MMIC Amplifiers for 5760 MHz and Down

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The Simple and Cheap Transverter for 5760 MHz has helped get more folks on 5760. Sometimes a system needs a bit more gain to work properly, either for the LO, RX, or TX.

.I described some MMIC amplifers for 10 GHz[1] in 2024. At 10 GHz, most MMICs are running out of gas, and component selection is important. Life at 5760 MHz and lower microwave bands is much easier -- available inexpensive MMICs have good gain, and ordinary chip capacitors and SMA connectors work reasonably well, so expensive parts aren't needed.

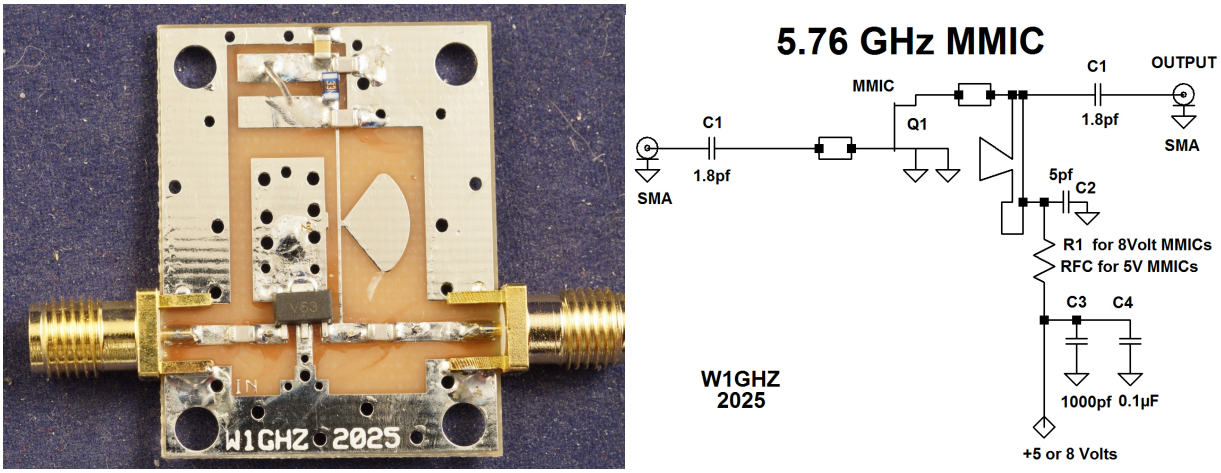

Figure 1 – MMIC Amplifier for 5760 MHz

My 5760 MMIC amplifier PC board in Figure 1 looks a lot like the 10 GHz version, only larger, since the quarter-wave stubs are nearly twice as long. Several of the promising MMICs were tested in this circuit with results shown below.

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1. https://www.w1ghz.org/Preamps/10_GHz_Preamp-Simple_and_Cheap.pdf

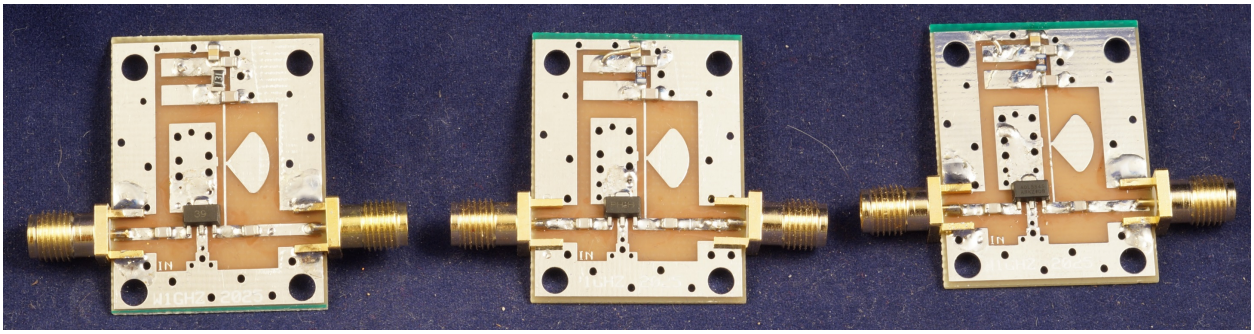

Figure 2 – MMIC Amplifiers for 5760 with GALI-39, PHA-1H, and ADL5545 MMICS

Gain of the MMIC amplifiers with the four different MMICs shown in Figures 1 and 2, the GVA-63, GALI-39, PHA-1H, and AD5545 are plotted in Figure 3 from 1 to 6 GHz.

