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A Free & Open Forum For Electronics Enthusiasts & Professionals

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June 01, 2022, 02:25:59 pm


This topic

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 **Author**

Topic: Should I return a Keithley 238? (Read 9029 times)

volvo_nut_v70 and 0 Guests are viewing this topic.

leighcorrigan

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



 **Should I return a Keithley 238?**

« on: August 20, 2020, 08:40:15 pm »

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Hi Friends,

I am new to this forum, so please forgive me if I am not completely familiar with the ways of posting. The repair thread seemed appropriate for this topic.

I purchased a Keithley 238 on eBay to do some research on low current applications, thinking that it was in good working condition and the price was right (~750 USD).

My concern began when I received a Keithley 238 in the mail today. The legs were missing and some of the screws as well. Big deal, right? On closer inspection of the enclosure, I noticed contamination on the inner surface of the case near the multitap transformer.
[attach=1]

I am not an electrical engineer by training, but I know what looks suspicious as I have had experience repairing other Keithleys before. There seems to be contamination from either a poor repair or a hot component that melted some plastic. The capacitor adjacent to the LM323K (see picture) has the same contamination as the board and the case above. The capacitor does not look damaged, but there is some contamination facing the heat sink. I cannot see where the source of this contamination is from. Does anyone have an idea? Maybe the transformer wires have been slow roasted over time by the LM323K heat sink.
[attach=2][attach=3][attach=4][attach=5]

From the other side of the circuit board, there is a blank silicone board that might act as an insulator to prevent shorting. It seems out of place and kind of lazy... Would this be original? I ask because it does not match the other boards. This area is where I would expect to see signs of modification or maybe some damage on the bottom side since the transformer wires are in the way on the other side. [attach=6]

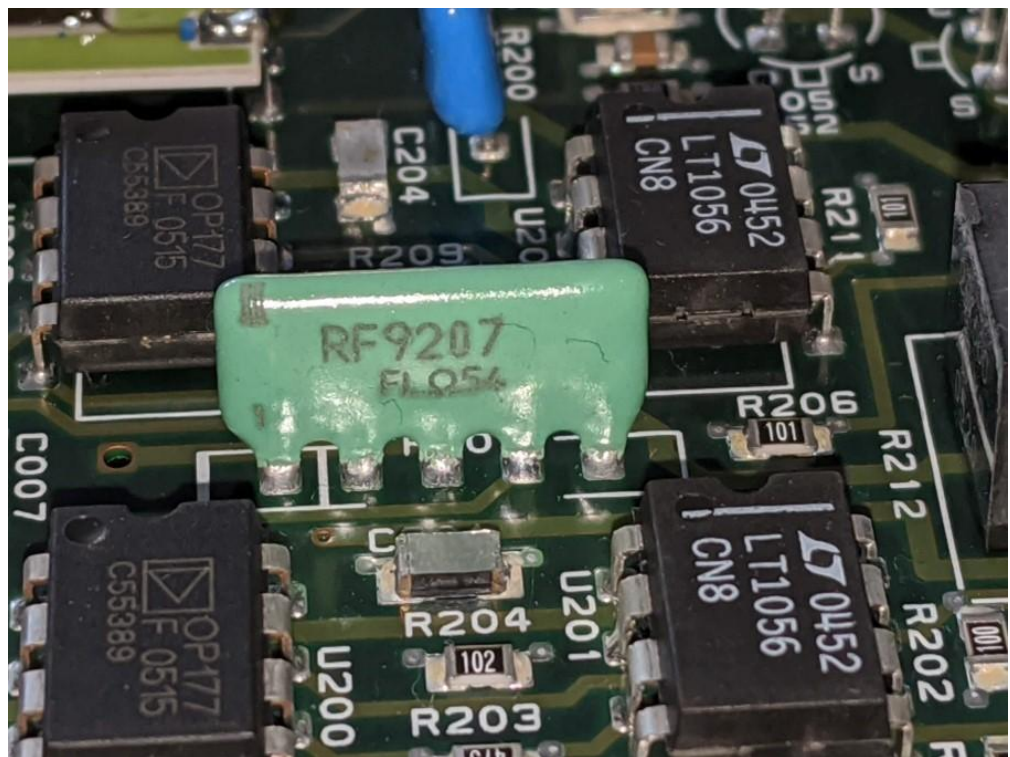
I removed this shield by taking some screws out of the boards and slipping the sheet away from the support rails. I see that there are post-manufacturing soldering jobs around the location of where I first saw the contamination on the other side. [attach=7]

The manual specifies that there are three variations of this board: 236 [default], 237 [high voltage], 238 [high amperage]. Would these solder jobs be associated with adapting the Keithley 236 to a 238 board in the factory or has someone attempted to repair this instrument? I am aware that there are forum members who have converted there 236 to a 237 before and understand that the 238 is a modification of the 236. Could the contamination be consider normal? The instrument in my possession is marked as a 238, so I don't think someone has unofficially upgraded the device.

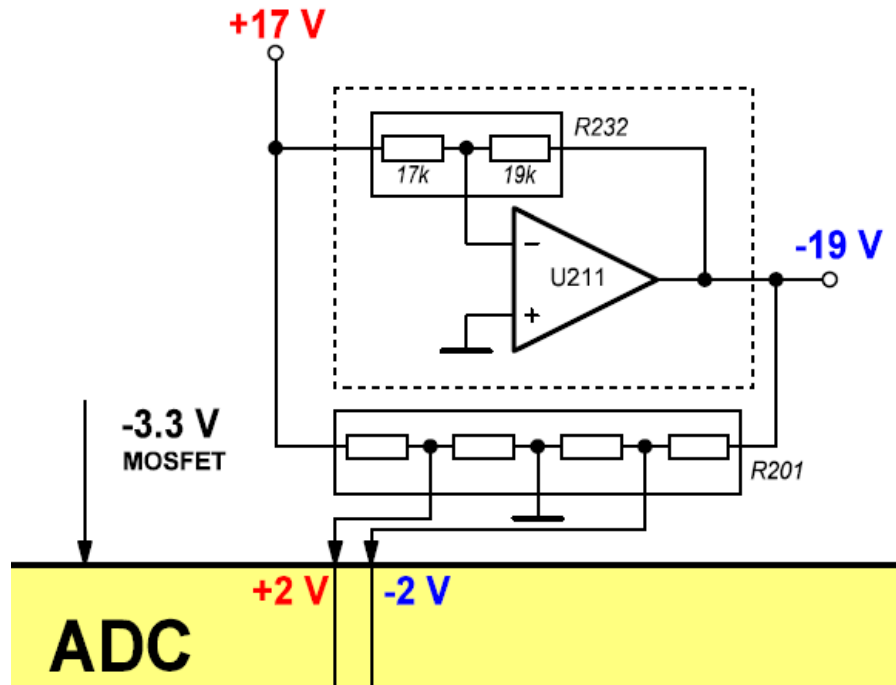
I am considering returning this device, but I want to know if I am overthinking things here. The instrument powers on and apart from the noisy fan, it seems to be in good working order. I do not have a 3 lug triaxial test lead for it yet because I did not want to pay 325 USD until I could inspect the instrument. Was 750 USD a good price for a Keithley in this condition? I want to be fair to the seller.

Thank you for reading my post and I appreciate any advice or thoughts that you may provide as a community.

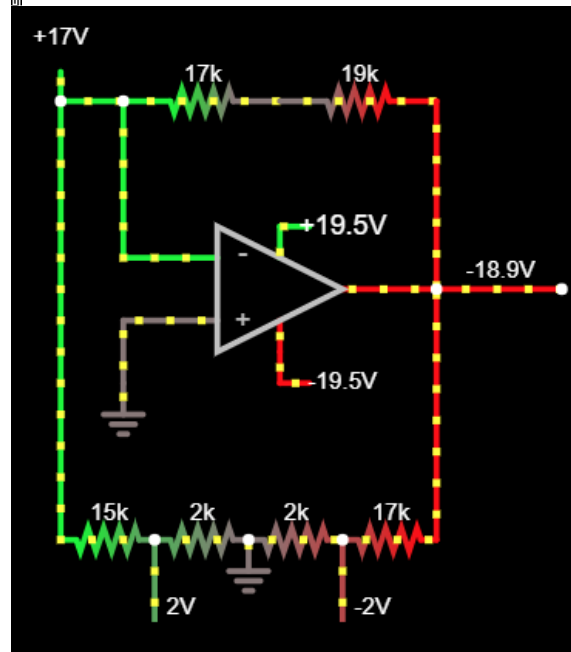
Regards.



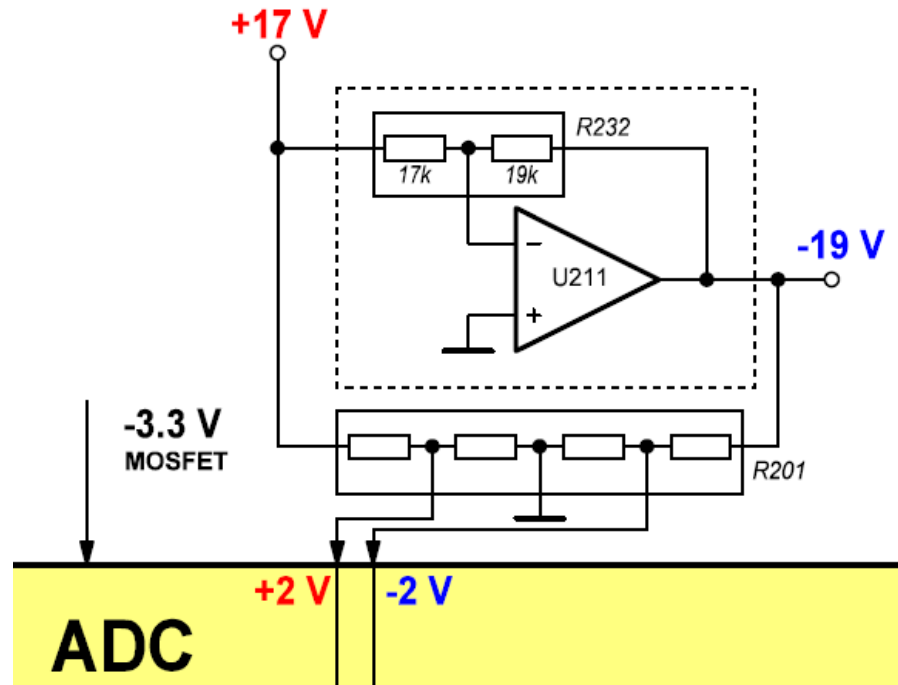
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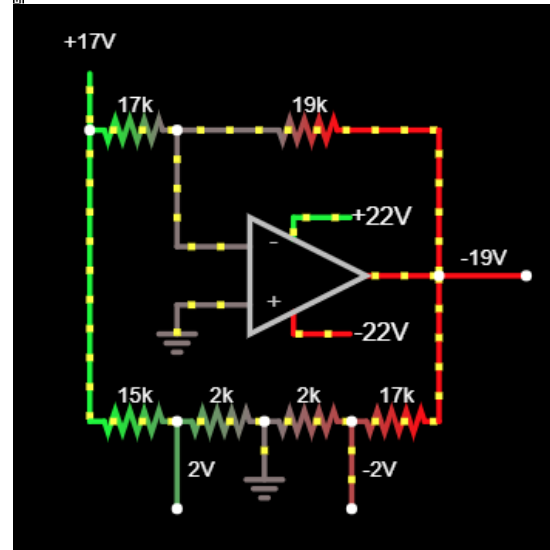
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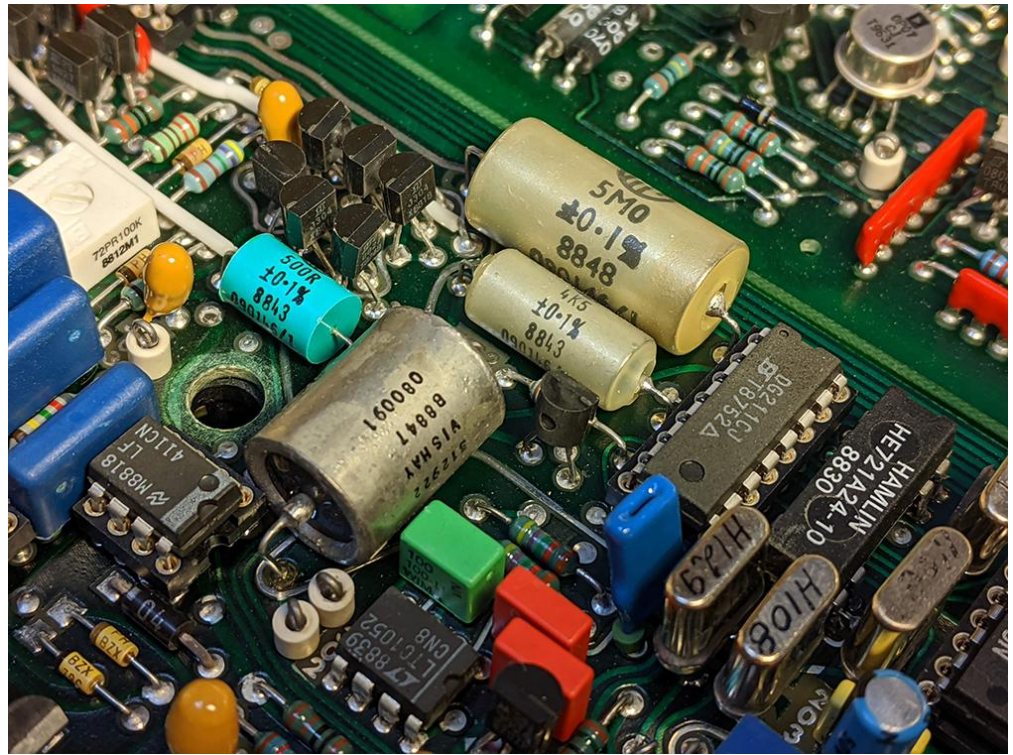
IMG_20200820_153655.jpg (530.42 kB, 4032x3024 - viewed 416 times.)



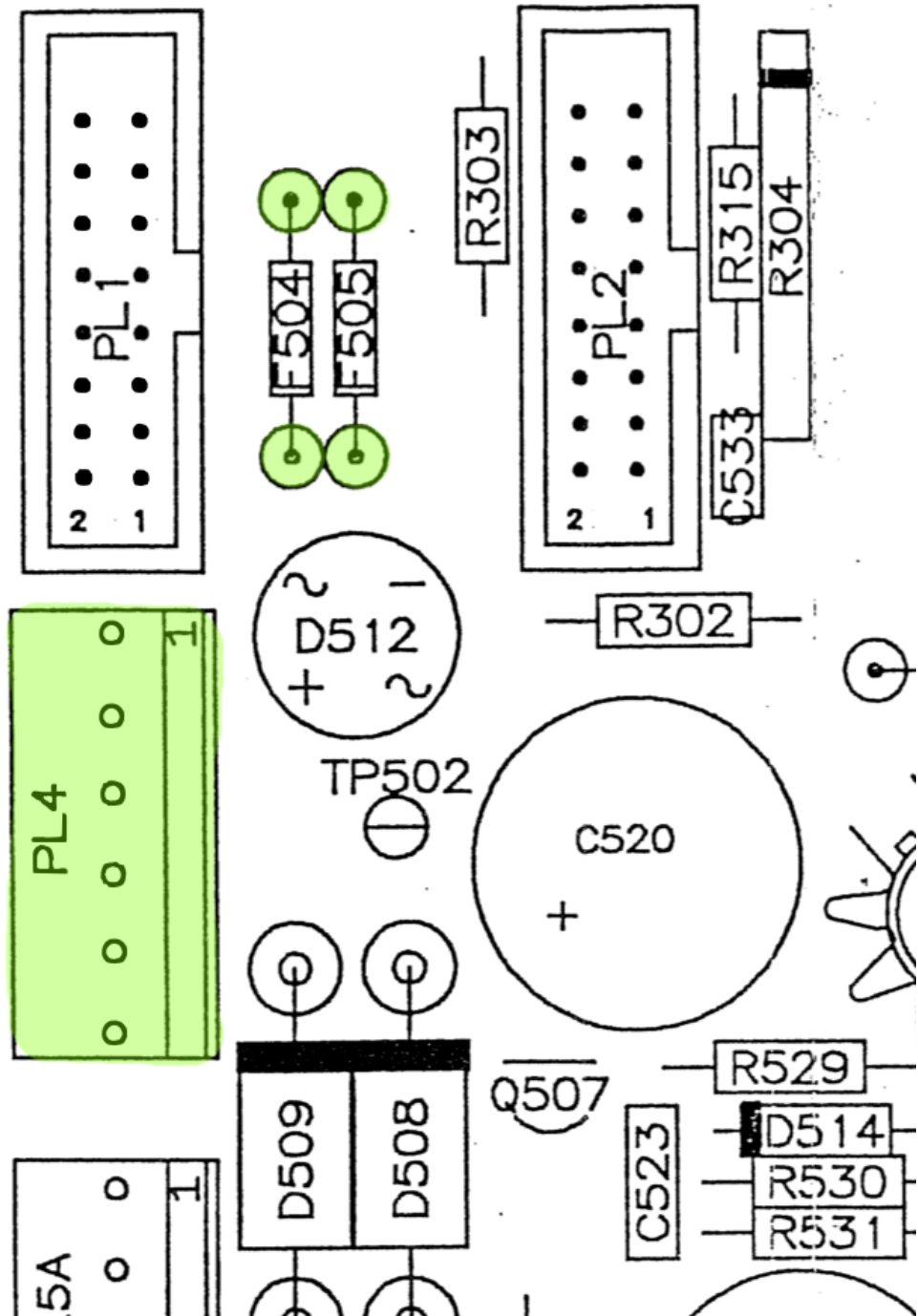
IMG_20200820_153713.jpg (755.38 kB, 4032x3024 - viewed 346 times.)



IMG_20200820_153704.jpg (340.36 kB, 4032x3024 - viewed 296 times.)



IMG_20200820_150257.jpg (480.42 kB, 3024x4032 - viewed 345 times.)



IMG_20200820_150702.jpg (542.85 kB, 3024x4032 - viewed 394 times.)

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MASc, EIT, PhD Candidate

Re: Should I return a Keithley 238?
« Reply #1 on: August 20, 2020, 09:24:59 pm »

Say Thanks Reply Quote

I cant really comment on whether or not you should return it.. thats an issue of whether or not what you purchased was fairly and clearly represented by the seller.

However, I can say that somebody attempted repair.

I can say for sure that the Keithley factory would not do a solder job as shown in the pictures.

So the contamination came from the previous capacitor? Did you discover where it came from? It obviously wasnt cleaned up.

Maybe all thats needed is a cleanup job.

E-Design
Regular Contributor



Posts: 188
Country:
Hardware Design Engineer

Report to moderator Logged

The greatest obstacle to discovery is not ignorance - it is the illusion of knowledge.

The following users thanked this post: leighcorrigan

evac

Contributor

Posts: 22

Country:



Re: Should I return a Keithley 238?

« Reply #2 on: August 20, 2020, 09:35:03 pm »

Say Thanks Reply Quote

The clear fibreglass board on the bottom is original, I have the same on my 237.

The flux residue on the bottom of the PCB is likely a sign of a repair, looking at what those solder joints connect to would give you an indication of what was replaced and potentially what the problem was.

The soldering work also seems quite poor, and the fact that they didn't clean the board suggests it wasn't an official repair.

Looking at the location of those solder joints, could it be the transformer that was replaced?

I think the digital board is different between the 238 and 236/237, so not sure if a conversion is possible.

In any case, the affected area is the power supply section, I would be more concerned if I would see such poor repair work near the analog sections.

If the unit would be in operating properly and in spec, I would be okay with such condition, assuming also the rest of the boards didn't show signs of a more extensive (and poorly done) repair.

Report to moderator Logged

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #3 on: August 20, 2020, 10:13:33 pm »

Say Thanks Reply Quote

Hi E-deisgn and evac.

Thank you for your input. I believe that both of you are correct about the repair job. Without taking the board out of the enclosure, I am guessing that some of the components were capacitors. The transformer was not replaced in this case, but the contamination is very close to it.

Apart from the poor repair job, nothing else seems modified. The seller advertised the unit with the following message: "Unit was in working condition prior to being removed from service." A calibration sticker has been placed over the reset button, but I do not know if it is official. Any way of telling?

Let me know if anyone wants additional pictures for reference to benefit the community. I don't see a lot of Keithley 238 representation out there.

Report to moderator Logged

MASC, EIT, PhD Candidate

garrettm

Frequent Contributor



Posts: 252

Country:



Re: Should I return a Keithley 238?

« Reply #4 on: August 20, 2020, 11:43:58 pm »

Say Thanks Reply Quote

I'd at least show the seller pictures of the poor repair and see if he/she would be willing to give you a partial refund. Clearly this isn't worth as much as the seller thought it should be. In my experience, most sellers are willing to offer a partial refund to avoid paying return shipping on a "not as described" case. So it's worth a try.

Though you really need to test the unit before proceeding any further. I would recommend using only triax when testing, as these units are very susceptible to external noise. I used some Trompeter triax to BNC adapters (E1 wiring) with Pomona low triboelectric BNC cables and kept getting weird noise spikes / random jumps in the output. Once my Keithley triax arrived, all that all went away.

Report to moderator Logged

The following users thanked this post: leighcorrigan

leighcorrigan

Frequent Contributor



Re: Should I return a Keithley 238?

« Reply #5 on: August 20, 2020, 11:58:31 pm »

Say Thanks Reply Quote



Posts: 393

Country:

Nuclear Materials Scientist



Hi Garrettm,

You are correct. I plan on negotiating with the seller. Considering the enclosure panels look like they have been worn extensively, he may already know that the unit is modified. I am in the process of carefully photographing the interior. 🐜

For now, I have ordered a Keithley 6171 adapter (2 lug to 3 lug converter) for my Keithley 6011 (2 lug triax to allegator test leads) so that I can perform measurements with my Keithley 2000. For now, I do not want the Keithley 238 anywhere near my precious Keithley 6485 ammeter. In the process of purchasing the Keithley 6171, I was debating whether to purchase a 237-ALG-2, but I couldn't justify the extra 200 USD.

Regrads.

[Report to moderator](#) Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist

 **Re: Should I return a Keithley 238?**« **Reply #6 on:** August 21, 2020, 02:06:30 am »[Say Thanks](#)[Reply](#)[Quote](#)**Quote from: evac on August 20, 2020, 09:35:03 pm**

Looking at the location of those solder joints, could it be the transformer that was replaced?

Now that I have had time to look at the pictures, I think it is the transformer taps. Appologies, evac!



The flux on the bottom of the board correspond entirely with the coloured wire taps. I suppose I should lift the transformer and clean around the board with methonal, kimwhipes, and an air can. I wonder how the capacitor got dirty then. 🤔

This could be a very easy fix considering I took the entire instrument apart and know that no other component has been replaced.

Cheers.

[Report to moderator](#) Logged

MASc, EIT, PhD Candidate

evac

Contributor

Posts: 22

Country:

 **Re: Should I return a Keithley 238?**« **Reply #7 on:** August 21, 2020, 10:35:04 am »[Say Thanks](#)[Reply](#)[Quote](#)

I don't have a lot of experience with transformer failures, but if something would have caused one of the windings to short internally and overheat, it could be possible that some burned enamel/epoxy would spew out.

The path of least resistance for something to spew out would probably be the openings where the wires are, at the top and bottom of the transformer, and this would seem to match where the stains are.

The question would then be why was the transformer replaced.

Given that there are no signs of repair on other components, I guess we can rule out other sections of the unit failing and shorting the transformer.

Looking at your flag and currency of purchase, I guess the unit came from 110V mains environment so unlikely to have been overvoltage due to wrong line select.

Perhaps it was just an isolated failure due to ageing?

Of course, what really matters is if the unit performs as expected, so once your adapter arrives, I guess you will have the answer to whether the unit should be returned.

Even if the unit works as expected, I would follow garrettm's advice to raise the issue to the seller. I've had the similar experiences where the item was overall working, but had some damage/issue that was not described, and in some cases the seller was willing to give a partial refund.

Regarding the calibration sticker, there are likely plenty of calibration labs that would be able to calibrate such an SMU, not just Keithley, so even a non-official calibration would be a good sign. Typically, there would be stickers not just on the calibration enable switch, but also on the top/bottom panels such that the unit cannot be opened without breaking one of the calibration seals.

You should also find a sticker with the calibration date, from the calibration lab.

In some cases, the sticker might also include a reference number and depending on the lab they may be able to provide you a copy of the calibration report.

« Last Edit: August 21, 2020, 10:39:32 am by evac »


Report to moderator  Logged

 **leighcorrigan**

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



 **Re: Should I return a Keithley 238?**

« Reply #8 on: August 21, 2020, 11:24:20 pm »

Say Thanks

Reply

Quote


Well, this is turning into a legitimate repair log now...

[attach=1]

I ended up cleaning the back of the digital board where the replacement transformer taps were resoldered. This was done with 99 % isopropanol and q-tips because I don't have a way of acquiring methonal for the time being thanks to COVID. The way I clean is I start by dissolving the solidified flux and then I use a dry q-tip to clean towards the flux, starting at the perimeter of the liquid where the contamination is the least. The contamination doesn't spread far this way and I can reduce the amount of q-tips used as I have a recycle pile, in order of cleanliness. The process is repeated until I do not see residue in hard reflected light coming from a lamp. It is a huge improvement over what it looked like when I received the hardware. As it is the digital side of business, I doubt the flux will make an impact on performance, but this is a matter of pride!

[attach=2]

The 80mm axial fan also needs attention because it makes clunky noises as if the axial is rubbing. Turns out the 126LF by ETRI is a sleeve type bearing, which breaks down much faster than a ball bearing type and can only be used in a horizontal position. They have a lifespan around 6 years of continuous operation. Sometimes you can fix these by opening them up and lubricating the shaft. This is done by rotating a circular plate on the opposite side of the sticker, removing an end plug that applies pressure to the shaft, removing a retaining ring and some washers. Unfortunately, the

lubrication did not fix my problem. 

[attach=3][attach=4]

With some searching, I managed to find the original datasheet for the fan. Obtaining a new one is difficult, so I decided to go with a ball bearing type alternative. The OA80AP-11-1TB from Orion seems to be a good candidate, although I do not know if it has a threaded grounding hole. You can either reuse the original power connector or purchase a 3-position connector (0009503031) from Molex with chrimp interconnectors (0008500108). I took these ideas from a blog:

<https://www.nicolas.tv/blog/keithley-236-repair>

[attach=5][attach=6]

The lithium ion battery from Duracell seems to be functioning as it reads 3 volts when using a DMM. The model number for this battery is DL2450, but you can find one under the name of CR2450 as well.


[attach=7]

Another good thing about this instrument has the latest firmware package (I think). Is this a G version?

[attach=8][attach=9]

While preparing to clean the other side the the digital board, I found another problem that I still need to look into. There is a damaged component between the 'int dt 7130 SA100P delta delta U9502P' (Keithley designates this part as U12 in the KE 236 service manual) and the 'M45AB LM323K steel' (VR1). The component in question looks to be a capacitor based on schematics I found in the Keithley 236 service manual (C35). How would it break in this way? For some reason this component is not identified as a replacable part in the Keithley 238 service manual, so I am uncertain about the exact specifications of the component.

[attach=10][attach=11]

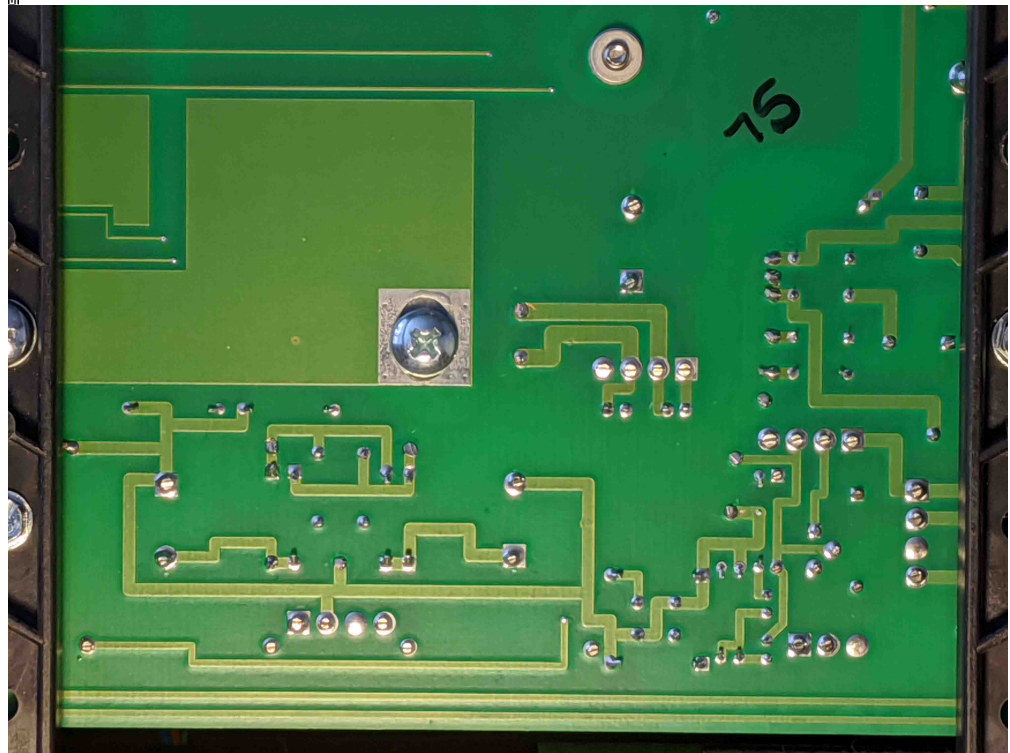
Can I assume that the capacitor for the Keithley 238 is the same as the C35 found in the Keithley 236 service manual? 

Circuit Design	Description	Keithley Part Number
C35	CAP,.01uF,20%,50V,CERAMIC	C-365-.01

Also, does anyone have schematics for the Keithley 238? I don't have them in the service manual version I own.



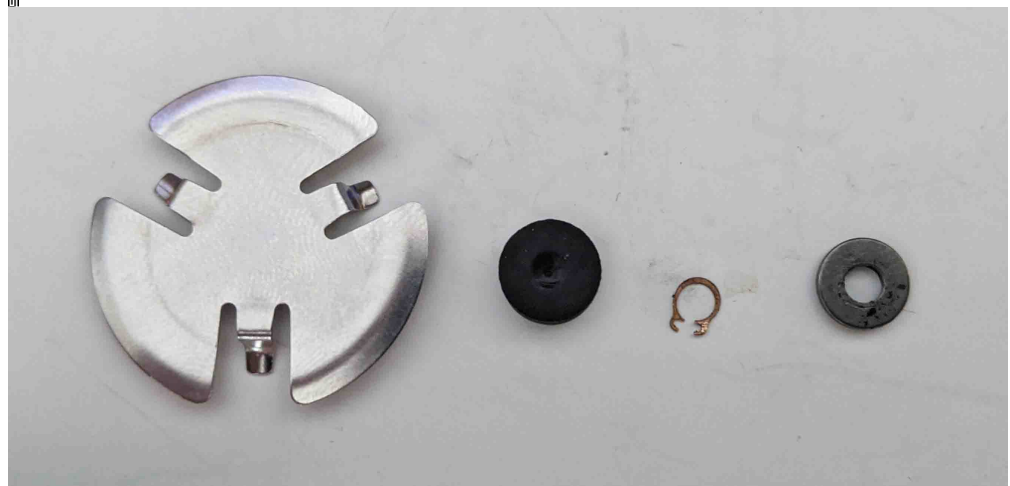
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IMG_20200821_154515.jpg (220.04 kB, 4032x3024 - viewed 156 times.)



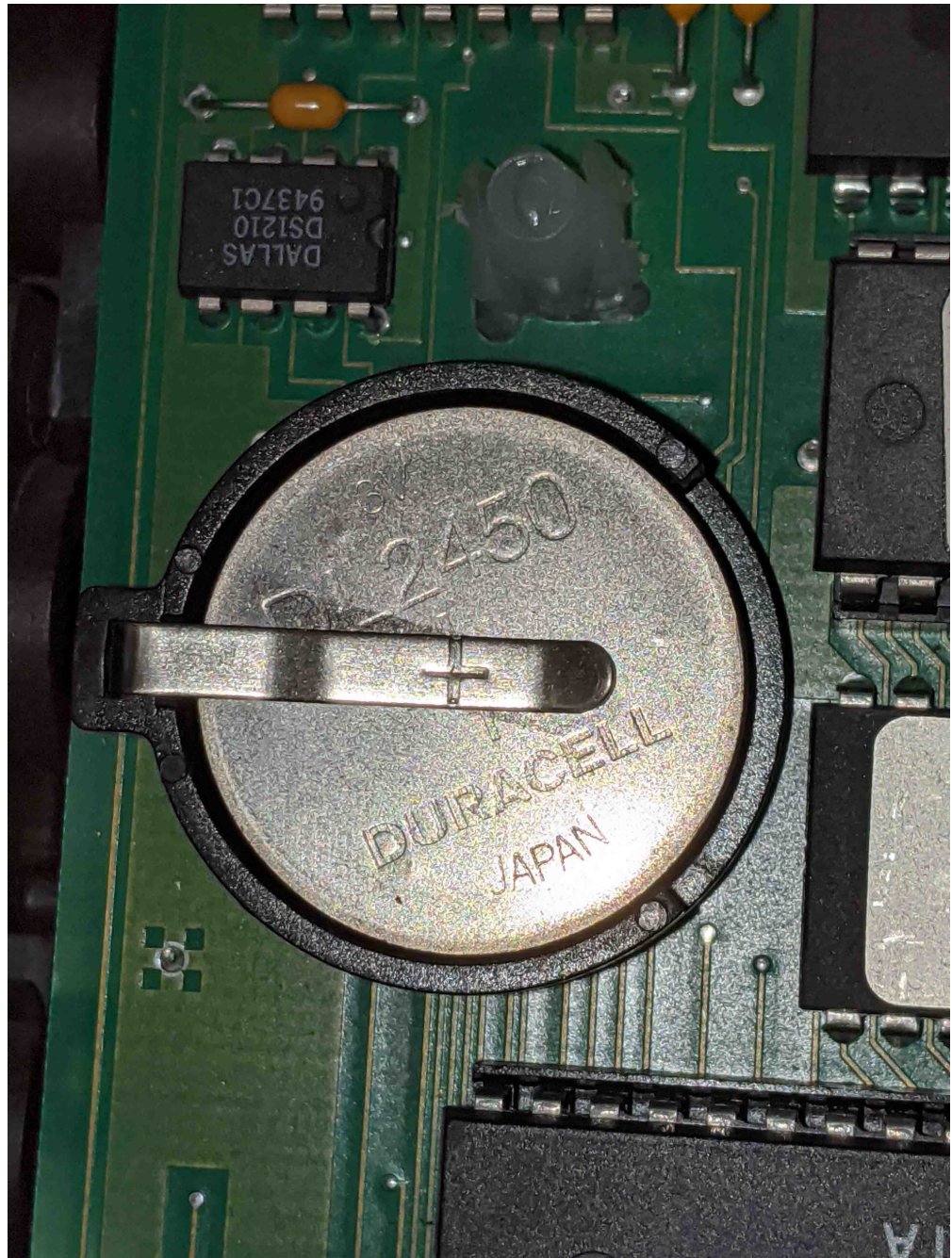
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126LF-2182-000.pdf (97.88 kB - downloaded 42 times.)

