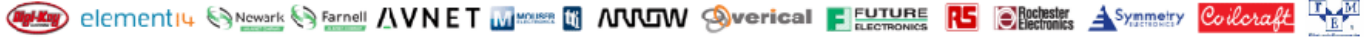




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Author

Topic: **Fluke 732B DC Standard Teardown** (Read 17406 times)

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free_electron
Super Contributor



Posts: 7228

Country:



Fluke 732B DC Standard Teardown
« on: April 08, 2013, 04:15:16 am »

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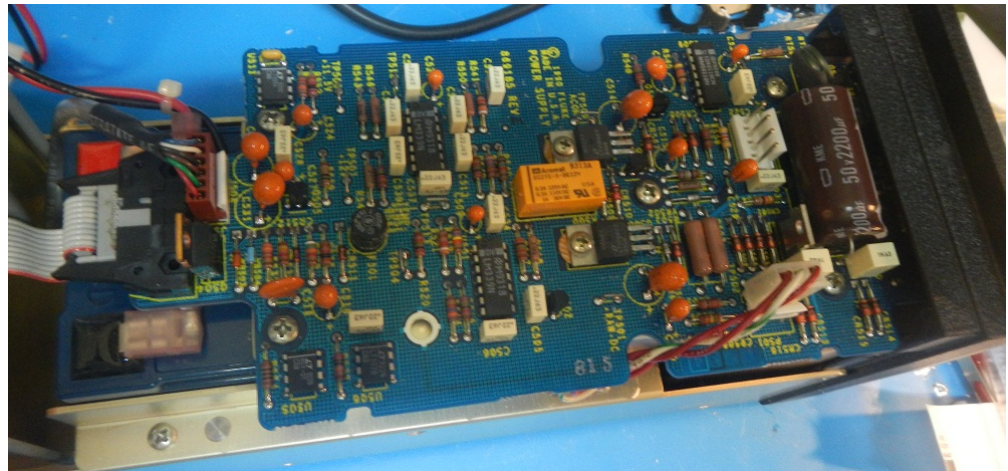
Right. The last guy that was using the standard forgot to plug it back in mains power. The end result : a cold reference and a dead battery ... Time to take out the screwdriver and pop it open. By now the Pavlovian conditioning of real volt-nuts is kicking in and they should be salivating heavily

You saw it first on EEVblog !

Here is the beastie:

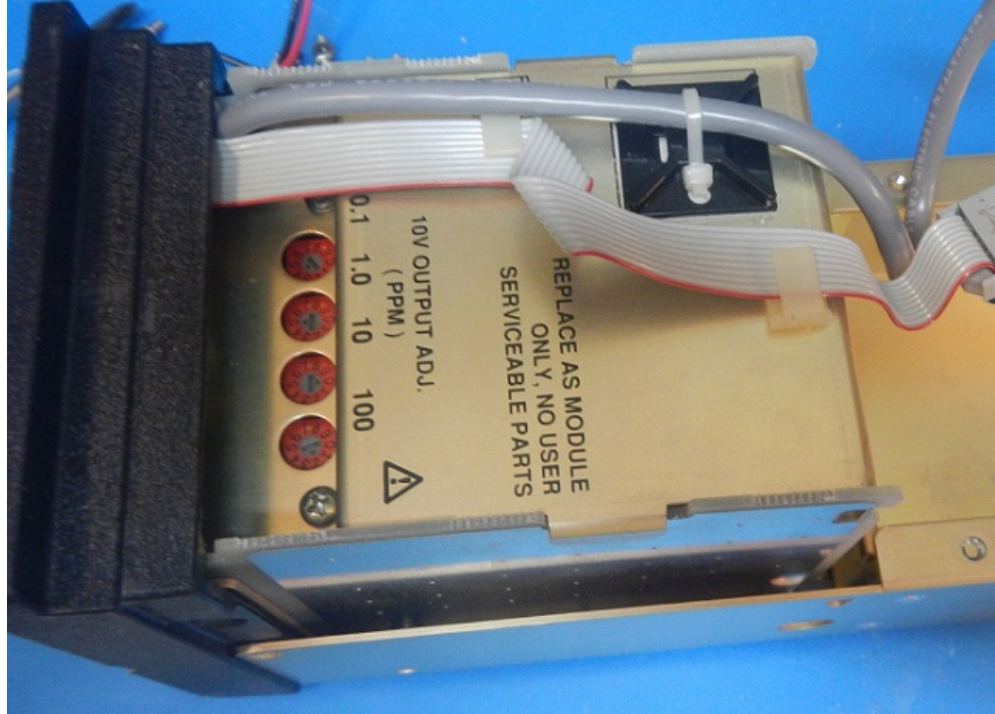
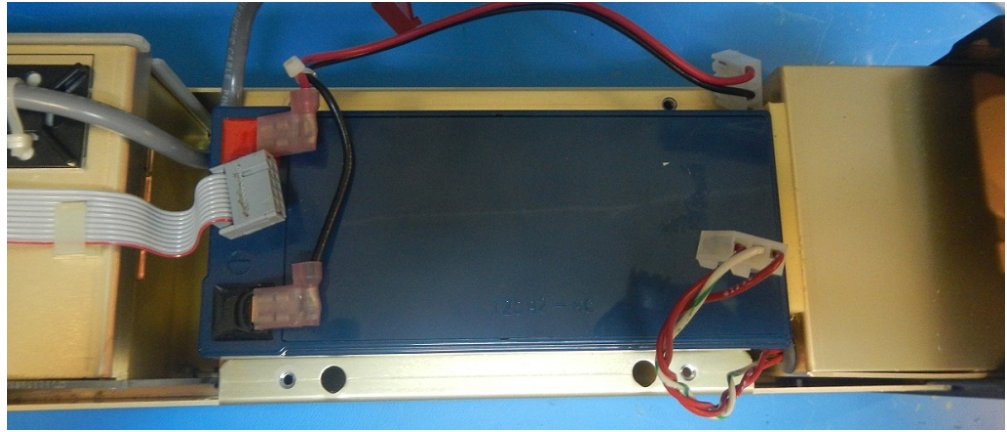


Yes boys and girls , an honest to -whatever deity you adhere to- metrology grade Fluke 732B DC standard. Making an exact 10.00000 volts as well as a very accurate 1.018 volts. All provided you connect it right and treat it right.



