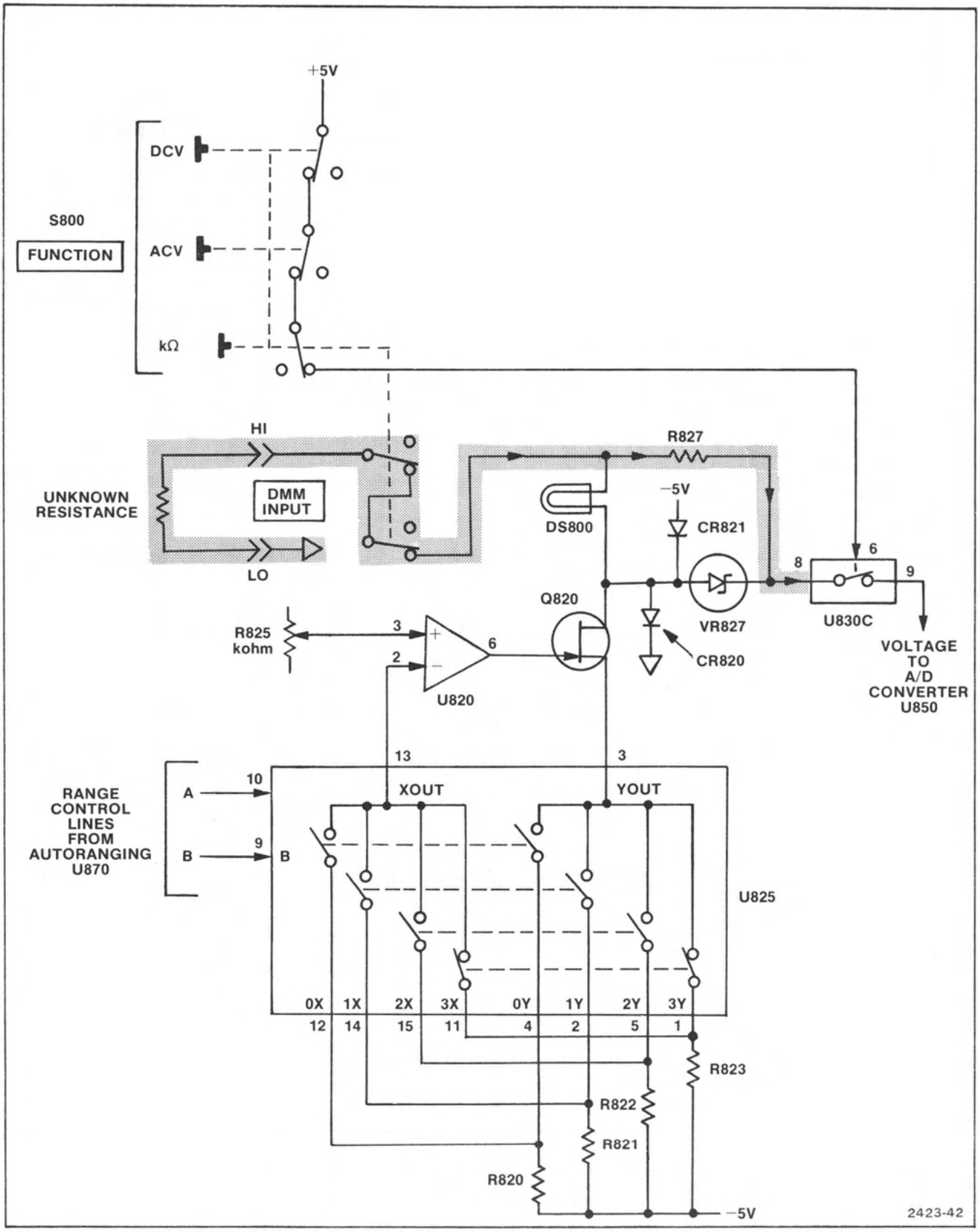


Fig. 3-17. Simplified diagram of the ohms converter circuitry.

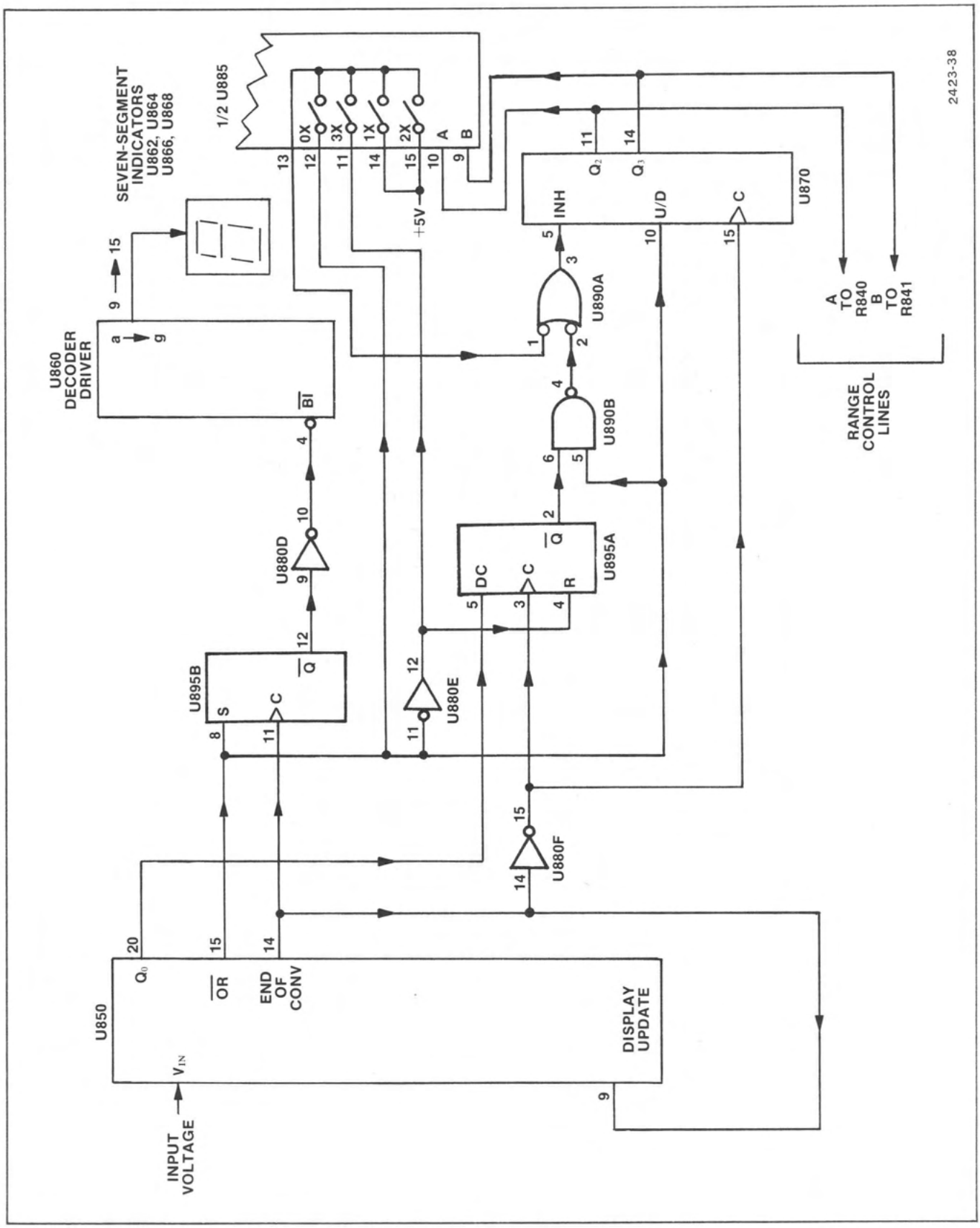


Fig. 3-18. Simplified diagram of the autoranging circuitry.

If U870 has not reached its highest count, a LO will remain on pin 5, and U870 will continue to increment until sufficient voltage is applied to U850 pin 3 to clear up the underrange condition or until the DMM input range has been set for the highest voltage available from the input circuitry.

When the voltage level at U850 pin 3 becomes sufficient to clear an underrange condition, the Q_0 output of U850 pin 20 will go LO, applying a LO to U895A pin 5. With a LO on pin 5 of U895A, the next clock pulse (EOC) to U895A pin 3 will switch the U895A $\overline{Q}$ output (pin 2) HI, putting a LO on U890B pin 4. This LO is inverted by U890A to put a HI on U870 pin 5 to inhibit U870 from further counting. The Q_2 and Q_3 outputs of U870 (pins 11 and 14) control analog switch U885. The decimal point position is set by the Y switch that remains closed when U870 stops incrementing.

Overrange Condition

In an overrange condition, pin 15 of U850 will be LO. The LO is fed to U880E where it is inverted to a HI to reset U895A (pin 4). The LO is also present at U870 pin 10, and it causes U870 to count down (decrement) with each clock pulse. The Input Attenuator (DCV and ACV mode) or Ohms Converter (kΩ mode) is adjusted by the output of U870 until the voltage at U850 pin 3 is lowered, and the overrange condition is cleared. At that point pin 20 of U850 goes LO, and U870 is inhibited from further counting (as with the underrange condition). The action of U885 switching controlled by pins 11 and 12 is reversed; the counter will be inhibited when the Q_2 and Q_3 outputs of U870 are at their lowest count.

If the overrange condition still exists, U850 pin 15 will remain LO. This LO is applied to U895B pin 8, and with each clock pulse (EOC) U895B will change state. The Q output signal at U895B pin 12 will be inverted by U880D and applied to U860 pin 4. This causes the seven-segment LED indicators to blink, indicating that the DMM is still in an overrange condition.

READOUT LOGIC AND DISPLAY (Diagrams 12 and 13)

Figure 3-19 shows a simplified diagram of the Readout Logic and Display.

At the end of the conversion interval, the A/D Converter U850 has completed converting the analog input into bcd digital information, and the net count is transferred to static latches within the A/D Converter. This information is time multiplexed out of the A/D Converter and supplied to the Decoder Driver U860 one digit at a time. Digit one is the most significant digit. The outputs of the seven-segment Decoder Driver are connected to the seven anode segments of the four LED indicators. The corresponding segment anodes in each indicator are connected in parallel. The cathode of each indicator is connected to a digit-select output of the A/D Converter through Buffer Amplifiers Q886, Q887, Q888, and Q889. One at a time, these amplifiers are turned on to enable the LED indicator that corresponds to the digit being supplied by the A/D Converter at that time.

The decimal points of the seven-segment indicators are connected to the digit-select outputs of U850 through analog switch U885 and Buffer Amplifier Q885. The decimal point that will be enabled is selected by the Autoranging circuit.

Minus Sign

Figure 3-20 shows a simplified diagram of the Minus Sign circuit with the FUNCTION switch shown in the DCV mode. This circuit produces a minus sign (−) when a negative polarity dc voltage is applied to the DMM INPUT jacks.

During display of the most significant digit, D1, U850 pin 19 will be HI which puts a HI on U890 pin 9. If U850 pin 22 is also HI, because a negative polarity signal is applied to pin 3 of U850, then pin 10 of U890 will go LO. The LO is applied to pin 12 of U890 and inverted to a HI at pin 11 of U890. The HI turns on Q890, which turns on the center (g) segment of U862 (LED indicator). Pin 13 of U890D is held HI by U880B unless a low-line condition exists. See the discussion of Low Line Indicator in this section for the operation of the Low Line Indicator circuitry.

Since the most significant digit (D_1) is a half-digit display (1 or blank), the center segment of LED U862 is only used for the minus indication. For the rest of the digit intervals (D_2, D_3, and D_4) U850 pin 19 will be LO. The LO is fed to U890C, inverted to a HI, and then inverted to a LO again by U890D to hold Q890 off during the remaining digit display times. The center segments of the other three LED indicators are then controlled only by the U860 g segment output pin 14.

In the ACV and kΩ modes, analog switch U840C is switched to hold a LO on U890C pin 8. This LO inhibits the signal on the D1 output of U850 pin 19 from passing to the base of Q890 and the minus sign will not be enabled.

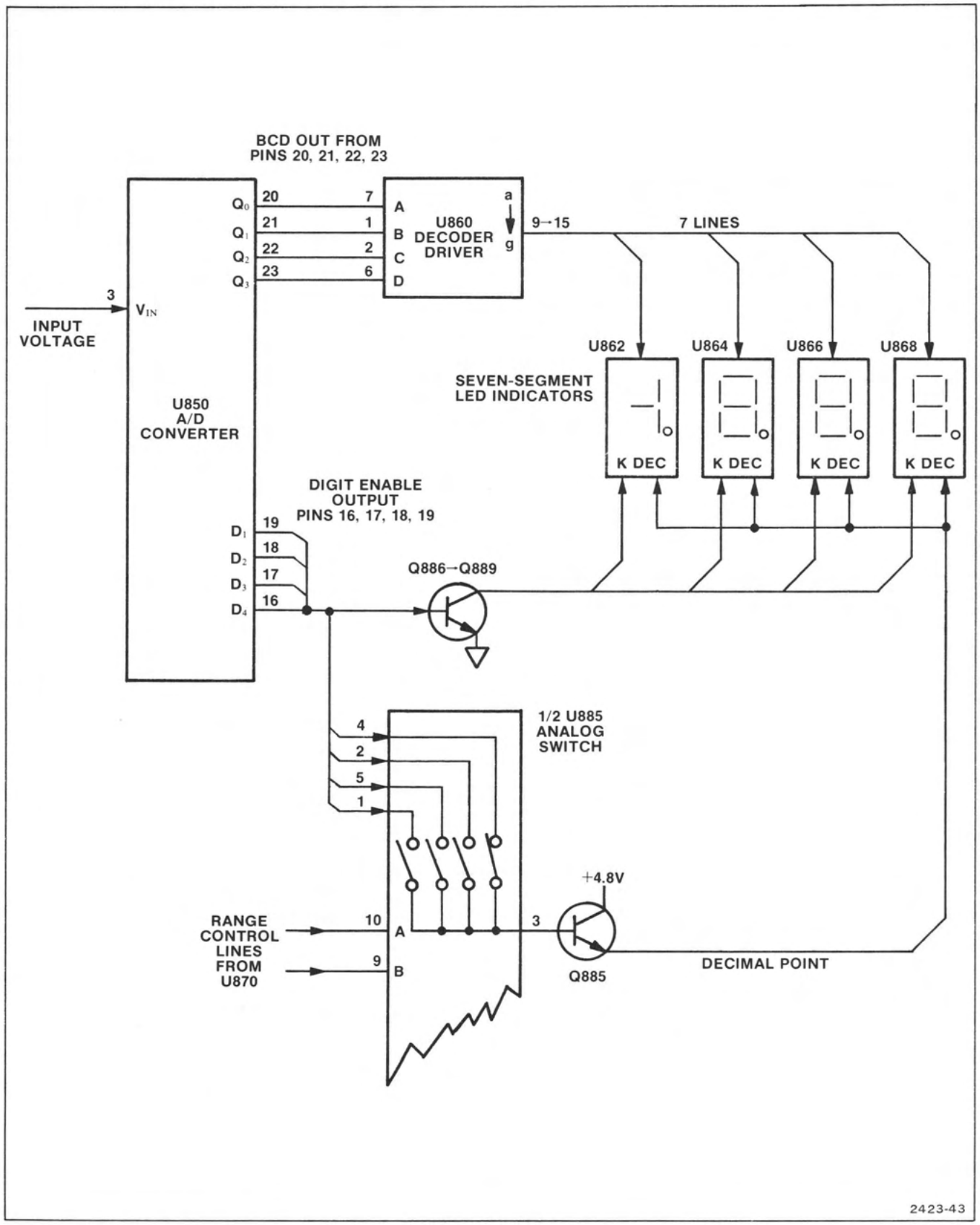


Fig. 3-19. Simplified diagram of the readout logic and display.

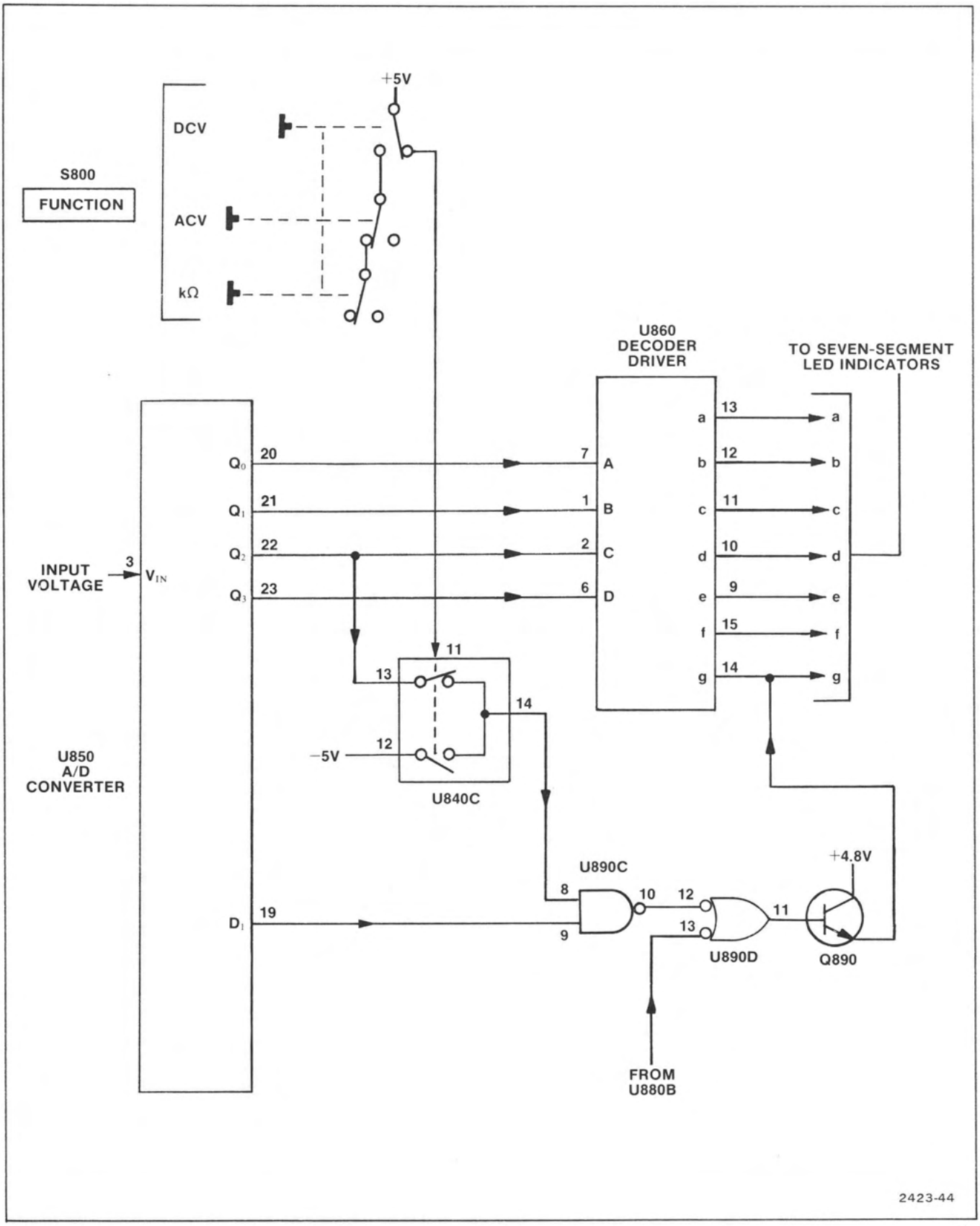


Fig. 3-20. Simplified diagram of the minus sign circuitry.

POWER SUPPLY (Diagram 14)

Figure 3-21 shows a simplified diagram of the DMM power supply. The DMM power supply operates independently of the oscilloscope power supply.

DMM Power Supply Operation

When power is first applied, there is no voltage across C901 and VR900 is turned off. Applying the power forward biases Q900, and when Q900 conducts, Q910 is also biased on. The collector current of Q910 flows through T900 pins 3 and 4 back to the power source. T900 pins 1 and 2 connect to a positive feedback winding that rapidly raises the base voltage of Q910 to get a fast turn on. The collector current and the current in the primary winding of T900 will increase until the voltage across the Q910 emitter resistors R914 and R912 reaches approximately 0.7 V. At that point, Q905 becomes forward biased and limits any further increase in current through Q910.

When T900 primary winding (pins 3 and 4) current stops increasing, the voltage induced in all the windings drops to zero. The base voltage of Q910 decreases and Q910 starts to shut off. The magnetic field in T900 starts to collapse and the polarity of the voltage across the T900 windings reverses. Q910 turn off is completed by the reverse bias developed across the T900 feedback winding (pins 1 and 2). As the field continues to collapse, the induced voltage at T900 pin 3 is more positive than the voltage at pin 4. CR902 becomes forward biased and C901 charges. When the voltage across C901 exceed 7.6 V, VR900 conducts and turns off Q900. Capacitor C901 will continue to charge until the induced voltage from T900 primary winding (pins 3 and 4) falls below the charge on C901. Then CR902 becomes reverse biased, and C901 will discharge at a constant rate through Q901. Transistors Q900 and Q910 are biased off until the voltage across C901 falls below 7.6 V to turn VR900 off. With VR900 off, Q900 becomes forward biased again and the cycle repeats itself.

During the time Q910 is turned off, power is delivered to the secondary winding from the magnetic field collapse around the T900 windings. The voltage induced in the secondary windings is proportional to the energy stored in the magnetic field and the load on the transformer. The voltage level that C901 charges to is dependent on the load current. The heavier the load, the lower the voltage on C901 and the shorter the length of time that Q900 will be held off. Any changes in load current are reflected to the circuitry in the primary, and regulation occurs because the amount of time between current pulses is increased or decreased. Regulation of changes in the dc input voltage is accomplished by the limiting action of Q905. A fixed amount of energy is stored in the T900 magnetic field by each current pulse.

Low Voltage Rectifier and Filter

Ac voltage from the secondary winding of T900 is rectified and filtered by conventional networks. The +4.8 V supply requires no secondary regulation.

+2.5 V Regulator

U960 provides a +2.5 V reference for the +5 V and −5 V regulators. This reference voltage is also used by the A/D Converter U850 pin 3 via U840B.

Secondary Regulators

The regulation of the +5 V is accomplished by pass transistor Q970 and error amplifier U970B.

The regulation of the −5 V is accomplished by pass transistor Q980 and error amplifier U970A.

Battery Check

Figure 3-22 shows a simplified diagram of the Battery Check circuit, showing all the DMM FUNCTION switch push buttons out (released).

A negative voltage from the T900 secondary winding pin 6, is rectified by CR955. This rectification takes place on the part of the input cycle when Q910 is on supplying current to the T900 primary winding. The voltage across the secondary of T900 is proportional to the input voltage across the primary when Q910 is turned on. Capacitor C955 charges to a voltage level that is proportional to the dc input voltage. The Battery Check line voltage across C955 is divided by R955, R957, and R958 to a value proportional to one-tenth of the actual input dc voltage and applied to U850 pin 3 through U830D.

In Battery Check mode, the decimal point is set for the nominal battery voltage. This is accomplished by a HI applied to U870 pin 1 from the FUNCTION switch S800. The HI presets U970 Q_2 output line pin 11 to the level present on pins 3, 4, and 12; output line Q_3 pin 14 is preset to the level present on pins 9 and 13 of U870. Autoranging is inactive, and an overrange condition will be indicated if the dc input voltage to the DMM exceeds 20 V.

Overrange can occur if the instrument is connected to either an external dc supply or ac power input source. The DMM input voltage may still be within acceptable range for safe operation of the DMM (+9 V to +32 V).

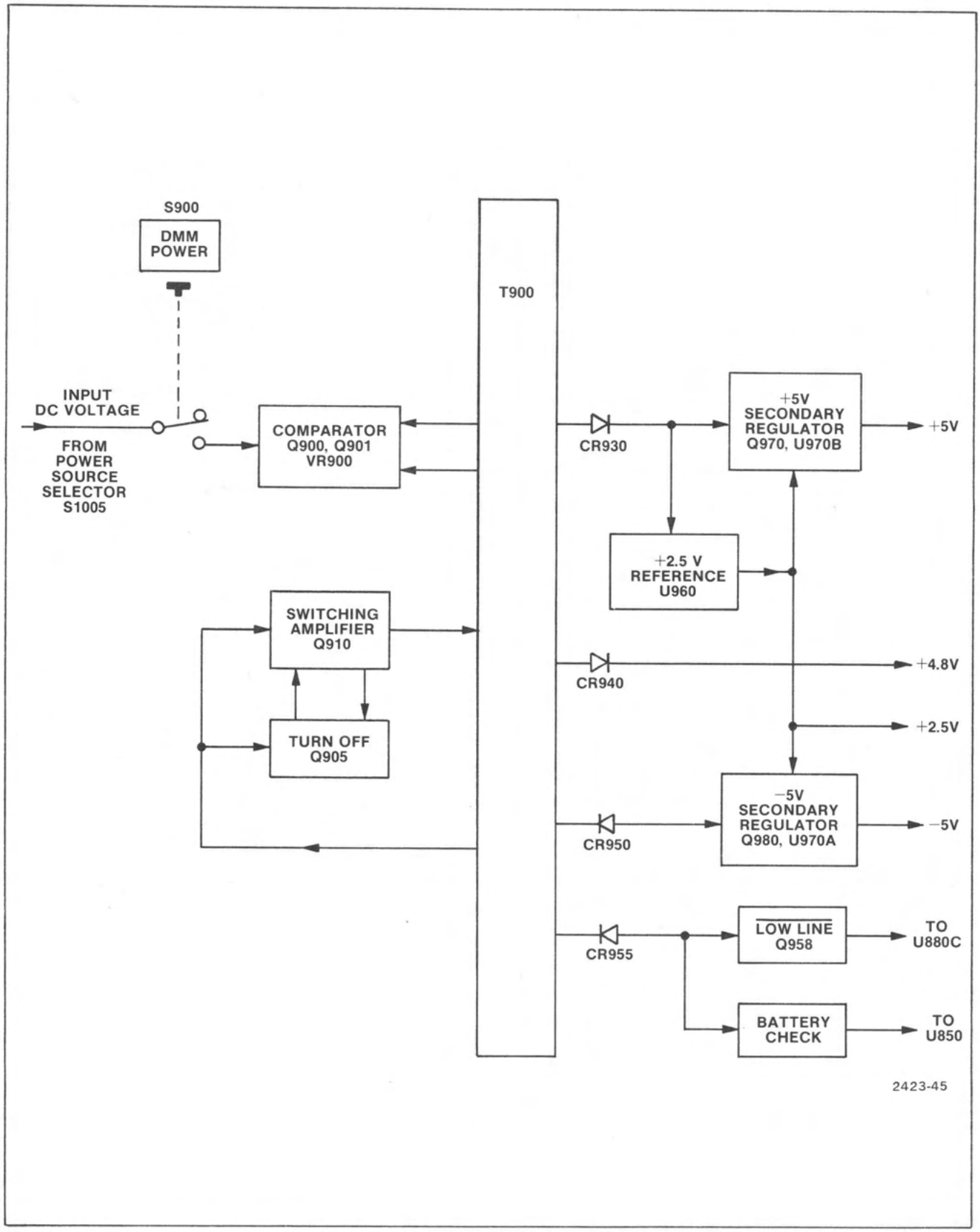


Fig. 3-21. Simplified block diagram of the DMM power supply.

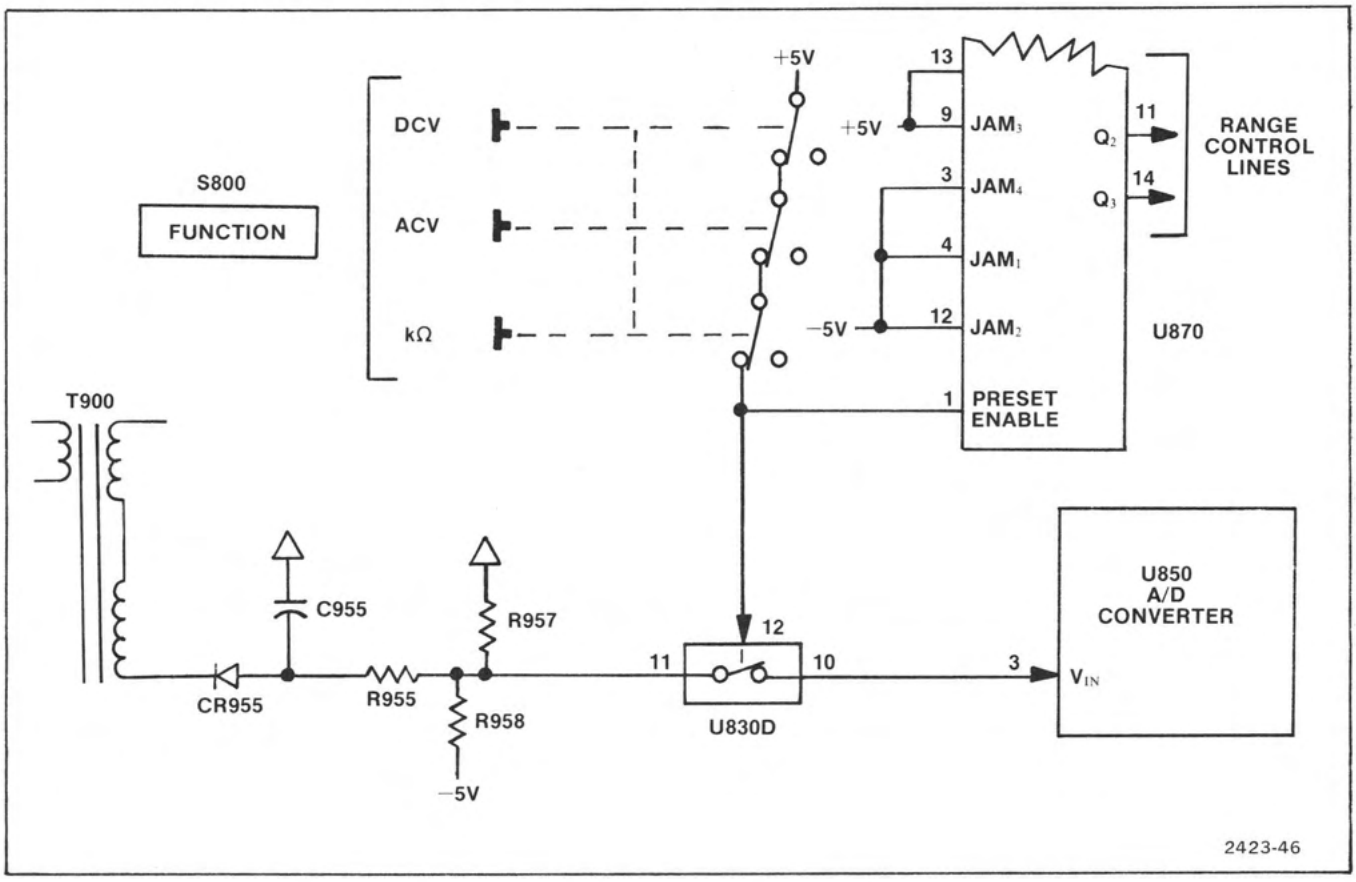


Fig. 3-22. Simplified diagram of the battery check function.

Low Line Indicator

Figure 3-23 shows a simplified diagram of the Low Line Indicator. Also see Diagrams 12 and 14 in the Diagrams section of this manual.

If the voltage of the internal battery or the external dc power source is low, the Low Line Indicator circuit will produce a low-line indication when the DMM is turned on. From the previous discussion of the Battery Check function it was shown that the voltage across C955 is proportional to the dc power souce voltage of the DMM. If this dc voltage becomes too low, Q958 will turn on and put a LO on the LOW LINE output to CR890 (Diagram 12). The LO reverse biases CR890 and releases the HI from U880C pin 7, allowing U880C and U880B to oscillate. The oscillator alternately allows a normal display and a low-line indication from the LED readout. Low-line indication is accomplished when a HI from U880C is applied to U895B pin 10. This HI resets U895B pin 12 to a HI state; U880D inverts the signal and applies a LO to U860 pin 4. A LO on U860 pin 4 blanks the segment-controlling outputs of U860. At the same time, U880B inverts the HI from U880C and applies a LO to U890D pin 13. U890D pin 12 is held HI by U890C, so the output of U890D is a HI. This HI then turns on the center segment of all LED indicators (U862 through U868) by switching on Q890. The resultant low-line indication display is "-.--". On the next half cycle of the oscillation the conditions reverse, and the normal display is permitted to be displayed.

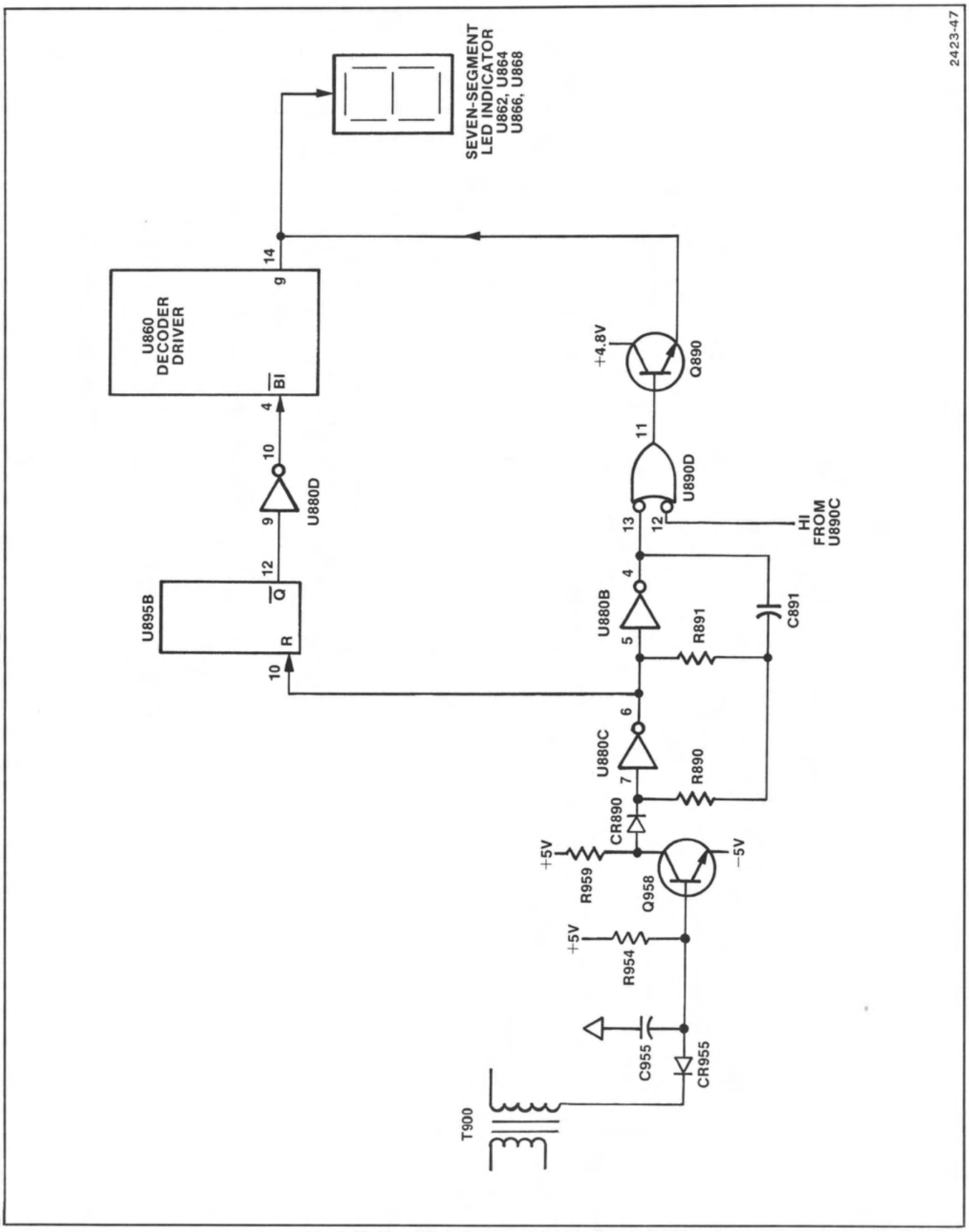


Fig. 3-23. Simplified diagram of the low line indicator.

PERFORMANCE CHECK

INTRODUCTION

This section contains a procedure for checking instrument performance without removing the cabinet or making internal adjustments (external operator's adjustments are made as needed). Only the performance essential to measurement accuracy and correct operation is checked. The procedure is also useful as an aid in troubleshooting and preventive maintenance. To aid in locating a step in the Performance Check procedure, an index precedes the procedure.

PERFORMANCE CHECK INTERVAL

To ensure instrument accuracy, check the performance of the 305 every 1000 hours of operation, or every six months if used infrequently. If specifications are not met, see the Adjustment Procedure in Section 6 of this manual.

LIMITS AND TOLERANCES

The limits and tolerances given in this procedure are valid, after a 5 minute warm-up period, if the 305 was calibrated and is performance checked in an ambient temperature of +20° C to +30° C. All limits and tolerances given are for the 305 itself and do not include test equipment tolerances.

PARTIAL PROCEDURES

If one part of the 305 measurement capability is critical to your application, you may wish to perform a partial procedure to check that part at intervals more frequent than 1000 hours. Also, if you have replaced components, check the performance of the repaired circuitry by performing a partial procedure. To make partial procedures easier to perform, the performance check is divided into several sections, each of which stands alone. An equipment-required list and set of instructions are provided at the beginning of each section.

EQUIPMENT REQUIRED

The complete Performance Check requires the equipment (or equivalent) listed in Table 4-1.

Table 4-1

TEST EQUIPMENT REQUIRED

Description	Minimum Specifications	Use	Example
1. Digital Multimeter	Accuracy, 0.1% or better.	Power Supply check.	TEKTRONIX DM 502[a] Digital Multimeter.
2. Time-Mark Generator	Accuracy, 0.3% or better.	SEC/DIV check.	TEKTRONIX TG 501[a] Time Mark Generator.
3. Square-Wave Generator	Frequency, 1 kHz at 25 V, 100 kHz at 0.5 V; risetime 5 ns or less.	VOLTS/DIV compensation check. Risetime check.	TEKTRONIX PG 506[a] Calibration Generator.

[a] **Requires TM 500-Series Power Module.**

Table 4-1 (cont)

Description	Minimum Specifications	Use	Example
4. Amplitude Calibrator	Amplitude accuracy within 0.5%; amplitude range, 20 mV to 50 V; output frequency, 1 kHz square wave.	Vertical gain.	TEKTRONIX PG 506[a] Calibration Generator.
5. Leveled Sine-Wave Generator	Amplitude cannot vary more than 1% from 50 kHz to 5 MHz; amplitude, at least 5 V p-p into 50 Ω.	Vertical Bandwidth check.	TEKTRONIX SG 503[a] Sine Wave Generator.
6. Low-Frequency Sine-Wave Generator	5 Hz to 50 kHz.	Trigger Sensitivity.	TEKTRONIX SG 502[a] Oscillator.
7. DC Power Supply	Output, Variable from 5 V to 32 V at 1 A.	Power supply range and low-battery indication.	TEKTRONIX PS 503A[a] Triple Power Supply.
8. DC Voltage Calibrator	Voltage, 10 mV to 1000 V; accuracy, 0.01%.	DCV accuracy.	Fluke 341A DC Voltage Standard.
9. AC Voltage Calibrator	Voltage, 10 mV to 700 V rms; voltage accuracy, 0.05%; frequency range, 50 Hz to 500 Hz.	ACV accuracy.	1. Fluke 5200 Calibrator and 5205A Amplifier. 2. Fluke 5200 Calibrator and 5215A Amplifier.
10. Resistance Standard	Range, 10 Ω to 2 MΩ. Accuracy, 0.03%.	Ohms accuracy.	ESI Dekabox Model DB 75 Resistance Standard. Use with item 11.
11. 1 MΩ Precision Resistor	Tolerance 0.1%.	Ohms accuracy.	
12. Bnc-to-probe-tip adapter	Connector, bnc male to probe tip.	Signal interconnection.	Tektronix Part Number 013-0084-02.
13. Termination (2 required)	Impedance, 50 Ω; connectors, bnc.	Signal termination.	Tektronix Part Number 011-0049-01.
14. Cables (2 required)	Impedance, 50 Ω; length 42"; connectors, bnc.	Signal interconnection.	Tektronix Part Number 012-0057-01.
15. T connector	Connectors, 2 bnc female to 1 bnc male.	Signal interconnection.	Tektronix Part Number 103-0030-00.
16. Attenuator (2 required)	Attenuation factor 10; impedance, 50 Ω; connectors, bnc.	Signal attenuation.	Tektronix Part Number 011-0059-02.
17. Dual-Input Coupler (2 required)	Impedance, 50 Ω.	Triggering check.	Tektronix Part Number 067-0525-00.
18. 10X Probe		VOLTS/DIV compensation check.	Included with 305.
19. DMM Probe		DMM check.	Included with 305.

[a] Requires TM 500-Series Power Module.

INDEX TO PERFORMANCE CHECK

PART I OSCILLOSCOPE

PART II DMM

A. POWER SUPPLY AND DISPLAY

Equipment Required

1. DC Power Supply.
2. Time-Mark Generator.
3. Digital Voltmeter.
4. Cable, 50 Ω, Bnc.
5. Termination, 50 Ω, Bnc.
6. Insulated Screwdriver.

305 Control Settings

NOTE

Connect the 305 to an appropriate power source, turn it on, and allow it to warm up for 5 minutes before starting Performance Check.

Power and Display

Power Source Selector	AC and EXT DC
SCOPE POWER	ON (In)
INTENSITY	As desired

Vertical (both channels if applicable)

VOLTS/DIV	10 m
VOLTS/DIV CAL	In detent
POSITION	Midrange (as required)
AC-GND-DC	GND
Display Mode	CH 1

Horizontal

SEC/DIV	1 m
SEC/DIV CAL	In detent
PULL: X10 MAG	In (X1)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as required.

1. Trace Rotation

a. Adjust INTENSITY control for a display of moderate intensity.

b. Use CH 1 POSITION control to move the trace to graticule center line.

c. CHECK—that trace is parallel to the graticule center line. If not, adjust TRACE ROTATION. (Accessible from bottom of cabinet.)

2. Turn-off Level

a. Turn off 305.

b. Unplug 305 from its ac power source.

c. Connect the dc power supply to the EXT DC VOLTAGE power source connectors on the 305.

d. Connect the digital voltmeter to the output of the dc power supply.

e. Set the dc power supply to 9.0 V and push SCOPE POWER ON (in).

f. Adjust the INTENSITY control to present a trace of moderate intensity.

g. Slowly lower the output voltage of the dc power supply until the oscilloscope trace disappears.

h. CHECK—that dc voltage is 7.0 V or less and that the low-line indicator (FLASHES WHEN LOW) does flash.

i. Return dc power supply setting to 9.0 V.

3. Geometry

a. Connect time-mark generator to CH 1 input via a 50 Ω bnc cable and 50 Ω termination.

b. Set the generator to produce 0.1 ms time markers.

c. Change the 305 settings as follows:

Display Mode	CH 1
SEC/DIV	0.1 m

d. Set:

AC-GND-DC	DC
CH 1 VOLTS/DIV	20 mV
SEC/DIV, SEC/DIV CAL, and Horizontal POSITION	Adjust for one time marker per division; align time marker with vertical graticule line.
Vertical Position	Fully ccw

e. Check—for "bowing" of time markers, from top to bottom of display, of 0.15 major division or less.

f. Disconnect generator, bnc cable, and termination.

NOTE

Due to the fast risetime of the markers, the visible display from the time-mark generator shows only the trailing edge. The portion of the time markers near the base line of the display is not suitable (not linear) for the geometry check; therefore, the VOLTS/DIV and Vertical POSITION settings above have been made to display the most linear portion of the marker trailing edge.

4. Compression

a. Set CH 1 VOLTS/DIV to 5 DIV CAL.

b. Adjust CH 1 VOLTS/DIV CAL to present a display of two divisions, centered about the center horizontal graticule line.

c. Position bottom of display to bottom graticule line.

d. CHECK—for 0.2 division or less compression.

e. Position top of display to top graticule line.

f. CHECK—for 0.2 division or less compression.

B. VERTICAL

Equipment Required

1. Amplitude Calibrator.
2. Square-wave Generator.
3. Leveled Sine-wave Generator.
4. Cable, 50 Ω, Bnc.
5. Termination, 50 Ω, Bnc.
6. 10X Probe (supplied with 305).
7. 10X Attenuator (2 required).
8. Dual-input Coupler.

305 Control Settings

NOTE

If you are performing a partial procedure, connect the 305 to an appropriate power supply, turn it on, and allow it to warm up for 5 minutes before starting Performance Check.

Power and Display

Power Source Selector	AC
SCOPE POWER	ON (In)
INTENSITY	As desired

Vertical

VOLTS/DIV (both)	5 m
VOLTS/DIV CAL (both)	In detent
POSITION (both)	Midrange (as required)
AC-GND-DC (both)	GND
Display Mode	CH 2
PULL: INVERT	Button in

Horizontal

SEC/DIV	.5 m
SEC/DIV CAL	In detent
PULL: X10 MAG	In (X1)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 2
LEVEL	As required

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Deflection Factor Accuracy

a. Connect the amplitude calibrator to CH 2 input via a 50 Ω bnc cable.

b. Set CH 2 AC-GNC-DC switch to DC.

c. CHECK—accuracy of CH 2 deflection factor using the VOLTS/DIV and amplitude calibrator settings given in Table 4-2.

d. Set:

CH 1 AC-GND-DC	DC
CH 2 AC-GND-DC	GND
Display Mode	CH 1
Trigger Source	CH 1

e. Move the 50 Ω bnc cable from CH 2 input to CH 1 input.

f. CHECK—accuracy of CH 1 deflection factor using the VOLTS/DIV and amplitude calibrator settings given in Table 4-2.

g. Set amplitude calibrator for a .1 V output.

Table 4-2

DEFLECTION FACTOR ACCURACY

VOLTS/DIV Setting	Amplitude Calibrator	Vertical Deflection (Major Divisions)
5 m	20 mV	3.88 to 4.12
10 m	50 mV	4.85 to 5.15
20 m	.1 V	4.85 to 5.15
50 m	.2 V	3.88 to 4.12
.1	.5 V	4.85 to 5.15
.2	1 V	4.85 to 5.15
.5	2 V	3.88 to 4.12
1	5 V	4.85 to 5.15
2	10 V	4.85 to 5.15
5	20 V	3.88 to 4.12
10	50 V	4.85 to 5.15
5 DIV CAL		4.85 to 5.15

2. Gate Current

a. Set the 305 controls as follows:

CH 1 VOLTS/DIV	5 m
CH 2 VOLTS/DIV	5 m
CH 1 AC-GND-DC	GND
CH 2 AC-GND-DC	GND
DISPLAY MODE	ALT

b. Position CH 1 trace to graticule center line and CH 2 trace to graticule bottom line.

c. Set CH 1 AC-GND-DC switch to DC and verify less than 0.1 divisions of trace shift. Return CH 1 AC-GND-DC switch to GND.

d. Position CH 1 trace to graticule bottom line and CH 2 trace to graticule center line.

e. Set CH 2 DC-GND-DC switch to DC and verify less than 0.1 divisions of trace shift.

3. VOLTS/DIV CAL Range

a. Set:

VOLTS/DIV (both)	20 m
Trigger Source	CH 1
Display Mode	CH 1
CH 1 AC-GND-DC	DC
CH 1 POSITION	Center display

b. Verify that amplitude calibrator is connected to CH 1 input, and it is set for .1 V output.

4. VOLTS/DIV Compensation Check

a. Connect test equipment to CH 2 input as shown in Figure 4-1.

b. Set CH 2 VOLTS/DIV to 5 m.

c. Set generator frequency to 1 kHz, and adjust generator amplitude control for a 5-division display.

NOTE

Adjust square-wave generator amplitude, and add or remove attenuators and termination as necessary to maintain a 5-division display for the following steps.

d. Adjust probe compensation for best flat-top waveform. (Refer to data sheet supplied with probe for probe compensation adjustment procedure.)

e. CHECK—CH 2 VOLTS/DIV switch settings for 0.15 division or less overshoot or rounding of a 5-division waveform (0.25 division or less at 5 V and 10 V settings). Do this for as many VOLTS/DIV settings as the test equipment will allow.

f. Set:

Display Mode	CH 1
Trigger Source	CH 1
CH 1 VOLTS/DIV	5 m

c. CHECK—display amplitude reduces from 5 divisions to 2 divisions or less when CH 1 VOLTS/DIV CAL control is turned fully counterclockwise. Move 50 Ω bnc cable from CH 1 input to CH 2 input.

d. Set:

Display Mode	CH 2
CH 2 AC-GND-DC	DC
Trigger Source	CH 2
CH 2 POSITION	To Center display

e. CHECK—display amplitude reduces from 5 divisions to 2 divisions or less when CH 2 VOLTS/DIV CAL control is turned fully counterclockwise.

f. Set both CAL controls to their detent positions.

g. Disconnect amplitude calibrator from 305.

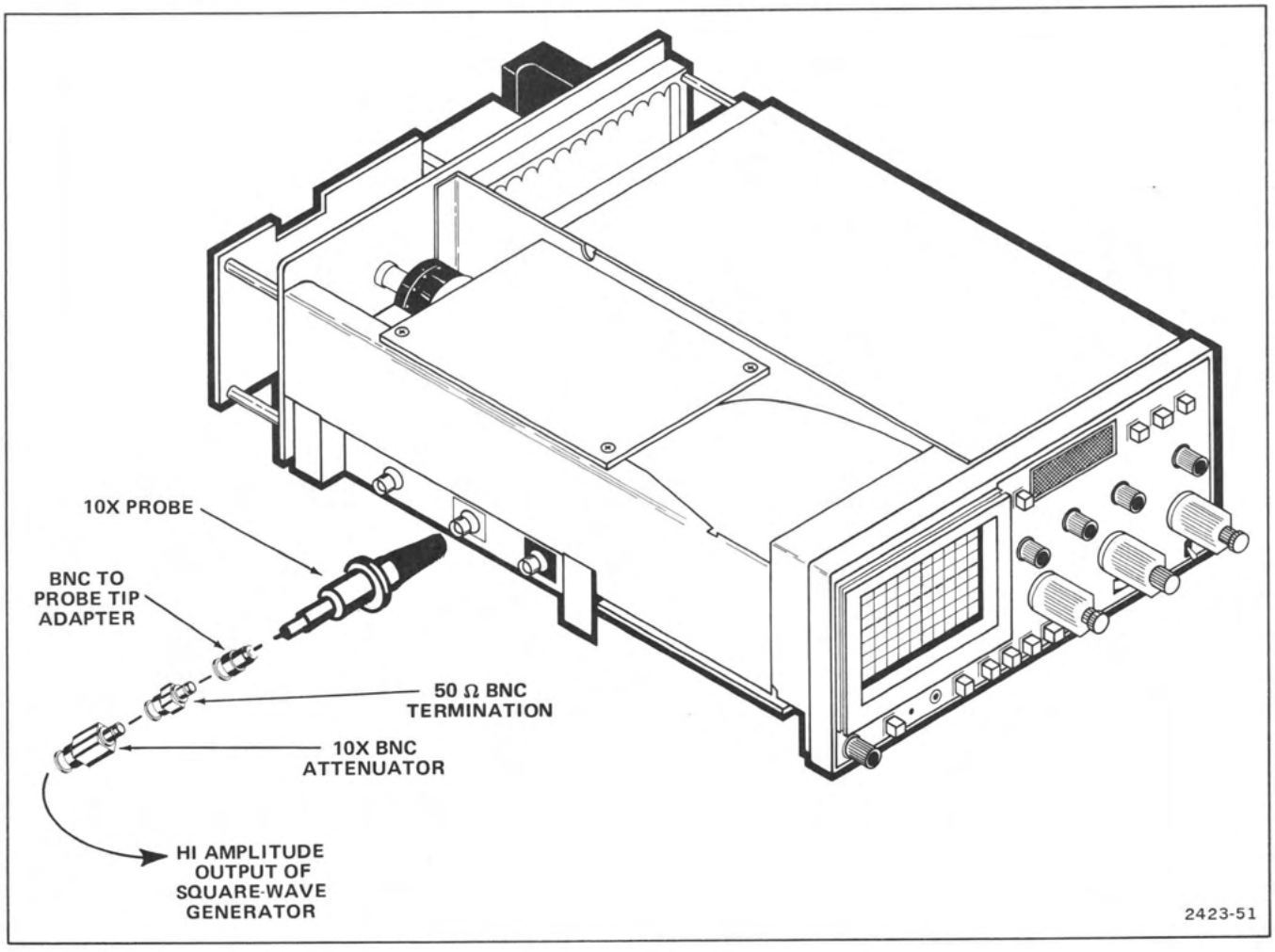


Fig. 4-1. Equipment setup for VOLTS/DIV compensation check.

g. Move test setup to CH 1 INPUT connector and set generator amplitude control for a 5-division display. (See NOTE above.)

h. CHECK—As many CH 1 VOLTS/DIV settings for 0.15 division or less overshoot or rounding of a 5-division waveform (0.25 division or less at 5 V and 10 V settings) as the test equipment will allow.

i. Disconnect test equipment from 305.

5. Position Range

a. Connect the leveled sine-wave generator to CH 1 input via a 50 Ω bnc cable and 50 Ω termination.

b. Set CH 1 VOLTS/DIV switch to 20 m, and adjust leveled sine-wave generator output for an 8 vertical division reference frequency display.

c. Rotate CH 1 POSITION control fully clockwise, then fully counterclockwise.

d. Verify that display moves beyond edge of the graticule in both positions.

e. Set:

Display Mode	CH 2
Trigger Source	CH 2
CH 2 VOLTS/DIV	20 m

f. Move bnc cable and termination to CH 2 input and repeat parts c and d for CH 2.

g. Disconnect the bnc cable and termination from the 305 CH 2 input.

6. Frequency Response (Bandwidth)

a. Connect equipment to CH 2 input as shown in Fig. 4-2. Add or remove attenuators as needed to maintain a 4-division display of the reference signal throughout the remainder of this step.

b. Set:

CH 2 VOLTS/DIV	5 m
CH 1 AC-GND-DC	GND

c. Set leveled sine-wave generator to reference frequency and adjust generator amplitude for a 4-division display.

d. Without readjusting amplitude, set generator frequency to 5 MHz.

e. CHECK—display amplitude is 2.8 divisions or greater.

f. Repeat parts c through e, for as many CH 2 VOLTS/DIV switch position as generator amplitude will allow.

g. Set:

CH 1 VOLTS/DIV	5 m
CH 2 AC-GND-DC	GND
CH 1 AC-GND-DC	DC
Display Mode	CH 1
Trigger Source	CH 1

h. Move test setup to CH 1 input connector. Add or remove attenuators as needed to obtain a 4-division reference frequency display.

i. Repeat parts c through e, for as many CH 1 VOLTS/DIV switch positions as generator amplitude will allow.

j. Disconnect test equipment from 305.

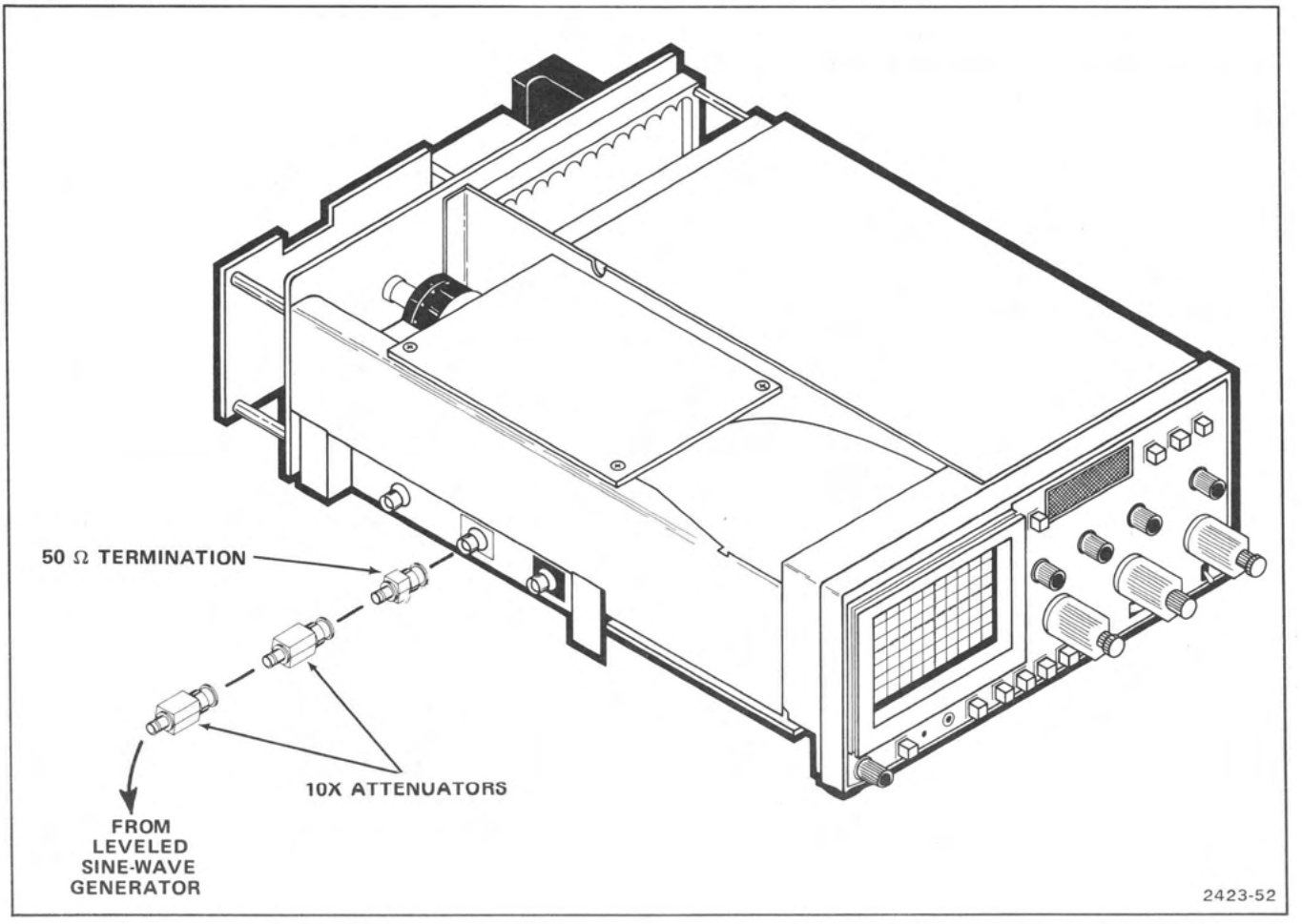


Fig. 4-2. Equipment setup for bandwidth check.

