

INSTRUCTION MANUAL
FOR
MODEL CS - 1554
DUAL - TRACE SYNCHROSCOPE

C O N T E N T S

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BEFORE plugging the AC cord into a power outlet, MAKE SURE that your line voltage corresponds to the operating voltage to which the instrument is set.

SECTION 1. GENERAL and FEATURES

The model CS-1554 is an all solid state dual-trace synchroscope (triggering oscilloscope) with a 130 mm CRT, which provides 10 MHz bandwidth and sweep rates of 0.5 μ sec/cm to 0.5 sec/cm. The scope can be used as an ordinary scope with a single trace, or, when comparing of two different waveforms, it can provide two separate traces which in many ways is like having two scopes.

The model CS-1554 is a widely-used synchroscope for observing and measuring waveforms on various electric and electronic equipment.

— Features —

- (1) Fast time to warm-up.
- (2) Two vertical amplifiers having the same performance, a high-sensitivity (10 mV/cm) and wide frequency bandwidth (DC ~ 10 MHz).
- (3) When dual-trace display, the sweep can be triggered by CH1 signal only.
- (4) POLARITY switch provides to invert the polarity of CH2 signal.
- (5) Dual-trace display in either Chopped or Alternate mode.
- (6) ADD position of the MODE switch provides to display the sum of two signals, and the difference between two signals by the POLARITY switch.
- (7) Low power consumption, small and light-weight.
- (8) TV-H and TV-V sweep rates for observing TV video signals.
- (9) Build-in calibrator, 1 KHz square wave.

SECTION 2. SPECIFICATIONS

2 - 1 CATHODE RAY TUBE (CRT) : 130 ARB 1

2 - 2 VERTICAL SECTION

Mode : CH1 only, CH2 only, CHOPPED, ALTERNATE
and ADD

Deflection sensitivity (factor): 0.01 V/cm ~ 20 V/cm \pm 5%, continuously
(common to both channels) adjustment in all 11 ranges.

Rise time : 35 n sec.
(common to both channels)

Input impedance : 1M Ω shunted by 38PF
(common to both channels)

Frequency response : DC DC ~ 10 MHz (-3 dB)
 (common to both channels) AC 2Hz ~ 10 MHz (-3dB)
 Overshoot : Less than 3% (100 KHz square wave)
 (common to both channels)
 Tilt : Less than 5% (AC, 50 Hz square wave)
 (common to both channels)
 Isolation (between channels) : More than 55 dB at 1 KHz
 Chopping frequency : 140 KHz
 POLARITY inversion : Polarity of CH2 signal can be inverted.
 Maximum input voltage : 300V (DC + AC peak) or 600 Vpp

2 - 3 SWEEP SECTION

Sweep rate : 0.5 μ sec/cm ~ 0.5 sec/cm \pm 5%, continuously variable in all 19 ranges.
 TV - V (3.6m sec/cm)
 TV - H (13 μ sec/cm)
 Sweep magnification : Each sweep rate can be increased 5 times by horizontally expanding the center portion of display.
 Linearity : Less than 3% (0.5 sec/cm ~ 2 μ sec/cm ranges)
 Less than 5% (1 μ sec/cm ~ 0.5 μ sec/cm ranges)

2 - 4 SWEEP TRIGGERING

Mode : Automatic triggering or adjustable triggering at desired level.
 Source and signal requirement : Internal triggering (available with a signal which provides more than 10 mm deflection on the CRT)
 CH1 (available with a signal more than 10 mVpp)
 External triggering (available with a signal more than 1 Vpp)
 Coupling : AC 30 Hz ~ 10 MHz (with AUTO position)
 50 Hz ~ 10 MHz)
 LF 5 Hz ~ 10 KHz (" 10 Hz ~ 10 KHz)
 DC DC ~ 10 KHz (" 10 Hz ~ 10 KHz)

Trigger slope : Either positive or negative slope of the triggering signal.

2 - 5 EXTERNAL HORIZONTAL AMPLIFIER

Deflection sensitivity : 250 mV/cm
(factor)
Frequency response : DC ~ 1 MHz (-3 dB)
Input impedance : 100 K Ω (\pm 20 %) shunted by less than 60 PF

2 - 6 CALIBRATOR : 10 Vpp and 1 Vpp \pm 5%, 1 KHz square wave

2 - 7 INTENSITY MODULATION VOLTAGE : More than 15 Vpp

2 - 8 POWER REQUIREMENT : AC 100V (117V, 230V) 50/60 Hz, 27 watts

2 - 9 DIMENSION : Width 250 mm (9 - 7/8")
(include all protrusion) Height 224 mm (8 - 7/8")
Depth 438 mm (17 - 2/8")

2 - 10 WEIGHT : 8.4 Kg (18.6 Lbs)

2 - 11 ACCESSORIES furnished

Probe (PC - 12) 2 : Attenuation 10 X
Input impedance 10 M Ω shunted by 15 PF
Cable assembly (CA - 36) : Shielded cable terminated on one end
..... 1 with a dual banana plug and on the other
end with alligator clips.
Instruction manual 1
Fuse (1A) 1
(0.5A for 230V source)
..... 1

SECTION 3. CIRCUIT DESCRIPTION

Refer to Attached Fig. 2 and Fig. 3.

3 - 1 GENERAL

Input signals to be displayed are applied to the input terminals CH1 and CH2, and then these signals are connected to the vertical amplifier CH1 and CH2 respectively through the attenuator networks.

In the vertical amplifier the signals are amplified and coupled through

the dual-trace switching gate to the output amplifier. The dual-trace switching gate determine the channel on which signal to be coupled to the output amplifier.

The signal from the output amplifier is coupled to the deflection plates of the cathode ray tube (CRT).

The vertical section consists of the direct coupling differential amplifiers through all its stages, since an high-stability performance should be required especially.

The sample of the output amplifier's output is applied to the triggering source switch for internal triggering source. This triggering source switch determines the source of the trigger signal and triggering slope, and coupled the signal to the square wave shaper circuit.

The square wave produced is turned into trigger pulse, through the differential circuit, which drives the gate multivibrator circuit together with sawtooth wave from the hold-off circuit.

The gate multivibrator circuit is activated with the trigger pulse, which forms the dc loop together with the Miller integrator circuit, and hold-off circuit, to deliver the sweep voltage (sawtooth wave). This sweep voltage is coupled through the horizontal amplifier to the deflection plates of the CRT.

Other circuit explanation are discussed in each article.

3 - 2 VERTICAL SECTION

3 - 2 - 1 INPUT CIRCUIT and ATTENUATOR

Input signals applied to the VERTICAL INPUT 1 and 2 connector can be ac-coupled, dc-coupled or internally disconnected by the AC-GND-DC selector switch. And then, these signals passed through the above switch are coupled to the frequency-compensated attenuators which attenuated too large signal to the desired amount. The input impedance of each channel is 1 M Ω shunted by 38 PF through 11 ranges.

3 - 2 - 2 VERTICAL AMPLIFIER

The output signals from the attenuator networks above mentioned are applied through the excessive input protection circuits using FET (Field Effect Transistor) Q₂ (in CH2) and Q₄ (in CH1), to the vertical amplifiers. This protection circuits utilizing a better diode characteristic of FET limits V_{GDS} of Q₅ (in CH2) and Q₇ (in CH1) below 1 volt. FET Q₅ and Q₇ are used as a source follower circuit with a high input impedance to the input circuit. Also, FET Q₆ (in CH2) and Q₈ (in CH1) are used to form a balanced

circuit for reducing the effect of a drift due to variation of power source voltage and temperatures. Further, the following stages Q_{9,10} (in CH2) and Q_{11,12} (in CH1) provide a low output impedance and their output signals are connected to the differential amplifiers Q_{13,14} (in CH2) and Q_{15,16} (in CH1). The dc level of balanced signal is adjusted by the source resistor VR_{101a} (in CH2) and VR_{102a} (in CH1) as DC BAL to obtain the balance of the emitter GAIN circuit. VR₁₀₃, VR₁ (in CH2) and VR₁₀₄, VR₃ (in CH1), placed in the emitters of Q_{13,14} and Q_{15,16} respectively, provide to adjust the gain, and Q_{17,18} VR_{101b} VR₂ (in CH1) Q_{19,20} VR_{102b} VR₄ shift the dc level to position the trace on the CRT at the proper position horizontally. The signal from CH1 is coupled directly to the dual-trace switching gate, but the signal from CH2 is coupled through the CH2 POLARITY switch to the dual-trace switching gate circuit.

The dual-trace switching gate determines whether the CH1 signal or CH2 signal passes on to the differential amplifier Q₂₃ ~ Q₂₆ through the emitter follower Q₂₁ ~ Q₂₂.

This amplifier Q₂₃ ~ Q₂₆ are connected in a cascade connection to reduce the Miller effect to the signal at a higher RF region. This allows the differential amplifier to provide a sufficient bandwidth.