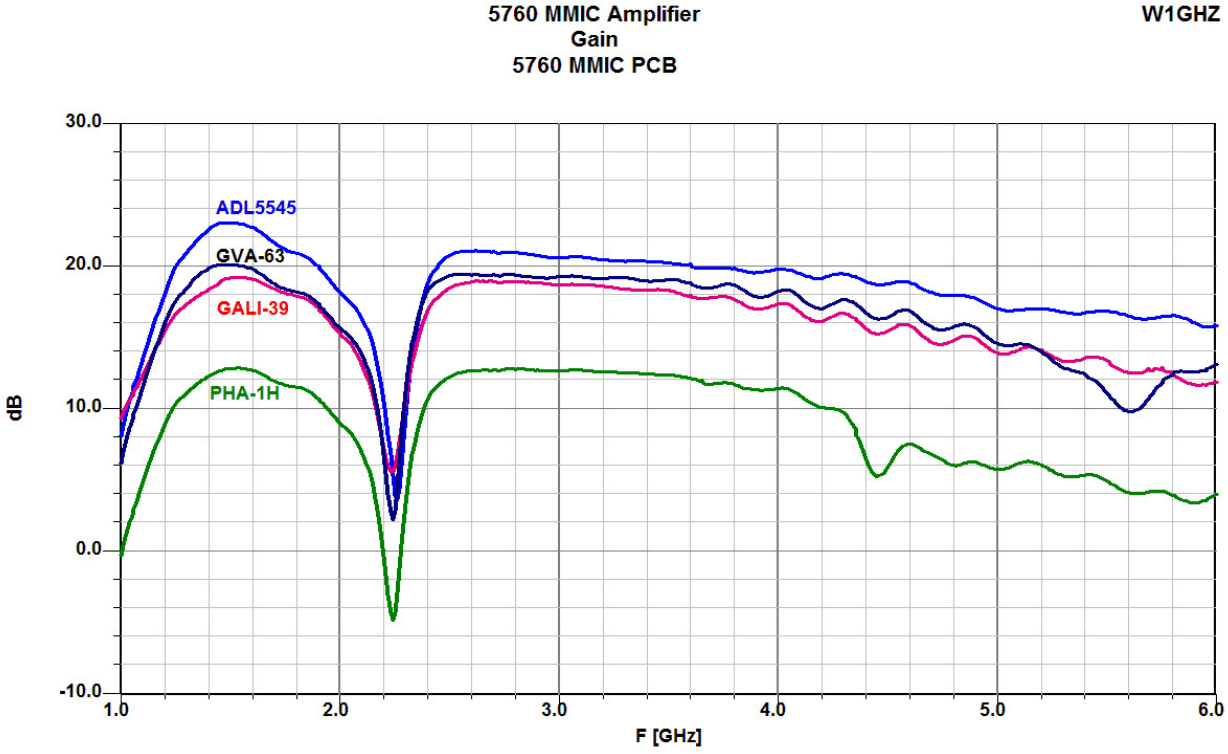

Figure 3 – MMIC 5760 MHz Amp Gain for ADL5545, GVA-63, GALI- 39, and PHA-1H

The 5760 MMIC amplifier shows good gain from 3 to 6 GHz with the GVA-63, GALI-39, and AD5545. The large dip around 2.2 GHz is due to the ¼ wave bias stub combination becoming a single ¼ wave stub at the lower frequency and acting as a short circuit rather than an open circuit. The PHA-1H gain falls off a bit above 4 GHz – my hope was that this MMIC would provide higher power output even with the lower gain. Another MMIC which provides good performance is the GVA-62, which has flat gain of about 16 dB at lower frequencies; an example is shown in Figure 5.

