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## tech tips

# Identifying   Television   SMPS   Problems

Many of todays television receivers use switch mode power supplies (SMPS, "choppers" or "switchers") to regulate the DC voltage that powers the horizontal output stage. The SMPS also provides most of the low voltages that were produced by the scan-derived supplies. The SMPS provides excellent B+ regulation and removes that extra load that the scan-derived supplies placed on the horizontal stages.

The SMPS also provides a means of safety shutdown should the horizontal output stage produce excessive high voltage or draw too much current. Protection circuits shut down the SMPS when either of these conditions occurs. This can cause a problem for a servicer since a startup or shutdown condition can be caused by a problem in either the horizontal output stages or in the SMPS

This Tech Tip explains how to determine if the startup or shutdown problem is caused by the SMPS or by the horizontal output stage. Refer to Tech Tip #203 for information on how the SMPS used in television receivers work, and Tech Tip #205 for further information on troubleshooting television SMPS.

## Troubleshooting  Overview

Troubleshooting the horizontal circuits in a chassis that uses a SMPS to supply Bt to the horizontal output transistor involves troubleshooting a power supply that is part of another power supply. A dead set might be caused by a bad horizontal stage or by a bad SMPS. The set might run for a short time, and then shut down - this, too, could be caused by problems in either the horizontal circuits or the SMPS.

*NOTE:  The horizontal output stage is a type of switched mode power supply. In this Tech Tip, however, when we refer to SMPS we are referring to the supply that provides the DC to the horizontal output transistor (H. O. T.)*

The procedures in Tech Tip #131 explained how to service the horizontal startup and shutdown stages in older conventional chassis that did not use a SMPS. Many of those procedures apply to today's chassis that use a SMPS to power the horizontal stages. There are two major differences, however. First, you can not longer use your PR57 Variable AC Power Supply to reduce the DC to the horizontal output stages. This is because the B+ is now provided by the SMPS and a SMPS will provide a constant output voltage as the applied AC input voltage is changed.
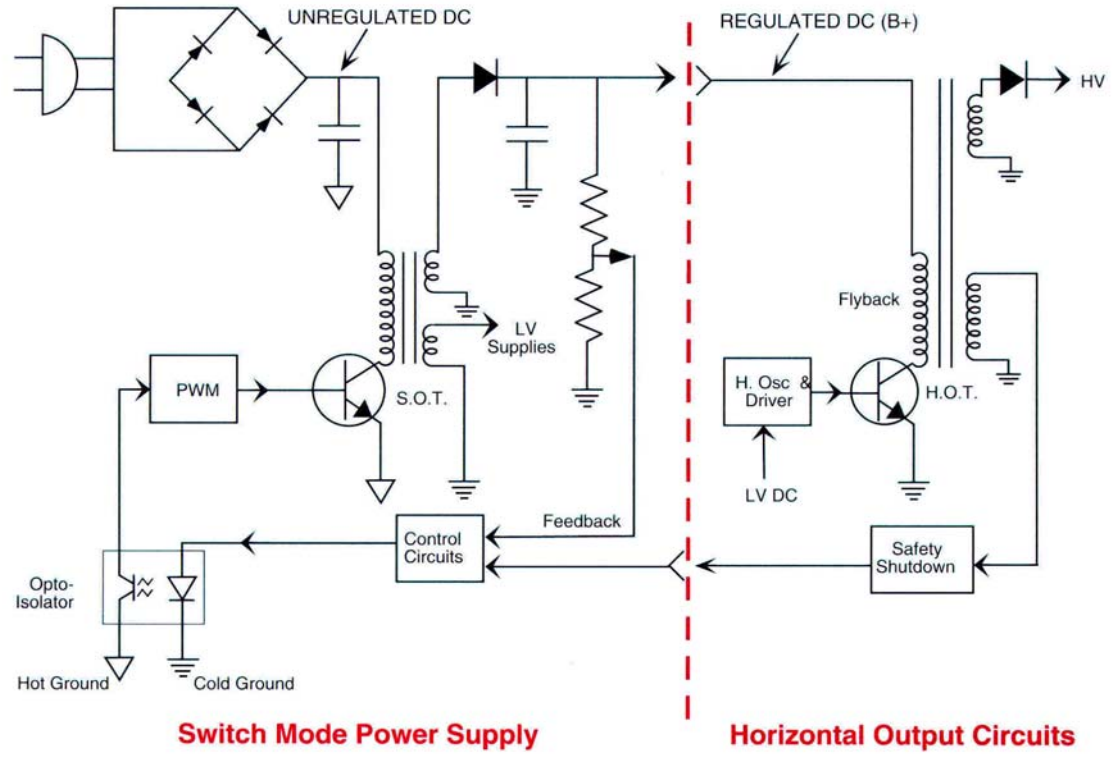


