PS 5010 troubleshooting (no negative, erratical display)

Date (https://groups.io/g/TekScopes/topic/81359199?p=Created%2C%2C%2C20%2C2%2C0%2C0)

Martin (/g/TekScopes/profile/@musaeum) 2021-03-15 (https://groups.io/g/TekScopes/message/180408)

Hi all,

I just started to troubleshoot my PS5010. Symptoms are a missing negative output and an erratic display when I switch on the outputs with the on/off key. The supply starts up fine, 5V and plus supply is working as it should. Negative supply can be dialed in as I wish, the relay is clicking when I increase current limit. But it does not give any output at all.

When I switch on the supplies with the on/off key, more often than not and when it is not selected, all the numbers and LEDs of the positive supply go off, then go back on a little later and randomly alternate with the display of the negative supply. When the supplies are in off-mode the display returns to normal.

If anybody has an idea of what that could mean I would be glad to hear about!

cheers
Martin

Reply Like More

Martin (/g/TekScopes/profile/@musaeum) 2021-03-15 (https://groups.io/g/TekScopes/message/180410)

First update: I discoverd the switch that allows to select between front and rear panel... it has contact problems.
I toggled it many times until the negative supply came up. Now it seems to work as it should, too.

Remains the erratic display...

cheers
Martin

Reply Like More

Martin (/g/TekScopes/profile/@musaeum) 2021-03-15 (https://groups.io/g/TekScopes/message/180411)

Second update: after further RTFM it seems that blanking of the display occurs when "the supply is neither in the constant current or constant voltage mode. This happens when the output is foldback current limited or driven into overload by an external source.

Interesting. I have these blinking displays although there is only a DMM connected to them. The DMM displays the correct voltage (with less than 1% deviation). So no overcurrent and no external source...

TBC - cheers
Martin

Reply Like More


Martin (/g/TekScopes/profile/@musaeum) 2021-03-17 (https://groups.io/g/TekScopes/message/180502)

Third update: I made some experiments and found out that, once I let some current flow (200mA), the blinking stops and the display is steady.

Then I tested the module in may "Rack"-TM5006 frame, and to my surprise the display was fine there. Back into the other frame it.... still.... was.... fine!!
I decided to do some alignments and put the module back in the racked frame, this time in the high-power compartment at the right. Well, the display started acting up again, and remained so in both frames! Suspecting the hi-power switch on the module I did the same as I did to the front-back-switch, a lot of actuations. And indeed, that cured the fault.

So my conclusions are:

- the PS5010 is well built and rather precise power supply... :-)
- the linear switches used in many Tek equipments are prone to contact problems that can have all sorts side effects. Actuating all these switches should be the first thing to do when troubleshooting.

I didn't resort to cleaning the switches, just actuating seems to do the job, at least for a good while. If the supply acts up again I know what to do.

cheers
Martin

Reply Like More


ditter2 2021-03-17 (https://groups.io/g/TekScopes/message/180530)

Hello Martin,

I designed the analog circuitry in the PS5010, although that was nearly 45 years ago…

The front/rear switch not only selects the output terminals, but the remote sense inputs for voltage regulation as well. So if the switch is intermittent, you many have one of the sense inputs open, which would explain the lack of regulation.

The power supply goes through voltage and current ramps when the output is cycled to protect the relay from damage in fault conditions. The loop balance monitors are not monitored during this ramp cycle.

I have found those switches commonly used in TM500/5000 and 5100 series remain reliable if operated in a very clean environment, but have problems when there is dust in the air. They are not sealed, and lubricated with grease. Dust will get into the grease and make its way into the contact surface, which causes them to become intermittent. Also, the grease cakes up when it gets dirty, making the switch spring return not operational.
Steve

Reply Like More


Martin (/g/TekScopes/profile/@musaeum) 2021-03-18 (https://groups.io/g/TekScopes/message/180533)

Hi Steve,

thanks for your insights. I did understand what you said about the front/rear switch, but I could not altogether follow what you said about the voltage and current ramps. In particular, the error-condition (i.e. erratical blinking of pos and neg supply), when present, was permanent. It only disappeared once I got a certain amount of current flowing. And finally it turned out it was related somehow to the hi/lo switch.