Wideband Microwave MMIC Amplifiers

Printed circuit boards are often ordered with several designs included on a single panel to keep costs down and keep these boards affordable. The size of the designs vary, so the resulting jigsaw puzzle sometimes ends up with an empty corner. I have a few small useful boards that fit in small corners. One of them is a simple untuned MMIC amplifier shown in Figure 4. I have used a number of these over the years, and occasionally given them away, so some of you have seen them. The board is just a MMIC with 50Ω lines and a small 3-terminal regulator for the desired voltage, so it can drop in anywhere some extra dB are needed. Bias voltage for the MMIC is supplied by an SMD RF choke – 33 uH seems to work well. The RF choke seems to limit performance at 10 GHz, but these amps on thin 1/32" PC material seem to work fine anywhere below 6 GHz. For MMICs requiring a dropping resistor like the GALI-39, I use an 8-volt regulator, cut the line to the RF choke, and add a resistor.

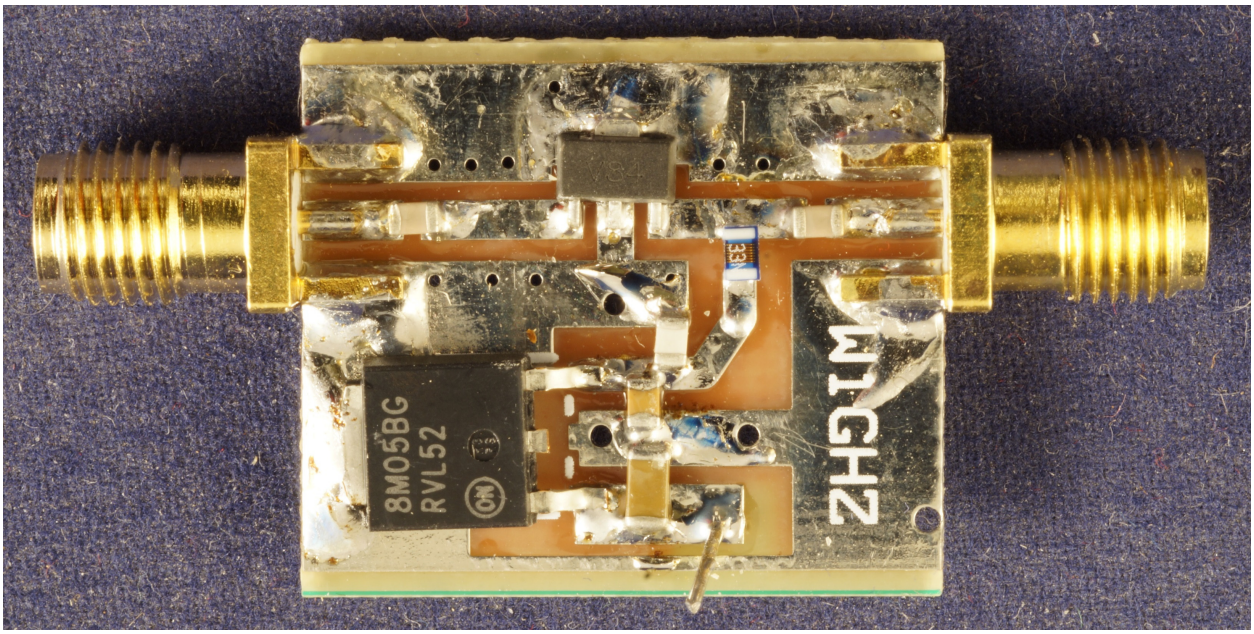

Figure 4 – Wideband Microwave MMIC amplifier

Figure 5 shows the performance of the wideband amplifier with three of the same MMICs as Figure 3, the GVA-64, the GALI-39, the ADL5545, plus a GVA-62. Gain is only slightly lower than the 5760 MMIC amplifier at 5760, but is good down to at least 1 GHz. The high gain at lower frequencies might be a problem, for instance, if the amplifier follows a frequency multiplier; otherwise, these small amps are quite handy.

