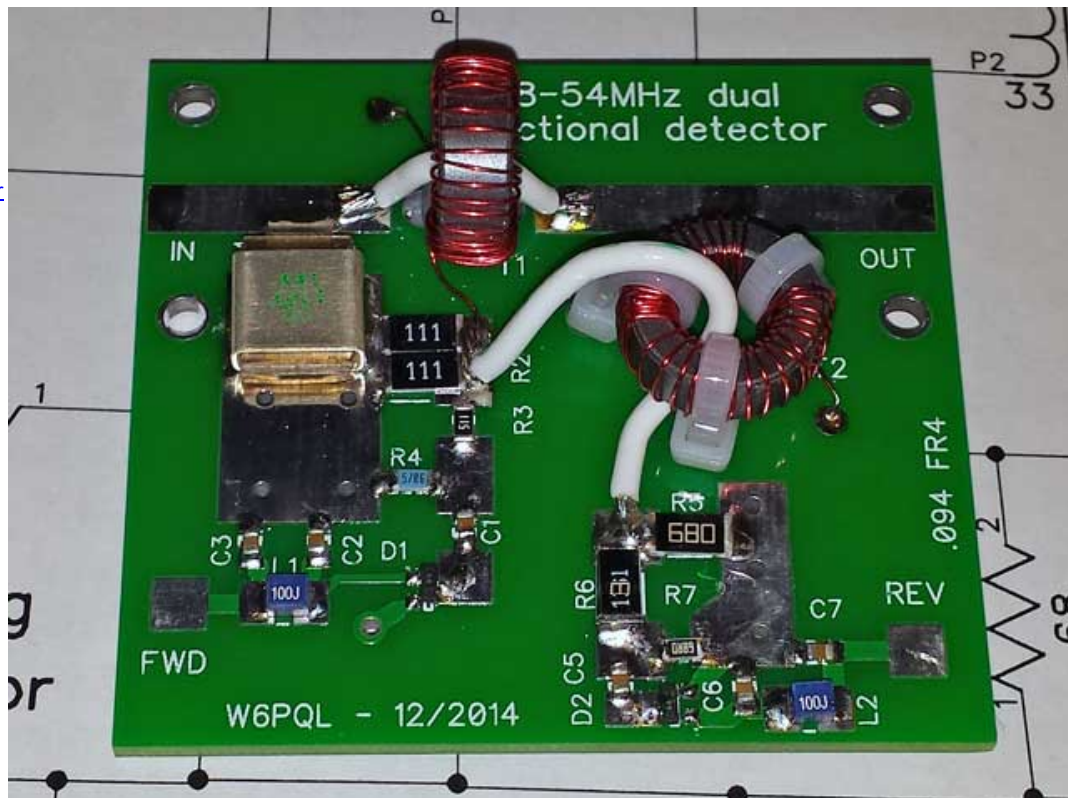


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A 1.8 to 54MHz Dual Directional Detector

an experimenter's
kit is available
for this project



This can be very useful as the core of a power meter, or as a component in an amplifier system.

It provides the ability to measure forward and reflected power levels; this is especially important in detecting high reflected power conditions, such as a damaged antenna, or when we forget to connect the coax to the output of an amplifier (I've done that more than once). It can provide the danger signal to the system's [control board](#), so it can shut things down if necessary.

The board can also be used to measure high power levels precisely if used with the help of one of the many precision power meters, which typically read only up to 100 milliwatts or so; by excluding the diodes and taking the power directly from the outputs of the attenuators (which can be set to any value), precision measurements can be made over the entire bandwidth.

