

INSTRUCTION MANUAL

Serial Number _____

5103N OSCILLOSCOPE SYSTEM

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

Old Model	New Model	Comparison of Main Characteristics
DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 nsec into 50 Ω .	107 - Risetime less than 3.0 nsec into 50 Ω .
108	PG 501 - 5 V output pulse; 3.5 nsec Risetime.	108 - 10 V output pulse; 1 nsec Risetime.
111	PG 501 - Risetime less than 3.5 nsec; 8 nsec Pretrigger pulse delay.	111 - Risetime 0.5 nsec; 30 to 250 nsec Pretrigger Pulse delay.
114	PG 501 - ± 5 V output.	114 - ± 10 V output. Short proof output.
115	PG 501 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; ± 5 V dc Offset; short proof output. Has ± 5 V output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ± 10 V output. Short proof output.
PG 502 replaces 107	PG 502 - 5 V output	108 - 10 V output.
108	PG 502 - Risetime less than 1 nsec; 10 nsec Pretrigger pulse delay.	111 - Risetime 0.5 nsec; 30 to 250 nsec Pretrigger pulse delay.
111	PG 502 - ± 5 V output.	114 - ± 10 V output. Short proof output.
114	PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; ± 5 V output. Short proof output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ± 10 V output. Short proof output.
115	PG 502 - Does not have Paired, Delayed, Undelayed and output locked mode; ± 5 V output.	2101 - Paired, Delayed, Undelayed and output locked on mode; 10 V output.
2101		
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude, 60 V output.	106 - Positive and Negative-going trigger output signal, 50 nsec and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191	SG 503 - Frequency range 250 kHz to 250 MHz.	191 - Frequency range 350 kHz to 100 MHz.
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. Only one time-mark can be generated.	180A - Marker outputs, 5 sec to 1 μ s. Sinewave available at 5, 10, and 50 MHz. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be stacked.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000, plus 10 MHz sinewave.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. Only one time-mark can be generated.	2901 - Marker outputs, 5 sec to 0.1 μ s. Sinewave available at 5, 10, and 50 ns. Separate trigger pulses, from 5 sec to 0.1 μ s. Multiple time-marks can be stacked.



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

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

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type (or Part Number) and Serial or Model Number with all requests for parts or service.

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MANUAL CHANGE INFORMATION

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

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

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

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CARTON ASSEMBLY
(Part No. 065-0150-00)

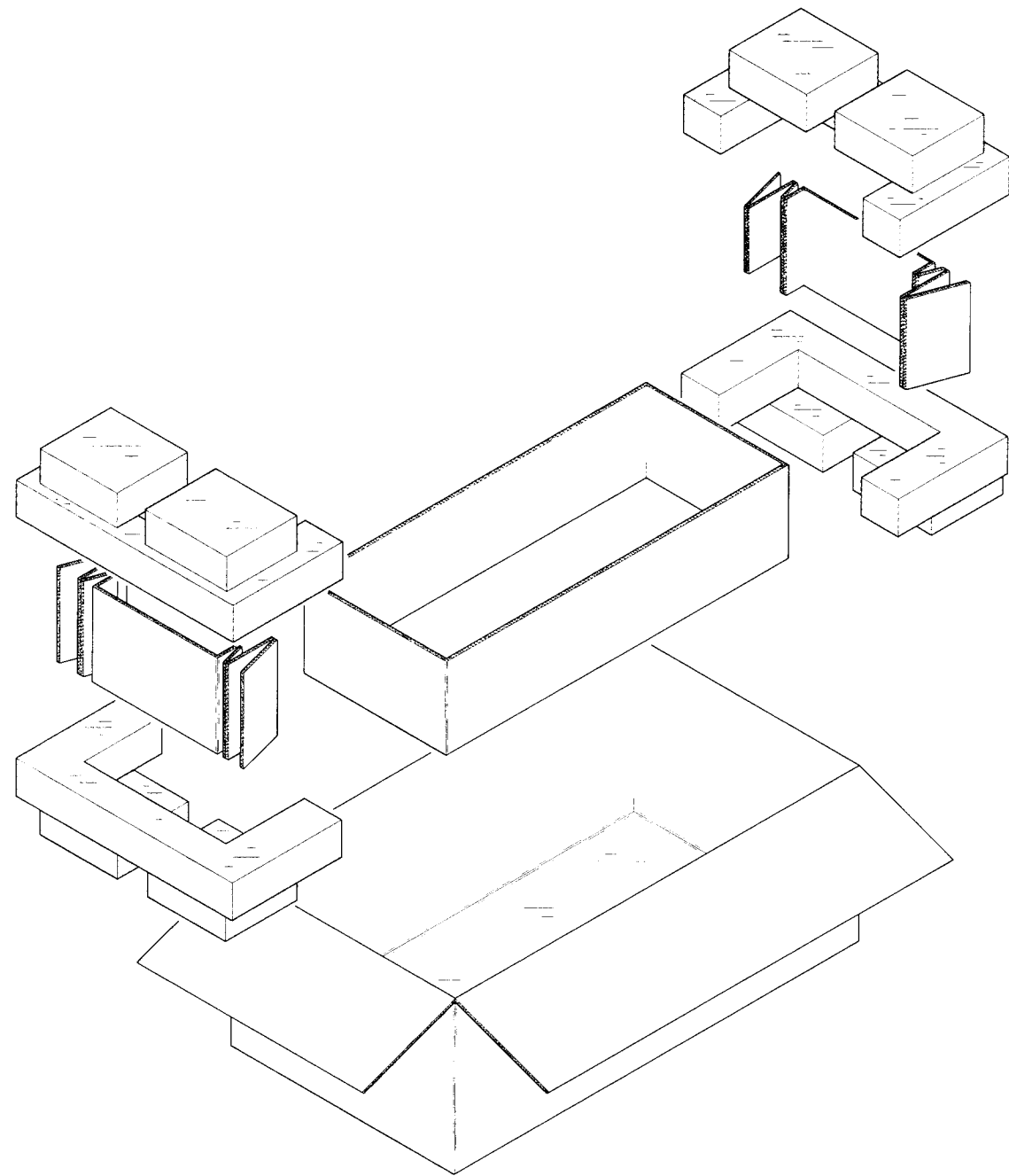


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	Y	1	2	3		4
4-	065-0150-00			1						CARTON ASSEMBLY, for display & power modules

CARTON ASSEMBLY
(Part No. 065-0152-00)

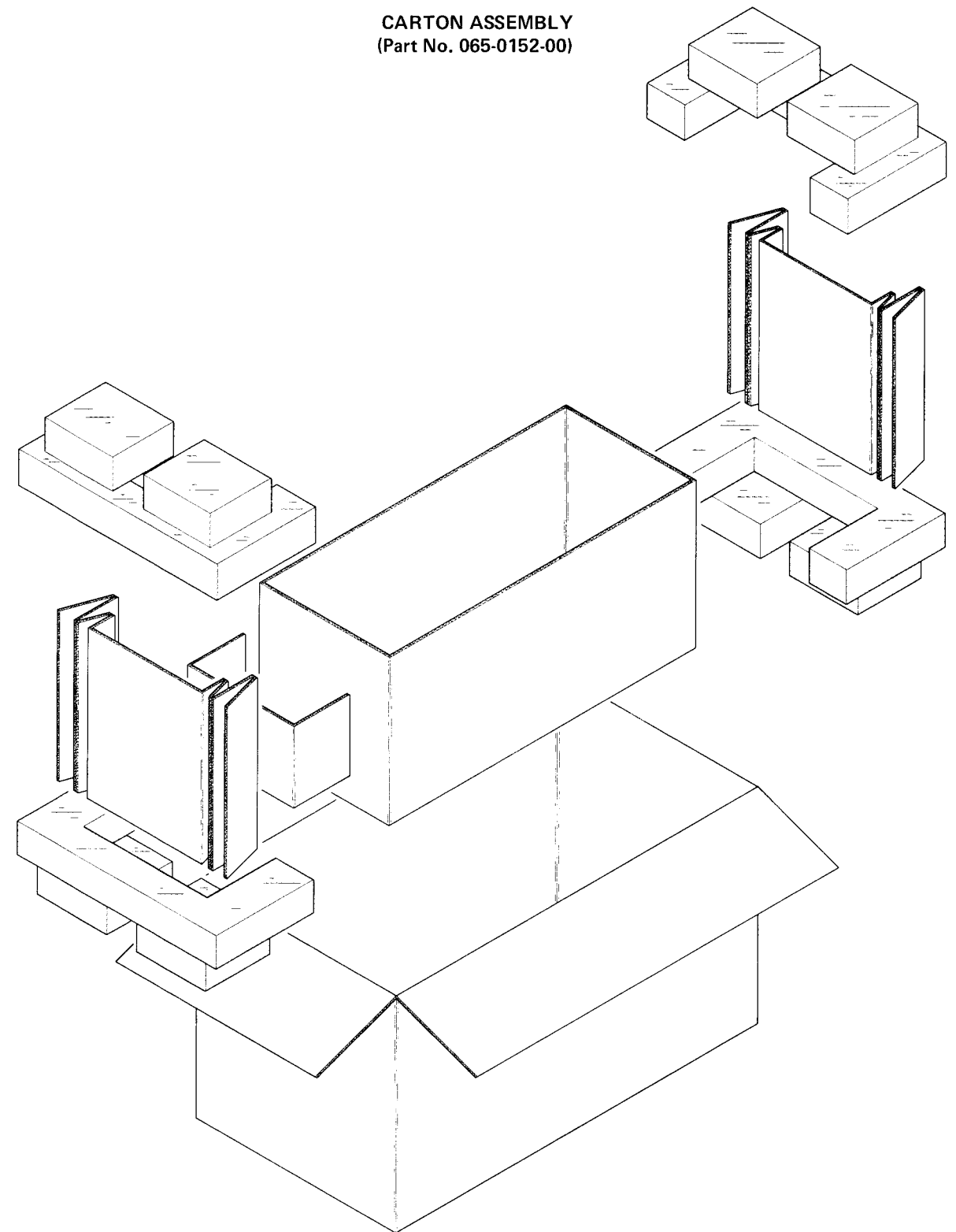


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	Y	1	2	3		4
4-	065-0152-00			1						CARTON ASSEMBLY, for bench system only

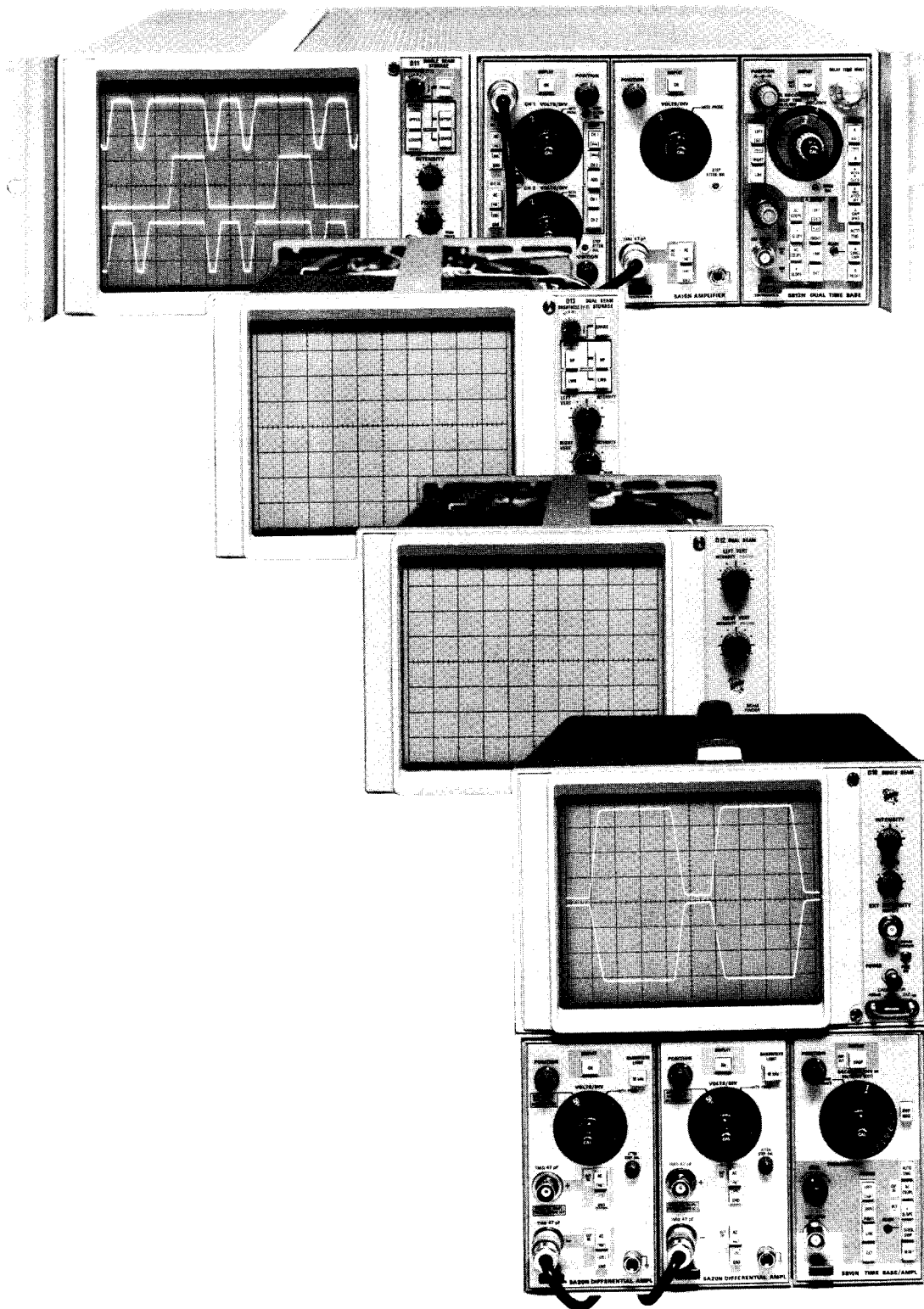
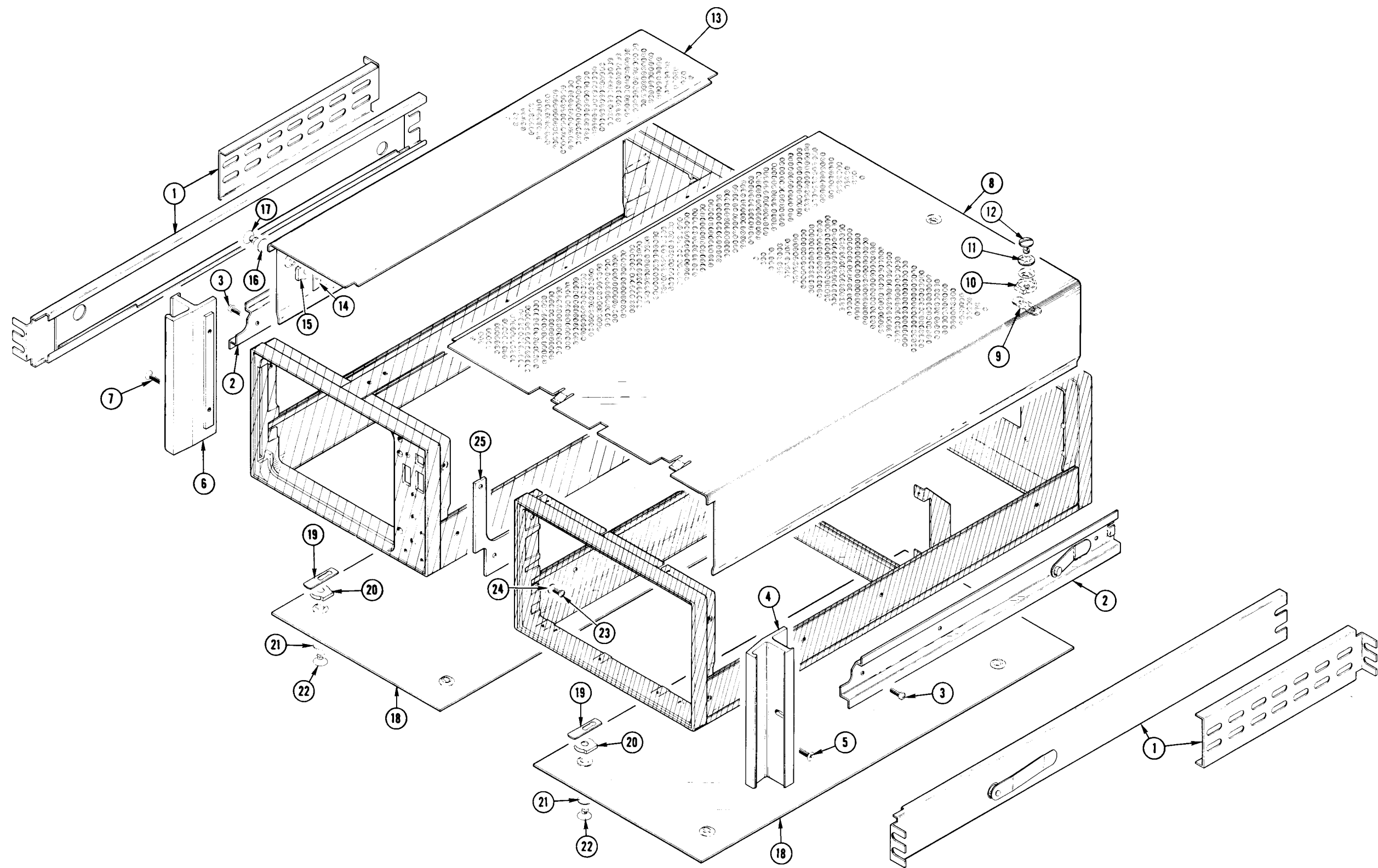


Fig. 1-1. 5100-Series Oscilloscope System.



SECTION 1

SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The 5103N Power Supply/Amplifier module is an inter-connection unit for the display module and plug-in units. It is operated with a display module, and comprises one-half of the 5100-series oscilloscope mainframe. It accepts up to three plug-in units and provides pre-amplification for the deflection signals. The center and left plug-in compartments are connected to the vertical deflection system, and the right plug-in compartment is connected to the horizontal deflection system. Electronic switching between the left and center plug-ins allow a multi-trace vertical display (chopped and alternate time-sharing modes). The unit also contains regulated DC-voltage supplies to provide power to the instrument system.

The following electrical characteristics apply over an ambient temperature range of 0°C to +50°C.

In this manual the word Volts/Div or division refers to major graticule division.

NOTE

Many of the measurement capabilities of the 5100-Series Oscilloscope are determined by the choice of display modules and plug-in units. The following electrical characteristics apply to the Power Supply/Amplifier unit only, unless noted otherwise. For display modules or plug-ins only, see the specification section of the manual for that unit.

Power Transformer

The transformer permits operation from 100-volt, 110-volt, 120-volt, 200-volt, 220-volt, and 240-volt sources with power line frequencies of from 50 to 60 hertz and 400 hertz.

TABLE 1-1
ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Vertical and Horizontal Amplifiers		
Input Signal Amplitude (Differential Input)		50 millivolts per displayed division, vertical and horizontal.
Horizontal Centering		0.5 division or less.
Bandwidth	DC to at least 2.5 megahertz.	
X-Y Phase Difference (Checked with two plug-ins of the same type)	1° or less to 100 kilohertz.	
Sensitivity Change	Accuracy degrades by up to 1% when operated in split-screen storage.	

CARTON ASSEMBLY
 (Part No. 065-0161-00)

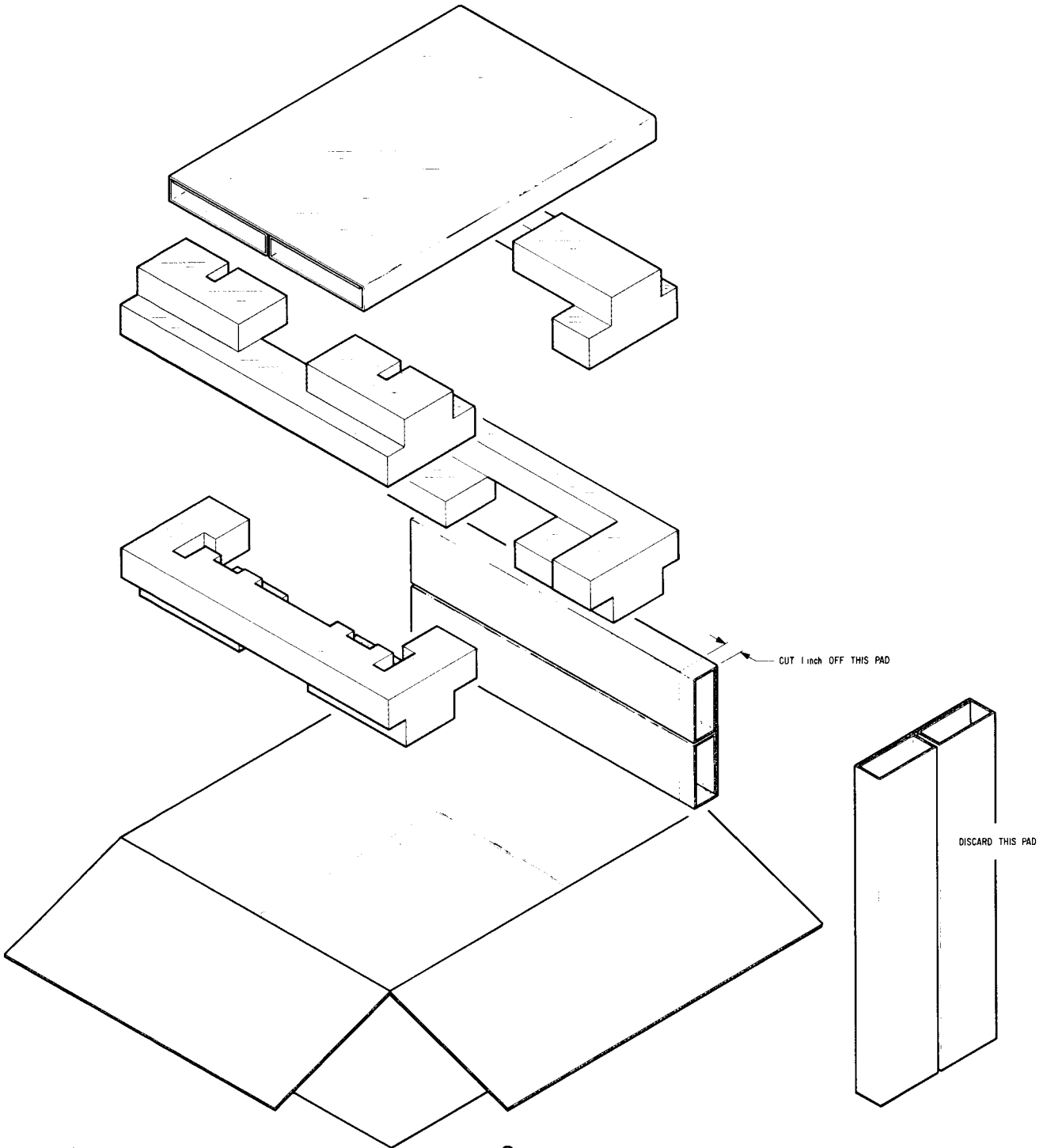


Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q						Description	
		Eff	Disc		y	1	2	3	4		5
4-	065-0161-00			1							CARTON ASSEMBLY, for rackmount system only

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Channel Switching		
Chop Clock Frequency	About 200 kilohertz.	
Channel Chop Rate	About 100 kilohertz.	
Plug-In Chop Rate	About 50 kilohertz.	
Alternate Frequency	Sweep rate (once each sweep).	
Plug-In Alternate Rate		One-half sweep rate (once every two sweeps).
Channel Alternate Rate		One-fourth sweep rate (once every four sweeps).