7. Rise Time

a. Set controls as follows:

CH 1 VOLTS/DIV	5 m
SEC/DIV	1 μ
Trigger SLOPE	− (pressed in)

b. Connect fast rise + output of square-wave generator to CH 1 input via 50 Ω coaxial bnc cable and 50 Ω termination. Use attenuators as necessary.

c. Set square-wave generator output controls to produce a 4-division display of a 100 kHz square wave.

d. Set the Horizontal POSITION control to align the positive-going transition of the square wave with the center vertical graticule line.

e. Pull X10 MAG knob to the out position. Display should be approximately as shown in Fig. 4-3.

f. CHECK—rise time should be 70 ns (3.5 minor divisions) or less. The rise time is the time between the 10% and 90% amplitude points on the positive-going transition, as Fig. 4-3 shows.

g. Press PULL: X10 MAG knob in, and disconnect generator cable and termination from the 305.

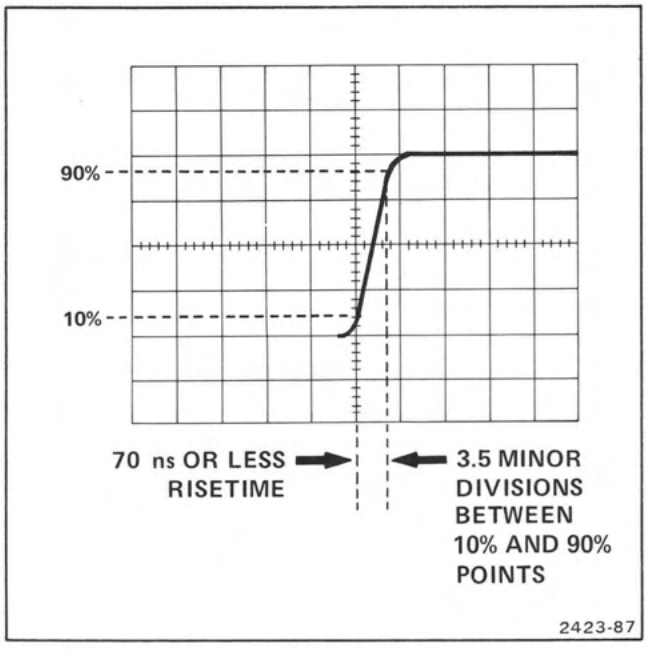


Fig. 4-3. Idealized display of rise time.

8. ALT Display

a. Set the following controls to:

AC-GND-DC (both)	GND
Display Mode	ALT
Vertical POSITION (both)	Midrange

b. Verify that two traces appear on the crt.

c. If necessary, separate the traces with the POSITION control(s).

d. Set the SEC/DIV control to 20 m.

e. CHECK—that the traces occur alternately.

9. CHOP Display

a. Move the Display Mode switch from ALT to CHOP.

b. CHECK—that the traces now occur simultaneously.

10. Channel 2 PULL: INVERT

a. Set:

CH 2 VOLTS/DIV	10 m
SEC/DIV	.2 m
Display Mode	CH 2
Trigger Source	CH 2
CH 2 AC-GND-DC	DC

b. Connect the amplitude calibrator via a 50 Ω bnc cable to CH 2 input.

c. Set the amplitude calibrator output for 20 mV.

d. PULL: INVERT switch to the INVERT position (knob out).

e. CHECK—that the display inverts when the PULL: INVERT switch is pulled to the INVERT position.

f. Press the PULL: INVERT switch back to the normal position (knob in).

11. ADD Deflection Factor

a. Set the following controls to:

CH 1 VOLTS/DIV	10 mV
Display Mode	ADD
AC-GND-DC (both)	DC

b. Connect the amplitude generator to CH 1 and CH 2 inputs via a 50 Ω bnc cable and dual-input coupler.

c. CHECK—for approximately 4 divisions of vertical deflection.

12. Common Mode Rejection Ratio

a. Connect the sine-wave generator to CH 1 and CH 2 inputs via a 50 Ω bnc cable, 50 Ω termination, and dual input coupler.

b. Set the 305 controls as follows:

CH 1 VOLTS/DIV	5 m
CH 2 VOLTS/DIV	5 m
CH 2 PULL: INVERT	Out
Display Mode	CH 1
SEC/DIV	1 μ

c. Adjust the sine-wave generator for an 8-division vertical display of 1 MHz signal.

e. Set Display Mode to ADD and verify less than 0.4 division of vertical deflection.

f. Press CH 2 PULL : INVERT switch in.

g. Disconnect bnc cable, termination, and dual-input coupler from the 305.

C. TRIGGERING

Equipment Required

1. Leveled Sine-wave Generator
2. Low-frequency Generator.
3. Cable, 50 Ω, bnc.
4. Termination, 50 Ω, Bnc.
5. Dual-input Coupler (2 required).
6. Attenuator, 10X, 50 Ω, Bnc.

305 Control Settings

NOTE

If you are performing a partial procedure, connect the 305 to appropriate power supply, turn it on, and allow it to warm up for 5 minutes before starting Performance Check.

Power and Display

Power Source Selector	AC
SCOPE POWER	ON (In)
INTENSITY	As desired

Vertical

VOLTS/DIV (both)	50 m
VOLTS/DIV CAL (both)	In detent
POSITION (both)	Midrange (as required)
AC-GND-DC (both)	DC
Display Mode	CH 1
CH 2 PULL: INVERT	Button in

Horizontal

SEC/DIV	2 m
SEC/DIV CAL	In detent
PULL: X10 MAG	In (X1)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	As required

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Auto Trigger Sensitivity

a. Connect test equipment to CH 1, CH 2, and EXT TRIG inputs as shown in Fig. 4-4.

b. Check that a stable display can be obtained at each of the frequencies and settings listed in Table 4-3. Use low-frequency sine-wave generator for 200 Hz through 500 Hz and leveled sine-wave generator for 5 MHz.

Table 4-3

AUTO TRIGGER SENSITIVITY

Generator Frequency	Amplitude (VOLTS/DIV at 50 mV)	SEC/DIV	Trigger Source
200 Hz	2 div	2 m	CH 1, CH 2
200 Hz	2 div	2 m	EXT
500 Hz	0.5 div	2 m	CH 1, CH 2
500 Hz	0.4 div	2 m	EXT
5 MHz	1 div	1 μ	CH 1, CH 2
5 MHz	70 mV[a]	1 μ	EXT

[a] **Set leveled sine-wave generator for 1.4 div of reference signal. Change frequency to 5 MHz without changing amplitude of generator.**

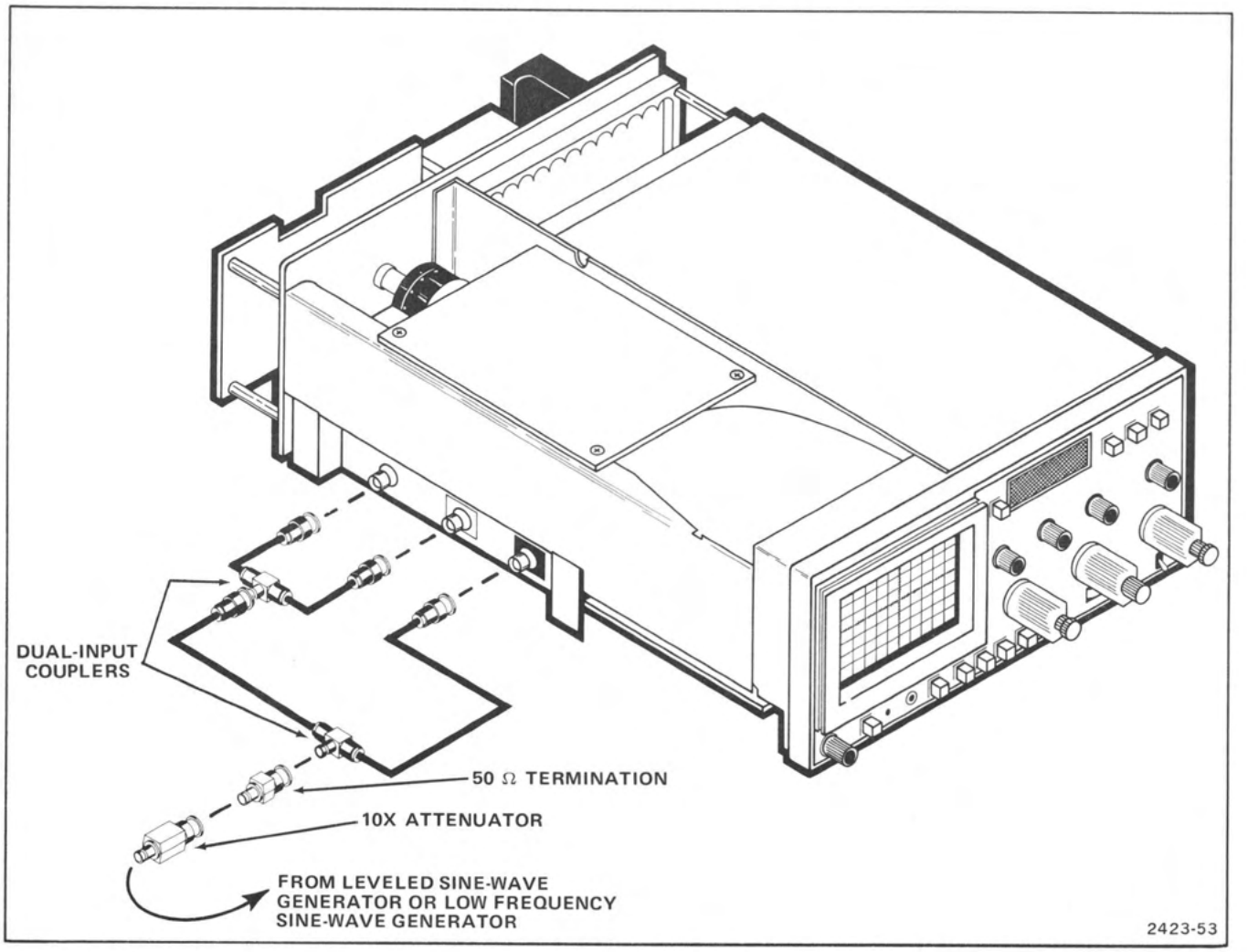


Fig. 4-4. Equipment setup for trigger sensitivity.

2. Normal Trigger Sensitivity

a. Set the AUTO-NORM (Trigger Mode) switch to NORM.

b. Check that a stable display can be obtained for each of the conditions listed in Table 4-4. Adjust TRIGGER LEVEL control as necessary. Use low frequency sine-wave generator for 60 Hz, leveled sine-wave generator for 50 kHz through 5 MHz.

c. Disconnect the test setup of Fig. 4-4 from the 305.

Table 4-4

NORMAL TRIGGER SENSITIVITY

Source	Coupling	Slope	Generator Frequency	Display Amplitude
CH 1	AC,DC	+,–	60 Hz	0.3 div
			50 kHz[a]	0.3 div
			5 MHz	0.75 div
CH 2	AC,DC	+,–	60 Hz	0.3 div
			50 kHz	0.3 div
			5 MHz	0.75 div
EXT	AC,DC	+,–	60 Hz	0.3 div
			50 kHz	0.3 div
			5 MHz	1.0 div[b]

[a] Leveled sine-wave generator reference frequency.

[b] Set amplitude with leveled sine-wave generator at 50 kHz reference frequency. Then change frequency to 5 MHz without changing generator amplitude.

3. Internal Trigger Level Range

a. Set the controls as follows:

Display Mode	CH 2
CH 2 VOLTS/DIV	5 m
SEC/DIV	2 m
Trigger Source	CH 2
AUTO-NORM	AUTO

b. Connect the low-frequency sine-wave generator via a bnc cable and 50 Ω termination to the CH 2 input.

c. Adjust generator to provide a 6-division display at 500 Hz.

d. Center the display vertically.

e. Use Horizontal POSITION control to position start of sweep at center vertical graticule line.

f. Rotate the TRIGGER LEVEL control fully clockwise and fully counterclockwise.

g. CHECK—that the display triggers at all points on the waveform at least 2 divisions from the center horizontal graticule line (up and down) as the TRIGGER LEVEL control is adjusted.

4. External Trigger Level Range

a. Set the controls as follows:

CH 2 VOLTS/DIV	.2
Trigger Source	EXT (both buttons released)
SLOPE	+

b. Adjust the generator output to provide a 5-division display.

c. Center the display vertically.

d. Rotate TRIGGER LEVEL control fully clockwise and fully counterclockwise.

e. CHECK—that the display triggers at all points on the waveform from 2 divisions above to 2 divisions below the center horizontal graticule line as the TRIGGER LEVEL control is adjusted.

f. Change the SLOPE to − and repeat part e.

g. Disconnect test setup from the 305.

D. HORIZONTAL

Equipment Required

1. Time-mark Generator.
2. Amplitude Calibrator.
3. Cable, 50 Ω, Bnc.
4. Termination, 50 Ω, Bnc.
5. Low-frequency Sine-wave Generator.

305 Control Settings

NOTE

If you are performing a partial procedure, connect the 305 to its appropriate power supply, turn it on, and allow it to warm up for 5 minutes before starting Performance Check.

Power and Display

Power Source Selector	AC
SCOPE POWER	ON (In)
INTENSITY	As desired

Vertical

VOLTS/DIV (both)	As needed
VOLTS/DIV CAL (both)	In detent
POSITION (both)	Midrange (as required)
CH 1 AC-GND-DC	DC
CH 2 AC-GND-DC	GND
Display Mode	CH 1

Horizontal

SEC/DIV	1 μ
SEC/DIV CAL	In detent
PULL: X10 MAG	In (X1)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	As required

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. SEC/DIV Accuracy

a. Connect test equipment to CH 1 input as shown in Fig. 4-5.

b. Set time-mark generator for 1 μs markers.

c. Set CH 1 VOLTS/DIV so display amplitude is about 3 divisions. Change CH 1 VOLT/DIV switch setting as necessary to maintain about 3 divisions of deflection for the remainder of this step.

d. CHECK—SEC/DIV accuracy within 3% (1.2 minor divisions) over center 8 major divisions displayed (see Fig. 4-6) using equipment settings given in Table 4-5.

Table 4-5

SEC/DIV ACCURACY

SEC/DIV	Time-mark Generator
1 μ	1 μs
2 μ	2 μs[b]
5 μ	5 μs
10 μ	10 μs
20 μ	20 μs[b]
50 μ	50 μs

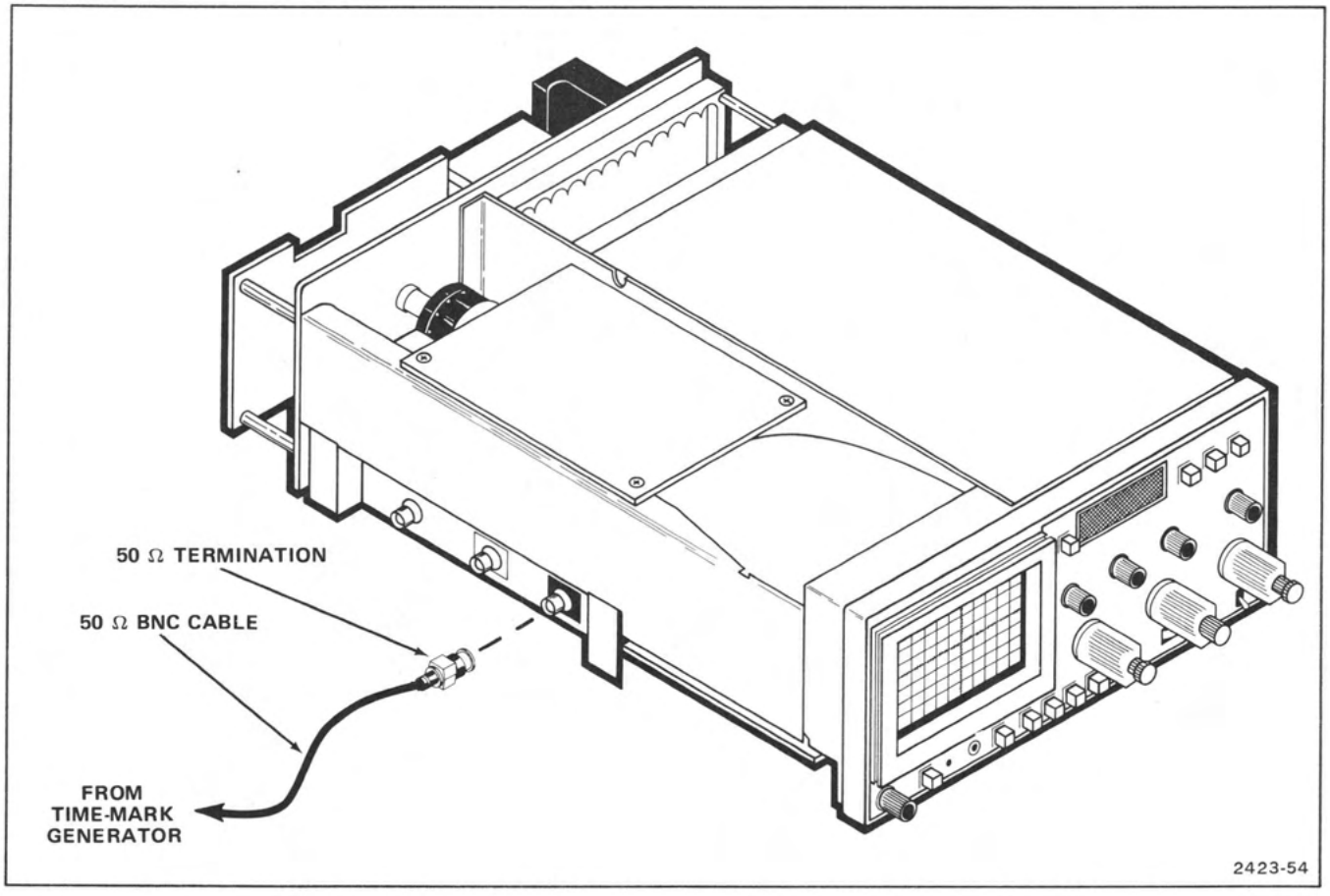


Fig. 4-5. Equipment setup for SEC/DIV accuracy.

Table 4-5 (cont)

SEC/DIV	Time-mark Generator
.1 m	0.1 ms
.2 m	0.2 ms[b]
.5 m	0.5 ms
1 m	1 ms
2 m	2 ms[b]
5 m	5 ms
10 m	10 ms
20 m	20 ms[b]
50 m[a]	50 ms[a]
.1[a]	0.1 s
.2[a]	0.2 s[b]
.5[a]	0.5 s

[a] Change Trigger Mode to NORM. Reduce intensity as needed.

[b] If the time-mark generator you are using does not have decade multiples of 2, use decade multiples of 1 and check for 2 time markers per division.

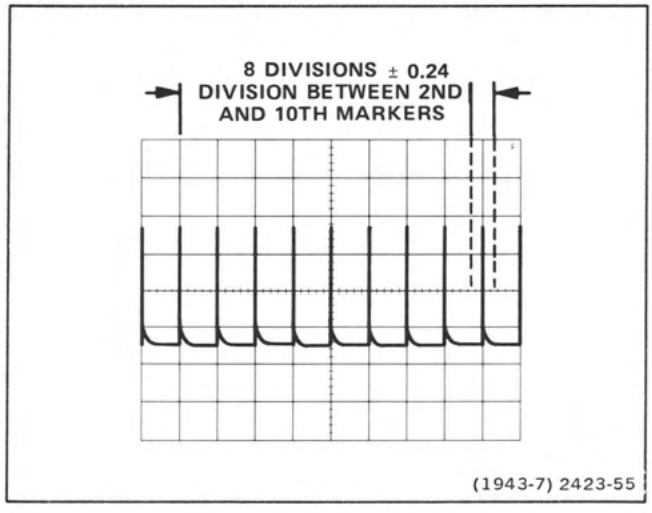


Fig. 4-6. SEC/DIV accuracy.

2. SEC/DIV CAL

a. Set SEC/DIV to 1 m.

b. Set generator to 5 ms time markers.

c. Rotate SEC/DIV CAL control fully counterclockwise.

d. CHECK—distance between time markers is 2 divisions or less.

e. Return SEC/DIV CAL control to detent position.

3. Horizontal POSITION Range

a. Set Trigger Mode to AUTO (in).

b. Turn horizontal POSITION control fully clockwise.

c. CHECK—start of sweep should be right of the center vertical graticule line.

d. Turn horizontal POSITION control fully counterclockwise.

e. CHECK—end of sweep should be left of the center vertical graticule line.

4. Magnified SEC/DIV Accuracy

a. Set:

PULL: X10 MAG Out (X10)

b. CHECK—magnified SEC/DIV within 5% (2 minor divisions) over center 8 divisions displayed (see Fig. 4-7) using equipment settings given in Table 4-6 (accuracy applies over entire magnified sweep length except as noted in Table 4-6).

c. Disconnect time-mark generator from 305.

Table 4-6

MAGNIFIED SEC/DIV ACCURACY

SEC/DIV	Time-mark Generator	Portions of Total Sweep Length Excluded From Measurement
1 μ	.1 μs	First 10 divisions and all divisions past 90 divisions
2 μ	.2 μs[b]	
5 μ	.5 μs	
10 μ	1 μs	
20 μ	2 μs[b]	
50 μ	5 μs	
.1 m	10 μs	
.2 m	20 μs[b]	
.5 m	50 μs	
1 m	.1 ms	
2 m	.2 ms[b]	
5 m	.5 ms	
10 m	1 ms	
20 m	2 ms[b]	
50 m[a]	5 ms	
.1 [a]	10 ms	
.2 [a]	20 ms[b]	
.5 [a]	50 ms	

[a] **Set Trigger Mode to NORM.**

[b] **If the time-mark generator you are using does not have time-markers which are decade multiples of 2, use multiples of 1 and check for 2 time markers per division.**

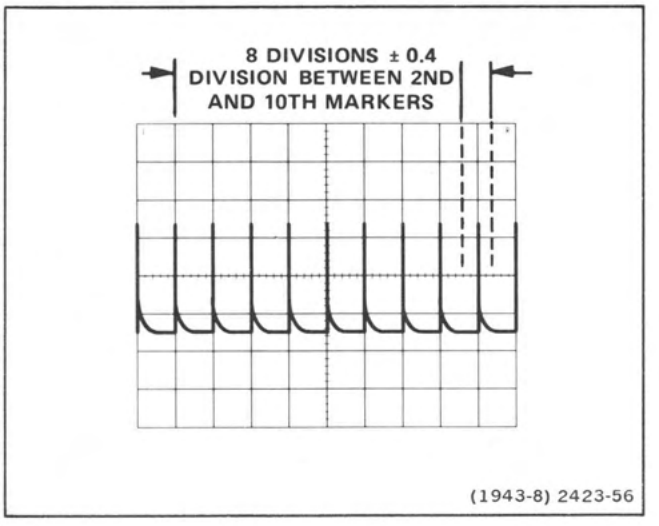


Fig. 4-7. Magnified SEC/DIV accuracy.

5. External Horizontal Sensitivity

a. Connect equipment to CH 1 input as shown in Fig. 4-8.

CAUTION

Reduce display intensity in X-Y mode. A bright stationary dot may damage crt phosphor.

b. Set:

SEC/DIV	X-Y
CH 1 VOLTS/DIV	.2
Display Mode	X-Y (CH 2)

c. Set amplitude calibrator output to 1 V.

d. Adjust CH 1 POSITION control to locate display within graticule area.

e. CHECK—display is a pair of dots, separated horizontally by 5 divisions ±4% (4.8 to 5.2 divisions).

f. Disconnect amplitude calibrator from CH 1 input.

6. X-Axis Bandwidth

a. Change control settings as follows:

CH 1 VOLTS/DIV	5 m

b. Connect low-frequency sine-wave generator to CH 1 input via a 50 Ω bnc cable and 50 Ω termination.

c. Set generator frequency to 1 kHz.

d. Adjust generator output amplitude to produce horizontal deflection of 8 divisions.

e. Change the generator frequency to 150 kHz.

f. CHECK—that the horizontal deflection is 5.6 divisions or more.

g. Disconnect test equipment from 305.

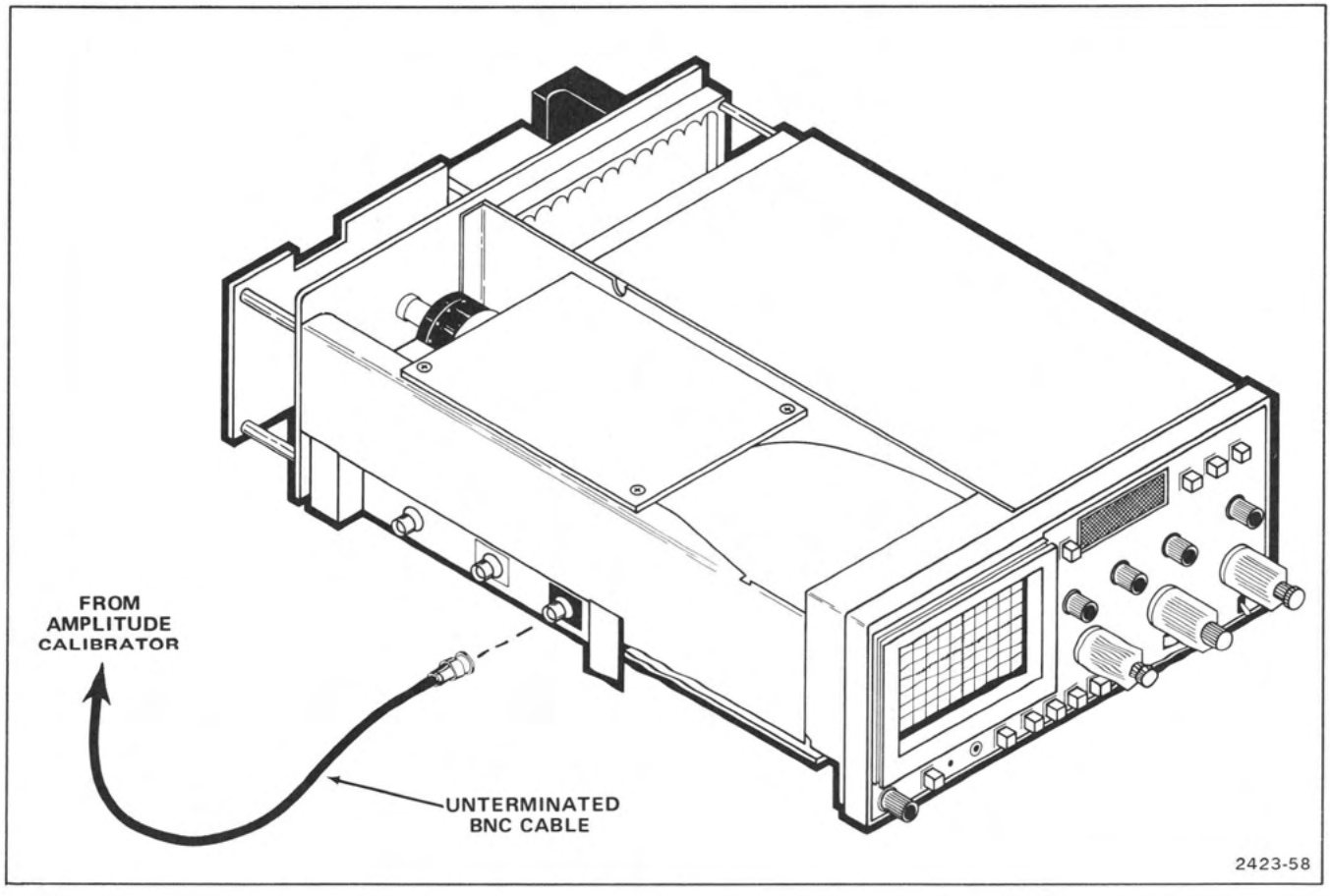


Fig. 4-8. Equipment setup for external horizontal sensitivity.

E. CALIBRATOR

Equipment Required

1. 10X Probe (supplied with 305).

305 Control Settings

NOTE

If you are performing a partial procedure, connect the 305 to its appropriate power supply, turn it on, and allow it to warm up for 5 minutes before starting Performance Check.

Power and Display

Power Source Selector	AC
SCOPE POWER	ON (In)
INTENSITY	As desired

Vertical (both channels if applicable)

VOLTS/DIV (CH 1)	10 m
VOLTS/DIV CAL (CH 1)	In detent
POSITION (CH 1)	Midrange (as required)
AC-GND-DC (CH 1)	DC
Display Mode	CH 1

Horizontal

SEC/DIV	1 m
SEC/DIV CAL	In detent
PULL: X10 MAG	In (X1)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	Fully clockwise

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Calibrator Amplitude

a. Connect a 10X probe to the CH 1 input.

b. Touch the probe tip to the .3 V CAL OUT pin connector contact.

c. Check display for 3 divisions of vertical deflection.

DMM

Equipment Required

1. DC Voltage Calibrator.
2. AC Voltage Calibrator.
3. Resistance Standard.
4. DC Power Supply.
5. Digital Voltmeter (DVM).
6. DMM Probes.

305 DMM Control Settings

NOTE

If you are performing a partial procedure, connect the 305 to its appropriate power supply, turn DMM on, and allow it to warm up for 5 minutes.

305 Settings

DMM POWER	ON
SCOPE POWER	OFF
FUNCTION	DCV
Power Source Selector	AC/EXT DC

1. Power Supply Range & Low-Battery Indicator

a. Disconnect the 305 from ac power source.

b. Connect the DC Power Supply to the EXT DC VOLTAGE connectors.

c. Connect the DVM HI and LO leads across the DC Power Supply terminals.

d. Vary the output of the power supply between +7.0 V and +34 V, and check that the 305 DMM display remains lighted continuously.

e. Vary the output of the power supply between +5.8 V and +7.0 V, and check that the DMM display alternates between the normal display and "- . - - - ."

f. Turn off the DC Power Supply and disconnect it from the EXT DC VOLTAGE connectors.

2. DC Voltage Accuracy

a. Connect 305 power cord to ac power source, and push DMM POWER button in.

b. Plug the DMM probes into the connectors marked DMM INPUT (LO and HI).

c. Set FUNCTION to DC.

d. Connect the DMM probes to the output of the DC Voltage Calibrator.

e. Turn on the calibrator, and set it as listed in Table 4-7.

f. CHECK—DMM readout against the tolerances given for each calibrator setting.

Table 4-7

DC VOLTAGE ACCURACY

Calibrator Voltage (V)	DMM Reading	Allowable Error
±1.900 V	±1.900	±4 counts
±19.00 V	±19.00	±4 counts
±190.0 V	±190.0	±4 counts
±1000 V	±1000	±3 counts

3. Autoranging

a. Set the DC Voltage Calibrator to 27.500 V.

b. CHECK—for readout of 27.5 ±2 counts.

c. Set the DC Voltage Calibrator to 17.500 V.

d. CHECK—for readout of 17.50 ±4 counts.

e. Turn off and disconnect DC Voltage Calibrator.

4. AC Voltage Accuracy

a. Set FUNCTION to AC.

b. Connect the DMM probes to the output of the AC Voltage Calibrator.

c. Turn on the calibrator, and set it as listed in Table 4-8.

d. CHECK—DMM readout against the tolerances given for each calibrator setting.

e. Turn AC calibrator off and disconnect probe from it.

Table 4-8

AC VOLTAGE ACCURACY

Calibrator		DMM Reading	Allowable Error (Counts)
Voltage (V)	Frequency (Hz)		
1.9000	50	1.900	±20
1.9000	500	1.900	±20
19.000	50	19.00	±20
19.000	500	19.00	±20
190.00	50	190.0	±20
190.00	500	190.0	±20
700.0	50	700.0	±14
700.0	500	700.0	±14

5. Resistance Accuracy

a. Set FUNCTION to kΩ.

b. Connect the DMM probes to the Resistance Standard.

c. Set the Resistance Standard to the values listed in Table 4-9.

d. CHECK—DMM readout against the tolerances given for each resistance value.

Table 4-9

RESISTANCE ACCURACY

Resistance Standard (Ω)	DMM Reading	Allowable Error (Counts)
0.0	.000	±3
10.0	.010	±3
1.9000 K	1.900	±14
19.000 K	19.00	±14
190.00 K	190.0	±14
1900.0 K	1900	±14

e. Disconnect DMM probes from the resistance standard.

MAINTENANCE

This section contains information for performing preventive maintenance, troubleshooting and corrective maintenance.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, lubrication, and recalibration. Preventive maintenance, performed on a regular basis, may prevent instrument malfunction and will ensure the reliability of the instrument. The severity of the environment in which the instrument is used determines the frequency of maintenance. Preceding readjustment is an appropriate time to perform preventive maintenance.

CLEANING

The 305 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. Dirt also provides an electrical conduction path that may result in instrument failure. The cabinet reduces the amount of dust reaching the interior. Operating the instrument without the cabinet in place necessitates more frequent cleaning.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. In particular, avoid chemicals which contain benzene, toluene, xylene, acetone, or similar solvents. Recommended cleaning agents are isopropyl alcohol (Isopropanol) or ethyl alcohol (Fotocol or Ethanol).

Exterior

Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or small brush. The brush is particularly useful for dislodging dirt on and around the controls. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

CAUTION

To prevent getting water inside the instrument during external cleaning, use only enough water to dampen the cloth or swab.

Interior

To clean the interior, blow off built up dust with dry, low-pressure air. Remove any remaining dust with a soft brush or cloth dampened with a solution of mild detergent and water. Use a cotton swab for cleaning in narrow spaces. If these methods do not remove all the dust or dirt, the instrument may need to be disassembled and washed. Components may be spray washed using a 5% solution of water and mild detergent as follows:

1. Cabinet Removal. Refer to Component Removal and Replacement for instructions on cabinet removal.
2. Remove easily accessible shields and covers.
3. Spray wash and thoroughly rinse the component.
4. Blow dry the component with low velocity air.
5. Spray all switch contacts with isopropyl alcohol, wait for 60 seconds, and blow dry with low velocity air.
6. Heat dry all components in an oven or compartment using low temperature (125° to 150°) circulating air.

Cathode-Ray Tube (CRT)

Clean the plastic light filter and the crt face with a soft, lint-free cloth dampened with denatured alcohol.

INSPECTION

External Inspection

Table 5-1 is a list of external items to be inspected for damage or wear. Items that would cause serious or further damage to the instrument should be repaired immediately.

Internal Inspection

Inspect the instrument for internal damage or wear using Table 5-2

CAUTION

Instruments that appear to have been dropped, or otherwise abused, should be checked by qualified instrument repair technicians to verify correct operation and adjustment.

Table 5-1

EXTERNAL INSPECTION CHECKLIST

Item	Inspect for	Repair action
Cabinet, front-panel cover, front panel, and rear panel	Cracks, scratches, deformations, and damaged hardware or gaskets.	Touch-up paint scratches. Replace cracked, deformed or damaged parts.
Carrying handle	Correct operation.	Replace damaged parts.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, damaged connectors.	Repair frayed cables. Replace damaged or missing items. Repair damaged parts.
Front panel controls	Missing, damaged, or loose knobs or push buttons. Binding controls.	Tighten loose knobs. Repair or replace missing or damaged controls. Determine cause of binding controls and repair.
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connector.	Replace damaged parts. Clean or wash out dirt.

Table 5-2

INTERNAL INSPECTION CHECKLIST

Item	Inspect for	Repair action
Circuit boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit run plating.	Clean solder corrosion with an eraser and flush with isopropyl alcohol. Resolder connections. Determine cause of burned items and repair. Repair damaged circuit runs.
Chassis	Dents, deformation, and damaged hardware.	Straighten, repair, or replace damaged hardware.
Resistors	Burned, cracked, broken, or blistered.	Replace damaged resistors.
Solder Connections	Cold solder or rosin joints.	Resolder and clean joint with isopropyl alcohol.
Wiring and Cables	Loose plugs or connectors. Burned, broken, or frayed.	Firmly seat connectors. Repair or replace damaged wire or cables.
Capacitors	Damaged or leaking cases. Corroded solder on terminals or leads.	Replace capacitors that have damaged or leaking cases. Clean solder connections and flush with isopropyl alcohol.

Table 5-2 (cont)

INTERNAL INSPECTION CHECKLIST

Item	Inspect for	Repair action
Semiconductors	Loosely inserted in sockets. Bent pins.	Remove items with bent pins, carefully straighten the pins with long-nose pliers, and re-insert firmly (be sure that the straightening action hasn't cracked the pin such that it will break easily). Firmly seat all loose semiconductors.
Push-button controls	Binding controls. Missing push buttons.	Determine cause of binding control and repair. Replace push buttons.

LUBRICATION

Push-Button Switches

These switches are lubricated prior to leaving the factory and should not require further lubrication. However, if they become electrically noisy, cleaning and lubricating with Electronic Chemical Corporation No Noise® may resolve the problem.

Cam Switches

In most cases the factory lubrication of these switches should be adequate for the life of the instrument. If the switch has been disassembled for replacement of switch sub-parts, General Electric Versilube® silicone grease may be used if applied sparingly so that the lubricant does not get on the contacts. Refer to Fig. 5-1 for the following lubrication instructions (instruction numbers are also lubrication point locators on the figure):

WARNING

Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.

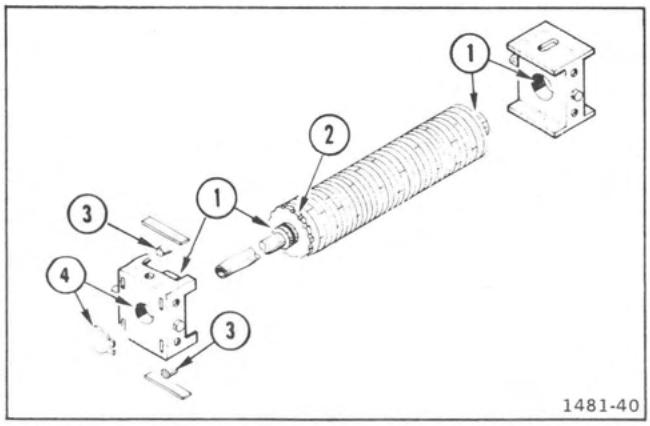


Fig. 5-1. Typical cam switch.

1. Apply lubricant to the drum journals and mating surface in the mounting bearings.

2. Apply lubricant to the wear surface of the index wheel.

3. Apply lubricant to the index roller and roller guide in the front bearing. A thin film should be applied to the inner face of the detent springs if more than one spring is replaced.

4. Ensure that some lubricant is present at the interface between the bearing and retainer clip.

SERVICING THE BATTERY

The cells which make up the battery have been selected to meet specific performance requirements and can be expected to maintain relatively equal capabilities throughout the battery operating life. Upsetting this balance of equality by introducing a strong cell into a weak battery, or a weak cell into a strong battery, will cause reverse charging of the weakest cells, as explained in the Operating Instructions.

Gas evolution and recombination takes place during battery charging. This creates a pressure within the cells which they normally can withstand. If a cell becomes defective, or a circuit failure causes the recommended charge rate to be exceeded, excessive pressure builds up. The pressure may rupture a relief vent, exhausting the gas. Rupturing may shorten the life of the battery, and the surrounding areas will be coated with a corrosive substance.

The battery should be inspected every six months or every 500 operating hours, whichever occurs first. The

entire battery should be replaced if venting or excessive corrosion has occurred. The cover plate on the power connector side must be removed to expose one side of the battery. Sight between the cells to check for obvious corrosion or venting on the circuit board side. If a more thorough check of the circuit board side is desired, remove the battery in accordance with the Battery Pack removal instructions in the Maintenance section.

TROUBLESHOOTING

The following information is provided to help you troubleshoot the instrument. Information contained in other sections of the manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is helpful in locating troubles, particularly where integrated circuits are used.

TROUBLESHOOTING AIDS

Diagrams

Complete circuit diagrams are on the foldout pages in the Diagrams section located at the rear of this manual. The circuit number and electrical value of each part is shown on the diagrams (see the first page of the Diagrams section for the definition of the reference designators used to identify parts). Important voltages and waveforms are indicated on the diagrams.

Circuit Board Locator

Figure 5-2 shows the location of the circuit boards within the instrument.

Circuit Board Illustrations

Each circuit diagram has an associated circuit board illustration located back of a pullout opposite the circuit diagram. Each circuit component shown on the circuit diagrams is identified on the circuit board illustration by its circuit number. Circuit number locations on the board are identified with a grid index system.

Troubleshooting Chart

Troubleshooting charts are provided in Figs. 5-3 and 5-4 to aid in locating problem areas.

Semiconductor Lead Configurations

Typical semiconductor lead configurations are shown in Fig. 5-5.

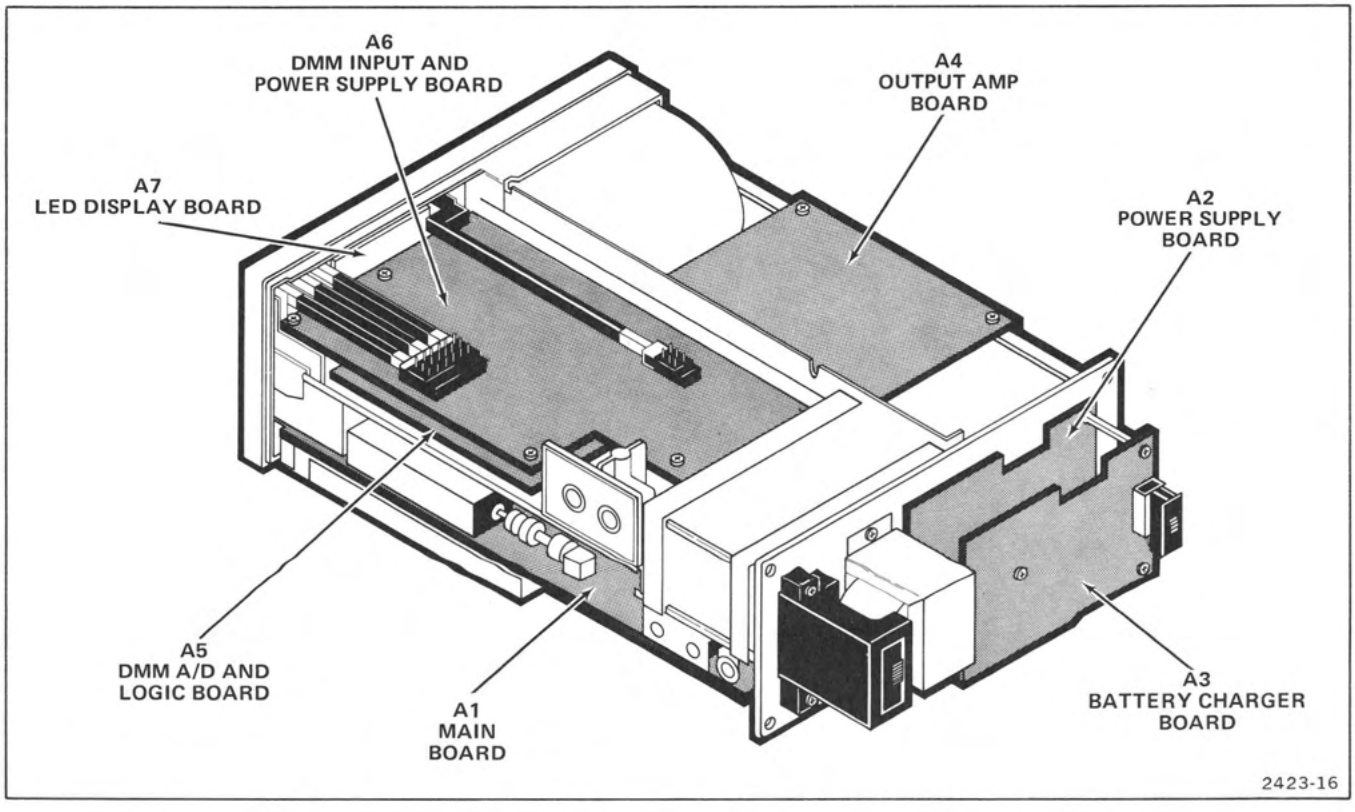


Fig. 5-2. Circuit board locations.

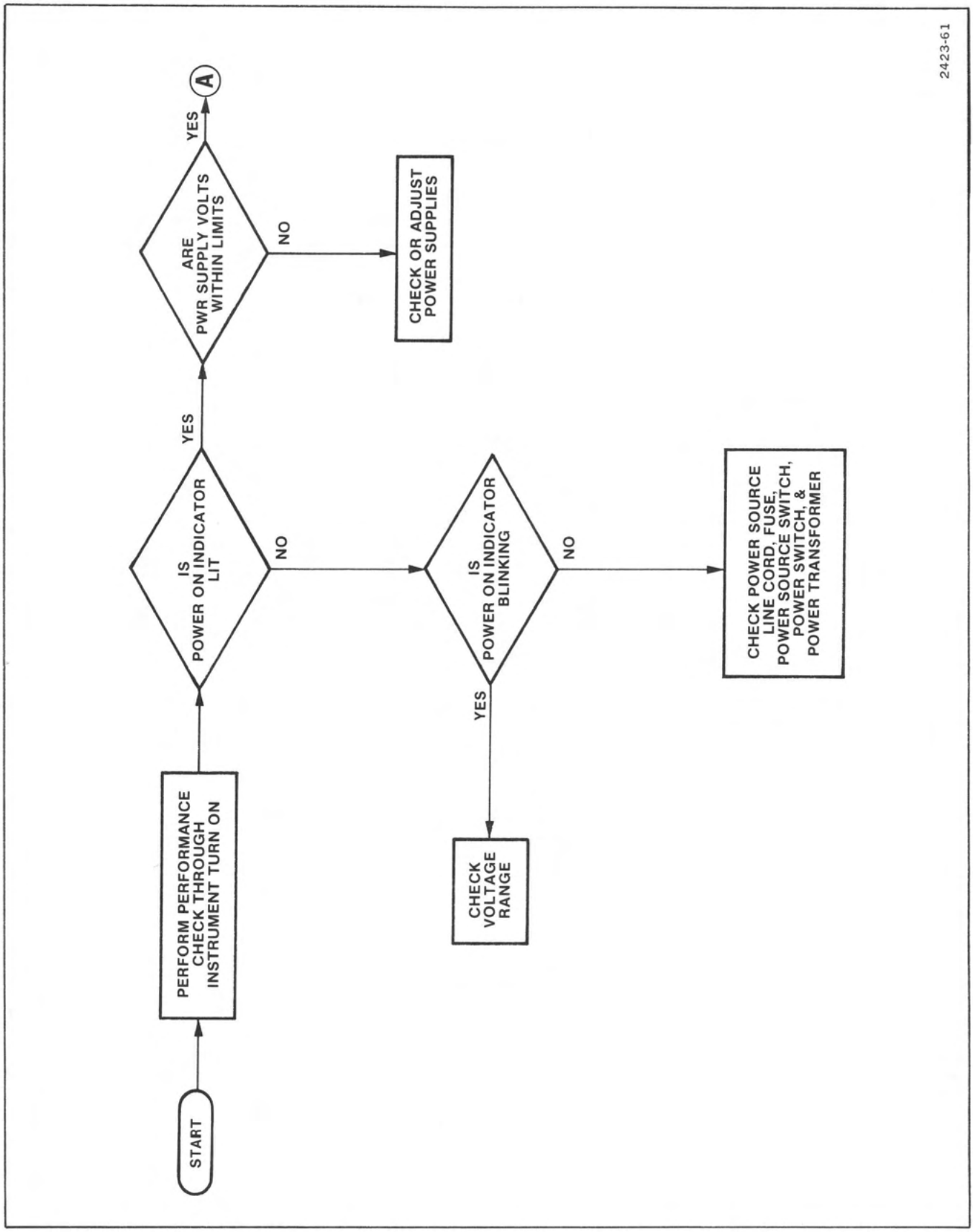


Fig. 5-3. Troubleshooting Chart—Oscilloscope (sheet 1 of 4).

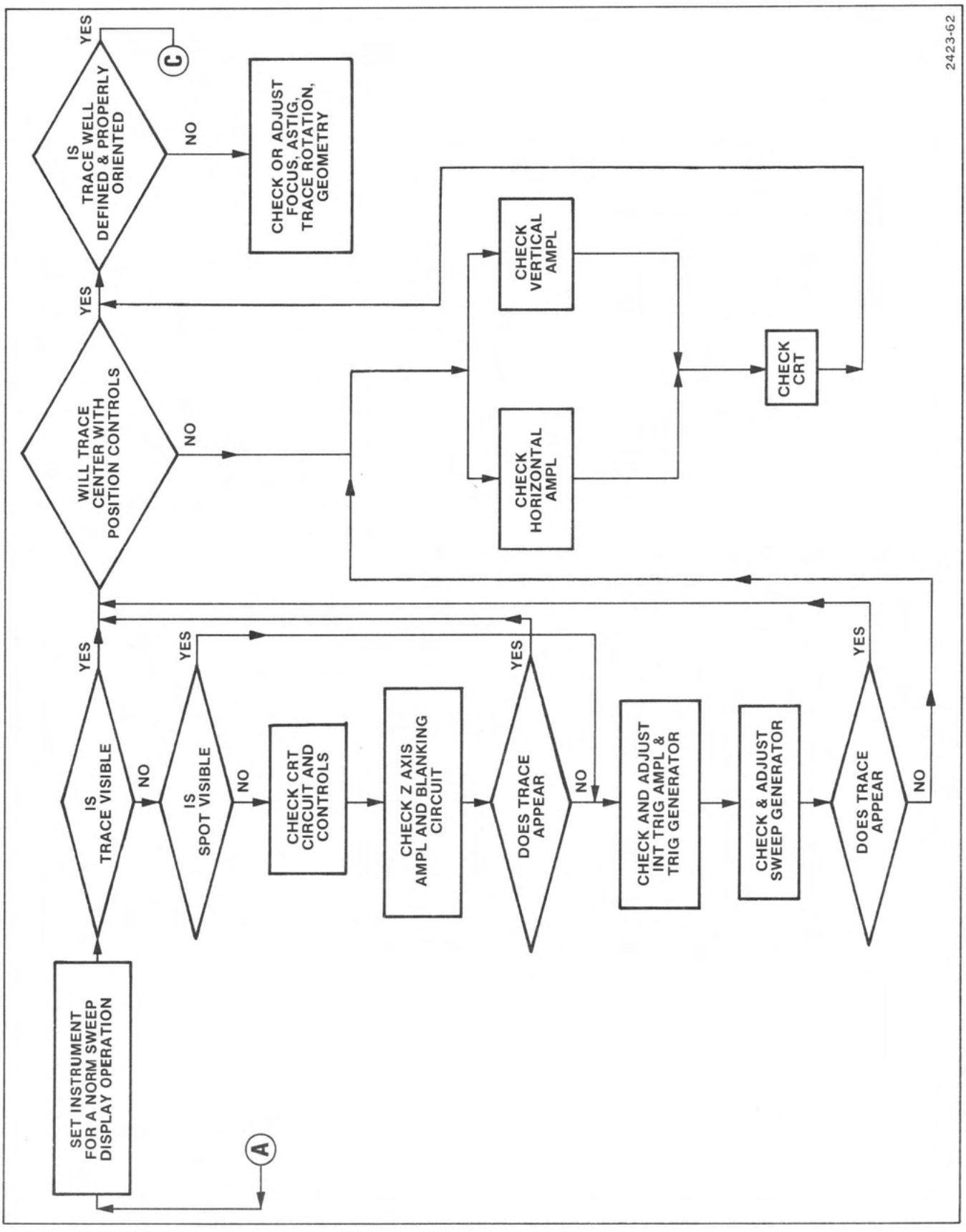


Fig. 5-3. Troubleshooting Chart—Oscilloscope (sheet 2 of 4).

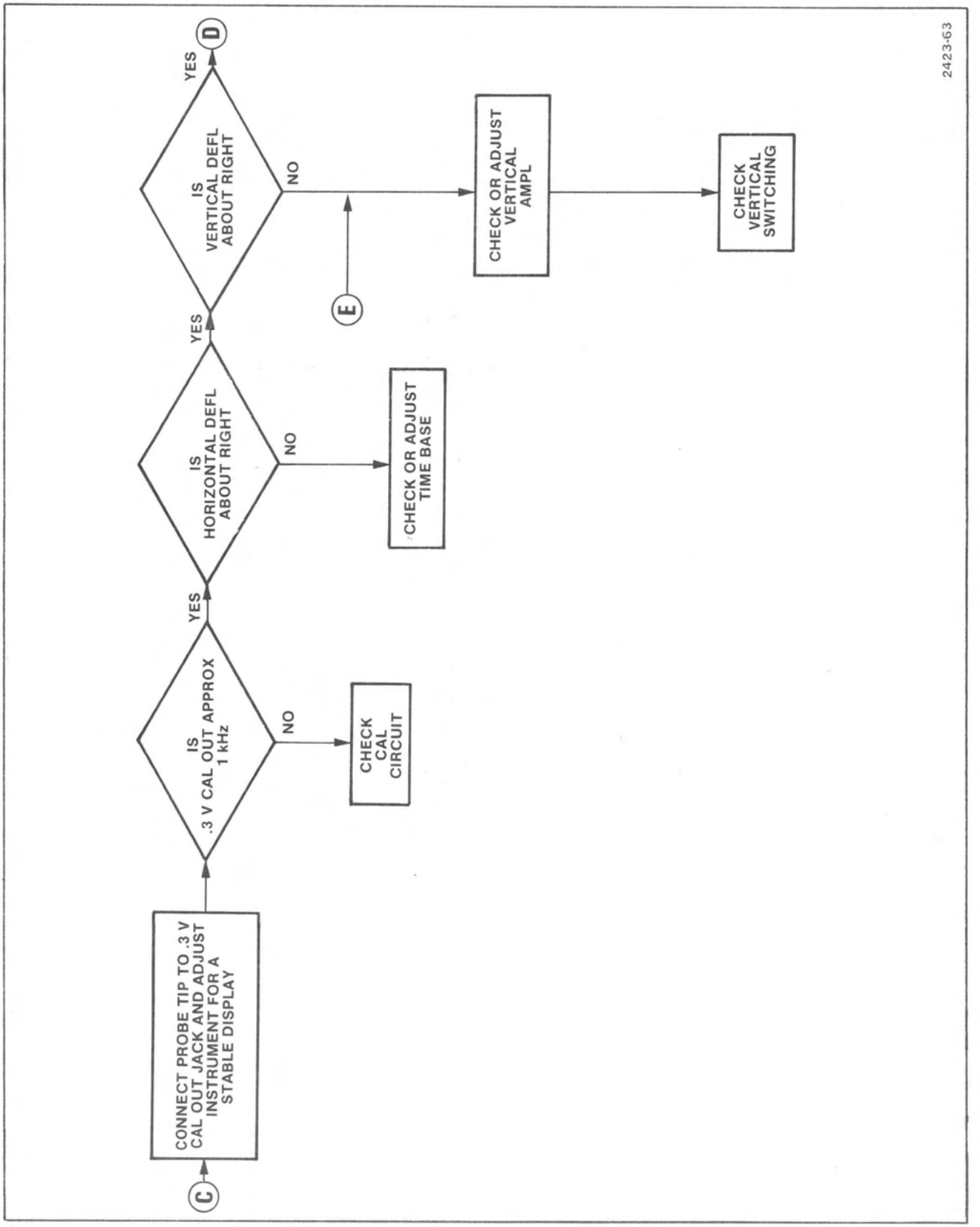


Fig. 5-3. Troubleshooting Chart—Oscilloscope (sheet 3 of 4).

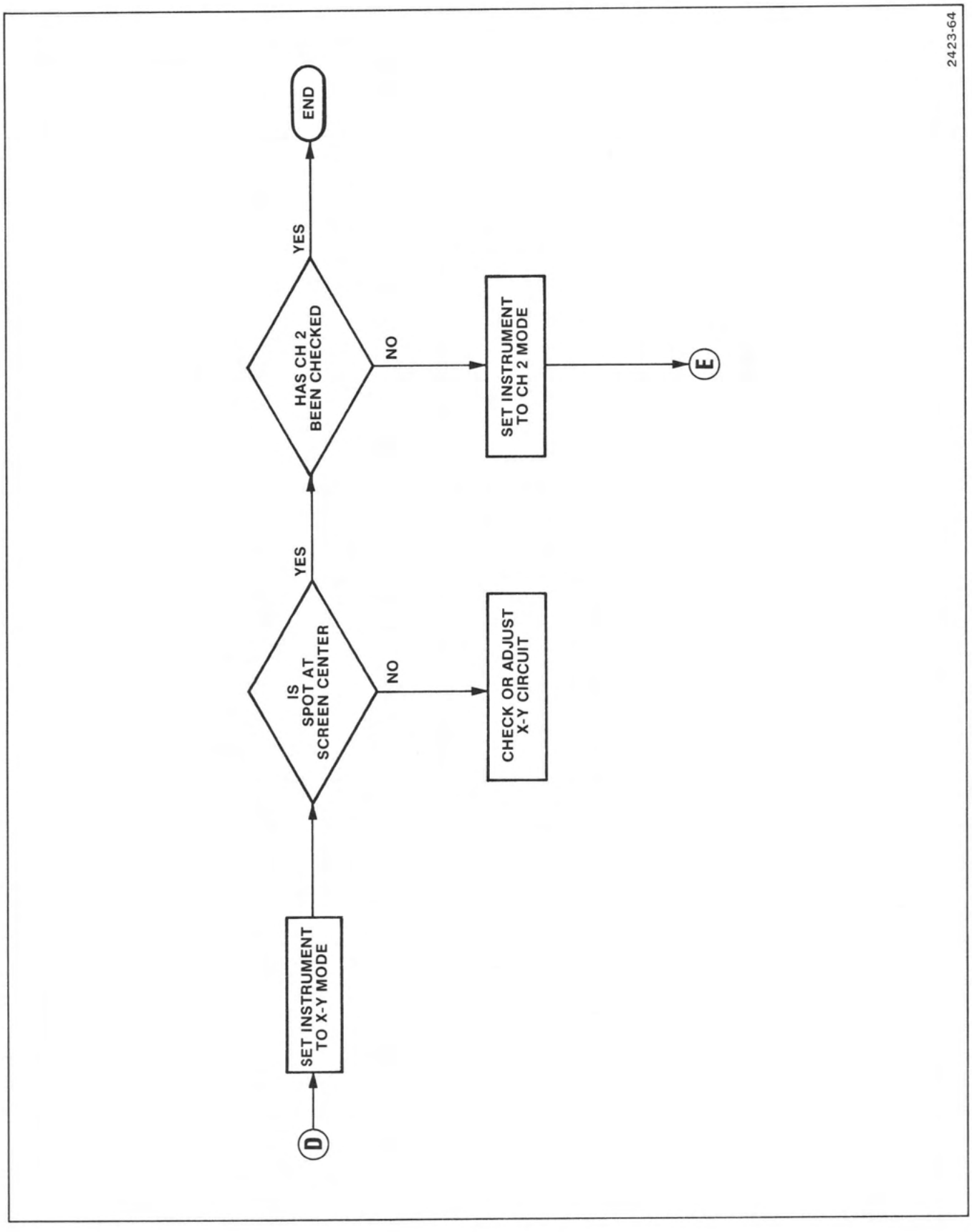


Fig. 5-3. Troubleshooting Chart—Oscilloscope (sheet 4 of 4).