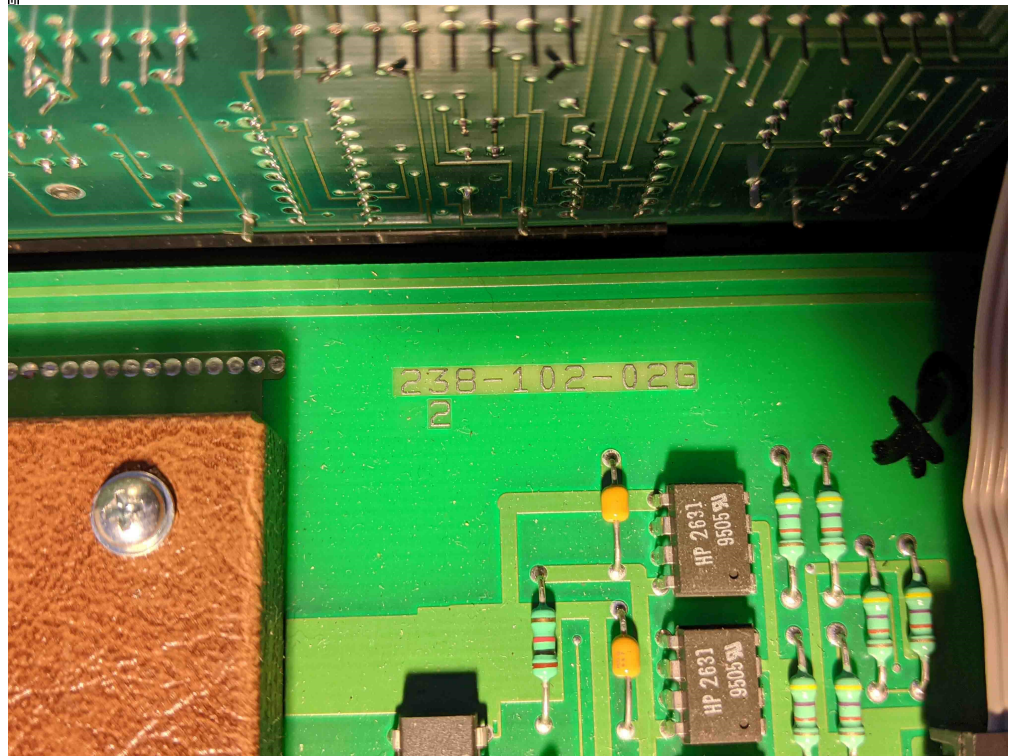
OA80AP-11-1TB.pdf (204.45 kB - downloaded 34 times.)



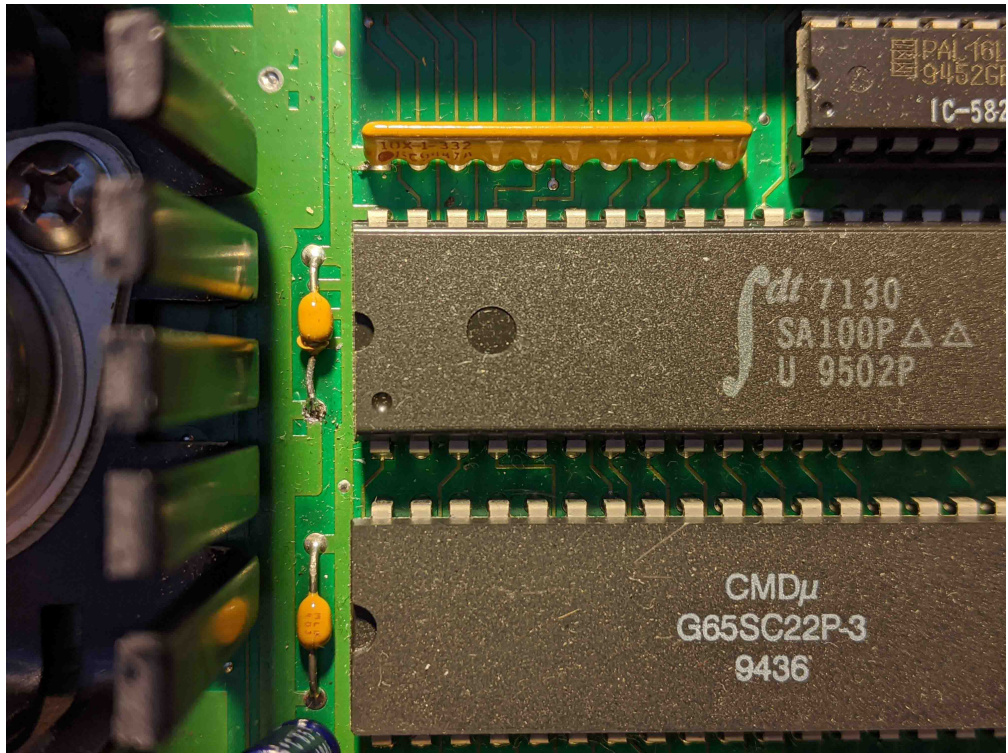
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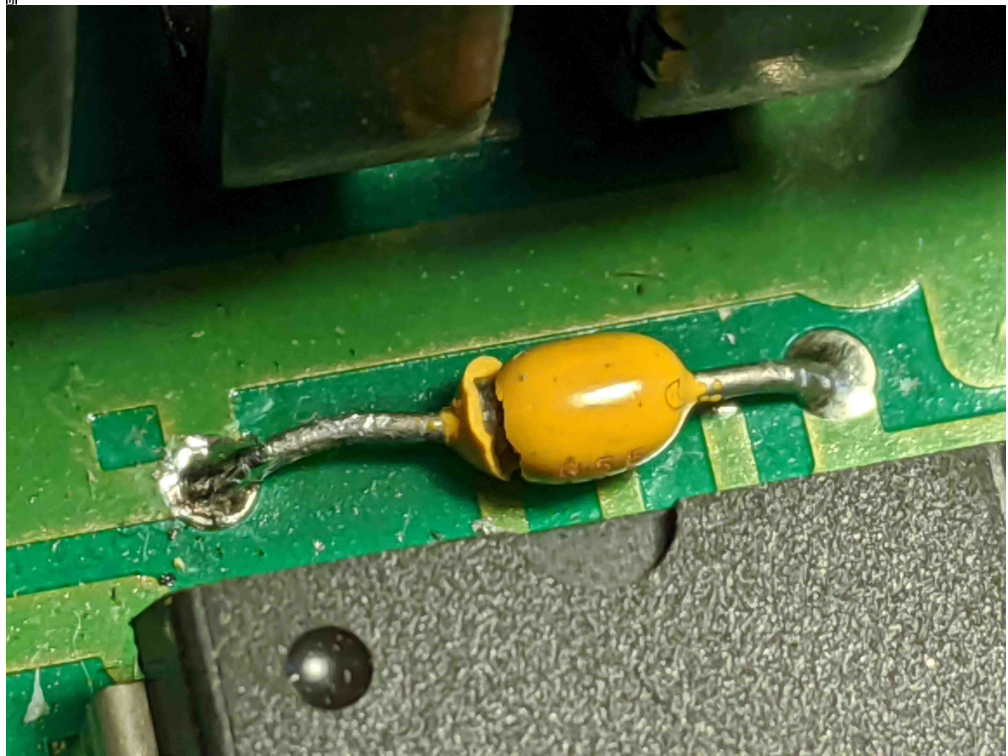
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IMG_20200821_184936.jpg (771.3 kB, 4032x3024 - viewed 118 times.)



IMG_20200821_164634.jpg (397.82 kB, 4032x3024 - viewed 116 times.)



IMG_20200821_164218.jpg (246.17 kB, 4032x3024 - viewed 186 times.)

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MASc, EIT, PhD Candidate

leighcorrigan


Frequent Contributor

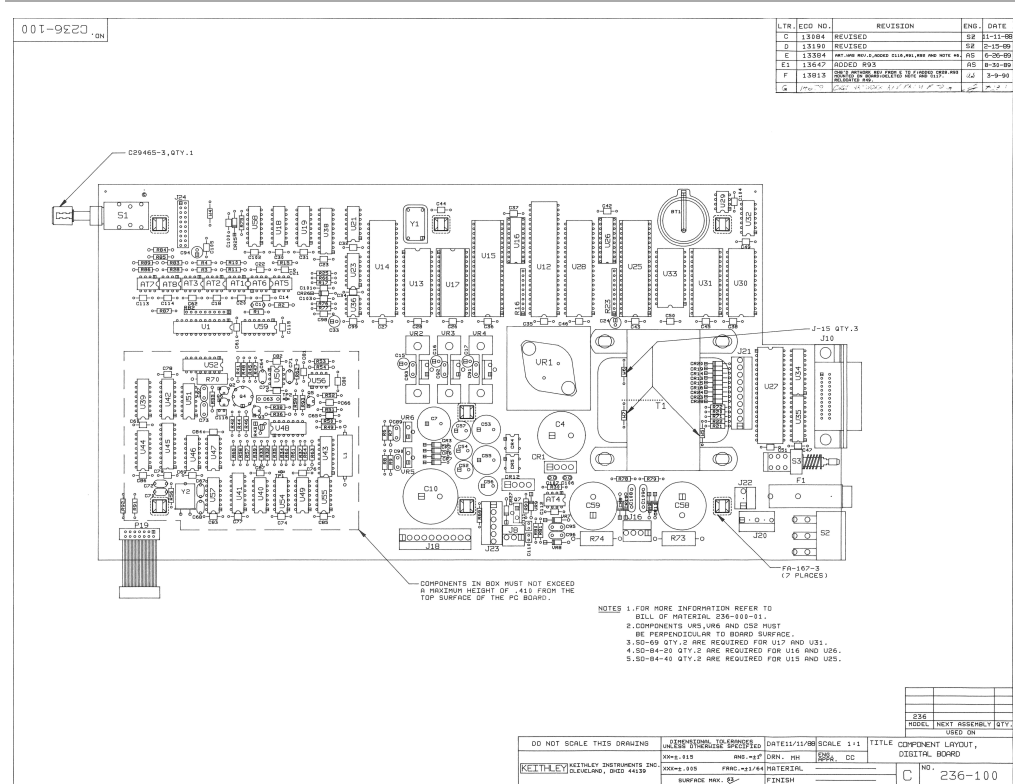


Re: Should I return a Keithley 238?
« **Reply #9** on: August 21, 2020, 11:31:34 pm »

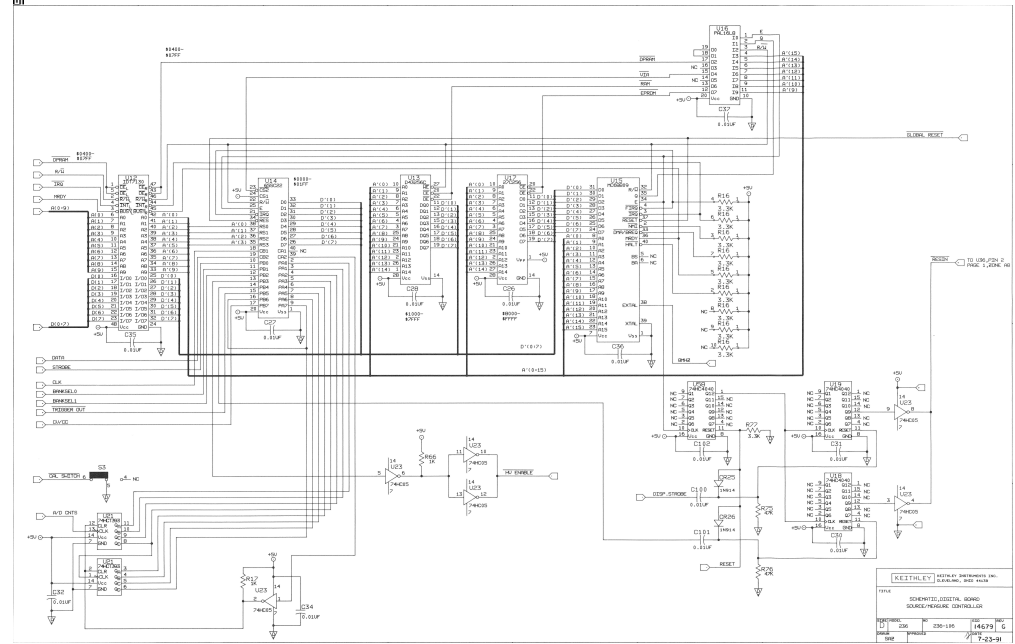
[Say Thanks](#) [Reply](#) [Quote](#)

Due to the attachment limitations, I was unable to post the schematics. Here are references for the Keithley 236/237 model.

Posts: 393
Country: 
Nuclear Materials Scientist

K236 - C35.jpg (1654.18 kB, 8048x6191 - viewed 110 times.)



K236 - U12.jpg (1740.25 kB, 9096x5796 - viewed 87 times.)

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MASc, EIT, PhD Candidate

 **garrettm**
Frequent Contributor


Posts: 252
Country: 


Re: Should I return a Keithley 238?
« Reply #10 on: August 22, 2020, 03:54:48 am »
Say Thanks Reply Quote

The digital board is looking great! Good job.

The capacitor looks like a 10nF or 100nF axial decoupling capacitor for the digital ICs. Not a terribly critical component but should be replaced.

It looks like someone either dropped a screwdriver on it when they replaced the transformer or they were using it as a reference point for measuring voltage and were very rough with the alligator clip. Either way, a very careless act on behalf of the previous owner and/or repairman.

This is why I always pull used equipment apart and thoroughly inspect every inch before turning it on. I remember opening up an HP 6186C HV current source only to find the AC mains was shorted via the neon bulb pulled out of its holder. Good thing I didn't turn it on! Looking further I found the current sense resistor had been cut. After fixing all that nonsense, I turned fired it up and it worked just fine. Goes to show you can't trust anyone who doesn't show the equipment turned on and working.

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The following users thanked this post: leighcorrigan

garrettm
Frequent Contributor



Posts: 252
Country:

Re: Should I return a Keithley 238?
« **Reply #11 on:** August 22, 2020, 04:01:55 am »

[Say Thanks](#) [Reply](#) [Quote](#)

Just noticed that your fan was an ETRI. I have two 237s and both use NMB. Maybe yours was replaced previously? I can open up one of them and take a picture of the fan if you would like.

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The following users thanked this post: leighcorrigan

leighcorrigan
Frequent Contributor



Posts: 393
Country:
Nuclear Materials Scientist

Re: Should I return a Keithley 238?
« **Reply #12 on:** August 22, 2020, 02:37:26 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

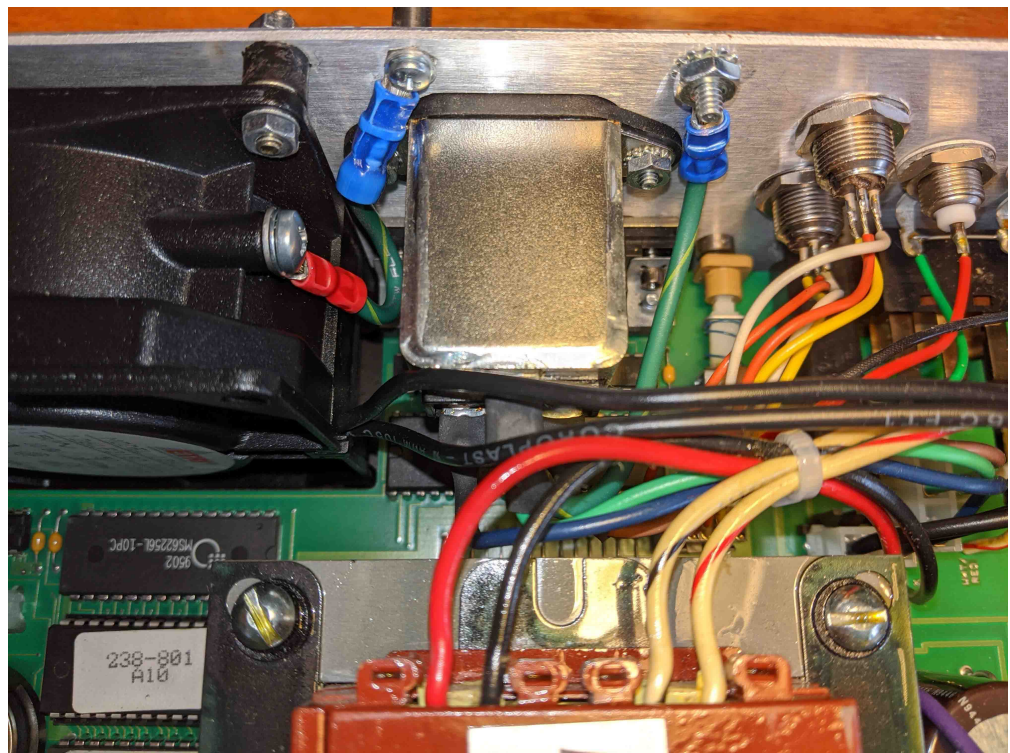
Quote from: garrettm on August 22, 2020, 04:01:55 am

Just noticed that your fan was an ETRI. I have two 237s and both use NMB. Maybe yours was replaced previously? I can open up one of them and take a picture of the fan if you would like.

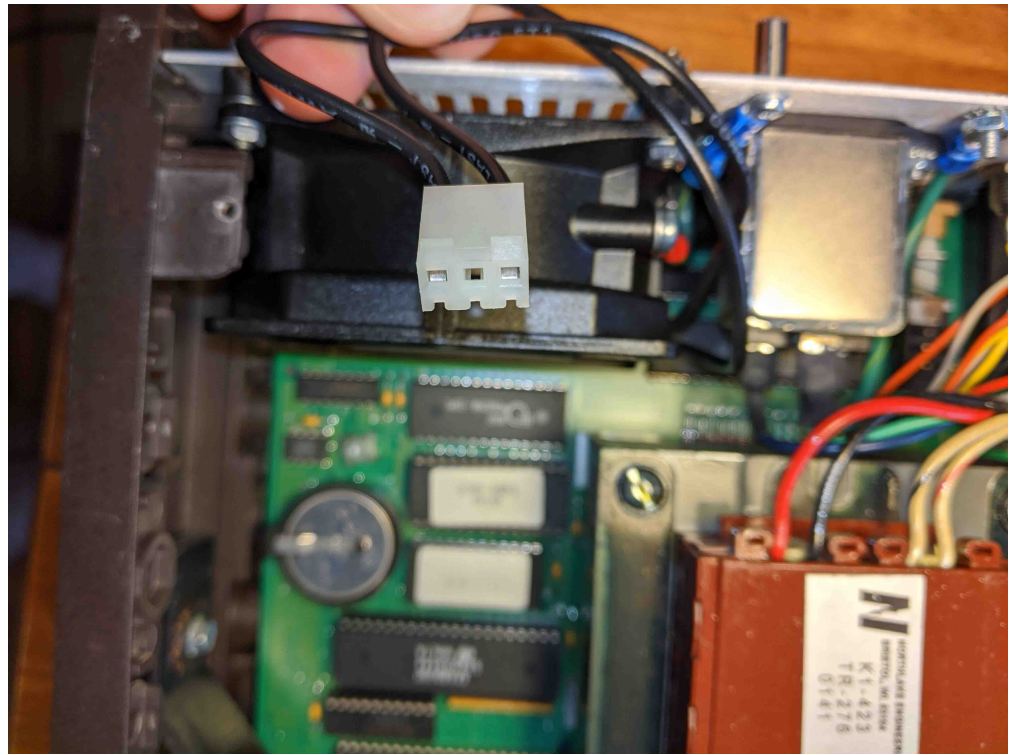
Please do. I have not ordered new parts yet and I want to keep myself open for other candidates. Are your fans grounded with a grounding screw like mine? [attach=1]

Come to think of it, the fan might have been replaced seeing the crimp connectors are different colors.

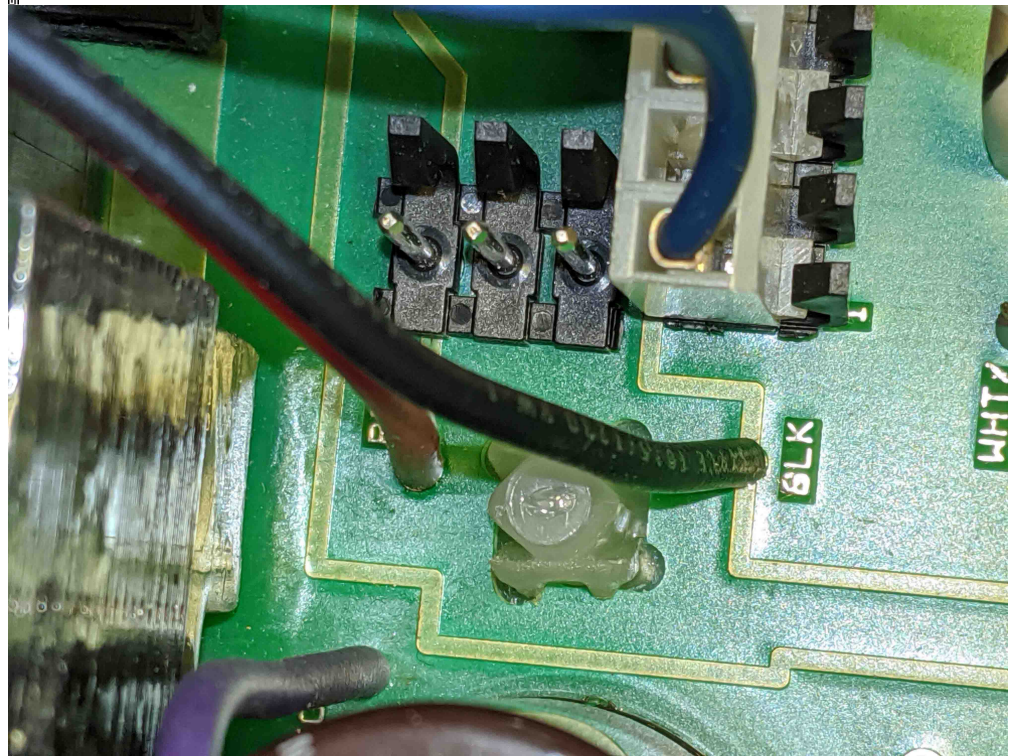
Oddly enough, there are 3 positions on the board termination but only two are used. The centre pin is not connected to ground on my instrument. [attach=2][attach=3]



IMG_20200822_102413.jpg (395.36 kB, 4032x3024 - viewed 140 times.)



IMG_20200822_102439.jpg (209.69 kB, 4032x3024 - viewed 119 times.)



IMG_20200822_102518.jpg (423.74 kB, 4032x3024 - viewed 128 times.)

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MASc, EIT, PhD Candidate

evac
Contributor

Posts: 22
Country:

Re: Should I return a Keithley 238?
« **Reply #13** on: August 22, 2020, 03:29:10 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

In my 237, the fan is an NMB 3115PS-12W-B30, apparently NMB has updated the part number to 08038PB-A1L-AA-00.

According to the datasheet it will do 2700RPM/26.5CFM/33dB@50Hz or 3200RPM/32CFM/38dB@60Hz.

I will also need to replace mine as the bearings are worn out, but I think I will try to find something a little bit more silent with not too different air flow.

Report to moderator  Logged


The following users thanked this post: leighcorrigan

leighcorrigan

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



Re: Should I return a Keithley 238?


« Reply #14 on: August 22, 2020, 03:32:38 pm »

Say Thanks

Reply

Quote

Thanks for the info. The specifications you stated are similar to what the ETRI is.

Interesting that you propose a more consistent fan. Good point! 

Report to moderator  Logged


MASc, EIT, PhD Candidate

Twoflower

Frequent Contributor



Posts: 704

Country: 



Re: Should I return a Keithley 238?

« Reply #15 on: August 22, 2020, 03:49:59 pm »

Say Thanks

Reply

Quote

By the way here some pictures from the inside:

<https://www.eevblog.com/forum/testgear/keithley-238-restoration/>

In the first post, first picture it looks like the same (grounded) fan, while in the last post there's a different fan. EDIT: The other fan type is s grounded as well but at a different place.

I was surprised about the used ground-lugs. The Crimping looks cheap but they seem to be original.

« Last Edit: August 22, 2020, 03:54:10 pm by Twoflower »

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The following users thanked this post: leighcorrigan

garrettm

Frequent Contributor



Posts: 252

Country: 



Re: Should I return a Keithley 238?

« Reply #16 on: August 22, 2020, 08:36:52 pm »

Say Thanks

Reply

Quote

The ground lead looks identical to my units, red and blue crimped ring terminals as well as orientation with my other SMU. The other one, which I took photos of, used a different orientation for the fan with a longer ground lead.

As evac posted earlier, the NMB model is 3115PS-12W-B30. These are in both of my units.

Now that I look closer, your fan actually seems to be factory original, the mounting orientation and ground lead matches my other SMU and the two pin connector looks original. So maybe Keithley used two different models for the fan.

At any rate, I agree with evac. If you can find a quieter fan with the same CFM for your line frequency you should probably be okay. My fans are reasonably quiet, but if either of you find a better replacement let me know.



IMG1284.jpg (813.24 kB, 1310x1049 - viewed 88 times.)



IMG1286.jpg (773.67 kB, 1031x1199 - viewed 66 times.)

« Last Edit: August 22, 2020, 08:49:18 pm by garrettm »

Report to moderator Logged

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #17 on: August 23, 2020, 03:55:19 pm »

Say Thanks Reply Quote

Everything in my Keithley 238 looks original with the exception of the transformer. Whoever replaced it was lazy, but at least they replaced the transformer with whatever was described in the service manual (TR-276). To avoid another future fire hazard, I pulled the wire taps away from the neighbouring LM323K heat sink with some cable ties.

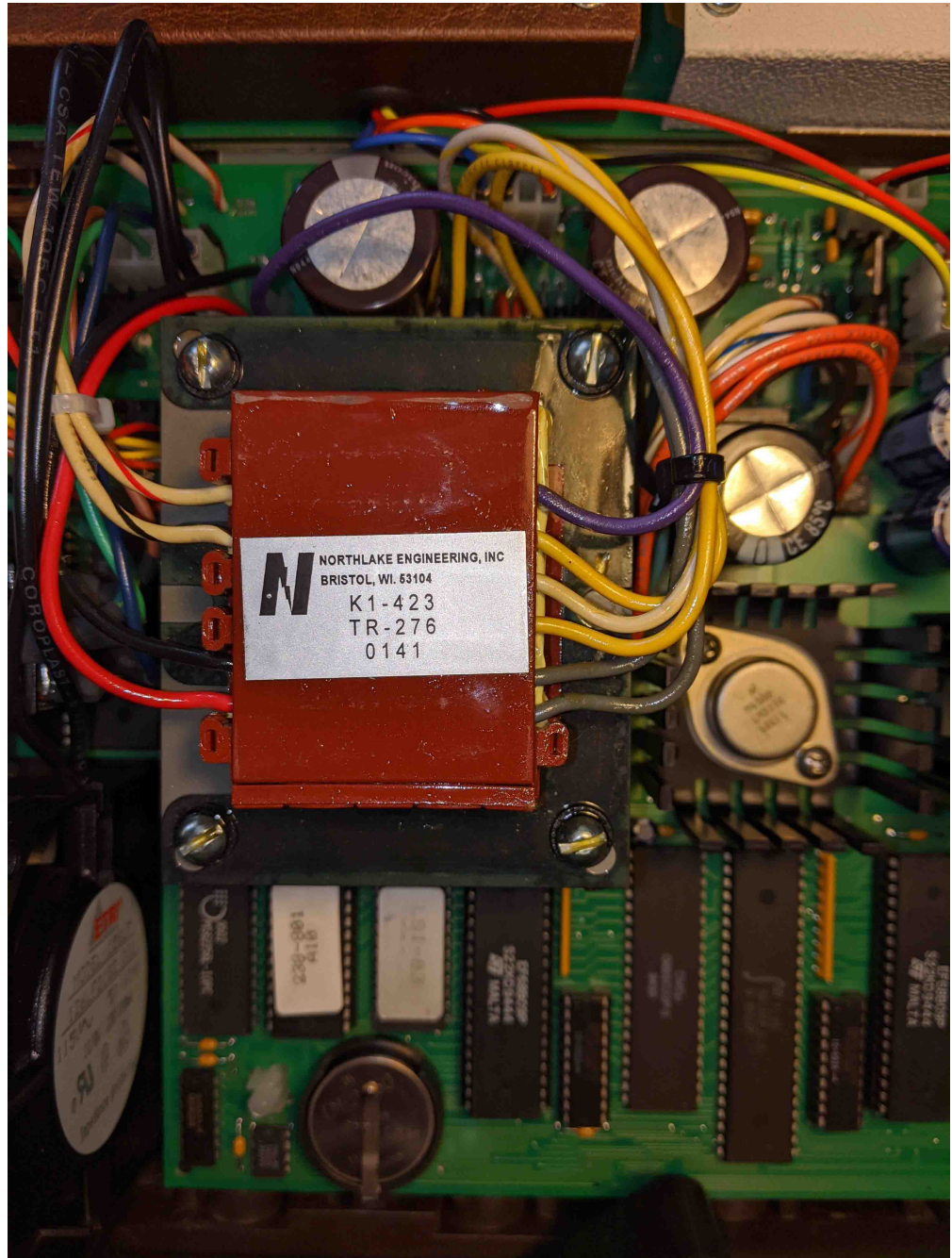
[attach=1]

A feature of my Keithley is that it has fake leather coated shields, which I find hilarious. I guess that the older versions of this instrument use a white coating only.

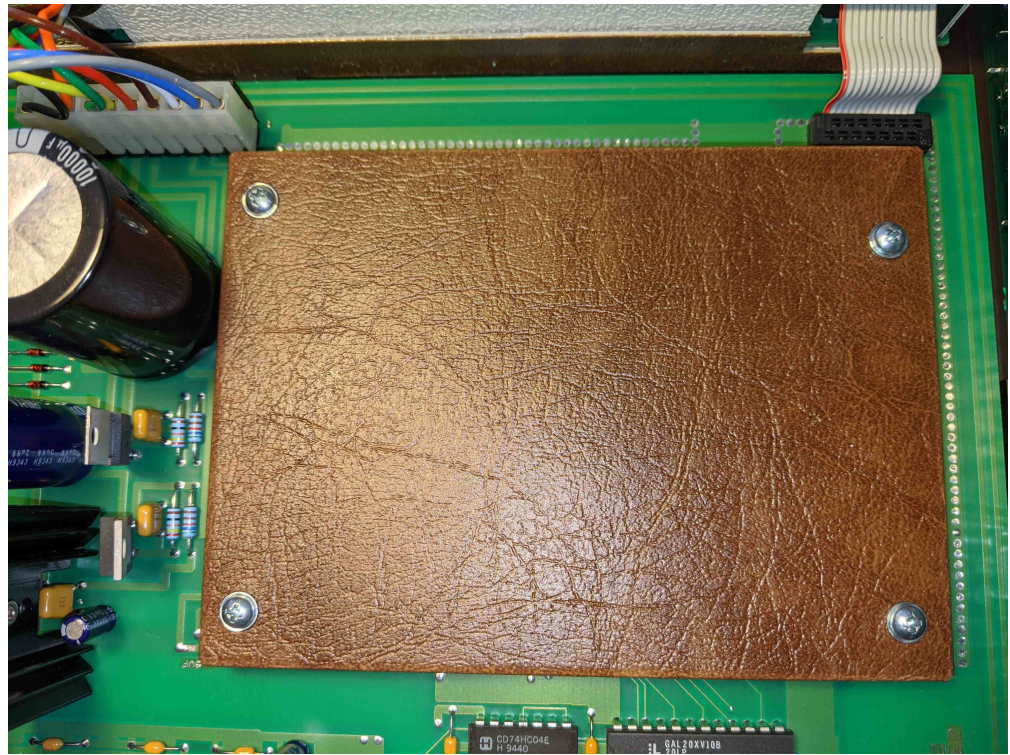
[attach=2][attach=3]

I did some browsing and came up with the attached spreadsheet as a list of candidates for an axial fan replacement. There isn't much difference between each model unfortunately, but if you are willing to spend a lot more money (44.40 USD) you can get the 8500N by ebm-papst Inc. It has a flow rate of 1.02 m³/min [36 CFM] at 34 dB with sintec bearings, which should last longer than sleeve bearings. I will likely use this one as I hate noise and for what I am using it for, it will be running often. Too bad this instrument doesn't have better heat management.

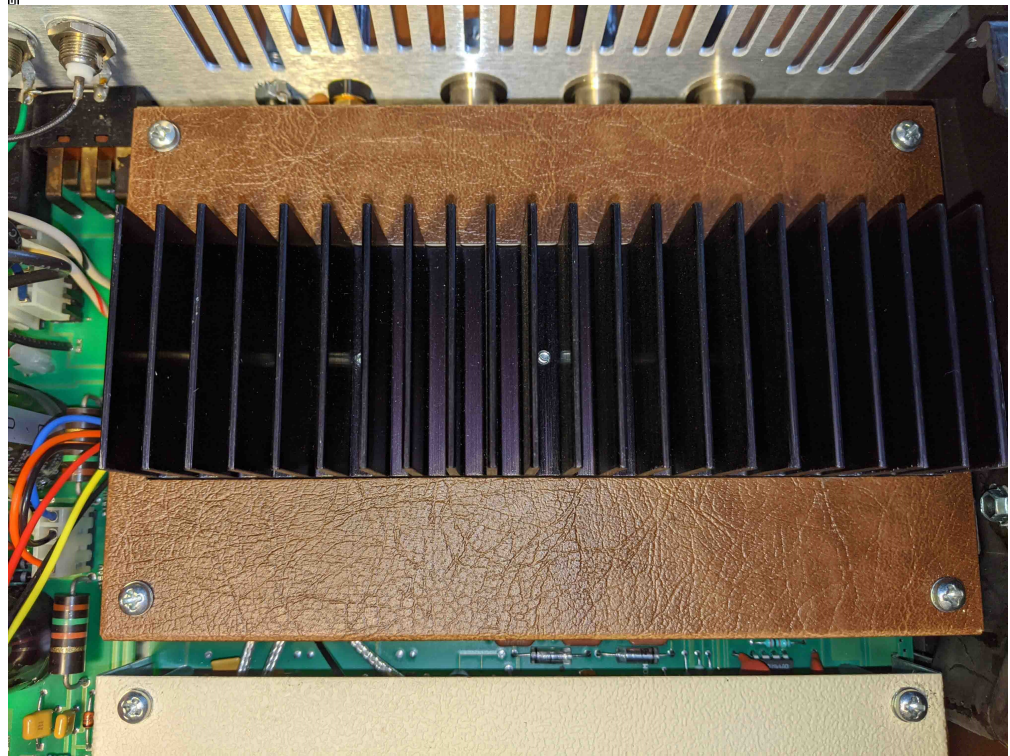
[attach=4]



IMG_20200823_113412.jpg (303.78 kB, 3024x4032 - viewed 113 times.)



IMG_20200823_114127.jpg (1870.44 kB, 4032x3024 - viewed 86 times.)



IMG_20200823_114143.jpg (1166.31 kB, 4032x3024 - viewed 113 times.)

axial fan candidates.xlsx (11.35 kB - downloaded 25 times.)

[Report to moderator](#) [Logged](#)

MASc, EIT, PhD Candidate

Qw3rtzuiop
Regular Contributor

Re: Should I return a Keithley 238?
« **Reply #18 on:** August 23, 2020, 05:18:11 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

My 236 had a Papst 8830N fan installed. But the fan isn't silent either but there was some corrosion at the fan. Maybe the bearings are already damaged.



Posts: 182
Country: 

Edit: Removed the image. I mixed up some files on my HDD. The image wasn't from me.