The output signal of the above differential amplifier are fed through Q₂₇, Q₂₈, which presents low output impedance, to final stage amplifier. Also, the same output signal fed through Q₄₃, Q₄₄ serving as a Buffer and level shifter to the sweep trigger circuit for internal triggering source. VR₆ (INT DC ADJ) provides to adjust dc level of the trigger signal for a zero volt.

The final stage Q₂₉ ~ Q₃₂, which forms a cascade differential circuit is a frequency-compensated amplifier by TC₁ capacitor. In this stage, the signal is sufficiently amplified and directly connected to the vertical deflection plates of the CRT.

The overall gain of the above mentioned vertical amplifier is approximately 60 dB, which corresponds to a deflection sensitivity (factor) of 10 mV/cm measured on the CRT screen. Also, the frequency response of the vertical amplifier is DC to 10 MHz (-3 dB).

3 - 2 - 3 DUAL-TRACE SWITCHING GATE CIRCUIT

D₁ ~ D₄ (in CH2), D₅ ~ D₈ (in CH1) from the switching gate circuits. The four-diode gate can be considered as a switch that select the channel signal desired to be applied to the output amplifier. Two square wave outputs inverted to each other in their polarity which are produced from the

switching multivibrator Q₄₁, Q₄₂, turn the four-diode gate circuits on and off. Thus, the preceding vertical amplifiers are switched alternately by the switching gate.

3 - 2 - 4 SWITCHING MULTIVIBRATOR and CHOP-BLANKING CIRCUIT

The multivibrator Q₄₁, Q₄₂ is operated as a flip-flop or an astable multivibrator by biasing transistors. In the CHOPPED mode, the multivibrator operates as an astable multivibrator with 140 KHz repetition rate, from which the square wave output turns the four-diode gates on and off.

In the ALTER mode, the multivibrator operates as a flip-flop. Then, the signal to trigger the multivibrator is applied from the gate multivibrator in the sweep circuit through the unblanking amplifier and triggering circuit to the bases of Q₄₁, Q₄₂. Accordingly, at the end of each sweep, the output of the flip-flop is inverted and turned the four-diode gate on and off.

In the ADD mode, the power supply to the switching multivibrator is disconnected. Therefore, the four-diode gates of both channels are opened, and the added signal of CH1 and CH2 signal is connected to the output amplifier.

Also, in the CHOPPED mode, when the multivibrator is inverted, the pulses appears at the emitter of the multivibrator. The pulses is amplified by Q₄₅ and together with unblanking signal coupled to the grid 1 of the CRT for unblanking the switching interval trace and transient distortion during the chopping period.

3 - 2 - 5 TRIGGER SIGNAL AMPLIFIER

In the CH1 position of the SOURCE switch, the sweep is triggered by the trigger signal applied from CH1 only.

Therefore, the trigger signal is applied from the emitter of Q₁₁, Q₁₂ (with a low output impedance), placed in front of the switching gate circuit, to the emitter follower Q₃₃, Q₄₇ which offers no disturbance to the preceding stage.

For eliminating a drift, the circuit is composed as a balanced amplifier.

Further, the trigger signal is connected through Q₃₄, Q₃₅ (amplifier), Q₃₆, Q₃₇ (serving as impedance conversion), PNP junction Q₃₈, Q₃₉ (amplifier and level shifter) and Q₄₀ (emitter follower with a low output impedance) to the sweep trigger circuit.

Also, the dc level of the trigger signal amplified in the above stages is adjusted by the emitter resistor VR₅.

3 - 3 SWEEP TRIGGER CIRCUIT

3 - 3 - 3 PHASE INVERTER and LIMITER CIRCUIT

The TRIG SOURCE switch determines the source of the trigger signal to be coupled to this stage Q_6 , Q_7 . This circuit is a sort of differential amplifier with a ground potential input which, because of its narrowed dynamic range, limits the level of its input signal to a certain level. At the same time, this stage operates as a phase inverter. That is, in the positive (+) position of the SLOPE switch, the trigger signal is coupled to the base of Q_6 . While in the negative (-) position, the signal is coupled to the base of Q_7 , this causes the circuit to deliver the phase inverted output. In the above operation, the transistor with no input signal is biased through VR_{105a} to adjust the triggering level. Also, in the AUTO position, the circuit with a ground potential input circuit is biased with a fixed bias.

In the AC position of the COUPLING switch, a dc component of the trigger signal is blocked by the coupling capacitor C_{110} and a frequency-component of trigger signal is coupled to the COUPLING switch. Then, triggering frequency bandwidth is 30 Hz ~ 10 MHz (50 Hz ~ 10 MHz, with the AUTO position). In the LF position, since a noise and unwanted component of the chopping signal are rejected by the capacitor C_{111} (placed in the input circuit), triggering frequency bandwidth is down to a very low frequency i.e. 5 Hz ~ 10 KHz (10 Hz ~ 10 KHz with the AUTO position). In the DC position, the sweep is triggered with frequencies down to dc, since the trigger signal is directly coupled to the sweep trigger circuit. Also, same as LF position, the capacitor C_{111} placed in the input circuit, triggering frequency bandwidth is DC ~ 10 KHz.

3 - 3 - 2 SQUARE WAVE SHAPER CIRCUIT

This stage consists of the Schmitt Circuit Q_8 , Q_9 mainly. In this circuit, when the input level of the trigger signal reaches a certain level or more, the Schmitt Circuit produces a uniform square wave with a constant level from the input signal. This square wave is coupled through the differential circuit to the gate multivibrator Q_{10} ~ Q_{13} as a triggering signal. With in the AUTO position, the bistable multivibrator is turned into the astable multivibrator with 40 ~ 50 Hz repetition. in this time, if the input signal is not applied a sweep repetition rate is at 40 ~ 50 Hz. Since this astable multivibrator oscillates feebly, it will be pulled in easily synchronized with the input signal if supplied.

3 - 4 SWEEP CIRCUIT

3 - 4 - 1 GATE MULTIVIBRATOR, MILLER INTEGRATOR and HOLD-OFF CIRCUIT

The gate multivibrator $Q_{10} \sim Q_{13}$, i.e. a bistable multivibrator of the square wave shaper circuit, the Miller integrator $Q_{17} \sim Q_{23}$ and the hold-off circuit Q_{14} , which driven under control from the triggering signal, form a dc loop to generate a sawtooth wave. When adjustable triggering, by adjusting the STABILITY control the multivibrator is set in the condition which make it ready to be inverted the state of itself with the triggering signal coming. Namely, when the triggering signal led from the square wave shaper, the state of the multivibrator is changed and the switching diodes $D_3 \sim D_4$ turned off.

This charges the time-base capacitors inserted in the gate circuit of FET Q_{17} in accordance with the time constant depending on the value of the time-base capacitor and resistor. While, this charging signal is received through a high input impedance by FET Q_{17} , from which it is applied to the following stage $Q_{18} \sim Q_{19}$. This stage $Q_{18} \sim Q_{19}$ provides to amplify the charging signal, but also inverts the phase of the signal.

The output of the emitter follower Q_{20} with a low output impedance fed to the horizontal amplifier, from which amplified signal is fed as the sweep voltage to the horizontal deflection plates of the CRT to display a trace.

A part of the output of Q_{20} is fed back through Capacitor C_{14} and Diode D_5 to one side of the time-base capacitor above mentioned. This enables the time-base capacitor to be charged with a constant current, thereby providing the charging waveform with a better linearity. The hold-off circuit feeds the charging waveform with a delay back to the input of the gate multivibrator until it reaches a given level, then it inverts the state of the gate multivibrator to the original condition to complete one sweep.

3 - 4 - 2 INVERTER CIRCUIT

The gate multivibrator produces a negative pulse as output signal during a display. To obtain a positive pulse for the unblanking signal, this pulse is inverted in phase through the inverter circuit Q_{15} . The positive signal produced, together with the chop-blanking signal, is coupled to the grid of the CRT and cut off the CRT in the period of the blanking and without input signal. Also, in the ALTER mode the output of the inverter is coupled through the differential circuit to the triggering circuit as trigger pulse for driving the flip-flop Q_{41} , Q_{42} .

3 - 4 - 3 HORIZONTAL AMPLIFIER CIRCUIT

The sawtooth wave output of the Miller circuit is applied to emitter follower Q₂₁, with a low output impedance. The output of emitter follower is fed to the differential amplifier Q₂₂, Q₂₃.

The variable resistor VR₆ (MAG CENT) provides the shift of the bias of Q₂₃ to adjust the dc balance, which may be changed when the MAG switch is pulled out or in.

The amplifier is also provided with the variable resistor VR₇ (POS ADJ1) which inserted between the emitter resistor R₅₄ and R₅₅ of Q₂₂, Q₂₃, and provides to adjust a waveform position appearing on the CRT screen horizontally.

