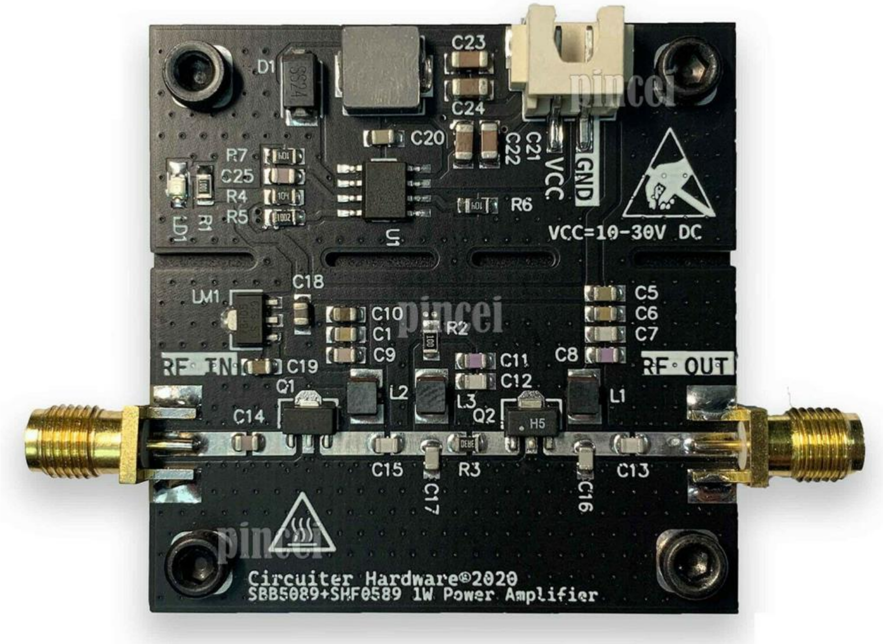
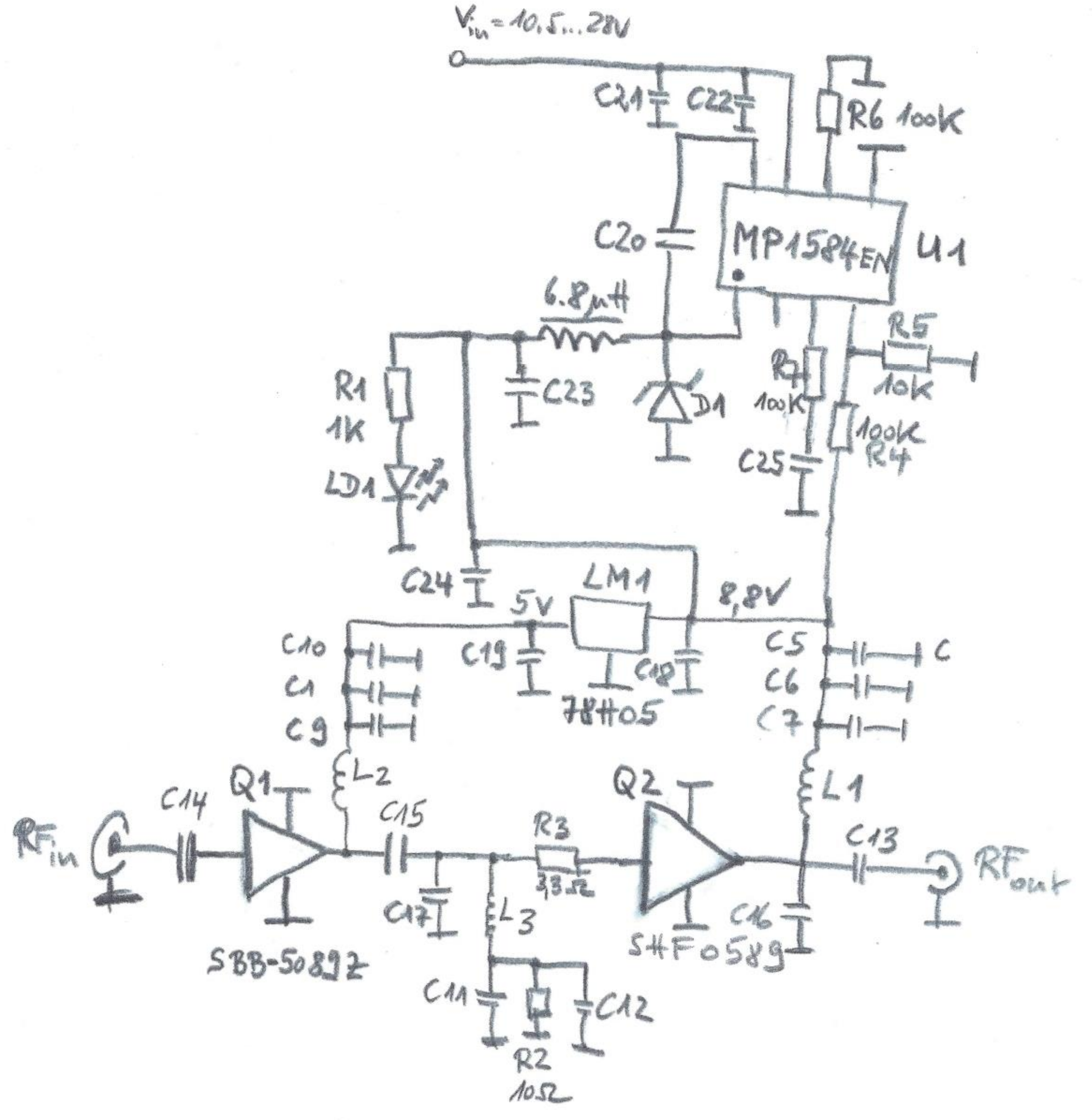
2-Watt Chinese Amplifier 40 – 1200 MHz