« Last Edit: August 29, 2020, 05:46:22 pm by Qw3rtzuioip »


Report to moderator  Logged

The following users thanked this post: leighcorrigan

 **leighcorrigan**

Frequent Contributor



Posts: 393
Country: 

Nuclear Materials Scientist



 **Re: Should I return a Keithley 238?**

« Reply #19 on: August 23, 2020, 05:23:53 pm »

Say Thanks Reply Quote

Anyone else know what is inscribed on this capacitor label? Without the Keithley 238 service manual, I don't have a way to verify the specifications are of this part. My best guess, based on the 236/237 service manual is that it is a ceramic 0.01 uF, 20 %, 50 V located at C35 connected to U12 (7130SA100P). I want to say that the part can be replaced by the SA105E103MAR byAVX Corporation.

I think it reads:

"ASE

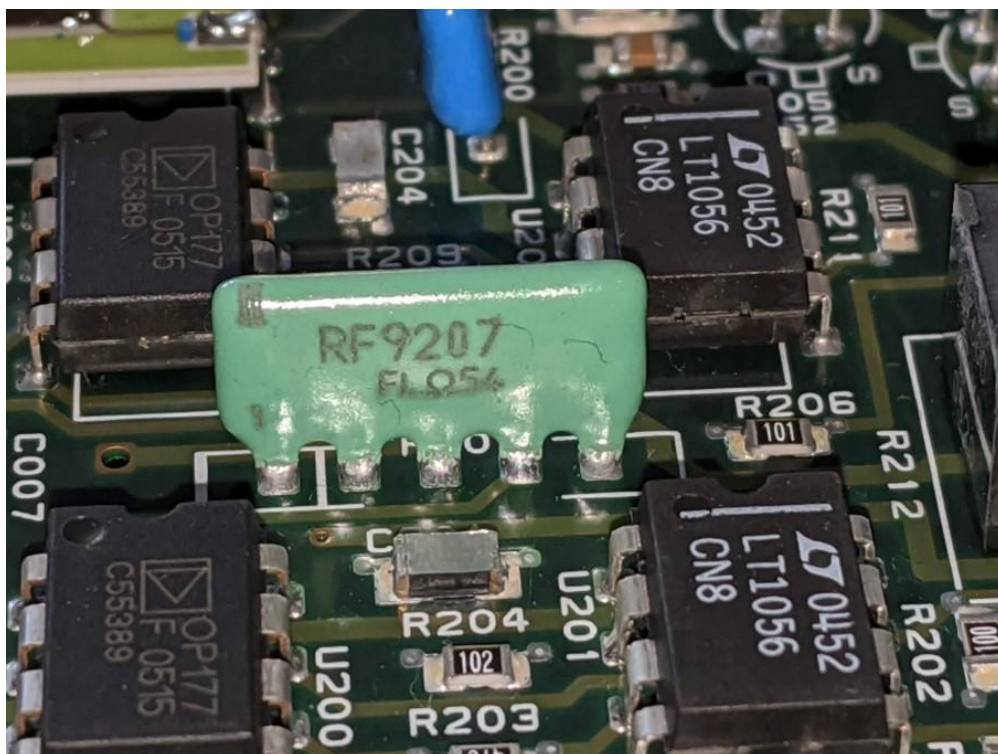
1.03

MLD

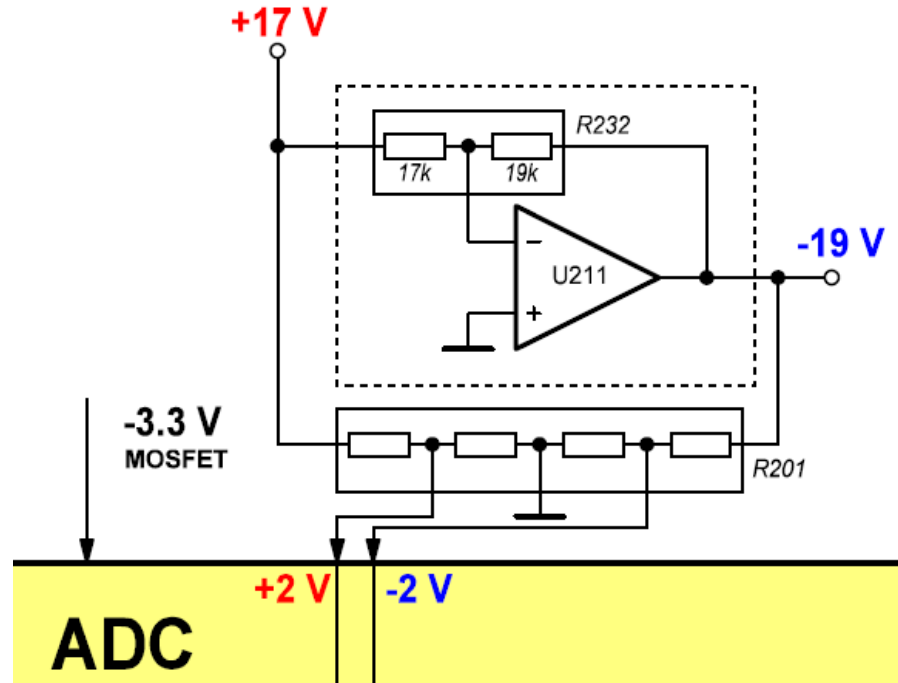
403"

Any help would be appreciated 😊

[attach=1][attach=2]



IMG_20200823_124218.jpg (355.78 kB, 3024x4032 - viewed 84 times.)



IMG_20200823_124240.jpg (314.78 kB, 3024x4032 - viewed 65 times.)

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393
Country:

Nuclear Materials Scientist

Re: Should I return a Keithley 238?

« Reply #20 on: August 23, 2020, 05:29:59 pm »

Say Thanks Reply Quote

Quote from: Qw3rtzuop on August 23, 2020, 05:18:11 pm

My 236 had a Papst 8830N fan installed.

The specifications for your fan are much lower than original components (0.9 m³/min [32 CFM]). You might want to upgrade to an even noisier version!

Before considering an upgrade, you could try and grease up the shaft or bearings. Sometimes it can give back a little life to it.

Report to moderator Logged

MASc, EIT, PhD Candidate

Qw3rtzuop

Regular Contributor



Posts: 182
Country:



Re: Should I return a Keithley 238?

« Reply #21 on: August 23, 2020, 05:54:14 pm »

Say Thanks Reply Quote

Quote from: leighcorrigan on August 23, 2020, 05:23:53 pm

I think it reads:
"ASE
1.03

103 is 10 nF (same as in the 236/237). I don't know why it should be a different value on the 238. It's just a decoupling cap. The exact value isn't mission critical.

Report to moderator Logged

The following users thanked this post: leighcorrigan

leighcorrigan

Frequent Contributor



Re: Should I return a Keithley 238?

« Reply #22 on: August 23, 2020, 07:09:11 pm »

Say Thanks Reply Quote

Quote from: Qw3rtzuop on August 23, 2020, 05:54:14 pm



Posts: 393
Country:
Nuclear Materials Scientist

103 is 10 nF (same as in the 236/237). I dont know why it should be a different value on the 238. Its just a decoupling cap. The exact value isnt mission critical.

Thank you Qw3rtzuiop for your input. My guess is that there is nothing different about the 236/237/238 digital board design, so I assumed that the capacitors are the same. I don't know much about capacitors or the functionality of the capacitor for this application. My educational background is in chemical/materials/nuclear engineering, so when it comes to electronics I only know the basics. 😞

[Report to moderator](#) Logged

MASc, EIT, PhD Candidate

Howardlong

Super Contributor



Posts: 5206
Country:



Re: Should I return a Keithley 238?

« **Reply #23** on: August 23, 2020, 07:34:29 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

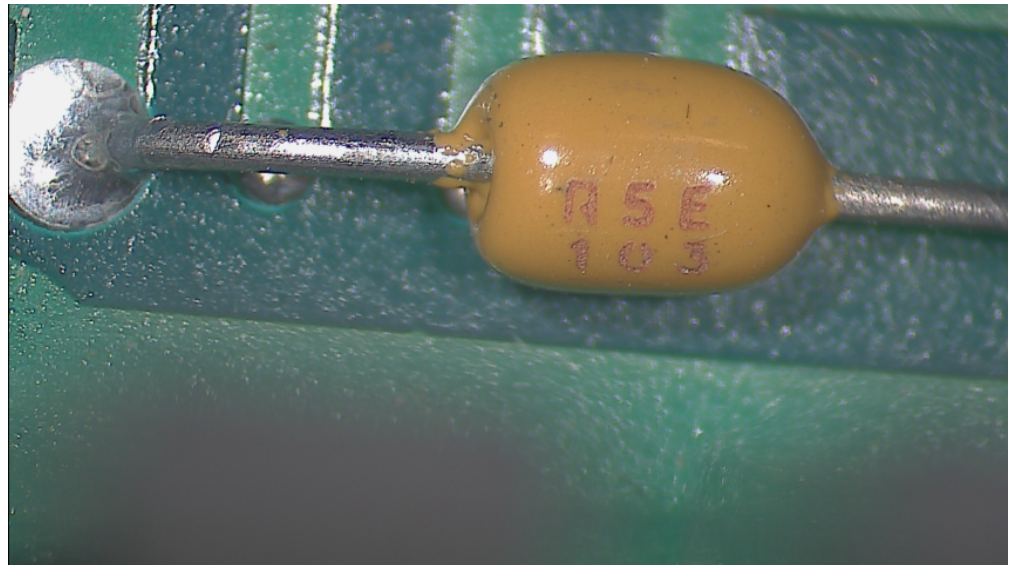
I had my 238 on the bench preparing to do a video, so I popped it open. It's a 10nF.

I don;t have the splattering over the transformer, I wonder if it's lamination lacquer, applied after installation? Perhaps the transformer had loose laminations.

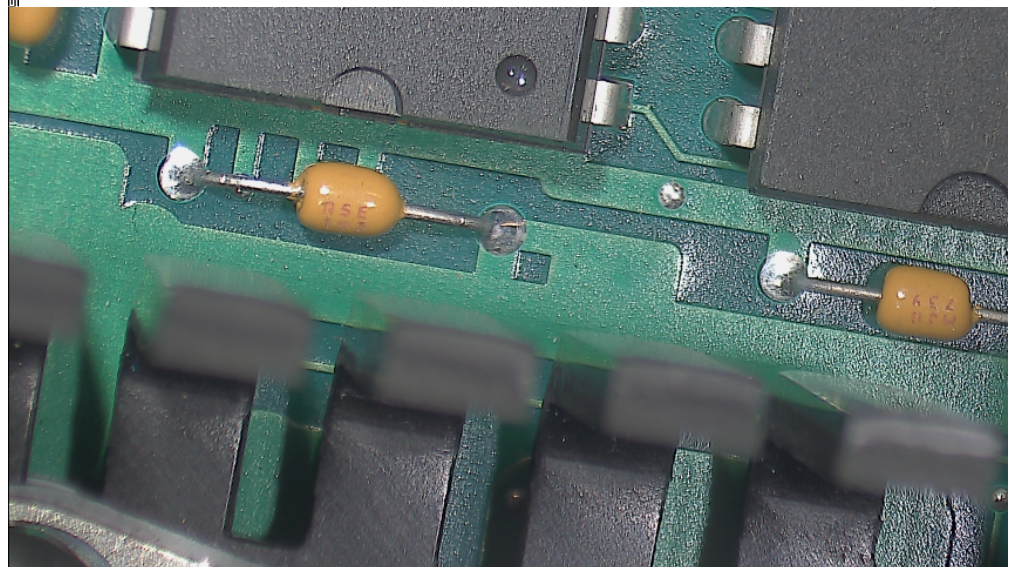
Edit: Fan in mine is NMB 3115PS-12W-B30.

[attachimg=1]

[attachimg=2]



2020-08-23_20-20-24 (Small).png (785.45 kB, 853x480 - viewed 78 times.)



2020-08-23_20-26-53 (Small).png (983.22 kB, 853x480 - viewed 80 times.)

« Last Edit: August 23, 2020, 07:37:17 pm by Howardlong »

[Report to moderator](#) Logged

The following users thanked this post: leighcorrigan

Howardlong

Super Contributor



Posts: 5206

Country:



Re: Should I return a Keithley 238?
« Reply #24 on: August 23, 2020, 07:43:11 pm »

Say Thanks

Reply

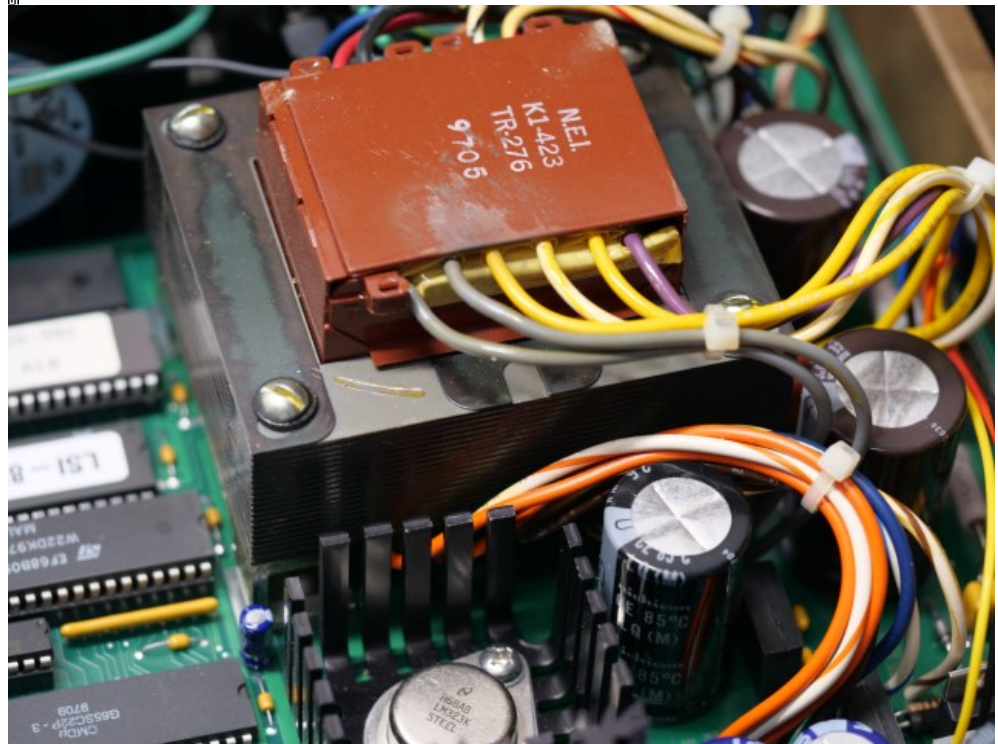
Quote

Fan & transformer pics inside my 238

[attachimg=1][attachimg=2]



P1001585 (Small).JPG (99.38 kB, 640x480 - viewed 87 times.)



P1001584 (Small).JPG (129.14 kB, 640x480 - viewed 93 times.)

Report to moderator Logged

The following users thanked this post: leighcorrigan

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



jogri

Frequent Contributor



Posts: 366

Country:



leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Howardlong

Super Contributor



Posts: 5206

Country:



Re: Should I return a Keithley 238?

« Reply #25 on: August 23, 2020, 07:52:20 pm »

Say Thanks

Reply

Quote

Quote from: Howardlong on August 23, 2020, 07:43:11 pm

Fan & transformer pics inside my 238

[attaching=1][attaching=2]

What firmware version is yours?

Report to moderator

Logged

MASc, EIT, PhD Candidate

Re: Should I return a Keithley 238?

« Reply #26 on: August 23, 2020, 07:57:27 pm »

Say Thanks

Reply

Quote

Btw, the japanese 100/200V model of the 236/237 uses a different transformer, so i wouldn't be surprised if they did the same thing for the 238 and your unit got its transformer swapped because someone bought the japanese version, (blew the transformer) and had to replace it.

Report to moderator

Logged

The following users thanked this post: leighcorrigan

Re: Should I return a Keithley 238?

« Reply #27 on: August 23, 2020, 08:07:26 pm »

Say Thanks

Reply

Quote

Quote from: Howardlong on August 23, 2020, 07:43:11 pm

Fan & transformer pics inside my 238

[attaching=1][attaching=2]

My transformer is a replacement, so it is manufactured differently. I think the resin is pretty common because I bought a stepup transformer for another project and it had something similar on it. Can't really comment much on the design reasoning. Makes it difficult to use a screw driver on it though.

Report to moderator

Logged

MASc, EIT, PhD Candidate

Re: Should I return a Keithley 238?

« Reply #28 on: August 23, 2020, 08:08:32 pm »

Say Thanks

Reply

Quote

Quote from: Howardlong on August 23, 2020, 07:34:29 pm

I had my 238 on the bench preparing to do a video, so I popped it open. It's a 10nF.

This is great! Thank you so much for the image.

Report to moderator

Logged

MASc, EIT, PhD Candidate

Re: Should I return a Keithley 238?

« Reply #29 on: August 23, 2020, 08:13:07 pm »

Say Thanks

Reply

Quote

Quote from: leighcorrigan on August 23, 2020, 08:08:32 pm

Quote from: Howardlong on August 23, 2020, 07:34:29 pm

I had my 238 on the bench preparing to do a video, so I popped it open. It's a 10nF.

This is great! Thank you so much for the image.

REV A10 apparently.

I recommend doing a factory reset when you first use it. I wasted a long time trying to get some GPIB software working on it, it turns out it had some obscure setting saved away somewhere.

[attachimg=1]



P1001589 (Small).JPG (86.88 kB, 640x480 - viewed 188 times.)

« Last Edit: August 23, 2020, 08:14:49 pm by Howardlong »

Report to moderator Logged

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #30 on: August 24, 2020, 01:51:30 am »

Say Thanks Reply Quote

Quote from: Howardlong on August 23, 2020, 07:34:29 pm

I don't have the splattering over the transformer, I wonder if it's lamination lacquer, applied after installation? Perhaps the transformer had loose laminations.

[attachimg=1]
[attachimg=2]

The lacquer is something I have seen before, but not to the extent seen on this Keithley. It is coming off the wire taps too. The last time I saw this stuff was when I purchased a step-up transformer for a temperature control unit. It can usually be found in and around the screws holding the iron core together, and down the sides. My guess is that it keeps things from shaking apart.

The original transformer has been replaced. I think the it might have experienced a short while it aged -- that's what the others have said. Not exactly ideal, but at least the rest of the equipment seems to be in working condition.

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Re: Should I return a Keithley 238?

« Reply #31 on: August 24, 2020, 01:54:10 am »

Say Thanks Reply Quote

Quote from: jogri on August 23, 2020, 07:57:27 pm



Posts: 393
Country: 🇨🇦
Nuclear Materials Scientist

leighcorrigan

Frequent Contributor



Posts: 393
Country: 🇨🇦
Nuclear Materials Scientist

Howardlong

Super Contributor



Posts: 5206
Country: 🇬🇧

Howardlong

Super Contributor



Posts: 5206
Country: 🇬🇧

leighcorrigan

Frequent Contributor



Posts: 393

Btw, the japanese 100/200V model of the 236/237 uses a different transformer, so i wouldn't be surprised if they did the same thing for the 238 and your unit got its transformer swapped because someone bought the japanese version, (blew the transformer) and had to replace it.

Good point. Sorry, I must have missed your message.

Report to moderator Logged

MASc, EIT, PhD Candidate

Re: Should I return a Keithley 238?

« Reply #32 on: August 24, 2020, 02:04:35 am »

Say Thanks Reply Quote

The 2- to 3-lug triax adapter arrives tomorrow, which means I can finally use my 6011 test leads to test the instrument. When I know the Keithely 238 works, I may consider the purchase of a 237-ALG-2 because I need a longer chord length if I am to attach the triax to rear. 🤔

With luck, I may have an instrument that can source 1 A to 100 fA within specifications. 🤖

I'll start with a Keithley 2000 DMM and work my way to a Keithley 6485 picoammeter if I feel that the Keithley 238 is safe to operate. 🤖

Report to moderator Logged

MASc, EIT, PhD Candidate

Re: Should I return a Keithley 238?

« Reply #33 on: August 24, 2020, 08:22:45 am »

Say Thanks Reply Quote

Quote from: leighcorrigan on August 24, 2020, 02:04:35 am

With luck, I may have an instrument that can source 1 A to 100 fA within specifications. 🤖

Down at the fA level, the source spec is +/- (0.3% +450fA), and the measure spec is +/- (0.3% + 100fA).

You probably know this already, but achieving measurements at this level needs a good deal of care, and frankly I've yet to figure out all the variables to achieve *repeatable* measurements below 10pA. A couple of weeks ago I bought a humidity meter for the bench to see if there was correlation, and the jury's still out.

Certainly you need to do any measurements with the DUT inside Faraday boxes.

Quote

I'll start with a Keithley 2000 DMM and work my way to a Keithley 6485 picoammeter if I feel that the Keithley 238 is safe to operate. 🤖

Report to moderator Logged

Re: Should I return a Keithley 238?

« Reply #34 on: August 24, 2020, 10:29:47 am »

Say Thanks Reply Quote

Keithley 238 service manual (originally in xdevs, seems to be down for me at the moment)
<https://1drv.ms/b/s!Ak3HU3AygNouh5A5-XqGaKqFAGOIQ?e=1MrPoG>

Report to moderator Logged

The following users thanked this post: leighcorrigan

Re: Should I return a Keithley 238?

« Reply #35 on: August 24, 2020, 12:50:42 pm »

Say Thanks Reply Quote

Quote from: Howardlong on August 24, 2020, 08:22:45 am

You probably know this already, but achieving measurements at this level needs a good deal of care, and frankly I've yet to figure out all the variables to achieve *repeatable* measurements below 10pA. A couple of weeks ago I bought a humidity meter for the bench to see if there was correlation, and the jury's still out.

Certainly you need to do any measurements with the DUT inside Faraday boxes.

Country: 

Nuclear Materials Scientist



That is really tough to hear. Maybe its about the settings and getting the environmental conditions right, but I find what you say hard to believe. Is there something wrong with your Keithley 238?

For example, my Keithley 6485 picoammeter has a standard deviation of 4.45 fA over 25 hours after a 5 hour warmup with a shield cap on the BNC input. The room I have it in is not temperature or humidity controlled. When I took these measurements, I wanted to determine the worst case scenario as it was raining out during recording. The settings are as follows:

AZERO = TRUE (This humidity and temperature compensation feature might give higher stability compared with your description of the Keithley 238)

NPLC = 30

Digital Filter: Advanced; Count = 5; Noise Tolerance = 5; Type: Repeating (There is clearly AC noise on the signal if I don't apply a filter. I need to consider the purchase of a battery or an isolation transformer to connect all my instruments)

By the way, I am able to achieve instantaneous measurements on startup from a software interface I wrote for the Keithley 6485 with LabView.

[attach=1]

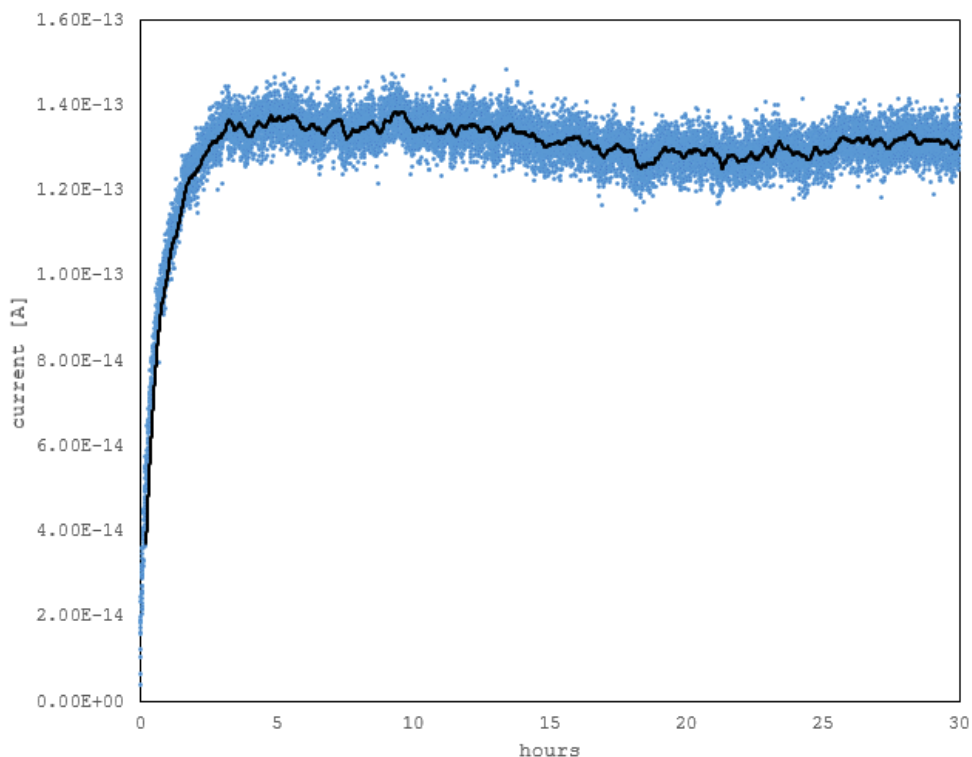
As another related example, I have a Keithley 261 current source that also uses a BNC output. I get very reasonable and repeatable responses with my Keithley when dialing current values all the way down to the 1 fA range. Mind you, neither of them have been calibrated since 2008 and the readings were taken from the display, not through DAQ.

[attach=2]

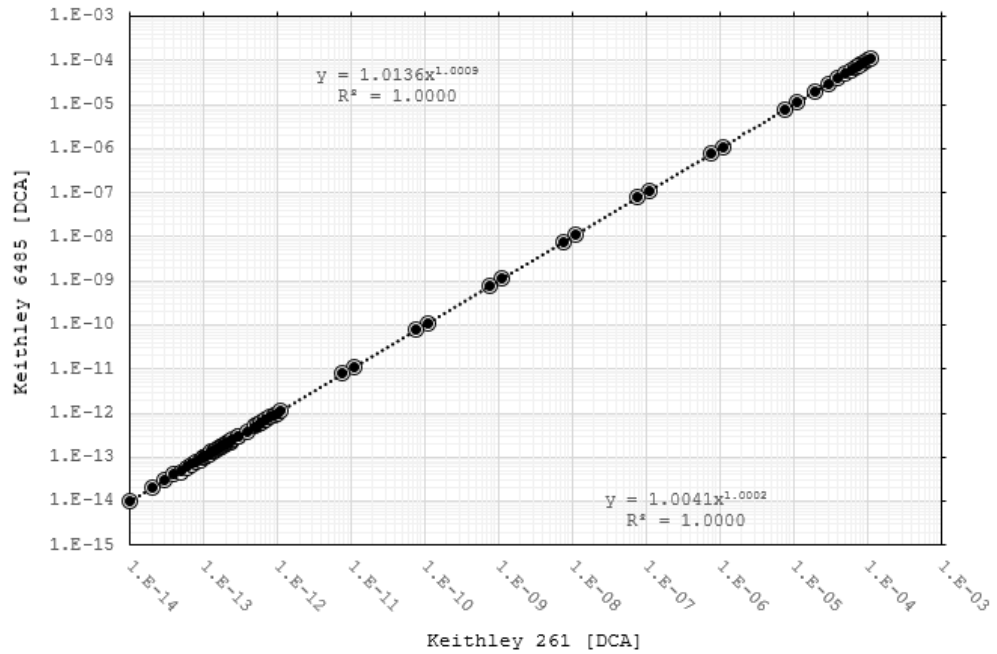
EDIT: I forgot to mention what the dots represent. The black dots are negative and the white dots are positive current values.

I hope you can resolve your issue. I will test my Keithley 238 whenever I get my adapter and get back to you about my findings.

Keithley 6485 Warmup Period and Stability



 Keithley 6485 - warmup and stability.PNG (40.58 kB, 646x535 - viewed 104 times.)



Keithley 6485 - characterization.PNG (39.21 kB, 664x447 - viewed 98 times.)

« Last Edit: August 24, 2020, 12:57:59 pm by leighcorrigan »

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #36 on: August 24, 2020, 12:53:58 pm »

Say Thanks

Reply

Quote

Quote from: Howardlong on August 24, 2020, 10:29:47 am

Keithley 238 service manual (originally in xdevs, seems to be down for me at the moment)
<https://1drv.ms/b/s!Ak3HU3AygNouh5A5-XqGaKqqFAGOIQ?e=1MrPoG>

This is, by far, a better resolution than the version I had. Thank you for this.

Anyone know where the schematics can be found?

Report to moderator Logged

MASc, EIT, PhD Candidate

Howardlong

Super Contributor



Posts: 5206

Country:



Re: Should I return a Keithley 238?

« Reply #37 on: August 24, 2020, 02:58:27 pm »

Say Thanks

Reply

Quote

Quote from: leighcorrigan on August 24, 2020, 12:53:58 pm

Quote from: Howardlong on August 24, 2020, 10:29:47 am

Keithley 238 service manual (originally in xdevs, seems to be down for me at the moment)
<https://1drv.ms/b/s!Ak3HU3AygNouh5A5-XqGaKqqFAGOIQ?e=1MrPoG>

This is, by far, a better resolution than the version I had. Thank you for this.

Anyone know where the schematics can be found?

Not for the 238, but the schematics for the 236 & 237 are included in this scan:

<https://1drv.ms/b/s!Ak3HU3AygNouh5A6AFBrz9ieVgXadw?e=Ti5yct>

docs.xdevs.com seems to be offline at the moment, I downloaded everything from there for the 236/7/8 a few months ago, but I never found the 238 schematics anywhere.

Report to moderator Logged

Howardlong

Super Contributor

Re: Should I return a Keithley 238?

« Reply #38 on: August 24, 2020, 03:03:56 pm »

Say Thanks

Reply

Quote



Posts: 5206

Country:



Quote from: leighcorrigall on August 24, 2020, 12:50:42 pm

Quote from: Howardlong on August 24, 2020, 08:22:45 am

You probably know this already, but achieving measurements at this level needs a good deal of care, and frankly I've yet to figure out all the variables to achieve *repeatable* measurements below 10pA. A couple of weeks ago I bought a humidity meter for the bench to see if there was correlation, and the jury's still out.

Certainly you need to do any measurements with the DUT inside Faraday boxes.

That is really tough to hear. Maybe its about the settings and getting the environmental conditions right, but I find what you say hard to believe. Is there something wrong with your Keithley 238?

For example, my Keithley 6485 picoammeter has a standard deviation of 4.45 fA over 25 hours after a 5 hour warmup with a shield cap on the BNC input. The room I have it in is not temperature or humidity controlled. When I took these measurements, I wanted to determine the worst case scenario as it was raining out during recording. The settings are as follows:

AZERO = TRUE (This humidity and temperature compensation feature might give higher stability compared with your description of the Keithley 238)

NPLC = 30

Digital Filter: Advanced; Count = 5; Noise Tolerance = 5; Type: Repeating (There is clearly AC noise on on the signal if I don't apply a filter. I need to consider the purchase of a battery or an isolation transformer to connect all my instruments)

By the way, I am able to achieve instantaneous measurements on startup from a software interface I wrote for the Keithley 6485 with LabView.

[attach=1]

As another related example, I have a Keithley 261 current source that also uses a BNC output. I get very reasonable and repeatable responses with my Keithley when dialing current values all they way down to the 1 fA range. Mind you, neither of them have been calibrated since 2008 and the readings were taken from the display, not through DAQ.

[attach=2]

EDIT: I forgot to mention what the dots represent. The black dots are negative and the white dots are positive current values.

I hope you can resolve your issue. I will test my Keithley 238 whenever I get my adapter and get back to you about my findings.

I would not be surprised if my issues are down to operator error.

Sometimes I can get the setup to settle at around 150fA. Other times it's into the single digit picoamps. I've yet to figure out why.

I have a 236 that also exhibits the same behaviour, so I was stating to think it was environmental. If not, it's still likely to be the operator!

Key is to use a Faraday enclosure, and to sync sampling wit the line freq for starters. I tried double shielding but that didn't seem to make much difference.

Report to moderator Logged

leighcorrigall

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #39 on: August 24, 2020, 03:34:39 pm »

Say Thanks Reply Quote

Quote from: Howardlong on August 24, 2020, 03:03:56 pm

I would not be surprised if my issues are down to operator error.

Sometimes I can get the setup to settle at around 150fA. Other times it's into the single digit picoamps. I've yet to figure out why.

I have a 236 that also exhibits the same behaviour, so I was stating to think it was environmental. If not, it's still likely to be the operator!

Key is to use a Faraday enclosure, and to sync sampling wit the line freq for starters. I tried double shielding but that didn't seem to make much difference.

Interesting that it happens to multiple instruments. Is the noise present when you connect an end cap to your triax connectors?

LowLevMsHandbk.pdf (1776.81 kB - downloaded 126 times.)

Report to moderator Logged

MASc, EIT, PhD Candidate

Howardlong

Re: Should I return a Keithley 238?

Super Contributor



Posts: 5206

Country:



« Reply #40 on: August 24, 2020, 07:59:33 pm »

Say Thanks

Reply

Quote

Quote from: leighcorrigan on August 24, 2020, 03:34:39 pm**Quote from: Howardlong on August 24, 2020, 03:03:56 pm**

I would not be surprised if my issues are down to operator error.

Sometimes I can get the setup to settle at around 150fA. Other times it's into the single digit picoamps. I've yet to figure out why.

I have a 236 that also exhibits the same behaviour, so I was stating to think it was environmental. If not, it's still likely to be the operator!

Key is to use a Faraday enclosure, and to sync sampling with the line freq for starters. I tried double shielding but that didn't seem to make much difference.

Interesting that it happens to multiple instruments. Is the noise present when you connect an end cap to your triax connectors?

No, there's an offset of about 140fA on the 238, and once it's been on for a short while, it's +/- 10fA on the display, i.e., the ADC's lsb. This without end caps, just no cables connected, I don't have any end caps. The 236 is in situ right now, and would take a while to extract and remove the cables.

To be fair I made the cables myself from Trompeter PL75-7 triaxial plugs and Belden 9222 triaxial cable, and they just have croc clip terminations, there's no bulkhead into the Faraday box... the Faraday box being a couple of aluminium roasting tins, one on top of the other. Good enough for absolute nA resolution, in fact good enough for 10pA absolute resolution & 100fA relative resolution, if you don't sneeze!

For my use cases it's not really a problem, my measurement requirements are typically ≥ 1 nA resolution, I use it as a precision power supply & for measuring current for button cell powered devices in development.

Thanks for the link, I'd forgotten about that, probably worth a re-read.

Report to moderator Logged

 leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist

**Re: Should I return a Keithley 238?**

« Reply #41 on: August 24, 2020, 09:10:24 pm »

Say Thanks

Reply

Quote

Quote from: Howardlong on August 24, 2020, 03:03:56 pm

I would not be surprised if my issues are down to operator error.

Sometimes I can get the setup to settle at around 150fA. Other times it's into the single digit picoamps. I've yet to figure out why.

I have a 236 that also exhibits the same behaviour, so I was stating to think it was environmental. If not, it's still likely to be the operator!

Key is to use a Faraday enclosure, and to sync sampling with the line freq for starters. I tried double shielding but that didn't seem to make much difference.

