INSTRUCTION MANUAL

OSCILLOSCOPE

MODEL 5530 GR

KIKUSUI ELECTRONICS CORP.

Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

WARNING

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

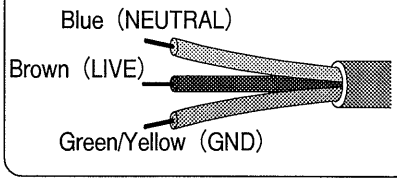
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

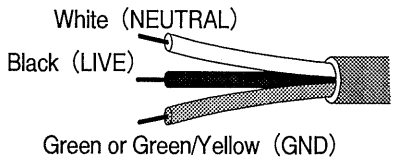
WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

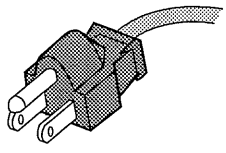
☐ Without a power plug



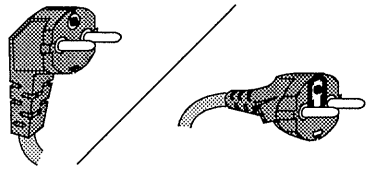
☐ Without a power plug



☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

 Kikusui Part No. Z9-000-027 IB001681

KIKUSUI

DUAL TRACE OSCILLOSCOPE MODEL 5530GR

This is a Dual Trace Oscilloscope replaced with a Internal Graticule Cathode Ray Tube (Non-illuminated).

Other specifications compare with those of model 5530.

(Text-contents and circuit diagram of this manual are explained as model 5530)

The graticule is a 1 div. = 1 cm and an illuminative graticule is supplied with this scope so as to be a great convenience for taking photos.

CHARACTERISTIC

* Employing Internal Graticule CRT (Non-illuminated)

  Black Color Internal Graticule is processed on the CRT and can be observed precisely with no parallax.

ACCESSORY SUPPLIED (ADDITIONAL)

Graticule ..... (S3-050-161) ... 1

HOW TO FIX THE GRATICULE

Take off screws which fix a bezel (4-position), and replace filter with graticule.

CONTENTS

1. GENERAL

1.1 General

MODEL 5530 Oscilloscope is a dual-channel wide-band oscilloscope with a 133 mm (5.24 in.) round mesh-type post accelrator CRT. The maximum sensitivity of the vertical axis is 1 mV/DIV (when in 5 x MAG operation) and the highest frequency response is 35 MHz. The oscilloscope can be switched to an X-Y mode in one-touch operation.

Regarding the trigger system, trigger sources are selectable independently for CH1 and CH2. The sweep time range is as wide as 0.5 sec ~ 0.2 µsec. The maximum sweep speed is 40 nsec/DIV (when in 5 x MAG operation).

The circuits employ IC's, thereby improving the operation reliability.

The oscilloscope is suitable for observation of various types of signals of analog circuits, digital circuits, etc.

1.2 Features

o o Delay line in vertical axis:

A delay line is incorporated in the vertical axis, thereby facilitating observation of rise-up section of fast pulse signal, etc.

o Full employment of IC's:

IC's are fully employed in the trigger circuit and time axis circuit which are cardinally important sections of the oscilloscope, ensuring smooth and stable triggering.

o Convenient trigger mode selection:

Four trigger modes of CH1, CH2, LINE, and EXTERNAL are possible. When oparated in the CH1 or CH2 trigger mode, the phase relation ship between the two vertical channels can be checked in an one-touch operation without requiring to change the connections of input connectors. With the LINE trigger mode, signals which are in certain relationships with the AC line frequency can be displayed stably.

o Single-sweep operation:

A single-sweep circuit also is incorporated. In combination with the DC-coupling circuit, the single-sweep circuit improves further the applicability of the oscilloscope.

o One-touch pushbuttons:

One-touch pushbuttons which ensure positive operations are fully employed. Especially, switching to the X-Y mode can be done simply by depressing a single one-touch pushbutton switch.

o Automatic CHOP/ALT switching:

When in the dual-channel operation, the sweep mode is automatically switched between CHOP mode and ALT mode being linked to the TIME/DIV selector switch -- in the CHOP mode when the sweep speed is 1 msec or lower or in the CHOP mode when the sweep speed is 0.5 msec or faster.

o Maximum sweep speed 40 nsec/DIV (when in 5 x MAG operation) :

In conjunction with the excellent performance of the trigger circuit, this fast sweep speed enables observation of high speed pulse signals.

o Clear trace at high sweep speeds:

When the zero level of the displayed waveform is required to be checked or when the slanting angle of the base line is required to be checked, such can done by grounding the input signal even when the sweep is at the maximum speed in the AUTO mode. The improved AUTO circuit ensures a bright but glickerless trace even at higher sweep speeds.

o Trace rotation coil:

A trace rotation coil is incorporated so that slanting of the base line due to terrestial magnetism or other external cause can be easily compensated for.

o Mesh-type post-accelerator CRT:

This CRT has a high beam penetration factor and displays bright and sharp traces.

1.3 Construction:

The instrument set consists of the following:

Oscilloscope (main unit)		1
Accessories	Parts code	
MODEL 960 BNC probe (10:1, 1:1) ..	(89-03-0220) ...	2
MODEL 942A terminal adapter	(W4-986-011) ...	1
Fuse (slow blow, 1 A)	(99-02-0101) ...	1
Fuse (slow blow, 0.5 A)	(99-02-0100) ...	1
Instruction manual	(Z1-560-020) ...	1

2. SPECIFICATIONS

Vertical Deflection

Item	Specification	Remarks
Sensitivity	5 mV/DIV ~ 5 V/DIV, 10 ranges 1 mV/DIV ~ 1 V/DIV (Note)	1-2-5 sequence
Sensitivity accuracy	Within ±3% of panel indicated value, with the variable control in CAL'D position	Whithin ±5% when in 5 x MAG operation
Frequency response	DC : DC ~ 35 MHz AC : 2 Hz ~ 35 MHz DC : DC ~ 10 MHz (Note) AC : 2 Hz ~ 10 MHz (Note)	Within -3 dB, with 50 kHz 8 DIV reference
Continuous sensitivity control	Can be attenuated 2.5 times or over of panel indicated value	
Rise time	10 nsec (35 MHz) 35 nsec (10 MHz) (Note)	
Input impedance	1 MΩ ±2%, 25 pF ± 2pF	Parallel
Input terminal	BNC type receptacle	
Maximum allowable input voltage	400 V	DC + AC peak, AC 1 kHz or less
Input couplin mode	AC and DC	
Trace shift by DC offset	0.2 DIV or less at 5 mV/DIV range	When switched between DC and GND
Trace shift by range switch	0.2 DIV or less when all ranges are switched	With AC/DC/GND in GND state
Trace shift by 5 x MAG	2 DIV or less when POSITION knob is PULL-PUSH operated	With AC/DC/GND in GND state

Item	Specification			Remarks
Linearity	When a 4 DIV signal at screen center is moved vertically for the full span of screen, change of signal in vertical amplitude is within ±0.2 DIV.			At frequency 100 kHz or lower, including linearity of CRT.
Signal delay time	Approx. 150 nsec			With delay cable
Common mode rejection	100 : 1 or over, at 50 kHz			With accuracies of CH1 and CH2 accurately set at the same value.
Isolation of the between CH1 and CH2	1000 : 1 or over with 100 kHz 8 DIV reference			When both CH1 and CH2 are set at 5 mV/DIV range; operated in DUAL mode with signal for effective full screen applied to one channel and the other channel terminated with 50 Ω.
Polarity	Polarity of CH2 alone can be inverted			
Operation modes of vertical channels	CH1	Channel 1 alone		
	CH2	Channel 2 alone		
	DUAL (automatic switching)	ALT	CH1 and CH2 are alternately swept.	ALT sweep for 0.5 msec~0.2 μsec
		CHOP	CH1 and CH2 are switched at approx. 200 kHz.	CHOP sweep for 0.5 sec ~ 1 msec
	ADD	CH1 ± CH2		

(Note): With the POSITION knob set in the PULL state. (5 x MAG Operation)

Horizontal deflection

Item	Specification	Remarks
Sweep time	0.2 µsec/DIV ~ 0.5 sec/DIV	20 ranges, 1-2-5 sequence
Sweep time accuracy	±3% or better	VARIABLE knob set in CAL'D position.
Continuous sweep time control	Controllable by 2.5 times or over of panel indicated value.	
Sweep magnification	5 times	
Magnification accuracy	0.5 sec/DIV ~ 1 µsec/DIV: ±3% 0.5 µsec/DIV ~ 0.2 µsec/DIV: ±5%	
Position shift caused by magnification	Within ±1 DIV at screen center	

Trigger

Item	Specification			Remarks
Trigger signal	INT	CH1	Triggered with CH1 signal	
		CH2	Triggered with CH2 signal	
	EXT	Triggered with external signal		
	LINE	Triggered with AC LINE signal		
Coupling	DC, AC, and HF REJ			
Polarity	"+" and "-"			

Item	Specification		Remarks
Internal trigger sensitivity	DC: DC ~ 10 MHz	0.5 DIV	In terms of amplitude on screen
	10 MHz ~ 35 MHz	1 DIV	
	AC: 5 Hz ~ 10 MHz	0.5 DIV	
	10 MHz ~ 35 MHz	1 DIV	
	HF REJ: DC ~ 50 kHz	0.5 DIV	
	DC: DC ~ 10 MHz	0.5 DIV	When vertical axis is in 5 x MAG operation
	AC: 5 Hz ~ 10 MHz	0.5 DIV	
	HF REJ: DC ~ 50 kHz	0.5 DIV	
External trigger sensitivity	DC: DC ~ 10 MHz	0.1 V	
	10 MHz ~ 35 MHz	0.2 V	
	AC: 5 Hz ~ 10 MHz	0.1 V	
	10 MHz ~ 35 MHz	0.2 V	
	HF REJ: DC ~ 50 kHz	0.1 V	
AUTO	Satisfies the specification of trigger sensitivity for signal with repetition frequency of 20 Hz or over.		When no trigger signal is applied, the sweep circuit operates in free-run mode.
NORM	Satisfies the specification of trigger sensitivity.		When no trigger signal applied, trace is in the standby state and not displayed.
SINGLE	Single sweep. The all trigger specification described above are satisfied. The trigger circuit is reset again with the RESET button.		The trigger circuit is ready to produce a sweep untill input signal is applied.
External trigger input impedance	Approx. 100 kΩ, 30 pF or less		Parallel
Input terminal	BNC type receptacle		
Maximum allowable input voltage	100 V (DC + AC peak)		AC 1 kHz

External sweep amplifier (X-Y)

Item	Specification	Remarks
System	X-Y system: CH1 for X CH2 for Y	X; Horizontal axis Y: Vertical axis
Sensitivity	X: 5 mV/DIV ~ 5 V/DIV Y: 5 mV/DIV ~ 5 V/DIV	10 steps, both X and Y
Frequency response	X: DC ~ 2 MHz Y: DC ~ 35 MHz	Within -3 dB
Input impedance	1 MΩ ±2%, 25 pF ± 2% , (X-Y) both X and Y	Parallel

Calibration voltage

Item	Specification	Remarks
Waveform	Square-wave	
Polarity	Positive	
Output voltage	1 V p-p	
Output voltage accuracy	± 3% or better	
Frequency	1 kHz ± 25%	
Duty ratio	45 : 55 or less	
Rise time	Approx. 150 nsec	
Output terminal	Hook terminal	

Z-axis amplifier

Item	Specification	Remarks
Intensity modulation	Intensity modulation discernible with 3 V p-p input signal. Trace becomes darker with positive input and becomes brighter with negative input.	
Frequency response	DC ~ 1 MHz	
Input resistance	Approx. 10 kΩ	
Input terminals	BNC type receptacle	

CRT

Item	Specification	Remarks
Type	133 mm (5.24 in.) round-type CRT, post accelerator	
Phosphor	B 31	
Acceleration voltage	Approx. 1400V / 4.2kV	Total acceleration voltage approx. 5.6 kV
Effective area	8 DIV x 10 DIV	* Note
Trace and graticule alignment	Adjustable by rotation coil. electrically	
Blanking	With G1	
Illumination	Brightness is continuous variable.	

* Note

Model 5530 : 1 DIV ≅ 9.5 mm (0.37 in)

Model 5530GR : 1 DIV = 10 mm (0.39 in)

Power requirement

Item	Specification	Remark
AC line voltage	100 V, 115 V, 215 V, 230 V (within ± 10% of each of these nominal voltages)	Selectable with plug located at rear panel
Frequency	50 Hz ~ 60 Hz	
Power consumption	Approx. 48 VA	

Mechanical specification

Item	Specification	Remarks
External dimensions	370 W × 165 H × 525 D mm (14.57W × 6.50H × 20.67D in.)	Handle in portable state
	370 W × 165 H × 460 D mm (14.57W × 6.50H × 18.11D in.)	Maximum dimensions
	370 W × 190 H × 460 D mm (14.57W × 7.48H × 18.11D in.)	Handle in case top position
	310 W × 150 H × 400 D mm (12.20W × 5.91H × 15.75D in.)	Cabinet dimensions
Weight	Approx. 9.5 kg (20.9 lb.)	Without accessory

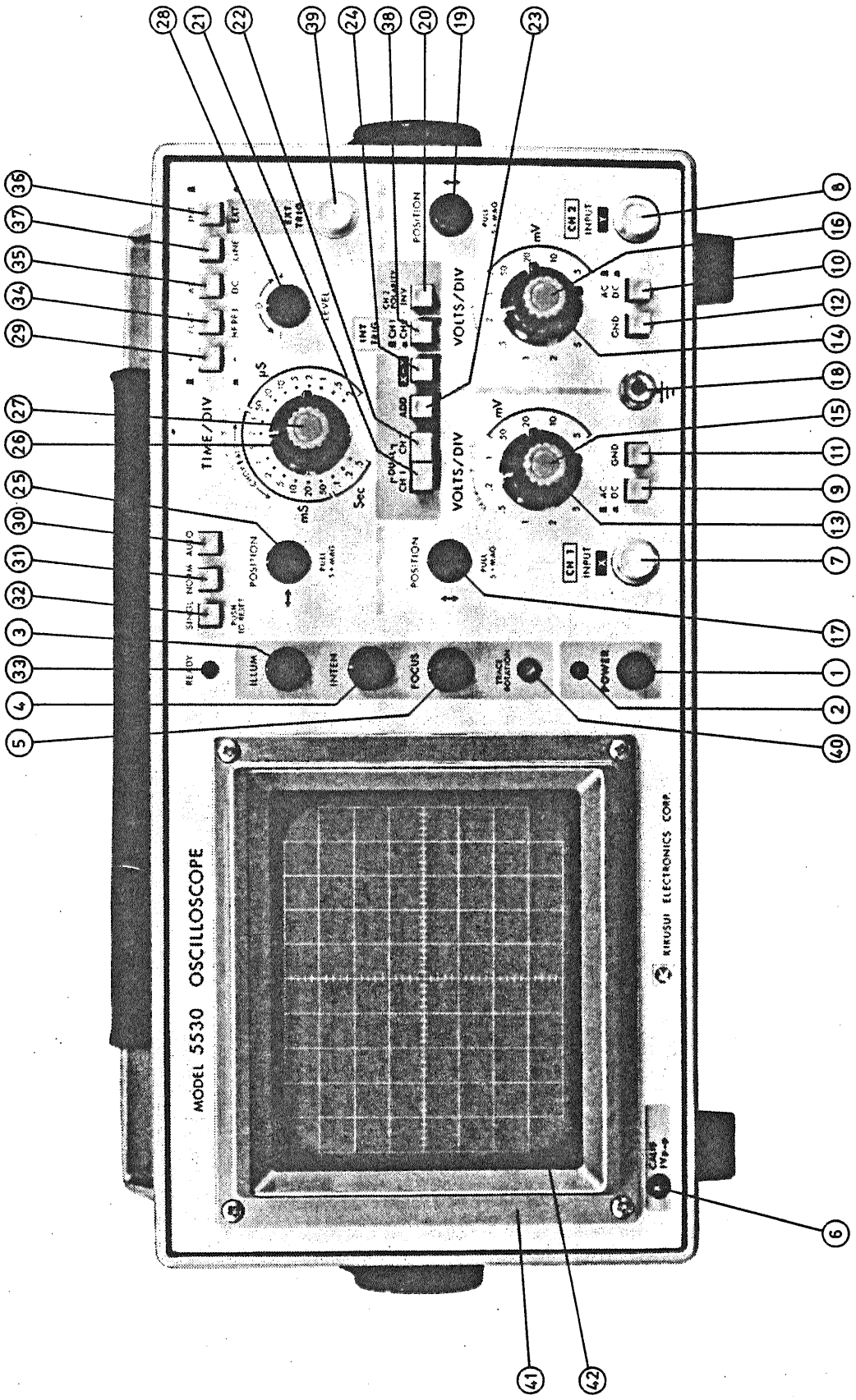

MODEL 5530 OSCILLOSCOPE
RIKUSUI ELECTRONICS CORP.
TIME/DIV
VOLTS/DIV
VOLTS/DIV
POSITION
POSITION
POSITION
LEVEL
ILLUM
INTEN
FOCUS
TRACE ROTATION
POWER
CH 1 INPUT
CH 2 INPUT
AC DC
GND
READY
CAL
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Fig. 1

3. OPERATION

3.1 Explanation of Front Panel (Fig. 1)

Function of the knobs, terminal and so on are explained in this section. Regarding the double-knobs, the function of the black knobs are displayed with black letters, and those of the red knobs are displayed with red letters.

