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tech tips

Understanding The TVA92's Horizontal Output Device Sub & Drive

The TVA92's Horiz Output Device Sub & Drive provides a substitute horizontal output transistor that enables you to power-up and test the horizontal output, high voltage and scan-derived circuits at full operating potentials to confirm their operation before you invest time and money in a new replacement output transistor. This Tech Tip explains the how the Horizontal Output Device Sub & Drive works and how to use it

When To Use The Horizontal Output Sub & Drive

Use the Horizontal Output Device Sub & Drive when the chassis horizontal output transistor (HOT) is defective. You will want to use the Output Sub before you order a replacement transistor or calculate a repair estimate because it allows you to test the entire output and high voltage circuits at full operating potentials, as well as test the entire chassis by viewing the picture on the CRT.

The Horizontal Output Sub & Drive is very useful for isolating difficult horizontal problems such as insufficient drive current or low transistor gain (beta). These problems cause reduced high voltage and horizontal deflection, which are symptoms of a horizontal output stage problem.

Flyback pulses are used by the scan supplies to provide the DC voltage to power the horizontal oscillator and driver stages. Without flyback pules there will be no DC to run the oscillator, and without the oscillator there will be no flyback pulses. The Horizontal Output Device Sub & Drive powers the output stage to troubleshoot these problems.

Finally, use the Horizontal Output Device Sub & Drive to isolate problems that affect the frequency or waveshape of the drive signal. Drive problems alter the switching action of the HOT so it cannot match-up the resonant timing of the output stage. This causes transistor failure, flyback squealing, deflection foldover and other unusual symptoms.

Understanding The Horizontal Output Device Sub & Drive

To better understand how the HOT (or similar output device) can be substituted with the TVA92, we need to briefly review the function of the horizontal output transistor. The operation of the HOT is illustrated in Figure 1.

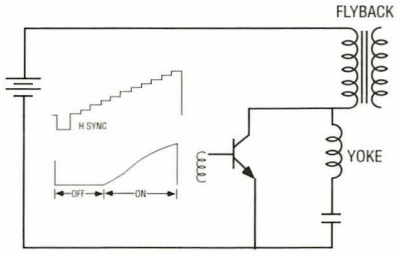

Fig. 1 The HOT turns on 30-35 uS before horiz sync providing a conduction path for flyback and yoke currents.

The HOT acts as an on/off switch for the current in the primary of the flyback transformer. The transistor is switched on and off at a 15,734 Hz rate by a current drive signal applied its base. It is turned on approximately 30-35 µS before horizontal sync.

When turned on, the transistor provides a path for current to flow from the B+ power supply into the flyback and yoke. Since these are inductive components, the current increases at a linear rate, but when the transistor is switched off the current suddenly drops. The sudden change in current produces a large amplitude flyback pulse at the collector of the HOT.

The HOT remains off during the retrace period while the resonant action of the output circuit reverses the current flow. The HOT stays switched off for a brief time following retrace while the damper diode conducts.

The TVA92's Horiz Output Device Sub & Drive provides a substitute horizontal output transistor as illustrated in Figure 2. This internal subbing transistor works just like the HOT in the chassis as it switches

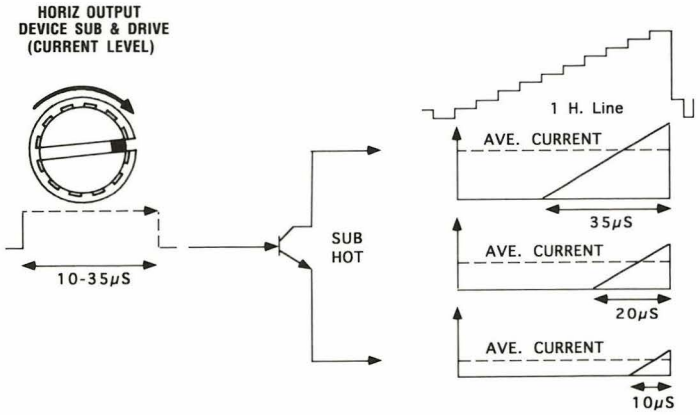

Fig. 2 The TVA92 provides a substitute horiz output transistor switched by a variable horiz drive.

on and off to complete the current path for flyback and yoke.