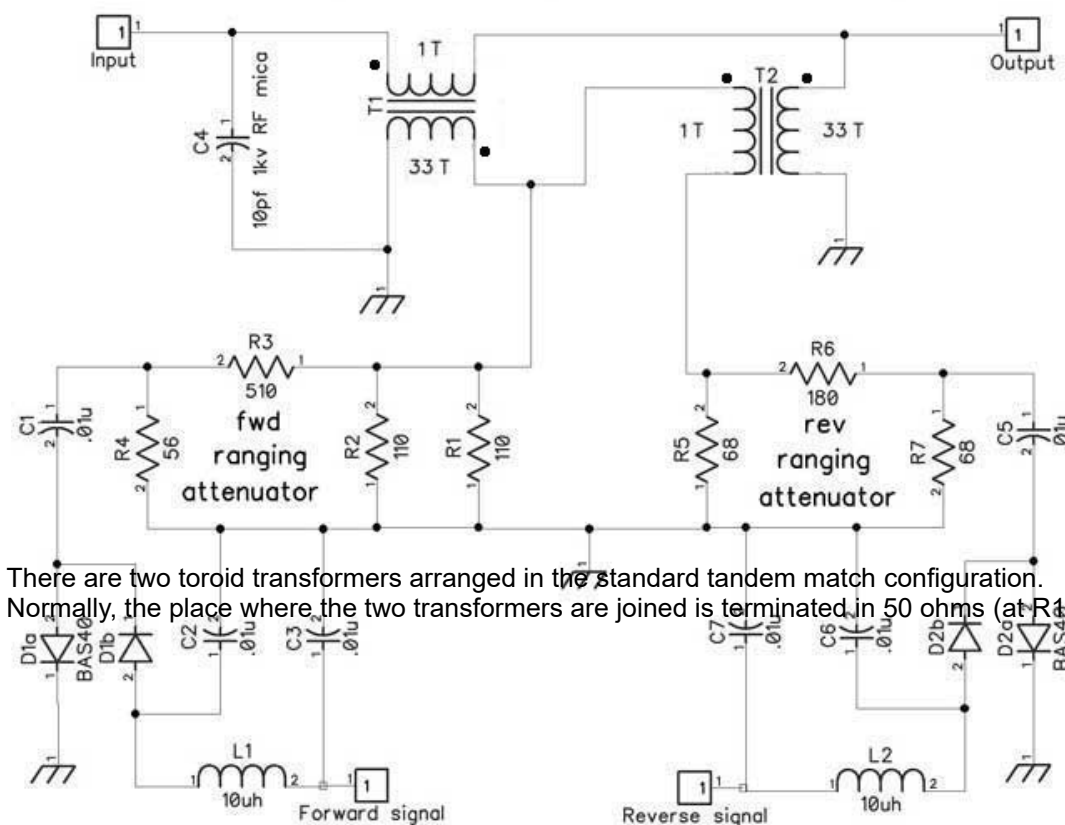
The small board shown here can be set up for as little as 100w full scale, or as much as we can legally run. This particular one is set up for 1kw, but can be set at any of the aforementioned power levels with changes to 2 or 3 resistors. Board material is 2oz .094 FR4 (thicker than standard .062 so it can be used for higher power).

A variant of the well-published "Tandem Match", it can measure forward and reflected power at the same time, without having to throw a switch to do it. Here's how it works:

Comments? email to

JIM@W6PQL.COM

1.8 to 54 MHz dual directional detector
 Nominal transformer coupling factor is 30db
 Default attenuation values are:
 fwd - 27db for 1kw full scale
 rev - 17db for 100w full scale
 Full scale signal output is 750mv
 with outputs loaded by 5k (for best linearity)