To obtain the rated gain as selected by the MAG switch, the switch provides selection of VR₈ (GAIN ADJ) and VR₉ (MAG ADJ) inserted in the emitter circuit of Q₂₂, Q₂₃. In case the trace is swept by an external signal, the signal is connected from the EXT HOR connector to the variable resistor VR_{106b} (GAIN), where its gain adjusted. The signal from VR_{106b} is applied to FET Q₁₆ (serving as an impedance conversion) and then to the horizontal amplifier mentioned above.

The variable resistor VR₄ (POS ADJ2) is provided to adjust the dc level of the external signal to the same level as the mean voltage of the internal sweep signal in order to position the waveform to the center horizontally of the CRT screen. In this case, the horizontal amplifier provides a deflection sensitivity (factor) of 250 mV/cm and a frequency bandwidth of DC - 1 MHz (-3 dB).

3 - 5 CALIBRATOR CIRCUIT

The calibrator consists of 1 KHz multivibrator Q₁, Q₂ and the Schmitt circuit mainly. The output of the 1 KHz multivibrator is fed to the Schmitt circuit. The Schmitt circuit turns the 1 KHz signal led from the multivibrator into the square wave signal which is connected to the resistive voltage divider.

Thus, calibration voltage 10 Vpp and 1 Vpp are delivered to the CAL terminals 10 Vpp and 1 Vpp.

3 - 6 POWER SUPPLY CIRCUIT

The AC source voltage is applied to the primary windings of the power transformer. The high tension voltage induced across the high tension secondary windings is rectified by high tension selenium rectifiers D₁₀₁ and D₁₀₂ on the double voltage rectification basis to provide high tension voltage for the CRT.

The voltage induced across the low tension secondary windings of the transformer is rectified by diodes D103, D104, D9 and D10 to provide the B supply voltage.

The low tension voltage for the vertical and horizontal amplifiers are supplied by the stabilized B supply through the regulator Q24 and Zener diode D7.

SECTION 4. OPERATING PROCEDURE

Refer to Attached Fig 1.

Table 1. Shows the description of the front-panel controls and connectors.

Table 1. FRONT-PANEL CONTROLS & CONNECTORS

Ref. NO	Front-panel controls & connectors	Description of function & operation
①	SOURCE [INT,CH1,EXT]	<p>Triggering source switch</p> <p>Selects the source of the triggering signal.</p> <p>INT : The sweep is triggered by the vertical input signal. When dual-trace display, it is difficult to obtain a stable display, because a composite signal of CH1 and CH2 input signal is used as a triggering signal.</p> <p>CH1 : The sweep is triggered by the CH1 input signal only. When dual-trace display, therefore, the signal desired to be used as the triggering signal should be connected to the VERT INPUT 1 connector and the proper triggering signal is obtained for a stable display.</p> <p>EXT : In this position, the sweep is triggered by the signal applied to the EXT TRIG connector ⑧.</p>
②	SLOPE [+ , -]	<p>Triggering slope switch</p> <p>Determines whether positive-going (+) or negative-going (-) portion of the trigger signal which trigger the sweep circuit.</p> <p>(+) : When the SLOPE switch is in the (+) position, the display will start with the positive - going portion of the waveform.</p>

Ref. NO	Front-panel controls & connectors	Description of function & operation
		<p>When in the (-) position, the display will start with the negative -going portion of the waveform.</p>
③	<p>COUPLING [AC,LF,DC]</p>	<p>Triggering coupling switch</p> <p>Three methods of coupling trigger signal to the sweep trigger circuit can be selected by this switch. Each position of this switch should be selected, considering whether the triggering signal is dc or ac, and triggering frequency.</p> <p>AC : In the AC position, the dc component of the trigger signal is blocked. The AC position is available at the triggering frequencies of 30 Hz ~ 10 MHz.</p> <p>LF : In the LF position, the sweep is triggered with ac component (5 Hz ~ 10 KHz) of the trigger signal. When dual-trace display in the CHOP mode, the LF position is useful. The LF position provides a stable display without disturbing triggering, caused from noise and switching signal component of chopping.</p> <p>DC : In the DC position, the sweep can be triggered by signals containing dc components. in this time, for dc coupling, the AUTO of the TRIG LEVEL control ③ must be out of operation. With the SOURCE switch set in the INT position, a changes of dc component resulted from interacting with adjustment of the vertical position is added to the input signal therefore, the triggering level is changed depending on the position of a display on the CRT. Note that the exceeding amount of dc component, in case of EXT TRIG, makes the TRIG LEVEL changed largely and the sweep ceased.</p>

Ref. NO	Front-panel controls & connectors	Description of function & operation
④	SWEEP TIME/CM	<p>Sweep rate selector switch</p> <p>This switch provides selection of 19 calibrated sweep rates ranging from 0.5 μ sec/cm to 0.5 sec/cm in 1-2-5 steps. Further it provides selection of TV-H and TV-V for observing TV video signal, and also EXT. With the VARIABLE/HOR GAIN control ⑤ set to the CAL position the indicated sweep rate shows a sweep time per 1 cm on the CRT screen.</p>
⑤	VARIABLE/HOR GAIN CAL	<p>Sweep rate fine adjustment and horizontal gain control.</p> <p>It provides continuously variable sweep rate between ranges throughout 19 ranges.</p> <p>In the CAL position (fully clockwise) the indicated sweep rates calibrated.</p> <p>Also, in the EXT position of the SWEEP TIME/CM ④, it provides horizontal gain adjustment and clockwise rotation increase the amplitude of the waveform.</p>
⑥	STABILITY	<p>Trigger stability control.</p> <p>In the fully clockwise position, the sweep free runs regardless of the sweep trigger circuit. in this time the sweep can not be triggered in spite of a presentation of the trace.</p> <p>Turning the control counterclockwise gradually, the sweep circuit will be placed in ready to be triggered state.</p> <p>The sweep circuit makes a display only when the input signal is applied.</p> <p>(Even in ready to be triggered state, the sweep circuit makes no display, if the TRIG LEVEL is placed at improper position.</p> <p>When in the AUTO position, on the other hand, it provides a sweep at 40 ~ 50 Hz repetition rate, even if there is no input signal.)</p> <p>In this condition, the sweep is triggered by the</p>

Ref. NO	Front-panel controls & connectors	Description of function & operation
		<p>input signal completely. Further counterclockwise rotation, the sweep will cease.</p>
⑦	<p>TRIG LEVEL</p> <p>AUTO</p>	<p>Triggering level control for adjustable triggering at desired level.</p> <p>It provides triggering phase adjustment which determine the point on the waveform at which the sweep will be triggered.</p> <p>In the AUTO position (fully counterclockwise), automatic triggering is obtained. In this position, the sweep is triggered whenever the input signal applied.</p> <p>When input signals are not present, the sweep automatically triggers at 40 ~ 50 Hz repetition rate.</p> <p>In the AUTO position, however, it doesn't provide a triggering level adjustment. When the input signal is intricated waveform, the sweep is not easy to be triggered than adjustable triggering.</p>
⑧	EXT TRIG	<p>External trigger signal input connector.</p> <p>When using this connector, the SOURCE switch should be set to the EXT position.</p>
⑨	<p>◆ POSITION</p> <p>PULL MAG × 5</p>	<p>Horizontal position control</p> <p>Waveform can be moved to the desired position horizontally by this control.</p> <p>With the clockwise rotation, the waveform moves in the right direction, with the counterclockwise rotation, it moves in the left direction.</p> <p>Sweep magnifier switch</p> <p>With the switch pulled out, a sweep rate can be increased 5 times by horizontally expanding of the center division of display. In this time, the intensity of a display decreases a little.</p>

Ref. NO	Front-panel controls & connectors	Description of function & operation
⑩	<p>◆ POSITION</p> <p>DC BAL</p>	<p>CH2 vertical position control</p> <p>Controls the vertical position of the waveform CH2 displayed. With the clockwise rotation, the waveform moves upward. With the counterclockwise rotation, the moveform moves downward.</p> <p>CH2 dc balance adjustment</p> <p>The screwdriver adjustment provides to make the waveform stationary when the GAIN control ⑬ is rotated.</p>
⑪	<p>◆ POSITION</p> <p>DC BAL</p>	<p>CH1 vertical position control</p> <p>Operates in the same manner as for CH2.</p> <p>CH1 dc balance adjustment.</p> <p>Operates in the same manner as for CH2</p>
⑫	VOLTAGE/CM	<p>CH2 vertical attenuator</p> <p>The indicated value means a voltage per 1 cm of deflection on the CRT. The fully clockwise rotation of the VARIABLE control ⑬ provides a deflection of the indicated value correctly.</p> <p>For obtaining a desired deflection of the waveform on the CRT screen set the VOLTAGE/CM ⑫ to the proper position.</p> <p>This provides 11 ranges of 0.01 V/cm ~ 20 V/cm.</p>
⑬	<p>VARIABLE</p> <p>CAL</p>	<p>CH2 vertical attenuator adjustment</p> <p>Provides continuously variable between the ranges of the VOLTAGE/CM ⑫ .</p> <p>In the CAL position (fully clockwise), the attenuator is calibrated.</p>
⑭	VOLTAGE/CM	<p>CH1 vertical attenuator</p> <p>Operates in the same manner as the VOLTAGE/CM ⑫ .</p>
⑮	VARIABLE	<p>CH1 vertical attenuator adjustment</p>

