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Author — Topic: Rigol DG1022 improvement thread (Read 1195 times)

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c4757p
Super Contributor

Posts: 7514
Country:

Rigol DG1022 improvement thread

« **on:** August 18, 2014, 08:09:36 AM »

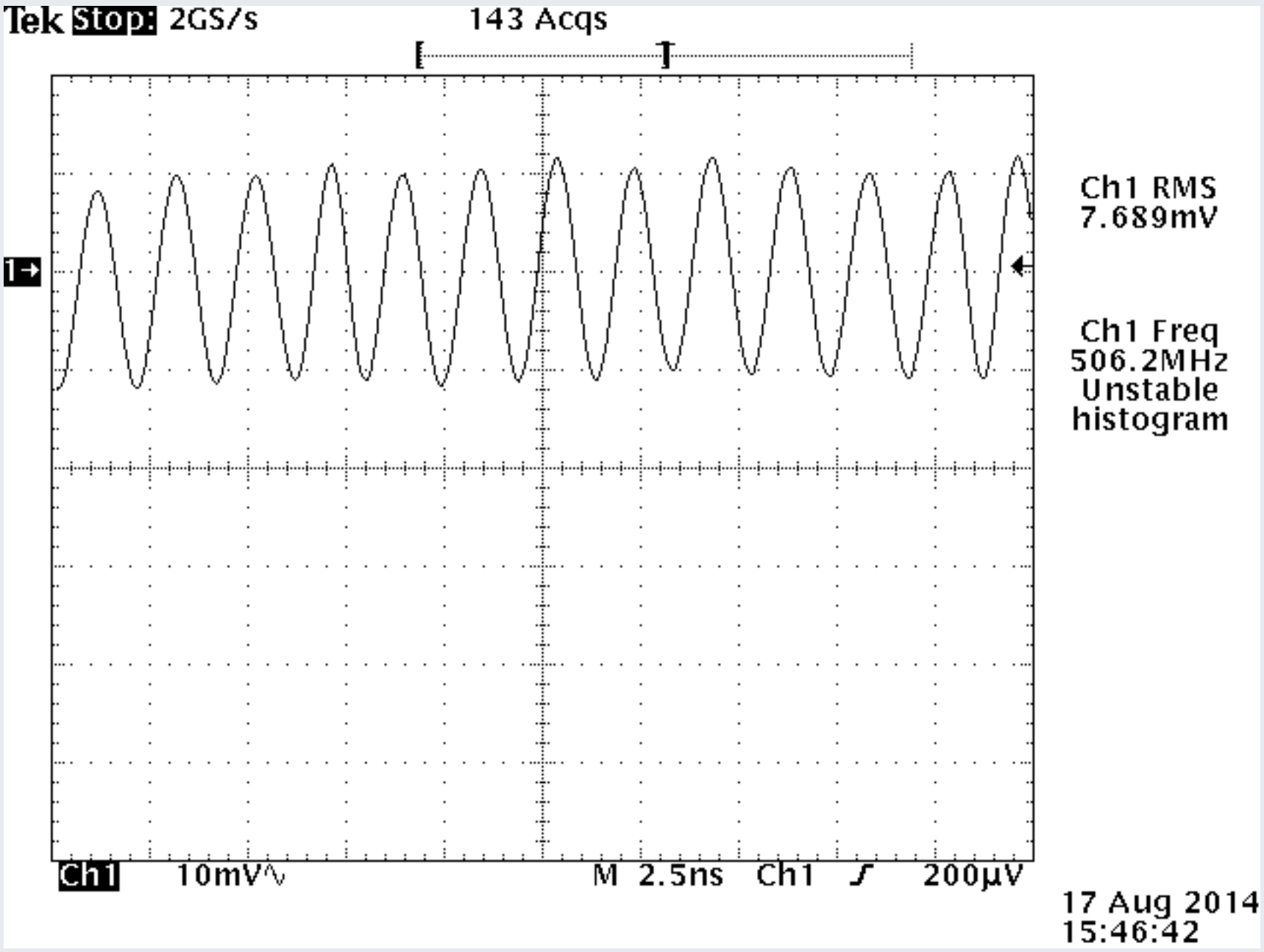
Quote

Two separate 'repair'/awful design correction attempts in this thread.

