DELAY TRIGGERED SWEEP OSCILLOSCOPE

HIGH STABILITY

CS-1830

DUAL TRACE OSCILLOSCOPE

INSTRUCTION MANUAL

TRIO

FEATURES

- The vertical axis provides high sensitivity (5 mV/div) and wide bandwidth (30 MHz, −3 dB). [2 mV, 20 MHz (− dB) with 5 ▶ 2 mV switch]
- Excellent brightness and error-free measurement with the use of square, domed, mesh type, rear-stage acceleration (6kV) CRT.
- Delay sweep function that enlarges any given portion of signal for easy observation.
- ALT delay sweep function individually sets for delay and nondelay observations of CH1 and CH2 slopes of internal and external sync signals.
- Fix sync function for automatic synchronization of varies waveforms.
- Distortion-free observation of signals up to 30 MHz.
- Selection of 5 sync signals, ALT, CH1, CH2, LINE and EXT.
- Sync coupling for AC, LF REJ, HF REJ, and DC assures stabilized synchronization of various types of waveforms.
- ALT and CHOP switches are provided for ALT or CHOP observation throughout all ranges.
- Auto free-run system enables the trace to be checked even at no-signal time.
- HOLDOFF function for stabilized synchronization of complex signals such as video signals and logic signals.
- X-Y changeover system allows CH1 amplifier to be used as Y axis amplifier and CH2 amplifier as X axis amplifier.
- Single sweep function for observation of a single waveform.
- Spot illumination of CRT permits the waveform on the scale to be photographed.
- The adoption of IC's in the logic changeover circuit provides for improved reliability.

CONTENTS

SPECIFICATIONS

Cathode Ray Tube

Type:
140 CGB 31

Acceleration voltage:
6 kV

Scale:
8 div × 10 div (1 div ≒ 9.5 mm)

Vertical Axis (CH1 and CH2)

Deflection Factor:
2 mV/div — 5 V/div ± 3%

Attenuator:
5 mV/div — 5 V/div, 1-2-5 steps
Fine adjustment between 10 and PULL 2 mV/div ranges

Input impedance:
1 MΩ ± 2%
23 pF ± 3 pF

Frequency response:

DC	DC — 30 MHz (within −3dB) at 5 mV/-div −0.2V/div [DC — 20 MHz (within −3dB) at PULL 2 mV/div]
AC	5 Hz — 30 MHz (within −3dB) at 5 mV/-div −0.2V/div [5 Hz — 20 MHz (within −3dB) at PULL 2 mV/div]

Risetime:
11.7 nsec (30 MHz) or less, 17.5 nsec (20 MHz) or less.

Overshoot:
3% or less (100 kHz square wave)

Crosstalk:
Better than −60 dB (alternate), better than −40 dB (chop).

Operating modes:

CH1	CH1 only
CH2	CH2 only
DUAL	Dual trace
ADD	Single trace algebraic sum of CH1 and CH2 (single trace algebraic difference of CH1 and CH2 when CH2 signal is inverted.)

Dual-trace Changeover
TRIG SOURCE in ALT postion: Alternate trace in all SWEEP TIME/DIV ranges.
TRIG SOUTCE in any position other than ALT: Trace chopped at PULL CHOP.

CHOP frequency:
Approx. 200 kHz

CH2 polarity:
Normal or inverted

Maximum input voltage:
600 Vp-p or 300V (DC + AC peak)

Maximum undistorted amplitued:
More than 8 div (DC — 30 MHz)

Horizontal Axis (Horizontal input thru CH2 input) [X5 MAG not inclued]

Deflection factor:
Same as vertical (CH2)

Input impedance:
Same as vertical (CH2)

Frequency response:

DC	DC — 2 MHz (within −3 dB)
AC	5 Hz — 2 MHz (within −3 dB)

X-Y operation:
with SWEEP TIME/DIV switch in X-Y position, the CH1 input becomes the Y-axis input and the CH2 input becomes the X-axis input. The X-Y position control become the horizontal position control.

X-Y phase difference:
3° or less at 100 kHz

Sweep Circuit (Common to CH1 and CH2)

Sweep system:
NORM: Triggered sweep.
AUTO: Automatic sweep. Sweep is obtained without input signal.
SINGLE: Single sweep.

Sweep time:
0.2 μs/div — 0.5s/div ±3%, 1-2-5 steps, 20 ranges, adjustable

Sweep magnification:
Obtained by enlarging the above sweep 5 times (±10%) from center.

Linearity:
±3% (±10% for 0.5 μs and 0.2 μs/div ranges with X5 MAG)

Triggering Source:

Internal:

ALT Triggered by CH1 or CH2 vertical input signal.
CH1 Triggered by CH1 input signal.
CH2 Triggered by CH2 input signal.
LINE Triggered by power line frequency.

External

EXT Triggered by an external signal applied to EXT TRIG jack.

Maximum input voltage:

50V (DC + AC peak)

Type:

Normal (NORM), automatic (FIX).
In automatic mode, the sweep triggers automatically without an input signal.

Coupling:

AC, LFREJ, HFREJ, and DC

Sensitivity (Based on sine wave):

Coupling	Bandwidth (Hz)	Minimum Sync Voltage	
		INT (div)	EXT (Vp-p)
AC	20 ~ 25M 10 ~ 30M	0.5 1	1 5
DC	DC ~ 25M DC ~ 30M	0.5 1	1 5
FIX	40 ~ 20M 20 ~ 25M	0.5 1	2 5
LF REJ HF REJ	Attenuate below 10 kHz. Attenuate above 100 kHz.		

Video Sync:

FRAME: Synchronized with vertical sync signal
LINE: Synchronized with horizontal sync signal

FOLDOFF:

Continuously variable from zero (NORM) to more than 10 times (MAX).

Delay Sweep

Delay time:

1 μs — 100 ms, 5 ranges
Fine adjustment between ranges

ALT:

Delay time can be set individually for CH1 and CH2 in ALT sweep mode by CH1 DELAY and CH2 DELAY switches.

Jitter:

5,000 : 1

Intensity modulation:

Delay sweep set portion illuminated

Calibration voltage:

Square wave, positive polarity
0.5V ±1%, reference level 0V
1 kHz ±3%

Intensity Modulation

Input voltage:

More than +2V (TTL compatible)

Input impedance:

10 kΩ

Bandwidth:

DC — 5 MHz

Maximum input voltage:

50V (DC + AC peak)

Trace rotation:

Trace angle adjustable on front panel

Power Requirements

Power supply voltage:

AC 100/120/220/240V ±10%, 50/60 Hz

Power consumption:

Approx. 30W

Dimensions

Width: 260 mm (277 mm)
Height: 190 mm (204 mm)
Depth: 375 mm (440 mm)
Figures in ( ) show maxomum size.

Weight:

Approx. 8.6 kg

Accessories

Probe (PC — 22) .... 2 pieces
Attenuation 1/10
Input impedance 10 MΩ,
less than 18 pF

Replacement fuse
0.7A 2
0.3A 2

Instruction manual .... 1 copy

CONTROLS ON PANELS

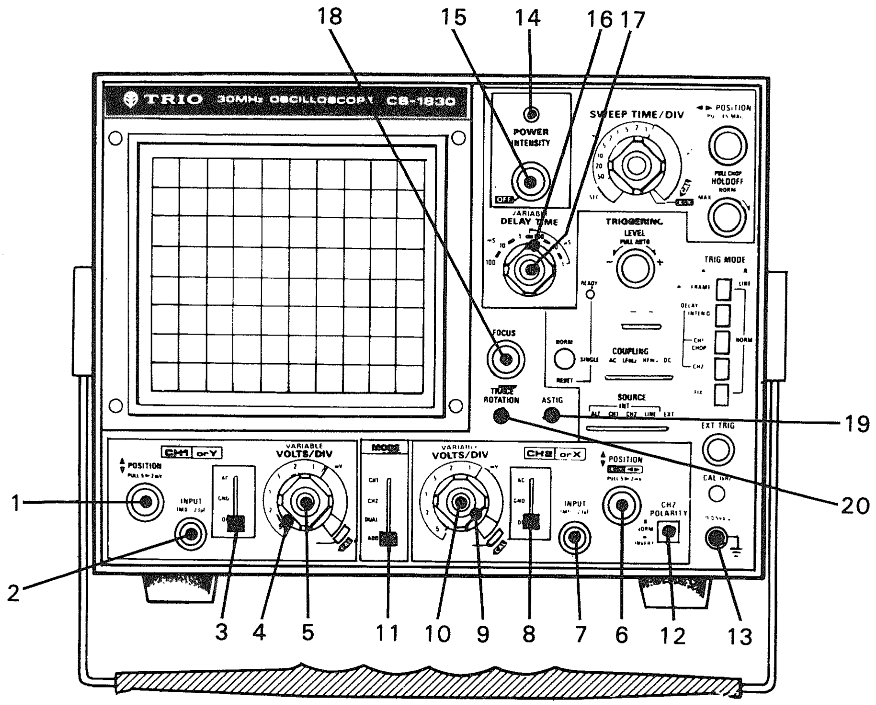


Fig. 1 Front panel controls and indicators

Controls on Front Panel

1. ▲▼ POSITION/PULL 5 ▶ 2mV

This control adjusts vertical position during CH1 operation and Y position during X-Y operation. Trace can be set to any desired position. A right turn of the control will shift trace upward, and the left turn downward.

When the knob is pulled at 5 mV/div of VOLTS/DIV (4), the sensitivity is increased to 2 mV/div. The sensitivity remains the same when the knob is pulled at any position other than 5 mV/div.

2. INPUT

Vertical input terminal for CH1, and Y input terminal for X-Y operation.

3. AC-GND-DC

Vertical input selector for CH1, and Y input selector for X-Y operation.

AC: The DC component of input signal is blocked by capacitor.

GND: The input terminal opens and the input of internal amplifier is grounded.

DC: The input terminal is directly connected to the amplifier and all components of input signal are amplified.

4. VOLTS/DIV

Vertical attenuator for CH1, or for Y during X-Y operation. The scale is graduated in voltage per "div" on CRT screen. Calibrated voltage is indicated when VARIABLE (5) is turned fully clockwise.

Set this control for proper waveform according to the input voltage used. Selectable in 10 ranges from 5 mV/div to 5V/div.When PULL 5 ▶ 2 mV (1) is pulled at 5 mV/div, the sensitivity is increased to 2 mV/div.

5. VARIABLE

Vertical sensitivity fine control for CH1. It is also used to control Y during X-Y operation. It continuously controls between 10 ranges of VOLTS/DIV. In the extrme clockwise (CAL) position, the vertical attenuator is calibrated.

6. ▲▼ POSITION/X-Y ◀▶/PULL 5 ▶ 2 mV

Vertical position adjuster for CH2. It has the same function as ▲▼ POSITION/PULL 5 ▶ 2 mV (1). During X-Y operation, it is used as X position adjuster.

7. INPUT

Vertical input terminal for CH2 or X input terminal for X-Y operation.

8. AC-GND-DC

Vertical input selector for CH2. It has the same function as AC-GND-DC (3). During X-Y opration, it is used as X input selector.

9. VOLTS/DIV

Vertical attenuator for CH2. It has the same function as VOLTS/DIV (4). During X-Y operation, it is used as X attenuator.

10. VARIABLE

Vertical sensitivity fine control for CH2. It has the same function as variable (5). During X-Y operation, it is used as X fine adjuster.

11. MODE

Mode selector has the following functions:

CH1: Only the input signal to CH1 is displayed as a single trace.

CH2: Only the input signal to CH2 is displayed as a single trace.

DUAL: Dual trace operation; both the CH1 and CH2 input signals are displayed on two separate trace. With SOUTCE (21) in ALT position, ALT operation is effected independently of other switches. With SOURCE in any position other than ALT, CHOP operation at about 200 kHz is effected provided PULL CHOP switch (33) is pulled. For ALT operation, depress this switch.

ADD: Algebraic sum of both channels (or algebraic differnce in INVERT position of CH2 POLARITY) is displayed as a single trace. When SOURCE is in ALT or CH1 position, the sweep is triggered with CH1 input signal.
When SOURCE is in CH2 position, the sweep is triggered with CH2 input signal.

12. CH2 POLARITY

CH2 polarity changeover switch.

13. GND

GND terminal.

14. LED Pilot Lamp

This lamp lights when POWER (15) is ON.

15. POWER/INTENSITY

Turn this knob fully counterclockwise and the power is OFF. Turn it clockwise to turn on the power and adjust the intensity.

16. DELAY TIME

Delay time control has 5-range settings from 1 μs to 100 ms. Obtain approximate delay time required for the waveform to be observed from SWEEP RANGE and the scale on the CTR screen, and set the control to the range including that time.

17. VARIABLE

This control is used for fine adjustment of delay time. Since it is of a backlash type, first turn the knob for coarse adjustment, then turn it counterclockwise for fine adjustment. Turn the knob to shift the delay position (illuminated) as desired. The delay sweep is started at the left of the illuminated portion. A right turn of the knob lengthens the delay time.

18. FOCUS

Spot focus control to obtain optimum waveform according to brightness.

19. ASTIG

Astigmatism adjustment provides optimum spot roundness and brightness when used with FOCUS (18). Once it is adjusted, no further adjustments are required.

19. TRACE RPTATION

This is used to eliminate inclination of horizontal trace.

