PGA103+ Low noise, high dynamic range preamp for VHF and UHF

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Introduction

The PGA103+ from MCL achieves sub 0.5dB noise figure (NF) at 144MHz and better than 0.55dB at 432MHz. It should also provide around 0.8dB NF at 1296MHz.The gain at 144MHz is approximately 26dB and 25dB at 432MHz.
MCL claim that the device is useable from 50MHz to over 3000MHz, it is perfectly useable down to at least 30MHz by using a larger value input coupling capacitor.

Circuit schematic and assembly

The schematic really could not be simpler. The PCB is designed to accept 0603 size SMD parts

The initial PCBs are designed for cable termination input, but SMA through-board PCBs will also be available in the New Year.

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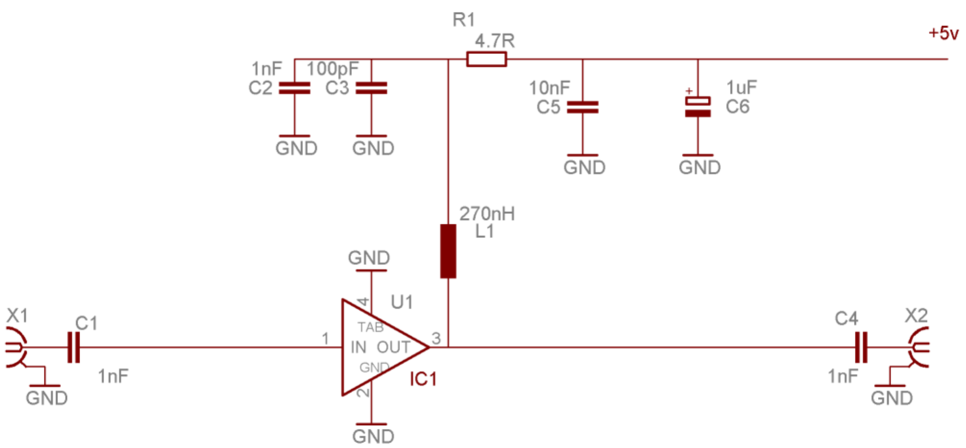

Figure 1 shows the circuit schematic of the basic PGA103+ amplifier. R2 is not shown in this schematic.

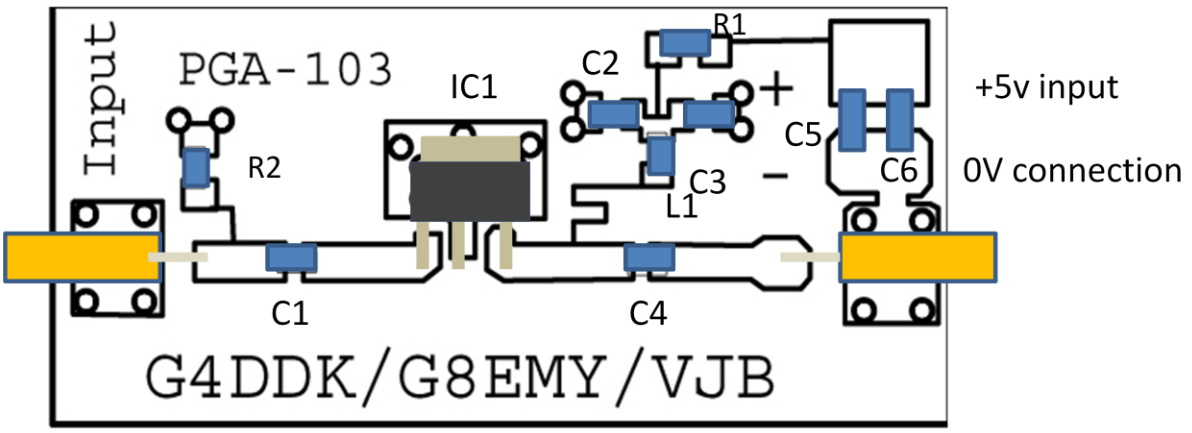

Figure 1 shows the component placement for the PGA AMP C5 and C6 are fitted across the input power pads. R2 is an optional 1MΩ 0603 size SMD part to act as a static leak

Table 1

Component	Value	Package
R1	4.7Ω	SMD0603
C1,3,4	1000pF	SMD0603
C2	100pF	SMD0603
C5	1µF	Case A size
L1	220 - 330nH	1618
IC1	PGA103+	SOT89
R2	1MΩ	SMD0603 optional Not supplied in the kit

Table 1 gives the component values for a basic PGA Amplifier.

