

# CO-1506

130mm OSCILLOSCOPE

INSTRUCTION MANUAL

## FEATURES

- High 20 mV/cm vertical sensitivity and a wide frequency response up to 1.5 MHz.
- Considerable reduction of weight and size as compared with conventional 130 mm type oscilloscopes, allowing perfect portability.
- More intensity and contrast due to the use of bluish-green phosphor (B31) in CRT.
- Vertical styling for easy installation in a limited space.

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## SPECIFICATIONS

<b>Cathode ray tube</b>	130BE31	<b>Sweep circuit</b>	
<b>Vertical amplifier</b>		<b>Sweep frequency</b>	10 to 100 Hz, 100 to 1kHz, 1 to 10kHz, and 10 to 100kHz (continuously adjustable between ranges)
<b>Deflection sensitivity</b>	20 mV/cm or more	<b>Synchronizing</b>	Internal negative synchronizing possible with 10 mm amplitude or less on CRT screen.
<b>Frequency response</b>	DC: DC to 1.5 MHz (−3dB) AC: 2 Hz to 1.5 MHz (−3dB)	<b>Power source</b>	AC100V/117V/230V,50/60Hz
<b>Input resistance</b>	1MΩ (±5%)	<b>Power consumption</b>	15 Watts
<b>Input capacitance</b>	Approx. 35 pF	<b>Dimensions</b>	Maximum width: 150mm (154 mm) Maximum height: 220 mm (246 mm) Maximum depth: 410 mm (445 mm) Values in ( ) are maximum dimensions
<b>Attenuator</b>	1, 1/10, 1/100 (within ±5% inter-range error)	<b>Weight</b>	6.2 kg (13.7 lbs.)
<b>Gain control</b>	Variable up to 22dB or more	<b>Accessories</b>	Instruction manual . . . . . 1 Fuse (0.3A – in the area of 230V power supply) . . . . . 2 Fuse (0.5A – in the area of 117V power supply) . . . . . 2 Shielded lead with banana plug (CA-46) . . . . . 1
<b>Permissible input voltage</b>	600 Vp-p (DC + AC peak)		
<b>Drift</b>	Thermal: 1 mm/°C or less at 20mV/cm Time: 15 mm/hr or less 15 min. after switch on		
<b>Overshoot</b>	5% or less on 100kHz square wave		
<b>Horizontal amplifier</b>			
<b>Deflection sensitivity</b>	500 mV/cm or more		
<b>Frequency response</b>	DC to 250kHz (−3dB) at the maximum point of H. GAIN control		
<b>Input resistance</b>	1MΩ (±20%)		
<b>Input capacitance</b>	Approx. 40pF		
<b>Permissible response</b>	100 Vp-p		

## CIRCUIT DESCRIPTION

### VERTICAL SECTION

The input signal applied to V. INPUT passes through the DC coupler (DC) or AC coupler incorporating a capacitor (AC) and is then fed to the attenuator; the selection between the DC coupler and AC coupler is effected by manipulating V. INPUT terminals. The attenuator provides setting of 1, 1/10 or 1/100 so that the input signal may be attenuated to a certain range of voltage that can be accepted by the vertical amplifier.

The vertical amplifier is a direct-coupled differential amplifier consisting of FET Q1 and silicon transistors Q2 ~ Q5, allowing stable DC amplification.

### HORIZONTAL SECTION

The horizontal section is composed of the synchronizing input voltage limiting circuit Q6, time base sawtooth wave generator Q7 ~ Q10, horizontal amplifier Q12 ~ Q14 and the blanking voltage amplifier Q11.

The synchronizing input voltage limiting circuit suppresses the synchronizing signal, picked up from the emitter of Q5 at the final stage of the vertical amplifier, to a constant level which is then applied to the sawtooth wave generator, thus assuring stable synchronization.

The sawtooth wave generator includes the diode D1 for stabilizing the DC level, while the multivibrator consisting of Q7 and Q8 generates sawtooth waves. Transistor Q9 inserted in the emitter circuit of transistor Q8 is a current

limiter which improves the linearity of the sawtooth waves. Transistor Q10 inverts the polarity of sawtooth waves, performing negative-to-positive going sweep so as to meet the requirements in relation to the number of the horizontal amplifier stages which follows.

The horizontal amplifier is a one-stage direct-coupled differential amplifier consisting of FET Q12 and silicon transistors Q13 and Q14. This configuration ensures stable DC amplification. That is, a very low speed of sweeping below 1 Hz can be achieved through H. INPUT terminal (8).

In the blanking voltage amplifier, the negative going pulses from the Q8 collector are amplified to positive going pulses which are then applied to the cathode of CRT, thus blanking over a range from 10 Hz to 100kHz for ease of observation on the CRT screen.

### POWER SUPPLY CIRCUIT

The power supply circuit provides +8 V and -15 V through the voltage stabilizer consisting of zener diodes D2 and D3, in addition to 180 V (approx.) through the full-wave rectifier composed of the diodes D6 and D7 to supply to the collector circuit of the final stage of each amplifier.

### HIGH VOLTAGE POWER SUPPLY CIRCUIT

This circuit supplies -1500 V through the full-wave voltage doubler rectifier composed of the high voltage diodes D1 and D2 to the CRT circuit.