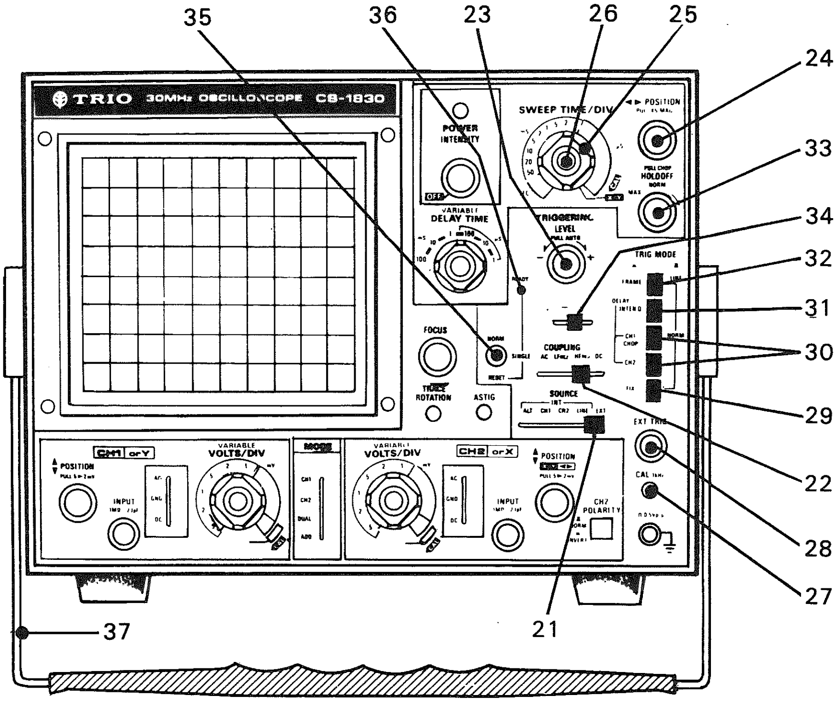


Fig. 2 Front panel controls and indicators

21. SOURCE

Sync signal select switch functions as follows:

ALT: With MODE (11) in CH1 position, the sweep is triggered with CH1 input signal. In CH2 position, it is triggered with CH2 input signal.
IN DUAL position, CH1 trace is triggered by CH1 input signal and CH2 trace is triggered by CH2 input signal and ALT operation is effected independently of other switches, If, in this case, the traces of CH1 and CH2 are extremely away from each other, the traces cannot be triggered easily.
When the input signal is higher than 10 kHz, set COUPLING (22) to LFrej to facilitate the triggering. When TRIG MODE is in FRAME position, only the CH1 input signal is triggered.

CH1: CH1 vertical input becomes trigger signal.

CH2: CH2 vertical input becomes trigger signal.

LINE: Triggered to power line frequency.

EXT: Signal fed to EXT TRIG (28) becomes trigger signal.

22. COUPLING

This is used for selection of 4 types of sync coupling; AC, LFrej, HFrej and DC.

23. LEVEL/PULL AUTO

Sync level adjustment determines point on wave form slope when sweep starts; (−) equals most negative point of treggering and (+) equals most positive point of triggering.
By pulling the LEVEL knob, AUTO sweep is effected; the sweep is set in free-running state even when no trigger input signal is applied, with fly-back line displayed on CRT; with trigger signal, trigger sweep is effected where trigger level is adjustable. For single sweep operation, push the knob.

24. ◀▶POSITION/PULL ×5MAG

Horizontal position adjuster to shift trace to any desited horizontal position. A right turn of the adjuster will shift the trace to right, and vice versa. Push-pull switch selects ×5 magnification when pulled out; normal when pushed in. Brightness is slightly decreased.

25. SWEEP TIME/DIV

Horizontal sweep time selector. It selects sweep time of 0.2 μs/div to 0.5s/div in 20 ranges. X-Y operation is possible by turning the knob fully clockwise. When VARIABLE (26) is turned fully clockwise to the CAL position, calibrated reading is obtained, which is the sweep time per "div".

26. VARIABLE

Used for fine adjustment of sweep time. Continuous adjustment between 20 ranges of SWEEP TIME/DIV is possible. Sweep time is calibrated at the extreme clockwise postion (CAL).

27. CAL

Calibration voltage terminal. Calibration voltage is 0.5V at about 1 kHz square wave.

28. EXT TRIG

Input for external trigger signal. External trigger signal is applied to this terminal with SOURCE (21) set to EXT position.

29. NORM/FIX

NORM: The triggering level is selected by LEVEL control (23).

FIX: The triggering level is automatically set at the average level of the waveform used for triggering.

30. NORM/DELAY CH1, CH2

Delay setting switch. CH1 is delayed by pressing the CH1 switch and CH2 delayed by the CH2 switch regardless of the position of the DELAY INTEND (32).

In ALT mode, CH1 and CH2 are delayed or non-delayed individually by using CH1 and CH2 switches.

In CHOP mode, CH1 and CH2 are delayed simultaneously by pressing the DELAY CH1 (CHOP) switch. The DELAY CH2 switch has no effect on delay operation. In normal mode, normal sweep is obtained.

31. NORM/DELAY INTEN'D

NORM: The brightness adjusted by INTENSITY is unmodulated.

DELAY INTEN'D: The brightness of the spot determined by DELAY TIME (16) and VARIABLE (17) is modulated. Modulation is released by pressing DELAY CH1, CH2.

32. NORM (LINE)/FRAME

NORM: In this position, normal waveform is observed or the oscilloscope is synchronized with horizontal sync signal of video signal.

FRAME: In this position, the oscilloscope is set in VIDEO MODE and the vetical (TV.V) sync circuit is activated. The oscilloscope is synchronized with vertical sync signal of video signal.

33. HOLDOFF/PULL CHOP

Holdoff time adjuster. In NORM position, holdoff time is minimum. In MAX position, it is more than 10 times that in NORM position.

CHOP operation is effected when SOURCE (21) is in any position other than ALT.

34. SLOPE

This switch is used to select sync polarity.

+: Sweep is triggered on positive-going slope of waveform.

−: Sweep is triggered on negative-going slopope of waveform.

35. NORM, SINGLE, RESET

NORM: This position is used for normal trigger sweep.

SINGLE: This position is used for single sweep. In RESET position, the oscilloscope is set in trigger standby mode and the READY lamp (36) lights. With input signal applied, sweep is effected only once and the lamp goes off. When photographing the waveform on the scale, this switch should be set in RESET position.

36. READY

This lamp indicates that the oscilloscope is ready for single sweep observation. In NORM sweep mode, the lamp keeps lighting.

37. HANDLE

This handle also serves as a stand of the oscilloscope.

CONTROLS ON SIDE PANEL

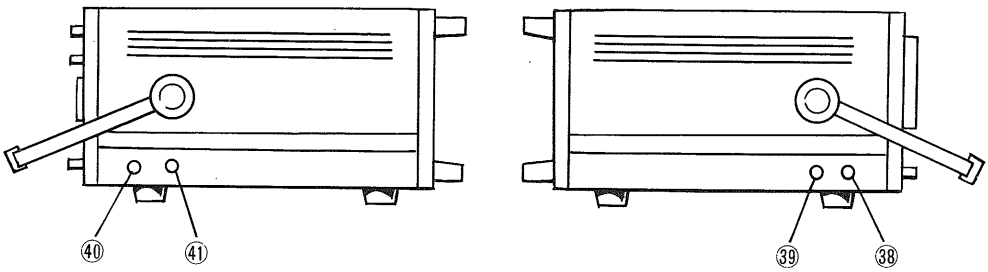


Fig. 3 Side panel facilities

38. VARI. ATT. DC BAL

For adjustment of CH1 (or Y) vertical DC balance. Adjustment should be made so that the waveform position is not shifted when VARIANLE (5) is turned.

39. STEP. ATT. DC BAL.

For adjustment of CH1 (or Y) vertical DC balance. Adjustment should be made so that the waveform position is not shifted when VOLTS/DIV (4) is turned.

40. VARI. ATT. DC BAL.

For adjustment of CH2 (or X) vertical DC balance. The function of this control is the same as that of VARI. ATT. BAL. (38).

41. STEP. ATT. DC BAL.

For adjustment of CH2 (or X) vertical DC balance. The function of this control is the same as that of STEP. ATT. BAL. (39).

CONTROLS ON REAR PANEL:

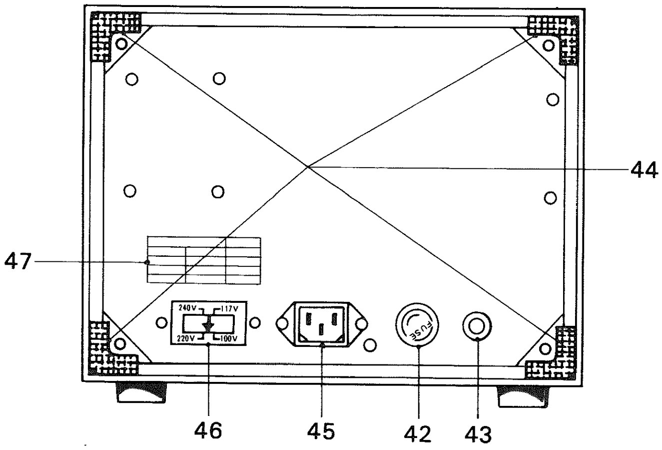


Fig. 4 Rear panel facilities

42. Fuse Holder

Fuse rated at 0.5A should be used for 220/240V operation. For operation on 100/120V, be sure to use a 0.7A fuse.

43. Z AXIS INPUT

Intensity modulation terminal. Intensity is modulated at voltages of more than +2V.

44. Cord Reel

Used to wind power cord when the oscilloscope is to be carried or stored. It also serves as a stand when the oscilloscope is used in upright position.

45. Power Connector

AC power connector. For connection, use the supplied cord.

46. Power Voltage Selector

Set this switch to the correct operting voltage.

47. Voltage Indicating Plate

Use voltages and fuses specified.

OPERATION

PRELIMINARY OPERATION

To ensure correct opertion, set the oscilloscope as illustrated below before switching on the power.

For detailed instructions, refer to "Controls on Panels".

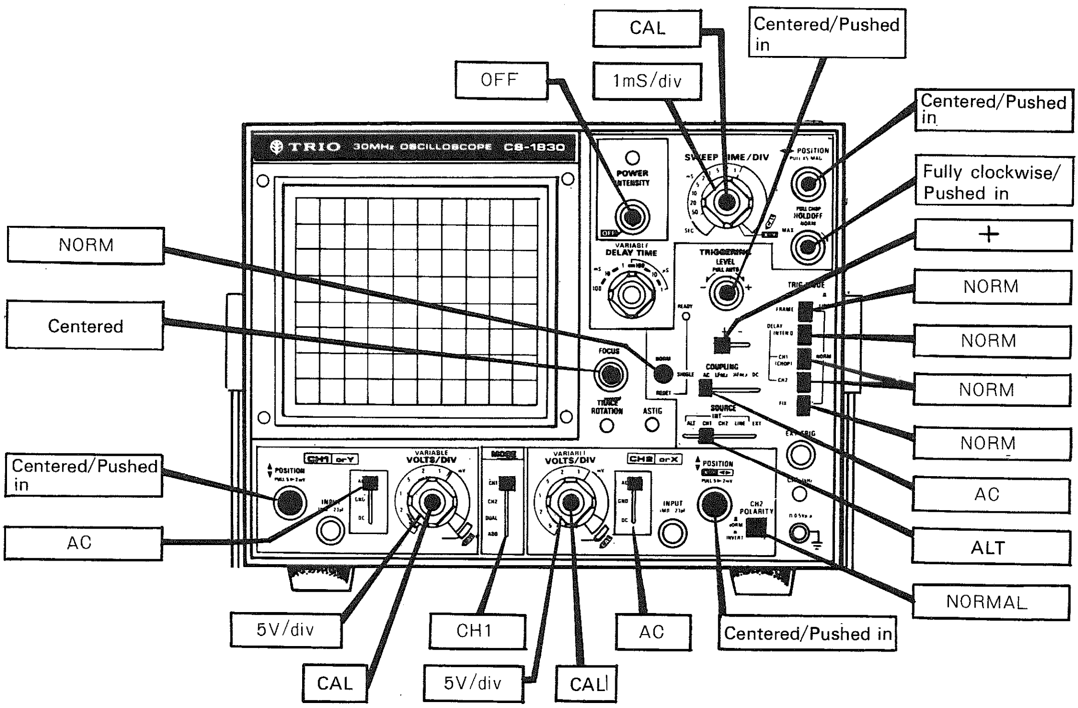


Fig. 5 Initial setting

OPERATING PROCEDURES (figures in [ ] denote CH2)

1. Set the power voltage selector to the correct voltage observing the arrow mark on the plug.
2. Turn POWER (15) clockwise. The power is turned to ON and LED pilot lamp (14) lights.
3. Trace will be displayed. If no trace appears at the center of the screen, adjust POSITION (1) [6]. Adjust brightness by INTENSITY (15). If trace is unclear, adjust FOCUS (18).
4. The oscilloscope is now ready for measurement. For measurement, proceed as follows: Apply a signal voltage to INPUT (2) [7]. Then turn VOLTS/DIV (4) [9] clockwise until the waveform is properly displayed on the scope.
   By setting MODE (11) and SOURCE (21) to CH1, the CH1 input signal to INPUT (2) will appear. Similarly, by setting MODE and SOURCE to CH2, then the input signal to CH2 INPUT (7) will appear. At DUAL position, two waveforms are displayed on the screen. Dual-trace sweep is generated by two methods; alternate and chop.
   At ADD position, algebraic sum of CH1 and CH2 (CH1 + CH2) is obtained. When PULL INVERT (7) knob is pulled, the input to CH2 is applied to CH1 in reverse polarity and thus algebraic difference (CH1 − CH2) is obtained.
5. When the signal voltage is more than 5mV and waveform fails to appear on the screen, the oscilloscope may be cheked by feeding input from CAL (27). Since calibration voltage is 0.5V, the waveform becomes 5 div at the 0.1V/div position on VOLTS/DIV.
6. By setting LEVEL (23) to NOR position, the free-running auto function is released. The waveform disappears when LEVEL is turned colckwise or counterclockwise and appears again at the approximate mid position of it. In both NOR and AUTO modes, triggering level can be adjusted.
7. When DC component is measured, set AC-GND-DC (3) [8] to DC. If, in this case, the DC component contains "+" potential, the waveform moves upward and if it contains "−" potentioal, the waveform moves dounward.
   The reference point of "0" potential is checked at GND position.

TRIGGERING

To observe a stationaty input signal waveform, the sweep circuit must be triggered correctly. This can be accomplished either by the input signal (internal triggering) or by applying a signal, having a specific relationship (a multiple of integer) with input signal in terms of time, to the external trigger terminal (external triggering).

Internal Triggering:

By setting TRIGGERING SOURCE (21) to INT (ALT CH1, CH2 or LINE), the input signal is connected to the internal trigger circuit. In this position, a part of the input signal fed to the input terminal (2 or 7) is applied from the vertical amplifier to the trigger circuit to cause the trigger signal triggered with the input signal to drive the sweep circuit.

External Triggering:

External triggering is accomplished by setting the SOURCE switch (21) to EXT provided a trigger signal is applied to the external trigger input terminal (28). External triggering is useful when you wish to trigger with a signal differednt from the input signal. It should be noted, however, that the trigger signal must have a relationship with the input signal in terms of time to ensure effective observation of waveform.

