

Modification to Perseus SDR to Use an Eternal Clock by Mark Goldberg W7MLG

WARNING: The modification shown on this web page involves removing small SMT parts, cutting a trace, adding wires to SMT pads and drilling a hole in the rear panel of the Perseus SDR. If you do not have the necessary equipment and skill to accomplish these changes, you should not attempt them. You should take all required ESD protection precautions. If the input level from the external clock is too high it may damage the Perseus SDR. These changes will most certainly void any warranty. THIS COULD PERMANENTLY DAMAGE THE PERSEUS AND TURN IT INTO A BRICK. I accept no responsibility for anyone following the procedures shown on this web page. YOU HAVE BEEN WARNED!

Performance data has been moved here [Performance](#).

With that out of the way, I have designed a modification to allow the Perseus SDR to use an external clock. The internal clock is about 80 MHz, but it drifts quite far from the nominal frequency. I am using the Perseus for frequency measurements and need an accurate clock. I obtained a high quality Wenzel oscillator that produces 80 MHz when locked to an external reference and want to use that clock instead. I use this to test my TCXO boards described [here](#).

I also use it for general measurements as described [here](#).

The Perseus uses a Linear Technology LTC2206 14 bit Analog to Digital Converter. From the device data sheet, the recommended circuit to use an external 50 ohm clock looks like this.

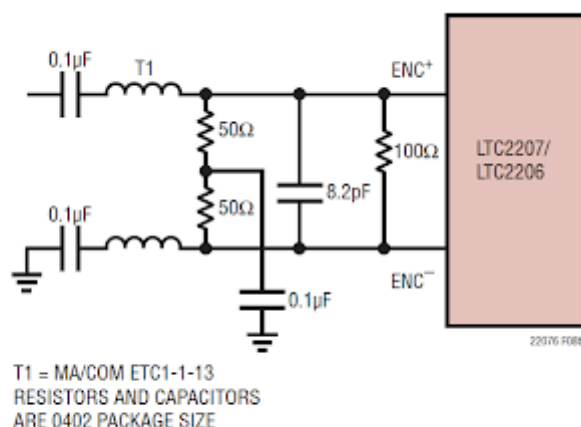
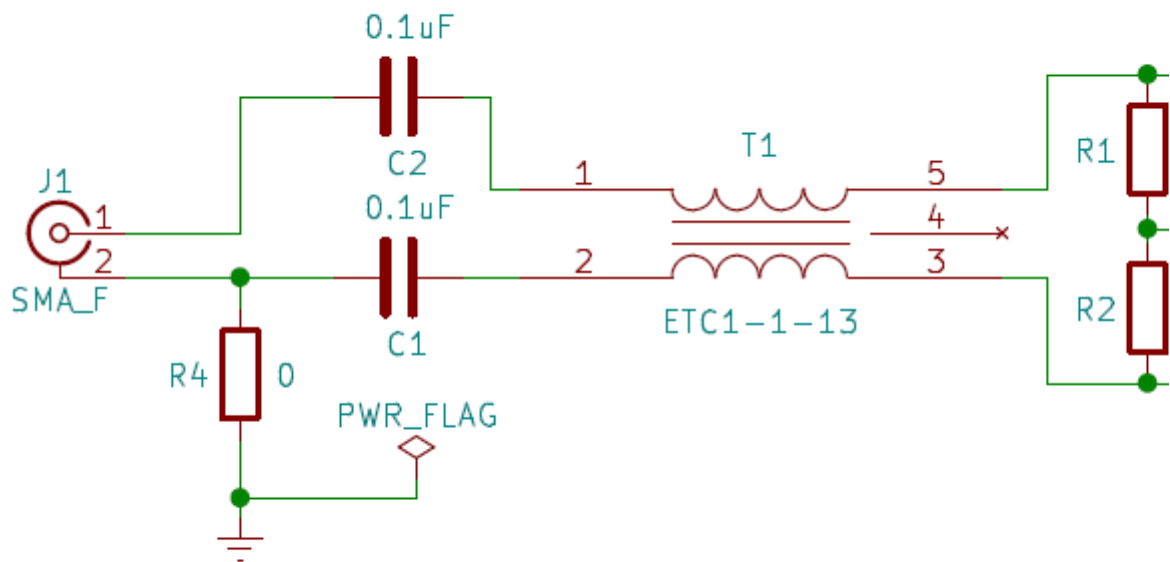


Figure 8b. Transformer Driven Encode

(Click on image to enlarge.)

I set out to duplicate this circuit on a small board, with a 50 Ohm SMA connector input on the end of a short coax. The connector can be mounted on the back panel of the Perseus.