① POWER — This is a push button switch for instrument power ON-OFF. Depressed and locked state is ON, pressed again and popped-up state is OFF.

② — This is a LED for power ON indicator. When power switch is ON state, the LED lights.

③ ILLUM — This knob is used for control of illumination of CRT screen scale. The screen is brightened with clockwise rotation and vice versa.

④ INTEN — This knob is used for trace brightness control. Trace brightness increases when this knob is turned clockwise, and vice versa.

⑤ FOCUS — In conjunction with ASTIG control (internal semi-fixed resistor), this knob should be so adjusted that the spot or trace displayed on CRT screen is made most well-defined.

⑥ CALLIB(Vp-p) — These terminals provide a square-wave signal for sensitivity calibration and probe phase adjustment. Its frequency is approximately 1 kHz, and its output voltage is 1 Vp-p. The signals are available at the chip terminals on the front panel.

Vertical Deflection

The functions of controls and terminals of CH1 and CH2 are identical. The explanation on CH1 is directly applicable to CH2 also.

⑦CH1 (X) ⑧CH2 (Y)

These are vertical input terminals and they also used as terminals for X-Y operation input terminal. Terminals are BNC receptacles, and also used when the probe are used.

⑨⑩ AC DC

This is a push button switch for selection of input coupling of vertical input signal. Input coupling is DC coupling when the button is returned in upper position. On AC coupling, if the input signal includes a DC component, it is blocked, and the AC component alone is measured. On DC coupling, all component of a input signal is measured.

⑪ ⑫ GND

When GND terminal is depressed, the input signal is disconnected from the vertical amplifier at the INPUT terminal (BNC type terminal). The amplifier input is connected to the ground. By depressing the GND push button, the zero volts level of the trace displayed on the CRT screen can be readily checked.

⑬ ⑭ VOLTS/DIV

The black knob is used for selection of vertical deflection sensitivity, covering 5 mV/DIV to 5 V/DIV in 10 ranges. The value of each switch position indicates the voltage sensitivity per 1 DIV of vertical deflection on CRT screen with the variable knob turned to the extermely clockwise position (CAL'D position).

⑮ ⑯ VAR ◀▼CAL'D

This knob is used for continuously variable attenuation of the input signal, and VAR means variable. When the knob is turned to the extermely counterclockwise position, the signal is attenuated to approximately 1/2.5 . The letters of CAL'D mean that the sensitivity of the vertical amplifier is calibrated for the red knob on CAL'D position, when the red knob is turned fully clockwise.

⑰ ⑲ POSITION ↕

This knob is used for vertical positioning of the spot or trace displayed on the CRT screen.
When turning it clockwise the spot or trace shifts upward.
It shifts downward by counterclockwise rotation.

⑱ GND (terminal) This terminal is electrically connected to panel, chassis and case. . (Both of CH1 and CH2)

⑳ CH2 POLARITY INV  This push button switch is used for 180° phase inversion of input signal of CH2. The phase is inverted on depressed state.

The function explaind above, except GND and POLARITY, are identical for both CH1 and CH2.

This interlocking switch with four units selects the operating modes of amplifiers of CH1 and CH2 as below.

㉑ CH1 The vertical amplifier of CH1 operates alone, and the MODEL 5530 operates as a single-channel oscilloscope.

㉒ CH2 The vertical amplifier of CH2 operates alone, and the MODEL 5530 operates as a single-channel oscilloscope.

㉑ ㉒ ┌DUAL┐ CH1 CH2 The vertical amplifier of CH1 or CH2 is operated by switching in the CHOP mode or ALT mode, by pushing both of the button CH1 and CH2, and the MODEL 5530 operates as a dual channel oscilloscope. The sweep circuit operates in the CHOP mode for ranges from 0.5s/DIV to 1ms/DIV and in the ALT mode for ranges from 0.5mS/DIV to 0.2μs/DIV.

㉓ ADD Signals applied to the CH1 OR X and CH2 OR Y connectors are algebraically added and the sum is displayed on the CRT. The INVERT switch ⑳ in Channel 2 allows the display to be CH1 + CH2 or CH1 - CH2.

㉔ X-Y This button is used for an external sweep by X-Y system. CH1 operates as X axis (Horizontal), and CH2 operates as Y axis (Vertical). The frequency range of X axis is DC ~ 2MHz, -3dB.

Horizontal deflection

㉕ ↔ POSITION — For horizontal positioning of the spot or trace displayed on the CRT screen. It shifts rightward with clockwise turning, and vice versa.

PULL 5X MAG — The POSITION knob is used in common for this function also. As the knob is pulled out, the horizontal amplitude of the trace is magnified by a factor of 5 without shift of the trace. The center of expansion is the center of the graticule. On X-Y operation , the trace is not magnified.

㉖ TIME/DIV — A sweep time from 0.5s/DIV to 0.2μs/DIV in 20 ranges. The value of each position indicates the sweep time per 1 DIV of horizontal sweep under the state that the variable knob ㉗ (red) is turned to the extermely clockwise position (CAL'D position).

㉗ VAR ↙ ▼CAL'D — Sweep time is continuously variable by this red knib. The value is varied to approximately 1/2.5, when the knob is turned to the extermely counterclockwise position. The letters of CAL'D means that the sweep time is calibrated on the position that the red knob is turned fully clockwise.

㉘ LEVEL (0, −, +) — This knob is used for adjustment of trigger level. A point at where the sweep start on the trigger signal waveform is adjusted by this knob. Polarity of trigger level becomes positive when the knob is turned clockwise. It becomes negative by counterclockwise rotation.

㉙ + ▮ / − ▬ — This pull-push switch selects a slope of the trigger signal. The same knob is used, for trigger level adjustment. The trigger circuit is triggered on a positive-going slope, when the knob is pushed in the ▮ + state. It is triggered on a negative-going slope, when the knob is pulled in the ▬ − state.

㉚ AUTO

A sweep for time base free runs by depressing the push button switch. The trace line is displayed on the CRT screen without any measured signal. The circuit is triggered when a measured signal of 20Hz or over and of an amplitude of 0.5DIV or over as displayed on the CRT screen is applied.
(If the trigger level is within a range of the level of input signal, sweep is synchronized to a signal measured. A sweep free runs for the input signal level over the trigger level set.)

㉛ NORM

A sweep for time base is ready to sweep for no signal measured. A sweep is only produced and synchronized to input signal, when the trigger signal level is a range of 'peak to peak' value of the input signal.

㉜ SINGLE

This push button is used for a single sweep. The SINGLE button itself and the other buttons (the AOUT, the NORM) are recovered to the state before depressed by pushing the SINGLE button.

PUSH TO RESET

'SINGLE' explained before and 'PUSH TO RESET' are an identical switch. A sweep generator circuit is prepared for another single-sweep display by pressing the PUSH TO RESET button again, after one single sweep display have finished.

㉝ READY

The time axis is ready to produce a single sweep, when the READY LED lights.

㉞ FLAT ▙
HF REJ ▁

This push button switch is used for selecting the coupling state of trigger signal. A trigger signal from CH1, CH2, NORM and EXT is applied to the input with no modulation. In the HF REJ position, the high frequency component or noise superimposed on the signal measured of approximately 50kHz or over is attenuated before applying to the trigger input by inserting a low pass filter with cut off frequency of approximately 50kHz.

㉟ ▙ AC
▁ DC

This push button switch is used for selecting the coupling state of trigger signal. On the AC position, the DC component is cut off, and triggering is made with the AC component alone.
On the DC position, triggering is made with all component including DC component.

㊱ ▙ INT — Displayed signal (CH 1 or CH 2) are used as trigger signals. The trigger signal of CH 1 or CH 2 is selected with the push button switch ㊳ .

▁ EXT — A signal applied to the EXT TRIGGER IN terminal ㊴ operates as the trigger signal source.

㊳ — These push button select the type of trigger signal source as below.

▙ CH 1 — The measured signal of CH1 alone is used as the trigger signal. When CH2, DUAL or ADD is selected as vertical mode of operation, the signal applied to the CH1 operates as the trigger signal source.

▁ CH 2 — The measured signal of CH2 alone is used as the trigger signal. When CH1 ,DUAL or ADD is selected as vertical mode of operation, the signal applied to the CH2 operates as the trigger signal source.

㊲ LINE — When the LINE button ㊲ is pressed, triggering is effected in synchronization with the AC line frequency.
This mode of operation is especially advantageous for observation of a signal which has a certain time relationship with respect to the AC line frequency. If the triggering polarity ("+" or "−") dose not conform with that of the panel indication ㉙ , connect the AC plug in the reverse polarity.

㊴ EXT TRIG — Input terminal for external trigger signal.
The circuit is trigged by the input signal to this terminal, when the INT, EXT switch ㊱ is set in the EXT state.

㊵ TRACE ROTATION — Semi-fixed resistor for adjustment of horizontal incline of traces. Horizontal incline of terrestrial magnetism effects is adjusted.

㊶ — Bezel to which attachment for photography can be mounted by an action.

㊷ — Scale plate. Brightness of graticule line is adjustable by the ILLUM ③ knob.

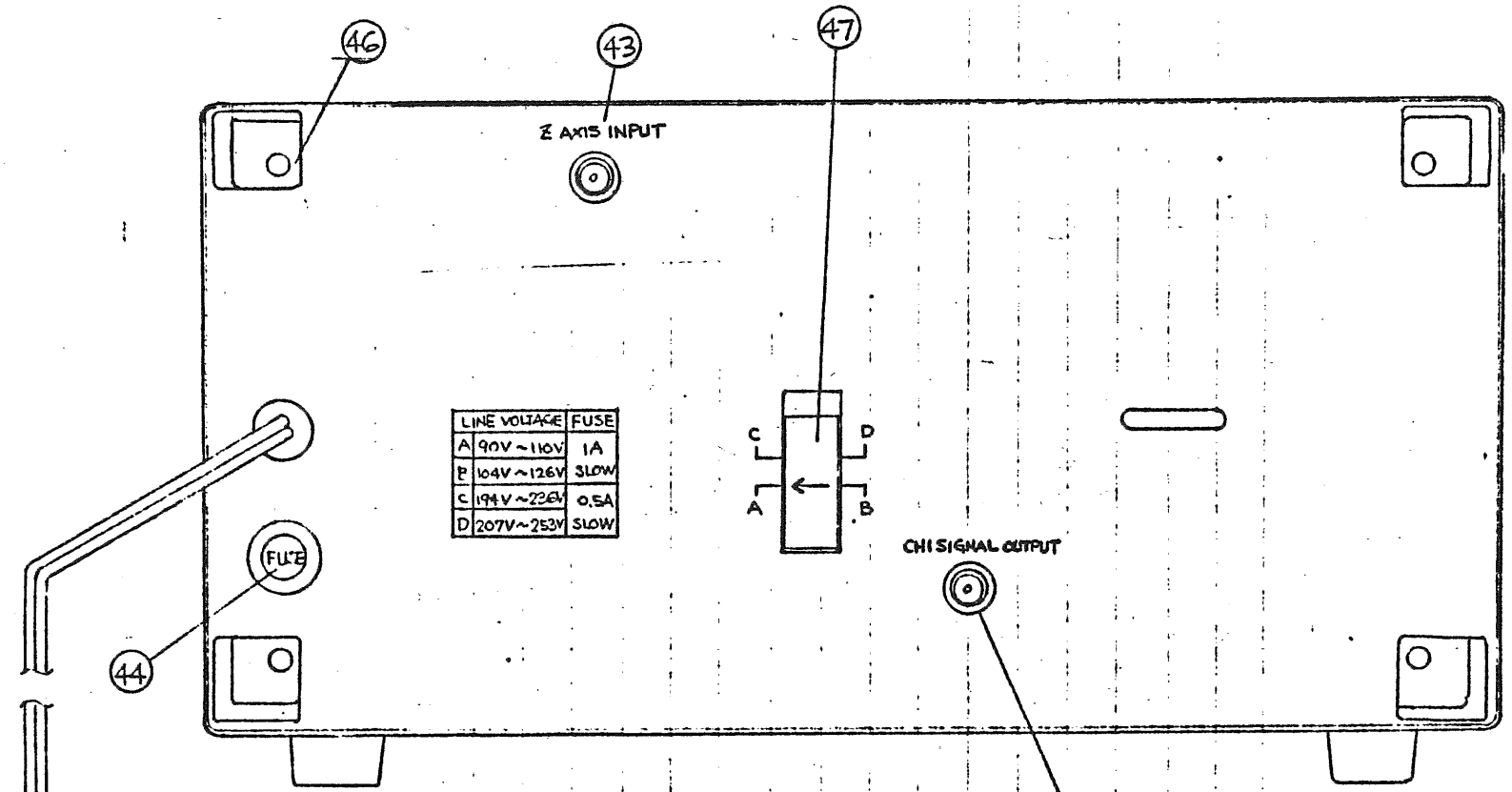


Fig 2

3.2 Explanation of Rear Panel (Fig. 2)

The Z AXIS INPUT terminal, the fuse holder, power cord, AC voltage selecting connector and so on are located on the rear panel.

Some of these name are printed on the rear panel.

(43)	Z AXIS INPUT	The input terminals for the intensity modulation input from an external signal source.
(44)	FUSE	Fuse holder. The fuse is 1 ampere slow blow type . and is removable by turnig the cap counterclockwise.
(45)		Power cord. The plug must be connected to power line of the specified voltage.
(46)		Cord winders combined with feet. They are used as feet, when the instrument is vertically stood.
(47)		The connector is for selecting the AC voltage of the instrument.

3.3 Caution on Operation

Supply line voltage

The MODEL 5530 can be operated safely under the fluctuating range of the specified voltage within ±10% in the specified supply line voltage.
If it is operated with the line voltage over ±10% of the specified voltage, malfunctioning or damage may result.
Operate the MODEL 5530 with the range of the voltage within ±10% in the specified supply line voltage with an appropriate means.

Ambient temperature

The ambient temperature range for normal operation is 0°C ~ 40°C (32°F ~ 104°F).

Environments

If the MODEL 5530 is operated for long period in high temperature and high humidity, troubles may be caused and the life may be shortened. Strong magnetic field or electromagnetic field also affects the measurement with the oscilloscope.