Fig. 6 shows that the sweep circuit is driven by the gate signal when the gate signal in the burst signal is applied to the input terminal.

Fig. 6 also shows the input/output signals, where the burst signal generated from the gate signal is applied to the instrument under test.

Thus, accurate triggering can be achieved without regard to the input signal fed to the terminals (2) and (7), so that no further triggering is required even when the input signal is varied.

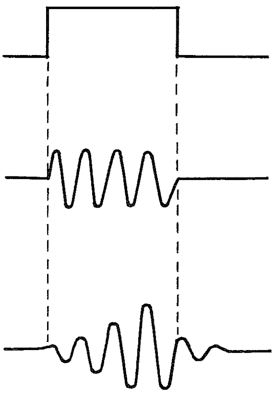


Fig. 6 External triggering

Coupling:

The COUPLING switch (22) is a switch to select the coupling mode of trigger signal to the trigger circuit according to the type of trigger signal (DC, AC, signal superposed on DC, signal with low frequincy noise, signal with high frequency noise, etc.).

AC:

The AC (capacitance) coupling permits triggering by AC component only; DC component in trigger signal is cut off. This range is normally used triggering is stabilized without regard to DC component. Note that if the frequency of trigger signal is less than 10 Hz, the signal level becomes low which results in diffidcuty of triggering.

LF REJ:

Trigger signal is fed to the trigger circuit via a high pass filter where the low frequency component (less than 10 kHz) is eliminated and thus triggering is effected only by the high frequency component. As shown in Fig. 7, when the trigger signal contains low frequency noise (particularly hum), it is eliminated so that triggering is stabilized.

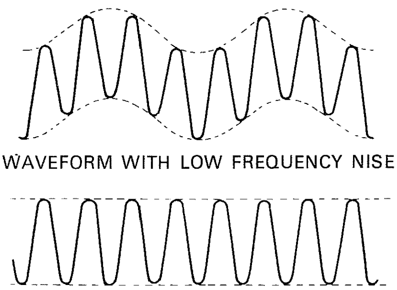


Fig. 7 Effect of LF rejection in sync coupling

HF REJ:

In contrast with LF REJ, the trigger signal is fed via a low pass filter where high frequency component (more than 100 kHz) is eliminated and thus triggering is effected only by low frequency component. Fig. 8 shows that the high frequency noise contained in the waveform is eliminated so that triggering is stabilized.

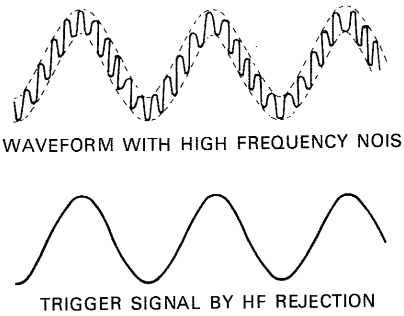


Fig. 8 Effect of HF rejection in sync coupling

DC:

Trigger signal is directly coupled with the trigger circuit and triggering is effected by DC. This method is advantageous when triggering with a low frequency signal less than 10 Hz or a lamp waveform that varies with slow repeating DC.

Triggering Level:

Trigger point on waveform is adjusted by the LEVEL (23) and SLOPE (34) controls. Fig. 9 shows the relationship between the SLOPE and LEVEL of trigger point. Triggering level can be adjusted as necessary.

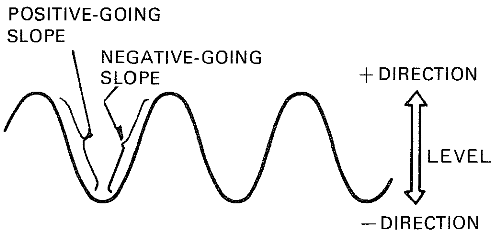


Fig. 9 Triggering slope and level

Auto Trigger:

By setting the MODE (23) to AUTO the sweep circuit becomes the free-running state as long as there is no trigger signal, permitting the check of GND level. When a trigger signal is present, the trigger point can be determined by the LEVEL and SLOPE for observation as in the normal trigger signal. When the triggering level exceeds the limit, the trigger circuit also becomes the free-running state where the waveform starts running. When LEVEL is in NOR position, there is no sweepage nor trace when trigger signal is absent or the triggering level exceeds the limit.

FIX:

When NORM/FIX(29) is set to FIX, triggering is always effected in the center of waveform, eliminating the need for adjusting the triggering level. As shown in Fig. 10 (A) or (B), when NORM/FIX set to NOR and the triggering level is adjusted to either side of the signal, the trigger point is deviated as the input signal becomes small which, in turn, stops the sweep operation.

By setting NORM/FIX to FIX, the triggering level is automatically adjusted in the approximate center of the waveform and the signal is synchronized regardless of the position of LEVEL as shown in Fig. 10 (c).

When the input signal is suddenly changed from a square waveform to a pulse waveform, the trigger point is shifted extremely toward the "−" side of the waveform unless the triggering level is readjusted as shown in Fig. 11 (A). See Fig. (A)-(2), (3).

Also, if the trigger point has been set to the "−" of square waveform (Fig. 11 (B)-(1)) and the input signal is changed to a pulse signal, the trigger point is deviated and the sweepage stops. When this happens, set FIX/NORM to FIX position and the triggering is effected in the approximate center of the waveform, making it possible to observe a stabilized waveform. Fig. 11 (C).

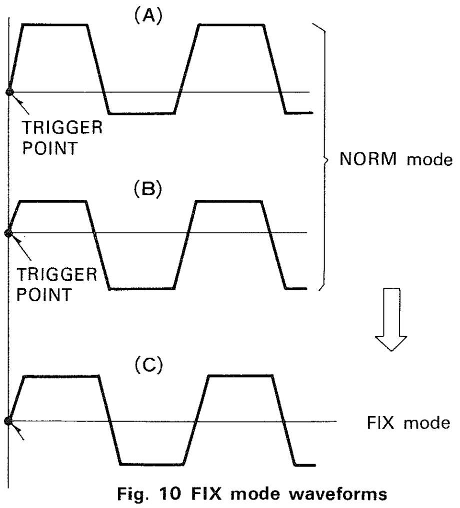


Fig. 10 FIX mode waveforms

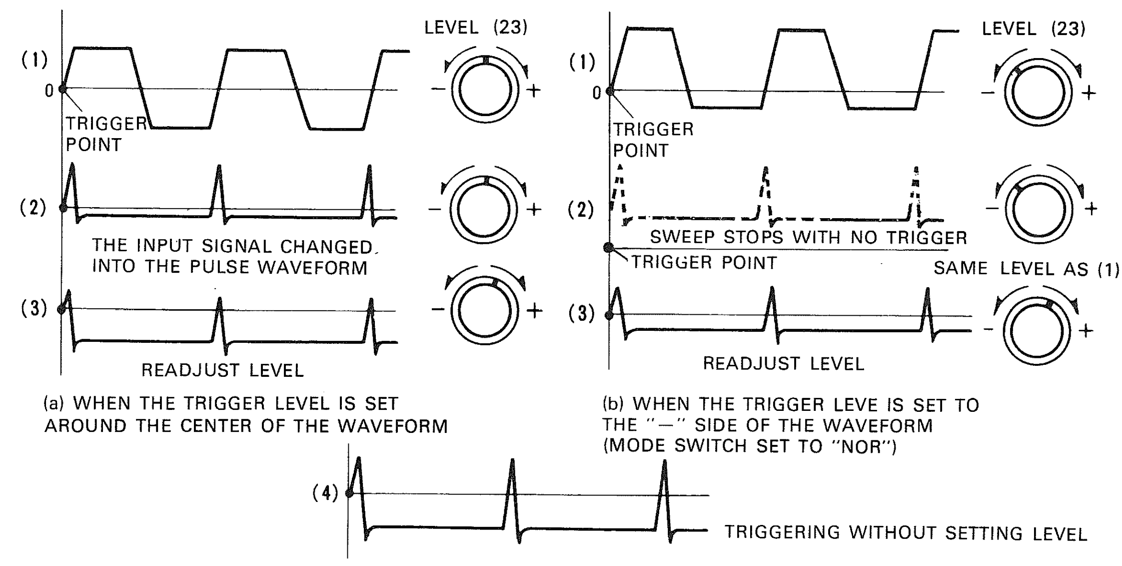


Fig. 11

DELAY SWEEP

Any desired portion of waveform can be magnified for easy observation (Fig. 12 shows an example of observation of the enlarged rising portion of square wave).

1. Using SWEEP TIME/DIV (25), read the approximate delay time of the portion to be magnified (about 3.5 ms in Fig. 12-a).
2. Next, set DELAY TIME (16) to the range which includes the delay time (10-1 ms range in Fig. 12-a).
3. Press INTEN'D (31) and the waveform is partially intensity modulated. Turn VARIABLE (17) so that the starting point of the portion to be magnified comes to the left end of the modulated waveform (Fig. 12-b).
4. Press DELAY (30) corresponding to the channel to be observed and delay sweep is effected starting at the set point (Fig. 12-c).
5. Under this condition, adjust SWEEP TIME/DIV (25) and the desired portion of the waveform can be magnified (In Fig. 12-d, SWEEP TIME/DIV (25) is set to 0.2 ms/DIV

If it is desired to observe the same input in dual-trace mode, follow the above steps 1, 2 and 3 and then press either CH1 or CH2 DELAY (30). In this way, one channel can be observed in normal sweep and the other in delay sweep, thus permitting comparison of two waveforms.

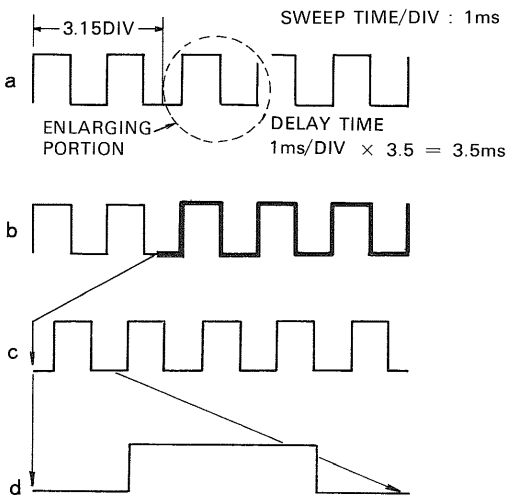


Fig. 12

Triggering with HOLDOFF:

When a series of complex pulses appear periodically as shown in Fig. 13, it sometimes happens that the waveform is displayed double without being synchronized as illustrated in Fig. 14 depending on the setting of sweep time.
In this case, the waveform can be synchronized by continuously varying the sweep time with SWEEP VARIABLE (26), but this method is unpractical because the time base is not calibrated.
To obtain a stabilized synchronization, turn HOLD-OFF (33) slowly clockwise from the NOR position to change the sweep cycle (time base remains the same) so that the sweepage is started at the same point of the waveform at all times.
If a jitter appears when trigger level is adjusted to the maximum setting, adjust the HOLDOFF control until sync signal is stabilized.

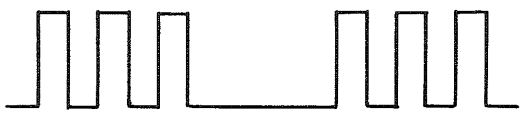


Fig. 13 HOLDOFF used

Single Sweep Operation:

Irregular waveforms of voice signals or instantaneous waveforms (chattering) which occur when mechanical switches are manipulated are displayed double and cannot be observed clearly, if the normal repeating sweep is rsed.
In this instance, set SINGLE position and the sweepage is made only once with the initial sync signal to permit easy observation. This method is also advantageous when photographing such waveforms. To set the oscilloscope in the trigger standby state after the completion of single sweep, NORM/SINGLE (35) set to RESET (READY lamp (36) will light).
The single sweep will now start again when a sync signal is applied. The READY lamp goes off at the completion of the sweep.

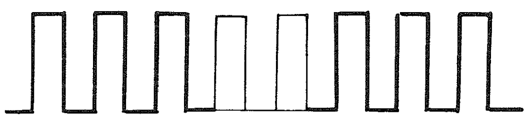


Fig. 14 HOLDOFF not used

PHOTOGRAPHING

The waveform on the scale of CRT screen can be photographed.

Normal sweep

When photographing, be sure to use a camera whose shutter set is not interlocked with the film winder.

1. Apply a signal to be observed to the input terminal and trigger so that the waveform stays still.
2. Under this condition, take a photograph of the waveform.
3. Next, set SWEEP TIME/DIV (25) to 0.1 ms and TRIG LEVEL (23) to PULL AUTO. Then, set NORM/SINGLE switch (35) to RESET and hold the switch in that position. The scale can be photographed by the light of the spot.
4. Adjust the brightness of the scale with INTENSITY (15) and operate the camera for double-exposure. The scale and the waveform can be photographed together.

Single Sweep

1. In NORM sweep, adjust the intensity of the scale with INTENSITY (15) with the oscilloscope operated as outlined in item (3) and take a photograph of the scale. In this case, the shutter speed of the camera should be set to "B".
2. Next, set the camera shutter to "full open" position.
   Push TRIG LEVEL (23) and turn for optimum triggering, and set NORM/SINGLE switch (35) to SINGLE. Then reset the oscilloscope so that it can be triggered.
3. Apply a signal to be observed to the input terminal.
4. With the signal applied, the oscilloscope completes a sweep and READY goes off. Operate the shutter of the camera.

MEASUREMENTS OF PULSE RISING (FALLING) TIME

The scales 10% and 90% on the CRT screen are used for accurate measurements of pulse rising (falling) time. To measure pulse rising time, proceed as follows:

1. With a pulse signal applied to the input terminal, adjust VOLTS/DIV (4) [9] and VARIABLE (5) [10] so that the pulse amplitude is set to the 0 and 100% scales (Fig. 15).
2. Turn SWEEP TIME/DIV (25) to magnify the rising portion of the waveform as large as possible [VARIABLE (26) should be set to CAL position].
3. Adjust ◀▶ POSITION (24) to set the waveforms at 10% and 90% to the vertical center scale respectively, then measure T1 and T2 using the horizontal center scale. The pulse rising (falling) time is T1 + T2.