Matthias, DD1US, 5.5.2021, Rev 1.0

Recently I bought an amplifier module from China on Ebay. It is a module with a two-stage RF amplifier and a power management circuit (consisting of a DC-DC-Converter and a linear voltage regulator). The PCB is mounted on a heatsink. The two-stage design is comprised of two MMICs from Qorvo: an SBB-5089 (originally from RFMD) and an SHF-0589 (originally from Sirenza Microdevices). Here are some pictures:



I did not find a schematic of the amplifier in the internet and therefore I created a sketch of it.



Q1 SBB5089Z
InGaP HBT
0.05 - 6 GHz
0.1 W

Q2 SHF0589
GaAs HFET
0.05 - 3 GHz
2W

LM1 78H05
5V lin. reg.

U1 MP1584EN
DC-DC-Buckconverter
5 - 28 V

The schematic and also the layout of the PCB are almost identical to the 1W version using an SHF0289 MMIC in the second stage (see separate report).

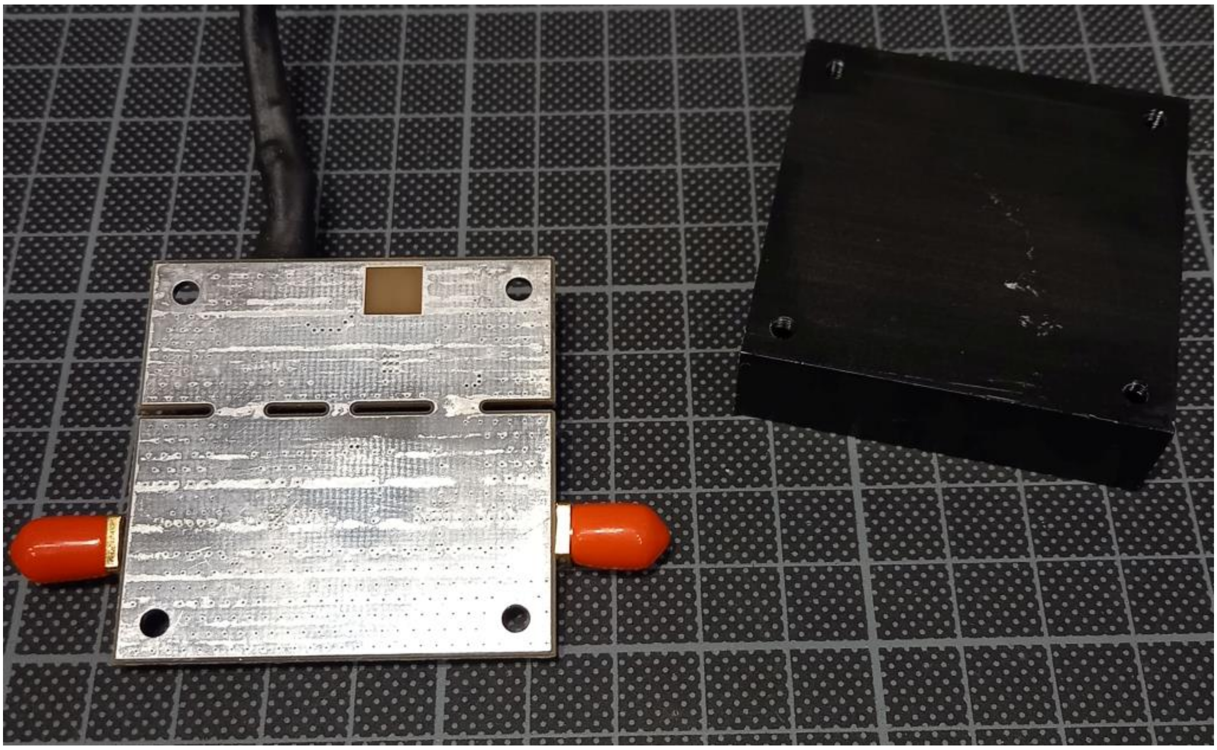
The seller specified a supply voltage range of 10 … 30V, a DC input power of 5W, a frequency range of 40 … 1200 MHz and a gain of 25dB or higher. The specified RF output power is specified to be 2W or higher.

