PS163 DUAL TRACE TRIGGERED SWEEP OSCILLOSCOPE

INSTRUCTION MANUAL

SENCORE

"the all american line"

SENCORE SAFETY REMINDERS

When testing electronic equipment, there is always a danger present. Unexpected high voltages can be present at unusual locations in defective equipment. The technician should become familiar with the device he is working on and observe the following precautions.

1. An isolation transformer should always be used on equipment having the chassis tied to one side of the AC power line. The case of the PS163 is connected to the earth ground side of the AC line through the third wire of the line cord. If the chassis of the equipment being serviced is connected to the other side of the AC line, a severe shock hazard will be present. In addition, as soon as the PS163 ground lead is connected to the chassis the resultant short circuit will fuse the ground clip of the scope to the chassis of the equipment being serviced, and blow the fuse to your service bench.

2. When making test lead connections to high voltage points, remove the power. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket as a safety precaution and stand on an insulated floor to reduce the possibility of shock.

3. Discharge filter capacitors before connecting test leads to them. Capacitors can store a charge that could be dangerous to the technician.

4. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.

5. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.

6. Do not work alone when working on hazardous circuits. Always have another person close by in case of accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with higher voltages.

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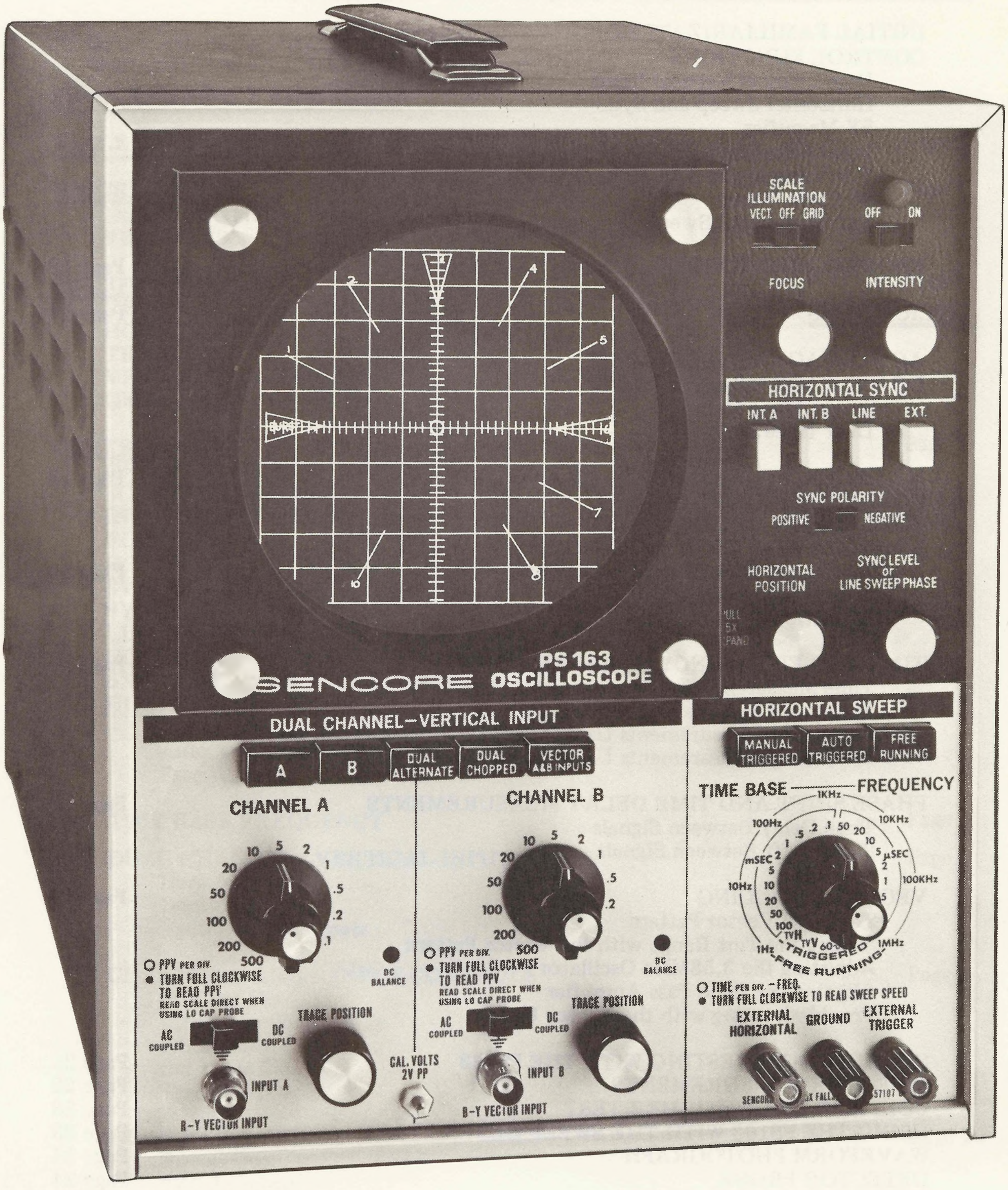


PS163 Dual Channel - Dual Trace Triggered Sweep Oscilloscope

DESCRIPTION

INTRODUCTION

The rapid changes which are taking place in electronics today are causing engineers, designers, technicians and instructors to take a critical look at the equipment they will need to keep pace with these changes. The dramatic increase of solid state components being used has created different test equipment requirements than the tube circuits of the past. The increasing use of Field Effect Transistors and Integrated Circuits are other important facts to consider.

What do all these changes mean to the area of oscilloscopes? First, the lower potentials used in these circuits and the much lower signal levels call for an instrument with increased sensitivity if it is to be practical for the design and servicing of solid state circuits. More emphasis is being placed on critical waveform analysis and the comparison of waveforms, particularly the timing of "concurrent" waveforms present in much of the equipment used today. This includes the fields of television, computors, and particularly the educational field. The instrument to fill these applications requires triggered operation for the meaningful measurement of pulse time and concurrent waveform comparison. It must have full dual trace capability if any comparisons are to be made. In addition, it must be simple to operate and provide full versatility.

The PS163 fulfills these requirements and more. Ease of operation has been one of the important design considerations of the PS163. The Free Running sweep feature has been added to simplify operation for those not familiar with triggered sweep scopes. The PS163 incorporates the latest in solid state design to assure long and trouble free service. A glance at other features of this practical instrument will point out its many uses and advantages.

FEATURES

*** EXTREMELY STABLE triggered sweep with full bandwidth capability in both automatic and manual triggered modes, PLUS free running capability for use as a sync-sweep service oscilloscope.

*** COMPLETE DUAL TRACE capability with pushbutton selection of CHANNEL A, CHANNEL B, DUAL ALTERNATE or DUAL CHOPPED displays, PLUS Sencore's exclusive VECTOR mode for direct display of phase relationships.

*** VERTICAL INPUT SENSITIVITY of 5mV/cm direct. 50mV/cm with low capacity probe. Input attenuator calibrated to read directly when using low capacity probe. Gain continuously variable between attenuator positions.

*** BANDWIDTH of DC to 8MHz-3db, useable to 15MHz. Negligible overshoot, typically 1% or less.

*** CALIBRATED TIME BASE rates from .1 microsecond to .1 second per division in 19 positions plus TVV, TVH, 60Hz and EXT. positions. Sync separator automatically added in TVV and TVH sweep positions for rock solid display of complex TV waveforms. 60Hz and EXT. positions provided for line sweep and use with sweep generators.

*** FRONT PANEL correlation between sweep speed and frequency for ease of operation. Sweep speed continuously variable between steps. 5X magnification provided.

*** PUSHBUTTON SELECTION of trigger sources: Internal Channel A, Internal Channel B, Line or External.

*** HIGH INPUT IMPEDANCE of 10 megohm shunted by 11pf using low capacity probe. 1 megohm shunted by 35pf at input terminals.

*** FULLY PROTECTED Field Effect Transistor input. Maximum input voltage with the Low Capacity Probe is 5000 volts peak to peak AC, or 1000 volts DC. This allows measurements of signals that can destroy other oscilloscopes.

*** ILLUMINATED full size 10 x 10cm grid PLUS illuminated vector grid at the flip of a switch. No separate grids to change or become misplaced.

*** RETRACTABLE TIP on special 5KV low capacity probe for ease of connection in hard to reach places.

*** SOLID STATE for dependable accuracy and reliability. 2KV regulated CRT supply with DC blanking for brightest, sharpest trace possible.

SPECIFICATIONS

VERTICAL (CHANNEL A and B)

Sensitivity	.005V/cm to 50V/cm in 13 ranges. FRONT PANEL calibrated from .05 V/cm to 500V/cm for direct reading with low capacity probe. Gain continuously variable between range positions.
Bandwidth	DC to 8MHz -3db. Useable to 15MHz.
Overshoot	Negligible. Typically 1% or less.
Accuracy	± 2%
Rise Time	40 nanoseconds
Input Voltage	5KV peak to peak AC or 1KVDC maximum through low capacity probe.
Input Impedance	10 megohms shunted by 11pf using low capacity probe. 1 megohm shunted by 35pf at input terminals.

HORIZONTAL

Time Base Range Triggered	.1 microsecond/cm to .1 second/cm in 19 calibrated ranges, continuously variable between steps. Additional TVV and TVH provide correct time base to view vertical or horizontal frames of TV waveforms.
Free Run	.1Hz to 1MHz in 19 ranges, continuously variable between steps.
Accuracy	± 2%(Triggered mode only)
Sweep Magnification	5X, 5% accuracy (not calibrated on .1, .2, and .5uSec/cm)
Horizontal Input	Variable, uncalibrated
Sensitivity	Direct: Less than 750mV required for one cm of deflection. With 5X expand: Less than 150mV required for one cm of deflection.
Input Impedance	1 megohm shunted by 40pf.

TRIGGERING

Manual	Sync level adjustable.
Automatic	Base line reference remains in absence of a trigger source.
Free Run	Conventional sync-sweep operation.
Source	Channel A, Channel B, Line or external. Positive or negative slope polarity.
Level Requirements	
Internal	1cm of display
External	15mV minimum. Input impedance: 1 megohm shunted by 40pf.

VECTOR or X-Y MODE

Sensitivity	.005V/cm to 50Vcm direct. .05V/cm to 500V/cm using low capacity probe.
Frequency Response (-3db)	DC to 8MHz vertical. DC to 7MHz horizontal
Display	Channel A vertical Channel B horizontal
Phase Shift	Negligible. Typically less than 3° at 5MHz.

GENERAL

Rear Access	Vertical deflection plates, ground, 15V peak to peak horizontal sawtooth and Z axis input.
Calibrate output	1KHz, 2V peak to peak square wave through front panel output pin.
Chopped Mode Rate	100KHz.
CRT	5UP1 Flat face round 5 inch, P-1 phosphor, double shielded.
CRT Supply	2KV, 30KHz regulated RF supply.
Retrace Suppression	DC coupled unblanking of CRT.
Graticule	2 layer illuminated, with switch selection of 10 x 10cm grid or 30° vector reference.
Power Requirements	105 to 130 VAC, 60Hz 60 watts.
Size	12 inches high, 10 inches wide and 15½ inches deep.
Weight	30 lbs.