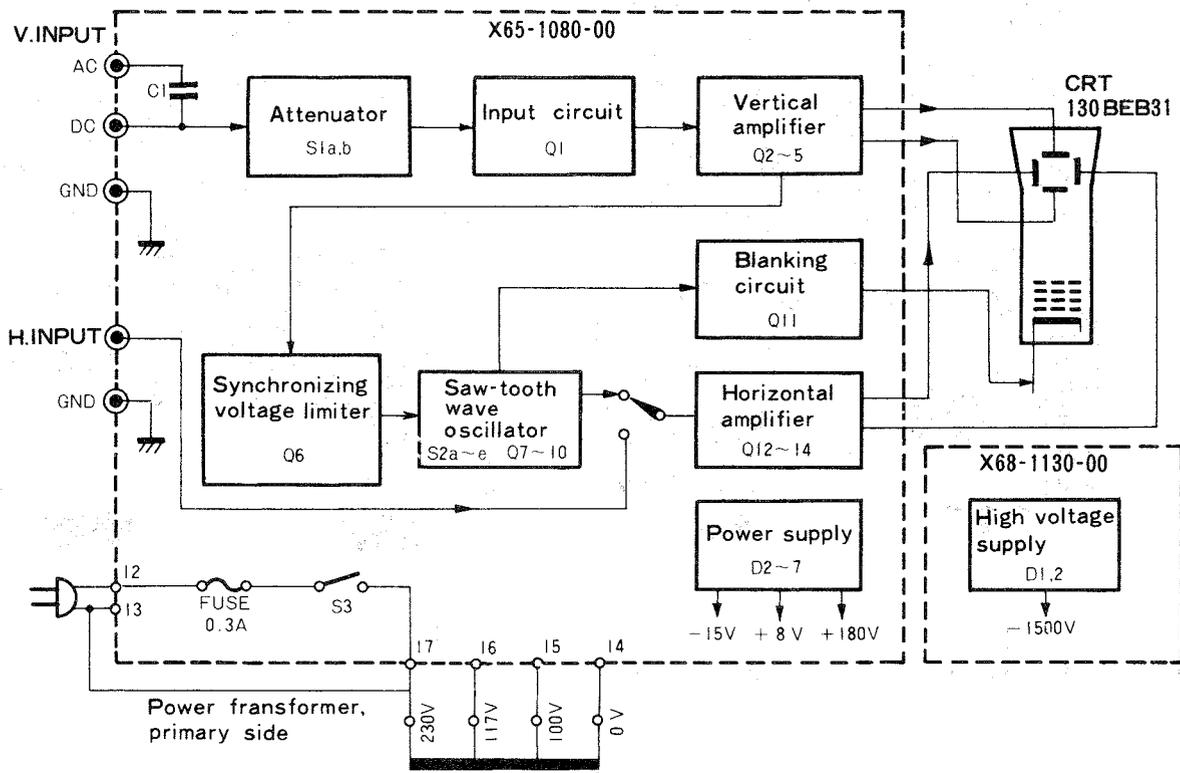


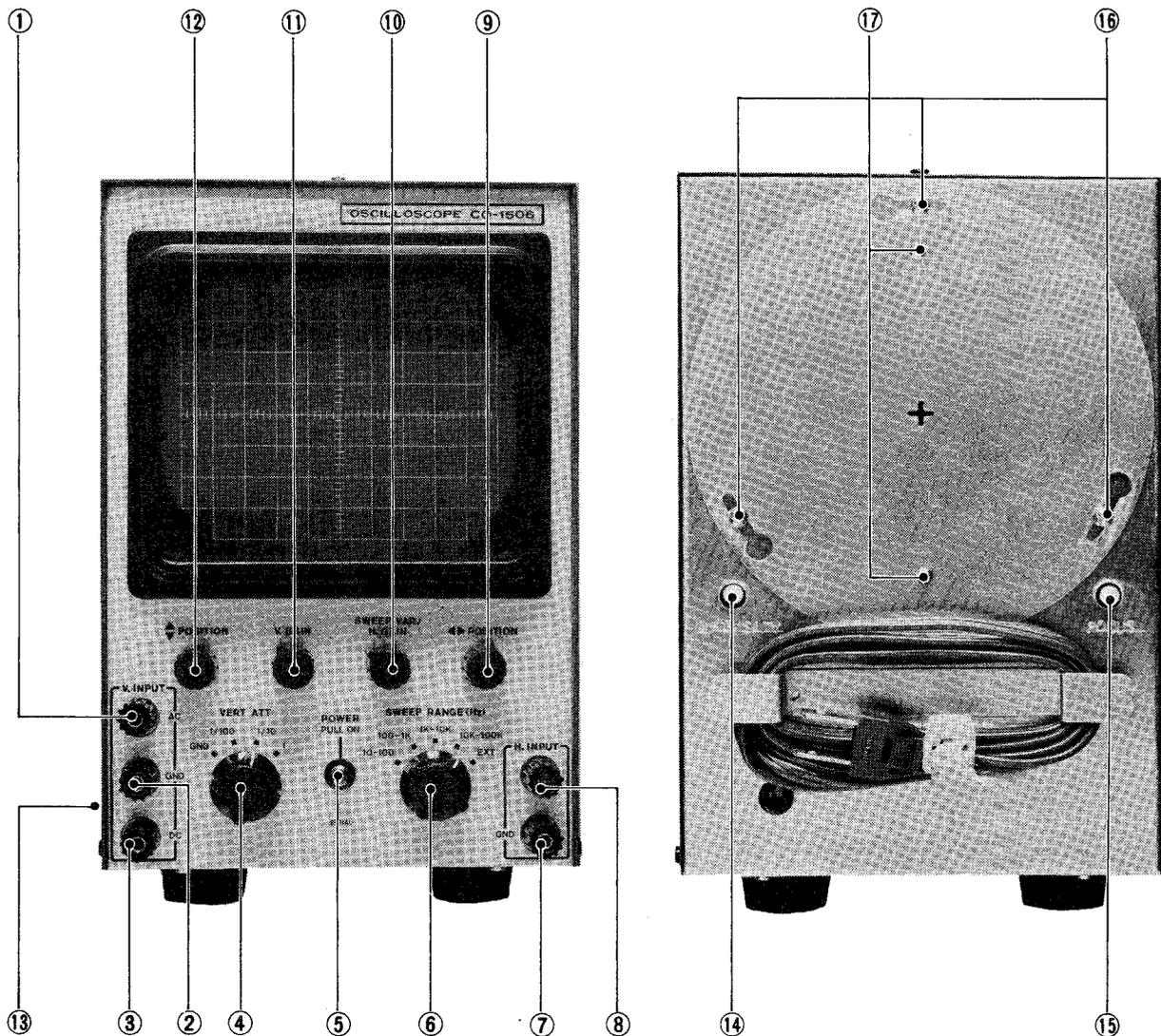
Fig. 1 BLOCK DIAGRAM OF CO-1506

## PANEL CONTROLS AND THEIR FUNCTIONS

### FRONT PANEL

- (1) **AC**  
This is the vertical input terminal coupled to V. ATT (4) through a capacitor to cut off DC component contained in vertical input signal. It is used only when AC component is to be observed.
- (2) **GND**  
This is the earth terminal for vertical input signal.
- (3) **DC**  
This is the vertical input terminal directly coupled to V. ATT (4). It is used to observe vertical input signal containing DC component.

- (4) **VERT ATT**  
This is the vertical attenuator. It is used to attenuate a signal voltage fed to AC terminal (1) or DC terminal (3) to the amplitude suited for observation on CRT screen.  
When it is set to the 1 position, the signal fed to AC terminal (1) or DC terminal (3) is directly fed to the vertical amplifier. At the 1/10 or 1/100 position, the waveform amplitude is reduced to 1/10 or 1/100. At the GND position, the input of the vertical amplifier is connected to the earth.
- (5) **POWER**  
This is the power switch. To turn on the power, pull



the knob of the switch; the red mark on the shaft appears.

**(6) SWEEP RANGE (Hz)**

This is the sweep frequency selector switch and is used with SWEEP VAR/H. GAIN (10). It adjusts the number of peaks of waveform displayed on CRT to the number suitable for observation. At the EXT position, the amplified horizontal signal is connected to H. INPUT (8) through SWEEP VAR/H. GAIN (10).

**(7) GND**

This is the earth terminal for horizontal input signal.

**(8) H. INPUT**

This is the external input signal terminal for the horizontal amplifier.

**(9) ◀▶ POSITION**

This is the horizontal position adjuster. It shifts the position of the waveform on CRT to left or right. A clockwise turn will shift the waveform to right.

**(10) SWEEP VAR/H.GAIN**

This is used to fine adjust sweep frequencies and the gain of external horizontal signal. When SWEEP RANGE (6) is set to the internal sweep range (10 ~ 100kHz), it functions as a sweep frequency fine adjuster to adjust the number of peaks of waveform on CRT. When SWEEP RANGE (6) is set to EXT position, it adjusts the gain of the signal connected to H. INPUT (8), changing the amplitude in the horizontal direction displayed on CRT. It should be noted that the frequency response of the horizontal amplifier varies according to the rotation of the knob.

**(11) V. GAIN**

This is the vertical gain control. It is used with VERT ATT (4) to adjust the size of amplitude of waveform on CRT. When the amplitude cannot be properly adjusted with this knob alone, change the position of VERT ATT (4).

**(12) ▲▼ POSITION**

This is the vertical position adjuster. It is used to shift the position of waveform on CRT. A clockwise turn will shift the waveform upward.

## **SIDE PANEL**

**(13) DC BAL**

This is the DC balance control for the vertical amplifier. It should be adjusted so that the bright line does not shift when the knob of V. GAIN (11) is turned.

## **REAR PANEL**

**(14) INTENSITY**

This is the bright line control. It is used to adjust the intensity of light of waveform on CRT. A clockwise turn will increase the light intensity.

**(15) FOCUS**

This is the focus control to obtain the sharpest image of waveform on CRT.

**(16) CLAMPING SCREW FOR THE CRT**

**(17) CLAMPING SCREW FOR THE CRT BAND**

# OPERATING INSTRUCTIONS

## GENERAL METHODS OF OPERATION

A waveform to be viewed is fed to V. INPUT terminals (1) and GND (2) or (2) and DC terminal (3). Adjust the controls VERT.ATT (4) and V. GAIN (11) so that the displayed waveform is 40 to 60 mm high on the vertical axis. For adjustments, refer to the items 4 and 11 of the operating procedure outlined on the panel. Then obtain an appropriate number of waveform peaks by adjusting the controls SWEEP RANGE (6) and VAR/H.GAIN (10). The displayed waveform must be synchronized to a steady state. If the waveform contains only a single complete cycle on CRT, it means that the time base frequency is identical with the frequency of the signal being displayed. In contrast with this, if the waveform contains five peaks, the time base frequency is 1/5 of the frequency being displayed. Waveforms displayed with frequencies as low as below 50 Hz may cause flickering on CRT due to the slow movement of spot.

This phenomenon is eliminated as the time base frequency gets higher than 50 Hz. By using the V. INPUT DC terminal, the DC component of displayed waveform can be measured or frequencies below 10 Hz can be viewed. When observing AC component only, the V. INPUT AC terminal is used.

The polarity of displayed waveform is positive in the upper direction of CRT and in the right-direction when viewed in the horizontal direction.

