Low-noise broadband preamplifier for satellite operation

DD1US, Matthias Bopp, April 23rd 2025, rev 1.1

The sensitivity of the reception system is a very important parameter, especially for satellite operation. Of course, the rule still applies that the antenna is the most important factor if you want to optimise your system. However, the overall noise figure of the reception system also plays a major role. In particular, cable losses between the aerial and the receiver must be compensated for and, in addition, standard receivers usually have a noise figure in the range of 4 to 10 dB. A low-noise preamplifier can improve the system noise figure of the receiver chain and thus the signal-to-noise ratio.

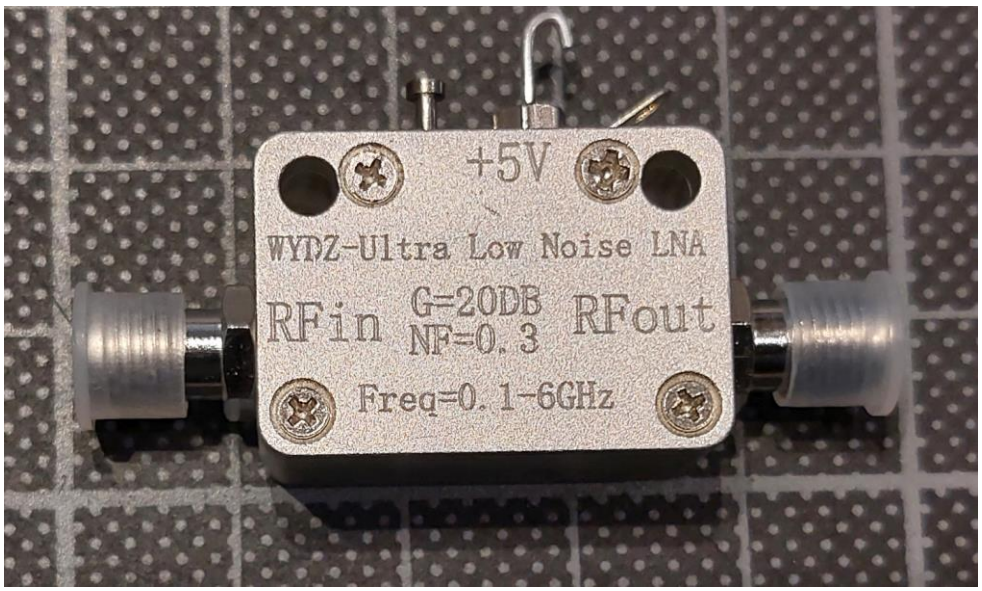
I will describe below a very low-noise broadband amplifier that has recently become available very cheaply from Ali-Express in China under the name "WYDZ-Ultra Low Noise LNA".
I bought it for less than 22 € including shipping and taxes.

The specified frequency range is 0.1 to 6 GHz. It is advertised with a noise figure (NF) of 0.3 dB and a gain (Gp) of 20 dB.

Naturally, I was very sceptical about this data, but I ordered such an amplifier anyway to find out what it actually does. I was looking for a low-noise broadband preamplifier for my noise measurement setup.

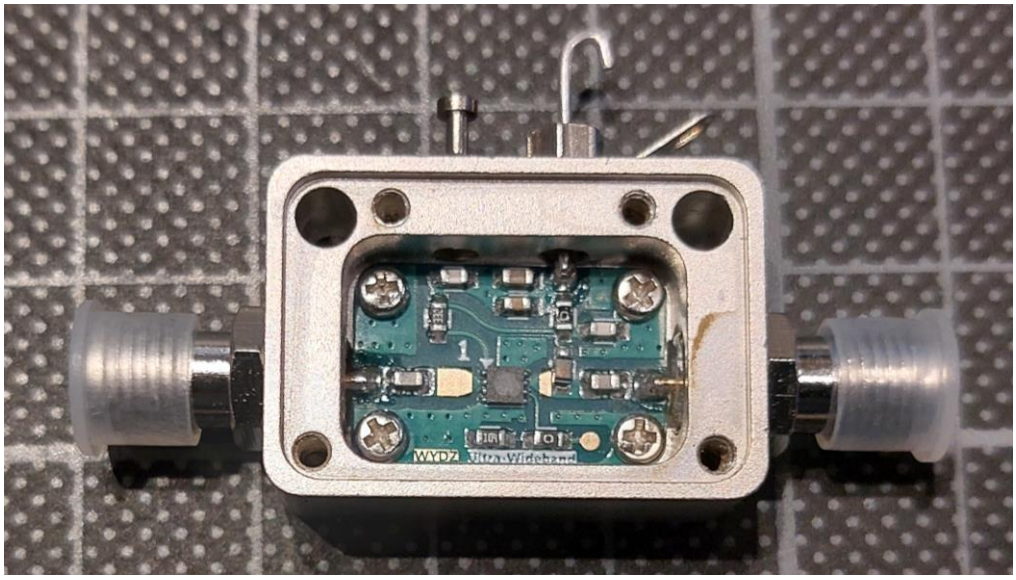
It was delivered within 2 weeks without any problems.