Hello Hardward Long,

Here are two lazy examples I made using the Keithley 238 as a source:

Trial 01:

[attach=1]

[attach=2]

Notes:

-no shielding

-connections: Keithley 238, 6171, 6011, alligator to BNC, 6485

-no warmup wait

-0.0001 nA was used as a relative measurement because the Keithley 238 delivers 100 uA on standby



Trial 02:

[attach=3]

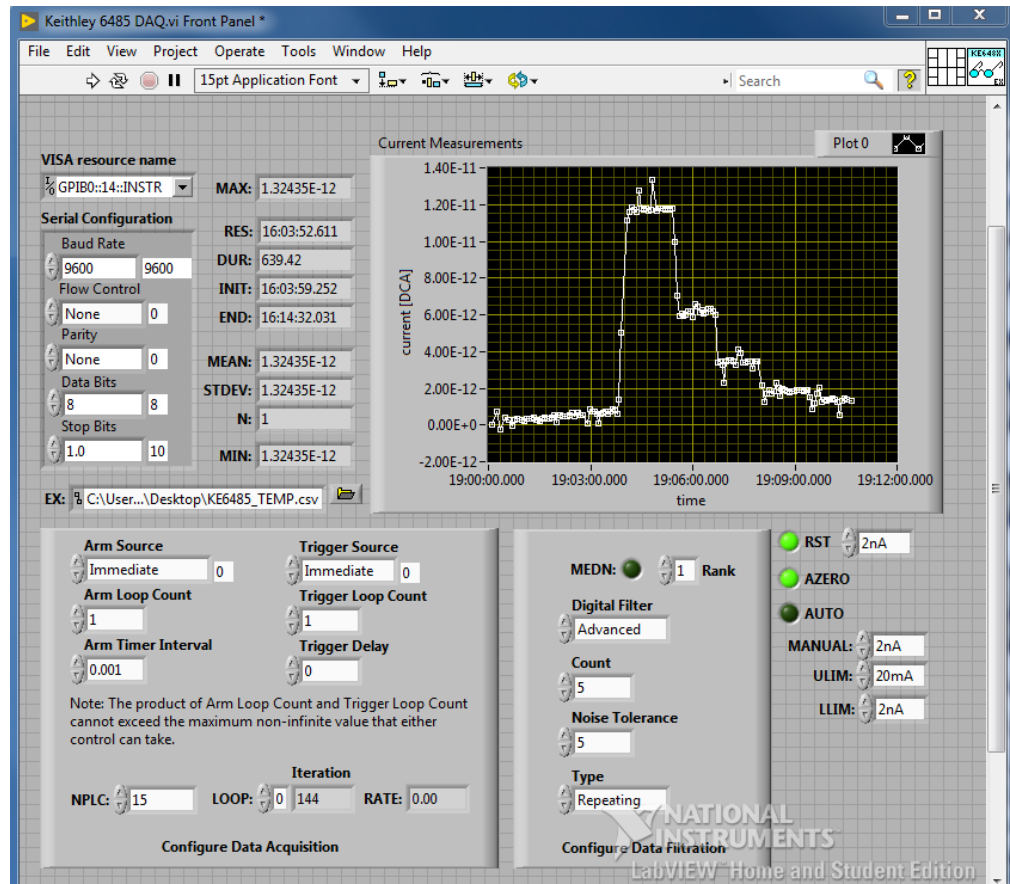
[attach=4]

- ground shielding (triax ground)
- connections: same as Trial 01 with the exception of the ground
- after Trial 01, no warmup wait
- 0.0001 nA was used as a relative measurement
- source followed similar pathway as Trial 01

I have confidence that the instrument is working well and can now order replacement parts.



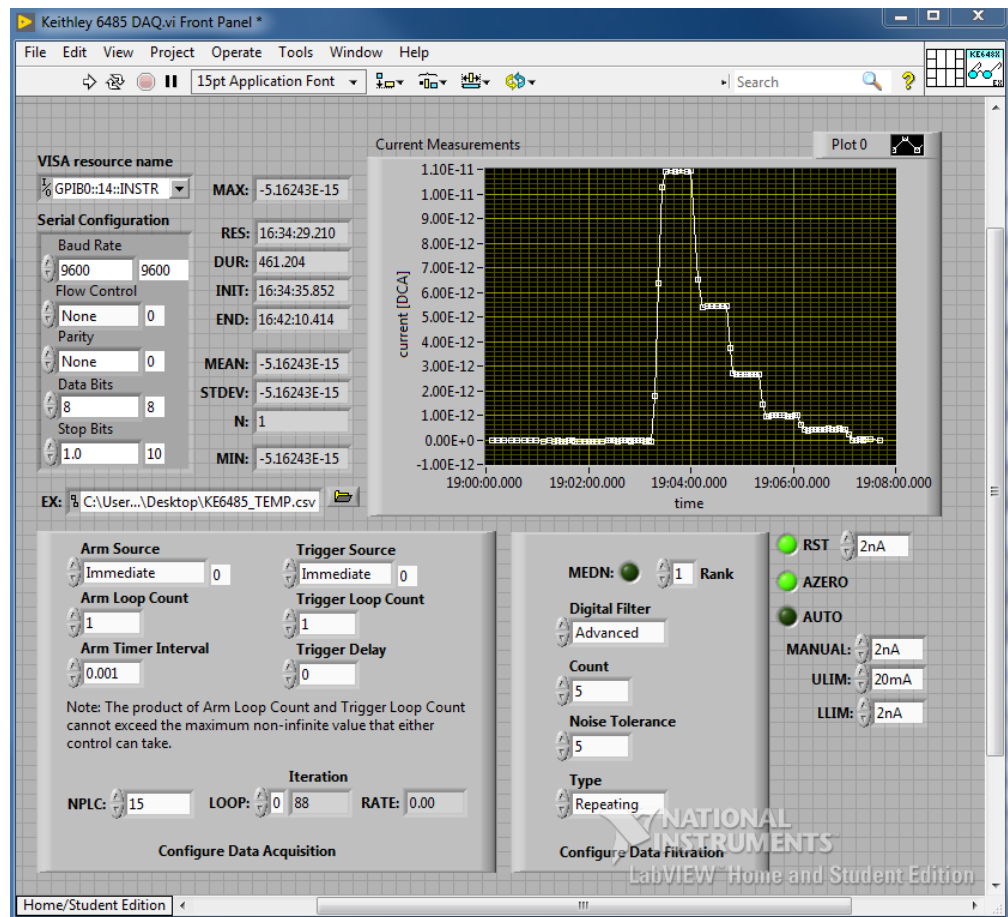
IMG_20200824_162622.jpg (261.49 kB, 3024x4032 - viewed 133 times.)



Keithley 6485 - no shielding, alligator clips, picoamp range.PNG (119.59 kB, 837x735 - viewed 83 times.)



IMG_20200824_163322.jpg (189.98 kB, 3024x4032 - viewed 83 times.)



Keithley 6485 - aluminum shield, alligator clips, picoamp range.PNG (125.36 kB, 835x762 - viewed 79 times.)

[Report to moderator](#) Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« **Reply #42 on:** August 26, 2020, 11:15:50 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Today, FedEx delivered a DigiKey order of all the replacement parts for the Keithley 238. I hope this information can be useful to others that need to replace the following:

cylindrical bumper (feet) assembly:
 4 x feet: Keystone Electronics, 728
 4 x crews: RAF Electronic Hardware, 0833-S-12
 [attach=1]
 [attach=2]

backside panel screws:
 4 x screws: Pomona Electronics, 4862
 [attach=3]
 [attach=4]

fan assembly and receptacle:
 1 x axial fan: 8500N (be aware that the grounding hole is unthreaded and this fan is expensive)
 1 x kit: Molex, 0766500095 (separate parts: 1 x 08-50-0106, 2 x 09-50-3031)
 [attach=5]
 [attach=6]
 [attach=7]
 [attach=8]

capacitor:
 1 x SA105C103MAR (replacement for C35 location: 10000 pF, $\pm 20\%$, 50 V, Ceramic)
 [attach=9]

The instrument has been powered on for 3 hours since the repair. Hopefully, I can perform a few studies to determine the stability, accuracy and precision of the instrument before bed time.



foot assembly.jpg (248.34 kB, 3024x4032 - viewed 63 times.)



foot assembly 2.jpg (301.06 kB, 4032x3024 - viewed 47 times.)



back panel screw fastening.jpg (190.48 kB, 3024x4032 - viewed 73 times.)



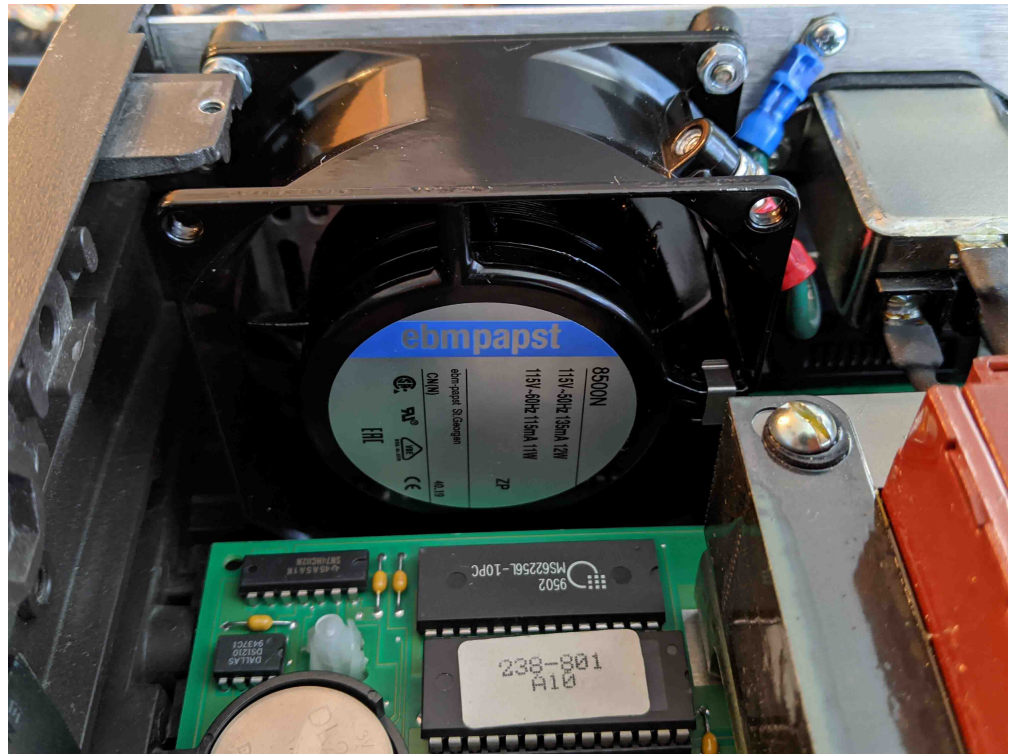
back panel screw fastened.jpg (105.05 kB, 2898x2174 - viewed 56 times.)



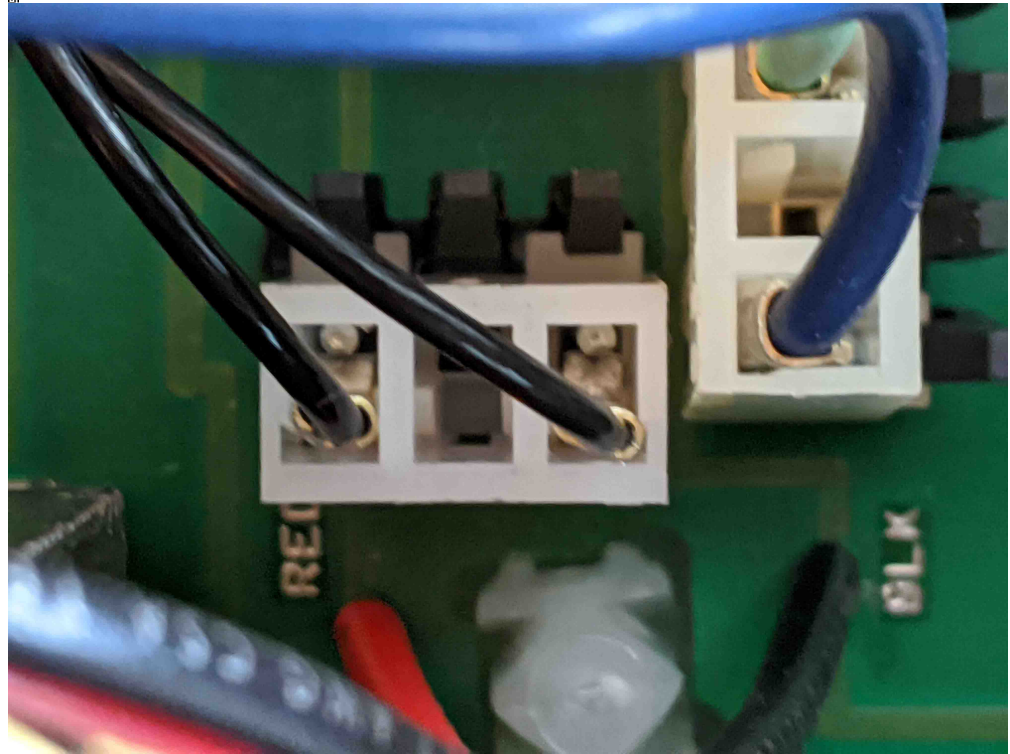
fan comparison.jpg (220.44 kB, 4032x3024 - viewed 71 times.)



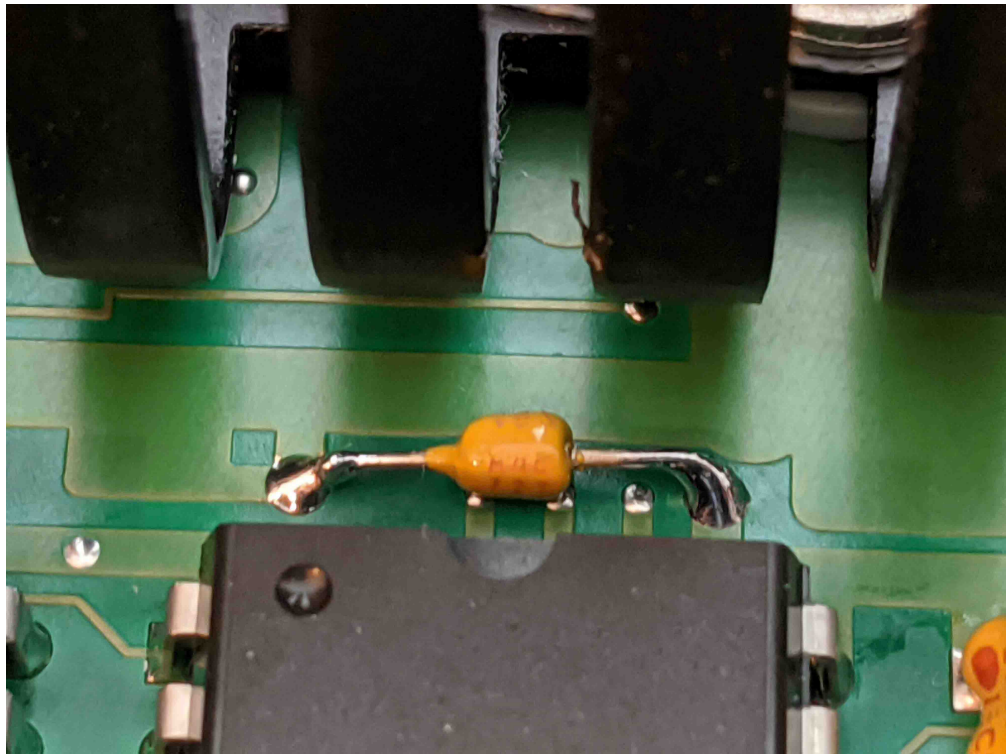
fan unthreaded grounding hole.jpg (139.15 kB, 3024x4032 - viewed 58 times.)



isometric view of the fan assembly.jpg (234.84 kB, 4032x3024 - viewed 74 times.)



fan receptacle.jpg (172.07 kB, 4032x3024 - viewed 68 times.)



C35 replacement capacitor.jpg (169.12 kB, 4032x3024 - viewed 86 times.)

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MASc, EIT, PhD Candidate

The following users thanked this post: MiDi

Howardlong

Super Contributor



Posts: 5206

Country:



Re: Should I return a Keithley 238?

« Reply #43 on: August 27, 2020, 11:04:02 am »

Say Thanks

Reply

Quote

I'll be interested to learn your settled current measurement offsets and noise sans DUT, with and without any cable assemblies.

Report to moderator Logged

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #44 on: August 27, 2020, 02:31:01 pm »

Say Thanks

Reply

Quote

Quote from: Howardlong on August 27, 2020, 11:04:02 am

I'll be interested to learn your settled current measurement offsets and noise sans DUT, with and without any cable assemblies.

Since last night, I have been trying to get a stable reading. I have a constant leakage of -5E-13 DCA and it might be the cable used for the electrometer. I have had better measurement success in the past, but for whatever reason I have not been able to reproduce the study. Here are the past examples:

[attach=1]

Taken from the first example: 2.0E-13 DCA +/- 1.4E-14

[attach=2]

Looks like I need to get a proper low noise cable for the sub-nanoamperage range...

KE238 - picoamperage range.pdf (123.09 kB - downloaded 38 times.)

KE238 - 200 fA.pdf (46.5 kB - downloaded 33 times.)

Report to moderator Logged

MASc, EIT, PhD Candidate

garrettm

Frequent Contributor



Posts: 252

Country:



Re: Should I return a Keithley 238?
 « Reply #45 on: August 28, 2020, 01:51:45 am »

Say Thanks

Reply

Quote

Quote from: Howardlong on August 24, 2020, 07:59:33 pm

No, there's an offset of about 140fA on the 238, and once it's been on for a short while, it's +/- 10fA on the display, i.e., the ADC's lsb. This without end caps, just no cables connected, I don't have any end caps. The 236 is in situ right now, and would take a while to extract and remove the cables.

To be fair I made the cables myself from Trompeter PL75-7 triaxial plugs and Belden 9222 triaxial cable, and they just have croc clip terminations, there's no bulkhead into the Faraday box... the faraday box being a couple of aluminium roasting tins, one on top of the other. Good enough for absolute nA resolution, in fact good enough for 10pA absolute resolution & 100fA relative resolution, if you don't sneeze!

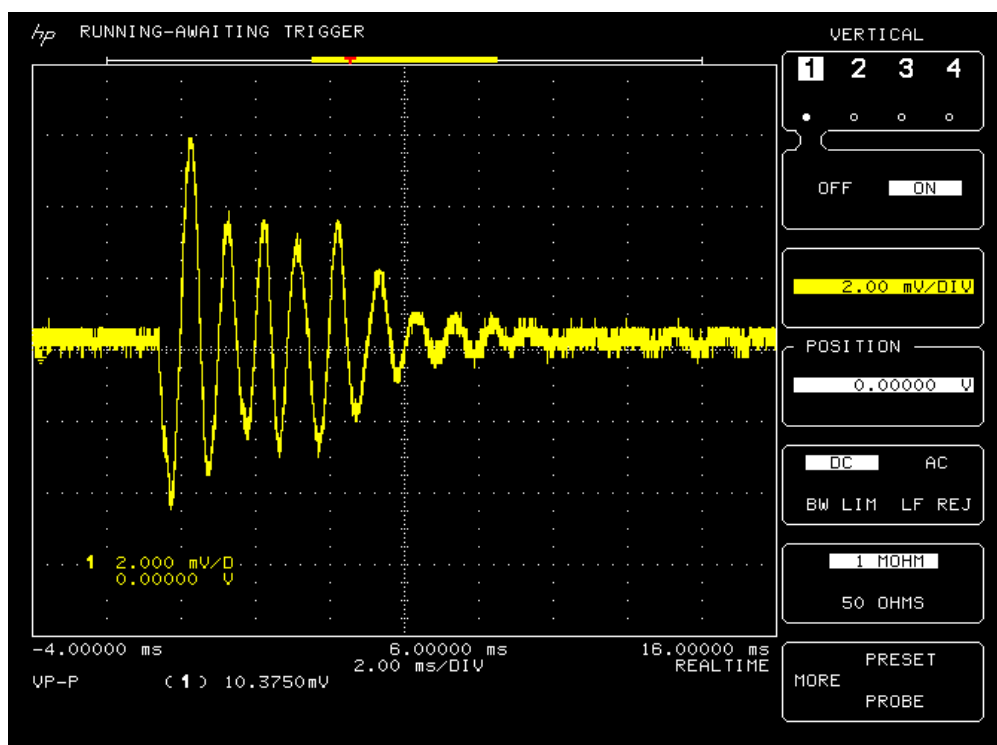
For my use cases it's not really a problem, my measurement requirements are typically $>=1$ nA resolution, I use it as a precision power supply & for measuring current for button cell powered devices in development.

Thanks for the link, I'd forgotten about that, probably worth a re-read.

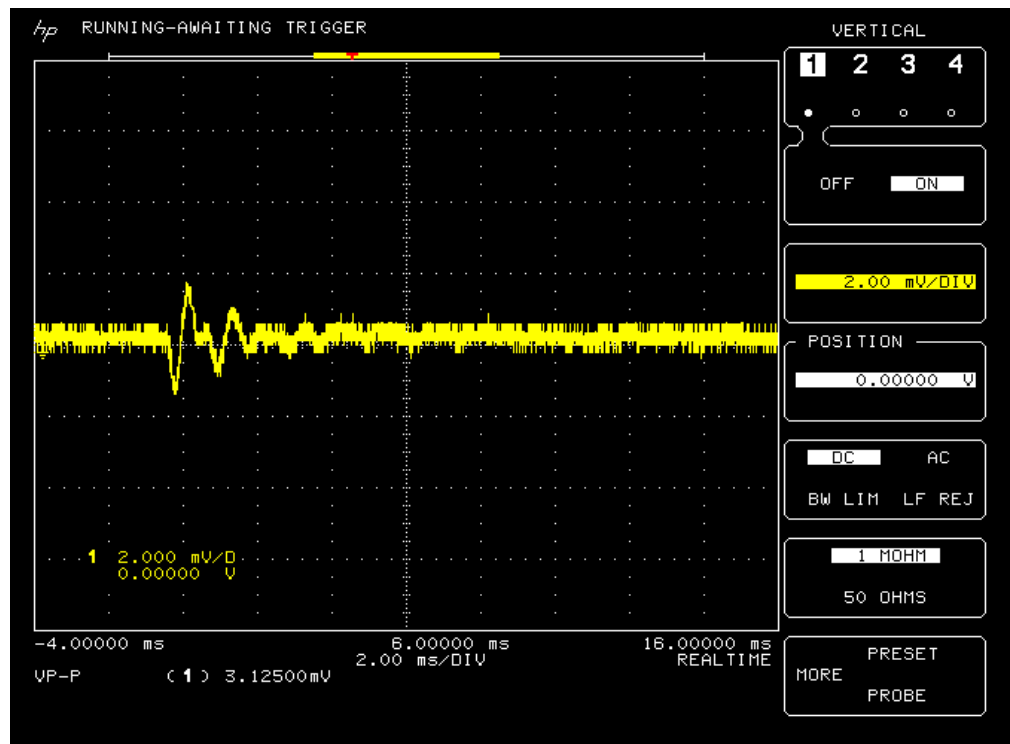
As far as I am aware, Keithley uses Trompeter triax connectors on their newer cables--previously they used Specialty Connector Co. So your connectors should be fine. The Belden 9222 cable--from what I have heard--isn't low triboelectric, so the setup could be sensitive to vibration. At fempto ampere levels, vibration from the fan could become a significant noise source with bad cable. I once tested some milspec triax and found it to be the most triboelectric cable I've ever seen, even worse than all my standard 50ohm coax. To test your wiring, connect a cable to your oscilloscope using a triax to BNC adapter, then hit the cable in the middle with a rod or flick it with your finger. Depending on the amplitude of the pulse on the scope, you maybe have marginal to just plain bad cable. You need to set the trigger near zero, the vertical to about 1-10mV and horizontal to maybe 5-2mS to capture a signal. You might have to fiddle with the scope before you capture a pulse. Good triax will not trigger the scope, at least my Keithley cable using the inner shield and center conductor was not able to trigger the scope even with a hearty flick.

Consistently sourcing 10 pA should be achievable after warm up. Are you using proper guarding? To maintain low leakage you have to guard the output HI all the way to the DUT. If the DUT sits on top of something, then that plane needs to be connected to guard. Then the entire assembly needs to be shielded at earth potential. Double shielding isn't very helpful for controlling leakage. The output LO / return does not require guarding or shielding, but it doesn't hurt to shield it.

I was lucky enough to get an HP test fixture used for their semiconductor parametric analyzers and with proper Keithley triax I was able to stably measure ~ 100 fA steps with my 617 electrometer while sourcing current from my 237. Any offset current at the 23x, if stable, can be nulled out by adjusting the output to be negative or positive a few counts while measuring with a picoammeter. Once that is done you should get repeatable results.

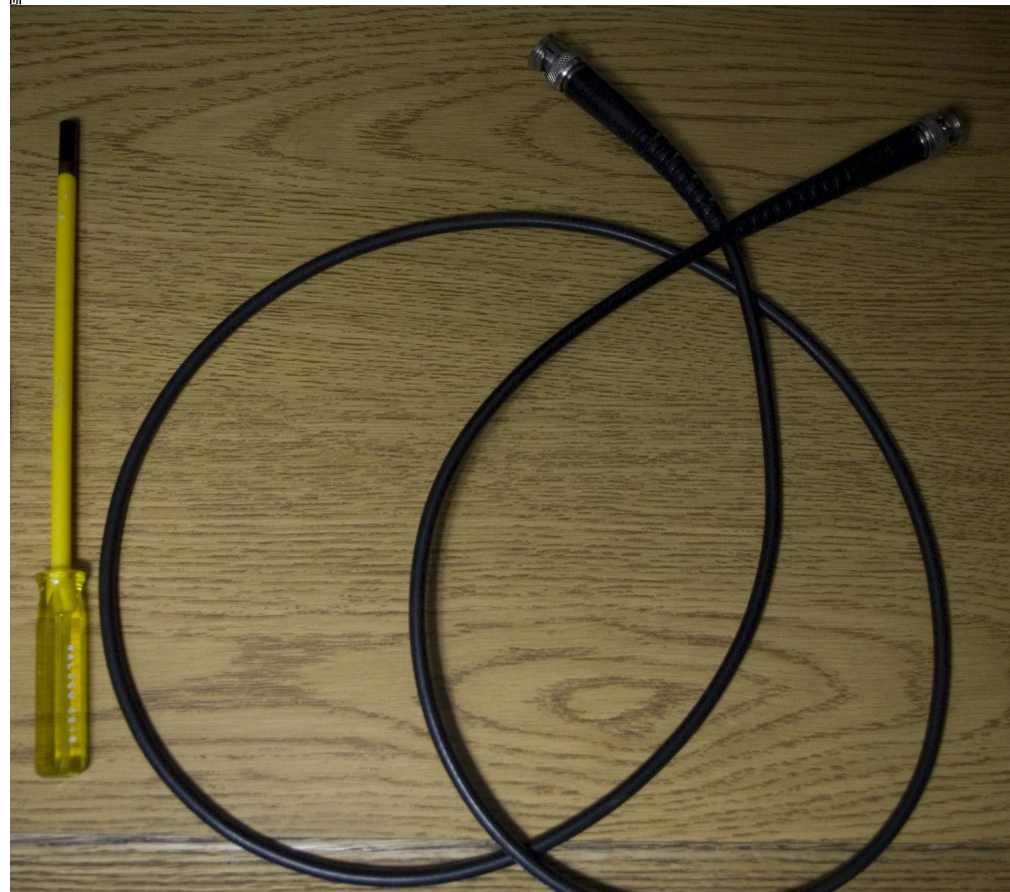


Pomona_4964_SS_hard_tap.png (6.6 kB, 672x496 - viewed 54 times.)



Pomona_4964_SS_light_tap.png (5.92 kB, 672x496 - viewed 50 times.)

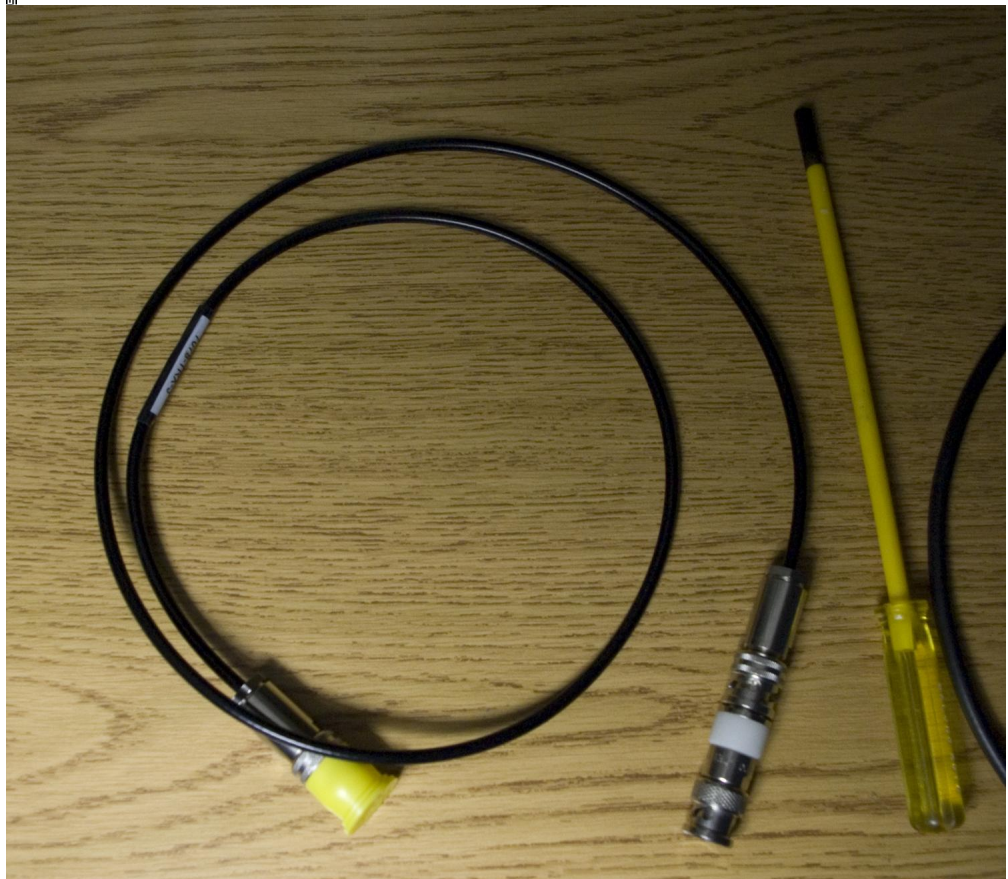
Pomona_4964_datasheet.pdf (33.51 kB - downloaded 28 times.)



IMG1289.jpg (1404.75 kB, 1500x1331 - viewed 57 times.)



IMGP1290.jpg (877.84 kB, 1500x1124 - viewed 55 times.)



IMGP1287.jpg (1423.26 kB, 1500x1315 - viewed 56 times.)



IMG1288.jpg (1081.17 kB, 1232x1500 - viewed 61 times.)

Report to moderator Logged

The following users thanked this post: Howardlong, leighcorrigan

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #46 on: August 28, 2020, 04:18:16 am »

Say Thanks

Reply

Quote

Quote from: leighcorrigan on August 27, 2020, 02:31:01 pm

Since last night, I have been trying to get a stable reading. I have a constant leakage of $-5E-13$ DCA and it might to be the cable used for the electrometer. I have had better measurement success in the past, but for whatever reason I have not been able to reproduce the study.

Good news. I figured out the problems that was causing measurement problems. I am now able to repeat the previous study exactly with the same standard deviation ($< 1.4E-14$) and precision as before. The trick is proper grounding and to shield with as little contact as possible. My setup is not fancy at all. Tin foil, banana clips, and a Keithley 6011 with a 6171 adapter.

[attach=1]

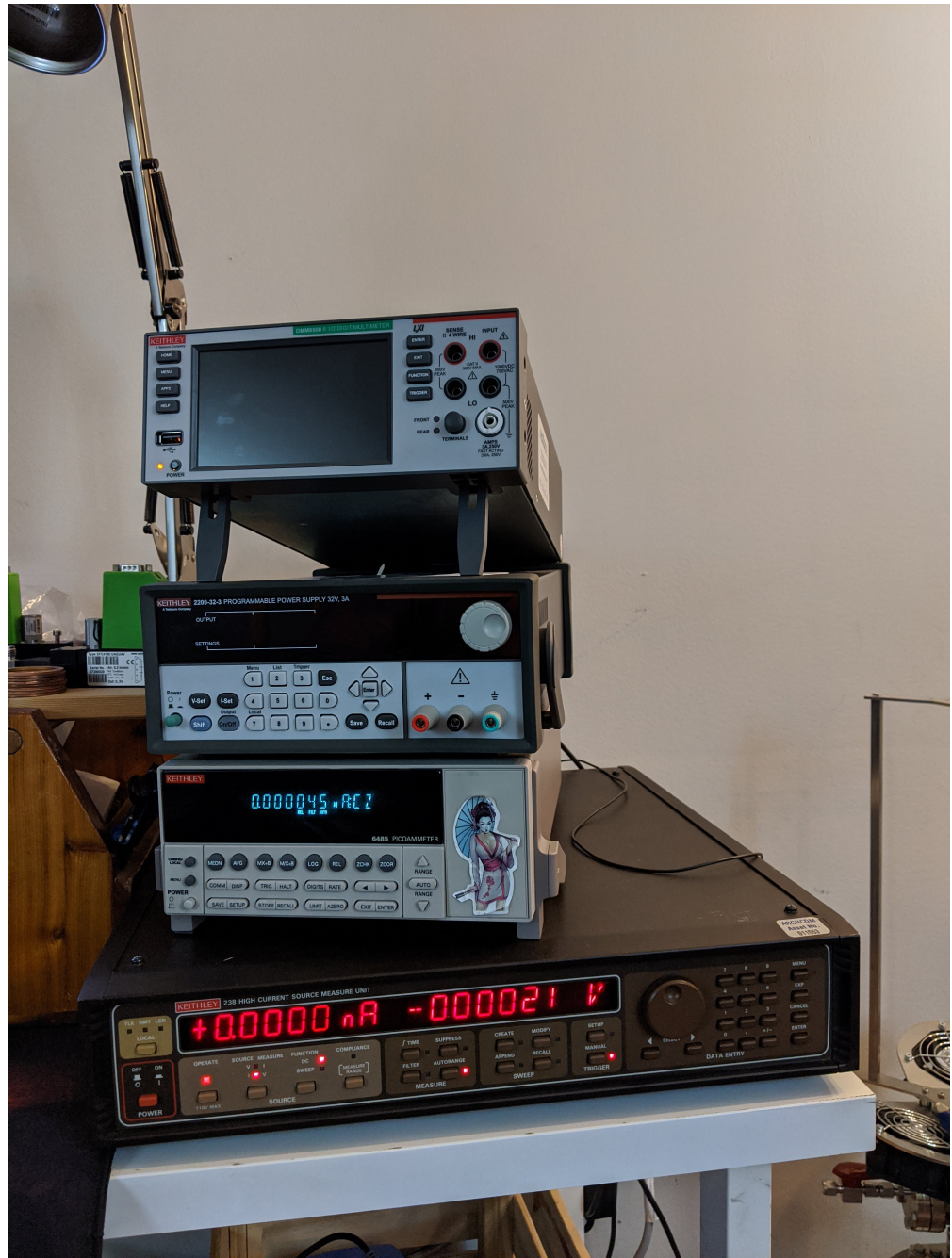
[attach=2]

[attach=3]

KE6485_TEST7.pdf (151.51 kB - downloaded 20 times.)



IMG_20200828_001225.jpg (1424.36 kB, 3024x4032 - viewed 77 times.)



IMG_20200828_001508.jpg (2061.3 kB, 3024x4032 - viewed 77 times.)

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MAsc, EIT, PhD Candidate

garrettm
Frequent Contributor

Re: Should I return a Keithley 238?
« Reply #47 on: August 28, 2020, 05:22:42 am »

[Say Thanks](#) [Reply](#) [Quote](#)

I forgot to ask how the new fan has been? Just comparing dB vs CFM from the datasheet doesn't tell the whole story.

[Report to moderator](#) Logged



Posts: 252
Country:



leighcorrigan
Frequent Contributor

Re: Should I return a Keithley 238?
« Reply #48 on: August 28, 2020, 01:27:49 pm »

[Say Thanks](#) [Reply](#) [Quote](#)



Posts: 393

Country:

Nuclear Materials Scientist



Quote from: garrettm on August 28, 2020, 05:22:42 am

I forgot to ask how the new fan has been? Just comparing dB vs CFM from the datasheet doesn't tell the whole story.