The position of the waveform on CRT can be centered by adjusting the controls (9) and (12). Since the waveform shifts up or down depending on the polarity of the DC component, it must be corrected by adjusting the control (12). If the waveform cannot be set in the center of the screen even after the adjustment of the control (12), it is an indication that the DC component is too high and, therefore, the controls (4) and (11) must be adjusted appropriately until the waveform is centered.

To measure the voltage of the displayed waveform, calibrate the amplitude of the waveform appropriately using the scale on the screen as a guide and read the sensitivity obtained.

Calculate the voltage according to the equation below.

$$\text{Voltage} = \text{Amplitude} \times \text{sensitivity}$$

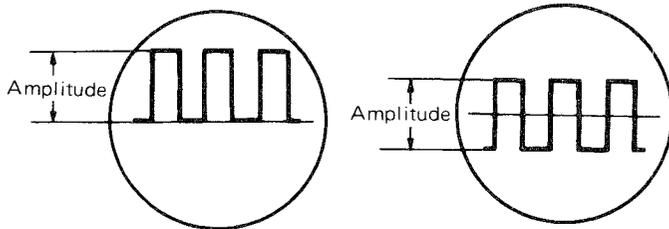
As an alternative, the voltage can be obtained by a proportional calculation method using a waveform of a known voltage; for example, if the amplitude of the signal having 3Vpp of voltage is 4 cm (the sensitivity of the oscilloscope is  $3V_{pp} \div 4 \text{ cm} = 0.75V/cm$ ) and the amplitude of unknown waveform is 6 cm, then:

$$\frac{3V_{pp}}{4 \text{ cm}} = \frac{XV_{pp}}{6 \text{ cm}} \quad \text{so} \quad \frac{3V_{pp} \times 6 \text{ cm}}{4 \text{ cm}} = XV_{pp}$$

$$\text{Therefore, } X = 4.5V_{pp}$$

All levels on the oscilloscope are in peak-to-peak values and, therefore, must be converted into corresponding effective values since effective values are commonly used in practice. In this conversion, however, it should be noted that the relationship between the effective value and the amplitude varies according to the type of waveform. Some typical relationships between two are given for reference:

Waveforms	Effective values (rms)
	$\frac{A}{2\sqrt{2}} = 0.354A$
	$\frac{A}{2} = 0.5A$
	$\frac{A}{\sqrt{2}} = 0.707A$
	$\frac{A}{2\sqrt{3}} = 0.288A$
	$\frac{A}{2} = 0.5A$
	$\frac{A}{2} \sqrt{1 - \frac{4\phi}{2\pi}}$

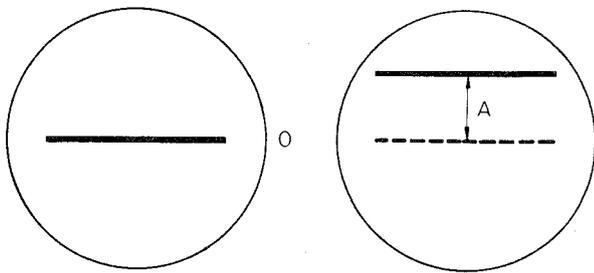


(Positive square wave)  
With AC-DC selector switch  
set at position DC.

With AC-DC selector switch  
set at position AC.

**Fig. 2 Measurement of AC and DC components**

DC voltages are measured as displacements of the bright line through the V. INPUT DC terminal (13). A DC voltage displayed on the CRT is directly read as its effective value.



$$\text{Sensitivity (V/cm)} \times A \text{ cm} = \text{Voltage (V)}$$

Fig. 3 DC voltage measurement

## MEASUREMENT WITH LISSAJOUS' FIGURES

### 1. Frequency measurement

Lissajous' figures are often used as a means of measuring frequencies of signals. For measurement, first set the SWEEP RANGE (6) to the EXT position and connect a signal generator between the GND (7) and H. INPUT (8). Adjust the horizontal amplitude to about 4 ~ 6 cm. Next, apply a signal of unknown frequency to the AC terminal (1) and the GND terminal (2). Adjust the vertical amplitude to about 4 ~ 6 cm.

As the signal generator is slowly controlled for continuous change in the frequency, the following patterns will appear at certain frequencies (see Fig. 4). As a rule, when the pattern is a straight line or a true circle, it means that the unknown frequency is equal to the frequency of the signal generator.

The displayed Lissajous' figure will only become stationary when one of the frequencies is an integral multiple of the other. Therefore, the unknown frequency can be obtained by calculation.

### 2. Measurement of phase difference

As in the case of the preceding item, Frequency Measurement, when two signals of the same frequency are applied to H. INPUT and V. INPUT (for example, R and L signals in stereo mode), the pattern on the CRT screen becomes a straight line slanting from the upper right to the lower left if they are in the same phase. As the signals become out of phase, the Lissajous' figure gets more like a circle and when the signals reach a state of 90° phase difference, then the pattern becomes a true circle. In measuring and calculating phase differences we designate the horizontal amplitude as "X" and the horizontal excursion of the Lissajous' figure as "x". The phase difference  $\theta$  is then found from:

$$\sin \theta = x/X$$

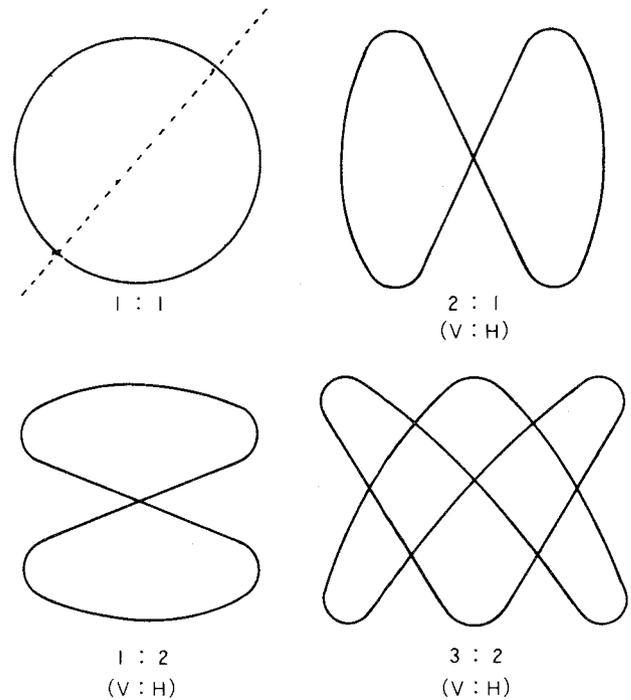


Fig. 4 Frequency measurement with Lissajous' figure

Also in this measurement, phase difference between the horizontal and vertical circuits of the oscilloscope itself can be set to "zero" over a range up to approximately 2kHz by turning H. CAIN (10) to the maximum clockwise position. It should be noted that a measurement with a frequency above 2kHz will cause an error in the phase. The frequency range in which the phase difference between V and H is "zero" is reduced down to about 500 Hz at the 1/2 position of the H. GAIN (10).

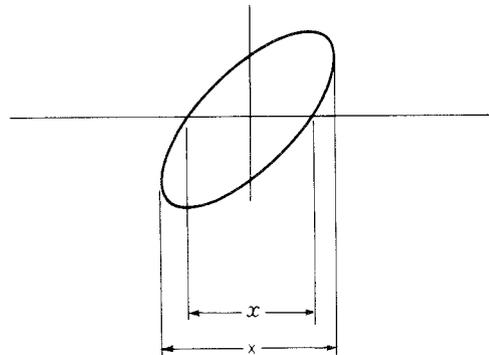


Fig. 5 Phase measurement with Lissajous' figure

## APPLICATIONS

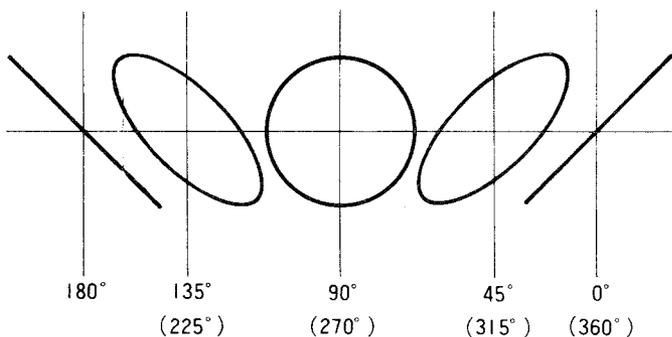


Fig. 6. Representative Lissajous' patterns

### CAUTION:

When H. INPUT (8) is used, the frequency response of the horizontal amplifier varies according to the position of the VAR/H. GAIN (10) knob (approximately 25kHz at the center position).

