MODEL 553P
DUAL TRACE TRIGGER
OSCILLOSCOPE
OPERATION MANUAL

KIKUSUI ELECTRONICS CORP.

CONTENTS

1. INTRODUCTION

Model 553P Oscilloscope is a dual trace oscilloscope of trigger sweep system. 5-inch helical post accelerating type C.R.T., with 3kV accelerating potential for bright displays.

It is all purpose high-grade oscilloscope, featuring two phenomena of the vertical axis by the electronic switching system, the frequency bandwidth DC 7MHz, and maximum sensitivity of 10mV/cm.

Field effect transistors are used for the input circuit of the vertical axis, giving superb stability.

The horizontal axis has a time-base oscillator of the range 1 sec/cm ~ 1 μS/cm, and is capable of measuring down to 0.2 μS/cm by means of a 5-times magnifier.

The model 553P has an external terminal in horizontal amplifier. Bandwidth of external terminal sensitivity and frequency has range more than 0.2 Vp-p/cm, 200kHz -3dB by means of 5-times magnifier.

And others, has calibration voltage of 1 kHz square wave.

Specifications

VERTICAL

Calibrated Deflection Factor :	10 mV/cm ~ 20/cm, accuracy ±3%, 11 calibrated steps, 1-2-5 sequence
Bandwidth :	For DC connection, DC ~ 7 MHz, within -3dB For AC connection, 2 Hz ~ 7 MHz, within -3dB

Input Impedance:	1 MΩ paralleld by 38 pF
Input Terminal	UHF type receptacle (applicable to M type also)
Max. Input Voltage:	400 V in a range of 10 mV 600 V in a range exceeding 20 mV
-	Both indicate peak AC value plus DC
Risetime	Approx. 0.05 μs
Display Mode:	CH1; Channel 1 only ALTER; Dual-trace, alternate between channels CHOP; Dual-trace, choped between channel at 100kHz CH1 INV; Display signal from channel 1 can be inverted CH2; channels 2 only

Time-Base

Sweep Time:	1 μs/cm - 1 sec/cm in 19 calibrated steps, 1-2-5 sequence
Time Base Sweep Accuracy:	±5%
Sweep Magnifier:	X5, accuracy ±5%

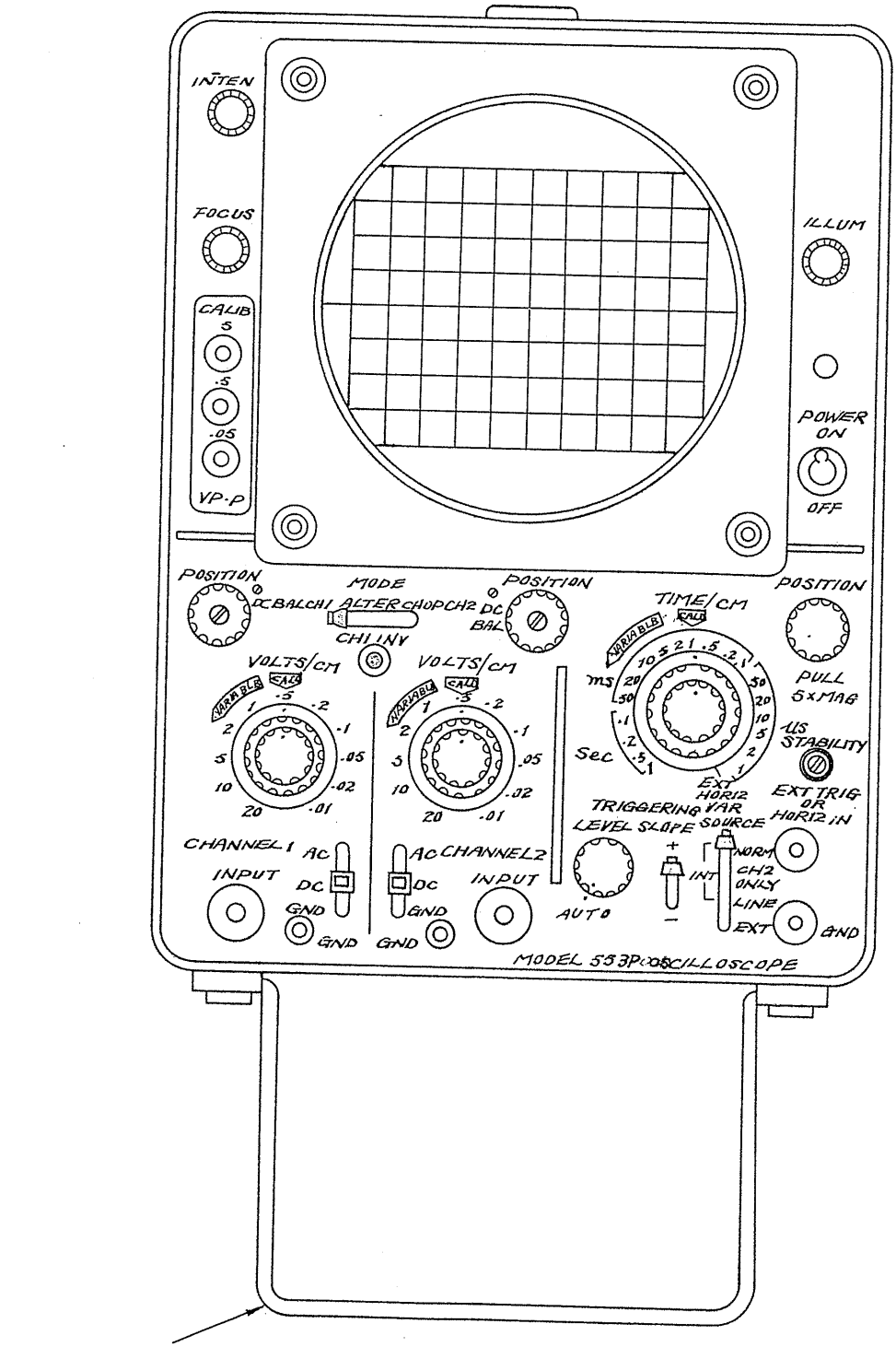
Triggering

Triggering system:	Normal triggering sweep and automatic triggering sweep
Triggering signal:	+,- of external, internal and line

Trigger sensitivity	(Internal) 50 Hz - 5 MHz in vertical display of 10 mm 20 Hz - 7 MHz in vertical display of 20 mm (External) 50 Hz - 4 MHz at input of 1 Vp-p and 20 Hz - 7 MHz at input of 2 Vp-p
Horizontal	
Sensitivity	Approx. 1 VP-P/cm; approx. 0.2 Vp-p/cm in case sweep magnifier is operated.
Bandwidth:	2 Hz - 200 kHz, within - 3dB
Input Impedance:	Approx. 1 MΩ paralleled by less than 40 PF
Calibrator	
Output Waveform;	Squarewave of 1 kHz
Output Voltage:	3 rangess of 5, 0.5, 0.05 Vp-p
Voltage Accuracy:	± 3%
Others	
Cathode-ray Tube	E 2038B 31
Accelerating Voltage:	Approx. 3000 V
Display Area:	10 x 8 cm
Intensity Modulation:	Over 10 Vp-p, coupled to the Cathode

