




Part #:	Curiosity Nano	 MICROCHIP	AUTHORIZED DISTRIBUTOR 
Description:	<ul style="list-style-type: none"> • Pocket-sized boards include a PIC, AVR, or SAM MCU • On-board debugging capabilities 		Download Datasheet

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 Author

Topic: **A Tektronix TDS3014B with two strange issues** (Read 10493 times)

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bsproj

Contributor



Posts: 8

Country: 



 **A Tektronix TDS3014B with two strange issues**

[Say Thanks](#)

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[Quote](#)

« on: July 26, 2016, 10:58:17 pm »

Hi,

i've recently bought an used TDS3014B ([service manual](#)). It works perfectly, except for 2 apparently unrelated issues.

The first issue is a strange overheating of the power supply board.

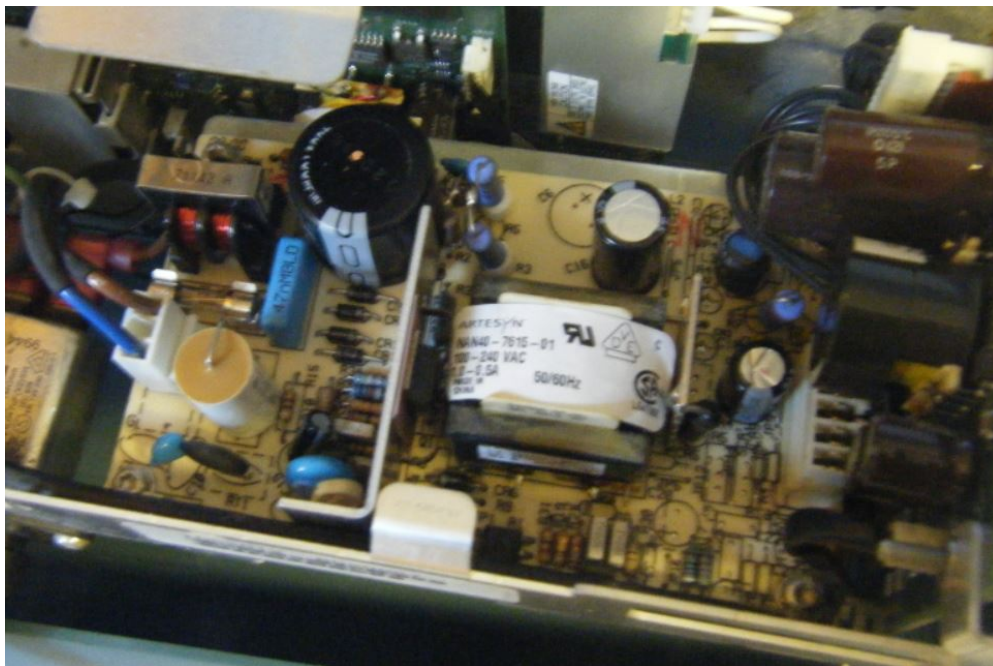
This overheating occurs only when the **oscilloscope is turned off**. The heat is produced by two resistors of the RC snubber network located on the Artesyn NAN40-7615-01 customized power supply board ([datasheet](#)). The

These resistors reach a temperature of approx 80-90 °C when the oscilloscope is turned off or when the board is totally disconnected from any load. This make the oscilloscope rear cover hot, about 40 °C. When the oscilloscope is turned on (or when a load is applied to the output of the PSU), the overheating disappears. Anyway, the output voltage of the output board is correct (15 V).

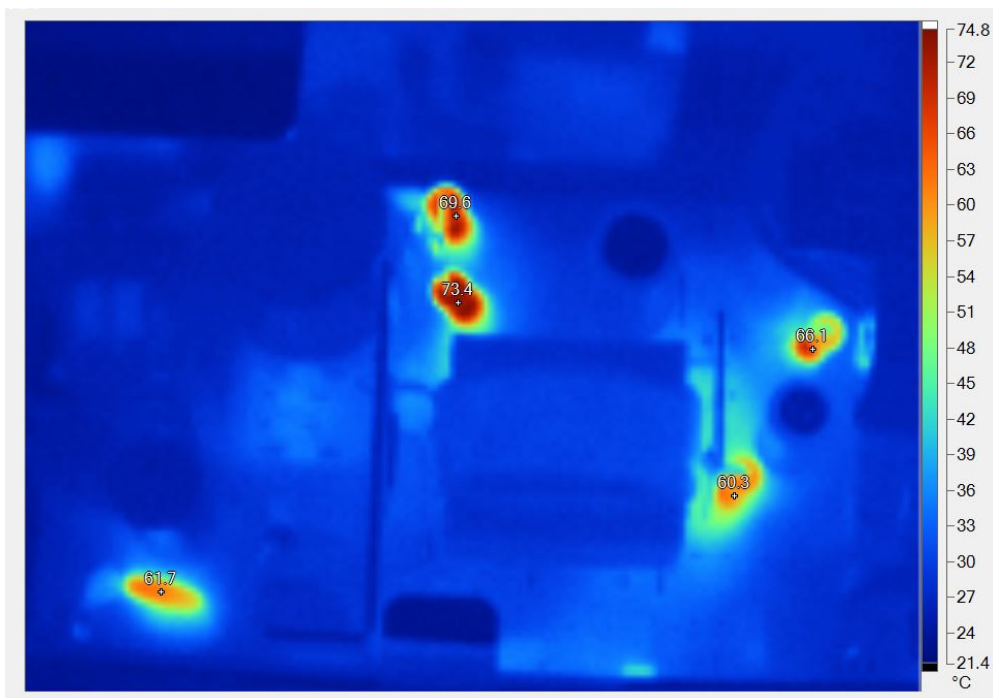
The mains voltage is 230 V with a frequency of 50 Hz (Italy). The design of this switching PSU appears very simple, maybe similar to the following schematic.

Is this overheat common in this kind of PSU? Are there any forumers with the same problem?

