INSTRUCTION MANUAL FOR

OSCILLOSCOPE

MODEL 537

KIKUSUI ELECTRONICS CORPORATION, JAPAN

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1. GENERAL

The Kikusui Model 537 is a compact, highly reliable, universal purpose oscilloscope which employs a compact 75-mm-screen cathode-ray tube, solid-state electronics, and unique lightweight metallic alloy housing.

The vertical system provides a sensitivity of 10 mV/div or over and a frequency bandwidth of 0 - 5 MHz. It has a direct CRT input terminal which responds to up to approximately 100 MHz and can be used to monitor a transmitter output.

The time axis circuit provides sweep frequencies of 10 Hz - 100 kHz and TV H sweep, and synchronizing with INT "+", INT "-", and EXT. When this circuit is switched over to the external sweep mode, it provides a deflection sensitivity of 200 mV/div or over and a frequency band of 2 Hz - 400 kHz. The external signal is applicable through a front panel connector. This mode can be employed for X-Y operation of the oscilloscope, providing a high operation flexibility.

The oscilloscope internally generates a 1 kHz quality square wave signal which may be used to calibrate the vertical deflection sensitivity and to check the probe performance. The square wave generator has a good stability against line voltage variation and provides a reliable reference signal.

Since solid-state electronics is employed throughout the circuits, the oscilloscope can start operating only in less than 20 seconds after its power is turned on. Since heat-generating components and hence the instrument wattage are minimized, the drift is very small and an improved operation reliability is attained.

2. SPECIFICATIONS

VERTICAL DEFLECTION SYSTEM

Item	Specification	Remarks
Sensitivity	10 mV/div or over	1 div = 6 mm
Coupling	AC and DC	
Frequency bandwidth	AC coupling: 2 Hz - 5 MHz DC coupling: 0 - 5 MHz	50 kHz reference, within -3 dB
Attenuator	1/1, 1/10, and 1/100 (with frequency response compensation)	
Attenuation accuracy	Better than ±3%	
Input impedance	1 MΩ ±2%, 38 pF ±2 pF	
Input terminal	M-type plug	
Maximum allowable input voltage	1/1 range: 400 Vp-p Other ranges than 1/1: 600 Vp-p	Voltages are as DC + AC peak. AC frequency below 1 kHz.
Direct CRT terminal	Sensitivity: 10 V/div or over Response: Up to approx. 100 MHz	Maximum input voltage 100 Vp-p

HORIZONTAL DEFLECTION SYSTEM (EXTERNAL SWEEP AMPLIFIER)

Item	Specification	Remarks
Sensitivity	200 mV/div or over	1 div = 6 mm
Coupling	AC coupling	
Frequency bandwidth	2 Hz - 400 kHz (1 kHz reference)	Amplitude 10 div reference, within -3 dB
Input impedance	Approx. 220 kΩ, approx. 25 pF	

TIME AXIS

Item	Specification	Remarks
Sweep frequency	10 Hz - 100 kHz, and TV.H	With TV.H, two waveforms of video signal are displayed on CRT screen.
Synchronizing	INT ("+" and "-", selectable) EXT (Synchronized with a signal of 100 mVp-p and over, for a range of 20 Hz - 5 MHz)	 When sine wave is used.

CALIBRATION VOLTAGE

Item	Specification	Remarks
Waveform	Square wave, approx. 1 kHz	
Output voltage	50 mVp-p and 1 Vp-p (tow out put voltages)	Regulated output
Output voltage accuracy	Better than ±3%	

CRT

Item	Specification	Remarks
Type	75 mm, round screen CRT	
Acceleration voltage	Approx. 1.2 kV	

POWER REQUIREMENTS

Item	Specification	Remarks
Voltage	[illegible] V ±10%	
Frequency	50 - 60 Hz	
Wattage	Approx. 18 VA	

DIMENSIONS AND WEIGHT

Item	Specification	Remarks
Dimensions	200 mm W x 155 mm H x 155 mm D	Maximum dimensions
	200 mm W x 140 mm H x 285 mm D	Housing only
Weight	Approx. 5.0 kg	

ACCESSORIES

Type 941B Terminal Adaptor 1

Instruction Manual 1

[illegible] 1

3. EXPLANATION OF THE FRONT PANEL

INTEN

POWER
OFF

CRT intensity (brightness) control and oscilloscope main power switch. The power turns on as the knob is turned from its extremely counterclockwise position, and the spot (trace) becomes brighter as the knob is turned clockwise.

FOCUS

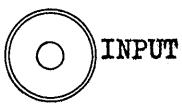
For CRT spot (trace) focussing. The knob must be adjusted so that the sharpest image is displayed on the CRT screen.

CALIBRATOR

1 Vp-p

50 mVp-p

Reference voltage output terminals for 1 Vp-p and 50 mVp-p used for instrument sensitivity and probe calibration. The signals are zero-volt-referenced positive-going square wave of approximately 1 kHz.



Input terminals for vertical axis amplifier. The signal to be measured is applied to these terminals with lead wires or shielded cable.

Type 957M Low-capacitance Probe (option) can be used with this oscilloscope, to reduce the loading effect caused to the measured signal source and thereby to make the measurement more accurate.

AC DC

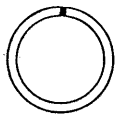
Pushbutton switch to select coupling of vertical axis input. The depressed state is for DC coupling and the popped out state is for AC coupling.

VERT GAIN

1/100 1/10 1/1

Pushbuttons to select vertical deflection sensitivity in 3 steps. The sensitivity is maximum (unity) when 1/1 button is depressed; it is reduced by a factor of 1/10 or 1/100 when the 1/10 or 1/100 button, respectively, is depressed.

