MODEL 555

OSCILLOSCOPE

OPERATION MANUAL

KIKUSUI ELECTRONICS CORP.

CONTENTS

PART 1.

GENERAL CHARACTERISTICS.

The Model 555 Oscilloscope is compact, light weight, highly reliable and easy to operate. This is made possible through the extensive use of semi-conductors.

The oscilloscope uses a 133 mm (approx 5 inch) cathode ray. (Braun) tube. The oscilloscope incorporates an in-built 1 kHz square wave oscillator for calibration purposes.

SPECIFICATIONS

Vertical Amplifier

* Sensitivity:	0.02 V/cm to 10 V/cm in 9 steps (decades of 1.2 & 5)
* Calibration Accuracy:	±3 % (at correct mains voltage)
* Bandwidth (-3 db approx.):	DC to 7 MHz
* Rise Time:	50 nS
* Input Impedance:	1 Megohm 33pF
* Max allowable input Voltage:	600 V p-p

Time Base

* Sweep Range:	1 μ sec/cm to 1 sec/cm in 19 steps (decades of 1.2 & 5)
* Accuracy:	±5 % (at correct mains voltage)
* Expanded Sweep:	5 times ±5 % accuracy (at correct mains voltage)

External Sweep

* Deflection Sensitivity:	1 V p-p/cm. 200 mV p-p/cm using 5 times magnifier. 200 mV to 10 V/cm adjustable continuously in conjunction with AMPLITUDE control.
* Frequency Response (-3 db):	2 Hz to 200 kHz
* Input Impedance:	1 Megohm 40pF

Synchronization

* Synchronous System:	Self-excited trigger sweep.
* Synchronous Signal:	Internal, external, mains frequency.
* Trigger Range	Internal 50 Hz to 5 MHz for 10 mm trace on CRT. 20 Hz to 7 MHz for 20 mm trace on CRT. External 50 Hz to 5 MHz $\geqq$ 1 V p-p 20 Hz to 7 MHz $\geqq$ 2 V p-p

Calibration

* Output Wave-form:	1 kHz square wave (approx)
* Voltage:	5, 0.5 0.05 V p-p
* Accuracy:	$\pm$3 %

Power Requirement ---220---Volts 50/60 Hz

Physical Dimensions (overall)

Width	205 mm
Height	295 mm
Length	450 mm

* Weight	11 kg (approx)

C. R. T.

* Braun tube:	Type 5 UP1F or 5 UP7F

* Accelerating Voltage:	1.6 kV (approx)
* Effective surface viewing area:	10 x 8 cm
* Brilliance modulation:	$\geqq$ 10 V p-p

Accessories

Low capacitance probe Type 957M (X 10 magnification)	1
Terminal Adaptor Type 941B	1
Operation Manual	1
Test Data	1
Short Bar	1

CAUTION

Power Supply Voltage.

The standard power voltage for Model 555 is 220 V. If the power voltage is within $\pm$5 % of 220 V, it can be used as it is. If the trigger oscilloscope is not used within the specified range of voltage, poor action or trouble will be caused. Accordingly, adjust the voltage and use it.

ENVIRONMENTAL OPERATING CONDITIONS

Temperature.

The Model 555 oscilloscope will function effectively within ambient temperatures of 0°C to 40°C.

Atmosphere.

The instrument should not be installed

* in DUSTY ATMOSPHERE

* in HEATED ATMOSPHERE without proper ventillation

* near equipment generating STRONG MAGNETIC FIELDS

* in Areas where CORROSIVE GASES are present

Voltage input.

DO NOT apply any test voltages in excess of the specified figure to the input.

These voltages are:-

Max of 600 V p-p to the vertical input

Max of 100 V p-p to the horizontal input

Voltages greater than 600 V p-p MUST NOT be applied to the Low-Capacity-Probe Type 957M

Deflection Characteristics-Limitation.