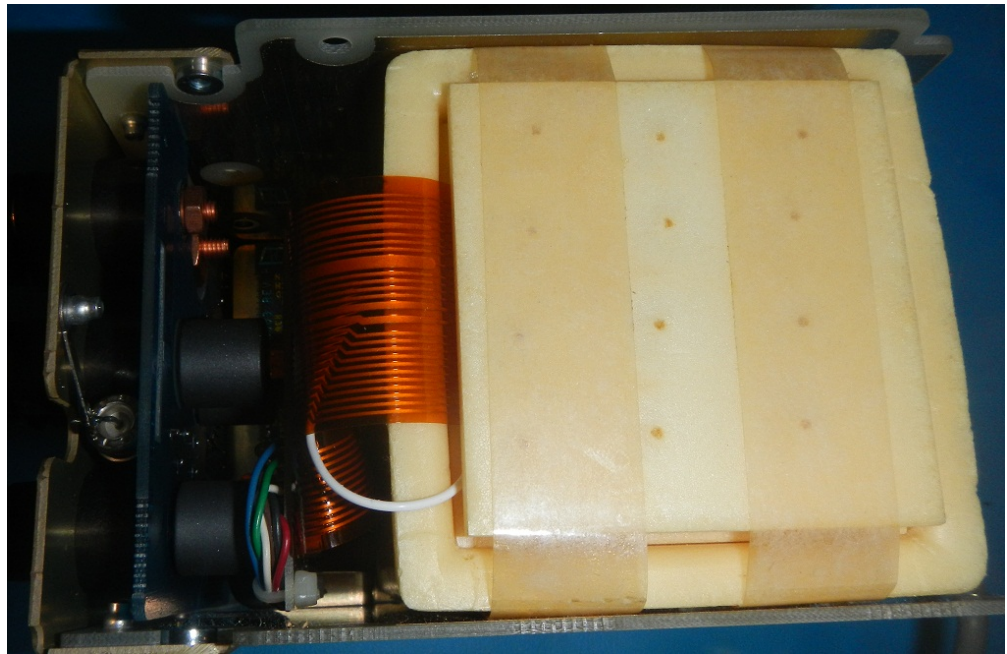
Covers off. The main control board is essentially a power supply and a battery charger/conditioner. To attain this precision this machine needs to run off its built in 12 volts 7Ah lead-gel battery pack. When in idle, the machine is connected to a mains supply line that keeps the battery charged. When doing the calibration you float this unit by unplugging it from the mains supply. The battery charger has a fast charge and trickle charge mode. A monitoring circuit built around some lm339 comparators monitors battery voltage as well as oven temperature. A flipflop made with a 4011 latches any fault condition in either charger / battery or oven and turns off the 'in CAL' led at which point it is -game over- : you lost your reference... a switching inverter makes a negative 6 volts as additional feed for the reference oven.

The lead gel pack is a standard battery pack as you find in motorcycles , UPs systems and alarm systems. Nothing special.

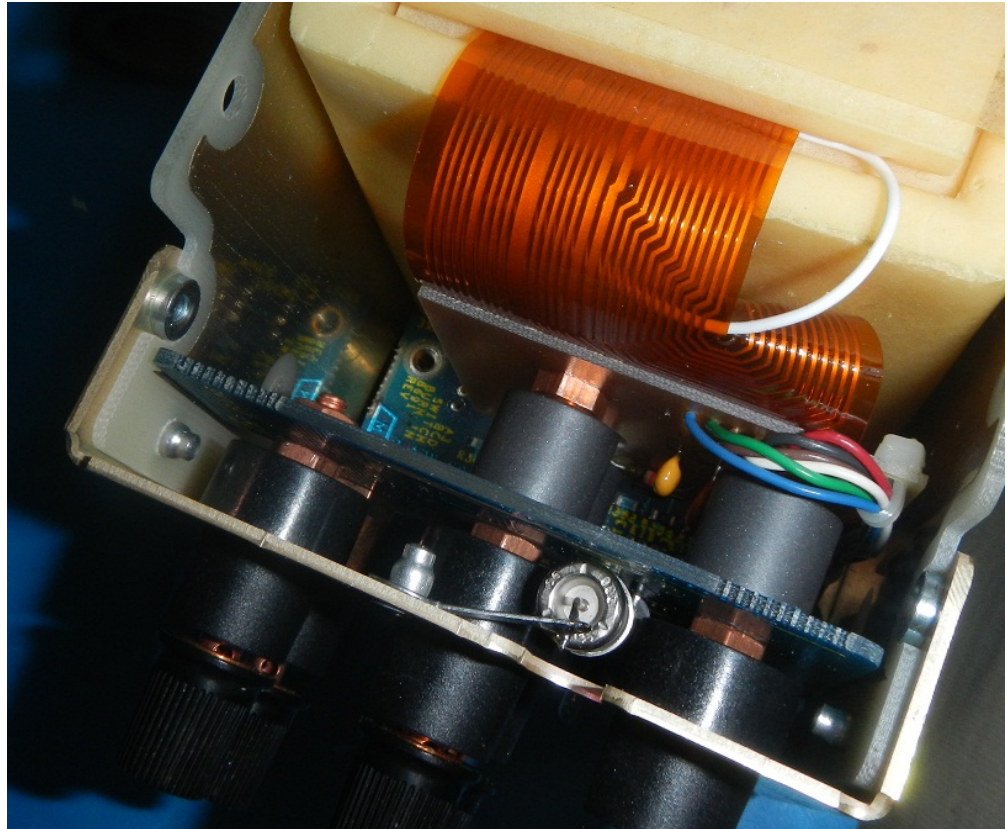


The business end of the machine : the source unit. This module is where all the black magic happens. The top has a couple of BCD switches (these are NOT potentiometers !) that allow fine-trimming of the reference source. This can only be done if the source has stabilized for several days. The alignment is done against a primary standard using a null-voltmeter. Any fiddling with these requires a few hours of 'settling time' ... the reason for not using potentiometers is simple : the mechanical stresses and vibration may cause the wipers to shift ever so slightly giving an undesired drift. with these switches this will not happen.