VARIABLE

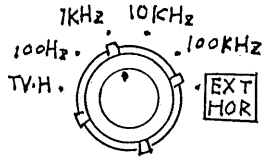


Continuously-variable control of vertical deflection sensitivity. The sensitivity becomes maximum when the control is turned to the extremely clockwise position. The variable range is up to approximately 10 times. When the 1/1 button of VERT GAIN selector is depressed and this control is turned to the extremely clockwise position, the vertical deflection sensitivity becomes 10 mV/div or higher.

POSITION

Vertical positioning of the spot (or trace) on the CRT screen.

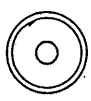
SWEEP RANGE



Outer knob: Selects sweep frequency in 5 steps. When this knob is turned to the extremely clockwise position (EXT HOR position), the input signal for horizontal amplifier is connected to the EXT HOR terminal to operate in the external sweep mode.

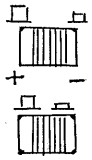
Inner knob (red knob): For continuously-variable control of time-axis sweep frequency.

EXT HOR/SYNC IN



Used in common as external synchronizing signal input terminal and as external sweep signal input terminal for horizontal amplifier.

EXT INT



These pushbutton switches select synchronization modes.

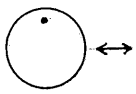
The upper switch selects the synchronizing signal source. When it is depressed for INT SYNC mode, sweep is synchronized with the measured signal itself; when it is set in the popped out state for EXT SYNC mode, sweep is synchronized by external signal applied through SYNC IN terminal.

The lower switch selects the synchronizing polarity for INT SYNC operation. The depressed state is for synchronizing with a negative-going slope of the trigger signal, and the popped out state is for that with a positive-going slope.

HOR GAIN

For continuously-variable control of horizontal deflection sensitivity. The sensitivity increases as this knob is turned clockwise.

POSITION



Horizontal positioning of the spot (or trace) on CRT screen.

4. EXPLANATION OF THE BOTTOM AND REAR PANELS

Bottom Panel

DC BAL

This control should be so adjusted (with a screwdriver) that the base line of trace is not vertically shifted when the vertical sensitivity VARIABLE knob is turned.

ASTIG

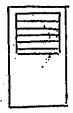
For astigmatism adjustment. This control should be so adjusted (with a screwdriver) in combination with the FOCUS control on the front panel that sharpest image is displayed on CRT screen. This control has been correctly adjusted at the factory prior to shipment and field adjustment is rarely required.

Rear Panel

GND

Direct input terminals for CRT vertical deflection plates.

DIRECT



INT

AMP

Selects vertical deflection circuit. The DIRECT position is for application of the external signal (connected to the direct input terminal) to CRT vertical deflection plates through capacitors. The INT AMP position is for application of the vertical amplifier output to the CRT, the external signal being connected to the vertical input terminal on the front panel.

Fuse holder containing a 0.5 A fuse.

5. OPERATION EXPLANATION

Before Turning On The Power

Set the controls and switches on the panels as shown below, and then connect the power cord to a line power outlet of 100 V, 50/60 Hz.

CRT	INTEN:	POWER OFF position
	FOCUS:	Mid-position
Vertical axis	POSITION:	Mid-position
	VERT GAIN:	Depress the 1/1 button.
	AC DC:	Depress (DC-coupling)
	VARIABLE:	Mid-position
Time axis	POSITION:	Mid-position
	HOR GAIN:	Mid-position
	SWEEP RANGE:	1 kHz
	VARIABLE:	Mid-position
	EXT INT:	Depress (INT state)
	+ −	Depress ("-" state)
Rear panel	DIRECT/INT-AMP:	INT AMP position

After the above setting is complete, turn clockwise the INTEN knob to turn on the power. The knob may be turned to the fully clockwise position for the maximum trace brightness. The trace should be displayed on the CRT screen in approximately 20 seconds after turning on the power. When the trace is displayed, move the trace to the vertical center of the screen by means of the POSITION control, and adjust the FOCUS knob so that the trace image is made very sharp. Turn the INTEN knob to obtain appropriate trace brightness.

Connect the CALIBRATOR 50 mVp-p output terminal to the VERT INPUT terminal with lead wires, so that the calibration voltage signal (square wave) is displayed on the CRT screen. Adjust the SWEEP RANGE knob (red knob) so that the displayed calibration voltage waveform becomes stationary. Under this state, manipulate the synchronizing signal polarity selector switch and the vertical VARIABLE knob to understand the corresponding change in the displayed waveform, because such understanding will be helpful in reading Section 6 "Operating Procedure."

SYNCHRONIZING CIRCUIT AND SWEEP GENERATOR

The sweep generator produces a sawtooth waveform with which the trace is swept horizontally to display the measured signal on the CRT screen. The sweep speed is selected with the SWEEP RANGE knob on the front panel.

The synchronizing circuit produces a signal to synchronize the sawtooth sweep signal with the measured waveform, in the INT or EXT synchronizing mode.

HORIZONTAL AMPLIFIER

The horizontal amplifier amplifies the output of the sweep generator to a level sufficient for horizontal deflection and positioning of the sweep on the CRT screen. When the external sweep operation is selected, the amplifier is disconnected from the sweep generator and amplifies an external signal for Lissajous figure display and phase measurement.

VERTICAL AMPLIFIER

The vertical amplifier amplifies the signal to be observed to a level sufficient for vertical deflection and positioning of the waveform on the CRT screen. The amplifier is a DC-coupled wide-band push-pull type. The signal connected to the VERT INPUT terminal is fed through the VERT GAIN circuit (attenuator with factors of 1/1, 1/10, and 1/100) and the cathode follower (Q101) to the 3rd-stage transistors Q105 and Q106. To make the

best use of its performance, the DC amplifier must be DC-balanced. For this purpose the DC amplifier is incorporated with the DC BAL control (semi-fixed resistor). Refer to Section 8 "Maintenance" for details of DC-balance adjustment.