* Vertical axsis

Frequencies higher than 4 MHz tend to be distorted. Traces on the CRT face should therefore be kept below 4 cm in amplitude.

* External sweep

In should be considered that input signal more than 10 V p-p may produce distotion in waveform.

CONTROLS

* POWER ON/OFF

* ILLUM ON/OFF. Illuminates the graticules on the dial.

* FOCUS. For focussing the spot to a point.

* INTENSITY. For adjusting the brilliance of the spot.

VERTICAL

* VOLTS/CM: Nine position sensitivity selector in nine ranges from 0.02 to 10 V/cm.

* VARIABLE: This is in tandem with the VOLTS/CM selector and is a fine adjustment for the same. Calibration over the nine ranges selected by the VOLTS/CM selector switch is made when the VARIABLE control is set at CAL'D.

* POSITION: Controls the vertical movement of the trace.

* AC DC: Used for selection of input. To AC when the wave-form has no DC component and to DC when a DC component is present.

* DC BAL. Slotted pre-set potentiometer for adjusting DC balance of the vertical amplifier.

HORIZONTAL

* TIME/CM: 20 position Time-base selector in 19 ranges from 1 μ sec/cm to 1 sec/cm. The twentieth position is labelled EXT and is used in conjunction with an external time-base applied to EXT HORIZ IN terminal.

* VARIABLE: This is in tandem with the TIME/CM selector and is used as a fine adjustment for the same. Calibration is carried out when the VARIABLE control is set at CAL'D. When an external time base is used the VARIABLE control regulates the sensitivity of the time-base.

* STABILITY: Slotted pre-set potentiometer adjusts the stability of the time base oscillator.

* HORIZ. POSITION: Controls the lateral movement of the trace.

* PULL 5 X MAG: A Pull-ON switch mounted on the same shaft as the HORIZ POSITION control. Expands the horizontal sweep five times and consequently increases the sensitivity of the horizontal (time base) amplifier five times. Effective also when the EXT HORIZ IN terminal is used.

TRIGGERING

LINE-INT-EXT: Selects triggering source

- LINE — Mains frequency used for triggering
- INT — Wave-form under observation used for triggering
- EXT — External source applied to EXT TRIG IN terminal used for triggering.

LEVEL: In tandem with the LINE-INT-EXT control. Adjusts the triggering level. When set in the fully anti-clockwise position at AUTO, no trigger sampling is done and sweeping is done automatically.

NOTE: In the rack-mounted version the controls are changed slightly but the same facilities are retained.

TERMINALS/SOCKETS

VERTICAL

* INPUT:	Coaxial input for the wave-form under analysis. (M Type)
* GND:	Chassis ground

HORIZONTAL

* EXT HORIZ IN.	For an external time-base. See also TIME/CM control
* GND	Ground associated with EXT HORIZ IN.

TRIGGERING

* EXT TRIG IN.	External triggering source
* GND:	Ground associated with EXT TRIG IN.

REAR PANEL (See Figure 1)

* EXTERNAL CRT CATHODE :	For brilliance modulation.
* FUSE:	1 Amp slow-blow cartridge type fuse.

CALIBRATOR VOLTS

Three sockets from which the internal square-wave calibrator signal is available at 5, 0.5 and 0.05 V p-p.