Power Source:	V ± 10%, 50/60 Hz	
Power Consumption:	Approx. 41 VA	
Dimensions (max.):	206 mm in width, 295 mm in heigh	
	460 mm in depth	
Weight:	Approx. 11 kg	
Included Accessories:	957M probe of low capacitance	2
	941B terminal adaptor	2
	Operation manual	1
	Test data	1

2. DESCRIPTION OF PANEL CONTROLS



Functions of Knobs, Terminals

POWER ON OFF:	Switches power supply on and off
ILLUM:	An adjusting knob for controllable illumination of graticule
CALIB:	An output terminal for time and amplitude calibration
FOCUS:	An adjusting knob for focusing CRT
INTENSITY:	An adjusting knob for CRT brightness
VOLTS/CM:	A switch for selecting sensitivity;
VERTICAL	11 ranges of 0.01 - 20 V/cm are calibrated when a knob "VARIABLE" is set at "CALD" position
VARIABLE:	A fine adjusting knob of "VOLTS/CM" switch
POSITION:	A knob for vertically shifting the trace
INPUT:	An input terminal of Vertical axis
AC, DC, GND:	A switch for selecting input circuit connection; AC, DC connections are optionally selected; GND cuts off Amplifier/ Input terminal connection and Amplifier side is directly connected to GND

CH1 INV: A push switch; When yellow indication appears, the polarity of CH1 being switched over, the trace waveform is invertd 180°.

DC BAL: A semi - fixed resistor for DC balance adjustment of Vertical Deflection Amplifier

MODE: A selecting switch with 4 positions performing the following function

CH1: Actuates CH1, only Vertical Deflection Amplifier and CH2 remain stopped

ALTER; Operates alternate sweeping of CH1 and CH2 of the Vertical Deflection Amplifier; by initially sweeping signals of CH1 being traced, then signals of CH2 are traced by a subsequent sweep

CHOP; Channel switching occurs successively at a rate of approx. 100 kHz between CH1 and CH2

CH2; Actuates CH2 only and CH1 stops

TIME/CM: A selecting switch for sweep time; desired sweep time is calibrated by the knob " VARIABLE " positioned

	at "CAL'D"
	When the switch "TIME/CM" is set at the position "EXT HORIZ", sweeping comes to stop and the input of Horizontal Amplifier is connected to the terminal "HORIZ IN". On this occasion, the knob "VARIABLE" acts as a sensitivity controller of the Horizontal Amplifier.
VARIABLE:	A knob for fine adjustment of horizontal sweep; this serves concurrently with the sensitivity controller of Horizontal Amplifier.
EXT TRIG or HORIZ IN:	Used in combination with the external trigger input terminal and external horizontal input terminal; when the switch "TIME/CM" is set at "EXT HORIZ" this terminal acts as an input terminal of the Horizontal Amplifier.
POSITION:	A knob for horizontally shifting the trace
STABILITY:	A semi-fixed rheostat for stability adjustment of the horizontal sweep

oscillator

PULL 5X MAG. — Upon pulling this knob out, the amplitude of horizontal sweep is enlarged 5 times.

TIME-BASE

- This magnifies the sensitivity of the Horizontal Amplifier five times. When the HORIZ IN terminal is used, the sensitivity is approximately 0.2 V/cm with this knob pulled out, and approximately 1 V/cm with the knob pushed in.

TRIGGERING SOURCE: — A selecting switch for the triggering signal source

- NORM; External trigger for the waveform to be monitored. Triggerable by two signals of CH1 and CH2.
- CH2 ONLY; Triggerable by a single signal of CH2 Only
- LINE; Triggerable by the power frequency
- EXT; Triggerable by a signal applied to the terminal "EXT TRIG"

SLOPE ±: — A polarity switchover switch of triggering

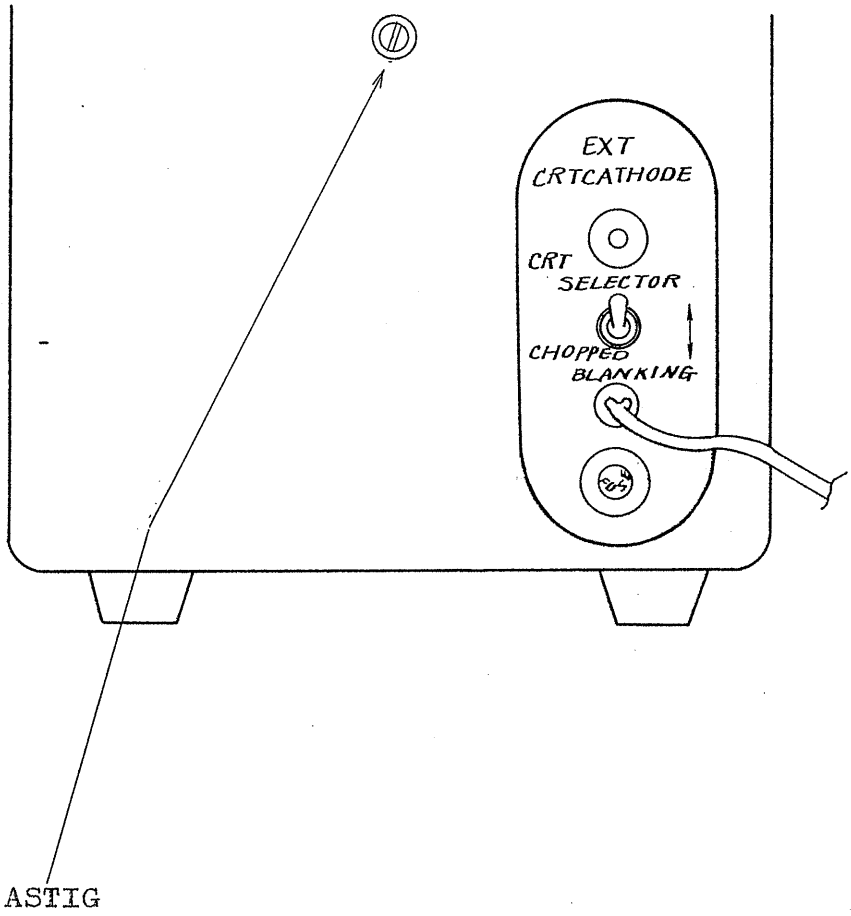
LEVEL: — A knob for adjustment of the triggering level

The controller of LEVEL determines portions of the triggering signal waveform where sweeping is started. At a position the knob is turned to extreme left "AUTO", there is no selection of the triggering level and an automatic sweep is performed.

3. DESCRIPTION OF REAR PANEL DESIGN

Rear Panel

CRT SELECTOR	A switch for the Cathode connection of the cathode ray tube (hereafter called CRT); when pushing up the switch, a terminal "EXT CRT CATHODE" comes into connection, while an internal chopeed blanking signal is kept connected when pulling it down. Ordinarily, the switch is desirable, pulled down.
EXT CRT CATHODE (Z-Axis Terminal)	A terminal for transmitting an external signal to the Cathode of CRT; the terminal serves to transmit trace-brightness modulation signals.



ASTIG: An Astigmatism controller of CRT

4. OPERATION

Power Supply Voltage

This model is so designed to operate safely under the fluctuating range of the rated voltage within 10% in the primary supply. For the sake of obtaining high reliability and long durability of the components, it is recommended to use this model at the rated voltage as practicable as possible.

