

Simple RF Power Monitor

Paul Wade W1GHZ ©2020 updated Dec 2020
w1ghz@arrl.net

For a recent transverter project, I wanted to monitor output power and display it on an LED bargraph¹, but I didn't want the size and complexity of a directional coupler. The power detector is an AD8307, a logarithmic power detector with output linear in dB, about 25 mv/dB. I remembered seeing something on the AD8307 data sheet (www.analog.com) – measuring power using a resistive tap, in Figure 41. The RF detector chip is connected by a 100K resistor, which forms a resistive divider with the 50 ohm input resistor at the detector, so that the RF voltage reaching the detector is roughly 60 dB down. The 100K resistor adds minimal loading to the 50 ohm circuit, and the stray capacitance is negligible at VHF. A quick test with a 47K resistor gave about 50 dB attenuation, so I used 10K, shown in the closeup photo, for this 30 watt module. Figure 2 shows the 10K resistor right at the output SMA connector with a short coax connection to an AD8307 detector board from China; they sell the whole board for less than the price of the IC alone. I set up the LED bargraph for about 2 dB per step, so the power range displayed is about 20 dB, roughly 0.4 watts to 40 watts.

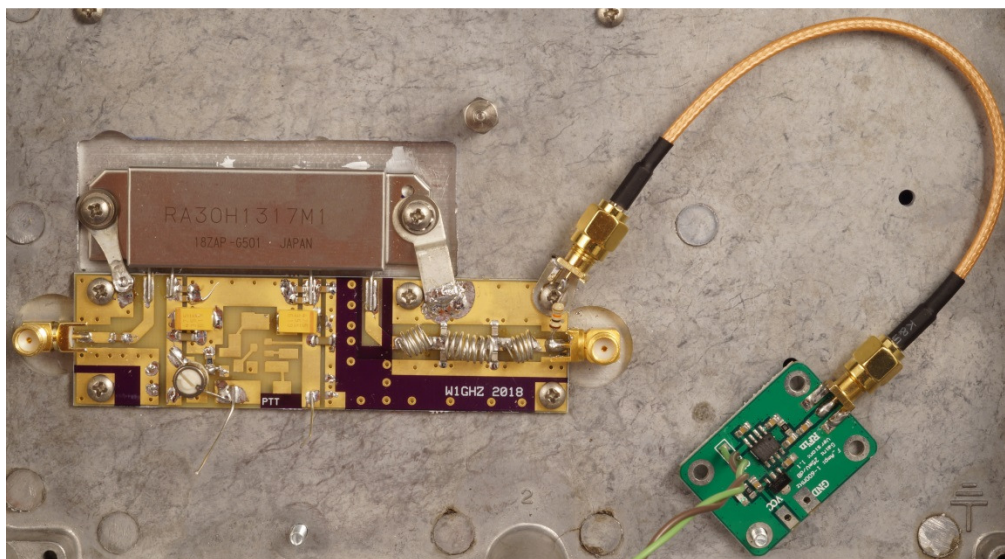


Figure 2 – Simple RF power detector with resistive divider

Resistive Coupling

The coupling is easily calculated, since this is simply a resistive voltage divider with 50 ohms at the bottom. The coupling is:

$$\text{Coupling} = 20\log\left(\frac{50}{R}\right) \text{ dB}$$

About 46 dB for a 10K resistor, and about 66 dB for 100K.

After putting the transverter together, I was curious how well the resistive coupling actually worked. I cut a section of 50-ohm line from a spare PC board, put SMA connectors on each end plus one for the coupling tap resistor, a common ¼ watt resistor. Then I used my **miniVNA Tiny** to measure several values of coupling resistor, with results shown in Figure 3. The 47K and 100K resistors have large coupling values at low frequencies, but the coupling decreases with frequency. The 10K resistor has fairly flat coupling up to 200 MHz, around 43dB, which provides a couple of milliwatts output for 40 watts on the transmission line. Above 200 MHz, all the resistors have about the same coupling, decreasing with frequency – this suggests that stray capacitance through the resistor is dominating. A quick calculation suggests that the capacitance is just under 0.1 pf. Loss due to the resistive tap was too small to measure.