TABLE 1-2
ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance
Temperature	
Operating Range	0°C to +50°C.
Non-operating Range	-40°C to +70°C.
Altitude	
Operating Range	To 15,000 feet.
Non-operating Range	To 50,000 feet.
Vibration Range	To 0.015 inch peak-to-peak displacement at 50 cycles per second.
Shock Range	To 30 g's, 1/2 sine, 11 milliseconds duration.

TABLE 1-3
MAINFRAME PHYSICAL DATA
(5103N with a Display Unit)

Characteristic	5100-Series Oscilloscope	R5100-Series Oscilloscope
Dimensions (maximum)		
Height (overall)	11.6 in. (29.5 cm)	5.2 in. (13.2 cm)
(cabinet)	10.5 in. (26.7 cm)	
Length (overall)	19.9 in. (50.5 cm)	20.0 in. (51.0 cm)
(cabinet)	18.3 in. (46.5 cm)	18.3 in. (46.5 cm)
Width (overall)	8.4 in. (21.4 cm)	19.0 in. (48.3 cm)
(cabinet)		16.8 in. (42.7 cm)
Net Weight	≈22.8 lbs. (10.3 kg)	≈23.5 lbs. (10.7 kg)
Shipping Weight	≈30.0 lbs. (13.6 kg)	≈39.0 lbs. (17.7 kg)
Export Weight	≈45.0 lbs. (20.4 kg)	≈59.0 lbs. (26.8 kg)

MECHANICAL PARTS LIST-TYPE 5103N

FIGURE 3 RACKMOUNT CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q f y	Description
		Eff	Disc		
3-1	351-0195-00			1	TRACK, slide-out (pair) w/hardware
-2	351-0104-00			1	SLIDE, section, basic tilt (pair) w/hardware
	- - - - -			-	mounting hardware: (not included w/slide)
-3	212-0004-00			6	SCREW, 8-32 x 0.312 inch, PHS
	210-0858-00			6	WASHER, flat, (used as spacer under slide)
-4	407-0899-02			1	BRACKET, right
	- - - - -			-	mounting hardware: (not included w/bracket)
-5	212-0040-00			2	SCREW, 8-32 x 0.375 inch, 100° csk, FHS
-6	407-0899-00			1	BRACKET, left
	- - - - -			-	mounting hardware: (not included w/bracket)
-7	212-0040-00			2	SCREW, 8-32 x 0.375 inch, 100° csk, FHS
-8	390-0191-00			1	CABINET SIDE, right
	- - - - -			-	cabinet side includes:
	214-0812-00			4	LATCH ASSEMBLY
	- - - - -			-	each latch assembly includes:
-9	386-0226-00			1	PLATE, locking
-10	386-0227-00			1	PLATE, index
-11	214-0604-00			1	SPRING, latch
-12	214-0603-01			1	PIN, securing
-13	390-0194-00			1	CABINET SIDE, left
	- - - - -			-	cabinet side includes:
	214-0812-00			2	LATCH ASSEMBLY
	- - - - -			-	each latch assembly includes:
-14	386-0226-00			1	PLATE, locking
-15	386-0227-00			1	PLATE, index
-16	214-0604-00			1	SPRING, latch
-17	214-0603-01			1	PIN, securing
-18	390-0222-00			2	CABINET BOTTOM
	- - - - -			-	each cabinet bottom includes:
	214-0812-00			4	LATCH ASSEMBLY
	- - - - -			-	each latch assembly includes:
-19	386-0226-00			1	PLATE, locking
-20	386-0227-00			1	PLATE, securing
-21	214-0604-00			1	SPRING, latch
-22	214-0603-01			1	PIN, securing
-23	212-0103-00			3	SCREW, 8-32 x 0.375 inch, HSS
	212-0104-00			3	SCREW, 8-32 x 0.750 inch, HSS
-24	210-0008-00			10	WASHER, lock, internal, 0.172 ID x 0.331 inch OD
-25	361-0389-00			1	SPACER, flat, for spacing of display & power units

SECTION 2

OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of this manual.

General

To effectively use the 5103N, the operation and capabilities of the instrument must be known. The 5103N Power Supply/Amplifier module forms the basis of an oscilloscope system, and requires a display module and plug-ins to complete the system. This section describes interconnection and general operation of the units, including preliminary information for first-time turn-on, selection and installation of plug-ins, general operating information, and some basic oscilloscope applications.

Detailed operating information for a specific display module or plug-in is given in the instruction manual for that unit.

PRELIMINARY INFORMATION

Rackmounting

The 5103N Power Supply/Amplifier module and the display module can be fastened together stacked or side by side, permitting operation as a bench oscilloscope, or it can be operated in a standard 19-inch rack. Complete instructions for rackmounting are given in Section 6, Rackmounting.

NOTE

Before attempting to operate the instrument, make sure the module wiring interconnections are correct, and if display modules have been changed, that the correct auxiliary board is installed in the socket on the plug-in interface board.

Operating Voltage

CAUTION

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

NOTE

The power cord on Tektronix instruments may conform to either IEC or the older NEC requirements, as follows:

Conductor	USA & Canada	IEC
Line	Black	Brown
Neutral	White	Light Blue*
Safety-Earth	Green w/yellow stripe	Green w/yellow stripe

*Tinned copper conductor.

Power Transformer

The 5100-Series Oscilloscope is to be operated from either a 120-volt or a 220-volt nominal line voltage source. This transformer is wired to permit one of three regulating ranges to be selected for either 120-volt or 220-volt nominal operation. The range for which the primary taps are set is marked on the rear panel of the instrument. Use the following procedure to obtain correct instrument operation from the line voltage available.

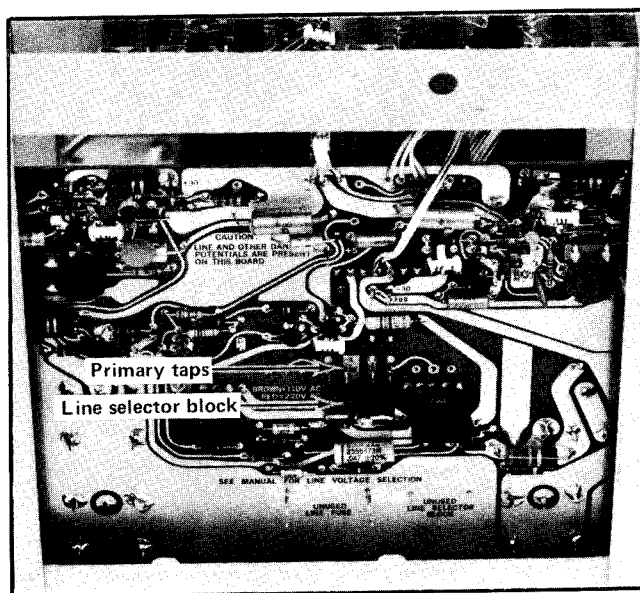


Fig. 2-1. Location of the line-selector block on the Power Supply circuit board.

1. Disconnect the instrument from the power source.
2. Remove the bottom dust cover of the instrument to gain access to the Power Supply circuit board.
3. To convert from 120 volts to 220 volts nominal line voltage, or vice versa, remove the line-selector block from the square-pin connectors (see Fig. 2-1) and replace it with the other block. Remove the line fuse from the fuse holder located on the rear panel of the display module and replace

MECHANICAL PARTS LIST-TYPE 5103N

FIGURE 2 BENCH CABINET (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † y	Description
		Eff	Disc		
2-25	348-0208-00			2	FOOT, cabinet, left front & right rear
-26	348-0074-00			2	FOOT, bail limiting, right front & left rear
	- - - - -			-	mounting hardware for each: (not included w/foot)
-27	211-0532-00			2	SCREW, 6-32 x 0.75 inch, Fil HS
-28	210-0457-00			2	NUT, keps 6-32 x 0.312 inch
-29	348-0207-00			2	FOOT, cabinet, right front & left rear
-30	348-0275-00			1	FLIPSTAND
-31	212-0105-00			2	SCREW, 8-32 x 0.312 inch, HEX STL CD PL
-32	212-0008-00			2	SCREW, 8-32 x 0.50 inch, PHS
-33	210-0008-00			2	WASHER, lock, internal, 0.172 ID x 0.331 inch OD
-34	361-0388-00			2	SPACER, flat, for spacing of DISPLAY & POWER units
-35	343-0256-00			2	RETAINER BLOCK, plastic
	- - - - -			-	mounting hardware for each: (not included w/retainer block)
-36	211-0531-00			2	SCREW, 6-32 x .0375 inch, Fil HS

Operating Instructions—5103N

it with one having the correct rating. The unused line-selector block and line fuse can be stored on the Power Supply circuit board. Change the line-cord power plug to match the power-source receptacle or use an adapter.

NOTE

The 120-volt block is color coded brown, and it connects the transformer primary windings in parallel. The 220-volt block is color coded red, and it connects the primary windings in series.

4. To change regulating ranges, place the line-selector block on the desired set of square pins. Select a range which is centered about the average line voltage to which the instrument is to be connected (see Table 2-1).

5. Change the nominal line voltage information on the rear panel of the instrument. Use a non-abrasive eraser to remove the previous data, and mark in new data with a pencil.

6. Replace the bottom dust cover and apply power to the instrument.

CAUTION

Damage to the instrument may result from incorrect placement of the line-selector block.

TABLE 2-1

Standard Transformer (SN BO50000 - below)

Line Selector Block Position	Regulating Ranges
L Do not use	Internally disconnected
M (110 V Nominal)	99 VAC to 121 VAC
H (120 V Nominal)	108 VAC to 132 VAC

Universal Transformer (SN BO50000-up)

Line Selector Block Position	Regulating Ranges	
	120-Volts Nominal	220-Volts Nominal
L	90 VAC to 110 VAC	180 VAC to 220 VAC
M	99 VAC to 121 VAC	198 VAC to 242 VAC
H	108 VAC to 132 VAC	216 VAC to 264 VAC
Line Fuse Data	1.6 A slow-blow	1A slow-blow

Operating Temperature

The 5103N can be operated where the ambient air temperature is between 0°C and +50°C. The instrument can be stored in ambient temperature between -40°C and +70°C. After storage at a temperature beyond the operating limits, allow the chassis temperature to come within the operating limits before power is applied.

A thermal cutout in the display module provides thermal protection and disconnects the power to the instrument if the internal temperature exceeds a safe operating level. This device will automatically re-apply power when the temperature returns to a safe level.

PLUG-IN UNITS

General

The 5103N is designed to accept up to three Tektronix 5-series plug-in units. This plug-in feature allows a variety of display combinations and also allows selection of bandwidth, sensitivity, display mode, etc., to meet the measurement requirements. In addition, it allows the oscilloscope system to be expanded to meet future measurement requirements. The overall capabilities of the resultant system are in large part determined by the characteristics of the plug-ins selected.

Installation

To install a plug-in unit into one of the plug-in compartments, align the slots in the top and bottom of the plug-in with the associated guides in the plug-in compartment. Push the plug-in unit firmly into the plug-in compartment until it locks into place. To remove a plug-in, pull the release latch on the plug-in unit to disengage it and pull the unit out of the plug-in compartment. Plug-in units can be removed or installed without turning off the instrument power. It is not necessary that all of the plug-in compartments be filled to operate the instrument; the only plug-ins needed are those required for the measurement to be made.

When the display unit is calibrated in accordance with the calibration procedure given in the display unit instruction manual, the vertical and horizontal gain are standardized. This allows calibrated plug-in units to be changed

MECHANICAL PARTS LIST-TYPE 5103N

FIGURE 2 BENCH CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † y	Description
		Eff	Disc		
2-1	200-0728-01			1	COVER, handle end, front
-2	200-0728-00			1	COVER, handle end, rear
-3	367-0116-00			1	HANDLE, carrying
	- - - - -			-	mounting hardware: (not included w/handle)
-4	212-0597-00			4	SCREW, shouldered, 10-32 x 0.355 inch
-5	386-1624-00			2	PLATE, retaining
-6	386-1283-00			2	PLATE, handle mounting, plastic
-7	390-0193-00			1	CABINET SIDE, left
	- - - - -			-	cabinet side includes:
	214-0812-00			4	LATCH ASSEMBLY
	- - - - -			-	each latch assembly includes:
-8	386-0226-00			1	PLATE, locking
-9	386-0227-00			1	PLATE, index
-10	214-0604-00			1	SPRING, latch
-11	214-0603-01			1	PIN, securing
-12	390-0192-00			1	CABINET SIDE, right
	- - - - -			-	cabinet side includes:
	214-0812-00			4	LATCH ASSEMBLY
	- - - - -			-	each latch assembly includes:
-13	386-0226-00			1	PLATE, locking
-14	386-0227-00			1	PLATE, index
-15	214-0604-00			1	SPRING, latch
-16	214-0603-01			1	PIN, securing
-17	390-0190-00			1	CABINET BOTTOM
	- - - - -			-	cabinet bottom includes:
	214-0812-00			4	LATCH ASSEMBLY
	- - - - -			-	each latch assembly includes:
-18	386-0226-00			1	PLATE, locking
-19	386-0227-00			1	PLATE, index
-20	214-0604-00			1	SPRING, latch
-21	214-0603-01			1	PIN, securing
-22	348-0073-00			2	FOOT, bail limiting, left front & right rear
	- - - - -			-	mounting hardware for each: (not included w/foot)
-23	211-0532-00			2	SCRFW, 6-32 x 0.75 inch, Fil HS
-24	210-0457-00			2	NUT, keps, 6-32 x 0.312 inch

from one plug-in compartment to another without recalibration. However, the basic calibration of the individual plug-in units should be checked when they are installed in this system to verify their measurement accuracy. See the operating instructions section of the plug-in unit manual for verification procedure.

Selection

The plug-in versatility of the 5100-series oscilloscope allows a variety of display modes with many different plug-ins. The following information is provided here to aid in plug-in selection.

To produce a single-trace display, install a single-channel vertical unit (or dual-channel unit set for single-channel operation) in either of the vertical (left or center) compartments and a time-base unit in the horizontal (right) compartment. For dual-trace displays, either install a dual-channel vertical unit in one of the vertical compartments or install a single-channel vertical unit in each vertical compartment. A combination of a single-channel and a dual-channel vertical unit allows a three-trace display; likewise, a combination of two dual-channel vertical units allows a four-trace display.

To obtain a vertical sweep with the input signal displayed horizontally, insert the time-base unit into one of the vertical compartments and the amplifier unit in the horizontal compartment. If a vertical sweep is used, there is no retrace blanking; however, if used in the right vertical (center) compartment, internal triggering is provided.

For X-Y displays, either a 5A-series amplifier unit or a 5B-series time-base unit having an amplifier channel can be installed in the horizontal compartment to accept the X signal. The Y signal is connected to a 5A-series amplifier unit installed in a vertical compartment.

Special purpose plug-in units may have specific restrictions regarding the compartments in which they can be installed. This information will be given in the instruction manuals for these plug-ins.

GENERAL OPERATING INFORMATION

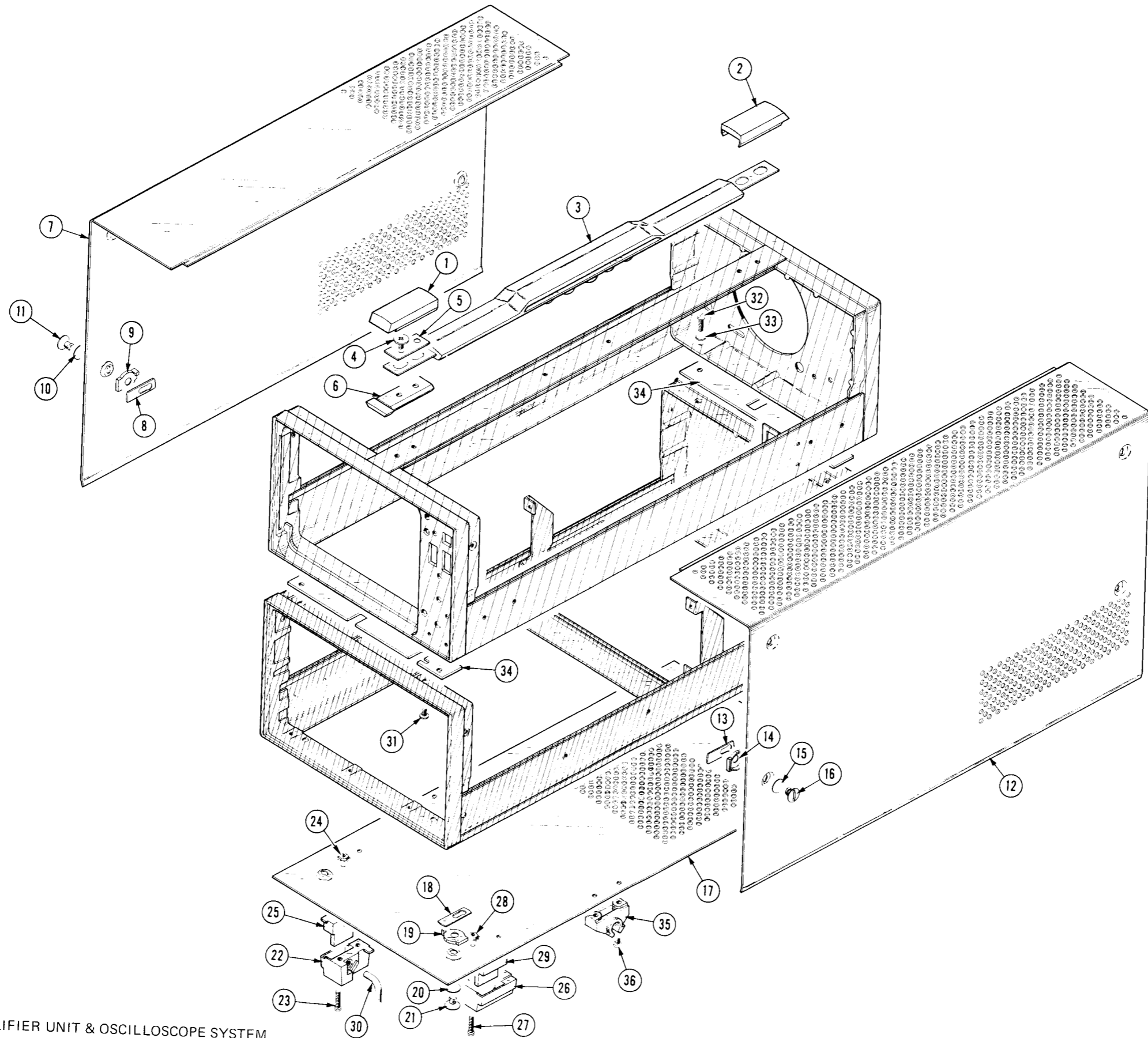
Display Switching Logic

General. The electronic switching for time-shared displays is produced at the plug-in interface within the mainframe; however, the switching logic is selected on the plug-in units. The system allows any combination of plug-ins and Display switch settings. Refer to the individual plug-in manuals for specific capabilities and operating procedures.

Vertical Plug-in Compartments. When a vertical plug-in is in the active mode (Display button pushed in), a logic level is applied to the switching circuit in the mainframe and a display from this plug-in will occur. When two plug-ins are both active in the vertical compartments, a multi-trace display will occur (Alternate or Chopped). When no plug-in is in the active mode, the signal from the left compartment will be displayed. A time-base unit operated in one of the vertical compartments has a permanent internal connection to apply a logic level to the switching circuit; thus, a vertical trace produced by this unit will always be displayed.

Horizontal Plug-in Compartment. Alternate or Chopped display switching is selected on a time-base unit operated in the horizontal compartment. When the Display switch is out (Alt), a negative impulse is supplied at the end of the sweep to allow alternate switching between plug-ins and plug-in channels. When the Display switch is pushed in (Chop), a chopped display will appear if a multi-trace display is required by the plug-ins in the vertical compartments. An amplifier plug-in unit operated in the horizontal compartment has a permanent internal connection to provide a chopped display if it is required.

Switching Sequence. Four display time slots are provided on a time-sharing basis. When two vertical plug-ins are active, each receives two time slots and the switching sequence is left, left, right, right, etc. The two time slots allotted to each plug-in are divided between amplifier channels in a dual-trace unit; if two dual-trace plug-ins are active, then the switching sequence is left Channel 1, left Channel 2, right Channel 1, right Channel 2, etc. If only one vertical plug-in is active, it receives all four time slots. The switching sequence is the same for both the Alternate and Chopped display modes.



5103N POWER SUPPLY/AMPLIFIER UNIT & OSCILLOSCOPE SYSTEM

Vertical Display Mode

Display On. To display a signal, the Display button of the applicable vertical plug-in unit must be pushed in to activate the unit. If two plug-ins are installed in the vertical compartments and only the signal from one of the units is wanted, set the Display switch of the unwanted unit to Off (button out). If neither plug-in is activated, the signal from the left unit will be displayed. Both plug-ins can be activated for multi-trace displays.

Alternate Mode. The alternate position of the time-base unit Display switch produces a display which alternates between activated plug-ins and amplifier channels with each sweep of the CRT. The switching sequence is described under Display Switching Logic in this section. Although the Alternate mode can be used at all sweep rates, the Chop mode provides a more satisfactory display at sweep rates from about one millisecond/division to five seconds/division. At these slower sweep rates, alternate-mode switching becomes difficult to view.

Chopped Mode. The Chop position of the time-base unit Display switch produces a display which is electronically switched between channels at a 200-kilohertz rate. The switching sequence has been discussed earlier. In general, the Chop mode provides the best display at sweep rates slower than about one millisecond/division or whenever dual-trace, single-shot phenomena are to be displayed. At faster sweep rates, the chopped switching becomes apparent and may interfere with the display.

Dual-Sweep Displays. When a dual-sweep time-base unit is operated in the horizontal compartment, the alternate and chopped time-shared switching for either the A or B sweep is identical to that for a single time-base unit. However, if both the A and B sweeps are operating, the 5103N operates in the independent pairs mode. Under this condition, the left vertical unit is always displayed at the sweep rate of the A time base and the right vertical unit is displayed at the sweep rate of the B time base (non-delayed sweep only). This results in two displays that have completely independent vertical deflection and chopped or alternate sweep switching.

Dual-Beam Displays. When a dual-beam display module is operated with the 5103N, the switching sequence is altered slightly. Between-channel switching occurs; however, switching between plug-ins is not necessary and does not occur. Also, the left vertical unit is always displayed by the upper CRT beam and the right vertical unit is displayed by the lower CRT beam.