CONTROLS

OFF-ON SWITCH

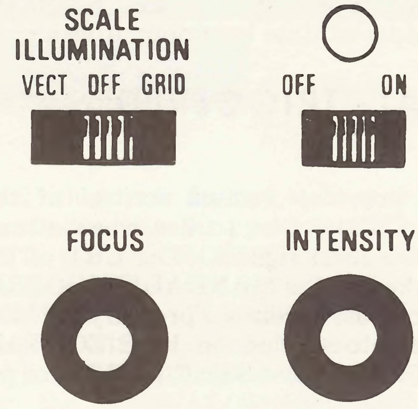
This switch controls the power applied to the unit. The ON condition is shown by a pilot lamp directly above the switch.

SCALE ILLUMINATION

Either the standard 10 x 10cm grid or the vector grid may be illuminated for trace reference. The vector grid is calibrated with 30° reference points to show proper placement of the color vector "petal" pattern. An off position is also provided.

INTENSITY CONTROL

This control adjusts the brilliance of the trace. Trace brilliance may vary somewhat during operation of the PS163 when using the 5X expand at higher frequencies. If the PS163 is to be operated under a stand-by condition for any length of time, it is recommended that the intensity be reduced to prevent burning the face of the CRT.



FOCUS

This control adjusts the sharpness of the trace. Adjust for sharpest trace in center of screen.

HORIZONTAL SYNC

This switch allows selection INT. A, INT B, LINE, or EXT sources for sync information. EXT sync signal is applied to the EXTERNAL TRIGGER input.

SYNC POLARITY

This switch selects the slope of the sync signal used to trigger the time base. The POSITIVE position will cause triggering on a positive going signal; the NEGATIVE position will cause triggering on a negative going signal.

SYNC LEVEL

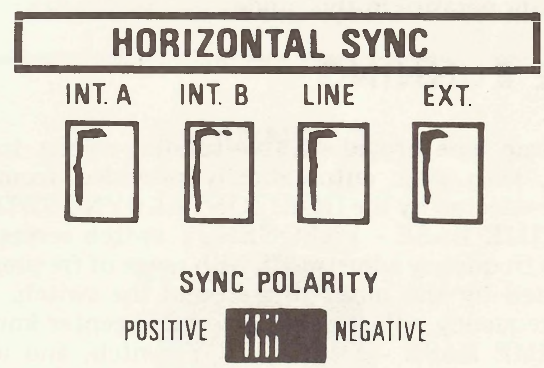
This control functions in MANUAL TRIGGERED HORIZONTAL SWEEP mode only. It is used to adjust the level of sync signal necessary to produce sweep and provide a stable display.

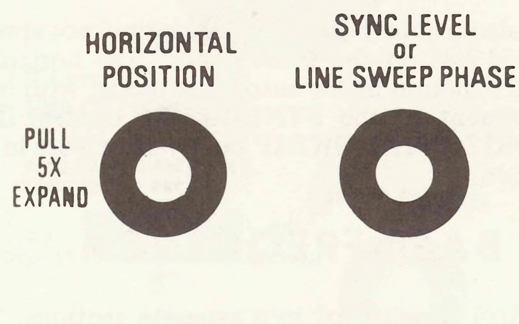
LINE SWEEP PHASE

This control functions in the 60 cycle position of the TIME BASE - FREQUENCY switch only. It is used to adjust the phase of the internal 60 Hertz sine wave applied to the horizontal amplifier for line sweep.

HORIZONTAL POSITION

This control adjusts the horizontal position of the trace in all functions except the VECTOR A+B VERTICAL INPUT MODE. The CHANNEL B TRACE position control will adjust the horizontal trace position in the VECTOR mode.





5X EXPAND

The 5X EXPAND is activated by a push-pull switch coupled to the HORIZONTAL POSITION control. When this switch is in the out position, the center two centimeters of the horizontal trace are expanded to a full 10cm wide display.

HORIZONTAL SWEEP

This pushbutton switch provides selection of four different modes of time base operation.

MANUAL TRIGGERED

This mode provides manual control of the SYNC LEVEL, and is the best to use when attempting to view very low level signals. The CRT of the PS163 will be blanked in the MANUAL TRIGGERED mode until the time base receives a properly adjusted trigger pulse. (Refer to section on HORIZONTAL SYNC, SYNC POLARITY, and SYNC LEVEL for proper adjustment of these controls).

AUTO TRIGGERED

In this mode, the time base will provide a free running sweep in the absence of a trigger signal. The time base will automatically switch to true calibrated triggered sweep operation as soon as a trigger signal is applied. The SYNC LEVEL is preset, and the control is inoperative in this mode.

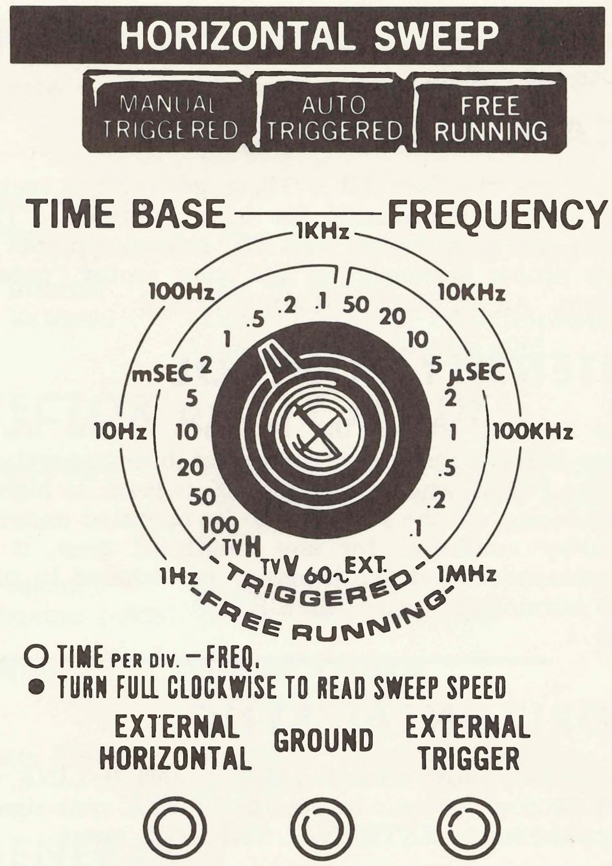
FREE RUNNING

The time base provides a free running sweep in this mode, with sync automatically provided from the source selected by the HORIZONTAL SYNC SWITCH. The TIME BASE - FREQUENCY switch serves as a course frequency adjustment, with range of frequencies indicated by the outer ring around the switch. The fine frequency adjustment is the small center knob of the TIME BASE - FREQUENCY switch, and is adjusted for a locked in pattern.

There is also a fourth mode of operation not specifically called out on the front panel. The horizontal sweep will function in the automatic mode, with manual adjustment of the SYNC LEVEL control if all three HORIZONTAL SWEEP push buttons are in the out position.

TIME BASE-FREQUENCY

This control consists of two separate sections. The first is an outer switch showing sweep rate per division. This switch also shows the approximate sweep rate in cycles per second to aid the technician in determining the correlation between time base rates and frequency. Two additional positions (TV Hor-



izontal and TV Vertical) provide preset sweep frequencies for convenient display of television signals. A sync separator circuit is automatically switched in when the TV Vertical or TV Horizontal positions are selected. The 60 Hertz position of this switch connects the 60Hz line signal to the horizontal deflection amplifier. The phase can be adjusted by the LINE SWEEP PHASE control.

The EXT. position allows an external signal to provide horizontal sweep. This signal should be connected to the EXTERNAL HORIZONTAL jack.

The second section is the small knob in the center of the outer switch. This control operates as an uncalibrated fine frequency control in all normal sweep positions, and as a horizontal gain control in the 60Hz and EXT. sweep positions. For normal operation of the calibrated sweep speeds, this control should be turned to the clockwise end of its rotation until it snaps into the detent provided.

DUAL CHANNEL-VERTICAL INPUT

This push button switch gives instant selection of five different "displays" or modes of operation. The CHANNEL A and CHANNEL B modes provide single trace display of the selected channel.

DUAL ALTERNATE

This switch provides dual trace display of the CHANNEL A and CHANNEL B signals. The signal from one input channel, CHANNEL A for example, is displayed on the first sweep cycle. On the next sweep cycle the other channel is displayed. This is the recommended mode to use for most dual trace operations.

DUAL CHOPPED

This dual trace mode is most useful at slow sweep speeds and when it is desired to have dual trace display when using the 60 cycle or EXT. sweep provisions. The DUAL CHOPPED mode uses a 100KHz square wave to switch the input between CHANNEL A and CHANNEL B. This will provide a continuous steady display of both channels at slow sweep speeds. The DUAL CHOPPED mode is intended to be used only with the MANUAL TRIGGERED and FREE RUNNING sweep modes. The AUTO TRIGGERED function, because of its extreme sensitivity, will tend to trigger on the 100KHz chopping signal.

VECTOR A&B INPUTS

This display mode converts the PS163 to a full sensitivity Vector scope or X-Y scope. The input to CHANNEL A will be displayed vertically; the input to CHANNEL B will be displayed horizontally.

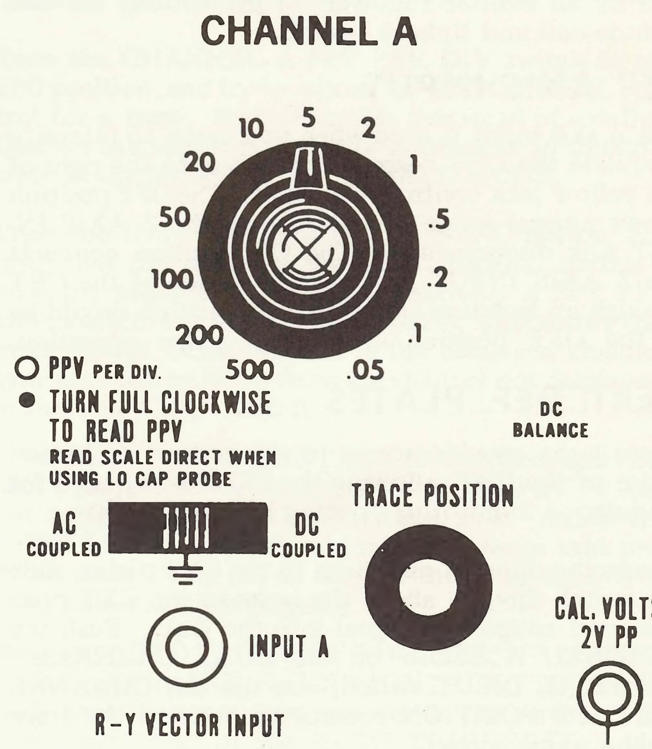
CHANNEL A and B INPUT CONTROLS

The CHANNEL A and CHANNEL B amplifiers are electrically identical and a description of one will apply to the other.

PPV PER DIV.

This switch adjusts the input sensitivity of the amplifiers, and is calibrated in volts per division. The center knob of this switch is a vernier control that adjusts the sensitivity of the amplifier between switch positions. For normal operation with calibrated input this control should be turned fully clockwise until it snaps into the detent provided.