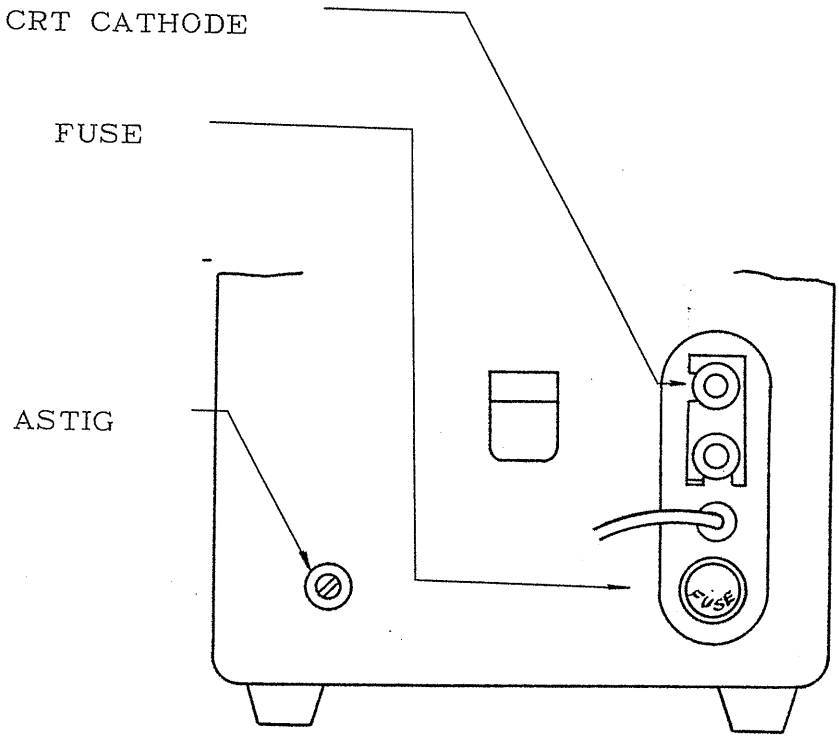


Fig. 1

PART 2.

INITIAL SETTING-UP PROCEDURE.

1. Until the user is familiar with the operation of the oscilloscope it is recommended that the initial setting of controls be made as follows:-

INTENSITY	mid-point
FOCUS	mid-point
ILLUM	ON
VOLTS/CM	0.02
VARIABLE	CAL'D
AC DC	DC
TRIGGERING	
SOURCE	INT
LEVEL	AUTO
TIME/CM	1mS
VARIABLE	CAL'D
POSITION	Mid point
POWER	OFF

The drill as set out in the following paragraphs will familiarise the user with all the controls.

2. After setting the controls as indicated above check that the power source is of the correct voltage and frequency.

3. Throw the POWER switch ON and after a brief warm-up period, a bright horizontal line will appear on the CRT face. If the controls are set at some position other than that recommended in para.

1. above, the trace will not appear in the centre of the display.

4. Adjust the brilliance of the trace with the INTENSITY control. A too brilliant trace will cause damage to the phosphor on the tube face. Brilliance should therefore be adjusted just enough for adequate viewing.

5. Connect the coaxial VERTICAL INPUT terminal to the 0.05 V CALIB socket.

A wave-form with an amplitude of 2.5 cm, as illustrated in Figure 2, will appear on the screen.

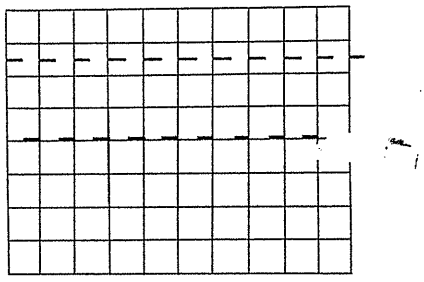


Fig. 2

6. Adjust thc position of the trace on the screen with the help of the VERTICAL POSITION and HORIZONTAL POSITION controls.

7. TURN the VOLTS/CM VARIABLE control counterclockwise and the amplitude of the trace will decrease.

8. Turn the TIME/CM VARIABLE control and notice a change in sweep time.

9. Throw the TRIGGERING SOURCE switch to INT —— and notice that sweeping takes place from the negative part of the square wave. Note the difference when the switch is restored to INT.

10. Turn the LEVEL control clockwise away from AUTO and note the temporary disappearance of the trace which, however, reappears in the middle of the screen. Sweeping will cease on the disconnection of the VERTICAL INPUT.

11. Restore the LEVEL control to AUTO, pull the 5 x MAG switch ON and note a five fold expansion of the width of the trace.