**Switch Mode Power Supply**          **Horizontal Output Circuits**

*Fig. 1: The regulated DC for the horizontal output stage is produced by a SMPS. The SMPS  receives unregulated DC from the AC fine.*

The second difference in troubleshooting startup and shutdown conditions is a result of how the protection circuits produce shutdown. Shutdown was usually achieved by removing the drive signal to the horizontal output transistor, or by turning off the B+ regulator. In chassis that use a SMPS however, shutdown is achieved by turning off the SMPS.

Most SMPS chassis have a secondary (or "standby") SMPS which powers the remote control circuits. Since the main power supply won't start if the remote control is dead, check the secondary supply and the remote control circuits before testing the main supply and the horizontal output stages. See Tech Tip #205 for more information.

## The Key Test Points

Just as the horizontal output transistor (H.O.T.) provides the most important test point when testing the horizontal stages, the SMPS output transistor (S.O.T.) provides the best starting point when troubleshooting a switch mode power supply. Collect as many clues as possible from both test points the first few seconds after you apply power to separate startup problems from shutdown problems.

In the following steps you will monitor the output of the SMPS S.O.T. with Channel A of your Waveform Analyzer and the horizontal retrace pulse (collector of the H.O.T.) with Channel B. You will preset the Waveform Analyzer controls so that you can see any signal, even if it is only present. in the circuit for a moment.

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**WARNING**

This procedure ties the "hot" and "isolated" grounds together. It **is absolutely essential that the chassis be connected to an isolation transformer, such as the Sencore *PR57 AC POWERITE.***

Observe safety precautions to avoid shock hazards. Some signals can be over 1200 volts. The input of your measuring instruments must be protected to a higher voltage than this. Using the Waveform Analyzer with its supplied probes, provides protection to 2500 volts.

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Follow these steps:

1. Connect the Channel A probe to the terminal on the switching power transistor which connects to the primary of the switching transformer (The collector if the transistor is a bipolar type, or the drain if a FET is used).

2. Connect the Channel A probe ground to the ground of the switching supply's primary winding (normally the "hot" ground).

3. Connect the Channel B probe to the collector of the H.O.T.

4. Connect the Channel B probe ground to the ground of the horizontal output stage (normally isolated or "cold" ground).

*NOTE: for correct measurements you must connect BOTH grounds. This will not damage the chassis, as long as it is plugged into an isolation transformer. If you don't make both ground connections the switcher transformer will cause waveform distortion in the waveforms.*

5. Preset the controls on your test instruments as follows:

PR57:
  a. Set for a 117 volt output before connecting the chassis
  B. Select the "1.5 Amp" range.
  c.Turn off the PR57 and connect the chassis.

Waveform Analyzer:
  a. Set the Ch.A VOLTS/DIV to "100".
  b. Set the Ch.B VOLTS/DIV to "200".
  c. Set both INPUT COUPLING switches to "AC".
  d. Set the TIMEBASE-FREQ switch to "10 microsecond".
  e. Set the TRIGGERING controls:
    SOURCE to "CH B".
    MODE to "Auto".
    POLARITY to "+".
    LEVEL to "0".
  f. Press the "A&B" CRT SELECTOR button.
  g. Position the Ch. A trace on the second major CRT marking from the top of the screen.
  h. Position the Ch. B trace 1/2 of a major CRT marking from the bottom of the screen.

i. Press the Channel A "DCV" DIGITAL READOUT button.

Now you are ready to observe the events that take place as soon as you apply power to the chassis. The first thing you need to know is whether a waveform appears in either of the test points.