The board schematic looks like this. R4 may or may not be used, depending on what provides the lowest measured phase noise. I did not use R4.



Here is the BOM. I usually buy 100 of the small, cheap parts as there is a big price break, and they get lost easily. Quantities can be changed to match the schematic, although spares of the 0603 parts are suggested, as they get lost easily. I only ordered 10 of the 8.2 pF caps, as they are somewhat pricey.

Bill Of Materials						
Quantity	Source	Part Number	Description	Customer Reference	Unit Price USD	Extended Price USD
0	Digikey	J502-ND	CONN SMA JACK STR 50OHM EDGE MNT	J1 Not Used	\$3.7300	\$0.00
100	Digikey	1276-3505-1-ND	RES SMD 49.9 OHM 1% 1/10W 0603	R1 R2	\$0.0092	\$0.92
100	Digikey	1276-3482-1-ND	RES SMD 100 OHM 1% 1/10W 0603	R3	\$0.0092	\$0.92
1	Digikey	1465-1217-1-ND	TRANSFORMER	T1	\$2.4800	\$2.48

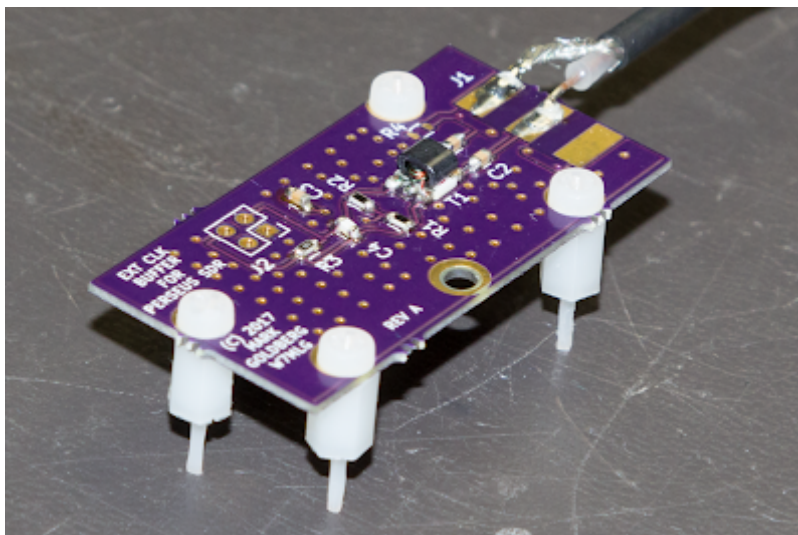
10	Digikey	399-7964-1-ND	CAP CER 8.2PF 50V C0G/NP0 0603	C4	\$0.1990	\$1.99
100	Digikey	399-1281-1-ND	CAP CER 0.1UF 25V X7R 0603	C1 C2 C3	\$0.0136	\$1.36
1	Hamfest	Unknown	SMA Female Panel Mount to pigtail (NOT RP-SMA)	J1 Used	Unknown	Unknown
					Total	\$7.67

The board can be ordered from OSHPark at this [OSHPark Link](#).

You may make these for yourself, but please do not make and sell them commercially. See the Copyright notice at the bottom of the page. If you are crazy enough to want to produce these commercially, contact me at <my call>@arrl.net and we can work something out.

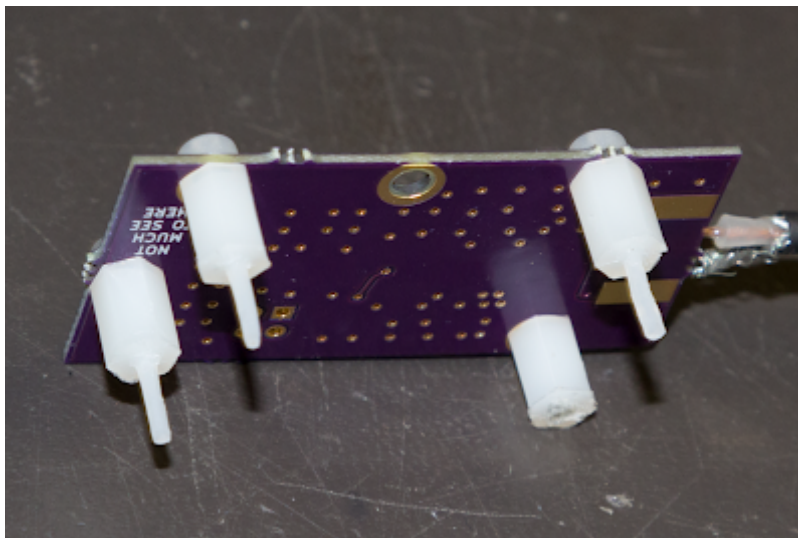
I ordered the board from OSHPark in 2 oz copper, 0.8mm thickness so the ground plane will be better. You have to order three for about \$6.10.

