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tech tips

Understanding & Using The HA2500's Sub Drives

When horizontal drive to the horizontal output stage is missing, expensive horizontal output stage components cannot be determined good or bad. If horizontal drive to the output stage is defective due to noise, interference, or intermittents, the output stage operates improperly causing misleading symptoms making troubleshooting difficult.

The HA2500's Dynamic Tests include a "DRIVE" section. The "DRIVE" section includes the Base Sub Drive and Gate Sub Drive functions. These functions substitute the horizontal drive signal at the base or gate of the horizontal output transistor to test the horizontal output stage and isolate horizontal drive related problems. Measurements before and during drive substitution analyze the horizontal output stage. This Tech Tip explains the HA2500's Base Sub Drive and Gate Sub Drive Dynamic Tests and covers how to use and interpret drive results.

Understanding The HA2500's Base Sub Drive And Gate Sub Drive

To properly substitute horizontal drive to the base or gate of a horizontal output transistor requires closely duplicating the drive signals to bipolar and MOSFET transistor types. These transistor types have dramatically different input drive requirements. For this reason, the HA2500 provides a Base Sub Drive output to drive the base of bipolar output transistors and a Gate Sub Drive output to drive the gate of MOSFET horizontal outputs. To determine the chassis horizontal output transistor type, reference the schematic or use a semiconductor replacement guide book.

Bipolar horizontal output transistors and stages vary considerably in frequency,

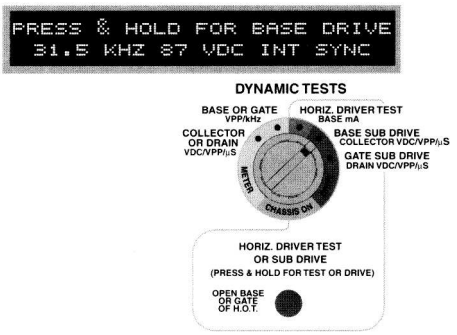

Fig. 1. The HA2500's "DRIVE" functions substitute horizontal drive to the base or gate of the horizontal output transistor.

switching speeds, and current levels. A substitute base drive must apply the proper frequency and drive current to permit proper output transistor operation. The base drive must not under or over drive current to the horizontal output transistor's base or its switching time and transistor efficiency is reduced, causing output transistor heating and failure.

The Base Sub Drive output may be used to substitute drive to the base of any bipolar horizontal output transistor. The Base Sub Drive circuit blocks and chassis connections are shown in Fig. 2. The Base Sub Drive requires all three Dynamic Tests Lead connections to the chassis horizontal output transistor.

At the heart of the HA2500's Base Sub Drive circuitry is a variable current amplifier. Horizontal drive is input to the amplifier from the HA2500's internal frequency generator or from an external sync input. The horizontal drive signal switches the variable drive current amplifier to alternately apply a positive and negative voltage to the base of the horizontal output transistor. The positive voltage forward biases the output transistor producing base current and transistor conduction. The negative voltage switches the horizontal output transistor off.

The variable drive current amplifier dynamically adjusts the drive current to the base of the chassis horizontal output transistor for proper collector current and best switching efficiency. The drive current amplifier outputs a positive turn-on voltage and produces base current according to the variable DC voltage applied from a linear voltage regulator. The output voltage of the regulator is controlled by a comparator.

