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EEVblog Electronics Community Forum » Electronics » Repair » A Tektronix TDS3014B with two strange issues

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 Author

Topic: A Tektronix TDS3014B with two strange issues (Read 8214 times)


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bsproj

Contributor



Posts: 8

Country: 



 **A Tektronix TDS3014B with two strange issues**

« on: July 27, 2016, 08:58:17 am »

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 of cycles/div) for any sampling rate higher than 5 MS/s. This periodic noise is very clear if I use the "average" acquisition mode.

(click for high resolution)

Is this normal for the TDS3000B series?

Thank you.

Niki
(Italy)

« Last Edit: July 27, 2016, 09:01:03 am by bsproj »

Logged

Jay_Diddy_B

Super Contributor



Posts: 1776

Country:

Re: A Tektronix TDS3014B with two strange issues

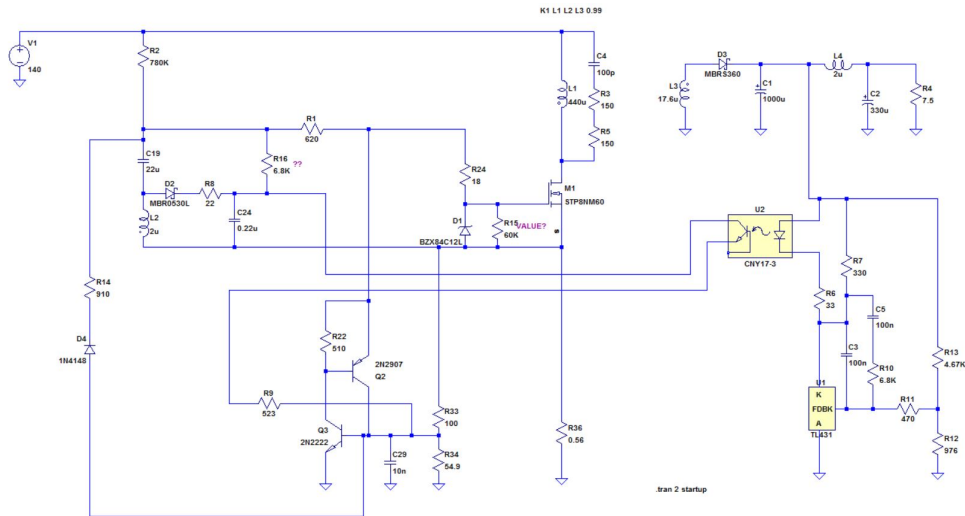
« Reply #1 on: July 27, 2016, 10:22:39 am »

Niki,

Welcome to the forum !!

You are lucky, I have just finished repairing a TDS3012. I am waiting for some case parts before I post details of my repair.

I traced out the circuit for the Artesyn NAN40-7615-01 Power Supply to help me repair. After I traced the schematic I made an LTspice model to confirm that I have the circuit correct. The circuit is not 100% accurate, but it is very close.