The high voltage supply power for cathode ray tube is being stabilized, this model has a characteristic that there occurs a considerably less change in the deflection sensitivity caused either by controlling CRT's intensity or by the voltage fluctuation of the primary power supply and brightness control in monitoring can be easily done without affecting other functions.

Installation Location

The recommended ambient temperature around the location where the model is to be installed should be kept in a range from $0^{o}C$ to $40^{o}C$.

For best operation refrain from selecting a location with dust and high humidity. Also take into consideration air ventilation in case of using the model near any other instruments generating heat. Also, please refrain from using this model in the vicinity of intensive magnetic fields or in corrosive gas, surroundings

otherwise the model will be unfavourably effected.

Allowable Voltage at Terminals

If each terminal should be applied an excessive Voltage, the interior component may be damaged, so it is to be observed with caution that the vertical input terminal is to be applied with a voltage not exceeding 600V, 400V at 10mV range and horizontal input terminal is not exceeding 100V (AC peak plus DC), respectively.

Take care, also, not to apply any voltage exceeding 600V (AC peak plus DC) for the attached low input resistance probe, 957M type.

Caution on Deflection Characteristics

In waveform monitoring of high frequencies over 4 - 5 MHz, please observe with care that the amplitude used is kept below 4 cm, as deformation occurs otherwise.

5. INITIAL OPERATION

Initial Operation

Trace will appear by following the below, sequence procedure. By repetitive performance of this sequence procedure the user will become pro-efficient in the operation of this model.

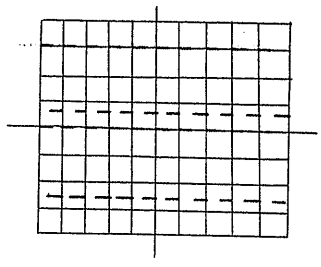
1. Set the position of each control knob as follows.

Control Knob	Position
INTENSITY	Approx. middle
FOCUS	"
ILLUM	"
MODE	ALTER
CH1 INV	Pushed in
CHANNEL 1	
POSITION	Approx. middle
VOLTS/CM	2
VARIABLE	CAL'D
AC DC GND	AC
CHANNEL 2	
POSITION	Approx. middle
VOLTS/CM	2
VARIABLE	CAL'D
AC DC GND	AC
TIME/CM	1 mS
VARIABLE	CAL'D

POSITION PULL 5X MAG	As pushed in approx. middle
TRIGGERING	
LEVEL	AUTO
SLOPE	+
SOURCE	NORM

2. Upon completion of the above knob positioning, the power supply cord is connected to a power source as stipulated.
3. Set the knob "POWER" at "ON" position. About twenty seconds later, two luminous lines should appear on the CRT screen.
4. Turn "INTENSITY" for proper luminance.
5. When connecting "CALIB 5 Vp-p" to the input terminals of Channel 1 (hereafter called CH1) and Channel 2 (hereafter called CH2), two squarewaves with amplitudes of 2.5 cm as shown in Fig. 3 appear on the screen.

Fig. 3



6. Turn the knob "POSITION" to shift the trace vertically and horizontally. For the convenience of monitoring,

the trace of CH1 is desirably appears above the scale while that of CH2 appears below the scale.

7. When the knob "PULL INV CH1" is pulled out, the trace of CH1 is only inverted 180°. Normally, the knob is to be kept pushed in.

8. By turning the switch "VOLTS/CM" and the knob "VARIABLE" counterclockwise, the amplitude in Fig. 3 will become smaller.

9. Check the varying sweep time by turning the switch "TIME/CM" and knob "VARIABLE".

10. Switch "MODE" from "ALTER" to "CH 1". CH1 only traces and CH2 will disappear. If the switch is set at "CH2", then CH2 only trace, and CH1 will disappear.

11. Set the "MODE" switch at "CHOP ". The traces of CH1 and CH2 appear in dual-trace pattern on the screen, however those traces look instabilized as the waveforms of CH1 and CH2 are alternately switched over at a rate of approx. 10 μs (100 kHz).

    As long as the switch "TRIGGERING SOURCE" is positioned at "NORM", the time base is triggered by the outputs of CH1 and CH2. Accordingly, at "CHOP ", the outputs of CH1, CH2 are alternately chopped at a rate of approx. 100 kHz, wherein the time base is triggered. In this case, the trace is not stabilized unless there exists synchronous relation (a ratio of multiple in integral

number) between the horizontal sweep time and the chopping frequency.
When positioning the switch " TRIGGERING SOURCE " at " CH 2 ONLY ", then the trigger is generated by the output of CH 2 ONLY and the trace becomes stabilized.
It is necessary to select a setting position for the switch " MODE " between " ALTER " and " CHOP ", depending upon the sweep time.

12. Set the switch " MODE " at " CH 1 " and the switch " TRIGGERING SOURCE " at " NORM " position.

13. When turning the knob " TRIGGERING LEVEL " clockwide from " AUTO " position, the trace disappears for a moment, but appears again while turning. Under this condition, the elimination of the input signal for CH 1 (by setting the switch " AC DC GND " at " GND ") results in a stop of the sweep.
For purpose of normal monitoring , the knob " LEVEL " is to be set at " AUTO ".

14. After returning the knob " TRIGGERING LEVEL " to " AUTO " position, set the switch " TRIGGERING SLOPE " at ⊖ side.
Triggering starts from negative going portion of the sqarewave, with tracing moving from the upper side into the lower side.
If the switch is set at ⊕ side, then

triggering starts from a positive going position.

15. Pull out the knob "POSITION" of TIME-BASE to actuate a X5 magnifier. The trace width is enlarged 5 times. The sweep time in this enlarged condition is equivalent to 1/5 of the value indicated by the knob "TIME/CM". Ordinarily, the knob is kept pushed in.

16. Turn the switch "TIME/CM" to "HORIZ" and connect "5 Vp-p" of "CALIB" to the terminal "HORIZ IN". The knob "VARIABLE" for "TIME/CM", then acts as a sensitivity controller of the horizontal axis enabling a lissajous figure to be worked out.

The above sequence is a basic way of operation procedure.

6. FUNDAMENTAL USE

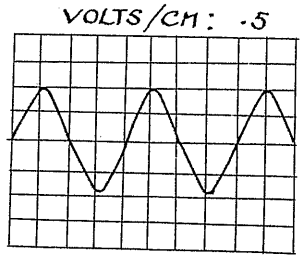
Measurement of AC Voltage

For measuring either AC waveforms, excluding DC or AC components, only extracted from AC waveforms combined with DC, the vertical switch "AC DC GND" is to be set at "AC" position.

1. By setting the switch "AC, DC, GND" at "AC" and the knob "VARIABLE" for the vertical at "CAL'D" position, determine the value of VOLTS/CM in a way that the waveform displays a suitable amplitude within the scale area.
2. Read the amplitude of the waveform in "cm". The value of voltage is, obtained by the following formula:

   Voltage = Vertical amplitude length x VOLTS/CM x Probe magnifications, wherein, the magnification ratio of attached 957M type probe is 10, the length of vertical amplitude is 4 cm, VOLTS/CM is 0.5, therefore,

   Voltage = 4 x 0.5 x 10 = 20 Vp-p

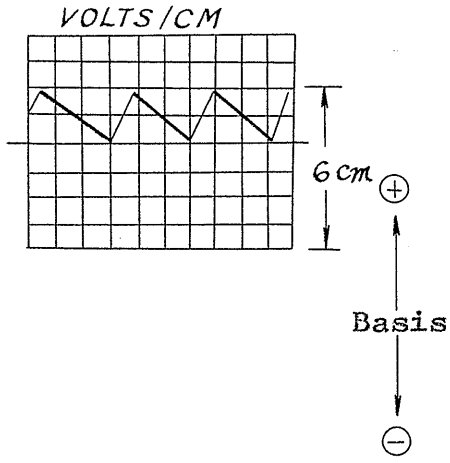


Measurement of Instantaneous Voltage

To measure the DC level at an optionally selected point of the waveform, the following steps are to be performed.

