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tech tips

# Troubleshooting With The HA2500's Horizontal Output Load Tests

Loading problems cause strain or damage to power supply or horizontal output stage components when AC power is applied to a defective chassis. Horizontal output timing problems or HV/deflection regulator problems cause the X-ray shutdown circuits to shut down the chassis. These problems and others leave the technician with no easy way to determine if circuits are working or a means to pinpoint the problem.

The HA2500's Load Tests are specifically designed to detect horizontal output stage defects and to troubleshoot difficult B+ loading or timing problems. This Tech Tip covers how to use the Load Tests to troubleshoot B+, horizontal output, and flyback secondary circuits with no AC power applied to the chassis. Refer to Tech Tip #219 and Tech Tip #220, for information on how the Load Test works and how to set up and interpret the Load Tests results.

### Load Tests Setup Problems

Many severe horizontal output stage defects become apparent during the Load Tests Setup. Chart 1 lists three common combinations of readouts when chassis defects prevent normal Load Tests Setup and lists their likely causes.

**1.** In the first listing of Chart 1, the Load Tests Setup is not producing flyback voltage pulses in the horizontal output stage being tested. No voltage pulses are indicated by a VPP readout near zero as you increase the Load Tests B+ Volts Control. When you see this, select "LOAD TESTS" and note the mA readout. A mA readout near zero indicates the chassis horizontal output stage is not drawing current from the Load Tests B+ power supply. Dashed lines in the % and µS readouts further indicate that there are no flyback pulses in the horizontal output stage.

The most likely cause of this condition is an improper connection to the horizontal output stage. A less likely cause is an open flyback transformer or B+ coil in the horizontal output stage.

**2.** In the second listing in Chart 2, excessive Load Tests B+ supply current is being drawn by the chassis horizontal output stage. If the mA readout is approximately 250 mA, the maximum output current of the Load Tests B+ power supply, a "Limiting" indicator appears in the center display. This level of current prohibits any further increase in the Load Tests B+ voltage or DCV readout as you increase the Load Tests B+ Volts Control.

Select "LOAD TESTS" and note the mA and % readouts. The mA readout nears or exceeds 250 mA when the current is limited. A % readout of <1% indicates the Load Tests B+ supply current is larger than the current in the Load Tests switching transistor used to energize the horizontal output stage. A less than 1% readout indicates a DC short on the Load Tests B+ power supply. The next section in this Tech Tip discusses isolating DC shorts or leakage.

**3.** The third listing in Chart 2 is a condition that does not produce sufficient VPP during the Load Tests Setup. When this indication is accompanied by a higher than normal µS readout, suspect the horizontal yoke current path. The yoke may simply be unplugged from the board, or one of its series components may be open or have a bad solder connection. While this condition lowers the % readout, it usually remains in a normal range.

| Load Tests Setup Readouts | | Load Tests Readouts | | | Likely Causes |
|---|---|---|---|---|---|
| DCV | VPP | mA | % | µS | |
| 1. Adj. Norm | 0.0 VPP | 0 mA | -- % | --- µS | Wrong Connection. Open in Horiz. Output. No Load Test volts. |
| 2. Stops Increasing "Limiting" | 0 or low | Approx. 250 mA | < 1% | | DC short (See Fig. 1) Wrong Connection |
| 3. Adj. Norm | Low | Low | Norm | | Horiz. Yoke Open |

***Chart 1: Common Load Tests Setup Readouts when severe chassis defects prevent normal setup and their likely causes.***

### Troubleshooting With The Load Test

If the Load Tests readouts indicate high current and /or low efficiency and/or bad µS readings, a problem exists in the horizontal output stage. You can use the Load Tests readouts to help isolate the defect. Chart 2 lists common combinations of Load Tests readouts and their likely causes.

### Troubleshooting High mA & Low % Load Tests Readouts

There are commonly three types of shorts or leakage problems which cause extra current (loading) of the chassis B+ supply. The Load Tests readouts can determine the type of short or leakage

| Load Tests Readouts | | | Likely Causes |
|---|---|---|---|
| mA | % | µS | |
| High mA | Very Low <6% | | Improper connection. DC leakage. (See Fig.1) |
| High mA | Low % 6-50% | | Horiz. Out Defect ñ Shorted inductor turn(s), secondary short, leaky or open component. (See Fig. 2) |
| Normal mA | Low % | Near Normal or low µS | Load Test Freq. Hi or B+ Low Horiz. Out Defect ñ Shorted inductor turn(s), sec. short, leaky component. (See Fig. 3) |
| Normal mA | Normal % | Low µS | Horiz. Out Timing ñ Retrace capacitor. Display runs higher resolution or frequency. |
| Low mA | Normal % | High µS | Yoke or series components. |

***Chart 2: Common Load Tests combination of readouts and likely causes.***

(loading) problem and help you isolate it. The three types include:

1. A low resistance path for direct current (DC short to ground) on the B+ supply.
2. A DC leakage (higher resistance B+ to ground) on the B+ supply.
3. An AC short or leakage path in the horizontal output stage.