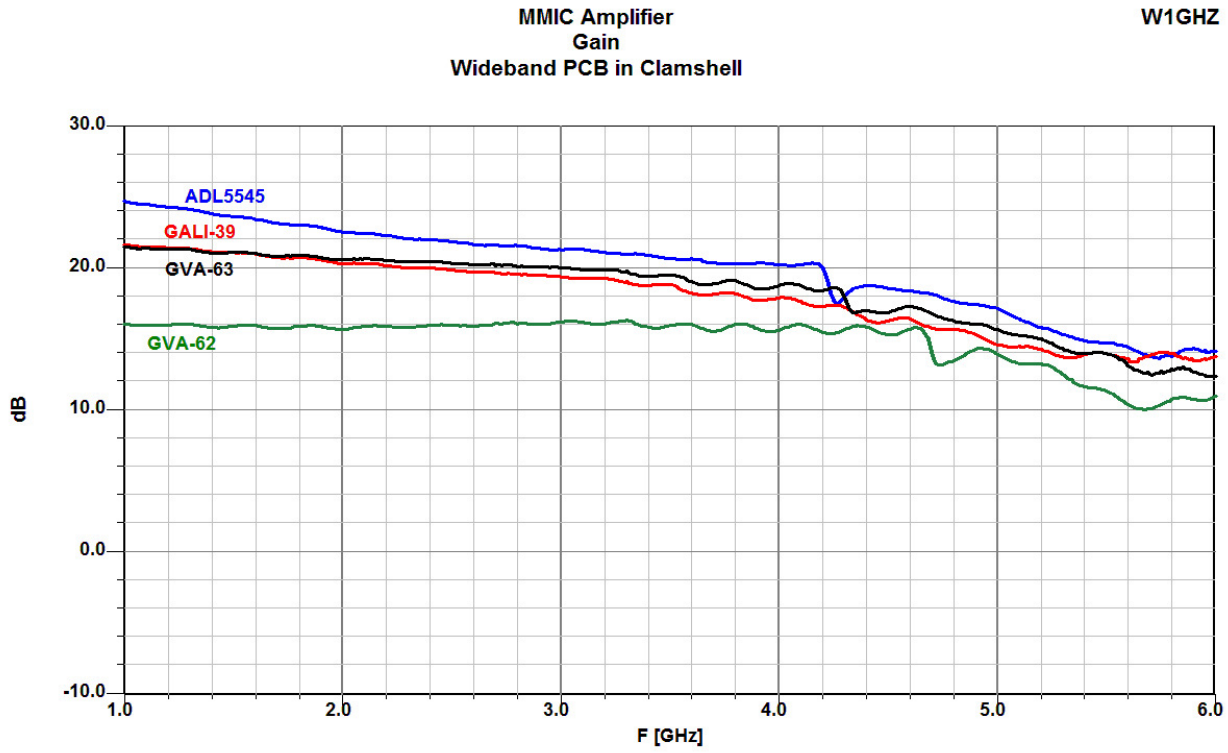

Figure 5 – Performance of wideband microwave MMIC amplifiers

The wideband MMIC PC boards work quite well. Figure 6 shows a gain comparison between the 5760 MMIC Amplifier boards and the wideband version for several MMICs. The noise figures measured for the two versions are very similar. The maximum power that a MMIC can produce can also be useful. Table 1 below shows noise and associated gain plus roughly saturated power and associated gain for several MMICs, all in the wideband MMIC PC boards. Most of them produce +10 to +13 dBm, but the PHA-1H can deliver +19 dBm if driven hard.

Device	NF	Gain	Power	Gain
			~Sat	~Sat
GVA-63	4.9 dB	13.2 dB	13 dBm	8 dB
GVA-62	6	12.6	13.5	8.5
GALI-39	3.5	13.8	13	8
ADL5545	5.7	15.5	10	10
GVA-123	5	15.2	15	10
ERA-1	5.3	8.2	11	6
ADL5611			13	8
PHA-1H			19	6
GVA-84			15	7