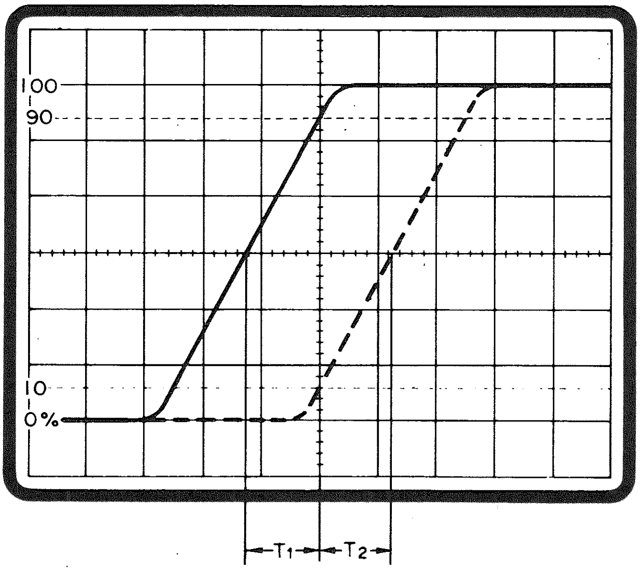


Fig. 15

APPLICATIONS

APPLICATIONS OF DUAL-TRACE OPERATION

Introduction:

The most obvious and yet the most useful feature of the dual-trace oscilloscope is that it has the capability for viewing simultaneously two waveforms that are frequency or phase-related, or that have a common synchronizing voltage, such as in digital circuitry. Simultaneously viewing of input and ets output is an invariable aid to the circuit designer or the repairman. Several possible applications of the dual-trace oscilloscope will be reviewed in detail to familiarize the user further in the basic operation of this oscilloscope.

Frequency Divider Waveforms Viewing:

Fig. 16 illustrates the waveform involved in a basic divide-by-two circuit. Fig. A indicates the reference or colck pulse train. Fig. B and Fig. C indicates the possible outputs of the divide-by-two circuitry. Fig. 16 also indicates the settins of specific oscilloscope controls for viewing these waveforms. In addition to these basic control settings, the TRIGGERING LEVEL control, as well as the CH1 and CH2 vertical position controls should be set as required to produce suitable displays. In the drawing of Fig. 16, the waveform levels of 2 div are indicated. If the exact voltage measurements of the CH1 and CH2 are desired, the CH1 and CH2 VARIABLE controls must be placed in the CAL position. The CH2 waveform may be either that indicated in Fig. 16B or Fig. 16C the divide-by-two output waveform is shown which occurs during the falling time of pulses. In this case, the output waveform is shifted with respect to the leading edge of the reference frequency pulse by a time interval corresponding to the pulse width.

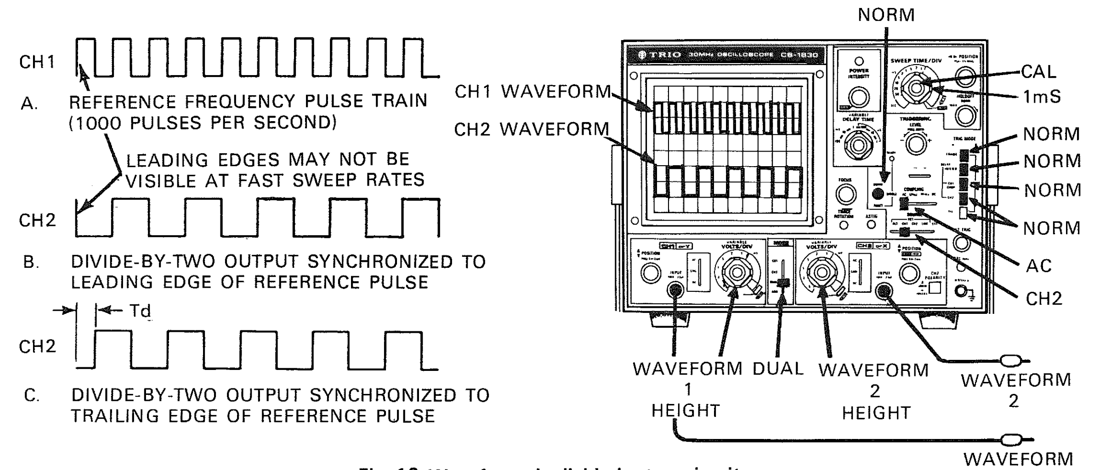


Fig. 16 Waveforms in divide-by-two circuit

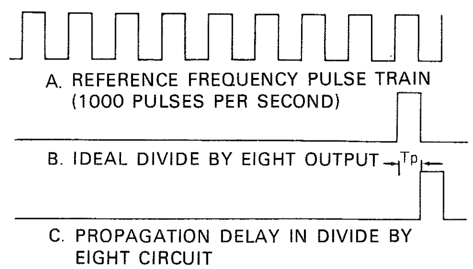


Fig. 17 Waveforms in divide-by-eight circuit

Divide-by-8 Circuit Waveforms:

Fig. 17 indicates waveform relationships for a basic divide-by-eight circuit. The oscilloscope settings are identical to those used in Fig. 16. The reference frequency of Fig. 17A is supplied to the CH1 input, and the divide-by-eight output is applied to the CH2 input. Fig. 17 indicates the time relationship between the input pulses and output pulses.

In an application where the logic frequency, the accumulated rise time effects of the consecutive stages produce a built-in time propagation delay which must be compensated for Fig. 17C indicates the possible time delay which may be introduced into a frequency divider circuit. By using the dual-trace oscilloscope, the input and output waveforms can be superimposed (ADD) to measure the exact amount of propagation delay that occurs.

Propagation Delay Time Measurement:

An example of propagation delay in a divide-by-eight circuit was given in the previous paragraph. Significant propagation delay may occur in any circuit. This oscilloscope has features which simplify measurement of propagation delay time. Fig. 18 shows the resultant waveforms when the dual-trace presentation is combined into a single-trace presentation by selecting the ADD position of the MODE switch. With CH2 POLARITY switch in the normal position (pushed in) the two inputs are algebraically added in a single-trace display. Similarly, in the inverted position (pull) the two inputs are algebraically subtracted. Either position provides a precise display of the propagation time (Tp). Using the calibrated time base (CAL). Tp can be measured. A more precise measurement can be obtained if the Tp portion of the waveform is expanded horizontally by pulling the X5 MAG control. It also may be possible to view the desired portion of the waveform at a faster sweep speed.

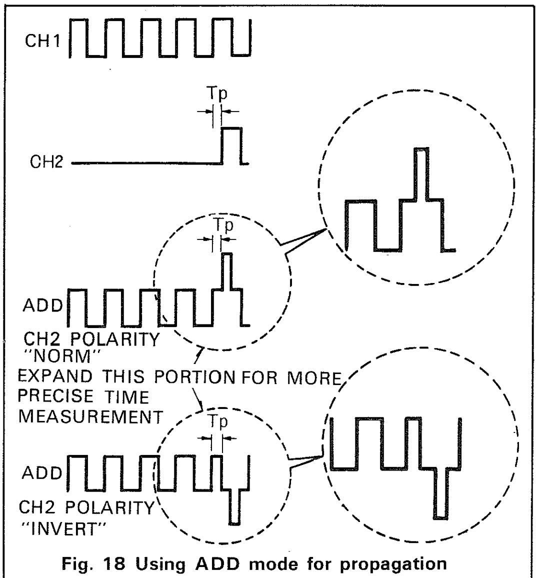


Fig. 18 Using ADD mode for propagation time measurement

Distortion Measurement:

Distortion of an amplifier may be measured with this oscilloscope. This measurement is especially variable when the slope of a waveform must be faithfully reproduced by an amplifier. Fig. 19 shows the testing of a circuit using a triangular wave, such as is found in the limiter circuit of a transmitter modulator. The measurement may be made using any type of signal; merely use the type of signal for testing that is normally applied to the amplifier during normal operation. The procedure for distortion testing is as follows:

1. Apply the type of signal normally encountered in the amplifier under test.
2. Connect CH1 probe to the input of the amplifier and CH2 probe to the output of the amplifier. It is preferabble if the two signals are not inverted in relationship to each other, but inverted signals can be used.
3. Set CH1 and CH2 AC-GND-DC switches to AC.
4. Set the MODE switch to DUAL.
5. Set SOURCE switch to CH1 and adjust controls as described in the procedure for synchronizing waveforms.
6. Adjust CH1 and CH2 POSITION controls to superimpose the waveforms directly over each other.
7. Adjust CH1 and CH2 vertical sensitivity controls (VOLTS/DIV and VARIABLE) so that the waveforms are as large as possible without exceeding the limits of the scale, and so that both waveforms are exactly the same height.
8. Now, set the MODE switch to ADD position and the CH2 POLARITY switch to the PULL INVERT position (if one waveform is inverted with respect to the other, use normal CH2 polarity).

   Adjust the fine vertical sensitivity control (CH2 VARIABLE) for the minimum remaining waveform; if the two waveforms are exactly the same amplitude and same waveform and there is no distortion, the waveforms will cancel and there will be only a straight horizontal line remaining on the screen.

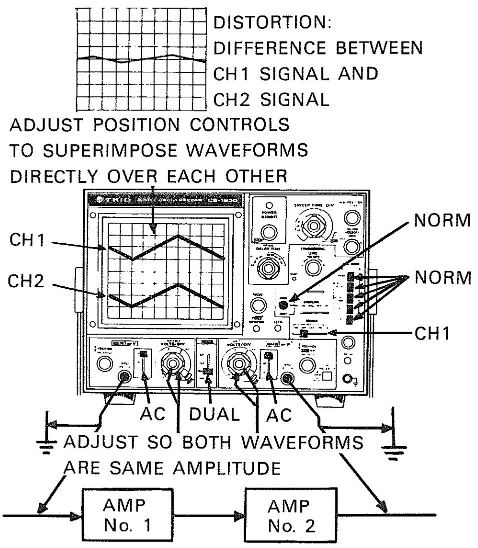


Fig. 19 Distortion measurement

Gated Ringing Circuit (burst circuit):

Fig. 20 shows a burst circuit. The basic settings of control knobs are the same as those in Fig. 16. The waveform EA is the reference waveform and is applied to CH2 input. All other waveforms are sampled at CH1 and compared to the reference waveform of CH2. The burst signal can be examined more colsely either by increasing the sweep time or by pulling the ◀▶ POSITION control to obtain 5 times magnification.

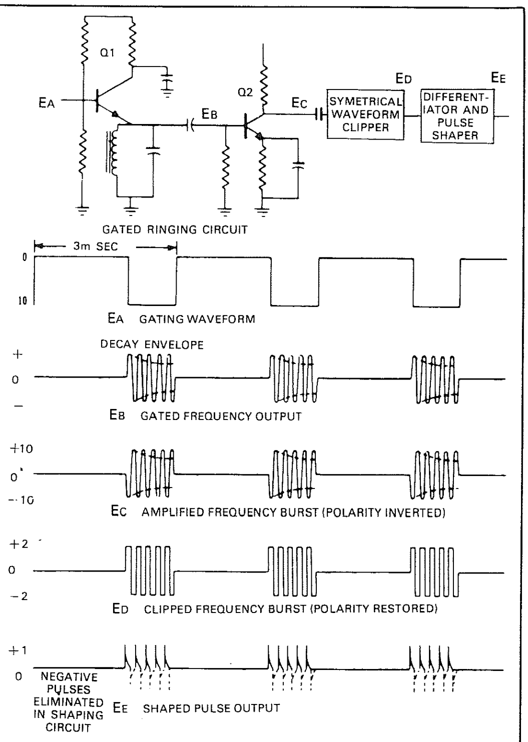


Fig. 20 Gated ringing circuit and waveforms

Delay Line Test:

The dual-trace feature of the oscilloscope can also be used to determine the delay times of transmission type delay lines as well as ultrasonic type delay lines. The output of delay lines is observed on CH2 while being synchronized with the input pulse of CH1. The interval between pulses should be large compared to the delay time to be observed. In addition to determining delay time, the pulse distortion inherent in the delay line can be determined by examination of the delay pulse observed on CH2 waveform display.

Fig. 21 shows the typical oscilloscope settings as well as the basic test circuit. Typical input and output waveforms are shown on the oscilloscope display. In addition to determining the delay characteristics of the line, the output waveform reveals any distortion that may be introduced from an impedance mismatch.

Stereo Amplifier Servicing:

Another convenient use for dual-trace oscilloscope is in troubleshooting stereo amplifiers. If identical amplifiers are used and the output of one is weak, distorted or otherwise abnormal, the dual-trace oscilloscope can be efficiently used to localize the defective state. With an identical signal applied to the inputs of both amplifiers, a side-by-side comparison of both units can be made by progressively sampling identical signal points in both amplifiers. When the defective of malfunctioning stage has been located, it can be immediately observed and analyzed.

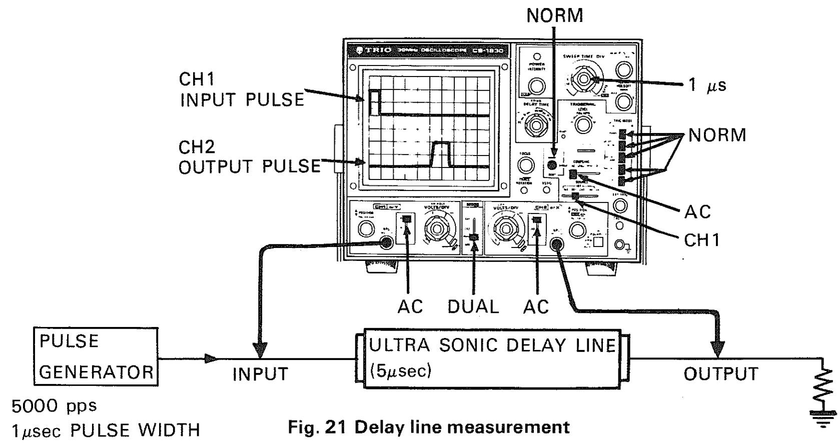


Fig. 21 Delay line measurement

Amplifier Phase Shift Measurements:

In the square wave testing section of this manual, square wave distortion is explained in terms of phase shift of the signal components which comprise the square wave. These phase shifts can be verified directly by providing a sign wave input signal to the amplifier and observing the phase of output signal with respect to the input signal.

In all amplifiers, a phase shift is always associated with a change in amplitude response. For example, at the −3 dB response point, a phase shift of 45° occurs. Fig. 22 illustrates a method of determining amplifier phase shift directly. In this case, the measurements are being made at approximately 5000 Hz. The input signal is used as a reference and is applied to the CH1 input jack.