Ref. NO	Front-panel controls & connectors	Description of function & operation
		Operats in the same manner as the VARIABLE CAL ⑬ .
⑯	AC - GND - DC	<p>CH2 input coupling switch</p> <p>In the DC position, a input signal connected to the amplifier directly so that all components of the input signal are amplified.</p> <p>In the GND position, the input signal path is broken and the input to the amplifier internal is grounded.</p> <p>In the AC position, dc component of the input signal is blocked by a capacitor</p>
⑰	AC - GND - DC	<p>CH1 input coupling switch</p> <p>Operates in the same manner as the AC-GND-DC switch ⑯ .</p>
⑲	VERT INPUT 2	CH2 vertical input connector
⑱	GND	CH2 Grounding terminal
㉑	VERT INPUT 1	CH1 vertical input connector
㉒	GND	CH1 Grounding terminal
㉓	MODE {CH1,CH2, CHOP,ALTER,ADD}	<p>Mode switch</p> <p>Selects the vertical mode</p> <p>CH1 : CH1 input signal displays.</p> <p>CH2 : CH2 input signal displays.</p> <p>CHOP: Dual-trace display in the CHOPPED mode by electronic switching between both channels at 140 KHz repetition, rate.</p> <p>In this case, the COUPLING switch ③ should be set to the LF position to obtain a stable display without disturbing triggering due to unwanted switching signal.</p> <p>When observing a signal above 10 KHz, the MODE switch should be set to the ALTER position.</p> <p>ALTER: This position provides a dual-trace display, the channel displayed changes at the end of each sweep. If low sweep rate desired, the</p>

Ref. NO	Front-panel controls & connectors	Description of function & operation
		<p>CHOP position provides best result.</p> <p>ADD : In the ADD position, the sum of two signals from both channels is displayed, containing a shift caused from the \blacklozenge POSITION ⑩ & ⑪ .</p> <p>With the CH2 POLARITY switch ⑫ set to the INV position, a difference between signals can be observed.</p> <p>In this case, the direction of waveform movement caused by operating \blacklozenge POSITION controls is inverted to each channel.</p>
⑫	<p>CH2 POLARITY</p> <p><input type="checkbox"/> NORM</p> <p><input type="checkbox"/> INV</p>	<p>CH2 polarity switch</p> <p>Provides the selection of NORM and INV</p> <p><input type="checkbox"/> NORM: With the knob depressed, provides NORM position.</p> <p>In this position, a waveform appearing on the CRT is same as the input signal as to their polarity.</p> <p><input type="checkbox"/> INV: With the Knob protruded, provides INV position.</p> <p>In this position, a waveform appearing on the CRT is opposite to the input signal as to their polarity.</p> <p>The direction of waveform movement caused by operating the \blacklozenge POSITION ⑩ is inverted and also the vertical position inverted.</p>
⑬	FOCUS	<p>Focus control</p> <p>Provides adjustment for a sharp trace or spot.</p> <p>To obtain a good viewing display, adjust the FOCUS considering intensity of brightness.</p>
⑭	INTENSITY	<p>Intensity control</p> <p>Controls brightness of the trace to the desired brightness.</p> <p>Turning the control counterclockwise, a waveform</p>


Ref. NO	Front-panel controls & connectors	Description of function & operation
		disappears.
②	(Neon bulb)	Neon bulb This neon bulb lights, when the POWER switch interlocked with the SCALE IL set on.
②	POWER/SCALE IL	Power switch and scale illumination In the OFF position (fully counterclockwise), the power disconnected. Turning the knob clockwise, the power is on and the graticule is illuminated. Further clockwise rotation increases illumination.
②	CAL  10 Vpp, 1 Vpp	Calibrator output terminal Provides 1 KHz square wave, 10 Vpp and 1 Vpp.
②	(Ornamental head screw)	Together with nuts mounts the filter, graticule and bezel adapter to the front-panel.
③	(Ornamental nut)	When replacing a bezel adapter or removing graticule, remove the nuts on the each corners of the front-panel.
④	(Graticule)	A green filter and transparent sheet are placed inside or outside of the graticule respectively. Internal graticule is 10 cm horizontally x 8 cm vertically.
④	(Bezel adapter)	When taking photos, this can be replaced with a close-up bezel adapter BA-5 (Optional).

Table 2. Shows the description of the controls, connectors and etc, located on the rear-panel.

TABLE 2. REAR-PANEL CONTROLES & CONNECTIONS

Ref. NO	Rear-panel controls & connectors	Description of function & operation
④	EXT HORIZ GND	External horizontal input connector Connector to which horizontal deflection signal connected. With the EXT position of the SWEEP TIME/CM ④, a signal connected to this connector is coupled to the horizontal amplifier. Grounding terminal
⑤	INT MOD	Intensity modulation input connector Intensity modulation can be made with a signal more than 15 Vpp.
⑥	ASTIG	Astigmatism adjustment Together with the FOCUS ②, provides a means for obtaining a sharp, well defined display over the entire trace length. The adjustment has been pre-adjusted for obtaining a sharp spot so that, this adjustment doesn't require so often.
⑦	(Line voltage selector)	Set this selector to be matched to the line voltage (i.e. 100, 117 or 230 V)
⑧	(Fuse-holder)	Fuse (1 A) If using the instrument in 230 V line voltage area, this 1 A fuse should be replaced with 0.5 A fuse furnished.
⑨	(Power cord compartment)	When transporting the instrument, provides storage for a power cord.

4 - 1 GENERAL OPERATION

Refer to Table 1 and Attached Fig. 1.

4 - 1 - 1 FIRST-TIME OPERATION

(1) Set the front-panel controls and connectors as follows :

(CONTROLS)

① SOURCE

(SETTING)

INT

② SLOPE	+
③ COUPLING	AC
④ SWEEP TIME/CM	1 ms/cm
⑤ VARIABLE/HOR GAIN	Fully clockwise
⑥ STABILITY	Fully clockwise
⑦ TRIG LEVEL	Centered
⑨ ◀ POSITION	Centered
⑩ ◆ POSITION	Centered
⑪ ▲ POSITION	Centered
⑫ VOLTAGE/CM	20 V/cm
⑬ VARIABLE	Fully clockwise
⑭ VOLTAGE/CM	20 V/cm
⑮ VARIABLE	Fully clockwise
⑯ AC-GND-DC	AC
⑰ AC-GND-DC	AC
⑱ MODE	CH1
㉓ CH2 POLARITY	☐ NORM
㉔ FOCUS	Centered
㉕ INTENSITY	Centered
㉖ POWER/SCALE IL	POWER off

- (2) Connect the power plug to a power source that meets the voltage and frequency requirement of the instrument.
- (3) Turn the POWER switch ㉖ clockwise and the neon-bulb lights. (indicates that the instrument is on)
- (4) Soon, the trace appears on the CRT screen.
If the trace is not positioned at the center of the screen adjust the ◆ POSITION control ⑩ and ◀ POSITION control ⑨ to position the trace at the center of the screen. To obtain the desired brightness of the trace, adjust the INTENSITY control ㉕. Also adjust the FOCUS control ㉔ for a sharp display.
- (5) Turn the STABILITY control ⑥ counterclockwise until the trace will disappear abruptly.
- (6) Turn the TRIG LEVEL control ⑦ to the AUTO position (fully counterclockwise) where the trace will appear again.
- (7) Now, the instrument is ready for measurement. So connected the signals to be displayed to the VERT INPUT 2 connector ⑲ and VERT INPUT 1 connector ⑳.
- Turn the VOLTAGE/CM switch ⑭ to the position which provides a proper amplitude of waveform on the CRT screen.

In this time, to obtain a display of the signal connected to the VERT INPUT 2 connector ⑬, switch the MODE switch ② from the CH1 position to CH2.

With the CHOP position of the MODE switch ②, two signals applied to the VERT INPUT 2 ⑬ and VERT INPUT 1 ⑭ connectors are switched at 140 KHz repetition rate and displayed continuously.

In the ALTER position, two signals are alternately displayed.

In the ADD position, the added signal of two signals is displayed.