The assembled board looks like this. It is designed to be mounted on nylon standoffs. I used standard M2 Male-Female 6mm long Nylon standoffs, but trimmed the male threaded part down to fit into the holes in the Perseus board.



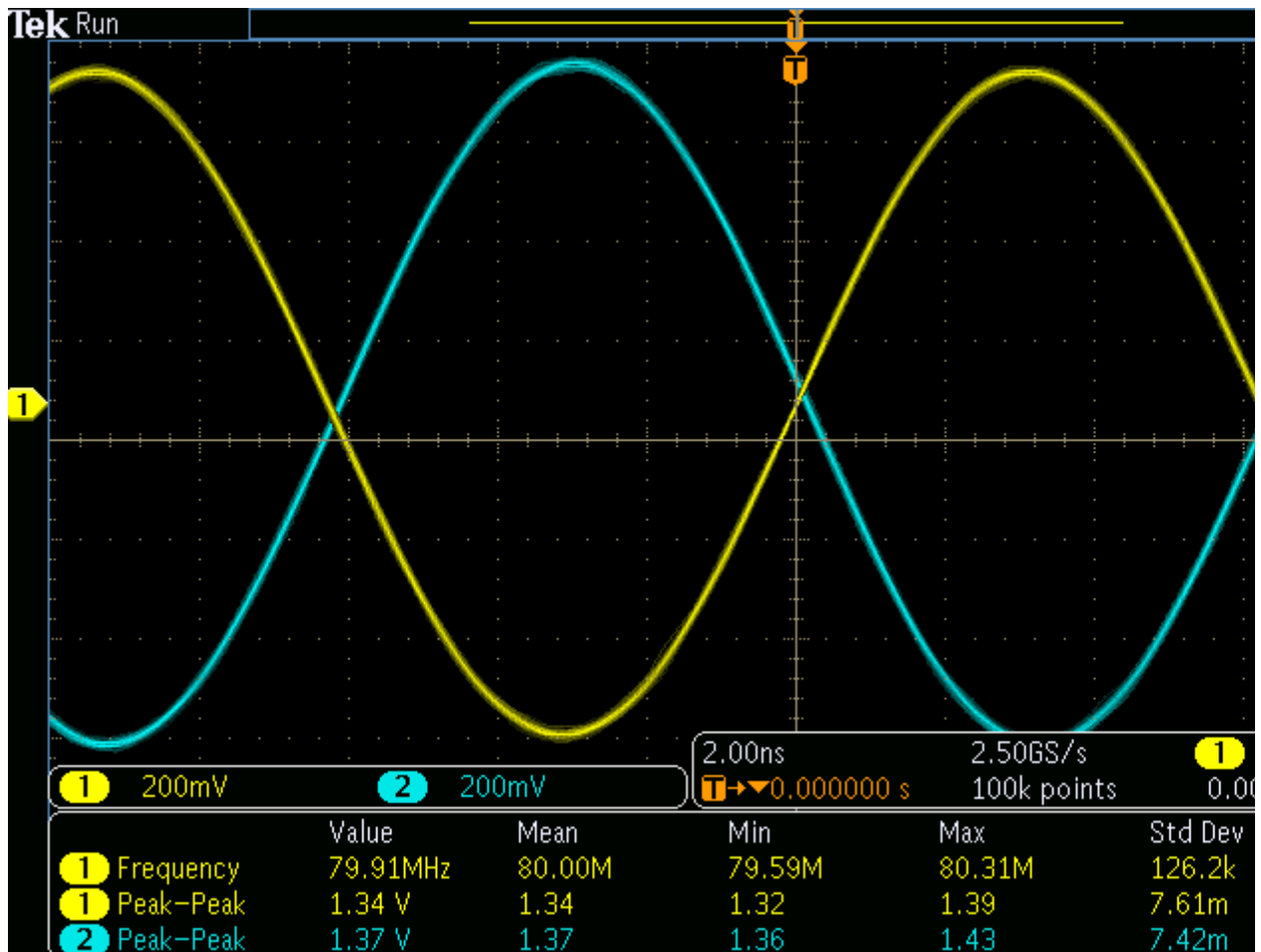
(Click on image to enlarge.)

The bottom of the board looks like this.