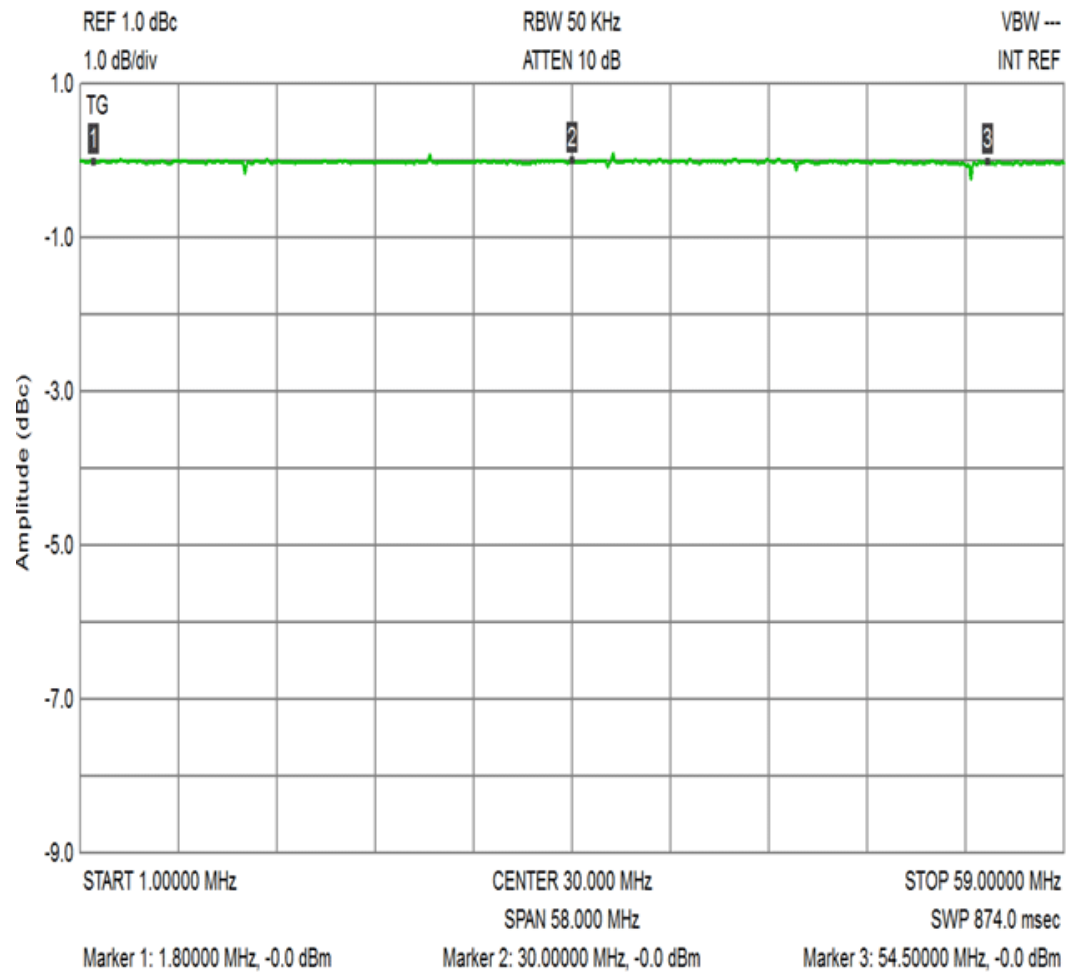


There are two toroid transformers arranged in the standard tandem match configuration. Normally, the place where the two transformers are joined is terminated in 50 ohms (at R2, R3). The sample port (R5, R6, R7) is where the signal is taken.

All fine for measuring in one direction only; to measure power in the other direction, the transformer interconnections need to be switched, or the input and output ports reversed.

I thought there must be an easier way to measure both at once, and there was. The power levels at R1, R2, R3 are constant, no matter what the swr is. Since we need to reduce the power sampled here by 27db for our detector diodes anyway, I replaced the normal 50z termination with a 27db attenuator (R1-R4), which also serves as a very good 50z termination. The output of this attenuator feeds the diodes, which sample the forward power level.