The second issue is a **noise at high sampling rates**. The noise is **totally absent** when the sampling rate is less than 5 MS/s (> 400 µs/div). For any sampling rate equal or higher than 5 MS/s, the tracks appear a little bit more noisy. In particular, you can see a periodic noise, similar to a low level sine or square wave. This noise has the exactly same aspect on the screen (same amplitude and same number



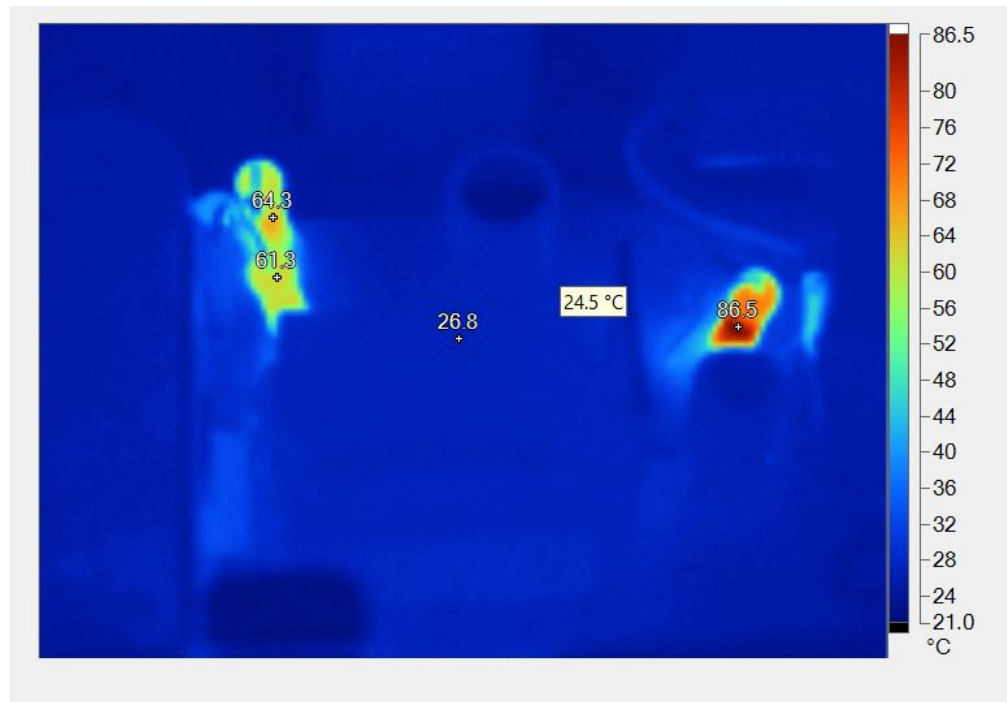
And here is a thermal image of the power supply, this was taken with the scope running.



The hot parts are:

RT1
 R3 and R5, snubber for the MOSFET.
 D3 Output rectifier
 R7 which is a load resistor on the output.

Here is a thermal image with the scope off. The power supply is running all the time the scope is plugged in.



The hot parts are:

R3, R5 snubber
R7 across the 15V output.

These thermal images were taken with the scope running from 115V. The temperatures may be different if the scope is powered from 230V.


The temperatures you are measuring are probably normal, but I would check the value of R7. If R7 is open, the temperature of R3 and R5 will increase.
When the scope is on, the fan is running, so the resistors are cooled by the fan.

Thank me, if this helps.


Regards,

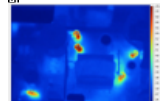
Jay_Diddy_B




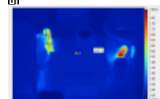
 nan40-7615-01.JPG (104.94 kB, 1655x861 - viewed 6976 times.)




 nan40-7615-01 PS.JPG (91.07 kB, 966x642 - viewed 6470 times.)



 Thermal image running.JPG (55.97 kB, 968x676 - viewed 6000 times.)



 Thermal image off.JPG (36.8 kB, 768x537 - viewed 6026 times.)

« Last Edit: July 27, 2016, 12:30:56 am by Jay_Diddy_B »

Report to moderator  Logged

The following users thanked this post: bsproj, guy232

tautech
Super Contributor
■■■



Posts: 18751
Country:
Taupaki Technologies Ltd. NZ
Siglent Distributor

Jay_Diddy_B
Super Contributor
■■■
Posts: 2216
Country:

Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #2 on: July 27, 2016, 12:35:06 am »

Frequency of the SMPS operation for both on and off modes might help diagnose the health of the PSU for the OP and others finding this thread. Easy enough to do with a scope probe held near the x former and no direct connection needed. 😊

Report to moderator Logged

Avid Rabid Hobbyist

The following users thanked this post: bsproj

Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #3 on: July 27, 2016, 01:36:28 am »

Quote from: tautech on July 27, 2016, 12:35:06 am

Frequency of the SMPS operation for both on and off modes might help diagnose the health of the PSU for the OP and others finding this thread. Easy enough to do with a scope probe held near the x former and no direct connection needed. 😊

Tautech asked, so here they are:

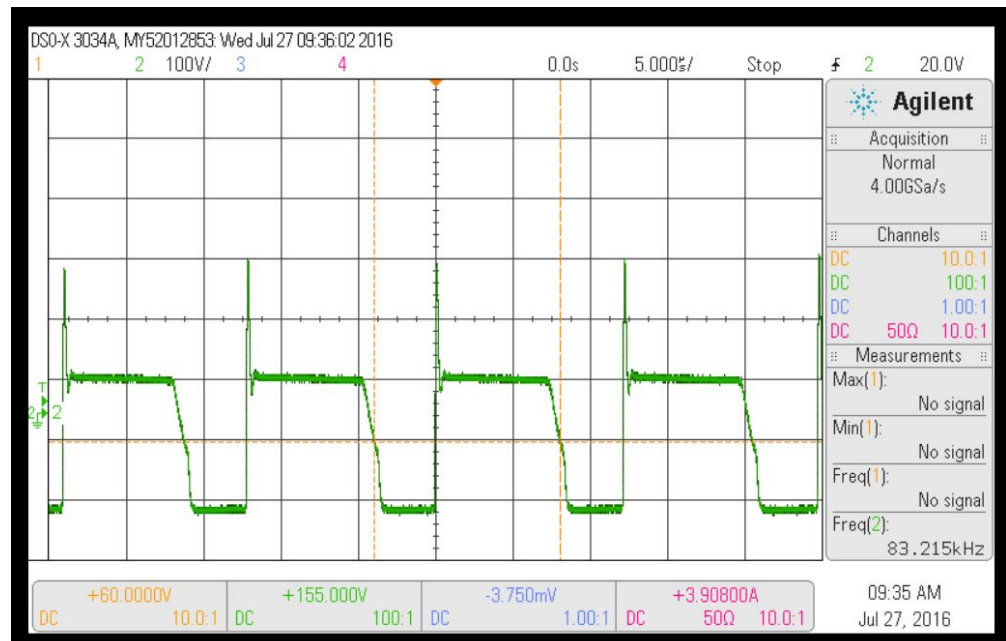
Note: The scope was powered using an Elgar 501 AC Power Supply, the output is floating. This allows me to connect the scope ground clip to the source of the MOSFET. The scope tip was connected to the Drain of the MOSFET. So the scope pictures are Vds.