6. OPERATING PROCEDURE

6.1 VERTICAL DEFLECTION SENSITIVITY CALIBRATION

Prior to voltage measurement of the displayed waveform, the vertical deflection sensitivity of the oscilloscope must be calibrated. For this calibration, set at first the switches and controls as below.

Vertical axis	POSITION:	Mid-position
	VERT GAIN:	The 1/1 button depressed.
	AC DC:	Popped out state (AC-coupling)
	VARIABLE:	Mid-position
Time axis	POSITION:	Mid-position
	HOR GAIN:	Mid-position
	SWEEP RANGE:	1 kHz
	EXT INT:	Depressed state (INT state)
	+ -	Depressed state ("-" state)

(1) Under the above setting, connect the 50 mVp-p CALIBRATOR output to the VERT INPUT terminal, so that the calibration voltage waveform is displayed on the screen.

(2) When the vertical amplitude of the displayed calibration signal waveform is adjusted to 5 div by turning the vertical VARIABLE control (grey knob), the vertical amplifier sensitivity is calibrated at 10 mVp-p/div.

(3) When the 1/10 button of the VERT GAIN selector is depressed without turning the vertical VARIABLE control (grey knob), the sensitivity becomes 100 mVp-p/div; when the 1/100 button is depressed, the sensitivity becomes 1 Vp-p/div.

The above is an example of a particular case. In general the sensitivity of the vertical amplifier is given by the below equation.

$$\text{Sensitivity of vertical amplifier} = \frac{E_{cal}}{\ell} \quad (\text{Vp-p/div})$$

where, E_{cal}: Calibration voltage (Vp-p) applied to VERT INPUT terminal.

ℓ_{div}: Vertical amplitude of calibration voltage waveform displayed on CRT screen.

The vertical amplifier sensitivity can be calibrated to a suitable value for measurement by adjusting the VARIABLE knob and VERT GAIN selector pushbuttons as required. (See Fig. 1.)

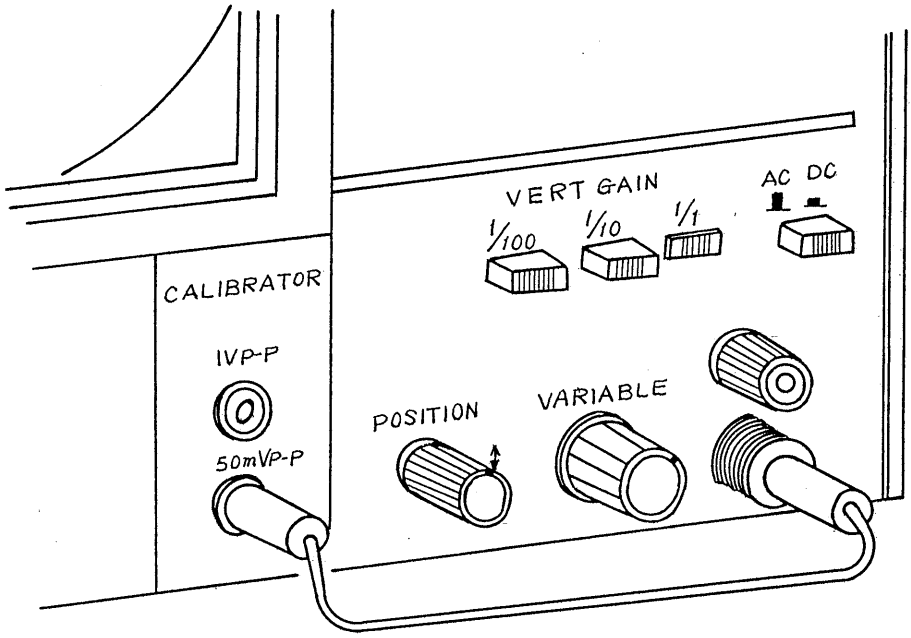


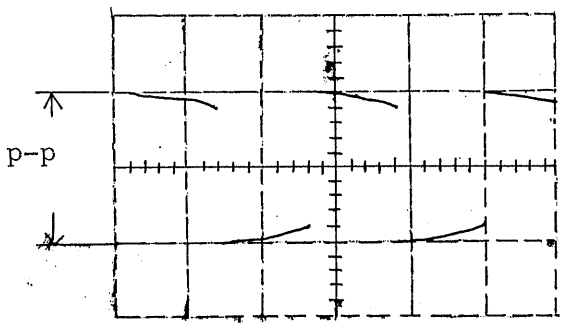
Fig. 1 Vertical amplifier sensitivity calibration

6.2 WAVEFORM OBSERVATION

Apply the signal to be observed to the VERT INPUT and GND terminals. Adjust the VERT GAIN selector and SWEEP RANGE selector so that the signal is displayed with appropriate vertical and horizontal amplitudes on the CRT screen. When the amplitude of the signal to be observed is unpredictable, depress the 1/100 button of the VERT GAIN selector and set the AC-DC switch in the AC state. The AC-DC switch selects the input coupling mode. The depressed state is for DC coupling and the popped out state is for AC coupling.