Time to do a bit of stripping ..

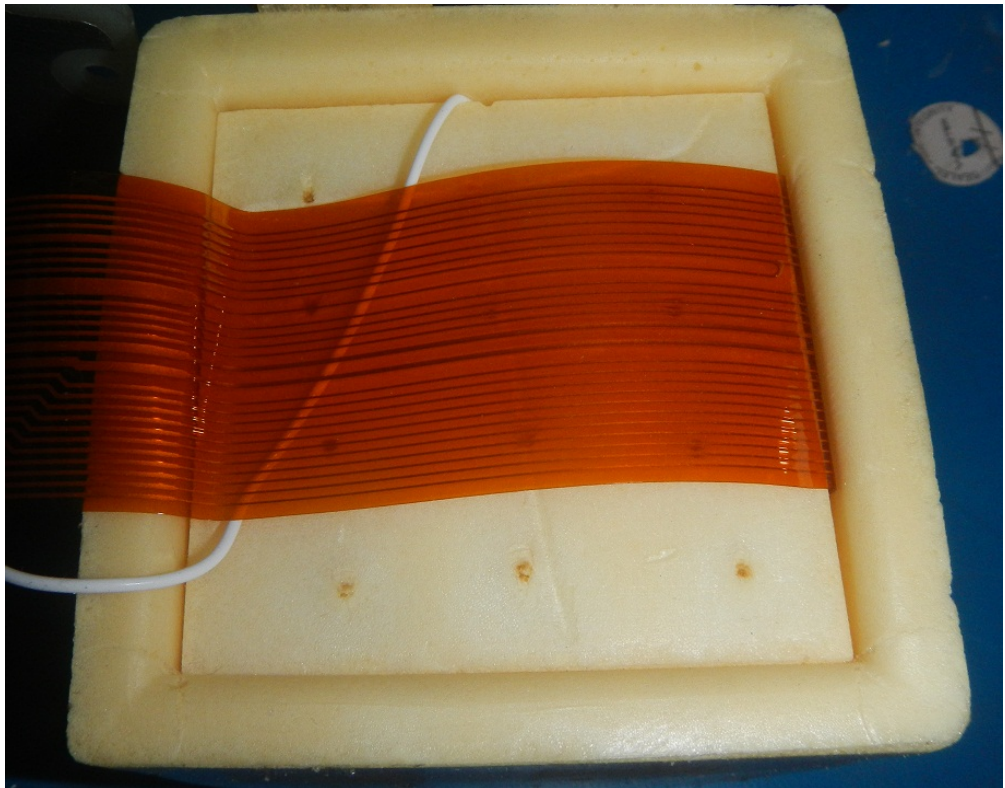


The first thing we notice is a big isolated pack. That's where the oven is. A kapton foil semi-rigid PCB comes out of the foampack as well as a single teflon wire. The big grey blocks are ferrite sleeves that sit over the banana jacks.

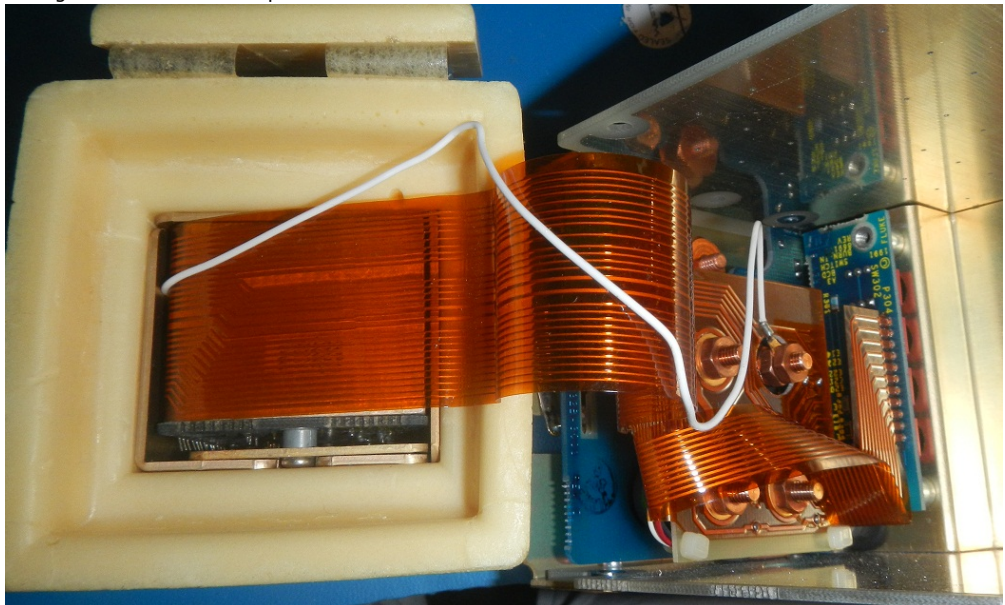


A close-up of the the front PCB. this pcb holds the 4 LED's as well as a 555 timer to make the 'low bat' led blink a single gas surge-arrester connects the COM terminals to the chassis. At the bottom you see the circuit board holding the BCD switches.

It's strip-tease time.. (By now the volt-nuts are sitting at the tip of their chair frantically waving dollar bills around)



Taking the cover off the isopack reveals .. more foam... drat...