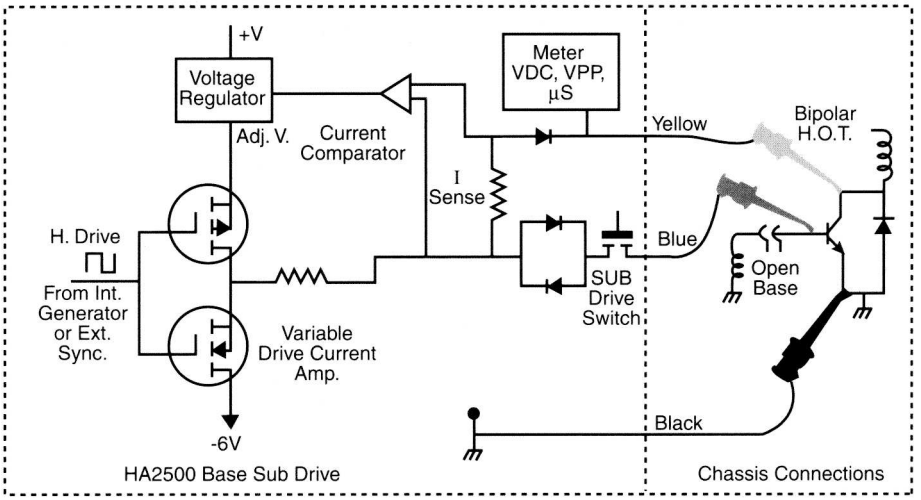

Fig. 2: A variable base current drive amplifier is used for the HA2500's Base Sub Drive output.

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The comparator monitors the H.O.T.'s junction voltages to determine conduction currents. The comparator dynamically increases or decreases the voltage to the drive current amplifier, increasing or decreasing the base current for best transistor switching and efficiency.

Unlike the HA2500's Base Sub Drive, horizontal drives available on other Sencore Analyzers are fixed voltage and current outputs. The drive current is commonly more or less than is needed to optimize switching and operation of the horizontal output transistor when driving the transistor base. This can lead to improper operation or transistor heating.

The HA2500's Gate Sub Drive is optimized to drive the gate of a MOSFET horizontal output transistor. The characteristics of a MOSFET drive output circuit is much less complex because of the high impedance gate of a MOSFET output transistor. A MOSFET transistor requires only an applied voltage to be switched on or off. By applying a voltage greater than four volts to the gate, the MOSFET is biased on. Reducing the gate voltage to near zero causes the MOSFET to be turned off.

The HA2500's Gate Sub Drive output uses a voltage amplifier (see Fig. 3). A horizontal drive signal is input to the amplifier from the internal frequency generator or from a decoded external sync input. The input to the voltage amplifier switches a positive 12 volts to the gate drive output during the positive cycle. During the negative input cycle, a voltage near ground or zero volts is applied to the gate drive output. In this manner, the drive output is alternately switched between approximately 12 volts and 0 volts. The drive output voltage to the gate of the MOSFET horizontal output transistor properly switches it on and off producing normal horizontal output stage operation.

When To Use The HA2500's Base Sub Drive Or Gate Sub Drive

If the horizontal drive signal is present and the horizontal output stage is producing normal high voltage and/or deflection with no unusual noises or picture interference, there is no reason to suspect a drive problem. At other times, when troubleshooting horizontal related symptoms, the horizontal drive signal should become suspect and prompt the use of the Base Sub Drive or Gate Sub Drive.

When the horizontal drive signal is missing, it prevents the horizontal output stage from functioning. This can be confirmed with the Base Or Gate Dynamic Tests. If the VPP reading is near zero, there is no horizontal drive waveform. If you need to determining the total repair costs to repair or refurbish the display, the "Drive" Dynamic Tests enable you to drive the horizontal output stage to full operating potential to identify problems.

Other horizontal problems can be caused by defects in the horizontal drive waveform to the horizontal output stage. The horizontal drive waveform may be intermittent or be changing rapidly in frequency or phase. The horizontal drive waveform may be modulated with noise or ringing distortions causing transient switching of the horizontal output transistor. The drive waveform may be fluctuating in level or input drive current causing erratic horizontal output operation. Although these problems are caused by stages other than the horizontal output stage, the defects affect the horizontal output stage causing output transistor failures, unusual noises, or picture interference. Some of these subtle defects may also result in unusual Base Or Gate Dynamic Test readouts.