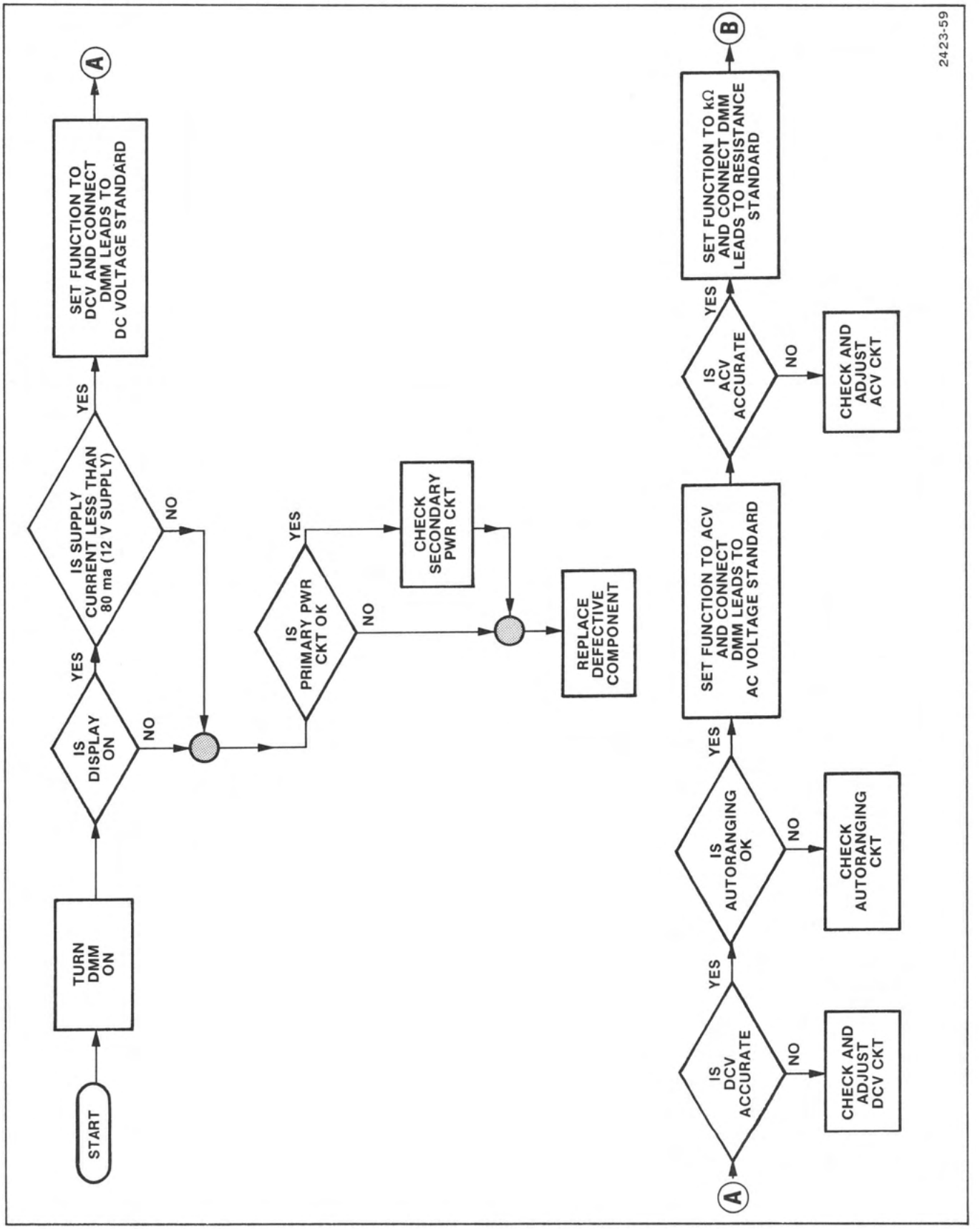


Fig. 5-4. Troubleshooting Chart—DMM (sheet 1 of 2).

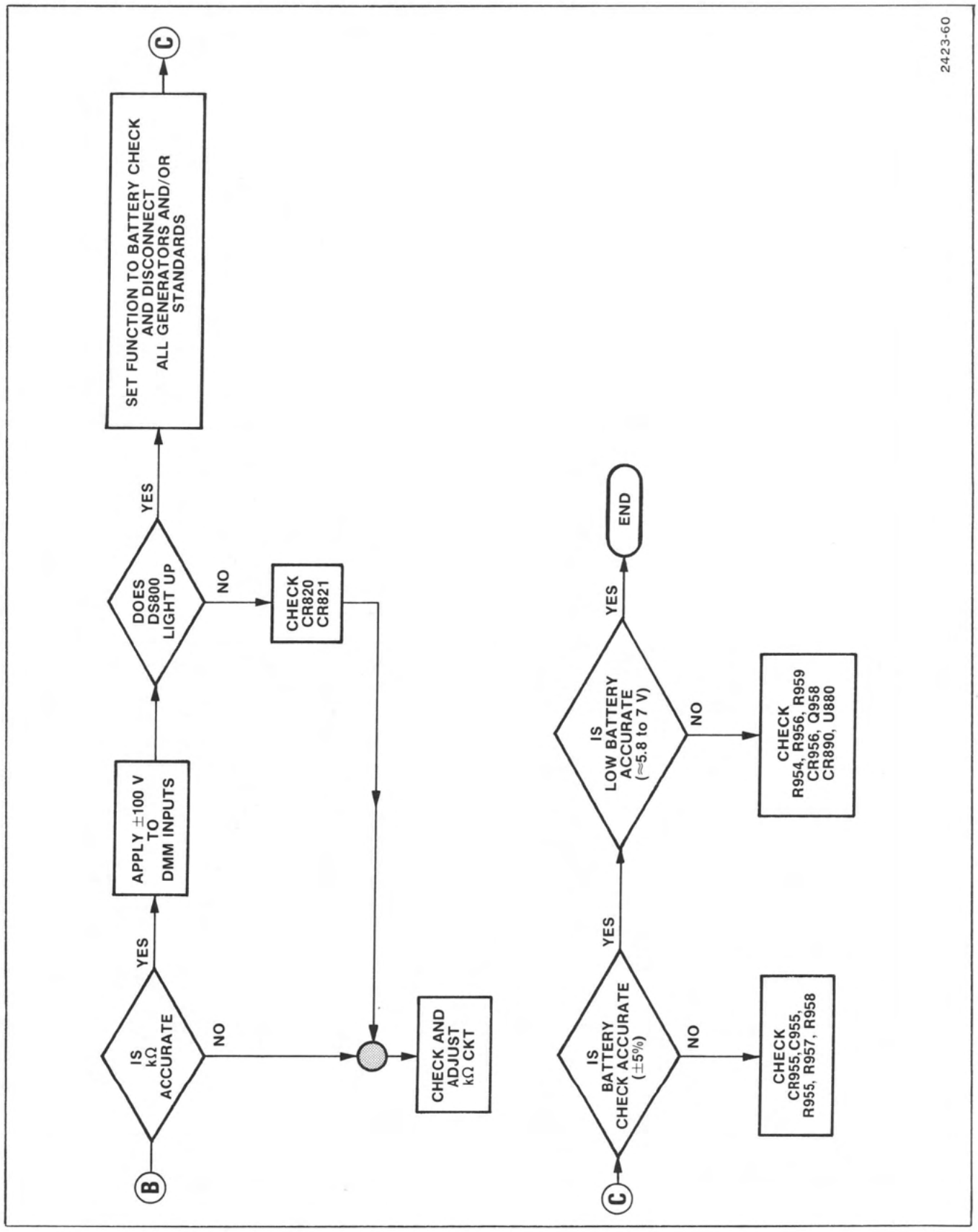


Fig. 5-4. Troubleshooting Chart—DMM (sheet 2 of 2).

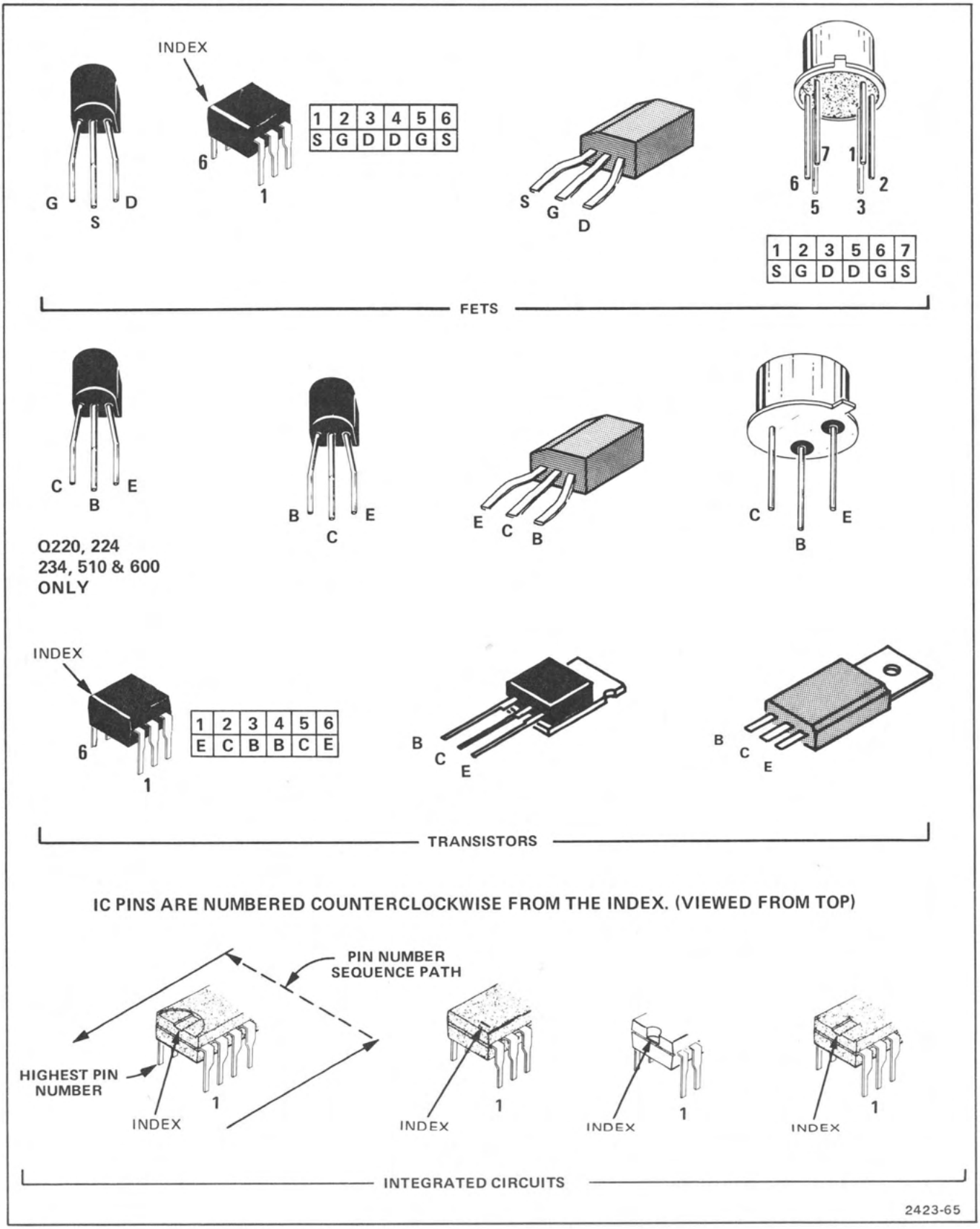


Fig. 5-5. Semiconductor lead configuration.

TROUBLESHOOTING EQUIPMENT

The majority of troubleshooting for the instrument can be accomplished with a digital multimeter and a general purpose oscilloscope. If transistor and linear integrated circuits are tested rather than substituted, a curve tracer is required. Test equipment requirements are as follows:

1. Digital multimeter.

   a. Dcv range; −2 kV to +500 V.
   b. Acv range; at least 250 V.
   c. Resistance range; at least 10 MΩ

2. Oscilloscope, general purpose; frequency response, dc to at least 5 MHz.

NOTE

With few exceptions (−2 kV and 10 MΩ) another 305 DMM Oscilloscope should perform all troubleshooting requirements of the above equipment.

3. Dynamic semiconductor tester; the TEKTRONIX 576, 577 D1, or 577 D2 Curve Tracers with the 177 and 178 Test Fixtures. Also the TEKTRONIX 5000- or 7000-Series Oscilloscope mainframe with plug-in modules 5CT1N or 7CT1N provides semiconductor testing capability.

TROUBLESHOOTING TECHNIQUES

Preliminary Troubleshooting Procedure

This preliminary troubleshooting procedure is arranged to check the simple trouble possibilities before proceeding with extensive troubleshooting. The first checks ensure proper connection, operation, and adjustment. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, it should be replaced using the replacement procedure given under Corrective Maintenance.

1. CHECK CONTROL SETTINGS. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the function or operation of any control, see the Operating Instructions section of this manual.

2. CHECK ASSOCIATED EQUIPMENT. Before proceeding with troubleshooting, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected, and interconnecting cables are not defective. Also check the power source.

3. VISUAL CHECK. Visually check that portion of the instrument that symptoms point to as the most likely source of the malfunction. Many troubles can be located by visible indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

4. INSTRUMENT PERFORMANCE. Check instrument operation or affected circuit by conducting the Performance Check procedures of Section 4. An apparent trouble may only be a result of misadjustment and be easily corrected by proper adjustment. (Adjustment instructions are provided in Section 6).

5. ISOLATE TROUBLE TO A CIRCUIT. To isolate trouble to a circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by taking voltage and waveform readings. Incorrect operation of all circuits often indicates trouble in the power supply. Check for correct voltages of the individual supplies. A defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits. Approximate power supply tolerances are listed in Table 5-3.

Table 5-3

POWER SUPPLY TOLERANCE

Supply	Tolerance
+150 V	±7%
+77 V	±4%
+5 V	±2.7%
+3 V	±0.7%
−3 V	±1.2%

6. CHECK CIRCUIT BOARD CONNECTIONS. After the trouble has been isolated to a particular circuit, again check for loose or broken connections, improperly seated transistors, and heat-damaged components.

7. CHECK VOLTAGES AND WAVEFORMS. The defective component can often be located by checking for the correct voltage or waveform in the circuit. Waveforms and voltages are located on or adjacent to the schematic diagrams in the foldout section at the rear of the manual.

NOTE

Voltages and waveforms given on the diagrams are not absolute and therefore may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the voltage and waveform set up procedures in the Diagrams section. Individual deviations should be noted on the circuit diagrams for future reference.

8. CHECK INDIVIDUAL COMPONENTS. The following procedures describe methods of checking individual components. Two-lead components that are soldered in place are best checked by first disconnecting one end. This isolates the measurement from the effects of surrounding circuitry. See Fig. 5-6 for component value identification.

WARNING

To prevent electrical shock or circuit damage, the power switch must be turned off before removing or replacing components.

a. Semiconductors. A good check of transistor operation is actual performance under operating conditions. A transistor can be most effectively checked by substituting a new component (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.

(1) When troubleshooting transistors in the circuit with a voltmeter, measure the emitter-to-base and emitter-to-collector voltages to determine if the voltages are consistent with normal circuit voltages. Voltages across a transistor vary with the type of device and the circuit function. Some of these voltages are predictable. The emitter-to-base voltage of a conducting silicon transistor will normally be from 0.6 to 0.8 V. The emitter-to-collector voltage of a saturated transistor is about 0.2 V. Because these values are small, the best way to check them is by connecting the voltmeter across the junction and using a sensitive voltmeter setting, rather than by comparing two voltages taken with respect to ground (both leads of the voltmeter must be isolated from ground if this method is used). If values less than these are obtained, either the device is short-circuited or no current is flowing in the circuit. If values are in excess of the base-to-emitter values given, the junction is back biased or the device is defective. Values in excess of those given for emitter-to-collector voltage could indicate either a nonsaturated device operating normally or a defective (open-circuited) transistor. If the device is conducting, voltage will be developed across resistances in series with it; if it is open, no voltage will be developed across resistances in series with it unless current is being supplied by a parallel path.

(2) When troubleshooting a field effect transistor, the voltages across its elements can be checked in the same manner as for transistors. However, it should be remembered that normal depletion-mode operation has the gate to source junction reverse biased, but the enhanced mode has the junction forward biased.

(3) IC (integrated circuits) can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is essential to troubleshooting circuits using ICs. Use care when checking voltages and waveforms around the ICs to ensure adjacent leads are not shorted together. A convenient means of clipping a test probe to the IC is with an IC test clip.

b. Diodes. A diode can be checked for an open or short circuit by measuring the resistance between terminals with an ohmmeter set to the R X 1000 scale. The diode resistance should be very high in one direction and very low when the meter leads are reversed.

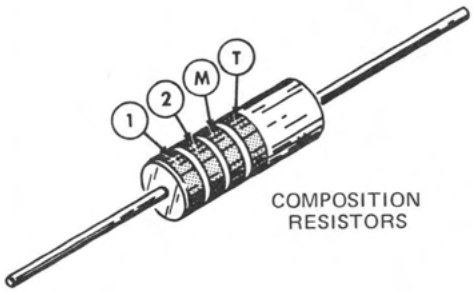
CAUTION

Do not use an ohmmeter scale that can supply a high current to the circuit under test. High currents can damage diodes. Check diodes in the same manner as transistor emitter-to-base junctions. Silicon diodes should have 0.6 to 0.8 Vacross the junction when conducting. Higher readings indicate that they are either back biased or defective depending on polarity.

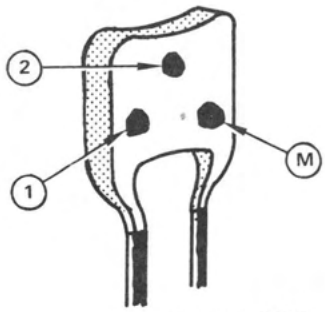
c. Resistors. Check the resistors with an ohmmeter. Check the parts list for tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies considerably from the specified value.

d. Inductors. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit.

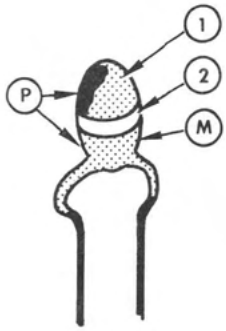
COLOR CODE



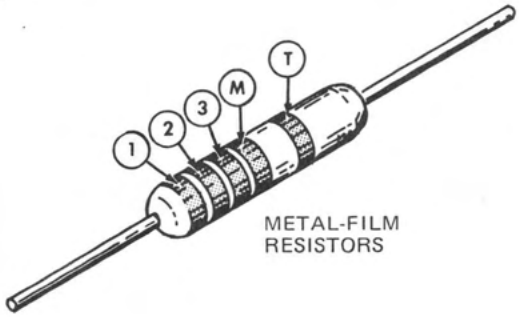
COMPOSITION RESISTORS



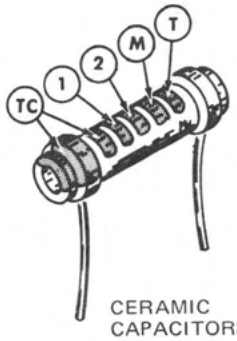
SMALL DISC CAPACITORS



DIPPED TANTALUM ELECTROLYTICS



METAL-FILM RESISTORS



CERAMIC CAPACITORS

(1) (2) and (3) — 1st, 2nd, and 3rd significant figures

(M) —multiplier (T) —tolerance

(TC) —temperature coefficient

(P) —polarity and voltage rating

(T) and/or (TC) color code may not be present on some capacitors

COLOR	SIGNIFICANT FIGURES	RESISTORS		CAPACITORS			DIPPED TANTALUM VOLTAGE RATING
		MULTIPLIER	TOLERANCE	MULTIPLIER	TOLERANCE		
					over 10 pF	under 10 pF	
BLACK	0	1	— — —	1	±20%	±2 pF	4 VDC
BROWN	1	10	±1%	10	±1%	±0.1 pF	6 VDC
RED	2	10^2 or 100	±2%	10^2 or 100	±2%	— — —	10 VDC
ORANGE	3	10^3 or 1 K	±3%	10^3 or 1000	±3%	— — —	15 VDC
YELLOW	4	10^4 or 10 K	±4%	10^4 or 10,000	+100% −9%	— — —	20 VDC
GREEN	5	10^5 or 100 K	±½%	10^5 or 100,000	±5%	±0.5 pF	25 VDC
BLUE	6	10^6 or 1 M	±¼%	10^6 or 1,000,000	— — —	— — —	35 VDC
VIOLET	7	— — —	±1/10%	— — —	— — —	— — —	50 VDC
GRAY	8	— — —	— — —	10^{-2} or 0.01	+80% −20%	±0.25 pF	— — —
WHITE	9	— — —	— — —	10^{-1} or 0.1	±10%	±1 pF	3 VDC
GOLD	—	10^{-1} or 0.1	±5%	— — —	— — —	— — —	— — —
SILVER	—	10^{-2} or 0.01	±10%	— — —	— — —	— — —	— — —
NONE	—	— — —	±20%	— — —	±10%	±1 pF	— — —

(1861-20A) 2423-85

Fig. 5-6. Component value identification.

e. Capacitors. A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

9. CURRENT CHECKS.

a. The 305 Oscilloscope section current drain should not exceed 700 mA under the following conditions:

Input Signal Frequency	5 MHz
Input Signal Amplitude	Adjust for 8 division of display
External Dc Input Voltage	12 Vdc
Scope Intensity	Maximum
DMM Power	Off (out)

b. The 305 DMM section current drain should not exceed 80 mA under the following conditions:

External Dc Input	12 Vdc
DMM Power	On (in)
Oscilloscope Power	Off (out)

CORRECTIVE MAINTENANCE

OBTAINING REPLACEMENT PARTS

Most electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, you should be able to obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix, Inc., please check the Replaceable Electrical Parts list for the proper value, rating, tolerance, and description.

NOTE

All replaceable parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Some parts are manufactured or selected by Tektronix, Inc., to satisfy particular requirements, or are manufactured for Tektronix, Inc., to our specifications. Most of the mechanical parts have been manufactured by Tektronix, Inc. To determine the manufacturer of a part, refer to the Parts List Cross Index of Code Number to Manufacturer found in the Replaceable Electrical Parts list.

When ordering replacement parts from Tektronix, Inc., include the following information:

1. instrument type,

2. instrument serial number,

3. a description of the part (if electrical, include circuit number), and

4. Tektronix part number.

SOLDERING TECHNIQUES

WARNING

Before soldering, turn the instrument off, disconnect it from the power source, make certain the Power Source Selector switch is out of the Battery position, and allow approximately 3 minutes for the filter capacitors in the power supply to discharge.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques, which apply to maintenance of any precision electronic equipment, should be used when working on this instrument. Use only 60/40 rosin-core electronic-grade solder. The choice of soldering iron is determined by the repair to be made. When soldering on circuit boards, use a 15- to 25-watt pencil-type soldering iron with a 1/8-inch wide, wedge-shaped tip. Keep the tip properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the wiring from the base material. Avoid excessive heat; apply only enough heat to remove the component or to make a good solder joint. Also, apply only enough solder to make a firm solder joint; do not apply too much solder.

COMPONENT REMOVAL AND REPLACEMENT

WARNING

To avoid electric shock, disconnect the instrument from the power source and remove the battery pack before removing or replacing any components.

The exploded-view drawing associated with the Replaceable Mechanical Parts list may be helpful in the removal or disassembly of individual components or subassemblies. Component locations are shown in the Diagrams and Circuit Board Illustrations section.

Circuit Boards

If a circuit board is damaged beyond repair, replace the entire board assembly. Part numbers are given in the Replaceable Electrical Parts list for completely wired circuit boards. Refer to Fig. 5-2 for circuit board locations.

Cabinet (Figure 5-7)

1. Remove the cover securing screw from the rear cover.

2. Remove the rear cover from the frame spacer.

3. Remove the frame spacer from the instrument and power cord.

4. Remove two screws from under the cabinet near CH 1 [X], CH 2 [Y], and EXT TRIG inputs.

5. Grip the front edge of the front panel with one hand and the cabinet with the other hand. Gently pull the cabinet off toward the rear of the instrument, maintaining a firm grip on the front panel.

6. To reinstall the cabinet reverse the removal procedure. Be careful not to bind or force the cabinet during reinstallation.

7. Insert the frame spacer with the power cord threaded through its opening.

8. Place the power cord in its frame spacer notch, install the rear cover, and tighten the cover securing screw.

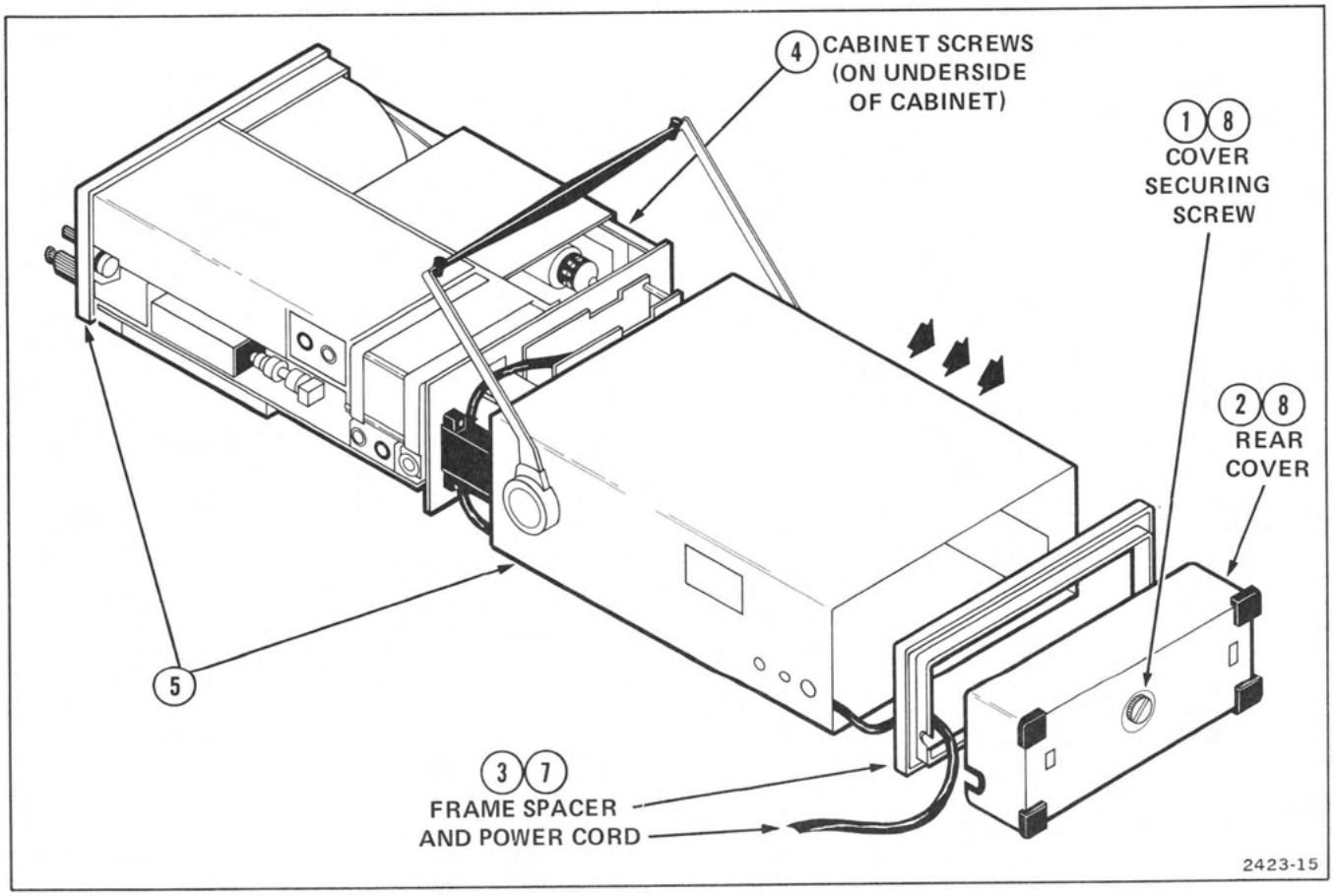


Fig. 5-7. Instrument cabinet removal.

Battery Pack (Figure 5-8)

1. Remove cabinet.

2. Release securing clamp.

3. Hold the instrument with one hand, and pull the Battery Pack out of the side of the instrument.

4. Reinstall the Battery Pack by reversing the removal procedure.

Output Amplifier Board (Figure 5-9)

1. Remove the three screws from Output Amplifier board.

2. Disconnect all connectors and make note of their location.

3. To reinstall the Output Amplifier board, reverse the removal procedure.

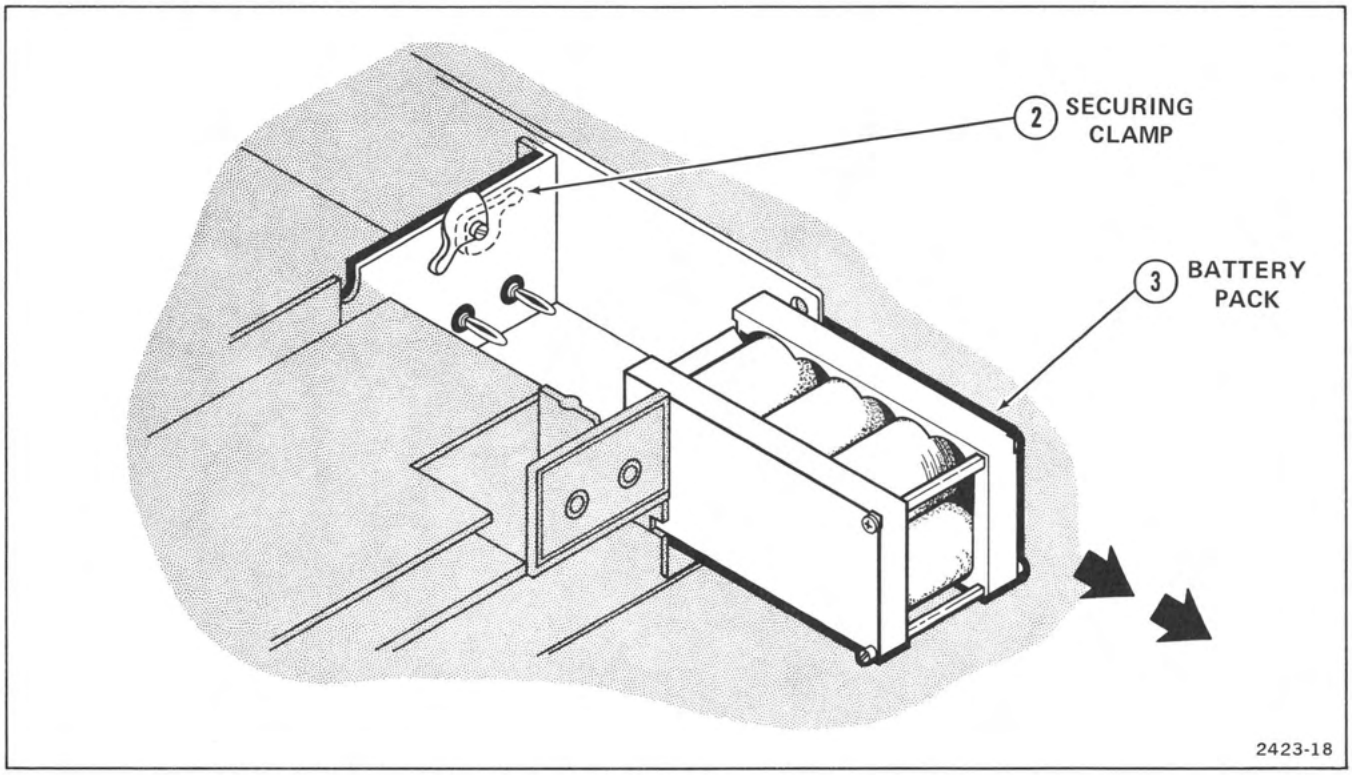


Fig. 5-8. Battery pack removal.

Main Board (Figure 5-10)

1. Disconnect all connectors and make note of their location.

2. Remove the SEC/DIV, CH 1 VOLTS/DIV, and CH 2 VOLTS/DIV knobs; along with the associated CAL knobs (1/16 and 0.050 inch hex wrenches required).

3. Remove the screws from the Main board.

4. Disconnect the two male pin connectors that connect the power supply board (PV and PX connectors) to the Main board (X and Y connectors). These are disconnected from the power supply board side of the instrument.

5. Make sure both CH 1 and CH 2 AC-GND-DC switches are in GND position.

6. Gently pull the Main board up and toward the rear of the instrument.

7. To reinstall the Main board, reverse the removal procedure.

NOTE

Be sure to correctly position the ON light through the hole in the front panel.

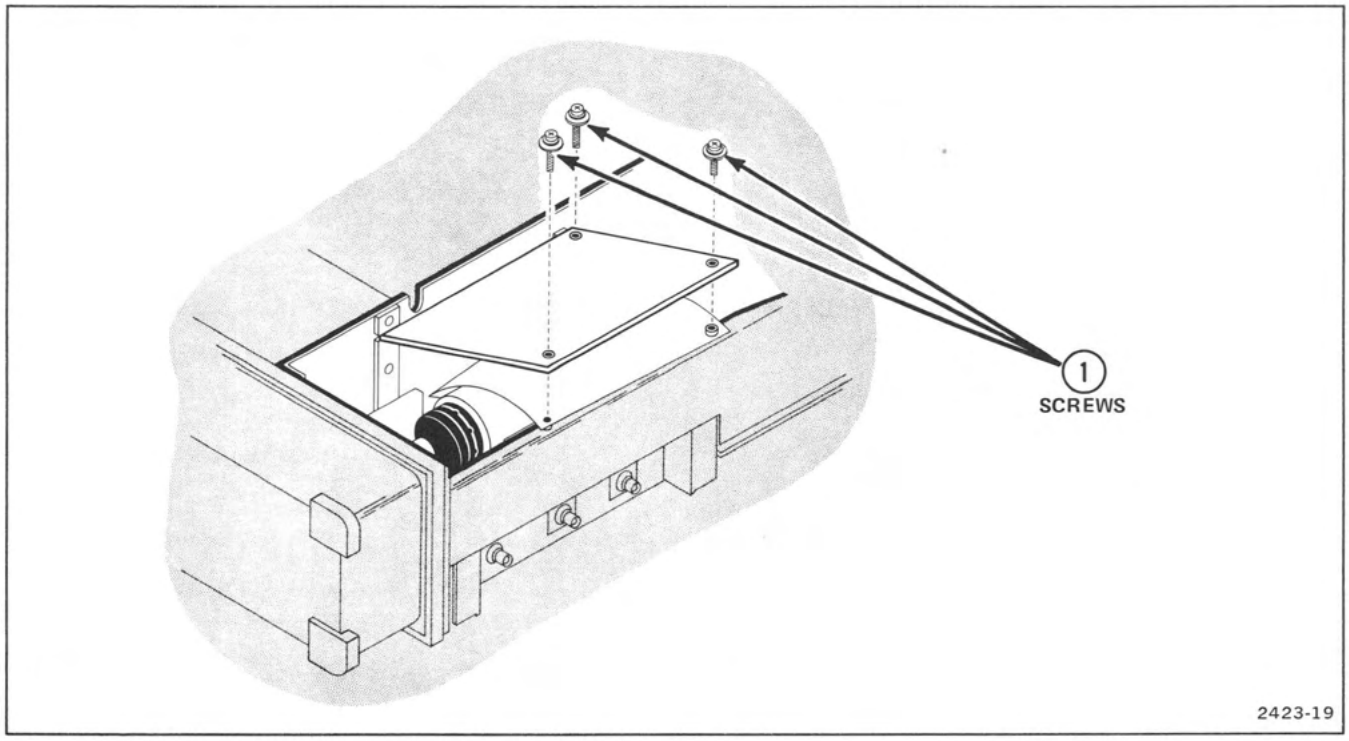


Fig. 5-9. Output amplifier board removal.

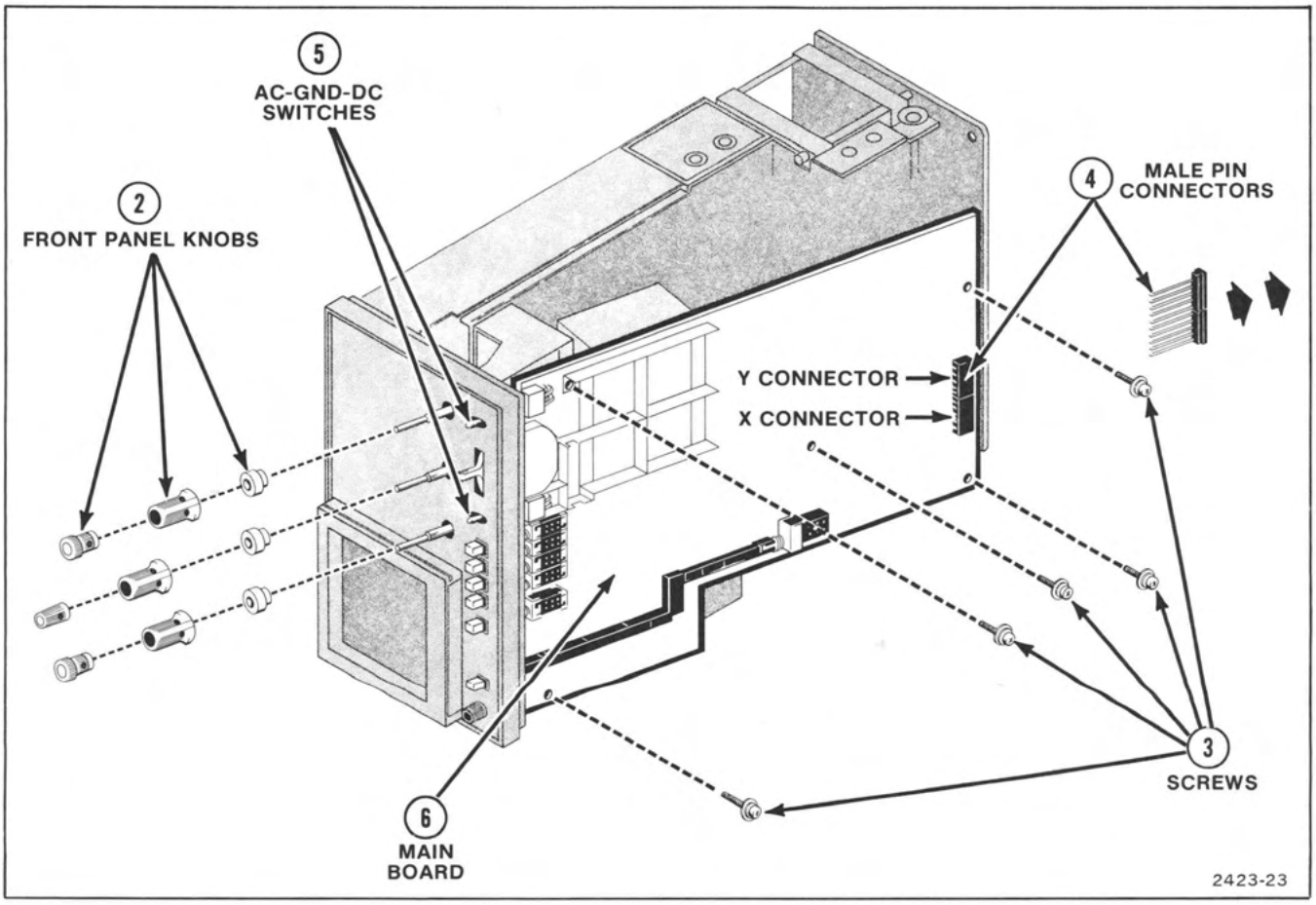


Fig. 5-10. Main board removal.

Battery Charger Board and Power Supply Board (Figure 5-11)

1. Unsolder the wires from the holes marked, PU, PV, PW, and PZ on the Battery Charge board (upper left side of the board). Note wire color codes for reassembly reference.

2. Disconnect all Battery Charger board connectors and make note of their location.

3. Remove three screws.

4. Remove the Battery Charger board.

5. To reinstall the Battery Charger board, reverse the removal procedure. To remove the Power Supply board, continue.

6. Disconnect all Power Supply board connectors and make note of their location.

7. Remove the three hexagonal spacers.

8. Disconnect the male pins from PV and PX connectors which connect the Power Supply board to the Main board.

9. Remove the Power Supply board.

10. To reinstall the Power Supply board and Battery Charger board, reverse the removal procedure.

DMM Input and Power Supply Board and DMM A/D and Logic Board (Figure 5-12)

To remove the boards refer to Fig. 5-12A.

1. Remove the screw holding the DMM top insulator.

2. Remove the DMM top insulator.

3. Disconnect all connectors to the DMM Input and Power Supply board (note location for reassembly reference).

4. Remove the three screws from the top of the DMM Input and Power Supply board.

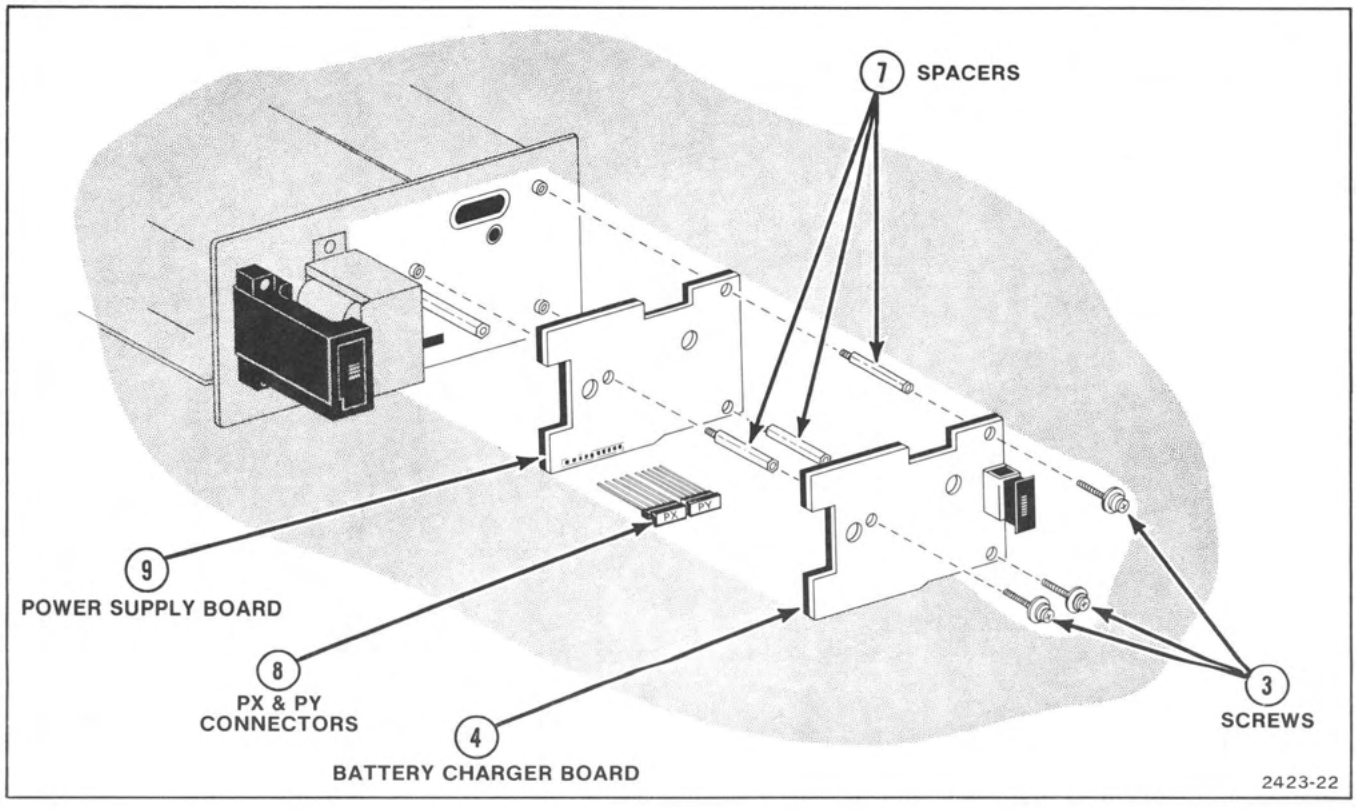


Fig. 5-11. Battery charger and power supply board removal.

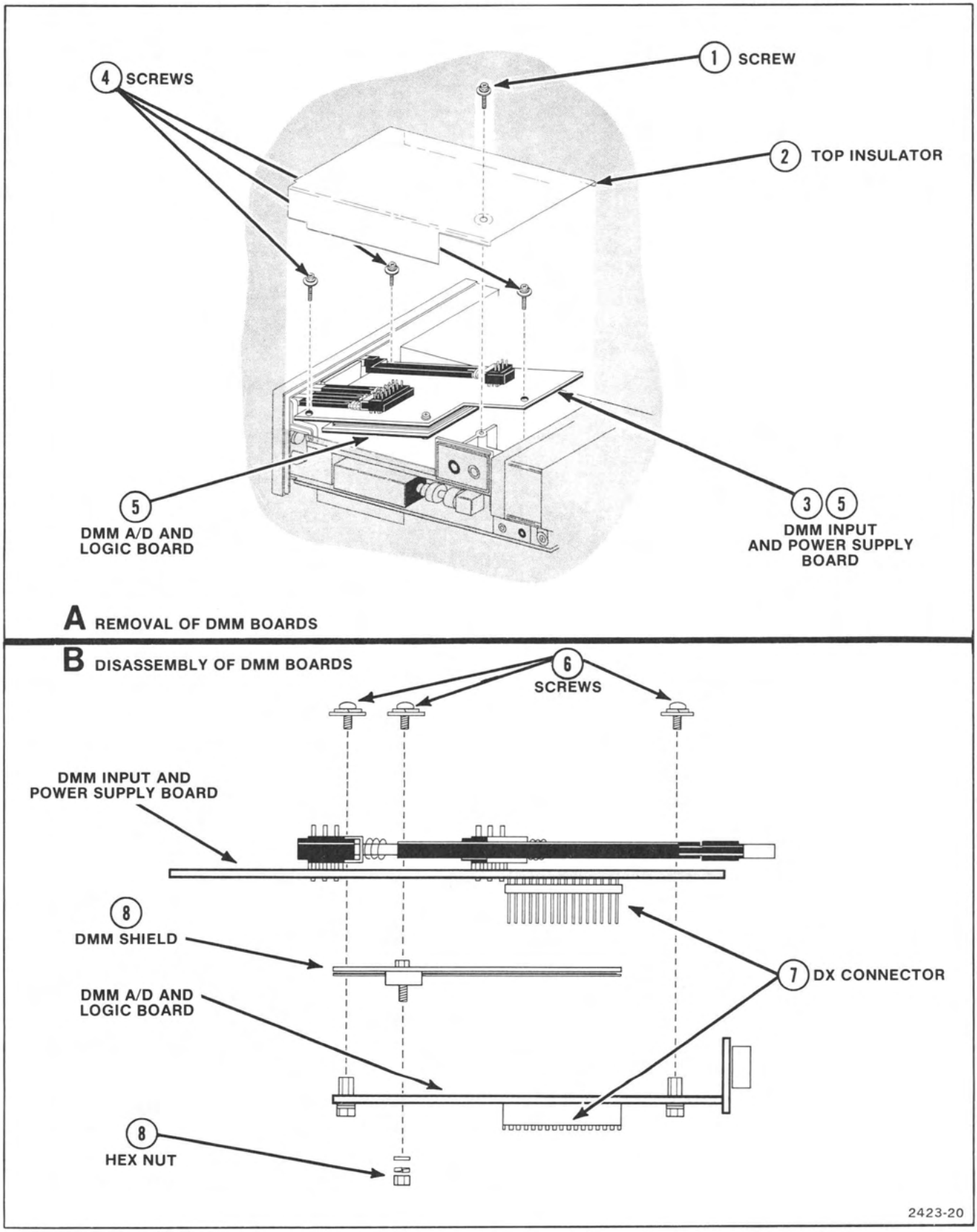


Fig. 5-12. Removal and disassembly of DMM boards.

5. Carefully pull the two DMM boards up and away from the front panel.

To disassemble the two DMM boards, refer to Fig. 5-12B.

6. Remove the three screws from the top of the DMM Input and Power Supply board.

7. To separate the boards, pull the boards apart, taking care not to damage the male pins of the DX connector.

8. To remove the DMM shield from the DMM A/D and Logic board, remove the hex nut.

9. To reinstall the boards, reverse the disassembly and removal procedures.

CRT

1. Unscrew the black nylon pressure screw from directly behind the center of the crt socket by using a 3/16-hex wrench. (A hole in the Power Supply and Battery Charger board is provided for this purpose.)

2. Loosen the two captive screws at the bottom of the crt bezel, do not remove them.

3. Pull the bezel away from the crt face.

4. Carefully disconnect the crt base socket while pushing the crt forward. When the socket has been disconnected, push the crt forward and pull it from the shield. Avoid damaging the trace rotation coil which is located inside the shield.

5. To reinstall the crt, reverse the removal procedure.

CAUTION

When screwing the black nylon pressure screw up against the crt socket, DO NOT exert more than just a holding pressure against the socket or the crt might be damaged.

Transistors and Integrated Circuits

Transistors and IC (integrated circuits) 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 adjustment of the instrument. When a transistor is replaced, check the operation of the part of the instrument that may be affected.

Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket and cut the leads to the same length as on the component being replaced. See Fig. 5-5 for basing diagrams.

To remove the 14-, 16-, and 20-pin integrated circuits, pull slowly and evenly on both ends of the device. Try to avoid having one end of the IC disengage from the socket before the other, since this may damage the pins.

WARNING

Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.

The chassis-mounted power supply transistors and their mounting bolts are insulated from the chassis. In addition, silicone grease is used to increase heat transfer capabilities. Reinstall the insulators and replace the silicone grease when replacing these transistors. The grease should be applied to both sides of the mica insulators, and should be applied to the bottom side of the transistor where it comes in contact with the insulator.

NOTE

After replacing a power transistor, check that the collector is not shorted to ground before applying power.

READJUSTMENT AFTER REPAIR

After any electrical component has been replaced, the adjustments for that particular circuit should be checked, as well as the adjustment of other closely related circuits. Since the power supply affects all circuits, adjustment of the entire instrument should be checked if work has been done in the power supply or if the transformer has been replaced.

INSTRUMENT REPACKAGING

Should reshipment become necessary, reuse the carton in which your instrument was shipped. If the original

packaging is unfit for use or is 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. Use a carton having a test strength of at least 275 pounds.

2. Surround the instrument with polyethylene sheeting to protect the finish and prevent packing material from entering 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.

REQUIRED RESHIPMENT INFORMATION

If the instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag containing the following information:

1. Owner's name and address, with the name of an individual at your firm who can be contacted.

2. Complete instrument serial number.

3. Description of the services required.

ADJUSTMENT PROCEDURE

This is an adjustment procedure only. It does not check all instrument specifications. For instance, vertical gain is checked only at the VOLTS/DIV setting at which it is adjusted (5 m). If the 305 operates normally, performance of the adjustment procedure will ensure optimum operation. If you wish to verify instrument specifications after performing the adjustment procedure, refer to the Performance Check section of this manual.

INTRODUCTION

CALIBRATION INTERVAL

To ensure measurement accuracy, check the calibration of the 305 every thousand hours of operation, or every six months if used infrequently.

TEKTRONIX FIELD SERVICE

Tektronix, Inc. provides complete instrument repair and recalibration at local Field Service centers and at the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

LIMITS AND TOLERANCES

All limits and tolerances listed in this procedure are calibration guides and should not be interpreted as instrument specifications unless they are also found in the Specification section of this manual (Section 1).

All limits and tolerances listed are for the 305 under test and do not include test equipment error.

All limits and tolerances listed are for an ambient temperature of +20°C to +30°C (+68°F to +86°F).

PARTIAL PROCEDURES

If one aspect of the 305 measurement capability is critical to your application, you may wish to perform a partial adjustment procedure at intervals more frequent than 1000 hours. Also, if you have replaced components you should check the adjustment of the circuit repaired. To make partial procedures easier to perform, the adjustment procedure is divided into several sections, each of which stands alone. An equipment required list and setup instructions are given at the beginning of each section.

USING THIS PROCEDURE

Index

An index precedes the Adjustment Procedure as an aid in locating individual steps.

Control Settings and Test Setups

Control settings and test setups are included (when required) at the beginning of each procedure. Titles for external instrument controls or screwdriver adjustments are fully capitalized (e.g., VOLTS/DIV, FOCUS, etc.), and internal adjustments are initial capitalized (e.g., Zero, Trig, etc.).

CABINET REMOVAL

Performance of the adjustment procedure requires removal of the instrument cabinet (refer to Component Removal and Replacement in the Maintenance section of this manual).

EQUIPMENT REQUIRED

The test equipment and accessories required for the adjustment procedures are listed in Table 6-1. Test equipment is assumed to be correctly calibrated and operating within its design specifications. Detailed operating instructions for the test equipment are not given in the procedures. Refer to the instruction manual for the test equipment if more information is needed.

Table 6-1

TEST EQUIPMENT REQUIRED

Description	Minimum Specifications	Use	Example
1. Digital Multimeter	Accuracy, 0.1% or better.	Power supply adjust. Battery charger check.	TEKTRONIX DM 502[a] Digital Multimeter.
2. Time-Mark Generator	Accuracy 0.3% or better.	SEC/DIV adjust.	TEKTRONIX TG 501[a] Time Mark Generator.
3. Square-Wave Generator	Frequency, 1 kHz at 25 V, 100 kHz at 0.5 V; rise time, 5 ns or less.	Input compensation. Rise time adjust.	TEKTRONIX PG 506[a] Calibration Generator.
4. Amplitude Calibrator	Amplitude accuracy within 0.5%; amplitude range 20 mV to 50 V; output frequency 1 kHz square wave.	Vertical gain.	TEKTRONIX PG 506[a] Calibration Generator.
5. Leveled Sine-Wave Generator	Amplitude flat within 1% from 50 kHz to 5 MHz; amplitude, at least 5 V p-p into 50 Ω.	Bandwidth check. High frequency trigger sensitivity.	TEKTRONIX SG 503[a] Sine Wave Generator
6. Low-Frequency Sine-Wave Generator	5 Hz to 50 kHz.	Trigger sensitivity.	TEKTRONIX SG 502[a] Oscillator.
7. DC Power Supply	Output Variable from 5 V to 32 V at 1 A.	Power supply range and low-battery indication.	TEKTRONIX PS 503A[a] Triple Power Supply.
8. DC Voltage Calibrator	Voltage, 10 mV to 1000 V; accuracy, 0.01%.	DCV accuracy.	Fluke 341A DC Voltage Standard.
9. AC Voltage Calibrator	Voltage, 10 mV to 700 V rms; voltage accuracy, 0.05%; frequency range, 50 Hz to 500 Hz.	ACV accuracy.	1. Fluke 5200 Calibrator and 5205A Amplifier. 2. Fluke 5200 Calibrator and 5215A Amplifier.
10. Resistance Standard	Range, 10 Ω to 2 MΩ. Accuracy, 0.03%.	Ohms accuracy.	ESI Dekabox Model DB 75 Resistance Standard. Use with item 11.
11. 1 MΩ Precision Resistor	Tolerance 0.1%.	Ohms accuracy.	
12. Bnc to probe-tip adapter	Connector, bnc-male-to-probe tip.	Signal interconnection.	Tektronix Part Number 013-0084-02.
13. Termination (2 required)	Impedance, 50 Ω; connectors, bnc.	Signal termination.	Tektronix Part Number 011-0049-01.
14. Cables (2 required)	Impedance, 50 Ω; length 42"; connectors, bnc.	Signal interconnection	Tektronix Part Number 012-0057-01.
15. T connector	Connectors, 2 bnc female to 1 bnc male.	Signal interconnection.	Tektronix Part Number 103-0030-00.
16. Attenuator (2 required)	Attenuation factor 10; impedance, 50 Ω; connectors, bnc.	Signal attenuation.	Tektronix Part Number 011-0059-02.

[a] **Requires TM 500-Series Power Module.**

Table 6-1 (cont)

Description	Minimum Specifications	Use	Example
17. Dual-Input Coupler (2 required)	Impedance, 50 Ω.	Triggering check and adjustment.	Tektronix Part Number 067-0525-01.
18. Test Oscilloscope	Bandwidth ≥5 MHz; sensitivity 5 mV/div.	Vertical high frequency compensation. DMM noise canceling.	SONY-TEKTRONIX 305 or any general purpose oscilloscope meeting minimum specifications.
19. 10X Probe			Included with 305.
20. Screwdriver	3" shaft, 3/32" blade.		Xcelite R-3323.
21. Shorting Strap		Calibrator adjustment. DMM Input leakage check.	Field Manufactured from alligator clips and wire.
22. Variable auto transformer	115 V.	Power source input for all adjustments.	General Radio W8MT3VM.
23. Non-metallic alignment tool	1/8" blade.	High frequency compensation.	Tektronix Part Number 003-0675-00.

ADJUSTMENT EQUIPMENT ALTERNATIVES

All of the listed test equipment is required to completely adjust this instrument. However, complete adjustment may not always be necessary or desirable. The user may be satisfied with adjusting only selected characteristics, thereby reducing the amount of test equipment actually required.

The equipment listed in the Adjustment Procedure is based on the first item of equipment given as an example of applicable equipment. When other equipment is substituted, control settings or adjustment setup may need to be altered to meet the requirements of the substitute equipment. If the exact item of test equipment given as an example in the test equipment list is not available, first check the Specifications column carefully to see if any other equipment is available which might suffice. Then check the Usage column to see what this item is used for. If used for an adjustment that is of little or no importance to your measurement requirements, the item and corresponding step(s) can be deleted.

EQUIPMENT PREPARATION

For the instrument to meet its performance specifications, it must be adjusted in an ambient temperature of +20°C to +30°C (+68°F to +86°F).

Remove the instrument cover (see Component Removal and Replacement in the Maintenance section).

WARNING

To prevent electrical shock with the cover removed, do not touch exposed connections or components when the instrument is turned on, or connected to a power source.

Set the Power Source Selector switch to one of the AC operating positions. Set the AC Input Voltage switch to 115 V. Connect the instrument to the ac power source through a variable autotransformer and adjust the variable autotransformer for 111 V (midrange).

Turn on the instrument (SCOPE POWER or DMM POWER) and allow it at least 5 minutes to warm up and stabilize at the ambient temperature.

INDEX TO ADJUSTMENT PROCEDURE

A. POWER SUPPLY AND DISPLAY

Equipment Required

1. Digital Voltmeter.
2. Time-mark Generator.
3. Shorting Strap.
4. Screwdriver.
5. Variable Autotransformer.

Preliminary Control Settings

NOTE

Before commencing this procedure: (1) Perform the Equipment Preparation Procedure described in this section; (2) see the Adjustment Location foldouts located in the Diagram section for location of adjustments and test points.

