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Author Topic: Fluke 540B and thermocouple drift (Read 1610 times)

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Roman oh
Contributor

Posts: 32
Country:

Fluke 540B and thermocouple drift
« **on:** April 11, 2021, 11:26:02 pm »

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I have finally dusted off my Fluke 540B, and made a little battery eliminator, and have started playing with it. Having satisfied myself that all the circuits are working correctly, I watch it in DC transfer mode (DC from a Fluke 332B which I am confident is far more stable than the effect I am about to describe). The unit nulls correctly, reversal error with the original thermal element is within spec, but over a period of several minutes, the null detector needle drifts to the left - about 5-10 minutes to end of scale in high sensitivity mode (about 0.01% of FS).
If I apply 7mV from a stable source in lieu of the thermocouple, the reading remains rock solid. The reversing switch in the A54 appears to be repeatable and work as expected.
Now, I happen to have a small number of vacuum mounted thermocouple elements and octal bases in my "junk box" (some look unused, till now) so I made up some adapters and tried some of these plugged into the socket of the A54 voltage unit of the 540B. To a greater or lesser extent, they ALL seem to show some drift over a period of minutes - some positive, some negative. As Murphy would have it, the one with (almost) imperceptible drift also has a shocking reversal error.
Is this a common issue with vacuum mounted thermocouple elements? Is my small cache just junk?
Or should I be looking elsewhere for something?
Appreciate any help or advice.

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ManateeMafia
Frequent Contributor

Re: Fluke 540B and thermocouple drift
« **Reply #1 on:** April 12, 2021, 12:01:22 am »

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Posts: 727
Country:

Your issue reminds me of the last time I adjusted a Fluke 752A. It would drift after I nulled it and it turned out to be dirty contacts in one of the switch assemblies. Perhaps some old leaky batteries may have caused corrosion somewhere inside the unit? I have one where they were bad enough to cause corrosion on the back plate.

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1audio
Frequent Contributor
Posts: 265
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #2 on:** April 12, 2021, 06:28:29 am » Say Thanks Reply Quote

I have a late example of a 540B with the regulator upgrade (an LM317 for the reference voltage) factory installed along with the rotary polarity reversal switch that is supposed to work better. It shows the same slow negative drift for about 3-5 minutes, maybe more and then seems stable. I was feeling like you, that something was wrong but I get the same result using the 540B with an A55 external converter. I think the very high resolution (.001% or 10 PPM) shows the small variations a lot. My guess is its the slow thermal stabilization we are seeing.

My next challenge is that the 540B frequency response doesn't seem to match the external A55 converters or my 3 other meters. I have 2 Fluke 931B's and calibrating then has proven to be really challenging. I'm not really sure who to trust any more. I have a Fluke 8922 and an HP 3403A that seem to meet spec but don't really agree or agree with the thermal converters. I have a Fluke 8506A who's thermal converter decided to fail just as I started this project. Fluke says the last price on the part was $700 but that was 15 years ago. I think this is the "man who has too many clocks" problem.

All of this was so I can calibrate a vintage Optimation AC110 calibrator. I'm getting closer and learning a lot but its very slow going. And sure needs a lot of stuff.:
Fluke 732A
ESI RV722 KVD
Valhalla 2701
Fluke 540B
Fluke 931B
Assorted Thermal converters
2 Ratiotrans
Prema 6001
Keithley 2015
TeK 191 signal generator
etc.

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ap
Frequent Contributor
Posts: 265
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #3 on:** April 12, 2021, 06:41:15 am » Say Thanks Reply Quote

In general, TVCs are very sensitive to thermal changes, be it through air drafts, small changes in ambient temperature, thermal equilibration effects and so on. So you cannot expect a TVC to stay stable over a longer period of time. The key is to do the measurements in a short time and average the reversal voltages. So AC, DC+, DC-, AC. What you see is expectable.