1. Set the position of the switch "AC DC GND" at "DC".
2. Set "TRIGGERING LEVEL" at "AUTO" position.
3. Adjust the position of the trace in conformity with the lowest line of the scale, to determine a basis on the graticule, after positioning the switch "AC DC GND" at "GND".
   If the voltage to be measured is negatively less than the standard voltage, the position of the trace should be adjusted to the top line of the scale.

   The basis thus set up acts also as that for DC measurement, therefore, the Vertical POSITION should not be moved while measuring.
   Return the switch to "DC".



4. The Vertical is applied the measuring voltage. For reading the voltage, the distance between the basis and a position to be read out is measured in cm, and from formula:
   Instantaneous voltage = Vertical amplitude measured from the basis x VOLTS/CM x probe magnifications, the voltage in question is obtained as
   6 x 1 x 10 = 60 V.

How to trigger in dual-trace operation

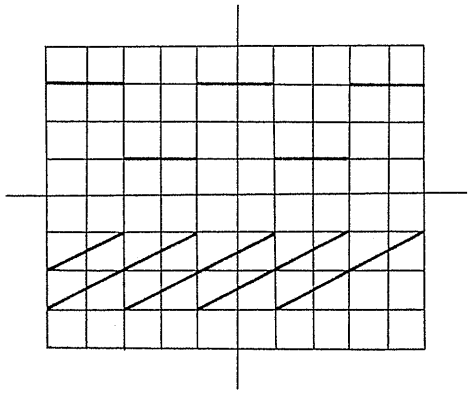
The Time Base can be triggered by either or both of the two signals in monitoring (applied to CH1 and CH2).

1. When triggering by the two signals, the switch "TRIGGERING SOURCE" and the switch "MODE" of the Vertical are to be positioned at "NORM" and "ALTER", respectively.
2. When triggering by either of them, it should be strictly observed to select a signal of a lower frequency for triggering, otherwise the trace of the lower frequency signal is not stabilized resulting in difficult monitoring.
3. When triggering only with one of the two signals, it observed conclusively that the signal used for triggering be applied to CH2 and the switch "TRIGGERING SOURCE" be positioned at "CH2 ONLY". Under this condition, a trigger is generated with the

output of CH2 ONLY.

Alternatively, the switch, "TRIGGERING SOURCE" may be positioned at "EXT" and a triggering signal be applied to the terminal "EXT TRIG". The voltage necessary for a triggering 1 - 2 Vp-p.

The switch "MODE" can be used at a position of either "ALTER" or "CHOP".



Signal A

Signal B

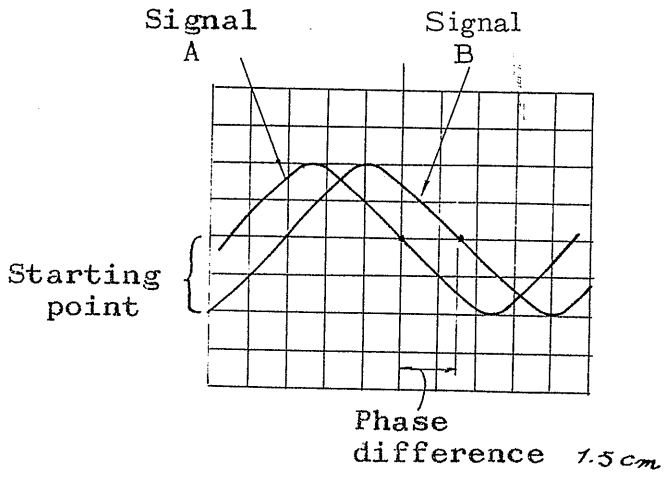
When triggering with the signal A, the trace of the signal B is not stabilized making the monitor impracticable.

Signal A is higher in frequency than signal B. The frequency ratio is always kept as multiples of integral number.

Measurement of Phase Difference

For comparative measurement of the phase difference in two sinewaves of identical frequencies, the dual-trace operation mode can be suitably applied.

1. Signals to be measured are applied to the input terminals of CH1 and CH2 respectively. The switch "MODE" and the switch "TRIGGER SOURCE" are positioned at either "ALTER" or "CHOP" and "CH2 ONLY", respectively.
2. The knob "VERTICAL POSITION" is adjusted so that both vertical center lines of the two signals traced on the screen come together.
3. By adjusting the switch "TIME/CM" and knob "VARIABLE" of TIME-BASE, one cycle period of signals to be monitored is set at approx. 9 cm horizontally. Under this condition, a horizontal distance of 1 cm represents a phase angle of 40^{o}.



Example:

Supporting that the horizontal distance between points of signal intersect, is 1.5 cm, therefore the phase difference would be

$40^{o} \times 1.5 = 60^{o}$

In Fig. , signal B is 60^{o} behind signal A in phase angle, and a positive trigger is applied by signal A.

The "TRIGGERING LEVEL" knob determines the starting positions of both signals.

In the case of less phase difference between both signals and accordingly impracticable reading on the scale, "HORIZONTAL POSITION" knob should be pulled thereby actuating a X5 magnifier which enlarges readings. Under this situation, a distance of 1 cm corresponds to a phase difference of 8^{o}.

Measurement of Phase Difference by Use of Lissajous Figure

For comparative measurements of the phase difference in two signals of identical frequencies, a measurement by use of a lissajous figure also is applicable.

For this method, it is necessary to take care of a phase difference between the vertical amplifier and horizontal amplifier in the oscilloscope itself.

Prior to measuring, determine the value of that particular

phase difference in the oscilloscope.

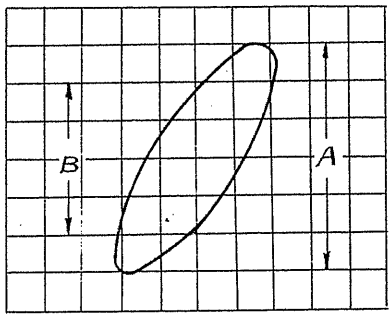
1. Set the switch "TIME/CM" at "EXT HORIZ" position.
2. Apply signals to be measured at the terminals "VERTICAL INPUT" and "EXT HORIZ IN".

   Then adjust the vertical and horizontal amplitudes according to the scale and read A, B values.

   Thus, the value of phase difference in question is obtained below.