12. Put the TIME/CM switch to EXT and connect the EXT HORIZ IN terminal to the CALIB 5 V socket. The TIME/CM VARIABLE control now serves as horizontal axis sensitivity adjustor. Sensitivity is equal to or better than 0.2 V/cm with 5 x Mag. pulled ON and equal to or better than 1 V/cm with it pushed OFF.

The foregoing drill should have now familiarised the user with all the controls.

PART 3.

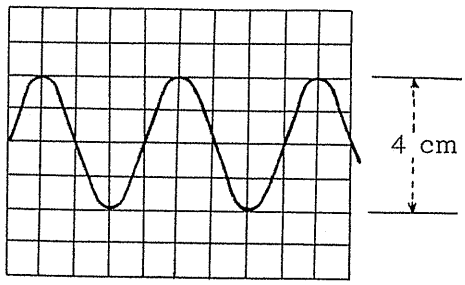
OPERATION OF THE OSCILLOSCOPE FOR SPECIFIC MEASUREMENTS.

Measurement of AC Voltage.

1. Apply the unknown voltage under investigation to the INPUT terminal through the low capacity probe Type 957M

2. Throw the AC DC switch to AC, the VOLTS/CM VARIABLE switch to CAL'D and the VOLTS/CM Selector to a setting that will allow a few cycles of the wave form to be displayed on the screen.

3. Read off the amplitude of the wave form in cm against the graticules. The Voltage of the source under investigation is then equal to Vertical Amplitude X VOLTS/CM setting X magnification of the probe. See example below.



Vertical amplitude = 4 cm.

VOLTS/CM setting = 0.5

Probe magnification (Type 957 M) = 10

Unknown Voltage = 4 x 0.5 x 10
= 20V p-p

Fig. 3.

Measurement of Voltage with a DC Component.

1. Connect the probe to the INPUT terminal.

2. Set the AC DC switch to DC.

3. TRIGGER LEVEL to AUTO.

4. A reference line now has to be arbitrarily fixed. Apply the probe to the ground terminal and bring the straight-line horizontal trace to the lower limit of the dial. If the unknown voltage has a negative DC component then the reference line will have to be moved to the upper limit of the dial. Once this reference has been fixed the VERTICAL POSITION control should not be touched while the measurement is being made.

5. Apply the probe to the voltage to be measured.

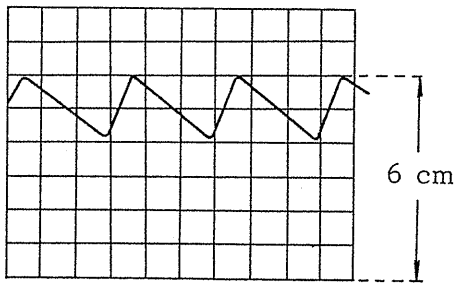
6. Read off the amplitude of the wave-form with reference to the reference line and its value is now equal to Vertical amplitude from reference line X VOLTS/CM setting X magnification of probe. See example below.

Vertical amplitude = 6 cm

VOLTS/CM setting = 1

Probe magnification =10

Unknown Voltage 6 x 1 x 10 = 60 V.



Standard.

Fig. 4

Measurement of Time (Period)

1. Set the TIME/CM VARIABLE control to CAL'D

2. Set TIME/CM Selector to a range so that at least one complete wave-form is displayed.

3. Use the Vertical and Horizontal POSITION controls to get the trace into a suitable position for taking measurements. See Fig. 5

below. An example of how the measurement is now made is given below.

Length of one wave form = 6 cm

TIME/CM setting = 1mSec.

Time (Period) 6 x 1 = 6mSec.

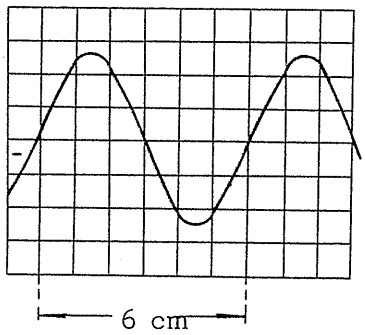


Fig. 5

With the 5 X MAG switched pulled ON, the measurement is modified as follows:-

$$\text{Time (period)} = \frac{\text{Length of one waveform X TIME/CM setting.}}{5}$$

Measurement of Frequency.

