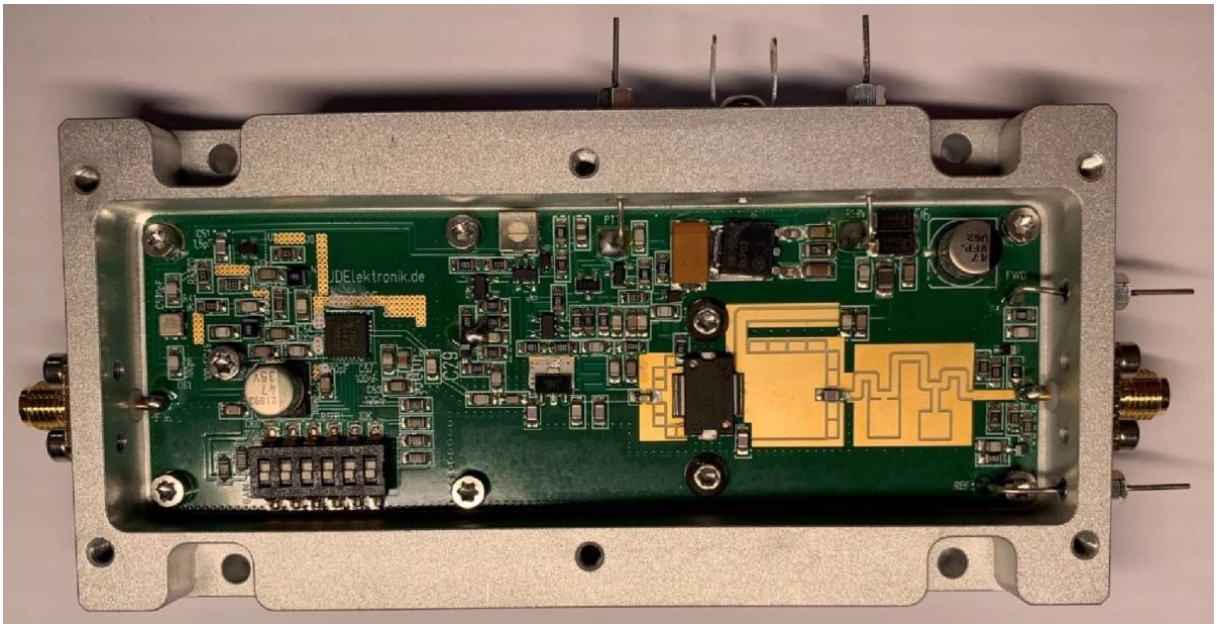
Analysis of a 2.4 GHz 20W amplifier from JDElektronik

Matthias, DD1US, April 13th 2024, rev 1.1

Some time ago, I acquired a 13cm power amplifier for QO-100 from JDElektronik (Joerg Delvos DJ4ZZ), which was especially designed to be driven by an SDR with its limited output power. Here are the key features as advertised by the seller of this PA:

- Pout = 20W@28.7V / 10W@13.8V
- Gp > 50dB
- Integrated programmable attenuator up to 30dB attenuation in 0.5dB steps
- Pin = -20dBm … +10dBm
- Integrated SAW-Filter
- RF-Vox & PTT-Input
- Integrated detectors for FWD & REF power

Here is a picture of the inside of such an amplifier, which comes in very nice milled aluminium encasing with SMA jacks at the input and output. The gold plated PCB is using an RF suitable substrate from Rogers.



The RF input signal is first passing a SAW filter centered at 2.4GHz and then amplified by a first BGA614 MMIC stage.

Next, it is amplified by a BGA7205 variable gain amplifier. This amplifier features six digital inputs to set its gain. The gain of the amplifier can be programmed in 0.5dB steps in a range of 30dB using the DIP-switches inside the encasing. The overall maximum gain of the complete amplifier chain is more than 50dB.