X-Y Operation

In some applications, it is desirable to display one signal versus another (X-Y) rather than against an internal sweep. The flexibility of the plug-in units available for use with the 5103N provides a means for applying a signal to the horizontal deflection system for this type of display. Some of the 5B-series time-base units can be operated as amplifiers in addition to their normal use as time-base generators, or an amplifier unit can be installed in the horizontal compartment. The latter method provides the best X-Y display, particularly if two identical amplifier units are used, since both the X and Y input systems will have the same capabilities and characteristics. In either case, the mainframe bandwidth and sensitivity are equal and inherent phase shift is adjustable to 0 degrees in the display module. For further information on obtaining X-Y displays, see the plug-in unit manuals.

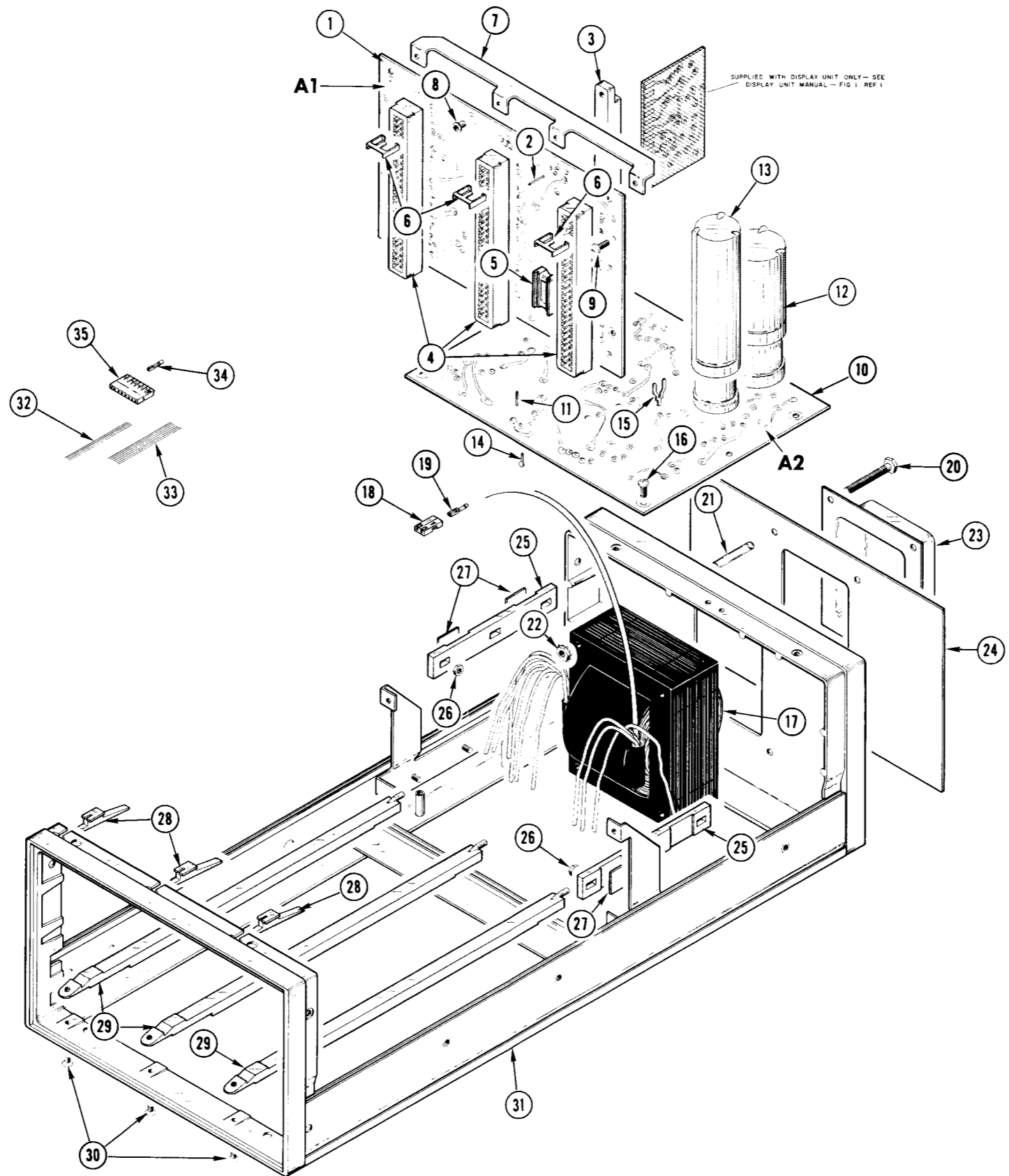
Raster Display

A raster-type display can be used to effectively increase the apparent sweep length. For this type of display, the trace is deflected both vertically and horizontally by sawtooth signals, and is accomplished by installing a 5B-series time-base unit in one of the vertical compartments as well as one in the horizontal compartment. Normally, the unit in the vertical compartment should be set to a slower sweep rate than the one in the horizontal compartment; the number of horizontal traces in the raster depends upon the ratio between the two sweep rates. Information can be displayed on the raster using the Ext Intensity Input to provide intensity modulation of the display. This type of raster display could be used to provide a television-type display. Complete information on operation using the Z-axis feature is given in the operating instructions section of the display module manuals.

BASIC OSCILLOSCOPE APPLICATIONS

General

The 5100-Series Oscilloscope and its associated plug-in units provide a very flexible measurement system. The capabilities of the overall system depend mainly upon the plug-ins that are chosen for use with this instrument. The following information describes the procedures and techniques for making basic measurements. These applications are not described in detail, since each application must be adapted to the requirements of the individual measurement. Specific applications for the individual plug-in units are described in the manuals for those units. The overall system can also be used for many applications which are not described in detail either in this manual or in the manuals for the individual plug-in units. Contact your local Tektronix Field Office or representative in making specific measurements with this instrument.



5103N POWER SUPPLY/AMPLIFIER UNIT & OSCILLOSCOPE SYSTEM

The following books describe oscilloscope measurement techniques which can be adapted for use with this instrument.

Harley Carter, "An Introduction to the Cathode Ray Oscilloscope", Philips Technical Library, Cleaver-Hume Press Ltd., London, 1960.

J. Czech, "Oscilloscope Measuring Techniques", Philips Technical Library, Springer-Verlag, New York, 1965.

Robert G. Middleton, "Scope Waveform Analysis", Howard W. Sams & Co. Inc., The Bobbs-Merrill Company Inc., Indianapolis, 1963.

Robert G. Middleton and L. Donald Payne, "Using the Oscilloscope in Industrial Electronics", Howard W. Sams & Co. Inc., The Bobbs-Merrill Company Inc., Indianapolis, 1961.

John F. Rider and Seymour D. Uslan, "Encyclopedia of Cathode-Ray Oscilloscopes and Their Uses", John F. Rider Publisher Inc., New York, 1959.

John F. Rider, "Obtaining and Interpreting Test Scope Traces", John F. Rider Publisher Inc., New York, 1959.

Rufus P. Turner, "Practical Oscilloscope Handbook", Volumes 1 and 2, John F. Rider Publisher Inc., New York, 1964.

Peak-to-Peak Voltage Measurements—AC

To make peak-to-peak voltage measurements, use the following procedure:

1. Set the Input Coupling on the vertical plug-in unit to GND and connect the signal to the input connector.
2. Set the Input Coupling to AC and set the Volts/Div switch to display about 5 or 6 vertical divisions of the waveform. Check that the Variable Volts/Div control (red knob) is in the Cal position.
3. Adjust the time-base triggering controls for a stable display and set the Seconds/Div switch to display several cycles of the waveform.
4. Turn the vertical Position control so the lower portion of the waveform coincides with one of the graticule lines below the center horizontal line, and the top of the

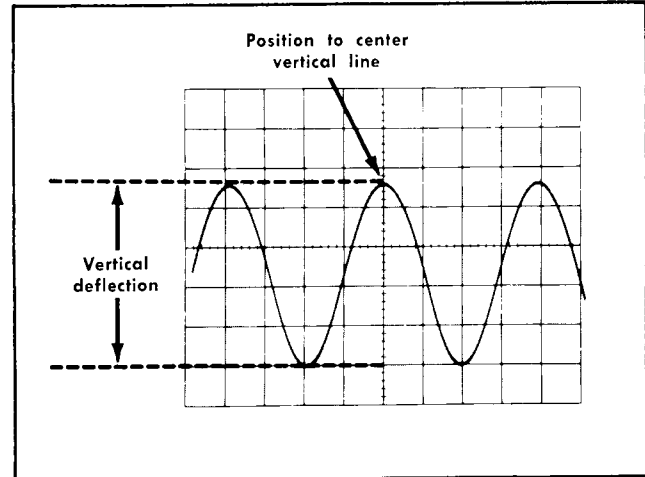


Fig. 2-2. Measuring peak-to-peak voltage of a waveform.

waveform is in the viewing area. Move the display with the horizontal Position control so one of the upper peaks is aligned with the center vertical reference line (see Fig. 2-2).

5. Measure the vertical deflection from peak to peak (divisions).

NOTE

This technique may also be used to make measurements between two points on the waveform, rather than peak to peak.

6. Multiply the distance (in divisions) measured in step 5 by the Volts/Div switch setting. Also include the attenuation factor of the probe, if applicable.

EXAMPLE: Assume a peak-to-peak vertical deflection of 4.6 divisions and a Volts/Div switch setting of 5 V.

$$\text{Peak-to-peak volts} = \frac{4.6}{(\text{divisions})} \times 5 \text{ (Volts/Div setting)} = 23 \text{ volts}$$

NOTE

If an attenuator probe not having the capability to change the scale factor readout (Volts/Div) is used, multiply the right side of the above equation by the attenuation factor.

Instantaneous Voltage Measurement—DC

To measure the DC level at a given point on a waveform, use the following procedure:

MECHANICAL PARTS LIST-TYPE 5103N

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † y	Description
		Eff	Disc		
1-27	342-0082-00			3	INSULATOR
-28	351-0293-00			3	GUIDE, plug-in, upper
-29	351-0286-00	B010100	B039999	3	GUIDE, plug-in, lower
	351-0286-01	B040000	B062225	3	GUIDE, plug-in, lower
	351-0286-02	B062226	B065347	3	GUIDE, plug-in, lower
	351-0286-04	B065348		3	GUIDE, plug-in, lower
	- - - - -			-	mounting hardware for each:(not included w/guide)
-30	211-0105-00			1	SCREW, 4-40 x 0.188 inch, 100 deg csk, FHS
-31	426-0738-00			1	FRAME ASSEMBLY
	- - - - -			-	frame assembly includes:
	210-0617-00	XB030000		3	EYELET, 0.089 OD x 0.125 inch long
	131-1254-01	XB030000		3	CONTACT, electrical, ground
-32	175-0826-00			ft	WIRE, electrical, 3 wire ribbon, 3 inches long
-33	175-0829-00			ft	WIRE, electrical, 6 wire ribbon, 3 inches long
	131-1199-00			1	LINK, terminal connector, block (red)
	- - - - -			-	link, terminal includes:
-34	131-0707-00			2	CONNECTOR, terminal
-35	352-0166-02			1	HOLDER, terminal connector, 8 wire (red)
	131-1200-00			1	LINK, terminal connector, block (brown)
	- - - - -			-	link terminal connector includes:
	131-0707-00			2	CONNECTOR, terminal
	352-0166-01			1	HOLDER, terminal connector 8 wire (brown)

STANDARD ACCESSORIES

070-1143-00 1 MANUAL, instruction (not shown)

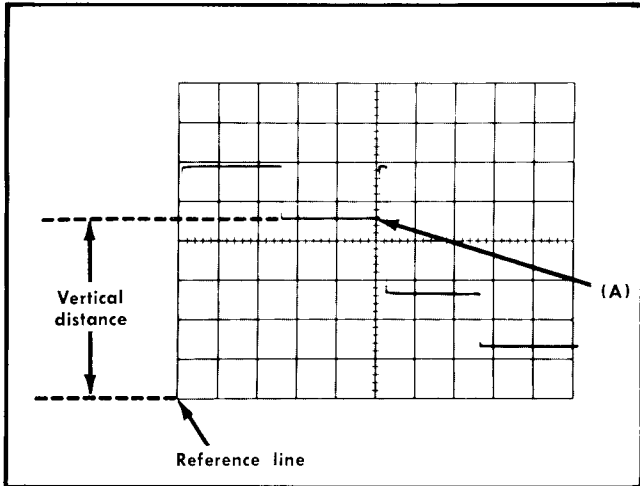


Fig. 2-3. Measuring instantaneous DC voltage with respect to a reference voltage.

1. Set the Input Coupling of the vertical plug-in unit to GND and position the trace to the bottom line of the graticule (or other selected reference line). If the voltage to be measured is negative with respect to ground, position the trace to the top line of the graticule. Do not move the vertical Position control after this reference has been established.

NOTE

To measure a voltage level with respect to a voltage other than ground, make the following changes to step 1: Set the Input Coupling switch to DC and apply the reference voltage to the input connector, then position the trace to the reference line.

2. Connect the signal to the input connector. Set the Input Coupling to DC (the ground reference can be checked at any time by setting the Input Coupling to GND).

3. Set the Volts/Div switch to display about 5 or 6 vertical divisions of the waveform. Check that the Variable Volts/Div control (red knob) is in the Cal position. Adjust the time-base triggering controls for a stable display.

4. Measure the distance in divisions between the reference line and the point on the waveform at which the DC level is to be measured. For example, in Fig. 2-3 the measurement is made between the reference line and point A.

5. Establish the polarity. The voltage is positive if the signal is applied to the + input connector and the waveform is above the reference line.

6. Multiply the distance measured in step 4 by the Volts/Div switch setting. Include the attenuation factor of the probe, if applicable (see the note following the Peak-to-Peak Voltage Measurement example).

EXAMPLE: Assume that the vertical distance measured is 4.6 divisions, the polarity is positive, and the Volts/Div switch setting is 2 V.

$$\text{Instantaneous Voltage} = 4.6 \text{ (divisions)} \times 2 \text{ (Volts/Div)} = +9.2 \text{ volts}$$

Comparison Measurements

In some applications, it may be necessary to establish a set of deflection factors other than those indicated by the Volts/Div or Seconds/Div switches. This is useful for comparing signals to a reference voltage amplitude or period. To establish a new set of deflection factors based upon a specific reference amplitude or period, proceed as follows:

VERTICAL DEFLECTION FACTOR

1. Apply a reference signal of known amplitude to the vertical input connector. Using the Volts/Div switch and Variable Volts/Div control, adjust the display for an exact number of divisions. Do not move the Variable Volts/Div control after obtaining the desired deflection.

2. Divide the amplitude of the reference signal (volts) by the product of the deflection in divisions (established in step 1) and the Volts/Div switch setting. This is the Deflection Conversion Factor.

$$\text{Deflection Conversion Factor} = \frac{\text{reference signal amplitude (volts)}}{\text{deflection (divisions} \times \text{Volts/Div setting)}}$$

3. To determine the peak-to-peak amplitude of a signal compared to a reference, disconnect the reference and apply the signal to the input connector.

4. Set the Volts/Div switch to a setting that provides sufficient deflection to make the measurement. Do not readjust the Variable Volts/Div control.

5. To establish a Modified Deflection Factor at any setting of the Volts/Div switch, multiply the Volts/Div switch setting by the Deflection Conversion Factor established in step 2.

$$\text{Modified Deflection Factor} = \text{Volts/Div setting} \times \text{Deflection Conversion Factor}$$

SECTION 9

MECHANICAL PARTS LIST

FIGURE 1 EXPLODED & STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q t y	Description
		Eff	Disc		
1-1	670-1340-00			1	CIRCUIT BOARD ASSEMBLY--INTERFACE A1
	- - - - -			-	circuit board assembly includes:
	388-1899-00			1	CIRCUIT BOARD
-2	131-0608-00			12	TERMINAL, pin, 0.50 inch long
-3	131-1043-00			1	CONNECTOR, receptacle, 18/36 contact
-4	131-1078-00			3	CONNECTOR, receptacle, 28/56 contact
-5	136-0269-00			1	SOCKET, integrated circuit, 14 pin
-6	214-1593-02			6	KEY, connector polarizing
-7	386-1938-00			1	STIFFENER, circuit card
	- - - - -			-	mounting hardware: (not included w/stiffener)
-8	210-0777-00			4	RIVET, blind
	- - - - -			-	mounting hardware: (not included w/circuit board assembly)
-9	213-0146-00			4	SCREW, thread forming, 6-20 x 0.312 inch, PHS
-10	670-1339-00			1	CIRCUIT BOARD ASSEMBLY--POWER SUPPLY A2
	- - - - -			-	circuit board assembly includes:
	388-1898-00			1	CIRCUIT BOARD
-11	131-0608-00			14	TERMINAL, pin, 0.365 inch long
	131-0589-00			14	TERMINAL, pin, 0.50 inch long
-12	200-0293-00			1	COVER, capacitor, 1.365 ID x 2.562 inches long
-13	200-0294-00	B010100	B043669	2	COVER, capacitor, 1 ID x 3.562 inches long
	200-0294-00	B043670		1	COVER, capacitor, 1 ID x 3.562 inches long
-14	214-0579-00			4	PIN, test point
-15	344-0154-00			6	CLIP, fuse
	- - - - -			-	mounting hardware: (not included w/circuit board assembly)
-16	211-0504-00			6	SCREW, 6-32 x 0.25 inch, PHS
-17	- - - - -			1	TRANSFORMER
	- - - - -			-	transformer includes:
-18	352-0198-00			1	HOLDER, terminal connector, 2 wire (black)
-19	131-0622-00			2	CONNECTOR, terminal
	- - - - -			-	mounting hardware: (not included w/transformer)
-20	212-0516-00	B010100	B049999	4	SCREW, 10-32 x 2 inches, HHS
	212-0522-00	B050000		4	SCREW, 10-32 x 2.50 inches, HHS
	210-0812-00	B062200		4	WASHER, fiber 0.188 ID x 0.377 OD
-21	166-0226-00	B010100	B049999	4	TUBE, insulating, 0.188 ID x 1.125 inches long
	166-0457-00	B050000		4	TUBE, insulating, 0.190 ID x 1.875 inches long
-22	220-0410-00			4	NUT, keps, 10-32 x 0.375 inch
-23	200-0772-02			1	COVER, transformer
-24	333-1425-00			1	PANEL, rear
-25	343-0315-00			2	CLAMP, transistor
	- - - - -			-	mounting hardware for each: (not included w/clamp)
-26	210-0407-00			3	NUT, hex., 6-32 x 0.25 inch

6. Measure the vertical deflection in divisions and determine the amplitude by the following formula:

$$\text{Signal Amplitude} = \frac{\text{Modified Deflection Factor}}{\text{deflection (divisions)}} \times$$

EXAMPLE: Assume a reference signal amplitude of 30 volts, a Volts/Div switch setting of 5 V and a deflection of four divisions. Substituting these values in the Deflection Conversion Factor formula (step 2):

$$\frac{30 \text{ V}}{(4) (5 \text{ V})} = 1.5$$

Then, with a Volts/Div switch setting of 2 V, the Modified Deflection Factor (step 5) is:

$$(2 \text{ V}) (1.5) = 3 \text{ volts/division}$$

To determine the peak-to-peak amplitude of an applied signal which produces a vertical deflection of five divisions with the above conditions, use the Signal Amplitude formula (step 6):

$$(3 \text{ V}) (5) = 15 \text{ volts}$$

SWEEP RATE

1. Apply a reference signal of known frequency to the vertical input connector. Using the Seconds/Div switch and Variable Seconds/Div control, adjust the display so that one cycle of the signal covers an exact number of horizontal divisions. Do not change the Variable Seconds/Div control after obtaining the desired deflection.

2. Divide the period of the reference signal (seconds) by the product of the horizontal deflection in divisions (established in step 1) and the setting of the Seconds/Div switch. This is the Deflection Conversion Factor.

$$\text{Deflection Conversion Factor} = \frac{\text{reference signal period (seconds)}}{\text{horizontal deflection (divisions)} \times \text{Seconds/Div switch setting}}$$

3. To determine the period of an unknown signal, disconnect the reference and apply the unknown signal.

4. Set the Seconds/Div switch to a setting that provides sufficient horizontal deflection to make an accurate measurement. Do not readjust the Variable Seconds/Div control.

5. To establish a Modified Deflection Factor at any setting of the Seconds/Div switch, multiply the Seconds/

Div switch setting by the Deflection Conversion Factor established in step 2.

$$\text{Modified Deflection Factor} = \text{Seconds/Div switch setting} \times \text{Deflection Conversion Factor}$$

6. Measure the horizontal deflection in divisions and determine the period by the following formula:

$$\text{Period} = \frac{\text{Modified Deflection Factor}}{\text{horizontal deflection (divisions)}} \times$$

EXAMPLE: Assume a reference signal frequency of 455 hertz (period 2.2 milliseconds), a Seconds/Div switch setting of .2 ms, and a horizontal deflection of eight divisions. Substituting these values in the Deflection Conversion Factor formula (step 2):

$$\frac{2.2 \text{ ms}}{(8) (0.2 \text{ ms})} = 1.375$$

Then, with a Seconds/Div switch setting of 50 μ s, the Modified Deflection Factor (step 5) is:

$$(50 \mu\text{s}) (1.375) = 68.75 \text{ microseconds/division}$$

To determine the time period of an applied signal which completes one cycle in seven horizontal divisions, use the Period formula (step 6):

$$(68.75 \mu\text{s}) (7) = 481 \text{ microseconds}$$

This product can be converted to frequency by taking the reciprocal of the period (see application on Determining Frequency).

Time Period Measurement

To measure the time (period) between two points on a waveform, use the following procedure:

1. Connect the signal to the vertical input connector, select either AC or DC input coupling, and set the Volts/Div switch to display about four divisions of the waveform.

2. Set the time-base triggering controls to obtain a stable display. Set the Seconds/Div switch to the fastest sweep rate that will permit displaying one cycle of the waveform in less than eight divisions (some non-linearity may occur in the first and last graticule divisions of display). Refer to Fig. 2-4.

3. Adjust the vertical Position control to move the points between which the time measurement is made to the

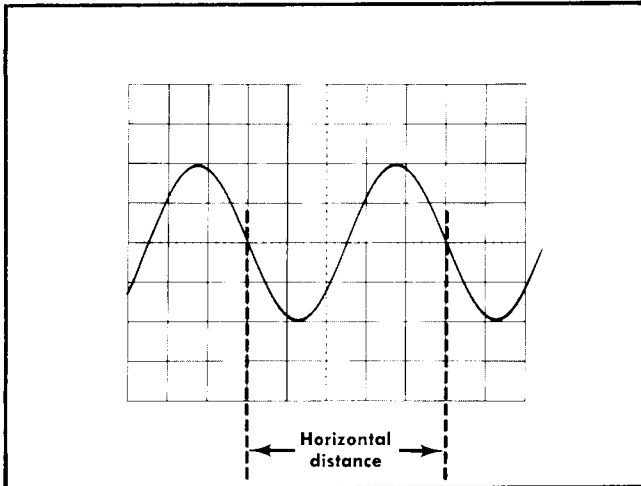


Fig. 2-4. Measuring time duration (period) between points on a waveform.

center horizontal line. Adjust the horizontal Position control to center the time-measurement points within the center eight divisions of the graticule.

4. Measure the horizontal distance between the time measurement points. Be sure the Variable Seconds/Div control is in the Cal position.

5. Multiply the distance measured in step 4 by the setting of the Seconds/Div switch.

EXAMPLE: Assume that the horizontal distance between the time-measurement points is five divisions and the Seconds/Div switch is set to .1 ms.