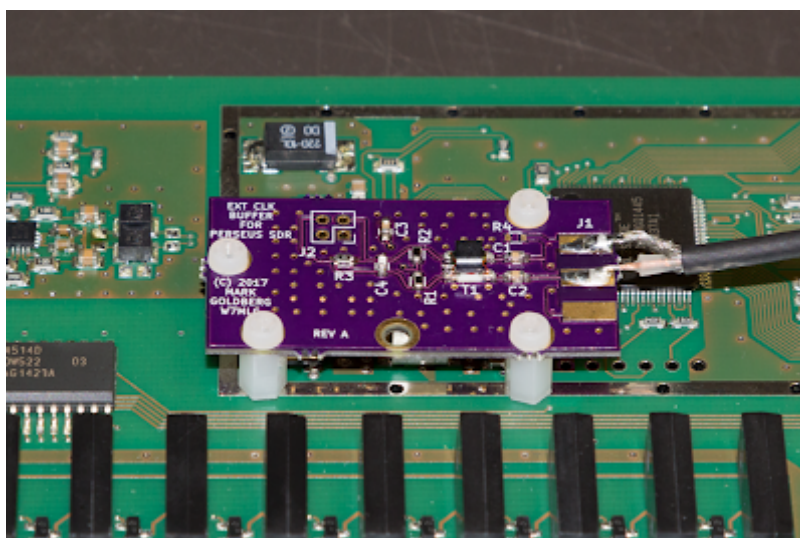
(Click on image to enlarge.)

Note that there is a ground plane of both sides of the board surrounding all of the circuitry, with many stitched vias connecting the two sides of the board. With the Wenzel oscillator producing about 11 dBm, the two outputs to EXT+ and EXT- look like this unloaded.



The LTC2206 datasheet says to use a differential EXT input that is as large as possible, and specifies various parameters with a differential input of 2 V peak to peak. This is about 2.7 V peak to peak. When connected to the inputs, connecting the scope grounds created a 60 Hz ground loop that made it difficult to get a decent measurement. I tried lowering the input level with no apparent performance change, so I left it at 2.7 V.

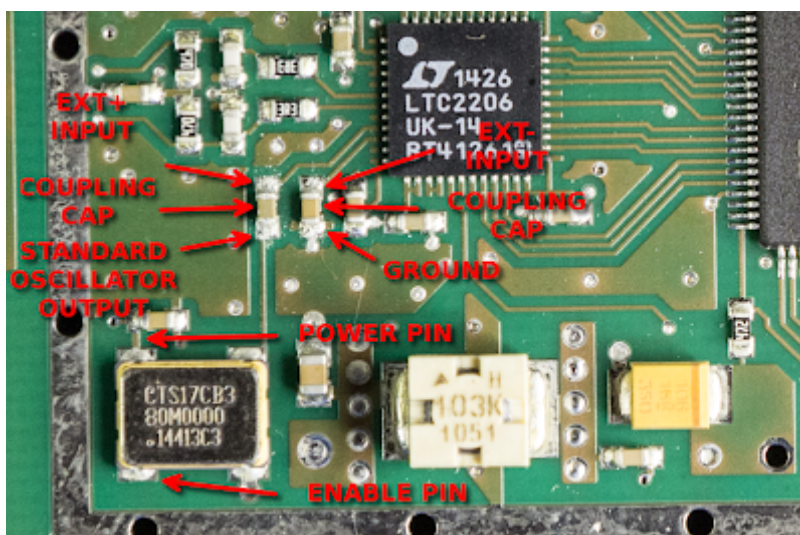
I did a fit check before connecting the board.



(Click on image to enlarge.)

It seems to fit correctly.

The original circuitry in the Perseus uses a single ended clock input to the EXT+ and EXT- pins with coupling caps to the oscillator output and ground as shown in this picture. The caps appear to be .1 uF caps as specified in the datasheet. The standard clock oscillator has an enable input, but it is connected to the supply voltage with a trace under the chip. If the original oscillator is not disabled, there are spurs visible in the Perseus output, likely crosstalk from the original oscillator on a slightly different frequency. So, I decided I needed to disable the original oscillator. The following picture shows all of these connections.



