TRIGGERED SWEEP OSCILLOSCOPE

HIGH STABILITY

# CS-1562A

DUAL TRACE OSCILLOSCOPE

# INSTRUCTION MANUAL

TRIO

# CONTENTS

# FEATURES

* The adoption of ICs throughout assures high performance and improved reliability.
* Vertical axis of low input capacitance (22 ±3pF) for 2-channel operation provides high sensitivity and wide band-width (10 mV/div, 10 MHz).
* The high voltage power for CRT as well as the power for other circuits is fully stabilized because of the use of DC-DC converter, thus the sensitivity and brightness are completely free from effects of voltage variations.
* Low power comsumption (20W) for cool operation.
* X-Y operation is possible with CH2 amplifier used as X axis.

  The horizontal axis sensitivity is as high as 10mV/div, permitting accurate calibrations.
* Time base switch allows changeover between CHOP and ALT and between V (vertical) and H (horizontal) of TV sync separator circuit, automatically and electronically.
* At AUTO position of TRIG LEVEL, it is possible to check the brightness at no-signal time and to adjust triggering level of input waveforms.
* All component parts are cleverly mounted on circuit boards for improved reliability.
* Easy correction of horizontal trace angle with unique trace rotation system.

# SPECIFICATIONS

**Type of Cathode Ray Tube:** C529P31B or 130BEB31

**Acceleration Voltage:** 2kV

## Vertical Axis (for both CH1 and CH2)

**Sensitivity:** 10 mV/div~20 V/div ±5%

**Attenuator:** 10 mV/div to 20V/div in 11 calibrated ranges in 1-2-5 sequence. Variable between ranges. ±5% on all ranges.

**Input Impedance:** 1 MΩ ±5%

**Input Capacitance:** Approx. 22 pF

**Frequency Response:** DC DC-10 MHz (less than −3 dB)
AC 2 Hz~10 MHz (less than −3 dB)

**Rising Time:** Less than 35 nsec.

**Overshoot:** Less than 3%
(at 100 kHz square wave)

**Cross-talk:** Better than 70 dB at 1 kHz

**Operating Mode:**
CH1 Channel 1 only
CH2 Channel 2 only
DUAL 2-channel (CHOP and ALT are automatically selected by SWEEP TIME/DIV) 0.5μs/-div~0.5 ms/div ALT (alternate sweep)
1 ms/div~0.5 s/div: CHOP (200 kHz switching)

**CHOP Frequency:** 200 kHz ±20%

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

## Sweep Circuit

**Sweep System:** Triggered and automatic. In automatic mode, sweep is obtained without input signal.

**Sweep Time:** 1 μs/div to 0.5 s/div in 18 calibrated ranges, in 1-2-5 sequence.
Variable between ranges.
Sweep time accurancy: ±5%

**Magnifier:** 5 times ±10% (PULL x 5 MAG)

**Linearity:** 3% or less distoration (5 μs/div ~ 0.5 s/div)
5% or less distoration
(1 μs/div~2 μs/div)

## Triggering

**Source:**
INT: Changeover by MODE Switch
(DUAL: CH1 input signal only)
EXT: EXT TRIG input signal

**Sync Section:**
NOR: positive and negative
TV: positive and negative
(TVH and TVV are automatically switched by SWEEP TIME/DIV)
TVH (TV-Line): 1 μs/div~50 μs/div
TVV (TV-Frame):
0.1 ms/div~0.5 s/div

**Triggering Voltage:** CH1 and CH2.....Amplitude on CRT screen, more than 1 div

**Triggering Range:** INT: 20 Hz ~ 10 MHz
EXT: DC ~ 10 MHz

## Horizontal Axis (CH2 input)

**Operating Mode:** X-Y mode is selected by SWEEP TIME/DIV.
CH1: Y axis
CH2: X axis

**Sensitivity:** Same as CH2
(10 mV/div~20 V/div ±5%)

**Frequency Response:** DC DC − 1 MHz (less than −3dB)
AC 2 Hz − 1 MHz (less than −3dB)

**Input Impedance:** Same as CH2 (1 MΩ ±5%)

**Input Capacitance:** Same as CH2 (approx 22pF)

**Calibrating Voltage:** 1 Vp-p ±5% (50/60 Hz square ware)

## Intensity Modulation

**Input Voltage:** TTL level

**Input Impedance:** 10 kΩ ±20%

**Trace Rotation:** Trace angle is adjustable by panel surface adjuster.

## Power Source

**Power Supply Voltage:** 100/117/220/240V ±10%, 50/60 Hz

**Power Consumption:** 20 W

## Dimensions and Weight

**Width:** 260 mm (277 mm)

**Height:** 190 mm (204 mm)

**Depth:** 375 mm (433 mm)

Figures in ( ) show maximum sizes.

**Weight:** 8 kg

## Accesories

**Probe*:** PC-21 .................................. 2

Damping.......................... 1/10

Input impedance ........... 10 MΩ

Input capacitance ............. less than 18 pF

(* Not all of sets have these.)

**Pin-plug:** Non-shorting type .................. 1

**AC Power Cord:** ........................................................ 1

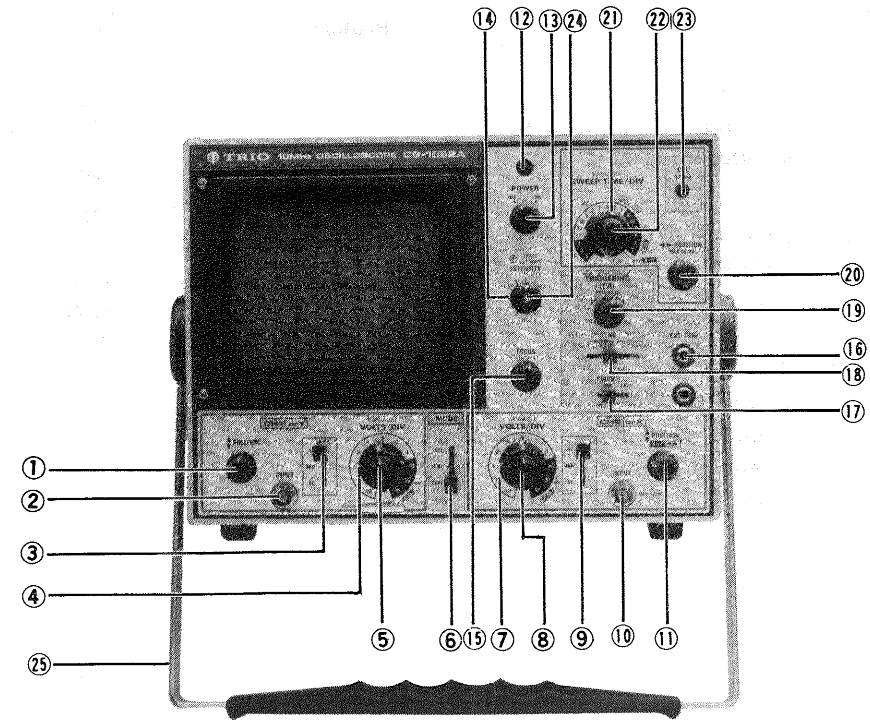
**Replacement Fuse:** 0.3A.................................... 2

0.7A.................................... 2

**Instruction Manual:** 1 copy

# CONTROLS ON PANELS

## Front Panel




### 1. ⇕ POSITION Control

Vertical position adjustment for CH1 trace. Becomes vertical position adjustment when SWEEP TIME/DIV (21) is in the X-Y position.

### 2. INPUT Jack

Vertical input jack for CH1 (or Y in X-Y mode).

### 3. AC-GND-DC Switch

Vertical input selector for CH1 (or Y).

**DC** Direct input of AC and DC component of input signal.

**GND** Opens signal path and grounds input to vertical amplifier. This provides a zero-signal base line, the position of which can be used as a reference when performing DC measurements.

**AC** Blocks DC component of input signal.

### 4. VOLTS/DIV Switch

Vertical attenuator for Channel 1 Vertical sensitivity is calibrated in 11 steps from .01 to 20 volts per div. This control adjusts vertical sensitivity when the SWEEP TIME/DIV switch (21) is in the X-Y position.

### 5. VARIABLE Control

CH1 vertical attenuator adjustment.
Fine control of CH1 vertical sensitivity.
In the extreme clockwise (CAL) position, the vertical attenuator is calibrated.

### 6. MODE Switch

**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:** The CH1 and CH2 waveforms are displayed at the same time, permitting dual trace observation. In this case, only the CH1 signal is synchronized. Selection between ALT and CHOP operations is automatically accomplished by turning SWEEP TIME/DIV. In the CHOP operation, the signals of both channels are alternately switched in the range of 0.5s to 1ms, by about 200kHz signal; in the ALT operation, these signals are alternately switched for each sweep in the range of 0.5ms to 1$\mu$s.

## 7. VOLT/DIV Switch

Vertical attenuator for Channel 2.
Vertical sensitivity is calibrated in 11 steps from .01 to 20 volts per div. This control adjusts horizontal sensitivity when the SWEEP TIME/DIV switch (21) is in the X-Y position.

## 8. VARIABLE Control

CH2 vertical attenuator adjustment. Fine control of CH2 vertical sensitivity.
In the extreme clockwise (CAL) position, the vertical attenuator is calibrated.

## 9. AC-GND-DC Switch

Vertical input selector for CH2 (orX). It has the same function as AC-GND-DC (3).

## 10. INPUT Jack

Vertical input jack for CH2 (or X).

## 11. ▲▼ POSITION Control/X-Y ◄► Control

Vertical positon adjustment for CH2 trace.
Becomes horizontal position adjustment when SWEEP TIME/DIV(21) is in the X-Y position.

## 12. LED Pilot Lamp

This lamp lights as the power switch ILLUM (13) is turned on.

## 13. POWER Switch

A right turn will set the power to ON.

## 14. INTENSITY Control

Adjusts the brightness of spots and waveforms for easy viewing. Clockwise rotation increases the brightness of trace and counterclockwise rotation disappears the trace.

## 15. FOCUS Control

Spot Focus control to obtain optimum waveform according to brightness.

## 16. EXT TRIG Jack

External trigger terminal. For external triggering, external sync voltage (more than 1 Vp-p) should be applied, with SOURCE switch (17) set to EXT.

## 17. SOURCE Switch

Selects triggering source for the sweep. (INT or EXT)

**INT:** Sweep is triggered by CH1 signal when MODE switch is in CH1 or DUAL position. Sweep is triggered by Channel 2 signal when MODE switch is in CH2 position.

**EXT** Sweep is triggered by an external signal applied at the EXT TRIG jack 16.

## 18. SYNC Switch

Sync separator switch. It picks up sync signal component in TV video signal and applies to sync circuit for component in TV video signal and applies to sync circuit for complete synchronization of video signal being viewed.

**NORM ±:** Used for viewing all waveforms except TV composite video signals.
At "+" polarity, sweep is triggered on positive-going slope of waveform and, at "−" polarity, on negative-going slope of waveform.

**TV ±:** In the TV positions, the sync pulses of a television composite video signal are used to trigger the sweep; the vertical sync pulses (TVV: frame) are automatically selected for sweep times of 0.5s/div to 0.1 ms/div and horizontal sync pulses (TVH: line) are automatically selected for sweep times of 50 μs/div to 1 μs/div.
Polarity should be set to match that of video signal as shown in the illustration.

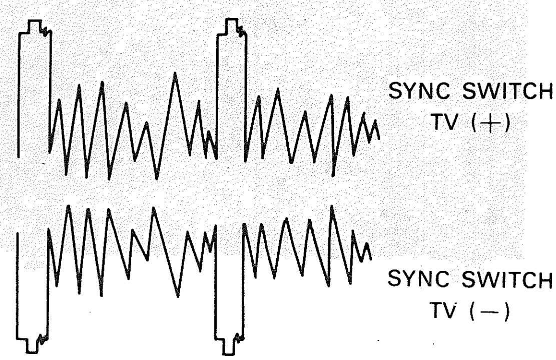



Fig. 1

## 19. LEVEL Control

Sync level adjustment determines points on waveform slope where sweep starts; (−) equals most negative point of triggering and (+) equals most positive point of triggering.

**PULL AUTO Switch**
Push-pull switch selects automatic triggering when pulled out (PULL AUTO). When automatic triggering, a sweep is generated even without an input signal. Triggered sweep operation when trigger signal is present, automatically generates sweep (free-running) in absence of trigger signal.

## 20. ◄► POSITION Control

Rotation adjusts horizontal position of traces (both traces when operated in the dual trace mode). Push-pull switch selects X5 magnification when pulled out (PULL X5 MAG): normal when pushed in. Brightness is slightly decreased.

## 21. SWEEP TIME/DIV Switch

Horizontal sweep time selector. Selects calibrated sweep times of 1 $\mu$s/div (microsecond per division) to 0.5 s/div in 18 steps. In the X-Y position, this switch disables the internal sweep generator and permits the CH2 input to provide horizontal sweep.

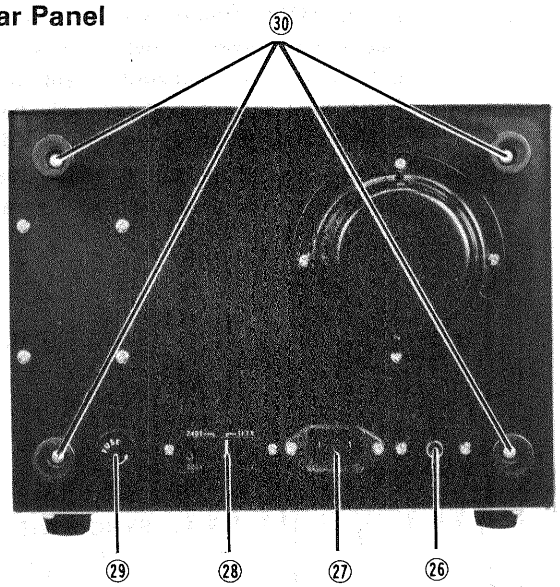
## 22. VARIABLE Control

Fine sweep time adjustment. In the extreme clockwise position (CAL), the sweep time is calibrated.

## 23. CAL 1Vp-p Terminal

Calibration voltage jack. Calibration voltage is 1Vp-p of square wave with synchronized power source.

### Rear Panel




CAL 1Vp-p: This is used for calibration of the vertical amplifier attenuators and to check the frequency compensation adjustment of the probe used with the oscilloscope.

## 24. Trace Rotation

This is used to eliminate inclination of horizontal trace.

## 25. Handle

Use this handle to mount the oscilloscope in a slant position.

## 26. Z AXIS INPUT Jack

Intensity modulation jack. TTL logic-compatible, high logic increase brightness low logic decrease brightness.

## 27. Power Connector

For connection of the supplied AC power cord.

## 28. AC Voltage Selector

The CS-1562A may be operated from 100V, 120V, 220V, 240V, putting the AC Voltage Selector in the place of another.

## 29. Fuse Holder

For 100 ~ 117V operation a 0.7 ampere fuse should be used.

For 220 ~ 240V operation a 0.3 ampere fuse should be used.

## 30. Cord Reel

Wind power cord when the oscilloscope is to be carried or stored. They also serve as a stand when the oscilloscope is used in upright position.

# OPERATION

## PRELIMINARY OPERATION

When operating this oscilloscope, refer to panel controls and their functions (see page 4).

When starting this oscilloscope set initially, set the operation controls as follows and the set may be turned on safely.