The VARIABLE control is adjusted as required to provide a complete cycle of the input waveform displayed on 8 div horizontally, while the waveform amplitude is set to 2 div. The 8 div display represents 360° at the displayed frequency and centimeter represents 45° of the waveform.

The vertical attenuator contols of CH2 are adjusted as required to produce waveform amplitude of 2 div. The CH2 POSITION control is the adjusted so that the CH2 waveform is displayed on the same horizontal axis as the CH1 waveform. The distance between the two waveforms then represents the phase shift between the two waveforms. In this case, the zero crossover points of the two waveforms are compared. The illustration shows a phase difference of 1 div which means a phase shift of 45°

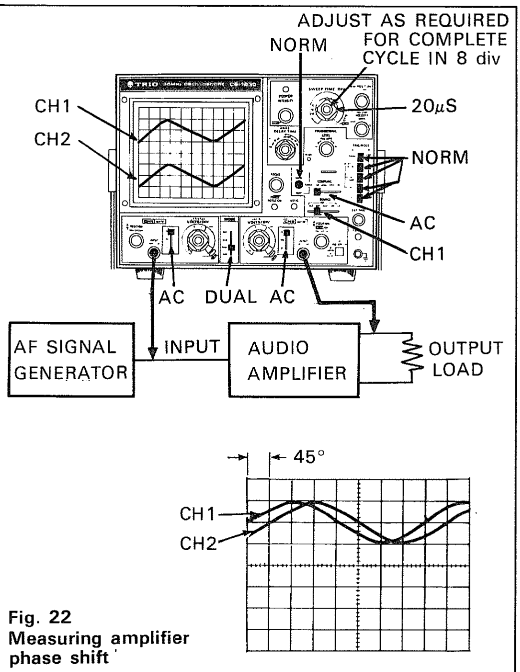


Fig. 22
Measuring amplifier phase shift

Television Servicing:

Many of the television servicing procedures can be performed using single-trace operation. These are outlined later in the application section covering single-trace operation. One of these procedures, viewing the multi-burst signal in the VITS (vertical interval test signal), can be accomplished more effectively using a dual-trace oscilloscope. The VITS signal is specifically used for characteristic checks of the transmission system of a broadcast station or a network including repeater station or for changeover of transmission system. In many cases, this signal dies not appear in the normal video signals. Even when it is included in the signals, the method of inserting the information is different depending on broadcast stations. Also, the VITS information on Field 1 (1st interlaced scanning) and Field 2 (2nd interlaced scanning) are different in many cases. Examples of VITS signal is shown in Fig. 23.

Because the oscilloscope sweep is synchronized to the vertical blanking signal, the waveform of Field 1 cannot be distinguished from that of Field 2. This causes the VITS signals to be superimposed onto each other, resulting in a difficulty of viewing. With dual-trace operation using the same input, the waveform can be viewed separatily without overlapping because of the effects of oscilloscope's alternate sweep operation and interlaced scanning or TV signal.

The possibility of viewing VITS signal provides an important role in servicing TV sets. This VITS signal can localize trouble to the antenna, tuner, 1F or video sections and shows when realignment may be requered. The following procedures show how to analyze and interpret oscilloscope displays of the VITS.

The VITS is transmitted during the vertical blanking interval. On the television set, it can be seen as a bright whit e line above the top of the picture, when the vertical linearity or height is adjusted to view the vertical blanking interval (on TV sets with internal retrace blanking circuits, the blanking circuits must be disabled to see the VITS).

The transmitted VITS has a specific frequency, amplitude and waveform as shown in Fig. 23. The television networks use the precision signals for adjustment and checking of network transmission equipment, but the multiburst signal in VITS can also be used fo checking the operating condition of TV set. The first frame of VITS at the "B" section (line 18) in Fig. 22 begins with a white reference signal, followed by sine wave frequencies of 0.5 MHz, 1.0 MHz, 2 MHz, 3 MHz, 4.0 MHz and 3.58 MHz. This sequence of frequencies is called the "multi-burst" which is very useful.

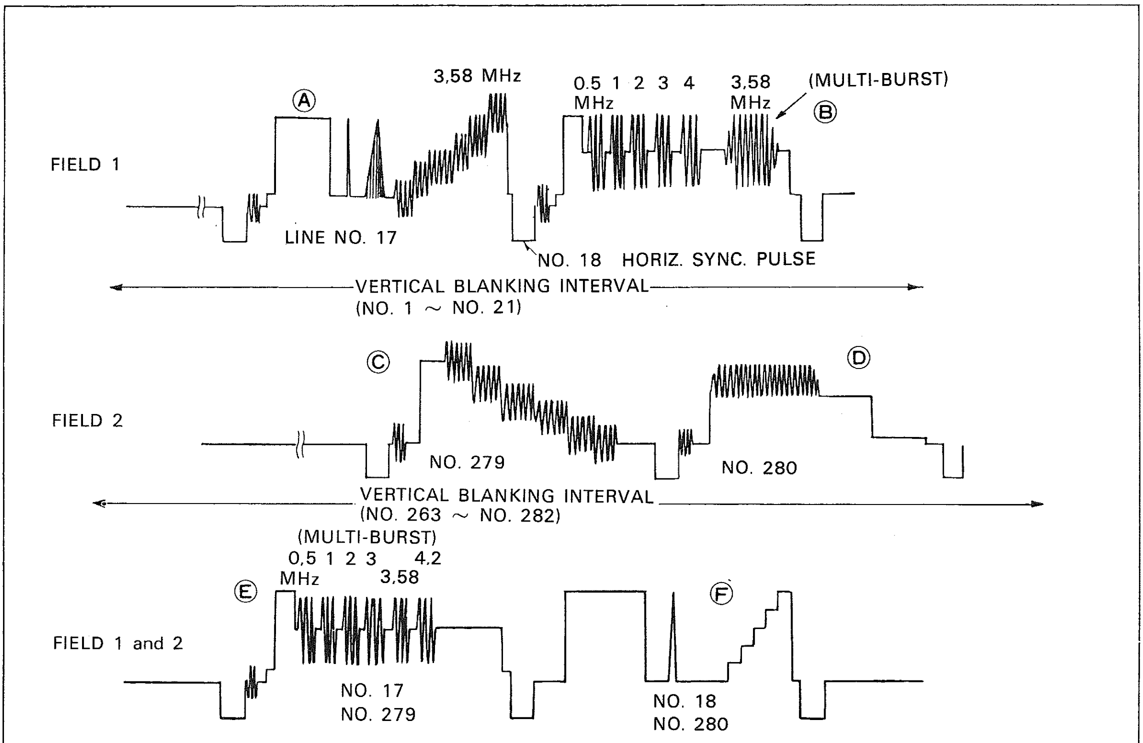


Fig. 23 VITS signal, Fields 1 and 2

The VITS other than the multi-burst signal is different depending on broadcast station. VITS staircase waveform containing burst signal of 3.58 MHz is valuable to the network, but have less value to the service technician. As Field 1 is interlaced with Field 2, the line 17 is followed by the line 279 and the line 18 is follosed by the line 280. The entire VITS appears at the bottom of the vertical blanking pulse and just before the first line of video. Each of the multi-burst frequencies is transmitted at equal strength. By observing the comparative amplitudes of these frequencies after the signal is processed through the television receiver, the frequency response of the set is checked.

All frequencies of multi-burst are transmitted at the same level, but will appear as shown in Fig. 22 even on a good color television set, due to its response curve; showing the allowable amount of attenuation for each multi-burst frequency. Remember that −6 dB equals half the reference voltage (the 2.0 MHz modulation should be used for reference).

To localize trouble, start by observing the VITS at the video detector. This will localize trouble to a point either before or after the detector. If picture quality of each channel is different, the trouble is in the tuner or antenna system. If the picture quality is the same for all channels but the multi-burst is abnormal, then the trouble may be in the IF stage.

As another example, let us assume that we have a set on the bench with a very poor picture. Our oscilloscope shows the VITS at the video detector to be about normal except that the burst at 2.0 MHz is low compared to other burst signal. This suggests an IF trap is detuned into the passband, chopping out frequencies about 2 MHz below the picture carrier frequency. Switch to another channel. If amplifier requires realignment. If the picture quality is the same, then our reasoning is right, and the IF the picture quality of another channel is normal, the FM trap at the tuner input is misadjusted. Fig. 25 shows the method of viewing the VITS waveforms.

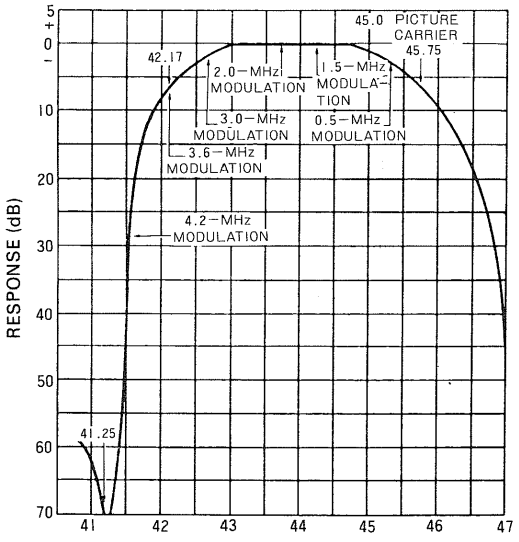


Fig. 24 Color TV IF amplifier response curve

1. Set a color TV receiver to the station transmitting color signals containing VITS.
2. The method shown in Fig. 25 is used to obtain Field 2 vertical signal on CH1.
3. Set the oscilloscope and the receiver into operation. Connect the CH1 probe (set at 10 : 1) to the test point of video detector or other desired test point in the video section of the television receiver.
4. Set the SLOPE switche as follows:
   A. If the sync and blanking pulses of the observed video signal are positive, use the + switch position.
   B. If the sync and blanking pulses are negative, use the −switch position.
5. Adjust the sweep time VARIABLE control so that 2 vertical fields are displayed on the oscilloscope screen.
6. Connect the CH2 probe (set to 10 : 1) to the same test point as does the CH1 probe.
7. Set the MODE switch to DUAL position.
8. Place the sweep time VARIABLE in the CAL position.
9. Set the SWEEP TIME/DIV control to the 0.1 ms/div position to expand the display. The VITS information will appear toward the right hand portion of the expanded waveform displays. The waveform information on each trace may appear as shown in Fig. 23. Because there is no provision for synchronizing the oscilloscope display to either of the two fields which comprise a complete vertical frame, it cannot be predicted which field display will appear on the CH1 or CH2.
10. With the delay sweep applied (see page 13), adjust VITS signals as shown in Fig. 23.
11. Once the CH1 and CH2 displays have been identified as being either Field 1 or Field 2 VITS information, the probe corresponding to the waveform display can be used for signal-tracing and troubleshooting, and the remaining probe should be left at the video detector test point to insure that the sync signal is not interrupted. If the sync signal is interrupted, the waveform displays may be reversed because, as previously explained, there is no provision is the oscilloscope to identify either of the two vertical fields which comprise a complete frame.

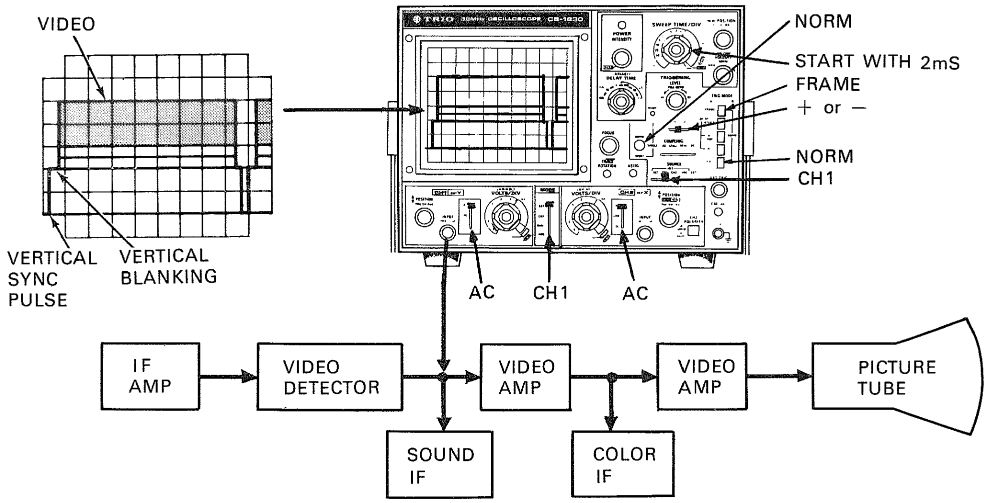


fig. 25 Set-up for viewing fields 1 and 2 of VITS information.

APPLICATIONS OF SINGLE-TRACE OPERATION

Introduction:

In addition to the dual-trace applications previously outlined, there are, of course, many service and laboratory applications where only single-trace operation of the oscilloscope is required.

Single-trace Operation and Peak-to-peak Voltage Readings:

For general troubleshooting and isolation of troubles in television receivers, the oscilloscope is an indispensable instrument. It provides a visual display of absence or presence of normal signals. This method (signal-tracing) may be used to trace a signal by measuring several points in the signal path. As measurements proceed along the signal path, a point may be found where the signal disappears. When this happens, the source of trouble has been located.

However, the oscilloscope shows much more than the mere presence or absence of signal. It provides a peak-to-peak voltage measurement of the signal as well as presentation of waveforms. The schematic diagram or accompanying service data on the equipment being serviced usually includes waveform pictures. These waveform pictures include the required sweep time and the normal peak-to-peak voltage. Compare the peak-to-peak voltage readings on the oscilloscope withe those shown on the waveform pictures.

Composite Video Waveform Analysis:

Probably the most important waveform in television servicing is the composite waveform consisting of the video signal, the blanking pedestal signal and the sync pulses.Fig. 26 and Fig. 27 stow typical pscilloscope thaces when observing composite vedeo signals synchronized with horizontal sync pulses and vertical blanking pulses. Composite video signals can be observed at various stages of the television receiver to determine whether circuits are performing normally. Knowledge of waveform makeup, the apperance of a normal waveform, and the causes of various abnormal waveforms help the technician locate and correct many problems. The technicinan should study such waveforms in a television receiver known to be in good operating condition, noting the waveform at various points in the video amplifier.