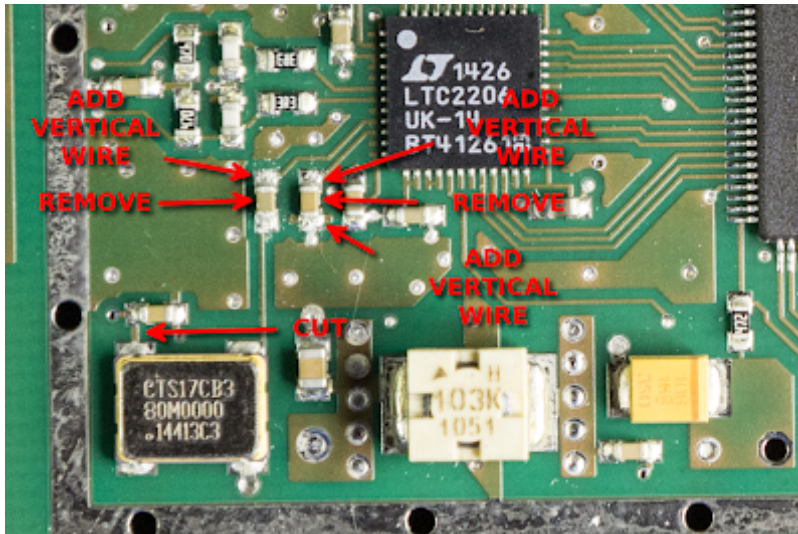
(Click on image to enlarge.)

In order to install the buffer board, the following needs to be done. **SEE THE WARNINGS AT THE TOP OF THIS PAGE.**

1. Remove the coupling caps from the standard oscillator output to EXT+ and ground to EXT- inputs to the ADC.
2. Disable the standard oscillator by cutting the trace to the supply voltage and the enable pin.

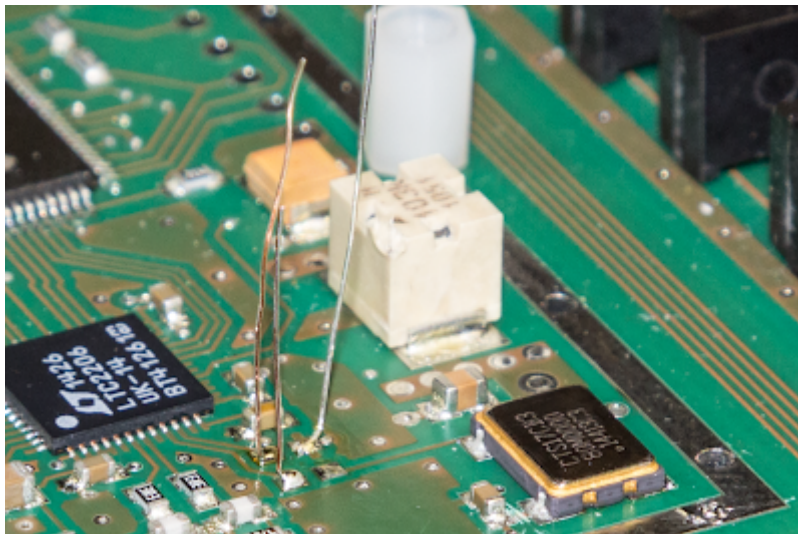
3. Connect 3 wires to the coupling cap pads. These will be used to connect to the buffer board.

All this is shown in the picture below.



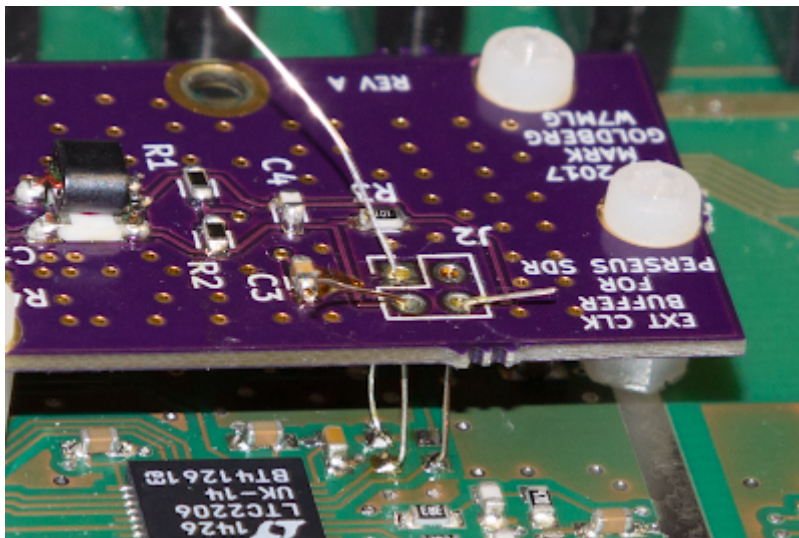
(Click on image to enlarge.)

I removed the caps, installed the wires and cut the trace and it looks like this, ready to install the buffer board.