- (8) When no waveform appears on the CRT screen, in spite of the applied signal mentioned above are estimated more than 0.01 Vpp, it can be confirmed whether the instrument operates properly, or not by applying a calibrator square wave voltage from the CAL $\bar{\Pi}$ terminal ⑮ to the VERT INPUT 2 connector ⑬ or VERT INPUT 1 connector ⑭.

Since a calibration voltage are 10 Vp-p and 1 Vpp, a deflection of the waveform will be 5 and 0.5 cm respectively if the VOLTAGE/CM switch ⑭ is set to the 2 V/cm position.

- (9) Turning the TRIG LEVEL, control ⑦ clockwise, the waveform will disappear and reappear with about a half of its rotation. In this position, the TRIG LEVEL control ⑦ provides a means for adjustment of the phase in which the sweep triggered. Further clockwise rotation of the control causes the waveform to disappear again.

- (10) When measuring the waveform containing dc component in it, the AC-GND-DC switch ⑰ should be set in the DC position.

In this case, the waveform shifts upward if the signal contains the positive dc voltage. Also, if the signal contains the negative dc voltage, the waveform shifts downward.

The reference position of zero volt on the CRT screen is confirmed by the setting the AC-GND-DC switch ⑰ to the GND position.

4 - 1 - 2 PRACTICAL MEASUREMENT

- (1) Ordinary waveform observation (with single trace display)

Set the MODE switch ② to the CH1 or CH2 which desired to be used.

Adjust the VOLTAGE/CM ⑭ and VARIABLE ⑮ (in CH2 VOLTAGE/CM ⑱, VARIABLE ⑲) for the desired deflection of the waveform.

Generally, the AC-GND-DC switch ⑰ (in CH2 ⑳) should be set to the AC position. If the signal to be observed is very low (below 5 Hz) or containing dc component, set the AC-GND-DC switch ⑰ to the DC position.

When amount of dc component is much larger than that of ac component, set the AC-GND-DC switch ⑦ to the AC position to block dc component. When using CH2, polarity of the input signal can be inverted by the CH2 POLARITY switch. With the SWEEP TIME/CM ④, adjust cycles of the signal appearing on the CRT.

With the VARIABLE control ⑤, adjust the sweep rate and make the waveform legible to observe. If the sweep time is longer than the period of the signal to be measured, there appears a large number of waveforms on the CRT.

But, if the sweep time is shorter than the period, only portion of a cycle is displayed. This portion of a cycle corresponds to the duration from the time at which the sweep triggered to the end of sweep time. The shorter the sweep time becomes, the lower the intensity of the trace becomes.

The MAG \times 5 switch pulled out increases sweep rate 5 times by expanding center division of the display. Set the STABILITY ⑥ so that the sweep is triggered at a point a little counterclockwise to the middle of the rotation.

In other words, set the control just before the point at which the trace appears on the CRT when there presents no input signal at the input.

Set the SOURCE switch ① in the INT or CH1 position and the COUPLING ③ to the AC position.

When the signal to be displayed is below 50 Hz, the COUPLING switch ③ should be set to the LF position.

Also, when the COUPLING switch ③ set to the DC position, the triggering level may shift depending on the rotation of the \blacklozenge POSITION control and amount of dc component, since the sweep is triggered by the signal containing dc component.

With the TRIG LEVEL ⑦ set at the point a little counterclockwise to the middle of rotation, adjust the point on the slope at which the sweep is triggered while observing the waveform.

Note that it becomes difficult to make the sweep triggered if the waveform is too small (less than 1 cm on the CRT). When the TRIG LEVEL control ⑦ is turned to the AUTO position fully counterclockwise, the triggering level is fixed and the sweep becomes automatic triggering. But, even if the COUPLING switch ③ set to the DC, it is impossible to be triggered by dc component of the input signal.

Also, when in the AUTO position, the waveform appears on the CRT screen at the all time without input signal. The sweep can be triggered stable

by ordinary waveform, but a random signal, intricate waveform signal or low frequency below 10 Hz cause the display unstable.

In this case, adjust the TRIG LEVEL control ⑦ with the AUTO position set off.

It should be noted that if this scope is used for a quantitative measurement, the power source voltage must be regulated as far as possible and the INTENSITY control ⑤ should not be manipulated during the measurement.

(2) Dual-trace display

Set the MODE switch ② to CHOP or ALTER position. When dual-trace display, set the SOURCE switch ① to CH1 or EXT.

With the CH1 position, the sweep can be triggered by only signal CH1 or with EXT position the sweep can be triggered by the signal which has integral relationship with the external triggering signal supplied to the EXT TRIG connector ⑧ .

Even with the INT position, the sweep can be triggered if the signals of CH1 and CH2 are the same signal in frequency and phase.

In this case, however, dc component of the vertical position and switching signal of chopping supplied to the sweep trigger circuit makes the display unstable.

In the CHOP mode especially, it is impossible to obtain a stable display setting the SOURCE switch ① set to the CH1 without the COUPLING switch ③ set to the LF position.

In the ALTER position of the MODE switch ② , the channel displayed changes at the end of each sweep, therefore, low sweep rate causes the observation difficult.

Also during the display of CH1, a single-shot signal can not be observed since CH 2 signal is not displayed during the display of CH1.

The ALTER position provides a display of higher frequency signal desirably.

In the CHOP position, signals to be displayed are switched by 140 KHz chopping signal. If low sweep rate desired, this provides a well display.

When the SOURCE switch set to CH1 or EXT position, with the COUPLING switch ③ set to LF position the input signal upto 10 KHz makes a well-display.

In the ADD position, the sum of signals from both channels are displayed. Since the sum of two signals is containing dc component of the vertical position, a composite waveform of CH1 and CH2 will appear at the center vertically on the CRT, if the waveforms of both channels are positioned symmetrical to the center vertically on the CRT screen.

In this ADD position, with the INV position of the CH2 POLARITY switch

the signal of CH2 inverted in phase is added to the signal of CH1, it means that the difference between CH1 and CH2 signals obtained on the CRT screen. For operation of the other controls, refer to (1) Ordinary waveform observation (with single-trace display).

(3) Observation of intensity modulation

Connect the external intensity modulation signal to the INT MOD connector ④ on the rear-panel of the instrument.

The INT MOD connector is directly connected to the cathode of the CRT, therefore, the intensity of the waveform increases with a negative modulation signal and the intensity decreases the intensity with a positive modulation signal.

(4) Measurement using the probe (PC - 12)

When using the probe, mind the following description.

The actual value of an input signal measured using the probe is ten times as large as the measured value.

Since the rated maximum input voltage of the probe is 350 V, don't apply a voltage more than 350 V to the probe.

SECTION 5. APPLICATIONS

The following information describes the procedure and techniques for making basic measurements.

These basic measurements can be applied to a wide variety of uses.

5 - 1 VOLTAGE, TIME-DURATION and FREQUENCY MEASUREMENT

To make a voltage measurement, use the following description.

If the signal containing dc component is desired to be measured, the AC-GND-DC switch should be set to the DC position.

To determine the reference line on the CRT screen, connect the reference voltage to the VERT INPUT or the probe if used, with the TRIG LEVEL control ⑦ set to the AUTO position.

If zero volt used as the reference voltage, the AC-GND-DC switch must be set to the GND position to make the ground reference.

Set the ◆POSITION control to move the reference line to the bottom line of the graticule. But if the input voltage is negative, the reference line should be set to the top line of the graticule.

Note that the ground reference is not available, the reference line should be calibrated each time the VOLTAGE/CM changes.

Since the reference line serves a standard for dc measurement, don't move the ◆ position control after a measurement has been completed.

Now, supply the signal to be measured to the VERT INPUT connector used and set the VARIABLE/HOR GAIN control to the CAL position, with the proper setting of the VOLTAGE/CM switch. Measure the vertical deflection (from the reference line) of the waveform displayed. The voltage are determined as follows:

$$\text{Voltage} = \text{vertical deflection (cm)} \times \text{VOLTAGE/CM setting} \times \text{probe attenuation factor}$$

When using the probe furnished, attenuation factor is 10X.

To make a time-duration measurement, set the SWEEP TIME/CM switch ④ to provide the distance of two points to be measured on the waveform easy to be measured.

in this time, the VARIABLE/HOR GAIN control should be set to the CAL position. Turn the \blacktriangleleft POSITION control to move the points between which the measurement will be made to the graticule horizontal centerline.

Also, turn the \blacktriangleright POSITION control to move the starting point of the time measurement to the vertical graticule line. Then, measure the horizontal distance between the time measurement points.

The time duration is determined as follows:

$$\text{Time duration} = \frac{\text{horizontal distance (cm)} \times \text{SWEEP TIME/CM setting}}{\text{magnification}}$$

The frequency of a periodically signal can be determined as follows:

Measure the time duration of one cycle of the waveform as described in the previous time duration measurement.