DO NOT TRY THIS AT HOME, DO NOT TRY THIS IF YOU ARE NOT FAMILIAR WITH SWITCHING POWER SUPPLIES.

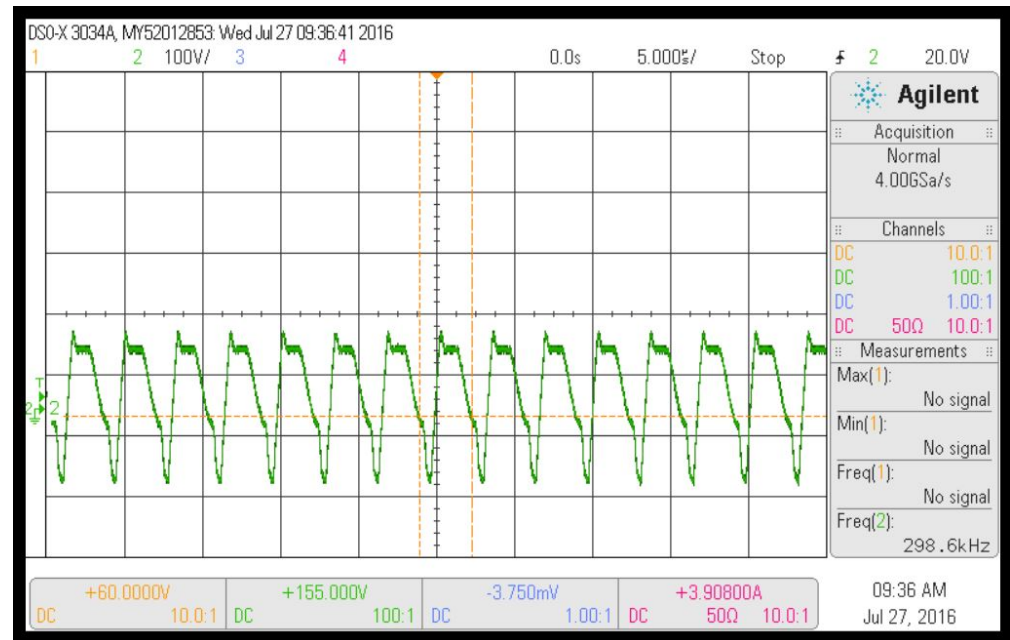
A Tektronix 100x, high voltage probe, P6009 was used for this measurement.

These measurements were taken with a line voltage of 110V ac.

With scope on, the switching frequency is around 84kHz



With scope off, the switching frequency is close to 300 kHz.



I believe that this type of power supply will either work or be severely damaged, I have never seen one half-working.

In order to fix this one I changed:

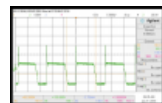
The main MOSFET (blown up)
The 0.56 flameproof resistor, R36, in the MOSFET source (fused open)
The 100 Ohm resistor, R33, blown open.
D1, gate drive Zener, blown short
Q2 and Q3 just in case, they are cheap.

I checked the bridge rectifier, the fuse, and RT1, in my case these parts were o.k.

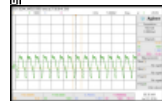
These power supply are fairly readily available new. It is a 5 x 3 x 1.2 inch form factor, 40W and 15V output. The -01 in the part number may mean that the output was set, by changing a resistor to 14.6V for some reason. I would use LPS44 from Artesyn (\$45.90 USD from Digikey).

Regards,

Jay_Diddy_B



VDS running.JPG (101.97 kB, 1033x666 - viewed 5895 times.)



VDS scope off.JPG (104.81 kB, 1024x655 - viewed 5885 times.)

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The following users thanked this post: tautech, bsproj



Re: A Tektronix TDS3014B with two strange issues

« Reply #4 on: July 27, 2016, 02:11:38 am »

Say Thanks Reply Quote

Thanks Jay.

The probe on the MOSFET gate would have been sufficient and at much lower voltage.

That is alarming that this rather crude (not taking the piss) SMPS runs at 300 kHz with no load.



Posts: 18751
Country:

Taupaki Technologies Ltd. NZ
Siglent Distributor

Hydrawerk

Super Contributor



Posts: 2393
Country:

bsproj

Contributor

Posts: 8
Country:

tautech

Super Contributor



Posts: 18751
Country:

Taupaki Technologies Ltd. NZ
Siglent Distributor

Jay_Diddy_B

Super Contributor

Posts: 2216
Country:

That snubber is definitely working overtime in the original design based on your RE schematic.

Time for some tweaks?

Edit

I much prefer the method used in the image from AOE: zener and diode.

« Last Edit: July 27, 2016, 02:14:35 am by tautech »

Report to moderator Logged

Avid Rabid Hobbyist

Re: A Tektronix TDS3014B with two strange issues

« Reply #5 on: July 27, 2016, 02:39:13 am »

Say Thanks Reply Quote

Well, your link was broken, i repaired it. http://www.pewa.de/DATENBLATT/DBL_TEK_TDS3000-SERVICE-MANUAL_ENGLISCH.PDF

Report to moderator Logged

Amazing machines. <https://www.youtube.com/user/denha> (It is not me...)

The following users thanked this post: bsproj

Re: A Tektronix TDS3014B with two strange issues

« Reply #6 on: July 27, 2016, 08:27:25 am »

Say Thanks Reply Quote

Hi,
thank you a million for your detailed report. I'll check the value of the load resistor R7 just to be sure. Anyway the overheating of my PSU is probably normal using the oscilloscope with 230 V mains. Maybe is a really good idea to replace this PSU with a more reliable one, like the mentioned Artesyn LPS44.

