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📖 Author   Topic: TDS3014 adventures (Read 2312 times)

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james_s   📎 **TDS3014 adventures**   **Say Thanks**   **Reply**   **Quote**
Super Contributor   « **on:** September 21, 2019, 05:56:50 pm »

🟩🟩🟩
Posts: 10487
Country: 🇺🇸
👤💬

So I scored this dead TDS3014 for free, initial investigation was not promising, all the voltages looked good but there were no signs of life other than the backlight. Then upon further investigation I noticed that one of the two oscillator cans didn't seem to have any output. Could it really be that simple? I poked around and measured both and found identical conditions on the other pins but this one had no output. I thought perhaps something was shorting the output but I'd expect to see *something* on the output in that case but this was flatlined.

Ok so I start digging through my stash of scrap boards I found a similar looking 28MHz oscillator, nowhere near the 75.75MHz of the original but I thought it might at least invoke some small sign of life and tell me if I was on the right track. So I popped that in and imagine my surprise and elation when I hit the power switch and the scope burst to life with the splash screen immediately appearing on the screen. Woohoo!! Then it proceeded to boot up fully and display a trace, although not too surprisingly it feels very sluggish. Still, progress! Seeing formerly dead equipment spring back to life is the sort of thing that makes life worth living 😃

Sooo now I need a 75.75MHz oscillator, I have to assume that Tek had a good reason for using an odd value like that. I have not had much luck with the usual suppliers but maybe I've missed something. The original part is a Fox 401 series with a 5x7mm package, powered by 3.3V. I'm not opposed to adapting something in a different package if I need to. I'm open to buying a used part if anyone has one, maybe one of you has a scrap TDS mainboard with bad ASICs or something?

I need some knobs too, oddly a bunch of them are crumbling to bits, those are readily available on ebay though. I'd also love to find the optional comm module but first things first.
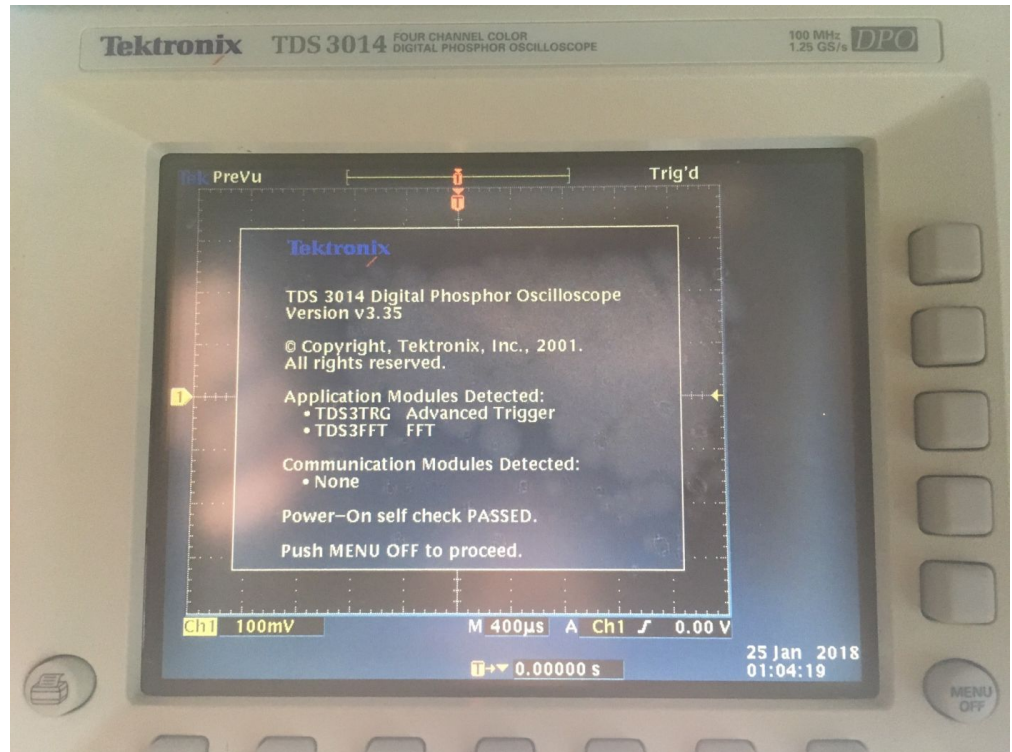
TDS3014 display.jpg (147.15 kB, 1400x1050 - viewed 310 times.)
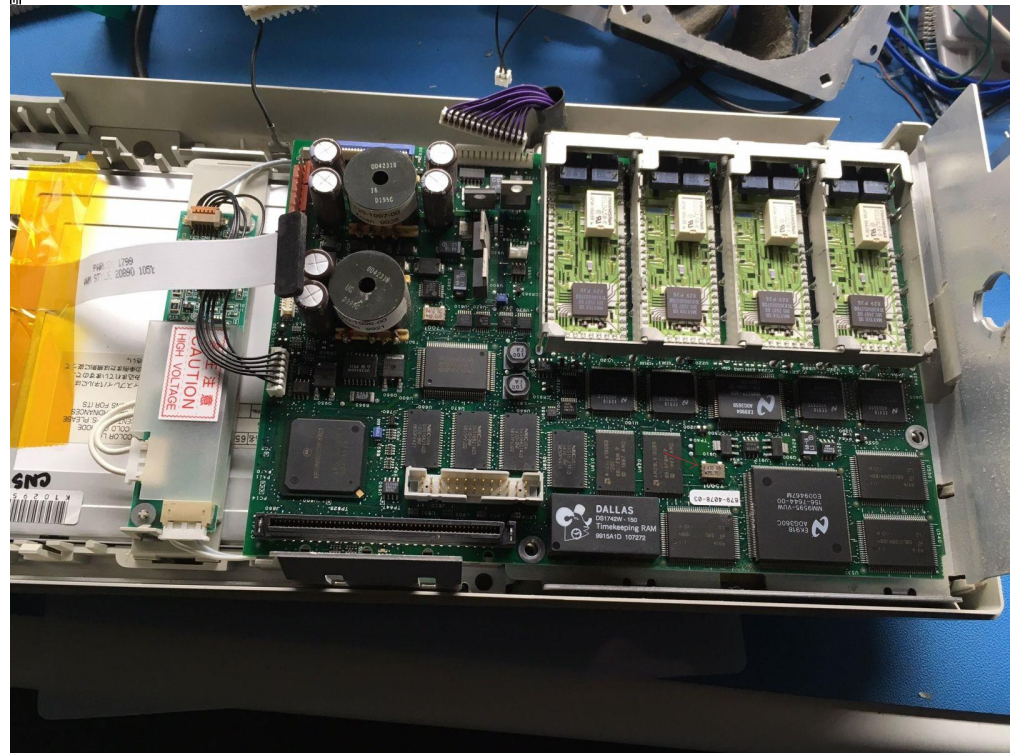
TDS3014 main.jpg (298.76 kB, 1600x1200 - viewed 346 times.)

« Last Edit: September 30, 2019, 01:26:56 am by james_s »

Report to moderator   Logged

☐ **texaspyro**

Super Contributor

●●●

Posts: 1332

🙎 ✉ 🗨

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #1 on:** September 22, 2019, 03:50:40 am »

Say Thanks   Reply   Quote

There are a lot of programmable oscillator chips out there these days.   Most distributors of these devices offer programming services.

Report to moderator   Logged

☐ **DaJMasta**

Re: TDS3014 adventures (seeking 75.75MHz oscillator)

Say Thanks   Reply   Quote

Super Contributor

Posts: 1793
Country: 🇺🇸

« **Reply #2 on:** September 22, 2019, 04:34:54 am »

If it'll run on a 28MHz oscillator, you may be able to get something in the same ballpark (70-80MHz) that will work fine. It would be worth checking timekeeping functions and stuff, but if it's got an RTC, the sampling should be controlled by its own clock, so it may not actually be that critical to nail the frequency. There's definitely the chance it's important, as you mention, but it's worth trying.

It's an odd number for a signal generator, but if you can generate the frequency (or maybe like a 25.25MHz squarewave and filter out the fundamental) you can probably test to see if it actually is the thing that needs the fix.

Another potential replacement option is a VCO or DDS generator chip capable of generating your frequency, but it's probably worth looking around for a crystal first, as it would be a bunch of extra stuff to do.

Is it possible that it's not actually a 75.75MHz oscillator and that's some other package marking?

Report to moderator   🏁L Logged

http://www.medpants.com/ - W3BSN

🟢 **blueskull**
Supporter
🟦🟦🟦🟦

Posts: 12849
Country: 🇨🇳
Power Electronics Guy
👤 ✉ 💬

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #3 on:** September 22, 2019, 04:42:36 am »

Say Thanks   Reply   Quote

Is that a 5032 or 7050? I might have a few SiTime ones and I have the programmer. PM me if you want me to program one for you. I'm in US, and I need a shipping label, of course.

Report to moderator   🏁L Logged

The following users thanked this post: james_s

🟢 **james_s**
Super Contributor
🟦🟦🟦

Posts: 10487
Country: 🇺🇸
👤 💬

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #4 on:** September 22, 2019, 05:30:58 am »

Say Thanks   Reply   Quote

I actually was just coming here to say I ordered a programmable oscillator from digikey that theoretically ought to be a drop-in replacement. It was only about 8 bucks so worth a shot at least.

It boots with the 28MHz oscillator but it doesn't really work properly. It will display the compensator waveform and the menu works for the most part but a lot of things feel weird. I'm going to wait until the new part comes before I bother to mess with it further.