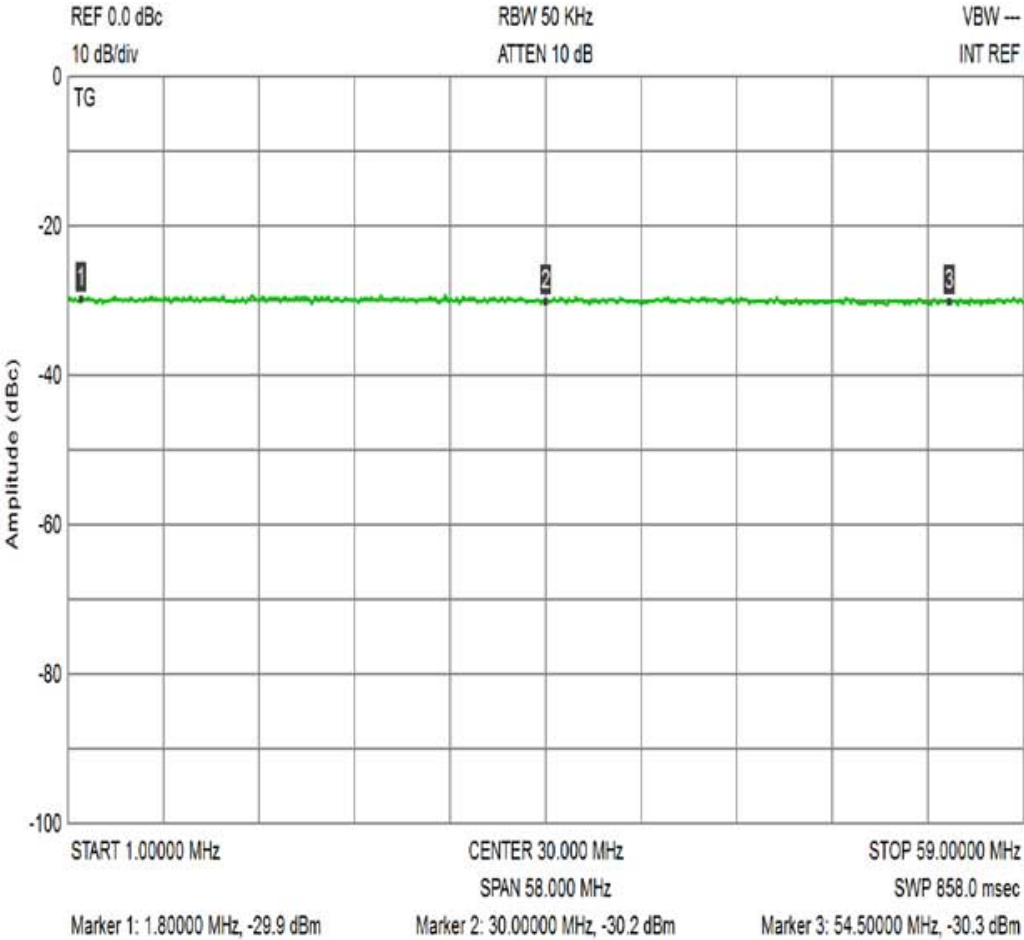
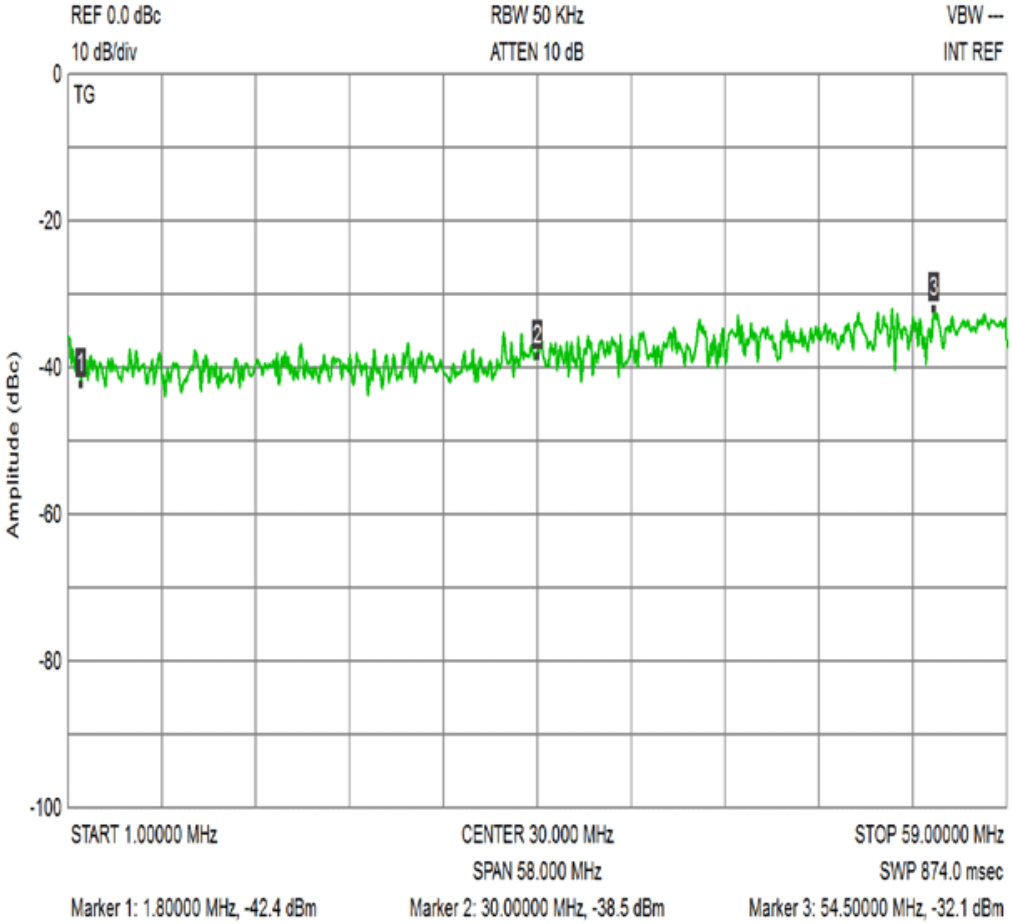
The reverse power port should be sampled 10db higher than the forward to provide a full scale equivalent of 2 to 1 swr, which is the max swr your sspa system should have to tolerate. You can set it up for anything you want, but that's the recommendation. This way, when used with your system's control circuits, 100w reflected power will trigger the safety switch. The power level at this connection point DOES vary with swr.