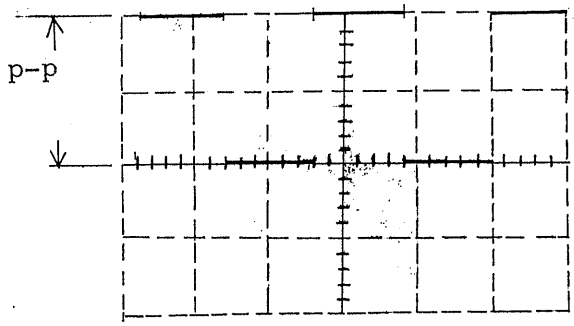
If a low frequency square wave is displayed employing the AC-coupling, the displayed waveform will have sags as shown in (waveform-1). In such a case the DC-coupling should be used to display the waveform without distortions as shown in (waveform-2). If a ripple component superimposed on a DC component is displayed employing the DC coupling, the displayed waveform will be as shown in (waveform-3) and the required ripple component will be displayed with an insufficient amplitude. In such a case the AC-coupling should be used to eliminate the DC component and display the required AC component alone with a sufficient amplitude.

AC coupling

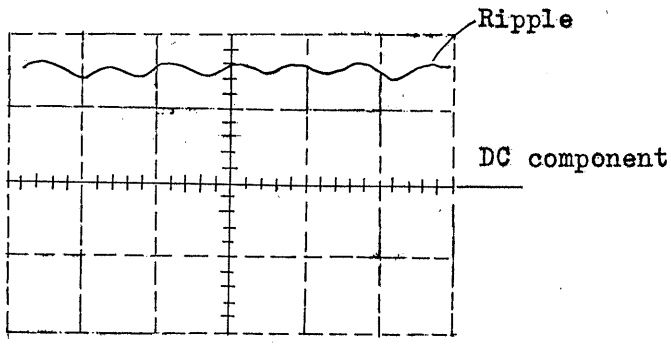


(Waveform-1)

DC coupling



(Waveform-2)



(Waveform-3)

In accordance with the frequency of the signal to be displayed, adjust the sweep frequency by means of the SWEEP RANGE selector switch. (See Fig. 2.) The VARIABLE control (the red inner knob) can continuously cover the span between the two adjoining ranges and the displayed waveform can be made stationary by adjusting this control appropriately. In general the sweep frequency should be a sub-multiple of the frequency of the signal to be measured. Proper synchronization is realized when the following condition is satisfied.

Sweep frequency = Observed signal frequency x 1/n

(where, n = 1, 2, 3, ...)

The sweep amplitude as displayed on the CRT screen is adjustable by means of the HOR GAIN control.

6.3 TV H

The TV H position is provided on the SWEEP RANGE selector for convenient observation of circuit waveforms of the TV receiver set. Set the SWEEP RANGE selector in the 100 Hz position and adjust the inner knob (red knob) so that two vertical cycles of the television signal is displayed on the screen. Keeping the inner knob in this position, turn the outer knob to the TV H position. When this is done, two cycles of horizontal system of the television set should be automatically displayed on the CRT screen of the oscilloscope.

6.4 SYNCHRONIZATION

For general waveform observation, set the pushbutton switch in the INT "+" or "-" position. (See Fig. 2.) When the input signal frequency is high and amplitude is small, triggering may become unstable. In such a case, set the pushbutton switch in the EXT state and apply to the SYNC IN terminal an external signal of which frequency is the same with the measured signal and voltage is not lower than approximately 100 mVp-p.

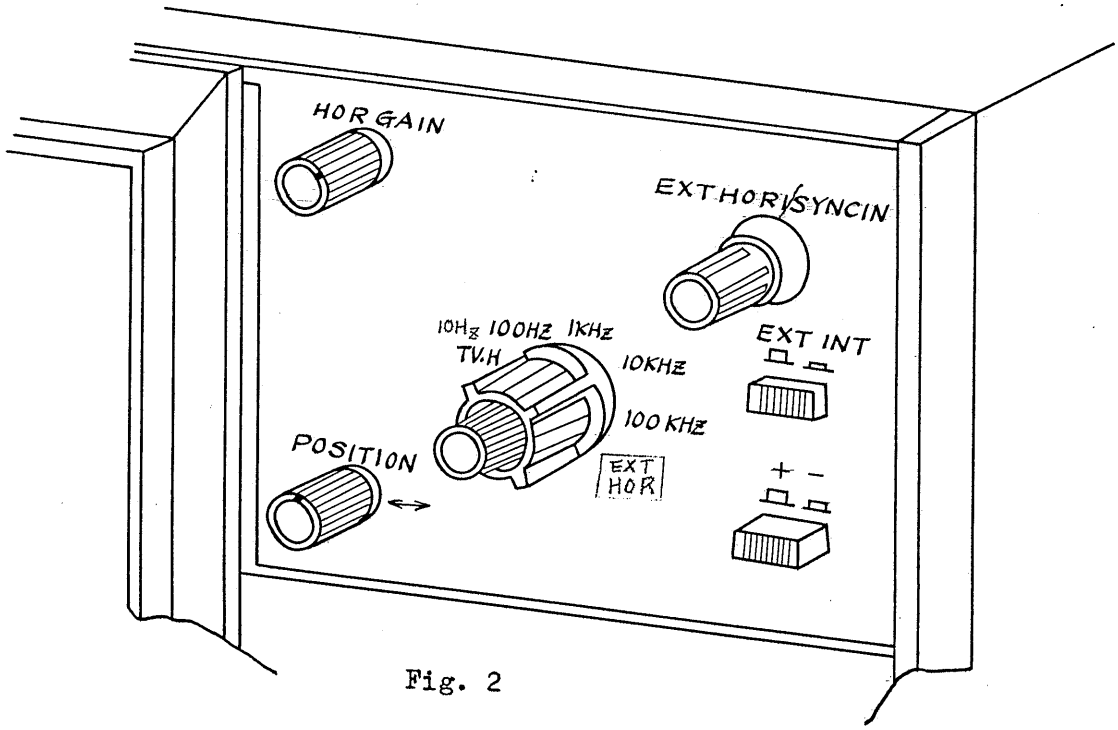


Fig. 2

6.5 HORIZONTAL AMPLIFIER

For Lisajous figure observation and phase measurement by applying an external signal to the horizontal amplifier, turn the SWEEP RANGE selector to the EXT position and connect the external signal to the EXT HOR terminal. The horizontal deflection sensitivity is adjustable by means of the HOR GAIN knob.

