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tech tips

Servicing Startup And Shutdown Problems With The SC61

Most television receivers and monitors use at least one safety shutdown circuit and circuits to start the horizontal stages when power is first applied. This Tech Tip explains how to use the Sencore SC61 Waveform Analyzer™ and the PR57 AC ''POWERITE''® to isolate problems in these circuits.

Why Use Shutdown Circuits?

Safety shutdown circuits prevent the high voltage stages from operating unsafely. Their main function is to safely shut down the set if a problem causes the high voltage to rise too high. They also prevent power supply problems from damaging other components in the receiver.

The safety circuits have sensors which monitor the signal at one or more test points related to the horizontal circuits. Four typical signal sources are: 1) A flyback transformer winding, 2) The DC from the regulator, CRT screens or focus, or video outputs, 3) The current returning from the picture tube, and 4) The current in the emitter of the horizontal output transistor. Some receivers use only one of these sensing methods, while others may use several.

If a detector finds a signal which is too large, it kills the horizontal output. The three most common shutdown methods are: 1) Shorting the drive signal to the output stage, 2) Stopping the B+ feeding the output transistor, and 3) Blocking the DC to the horizontal oscillator or driver. Since the horizontal oscillator operates with scan-derived power from the flyback transformer, any method which blocks the horizontal signal results in a complete shutdown of the horizontal circuits.

The Startup Circuits

The set needs startup circuits because the horizontal oscillator receives its power supply from the flyback transformer. This forms a closed loop, which cannot get started without help from an external power source. There are two kinds of startup circuits: 1) Kick starters, and 2) Trickle starters.

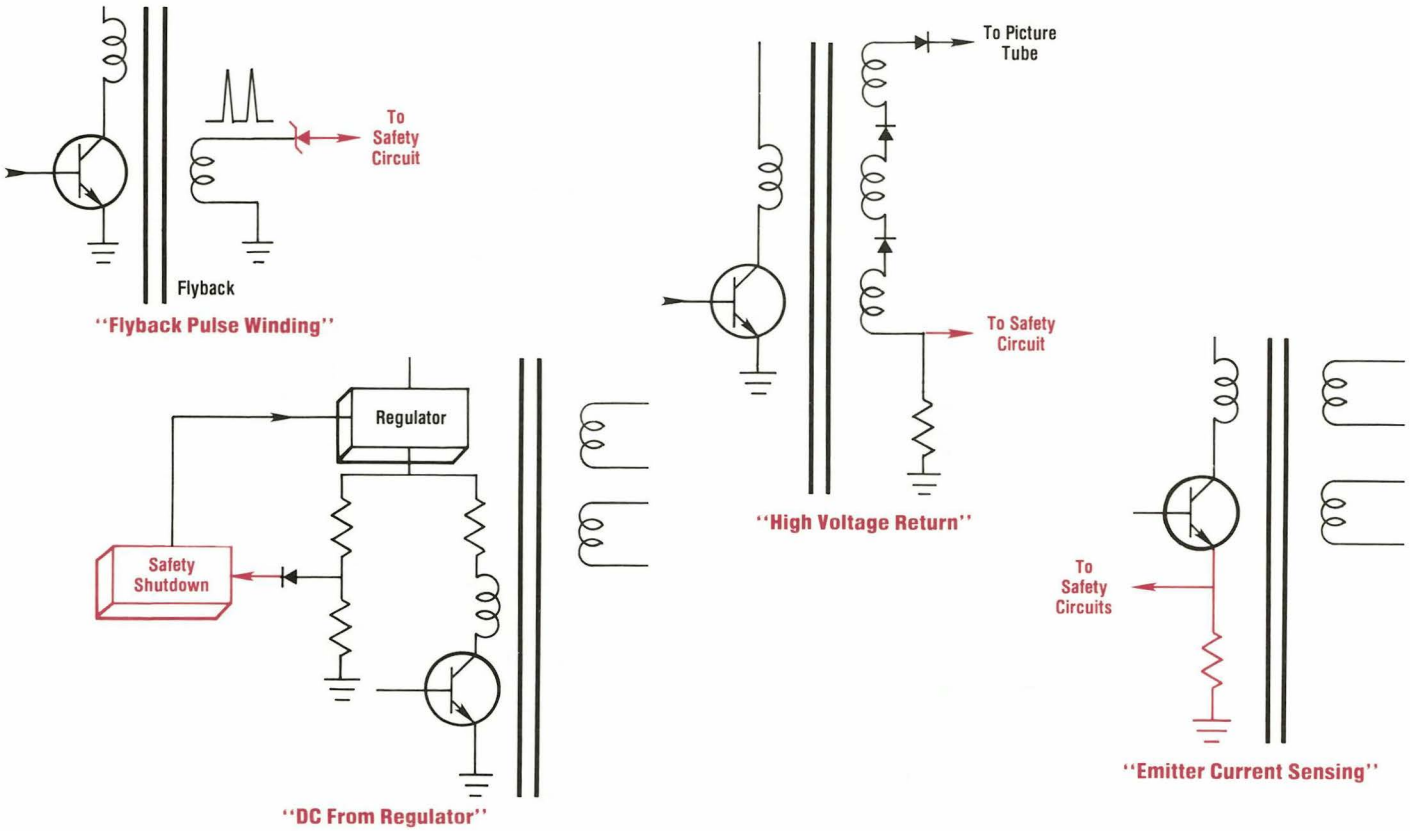

Fig. 1: Safety circuits use one of these four methods of determining if one of the horizontal circuits is producing too much voltage or current.