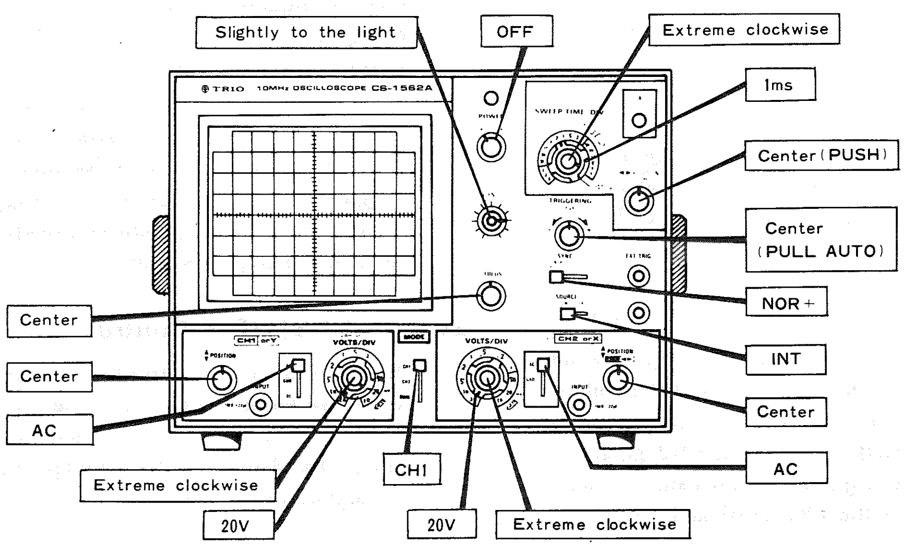



Fig. 2

## OPERATING PROCEDURES

Insert the supplied AC power cord to the power connector and power source. The CS-1562A is designed to be operated on AC 117/230V. Confirming your power source voltage before insert the power connector.

(1) Turn POWER (13) clockwise. The power is turned to ON and LED pilot lamp (12) lights.

(2) Horizontal axis will be displayed. When trace does not appear at the center of the screen, adjust POSITION (1) and POSITION PULL X5 MAG (20).
Adjust brightness with INTENSITY (14). If trace is unclear, adjust FOCUS (15).

(3) The oscilloscope is now ready for measurements. Apply a signal to be measured to INPUT (2). Turn VOLTS/DIV (4) clockwise to obtain the desired size of waveform.
Set the SOURCE (17) to INT position and the MODE (6) to CH2 position, the signal applied to INPUT (10) is then displayed. By setting the MODE (6) to DUAL position, both the CH1 signal applied to INPUT (2) and the CH2 signal to INPUT (10) are displayed.

(4) When the signal voltage is more than 0.01V and waveform fails to appear on the screen, the oscilloscope may be checked by feeding input from CAL 1V-p-p (23). Since calibration voltage is 1Vp-p, the waveform becomes 5 div high at the 0.2V/div position.

(5) By pushing LEVEL (19), the free-running auto function is released. The waveform disappears when the knob is turned clockwise, and appears again at the approximate mid position of it. Sync phase is also adjustable in this case. The waveform will again disappear when the knob is turned counterclockwisefrom the mid position.

(6) When DC component is measure, set AC-GND-DC to DC position. If, in this case, the DC component contains plus "+" potential, the waveform moves upward and if it contains minus "−" potential, the waveform moves downward.
The reference point of "0" potential can be checked at GND position.

# APPLICATIONS

## DUAL-TRACE APPLICATIONS

### Introduction:

The most obvious and yet the most useful feature of the dual-trace oscilloscope is that it has the capability for simultaneously viewing two waveforms that are frequency or phase-related, or that have a common synchronizing voltage, such as in digital circuitry. Simultaneous viewing of input and its output is an invaluable 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:

Fig. 4 illustrates the waveform involved in a basic divide-by-two circuit. Fig. A indicates the reference or clock pulse train. Fig. B and Fig. C indicate the possible outputs of the divide-by-two circuitry. Fig. 4 also indicates the settings of specific oscilloscope controls for viewing these waveforms. In addition to these basic control settings, the TRIGGERING LEVEL control, as well as the Channel 1 and Channel 2 vertical position controls should be set as required to produce suitable displays. In the drawing of Fig. 4, the waveform levels of 2div are indicated. The Channel 1 waveform may be either that indicated in Fig. 4B or Fig. 4C. In Fig. 4C, the divide-by-two output waveform is shown for the case where the output circuitry responds to a negative-going waveform. 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.

## Divide-by-8 Circuit Waveforms:

Fig. 3 indicates waveform relationships for a basic divide-by-eight circuit. The basic oscilloscope settings are identical to those used in Fig. 4. The reference frequency of Fig. 3A is supplied to the Channel 2 input, and the divide-by-eight output is applied to the Channel 1 input. Fig. 3 indicates the ideal time relationship between the input pulses and output pulses.

In an application where the logic circuitry is operating at or near its maximum design frequency, the accumulated rise time effects of the consecutive stages produce a built-in time propagation delay which can be significant in a critical circuit and must be compensated. Fig. 3C indicates the possible time delay which may be introduced into a frequency divider circuit. By use of the dual-trace oscilloscope, the input and output waveforms can be superimposed (ADD or SUB) to determine the exact amount of propagation delay that occurs.

Significant propagation delay may occur in any circuit with several consecutive stages. Using the procedures given for calibrated time measurement, Tp can be calculated. A more precise measurment can be obtained if the Tp portion of the waveform is expanded horizontally. This may be done by pulling the PULL × 5 MAG control. It also may be possible to view the desired portion of the waveform at faster sweep speed.

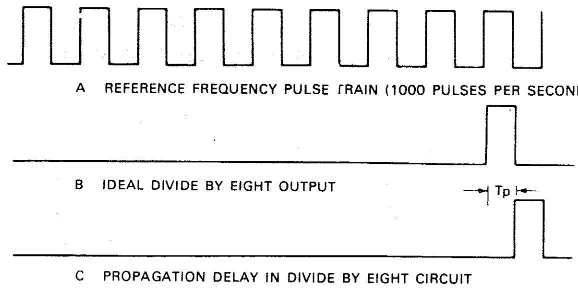



**Fig. 3** Waveforms in divide-by-eight circuit

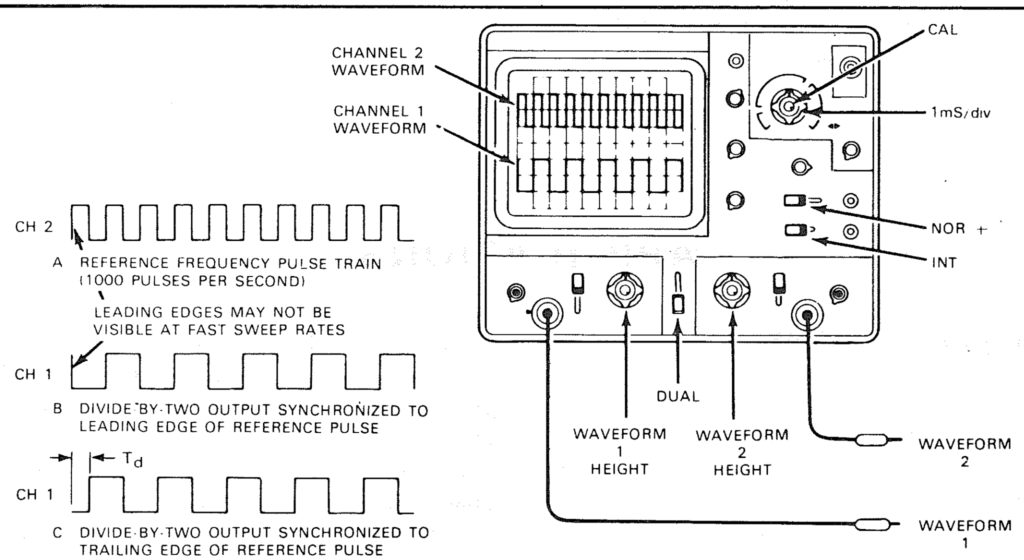



**Fig. 4** Waveforms in divide-by-two circuit

## Digital Circuit Time Delay Measurement:

A dual-trace oscilloscope is a necessity in designing, manufacturing and servicing digital equipment. A dual-trace oscilloscope permits easy comparison of time relationships between two waveforms. In digital equipment, it is common for a large number of circuits to be synchronized, or to have a specific time relationship to each other. Many of the cirucits are frequency dividers as previously described, but waveforms are often time-related in many other combinations. In the dynamic state, some of the waveforms change, depending upon the input or more mode of operation. Fig. 5 shows a typical digital circuit and indentifies several of the points at which waveform measurements are appropriate. The accompanying Fig. 5 shows the normal waveforms to be expected at each of these points and their timing relationships. The individual waveforms have limited value unless their timing relationship to one or more of the other waveforms is known to be correct. The dual-trace oscilloscope allows this comparison to be made. In typical fashion, waveform No. 3 would be displayed on Channel 2 and waveform No.4 through No. 8 and No.10, would be displayed on Channel 1 although other timing somparisons may be desired. Waveforms No. 11 through No. 13 would probably be displayed on Channel 2 in relationship to waveform No. 8 or No. 4 on Channel 1.

In the family of time-related waveforms shown in Fig. 6, waveform No. 8 or No. 10 is an excellent sync source for viewing all of the waveforms; there is but one triggering pulse per frame. For convenience, external sync using waveform No. 8 or No. 10 as the sync source may be desirable. With external sync, any of the waveforms may be displayed without readjustment of the sync controls. Waveforms No. 4 through No. 7 should not be used as the sync source because they do not contain a triggering pulse at the start of the frame. It would not be necessary to view the entire waveforms as shown in Fig. 6 in all cases. In fact, there are many times when a closer examination of a portion of the waveforms would be appropriate. In such cases, it is recommended that the sync remain unchanged while the sweep speed be increased or X5 MAG control used to expand the waveform display.

