

## ► Vertical Deflection System

The pre-amplifier of the vertical deflection system is an electronically switched dual-trace system. The characteristics and accuracy in the following description are applicable to both CH 1 and CH 2, unless otherwise specified.

### Deflection Sensitivity

Ten (10) calibrated ranges from 5 mV/cm to 5 V/cm are provided to ensure an optimum deflection sensitivity for any measurement. Variable attenuation is possible with the VARIABLE control which decreases the sensitivity by 1/2.5 (or more) of the calibrated value. Thus a low sensitivity of approximately 12.5 V/cm.

### Frequency Bandwidth

The bandwidth corresponding to the position of the AC-GND-DC switch is:

DC coupling	5 mV range	DC — 250 MHz	—3 dB
	Other ranges	DC — 300 MHz	—3 dB
AC coupling	5 mV range	3 Hz — 250 MHz	—3 dB
	Other ranges	3 Hz — 300 MHz	—3 dB

### Rise Time

5 mV range	1.4 nsec
	(nsec = $10^{-9}$ second)
Other range	1.2 nsec

### Frequency Bandwidth

50 MHz range	DC — 50 MHz	—3 dB
	(rise time 7 nsec)	
FULL range	DC — 300 MHz	—3 dB

### Square Wave Characteristics

The square wave characteristics differ somewhat depending on the position of the VOLTS/CM switch as shown in the following. The values shown are for an input square wave with a rise time of less than 300 psec.

VOLTS/CM switch in 5 mV, 10 mV position		Other positions	
Overshoot	3 % or less	Overshoot	5 % or less
Undershoot	2 % or less	Undershoot	3 % or less
Ringing	3 % or less	Ringing	2 % or less
Sag (at 1 MHz)	1 % or less	Sag (at 1 MHz)	1 % or less
Sag (at 60 Hz)	1 % or less	Sag (at 60 Hz)	1 % or less

### Signal Delay Time

Approximately 80 nsec.

### Input Signal Coupling Mode

Three (3) coupling modes, AC, DC and GND (to identify the ground potential on display) are available.

In the DC position, the input signal is coupled directly to the vertical amplifier and in the AC position, it is coupled through a blocking capacitor. Attenuation for the low AC frequency in the AC position is 3 dB at approximately 3 Hz.

### Input Impedance

Direct	1 megohm	shunted by 14 pF
With probe	10 megohm	shunted by approx. 8.5pF
	(10 : 1)	

### Maximum Input Voltage

500 V (DC + AC peak)

### Mode Selection

CH 1	CH 1 only
CH 2	CH 2 only
ALT.	Alternate sweep of CH 1 and CH 2
CHOP	Chopped switching (at approx. 1 MHz) of CH 1 and CH 2
ADDED	CH 1 ± CH 2

### Polarity Inversion

The polarity of the CH 2 display can be switched to NORM (normal) or INV (inverted).

### Common Mode Rejection Ratio

In the ADDED (CH 1 — CH 2) mode, CH 1 and CH 2 form a sort of differential input circuit. The common mode rejection ratio (CMRR) in this mode is more than 20 : 1 (for an input signal of 10 MHz).

### Linearity

When a signal displayed at the center of the CRT with a vertical amplitude of 20 mm is moved to the top or bottom of the horizontal graticule scale, the variation in the vertical amplitude of the display is within  $\pm 2\%$  ( $\pm 0.4$  mm).

### Drift

The drift, or vertical shift of a display with time is:  
 5 mm/hour — 5 mV range  
 3 mm/hour — other range  
 (When measured 15 minutes after the power is applied.)

## CH 2 OUT Signal

The input signal fed to the CH 2 input is amplified by five and is available at the CH 2 OUT terminal. The performance shown in Table 1-1 is obtained when the CH 2 OUT is connected to the CH 1 INPUT (cascade connection of CH 1 and CH 2), and both VOLTS/CM switches are in the 5 mV/cm positions with the VARIABLE control in the CALIB position.

Table 1-1

Item	Performance and Accuracy
Sensitivity	1 mV/cm $\pm 3\%$
Bandwidth	DC – 30 MHz –3 dB
Noise	5 mm p-p or less

## Internal Trigger Selection

To ensure stable triggering in internally triggered dual-trace measurements, the trigger signal can be selected from either CH 1 or CH 2.

## ► Horizontal Deflection System

The horizontal deflection system provides three functions.

Main sweep	(A sweep)
Delayed sweep	(B sweep)
External sweep	(XY scope)

### A Sweep Time (A TIME/CM)

Twenty-seven (27) calibrated sweep times from 10 nsec/cm to 5 sec/cm are available. Continuous variation of the sweep time is also possible by using the A VARIABLE control which reduces the rated sweep time by 1/2.5 times (or more). The slowest sweep time is 12.5 sec/cm (or more).

The accuracy of each sweep time with the VARIABLE control in the CALIB position is within  $\pm 3\%$  of the rated value.

### B Sweep Time (B TIME/CM)

Twenty-four (24) calibrated sweep times from 10 nsec/cm to 0.5 sec/cm the B TIME/CM VARIABLE control on the right side parallel functions similar to the A VARIABLE.