   Phase angle between two signals $\theta = \mathrm{Sin}^{-1}\frac{B}{A}$

   Value of real phase angle = θ - Amplifier's particular phase angle

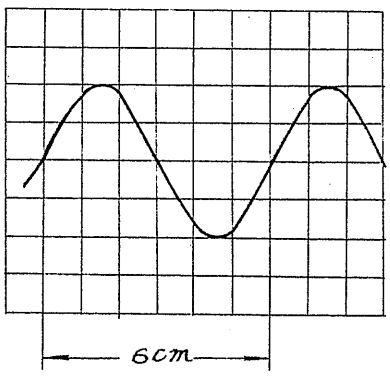


Measurement of Time

The measurement capabilities for periods, frequencies and risetimes of signals to be monitored are offered with use of the calibrated Time Base. The time indicated by the switch "TIME/CM" implies a time length necessary

to sweep horizontally one division of 1 cm on the scale. When the switch indicates 1 ms and 1μs, said time is $1/10^3$ sec per cm and $1/10^6$ sec per cm, respectively. For measuring the time length between two difference points on the waveform, the following sequence steps are to be performed.

1. By adjusting the switch "TIME/CM", the distance between two points is set within the scale area with the highest possible range.
2. By the knob "VERTICAL POSITION", the middle of both points is shifted to coincide with the horizontal center, adjust the first point to be measured in a position according to the scale, by the knob "HORIZONTAL POSITION".



Length of horizontal distance: 6 cm

Value of TIME/CM: 1 mS

Time: 6 x 1 = 6 mS

In case the pull-acting X5 magnifier is used, the value is obtained below in TIME/CM.

$$\text{Time distance} = \frac{\text{Length of horizontal distance x TIME/CM}}{5}$$

Measurement of Frequency

The frequency of a repetitively periodic wave can be obtained, as already described before, by measuring the time period and pitch distance.

$$\text{Frequency} = \frac{1}{\text{One cycle time}}$$, wherein

Horizontal length of one cycle: 6 cm

TIME/CM : 1 mS

Frequency= 1/6 mS ≒ 167 Hz

7. BRIEF DESCRIPTION OF CIRCUIT

The 553P type amplifier offers the max. sensitivity of 10 mV/cm with AC or DC.

The circuit is composed of multi-stage differential amplifiers comprising FET in the input stage, and special care has been taken in design against temperature change to protect the differential amplifier up to the third stage and FET circuit in the primary stage as well.

Vertical axis

Input Attenuator

The frequency-compensated attenuators are incorporated in the input circuit to give the switch "VOLTS/CM" a selection of 11 calibrated ranges.

DC BAL

R_{205} and R_{221} are adjusted so, source current of Q_{201}, Q_{202} in CH1 are the same value and those Q_{207}, Q_{208} in CH2 also are of the same value.

As long as the resistor "DC BAL" is properly adjusted, there occurs no change in the position of CRT trace even if "VOLTS/CM" switch and "VARIABLE" are turned.

Input Source Follower

Source followers Q_{203}, Q_{204} in CH1 and Q_{209}, Q_{210} in CH2 function to separate the fluctuation of

capacitance when varying "VARIABLE" and make high input impedance.

R_{202}, R_{203} (CH1) and R_{218}, R_{219} (CH2) are current limiting resistors to protect FET from damage when excessive voltage is applied to input terminal.

Emitter Follower

Emitter followers Q_{203}/Q_{204} (CH1), Q_{209}/Q_{210} (CH2) and Q_{305}, Q_{306} are used for low impedance drives to the following stage.

Differential Amplifier

Q_{301}, Q_{302} (CH1) and Q_{314}, Q_{315} (CH2) are differential amplifiers, and R_{306}, R_{362} are sensitivity controllers for calibrating the range of the max. sensitivity for "VOLTS/CM" switch. R_{305}, R_{361} are VARIABLE VOLTS/CM directly coupled to the control panel. The output from this stage is fed to the output amplifier through the diode-gate circuit.

CH1 INV

S_{302} is a switch which provides alternating polarity for the signal from the preceding stage.

CH2 ONLY

In CH2, there is provided a trigger amplifier for the third-stage amplification. The amplifier amplifies a signal properly at Q_{316}, Q_{317}, Q_{318} for use as a triggering signal.

Switching Circuit

The switching circuit is composed of two diode-gate circuits, blocking oscillator, and multi-vibrators. In operation of CH1 only, both the blocking oscillator Q_{311} and multi-vibrator Q_{312}, Q_{313} cease their function, however Q312 is on-condition circuited, supplying its voltage to emitters Q_{301}, Q_{302} so that CH1 is ready to operate, while the operation of CH2 is kept suspended as Q_{313} is off-condition and emitters Q_{314}, Q_{315} are not supplied voltage.

Output Amplifier

A D-C amplifier to amplify the signal sent from emitter followers Q_{305}, Q_{306} of the input amplifier in the preceding stage and to deflect the electron beam of CRT. The signals applied to Q_{307} and Q_{308} drive Cathodes V_{301A} and V_{301B}, respectively, which act as grounded grid amplifier.

The triggering signal NORM is taken from the emitter follower Q_{306}, and supplied to the Time-Base through Q_{309}. A capacitor arranged between emitters of Q_{307} and Q_{308} is for high frequency compensation.

Horizontal axis

Trigger Amplifier

In circuits of Q_{401} and Q_{402}, S_{402} are arranged so that a negative output is generated in either a negative

or positive triggering signal.

When the Schmitt trigger circuit Q_{403} , Q_{404} in the following stage operates as " AUTO " , bias is fixed and output is supplied to the next stage through a coupled condenser.

When the Schmitt cirucit is triggering operation, the operating point of Q_{403} is varied by R_{425} through R_{402} .

Schmitt Trigger Circuit

Schmitt trigger circuit Q_{403}, Q_{404} convertsthe triggering signal into that of a constant amplitude, and applies a trigger [illegible] to the sweep generator in the following stage with a fixed amplitude irrespective of the input.

Sweep Generator

Q_{501}, Q_{502} is Schmitt multi-vibrator, and a blanking signal is taken from the collector of Q_{502} , being amplified by Q_{503} to be applied to CRT.

The trigger input of the sweep generator circuit starts its operation with a negative signal, and Q_{504} begins Mirrer run - up.

The output is taken by the emitter follower Q_{508}, a part of which is supplied to hold-off circuit Q_{507}, CR_{505}, QCR_{501} and R504, and the operation of Q_{501} in the primary stage is kept fixed for proper time length. Circuit

with R501, R502, R503, and QCR502 is for fine adjustment of the bias current at Q501.

Horizontal Amplifier

This is an amplifier for amplification of the sweep signal which is supplied from the sweep generator and apply that signal amplified to the deflection plate of CRT. The sweep signal is applied to Q707 through the emitter follower Q704, and drives the emitter Q705 which operate as base grounded.

The output of Q705 is applied in high voltage to the deflection plate. R714 is for changing the position of the horizontal axis and varies the operating point of Q705.

The capacitor C707 put between emitters of Q707 and Q708 is for high frequency compensation, and R728 is a semi-fixed resistor adjusting the sensiticity of this stage.

R734 is a semi-fixed resistor to calibrate the sensitivity of x5 magnification.

Sensitivity Calibrator

This is a generator of positive going squarewave of approx. 1000Hz. Q801, Q802 are self-runing multi-vibrator whereby the collector output of Q802 is supplied to Q803 of the following stage.

Q803 acts as a limitter, producing outputs of three voltages by voltage divider.

High Voltage Rectifying Circuit

The accelerating potential of CRT is generated by x 6 multiplying rectifier from the power transformer of about AC 250 V.

