A ¼ Watt No-tune Amplifier for Cheap and Simple Transverters

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I have described transverters for bands from 10 GHz down to 144 MHz (www.w1ghz.org), keeping them cheap and simple as well as easy to build. Most of them have an output power around 10 milliwatts, +10 dBm, or a few dB more with some of the newer MMICs. Higher power requires an external amplifier, but compatible ones are not readily available for some of the bands.

A few newer MMICs offer higher power: the GVA-92+ for ~1/4 watt, the ADL5324 for ~1/2 watt, and the GVA-91+ offers nearly 1 watt. These are all specified for the wireless networking bands around 900 MHz or 2.4 GHz, and require external tuning for the specific frequency range. They will work at other frequencies, but the data sheets give no hints for tuning at other frequencies. I once played with a GVA-91+ at 144 MHz and saw lots of power before I let the smoke out – that's a lot of power in a tiny SOT-89 package, and heatsinking is definitely required.

Recently I saw a new MMIC from Minicircuits, the PHA-102+, rated at +24 dBm in a 50-ohm system (no tuning) with gain up to 6 GHz. I soldered one to a Universal MMIC PC board and fired it up. At the usual 5 volts, it showed the specified gain of about 13 dB, but output power was only about +21 dBm, around 120 mW. The higher power is specified at 9 volts, so I started cranking up the voltage; at 9 volts, output power at 902 MHz was 25.2 dBm with +13 dBm drive, all I had from the signal generator. Things were pretty warm to the touch.

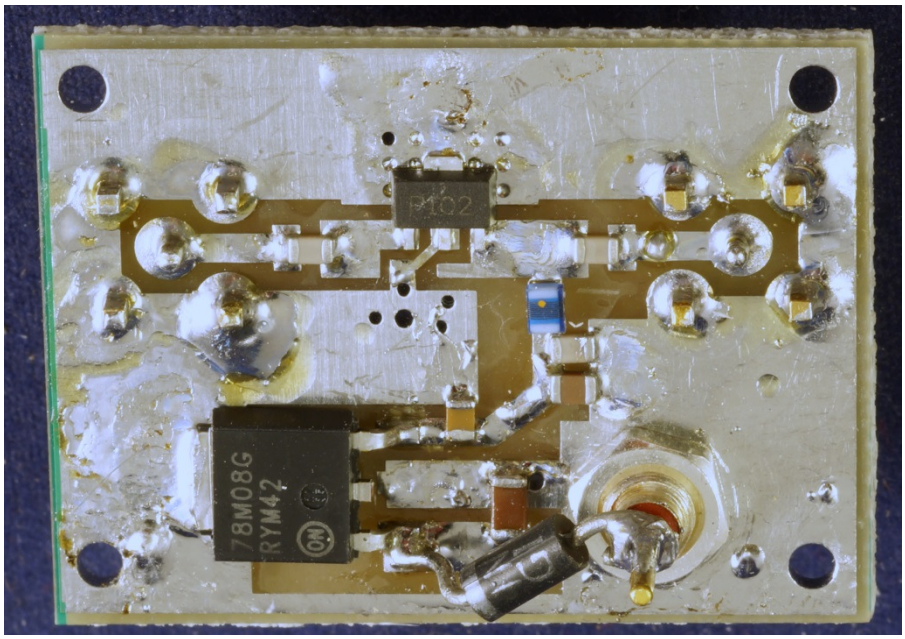

Figure 1 – Complete GVA-102 ¼ watt amplifier

The Universal MMIC PC board has a footprint for an SMT three-terminal regulator. I had some 8-volt 78M08 regulators on hand, but no 9-volt version. Since the output power at 8 volts was nearly as good, +24.9 dBm, with lower current, this seemed like a reasonable approach. Figure 1 is a photo of the finished amplifier prototype. I used 18 pf blocking capacitors and an 82 nh RF choke; the values are rather arbitrary and not optimized. They are rather small for VHF, which is why performance seen below drops off at lower frequencies. The other capacitors are bypassing for the MMIC and the voltage regulator.

With 12 volts into the voltage regulator, even more heat is dissipated. I ran it overnight at full power to make sure the amplifier is viable – the PC board temperature was about 50°C, while the temperature of the top of the MMIC and IC packages was lower, showing that the packages are heat sunk to the PC board. I think a little better heatsink is needed, perhaps one of the stick-on variety used for chips like the Raspberry Pi.