It is advisable to set VAR/H. GAIN (10) to the position of a highest possible gain.

If the input signal is large, the measurement should be performed with an attenuator inserted between the GND (7) and H. INPUT (8) as shown in Fig. 7. In this case, VAR/H. GAIN (10) should also be set to the position of a highest possible gain.

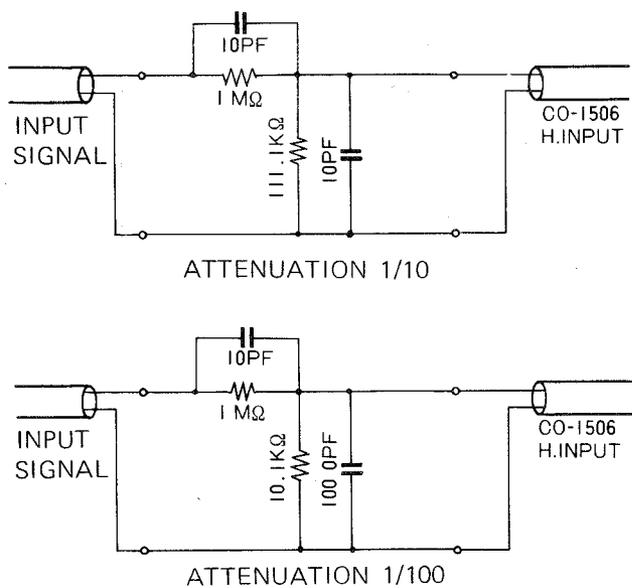


Fig. 7 Connection of attenuator

### MEASURING AUDIO AMPLIFIER FREQUENCY RESPONSE

Supply a sine wave to the AUX terminal of the audio amplifier from a signal generator and connect the speaker output terminals of the amplifier to V. INPUT (1) and GND (2). The audio amplifier may have a typical frequency response as shown in Fig. 8. This response, however, will vary as shown in Fig. 9 by using the tone control or loudness control.

The amplifier frequency response should be measured by reading the amplitude displayed on CRT for each of different frequencies while maintaining the signal generator at a constant output level.

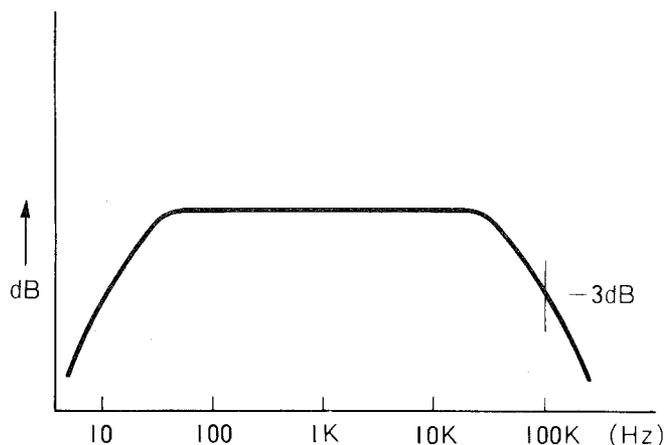


Fig. 8 An example of frequency response

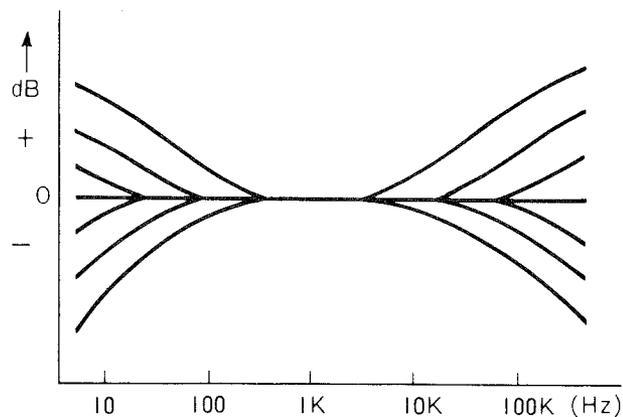


Fig. 9 Frequency response affected by the tone and loudness controls

## SQUARE WAVE SIGNALS AND FREQUENCY RESPONSE

Use of a square wave in place of the sine wave will provide an approximate frequency response of the amplifier by checking the output waveform of the square wave.

## ALIGNING THE IF RESPONSE OF FM OR TV SETS

To check the overall response of the intermediate frequency transformers of an FM receiver, the SWEEP RANGE (6) should be set to EXT position. Then connect the output leads of a sweep generator to the mixer and chassis of the receiver and the sweep output to the H. INPUT of the oscilloscope. Also, connect the oscilloscope to the test point or output terminal of the limiter of the FM receiver. This connection may be made by using a shielded cable with about 100kΩ resistor provided at the point of connection to the receiver. The oscilloscope should be set to the maximum sensitivity while the sweep generator output level should be set as low as possible. The cable from the sweep generator and other leads from CO-1506 must be adequately away from the body of the receiver or must not cross each other to avoid interaction.

The above same connections also apply to the response check of TV receivers for either the video IF or audio IF response. Use point B for measurements of FM receiver IF transformers and tracking, and use point A for detector adjustment.

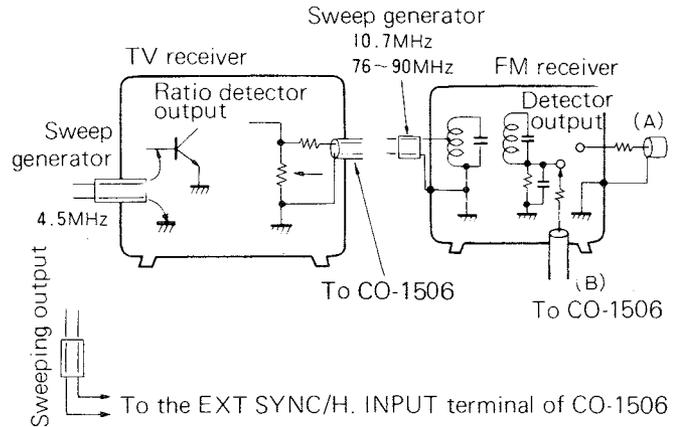


Fig. 10 Viewing the IF frequency responses

	Frequency response of amplifier	Square wave output	
		100Hz	1 KHz
①	Gain reduced at high-frequency		
②	Gain rises at high-frequency		
③	Gain reduced at low-frequency		
④	Gain rises at low-frequency		
⑤	With loudness control set ON.		
⑥	Gain having waving characteristic curve		

## ALIGNING AM RECEIVERS

A typical adjustment of AM receivers is that of the IF transformers. Connections are made from the sweep generator to the receiver at the rotor and stator of the receiver variable capacitor. The leads from CO-1506 are connected across the volume control variable resistor of the detector circuit observe the detector output.

Sweep generator connected at the 455 kHz IF input or RF output

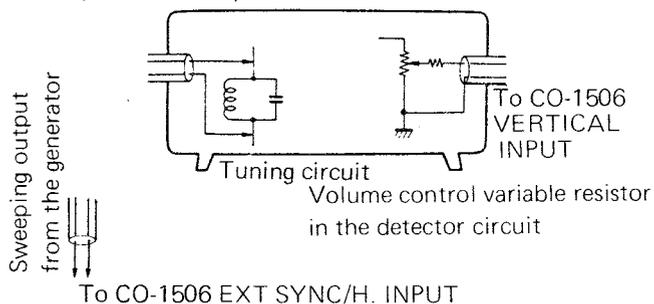


Fig. 11 Adjusting AM receiver

## MODULATION MEASUREMENT

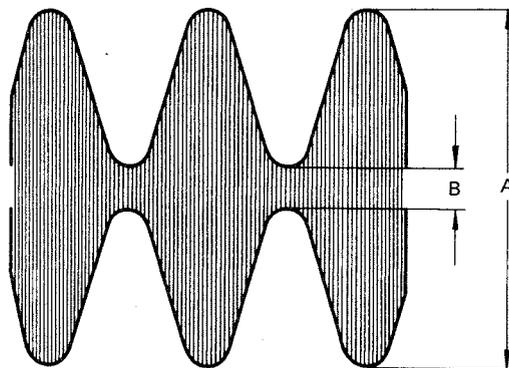
The CO-1506 works if the measured modulated carrier is below 1.5MHz. Connect the modulated carrier to V. INPUT (1) and adjust with VERT ATT (4) and V. GAIN (11) to produce an envelope as shown in Fig. 12.