Using the formula:

$$\begin{aligned} \text{Period} &= \text{horizontal distance (divisions)} \times \text{Seconds/Div switch setting} \\ &= (5) (0.1 \text{ ms}) = 0.5 \text{ ms} \end{aligned}$$

The period is 0.5 millisecond.

Determining Frequency

The time measurement technique can also be used to determine the frequency of a signal. The frequency of a periodically recurrent signal is the reciprocal of the time duration (period) of one cycle. Use the following procedure:

1. Measure the period of one cycle of the waveform as described in the previous application.

2. Take the reciprocal of the period to determine the frequency.

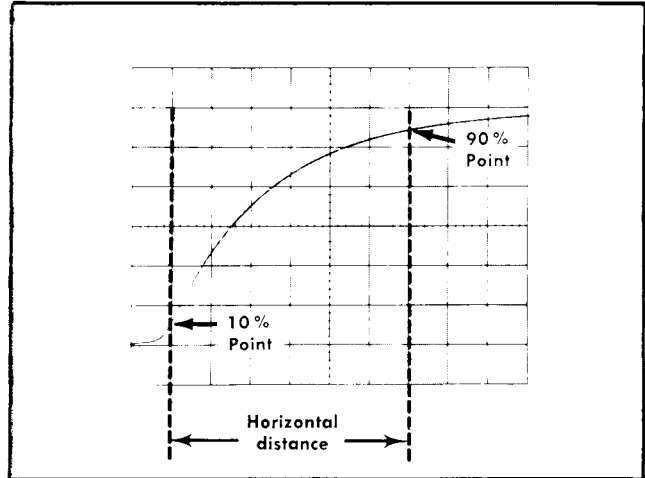


Fig. 2-5. Measuring risetime.

EXAMPLE: The frequency of the signal shown in Fig. 2-4, which has a period of 0.5 millisecond, is:

$$\text{Frequency} = \frac{1}{\text{period}} = \frac{1}{0.5 \text{ ms}} = 2 \text{ kilohertz}$$

Risetime Measurements

Risetime measurements employ basically the same techniques as the time-period measurements. The main difference is the points between which the measurement is made. The following procedure gives the basic method of measuring risetime between the 10% and 90% points of the waveform.

1. Connect the signal to the input connector.

2. Set the Volts/Div switch and Variable Volts/Div control to produce a display an exact number of divisions in amplitude.

3. Center the display about the center horizontal line with the vertical Position control.

4. Set the time-base triggering controls to obtain a stable display. Set the Seconds/Div switch to the fastest sweep rate that will display less than eight divisions between the 10% and 90% points on the waveform (see Fig. 2-5).

5. Determine the 10% and 90% points on the rising portion of the waveform. The figures given in Table 2-2 are for 10% up from the start of the rising portion and 10% down from the top of the rising portion (90% point).

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

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.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears 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.

Mounting hardware must be purchased separately, unless otherwise specified.

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 or model 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.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

TABLE 2-2

Divisions of display	10% and 90% points	Divisions vertically between 10% and 90% points
4	0.4 and 3.6 divisions	3.2
5	0.5 and 4.5 divisions	4.0
6	0.6 and 5.4 divisions	4.8
7	0.7 and 6.3 divisions	5.6
8	0.8 and 7.2 divisions	6.4

6. Adjust the horizontal Position control to move the 10% point of the waveform to the second vertical line of the graticule. For example, with a six-division display, the 10% point would be 0.6 division up from the start of the rising portion.

7. Measure the horizontal distance between the 10% and 90% points. Be sure the Variable Seconds/Div control is in the Cal position.

8. Multiply the distance measured in step 7 by the setting of the Seconds/Div switch.

EXAMPLE: Assume that the horizontal distance between the 10% and 90% points is six divisions and the Seconds/Div switch is set to 1 μ s.

Using the period formula to find risetime:

$$\begin{aligned} \text{Risetime} &= \frac{\text{horizontal distance}}{\text{period}} \times \text{Seconds/Div setting} \\ &= (6) (1 \mu\text{s}) = 6 \text{ microseconds} \end{aligned}$$

The risetime is 6 microseconds

Time Difference Measurements

When used in conjunction with a calibrated time-base plug-in unit, the multi-trace feature of the 5100-series oscilloscope permits measurement of time difference between two or more separate events. To measure time difference, use the following procedure:

1. Set the Input Coupling switches of the amplifier channels to either AC or DC.

2. Set the Display Mode switch on the time-base unit to either Chop or Alt. In general, Chop is more suitable for low-frequency signals and the Alt position is more suitable for high-frequency signals. More information on determining the mode is given under Vertical Display Mode in this section.

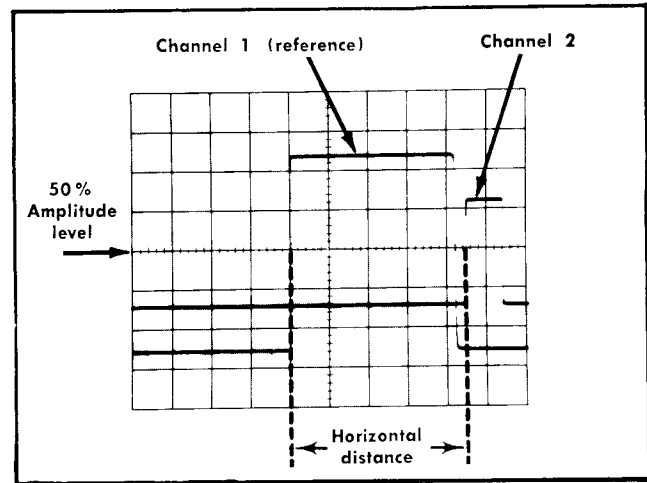


Fig. 2-6. Measuring time difference between two pulses.

3. Set the Triggering Mode switches to trigger the display on Channel 1 (or Left Plug-in).

4. Connect the reference signal to the Channel 1 input connector and the comparison signal to the Channel 2 input connector. The reference signal should precede the comparison signal in time. Use coaxial cables or probes which have similar time-delay characteristics to connect the signal to the input connectors.

5. If the signals are of opposite polarity, push the Invert button to invert the Channel 2 display. (Signals may be of opposite polarity due to 180° phase difference; if so, take this into account in the final calculation.)

6. Set the Volts/Div switches to produce about four divisions of displayed waveform.

7. Set the time-base triggering controls for a stable display. Set the Seconds/Div switch for a sweep rate which shows three or more divisions between the measurement points, if possible.

8. Adjust the vertical Position controls to bring the measurement points to the center horizontal reference line.

9. Adjust the horizontal Position control so the Channel 1 waveform (reference) crosses the center horizontal line at a vertical graticule line.

10. Measure the horizontal distance between the two measurement points (see Fig. 2-6).

Operating Instructions—5103N

11. Multiply the measured distance by the setting of the Seconds/Div switch.

EXAMPLE: Assume that the Seconds/Div switch is set to $50 \mu\text{s}$ and the horizontal distance between measurement points is four divisions.

Using the formula:

$$\begin{aligned} \text{Time Delay} &= \text{Seconds/Div setting} \times \text{horizontal distance (divisions)} \\ &= (50 \mu\text{s}) (4) = 200 \mu\text{s}. \end{aligned}$$

The time delay is 200 microseconds.

Multi-Trace Phase Difference Measurement

Phase comparison between two or more signals of the same frequency can be made using a dual-trace plug-in or two single-trace plug-ins. This method of phase difference measurement can be used up to the frequency limit of the vertical system. To make the comparison, use the following procedure:

1. Set the Input Coupling switches of the amplifier channels to either AC or DC.

2. Set the Display Mode switch on the time-base unit to either Chop or Alt. In general, Chop is more suitable for low-frequency signals and the Alt position is more suitable for high-frequency signals. More information on determining the mode is given under Vertical Display Mode in this section.

3. Set the Triggering Mode switches to trigger the display on Channel 1 (or Left plug-in).

4. Connect the reference signal to the Channel 1 input connector and the comparison signal to the Channel 2 input connector. The reference signal should precede the comparison signal in time. Use coaxial cables or probes which have similar time-delay characteristics to connect the signals to the input connectors.

5. If the signals are of opposite polarity, push the Invert button to invert the Channel 2 display. (Signals may be of opposite polarity due to 180° phase difference; if so, take this into account in the final calculation.)

6. Set the Volts/Div switches and the Variable Volts/Div controls so the displays are equal and about five divisions in amplitude.

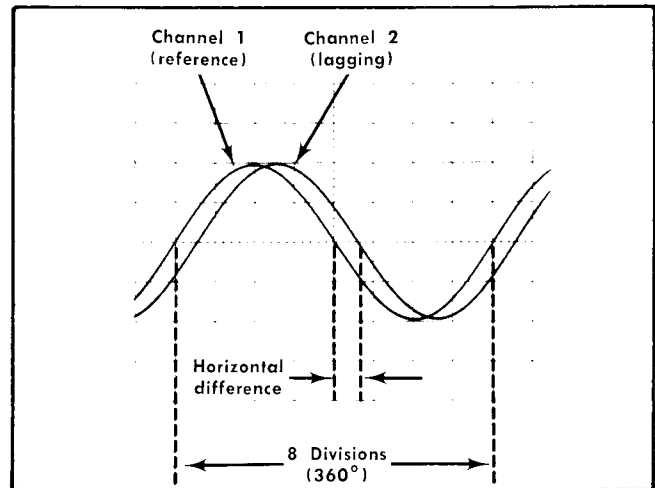


Fig. 2-7. Measuring phase difference.

7. Set the time-base triggering controls to obtain a stable display. Set the Seconds/Div switch to a sweep rate which displays about one cycle of the waveform.

8. Move the waveforms to the center of the graticule with the vertical Position controls.

9. Turn the Variable Seconds/Div control until one cycle of the reference signal (Channel 1) occupies exactly eight divisions between the second and tenth vertical lines of the graticule (see Fig. 2-7). Each division of the graticule represents 45° of the cycle ($360^\circ + 8 \text{ divisions} = 45^\circ/\text{division}$). The sweep rate can be stated in terms of degrees as $45^\circ/\text{division}$.

10. Measure the horizontal difference between corresponding points on the waveforms.

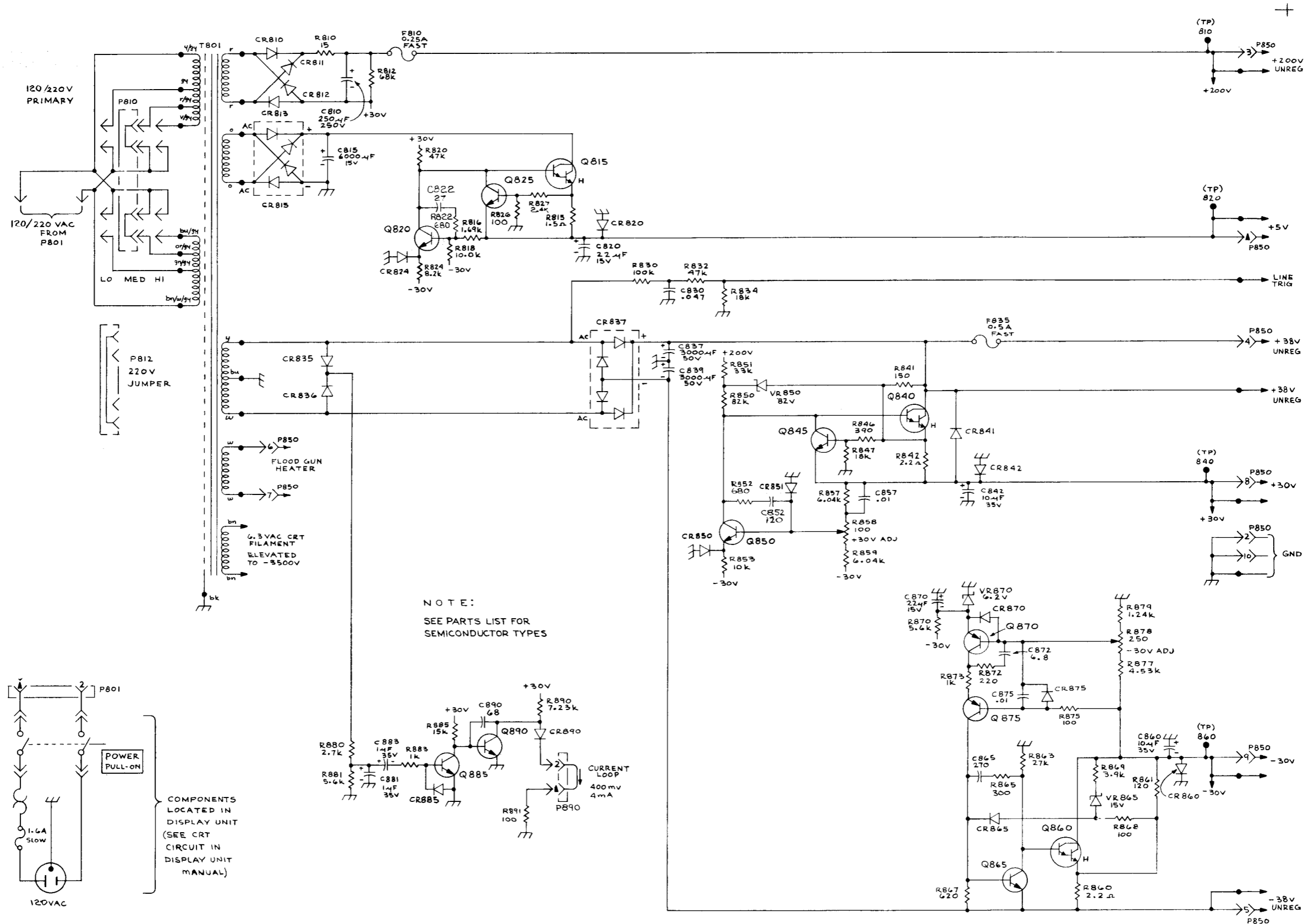
11. Multiply the measured distance (in divisions) by $45^\circ/\text{division}$ (sweep rate) to obtain the exact amount of phase difference.

EXAMPLE: Assume a horizontal difference of 0.6 division with a sweep rate of $45^\circ/\text{division}$ as shown in Fig. 2-7.

Using the formula:

$$\begin{aligned} \text{Phase Difference} &= \text{horizontal difference (divisions)} \times \text{sweep rate (degrees/division)} \\ &= (0.6) (45^\circ) = 27^\circ \end{aligned}$$

The phase difference is 27° .



A2 POWER SUPPLY BOARD

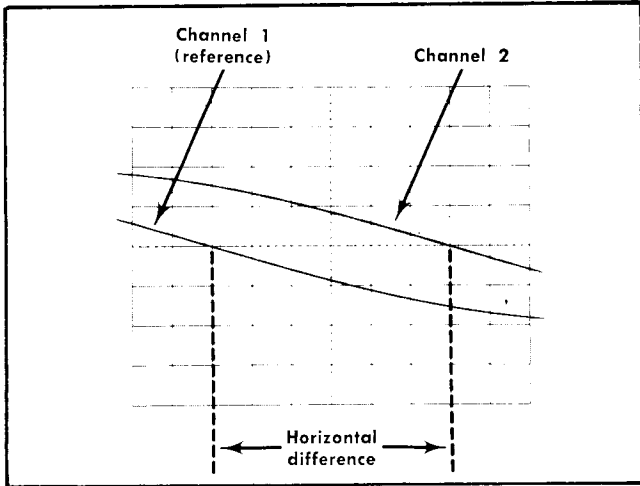


Fig. 2-8. High-resolution phase-difference measurement with increased sweep rate.

High Resolution Phase Measurements

More accurate dual-trace phase measurements can be made by increasing the sweep rate (without changing the Variable Seconds/Div control setting). One of the easiest ways to increase the sweep rate is with the SWP MAG (10X) button on the time-base unit. The magnified sweep rate is automatically indicated by the knob-skirt scale-factor readout.

EXAMPLE: If the sweep rate were increased 10 times with the magnifier, the magnified sweep rate would be $45^\circ / \text{division} \div 10 = 4.5^\circ / \text{division}$. Fig. 2-8 shows the same signals as used in Fig. 2-7, but with the SWP MAG button pushed in. With a horizontal difference of six divisions, the phase difference is:

$$\begin{aligned} \text{Phase Difference} &= \text{horizontal difference (divisions)} \times \text{magnified sweep rate (degrees/division)} \\ &= (6) (4.5^\circ) = 27^\circ \end{aligned}$$

The phase difference is 27° .

X-Y Phase Measurements

The X-Y phase measurement method can also be used to measure the phase difference between two signals of the same frequency. The phase angle is determined from the Lissajous pattern as outlined in the following steps:

1. Insert an amplifier plug-in unit into one of the vertical plug-in compartments and an amplifier of the same type into the horizontal plug-in compartment.

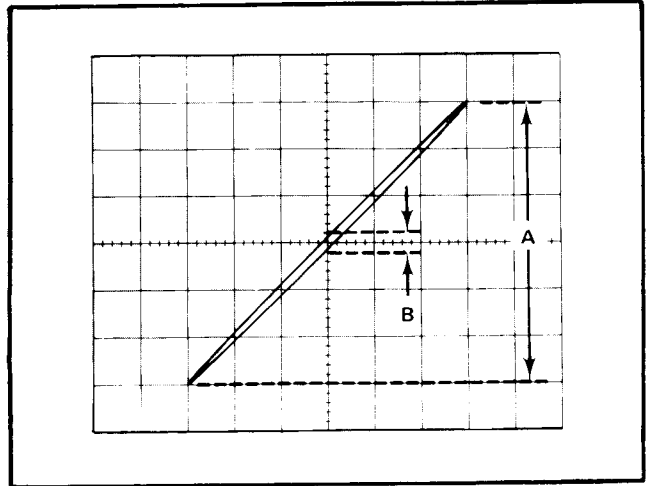


Fig. 2-9. Phase difference measurement from an X-Y display.

2. Connect a signal to the input connector of each plug-in and select the desired input coupling.

3. Position the display to the center of the screen and adjust the Volts/Div switches to produce a display six divisions vertically (Y) and six divisions horizontally (X).

4. Center the display in relation to the center vertical graticule line. Measure the distances A and B as shown in Fig. 2-9. Distance B is the vertical measurement between the two points where the trace crosses the center vertical line. Distance A is the maximum vertical amplitude of the display.

5. Divide B by A to obtain the sine of the phase angle (Φ) between the two signals. The angle can then be obtained from a trigonometric table. If the display appears as a diagonal straight line, the two signals are either in phase (tilted upper right to lower left), or 180° out of phase (tilted upper left to lower right). If the display is a circle, the signals are 90° out of phase. Fig. 2-10 shows the Lissajous displays produced between 0° and 360° . Notice that above 180° phase shift, the resultant display is the same as at some lower angle.

EXAMPLE: Assume a display as shown in Fig. 2-9 where A is 6 divisions and B is 0.4 division.

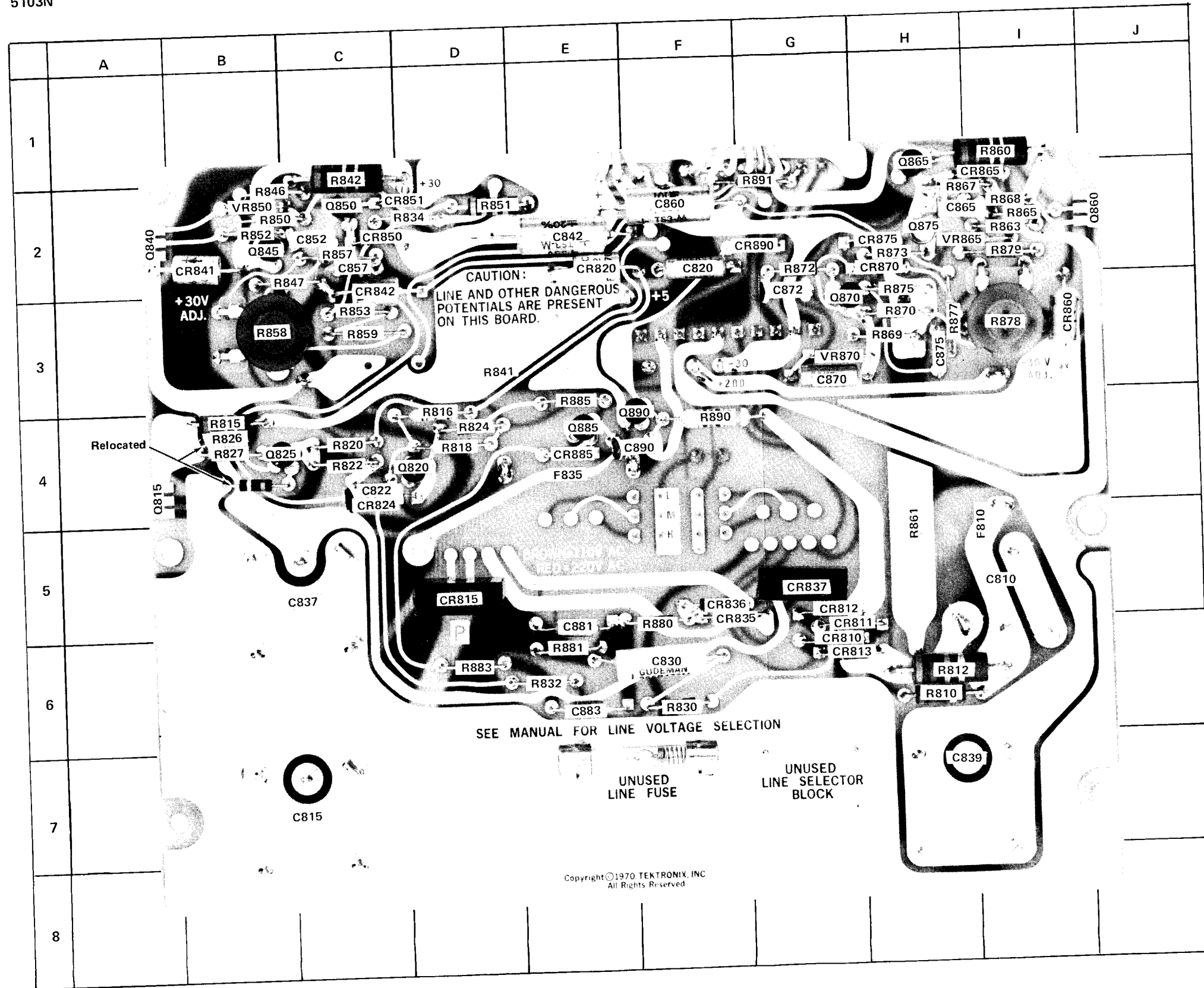
Using the formula:

$$\text{Sine } \Phi = \frac{B}{A} = \frac{0.4}{6} = 0.0667$$

From the trigonometric tables (or slide rule):

$$\Phi = \arcsin 0.0660 = 3.82^\circ$$

POWER SUPPLY BOARD PARTS LOCATION GRID



CKT NO	GRID LOC	CKT NO	GRID LOC
C810	I-5	Q875	H-2
C815	C-5	Q885	E-4
C820	F-2	Q890	F-4
C822	C-4		
C830	F-6		
C837	C-7		
C839	H-7	R810	H-6
C842	E-2	R812	H-6
C852	C-2	R815	B-4
C857	C-2	R816	D-4
C860	F-2	R818	D-4
C865	H-2	R820	C-4
C870	G-3	R822	C-4
C872	G-3	R824	D-4
C875	H-3	R826	B-4
C881	E-5	R827	B-4
C883	E-6	R830	F-6
C890	F-4	R832	E-6
		R834	D-2
		R841	D-3
		R842	C-1
		R846	B-2
CR810	G-6	R847	C-2
CR811	G-6	R850	B-2
CR812	G-5	R851	D-2
CR813	G-6	R852	B-2
CR815	G-5	R853	C-3
CR820	E-2	R857	C-2
CR824	C-4	R858	B-3
CR835	F-5	R859	C-3
CR836	F-5	R860	I-1
CR837	D-5	R861	H-5
CR841	B-2	R863	I-2
CR842	C-2	R865	I-2
CR850	C-2	R867	H-2
CR851	D-2	R868	I-2
CR860	I-3	R869	H-3
CR865	I-2	R870	H-3
CR870	H-2	R872	G-2
CR875	H-2	R873	H-2
CR885	E-4	R875	H-3
CR890	G-2	R877	H-3
		R878	I-3
		R879	I-2
		R880	F-5
VR850	B-2	R881	E-6
VR865	I-2	R883	D-6
VR870	G-3	R885	E-3
		R890	F-4
		R891	G-2
F810	I-5		
F835	E-4		
Q815	A-4		
Q820	D-4		
Q825	B-4		
Q840	A-2		
Q845	B-2		
Q850	C-2		
Q860	J-2		
Q865	H-1		
Q870	G-3		