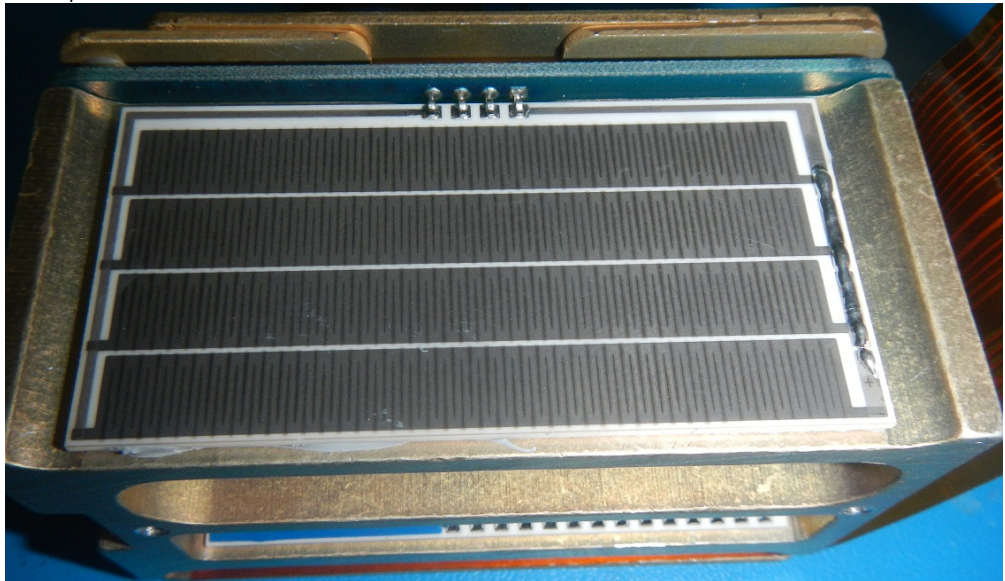
Removing that bit of foam shows a massive chunk of metal with, what appears to be a circuit board, inside.

This image shows the entire interconnect. The semi-rigid PCB splits of into 2 branches. one goes to the front board holding the BCD switches. The other end goes to a stiffener board and is screwed directly onto the brass banana terminals. The original design had the 4 terminals screwed down. but apparently there is something going on as they deliberately drilled out one terminal and connected that using the white terminal. The semi-rigid cable holds a trace and you can clearly see the drilling was done afterwards. I ohmed the connection out and there is no cut in the flex , so this is not a 'repair' but an intentional modification. This wire carries the 1.018 volts. Possibly there was a leakage or some other weird effect present requiring additional isolation.

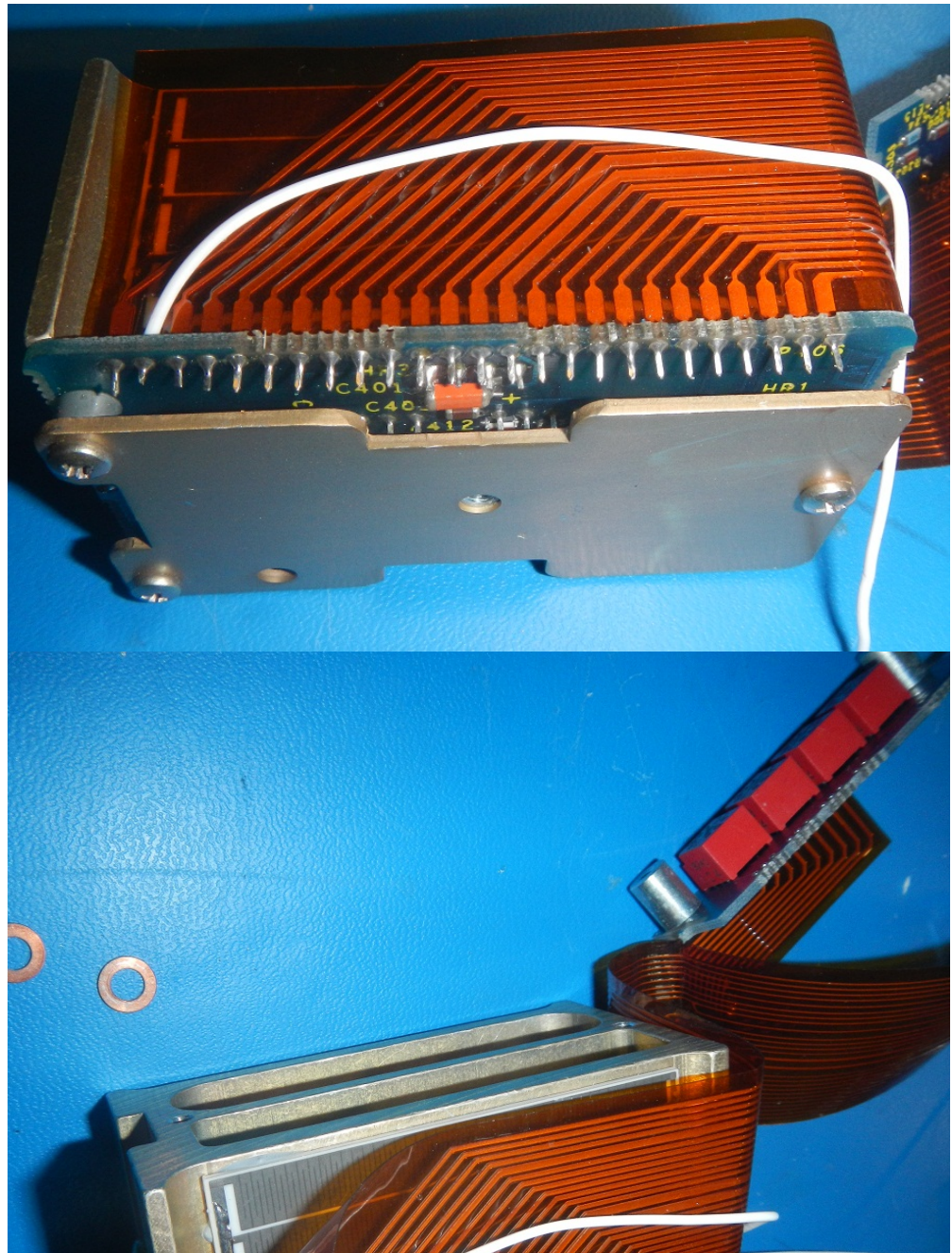
Removing the source from its isopack reveals a single power transistor bolted on the case. Surely that can't be the heater ?