Realigning the supplies was straightforward and easy to do... well designed, as I said. Currently I have two PS5004 precision supplies in the frame. Both turned out OK, so I started the alignment. But theres a weird thing, something I've never seen before: a corse and fine alignment pot that is realigned several times on later steps! Usually a pot is aligned and you don't touch it anymore. Do you know anything about that module, too?

cheers
Martin

Reply Like More


ditter2 2021-03-20 (https://groups.io/g/TekScopes/message/180667)

Hello Martin,

On the PS5010, my reference to the voltage and current ramping is the programming that takes place in the current and voltage limit DACs on a user request through front panel ON/OFF switch, or through remote control. This action takes place in both ON > OFF and OFF > ON operations. If you are monitoring the DAC outputs with a scope when the Output is toggled, you will see this programming action. It is to protect the output relay. Because the supply will normally go into CC mode during this transition, the software does not monitor the loop status during this time, to prevent reporting of the mode change.

If you need to draw a small amount of current to get regulation, then the minimum load is not sufficient to keep the output regulated. This could be either in the supply itself, or possibly (??) C-E leakage around the pass transistor in the mainframe. That would explain different amounts of the effect in different mainframe slots.

For the PS5004 – I designed all of it. For some fun, get a schematic and quickly try to find the precision 16 bit DAC needed to support the output resolution. If you are looking for a large “brick”, you won’t find it. 16 bit DACs were available at the time, but cost about 2.5 times the proposed manufacturing cost target for the entire built and tested instrument. The DAC I designed is a gated charge pump, using simple digital counter logic to set the duty factor of the current gate clock. BTW, Sony independently came up with the same idea for the 16 bit DACs needed in CD players about the same time.

I believe the part of the cal procedure you are referring to asks you to set output V to max, then back down one count (If my memory is correct – that was designed 40 years ago.) What you are doing is setting the full scale of the fine span of the DAC. Rather than take the full 16 bit resolution in one span, there are two charge pumps, scaled – I believe 200 counts (Each is 8 bits, the fine is 1/200th the coarse. They don’t map 1:1 with the digital pot coarse-fine range). Since calibration requires use of the digital knobs to set ranges, and the display is a volt meter measuring the measured output (not the programmed value as in the PS5010), the only way to set known values with the knob is at the extremes. So “0” is easy to set – turn both knobs to the left several turns and you can calibrate out the offsets in the system. Turn either or both knobs to the right several turns and you are at full scale – it is now possible to set the full span gain of the coarse current pump. Turning only the fine control down one “click” reduces the coarse stage DAC count by 1, and sets the fine DAC to is max scale. Now the user can calibrate the full scale of the fine . The order might not be the same as what I wrote in the cal procedure 40 years ago, but the process is the same.
Steve

Reply Like More


Martin (/g/TekScopes/profile/@musaeum) 2021-03-21 (https://groups.io/g/TekScopes/message/180676)

Hi Steve,

interesting... I like this supply and use it quite often. You can even use it to drive and control a transistor's base!

When I first used these PS5004 I thought the display was digitally controlled, but since it was able to show a negative voltage or a bit above 20V I began to doubt. And indeed.

For the alignment I was referring to the fact that alignment of the same 3 pots (zero, fine and coarse) is done several times in different chapters.

FIRST: §2 "Full Scale (R2043) and Fine Span (R2044) Presets"
This comes right after §1 coarse reference adjust (the switch).
A note says this should only be done when the reference IC has been changed. It consists of aligning the pots for a voltage of 6,550 volts.

SECOND: §4 "Zero Output Adjust (R3062)"
There is an instruction of how to connect the PS5004 to the voltmeter that I did not really understand. It says
"Connect the PS 5004 OUTPUT to the digital voltmeter input using a bnc cable and a pair of bnc-to-banana plug adapters. The shield side of the bnc is connected to the PS 5004 OUTPUT terminal, and the voltmeter Low input. The voltmeter guard is driven by the Low input. Connect the patch cable from the PS 5004 OUTPUT terminal to the ground post connector."
Anyone else who finds that substandard in terms of clarity? It looks like a cut&paste mess to me, but did Tektronix already have text processing these days?

THIRD: §§5&6: "Full Scale Adjust (R2043) & Fine Span Adjust (R2044)"
This time you align the same pots as in §2 with reference to the real output (in CAL mode). The pots had to be turned quite a bit (plusminus 2 revolutions) to get the right voltage here. But that means that the preset alginment in §2 was useles... No?

FOURTH: §7 "Full Scale (R2043), Fine Span (R2044), and Zero Output (R3062) Final Adjusts"

This time all three pots are re-aligned with reference to the real output, with the unit in normal RUN mode (not CAL mode).
Again, I wonder what the alignments in §§2, 4, 5 & 6 were good for. I could have started the whole alignment right here, skipping the previous steps, couldn't I?
Perhaps not because these alignments interact somewhat, so you would have to repeat the steps in §7 several times if the previous steps haven't been done.