I checked the input voltage range and indeed, based on the switched mode power supply the output signal did not change with an input voltage range between 10.5 V and 30 V. The corresponding current is reduced at higher supply voltages. As the DC-DC-Buck-Converter is only specified for an input voltage up to 28V I recommend to use a supply voltage between 10.5 V and 28.

The first stage is supplied with the 5V voltage stabilized by the 78H05 linear voltage regulator. The second stage is supplied with the 8.8V voltage supplied from the DC-DC-Converter. As the absolute maximum rating of the SHF-0589 is 9V this seems to be marginal but ok.

The quiescent current of the PA module is about 710 mA at a supply voltage of 12V. This is a DC input power of about 8.5W and thus much higher than specified by the supplier.

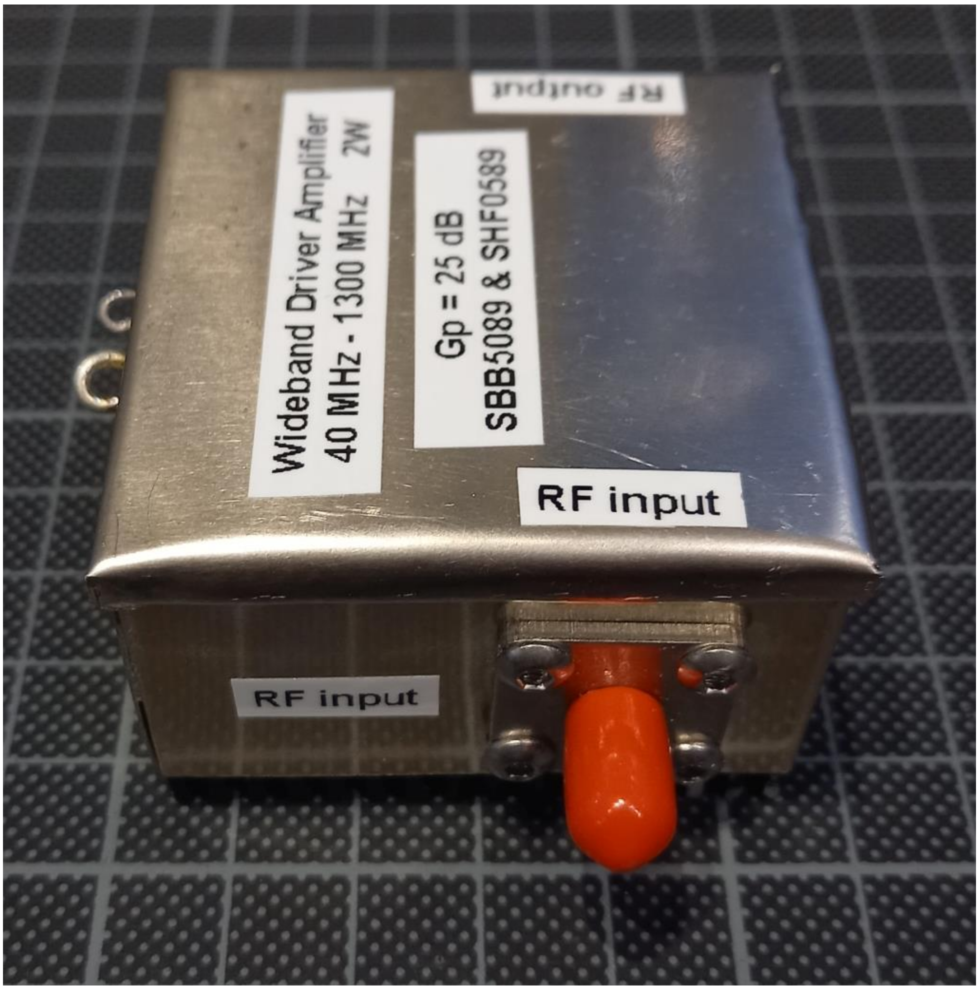
The second amplifier gets quite hot and I checked how the PCB is mounted on the heatsink: there is not thermal grease used to minimize the thermal resistance. Also, in the datasheet of the SHF-0589 it is recommended to place screws close to the device which is not the case at the module I got. Below you can find a picture of the backside of the PCB and the heatsink:

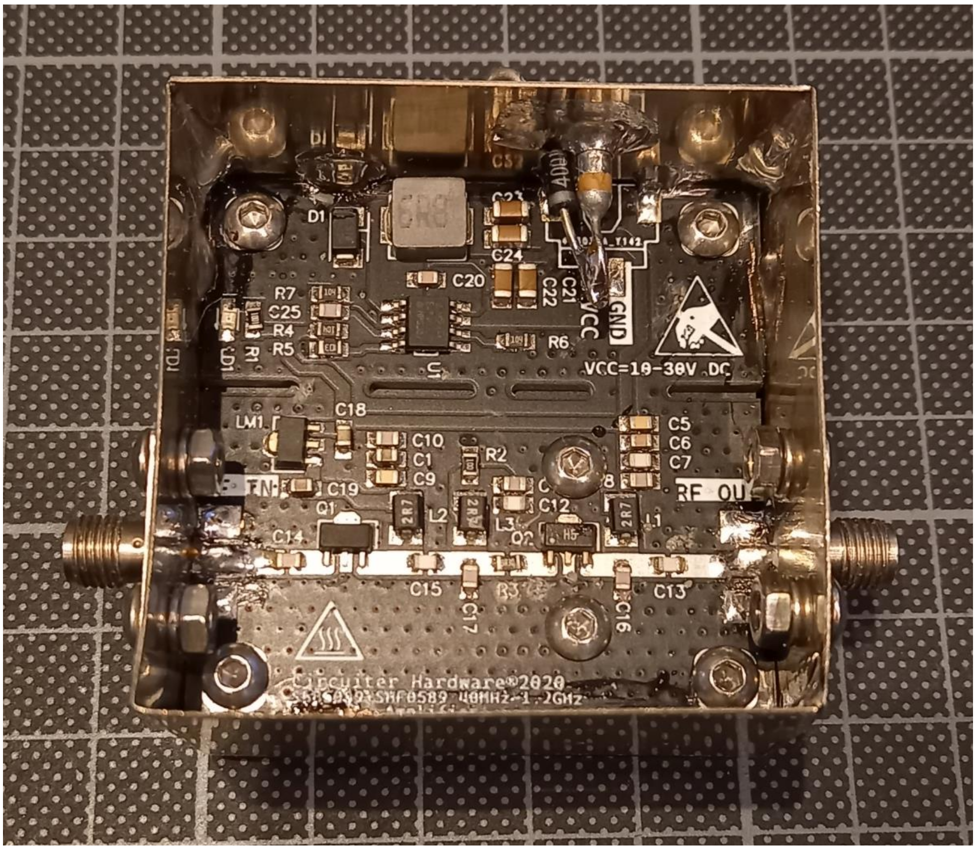


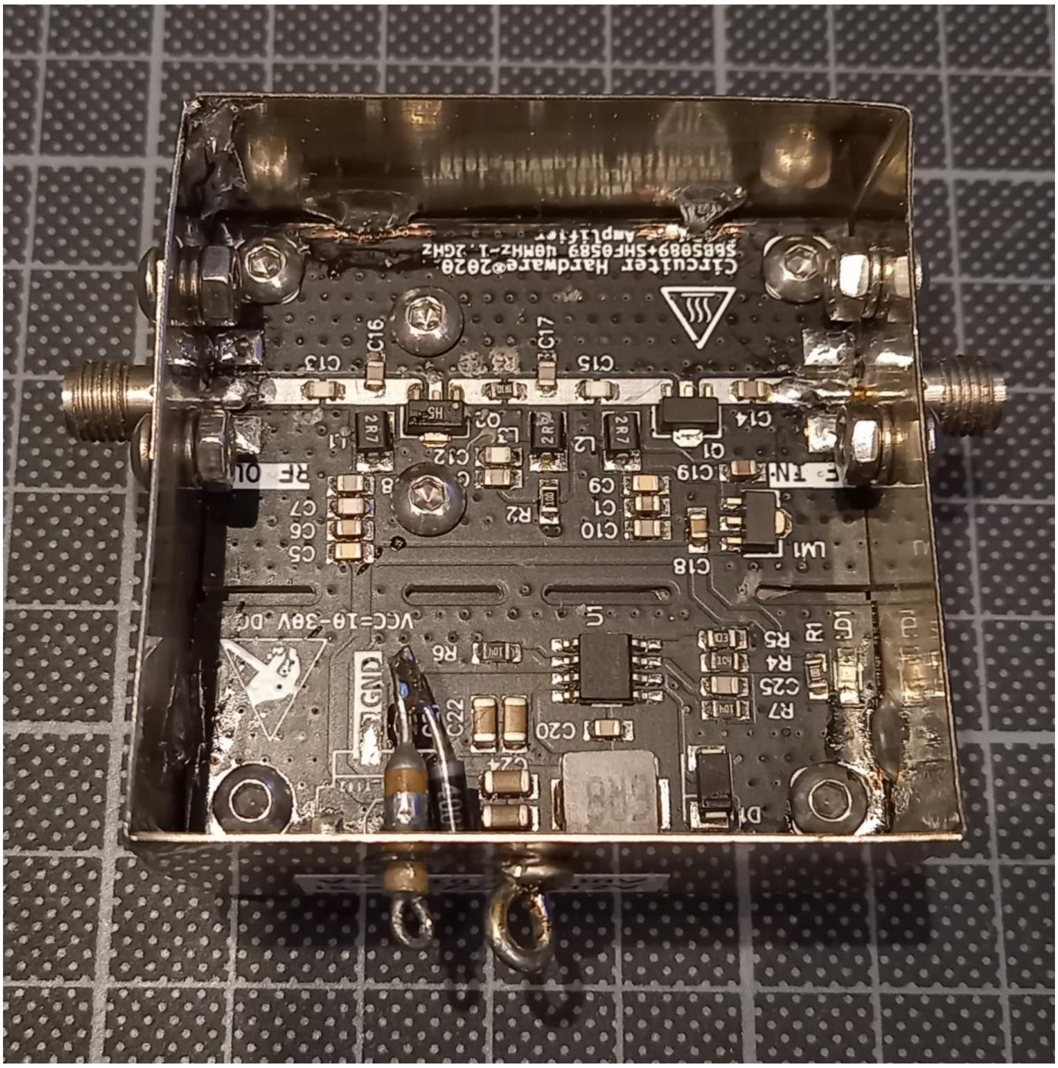
Therefore, I added 2 M3 screws close to the second MMIC (see later photograph) and mounted the PCB on the heatsink with some thermal grease (Arctic 5). In addition, I put a metal shielding around the PCB and replaced the original SMA sockets with large SMA flange sockets. This makes the whole setup mechanically and electrically much more robust.

Nevertheless, the second MMIC still gets quite hot. For longer operations a larger heatsink or a little fan is required otherwise the module will get too hot.