Brightness of the CRT

Do not make the trace excessively bright or do not leave a stationary spot for long period on the screen. The life may be shortened with such an operation.

Allowable voltage to the input terminal

The allowable maximum input voltage to the each input terminal and each probe are shown in the below table.
If a voltage exceeding the specified value is applied, the MODEL 5530 may be damaged.

The CH1 terminal and the CH2 terminal 5 mV range of VOLTS/DIV Other ranges of VOLTS/DIV	 400V (DC + ACpeak) 600V (DC + ACpeak)
Probe (960 BNC)	600V (DC + ACpeak)
EXT TRIG IN terminal	100V (DC + ACpeak)
Z AXIS IN terminal	100V (DC + ACpeak)

For the signal of the frequency of 1 kHz or below.

3.4 Change of Supply Line Voltage

Input line voltage is changeable, as some taps of transformer are provided for operation with line voltage exceeding 100V.

As an AC plug can be used with line voltage of 125V or below, it must be alternated to an appropriate with line voltage of 125 V or over.

Use a fuse shown in following Table.

Symbol	Center voltage	Operating voltage range	Fuse
A	100 V	90 ~ 110 V	1 A slow blow
B	115 V	104 ~ 126 V	
C	215 V	194 ~ 236 V	0.5 A slow blow
D	230 V	207 ~ 253 V	

4. OPERATION

Before turning on the power, set the controls on the front panel as follows.

①	POWER				OFF
④	INTEN				Approx. center
⑤	FOCUS				Approx. center
	CH1-CH2-ADD			㉑	The CH1 is depressed
	Trigger	㉘	LEVEL		Approx. center
		㉞	FLAT-HF REJ		FLAT
		㉟	AC-DC		AC
		㊱	INT-EXT		INT
			SINGLE-NORM-AUTO	㉚	AUTO
		㊳	CH1-CH2		CH2
㉖	TIME/DIV				0.2 mS
㉕	POSITION (Horizontal)				Approx. center
㉑	CH1	⑰	POSITION (Vertical)		Approx. center
		⑬	VOLTS/DIV		0.2 V (Red knob is in the CAL'D position)
		⑨	AC-DC		DC
		⑪	GND		The GND is depressed

Connect the power cord to a power line receptacle of the specified voltage, and push on the POWER ① switch.
The power switch cliks, and the power is supplied to the MODEL 5530.
The LED ② indicator turn on.
In some ten seconds later, turn futher the INTEN ④ knob clockwise until the trace is displayed with an appropriate brightness.

Focus ⑤ Adjustment

Move the trace to the center of CRT screen by adjusting the POSITION ⑰ of the CH1 and the horizontal POSITION ㉕ knobs. Adjust the FOCUS ⑤ knob for the sharpest and the most welldefined display.

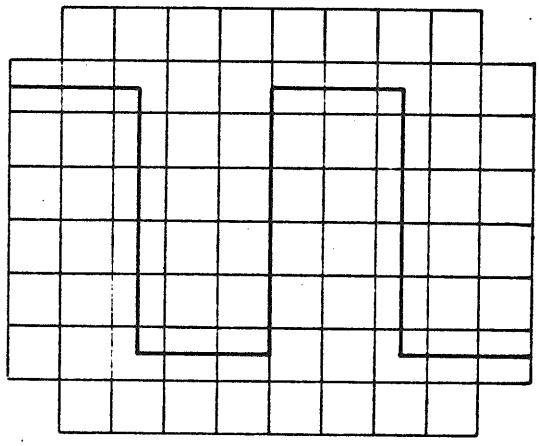
4.1 Display of Calibration Signal Waveform

Display on the CRT screen the square wave calibration signal of the MODEL 5530 (the CALIB ⑥ terminal) by connecting the BNC terminal adaptor (supplied) to the input terminal ⑦ of the CH1 and using as short lead cable as possible.

Set the controls of the front panel as follows.

⑨	AC DC (CH1)	DC
⑪	GND (CH1)	No depressed state
⑬	VOLTS/DIV (CH1)	10 mV
⑮	VAR CAL'D (CH1)	CAL'D
㉖	TIME/DIV	0.2 mS
㉗	VAR CAL'D	CAL'D
㉙	+, -	+
	The other knobs	The position explained before

When the above setting is made, the square wave with an amplitude of 5 DIV is displayed on the CRT screen.



Turn the VOLTS/DIV ⑬ knob by step counterclockwise. The vertical amplitude of the displayed waveform is reduced correspondingly.
The amplitude is continously reduced as the variable knob ⑮ is turned counterclockwise. Thus, the functions of the VOLTS/DIV switch and variable control on the input signal can be ensured.

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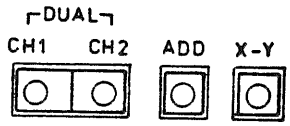
4.2 Dual Channel Mode and ADD Mode

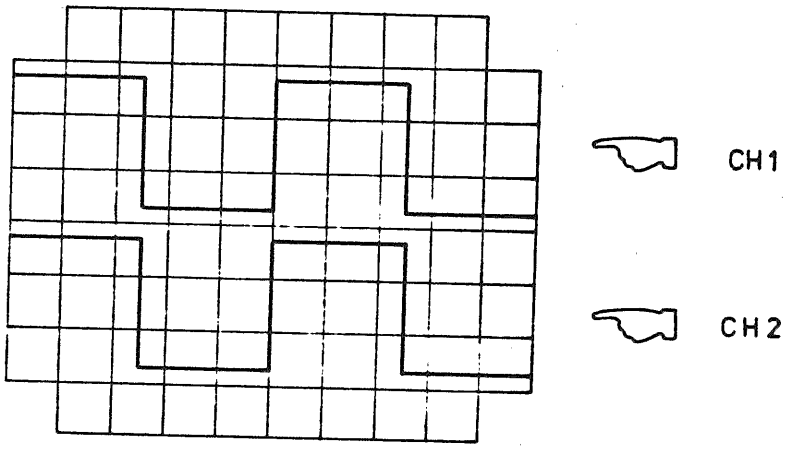
Dual Channel Mode

Set the CH1 (21) and the CH2 (22) switch in the DUAL state. (Both of the CH1 and the CH2 together.) In the above operating state, the calibration voltage was applied to the CH1 but not the CH2.

Now, apply the calibration voltage to the CH2 also.

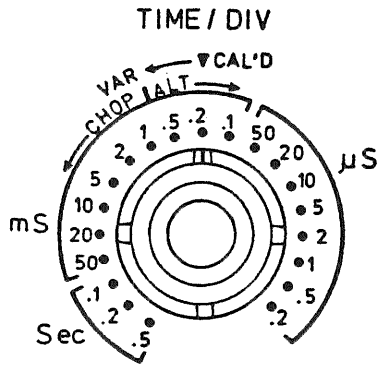
Triggering must be made with the signal applied to the CH1.





If CH2 signal is synchronizable with respect to CH1 signal, both signal are displayed as stationary waveforms on the CRT screen.

The MODEL 5530 has no individual push button for the CHOP and the ALT but has the DUAL button only. Actually, selection of the chop and alternate sweep modes are linked with the TIME DIV (26) switch in the CHOP mode for the 0.5s/DIV ~ 1ms/DIV and in the ALT mode for the 0.5ms/DIV ~ 0.2μs/DIV ranges.



When the MODEL 5530 is operated in the CHOP range and the CH1 signal is low level with poor S/N ratio, triggering may be unstable.
The HF REJ (34) button can be effectively utilized in such a case, for it is provided to eliminate undesirable high frequency components higher than 50kHz from the trigger signal.

ADD Mode (23)

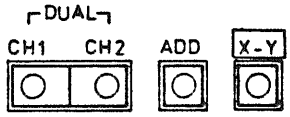
When the ADD button of the (23) is depressed the result of addition or subtraction of the CH1 and CH2 signals is displayed on the CRT screen.

CH1 ± CH2 = The Waveform of the ADD mode

To observe the result of subtraction or the difference between the two signals, the POLARITY (20) button must be depressed.
When this is done, the phase of the CH2 signal is varied by 180° .

4.3 X-Y Mode (24)

Depress the X-Y button of the (24). By this operation, the CH1 is set for X axis, and the CH2 is set for Y axis.



The electrical characteristics of the Y axis in this case is the same with that of CH2. That of the X axis, however, becomes such that the frequency range is DC ~ 2MHz for -3dB, and the variable (15) control and the POSITION (17) control of the CH1.
Trace shift in the X-Y operation becomes faster than the case of the normal operation. Other electrical performance is the same with that of CH1.

Apply the calibration voltage signal to both X and Y axis.
Adjust the VOLTS/DIV (13) (14) switch of both channels so that appropriate amplitude is obtained and two spots are displayed on the diagonal line of the CRT screen. When this is done, a Lissajou's figure for frequency ratio 1:1 and phase angle difference zero or almost zero is displayed on the screen.

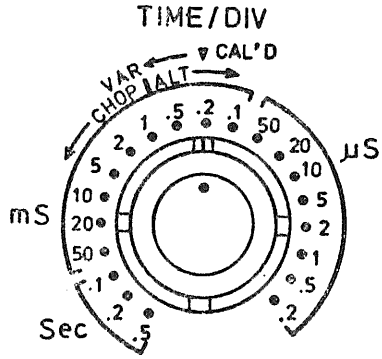
Under the X-Y mode also, the 5X MAG function which is linked with the horizontal POSITION (25) knob remains idle.

4.4 Z AXIS INPUT (43)

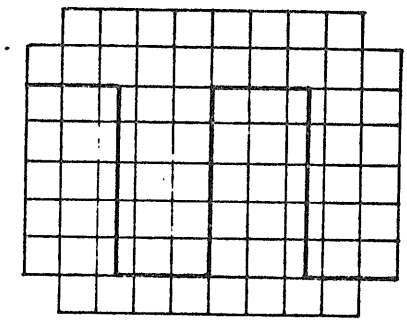
The INTEN MOD terminals which accept an external intensity modulation signal is located on the rear panel.

Z AXIS INPUT

4.5 Trigger and Time Axis



This calibration voltage signal is a square wave of approximately 1 kHz. When the TIME/DIV (26) switch is set in the 0.2mS position, one repetition of the square wave is displayed with a horizontal amplitude of approximately 5 DIV.



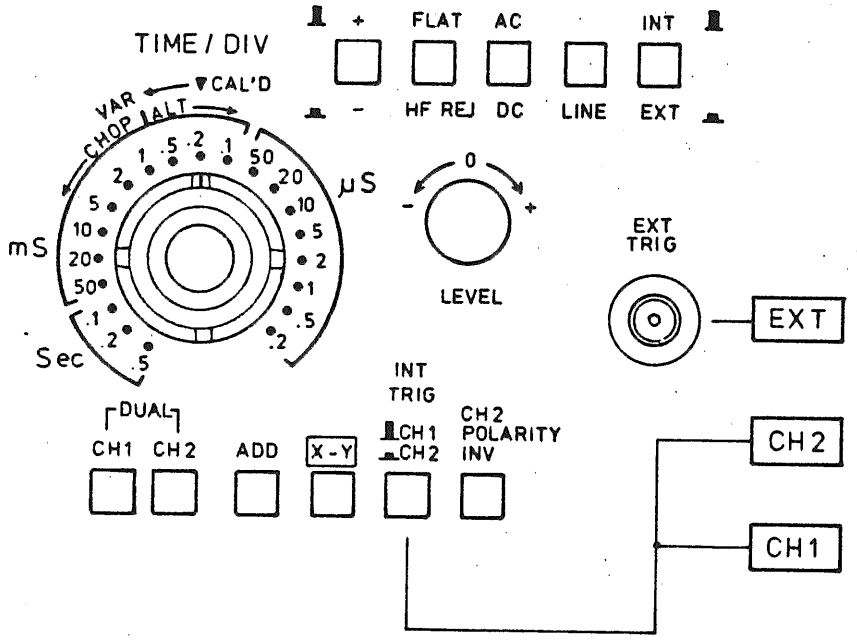
As the TIME/DIV switch is turned clockwise, the sweep time becomes faster and vice versa. The sweep.time is continuously adjustable with the variable (27) knob.

4.6 Type of Trigger Signal Source

To display the measured signal as a stationary waveform on the CRT screen, a trigger signal which is synchronized with the measured signal must be applied to the trigger circuit so that the sweeps of the time axis are initiated in synchronization whith the measured signal.

There are three types of trigger signal source.

They are the CH1 mode (Triggered by the CH1 signal.), the CH2 mode (Triggered by the CH2 signal.) and the EXT mode.



4.6.1 Internal Trigger (CH1, CH2) (38)

Under the internal trigger, the measured input signal is picked up as a trigger signal at a certain point in the vertical amplifier, and applied to the trigger circuit after the signal is amplified to an appropriate level by the trigger amplifier. Under the NORM mode, the trigger signal is the waveform (CH1 Under the CH1 mode, the trigger signal is the only input signal to CH1. signal is the only input signal to the CH1.

Under the CH2 mode, the input signal to the CH1 is the only trigger signal. When the signal of the CH1 is synchronized with the signal of the CH2, the waveform of the CH2 can be observed with triggering by the signal to the CH1, and vice versa.

4.6.2 External Trigger (EXT TRIG) (39)

Under the EXT trigger mode, the trigger circuit can be directly driven without effects which could be caused by the vertical amplifier. For example, under the internal trigger mode, when the VOLTS DIV switch is turned, the voltage applied to the trigger circuit is affected, and the triggering may become unstable for some input signal waveforms.
Under the external trigger mode, the trigger circuit is stably driven irrespective of turning of any controls of the vertical amplifier circuit so far as they do not affect the external trigger circuit. As for the external trigger signal, a signal of less than approximately 10Vp-p must be used.

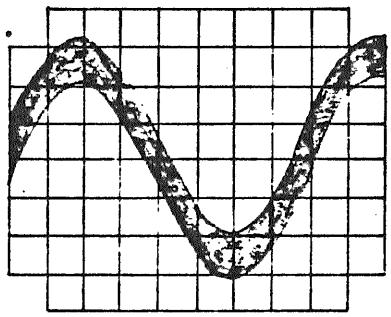
4.7 AC and DC (35)

The triggering method of the MODEL 5530 is widely utilized for many use, because DC coupling can be selected for the coupling of the trigger input. Especially, it is available for the trigger signal of DC ~ 5kHz or single sweep. AC coupling is used for general purpose such as the trigger signal of 5Hz ~ 35MHz or the trigger signal with DC component.

4.8 FLAT and HF REJ (34)

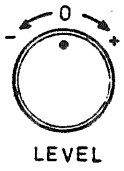
Under the HF REJ mode, a low pass filter with a cut off frequency of approximately 50kHz, -3dB, is inserted before the trigger input circuit.
This mode switch is utilized, when the obstructive high frequency component or noise which are superimposed on the original trigger signal is included.
Under the dual-channel mode operation, the TIME/DIV (26) is set in the CHOP mode, the jitter of synchronization may be reduced.

Waveform with a high frequency component (higher than 50kHz) superimposed on the original signal.



Under the FLAT mode, the stable triggering is always made for the trigger signal of a range of DC ~ 35 MHz.

4.9 LEVEL (28) knob and ± (29) slope setting



LEVEL

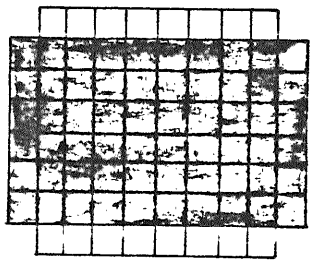
Apply a sine wave or triangle wave signal of approximately 1 kHz to the CH1 input signal. (Adjust the level of the input signal or the vertical variable attenuator so that waveform more than 6 DIV is displayed on the CRT screen.)

Setting of the controls are shown as follows.