The sub transistor is switched by a drive signal generated inside the TVA92. This drive signal is controlled by the HORIZ OUTPUT SUB & DRIVE Control. In the "Off" detent position the subbing transistor remains out of the circuit (>10 megohm) and the chassis is free to operate without influence from the TVA92.

Turning the HORIZ OUTPUT DEVICE SUB & DRIVE Control clockwise connects the TVA92's subbing transistor to the chassis and increases the pulse width of the drive signal as shown is Figure 3. This makes the sub transistor conduct longer and increases the amount of current that flows

the possibility of damaging either the chassis or the sub transistor

The switching of the subbing transistor is synchronized to the video signal that is supplied to the chassis by the TVA92 and VG91. Thus, the chassis horizontal output stage is in sync with the video. A properly working chassis will produce near normal high voltage and the CRT will show near normal video, color and deflection when you are subbing with the Horiz Output Device Sub & Drive. Because deflection timing varies slightly between chassis, the video on the CRT may be shifted on some chassis.

You may use the "DCV", "PPV" and "µS" Dynamic Tests to monitor the horizontal

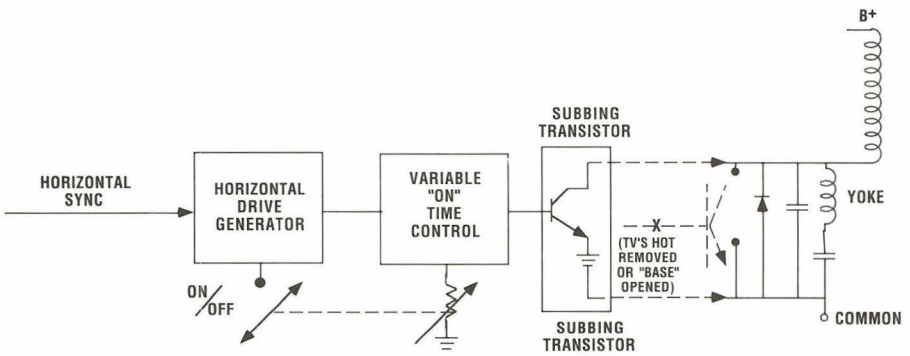

Figure 3. Increasing the conduction time of the subbing transistor allows higher current to pass through the subbing transistor.

through the subbing transistor and through the flyback primary circuit. This current is displayed in the HORIZ OUTPUT TESTS Readout. By varying the conduction time you can slowly increase the current level (power) to the output stage while monitoring for problems.

Note that the current flowing through the subbing transistor is a result of the chassis B+ supply, horizontal output stage and flyback circuit. The TVA92 does not supply current to the chassis. Different chassis will produce different currents level at the same setting of the HORIZ OUTPUT DEVICE SUB & DRIVE Control. The current reading is the average current in the circuit. The peak current in the circuit may be as high as 3 or 4 amps.

The current allowed to pass through the subbing transistor is limited to 1.5 amps. This level allows you to adequately test most horizontal output stages but reduces

output circuit while you are using the Horizontal Output Device Sub & Drive. These measurements will closely agree with results when a replacement output transistor is installed in a working chassis.

Preparing To Use The Output Drive Sub & Drive

Improper loading, timing or B+ voltage may produce excessive voltages or currents which may damage TV or TVA92 circuits when using the Horiz Output Device Sub & Drive. Before you substitute with the Output Device Sub & Drive always do the following:

1) Disable the chassis horizontal output transistor

2) Check for any abnormal loading or timing problems

3) Test the B+ power supply voltage

You can disable the chassis HOT by either removing it from the chassis or by opening the circuit path to the base. If the chassis HOT is shorted, it must be removed. A shorted transistor is indicated by a reading of approximately "250 mA" in the Horiz Output Load Test, or by a B+ voltage of only a few volts.