You should suspect the horizontal drive signal problems and use the SUB DRIVE when:

1. The horizontal output stage is dead (No Collector Or Drain DCV, VPP or uS readings) and the Base Or Gate VPP readings are near 0. (No Drive)
2. High voltage and/or deflection is reduced with lower than normal Collector Or Drain VPP readings but normal DCV readings. (Insufficient Drive)
3. Noises are heard in the flyback or other components of the horizontal output stage. (Noise or distortions in drive)
4. CRT picture has horizontal phase tearing, loss of sync, or other interference from top to bottom. (Erratic drive frequency or phase)
5. Horizontal output transistor gets abnormally hot and eventually fails. (Weak/faulty drive)
6. Intermittent readings are seen on the Base Or Gate readouts or Horiz. Driver Test readouts. (Intermittent drive)

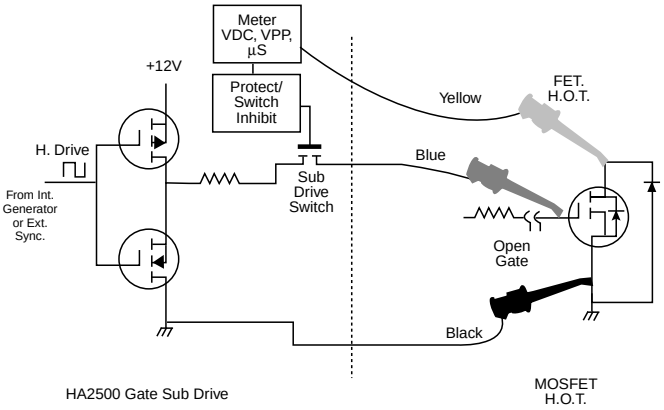

Fig. 3: The HA2500's Gate Sub Drive Output and Horizontal Output stage connections.

Dynamic Test Measurements During Base Sub Drive Or Gate Sub Drive

When the BASE SUB DRIVE or GATE SUB DRIVE positions of the DYNAMIC TESTS Switch are selected, the HA2500 meters its horizontal test frequency and the DC voltage measured at the chassis H.O.T. collector or drain (see Fig. 4). The frequency and VDC readings are displayed in the center fluorescent panel. These readouts help determine if normal B+ voltage is present to the H.O.T collector and if the