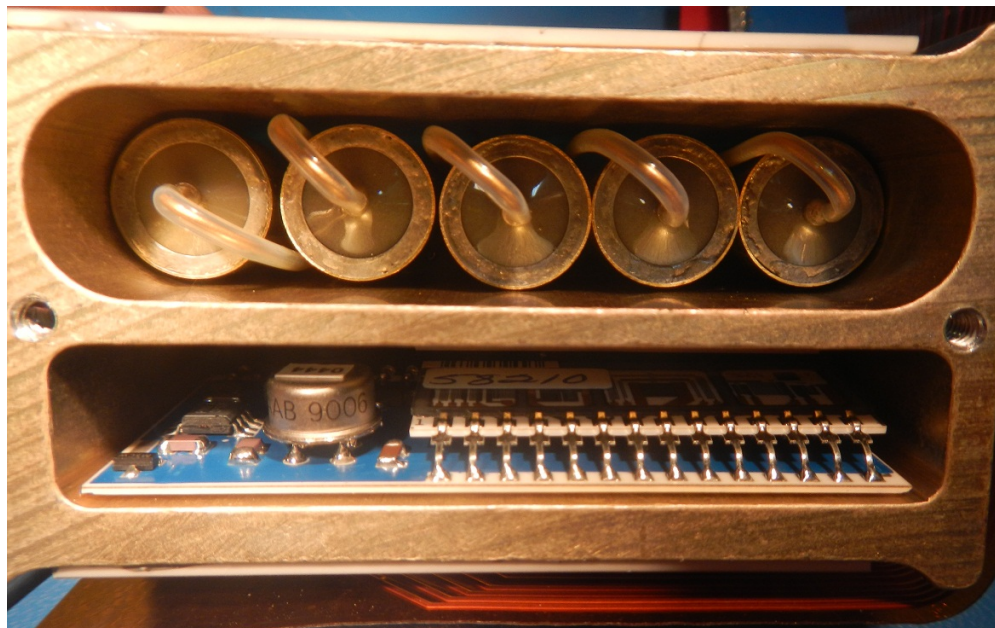
Stripping the outer shell reveals the truth : this is the heater ! An Alox (aluminum-oxide) substrate based power resistor !



Flipping the package over shows the semi-rigid interconnect and.. another heater ! hoho ! These guys aren't kidding around.....



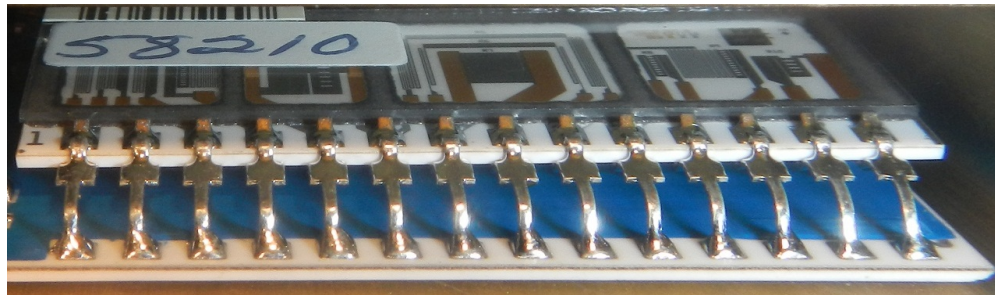
The side shows two cavities: one that holds special temperature compensated resistors , the other holding 3 hybrid circuits.



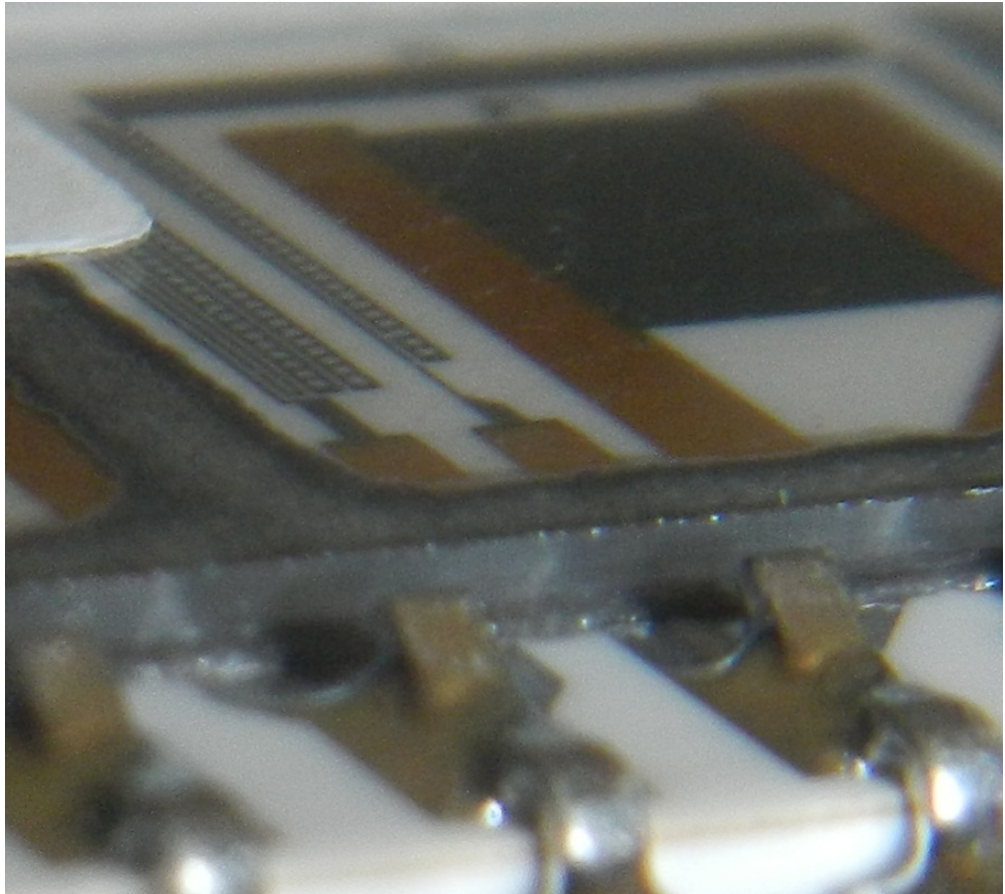
One hybrid is soldered onto the bottom circuit board. This seems to be a simple resistor network. (the top one in the picture)