Having measured the time (period) of one cycle as above the frequency is deduced as follows:-

$$\text{Frequency} = \frac{1}{\text{Time of one cycle}}$$

Using the same example as given above

$$\text{Frequency} = \frac{1}{6 \text{ mSec.}} = 167 \text{ Hz}$$

Phase Measurement

Lissajou figures are used for measuring the phase difference between two signals of the same frequency. The inherent phase difference between the vertical and horizontal amplifiers must first be ascertained before any

other phase measurements are made.

The procedure for phase measurement is as follows:-

1. TIME/CM switch to EXT

2. The two signals to be compared are applied to VERTICAL INPUT and EXT HOR IN terminals respectively.

A lissajou figure will appear on the tube face. One example of how phase angle can be measured is given below:

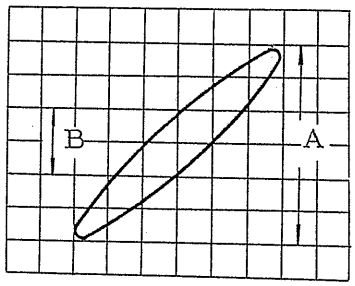


Fig. 6.

Measure A and B

Phase angle $\theta = \sin^{-1} \frac{B}{A}$

Actual phase difference between the two signals is :

θ - inherent phase angle between vertical & Horizontal amplifiers.

PART 4.

MAINTENANCE AND ALIGNMENT PROCEDURES.

This section deals with maintenance and alignment of the equipment and involves the adjustment of the pre-set controls. The procedures enumerated in this section should be attempted only when the front panel controls fail to give the required response.

Removal of the instrument from its cabinet.

CAUTION. Do NOT attempt to remove the outer case with the power connected.

Remove the three screws as indicated in the diagram (two in the rear and one in the underside). This loosens the outer cover which may now be pulled out.