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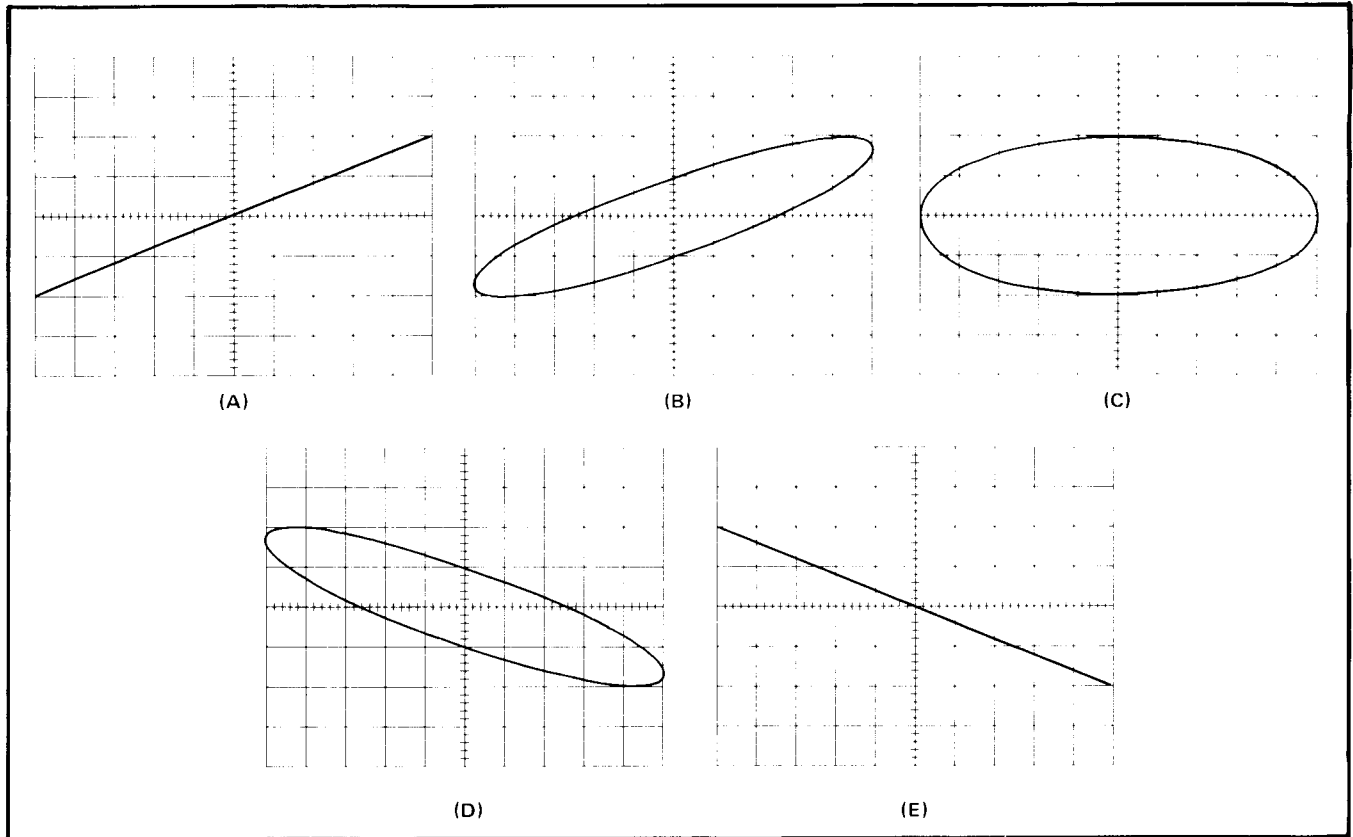
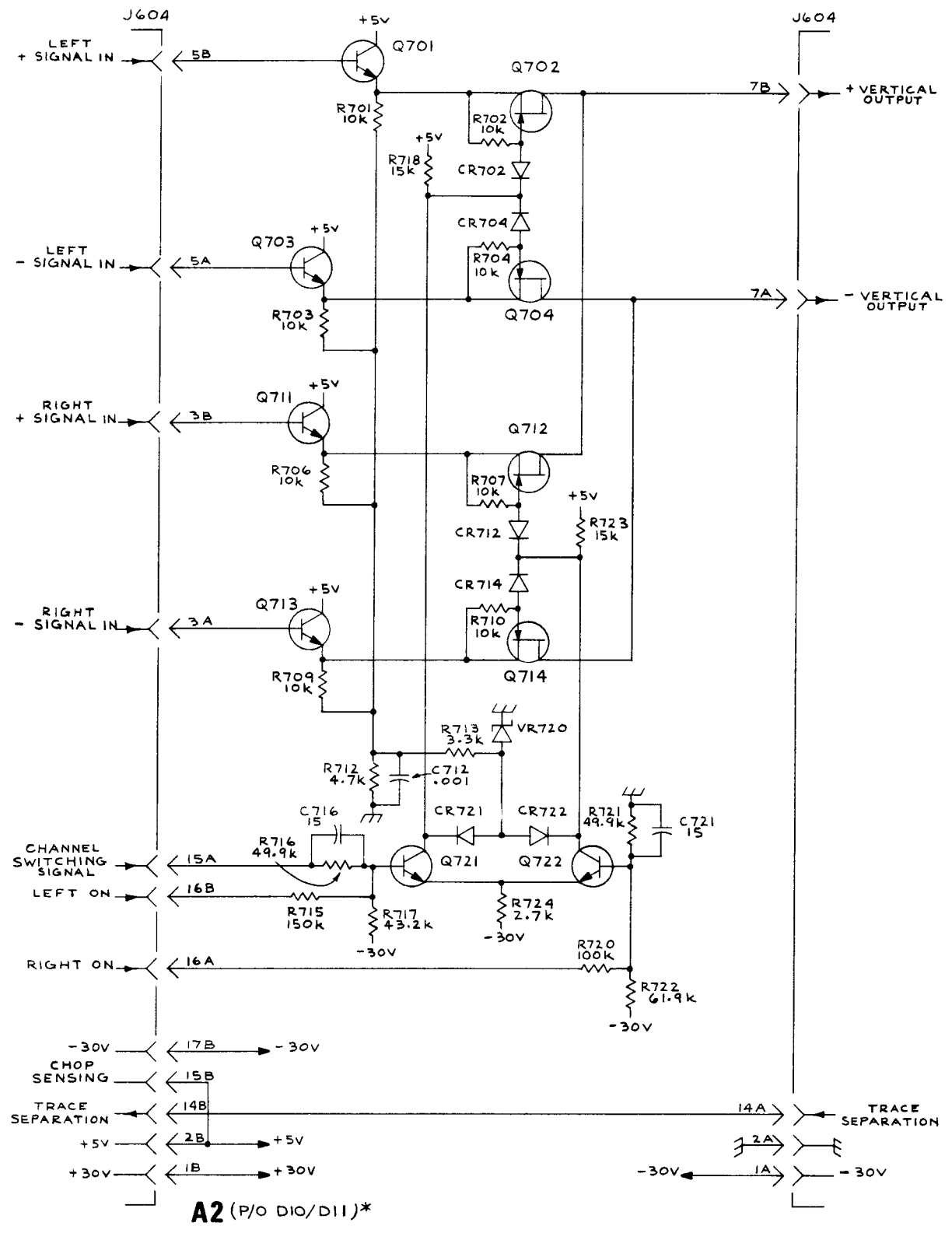
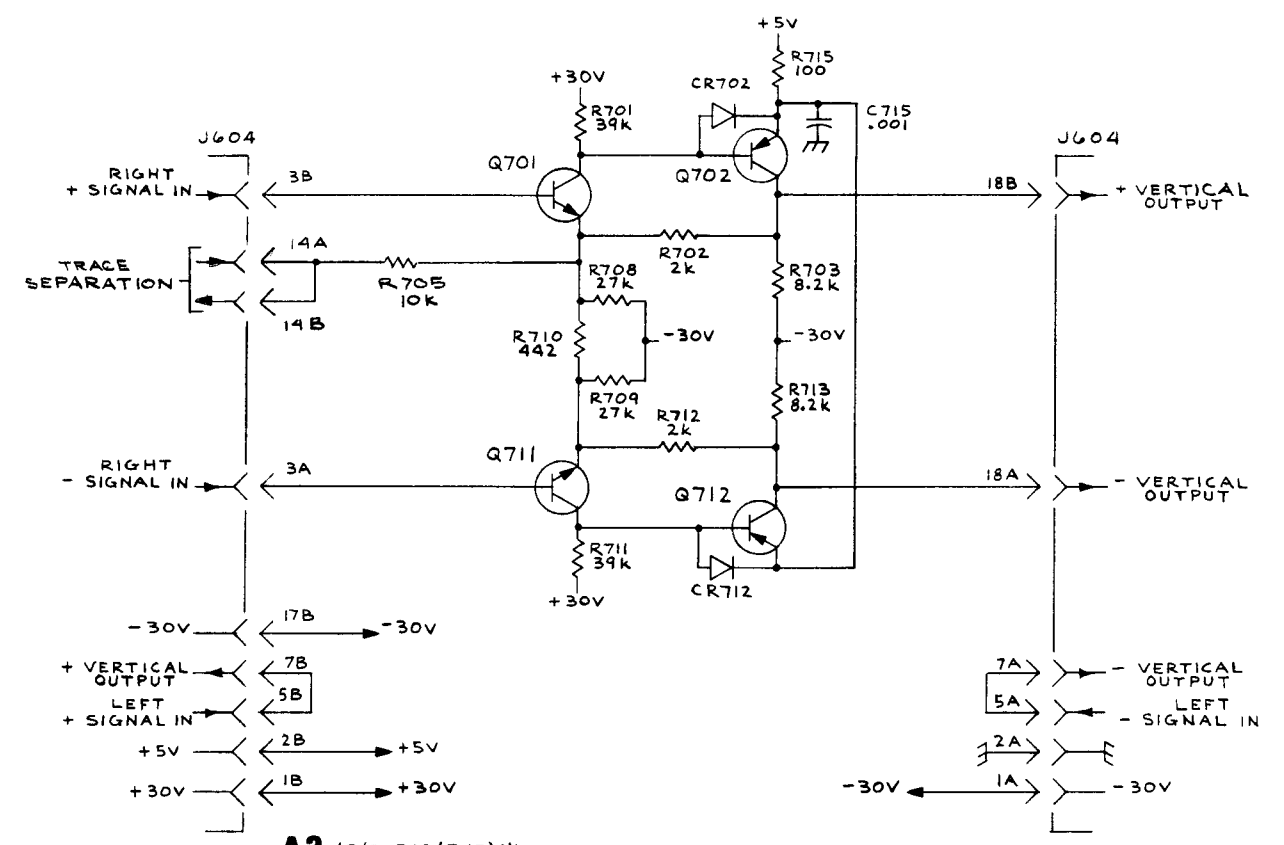


Fig. 2-10. Phase of a Lissajous display. (A) 0° or 360° , (B) 30° or 330° , (C) 90° or 270° , (D) 150° or 210° , and (E) 180° .



SINGLE BEAM



DUAL BEAM

NOTE:
 * DIAGRAMS ARE PRESENTED HERE FOR CONVENIENCE. PARTS LIST, BOARD PHOTOS, AND COMPONENT LOCATION GRIDS LOCATED IN THE DISPLAY UNIT MANUALS.

SECTION 3

CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section of the manual contains an electrical description of the circuits in the 5103N Power Supply/Amplifier unit, and discusses their relationship to the other instruments comprising the Oscilloscope System. An overall block diagram of the unit and complete schematics are given on pullout pages at the back of this manual.

BLOCK DIAGRAM DESCRIPTION

Vertical signals to be displayed on the cathode-ray tube are applied to the Interface circuit from both vertical plug-in compartments. With single-beam display units, the Interface circuit determines whether the signal from the left and/or right vertical unit is displayed; with dual-beam units, the Interface circuit establishes the proper routing to associate the left vertical plug-in signal with the upper CRT beam and right vertical plug-in signal with the lower CRT beam. The Vertical Amplifier circuit provides intermediate amplification between the vertical plug-in units and the deflection amplifiers in the display unit.

Time-base and external signals for horizontal display on the CRT are connected to the Interface circuit from the horizontal plug-in compartment. The Horizontal Amplifier circuit provides intermediate amplification between the horizontal plug-in unit and the deflection amplifier in the display unit.

Additionally, the Interface circuit provides an interconnection of logic levels, time-base triggering signals, display-related signals, and power-supply voltages between the plug-in units and the display unit.

The Low-Voltage Regulator circuits provide the voltage necessary for operation of the oscilloscope system. These voltages are connected to all circuits within the instrument. Also included in this circuit is the Calibrator, which produces a square-wave output with accurate amplitude at a repetition rate of twice the power-line frequency. This output signal is useful for calibration and probe compensation, and is available at the front panel of the display unit.

INTERFACE

General

The Interface circuit provides an interconnection of signals, logic levels, and power-supply voltages between plug-in units and the oscilloscope mainframe. It incorporates circuits that determine the vertical display mode and amplify the vertical and horizontal display signals. Functions of interconnections not discussed are labelled on the Interface diagram.

Clock Generator

The Clock Generator stage produces a 200-kilohertz timing signal (clock) for chopping between vertical plug-ins and amplifier channels within the plug-ins. This circuit consists of Q620, Q626, and their associated passive components, which are connected as a multivibrator. When the multivibrator receives a chop actuate level (+5 volts), it free runs at a 200-kilohertz rate. (The chop actuate level is routed through the vertical plug-ins to the time-base unit, and is present at contact A20 of J603 when a multi-trace display is required and the time-base Display switch is set to Chop.) The chop actuate level also disables Q630, locking out alternate-drive pulses. The Clock Generator has two outputs; one is sent to the Countdown circuit as a timing signal, and the other is sent to the CRT circuit in the display unit to blank the chop-switching transients.

Countdown Circuit

The Countdown produces the display switching signal for both the Alternate and Chopped switching modes. This circuit is composed of U640 and its discrete passive components, which are connected as a pair of RS flip-flops. Each flip-flop is a divide-by-two counter, and the first one drives the second. The Countdown Circuit is activated by a negative-going transition, which can come from either the Clock Generator or from the time-base plug-in unit via grounded-base amplifier Q630. The Clock Generator input results in chopped-mode vertical switching. The input from the time-base unit coincides with the end of each sweep, and results in alternate-mode vertical switching. The output from the divide-by-two portion of the Countdown Circuit (U640A-U640B) is sent via contacts B21 of J601 and J602 to the channel-switching circuits incorporated within dual-trace vertical plug-in units. The outputs from the divide-by-

Circuit Description—5103N

four portion of the Countdown Circuit (U640C-U640D) are used for plug-in switching; one output is sent to contact A15 of J604 to produce plug-in switching on the single-beam-display auxiliary board, and the other output is sent via contact B21 of J603 to produce dual-sweep switching in dual time-base units. The vertical mode switching sequence and some of the display combination possibilities are fully discussed under General Operating Information in the Operating Instructions section of this manual.

Auxiliary Boards

Because switching between plug-ins is required for simultaneous viewing of displays on single-beam cathode-ray tubes and not required for use with dual-beam cathode-ray tubes, an auxiliary board is supplied with each display unit to provide the correct signal-routing function. An auxiliary board plugs into J604 on the Interface circuit board, and becomes part of the Interface circuit. The single-beam auxiliary board accepts the push-pull signal outputs from both vertical plug-ins. Emitter followers Q701, Q703, Q711, and Q713 provide a high-impedance input to two pairs of grounded-gate FET amplifiers, Q702-Q704 and Q712-Q714. The switching circuit consists of Q721 and Q722, connected as a comparator. Plug-in "on" logic levels are applied to the switching circuit in addition to the switching signal from the Countdown Circuit. The switching circuit permits only one pair of amplifiers to be on at a time, thus permitting only one of the two vertical plug-in signals to pass to the Vertical Amplifier. In the chopped switching mode, the switching between pairs of amplifiers occurs at a 50-kilohertz rate (switching occurs on both the negative- and positive-going transition), and in the alternate mode, switching occurs at the end of every second sweep. If no "on" logic level is applied to the switching circuit from either vertical plug-in, Q702 and Q704 will remain on, passing any signal from the left vertical plug-in.

The dual-beam auxiliary board has no switching circuit. It routes the signal from the left vertical plug-in to the Vertical Amplifier circuit on the Interface circuit board, and amplifies the signal from the right vertical plug-in. The amplifier circuit on the dual-beam auxiliary board is identical to the Vertical Amplifier which is discussed next, and consists of Q701, Q702, Q711, and Q712. The output of this amplifier is sent directly to the lower-beam deflection amplifier in the display unit.

Vertical Amplifier

The Vertical Amplifier circuit provides approximately 10X amplification of the vertical signal before passing it to the vertical deflection amplifier in the display unit. The Vertical Amplifier consists of Q650, Q658, Q660, Q668, and their associated passive components, connected in a differential configuration. The output signal is in phase with the output of the vertical plug-in.

Horizontal Amplifier

The Horizontal Amplifier consists of Q670, Q678, Q680, Q688, and their associated passive components. The circuit is nearly identical to the Vertical Amplifier just described. It receives a push-pull input directly from the horizontal plug-in compartment via contacts A7, A13, B7, and B13 of J603. The two halves of this amplifier are balanced in the quiescent condition by adjustment of R675, Horiz Cent. The output of the Horizontal Amplifier is sent to the horizontal deflection amplifier in the display unit.

POWER SUPPLY

General

The Power Supply circuit provides the low-voltage operating power for the oscilloscope system from three regulated supplies and three unregulated supplies. Electronic regulation is used to provide stable, low-ripple output voltages. The circuit also includes the calibrator circuit to produce an accurate square-wave output.

Power Input

Power is applied to the primary of transformer T801 through the display unit (fuse F201, thermal cutout S200, and Power switch S201), and the line-selector block, P810. The line-selector block allows changing the primary-winding taps of T801 to fit different line requirements.

Low-Voltage Rectifiers and Unregulated Outputs

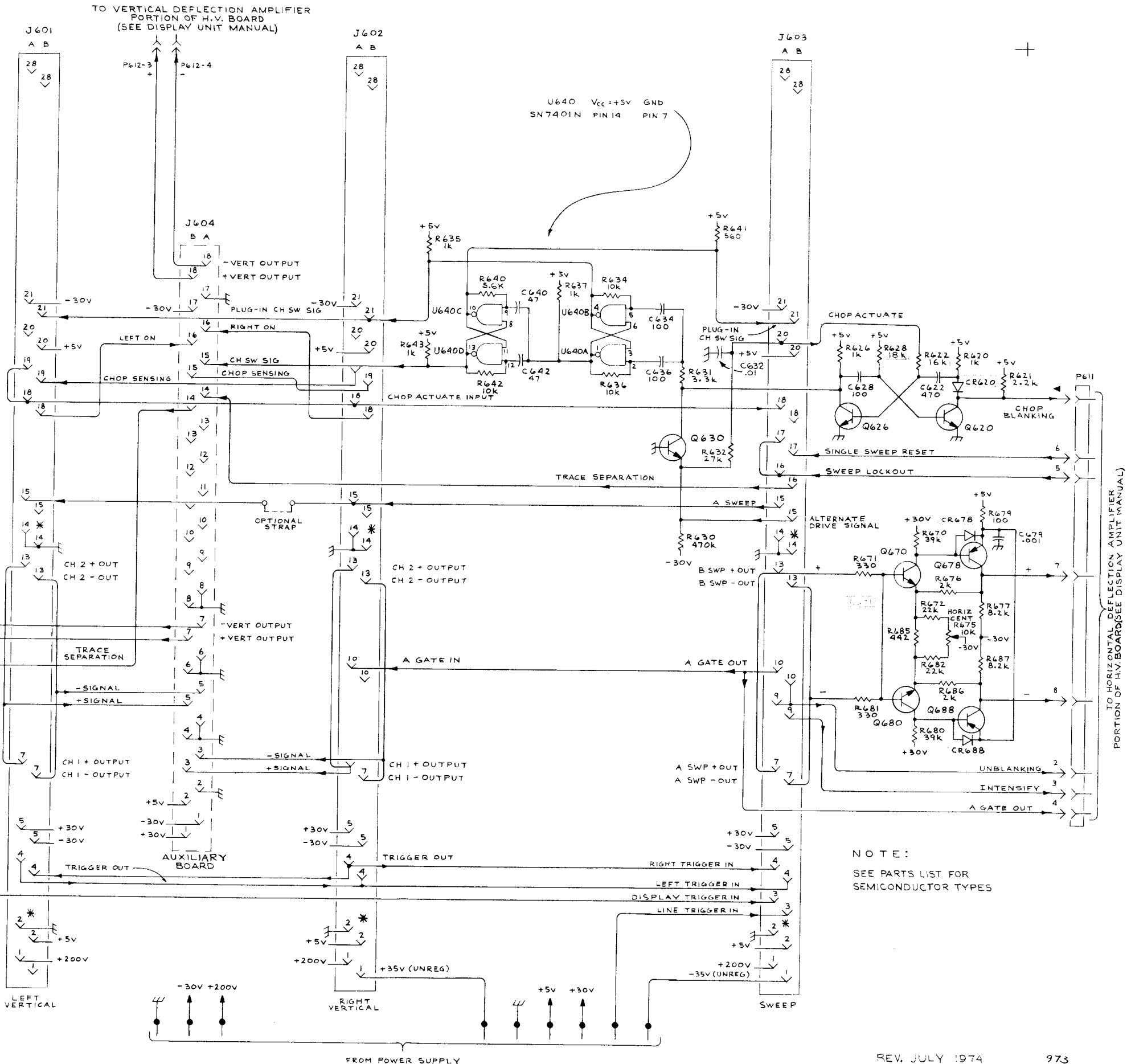
The full-wave bridge rectifiers and associated filter components in the secondaries of T801 provide filtered DC voltages for operation of the oscilloscope system or for regulation by the Low-Voltage Regulators. The unregulated outputs are +200 volts, +38 volts, and -38 volts. The +205-volt and +38-volt outputs to the display unit are fuse-protected by F810 and F835 respectively.