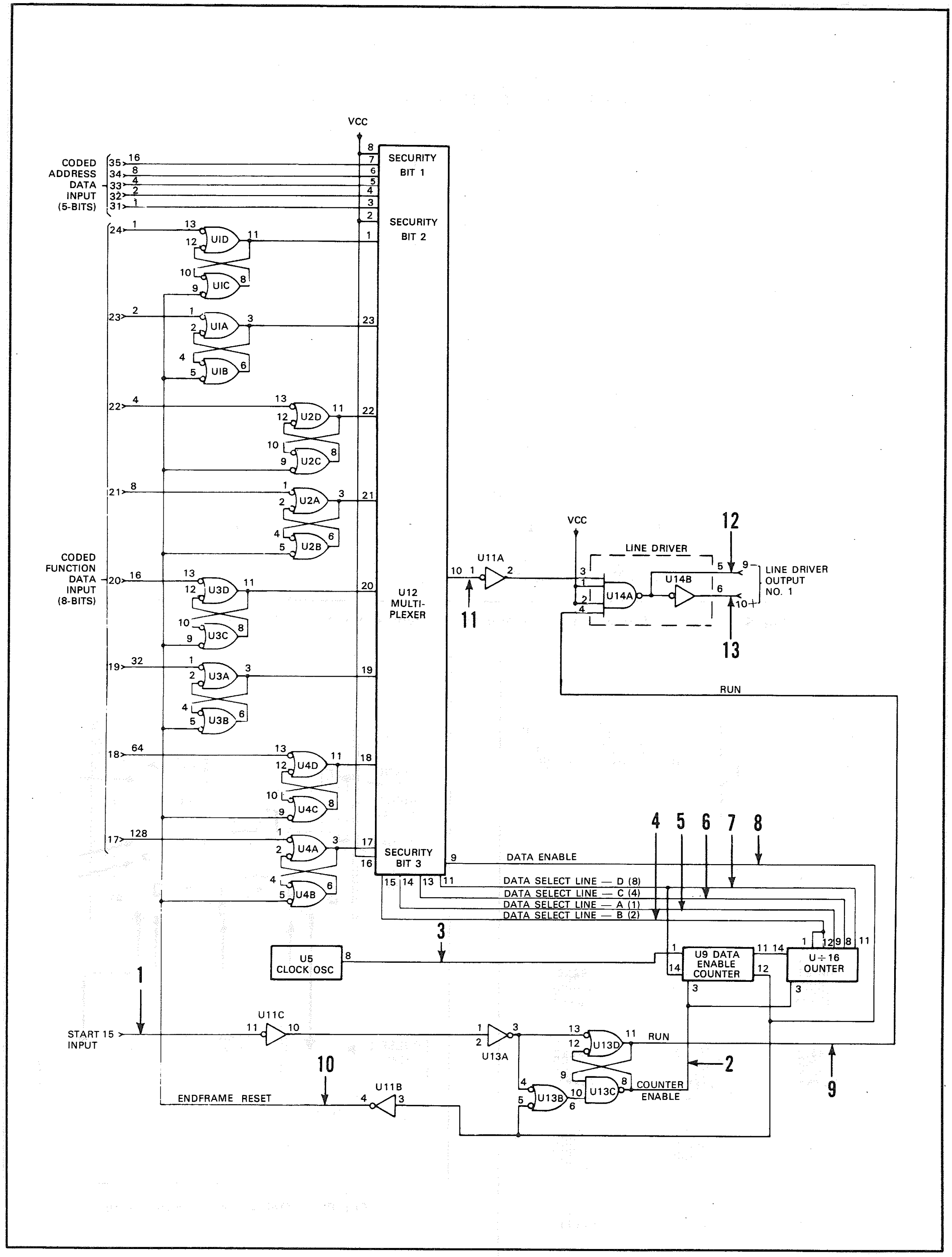



**Fig. 5** Typical digital circuit using several time-related waveforms

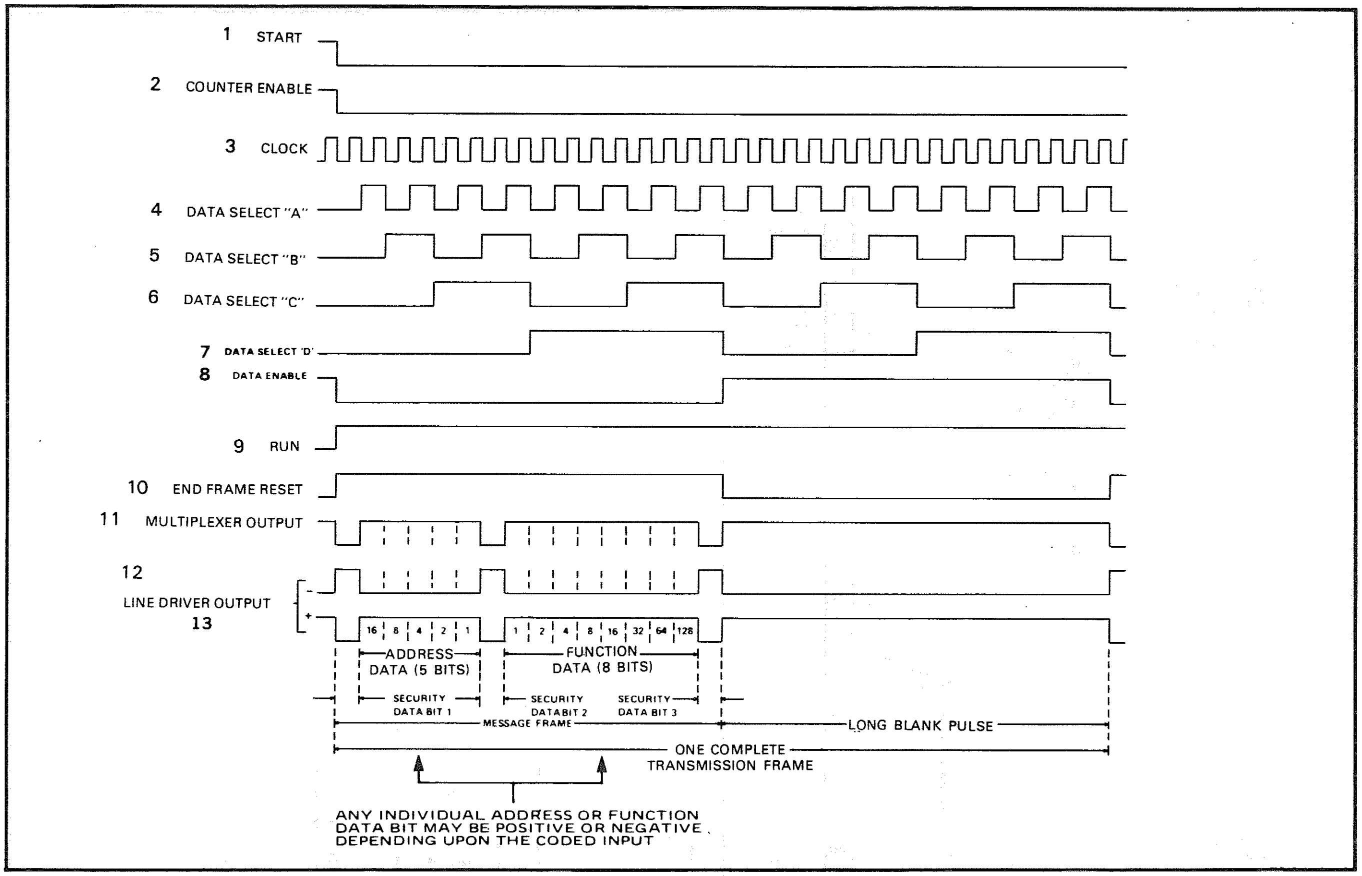



**Fig. 6** Family of time-related waveforms from typical digital circuit in Fig. 5

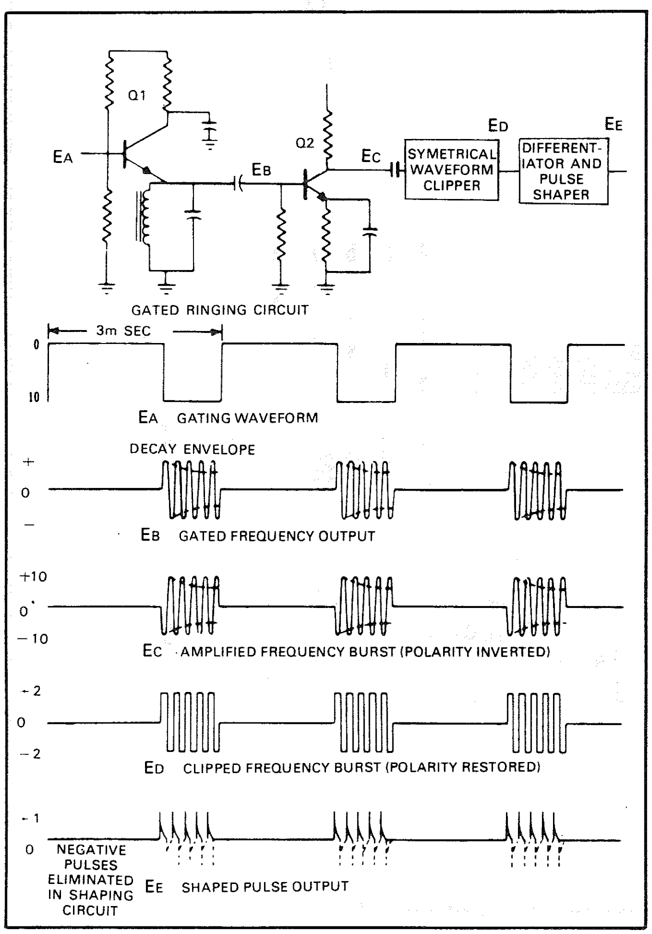



**Fig. 7** Gated ringing circuit and waveforms

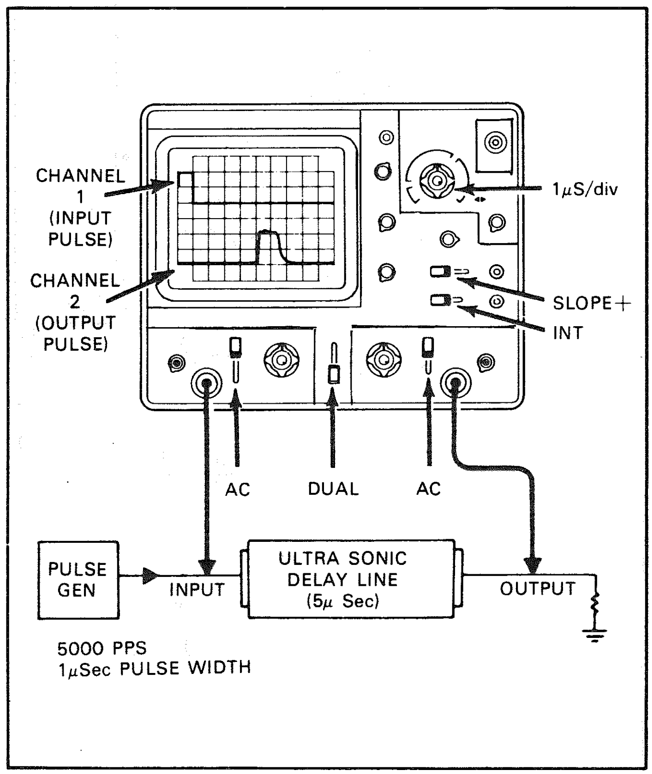



**Fig. 8** Delay line measurements

## Gated Ringing Circuit(burst circuit):

The circuit and waveforms of Fig. 7 are shown to demonstrate the type of circuit in which the dual-trace oscilloscope is effective both in design and troubleshooting applications.

Fig. 7 shows a burst circuit. The basic oscilloscope control settings are identical to those of Fig. 4. Waveform A is the reference waveform and is applied to CH1 input. All other waveforms are sampled at CH2 and compared to the reference waveform of CH1. The frequency burst signal can be examined more closely either by increasing the sweep time per division to 0.5 ms per division or by pulling out on the ◀▶ POSITION control to obtain 5 times magnification. This control can then be rotated as desire to center the desired waveform information on the oscilloscope screen.

## 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 input pulse can be used to trigger or synchronize the Channel 1 display and the delay line output can be observed on CH2. A repetitive type pulse will make it possible to synchronize the displays. The interval between repetitive pulses should be large compared to the delay time to be investigated. 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. 8 shows the typical oscilloscope settings as well as the basic test circuit. Typical input and output waveforms are shown on the oscilloscope display. Any pulse stretching and ripple can be observed and evaluated. The results of modifying the input and output terminations can be observed directly. A common application of the delay line checks is found in color television receivers. Fig. 9 shows the oscilloscope settings and typical circuit connections to check the "Y" delay line employed in the video amplifier section. The input waveform and output waveform are compared for delay time, using the horizontal sync pulse of the composite video signal for reference. The indicated delay is approximately one microsecond. In addition to determining the delay characteristics of the line, the output waveform reveals any distortion that may be introduced from an inpedance mismatch or a greatly attenuated output resulting from an open line.

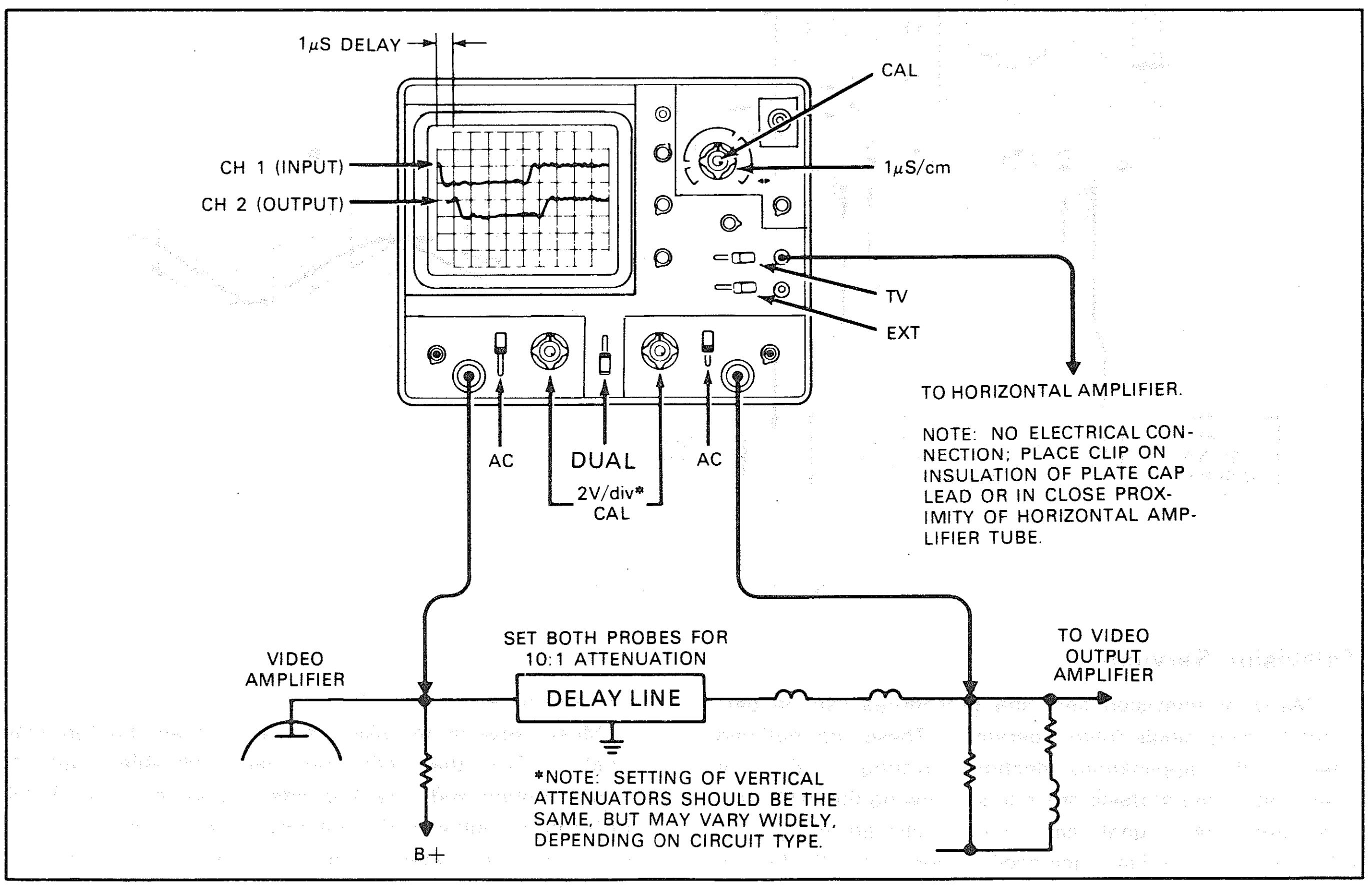



**Fig. 9** Checking "Y" delay line in color television receivers

## Stereo Amplifier Servicing:

Another convenient use for a 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 or malfunctoning stage has been located, the effects of whatever troubleshooting and repair methods are employed can be observed and analyzed immediately.

## Amplifier Phase Shift Measurements:

Phase measurements can be made by several methods using oscilloscopes. Typical applications are in circuits designed to produce a specific phase shift, and measurement of phase shift distoration in audio amplifiers and networks.

In all amplifiers, a phase shift is always associated with a change in amplitude response. For example, at the −3dB response points, a phase shift of 45° occurs. Phase measurements can be performed by operating the oscilloscope either in the dual-trace mode or the X-Y mode. This method uses the dual-trace mode to measure amplifier phase shift directly. Fig. 10 illustrates this method. In this particular case, the measurements are being made at approximately 5000Hz. The input signal to the audio amplifier is used as a reference and is applied to the Channel 1 input jack.

The sweep time VARIABLE control is adjusted as required to provide a complete cycle of the input waveform display on 8div horizontally. A waveform heigh of 2div is used. The 8div display represents 360° at the displayed frequency and each division represents 45° of the waveform. The signal developed across the output of the audio amplifier is applied to the Channel input jack.

The vertical attenuator controls of Channel 2 are adjusted as required to produce a peak-to-peak waveform of 2 divisions as shown in Fig. 10. B. The Channel 2 POSITION control is then adjusted so that the Channel 2 waveform is displayed on the same horizontal axis as the Channel 1 waveform as shown in Fig. 10. B. The distance between corresponding points on the horizontal axis for the two waveforms then represents the zero crossover points of the two waveforms are compared. It is shown that a difference of 1 div exists. This is then interpreted as a phase shift of 45°.

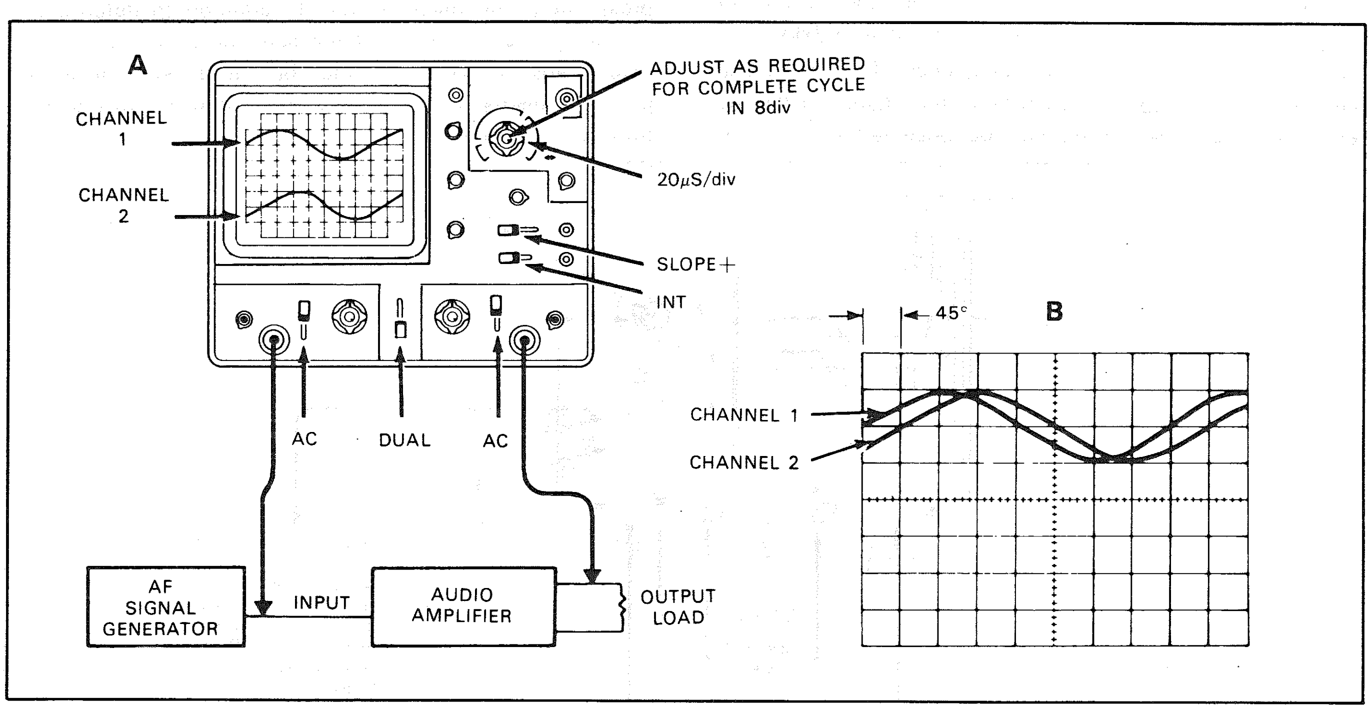



**Fig. 10** Measuring amplifier phase shift

## Television Servicing:

Many of television servicing procedures can be performed using single-trace operation. These are outlined later in the applications section covering single-trace operations. One of these procedures, viewing the VITS (vertical interval test signal), can be accomplished much more effectively using a dual-trace oscilloscope. As outlind in the single-trace applications section and as shown in Fig.11, the information on the Field 1 and Field 2 vertical blanking interval pulse is different. This is shown in detail in Fig. 11. Also, because the oscilloscope sweep is synchronized to the vertical blanking interval waveform, the Field 1 and Field 2 waveforms are superimposed onto each other. With dual-trace operation, the signal information on each blanking pulse can be viewed separately without overlapping. Fig. 13 indicates the oscilloscope control setting for viewing the alternate VITS.