This modulation envelope is a result of constant modulating frequency which will be displayed with stability on the scope when synchronized with controls (6) and (10).

To find the degree of modulation, measure maximum and minimum values A and B.

$$\frac{A - B}{A + B} \times 100 \dots \text{Modulation in \%}$$

Another method of modulation measurement is the use of a trapezoidal pattern. In this method, the modulated radio signal to be measured is fed to AC terminal (1) with SWEEP RANGE (6) set to EXT position. In this set-up, the modulating signal applied to H. INPUT (8) will produce a trapezoid or rectangular pattern on the scope. Assume the longer side as A and the short side B, then the above same equation applies to find the degree of modulation.



$$\frac{A - B}{A + B} \times 100\{\%\}$$

Fig. 12 How to measure modulation degree

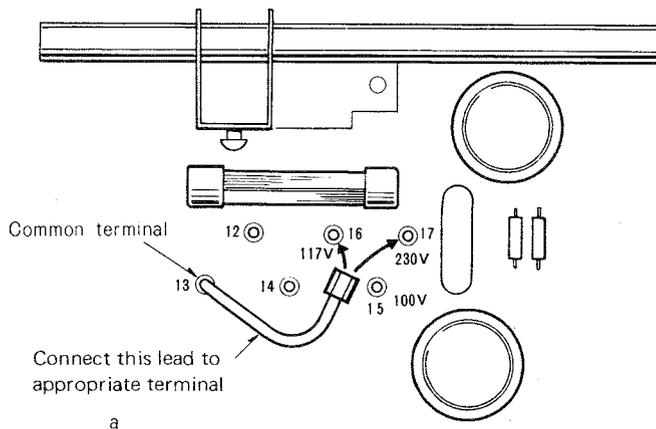


Fig. 13 Method of selecting power supply voltage

## CAUTIONS ON HANDLING THE SET

1. Select a place not exposed to direct sunbeam for installation of this oscilloscope. Internal temperature rise caused by the sunbeam makes the oscilloscope unstable or damages the transistors.
2. Do not operate the oscilloscope in a room where high temperature and humidity prevail.
3. Do not operate this oscilloscope in a place where mechanical vibrations prevail or a place near an equipment which generates strong flux of magnetic force or impulse voltages.
4. With 230 V power supply, use 0.3 A fuse; with 117 V power supply, use 0.5 A fuse. Be sure to use the fuse of correct ampere fuse. Also, the voltage selector terminals are located on the printed circuit board of bottom side.

### CAUTION:

The voltage setting should be performed only after turning the power off since the selector terminals are near the dangerous –1600 V high voltage circuits.

5. Do not apply input voltage to V. INPUT (7) and (8) in excess of 600 Vpp, and to H. INPUT (6) and (7) in excess of 100 Vpp.
6. The alignment of the bright line will be affected by the terrestrial magnetism depending on the position in which the oscilloscope is placed with respect to the poles of the earth. Consequent correction is required in the particular position of the oscilloscope.

Line voltage (V)	Common terminal number	Selector terminals
100	13	15
117	13	16
230	13	17

## MAINTENANCE

### 1. Removing the case and bottom plate:

Remove the six screws from the sides, and the two screws from the top plate of the cabinet, using a Phillips head screw-driver. To remove the bottom plate, unscrew the four screws with a Phillips head screwdriver.

### 2. Replacing the fuse:

- (a) Remove the bottom plate.
- (b) Remove the fuse located on the printed circuit board and replace (see Fig. 13).
- (c) If the fuse is blown, be sure to check for the cause and correct. Turn the power on after replacement.
- (d) With 230 V power supply, use 0.3 A fuse.

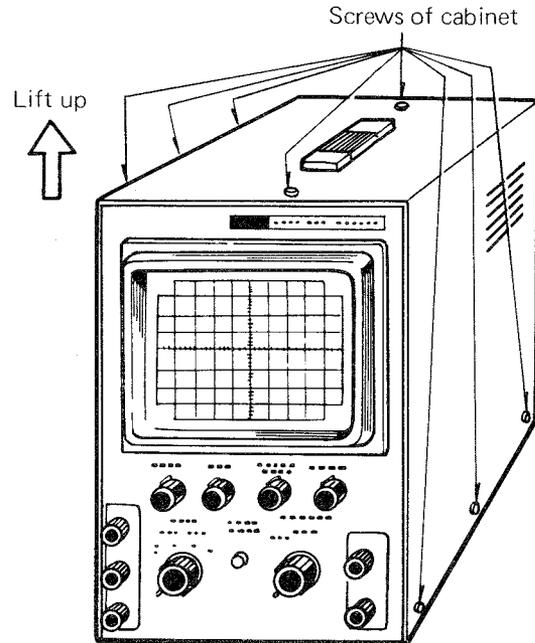
### CAUTION:

Before fuse replacement, turn the power off and discharge all capacitors near the fuse holder.

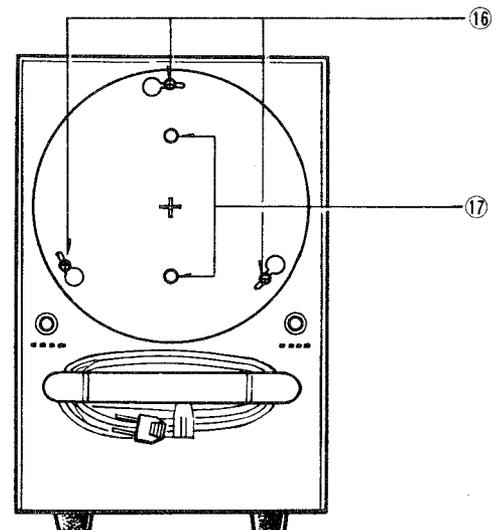
## MAINTENANCE AND ADJUSTMENT

### 3. Aligning the CRT bright line:

- (a) Loosen the three screws (16) clamping the CRT. The CRT band clamping screws (17) should not be loosened since they hold the CRT in place (see Instructions for rear panel on page 5).



Removing the case from the cabinet



16. Clamping screw for the CRT
17. Clamping screw for the CRT band

Fig. 14

- (b) Place the oscilloscope in the normal operating position with respect to the poles of the earth.
- (c) Turn the CRT by the cover until the bright line is aligned horizontal on the screen. The CRT should be in close contact with the scale plate.
- (d) After alignment, retighten the clamping screws (16) alternately and uniformly making sure that the bright line horizontal alignment is not changed.

**CAUTION:**

Be careful not to touch the CRT printed circuit board, CRT socket, polyethylene-coated cable and other high voltage circuits. When checking into this section, never fail to turn power off and discharge the stored high voltage.

**ADJUSTMENTS**

**1. DC BAL adjustment:**

If the waveform becomes out of center or the bright line shifts up and down as the V. GAIN (11) is turned, it should be corrected by adjusting DC BAL (13).

In this adjustment, the VERT ATT (4) must be set to GND, the V. GAIN (11) to the fully counterclockwise position, and the POSITION (12) to a point at which the bright line is aligned in the center of the scope. Then turn the V. GAIN (11) clockwise and, if the bright line deviates, adjust the DC BAL (13) with a small screwdriver so that the deviation is just made up for toward the center of the scope, the same condition as at the full counterclockwise position of the V. GAIN (11). Repeat this adjustments until the bright line stays unchanged in both the clockwise and counterclockwise positions of the V. GAIN (11).

Adjustment of DC balance should begin approximately 15 after switch-on and the oscilloscope has become stable.

**2. Adjustment of VERT. ATT**

Remove the bottom plate. Supply a 1kHz (approx.) square wave to the AC terminal (1) and the GND (2). Set the VERT ATT (4) to the 1 position and adjust the signal generator so that an amplitude of approximately 4 cm is obtained on the scope with the V. GAIN (11) in the fully clockwise position.