Box

The PGA AMP fits comfortably into one of the Schubert tin plate boxes. I chose to use the 20mm x 20mm x 55mm size with BNC cut out at the ends (FG2B). These boxes are available in the UK from G3NYK and in Germany from Eisch Electronic. Schubert (as far as I know) do not make the box with SMA connector size cut outs. However, soldering four-hole size SMA connectors over the BNC cut out, the flange of the SMA connector nicely covers up the larger BNC entry size hole. The connectors could be BNC, if preferred.

There are many ways to mount the PCB in the box. I chose to solder the board in vertically and make a short wire link from the SMA spill to the PCB input. The output uses a short length of PTFE coaxial cable between the PCB and the output SMA connector. It may be better to cut the end from the PCB so that the input pad is closer to the input connector.

I chose to solder a 78M05 5V/500mA SMD regulator to the ground-plane side of the PCB with 10µF/ 20V working tantalum capacitors for decoupling. This ensures that whatever the input supply voltage variation no more than +5V appears at the PGA AMP.

I used a Tusonix 1500pF solder-in feed-through capacitor to bring the supply into the box.

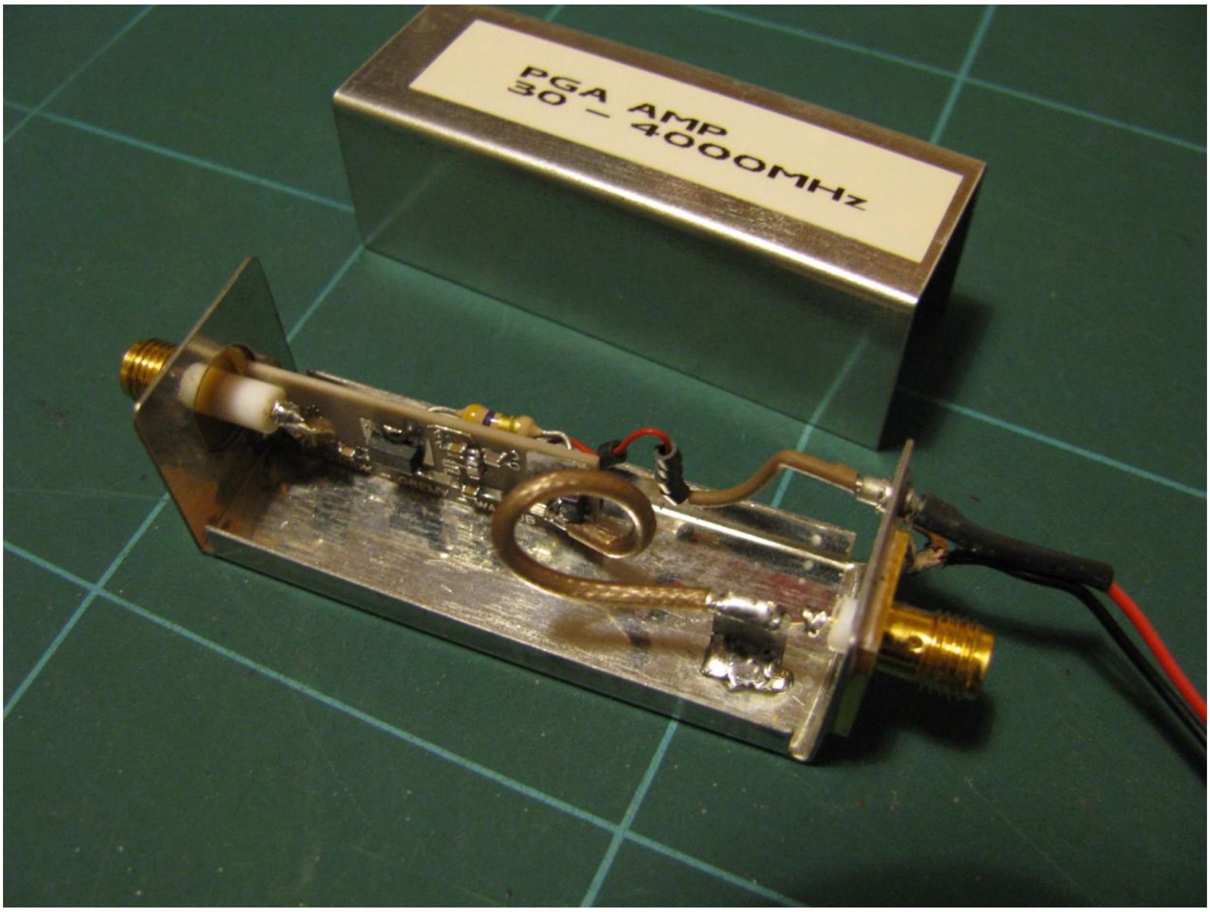

Photo 1 shows the PGA Amplifier fitted into a Schubert tin plate box. This is actually a photo of the original Arlon version of the PCB. In the FR4 version described in this article the external leaded 4.7Ω is replaced with an 0603 SMD resistor.

Results

Table 2 shows the results of my measurements on the prototype boxed PGA AMP. The usual caveats apply, i.e. systematic uncertainties in the measurements, particularly of the noise figures, test equipment calibration , quoting noise figures to hundredths of a dB! etc. But do note that these numbers were obtained using the original Arlon PCB. The numbers with the FR4 PCB are almost identical.

Table 2

Frequency (MHz)	Noise figure (dB)	Insertion gain (dB)	Input IP3 (dBm)	Input return loss (dB)	Output return loss (dB)	Psat Output (dBm)
30	0.5	26.2				
50	0.5	26.2		3.8		
70	0.5	25.9		5.2		22.1
144	0.46	25.2	+11.8	8.7	22	22.5
432	0.52	21.6	+10.5	10.6		
1296	0.8	14.1	+20.5	14.7	15.4	24.5

Table 2 Measured performance of one sample of the PGA103+ amplifier mounted in the recommended tin plate box.

Summary