Most network television signals contain built-in test signal (VITS) that can be very valuable tool in troubleshooting and servicing video equipment. The VITS can localize trouble to the antenna, tuner, IF or video sections and shows when realignment may be required. The VITS signal is being used in some television receivers for automatic color correction.

The VITS singal is transmitted during the vertical blanking interval. On the television set, they can be seen as a bright white 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 circuit must be disabled to see these signals.)

The transmitted VITS is precision sequence of specific frequency, amplitude and waveform as shown in Fig. 11. Television networks use the precision signals for adjustment and checking of network transmission equipment, but the technician can use them to evaluate television set performance in VITS can also be used for checking the operating condition of TV sets. The first frame of VITS at the "B" section (line 18) in Fig. 11 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".

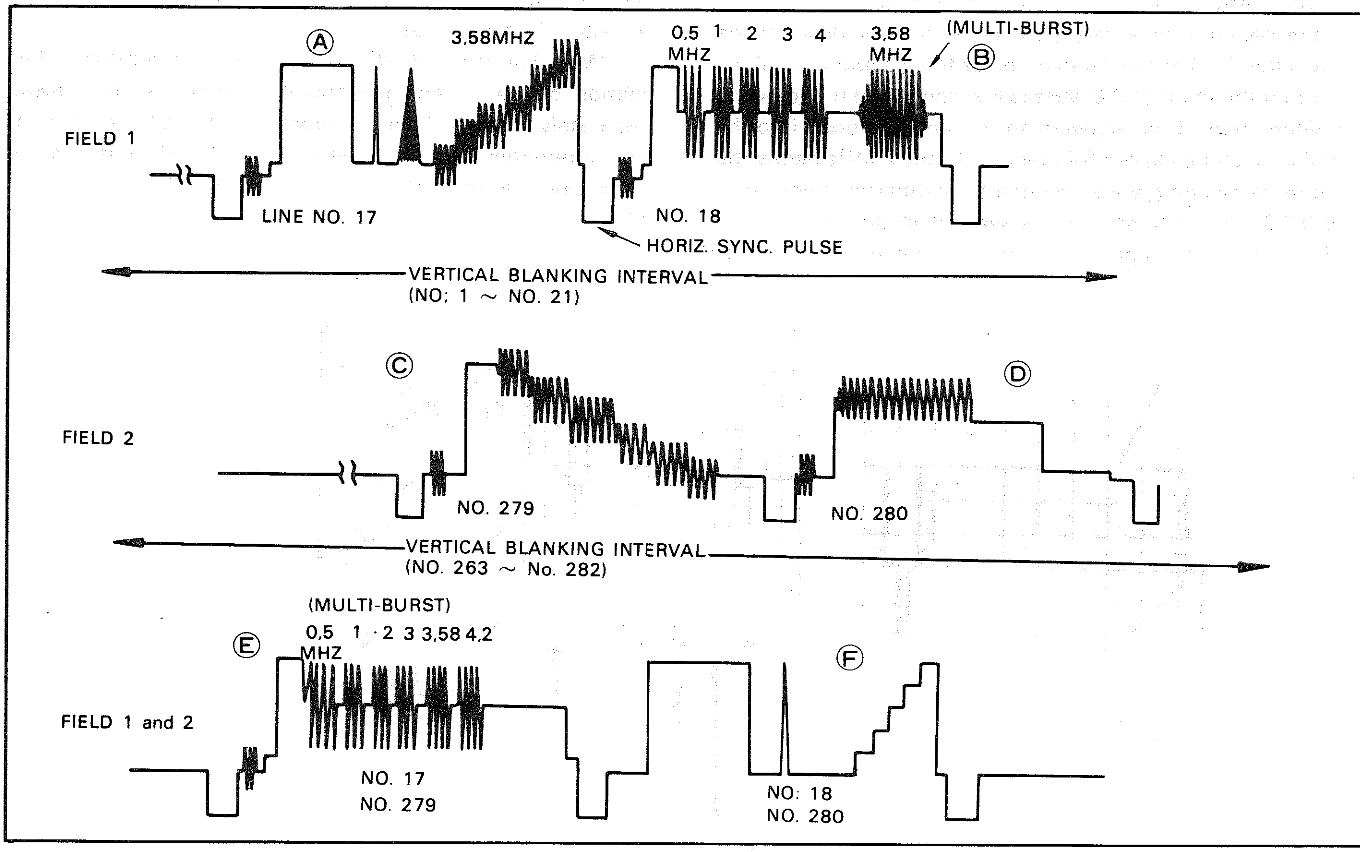



**Fig. 11** VITS signal, Fields 1 and 2

This multi-burst portion of the VITS is the portion that can be most valuable to the technician. The second line of Field 1 and Field 2 (lines 18 and 280), which may contain the sine-squared pulse, window pulse and the staircase of 3.58 MHz bursts at progressively lighter shading. These are valuable to the network, but have less value to the technician. As seen on the television screen, Field 1 is interlaced with Field 2 so that line 17 is followed by line 279 and line 18 is followed by line 280. The entire VITS appears at the bottom of the vertical blanking pulse and just before the first line of video.

Now to analyze the waveform. All frequencies of the multi-burst are transmitted at the same level, but should not be equally coupled through the receiver due to its response curve. Fig. 12 shows the desired response for a good color television receiver, identifying each frequency of the multi-burst and showing the allowable amount of attenuation for each. 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 the multi-burst is normal at the detector, check the VITS on other channels. If some

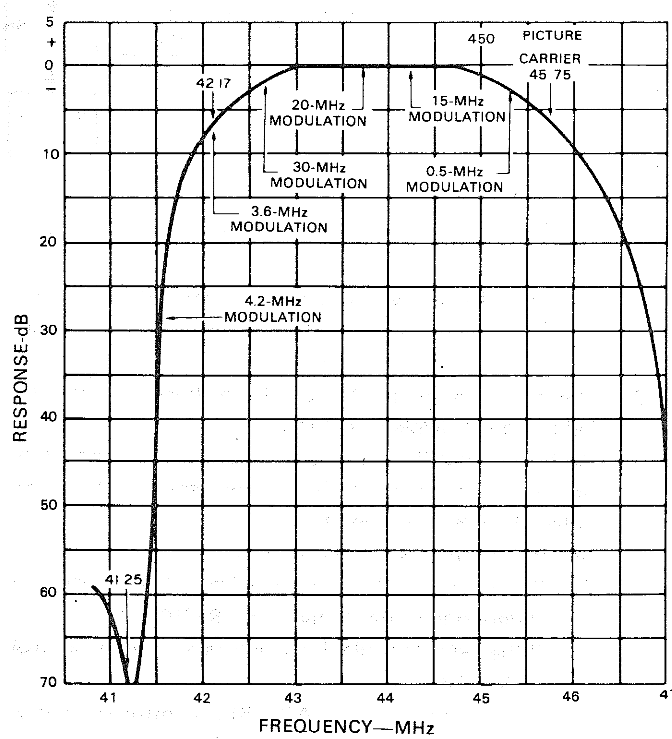



**Fig. 12** Color TV IF amplifier response curve

channels look okay but others do not, you probably have tuner or antenna-system troubles. Don't overlook the chance of the antenna system causing "holes" or tilted response on some channels. If the VITS is abnormal at the video detector on all channels, the trouble is probably in the IF amplifier stages.

As another example, let us assume that we have a set on the bench with a very poor pecture. 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 the bursts on either side. 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 carrying VITS. If the same thing is seen, then our reasoning is right, and the IF amplifier requires realignment. If the poor response at 2 MHz is not seen on other channels, may be an FM trap at the tuner input is misadjusted, causing a bite on only one channel. Other traps at the input of the set could similary be misadjusted or faulty.

If the VITS response at the detector output is normal for all channels, the trouble will be in the video amplifier. Look for open peaking coils, off-value resistors, solder bridges across foil patterns, etc.

With dual-trace oscilloscope operation, the signal information on each vertical blanking interval can be viewed separately without trace overlapping, although the information alternates with each field. Fig. 13 indicates the oscilloscope control setting for viewing the alternate vertical blanking intervals.

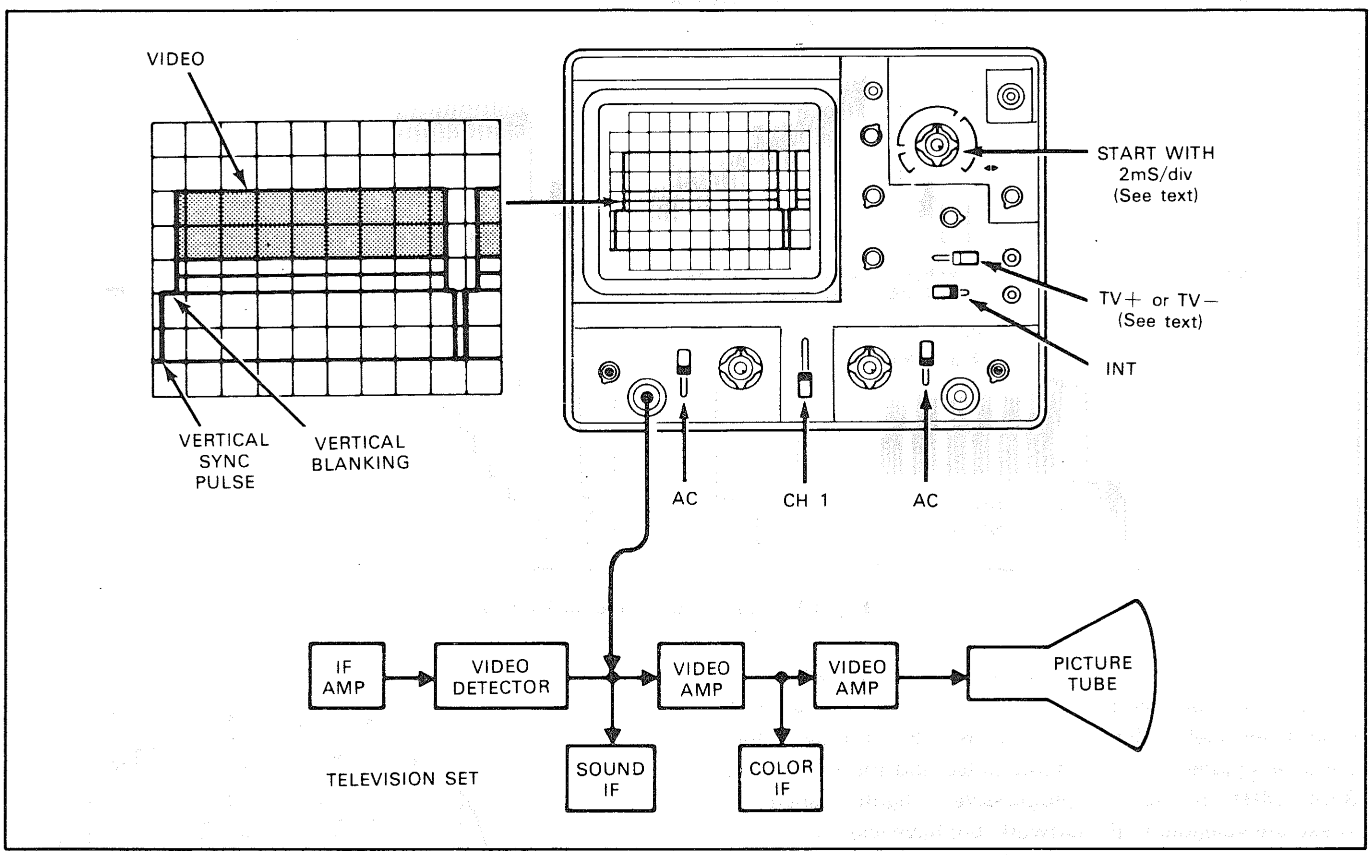



**Fig. 13** Set-up for viewing fields 1 and 2 of VITS information

1. The color TV receiver on which the vertical interval information is to be viewed must be set to a station transmitting a color broadcast.
2. The control settings of Fig. 13 are those required 2-field vertical display on CH1.
3. With the oscilloscope and the TV receiver into operating, connect the CH1 probe (set to 10 : 1) to video detector test point.
4. Set the SYNC switch as follows:
   A. If the sync and blanking pulses of the observed Video signal are psitive, use SYNC TV +.
   B. If the sync and blanking pulses are negative, use SYNC TV −.
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 video detector point.
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. This expands the display by increasing the sweep speed. 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. 11. 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 display.

10. Pull the ◄►POSITION control outward to obtain an additional X5 magnification. Rotate the control moving the trace to the left until the expanded VITS information appears as shown in Fig. 11. Because of the low repetition rate and the high sweep speed combination, the brightness level of the signal displays will be reduced.
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 which is to be used for signal-tracing and troubleshooting can be used, 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 in the oscilloscope to identify either of the two vertical fields which comprise a complete frame.

## SINGLE-CHANNEL APPLICATIONS

### Introduction:

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

### Television Servicing:

A triggered sweep oscilloscope is advantageous in servicing and aligning television receivers. This oscilloscope also includes several features that were incorporated to make television servicing easier and more comprehensive.

* With the SYNC switch set to TV position, the SWEEP TIME/DIV control automatically selects the TV vertical sync at sweep speeds appropriate for viewing frames and TV horizontal sync at sweep speeds appropriate for viewing lines.
* Wide bandwidth for high resolution video and high speed pulse presentation.

### 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 the 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 touble 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. The schematic diagram or accompanying service data on the equipment being serviced usually includes waveform pectures. These waveform pectures include the required sweep time and the normal peak-to-peak voltage. Compare the peak-to-peak voltage readings on the oscilloscope with those shown on the waveform pictures. Any abnormal readings should be followed by additional readings in the suspected circuits until the trouble is isolated to as small an area as possible.

### Composite Video Waveform Analysis:

Probably the most important waveform in television servicing is the composite waveform consisting of the video signal, the blanking pedestals signal and the sync pulses. Fig. 14 and Fig. 15 show typical oscilloscope traces when observing composite video 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 technician 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.