Since one would normally place this component between the output of the amplifier deck and the t/r switch, we'd like it to lose zero power performing its work; it comes about as close as you can get. The insertion loss was so little, I had trouble measuring any at all.

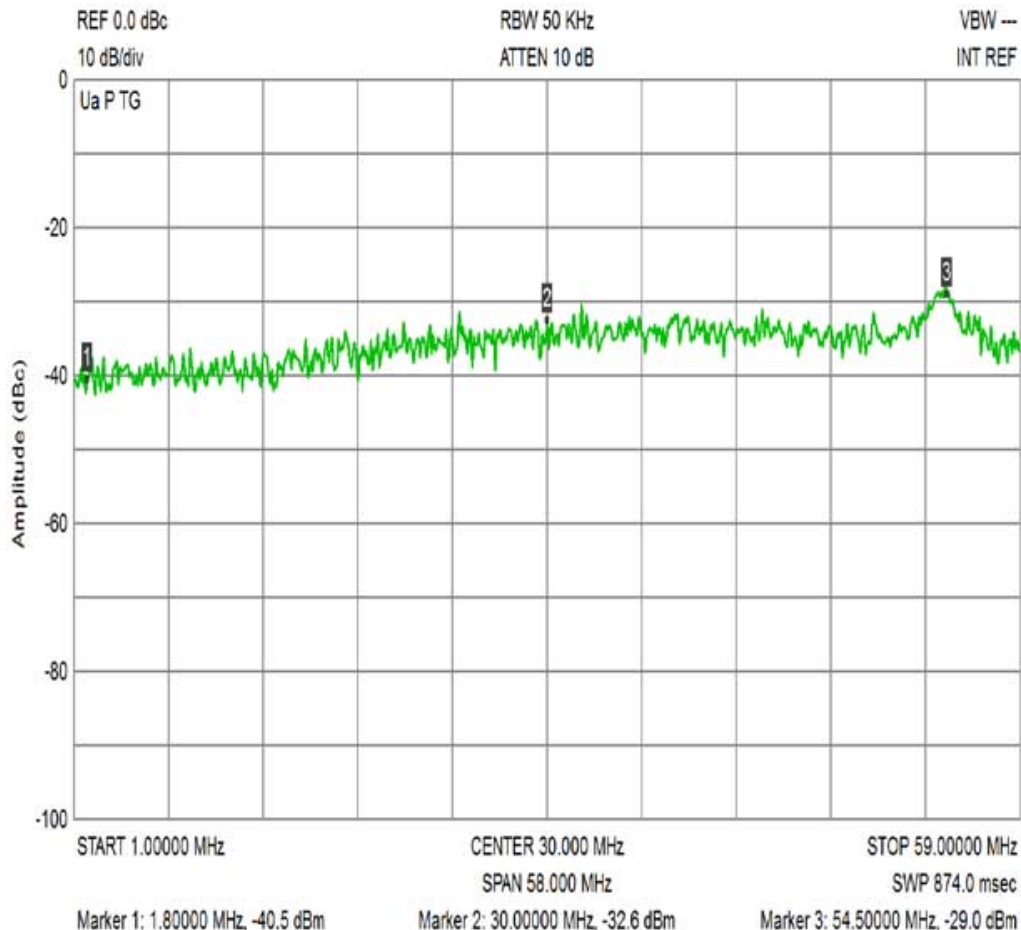
Return loss, or the residual VSWR it creates when inserted into the transmit path, should be minimal; in this case, it is also insignificant; return loss exceeds 30db, equivalent to a VSWR of less than 1.05 to 1.