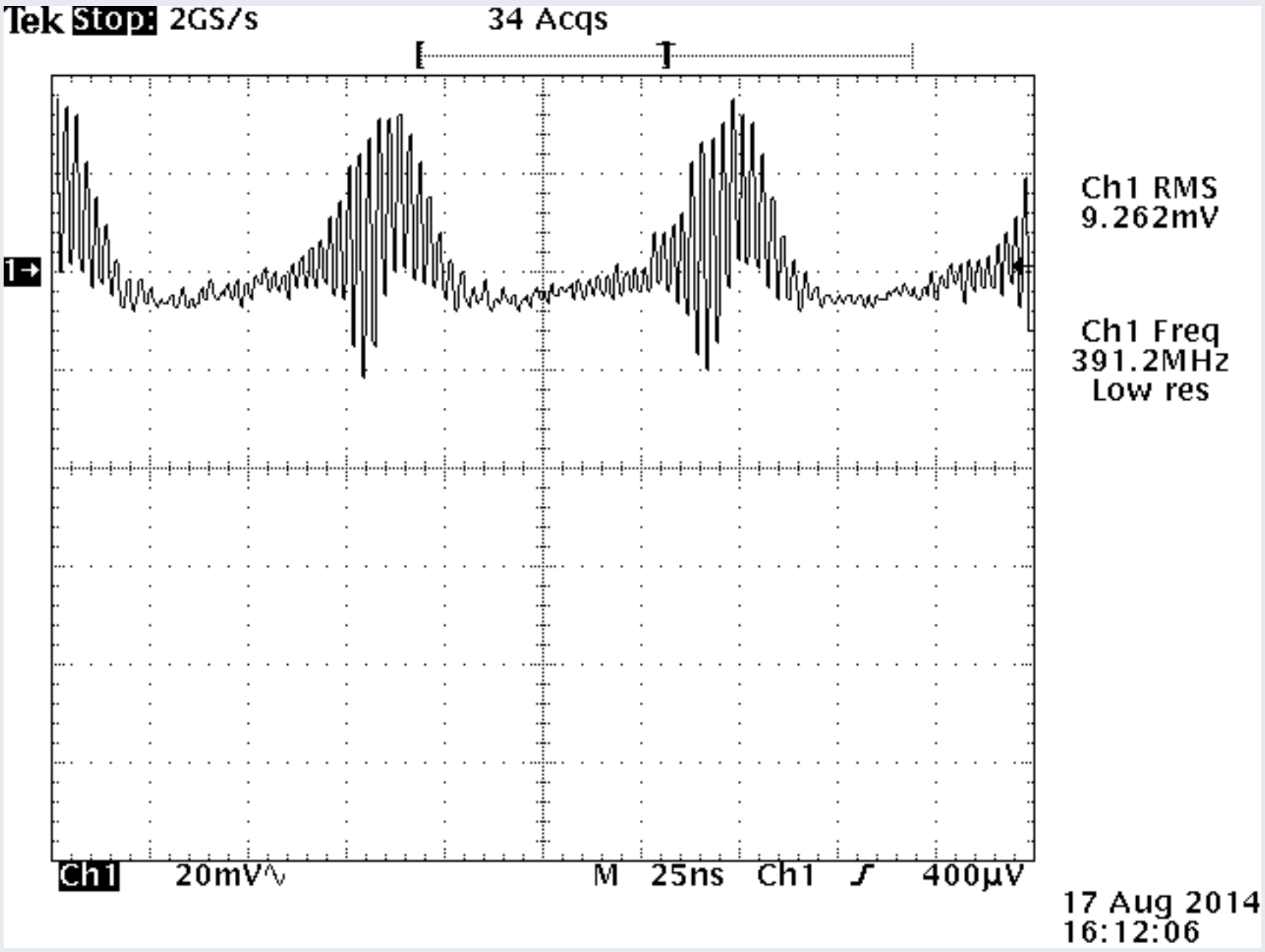
The DG1022 has a pretty noisy output. All the noise is above the bandwidth, making it pretty easy to remove with an LPF - though the bands are *close* (within less than half a decade), requiring a good, precise filter. I've designed and tested a nice, inline output filter for it, seventh order Bessel with integrated common-mode filter, which puts the output noise down within the noise floor of my scope. I'll post more on that later - PCBs, BOM, plus I have a couple extras (first come, first served).

However, while I was characterizing it, I had to push something else onto my stack:

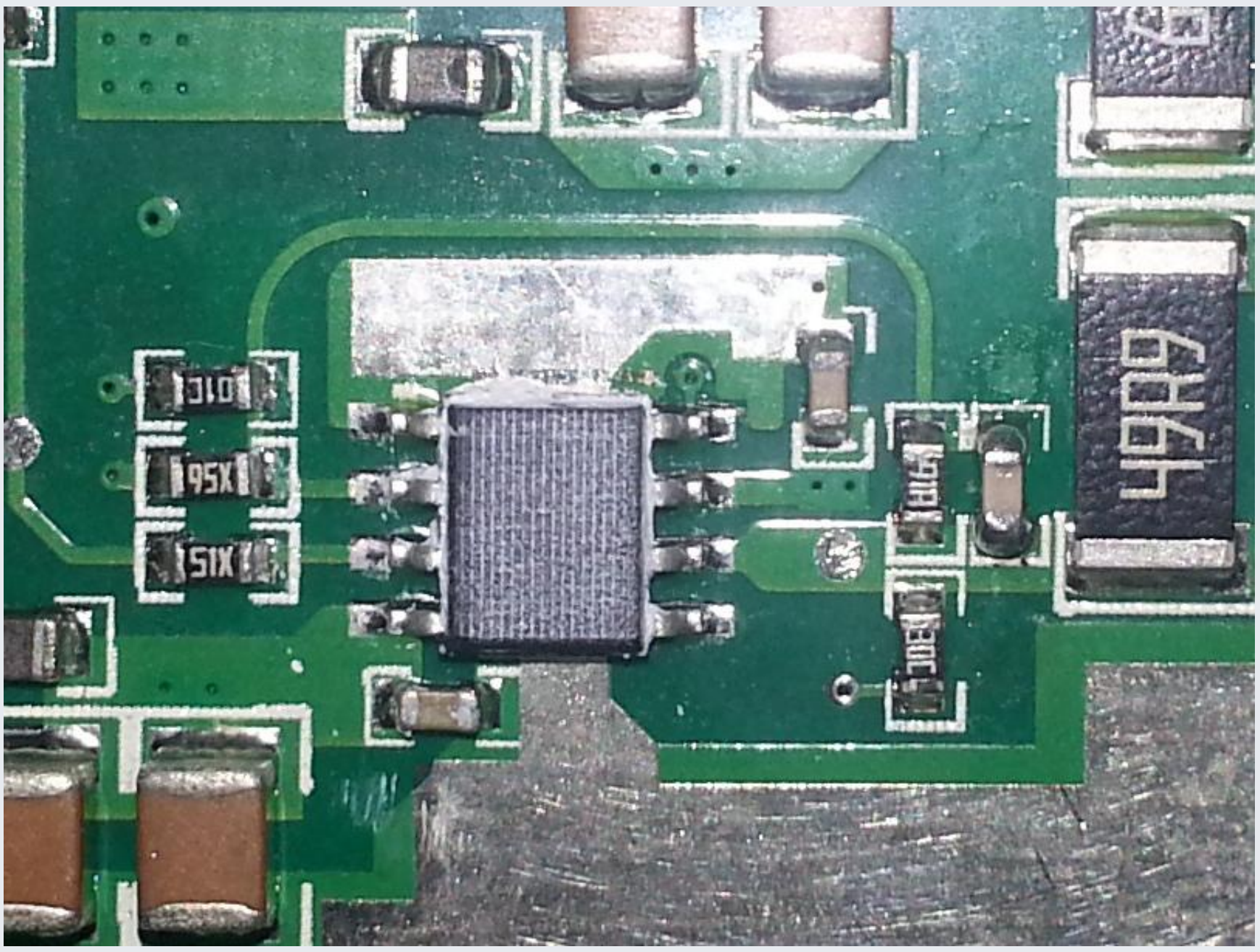
My Rigol DG1022U does this sometimes:



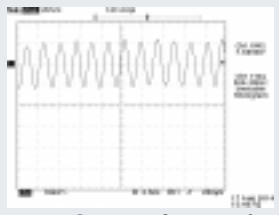
But sometimes, it even does *this*:



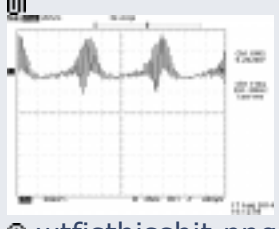
The cause appears to be related to this, er, *special* output amplifier layout:



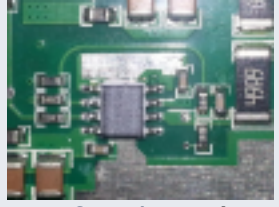
I've confirmed that another unit does the first one, but not the second. A bit more later tonight on an attempt to fix it. Has anybody else seen output amplifier instability like this?



wtf.png (3.62 kB, 640x480 - viewed 426 times.)



wtfisthisshit.png (3.54 kB, 640x480 - viewed 427 times.)



wtfrigol.jpg (276.87 kB, 808x606 - viewed 503 times.)

« *Last Edit: August 18, 2014, 08:18:03 AM by c4757p* »

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c4757p

Super Contributor

Posts: 7514

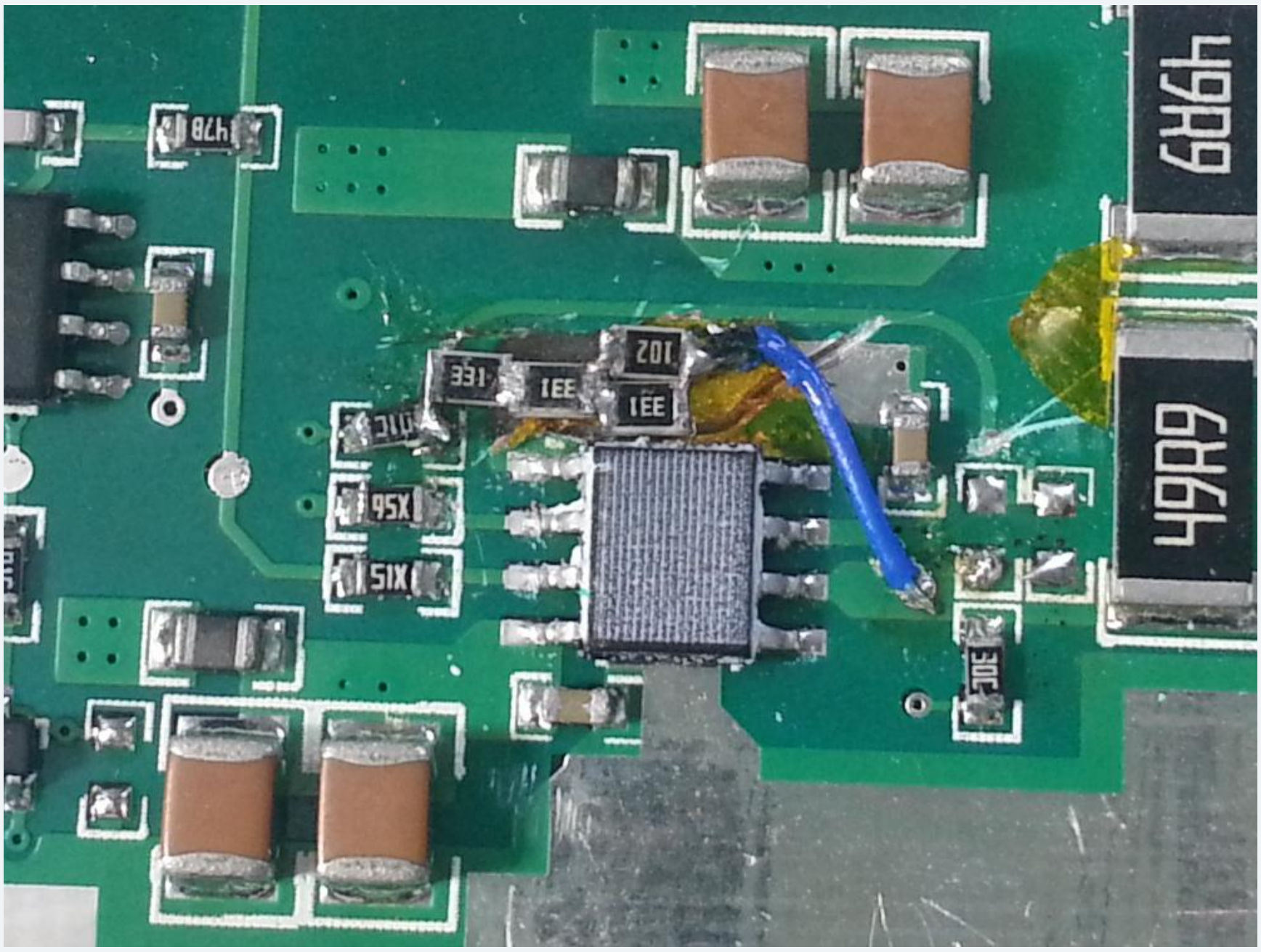
Country:

Re: Rigol DG1022 improvement thread

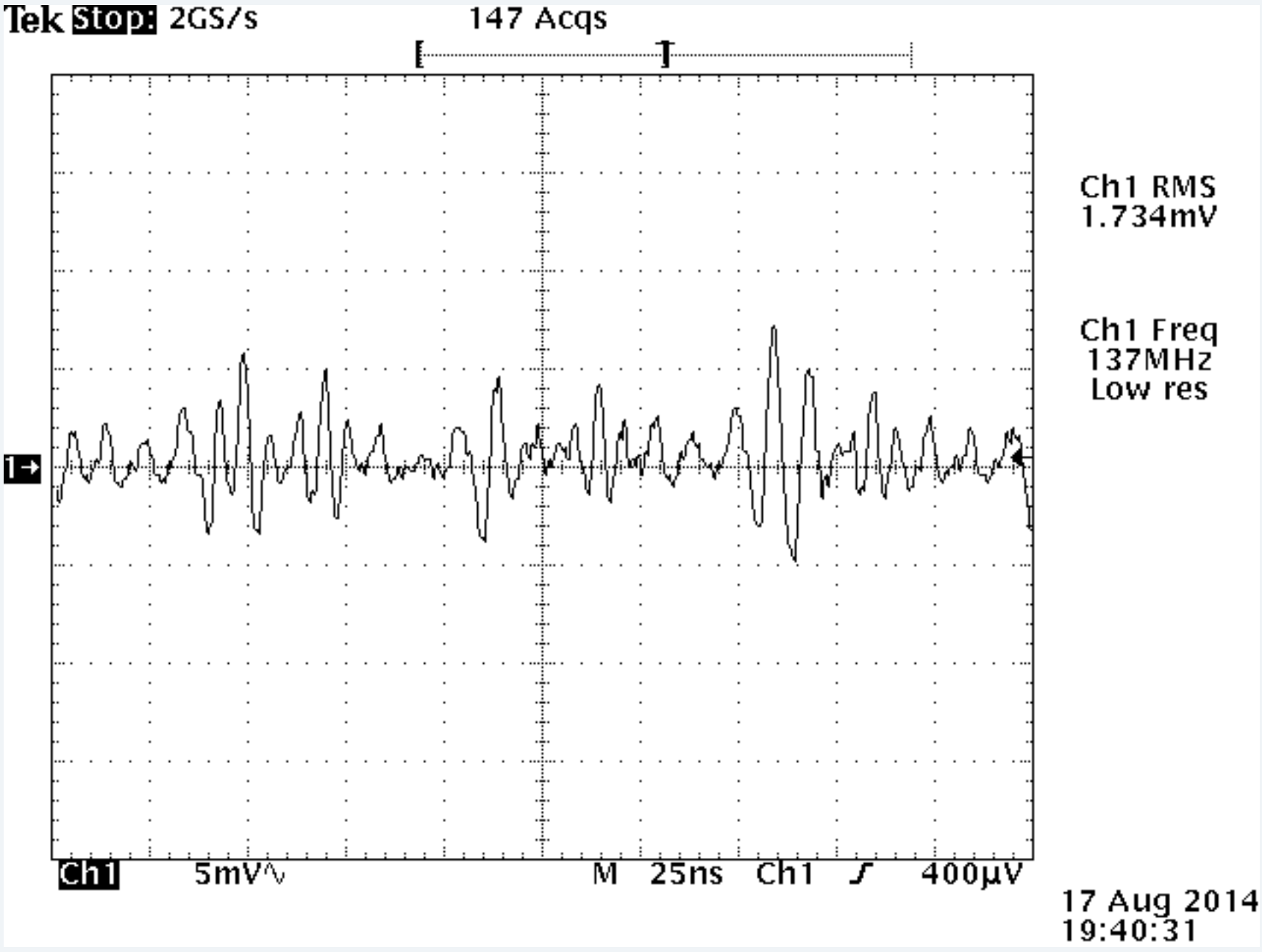
« **Reply #1 on:** August 18, 2014, 09:54:30 AM »

Quote

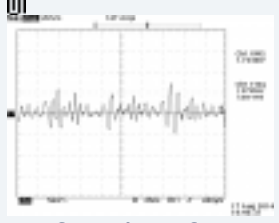
Bodge time! Look at this hideous atrocity. This is what happens when I attempt PCB modification on a board that's still mounted in chassis.



Fixed, though. Here's the worst I can get (which matches with another, better behaved unit):



hideous.jpg (314.27 kB, 1000x750 - viewed 390 times.)



after_loopfix.png (3.6 kB, 640x480 - viewed 373 times.)