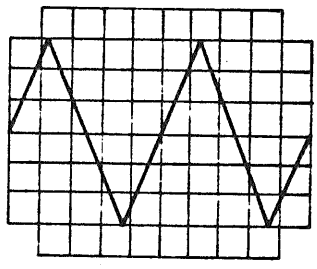
(34) FLAT HF REJ ..... FLAT
(35) AC DC ..... AC
(38) CH1 CH2 NORM EXT CH1
(26) TIME/DIV 0.2mS/DIV
AUTO, NORM, SINGLE..... (30) AUTO
(29) ± slope ..... +

The display on the CRT screen free runs on the fully counterclockwise position of the LEVEL (28) control. The display is synchronized at the certain position with turning gradusly the LEVEL control clockwise. The start point of the display shift from lower position to upper position, and the display free runs again.

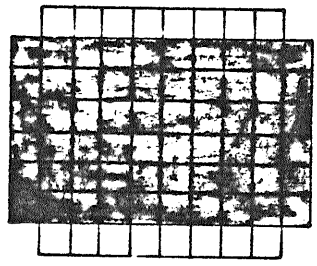
The display is observed in inverse order explained above on the CRT screen with turning the LEVEL knob counterclockwise.



(a) free run

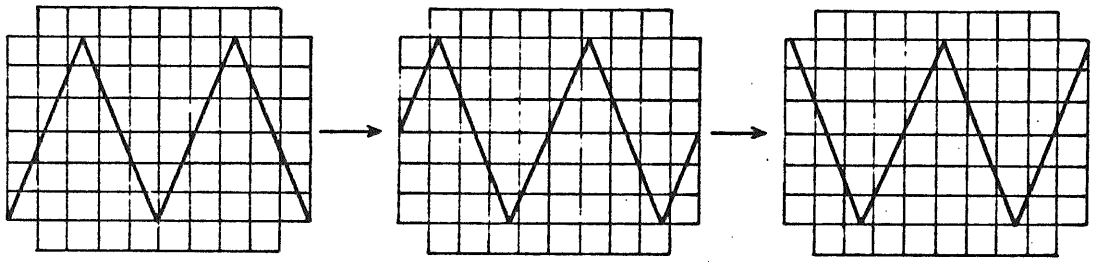


(b) synchronised

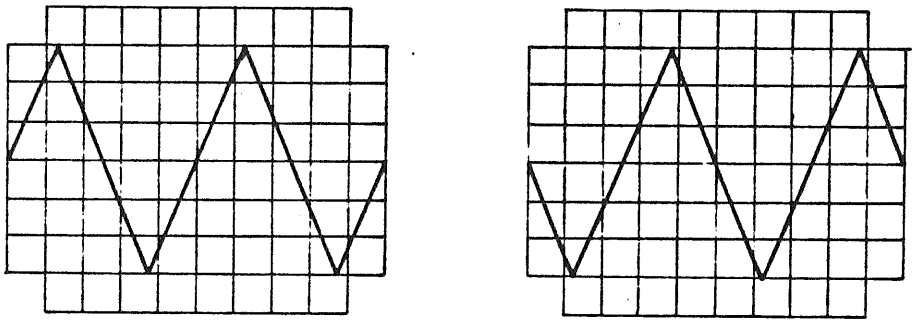


(c) free run

The displayed waveform shifts from right to left on the stable display with turning the LEVEL knob clockwise (The position does not shift, and the phase shifts.), and the start point of the display shifts from lower position to upper position.
(the shift of trigger level)



Set the ± (29) slope switch in the "-" ⎍ state. The slope of the start point of the display becomes inverse. It means that trigger is made in the negative-going portion.



+ −

4.10 AUTO mode (30)

Set the MODE selector in the AUTO (30).
Adjust the VOLTS/DIV knob and the variable control so that a waveform is displayed with an amplitude of approximately 0.5 DIV.
Adjust the trigger level LEVEL (28) control and the attenuayed stationary display is obtained. (The display is visible with setting the TIME/DIV knob to 1mS/DIV.) The stationary display is obtained for an amplitude of 8 DIV or more.

Under the AUTO mode, the time axis is automatically swept even when no trigger input signal is being applied. A bright trace is displayed even at fast sweep ranges and the zero level can be readily checked.

4.11 NORM mode (31)

Under the NORM mode, the time axis in the stand-by state and the traces disappears from the CRT screen when no trigger signal is being applied, the level of the input signal to the EXT TRIG IN terminal is less than 200 mVp-p, or when the LEVEL control is turned exceeding the triggering point.

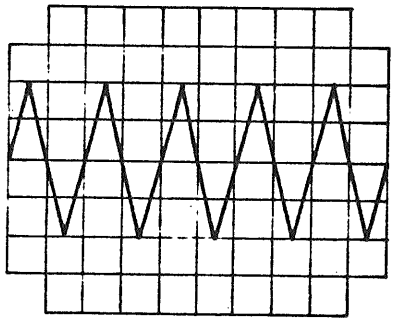
4.12 SINGLE mode (32)

Operate as following procedure for a single sweep.

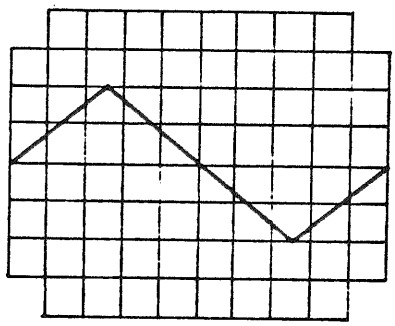
(A) Apply a repetitive waveform to the CH1 (21) or CH2 (22) input, and set the mode selector in the NORM (31) mode. Display the stationary waveform on the CRT screen by adjusting the trigger level LEVEL (28) control.
(B) Set the MODE selector in the SINGLE (32) mode.
(C) Remove the signal from the input terminal.
(D) Push the SINGLE (32) switch again. (PUSH TO RESET operation)
(E) The READY (33) indicator lights and the time axis is in the stand-by state, When a finger is taken off from the button and the button is turned back.
(F) Again apply the signal measured to the input. A sweep is triggered by the signal, and a single trace is presented with a single sweep. The READY (33) indicator light goes out. The time axis is not operated again, until the SINGLE button is pressed again.

4.13 Sweep Magnification (PULL 5 X MAG) (25)

When a particular section of the input signal is required to be expanded for detailed observation, the requirement may be met by using a fast sweep speed. However, if the required section is located apart from the starting point of the sweep, the required section may run out of the viewing screen. In such a case, pull out the POSITION (25) knob (set in the 5 x MAG state). The required section is horizontally expanded by a factor of 5 from the screen center.



(a) Before magnifier



(b) After magnifier

When the 5xMAG function is affected, the sweep time becomes as below.

(TIME/DIV indication) X 1/5 = Sweep time / DIV

When the sweep is magnified, the trace brightness is reduced. The use of the sweep magnification should be limited to the below cases.

(1) When a particular section which is located apart from the sweep start point is required to be magnified for observation of details.

(2) When a sweep time of faster than 0.2μs/DIV is required.

4.14 Application method of Vertical Input Signal

4.14.1 Using with Coverd Wires

Attach the BNC terminal adaptor (supplied) to the vertical input terminal , and apply the input signal through the covered wires. Note, however, that measurement under this method may be unstable because the input wire are susceptible to induction noise interference when they are long or when the input signal source impedance is high. The displayed characteristics may be affected because the stray capacitance with respect to the ground is large. As compared with the case the 10:1 probe is used, this method is susceptible to mutual interference with the measured circuit and other undesirable effects.

4.14.2 Using with Shielded Cable

By the use of a shielded cable, external noise introduced in the input connection can be eliminated. However, the use of a shielded cable is disadvantageous in that the capacitance between signal source and ground become large (50 pF/m ~ 100 pF/m) and, therefore, the use is not suitable for input connection when the signal source impedance is substantially high or when a signal which includes higher frequency components is to be measured.

4.14.3 Using with Coaxial Cable

When the signal source impedance is 50Ω or 75Ω, a coaxial cable of the matched impedance may be used for input signal connection. When an impedance-matched coaxial cable is used, the input signal can be connected without attenuation for higher frequency components also. Impedance matching can be accomplished by connecting a pure resistance "R" of 50Ω or 75Ω corresponding to the characteristic impedance of the cable, in the input side of the oscilloscope as illustrated below.

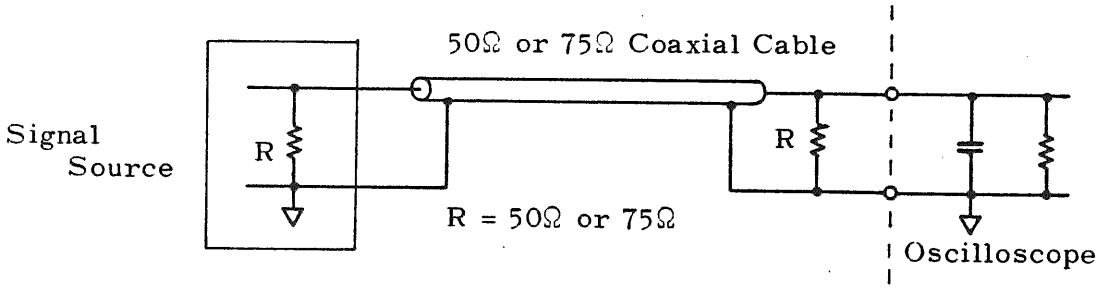
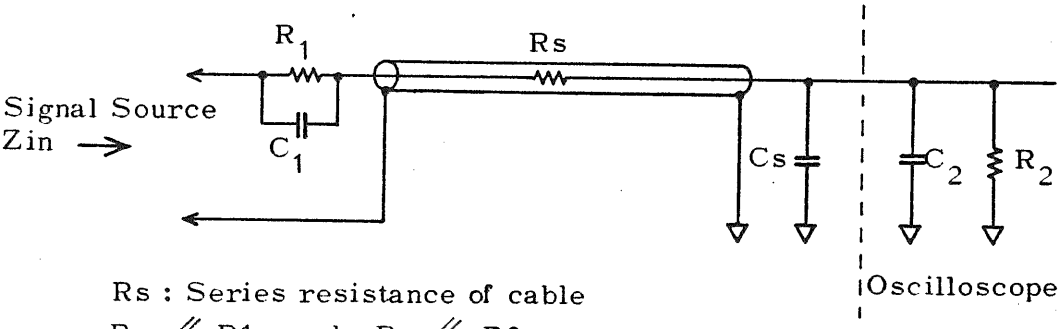


Fig. A

4.14.4 Using with Probe

The input signal can be applied through the 10:1 probe which is supplied as an accessary of the oscilloscope. The probe provides electrical shielding from the oscilloscope to the probe, and eliminates external noise.



Rs : Series resistance of cable

Rs ≪ R1 and Rs ≪ R2

$$Zin = \frac{R1 + R2}{\omega C (R1 + R2) + 1} \qquad C = \frac{C1 \times (C2 + Cs)}{C1 + C2 + Cs}$$

Cs = (Stray capacitance) + (Cable capacitance)

Attenuation resistor R1 and its parallel capacitor C1 make up a wide-band attenuator which minimizes the loading effect on the measured signal source when the signal source impedance is high and which is suitable for measurement of signals which include higher frequency components. The attenuation ratio is 10:1 as expressed by below equation.

Attenuation ration: $\frac{R2}{R1 + R2} = \frac{1M\Omega}{9M\Omega + 1M\Omega} = \frac{1}{10}$

The purpose of the circuit is not to divide the voltage level to 1/10 but is to reduce the loading effect on the measured signal source.

4.14.5 Precaution in Using the Probe

(1) The specified maximum allowable input voltage must not be exceed.

(2) The accessary ground wires must be connected when the oscilloscope is used at a high sensitivity for a wide frequency range. Both of them must be connected also when the oscilloscope is used in dual channel mode.

(3) The phase of the probe must be accurately calibrated. The probe supplied as an accessary of the MODEL 5530 must be used.

(4) The probe must be protected against abnormally large mechanical shock, vibration, bent and pull.

(5) The main body and tip of the probe is not highly heat resistant. Do not make soldering near the probe under the state that the lead wire is being connected to the probe.

4.15 Voltage Measurement

4.15.1 DC Voltage measurement

(1) Set the MODE selector in the AUTO (30) mode and the time axis in the free running mode, and display a trace by setting the TIME/DIV (26) switch at a position approximately 1 mS/DIV.

(2) Set the input coupling selector of the vertical input in the GND state. The trace position under this state is corresponding to zero volts level. By turning the POSITION (17) or (19) control, move the trace to a position where is convenient for waveform observation.

(3) Set the input coupling selector (9) or (10) in the DC state. Apply the measured voltage to the vertical input terminal, and measure the movement of the trace on the CRT screen.

(4) If the trace is deflected off the CRT screen when the measured voltage is applied to the input terminal, turn the VOLTS/DIV switch counterclockwise to a position where an appropriate deflection on the CRT screen in response to application of the measured signal is obtained.

(5) If the trace is moved upward, the polarity of the measured signal is positive; if the trace is moved downward, the polarity of the measured signal is negative.

(6) The measurement may be with the variable (15) of (16) knob turned to the extremely clockwise position (CAL'D position) where the voltage sensitivity per 1 DIV on graticule is calibrated and quantitave measurement of the measured signal voltage can be easily made as below.

* When the measured signal is directly applied to the input terminal:

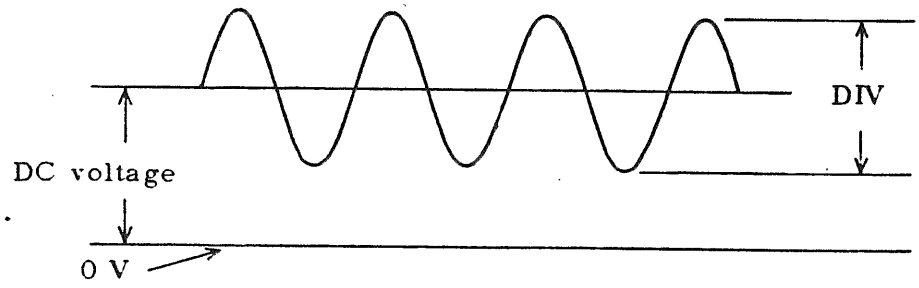
voltage V = (VOLTS/DIV indication) x (deflection amplitude in DIV)

* When the 10:1 probe is used:

voltage V = (VOLTS/DIV indication) x (deflection amplitude in DIV) x 10

4.15.2 AC Voltage Measurement

Regarding measurement if an AC component superimposed on a DC component, if measurement is made with the input coupling selector (9) or (10) set in the DC state and if the DC component is sufficiently large as compared with the AC component, the trace will be deflected off the CRT screen and the AC component will disappear. It may be possible to move the trace of the AC component back on to the CRT screen by turning the vertical POSITION (17) or (19) control. Another method of bringing the waveform of the AC component on the CRT screen is to turn the VOLTS/DIV (13) or (14) switch to a lower sensitivity position. The most effective and generally practiced method, however, is to set the input the coupling selector in the AC state so that the DC component is cut off and the AC component alone is displayed with appropriate amplitude on the CRT screen.



In the AC measurement, the voltage (Vp-p) is caliculated as below.

voltage Vp-p = (VOLTS/DIV indication) x (deflection amplitude in DIV)

When the 10:1 probe used, the voltage (Vp-p) is caliculated as below.