Table 1

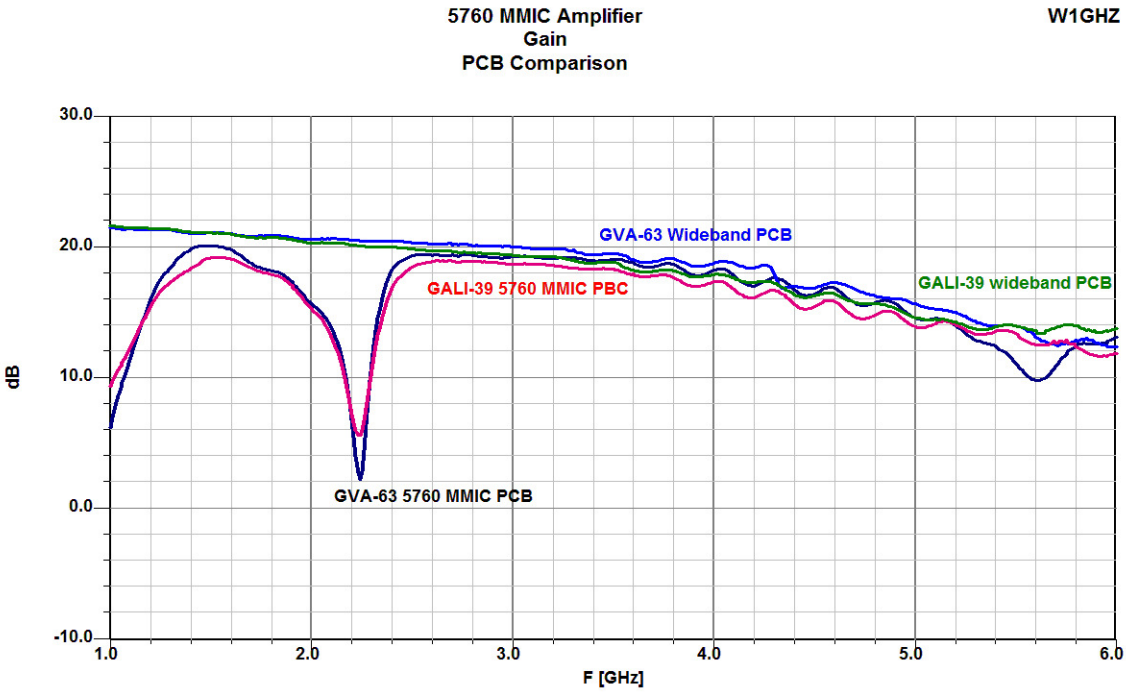

Figure 6 – Comparison of 5760 MMIC PCB and wideband MMIC PCB

Performance of some of the higher power MMICs from Table 1 above is shown in Figure 7. The power levels listed in the table are driven hard, with significant gain compression. Sometimes we just need a bit more power.