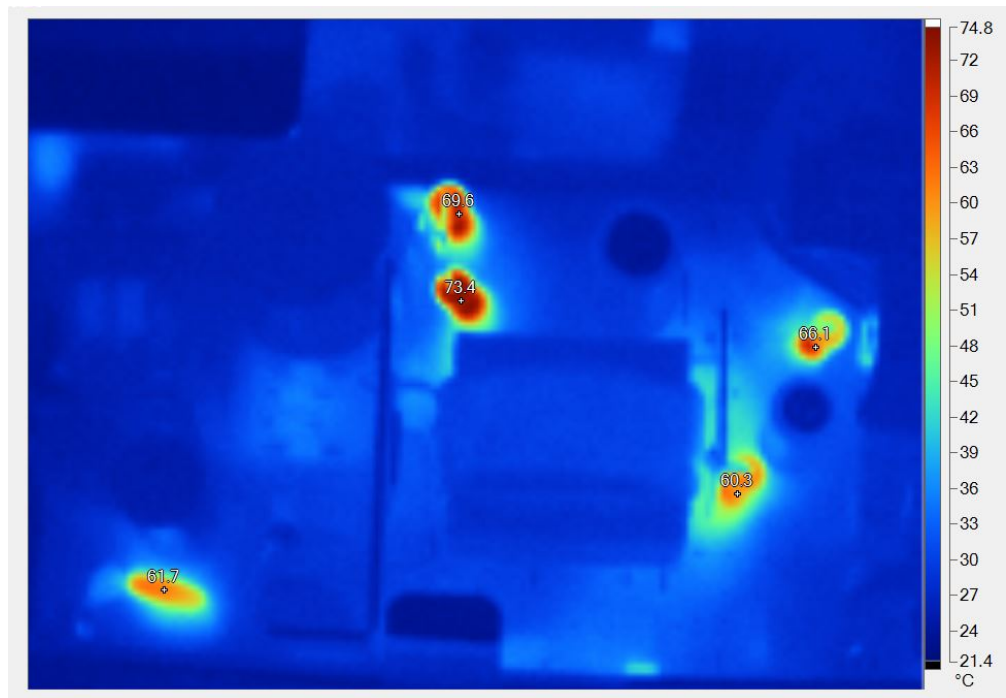


The LTspice model is missing the input filter, inrush thermistor (PTC), rectifier and the bulk capacitor.

Here is a picture of the board installed in the scope:



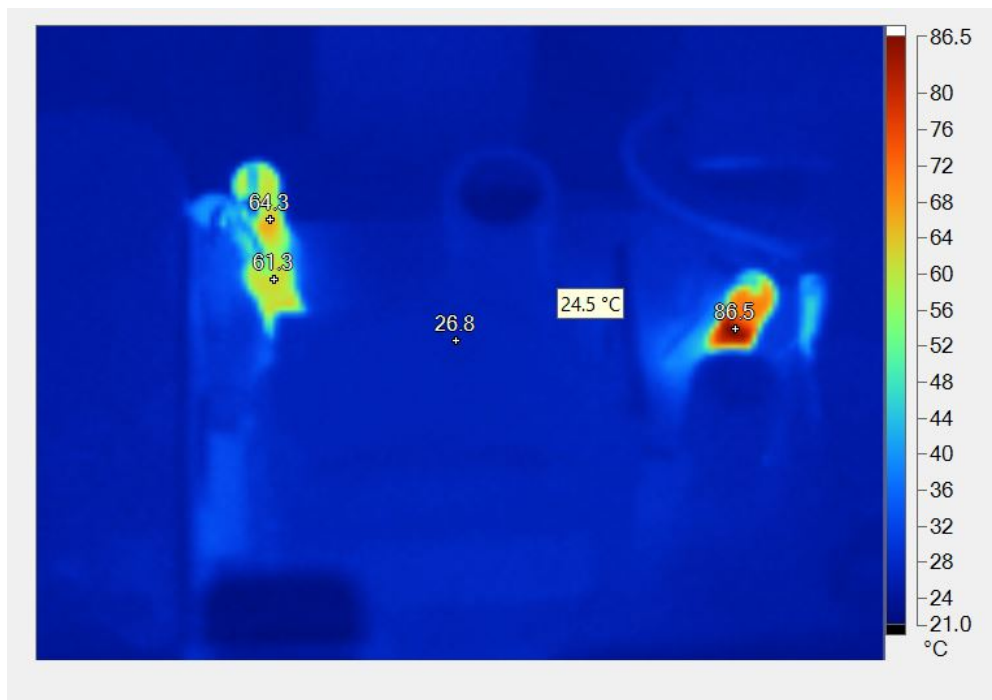
And here is a thermal image of the power supply, this was taken with the scope running.



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,

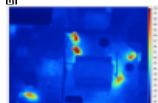
Jay_Diddy_B



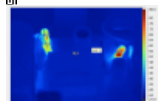
nan40-7615-01.JPG (104.94 kB, 1655x861 - viewed 4388 times.)



nan40-7615-01 PS.JPG (91.07 kB, 966x642 - viewed 4007 times.)



Thermal image running.JPG (55.97 kB, 968x676 - viewed 3591 times.)



Thermal image off.JPG (36.8 kB, 768x537 - viewed 3628 times.)

« Last Edit: July 27, 2016, 10:30:56 am by Jay_Diddy_B »

Logged

The following users thanked this post: bsproj, guy232

tautech

Super Contributor



Posts: 14770

Country:

Taupaki Technologies Ltd. NZ
Siglent Distributor



Jay_Diddy_B

Super Contributor



Posts: 1776

Country:

Re: A Tektronix TDS3014B with two strange issues

« Reply #2 on: July 27, 2016, 10:35:06 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. 😊

Logged

Avid Rabid Hobbyist

The following users thanked this post: bsproj

Re: A Tektronix TDS3014B with two strange issues

« Reply #3 on: July 27, 2016, 11:36:28 am »

Quote from: tautech on July 27, 2016, 10:35:06 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:

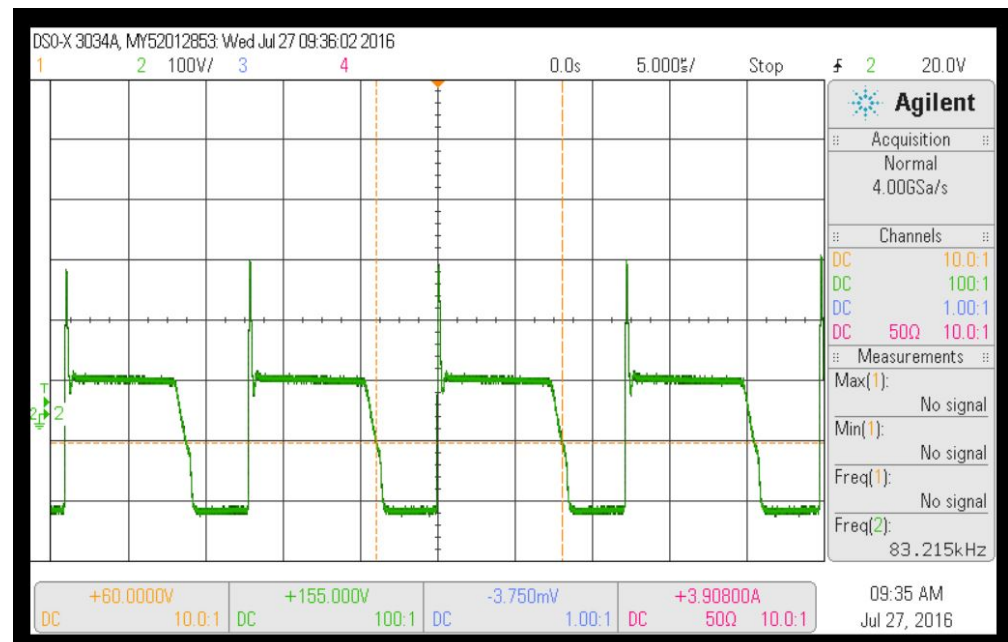
Note: The scope was powered using an Elgar 501 AC Power Supply, the output is floating. This allows me to connect the scope ground clip to the source of the MOSFET. The scope tip was connected to the Drain of the MOSFET. So the scope pictures are Vds.

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

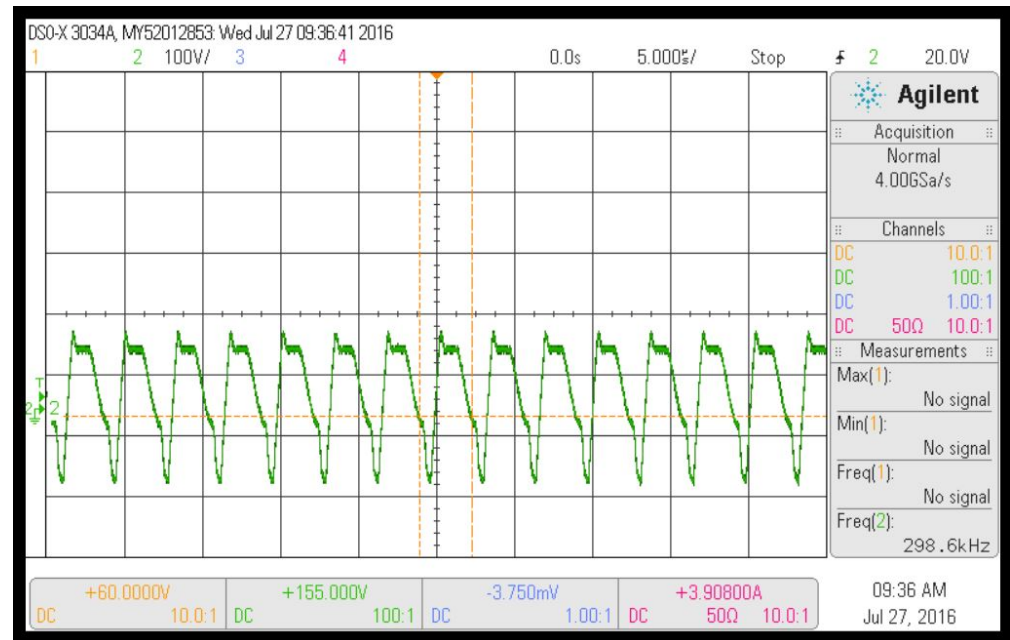
A Tektronix 100x, high voltage probe, P6009 was used for this measurement.