Note that the frequency of a signal is the reciprocal of the time duration of one cycle.

$$\text{Frequency (Hz)} = \frac{1}{\text{time duration (sec)}}$$

5 - 2 TIME-DIFFERENCE MEASUREMENT

The measurement of time difference between two separate events of the same repetition rate is described as follows:

Set the MODE switch ② to either CHOP or ALTER position.

In case the signals are with higher frequencies or time-difference is small, the ALTER position provides a stable display than the CHOP position.

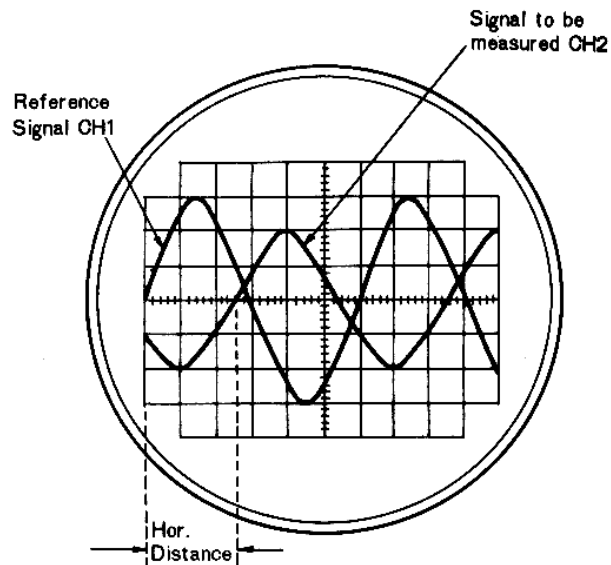
Apply the reference signal to the VERT INPUT 1 connector ④ and comparison signal to the VERT INPUT 2 connector ⑤. The reference signal should precede the comparison signal in time.

Then, set the SOURCE switch ① to the CH1 position or to the EXT position with the EXT TRIG connector ⑧ applied the reference signal.

Set the VOLTAGE/CM switch and the VARIABLE control to the proper waveform in amplitude, and the SWEEP TIME/CM switch ④ to a position of its rotation where a time difference will be determined easily.

in this time, the VARIABLE ⑤ must be kept in fully clockwise CAL position. Measure the horizontal distance between the CH1 waveform and CH2 waveform.

The time-difference is determined as follows.



Measuring time difference between two signals

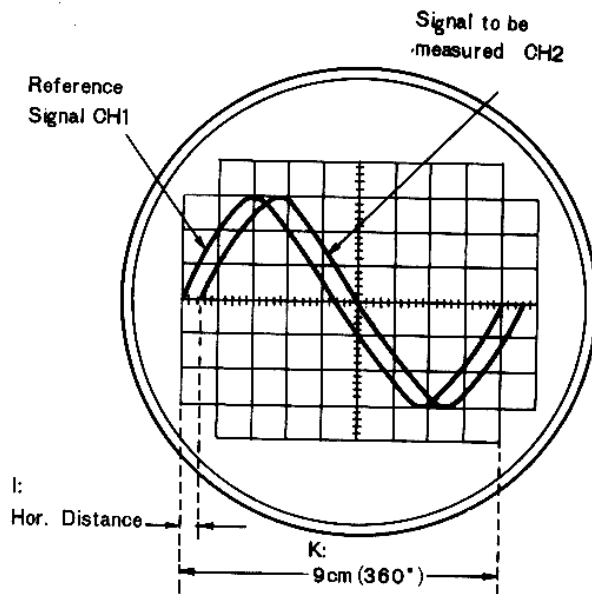
$$\text{Time Delay} = \frac{\text{SWEEP TIME/CM setting} \times \text{horizontal distance (cm)}}{\text{magnification}}$$

5 - 3 PHASE MEASUREMENT

Phase comparison between two signals of the same frequency can be made using the dual-trace display. The instruction of the phase measurement is the same as 5-2. TIME-DIFFERENCE MEASUREMENT except the following description. Adjust the VARIABLE control so that the waveforms are equal in amplitude and the POSITION control to move the waveforms to the center of the graticule line.

Set the SWEEP TIME/CM switch and the VARIABLE control ⑤ to the position of the rotation which provides a phase difference to be determined easily. in this time, with the controls are set to provides 1 cycle of the reference signal occupies exactly 9 cm horizontally and then, 1 cm of the graticule presents 40° of the cycle.

Measure the horizontal distance between corresponding points on



Measuring phase difference

the waveforms.

The phase difference is determined as follows:

$$\text{Phase Difference} = \frac{l \text{ (cm)}}{K \text{ (cm)}} \times 360^\circ$$

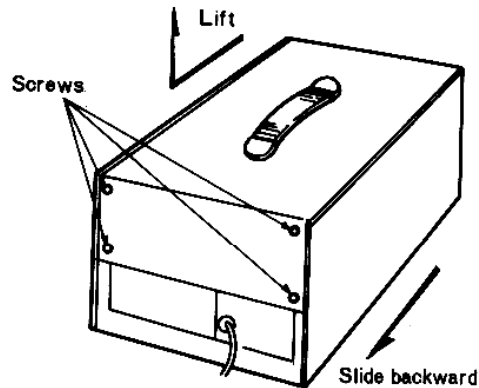
Where : l Horizontal distance measured above.

K Horizontal distance of 1 cycle of the reference waveform.

SECTION 6. MAINTENANCE and ADJUSTMENT

6 - 1 PRECAUTION

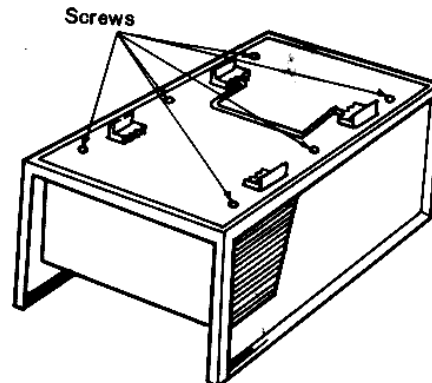
- (1) Don't place the instrument where exposed to direct sunbeam for installation.
- (2) Refrain from operating the instrument where high temperature and humidity prevail.
- (3) Also, refrain from operating the instrument where mechanical vibration prevails and near the equipment which generates strong line of magnetic force or impulse voltage.
- (4) When the line voltage is other than 100 V, i.e. 117 or 230 V, set the line voltage selector to the position of 117 or 230 V.
For 230 V operation, use the fuse (0.5A) furnished.
- (5) The maximum input voltage to the vertical amplifier is 300 V. (DC + AC peak)
- (6) Never leave the instrument for a long time with a spot represented on the CRT screen.



6 - 2 MAINTENANCE

6 - 2 - 1 REMOVAL of CABINET PLATES

- (1) Remove four screws located on the rear-panel of the instrument.
- (2) While holding the top plate at the handle, slide the plate backward approx. 10 m/m and lift upward, then it comes off the side frames quite easily.
- (3) Slide the side plate backward after removal of the top plate until they come off the side frame.
- (4) Remove six screws located on the bottom plate. Draw the plate backward while lifting its rear end up a little and it comes off the side frames.



Addition to above procedures, the side plate and top plate can be separated independently.

CAUTION: When performing the above procedure, never fail to turn off the power. Also, be carefully not to touch a high tension voltage section, up to 2500 V, after removal of the case plates.

6 - 2 - 2 ASSEMBLY of CABINET PLATES

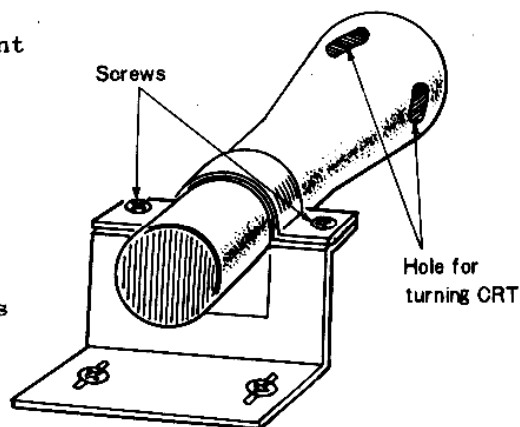
To assemble the removed plates to the case frames, reverse the order given in 6-2-1 REMOVAL of CABINET PLATES.

Note that the top plate should be assembled to the frames while sliding it forward with the handle being depressed by the hand.

CAUTION: When performing the above procedure, be carefully not to touch a cathode ray tube socket carries a high tension voltage as high as approx. 1300 V.

6 - 2 - 3 CORRECTION of CRT POSITION

- (1) Remove the top plate from the instrument in accordance with 6-2-1 REMOVAL of CABINET PLATES.
- (2) Loosen two screws located on the CRT bracket sufficiently.
- (3) Rotate the CRT through the hole in the shielding cover so the trace coincides with one of the horizontal graticule line.