In the meantime I've been doing a deep cleaning. The plastic on this thing is crazy brittle and I've had to glue a few clips and tabs. Almost every one of the knobs has cracked into pieces too, maybe the high temperature from being in Hawaii? I bought a set of new knobs that will fix that right up. The screen also has a bit of weirdness that turns out to be some delamination of the rear polarizer film. Since there is also one stuck pixel I may splurge and spend the 80 bucks or so on a replacement but that can also wait until it's fully working.

Is there a way to hack it into the 500MHz model without the comm module? Looks like people want a few hundred bucks for that option module and I have no real use for it beyond unlocking features.

« *Last Edit: September 22, 2019, 05:33:24 am by james_s* »

Report to moderator   🏁L Logged

🟢 **james_s**
Super Contributor
🟦🟦🟦

Posts: 10487
Country: 🇺🇸
👤 💬

📎 **Re: TDS3014 adventures (seeking 75.757MHz oscillator)**
« **Reply #5 on:** September 22, 2019, 10:54:25 pm »

Say Thanks   Reply   Quote

So I was messing around at my bench today and the oscillator from the scope was sitting there still so I decided to solder some wires to it and play around. In the process I cleaned the rust off and noticed that it actually says 75.757 on it which I'm fairly sure is the frequency as there is another identical part in a different area that says 48.000 which is a frequency I've seen elsewhere.

Anyway I hooked it up to power and yep, still stone dead. I tried turning the voltage up as high as about 6V with no signs of life, then I turned the voltage down and was surprised to note that when I got down to around 2.2V it woke up, with an output of about 25MHz. I could turn the voltage up and the waveform would start to get ugly and then abruptly around 2.8V it would suddenly go dead, turn the voltage down and it would wake up again. I experimented, heating it up to the point where the wires desoldered from it and up until then the characteristics changed very little except it would run at a slightly higher voltage. I then used freeze spray to make it very cold and again surprisingly little difference.

So I'm really curious at this point what is going on with this thing. Is it likely that it is itself a programmable oscillator with a 25MHz source clocking an internal PLL that has failed? It's academic at this point since it's obviously defective but this is not a failure mode I've ever encountered or expected.

oscillator.jpg (47.54 kB, 640x480 - viewed 92 times.)

Report to moderator   Logged

blueskull

james_s
Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #6 on:** September 22, 2019, 11:03:03 pm »

Say Thanks   Reply   Quote

Oh hang on a sec, the frequency it's running at is almost precisely 1/3rd of the expected 75.757 MHz, is it possible that the crystal is oscillating in the wrong mode? I am not very knowledgeable about crystal oscillators but I do recall there are multiple frequencies they can oscillate at depending on how they are driven.

Report to moderator   Logged

blueskull
Supporter

Posts: 12849
Country: 🇨🇳

Power Electronics Guy

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #7 on:** September 22, 2019, 11:43:00 pm »

Say Thanks   Reply   Quote

> Quote from: james_s on September 22, 2019, 11:03:03 pm
>
> Oh hang on a sec, the frequency it's running at is almost precisely 1/3rd of the expected 75.757 MHz, is it possible that the crystal is oscillating in the wrong mode? I am not very knowledgeable about crystal oscillators but I do recall there are multiple frequencies they can oscillate at depending on how they are driven.

It could have a 3rd overtone crystal (as the name implies, fosc=3*fres) inside, which requires pretty good low noise power supply and good tuning network to work.

Normally, for an oscillator module, it should have all of those inside, but since it's broken, it could be reduced to a janky fundamental oscillator.

Report to moderator   Logged

The following users thanked this post: TiN, james_s

edavid
Super Contributor

Posts: 2902
Country: 🇺🇸

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #8 on:** September 23, 2019, 01:10:10 am »

Say Thanks   Reply   Quote

Oddly enough, it seems to be a standard frequency... this company sells them for $1.44 each:

https://www.knjn.com/ShopOscillators.html

Or maybe you could get a sample from Ecliptek:

http://www.ecliptek.com/stocksearch/stock.aspx?PartNumber=EHF1125TS-75.757M

I think it would be better to avoid using a programmable oscillator, since they tend to have high jitter, which is really not great for an oscilloscope sampling clock.

« *Last Edit: September 23, 2019, 01:19:44 am by edavid* »   Report to moderator   Logged

The following users thanked this post: james_s, Mr. Scram

james_s

Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures (seeking 75.75MHz oscillator)   Say Thanks   Reply   Quote
« **Reply #9 on:** September 23, 2019, 01:29:17 am »

Oh hey that's great, that place hadn't come up in any of my earlier searches. Never heard of them before but I ordered one and will see what happens.

Report to moderator   Logged
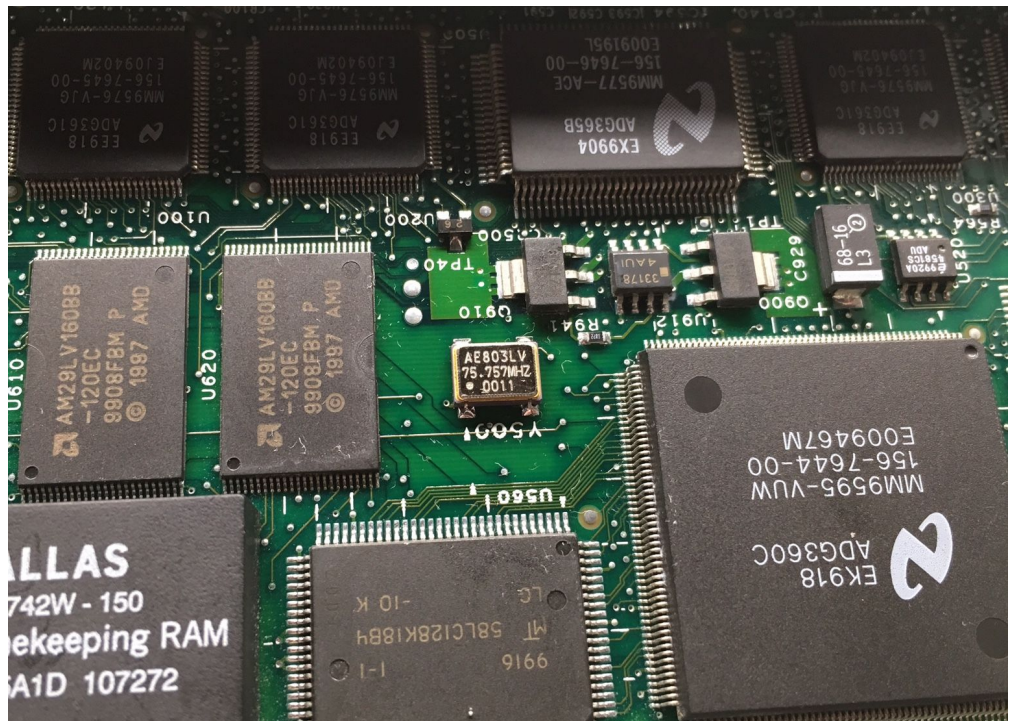
james_s

Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures (seeking 75.75MHz oscillator)   Say Thanks   Reply   Quote
« **Reply #10 on:** September 27, 2019, 03:10:46 am »

The new oscillator arrived today so I installed it and I'm pleased to report that the scope is now working perfectly! While I was waiting for that, I completely disassembled the scope and cleaned everything, bought a full set of replacement knobs for $60 since the originals were all cracked or broken, and I bought a NOS display for $65 because the original had the rear polarizer starting to delaminate, a stuck pixel and the backlight was getting tired. I reflashed one of the option modules with the code that unlocks all the features and now finally I put it all back together. All four channels work, all the buttons and knobs work, floppy drive works, everything great. I'm super excited to have this.

The only negative is that the plastic is all crazy brittle for some reason, I had to glue a number of clips and I'll need to be gentle with the rest of the thing, I have no idea why that's so bad or if there's anything that can rejuvenate brittle ABS. Also it doesn't have a comm module so I can't do the 500MHz bandwidth upgrade. Anyone got one of those for less than ebay prices, maybe even one I can borrow briefly to do that? Serial or GPIB is fine.

TDS_osc.jpg (338.06 kB, 1542x1110 - viewed 161 times.)

TDS3014.jpg (426.05 kB, 1730x1268 - viewed 138 times.)

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giosif
Frequent Contributor

Posts: 430
Country: 🇬🇧

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #11 on:** September 28, 2019, 03:58:14 pm »

Say Thanks   Reply   Quote

Still holding a grudge for getting the scope before me 🙂 , but have to admit it's definitely in better hands than mine.
I would have never thought of checking something like the oscillator.
Nice job with the repair! 👍🙂

Report to moderator   Logged

The following users thanked this post: james_s

james_s
Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #12 on:** September 28, 2019, 04:12:23 pm »
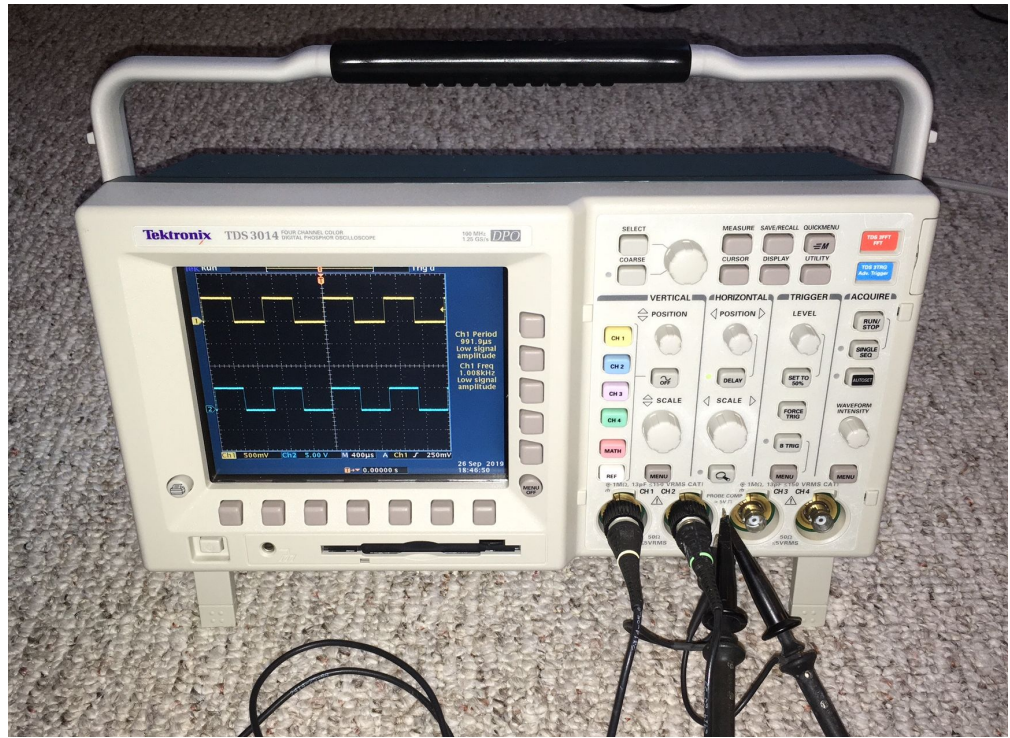
Say Thanks   Reply   Quote