Thanks for asking. Honestly, the fan is the worst part of this instrument. It is tough to admit, because the instrument is amazing despite its shortcomings. It is definitely an American design: loud, overweight, and a showoff. Yet, we love them anyways. 🤔

Although the fan runs smoothly, the noise level is about the same as the stock fan. Airflow on the other hand is incredible. I can feel the air passing through the exhaust vents above the outputs. Having consistent and high volumetric flow should help with stable readings by regulating the internal temperature with the environment. Yet, if I didn't know how well this instrument can source current in its present state, I would assume that the vibrations from the fan would cause huge disturbances in the measurements -- not sure how Keithley managed to accomplish this feat. My Keithley 6500 and 2200-32-3 by comparison both have powerful fans which I barely notice. I used to think my Keithley 224 was noisy, but now all I hear is the white noise coming from the Keithley 238. 🤔

When I have the time, or run out of patience, I might consider dampening the noise with fire-resistant padding. The major problem is the paneling acts as a diaphragm. Maybe I can add some wood paneling and an orange carpet to stay true to the retro appearance.

Report to moderator Logged

MASc, EIT, PhD Candidate

The following users thanked this post: garrettm

 leighcorrigall

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #49 on: August 28, 2020, 06:18:41 pm »

Say Thanks

Reply

Quote

Attached is a log plot of the Keithley 238 sourcing 0.1 pA (100 fA) to 0.1 mA to a Keithley 6485 calibrated in 2009. No baseline corrections were made only a zero check and correction on the Keithley 6485 hours before measurements were taken.

[attach=1][attach=2]

> At the 0.1 pA range, I think that I am running into noise issue due to the lousy electrical setup. This is why the signal appears coarse at 0.1 pA and stabilizes around 1 pA. Can anyone else confirm? Keep in mind that the 0.0000 nA setpoint appears extremely noisy because of the log plot.

> The end of the graph shows a significant settling time from 1E-4 to 0.0000 nA. This observation is difficult to decouple because both the source and meter could be impacting settling time. My guess is that it has more to do with my picoammeter than it does with the SMU.

> The picoammeter I am using is capable of measuring down to 1 fA which was tested with a trustworthy Keithley 261 picoampere source calibrated in 2007.

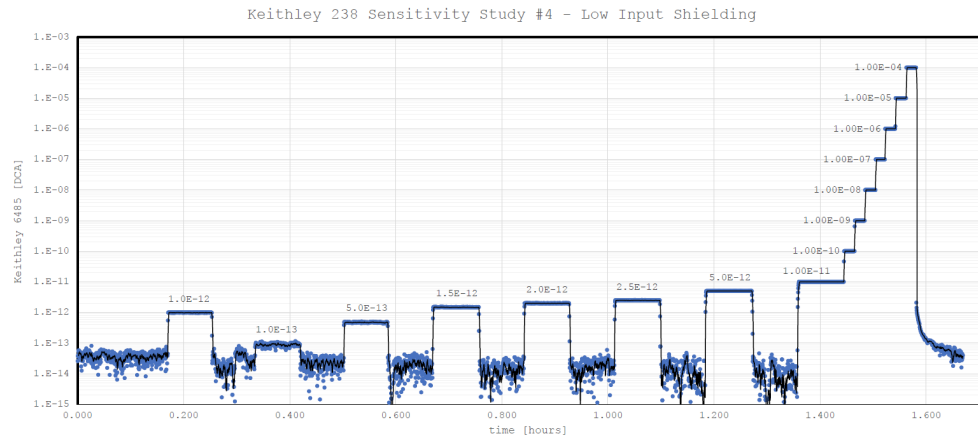
> I am certain that the instrument can source up to 1 A, but I would rather not push my Keithley 6485 to its 20 mA limit. Instead, I might switch to the Keithley 6500 as it can easily handle 3 A and was calibrated 10 days ago.

> This is the cost breakdown of the Keithley 238:

- 907.32 CAD (original eBay price, including shipping and taxes)
 - 121.80 CAD (replacement parts; mainly the fancy fan that cost about 63 % of the total cost)
 + 183.14 CAD (negotiated refund, including taxes)
 =====
 = 968.66 CAD [735.82 USD] I think I did pretty well for myself.

Once again, I would like to take this time to thank everyone involved with this process! It has been a pleasure and I am so glad to be part of a community that is supportive and knowledgeable.

📄 KE6485_TEST8.pdf (273.9 kB - downloaded 15 times.)



📄 TEST8.PNG (99.31 kB, 1571x729 - viewed 52 times.)

« Last Edit: August 29, 2020, 04:26:47 pm by leighcorriganl »

Report to moderator Logged

MASc, EIT, PhD Candidate

Howardlong

Super Contributor



Posts: 5206

Country:



Re: Should I return a Keithley 238?

« Reply #50 on: August 28, 2020, 09:02:04 pm »

Say Thanks Reply Quote

I tried measuring my 238 current with a 236. It didn't go too well once you're down to the sub 100pA, there's an offset and about a 7% inaccuracy (reads low) starts creeping in. FWIW, a similar thing happens if I measure the 236 current with the 238.

It turns out that's not at the source, it's in the measurement side: I have a calibrated Keysight 34465A DMM here that has resolution down to 1pA, and as a source the 238 seems pretty reasonable, although that too is a crap shoot below 10pA and I'm doing it by eye. There isn't an obvious offset though when measuring with the Keysight.

The noise isn't too bad when measuring with the 236, it's just the offset that creeps in, which can be nulled out, but the inaccuracy can't.

Have you tried doing any low current measurements with your 238?

Report to moderator Logged

leighcorriganl

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #51 on: August 29, 2020, 04:26:06 pm »

Say Thanks Reply Quote

Quote from: Howardlong on August 28, 2020, 09:02:04 pm

Have you tried doing any low current measurements with your 238?

No, I have not. Looking over the specifications, it is difficult to tell what the maximum applied current is. Does the Keithley 238 have a maximum rating of 1 A with 100 uA resolution? If so, this is an incredible instrument! Can you point me to instructions on how to use the instrument as an ammeter? I will use my Keithley 261 picoampere source to measure from 10 fA to 0.1 mA. I suppose this instrument also measures voltage simultaneously, correct?

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorriganl

Frequent Contributor



Posts: 393

Country:

Re: Should I return a Keithley 238?

« Reply #52 on: August 29, 2020, 07:34:13 pm »

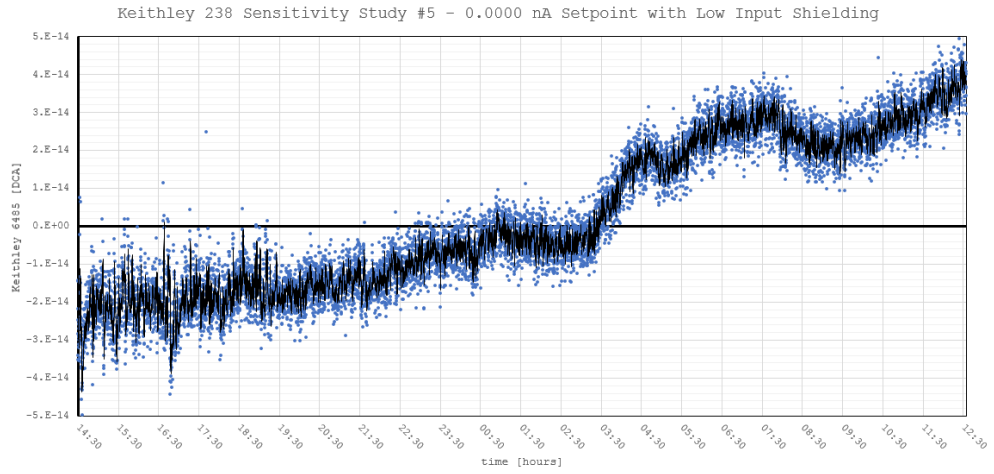
Say Thanks Reply Quote

Attached is a baseline when the Keithley 238 source is set to 0.0000 nA while the Keithley 6485 measures using the sample setup as before. Instability seems to be a result of last nights rainstorm starting around 3 AM.

[attach=1]

I = 1.8E-15 +/- 2.0E-14 DCA

Nuclear Materials Scientist



test9.PNG (119.73 kB, 1162x555 - viewed 138 times.)

Report to moderator Logged

MASc, EIT, PhD Candidate

Howardlong

Super Contributor



Posts: 5206

Country:



Re: Should I return a Keithley 238?

« Reply #53 on: August 29, 2020, 07:34:42 pm »

Say Thanks Reply Quote

Quote from: leighcorrigan on August 29, 2020, 04:26:06 pm

Quote from: Howardlong on August 28, 2020, 09:02:04 pm

Have you tried doing any low current measurements with your 238?

No, I have not. Looking over the specifications, it is difficult to tell what the maximum applied current is. Does the Keithley 238 have a maximum rating of 1 A with 100 uA resolution? If so, this is an incredible instrument! Can you point me to instructions on how to use the instrument as an ammeter? I will use my Keithley 261 picoampere source to measure from 10 fA to 0.1 mA. I suppose this instrument also measures voltage simultaneously, correct?

Yes, although my instrument's compliance at 1A cuts in at +0.99970A and -1.00030 A. It certainly gives rock solid 10uA resolution readings between -1.00030A and +0.99970A, for example 1V sourced from the SMU into a 1 ohm resistor. This was in 4 wire mode, linecycle period.

FWIW, my most common use case is as a precision power supply for button cell operated devices, so I can calculate deep sleep currents and estimate battery life, so yes it will source voltage and measure current (Source V, Measure I). I rarely use it for source I, measure V.

To use as an ammeter, set to Source V, Measure I, set the Source voltage to zero, and compliance current to a suitable value. With the Chassis/OutputLO link in the back, note that it's not floating, LO Output will have a low impedance to chassis and line earth.

Report to moderator Logged

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #54 on: August 30, 2020, 03:48:20 am »

Say Thanks Reply Quote

Quote from: Howardlong on August 29, 2020, 07:34:42 pm

To use as an ammeter, set to Source V, Measure I, set the Source voltage to zero, and compliance current to a suitable value. With the Chassis/OutputLO link in the back, note that it's not floating, LO Output will have a low impedance to chassis and line earth.

Thanks for the instructions. I was searching for some sort of button combination or menu. Turns out it was right there in front of me.

I have used the same setup as I have before, but I replaced the Keithley 6485 with a calibrated Keithley 261 picoampere source. Here are some quick results:

Keithley 261 Keithley 238
0.00E-12 1.00E-13 <- I used this value as an offset because I do not know how or if relative measurements can be made

0.10E-12 0.00E+00 <- The relative offset was programmed into the ampere sourcing
 1.10E-12 1.00E+12 <- Again.
 0.01E-11 0.00E+00 <- Again.
 0.11E-11 1.00E-12 <- Again.
 1.01E-11 1.00E-11 <- Again.
 1.00E-10 1.00E-10 <- At this point, there isn't much point in doing this because I have ran out of decade positions.
 1.00E-09 1.00E-09
 1.00E-08 1.00E-08
 1.00E-07 1.00E-07
 1.00E-06 1.01E-06
 1.00E-05 1.01E-05
 10.00E-05 1.00E-04

Please note that the Keithley 261 in this case is a decade box with 3 significant digits. The readings made for the Keithley 238 are gauged from the display and lack precision. I rounded the digits to 0.00 digits for simplicity and to match the source. The factor of 10 uses the same decade position most of the way up for consistency. I am impressed by how stable the reads are, even at 1 NPLC.

I have yet to make a LabView program for measuring and sourcing for the Keithley 238. If you are looking for something more detailed, you'll have to give me some time to familiarize myself with the instrument communication. As far as I am concerned, this instrument seems to be in good working order -- at least as an ammeter.

EDIT: It looks like I didn't wait long enough before using the Keithley 261, this is why I needed an offset. The Keithley looks to be precise enough (<<< 1 % error).

Tomorrow I will redo the study, but with greater detail and with the Keithley 2200-32-3 for the 0.1 mA to 1 A range. It is brand new and calibrated as of a few months ago.

[Report to moderator](#) [Logged](#)

MASc, EIT, PhD Candidate

garrettm
Frequent Contributor



Posts: 252
Country:



Re: Should I return a Keithley 238?

« **Reply #55 on:** August 30, 2020, 05:46:16 am »

[Say Thanks](#) [Reply](#) [Quote](#)

Quote

I used this value as an offset because I do not know how or if relative measurements can be made

If you are trying to zero the built-in picoammeter or voltmeter of the 23x series SMUs before taking a measurement, simply press "suppress". This stores the current reading and subtracts it from each new reading. It's essentially a null feature in disguise and should be used to remove zero offsets originating from the 23x SMU or those generated by the DUT.

[Report to moderator](#) [Logged](#)

The following users thanked this post: leighcorrigall

garrettm
Frequent Contributor



Posts: 252
Country:



Re: Should I return a Keithley 238?

« **Reply #56 on:** August 30, 2020, 05:50:09 am »

[Say Thanks](#) [Reply](#) [Quote](#)

I forgot to add, if you are using the 23x for measurement only (i.e. no sourcing) you should "zero" the output using a DMM or picoammeter. This may require that the output voltage / current be positive or negative a few counts (as opposed to setting it to 0.0000 etc.). Then you would use the suppress key after this is done.

[Report to moderator](#) [Logged](#)

leighcorrigall
Frequent Contributor



Posts: 393
Country:

Re: Should I return a Keithley 238?

« **Reply #57 on:** August 30, 2020, 01:47:07 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Quote from: garrettm on August 30, 2020, 05:46:16 am

If you are trying to zero the built-in picoammeter or voltmeter of the 23x series SMUs before taking a measurement, simply press "suppress". This stores the current reading and subtracts it from each new reading. It's essentially a null feature in disguise and should be used to remove zero offsets originating from the 23x SMU or those generated by the DUT.

Nuclear Materials Scientist



Thanks for the tips. It appears that the suppress feature is not working at the lowest decimal place on my unit.

Here are the steps I took:

- set the integral time to 1 NPLC and the filter to 32 readings
- wait for the measurement to settle (- 0.00002 nA)
- activate the suppress function (it then shows current in units of mA just before going back to the measurement of - 0.00002 nA)

Now, if I add a bias of 0.20E-12 A with the Keithley 261, the suppress feature works. However, I still get the -0.00002 nA offset. I also can hear something tinkering away while the suppress feature is activating. I guess that there are a few components that are not solid state.

[Report to moderator](#)

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist

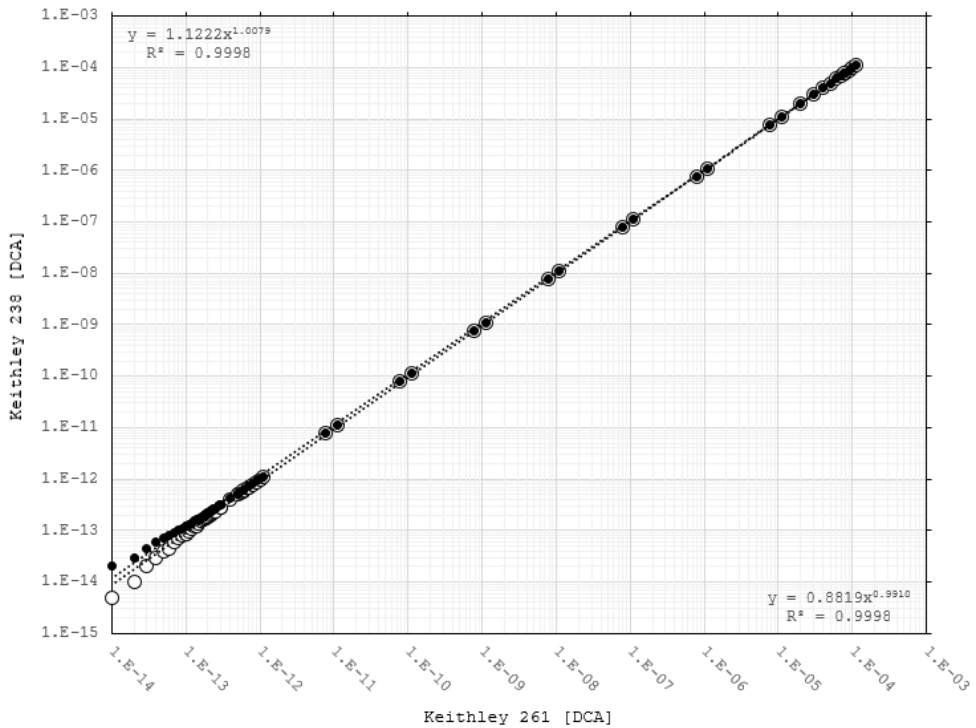


Re: Should I return a Keithley 238?

« Reply #58 on: August 30, 2020, 05:00:52 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Attached is a log-log comparison of the Keithley 238 with a Keithley 261. No corrections were made to the -0.02 pA bias. For this reason, there is a significant deviation below 0.1 pA which can be corrected for post-measurement. White dots represent negative current and black dots represent positive current. Keep in mind that the Keithley 261 is a decade box with 3 significant digits precision whereas the Keithley 238 has 5.5 digits. All digits for the Keithley 238 were recorded after a stable reading was observed. Error can be attributed to both instruments in addition to the ghetto electrical setup.



Keithley 238 Characterization with Keithley 261.PNG (56.51 kB, 754x560 - viewed 98 times.)

« Last Edit: August 30, 2020, 05:13:28 pm by leighcorrigan »

[Report to moderator](#)

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Re: Should I return a Keithley 238?

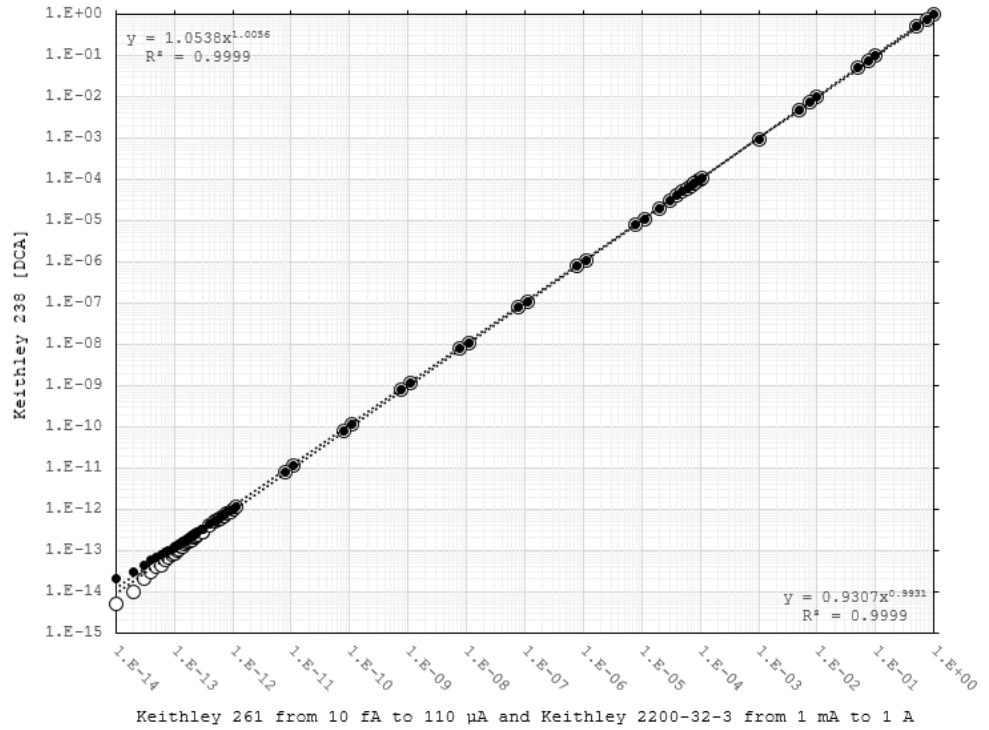
« Reply #59 on: August 30, 2020, 06:16:32 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

This attachment includes contributions from the Keithley 2200-32-3. Note that 0.0010 A has an 8.5 % error because of the 2 digits of precision, whereas at 1.0000 A the error is as low as 0.03 %.

Country: 🇨🇦

Nuclear Materials Scientist



Keithley 238 full range characterization.PNG (60.31 kB, 751x559 - viewed 96 times.)

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MASc, EIT, PhD Candidate

leighcorrigall

Frequent Contributor



Posts: 393

Country: 🇨🇦

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #60 on: August 30, 2020, 07:46:29 pm »

Say Thanks

Reply

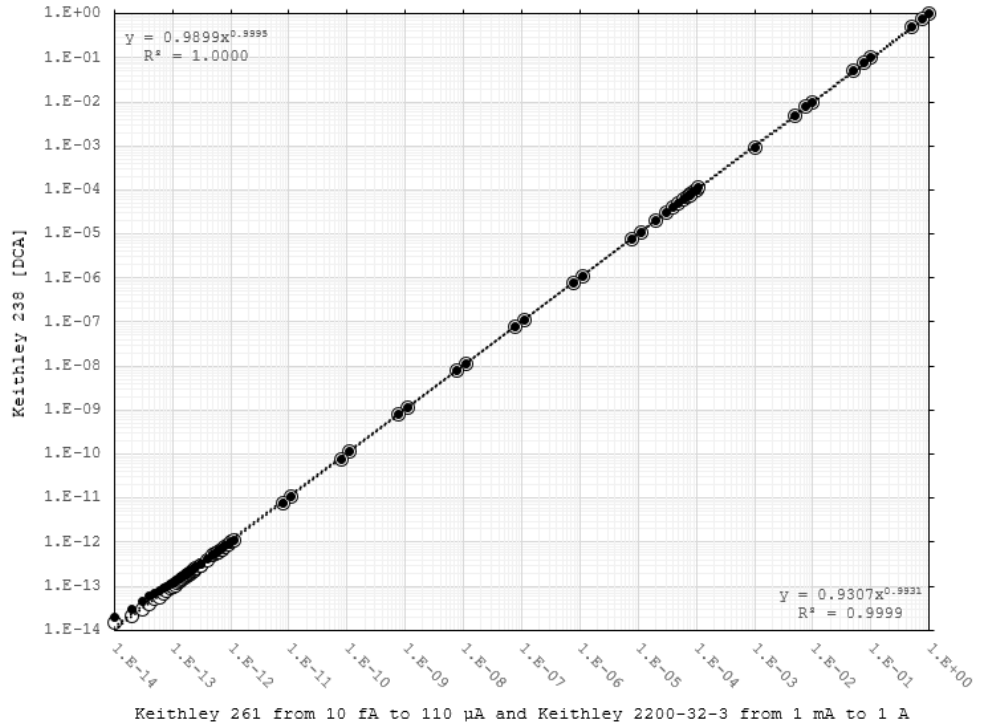
Quote

Attached is the same figure but instead with a constant compensation below 1 pA:

- +10.4 fA offset negative measurements
- 17.6 fA offset positive measurements

In conclusion, my Keithley 238 can reliably measure 50 fA to 0.11 mA with a mean error of less than 0.5 % (maximum: 2.21 % and minimum: 0.01 %) compared with my Keithley 261. Below 50 fA, the error drastically increases to an average of 5 % (maximum: 18 % and minimum: 1.83 %) for a variety of reasons. To achieve better results, I would need to purchase remote sense leads.

Above 1 mA, it can be assumed that the instrument can measure accurately with much less than 1 % error. Error is difficult to assess because I do not have a way of sourcing more precise currents unless I purchase an additional triax test lead for my Keithley 224 programmable current source, which is capable of sourcing up 100 mA. 🛠️



Keithley 238 full range characterization with constant compensation.PNG (60.13 kB, 754x560 - viewed 49 times.)

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #61 on: August 31, 2020, 01:12:55 am »

Say Thanks

Reply

Quote

Quote from: garrettm on August 28, 2020, 05:22:42 am

I forgot to ask how the new fan has been? Just comparing dB vs CFM from the datasheet doesn't tell the whole story.

Yesterday, I placed rubber o-rings on the standoff threads before fastening the fan to the back end of the Keithley 238. This significantly reduced the vibrations from the fan. The applied torque is enough to compress the o-rings flat, but not enough that they become rigid with the case. I think the noise issues are more about the enclosure design than the fan itself. If you were to replace your fan, I would suggest finding better standoffs as well.

Report to moderator Logged

MASc, EIT, PhD Candidate

The following users thanked this post: garrettm

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #62 on: August 31, 2020, 01:17:45 am »

Say Thanks

Reply

Quote

Quote from: garrettm on August 28, 2020, 01:51:45 am

As far as I am aware, Keithley uses Trompeter triax connectors on their newer cables--previously they used Specialty Connector Co.

Would you happen to know the connector type used on the board that leads to the triax connectors on the back? I am thinking of purchasing some cables with this type of connection to BNC so that I can avoid paying for triax leads. Thanks.

Report to moderator Logged

MASc, EIT, PhD Candidate

garrettm

Frequent Contributor



Posts: 252

Country:



Re: Should I return a Keithley 238?

« Reply #63 on: August 31, 2020, 01:18:36 am »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote

Attached is the same figure but instead with a constant compensation below 1 pA:

+10.4 fA offset negative measurements
-17.6 fA offset positive measurements

That's +- 1 to 2 counts on the display, which is excellent if you ask me. If you saw say 5 or 6 counts offset, suppress should take you to +-1 count on the 1 nA range. Asking for anything more than this is a bit much really--we are literally at the noise floor of the instrument here. If you want to really measure femto ampere levels of current, the 617 has a 1.9999 pA range which gives 0.1 fA resolution. If you can find a good deal for one, say 200 USD, it wouldn't be a bad piece of kit to pick up. They have a built-in voltage source, can measure coulombs and of course the usual volts amps and ohms to five digits FS.

Quote

In conclusion, my Keithley 238 can reliably measure 50 fA to 0.11 mA with a mean error of less than 0.5 % (maximum: 2.21 % and minimum: 0.01 %) compared with my Keithley 261. Below 50 fA, the error drastically increases to an average of 5 % (maximum: 18 % and minimum: 1.83 %) for a variety of reasons.

You have to look at the +- counts in the accuracy specifications. It's this term that dominates the error at the lower outputs of each range. (This is why they separate error terms.) For the 23x SMUs Keithley states +-100 fA or 10 counts linearity on the 1 nA range. So 50 fA is again excellent.

Quote

To achieve better results, I would need to purchase remote sense leads.

The remote sense leads are really for kelvin measurements of the DUT. I don't think it improves the picoammeter accuracy, just removes the voltage drops associated with cabling and the SMU. But I could be wrong on this, I'll have to re-read the manual.

Quote

Error is difficult to assess because I do not have a way of sourcing more precise currents

There is no need for the 224. All you need is a set of precision 0.01% resistors / standard resistors and an accurate DMM--your Keithley 2000 will do just fine.

Using an external current shunt, the current measured by the built-in picoammeter is then V_{out}/R_{shunt} . To test accuracy, you would measure the voltage across the shunt resistor V_R and multiply by R_{shunt} to get I_{out} . This can be done automatically using the math function on the DMM. Then just compare the displays or do the math and comparison in Matlab directly. To minimize errors you have to operate the shunt/load resistor at very low power, say 100mW maximum, to avoid resistor temperature coefficients from creeping into the measurement.

For large currents, the Leeds Northrup 4385 shunt box is a nice addition to any lab. It covers measurements from 75 mA to 15 A with I believe 0.02% accuracy. I bought mine for less than 50 USD, which is a steal considering it can also be used as a precision 4 wire resistor from 10 mohm to 2 ohm. I also have a set of Guildline standard resistors from 1 ohm to 10 kohm.

« Last Edit: August 31, 2020, 02:20:23 am by garrettm »

[Report to moderator](#)

garrettm

Frequent Contributor



Posts: 252

Country:



Re: Should I return a Keithley 238?

« Reply #64 on: August 31, 2020, 01:22:14 am »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote from: leighcorrigan on August 31, 2020, 01:17:45 am

Would you happen to know the connector type used on the board that leads to the triax connectors on the back? I am thinking of purchasing some cables with this type of connection to BNC so that I can avoid paying for triax leads. Thanks.

From what I can tell, those looked like standard SMB connectors. I didn't pull mine off to see if was really triaxial or not, but I don't think it is.

[Report to moderator](#)

garrettm

Re: Should I return a Keithley 238?

« Reply #65 on: August 31, 2020, 01:54:58 am »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Frequent Contributor



Posts: 252

Country:



A caution with using standard or "low triboelectric" coax is that the guard will be exposed on the outside of the output HI lead. Not really an issue if you are below 40V, but can be dangerous if operating above that.

You will also want to test any potential coaxial cabling before committing to using it. In my earlier post, using a very light tap on some supposedly "low" triboelectric cable saw 3mVpp into 1 megohm. This implies a surge current of 1.5 nA peak, which would overload the picoammeter on the 1nA range. This could easily be induced by gently moving the cable or letting it sway in the air or even irregular air pressure hitting it from a ceiling fan.

That said, I don't think the inner cabling is triaxial. So apparently Keithley found a source of good coax. If we could figure out the model and manufacturer of the stock cabling that could save a lot of hassle looking for suitable cabling to avoid the triax tax.

« Last Edit: August 31, 2020, 01:56:52 am by garrettm »

Report to moderator Logged

 evac

Contributor

Posts: 22

Country:

**Re: Should I return a Keithley 238?**

« Reply #66 on: August 31, 2020, 10:40:32 am »

Say Thanks

Reply

Quote

The triax connectors on the back are not insulated, so the shield connects to chassis ground and internally the cable from the board to the connector only carries guard+force, and can be a standard coax cable (with adequate voltage rating).

I'm not sure how good of an idea it would be to convert the outputs to BNC. I'm assuming you would get rid of the triax shield, and connect guard+force to the BNC shield and center, respectively.

Like garrettm said, this would make for an unsafe setup, because every part of the BNC connector could potentially be at a high voltage. Also, you would need to use isolated BNC connectors on the back (with adequate isolation voltage rating) to avoid shorting the guard to chassis.

The triax connections are there for a reason, and changing to BNC would either come at the cost of safety (no shield) or accuracy (no guard).

In my opinion, taking the DIY route and buying connectors + cable is not a bad option, and not as crazy expensive as buying pre-made cables.

« Last Edit: August 31, 2020, 10:42:32 am by evac »

Report to moderator Logged

 leighcorrigall

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist

**Re: Should I return a Keithley 238?**

« Reply #67 on: August 31, 2020, 12:47:26 pm »

Say Thanks

Reply

Quote

Quote from: garrettm on August 31, 2020, 01:18:36 am

If you want to really measure femto ampere levels of current, the 617 has a 1.9999 pA range which gives 0.1 fA resolution.

I considered getting one of these, but I already have a Keithley 6485 and although it does not have the sensitivity it has other features that make it worthwhile.

Quote from: garrettm on August 31, 2020, 01:18:36 am

There is no need for the 224. All you need is a set of precision 0.01% resistors / standard resistors and an accurate DMM- your Keithley 2000 will do just fine.

Using an external current shunt, the current measured by the built-in picoammeter is then V_{out}/R_{shunt} . To test accuracy, you would measure the voltage across the shunt resistor V_R and multiply by R_{shunt} to get I_{out} . This can be done automatically using the math function on the DMM. Then just compare the displays or do the math and comparison in Matlab directly. To minimize errors you have to operate the shunt/load resistor at very low power, say 100mW maximum, to avoid resistor temperature coefficients from creeping into the measurement.

Thank you for reminding me of this. I looked into this a month ago but then couldn't justify spending 100s of dollars on Vishay resistors that seem to be incredibly difficult to order. Do you have a source?

Report to moderator Logged

MASc, EIT, PhD Candidate

 leighcorrigall

Frequent Contributor

**Re: Should I return a Keithley 238?**

« Reply #68 on: August 31, 2020, 12:58:21 pm »

Say Thanks

Reply

Quote

Quote from: evac on August 31, 2020, 10:40:32 am



Posts: 393

Country:

Nuclear Materials Scientist



I'm not sure how good of an idea it would be to convert the outputs to BNC.
I'm assuming you would get rid of the triax shield, and connect guard+force to the BNC shield and center, respectively.

No, I would not be replacing my triax connectors. My idea is to have an easy method of connecting my Keithley 6485 and Keithley 261, which both use BNC. Neither of these instruments are carrying voltages of any significance.

Quote from: evac on August 31, 2020, 10:40:32 am

In my opinion, taking the DIY route and buying connectors + cable is not a bad option, and not as crazy expensive as buying pre-made cables.

True, but this is where I might draw the line on self-learning. I'd rather have a cable that is guaranteed to work than to find out the hard way I purchased the wrong materials or something. Why haven't I seen a video tutorial on YouTube about DIY triax? This would be a popular video, at least for me.

[Report to moderator](#) [Logged](#)

MASc, EIT, PhD Candidate

evac

Contributor

Posts: 22

Country:



Re: Should I return a Keithley 238?

« **Reply #69 on:** August 31, 2020, 01:07:27 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote from: leighcorrigall on August 31, 2020, 12:58:21 pm

Why haven't I seen a video tutorial on YouTube about DIY triax? This would be a popular video, at least for me.

You can find some videos if you just search for "triax cable" or "triaxial cable".


- [TiN from xDevs making triaxial cables:](#)

Assemble of custom triaxial cable using CNMC wire and Trompeter c...




- Marco Reps also covered DIY triax on his Keithley 236 videos:

Keithley 236 Source Measure Unit and Triaxial Cables



- And another one that has a good overview of all the connector parts:

How to Make a Tri-axial Cable



« Last Edit: August 31, 2020, 01:10:22 pm by [evac](#) » Report to moderator Logged

The following users thanked this post: [leighcorrigan](#)

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?
« Reply #70 on: August 31, 2020, 01:15:40 pm »

Say Thanks Reply Quote

Quote from: [evac](#) on August 31, 2020, 01:07:27 pm

Quote from: [leighcorrigan](#) on August 31, 2020, 12:58:21 pm

Why haven't I seen a video tutorial on YouTube about DIY triax? This would be a popular video, at least for me.

You can find some videos if you just search for "triax cable" or "triaxial cable".

- TiN from xDevs making triaxial cables:
- Marco Reps also covered DIY triax on his Keithley 236 videos:
- And another one that has a good overview of all the connector parts:

What was I thinking. A 7078-TRX-BNC adapter is much a far better solution than adding a BNC connector to the case.

Also, thank you for the links. I have not seen the first video you linked. I'll definitely check it out Evac!

« Last Edit: August 31, 2020, 05:44:10 pm by leighcorriganl »


Report to moderator  Logged

MASc, EIT, PhD Candidate

 **evac**

Contributor

Posts: 22

Country:  **Re: Should I return a Keithley 238?**

« Reply #71 on: August 31, 2020, 01:22:18 pm »

Say Thanks

Reply

Quote

Quote from: leighcorriganl on August 31, 2020, 01:15:40 pm

What was I thinking. A 7078-TRX-BNC adapter is much a far better solution than adding a BNC connector to the case.



That would work, but the official price is pretty crazy for just an adaptor.


However, there's one on eBay right now for \$45, which is more reasonable.

Report to moderator  Logged **wizard69**

Super Contributor



Posts: 1079

Country:  **Re: Should I return a Keithley 238?**

« Reply #72 on: August 31, 2020, 06:48:10 pm »

Say Thanks

Reply

Quote

Quote from: leighcorriganl on August 20, 2020, 10:13:33 pm

Hi E-deisgn and evac.

Thank you for your input. I believe that both of you are correct about the repair job. Without taking the board out of the enclosure, I am guessing that some of the components were capacitors. The transformer was not replaced in this case, but the contamination is very close to it.