6.6 SPOT OR TRACE POSITIONING

The position of the spot or trace on the CRT screen is adjustable by means of the vertical and horizontal POSITION controls. (Fig. 3)

6.7 SIGNAL POLARITY V.S. SPOT DEFLECTION DIRECTION

For the vertical axis, the spot moves upward in response to a positive-going signal and vice versa. For the horizontal axis, the spot is deflected from left to right with the sawtooth signal of the sweep generator.

6.8 CRT ADJUSTMENT

The brightness and sharpness of the spot or trace displayed on the CRT screen is adjustable by means of the INTEN control and FOCUS control. (Fig. 4)

6.9 POWER SWITCH

The power switch is constructed in common with the INTEN control. The power is turned off when the INTEN control knob is turned to the extremely counterclockwise position.

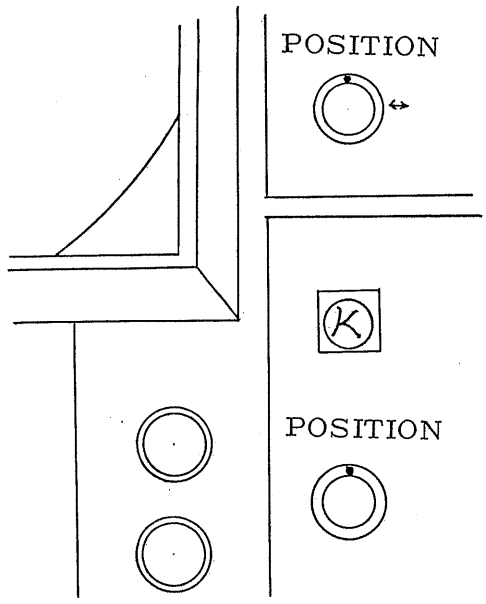


Fig. 3

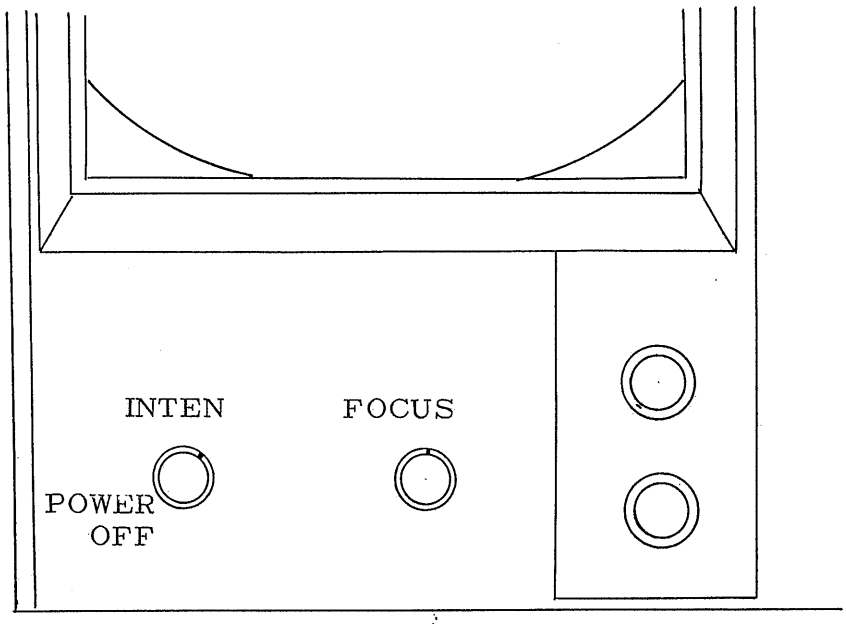
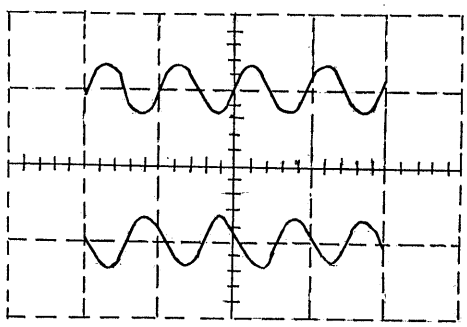


Fig. 4

6.10 THE USE OF DIRECT CRT INPUT TERMINAL

When the DIRECT/INT-AMP switch (slide switch) located on the rear panel is thrown to the DIRECT position, the vertical deflection plates of the CRT are connected through capacitors to the DIRECT INPUT terminal which also is located on the rear panel. Using the DIRECT INPUT terminal, the oscilloscope can measure a signal with a response of up to approximately 100 MHz and with a sensitivity of approximately 10 V/div. This method may be used to monitor a transmitter output and other purposes. To observe an amplitude-modulated signal, the modulating signal as an external synchronizing signal may be applied to the SYNC IN connector so that the displayed waveform is made stationary and the modulation degree of the waveform can be easily measured.



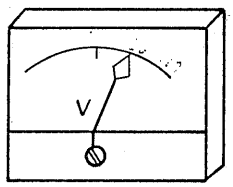
(Observation of an amplitude-modulated waveform)

- o The vertical POSITION control is effective for the above DIRECT mode of operation also.

- o If the signal to be measured is applied to the VERT INPUT terminal of the front panel while the oscilloscope is set in the DIRECT mode of operation, a waveform after all will be displayed on the screen. Note, however, that the frequency response and other performances of the vertical amplifier in such a case are unreliable.