An IIP3 of +10.5dBm at 432MHz is also pretty impressive for a device delivering over 20dB of gain and around 0.5dB noise figure.

At 1296MHz the IIP3 is also extremely good at over +20dBm. However, this figure could be improved significantly by careful selection of the device operating point. Potentially, it could be as high as +26 to +30dBm. These are the numbers achieved at 1.9GHz in the original cellular radio base station mast head preamplifier application of this device.

One of the advantages of this small high performance amplifier is that it is so small that it can be fitted inside many existing transceivers as an alternative receiver front end or even a replacement driver stage, possibly giving a large increase in receiver or restoring transmitter performance.

A concern for many 144MHz band users is strong signal effects from Band 2 FM broadcast stations. However, unless you live or operate very close to one of these monsters they probably don't cause the average radio amateur any problem.

Traditionally, the input selectivity provided by low loss input matching circuits has been used to reduce the effects of FM broadcast stations. These 'filters' are not always as effective as we might imagine! In the PGA AMP the very high IIP3 provides additional protection against Band 2 broadcast signals as well as against close-in paging signals and some in-band signals from the bigger contest stations.

Where additional protection from Band 2 is required a simple high pass filter can be used at the PGA AMP input. DJ7VY and LA8AK (SK) both recommended this approach as it can give extremely low losses at the preamplifier input (<0.13dB) together with close on 50dB rejection of the more troublesome stations in Band 2. I recommend the DJ7VY 130MHz HPF design (VHF Comms, Vol. 10, Spring 1/1978) , although this is now known not to be an optimum design.

It may be convenient to build the HPF into a separate box from the preamp and only connect it if it is required. Indeed you would have a few problems fitting the DJ7VY HPF into the same Schubert box as the preamp. Most 144MHz operators should not find it necessary to use the filter.

Filtering above 144MHz is probably best left to a low loss bandpass filter located at the preamplifier output, although an input 400MHz HPF might also be practical.

73 de Sam, G4DDK/W5DDK and Kent, WA5VJB/G8EMY