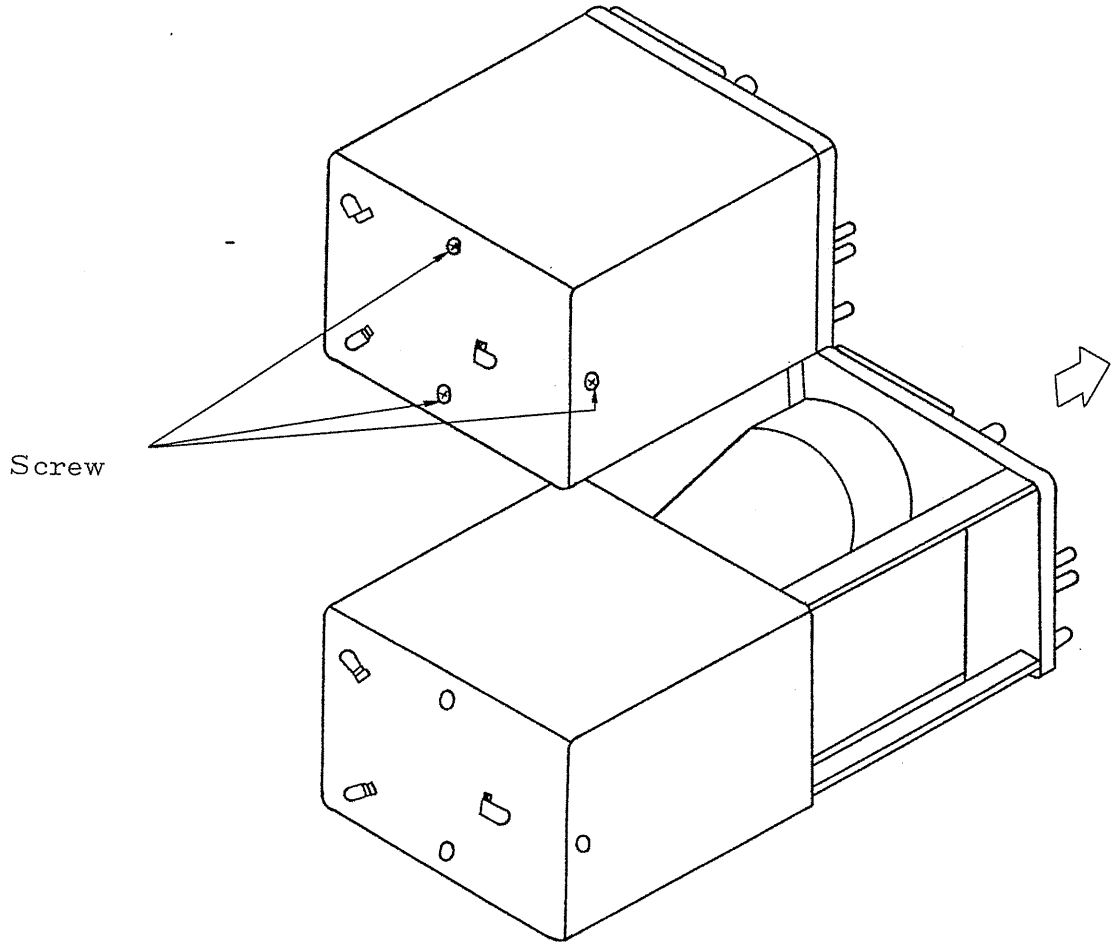


Fig. 7

DC BAL Adjustment.

1. Set all controls as given in the Initial Setting-up Procedure (Part 2.)
2. Short circuit the VERTICAL INPUT terminals.
3. Bring the trace to the centre of the scale using the VERTICAL POSITION control.
4. Turn the VOLTS/CM VARIABLE control and if the base moves

then DC BAL needs adjusting. Adjust DC BAL (slotted preset potentiometer) and VOLTS/CM VARIABLE control in turn until the latter finally has no effect on the movement of the base.

It may also be necessary, during this adjustment, to use the POSITION control from time to time.

5. Remove the short circuit from the VERTICAL INPUT

STABILITY Adjustment.

1. Apply a sine wave input in the range 10 kHz to 50 kHz to the VERTICAL INPUT.
2. Set the VOLTS/CM switch to 1 and by adjustment of the TIME/CM control produce one or two complete wave-forms on the screen
3. Set TRIGGERING LEVEL control to AUTO and TRIGGERING SOURCE to INT.
4. If STABILITY (slotted pre-set potentiometer) is now turned counterclockwise, sweeping will stop. The control should be set to a point at which sweep action just begins.
5. Turn TIME/CM and VARIABLE controls alternately and confirm that synchronisation is stable over all ranges.
6. Extend the frequency input from 20 Hz to 7 MHz and confirm that synchronisation is stable over the whole range.

If found unstable re-adjust STABILITY.

ASTIGMATISM Adjustment.

(This is a slotted pre-set potentiometer accessible at the rear of the instrument)

Produce a sine-wave on the tube display, adjust ASTIG and FOCUS until the trace is of uniform thickness throughout.

Note: Subsequent adjustments are carried out with the cover removed. Due care should be exercised as dangerously high voltages are used in the CRT.

Calibration of the Deflection Sensitivity of the Vertical Amplifier.

1. Set VOLTS/CM to 0.02
2. Set VARIABLE to CALD
3. Feed a square wave 0.05 p-p to VERTICAL INPUT
4. Adjust RV 202 (slotted pre-set potentiometer) until the wave form has an amplitude of 2.5 cm. RV 202 is located on the vertical amplifier chassis.

Calibration of VOLTS/CM Control.

The following procedure is required for adjusting the input capacitance to the correct value which is 33pF.