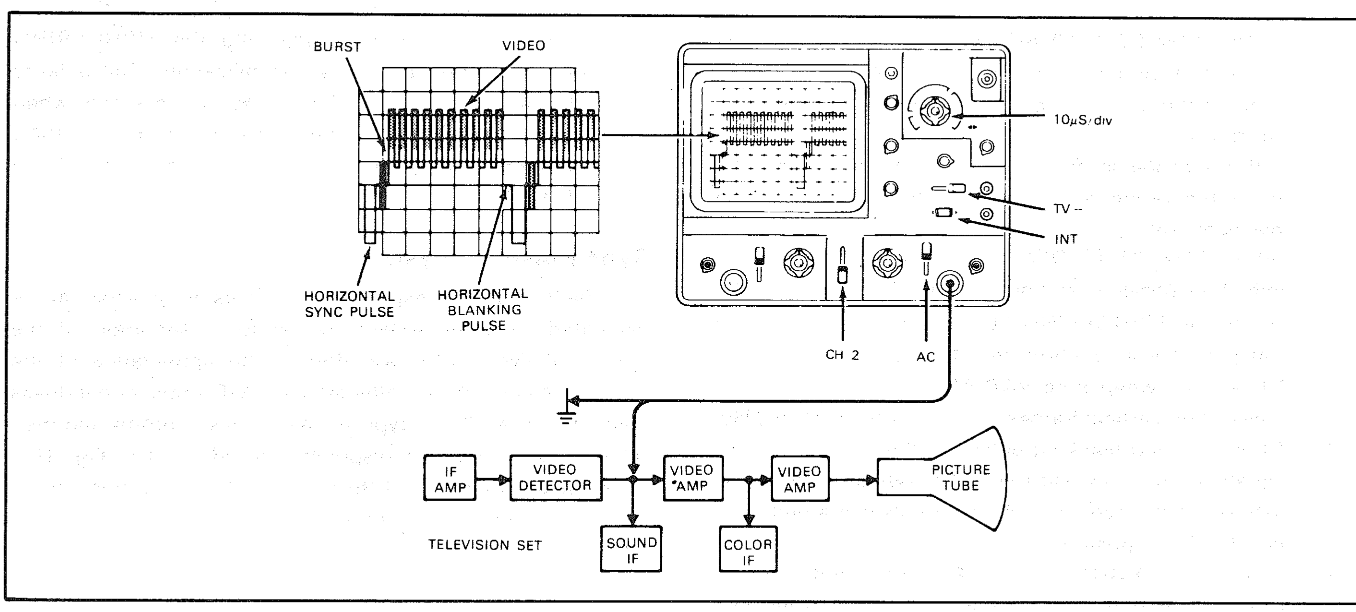



**Fig. 14** Set up for viewing horizontal fields of composite video signal

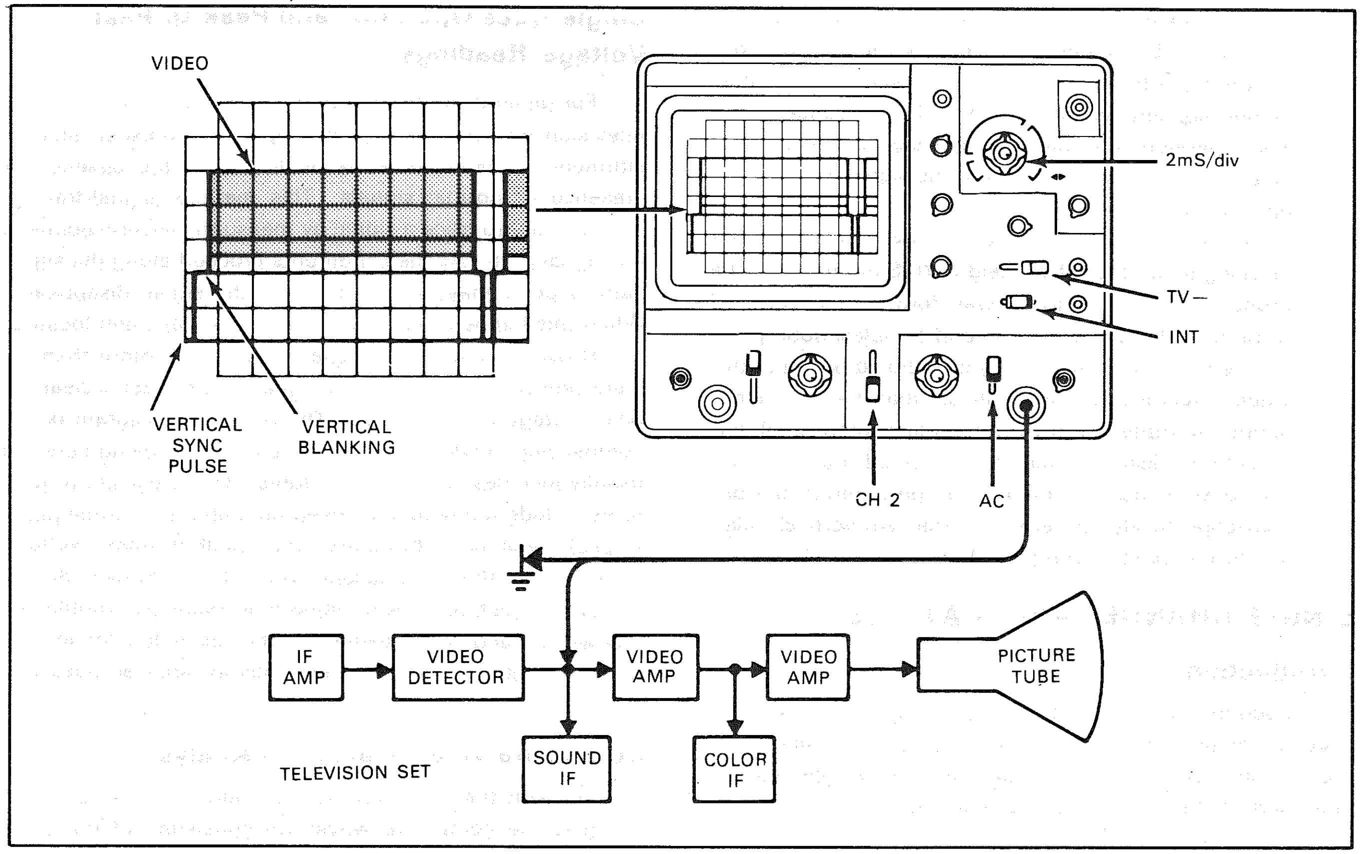



**Fig. 15** Set-up for viewing vertical fields of composite video signal

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 10$\mu$s/div position for observing TV horizontal lines or to the 2ms/div position for observing TV vertical frames.
4. Set the SYNC switch to the TV+ position.
5. Set the SOURCE switch to the INT position.
6. Pull the TRIGGERING LEVEL control to the AUTO position.
7. Set the CH2 DC-GND-AC 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 for 10 : 1 attenuation, connect the tip of the probe to th 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 SYNC switch to the TV+ position; if the sync and blanking pulses are negative, use the TV− 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, pull the ◄►POSITION control for X5 magnification. Rotate the same control left or right to select the desired portion of the waveform to be viewed.
16. Composite video waveforms may be checked at other points on the video circuits by moving the probe tip to those points and changing the VOLTS/DIV control setting as required to keep the display within the limits of the scale, and by readjusting the TRIGGERING LEVEL control to maintain stabilization. The polarity of the observed waveform may be reversed when moving from one monitoring point to another; therefore, it may be necessary to reverse the polarity of the SYNC.

## Sync Pulse Analysis:

The IF amplifier 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. 16. Sync pulse waveform distortions produced by positive or negative limiting in IF overload conditions are shown in Fig. 17.

| 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 AND WHITE STRIATIONS FOLLOWING A SHARP CHANGE IN PICTURE SHADING |
| LOSS OF LOW FREQUENCY RESPONSE | | | CHANGE IN SHADING OF LARGE PICTURE AREAS, SMEARED PICTURE |

**Fig. 16** Analysis of sync pulse distortion

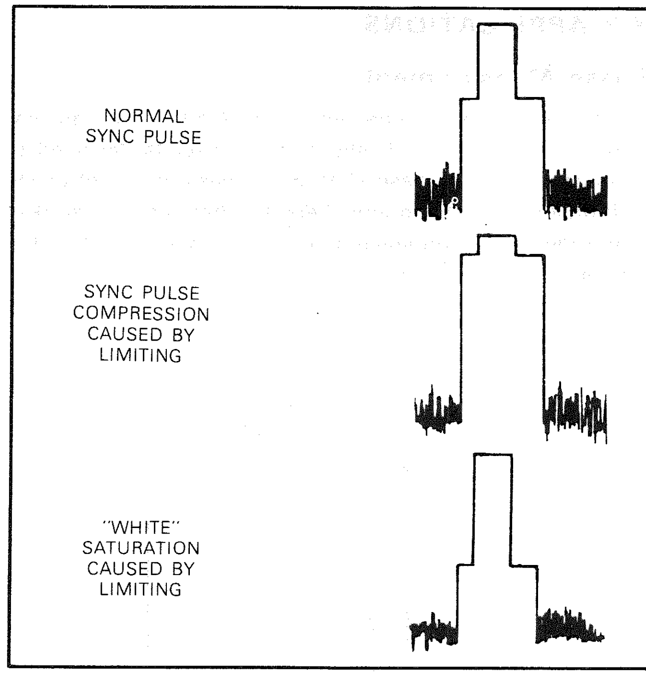



**Fig. 17** Sync pulse waveforms

## FM RECEIVER ADJUSTMENTS

1. Connect a sweep generator to the mixer input of the FM receiver. Set the sweep generator for a 10.7MHz centered sweep.
2. Connect the sweep voltage output of the sweep generator to the Channel 2 input jack of the oscilloscope and set the oscilloscope 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. 18A.
5. Set the marker generator precisely to 10.7MHz. 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 10.7MHz "pip" should appear in the center (see Fig. 18B.)
   Adjust the demodulator according to the manufacturer's instructions so the marker moves an equal distance from the center as the marker frequency is increased and decreased an equal amount from the 10.7 MHz center frequency.

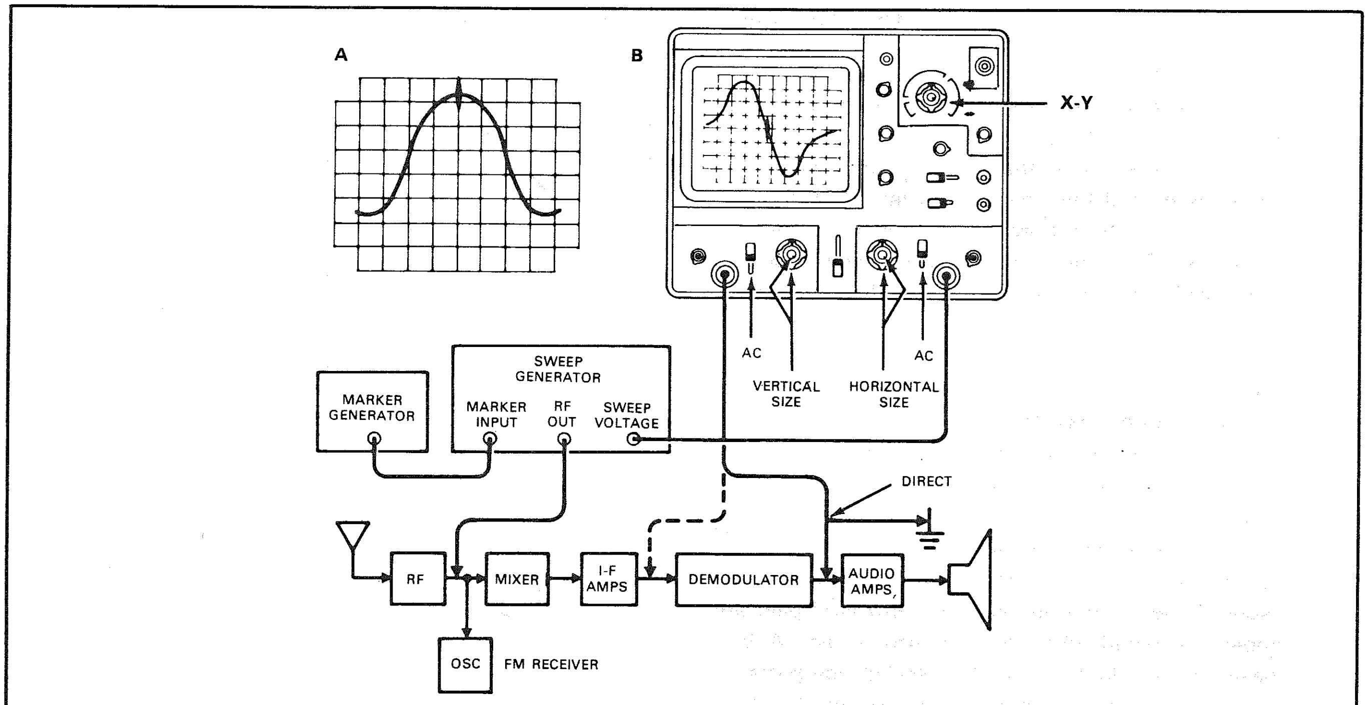



**Fig. 18** Typical FM receiver alignment set-up

## X-Y APPLICATIONS

### Phase Measurement:

Phase measurements may be made with an oscilloscope. Typical applications are in circuits designed to produce a specific phase shift, and measurement of phase shift distortion in audio amplifiers or other audio networks. Distortion 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. 19).

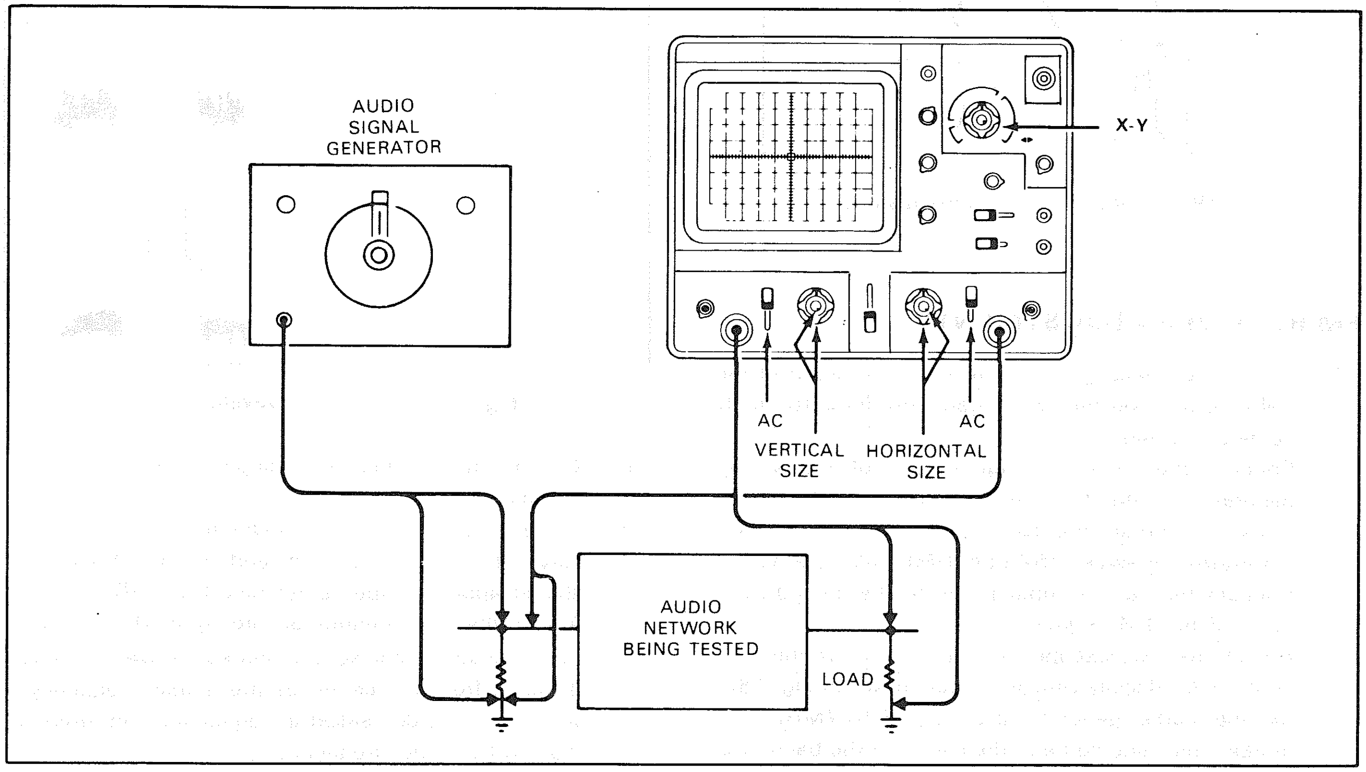



**Fig. 19** Typical phase measurement alignment set-up

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. If desired, the circuit's output may be observed on the oscilloscope. 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 SWEEP TIME/DIV 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. 20. If the two signals are in phase, the oscilloscope trace is a straight diagonal 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) than 90° produces an elliptical oscilloscope pattern. The amount of phase shift can be calculated from the oscilloscope trace as shown in Fig. 21.