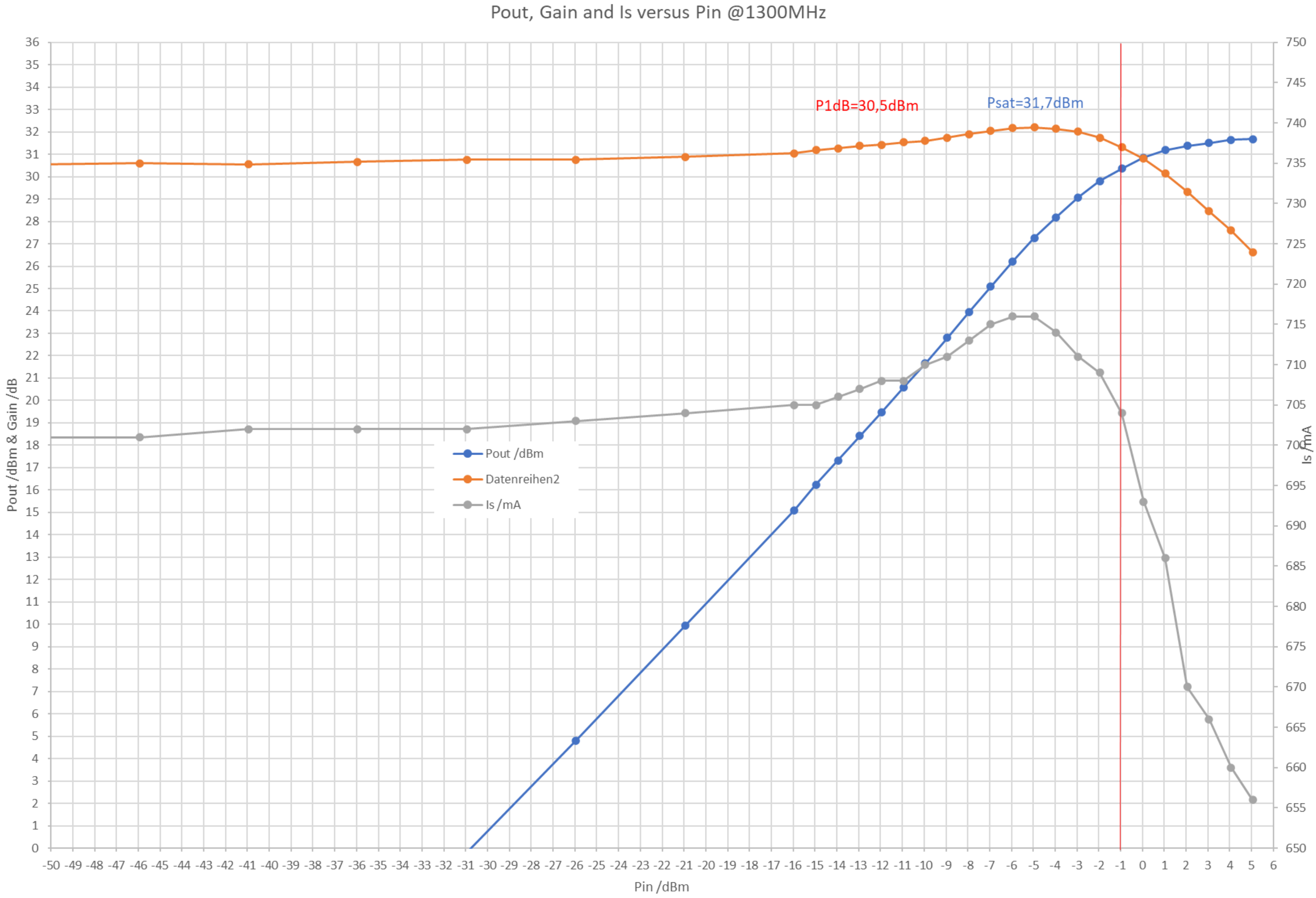
Here are some pictures of the module:


RF output
Wideband Driver Amplifier
40 MHz - 1300 MHz 2W
Gp = 25 dB
SBB5089 & SHF0589
RF input
RF input


GND
VCC
VCC=10-30V DC
RF OU
Circuiter Hardware®2020


Circuiter Hardware©2020
SBB5089+SHF0589 40MHz-1.2GHz
Amplifier
VCC=10-30V DC
GND

First, I measured the device first at 1300 MHz as I was considering to use it as a driver amplifier for my HPA in the 23cm ham radio band. With a supply voltage of 12 V the quiescent current consumption was about 710 mA which corresponds to a DC input power of 8.5 W.