The Load Test's mA and % readouts can be used to determine what type of loading problem exists and provide feedback to isolate the defect. A Load Tests mA readout of approximately 250 mA with a Load Tests efficiency % readout of "<1%" indicates a low resistance DC short to ground on the B+ power supply. This is the maximum current which can be output by the Load Test B+ volts supply.

Before assuming a circuit short, check for proper test lead clip connections to the chassis horizontal output circuit points.

A DC short is a direct current path between the Load Tests B+ power supply output (orange test clip) and power supply ground (black test clip). You can further confirm a DC short by connecting only the orange and black test lead clips to the chassis horizontal output stage. If the mA readout remains near 250 mA, you have confirmed a DC short.

There are many possible DC short paths, as shown in Figure 1. A DC short or leakage path can be caused by a leaky filter capacitor, diode, or regulator component in B+ path of the chassis. Defects may also be from shorts or leakage paths in the horizontal output stage or other stages connected to the B+ power supply path. A DC short should be corrected before applying AC power to the chassis to prevent power supply damage.

The most likely cause of a DC short on the B+ supply is a shorted horizontal output transistor. Remove the chassis horizontal output transistor and note the Load Test mA readout. If the mA reading now remains near zero or less than 5 mA, you have confirmed that the horizontal output transistor is shorted.

***Caution:*** *The Load Test energizes the horizontal output circuit. Remove a test clip or turn the Load Tests B+ Volts to 0 VDC when unsoldering or testing components.*

If opening the horizontal output transistor does not remove the short, continue to open possible short paths. The opened component or current path that reduces the mA reading near zero identifies the short.

Loading problems which are not low resistance or DC shorts produce high mA readouts and/or low efficiency % readouts. Loading problems typically cause mA readouts between 70 and 200 mA and/or efficiency % readings between 6% and 50%. The first step in isolating a loading problem is to determine if the added load current is caused by DC loading or AC loading.

The Horiz Output Load Test can be used to determine which type of loading problem exists and to isolate the defect. Most DC loading problems reduce the efficiency % readout below 5% while AC loading problems produce efficiency % readouts ranging between 6% and 50%.

To determine a DC loading problem from an AC loading problem, disconnect the yellow test lead clip from the chassis horizontal output stages (see Figure 2).

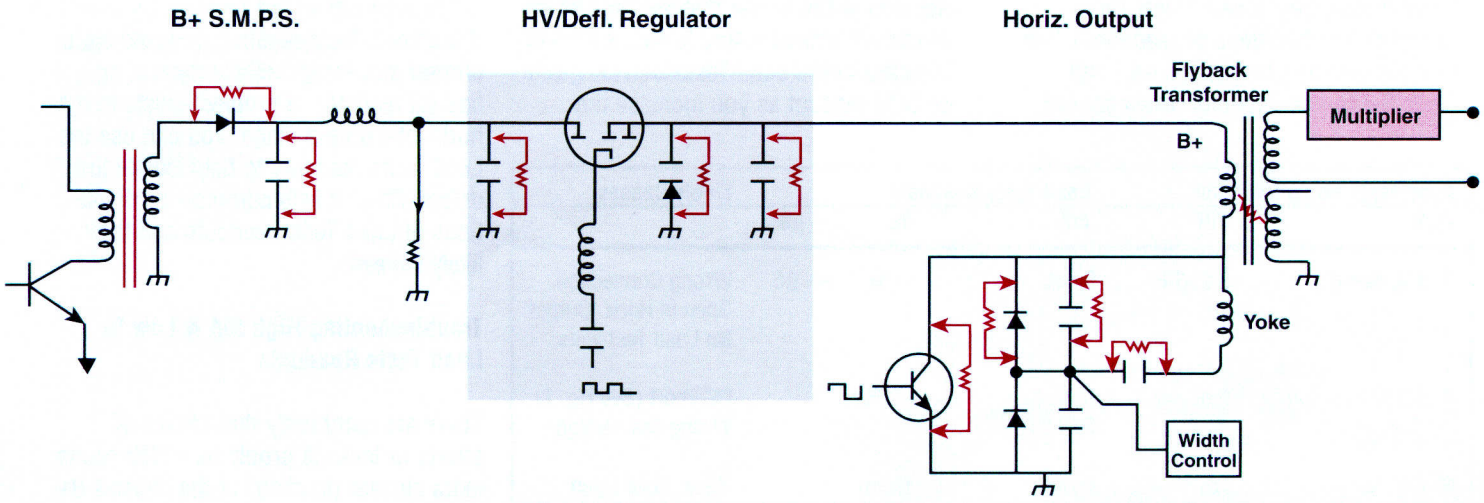


***Fig. 1: Possible DC short or leakage paths which can load down the chassis B+ power supply and cause a high Load Tests mA readout.***