To set up the oscilloscope for viewing composite video waveforms, use the following procedures:

1. Tune the television set to a local channel.
2. Set the MODE switch to CH2 position.
3. Set the SWEEP TIME/DIV switch to the 10μs/div position for observing TV horizontal lines or to the 2ms/div position for observing TV vertical frames.
4. For horizontal line, set LINE/FRAME switch to LINE. For vertical frame, set the switch to FRAME.
5. Set the SOURCE switch to the CH2 position.
6. Set the TRIGGERING LEVEL control to the AUTO position.

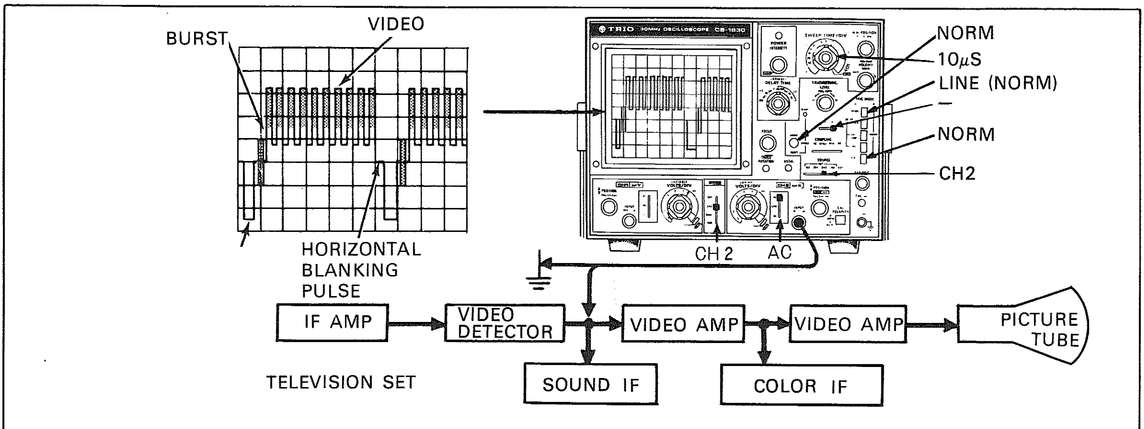


Fig. 26 Set-up for viewing horizontal fields of composite video signal

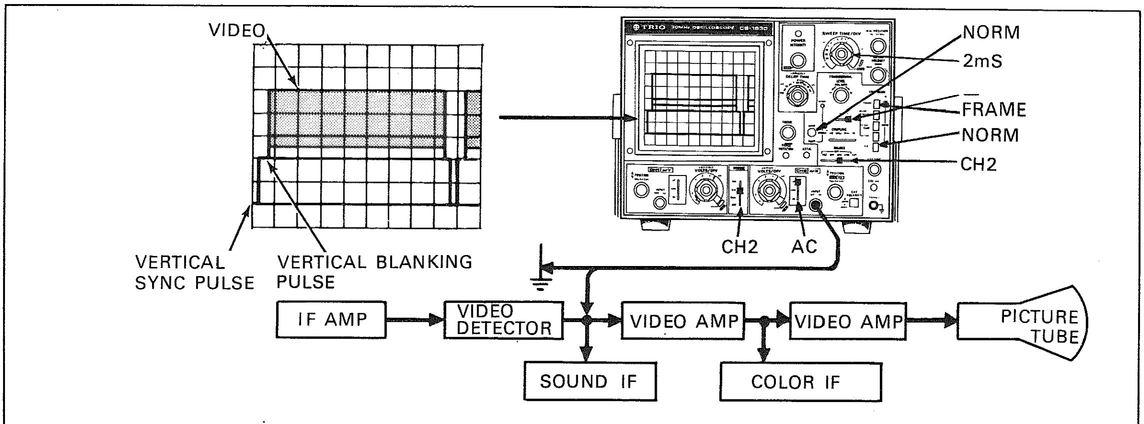


Fig. 27 Set-up for viewing vertical fields of composite viedo signal

7. Set the CH2 AC-GND-DC switch to the AC position.
8. Connect a probe cable to the CH2 INPUT jack. Connect the ground clip of the probe to the television set chassis.
   With the probe set to 10 : 1 attenuation, connect the tip of the probe to the video detector output of the television set.
9. Set the CH2 VOLTS/DIV switch for the largest vertical deflection possible without going off-scale.
10. Rotate the TRIGGERING LEVEL control to a position that provides a synchronized display.
11. Adjust the sweep time VARIABLE for two horizontal lines or two vertical frames of composite video display.
12. If the sync and blanking pulses of the displayed video signals are positive, set the SLOPE switch to the + position; if the sync and blanking pulses are negative, use the − position.
13. Push in the TRIGGERING LEVEL control and rotate to a position that provides a well synchronized display.
14. Adjust the INTENSITY and FOCUS controls for the desired brightness and best focus.
15. To view a specific portion of the waveform, such as the color burst, using delay sweep (see page 13), enlarge the desired portion of the waveform.
16. The polarity of the observed waveform may be reversed when moving from one monitiring point to another; therefore, it may be necessary to reverse the polarity of the SLOPE switch.

Sync Pulse Analysis:

The IF response of a television receiver can be evaluated to some extent by careful observation of the horizontal sync pulse waveform. The appearance of the sync pulse waveform is affected by the IF amplifier bandpass characteristics.
Some typical waveform symptoms and their relation to IF amplifier response are indicated in Fig. 28. Sync pulse waveform distortions produced by positive or negative limiting in IF overload conditions are shown in Fig. 29.

CIRCUIT DEFECT	HORIZONTAL PULSE DISTORTION	OVERALL RECEIVER FREQUENCY RESPONSE	EFFECT ON PICTURE
NORMAL CIRCUIT			PICTURE NORMAL
LOSS OF HIGH FREQUENCY RESPONSE			LOSS OF PICTURE DETAIL
EXCESSIVE HIGH FREQUENCY RESPONSE, NON-LINEAR PHASE SHIFT			FINE VERTICAL BLACK & WHITE STRIATIONS FOLLOWING A SHARP CHANGE IN PICTURE SHADING
LOSS OF LOW FREQUENCY RESPONSE			CHANGE IN SHADING OF LARGE PICTURE AREAS. SMEARED PICTURE

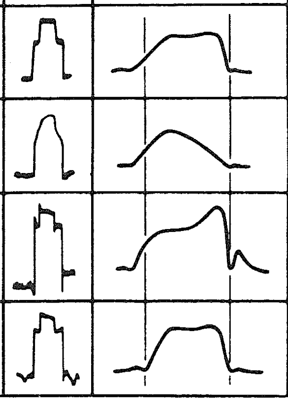


Fig. 28 Analysis of sync pulse distortion

FM RECEIVER ADJUSTMENTS

1. Connect a sweep generator to the mixer input of the FM receiver. Set the sweep generator for a 10.7 MHz center sweep.
2. Connect the sweep voltage output of the sweep generator to the CH2 input jack of the oscilloscope and set the osilloscope controls for external horizontal sweep (SWEEP TIME/DIV to X-Y).
3. Connect the vertical input probe to the demodulator input of the FM receiver.
4. Adjust the oscilloscope vertical and horizontal gain controls for display similar to that shown in Fig. 30A.
5. Set the marker generator precisely to 10.7 MHz. The marker "pip" should be in the center of the bandpass.
6. Align the IF amplifiers according to the manufacturer's specifications.
7. Move the probe to the demodulator output. The "S" curve should be displayed, and the 10.7 MHz "pip" should appear in the center (see Fig. 30B).
   Adjust the demodulator according to the manufacturer's instructions so the marker moves equal distance from the center as the marker frequency is amplified equal amount from the 10.7 MHz center frequency.

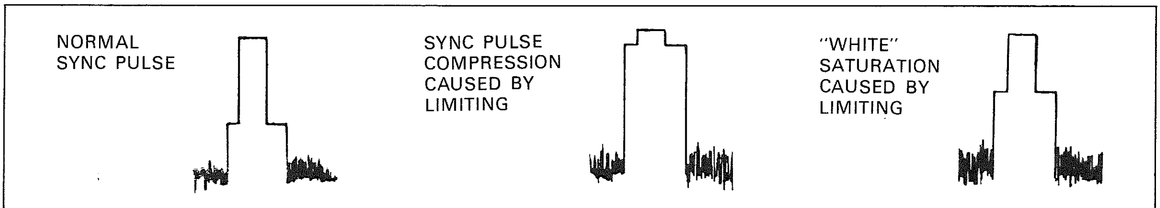


Fig. 29 Sync pulse waveforms

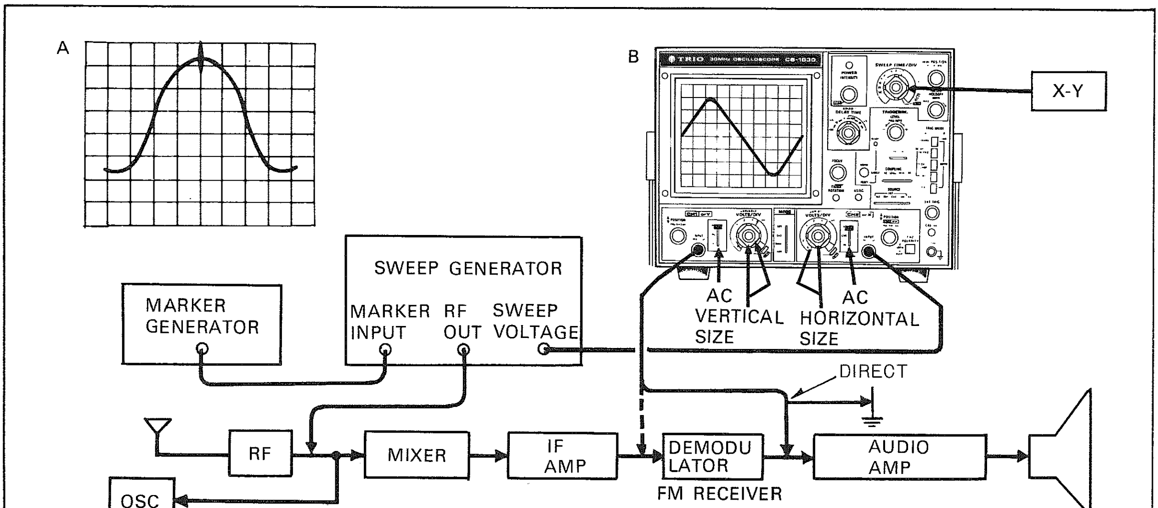


Fig. 30 Typical FM receiver alignment set-up

APPLICATION OF X-Y OPERATION

Phase Measurement:

Phase measurements may be made with an oscilloscope. Typical applications are incircuits designed to produce a specific phase shift, and measurement of phase shift distortion in audio amplifiers or other audio networks. Distortions due to non-linear amplification is also displayed in the oscilloscope waveform.

A sine wave input is applied to the audio circuit being tested. The same sine wave input is applied to the vertical input of the oscilloscope, and the output of the tested circuit is applied to the horizontal input of the oscilloscope. The amount of phase difference between the two signals can be calculated from the resulting Lissajous' waveform.

To make phase measurements, use the following procedures (refer to Fig. 31).

1. Using an audio signal generator with a pure sinusoidal signal, apply a sine wave test signal to the audio network being tested.
2. Set the signal generator output for the normal operating level of the circuit being tested. Observe the circuit's output on the oscilloscope and if the test circuit is overdriven, the sine wave display is clipped and the signal level must be reduced.
3. Connect the CH2 probe to the output of the test circuit.
4. Set the MODE to X-Y.
5. Connect the CH1 probe to the input of the test circuit.
6. Adjust the CH1 and CH2 gain controls for a suitable viewing size.
7. Some typical results are shown in Fig. 32. If the two signals are in phase, the oscilloscope trace is a straight line. If the vertical and horizontal gain are properly adjusted, this line is at 45° angle. A 90° phase shift produces a circular oscilloscope pattern. Phase shift of less (or more) the 90° produces an elliptical Lissajous pattern. The amount of phase shift can be calculated by the method shown in Fig. 33.

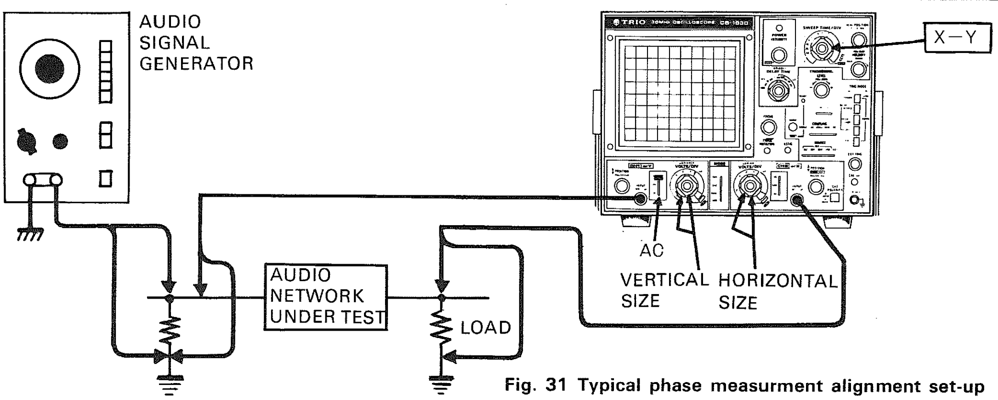


Fig. 31 Typical phase measurment alignment set-up

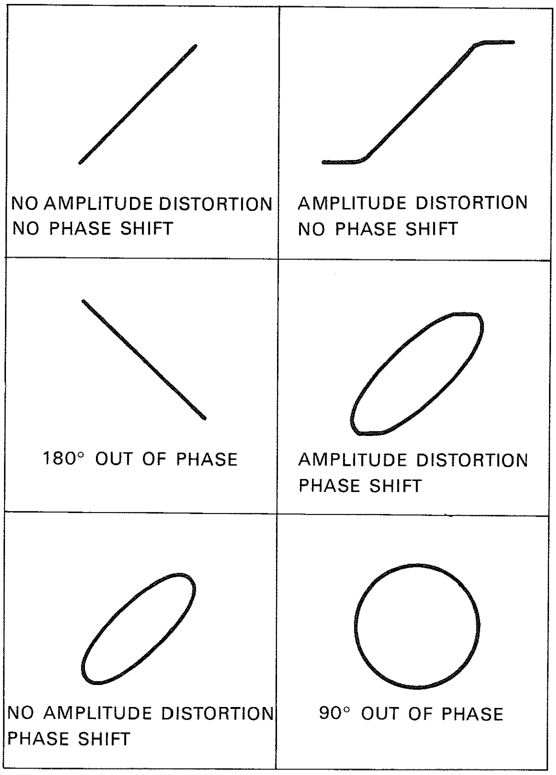


Fig. 32 Typical phase measurement oscilloscope displays

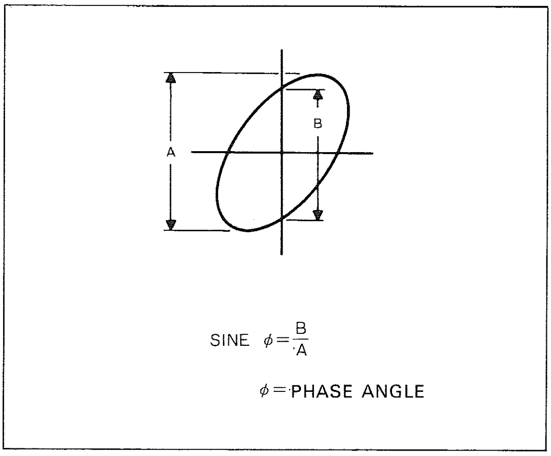


Fig. 33 Phase shift calculation

Frequency Measurement:

1. Connect the sine wave of known frequency to the CH2 input of the oscilloscope and set the MODE to X-Y.
2. Connect the CH1 probe to the signal to be measured.
3. Adjust the CH1 and CH2 for proper sizes.
4. The resulting Lissajous' pattern shows the ratio between the two frequencies (see Fig. 34).