1. Connect a capacitance bridge across the VERTICAL INPUT terminals.
2. Set VOLTS/CM to 0.02 and adjust trimmer CV206 until the input capacitance as measured on the bridge is 33pF.
3. Set VOLTS/CM to 0.05 and in the same way adjust input capacitance to 33pF with the use of trimmer CV202B.
4. Carry out the same procedure for all the other ranges of the VOLTS/CM switch in accordance with the table below.

VOLTS/CM Switch	Trimmer Capacitor	Adjustment
0.02	CV 206	33pF
0.05	CV 202B	33pF
0.1	CV 203B	33pF
0.2	CV 204C	33pF

VOLTS/CM Switch	Trimmer Capacitor	Adjustment
1 2 5 10	CV 205C	33pF

These trimmer capacitors are located on the Vertical Amplifier Chassis and are grouped together as shown in Figure 8.

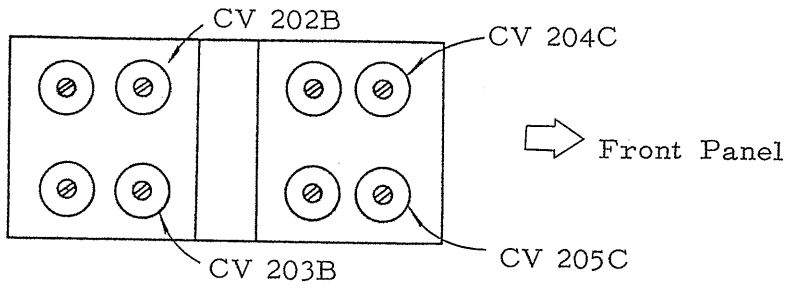


Fig. 8

After these adjustments have been made the input capacitance may have changed. Re-adjust if necessary.

Sweep Time Calibration.

1. Apply a time mark generator output (set at 1mS) to the VERTICAL INPUT Terminal.
2. Set TIME/CM to 1mS and VARIABLE to CAL'D.
3. Adjust RV602 (slotted pre-set potentiometer) until the marker signal coincides with the appropriate marking on the dial.
4. Pull 5 x MAG ON and adjust RV603 so that five times the number of markers appear on the scale as seen when RV602 was adjusted.

   Note RV602 & RV603 are located on the Horizontal Amplifier

chassis.

5. The above adjustments are adequate in the 1 sec. to 50 μsec. range. Adjustments are made to trimmer condensers C501E and C501G in accordance with the table below the 20 μsec. to 1 μsec. range.

TIME/CM	CONTROL	REMARKS
1 msec.	RV 602	
10 μsec.	C501E	To be done only after 1 msec. range adjustment has been made.
1 μsec.	C501G	

Note:- Trimmer capacitors C501E and C501G are located in the Time Base Timing Switch (TIME/CM). See Figure 9 Below.

