A Personal Beacon for 10 GHz

(Which can't possibly work)

Paul Wade W1GHZ ©2010
w1ghz@arrl.net

A beacon signal is extremely useful for microwave operation. It can provide you with at least three important things:

1. Assurance that your receiver is working
2. A frequency reference
3. A heading for aligning your antenna

Even if the beacon frequency is not accurately known, any two stations that hear the beacon can use it to meet on a common frequency, for example, 50 KHz below the beacon.

If there is no beacon within normal range on a particular band, we may have to resort to a local weak signal source. Hearing this source can at least provide the first two items on our list. The source can come from a frequency reference, for instance a GPS-locked oscillator, to provide an accurate microwave frequency. The N5AC A32 Synthesizer available from Down East Microwave is an easy way to do this, providing a number of selectable output frequencies for various microwave bands. A popular choice is 1152 MHz – calling frequencies on almost all the microwave bands are multiples of this frequency.

The A32 source alone has enough harmonic output to be heard at close range up to at least 10368 MHz, so it can be used as a weak signal source. But what about a beacon?

The LO chain in my 10 GHz transverter gets from 1134 MHz to 10 GHz with a few MMICs and pipe-cap filters. Certainly this could be retuned to make a 10 GHz beacon, but I'd hate to cut up an expensive transverter Teflon PC board to do it. What about a cheap PC board from ExpressPCB? The ordinary fiberglass-epoxy boards in my multiband transverter don't seem to know that they can't work work at 3456 MHz, so I decided to try one for 10 GHz. The experts say this can't possibly work, but we aren't going to tell the boards.

Our design philosophy is still: GAIN IS CHEAP. Keep line short and use enough MMICs to overcome losses, and there might be something left at the output. The thick board will definitely radiate, but so what? We can put it in a box, as long as it doesn't oscillate. I sketched out a rough schematic, prettied up in Figure 1, that I thought might work. It starts with a MMIC tripler and a ¾" pipe-cap filter tuned to 3456 MHz, then an amplifier before another tripler to 10368 MHz. Here it is cleaned up and amplified by two ½" pipe-cap filters and two MMIC amplifier stages. All the capacitors are ordinary chip caps – they are probably lossy, but gain is cheap.

I drew up the artwork using ExpressPCB software and made it part of a Miniboard, to take advantage of space left over from another project on the Miniboard. When cut the boards up and started to put one together, I found that I had left out some of the plated-thru holes that provide good grounding. I had to drill some holes and add ground wires, which never work as well for RF.

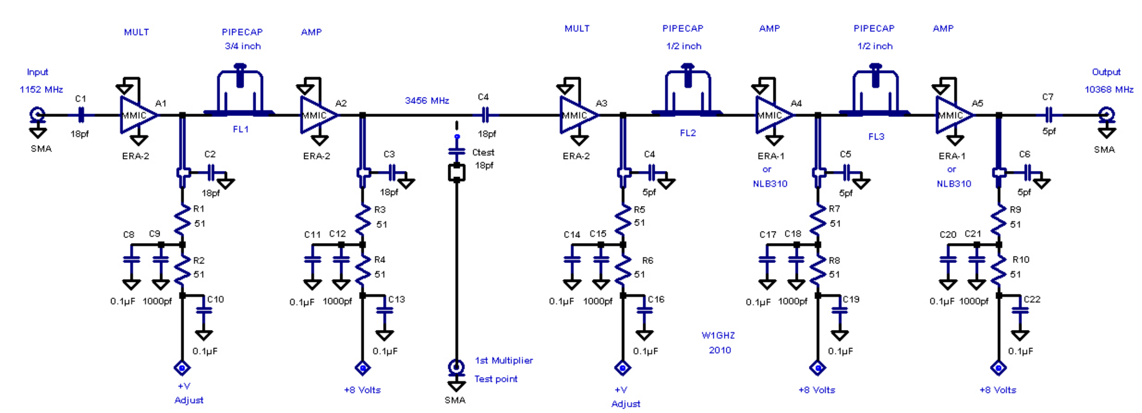

Figure 1 – Schematic Diagram of the 10 GHz multiplier

I assembled the first multiplier and amplifer stage, so that I could tune the first pipe cap. Then I found that I had also forgotten to put in the intermediate test point – that's what happens when you try to rush something. Tacking on a scrap of semi-rigid cable gave enough output to tune the pipe cap, but it wasn't as much as I'd hoped for. Still, why not finish assembly and see what happens.

I added the remaining stages and tuned it up – it actually had output at 10 GHz. After some fiddling, and adjusting the voltage on each multiplier for maximum output, it really had output – roughly +13 dBm. Since this was far more than expected, I added a waveguide filter at the output to make sure it was really at 10368 MHz. Without the filter, the output is clean enough for a temporary low-power beacon, but a filter is needed before adding an amplifier or putting one in a high place.