Well if it makes you feel any better, I never win anything and am never the first to encounter and jump on a deal like this, so this is probably a one-off experience 🙂

As far as the oscillator, once I'd checked all the voltages, it kind of seemed like the next logical place to look since there was no sign of any activity anywhere. Once I get sucked into a project like this I tend to obsess over it and power through it until I'm finished.

Report to moderator   Logged

giosif
Frequent Contributor

Posts: 430
Country: 🇬🇧

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« **Reply #13 on:** September 29, 2019, 05:19:57 pm »

Say Thanks   Reply   Quote

Ok, no grudges anymore. 🙂 🙂

That is good, to get focused on a project until it's done.
Others... ok... Me, I tend to start a few projects in parallel and I have the feeling that leads to more of them ending up in limbo state.

Report to moderator   Logged

📎 **Re: TDS3014 adventures (seeking 75.75MHz oscillator)**

Say Thanks   Reply   Quote

« **Reply #14 on:** September 29, 2019, 06:04:51 pm »

Oh I absolutely have that problem as well, but then occasionally something like this gets me excited and I really focus on it and don't get stuck to the point of burning out.

I ended up taking this apart again last night after I noticed the RTC was stopping when it was powered off. Obviously the battery in the dreaded DS1742 was failing although it still was keeping the data in the SRAM. At one point in time I thought those Dallas chips with the integrated battery were a neat idea but after dealing with discontinued older ones I now in a handful of devices think they are absolutely stupid, I mean how hard would it have been to build a coin cell holder into the top? Lithium coin cells almost never leak but I digress. Anyway I desoldered the chip and installed a socket, then popped it in my TL866 and read it as an EEPROM saving the contents to a file.

Then on to the surgical procedure, first cut the plastic shell with a razor knife and carefully peel off a section to expose the epoxy. With the help of a little hot air I softened the epoxy and carefully dug out the old battery which I then measured out of curiosity and found it was only 0.6V, pretty remarkable that it held the NVRAM contents. In this scope there was sufficient space that I was able to graft a CR2032 holder right onto the top of the chip, it's not pretty but it does the job.

Pop it back in the TL866 and load the contents back on it, then install it back in the scope and power that up for a test. All looks good, reference waveforms still intact, date and time are waaaaay off so I set those and it appears to be working fine. Then I check the error log and wait a sec, ok that's not right, I'm reasonably confident that this scope has not been powered on continuously since the year 213 BC unless I've stumbled into something *really* strange. I suppose it would explain the brittle plastic though.
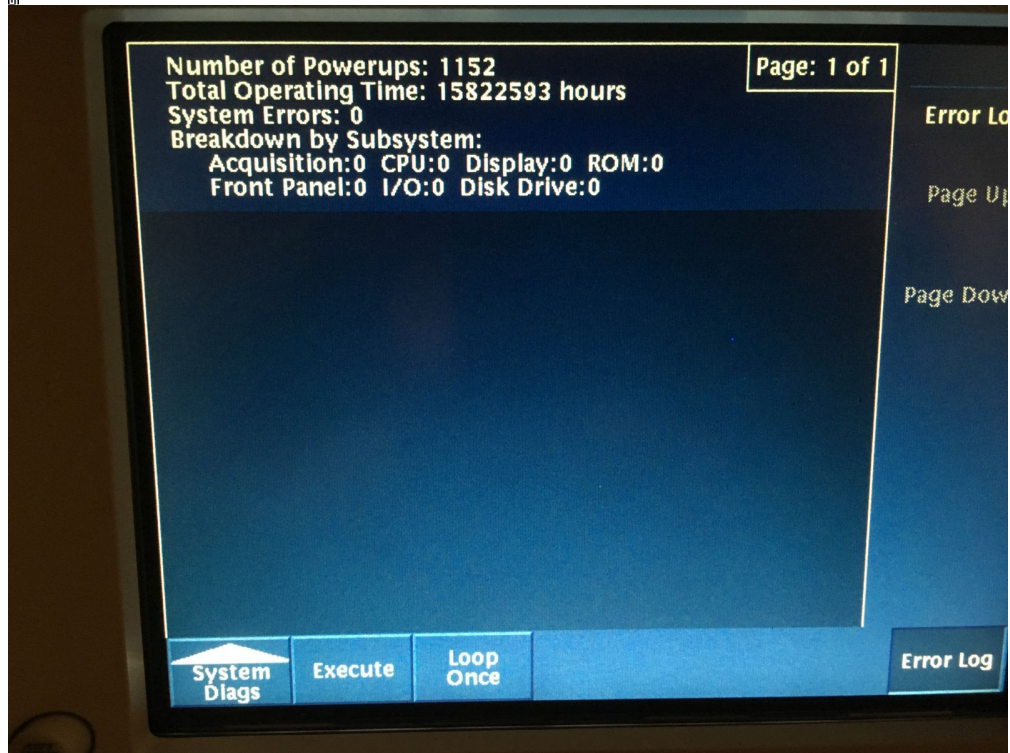
Ok so back to the drawing board. Pop the newly modified Dallas chip out and back into the TL866 it goes. A couple hours of messing around and dozens of back and forths between the scope and programmer and eventually I figured out that reading these Dallas NVRAMs in the TL866 is not reliable, it seems the first read is almost always corrupted to some degree but read it a couple more times and it gets a clean read. Unfortunately I had only that one dump that I did initially so now I'm *really* glad that the calibration values are not stored in this as on some older scopes, incidentally neither are the power-on cycles. I worked out experimentally that the power on hours are stored in a series of bytes starting at x7E0. I'm not absolutely positive of the format but I suspect the time is stored as seconds, before realizing this I experimentally found that x0210 resulted in a display of 2252 hours which is pretty close to what it had prior to this little adventure. At this point I decided to quit while I was ahead and call it good before I break a pin off the DS1742 or plug it in wrong and fry something while trying to get the hours exactly right.

Sooo back together, put it through its paces and now I'm fairly confident that it's 100% working now. I bit the bullet and bought a GPIB/RS232/VGA comm module for $240 which is more than I had invested in the whole project up until now but I figure I'm still ahead as this should allow me to turn it into what is effectively a TDS3054 which I can take advantage of when needed by borrowing probes from my TDS784C boat anchor.

Once the dust settles and I'm satisfied that this is going to stay working I think I might try to repay the generosity that got me this thing and offer the TDS320 I've been using as my "portable" scope until now to someone who needs a scope but I need to find a suitable box. It has displayed a calibration error ever since I tried to back up the stupid Dallas chip it uses and getting it calibrated would cost more than it's worth. I'll post that elsewhere when I decide what to do.

ds1742 external battery.jpg (254.21 kB, 1600x1200 - viewed 234 times.)

Number of Powerups: 1152
Total Operating Time: 15822593 hours
System Errors: 0
Breakdown by Subsystem:
    Acquisition:0 CPU:0 Display:0 ROM:0
    Front Panel:0 I/O:0 Disk Drive:0

Page: 1 of 1

Error Lo

Page U

Page Dow

System Diags   Execute   Loop Once   Error Log

tds hours.jpg (239.44 kB, 1600x1200 - viewed 214 times.)
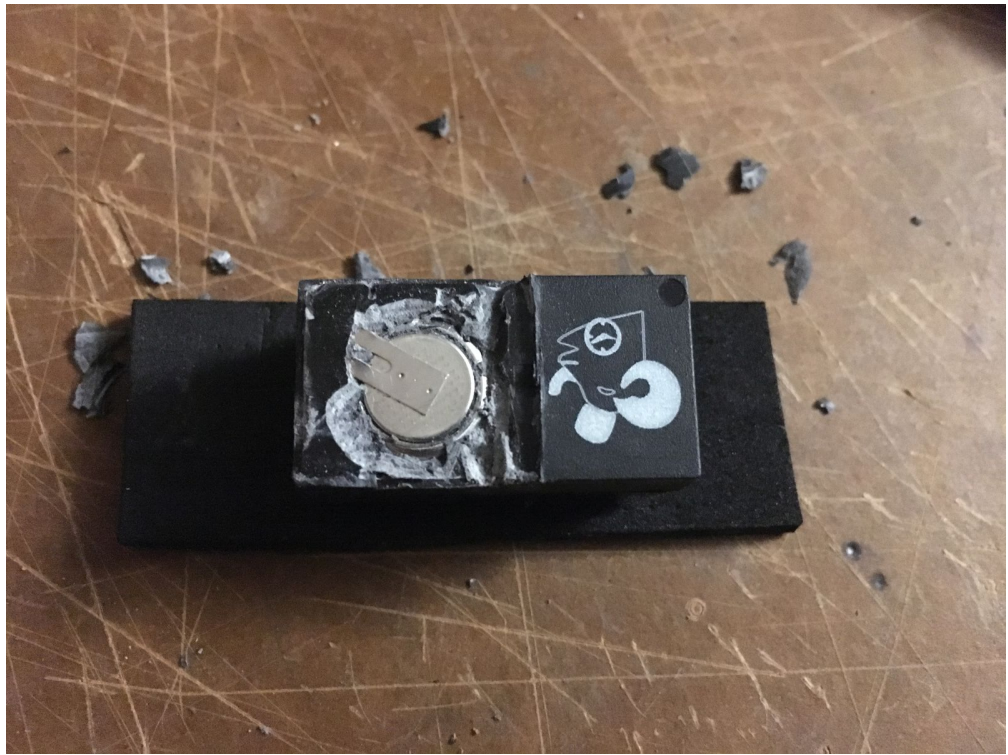
ds1742 surgery.jpg (258 kB, 1600x1200 - viewed 239 times.)