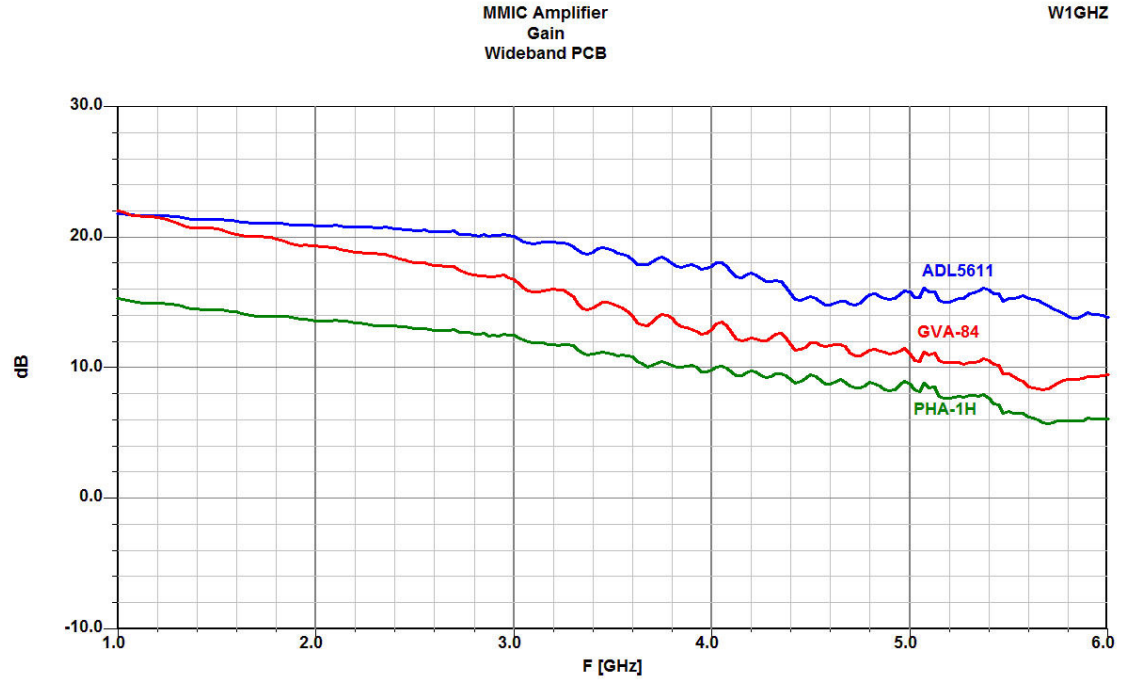

Figure 7 – Small signal performance of some higher power MMICs

The best MMIC for 5760 amplifiers

An outstanding MMIC for 5760 MHz and lower microwave bands is the obsolete MGA-86576, which has high gain and low noise figure. I used one in 1992 in my first 5760 transverter as the front end – it still measures a system NF under 3 dB. The power amp failed years ago, but I intend to get it back on the air soon.

Figure 7 shows three MMIC amplifiers I built using the MGA-86576. The center one is the first one I built. It uses the wideband MMIC board, but with bias thru a ¼ watt resistor. My 5760 front end uses a similar construction, so I wanted to see how well it works.

The one on the right is my prototype MMIC amplifier for 5760 – I took a preamp board and scraped off the bias stub. The small green board\, one of the leftover corner designs, is a 3-terminal regulator in an SOT-89 package with bypass caps – the MMIC doesn't need a lot of current.

The one on the left is a wideband microwave MMIC board like the ones above.

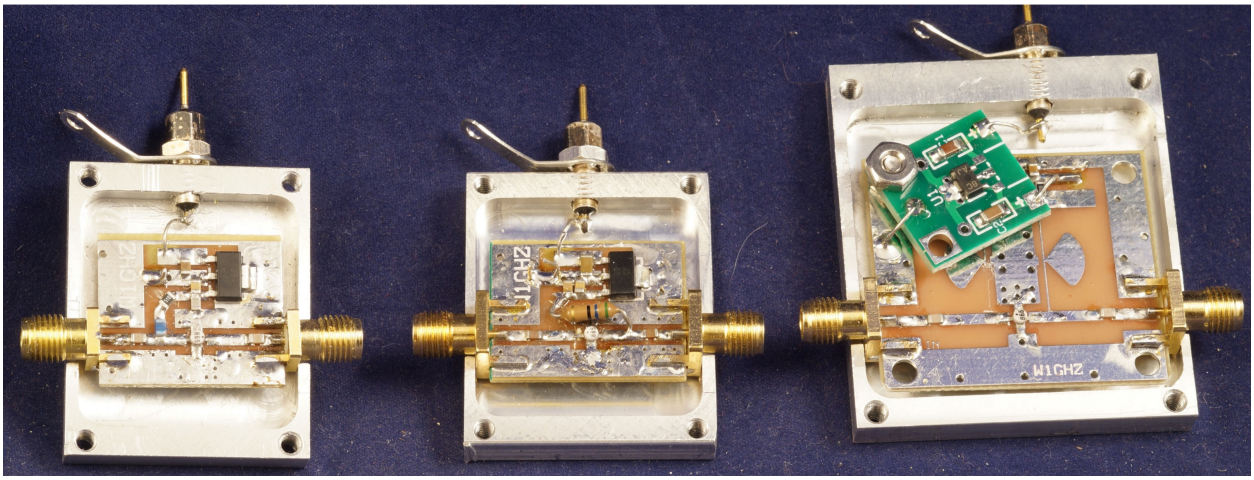

Figure 8 – MMIC amplifier using the MGA-86576

The three MMICs above are the last in my stash. One is branded HP, another Agilent, and the third Avago. I also bought some on ebay: two from a US vendor for about $20 (1992 cost ~$10 each), which seem to work well, and 10 from a far-east supplier – the first two I tried were NFG. If you can find good MMICs, they are really nice. Good luck.

Performance of all three amps is pretty good with good gain at 5760 and higher gain at lower frequencies. The MMIC amplifier prototype shows the expected large dips at lower frequencies. Figure 8 plots S11 as well as gain. The MGA-86576 has poor return loss at lower frequencies; it was only speced from 2 to 8 GHz , although I've used one at 1296 with a little inductive tuning. Noise Figure of all three amps is below 3 dB. If the MGA-86576 were still available, I'd have many uses for them.