6 - 3 ADJUSTMENT

This instrument has been factory adjusted for the following adjustments, accordingly if re-adjustment needed, it should be completed after calibrating power source voltage.

6 - 3 - 1 DC BAL ADJUSTMENT

The reference number in a parenthesis () is for CH2.

- (1) Set the AC-GND-DC switch ⑰ (⑱) to the GND position.
- (2) Turn the VARIABLE control ⑮ (⑲) fully counterclockwise.
- (3) Set the ◆POSITION control ⑪ (⑩) to move the trace to the horizontal centerline of graticule.
- (4) When the VARIABLE control ⑮ (⑲) turned fully clockwise, the trace moves, adjust the DC BAL screwdriver adjustment located in the ◆POSITION ⑪ (⑩) control knob to position the trace to the horizontal centerline of

graticule.

- (5) Repeat steps (2) through (4) until the trace remains stationary even when the VARIABLE control ⑮ (⑬) is turned.

6 - 3 - 2 VERTICAL ATT (VOLTAGE/CM) ADJUSTMENT

This adjustment needs the square wave generator (1 KHz square wave, 50 mV ~ 100 Vpp output voltage)

- (1) Remove the bottom plate of the instrument by following 6-2-1 REMOVAL of CABINET PLATES.
- (2) Apply the square wave signal from the generator provided to the VERT INPUT connector.
- (3) With the VOLTAGE/CM set to the 0.02 V/cm position, adjust the trimmer capacitor TC 1-8 on the printed circuit board of the attenuator until the square waveforms are well shaped on the CRT screen.
- (4) Adjust each range of the VOLTAGE/CM in the same manner.

Table below shows the ranges to be adjusted with the trimmer capacitors.

Range (V/cm)	Trimmer capacitor	Range (V/cm)	Trimmer capacitor
0.02	TC 1-8	1	TC 1-4
0.05	TC 1-0	2	—
0.1	TC 1-2	5	—
0.2	TC 1-7	10	TC 1-6
0.5	TC 1-9	20	—

6 - 3 - 3 ADJUSTMENT of PROBE and SHUNT CAPACITANCE

- (1) Set the VOLTAGE/CM to the 0.01 V/cm position.
- (2) Connect the probe to the VERT INPUT connector ⑳ (in CH2 ⑲) and apply 1 KHz square wave to the tip of the probe.

Now, adjust the trimmer capacitor of the probe to make well-shaped square waveform on the CRT screen.

in this time, the voltage is attenuated to 1/10 of input signal, but impedance and shunt capacitance are 10 MΩ and 15 PF.

- (3) With the VOLTAGE/CM set to 0.02 V/cm, adjust the trimmer capacitor 1-7 on the printed circuit board of the attenuator to make well-shaped square wave on the CRT.
- (4) Adjust each range of the VOLTAGE/CM in the same manner.

Table below shows the range to be adjusted with the trimmer capacitors.

Range (V/cm)	Trimmer Capatitor	Range (V/cm)	Trimmer Capacitor
0.02	TC 1.7	1	TC 1,3
0.05	TC 1.9	2	—
0.1	TC 1.4	5	—
0.2	—	10	TC 1,5
0.5	—	20	—

6 - 3 - 4 VERTICAL SENSITIVITY ADJUSTMENT

- (1) Remove the bottom plate of the instrument by following 6-2-1 REMOVAL of CABINET PLATES.
- (2) With the VOLTAGE/CM set to the 0.01 V/cm position, turn the VARIABLE fully clockwise to the CAL position
- (3) Apply the square wave of 0.04 Vpp to the VERT INPUT connector
- (4) Adjust the variable resistor VR₃ (GAIN ADJ1 for CH1) and VR₁ (GAIN ADJ2 for CH2) to make 4 cm deflection of waveforms on the CRT screen.

6 - 3 - 5 SWEEP RATE ADJUSTMENT (HORIZONTAL SENSITIVITY) and TRACE LENGTH ADJUSTMENT

- (1) Remove the bottom and side plates of the instrument by following 6-2-1 REMOVAL of CABINET PLATES.
- (2) Set the SWEEP TIME/CM to the 0.1 ms/cm position and turn the VARIABLE ⑤ to fully clockwise position CAL.
- (3) Apply the frequency -calibrated 1 KHz sine wave to the VERT INPUT connector, and adjusted the ◀ POSITION control to move the waveform to the vertical center of the screen and the ▶ POSITION control to move the starting point of the waveform to the first graticule line.
- (4) Adjust the variable resistor VR₃ (GAIN ADJ) on the side printed circuit board to make length of one cycle of 1 KHz sine wave 10 cm horizontally on the CRT screen.

in this time, the length of the trace may be changed, adjust the variable resistor VR₅ (WID) on the same printed circuit board. Variable resistor VR₅ (WID) is so designed that it adjusts the length of the trace by changing only the ending point of the waveform with the starting point and sweep rate left unchanged.

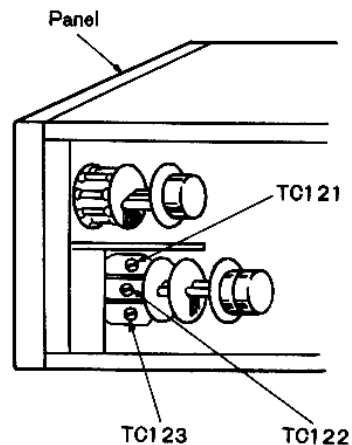
Note that the above adjustment should be performed while operating the ▶ POSITION control ⑨ and TRIG LEVEL control ⑦ in order to keep the starting point at the center of the first vertical graticule line.

- (5) The ranges from 0.5 S/cm to 0.1 mS/cm of the SWEEP TIME/CM are adjusted in the same manner, But, For the ranges from 50 μS/cm to 0.5 μS/cm, with

the setting of the sine wave input signal listed in the table below, adjust the trimmer capacitor furnished with the rotary switch for SWEEP TIME/CM without operating the variable resistor VR₈ and VR₅.

Note that the adjustment of these ranges must be performed after the adjustment of 0.5 S/cm ~ 0.1 mS/cm.

SWEEP TIME/CM	Input sine wave frequency	Trimmer Capacitor
10 μ S/cm	10 KHz	TC 121
1 μ S/cm	100 KHz	TC 122
0.5 μ S/cm	200 KHz	TC 123



6 - 3 - 6 MAG \times 5 ADJUSTMENT

- (1) Set the SWEEP TIME/CM ④ to the 1 mS/cm position and apply the sine wave with about 1 KHz frequency to the VERT INPUT connector.
- (2) Adjust the sine wave generator for the proper frequency and \blacktriangleleft POSITION control to lies each peak of 11 upper and lower peaks of the waveform on the each vertical graticule lines.
- (3) When the MAG \times 5 switch ⑨ is pulled out, adjust the variable resistor VR₉ (MAG ADJ) on the side printed circuit board to make a distance between peaks 5 cm on the CRT screen.

6 - 3 - 7 MAG CENTER ADJUSTMENT

- (1) Set the SWEEP TIME/CM to the 0.1 mS/cm position, and apply the 1 KHz square wave to the VERT INPUT connector so a cycle of the waveform lies on between the first and last vertical graticule line.
- (2) Set the \blacktriangleleft POSITION control at the middle of rotation and, in this time a little vertical shift is allowable if any.
- (3) With the MAG \times 5 switch ⑨, pulled out, adjust the variable resistor VR₈ (MAG CENT) on the lower printed circuit board until the rising (or falling) point at the center of the waveform coincide with that of the waveform which provided with the normal position of the MAG \times 5 switch.
- (4) Repeat step (1) through (3) above until the rising (or falling) point at the center of the waveform remains unshifted even when the MAG switch operated.
- (5) Adjust the VR₇ (POS ADJ 1) on the side printed circuit board to position the starting point of the wave form to the first vertical graticule line.

6 - 3 - 8 HORIZONTAL POSITION ADJUSTMENT

- (1) To adjust the horizontal position of the display under the ordinary sweep condition, proceed as follows:

With the ◀▶ POSITION set at the middle of its rotation, adjust the VR₇(POS ADJ 1) on the side printed circuit board to position the starting point of the waveform to the first vertical graticule line.

- (2) When in the EXT position of the SWEEP TIME/CM, the horizontal position adjustment is made through adjusting the variable resistor VR₄ (POS ADJ 2) on the same board to position the spot to the horizontal centerline of the graticule after previous adjustment (1) .

6 - 3 - 9 TRIGGER STABILITY ADJUSTMENT

Variable resistor VR₃ (STAB ADJ) on the side printed circuit board provides for changing to the coverage provided by the STABILITY control Ⓢ on the front-panel.