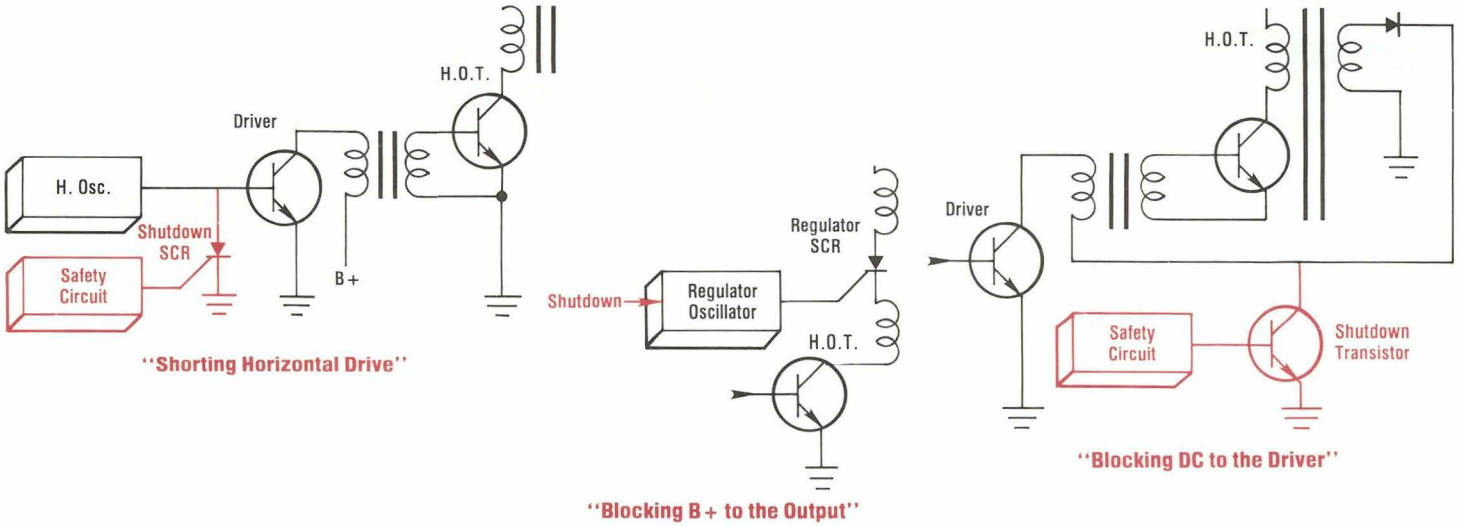

Fig. 2: The safety circuits trigger one or more of these circuits to stop the horizontal circuits.

The trickle starter is more common. It feeds a small amount of current directly from the AC line bridge rectifiers to the oscillator. The current is enough to start the oscillator, but not enough to sustain operation. The low level of drive produced is enough to generate current in the scan-derived power supplies. The power from these circuits builds quickly and takes over the operation of the oscillator and driver from the startup supply.

The kick starters are used in chassis with separate hot and cold grounds. These receivers use the flyback transformer to isolate most of the chassis from the AC line. The kick starter produces a voltage to the oscillator for a few milliseconds when power is first applied. If the output produces scan-derived power fast enough, it will sustain operation of the oscillator and the driver. If not, the set dies and cannot be restarted until the power switch has been turned off long enough for a capacitor to discharge.

A problem in servicing these circuits is that startup and shutdown problems often give similar symptoms. You cannot have a shutdown problem if the set never started in the first place. Shutdown may happen so quickly that you didn't notice the brief period of operation. That's where good methods help.

The Main Test Point

There is one test point which gives the most information about startup and shutdown problems. If your test equipment is properly protected, you can connect to the collector of the horizontal output transistor (HOT). Protection is important, since the test point normally has between

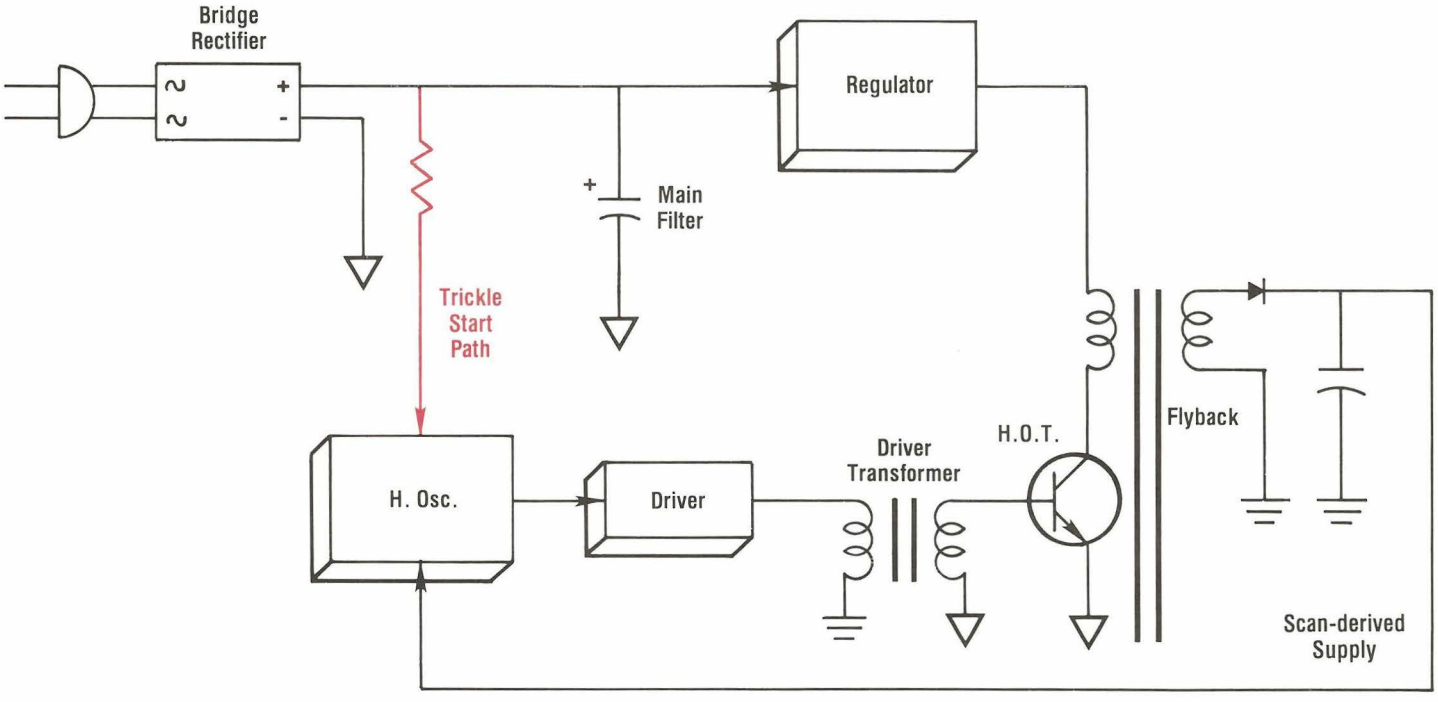

Fig. 3: The common "trickle start" circuit allows a small amount of current to pass from the unregulated power supply until the scan-derived supply takes over.