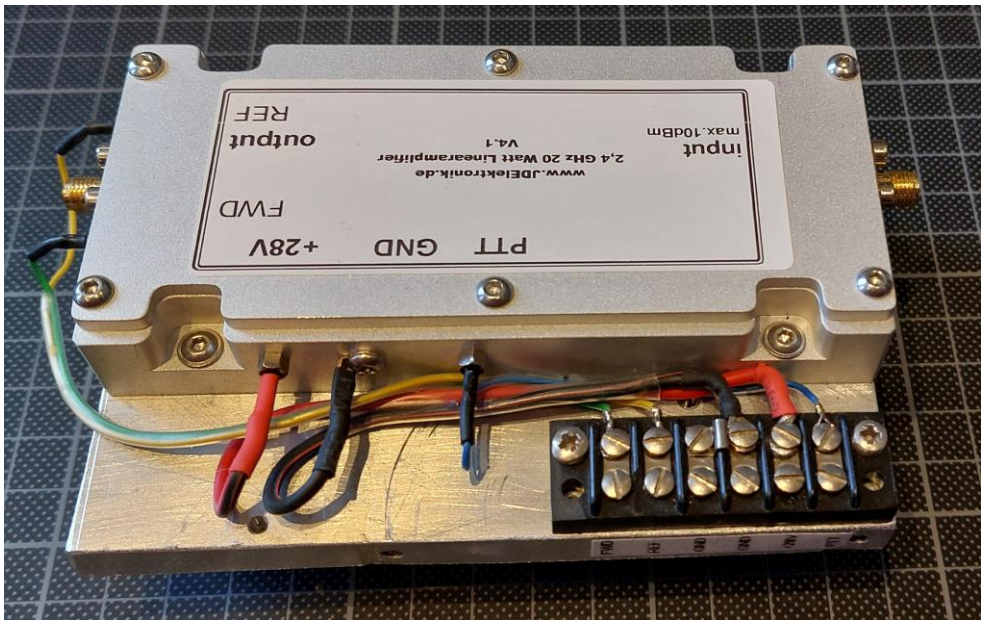
Thus, you can drive such a PA directly from an Adalm Pluto SDR, LimeSDR or other similar SDRs.

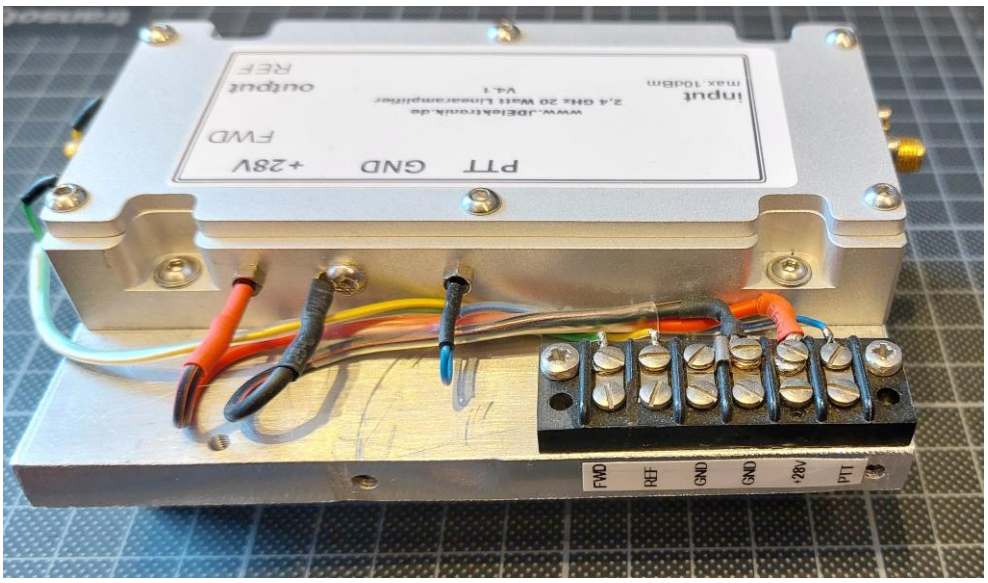
Before the signal reached the final power amplifier stage it is amplified by a MMG30271 pre-driver.
The final high power stage is using a discrete BLP9G0722 LDMOS transistor.

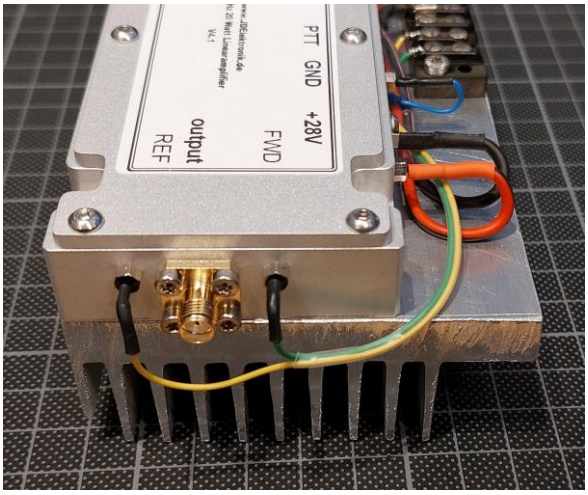
Between the final amplifier stage and the RF output jack a dual directional detector is implemented on the PCB, which couples part of the forward and reflected power to two detector diodes. Their DC output voltages, which are proportional to the measured RF power levels, are available at the outside of the module by feed-through capacitors.