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:

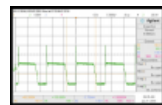
The main MOSFET (blown up)
 The 0.56 flameproof resistor, R36, in the MOSFET source (fused open)
 The 100 Ohm resistor, R33, blown open.
 D1, gate drive Zener, blown short
 Q2 and Q3 just in case, they are cheap.

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

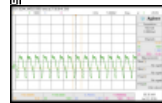
These power supply are fairly readily available new. It is a 5 x 3 x 1.2 inch form factor, 40W and 15V output. The -01 in the part number may mean that the output was set, by changing a resistor to 14.6V for some reason. I would use LPS44 from Artesyn (\$45.90 USD from Digkey).

Regards,

Jay_Diddy_B



VDS running.JPG (101.97 kB, 1033x666 - viewed 3572 times.)



VDS scope off.JPG (104.81 kB, 1024x655 - viewed 3576 times.)

Logged

The following users thanked this post: tautech, bsproj



Re: A Tektronix TDS3014B with two strange issues

« Reply #4 on: July 27, 2016, 12:11:38 pm »

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: 14770
Country:

Taupaki Technologies Ltd. NZ
Siglent Distributor



Hydrawerk

Super Contributor



Posts: 2365
Country:

bsproj

Contributor



Posts: 8
Country:



tautech

Super Contributor



Posts: 14770
Country:

Taupaki Technologies Ltd. NZ
Siglent Distributor



Jay_Diddy_B

Super Contributor



Posts: 1776
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, 12:14:35 pm by tautech »

Logged

Avid Rabid Hobbyist

Re: A Tektronix TDS3014B with two strange issues

« Reply #5 on: July 27, 2016, 12:39:13 pm »

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

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, 06:27:25 pm »

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!

Logged

Re: A Tektronix TDS3014B with two strange issues

« Reply #7 on: July 27, 2016, 07:30:56 pm »

Quote from: bsproj on July 27, 2016, 06:27:25 pm

Thanks for your help!

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

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

Logged

Avid Rabid Hobbyist

Re: A Tektronix TDS3014B with two strange issues

« Reply #8 on: July 27, 2016, 08:13:22 pm »

Quote from: bsproj on July 27, 2016, 06:27:25 pm

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'. Aztec was acquired by Artesyn.

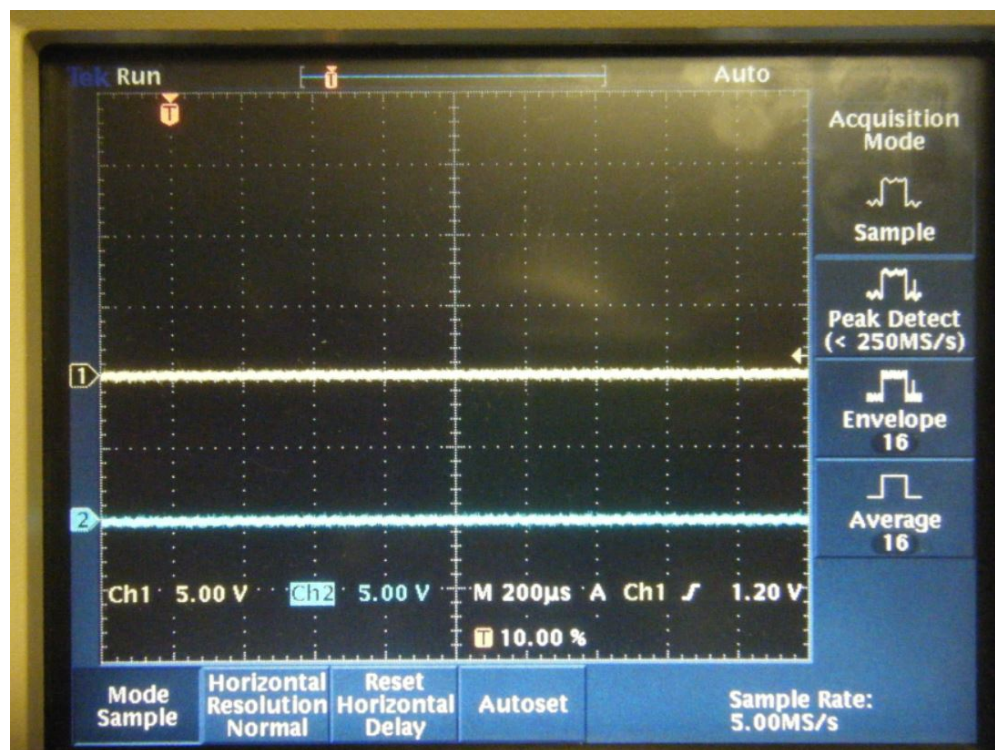
If you do anything, you could change all the electrolytic capacitors in the power supply with good quality 105C capacitors from a component distributor. Do not buy them on eBay etc.