The accuracy of each TIME/CM position with the B TIME/CM VARIABLE control in the CALIB position is within  $\pm 3\%$  of the rated value.

## Sweep Linearity

The linearity of both the A and B sweeps at any position of the TIME/CM switch is within  $\pm 3\%$  of the rated value.

## Sweep Magnifier

The display can be magnified horizontally by 10 times.

## Maximum Sweep Time

1 nsec/cm

## Delay Time

A continuously variable sweep delay from 1  $\mu$ sec to 50 sec is available and by using the A VARIABLE control, the delay can be extended up to approx. 125 sec. When a calibrated delay time is not required, a delay time between 20 nsec and 0.5 usec is available.

## Delay Jitter

When the display is magnified by the delayed sweep, jitter is caused on the display. The amount of jitter is within 20000 : 1 which is determined by the ratio of A and B TIME/CM range.

## Single Sweep

Two single sweep modes, normal and delayed, are available.

## External Sweep

In order to sweep the horizontal axis with an external signal, the external signal may be fed to the CH 2 INPUT terminal of the vertical deflection circuit.

Performance is shown in Table 1-2.

Table 1-2

Item	Performance and Accuracy
Input Impedance	1 megohm shunted by 14 pF
Deflection Sensitivity	5 mV/cm – 5 V/cm (within $\pm 3\%$ of rated value of CH 2 VOLTS/CM switch when variable is positioned at CALIB) Continuously varied from 5 mV/cm to 12.5 V/cm with VARIABLE
Frequency Bandwidth	DC – 4 MHz within –3 dB
Bandwidth applicable to phase measurement	DC – 2 MHz (phase difference at 2 MHz : 3° or less)

## ► Triggering

Individual triggering is provided for each sweep; the A triggering for the A sweep and B triggering for the B sweep.

**— A Triggering —****Type of Trigger Signal Source**

4 positions      Internal (INT)  
                      External (EXT,  $\text{EXT} \div 10$ )  
                      Power Source (LINE)

Maximum Input Voltage       $\pm 5$  V (SOURCE switched to EXT)  
     $\pm 50$  V (SOURCE switched to  $\text{EXT} \div 10$ )  
 Maximum Peak Voltage      500 V (dc + ac peak or ac peak to peak)

**Slope**

+      (triggered by positive going slope of input signal)  
 -      (triggered by negative going slope of input signal)

**Triggering Frequency Range and Trigger Level**

The triggering frequency range and level are shown in Table 1-3.

**Auto and Normal Trigger Mode**

The A SWEEP MODE switch is used to select AUTO or NORMAL triggering mode of the A SWEEP. In the AUTO mode, the sweep circuit will not be triggered by signals below 50 Hz even if the COUPLING switch is set in the DC position. When a trigger signal is not present, the sweep will freerun. In the NORMAL trigger mode, the sweep can be triggered from DC. When a trigger signal is not present, only a spot will appear on the CRT.

**Trigger Input Coupling Mode**

Modes:              AC, LF REJ, HF REJ, and DC  
 Triggerable frequency range of each mode is shown in Table 1-3.

**— B Triggering —****Input Impedance and Maximum Input, Peak Voltage of External Trigger Signal Input Connector (TRIG INPUT)**

Input Impedance              1 megohm shunted by 20 pF or less

**Trigger Signal Sources**

Any one of four (4) triggering signal sources, i.e. INT, EXT,  $\text{EXT} \div 10$ , and LINE can be selected.

Table 1-3 Triggerable Frequency Range and Level of A Triggering

A SWEEP MODE	COUPLING	Triggerable Frequency Range	Trigger Level	
			Internal Trigger (display amplitude)	External Trigger (voltage)
NORM and AUTO	DC	DC — 20 MHz	4 mm or more	0.1 Vp-p or more
		20 MHz — 50 MHz	10 "	0.15 "
		50 MHz — 100 MHz	15 "	0.2 "
		100 MHz — 150 MHz	20 "	0.25 "
		150 MHz — 200 MHz	25 "	0.3 "
		200 MHz — 300 MHz	30 "	0.35 "
		300 MHz — 500 MHz	_____	0.4 "
	AC	30 Hz — 20 MHz	4 mm or more	0.1 Vp-p or more
		20 MHz — 50 MHz	10 "	0.15 "
		50 MHz — 100 MHz	15 "	0.2 "
		100 MHz — 150 MHz	20 "	0.25 "
		150 MHz — 200 MHz	25 "	0.3 "
		200 MHz — 300 MHz	30 "	0.35 "
		300 MHz — 500 MHz	_____	0.4 "
	LF REJ	50 kHz — 20 MHz	4 mm or more	0.1 Vp-p or more
		20 MHz — 50 MHz	10 "	0.15 "
		50 MHz — 100 MHz	15 "	0.2 "
		100 MHz — 150 MHz	20 "	0.25 "
		150 MHz — 200 MHz	25 "	0.3 "
		200 MHz — 300 MHz	30 "	0.35 "
		300 MHz — 500 MHz	_____	0.4 "
	HF REJ	30 Hz — 10 kHz	4 mm or more	0.1 Vp-p or more

Note: In the AUTO mode, input signals below 50 Hz will not trigger the sweep circuit even if the COUPLING switch is set to the DC position.

