Update – A Personal Beacon for 10 GHz

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The prototype of the 10 GHz personal beacon worked surprisingly well. I had forgotten some of the grounding plated-thru holes in the PC board, so I had to drill holes and add wires for grounding. The next batch of boards has the plated-thru holes for proper grounding. I also added a test point after the first tripler to aid in tuneup. Some of these boards have been successfully built by other hams, while others had some questions.

We also recently moved to a new QTH in Vermont, and it has taken over a year before I was settled enough to get back to this project. I recently built up one of the newer boards and took notes so I can answer the questions and provide some hints. I also found a better way to put the probes into pipe-cap filters – I've had a couple fall into the pipe caps during assembly, and it is really hard to get them out again.

The completed unit is shown in Figure 1. The middle connector is the test point for the first tripler – it is connected by soldering C4 to the side transmission line as Ctest for tuning the first pipe cap, then moving the capacitor to its normal position before finishing tuneup. Tuning was smooth, and I measured almost 10 dBm at 3456 MHz at the test point. Screw depth is nearly the full height of the pipe cap.

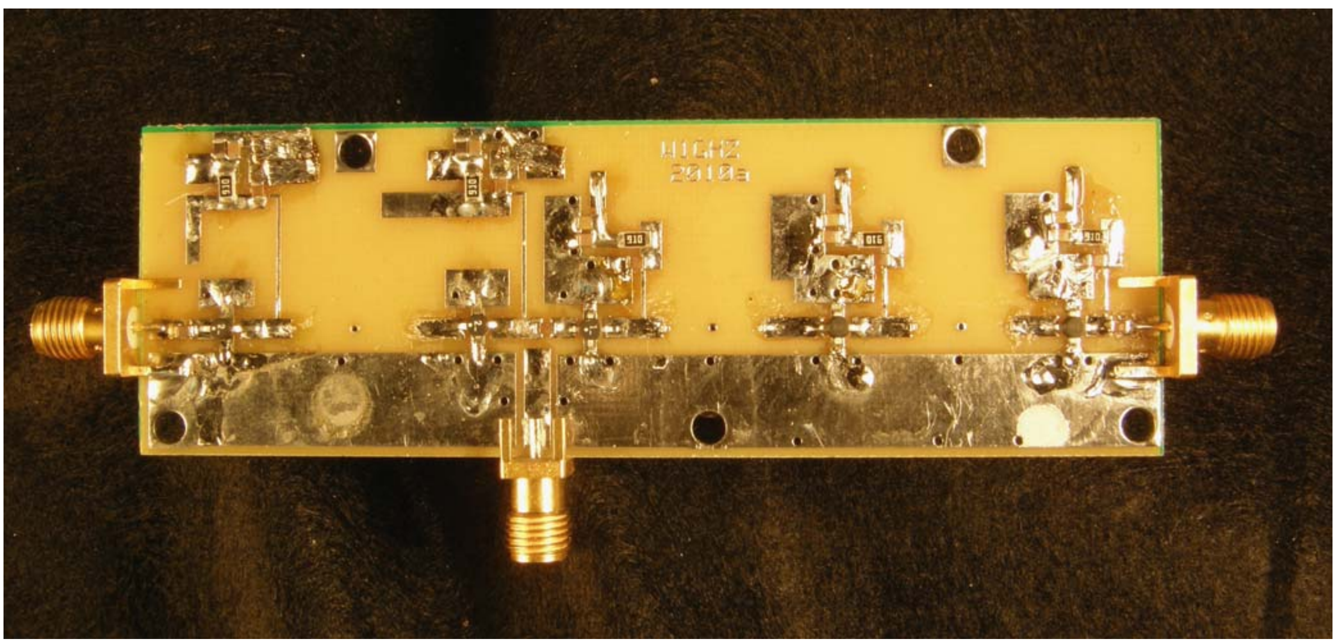

Figure 1 - 10 GHz Personal Beacon

After moving C4 to the normal position, I decided to be brave and tune both of the 10 GHz pipe-cap filters at once. If both screws are set to the same depth, they should be on the same frequency, so they should be adjusted together. Once there is a glimmer of output, the screws can be tuned for maximum output. Screw depth in the ½ inch pipe caps should be roughly 3/16 inches. Since the input to the second tripler is at 3456 MHz, harmonics are widely separated in frequency, and there should be only one response in this range – a spectrum analyzer is not necessary for tuneup Output at 10.368 GHz is about 11 dBm.