Power and Display

SCOPE POWER	ON (In)
DMM POWER	OFF (Out)

Vertical

VOLTS/DIV (both)	5 m
VOLTS/DIV CAL (both)	In detent
POSTION (both)	Midrange (as required)
AC-GND-DC (both)	GND
Display Mode	CH 1
PULL: INVERT	OFF (In)

Horizontal

SEC/DIV	1 m
SEC/DIV CAL	In detent
PULL: X10 MAG	OFF (In)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	As needed for stable display

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Adjust +3 V Supply (R1084)

NOTE

If this power supply is adjusted, the entire Adjustment Procedure must be performed. When performing a complete Adjustment Procedure, adjust the power supply for the exact specified voltage. When performing a partial procedure, do not adjust the supply if it is within its operating tolerance.

a. Connect a digital voltmeter between +3 V test point (on main board near FOCUS control) and ground.

b. CHECK—reading is 2.98 to 3.02 V.

c. ADJUST—R1084 (on battery charger board) for 3.00 V.

d. Disconnect the voltmeter.

2. Adjust Intensity Limit (R1200)

a. Connect the digital voltmeter HI probe on TP1234 (+) and LO probe on TP1236 (−) (located on battery charger board).

b. Rotate INTENSITY fully clockwise.

c. ADJUST—R1200 (Inten Limit) for 0.33 V.

d. Set INTENSITY for a comfortable viewing level.

e. Remove the voltmeter probe tips from the 305.

3. Adjust Calibrator (R61)

a. Connect a shorting strap between TP20 and TP21 (on main board).

b. Connect the digital voltmeter HI probe to the .3 V CAL OUT jack, and connect the LO probe to chassis ground.

c. ADJUST—R61 for 0.3 V.

d. Disconnect the voltmeter and shorting strap.

4. Adjust FOCUS (R1210) and ASTIGMATISM (R1308)

a. Set:

VOLTS/DIV (both)	5 DIV CAL
Display Mode	ALT
Vertical POSITION (both)	Both traces visible

b. ADJUST—R1210 (FOCUS) and R1308 (ASTIG) for the best definition of both traces.

5. Adjust TRACE ROTATION (R1320)

a. Set:

VOLTS/DIV (CH 1)	5 m
Display Mode	CH 1

b. Adjust vertical POSITION to place the trace on the center horizontal graticule line.

c. ADJUST—R1320 (TRACE ROTATION) to align the trace with the center horizontal graticule line.

6. Adjust Geometry (R1310)

a. Connect a time-mark generator as shown in Fig. 6-1 and set for 1 ms time markers.

b. Set:

AC-GND-DC (CH 1)	DC
VOLTS/DIV (CH 1)	20 mV
TRIGGER LEVEL	Stable display
SEC/DIV, SEC/DIV CAL, and Horizontal POSITION	Adjust for one time marker per division.
Vertical POSITION	Fully counterclockwise

NOTE

Due to the fast risetime of the markers, the visible display shows only the trailing edge. The portion of the time markers near the base line of the display is not suitable (not linear) for the geometry adjustment; therefore, the VOLTS/DIV and Vertical POSITION settings above have been made to display the most linear portion of the marker trailing edge.

c. ADJUST—R1310 (Geom) for minimum curvature (bowing) of the time marks.

NOTE

This adjustment may affect the TRACE ROTATION adjustment. If so, the Geometry and TRACE ROTATION adjustments should be alternately performed until they have the least amount of interaction. The TRACE ROTATION adjustment can be made without disconnecting the time-mark generator by setting the CH 1 Input Coupling to GND.

d. Disconnect the time-mark generator.

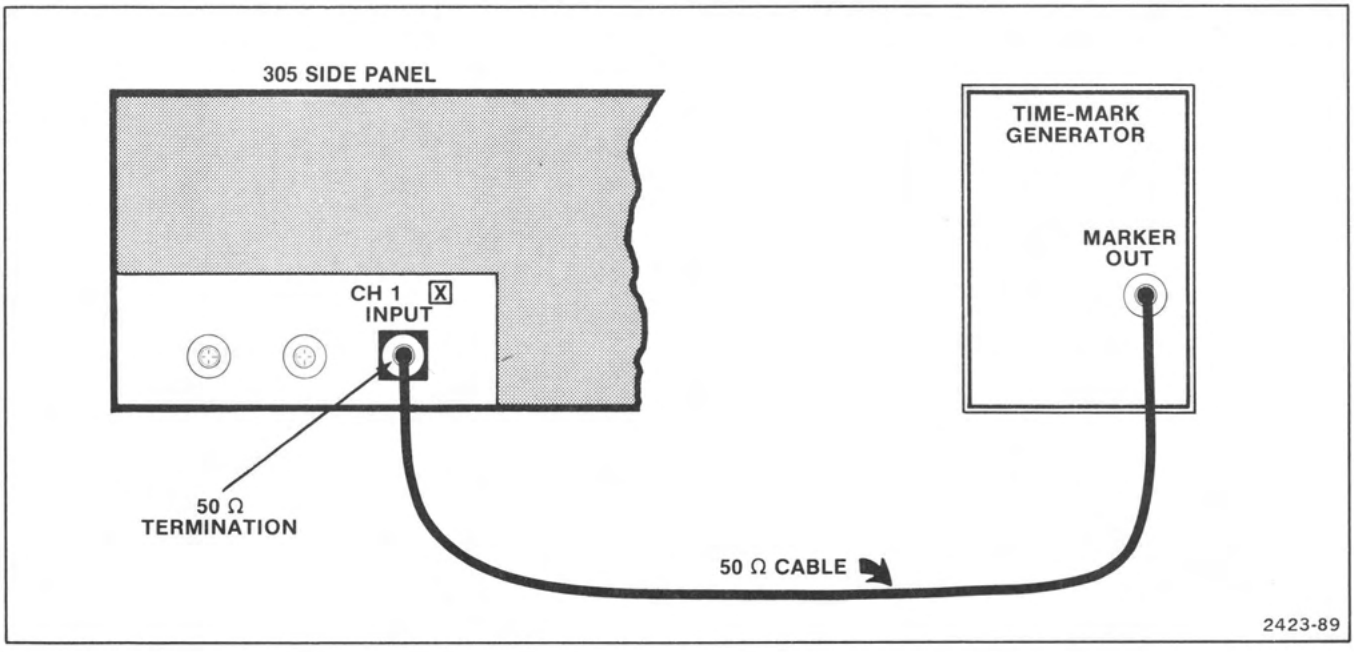


Fig. 6-1. Geometry test setup.

B. VERTICAL

Equipment Required

1. Leveled Sine-wave Generator.
2. Amplitude Calibrator.
3. Square-wave Generator.
4. Low-capacitance Screwdriver.
5. Non-metallic Screwdriver or Alignment Tool.
6. Attenuator, 10X, Bnc.
7. Termination, 50 Ω, Bnc.
8. Dual-input Coupler.
9. Probe-tip-to-bnc Adapter.
10. Cable, 50 Ω, Bnc.
11. 10X Probe.
12. Digital Voltmeter.

Preliminary Control Settings

NOTE

If you are performing a partial adjustment procedure: (1) Perform the Equipment Preparation Procedure described in this section; (2) see the Adjustment Location foldouts located in the Diagram section for location of adjustments and test points.

Power and Display

SCOPE POWER	ON (In)
DMM POWER	OFF (Out)
INTENSITY	Comfortable viewing level

Vertical

VOLTS/DIV (both)	5 m
VOLTS/DIV CAL (both)	In detent
POSITION (both)	Midrange (as required)
AC-GND-DC (both)	DC
Display Mode	CH 1
PULL: INVERT	OFF (In)

Horizontal

SEC/DIV	1 m
SEC/DIV CAL	In detent
PULL: X10 MAG	OFF (In)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	As needed for stable display

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Adjust Limit Centering (R208)

a. Connect a leveled sine-wave generator as shown in Fig. 6-2 and set it for a 50 kHz, 8 vertical division display.

b. ADJUST—R208 for a maximum amplitude display.

c. Disconnect the generator from the 305.

2. Adjust DC Bias (R265)

a. Connect digital voltmeter HI and LO leads between P280 and P260 (on vertical output amplifier board) (polarity doesn't matter).

b. ADJUST—CH 1 Vertical POSITION control for a reading of 0 V.

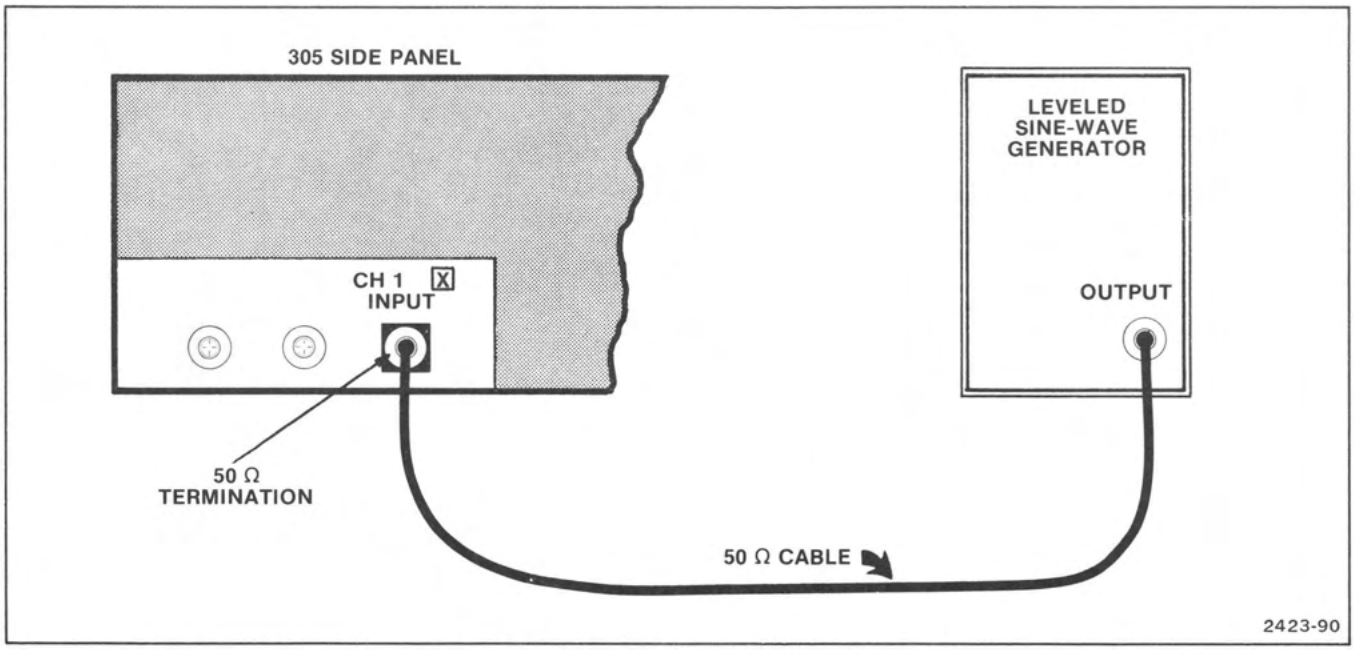


Fig. 6-2. Limit centering test setup.

c. Disconnect the LO voltmeter lead and reconnect it to ground.

d. ADJUST—R265 for a reading of 38 V.

e. Disconnect the voltmeter leads from the 305.

3. Compression Check

a. Set CH 1 input to AC.

b. Set CH 1 VOLTS/DIV switch to 5 DIV CAL.

c. Adjust CH 1 VOLTS/DIV CAL and POSITION for a 2-division display, centered vertically on the center horizontal graticule line.

d. Rotate POSITION control to move bottom of display to bottom graticule line.

e. Check for 0.15 division (or less) of compression.

f. Rotation POSITION control to move top of display to top graticule line.

g. Check for 0.15 division (or less) of compression.

h. If compression is greater than 0.15 division during either part e or g, repeat steps 1 and 2.

i. Return CH 1 VOLTS/DIV CAL to the detent (calibrated) position.

4. Adjust CH 1 Step Attenuator Balance (R102)

a. Set:

AC-GND-DC (both)	GND
VOLTS/DIV (both)	20 m

b. Rotate CH 1 POSITION control to move the CH 1 trace to the center horizontal graticule line.

c. Set CH 1 VOLTS/DIV to 50 m.

d. ADJUST—R102 (Channel 1 STEP ATTEN BALANCE) to recenter the trace to the center horizontal graticule line.

e. Set CH 1 VOLTS/DIV to 20 m and repeat parts b through d until there is no trace shift when switching between the 20 m and 50 m CH 1 VOLTS/DIV switch settings.

5. Adjust CH 2 Step Attenuator Balance (R122)

a. Set:

Display Mode	CH 2
Trigger Source	CH 2 (In)

b. Rotate CH 2 POSITION control to move the CH 2 trace to the center horizontal graticule line.

c. Set CH 2 VOLTS/DIV to 50 m.

d. ADJUST—R122 (Channel 2 STEP ATTEN BALANCE) to recenter the trace to the center horizontal graticule line.

e. Set CH 2 VOLTS/DIV to 20 m and repeat parts b through d until there is no trace shift when switching between the 20 m and 50 m CH 2 VOLTS/DIV switch settings.

6. Adjust CH 2 Gain (R137)

a. Set:

AC-GND-DC (CH 2)	DC
VOLTS/DIV (both)	5 m

b. Connect an amplitude calibrator as shown in Fig. 6-3A and set the standard amplitude output for 20 mV amplitude.

c. ADJUST—R137 (CH 2 Gain) for a 4-vertical division display.

7. Adjust CH 1 Gain (R117)

a. Set:

AC-GND-DC (CH 1)	DC
Display Mode	ADD
PULL:INVERT (CH 2)	ON (Out)

b. Connect amplitude calibrator to CH 1 and CH 2 inputs as shown in Fig. 6-3B.

c. ADJUST—R117 (CH 1 Gain) for signal cancellation.

d. Disconnect the amplitude calibrator and dual-input coupler from the 305.

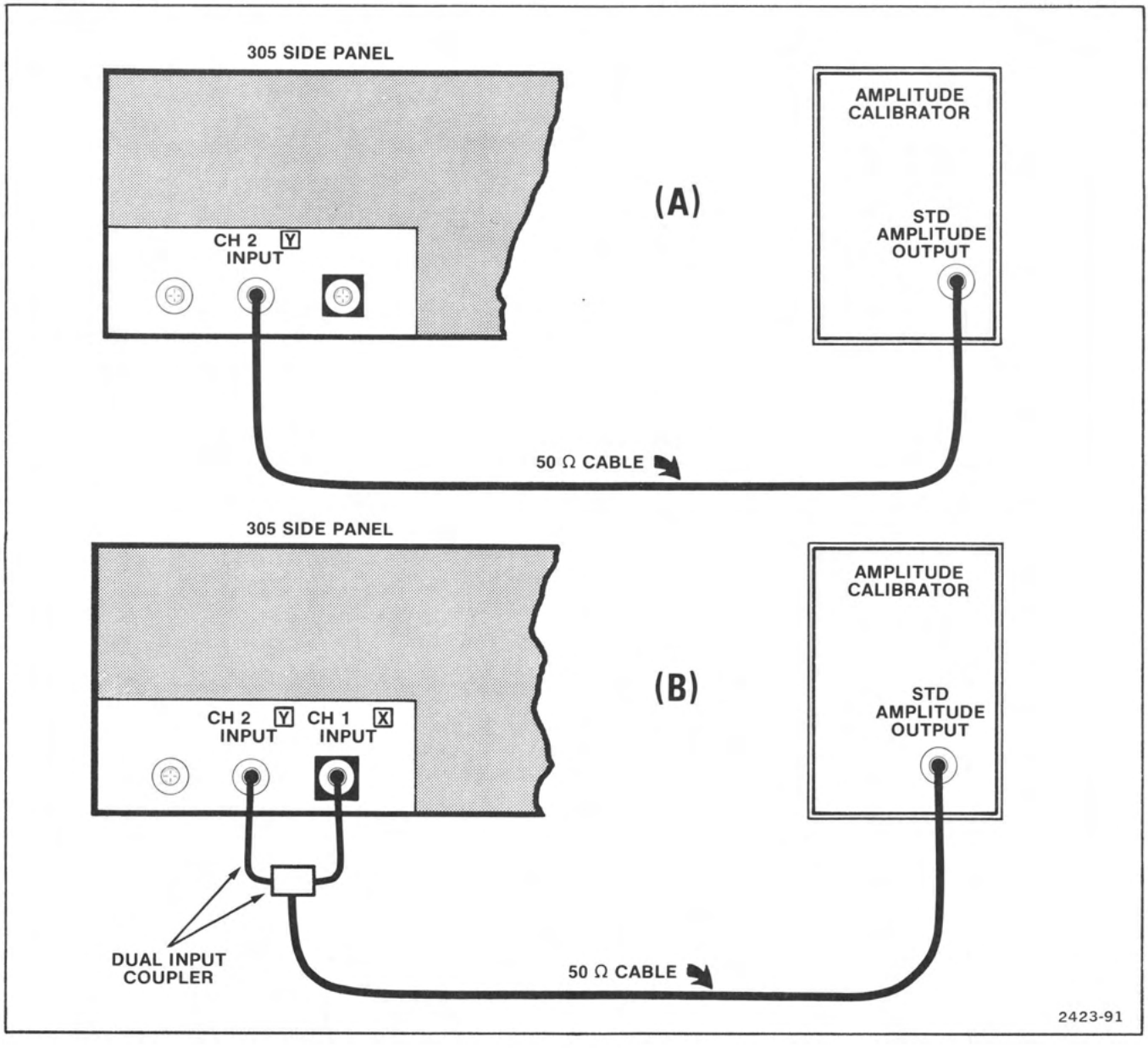


Fig. 6-3. Vertical gain test setup.

8. Adjust High Frequency Compensation (C110, C130, C207, R207, C250A, & C270A)

NOTE

Make all adjustments in this step using a non-metallic screwdriver or alignment tool.

a. Set:

Display Mode	CH 2
AC-GNC-DC (CH 1)	GND
PULL: INVERT (CH 2)	OFF (In)
SEC/DIV	50 μ

b. Connect square-wave generator fast rise + output to the CH 2 input as shown in Fig. 6-4 and set positive transition output for a 10 kHz, 4 vertical division display centered on the graticule.

c. Connect a test oscilloscope probe tip to P260 (ground clip to 305 chassis ground) and adjust the oscilloscope for several cycles of a 4 vertical division display.

d. ADJUST—C250A for the best flat top on the front corner of the rising edge of the waveform on the test oscilloscope.

e. Disconnect the test oscilloscope from the 305.

f. Set PULL: X10 MAG to ON (out) and adjust Horizontal POSITION to display a positive-going transition on the 305 crt screen.

g. ADJUST—C270A for the best flat top on the front corner of the waveform rising edge.

h. Set the square-wave generator for a 100 kHz, 4 vertical division display.

i. Set SEC/DIV switch to 5 μ, and rotate Horizontal POSITION control to display a positive transition of the waveform.

j. ADJUST—C207, R207, and C130 for the best flat top on the corner of the waveform rising edge.

k. Set:

Display Mode	CH 1
AC-GND-DC (CH 2)	GND
AC-GND-DC (CH 1)	DC
Trigger Source	CH 1 (In)

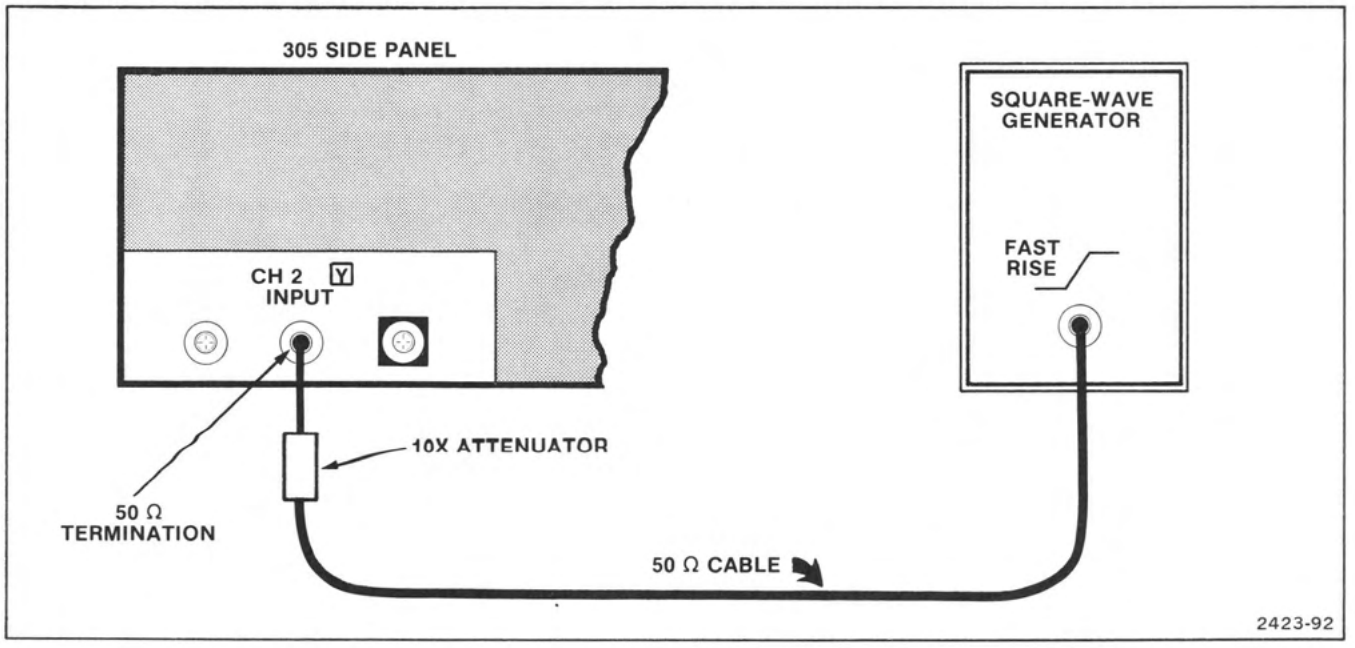


Fig. 6-4. High frequency compensation test setup.

l. Move the square-wave generator output from CH 2 INPUT to CH 1 INPUT.

m. Set Horizontal and Vertical POSITION controls to display the front corner of the waveform rising edge.

n. ADJUST—C110 for the best flat top on the front corner of the waveform rising edge.

o. Set PULL: X10 MAG to OFF (in) and disconnect the generator fast rise output from the 305.

9. Adjust CH 2 VOLTS/DIV COMPENSATION (C14A, C14B, C15A, & C15B)

a. Set:

VOLTS/DIV (both)	5 m
Display Mode	CH 2
AC-GND-DC (CH 2)	DC
AC-GND-DC (CH 1)	GND
Trigger Source	CH 2 (In)
SEC/DIV	.5 m

NOTE

During this adjustment procedure, reset the generator output, and add or remove the 10X attenuator or 50 Ω termination (or both) to maintain a display of about 5 vertical divisions. Removal of the termination does not affect this adjustment because of the low frequency involved.

b. Connect a square-wave generator as shown in Fig. 6-5 and set the high amplitude output for a 1 kHz, 5 vertical division display (see NOTE above). Set Horizontal POSITION control to display the front corner of the waveform rising edge.

c. Adjust the probe compensation for the best flat top on the front corner of the waveform rising edge. (Refer to data sheet supplied with probe for compensation adjustment procedure.) Do not change the probe compensation during the remainder of Vertical adjustments.

d. Set CH 2 VOLTS/DIV to 50 m.

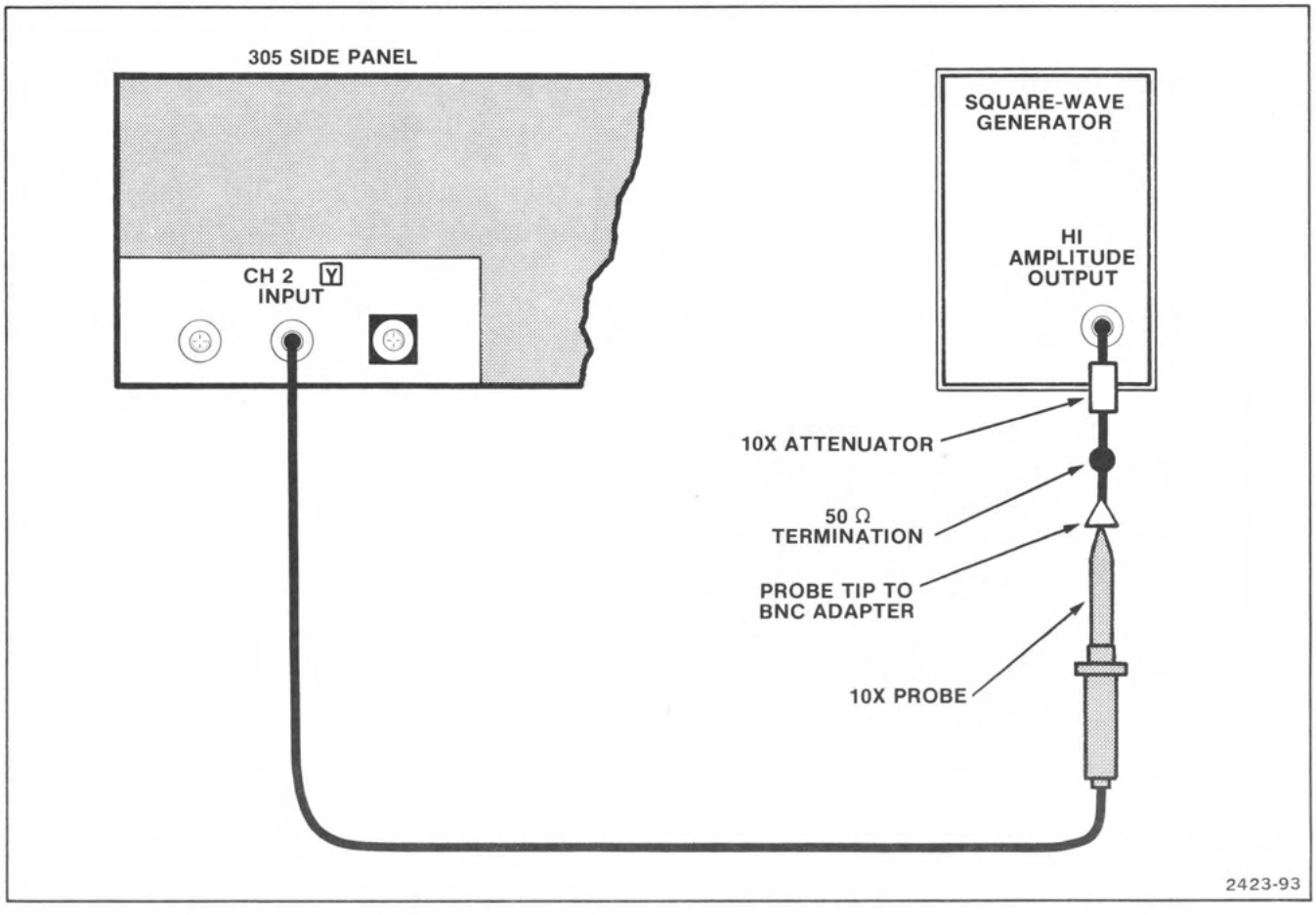


Fig. 6-5. Attenuator compensation test setup.

e. ADJUST—C15A for the best flat top and C15B for the best front corner on the waveform.

f. Set CH 2 VOLTS/DIV to .5.

g. ADJUST—C14A for the best flat top and C14B for the best front corner on the waveform.

10. Adjust CH 1 VOLTS/DIV Compensation (C1, C4A, C4B, C5A, & C5B)

a. Set:

Display Mode	CH 1
AC-GND-DC (CH 1)	DC
AC-GND-DC (CH 2)	GND
Trigger Source	CH 1 (In)

b. Move the probe connector from CH 1 INPUT to CH 2 INPUT. Adjust generator output and add termination and attenuator if necessary to obtain a 5 vertical division display.

NOTE

During this adjustment procedure, reset the generator output, and add or remove the 10X attenuator or 50 Ω termination (or both) to maintain a display of about 5 vertical division. Removal of the termination does not affect this adjustment because of the low frequency involved.

c. ADJUST—C1 for the best front corner on the waveform.

d. Set CH 1 VOLTS/DIV to 50 m.

e. ADJUST—C5A for the best flat top and C5B for the best front corner on the waveform.

f. Set CH 1 VOLTS/DIV for .5.

g. ADJUST—C4A for the best flat top and C4B for the best front corner on the waveform.

h. Disconnect the probe and generator from the 305.

C. TRIGGER

Equipment Required

1. Low-frequency Sine-wave Generator.
2. Dual-input Coupler.
3. Termination, 50 Ω, Bnc.
4. Cable, 50 Ω, Bnc.
5. Screwdriver.

Preliminary Control Settings

NOTE

If you are performing a partial adjustment procedure: (1) Perform the Equipment Preparation Procedure described in this section; (2) see the Adjustment Location foldouts located in the Diagram section for location of adjustments and test points.

Power and Display

SCOPE POWER	ON (In)
DMM POWER	OFF (Out)
INTENSITY	Comfortable viewing level

Vertical

VOLTS/DIV (both)	5 m
VOLTS/DIV CAL (both)	In detent
POSITION (both)	Midrange (as required)
AC-GND-DC (CH 1)	DC
Display Mode	CH 1
PULL: INVERT	OFF (In)

Horizontal

SEC/DIV	2 m
SEC/DIV CAL	In detent
PULL: X10 MAG	OFF (In)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	NORM
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	As needed for stable display

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Adjust Trigger DC Level (R326B and R317)

a. Connect a low-frequency sine-wave generator as shown in Fig. 6-6 and set the output for a 500 Hz, 6 vertical division display.

b. Set Horizontal POSITION control to observe the start of the sweep. Set Vertical POSITION control to vertically center the display above and below the center horizontal graticule line.

c. Set TRIGGER LEVEL so start of sweep begins at the center horizontal graticule line.

d. Set AC-DC (Trigger Coupling) to DC (in).

e. ADJUST—R326B (Trig) so start of sweep begins at the center horizontal graticule line.

f. Set Trigger Source to EXT (both buttons out).

g. ADJUST—R317 so start of sweep begins at the center horizontal graticule line.

NOTE

This adjustment is very sensitive and it may have to be slowly rotated in both directions several times before the correct triggering point is found.

2. Adjust TTL Trigger Level (R376)

a. Set:

VOLTS/DIV (CH 1)	50 m
TRIGGER LEVEL	TTL

b. Set generator output for an 8 vertical division display.

c. ADJUST—R376 (TTL) so that the sweep starts 2.8 divisions above the center horizontal graticule line.

NOTE

To check the sweep start point, use the Horizontal POSITION control to move the start of the sweep to the center vertical graticule line, and take reading from the minor division marks.

d. Disconnect the generator from the 305.

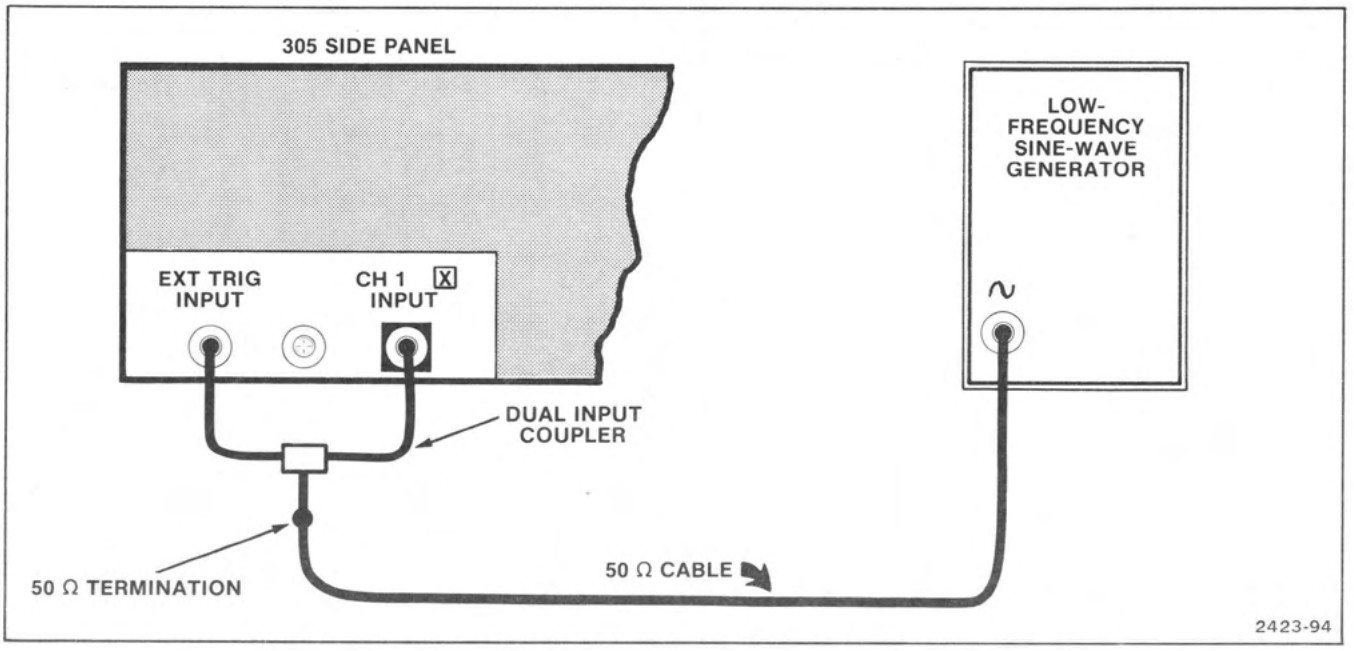


Fig. 6-6. Trigger test setup.

D. HORIZONTAL

Equipment Required

1. Time-mark Generator.
2. Amplitude Calibrator.
3. Termination, 50 Ω, Bnc.
4. Cable, 50 Ω, Bnc.
5. Non-metallic alignment tool.
6. Screwdriver.

Preliminary Control Settings

NOTE

If you are performing a partial adjustment procedure: (1) Perform the Equipment Preparation Procedure described in this section; (2) see the Adjustment Location foldouts located in the Diagram section for location of adjustments and test points.

Power and Display

SCOPE POWER	ON (In)
DMM POWER	OFF (Out)
INTENSITY	Comfortable viewing level

Vertical

VOLTS/DIV (both)	.2
VOLTS/DIV CAL (both)	In detent
POSITION (both)	Midrange (as required)
AC-GND-DC (both)	DC
Display Mode	CH 1
PULL: INVERT	OFF (In)

Horizontal

SEC/DIV	1 m
SEC/DIV CAL	In detent
PULL: X10 MAG	OFF (In)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	As needed for stable display

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Adjust DC Level (R601) and Horizontal Gain (R589)

a. Connect a time-mark generator as shown in Fig. 6-7 and set it for 1 ms time markers.

b. ADJUST—R601 (on output amplifier board) for the best alignment of time markers with vertical graticule lines, especially at right and left end of display.

NOTE

As an aid in adjusting the linearity, observe the spacing between the 1st and 2nd time markers and 10th and 11th time markers in relation to the vertical graticule lines. Ideal linearity would result when all displayed time markers maintain a 1 time marker per division relationship when the Horizontal POSITION control is used to move the time markers slowly across the screen.

c. ADJUST—R589 for 1 time marker per division over the center 8 divisions.

2. Adjust Magnifier Registration (R593)

a. Set PULL: X10 MAG on (out).

b. Set the time-mark generator for 5 ms time markers.

c. Set Horizontal POSITION control to align the middle time marker (of 3) with the center vertical graticule line.

d. Set PULL: X10 MAG off (in).

e. ADJUST—R593 to align the middle time marker (of 3) with the center vertical graticule line.

f. Repeat parts a through d until there is no change in marker alignment between the magnified and un-magnified display.

3. Adjust Sweep Length (R530B)

a. Set PULL: X10 MAG off (in).

b. Set the time-mark generator for 1 ms time markers.

c. ADJUST—R530B for a 12 horizontal division display (13 time markers). (Use Horizontal POSITION control to move first two time markers off screen to the left while adjusting for 13th time marker to align with right edge of graticule line.)

4. Adjust 5 μs Timing (C562)

a. Set SEC/DIV to 5 μ.

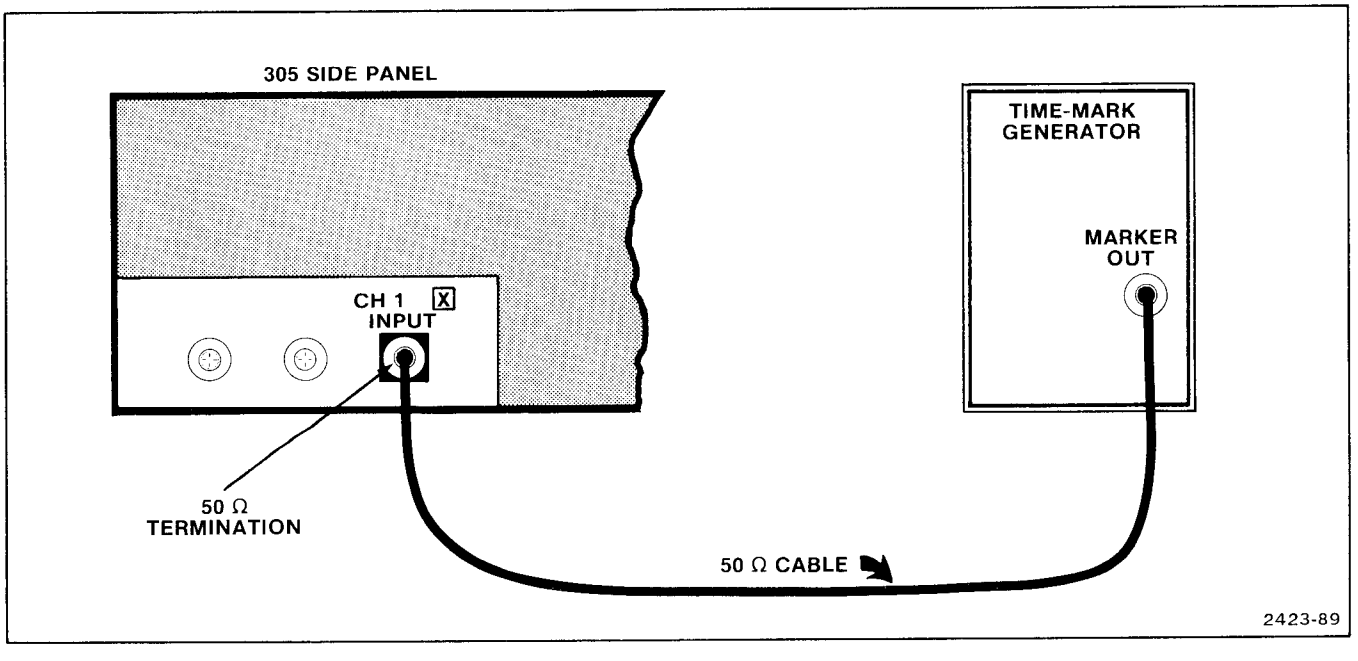


Fig. 6-7. Horizontal test setup.

b. Set the time-mark generator for 5 μs time markers.

c. ADJUST—C562 for 1 time marker per division.

5. Adjust 5 μs Magnified Timing (C612A)

a. Set PULL: X10 MAG on (out).

b. Set the time-mark generator for 0.5 μs time markers.

c. ADJUST—C612A for 1 time marker per division.

d. Repeat adjustments steps 4 and 5 for best timing adjustment for both magnified and unmagnified display.

6. Adjust High Speed Magnified Timing (C635)

a. Set SEC/DIV to 1 μ.

b. Set PULL: X10 MAG on (out).

c. Set the time-mark generator for 0.1 μs time markers.

d. ADJUST—C635 for 1 time marker per division. Re-adjust C612A and R601 if necessary.

e. Check for less than .32 divisions error over the center 8 divisions for the .1 μ, .2 μ, and .5 μ settings of the SEC/DIV switch.

7. Adjust X-axis Gain (R143)

a. Set:

VOLTS/DIV (CH 1)	5 m
SEC/DIV	X-Y
PULL: X10 MAG	OFF (In)
Display Mode	CH 2 (X-Y)

b. Connect an amplitude calibrator as shown in Fig. 6-8 and set the standard amplitude output for 20 mV amplitude.

c. ADJUST—R143 (X-Gain) for a 4-division horizontal display between the two dots.

d. Disconnect the calibrator from the 305.

f. Repeat steps 4, 5, and 6 as necessary; re-adjusting C635, C612A, and R601 for the best compromise for the .1 μ, .2 μ, and .5 μ positions of the SEC/DIV switch.

g. Repeat step 2, magnifier registration adjustment.

h. Disconnect time-mark generator from the 305.

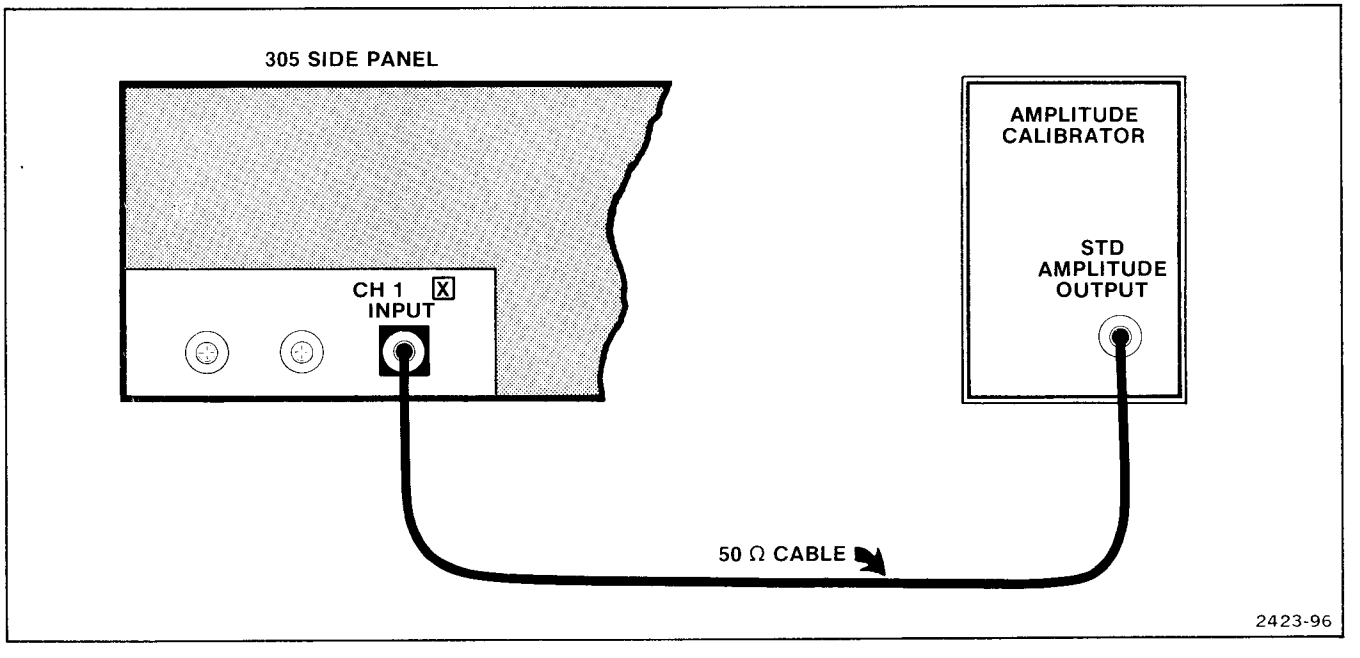


Fig. 6-8. X-axis gain test setup.

E. DMM

Equipment Required

1. Dc Voltage Standard.
2. Ac Voltage Standard.
3. 1 MΩ Precision Resistor.
4. Test Oscilloscope.
5. Shorting Strap.
6. DMM Probes (Standard Accessory).

Preliminary Control Settings

NOTE

If you are performing a partial adjustment procedure: (1) Perform the Equipment Preparation Procedure described in this section; (2) see the Adjustment Location foldouts located in the Diagram section for location of adjustments and test points.

Power and Display

SCOPE POWER	ON (In)
DMM POWER	ON (In)
INTENSITY	Comfortable viewing level

Vertical

VOLTS/DIV (CH 1)	.2
VOLTS/DIV CAL (CH 1)	In detent
POSITION (CH 1)	To center trace
AC-GND-DC (CH 1)	DC
Display Mode	CH 1

Horizontal

SEC/DIV	1 m
SEC/DIV CAL	In detent
PULL: X10 MAG	OFF (In)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	As needed for stable display

DMM

FUNCTION	DCV (In)

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Adjust DC Zero (R803)

a. Connect the DMM probe leads to the instrument HI and LO DMM input jacks and short the probe tips together.

b. ADJUST—R803 (Zero) for a .000 display with a flashing − (minus) sign (the display is alternating between .000 and −.000).

2. Check Input Leakage Current

NOTE

This check determines if there is excess current leakage in FET switch U805. If display is greater than ±1 count from .000, U805 has current leakage and should be replaced.

a. Connect a shorting strap between U800 pins 2 and 6.

b. CHECK—Display is no more than .000 ±1 count.

c. Disconnect the shorting strap and unshort the DMM probe tips.

3. Adjust DCV (R855)

a. Connect a dc voltage standard to the DMM through the DMM probes (HI to + and LO to −), and set the dc standard for an output of +1.9000 V.

b. ADJUST—R855 (DC) for a display of 1.900.

c. Disconnect the DMM probes from the dc standard, and turn the dc standard off.

4. Adjust ACV (R853)

a. Set FUNCTION to ACV (in).

b. Connect an ac voltage standard to the DMM through the DMM probes and set the ac standard for an output of 1.9000 V.

c. ADJUST—R853 (AC) for a display of 1.900.

d. Turn the ac standard off, and disconnect the DMM probes from the ac standard.

5. Adjust Ohms (R825)

a. Set FUNCTION to kΩ (in).

b. Connect the DMM probe tips across a precision 1 mΩ resistor.

c. ADJUST—R825 (kΩ) for a reading of 1000.

d. Disconnect the DMM probes from the resistor.

6. Adjust Converter Noise Cancellation (R995)

a. Connect a 10X probe to the 305 CH 1 input. Place the probe ground lead on the negative lead of C900 (ground). Connect the probe tip to TP800.

b. ADJUST—R995 for minimum noise level on oscilloscope display.

NOTE

Noise makes the trace look thicker and creates what appears to be multiple traces. When adjusting for minimum noise the multiple traces and noise thickness seems to converge into a single trace making it better defined, similar to the focus or astigmatism adjustments.

c. Disconnect the 10X oscilloscope probe from TP800 and ground.

d. Turn SCOPE POWER and DMM POWER off (out) and disconnect the 305 from the ac power source.

F. EXTERNAL DC AND BATTERY OPERATION

Equipment Required

1. Dc Power Supply.
2. Digital Multimeter.

Preliminary Control Settings

1. Set the Power Source Selector switch to EXT DC and connect the 305 to a dc power supply. Turn on the dc power supply and set the output for +9.00 V.

NOTE

Use the digital voltmeter section of the external digital multimeter to check the output of the dc power supply as required.

2. Turn on the 305 (SCOPE POWER and DMM POWER) and allow at least 5 minutes for warmup.

Display

INTENSITY	Comfortable viewing level
FOCUS	Best defined trace
ASTIGMATISM	Best defined trace

Vertical

VOLTS/DIV (both)	5 DIV CAL
VOLTS/DIV CAL (both)	In detent
POSITION (both)	Midrange
AC-GND-DC (both)	GND
Display Mode	CH 1
PULL: INVERT	OFF (In)

Horizontal

SEC/DIV	1 m
SEC/DIV CAL	In detent
PULL: X10 MAG	OFF (In)
POSITION	Midrange (as required)

Trigger

AUTO-NORM (Mode)	AUTO
SLOPE	+
AC-DC (Coupling)	AC
Source	CH 1
LEVEL	Center of + SLOPE

DMM

FUNCTION	DCV (In)

NOTE

In the following procedures, unless otherwise specified, set INTENSITY, TRIGGER LEVEL, POSITION, ASTIGMATISM, FOCUS, and TRACE ROTATION controls as necessary.

1. Check External DC Voltage Range

a. Connect the digital voltmeter function of the external digital multimeter; LO lead to chassis ground and HI lead to the +3 V test point (main board). Note the reading.

b. Vary the dc power supply output from +9 to +32 V.

c. CHECK—the reading in part a does not vary more than ±12 mV.

d. Disconnect the voltmeter from the 305.

2. Check Battery Check Function

a. Set FUNCTION (all buttons) to OFF (out).

b. Connect digital voltmeter function of the external digital multimeter; LO lead to the ground end of C900 and HI lead to the + end of C900.

c. Set dc power supply output for a reading of +6 V across C900.

d. CHECK—305 DMM reading is between 5.70 and 6.30.

e. Set the dc power supply for a reading of +10 V across C900.

f. CHECK—305 DMM reading is between 9.50 and 10.50.

g. Turn off the dc power supply, 305 Oscilloscope, and DMM. Disconnect the 305 dc power leads from the dc power supply.

3. Check Battery Charging Current

a. Set the Power Source Selector switch to AC/FULL CHG.

b. Remove the battery pack from the 305 (refer to Component Removal and Replacement in the Maintenance section).

c. Connect the dc ammeter function of the external digital multimeter to the 305 battery connectors.

NOTE

If the dc ammeter being used is polarity sensitive, the battery input connector toward the front of the 305 is positive.

d. Connect the 305 to an ac power source.

e. CHECK—charging rate is between 150 and 180 mA.

f. Set the Power Source Selector switch to AC/TRICKLE CHG.

g. CHECK—charging rate is between 45 and 75 mA.

h. Turn off the 305 and unplug it from the ac power source.

i. Disconnect the ammeter from the 305.

j. Reinstall battery pack and cabinet.

k. Check instrument for proper operation after reassembly.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

ITEM NAME

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.

ABBREVIATIONS

ACTR	ACTUATOR
ASSY	ASSEMBLY
CAP	CAPACITOR
CER	CERAMIC
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
ELCTLT	ELECTROLYTIC
ELEC	ELECTRICAL
INCAND	INCANDESCENT
LED	LIGHT EMITTING DIODE
NONWIR	NON WIREWOUND
PLSTC	PLASTIC
QTZ	QUARTZ
RECP	RECEPTACLE
RES	RESISTOR
RF	RADIO FREQUENCY
SEL	SELECTED
SEMICOND	SEMICONDUCTOR
SENS	SENSITIVE
VAR	VARIABLE
WW	WIREWOUND
XFMR	TRANSFORMER
XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
0000L	MATSUSHITA ELECTRIC	200 PARK AVENUE, 54TH FLOOR	NEW YORK, NY 10017
0000M	SONY/TEKTRONIX CORPORATION	P O BOX 14, HANEDA AIRPORT	TOKYO 149, JAPAN
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
19209	GENERAL ELECTRIC CO., ELECTRONIC CAPACITOR AND BATTERY PRODUCTS DEPT. BATTERY PRODUCTS SEC.	P. O. BOX 114	GAINESVILLE, FL 32601
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
29604	STACKPOLE COMPONENTS COMPANY	P O BOX 14466	RALEIGH, NC 27610
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50157	MIDWEST COMPONENTS INC.	P. O. BOX 787 1981 PORT CITY BLVD.	MUSKEGON, MI 49443
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71744	CHICAGO MINIATURE LAMP WORKS	4433 RAVENSWOOD AVE.	CHICAGO, IL 60640
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80031	ELECTRA-MIDLAND CORP., MEPCO DIV.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-5565-00			CKT BOARD ASSY:MAIN	80009	670-5565-00
A2	670-5567-00			CKT BOARD ASSY:POWER SUPPLY	80009	670-5567-00
A3	670-5571-00			CKT BOARD ASSY:BATTERY CHARGER	80009	670-5571-00
A4	670-5566-00			CKT BOARD ASSY:OUTPUT AMPLIFIER	80009	670-5566-00
A5	670-5568-00			CKT BOARD ASSY:A/D AND LOGIC	80009	670-5568-00
A6	670-5569-00			CKT BOARD ASSY:DMM INPUT & POWER SUPPLY	80009	670-5569-00
A7	670-5570-00			CKT BOARD ASSY:LED DISPLAY	80009	670-5570-00
BT1015	146-0012-01			BATTERY,STORAGE:7.2V,1800 MAH	19209	41B002HD13
C1	281-0236-00			CAP.,VAR,CER DI:2.8-10PF,250V	0000M	281-0236-00
C2	285-1167-00			CAP.,FXD,PLSTC:0.022UF,10%,400V	0000M	285-1167-00
C3	283-0329-00			CAP.,FXD,CER DI:0.39PF,10%,500V	0000M	283-0329-00
C4A	281-0237-00			CAP.,VAR,CER DI:3.3-18PF,250V	80009	281-0237-00
C4B	281-0235-00			CAP.,VAR,CER DI:3.5-10PF,+50-10%,250V	0000M	281-0235-00
C4C	283-0597-00			CAP.,FXD,MICA D:470PF,10%,300V	00853	D153E471K0
C5A	281-0237-00			CAP.,VAR,CER DI:3.3-18PF,250V	80009	281-0237-00
C5B	281-0235-00			CAP.,VAR,CER DI:3.5-10PF,+50-10%,250V	0000M	281-0235-00
C5C	283-0288-00			CAP.,FXD,CER DI:35PF,10%,500V	0000M	283-0288-00
C6	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C7	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C12	285-1167-00			CAP.,FXD,PLSTC:0.022UF,10%,400V	0000M	285-1167-00
C13	283-0329-00			CAP.,FXD,CER DI:0.39PF,10%,500V	0000M	283-0329-00
C14A	281-0237-00			CAP.,VAR,CER DI:3.3-18PF,250V	80009	281-0237-00
C14B	281-0235-00			CAP.,VAR,CER DI:3.5-10PF,+50-10%,250V	0000M	281-0235-00
C14C	283-0597-00			CAP.,FXD,MICA D:470PF,10%,300V	00853	D153E471K0
C15A	281-0237-00			CAP.,VAR,CER DI:3.3-18PF,250V	80009	281-0237-00
C15B	281-0235-00			CAP.,VAR,CER DI:3.5-10PF,+50-10%,250V	0000M	281-0235-00
C15C	283-0288-00			CAP.,FXD,CER DI:35PF,10%,500V	0000M	283-0288-00
C16	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C17	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C52	285-1117-00			CAP.,FXD,PLSTC:0.018UF,2%,100V	0000M	285-1117-00
C60	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C65	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C100	290-0803-00			CAP.,FXD,ELCTLT:6.8UF,20%,20V	80009	290-0803-00
C103	290-0803-00			CAP.,FXD,ELCTLT:6.8UF,20%,20V	80009	290-0803-00
C110	281-0205-00			CAP.,VAR,PLSTC:4-65PF,100V	80031	2810C5R565QJ02F0
C111	283-0108-00			CAP.,FXD,CER DI:220PF,10%,200V	56289	272C13
C120	290-0803-00			CAP.,FXD,ELCTLT:6.8UF,20%,20V	80009	290-0803-00
C123	290-0803-00			CAP.,FXD,ELCTLT:6.8UF,20%,20V	80009	290-0803-00
C130	281-0205-00			CAP.,VAR,PLSTC:4-65PF,100V	80031	2810C5R565QJ02F0
C131	283-0108-00			CAP.,FXD,CER DI:220PF,10%,200V	56289	272C13
C171	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C175	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C181	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
C183	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
C185	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C187	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C195	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C196	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C197	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C204	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
C207	281-0236-00			CAP.,VAR,CER DI:2.8-10PF,250V	0000M	281-0236-00
C226	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C228	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C236	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C250A	281-0236-00			CAP.,VAR,CER DI:2-8-10PF,250V	0000M	281-0236-00
C250B	281-0511-00			CAP.,FXD,CER DI:22PF,+/-2.2PF,500V	72982	301-000C0G0220K
C251	283-0240-00			CAP.,FXD,CER DI:1PF,20%,500V	56289	53C141
C253	281-0773-00	X300321		CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C255	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C256	290-0164-00			CAP.,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA7
C270A	281-0236-00			CAP.,VAR,CER DI:2-8-10PF,250V	0000M	281-0236-00
C270B	281-0511-00			CAP.,FXD,CER DI:22PF,+/-2.2PF,500V	72982	301-000C0G0220K
C271	283-0240-00			CAP.,FXD,CER DI:1PF,20%,500V	56289	53C141
C273	281-0773-00	X300321		CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C275	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C276	290-0164-00			CAP.,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA7
C295	290-0725-00			CAP.,FXD,ELCTLT:100UF,+75-10%,50V	56289	30D107G050DH9
C296	290-0725-00			CAP.,FXD,ELCTLT:100UF,+75-10%,50V	56289	30D107G050DH9
C297	285-1166-00			CAP.,FXD,PLSTC:0.047UF,5%,200V	80009	285-1166-00
C300	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C301	283-0329-00			CAP.,FXD,CER DI:0.39PF,10%,500V	0000M	283-0329-00
C304	283-0128-00			CAP.,FXD,CER DI:100PF,5%,500V	72982	871-536T2H101J
C318	290-0803-00			CAP.,FXD,ELCTLT:6.8UF,20%,20V	80009	290-0803-00
C325	281-0811-00			CAP.,FXD,CER DI:10PF,10%,100V	72982	8035D2AADC1G100K
C326	281-0811-00			CAP.,FXD,CER DI:10PF,10%,100V	72982	8035D2AADC1G100K
C328A	290-0776-00			CAP.,FXD,ELCTLT:22UF,+50-10%,10V	0000L	ECE-A10V22L
C328B	290-0776-00			CAP.,FXD,ELCTLT:22UF,+50-10%,10V	0000L	ECE-A10V22L
C336	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C356	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C372	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C400	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C402	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C404	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C500	290-0820-00			CAP.,FXD,ELCTLT:2.2UF,+75-10%,50V	0000M	290-0820-00
C502	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C503	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	72982	8035D2AADC0G101K
C507	283-0028-00	X300481		CAP.,FXD,CER DI:0.0022UF,20%,50V	56289	19C606
C508	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C527A	283-0142-00			CAP.,FXD,CER DI:0.0027UF,5%,200V	72982	875-571-Y5E0272J
C527B	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C527C	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C533	290-0523-00	X300217		CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C542	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C543	290-0803-00			CAP.,FXD,ELCTLT:6.8UF,20%,20V	80009	290-0803-00
C544	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C550	290-0740-00			CAP.,FXD,ELCTLT:68UF,20%,16V	0000M	290-0740-00
C560A-C	295-0169-00			CAP.,SET,MTCHD:1UF,0.01UF,0.001UF,MTCHD 1%	80009	295-0169-00
C560D	283-0144-00			CAP.,FXD,CER DI:33PF,2%,500V	72982	801-547P2G330G
C562	281-0205-00			CAP.,VAR,PLSTC:4-65PF,100V	80031	2810C5R565QJ02F0
C581	290-0820-00			CAP.,FXD,ELCTLT:2.2UF,+75-10%,50V	0000M	290-0820-00
C588	283-0195-00			CAP.,FXD,CER DI:680PF,5%,50V	72982	8121N075C0G0681J
C592	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C594	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C595	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C600	285-1166-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	80009	285-1166-00
C604	285-1166-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	80009	285-1166-00
C605A	285-1166-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	80009	285-1166-00
C605B	285-1166-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	80009	285-1166-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C612A	281-0095-01			CAP.,VAR,PLSTC:0.25-1.5PF,600V	0000M	281-0095-01
C620A	285-1166-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	80009	285-1166-00
C620B	285-1166-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	80009	285-1166-00
C630	283-0240-00			CAP.,FXD,CER DI:1PF,20%,500V	56289	53C141
C632	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C635	281-0095-01			CAP.,VAR,PLSTC:0.25-1.5PF,600V	0000M	281-0095-01
C636	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C690	290-0725-00			CAP.,FXD,ELCTLT:100UF,+75-10%,50V	56289	30D107G050DH9
C692	290-0725-00			CAP.,FXD,ELCTLT:100UF,+75-10%,50V	56289	30D107G050DH9
C700	283-0231-01			CAP.,FXD,CER DI:470PF,10%,500V	0000M	283-0231-01
C702	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
C703	283-0108-00			CAP.,FXD,CER DI:220PF,10%,200V	56289	272C13
C708	285-1166-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	80009	285-1166-00
C709	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C712	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C800	285-1077-00			CAP.,FXD,PLSTC:0.10UF,20%,600V	14752	230B1F104
C801	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C810	285-1165-00			CAP.,FXD,PLSTC:0.1UF,20%,100V	0000M	285-1165-00
C811	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C814	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
C850	285-1165-00			CAP.,FXD,PLSTC:0.1UF,20%,100V	0000M	2851165-00
C852	285-1165-00			CAP.,FXD,PLSTC:0.1UF,20%,100V	0000M	285-1165-00
C853	285-1165-00			CAP.,FXD,PLSTC:0.1UF,20%,100V	0000M	285-1165-00
C891	285-1165-00			CAP.,FXD,PLSTC:0.1UF,20%,100V	0000M	285-1165-00
C900	290-0725-00			CAP.,FXD,ELCTLT:100UF,+75-10%,50V	56289	30D107G050DH9
C901	290-0776-00			CAP.,FXD,ELCTLT:22UF,+50-10%,10V	0000L	ECE-A10V22L
C902	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C905	281-0786-00	300001	300160	CAP.,FXD,CER DI:150PF,10%,100V	72982	8035D2AADX5P151K
C905	281-0812-00	300161		CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C930	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C940	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C941	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C950	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C951	283-0084-00	X300481		CAP.,FXD,CER DI:270PF,5%,1000V	72982	838-533B271J
C952	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	72982	838-533B271J
C955	290-0820-00			CAP.,FXD,ELCTLT:2.2UF,+75-10%,50V	0000M	290-0820-00
C971	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C980	290-0776-00			CAP.,FXD,ELCTLT:22UF,+50-10%,10V	0000L	ECE-A10V22L
C981	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C1000	283-0279-00			CAP.,FXD,CER DI:0.001UF,20%,3000V	56289	55C153
C1001	283-0279-00			CAP.,FXD,CER DI:0.001UF,20%,3000V	56289	55C153
C1002	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C1003	290-0826-00			CAP.,FXD,ELCTLT:2200UF,+100-10%,35V	0000M	290-0826-00
C1004	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C1010	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C1030	290-0833-00			CAP.,FXD,ELCTLT:100UF,+50-10%,50V	0000M	290-0833-00
C1048	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C1066	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C1068	285-1166-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	80009	285-1166-00
C1070	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C1072	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C1095	290-0771-00			CAP.,FXD,ELCTLT:220UF,+50-10%,10VDC	0000L	ECE-A10V220L
C1100	285-1117-00			CAP.,FXD,PLSTC:0.018UF,2%,100V	0000M	285-1117-00
C1120	285-1117-00			CAP.,FXD,PLSTC:0.018UF,2%,100V	0000M	285-1117-00
C1130	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223