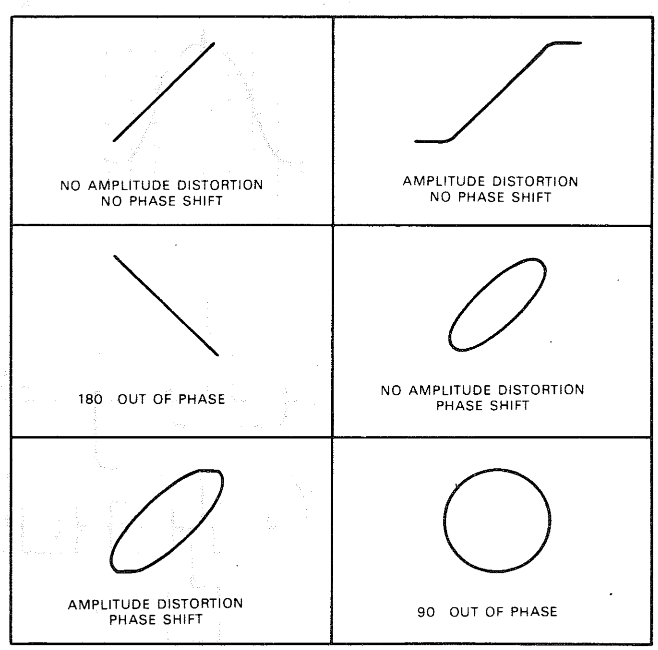



**Fig. 20** Typical phase measurement oscilloscope displays

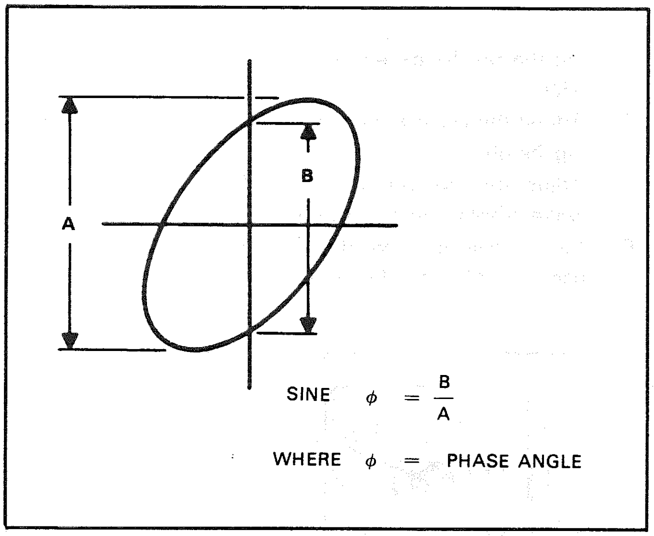



**Fig. 21** Phase shift calculation

## Frequency Measurement:

Procedure:

1. Connect the sine wave of known frequency to the CH2 INPUT jack of the oscilloscope and set the SWEEP TIME/DIV control to X-Y. This provides external horizontal input.
2. Connect the vertical input probe (CH 1 INPUT) to the unknown frequency.
3. Adjust the Channel 1 and 2 gain controls for a convenient, easy-to-read display.
4. The resulting pattern, called a Lissajous pattern, shows the ratio between the two frequencies. See Fig. 22.

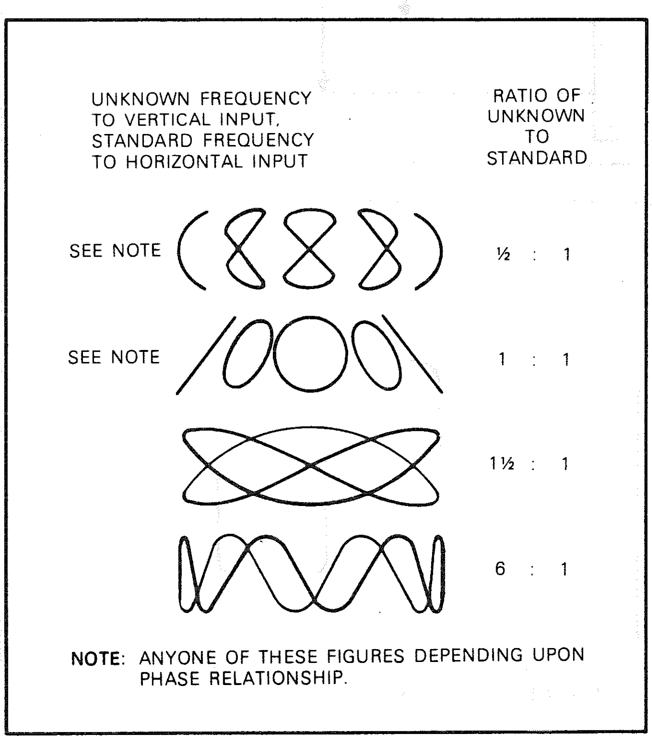



**Fig. 22** Lissajous' waveforms used for frequency measurement

## AMPLIFIER SQUARE WAVE TEST

### Introduction:

A square wave generator and a low-distoration the oscilloscope such as this instruments can be used to display various types of distortion present in electric circuits. A square wave of a given frequency contains a large number of odd harmonics of that frequency. If a 500 Hz square wave is injected into a circuit, frequency components of 1.5 kHz, 2.5 kHz and 3.5 kHz also are provided. Since vacuum tubes and transistors are non-linear, it is difficult to amplify and reproduce a square wave which is identical to the input signal. Interelectrode capacitances, junction capacitances, stray capacitances as well as limited device and transformer response are a few of the factors which prevent faithful reproduction of a square wave signal. A well-designed amplifier can minimize the distortion caused by these limitations. Poorly designed or defective amplifiers can introduce distortion to the point where their performance is unsatisfactory.

As stated before, a square wave contains a large number of odd harmonics. By injecting a 500Hz sine wave into an amplifier, we can evaluate amplifier response at 500Hz only, but by injecting a square wave of the same frequency we can determine how the amplifier would respond to input signals from 500 Hz up to the 15th or 21st harmonic.

The need for square wave evaluation becomes apparent if we realize that some audio amplifiers will be required during normal use to pass simultaneously a large number of different frequencies. With a square wave, we have a controlled signal with which we can evaluate the input and output quality of a signal of may frequencies (the harmonics of the square wave) which is what the amplifier sees when amplifying complex waveforms of musical instruments or voices.

The square wave output of the signal generator must be extremely flat so that it does not contribute to any distortion that may be observed when evaluating amplifier response. The oscilloscope vertical input should be set to DC as it will introduce the least distortion, especially at low frequencies. When checking amplifier response, the frequency of the square wave input should be varied from the low end of the amplifier bandpass up toward the upper end of the bandpass; however, because of the harmonic content of the square wave, distortion will occur before the upper end of the amplifier bandpass is reached.

It should be noted that the actual response check of an amplifier should be made using a sin wave signal. This is especially important in an limited bandwidth amplifiers (voice amplifier).

The square wave signal provides a quick check of amplifier performance and will give an estimate of overall amplifier quality. The square wave also will reveal some deficiencies not readily apparent when using a sine wave signal. Whether a sine wave is used for testing the amplifier, it is important that the manufacturer's specifications on the amplifier be known in order to make a better judgement of its performance.

## Testing Procedure (refer to Fig. 23):

1. Connect the output of the square wave generator to the input of the amplifier being tested.
2. Connect the CH2 probe of the oscilloscope to the output of the amplifier being tested.
3. If the DC component of the circuit being tested is sufficiently low to allow both the AC and DC component to be viewed, use the DC position of the AC-GND-DC switch.
   However, the AC position may be used without affecting the results except at very low frequencies (below 5Hz).
4. Adjust the vertical gain controls for a convenient viewing height.
5. Adjust the sweep time controls for one cycle of square wave display on the screen.
6. For a close-up view of a portion of the square wave, use the X5 magnification.

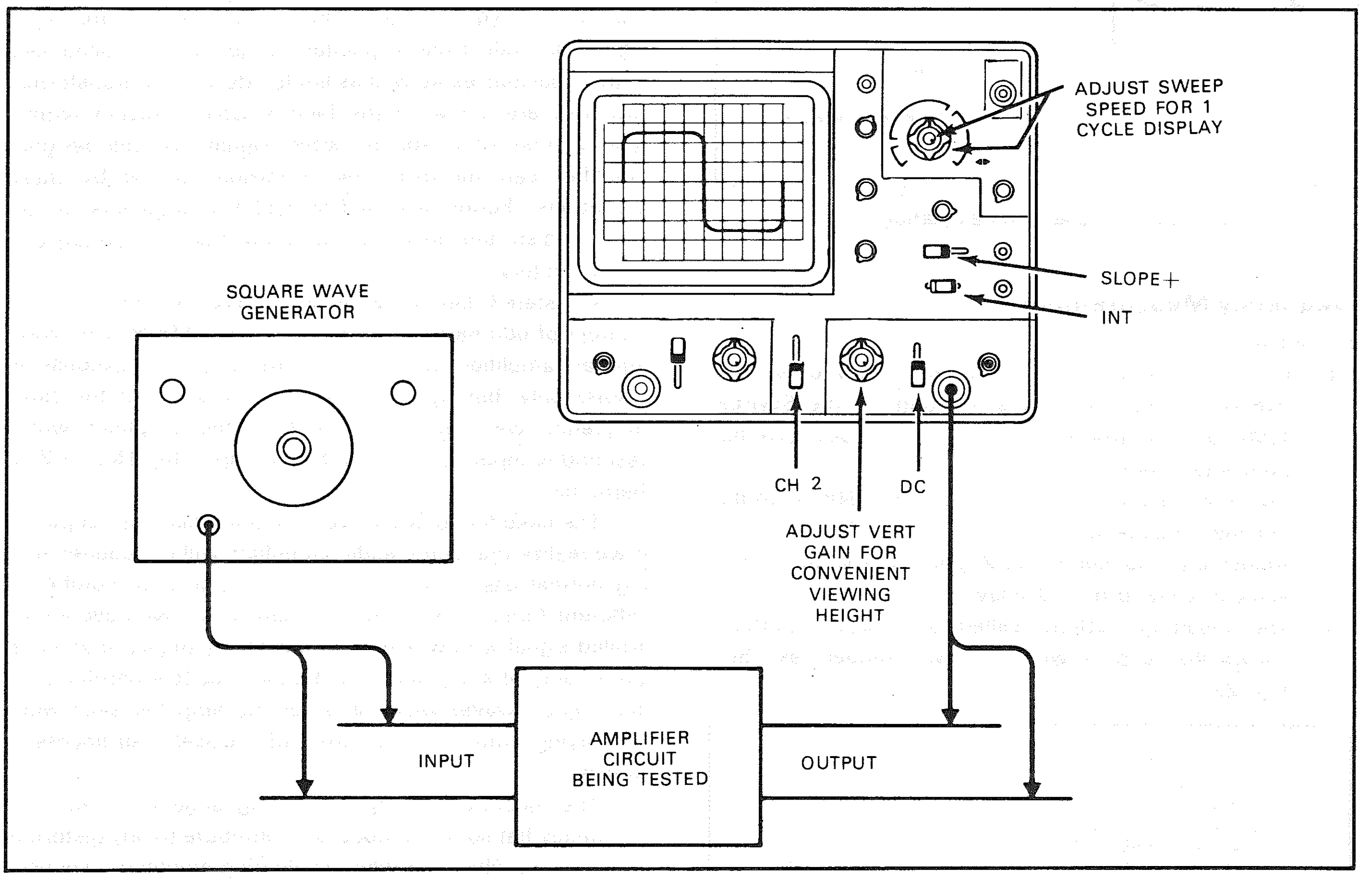



**Fig. 23** Equipment set-up for square wave testing of amplifiers

## Analysing the Waveforms:

The short rise time which occurs at the beginning of the half-cycle is created by the in-phase sum of the medium and high frequency sine wave components. The same holds true for the rapid drop at the end of the half-cycle from maximum amplitude to zero amplitude at the 180° or half-cycle point. Therefore, a theoretical reduction in amplitude alone of the high frequency components should produce a rounding of the square corners at all four points of one square wave cycle (See Fig. 24).

Distortion can be classified into three distinct categories:

1. The first is frequency distortion and refer to the change from normal amplitude of a component of a complex waveform. In other words, the introduction in an amplifier circuit of resonant networks or selective filters created by combination of reactive components will created peaks or dips in an otherwise flat frequency response curve.

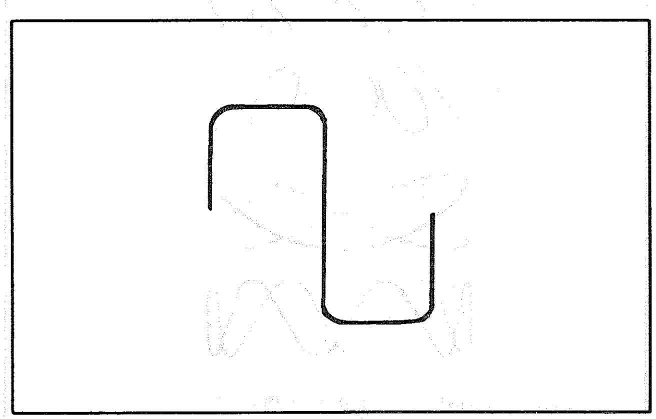


**Fig. 24** Square wave response with high frequency loss

2. The second is non-linear distortion and refers to a change in waveshape produced by application of the waveshape to non-linear components or elements such as vacuum tubes, an iron core transformer and in an extreme case, a deliberate non-linear circuit such as a clipper network.
3. The third is delay or phase distortion, which is distortion produced by a shift in phase between some components of a complex waveform.

In actual practice, a reduction in amplitude of a square wave compnent (sinusoidal harmonic) is usually caused by a frequency-selective network which includes capacity, inductance or both. The presence of the C or L introduces a difference in phase angle between components, creating phase distortion or delay distortion. Therefore, in square wave testing of practical circuitry, we will usually find that the distorted square wave includes a combination of amplitude and phase distortions.

In a typical wide band amplifier, a square wave check accurately reveals many distortion characteristics of the circuit. The response of an amplifier is indicated in Fig. 25, revealing poor low-frequency response along with the overcompensated high-frequency boost. A 100Hz square wave applied to input of the amplifier will appear as in Fig. 26A. This figure indicates satisfactory medium frequency response (approximately 1kHz to 2kHz) but shows poor low frequency response. Next, a 1kHz square wave applied to the input of the this same amplifier will appear as in Fig. 26B. This figure displays good frequency response in the region of 1000 to 4000Hz but clearly reveals the overcompensation at the higher 10 kHz region by the sharp rise at the top of the leading edge of the square wave.

As a rule of thumb, it can be safely said that a square wave can be used to reveal response and phase relationships up to the 15th or 20th odd harmonic or up to approximately 40 times the fundamental of the square wave. Using this rule of thumb, it is seen that wide-band circuitry will require at least two frequency check to properly analyze the complete spectrum.

In the case illustrated by Fig. 25, a 100Hz square wave will encompass components up to about 4kHz. To analyze above 4kHz and beyond 10,000Hz, a 1kHz square wave should be used satisfactory.