900 and 1500 volts (peak-to-peak). Most scopes are protected to only 600 volts, and some to only 400 volts. The Sencore SC61 Waveform Analyzer, however, can make measurements to 2000 volts, and is protected against overloads to 3000 volts.

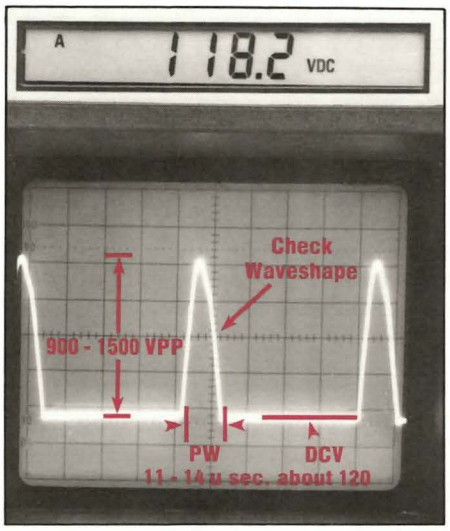

Fig. 5: Use your SC61 Waveform Analyzer to check these main waveform parameters. Except for waveshape, all other measurements are made with the digital readout.

To analyze this signal, you need to know its normal makeup. In the next few paragraphs, we will explain the signal in general terms. See Sencore Tech Tip #118 if you want more details about analyzing this signal.

Waveshape: Figure 5 shows the ideal waveshape. The two most common waveform defects are a deep saddle or a noisy baseline. A deep saddle often shows there is a short—either in the flyback itself or in one of its loads. Since the normal saddle depth varies from one receiver to the next, be sure you compare the measured waveform to the schematic to see how much is normal. Hash, ringing, or noise on the baseline could be caused by a mechanical defect (such as a cracked core), or by a defect in the driver transformer.

DC Voltage: Improper DC voltage can cause either startup or shutdown problems. Startup problems are often caused by a failure in the power supply circuits. Shutdown problems can be caused by the regulator allowing too much voltage to be applied to the output transistor. Voltages which are low (but present) indicate a bad power supply or excessive loading in the output stage, due to a bad output transistor or to a load on the secondary of the flyback transformer which is drawing too much current.

Peak-to-Peak Level: The amplitude of the collector signal tells whether the output stage is running efficiently. If the pulse is too large, the high voltage will build too high, and trigger the shutdown circuits. Excessive amplitude may be caused by a bad DC regulator, the pulse being too narrow, or by an open in one of the secondary flyback loads.

Pulse Width: If the flyback pulse is too narrow, the high voltage increases rapidly. The pulse should be between 12 and 14 microseconds. The SC61's △ TIME function lets you quickly check for the correct time. (Remember to make the reading from the 10% to the 10% levels on the pulse, not from the baseline to the baseline.) The most common cause of a narrow flyback pulse is a reduction in the capacitance between the emitter and the collector of the output transistor.

The First Step

Your first troubleshooting step needs to separate startup from shutdown problems.