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C1131	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C1138	290-0740-00			CAP.,FXD,ELCTLT:68UF,20%,16V	0000M	290-0740-00
C1150	290-0740-00			CAP.,FXD,ELCTLT:68UF,20%,16V	0000M	290-0740-00
C1152	290-0740-00			CAP.,FXD,ELCTLT:68UF,20%,16V	0000M	290-0740-00
C1156	290-0821-00			CAP.,FXD,ELCTLT:10UF,+50-10%,160V	0000M	290-0821-00
C1161	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
C1166	290-0821-00			CAP.,FXD,ELCTLT:10UF,+50-10%,160V	0000M	290-0821-00
C1169	290-0755-00			CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C1206	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C1218	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131N300Z5U0103P
C1230	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C1232	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C1238	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C1240	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C1244	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
CR110	152-0246-00			SEMICOND DEVICE:SILICON,400PIV,200MA	80009	152-0246-00
CR145	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR147	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR148	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR170	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR171	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR172	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR173	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR175	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR180	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR181	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR182	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR183	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR200	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR210	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR217	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR220	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR221	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR226	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR228	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR231	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR236	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR255	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR256	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR275	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR276	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR298	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR299	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR310	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR312	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR314	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR316	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR320	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR386	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR500	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR502	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR503	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR510	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR522	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR581	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00

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CR585	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR594	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR596	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR600	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR602	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR700	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR702	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR800	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR801	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR814	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR820	152-0246-00			SEMICOND DEVICE:SILICON,400PIV,200MA	80009	152-0246-00
CR821	152-0246-00			SEMICOND DEVICE:SILICON,400PIV,200MA	80009	152-0246-00
CR890	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR902	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR903	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR904	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR930	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR940	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR950	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	80009	152-0333-00
CR955	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR956	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR973	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR983	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1001	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	80009	152-0488-00
CR1003	152-0447-00			SEMICOND DEVICE:RECT,SI,1A	0000M	152-0447-00
CR1004	152-0447-00			SEMICOND DEVICE:RECT,SI,1A	0000M	152-0447-00
CR1015	152-0447-00			SEMICOND DEVICE:RECT,SI,1A	0000M	152-0447-00
CR1040	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1051	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1052	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1060	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR1062	152-0694-00			SEMICOND DEVICE:RECT,SI,420V,1A	0000M	152-0694-00
CR1071	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1072	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1084	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1100	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1120	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1130	152-0694-00			SEMICOND DEVICE:RECT,SI,420V,1A	0000M	152-0694-00
CR1131	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1136	152-0694-00			SEMICOND DEVICE:RECT,SI,420V,1A	0000M	152-0694-00
CR1138	152-0694-00			SEMICOND DEVICE:RECT,SI,420V,1A	0000M	152-0694-00
CR1156	152-0694-00			SEMICOND DEVICE:RECT,SI,420V,1A	0000M	152-0694-00
CR1160	152-0694-00			SEMICOND DEVICE:RECT,SI,420V,1A	0000M	152-0694-00
CR1162	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1163	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1166	152-0694-00			SEMICOND DEVICE:RECT,SI,420V,1A	0000M	152-0694-00
CR1208	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1218	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR1222	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR1226	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR1228	152-0242-00			SEMICOND DEVICE:SILICON,225V,200MA	80009	152-0242-00
CR1244	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
CR1246	152-0327-00			SEMICOND DEVICE:SIG,SI,BAX 13	0000M	152-0327-00
DS800	150-0131-00			LAMP,INCAND:120V,0.025A	71744	120PS

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DS1050	150-1057-00			LT EMITTING DIO:GREEN,20MA	0000M	150-1057-00
F1000	159-0163-00			FUSE,CARTRIDGE:0.25A,250V,0.2 SEC	0000M	159-0163-00
F1000	----- -----			(115V OPERATION ONLY)		
F1000	159-0164-00			FUSE,CARTRIDGE:0.1A,250V,5 SEC	0000M	159-0164-00
F1000	----- -----			(230V OPERATION ONLY)		
F1002	159-0156-00			FUSE,CARTRIDGE:1.5A,250V	0000M	159-0156-00
F1015	159-0059-00			FUSE,WIRE LEAD:5A,FAST-BLOW	71400	GFA5
L195	108-0692-00			COIL,TOROID:FIXED,270UH	0000M	108-0692-00
L196	108-0692-00			COIL,TOROID:FIXED,270UH	0000M	108-0692-00
L402	108-0692-00	300001	300160	COIL,TOROID:FIXED,270UH	0000M	108-0692-00
L402	108-0948-00	300161		COIL,RF:FIXED,100UH,10%,FERRITE	0000M	108-0948-00
L404	108-0692-00	300001	300160	COIL,TOROID:FIXED,270UH	0000M	108-0692-00
L404	108-0948-00	300161		COIL,RF:FIXED,100UH,10%,FERRITE	0000M	108-0948-00
L550	108-0587-00			COIL,RF:FIXED,5.6MH	0000M	108-0587-00
L632	108-0692-00			COIL,TOROID:FIXED,270UH	0000M	108-0692-00
L636	108-0692-00			COIL,TOROID:FIXED,270UH	0000M	108-0692-00
L1060	108-0906-00			COIL,RF:FIXED,1MH	0000M	108-0906-00
L1300	108-0671-00			COIL,TUBE DEFL:TRACE ROTATION	0000M	108-0671-00
Q100A,B	151-1116-00			TRANSISTOR:FET DUAL,SI,N-CHAN,2SK18A-Y	0000M	151-1116-00
Q110	151-1092-00			TRANSISTOR:FET,N CHANNEL,SI,2SK23A	0000M	151-1092-00
Q113	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q120A,B	151-1116-00			TRANSISTOR:FET DUAL,SI,N-CHAN,2SK18A-Y	0000M	151-1115-00
Q130	151-1092-00			TRANSISTOR:FET,N-CHANNEL,SI,2SK23A	0000M	151-1092-00
Q133	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q140	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q145	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q147	151-0665-00			TRANSISTOR:PNP,SI,2SA733 TO-92	0000M	151-0665-00
Q200	151-0611-00			TRANSISTOR:NPN,SI,2SC1674	0000M	151-0611-00
Q203	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q210	151-0611-00			TRANSISTOR:NPN,SI,2SC1674	0000M	151-0611-00
Q213	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q220	151-0216-00			TRANSISTOR:SILICON,PNP	80009	151-0216-00
Q222	151-1111-00			TRANSISTOR:FET,N-CHAN,SI,2SK43-2,TO-92	0000M	151-1111-00
Q224	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q230	151-0216-00			TRANSISTOR:SILICON,PNP	80009	151-0216-00
Q232	151-1111-00			TRANSISTOR:FET,N-CHAN,SI,2SK43-2,TO-92	0000M	151-1111-00
Q234	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q260	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q280	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q310A,B	151-1112-00			TRANSISTOR:FET,DUAL,SI,2SK97-1,6 DIP	0000M	151-1112-00
Q316	151-1092-00			TRANSISTOR:FET,N-CHANNEL,SI,2SK23A	0000M	151-1092-00
Q320	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q322	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q325	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q336	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q350A,B	151-0670-00			TRANSISTOR:PNP,DUAL,SI,2SA884,6 DIP	0000M	151-0670-00
Q390	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q500	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q510	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q520A,B	151-1112-00			TRANSISTOR:FET,DUAL,SI,2SK97-1,6 DIP	0000M	151-1112-00
Q525	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q526	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q528	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00

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Q575	151-1111-00			TRANSISTOR:FET,N-CHAN,SI,2SK43-2,TO-92	0000M	151-1111-00
Q580	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q585A,B	151-0670-00			TRANSISTOR:PNP,DUAL,SI,2SA884,6 DIP	0000M	151-0670-00
Q594	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q600	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q605	151-0672-00			TRANSISTOR:PNP,SI,2SA639S,TO-92	0000M	151-0672-00
Q610	151-0677-00			TRANSISTOR:NPN,SI,2SC926A-5,TO-202	0000M	151-0677-00
Q620	151-0672-00			TRANSISTOR:PNP,SI,2SA639S,TO-92	0000M	151-0672-00
Q630	151-0677-00			TRANSISTOR:NPN,SI,2SC926A-5,TO-202	0000M	151-0677-00
Q635	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q704	151-0677-00			TRANSISTOR:NPN,SI,2SC926A-5,TO-202	0000M	151-0677-00
Q708	151-0672-00			TRANSISTOR:PNP,SI,2SA639S,TO-92	0000M	151-0672-00
Q820	151-1111-00			TRANSISTOR:FET,N-CHAN,SI,2SK43-2,TO-92	0000M	151-1111-00
Q885	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q886	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q887	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q888	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q889	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q890	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q900	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q901	151-1092-00			TRANSISTOR:FET,N-CHANNEL,SI,2SK23A	0000M	151-1092-00
Q905	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q910	151-0601-00			TRANSISTOR:NPN,SI,2SC1475	0000M	151-0601-00
Q958	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q970	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q980	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q1010	151-0671-00			TRANSISTOR:NPN,SI,2SC1983,TO-220	0000M	151-0671-00
Q1015	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q1060	151-0688-00			TRANSISTOR NPN,SI:2SA671	0000M	151-0688-00
Q1061	151-0688-00			TRANSISTOR NPN,SI:2SA671	0000M	151-0688-00
Q1062	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q1064	151-0601-00			TRANSISTOR:NPN,SI,2SC1475	0000M	151-0601-00
Q1066	151-0601-00			TRANSISTOR:NPN,SI,2SC1475	0000M	151-0601-00
Q1090	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q1100	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q1110	151-0669-00			TRANSISTOR:NPN,SI,2SC1816-03,TO-220	0000M	151-0669-00
Q1115	151-0669-00			TRANSISTOR:NPN,SI,2SC1816-03,TO-220	0000M	151-0669-00
Q1120	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q1148	151-1087-00			TRANSISTOR:NPN,SI,2SC1364	0000M	151-1087-00
Q1160	151-0677-00			TRANSISTOR:NPN,SI,2SC926A-5,TO-202	0000M	151-0677-00
Q1161	151-0677-00			TRANSISTOR:NPN,SI,2SC926A-5,TO-202	0000M	151-0677-00
Q1169	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q1212	151-0665-00			TRANSISTOR:PNP,SI,2SA733,TO-92	0000M	151-0665-00
Q1218	151-0677-00			TRANSISTOR:NPN,SI,2SC926A-5,TO-202	0000M	151-0677-00
Q1236	151-0667-00			TRANSISTPR:NPN,SI,2SC926A-5,TO-202	0000M	151-0667-00
R1	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R2	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4A	321-0790-01			RES.,FXD,FILM:990K OHM,0.5%,0.125W	91637	HFF1104G99002D
R4B	321-1289-01			RES.,FXD,FILM:10.1K OHM,0.5%,0.125W	91637	MFF1816G10101D
R5A	321-0807-01			RES.,FXD,FILM:900K OHM,0.5%,0.125W	91637	MFF1816G90002D
R5B	321-0389-01			RES.,FXD,FILM:110K OHM,0.5%,0.125W	91637	MFF1816G11002D
R6	321-0481-01			RES.,FXD,FILM:1M OHM,0.5%,0.125W	91637	MFF1816G10003D
R7	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R8	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R11	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515

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R12	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R14A	321-0790-01			RES.,FXD,FILM:990K OHM,0.5%,0.125W	91637	HFF1104G99002D
R14B	321-1289-01			RES.,FXD,FILM:10.1K OHM,0.5%,0.125W	91637	MFF1816G10101D
R15A	321-0807-01			RES.,FXD,FILM:900K OHM,0.5%,0.125W	91637	MFF1816G90002D
R15B	321-0389-01			RES.,FXD,FILM:110K OHM,0.5%,0.125W	91637	MFF1816G11002D
R16	321-0481-01			RES.,FXD,FILM:1M OHM,0.5%,0.125W	91637	MFF1816G10003D
R17	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R18	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R20	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R52	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R54	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R60	321-0338-00			RES.,FXD,FILM:32.4K OHM,1%,0.125W	91637	MFF1816G32401F
R61	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R62A	321-0649-00			RES.,FXD,FILM:2.19K OHM,0.25%,0.125W	91637	MFF1816D21900C
R62B	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R63	321-0126-03			RES.,FXD,FILM:200 OHM,0.25%,0.125W	91637	MFF1816D200R0C
R65	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R100	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R101	321-0068-00	300001	300250X	RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
R102	311-2005-00			RES.,VAR,NONWIR:CKT BD,100 OHM,10%,0.5W	0000M	311-2005-00
R103	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R104	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R105	311-1994-00			RES.,VAR NONWIR:CKT BD,1K X 1K OHM,20%,0.1W	0000M	311-1994-00
R106A-E	307-0618-00			RES.,NTWK,FXD FI:100 OHM,5%,200 OHM,0.25%	0000M	307-0618-00
R107	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R109	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R111	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R112	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R113	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R114	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R115	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R116	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
R117	311-0605-00			RES.,VAR,NONWIR:200 OHM,10%,0.50W	73138	82-23-1
R118	311-1998-00			RES.,VAR,NONWIR:PNL,10K OHM,10%,0.1W,LINEAR	0000M	311-1998-00
R120	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R121	321-0068-00	300001	300250X	RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
R122	311-2005-00			RES.,VAR,NONWIR:CKT BD,100 OHM,10%,0.5W	0000M	311-2005-00
R123	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R124	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R125	311-1992-00			RES.,VAR,NONWIR:CKT BD,1K OHM,20%,0.1W,DPDT	0000M	311-1992-00
R126A-E	307-0618-00			RES.,NTWK,FXD FI:100 OHM,5%,200 OHM,0.25%	0000M	307-0618-00
R127	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R129	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R131	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R132	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R133	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R134	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R135	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R136	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
R137	311-0605-00			RES.,VAR,NONWIR:200 OHM,10%,0.50W	73138	82-23-1
R138	311-1998-00			RES.,VAR,NONWIR:PNL,10K OHM,10%,0.1W,LINEAR	0000M	311-0998-00
R140	321-0147-00			RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
R142	321-0147-00			RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
R143	311-0635-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	73138	82-32-0
R144	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015

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R145	321-0208-00			RES.,FXD,FILM:1.43K OHM,1%,0.125W	91637	MFF1816G14300F
R147	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R148	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R149	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R170	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R171	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R172	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R180	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R181	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R182	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R183	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R185	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R187	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R195	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R196	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R197	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R200	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R201	321-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
R203	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
R204	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R205	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R206	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R207	311-1986-00			RES.,VAR,NONWIR:CKT BD,50K OHM,20%,0.5W	0000M	311-1986-00
R208	311-1982-00			RES.,VAR,NONWIR:CKT BD,200 OHM,20%,0.5W	0000M	311-1982-00
R210	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R211	321-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
R213	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
R216	321-0255-00			RES.,FXD,FILM:4.42K OHM,1%,0.125W	91637	MFF1816G44200F
R217	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R221	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R222	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R224	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R226	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R228	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R231	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R232	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R234	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R236	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R250	321-0314-00			RES.,FXD,FILM:18.2K OHM,1%,0.125W	91637	MFF1816G18201F
R251	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	91637	MFF1816G49902F
R252	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R253	321-0362-00			RES.,FXD,FILM:57.6K OHM,1%,0.125W	91637	MFF1816G57601F
R254	321-0381-00			RES.,FXD,FILM:90.9K OHM,1%,0.125W	91637	MFF1816G90901F
R255	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R256	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R260	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R265	311-1988-00			RES.,VAR,NONWIR:CKT BD,200K OHM,20%,0.5W	0000M	311-1988-00
R270	321-0314-00			RES.,FXD,FILM:18.2K OHM,1%,0.125W	91637	MFF1816G18201F
R271	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	91637	MFF1816G49902F
R272	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R273	321-0362-00			RES.,FXD,FILM:57.6K OHM,1%,0.125W	91637	MFF1816G57601F
R274	321-0381-00			RES.,FXD,FILM:90.9K OHM,1%,0.125W	91637	MFF1816G90901F
R275	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R276	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R280	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615

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R295	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R296	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R297	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R298	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R304	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R306	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	91637	MFF1816G10003F
R312	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
R314	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R315	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R317	311-1982-00	300001	300216	RES.,VAR,NONWIR:CKT BD,200 OHM,20%,0.5W	0000M	311-1982-00
R317	311-0605-00	300217		RES.,VAR,NONWIR:200 OHM,10%,0.50W	73138	82-23-1
R318	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R319	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R320	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R321	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R322	321-0201-00			RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
R323	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R324	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R325	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R325A	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R326A	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R326B	311-1985-00			RES.,VAR,NONWIR:CKT BD,10K OHM,20%,0.5W	0000M	311-1985-00
R327	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R328	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R330	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R332	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R336	315-0101-00	X300217		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R350	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R352	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R356	315-0101-00	X300217		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R370	311-1998-00			RES.,VAR,NONWIR:PNL,10K OHM,10%,0.1W,LINEAR	0000M	311-1998-00
R371	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
R371	315-0304-00			RES.,FXD,CMPSN:300K OHM,5%,0.25W	01121	CB3045
R371	315-0364-00			RES.,FXD,CMPSN:360K OHM,5%,0.25W	01121	CB3645
R372	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R374	315-0910-00			RES.,FXD,CMPSN:91 OHM,5%,0.25W	01121	CB9105
R375	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R376	311-1985-00			RES.,VAR,NONWIR:CKT BD,10K OHM,20%,0.5W	0000M	311-1985-00
R384	321-0213-00			RES.,FXD,FILM:1.62K OHM,1%,0.125W	91637	MFF1816G16200F
R388	321-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.125W	91637	MFF1816G14700F
R390	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R392	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R394	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R398	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R399	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R400	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R402	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R404	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R500	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R501	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R502	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R503	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R504	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R505	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R508	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

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R514	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R524	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R526	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R527A	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R527B	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R528	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R530A	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R530B	311-1266-00			RES.,VAR,NONWIR:2.5K OHM,10%,0.50W	32997	3329P-L58-252
R531	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R532	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R533	315-0300-00	X300217		RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R540	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R542	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R544	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R570A	321-0510-07			RES.,FXD,FILM:200 MEG OHM,0.1%,0.125W	91637	HFF1813C20003B
R570B	321-0648-02			RES.,FXD,FILM:500K OHM,0.5%,0.125W	24546	NC55C5003D
R570C	321-0648-02			RES.,FXD,FILM:500K OHM,0.5%,0.125W	24546	NC55C5003D
R570D	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R570E	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R570F	321-0289-01			RES.,FXD,FILM:10K OHM,0.5%,0.125W	91637	MFF1816G10001D
R570G	321-0816-01			RES.,FXD,FILM:5K OHM,0.25%,0.125W	24546	NC55C5001C
R575	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R577	321-0414-00			RES.,FXD,FILM:200K OHM,1%,0.125W	91637	MFF1816G20002F
R578	311-1993-00			RES.,VAR,NONWIR:CKT BD,10K OHM,20%,0.1W	0000M	311-1993-00
R579	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R581	311-1998-00			RES.,VAR,NONWIR:PNL,10K OHM,10%,0.1W,LINEAR	0000M	311-1998-00
R582	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R584	321-0754-01			RES.,FXD,FILM:900 OHM,0.5%,0.125W	0000M	321-0754-01
R585	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R586	321-0097-03			RES.,FXD,FILM:100 OHM,0.25%,0.125W	91637	MFF1816D100R0C
R587	321-0255-00			RES.,FXD,FILM:4.42K OHM,1%,0.125W	91637	MFF1816G44200F
R588A	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	CB3905
R588B	321-0131-00			RES.,FXD,FILM:226 OHM,1%,0.125W	91637	MFF1816G226R0F
R589	311-0634-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	82-31-0
R590	321-0255-00			RES.,FXD,FILM:4.42K OHM,1%,0.125W	91637	MFF1816G44200F
R592A	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R592B	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R593	311-1983-00			RES.,VAR,NONWIR:CKT BD,500 OHM,20%,0.5W	0000M	311-1983-00
R594	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R595	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R596	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R597	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R598	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R600	321-0265-00			RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F
R601	311-1985-00			RES.,VAR,NONWIR:CKT BD,10K OHM,20%,0.5W	0000M	311-1985-00
R602	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R604	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R605	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R606	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R607	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R612	321-0405-00	300004	300320	RES.,FXD,FILM:162K OHM,1%,0.125W	91637	MFF1816G16202F
R612	321-0408-00	300321		RES.,FXD,FILM:174K OHM,1%,0.125W	91637	MFF1816G17402F
R614	321-0405-00	300001	300320	RES.,FXD,FILM:162K OHM,1%,0.125W	91637	MFF1816G16202F
R614	321-0408-00	300321		RES.,FXD,FILM:174K OHM,1%,0.125W	91637	MFF1816G17402F
R615	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

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R620	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R622	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R624	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R630	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	91637	MFF1816G10003F
R632	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R634	321-0316-00			RES.,FXD,FILM:19.1K OHM,1%,0.125W	91637	MFF1816G19101F
R635	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	91637	MFF1816G10003F
R636	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R650	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R690	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R692	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R700	315-0203-00	300001	300250	RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R700	315-0123-00	300251		RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R701	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R702	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R703	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R708	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R710	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R711	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R712	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
R714	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R800	325-0282-00	300001	300110	RES.,FXD,FILM:10M OHM,1%,1W,TC=50 PPM/DEG	0000M	325-0282-00
R800	325-0282-01	300111		RES.,FXD,FILM:10M OHM,1%,1W,TC=25 PPM/DEG	0000M	325-0282-01
R801	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R802A-D	307-0608-00			RES.,NTWK,FXD FI:PRCN DECADE VOLTAGE DIVIDER	0000M	307-0608-00
R803	311-0613-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	73138	82-27-0
R804	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R805	315-0392-00	X300051		RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R810	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R811	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R812	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R814	315-0225-00			RES.,FXD,CMPSN:2.2M OHM,5%,0.25W	01121	CB2255
R815	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R816	315-0225-00			RES.,FXD,CMPSN:2.2M OHM,5%,0.25W	01121	CB2255
R820	321-0481-04			RES.,FXD,FILM:1M OHM,0.1%,0.125W	91637	HFF1816D10003B
R821	321-0644-00			RES.,FXD,FILM:100K OHM,0.25%,0.125W	91637	MFF1816C10002C
R822	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R823	321-0193-03			RES.,FXD,FILM:1K OHM,0.25%,0.125W	91637	MFF1816D10000C
R824	321-0252-00			RES.,FXD,FILM:4.12K OHM,1%,0.125W	91637	MFF1816G41200F
R825	311-2005-00			RES.,VAR,NONWIR:CKT BD,100 OHM,10%,0.5W	0000M	311-2005-00
R826	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R827	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R828	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R829	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R833	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R834	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R835	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R836	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R838	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R839	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R840	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R841	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R850	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R851	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
R852	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745

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R853	311-1980-00			RES.,VAR,NONWIR:CKT BD,5K OHM,10%,0.5W	0000M	311-1980-00
R854	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816G40201F
R855	311-1979-00			RES.,VAR,NONWIR:CKT BD,2K OHM,10%,0.5W	0000M	311-1979-00
R856	321-0313-00			RES.,FXD,FILM:17.8K OHM,1%,0.125W	91637	MFF1816G17801F
R857	321-0235-00			RES.,FXD,FILM:2.74K OHM,1%,0.125W	91637	MFF1816G27400F
R858	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R860	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R861	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R862	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R863	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R864	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R865	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R866	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R870	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R871	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R872	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R873	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R874	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R875	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R876	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R877	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R881	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R882	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R884	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R885	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R886	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R887	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R888	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R889	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R890	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R891	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R895	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R896	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R900	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R902	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R905	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R907	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R910	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R912	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R914	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R954	315-0244-00			RES.,FXD,CMPSN:240K OHM,5%,0.25W	01121	CB2445
R955	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R956	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R957	321-0227-00			RES.,FXD,FILM:2.26K OHM,1%,0.125W	91637	MFF1816G22600F
R958	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R959	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R960	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R970	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R972	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R975	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R980	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R981	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R982	315-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
R985	321-0692-00			RES.,FXD,FILM:49.9K OHM,0.5%,0.125W	91637	MFF1816G49901D
R986	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R995	311-1985-00			RES.,VAR,NONWIR:CKT BD,10K OHM,20%,0.5W	0000M	311-1985-00
R1003	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1006	307-0114-00			RES.,FXD,CMPSN:6.2 OHM,5%,0.25W	01121	CB62G5
R1008	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R1015	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1034	321-0331-00			RES.,FXD,FILM:27.4K OHM,1%,0.125W	91637	MFF1816G27401F
R1036	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R1038	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R1040	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R1042	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R1044	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R1046	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R1048	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R1050	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R1052	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R1060	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R1062	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R1064	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R1066	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1068	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R1069	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1070	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R1071	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R1072	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R1073	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R1074	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R1078	321-0093-00			RES.,FXD,FILM:90.9 OHM,1%,0.125W	91637	MFF1816G90R90F
R1080	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R1082	321-0093-00			RES.,FXD,FILM:90.9 OHM,1%,0.125W	91637	MFF1816G90R90F
R1084	311-0635-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	73138	82-32-0
R1086	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R1090	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1092	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R1094	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R1100	321-0215-00			RES.,FXD,FILM:1.69K OHM,1%,0.125W	91637	MFF1816G16900F
R1110	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R1115	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R1120	321-0215-00			RES.,FXD,FILM:1.69K OHM,1%,0.125W	91637	MFF1816G16900F
R1140	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R1142	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R1144	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R1148	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1156	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R1160	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1161	321-0807-00			RES.,FXD,FILM:900K OHM,1%,0.125W	91637	HFF1104F90002F
R1162	321-0339-00			RES.,FXD,FILM:33.2K OHM,1%,0.125W	91637	MFF1816G33201F
R1164	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1165	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R1166	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	91637	MFF1816G30101F
R1167	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1168	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R1169	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R1200	311-0698-00	300001	300380	RES.,VAR,NONWIR:1M OHM,0.50W	73138	82-36-0
R1200	311-0606-01	300381		RES.,VAR,NONWIR:TRMR,500K OHM,10%,0.5W	0000M	311-0606-01
R1202	311-1999-00			RES.,VAR,NONWIR:PNL,1M OHM,10%	0000M	311-1999-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1206	315-0205-00			RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R1208	315-0164-00			RES.,FXD,CMPSN:160K OHM,5%,0.25W	01121	CB1645
R1210	311-1987-00			RES.,VAR,NONWIR:CKT BD,100K OHM,20%,0.5W	0000M	311-1987-00
R1212	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R1213	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1214	315-0475-00			RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
R1216	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R1218	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R1220	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1222	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1224	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
R1226	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
R1228	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1229	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1234	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R1236	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R1238	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1244	321-0413-00			RES.,FXD,FILM:196K OHM,1%,0.125W	91637	MFF1816G19602F
R1300	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
R1302	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R1306	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R1308	311-1989-00			RES.,VAR,NONWIR:CKT BD,1 MEG OHM,20%,0.5W	0000M	311-1989-00
R1310	311-1988-00			RES.,VAR,NONWIR:CKT BD,200K OHM,20%,0.5%	0000M	311-1988-00
R1312	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R1320	311-1985-00			RES.,VAR,NONWIR:CKT BD,10K OHM,20%,0.5W	0000M	311-1985-00
RT205	307-0122-00			RES.,THERMAL:50 OHM,10%	50157	3D1515
RT588	307-0122-00			RES.,THERMAL:50 OHM,10%	50157	3D1515
S2	260-1910-00			SWITCH,TOGGLE:DPDT,250V,AC/GND/DC	0000M	260-1910-00
S4	263-1173-00			SW,CAM ACTR AS:VOLTS/DIV	80009	263-1173-00
S12	260-1910-00			SWITCH,TOGGLE:3P3T,250V,AC/GND/DC	80009	260-1910-00
S14	263-1173-00			SW,CAM ACTR AS:VOLTS/DIV	80009	263-1173-00
S20	214-2288-02			LEVER,SWITCH:STYLE A,17.5 DEG,W/CONTACTS	80009	214-2288-02
S120A,B	311-1992-00			RES,VAR,NONWIR:CKT BD,1K OHM,20%,0.1W DPDT	0000M	311-1992-00
S300A-D	260-1906-00			SWITCH,PUSH:4 BTN(3) 2P3(1) 4P,TRIG	0000M	260-1906-00
S380	260-1771-00			SWITCH,PUSH:1 BUTTON,DPDT	80009	260-1771-00
S570	263-1174-00			SWITCH CAM ACTR AS:TIME/DIV	80009	263-1174-00
S583A,B	311-1993-00			RES,VAR,NONWIR:CKT BD,10K OHM,20%,0.1W	0000M	311-1993-00
S800A-C	260-1905-00			SWITCH PUSH:3 BTN(1) 2 POLE (2) POLE	0000M	260-1905-00
S900	260-1771-00			SWITCH,PUSH:1 BUTTON,DPDT	80009	260-1771-00
S1001A,B	260-1917-00			SWITCH,SLIDE:DPDT,3A,250VAC	0000M	260-1917-00
S1005A,B	260-1731-00			SWITCH,SLIDE:DP3T,1A,12VAC,CKT CARD TERM.	29604	68-0328
S1030A,B	260-1771-00			SWITCH,PUSH:1 BUTTON,DPDT	80009	260-1771-00
T900	120-1169-00			XFMR,CONVERTER:	0000M	120-1169-00
T1001	120-1186-00			XFMR,PWR,STPDN:	0000M	120-1186-00
T1060	120-1177-00			TRANSFORMER,CUR:	0000M	120-1177-00
T1150	120-1184-00			XFMR,CONVERTER:	0000M	120-1184-00
U20A,B	156-0366-00			MICROCIRCUIT,DI:DUAL D-TYPE F-F	80009	156-0366-00
U100A-D	156-0197-00			MICROCIRCUIT,LI:5 TRANSISTOR ARRAY	80009	156-0197-00
U120A-D	156-0197-00			MICROCIRCUIT,LI:5 TRANSISTOR ARRAY	80009	156-0197-00
U180A-D	156-0349-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U185A-F	156-0494-00			MICROCIRCUIT,DI:HEX INVERTER/BUFFER	80009	156-0494-00
U260	156-1165-00			MICROCIRCUIT,LI:VERT OUTPUT AMPL	0000M	156-1165-00
U280	156-1165-00			MICROCIRCUIT,LI:VERT OUTPUT AMPL	0000M	156-1165-00
U330A-E	156-0197-00			MICROCIRCUIT,LI:5 TRANSISTOR ARRAY	80009	156-0197-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U390A-D	156-0381-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL OR GATES	80009	156-0381-00
U500A,B	156-0388-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	80009	156-0388-00
U570	156-1114-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-1114-00
U800	156-1114-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-1114-00
U805	156-0514-03			MICROCIRCUIT,DI:DIFF 4-CHANNEL MUX	0000M	156-0514-03
U810A,B	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U820	156-1114-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-1114-00
U825	156-0514-03			MICROCIRCUIT,DI:DIFF 4-CHANNEL MUX	0000M	156-0514-03
U830A-D	156-0289-00	300001	300510	MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0289-00
U830A-D	156-0644-00	300511		MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U840A-C	156-0515-00			MICROCIRCUIT,DI:TRIPLE 3-CHAN MUX	80009	156-0515-00
U850	156-1154-00			MICROCIRCUIT,DI:3.5 DIGIT AID CONVERTER	0000M	156-1154-00
U860	156-0795-00			MICROCIRCUIT,DI:BCD 7-SEG LCHDCDR/DRVR	80009	156-0795-00
U862	150-1056-00			LAMP,LED DSPL:RED	0000M	150-1056-00
U864	150-1056-00			LAMP,LED DSPL:RED	0000M	150-1056-00
U866	150-1056-00			LAMP,LED DSPL:RED	0000M	150-1056-00
U868	156-1056-00			MICROCIRCUIT,LI:DIFFERENTIAL COMPARATOR	04713	MC1514L
U870	156-1159-00			MICROCIRCUIT,DGTL:UP/DOWN COUNTER	0000M	156-1159-00
U880A-F	156-0494-00			MICROCIRCUIT,DI:HEX INVERTER/BUFFER	80009	156-0494-00
U885	156-0514-03			MICROCIRCUIT,DGTL:DIFF 4-CHANNEL MUX	0000M	156-0514-03
U890A-D	156-0350-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0350-00
U895A,B	156-0366-00			MICROCIRCUIT,DI:DUAL D-TYPE F-F	80009	156-0366-00
U960	156-1166-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	0000M	156-1166-00
U970A,B	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U1060A-D	156-0495-00			MICROCIRCUIT,LI:OPNL AMPLGL SUPPLY	80009	156-0495-00
U1140A,B	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U1230	156-1114-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-1114-00
U1240	119-1035-00			MODULE,HV:	0000M	119-1035-00
V1300	154-0667-02			ELECTRON TUBE:CRT,P31	80009	154-0667-02
VR603	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00
VR827	152-0306-00			SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	80009	152-0306-00
VR900	152-0217-00			SEMICOND DEVICE:ZENER,0.4W,8.2V,5%	80009	152-0217-00
VR981	152-0127-00			SEMICOND DEVICE:ZENER,0.4W,7.5V,5%	80009	152-0127-00
VR1066	152-0395-00			SEMICOND DEVICE:ZENER,0.4W,4.3V,5%	04713	1N749A
VR1080	152-0696-00	300001	300590	SEMICOND DEVICE:ZENER,0.4W,4.3V,5%	04713	1N749A
VR1080	152-0724-00	300591		SEMICOND DEVICE:ZENER,0.4W,4.7V,RD4.7E	0000M	152-0724-00
VR1304	152-0265-00			SEMICOND DEVICE:ZENER,0.4W,24V,5%	80009	152-0265-00
W101	131-0566-00			LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
W121	131-0566-00			LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1

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 (μF).

Resistors = Ohms (Ω).

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.

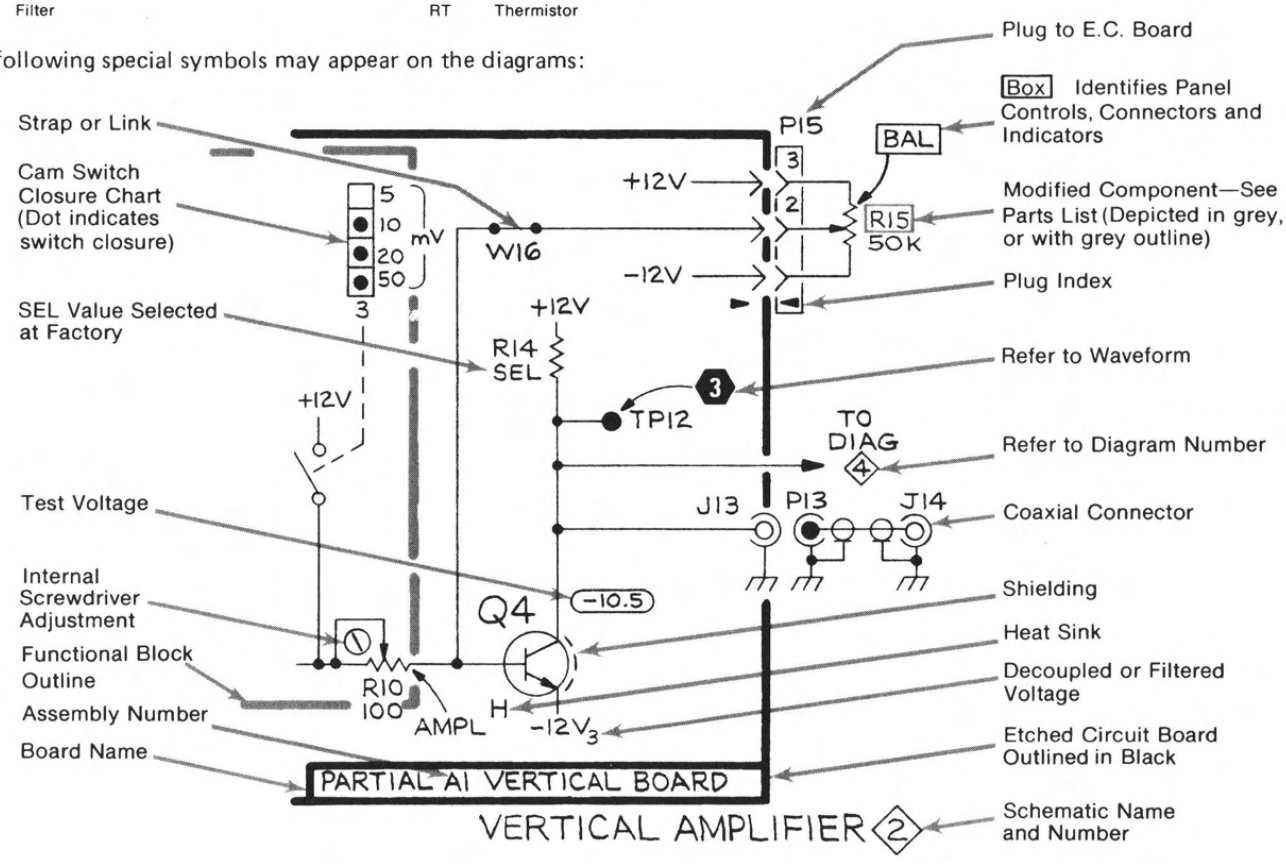
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

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)	Q	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:



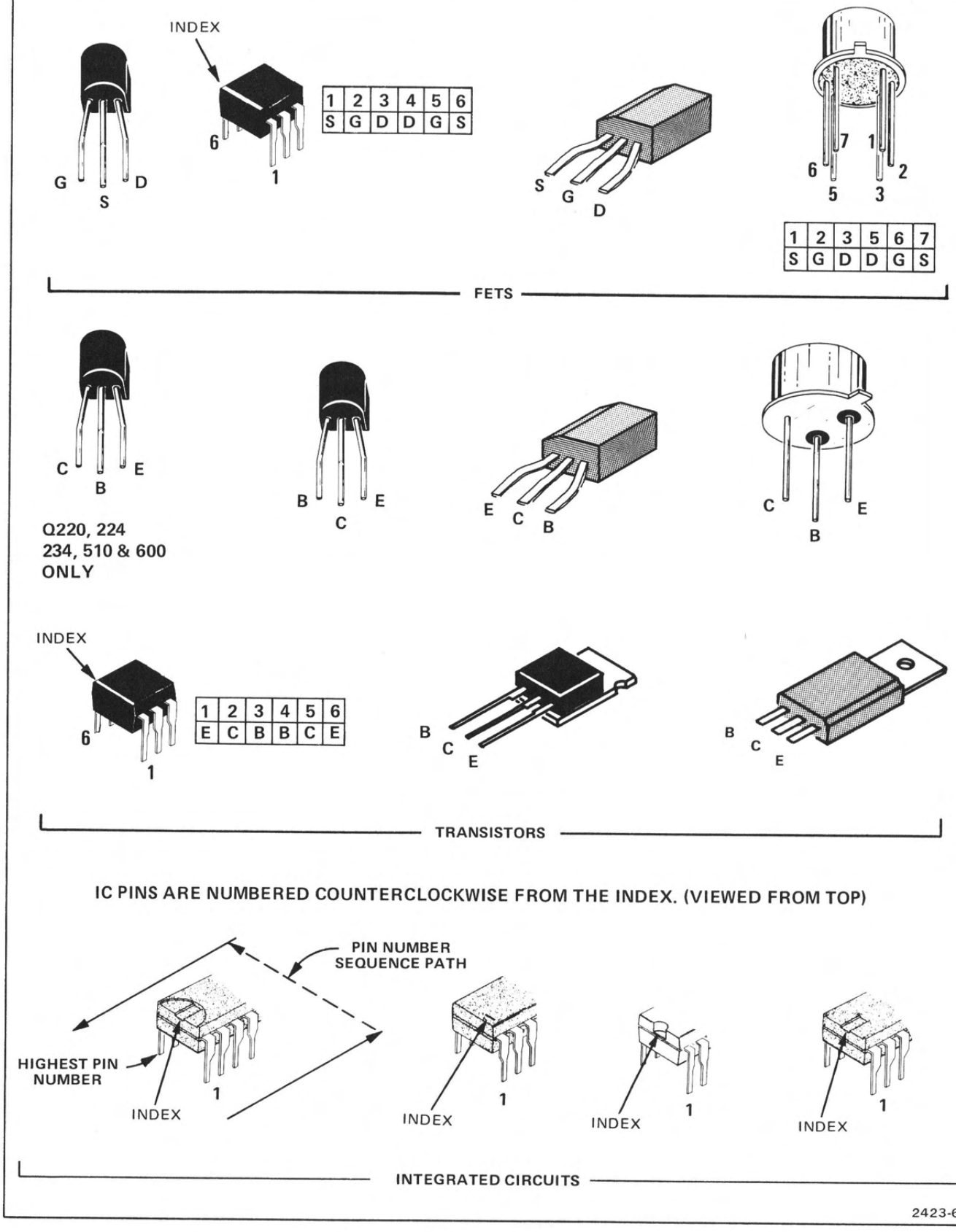


Figure 8-1. Semiconductor lead configurations.

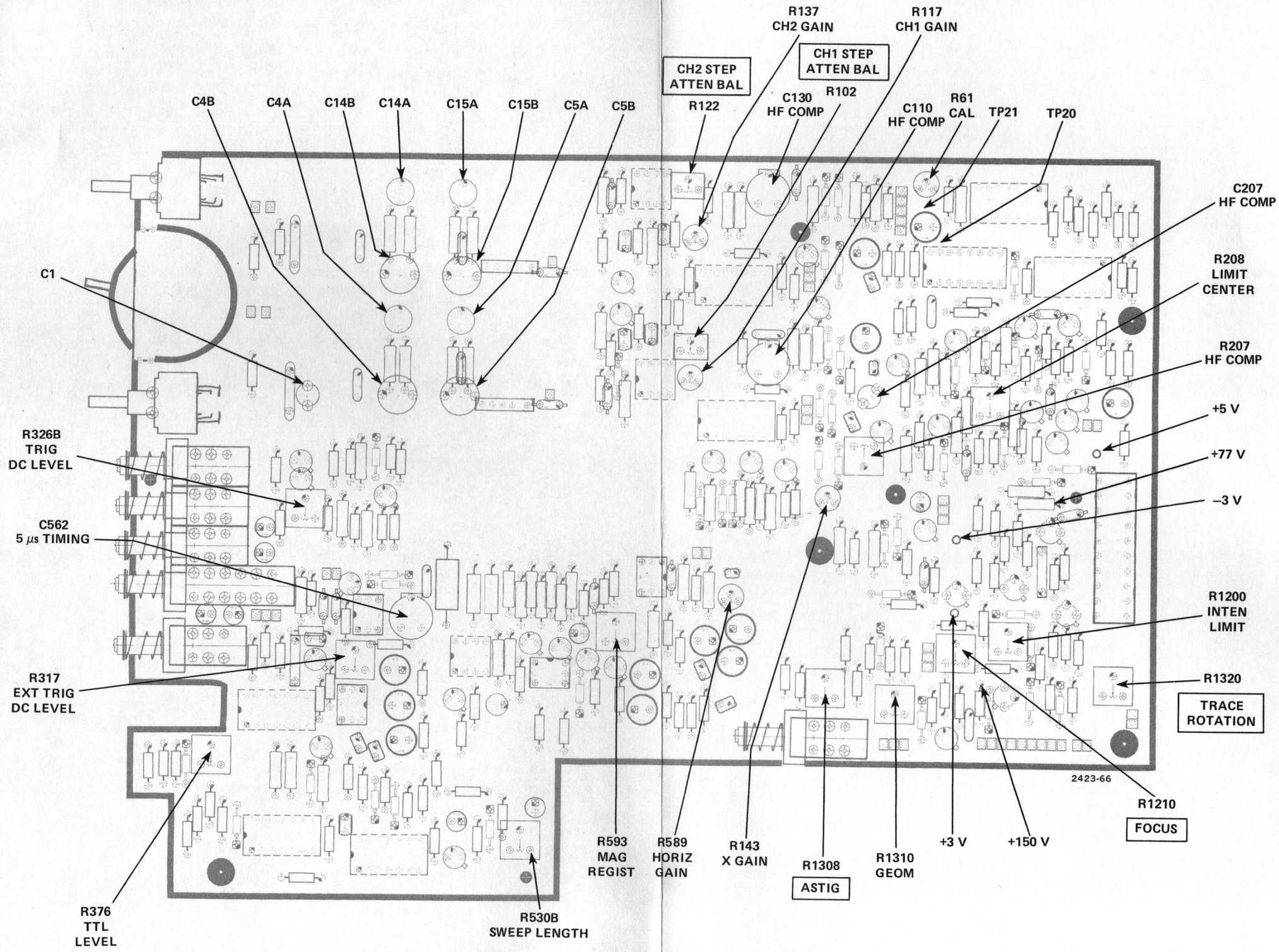


Figure 8-2. Adjustment locations, main board.

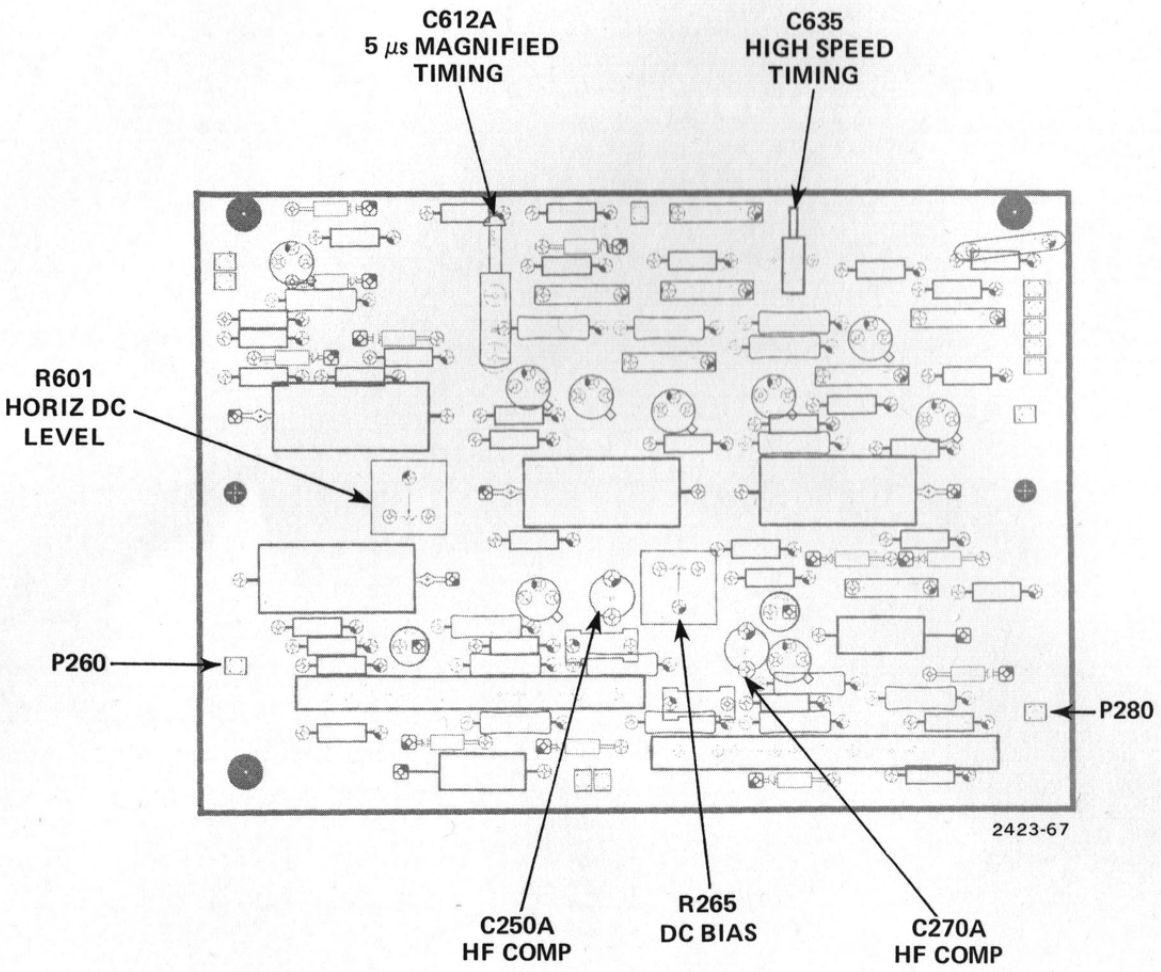


Figure 8-3. Adjustment locations, output amplifier board.

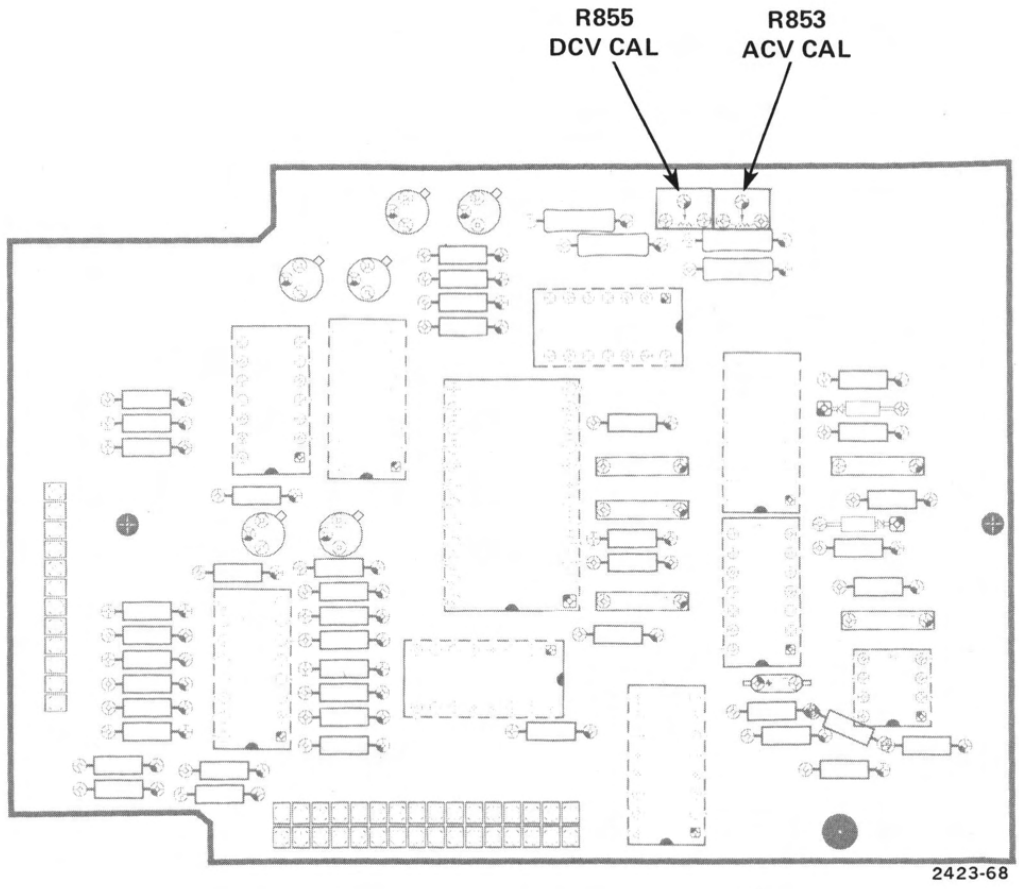


Figure 8-4. Adjustment locations, DMM A/D and logic board.

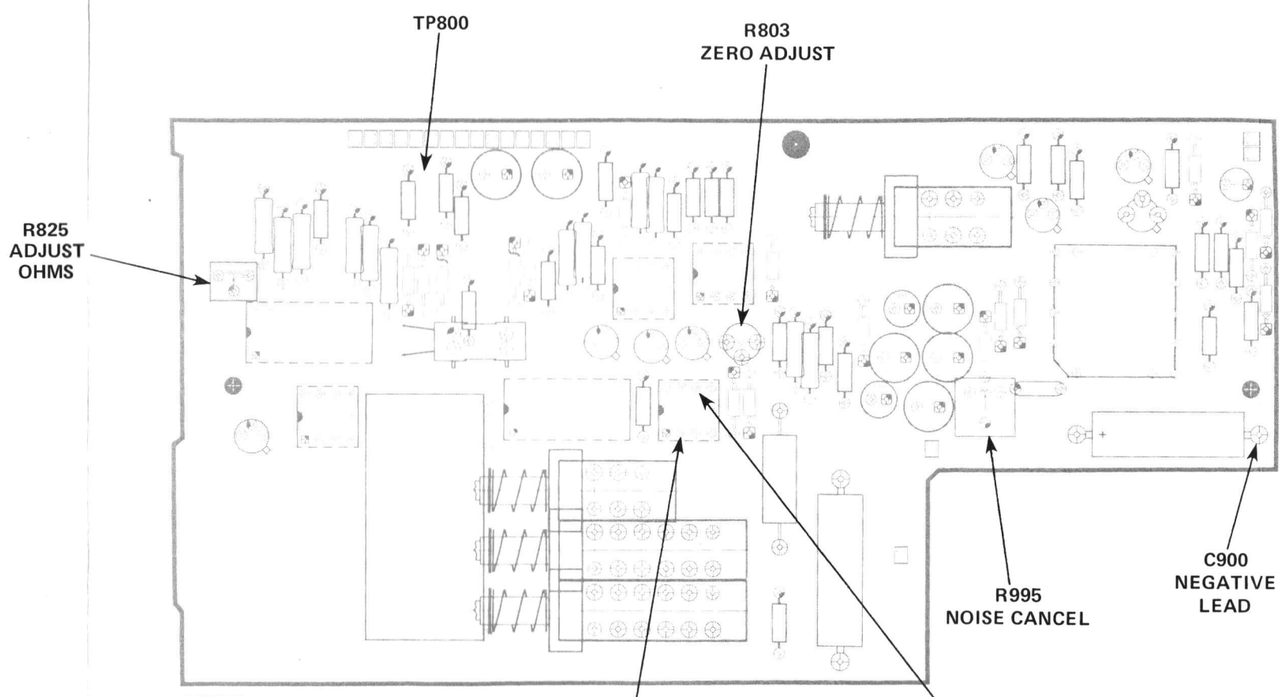


Figure 8-5. Adjustment locations, DMM input board.