A circuit Q_{901}, Q_{902} is control circuit for maintaining constant accelerating potential against fluctuation of the power voltage and load.

CRT Circuit

The unblanking signal is such that CRT is cut off during the period from completion of the sweep to commencement of the following sweep, and the blanking signal from the sweep generator Q_{503} is applied, through R_{514}, R_{926}, R_{927}, R_{928} and C_{918}, to the control grid of CRT.

Q_{903} stabilizing the current, actuates to prevent the waveform from deformation or distortion which is caused by integration of the blanking signal from Q_{503} through R_{514}, R_{926} and R_{927}.

The chopped blanking signal from the blanking oscillator is, through the emitter follower Q_{217}, applied to the CRT Cathode.

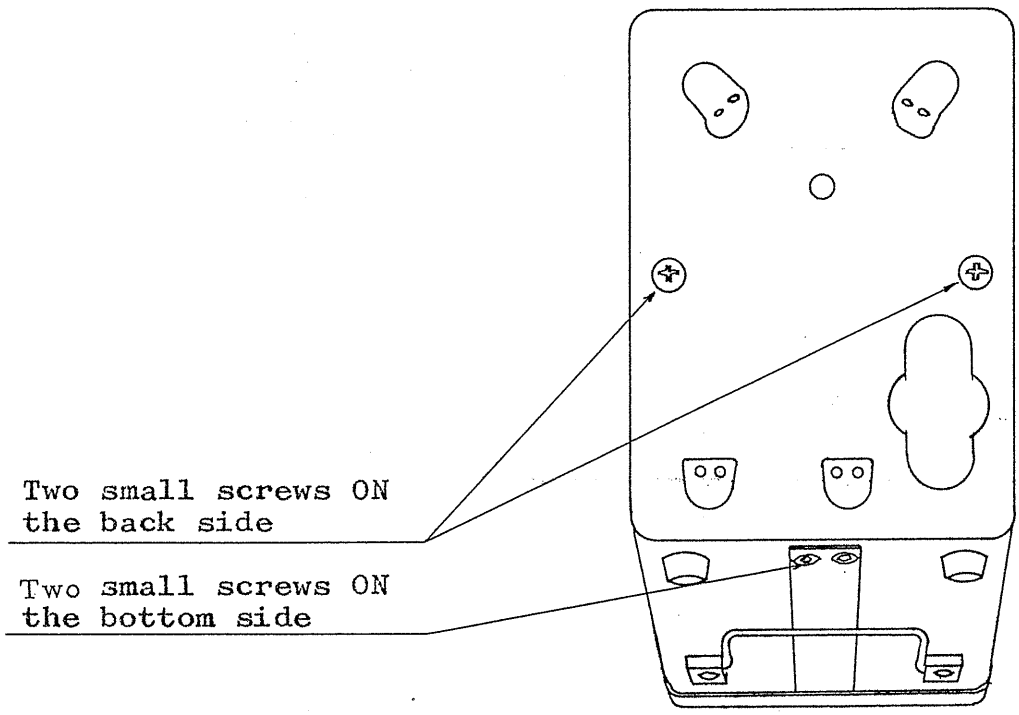
Power supply circuit

Power output available, there are three stabilized outputs +15 V, +50 V, -50 V and unstabilized output +300 V. For stabilization of the power output, an all-transistorized circuit of series control is employed.

8. MAINTENANCE

Removal of Outer Case

For correcting or adjusting functions of internally built-in components which become necessary in case changes in the property of every component which will increase the measuring error caused by long-time use. For this, two small screws of the back side and two of the bottom side are provided for to permit removal of the care, giving access to the interval components.



It is strongly suggested to do the above only after the power source is disconnected, otherwise the repair-man may become another statistic!

Adjustment

Adjustment of DC BAL

1. Set the switch "MODE" at "CH1" position and switch "AC DC GND" at "GND" position.
2. Put the trace in the middle of the scale by adjusting the knob "VERTICAL CH1 POSITION".
3. Try to turn the knob "VARIABLE" for "VOLTS/CM". If the trace shifts up and down, set "DC BAL" which will put the trace in position.
   As the vertical position of the trace moves up and down by turning "DC BAL", try to stop the trace in the middle of the scale by repetitive adjustment of "VERTICAL POSITION".
   The same way is applied in adjustment of CH2.

STABILITY

1. A sinewave of 10 kHz - 50 kHz is applied to the vertical input of CH1.
2. A test waveform with a vertical amplitude of 1 cm formed by the switch "VOLTS/CM" and one or two cycles formed by the switch "TIME/CM" is traced on

the screen.

3. The knob "TRIGGERING LEVEL" is set at "AUTO", "TRIGGERING SOURCE" at "NORM" and "TRIGGERING SLOPE" at +.
4. As the sweep comes to a stop turn to the right, the simi-fixed variable rheostat on the printed base for adjusting stability, the variable resistor set for effect a little before the sweep stops.
   The semi-fixed variable resistor is mounted on the panel.
5. By alternately turning the switch "TIME/CM" and knob "VARIABLE", check all the ranges synchronization which is stabilized.
6. With a monitored frequency ranging 20 Hz - 7 MHz, it is checked to confirm synchronizing performance.
   If not stabilized yet, another adjustment is needed.

ASTIG Adjustment

This is done by the semi-fixed variable resistor provided on the printed base.

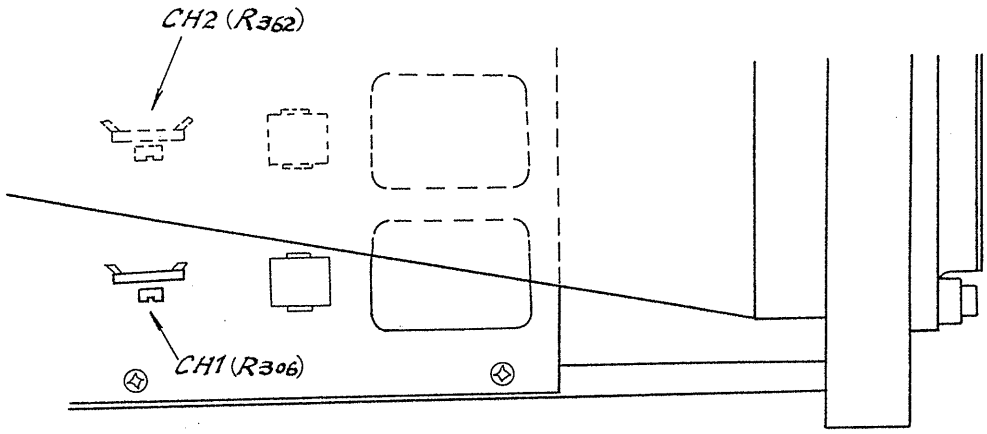
1. Trace sinewave all over the scale area.
2. Adjust "ASTIG" in combination with "FOCUS" so that overall luminous lines present an identical thickness.

Vertical Base Voltage Sensitivity

1. Set "VOLTS/CM" at 0.01X.

2. Set "VARIABLE" at "CAL'D".
3. Apply a squarewave of 0.04 Vp-p to the vertical input.
4. Adjust R_{306} (CH1), R_{362} (CH2) so that the vertical amplitude appears 4 cm in length.

To plan view



Correcting Calibration of "VOLTS/CM" switch

This switch functions to control both the input capacity and frequency characteristics.