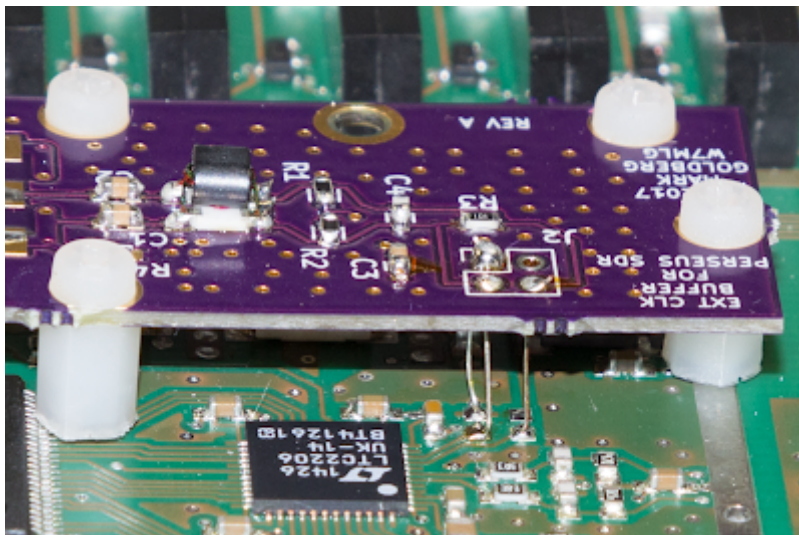
(Click on image to enlarge.)

After the buffer board is installed but before soldering the wires to the buffer board, it looks like this. Note that the wires are all a slightly different length, making it easier to push them through the holes on the buffer board one at a time.



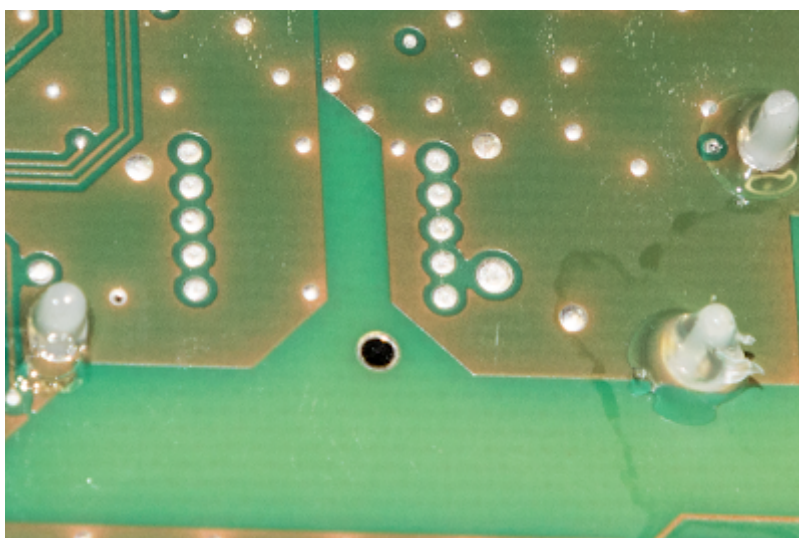
(Click on image to enlarge.)

After soldering, cutting the wires and cleaning up the flux, it looks like this.



(Click on image to enlarge.)

On the bottom of the board, there is a dollop of hot glue to hold on the mounting posts.

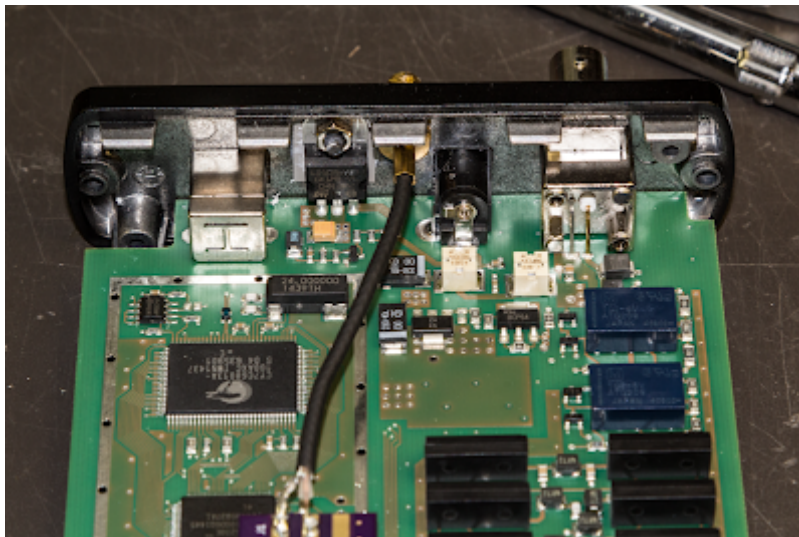


(Click on image to enlarge.)