## Analyzing Startup Conditions

Watch for results on your Waveform Analyzer during each step of applying power. Each step provides valuable clues to help you get right to the problem. These steps are outlined in the Trouble Tree shown in Figure 2, and are explained in more detail in the following steps.
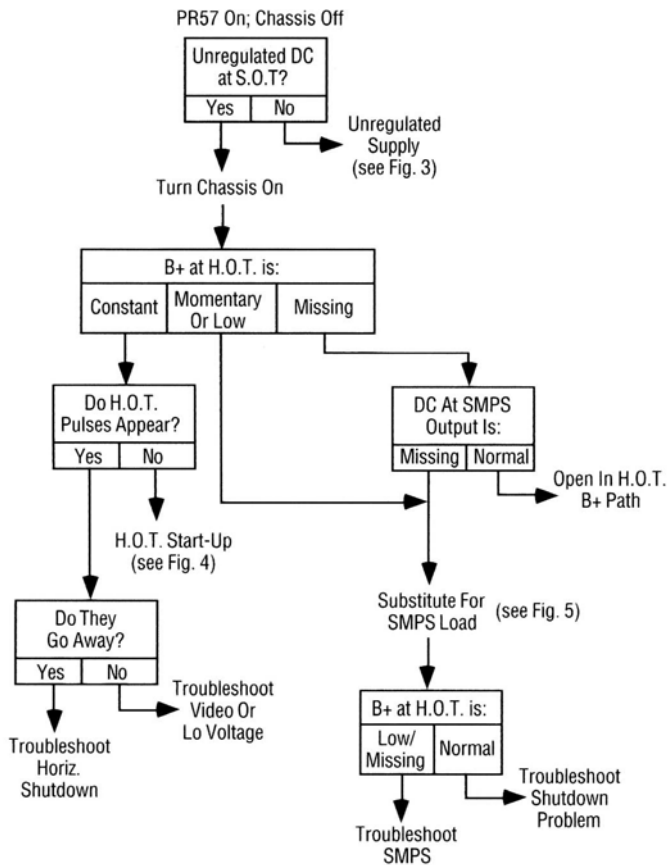
### Unregulated DC To SMPS
There should be about 150-160 volts present at the drain (or collector) lead of the SMPS output device with the PR57 turned on and the chassis turned off. If this voltage is present, you know that the switcher's unregulated DC supply is working. If the voltage is low or missing move to the Trouble Tree in Figure 3 which isolates problems related to the unregulated DC supply, an open SMPS transformer primary winding, or a shorted switching output device.

Move your probe to the input side of the primary winding (the end connected to unregulated DC) helps isolate the cause. If you see full DC on the input terminal the transformer primary or some other series connection is open. If you see a lower than normal DC the switching transistor (or a parallel component) is likely shorted.

If your troubleshooting points to the unregulated DC supply don't forget to check for a blown fuse. An open fuse can indicate that one of the power supply bridge diodes is shorted, or that there is a short in the switching supply. Check the diodes before moving on. If the input fuse is blown and the unregulated power supply diodes are good, suspect a shorted switcher transistor.

### Confirm Proper B+ Voltage To H.O.T.
If the unregulated DC voltage is present at the S.O.T., press the Channel B DCV button to measure the B+ voltage at the horizontal output device when you turn the chassis on. (This is the regulated DC

## Fig. 2 flowchart

PR57 On; Chassis Off

Unregulated DC at S.O.T? — Yes / No

No → Unregulated Supply (see Fig. 3)

Yes → Turn Chassis On

B+ at H.O.T. is: — Constant / Momentary Or Low / Missing

Constant → Do H.O.T. Pulses Appear? — Yes / No

No → H.O.T. Start-Up (see Fig. 4)

Yes → Do They Go Away? — Yes / No

Yes → Troubleshoot Horiz. Shutdown

No → Troubleshoot Video Or Lo Voltage

Momentary Or Low / Missing → DC At SMPS Output Is: — Missing / Normal

Normal → Open In H.O.T. B+ Path

Missing → Substitute For SMPS Load (see Fig. 5)