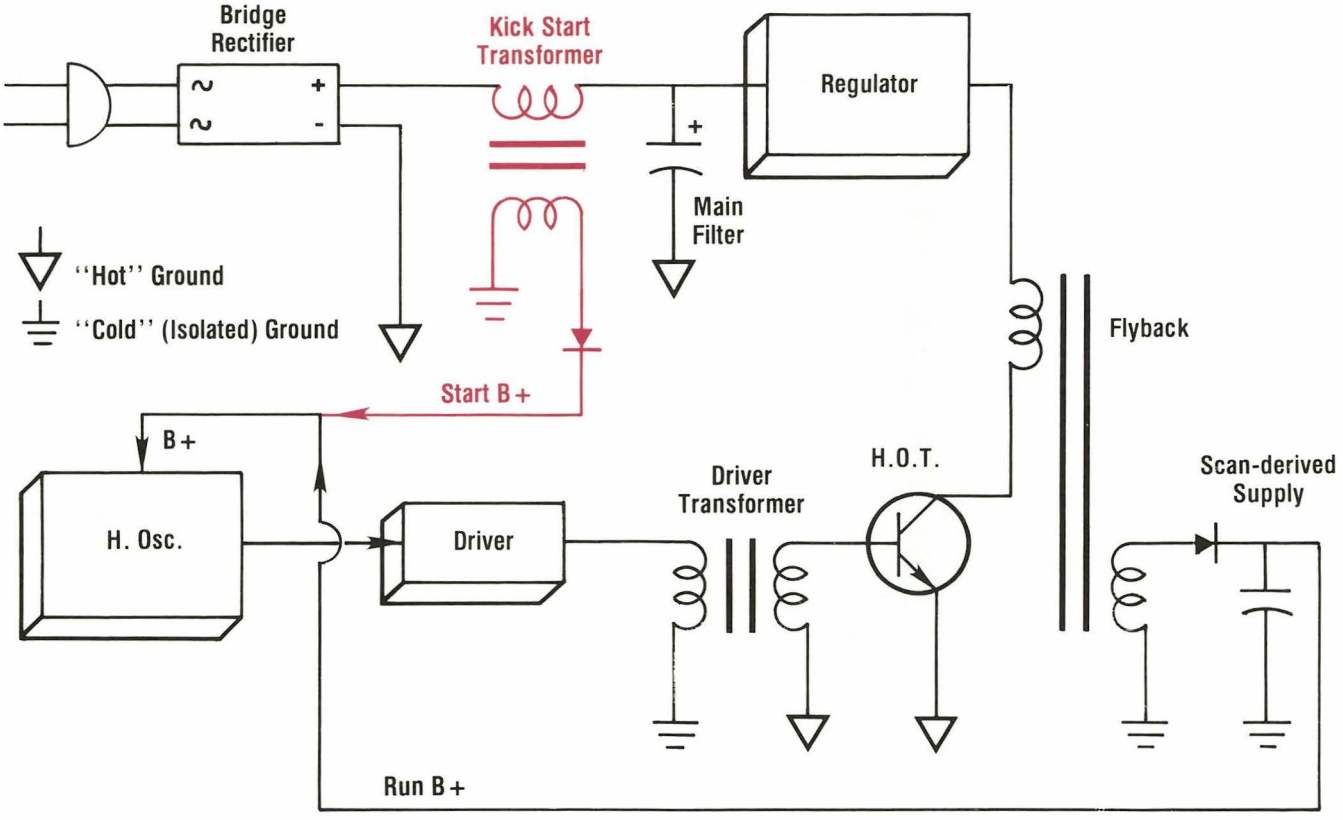

Fig. 4: A common kick starter places a transformer in series with the main filter capacitor. The transformer produces a single pulse while the capacitor charges, which should be enough to get the oscillator started.

WARNING

1. **Always connect the TV to an isolation transformer before making connections to the internal circuits.**
2. **Do not try these procedures with test equipment protected to less than 2000 volts DC plus peak AC.**
3. **Observe all precautions applying to testing circuits with high operating potentials.**

This must be done when you first apply power, since a quick shutdown has the same outward symptoms as a startup problem. The collector of the output transistor lets you do this reliably.

The following procedures will use the features of the SC61 Waveform Analyzer and the PR57 ''POWERITE''® Variable AC Power Supply. The ''POWERITE'' provides the needed isolation and variable output for effective troubleshooting.

Before you apply power to the TV, get your SC61 Waveform Analyzer ready to observe the collector at the moment of turn-on. Connect the Channel A probe to the transistor collector and the probe's ground to the chassis. Then follow these steps:

1. Set the ''CHANNEL A'' VOLTS/DIVISION switch to ''200''.
2. Set the ''CHANNEL A'' INPUT COUPLING switch to ''DC''.
3. Set the TIMEBASE-FREQ switch to ''10 microseconds.''
4. Set the TRIGGER MODE switch to ''Auto''.

(NOTE: Don't use the ''TV'' mode, since you are not looking at composite video.)

5. Set the TRIGGER LEVEL control to ''0'' to detect any signal that comes along.
6. Press the ''CHANNEL A'' DCV Digital Readout selector button.

Your SC61 is now set up and ready to display whatever happens the first few moments after you apply the power. Set your variable, isolated supply to normal line voltage, and watch the SC61's CRT as you turn on the power.

If flyback pulses appear, and stay on the screen, you don't really have a startup or a shutdown problem. Some other circuit is causing a symptom that looks like a dead receiver. You may have lost high voltage or might have a bad video circuit or deflection yoke.

If flyback pulses build and then disappear, you know that the set started, and was then shut down. Some shutdowns happen in less than a second. Others may not occur until the CRT filaments warm up and the picture tube begins to draw beam current. In either case, use the ''shutdown'' methods described next.

If no flyback pulses appear, glance at the digital display to see if there is any DC voltage present. Then, follow the ''start-up'' troubleshooting procedures described later.

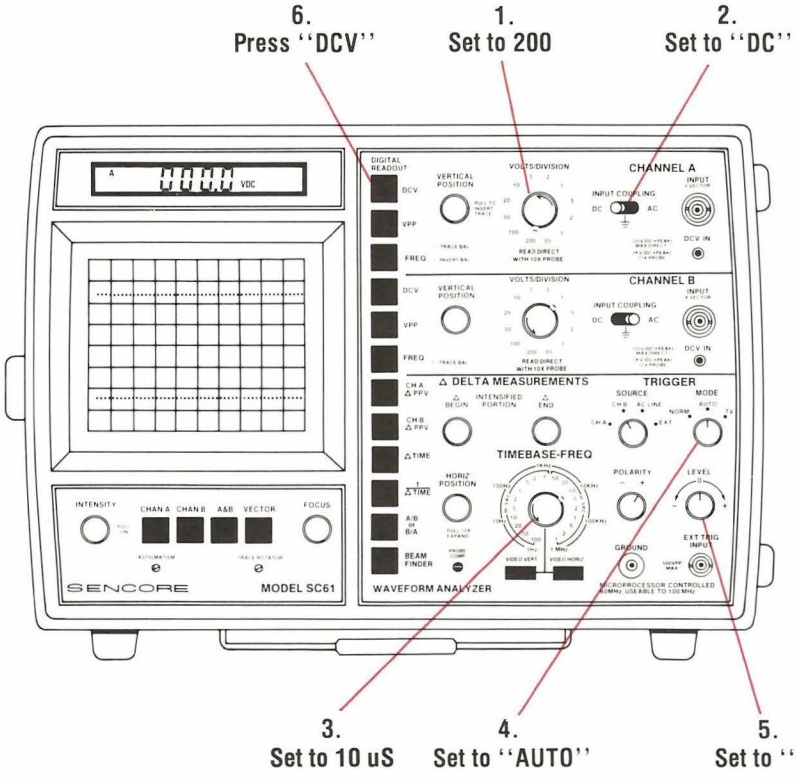

Fig. 6: Before turning on the TV, set the SC61 up to view whatever happens when power is first applied.

