Trying to improve on SWR readings, add 6m and power from 5Volts 24/12/2017

After building the W8TEE K2ZIA analyser I tested it for proper functioning and found the reading was quite a bit off. Reading that should be around 1.2:1 were a perfect 1:1 and 2:1 were around 1.6:1. There also was a difference in reading over the frequency spectrum I did not quite like and wanted to improve.

At first I suspected an SWR calculation error but as it turned out it seems like it is a hardware issue. I have to thank Jim G3ZQC for helping me get on track again.

Here I will describe my solution.
I address several design “flaws” or perhaps I should better say enhancements. And a small software correction. Almost all parts fit on original positions. So no extra PCB’s or lots of floating components.

The parts we need are:
(parts are for modification 1-3, modification 5 is code only but important for modification 6 you need another DDS module).

2 diodes like 1n34 (Same as the diodes used in the bridge circuit)
2 resistors 100 kilo ohm
1 resistor 82 ohms
1 resistor 18 ohms
1 MCP602 or other rai-to-rail opamp (to replace LM385)

1 Modification of the opamp circuit to compensate for the diodes in the measuring bridge.
2 Using a stronger MMIC to get more output power
3 Modification to have a better impedance match on the DDS filter
4 Run everything from 5 volts (Optional)?
5 Compensation in the code for a better indication
6 Modifications for 6m

1 The modification of the opamp circuit

The modification of the opamp circuit I use is seen in many designs, it is a way to compensate for the voltage drop in the diodes in the measuring bridge. Using the same type of diodes in the feedback circuit of the opamp as you use in the measuring bridge.
Since we do not use the gain in the opamp anymore we also change some resistors.

The circuit looks like this.

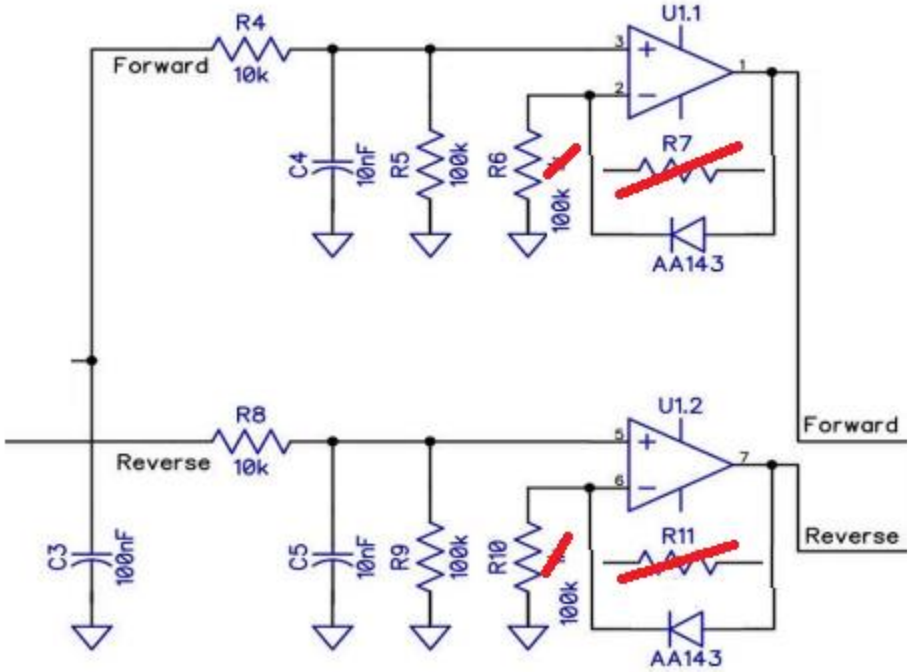

Figure 1, schematic of modification of feedback on the opamp.

R6 and R10 are changed to 100K, R7 and R11 are both changed to diodes. Use the same type as you did for the bridge. For the opamp I recommend a rail-to-rail type like MCP602.