The bottom hybrid holds a bunch of opamps , transistors, a weird metal can with 4 legs... and.. another hybrid soldered on top of it ? wtf ? hybrids soldered on hybrids ?

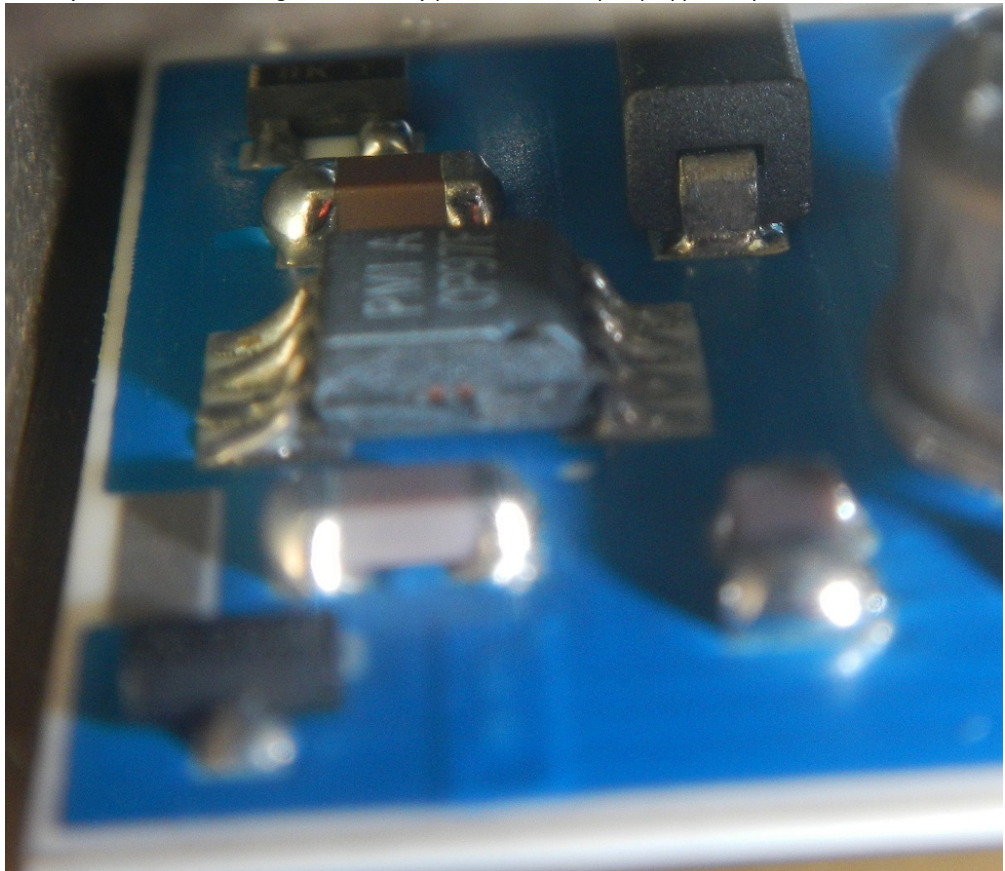
It turns out this top hybrid is an ultra precision resistor chain. this hybrid has resistor ladders and is covered with a quartz plate that hermetically seals them away. These resistors are laser trimmed through the glass plate. The structure is so that they can cut away segments of the resistor to increase the value.



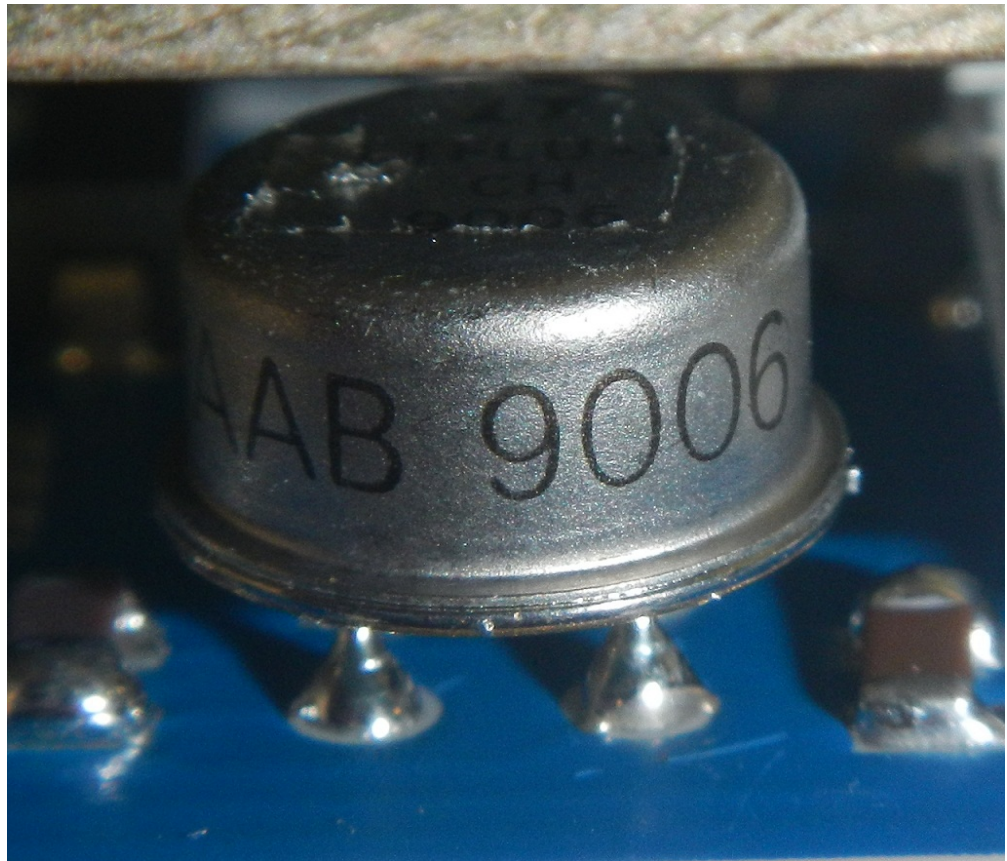
The image below shows a closeup of the trimming structure. They can trim both up and down by shooting open either a horizontal or a vertical bar in the grid. This has got to be super expensive...