Yes the repairs look like crap. It is so bad that I might consider reworking some of those repairs. Of course the board isn't in front of me but the solder joints look like crap. If you are going to rework those replacing some of the caps at those bad joints might be advisable. The thinking here is that the tech was a hack and probably didn't take care with what he was installing.

Quote

Apart from the poor repair job, nothing else seems modified. The seller advertised the unit with the following message: "Unit was in working condition prior to being removed from service."

I wouldn't doubt that one bit. The problem is these instruments are often purchased from liquidators or via company sales. That is the items are coming off production lines that have been shut down. It is very likely that the unit was in use at the time the original sales was made.

Quote

A calibration sticker has been placed over the reset button, but I do not know if it is official. Any way of telling?

It is a calibration sticker and needs to be taken at face value. Internal metrology departments can implement very specific calibration procedures for hardware dedicated to a specific usage. If the instrument sits in a production line they might only check calibration on one specific range / function.

Any meter bought used needs to be evaluated and possibly re calibrated for general purpose usage. The only way I might accept a sticker is if it comes from the instrument manufactures cal lab. Because I've seen manufactures work with external labs to implement a machine specific cal procedure.

Quote

Let me know if anyone wants additional pictures for reference to benefit the community. I don't see a lot of Keithley 238 representation out there.

By the way nice pictures.

As for returning the unit I don't think anything you have described justifies it. You have to assume that used instruments have had work done to them. It is like buying a used car from a used car dealer, in many cases the dealer has no idea what has been done to the vehicle. That doesn't mean that there are not disgusting used car dealers out there, just that you can get sold a car that appears to be fine to them at the time of sale.

Report to moderator  Logged **garrettm**

Frequent Contributor

 **Re: Should I return a Keithley 238?**

« Reply #73 on: September 01, 2020, 06:26:25 am »

Say Thanks

Reply

Quote

Quote

Thank you for reminding me of this. I looked into this a month ago but then couldn't justify spending 100s of dollars on Vishay resistors that seem to be incredibly difficult to order. Do you have a source?



Posts: 252
Country:



Leigh Corrigall

Frequent Contributor



Posts: 393
Country:

Nuclear Materials Scientist



Howard Long

Super Contributor



Posts: 5206
Country:

You don't have to get Vishay resistors. I have a decade set of 0.5 W KOA-Speer 5ppm 0.01% metal films and the aforementioned Guildline and Leeds Northrup resistors. eBay is a good place to look for standard resistors, but expect to pay 40 to 100 per each one. But these save you money in the long run by calibrating your gear at home.

Wire wound or metal film type should be much less than a true standard resistor.

You can also find resistors that are somewhere in the middle of the two, such as the Julie Research 1ohm on eBay:

<https://www.ebay.com/itm/Julie-Research-Ohm-Labs-CH48T4HK-1-Ohm-005-Hermetic-Resistor-Heat-Sink-R48/202568048586?hash=item2f29ff1fca:g:zT4AAOSwZntcP4Ve>

Note that absolute accuracy of the resistor isn't critical if you have an accurate ohmmeter. Your Keithley 2000 is much more accurate than 0.01% for resistances below 1Mohm. What we really care about is the temperature and voltage coefficients. At low ohmic values, temp. co. dominates the measurement error. At high ohmic values voltage coefficients can quickly become the larger error source. Then there is stability to consider: PPM / yr drift. But when your DUT is only 4.5 to 5.5 digits, the requirements to calibrate it aren't as demanding.

[Report to moderator](#) [Logged](#)

Re: Should I return a Keithley 238?

« **Reply #74 on:** September 20, 2020, 01:30:51 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Hi everyone,

I thought I might provide some progress with my Keithley 238. I spent some time developing my own software with LabVIEW to remotely program the Keithley 238.

This is an example of the current source error over a period of 15 mA to 100 fA (510 step changes) with the following parameters:

[attachimg=1]

Keithley 238 Settings

Set Current Range: Auto range (much more precise than a fixed range for obvious reasons)

Sweep: Logarithmic Staircase

Step Time: 65 seconds

Number of Counts per Decade: 50

Note: The range is limited to 15 mA to avoid destroying my Picoammeter.

Keithley 6485 Settings

NPLC: 5

AZERO: ON

AUTO: ON

Digital Filter: Advanced (Mean Filter)

Type: Repeating

Counts: 5

Noise Tolerance: 5

Median Filter: OFF

Note: Recorded measurements from the Keithley 6485 were averaged for 30 seconds prior to a step-change made by the Keithley 238

EDIT: There are 2 lines drawn on the graph in blue (Keithley 6485) and red (Keithley 238) that indicate the instruments involved. The redline is better represented as a set of dots.

I plan on estimating the standard deviation soon, but I am too busy today to learn how to do this for 510 select time intervals with Excel.

2020 09 18 - 15m to 100f.pdf (71.42 kB - downloaded 29 times.)

« *Last Edit:* September 20, 2020, 01:34:34 pm by leighcorrigall »

[Report to moderator](#) [Logged](#)

MASc, EIT, PhD Candidate

Re: Should I return a Keithley 238?

« **Reply #75 on:** September 21, 2020, 04:44:24 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

You may remember I was having difficulties achieving repeatable measurement results on the 236 and 238 I have here on very low currents, sub 10pA or so.



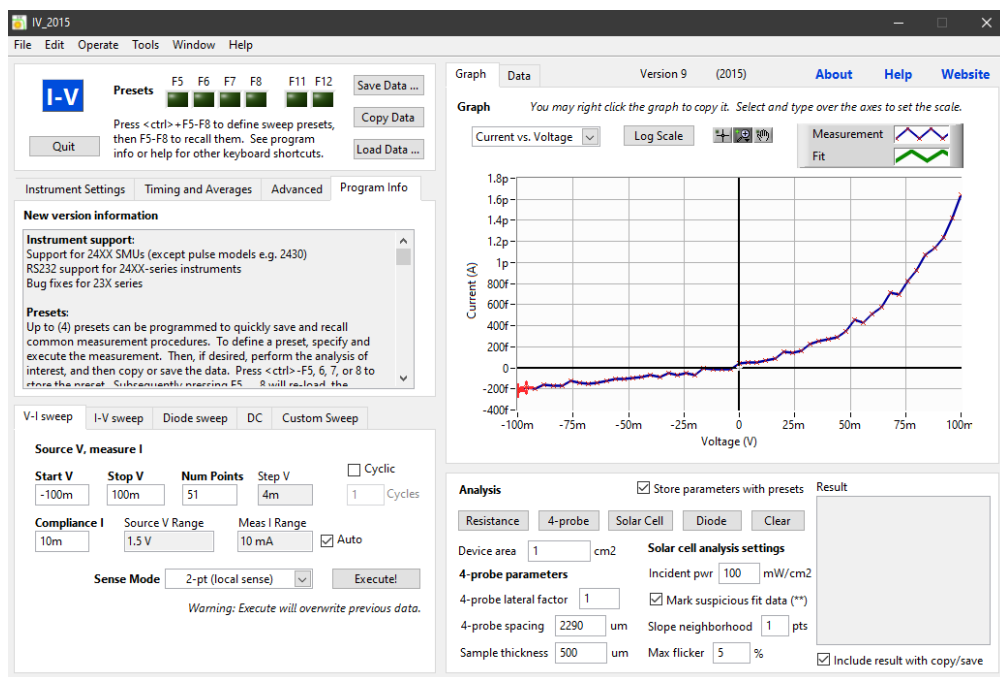
One of the interesting things gleaned from this thread was when I removed the triax cables, the offset current seemed to be far lower (~100fA) than with the cables in (several pA) in source V / measure I mode.

In the end it seemed that just the Hi Output cable was going to be a cause of this, so today I received a kosher 237-ALG-2 cable, freshly rolled on the thighs of virgin unicorns, and used that for my Hi Output cable instead of the homebrew cable I made. The other two cables remained the same, although I'm not using the sense cable for this as currents are so tiny.

Here's a rather nice trace of a PNP signal transistor (MMDT3906) used as a diode from -100mV to 100mV.

With the old homebrew cable, there was a lot of leakage, so there was usually a significant offset which varied a lot, rather unpredictably, and it's still not clear to me why that would be. I aim to disassemble the connector and give it an ultrasonic bath and see what that does: I admit to making that cable without any gloves.

[attach=1]



Screenshot 2020-09-21 173253.png (80.16 kB, 1033x693 - viewed 130 times.)

Report to moderator Logged

Howardlong

Super Contributor



Posts: 5206

Country:



Re: Should I return a Keithley 238?

« Reply #76 on: September 21, 2020, 04:51:44 pm »

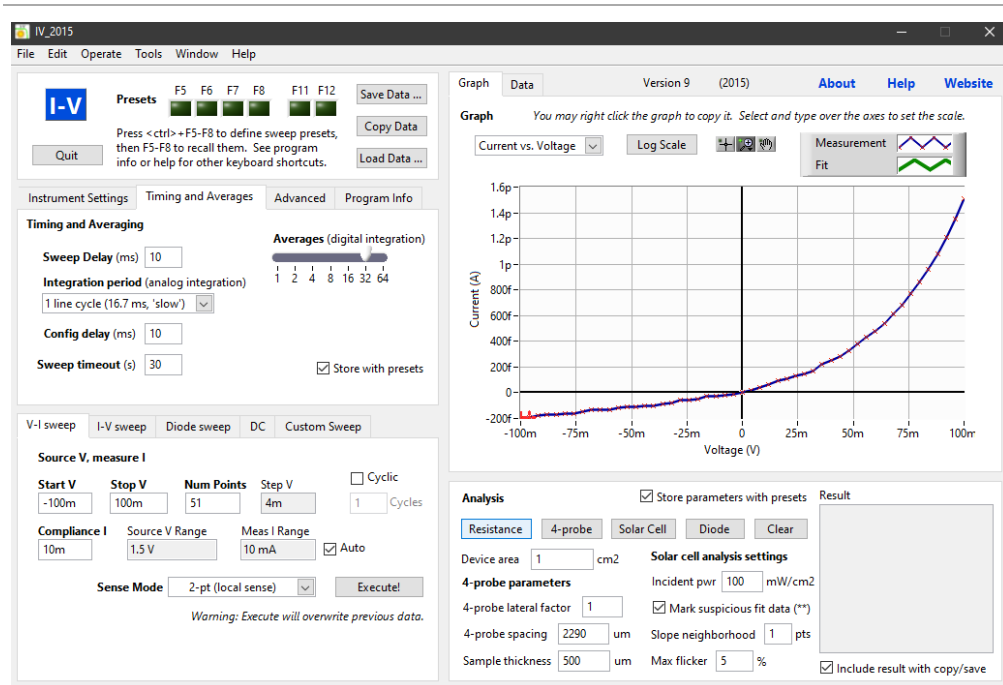
Say Thanks

Reply

Quote

...and with 32x averaging

[attachimg=1]



Screenshot 2020-09-21 175103.png (75.41 kB, 1033x692 - viewed 119 times.)

Report to moderator Logged

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #77 on: September 21, 2020, 05:13:48 pm »

Say Thanks Reply Quote

Quote from: Howardlong on September 21, 2020, 04:44:24 pm

I admit to making that cable without any gloves.

Bingo! This might be the leading cause. I would suggest using isopropanol or methanol to clean the parts. You cannot let it dry out slowly or a white residue might remain. A good way of getting rid of contamination is with Kim Wipes or something else that does not leave trace fibres. Ultrasonic cleaners are wonders, but they can be too aggressive when using elevated temperatures or with high concentrations of some solvents.

I am glad you figured it out. Sometimes these things can happen, which is why I want to buy a pre-fabricated cable myself. For now, I will use my Keithley 6011 with a 6171. My problem now is cable length. How is your new cable for length?

By the way, where did you get that software from? I was trying to get it from CalTech a few weeks ago but the website was down. I ended up writing my own LabVIEW interface, which is fine because I am not limited to the closed-source package.

As an update, I made a mistake in my Excel spreadsheet the other day, the mean was carried out over 10 seconds instead of 30 seconds. I was preoccupied and didn't look over my formulas.

Attached are additional charts that characterize my Keithley 238 with the Keithley 6485 if you are interested.

I plan on getting my instrument calibrated because I don't have time to come up with my own method at the moment and it's cheaper to pay 450 CAD to have it done in a week. When I receive the instrument back, I will rerun the analysis to check it against my Keithley 6485. Maybe the error is more to do with my picometer than my SMU. We shall see.

- 2020 09 18 - measurement error.pdf (69.23 kB - downloaded 16 times.)
- 2020 09 18 - standard deviation.pdf (70.42 kB - downloaded 19 times.)
- 2020 09 18 - voltage measure.pdf (39.14 kB - downloaded 42 times.)

Report to moderator Logged

MASC, EIT, PhD Candidate

 **Howardlong**

Super Contributor



Posts: 5206

Country: 



 **Re: Should I return a Keithley 238?**

« Reply #78 on: September 22, 2020, 01:14:04 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

I semi-disassembled the connector on my homebrew cable and gave it a good clean in the ultrasonic bath, followed by a couple of rinses in deionised water. The results are much better, but noticeable is that there's a residual resistive path, ITRO 1Tohm or so ($\sim 100\text{fA}$ @ 100mV), so I may need to do some more work.

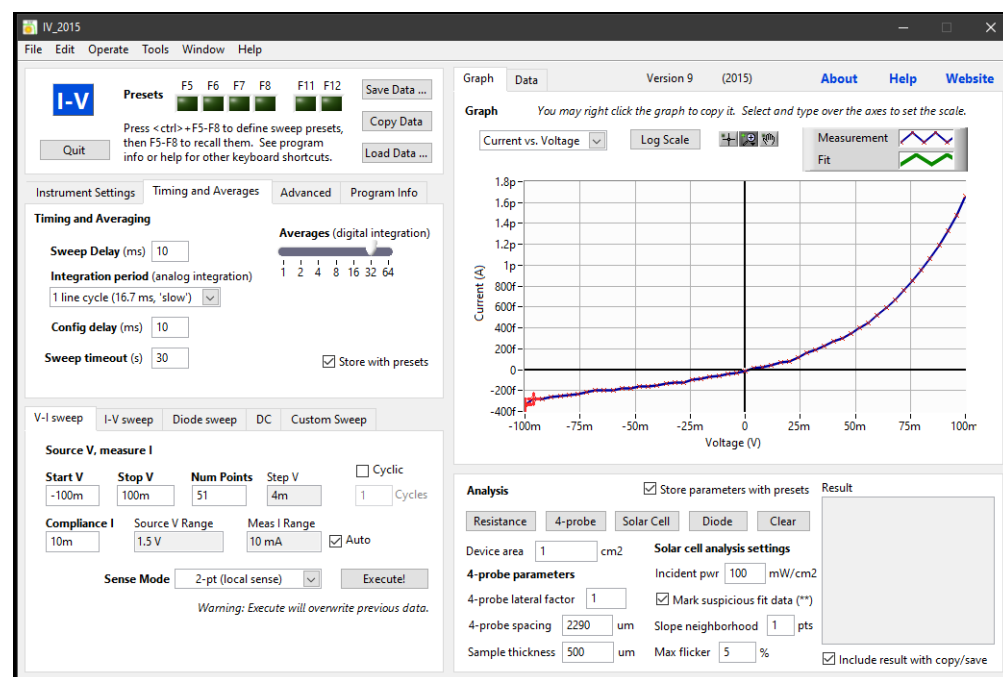
[attaching=1]


Here is a link for the IV software that seems to work:

<http://mkelzenb.caltech.edu/software/IV/index.html>

Alternatively, here's a link to a copy I downloaded a few months ago

https://1drv.ms/u/s!Ak3HU3AygNouh7JxAML_ib5IMX9KJQ?e=kwGQAP



 Screenshot 2020-09-22 140144.png (76.87 kB, 1040x699 - viewed 87 times.)

[Report to moderator](#)  [Logged](#)

 **leighcorrigan**

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



 **Re: Should I return a Keithley 238?**

« Reply #79 on: October 07, 2020, 01:52:24 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Hi guys,

Still waiting on my device to be calibrated and characterized. The voltage source/measure is slightly out of specifications between 30 and 70 DCV, but the current source/measure range is spot on. Luckily, the voltage can be characterized with any typical 6.5-digit multimeter, so this should not be a problem at all. I am going to use a Keithley DMM6500 to do this that was calibrated only a month ago.

Just wondering if anyone could tell me **what the difference between the Keithley 2600-ALG-2 and the Keithley 237-ALG-2.**

Here is a link to the descriptions:

<https://www.nubicom.co.kr/download/keithley/catalog/08Accessories.pdf>

Model 237-ALG-2: Low noise triax cable (SC-22) terminated with a 3-slot male triax connector on one end and 3 alligator clips on the other.

Model 2600-ALG-2: 2 m (6.6 ft) cable terminated with a 3-slot male triax connector on one end and 3 alligator clips on the other.

The 237-ALG-2 is said to be "low noise", but would it be better or worse than the 2600-ALG-2. I am

asking because I can get the 2600-ALG-2 cheaper, and I am hoping that it might be better. Is this true?

Report to moderator  Logged


MASc, EIT, PhD Candidate

jogri

Frequent Contributor



Posts: 366

Country: 



 **Re: Should I return a Keithley 238?**

« **Reply #80 on:** October 07, 2020, 02:30:16 pm »

Say Thanks

Reply

Quote

The 2600 is not designed to handle the 1.1 kv output of the 237, but given the fact that Keithley's documentation can only be described as piss-poor/not existing at all chances are that you won't find more detailed specs for those cables (i have already tried that months ago but to no avail).


Report to moderator  Logged

garrettm

Frequent Contributor



Posts: 252

Country: 



 **Re: Should I return a Keithley 238?**

« **Reply #81 on:** October 07, 2020, 07:24:12 pm »

Say Thanks

Reply

Quote

Quote from: jogri on October 07, 2020, 02:30:16 pm

The 2600 is not designed to handle the 1.1 kv output of the 237, but given the fact that Keithley's documentation can only be described as piss-poor/not existing at all chances are that you won't find more detailed specs for those cables (i have already tried that months ago but to no avail).

I'm not sure what you are on about, but looking up the user manuals on Tektronix's website I can see the main difference in each is in the voltage ratings (as you alluded to but didn't specify).

The 237-ALG-2 is rated for the voltages present on a 237 SMU: 600 V peak center conductor to inner shield; 1,300 V peak center conductor and inner shield to outer shell.

Since guard is at nearly the same voltage as the center conductor, this 600V limit is not violated even when you output 1100V. Thus you can use the full output voltage without issue.

The 2600-ALG-2 is rated for a lot lower working voltage: 42V peak center conductor to inner shield and 42V peak center conductor and inner shield to outer shell.

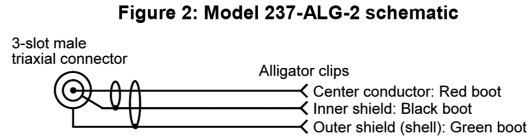
The 2600-ALG can probably go a lot higher than this, but that's what Keithley decided to rated it for.

(They are essentially the exact same cable. With the only difference in how they attached/insulated the extension leads for the alligator clips.)

TL;DR, do not use a 2600-ALG with a 237 SMU. Instead, use the original cable that was designed for the instrument: 237-ALG.

Mechanical characteristics

A schematic of the cable is shown in the figure below.



Electrical characteristics

Working voltage: 600 V peak center conductor to inner shield; 1,300 V peak center conductor and inner shield to outer shell

Contact resistance: < 0.5 Ω

Insulation resistance: $10^{15} \Omega$, center conductor to inner shield (500 V test voltage, 23 °C at < 40 percent relative humidity)

General characteristics

Operating environment: 32 °F to 122 °F (0 °C to 50 °C), up to 70 percent relative humidity at ≤ 95 °F (35 °C)

237-alg-2.png (131.86 kB, 2178x1300 - viewed 78 times.)

The Model 2600-ALG is a 2-meter (6.6ft.) triax cable that is terminated with a 3-slot male triax connector on one end and alligator clips on the other end.

Specifications

Working Voltage: 42V peak center conductor to inner shield.
42V peak center conductor and inner shield to outer shell.

Operating Environment: 0°C to 50°C, up to 70% RH at ≤ 35 °C.

Contact Resistance: <0.5 Ω .

Insulation Resistance: $10^{15}\Omega$, center conductor to inner shield (23°C @ <40% RH).

2600-alg-2.png (83.9 kB, 2119x629 - viewed 85 times.)

« Last Edit: October 07, 2020, 07:34:11 pm by garrettm »

Report to moderator Logged

The following users thanked this post: alm

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #82 on: October 07, 2020, 07:56:31 pm »

Say Thanks

Reply

Quote

Quote from: garrettm on October 07, 2020, 07:24:12 pm

(They are essentially the exact same cable. With the only difference in how they attached/insulated the extension leads for the alligator clips.)

TL;DR, do not use a 2600-ALG with a 237 SMU. Instead, use the original cable that was designed for the instrument: 237-ALG.

Can you please be more specific? I do not own either cable and would very much like to know the differences. How is the 2600-ALG insulated differently than the 237-ALG?

I plan to buy a new cable for the Keithley 238. Looking at what the 2600-ALG is recommended for, the Keithley 2635B SMU has source specifications (max 10 A with 0.1 fA resolution, max 200 V with 100 nV resolution) beyond the Keithley 238 (max 1 A with 100 fA resolution, max 110 V with 100 uV resolution). Given this information, I should be able to assume that the 2600-ALG is suitable for the Keithley 238 but not necessarily the 237 given the higher voltage range. What do you think?

Report to moderator Logged

MASc, EIT, PhD Candidate

jogri

Frequent Contributor



Re: Should I return a Keithley 238?

« Reply #83 on: October 07, 2020, 08:09:16 pm »

Say Thanks

Reply

Quote

Quote from: garrettm on October 07, 2020, 07:24:12 pm

I'm not sure what you are on about, but looking up the user manuals on Tektronix's website I can see the main difference in each is in the voltage ratings (as you alluded to but didn't specify).



Posts: 366
Country:

garrettm
Frequent Contributor



Posts: 252
Country:

Then answer me these question:

- what is the maximal current allowed for those cables?
- how small is the minimal bend radius?
- what materials were used for the cable and connectors and how thick is the center conductor (amp rating)?
- those cables might be used for ACish stuff, what is the capacitance of the cable?

Keithley just lists the absolute bare minimum on those "data sheets", is it too much to ask to put the bloody amp rating on a data sheet of a 300 USD cable? The answer to that question should be more than "heck if i know"

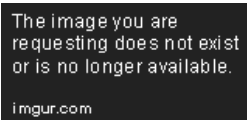
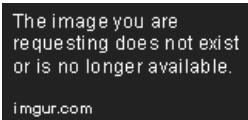
[Report to moderator](#) [Logged](#)

Re: Should I return a Keithley 238?
« **Reply #84 on:** October 07, 2020, 08:26:55 pm »

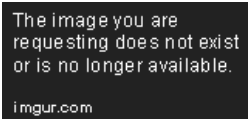
[Say Thanks](#) [Reply](#) [Quote](#)

BTW, I did some tests with a piece of Pomona 5223 triax that uses Belden 9222 cable and found it to be the absolute worst cable imaginable for low current measurements. It's sensitivity to physical movement and vibration is worse than even the worst coaxial cable I have tested so far. But to be fair, the 5223 was intended to be used for low leakage RF stuff, not low leakage DC measurements.

To test sensitivity to small impacts I made a simple pendulum out of some copper wire, a vice and an IC grabber. Nothing fancy, but it got the job done.

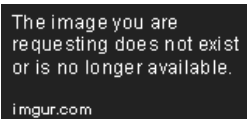
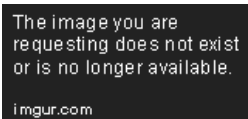


To monitor the activity of the cables during impact I used a Keithley 427 current amplifier set to 1 V/nA (or 1 mV/pA) and scope set to trigger just above the noise floor of the current amplifier (around +-150pA peak). Turns out this is sensitive enough to see even HP and Keithley cables generate charges under stress. Though they barely register at pendulum positions 3 and 4.

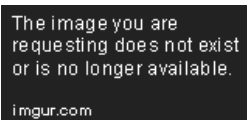
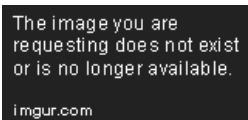


To qualitatively know what a "bad" response looks like we first need to see how a known "good" cable responds to stimuli.

Keithley at pendulum position 4. Doesn't respond to any other setting. Sensitivity to flexing and nearby vibrations were undetectable.



HP at pendulum position 3, not as good as Keithley but still very good. Oddly, the cable's response at pendulum position 4 isn't much worse. Sensitivity to flexing and nearby vibrations were undetectable. Note the change in scale, 200mV / division over 500mV / division.



And now what we've all been waiting for: Pomona's 5223 / Belden 9222 cable.

Note: Scope is set to persistence mode and 10 pendulum drops were performed to show repeatability.

Pendulum position 1, barely has enough energy to touch the cable and the response is quite large.

The image you are requesting does not exist or is no longer available.

imgur.com

Pendulum position 2, audible light tap. This time the response is so large that it begins to clip on the oscilloscope's display! That's over 2nA peak current generated.

The image you are requesting does not exist or is no longer available.

imgur.com

The cable was also extremely sensitive to nearby vibrations (e.g. tapping one of the books) and wildly sensitive to flexing the cable.

As we can see Belden 9222 is a very poor choice for cable. It simply generates too much charge while being moved or around vibrations.

That said, it may be fine if you have a very stable environment that doesn't contain much in the way of vibrations and movement. But as a general purpose test lead, I would advise against using it for anything but low leakage RF test setups.

« Last Edit: October 09, 2020, 12:23:23 am by garrettm »

Report to moderator  Logged

The following users thanked this post: leighcorrigall

 **garrettm**
Frequent Contributor



Posts: 252
Country: 
  

 **Re: Should I return a Keithley 238?**

« Reply #85 on: October 07, 2020, 08:50:35 pm »

Say Thanks

Reply

Quote

Quote from: jogri on October 07, 2020, 08:09:16 pm

Then answer me these question:

- what is the maximal current allowed for those cables?
- how small is the minimal bend radius?
- what materials were used for the cable and connectors and how thick is the center conductor (amp rating)?
- those cables might be used for ACish stuff, what is the capacitance of the cable?

Keithley just lists the absolute bare minimum on those "data sheets", is it too much to ask to put the bloody amp rating on a data sheet of a 300 USD cable? The answer to that question should be more than "heck if i know"

- 1) Well said. Max current should be stated. HP/Agilent at least did this with their cables (1A and 1.6A for GNDU, Keysight makes a newer cable with 4.2A).
- 2) To be honest, I've never seen a bend radius stated outside of Ethernet cable datasheets. I'm sure many cables state this, but even more omit it. HP/Agilent never stated this parameter for their triax cables.
- 3) Materials and wire gauge used in the triax cable are stated somewhere... I remember reading about the construction of the cable to minimize charge generation. I attached the SC-22 datasheet, it has some, but not all of this information. Keithley uses Mueller Electronics alligator clips for the 237-AGL and other cables like it.
- 4) Again, I agree. They should have the inner shield to outer shield and center conductor to inner shield capacitances stated. HP/Agilent stated this for their cables.

P.S.

If anyone is looking for info on HP/Agilent cables I have a post with some data on them:

<https://www.eevblog.com/forum/metrology/hp-agilent-keysight-highlow-current-triaxial-cables-how-to-tell-them-apart/msg3216006/#msg3216006>

 Keithley SC22 Triax Cable Datasheet.pdf (82.54 kB - downloaded 22 times.)

 Keithley CS-631 Male Triax Connector Datasheet.pdf (577.16 kB - downloaded 18 times.)

« Last Edit: October 07, 2020, 09:18:43 pm by garrettm »

Report to moderator  Logged

 **garrettm**
Frequent Contributor



 **Re: Should I return a Keithley 238?**

« Reply #86 on: October 07, 2020, 09:15:16 pm »

Say Thanks

Reply

Quote

Quote from: leighcorrigall on October 07, 2020, 07:56:31 pm



Posts: 252

Country:



E-Design

Regular Contributor



Posts: 188

Country:

Hardware Design Engineer



leighcorrigall

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Can you please be more specific? I do not own either cable and would very much like to know the differences. How is the 2600-ALG insulated differently than the 237-ALG?

I plan to buy a new cable for the Keithley 238. Looking at what the 2600-ALG is recommended for, the Keithley 2635B SMU has source specifications (max 10 A with 0.1 fA resolution, max 200 V with 100 nV resolution) beyond the Keithley 238 (max 1 A with 100 fA resolution, max 110 V with 100 uV resolution). Given this information, I should be able to assume that the 2600-ALG is suitable for the Keithley 238 but not necessarily the 237 given the higher voltage range. What do you think?

That's my best guess, I don't know for certain. That said, Keithley only makes SC-22 as far as I am aware, so the triaxial cable must be the same. HP/Agilent made two separate types of cable for low and high current connections. Keithley apparently does not do this. Keithley also only uses SC-631 connectors now, so those must also be the same. Previously they used Specialty Connectors Co parts but have since move on to either a custom part made by Trompeter/Cinch or an in house solution (the bands around the connector look the same as Trompeter parts). So the only possible difference there could be is in the way the triax is bonded to the extension wires. The alligator clips are the same Mueller Electronics parts.

If the 2600-AGL is sold as a stock accessory for the 2635B, then I'd say you should be okay to use it with the 238 SMU. It clearly can be used above 42V, so the 110V max of the 238 shouldn't be an issue. I think Keithley is just following the European guidelines in human safety nonsense that cables which have exposed conductors (i.e. alligator clips that aren't fully insulated) should be rated no higher than 42V.

Specialty Connector Co BNC Triax Connectors.pdf (142.16 kB - downloaded 22 times.)

« Last Edit: October 07, 2020, 09:20:52 pm by garrettm »

Report to moderator Logged

Re: Should I return a Keithley 238?

« Reply #87 on: October 07, 2020, 10:06:50 pm »

Say Thanks Reply Quote

Quote from: leighcorrigall on October 07, 2020, 07:56:31 pm

I think Keithley is just following the European guidelines in human safety nonsense that cables which have exposed conductors (i.e. alligator clips that aren't fully insulated) should be rated no higher than 42V.

I can confirm, this is exactly the case.

Report to moderator Logged

The greatest obstacle to discovery is not ignorance - it is the illusion of knowledge.

Re: Should I return a Keithley 238?

« Reply #88 on: October 08, 2020, 04:29:22 pm »

Say Thanks Reply Quote

I contacted Keithley's technical support. They said the following about the 2600-ALG-2 and the 237-ALG-2:

"I was able to look at internal cable information and the triax portion of the cables are the same."

Other than that, they were completely useless in answering my questions. **They are likely not in a position to say anything contradictory about the datasheets** and insisted that I go with the 237-ALG-2 without justifying why.

As far as we know, they are the same cable with the exception of..

Quote from: garrettm on October 07, 2020, 07:24:12 pm

how they attached/insulated the extension leads for the alligator clips.

Obviously, I would not recommend the Keithley 2600-ALG-2 for the Keithley 237 or any other SMU with voltage capabilities above 200 V.

I purchased three new Keithley 2600-ALG-2 cables today on eBay for a total of 650 CAD to use with my Keithley 238 instead of a single retail price total of 490 CAD for the 237-ALG-2. The cables should be more than adequate for my SMU. Now I can rest easy that I have the right tools for low current measurements.

Thank you everyone for helping me and other future buyers to make the best decision for their products.

Report to moderator Logged

MASc, EIT, PhD Candidate

jogri
Frequent Contributor



Posts: 366
Country:



Re: Should I return a Keithley 238?
« Reply #89 on: October 08, 2020, 06:09:54 pm »

Say Thanks Reply Quote

Quote from: leighcorrigan on October 08, 2020, 04:29:22 pm

I purchased three new Keithley 2600-ALG-2 cables today on eBay for a total of 650 CAD to use with my Keithley 238 instead of a single retail price total of 490 CAD for the 237-ALG-2. The cables should be more than adequate for my SMU. Now I can rest easy that I have the right tools for low current measurements.

You were aware of this listing (was posted on the forum a few times)? <https://www.ebay.com/itm/Keithley-3-Lug-Triax-to-Ultraminiature-Triax-Jumper-Cable-6Ft-3m-Male-to-Male/193600451476?> The seller accepted a 30USD/cable offer for three cables for me, and since you only need to solder on some test leads contamination through dirty fingers shouldn't be an issue.

Report to moderator Logged

leighcorrigan
Frequent Contributor



Posts: 393
Country:
Nuclear Materials Scientist



Re: Should I return a Keithley 238?
« Reply #90 on: October 08, 2020, 07:19:48 pm »

Say Thanks Reply Quote

Quote from: jogri on October 08, 2020, 06:09:54 pm

You were aware of this listing (was posted on the forum a few times)? [URL removed] The seller accepted a 30USD/cable offer for three cables for me, and since you only need to solder on some test leads contamination through dirty fingers shouldn't be an issue.

I am aware. My application will require significant cable length because I am working in a fume hood and I cannot afford to make errors by improperly fabricating my own cables. Not that I have a problem with what you are doing, but I don't have the time nor the experience to do this. I would rather spend money up front than to spend more money over time to accomplish the same objective.

We have already discussed some of the risks of DIY cables and dirty fingers:

Quote from: Howardlong on September 21, 2020, 04:44:24 pm

You may remember I was having difficulties achieving repeatable measurement results on the 236 and 238 I have here on very low currents, sub 10pA or so.

[...]

In the end it seemed that just the Hi Output cable was going to be a cause of this, so today I received a kosher 237-ALG-2 cable, freshly rolled on the thighs of virgin unicorns, and used that for my Hi Output cable instead of the homebrew cable I made. The other two cables remained the same, although I'm not using the sense cable for this as currents are so tiny.

[...]

With the old homebrew cable, there was a lot of leakage, so there was usually a significant offset which varied a lot, rather unpredictably, and it's still not clear to me why that would be. I aim to disassemble the connector and give it an ultrasonic bath and see what that does: I admit to making that cable without any gloves.

In any case, I think that learning the technique of DIY is a good experience, but not for what I am attempting to do.

Thanks.

Report to moderator Logged

MASc, EIT, PhD Candidate

garrettm
Frequent Contributor



Re: Should I return a Keithley 238?
« Reply #91 on: October 09, 2020, 12:15:14 am »

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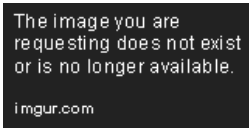
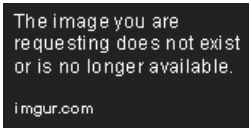
Quote from: jogri on October 08, 2020, 06:09:54 pm

You were aware of this listing (was posted on the forum a few times)? <https://www.ebay.com/itm/Keithley-3-Lug-Triax-to-Ultraminiature-Triax-Jumper-Cable-6Ft-3m-Male-to-Male/193600451476?> The seller accepted a 30USD/cable offer for three cables for me, and since you only need to solder on some test leads contamination through dirty fingers shouldn't be an issue.

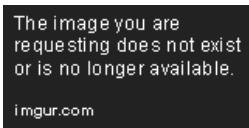
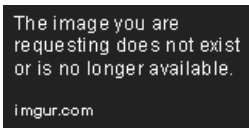
Posts: 252
Country: 
  

That's not a bad price. But those don't look like OEM cables from Keithley. That's a Trompeter connector on the end with PE insulation, clearly not the same as an SC-631 connector. I have some NEMAL 1729 triax cable that looks a lot like what's shown in the listing photos.