And what about the increased noise at high sampling rate? Does your TDS3012 present the same sudden increase of noise when you switch from 400 $\mu\text{s}/\text{div}$ (2.5 MS/s) to 200 $\mu\text{s}/\text{div}$ (5 MS/s)?

(click for high resolution)

Thanks for your help!

Report to moderator Logged

Re: A Tektronix TDS3014B with two strange issues

« Reply #7 on: July 27, 2016, 09:30:56 am »

Say Thanks Reply Quote

Quote from: bsproj on July 27, 2016, 08:27:25 am

Thanks for your help!

We do that with the "Say Thanks" botton at the top right of the post.

Jay asked for your thanks, it would be rude not to.

Report to moderator Logged

Avid Rabid Hobbyist

Re: A Tektronix TDS3014B with two strange issues

« Reply #8 on: July 27, 2016, 10:13:22 am »

Say Thanks Reply Quote

Quote from: bsproj on July 27, 2016, 08:27:25 am

Hi,
thank you a million for your detailed report. I'll check the value of the load resistor R7 just to be sure. Anyway the overheating of my PSU is probably normal using the oscilloscope with 230 V mains. Maybe is a really good idea to replace this PSU with a more reliable one, like the mentioned Artesyn LPS44.

And what about the increased noise at high sampling rate? Does your TDS3012 present the same sudden increase of noise when you switch from 400 $\mu\text{s}/\text{div}$ (2.5 MS/s) to 200 $\mu\text{s}/\text{div}$ (5 MS/s)?

(click for high resolution)

Thanks for your help!

Hi,

Power Supply

The NAN40-7615-01 is a well designed power supply and should be as reliable as any others. I am sure mine was killed by a surge on the line voltage input, probably lightning. The power supply is on if the scope is plugged in. I am sure that most of them are running 24 hours a day, 7 days a week.

The LPS44 is also a good power supply. The LPS44 was made by a power supply company called 'Aztec'. Astec was acquired by Artesyn.

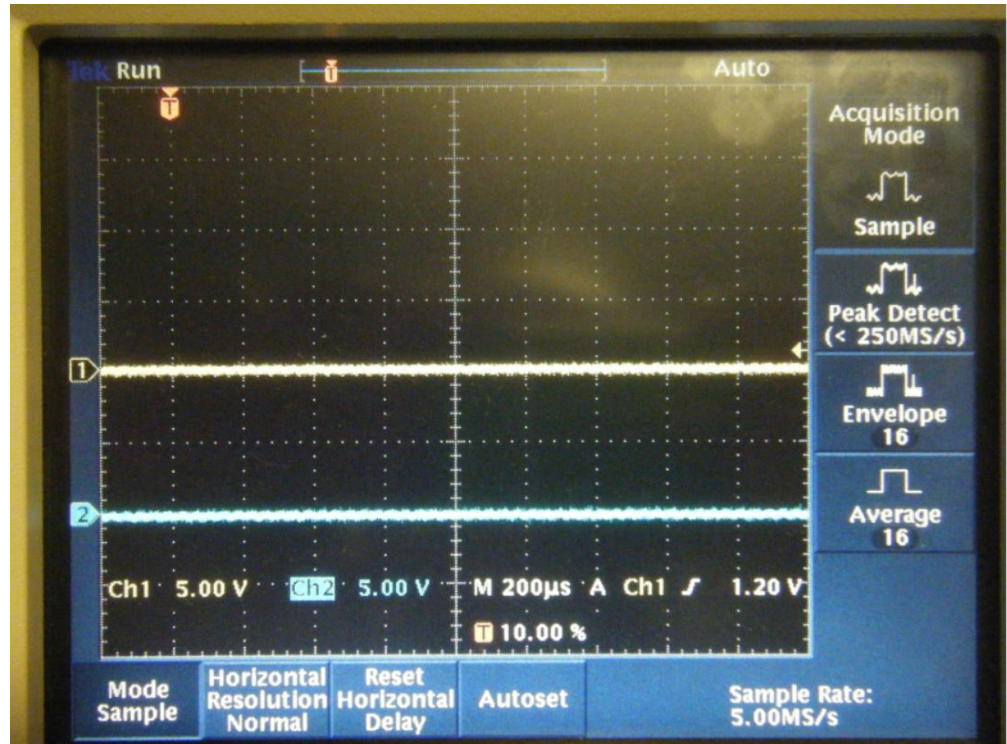
If you do anything, you could change all the electrolytic capacitors in the power supply with good quality 105C capacitors from a component distributor. Do not buy them on eBay etc.

Waveform noise

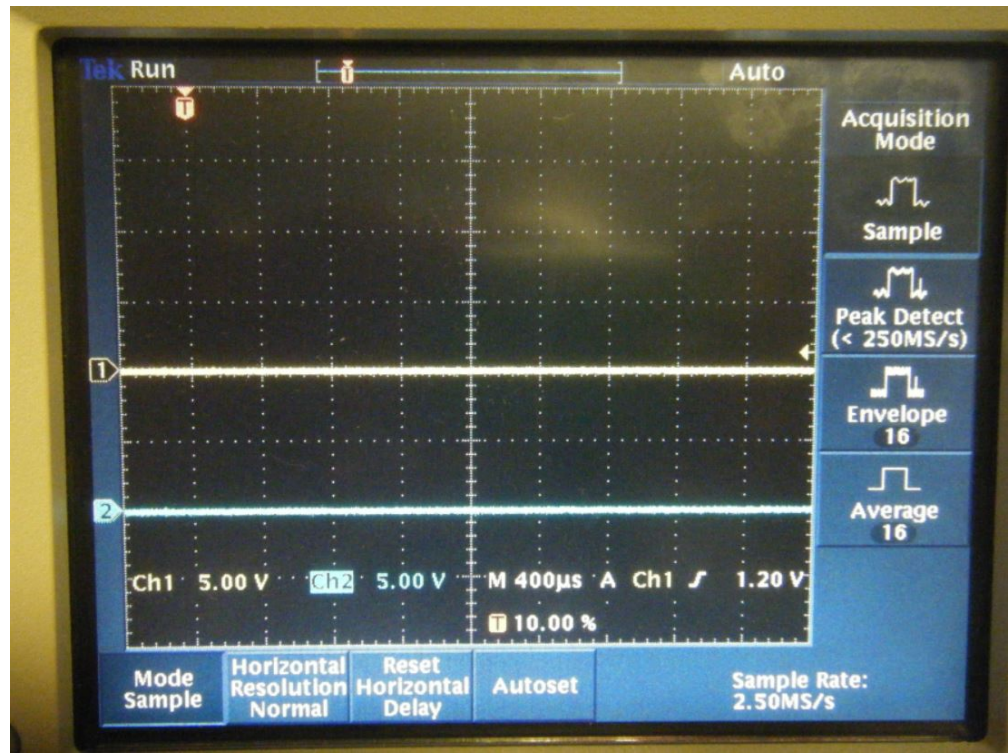
I set the TDS3012, two channel scope, to the same conditions as your scope:

5V/div, 200us/div and 400us/div

There is a noticeable increase in noise. Here are the photographs:
200us/div



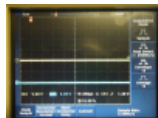
400us/div



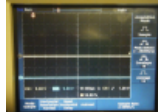
I do not have the floppy drive installed at the moment, so I used a camera.
It looks very similar to what you are seeing.

Ciao,

Jay_Diddy_B



200us.JPG (135.26 kB, 1096x818 - viewed 5847 times.)



400us.JPG (137.5 kB, 1100x822 - viewed 5841 times.)

« Last Edit: July 27, 2016, 10:16:48 am by Jay_Diddy_B »

Report to moderator Logged

The following users thanked this post: bsproj

bsproj
Contributor



Posts: 8
Country:

Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #9 on: July 27, 2016, 10:52:13 am »

Thanks Jay! So my Tek is in working order.

Your help has been very useful. *Grazie!*

Niki

Report to moderator Logged

HighVoltage
Super Contributor

Re: A Tektronix TDS3014B with two strange issues

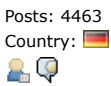
Say Thanks Reply Quote

« Reply #10 on: July 27, 2016, 01:58:00 pm »

A friend here in Germany has three TDS3000 series scopes and all of them suffered from a failing PSU.



Posts: 4463
Country:



One would not expect this from a Tektronix scope.

I still have one of these scope but don't use it much and so far it has not failed. There is some really good information in this thread, thanks for that.

[Report to moderator](#)

There are 3 kinds of people in this world, those who can count and those who can not.

MarkL

Supporter



Posts: 1658
Country:



Re: A Tektronix TDS3014B with two strange issues

« **Reply #11 on:** July 27, 2016, 04:29:52 pm »

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

The only reason these power supplies run all the time is to charge the battery pack. The scope doesn't need 24x7 power for anything else. I'm betting most scopes don't have the battery pack, given how outrageously expensive they are.

With a turned-off TDS3054 and no battery pack, I'm measuring real power 3.7W @ 120VAC and 7.4W @ 240VAC. Perhaps the extra heat dissipation is the reason for more failures at 240V.

Also fairly wasteful for no added benefit.

A real AC on/off switch could be a mod opportunity to preserve the power supply and save energy, but it unfortunately involves messing with the line wiring.

[Report to moderator](#)

Jwalling

Supporter



Posts: 1361
Country:

This is work?



Re: A Tektronix TDS3014B with two strange issues

« **Reply #12 on:** July 27, 2016, 06:02:53 pm »

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

Quote from: bsproj on July 27, 2016, 08:27:25 am

Hi,
thank you a million for your detailed report. I'll check the value of the load resistor R7 just to be sure. Anyway the overheating of my PSU is probably normal using the oscilloscope with 230 V mains. Maybe is a really good idea to replace this PSU with a more reliable one, like the mentioned Artesyn LPS44.

And what about the increased noise at high sampling rate? Does your TDS3012 present the same sudden increase of noise when you switch from 400 μ s/div (2.5 MS/s) to 200 μ s/div (5 MS/s)?

Thanks for your help!

FWIW, I see the same slightly increased noise on a TDS3054B.

Jay

[Report to moderator](#)

Jay

System error. Strike any user to continue.

The following users thanked this post: bsproj

bsproj

Contributor



Posts: 8
Country:



Re: A Tektronix TDS3014B with two strange issues

« **Reply #13 on:** July 28, 2016, 02:09:06 pm »

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

Thank you for your answers.

Quote from: MarkL on July 27, 2016, 04:29:52 pm

With a turned-off TDS3054 and no battery pack, I'm measuring real power 3.7W @ 120VAC and 7.4W @ 240VAC. Perhaps the extra heat dissipation is the reason for more failures at 240V.

Do you think a 120 VAC operation could increase the life expectancy of this PSU?

I've a few unused 240 VAC center-tapped transformer. I could use one of them as an autotransformer in order to obtain a 120 VAC socket.

Is this a good idea?

Niki

[Report to moderator](#)

MarkL

Supporter



Posts: 1658

Country:



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #14 on: July 28, 2016, 07:41:12 pm »

Quote from: bsproj on July 28, 2016, 02:09:06 pm

Thank you for your answers.

Quote from: MarkL on July 27, 2016, 04:29:52 pm

With a turned-off TDS3054 and no battery pack, I'm measuring real power 3.7W @ 120VAC and 7.4W @ 240VAC. Perhaps the extra heat dissipation is the reason for more failures at 240V.

Do you think a 120 VAC operation could increase the life expectancy of this PSU?

I've a few unused 240 VAC center-tapped transformer. I could use one of them as an autotransformer in order to obtain a 120 VAC socket.

Is this a good idea?

Niki

Who can say for sure if this will help, but a lower temperature is generally good for the longevity of any circuit. Make sure you preserve the ground continuity to the scope if you build a converter.

You might not save any energy, though, since there's going to be loss in your autotransformer. It will draw a small amount of power even if nothing is connected to the output and become a phantom load itself. (If you're concerned about the energy, that is.)

The back panel on my 3054 got noticeably hotter when running on 240V, although I didn't take it apart to confirm it was R3 + R5. Seems likely though, looking at the circuit from Jay_Diddy_B.