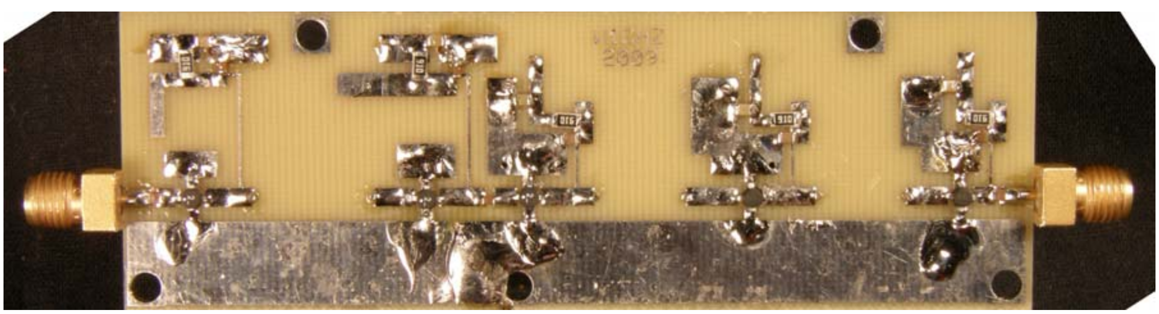

Figure 2 – Prototype of the 10 GHz multiplier board

My prototype unit is shown in Figure 2, and the pipe-cap side in Figure 3. I'll have to clean up the artwork and build a couple of clean units to determine final component values and performance. Since I did everything wrong in the prototype, a nice clean unit might work almost as well.

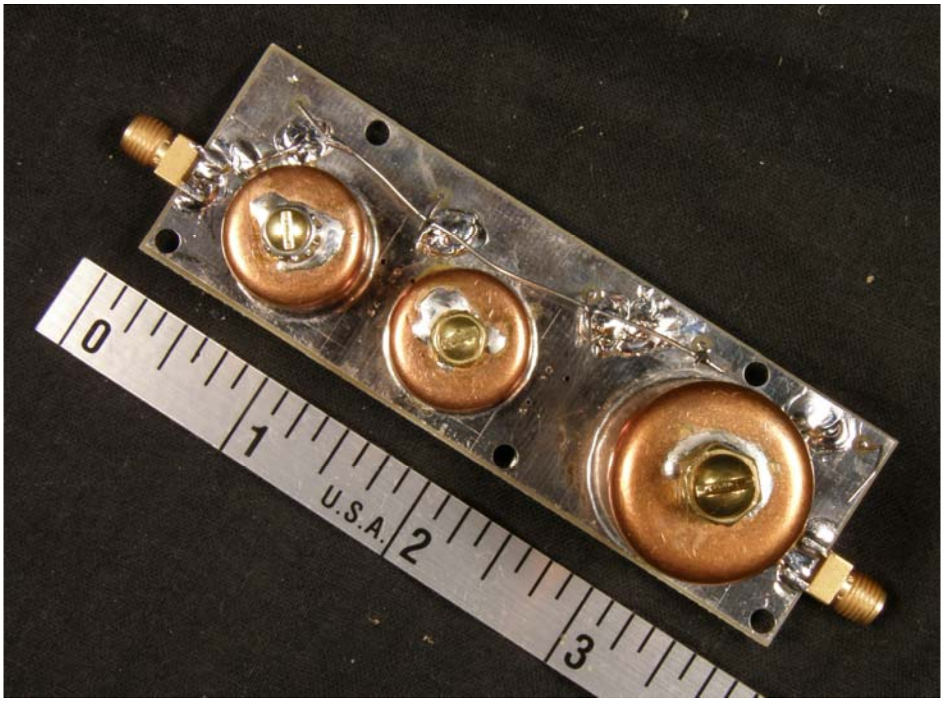

Figure 3 – Pipe-cap side of the 10 GHz multiplier

Phase noise from the A32 Synthesizer is definitely audible in the receiver, and shows up on the spectrum analyzer – Figure 4 is a poor photo of the spectrum.

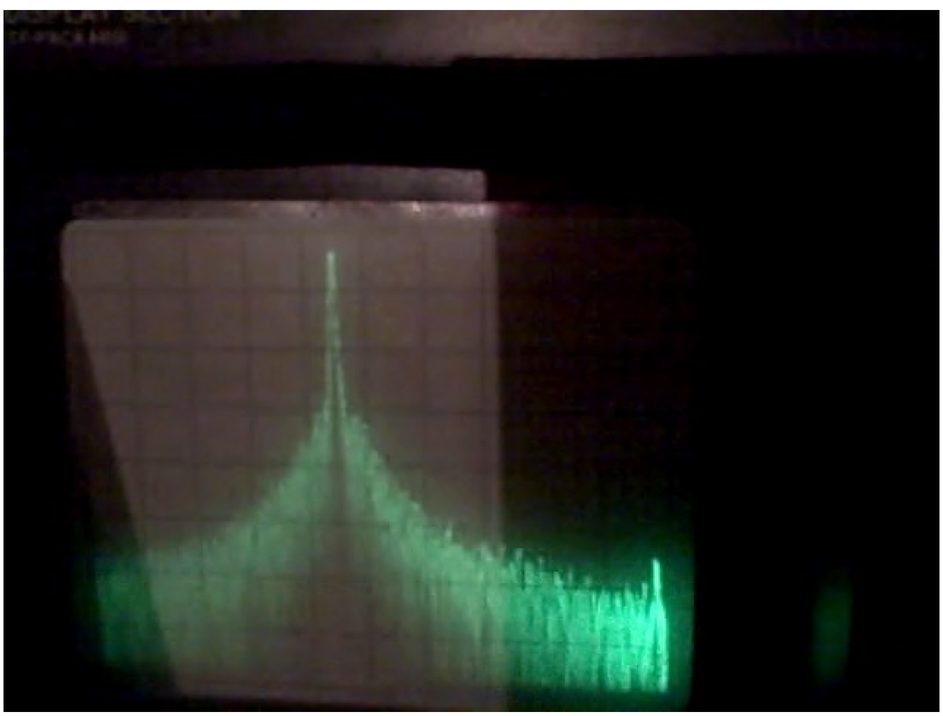
Figure 4 – Spectrum of the 10 GHz output (20 KHz/division)