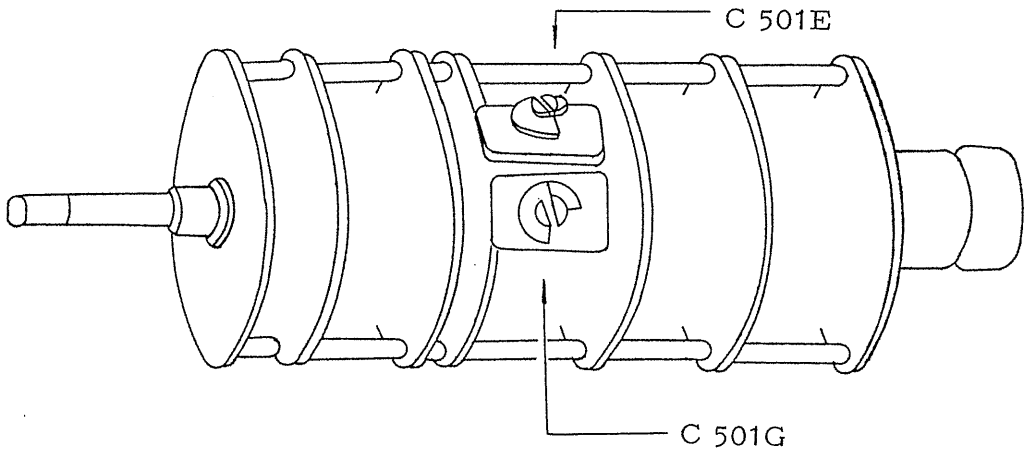


Fig. 9

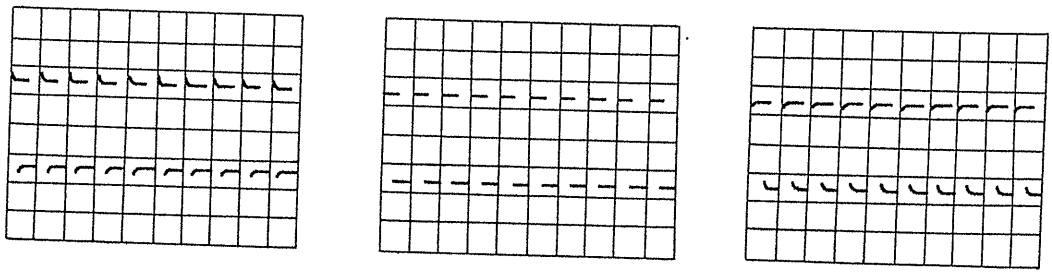
Alignment of the Vertical Amplifier for Correct Wide-Band Amplification.

1. Apply a 1 kHz square waveform to the VERTICAL INPUT. The square-wave source should be high grade and capable of giving an output voltage variable from 0.05 V to 100 V p-p.

2. Set VOLTS/CM to 0.05.

3. Adjust trimmer capacitors for the respective range (see table below) so that a proper square-wave form is produced on the scale (See Fig. 10).

VOLTS/CM Switch	TRIMMER CAPACITOR
0.02	
0.05	CV202A
0.1	CV203A
0.2	CV204A
0.5	
1	
2	CV205A
5	
10	



Incorrect Correct Incorrect

Fig.10

Trimmer capacitors CV202A to 205A are located on the VOLTS/CM switch. See Figuer 11.

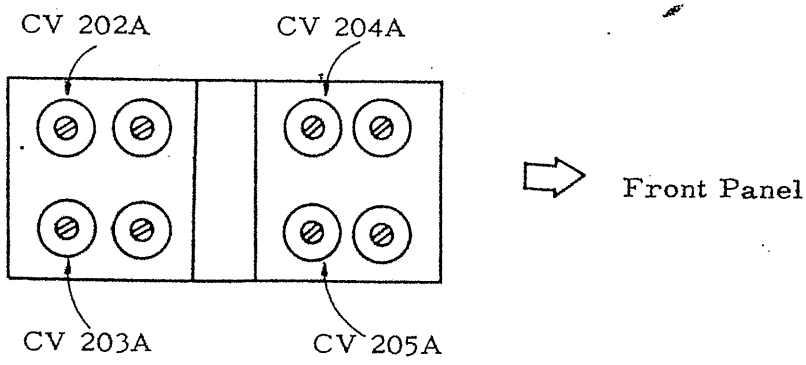


Fig. 11

Adjustment of Sweep Width.

The length of the sweep line is approximately 10.5 cm with 5 x MAG OFF. This adjustment is not essential unless the sweep line is less than 10 cm. If necessary the width is increased by adjusting RV403, located on the Time-Base Generator chassis and labelled SWP LENGTH. This adjustment is made only after Sweep Time Calibration has been completed.

Adjustment of Horizontal DC BAL

1. Set TIME/CM switch to EXT
2. Adjust slotted pre-set potentiometer RV-702 (found on Horizontal Amplifier Chassis and labelled HOR BAL) such that any movement of TIME/CM VARIABLE control does not cause the spot to move laterally.