A PMI (absorbed into Analog devices now) precision OP97 opamp apparently does some work ...



The mystery metal can had a little sticker on top... the only markings on the side ar KFXFAAB 9006 (i stuck a small mirror in there to look at the backside). googling yielded absolutely zippo... time to peel off the little sticker.. using tweezers i managed to peel it off..



And tadaa : a linear technologies part. LTFU-I CH 9006. judging from my standard the 9006 is the production date of this mystery part. the letters LTFU-1 seem to indicate a partnership between Linear Technologies and Fluke.
 Several sources claimed that these standards used the LTZ1000 , which is clearly not the case... it doesn't have enough pins.
 Digging around on the internet if found some references to this part on a Japanese website. It is a device similar to a Motorola SZA263 that was used in the older generation fluke calibrators. motorola discontinued it an Linear picked it up. It is a simply circuit consisting of 1 transistor and a zener diode in a hermetically sealed can. The black magic happens at semiconductor level. This zener diode is not constructed at the surface but buried in the silicon with the transistor built on top of it.

« Last Edit: April 08, 2013, 04:25:23 am by free_electron »

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Professional Electron Wrangler.

Any comments, or points of view expressed, are my own and not endorsed , induced or compensated by my employer(s).

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SeanB
 Super Contributor
 ●●●



Posts: 15100
 Country:

free_electron
 Super Contributor
 ●●●

Re: Fluke 732B DC Standard Teardown
 « Reply #1 on: April 08, 2013, 04:43:51 am »

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Re: Fluke 732B DC Standard Teardown
 « Reply #2 on: April 08, 2013, 04:45:47 am »

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

nope. it's assembled again. has been under power for a whole day and it's dead stable... i'll let it charge thoroughly, ship it 'hot' to the callab (under battery power) and it'll come back 'hot' (powered up during transport) and live happily ever after.

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



Posts: 7228

Country:


 ddavidebor

Super Contributor



Posts: 1135

Country:


 Rufus

Super Contributor



Posts: 2094


 amyk

Super Contributor



Posts: 6505


 Dr. Frank

Super Contributor



Posts: 1702

Country:


 quantumvolt

Frequent Contributor



Posts: 395

Country:


 amyk

Super Contributor



Posts: 6505



Professional Electron Wrangler.

Any comments, or points of view expressed, are my own and not endorsed, induced or compensated by my employer(s).

 Fluke 732B DC Standard Teardown
 « Reply #3 on: April 08, 2013, 05:09:21 am »

Say Thanks

Reply

Quote

Ooooooh O.O amazing piece of equipment

Report to moderator Logged

Davide Bortolami,
Fermium LABS srl
 Re: Fluke 732B DC Standard Teardown
 « Reply #4 on: April 08, 2013, 05:25:40 am »

Say Thanks

Reply

Quote

You can download the user manual from fluke with schematics and a theory of operation chapter.

http://us.flukecal.com/products/electrical-calibration/electrical-standards/734a-voltage-reference-dc-voltage-standard?quicktabs_product_details=4

Report to moderator Logged

 Re: Fluke 732B DC Standard Teardown
 « Reply #5 on: April 08, 2013, 11:23:19 am »

Say Thanks

Reply

Quote

Here you can see the resistors in the oven taken out(!):

<http://bbs.38hot.net/thread-177-1-1.html>

Interesting shape to them...

« Last Edit: July 15, 2013, 10:52:01 am by amyk »

Report to moderator Logged

 Re: Fluke 732B DC Standard Teardown
 « Reply #6 on: April 08, 2013, 11:33:40 am »

Say Thanks

Reply

Quote

Hello free_electron,

nice that you have a 732B as a teardown object (and happily working ever after).
Thank you for sharing.

As the schematics for the reference circuitry is not officially available, also not in the 732B manual, do you have complete planar pictures of upper and lower side of the PCB(s) in the oven assembly?

Would be interesting to re-engineer the schematics of the LTFLU version.

Frank

« Last Edit: April 08, 2013, 11:42:13 am by Dr. Frank »

Report to moderator Logged

 Re: Fluke 732B DC Standard Teardown
 « Reply #7 on: July 15, 2013, 09:25:08 am »

Say Thanks

Reply

Quote

I might be blind or have misunderstood, but it seems that the schematic of the reference board with the encapsulated Zener+Transistor is not here?

Well - if so, this manual for 732A contains a schematic (1983) that might be similar to early 732B (?):

http://www.ko4bb.com/Manuals/Fluke/Misc/732A_Users_Manual.pdf

Report to moderator Logged

 Re: Fluke 732B DC Standard Teardown
 « Reply #8 on: July 15, 2013, 10:52:51 am »

Say Thanks

Reply

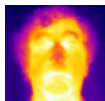
Quote

The thread in that Chinese forum above (I fixed the link) contains some RE'd schematics...