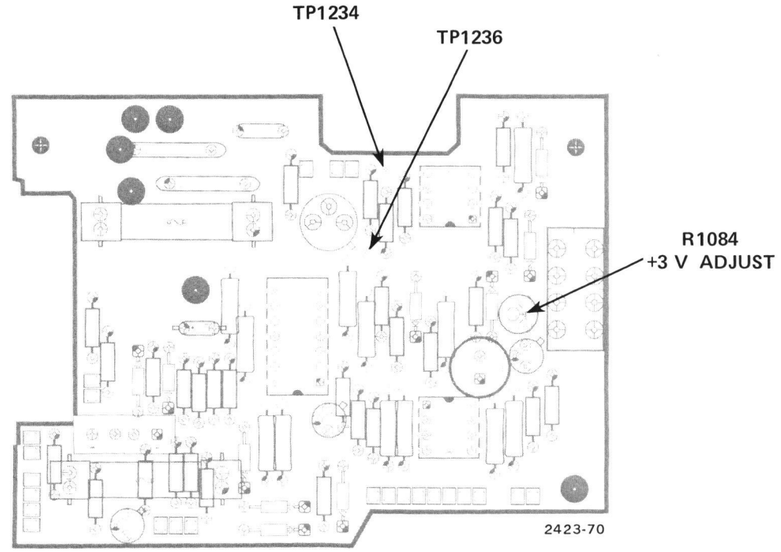
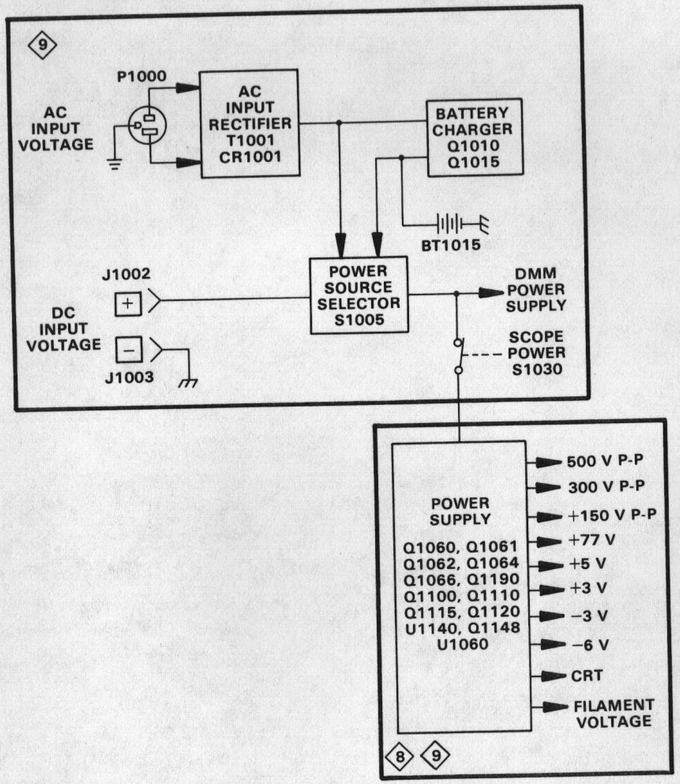
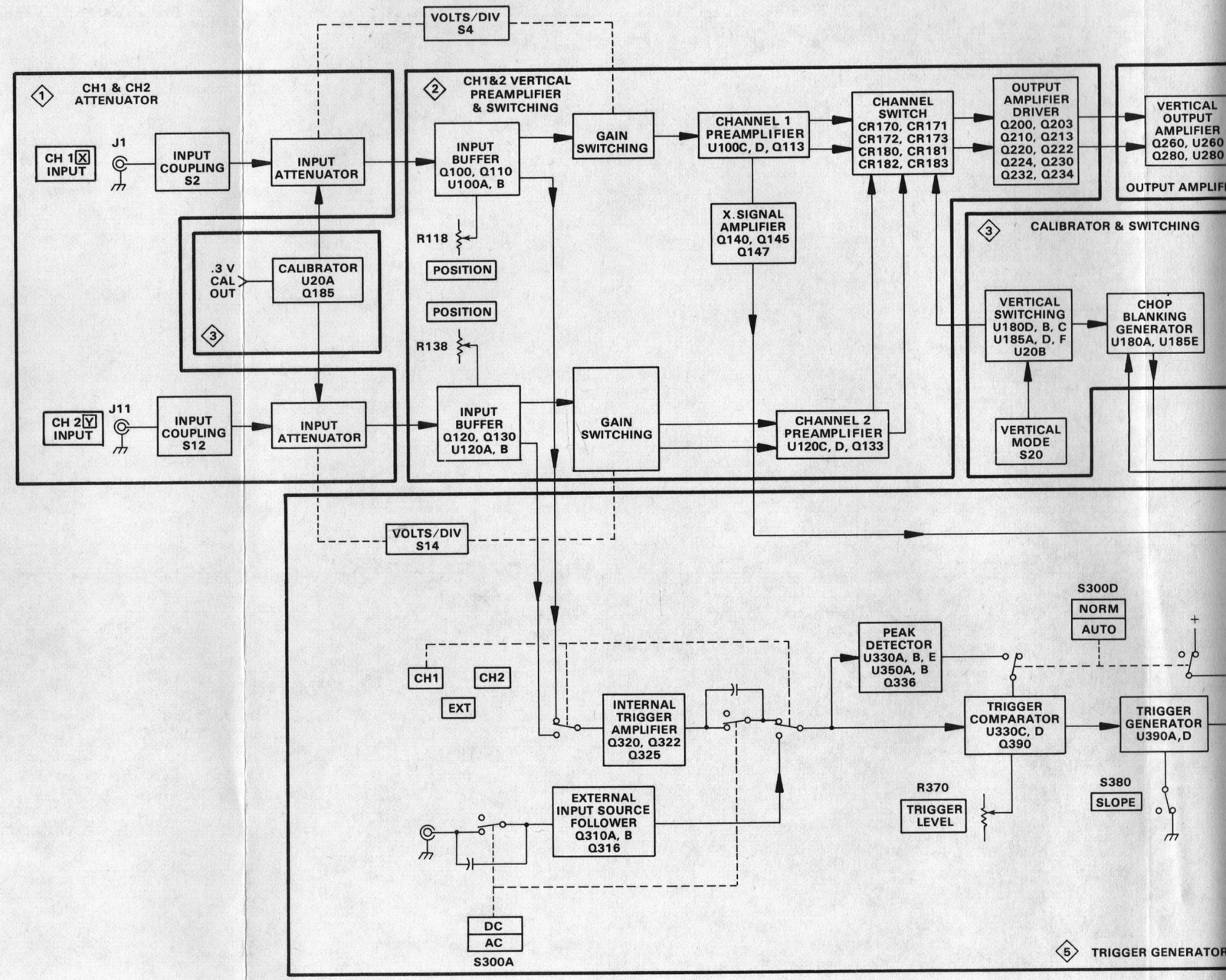
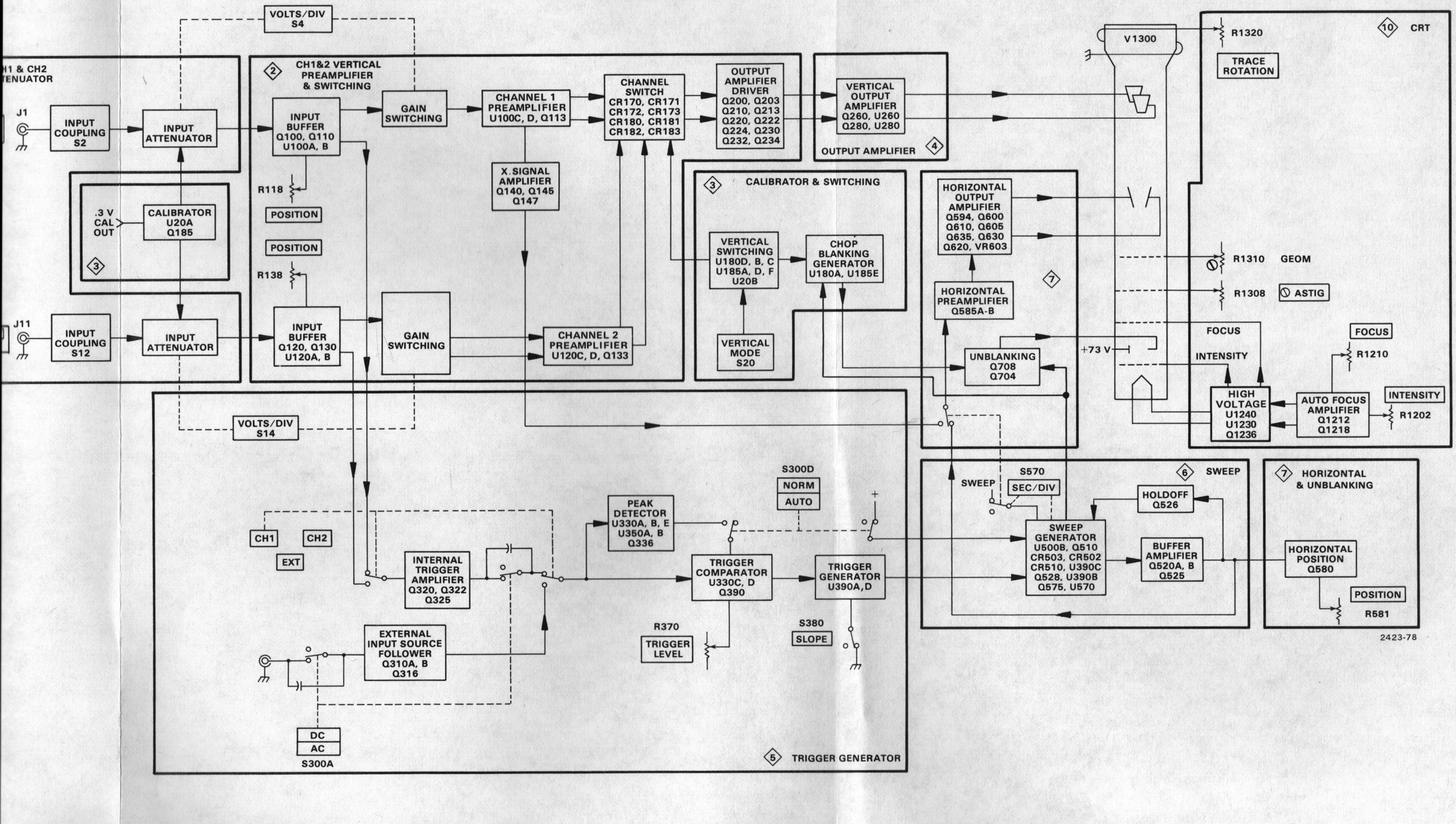


Figure 8-6. Adjustment locations, battery charger board.

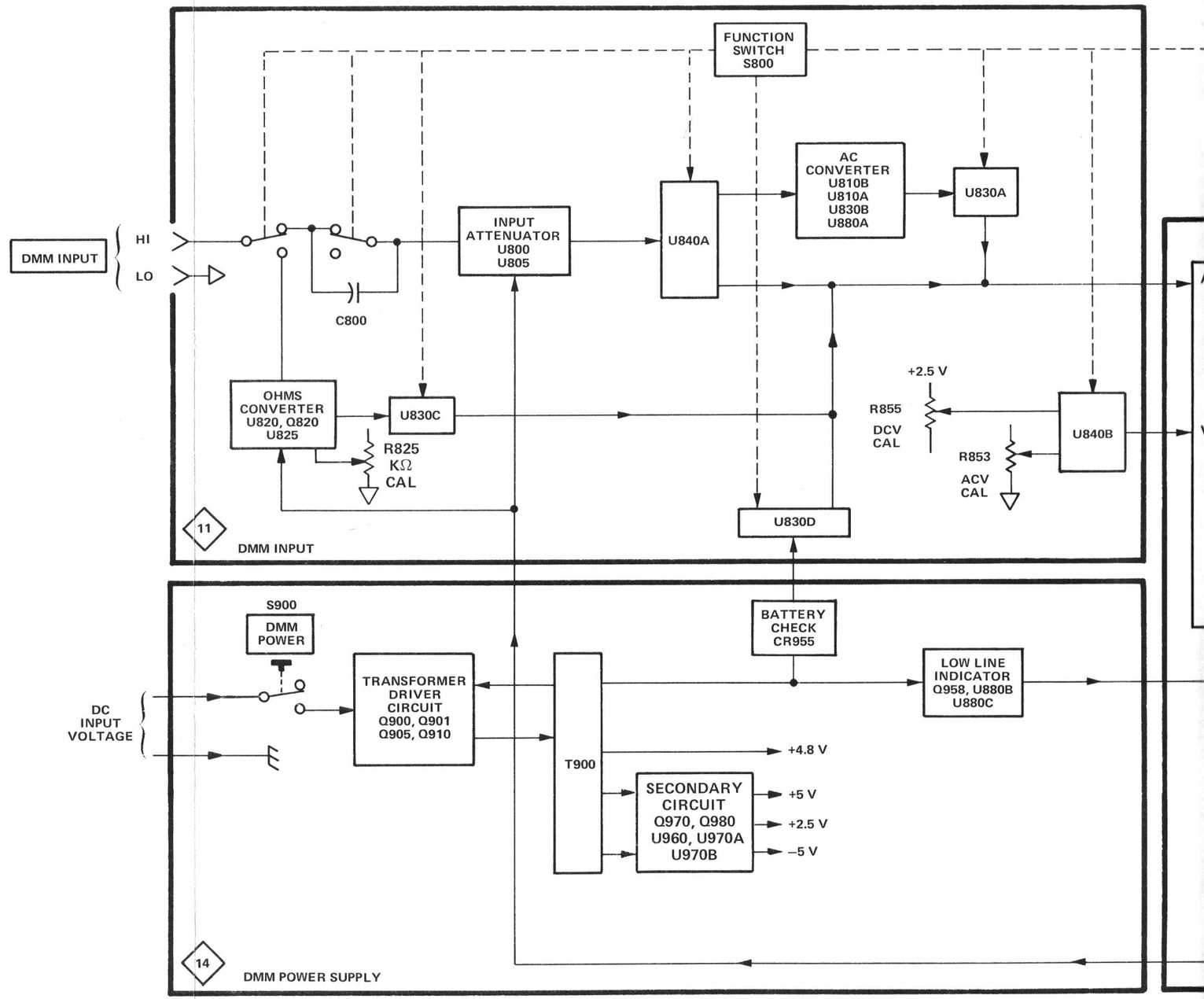




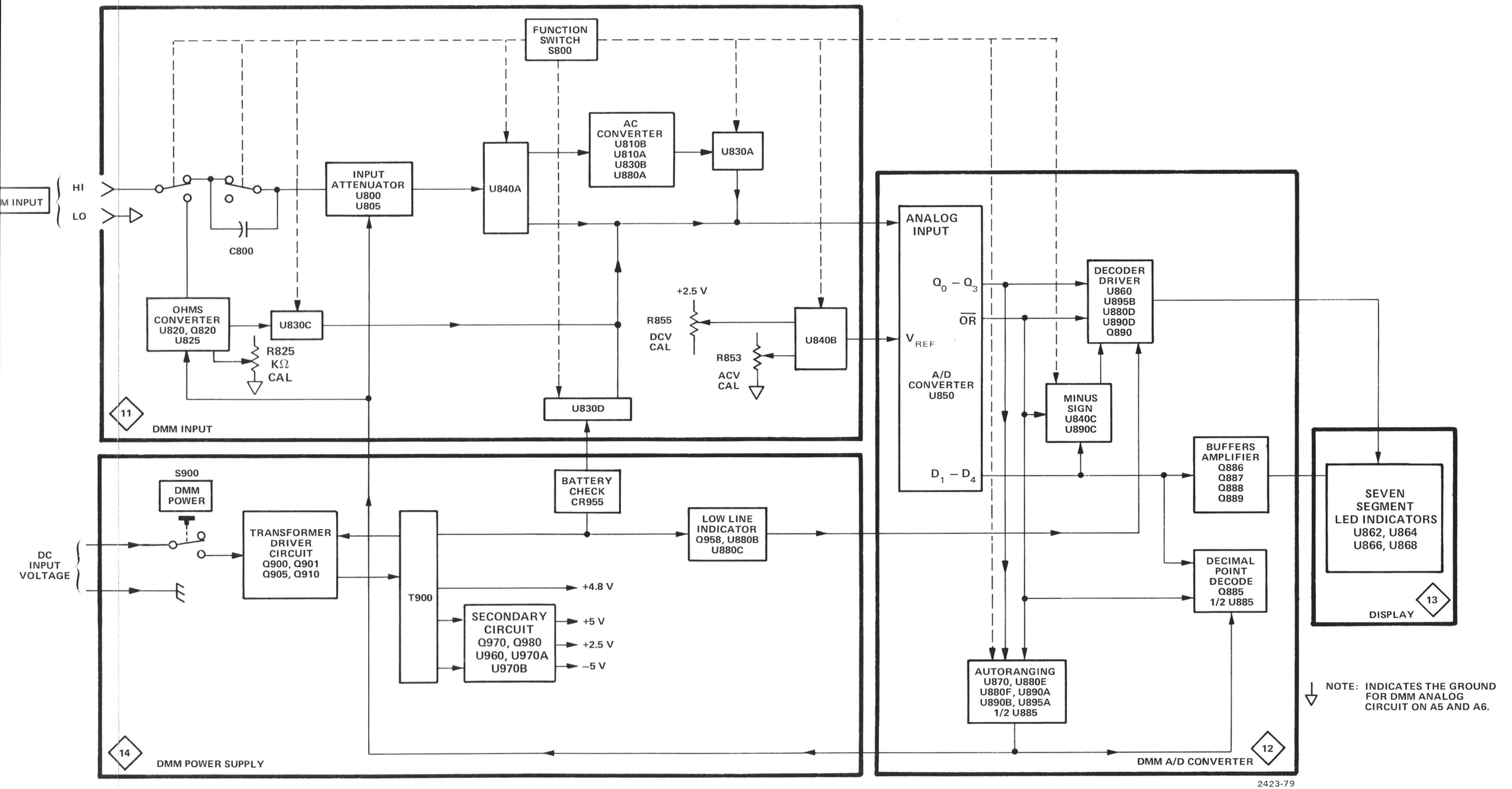
Block diagram of oscilloscope.



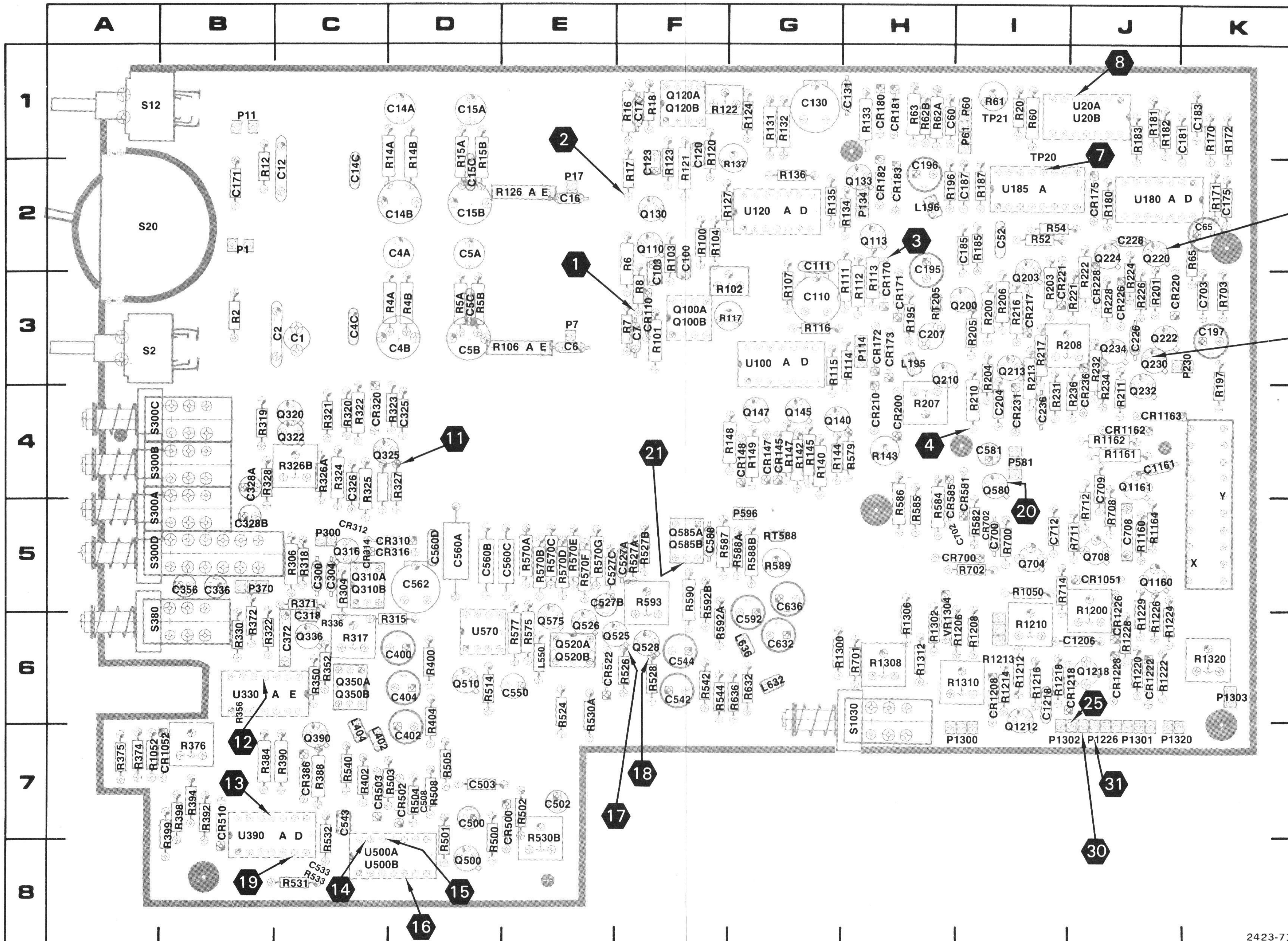
Block diagram of oscilloscope.

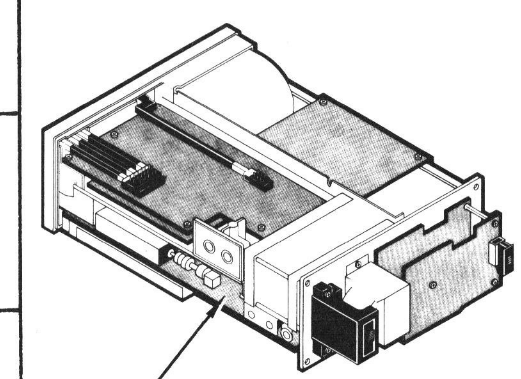


Block diagram of DMM.



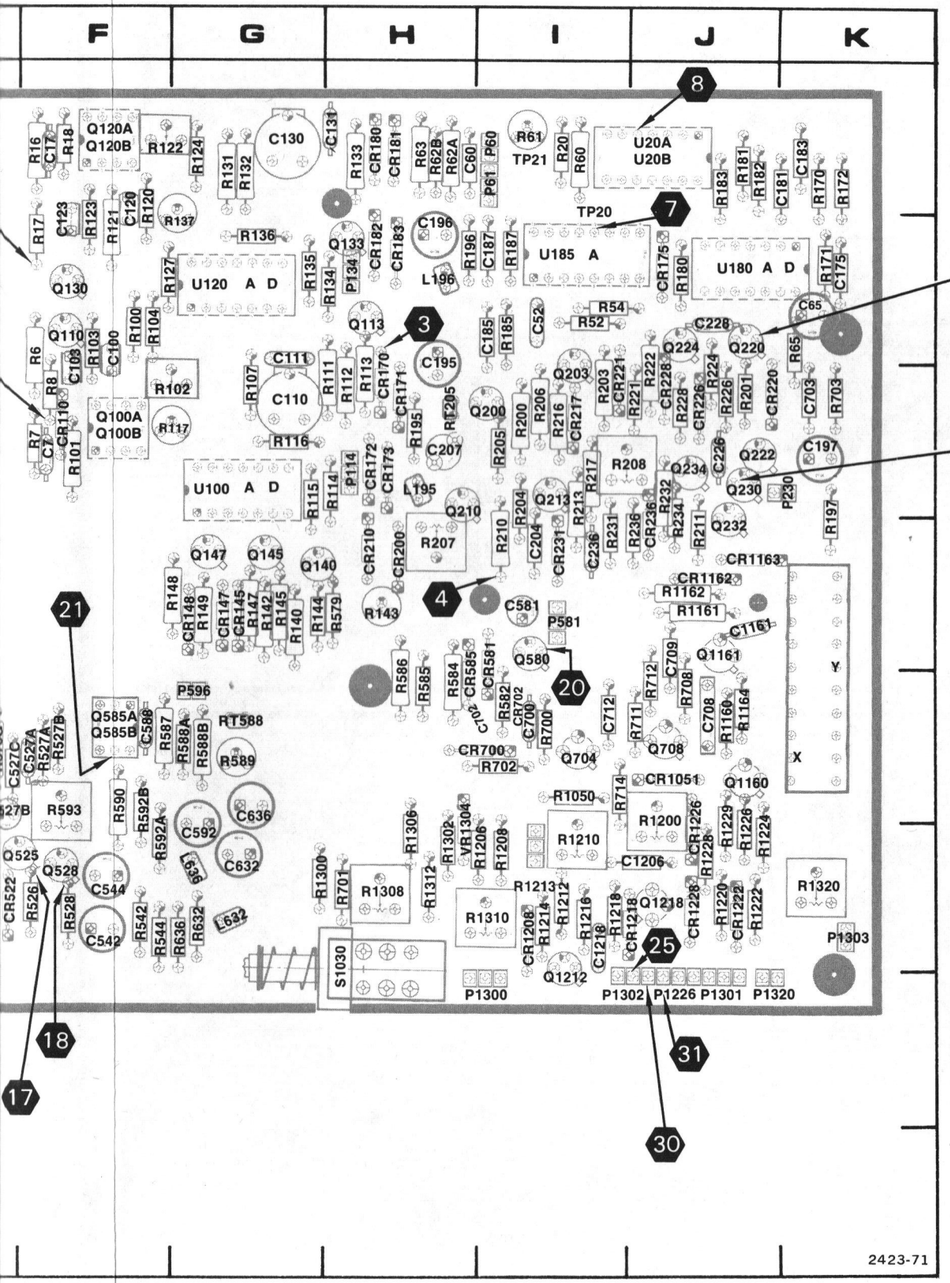
Block diagram of DMM.





CKT NO	GRID LOC
C1	3C
C2	3C
C4A	2D
C4B	3D
C4C	3C
C5A	2D
C5B	3D
C5C	3D
C6	3E
C12	2C
C14A	1D
C14B	2D
C14C	2C
C15A	1D
C15B	2D
C15C	2D
C16	2E
C17	1F
C52	2I
C60	1H
C65	2K
C100	2F
C103	2F
C110	3G
C111	2G
C120	1F
C123	2F
C130	1G
C131	1H
C171	2B
C175	2K
C181	1K
C183	1K
C185	2I
C187	2I
C195	2H
C196	2H
C197	3K
C204	4I
C207	3H
C226	3J
C228	2J
C236	4I
C300	5C
C304	5C
C318	6C
C325	4D
C326	4C
C328A	4B
C328B	5B
C336	5B
C356	5B
C372	6C
C400	6D
C402	7D
C404	6D
C500	7D
C502	6E
C503	7D
C507	†
C508*	7D
C527A	5F
C527B	5E
C527C	5E
C533*	8C
C542	6F
C543	7C
C544	6F
C550	6E

Figure 8-7. A1 main board.



A1
MAIN
BOARD

Figure 8-7. A1 main board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C1	3C	C560A	5D	L402	7C	Q1218	6J	R182	1J	R524	6E	R1310	6I
C2	3C	C560B	5D	L404	7C			R183	1J	R526	6F	R1312	6H
C4A	2D	C560C	5E	L550	6E	R2	3B	R185	2I	R527A	5E	R1320	6K
C4B	3D	C560D	5D	L632	6G	R4A	3D	R187	2I	R527B	5F		
C4C	3C	C562	5D	L636	6G	R4B	3D	R195	3H	R528	6F	RT205	3H
C5A	2D	C581	4I			R5A	3D	R205	3I	R530A	6E	RT588	5G
C5B	3D	C588	5F	P1	2B	R5B	3D	R206	3I	R530B	7E		
C5C	3D	C592	6G	P7	3E	R6	2F	R207	4H	R531	8C	S2	3A
C6	3E	C632	6G	P11	1B	R7	3F	R208	3I	R532	8C	S4	6D
C12	2C	C636	5F	P17	2E	R8	3F	R210	4I	R533*	8C	S12	1A
C14A	1D	C700	5I	P60	1I	R12	2B	R211	4J	R540	7C	S14	7D
C14B	2D	C702	5I	P61	1I	R14A	1D	R213	3I	R542	6F	S20	2A
C14C	2C	C703	3K	P134	2H	R14B	1D	R216	3I	R544	6F	S300A	5A
C15A	1D	C708	5J	P230	3K	R15A	1D	R217	3I	R570A	5E	S300B	4A
C15B	2D	C709	4J	P300	5C	R15B	1D	R221	3J	R570B	5E	S300C	4A
C15C	2D	C712	5I	P370	5B	R16	1F	R222	3J	R570C	5E	S300D	5A
C16	2E	C1161	4J	P581	4I	R17	2F	R224	3J	R570D	5E	S380	6A
C17	1F	C1206	6J	P596	5G	R20	1I	R226	3J	R570E	5E	S1030	6H
C52	2I	C1218	6I	P1226	7J	R52	2I	R228	3J	R570F	5E		
C60	1H			P1300	7I	R54	2I	R231	4I	R570G	5E	U20A	1J
C65	2K	CR110	3F	P1301	7J	R60	1I	R232	3J	R575	6E	U20B	1J
C100	2F	CR145	4G	P1302	7I	R61	1I	R234	3J	R577	6E	U100	3G
C103	2F	CR147	4G	P1303	6K	R62A	1H	R236	4J	R579	4G	U120	2G
C110	3G	CR148	4G			R62B	1H	R304	5C	R582	5H	U180	2J
C111	2G	CR170	3H	Q100A	3F	R63	1H	R306	5C	R584	5H	U185	2I
C120	1F	CR171	3H	Q100B	3F	R65	2K	R315	6D	R585	5H	U330	6B
C123	2F	CR172	3H	Q110	2F	R100	2F	R317	6C	R586	5H	U390	7B
C130	1G	CR173	3H	Q113	2H	R101	3F	R318	5C	R588A	5G	U500A	8C
C131	1H	CR175	2J	Q120A	1F	R102	3G	R319	4B	R588B	5G	U500B	8C
C171	2B	CR180	1H	Q120B	1F	R103	2F	R320	4C	R589	5G	U570	6D
C175	2K	CR181	1H	Q130	2F	R104	2F	R321	4C	R590	5F		
C181	1K	CR182	2H	Q133	2H	R106	3D	R322	4C	R592A	6F	VR1304	6H
C183	1K	CR183	2H	Q140	4G	R107	3G	R322	6B	R592B	5F		
C185	2I	CR200	4H	Q145	4G	R109	†	R323	4D	R593	5F		
C187	2I	CR210	4H	Q147	4G	R111	3G	R324	4C	R632	6B		
C195	2H	CR217	3I	Q200	3I	R112	3H	R325	4C	R636	6B		
C196	2H	CR220	3J	Q210	3H	R113	3H	R326A	4C	R700	5I		
C197	3K	CR221	3I	Q213	3I	R114	3H	R326B	4C	R701	6H		
C204	4I	CR226	3J	Q222	3J	R115	3G	R327	4D	R702	5I		
C207	3H	CR228	3J	Q224	2J	R116	3G	R238	4B	R703	3K		
C226	3J	CR231	4I	Q230	3J	R117	3G	R330	6B	R708	5J		
C228	2J	CR236	4J	Q232	4J	R120	1E	R336*	6C	R711	5J		
C236	4I	CR310	5D	Q234	3J	R121	2F	R350	6C	R712	5J		
C300	5C	CR312	5C	Q310A	5C	R122	1F	R352	6C	R714	5I		
C304	5C	CR314	5C	Q310B	5C	R123	3F	R356*	6B	R1050	5I		
C318	6C	CR316	5D	Q316	5C	R124	1G	R371	5C	R1052	7A		
C325	4D	CR320	4C	Q320	4C	R126	2E	R371	5C	R1160	5J		
C326	4C	CR386	7C	Q322	4C	R127	2F	R372	6B	R1161	4J		
C328A	4B	CR500	7E	Q325	4D	R129	†	R374	7A	R1162	4J		
C328B	5B	CR502	7D	Q336	6C	R131	1G	R375	7A	R1164	5J		
C336	5B	CR503	7C	Q350A	6C	R132	1G	R376	7B	R1200	5J		
C356	5B	CR510	7B	Q350B	6C	R133	1I	R384	7B	R1206	6I		
C372	6C	CR522	6E	Q390	7C	R134	2G	R388	7C	R1208	6I		
C400	6D	CR581	4I	Q500	8D	R135	2G	R390	7C	R1210	6I		
C402	7D	CR585	5H	Q510	6D	R136	2G	R392	7B	R1212	6I		
C404	6D	CR700	5I	Q520A	6E	R137	2G	R394	7B	R1213	6I		
C500	7D	CR702	5I	Q520B	6E	R140	4G	R398	7B	R1214	6I		
C502	6E	CR1051	5J	Q525	6F	R142	4G	R399	7B	R1216	6I		
C503	7D	CR1052	7B	Q526	6E	R143	4H	R400	6D	R1218	6I		
C507	†	CR1162	4J	Q528	6F	R144	4G	R402	7C	R1220	6J		
C508*	7D	CR1163	4J	Q575	6E	R145	4G	R404	6D	R1222	6J		
C527A	5F	CR1208	6I	Q580	4I	R147	4G	R500	7D	R1224	6J		
C527B	5E	CR1218	6I	Q585A	5F	R148	4G	R501	7D	R1226	6J		
C527C	5E	CR1222	6J	Q585B	5F	R149	4G	R502	7E	R1228	6J		
C533*	8C	CR1226	6J	Q704	5I	R170	1K	R503	7C	R1229	6J		
C542	6F	CR1228	6J	Q708	5J	R171	2K	R504	7D	R1300	6G		
C543	7C			Q1160	5J	R172	1K	R505	7D	R1302	6H		
C544	6F	L195	3H	Q1161	4J	R180	2J	R508	7D	R1306	6H		
C550	6E	L196	2H	Q1212	7I	R181	1J	R514	6D	R1308	6H		

*See Parts List for serial number ranges.

† Located on back of board.

Waveform Conditions

305 Setup

CH1 VOLTS/DIV	5 DIV CAL
CH1 CAL	CAL (in detent)
CH1 POSITION	5 DIV CAL signal graticule center
CH2 VOLTS/DIV	5 DIV CAL
CH2 CAL	CAL (in detent)
CH2 POSITION	5 DIV CAL signal graticule center
VERT MODE	CH1
Trigger Source	CH1
Trigger Coupling	AC
Trigger Mode	AUTO (p-p)
Trigger Slope	+
TRIGGER LEVEL	Midrange
SEC/DIV	1 m
SWEEP CAL	CAL (in detent)
DMM FUNCTION	All out (battery check)
INTEN	Midrange
POWER SOURCE	AC/FULL CHG
115 V/230 V	115 V
J800	20 V p-p, 500 Hz sine wave

Voltage Conditions

These voltages are typical values: actual values may vary as much as 20%.

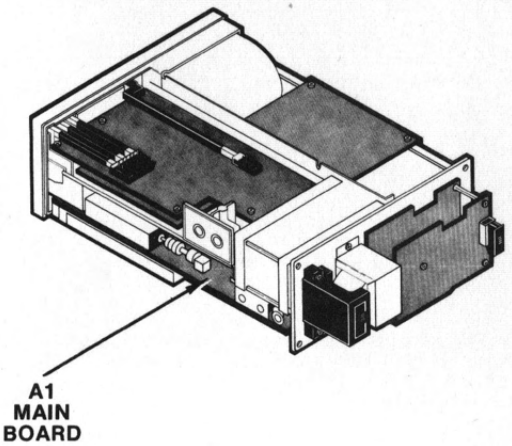
305 Setup

CH1 VOLTS/DIV	5 m
CH2 VOLTS/DIV	5 m
CH1 POSITION	Trace is graticule center
CH2 POSITION	Trace is graticule center

All other functions are same setting as above.

Test Oscilloscope

Probe	10X probe (10 MΩ input)
Ac-Gnd-Dc	Ac
Trigger Source	Int trigger



VOLTAGE & WAVEFORM CONDITIONS

CH1 X INPUT

J1

R1 150

C3 .039pF

P1

S2 COUPLING

DC

GND

AC

C2 .022

C1 2.8-10

R2 1M

CH1 X VOLTS/DIV PARTIAL S4 SEE ②

C4B 3.5-10

R4A 990K

C4A 3.3-18

R4B 10.1K

C4C 470

C5B 3.5-10

R5A 900K

C5A 3.3-18

R5B 110K

C5C 35

C6 1000

P7

CH1 SIGNAL TO R7 ②

5 DIV CAL SIGNAL FROM R62B ③

NOTES:

1. CLOSURE DOT INDICATES A CONTACTS CLOSED AND B CONTACTS OPEN.
2. B CONTACTS ARE ON CAM SIDE OF BOARD.
3. SWITCH SHOWN IN 5mV POSITION.
4. LOGIC SHOWN FOR CH1 AND CH2 SWITCHES.

mV: 5, 10, 20, 50
TTL: .1, .2, .5
V: 1, 2, 5, 10
5 DIV CAL

1 2 3 4 8 9

CH2 Y INPUT

J11

R11 150

C13 0.39pF

P11

S12 COUPLING

DC

GND

AC

C12 .022

R12 1M

C14B 3.5-10

R14A 990K

C14A 3.3-18

R14B 10.1K

C14C 470

C15B 3.5-10

R15A 900K

C15A 3.3-18

R15B 110K

C15C 35

C16 1000

P17

CH2 SIGNAL TO R17 ②

5 DIV CAL SIGNAL FROM R62B ③

CH2 Y VOLTS/DIV PARTIAL SEE ② S14

PARTIAL A1 MAIN BOARD

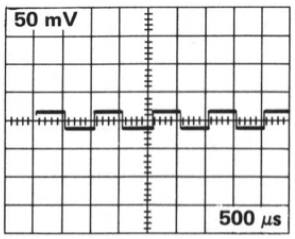
305 DMM OSCILLOSCOPE

REV A AUG 1979

CH1 & CH2 INPUT ATTENUATOR ①

NOTE: Waveforms conditions are listed on diagram <1>.

1



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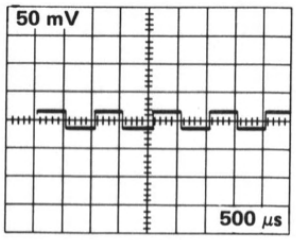

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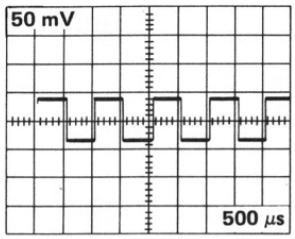

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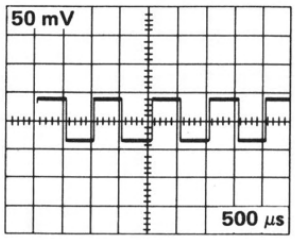

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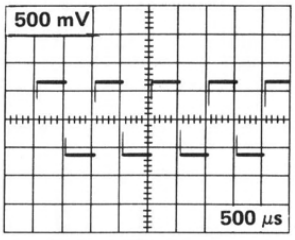

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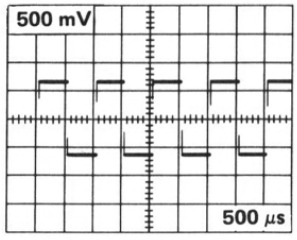
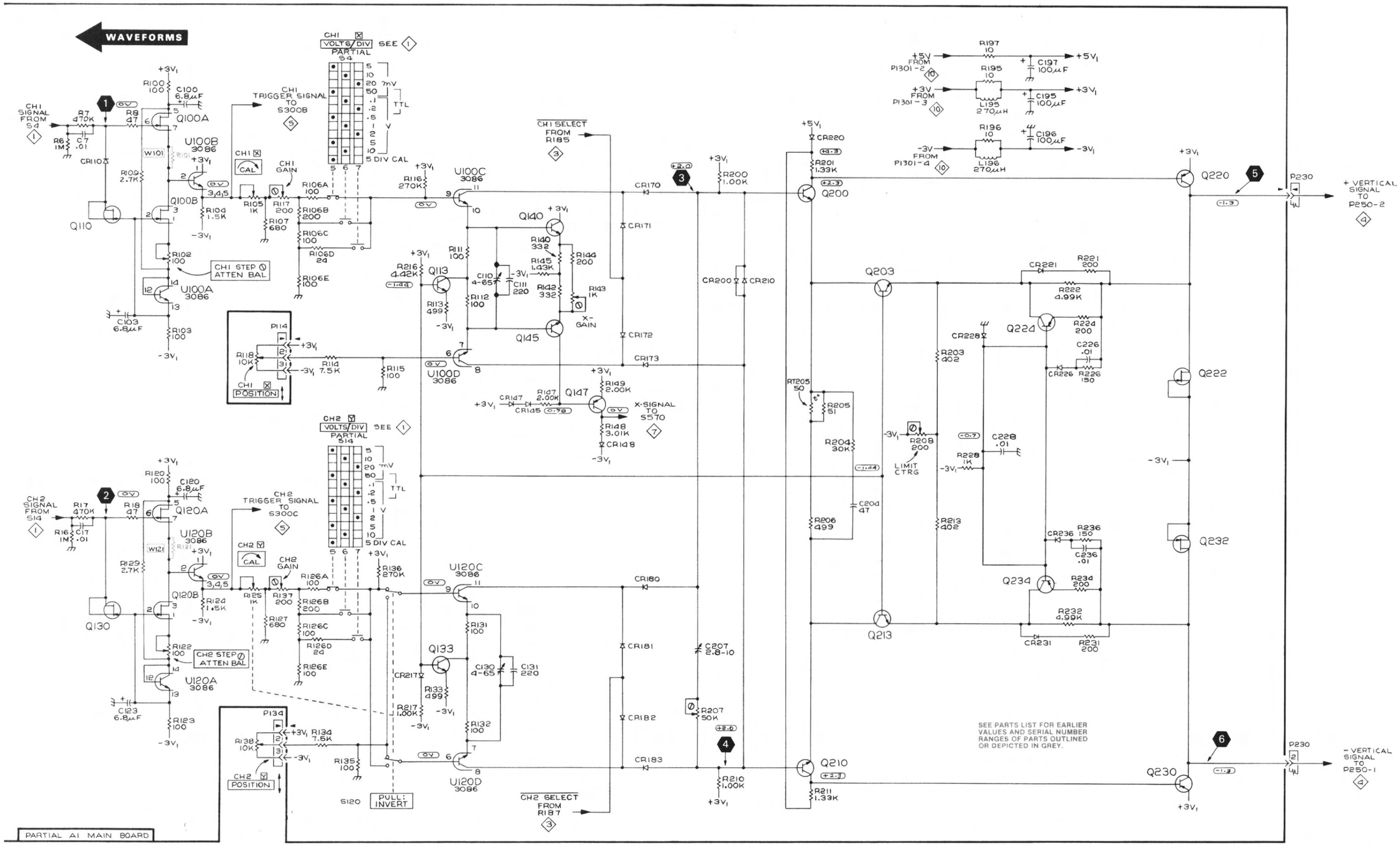




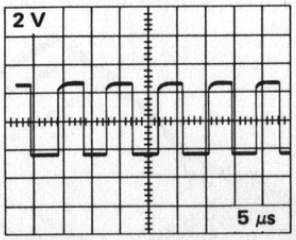
305 DMM OSCILLOSCOPE

REV A AUG 1979

CH1 & CH2 VERTICAL PREAMPLIFIER & CHANNEL SWITCH ⟨2⟩

NOTE: Waveforms conditions are listed on diagram ◇1◇ .

7



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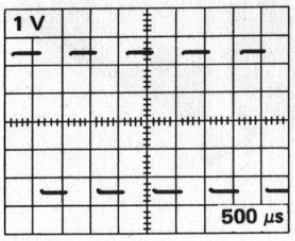
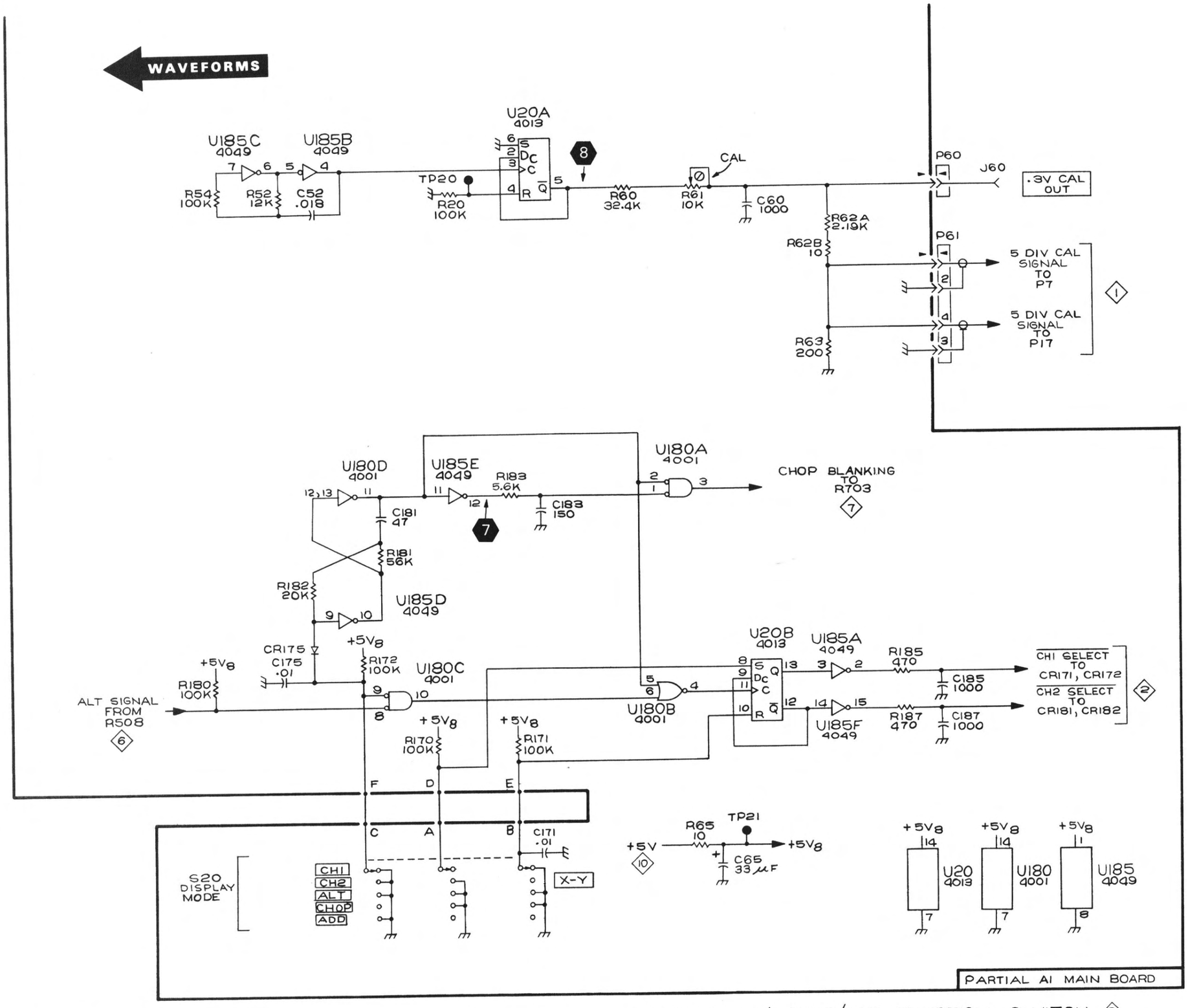
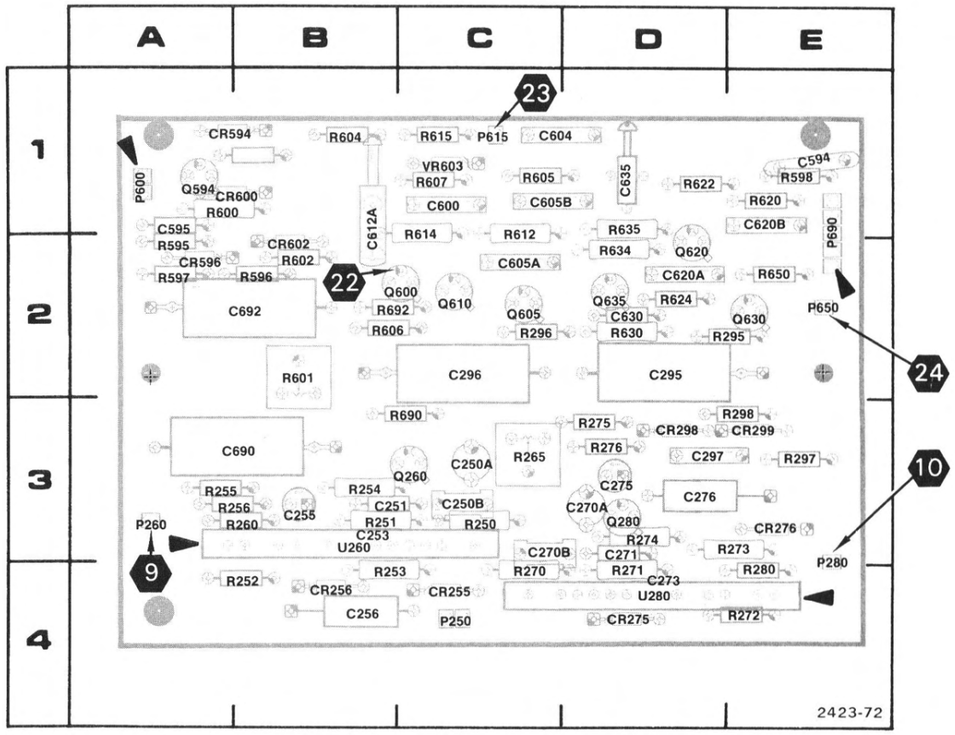


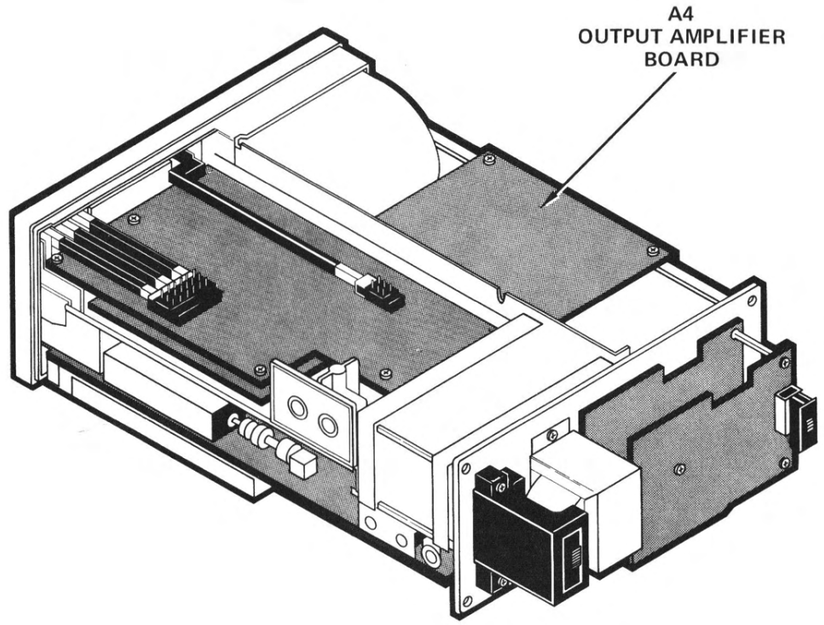

U185C 4049
U185B 4049
U20A 4013
R54 100K
R52 12K
C52 .018
TP20
R20 100K
8
R60 32.4K
R61 10K
CAL
C60 1000
P60
J60
.3V CAL OUT
R62A 2.19K
R62B 10
P61
5 DIV CAL SIGNAL TO P7
5 DIV CAL SIGNAL TO P17
R63 200
1
U180D 4001
U185E 4049
R183 5.6K
C183 150
C181 47
7
U180A 4001
CHOP BLANKING TO R703
7
R181 56K
R182 20K
U185D 4049
+5V8
CR175
C175 .01
R172 100K
U180C 4001
R180 100K
ALT SIGNAL FROM R508
6
U20B 4013
U180B 4001
U185A 4049
U185F 4049
R185 470
R187 470
C185 1000
C187 1000
CH1 SELECT TO CR171, CR172
CH2 SELECT TO CR181, CR182
2
R170 100K
R171 100K
F
D
E
C
A
B
C171 .01
S20 DISPLAY MODE
CH1
CH2
ALT
CHOP
ADD
X-Y
R65 10
TP21
C65 33µF
+5V
10
U20 4013
U180 4001
U185 4049
PARTIAL A1 MAIN BOARD



2423-72

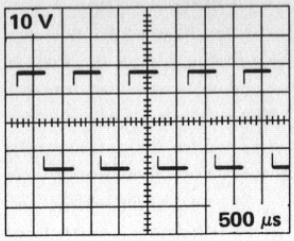
Figure 8-8. A4 output amplifier board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C250A	3C	C690	3B	Q600	2C	R296	2C	R692	2B
C250B	3C	C692	2B	Q605	2C	R297	3E		
C251	3B			Q610	2C	R298	3E	U260	3B
C253*	3B	CR255	4C	Q620	2D	R595	2A	U280	4D
C255	3B	CR256	4B	Q630	2E	R596	2B		
C256	4B	CR275	4D	Q635	2D	R597	2B	VR603	1C
C270A	3D	CR276	3E			R598	1E		
C270B	3C	CR298	3D	R250	3C	R600	1A		
C273*	4D	CR299	3E	R251	3B	R601	2B		
C275	3D	CR594	1A	R252	4B	R602	2B		
C276	3D	CR596	2A	R253	4B	R604	1B		
C295	2D	CR600	1B	R254	3B	R605	1C		
C296	2C	CR602	2B	R255	3A	R606	2B		
C297	3D			R256	3B	R607	1C		
C594	1E	P250	2G	R260	3B	R612	1C		
C595	1A	P260	3A	R265	3C	R614	1C		
C600	1C	P600	1A	R270	4C	R615	1C		
C604	1C	P615	1C	R271	4D	R620	1E		
C605A	2C	P650	2E	R272	4E	R622	1D		
C605B	1C	P760	2E	R273	3E	R624	2D		
C612A	1B	P690	1E	R274	3D	R630	2D		
C620A	2D			R275	3D	R634	2D		
C620B	1E	Q260	3C	R276	3D	R635	1D		
C630	2D	Q280	3D	R280	4E	R650	2E		
C635	1D	Q594	1A	R295	2D	R690	3C		



NOTE: Waveforms conditions are listed on diagram 1.

9 10



WAVEFORMS

+VERTICAL SIGNAL FROM P230-1
2

P250
2

C250A 2.8-10
C250B 22
R250 18.2K

+0.1

C251 1pF
R251 499K

+3V2 +77V1
11 3

9 INPUT OUTPUT 4

U260 STU-001

2 +FASTPATH
VERTICAL OUTPUT AMPL
8 -FASTPATH
1 CURRENT SOURCE
5 BIAS
6
7
10 -3V2

C256 1μF
CR256
+77V1

R254 90.9K

+3V2
Q260 -0.53
R256 150
R255 1K
-3V2
CR255
C255 2.2μF

DC BIAS
-3V2
R265 200K

C253 .01
R253 57.6K

R252 47K
+77V1

R260 360
+3.8
9
P260
+VERTICAL SIGNAL TO V1300-11 UPPER DEFLECTION PLATE
10

R274 90.9K

C271 1pF
R271 499K

+3V2 +77V1
11 3

9 INPUT OUTPUT 4

U280 STU-001

2 +FASTPATH
VERTICAL OUTPUT AMPL
8 -FASTPATH
1 CURRENT SOURCE
5 BIAS
6
7
10 -3V2

C276 μF
CR276
+77V1

C270B 22
C270A 2.8-10
R270 18.2K

+0.1

P250
-VERTICAL SIGNAL FROM P230-2
2

+3V2
Q280 -0.53
R276 150
R275 1K
-3V2
CR275
C275 2.2μF

C273 .01
RZ73 57.6K

R272 47K
+77V1

R280 360
+3.8
10
P280
-VERTICAL SIGNAL TO V1300-7 LOWER DEFLECTION PLATE
10

P690
+77V
R297 47
C297 .047
+77V1

+5V

FROM P1301
10
2 +5V
R298 1K

3 +3V
R295 10
C295 100μF
+3V2

4 -3V
R296 10
C296 100μF
-3V2

CR299
CR298
+3V2

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

PARTIAL A4 OUTPUT AMPL BD

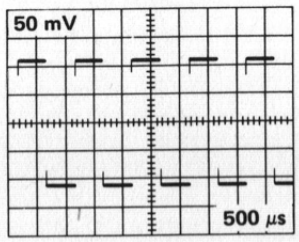
305 DMM OSCILLOSCOPE

REV A AUG1979

VERTICAL OUTPUT AMPLIFIER 4

NOTE: Waveforms conditions are listed on diagram <1>.