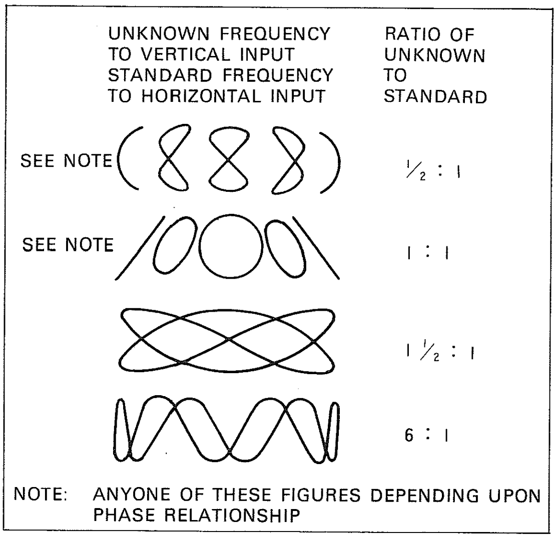


Fig. 34 Lissajous' waveforms used for frequency measurement

APPLICATIONS OF DELAY SWEEP

By using delay sweep, video signal can be enlarged for easy observation, proceed as follows (Fig. 35):

1. Set the control knobs on the oscilloscope as shown in Fig. 35 to observe video signal (Fig. 35-a).
2. With INTEN'D depressed, adjust DELAY TIME and VARIABLE so that the left end of the intensity modulation reaches near the end of the filed 1 (Fig. 35-b).
3. Press DELAY (CH1) and the oscilloscope is set in delay sweep mode while the waveform starting at the portion set by the intensity modulation is displayed (Fig. 35-c).
4. By adjusting SWEEP TIME/DIV, the waveform during vertical blanking time can be magnified for observation (Fig. 35-d).

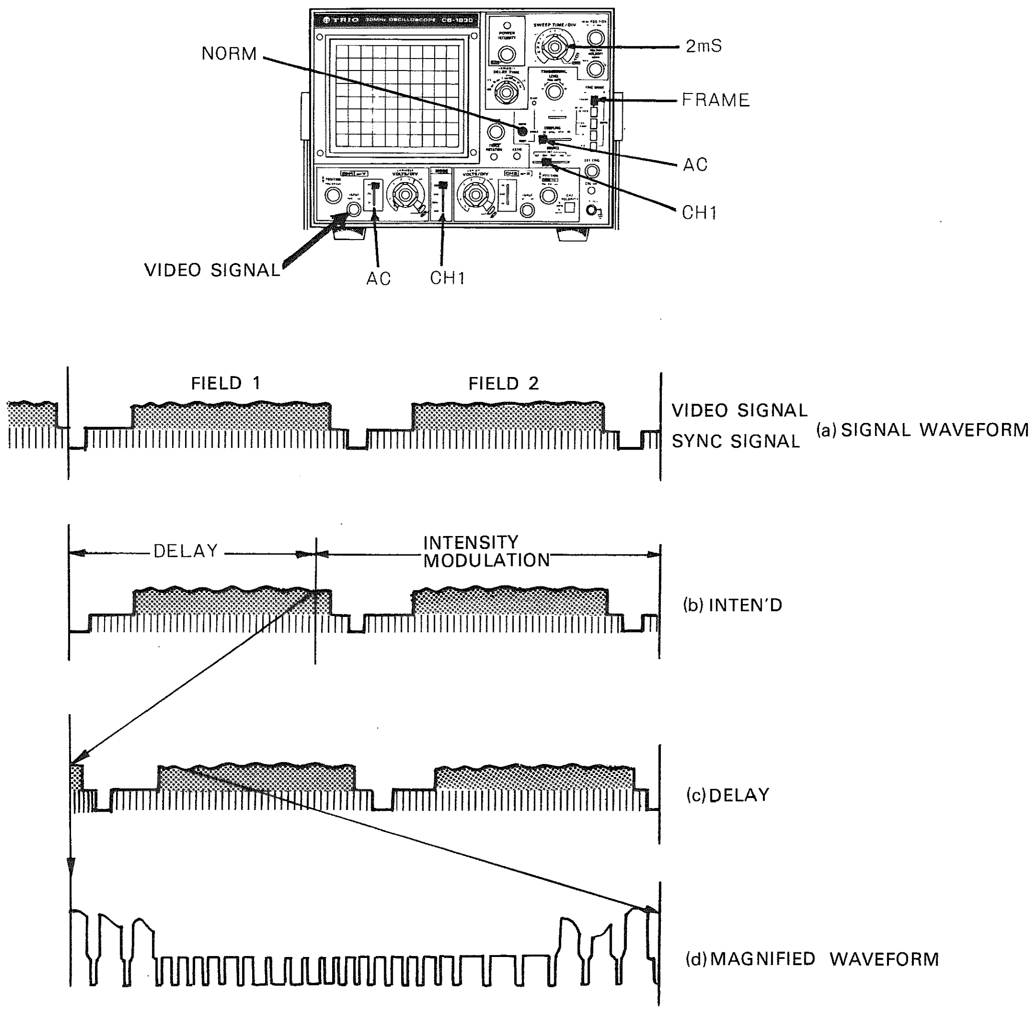


Fig. 35

PRECAUTIONS

1. Avoid using the oscilloscope in a location exposed to direct sunlight.
2. Select a place free from high temperature and humidity.
   Do not use the oscilloscope in a dusty location.
3. Do not operate the oscilloscope in a place where mechanical vibrations are excessive or a place near equipment which generates strong magnetic fields or impulse voltage.
4. This oscilloscope is factory set for AC 240V operation. For AC 100V, 117V or 220V operation, change the position of the plug of the voltage selector at the rear panel as indicated by the arrow mark. When the oscilloscope is to be operated with AC 100V, 120V, be sure to replace the fuse with one rated at 0.7A.
5. Do not apply input voltages exceeding their maximum ratings. The input voltage to the vertical amplifier is up to 300V (DC + AC peak), the input for EXT. TRIG is up to 50V (DC + AC peak), and the input to Z AXIS is up to 50V (DC + AC peak).
6. Do not increase the brightness of CRT unnecessarily.
7. Do not leave the oscilloscope for a long period with bright spot displayed on CRT. Reduce the brightness and soften the focus.
8. For X-Y operation, use the PULL X5 MAG switch in the PUSH position. If it is set in the PULL position, noise may appear in the waveform.
9. Setting the oscilloscope
   The oscilloscope is provided with a handle which can be fixed at 22.5° angle intervals, permitting it to be set either vertically, horizontally or aslant.
   Do not place any object on the oscilloscope or cover the ventilation holes of the case with a cloth or the like, as it will increase the temperature inside the case.

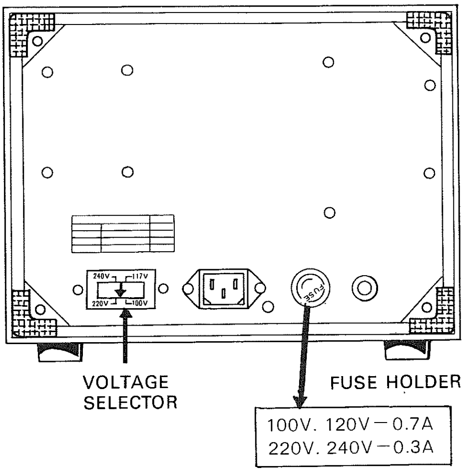


Fig. 36

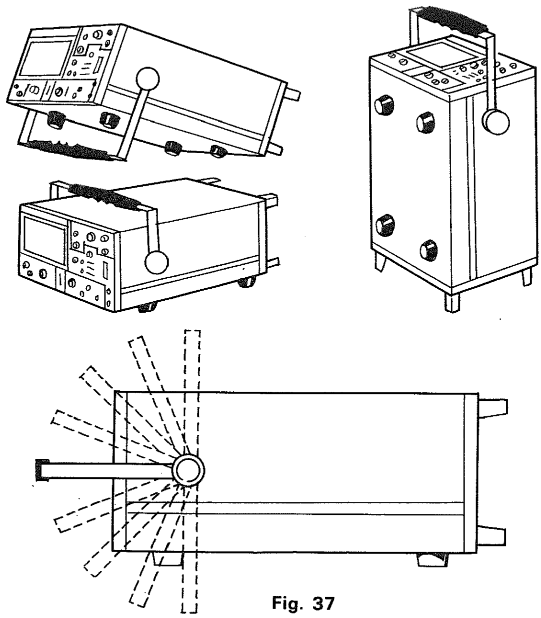


Fig. 37

MAINTENANCE AND ADJUSTMENT

MAINTENANCE

Removing the case:

1. Remove the seven screws from the top and side walls of the case, using a Phillips head screwdriver.

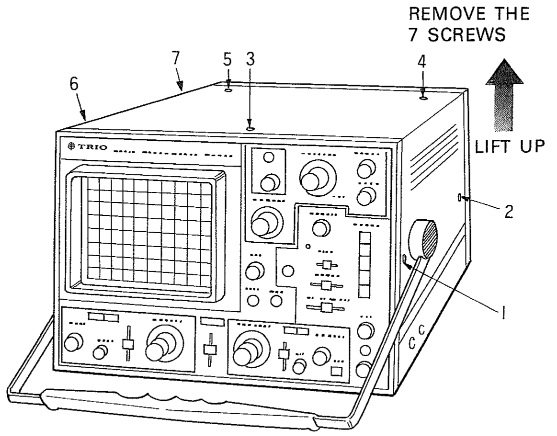


Fig. 38 Removing the top case

2. Hold the handle and lift up. The case is now ready for removal.
3. To remove the bottom plate, unscrew the four screws using a Phillips head screwdriver.

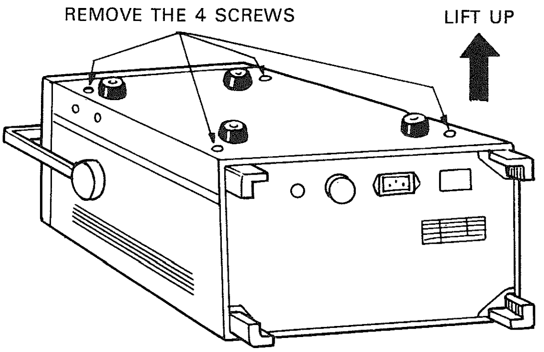


Fig. 39 Removing the bottom case

Caution: A high voltage (5000V) is present on the CRT socket. Before removing the case, be sure to turn off the power, and do not touch these parts with hand or a screwdriver even after the case has been removed.

ADJUSTMENT

Observe the following before making adjustments:

The oscilloscope is factory adjusted prior to shipment. If readjustment becomes necessary, the following points should be observed.

1. Check the power supply for correct voltage.
2. For adjustments, use a well insulated screweriver.
3. Before marking adjustments, be sure to turn on the power and wait until the unit is stabilized.
4. For adjustments, follow the procedures described below.
5. If special test instruments are required for adjustments, contact Trio's service station.

Adjustment of Power Supply and CRT Circuits:

1. Adjustment of low power voltage
   Measure the voltage at the No.8 pin of P306 and adjust VR304 for + 108V ±1%.
   Next, measure the voltage on the pins 2 through 5 of P306 and on the pin 1 of P304 to check that these voltages are /8V, +5V, +15V, +10V and +120V, respectively. (Fig. 40)
2. Adjustment high tension voltage
   Adjust VR303 so that the voltage on the pin 9 of P301 reaches −1.5 kV ±1% (CRT cathode voltage).
3. Intensity adjustment
   With INTENSITY knob set in the 11 o'clock position, adjust VR302 until the trace disappears, then adjust TC301 so that the brightness at the sweep starting point is the same as the brightness at other points (SWEEP TIME/DIV in 0.2 μs position). Finally, adjust the spot with FOCUS and ASTIG. (Fig. 40)
4. CRT trace rotation
   Adjust the TRACE ROTATION (front panel) until the trace is aligned with the horizontal line marked on the CRT scale. (Fig. 39)
5. Adjustment of pattern distortion
   Display a CAL voltage waveform over the full area of the CRT screen and make sure that a vertical line appears on each "div" of the horizontal scale. Adjust VR301 so that the vertical line is straight at any position on the screen. Next, adjust the spot with FOCUS and ASTIG once again. (Fig. 40)

Adjustments of CH1 Vertical Circuit:

Before making adjustments, set the knobs of oscilloscope as follows:

MODE CH1 position
VOLTS/DIV 5 mV/div position

5. CRT Center Adjustment (Fig. 42)
With the test terminals P401 and P402 of the vertical main amplifier shorted, adjust VR402 until the bright line comes in the center of CRT.
6. VARIABLE ATT DC BAL Adjustment (Fig. 40)
Adjust VR101 so that the bright line stays still at any position of VARIABLE of VOLTS/DIV.
7. STEP ATT DC BAL Adjutment (Fig. 41)
Adjust VR103 so that the bright line stays still at any position of VOLTS/DIV.
8. POSITION Adjustment (Fig. 40)
With POSITION knob set in the mechanical center position, adjust VR105 until the bright line is centered on CRT.
9. Sensitivity Adjustment (Fig. 42)
With a calibrated 1 kHz 0.5V signal applied, adjust VR401 for 5 DIV deflection.