Report to moderator Logged

The following users thanked this post: bsproj

bsproj

Contributor



Posts: 8

Country:



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #15 on: July 29, 2016, 10:20:50 pm »

Quote from: MarkL on July 28, 2016, 07:41:12 pm

The back panel on my 3054 got noticeably hotter when running on 240V

I've just tested the temperature running my 3014 with 120 VAC. The overheating is now less alarming.

Actually my Tek is connected to mains only some hours a day. This is enough to overheat it (especially during the summer), but not enough to be worried about the energy loss. So, I'm going to keep the autotransformer plugged in. I really hope this will increase the life expectancy of the PSU.

Thank you for your help.

Niki

Report to moderator Logged

hugo

Regular Contributor



Posts: 137

Country:



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #16 on: July 31, 2016, 01:47:12 am »

Hi Niki you've forgot to mention what is the room temperature !

Report to moderator Logged

bsproj

Contributor



Posts: 8

Country:

Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #17 on: July 31, 2016, 10:10:54 am »

Hi Hugo. The temperature is usually about 25±5 °C during the summer.

Report to moderator Logged



Jay_Diddy_B

Super Contributor



Posts: 2216

Country:



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

< Reply #18 on: July 31, 2016, 11:36:37 am >

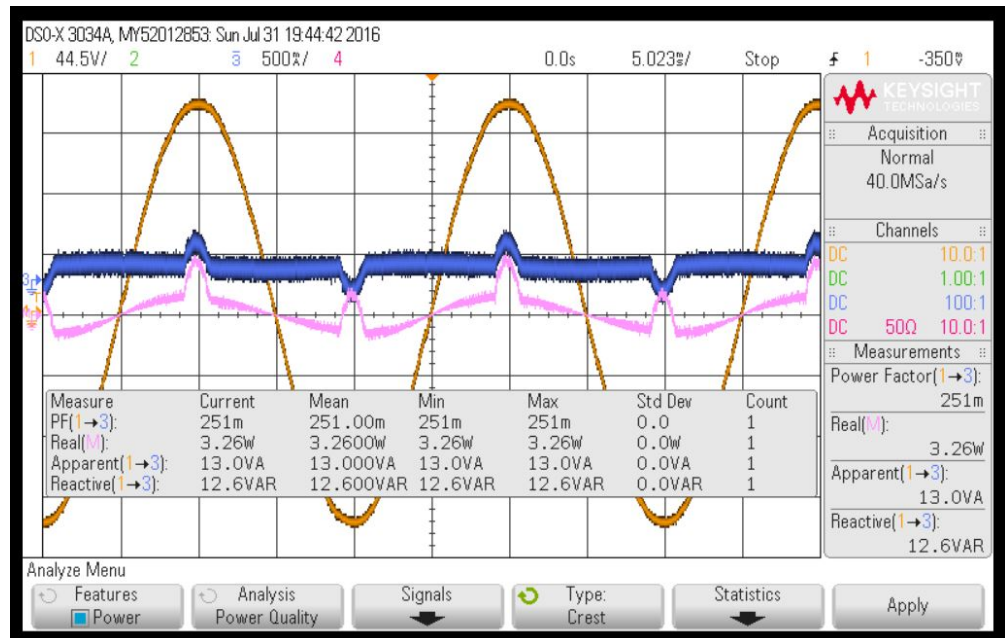
Hi Group,

I can confirm the input power measurements. These were made using a DSO-X 3034A with the Power Analyzer option. A current probe and voltage probe were used. I am measuring a TDS 3012 with the Artesyn NAN40-7615-01 Power Supply.

Input power was supplied using an Elgar 501 AC bench power supply.

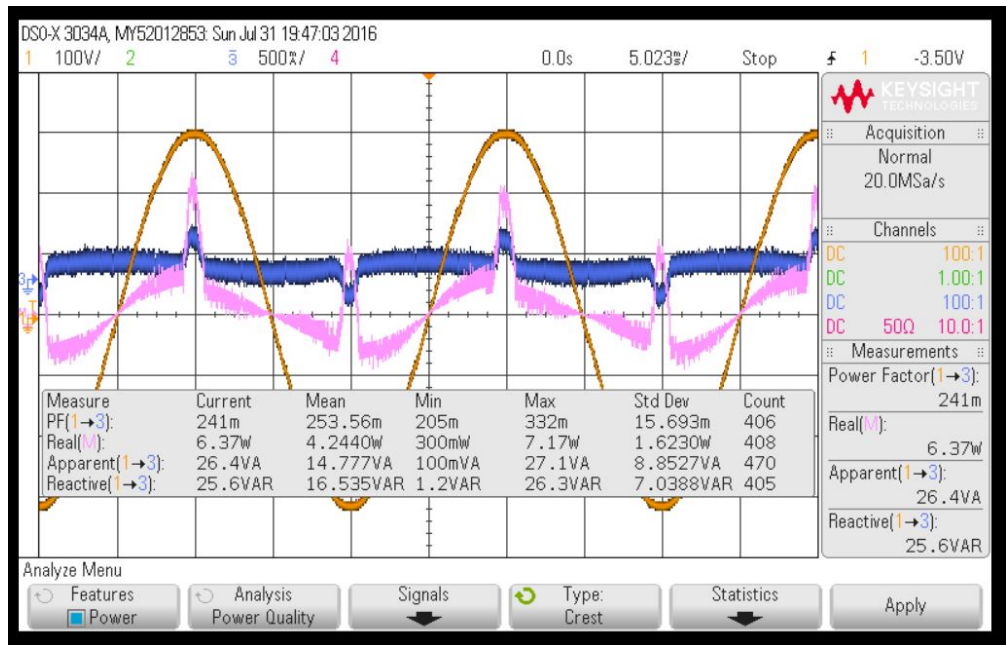
Here are the results:

110V



Power is 3.26W

230V

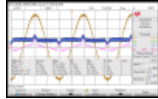


Power is 6.37W

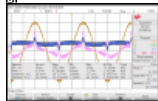
I will post a thermal image later.

Regards,

Jay_Diddy_B



110V PWR.JPG (120.76 kB, 1028x656 - viewed 5475 times.)



230V PWR.JPG (125.99 kB, 1026x659 - viewed 5550 times.)