Now, the region between 100Hz and 4000Hz in Fig. 25 shows a rise from poor low-frequency (100Hz to 1kHz) response to a flattening out from beyond 1000 and 4000Hz. Therefore, we can expect that the higher frequency components in the 100Hz square wave will be relatively normal in amplitude and phase but that the lower frequency components "B" in this same square wave will be strongly modified by the poor low-frequency response of this amplifier (See Fig. 26A).

If the combination of elements in this amplifier were such as to only depress the low frequency components in the square wave, a curve similar to Fig. 27 would be obtained. However, reduction in amplitude of the components, as already noted,is usually caused by a reactive element, causing in turn, a phase shift of the components, producing the strong tilt of Fig. 26A.

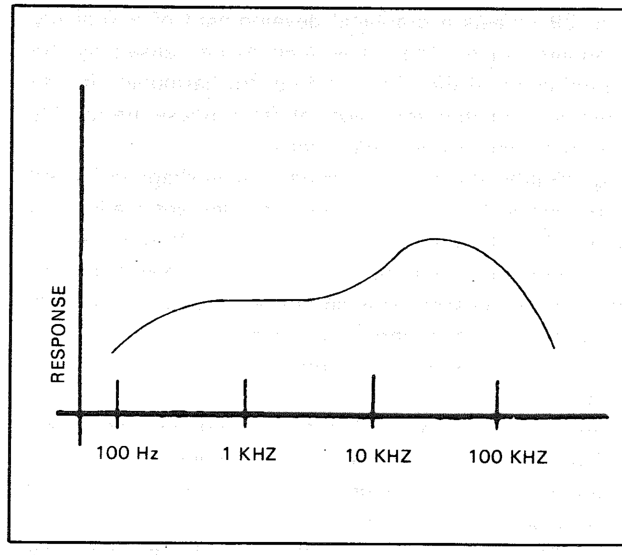



**Fig. 25** Response curve of amplifier with poor low and high ends

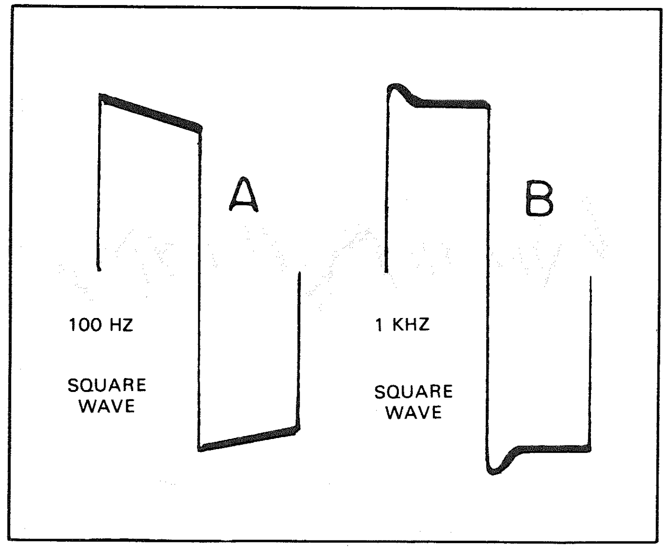



**Fig. 26** Resultant 100 Hz and 1 kHz square waves from amplifier in Fig. 25

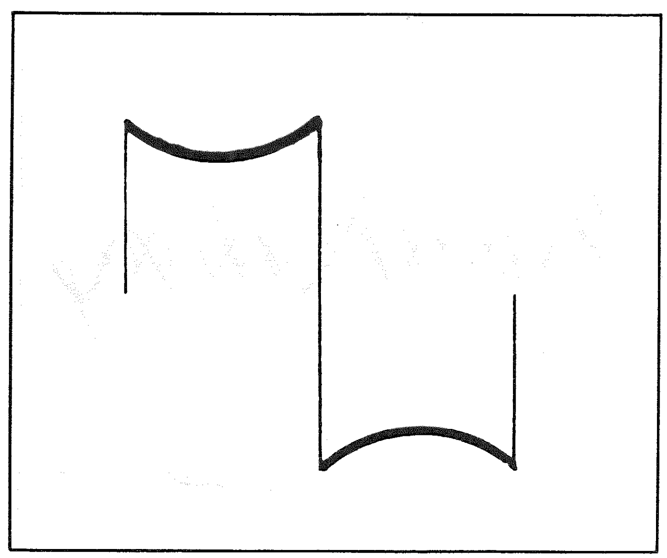


**Fig. 27** Reduction of square wave fundamental frequency component in tuned circuit

Fig. 28 reveals a graphical development of a similarly tilted square wave. The tilt is seen to be caused by the strong influence of the phase-shifted 3rd harmonic. It also becomes evident that very slight shifts in phase are quickly shown up by tilt in the square wave.

Fig. 29 indicates the tilt in square wave shape produced by a 10° phase shift of a low-frequency element in a leading direction. Fig. 30 indicates a 10° phase shift in a low frequency component in a lagging direction. The tilts are opposite in the two cases because of the difference in polarity of the phase angle in the two cases as can be checked through algebraic addition of components.

Fig. 31 indicates low-frequency components which have been reduced in amplitude and shifted in phase. It will be noted that these examples of low-frequency distortion are characterized by a change in shape of the flat portion of the square wave.

Fig. 26B, previously discussed, revealed high-frequency overshoot produced by rising amplifier response at the high frequencies. It should again be noted that this overshoot makes itself evident at the top of the leading edge of the square wave. This characterislic relationship is explained by remain being that in a normal well-shaped square wave, the sharp rise of the leading edge is created by the summation of a practically infinite number of harmonic components. If an abnormal rise in amplifier response occurs at high frequencies, the high frequency components in the square

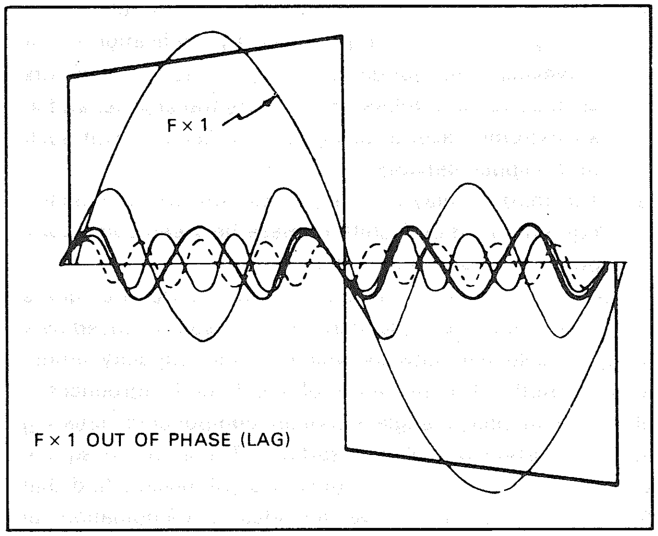



**Fig. 30** Tilt resulting from a phase shift of fundamental frequency in a lagging direction.

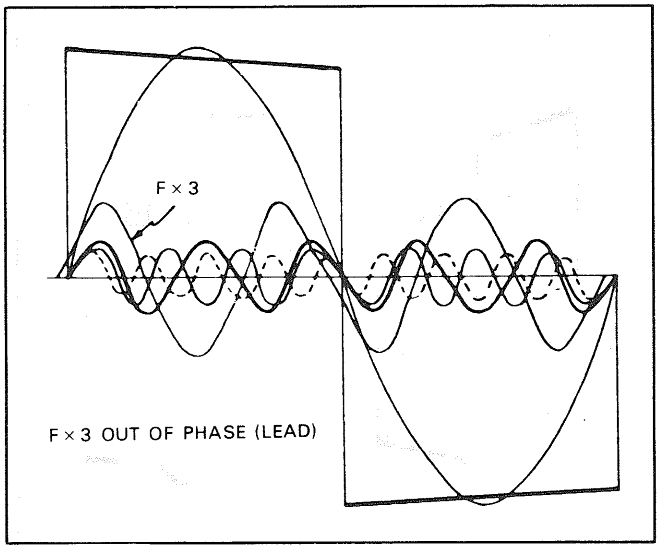



**Fig. 28** Square wave tilt resulting from 3rd harmonic phase shift

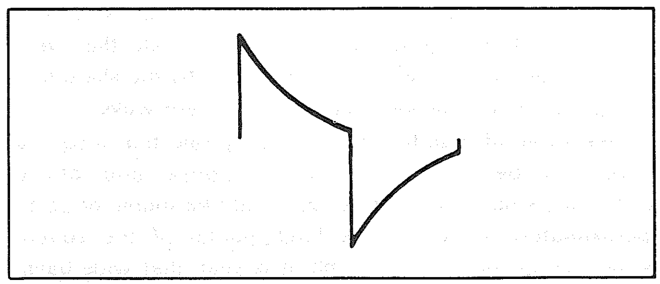


**Fig. 31** Low frequency component loss and phase shift

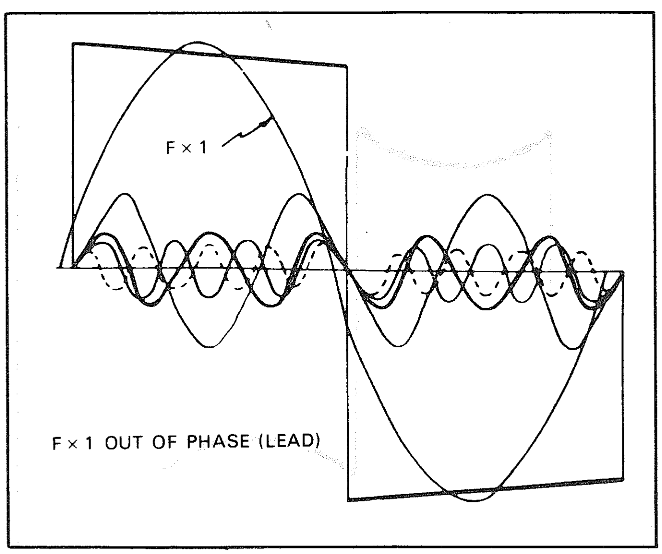



**Fig. 29** Tilt resulting from phase shift of fundamental frequency in a leading direction

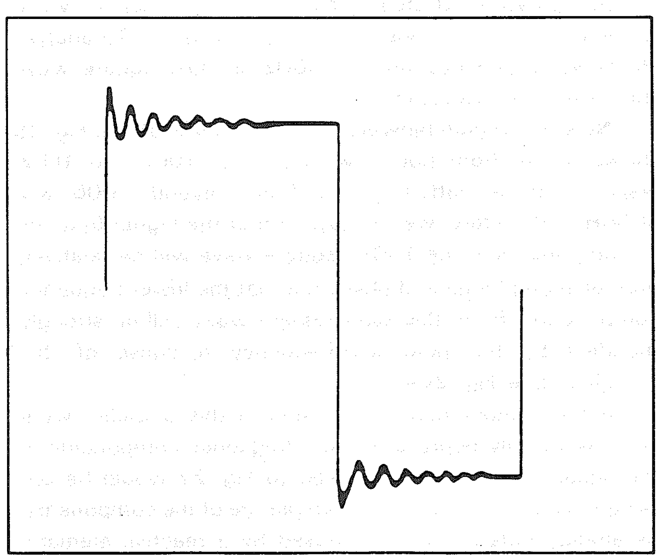


**Fig. 32** Effect of high-frequency boost and poor damping

wave will be amplified disproportionatly greater than the other components creating a higher algebraic sum along the leading edge.

Fig. 32 indicates high-frequency boost in an amplifier accompanied by a lightly damped "shock" transient. The sinusoidal type of diminishing oscillation along the top of the square wave indicated a transient oscillation in a relatively high "Q" network in the amplifier circuit. In this case, the sudden transition in the square wave potential from a sharply rising, relatively high frequency voltage, to a level value of low-frequency voltage, supplies the energy for oscillation in the resonant network. If this network in the amplifier is reasonably heavily damped, then a single cycle transient oscillation may be produced as indicated in Fig. 33.

Fig. 34 summarizes the preceding explanations and serves as a handy reference.

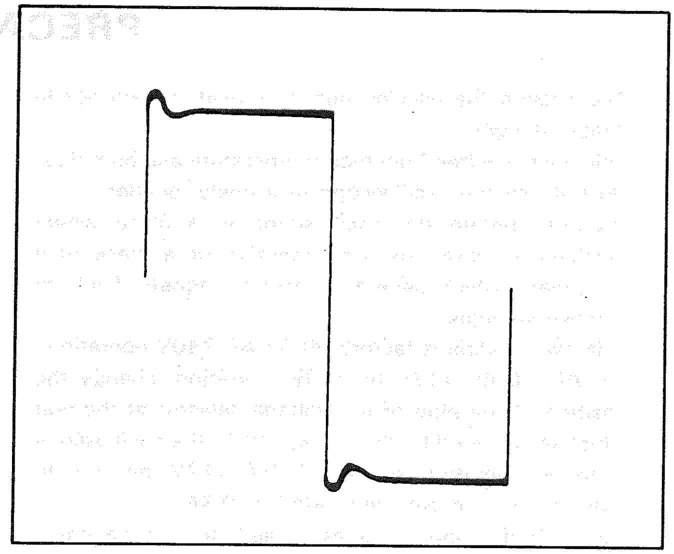


**Fig. 33** Effect of high-frequency boost and good damping

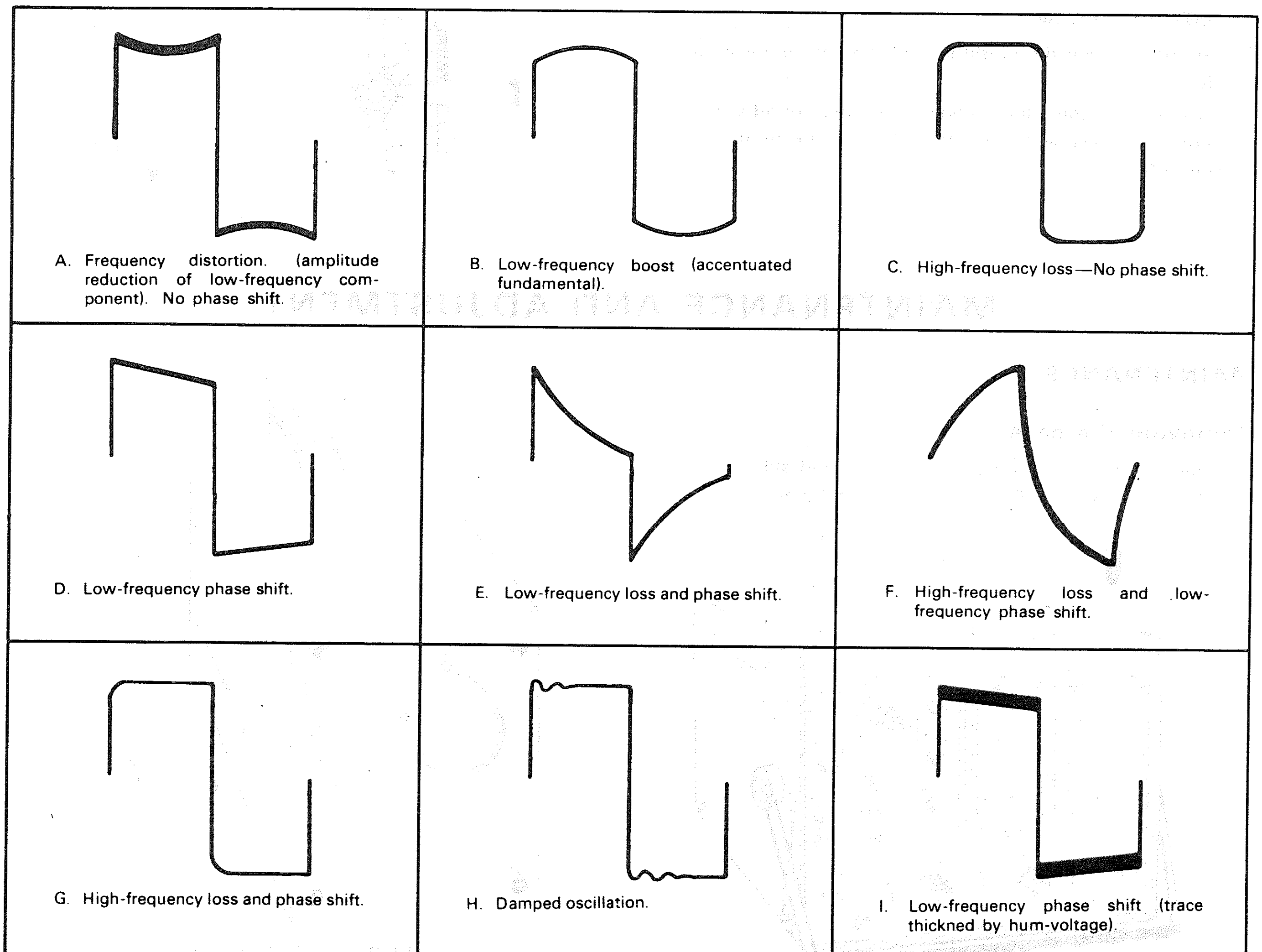



**Fig. 34** Summary of waveform analysis for square wave testing of amplifiers

# 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 voltages.
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. When the oscilloscope is to be operated with AC 100V, 117V, be sure to replace the fuse with one rated at 0.3A.
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 100V (DC+AC peak).
6. Do not increase the brightness of the CRT unnecessarily.
7. Do not leave the oscilloscope for a long period with a bright spot displayed on CRT. Reduce the brightness and soften the focus.
8. 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.