The input amplifiers are calibrated to read input voltage directly when using the Sencore 39G34 LO CAP PROBE. No multiplication of readings is required when using the LO CAP PROBE. The maximum input voltage with the LO CAP PROBE is 5000 volts peak to peak AC or 1000 volts DC. When a direct probe is used, all readings of the input voltage are multiplied by .1. The maximum input voltage direct is 600 volts DC plus peak AC.



INPUT COUPLING SWITCH

This switch is used to select the method of coupling the input signal to the amplifier. Use the AC COUPLED position for normal peak to peak waveform measurements. Use the DC COUPLED position when you wish to measure DC voltage. Use the center ground position to establish a zero reference for the amplifier.

DC BALANCE

This control is used to maintain the DC balance of the amplifier. Its function is similar to the zero adjust control on a VTVM. Should this control require adjustment, follow the procedure outlined in the CALIBRATION section of the Service Manual.

CAL. VOLTS 2V PP

A 2 volt peak to peak square wave output is provided on the front panel of the PS163 as a calibration check voltage and probe adjustment signal. The LO CAP PROBES may require a periodic checking for proper frequency compensation.

TRACE POSITION

This control normally adjusts the vertical position of the trace. The CHANNEL B TRACE POSITION control becomes a horizontal position control in the VECTOR function.

REAR PANEL INPUTS and CONTROLS

Access to the vertical deflection plates, the "Z" axis input and a sweep output signal are all available on the rear access panel of the PS163.

SWEEP OUT

This is a 15 volt peak to peak negative going sawtooth signal with frequency determined by the timè base switch. This is isolated from the time base circuit by an emitter follower for protection. Its uses include coil and flyback testing.

"Z" AXIS INPUT

The Z axis input is used when you desire to intensity modulate the CRT beam. The switch to the right of the yellow jack controls the input. The OFF position allows normal scope operation with the Z AXIS INPUT jack disconnected. The ON position connects the Z AXIS INPUT jack to the cathode of the CRT through an isolation capacitor. This switch should be in the OFF position on normal scope operation.

VERT. DEF. PLATES

These jacks provide access to the vertical deflection plates of the CRT, allowing the PS163 to be used for modulation monitoring or other lab experiments.

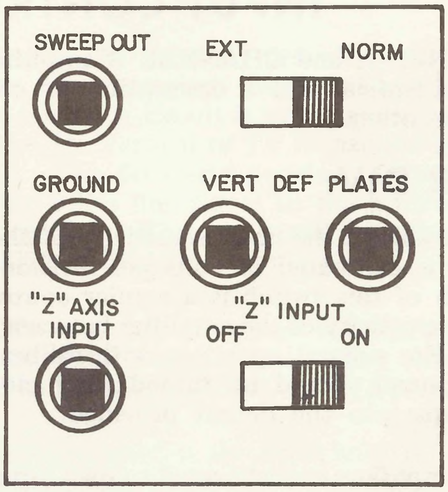
To use the direct connections to the CRT plates, slide the switch directly above the jacks to the EXT position, and couple the signal into the jacks. Push the CHANNEL A button on the DUAL CHANNEL - VERTICAL INPUT switch, and use the CHANNEL A TRACE POSITION control to position the trace on the scope screen.

ASTIGMATISM CONTROL

This control is adjusted along with the FOCUS control for a sharp trace in the center of the oscilloscope screen, and is located directly below the rear access panel.

CIRCUIT BREAKER

The power supply of the PS163 incorporates a circuit breaker for protection. Should a power supply overload occur, the breaker will trip. Reset by pressing red button fully in and releasing.



NOTE: When not using the VERT DEF PLATES jacks, the switch directly above the jacks should be in the NORM position. A drastic reduction of the vertical amplifier bandwidth, as well as improper operation of the DUAL ALTERNATE and DUAL CHOPPED modes will result if this switch is left in the EXT position.

OPERATING INSTRUCTIONS

INITIAL FAMILIARIZATION

This section contains a simple procedure that you can use to get acquainted with the operation of the controls on the PS163 oscilloscope.

SET UP

1. Plug the PS163 into a properly grounded AC outlet and slide the OFF - ON switch to the ON position. Note the indicator directly above the switch.

2. Use the 39G34 LOW CAPACITY PROBES to connect the CAL. VOLTS 2V PP output to the CHANNEL A and B inputs.

3. Set the front panel controls as follows:

SCALE ILLUMINATION	GRID
HORIZONTAL SYNC	INT.A
SYNC POLARITY	POSITIVE
HORIZONTAL SWEEP	AUTO TRIGGERED
TIME BASE - FREQUENCY (Center knob full clockwise)	.5mSec./DIV
VERTICAL INPUT	DUAL ALTERNATE
PPV PER DIV. (A&B) Center knob full clockwise	1V/DIV
INPUT COUPLING (A&B)	AC COUPLED

4. Adjust the FOCUS and INTENSITY controls for a sharp trace with useable brightness. Adjust the HORIZONTAL POSITION control so that the trace starts at the left hand edge of the 10x10 grid.

5. Use the CHANNEL A TRACE POSITION control to center the CHANNEL A trace in the upper half of the oscilloscope screen, and the CHANNEL B TRACE POSITION CONTROL to center the CHANNEL B trace in the lower half of the oscilloscope screen.

CONTROL FUNCTIONS

DUAL CHANNEL VERTICAL INPUT

Press the A and B VERTICAL INPUT buttons. Note that with the A button pushed, only the CHANNEL A waveform is displayed. The CHANNEL B waveform is displayed when the B button is pressed. Press the DUAL ALTERNATE and DUAL CHOPPED buttons and note that both the CHANNEL A and CHANNEL B waveforms are displayed. (When the chopped button is pushed, the waveform may not be stable. This is due to the influence of the 100KHz chopping signal on the trigger circuit when in the AUTO TRIGGERED mode.)

Press the VECTOR A&B INPUTS button, and note that the display is now two dots connected by a dim line. Adjust the CHANNEL A TRACE POSITION, and the CHANNEL B TRACE POSITION controls, and note that the CHANNEL A TRACE POSITION effects the vertical position of the display, and that the CHANNEL B TRACE POSITION effects the horizontal position of the display. Slide the SCALE ILLUMINATION switch to the VECTOR position, and note that the scale is now illuminated for the standard 10 bar color TV vector pattern. Return the SCALE ILLUMINATION switch to the GRID position, and press the A VERTICAL INPUT button.

HORIZONTAL SWEEP and SYNC

Press the MANUAL TRIGGERED HORIZONTAL SWEEP button, and adjust the SYNC LEVEL control for a locked in pattern. Note the range of rotation of the SYNC LEVEL control that produces a trace. Turn the CHANNEL A PPV PER DIV switch to the 10 position, and again adjust the SYNC LEVEL control. Note the range of rotation that produces a trace is narrower than before.

Turn the CHANNEL A PPV PER DIV switch to the 100 position, and try to adjust the SYNC LEVEL control for a trace. Note that with this small of a deflection on the screen it is nearly impossible to obtain a trace in the MANUAL TRIGGERED MODE.

Press the INT. B HORIZONTAL SYNC button, and note that the range of the SYNC LEVEL control is now the same as when the CHANNEL A PPV PER DIV. switch was set to the 1V/DIV. This shows that even though CHANNEL A is the displayed channel, sync may still be taken from the channel not displayed, in this case CHANNEL B.

Press the EXT. HORIZONTAL SYNC button, and connect a jumper wire from the CAL. VOLTS 2V PP output to the EXTERNAL TRIGGER jack. Adjust the SYNC LEVEL control, and note the range that produces trace. This shows the sensitivity of the PS163 to an external trigger signal.

Press the AUTO TRIGGERED HORIZONTAL SWEEP button, and the INT. A HORIZONTAL SYNC button. Note that the trace now appears on the screen. This is the advantage of the AUTO TRIGGERED mode. A trace will be produced even in the absence of a signal.

Turn the CHANNEL A PPV PER DIV switch back to the 1 position, and slide the SYNC POLARITY switch back and forth between the POSITIVE and NEGATIVE positions. Note that with the SYNC POLARITY switch in the POSITIVE position, the first half cycle of the displayed square wave is positive, and with the switch in the NEGATIVE position the first half cycle is negative.

Turn the TIME BASE - FREQUENCY switch counterclockwise to the 10mSec/DIV position, and back clockwise to the .1mSec./DIV position. Note that the slower the sweep speed, the larger the number of displayed cycles and the faster the sweep speed, the lower the number of displayed cycles. Leave the TIME BASE - FREQUENCY switch set to .1mSec/DIV.

Press the FREE RUNNING HORIZONTAL SWEEP button, and note how the sweep loses sync. Adjust the small center knob of the TIME BASE - FREQUENCY switch to lock in the square wave. Note that in the FREE RUNNING mode the horizontal sweep is the same as on a conventional sync sweep scope. The horizontal sweep frequency must be adjusted for a whole number of cycles of the displayed waveform. Press the AUTO TRIGGERED HORIZONTAL SWEEP button, and return the small knob on the TIME BASE - FREQUENCY switch to the full clockwise position.

5X MAGNIFIER

Turn the TIME BASE - FREQUENCY switch to the .5mSec/DIV position, and adjust the small center knob for 10 cycles of the displayed waveform in 10 divisions (one division per cycle). Pull on the HORIZONTAL POSITION control to activate the 5X EXPAND. Note that one cycle of the squarewave now occupies 5 divisions. Push the HORIZONTAL POSITION knob back in, and adjust it so that the trace starts back at the left hand edge of the 10x10 grid. Return the small center knob to the full clockwise calibrated position.

INPUT COUPLING

Slide the CHANNEL A INPUT COUPLING switch to the center ground position, and adjust the CHANNEL A TRACE POSITION control so that the trace is directly on the major horizontal grid line.

Slide the switch to the AC COUPLED position and note that the square wave is two divisions high, and that it is centered around the major horizontal grid line.

Slide the switch to the DC COUPLED position. Note that the square wave is still two divisions high, but that it is now two divisions above the major horizontal grid line. This indicates that the Cal VOLTS 2 V PP signal is changing from zero to positive, and back to zero gain.

TV Vertical and TV Horizontal

Connect a stable color bar generator such as the Sencore CG159 to the antenna terminals of a properly operating television receiver. Turn the pattern selector of the color bar generator to the crosshatch pattern, and adjust the receivers fine tuning, brightness and contrast controls to properly display the crosshatch pattern. Use the 39G34 LO CAP PROBE to connect the PS163 CHANNEL A input to the base or control grid of the first video amplifier stage. Adjust the controls on the PS163 as follows:

HORIZONTAL SYNC	INT.A
HORIZONTAL SWEEP	AUTO TRIGGERED
TIME BASE - FREQUENCY	TV V
VERTICAL INPUT	A
CHANNEL A PPV PER DIV	1V/DIV
INPUT COUPLING	AC COUPLED

Set the SYNC POLARITY switch to the POSITIVE position if the sync pulses at the test point are positive, and to the NEGATIVE position if the sync pulses are negative.