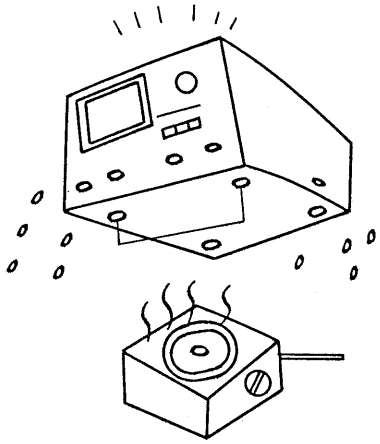
7. PRECAUTIONS

7.1 LINE VOLTAGE



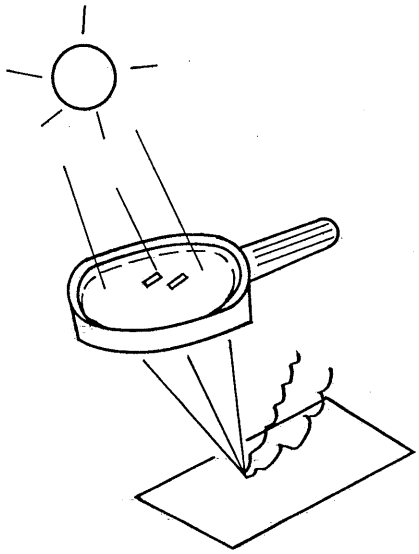
The oscilloscope operates stably for a line voltage range of [illegible] V AC. Do not supply any voltage out of this range. Use an appropriate voltage regulator if the line voltage in your area is not within this range. Note that the oscilloscope may be damaged if a voltage exceeding [illegible] V is applied.

7.2 AMBIENT TEMPERATURE



Ambient temperature also is an important factor for stable and safe operation of the oscilloscope. The ambient temperature should be within a range of +10°C to +40°C.

7.3 FLUORESCENT SCREEN PROTECTION



If a high intensity spot or trace is left stationary for a long period on the CRT screen, the corresponding section of the fluorescent screen may be burned. Do not excessively brighten the spot or trace, especially when it is stationary.

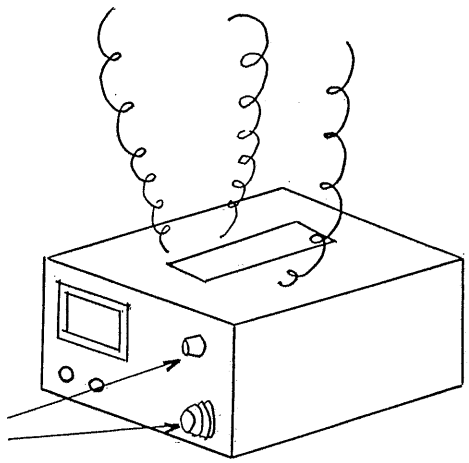
7.4 ALLOWABLE MAXIMUM VOLTAGES OF INPUT TERMINALS

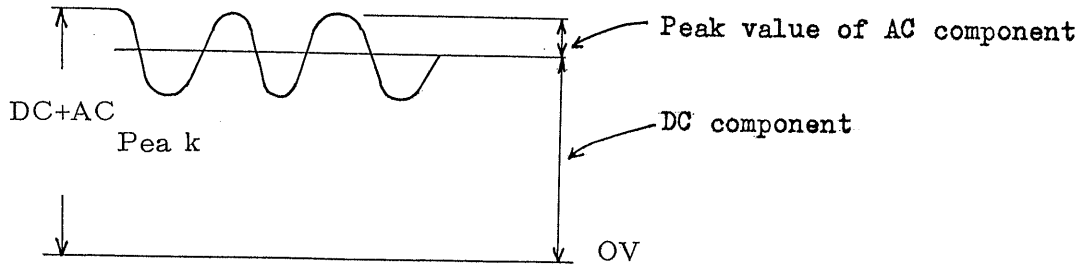
The allowable maximum voltage of the input terminals of the oscilloscope are tabulated as below. Not that the circuit will be damaged if a voltage higher than the allowable maximum voltage is applied.

Terminal	Allowable maximum voltage	Remarks
VERT IN	400 V (DC + AC peak, below 1 kHz)	When VERT GAIN switch is in the 1/1 state.
	600 V (DC + AC peak, below 1 kHz)	When VERT GAIN switch is in the 1/10 or 1/100 state.
EXT HOR/SYNC IN	100 V (DC + AC peak)	
DIRECT CRT INPUT	100 Vp-p	

Notes: The term (DC + AC peak) signifies the sum of the DC component and the peak value of the AC component. The allowable maximum voltage becomes lower when the frequency is higher. If the applied voltage is of the DC component alone, the maximum allowable voltage is plus or minus 400 V when the 1/1 button is depressed or plus or minus 600 V when the 1/10 or 1/100 button is depressed. If the applied voltage is of the AC component of lower than 1 kHz alone, the maximum allowable voltage is 400 Vp-p or 600 Vp-p depending upon the depressed VERT GAIN selector button. Note that a commercial line voltage nominated in terms of r.m.s. value can produce a peak-to-peak value of $2 \times \sqrt{2}$ times of the nominal voltage. For example, a line voltage of 100 V r.m.s. can produce a peak-to-peak voltage of approximately 280 V.

Should a dangerously
high voltage is applied .....





8. MAINTENANCE

8.1 REMOVING THE HOUSING

To pull out the main unit (chassis) from the housing, proceed as follows: Remove the clamping-screw in the center of the rear panel (see Fig. 5), and remove the rear cover. Remove the two clamping-screws from the bottom cover, and pull out slowly the chassis from the housing.