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Metrology and test gear and other stuff: www.ab-precision.com

Bill158
Regular Contributor
Posts: 97
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #4 on:** April 12, 2021, 08:10:30 pm » Say Thanks Reply Quote

Roman oh:
Everything you describe is normal for the 540B and the A55 Thermal Converters. I have a 540B, a set of A55 TCs and a set of Holt Instruments Model 20 TCs. All of these do exactly the same as you describe. This is mainly due to the thermocouple elements heating up the environment around them. This includes, to a certain amount, the metal can in which they are enclosed. The TC inside of the 540B is enclosed in a octal base metal can with some foam rubber wrapped around the actual thermocouple. I have taken mine apart. Also the Model 20 TCs, at least one. So the measurement of either the DC or AC source involves a very time consuming wait period until the drift seems stable. Some people wait for 5 minutes or more. I just wait until the drift seems more or less stable. Even switching from DC to AC does involve another waiting period. Usually less than a minute. So both the DC and AC sources must be stable during this period of waiting. Performing DC/AC transfers is very tedious and time consuming to say the least.

This is why FLUKE developed the 5790A AC Measurement Standard. This meter makes the whole process much less time consuming. Read the manual for this product for more information on how FLUKE accomplishes this.

Bottom line here is that your 540B and A55 TCs are working correctly.
Bill

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The following users thanked this post: Roman oh

1audio
Frequent Contributor
Posts: 265
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #5 on:** April 13, 2021, 02:37:51 am »
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Bill158: Do your thermal converters track pretty closely on frequency response? My collection is without data. One I bought because it was represented as having data arrived without and the vendor said he discarded it and who cares? Its all "down in the mud". I just want some insight into whether these have gross errors. My 540B does not seem to track the A55's above 100 KHz.

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Roman oh
Contributor
Posts: 32
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #6 on:** April 13, 2021, 11:12:02 am »
Say Thanks Reply Quote

Thanks, guys, for your comments. I shall approach my new "toy" with this reassurance.
Roman

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Bill158
Regular Contributor
Posts: 97
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #7 on:** April 13, 2021, 09:03:42 pm »
Say Thanks Reply Quote

Quote from: 1audio on April 13, 2021, 02:37:51 am

> Bill158: Do your thermal converters track pretty closely on frequency response? My collection is without data. One I bought because it was represented as having data arrived without and the vendor said he discarded it and who cares? Its all "down in the mud". I just want some insight into whether these have gross errors. My 540B does not seem to track the A55's above 100 KHz.

1audio:
I have never done a serious comparison of my two sets of TCs, the 540B and never over a frequency range. I believe (I haven't used them for a couple of years so my memory is poor in this issue) that I have compared them at 1 KHz, 10 KHz. I may have included the 540B but again please excuse my recollections of this. My A55's came with cal data from FLUKE done in 1996. The cal frequency data points on the A55's are at 50 KHZ, 1 MHz, 10 MHz, 20 MHz, 30 MHz and 50 MHz. See the attached pdf of the A55 10 volt TC for what the report shows. As you can see this A55 essentially has a flat response between 50 KHz and 1 MHz which is where the 540B could be checked. I have a FLUKE 5200A AC voltage standard to give me up to 100 volts and a 5215A to give me voltages from 100 volts to 1000 volts. But until recently I haven't had anything to give me stable voltages over 1 MHz. Now I have a HP 3325A, and a FLUKE 6071A which can get me to 50 MHz. So someday when I get "a round toit" I will do the experiment of comparing all of my TCs. But good point about checking the 540B. I sure never tried that.
Bill

FLUKE A55 10 V report.pdf (56.42 kB - downloaded 48 times.)

« *Last Edit: April 13, 2021, 09:09:17 pm by Bill158* »

Report to moderator Logged

1audio
Frequent Contributor
Posts: 265
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #8 on:** April 14, 2021, 05:44:04 am »
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I did an informal test of my 2 1V A55's and they track pretty well to 1 MHz. I need to switch setup to go further (pending). I have an old Tek191 that seems well suited up to 100 MHz. Downside is the max output is 5V P-P into 50 Ohms or approx 1.8V RMS. I have a wideband matching transformer that may get that to 7V. I'll test it and I can do a rough check for response to see if its way off.

I saw a recent write-up on Flukes calibration process and they are still using A55's as primary references.

I also discovered my .5V A55 was fried at some point and the heater is open. I opened it and its all buried in silicone.

I have a Ballantine .45V so I'm covered, and 3 micropots for extended HF.