Turn the TIME BASE - FREQUENCY switch to the TV H position, and note that in either the TV H or TV V sweep positions, the composite video waveform remains stable.

Turn the color bar generator pattern selector to the color bar position, and pull on the PS163 HORIZONTAL POSITION knob. Rotate the HORIZONTAL POSITION control and note the expanded waveform.

Push the HORIZONTAL POSITION knob back in, and adjust the HORIZONTAL POSITION control so the waveform starts at the left hand edge of the 10x10 grid.

60 Cycle Sweep

Use the 39G34 LO CAP PROBE to connect approximately 6.3 volts AC 60Hz from a filament circuit in the receiver to the CHANNEL A input. Turn the TIME BASE - FREQUENCY control to 60 Hertz sweep. Adjust the CHANNEL A PPV PER DIV switch for about 8 divisions of vertical deflection.

Adjust the LINE SWEEP PHASE control and note how this control effects the phase relationship between the input signal and the internal 60 cycle line sweep.

Turn the small center knob of the TIME BASE - FREQUENCY switch counter - clockwise until the display is two horizontal divisions wide, and note that this control now functions as a horizontal gain control.

Pull on the HORIZONTAL POSITION knob, and note that the 5X EXPAND functions in the 60 cycle sweep function. Push the HORIZONTAL POSITION knob back in, and return the small knob of the TIME BASE - FREQUENCY switch to its full clockwise calibrated position.

EXT. Horizontal Sweep

Connect a jumper wire from the CAL. VOLTS 2V PP output to the EXTERNAL HORIZONTAL jack. Turn the TIME BASE - FREQUENCY switch to the EXT position. Note that the horizontal sweep is now provided by the external signal. Turn the small center knob of the TIME BASE - FREQUENCY switch counter - clockwise until the display is two divisions wide, and note this control now functions as a horizontal gain control. Pull on the HORIZONTAL POSITION knob, and note that the 5X EXPAND also functions in the EXT. Horizontal sweep function.

PROBE COMPENSATION

The 39G34 low capacity probe contains an adjustable compensation capacitor (C1 on the schematic). The adjustment of this capacitor should be checked frequently to insure accurate square wave reproduction. The setup for adjusting this capacitor is as follows:

HORIZONTAL SYNC	INT A or INT B
SYNC POLARITY	POSITIVE
HORIZONTAL SWEEP	AUTO TRIGGERED
TIME BASE - FREQUENCY	.5mSec/DIV
VERTICAL INPUT	CHANNEL A or CHANNEL B (must be the same as HORIZONTAL SYNC above).
PPV PER DIV	.5V/DIV
INPUT COUPLING	DC COUPLED

Use the probe to be compensated to connect the CAL. VOLTS 2V PP to the selected channel, and adjust the INTENSITY, FOCUS, HORIZONTAL POSITION, and TRACE POSITION controls for a sharp viewable trace near the center of the 10 x 10 grid. Adjust C1 for a square wave with a flat top. If C1 is over compensated, the square wave will have a peak on the leading edge. If C1 is under compensated, the corner of the square wave will be rounded.

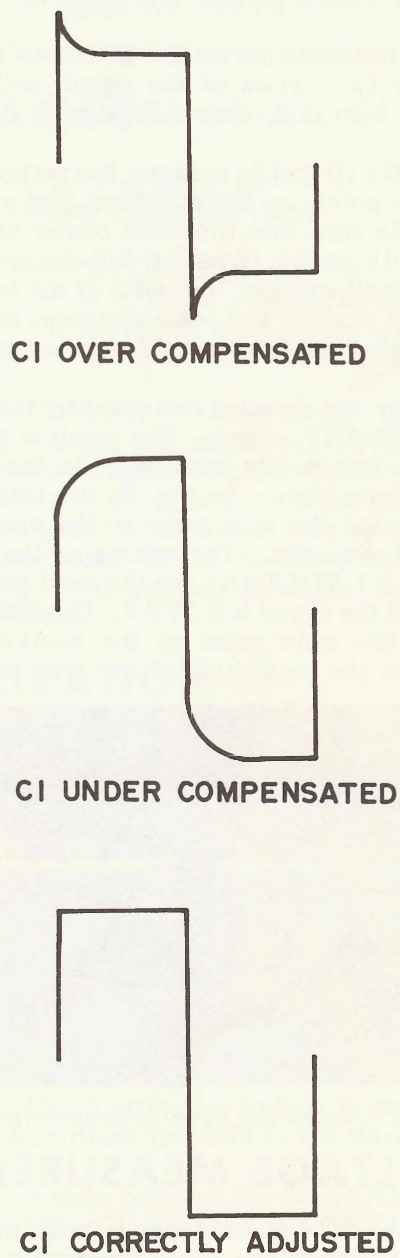


Fig. 1. Effect of C1 on square wave response.

APPLICATIONS

AC VOLTAGE MEASUREMENT

The measurement of AC voltages is one of the more important uses for an oscilloscope. The calibrated inputs of the PS163 make possible very accurate measurements using the following procedure:

1. Use one of the 39G34 LO CAP PROBES to connect the signal to be measured to either the CHANNEL A or B input. If the amplitude of the voltage to be measured is in doubt, start with the PPV PER DIV. switch set to the 500 position. Set the INPUT COUPLING switch to the AC COUPLED position.

2. Adjust the controls on the PS163 to display approximately two cycles of the signal, with an amplitude of at least one vertical division.

3. Use the 10 x10 grid to measure the vertical distance between the points on the waveform that you wish to measure. Be sure that the small center knob of the PPV PER DIV switch is turned full clockwise. When measuring small voltages, the width of the trace can be a significant part of the total distance, so make all measurements from the same side of the trace.

4. Multiply the distance measured by the setting of the PPV PER DIV switch. The result is the voltage between the two points measured. In the composite video waveform shown in Fig. 2, the total distance from the tip of the sync pulse to the most negative point is 2.2 divisions. The setting of the PPV PER DIV switch is 1 VOLT/DIV, so the total peak to peak amplitude of the signal is 2.2VP-P. The distance from the tip of the sync pulse to the blanking level is 1 division so the amplitude of the sync pulse is 1V.

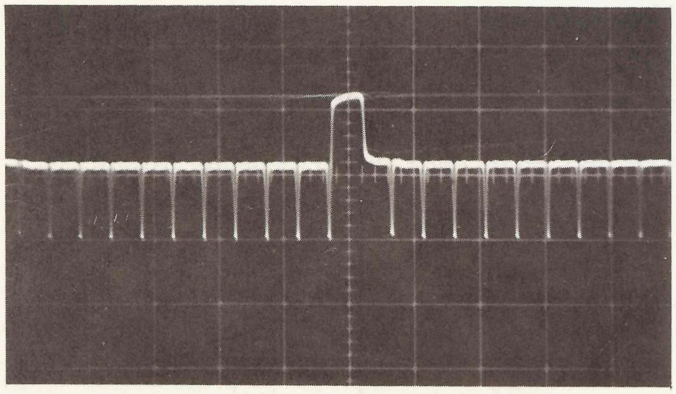


Fig. 2. Measuring peak-to-peak voltages.

DC VOLTAGE MEASUREMENT

The use of the DC coupled scope to measure both DC as well as AC signals can speed servicing in many circuits, especially solid state. With the DC coupled scope, servicing can be faster as you will not need to keep switching back and forth between the scope and the DC voltmeter. Here are two handy methods of making DC voltage measurements with the PS163.

SINGLE TRACE METHOD

1. Set the VERTICAL INPUT to CHANNEL A and the INPUT COUPLING switch to the center ground position.

2. Use the CHANNEL A TRACE POSITION control to center the trace on the major horizontal grid line of the scope graticule.

3. Set the coupling switch to DC and connect the probe to the point where the signal is to be measured.

Start with PPV PER DIV. switch set to 500 VOLTS/DIV and slowly turn the switch clockwise until the trace moves up or down between three and four centimeters. An upward movement indicates a positive voltage, a downward movement a negative voltage.

4. Note the number of centimeters or divisions the trace has moved from the center graticule line and multiply this by the setting of the vertical input switch. If the trace moves up 4 divisions and the PPV PER DIV. switch is set to 10 volts/Div., the voltage would be 10 volts/Div x 4 Div = +40 volts. NOTE: CHANNEL B may also be used for DC voltage measurements.

DUAL TRACE METHOD (Preferred)

This method takes advantage of the dual trace capability of the PS163 by using the CHANNEL B trace as a reference while measuring with CHANNEL A. Press the DUAL ALTERNATE VERTICAL INPUT button, set the CHANNEL A PPV PER DIV. switch so the expected voltage at the point to be measured is less than 6 times the switch setting, set both the CHANNEL A and B INPUT COUPLING switches to the center ground position. Adjust the CHANNEL A and B TRACE POSITION controls so both traces are lined up with the major horizontal grid line. Connect the CHANNEL A probe to the test point, and slide the CHANNEL A INPUT COUPLING switch to the DC Position. Using the CHANNEL B trace as a reference, count the number of divisions up or down the CHANNEL A trace moves and multiply by the setting of the PPV PER DIV. switch. If the CHANNEL A trace moves down 3.4 divisions and the PPV PER DIV. switch is set to .2 VOLTS/DIV., the measured voltage is .2 VOLTS/DIV.x-3.4 Div = -.68 volts.

MEASURING THE DC LEVEL of an AC SIGNAL

The DC level of an AC signal is often more important than the actual signal amplitude. The DC coupled PS163 makes the critical level measurements accurately using the following procedure.

Follow the set up procedure for the Dual Trace Methods of DC voltage measurements. In the composite video waveform in Fig. 3, the DC level of the blanking level is 2 divisions at 1 volt/Div. or 2 volts. The DC level of the top sync pulses is 3 divisions, or 3 volts. The DC level of the negative tips of the video information is 1 division at 1 volt per division or 1 volt.

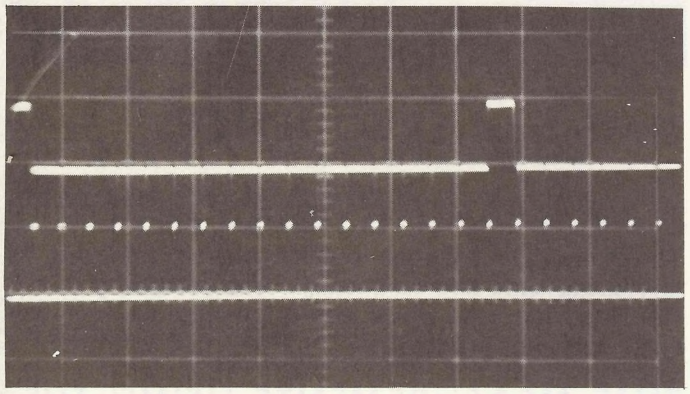


Fig. 3. Measuring DC level of video signal.

COMPARISON OF VOLTAGES

In some cases, such as a stereo amplifier, a comparison of a good working channel to the defective channel is a quick way of establishing the defective stage or component. The Dual Trace PS163 is an ideal instrument for this purpose.

1. Set the scope to AUTO TRIGGERED and press the DUAL ALTERNATE button on the VERTICAL INPUT switch. Use the TRACE POSITION controls to set each trace to the same reference point on the scope grid.