I then drilled a 1/4" hole in the rear plate (very carefully, made sure to catch all the aluminum shards and cleaned it thoroughly) by starting with a small drill and using

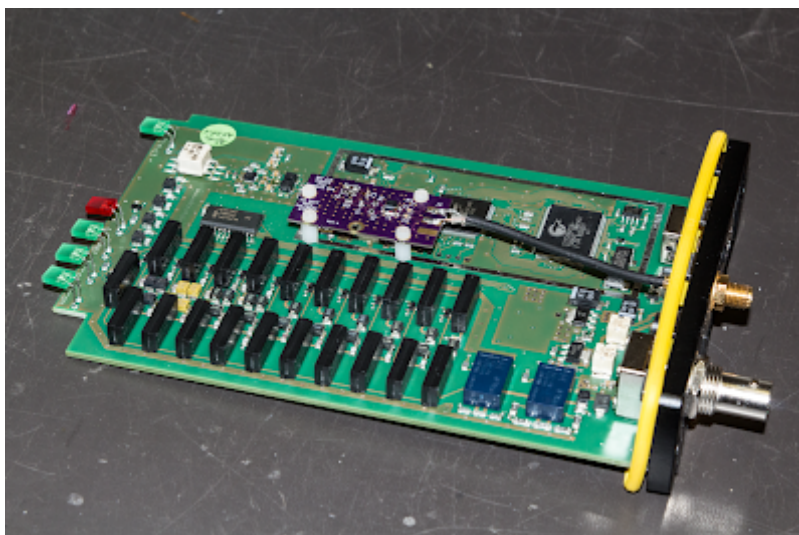
progressively larger bits until I reached the final size.

With the SMA connector installed in the rear plate, it looks like this.



(Click on image to enlarge.)

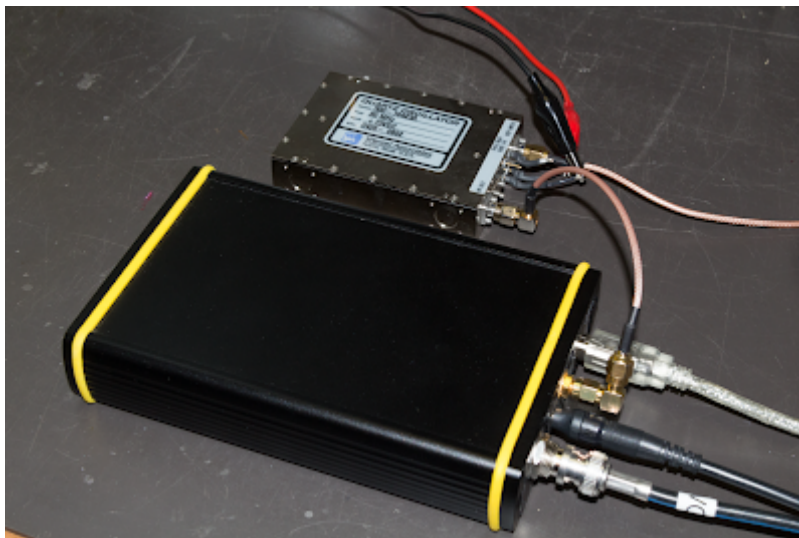
Here is another view.



(Click on image to enlarge.)