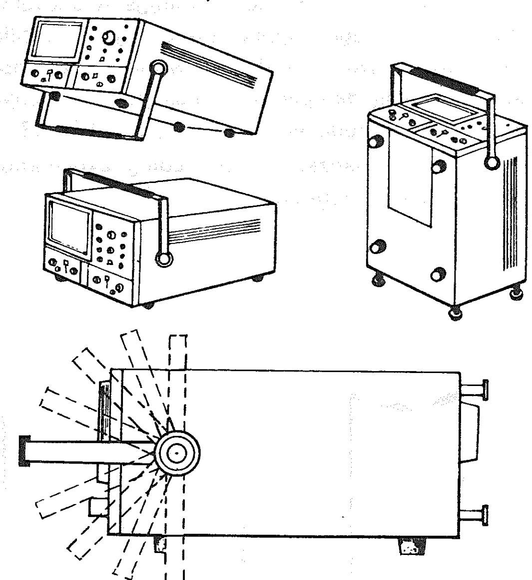


**Fig. 35**

# MAINTENANCE AND ADJUSTMENT

## MAINTENANCE

### Removing the case:

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

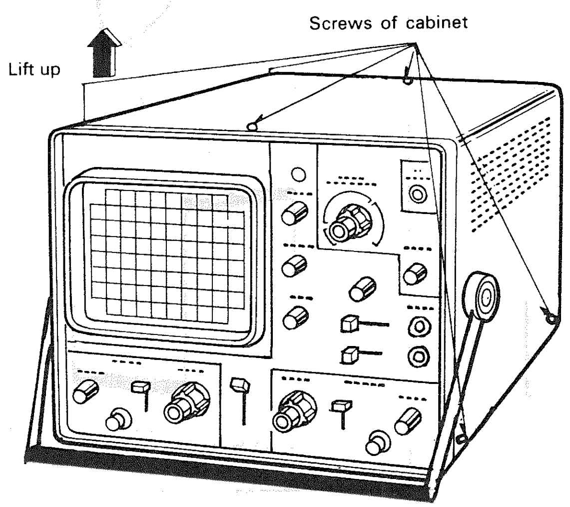



**Fig. 36**

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

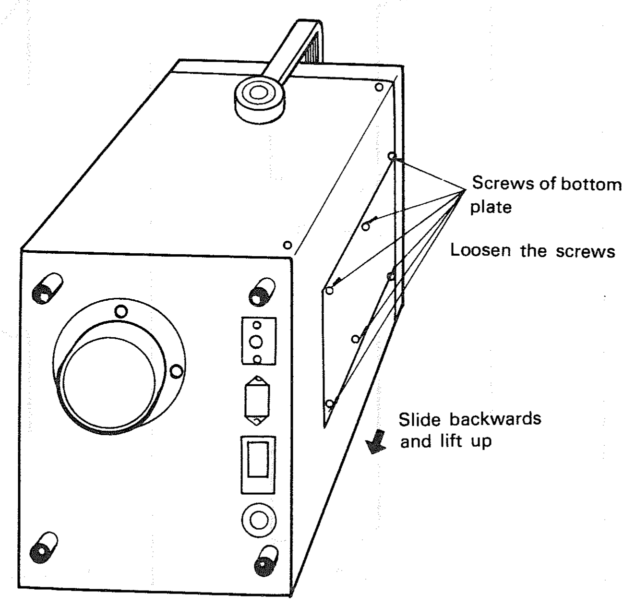



**Fig. 37** Removal of bottom plate

**Caution:** A high voltage (2000V) is present on the CRT socket and the lower printed circuit board. 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.

## AC Voltage selector:

The oscilloscope may be operated from 100V, 117V, 220V, 240V, putting the AC voltage selector in place of another. (Refer to Fig. 38)

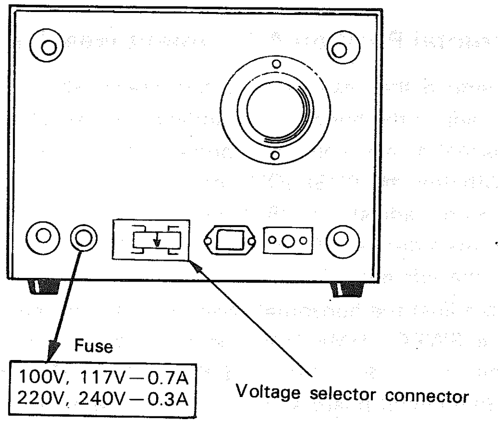



Fig. 38

## Adjustment of CRT bright line azimuth:

CRT bright line angle adjustment. Adjust the TRACE ROTATION (front panel) until the bright line is aligned with the horizontal line marked on the CRT scale.

## 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 screwdriver.
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.

### 180V ADJ Adjustment

1. Remove the bottom plate as described previously.
2. Adjust VR109 on the lower circuit board so that 180V appears on the No. 15 pin of the connector P110 on the same circuit board. (see Fig. 39)

### Blanking Voltage Adjustment

1. Pull the PULL AUTO knob to display a bright line on CRT.
2. Adjust VR108 on the lower circuit board through so that bright line disappears at 9 ~ 11 o'clock position of the brightness adjustment knob. (see Fig. 39)

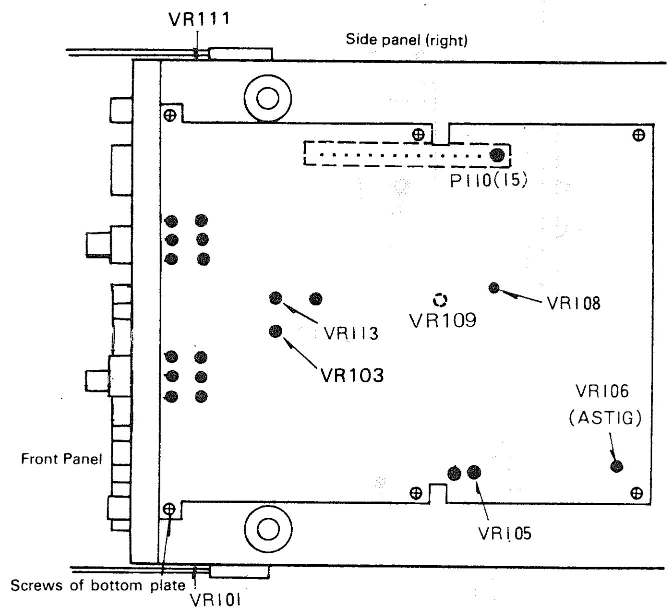



Fig. 39

### Step ATT DC BAL Adjustment (see Fig. 39):

This adjustment is required when the bright line moves up and down by turning the vertical attenuator (VOLTS/DIV).

1. Set the CH1 vertical input selector switch (AC-GND-DC) to GND. Then center the bright line by pulling the PULL AUTO knob.
2. Turn the vertical attenuator (VARIABLE) fully counterclockwise. Adjust VR101 through the hole on the left side of the case so that the bright line is not deflected as the attenuator VOLTS/DIV is turned.
3. Make adjustment for CH2 in the same manner using VR111 in the hole at the right side of the case.

### Variable DC BAL Adjustment (see Fig. 40):

This adjustment is requirred when the bright line moves up or down by turning the vertical attenuator VARIABLE.

1. Remove the case as described previously. For adjustment, use the auxiliary printed circuit board on the bottom.
   Adjust CH1 with VR401 from the left side and CH2 with VR402 from the top.
2. Turn the variable attenuator VARIABLE fully counterclockwise so that the bright line is centered on the scale. Then, turn the attenuator (VARIABLE) fully clockwise. If, at this time, the bright line shifts up or down, adjust VR401 or VR402 until it stays in the center position.
3. Repeat the above procedures until the bright line is stabilized when the attenuator (VARIABLE) is rotated.

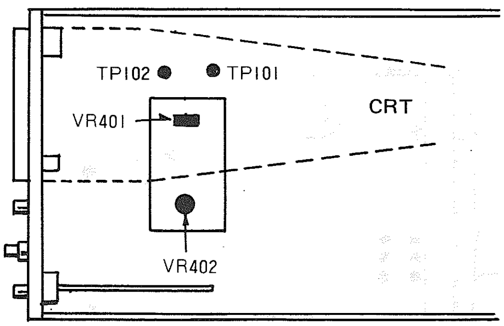



Fig. 40

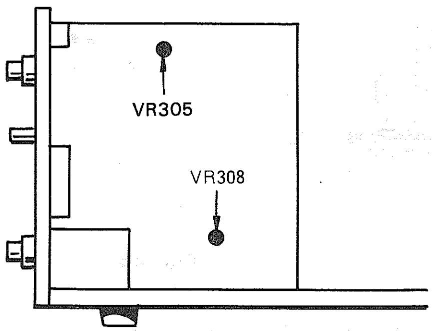



Fig. 41

## CRT Centering Adjustment

1. Remove the case as described previously.
2. Short the test terminals TP101 and TP102 on the lower printed circuit board. (see Fig. 40)
3. With a bright line displayed, adjust VR105 on the same circuit board so that the bright line comes to the vertical center position. (see Fig. 39)

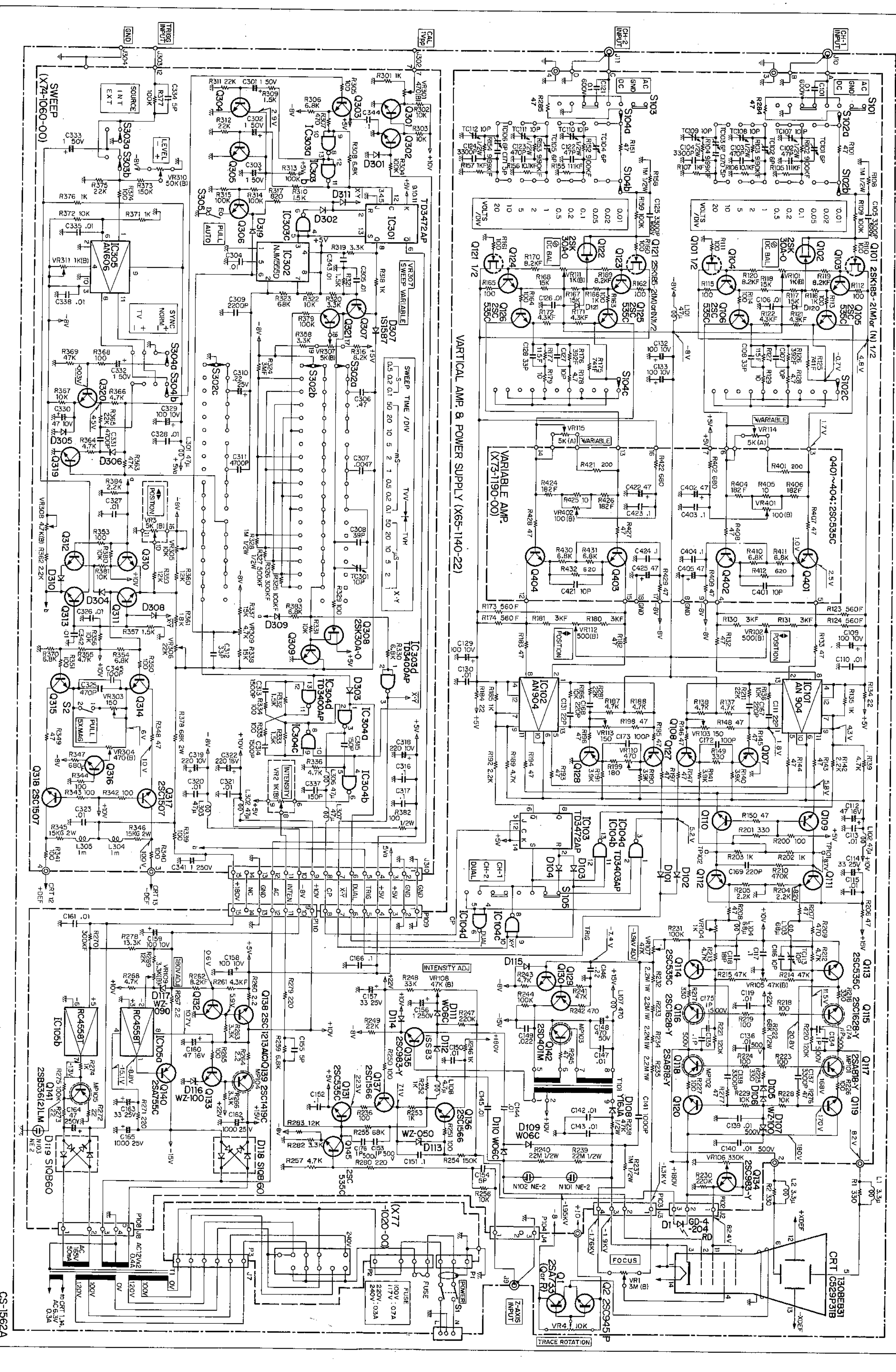
## Horizontal Position Adjustment (see Fig. 41)

1. Remove the case as described previously.
2. To adjust the horizontal position of waveform under the normal sweep condition, proceed as follows:
   With the ◄► POSITION set to its mechanical center position, adjust VR305 (POS ADJ) on the circuit board on the side wall of the case so that the waveform starts at the left end of the scale.
3. To adjust the horizontal position of the waveform when the SWEEP TIME/DIV is in the X-Y position, perform the same adjustment and then adjust VR308 on the same circuit board so that the bright spot comes to the center of the scale.

## ASTIG Adjustment (see Fig. 39)

Adjust VR106, on the lower printed circuit board, through the adjustment hole in the bottom cover until the bright line offers the same thickness. This adjustment should be performed at the same time with the FOCUS control. Once it is adjusted, no further adjustment is required.

# 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.

## MEMO

A product of

**TRIO-KENWOOD CORPORATION**

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