2. Use CHANNEL A on the working channel as your reference and CHANNEL B on the defective section. Connect both probes to the same point in each unit or amplifier, as shown in Fig. 4.

3. Note the deflection of the CHANNEL A and the CHANNEL B traces. They should be the same or very close if there is no defect at this point. When the CHANNEL B deflection does not match the A or reference channel, then the defective stage has been located.

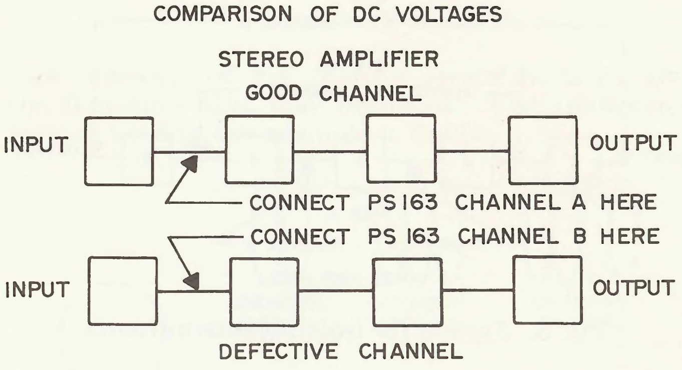


Fig. 4. Comparing voltages in stereo amplifier.

COMPARISON of AC SIGNALS

The same technique as above can be used to observe AC signals to locate a defective stage.

1. Use the TRACE POSITION controls to center the CHANNEL A trace in the upper half of the 10 x 10 grid, and the CHANNEL B trace in the lower half of the 10 x 10 grid. Use sync from CHANNEL A.

2. Connect CHANNEL A to the desired test point in the working channel and adjust the PS163 controls for a viewable waveform. Set the CHANNEL B PPV PER DIV switch to the same setting and connect it to the same test point in the other channel. The same amplitude waveform should be observed. If a difference exists, then you have located the defective area in the chassis.

LOCALIZATION of INTERMITTENTS

An intermittent condition is the most difficult to locate problem in any piece of electronic equipment. In many cases the trouble disappears as you try to make a measurement. The normal troubleshooting procedure with only one scope can waste much valueable time as you are only able to observe one test point at a time. A dual trace oscilloscope such as the Sencore PS163 allows you to observe two test points at the same time, and thus cut the time that it takes to locate the intermittent condition in half. Use the example of Fig. 5 with the following procedure to locate an intermittent problem in a 5 stage amplifier.

1. In the first step, connect the CHANNEL A probe to the input of Stage 1, and the CHANNEL B probe to the output of stage 5.

Observe the output of stage 5 and the input to stage 1 both before and after the intermittent occurs. The

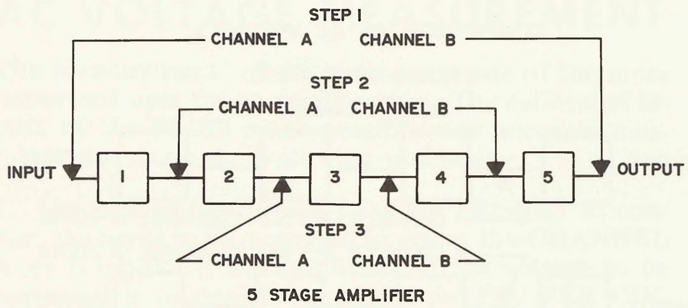


Fig. 5. System for isolating intermittents.

output of stage 5 should change, while the input to stage 1 should remain the same.

2. Step 2, connect the CHANNEL A probe to the input of stage 2, and the CHANNEL B probe to the output of stage 4. Observe the two waveforms both before and after the intermittent occurs. If the input to stage 2 remains the same, and the output of stage 4 changes, proceed with step 3. If both the waveforms change, the intermittent is located in stage 1. If both waveforms remain unchanged, the intermittent is located in stage 5.

3. Step 3, connect the CHANNEL A probe to the input of stage 3 and the CHANNEL B probe to the output of stage 3. If the output of stage 3 changes and the input remains the same, the intermittent is located in stage 3. If the input and output of stage 3 both change, the intermittent is located in stage 2. If both the input and output of stage 3 remain the same, the intermittent is located in stage 4.

Once the intermittent stage is located, monitor the input and output of that stage. Check each component by heating it, cooling it or lightly tapping on it. The intermittent component will cause the output of that stage to change.

GAIN and DISTORTION MEASUREMENTS

The gain and distortion of circuits such as a solid state audio amplifier are important service as well as design considerations. The Dual Trace PS163 is an ideal instrument for these measurements.

GAIN MEASUREMENTS

The small center knobs of both PPV PER DIV switches must be in the full clockwise calibrated position to measure gain.

1. Apply a signal to the input of the amplifier, and monitor this signal with CHANNEL A.

2. Connect CHANNEL B to the output of the amplifier, and adjust the input signal so no clipping occurs in the output waveform.

3. Measure the peak to peak amplitude of the input and output signals and divide the output signal by the input signal. For example, if the input signal is .25 VP-P and the output is 1.5VP-P, the gain is 1.5 divided by .25 or a gain of 6.

DISTORTION MEASUREMENTS

Once set up to measure gain it is a simple matter to also check for distortion.

1. Adjust the PS163 controls including the small center knob of the PPV PER DIV switch, to superimpose the CHANNEL A and B traces.

2. Observe the two waveforms. They should be exactly the same. A difference between the input and output waveform indicates distortion in the amplifier. (See also SQUARE WAVE TESTING).

TIME and FREQUENCY MEASUREMENTS

The following sections outline several methods of measuring time and frequency. The versatility of the PS163 makes text book results possible on even the most complex procedures.

TIME MEASUREMENTS USING THE CALIBRATED TIME BASE

The calibrated time base method of measuring frequency is the easiest one to use, because the only equipment needed is the PS163.

1. Connect the signal to be measured to either the CHANNEL A or B input of the PS163. and adjust the controls of the PS163 to display one or two cycles of the signal. Use AUTO TRIGGERED HORIZONTAL SWEEP and be sure that the small center knob of the TIME BASE - FREQUENCY switch is in the full clockwise position.

2. Use the 10x10 grid to measure the horizontal distance between the two points that you wish to measure.

3. Multiply the distance measured by the setting of the TIME BASE - FREQUENCY SWITCH.

Fig. 6 shows the waveform at the grid of the horizontal output tube in a television receiver. The width of the negative going pulse measured between points B and C is 1.1 divisions. The setting of the TIME

BASE - FREQUENCY switch is 10uSec/DIV, so this pulse is 11uSec wide. The horizontal distance for one complete cycle of the drive signal, as measured between points A and C is 6.3 divisions, so one complete cycle is 63uSec long.

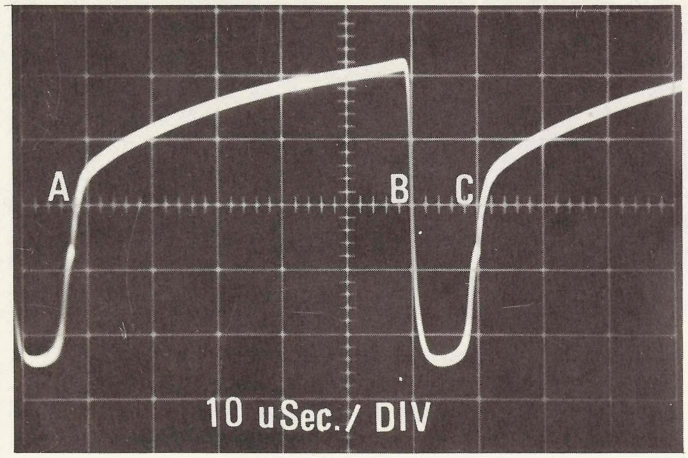


Fig. 6. Time measurement with PS163.

FREQUENCY MEASUREMENTS USING CALIBRATED TIME BASE

The formula for finding frequency if time is known is:

$$\text{Frequency} = \frac{1}{\text{Time in seconds for one cycle}}$$

The time for one cycle in Fig. 6 was 63 uSec., or .000063 seconds. 1 divided by .000063 equals 15,850Hz, or very close to the horizontal frequency of 15,750Hz.

FREQUENCY MEASUREMENTS USING LISSAJOUS FIGURES

The sensitivity and bandwidth of the PS163 VECTOR mode allow this type of measurement to be made from even the output of an RF generator up to 5MHz.

1. Connect the known frequency to the CHANNEL B input, and the unknown frequency to the CHANNEL A input.

2. Press the VECTOR VERTICAL INPUT button, and adjust the PS163 controls so that the entire pattern is visable on the screen.

3. Adjust the known signal frequency so that the pattern holds steady, and count the number of vertical and horizontal loops.

4. Use the following formula to find the unknown frequency.

$$\text{Known frequency X} \frac{\text{Number of hor. loops}}{\text{Number of vert. loops}}$$

The examples of Fig. 7 show several patterns, and the frequency that they represent. The known frequency used in the example is 600Hz.

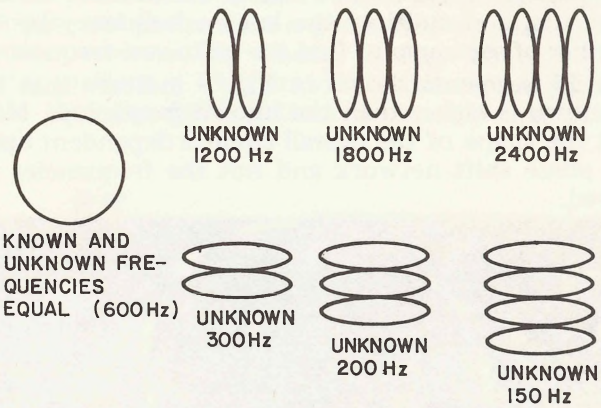


Fig. 7. Typical Lissajous patterns.

FREQUENCY MEASUREMENTS USING THE MODULATED RING

The VECTOR mode of the PS163 and the "Z" Axis input, are used to obtain a modulated ring pattern. Simply count the number of segments and multiply by the known frequency to find the unknown. This method will only work where the unknown frequency is higher than the known frequency.

1. Connect the signal generator to a phase shift network as shown in Fig. 8. The network shown is for audio frequencies and the component values may need to be reduced for higher frequencies.

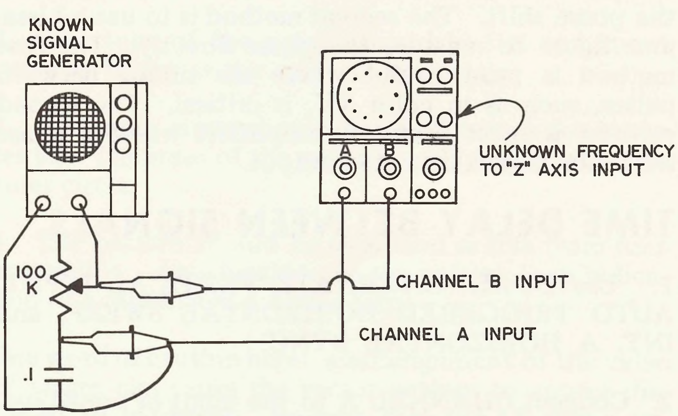


Fig. 8. Connections for frequency measurements using modulated ring method.

