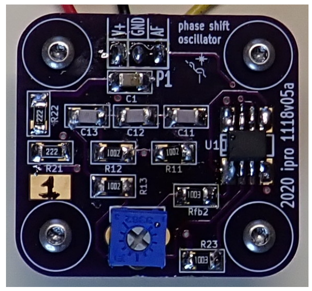
prsb phase shift oscillator adapter board.
1188
2020 ipro 1122v05a.
2020-12-18.



!635-b1-1. Phase shift oscillator. (36x33) = 1188 mm^2. See 2020 ipro 1122v05a.

The board is incorrectly marked “ipro 1118v05a”. This was the first phase shift oscillator OSHP board to be built. The plan is to test it as an AF generator to modulate tx2m RF. It creates a nice sine wave, 640 Hz. The U1 is a dual op-amp with the second op-amp used to buffer the output.

Fig. 1. The front of the board.

Fig. 2 shows the adapter board which provides an SMA.

Fig. 3 shows the KiCad schematic used to make the board. As of 2020-12-18, only one of the !635-b1 boards has been built (!635-b1-1). Table 1 shows the component values at the time of the first successful test, 2020-12-15. When I had first built the board, I had used different values but the board would not produce AF. Earlier, I had a successful test with a home-made board. I had decided to use different values on the OSHP board to get a different frequency. But I neglected to calculate the expected feedback I would need and the Rfb1 Rfb2 did not provide enough resistance. I changed a number of components in trying to track down the problem. Finally, I made the Rfb calculation and realized my error. So some values unrelated to the problem (e.g. R23) may be different from values in the original plan. As of 2020-12-18, the components on !635-b1-1 are still the same as on 20-15 and I’ll probably leave them that way. I haven’t started building the other two OSHP boards.

Table 2 shows some specs from the first successful text with the OSHP board.

1 Theory.

The oscillator generates AF with the first op-amp. The second op-amp is just there to buffer the output.

The oscillations are generated by a phase shifting feedback from the first op-amp output to its inverting input [in1-]. The phase shifting path has three parts, each providing 60° of shift. After all three parts, 180° of shift has occurred and the signal is of the opposite polarity from where it started. But since it's going into the inverting input, it's actually providing gain. Think about it as follows. A sine wave with a Vpp = 6 V will have peaks at +3 V and then 180° later be at -3 V. When the output is at +3 V, the shifted signal arriving at the inverting input at that moment will be the voltage from 180° earlier, -3 V. So the op-amp will try to raise the voltage at the output further.

There is a second feedback path (using Rfb) from the output to the inverting input. This path is not shifted and so attenuates the output. According to theory, the gain provided by the phase shifting feedback is about 29x minus some losses in the path. By adjusting the pot that is part of Rfb to be about the same, the gain and the losses are equal and the oscillation is stable.

Note that the shift provided by the first feedback path is dependent on frequency. Only at one frequency determined by R1x C1x is the phase shift exactly 180°Ṡo it's R1x and C1x that determine the frequency that the oscillator will generate. Using R and C for the values to use for each R1x and C1x,

$$f = \frac{1}{2\sqrt{6}\pi RC}. \quad (1)$$

2 Figures and tables.

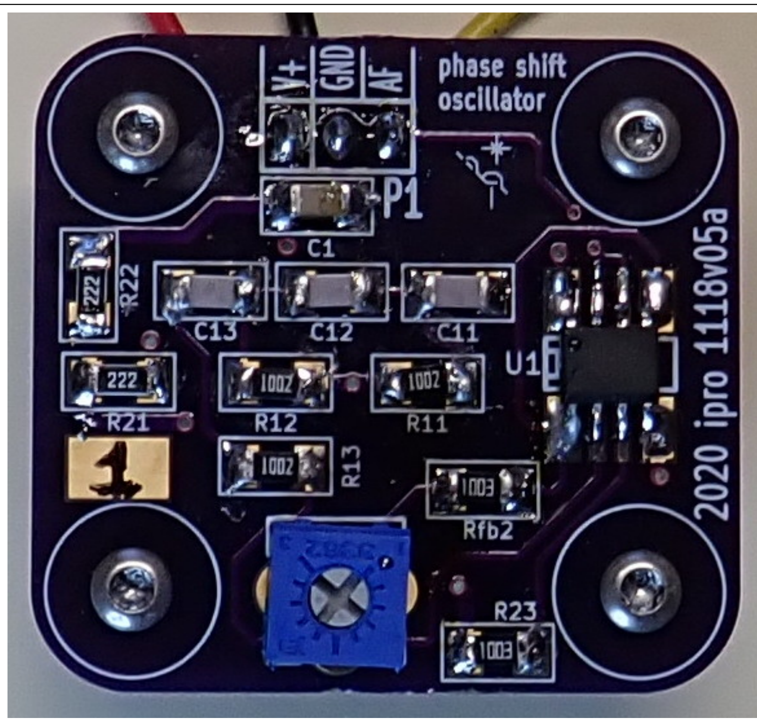


Figure 1: Front of board. The standoffs use #2 screws and are 11 mm high for correct interboard spacing when using rectangular headers.