Report to moderator   Logged

TheSteve

Supporter

Posts: 3070
Country: 🇨🇦

GHz

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« Reply #15 on: September 29, 2019, 06:37:18 pm »

Say Thanks   Reply   Quote

Will you trace out the serial portion of the plugin module, it does look like a DIY version of that should be possible.

Report to moderator   Logged

VE7FM

james_s

Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« Reply #16 on: September 29, 2019, 07:02:40 pm »

Say Thanks   Reply   Quote

Quote from: TheSteve on September 29, 2019, 06:37:18 pm

Will you trace out the serial portion of the plugin module, it does look like a DIY version of that should be possible.

Yeah that's the plan, it's probably not worth replicating the whole thing but the serial part looks like nothing more than a level shifter and possibly a buffer.

Report to moderator   Logged

tautech

Super Contributor

Posts: 16987
Country: 🇳🇿

Re: TDS3014 adventures (seeking 75.75MHz oscillator)
« Reply #17 on: September 29, 2019, 07:32:17 pm »

Say Thanks   Reply   Quote

Nice adventure, result and write up James ! 👍🙂

Report to moderator   Logged

~~Avid~~ Rabid Hobbyist

Taupaki Technologies Ltd. NZ
Siglent Distributor

james_s

Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures
« **Reply #18 on:** September 30, 2019, 01:28:42 am »

Say Thanks   Reply   Quote

In case anyone cares, I took a look at my notes today and the power-on hours are simply stored as the number of minutes in hex format in locations x7E0 through x7E4 in the DS1742W. I'm not sure why this wasn't immediately obvious to me last night, I guess I was tired.

« *Last Edit: October 11, 2019, 05:29:44 am by james_s* »

Report to moderator   Logged

james_s

Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures
« **Reply #19 on:** October 03, 2019, 06:26:36 am »
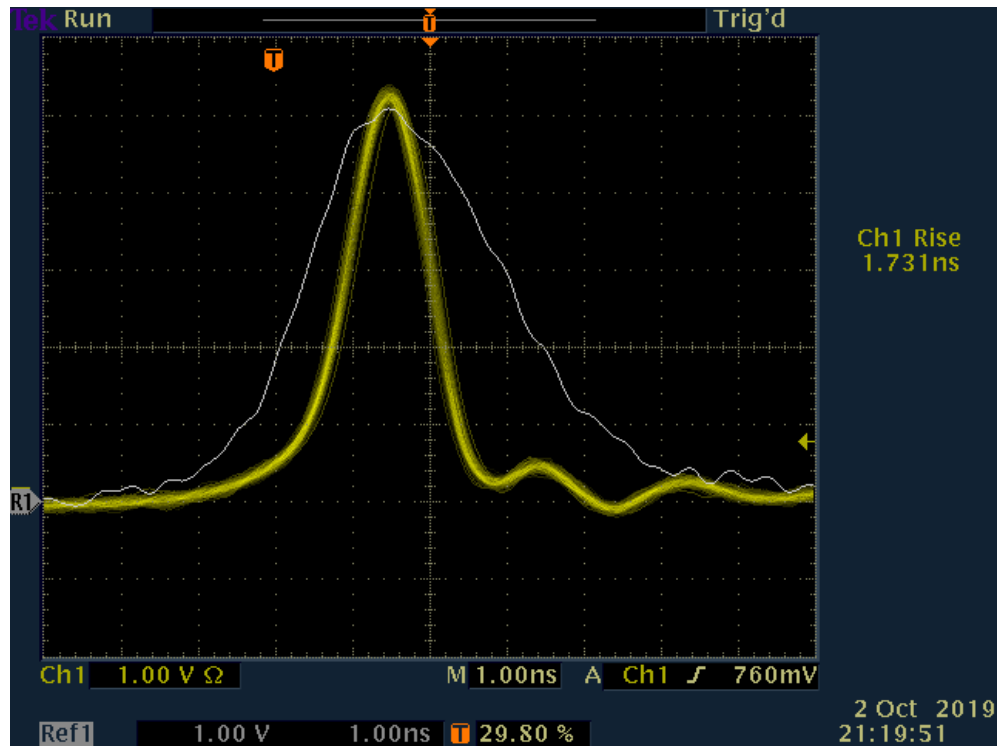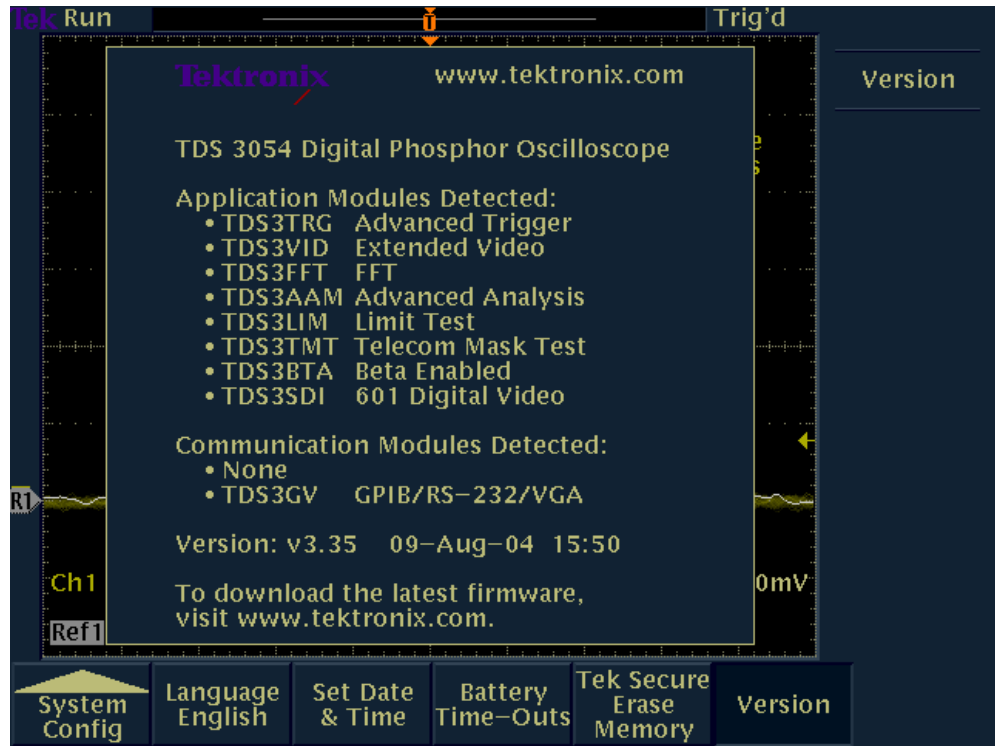
Say Thanks   Reply   Quote

The comm module arrived today and I was able to use the GPIB interface to easily set the model to TDS3054. After that it showed a DC offset so I ran the SPC routine which passed and took care of that, then I connected my pulser to verify the bandwidth and this confirms a substantial improvement relative to the reference waveform I saved prior to the upgrade. With this done I updated the firmware to 3.41 necessitating another SPC and now it's all good to go. I'm a bit surprised there are still so many lesser models that have not been upgraded to 500MHz given it's so trivially easy to do.

I do intend to reverse engineer the serial portion of the comm module, it might be a few weeks before I have time to dig into that though.

TEK00023.PNG (13.05 kB, 640x480 - viewed 83 times.)

TEK00021.PNG (10.95 kB, 640x480 - viewed 106 times.)

Report to moderator   Logged

james_s

Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures
« **Reply #20 on:** October 11, 2019, 05:35:58 am »
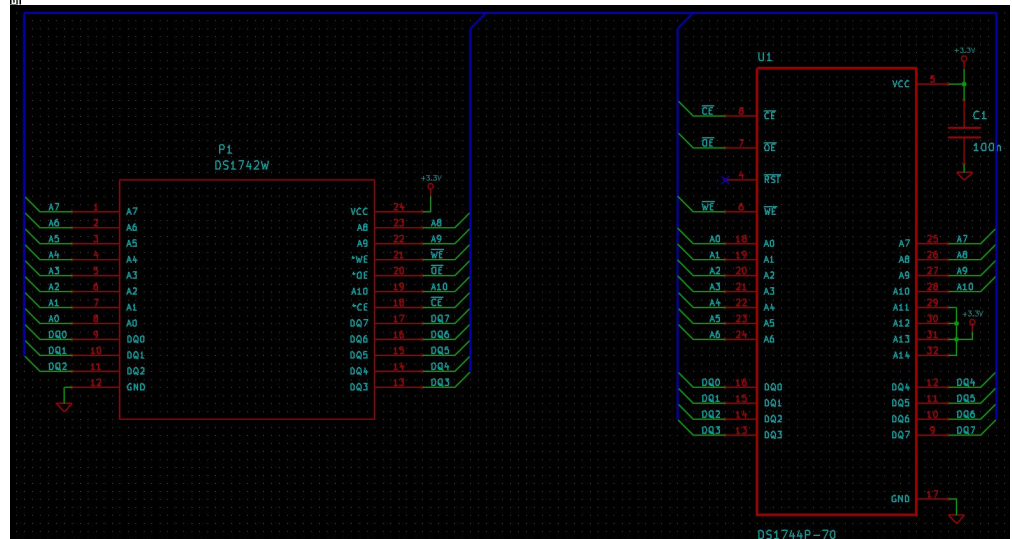
Say Thanks   Reply   Quote

After working fine for a while my repaired DS1742W crapped out. It would still function fine with the scope on but every time I shut it off the memory and time get randomly corrupted. The battery is fine and still connected, after messing around with it for a while I suspect the power controller IC inside it has failed, perhaps it was damaged accidentally with 5V from the programmer.