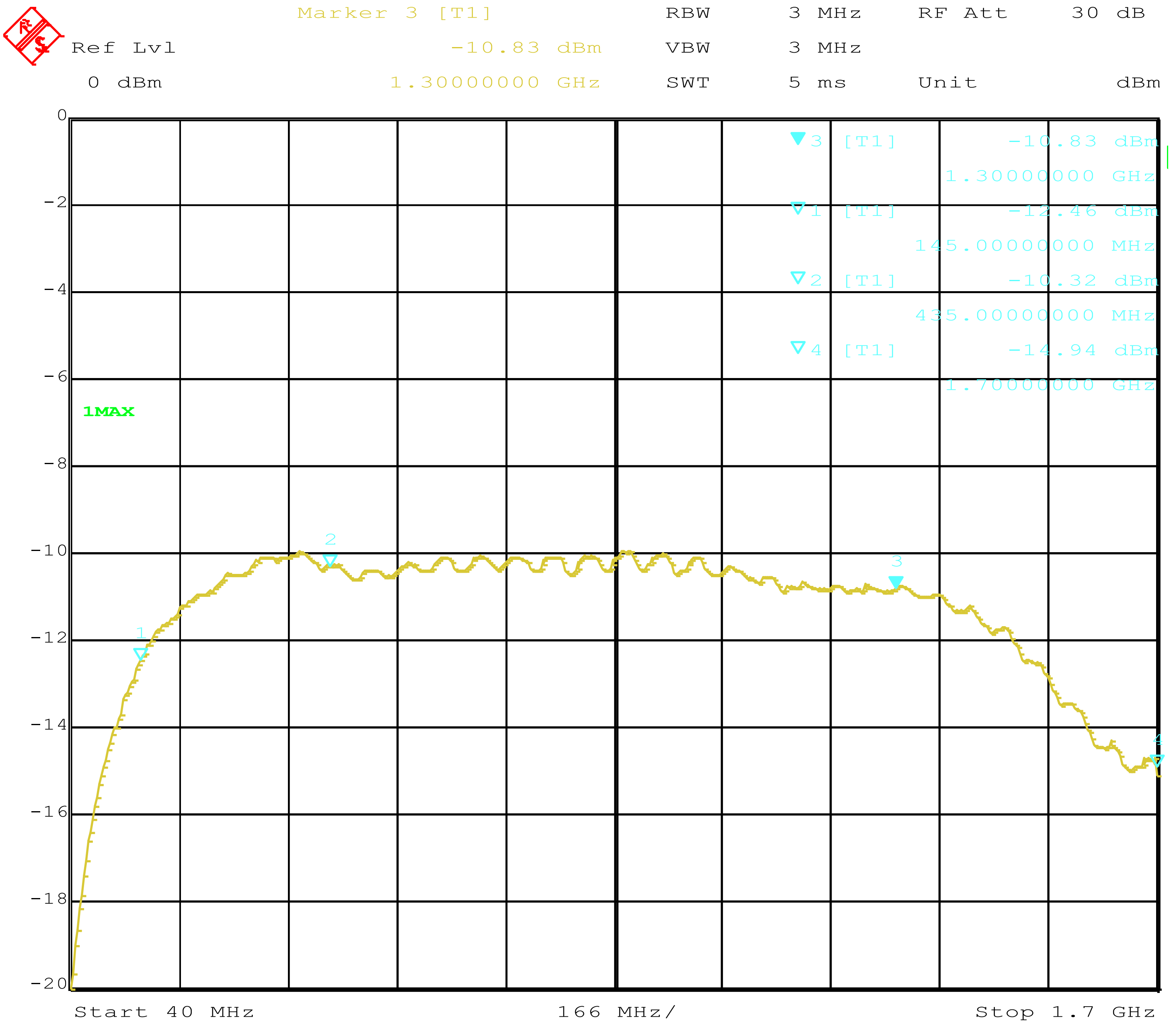


At 1300 MHz the maximum output power is +31.7 dBm or 1.45 W and the associated gain is 27 dB. The small signal gain at low input power levels is about 32 dB.

When the amplifier gets in compression the DC input current drops significantly. This might limit the maximum output power in compression.

The specified output power of the device of “2W or more” seems to be too optimistic. Nevertheless, the measured output power of 1.5W is still sufficient for my application.

Next, I swept the amplifier while being in saturation to see, whether the maximum output power might be higher at other frequencies.