Here's some pictures of the NEMAL 1729 triax I got from buying some bulkhead connectors. This may be what those cables are using, or at least somewhat similar. Looks like FEP jacket with PE inner dielectrics and silver plated copper conductors. I haven't tested its suitability for low current measurements as the cables are too small (< 1ft long), but it doesn't seem like it would be a good choice. The vast majority of triax/twinax is actually meant for either commercial or military/aerospace communications and low leakage RF. Very few cables used in these environments are remotely suitable for use with SMUs and electrometers. This, of course, is why Keithley made the SC-22 and HP/Yokogawa rolled their own (I'm pretty sure the HP cables were originally made in Japan by the Yokogawa-HP joint venture. I'm not sure if Keysight does this in Malaysia now or still gets it from Japan).



Here's a somewhat ugly looking scrap to show what Keithley's SC-22 looks like. It uses tinned copper for the outer shield and bare copper for the inner shield and center conductor. The outer jacket is PVC. The dielectric used between outer shield and inner shield is PE and between inner shield and center conductor is graphite coated PE. Looking at the SC-22 datasheet, the center conductor has a diameter of 0.063 in, which I believe is about 16 AWG (stranded). (I counted 24 strands in the center conductor, if anyone was curious.)



« Last Edit: October 09, 2020, 12:27:23 am by garrettm »


Report to moderator  Logged

The following users thanked this post: leighcorrigall

 **jogri**
Frequent Contributor
 



Posts: 366
Country: 
  

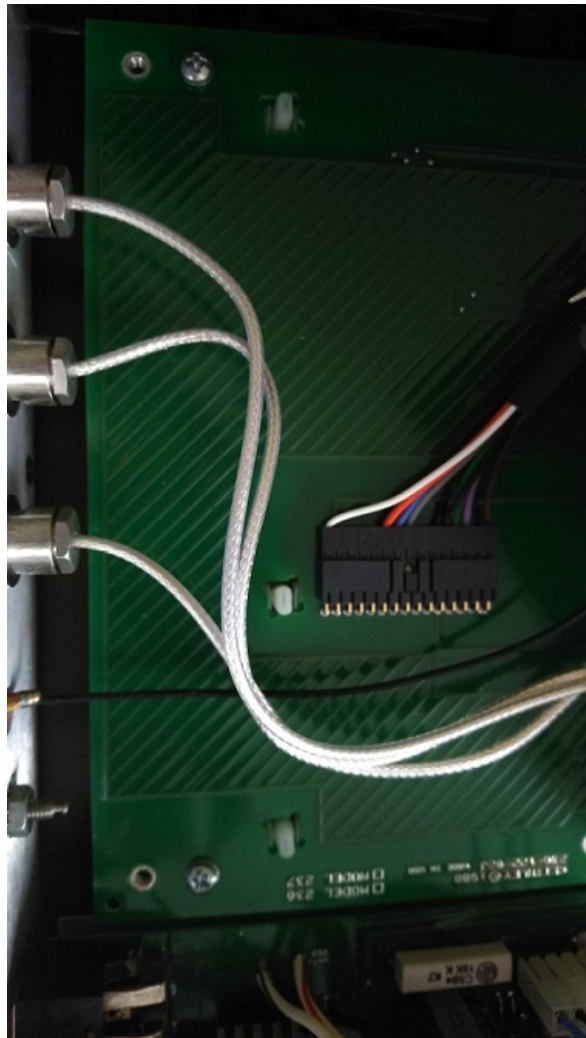
 **Re: Should I return a Keithley 238?**
« Reply #92 on: October 09, 2020, 10:39:44 am »

Say Thanks Reply Quote

Quote from: garrettm on October 09, 2020, 12:15:14 am

That's not a bad price. But those don't look like OEM cables from Keithley. That's a Trompeter connector on the end with PE insulation, clearly not the same as an SC-631 connector. I have some NEMAL 1729 triax cable that looks a lot like what's shown in the listing photos.

I wouldn't dismiss it that fast, here's a picture of the internal triax connections of a 236/237 SMU:



Same style of cable (give it a few years of UV and it probably gets the yellow/orange taint) and connectors, the only difference is that this is a sub-miniature Triax to female triax. Sadly, there are no markings on the cable and connectors, so i can't say for sure if this is the exact same cable, but since the seller has a good reputation i am rather certain that those are the same cables that Keithley used inside their 236/237 SMUs, so they should be more than good enough for this job.

Btw, i may have an answer why the Belden 9222 is that bad at low DC currents: I tried making some triax cables with it a while ago and noticed that the inner jacket tends to get pushed out A LOT when you move the cable. I had the entire cable on my desk and by the time i wanted to attach the pins i noticed that the inner jacket (w conductor) stood out a few mm more than it should. Cut it back to the required length, handled the cable for a minute or two while i attached other parts->same problem again, the inner jacket was too long. End of my attempt at using the 9222 for triax cables (what a shame though, it was the only triax i could find that was rated for 1.2 kV)
So it looks like the inner jacket can move somewhat freely inside the cable, wouldn't be surprised if that's the reason for its bad behaviour at low DC currents.

[Report to moderator](#) [Logged](#)

Howardlong

Super Contributor



Posts: 5206

Country:



Re: Should I return a Keithley 238?

« **Reply #93 on:** October 09, 2020, 12:34:35 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Possibly one of several reasons the 9222 isn't great for this application is that it uses polyethylene rather than teflon in its insulation, although I was hoping that the guard would have gone a long way to mitigating against this.

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garrettm

Frequent Contributor



Re: Should I return a Keithley 238?

« **Reply #94 on:** October 09, 2020, 06:32:33 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Quote from: jogri on October 09, 2020, 10:39:44 am

I wouldn't dismiss it that fast, here's a picture of the internal triax connections of a 236/237 SMU:



Posts: 252
Country:



Ah, but the cabling used inside the 23x SMUs is actually coaxial! Unplug one of the connectors from the mainboard to see for yourself. (They are normal SMB connectors.) Similarly, my HP 16088B semiconductor test fixture uses coax on the inside while providing triax connectors externally. Coax can be low triboelectric. Out of all my random assortment of coaxial cables I managed to find one that competes very well with the Keithley and HP special brew triaxial cables. If I get time this weekend, I'll upload some tests of it. HP also lists a low noise coaxial cable for their SMUs, though I haven't had any luck finding any online for testing.

Quote from: jogri on October 09, 2020, 10:39:44 am

Same style of cable (give it a few years of UV and it probably gets the yellow/orange taint) and connectors, the only difference is that this is a sub-miniature Triax to female triax. Sadly, there are no markings on the cable and connectors, so i can't say for sure if this is the exact same cable, but since the seller has a good reputation i am rather certain that those are the same cables that Keithley used inside their 236/237 SMUs, so they should be more than good enough for this job.

Well my friend, you don't have enough milspec cables in your lab! FEP is commonly found in brown/tan color as well as blue, but I'm not sure about clear/optically transparent. So that's not UV darkening of the jacket on the NEMAL cable, that is simply its natural coloration from the factory. Again these are not the same cables used inside the 23x SMUs. I've repaired three of these units, two 237s and one 236 and none of them used true triaxial cable inside the instrument. That seller just put "Keithley" in the listing title to get more hits from searches on eBay. Those are some surplus milspec / aerospace cables used for who knows what. I say this from having bought auction lots of surplus NASA gear and seen all the weird and wonderful shenanigans that they use and spend absurd amounts of money on.

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imgur.com

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imgur.com

The image you are requesting does not exist or is no longer available.

imgur.com

« Last Edit: October 09, 2020, 06:35:16 pm by garrettm »

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The following users thanked this post: leighcorrigan

leighcorrigan

Frequent Contributor



Posts: 393
Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #95 on: October 29, 2020, 03:25:01 pm »

Say Thanks

Reply

Quote

Hello Everyone,

I have been busy lately and I want to update you on some of the progress I have made.

The Keithley 238 is still being calibrated at a local shop because they forgot about it. 🤔

In the meantime, I purchased another Keithley 238 because I really like these instruments and I think they are a great deal compared to newer SMUs. The instrument is in flawless condition and is within specifications other than the sub-nano ampere range. While using a Keithley 2600-ALG-2, I notice that a constant -0.00067 nA offset appears for both the negative and positive range. Is this something I can fix by calibrating the unit? My plan is to provide an extremely low current reference to the Keithley 238 while in calibration mode.

Steps:

- 1) Correct for the offset (source voltage with a secondary Keithley 238 that has been verified with a Keithley DMM6500, measure with the Keithley 238 during calibration)
 - Apply a guarded external calibrated voltage of 0.0001 V with an OhmiteRX-1M1009 resistor (100 GOhm) to produce 1 fA (verified with a Keithley 6485 picoammeter)
 - Enter the calibration mode of the Keithley 238 (C0X) over GPIB
 - Calibrate the offset in the 1 nA measuring range (C42X)

- 2) Measure a 1 GOhm resistor for calibrating the Keithley 238 sub-nano ampere range
- a) Method 1
- Apply a guarded external calibrated current of 1.0000 nA with an OhmiteRX-1M1009 resistor (1 GOhm) to produce a measured voltage (source current with a Keithley 238 that has been verified with a Keithley 6485 picoammeter, measure voltage with a Keithley DMM6500)
- b) Method 2
- Apply a guarded external calibrated voltage of 1.0000 V with an OhmiteRX-1M1009 resistor (1 GOhm) to produce a 1.0000 nA current (source voltage with a Keithley 238 that has been verified with a Keithley DMM6500, measure current with a Keithley 6485 picoammeter)
- 3) Calibrate the Keithley 238 sub-nano ampere range
- Apply a guarded external calibrated voltage of 0.90000 V with an OhmiteRX-1M1009 resistor (1 GOhm) to produce a 0.9000 nA current, according to the 1 GOhm resistance value estimated in step 2.

Is there an easier way to measure a 1 GOhm resistor? Keep in mind that my Keithley DMM6500 can only measure up to 150 MOhms. Which of the two methods would be more accurate?

Thanks for your help!

[Report to moderator](#)  Logged


MASc, EIT, PhD Candidate

jogri

Frequent Contributor



Posts: 366

Country: 



 **Re: Should I return a Keithley 238?**

« Reply #96 on: October 29, 2020, 03:58:19 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Well, the usual way to do it is to crank up the voltage and then measure the voltage drop across it and a known, smaller resistor...

But why limit yourself to a 1 V output when the 238 can go up to 110 V? I'd suggest a voltage sweep from 1-110 V, that way you can apply Ohm's law and get the resistance from the slope of the UI-graph, including the error of the measurement (from the deviation).

[Report to moderator](#)  Logged


The following users thanked this post: leighcorrigan

leighcorrigan

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



 **Re: Should I return a Keithley 238?**

« Reply #97 on: October 29, 2020, 04:20:35 pm »

[Say Thanks](#)


[Reply](#)

[Quote](#)

Quote from: jogri on October 29, 2020, 03:58:19 pm

I'd suggest a voltage sweep from 1-110 V, that way you can apply Ohm's law and get the resistance from the slope of the UI-graph, including the error of the measurement (from the deviation).

This is why I cannot call myself an electrical engineer. You are brilliant. I have done similar sweeps to measure volumetric rates for other applications, but I had not thought about using the same concept for resistance. I am so glad this forum exists!

THANK YOU! 

[Report to moderator](#)  Logged


MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



 **Re: Should I return a Keithley 238?**

« Reply #98 on: November 07, 2020, 05:37:42 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

I am in the process of upgrading a recent Keithley 238 (A06) purchase to the A10 version. It can be done by reprogramming the old EPROMS or by purchasing blank replacements. I plan to purchase a programmer such as the Batronic BX32P, which Marco Reys used in his video <https://youtu.be/DLp8jdxnypc>. There are cheaper alternatives out there and I am still looking into which ones are compatible with the Keithley 238 chipset.

According to what I have interpreted from the service manual, the calibration constants are stored separately from the firmware at U33 with an LSI-83 EEROM. Hopefully, this means that I do not have to recalibrate the instrument once I have completed the upgrade. Can anyone confirm this?

Also, I have decided to buy new EPROMS for the A10 upgrade so that I still have the A06 as a backup if something happens. The new chips are about 5 CAD each. No big deal.

If I were to guess, the following chips are needed:

U17 (238-800-*): AMD AM27C256-205DC, where 205 represents the speed option, D represents the 28-pin ceramic DIP, and C represents the commercial operating range of 0 to 70 Celsius. I was able to read this from the chip because the label was not covering it. The service manual provides the following description: 32Kx8 EPROM 27C256 (238-800-*), where the * represents the firmware version.

The service manual provides the following description: 65Kx8 CMOS EPROM 27C512 (238-801-*), where the * represents the firmware version. The problem is that I cannot identify the U31 chip because it is covered by a label.

Applying the same logic to the U31 (238-801-*), I should order the following:

U31 (238-801-*): AMD AM27C512-205DC 🙄

Can anyone confirm the information on the EPROM located at U31? I do not want to remove the firmware label and risk erasing the firmware.

« Last Edit: November 08, 2020, 04:38:04 pm by leighcorriganl »

Report to moderator Logged

MASc, EIT, PhD Candidate

Qw3rtzuiop

Regular Contributor



Posts: 182

Country:



Re: Should I return a Keithley 238?

« Reply #99 on: November 07, 2020, 06:07:30 pm »

Say Thanks

Reply

Quote

Quote from: leighcorriganl on November 07, 2020, 05:37:42 pm

Can anyone confirm the information on the EPROM located at U31? I do not want to remove the firmware label and risk erasing the firmware.

You can remove the label. It will take some amount of UVC to erase it. And if you are indoor there is not much of it at all.

But i can confirm the 801 can be a AM27C512-205DC. I installed it because my unit had an OTP variant of the AM27C512 EPROM in it.

Report to moderator Logged

The following users thanked this post: leighcorriganl

leighcorriganl

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #100 on: November 10, 2020, 11:15:20 pm »

Say Thanks

Reply

Quote

The integrated chips have arrived and I am in the middle of replacing the basics. Turns out that I did not order nearly enough... 🙄

U17:

Original: AM27C256-205DC (AMD)

Replacement: AM27C256-120DC (AMD, speed upgrade)

Result: TBD, still waiting on the EPROM programming that is arriving by mail

U31:

Original: AM27C512-205DC (AMD, assumed from the service manual)

Replacement: AM27C512-120DI (AMD, broad temperature range and speed upgrade)

Result: TBD, still waiting on the EPROM programming that is arriving by mail

U15 & U25:

Original: ST 2 9122 EF68B09P (ST Micro Electronics)

Replacement: MC68B09CP (Motorola)

Result: U25 has been replaced and the instrument powers on, U15 still requires a replacement

I originally purchased a PAL16L8ACN to replace U16, but the Keithley 238 (A06) does not seem to accept this chip. Do I have to program it first or is there something wrong with the part number? I thought these were logic chips:

U16:

Original: PAL16L8ACN 120GRX0 IC-582-A (Monolithic Memories Inc)

U26:

Original: PAL16L8ACN 016IRFX IC-682-A (Monolithic Memories Inc)

Does anyone have experience with U16 and U26 replacement? I suspect it has to do with the 'IC-

582A' and 'IC-682-A', respectively. Attached is a reference for the digital board components with U25 replaced and all others original.

 Replaceable Digital Board Components.pdf (367.97 kB - downloaded 63 times.)

[Report to moderator](#)  Logged

MASc, EIT, PhD Candidate

 **Howardlong**

Super Contributor



Posts: 5206

Country: 



 **Re: Should I return a Keithley 238?**


« **Reply #101 on:** November 10, 2020, 11:25:07 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote from: leighcorrigan on November 10, 2020, 11:15:20 pm

The integrated chips have arrived and I am in the middle of replacing the basics. Turns out that I did not order nearly enough... 

U17:

Original: AM27C256-205DC (AMD)

Replacement: AM27C256-120DC (AMD, speed upgrade)

Result: TBD, still waiting on the EPROM programming that is arriving by mail

U31:

Original: AM27C512-205DC (AMD, assumed from the service manual)

Replacement: AM27C512-120DI (AMD, broad temperature range and speed upgrade)

Result: TBD, still waiting on the EPROM programming that is arriving by mail

U15 & U25:

Original: ST 2.9122 EF68B09P (ST Micro Electronics)

Replacement: MC68B09CP (Motorola)

Result: U25 has been replaced and the instrument powers on, U15 still requires a replacement

I originally purchased a PAL16L8ACN to replace U16, but the Keithley 238 (A06) does not seem to accept this chip. Do I have to program it first or is there something wrong with the part number? I thought these were logic chips:

U16:

Original: PAL16L8ACN 120GRX0 IC-582-A (Monolithic Memories Inc)

U26:

Original: PAL16L8ACN 016IRFX IC-682-A (Monolithic Memories Inc)

Does anyone have experience with U16 and U26 replacement? I suspect it has to do with the 'IC-582A' and 'IC-682-A', respectively. Attached is a reference for the digital board components with U25 replaced and all others original.

Are you sure the PALs & MPUs require replacement?

Is it not just an EPROM rewrite?


[Report to moderator](#)  Logged

 **leighcorrigan**

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



 **Re: Should I return a Keithley 238?**

« **Reply #102 on:** November 10, 2020, 11:43:01 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote from: Howardlong on November 10, 2020, 11:25:07 pm

Are you sure the PALs & MPUs require replacement?

Is it not just an EPROM rewrite?

The second Keithley 238 (A06) that I purchased is experiencing some glitches which might be old chips or the firmware. The replacement cost is cheap, so I might as well do them all by ordering them from the same legacy distributor. On another repair thread, someone discovered that a chip was faulty in a Keithley 237, which was causing some of the faulty readings. I am just trying to do the easy stuff before I get into the dirty work of replacing capacitors and other vulnerable components.

Attached is an example of a glitch. Notice that the 'operate' indicator is not even on?



IMG_20201109_235216.jpg (1844.61 kB, 4016x3008 - viewed 151 times.)

[Report to moderator](#) Logged

MASc, EIT, PhD Candidate

garrettm
Frequent Contributor



Posts: 252
Country:



Re: Should I return a Keithley 238?

« **Reply #103 on:** November 11, 2020, 05:34:47 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

The issue with the operate annunciator could be on the display board. I just fixed a Wavetek 90 sig. gen. and a Racal-Dana 5002 wideband voltmeter that needed some simple logic/multiplexing ICs replaced for the keyboards to work right.

When I get some time later today I'll have a look at the service manual and let you know what IC's I would take a look at. Still doesn't hurt to update the firmware.

What other glitches are you experiencing with the unit?

« *Last Edit:* November 11, 2020, 05:40:36 pm by garrettm »

[Report to moderator](#) Logged

Howardlong
Super Contributor



Posts: 5206
Country:



Re: Should I return a Keithley 238?

« **Reply #104 on:** November 11, 2020, 05:39:37 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Quote from: leighcorrigan on November 10, 2020, 11:43:01 pm

Quote from: Howardlong on November 10, 2020, 11:25:07 pm

Are you sure the PALs & MPUs require replacement?

Is it not just an EPROM rewrite?

The second Keithley 238 (A06) that I purchased is experiencing some glitches which might be old chips or the firmware. The replacement cost is cheap, so I might as well do them all by ordering them from the same legacy distributor. On another repair thread, someone discovered that a chip was faulty in a Keithley 237, which was causing some of the faulty readings. I am just trying to do the easy stuff before I get into the dirty work of replacing capacitors and other vulnerable components.

Attached is an example of a glitch. Notice that the 'operate' indicator is not even on?

What happens when the glitch occurs, does it hang? Are the symptoms always the same?


I did have a glitch problem with one of mine, where it turned out the coin cell battery backup holder wasn't making proper connection, the finger on top wasn't holding the battery down firmly. Once I'd fixed that, by bending the finger back appropriately, it's been fine.

 leighcorrigan

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist

 **Re: Should I return a Keithley 238?**

« Reply #105 on: November 11, 2020, 06:07:36 pm »

Say Thanks

Reply

Quote

Quote from: Howardlong on November 11, 2020, 05:39:37 pm

What happens when the glitch occurs, does it hang? Are the symptoms always the same?

I did have a glitch problem with one of mine, where it turned out the coin cell battery backup holder wasn't making a proper connection, the finger on top wasn't holding the battery down firmly. Once I'd fixed that, by bending the finger back appropriately, it's been fine.

The glitch does not hang on the Keithley 238 (A06), I changed the source mode afterwards and it pretended nothing happened by returning to zero. I believe that there are glitches when sweeping as the source repeatedly fails at a specific range. What I mean is that the current doesn't change for a few steps and then resumes as if nothing happened.

[attach=1]

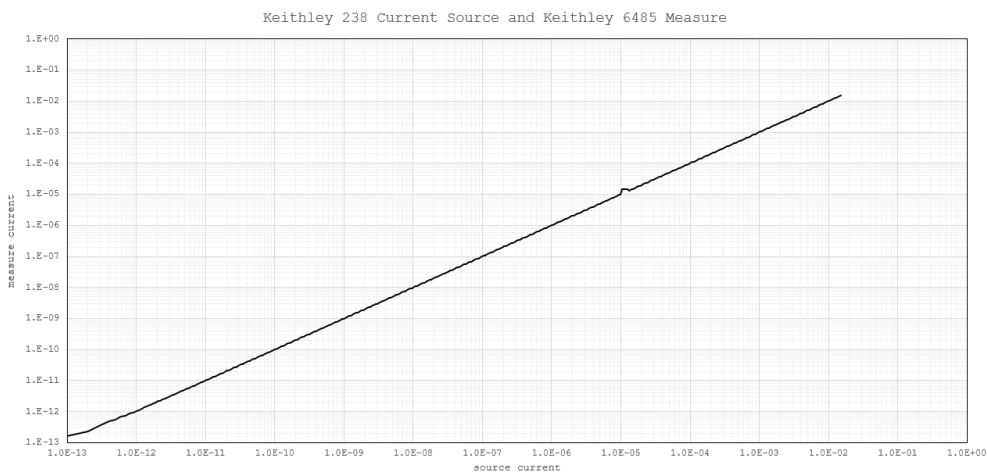
When I manually verify the range with the Keithley 6485, it meets specifications. So something is either messed up in the firmware or the digital hardware has math problems when a certain operation is given.

The voltage measure during the same operation is also suspicious. The voltage measure seems to be misaligned corresponding to the various current ranges (10 mA through 1 nA). I assume that these corresponding voltage misalignments must occur at higher current sources too, but I have not verified. This does not occur on the other Keithley 238 (A10) model. Either the voltage needs to be calibrated or something else is going on. I believe that the voltage misalignments are all related somehow because the pattern is highly consistent with the current ranges.

[attach=2]

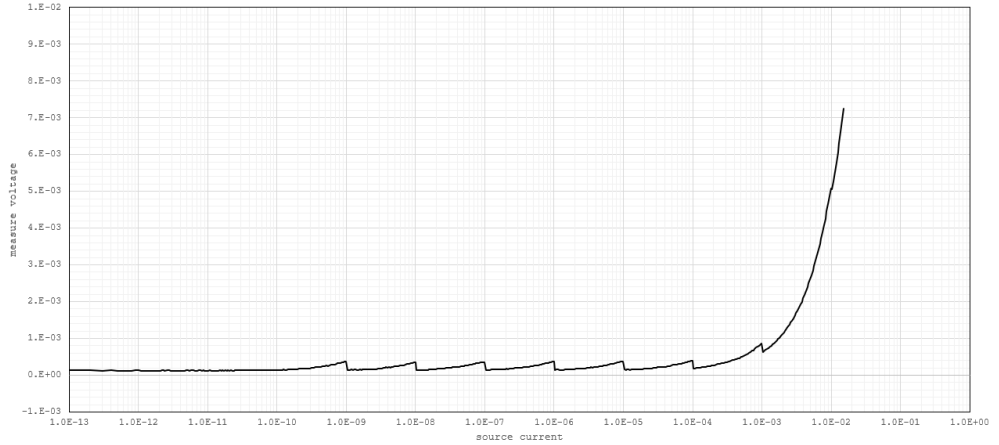
Other than that, the instrument performs within specification. As I have gone through all the combinations according to the calibration procedure.

The battery was replaced and the finger is holding it down firmly.



 repeatable glitch at the 1E-5 A range.PNG (71.48 kB, 1279x613 - viewed 38 times.)

Keithley 238 Current Source and Measure



[[voltage ranging seems to be misaligned suggesting that it may need calibration.PNG (73.58 kB, 1278x613 - viewed 39 times.)

Report to moderator Logged

MASc, EIT, PhD Candidate

RomDump
Regular Contributor



Posts: 89
Country:

Re: Should I return a Keithley 238?
« Reply #106 on: November 11, 2020, 07:03:44 pm »

Say Thanks Reply Quote

Quote from: leighcorrigan on November 10, 2020, 11:15:20 pm

U16:
Original: PAL16L8ACN 120GRX0 IC-582-A (Monolithic Memories Inc)

U26:
Original: PAL16L8ACN 016IRFX IC-682-A (Monolithic Memories Inc)

Does anyone have experience with U16 and U26 replacement? I suspect it has to do with the 'IC-582A' and 'IC-682-A', respectively. Attached is a reference for the digital board components with U25 replaced and all others original.

Did I miss something? These are custom programmed chips. Do you have a PAL programmer with the PAL Jedec file or the original Equation file?

If you can get the Jedec file you can convert it to GAL CHIP which is easier to program.

If you don't have the JEDEC file or EQN file, you can use known good PAL you can build a device to try every logic combination and create a EQN file.

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--
RomDump

leighcorrigan
Frequent Contributor



Posts: 393
Country:
Nuclear Materials Scientist

Re: Should I return a Keithley 238?
« Reply #107 on: November 11, 2020, 07:40:47 pm »

Say Thanks Reply Quote

Quote from: RomDump on November 11, 2020, 07:03:44 pm

Quote from: leighcorrigan on November 10, 2020, 11:15:20 pm

U16:
Original: PAL16L8ACN 120GRX0 IC-582-A (Monolithic Memories Inc)

U26:
Original: PAL16L8ACN 016IRFX IC-682-A (Monolithic Memories Inc)

Does anyone have experience with U16 and U26 replacement? I suspect it has to do with the 'IC-582A' and 'IC-682-A', respectively. Attached is a reference for the digital board components with U25 replaced and all others original.

Did I miss something? These are custom programmed chips. Do you have a PAL programmer with the PAL Jedec file or the original Equation file?

If you can get the Jedec file you can convert it to GAL CHIP which is easier to program.

If you don't have the JEDEC file or EQN file, you can use known good PAL you can build a device to try every logic combination and create a EQN file.

Well, I didn't know it needed programming. Do you know how reliable these chips are? I am trying to debug some glitches that are happening. Thanks.

[Report to moderator](#) Logged

MASc, EIT, PhD Candidate

garrettm
Frequent Contributor



Posts: 252
Country:

Re: Should I return a Keithley 238?
« **Reply #108 on:** November 11, 2020, 11:14:31 pm »

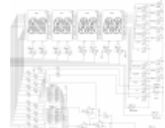
[Say Thanks](#) [Reply](#) [Quote](#)

Looking at the display schematic for the 236/7 SMUs--since the 238 service manual doesn't provide one--I would think U10 might be the cause of the unlit operate light.

U10 appears to be a 5895A-2, 8-bit serial, latched source driver that works with U8 (an 8-channel sink driver) to control a portion of the the LED indicators and multi-segment display. U8 outputs 5 through 8 are left unused.

If output 4 or 5 on U10 was having issues, I would think there should also be errors in the last four multi-segment displays... It is also possible that the LED is bad, but I've yet to see an LED fail when used as a low power indicator lamp.

U8_2596AU.pdf (63.24 kB - downloaded 31 times.)
 U10_5895A-2.pdf (388.19 kB - downloaded 30 times.)



display_schematic.png (1002.78 kB, 1906x1607 - viewed 78 times.)

« Last Edit: November 11, 2020, 11:24:42 pm by garrettm »

[Report to moderator](#) Logged

RomDump
Regular Contributor



Posts: 89
Country:

Re: Should I return a Keithley 238?
« **Reply #109 on:** November 12, 2020, 02:04:07 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Quote from: leighcorrigan on November 11, 2020, 07:40:47 pm

Well, I didn't know it needed programming. Do you know how reliable these chips are? I am trying to debug some glitches that are happening. Thanks.

I really doubt the PAL's are bad since the unit appears to be semi-working but I can be wrong. From your schematic U16 is an address decoder for the 6809. You can probably figure out the logic by knowing what address each device on the bus is located, (it is printed on the schematic). If you probe, only one line should be active at a time.

I didn't see U26 on your schematic you posted so I don't know the function.

I don't understand the term "Glitching". Is the CPU resetting in between measurements? Is the measurements having erroneous data corruption?

[Report to moderator](#) Logged

--
RomDump

leighcorrigan
Frequent Contributor



Posts: 393
Country:
Nuclear Materials Scientist

Re: Should I return a Keithley 238?
« **Reply #110 on:** November 12, 2020, 03:27:11 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Quote from: RomDump on November 12, 2020, 02:04:07 pm

I don't understand the term "Glitching". Is the CPU resetting in-between measurements? Are the measurements having erroneous data corruption?

I have already presented some of the glitches as figures and an image of the front panel. Instead, I will move onto another example.



In an attempt to run another sweep, the computer controlling the GPIB interface crashed twice. I ended up redefining the current sweep program from 15 mA < I < 0 nA to 1 mA < I < 0 nA. The hope was by replacing U25 with a new Motorola chip, the glitch may disappear. The results are as follows for the Keithley 238 (A06) current sweep:

[attach=1] (15 mA to 0 nA)

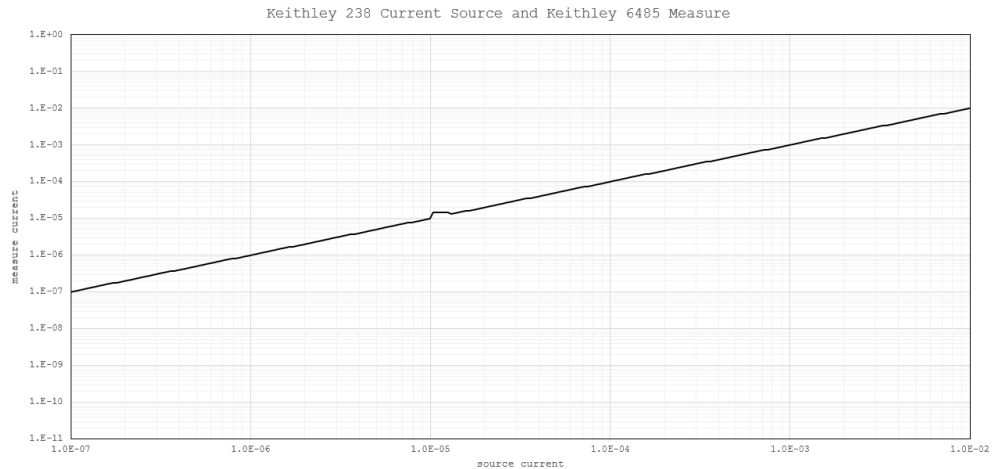
[attach=2] (1 mA to 0 nA)

****All parameters remained the same with the exception of the starting parameter.****

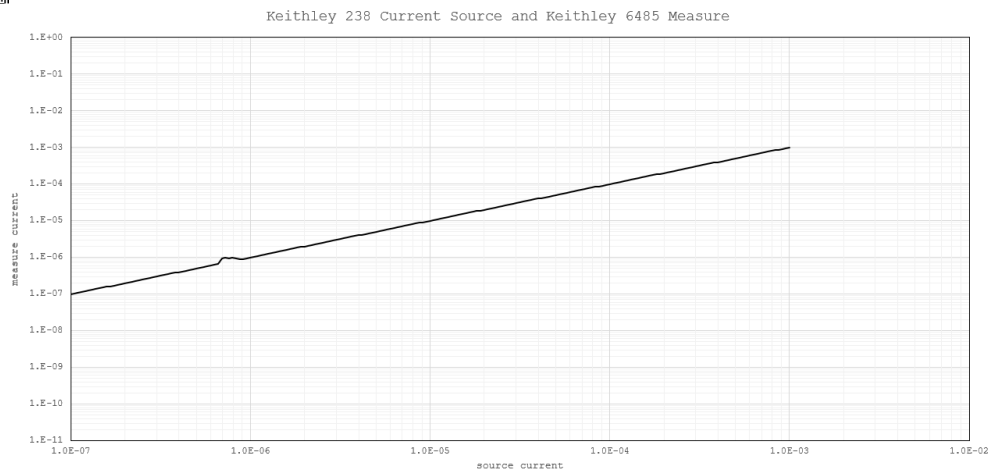
What you may notice is that the anomaly has shifted equal distance across as the difference in the starting current. This suggests a problem with the digital board rather than the analogue board. The anomaly is repeatable and appears in the exact same area, depending on the sweep range provided. This is one example of what I mean by 'glitch'. If I manually enter a DC current in the range of the anomaly, the Keithley 6485 indicates that the source matches the measurement well within specifications.

[attach=3]

I am really hoping this can be remedied by upgrading the firmware from A06 to A10. Maybe it has to do with the memory where the sweep data is stored prior to GPIB data transfer. This is what I am trying to find out by replacing chips.



15 mA to 0 nA sweep.PNG (59.06 kB, 1280x616 - viewed 54 times.)



1 mA to 0 nA sweep.PNG (58.69 kB, 1281x615 - viewed 55 times.)



DC current source.PNG (759.31 kB, 674x510 - viewed 84 times.)

[Report to moderator](#) Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« **Reply #111 on:** November 12, 2020, 03:33:44 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote from: garrettm on November 11, 2020, 11:14:31 pm

Looking at the display schematic for the 236/7 SMUs--since the 238 service manual doesn't provide one--I would think U10 might be the cause of the unlit operate light.

The operate light typically turns on when it is supposed to. The strange thing about the picture is that the machine was not in an operate mode when it was indicating a source value. This does not seem normal to me because I own another Keithley 238 (A10) that have never done this before. I am only experiencing these glitches on the A06 instrument. The more I play around with it, the more I think it has to do with the digital hardware or the software.

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MASc, EIT, PhD Candidate

RomDump

Regular Contributor



Posts: 89

Country:



Re: Should I return a Keithley 238?

« **Reply #112 on:** November 12, 2020, 05:07:12 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote from: leighcorrigan on November 12, 2020, 03:27:11 pm

In an attempt to run another sweep, the computer controlling the GPIB interface crashed twice.

What do you mean crashed? Stopped responding? Did you have to Power Cycle?

Quote from: leighcorrigan on November 12, 2020, 03:27:11 pm

What you may notice is that the anomaly has shifted equal distance across as the difference in the starting current. This suggests a problem with the digital board rather than the analogue board. The anomaly is repeatable and appears in the exact same area, depending on the sweep range provided. This is one example of what I mean by 'glitch'.

The Plot is showing corrupted Data. I assumed that the data from the ADC is first stored in the DUAL

Port ram U12 IDT7130. Maybe something is wrong with this chip or the transfer to/from this chip. This is just a guess based on what you presented me, but I would look around this area. If you had a logic analyzer you could check what is happening with the bus. Also capture the data to the Dual Port Ram.

Report to moderator Logged

--
RomDump

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #113 on: November 12, 2020, 05:12:47 pm »

Say Thanks

Reply

Quote

Quote from: RomDump on November 12, 2020, 05:07:12 pm

Quote from: leighcorrigan on November 12, 2020, 03:27:11 pm

In an attempt to run another sweep, the computer controlling the GPIB interface crashed twice.

What do you mean crashed? Stopped responding? Did you have to Power Cycle?

The PC laptop is garbage. It literally crashed twice as I was running a LabVIEW code I was running. What I mean by crashed, is that it unexpectedly restarted.

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #114 on: November 12, 2020, 05:16:01 pm »

Say Thanks

Reply

Quote

Quote from: RomDump on November 12, 2020, 05:07:12 pm

Quote from: leighcorrigan on November 12, 2020, 03:27:11 pm

What you may notice is that the anomaly has shifted equal distance across as the difference in the starting current. This suggests a problem with the digital board rather than the analogue board. The anomaly is repeatable and appears in the exact same area, depending on the sweep range provided. This is one example of what I mean by 'glitch'.