11



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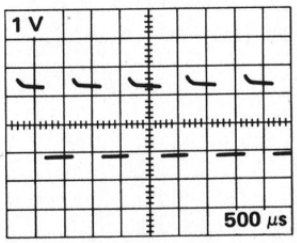

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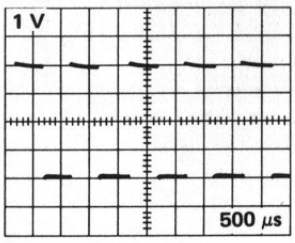
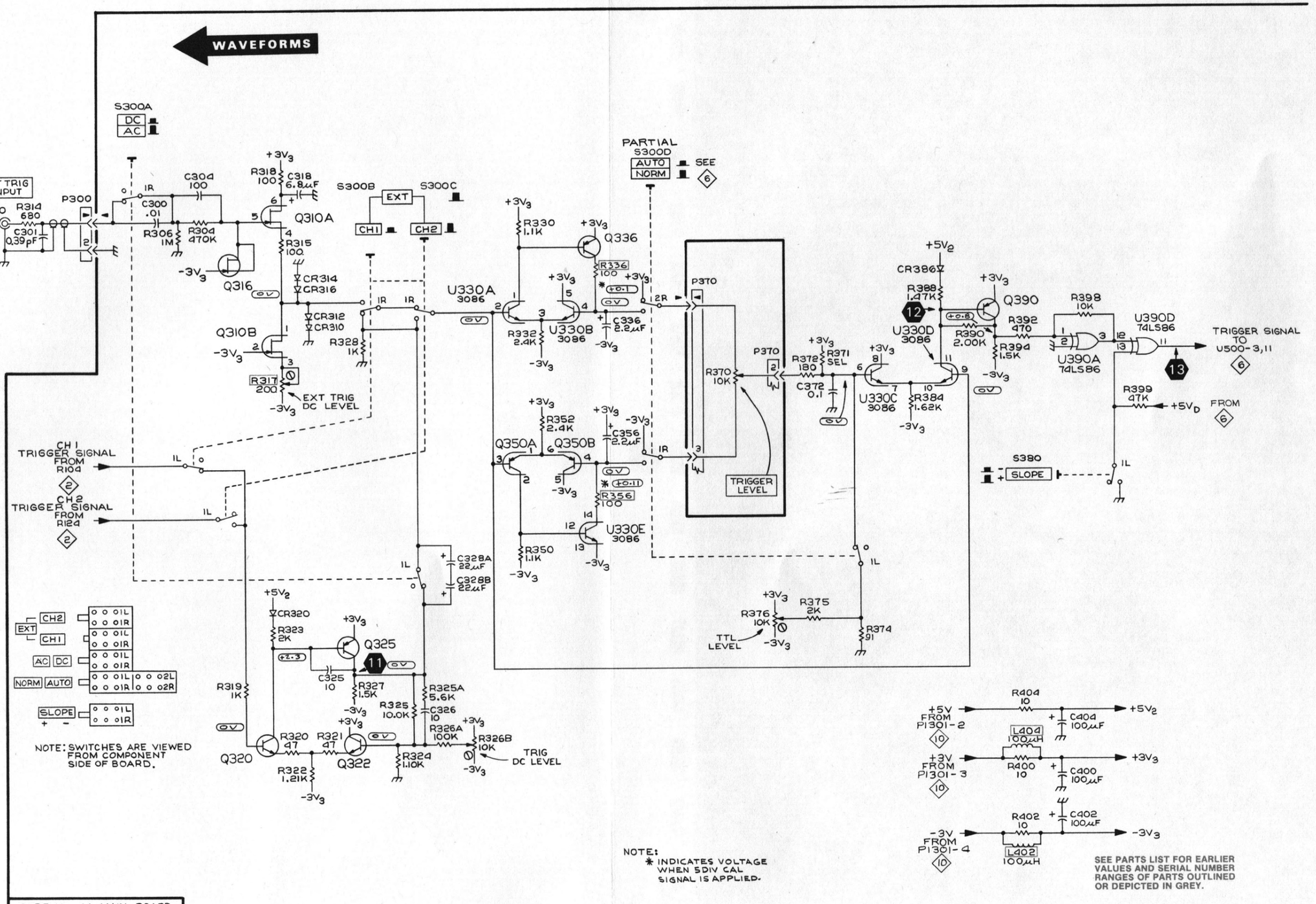
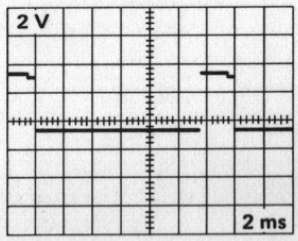




PARTIAL A1 MAIN BOARD

NOTE: Waveforms conditions are listed on diagram ◇1◇ .

14



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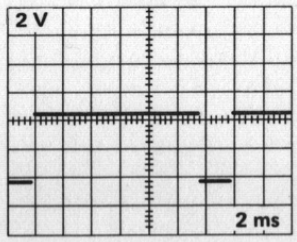

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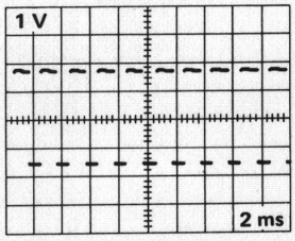

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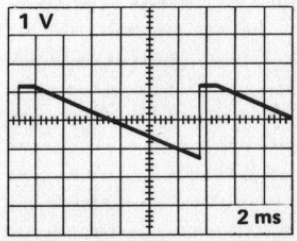

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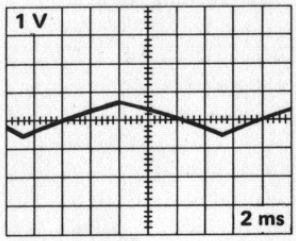

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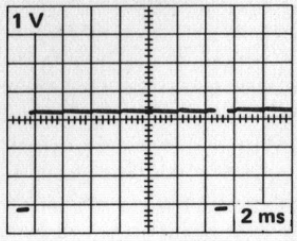


WAVEFORMS

TRIGGER SIGNAL FROM U390-11 ◇5

U500A 74LS74 16 R501 3K C500 2.2µF R500 10K CR500 Q500 R502 1K C502 33µF CR502 CR503

PARTIAL S300D AUTO NORM SEE ◇5

U390C 74LS86 CR510

U500B 74LS74 15 R504 4.7K C508 0.01µF R505 47K R508 1K C507 .0022

ALT SIG TO U180-8 ◇3

GATE TO R700 ◇7

CR702 C702 150

U390B 74LS86 19 R503 2K C503 100

R528 4.3K R530A 750 R530B 2.5K SWEEP LENGTH R531 7.5K R532 15K R533 30 C533 2.2µF

R579 30K R578 10K SWEEP CAL R570B 500K R570A 2M R570C 500K R570D 50K R570E 50K R570F 10K R570G 5.00K

R577 200K R575 100K U570 3160 Q575

L550 5.6mH C550 68µF Q510

C560A 1µF C560B .01 C560C 1000 C560D 33 C562 4-65

+5V FROM P1301-2 ◇10 R544 10 R540 10 C544 100µF C543 6.8µF C542 100µF

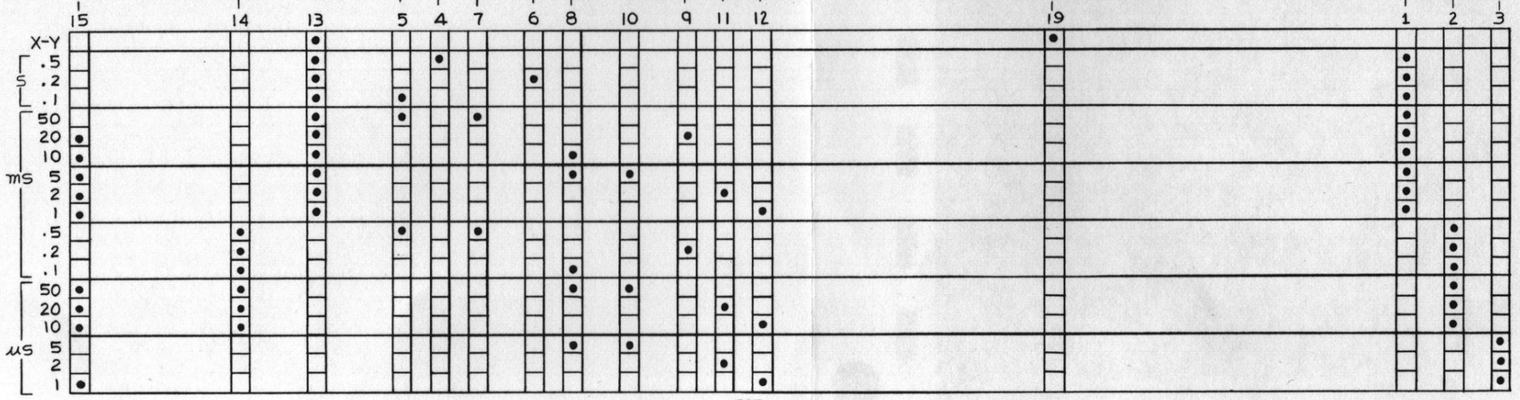
-3V FROM P1301-4 ◇10 R542 10 R531

R514 47 Q520A Q520B Q525 17 R526 1.5K R524 47 CR522 SWEEP TO R584 ◇7

R527B 20K R527A 100K Q526

18 Q528 C527A 2700 C527C .01 C527B 1µF

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.



SEE ◇7 PARTIAL S570 SEC/DIV SHOWN IN X-Y POSITION

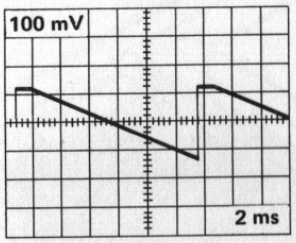
U390 +5V$_D$ 14 7

U500 +5V$_D$ 14 7

PARTIAL A1 MAIN BOARD

NOTE: Waveforms conditions are listed on diagram ◇1◇ .

20



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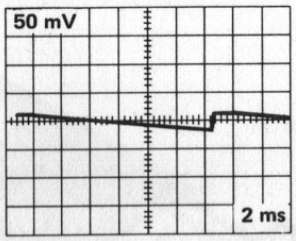

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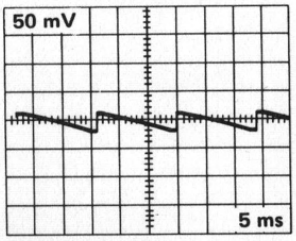

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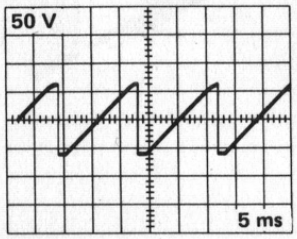

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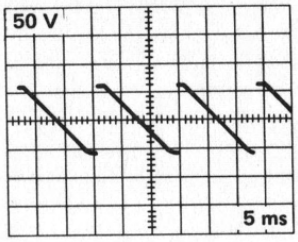
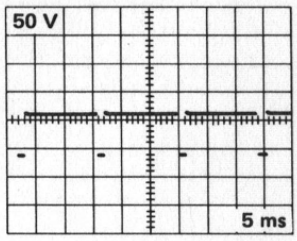


25



WAVEFORMS

SWEEP FROM Q525 ◇6

R584 900 · CR585 · 20 · Q580 · (-0.17) · R582 680 · -3V5 · C581 2.2µF · -3V5 · CR581 · P581 3 2 1 · R581 10K · POSITION

R585 200 · R586 100 · S583 PULL: X10 MAG

+3V5 · R587 4.42K · RT588 50 · R588A 39 · R588B 226 · HORIZ GAIN · R589 500 · +3V5 · R590 4.42K · Q585B

X SIGNAL FROM Q147 ◇2 · Q585A · (-0.13) · C588 680 · (-1) · P596 P600 2 1 · MAGNIFIER REGISTRATION · R593 500 · 21

R592B 1.5K · R592A 30 · C592 100µF · -3V5

16 18 17 · X-Y .5 .2 .1 · 50 20 10 5 2 1 mS · .5 .2 .1 · 50 20 10 5 2 1 µS · SEC/DIV SEE ◇6

PARTIAL S570

+3V FROM P690-3 ◇4 · R690 30 · C690 100µF · +3V6

-3V FROM P690-4 ◇4 · R692 30 · C692 100µF · -3V6

FROM P600-1 ◇7 · R598 47

+5V FROM P690-2 ◇4 · +5V

+5V · C594 33µF · R594 5.6K · CR594 · CR600 · R600 5.6K · CR602 · Q594 · (0V) · (-0.4) · -3V6 · 22 · Q600 · -3V6

C595 .01 · R595 18K · CR596 · R597 1.3K · R596 3K · -3V6

R601 10K · -3V6 · HORIZ DC LEVEL · R602 62K

R612 174K · R614 174K · C612A 0.25-1.5pF · +3V6 · R606 3K · C600 .047 · Q610 · -3V6

+150V · VR603 5.1V · C604 .047 · R604 1M · -3V6 · R607 10K · +150V · R605 4.7K · C605B .047 · C605A .047 · Q605 · (+80.3) · R622 10K · R615 1K · 23 · P615 · + HORIZONTAL SIGNAL TO V1300-2 RIGHT DEFLECTION PLATE ◇10

+150V · R620 10K · C620B .047 · Q620 · 24 · R650 1K · (+62.4) · P650 · - HORIZONTAL SIGNAL TO V1300-4 LEFT DEFLECTION PLATE ◇10

R635 1M · C635 .25-1.5pF · R630 1M · (0V) · R634 19.1K · -3V6 · +3V6 · C630 1pF · R624 3K · C620A .047 · Q635 · -3V6 · Q630

+150V · P690 5 4 · +150V FROM P1301 ◇10

NOTE: ▽3 INDICATES THE GROUND FOR THE HORIZ AMPLIFIER ON A4

PARTIAL A4 OUTPUT AMPLIFIER BD

+77V · C709 .01 · R708 3.6K · C708 .047 · +77V · R710 30K · (+7.4) · R712 750K · Q708 · R711 2K · 25 · P1302 · UNBLANKING TO V1300-9 ◇10 · R714 1K · C712 .01 · Q704 · (+.62)

6POT KILLER FROM S1030 ◇9 · R701 47K

CHOP BLANKING FROM U180-3 ◇3 · C703 220 · R703 10K

GATE FROM R508 ◇6 · R700 20K · C700 470 · R702 3K · CR700

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

PARTIAL A1 MAIN BOARD

L636 270µH · +3V FROM P1301-3 ◇10 · R636 10 · C636 100µF · +3V5

R632 10 · C632 100µF · -3V FROM P1301-4 ◇10 · L632 270µH · -3V5

+77V FROM R1164 ◇10 · +77V

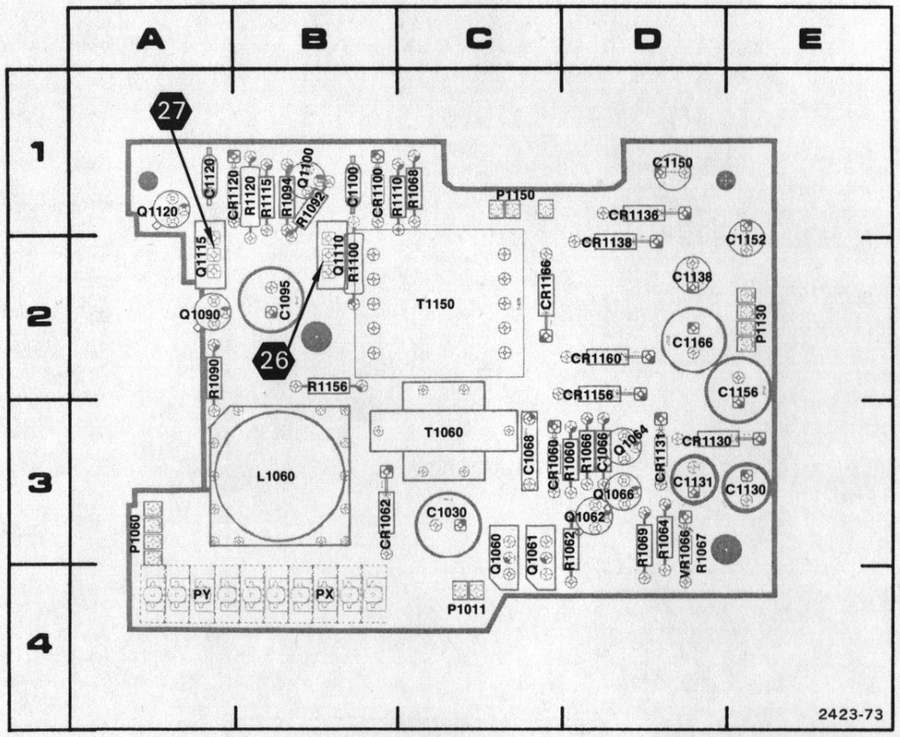
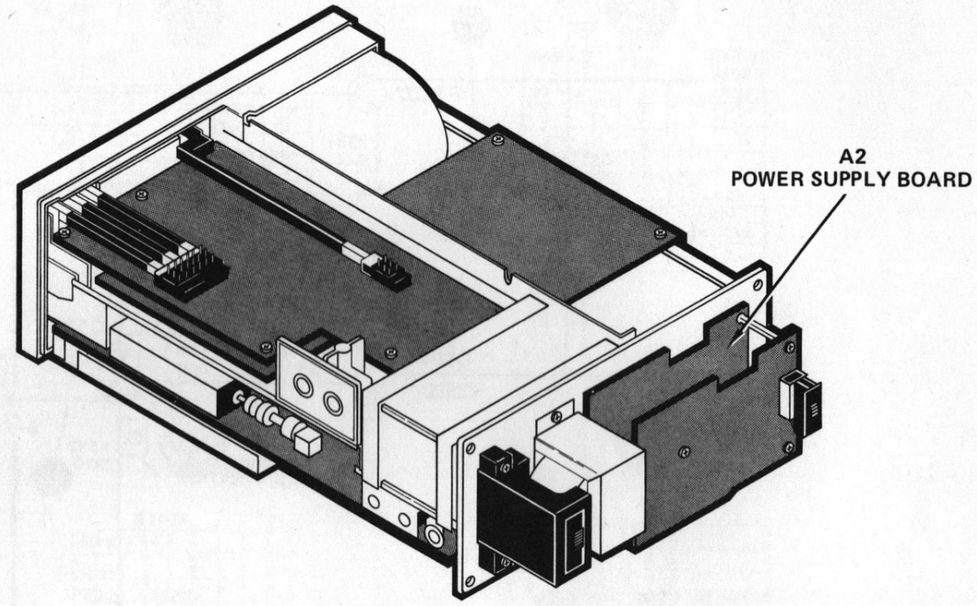


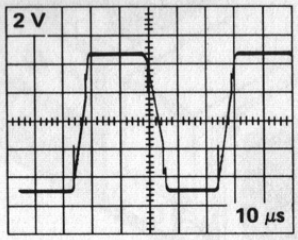
Figure 8-9. A2 power supply board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CRT NO	GRID LOC
C1030	3C	L1060	3B	R1090	2A
C1066	3D			R1092	1B
C1068	3C	P1011	4C	R1094	1B
C1095	2B	P1060	3A	R1100	2B
C1100	1B	P1130	2E	R1110	1B
C1120	1A	P1150	1C	R1115	1B
C1130	3E			R1120	1B
C1131	3D	Q1060	3C	R1156	2B
C1138	2D	Q1061	3C		
C1150	1D	Q1062	3D	T1060	3C
C1152	1E	Q1064	3D	T1150	2C
C1156	2E	Q1066	3D		
C1166	2D	Q1090	2A		
		Q1100	1B	VR1066	4D
CR1060	3C	Q1110	2B		
CR1062	3B	Q1115	2A		
CR1100	1B	Q1120	1A		
CR1120	1B				
CR1130	3D	R1060	3D		
CR1131	3D	R1062	4D		
CR1136	1D	R1064	3D		
CR1138	2D	R1066	3D		
CR1156	2D	R1067	4D		
CR1160	2D	R1068	1C		
CR1166	2C	R1069	4D		

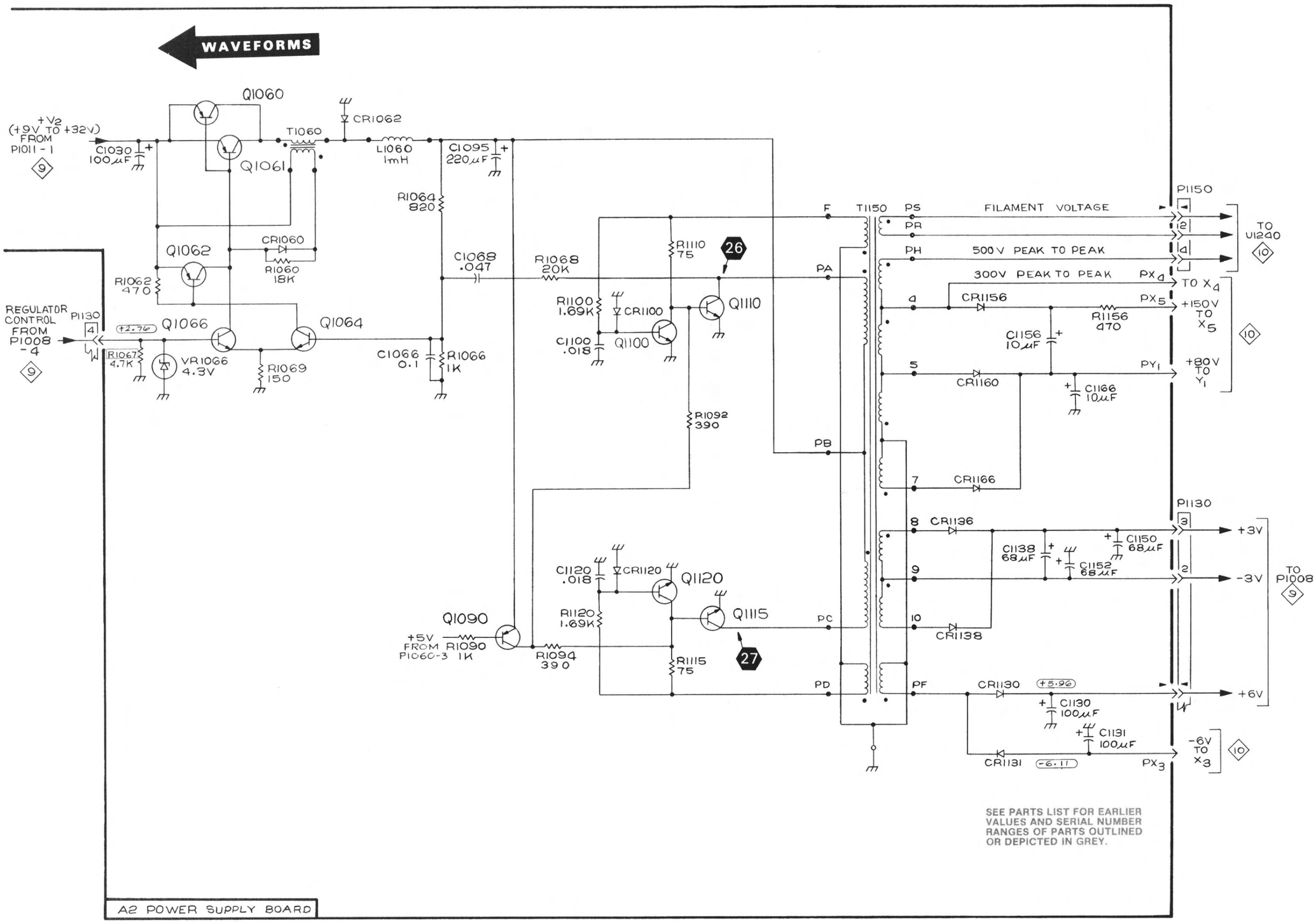


NOTE: Waveforms conditions are listed on diagram 1 .

26 27



WAVEFORMS



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

A2 POWER SUPPLY BOARD

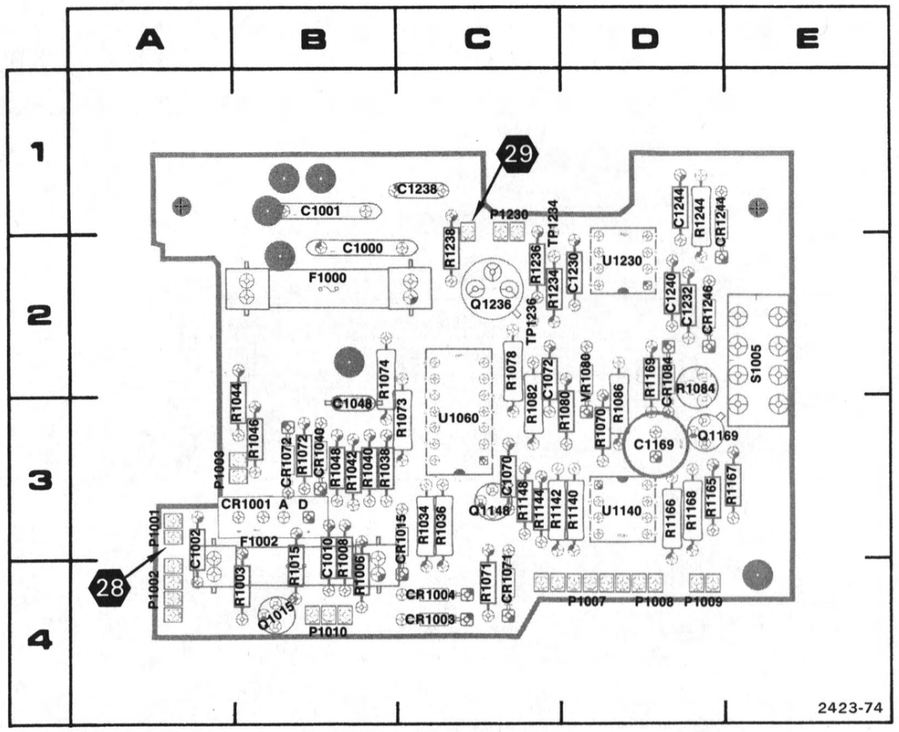
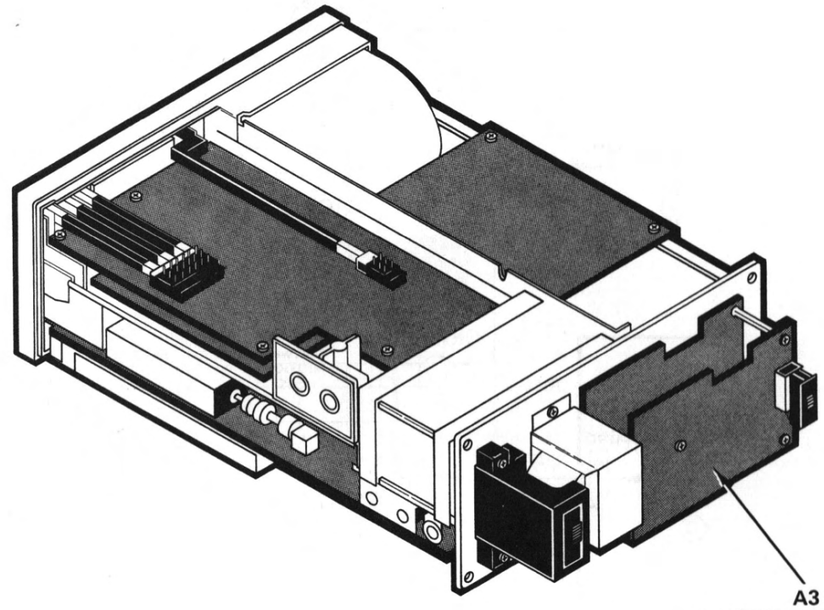


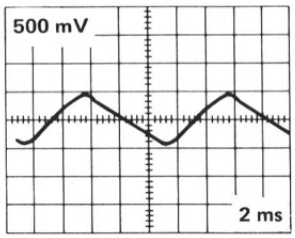
Figure 8-10. A3 battery charger board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C1000	2B	F1002	3B	R1046	3B	U1140	3D
C1001	1B			R1048	3B	U1230	2D
C1002	3A	P1001	3A	R1070	3D		
C1010	4B	P1002	4A	R1071	4C	VR1080	2D
C1048	3B	P1003	3A	R1072	3B		
C1070	3C	P1007	4D	R1073	3C		
C1072	2C	P1008	4D	R1074	2B		
C1169	3D	P1009	4D	R1078	2C		
C1230	2D	P1010	4B	R1080	3D		
C1232	2D	P1230	1C	R1082	3C		
C1238	1C			R1084	2D		
C1240	2D	Q1015	4B	R1086	3D		
C1244	1D	Q1148	3C	R1140	3D		
		Q1169	3D	R1142	3C		
CR1001	3B	Q1236	2C	R1144	3C		
CR1003	4C			R1166	3D		
CR1004	4C	R1003	4B	R1165	3D		
CR1015	3C	R1006	4B	R1167	3E		
CR1040	3B	R1008	4B	R1168	3D		
CR1071	4C	R1015	4B	R1169	2D		
CR1072	3B	R1034	3C	R1234	2C		
CR1084	2D	R1036	3C	R1236	2C		
CR1244	1D	R1038	3B	R1238	2C		
CR1246	2D	R1040	3B	R1244	1D		
		R1042	3B				
F1000	2B	R1044	3B	U1060	3C		

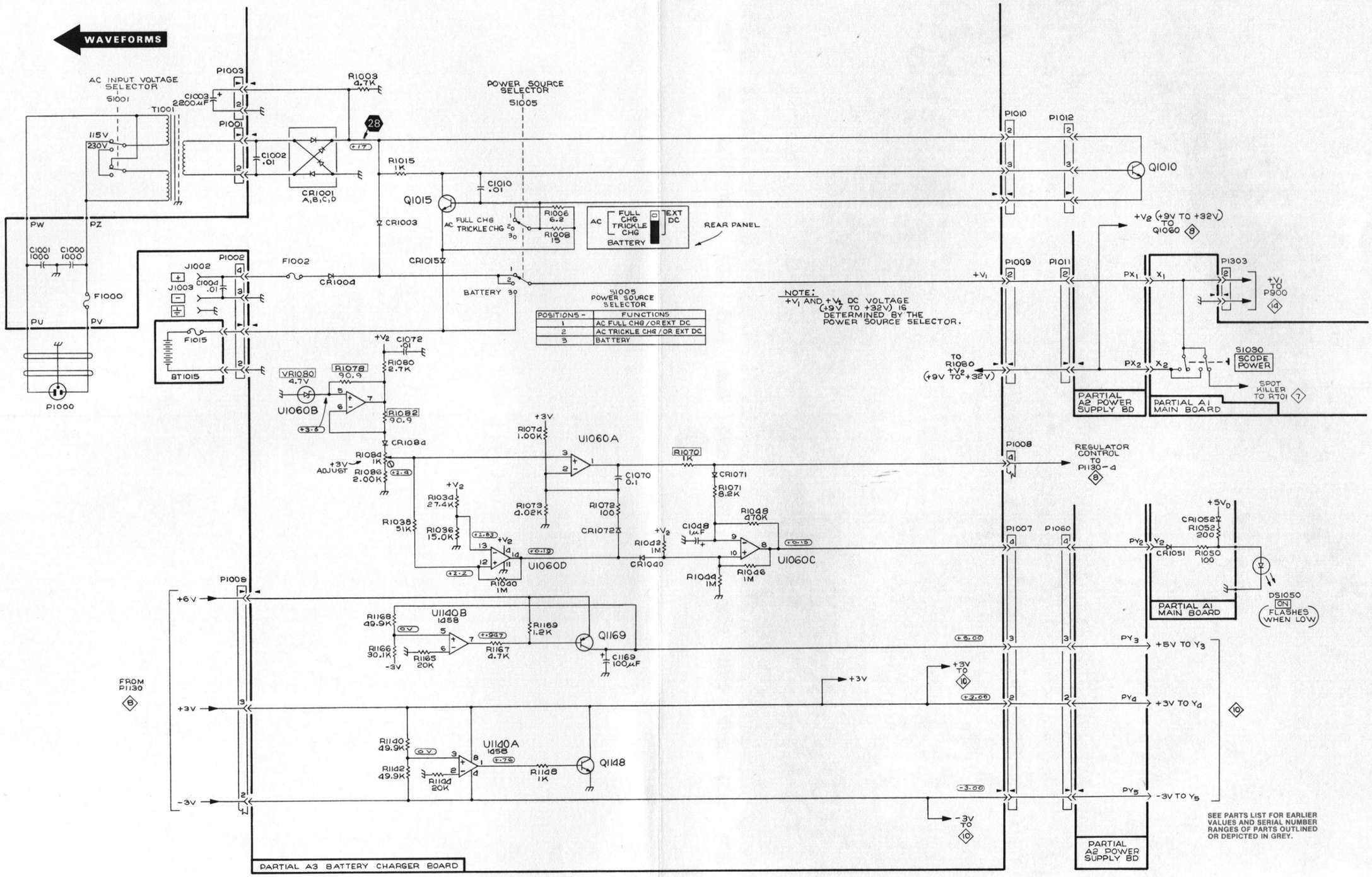


NOTE: Waveforms conditions are listed on diagram ◇1◇ .

28



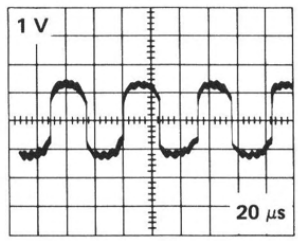
WAVEFORMS



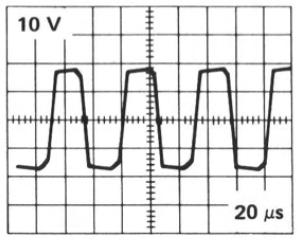
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

NOTE: Waveforms conditions are listed on diagram ◇1◇ .

29



30



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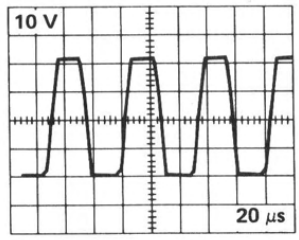

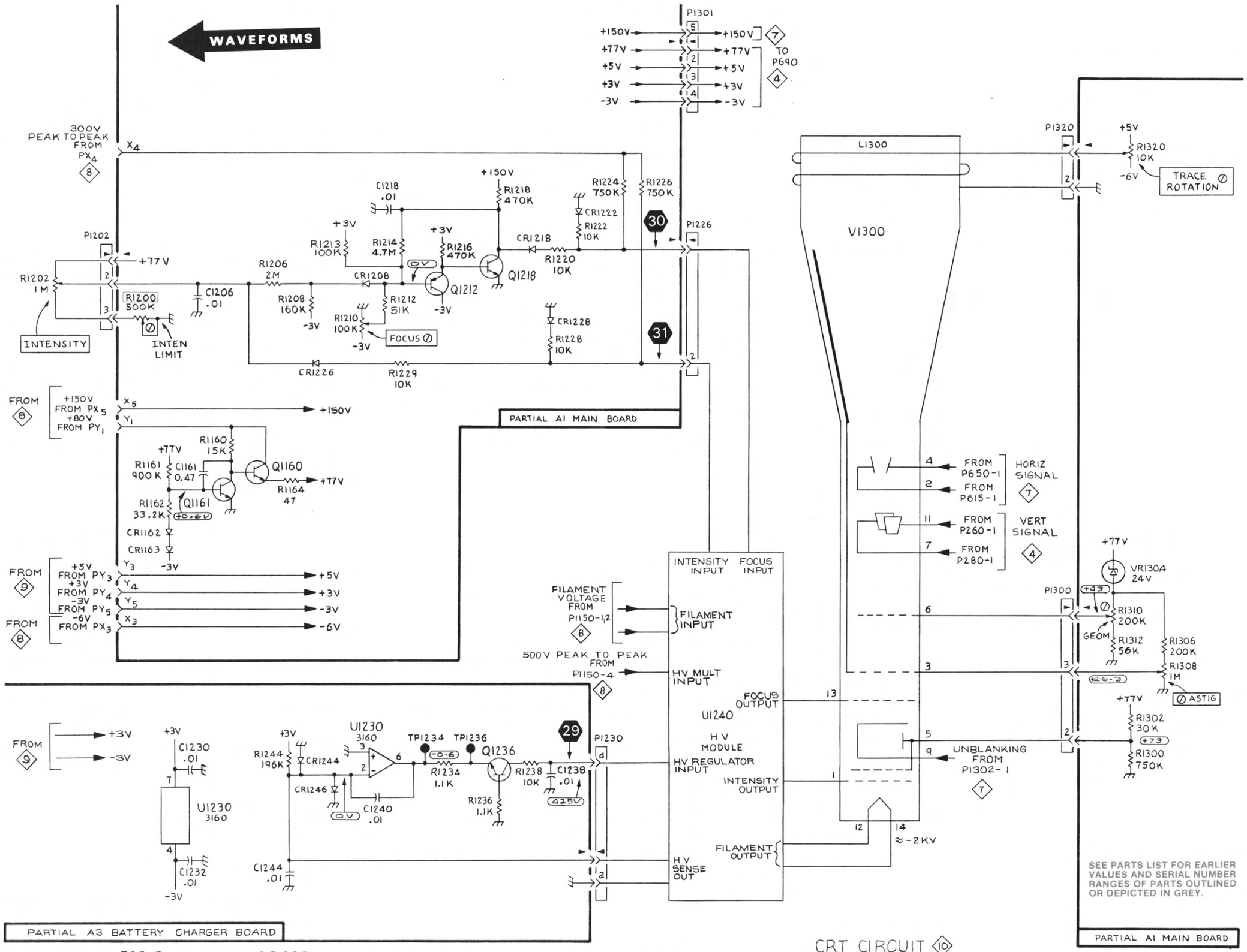

305 DMM OSCILLOSCOPE

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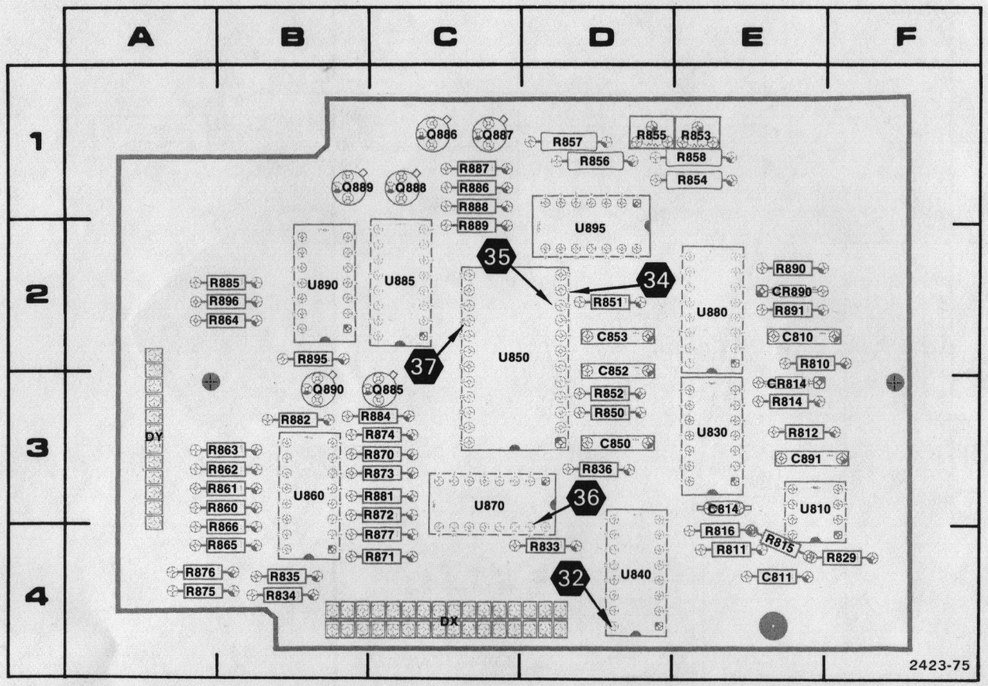
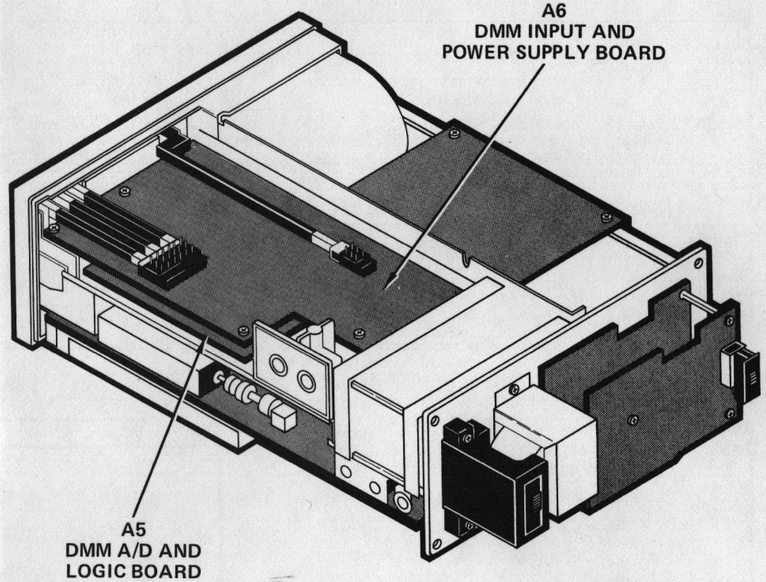


Figure 8-11A. A5 DMM A/D and logic board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CRT NO	GRID LOC	CRT NO	GRID LOC
C810	2E	R816	4E	R870	3C	U840	4D
C811	4E	R829	4F	R871	4C	U850	2C
C814	3E	R832	3D	R872	3C	U860	3B
C850	3D	R833	4D	R873	3C	U870	3C
C852	2D	R834	4B	R874	3C	U880	2E
C853	2D	R835	4B	R875	4A	U885	2C
C891	3E	R836	3D	R876	4A	U890	2B
		R850	3D	R877	4C	U895	2D
CR814	3E	R851	2D	R881	3C		
CR890	2E	R852	3D	R882	3B		
		R853	1E	R884	3C		
Q885	3C	R854	1E	R885	2B		
Q886	1C	R855	1D	R886	1C		
Q887	1C	R856	1D	R887	1C		
Q888	1C	R857	1D	R888	1C		
Q889	1B	R858	1E	R889	2C		
Q890	3B	R860	3B	R890	2E		
		R861	3B	R891	2E		
R810	2E	R862	3B	R895	2B		
R811	4E	R863	3B	R896	2B		
R812	3E	R864	2B				
R814	3E	R865	4B	U810	3E		
R815	4E	R866	4B	U830	3E		



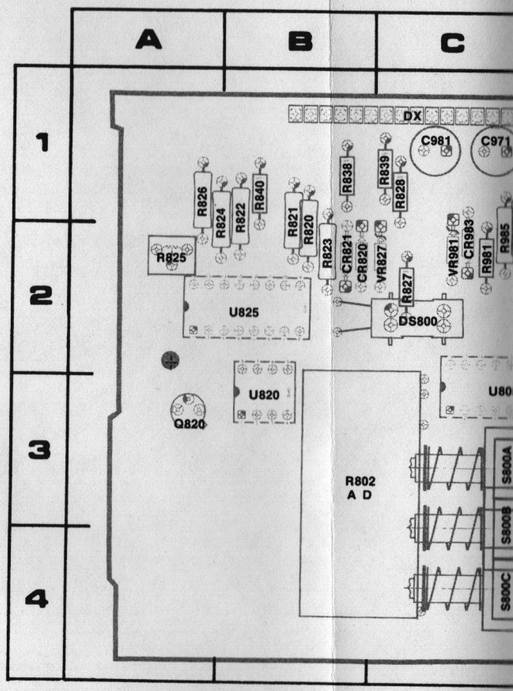
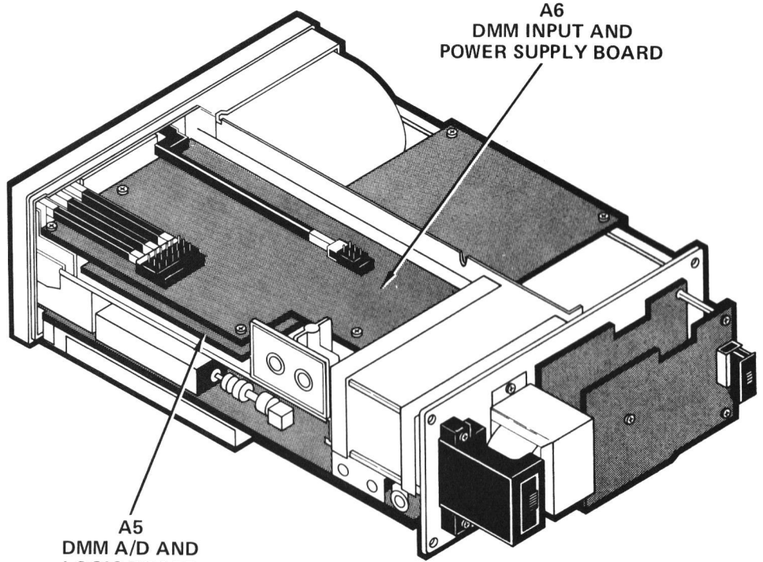


Figure 8-1

CKT NO	GR LO
C800	
C801	
C900	
C901	
C902	
C905	
C930	
C940	
C941	
C950	
C951*	
C952	
C955	
C971	
C980	
C981	
CR800	
CR801	
CR820	
CR821	
CR902	
CR903	
CR904	
CR940	
CR950	



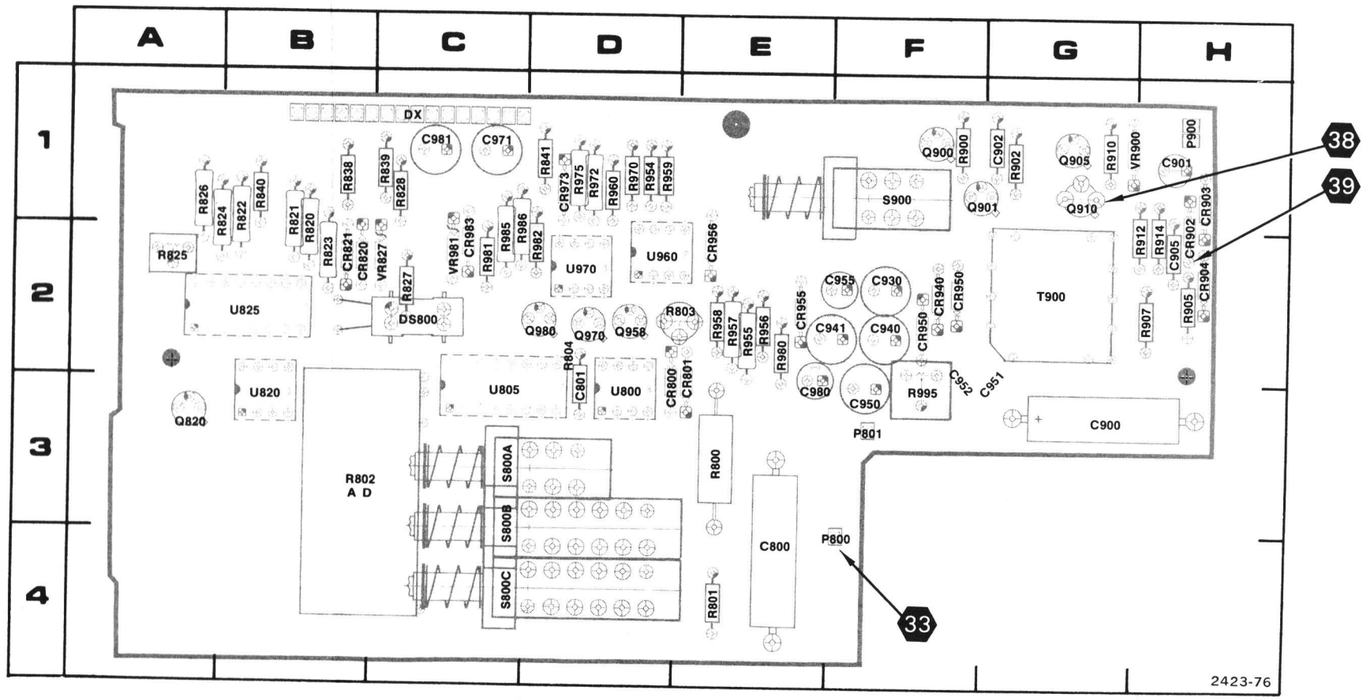


Figure 8-11B. A6 DMM input and power supply board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C800	4E	CR955	2E	R805*	†	R958	2E	VR827	2C
C801	3D	CR956	2F	R820	2B	R959	1D	VR900	1G
C900	3G	CR973	1D	R821	1B	R960	1D	VR981	2C
C901	1H	CR983	2C	R822	1B	R970	1D		
C902	1G			R823	2B	R972	1D		
C905	2H	DS800	2C	R824	1B	R975	1D		
C930	2F			R825	2A	R980	2E		
C940	2F	P800	4F	R826	1A	R981	2C		
C941	2F	P801	3F	R827	2C	R982	2D		
C950	3F	P900	1H	R828	1C	R985	2C		
C951*	2F			R838	1B	R986	2C		
C952	2F	Q820	3A	R839	1C	R995	3F		
C955	2F	Q900	1F	R840	1B				
C971	1C	Q901	1F	R841	1D	S800A	3C		
C980	3E	Q905	1G	R900	1F	S800B	3C		
C981	1C	Q910	1G	R902	1G	S800C	4C		
		Q958	2D	R905	2H	S900	1F		
CR800	3D	Q970	2D	R907	2H				
CR801	2E	Q980	2D	R910	1G	T900	2G		
CR820	2B			R912	2H				
CR821	2B	R800	3E	R914	2H	U800	3D		
CR902	2H	R801	4E	R954	1D	U805	3C		
CR903	1H	R802	3B	R955	2E	U820	3B		
CR904	2H	R803	2E	R956	2E	U825	2B		
CR940	2F	R804	2D	R957	2E	U960	2D		
CR950	2F					U970	2D		

*See Parts List for serial number ranges.

† Located on back of board.

NOTE: Waveforms conditions are listed on diagram ◇1◇.

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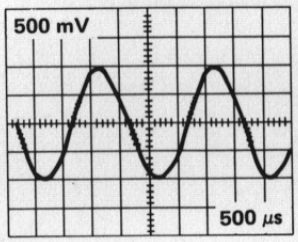

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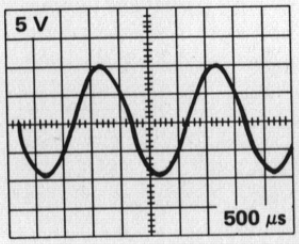

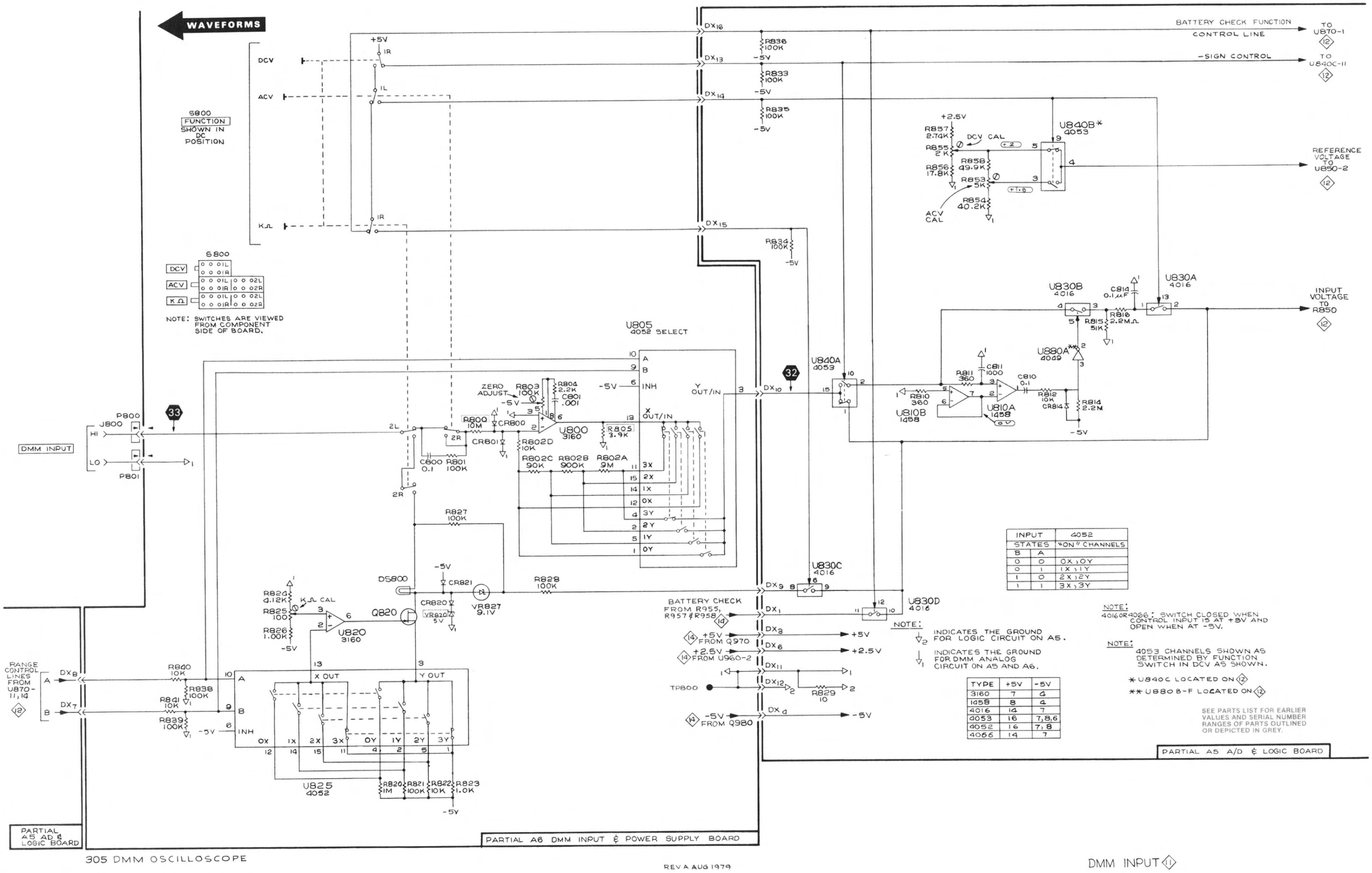

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NOTE: Waveforms conditions are listed on diagram 1.

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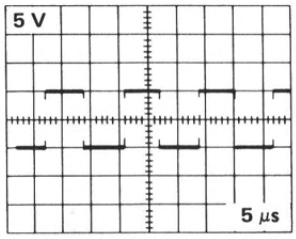

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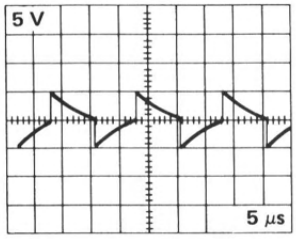

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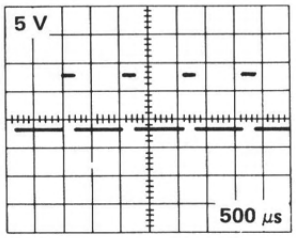

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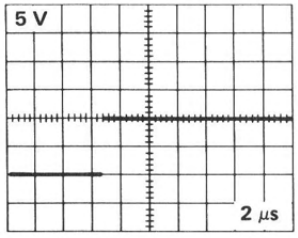


WAVEFORMS

U850 14433

INPUT VOLTAGE FROM U830-2 (11)

R850 1M

C850 0.1

REFERENCE VOLTAGE FROM U840B-4 (11)

LOW LINE FROM Q958 (14)

+4.8V FROM CR890 (14)

DX5

DX2

CR890

+4.8V

END OF CONV

DISPLAY UPDATE

C853 0.1

C852 0.1

R851 270K

R852 470K

R870 30K

R871 30K

R872 30K

R873 30K

R874 30K

R875 30K

R876 30K

R877 30K

U860 14511

R860 200

R861 200

R862 200

R863 200

R864 200

R865 200

R866 200

U880D 4049

R882 30K

R881 30K

U895B 4013

U840C* 4053

FROM S800 FUNCTION (11)

U890C 4011

U890D 4011

Q890

R895 3.3K

R896 200

Q889

Q888

Q887

Q886

R889 10K

R888 10K

R887 10K

R886 10K

TO U862, U864, U866, U868 (13)

U885 4052

Q885

R884 3.3K

R885 150

DP

U880C** 4049

U880B** 4049

R890 1M

R891 2.7M

C891 0.1

U880F** 4049

U880E** 4049

U895A 4013

U890B 4011

U890A 4011

U870 4029

BATTERY CHECK FUNCTION CONTROL FROM S800 VIA DX16 (11)

B TO R841

A TO R840

RANGE CONTROL LINES (11)

INPUT	4052
STATES	"ON" CHANNELS
B	A	
0	0	0X, 0Y
0	1	1X, 1Y
1	0	2X, 2Y
1	1	3X, 3Y

TYPE	+5V	-5V
4011	14	7
4013	14	7
4049	1	8

NOTE:
*U840A,B LOCATED ON (11)
**U880A LOCATED ON (11)

NOTE:
▽2 INDICATES THE GROUND USED FOR LOGIC CIRCUIT ON A5.

(11) → +5V

(11) → -5V

PARTIAL A6 DMM INPUT & POWER SUPPLY BOARD

PARTIAL A5 DMM A/D & LOGIC BOARD

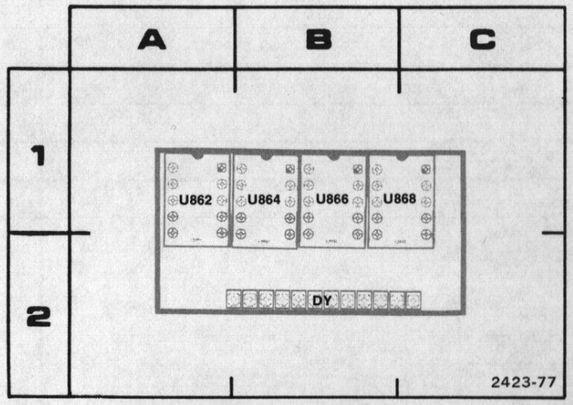
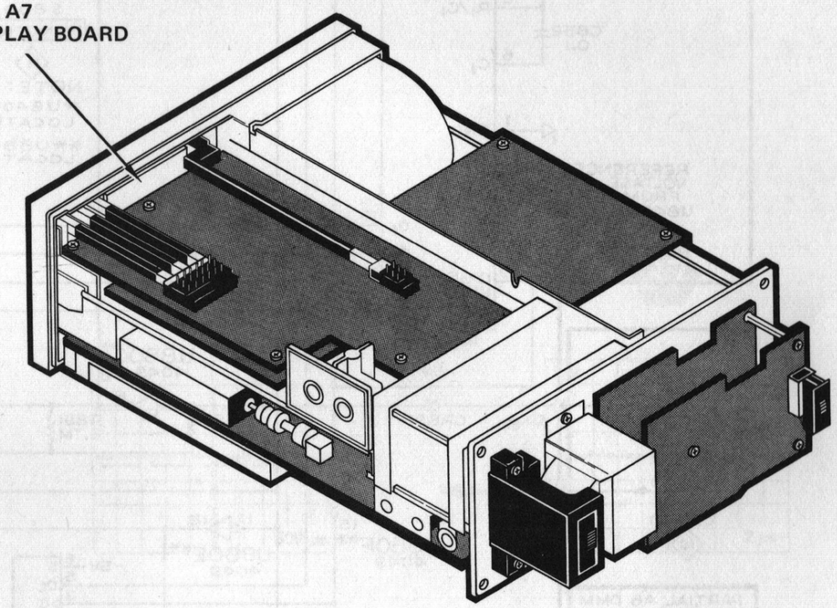
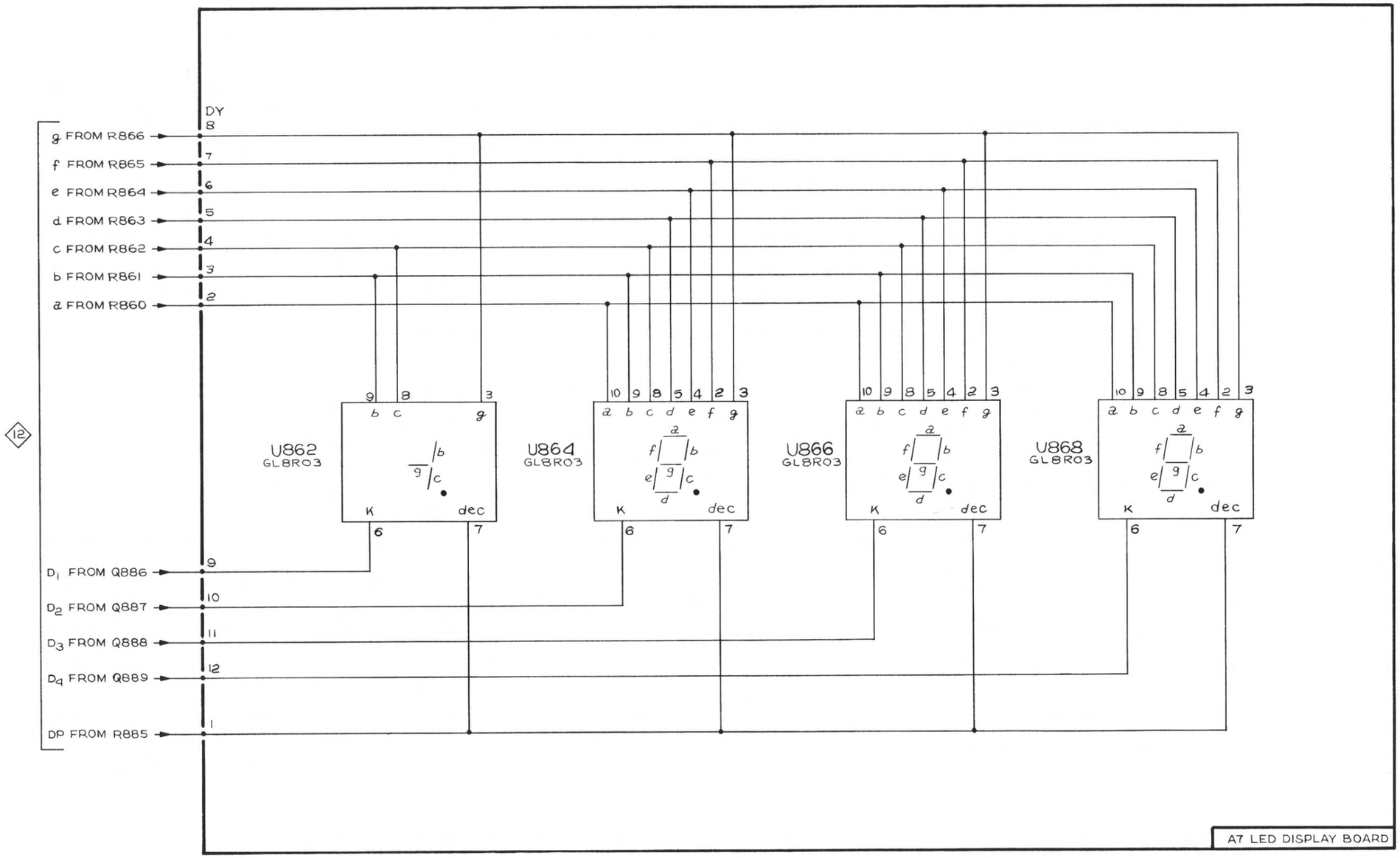


Figure 8-12. A7 LED display board.