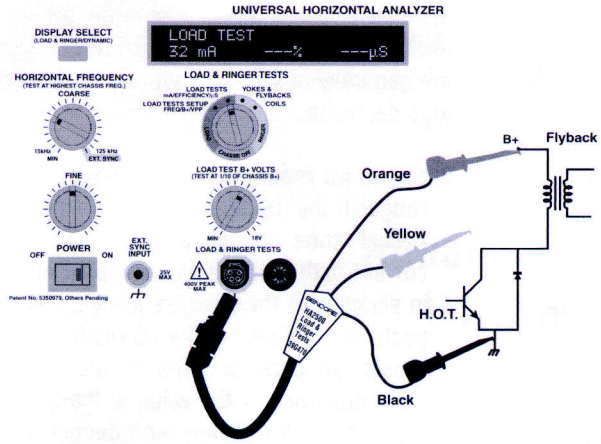


***Fig. 2: Removing the yellow test lead clip identifies DC shorts or leakage loading problems from AC loading problems.***

Removing the yellow clip stops alternating currents in the horizontal output stage and all power transferred to the flyback secondary circuits and shorted turns which may exist in transformers or coils of the horizontal output stage. With the yellow lead opened, the Load Tests Setup VPP reads near 0 VPP and the Load Tests % and µS readouts show dashed lines.

With the yellow lead clip opened, increase the Load Test B+ Volts to approximately 1/10 of the chassis norm. The Load Tests mA readout indicates the DC current to circuits powered by the Load Tests B+ power supply. This includes the horizontal output stage and perhaps the horizontal driver stage and others. These stages typically draw less than 5 mA of DC current from the Load Test B+ supply with the yellow clip open. If the current is much higher than this, suspect a DC short or leakage path on the B+ power supply. Isolate a DC leakage path in the same manner as isolating a DC short.

***Note:*** *Some horizontal output stages use a small DC current for horizontal yoke centering which may be seen during this DC current test.*

If the mA readout is higher than the typical range for the horizontal output stage being tested, but is less than 5 mA when the yellow clip is removed, the high current is a result of a severe AC current load in the horizontal output stage. The current demand may be caused by shorted turns in the inductors of the output stage or yoke. A short or leakage in a secondary component or circuit fed by the flyback may also be the cause (see Figure 3). It is also possible for the horizontal output transistor, damper diode, or retrace capacitor to be breaking down during the test.

Using a process of elimination and the Load Test readouts, you can isolate the AC loading problem to the horizontal output stage components or flyback transformer secondary loads. First remove the horizontal output transistor and damper diode and repeat the Load Test, comparing the mA readouts. A reduction in the mA readout indicates leakage in the transistor or damper.

***Note:*** *The HORIZ OUTPUT LOAD test can be performed with the horizontal output transistor and/or damper in or out of circuit. These components, if good, will not change the mA, %, or µS readouts.*

One method of isolating secondary shorts or loads is to open flyback secondary paths by unsoldering a flyback lead, scan diode, etc. Repeat the Load Test after opening secondary paths and compare the mA readout to the previous value. A large decrease in the mA readout confirms a problem with the load on that flyback winding. If high current remains after all the secondaries are open, a flyback shorted turn or leaky horizontal output stage component is likely.

Another method of isolating secondary loading is to use the HA2500's Collector Or Drain Dynamic Tests to measure secondary DC voltages and VPP. You may use the Dynamic Test Lead or optional Dynamic Tests DVM lead. Measured DC voltages and Peak-to-Peak flyback pulse amplitudes on the secondary windings of the flyback during the Load Test should measure 1/10 of normal. Waveforms or DC voltages which are considerably lower than 1/10 their norm or completely missing suggest a shorted component or circuit associated with that flyback winding or secondary.

***Note:*** *When measuring the output of voltage multipliers or focus dividers, use a voltage multiplier, such as the Sencore TP212. Measurements would be multiplied by 100 for comparison to the schematic when using the LOAD TEST and the TP212 X10 multiplier.*

If all the secondary voltages appear 1/10 of normal, the problem is likely caused by a shorted turn in the flyback or yoke or a component breaking down in the horizontal output stage. Opening components individually in the horizontal output stage including components in the horizontal yoke current path alter the operation of the horizontal output stage and the Load Tests Setup and Load Tests Readouts. Therefore, you must rely on individual component tests to isolate AC loading defects once they are isolated to the horizontal output stage. Use the RINGER test to check the flyback, yoke, and other coils for a shorted turn(s). A Sencore "Z-Meter" is r ecommended to test capacitors for value and leakage near their rated voltage potential.