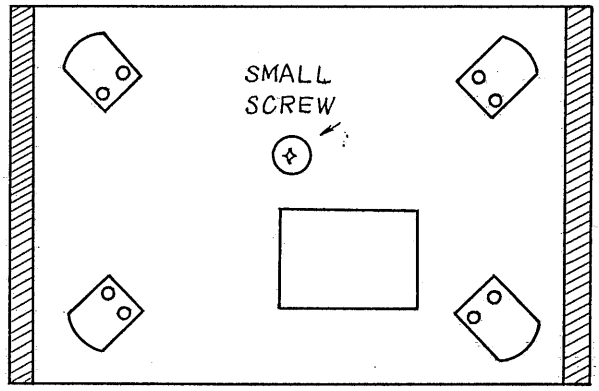


Fig. 5

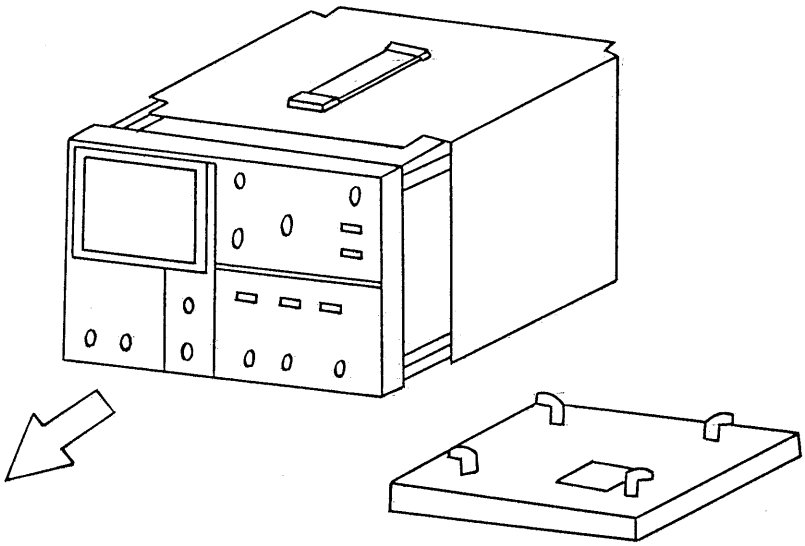


Fig. 6

8.2 VERT DC BAL ADJUSTMENT

If the trace on the CRT screen is vertically shifted as the VARIABLE knob of the vertical axis is turned with no signal being applied to the VERT INPUT terminal, adjust the VERT DC BAL control as follows: (Refer to Fig. 7.) Allow more than 10 minutes of stabilization period after turning on the oscilloscope power. Then, adjust the DC BAL control so that the trace is not vertically shifted. This DC BAL adjustment will be required after a circuit component (FET, transistor or other component) of the vertical amplifier has been replaced.

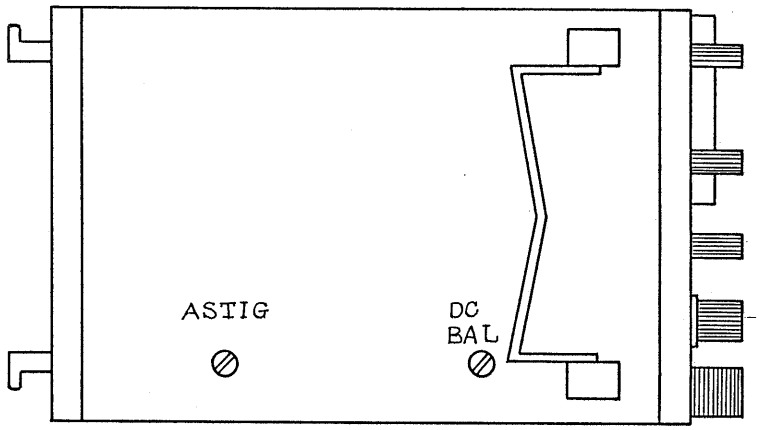


Fig. 7

8.3 ASTIG ADJUSTMENT

The astigmatism control is rarely required to be adjusted, excluding the case the cathode-ray tube is replaced. (Fig. 7)

8.4 ADJUSTMENT OF VERTICAL ATTENUATOR AND INPUT CAPACITANCE

When a component of the vertical attenuator is replaced, the following adjustment must be made. With the housing of the oscilloscope removed, check the frequency response of the attenuator by applying a quality square wave signal to the VERT INPUT terminal of the oscilloscope. If the response is unsatisfactory as represented by (waveform-4 and -5), adjust the frequency compensation semi-fixed capacitors C-202 (for the 1/10 range) and C206 (for the 1/100 range) (see Fig. 8) so that a response as represented by (waveform-6) is obtained.

Regarding the input capacitance, connect a capacitance meter to the VERT INPUT terminal, and adjust the input capacitance adjusting semi-fixed capacitors C-210 (1/1), C204 (1/10) and C208 (1/100) so that the input capacitance at each range is made 38 pF. Adjustment should be made in the order of ranges of 1/1, 1/10, and 1/100 of the VERT GAIN selector.