Waveform noise

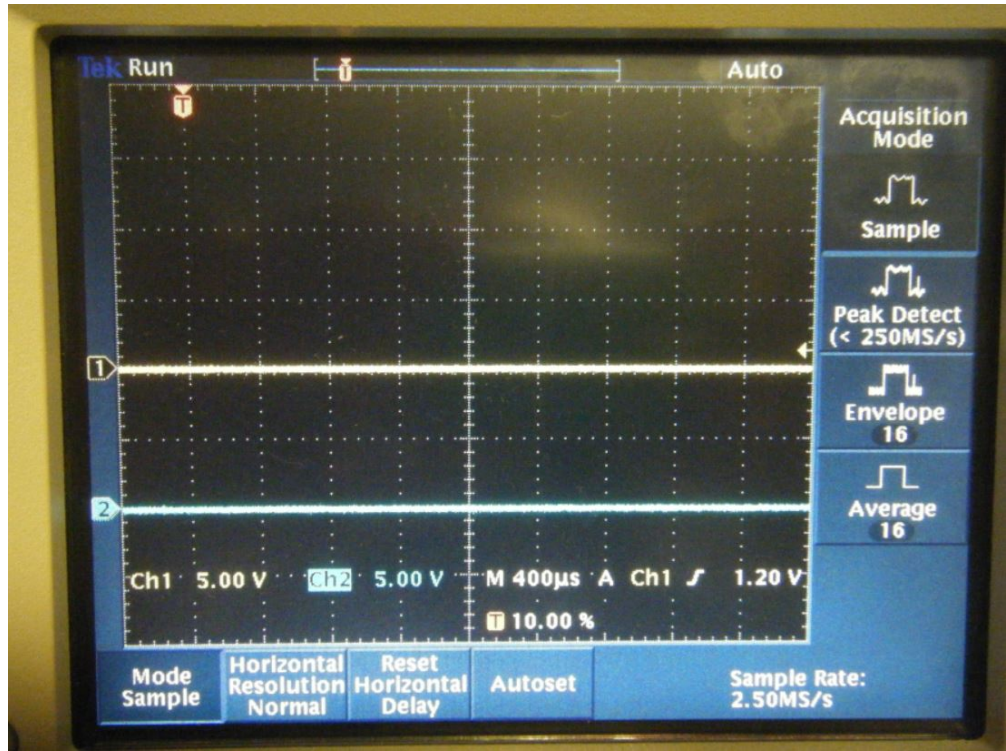
I set the TDS3012, two channel scope, to the same conditions as your scope:

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

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



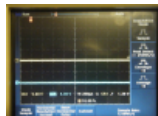
400us/div



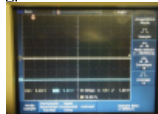
I do not have the floppy drive installed at the moment, so I used a camera.
It looks very similar to what you are seeing.

Ciao,

Jay_Diddy_B



200us div.JPG (135.26 kB, 1096x818 - viewed 3551 times.)



400us.JPG (137.5 kB, 1100x822 - viewed 3554 times.)

« Last Edit: July 27, 2016, 08:16:48 pm by Jay_Diddy_B »

Logged

The following users thanked this post: bsproj

bsproj
Contributor



Posts: 8
Country:

Re: A Tektronix TDS3014B with two strange issues

« Reply #9 on: July 27, 2016, 08:52:13 pm »

Thanks Jay! So my Tek is in working order.

Your help has been very useful. *Grazie!*

Niki

Logged

HighVoltage
Super Contributor

Re: A Tektronix TDS3014B with two strange issues

« Reply #10 on: July 27, 2016, 11:58:00 pm »

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



Posts: 4131
Country:

MarkL

Supporter



Posts: 1469
Country:

Jwalling

Supporter



Posts: 1140
Country:

This is work?

bsproj

Contributor



Posts: 8
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.

Logged

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

Re: A Tektronix TDS3014B with two strange issues

« Reply #11 on: July 28, 2016, 02:29:52 am »

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.