Shutdown Troubleshooting Methods

Most shutdowns happen so fast that you don't have time to take readings. Remember there are two possible causes of the shutdown: 1) An unsafe condition that should be stopped, or 2) A defective shutdown circuit which is causing a ''nuisance'' shutdown. Both look alike, until you *slow the shutdown response time.* Turn off the TV, to let the startup circuits reset, as you set up your test equipment for the next test.

Reduce the AC voltage supplied to the TV to 85 volts. This voltage is below the level that calls for regulation, which causes the output stage to operate at reduced levels. The DC level will change as you change the setting of the AC voltage coming into the set. You have manual control of the regulator circuit.

Watch the SC61 as you re-apply power to the set. Shutdown might still happen. If so, check the schematic to learn whether there is a small value resistor between the emitter of the output transistor and its power supply return. If there is a resistor, one of the shutdown circuits is monitoring the emitter current. If so, the TV might be drawing too much emitter current. If this is a possibility, use the Sencore Ringer to test the flyback.

If there is no emitter sensing resistor, the problem is most likely a nuisance shutdown. The output circuits are working at such a low level, that a shutdown should not occur with an 85 volt input voltage. Troubleshoot the shutdown circuits.

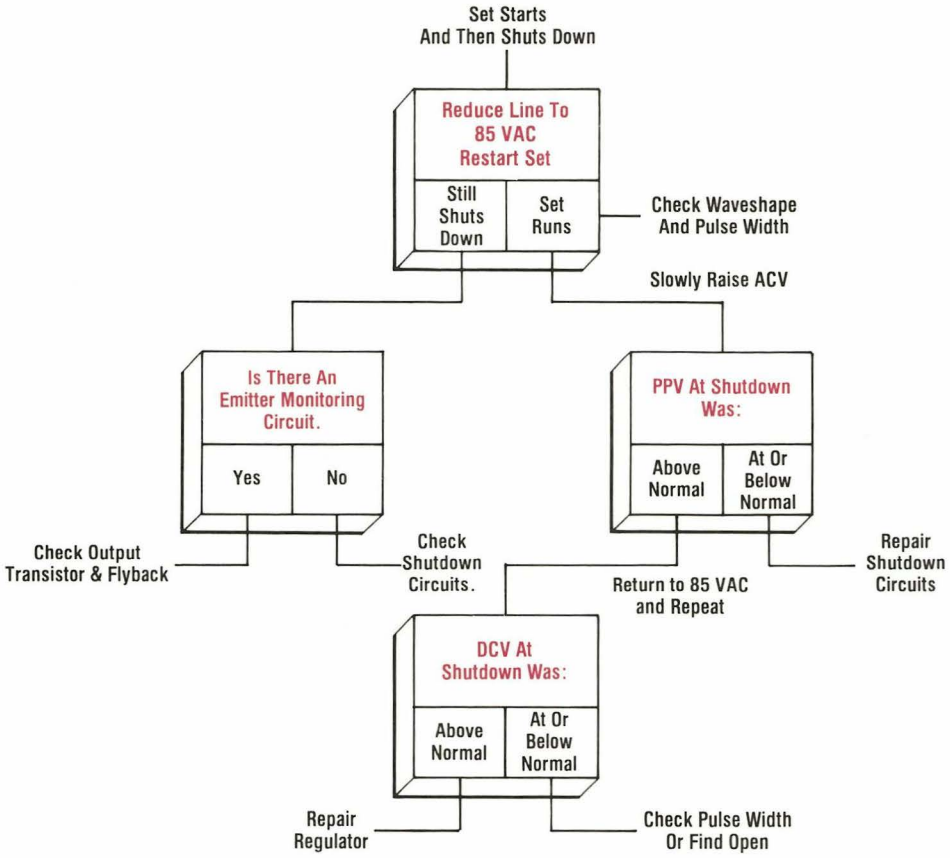

Fig. 7: Follow these steps to find out what is causing a shutdown condition in a TV.

In most cases, the set will operate at the reduced AC voltage. Carefully evaluate the collector signal for waveshape and pulse width. The peak-to-peak and DC voltages will be low, so don't worry about them. If the waveform is correct, continue to the next steps.

If The Set Runs At Reduced Voltage

In most cases, the receiver will operate at reduced AC line voltage. If the flyback pulse was normal (except for reduced peak-to-peak level), you need to observe the circuits as you increase the AC line voltage. You want to see what the circuits were doing *just before shutdown*.

First, watch the peak-to-peak voltage. If your schematic shows the peak-to-peak level at the output transistor, continue to monitor the collector. If it does not, use one of the flyback windings which shows a scope waveform. When possible, use the one which feeds the safety shutdown detector.

Choose the Channel A ''VPP'' button, and watch the digital display as you increase