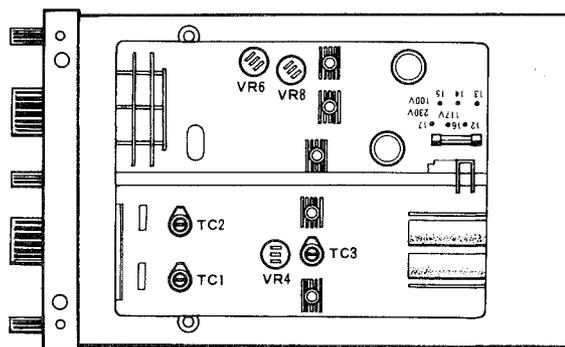
Set the SWEEP RANGE (6) to a position between 100Hz to 1kHz and obtain two to four peaks of waveform on the scope. Make sure that the waveform is ideal and shift the VERT ATT (4) to the 1/10 position. Increase the generator output by 20dB so that the waveform is approximately 4 cm in amplitude. If the waveform in this case is distorted, adjust the trimmer capacitor TC1 for an ideal waveform.

Use an insulated screwdriver for adjustment. Further shift the VERT ATT (4) to the 1/100 position and adjust TC2 for the same purpose.

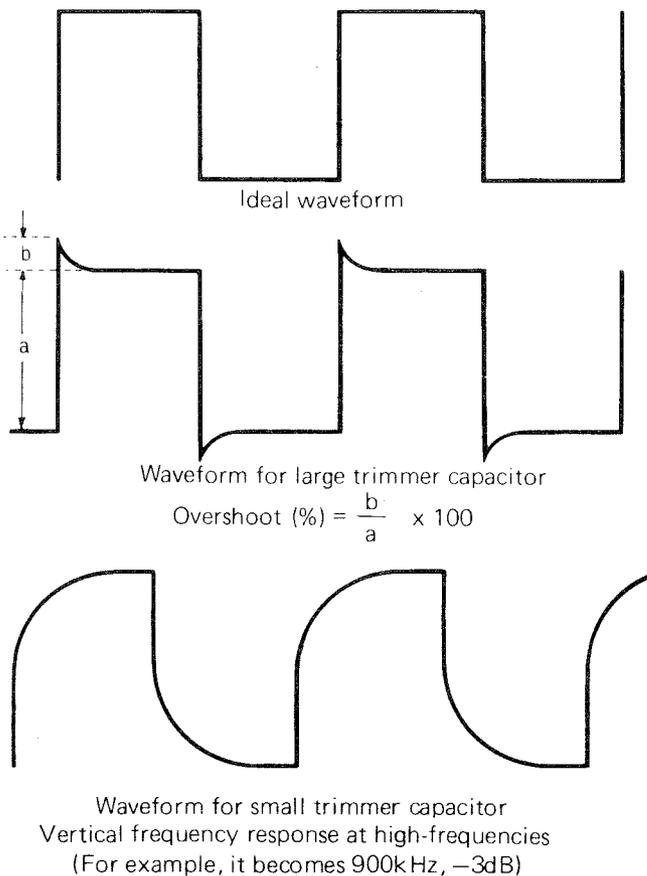
**3. Other adjustment**

When a 100kHz square wave is applied to the AC terminal (1) and GND (2), the overshoot is corrected by adjusting TC3.

The variable resistor VR4 is a vertical position control. With the POSITION (12) set to the center position, adjust it until the bright line comes in the center of the scope. The variable resistor VR6 is also used to set the bright line in the center of the scope, while VR8 is used to adjust the sweep width on the scope to approximately 10 cm.



**Fig. 15 Location of trimmer and semi-fixed variable resistors**



**Fig. 16 Square wave characteristic adjustment by trimmer capacitor**  
Vertical frequency response at high-frequencies (For example, it becomes 900kHz, -3dB)

# PARTS LIST

Ref. No.	Part No.	Description
-	A01-0258-02	Case
-	A10-0424-12	Chassis (1)
-	A10-0425-02	Chassis (2)
-	A20-0889-12	Panel
-	A40-0137-03	Bottom plate
-	B19-0141-04	Filter
-	B40-0765-14	Name plate
-	B41-0204-04	Name plate (Fuse)
-	B41-0111-04	Voltage indication plate(110~120V)
-	B41-0094-04	Voltage indication (220 ~ 240V)
-	B50-1289-10	Instruction manual
-	D32-0074-04	Shaft stopper
-	E01-1403-05	CRT socket
-	E23-0557-04	Grounding lug x 2
-	E30-0545-05	Power cord (line) with plug
-	E30-0436-05	Lead wire
-	F05-3011-05	Fuse (0.3A) x 2
-	F05-5013-05	Fuse (0.5A) x 2
-	F10-1535-04	Shielding plate
-	F11-0210-03	CRT shield
-	F15-0145-04	Felt (420 x 20)
-	F15-0186-04	Felt (170 x 10)
-	G13-0046-04	Cushion
-	G13-0068-04	Cushion x 2
-	G13-0042-14	Cushion x 2
-	G53-0015-14	Antenna bush
-	H25-0029-04	Polyethylene bag
-	J03-0010-05	Rubber leg x 4
-	J10-0025-03	Besel
-	J20-0298-04	CRT holder
-	J21-1326-14	CRT band (1)
-	J21-1327-14	CRT band (2)
-	J21-1328-03	Transformer bracket
-	J21-1329-04	Printed circuit board bracket (1)
-	J41-0006-00	Cord bushing
-	J61-0049-05	Cable wrapping band x 5
-	K01-0058-25	Grip
-	K21-0306-04	Knob x 4
-	K21-0290-14	Knob x 2
-	K29-0227-14	Knob (lod)
-	L02-0068-15	Powertransformer CRT (130BEB31)
-	X65-1080-01	Vertical, horizontal unit (in the area of 117V power supply)
-	X65-1080-21	Vertical, horizontal unit (in the area of 230V power supply)
-	X68-1130-01	High voltage unit
-	X67-1040-00	Cord with banana tip (CA-46)

# PARTS LIST OF X65-1080-00, 21

Ref. No.	Part No.	Description
<b>CAPACITOR</b>		
C1	C90-0021-05	Metal film 0.1μF 600WV
C2	CC45SL1H151J	Ceramic 150pF ±5%
C3	CQ08S1H152J	Polystyrene 1500pF ±5%
C4	CK45B2H103K	Ceramic 0.01μF ±10%
C5	CQ08S1H332J	Polystyrene 3300pF ±5%
C6, 7	CE04W1V101M	Electrolytic 100μF 35WV
C8	CC45CH1H101J	Ceramic 100pF ±5%
C10	CE04W1J010M	Electrolytic 1μF 63WV
C11	CC45SL1H330J	Ceramic 33pF ±5%
C12	CQ93M1H474M	Polystyrene 0.47μF ±20%
C13	CQ93M1H473M	Polystyrene 0.047μF ±20%
C14	CQ93M1H472M	Polystyrene 0.0047μF ±20%
C15	CC45SL1H391J	Ceramic 390pF ±5%
C16	CE04W1J010M	Electrolytic 1μF 63WV
C17	CC45SL1H470J	Ceramic 47pF ±5%
C18	CC45SL1H150J	Ceramic 15pF ±5%
C19	CE04W1J010M	Electrolytic 1μF 63WV
C20	CC45SL1H471J	Ceramic 470pF ±5%
C21	CC45SL1H331J	Ceramic 330pF ±5%
C22	CE04W2A221M	Electrolytic 220μF 100WV
C23	CE02W2E470	Electrolytic 47μF 250WV
C24	CE04W2A221M	Electrolytic 220μF 100WV
C25	CE02W2E470	Electrolytic 47μF 250WV
<b>RESISTOR</b>		
R1	RN14BK2H904F	Carbon 900kΩ ±1% 1/2W
R2	RN14BK2H1113F	Carbon 111kΩ ±1% 1/2W
R3	RN14BK2H994F	Carbon 990kΩ ±1% 1/2W
R4	RN14BK2H1012F	Carbon 10.1kΩ ±1% 1/2W
R5	RN14BK2H105F	Carbon 1MΩ ±1% 1/2W
R6	RD14BB2E105J	Carbon 1MΩ ±5% 1/4W
R7	RD14BB2E103J	Carbon 10kΩ ±5% 1/4W
R8	RD14BB2E473J	Carbon 47kΩ ±5% 1/4W
R9, 10	RD14BB2E822J	Carbon 8.2kΩ ±5% 1/4W
R11	RD14BB2E470J	Carbon 47Ω ±5% 1/4W
R12	RD14BB2E333J	Carbon 33kΩ ±5% 1/4W
R13,14	RD14BB2E332J	Carbon 3.3kΩ ±5% 1/4W
R15,16	RD14BB2E333J	Carbon 33kΩ ±5% 1/4W
R17~19	RD14BB2E272J	Carbon 2.7kΩ ±5% 1/4W
R21,22	RS14AB3D123J	Metal film 12kΩ ±5% 2W
R23,24	RD14BB2E222J	Carbon 2.2kΩ ±5% 1/4W
R25	RD14BB2E473J	Carbon 47kΩ ±5% 1/4W
R26	RD14BB2E334J	Carbon 330kΩ ±5% 1/4W
R27	RD14BB2E473J	Carbon 47kΩ ±5% 1/4W
R28	RD14BB2E102J	Carbon 1kΩ ±5% 1/4W
R29	RD14BB2E123J	Carbon 12kΩ ±5% 1/4W
R30	RD14BB2E182J	Carbon 1.8kΩ ±5% 1/4W
R31	RD14BB2E100J	Carbon 10Ω ±5% 1/4W
R32	RD14BB2E124J	Carbon 120kΩ ±5% 1/4W
R33	RD14BB2E222J	Carbon 2.2kΩ ±5% 1/4W
R34	RD14BB2E391J	Carbon 390Ω ±5% 1/4W
R35	RD14BB2E124J	Carbon 120kΩ ±5% 1/4W
R36	RD14BB2E223J	Carbon 22kΩ ±5% 1/4W
R37	RD14BB2E222J	Carbon 2.2kΩ ±5% 1/4W
R38	RD14BB2E563J	Carbon 56kΩ ±5% 1/4W
R39,40	RD14BB2E123J	Carbon 12kΩ ±5% 1/4W
R41	RD14BB2E471J	Carbon 470Ω ±5% 1/4W
R42	RD14BB2E100J	Carbon 10Ω ±5% 1/4W
R43	RD14BB2E684J	Carbon 680kΩ ±5% 1/4W
R44	RD14BB2E102J	Carbon 1kΩ ±5% 1/4W

