service clinic

Troubleshooting starter circuits in pulse-width modulated power supplies.

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THE AUGUST 1978 SERVICE CLINIC, WE discussed pulse-width modulation (PWM) power supplies, and briefly mentioned the starter circuit. Now let's explain this circuit in more detail. This circuit is absolutely indispensable because it gives the horizontal *oscillator* circuit a swift kick to get it started. The PWM circuit *must* receive gate pulses from this circuit to operate. So, all PWM power supplies use some form of starter circuit. Keep in mind that all this activity takes place in a fraction of a second! When power is applied, the B+ voltage comes up very quickly in all solid-state circuits. Oscillator, driver and horizontal-output circuits start just as quickly.

So, all it takes is a short pulse of DC voltage, somewhere near the right value to get the oscillator going. Once the oscillator is running, the horizontal-output stage starts, as well as the PWM supply, and everything takes off. Some of these stages use quite complex circuits, but basically they're all similar. For example, the RCA CTC-85 color chassis circuitry looks complicated but isn't (see Fig. 1).

The B+line (unregulated) is provided by a nonisolated bridge rectifier, from the AC line through L201—an AC line choke. At turn-on, a current pulse comes from the + terminal of the bridge and flows through the primary of start-up transformer T201. The current flows through this transformer because a large electrolytic 800-μF capacitor, C304, is connected to it (C304 later becomes a filter capacitor).

When a capacitor of this size is discharged, it resembles a short circuit to a current source. Translation: the current flows into the capacitor until it is fully charged. While this is flowing, we get a *pulse* of current through the primary of T201. The transformer's secondary develops the two DC voltages needed—+22 and +27 VDC through the rectifier diodes and filter capacitors. These DC voltages now feed the horizontal oscillator, driver and buffer stages. When these stages start operating, they generate drive pulses to feed the horizontal-output stage and the PWM circuitry (this is on the regulator-control module). The PWM circuit feeds a regulated B+ voltage to the horizontal-output stage.

Now that we've got our starting kick and things are going, we have to disable the starter circuit or it might interfere with the normal DC supplies, which are all developed by the flyback. The following method is used in all the starter circuits I've seen so far.

In Fig. 1, note D301 and D304, which are connected to the starting DC lines feeding the oscillator, driver, etc. During start-up, these two-diodes are reverse-biased and do nothing. There is a +DC voltage on their cathodes but no voltage at all on the anodes. This is because the normal supply voltage is not working *yet*. (Remember this is taking place in a very short time!)

Shortly thereafter, the oscillator circuit and other stages are fed their normal supply voltages, so that they continue operating. Now, the starter circuit has no AC supply to keep it running. The start voltage drops. The *starter* diodes are now reverse-biased and cut off (there is a + voltage on the cathodes, and no voltage at all on the anodes). This isolates the starter transformer from the DC lines, which stays inactive until the set is turned off again. This diode reaction is used for all the starter control circuits I've seen so far.

An interesting test, mentioned in the RCA *Technical Manual,* can be performed. If the starter circuit is not working, nothing happens. After checking the starter diodes, the filter capacitors, transformers, etc., for shorts and opens, you *can* start the horizontal oscillator by momentarily connecting a +22 VDC supply to the +27-volt input. All it takes is a very short current pulse somewhere near the normal voltage. (Although I haven't tried this, it looks as if you could do this with a bias box. The RCA manual suggests using a 22.5-volt battery, but these batteries are not very common.)

Check the starter circuit for a short DC pulse just as the set is turned on. It is best to use an analog meter because even a small kick of the needle is detectable. Set the meter to approximately the 15-volt scale so that the motion of the needle is easier to observe.

Most problems in these circuits can easily be located with the standard tests—checking diodes, filter capacitors, transformers, etc., for shorts or opens. In the RCA CTC-85 chassis, the entire B+ supply is isolated from the AC line by

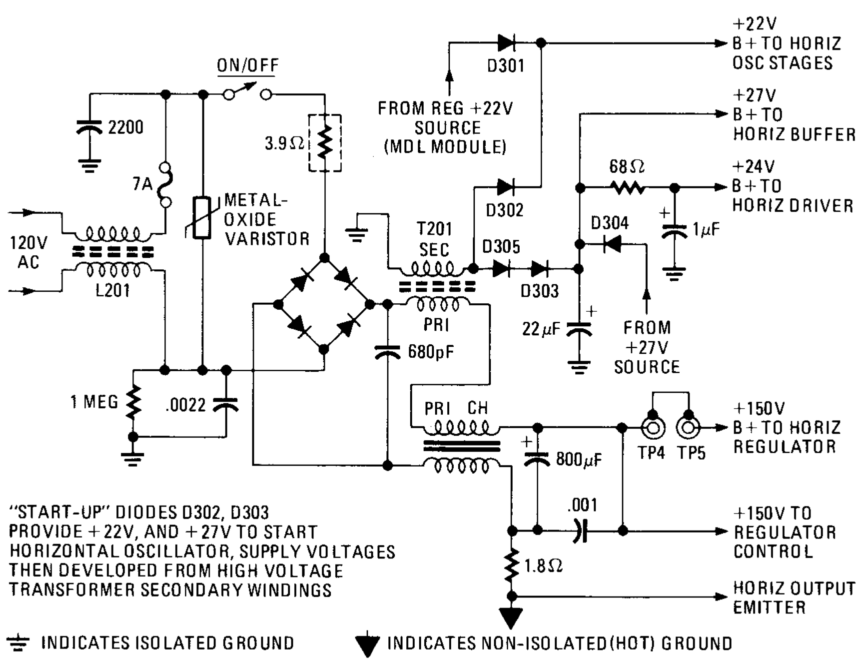

FIG. 1

the horizontal-output transformer; the unregulated B+ supply is not. This leads to the use of two "grounds," one isolated, the other "hot." However, this ground lead isn't really very hot, since it's only a very little way (one diode drop and a 1.8-ohm resistor) away from the isolated ground, or B− line. So little, in fact, that the hot ground can be used as the test equipment ground lead for voltage and waveform checks.

The starter circuit is not difficult to troubleshoot if you know what it does and how it does it. It's just that trying to explain the procedure isn't easy! The PWM won't work till the oscillator starts, the output stage won't work till the oscillator starts, but the output stage must be running to feed the oscillator! Something like the mythological worm with its tail in its mouth!

Thanks to RCA for the CTC-85 *Color Chassis Technical Manual,* which provided Fig. 1 and much data. **R-E**