Report to moderator Logged

c4757p

Super Contributor

Posts: 7514

Country:

Re: Rigol DG1022 improvement thread

« **Reply #2 on:** August 18, 2014, 10:40:23 AM »

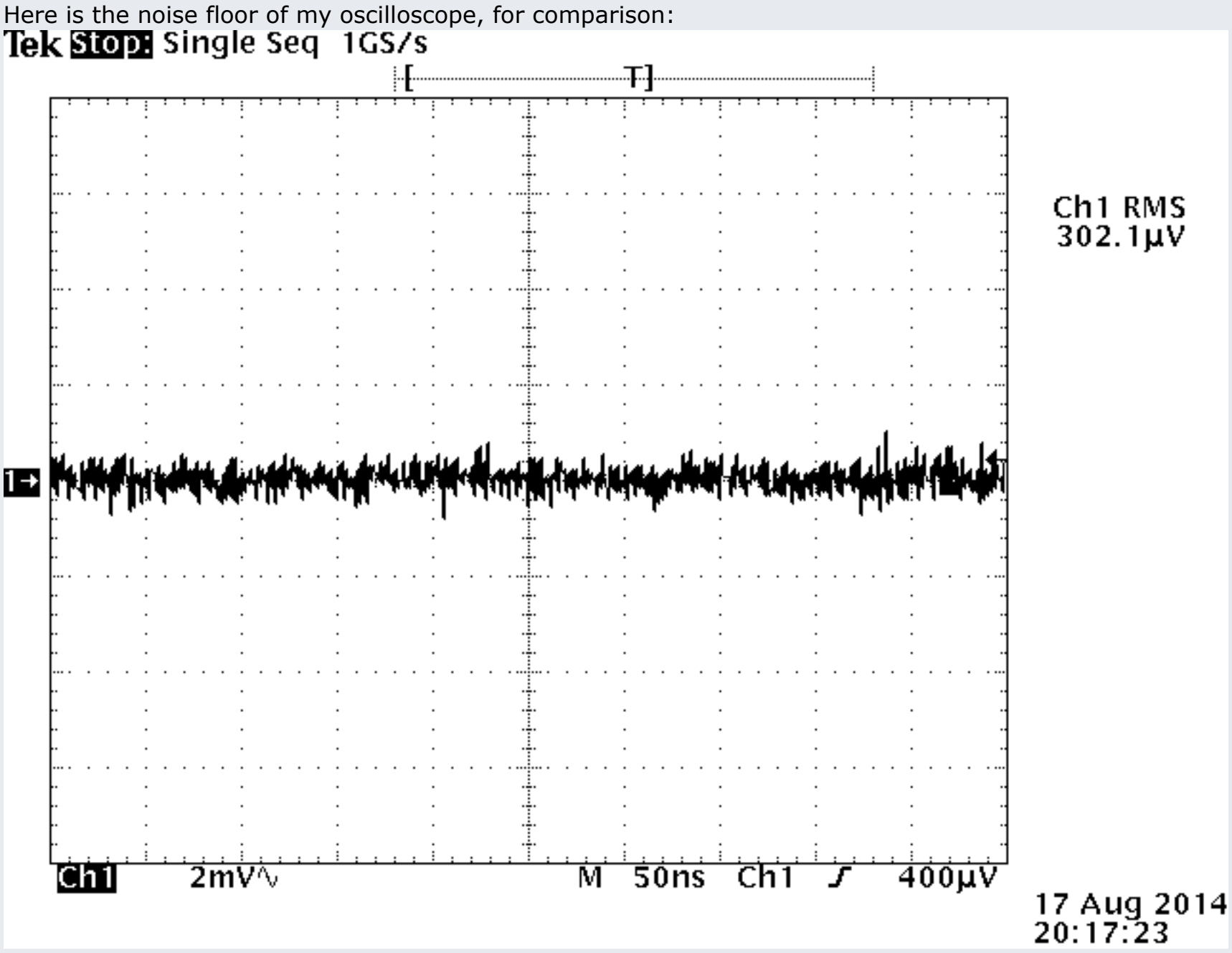
Quote

Now that *my* DG1022 is repaired to what *most* DG1022s should be, `(void)stack_pop(&dg1022);`

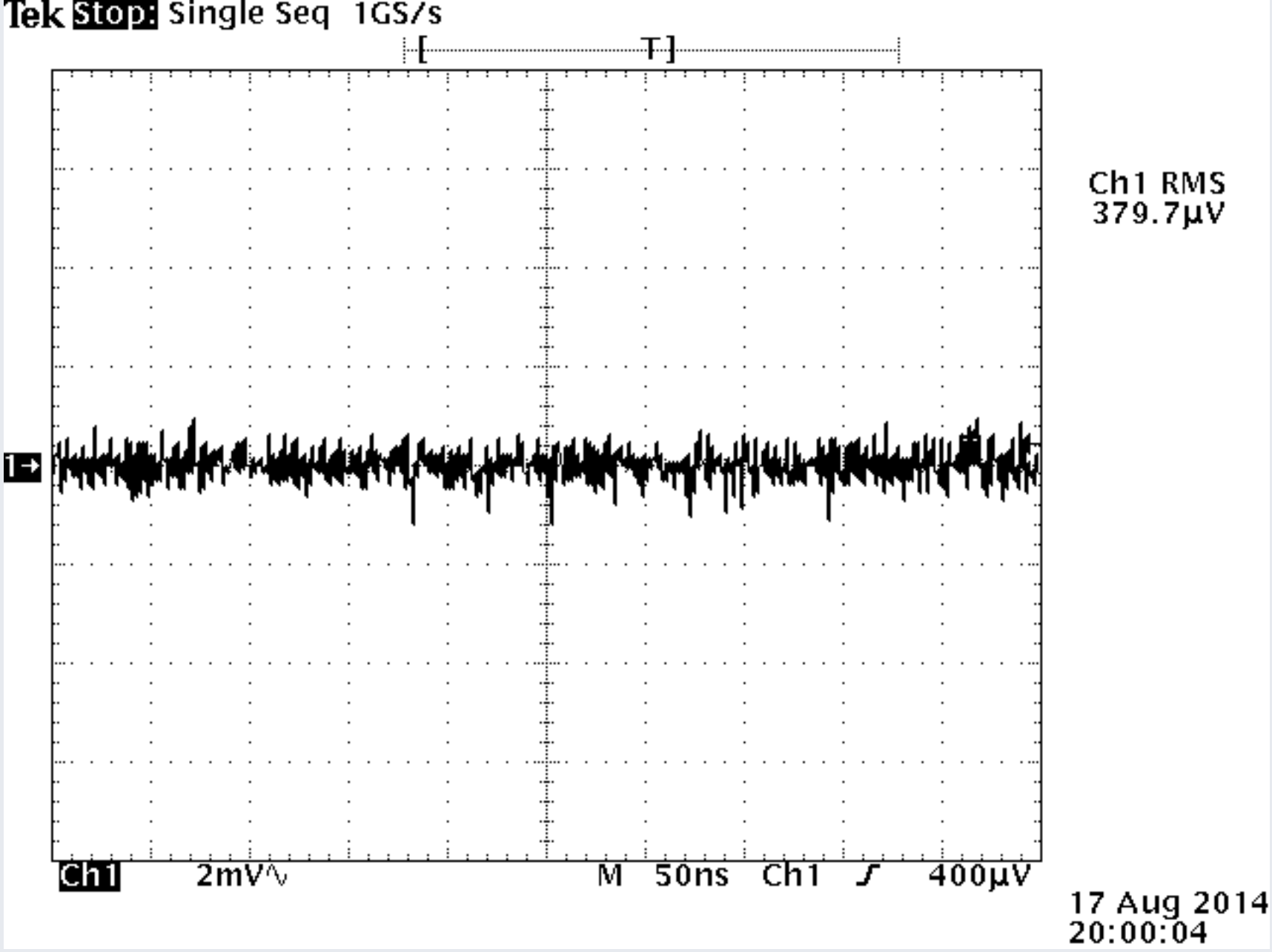
If you want to improve the output noise performance, there are two things you can do. The first is simple: Rigol uses *terrible* cables to run from the main board to the front panel jacks. They pick up a *ton* of common-mode and normal-mode garbage.