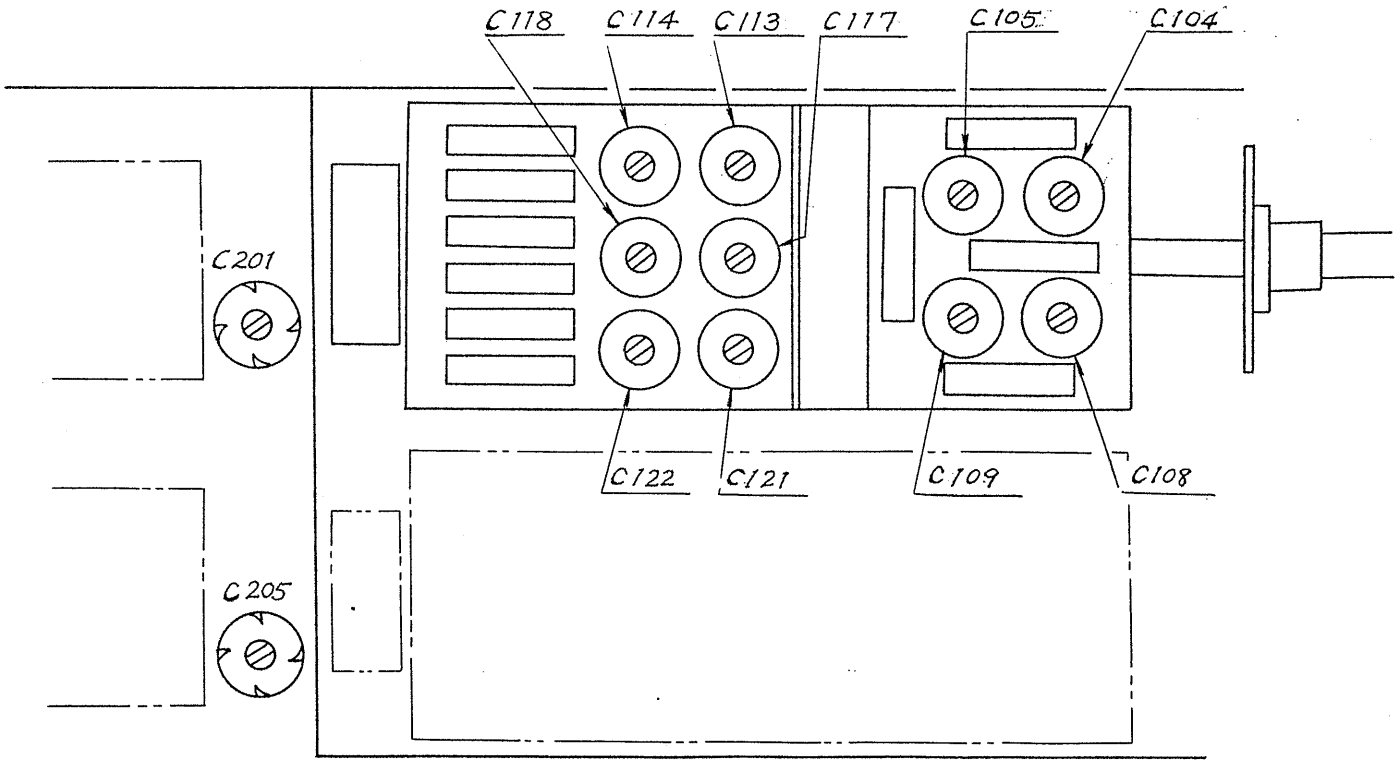
Input capacity:

1. Connect a capacity meter of 38 pF to the vertical input terminal.
2 Set "VOLTS/CM" at 0.01.

3. Adjust the input capacity to 38 pF by C_{201} (CH1), C_{205} (CH2).
4. Set "VOLTS/CM" at 0.02.
5. Adjust the input capacity to 38 pF by C_{104}.

Further adjustments are done in sequence by the following table.

VOLTS/CM	Trimmer Capacitor	Capacitance value to be adjusted
0.01	C_{201}(CH1), C_{205}(CH2)	38 pF
0.02	C_{104}	"
0.05	C_{108}	"
0.1	C_{113}	"
1	C_{117}	"
10	C_{121}	"



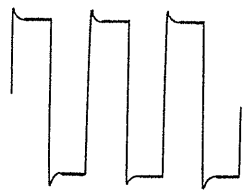
For CH1 and CH2, trimmer capacitors are mounted in a similar position arrangement between both channels, however printed boad are separated.

Frequency Characteristics (Compensator)

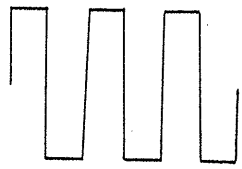
1. A high-performance squarewave generator producing repetitively periodic frequency of 1 kHz, output voltage of 0.04 - 80 Vp-p is connected to the vertical input terminal.
2. "VOLTS/CM" is set at 0.02.
3. The waveform is adjusted by C_{105} - C_{122} as shown in the figure.

   Further adjustments are accomplished as follows.

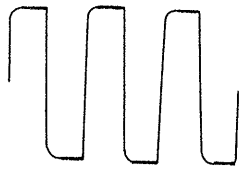
VOLTS/CM	Trimmer Condenser
0.02	C_{105}
0.05	C_{109}
0.1	C_{114}
1	C_{118}
10	C_{122}



NO GOOD



GOOD



NO GOOD

For CH1 and CH2, trimmer condensers are mounted in a similar position arrangement between both channels, however printed boad have been separated.

4. With the above adjustment performance, there usually occurs a slight change in the value of the input capacity. Please adjust the input capacity again.

Calibrated Voltage Adjustment (CALIB Vp-p)

In every range, "VOLTS/CM" needs to be correctly calibrated for voltage sensitivity.

1. Set "VOLTS/CM" of CH1 at 1 V.
2. Set "VARIABLE" at "CAL'D".
3. Apply 5Vp-p output of "CALIB" to the input terminal of CH1.
4. Adjust R810 to obtain a vertical amplitude of 5 cm.

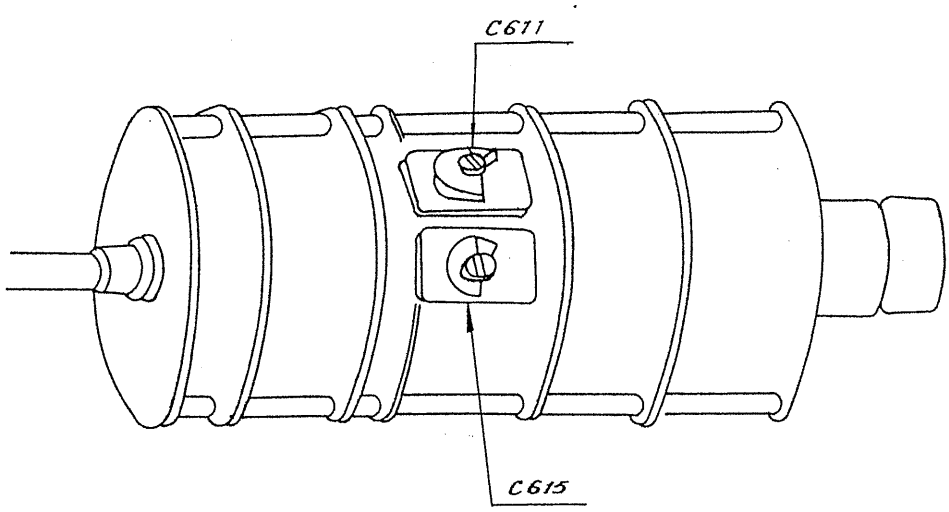
Sweep Time Adjustment

1. Connect a time-mark generator to the vertical input terminal.
2. Set "TIME/CM" and "VARIABLE" at 1 ms and "CAL'D", respectively.
3. Set the output of the time-mark generator at 1 ms.
4. Conform the marker signal to the scale of the graticule by R724 semi-fixed resistor.