Logged

Re: A Tektronix TDS3014B with two strange issues

« Reply #12 on: July 28, 2016, 04:02:53 am »

Quote from: bsproj on July 27, 2016, 06:27:25 pm

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

Logged

Jay

System error. Strike any user to continue.

The following users thanked this post: bsproj

Re: A Tektronix TDS3014B with two strange issues

« Reply #13 on: July 29, 2016, 12:09:06 am »

Thank you for your answers.

Quote from: MarkL on July 28, 2016, 02:29:52 am

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

Logged

MarkL

Supporter



Posts: 1469

Country:

Re: A Tektronix TDS3014B with two strange issues

« **Reply #14 on:** July 29, 2016, 05:41:12 am »

Quote from: bsproj on July 29, 2016, 12:09:06 am

Thank you for your answers.

Quote from: MarkL on July 28, 2016, 02:29:52 am

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.

Logged

The following users thanked this post: bsproj

bsproj

Contributor



Posts: 8

Country:



Re: A Tektronix TDS3014B with two strange issues

« **Reply #15 on:** July 30, 2016, 08:20:50 am »

Quote from: MarkL on July 29, 2016, 05:41:12 am

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

Logged

hugo

Regular Contributor



Posts: 117

Country:

Re: A Tektronix TDS3014B with two strange issues

« **Reply #16 on:** July 31, 2016, 11:47:12 am »

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

Logged

bsproj

Contributor



Posts: 8

Country:



Re: A Tektronix TDS3014B with two strange issues

« **Reply #17 on:** July 31, 2016, 08:10:54 pm »

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

Logged

Jay_Diddy_B

Super Contributor



Posts: 1776

Country:

Re: A Tektronix TDS3014B with two strange issues

« Reply #18 on: July 31, 2016, 09:36:37 pm »

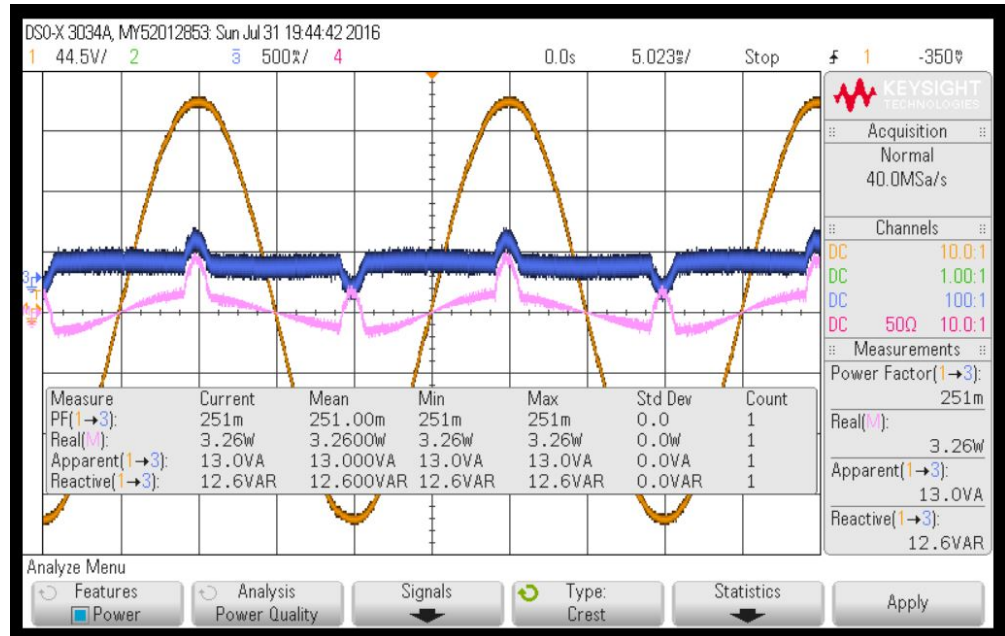
Hi Group,

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.