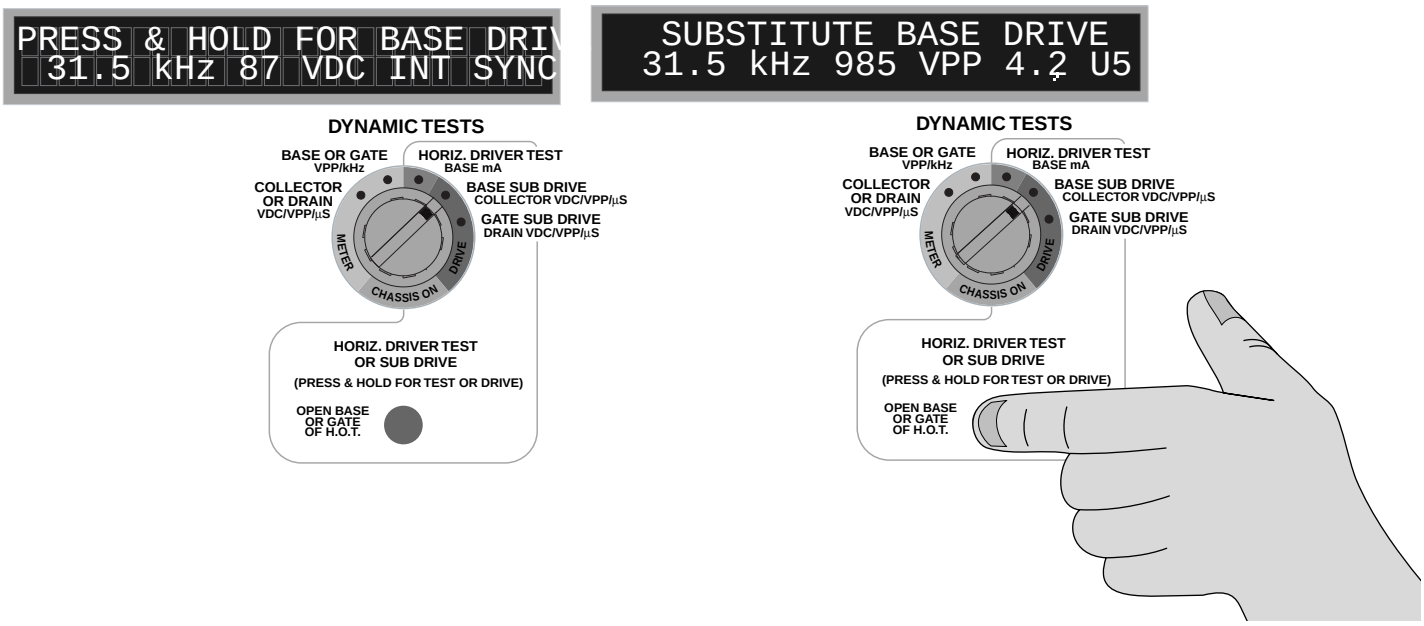

Fig. 4: HA2500 measurements before and during drive substitution analyze the horizontal output stage.

horizontal test frequency of the HA2500 is proper before applying drive.

The HORIZ. DRIVER TEST OR SUB DRIVE push button is used to enable the drive output to the base or gate of the H.O.T. Pressing and holding the HORIZ. DRIVER TEST OR SUB DRIVE push button outputs horizontal drive when either the BASE SUB DRIVE or GATE SUB DRIVE position of the DYNAMIC TESTS switch is selected.

When the HORIZ. DRIVER TEST OR SUB DRIVE test button is pushed, the HA2500 simultaneously provides three automatic measurements of the parameters at the collector or drain of the horizontal output transistor. The measurements include the DC voltage (DCV), the duration in microseconds (uS) of the inductive voltage pulse, and the peak-to-peak amplitude of the inductive voltage pulse produced by the horizontal output stage. These are the same measurements as displayed in the COLLECTOR OR DRAIN position of the DYNAMIC TESTS Switch.

Preliminary Steps To Applying Base Sub Drive Or Gate Sub Drive

Using the Base Sub Drive or Gate Sub Drive require that a good horizontal output transistor be installed in the chassis. If the horizontal output transistor was found shorted and removed or is suspected of being bad, a replacement should be soldered into the chassis.

Using the Base Sub Drive or Gate Sub Drive in a horizontal output stage that contains a severe loading or timing problem can cause damage to the horizontal output transistor and B+ supply components. Perform the HA2500 Load Tests to identify severe horizontal output stage defects and correct them. Do not use the Base Sub Drive or Gate Sub Drive functions if the Load Tests shows abnormally high or questionable load current, reduced efficiency, or unusual timing.

When performing the Base Sub Drive or Gate Sub Drive Dynamic Tests, the chassis horizontal drive signal must not be allowed to drive the base or gate of the chassis horizontal output transistor. Remove AC voltage to the chassis and open the circuit path leading from the driver stage output to the base or gate of the horizontal output transistor.

To open the base signal path, identify the base signal path and associated components. There is commonly a resistor, inductor and/or diode between the driver transformer and the H.O.T. base. You can unsolder the lead(s) at the base and lift it from the circuit board, opening the circuit path to the base. There is commonly a resistor between the MOSFET base and driver transistors. You can unsolder and lift a lead from the circuit board to open the signal path. Components from the H.O.T. base or gate to circuit ground should be left connected.

It is important to select the proper drive frequency for the horizontal output stage you are going to drive. A drive frequency above or below the horizontal output stage's designed range can cause excessive voltages or currents and added power dissipation.

Select the proper frequency for the output stage with the COARSE and FINE controls. If driving a horizontal output stage in a multi-frequency display that is not connected to an input signal generator, select a drive frequency near the high end of the display's horizontal frequency capabilities. Most multi-frequency displays default to a high frequency mode with no input sync signals.

If you have a generator with the proper test signal connected to the input(s) of the display, select a HA2500 frequency near that of the generator's horizontal sync frequency. This matches the HA2500's horizontal drive frequency to the mode selected by the display. To lessen the chance of error, you may use the EXT. SYNC INPUT to automatically lock the HA2500's horizontal drive to the generator frequency.