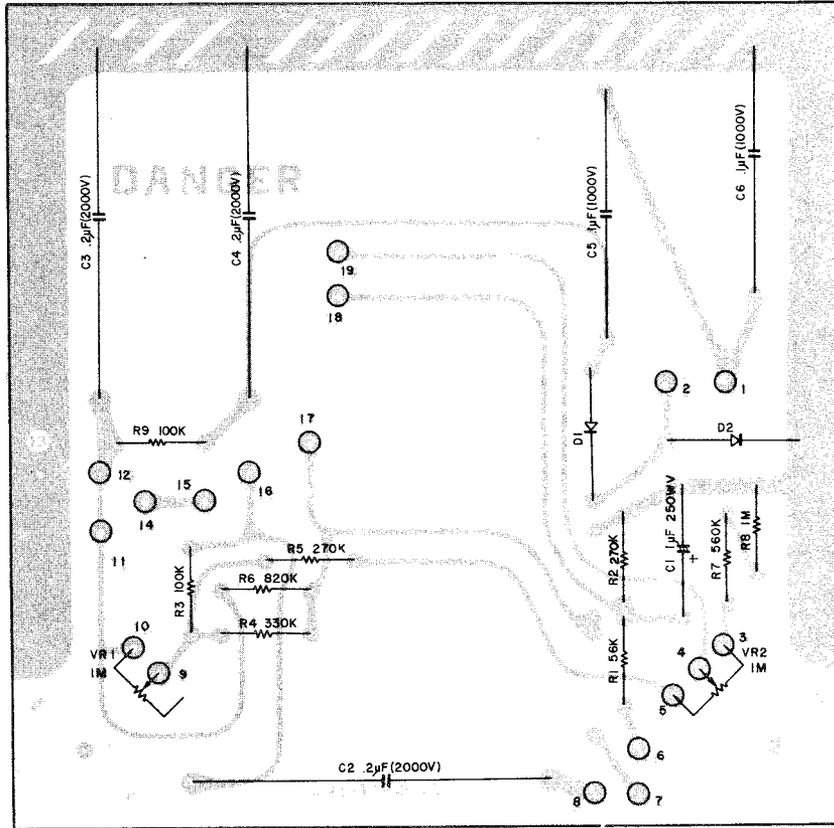
Ref. No.	Part No.	Description
R45	RN14AB3D473J	Metal film 47k $\Omega$ $\pm$ 5% 2W
R46	RD14BB2E103J	Carbon 10k $\Omega$ $\pm$ 5% 1/4W
R47	RD14BB2E123J	Carbon 12k $\Omega$ $\pm$ 5% 1/4W
R48	RD14BB2E332J	Carbon 3.3k $\Omega$ $\pm$ 5% 1/4W
R49	RD14BB2E100J	Carbon 10 $\Omega$ $\pm$ 5% 1/4W
R50	RD14BB2E103J	Carbon 10k $\Omega$ $\pm$ 5% 1/4W
R51,52	RN14BK2E4301F	Metal film 4.3k $\Omega$ $\pm$ 1% 1/4W
R53	RD14BB2E391J	Carbon 390 $\Omega$ $\pm$ 5% 1/4W
R54,55	RS14AB3D223J	Metal film 22k $\Omega$ $\pm$ 5% 2W
R56	RS14AB3D391J	Metal film 390 $\Omega$ $\pm$ 5% 2W
R57	RS14AB3F152J	Metal film 1.5k $\Omega$ $\pm$ 5% 3W
R58	RD14CB2E101J	Carbon 100 $\Omega$ $\pm$ 5% 1/4W
<b>SEMICONDUCTOR</b>		
Q1	2SK30A-0	FET
Q2, 3	2SC535-B	Transistor
Q4, 5	2SC2258	Transistor
Q6~9	2SC458-C	Transistor
Q10	2SA562-Y	Transistor
Q11	2SC2258	Transistor
Q12	2SK30A-0	FET
Q13,14	2SC2258	Transistor
D1	1N60	Diode
D2	MTZ8.2JB	Zener diode
D3	MTZ16JA	Zener diode
D4,5	V06C	Diode
D6, 7	V08J	Diode
<b>POTENTIOMETER</b>		
VR1	R03-1020-05	Variable resistor
VR2	R01-2009-05	Variable resistor
VR3	R03-6007-05	Variable resistor
VR4	R12-1003-05	Semi-fixed resistor
VR5	R03-8050-05	Variable resistor
VR6	R12-3002-05	Semi-fixed resistor
VR7	R03-3056-05	Variable resistor
VR8	R12-1002-05	Semi-fixed resistor
<b>MISCELLANEOUS</b>		
-	A22-0169-13	Sub-panel
-	E21-0101-05	Terminal x 5
-	E23-0046-04	Terminal x 17
-	E23-0048-04	Terminal x 7
-	F01-0820-04	Heat sink x 5
-	F05-3011-05	Fuse (0.3A)
-	J13-0020-05	Fuse holder x 2
-	J25-1191-13	Printed circuit board
L1, 2	L40-1011-03	Ferri-inductor
S1a, b	S29-1074-05	Rotary switch (1)
S2a~e	S29-3006-05	Rotary switch (2)
S3	S31-2004-05	Slide switch
TC1,2	C05-0010-15	Ceramic trimmer
TC3	C05-0029-15	Ceramic trimmer
N1	NE-2	Neon lamp