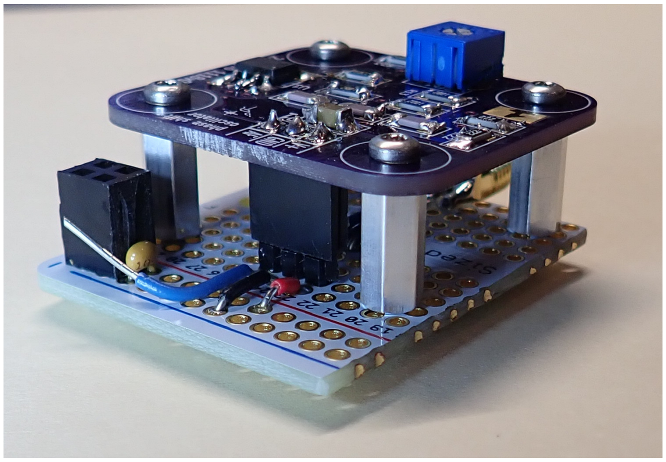


Figure 2: Board attached to its adapter providing an SMA ouput (in back of this picture and barely visible).

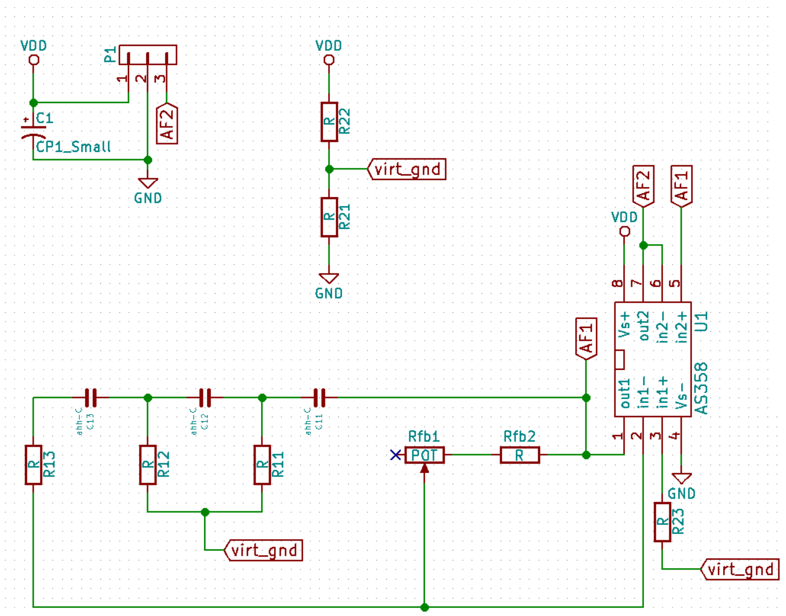


Figure 3: Schematic.

Table 1: Component values in build of first !635-b1 board at the first successful test, 2020-12-15.

Ref.	value	notes
U1	AS358	Dual op-amp.
R1x	10 kΩ	Part of phase shifting network.
C1x	10 nF	Part of phase shifting network.
C1	4.7 µF	Power supply bypass cap at board entrance.
R23	100k	Was higher in first build but changed while trying to make it work.
Rfb2	220 kΩ, !052	Constant part of Rfb.
Rfb1	100 kΩ	Pot. With Rfb2, it provides a range of 220k to 320k.
R21 and R22	each 2.2k	Part of voltage divider to create the virtual ground.
P1	rect. fem. header	Placed below the board to allow plugging into another board.

– In R1x and C1x, I using x to denote 1, 2, or 3.
– Rfb - R_{feedback}.

Table 2: Some specs from the first successful test with the OSHP board, 2020-12-15.

Spec.	value	notes
f_{expected}	650 Hz	
f_{measured}	640 Hz	Low by 1.5%.
PS voltage	6 V	Virtual ground at 3 V.
$Rfb_{\text{estimated}}$	29 10k = 290k	Rfb = 29 R1x.
Rfb_{measured}	300k	Rfb1 + Rfb2.