When the Base Sub Drive or Gate Sub Drive is used, proper operations and testing

results depend on the chassis providing normal B+ voltage to the horizontal output stage. The DCV readout indicates the chassis B+ voltage to the output stage before the HORIZ. DRIVER TEST OR SUB DRIVE test button is pushed. Check the DCV readout to be sure the chassis B+ voltage is present to the output stage before pushing the HORIZ. DRIVER TEST OR SUB DRIVE test button.

The proper level of chassis B+ voltage to the horizontal output stage is important when subbing base or gate drive. Improper B+ voltage can cause improper output stage operation and perhaps cause excessive voltages and currents. If the DCV readout is near the normal B+, you can push the HORIZ. DRIVER TEST OR SUB DRIVE to enable drive. If the DCV readout indicates much higher than normal, a B+ supply or HV/deflection regulator defect may exist.

A higher than normal B+ voltage may or may not indicate a defect. Many B+ power supplies and most HV/deflection regulators have a higher than normal B+ voltage when unloaded. Recall that the horizontal output stage is inactive because the base or gate is opened. When the HORIZ. DRIVER TEST OR SUB DRIVE button is pushed, the horizontal output stage draws current, loading the B+ supply, causing the B+ voltage to decrease to its normal regulated voltage.

However, if the B+ supply regulator is defective or the HV/deflection regulator is shorted, the B+ voltage may remain higher than normal when the HORIZ. DRIVER TEST OR SUB DRIVE button is pushed. Higher than normal B+ voltage causes excessive voltages and currents in the horizontal output stage threatening damage to the chassis H.O.T. To determine if the B+ voltage will decrease and regulate before applying drive, momentarily connect a 500-1000 ohm (10-20 watt) resistor from the B+ input to the horizontal output stage to ground. The DCV readout (B+ voltage) should decreases considerably if the B+ regulator(s) are working. If the HV/deflection regulator is shorted, there will be little change in the B+ voltage when the resistor is connected.

If the B+ voltage remains high, troubleshoot the B+ supply or HV/deflection regulator or use the HA2500 B+ Substitute Supply to substitute for the chassis B+ voltage.

The BASE SUB DRIVE or GATE SUB DRIVE Dynamic Tests drive the horizontal output transistor which produces collector and horizontal output stage currents. If used incorrectly or if severe chassis defects exist, excessive high voltage or currents may damage components in the chassis or HA2500.

Substituting horizontal drive to the base or gate of the chassis H.O.T. with the HA2500 requires that:

1. The Load Tests readings are normal, indicating no severe horizontal output stage defect.

2. A known good horizontal output transistor is properly installed in the chassis.

3. The Load & Ringer Test Lead clips are removed from the chassis.

4. AC voltage to the chassis is removed when unsoldering components or making Dynamic Test Lead connections.

5. The signal path between the base or gate of the horizontal output transistor and the drive transformer or drive amplifier is opened.