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Roman oh

Re: Fluke 540B and thermocouple drift
« **Reply #9 on:** April 15, 2021, 06:41:59 am »
Say Thanks Reply Quote

Contributor

Posts: 32
Country:

I read a write up in Fluke's "calibration in theory and practice" where they say that the thermal element in the 540B is "of a standard pattern" 5mA with a 90 ohm heater. However, when I opened the canister for a sticky-beak, I see two thermocouples which appear to be series connected. Another post I read somewhere - can't find it now - mentions two thermocouples "but only one of them powered" which I didn't understand. Do any of you knowledgeable people know what the configuration is?
Second question - the 540B handbook refers to an A55 manual, but I can't google up a copy of this anywhere - not even at Fluke where, if as 1audio suggests they are still actively using them, I would have expected luck. Does such a manual exist? Does anyone have a link?
Thanks
Roman

Report to moderator Logged

Bill158

Regular Contributor

Posts: 97
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #10 on:** April 15, 2021, 10:17:31 pm »

Say Thanks Reply Quote

Quote from: Roman oh on April 15, 2021, 06:41:59 am

> I read a write up in Fluke's "calibration in theory and practice" where they say that the thermal element in the 540B is "of a standard pattern" 5mA with a 90 ohm heater. However, when I opened the canister for a sticky-beak, I see two thermocouples which appear to be series connected. Another post I read somewhere - can't find it now - mentions two thermocouples "but only one of them powered" which I didn't understand. Do any of you knowledgeable people know what the configuration is?
> Second question - the 540B handbook refers to an A55 manual, but I can't google up a copy of this anywhere - not even at Fluke where, if as 1audio suggests they are still actively using them, I would have expected luck. Does such a manual exist? Does anyone have a link?
> Thanks
> Roman

Roman:
First I will assume that you are referring to the TC inside of the 540B, when you said you "opened the canister". You are correct, there are two TCs inside of the can. I am sure I have opened this before but I just forgot what was in there. See the picture of one of mine which was in my 540B when I first got it. I got another one from the action site. I am not too sure why two TCs. But if you read the 540B specs it does say that the input impedance is 182 ohms per volt. So one is probably just to increase the impedance from 90 ohms to 182 ohms. It is interesting that the input impedance of the A55 TC is 200 ohms per volt so if they use a 90 ohm 5 ma TC, there must be two inside the A55 also. I have just uploaded to K04BB a manual that I have for the A55 TC and the A550 Thermal Transfer Standard. The file name is "FLUKE A55 TC & A550 Trans Std.pdf". I don't know how long it will take K04BB to get it up on the site. You can download the file from the FTP site. I think I got this manual from the infamous action site. Looks like the A550 was FLUKE's first attempt at a way to use the A55 TC. This was probably replaced by the 540B and A45 Transfer switch. But the A550 sure seems like a difficult way to get a transfer.

Bill

IMG_2612.JPG (368.89 kB, 2592x1944 - viewed 118 times.)

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Roman oh
Contributor
Posts: 32
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #11 on:** April 15, 2021, 11:48:22 pm »

Say Thanks Reply Quote

Bill,
Thanks for uploading the manual - I shall keep an eye out for it. Usually takes him a few days to move it to an accessible area.
Not sure, though about your reasoning for the dual couples. 200 ohms per volt simply means 5mA at full scale; and I know that the thermocouples in the A55 (my set, at least) are all single unit VHF-type elements, 5mA, 90 ohms (I have replaced a couple in a former life). For the 540B, 182 ohms per volt means about 5.5mA full scale; looking at the circuit of the 540B this is consistent with 5mA for the thermocouple and a little bit for the protection amplifier, which remains in circuit. And the lowest range (0.5V FS) at 5mA equates to a 90 ohm heater, given that there is a 10 ohm resistor in series. And the 540B thermocouple output at FS is around 7mV, which is consistent with a single bead in the A55.
So I think there is something else going on, but what? Is it perhaps Fluke doing what they do with resistors - select pairs with equal and opposite parameters (in this case, reversal error?) to meet a tight spec?