The Plot is showing corrupted Data. I assumed that the data from the ADC is first stored in the DUAL Port ram U12 IDT7130. Maybe something is wrong with this chip or the transfer to/from this chip. This is just a guess based on what you presented me, but I would look around this area. If you had a logic analyzer you could check what is happening with the bus. Also capture the data to the Dual Port Ram.

I don't have a logic analyzer and I don't even know how to use one. My background is in material science. All I have is a few SMUs, DMMs, a PSU, and an electrometer.

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #115 on: November 12, 2020, 05:26:00 pm »

Say Thanks

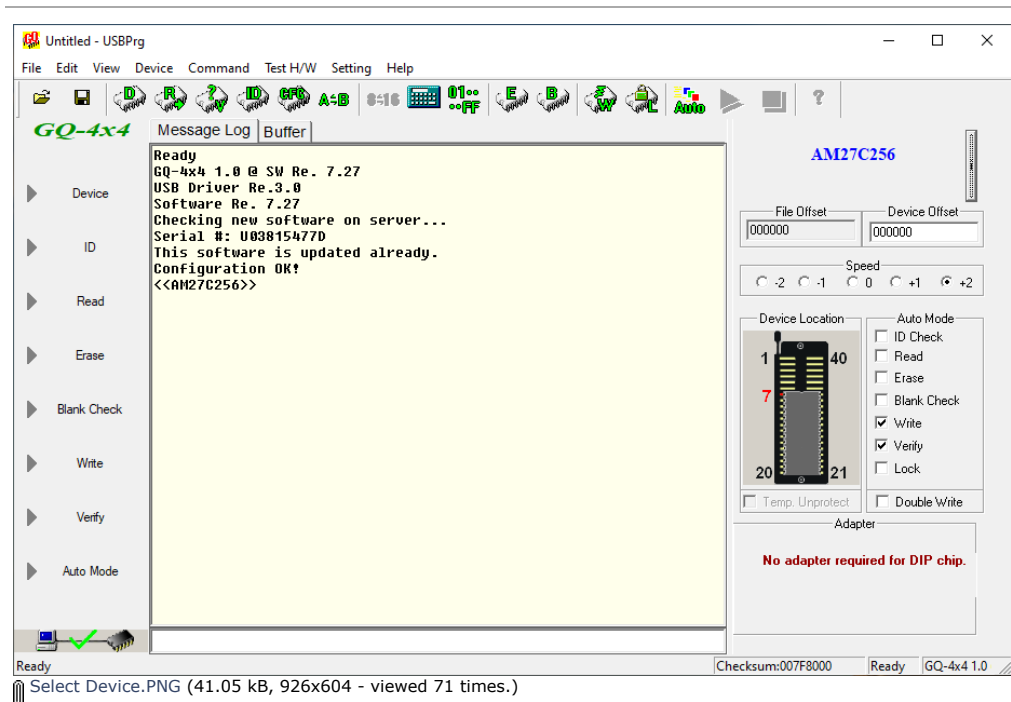
Reply

Quote

Are there any specific parameters that I need to adjust to program the EPROM firmware? My first attempt left the Keithley 238 showing random lights on the front panel. I used the following BIN files from xDevs.com:

<https://xdevs.com/doc/Keithley/238/firmware/>

Unfortunately, there are no instructions given. Should I leave the Device Offset and Speed alone?



[Report to moderator](#) Logged

MASc, EIT, PhD Candidate

RomDump

Regular Contributor



Posts: 89

Country:



Re: Should I return a Keithley 238?

« Reply #116 on: November 12, 2020, 05:54:11 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote from: leighcorrigan on November 12, 2020, 05:12:47 pm

Quote from: RomDump on November 12, 2020, 05:07:12 pm

Quote from: leighcorrigan on November 12, 2020, 03:27:11 pm

In an attempt to run another sweep, the computer controlling the GPIB interface crashed twice.

What do you mean crashed? Stopped responding? Did you have to Power Cycle?

The PC laptop is garbage. It literally crashed twice as I was running a LabVIEW code I was running. What I mean by crashed, is that it unexpectedly restarted.

Oh thought you meant the Keithley was crashing. It more looks like data corruption. I think the CPU, EPROM's, PALS are fine. If there was a problem with these the symptoms would be unresponsive unit. You should really check the dual port ram. Also the dual port ram may be fine but something on the power rail may be causing an issue, (i.e. 0.1uF capacitor C35). Blindly changing chips until the problem is resolved isn't really troubleshooting the root cause and is very expensive.

[Report to moderator](#) Logged

--

RomDump

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Re: Should I return a Keithley 238?

« Reply #117 on: November 12, 2020, 06:09:25 pm »

[Say Thanks](#)

[Reply](#)

[Quote](#)

Quote from: RomDump on November 12, 2020, 05:54:11 pm

Oh thought you meant the Keithley was crashing. It more looks like data corruption. I think the CPU, EPROM's, PALS are fine. If there was a problem with these the symptoms would be unresponsive unit. You should really check the dual port ram. Also the dual port ram may be fine but something on the power rail may be causing an issue, (i.e. 0.1uF capacitor C35). Blindly changing chips until the problem is resolved isn't really troubleshooting the root cause and is very

Nuclear Materials Scientist



expensive.

I doubt it is C35. My first Keithley 238 (A10) had a broken cap at that location and it did not make any difference.

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #118 on: November 12, 2020, 06:18:13 pm »

Say Thanks

Reply

Quote

Quote from: leighcorrigan on November 12, 2020, 05:26:00 pm

Are there any specific parameters that I need to adjust to program the EPROM firmware? My first attempt left the Keithley 238 showing random lights on the front panel. I used the following BIN files from xDevs.com:

<https://xdevs.com/doc/Keithley/238/firmware/>

Unfortunately, there are no instructions given. Should I leave the Device Offset and Speed alone?

The following codes are now displaying on the Keithley 238 (A06):

IOU CAL CHECKSUM

CAL INVALID ERROR

Somehow I managed to compromise the calibration constants and I wasn't even able to upgrade the firmware. Not great...

Report to moderator Logged

MASc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #119 on: November 23, 2020, 10:51:33 pm »

Say Thanks

Reply

Quote

Where to begin...

Professional Calibration:

Well, I received my Keithley 238 (A10) back from calibration. They informed me that there are source/measure ranges that cannot be fixed with calibration alone and suggested that I do a repair job with them. Attached is a summary of a full logarithmic current sweep before and after calibration and the calibration table which outlines the failures.

[attach=1]

Something is clearly wrong with the source/measure capabilities of the SMU above 15 V. The SMU also fails to be within the 10 uA range measurement specifications.

Keithley 6485 Measurement Validation

The Keithley 6485, which I used to measure the current sweeps before and after from the Keithley 238 (A10), appears to be within specifications as indicated by the first attachment. At least this is

good news.

Firmware Upgrading

The second Keithley 238 (A06) I purchased was refurbished similarly to the first unit (A10). It was in good working condition and appeared to be within specifications. I tried to update the firmware with the A10 BIN files found on xDevs.com <https://xdevs.com/doc/Keithley/238/firmware/> (**~~EDIT: DO NOT USE THIS FIRMWARE AS IT IS LIKELY CORRUPT! EDIT: xDevs.com has replaced the previous firmware~~**). The upgrade somehow resulted in the front panel showing random lights. Nothing I did seemed to make it function properly. When I rolled back the A06 firmware, the operating system returned to normal but error messages appear stating that my calibration constants were no longer valid.

Quote from: leighcorrigan on November 12, 2020, 06:18:13 pm

The following codes are now displaying on the Keithley 238 (A06):

IOU CAL CHECKSUM

CAL INVALID ERROR

Somehow I managed to compromise the calibration constants and I wasn't even able to upgrade the firmware. Not great...

~~There must be differences in the hardware as I have verified with another user that the A10 firmware they uploaded is correct.~~ **EDIT: A forum member named JxR has debunked this hypothesis because he has determined that the firmware he uploaded was incorrectly copied. He has provided firmware that should now be correct. I will test his corrected firmware and post my findings.**

Calibration of the Keithley 238 (A06)

The calibration of the Keithley 238 is a complicated mess according to the Service Manual. This can be greatly simplified, by having access to the following equipment:

- an electrometer (Keithley 6485) for the 10 mA to 1 nA range
- a 6.5 digital multimeter (Keithley DMM6500) or better for the entire voltage range and the 1 A to 100 mA range
- three triax cables, a BNC to triax adapter, two double banana to BNC adapters, and female to female BNC adapters

Attached is a spreadsheet that helps with the commands of each step. I have included the data I collected for each step so that it is easier for you to get a sense of the responses.

[attach=2]

Note:

- Since the calibration commands can be executed in any order you want, begin by calibrating the zero offsets to save time.
- There is very little indication of what is going on once the COX command is executed. Be aware of what you are doing for each step. You can always exit the calibration step and then verify that you have done a step correctly.
- The calibration button in the back must be inserted inward to permanently change the calibration constants. Once you have completed all steps, make sure the button is returned to the outward position. It might help to practice before getting too far into the calibration procedure.
- The uV range zero offsets is difficult to calibrate. You may have to experiment a bunch before getting it right. Take many samples before sending the offset value.

Anyway, hope this is beneficial to some folks! 🙏

📎 2020 09 18 - Logarithmic Sweep from 015 mA to 100 fA with 65 second time steps at 50 counts per decade at a rate of 5 NPLC.xlsx (3563.17 kB - downloaded 25 times.)

📎 2020 11 14 - Keithley 238 Calibration Procedure.xlsx (26.46 kB - downloaded 15 times.)

« Last Edit: November 25, 2020, 02:29:53 am by leighcorrigan »

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MASc, EIT, PhD Candidate

 **leighcorrigan**

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



📎 Re: Should I return a Keithley 238?

« Reply #120 on: November 23, 2020, 10:53:49 pm »

Say Thanks

Reply

Quote

Power Supply Checks

Since the professional calibration service representatives have said that my Keithley 238 (A10) has flaws, I thought I would begin by testing the power supplies to see if that was the source of problems. Recall, that this instrument had its transformer blow up and replaced before I inherited it so there could be secondary damage after the transformer taps.

I did an initial attempt and was surprised by how different the measurements were. This prompted me to test my Keithley 238 (A06) unit to see if I could correlate the results. Have I made a mistake with the identification of the digital common, floating common, and output common references?

Maybe there are mistakes in the Keithley Service Manual as they seem to have frequent mistakes in the documentation. Below is a physical representation of where most of the test points reside on the back of the digital board. In my opinion, it was much easier to access these pins from the back.

[attach=1]

Below are the results for both instruments:

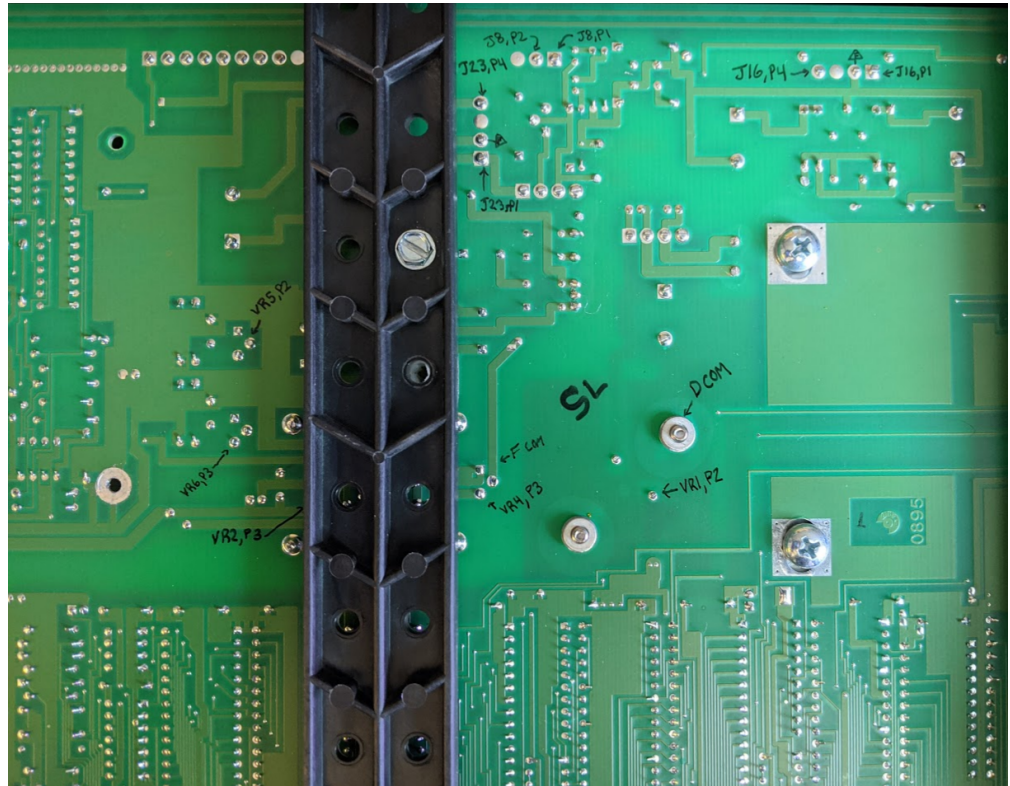
[attach=2]

The following did not match Table 3-3 from the Service Manual for both instruments:
 +5 DCV digital supply (actual: 4.98 V, 4.96 V)
 ±150 DCV floating supply (actual: +193.80/-193.50 V, +191.90/-190.05 V)

±24 DCV floating supply (+38.14/-38.14 V, +38.00/-37.93 V)

Note that I disconnected the ground from the output LO common before taking measurements.

I would be happy if someone else could kindly share their own results because I find it strange that both of my instruments share vary similar results to each other, even as they are very different builds.



Power Supply Checks - Physical Layout.PNG (2662.7 kB, 1213x951 - viewed 52 times.)

2020 11 23 - Keithley 238 - Power Supply Checks.xlsx (13.76 kB - downloaded 15 times.)

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MAsc, EIT, PhD Candidate

leighcorrigan

Frequent Contributor



Posts: 393

Country:

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #121 on: November 24, 2020, 03:42:03 pm »

Say Thanks Reply Quote

Quote from: leighcorrigan on November 23, 2020, 10:51:33 pm

EDIT: I will test his corrected firmware and post my findings.

Keithley 238 Firmware

A06: These .bin files copied from my own hardware and have been proven to work.
A10: These .bin files are the latest and were taken recently from a forum member named JxR. I confirm that they are working. ~~Do not download the firmware from xDevs.com because they are corrupt and will wreck your calibration constants.~~ xDevs.com has replaced the precious firmware.

BIN.zip (445.28 kB - downloaded 17 times.)

« Last Edit: November 25, 2020, 02:27:30 am by leighcorrigan »

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MAsc, EIT, PhD Candidate

TiN

Super Contributor



Re: Should I return a Keithley 238?

« Reply #122 on: November 25, 2020, 02:19:55 am »

Say Thanks Reply Quote

Firmware at xDevs repository is fixed now. I had no ability to test what people uploading before, as I don't have any 236/237/238's.

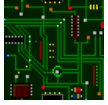
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Posts: 4517
Country:
#StopRussianWar

Zucca

Supporter



Posts: 3879
Country:
EE meid in Itali

leighcorrigan

Frequent Contributor



Posts: 393
Country:
Nuclear Materials Scientist

[YouTube](#) | [Metrology IRC Chat room](#) | Let's share T&M documentation? [Upload!](#) No upload limits for firmwares, photos, files.

The following users thanked this post: leighcorrigan

Re: Should I return a Keithley 238?
« Reply #123 on: November 25, 2020, 10:59:23 am »

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leighcorrigan amazing job, please continue to pump passion in your devices and share with us.



[Report to moderator](#)

Can't know what you don't love. St. Augustine
Can't love what you don't know. Zucca

The following users thanked this post: leighcorrigan

Re: Should I return a Keithley 238?
« Reply #124 on: November 26, 2020, 12:49:03 pm »

[Say Thanks](#) [Reply](#) [Quote](#)

Quote from: leighcorrigan on November 12, 2020, 03:27:11 pm

I am really hoping this can be remedied by upgrading the firmware from A06 to A10. Maybe it has to do with the memory where the sweep data is stored prior to GPIB data transfer.

Success! The glitches that I had originally observed were a result of the A06 firmware. There are no observable problems with the upgraded Keithley 238 that originally had the A06 version. For whatever reason, firmware version A10 has corrected the problems I observed while sweeping current.

[attachimg=1]

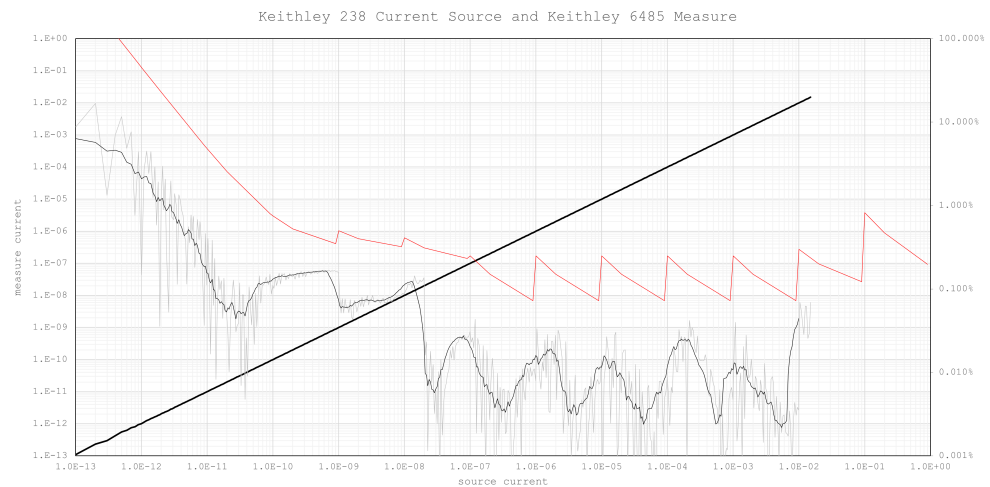
Legend:

The red line indicates the tolerance range of the Keithley 238 that was available from the specifications.

The thick black line indicates the current measurements of the Keithley 6485 that were sourced from the Keithley 238.

The grey line is the % error between the expected and observed current.

The thin black line is an average of 10 filter to smooth the % error.



2020 11 25 - Keithley 238 II (A10) LOG Sweep from 015 mA to 000 fA with 65 sec time steps at 50 counts per decade at a rate of 5 NPLC.png (945.25 kB, 4259x2133 - viewed 44 times.)

« Last Edit: November 26, 2020, 12:56:35 pm by leighcorrigan »

[Report to moderator](#)

MASc, EIT, PhD Candidate

 **leighcorrigall**

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



 **Re: Should I return a Keithley 238?**

« Reply #125 on: December 07, 2020, 03:44:53 pm »

Say Thanks

Reply



Quote

Hi Friends,

I want to discuss how I can diagnose a suspected physical defect of the 100 V measurement range of the Keithley 238 I (A10) model I have.

A calibration procedure was conducted with a Keithley 6500 DMM with 6.5 digits of precision that was calibrated in August 2020. Let's assume that the accuracy is better than 0.035 % for this instrument, which would be sufficient to calibrate that Keithley 238. I have already calibrated another Keithley 238 this way, so I think it is reasonable to assume that this method works.

After calibration, the instrument was able to source voltages between 15 V to 110 V with high accuracy, according to my Keithley 6500, another Keithley 238, and a Keithley 2200-32-3. However, when measuring voltages at this range, the instrument is well outside of specifications. The table below represents these voltage measurements:

[attaching=1]  

I performed another calibration procedure afterwards in an attempt to correct the shortcomings, but without success. It does not appear that results are a consequence of human error.

What I noticed while verifying the measurement ranges is that if I set the voltage compliance to 15 V, the Keithley 238 can measure 10 V precisely. However, setting the compliance limit to anything greater than 15 V will cause the instrument to use the 100 V range. The same 10 V measurement will read out of tolerance. I believe that the 100 V measurement range of this device is faulty.


On inspection of the service manual, it appears that the voltage sourcing and measuring are separated between two boards. The following simplified schematic appears to be what defines the voltage measurements. **Can anyone confirm this?** I am a humble materials scientist and not electrically trained but I am trying to learn.

[attaching=2]

I also notice that there are strong resemblances between the Keithley 238 and Keithley 236/7 design in this context, so I think that the following electrical schematic applies. The major differences being the R18, R16, R 17 assembly for the 1000 V range, and the K7 relay.

[attaching=3]

[attaching=4]

If I had to guess the cause of the 100 V range measurement problem, I would say that it has to do with either R4 or R15. I know this to be true because the 1.5 V measurement range (K6) seems to be in working order. Before I start tearing the board apart, does anyone have advice for me on where I could start? I believe I have most equipment necessary to diagnose and repair the board, I just need help on where to begin. 

Thanks for your thoughts and input.

Regards.

4.2 Voltage Measure Calibration:													
voltage compliance range	applied voltage	% accuracy	voltage offset	minimum	measured	maximum	LOW	HIGH	tolerance	% error	ABS(% error)	± % tolerance	
1.5	0.00000	0.028%		4.50E-04	-4.50000E-04	-0.00010	4.50000E-04	TRUE	TRUE	TRUE	#N/A	#N/A	#N/A
1.5	1.00000	0.028%		4.50E-04	9.99270E-01	0.99975	1.00073E+00	TRUE	TRUE	TRUE	0.025%	0.025%	0.073%
1.5	-1.00000	-0.028%		4.50E-04	-1.00073E+00	-0.99990	-9.99270E-01	TRUE	TRUE	TRUE	-0.010%	0.010%	0.073%
1.5	1.39982	0.028%		4.50E-04	1.39898E+00	1.39968	1.40066E+00	TRUE	TRUE	TRUE	0.001%	0.001%	0.060%
1.5	-1.40024	-0.028%		4.50E-04	-1.40108E+00	-1.39968	-1.39940E+00	TRUE	TRUE	TRUE	-0.027%	0.027%	0.060%
15	0.00000	0.025%		1.30E-03	-1.30000E-03	-0.0001	1.30000E-03	TRUE	TRUE	TRUE	#N/A	#N/A	#N/A
15	10.00000	0.025%		1.30E-03	9.99620E+00	9.9977	1.00038E+01	TRUE	TRUE	TRUE	0.023%	0.023%	0.038%
15	-10.00000	-0.025%		1.30E-03	-1.00038E+01	-9.9980	-9.99620E+00	TRUE	TRUE	TRUE	-0.020%	0.020%	0.038%
15	14.00000	0.025%		1.30E-03	1.39956E+01	13.9967	1.40052E+01	TRUE	TRUE	TRUE	0.027%	0.027%	0.034%
15	-14.00000	-0.025%		1.30E-03	-1.40058E+01	-13.9972	-1.39962E+01	TRUE	TRUE	TRUE	-0.027%	0.027%	0.034%
110	0.00000	0.025%		1.00E-02	-1.48838E-02	0.0018	5.11378E-03	TRUE	FALSE	FALSE	#N/A	#N/A	#N/A
110	30.00000	0.025%		1.00E-02	2.99824E+01	30.0411	3.00174E+01	TRUE	FALSE	FALSE	0.137%	0.137%	0.050%
110	-30.00000	-0.025%		1.00E-02	-3.00188E+01	-29.9228	-2.99837E+01	TRUE	FALSE	FALSE	-0.244%	0.244%	0.050%
110	70.00000	0.025%		1.00E-02	6.99721E+01	70.018	7.00271E+01	TRUE	TRUE	TRUE	0.026%	0.026%	0.039%
110	-70.00000	-0.025%		1.00E-02	-7.00326E+01	-69.910	-6.99778E+01	TRUE	FALSE	FALSE	-0.136%	0.136%	0.039%
110	100.00000	0.025%		1.00E-02	9.99675E+01	100.003	1.00038E+02	TRUE	TRUE	TRUE	0.000%	0.000%	0.035%
110	-100.00000	-0.025%		1.00E-02	-1.00035E+02	-99.888	-9.99650E+01	TRUE	FALSE	FALSE	-0.112%	0.112%	0.035%

 Keithley 238 I (A10) - Voltage Measurements.PNG (56.74 kB, 1506x402 - viewed 69 times.)

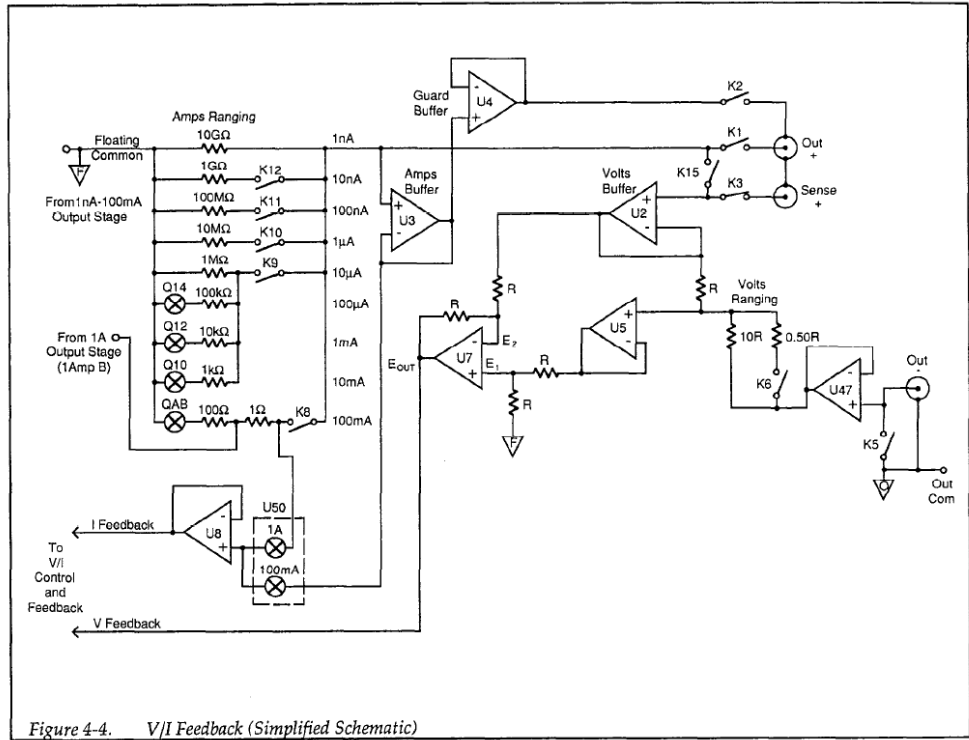
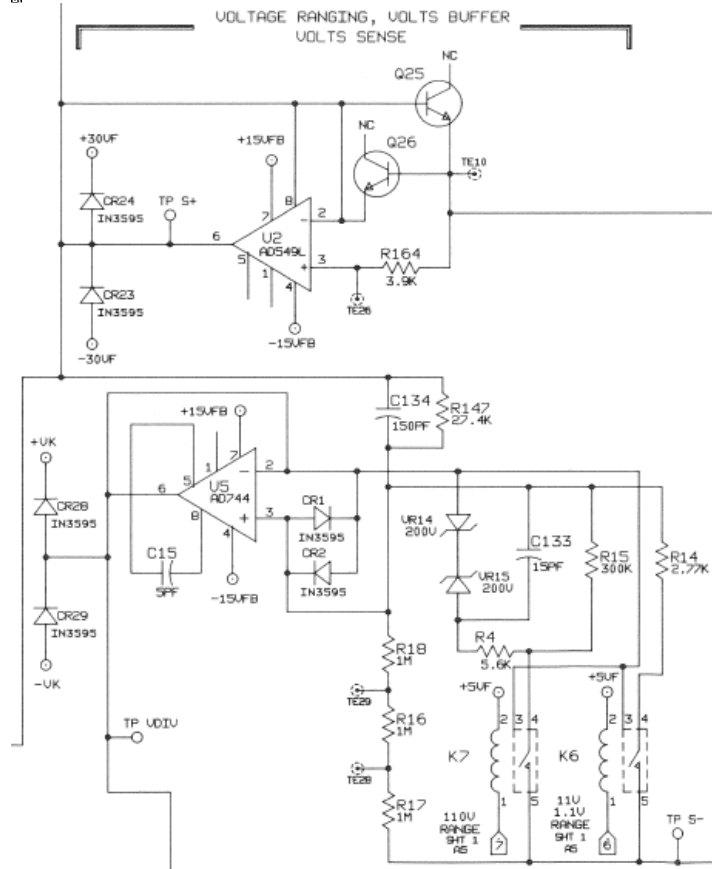



Figure 4-4.PNG (60.48 kB, 1035x789 - viewed 82 times.)



Analog Board Schematic IV Feedback (ref 236-126).PNG (63.42 kB, 463x563 - viewed 84 times.)

VOLTAGE

	SOURCE V			MEASURE V		
	RANGE (Max. Value)	STEP SIZE	ACCURACY (1 Year, 18°–28°C)	RESOLUTION 4-Digit	5-Digit	ACCURACY (1 Year, 18°–28°C)
236, 237	±1.1000 V	100 μ V	±(0.033%+ 650 μ V)	100 μ V	10 μ V	±(0.028%+ 300 μ V)
	±11.000 V	1 mV	±(0.033%+ 2.4 mV)	1 mV	100 μ V	±(0.025%+ 1 mV)
	±110.00 V	10 mV	±(0.033%+ 2.4 mV)	10 mV	1 mV	±(0.025%+ 10 mV)
237 Only	±1100.0 V	100 mV	±(0.04 %+ 240 mV)	100 mV	10 mV	±(0.035%+100 mV)
238 Only	±1.5000 V	100 μ V	±(0.033%+ 800 μ V)	100 μ V	10 μ V	±(0.028%+ 450 μ V)
	±15.000 V	1 mV	±(0.033%+ 2.7 mV)	1 mV	100 μ V	±(0.025%+ 1 mV)
	±110.00 V	10 mV	±(0.033%+ 2.4 mV)	10 mV	1 mV	±(0.025%+ 10 mV)

 voltage_accuracy.png (83.66 kB, 1293x527 - viewed 35 times.)

« Last Edit: December 09, 2020, 08:30:14 am by garrettm »


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leighcorrigall

Frequent Contributor



Posts: 393

Country: 

Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #127 on: December 08, 2020, 01:15:07 pm »

Say Thanks Reply Quote

Hi Garrettm,

Quote from: garrettm on December 08, 2020, 03:54:24 am

So if only for my own clarification, are you in Vsource/Imeasure mode or Isource/Vmeasure mode?

The Keithley 238 that I am verifying was set to measure voltage: I_source = 0 nA and V_measure.

To verify the 100 V measurement range, I measured a voltage source with a Keithley 6500 before measuring it with the Keithley 238. The difference between these numbers is well outside this tolerance as indicated by the spreadsheet screenshot attached to my last post. By comparison, this voltage measurement range has a significantly greater % error than the 1.5 V range, which should be more difficult to calibrate. However, voltage sourcing with the Keithley 238 at the 100 V range is spot on when measured by the Keithley 6500.

Clearly, there is something problematic with the board because the other Keithley 238 was calibrated exactly the same and does not act in this way. The other Keithley 238 can both measure and source voltage with a high degree of accuracy -- much less than the tolerance.

Also, my comment about compliance had nothing to do with measuring it. I was explaining how I was diagnosing the problem. If the Keithley 238 is set to measure voltage, it works great when the compliance voltage is set to 15 V. Anything greater allows the instrument to switch to the 100 V range, where it has no ability to stay within measurement tolerance. No matter what I do, the 100 V range is terrible. I suspect that it might have been caused by the transformer failure that occurred before I purchased it, which began this post.

Regards.

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MASc, EIT, PhD Candidate

leighcorrigall

Frequent Contributor



Posts: 393

Country: 


Nuclear Materials Scientist



Re: Should I return a Keithley 238?

« Reply #128 on: December 08, 2020, 05:33:28 pm »

Say Thanks Reply Quote

False alarm. 

The problem can be identified by inspecting the difference in measurements between the positive and the negative voltages of the same magnitude from +/- 1 to +/- 100 V. The offset voltage at 000.00 was the same as this difference at +/- 30, +/- 70, and +/- 100. I probably added this error by using triax adaptors, while converting between the Keithley 6500 and the Keithley 238 while calibrating. Even more so, the short procedure should be performed as close as possible to the instrument being calibrated.

Either I did not properly configure the offset voltages (C18X and C22X) and/or perform common mode

calibration (C1X). All readings are well within specifications. I used a brand new Keithley 2200-32-3, that was not part of the calibration procedure, to verify the measuring capabilities of the Keithley 238 I (A10) that I had troubles with.

I suppose the only problem is that this foolish mistake is now immortalized on the internet. Thanks for the sanity check, Garrett. I would have not bothered with calibrating it again had you not responded to my plea for help.

Oh well, at least now I know all my Keithley 238's are in good operational condition. 🤔



high-voltage verifaciton example.PNG (1051.3 kB, 692x790 - viewed 65 times.)

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MASc, EIT, PhD Candidate

The following users thanked this post: garrettm

garrettm
Frequent Contributor

Re: Should I return a Keithley 238?
« Reply #129 on: December 09, 2020, 07:15:30 am »

Say Thanks Reply Quote



Posts: 252

At least it wasn't a hardware fault! The main analog board is a pain to get to.


Are you manually entering the commands and data, or did you write a partially automated script? I could see it being pretty easy to accidentally send the wrong value if using manual entry. Even when partially or fully automated, calibration routines can be hard to get right, so don't feel bad.

Country: 

It's possible that the connectors and adapters are adding some thermal emfs to the measurement, though this shouldn't be much more than a millivolt. When shorting, you can use your female BNC to male banana adapter in tandem with the female 3-lug to male BNC adapter to plug directly into the input LO banana jack. That's about as direct as you can get without modifying a standard triax cable. Ironically, Keithley has a document that shows how to make a custom 3-lug triax to 4mm banana cable for the input HI, which wouldn't be a bad idea to have for calibration and general purpose lab work. They sell the 237-BAN-3A premade, but it's absurdly priced at 380 USD.

I think the suppress function should have nulled out that offset during testing. A stable offset can be easily fixed with calibration (assuming it isn't absurdly large). It's when the offset is noisy or drifts erratically that a repair is in order. My 237's 1.1kV Vsource range may need repair as it's zero offset jumps around erratically from 2 to 7 mV. The 110V source range has 6 mV of zero offset, but it's nice and stable. So calibration should buff that out nicely. The unit in question had a shorted Q19 on the output board and overheated 2.2Mohm resistors on the resonant converter. But it looks like I might need to dig a little deeper to find the remaining gremlins.


 [Connect-Adapt-Tools\[1\].pdf](#) (461.29 kB - downloaded 66 times.)

« Last Edit: December 09, 2020, 08:25:33 am by garrettm »

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The following users thanked this post: leighcorrigan

jogri
Frequent Contributor





Posts: 366
Country: 

 **Re: Should I return a Keithley 238?**

« Reply #130 on: December 09, 2020, 05:37:36 pm »

[Say Thanks](#) [Reply](#) [Quote](#)


Quote from: garrettm on December 09, 2020, 07:15:30 am

Ironically, Keithley has a document that shows how to make a custom 3-lug triax to 4mm banana cable for the input HI, which wouldn't be a bad idea to have for calibration and general purpose lab work. They sell the 237-BAN-3A premade, but it's absurdly priced at 380 USD.

Do you happen to have a link to that document? I'm currently in the process of making such cables for my 237, would be nice to know the proper way of doing that.

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Qw3rtzuiop
Regular Contributor





Posts: 182
Country: 


 

 **Re: Should I return a Keithley 238?**

« Reply #131 on: December 09, 2020, 08:59:03 pm »

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Here it is

 [manual_77.pdf](#) (72.16 kB - downloaded 44 times.)

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