6 - 3 - 10 CALIBRATING VOLTAGE ADJUSTMENT

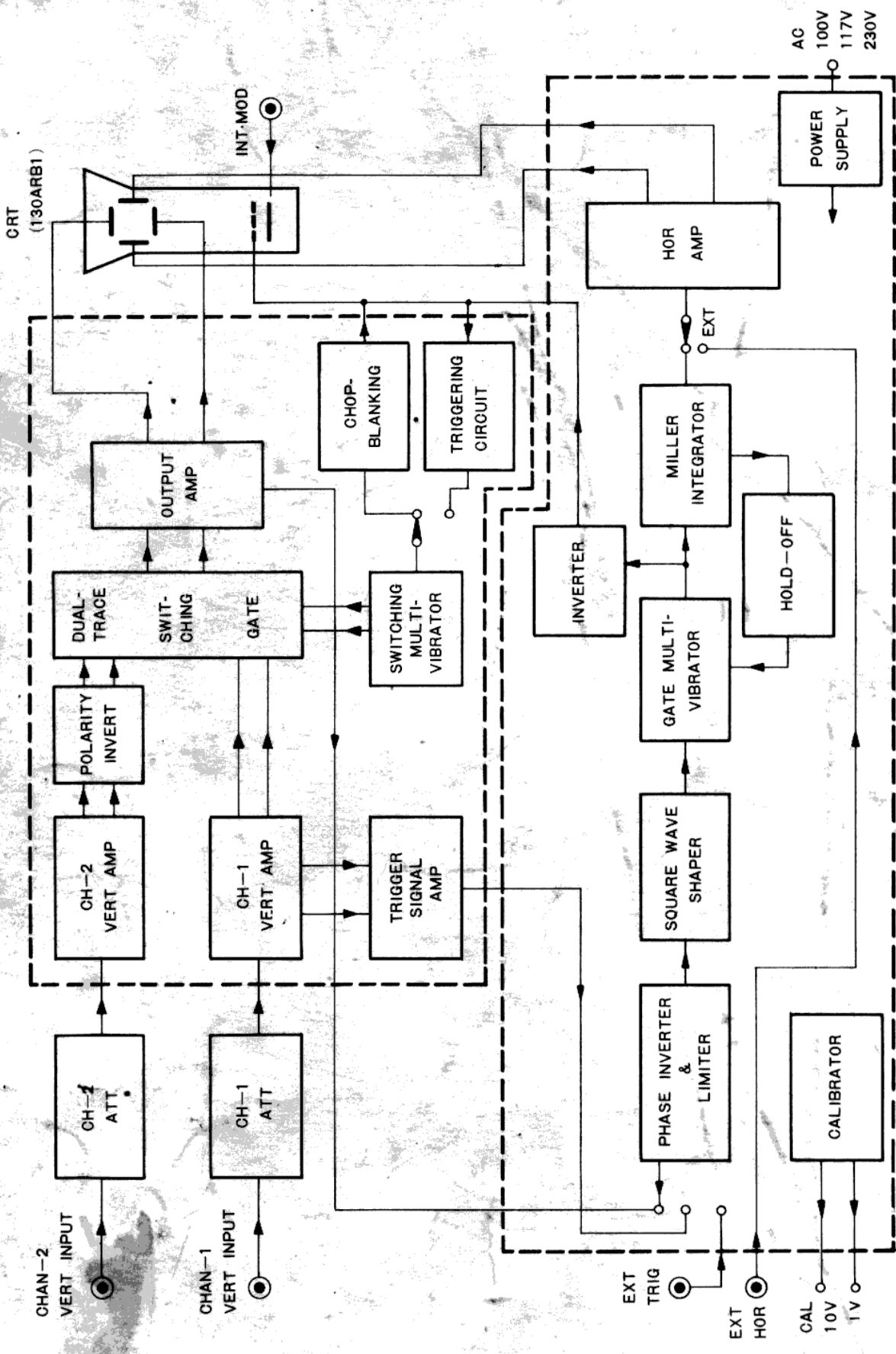
To make adjustment of the calibrator voltage, adjust the variable resistor VR₂ on the side printed circuit board to provide 10 V_{pp} (or 1 V_{pp}) of the 1 KHz square wave output. If the output is adjusted either 10 or 1 V_{p-p}, and the other is also adjusted properly.

6 - 3 - 11 ASTIG ADJUSTMENT

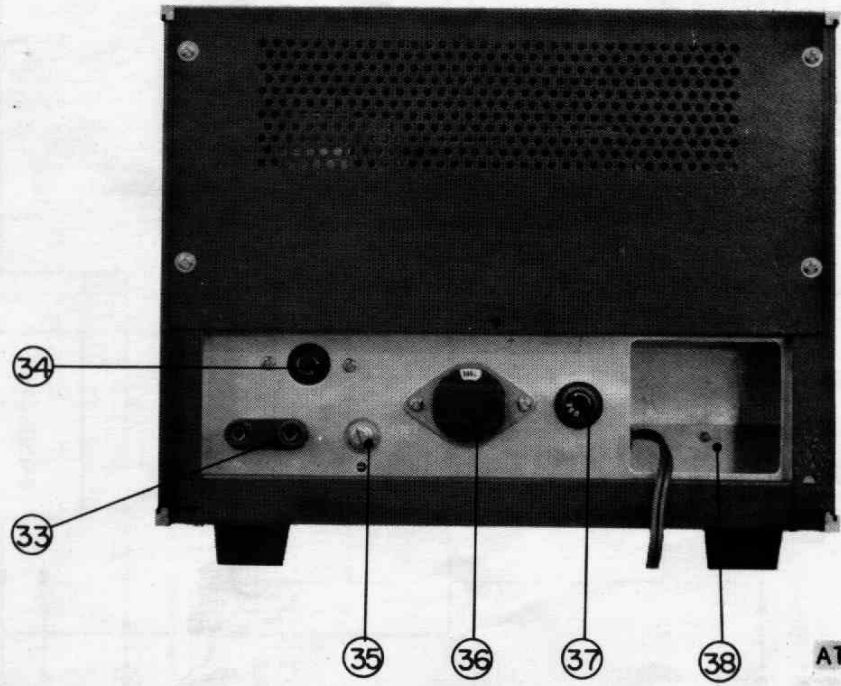
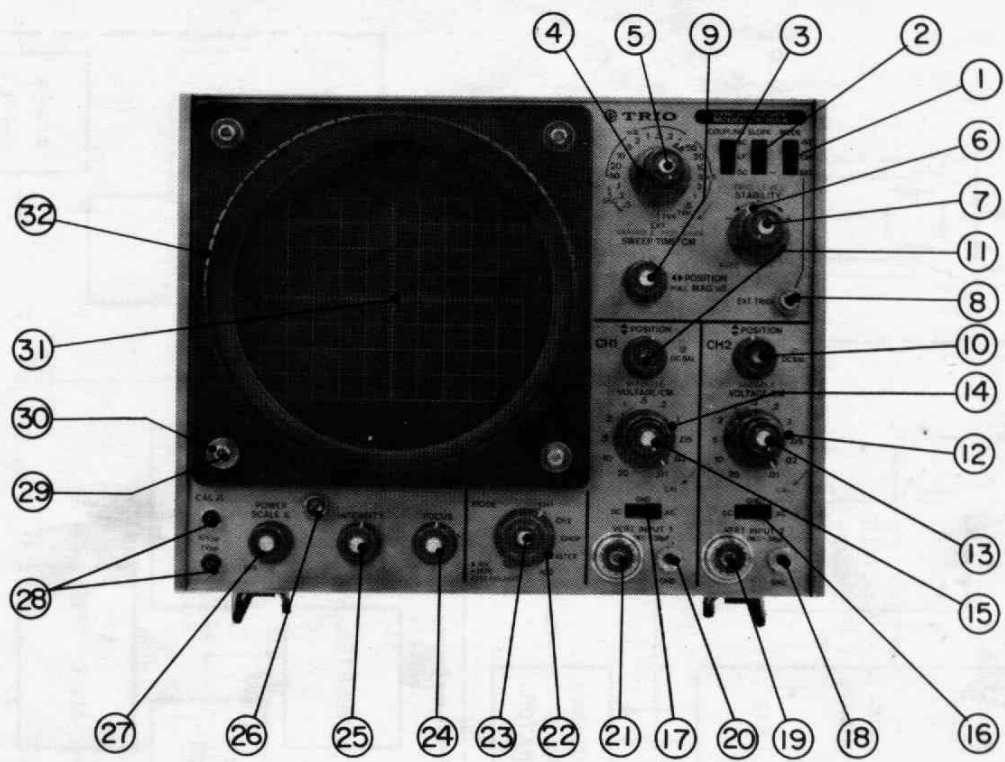
Adjust the ASTIG adjustment on the rear-panel to provide a well-defined trace over the entire trace length.

This adjustment should be completed together with the FOCUS control.

MODEL CS-1554 OSCILLOSCOPE BLOCK DIAGRAM



—Attached Fig 2—



ATTACHED Fig. 1