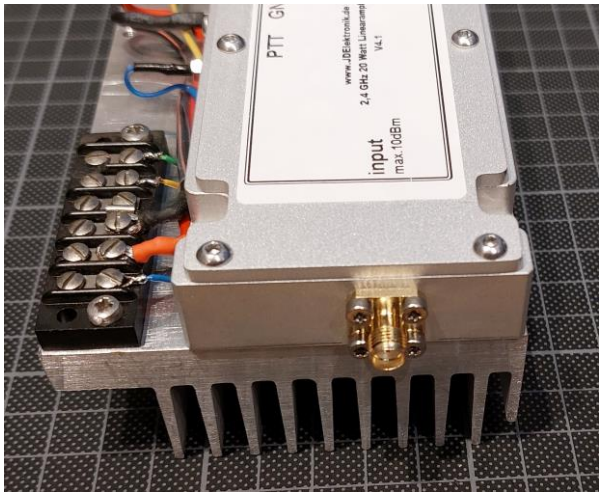
The complete amplifier module is powered by a single positive supply voltage in the range 13.8 to 28.7V. As there is a reverse polarity protection by a diode in the supply, the effective maximum supply voltage is 28V. Except for the final power amplifier stage, all other circuits are using internally regulated voltages.

I mounted my amplifier on a rather small heatsink, which turned out to be sufficient for normal SSB operations at shack temperatures. Here are some pictures of my setup:

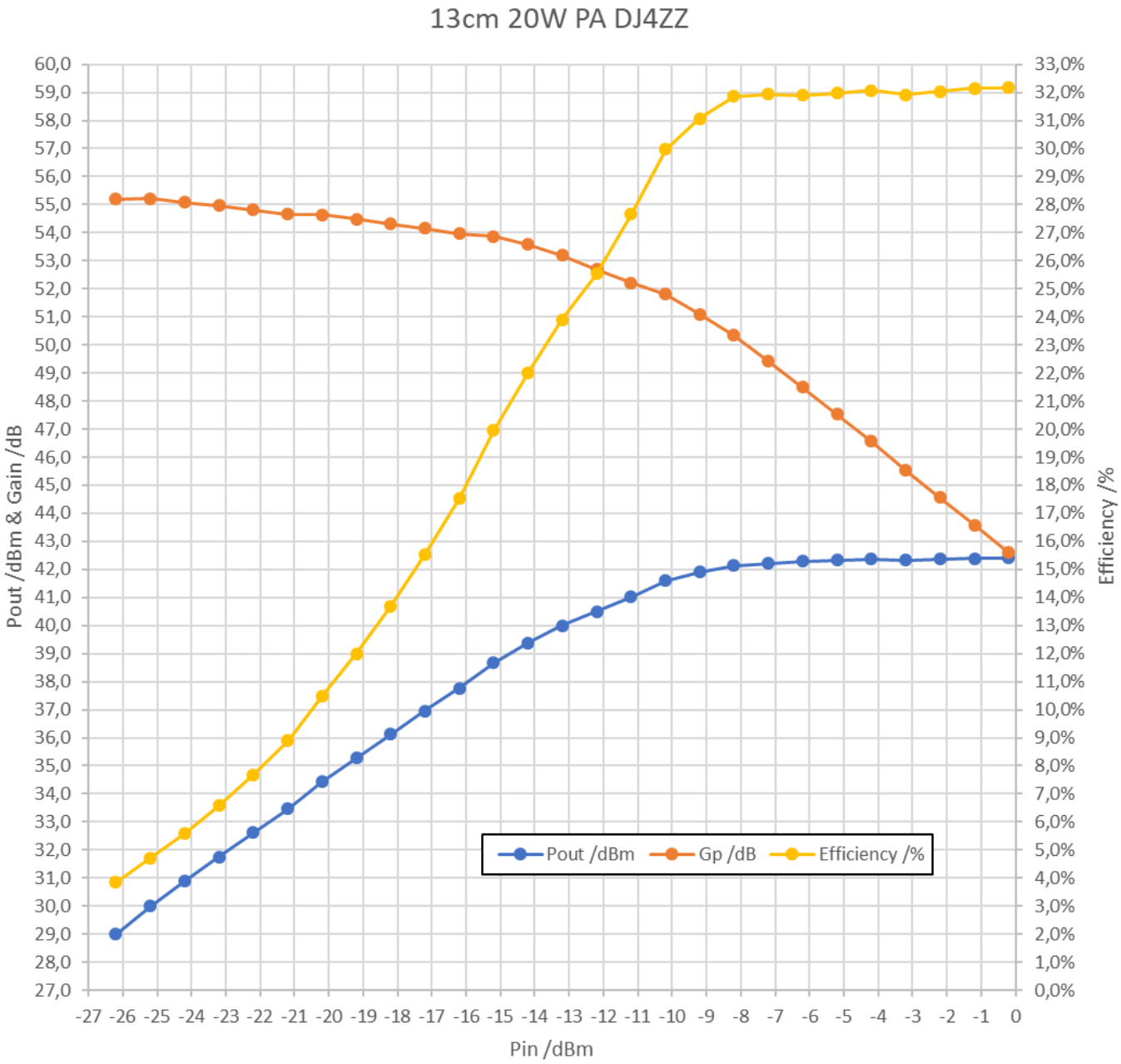





PTT GND +28V
FWD
output
REF


input
max. 10dBm

First, I measured output power and gain of the amplifier versus its input power at 2.4GHz using a supply voltage of 28V (internally 27.3V). I also measured the current consumption in order to be able to calculate the efficiency of the complete module as a function of input / output power. During this measurement, the DIP-switches inside the module were set for maximum gain of the amplifier (D0 to D5 were set to 1).