NOTE: The TVA92 provides some protection against a chassis HOT that is not disabled by switching the "base" test lead connection to ground when the Device Sub & Drive is used. Do not rely on this to protect the chassis or TVA92 circuits. The transistor cannot be fully disabled in this manner and damage will occur if the test leads become detached while subbing. Always disable the chassis horizontal output transistor.

Check for abnormal loading or timing problems use the Horiz Output Load Tests. If you detect any problems, correct them first. Also test the B+ power supply voltage with "DCV" Dynamic Test and correct any regulation problems.

Connecting To The Chassis

The Horizontal Output Device Sub and Drive is connected to the chassis HOT using the DYNAMIC TESTS Lead. The connections for the Device Sub and Drive are the same as for the other TVA92 Dynamic Tests:

Blue / "B" Base of output transistor (or gate of FET)

Red / "C" Collector of output transistor (or drain of FET)

Black / "E" Emitter of output transistor (or source of FET)

If the chassis HOT was removed, connect to the circuit board points or components which are the same as the elements of the transistor.

When connecting or disconnecting the Dynamic Tests Leads

1. Remove power to the chassis.

2. Connect the leads securely so they do not become detached during testing. Immediately remove power if they become detached.

3. Do not connect to the chassis if a "SUB BAD" indication is flashing in the digital displays.

Understanding The Device Sub Current Readings

The "Device Sub Current" position of the HORIZ OUTPUT TESTS Switch allows you to monitor the average current flowing through the subbing transistor. Remember this is the average current flowing in the flyback primary and yoke. Component failures in the horizontal output stage or flyback secondary, such as a flyback shorted turn, leaky filter capacitor, or an excessive load on a flyback secondary, will cause an increased power demand on the output stage. These failures result in increased conduction current through the sub transistor. Use the current readout to detect unusually high current levels.

The normal sub current varies between chassis and depends on the CRT size, the number of scan-derived circuits, and the efficiency of the output stage. Typical current in a small B&W chassis ranges from 300 to 500 mA, while current in a full size color chassis typically ranges from 500 to 1000 mA. Older full size color TVs with many flyback scan-derived powered circuits may have conduction currents as high as 1.5 amps.

The normal current flowing through the HOT is a rising sawtooth. When the transistor is conducting, the current rises to a peak of several amps. But current flows through the transistor for only approximately one half of 1 horizontal line. Therefore, a current meter in series with the HOT will measure the average conduction current. This current is only a fraction of the peak current flowing through the transistor.

The average conduction current of the subbing transistor is not the same as the current supplied to the output stage by the B+ supply. The B+ power supply only provides a fraction of the total current flowing through the output transistor's collector. This is because the yoke and flyback are inductive components that induce current back into the circuit as the current oscillates in the tuned output stage. The B+ power supply merely replenishes the circuit with additional current each time the transistor conducts.

Comparing The Sub Current Reading To The Schematic

The collector current measured by the TVA92 provides the most accurate indication of the current (power) in the output stage. It also provides the best means to monitor for normal or abnormal conditions while subbing than emitter current does. Emitter current (as is typically indicated on schematics) will flow through the sub transistor whenever drive applied, whether or not current is flowing through the output stage.

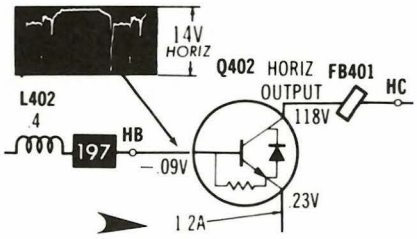

Fig. 5 - Some service schematics record the horizontal output transistor's emitter current level.

Many schematics show the normal emitter current through the horizontal output transistor. You can compare the TV92's current readout to the service literature to determine if the output stage is demanding extra current, or if it is operating normally. However, a small compensation is required to compare the two values.

To compare the TVA92's reading to a schematic you need to subtract the base current from the emitter current that is shown on the schematic. Table 1 shows the approximate base current of a typical horizontal output transistor for various collector current ranges displayed by the TVA92. For example, the schematic in Figure 5 shows a current of 1.2 amps. This chassis will read about 1 amp when tested with the TVA92 Horizontal Drive test (1.2 amps - 200 mA).