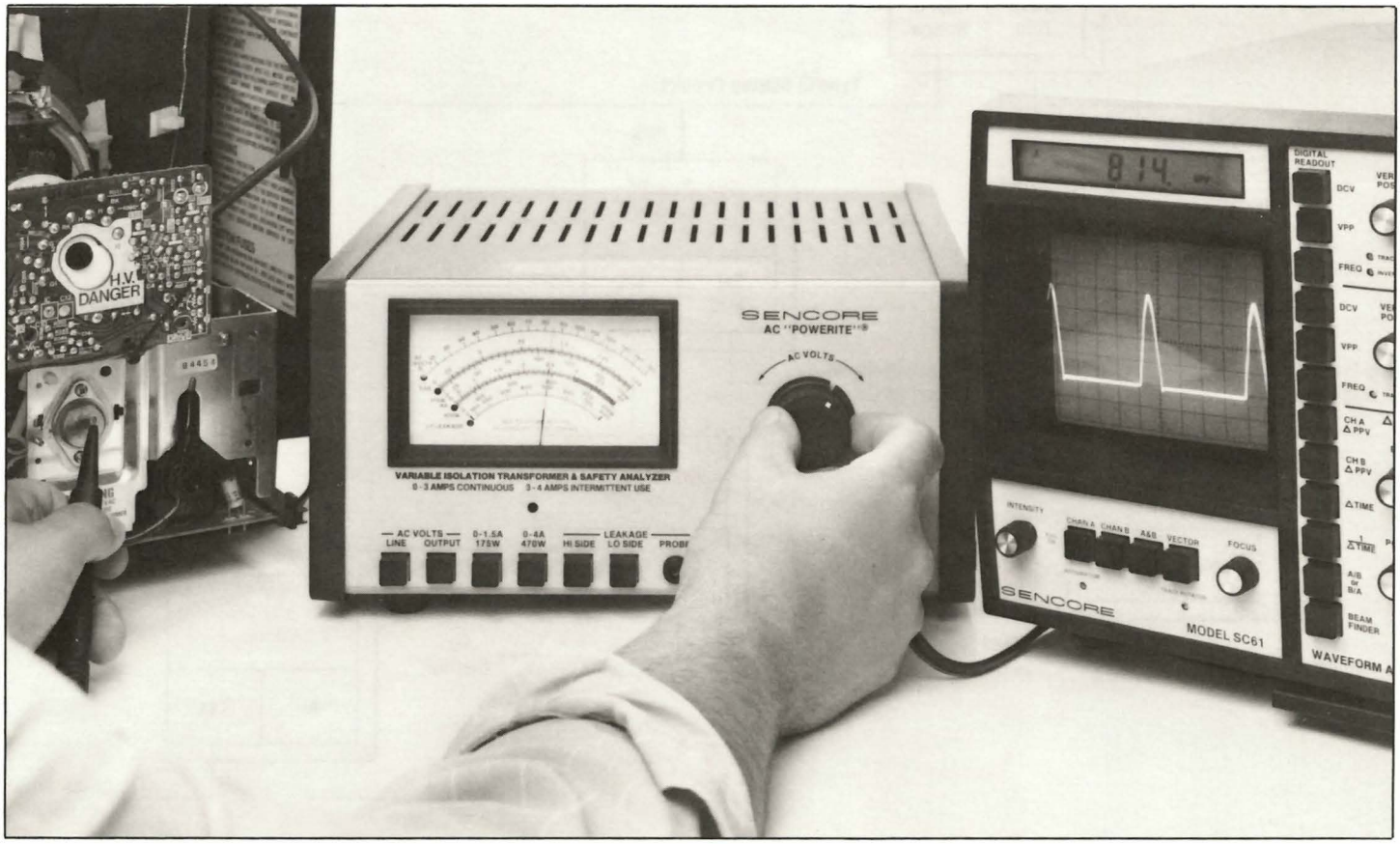

Fig. 8: When you reduce the AC voltage below the regulator's operating point, you have manual control of the voltage at the output transistor.

the AC line voltage. You need to know the level *just before* the shutdown happened. If the level was *at or below* the normal operating level, you have a nuisance shutdown caused by a detector that is too sensitive. If the level was *above* the normal level, the shutdown circuits are working correctly, and protecting from unsafe operating conditions. If so, you need to repeat the test to find out why the signal is too large.

Turn off the TV, to let the circuits reset, and return the AC voltage to 85 volts. This time, select the SC61's ''DCV'' button, to let you test the regulator. Turn on the set, and begin increasing the AC voltage. Just as before, you need to know the voltage level *before shutdown*.

If the DC level *rises above the normal level*, the regulator is at fault. (Don't worry if the voltage increases *after shutdown*, because it normally does when the output circuits no longer draw current.) See the last section of this Tech Tip for hints on finding regulator problems.

If the voltage stays *at or below the normal level*, the problem *is not the regulator*. The cause of the excessive peak-to-peak voltage may be an open flyback load, caused by a bad winding or an external component. Double check the waveshape and the pulse timing of the flyback signal to be certain the signal is correctly shaped and timed.

After each shutdown, you will need to reduce the AC voltage and restart the circuits. If the set uses a ''kick-start'' startup circuit, you will need to wait until the startup capacitor discharges before starting the circuit again. Trying to start the set before the capacitor is sufficiently drained, results in an apparent startup problem.

Startup Troubleshooting Methods

Startup problems have many causes. These include: 1) The startup circuits themselves, 2) The primary (unregulated) power supply, 3) The regulator for the output transistor, 4) The horizontal oscillator, 5) The horizontal driver, 6) The driver transformer, 7) The output transistor, 8) The damper diode, or 9) The flyback transformer. Follow these steps to find the problem.

First, confirm that the output stage is getting adequate power. If you follow the processes covered earlier, you've already tested for DC at the output transistor. If the DC level is at or above the normal level shown on the schematic, skip to the section called ''The Startup Circuits''. If the DC level is low or missing, follow these steps.