Roman

Report to moderator Logged

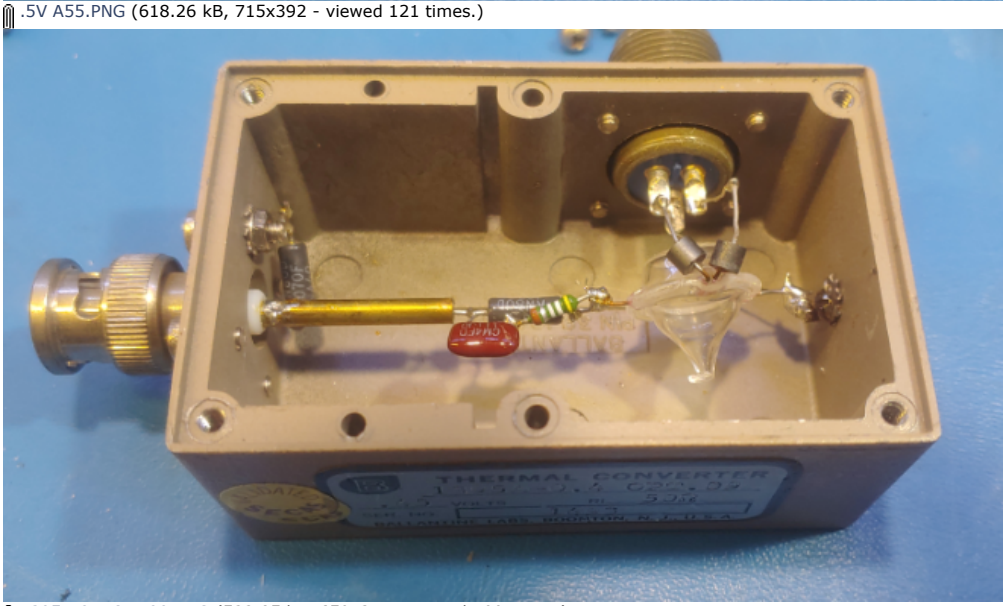
1audio
Frequent Contributor
Posts: 265
Country:

Re: Fluke 540B and thermocouple drift
« **Reply #12 on:** April 16, 2021, 03:32:32 am »

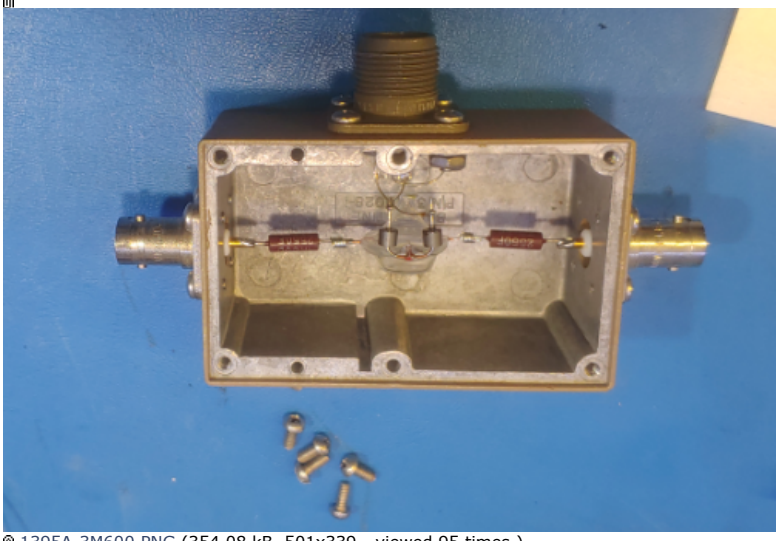
Say Thanks Reply Quote

The A55 and the other discrete TVC's use the "UHF" pattern TVC's. Its different from the 540B in the photo and there is only 1 in them. Attached are photos of the A55 .5V (the TVC is fried but the silicone makes repair not very attractive). The other two are Ballantine 1395 series converters. Not as big heavy or involved and imminently repairable (but calibration will still be needed). They do work with the 540B once you kludge a cable. Even the funky microphone connectors have become rare and expensive. And the A55's are not really polarized so you can get odd resuts with them in backwards.

.5V A55.PNG (618.26 kB, 715x392 - viewed 121 times.)



1395A-0.4 OPT.09.PNG (522.85 kB, 659x377 - viewed 109 times.)



1395A-3M600.PNG (354.08 kB, 501x339 - viewed 95 times.)