Note: If the chassis horizontal output transistor contains a damper diode, the TVA92's DEVICE SUB CURRENT Readout

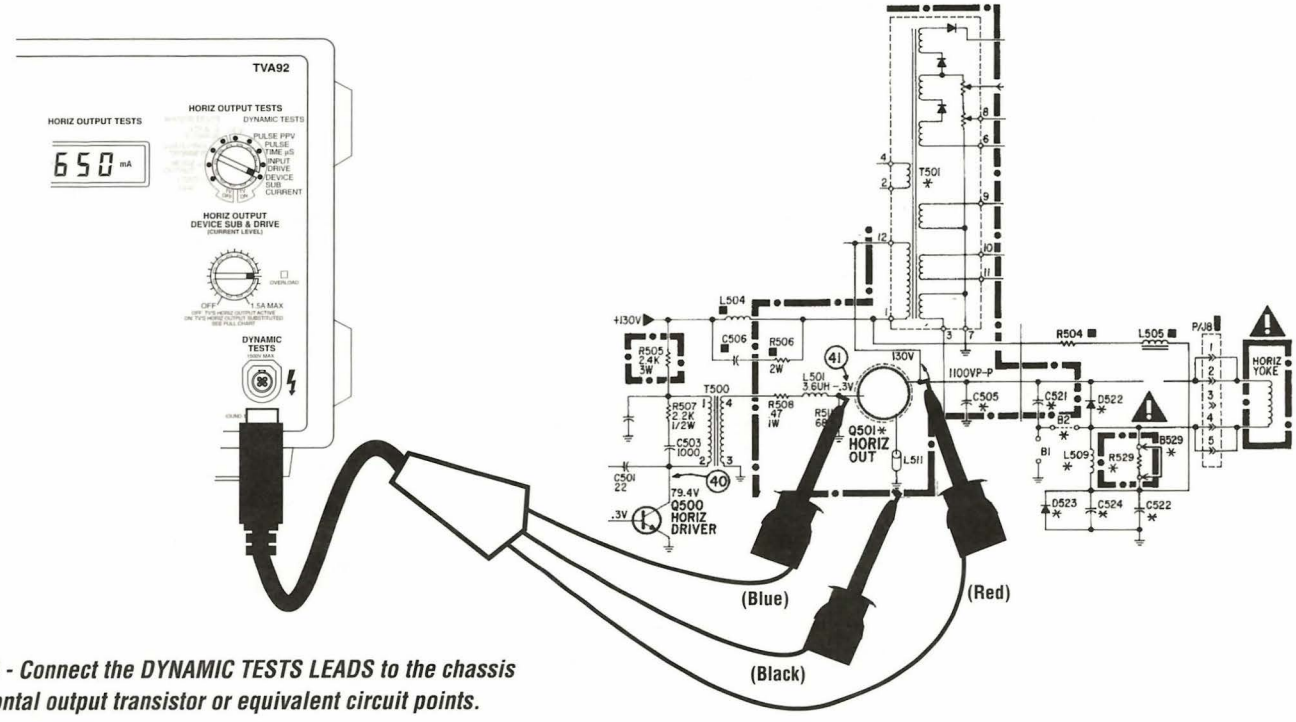

Fig. 4 - Connect the DYNAMIC TESTS LEADS to the chassis horizontal output transistor or equivalent circuit points.

may show up to twice the emitter current value indicated by the schematic.

The current measured by DEVICE SUB CURRENT Readout will vary with the operating conditions of the chassis. For example, the high voltage section delivers current for the CRT guns and the gun current varies with the dark and light picture objects. When comparing the TVA92's DEVICE SUB CURRENT Readout to the schematic, select the Color Bars video pattern and set the chassis brightness and contrast controls to midrange.