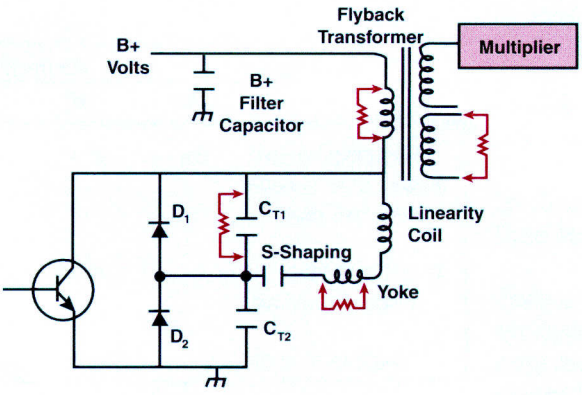


***Fig. 3: Possible AC shorts or leakage paths in a horizontal output stage.***

## Troubleshooting Unusual µS Readouts

The Load Tests µS readout provides an automatic measurement of the timing of the voltage pulses developed by the horizontal output stage. The pulse time should closely agree with the normal pulse time when full B+ voltage is applied to the chassis horizontal output stage. Therefore, timing defects or variations from normal can be detected with the Load Tests µS readout and corrected before applying AC to the chassis.

Timing problems in the horizontal output stage commonly cause X-ray shutdown symptoms and/or H.O.T. failures.

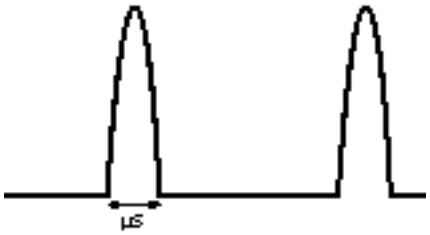


***Fig. 4: A normal flyback pulse at the collector or drain of the H.O.T during the Load Test.***

If the Load Tests µS readout is outside of the typical range or fluctuating by several µS, a timing problem in the horizontal output stage is indicated. There are commonly three variations of the µS readouts from the typical readout when loading or timing problems exist in the horizontal output stage. They include:

1. "---" readouts
2. Stable µS readouts below the typical range
3. Stable µS readouts above the typical range
4. µS readouts fluctuating by several µS

1. **A "--- µS" readout:** Dashed lines in the µS readout indicate that the flyback pulses normally produced during the Horiz Output Load Tests are not present. Confirm that the Load Test lead connections and Load Test Setup parameters are proper.

2. **Stable µS readout below the typical range:** A steady µS readout below the typical range for a particular chassis indicates a value change in one of the critical timing components in the horizontal output stage.

A reduced µS readout is common in horizontal output stages with a shorted flyback turn or shorts on the flyback secondary circuits. These faults effectively decrease the transformer or inductance value causing the µS readout to fall near or below the typical normal range. Shorted flyback turns and secondary loading problems typically cause higher than normal Load Test mA readings and low % efficiency readings. If the Load Tests indicate high mA and/or low % efficient readouts, ignore the unusual µS readout and isolate the excessive loading problem first.

If the µS readout is below the typical range and the mA and % readings are normal, a timing defect may exist. First check the display's frequency and resolution capabilities. The chassis horizontal output stage may be capable of displaying higher video resolutions at a faster horizontal scan frequency. This may have caused you to reference an improper row of the Typical µS Pulse Time Range Chart.

If the µS timing is confirmed low for the chassis, a timing defect in the horizontal output stage is likely. The pulse time is primarily determined by the values of the coil or flyback transformer applying B+ to the horizontal output stage and the timing or retrace capacitor(s). Check the retrace timing capacitors for reduced value and leakage.

While the yoke and its series components affect the timing of the horizontal output stage, component values typically must increase to cause a decrease in the µS readings. Therefore, these components are generally not suspect when µS readings decrease.

3. **Stable µS readouts above the typical range:** If the µS readout is above the typical range, suspect an open yoke current path. The yoke or components in series with the yoke are likely suspects. An increase in the uS readout reflects an increase in the retrace capacitor value or the value of the B+ coil or flyback transformer inductance. Since components do not increase value when defective, the retrace capacitors and B+ flyback transformer or coils are generally not suspect when µS readings increase.

4. **µS readouts fluctuating by several µS:** Readings that are changing values by several µS indicate that the waveshape of the flyback pulse is abnormal. The waveshape may have multiple flyback pulses or abnormal pulse shape or ringing. Severe output stage problems or loading problems in the flyback secondaries are likely causes. Fluctuating readings are commonly accompanied by high mA and low % efficiency Load Test results.

When troubleshooting timing problems and unusual µS readouts, it is sometimes helpful to use an oscilloscope to view the pulse at the collector or drain of the horizontal output transistor. A normal flyback pulse should look similar to that shown in Figure 4.



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