After scouring datasheets I found the still current DS1744 which appears to be identical except for being a 32k part vs 2k. It is also available in a PowerCap package instead of the ridiculous potted battery. If I tie the top four address lines high this should get me something equivalent to the DS1742W. I whipped up a quick adapter board this afternoon, once I've built and tested one I'll post the files.
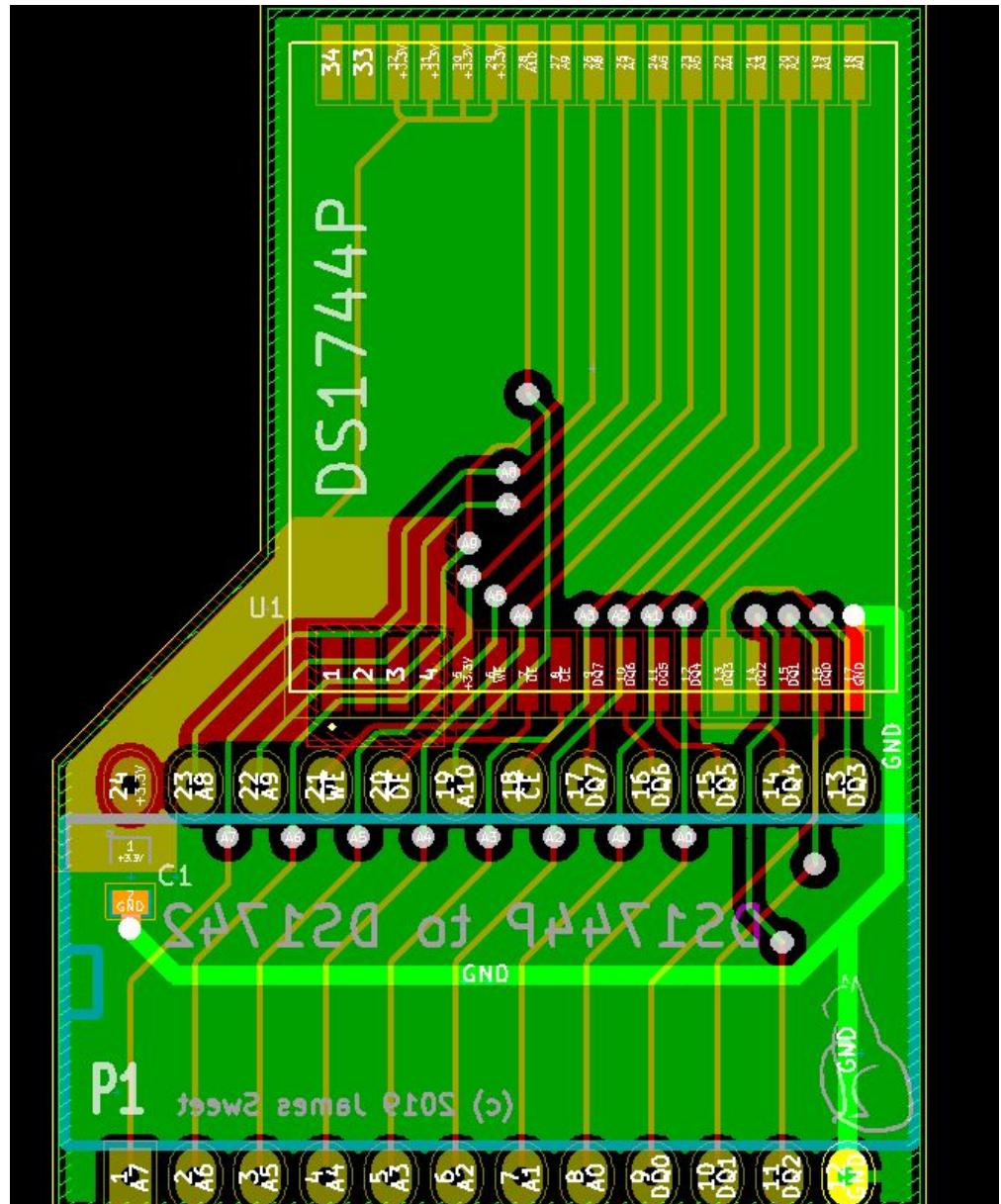
ds1742 adapter.jpg (125.44 kB, 657x799 - viewed 95 times.)

ds1742 sch.jpg (226.33 kB, 1569x843 - viewed 83 times.)

Report to moderator   Logged

ArcticGeek   **Re: TDS3014 adventures**

Regular Contributor

Posts: 79
Country: 🇺🇸

« **Reply #21 on:** October 11, 2019, 02:40:00 pm »

Say Thanks   **Reply**   **Quote**

James,

I think your solution sounds pretty good.   There are a couple other options that I considered but haven't been motivated enough to try yet:

1. A small interposer board that has male pins on one side (24 pins) and a female socket on the other for a 28 pin DS1744W part. The DS1744W is still available, and tying the upper address pins would work fine.   The only problem with this approach is the DS1744W part is going to be sitting roughly ~3/8" higher above the board due to the height of the sockets/headers. I don't know if this is a problem or not in a TDS3000 series scope, I haven't checked the Z height constraints.   The other issue is that in another 15 years or so you'll be stuck finding a replacement for DS1744W because its battery will be dead too, and that part might be obsolete by then.

2. A small interposer board that has male pins on 1 side (24 pins) and a discrete version of a RTC clock/cal and NVRAM. From what I can tell, a DS1558 would be a compatible RTC and NVRAM controller....and then you would add a 2K SRAM, a 32Khz crystal, and a coincell battery.   This would have the advantage that you could change the battery down the road should it ever expire and you would not have to worry about it becoming obsolete. It also would not be as tall as #1 above. The disadvantage is the design is more complex.

Report to moderator   🏁 Logged

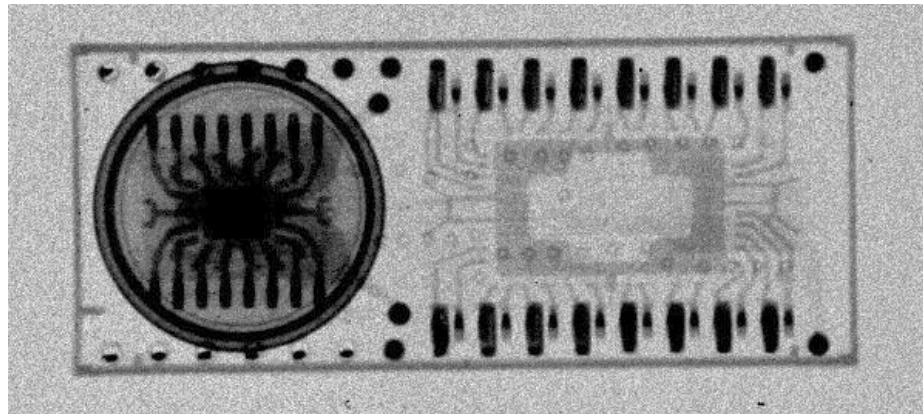 🟢 **james_s**

Super Contributor
⬛⬛⬛
Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures
« **Reply #22 on:** October 11, 2019, 05:16:24 pm »

Say Thanks   **Reply**   **Quote**

I briefly considered the first option, then decided I don't want to invest money in another stupid potted block, I'd just be dealing with it again 20 years from now when the parts are even more hopelessly obsolete niche items. Height would also be an issue as you suspect, the housing for the rear accessory port where the comm module, DSI interface or printer install only clears one side of the (socketed) DS1742 by about 1/8" so an offset adapter would be necessary. Given this constraint and my dislike for the potted battery, the surface mount PowerCap package seemed like the obvious choice, even if the replacement PowerCap becomes obsolete it's not potted so I can easily hack a new battery into it later.