Low-Voltage Regulators

-30-Volt Supply. The -30-Volt Supply, besides providing power to circuitry throughout the instrument, provides a reference-voltage source to establish operating levels for the feedback regulators in the +30-Volt and +5-Volt supplies. The regulator for the -30-Volt Supply is a feedback amplifier system which operates between ground and the unregulated -38 volts. Current to the load is delivered by the series-pass transistor, Q860, and the supply voltage is established by the drop across R877, R878, and R879. The feedback path is through R875, Q875, and Q865 to the base of Q860. Any variation in output voltage due to ripple, change of current through the load, etc., is immediately transmitted to the base of Q860 and nullified by a change in Q860 conduction, thus main-

* PINS 14A AND 14B ARE FOR SIGNAL GROUNDS ONLY (LOW NOISE GROUND). THE PINS ARE GROUNDED VIA THE INTERFACE AND LV POWER SUPPLY CIRCUIT BOARD GROUND LANES WHICH ARE CONNECTED TO CHASSIS GROUND. PIN 2A PROVIDES A RETURN FOR ALL GROUNDS EXCEPT SIGNAL GROUNDS, THE PIN IS DIRECTLY GROUNDED TO THE CHASSIS OF THE 5103N.

TO VERTICAL DEFLECTION AMPLIFIER
PORTION OF H.V. BOARD (SEE DISPLAY UNIT MANUAL)



A1 INTERFACE BOARD

5103N

REV. JULY 1974
INTERFACE CIRCUIT 1

taining a steady output. The output of the supply is set to exactly -30 volts by adjustment of R878, -30 V Adj. This control sets the conduction of Q870, which controls the bias levels of Q865 and Q860. CR865 and Q865 provide short-circuit protection by limiting the current through Q860.

+30-Volt Supply. The regulator for the +30-Volt Supply consists of series-pass transistor Q840 and error amplifier Q850. This is a feedback amplifier system similar to that just described for the -30 -Volt Supply. R858, +30 V Adj, provides an adjustment to set the output of the supply at exactly +30 volts. Q845 protects the supply in the event the output is shorted by limiting the current demanded from the series-pass transistor under excessive load. During normal operation, Q845 is biased off.

+5-Volt Supply. The regulator for the +5-Volt Supply consists of series-pass transistor Q815 and error amplifier Q820. Operation of this feedback amplifier system is similar to that described for the -30 -Volt Supply. The short-protection transistor, Q825, functions as described for Q845 in the +30-Volt Supply.

Line Trigger

A line-frequency signal is obtained from the secondary of T801 and attenuated by R830, R832, and R834 to provide a line-trigger source for the time-base plug-in unit.

CRT Heater Windings

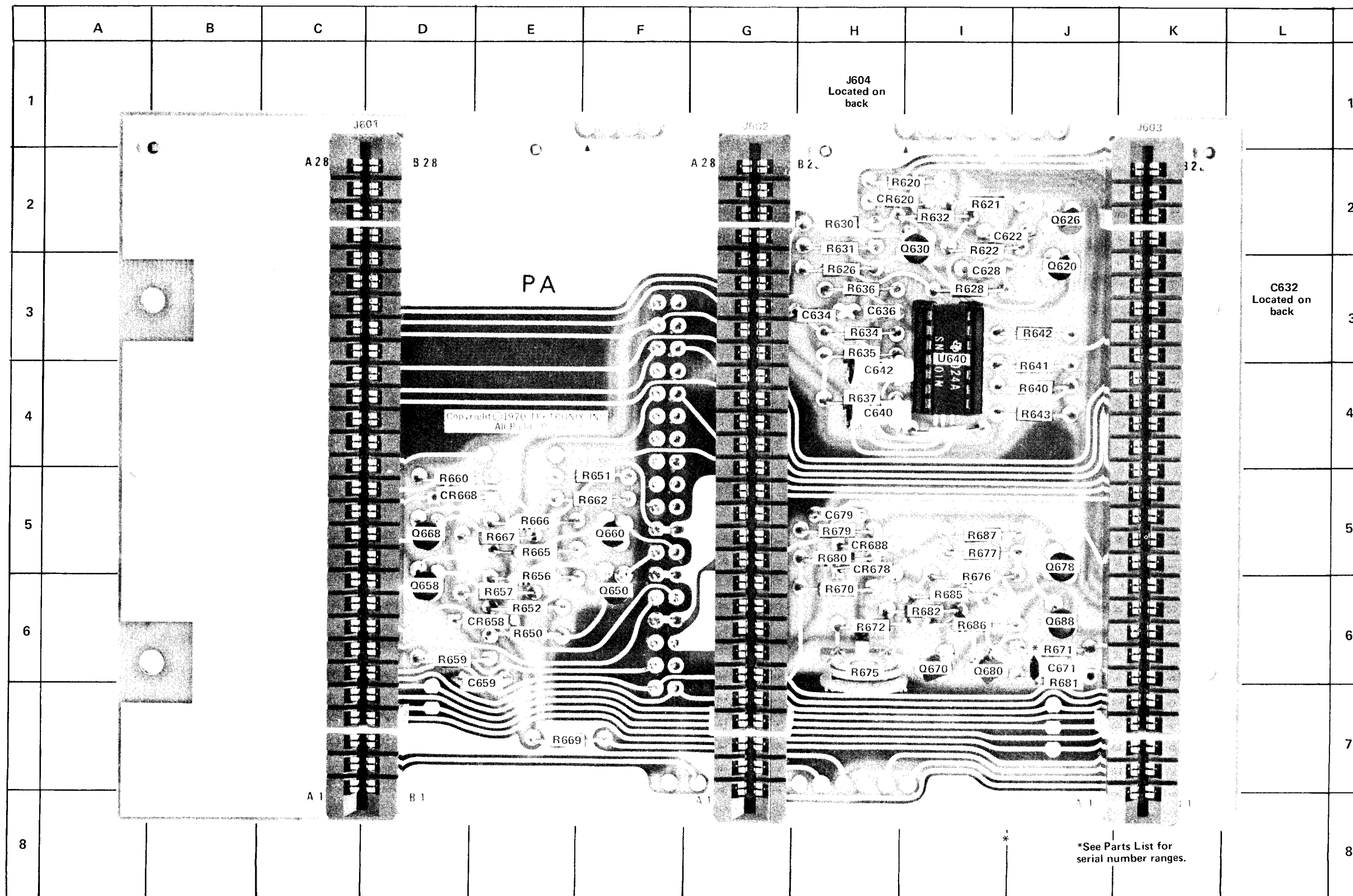
Two separate secondary windings are provided for the CRT writing-gun heaters and the flood-gun heaters. The writing-gun heaters are elevated to -3500 volts in the CRT circuit (display unit) to maintain a potential near that of the CRT cathode.

Calibrator

The Calibrator circuit composed of Q885, Q890, and their associated passive components produces a square-wave output with accurate amplitude and at a rate of twice the power-line frequency. This output is available at the probe test loop on the display unit front panel as a 4-milliampere (peak to peak) square-wave current, or as a 400-millivolt (ground to peak) square-wave voltage.

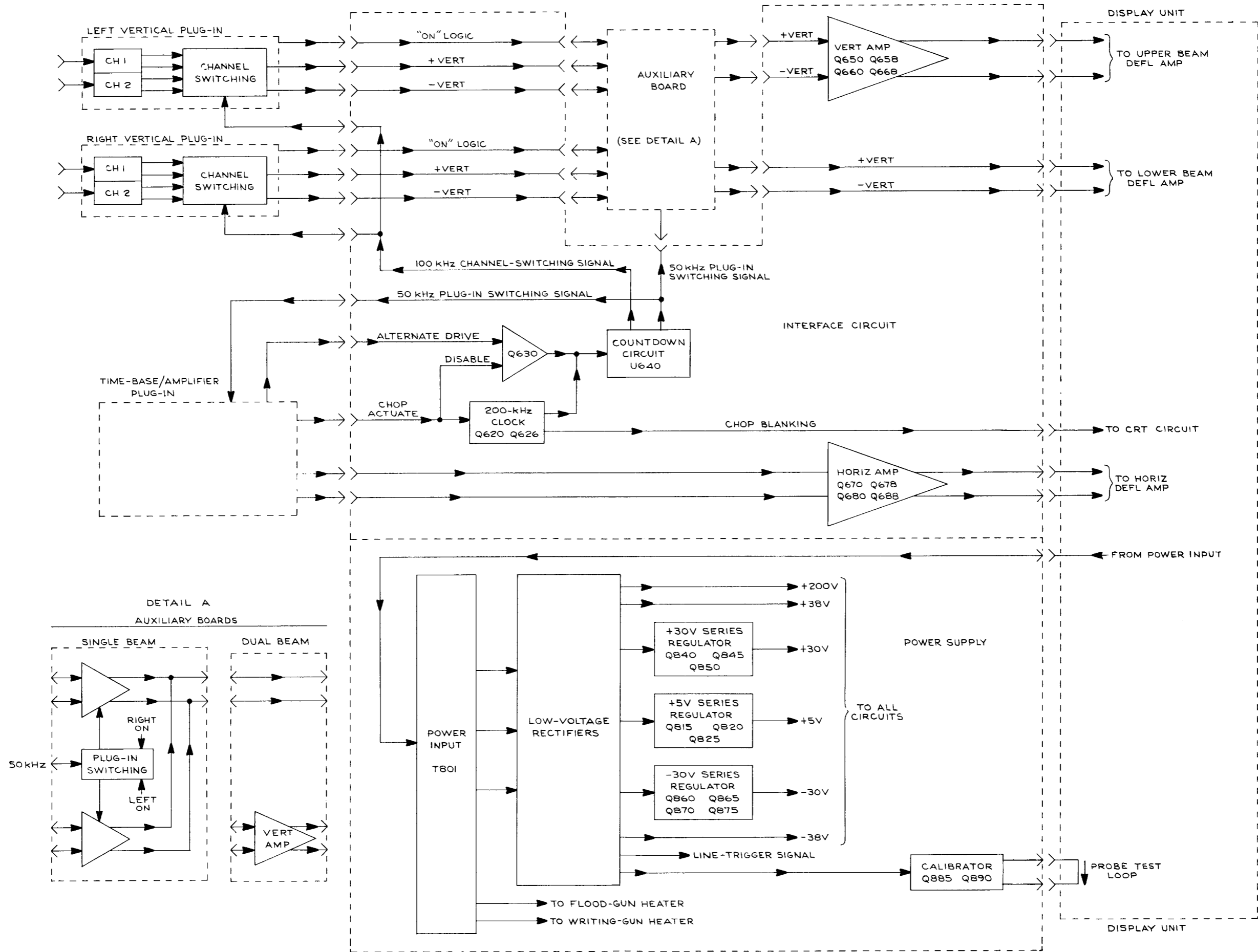
The resistive-capacitive network at the base of Q885 receives a pulsating DC voltage from full-wave rectifier CR835-CR836 and produces a nearly symmetrical switching signal for Q885 and Q890. As Q890 is alternately switched on and off at twice the line frequency, current through R890 is alternately switched through the transistor or through CR890, the probe test loop, and R891, producing the required test signal.

INTERFACE BOARD PARTS LOCATION GRID



*See Parts List for serial number ranges.

CKT NO	GRID LOC	CKT NO	GRID LOC
C622	J-2	R670	H-6
C628	I-3	R671	J-6
C634	H-3	R672	H-6
C636	H-3	R675	H-6
C640	H-4	R676	I-6
C642	H-4	R677	I-5
C659	E-7	R679	H-5
C671	J-6	R680	H-5
C679	H-5	R681	J-7
		R682	I-6
		R685	I-6
		R686	I-6
		R687	I-5
CR620	H-2		
CR658	E-6		
CR668	D-5		
CR678	H-5		
CR688	H-5	U640	I-3
Q620	J-3		
Q626	J-2		
Q630	I-2		
Q650	F-6		
Q658	D-6		
Q660	F-5		
Q668	D-5		
Q670	I-6		
Q678	J-5		
Q680	I-6		
Q688	J-6		
R620	I-2		
R621	I-2		
R622	I-2		
R626	H-3		
R628	I-3		
R630	H-2		
R631	H-2		
R632	I-2		
R634	H-3		
R635	H-3		
R636	H-3		
R637	H-4		
R639	I-4		
R640	J-4		
R641	J-4		
R642	J-3		
R643	J-4		
R650	E-6		
R651	F-5		
R652	E-6		
R656	E-6		
R657	E-6		
R659	D-6		
R660	D-5		
R662	F-5		
R665	E-5		
R666	E-5		
R667	E-5		
R669	E-7		



SECTION 4

SYSTEM MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual applies to all instruments in the 5100-series oscilloscope system, including display units and plug-in units. It contains information for preventive maintenance, troubleshooting, obtaining replacement parts, and replacing components and sub-assemblies.

5100 Panel Removal

WARNING

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

The cabinet panels of the 5100-series oscilloscope are held in place by slotted fasteners. To remove the panels, turn each fastener counterclockwise a quarter turn with a large screwdriver, coin, or similar device. Then the panels can be lifted away. The instrument should be operated with the panels in place to protect the interior from dust, and to eliminate shock hazard.

PREVENTIVE MAINTENANCE

General

Preventive maintenance, consisting of cleaning, visual inspection, etc., performed on a regular basis, will improve the reliability of the oscilloscope. Periodic checks of the semiconductor devices used in the system are not recommended as a preventive maintenance measure. See semiconductor-checking information given under troubleshooting. A convenient time to perform preventive maintenance is preceding instrument calibration.

Cleaning

CAUTION

Avoid the use of chemical cleaning agents which might damage plastic parts. Avoid chemicals con-

taining benzene, toluene, xylene, acetone, or similar solvents.

Exterior. Loose dust may be removed with a soft cloth or a dry brush. Water and mild detergent may be used; however, abrasive cleaners should not be used.

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

Calibration

To ensure accurate measurements, the performance of individual units comprising the 5100-Series Oscilloscope should be checked periodically. Complete calibration instructions are given in the manuals for each unit.

The calibration procedure can be helpful in isolating major troubles in a unit. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

TROUBLESHOOTING

General

The following is provided to augment information contained elsewhere in this and in other manuals when troubleshooting the 5100-Series Oscilloscope or its plug-in units. The schematic diagrams, circuit description and calibration sections should be used to full advantage. The circuit description sections give detailed information about circuit behavior and output requirements.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in the diagram section of each individual manual. The circuit number and electrical value of each component in this instrument system are shown on the diagrams (see first page

of each diagram section for definition of the reference designators used to identify components in each unit). Each main circuit is assigned a series of component numbers. Important voltages and waveforms are also shown on the diagrams. The portions of the circuits mounted on circuit boards are enclosed with blue lines.

Cam Switch Contact Identification. Cam switches shown on the diagrams are coded to indicate the position of the contact in the complete switch assembly counting from the front, or knob end of the switch, toward the rear. The contact closure chart given on the diagrams indicates when each contact is closed.

Circuit Boards. Pictures of the circuit boards are shown in the diagram sections. These pictures are located near their respective associated schematic diagrams to aid in cross reference between the diagrams and the circuit board pictures. Where applicable, circuit boards are identified by assembly numbers, which are used on the diagrams and in the parts lists to aid in locating the boards. Each electrical

component on the boards is identified by its circuit number. The circuit boards are also outlined on the diagrams with a blue line to show which portions of the circuit are located on a circuit board.

Component and Wiring Color Code. Colored stripes or dots on resistors and capacitors signify electrical values, tolerances, etc., according to the EIA standard color code. Components not color coded usually have the value printed on the body.

WARNING

This color code applies to leads within the 5100-Series Oscilloscope system only. Color code of the AC power cord is:

- | | |
|-----------------------------------|------------------------------|
| <i>Black</i> | <i>Line</i> |
| <i>White</i> | <i>Neutral</i> |
| <i>Green with a yellow stripe</i> | <i>Safety Earth (ground)</i> |

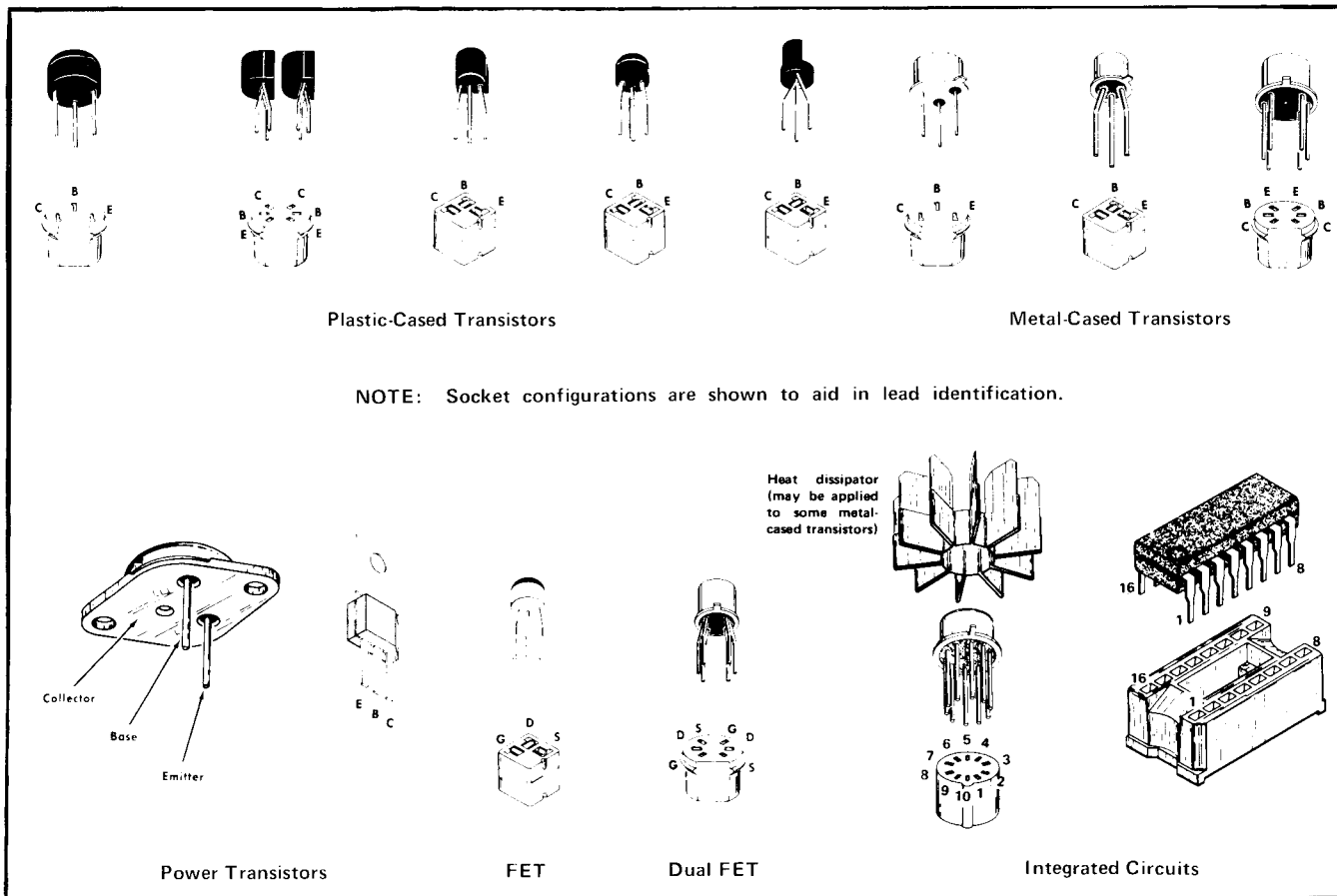


Fig. 4-1. Electrode configuration data for semiconductor devices.

SECTION 8

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

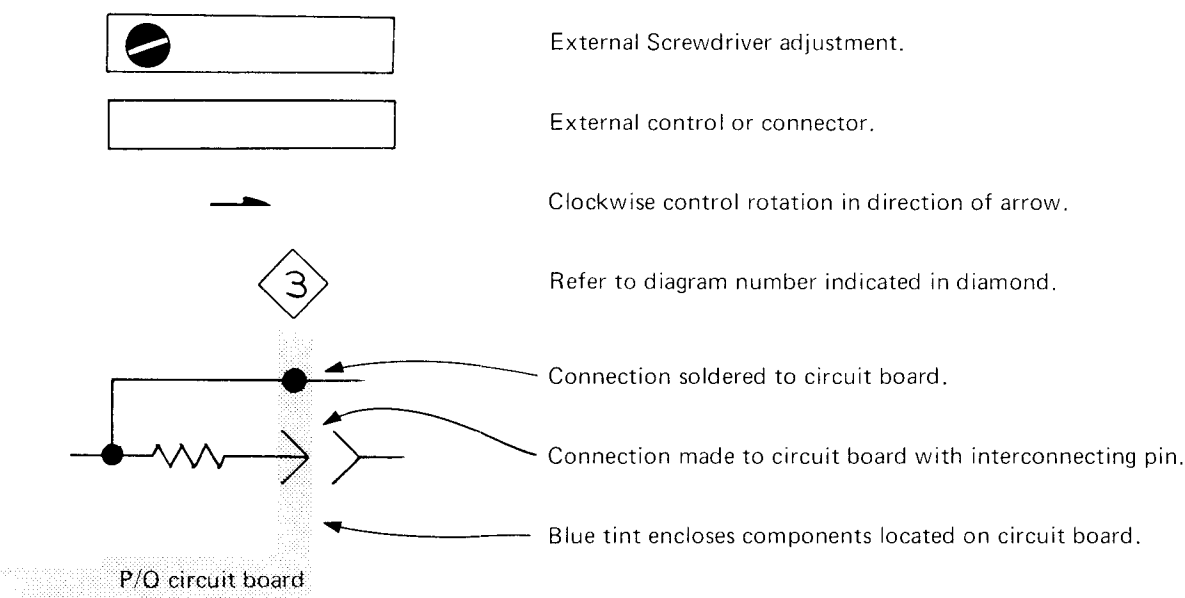
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors =	Values one or greater are in picofarads (pF).
	Values less than one are in microfarads (μF).
Resistors =	Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



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.)	LR	Inductor/resistor combination
AT	Attenuator, fixed or variable	M	Meter
B	Motor	Q	Transistor or silicon-controlled rectifier
BT	Battery	P	Connector, movable portion
C	Capacitor, fixed or variable	R	Resistor, fixed or variable
CR	Diode, signal or rectifier	RT	Thermistor
DL	Delay line	S	Switch
DS	Indicating device (lamp)	T	Transformer
F	Fuse	TP	Test point
FL	Filter	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
H	Heat dissipating device (heat sink, heat radiator, etc.)	V	Electron tube
HR	Heater	VR	Voltage regulator (zener diode, etc.)
J	Connector, stationary portion	Y	Crystal
K	Relay		
L	Inductor, fixed or variable		

Semiconductor Lead Configuration. Fig. 4-1 shows the lead configuration of the semiconductor devices used in this instrument.