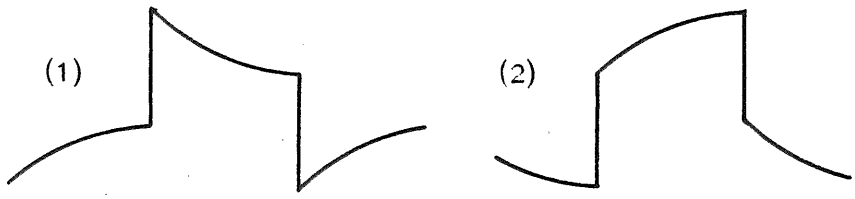
voltage Vp-p = (VOLTS/DIV indication) x (deflection amplitude in DIV) x 10

The rms value of a sine wave can be caliculated from the peak- to-peak value as below.

$$V_{rms} = \frac{Vp\text{-}p}{2\sqrt{2}}$$

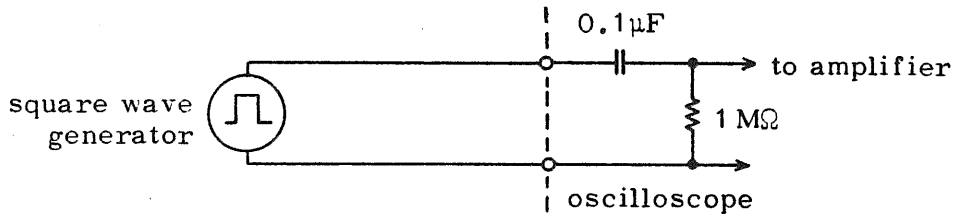
4.15.3 AC Coupling

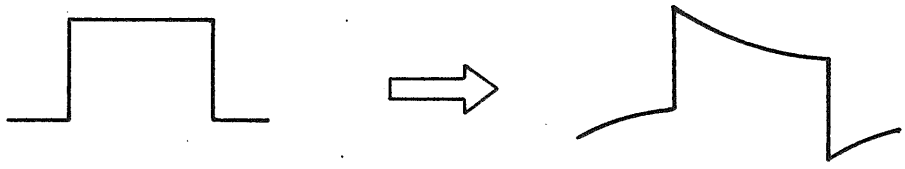
As explained in the above, an AC voltage superimposed on a DC voltage is measured in the AC coupling mode. With the AC coupling, however, when the frequency of the measured signal is less than 1kHz, attention must be paid to phase lead and lag and to amplitude reduction. Especially in the case of a square wave of repetition frequency of less than 1kHz, the waveform may be distorted with sag as illustrated below.



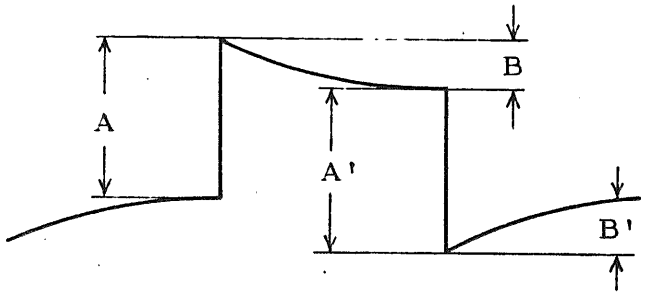
Waveform (1) indicates typical sag which is caused when the phase is leading and the amplitude is attenuated.
Waveform (2) indicates typical sag which is caused when the phase is lagging and the amplitude is attenuated.
From the viewpoint of waveform fidelity, the DC coupling is ideal because it causes no variation either in phase or amplitude.

The input impedance of the MODEL 5530 is 1 MΩ, with a coupling capacitor of 0.1μF. When a low frequency square wave of a stepwise voltage is applied, sag similar to that indicated with waveform (1) is caused.





The percentage of sag is caliculated as below.



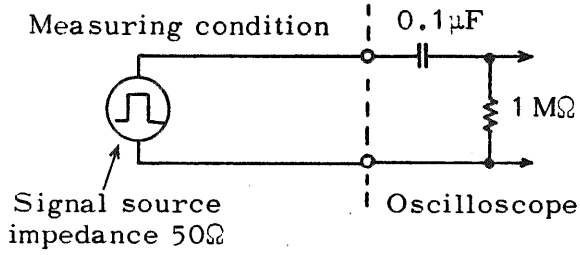
A : Basic amplitude

B : Sag

$$\text{Sag}\ (\%) = \frac{B}{A} \times 100 \qquad \text{or} \qquad \text{Sag}\ (\%) = \frac{B'}{A'} \times 100$$

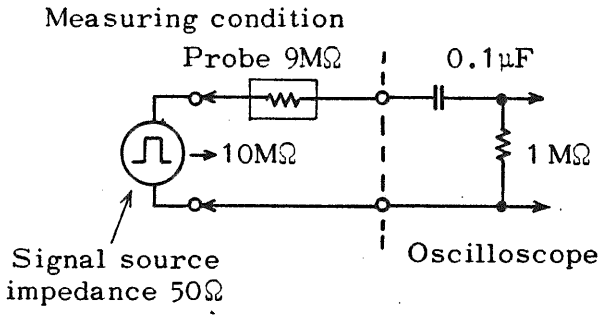
The degree of the MODEL 5530 is tabulated below.

Repetition Frequency	Sag(%)
10Hz	26
50"	4
100"	2
500"	0.6



The degree of sag when the 10:1 probe is used is as tabulated below.

Repetition Frequency	Sag (%)
10Hz	2.6
50"	0.4
100"	0.2
500"	0.06



As the value can be seen in the above tables, the degree of sag is reduced to approximately 1/10 when the 10:1 probe is used as compared with the case the input is directly applied to the MODEL 5530 of which input impedance is 1 MΩ.

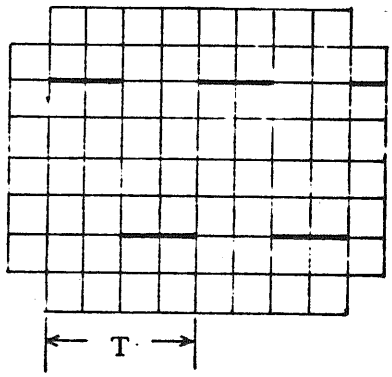
It must be noted, however, that the input signal voltage is reduced to 1/10 when the probe is used.

The 10:1 probe can be effectively used when the DC coupling cannot be used and yet observation of waveform with minimum sag is required.

5. MEASUREMENT

5.1 Time Interval Measurement

The time interval between two points on the displayed waveform can be measured by reading value of 'T' referring to the TIME/DIV (26) indication with the variable (27) control of the TIME/DIV switch turned to the CAL'D position



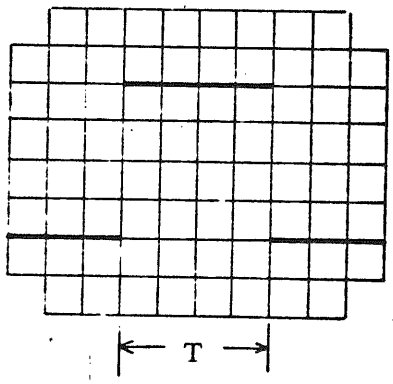
Time T (sec) = TIME/DIV (sec) x Read distance (DIV)
x Magnification factor .....(A)

Magnification factor is 1 when it is idle, and is 1/5 when it is affected.

5.2 Pulse Width Measurement

Set the measured pulse signal in the center of the screen, with an easily readable horizontal amplitude of 2 ~ 4 DIV.

Turn the variable (27) control of the TIME/DIC to the CAL'D position.



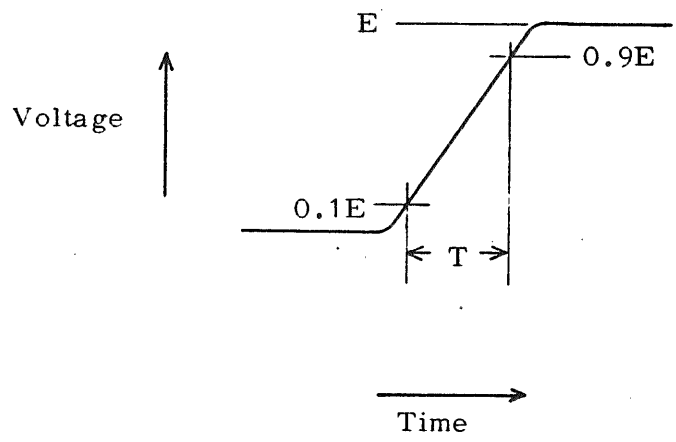
When the pulse width is narrow, effect the 5x MAG (25) function as required. Determine the distance of 'T' and caluculate the time interval using equation (A).

5.3 Measurement of Pulse Rise Time and Fall Time

In a similar manner as pulse width measurement, determine the distance 'T' and caliculate rise or fall time using equation (A). When the rise or fall time of the measured signal is sufficiently slow as compared with that of the MODEL 5530 itself (10 ns), the value can be directly read. When that of the measured signal is fast, the measured value must be corrected employing the below formula.

$$Tn = \sqrt{T^2 - To^2 - T_G{}^2}$$

Tn : True value
T : Measured value
To : Rise time of the MODEL 5530, 10 ns
(Calculated value)
T_G : Rise time of square wave generator



5.4 Frequency Measurement

There are three frequency measuring methods as below.

(1) The period per one cycle of waveform is caliculated employing equation (A) upon determing the time interval 'T', and the frequency is caliculated as the reciprocal of the period.

$$\text{Frequency } f \text{ (Hz)} = \frac{1}{\text{Period } T \text{ (sec)}}$$

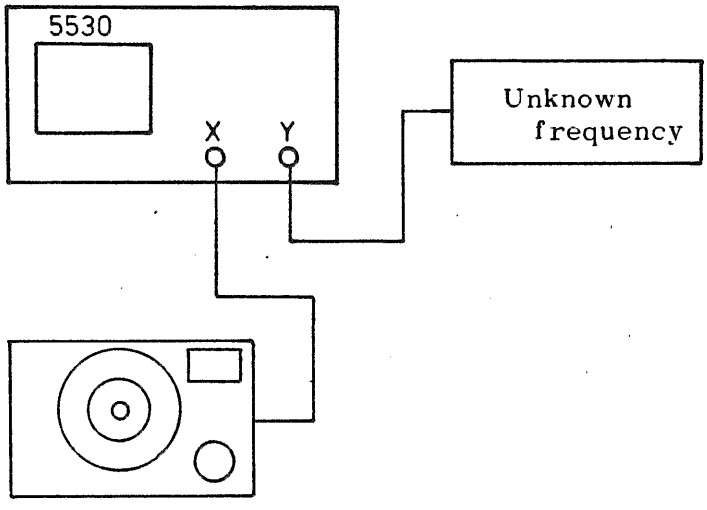
(2) The time interval per 10 ~ 20 cycles is determined, the number cycles per 10 DIV of graticule is counted, and the frequency is caliculated with the below formula.

$$\text{Frequency } f \text{ (Hz)} = \frac{N}{\text{TIME/DIV indication (sec)} \times 10}$$

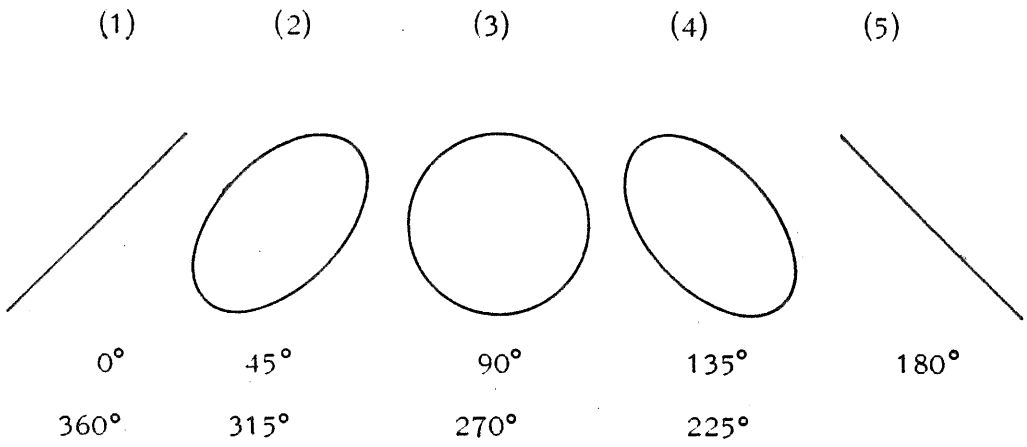
This method is advantageous over method (1) in that measuring errors are reduced as the number (N) of cycle is increased.

(3) In the above two methods, the frequency is measured through measuring the period. When the signal is less than 10kHz and is of a sine or other simple waveform, frequency measurement can be efficiently made by operating the oscilloscope in the X-Y mode, and displaying a Lissajou's figure.
For the operation method, refer to paragraph 4.3 X-Y mode. (Page 25)

Connection for frequency measurement



Adjust the sensitivities with the VOLTS/DIV switch and the variable control in accordance with the levels of the signals applied to the X axis and Y axis, so that the amplitudes are made almost equal for both axes.. As signal of the known frequency sourse is varied, a Lissajou's figure representing 1:1 as illustrated below is displayed on the CRT screen.



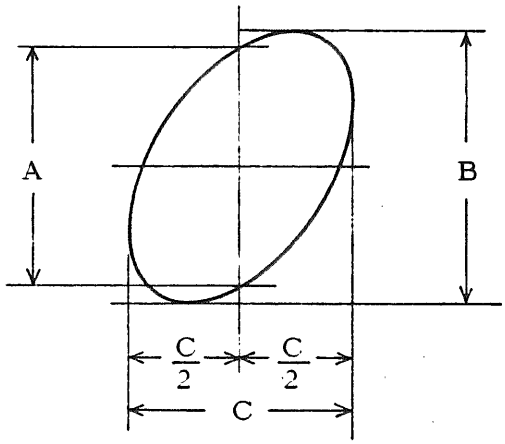
The Lissajou's figure which represents the frequency ratio of 1:1 is either a circle, an ellipse, or a line. When the frequency ratio approches 1:1, the figure continuously rotates in the order of (1) (5) (1).
As the frequency ratio approches still closer to 1:1, the rotation becomes slower and, ultimately, when the two signal frequencies have become exactly equal, the Lissajou's figure becomes stationary.
Now the unknown frequency is determined to be the same with the known frequency. This method using a Lissajou's figure representing 1:1 is the most simple but accurate method of frequency measurement, provided a continuously variable wide-range reliable signal generator is available.

5.5 Phase Difference Measurement

1) Phase Difference Measuremant with Lissajou's Figure

Operate the MODEL 5530 in the X-Y mode and display a Lissajou's figure as described in the paragraphs for frequency measurement.
In the case, the both X axis and Y axis amplifiers should be operated at their maximum sensitivities . Adjust the output of the signal source so that the amplitude of the displayed waveform is made more than a half of the screen in the center of the CRT screen. Determine the distances A and B on the graticule, and caliculate the phase difference employing the below formula.

$$\text{Phase difference } \theta = \text{Sin}^{-1} \frac{A}{B}$$



Disadvantages of phase difference measurement with Lissajou's figure are as follows:

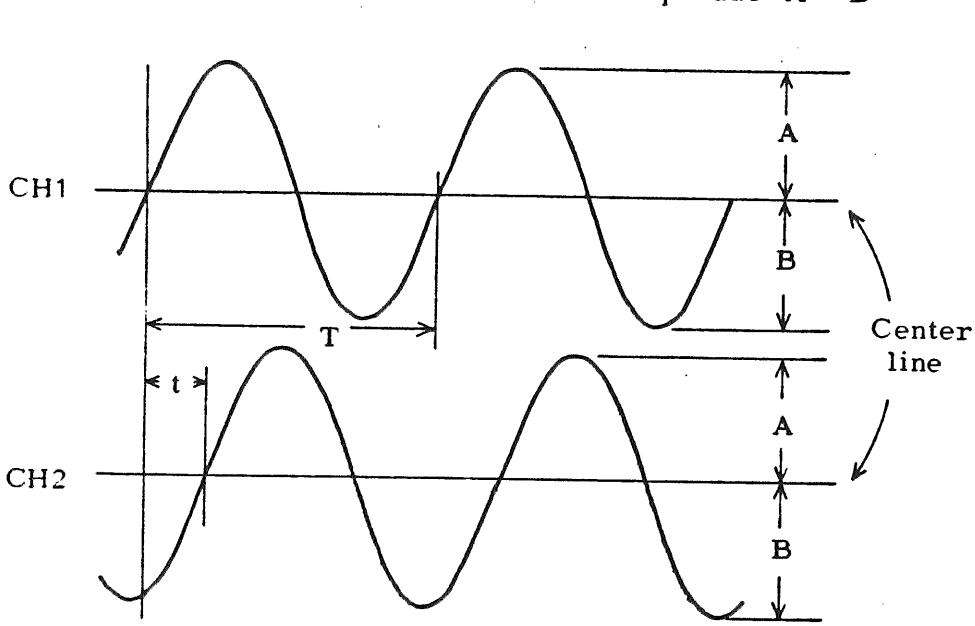
(1) With a conventional oscilloscope, the frequency response of X axis is not sufficiently wide and substantialy phase shift is caused within the oscilloscope.