The next steps are for alignment of the DMM and current output. I always end up with a quite precise power supply, the DMM usually shows -0,0001 when at minimum. But thats well within specs...

cheers
Martin

Reply Like More

ditter2 2021-03-21 (https://groups.io/g/TekScopes/message/180691)

Hello Martin,

The main voltage reference used in the PS5004 is a National Semiconductor LM399. These references are thermally stabilized, and after about 6 months of aging through normal use, have a stability which rivals standard cell primary voltage references.

However, the IC process did not support laser trimming, so the only downside to these otherwise great parts is they have about a 5 % initial voltage tolerance – a challenged to adjust to the precision required for an instrument with target accuracy of 0.01%. This is way beyond the acceptable adjust resolution of a 20 turn trimmer pot. I ended up with a bank of binary weighted resistors in the leg of a voltage divider to pre-select the voltage to be in range that can be adjusted by the 20 turn trimmers. Initially these were to be controlled with a DIP switch, but this would require the user to correctly enter the 4 bit binary code for each “try and miss” step during calibration. I found the cam operated DIP switch we ended up using, which simplifies this step by doing the proper binary coding for each increment/decrement.

As the manual reads, you would only need to perform this step when replacing the reference IC, as any aging drift should be adjustable with the range of the 20 turn trimmer. To set this coarse pre-selector switch, you need to adjust the span trimmers to the center of their range, which is a lot of turns for a 20 turn pot. The trimmers don’t have positive stops at the end, they just keep turning and a small “click” is felt in your screwdriver when you get to the end. So centering a 20 turn trimmer first requires turning to the end more than 20 turns (to assure you are at the end, then backing up 10 turns. This is why you see these span trimmers being adjusted so many times in the Cal procedure.

Second question:
If this is quoted directly from the manual (I don’t have access to my copy right now), it looks like there is a missing word that would help.
“Connect the PS 5004 OUTPUT to the digital voltmeter input using a BNC cable and a pair of BNC-to-banana plug adapters. The shield side of the BNC is connected to the PS 5004 OUTPUT terminal, and the voltmeter Low input.”
Should read:
Connect the PS 5004 OUTPUT to the digital voltmeter input using a BNC cable and a pair of BNC-to-banana plug adapters. The shield side of the BNC is connected to the PS 5004 - OUTPUT terminal, and the voltmeter Low input.” (add a minus sign between “PS4004” and “OUTPUT” - these should be Bold type face to indicated these are the connection point names)

A challenge in manual writing is that everyone, the engineers, technicians, and even manual writers themselves, are “too close” to the equipment we are writing about, and procedures are the same as we have all used over and over. So it is easy to assume the reader already knows something that we all know – but only because we are “insiders”. What this step is trying to say is to use a shielded BNC cable to measure these precision DC voltages, and make sure the shield is connected to the PS5004 negative output terminal, and the DMM low / guard terminal. It is important to drive the DMM Guard input and not leave it floating.

Third question: These are 20 turn trimmers, so needing to two resolutions is possible, especially if the instrument is being calibrated the first time after many years of storage. I think the need for the coarse adjustment is described above – it is necessary to get the range covered by the 20 turn span trimmers close enough to account for a 5% initial tolerance in the initial voltage reverence.
On this topic – if you are calibrating a PS5004 or any high precision instrument (Fluke DMM etc.) that has been not used for a decade or more, you should probably first power it up and let it run for a week or more. Large drifts from aging may be moisture absorption in components and circuit boards.

Final question – there is interaction between the span and zero adjustments. This results because Zero volts output is not actually zero. Studying the schematic, see the output has an active load on it that can sink small currents below 0 V. So the supply can be adjusted to negative output. In fact, the original design would allow precision adjustment of the output to minus 100 mV, but the supply can only sink a few mA in the negative direction, as it is not q four quadrant supply (only single pass transistor). The application would be measuring input offset in DC amplifiers, etc. I thought it would be quite useful, We did some customer trials with an engineering prototype, and the users found the feature to be confusing because of the current limitation when the output went negative. So we pulled it out. This feature is implemented only in the firmware – no hardware changes were made. Thus the supply actually has some output voltage when adjusted to Zero, which is removed by other offsets in the circuit. Thus the gain action of the coarse and fine span trimmers will move the zero output setting, which requires an iterative adjustment procedure.

Steve

← (https://groups.io/g/TekScopes/topic/81500744?p=%2C%2C%2C20%2C0%2C0%2C0%3A%3A%2C%2C%2C0%2C0%2C0%2C81500744)

→ (https://groups.io/g/TekScopes/topic/81506173?p=%2C%2C%2C20%2C0%2C0%2C0%3A%3A%2C%2C%2C0%2C0%2C0%2C81506173)