→ B+ at H.O.T. is: — Low/Missing / Normal

Low/Missing → Troubleshoot SMPS

Normal → Troubleshoot Shutdown Problem

*Fig. 2: Follow these steps to determine if a startup or shutdown problem is caused by the horizontal output stages or by the switch mode power supply.*
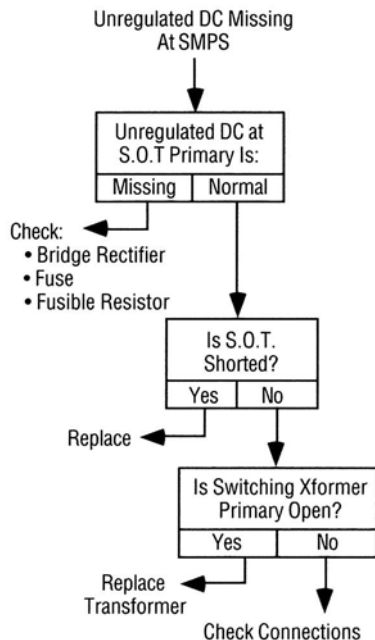
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output of the SMPS). Confirm that this voltage is correct. Normally it is about 130 VDC, but check the schematic for the exact amount. If this voltage is not correct it will cause shutdown. Troubleshoot the SMPS if the regulated Bt voltage is incorrect.

### Horizontal Shutdown

If the regulated DC output of the SMPS is correct carefully observe the CRT on your Waveform Analyzer as you turn on the chassis power. Pay special attention to the Channel B (H.O.T.) trace (the one near the bottom of the screen) while glancing at the Channel A (S.O.T.) trace soon after.

If horizontal pulses (and DC voltage) appear and then disappear, the chassis is starting up and then going into shutdown. Most chassis that use a SMPS turn off the SMPS when a shutdown condition occurs in the horizontal stages. Therefore, the DC voltage output from the SMPS will go away. A few chassis, however, may achieve shutdown by removing the horizontal drive. If so, the pulses at the H.O.T. will go away but the DC voltage will remain. In either case, the shutdown problem is likely caused by a defect in the

horizontal stage. Possible problems include a retrace time that is too short, (defective timing capacitor), excessive PPV (an open scan derived load if the chassis uses scan derived supplies), or a

## Fig. 3 flowchart

Unregulated DC Missing At SMPS

→ Unregulated DC at S.O.T Primary Is: — Missing / Normal

Missing → Check:
• Bridge Rectifier
• Fuse
• Fusible Resistor

Normal → Is S.O.T. Shorted? — Yes / No

Yes → Replace

No → Is Switching Xformer Primary Open? — Yes / No

Yes → Replace Transformer

No → Check Connections

*Fig. 3 Follow these steps to locate problems in the unregulated DC supply.*

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defective shutdown circuit. Information on how to troubleshoot shutdown problems is covered in other Tech Tips.

### Horizontal Running

If you observe pulses at the collector of the horizontal output transistor and they remain, the "dead set" symptom is not caused by a horizontal problem. Look for problems in the video amplifiers or one of the low voltage switcher power supplies that feeds other circuits.

## Fig. 4 flowchart

H.O. B+ No H. Start-Up

→ Is There Signal At H. Driver? — Yes / No

Yes → Fix Output Stage

No → Is There B+ At Oscillator Input? — Yes / No

Yes → Fix Oscillator

No → Fix Start-Up B+
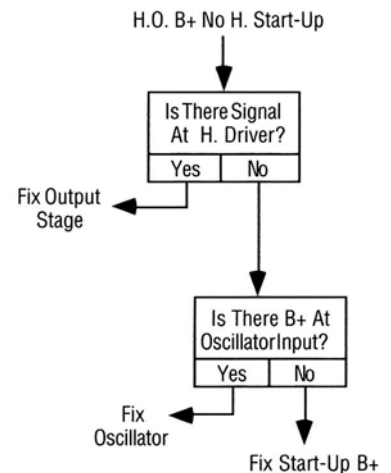
*Fig. 4 : Follow these steps to locate horizontal startup problems.*

### Horizontal B+ OK, No H.O.T. Pulses

If there is proper B+ voltage at the collector of the horizontal output transistor but no pulses, the SMPS is working. Follow the procedures in the Trouble Tree in Figure 4, which takes you through horizontal startup problems. These steps involve checking for horizontal drive. If there is no drive, check for a startup voltage at the horizontal oscillator.

## Separate The SMPS From The Horizontal Output Stage

If there is proper unregulated DC at the drain (or collector) of the switching

device, but there are no pulses, or only momentary pulses, you need to determine if the SMPS is defective, or if it is being loaded down or shut down by a defect in the horizontal stage. To do this you need to substitute a known load in place of the horizontal output, as shown in Figure 5. A 60 watt light bulb provides a suitable substitute load.