2. Connect the PS163 as shown and press the VECTOR VERTICAL INPUT button.

3. Adjust the control in the network until a circle or a near circle is obtained on the scope screen.

4. Apply the unknown frequency to the rear "Z" Axis jack on the PS163, and slide the "Z" AXIS switch to the ON position. Adjust the generator until the pattern stands still. Count the number of line segments, and multiply the known frequency by the number of segments to find the unknown frequency. The 11 segments shown in Fig. 9 indicate that the unknown is higher than the known frequency. Note that the shape of the overall circle is dependent upon the phase shift network and not the frequencies involved.

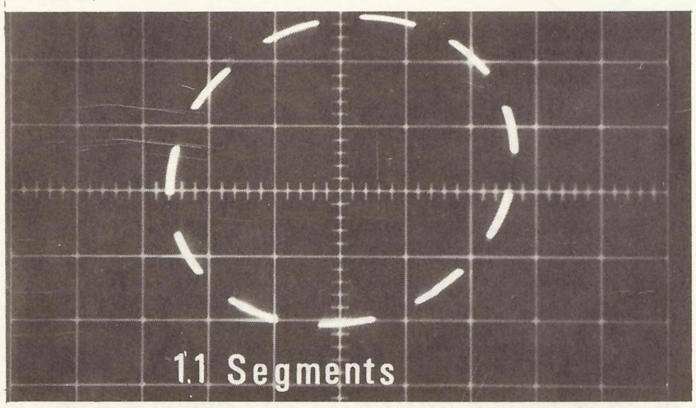


Fig. 9. Modulated ring showing unknown frequency 11 times the known frequency.

PHASE SHIFT and TIME DELAY MEASUREMENTS

There are two methods of measuring the phase shift or time delay between two signals. The first method is to measure the time delay between the two signals, and compare this to the total time of one cycle to find the phase shift. The second method is to use a Lissajous figure to measure the phase directly. The first method is most useful where the timing between pulses, such as in color TV, is critical. The second method is most useful in amplifiers where a phase shift can cause a distorted output.

TIME DELAY BETWEEN SIGNALS

1. Use DUAL ALTERNATE VERTICAL INPUT, AUTO TRIGGERED HORIZONTAL SWEEP, and INT. A HORIZONTAL SYNC.

2. Connect CHANNEL A to the input or nonadjustable signal. Connect CHANNEL B to the other, and adjust the PS163 controls for two cycles of information as shown in Fig. 10. The actual time delay between the two signals can be measured as follows:

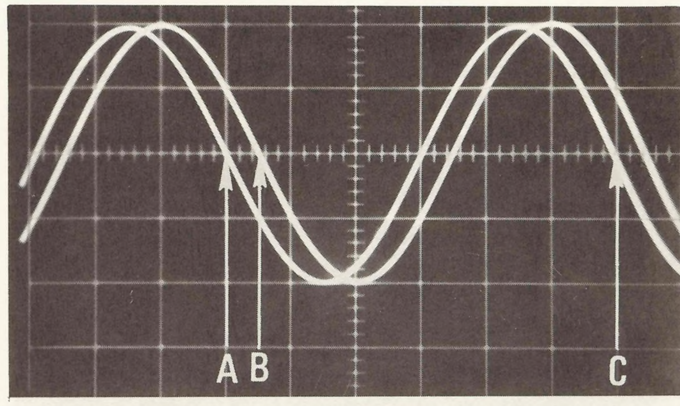


Fig. 10. Determining time delay between signals.

Count the number of horizontal divisions between the same points on the two waveforms. (A to B). Multiply this distance by the setting of the TIME BASE - FREQUENCY switch. In this example the distance is ½ division, the switch setting is .1mSec/DIV, and the actual time delay is .05 milliseconds.

The total time for one 360 degree cycle in Fig. 10 is .6mSec. The phase difference can be found with the following formula.

$$\text{Angle} = \frac{\text{Time Delay}}{\text{Period of one cycle}} \times 360 \text{ —}$$

$$\text{Angle} = \frac{.05}{6} \times 360$$

$$\text{Angle} = 30^{o}$$

PHASE SHIFT BETWEEN SIGNALS

The closely matched horizontal and vertical channels of the PS163 VECTOR mode allow this type of measurement to 5MHz.

1. Press the VECTOR VERTICAL INPUT button and AC couple CHANNEL A to one of the signals. Adjust the CHANNEL A PPV PER DIV and trace position for a vertical line four divisions high centered on the scope screen.

2. Disconnect CHANNEL A and AC couple CHANNEL B to the second signal. Adjust the CHANNEL B PPV PER DIV and TRACE POSITION controls for a horizontal line four division long
a horizontal line four division long centered on the scope screen.

3. Reconnect CHANNEL A to the first signal and use the following formula to find the phase angle. For Fig. 11.

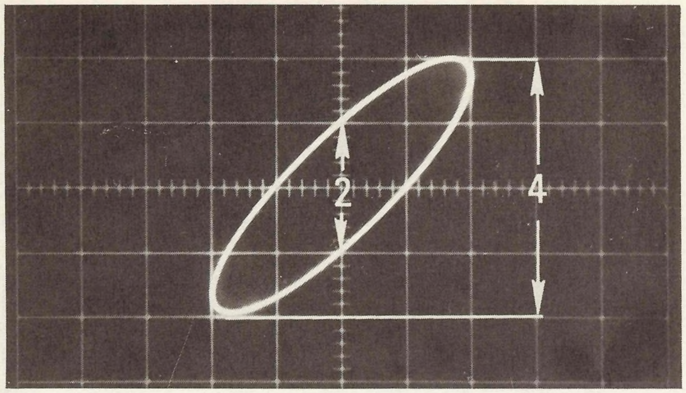


Fig. 11. Measuring phase shift between signals.

$$\text{Sine of Angle} = \frac{\text{DIVISION INSIDE OVAL}}{\text{DIVISIONS OUTSIDE OVAL}}$$

$$\text{Sine of angle} = \frac{2}{4}$$

$$\text{Sine of angle} = .5$$

$$\text{Angle} = 30^{\circ}$$

VECTOR SERVICING

The use of a vector scope to service color television receiver circuits is increasing in popularity. The vectorscope along with a good color bar generator is a very useful tool for troubleshooting and aligning the color circuits. Proper phase shift of the 3.58MHz oscillator bandpass alignment and frequency of the 3.58 are some of the important points that can be checked with the vector pattern.

The front panel VECTOR inputs of the PS163 make vector servicing even faster and easier than before. Here is the procedure for obtaining the vector pattern on the PS163.

1. Connect a standard color bar generator such as the Sencore Color King to the television receiver antenna terminals and use the 4.5MHz sound carrier to properly fine tune the receiver.

2. Depress the VECTOR VERTICAL INPUT button on the PS163. Connect the CHANNEL A probe to the output of the R-Y amplifier or other R-Y test point on the chassis. Connect the CHANNEL B probe to the B-Y test point.

3. Adjust the A and B PPV PER DIV switches to the same setting that gives a viewable pattern on the scope screen. Slide SCALE ILLUMINATION switch near the top of the PS163 to the VECTOR Position, to illuminate the proper vector markings.

If the settings of the CHANNEL A and B PPV PER DIV switches are not the same, a distorted vector pattern will result. If the switches are set to different settings, and the pattern is good, then a trouble exists in the receiver. The photo in Fig. 12 is a good vector pattern. The drawing is the ideal pattern. Note that the good pattern is close to that of the ideal.

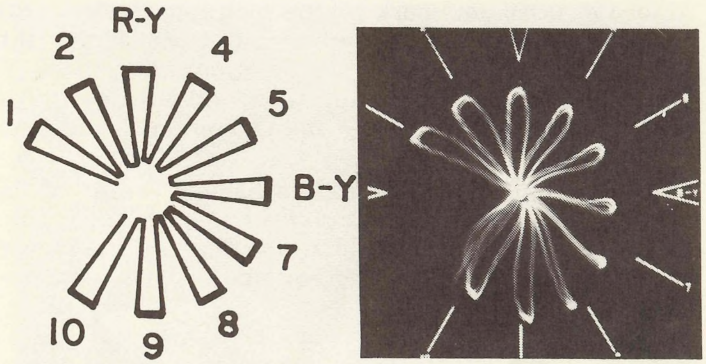


Fig. 12. Ideal and typical Vector patterns.

THE IDEAL VECTOR PATTERN

Become familiar with the four important points to look for in a good vector pattern.

1. The sides of the petals must be straight, extending from the center of the pattern to the top of the petal. They should not be bent or bowed or overlap each other.

2. The tops of the petals should be flat and about twice as bright as the sides of the petals.

3. The inner circle should be small with a dot in the center. The sides of the petals should just meet at the inner circle.

4. The pattern should be clean and as free from fuzz as possible. Any fuzziness in the pattern is an indication of a misaligned 4.5MHz trap.

One word of caution here: a misalignment of the video IF stages can cause the vector pattern to appear distorted or incorrect. Be sure that the IF stages are proper aligned before any alignment of the bandpass amplifier or other circuits in the color section are performed.

SETTING THE TINT RANGE WITH THE VECTOR PATTERN

The tint range may be adjusted, with the vector pattern, to provide the proper flesh tone at the mechnical center of the control. Rotate the tint control and note that the pattern will also rotate on the scope screen. The tint control should be centered and the burst phase adjusted so the third or R-Y bar points straight up at the R-Y mark on the vector graticule. Rotate the tint control to each end. The third bar should move at least one mark on the vector graticule, or 30 degrees either side of its proper position. If the tint control is to one side of its rotation when the R-Y bar is in its proper position, there will not be enough tint range to insure proper flesh tones on all stations.

Set the tint control to its mechanical center of its rotation. Rotate the tint control to each end. The third bar should move at least one mark on the vector graticule, or 30 degrees either side of its proper position.

ADJUSTING the 3.58 MHz OSCILLATOR

The vector pattern can be used to set the 3.58MHz color oscillator to its exact frequency. First, the reactance test point or other test point as indicated in the manufacturers service literature must be shorted out. There will be a barber pole effect on the receiver screen and the vector pattern will appear to be rotating. Adjust the 3.58 oscillator transformer or coil until the pattern stops, or is rotating the slowest. This is the correct setting of the 3.58MHz oscillator. Remove the short and check for proper color on the receiver screen.

ALIGNING THE BANDPASS AMPLIFIER

The vector pattern and its important points are all you need to align the bandpass amplifier in most color television receivers. Use the following procedure, along with the four important points of the vector pattern, to align tube or solid state bandpass amplifiers.

1. Adjust the chroma bandpass transformer for the best shape and amplitude of the vector pattern. The most common system is the single bandpass transformer with two adjustment slugs. Normally, the bottom slug is adjusted for the straightest sides down to the center of the pattern. The top slug for straight sides and maximum amplitude. (Be sure that the color level control on the receiver is set to about mid point here. An excess of color signal can overload the amplifier and distort the pattern making alignment impossible).