6. The Dynamic Test Lead clips are properly and securely connected to the H.O.T.

7. The proper HA2500 horizontal drive frequency be selected.

8. The proper B+ voltage be applied to the horizontal output stage.

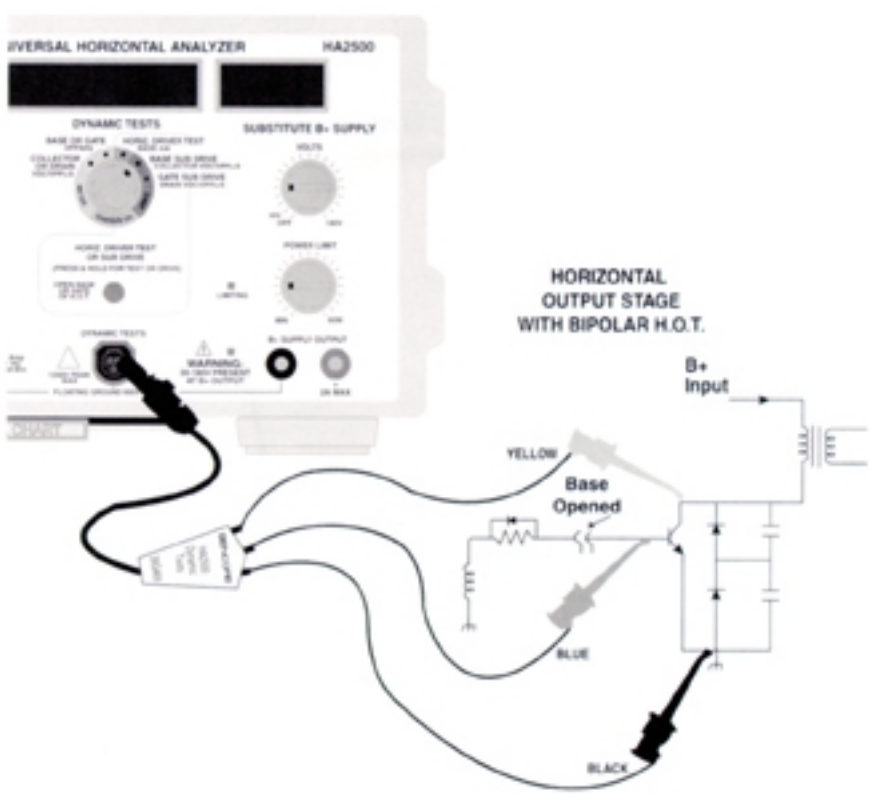

Fig. 5. Circuit connections and setup for substituting drive to the base of a horizontal output transistor.

How To Use The HA2500's Base Sub Drive Or Gate Sub Drive

To substitute base or gate drive, remove AC power to the chassis and unsolder components to isolate the base or gate of the horizontal output

transistor. Connect the Dynamic Tests Lead clips as used for the other Dynamic Tests. The Base Sub Drive and Gate Sub Drive require all three Dynamic Tests Lead connections to the chassis horizontal output transistor for proper drive operations. The blue test clip provides the drive output and is connected to the opened base or gate lead of the horizontal output transistor. The yellow lead is connected to the collector or drain of the output transistor and provides transistor current sampling and parameter measurements. The black clip provides a ground connection to the emitter or source.

To substitute drive to the base or gate of the horizontal output transistor:

1. Remove AC power to the chassis.
2. Open drive to the base or gate of the horizontal output transistor by unsoldering/lifting component(s) leads.
3. Connect Dynamic Test Lead.
   Yellow to collector or drain.
   Blue to base or gate.
   Black to horiz. ground (emitter or source)
4. Select “BASE SUB DRIVE” to drive the base of a bipolar horizontal output transistor. Select “GATE SUB DRIVE” to drive the gate of a MOSFET type output transistor.
5. Push the DIGITAL DISPLAY button to display Dynamic Tests readouts.

   Note: Changing positions of the DYNAMIC TESTS switch selects the DYNAMIC TESTS display.
6. Apply AC voltage to the chassis.
7. Read the display’s DCV readout to confirm proper B+ voltage.
8. Read the display’s kHz readout to confirm a proper test frequency. Adjust COARSE and FINE controls as needed.

   Note: *Improper B+ voltage or frequency can cause excessive voltages, currents or output transistor heating causing chassis component failures.*
9. Push & Hold the HORIZ DRIVER TEST OR SUB DRIVE test button.
10. Read the DCV, PPV, and uS readouts to test the horizontal output stage.

When the HORIZ. DRIVER TEST OR SUB DRIVE button is pushed, horizontal drive is output to the chassis H.O.T. The horizontal output stage becomes active and begins producing flyback voltage pulses and resulting HV and/or deflection. To determine if the horizontal output stage is operating normally, the HA2500 provides three simultaneous measurements. The measurements are identical to the Collector Or Drain VDC/VPP/uS measurements. Normal B+ voltage, VPP, and uS readings indicate the horizontal output stage is operating properly.