Here is a picture of the broadband amplifier, which is housed in a small aluminium housing with SMA sockets at the input and output. The +5 V power supply is provided by a feed-through capacitor.

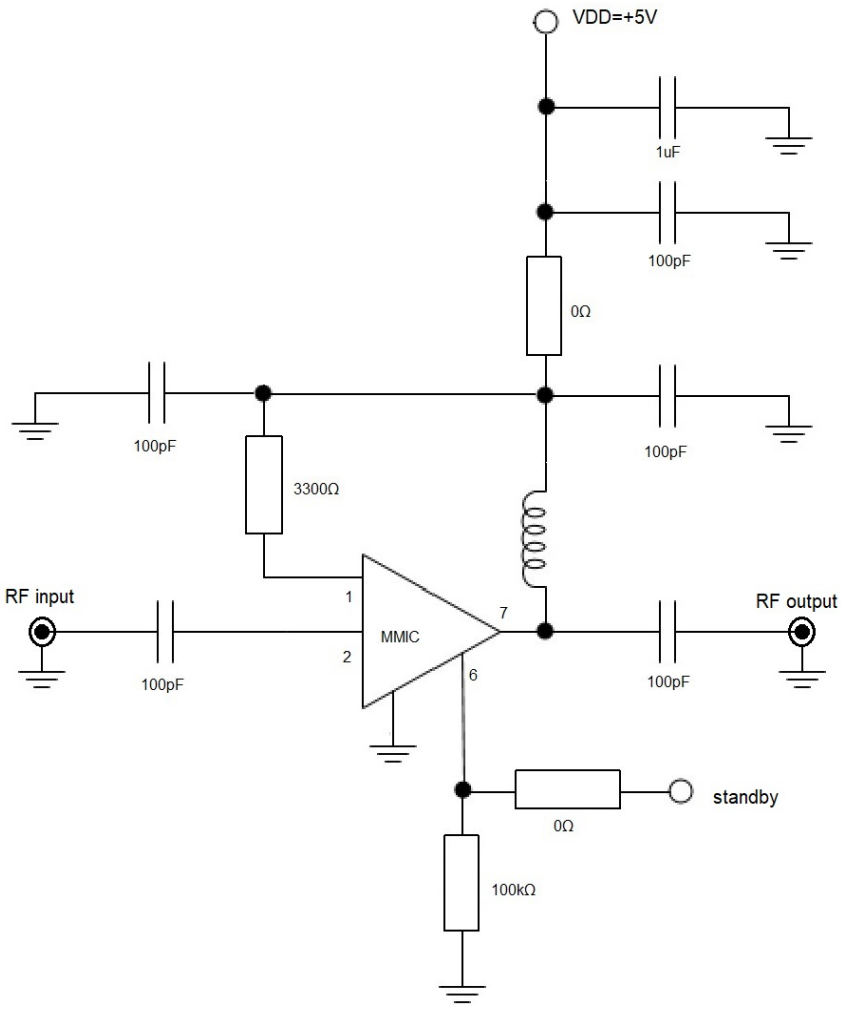


Naturally, I was curious to see what is inside and unscrewed it. Inside is a small circuit board labelled "WYDZ Ultra Wideband" with an integrated wideband amplifier in an 8 pin SMD package. The marking on the amplifier IC has been removed.

An analysis of the circuitry and a comparison of my own measurement results, explained later, with the specifications of commercially available wideband amplifier ICs strongly suggests that it is an monolithic integrated amplifier (MMIC) from Qorvo with the type designation QPL9547 (or a very good Chinese clone).



Here is the circuit diagram of the broadband amplifier:



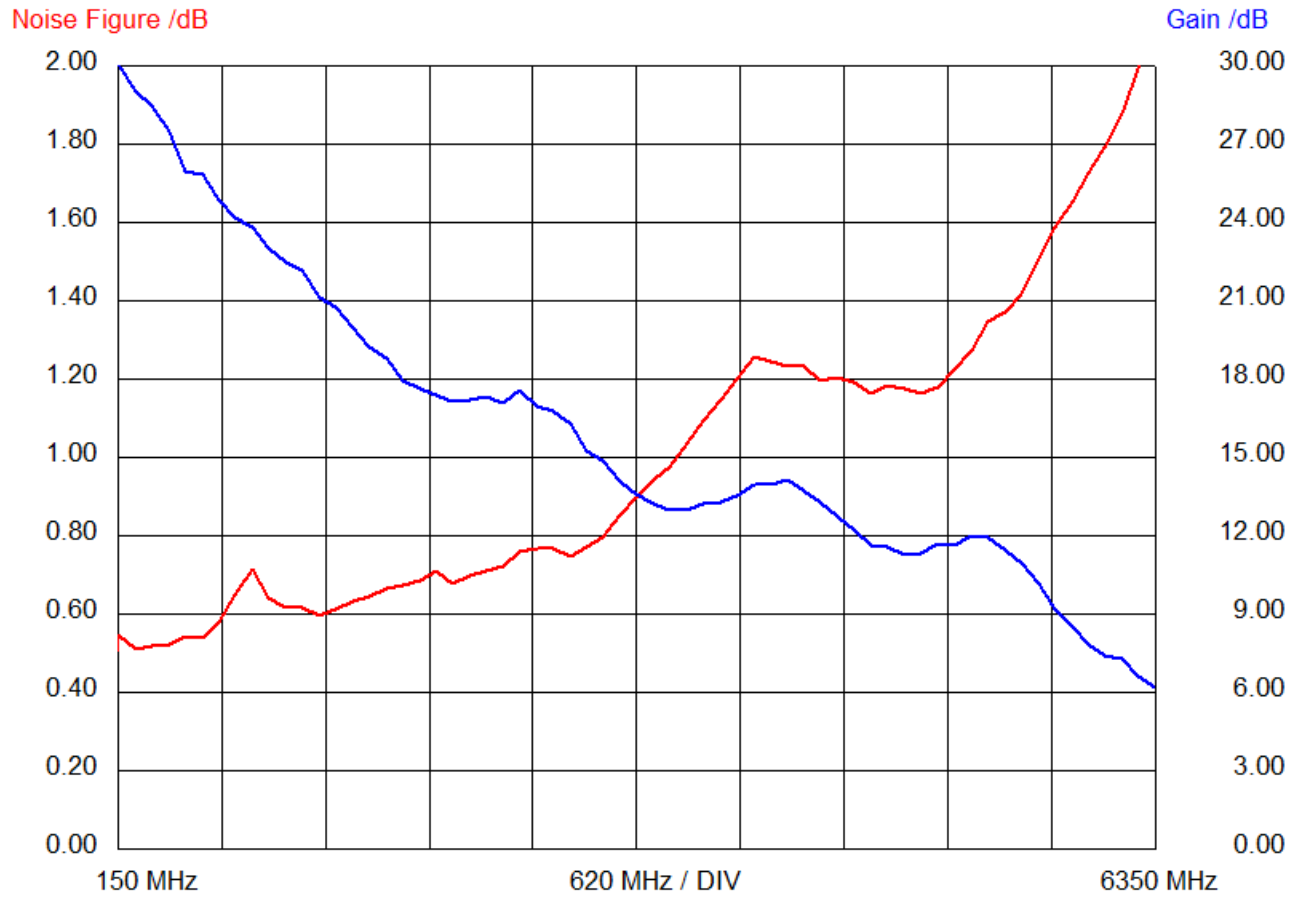
This MMIC QPL9547 is specified with a typical noise figure of 0.3 dB and a gain of 19.4 dB (at 1.9 GHz). However, it should be noted that this noise figure does not take into account the losses of the circuit board in particular.

Another interesting feature is its very good large-signal behaviour, which manifests itself with an output P1dB of +22.8 dBm (almost 200 mW) and an OIP3 of +39.2 dBm.

It can be set to a power-saving mode, i.e. switched off, using pin 6. However, this is not used here. Pin 6 is permanently connected to earth via a 100-kΩ-resistor. However, the function could be activated subsequently via the standby test pad.

Pin 1 is connected to the VDD supply voltage via a resistor. This resistor is used to set the bias current of the MMIC. In this amplifier module, the resistor is 3300 Ω and the current consumption of the two units I measured was 57 and 59 mA at a supply voltage VDD of 5.0 V.

I measured gain and noise figure of the broadband amplifier as a function of frequency.



The amplifier can be used very well in the range 145 to 3400MHz, whereby the gain drops from 30 dB to 13 dB above this frequency range and at the same time the noise figure increases from 0.5 dB to 1.0 dB.

Here are the measured values in the corresponding amateur radio bands:

frequency /MHz	gain /dB	Noise figure /dB
145	30	0.6
435	27.5	0.5
1296	22	0.6
2400	17.2	0.7
3500	13.1	1.0
5700	10.0	1.5

Although these values do not correspond to the advertised values, they are still respectable.

A maximum noise figure of 0.7 dB in the frequency range up to the 13cm band is particularly remarkable. The higher noise figure of the units I measured versus the MMIC datasheet is probably mainly due to the low-cost, presumably FR4-like material used for the circuit board.

The disadvantage of a broadband preamplifier is that it also receives signals outside the amateur radio bands and can therefore interfere the receiver due to blocking or intermodulation effects. Appropriate filters can help here. These are indispensable, especially if you also want to transmit in full-duplex mode.

However, many radio amateurs now also operate an often remote receiving station, e.g. in the SatNogs network. Such a preamplifier can be of particular interest here with broadband receiving antennas and should also be usable without a filter in many cases due to its good large signal behaviour.

This amplifier unit will be also useful as a low-noise broadband preamplifier for my noise measurement setup.

I am always happy to receive comments and queries. Please send them to me preferably by e-mail. You can find my current e-mail address on my homepage.

Best regards

Matthias DD1US

Homepage: http://www.dd1us.de