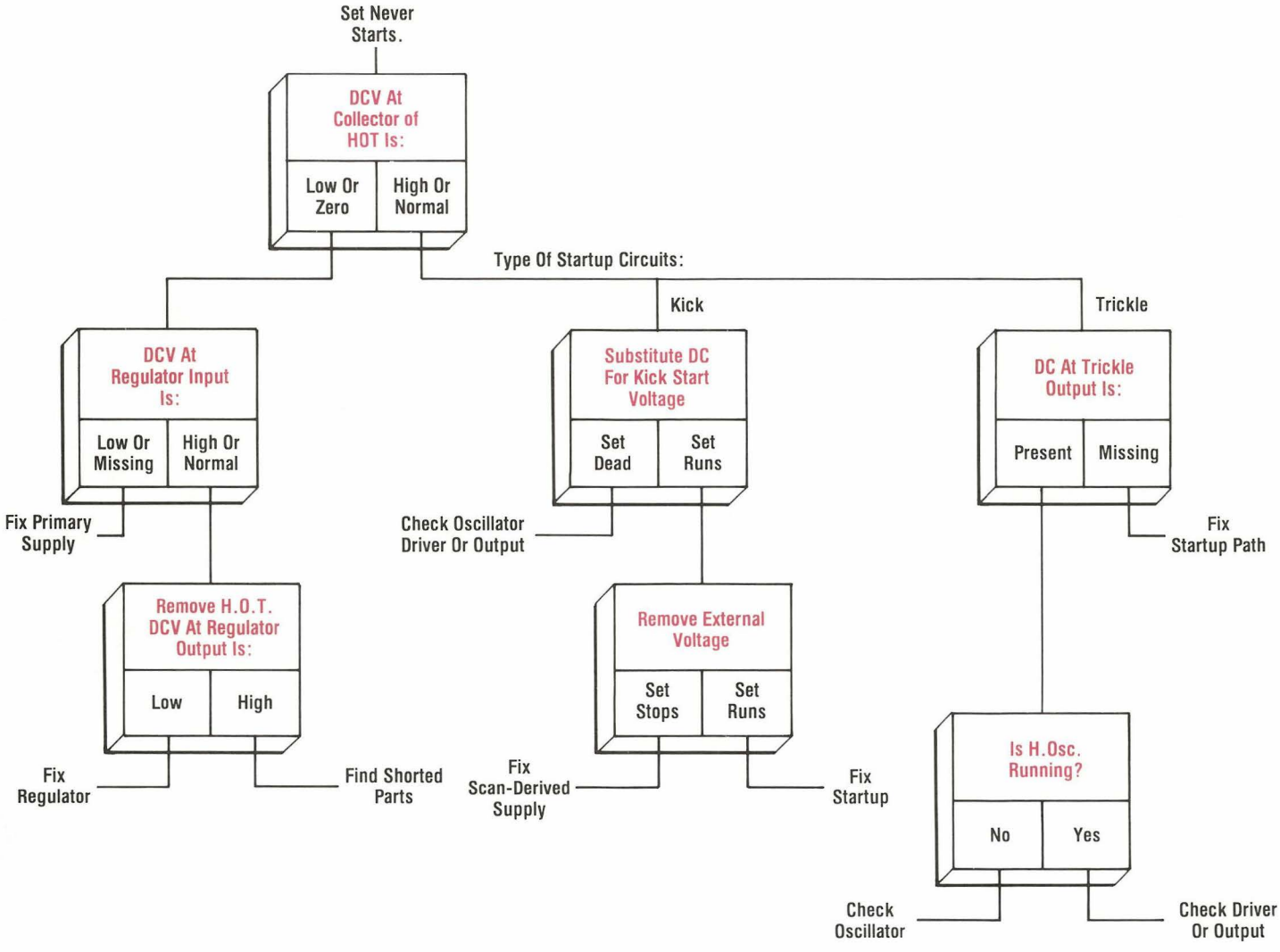

Fig. 9: Startup problems are quickly isolated when you follow these procedures.

If the voltage at the output transistor is low, the problem could be a shorted output transistor. You can usually isolate the transistor by removing the two mounting screws, to see whether the power supply voltage returns to normal. If the transistor is shorted, don't replace it until you have checked the flyback with a Sencore Ringer, since a shorted flyback can ruin your replacement transistor almost instantly.

If the transistor is good, move your SC61 probe from the transistor's collector to the input of the power transistor or SCR which regulates the DC voltage. This will take you to the output of the unregulated DC supply, usually powered from a rectifier bridge connected directly to the AC line.

If the DC at the regulator input is normal, troubleshoot the regulator. If the voltage is low or missing, you have a problem in the unregulated power supply. The trouble could be a bad diode, a dirty switch, a shorted filter capacitor, an open filter choke, or a blown fuse.

If the first step showed a DC voltage which is larger than the normal regulator output, something is preventing the drive from forming. Check the startup circuit path next.

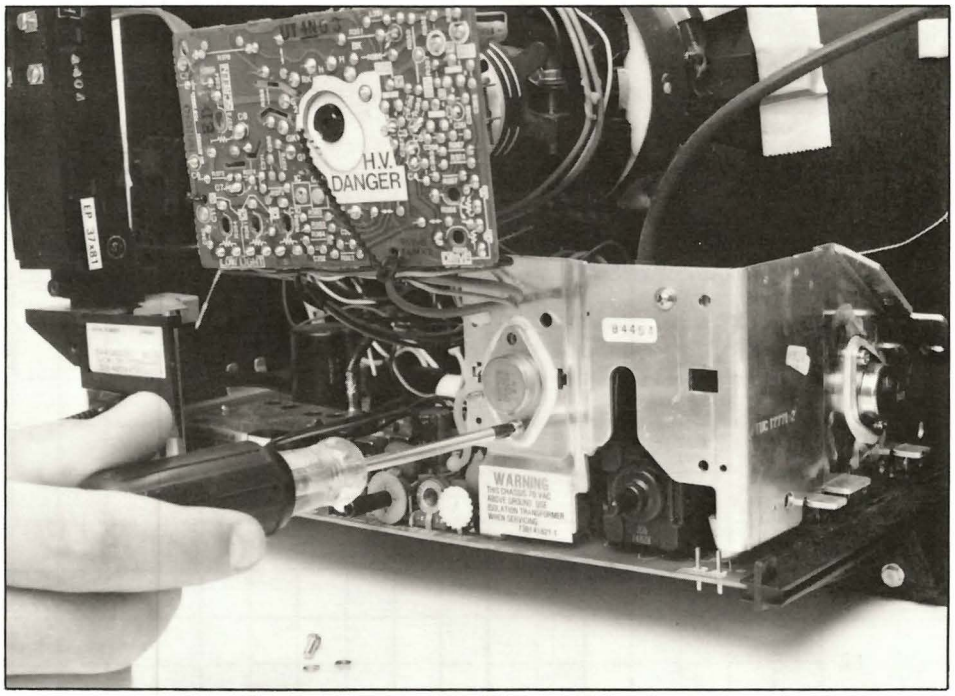

Fig. 10: Eliminate a shorted output transistor as a cause of low voltage by removing the mounting screws.