CRT NO	GRID LOC
U862	1A
U864	1B
U866	1B
U868	1C




DY
g FROM R866
f FROM R865
e FROM R864
d FROM R863
c FROM R862
b FROM R861
a FROM R860
D1 FROM Q886
D2 FROM Q887
D3 FROM Q888
D4 FROM Q889
DP FROM R885
U862 GL8R03
U864 GL8R03
U866 GL8R03
U868 GL8R03
K
dec
A7 LED DISPLAY BOARD

NOTE: Waveforms conditions are listed on diagram <1>.

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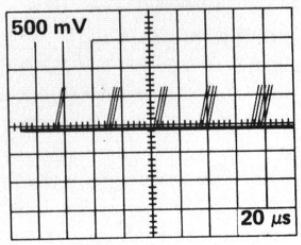

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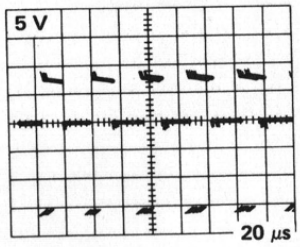
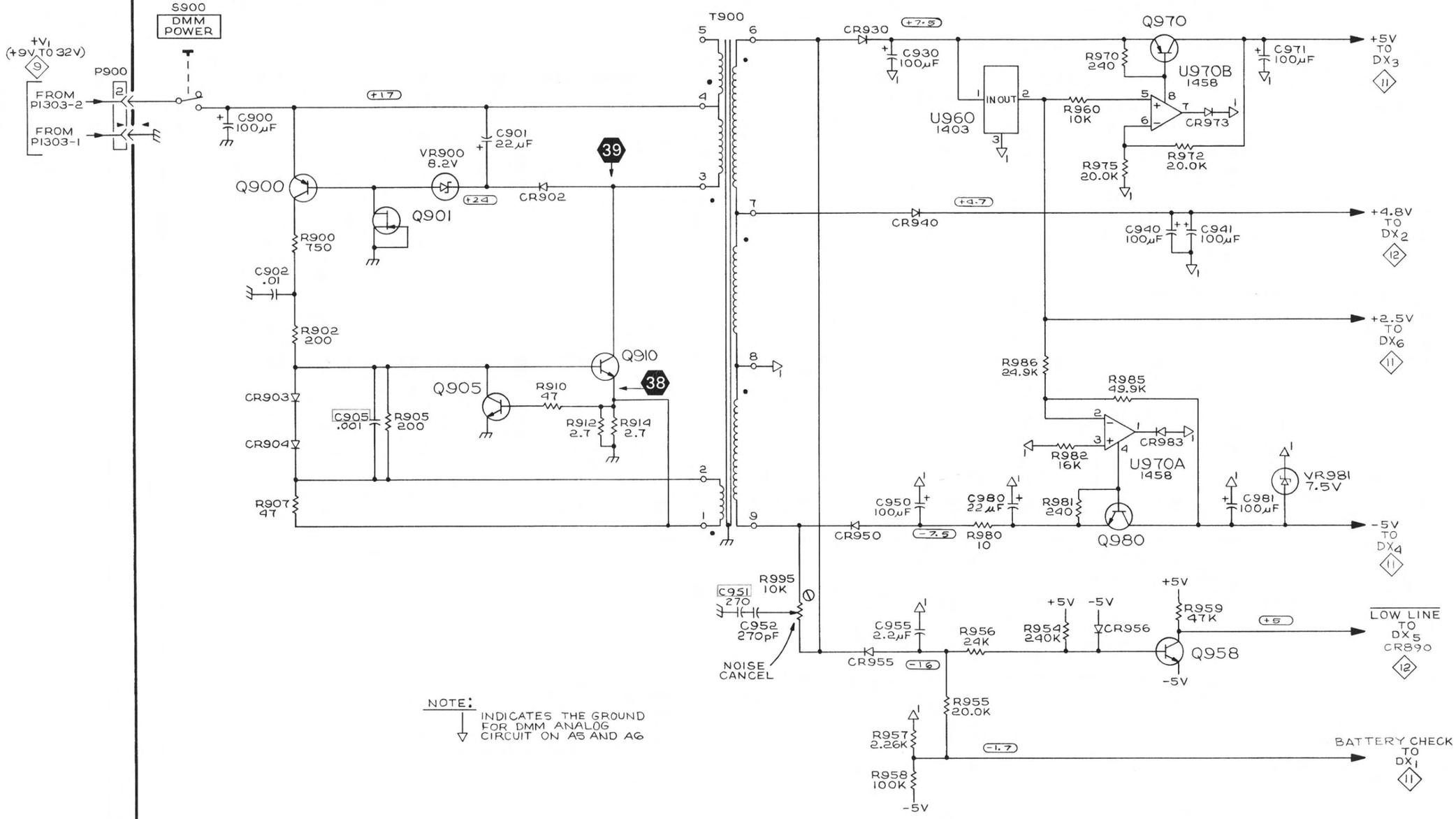
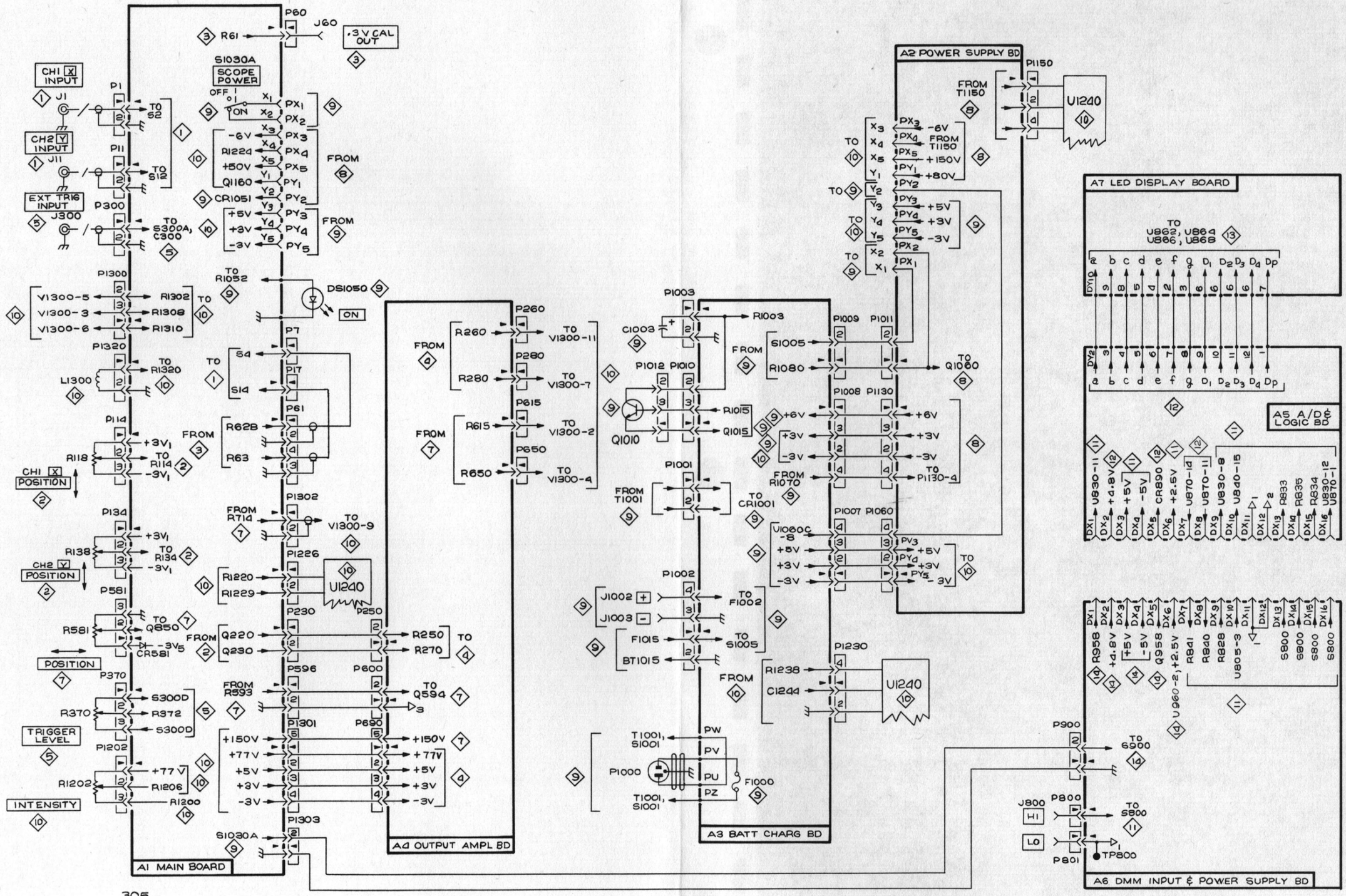


WAVEFORMS



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

PARTIAL A6 DMM INPUT & POWER SUPPLY BOARD



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CIRCUIT BOARD INTERCONNECTIONS ⟨15⟩

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

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.

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.

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 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.

ABBREVIATIONS

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

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OREGON 97005
000EX	O'HARA METAL PRODUCT COMPANY	542 BRANNAN STREET	SAN FRANCISCO, CA 94107
0000M	SONY/TEKTRONIX CORPORATION	P O BOX 14, HANEDA AIRPORT	TOKYO 149, JAPAN
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
01556	MITE CORPORATION, HELI-COIL PRODUCTS DIV.	SHELTER ROCK LANE	DANBURY, CT 06810
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
16428	BELDEN CORP.	P. O. BOX 1331	RICHMOND, IN 47374
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
71159	BRISTOL SOCKET SCREW, DIV. OF AMERICAN CHAIN AND CABLE CO., INC.	P O BOX 2244, 40 BRISTOL ST.	WATERBURY, CT 06720
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
78584	STEWART STAMPING CORP.	630 CENTRAL PARK AVE.	YONKERS, NY 10704
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
82647	TEXAS INSTRUMENTS, INC., CONTROL PRODUCTS DIV.	34 FOREST ST.	ATTLEBORO, MA 02703
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
83903	ACCURATE DIE AND STAMPING DIV., ALLIED PRODUCTS CORP.	1947 N. MAUD AVE.	CHICAGO, IL 60614
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
93907	CAMCAR SCREW AND MFG. CO.	600 18TH AVE.	ROCKFORD, IL 61101
95712	BENDIX CORP., THE ELECTRICAL COMPONENTS DIV., MICROWAVE DEVICES PLANT	HURRICANE ROAD	FRANKLIN, IN 46131
98291	SEALECTRO CORP.	225 HOYT	MAMARONECK, NY 10544

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	348-0080-01			4		FOOT,CABINET:BOTTOM	80009	348-0080-01
-2	390-0638-01			1		CABINET,SCOPE:	0000M	390-0638-01
						(ATTACHING PARTS)		
-3	211-0603-00			2		SCREW,MACHINE:6-32 X 0.312 INCH,HEX HD STL	83385	OBD
						- - - * - - -		
-4	200-1342-00			2		COVER,HANDLE:35.5MM OD X 14MM H,PLASTIC	0000M	200-1342-00
-5	386-3936-00			2		PLATE,MOUNTING:HANDLE,STEEL	0000M	386-3936-00
						(ATTACHING PARTS FOR EACH)		
-6	212-0033-00			1		SCREW,MACHINE:8-32 X 0.750 INCH,PNH STL	83385	OBD
-7	210-0008-00			1		WASHER,LOCK:INTL,0.172 ID X 0.331"OD,STL	78189	1208-00-00-0541C
						- - - * - - -		
-8	386-2182-00			4		PLATE,FRICTION:	0000M	386-2182-00
-9	343-0757-00			2		RETAINER,HANDLE:	0000M	343-0757-00
-10	334-3289-00			1		PLATE,IDENT:	0000M	334-3289-00
-11	367-0203-00			1		HANDLE,CARRYING:BLK VINYL MOLDED	0000M	367-0203-00
-12	366-1559-04			1		PUSH BUTTON:GRAY,OFF	0000M	366-1559-04
	384-1552-00			1		EXT SHAFT ASSY:	0000M	384-1552-00
-13	384-1101-00			1		. EXTENSION SHAFT:4.14 INCH LONG	80009	384-1101-00
-14	103-0186-02			1		. ADAPTER,EXT SFT:PUSH SW,0.60 OFFSET	80009	103-0186-02
-15	384-1292-00			1		. EXTENSION SHAFT:2.417 INCH LONG,PLASTIC	80009	384-1292-00
-16	366-1559-00			4		PUSH BUTTON:GRAY	80009	366-1559-00
-17	366-1559-02			1		PUSH BUTTONO:CHARCOAL,0.18 SQ X 0.43	80009	366-1559-02
-18	----- -----			1		CKT BOARD ASSY:MAIN(SEE A1 EPL)		
						(ATTACHING PARTS)		
-19	211-0116-00			6		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
						. CKT BOARD ASSY INCLUDES:		
	351-0448-01			1		. GUIDE ,SWITCH:W/SPRING AND ROLLER	80009	351-0448-01
						(ATTACHING PARTS)		
-20	210-0551-00			1		. NUT,PLAIN,HEX.:4-40 X 0.25 INCH,STL	83385	OBD
-21	211-0198-00			1		. SCREW,MACHINE:4-40 X 0.438 PNH,STL,POZ	77250	OBD
-22	210-0994-00			1		. WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
						- - - * - - -		
	----- -----			-		. . GUIDE ASSY INCLUDES:		
-23	214-1126-02			1		. . SPRING,FLAT:RED COLORED	80009	214-1126-02
-24	214-1127-00			1		. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-25	351-0448-00			1		. . GUIDE,SW ACTR:LEVER	80009	351-0448-00
-26	214-2288-02			1		. LEVER,SWITCH:STYLE A,17.5 DEG,W/CONTACTS	80009	214-2288-02
-27	337-2541-01			1		. SHIELD,ELECTRICAL:ATTENUATOR COVER	0000M	337-2541-01
-28	337-2560-00			1		. SHIELD,ELECTRICAL:ATTENUATOR	0000M	337-2560-00
						(ATTACHING PARTS)		
-29	211-0116-00			4		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
-30	337-2561-00			1		. SHIELD,ELECTRICAL:ATTENUATOR	0000M	337-2561-00
-31	----- -----			2		. SWITCH,TOGGLE:(SEE S2,S12 EPL)		
-32	----- -----			1		. SWITCH,PUSH:(SEE S300 EPL)		
-33	----- -----			1		. SWITCH,PUSH:(SEE S380 EPL)		
-34	361-0542-00			8		. SPACER,SWITCH:PLASTIC	71590	J-64281
-35	384-1516-00			1		. EXTENSION SHAFT:159,6MM L X 3.15MM OD	0000M	384-1516-00
-36	131-0963-00			1		. CONTACT,ELEC:GROUNDING	000EX	OBD
	334-3448-00	X300591		1		. MARKER,IDENT:MARKED NOTICE	80009	334-3448-00
	263-1173-00			1		. SWITCH CAM ACTUATOR ASSEMBLY:VOLTS/DIVISION	80009	263-1173-00
						(ATTACHING PARTS)		
-37	211-0116-00			4		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
	----- -----			-		. . ACTUATOR ASSY INCLUDES:		
	131-0963-00			1		. . CONTACT,ELEC:GROUNDING	000EX	OBD
-38	200-2166-00			1		. . COVER,CAM SW:15 ELEMENT	80009	200-2166-00
						(ATTACHING PARTS)		
-39	211-0008-00			4		. . SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-40	210-0004-00			4		. . WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
						- - - * - - -		
-41	210-0406-00			2		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-42	214-1139-02			1		. . SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	214-1139-03			1		. . SPRING,FLAT:RED COLORED	80009	214-1139-03
-43	214-1752-00			2		. . ROLLER,DETENT:	80009	214-1752-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-44	401-0180-00			1	. . BEARING,CAM SW:FRONT	80009	401-0180-00
					(ATTACHING PARTS)		
-45	354-0390-00			1	. . RING,RETAINING:0.338 ID X 0.025" THK,STL	79136	5100-37MD
					- - - * - - -		
-46	384-0878-20			1	. . SHAFT,CAM SW:TIME/CM FRONT,W/DRIVER	80009	384-0878-20
-47	105-0774-00			1	. . ACTUATOR,CAM SW:VOLTS/DIVISION	80009	105-0774-00
-48	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-49	401-0178-01			1	. . BEARING,CAM SW:CENTER/REAR	80009	401-0178-01
-50	376-0189-00			1	. COUPLING,SHAFT,RIGID:16MM DIA,SHAFT	0000M	376-0189-00
-51	213-0022-00			2	. . SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
-52	----- -----			1	. RESISTOR,VAR:(SEE R125,S120 EPL)		
-53	210-1042-00			1	. WASHER,LOCK:0.285 ID X 0.50 INCH OD	78189	1216-01-00-0541C
-54	214-2767-00			1	. SPRING,DETENT:STAINLESS STEEL	0000M	214-2767-00
-55	384-1515-00			1	. EXTENSION SHAFT:164MM L 3.15MM OD	0000M	384-1515-00
-56	131-0963-00			1	. CONTACT,ELEC:GROUNDING	000EX	OBD
	334-3448-00	X300591		1	. MARKER,IDENT:MARKED NOTIC	80009	334-3448-00
	263-1174-00			1	. SWITCH CAM ACTUATOR ASSEMBLY:TIME DIVISION	80009	263-1174-00
	131-0963-00			1	. . CONTACT,ELEC:GROUNDING	000EX	OBD
-57	200-2167-00			1	. . COVER,CAM SW:19 ELEMENT	80009	200-2167-00
					(ATTACHING PARTS)		
-58	211-0008-00			4	. . SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-59	210-0004-00			4	. . WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
					- - - * - - -		
-60	210-0406-00			2	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-61	214-1139-02			1	. . SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	214-1139-03			1	. . SPRING,FLAT:RED COLORED	80009	214-1139-03
-62	214-1752-00			2	. . ROLLER,DETENT:	80009	214-1752-00
-63	401-0180-00			1	. . BEARING,CAM SW:FRONT	80009	401-0180-00
					(ATTACHING PARTS)		
-64	354-0390-00			1	. . RING,RETAINING:0.338 ID X 0.025" THK,STL	79136	5100-37MD
					- - - * - - -		
-65	384-0878-19			1	. . SHAFT,CAM SWITCH:4.154 L X 0.248 OD	80009	384-0878-19
-66	105-0775-00			1	. . ACTUATOR,CAM SW:TIME/DIVISION	80009	105-0775-00
-67	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-68	401-0178-01			1	. . BEARING,CAM SW:CENTER/REAR	80009	401-0178-01
-69	376-0189-00			1	. COUPLING,SHAFT,RIGID:16MM DIA,SHAFT	0000M	376-0189-00
-70	213-0022-00			2	. . SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
-71	----- -----			1	. RESISTOR,VAR:(SEE R105 EPL)		
-72	210-1042-00			1	. WASHER,LOCK:0.285 ID X 0.50 INCH OD	78189	1216-01-00-0541C
-73	214-2767-00			1	. SPRING DETENT:STAINLESS STEEL	0000M	214-2767-00
-74	384-1514-00			1	. EXTENSION SHAFT:184.4MM L X 3.15MM OD	0000M	384-1514-00
-75	131-0963-00			1	. CONTACT,ELEC:GROUNDING	000EX	OBD
	334-3448-00	X300591		1	. MARKER,IDENT:MARKED NOTICE	80009	334-3448-00
	263-1173-00			1	. SWITCH CAM ACTUATOR ASSEMBLY:VOLTS/DIVISION	80009	263-0173-00
					(ATTACHING PARTS)		
-76	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. . ACTUATOR ASSY INCLUDES:		
	131-0963-01			1	. . CONTACT,ELEC:GROUNDING	000EX	OBD
-77	200-2166-00			1	. . COVER,CAM SW:15 ELEMENT	80009	200-2166-00
					(ATTACHING PARTS)		
-78	211-0008-00			4	. . SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-79	210-0004-00			4	. . WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
					- - - * - - -		
-80	210-0406-00			2	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-81	214-1139-02			1	. . SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	214-1139-03			1	. . SPRING,FLAT:RED COLORED	80009	214-1139-03
-82	214-1752-00			2	. . ROLLER,DETENT:	80009	214-1752-00
-83	401-0180-00			1	. . BEARING,CAM SW:FRONT	80009	401-0180-00
					(ATTACHING PARTS)		
-84	354-0390-00			1	. . RING,RETAINING:0.338 ID X 0.025" THK,STL	79136	5100-37MD
					- - - * - - -		
-85	384-0878-20			1	. . SHAFT,CAM SW:3.364 L X 0.248 OD	80009	384-0878-20
-86	105-0774-00			1	. . ACTUATOR,CAM SW:VOLTS/DIVISION	80009	105-0774-00
-87	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-88	401-0178-01			1	. . BEARING,CAM SW:CENTER/REAR	80009	401-0178-01
-89	376-0189-00			1	. COUPLING,SHAFT,RIDID:16MM DIA,SHAFT	0000M	376-0189-00
-90	213-0022-00			2	. . SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-91	----- -----			1	. RESISTOR,VAR:(SEE R578,S583 EPL)		
-92	210-1042-00			1	. WASHER,LOCK:0.285 ID X 0.50 INCH OD	78189	1216-01-00-0541C
-93	214-2767-00			1	. SPRING,DETENT:STAINLESS STEEL	0000M	214-2767-00
-94	----- -----			1	. SWITCH,PUSH:(SEE S1030 EPL)		
-95	131-0604-00			19	. CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
	131-0963-00			3	. CONTACT,ELEC:GROUNDING	000EX	OBD
-96	136-0514-00	300000	300216	2	. SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
	136-0514-00	300217		1	. SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
	136-0461-00			2	. SKT,PL-IN ELEC:CKT CARD CONTACT	80009	136-0461-00
	198-3986-00			1	. WIRE SET,ELEC:	0000M	198-3986-00
	131-0707-00			6	. . CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-97	175-0826-01			FT	. . CABLE,SP,ELEC:9,26 AWG,STRD,PVC JKT,RBN	08261	SS-0926-7
-98	352-0162-00			1	. . HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
-99	352-0171-00			2	. . HLDR,TERM CONN:1 WIRE BLACK	80009	352-0171-00
-100	136-0269-02			7	. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-101	136-0260-02			1	. SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C9316-18
-102	131-1030-00			10	. CONT ASSY,ELEC:CAM SWITCH,BOTTOM	80009	131-1030-00
	131-1031-00			18	. CONTACT ASSY,EL:CAM SWITCH,TOP	80009	131-1031-00
-103	136-0252-04	300000	300216	108	. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
	136-0252-04	300217		110	. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-104	131-0608-00			42	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	131-0589-00			6	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
	131-0566-00	X300251		2	. LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-105	214-0579-00			2	. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
	276-0543-02			2	. SHIELDING BEAD,:	80009	276-0543-02
-106	----- -----			1	ELECTRON TUBE:(SEE V1300 EPL)		
-107	----- -----			1	COIL,TUBE DEFL:(SEE L1300 EPL)		
-108	334-3360-00			1	MARKER,IDENTIFICATION:MARKED WARNING	0000M	334-3360-00
-109	348-0031-00			1	GROMMET,PLASTIC:0.156 INCH DIA	80009	348-0031-00
-110	337-2559-00			1	SHIELD,CRT:	80009	337-2559-00
					(ATTACHING PARTS)		
-111	211-0007-00			1	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
-112	210-0004-00			1	WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
					- - - * - - -		
-113	337-2628-00	X300111		1	SHIELD,ELEC:CONNECTOR	0000M	337-2628-00
-114	179-2638-00			1	WIRING HARNESS:CRT	80009	179-2638-00
					(ATTACHING PARTS)		
-115	211-0105-00			2	SCREW,MACHINE:4-40 X 0.188"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. WIRING HARNESS ASSY INCLUDES:		
-116	----- -----			1	. MODULE,HV:(SEE U1240 EPL)		
	----- -----			-	. (REPL UNDER PART NUMBER 179-2638-00 ONLY)		
	131-0707-00			17	. CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-117	175-0826-01			FT	. CABLE,SP,ELEC:9,26 AWG,STRD,PVC JKT,RBN	08261	SS-0926-7
-118	352-0171-00			4	. HLDR,TERM CONN:1 WIRE BLACK	80009	352-0171-00
-119	352-0169-02			1	. CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	352-0169-06			1	. CONN BODY,PL,EL:2 WIRE BLUE	80009	352-0169-06
-120	352-0161-00			1	. HLDR,TERM CONN:3 WIRE BLACK	80009	352-0161-00
-121	352-0162-00			2	. HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
-122	136-0266-01			1	. SKT,PL-IN ELEK:ELCTRN TUBE,12 CONT,W/LEADS	0000M	OBD
-123	386-1316-00			1	SUPPORT,CRT:REAR	80009	386-1316-00
-124	----- -----			1	CKT BOARD ASSY:OUTPUT AMP(SEE A4 EPL)		
					(ATTACHING PARTS)		
-125	211-0116-00			3	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-126	131-0589-00			13	. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-127	136-0252-04			27	. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-128	342-0430-00			1	INSULATOR,PLATE:CIRCUIT BOARD,W/SHIELD	0000M	342-0430-00
-129	337-2557-00			1	SHIELD,ELECTRICAL:INPUT COVER	0000M	337-2557-00
					(ATTACHING PARTS)		
-130	211-0101-00			2	SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-131	407-2147-01			1		BRACKET,INPUT:W/HARDWARE	0000M	407-2147-01
						(ATTACHING PARTS)		
-132	211-0025-00			2		SCREW,MACHINE:4-40 X 0.375 100 DEG,FLH STL	83385	OBD
-133	211-0101-00			2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
	----- -----			-		. INPUT BRACKET INCLUDES:		
-134	131-0106-00			3		. CONNECTOR,RCPT,:FEMALE,BNC	95712	9856-1
-135	210-0255-00			3		. TERMINAL,LUG:0.391" ID INT TOOTH	80009	210-0255-00
-136	337-2558-00			1		. SHIELD ELEC:INPUT BRACKET	0000M	337-2558-00
-137	386-3888-00			1		. PANEL,SIDE:	0000M	386-3888-00
-138	426-1528-00			1		FRAME,SUBPANEL:FRONT	0000M	426-1528-00
						(ATTACHING PARTS)		
-139	211-0268-00			2		SCREW,MACHINE:2-56 X 6.7MM,PNH	0000M	211-0268-00
-140	210-0001-00			2		WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
-141	211-0649-00			4		SCREW,MACHINE:2-56 X 4.1MM,FLH,STL	0000M	211-0649-00
-142	211-0269-00			1		SCREW,MACHINE:4-40 X 5.6MM FLH 100 DEG	0000M	211-0269-00
-143	211-0097-00			1		SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	OBD
-144	210-0004-00			1		WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
-145	129-0715-00			1		SPACER,POST:39.4MML,0.188 HEX	0000M	129-0715-00
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-1	366-1023-00			1		KNOB:GRAY	80009	366-1023-00
	213-0246-00			1		. SETSCREW:5-40 X 0.093 INCH L,HEX SOC	71159	OBD
-2	426-1072-00			10		FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-3	366-1405-06			2		KNOB:RED,CAL,0.127 ID,0.45 OD	80009	366-1405-06
	----- -----			-		EACH KNOB INCLUDES:		
	213-0048-00			1		. SETSCREW:4-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-4	366-1057-00			1		KNOB:GRAY	80009	366-1057-00
	213-0153-00			2		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-5	366-1031-03			1		KNOB:RED--CAL	80009	366-1031-03
	213-0246-00			1		. SETSCREW:5-40 X 0.093 INCH L,HEX SOC	71159	OBD
-6	366-1057-02			1		KNOB:CHARCOAL GY,0.252 ID	80009	366-1057-02
	213-0153-00			2		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-7	366-1057-01			1		KNOB:SIL GY,0.252 ID	80009	366-1057-01
	213-0153-00			2		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-8	358-0597-00			3		BUSHING,SLEEVE:6.5MM ID X 6.0 MM L	0000M	358-0597-00
-9	366-1189-00			2		KNOB:GRAY	80009	366-1189-00
	----- -----			-		. EACH KNOB INCLUDES:		
	213-0246-00			1		. SETSCREW:5-40 X 0.093 INCH L,HEX SOC	71159	OBD
-10	366-1189-03			1		KNOB:CHARCOAL GY,W/INDEX	80009	366-1189-03
	213-0246-00			1		. SETSCREW:5-40 X 0.093 INCH L,HEX SOC	71159	OBD
-11	366-1189-02			1		KNOB:SIL GY,W/INDEX	80009	366-1189-02
	213-0246-00			1		. SETSCREW:5-40 X 0.093 INCH L,HEX SOC	71159	OBD
-12	333-2414-00			1		PANEL,FRONT:	0000M	333-2414-00
-13	----- -----			1		RESISTOR,VAR:(SEE R1202 EPL)		
						(ATTACHING PARTS)		
-14	220-0739-00			1		NUT,PLAIN,HEX:POT MTG,M6,4.6MM LG X 8.0MM	0000M	220-0739-00
-15	210-3035-00			1		WASHER,FLAT:11.0MM OD X 7.6MM ID X 0.5MM	0000M	210-3035-00
-16	210-0046-00			1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
						- - - * - - -		
-17	----- -----			1		RESISTOR,VAR:(SEE R370 EPL)		
						(ATTACHING PARTS)		
-18	220-0739-00			1		NUT,PLAIN,HEX:4.6MM LG X 8.0MM BRS	0000M	220-0739-00
-19	210-3035-00			1		WASHER,FLAT:11.0MM OD X 7.6MM ID 0.5MM	0000M	210-3035-00
-20	210-0046-00			1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
						- - - * - - -		
-21	----- -----			1		RESISTOR,VAR:(SEE R581 EPL)		
						(ATTACHING PARTS)		
-22	220-0739-00			1		NUT,PLAIN,HEX:4.6MM LG X 8.0MM BRS	0000M	220-0739-00
-23	210-3035-00			1		WASHER,FLAT:11.0MM OD X 7.6MM ID 0.5MM	0000M	210-3035-00
-24	210-0046-00			1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
						- - - * - - -		
-25	----- -----			1		RESISTOR,VAR:(SEE R118 EPL)		
						(ATTACHING PARTS)		
-26	220-0739-00			1		NUT,PLAIN,HEX:4.6MM LG X 8.0MM BRS	0000M	220-0739-00
-27	210-3035-00			1		WASHER,FLAT:11.0MM OD X 7.6MM ID 0.5MM	0000M	210-3035-00
-28	210-0046-00			1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
						- - - * - - -		
-29	----- -----			1		RESISTOR,VAR:(SEE R138 EPL)		
						..ACHING PARTS)		
-30	220-0739-00			1		NUT PLAIN HEX:4.6MM LG X 8.0MM BRS	0000M	220-0739-00
-31	210-3035-00			1		WASHER,FLAT:11.0MM OD X 7.6MM ID 0.5MM	0000M	210-3035-00
-32	210-0046-00			1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
						- - - * - - -		
-33	426-1529-00			1		FRAME,LED DISPLAY:PLASTIC	0000M	426-1529-00
-34	378-0109-00			1		FILTER,LED DISPLAY:RED	0000M	378-0109-00
-35	200-1775-00			1		BEZEL:GREY PHENYLENE OXIDE MOLDED	0000M	200-1775-00
						(ATTACHING PARTS)		
-36	211-0664-00			2		SCREW,MACHINE:4-40,7.9MM LG,PH POZ	0000M	211-0664-00
						- - - * - - -		
-37	378-2016-01			1		FILTER,LT,CRT:BLUE POLYCARBONATE	0000M	378-2016-01
-38	331-0301-00			1		MASK,CRT:	0000M	331-0301-00
-39	131-0251-00			1		JACK,TIP:PANEL MTG,RED	98291	016-8010-2
-40	386-3952-00			1		PLATE,BEZEL MOUNTING:STAINLESS STEEL	0000M	386-3952-00
-41	386-3954-00			1		SUBPANEL,FRONT:	0000M	386-3954-00
						(ATTACHING PARTS)		
-42	211-0101-00			2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-43	----- -----			1		CHASSIS,SCOPE:		
	----- -----			-		(REPL UNDER PART NUMBER 441-1439-00 ONLY)		
						(ATTACHING PARTS)		
-44	211-0012-00			1		SCREW,MACHINE:4-40 X 0.375 INCH,PNH STL	83385	OBD
-45	210-0004-00			1		WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
						- - - * - - -		
-46	352-0409-01			1		HOLDER,CONN:W/HARDWARE,BLACK PLSTC	80009	352-0409-01
						(ATTACHING PARTS)		
-47	213-0107-00			1		SCR,TPG,THD FOR:4-40 X 0.25 INCH,FLH STL	93907	OBD
						- - - * - - -		
	----- -----			-		. HOLDER,TIP JACK INCLUDES:		
-48	136-0490-00			1		. JACK,TIP:BANANA JACK ASSY	80009	136-0490-00
						(ATTACHING PARTS)		
-49	210-0465-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-50	210-0223-00			1		. TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
						- - - * - - -		
-51	136-0491-00			1		. JACK,TIP:BANANA JACK ASSY	80009	136-0491-00
						(ATTACHING PARTS)		
-52	210-0465-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-53	210-0223-00			1		. TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
						- - - * - - -		
-54	343-0761-00			1		CLAMP CAPACITOR:25.2MM ID	0000M	343-0761-00
						(ATTACHING PARTS)		
-55	210-0586-00			1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
						- - - * - - -		
-56	213-0807-00			1		SCREW,GROUND:6-32 INT 0.25-32	0000M	213-0807-00
						(ATTACHING PARTS)		
-57	211-0544-00			1		SCREW,MACHINE:6-32 X 0.750,TRH STL	83385	OBD
-58	210-0465-00			1		NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	737.3	3095-402
-59	210-0046-00			1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
						- - - * - - -		
-60	348-0572-00			4		FOOT,CABINET:BLACK,W/CORD WRAP	0000M	348-0572-00
-61	200-2213-01			1		COVER,REAR:ALUMINUM	0000M	200-2213-01
						(ATTACHING PARTS)		
-62	213-0170-00			1		THUMBSCREW:8-32 X 0.82 INCH L,STL	80009	213-0170-00
-63	210-0804-00			1		WASHER,FLAT:0.17 ID X 0.375 INCH OD,STL	12327	OBD
-64	354-0324-00			1		RING,RETAINING:E SHAPE,0.102 ID X 0.270	79136	5133-14-MD
						- - - * - - -		
-65	342-0427-00			1		INSULATOR,PLATE:REAR COVER	0000M	342-0427-00
-66	348-0573-00			1		GROMMET,PLASTIC:BLACK,9.2MM ID	0000M	348-0573-00
-67	426-1530-00			1		FRAME,CABINET:	0000M	426-1530-00
-68	129-0702-00			1		SPACER,POST:43.6MM,0.25 HEX	0000M	129-0702-00
-69	386-4020-00			1		PLATE,SLIDE SWITCH:	0000M	386-4020-00
-70	----- -----			1		SWITCH,SLIDE:(SEE S1001A,B EPL)		
						(ATTACHING PARTS)		
-71	211-0101-00			2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-72	344-0315-00			1		CLIP,POWER CORD:	0000M	344-0315-00
						(ATTACHING PARTS)		
-73	211-0016-00			2		SCREW,MACHINE:4-40 X 0.625 INCH,PNH STL	83385	OBD
-74	210-0994-00			2		WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
						- - - * - - -		
-75	161-0033-24	300001	300710	1		CABLE ASSY,PWR,:3,18 AWG,125V,108.3 L	16428	OBD
	161-0033-26	300711		1		CABLE ASSY,PWR,:3,18 AWG,125V,101.3 L	16428	OBD
-76	220-0547-01			2		NUT,BLOCK:0.38 X 0.25 X 0.282"OA	80009	220-0547-01
						(ATTACHING PARTS FOR EACH)		
-77	211-0008-00			1		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-78	210-0004-00			1		WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
						- - - * - - -		
-79	210-0202-00			1		TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
						(ATTACHING PARTS)		
-80	211-0501-00			1		SCREW,MACHINE:6-32 X 0.125 INCH,PNH STL	83385	OBD
						- - - * - - -		
-81	334-3397-00			1		MARKER,IDENT:MARKED CAUTION	0000M	334-3397-00
-82	----- -----			1		TRANSFORMER:(SEE T1001 EPL)		
						(ATTACHING PARTS)		
-83	210-0407-00			2		NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-84	210-0006-00			1		WASHER,LOCK:#6 INTL,0.018THK,STL CD PL	78189	1206-00-00-0541C
-85	210-0202-00			1		TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-86	200-2259-00			1	COVER,SLIDE SWITCH:GRAY PLASTIC	0000M	200-2259-00
-87	----- -----			1	CKT BOARD ASSY:BATT CHARGER(SEE A3 EPL)		
					(ATTACHING PARTS)		
-88	211-0116-00			3	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	-----			-	. CKT BOARD ASSY INCLUDES:		
-89	131-0608-00			24	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-90	136-0252-04			12	. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-91	----- -----			1	. SWITCH,SLIDE:(SEE S1005A,B EPL)		
-92	136-0514-00			2	. SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
-93	344-0154-00			4	. CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE	80009	344-0154-00
-94	136-0269-02			1	. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-95	214-0579-00			2	. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-96	----- -----			1	CKT BOARD ASSY:POWER SUPPLY(SEE A2 EPL)		
					(ATTACHING PARTS)		
-97	129-0712-00			3	SPACER POST:37.2MM L,0.188 HEX	0000M	129-0712-00
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-98	136-0252-04			18	. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-99	131-0608-00			13	. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-100	342-0445-00			1	. INSULATOR,FILM:SWITCH REGULATOR XFMR	0000M	342-0445-00
-101	342-0446-00			1	. INSULATOR,FILM:DC-DC CONVERTER	0000M	342-0446-00
-102	136-0263-04			10	. SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	48059
-103	210-0008-00			1	WASHER,LOCK:INTL,0.172 ID X 0.331"OD,STL	78189	1208-00-00-0541C
-104	348-0055-00			1	GROMMET,PLASTIC:0.25 INCH DIA	80009	348-0055-00
-105	213-0806-00			1	THUMBSCREW:0.375-32 X 20MM L,9.5MM	0000M	213-0806-00
-106	348-0253-00			1	GROMMET,PLASTIC:1.24 X 0.739 X 0.108" OA	80009	348-0253-00
-107	105-0062-02			1	LATCH,THUMB:BATTERY BOX,AL	80009	105-0062-02
					(ATTACHING PARTS)		
-108	211-0140-00			1	SCREW SHOULDER:4-40 X .775 LG	0000M	211-0140-00
-109	210-0802-00	300001	300110	1	WASHER,FLAT:0.15 ID X 0.312 INCH OD	12327	OBD
	210-1318-00	300111		1	WASHER,FLAT:0.169 ID X 0.02 THK,STL	0000M	210-1318-00
-110	210-0948-00			1	WASHER,FLAT:0.166 ID X 0.03 THK,0.186 OD	83903	OBD
-111	210-0994-00			2	WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
					- - - * - - -		
-112	----- -----			1	TRANSISTOR:(SEE Q1010 EPL)		
					(ATTACHING PARTS)		
-113	210-0406-00			1	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
					- - - * - - -		
-114	342-0163-01			1	INSULATOR,PLATE:XSTR,0.675 X 0.625 X 0.001"	80009	342-0163-01
-115	386-3953-01			1	PLATE,SPACER:BATTERY,PLASTIC	0000M	386-3953-01
					(ATTACHING PARTS)		
-116	211-0008-00			1	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-117	210-0406-00			2	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-118	210-0054-00			2	WASHER,LOCK:SPLIT,0.118 ID X 0.212"OD STL	83385	OBD
					- - - * - - -		
	----- -----			-	. PLATE,SPACER INCLUDES:		
-119	210-0994-00			2	. WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
-120	211-0507-00			2	. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-121	210-0202-00			2	. TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
-122	129-0735-00			2	. SPACER,POST:7.6MM L,0.25 HEX	0000M	129-0735-00
-123	134-0013-00			2	. PLUG,TIP:BANANA	74970	108-753-17
					(ATTACHING PARTS FOR EACH)		
-124	210-0583-00			1	NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-125	210-0046-00			1	WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
-126	210-0269-00			1	TERMINAL,LUG:NON LOCKING,0.257" MTG HOLE	78584	OBD
					- - - * - - -		
-127	386-3951-01			1	PLATE BATTERY PACK:ALUMINUM	0000M	386-3951-01
					(ATTACHING PARTS)		
-128	211-0008-00			2	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-129	211-0007-00			2	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-130	129-0714-00			2	SPACER,POST:34MM L,W/4-40 BRASS	0000M	129-0714-00
					(ATTACHING PARTS)		
-131	211-0532-00			4	SCREW,MACHINE:6-32 X 0.75 INCH,FILH STL	83385	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-132	343-0780-00			1	CLAMP,BATTERY:	0000M	343-0780-00
-133	343-0779-00			1	CLAMP BATTERY:	0000M	343-0779-00
-134	342-0435-00			1	INSULATOR,PLATE:CABINET,TOP	0000M	342-0435-00
					(ATTACHING PARTS)		
-135	211-0008-00			1	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-136	210-0994-00			1	WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
					- - - * - - -		
-137	366-1559-04			1	PUSH BUTTON:GRAY, OFF	0000M	366-1559-04
	384-1553-00			1	EXT SHAFT ASSY:	0000M	384-1553-00
-138	384-1136-00			1	. EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
-139	103-0186-01			1	. ADAPTER,EXT SFT:PUSH SW,0.45 OFFSET	80009	103-0186-01
-140	384-1101-00			1	. EXTENSION SHAFT:4.14 INCH LONG	80009	384-1101-00
-141	366-1512-00			3	PUSH BUTTON:GRAY,0.18 SQ X 0.83 INCH LG	80009	366-1512-00
-142	384-1292-00			3	EXTENSION SHAFT:2.417 INCH LONG,PLASTIC	80009	384-1292-00
.	672-0757-00			1	CKT BOARD ASSEMBLY:DMM	0000M	672-0757-00
					(ATTACHING PARTS)		
-143	211-0116-00			3	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-144	----- -----			1	. CKT BOARD ASSY:POWER SUPPLY(SEE A6 EPL)		
					(ATTACHING PARTS)		
-145	211-0116-00			3	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	- -----			-	. . CKT BOARD ASSY INCLUDES:		
-146	131-2213-01			1	. . CONN,PLUG,ELEC:CKT BD,16 CONTACT	0000M	131-2213-01
-147	136-0514-00			4	. . SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
-148	136-0260-02			2	. . SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C9316-18
-149	214-0579-00			1	. . TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-150	136-0252-04			24	. . SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-151	131-0608-00	300001	300110	4	. . TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	131-0608-00	300111		2	. . TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	131-0589-00	300001	300110	4	. . TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
	131-0589-00	300111		2	. . TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-152	----- -----			1	. . SWITCH,PUSH:(SEE S900 EPL)		
-153	344-0154-00			2	. . CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE	80009	344-0154-00
-154	----- -----			1	. . SWITCH,PUSH:(SEE S800 EPL)		
-155	361-0411-00			6	. . SPACER,PUSH SW:0.13 W X 0.375 INCH L,PLSTC	71590	J64285-00
-156	337-2562-00			1	. SHIELD,ELECTRICAL:DMM CKT BD,W/INSULATORS	0000M	337-2562-00
-157	129-0716-00			3	. SPACER,POST:7MM L,W/4-40 INT-EXT THD BRASS	0000M	129-0716-00
					(ATTACHING PARTS FOR EACH)		
-158	210-0406-00			1	. NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-159	210-1002-00			1	. WASHER,FLAT:0.125 ID X 0.25 INCH OD,BRS	12327	OBD
-160	210-0054-00			1	. WASHER,LOCK:SPLIT,0.118 ID X 0.212"OD STL	83385	OBD
					- - - * - - -		
-161	361-0466-00			1	. SPACER,NONMETALLIC:7MM LG	0000M	361-0466-00
-162	----- -----			1	. CKT BOARD ASSY:DMM A/D & LOGIC(SEE A5 EPL)		
-163	131-2212-00			1	. . CONN,PLUG,ELEC:CKT BD,12 CONTACTS	0000M	131-2212-00
-164	136-0514-00			1	. . SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
-165	136-0269-02			3	. . SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-166	136-0260-02			5	. . SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C9316-18
167	136-0578-00			1	. . SOCKET,PLUG-IN:24 DIP,LOW PROFILE	73803	CS9002-24
-168	136-0702-01			1	. . SOCKET,PIN TERM:U/W 0.8MM DIA PIN	0000M	136-0702-01
-169	136-0252-04			18	. . SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-170	----- -----			1	. . CKT BOARD ASSY:LED(SEE A7 EPL)		
-171	210-0406-00			3	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-172	407-2145-00			1	BRACKET,SUPPORT:	0000M	407-2145-00
-173	129-0175-00			1	POST,NONMET:.75 LG X .188 HEX NYLON	80009	129-0175-00
-174	129-0713-00			1	SPACER POST:19.05MM L,W/4-40 BRASS	0000M	129-0713-00
-175	407-2146-01			1	BRACKET,INPUT:W/HARDWARE,PLSTC	0000M	407-2146-01
					(ATTACHING PARTS)		
-176	211-0603-00			2	SCREW,MACHINE:6-32 X 0.312 INCH,HEX HD STL	83385	OBD
-177	210-0006-00			2	WASHER,LOCK:#6 INTL,0.018THK,STL CD PL	78189	1206-00-00-0541C
					- - - * - - -		
	----- -----			-	. INPUT BRACKET INCLUDES:		
-178	214-0304-00			1	. INSERT,SCR THD:4-40 X 0.25 L,0.156 OD	01556	70015-04
-179	210-0202-00			2	. TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
					(ATTACHING PARTS FOR EACH)		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-180	210-0407-00			1	. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
					- - - * - - -		
-181	131-1958-00			2	. CONN,RCPT,ELEC:CKT CARD MOUNTED	80009	131-1958-00
-182	358-0584-01			1	. BUSHING,CONN:0.325 ID,PLASTIC	80009	358-0584-01
-183	358-0584-00			1	. BUSHING,CONN:0.325 ID,PLASTIC	80009	358-0584-00
-184	342-0433-00			1	INSULATOR,PLATE:POSITION POT,FRONT	0000M	342-0433-00
-185	342-0434-00			1	INSULATOR,PLATE:CHASSIS,BOTTOM	0000M	342-0434-00
-186	220-0547-01			1	NUT,BLOCK:0.38 X 0.25 X 0.282"OA	80009	220-0547-01
					(ATTACHING PARTS)		
-187	211-0105-00			1	SCREW,MACHINE:4-40 X 0.188"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
	334-3379-00	X300111		1	MARKER,IDENT:MARKED GROUNDSYMBOL	80009	334-3379-00
-188	441-1439-00			1	CHASSIS, SCOPE:	0000M	441-1439-00
	198-3985-00			1	WIRE SET,ELEC:	0000M	198-3985-00
	175-0825-01			FT	. CABLE,SP,ELEC:	08261	SS1026710610C-X
-189	175-0863-00			FT	. WIRE,ELECTRICAL:2 WIRE RIBBON	08261	SS-0222-1910610C
-190	175-0827-00			FT	. WIRE,ELECTRICAL:4 WIRE RIBBON	08261	SS-0426-710610C
	175-0861-00			FT	. WIRE,ELECTRICAL:4 WIRE RIBBON	08261	SS-0422-1910610C
-191	175-0828-00			FT	. WIRE,ELECTRICAL:5 WIRE RIBBON	08261	OBD
-192	175-0832-00			FT	. WIRE,ELECTRICAL:9 WIRE RIBBON	08261	SS-0926(1061)0C
	175-0826-01			FT	. CABLE,SP,ELEC:9,26 AWG,STRD,PVC JKT,RBN	08261	SS-0926-7
-193	131-0707-00	300001	300110	99	. CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	131-0707-00	300111		97	. CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-194	131-0621-00	300001	300110	6	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	131-0621-00	300111		8	. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-195	352-0171-00	300001	300110X	1	. HLDR,TERM CONN:1 WIRE BLACK	80009	352-0171-00
-196	352-0169-00	300001	300110	6	. HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
	352-0169-00	300111		5	. HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
	352-0169-03	300001	300110	1	. CONN BODY,PL,EL:2 WIRE ORANGE	80009	352-0169-03
	352-0169-03	300111		3	. CONN BODY,PL,EL:2 WIRE ORANGE	80009	352-0169-03
	352-0169-06			1	. CONN BODY,PL,EL:2 WIRE BLUE	80009	352-0169-06
	352-0169-09			1	. CONN BODY,PL,EL:2 WIRE WHITE	80009	352-0169-09
-197	352-0161-00			5	. HLDR,TERM CONN:3 WIRE BLACK	80009	352-0161-00
	352-0161-02			1	. CONN BODY,PL,EL:3 WIRE RED	80009	352-0161-02
	352-0161-09			1	. CONN BODY,PL,EL:3 WIRE WHITE	80009	352-0161-09
-198	352-0162-00	300001	300110	5	. HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	352-0162-00	300111		3	. HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	352-0162-08	300111		2	. CONN BODY,PL,EL:4 WIRE GRAY	80009	352-0162-08
-199	352-0163-00			2	. CONN BODY,PL,EL:5 WIRE BLACK	80009	352-0163-00
-200	352-0197-00	300001	300110	2	. CONN BODY,PL,EL:1 WIRE BLACK	80009	352-0197-00
	352-0197-00	300111		4	. CONN BODY,PL,EL:1 WIRE BLACK	80009	352-0197-00
-201	352-0198-00			2	. HLDR,TERM CONN:2 WIRE BLACK	80009	352-0198-00

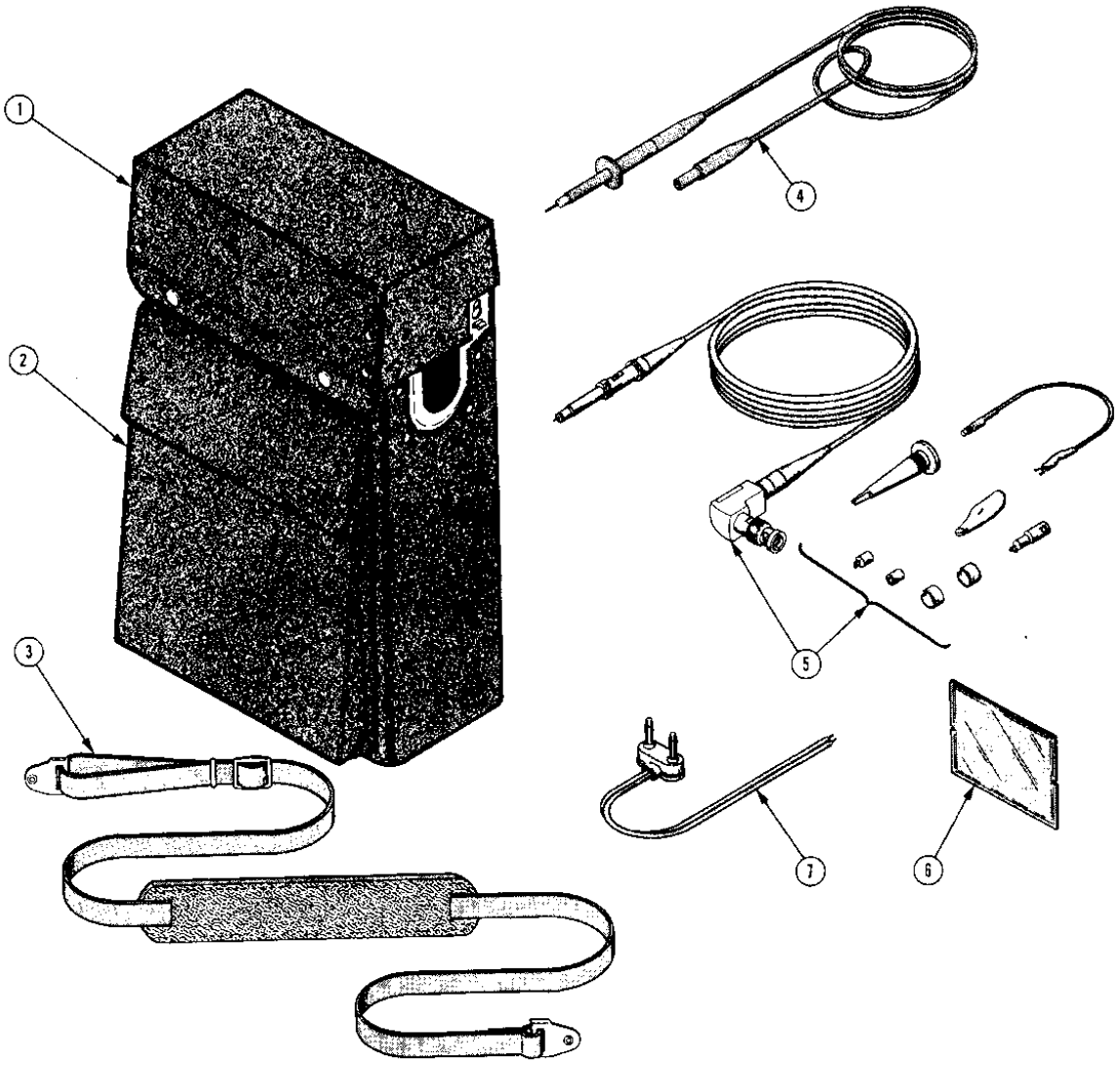

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3 -1	200-2260-00			1		COVER,CARYG CASE:	0000M	200-2260-00
-2	016-0401-00			1		CASE,CARRYING:	0000M	016-0401-00
-3	346-0131-00			1		STRAP ASSY,CRYG	0000M	346-0131-00
-4	012-0732-00			1		LEAD SET,ELEC:UL RATED	80009	012-0732-00
-5	010-6149-03			1		PROBE,VOLTAGE:P6149,2 METER,10X W/ACCESS	80009	010-6149-03
-6	331-0394-01			1		WINDOW,CRT:CLEAR,PLASTIC	0000M	331-0394-01
-7	012-0406-00			1		CABLE ASSY:PWR DL	0000M	012-0406-00
	159-0164-00			2		FUSE,CARTRIDGE:0.1A,250V,5 SEC	0000M	159-0164-00
	159-0163-00			1		FUSE,CARTRIDGE:0.25A,250V,0.2 SEC	0000M	159-0163-00
	159-0156-00			1		FUSE,CARTRIDGE:1.5A,250V	0000M	159-0156-00
	070-2423-01			1		MANUAL,TECH:SERVICE	80009	070-2423-01
	070-2424-00			1		MANUAL,TECH:OPERATORS	80009	070-2424-00
						OPTIONAL ACCESSORIES		
	016-0297-00			1		VISOR,CRT:	80009	016-0297-00
	016-0327-01			1		ADAPTER,CAMERA:EXTENSION	80009	016-0327-01
	103-0033-00			1		ADAPTER,CONN:BNC TO BINDING POST	95712	2048-2NT34
	378-0843-01			1		FILTER,LIGHT CRT:AMBER	80009	378-0843-01

Tektronix®
COMMITTED TO EXCELLENCE

MANUAL CHANGE INFORMATION

Date: 8-28-79 Change Reference: C12/879

Product: 305 DMM OSCILLOSCOPE Manual Part No.: 070-2423-01

DESCRIPTION

ELECTRICAL PARTS LIST CHANGES

CHANGE TO:

		EFF SN		REF
R1070	315-0102-00	300661	RES.,FXD,CMPSN:1K OHM,5%,0.25W	PC 80
U1060	156-1265-00	300661	MICROCIRCUIT,LI:OPER AMP,QUAD	PC 80
ADD:				
E200	276-0543-02	300661	SHIELDING BEAD:FERRITE CORE	M37161
E210	276-0543-02	300661	SHIELDING BEAD:FERRITE CORE	M37161
R1067	315-0472-00	300661	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	PC 80
VR820	152-0195-00	300711*	SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	M37802

*May also be present in some earlier SN instruments.

SCHEMATIC CHANGES

E200 is added to the base lead of Q200 and E210 is added to the base lead of Q210. Both are located on the A1 MAIN board and affect VERT PREAMP & SWITCHING diagram 2. The other components listed above are already shown in schematics and component location illustrations.