Since the harmonics are widely separated, the filters don't have to be really sharp. The probes can be a little longer, so the tuning isn't as sharp and the filters are less lossy. Probe lengths inside the pipe caps that I used are about 0.400 inches (10 mm) for the ¾ inch pipe cap and 0.175 inches (4.5 mm) for the ½ inch pipe caps. Don't forgot to allow for the board thickness, 0.062 inches (1.5 mm). With these probe lengths, the 3 dB bandwidth of the beacon is about 50 MHz.

I found that using disc capacitor leads for the probes makes it easier to control the depth, as shown in Figure 2. The leads fit the holes well, and the capacitor provides enough tension to keep them from slipping while soldering. Just measure the height to the bottom of the disc with the leads resting on the board, then insert the leads the desired distance plus the board thickness, 0.062 inches (1.5 mm). C4 is in the test position in this photo, ready for tuneup as soon as the capacitor leads are soldered and cut off. And the disc capacitor is still usable – a VHFer would never use more than ¼ inch lead length.

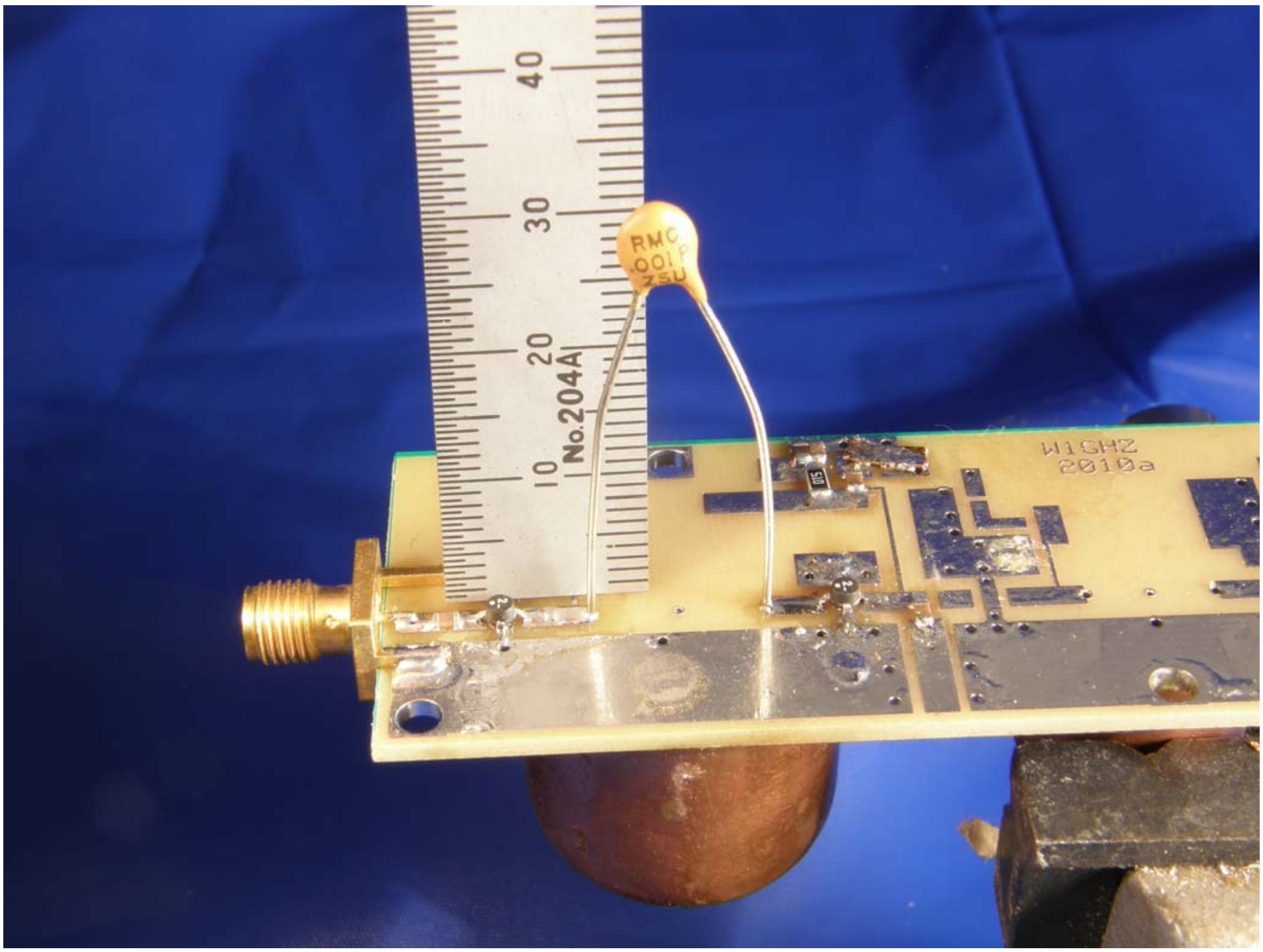

Figure 2 - Inserting probes into pipe-cap filters

A few notes on the board assembly. I left space for two bias resistors on each stage, to allow fine-tuning the bias currents. On the prototype, this seemed to help the multipliers. However, this unit seemed to work fine with 8 volts and 91 ohms for all stages, so I didn't fiddle. Instead, I grounded the extra pads on the first two stages with some solder-wick braid and just added jumper wires to the last three stages. Figure 3 shows the locations for these changes. The grounding braid on the first two stages can be seen in Figure 4, and the jumper wires are barely visible in Figure 1.