« Last Edit: July 31, 2016, 11:38:13 am by Jay_Diddy_B »

Report to moderator Logged

Jay_Diddy_B

Super Contributor



Posts: 2216

Country:



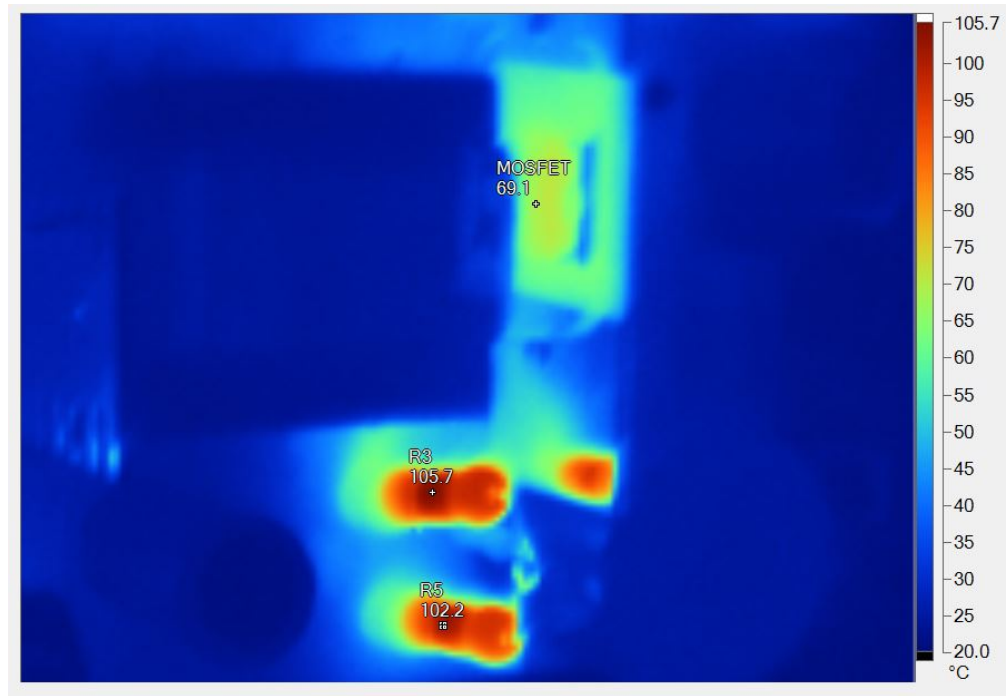
Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #19 on: July 31, 2016, 02:44:42 pm »

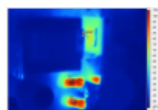
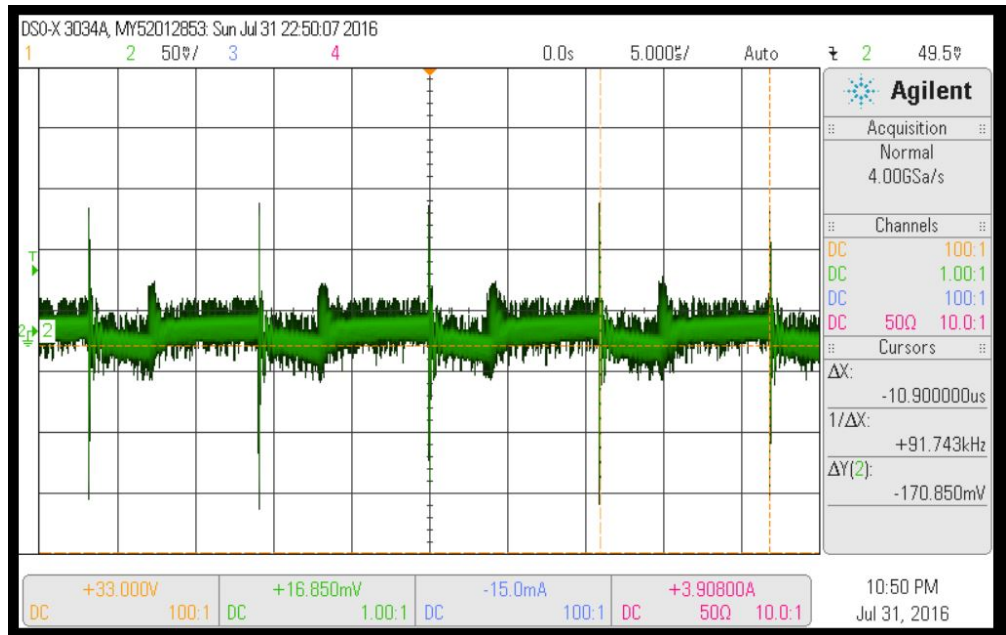
Hi Group,

Here is a thermal image of the Power Supply Board. The TDS3012 is powered from 220V (nominal) the scope is off. The hot parts are R3 and R5, the MOSFET is warm.

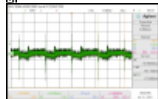


I am not sure if this is a problem, resistors can run hot like this. I think line voltage transients are more of a threat.

Here is a picture of the output voltage ripple with the scope on. The power supply is running around 91 kHz. The switching frequency was independent of the line voltage.



VIN_220V OFF.JPG (47.79 kB, 897x624 - viewed 5516 times.)



Power Supply ripple scope on.JPG (100.9 kB, 1024x648 - viewed 5557 times.)

« Last Edit: July 31, 2016, 02:46:36 pm by Jay_Diddy_B »

Report to moderator Logged

The following users thanked this post: bsproj

bsproj

Contributor



Posts: 8

Country:



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #20 on: July 31, 2016, 03:46:53 pm »

Hi Jay, thank you for your report. Your thermal image is consistent with my previous temperature measurements.

It's interesting that the different mains voltage causes a variation of 40 °C in the temperature of the two resistors. This make me more convinced to run my Tek at 120 VAC.

Report to moderator Logged

Jay_Diddy_B

Super Contributor



Posts: 2216

Country:



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #21 on: July 31, 2016, 05:36:49 pm »

Niki,

You could always move to a 120V country...

Regards,

Jay_Diddy_B

Report to moderator Logged

tautech

Super Contributor



Posts: 18751

Country:

Taupaki Technologies Ltd. NZ
Siglent Distributor



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #22 on: July 31, 2016, 08:12:27 pm »

IMO it would seem wise to power this DSO from a switched power strip and by doing so have the option to easily remove the power when not in use.
It might also be worthy of further modification of the snubber to reduce heat when the scope is not in use but powered.