2. Adjust the chroma takeoff coil for maximum amplitude with no distortion and straight sides of the petals. (Be sure to observe all the bars in the pattern, when making all of these adjustments, to be sure you are not increasing some while decreasing others.

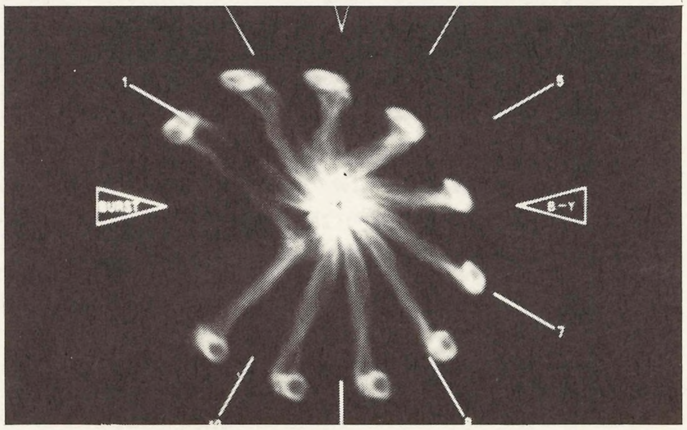


Fig. 13. Vector pattern showing incorrect 4.5MHz trap adjustment.

If the pattern appears fuzzy, as in Fig. 13, check the alignment of the 4.5MHz trap. Misalignment of this trap will cause the pattern to appear as shown and also cause sound interference in the color when the receiver is tuned to a station signal.

TROUBLESHOOTING WITH THE VECTOR PATTERN

Defects in the color circuits of any color receiver can be isolated by using the vector pattern and the dual trace PS163. Here are a few of the more common troubles and how they will appear on the vector scope; Weak or Loss of Red: The photo in Fig. 14 indicates a weak R-Y signal. The vertical amplitude of the vector pattern is low, and the pattern appears squeezed in the vertical direction. Note that the blue or B-Y signal appears to have the correct amplitude of signal. Here, a check of the R-Y difference amplifier and the demodulator circuits should locate the problem.

Weak or Loss of Blue: A weak blue or B-Y signal is indicated by a pattern that is narrow horizontally as shown in Fig. 15. A check of the B-Y difference amplifier and the demodulator stage should locate the problem. You can use the PS163 front panel vector inputs to display the vector pattern at the output of even the newer I. C. demodulator. You are no longer limited to just viewing a vector pattern at the output of the difference amplifiers.

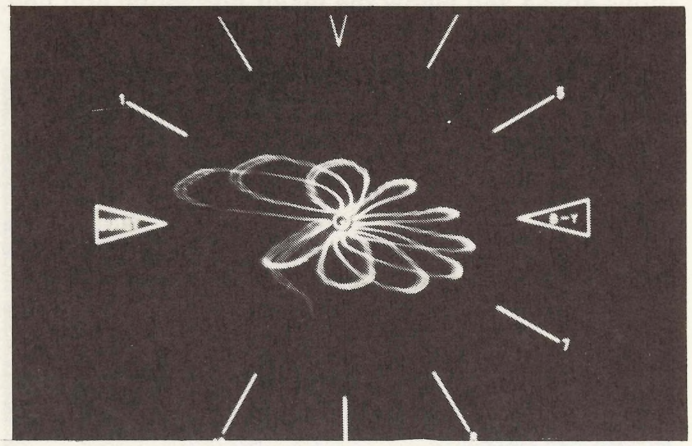


Fig. 14. Vector pattern showing weak red signal.

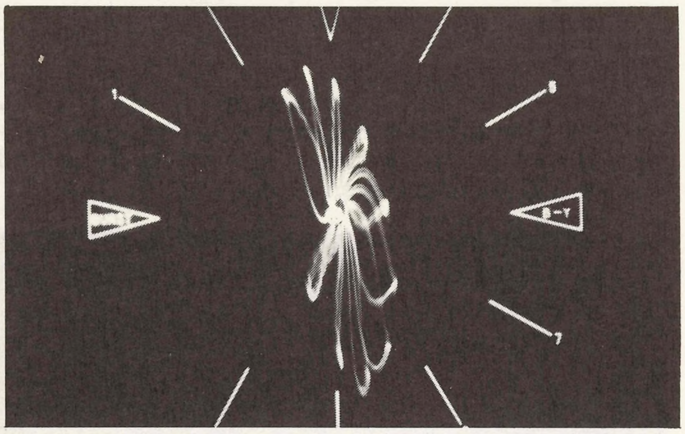


Fig. 15. Vector pattern showing weak blue signal.

Incorrect Phase Angle: The phase angle between the R-Y and B-Y signal is from 90 to 120 degrees, depending upon the receiver and the manufacturer. This angle is adjustable in most of the older receivers and is fixed in the newer sets. To set the phase angle, connect the scope and obtain a vector pattern as previously described.

Set the third or R-Y bar to its proper position and note the position of the sixth or B-Y petal. It should fall between the B-Y mark (90°) and the number 7 (120°) on the vector graticule. Adjust the demodulator phase transformer to position the B-Y petal on its correct mark. The R-Y petal will move slightly. It should be repositioned with the tint control to its proper mark and the position of the B-Y petal rechecked.

Most of the newer receivers have fixed components and do not require adjustment. If one of these fixed components is replaced, the angle should be checked to be sure that you are on or close to the proper angle.

An off value part can shift the angle so it is difficult for your customer to obtain flesh tones.

Total loss of Color: A total loss of color will result in no pattern except the blanking as shown in Fig. 16. The color oscillator, color killer, bandpass amplifier or demodulator could be at fault. Convert the PS163 from a vector scope back to a single or dual trace scope by pressing one of the other VERTICAL INPUT buttons and use normal troubleshooting procedures to locate the defective stage.

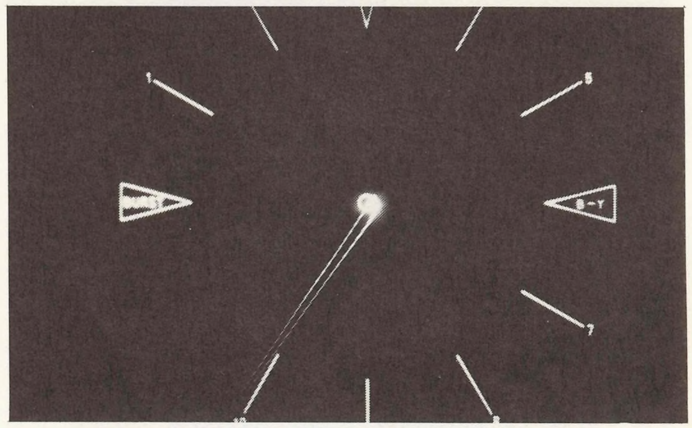


Fig. 16. Vector pattern obtained with no color output.

Solid State Chroma Amplifiers: In many of the newer receivers transistors are being used to drive the picture tube. The signal level is still quite high at this point, but the cathodes are being driven and not the control grids as was done with tube receivers. The probes must be connected to the cathodes of the CRT to obtain a vector pattern on these receivers. This will give an upside down and backwards looking pattern. This is normal. The important points about the vector pattern still remain the same. Use the 9 on the vector grid as the R-Y mark, the BURST as the B-Y mark, and the B-Y as the burst mark. It will also be necessary to shunt the video information to ground to obtain a clean vector pattern. To do this, temporarily connect a 20mfd electrolytic capacitor from the base of the video amp to ground.

SQUARE WAVE TESTING WITH THE PS163

Square wave testing of audio and video amplifier is a standard procedure with many advanced technicians. The response of the amplifier as well as many circuit troubles are easily determined by the shape and distortion present in the square wave. Loss of high frequency response, phase shift, poor low frequency response and ringing are a few of the problems that can be found with this method.

1. Connect a square wave generator to the input of the amplifier to be tested. Connect CHANNEL A at this point as a reference for comparison.

2. Connect CHANNEL B to the output of the amplifier. It can be connected across the speaker or across a resistor in place of the speaker. The resistor is preferred as the noise from the speaker can be annoying.

3. Compare the resultant waveform with the input and the ones shown in Fig. 17

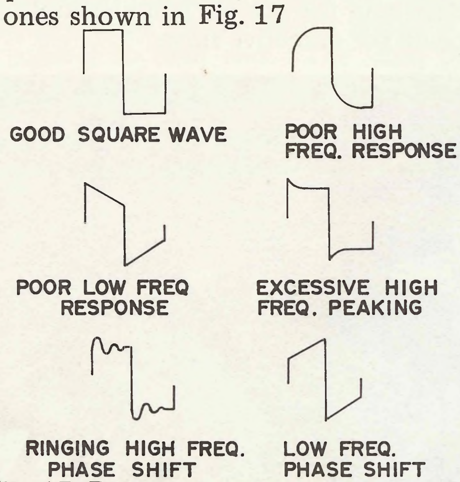


Fig. 17. Distorted square wave resulting from poor frequency response.

The best check on audio amplifiers is to use a low frequency, a mid frequency and a high frequency. Frequencies of 60Hz, 400Hz and 2KHz will check the amplifier at all extremes that it will encounter in normal use. If the amplifier passes a clean square wave, the response is about 10 times the frequency used. For example, if the 2KHz square is good, then the frequency response is good to at least 20,000 Hertz.

If the output square wave is not clean or like the input, then use the Signal Comparison method described earlier to locate the trouble.

RISE TIME MEASUREMENT

Rise time is that time between the 10% and 90% points on the leading edge of a pulse. Use the calbrated time base and the 5X expand on the PS163 to make this measurement.

1. Connect the PS163 to observe the desired pulse, and adjust the PS163 controls to obtain at least one cycle on the scope screen.

2. Adjust the PS163 PPV PER DIV switch, and the center knob of the PPV PER DIV switch so that the waveform is exactly 5 divisions high on the scope screen.

3. Use the TRACE POSITION and HORIZONTAL POSITION controls to center the waveform on the major vertical grid line, so that it is exactly 2½ divisions above and below the major horizontal grid line, as shown in Fig. 18.

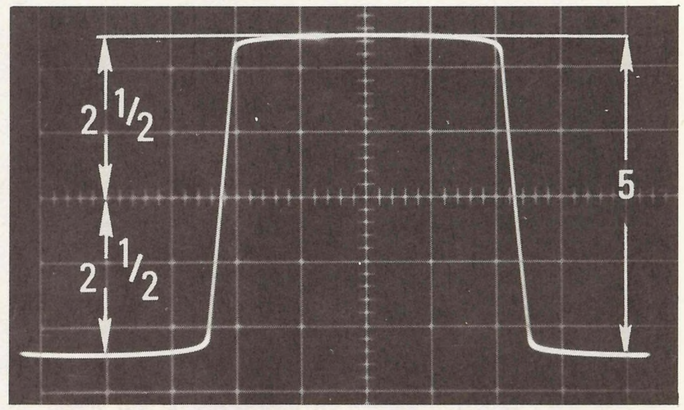


Fig. 18. Centering waveform for rise time measurement.

4. Pull the HORIZONTAL POSITION knob to activate the 5X expand, and adjust the HORIZONTAL POSITION control, so that the 10% point of the leading edge crosses at the intersection of the horizontal and vertical grid lines as shown in Fig. 19.