**To substitute for the H.O.T. load:**

1. Turn off the PR57

2. Disconnect the collector of the horizontal output transistor from the primary of the flyback transformer.

3. Locate the point where the feedback path connects to the SMPS DC output.

4. Connect a one side of a 60 watt light bulb to the SMPS DC voltage line after the feedback takeoff point.

*Do not connect the tight bulb in series with the flyback primary. This winding is not designed to handle a continuous current and may be damaged.*

5. Connect the other side of the light bulb

to the ground (emitter) of the horizontal output stage.

After you have connected the substitute load, turn on both your PR57 and the chassis. If the SMPS is operating the light bulb will light. The fact that the SMPS operates with a substitute load indicates that something in the horizontal section was likely causing it to shut down.

Also check the opto-isolators that couple the startup and shutdown signals back to the switcher from the circuits on the isolated side of the switcher transformer. These isolating components often couple the regulator control signal as well as the shutdown signal and a problem in the regulator loop can also cause shutdown.

If the SMPS still has no pulses at the S.O.T. (but the unregulated DC is correct) with the substitute load, you need to troubleshoot the SMPS as explained in Tech Tip #205.

## Testing the Components

Many problems will be related to bad capacitors. Use your LC102 Z Meter to make the usual tests of value and leakage

at rated voltage to find most capacitor failures. But don't forget that equivalent series resistance (ESR) in electrolytic capacitors is much more critical in the high frequencies involved with a SMPS than with other, low frequency power supplies. Always test ESR when you suspect a capacitor problem, even though the capacitor has good value and leakage.

If you suspect either the horizontal flyback or the SMPS flyback transformer, use the Z Meter Ringer test to check for shorts, shorted turns, or open windings.

Sometimes a transistor tests good at the low test voltages applied by a transistor tester, but breaks down (emitter to collector ) under load. If you suspect that a transistor is breaking down use your Z Meter leakage power supply to test for emitter-collector breakdown.

Similarly, if you suspect that a zener diode may be defective, use your Z Meter power supply to check for correct regulation. Details on using your Z Meter power supply to test these components are found in Tech Tip #112.
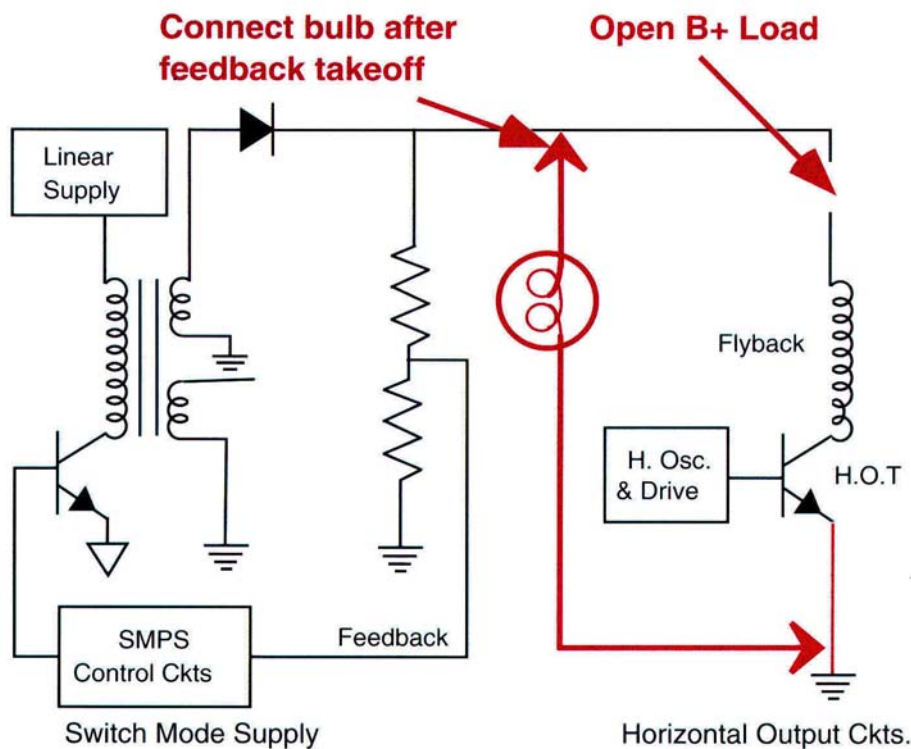


Fig. 5: Open the B+ to the H.O.T. and use a 60 watt fight bulb to substitute for the horizontal output load on the