(2) The measuring accuracy of phase difference is not very high.

For the above reasons, the below-described dual channel method is recomended for accurate measurement of phase difference.

2) Phase Difference Measurement in Dual Channel Method

Set the MODE selector of the vertical axis (21) (22) in the DUAL state, and depress the CH1 button of the trigger selector (38) . Apply signals to the CH1 (21) and CH2 (22) channels (the reference signal to the CH1 (21)) , and display waveform as illustrated below.



Phase defference $\theta^{\circ} = \frac{t}{T} \times 360^{\circ}$

Measure the phase difference with large amplitudes of displayed waveforms, by increasing the sensitivities of both channels.

As for the center lines of waveforms, set both the CH1 and CH2 in amplitudes A = B .

Then probes are to be used for measurement, use them for both channels and accurately adjust their phase characteristics employing the CALIB signal.

The dual-channel phase difference 't' can be measured and the leading or lagging state can be known at a glance.

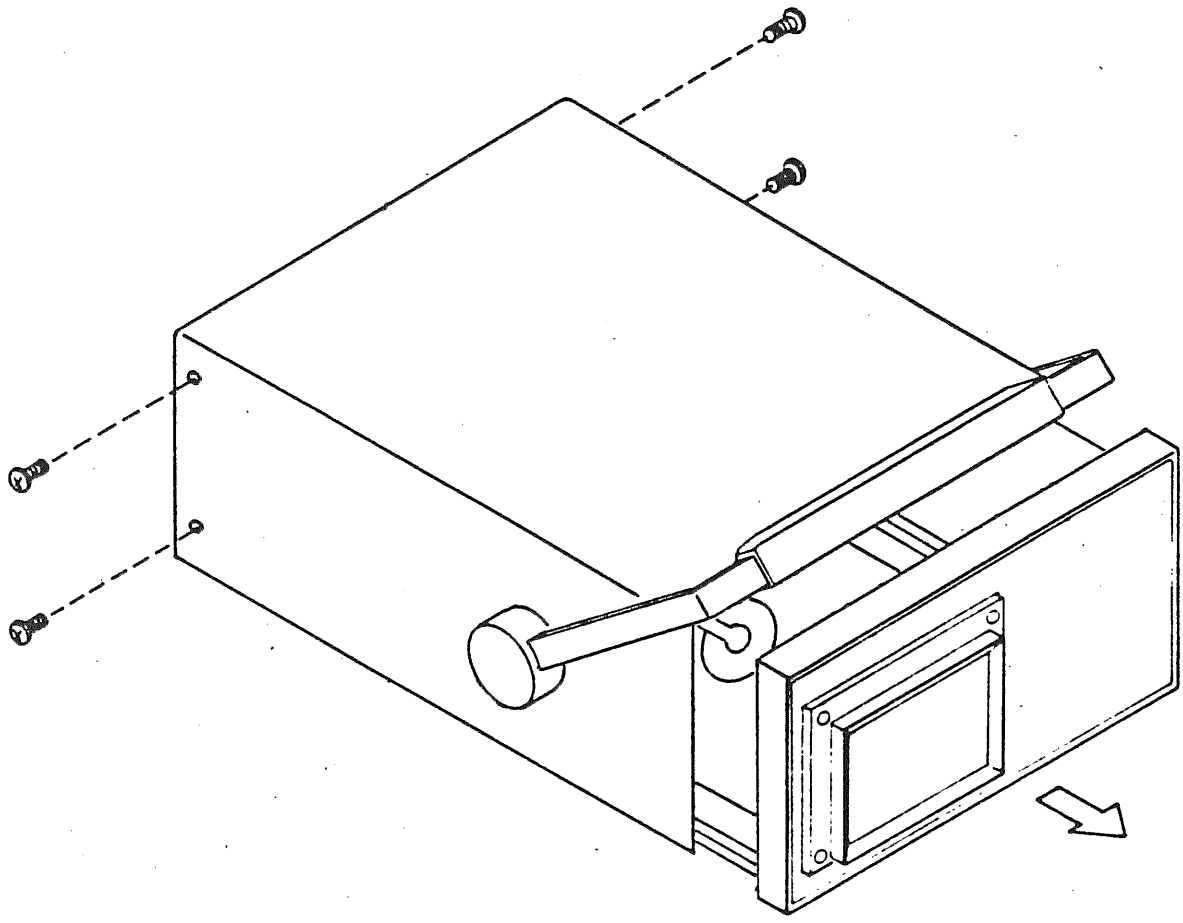
6. CALIBRATION

6.1 General

The MODEL 5530 should be calibrated at certain time intervals. Although calibration of overall performances is most recommendable, such partial calibration may serve the purpose that the time axis alone is calibrated when the time measuring accuracy is especially important or that the vertical axis alone is calibrated when the vertical sensitivity accuracy is of a prime importance. After the MODEL 5530 has been repaired, overall calibration is required although it depends on the type of repair. When a supply voltage (regulated or non-regulated) has been repaired, overall calibration is required. For accurate calibration service, it is most recomendable to contact Kikusui's representative in your area. Simple calibration procedures are explained in this section.

6.2 Removing the Case

To remove the case, remove the four screws (see the illustration) and pull out the chassis forward.



6.3 Check and Adjustment of DC supply Voltages

When calibrating the MODEL 5530, the DC supply voltages should be checked first of all. For voltage check, use a reliably calibrated digital voltmeter. The supply voltages are shown in the following table and the check and adjustment points are indicated in subsequent illustrations.

DC supply	Type	Voltage	Range	Adjustment	Note
+5V	Regulated	+5V	±0.1V		R722
+12V	Regulated	+12V	±0.06V	VR701	
-12V	Regulated	-12V	±0.12V		
+100V	Regulated	+100V	±5V	-	
+190V	Regulated	+190V	±10V	-	
-1320V	Regulated	-1320V	±10V	VR601	

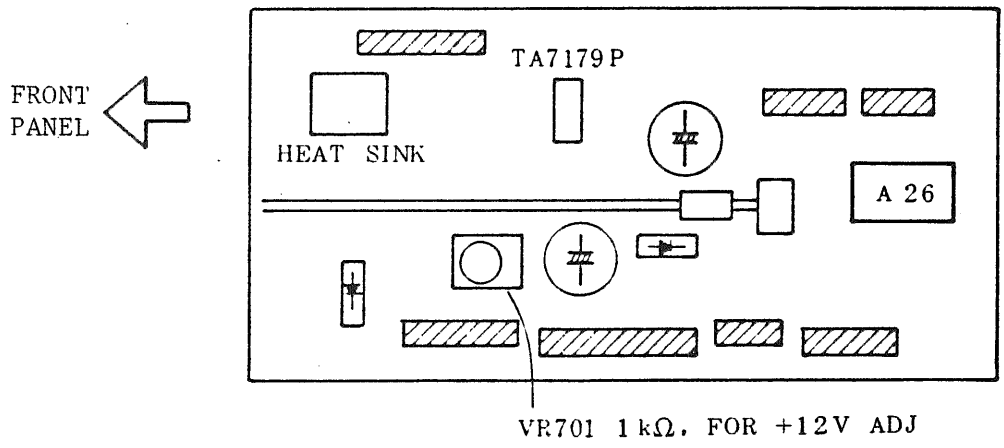
For voltage check, measure the voltage between each check point and the ground. Each voltage should be checked with an AC line voltage of 100 V ±5%. The -1320 V supply is for the CRT acceleration voltage. Note that the trace intensity, and vertical and horizontal deflection sensitivities are largely affected by this voltage.

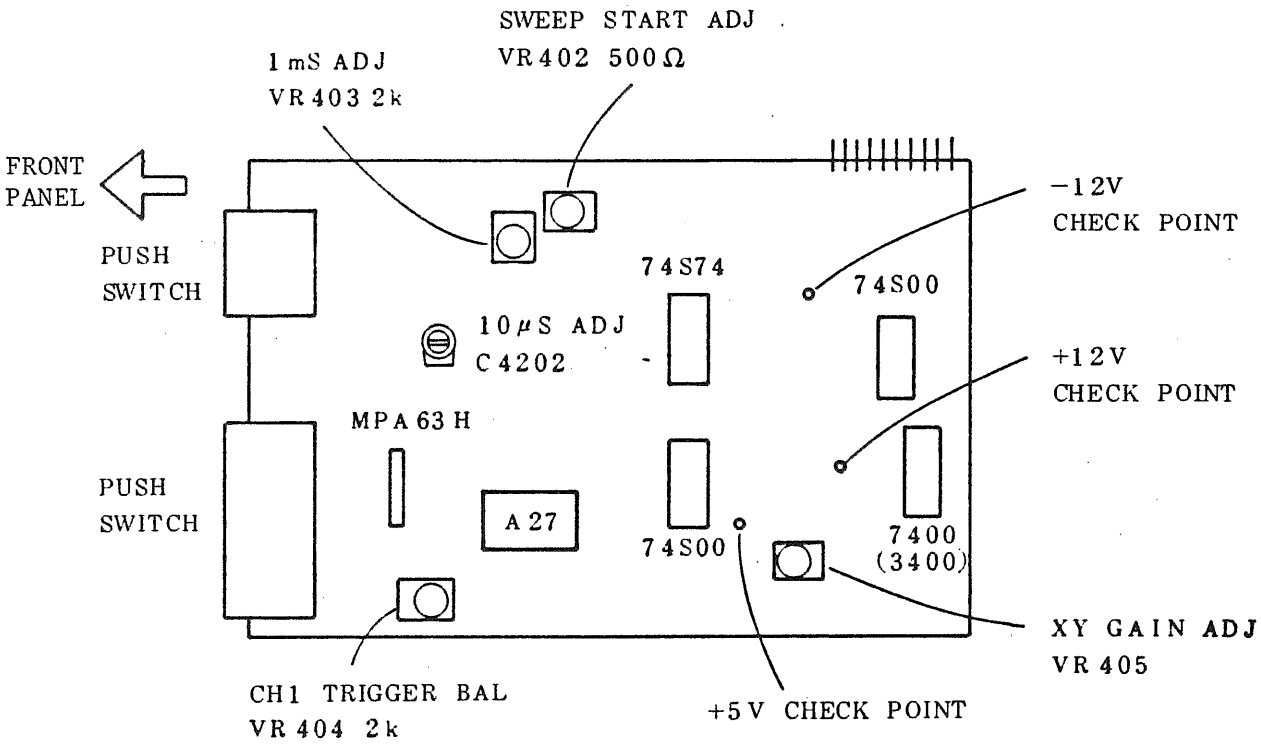
Notes: Check and adjust the DC power supply voltages in the following sequence:

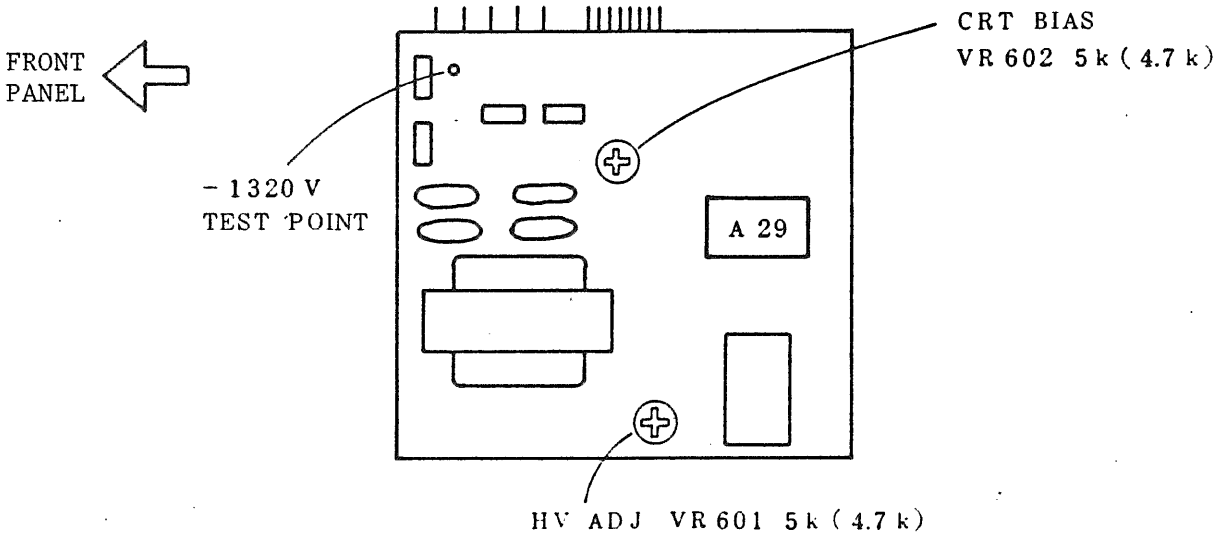
1. +12 V supply adjustment
2. -12 V supply check
3. +5 V supply check
4. +100 V supply check
5. +190 V supply check
6. -1320 V supply adjustment

To measure the -1320 V supply, of which internal impedance is high, use a voltmeter of a high input impedance (1000 MΩ or over.) Kikusui Model 149-05A or 149-10 Precision Digital Voltmeter is most recommendable.

For locations of the printed circuit boards, see illustrations on later pages of this instruction manual.


FRONT
PANEL
TA7179P
HEAT SINK
A 26
VR701 1kΩ, FOR +12V ADJ


SWEEP START ADJ
VR402 500Ω
1mS ADJ
VR403 2k
FRONT
PANEL
PUSH
SWITCH
74S74
74S00
−12V
CHECK POINT
10μS ADJ
C4202
+12V
CHECK POINT
MPA63H
PUSH
SWITCH
A 27
74S00
7400
(3400)
XY GAIN ADJ
VR405
CH1 TRIGGER BAL
VR404 2k
+5V CHECK POINT


FRONT
PANEL
CRT BIAS
VR602 5k(4.7k)
−1320V
TEST POINT
A 29
HV ADJ VR601 5k(4.7k)

6.4 DC BAL Adjustment of Vertical Axis

This adjustment is for minimizing the shift of the trace when the VARIABLE knob is turned.

(1) Depress the GND switch so that the vertical circuit becomes the GND state and the base trace line is displayed on the CRT screen.

(2) Turning the VARIABLE knob, so adjust VR201 for CH1 or VR206 for CH2 that the shift of the trace becomes minimum.

5 × MAG DC BAL adjustment (CH1, CH2, 1 mV DC BAL):

This adjustment is for minimizing the shift of the trace when the POSITION knob is pulled out to set the circuit in the 5 × MAG state.

(1) Depress the GND switch so that the vertical circuit becomes the GND state and the base trace line is displayed.

(2) So adjust VR203 for CH1 or VR208 for CH2 that, when the POSITION knob is pulled out, the trace shift becomes minimum.

INV BAL adjustment:

This adjustment is for minimizing the shift of the trace when the CH2 POLARITY INV switch is depressed.

(1) Depress the GND switch so that the vertical circuit becomes the GND state and the base trace line is displayed.

(2) So adjust VR209 (INV BAL control) that the shift becomes minimum when the CH2 POLARITY INV switch is depressed.

ADD BAL adjustment:

This adjustment is for minimizing the shift of the trace when the circuit is switched to the ADD state (with traces of both CH1 and CH2 set at the center of the screen).