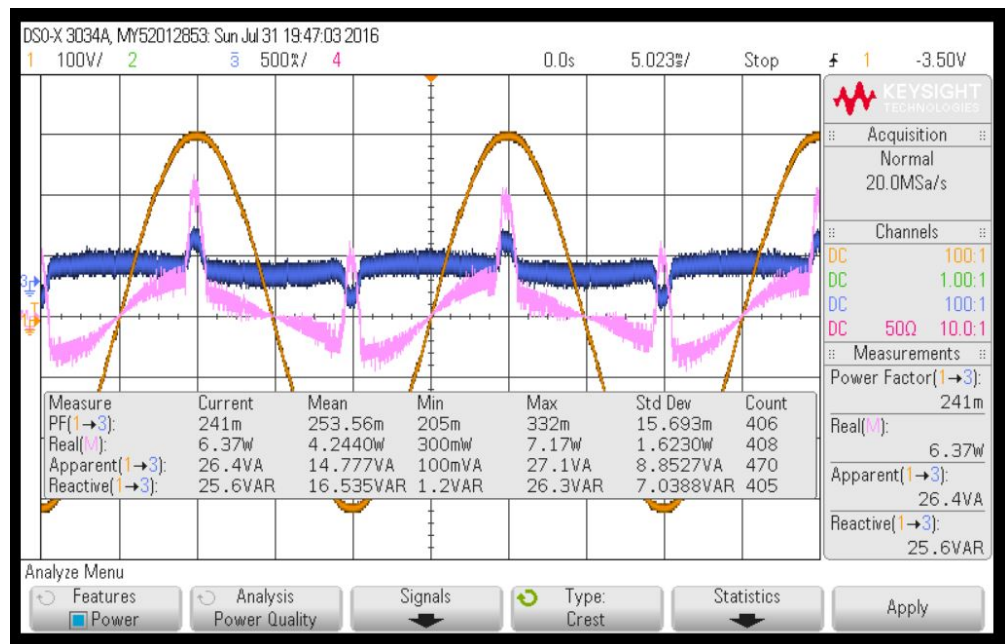
Here are the results:

110V



Power is 3.26W

230V

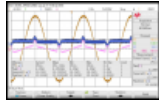


Power is 6.37W

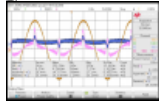
I will post a thermal image later.

Regards,

Jay_Diddy_B



110V PWR.JPG (120.76 kB, 1028x656 - viewed 3209 times.)



230V PWR.JPG (125.99 kB, 1026x659 - viewed 3292 times.)

« Last Edit: July 31, 2016, 09:38:13 pm by Jay_Diddy_B »

Logged

Jay_Diddy_B

Super Contributor



Posts: 1776

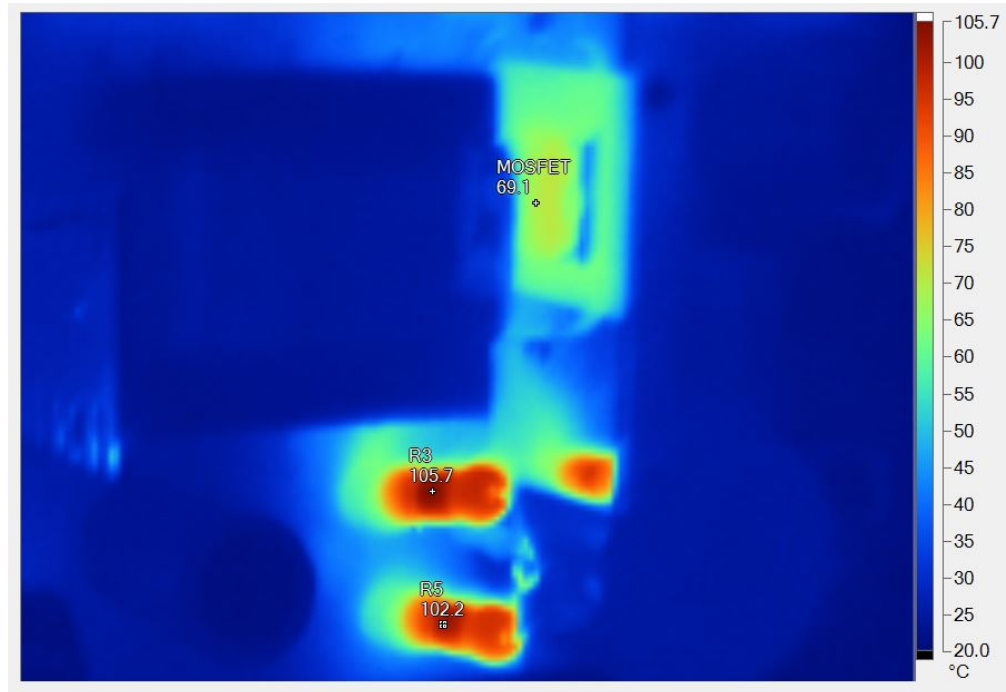
Country:

Re: A Tektronix TDS3014B with two strange issues

« Reply #19 on: August 01, 2016, 12:44:42 am »

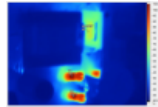
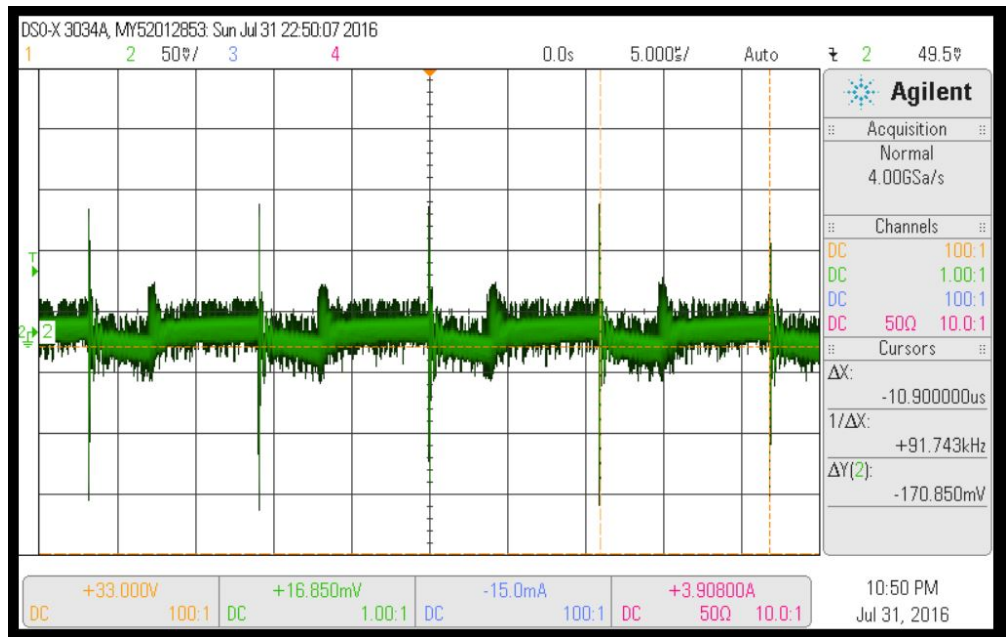
Hi Group,

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.

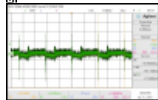


I am not sure if this is a problem, resistors can run hot like this. I think line voltage transients are more of a threat.

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 3260 times.)



Power Supply ripple scope on.JPG (100.9 kB, 1024x648 - viewed 3301 times.)

« Last Edit: August 01, 2016, 12:46:36 am by Jay_Diddy_B »

Logged

The following users thanked this post: bsproj

bsproj
Contributor



Posts: 8
Country:

Re: A Tektronix TDS3014B with two strange issues

« Reply #20 on: August 01, 2016, 01:46:53 am »

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.

Logged

Jay_Diddy_B
Super Contributor



Posts: 1776
Country:

Re: A Tektronix TDS3014B with two strange issues

« Reply #21 on: August 01, 2016, 03:36:49 am »

Niki,

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

Regards,

Jay_Diddy_B

Logged

tautech
Super Contributor

Re: A Tektronix TDS3014B with two strange issues

« Reply #22 on: August 01, 2016, 06:12:27 am »



Posts: 14770
Country:
Taupaki Technologies Ltd. NZ
Siglent Distributor



bsproj

Contributor



Posts: 8
Country:



Jay_Diddy_B

Super Contributor



Posts: 1776
Country:

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: August 01, 2016, 06:45:26 am by tautech »

Logged

Avid Rabid Hobbyist

Re: A Tektronix TDS3014B with two strange issues

« Reply #23 on: August 01, 2016, 06:36:31 am »

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 August 01, 2016, 03:36:49 am

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! 😊

Logged

Re: A Tektronix TDS3014B with two strange issues

« Reply #24 on: August 04, 2016, 07:15:27 am »

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 3278 times.)



TDS3012 foot 2.JPG (80.11 kB, 1120x710 - viewed 3176 times.)



TDS3012 hub assy.JPG (100.9 kB, 1136x746 - viewed 3150 times.)



TDS3012 hub cover.JPG (103.68 kB, 1175x760 - viewed 3275 times.)



tds3012 power switch button.JPG (84.77 kB, 1084x624 - viewed 3210 times.)

« Last Edit: August 04, 2016, 07:17:39 am by Jay_Diddy_B »

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