Unfortunately, I don't have a picture of my DG1022's output before replacing the cables. Already tossed out my old ones, and anyway, these have quite fragile connectors and I don't want to go plugging and unplugging them. I may have some to append to this thread in a while though; I know someone who, I think, has some spec-an shots of the same thing.

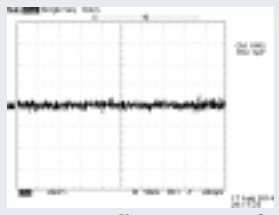
Here is the noise floor of my oscilloscope, for comparison:



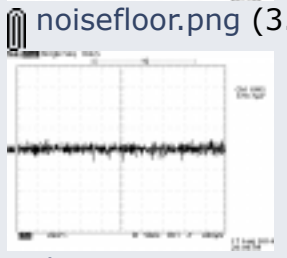
Here's the DC output of the DG1022 with the cable replaced. Probably, anyone who has an unmodified DG1022 can verify that it's normally much worse:



This one's easy: you just need a couple cables that aren't made of shit. TE Connectivity 2015357-3 is what I used. Be careful when replacing them - the gunk they stuck the original ones down with is very strong, and you could rip the sockets right off the PCB if you pull it off roughly.



noisefloor.png (3.11 kB, 640x480 - viewed 371 times.)



dc_0v_env4.png (3.28 kB, 640x480 - viewed 366 times.)

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c4757p

Super Contributor

Posts: 7514

Country:

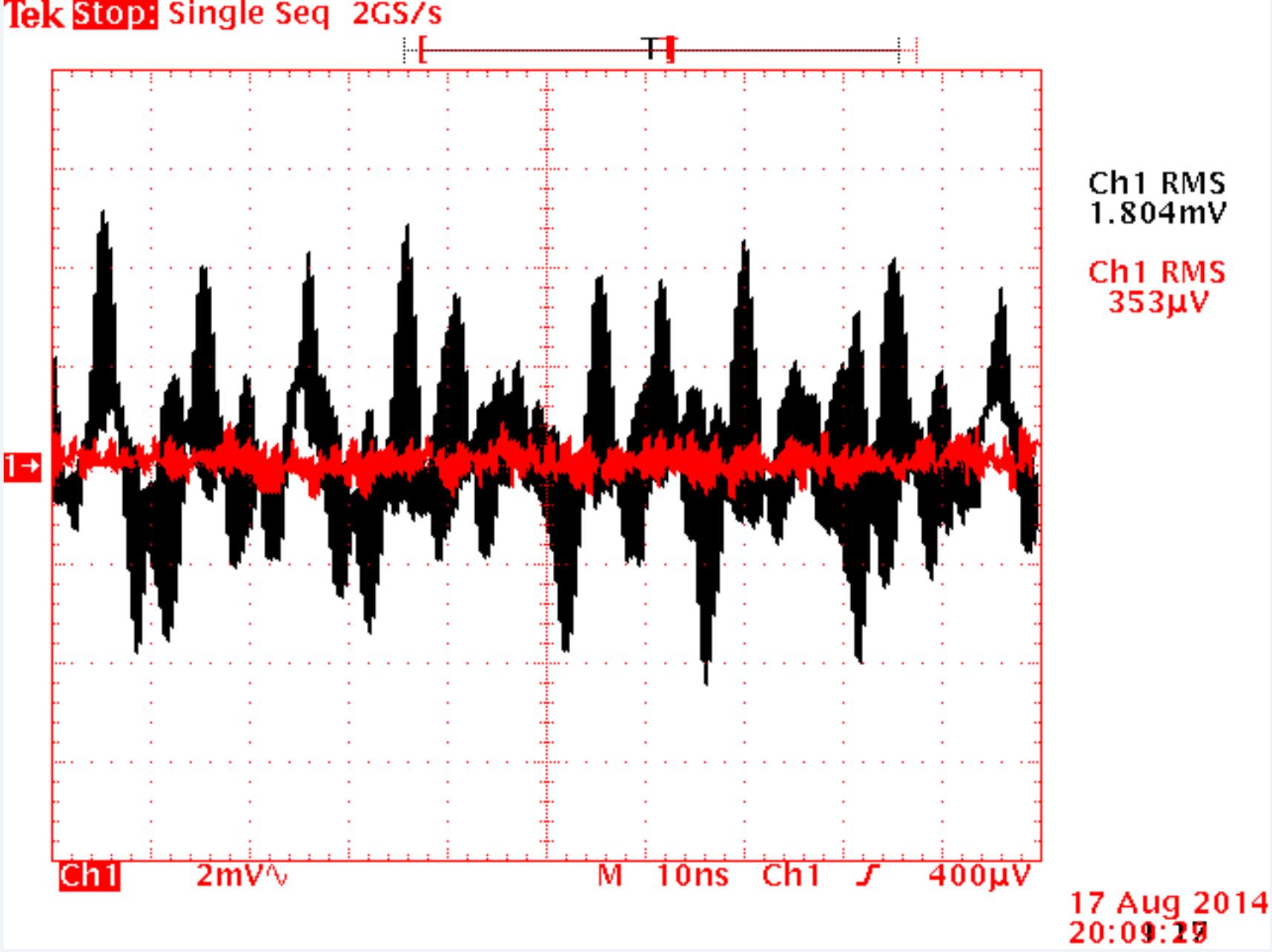
Re: Rigol DG1022 improvement thread

« **Reply #3 on:** August 18, 2014, 10:58:27 AM »

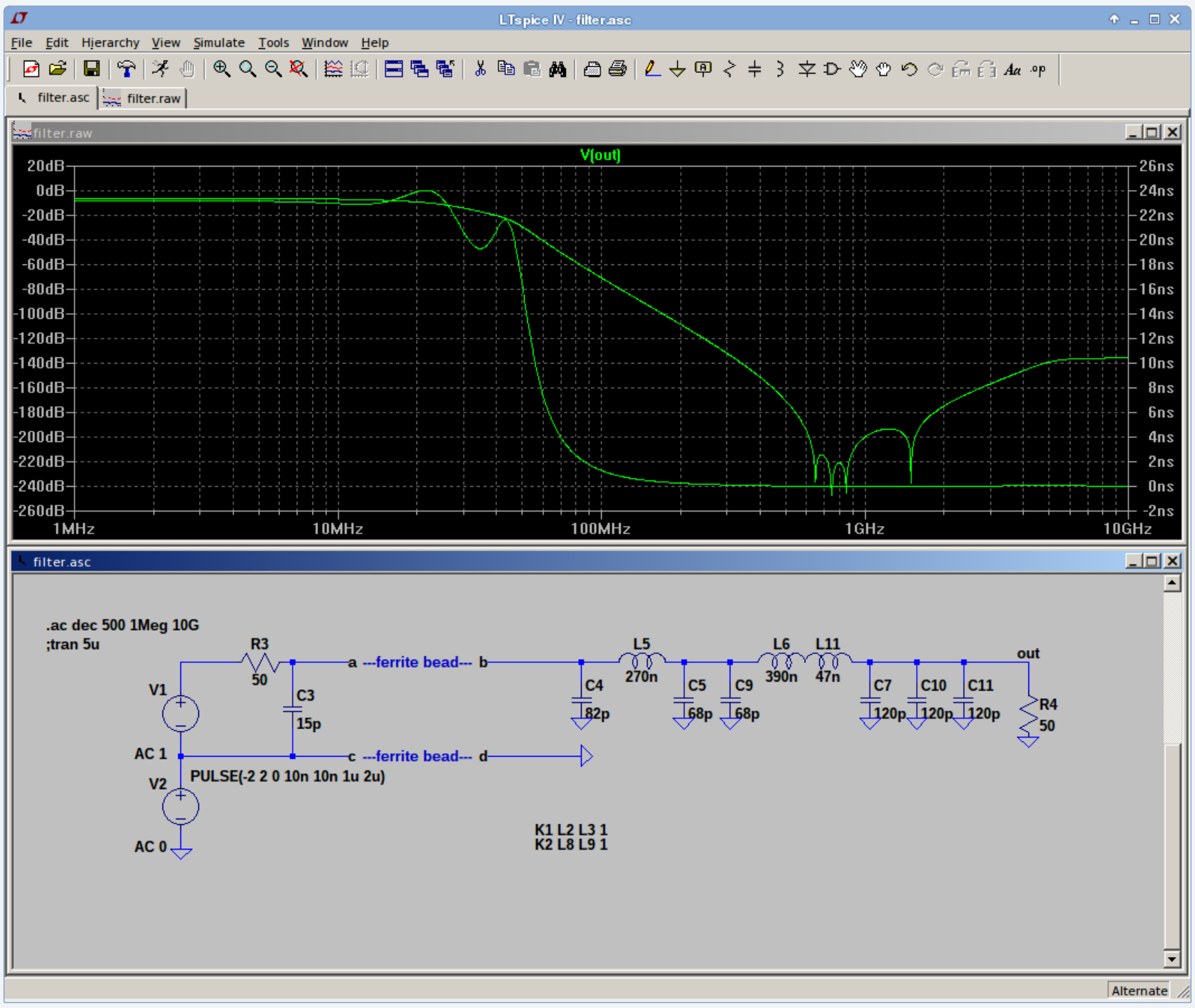
Quote

That's not all, though. Certain output modes cause significantly more output noise to be generated. You can see that in my second post. It's not much, but it *is* a good 5mVpp, which is *way* too much for an instrument that should be able to do 2mVpp output signal. When your SNR is less than unity, you can hardly call it a signal generator anymore, can you?