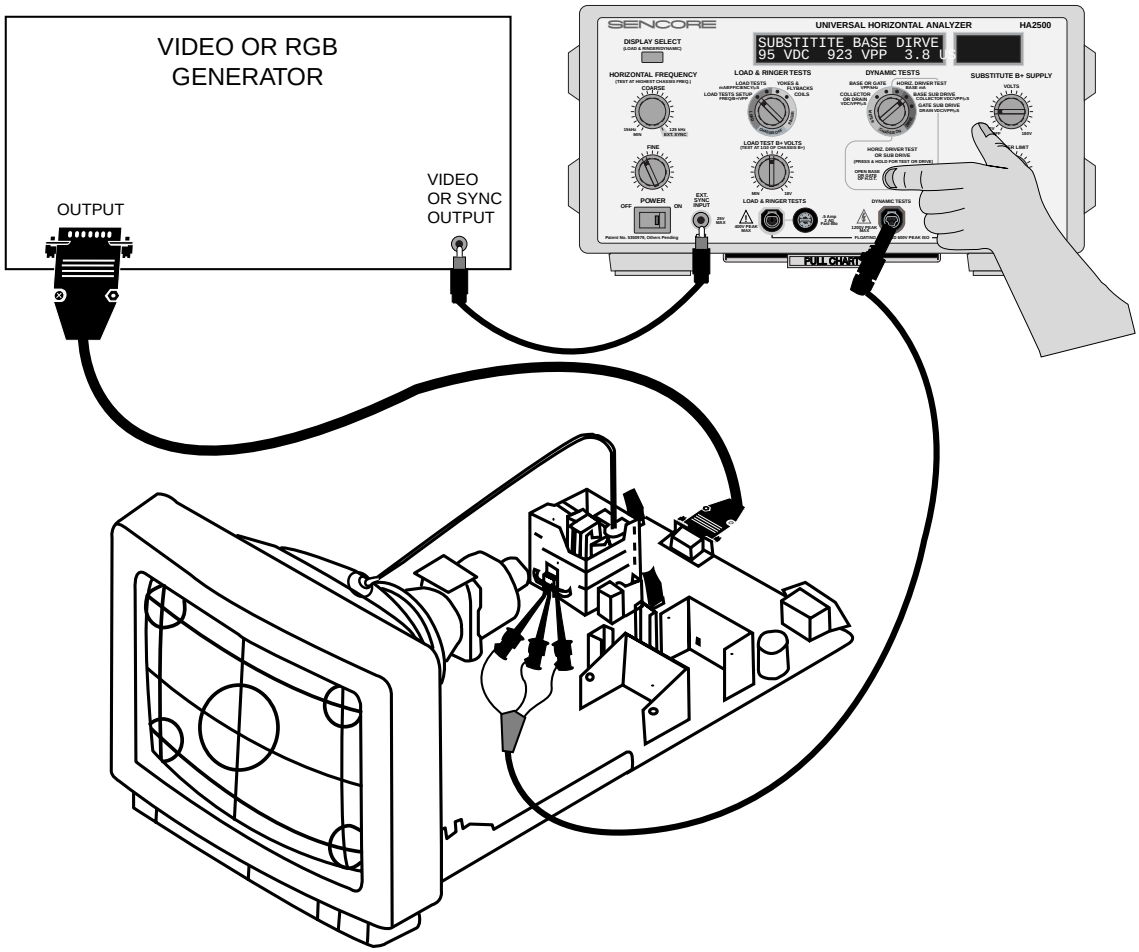

Fig. 6: Synced to the generator, the Sub Drive produces a locked video pattern on the CRT enabling testing of the other monitor stages.

An out-of-sync picture should be seen on the CRT screen if a generator signal is applied to the monitors input while subbing base or gate drive. Most monitors require about five seconds for the CRT filament to heat before a raster is seen. If a generator signal is not applied to the input of the display while subbing, the CRT screen remains dark or shows a snowy raster (TV).

Syncing Base Sub Drive Or Gate Sub Drive To A Signal Generator

The EXT. SYNC INPUT may be used to sync lock the generator's video on the CRT when using the Base Sub Drive or Gate Sub Drive. Connect a cable from the generator's horizontal sync or video output to the EXT. SYNC INPUT of the HA2500. Select the "EXT. SYNC" position of the COARSE control. The center fluorescent display should indicate the decoded horizontal drive frequency and an "EXT" indication. When locked to the generator, using the Base Sub Drive or Gate Sub Drive produces a locked video pattern on the CRT of a working chassis. This permits analyzing the high voltage, video, vertical, sync, CRT, and other circuitry of the video display for problems.