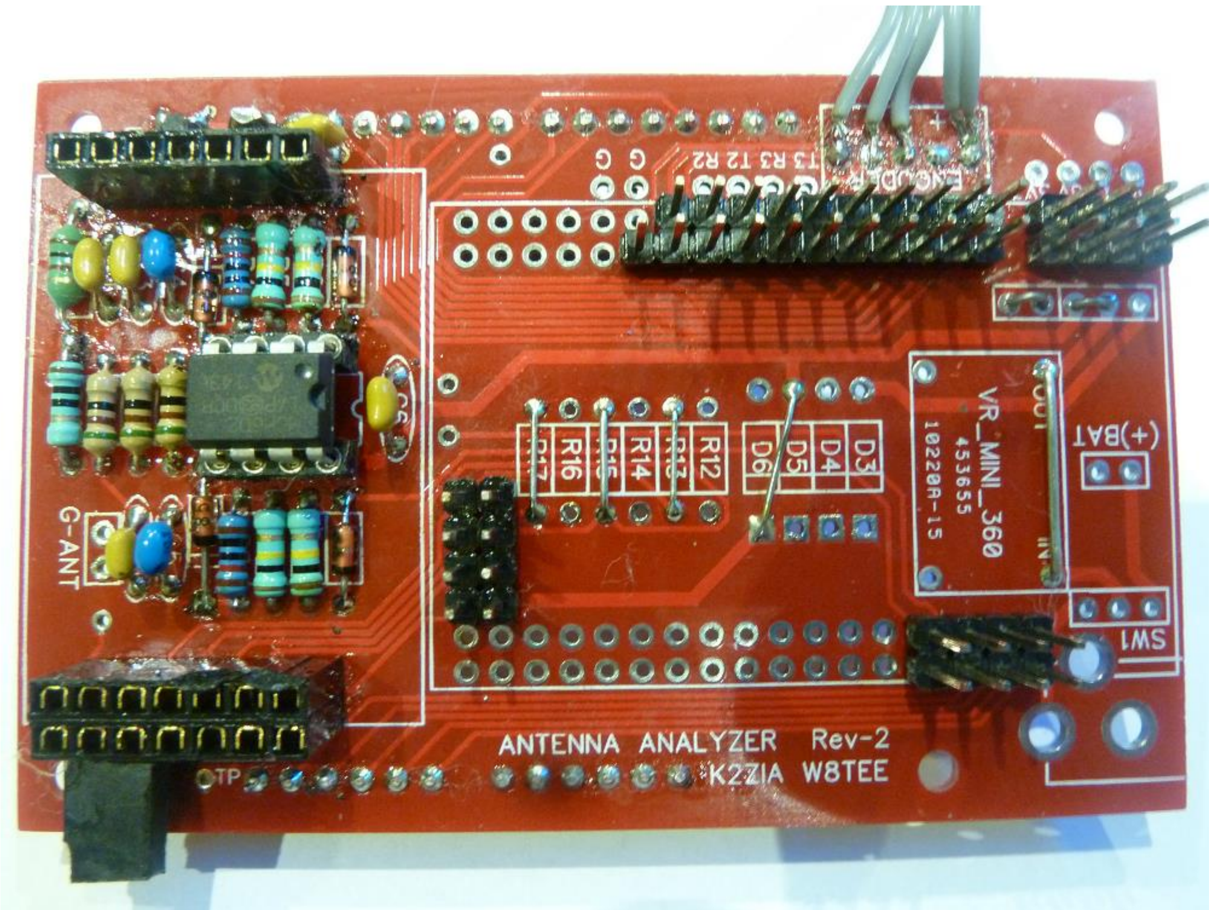

Figure 2, picture of the PCB with modified feedback circuit.

This is what the board looks like (I removed parts that I think were not needed, the missing bock converter and jumper wires are explained later).

2 Changing to a stronger MMIC

The MSA0385 in the original circuit is a MMIC that needs 5V to work properly. I is run from the 5V supply and has a 10 ohm resistor to supply the bias current.
The MMIC is probably running on 4.6 volts or so, but still the output seems to be a nice sine wave.

For some good measurements we need to have a stronger signal than het we have now, the easiest way to do that is using an other stronger MMIC.

The MSA0385 has a gain of about 10db, the MMIC I used is an ERA-3 this had about 10db more gain and works on 3.2volts. This would mean we need to change the 10R resistor, R19 to something like 27Ohms. My ERA-3 however had a flat bottom side on the sine wave so I changed back again to as low as 10 Ohms. Quite scary, but it did not really heat up, measurements are better but maybe one should better use 18 Ohms for R19 to be a bit more on the safe side.