Return loss rises above 6m, but is still in the useful range up to about 150MHz, where it rises to about 20db (1.25 to 1 swr).



This is the wideband coupling sweep of the on-board dual directional coupler; the coupling is almost exactly -30db from 160 through 6m, meaning if this were used to measure a 1kw transmitter, there would be 1w sampled.

1w is a bit too much for our detector diodes to handle (2 milliwatts is more like it), so that's why the attenuators are on the board.



And finally, the coupler itself must have good directivity (the ability to distinguish between forward and reflected power). This one exceeds 30db across it's entire range, more than enough for reliable measurements.

With careful positioning of those white coupling links passing through the transformer cores, I was even able to get useful directivity as high as 75MHz.

A bill of materials and a table describing how to set the board up for different power levels is listed below (the BOM lists only the 1kw/100w setup resistor values). If you are building this project from a kit I supplied, and:

- ◆ Your kit was shipped prior to December 29th (2016), [the assembly instructions are here](#).
- ◆ For kits shipped through June 12th (2018), [your assembly instructions are here](#).
- ◆ For kits shipped after June 12th (2018), [your assembly instructions are here](#).

Full scale power levels are not limited by the coupler itself, but by the attenuation required for best diode linearity. For example, the default 1kw/100w full scale attenuation setup will work fine at 1.5kw, there will just be a bit of compression from the output of the diodes as the only consequence.

That said, there is an easier way to configure the board for higher power levels...easier than changing the attenuator resistors. **The values chosen for the attenuators assume the diodes will be looking into a 3 to 5k ohm load**, a value determined experimentally to

produce good linearity. If you have the board attenuators set up for 1kw, you can achieve a 2kw range by just changing the load resistance to 650 ohms. This value was also determined experimentally, and turns out to be the correct load resistance for good linearity at a 2kw full scale power level.

Bill of Materials (BOM) for the standard 1kw/100w setup:

56	1206 Resistor	1
68	2512 Resistor	1
68	1206 Resistor	1
110	2512 Resistor	2
180	2512 Resistor	1
510	1206 Resistor	1
.01u	0805 Capacitor	6
10pf	1KV RF mica	1
10uh	1210 Inductor	2
5 inches	#16 Teflon wire	1
25 inches	#28 wire (T1)	1
26.5 inches	#28 wire (T2)	1
BAS40	Dual Diode	2
fastener	coax fastener	2
T1 core	28b0570-000	1
T2 core	5943004901	1
PC Board	PC Board	1
Tie Wrap	Tie Wrap	10

Full scale power setup table:

Full Scale power	2000w	1500w	1000w	500w	100w
Fwd Attenuation for full scale (DB)	30	29	27	24	17
Rev (2 to 1 SWR) Attenuation for full scale (DB)	20	19	17	14	7
R1	110	110	110	110	68
R2	110	110	110	110	
R3	750	700	510	400	180
R4	56	56	56	56	68
R5	68	68	68	75	130
R6	250	220	180	120	47
R7	62	62	68	75	130

Listed below are the part numbers for the resistors not supplied in the standard kit; these can be purchased from any of the major parts distributors.

750 ohms, 1206 size - CRCW1206750RJNEA

700 ohms, 1206 size - RK73H2BTDD6980F

400 ohms, 1206 size - CRCW1206412RFKEA

250 ohms, 2512 size - CRCW2512249RFKEG

220 ohms, 2512 size - CRCW2512220RJNEG

130 ohms, 2512 size - CRCW2512130RJNEG

130 ohms, 1206 size - RK73H2BTDD1300F

120 ohms, 2512 size - CRCW2512120RJNEG

75 ohms, 2512 size - CRCW251275R0JNEG

75 ohms, 1206 size - CRCW120675R0JNEA

47 ohms, 2512 size - CRCW251247R0JNEG