Jan 2014 Steve Sekol

I discovered this the hard way, and want to warn others who may be restoring a 555. Higher serial numbers are not compatible with older time base plug-ins which have not been modified. Failure to do so can damage the time base and possibly the vertical plug-in.

At serial number break 7000, the 555 scope was shipped with improved versions of the time base plug-ins. Their models rolled from 21 to 21A and 22 to 22A. The improvements are a shift to TD triggering to support the full vertical BW (> 30 MHz). Also, two trigger sources were added: "lower beam plug-in" and "upper beam plug-in". The latter picked off the trigger signal from a dedicated path within the vertical plug-in, which is sent through pin 5 of the 16 pin interface connector. The standard option is to pick the trigger off the vertical amplifier within the scope. The later 1 series plug-ins utilized this signal path to allow triggering from the channel one source, regardless of the display mode switch setting.

Because the 555 is a full dual beam scope, it is necessary to bus all possible trigger sources to both time bases, as each allows selecting a source from either the upper or lower beam signals. Thus Tek added two shielded coax cables between both plug-in interface connectors starting at s/n 7000 to support the 'A' model time bases. They chose pin 19 for the upper beam and pin 26 for the lower. While 14 of the contacts in the 32 pin time base connector were not used and available, some engineer at Tek managed to pick one (pin 19) that was used, at least on the time base plug-in side. It was never used on the scope side, so I suspect this was the source of the oversight.

To give better gain stability in the letter and 1 series plug-ins, Tek provides a regulated DC supply to power the plug-in tube heaters from. Pin 15 provides +75V when it sees a 150 mA current load to ground. The plug-ins connect the heaters of several tubes together, along with series or shunt resistors as necessary to get the total to present a 500 ohm load to ground on pin 15 This gives the 150 mA current sink at +75 V. Inside the scope, this pin is usually connected to a pair of tubes with 12 V heaters in series, which are then sourced from the +100 V regulated supply. (this is why many 530/540 series scopes will not operate without plug-ins – a couple of tubes in the scope will not have heater power without the plug-in installed.)

In the 555, the +75V plug-in heater power is derived from +100 V dropped by two tubes in the 21 or 22 time base plug-in that corresponds to the same vertical path (21 for the upper beam vertical plug-in, and 22 for the lower). The tubes are the Miller integrator which creates the ramp (V161, a 12AU6), and the disconnect diode pair that resets the integrator (V152, a 12AL5). The +100 V enters the time base on pin 21, passes through the V161 heater, then the V152 heater, and exits at +75 V on pin 20, with is directly connected to pin 15 of the vertical plug-in connector for the corresponding beam. There is no bridging between the upper and lower beam plug-ins at the +75V tap.

For some reason, both the original 21 and 22 time bases also connected the tap point between the heaters in V161 and V152 to pin 19. This would be approximately +87.5 V when correctly loaded with a vertical plug-in. You can see this in the heater connection diagram next to the LV power supply in the schematic pages of the manual. Although pin 19 was connected between the heaters on all 21 and 22 time base plug-ins ever built, it was never used or connected in the original (s/n 101 – 6999) 555 scopes. So I suspect the engineer who added the new trigger selections only looked at the interconnect diagram in the schematics, or the connections in an actual scope, and decided to use pin 19 for one of these signals.

The 21A and 22A do not wire the 87.5V tap between these two heaters to pin 19, as it is used to supply one of the new trigger signals to the expanded selector switch.

The problem occurs when an older 21 or 22 is installed inside a new scope (s/n 7000+) or an older scope that has been "upgraded" with the mod kit (040-0328-01). If both older time bases are installed and older letter series plug-ins are used in BOTH vertical channels, no damage is likely, unless one of the time bases is removed. The problem occurs when an older time base is used with a newer "A" model one, or a newer 1 series plug in is installed. In either case, the +87.5 V dropped by only the single 12AU6 in the 21 or 22 (non "A") plug-in can be shorted to a lower clamped voltage. This puts considerably more than 12 V across the heater, which opens it quickly causing the miller integrator tube (V161) to fail. The symptoms are the trace deflected off the right side of the CRT, and the Sawtooth output on the front panel of the damaged time base stuck at around +200 or so volts.

I have not studied the schematics of the 1 series plug-ins, but I suspect putting a low impedance from the tube heater driven from +100 V to the trigger signal output may damage the plug-in as well.

In my case, my newer 555 scope (s/n 7779) came with 21 and 22 time bases, swapped from an older scope, neither of which worked. I had acquitted a 21A and 22A to upgrade them with. In the process of turning of the scope which had multiple problems, I mixed and matched time base plug-ins in attempt to get at least one of the beams to sweep across the CRT. Not being aware of this fault mode, I suspect I took out the 12AU6 in the 21 time base by running the 22A through all of its trigger mode selections. After discovering this potential for damage, I checked and verified that the 21 had an open heater in V161.

My manual covers the lower serial number scopes, so it does not mention the "A" model time bases. I am not sure if a newer manual warns against this potential damage. The time base plug-ins are not easily user removable, as the retaining screw is located on the back side near the interface connector. They can only be removed when the scope covers are removed. So Tek may have thought that only "A" model time bases would be used in the newer scopes.

The documentation in the mod kit for older scopes does have a caution statement mentioning that unmodified time bases will not operate in modified scopes. It does not mention the potential for damage however.

It does contain a single step to modify older 21 or 22 time bases to allow use in a modified scopes. Simply remove the wire connected to pin 19 of the interface. It suggests making the break at the ceramic strip, which is nearly 5 inches from where the wire enters the plugin. As this trigger signal is high frequency, I would recommend removing it from the interface connector instead by unsoldering it.

If you own a 555 with 21 and 22 time bases, I would recommend removing this signal connection now, to avoid possible damage if you ever upgrade either. The connection was never used by the scope, so no functionality or performance is lost if you remove this wire.

- Steve