The Startup Circuits

These circuits supply a small amount of power to the horizontal oscillator and driver stages until the flyback generates enough scan-derived power to sustain operation. If something prevents the startup current from reaching the horizontal circuits, the set will remain totally dead at turn-on. If the scan-derived circuits are bad, the set may also fail to start, since the startup circuits only provide enough power for a few cycles of the oscillator and driver.

As explained earlier, there are two types of startup circuits. Your troubleshooting methods depend on which type is used. We will start with the ''kick-starter''.

The Kick Starter: The kick starter has only one chance to get things started when you first apply power. Use an external voltage to substitute for the startup voltage. If the set starts, you know that the horizontal oscillator, driver, and output circuits all work.

You still aren't certain whether the problem is the startup circuits or the scan-derived power supply. To find out, disconnect the external supply. If the set continues to run, you know that the scan-derived supply is completing the power loop, and the problem is in the startup circuits. If the set quits, the problem is in the scan-derived power supply feeding the horizontal circuits.

The Trickle Starter: This circuit provides a high impedance path between the unregulated DC supply and the horizontal oscillator. Trace the DC voltage path from the unregulated supply with the DC function of your SC61 Waveform Analyzer. If you find that the voltage disappears between the unregulated supply and the oscillator, you have an open component or bad connection.

If the voltage makes its way to the oscillator, check the oscillator output with your SC61. It may be running just fine, showing a problem in the driver or the output stage. If it's not running, but the startup voltage is present, troubleshoot the oscillator.

If there is an oscillator signal, move to the driver and the output circuits. You may find that the drive signal makes it all the way to the output transistor. If so, check the transistor for an open, and then check the flyback with a Sencore Ringer.

The Regulator Ties The Circuits Together

The regulator can be part of a startup or a shutdown problem. Regulator problems fall into three categories: 1) Opens, 2) Shorts, and 3) Poor regulation. Let's look at each in more detail.

Open Regulator: This will prevent the set from starting. This is easy to confirm, since there will be no DC voltage at the collector of the horizontal output. If there is voltage at the regulator input, the regulator is at fault.

An ''open'' does not always mean that the power transistor or SCR is open. It can also mean that the signal applied to the transistor base or the SCR gate is missing. Test the power transistor or SCR. If it checks okay, troubleshoot the circuits that drive it.

Shorted Regulator: This problem will cause an almost instantaneous shutdown, since the set will have high voltage as much as 50% higher than normal. As with an open, a ''shorted'' regulator may be caused by a regulator driver which lets the output stay on continually.

A set with a shorted regulator should start and run when you reduce the AC voltage to 85 volts, because this brings the raw DC voltage to about 100 volts. Since this is well below the regulated level, the output stages will be generating less high voltage than normal, preventing the safety shutdown circuits from firing.

When the regulator works correctly, it lets DC voltage rise until it reaches the

regulation point. It should then limit further change to keep the high voltage under control. When the regulator is defective, the DC voltage climbs above the normal operating level. When the increased DC allows the output to generate excessive high voltage, the safety circuits should shut down the set.

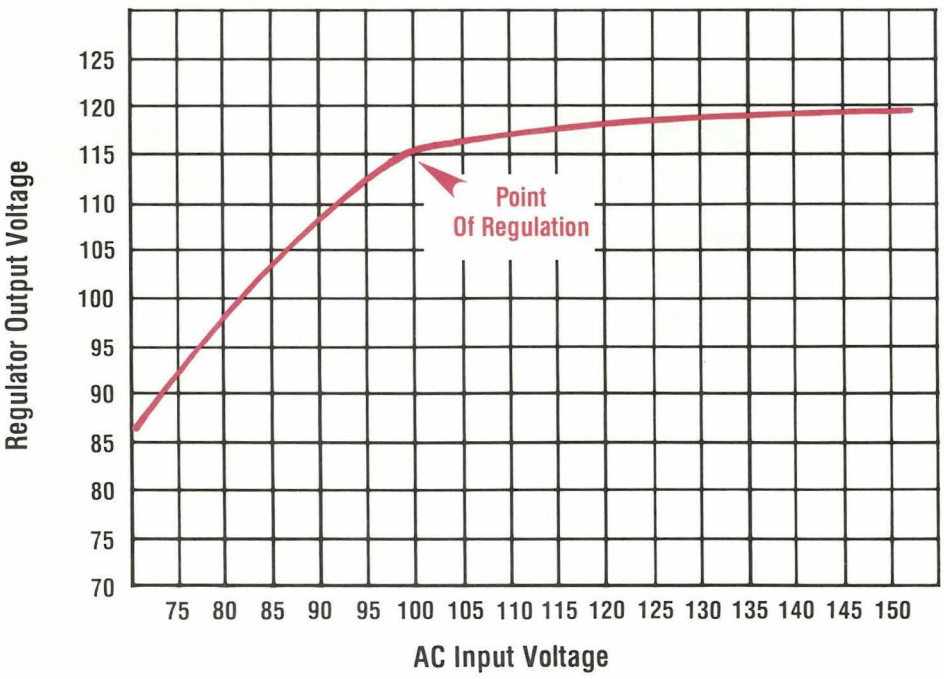

Fig. 11: Monitor the TV's regulator output as you slowly increase the PR57 output. The regulator output should rise until the regulation point is reached.

Sloppy Regulation: The regulator may allow the voltage to be a little higher than normal. Poor regulation may cause several problems. The set may shut down soon after being turned on, similar to a shorted regulator. In other cases, a sloppy regulator may cause intermittent shutdowns. These can be particularly difficult to find, since they only happen every few minutes, or even after several hours.

You can sometimes find intermittents by raising the line voltage enough to cause the shutdown to happen more often. The Sencore "POWERITE" lets you raise the voltage to 140 volts. This may let you see what is causing the problem, without waiting hours for it to occur. Monitor the DC at the collector test point to confirm the regulator is holding the voltage near normal, even with the increased input.

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