3 Better impedance match on the DDS filter

I guess this is something that is easily overlooked. The DDS boards, both the AD9850 and AD9851 have a 70Mhz lowpass filter. This filter is matched to about 140Ohms. On the board are 200 ohm resistor on the input and output od the filter.
With the MMIC that has about 50 ohms input parallel to the 200 ohms we have a 33 ohm load on a 140 ohm filter output. This makes certain frequencies a lot stronger than others. It is important to match the impedances and a good way would have been creating an other filter but we do not want a lot of SMD soldering. So we stick with the filter and make match using resistors.

For this we need to take out one resistor on the DDS board, tis is the 200 ohm [201] resistor next to the led. And on the input of the MMIC we put a resistor in series. 82 or 100 Ohms seems to be working fine. This resistor is in series with C7, so I lifted up one end from the board and put the resistor in between.

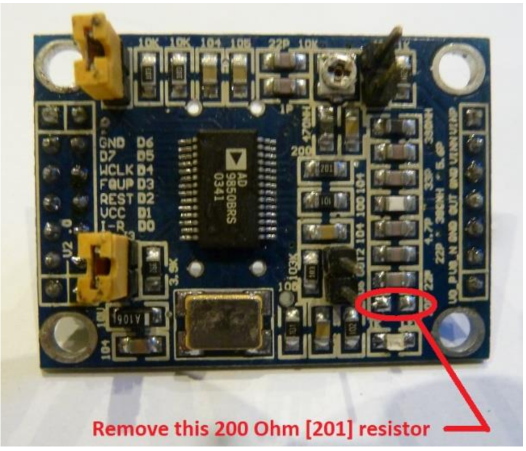

Figure 3, removing 200R resistor

Figure 4, adding 82R in series to C7.

I know this probably is not the best way to solve this problem but it is easy and gives a pretty useful output signal.

4 Run everything from 5 volts

Everything on 5 volts? This is not necessary for obtaining a good DDS signal. It could help to make the signal a bit stronger. Word has it the AD9851 needs 5 volts but I guess it could also work on a lower voltage. Since we seem to have better results with stronger signals I suggest we use 5 volts for the AD9850 as well as the AD9851.

D5 and D6 lower the voltage for the DDS so if we bridge these like in *Figure 2*, 5V will be on the DDS board. You can keep the diodes in place and put a wire across them.

On my board there is not a single diode or buck converter in the power supply circuit. I run my board from a 5volt phone power bank. If you plan to use the Buck converter you need a more expensive battery. The power bank is cheap and can easily be recharged from your phone charger or USB port.

If you want to use some 5V power source you should place a jumper wire between the buck in and output, 2 short jumpers right above the buck and the lumper over D5 and D6.
R12 – R17 can be used, but you could just as well put wires on R13,R15 and R17 positions.
See *Figure 2* for the right position for these jumpers.

5 Compensation in the code for a better indication

The modifications above are applied to get a better, more stable signal that does not differ too much over the whole frequency range.
It seems these hardware modifications are the most important to get a proper reading. However the readings are still quite a bit low.

The original calculation seems quite correct
VSWR = (FWD + REV) / (FWD - REV); //SWR calculation
However I could not get a proper reading. I needed a correction factor, I used this line, it is a simple linear correction and is proven to be quite correct, at least for the range I measured 1.1 to 5:1 it is only off by a few percent.

VSWR = (((((FWD + REV) / (FWD - REV)) -1) * 1.25) +1); // SWR calculation with a 1.25 correction factor

What it does is calculated SWR minus 1
Multiply by 1.25
Add 1 again.

This formula makes sure 1.0 values stay 1.0 and only everything above 1.1 get corrected.

6 Modifications for 6m

Well you actually did all important things using the modifications above. The only thing you need is a AD9851 DDS board and of course the code to go with it.
John Price, WA2FZW, is about to release a code that supports both the AD9851 and AD9850 DDS.
In the header file you can comment out <u>define 985x…</u> to select the right chip type.

Unfortunately I already had some trouble with cheap AD9851 boards. It seems there are counterfeit chips around that do not produce the right frequency. An internal clock multiplier is not working properly. It uses 4x30Mhz in stead of 6x30Mhz. I you have such a chip, you can change your code to divide by 120000000 instead of 180000000. This will give you proper frequency output up to 35Mhz. Unfortunately at 6m the signal is not strong enough.

73’

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