Multi-Connector Holders. The multi-connector holder is keyed with two triangles, one on the holder and one on the circuit board. When a connection is made perpendicular to a circuit board surface, the orientation of the triangle and the slot numbers on the connector holder is determined by the direction of the nomenclature marking (see Fig. 4-2).

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 5100-Series Oscilloscope and its plug-in units:

1. Semiconductor Tester

Description: Dynamic-type tester.

Purpose: To test the semiconductors used in this instrument system.

Recommended type: Tektronix Type 576 Transistor Curve Tracer or equivalent.

2. Multimeter

Description: VTVM, 10-megohm input impedance and 0 to 300 volts range, AC and DC; ohmmeter, 0 to 50 megohms. Accuracy, within 3%. Test probes must be insulated to prevent accidental shorting.

Purpose: To check voltages and for general troubleshooting in this instrument system.

NOTE

A 20,000 ohms/volt VOM can be used to check the voltages in this instrument if allowances are made for the circuit loading of the VOM at high-impedance points.

3. Test Oscilloscope

Description: Frequency response, DC to 2 megahertz minimum; deflection factor, 1 millivolt/division to 5 volts/division. A 10X, 10-megohm voltage probe should be used to reduce circuit loading for voltage measurements.

Purpose: To check operating waveforms in this instrument.

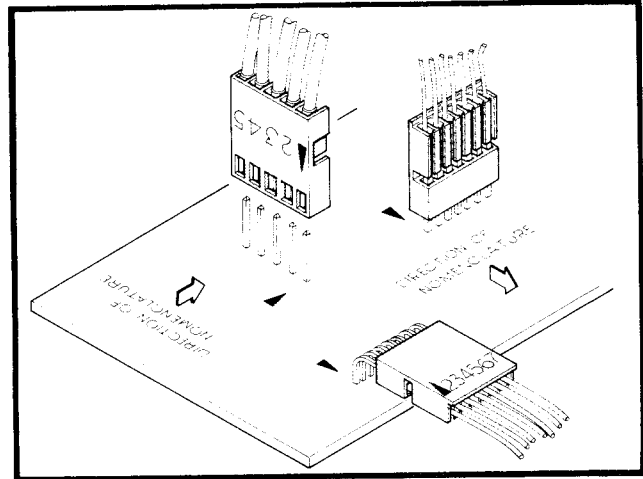


Fig. 4-2. Multi-connector holder orientation.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. When a defective component is located, it should be replaced following the replacement procedure given under Component Replacement.

1. Check Control Settings. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the operating instructions section of the manual for the instrument involved.

2. Check System and Associated Equipment. Before proceeding with troubleshooting of the 5100 system, check that the instruments in the system are operating correctly. Check for proper interconnection between the display unit and the power supply/amplifier unit. Check that the signal is properly connected and that the interconnecting cables or signal source are not defective. Also, check the power source. The associated plug-in units can be checked for proper operation by substituting other units which are known to be operating properly (preferably of the same types), or by interchanging plug-in units within the 5103N. If the trouble persists after substitution, the oscilloscope mainframe is probably at fault.

3. Visual Check. Visually check the portion of the instrument in which the trouble is suspected. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit board, damaged components, etc.

4. Check Instrument Calibration. Check the calibration of the 5100-Series Oscilloscope and its associated plug-ins, or check the affected circuit if the trouble appears in one circuit. The apparent trouble may only be a result of misadjustment or may be corrected by calibration. Complete calibration instructions are given in the calibration section of the manual for each instrument in the system.

5. Isolate the Trouble to a Circuit. To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. For example, poor focus indicates that the CRT circuit (includes high-voltage supplies) is probably at fault. When trouble symptoms appear in more than one circuit, check affected circuits by taking voltage and waveform readings.

Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltage of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits. Table 4-1 lists the tolerances of the power supplies in this instrument. These voltages are measured between the power-supply test points and ground on the Power Supply circuit board (see Fig. 5-1 in the calibration section of this manual for test point locations). If a power-supply voltage is within the listed tolerance, the supply can be assumed to be working correctly. If outside the tolerance, the supply may be misadjusted or operating incorrectly. Use the procedure given in the calibration section to adjust the power supplies.

TABLE 4-1
Power Supply Tolerances

Power Supply	Tolerance	Typical Ripple
+205 V	+180 V to +240 V	3 V or less
+30 V	+29.85 V to +30.15 V	3 mV or less
+5 V	+4.9 V to +5.1 V	2 mV or less
-30 V	-29.925 V to -30.075 V	2 mV or less

6. Check Voltages and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the first diagram page.

7. Check Individual Components. The following methods are provided for checking the individual components in the 5100-series instrument system. Components which are soldered in place are best checked by disconnecting one end, isolating the measurement from the effects of surrounding circuitry.

A. TRANSISTORS and INTEGRATED CIRCUITS



Power switch must be turned off before removing or replacing semiconductors.

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

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

B. DIODES

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



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

ELECTRICAL PARTS LIST-TYPE 5103N

A2 POWER SUPPLY Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description		
Resistors (cont)					
R861	307-0301-00		120 Ω	10 W	5%
R863	316-0273-00		27 k Ω	1/4 W	
R865	315-0131-00	B010100 B039999	130 Ω	1/4 W	5%
R865	315-0301-00	B040000	300 Ω	1/4 W	5%
R867	315-0621-00		620 Ω	1/4 W	5%
R868	315-0101-00		100 Ω	1/4 W	5%
R869	315-0392-00		3.9 k Ω	1/4 W	5%
R870	315-0562-00		5.6 k Ω	1/4 W	5%
R872	316-0221-00		220 k Ω	1/4 W	
R873	316-0102-00		1 k Ω	1/4 W	
R875	315-0101-00		100 Ω	1/4 W	5%
R877	321-0256-00		4.53 k Ω	1/8 W	Prec 1%
R878	311-1124-00		250 Ω , Var		
R879	321-0202-00		1.24 k Ω	1/8 W	Prec 1%
R880	316-0272-00		2.7 k Ω	1/4 W	
R881	315-0562-00		5.6 k Ω	1/4 W	5%
R883	316-0102-00		1 k Ω	1/4 W	
R885	316-0153-00		15 k Ω	1/4 W	
R890	322-0686-03		7.23 k Ω	1/4 W	Prec 1/4%
R891	321-0097-03		100 Ω	1/8 W	Prec 1/4%

C. RESISTORS

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

D. CAPACITORS

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

8. Repair and Readjust the Circuit. Special techniques required to replace the components in this unit are given under Component Replacement. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced. Calibration of the affected circuit may be necessary.

REPLACEMENT PARTS

Standard Parts

All electrical and mechanical part replacements for the 5100-series oscilloscope system can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts lists for value, tolerance, rating, and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the instrument performance.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These special parts are indicated in the parts list by an asterisk preceding the part number. Most of the mechanical parts used in this system have been manufactured by Tektronix. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., refer to the Parts Ordering Information and Special Notes and Symbols on the page immediately preceding each electrical parts list section. Include the following information:

1. Instrument Type (5103N, D10, 5A15N, etc.)
2. Instrument Serial Number
3. A description of the part (if electrical, include the circuit number)
4. Tektronix Part Number

COMPONENT REPLACEMENT

General

The exploded-view drawings associated with the mechanical parts lists (pullout pages) may be helpful when disassembling or re-assembling individual components or sub-assemblies.

Circuit Board Replacement

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

To remove or replace a board, proceed as follows:

1. Disconnect all leads connected to the board (both soldered lead connections and solderless pin connections).
2. Remove all screws holding the board to the chassis or other mounting surface. Some boards may be held fast by plastic mounting clips around the board edges (for example, the H.V. board in the display modules). For these, push the mounting clips away from the circuit board edges to free the board. Also, remove any knobs, etc., that would prevent the board from being lifted out of the instrument.
3. Lift the circuit board out of the unit. Do not force or bend the board.

ELECTRICAL PARTS LIST-TYPE 5103N

A2 POWER SUPPLY Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
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Transistors (cont)

Q865	151-0341-00		Silicon	NPN	TO-106	2N3565
Q870	151-0220-00		Silicon	PNP	TO-18	2N4122
Q875	151-0301-00		Silicon	PNP	TO-18	2N2907
Q885	151-0341-00		Silicon	NPN	TO-106	2N3565
Q890	151-0341-00		Silicon	NPN	TO-106	2N3565

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R810	302-0150-00	15 Ω		1/2 W		
R812	304-0683-00	68 k Ω		1 W		
R815	308-0685-00	1.5 Ω		1 W	WW	
R816	321-0215-00	1.69 k Ω		1/8 W	Prec	1%
R818	321-0289-00	10 k Ω		1/8 W	Prec	1%
R820	315-0473-00	47 k Ω		1/4 W		5%
R822	316-0681-00	680 Ω		1/4 W		
R824	316-0822-00	8.2 k Ω		1/4 W		
R826	315-0101-00	100 Ω		1/4 W		5%
R827	315-0242-00	2.4 k Ω		1/4 W		5%
R830	315-0104-00	100 k Ω		1/4 W		5%
R832	315-0473-00	47 k Ω		1/4 W		5%
R834	315-0183-00	18 k Ω		1/4 W		5%
R841	307-0300-00	150 Ω		10 W		5%
R842	308-0686-00	2.2 Ω		1 W	WW	5%
R846	316-0391-00	390 Ω		1/4 W		
R847	315-0183-00	18 k Ω		1/4 W		5%
R850	316-0823-00	82 k Ω		1/4 W		
R851	302-0333-00	33 k Ω		1/2 W		
R852	316-0681-00	680 Ω		1/4 W		
R853	315-0103-00	10 k Ω		1/4 W		5%
R857	321-0268-00	6.04 k Ω		1/8 W	Prec	1%
R858	311-1120-00	100 Ω , Var				
R859	321-0268-00	6.04 k Ω		1/8 W	Prec	1%
R860	308-0686-00	2.2 Ω		1 W	WW	5%

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

Transistor and Integrated Circuit Replacement

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



POWER switch must be turned off before removing or replacing semiconductors.

Replacement semiconductors should be of the original type or a direct replacement. Fig. 4-1 shows the lead configuration of the semiconductors used in this instrument system. When removing soldered-in transistors, use a suction-type de-soldering tool to remove the solder from the holes in the circuit board.

An extracting tool should be used to remove the 14- and 16-pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the IC. Try to avoid having one end of the IC disengage from the socket before the other end.

To replace one of the power transistors mounted on the chassis adjacent to the Power Supply circuit board, first unsolder the leads. Then, loosen the nuts on the plastic bar that clamps the transistor to the chassis. Remove the defective transistor. When replacing the transistor, use silicone grease on the metal tab to increase heat transfer from the transistor to the chassis.

Interconnecting Pin Replacement

NOTE

A pin replacement kit including necessary tools, instructions, and replacement pins is available from Tektronix, Inc. Order Tektronix Part No. 040-0542-00.

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

Switch Replacement

The following special maintenance information is provided for the cam-type switches and pushbutton switches used in this instrument system.



Repair of cam-type switches should be undertaken only by experienced maintenance personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance in maintenance of the cam-type switches, contact your local Tektronix Field Office or representative.

A. CAM-TYPE SWITCHES

NOTE

A cam-type switch repair kit including necessary tools, instructions, and replacement contacts is available from Tektronix, Inc. Order Tektronix Part No. 040-0541-00.

The cam-type switches consist of rotating cam drums which are turned by front-panel knobs, and sets of spring-leaf contacts mounted on adjacent circuit boards. The contacts are actuated by lobes on the cams. In the 5100-Series Oscilloscope system, the Volts/Div and Seconds/Div switches are of the cam type. These switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

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

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

ELECTRICAL PARTS LIST-TYPE 5103N

A2 POWER SUPPLY Circuit Board Assembly (cont)

Ckt No.	Grid Loc	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Semiconductor Device, Diodes						
CR810		*152-0107-00		Silicon	Replaceable by 1N647	
CR811		*152-0107-00		Silicon	Replaceable by 1N647	
CR812		*152-0107-00		Silicon	Replaceable by 1N647	
CR813		*152-0107-00		Silicon	Replaceable by 1N647	
CR815		152-0488-00		Silicon	Rectifier Bridge 200 V, 1.5 A	
CR820		152-0066-00		Silicon	1N3194	
CR824		152-0141-02		Silicon	1N4152	
CR835		*152-0107-00		Silicon	Replaceable by 1N647	
CR836		*152-0107-00		Silicon	Replaceable by 1N647	
CR837		152-0488-00		Silicon	Rectifier Bridge 200 V, 1.5 A	
CR841		152-0066-00		Silicon	1N3194	
CR842		152-0066-00		Silicon	1N3194	
CR850		*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR850		152-0141-02	B050000		Silicon	1N4152
CR851		*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR851		152-0141-02	B050000		Silicon	1N4152
CR860		152-0066-00		Silicon	1N3194	
CR865		152-0141-02		Silicon	1N4152	
CR870		*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR870		152-0141-02	B050000		Silicon	1N4152
CR875		*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR875		152-0141-02	B050000		Silicon	1N4152
CR885		*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR885		152-0141-02	B050000		Silicon	1N4152
VR850		152-0357-00		Zener	1N983B	400 mW, 82 V, 5%
VR865		152-0243-00		Zener	1N965B	400 mW, 15 V, 5%
VR870		152-0227-00		Zener	1N753A	400 mW, 6.2 V, 5%
Fuses						
F201		159-0019-00		1 A	3AG	Slw-Blo
F810		159-0028-00		1/4 A	3AG	Fast-Blo
F835		159-0025-00		1/2 A	3AG	Fast-Blo
Transistors						
Q820		151-0341-00		Silicon	NPN	TO-106 2N3565
Q825		151-0341-00		Silicon	NPN	TO-106 2N3565
Q845		151-0341-00		Silicon	NPN	TO-106 2N3565
Q850		151-0190-00		Silicon	NPN	TO-92 2N3906

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

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

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

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

B. PUSHBUTTON SWITCHES

The pushbutton switches are not repairable and should be replaced as a unit if defective. Use a suction-type desoldering tool to remove solder from the holes in the circuit board when unsoldering the switches.

Cathode-Ray Tube Replacement

The following procedure outlines the removal and replacement of the cathode-ray tube. Refer to Fig. 4-3.

WARNING

Use care when handling a CRT. Protective clothing and safety glasses should be worn. Avoid striking it on any object which might cause it to crack or implode. When storing a CRT, place it in a protective carton or set it face down in a protected location on a smooth surface with a soft mat under the faceplate to protect it from scratches.

A. REMOVAL:

1. Remove the bezel assembly, which is held in place with two screws. (The bezel assembly includes a snap-in implosion shield.)

2. For storage CRT's (D11, D13), disconnect the storage-element cable connector from the Storage circuit board. For dual-beam CRT's (D12, D13), disconnect deflection leads from neck pins.

NOTE

The red and black wires entering the CRT shield are connected to the trace-rotation coil inside the shield.

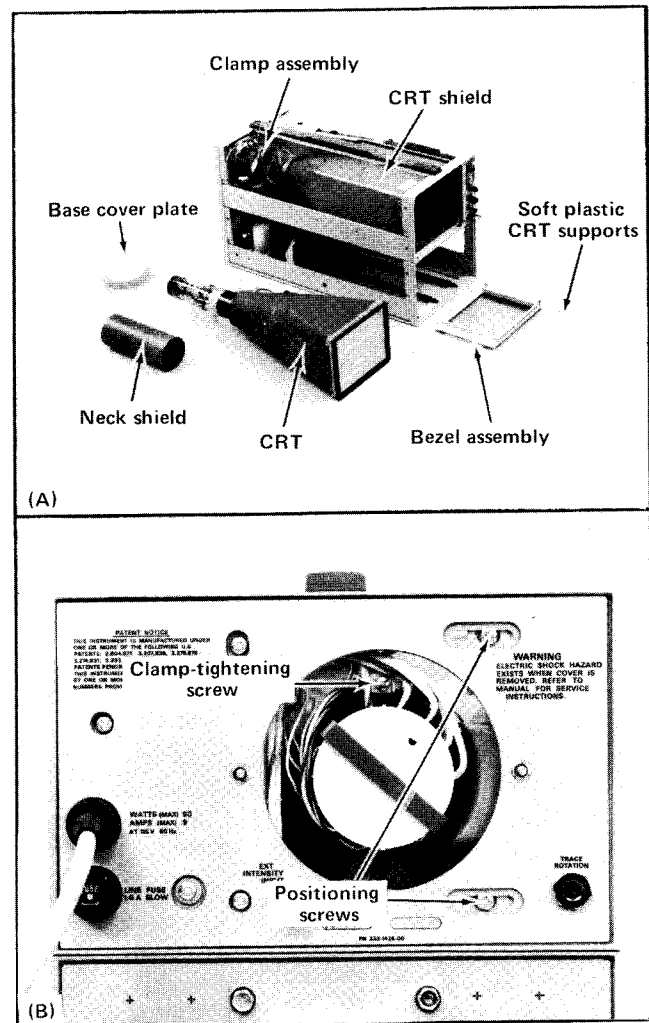


Fig. 4-3. Replacing the cathode-ray tube.

They will not hamper CRT removal and need not be unsoldered.

3. Remove the CRT base cover on the rear panel of the instrument.

4. Remove the CRT base socket.

5. Loosen the CRT clamp. The CRT and neck portion of the shield will be removed as a unit, and to facilitate removal, it may be best to remove all hardware from the CRT clamp (bracket and positioning screws, and clamp-tightening hardware).

6. With one hand on the CRT faceplate, push on the CRT base (and neck shield). Slide the CRT and neck shield forward, and at the same time feed the storage-element

ELECTRICAL PARTS LIST-TYPE 5103N

A1 INTERFACE Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Resistors (cont)				
R686	321-0222-00		2 k Ω	1/8 W Prec 1%
R687	315-0822-00		8.2 k Ω	1/4 W 5%
Integrated Circuit				
U640	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N

A2 POWER SUPPLY Circuit Board Assembly

*670-1339-00 Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C810	290-0511-00		250 μ F	Elect.	250 V	+75%-10%
C815	290-0510-00		6000 μ F	Elect.	15 V	+100%-10%
C820	290-0134-00		22 μ F	Elect.	15 V	
C822	281-0512-00		27 pF	Cer	500 V	10%
C830	285-0629-00		0.047 μ F	PTM	100 V	
C837	290-0509-00		3000 μ F	Elect.	50 V	+100%-10%
C839	290-0509-00		3000 μ F	Elect.	50 V	+100%-10%
C842	290-0175-00		10 μ F	Elect.	35 V	
C852	281-0550-00		120 pF	Cer	500 V	10%
C857	283-0003-00		0.01 μ F	Cer	150 V	
C860	290-0175-00		10 μ F	Elect.	35 V	
C865	281-0550-00	B010100 B039999	120 pF	Cer	500 V	10%
C865	281-0543-00	B040000	270 pF	Cer	500 V	10%
C870	290-0134-00		22 μ F	Elect.	15 V	
C872	281-0572-00		6.8 pF	Cer	500 V	± 0.5 pF
C875	283-0003-00		0.01 μ F	Cer	150 V	
C881	290-0267-00		1 μ F	Elect.	35 V	
C883	290-0267-00		1 μ F	Elect.	35 V	
C890	281-0549-00		68 pF	Cer	500 V	10%

System Maintenance—5103N

cable through the slot in the main portion of the CRT shield. Pull the CRT out of the instrument from the front, then remove the neck shield.

B. REPLACEMENT:

1. Slide the neck shield onto the CRT neck.
2. Make sure the soft plastic CRT faceplate supports are in place, then insert the CRT into the main shield while feeding the storage-element cable through the slot in the shield. Before the CRT is completely inserted, slide the CRT clamp over the neck shield.
3. With the CRT fully inserted and loose in the shield, mount the bezel assembly into place and tighten the bezel screws.
4. Mount the CRT clamp and positioning hardware, temporarily leaving it loose.
5. Position the rear of the CRT (socket end) so there is no tilt of the faceplate in relation to the bezel assembly. Tighten the positioning screws, then tighten the clamp hardware.
6. Place the CRT base socket onto the CRT base pins. Replace the cover. If applicable, connect the storage-element cable to the pin connectors on the Storage circuit board, and connect the deflection leads to the CRT neck pins.
7. Replacing the CRT will require partial instrument recalibration. Refer to the calibration section of the display unit manual.

Neon Bulb Replacement

To replace the knob-skirt deflection-factor readout bulbs, proceed as follows:

1. Remove the light shield.
2. Unsolder the defective bulb, and install its replacement.
3. Replace the light shield.

Power Transformer Replacement

Replace the power transformer only with a direct replacement Tektronix transformer. After the transformer has been replaced, check the power supply output voltages as outlined in the calibration section of this manual. Also, check the CRT operation as outlined in the calibration section of the display unit manual.

Fuse Replacement

Table 4-3 gives the rating, location, and function of the fuses used in this instrument system.

TABLE 4-1

Circuit Number	Rating	Function	Location
F20, F206	1/16 A Fast	Input Protection	5A20N/5A21N circuit board
F201	1.6 A Fast	Line-Voltage Input	Display unit rear panel
F810	0.25 A Fast	+205 V Unreg supply	5103N Power Supply board
F835	0.5 A Fast	+38 V Unreg supply	5103N Power Supply board

RECALIBRATION AFTER REPAIR

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. The Performance Check instructions in each manual provide a quick and convenient means of checking the instrument operation.

ELECTRICAL PARTS LIST-TYPE 5103N

A1 INTERFACE Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description	
Resistors (cont)				
R632	315-0273-00	27 k Ω	1/4 W	5%
R634	316-0103-00	10 k Ω	1/4 W	
R635	316-0102-00	1 k Ω	1/4 W	
R636	316-0103-00	10 k Ω	1/4 W	
R637	316-0102-00	1 k Ω	1/4 W	
R640	316-0562-00	5.6 k Ω	1/4 W	
R641	316-0561-00	560 Ω	1/4 W	
R642	316-0103-00	10 k Ω	1/4 W	
R643	316-0102-00	1 k Ω	1/4 W	
R650	315-0393-00	39 k Ω	1/4 W	5%
R651	316-0103-00	10 k Ω	1/4 W	
R652	315-0273-00	27 k Ω	1/4 W	5%
R656	321-0222-00	2 k Ω	1/8 W	Prec 1%
R657	315-0822-00	8.2 k Ω	1/4 W	5%
R659	316-0101-00	100 Ω	1/4 W	
R660	315-0393-00	39 k Ω	1/4 W	5%
R662	315-0273-00	27 k Ω	1/4 W	5%
R665	321-0159-00	442 Ω	1/8 W	Prec 1%
R666	321-0222-00	2 k Ω	1/8 W	Prec 1%
R667	315-0822-00	8.2 k Ω	1/4 W	5%
R669	316-0101-00	100 Ω	1/4 W	
R670	315-0393-00	39 k Ω	1/4 W	5%
R671	316-0331-00	330 Ω	1/4 W	
R672	315-0223-00	22 k Ω	1/4 W	5%
R675	311-1133-00	10 k Ω , Var		
R676	321-0222-00	2 k Ω	1/8 W	Prec 1%
R677	315-0822-00	8.2 k Ω	1/4 W	5%
R679	316-0101-00	100 Ω	1/4 W	
R680	315-0393-00	39 k Ω	1/4 W	5%
R681	316-0331-00	330 Ω	1/4 W	
R682	315-0223-00	22 k Ω	1/4 W	5%
R685	321-0159-00	442 Ω	1/8 W	Prec 1%

SECTION 5

CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section of this manual.