Setting The Horizontal Output Device Sub & Drive Level

Slowly increase the HORIZ OUTPUT DEVICE SUB & DRIVE Control while monitoring the DEVICE SUB CURRENT Readout. Continuing increasing the level until normal high voltage and deflection is reached. You can confirm proper operation by monitoring the CRT for proper raster and deflection. Monitor the center of the raster, and adjust the Horizontal Output Device Sub & Drive Control slightly beyond the level where normal video occurs.

Watch the current readout for unusual conditions. If you see the current climb over 1 amp, or if the overload light illuminates as you increase the Drive Control, there is a severe problem in the output stage. Turn the Horiz Sub & Drive to "Off" and use the Horiz Output Load Test to isolate the problem.

Note: Most CRT filaments are powered from the horizontal output stage. Allow a few seconds for the filaments to heat.

Most functioning output stages will operate normally with the HORIZ OUTPUT DEVICE SUB & DRIVE Control set to about mid range. Of coarse variations from this are normal depending on the normal current demand of the output stage.

The Sub Current readout also indicates if the horizontal output stage has some resistive losses which are making it inefficient or are loading it down. The flyback and yoke are typically high Q components with low resistive losses, and the secondary circuits draw a normal level of power that is easily replenished by the horiz output stage. Therefore, increasing the HORIZ OUTPUT DEVICE SUB & DRIVE Control beyond the level needed for full deflection and high voltage should not cause the sub current reading to significantly increase. But, if the horizontal output stage does have high resistive losses or abnormal secondary loading, the current will continue to increase as the HORIZ OUTPUT DEVICE SUB & DRIVE Control is increased. This indicates a leaky output component or abnormal loading. Some possible causes include a leaky output transistor, retrace cap, damper diode, scan-derived load or rectifier.

Using The Horizontal Output Device Sub & Drive

To substitute for the horizontal output transistor:

1. Remove AC power from the chassis.
2. Use the Horizontal Output Load Test to identify abnormal loading or timing problems and correct them.
3. Disable the chassis horizontal output transistor by removing it or by disconnecting the base drive signal.
4. Connect the DYNAMIC TEST LEADS to the DYNAMIC TESTS Jack and to the horizontal output transistor or equivalent circuit test points.
5. Set the HORIZ OUTPUT DEVICE SUB & DRIVE Control to "OFF".
6. Apply AC power to the chassis.
7. Use the "DCV" Dynamic Test to confirm proper B+ power supply voltage and correct if defective.
8. Set the HORIZ OUTPUT TESTS Switch to "Device Sub Current".
9. Increase the HORIZ OUTPUT DEVICE SUB & DRIVE Control setting.
   a. Monitor the DEVICE SUB CURRENT Readout for excessive current. Stop subbing if the current exceeds 1.5 amp, or if the overload light illuminates
   b. Monitor the CRT and adjust the level to just above the point where foldover disappears.
10. Read the Digital Readout to measure the subbing current level.

If normal high voltage is produced with a good video on the CRT, you can be sure that the horizontal output, high voltage, RF-IF, video, color, vertical, and CRT circuits are functioning properly.

If the CRT does not produce a raster, measure the high voltage and use the Dynamic Tests to analyze the horizontal output stage. If the high voltage is normal, the chassis has problems in a stage other than the horizontal output or high voltage stages. You may replace the chassis HOT, or continue to use the Horiz Output Device Sub & Drive with the other TVA92 Drive Signals and Tests to further isolate the problem.

The Horiz Output Device Sub & Drive does not confirm that the horiz oscillator and driver stages are functioning properly. Use the Input Drive Dynamic Test to confirm base drive. If the Input Drive test confirms a drive signal is present, all of stages are functional. If the Input Drive test shows the drive is missing troubleshoot the horizontal oscillator, driver or safety shutdown circuits.

For these TVA92 readings: (collector current)	Subtract this approximate base current from the schematic value:
100-250 mA	50 mA
250-500 mA	100 mA
500-800 mA	150 mA
800 mA - 1.2 A	200 mA
1.2 A - 1.5 A	250 mA

Table 1 - Subtract the approximate base current from the schematic current to obtain the TVA92 reading.