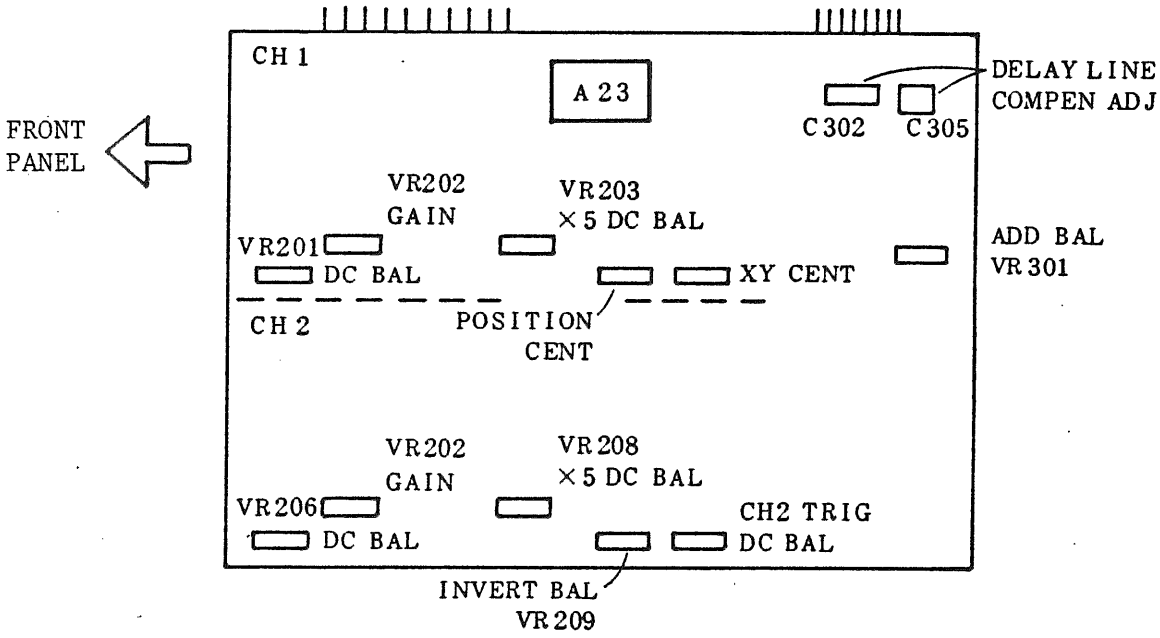
(1) Depress the GND switches of both channels so that they becomes the GND state. Position both traces overlapped at the center of the screen.

(2) So adjust VR301 (ADD BAL control) that the trace remains at the center of the screen when the operation is changed to the ADD mode.

The above control potentiometers are mounted on printed circuit board A23. Location of A23 is indicated in the illustration on a later page of this instruction manual.

6.5 Calibration of Vertical Deflection Sensitivity

Apply to the vertical input terminal (CH1 and CH2) a signal of 20 mVp-p and 1 kHz, using a square generator of an accuracy of 0.5% or better. So adjust the GAIN ADJ control (VR202 for CH1 and VR207 for CH2) on the front panel that, with the VOLTS/DIV switch set in the 5 mV position, the signal displayed on the screen becomes accurately 4 DIV. For each position of the VOLTS/DIV switch, apply a signal with an amplitude of 4 times of the VOLTS/DIV indicated value, and check the displayed signal amplitude. The normal indication for all ranges is that the displayed value is within ±3% of the indicated value.

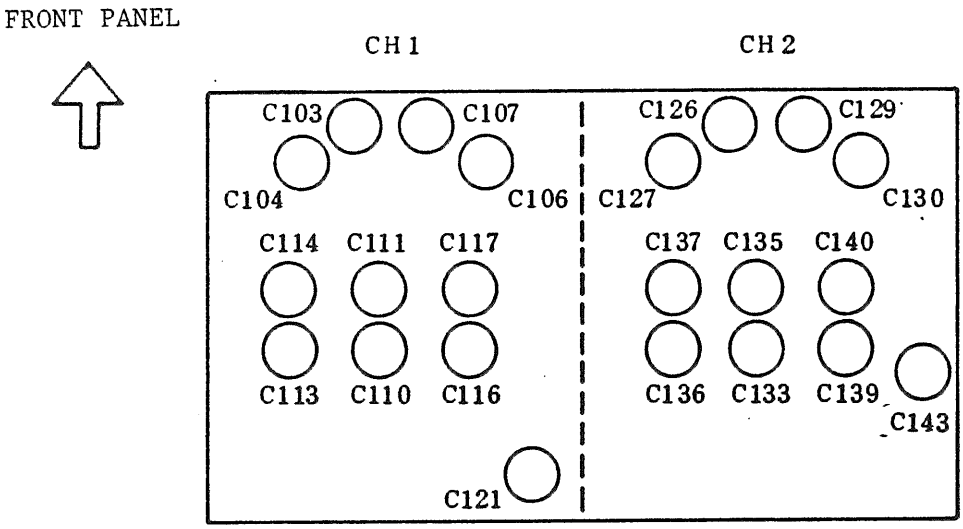


6.6 Input Capacitance Adjustment and Phase Compensation of Vertical Axes (VOLTS/DIV Ranges)

Unless the phase chracteristics at each position of the VOLTS/DIV switch are correctly adjusted, the frequency response may be degraded and the displayed waveforms may be distorted. The phase characteristics can be adjusted by varying the input capacitors and high-frequency compensation capacitors. For this adjustment, a capacitance meter for measurement of the input capacitance (24~26 pF) and a square wave generator which can provide a quality signal of approximately 1 kHz are required. For input capacitance measurement, bridge-type meters are inadequate. Use a low-capacitance C meter. For the 1 kHz square wave signal, the CALIB signal (for probe calibration) of this instrument can be used. When using a square wave generator, use an instrument which provides waveforms with less sags or overshoots and with a rise time of faster than 1 μsec. The trimmer capacitors for this adjustment are shown in the following table.

VOLTS/DIV switch position	CH1 Trimmer capacitors		CH2 Trimmer capacitors	
	Input capacitor	High frequency compensation capacitor	Input capacitor	High frequency compensation capacitor
5 mV	C121	-	C143	-
10 mV	C111	C110	C135	C133
20 mV	C114	C113	C137	C136
50 mV	C116	C116	C140	C139
0.1 V	C103	C104	C126	C127
0.2 V	C103	C104	C126	C127
0.5 V	C103	C104	C126	C127
1 V	C107	C106	C129	C130
2 V	C107	C106	C129	C130
5 V	C107	C106	C129	C130

Adjust the capacitance at 24.5 pF ±0.5 pF for all ranges except the 20 mV/DIV range which should be adjusted at 25.5 pF ±0.5 pF.

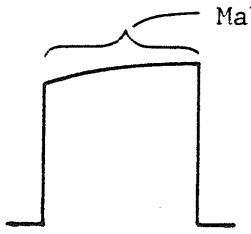


6.7 Adjustment of High-frequency Response of Vertical Amplifiers

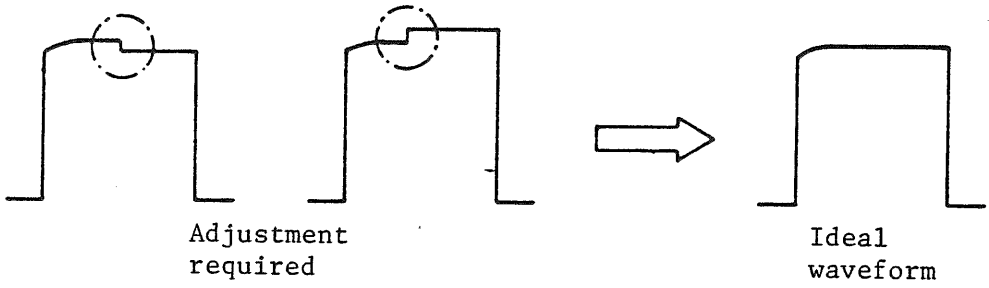
Adjust the high-frequency response of the vertical amplifiers using a quality square wave signal of rise time faster than 5 nsec and repetition frequency approximately 1 kHz.

(1) Apply the above square wave signal to the input terminal of CH1, set the VOLTS/DIV switch in the 5 mV position and the TIME/DIV switch in the 0.2 μsec position, and so adjust the signal generator output that a deflection amplitude of 4 DIV is obtained on the CRT screen.

(2) So adjust DELAY LINE COMPENSATION ADJ potentiometer VR302 and trimmer capacitor C305 of printed board A23 that the top section of the square wave becomes flat.



(3) If the displayed waveform in the above adjustment is as illustrated in the following, the cause is that delay line is mismatched. In such a case, adjust the waveform with DELAY LINE MATCHING ADJ potentiometer VR505 of printed board A28.



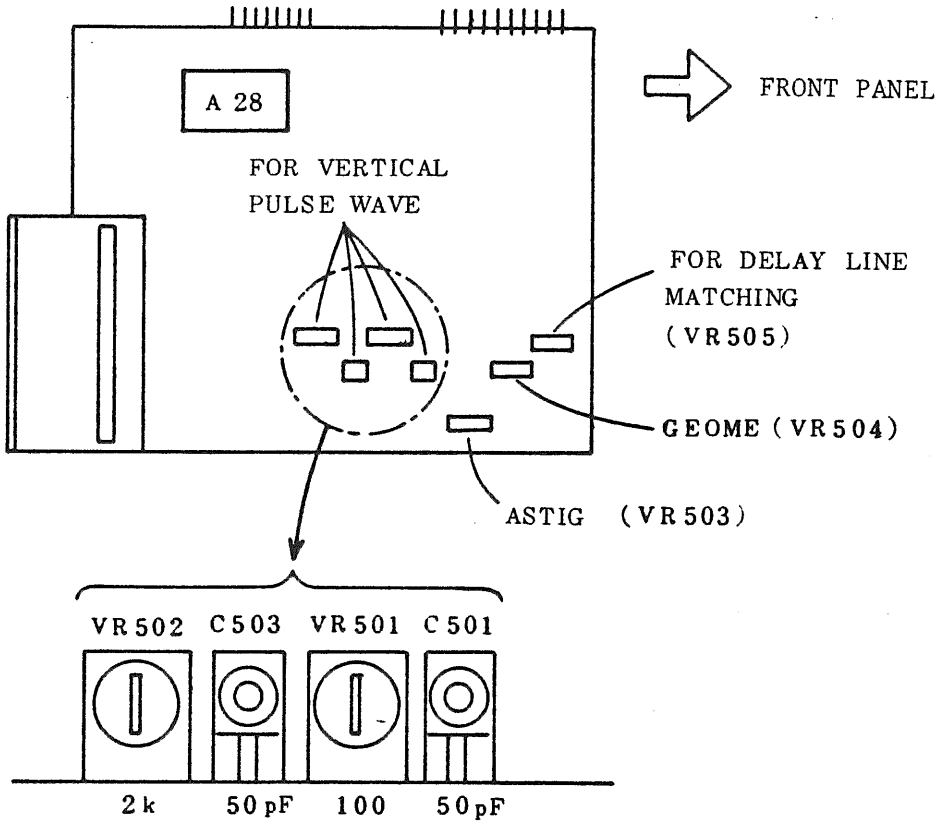
In this case, note that the vertical sensitivity is affected if VR505 is turned.

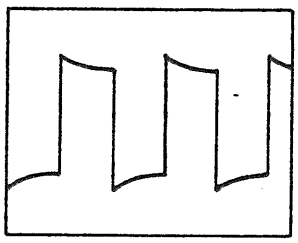
(4) Adjust the 1 MHz square wave characteristics with VR501 and C501 of printed board A28.

(5) Next, check the waveform at signal frequency 100 kHz. If reverse sag is found, adjust the waveform with VR502 and C503 of printed board A28.

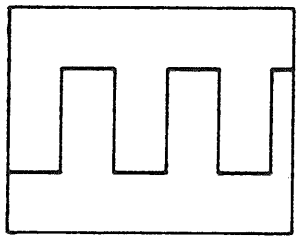
(6) changing the signal frequency to 10 kHz, 1 kHz, 100 Hz and 10 Hz, check for waveform distortions.

(7) For CH2 also, check for signal distortions at signal frequencies 1 MHz, 100 kHz, 10 kHz, 1 kHz, 100 Hz and 10 Hz.

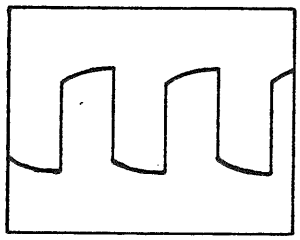




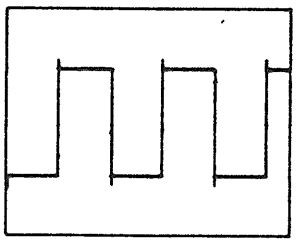
Adjustment
required

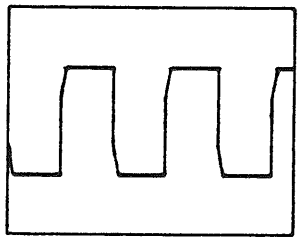


Ideal
waveform



Adjustment
required





6.8 Confirming the Frequency Response Bandwidth

To check the frequency response, a sine wave signal generator which can provide a constant voltage output with an accuracy of ±1.5% or better covering a frequency range of 50 kHz to 35 MHz is required.

Set the oscilloscope in the CH1 or CH2 operation mode, set the VOLTS/DIV switch in the 5 mV/DIV position, and apply a sine wave signal of 50 kHz with an amplitude of 8 DIV on the screen. Vary the frequency and check that the amplitude at 35 MHz is not less than 5.7 DIV (-3 dB), for both CH1 and CH2.

Note that this frequency response confirmation is requred whenever the high-frequency response has been adjusted as explained in Section 6.7.

6.9 Calibration of Sweep Time

Set the TRIGGER MODE switch and TIME/DIV switch as follows and apply to the vertical input terminal an accurate time marker signal of 1 msec or a 1 kHz signal (preferably a square wave).

TRIGGER MODE: AUTO
TIME/DIV: 1 mS

The sweep time accuracy specification is satisfied if the measured value is within ±3% of the dial indication. The 1 msec/DIV is used as the reference for other ranges and, therefore, this range should be calibrated especially accurately. So adjust the SWEEP CAL (VR403) semi-fixed resistor that the accuracy becomes better than ±0.5%. Also, pull up the POSITION knob to the PULL 5 MAG state and check that the accuracy is within ±0.5%.

Next, set the TRIGGER MODE switch and TIME/DIV switch as follows and apply to the vertical input terminal a time marker signal of 10 µsec or 100 kHz signal (preferably a square wave).