I also like option 2 and considered that as well, I came across the DS1744p before locating a suitable RTC though. I may design something around the DS1558 just for giggles, I would not be the least bit surprised if that's what lies within the DS1742 and related parts. I know from x-raying similar Dallas bricks that they contain off the shelf ICs which are almost certainly Dallas' own offerings. The DS1386 for example has a large QFP that may well be a DS1588. The limiting factor in the imaging of these is in digitizing the film as I lack a proper film scanner.
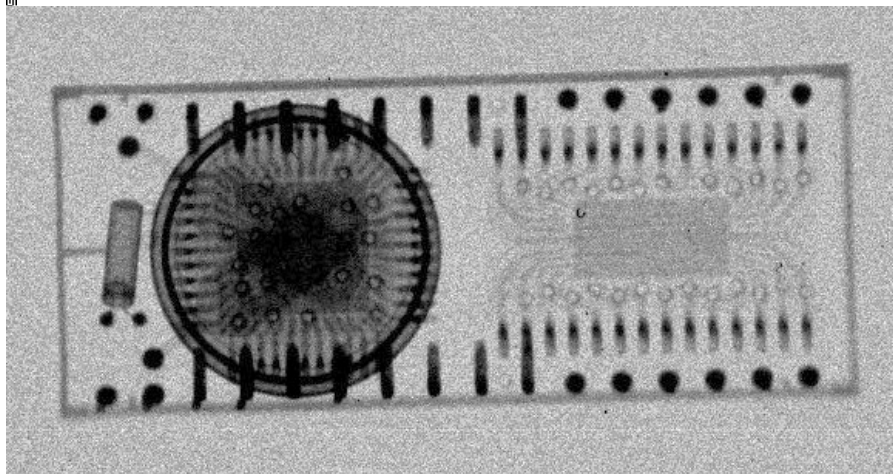

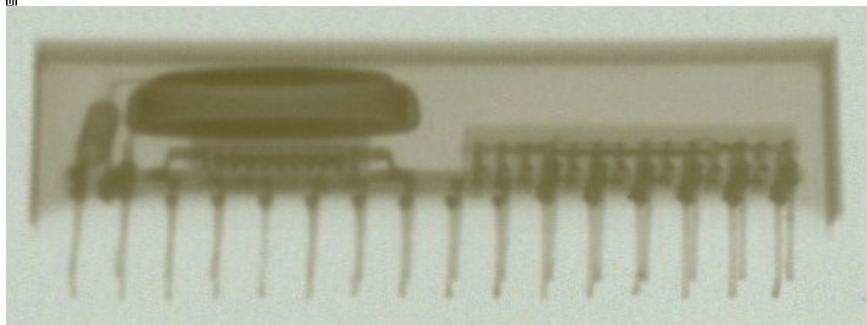DS1250 top hi kvp.jpg (73.16 kB, 596x267 - viewed 103 times.)
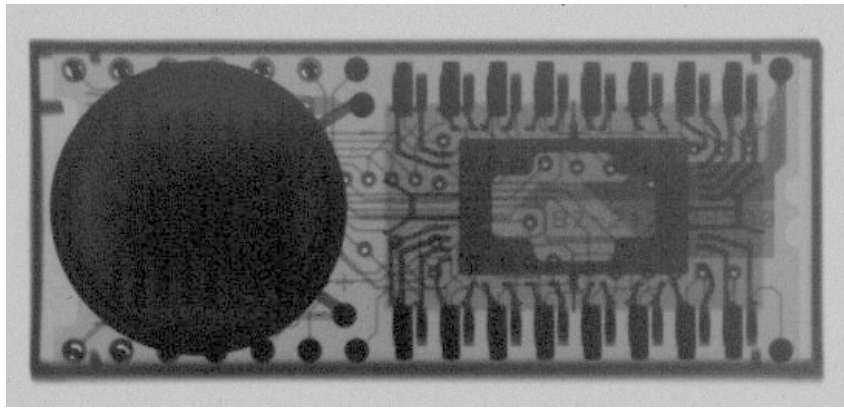
DS1250 top low kvp.jpg (37.45 kB, 548x261 - viewed 59 times.)
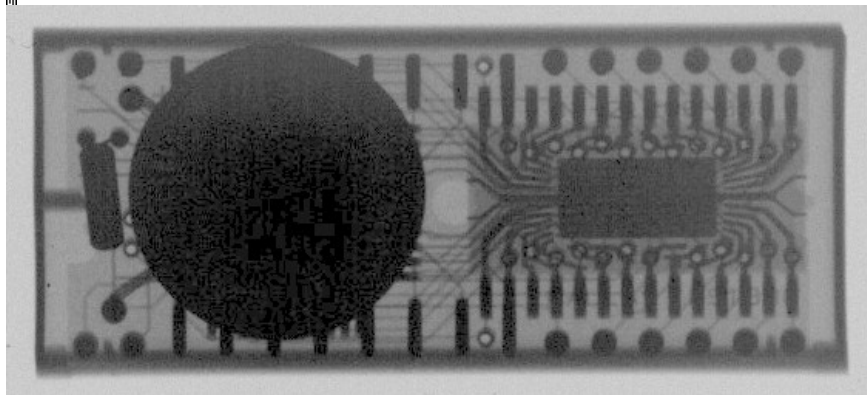
DS1386 top low kvp.jpg (37.33 kB, 564x253 - viewed 58 times.)

DS1386 top hi kvp.jpg (83.01 kB, 580x305 - viewed 70 times.)

DS1386 side.jpg (18.29 kB, 564x210 - viewed 79 times.)

« Last Edit: October 11, 2019, 05:26:23 pm by james_s »   Report to moderator   Logged

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🟩 james_s
Super Contributor
🟨🟨🟨

    Re: TDS3014 adventures   **Say Thanks**   **Reply**   **Quote**
    *« **Reply #23 on:** October 11, 2019, 10:34:38 pm »*

Posts: 10487
Country: 🇺🇸

DS1558 won't work, the register map is different, it has a lot more features and some things are moved around. Maybe there is another similar part that is the same as used in the DS174x parts.

Table 2. REGISTER MAP

ADDRESS	DATA								FUNCTION	RANGE
	B₇	B₆	B₅	B₄	B₃	B₂	B₁	B₀		
7FF	10 Year				Year				Year	00–99
7FE	X	X	X	10 Month	Month				Month	01–12
7FD	X	X	10 Date		Date				Date	01–31
7FC	BF	FT	X	X	X	Day			Day	01–07
7FB	X	X	10 Hour		Hour				Hour	00–23
7FA	X	10 Minutes			Minutes				Minutes	00–59
7F9	$\overline{OSC}$	10 Seconds			Seconds				Seconds	00–59
7F8	W	R	10 Century		Century				Control	00–39

OSC = STOP BIT   R = READ BIT   FT = FREQUENCY TEST

W = WRITE BIT   X = SEE NOTE BELOW   BF = BATTERY FLAG

Note: All indicated "X" bits are not used but must be set to "0" during write cycle to ensure proper clock operation.

📎 1742 map.jpg (89.2 kB, 1104x509 - viewed 41 times.)

ADDRESS	DATA								FUNCTION/RANGE	
	B₇	B₆	B₅	B₄	B₃	B₂	B₁	B₀		
7FFFFh	10 YEAR				YEAR				YEAR	00–99
7FFFEh	X	X	X	10 M	MONTH				MONTH	01–12
7FFFDh	X	X	10 DATE		DATE				DATE	01–31
7FFFCh	X	FT	X	X	X	DAY			DAY	01–07
7FFFBh	X	X	10 HOUR		HOUR				HOUR	00–23
7FFFAh	X	10 MINUTES			MINUTES				MINUTES	00–59
7FFF9h	$\overline{OSC}$	10 SECONDS			SECONDS				SECONDS	00–59
7FFF8h	W	R	10 CENTURY		CENTURY				CONTROL	00–39
7FFF7h	WDS	BMB4	BMB3	BMB2	BMB1	BMB0	RB1	RB0	WATCHDOG	—
7FFF6h	AE	Y	ABE	Y	Y	Y	Y	Y	INTERRUPTS	—
7FFF5h	AM4	Y	10 DATE		DATE				ALARM DATE	01–31
7FFF4h	AM3	Y	10 HOURS		HOURS				ALARM HOURS	00–23
7FFF3h	AM2	10 MINUTES			MINUTES				ALARM MINUTES	00–59
7FFF2h	AM1	10 SECONDS			SECONDS				ALARM SECONDS	00–59
7FFF1h	Y	Y	Y	Y	Y	Y	Y	Y	UNUSED	—
7FFF0h	WF	AF	0	BLF	0	0	0	0	FLAGS	—

X = Unused, Read/Writeable Under Write and Read Bit Control   AE = Alarm Flag Enable

FT = Frequency Test Bit   Y = Unused, Read/Writeable Without Write and Read Bit Control

$\overline{OSC}$ = Oscillator Start/Stop Bit   ABE = Alarm in Backup-Battery Mode Enable

W = Write Bit   AM1–AM4 = Alarm Mask Bits

R = Read Bit   WF = Watchdog Flag

WEN = Watchdog Enable Bit   AF = Alarm Flag

BMB0–BMB4 = Watchdog Multiplier Bits   0 = Reads as a 0 and Cannot Be Changed

RB0–RB1 = Watchdog Resolution Bits   BLF = Battery Low Flag

📎 1558 map.jpg (160.41 kB, 1073x877 - viewed 37 times.)

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🟢 james_s

Super Contributor

🟨🟨🟨

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures
« **Reply #24 on:** October 11, 2019, 11:13:46 pm »

Say Thanks   Reply   Quote

In retrospect I should have xrayed the virgin DS1742W before I hacked out the dead battery. Anyone got a dead one that hasn't been hacked up? Doesn't *really* matter but it would be cool to add that to the collection of images of these things.

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⬜ 2N3055

Super Contributor

🟨🟨🟨

Re: TDS3014 adventures
« **Reply #25 on:** October 11, 2019, 11:30:52 pm »

Say Thanks   Reply   Quote

How about M48T12 ?

Posts: 2175
Country: 🇭🇷

👤 ✉ 💬

Report to moderator　　🏁 Logged

james_s
Super Contributor
🟢🟢🟢
Posts: 10487
Country: 🇺🇸

👤 💬

Re: TDS3014 adventures
« **Reply #26 on:** October 11, 2019, 11:35:54 pm »

Say Thanks　　Reply　　Quote

It's 5V only so it wouldn't work in these scopes. If someone wants to send me one I'm happy to xray it though.

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ArcticGeek
Regular Contributor
🟡
Posts: 79
Country: 🇺🇸

👤 ✉ 💬

Re: TDS3014 adventures
« **Reply #27 on:** October 12, 2019, 04:08:30 pm »

Say Thanks　　Reply　　Quote

> **Quote**
>
> DS1558 won't work, the register map is different, it has a lot more features and some things are moved around. Maybe there is another similar part that is the same as used in the DS174x parts.