Report to moderator Logged

PA0PBZ

Super Contributor



Posts: 4110

Country:

**Re: Fluke 732B DC Standard Teardown**

« Reply #9 on: July 15, 2013, 12:26:50 pm »

Say Thanks

Reply

Quote

I was wondering about the 1.018 volts, so to answer my own question:

The Weston cell contained two electrodes immersed in a solution of cadmium sulfate, and produced a predictable 1.018 volts DC at room temperature.

Report to moderator Logged

Keyboard error: Press F1 to continue.

robrenz

Super Contributor



Posts: 3035

Country:

Real Machinist, Wannabe EE

**Re: Fluke 732B DC Standard Teardown**

« Reply #10 on: July 16, 2013, 10:46:42 am »

Say Thanks

Reply

Quote

Very nice, Thanks for taking the time to show this.

Report to moderator Logged

My video channel https://www.youtube.com/playlist?list=PLRe7NGdsY7s6sOTsRahdb_sx2oDwGbh_O

saturation

Super Contributor



Posts: 4788

Country:

Doveryai, no proveryai

**Re: Fluke 732B DC Standard Teardown**

« Reply #11 on: July 16, 2013, 12:43:56 pm »

Say Thanks

Reply

Quote

Most excellent, thanks freee-!

Report to moderator Logged

Best Wishes,

Saturation

ElectroIrradiator

Frequent Contributor



Posts: 614

Country:

More analog than digital.

**Re: Fluke 732B DC Standard Teardown**

« Reply #12 on: July 16, 2013, 02:15:09 pm »

Say Thanks

Reply

Quote

That is some serious adult content right there.

What fate befell the individual, which let the battery run out?

Report to moderator Logged

bingo600

Super Contributor



Posts: 1361

Country:

**Re: Fluke 732B DC Standard Teardown**

« Reply #13 on: July 16, 2013, 05:16:22 pm »

Say Thanks

Reply

Quote

Damm i'm envious ...

Why's all the nice affordable used-stuff available "over there".

I'm drooling heavily , and want one.....

Thanx for the nice teardown

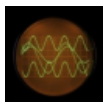
But give it to Dave for the next contest ... hint..hint

/Bingo

Report to moderator Logged

PA4TIM

Super Contributor

**Re: Fluke 732B DC Standard Teardown**

« Reply #14 on: July 16, 2013, 10:00:18 pm »

Say Thanks

Reply

Quote

They allways tell the 732B is a totally different class as the 731A, now I see why. My 731 A <http://www.pa4tim.nl/?p=2376> is not more as a reference, an opamp and some resistors. I made a LM399 standarsd, still planning to ovenise the whole thing and buils it in the 731A housing.

It is pretty stable but the temp in my lab is not. . It changes about 40 uV on 10V something like 8

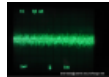
Posts: 1117
Country:
instruments are like rabbits,
they multiply fast

degrees temp change and relative humidity. (0.5 ppm / C) As soon as I can log temp and rH% I will log the voltage deviation over time.

Report to moderator

www.pa4tim.nl my collection measurement gear and experiments Also lots of info about network analyse
www.schneiderelectronicsrepair.nl repair of test and calibration equipment
<https://www.youtube.com/user/pa4tim> my youtube channel

branadic
Super Contributor



Posts: 1475
Country:

Re: Fluke 732B DC Standard Teardown
« Reply #15 on: July 17, 2013, 10:06:23 pm »

Say Thanks Reply Quote

Quote

I made a LM399 standarsd, still planning to ovenise the whole thing and buils it in the 731A housing.

Do you want to share your schematics? What does it look like?

I've build the "10V Buffered Reference" from LinearTechnology datasheet with LT1001 in ceramic package with 5ppm/K 0805 chip resistors for gain setting and a crystal heater on top (40.8±1.5°C but <0.1K regulation accuracy). The reference is now running several weeks on a 34401A under lab conditions (~22.4±0.5°C) and I can observe a drift by ±10µV correlating with humidity in the lab (corner value 1 RH<40%, corner value 2 RH>45%).

Can't say if this is a sensitivity of my reference or the 34401A.

I'm still searching for the ultimate circuit. One idea could be a LM334 current source in hermetical package feeding the LM399 combined with a chopper amp at the output.

So I'm interested in your solution.

« Last Edit: July 19, 2013, 06:00:42 am by branadic »

Report to moderator

Fluke 8050A | Prema 5000 | Prema 5017 SC | Advantest R6581D | GenRad 1434-G | Datron 4000A | Tek 2465A | VNWA2.x with TCXO upgrade and access to: Keysight 3458A, Keithley 2002, Prema 5017 SC, 34401A, 34410A, Keithley 2182A, HDO6054, Keysight 53230A and other goodies at work

SimonSatCom
Contributor

Posts: 12
Country:

Re: Fluke 732B DC Standard Teardown
« Reply #16 on: February 02, 2014, 01:35:23 pm »

Say Thanks Reply Quote

Very nice teardown. At the moment I'm trying to build my own precision reference using the LTZ1000A.

<http://www.simonthenerd.com/LTZ1000A.htm>

I have used the Fluke 732B as kind of my reference so it is nice to see some real pictures from inside the beast. 😊

Report to moderator

VR2XGI
Contributor

Posts: 5
Country:

I like voltage reference standard

Re: Fluke 732B DC Standard Teardown
« Reply #17 on: April 10, 2014, 02:24:11 pm »

Say Thanks Reply Quote

any Fluke 732A teardown?? 🙄

Report to moderator

73 de VR2XGI

VR2XGI
Contributor

Posts: 5
Country:

I like voltage reference standard

Re: Fluke 732B DC Standard Teardown
« Reply #18 on: April 10, 2014, 02:36:25 pm »

Say Thanks Reply Quote

Quote from: amyk on April 08, 2013, 11:23:19 am

Here you can see the resistors in the oven taken out(!):
<http://bbs.38hot.net/thread-177-1-1.html>
Interesting shape to them...

38hot is a very good forum , I have been there many year 🙄🙄🙄🙄

Report to moderator

73 de VR2XGI

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