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-20 dB Tap Attenuator

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Another device I've been meaning to build for a long time. The QRSS work has caused more interest in attenuators and transmission line monitoring, my current bodgy attenuator was tested with my most recent instrumentation and found quite lacking - more work on that instrument soon... Pi or Tee pads have precision issues, especially if you only stock E12 resistor values, so this tap is based on a transformer, the familiar 10:1 turns ratio -20 dB tap. It can offer quite good accuracy if carefully constructed and terminated correctly on all ports.

I tried various core materials and sizes. The FT50-61 was looking quite promising, especially at higher HF where its insertion loss is lower than type 43 material, but its performance didn't extend as well into lower frequencies so I settled on using an FT50-43 core. Physical construction in a diecast box limits the high-frequency response, and the inductance limits the low-frequency response. 10 turns on an FT50-43 is about 66 uH, using a 3 times the load resistance (50 Ohms) reactance (j150 Ohms) gives a lowest usable frequency of about 360 kHz. Experimentally roll-off starts to become annoying at about 400 kHz. On the high end the response is more difficult to predict and measure with my available equipment, I've only confirmed its response flat to 20 MHz, but a spot-test at 144 MHz using a 1 W HT as a signal source gave -20 dB to within my measurement accuracy at the tap port. Performance which I found quite surprising. I'm calling it 500 kHz to 20 MHz and have labelled it as

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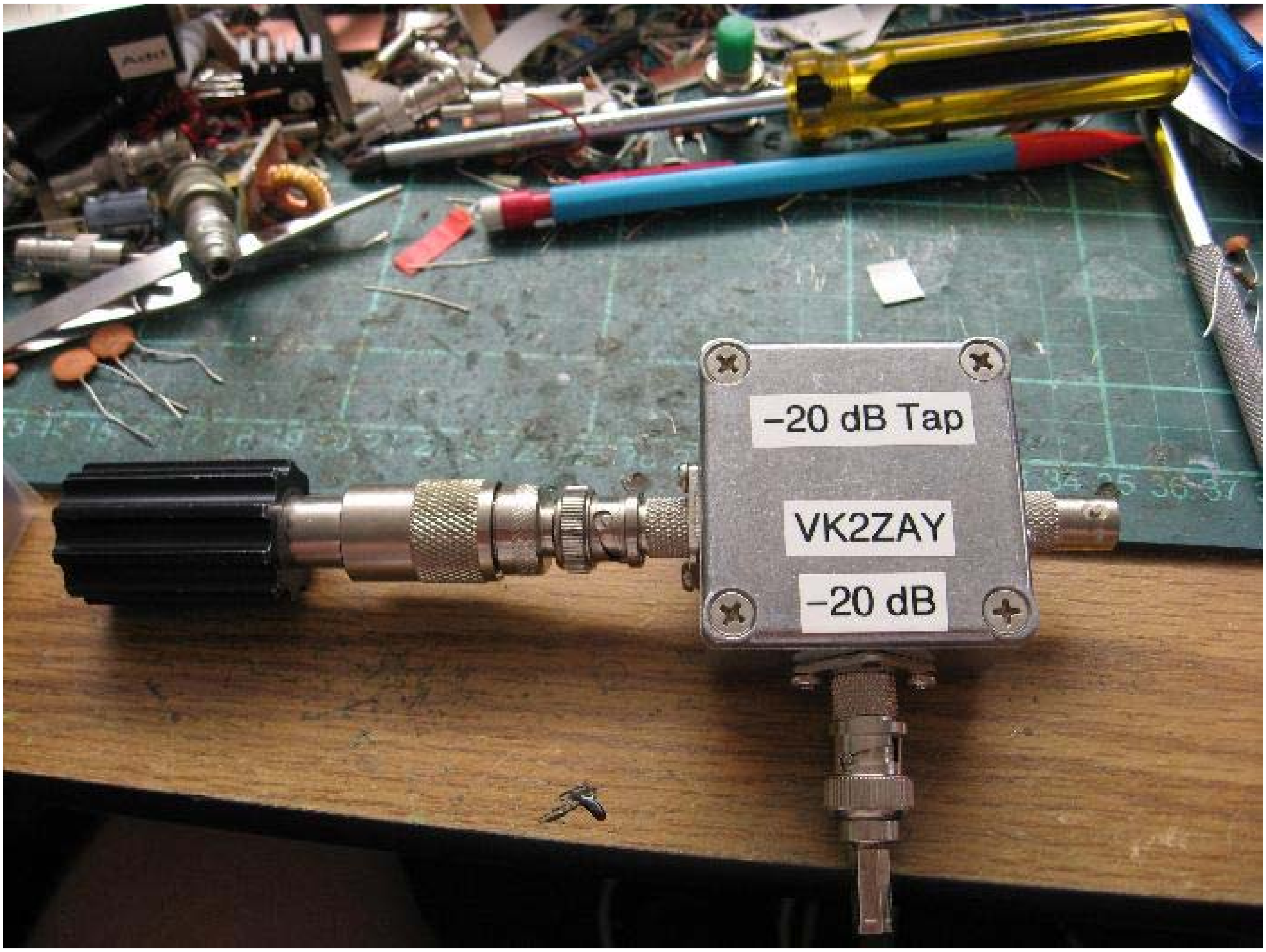

Precision wise my fairly limited measurement accuracy says better than +/- 0.3 dB 500 kHz to 20 MHz as long as both output ports are terminated properly. I can't stress that enough, if the "thru" or "tap" ports aren't terminated in 50 Ohms (or whatever you're measuring in/from - the BNCs are 50 Ohms units) the attenuation will be wrong. To be completely correct, the 10:1 turns ratio transformer reflects a resistance 100 times smaller than the tap termination in line with the thru termination. So 0.5 Ohms from a 50 ohm tap termination is added to a 50 Ohm thru termination (or a 1 % error). This means the total load impedance is slightly wrong, and the return loss seen looking into the input is measured slightly worse than just into a dummy load, but the effect is quite small and much better than my best -20 dB Pi attenuator constructed using E12 5% value resistors.

Notes

Construction using a binocular core might be superior.

You may be able to extend the HF performance by using a length of coax through the core, earthed at only one end to the box. This will minimise the impedance step created by transitioning from the coax/connectors into the lumen of the box where the wire to box geometry gives nothing like 50 Ohms of impedance. HF response will still be limited by mismatch effects (and eventually modeing inside the box), but type 43 ferrite is only good to low UHF anyway.

I've ordered some PCB-mount BNCs that are constructed like your typical SMA connector with four solder pins around the centre one. Using these and FT23-43 cores it should be possible to construct a similar but lower power device usable to low UHF. There is no reason why you couldn't "ring-bark" some RG-58 or RG-174 coax and construct the transformer directly over the coax, then re-complete the braid circuit with metal shim-stock or tape over the transformer. I once constructed a VHF directional coupler by passing insulated wire under the braid of a piece of RG-213, it worked quite well.

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