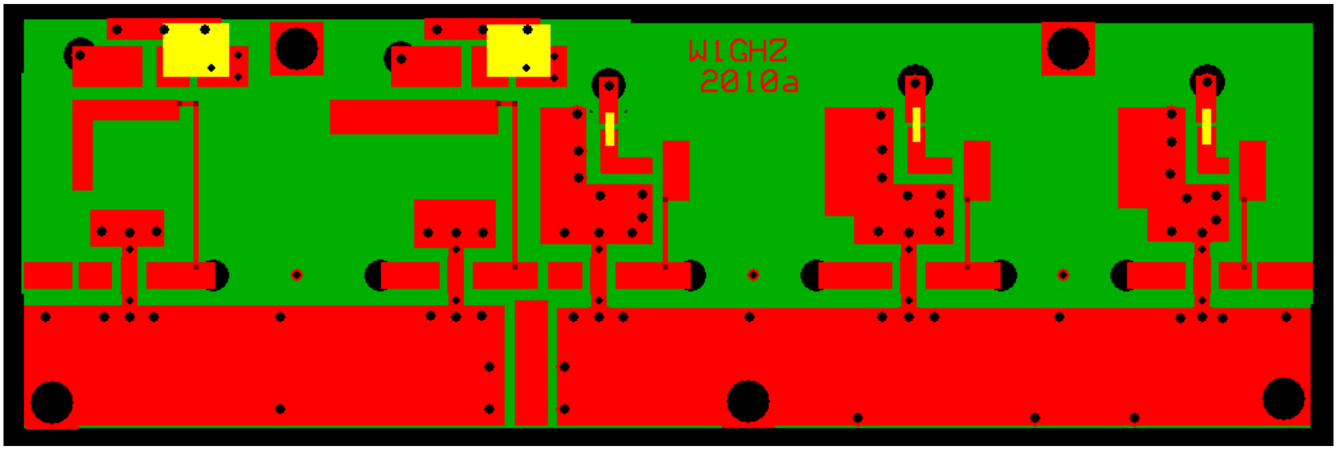

Figure 3 - Shorting locations in yellow

Update November 2012 – boards marked 2010b have the large pads changed like Figure 3.

I also experimented with keying. Removing the voltage from only the final stage reduced output by about 47 dB, while removing voltage only the next to last stage reduced output by 32 dB. Removing voltage from the last two stages reduced the output into the noise. Keying the last two stages produced no spurious outputs.

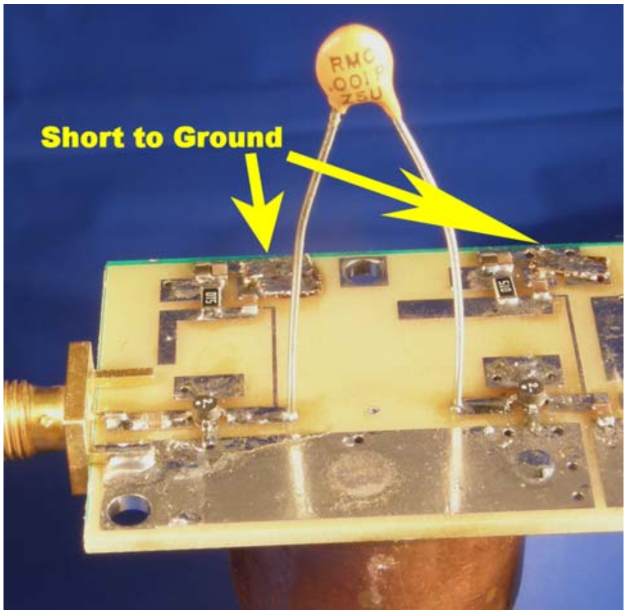

Figure 4 - Grounding braid for first two stages

The output spectrum is pretty clean – the only noticeable output is at 3456 MHz, about 35 db down. A short length of X-band waveguide will eliminate it.

In summary, reproducing the prototype result was straightforward and tuneup was smooth.