While it was still hot, I connected a VNA to measure gain and input VSWR, with the results shown in Figure 2. Gain is about 13 dB with good VSWR up to 3.4 GHz, then rolling off but with a convenient peak around 5.7 GHz. This covers all the transverters except 10 GHz.

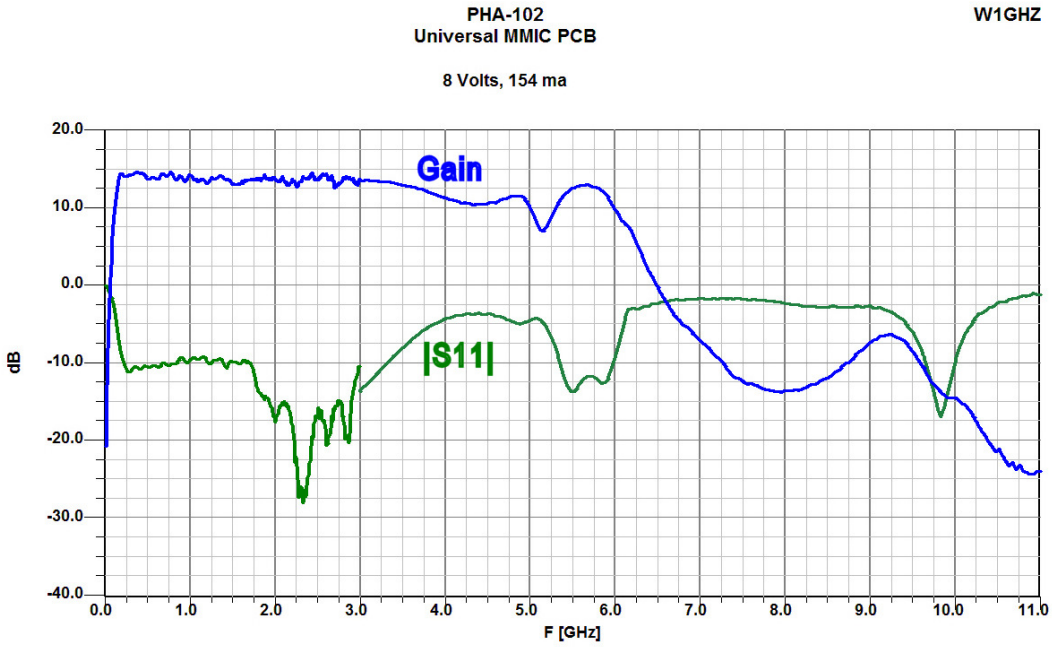

Figure 2 – PHA-102 amplifier small-signal performance

I measured output power at all the ham bands, although I didn't drive the amplifier to maximum; only +13 dBm was easily available up to 1 GHz, and +10 dBm above that, with only +7.4 dBm at 5760 MHz. Results are shown in Figure 3: even with the limited drive, +23 dBm is available up to 3400 and +17 dBm at 5760. With a bit more drive, the amplifier should easily provide ¼ watt or more up to 3400, which could provide a boost for a rover station without a lot of expense or power drain.