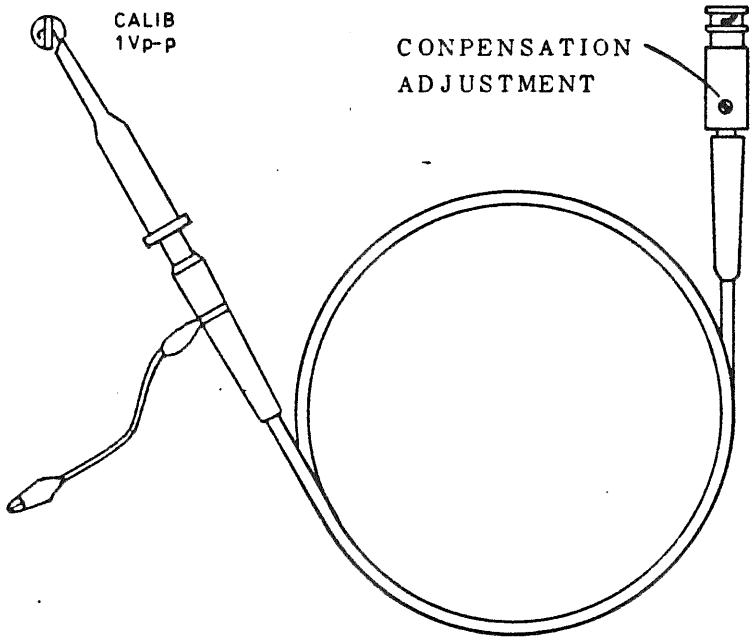
TRIGGER MODE: AUTO
TIME/DIV: 10 µsec

So adjust C4202 that the accuracy becomes better than ±5%. Also, pull up the POSITION knob to the PULL 5 × MAG state and check that the accuracy is within ±1.5%. Note that, when in the PULL 5 × MAG state, the accuracy requirment differs by range as follows:

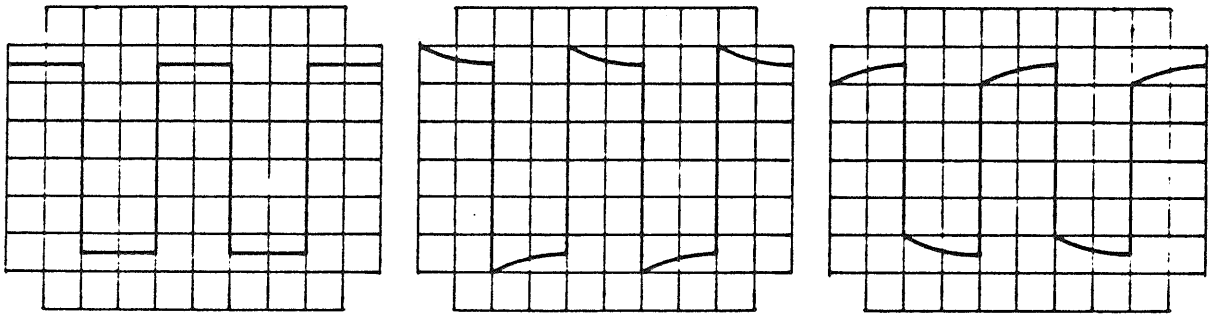
0.5 S ~ 1 μS/DIV: +1.5%
0.5 μS, 0.2 μS/DIV: +3%

6.10 Calibration of Probe

To calibrate the probe, use the 1-kHz 1-Vp-p signal of the calibration voltage terminal of the front panel.



Connect the probe to the CH1 or CH2 input terminal and set the range at 20 mV. Touch the 1 Vp-p calibration voltage terminal with the probe tip. A square wave signal with an amplitude of 5 DIV will be displayed on the screen. So adjust the compensator of the probe with a small screwdriver that an ideal waveform is obtained.



Ideal waveform

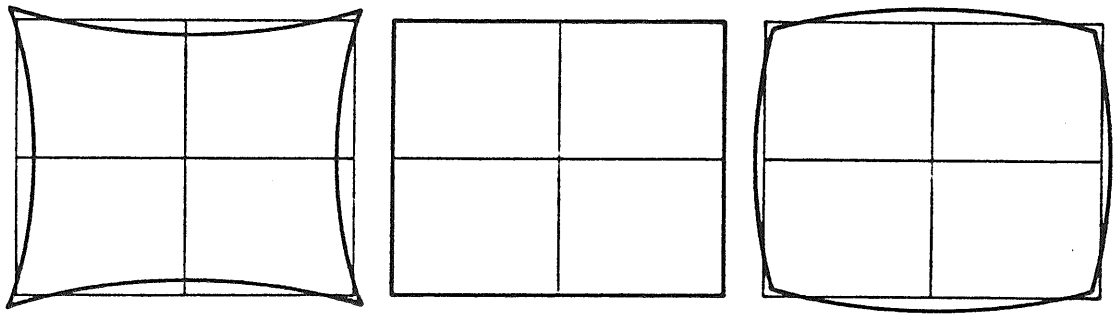
Adjustment required

Adjustment required

6.11 Adjustment of Astigmatism and Geometry

ASTIG (VR503): So adjust this control, together with the FOCUS control, that the displayed trace or spot becomes sharpest.

GEOMETRY (VR504): This control is for redusing geometrical distortion (pincushion distortion or barrel distortion) of the pattern displayed on the screen.

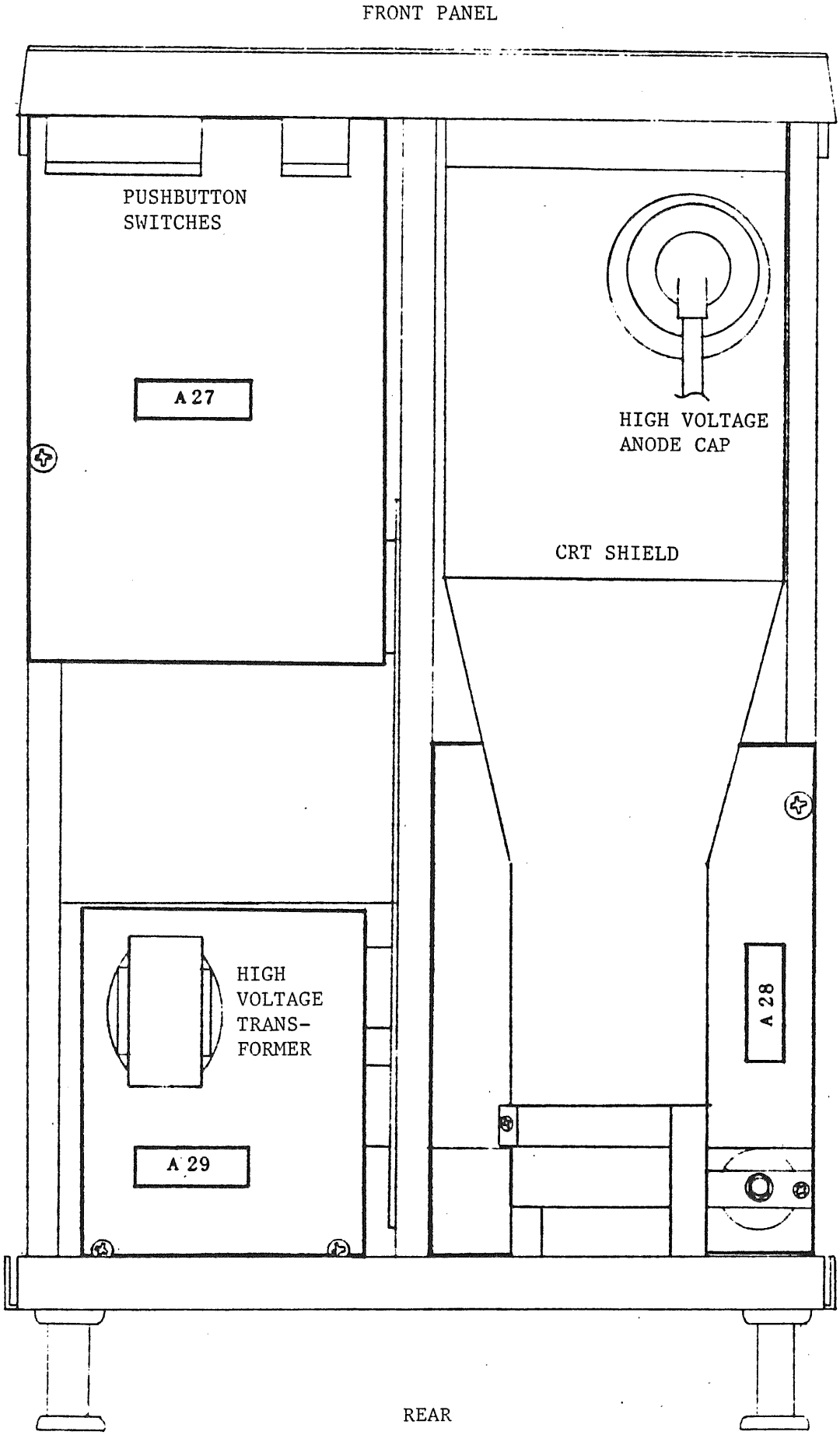


Pincushion distortion

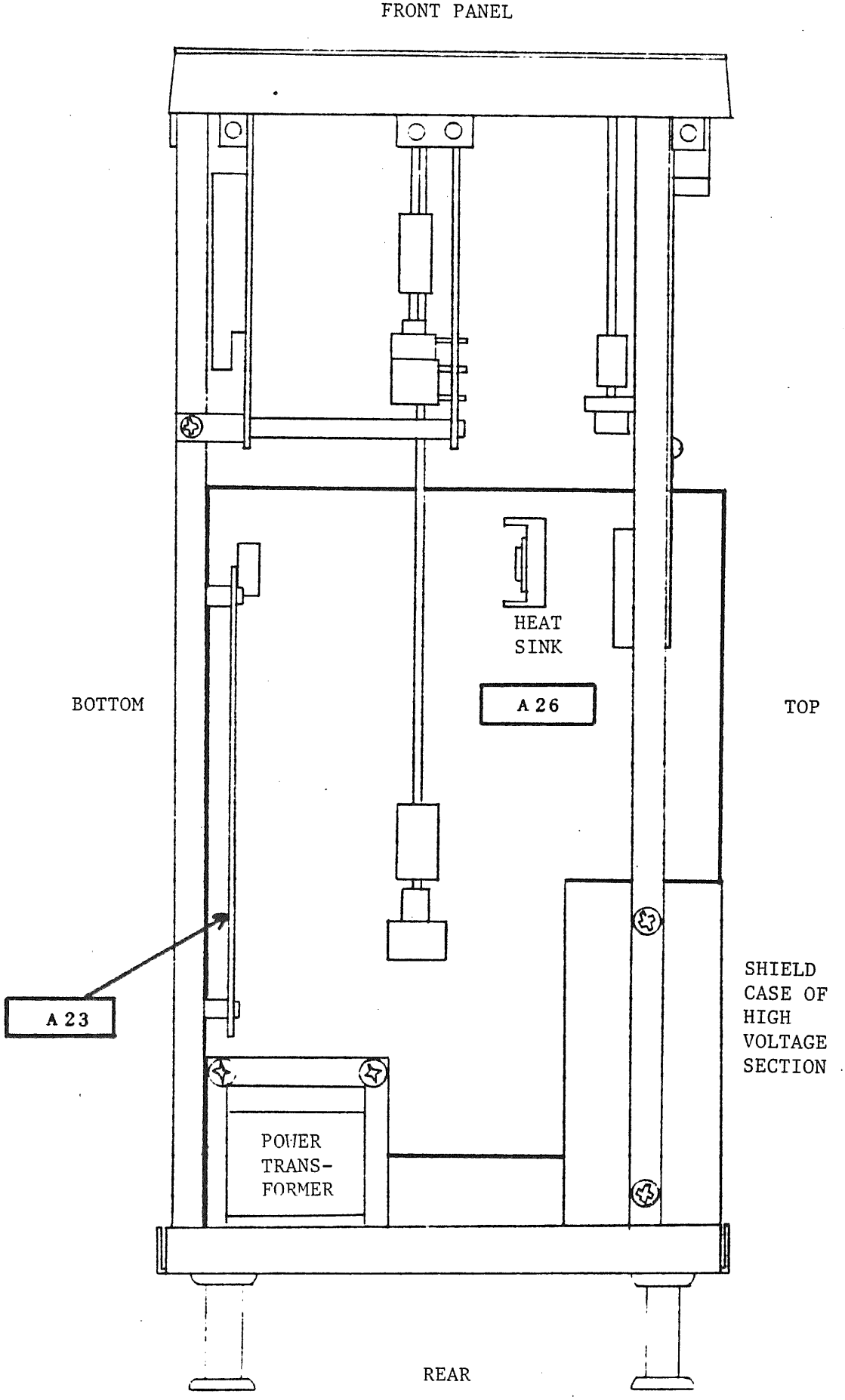
Normal waveform

Barrel distortion

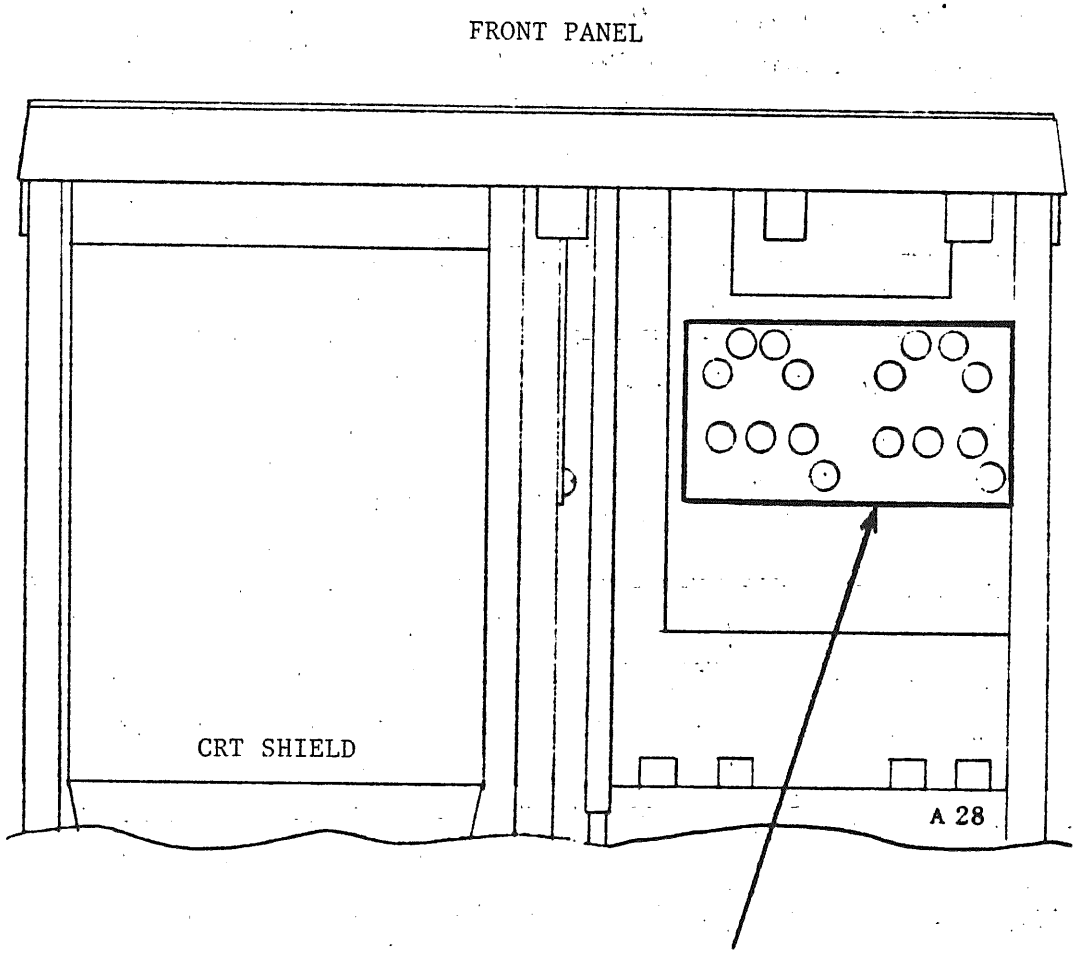
Layout of printed boards (top view)



Layout of printed boards (right-hand side view)



Layout of vertical VOLTS/DIV cotrols (bottom view)



Controls of input capacitances of respective ranges of vertical VOLTS/DIV switches of CH1 and CH2.

"CH1 SIGNAL OUTPUT" DESCRIPTION

This oscilloscope has added "CH1 SIGNAL OUTPUT" to connect a frequency counter and the other test equipment, located at the rear panel. The specification and schematic diagram are shown as follows.

Specification

Item	Specifications	Remarks
Output voltage	Approx. 20 mV/DIV, with 1 MΩ load Approx. 10 mV/DIV, with 50 Ω load	Output voltage per 1 DIV on CRT screen
Output impedance	Approx. 50 Ω	
Frequency response	DC to 35 MHz, within -3 dB	50Ω termination
DC level of output	Approx. 0 volts	

Schematic diagram