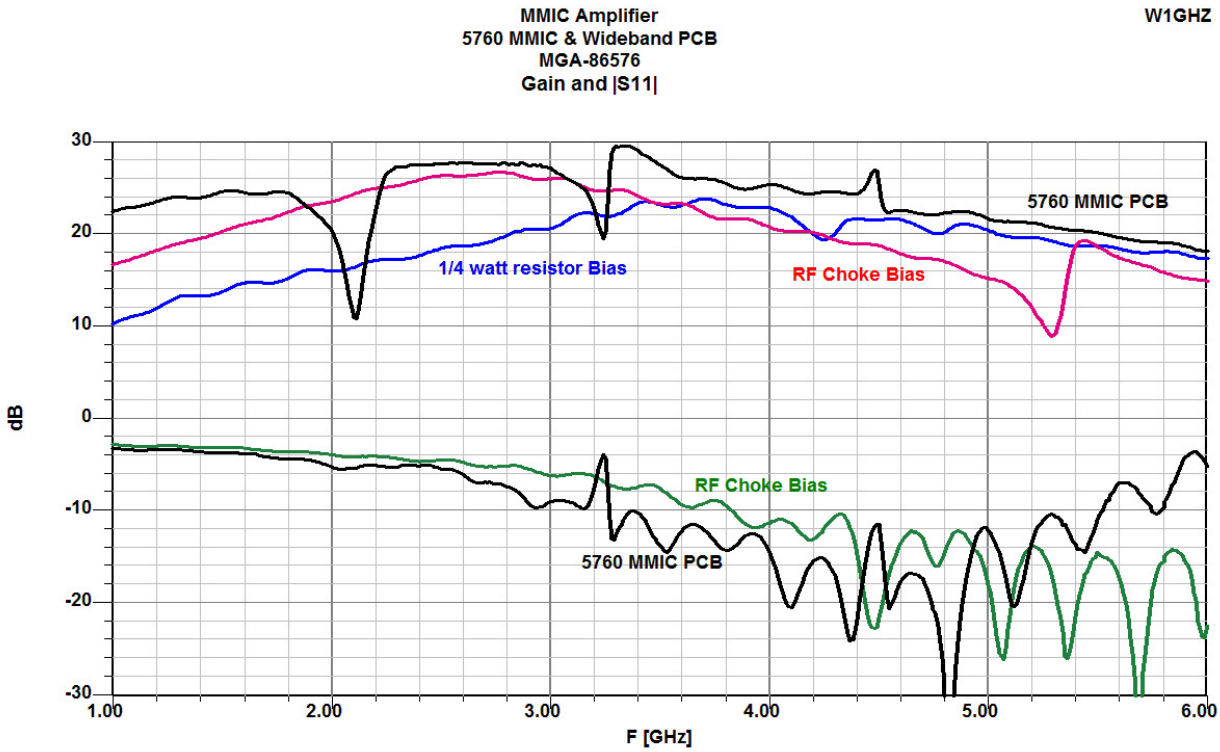

Figure 9 – Performance of MGA-86576 MMIC Amplifiers

Construction

These MMIC amplifiers are pretty straightforward to assemble, with ordinary cheap SMD components. The capacitor values shown in the schematic aren't critical – varying them to use what you have shouldn't change results more than tenths of a dB. SMA connectors are cheap edge mount for 1/32" (0.8mm) from ebay, which should be under a dollar each in modest quantities. One caution is that the whole PC board gets pretty hot while soldering the connectors, so I'd suggest putting the connectors on before more sensitive components.

Packaging

The small amplifiers on thin PC boards are not really robust, but can be fine inside a transverter if there isn't a lot of stress on the connectors and cables. For handy test and general purpose amplifiers, I like the clamshell construction shown in Figure 8, which fits around a finished and tested amplifier. Details are given in my 10 GHz Preamp paper[1]. I'm confident that amateur ingenuity can find other robust packaging techniques requiring less machining.

Summary

These MMIC amplifiers can provide useful gain at 5760 MHz and lower microwave bands. They are easy to build and provide good performance. PC boards are available.