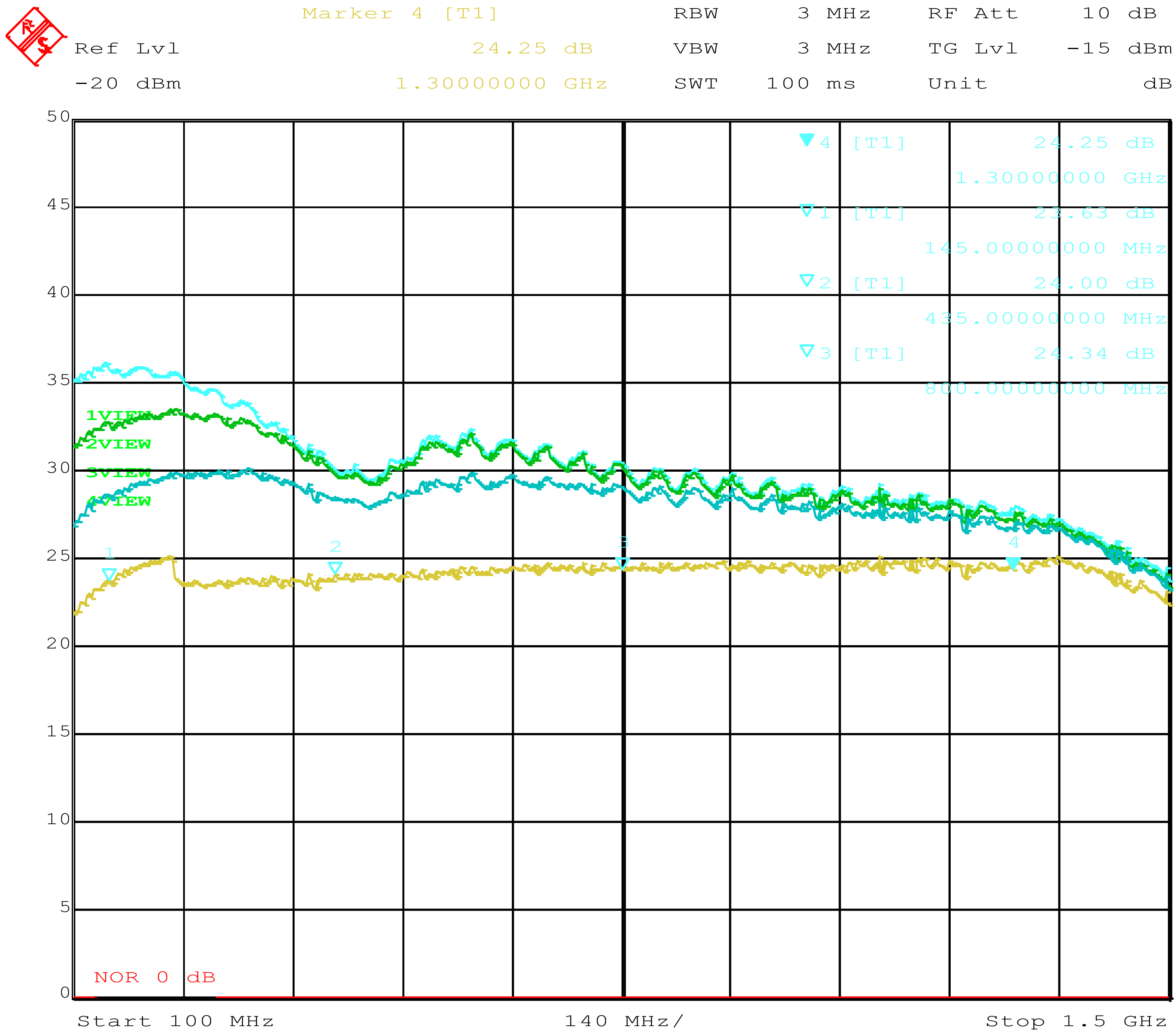
It turns out that the maximum output power is rather constant over the frequency range between 300 and 1300 MHz. At 435 MHz the output power is about 0.5dB higher than at 1300 MHz.

The maximum output power below 200 MHz drops significantly and is degraded by about 2dB already at 145 MHz.

I think the specification of the amplifier frequency range should be rather 200 – 1300 MHz instead of 40 – 1200 MHz.

Based on the results I decided not to spend additional time tuning the amplifier for more output power at 1300 MHz but rather use it as it is.

Finally, I measured the gain of the amplifier in a wide frequency range as a function of input power:



The curves were measured at input power levels of:

-16 dBm (light blue curve at the top)

-11 dBm (green curve)

-6 dBm (blue curve)

-1dBm (yellow curve at the bottom)

At low input signal levels the (small signal) gain is more than 35dB at 145 MHz. It drops at higher input power levels to about 24dB when the amplifier gets in strong compression.

Given the price of only 11 Euros including shipping this module is a nice broadband amplifier to boost the output level of typical signal generators for testing power amplifiers.

I can now generate a signal of about 1.5 W in the 23 cm Ham Radio band which is what I need to drive my high-power amplifier.

If you have comments or suggestions, please send them to my Email address which you can find below.

Kind regards

Matthias

Email: dd1us@amsat.org Website: www.dd1us.de