The sync decoder inside the HA2500 is capable of producing a horizontal test signal from several different types of external sync input signals. A standard NTSC composite video output may be used such as the STD VIDEO OUTPUT from the Sencore VG91 Universal Video Generator. Non-interlaced video is recommended for best frequency stability. Connect a cable with RCA phono jacks between the composite output of the generator and EXT. SYNC INPUT Jack of the HA2500.

A horizontal sync or composite sync signal from computer monitor RGB generators such as the Sencore CM2000, CM2125, CM125, and CM2220 may be used with the Ext. Sync Input. The ACCESSORY OUTPUT Jack found on the CM125 and CM2220 may be used to provide a composite sync input to the EXT. SYNC INPUT Jack of the HA2500. A cable for this application is available from Sencore (Part # 39G508).

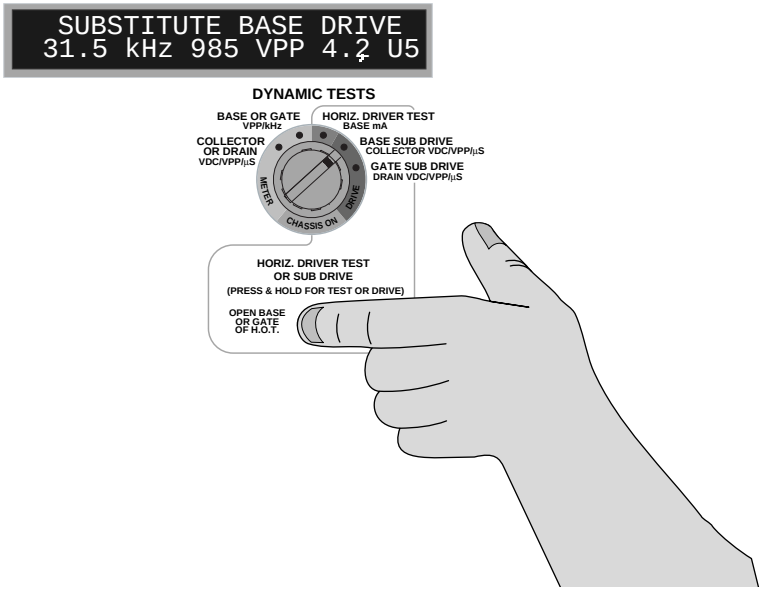

Fig. 7: The HA2500 monitors voltages in the chassis horizontal output stage and prohibits or disables drive output if conditions are threatening.

The Sencore CM2000 and CM2125 Computer Monitor Analyzers do not have an ACCESSORY OUTPUT Jack, but the DRIVE OUTPUT set to > 2 VPP may be used to provide a horizontal sync signal. A cable with a BNC connector to an RCA phono plug is needed.

HA2500 Diagnostics Provide Chassis & HA2500 Protection

Protection diagnostics avoids chassis and instrument damage in the event of threatening chassis conditions or user error. The HA2500 monitors voltages in the chassis horizontal output stage and prohibits or disables drive output if conditions are threatening.

The presence of peak-to-peak signal voltages at the collector or drain indicate undesirable conditions for subbing. A DC or peak-to-peak voltage at the base likely indicates an improper connection or failure to properly open the base signal path. If DC or peak-to-peak voltages are detected, the drive output is prohibited when the HORIZ. DRIVER TEST OR SUB DRIVE button is pushed.

While subbing drive, the HA2500 monitors the peak-to-peak voltage at the collector or drain. PPV readings exceeding 1,400 VPP on the collector of a bipolar horizontal output transistor or 900 volts at the drain of a MOSFET output transistor threatens the horizontal output transistor. Drive is interrupted to protect the chassis and HA2500.

If the HA2500 diagnostics detect abnormal peak-to-peak voltages and prohibit or disable Sub Drive, the digital display indicates that the drive is interrupted and the nature of the interrupt. Using the Base Sub Drive or Gate Sub Drive for extended periods is not recommended. Sub Drive is disabled after five minutes of continuous output.

For More Information,
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