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The following users thanked this post: Roman oh

1audio

Re: Fluke 540B and thermocouple drift
« **Reply #13 on:** April 17, 2021, 04:10:17 am »

Say Thanks Reply Quote

Frequent Contributor

Posts: 265
Country:

I found this for the HP version of TVC's: https://testequipment.center/Product_Documents/Agilent-11050A-Operations-Manual-7A2C8.pdf Keysight seems to have dumped support for older stuff and no more manuals there. I think a dumb idea.

In any case the HP manual has pretty good detailed info on what is in the TVC's.

Also attached is info from the HP 652 manual on using a TVC with enough info to build and use a test set with a null meter.

percentage the ac input changes. Typically, it changes 1.7 times. When making response measurements, the transfer characteristics of your particular thermal converter should be used. To determine the thermal transfer characteristic of your particular thermal converter, proceed as follows:

1. Set the 652A output amplitude to minimum.

2. Connect the 11049A Thermal Converter directly to the 50 Ω output of the 652A.

3. Connect the 419A DC Nullmeter across the dc output of the Thermal Converter.

4. Adjust the 652A output amplitude control for 1 V rms input to the Thermal Converter (use an ac voltmeter to monitor the ac input to the Thermal Converter).

5. Measure and record the dc output (E_i) of the Thermal Converter on the 419A.

6. Double the ac input to 2 V rms. Again, observe the null meter and record the reading (E_f).

7. Calculate the transfer ratio as follows:

$$\text{Transfer characteristic } (k) = \frac{E_f}{2\,E_i}$$

Table 5-3 assumes a transfer ratio of 2. The actual transfer ratio of your Thermal Converter should be applied to Table 5-3 as follows:

DC CHANGE ON 419A = the percentage of ac change times 7 mV times the transfer ratio.

For example, if the transfer ratio of your Thermal Converter is 1.7, a 1% change in the ac input (Table 5-3) would result in 70 μV (change in ac input) times 1.7 (transfer ratio) = 119 μV.

Table 5-3. Typical Thermal Converter Input/Output Change.

CHANGE AT AC INPUT OF THERMAL CONVERTER	CHANGE OF DC NULL METER INDICATION FROM NULL SETTING
+/- 0.25%	+/- 35 microvolts
+/- 1%	+/- 140 microvolts
+/- 2%	+/- 280 microvolts
+/- 3%	+/- 420 microvolts
+/- 4%	+/- 560 microvolts
The ac input is set for 7.0 mV at the output of the thermal converter.	

a. Connect equipment as shown in Figure 5-3. (Use a thermal converter with a known change in output for a given change at the input. If this information is not readily available, then Table 5-3 gives this information for a typical thermal converter connected as in Figure 5-3). Set both 652A output and reference supply to minimum before connecting. Thermal converter must be connected directly to 50 ohm output of 652A.

CAUTION

Do not exceed rated input of thermal converter. Any overload or high voltage transient may destroy thermoelement. When using the 652A FREQUENCY RANGE switch, momentarily turn down the output attenuator.

b. Set 652A controls as follows:

FREQUENCY RANGE . . . . . XI K
FREQUENCY dial 10
OUTPUT ATTENUATOR . . . . . 3.0 V
OUTPUT MONITOR . . . . . NORMAL

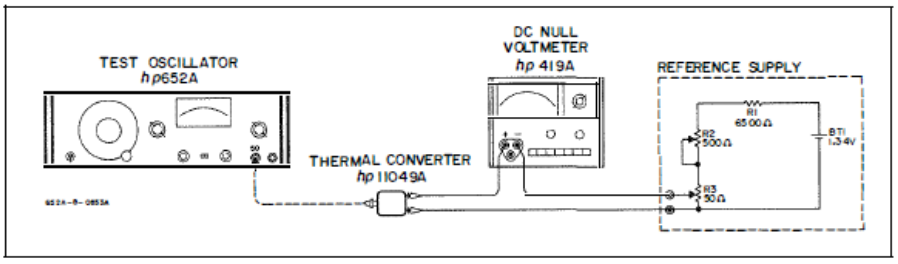

Figure 5-3. Flatness Tests.

5-3

HP 652 TVC application.PNG (121.59 kB, 621x851 - viewed 89 times.)

« *Last Edit: April 17, 2021, 04:30:47 am by 1audio* »

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