**Slope**

- + (Sweep is triggered by the positive going slope of the input signal), and
- (Sweep is triggered by the negative going slope of the input signal).

**Trigger Signal Input Coupling Mode**

Four types of trigger coupling modes are available: AC, LF REJ, HF REJ, and DC. The triggering frequency range of each mode is shown in Table 1–4.

**Input Impedance and Maximum Input, Peak Voltage of the External Trigger Signal Input Connector (TRIG INPUT).**

Input Impedance	1 megohm shunted by 20 pF or less
Maximum Input Voltage	±5 V (SOURCE switched to "EXT") ±50 V (SOURCE switched to "EXT ÷ 10")
Maximum Peak Voltage	500 V (dc + ac peak or ac peak to peak)

**Triggering Frequency Range and Trigger Level**

The triggering frequency range and level are shown in Table 1–4.

**► Signal Outputs****A GATE**

Positive square wave synchronized with A SWEEP, amplitude approx. 5 V p-p with a load of 100 kilohms or more.

Output resistance : 330 ohms

**B GATE**

Positive square wave synchronized with B SWEEP, amplitude approx. 5 V p-p with a load of 100 kilohms or more.

Output resistance : 330 ohms

**► Calibrator**

The calibration voltage is obtained from the CAL OUT connector. Characteristics of this output are shown in Table 1–5.

Table 1–5

Item	Characteristics and Accuracy	
Voltage	Square wave	5 mVp-p to 10 Vp-p in 11 steps, within ±2 %
Frequency	1 kHz ± 1 % or less	
Duty Ratio	49 : 51 or less	
Rise and Fall Time	Rise time	0.1 μsec or less
	Fall time	0.5 μsec or less

**Calibration Current**

The square wave current described in Table 1–6, flows through the current calibrator loop in the direction indicated by the arrow.

Table 1–6 Calibration Current Characteristics

Item	Characteristics and Accuracy	
Current	Square wave	5 mA p-p, within ±2 %
Frequency	1 kHz, within ± 1 %	

Table 1–4 Triggerable Frequency Range and Level of B Triggering

DLY'D (B) MODE	COUPLING	Triggerable Frequency Range	Trigger Level	
			Internal Trigger (display amplitude)	External Trigger (voltage)
TRIG'D	DC	DC — 20 MHz 20 MHz — 50 MHz 50 MHz — 100 MHz	4 mm or more 10 " 20 "	0.1 Vp-p or more 0.15 " 0.2 "
	AC	30 Hz — 20 MHz 20 MHz — 50 MHz 50 MHz — 100 MHz	4 mm or more 10 " 20 "	0.1 Vp-p or more 0.15 " 0.2 "
	LF REJ	50 kHz — 20 MHz 20 MHz — 50 MHz 50 MHz — 100 MHz	4 mm or more 10 " 20 "	0.1 Vp-p or more 0.15 " 0.2 "
	HF REJ	30 Hz — 10 kHz	4 mm or more	0.1 Vp-p or more

► Cathode Ray Tube Circuit

Cathode Ray Tube (CRT)

Type D13—500 GH/01, 5-inch rectangular type, parallax free, internally marked graticule.  
Effective  
Display Area 60 mm (vertical) x 100 mm (horizontal)

Acceleration Voltage

Approximately 15 kV

External Intensity Modulation

Minimum INT. MOD.  
VOLTAGE: +4 — +15 V  
Z AXIS INPUT  
Input Impedance: 15 kilohms shunted by 30 pF or less

► Power Requirements

Operating Range

By selecting an appropriate position of the LINE VOLTAGE switch located the rear panel, this instrument can be used with the line voltages (commercial power sources) shown in Table 1—7.  
(This model is normally supplied for use on 100 V sources. However, it can be modified easily for 200 V use when requested.)

Table 1—7 Operating Voltage

Source Voltage	Switch Position	Applicable Line Voltage Range
100 V	100 V	90 — 110 V
	115 V	105 — 126 V
200 V	200 V	180 — 220 V
	230 V	207 — 253 V

Line Frequency

50/60 Hz

Power Consumption

Approx. 150 W (at 100 V)

► Environmental Conditions

Temperature Range

The environmental temperature range for normal operation of this instrument is from —10°C to +50°C.

Humidity Range (Relative Humidity)

This instrument operates normally with a relative humidity of up to 90 % at 40°C.

Vibration

This instrument will operate normally after a vibration test wherein the instrument is subjected to vibrations with an amplitude of 1.5 mm peak-to-peak at 1000 cycles per minute along each of the three major axes for one hour.

Shock

Operation of this instrument is normal after three shock tests for each major axis.  
This can be performed by raising one edge of the equipment 5 cm above a rigid test bed (or, an incline of 30° degrees, maximum) and releasing it.

► Construction

External Dimensions

Approx. 215 mmW x 305 mmH x 485 mmL

Weight

Approx. 20 kg

Color

Front panel White aluminum  
Cabinet Munsell notation 5GY5/0.5 leather grain