NOTE

This procedure facilitates checking and adjusting the Low-Voltage Power Supply ONLY. For complete oscilloscope mainframe calibration (plug-in interface, deflection amplifiers, CRT circuits, etc.), refer to the calibration procedure given in the manual for the display unit.

Services Available

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

Equipment Required

For power-supply calibration, proper loading must be established to ensure correct operation and regulation of the low-voltage supplies. For best results, the 5103N should be operated with a display unit and plug-in units because this provides actual operating-condition loads for the supplies.

For measurement of the supply voltages, a precision DC voltmeter is required. The voltmeter must have an accuracy of within $\pm 0.1\%$, and a measurement range from about -35 volts to $+250$ volts. For example, a Fairchild Model 7050 Digital Multimeter, a Tektronix 7D13 Digital Multimeter (operated with a Tektronix 7000-Series Readout Oscilloscope), or any DC voltmeter meeting the listed requirements may be used.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to $+50^{\circ}\text{C}$ range. Make any adjustments at a temperature of $+25^{\circ}\text{C}$, $\pm 5^{\circ}\text{C}$.

a. Remove the bottom dust cover of the 5103N to gain access to the power supply circuit board. If necessary, set the line-selector block in accordance with the line voltage source to be used (see Section 2, Operating Voltage, in this manual for complete instructions).

b. Connect the 5103N to the line voltage source. Turn the Intensity control on the display unit counterclockwise and pull the Power switch out to turn the instrument on.

c. Allow a 20 minute warm up time before performing the calibration procedure.

Location of the power-supply test points and calibration adjustments is shown in Fig. 5-1. Table 5-1 shows the tolerances of the low-voltage supplies.

TABLE 5-1

Supply	Tolerance
-30 V	-29.925 V to -30.075 V
$+5\text{ V}$	$+4.9\text{ V}$ to $+5.1\text{ V}$
$+30\text{ V}$	$+29.85\text{ V}$ to $+30.15\text{ V}$
$+205\text{ V}$	$+180\text{ V}$ to $+240\text{ V}$

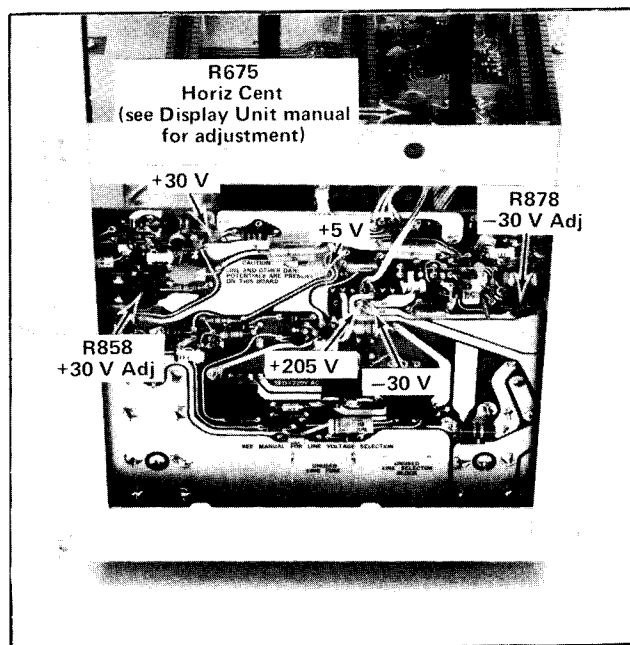


Fig. 5-1. Locations of power-supply test points and adjustment controls.

ELECTRICAL PARTS LIST-TYPE 5103N

AI INTERFACE Circuit Board Assembly (cont)

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Semiconductor Device, Diodes					
CR620	*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR620	152-0141-02	B050000		Silicon	1N4152
CR658	*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR658	152-0141-02	B050000		Silicon	1N4152
CR668	*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR668	152-0141-02	B050000		Silicon	1N4152
CR678	*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR678	152-0141-02	B050000		Silicon	1N4152
CR688	*152-0185-00	B010100	B049999	Silicon	Replaceable by 1N4152
CR688	152-0141-02	B050000		Silicon	1N4152

Connectors

J601	131-1078-00			Receptacle, electrical, 28/56 contacts	
J602	131-1078-00			Receptacle, electrical, 28/56 contacts	
J603	131-1078-00			Receptacle, electrical, 28/56 contacts	
J604	131-1043-00			Receptacle, electrical, 18/36 contacts	

Transistors

Q620	151-0190-00			Silicon	NPN	TO-92	2N3904
Q626	151-0190-00			Silicon	NPN	TO-92	2N3904
Q630	151-0341-00			Silicon	NPN	TO-106	2N3565
Q650	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q658	151-0220-00			Silicon	PNP	TO-18	2N4122
Q660	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q668	151-0220-00			Silicon	PNP	TO-18	2N4122
Q670	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q678	151-0220-00			Silicon	PNP	TO-18	2N4122
Q680	*151-0192-00			Silicon	NPN	TO-02	Replaceable by MPS6521
Q688	151-0220-00			Silicon	PNP	TO-19	2N4122

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R620	316-0102-00			1 k Ω	1/4 W	
R621	316-0222-00			2.2 k Ω	1/4 W	
R622	315-0223-00	B010100	B029999	22 k Ω	1/4 W	5%
R622	315-0163-00	B030000		16 k Ω	1/4 W	5%
R626	316-0102-00			1 k Ω	1/4 W	
R628	315-0223-00	B010100	B029999	22 k Ω	1/4 W	5%
R628	315-0183-00	B030000		18 k Ω	1/4 W	5%
R630	316-0474-00			470 k Ω	1/4 W	
R631	316-0332-00			3.3 k Ω	1/4 W	

Calibration—5103N

1. Power Supply Checks

a. Connect the precision DC voltmeter between each low-voltage test point and ground.

b. CHECK—Each supply is within the tolerance listed in Table 5-1.

2. Power Supply Voltage Adjustments

a. Connect the precision DC voltmeter between each test point (-30 V and $+30\text{ V}$) and ground.

b. ADJUST—R878, -30 V ADJ , and R858, $+30\text{ V ADJ}$, respectively, for voltmeter readings of exactly 30 volts.

This completes the Power Supply calibration for the 5103N.

SECTION 7 ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
CHASSIS						
Transistors						
Q815	151-0331-00	B010100	B070028	Silicon	NPN	G.E. Type "U" case Selected D40C5
Q815	151-0496-00	B070029		Silicon	NPN	
Q840	151-0331-00	B010100	B070028	Silicon	NPN	G.E. Type "U" case Selected D40C5
Q840	151-0496-00	B070029		Silicon	NPN	
Q860	151-0331-00	B010100	B070028	Silicon	NPN	G.E. Type "U" case Selected D40C5
Q860	151-0496-00	B070029		Silicon	NPN	
Transformer						
T801	*120-0692-00	B010100	B049999	Power	115 V	
T801	*120-0704-00	B050000		Power	115 V/230 V	
A1 INTERFACE Circuit Board Assembly						
	*670-1340-00			Complete Board		
Capacitors						
Tolerance $\pm 20\%$ unless otherwise indicated.						
C622	283-0032-00			470 pF	Cer	500 V 5%
C628	283-0060-00			100 pF	Cer	200 V 5%
C632	283-0002-00			0.01 μ F	Cer	500 V
C634	283-0060-00			100 pF	Cer	200 V 5%
C636	283-0060-00			100 pF	Cer	200 V 5%
C640	281-0519-00			47 pF	Cer	500 V 10%
C642	281-0519-00			47 pF	Cer	500 V 10%
C659	283-0000-00			0.001 μ F	Cer	500 V
C671	281-0593-00	B010100	B029999X	3.9 pF	Cer	500 V 10%
C679	283-0000-00			0.001 μ F	Cer	500 V

SECTION 6

RACKMOUNTING

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The R5100-Series Oscilloscope is designed for operation in a standard 19-inch wide rack which has Universal, EIA, RETMA, or Western Electric hole spacing. When properly mounted, this instrument will meet all electrical and environmental specifications given in Section 1.

Instrument Conversion

The 5100-Series Oscilloscope can quickly be converted from a bench model to a rackmount model, or vice versa. Field conversion kits, including the necessary tools, parts, and instructions are available from Tektronix, Inc. Order: 040-0583-00, Bench-to-rack conversion; 040-0584-00, Rack-to-bench conversion.

Mounting Method

This instrument will fit most 19-inch wide racks whose front and rear holes conform to Universal hole spacing. The slide-out tracks easily mount to the cabinet rack front and rear vertical mounting rails if the inside distance between the front and rear rails is within 10-9/16 inches to 24-3/8 inches. If the inside distance exceeds 24-3/8 inches, some means of support is required for the rear ends of the slide-out tracks (for example, make extensions for the rear mounting brackets).

Rack Dimensions

Height. At least 5-1/4 inches of vertical space is required to mount this instrument in a rack. If other instruments are operated in the rack, an additional 1/4 inch is required both above and below the R5100 to allow space for proper circulation of cooling air.

Width. A standard 19-inch wide rack may be used. The dimension of opening between the front rails must be at least 17-5/8 inches for a cabinet in which the front lip of the stationary section is mounted behind an untapped front rail as shown in Fig. 6-1A. If the front rails are tapped, and the stationary section is mounted in front of the front rail as shown in Fig. 6-2B, the dimension between the front rails should be at least 17-3/4 inches. These dimensions allow room on each side of the instrument for the slide-out tracks to operate so the instrument can move freely in and out of the rack.

Depth. For proper circulation of cooling air, allow at least two inches clearance behind the rear of the instrument and any enclosure on the rack. If it is sometimes necessary or desirable to operate the R5100 in the fully extended position, use cables that are long enough to reach from the signal source to the instrument.

Installing the Slide-Out Tracks

General Information. The slide-out tracks for the instrument consist of two assemblies, one for the left side of the instrument and one for the right side. Each assembly consists of three sections. A stationary section attaches to the front and rear rails of the rack, the chassis section attaches to the instrument (and is installed at the factory), and the intermediate section fits between the other two sections to allow the instrument to fully extend out of the rack.

The small hardware components included with the slide-out track assemblies are used to mount the tracks to the vertical rack rails having this compatibility:

1. Front and rear rail holes must be large enough to allow inserting a 10-32 screw through the rail mounting hole if the rails are untapped (see Fig. 6-1A).
2. Or, front and rear rail holes must be tapped to accept a 10-32 screw if Fig. 6-1B mounting method is used. Note in Fig. 6-1B right illustration that a #10 washer (not supplied) may be added to provide increased bearing surface for the slide-out track stationary section front flange.
3. Front and rear rail holes must be located on Universal spacing; that is, the sequence for the hole spacing is 1/2 inch, 5/8 inch, 5/8 inch, 1/2 inch, etc.

Because of the above compatibility, there will be some small parts left over. The stationary and intermediate sections for both sides of the rack are shipped as a matched set and should not be separated. The matched sets of both sides including hardware are marked 351-0195-00 on the package. To identify the assemblies, note that the automatic latch and intermediate section stop is located near the top of the matched set.

Mounting Procedure. Use the following procedure to mount both sides. See Fig. 6-1 for installation details.

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 or model 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.

SPECIAL NOTES AND SYMBOLS

- | | |
|-----------------|---|
| ×000 | Part first added at this serial number |
| 00× | Part removed after this serial number |
| *000-0000-00 | Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components. |
| Use 000-0000-00 | Part number indicated is direct replacement. |

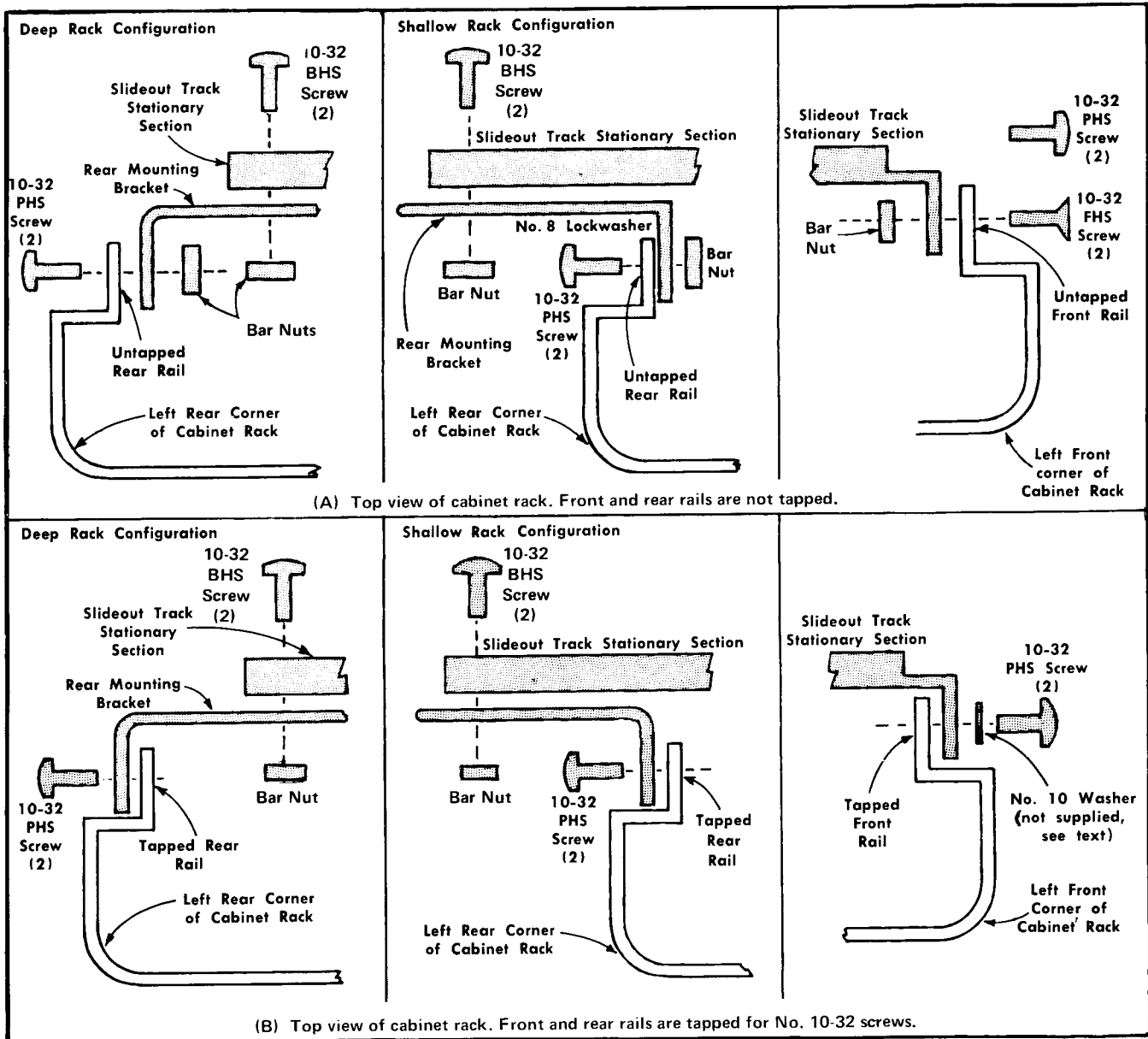


Fig. 6-1. Mounting the left stationary section (with its matched intermediate section, not shown in illustrations A and B) to the rack rails.

1. To mount the instrument directly above or below another instrument in a cabinet rack, select the appropriate holes in the front rack rails for the stationary sections, using Fig. 6-2 as a guide.

2. Mount the stationary slide-out track sections to the front rack rails using either of these methods:

(a) If the front flanges of the stationary sections are to be mounted behind the front rails (rails are countersunk or not tapped), mount the stationary sections as shown in Fig. 6-1A right illustration.

(b) If the front flanges of the stationary sections are to be mounted in front of the front rails (rails are tapped for

10-32 screws), mount the stationary sections as shown in Fig. 6-1B right illustration. To provide increased bearing surface for the screw head to securely fasten the front flange to the rail, a flat washer (not supplied) may be added under the screw head. However, consider that when this mounting method is used, the front panel will not fit flush against the front rail because of the stationary section and washer thickness. If a flush fit is preferred, method 2 (a) should be used.

3. Mount the stationary slide-out sections to the rear rack rails using either of these methods:

(a) If the rear rack rail holes are not tapped to accept 10-32 machine screws, mount the left stationary section

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

RACK RAIL TYPES

ALTERNATE TYPE DRILLING 0.187 THICK MOUNTING RAIL	19 1/25 ±0.062 CABINET OPENING FOR 19" PANEL	UNIVERSAL TYPE DRILLING 0.125-0.187 THICK MOUNTING RAIL
16 3/32	17 7/85 CLEAR OPENING	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
1250 0.625	1250 0.500	
0.250-0.000 TOP B	0.250-0.000 TOP B	
0.250-0.000 BOTTOM	0.250-0.000 BOTTOM	
TAP # 10-32 NF-2	TAP # 10-32 NF-2	

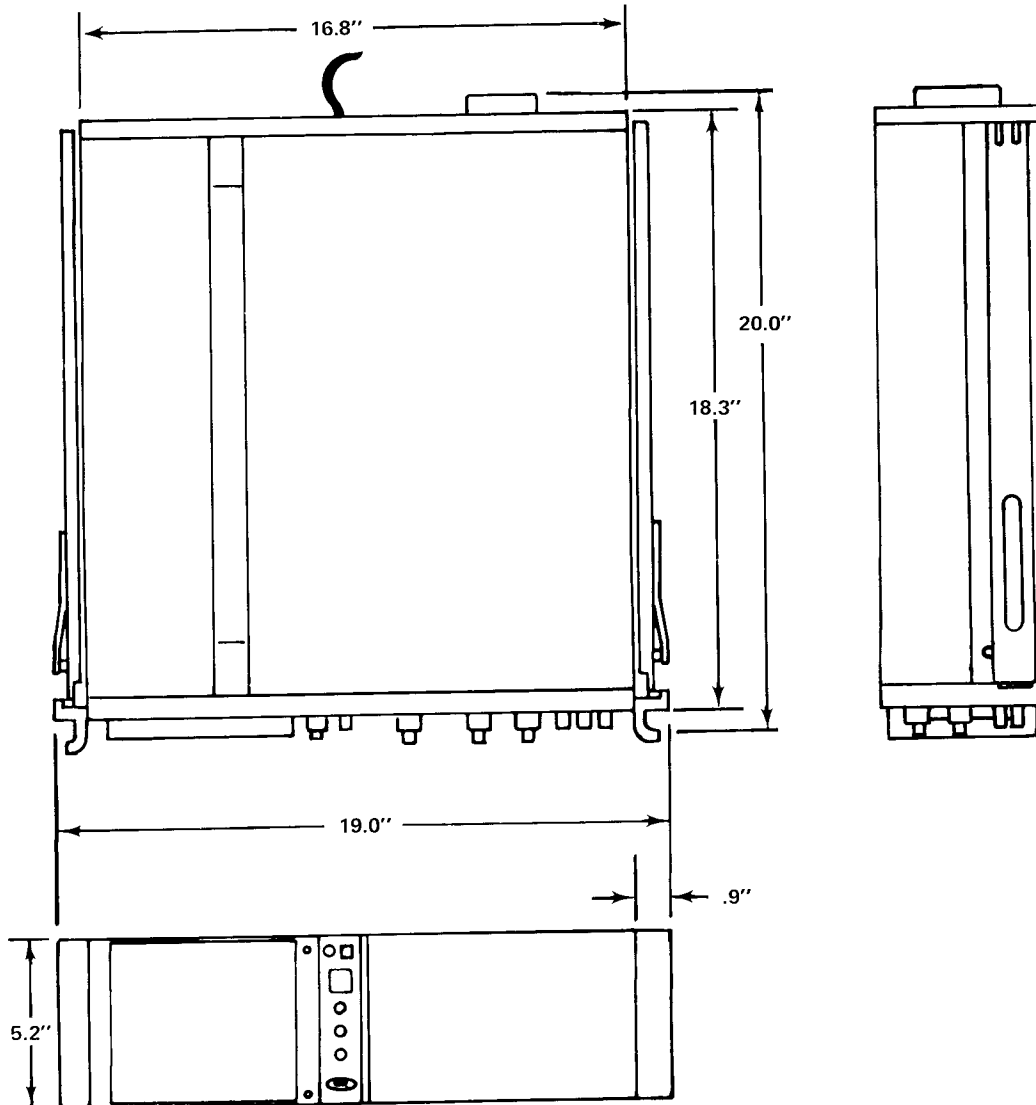
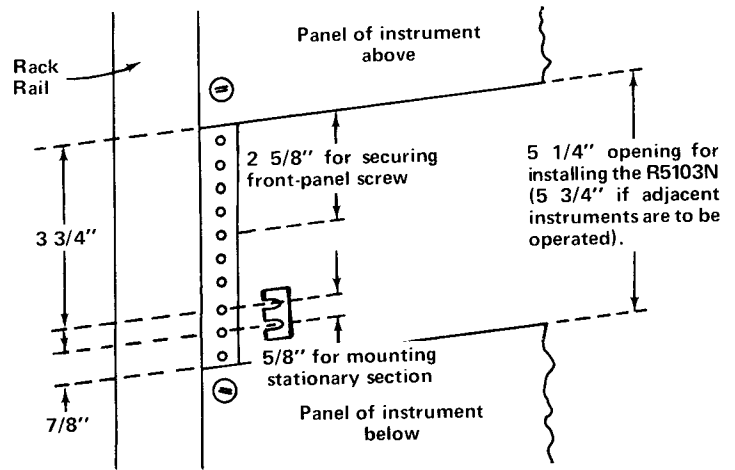


Fig. 6-2. Dimensional diagram.

Rackmounting—5103N

with hardware provided as shown in the left or center illustration of Fig. 3-1A. Note that the rear mounting bracket can be installed either way so the slide-out tracks will fit a deep or shallow cabinet rack. Use Fig. 3-1A as a guide for mounting the right stationary section. Make sure the stationary sections are horizontally aligned so they are level and parallel with each other.

(b) If the rear rack rail holes are tapped to accept 10-32 machine screws, mount the left stationary section with hardware provided as shown in the left or center illustration of Fig. 6-1B. Note that the rear mounting bracket can be installed either way so the slide-out tracks will fit a deep or shallow cabinet rack. Use Fig. 6-1B as a guide for mounting the right stationary section. Make sure the stationary sections are horizontally aligned so they are level and parallel with each other.

R5100 Installation and Adjustment

To insert the instrument into the rack, proceed as follows:

1. Pull the slide-out track intermediate sections out to the fully extended position.

2. Insert the instrument chassis sections into the intermediate sections.

3. Press the stop latches on the chassis sections and push the instrument toward the rack until the latches snap into their holes.

4. Again press the stop latches and push the instrument into the rack.

To adjust the slide-out tracks for smooth sliding action, loosen the screws used to join the stationary sections to the rails of the rack. Center the instrument, allowing the slide-out tracks to seek the proper width, then tighten the screws.

Maintenance

The slide-out tracks require no lubrication. The special dark gray finish on the sliding parts is a permanent lubrication.