Thanks to Jay and bsproj for investigation of this and sharing on the forum.

Edit spelling

« Last Edit: July 31, 2016, 08:45:26 pm by tautech »

Report to moderator Logged

~~Avid~~ Rabid Hobbyist

bsproj

Contributor



Posts: 8

Country:



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #23 on: July 31, 2016, 08:36:31 pm »

Hi tautech,
actually this is the perfect solution. My oscilloscope has already connected to a switched power strip, with a lot of other instruments. In my case is more convenient to use a DIY step-down transformer instead another switched socket.

Quote from: Jay_Diddy_B on July 31, 2016, 05:36:49 pm

You could always move to a 120V country...

It would be a good idea to kill two birds with a stone: I'll get a cooler Tek, and I'll improve my broken english!

Report to moderator Logged

Jay_Diddy_B

Super Contributor



Posts: 2216

Country:



Re: A Tektronix TDS3014B with two strange issues

Say Thanks Reply Quote

« Reply #24 on: August 03, 2016, 09:15:27 pm »

Hi,

I got the parts to complete the repair of my TDS3012. When I got the scope, it was literally a 'basket

case' The back was off, the floppy was out, the power supply was broken.

I repaired the power supply. I described the repair earlier in this thread. I needed to get the missing case parts.

Two missing feet



Two Hub assemblies to hold the handle on



Two hub covers, to hide the hub assemblies



The Power Switch Button



The total cost delivered around \$160.00

These parts will fit any of the following scopes:

TDS3012 TDS3014 TDS3032 TDS3034 TDS3052 TDS3054

Regards,

Jay_Diddy_B



TDS3012 foot 1.JPG (91.89 kB, 1133x740 - viewed 5487 times.)



TDS3012 foot 2.JPG (80.11 kB, 1120x710 - viewed 5521 times.)



TDS3012 hub assy.JPG (100.9 kB, 1136x746 - viewed 5764 times.)



TDS3012 hub cover.JPG (103.68 kB, 1175x760 - viewed 5958 times.)



tds3012 power switch button.JPG (84.77 kB, 1084x624 - viewed 5477 times.)

« Last Edit: August 03, 2016, 09:17:39 pm by Jay_Diddy_B »

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The following users thanked this post: focovario

Maxis

Contributor

Posts: 9

Country:



Re: A Tektronix TDS3014B with two strange issues

« Reply #25 on: September 24, 2018, 09:42:57 pm »

Say Thanks

Reply

Quote

Dear forum members,

This is my first post on this forum. I wanted to share my experience in fixing the TDS3014 power supply.

The power supply schematics traced Jay_Diddy_B helped me a lot in fixing my 3014.

The problem was in the mains flyback converter, which couldn't properly regulate its output voltage (was jumping from 19V to 23V up/down) causing the scope to do sporradic things, crashing SW, hanging, rebooting, etc.

The root cause of the failure was in the voltage reference/shunt regulator TL431. It was heating up like crazy leaving black spot of the burned PCB under it.

I've checked the other components, they seem to be in spec. After the replacement of TL431, the new regulator also heats up to 70 degrees. The output voltage with and w/o the load and the ripple figure are fine. I'm running the power supply from 240V AC mains. The scope runs like new again.

But now I'm questioning whether the problem is really fixed.

Is it normal that TL431 heats up so much?

I haven't seen it being glowing red on the thermal scan images kindly provided in this forum. Actually TL431 almost dissipates 400mW! It had left the same kind of burns on the PCB like the snubber network resistors and the load resistance.

If this is not a normal operation, IMHO, I can only assume that the optocoupler has degraded with the time and doesn't have the same Current Transfer Ratio (if the CTR would fall low). Hence TL431 is supposed to put more current through IR LED in order to keep the output voltage on target, which pushes the TL431 operating mode beyond the spec.

For the moment I'm waiting for the CNY17-3 optocoupler to arrive, then I'll try replacing it.

However, if such a heavy operating mode in standby is normal, IMHO, the TDS3000 power supply is prone to fail with the time.

I'm just wondering, is it only my scope or are TDS3000 having a glowing red reference IC when running from 240V AC?

Thank you!

All the Best,

Maxim


« Last Edit: September 24, 2018, 09:49:36 pm by Maxis »

Report to moderator  Logged

 **Maxis**

Contributor

Posts: 9

Country: 



 **Re: A Tektronix TDS3014B with two strange issues**

« Reply #26 on: September 25, 2018, 10:45:55 pm »

Say Thanks Reply Quote

Hello All!

A little update - couldn't get the original TCDT1103G, but quickly dropped in CNY17-3 (disconnecting the base of the phototransistor beforehand). Apart from a little pinout difference (and a package geometry too) these two parts have similar characteristics.

And bingo!

After the replacement of the optocoupler the current flowing through the IR LED is much lower. LM431 is barely warm. IMHO, since the scope was always connected to the mains for many years while sitting on the bench, the optocoupler has degraded (IMHO the IR LED did) and this was the root cause. So, in order to limit the output voltage, the LM431 had to pump lots of current though IR LED in order to compensate for the degraded Current Transfer Ratio. This caused TL431 dissipating around 500mW. Eventually this voltage reference got killed by the continuous overheating making the NAN power supply output unregulated (up to 30V instead of 14.7V). I wonder whether the output load resistance was tailored to limit the output voltage in such event (single fault protection) when the scope is OFF. Anyway apart from continuous rebooting and FW crashes the scope didn't burn 🤔🔥

What is amazing is that the Tektronix power converter (the one generating all the voltages from 14.7V and connected to the NAN AC/DC converter) supported the recurring overvoltage up to 30V protecting the rest of the scope (sometimes it's good to overdesign things)!

Now, IMHO, the scope is finally fixed and its thermal profile is not any different from presented above on the IR scans.

Maybe someone would find it helpful.

Thank you and all the Best,

Maxim

P.S. Now I'll try fixing/calibrating my 2245A with the old-new repaired TDS3014!

« Last Edit: September 25, 2018, 11:21:41 pm by Maxim »

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