5. Pull out "PULL 5X MAG" and adjust the magnifier by R_{734}.

The above adjustment covers a range of 1 sec - 50 μs, and for a range of 20 μs - 1 μs, trimmer capacitor are used.

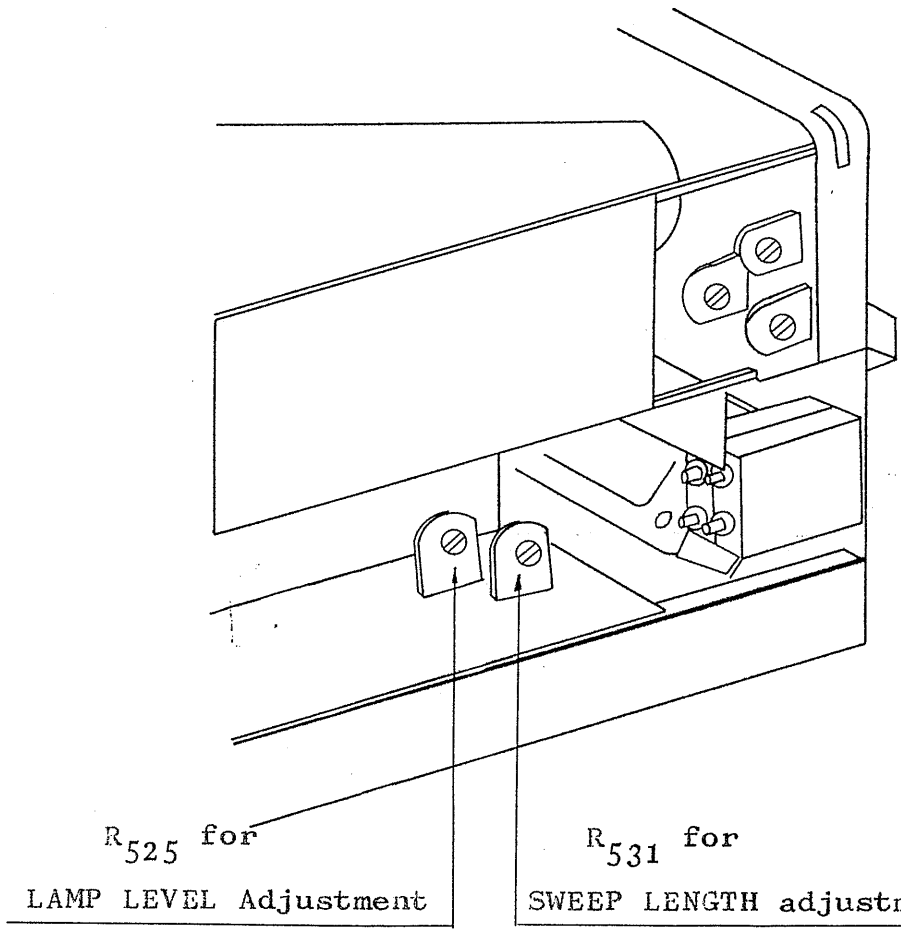
TIME/CM	adjustors	
1 ms	R_{728}	
10 μs	C_{611}	1 ms range is to be performed after adjustment.
1 μs	C_{615}	

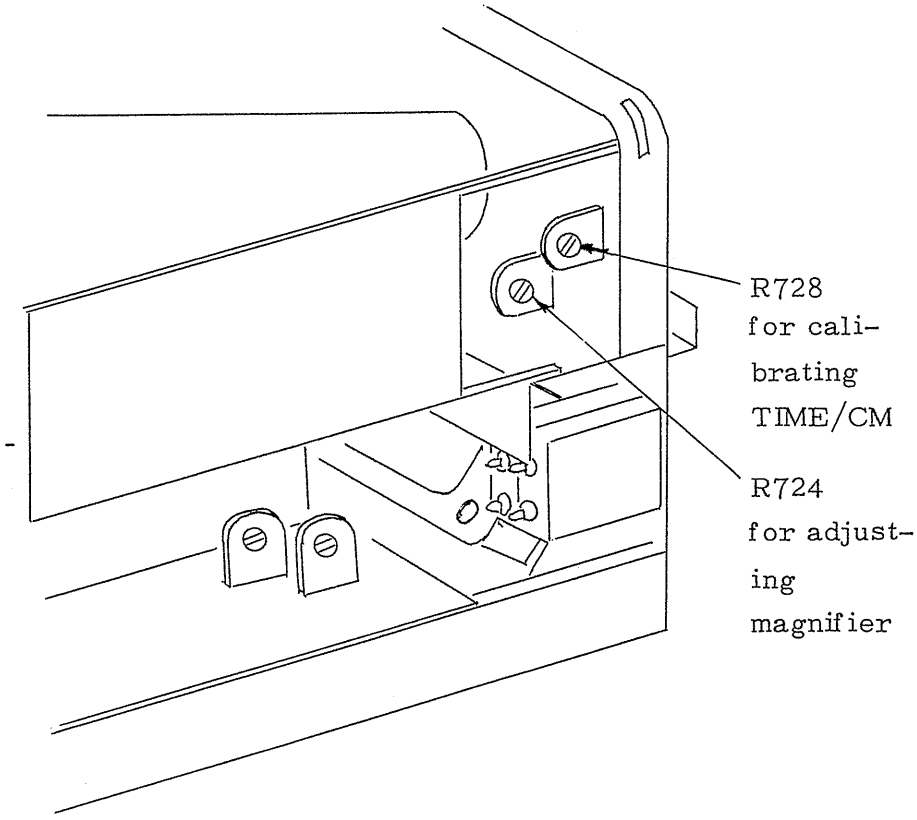


Sweep Length Adjustment

The length of the trace is approx. 10.5 cm at MAG OFF.

This adjustment is usually performed after completing the sweep time adjustment, this is not necessarily required, therefore an easy check is all right. However, if the length is less than 10 cm the semi-fixed resistor R_{531} is used for adjustment.





Maintenance of Probe

Occasional adjustments are necessary for the low-capacity probe, 957M type attached to the Oscilloscope Model 553p.It may happen that the property of the probe becomes damaged when receiving heavy physical shocks or being applied a voltage exceeding rated value. The probe uses a precision resistor for dividing voltage and a trimmer capacitor, for compensating high frequencies characteristic, therefore the best adapted positions of trimmer capacitor may be changed by a strong shock that results in the necessity of correctly calibrating them.

Adjustment of Trimmer capacitor

1. Connect the probe to the vertical amplifier.
2. Apply a squarewave of approx. 1000 Hz to the top end of the probe.
3. By turning the trimmer capacitor in compensator-box by use of screwdriver, adjust the waveform trace to the best condition.