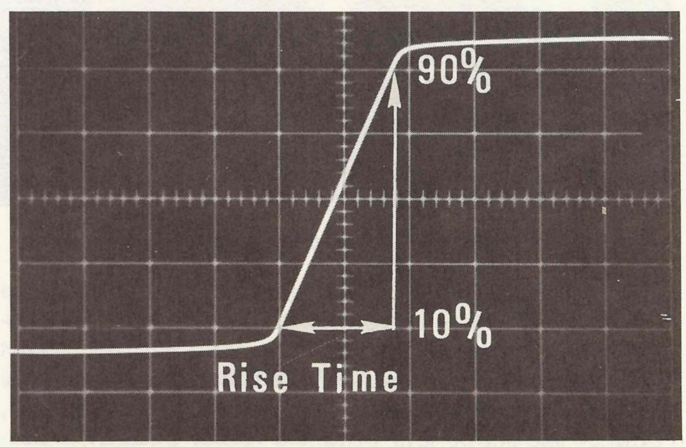


Fig. 19. Measuring rise time.

5. Measure the horizontal distance in graph screen divisions between the 10% and 90% points on the leading edge.

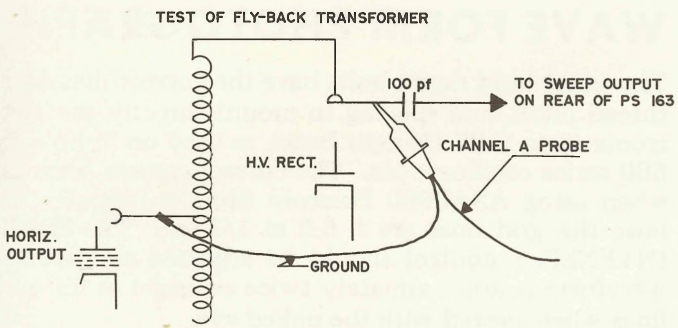
6. The rise time equals the distance measured in step 5, divided by 5 for the 5X expand, and multiplied by the setting of the TIME BASE - FREQUENCY switch. In Fig. 19 the distance is 1.8 divisions, and the setting of the TIME BASE - FREQUENCY switch is 20uSec/DIV.

$$\text{Rise Time} = \frac{1.8 \text{ DIV}}{5} \times 20\text{uSec/DIV}$$

$$= 7.2\text{uSec}$$

COIL and TRANSFORMER TEST

Shorted turns and defective coils can be located by a shock exciting technique. A good coil with a high Q will produce a damped wave effect on the scope screen. A defective coil will have less of a damped wave. Follow the procedure below, with Fig. 20 to test the flyback transformer in a television receiver.



NOTE: Turn power off when makeing test.

Fig. 20. Connections for transformer ringing test.

1. Connect the SWEEP OUTPUT signal from the rear of the PS163 through a 100pf capacitor to the plate lead from the High Voltage Rectifier.

2. Connect the CHANNEL A input to the plate lead from the High Voltage rectifier and the ground lead to the plate lead from the Horizontal Output tube.

3. Use the FREE RUNNING HORIZONTAL SWEEP, and set the TIME BASE - FREQUENCY switch to .1mSec/DIV.

The pattern produced by a good flyback transformer is shown in Fig. 21 A. Note the length of the damped wave. The pattern produced by a flyback transformer with a shorted turn is shown in Fig. 21 B. Note the much shorter length of the damped wave.

The test for the horizontal winding of the deflection yoke is similar to the flyback test.

1. Unplug the yoke from the chassis and connect the SWEEP out signal and the CHANNEL A input to the high side of the horizontal deflection winding.

2. Connect the ground lead to the low side of the winding and set the TIME BASE - FREQUENCY switch to 10uSec/DIV.

The indication for a good and bad yoke are similar to the results shown in Fig. 21A & B.

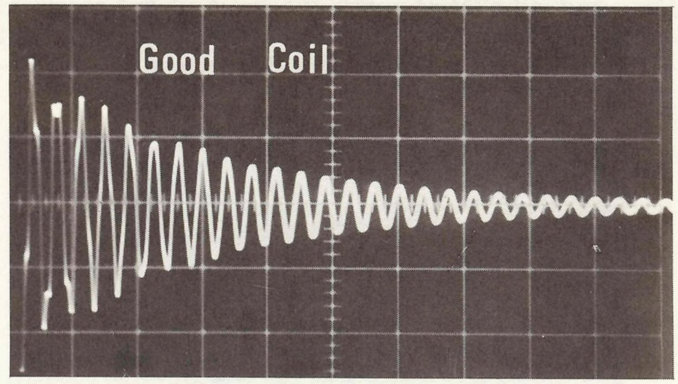


Fig. 21A. Waveform of good transformer.

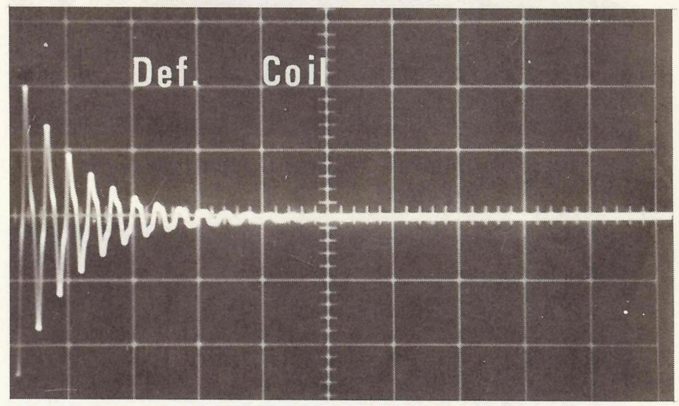


Fig. 21B. Rapid decrease in oscillations indicate defective transformer.

USING THE PS163 WITH A SWEEP GENERATOR

Use the 60 cycle position of the TIME BASE - FREQUENCY for sweep generators not equipped with a horizontal sweep signal. Interupt the blanking on the sweep generator and adjust the LINE SWEEP PHASE control to superimpose the trace and retrace patterns.

Use the EXT position of the TIME BASE - FREQUENCY for sweep generators equipped with a horizontal sweep signal. In this mode the LINE SWEEP PHASE control have no effect on the pattern, and the phase control on the sweep generator is adjusted to superimpose the trace and retrace patterns.

Fig. 22 shows the ideal response of the IF amplifiers in a modern color receiver. The color carrier (42.17 MHz) and the video carrier (45.75MHz) are at the 50% points on the curve, and are directly across from each other. The adjacent channel video carrier (39.75 MHz), the co-channel sound carrier (41.25MHz) and the adjacent channel sound carrier (47.25MHz) are on the base line indicating proper trap action 41.67 MHz and 42.67MHz mark the limit of the receivers color response. Note that 41.67MHz, 42.17MHz and 42.67MHz form a straight line, with equal spacing between the markers.

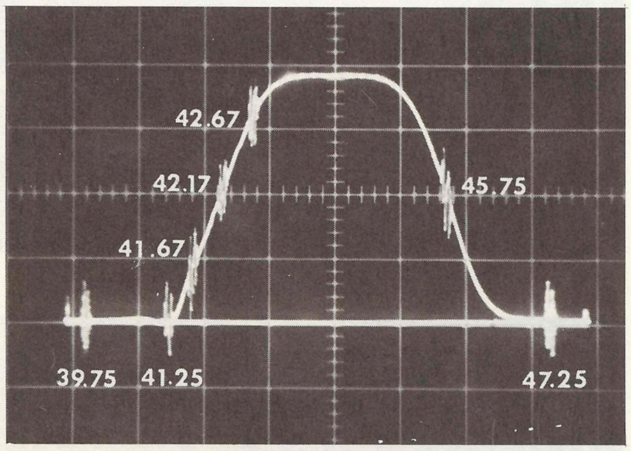


Fig. 22. Ideal IF response curve of color receiver.

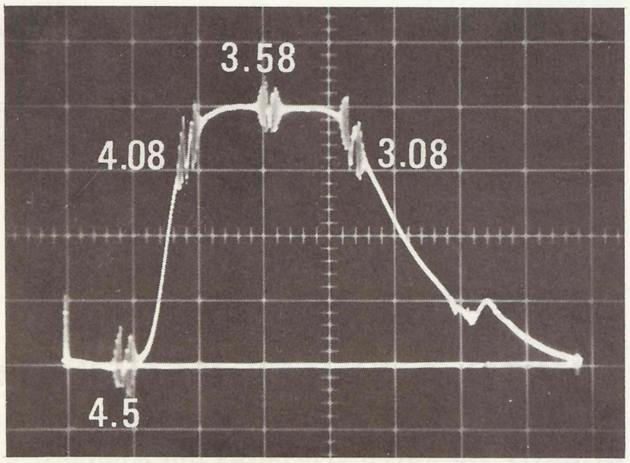


Fig. 23. Ideal chroma response curve.

Fig. 23 shows the ideal response of the chroma bandpass amplifiers in a modern color receiver. This curve was obtained using a Sencore SM152 sweep and marker generator, and injecting a VSM signal into the mixer stage of the tuner. 3.08MHz and 4.08MHz mark the limits of the receivers' color response, and they should fall at the 80% points on the curve as shown. The color carrier 3.58MHz is shown properly centered on the top of the response curve. The sound carrier (4.5MHz) is on the base line, indicating proper trap action.

WAVE FORM PHOTOGRAPH

The bezel hold down bolts have the correct diameter, thread pitch, and spacing to mount directly the Tektronix type C-27 Camera Bezel, as used on Tektronix 500 series oscilloscopes. The correct camera settings, when using ASA3000 Polaroid film, to properly expose the grid lines are f 5.6 at 1/5 sec. The PS163 INTENSITY control should be adjusted so that the waveform is approximately twice as bright as the grid lines when viewed with the naked eye.

DETECTOR PROBE (OPTIONAL)

The Sencore 39G41 extends the range of the PS163 to frequencies in excess of 200MHz. The most common use of this probe is to detect the presence of amplitude modulation of an RF carrier, such as trouble shooting the IF amplifiers of a TV receiver. The .005 volt per division sensitivity of the PS163 coupled with the voltage doubler action of the 39G41 detector probe allows the observation of signals all the way back to the output of the tuner. This probe can also be used to make relative measurements of a CW RF carrier. Use the PS163 DC COUPLED to measure the DC voltage from the probe. This DC voltage is directly proportional to the level of the RF carrier.

SERVICE AND WARRANTY

You have just purchased one of the finest oscilloscopes available on the market today. The PS163 has been inspected and tested twice at the factory. It has also passed a rugged use test by a Field Engineer in our Zero Defects test area.

If something should happen, the PS163 is covered by a standard 90 day warranty as explained by the warranty policy enclosed with your instrument. For best service on warranty work, return the PS163 directly to our Factory Service Division. Be sure to state the nature of the defect to assure rapid return to you.

If you wish to maintain your own PS163, we have enclosed a schematic, parts list and trouble chart. Any parts needed may be ordered directly from the Factory Service Division.

We reserve the right to examine defective components before an in-warranty replacement part is issued.

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