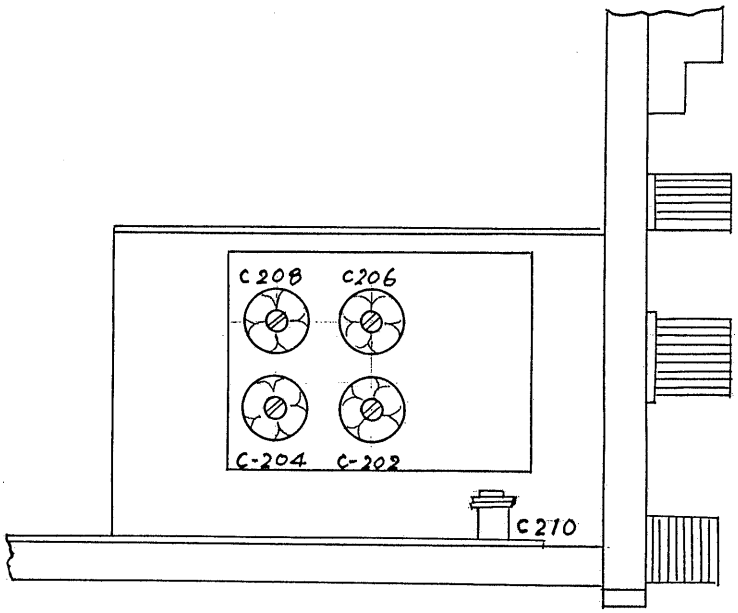
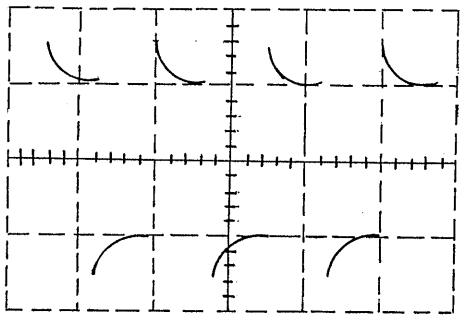
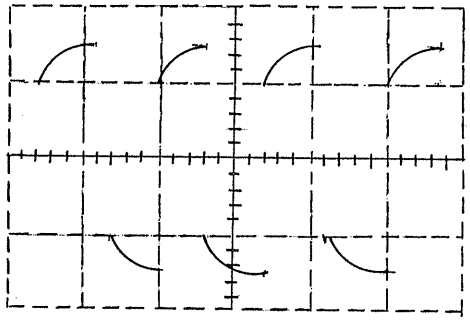


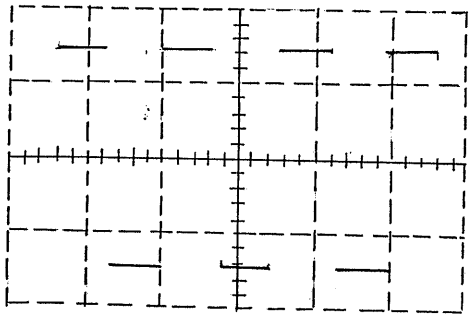
Fig. 8



(Waveform-4)



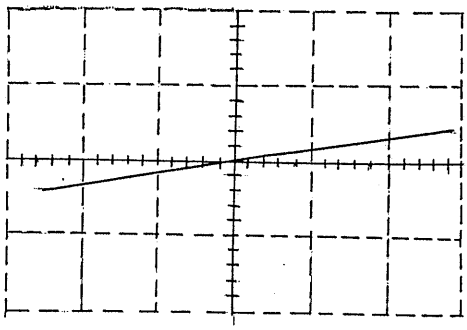
(Waveform-5)



(Waveform-6)

8.5 TRACE/GRATICULE PARALLELISM ADJUSTMENT

The base line of the horizontal trace may become non-parallel with the graticule scale as represented with (waveform-7) being disturbed by mechanical shocks or terrestrial magnetism. In such a case, make the trace parallel with the graticule scale in the following procedure. Remove the housing and loosen the CRT clamping-screw using a screwdriver. (Fig. 7) Holding the CRT at the portions indicated by the arrows, turn the cathode-ray tube so that the trace is made parallel with the graticule. Fix securely the CRT clamping-screw.



(Waveform-7)

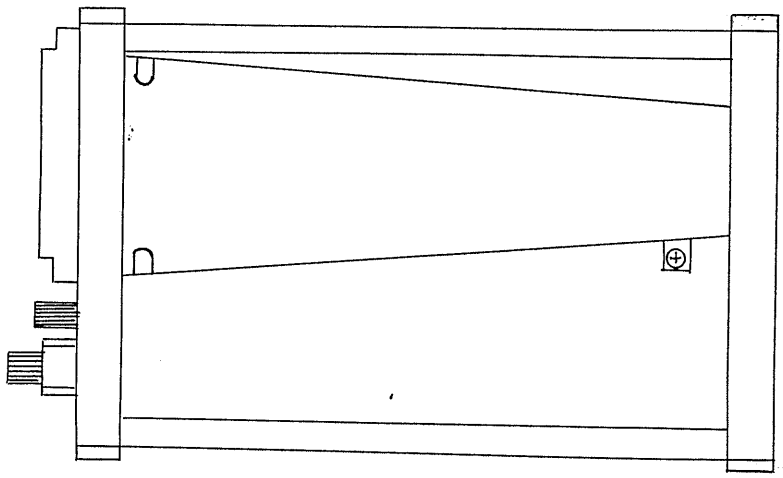


Fig. 9

8.6 REPAIR

The Model 537 Oscilloscope employs solid-state electronics and provides the highest reliability. So far as it is operated under the proper environments and voltage conditions, it has a long service life. However, if there should arise any failure, contact our agent in your district.

8.7 LOW-CAPACITANCE PROBE (OPTION)

As an accessory (option) for the Model 537 Oscilloscope, the Type 957M Low-capacitance Probe is available. This probe is advantageous for measurement of high frequency signals and high impedance circuits. When this probe is used in combination, the oscilloscope provides the below-mentioned performance. For the probe, order our agent in your district.

Specification of the Type 957M Probe

Input capacitance:	Approx. 20 pF or less
Input resistance:	10 MΩ
Attenuation:	-20 dB (1/10)