## PARTS LIST OF X68-1130-00

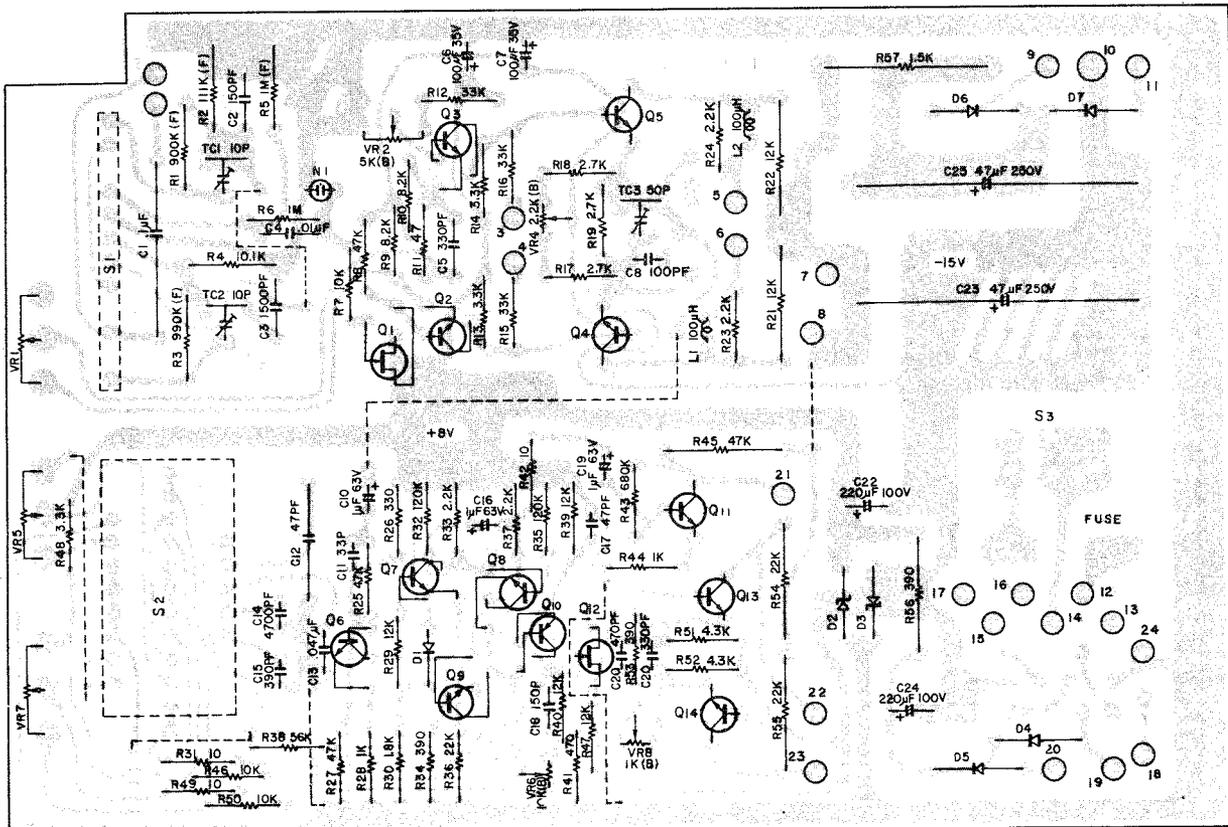
Ref. No.	Part No.	Description
<b>CAPACITOR</b>		
C1	CE02W2E010	Electrolytic 1 $\mu$ F 25WV
C2~4	C91-0510-05	Oil 0.2 $\mu$ F $\pm$ 20% 2000WV
C5, 6	C91-0506-05	Oil 0.1 $\mu$ F $\pm$ 20% 1000WV
<b>RESISTOR</b>		
R1	RD14BY2H563J	Carbon 56k $\Omega$ $\pm$ 5% 1/2W
R2	RD14BY2H274J	Carbon 270k $\Omega$ $\pm$ 5% 1/2W
R3	RD14BY2H104J	Carbon 100k $\Omega$ $\pm$ 5% 1/2W
R4	RD14BY2H334J	Carbon 330k $\Omega$ $\pm$ 5% 1/2W
R5	RD14BY2H274J	Carbon 270k $\Omega$ $\pm$ 5% 1/2W
R6	RD14BY2H824J	Carbon 820k $\Omega$ $\pm$ 5% 1/2W
R7	RD14BY2H564J	Carbon 560k $\Omega$ $\pm$ 5% 1/2W
R8	R92-1186-05	Metal film 1M $\Omega$ $\pm$ 5% 1/2W
R9	RD14BY2H104J	Carbon 100k $\Omega$ $\pm$ 5% 1/2W
<b>SEMICONDUCTOR</b>		
D1, 2	SHV-Z3	Diode
<b>MISCELLANEOUS</b>		
-	E23-0046-04	Terminal
-	J25-1192-13	Printed circuit board
VR1,2	R12-8006-05	Variable resistor

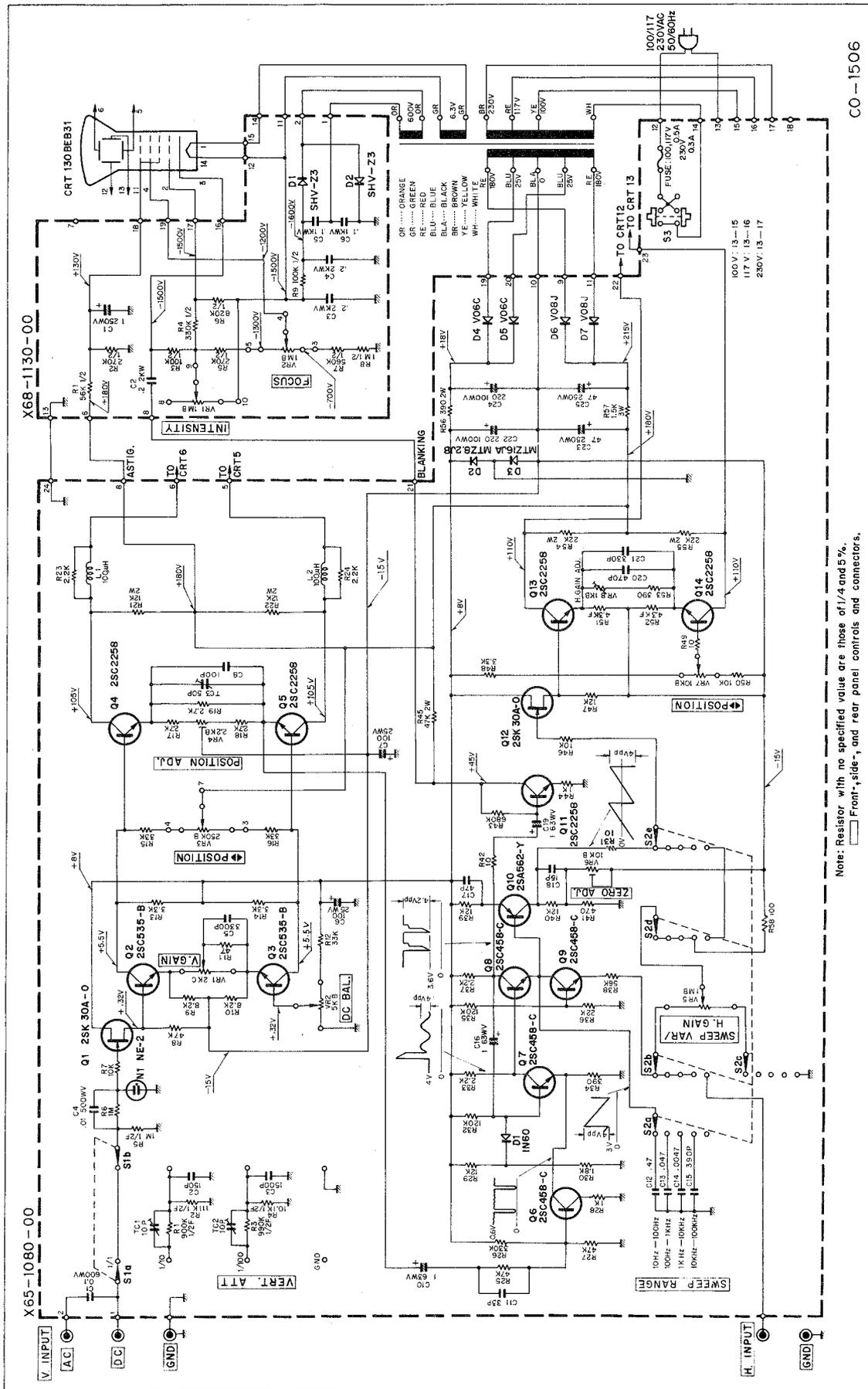
# PC BOARD

X68-1130-00



X65-1080-00, 21





Note: Resistor with no specified value are those of 1/4 and 5%.  
 □ Front, side, and rear panel controls and connectors.

**NOTE:** The circuit elements may be changed without notice owing to a technical innovation.

CO-1506