– PS - Power supply.

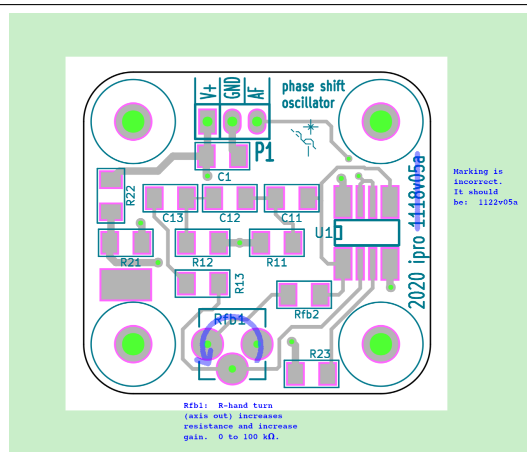


Figure 4: Gerbv layout, front, with annotations.

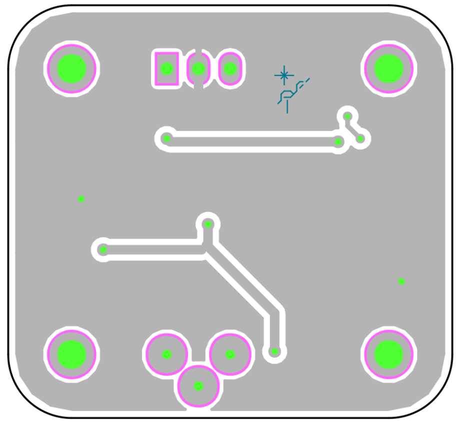


Figure 5: Gerbv layout, back, front view.

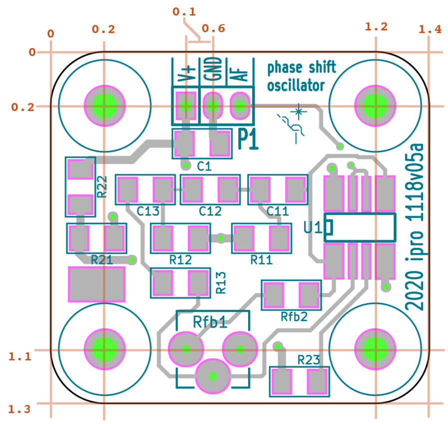


Figure 6: Gerbv layout dimensions. These are important for designing kicad modules for this board. I made a home-made board to fit it on (2020 ipro 1216v06d). I also make a kicad module so that it could be fit on other boards (2020 ipro 1122v05b). As of 2020-12-18, the kicad module hasn't been used yet. I'm waiting to do some experiments and decide what I want to design next. Maybe the kicad module won't be used until I design a full tx2m board.

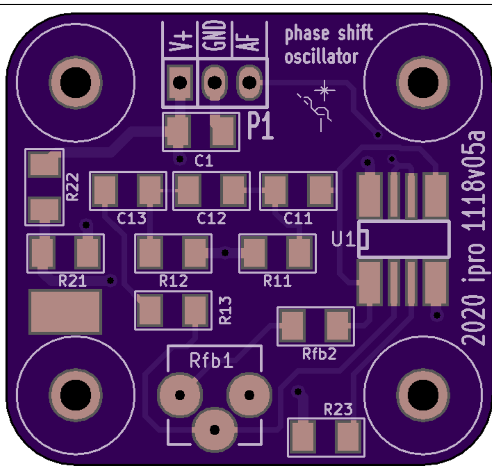


Figure 7: OSHP front.

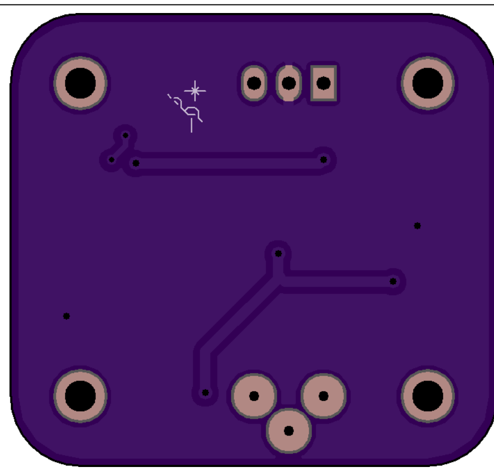


Figure 8: OSHP back (back view).