Adding an inline filter directly before the output connector corrects Rigol's poor filter design, bringing the output back under my scope's noise floor:



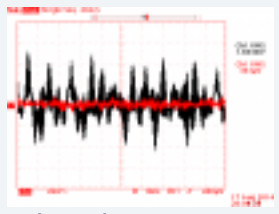
The nature of the noise requires a nice, sharp cutoff right after the function generator's bandwidth, because the bandwidth is 25 MHz and the noise starts at 70 MHz. The filter has to be close to flat at 25 MHz, and then "fully attenuated" half a decade later. This calls for a relatively high-order Bessel filter:



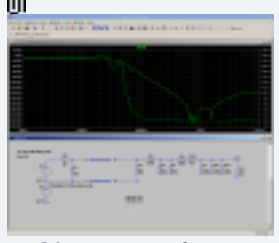
Excuse the lack of a proper model to hold the equivalent circuit for the common-mode chokes!

This filter works to bring every nasty bit of the DG1022's output under my scope's noise floor - good enough for me!

PCBs, schematic, BOM shortly. I have two spare PCBs (plus one already called for), which I'll give away free to anyone to whom I can send it for the price of a postage stamp. I'll share the project on OSH Park as well, so everyone else can have one for $just_above_nothing.



ba_dc_0v6_env4.png (9.76 kB, 640x480 - viewed 386 times.)



filter.png (58.46 kB, 1062x891 - viewed 379 times.)

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tautech

Super Contributor

Posts: 3973
Country:

Re: Rigol DG1022 improvement thread

« **Reply #4 on:** August 18, 2014, 11:12:34 AM »

Quote

I have noticed sometimes when the Chinese list ripple specs, the only way they can be reproduced on a DSO is with averaging on.
Eg: a SMPS bench unit(not Siglent) spec'ed @ >30 mV ripple will measure ~80 mV without averaging.

P-P ripple is very different with averaging on, but still P-P.
Is that right or wrong?
Certainly disingenuous.

Report to moderator Logged

~~Avid~~ Rabid Hobbyist & NZ Siglent Distributor

---

c4757p

Super Contributor

Posts: 7514
Country:

Re: Rigol DG1022 improvement thread

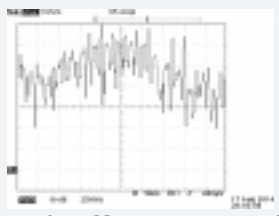
« **Reply #5 on:** August 18, 2014, 11:20:31 AM »

Quote

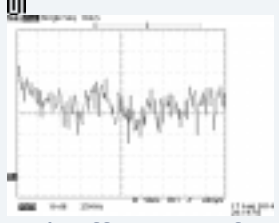
Depends on what you're trying to measure. Power supply ripple tends to be considered as purely periodic signal content, and averaging will select for that, allowing you to measure only that component of the signal. Averaging will select *against* anything that is not harmonically related to the trigger frequency, so both non-periodic signals and secondary signals at a different (non integer-multiple) frequency disappear.

The noise coming out of this signal generator is *not* one frequency + harmonics. It's either true noise, or just multiple frequencies - so averaging makes it disappear. This is why I instead used an envelope capture, which will accentuate it, and made sure to record the noise floor of the scope itself for comparison.

Here's an FFT, before and after - though this too is pessimistic, limited by the scope's noise floor:



dc_fft_0v6.png (3.45 kB, 640x480 - viewed 49 times.)



dc_fft_0v6_after.png (3.3 kB, 640x480 - viewed 43 times.)

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David Hess

Super Contributor

Posts: 2344
Country:

DavidH

Re: Rigol DG1022 improvement thread

« **Reply #6 on:** August 18, 2014, 11:58:46 AM »

Quote

The first oscillograph looks like what I would expect when sidebands produced by mixing between the sampling frequency and output frequency are above the Nyquist frequency. The mixing occurs when the DAC or ADC suffers from non-linearity or aperture error.

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---

c4757p

Super Contributor

Re: Rigol DG1022 improvement thread

« **Reply #7 on:** August 18, 2014, 12:00:10 PM »

Quote

Yes - except the output was *flat* for all of these. This is the DC "waveform"

Report to moderator Logged

Posts: 7514
Country:

c4757p

Super Contributor

Posts: 7514
Country:

Re: Rigol DG1022 improvement thread
« **Reply #8 on:** August 18, 2014, 12:32:13 PM »

Quote

Okay, here's the stuff.

An almost completely assembled board. You can see that this is fiddly - not for the faint of heart. The dual ferrites are particularly irritating to solder - I recommend reflow if available. Also pay attention to the orientation of these.

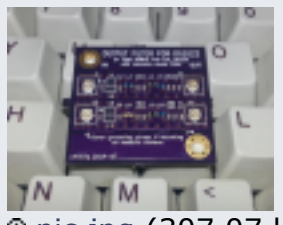
Gerbers are in gerbers.zip and can be sent off to damn near anyone. The KiCad project is in proj.zip, and there's a PDF of the schematic attached as well. The BOM can be imported by DigiKey's BOM importer.

There are still two boards left, so PM me if you want one. Beyond that, order them for about $9 from OSH Park, here

To connect it, simply use the replacement cables (get rid of the awful Rigol ones...) to connect the filters inline with each of the two channels. Mounting is tricky - I just stuck it to the case with tape

Edit: Updated BOM to include manufacturer part numbers

Note: The BOM as it is contains the exact number of the parts you need. However, if you drop one on the floor, you'll never see it again. (Guess why there's a part missing in my example photo.....) I highly recommend buying more of the inductors and capacitors than you need.



pic.jpg (307.07 kB, 1024x780 - viewed 398 times.)
gerbers.zip (19.07 kB - downloaded 11 times.)
proj.zip (80.47 kB - downloaded 15 times.)
dg1022f.pdf (56.75 kB - downloaded 36 times.)
bom.txt (0.98 kB - downloaded 37 times.)

« Last Edit: August 18, 2014, 01:37:39 PM by c4757p »

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