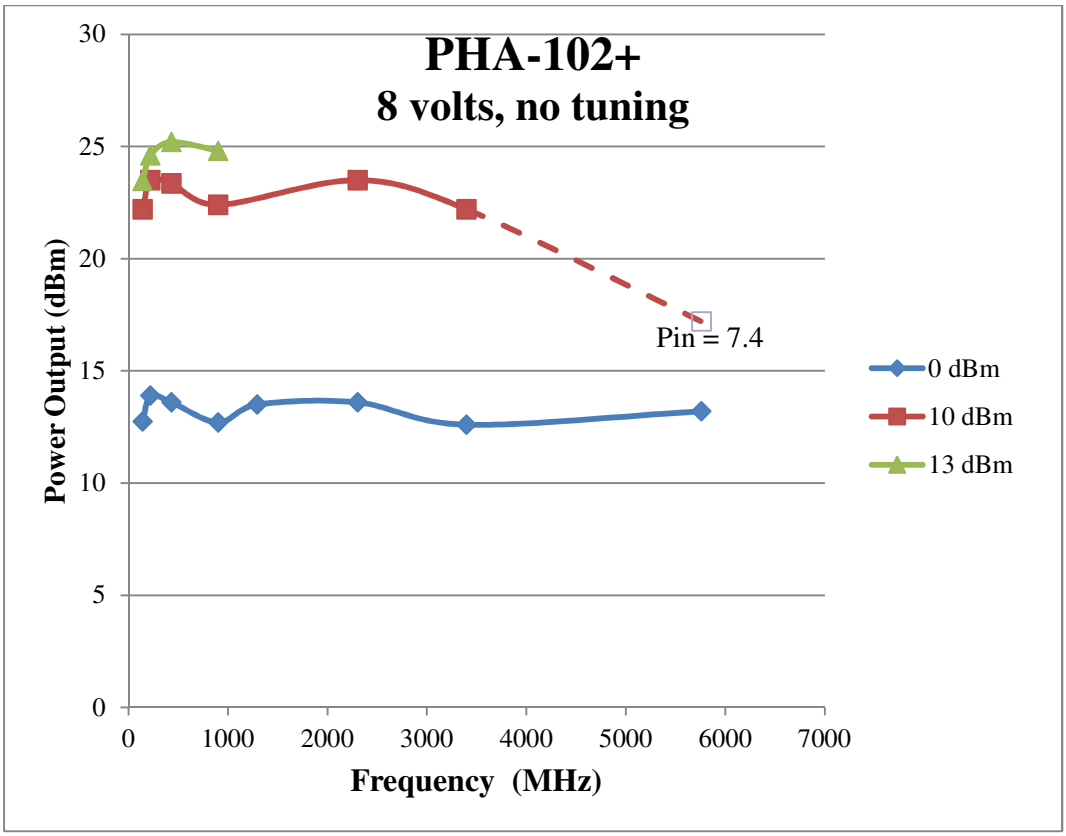

Figure 3 – PHA-102 amplifier power output

The amplifier looks to be pretty linear up to about ¼ watt out, as shown in Figure 4. An interesting thing about this MMIC is that the supply current is constant until the output power approaches the 1-dB compression point – then the current *decreases*. At this point the output harmonic levels increase dramatically. And the harmonic levels are fairly high even below this power level, as one might expect from such a broadband amplifier. With low-power transverters, we don't worry too much about harmonics and spurious responses, but ¼ watt is getting to the point where we might cause interference in some circumstances.

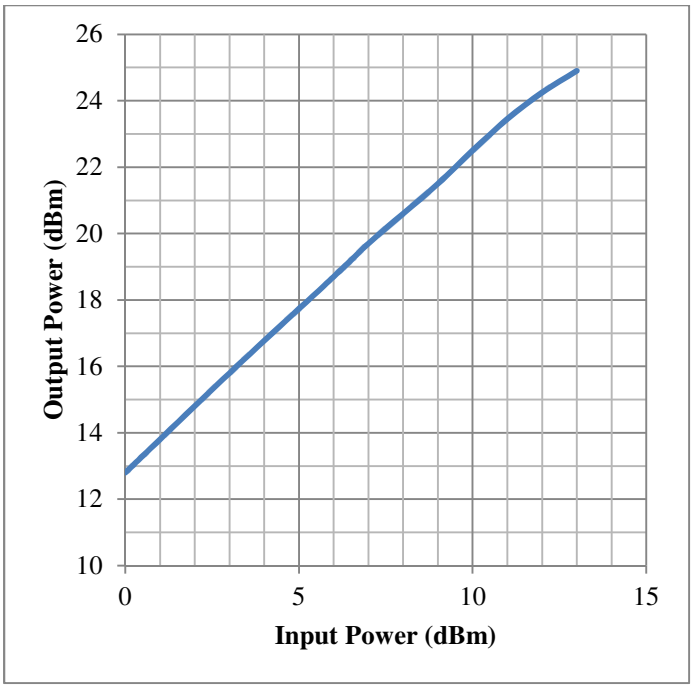

Figure 4 – PHA-102 Output power vs input power

The PC boards are available, and the PHA-102+ is available from Mouser, or Minicircuits is pretty good about providing free samples to hams. Assenbly is pretty straightforward, and no tuning is needed. This should be an easy way to enhance the cheap and simple transverters, or just a handy amplifier for the test bench.