Adjustment of CH2 Vertical Circuit:

Before making adjustments, set the knobs of oscilloscope as follows:

MODE CH2 position
VOLTS/DIV 5 mV/div position

10. VARIABLE ATT DC BAL Adjustment (Fig. 41)
Adjust VR106 until the bright line stays still at any position of VARIABLE of VOLTS/DIV.
11. STEP ATT DC BAL Adjustment (Fig. 41)
Adjust VR108 until the bright line stays still at any position of VOLTS/DIV.

12.POSITION Adjustment
With POSITION knob set in the mechanical center position, adjust VR112 until the bright line is centered on CRT. (Fig. 40)

13. Sensitivity Adjustment
With a calibrated 1 kHz 0.5V signal applied. adjust VR110 for 5 DIV deflection. (Fig. 40),

Horizontal Circuit Adjustment:

14. ◀▶ POSITION Adjustment (Fig. 43)
With ◀▶ POSITION knob set in the mechanical center postion, adjust VR10 so that the start point of bright line is at the left end of the scale.

15. X POSITION Adjustment (Fig. 43)
With MODE set in X-Y and X axis (CH2) input in GND, adjust VR12 until the bright spot is centered on the screen.

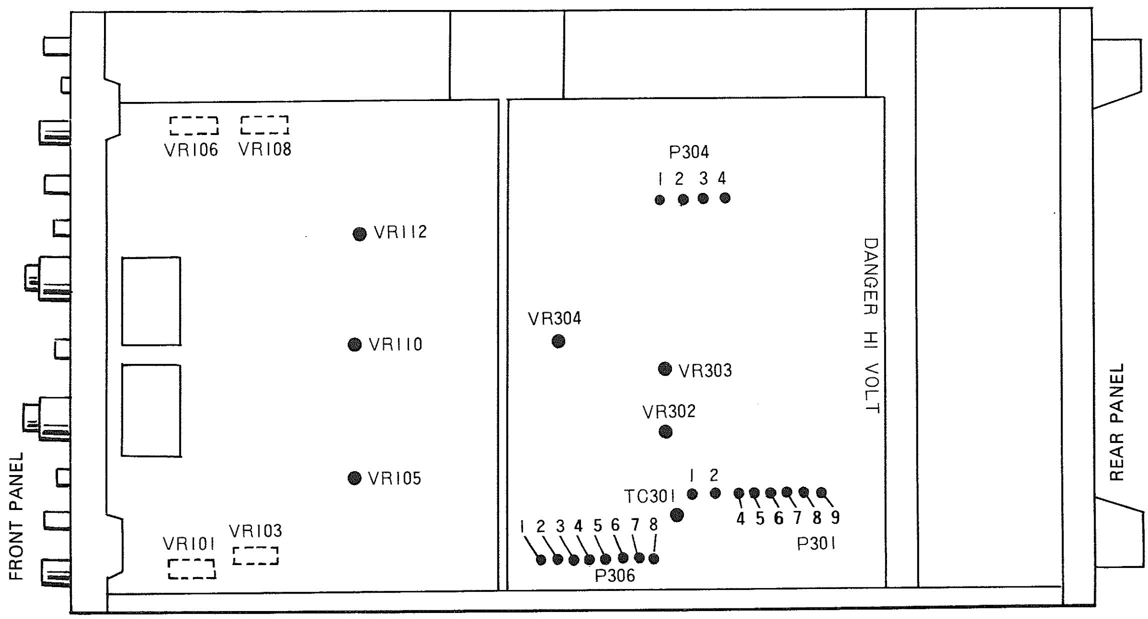
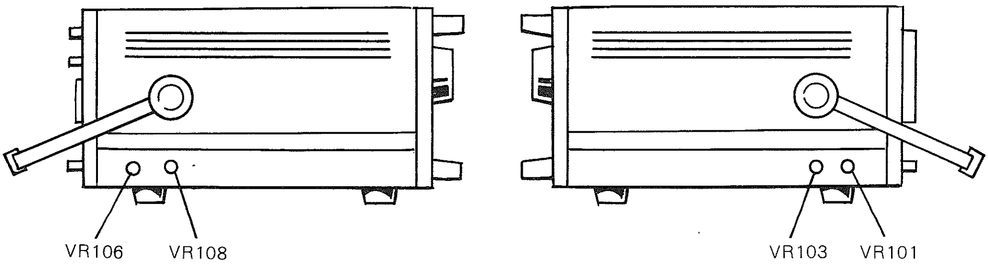


Fig. 40 Location of adjustments, bottom of scope



VR106 CH2 VARI ATT DC BAL.
VR108 CH2 STEP ATT. DC BAL.

VR101 CH1 VARI. ATT. DC BAL.
VR103 CH1 STEP ATT. DC BAL.

Fig. 41 Location of adjustments, right and left sides of scope

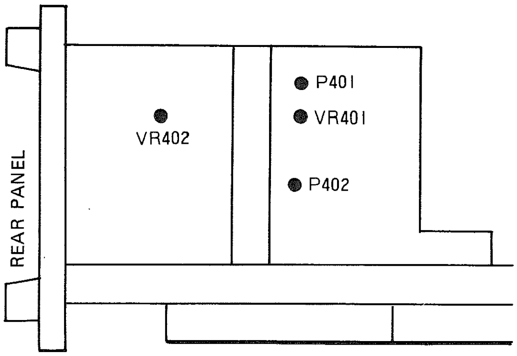


Fig. 42 Location of adjustment, left side of scope

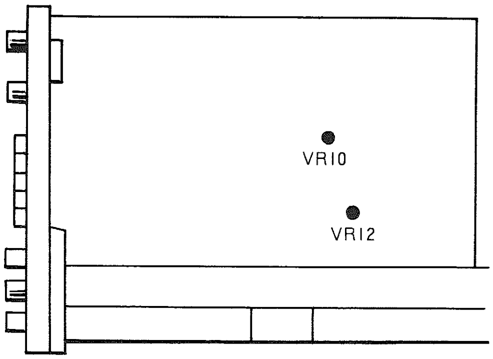
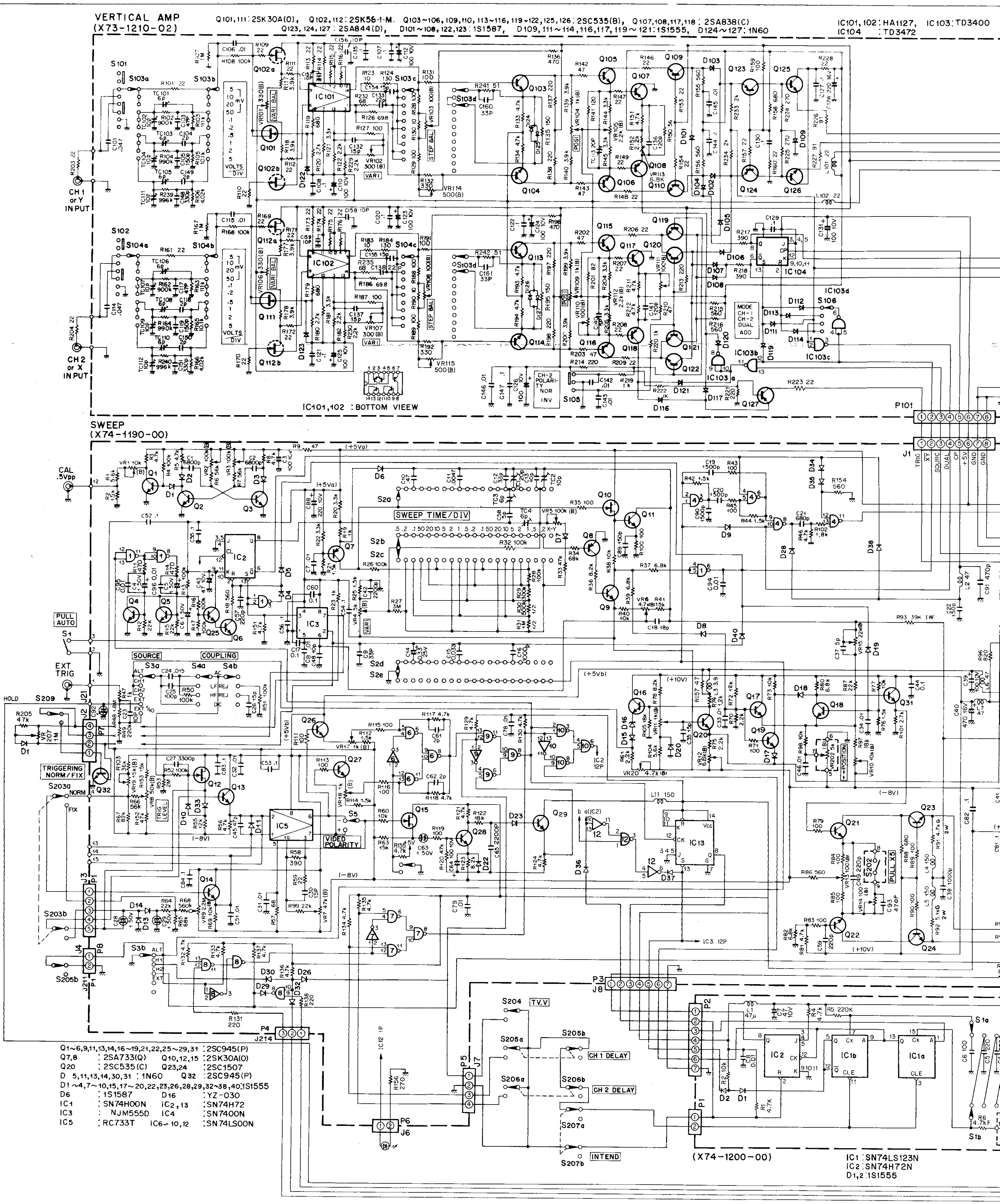


Fig. 43 Location of adjustments, right side of scope

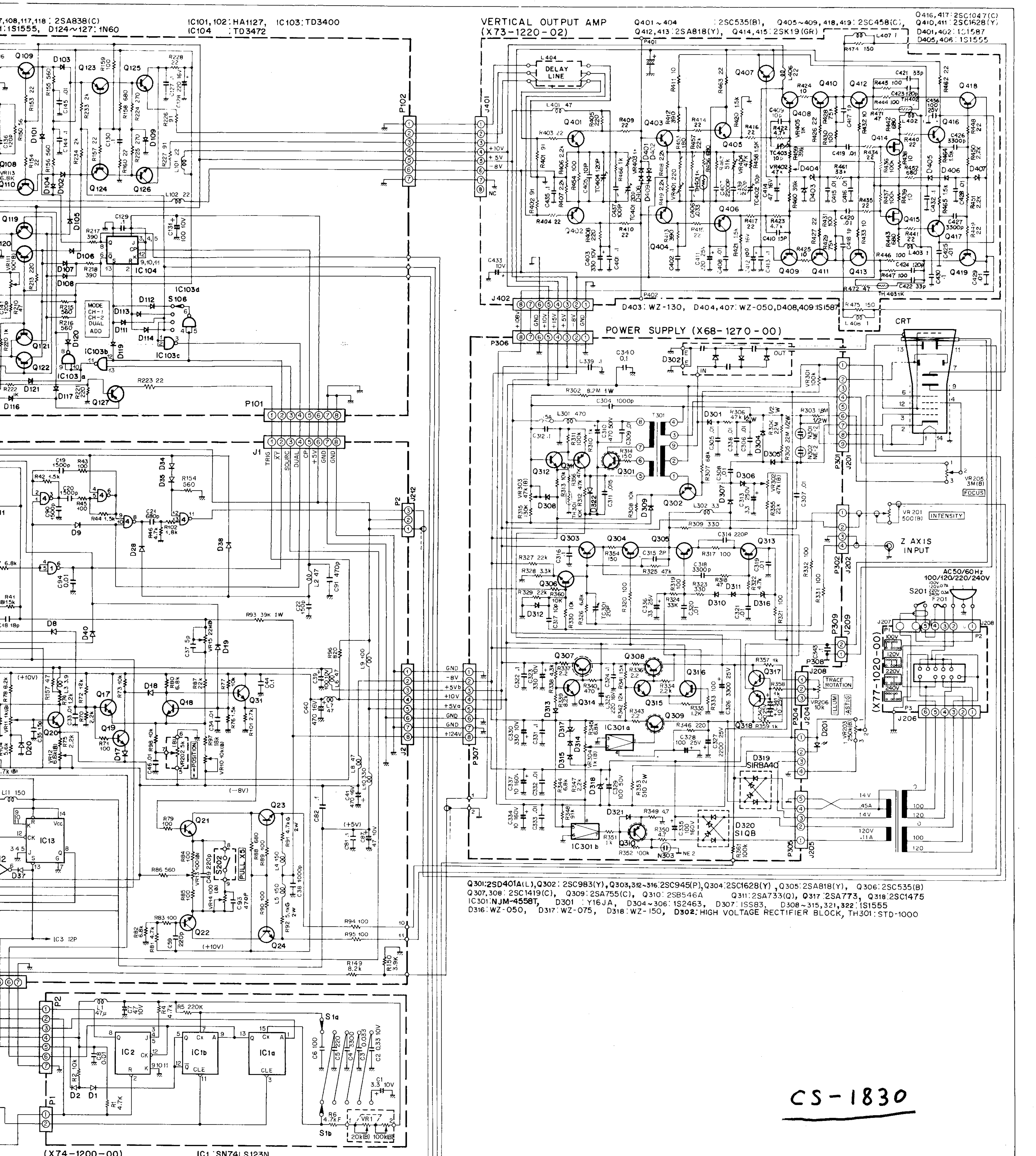
MEMO

MEMO

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



Note: Resistor with no specified value are those of 1/4W and ±5%. Also, the circuit elements may be changed without notice owing to a technical innovation.

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