@James
Yea, I was aware of the difference between the DS1742 and DS1558, but I believe it will still work. You will notice that address range XXX8 thru XXXF are identical between the two parts, its just that the DS1558 has some extra regs from 0 thru 7. Since the DS1558 has a full 512K of address space and the SRAM is only 2K, you can play a trick on the address bits of the DS1558 to fool it. The DS1558 will forward the chip select to the SRAM only if the address lies outside of the range of 0-F. If the address lies within the FFFFF0 and FFFFFF range then the DS1558 does not assert CS to the SRAM and it responds on the bus.

I believe the following trick will work:

The address pins A[0:10] of the SRAM are wired to the scope address pins A[0:10] as they should be.

Address pins A[0:2] of the DS1558 are wired as they should be to pins A[0:2] of the scope address bus. Address pin A3 of the DS1558 would be tied high to 5V. Addr A[4:10] of the DS1558 is connected to A[4:10] of the scope as well.   But address pin A11 (or any other higher address for that matter) of the DS1558 is connected to A3 of the scope. In this way, anytime A3 is low (such is the case in address range 0-7), the DS1558 will not recognize it as a valid range for it to respond on the bus and will forward the chip select to the SRAM. All of the other address bits of the DS1558 would need to be tied high to 5v.

Doing it this way, the DS1558 would respond on the bus anytime the address was in range of 7F8-7FF, and its register map would be identical to the DS1742. However, when the scope accesses address range 7F0-7F7 the DS1558 would see this address as 7FFE8-7FFEF and would not respond on the bus and forward the CS to the SRAM. This would have the effect of making the memory map of the DS1558 identical to the original DS1742.
The DS1558 regs at 7FFF0-7FFF7 are never accessible, but that's okay because they'll never be used anyway.

I haven't looked at this in super detail, but I'm fairly sure it would work. I hope my explanation makes sense!
« Last Edit: October 12, 2019, 06:07:06 pm by ArcticGeek »

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james_s
Super Contributor
🟢🟢🟢
Posts: 10487
Country: 🇺🇸

👤 💬

Re: TDS3014 adventures
« **Reply #28 on:** October 12, 2019, 06:23:41 pm »

Say Thanks　　Reply　　Quote

Hmm ok so looking over these maps again, they're *almost* identical except for one thing, BF the battery flag is at 7FC on the DS1742 and 7FFF3 in the DS1558. In this particular application I don't think that matters since as far as I know these scopes never look at the battery status. I might have to build something at some point just to see if it would work, I looked around and it seems the DS1558 is the only similar standalone RTC IC that they still make.

I've also pondered various solutions with a CPLD or small FPGA which could easily do any kind of address translation desired and it should also be possible to interface a modern serial RTC to the bytewide format. It might even work to use a serial FRAM based EEPROM combined with block RAM in the FPGA to eliminate the need for the SRAM and battery management.

I wonder if the still available TDS3054C still uses the same obsolete timekeeping RAM?

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ArcticGeek

Re: TDS3014 adventures

Say Thanks　　Reply　　Quote

Regular Contributor

🟨

Posts: 79
Country: 🇺🇸

👤 ✉ 💬

« **Reply #29 on:** October 12, 2019, 07:56:38 pm »

Yea, I had noticed the battery flag as well, but I would be very surprised if that bit is ever looked at in the Tek firmware.

To answer your question about the TDS3054C, yes, I believe it probably has the exact same DS1742W part. I have a TDS3014C and it has the DS1742W part. I haven't replace it yet, but as I recall it is getting close to the 10-year mark and will be due for replacement fairly soon.

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james_s
Super Contributor

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Posts: 10487
Country: 🇺🇸

👤 💬

Re: TDS3014 adventures
« **Reply #30 on:** October 12, 2019, 11:01:23 pm »

Say Thanks   Reply   Quote

Well this scope is fairly old, the DS1742 was date stamped '99 IIRC so you might still have some time. Mine was dead enough that the RTC wouldn't keep time but the RAM would hold its contents, that surprised me since the battery measured 0.6V. Anyway assuming my adapter works I'll send you one of the boards if you want, I had to get 5 of them and I'm unlikely to ever need more than one. I believe the DS1742W went out of production in 2018 which makes me wonder if Tek is still manufacturing these scopes or just selling existing stock. I was a bit shocked to see they still retail for over $20k new. That's a lot of money for something with a 10 year time bomb soldered to the mainboard.

Or you can of course just hack in a new battery, just don't use a programmer that will give the thing 5V to dump the contents. I'm thinking I'll just make up an adapter so I can use the switches, buttons and displays on one of my FPGA dev boards to just hand program the 4 bytes that store the on-hours. Everything else can be set through the menu in the scope.

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ArcticGeek
Regular Contributor

🟨

Posts: 79
Country: 🇺🇸

👤 ✉ 💬

Re: TDS3014 adventures
« **Reply #31 on:** October 13, 2019, 12:59:13 am »

Say Thanks   Reply   Quote

Yes, I would definitely be interested in getting one of your PCBs when you get them.   I'll send you a PM for the details - thanks much!

My TDS3014C is fairly old now, too, maybe around 10 years old I'm guessing.   I bought it on Ebay about 5 years ago and it wasn't new then.   I agree that $20K for a TDS3054C today would be a bit of a ripoff, these scopes are great for hobbyist use but a bit long in the tooth for professional use.   I don't know why Tek continues to use these Dallas/Maxim RTC chips that aren't replaceable. They started to use them in the 2465B scopes and have continued since then.   I haven't opened any of their brand new scopes, but I know that even the higher end TDS5104 and TDS7104 used these things.

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techman-001
Frequent Contributor

🟨🟨

Posts: 603
Country: 🇦🇺

Electronics technician for the last 47 years

👤 ✉ 💬

Re: TDS3014 adventures
« **Reply #32 on:** October 13, 2019, 01:24:11 am »

Say Thanks   Reply   Quote

Quote from: ArcticGeek on October 13, 2019, 12:59:13 am

> I don't know why Tek continues to use these Dallas/Maxim RTC chips that aren't replaceable. They started to use them in the 2465B scopes and have continued since then.   I haven't opened any of their brand new scopes, but I know that even the higher end TDS5104 and TDS7104 used these things.

This thread had me worried, then I remembered the scope I use everyday is made by HP (54601A HP DSO circa 1994) , and has no Dallas/Maxim RTC chip in it 😊

I'm pretty sure my only other scope, a Tek 7000 series mainframe doesn't have one either ;-)

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GPL; Forth for Cortex-M: https://mecrisp-stellaris-folkdoc.sourceforge.io/
GPL; Tethered Forth for MSP430: https://mecrisp-across-folkdoc.sourceforge.io
BSD3; https://learning-microprocessors.sourceforge.io

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james_s
Super Contributor

🟩🟩🟩

Posts: 10487
Country: 🇺🇸

👤 💬

Re: TDS3014 adventures
« **Reply #33 on:** October 13, 2019, 01:39:18 am »

Say Thanks   Reply   Quote

I remember thinking years ago that the Dallas chips seemed like a neat idea, this was after spending a lot of time cleaning up huge messes caused by leaking NiCd memory backup batteries on 80s arcade boards and vintage computers. I've also seen a number of computers completely destroyed by leaking lithium thionyl chloride batteries however it's very rare that I've ever seen a lithium coin cell leak and when it has happened the damage was localized to the battery holder. Anyway in retrospect

it's an idiotic idea to pot a battery inside a module, just use a battery type that is not prone to leaking!

In case anyone else is interested, I reverse engineered the serial portion of the TDS3GV comm module, there was already another thread on that which I'll link here rather than fragmenting information all over.

https://www.eevblog.com/forum/testgear/reverse-engineering-tektronix-tds3gv-module-for-tds3000-series-oscilloscopes/new/#new

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ArcticGeek
Regular Contributor

Posts: 79
Country: 🇺🇸

Re: TDS3014 adventures
« **Reply #34 on:** October 13, 2019, 02:21:40 am »

Say Thanks   *Reply*   *Quote*

There are some benefits of using these encapsulated RTC modules. Obviously, one benefit is that design is relatively simple compared to the added complexity of having a battery, holder, RTC, and SRAM.

But another benefit is guaranteed battery life. You would be surprised how poor the battery life of a NVRAM/RTC can be if the PCB is not completely clean of any type of flux residue/contamination.

I worked on a project some 20 years ago where I designed a custom Intel 386/486 computer platform, and that design used a Dallas RTC chip with an external lithium battery. As I recall the normal battery current was in the 200nA range; this would yield at least a 12 year life for the product. However, many boards failed early due to the battery being exhausted, and analysis found that the battery current on those failing cards was in the 20-50uA range - nearly 200 times the current! It was all caused be boards that were not perfectly clean, but yet even under the microscope they looked good and clean. The circuit itself was fairly simple, but yet just a little bit on uncleanliness caused dramatic reduction. it took quite a bit of effort to get the card supplier to keep the process in control.   The lesson I learned from this is you have to be very careful on these sub-uA circuits to make sure you keep stuff very clean.

Using an encapsulated module gets rid of any of these issues, and I can kinda understand how Tek sees the advantage of using them.

Report to moderator   *Logged*

---

texaspyro
Super Contributor

Posts: 1332
🇺🇸

Re: TDS3014 adventures
« **Reply #35 on:** October 13, 2019, 02:41:58 am »

Say Thanks   *Reply*   *Quote*

Quote from: ArcticGeek on October 13, 2019, 02:21:40 am

> The lesson I learned from this is you have to be very careful on these sub-uA circuits to make sure you keep stuff very clean.