Results

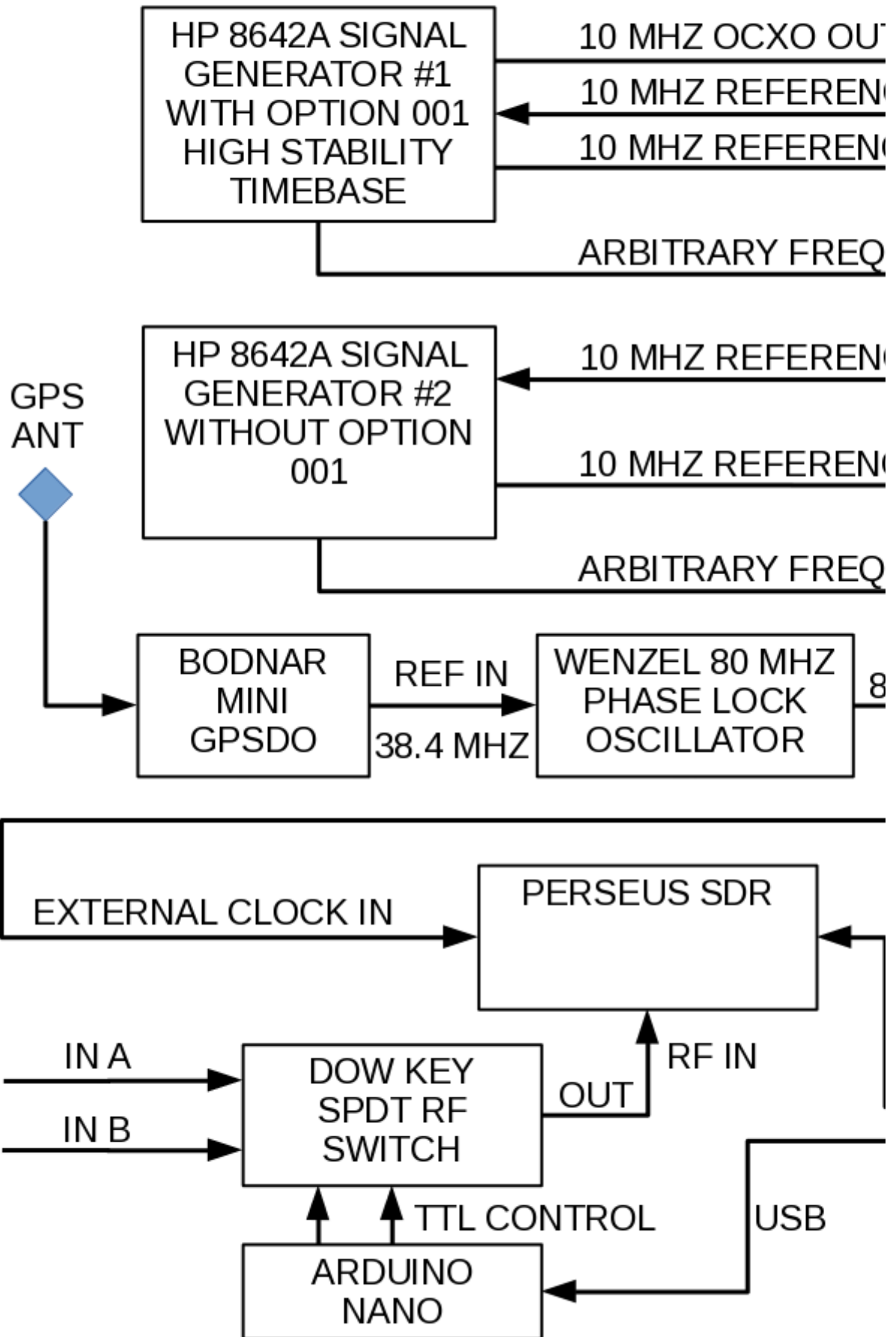
It seems to work so far with similar phase noise to the original oscillator, but way better frequency accuracy and stability. Here it is in use with the Wenzel oscillator. The normal start up sequence is to connect the power plug to the Perseus, then turn on the external oscillator, then connect the USB cable. It does not like it if the USB cable is connected with no clock.



(Click on image to enlarge.)

Here is a diagram of how it is connected up and used. The two signal generators are frequency locked to the same 10 MHz reference. I recently added a Bodnar Mini GPS Disciplined Oscillator that can output any frequency within a wide range as a reference. This drives the Wenzel Oscillator, and eventually the Perseus. The two references agree within 0.1 Hz. I can output two different signals from the two signal generators, and I can switch between measuring two things with the Perseus under software control.

The Bodnar followed by the Wenzel is an interesting combination, resulting in a very good clock to the Perseus. The Bodnar has excellent long term frequency stability, being locked to the GPS standards. The close in phase noise for the Bodnar is good, but there are some spurs in the output farther out. The signal from the Bodnar goes to the Wenzel and it locks a very clean oscillator to that. Any spurs above a few 10s of Hz are eliminated and it has very few of it's own. The result is quite good for the money paid.



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Here are some of my other sites:

Modifications to my RV, including solar power and extra storage:

<https://sites.google.com/site/marksrvmods/>

My Controleo2 based SMT Reflow Oven:

<https://sites.google.com/site/markcontroleo2build/>

My TS-590S MODs including a buffer board install for a panadapter:

<https://sites.google.com/site/marksts590smods/>

My TCXO Boards to replace the SO-3 in Kenwood TS-590 radios:

<https://sites.google.com/site/markstcxo/>

An explanation of various TCXO Characteristics in Kenwood TS-590

Radios: <https://sites.google.com/site/markstcxomeasurements/>

How I use Spectrum Lab Software to do frequency measurements:

<https://sites.google.com/site/spectrumlabtesting/>

Pictures I took of the 2017 Total Solar Eclipse from Menan Butte, Idaho:

<https://sites.google.com/site/marks2017eclipsephotos/>

Revised September 30, 2018

Subpages (1): [Performance](#)