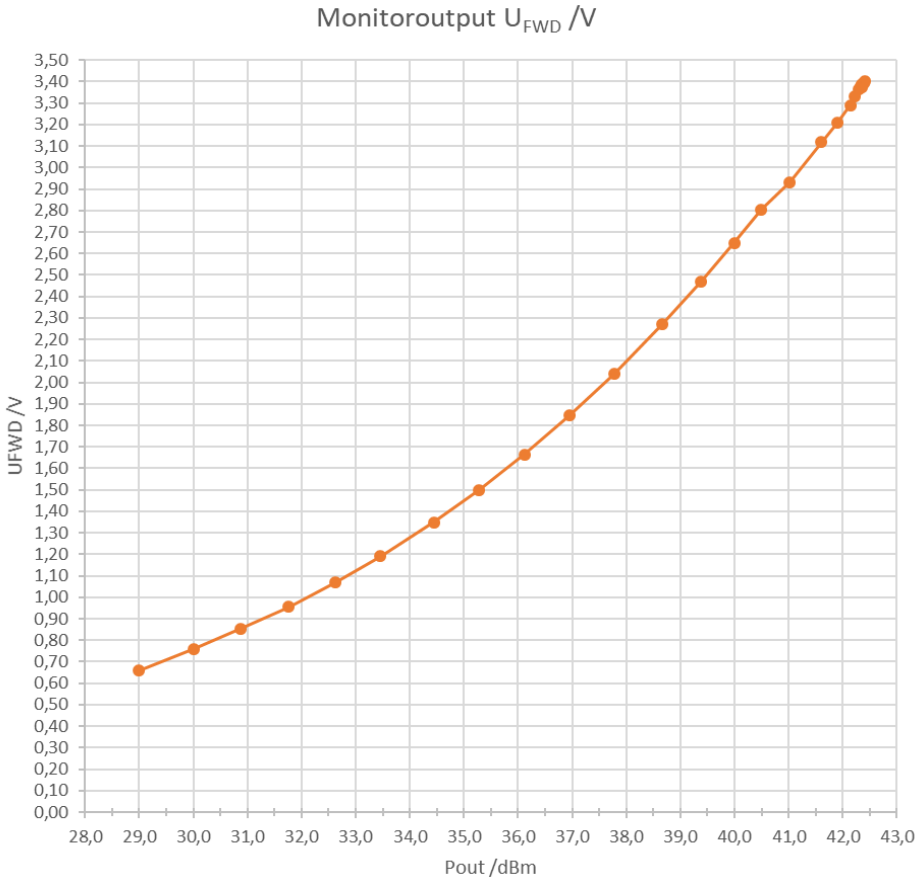


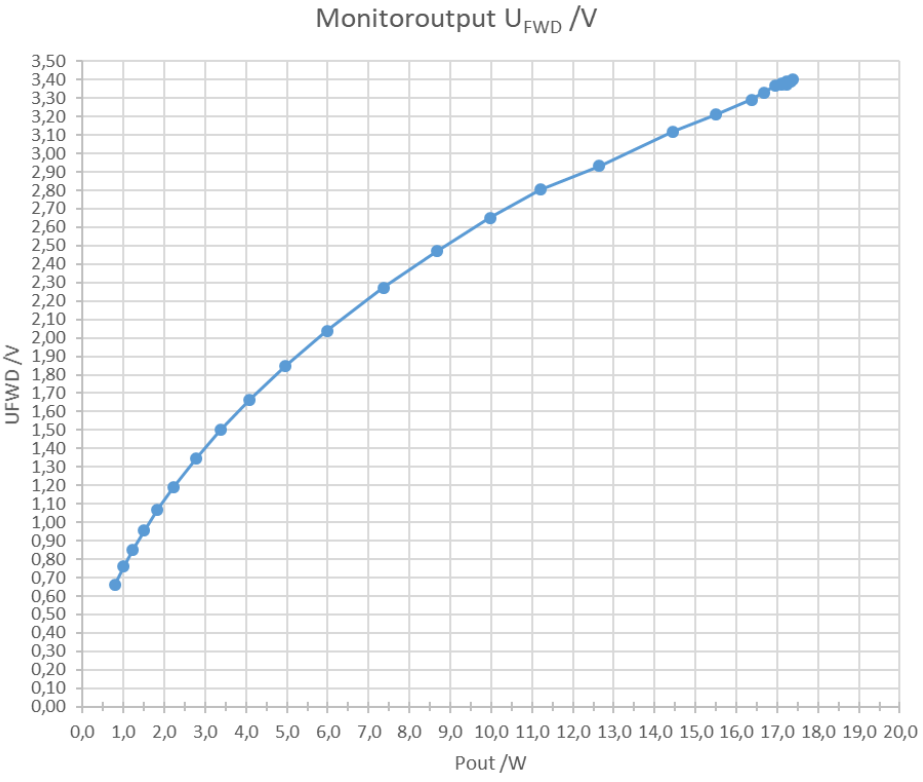
I measured a maximum gain of 55.2dB and a saturated output power of 42.4dBm (17.4W). Saturation is already achieved at an input power of -5dBm. As to be expected, maximum efficiency of 32.2% is reached when the amplifier is in saturation.

As we do not want to operate the amplifier in saturation, because this would result in poor intermodulation performance, an input power of -10dBm is suggested. This results in an output power of a 41dBm (12.6W). This level of -10dBm fits nicely to the maximum acceptable output power of the ADALM Pluto in order to also keep its signal clean. I have not performed any two tone or other intermodulation measurements.

The quiescent current consumption of the complete amplifier module (set at maximum gain) is 734mA. The maximum current consumption with the amplifier driven in full saturation is 1930mA @ 28V external supply voltage.

As mentioned before this amplifier module features dual directional couplers and thus forward and reflected power can be measured. The directional couplers are printed on the PCB and power is measured by diode detectors. I characterized only the coupler with detector measuring the forward power. Below please find the measured detector voltage versus output power at 2.4GHz. In the first diagram the x-axis is logarithmic (dBm), in the second it is linear (W).





In summary, this is a very nice amplifier module for operations on the narrowband transponder of QO-100.

Especially when used with SDR-Transceivers such as the ADALM Pluto or the LimeSDR no additional amplifier stages are needed as it is necessary with many other power amplifiers.

When operating with a linear upconverter/transverter with higher output power than the SDRs, the gain of the amplifier module can be adjusted to fit to the respective output power of the upconverter. Depending on the output power of your upconverter / transverter an additional fixed attenuator at its output may be needed. The levelling / fine tuning can be done with the integrated variable attenuator in 0.5dB steps.

The high output power of this amplifier module gives enough margin to use even smaller parabolic dishes as many use it during portable operations.

I find the monitor outputs for forward and reflected power very useful as it will allow you to monitor not only the output power of your transmit chain but also the VSWR of your antenna. Especially during portable operation, this avoids having to carry additional equipment.

I am not affiliated with the seller. I double-checked with Joerg DJ4ZZ when writing this review and he can still supply such PA modules for a price of 180€ including shipping in Germany. You can reach him at info@jdelektronik.de.

I am always grateful to get feedback and will be happy to answer questions.

Please direct them to the Email address, which you find below.

Best regards

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