One thing that is often overlooked is handling of watch batteries. A finger print across the edge of the cell can cause the battery to drain rather rapidly.   Never handle the batteries with bare hands!   Also, it can help to first clean the cells with alcohol.

Report to moderator   *Logged*

---

james_s
Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures
« **Reply #36 on:** October 13, 2019, 03:00:58 am »

Say Thanks   *Reply*   *Quote*

I think the PowerCap arrangement is a much better design though. One type of PowerCap can work with any number of RTC/NVRAM types, it's a lot more economical than keeping a whole selection of old products in production that all have a use-by date due to the encapsulated battery.

Also I'd much rather have a battery that doesn't last as long as it should than an instrument that needs to be sent in for an expensive repair. I mean Tek didn't even socket the part, clearly they did not intend it to be field replaced and 10 years is not all that long of a life for such an expensive piece of equipment.

Report to moderator   *Logged*

---

james_s
Super Contributor

Posts: 10487
Country: 🇺🇸

Re: TDS3014 adventures
« **Reply #37 on:** October 19, 2019, 07:50:33 pm »

Say Thanks   *Reply*   *Quote*

So I'm still waiting for my boards to arrive from JLC PCB so no movement there. I do however have some other stuff to share that some might find interesting. I decided to play with the DS1742W and threw together an adapter to connect it to one of my FPGA boards. The FPGA is not really doing much other than serving as a patch panel to conveniently route the switches and buttons as well as provide decoded hex displays. This shows selected address, byte to be written, and byte read with the byte read also shown on the red LEDs, convenient for manipulating individual bits.

So I started poking at the DS1742 while referring to the datasheet, I have a much easier time understanding something if I can actually see and touch it vs just studying the datasheet. Anyway I figured out why I've had difficulty programming these things in conventional EPROM programmers, it turns out that in order to modify any of the clock related registers you must first write a '1' into the 'W' bit of the control register, otherwise they are read-only. By default (with a dead/missing battery) it also seems to power up with frequency test enabled, this causes bit 0 of the seconds output to toggle at 512Hz which can cause strange behavior if it gets enabled by mistake. The DS1642 used in the TDS300 series has the same feature and it causes the displayed time to jump around erratically. Anyway I thought this was pretty cool stuff, I can hand program it, setting the time and date and watch the clock run and a setup like this is fully adequate for setting specific bytes like the power-on hours of the scope, no EPROM programmer needed and very little chance of anything getting accidentally corrupted.

As I was messing with this I happened to be looking at the status register when I bumped the DS1744 and the battery flag LED came on! Additional poking revealed that the fault that set me down the road of building a replacement DS1742W is actually a cracked joint down under the epoxy where the nickel strip that connected the original battery is soldered to the PCB. This means I should be able to repair it easily enough and that would have saved me 60 bucks. Since I already bought the parts I'm going to continue down the path of building a replacement and assuming that works I'll share the design so others can use it and keep the original DS1742W as a spare.

Incidentally the PowerCap version of the DS1744 arrived and it is a bare un-potted PCB with a commodity SRAM and DS1744D TQFP IC on the bottom. I don't think Maxim sells the bare DS1748D but it must be exactly what is in the currently made potted versions as well. Wish I could just buy that IC and build a direct fit DS1742W module.

Something else I think might be interesting to do at some point is further reverse engineer the TDS3000 and other instruments that use these NVRAMs and find out exactly what locations are used to store what. It would be very easy to wire up an FPGA board in place of the DSxxxx and use internal dual-port block RAM which can be monitored/dumped/poked live. This would be of greater interest to me on instruments like the TDS300 series that store the cal constants in the NVRAM, I have two of those and a friend has a third that all work fine but display a calibration error on power up. I was able to calibrate the voltage with difficulty but the timing calibration is too finicky for any sort of pulse generator I have access to. Perhaps it would be simpler to disassemble the firmware and attack it from the other direction, I don't know, I'm more of a hardware guy.
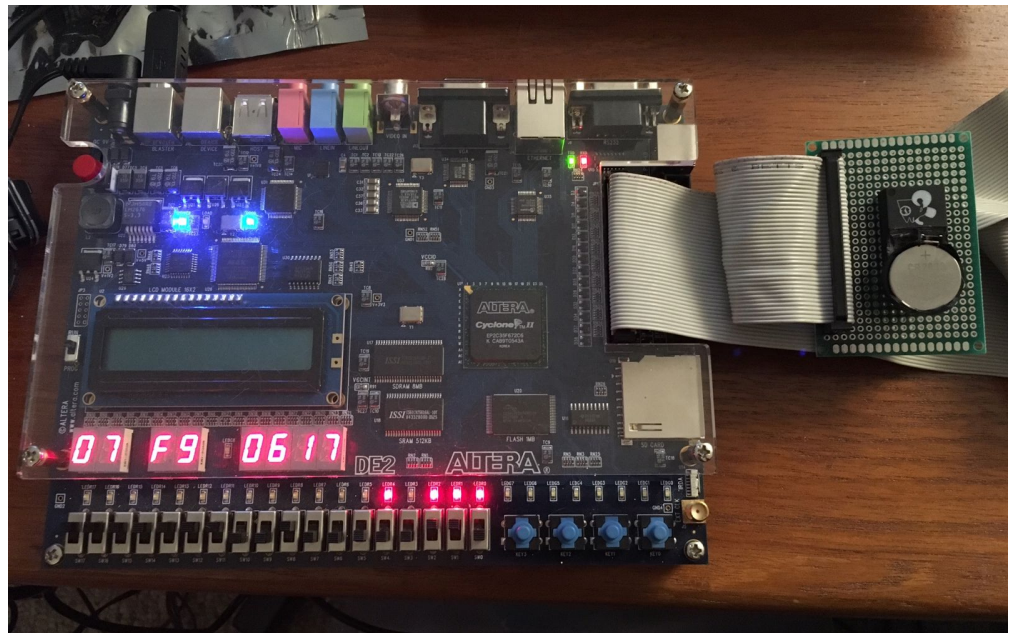
DS1742.jpg (251.76 kB, 1600x1008 - viewed 85 times.)

« Last Edit: October 21, 2019, 04:00:30 am by james_s »   Report to moderator   Logged

The following users thanked this post: edavid

---

james_s
Super Contributor

Posts: 10487
Country:

Re: TDS3014 adventures
« **Reply #38 on:** November 02, 2019, 06:56:35 am »   **Say Thanks**   **Reply**   **Quote**

Finally got the boards I ordered from JLC PCB and built the adapter today. I'm pleased to report that it worked perfectly right off the bat, just plug it in and go. After verifying that it worked, I used the FPGA board I was playing with before to set the power-on hours and now it's buttoned up and
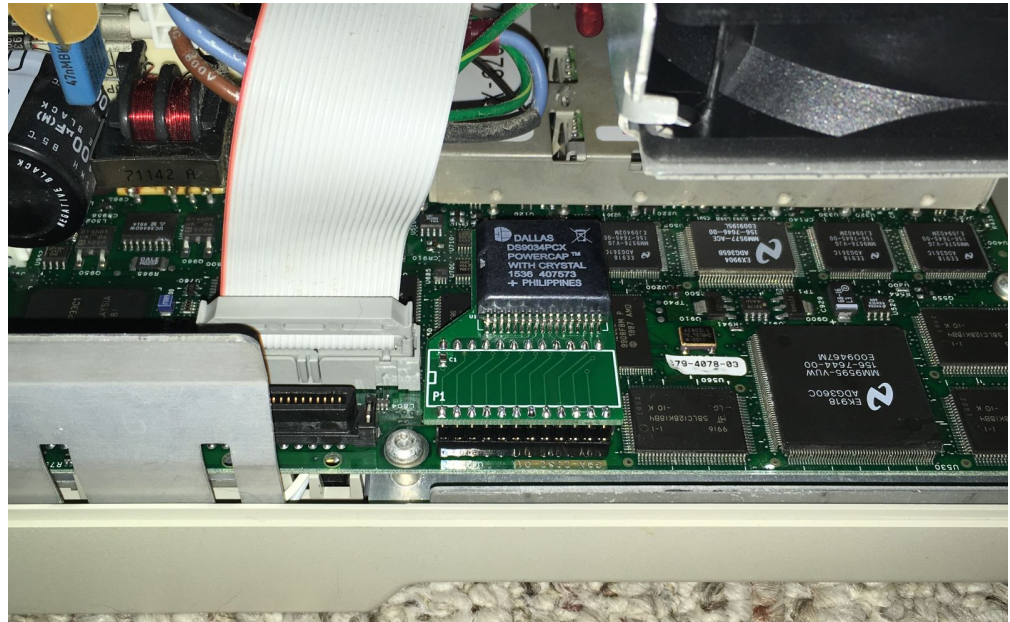
finished.

Adapter board gerbers and design files here:
https://github.com/james10952001/DS1744WP-to-DS1742W-adapter

This should work for any application of the DS1742W however you'll want to verify the mechanical fit if you are wanting to use it in anything other than a TDS3000.

📎 DS1742W adapter.jpg (277.05 kB, 1600x992 - viewed 101 times.)

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The following users thanked this post: edavid, ArcticGeek, 2N3055

☐ **giosif**

Frequent Contributor

🟨🟨

Posts: 430
Country: 🇬🇧

👤✉️💬

Re: TDS3014 adventures
« **Reply #39 on:** November 02, 2019, 05:10:43 pm »

Say Thanks   Reply   Quote

Congrats on your work and thank you for sharing with everyone else here!

Report to moderator   🏁 Logged

🟢 **ArcticGeek**

Regular Contributor

🟨

Posts: 79
Country: 🇺🇸

👤✉️💬

Re: TDS3014 adventures
« **Reply #40 on:** November 03, 2019, 03:03:03 am »

Say Thanks   Reply   Quote

Nice work - glad to see that it worked right out of box! Thanks for sharing with the community.

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