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Resistive Power Monitor

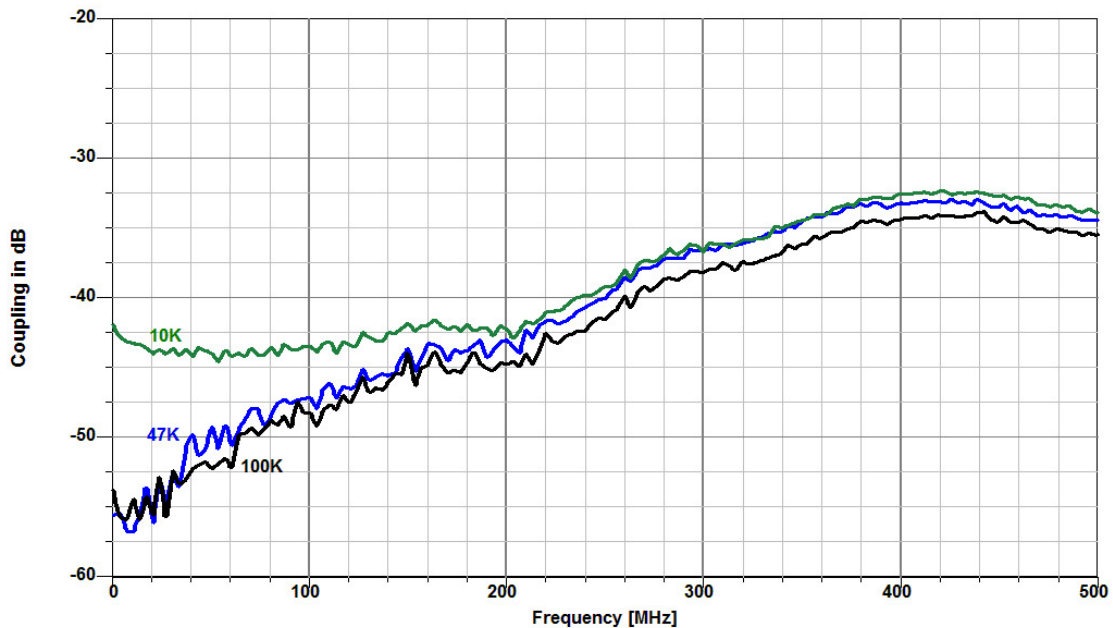


Figure 3 – Simple Resistive Power Monitor vs Frequency

Frequency Compensation

Somewhat later, it occurred to me that oscilloscope probes also use a resistive divider. They use capacitive compensation to achieve flat frequency response to deliver accurate waveforms. The same technique should work here:

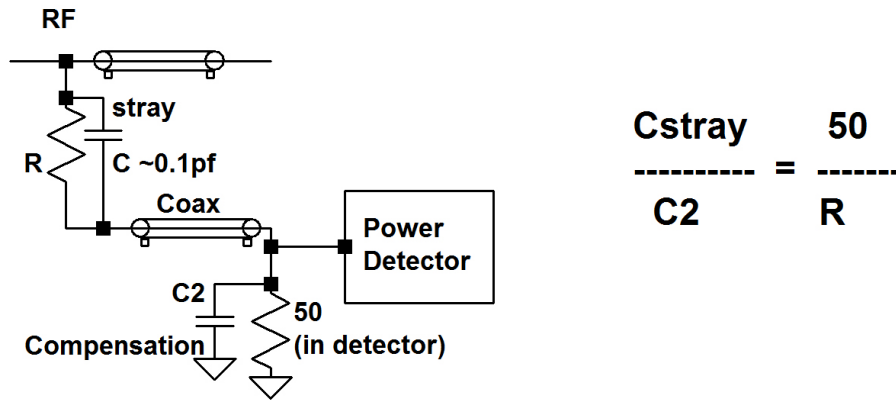


Figure 4 – Frequency compensation with a capacitor

For $R = 10\text{K}$ and C_{stray} estimated at 0.1 pf , C_2 should be about 20 pf . I use a lot of 18 pf chip capacitors in my microwave transverters, so I tacked one in and measured again, with the result in Figure 5 – the coupling is $44\text{ dB} \pm 2\text{ dB}$ through 432 MHz one the first try. Above 500 MHz , compensation still appears to help but is not as flat.

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Resistive Power Monitor
 Black = 10K Resistor
 Blue = 10K Resistor, 18 pf Compensation Capacitor

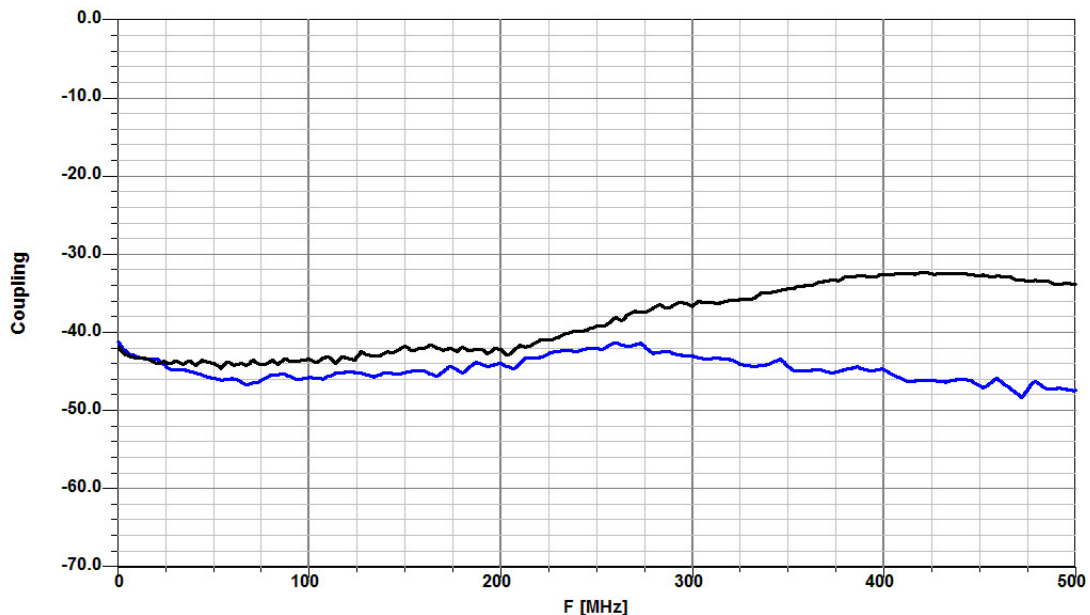


Figure 5 – Frequency response with capacitive frequency compensation

Summary

The power detector chips actually measure RMS voltage. They are more accurate and predictable than diode detectors, which detect peak voltage. Either will give erroneous indications when high VSWR is present. If you choose to use a resistive coupling tap for a power monitor, be aware that unusual readings are indications of a possible problem.

The resistive coupling tap is a simple, cheap way to monitor power at UHF and below.

References

1. www.w1ghz.org/PCBproj/bargraph.pdf
2. <https://www.electronics-notes.com/articles/test-methods/oscilloscope/scope-probe-compensation.php>