Low noise amplifier for 23cm EME

Rev 2.0
November 4th 2018
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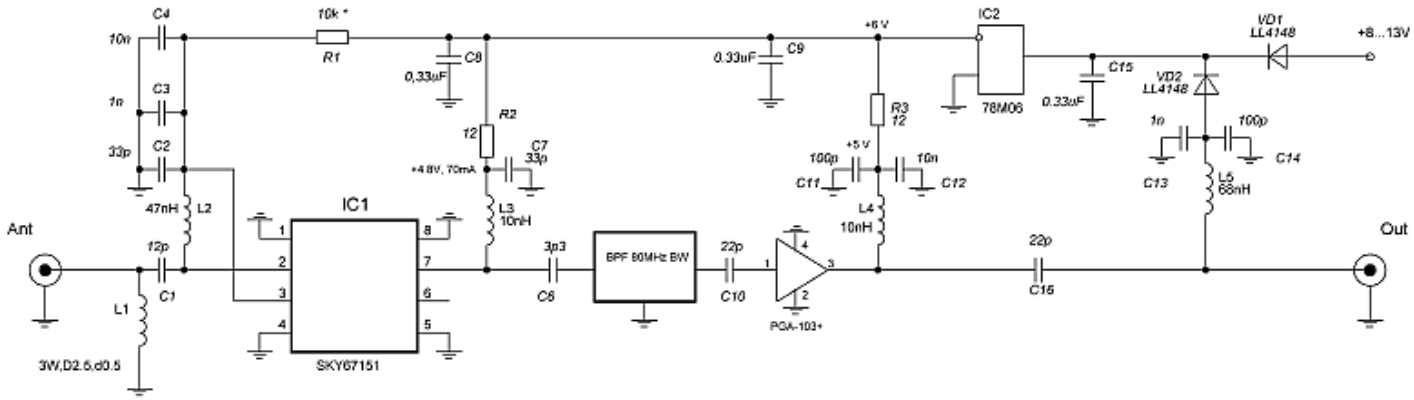
Hello,

I am presently constructing a portable station for EME (Earth-Moon-Earth) communication. Starting with the 23cm band I started to select a suitable low noise amplifier unit. Looking for the different options I decided to buy a ready-made amplifier from VHFdesign. This amplifier is specified to have a gain of >33dB and a noise figure of <0.3dB. With an OIP3=37dBm it provides good large signal capabilities. The maximum input power is +21dBm. The device needs a single supply voltage of +8 to+12V and the current consumption is 150mA. It is in a nice milled aluminium case and features SMA connectors at its input and output ports.

Here is a schematic of the amplifier:

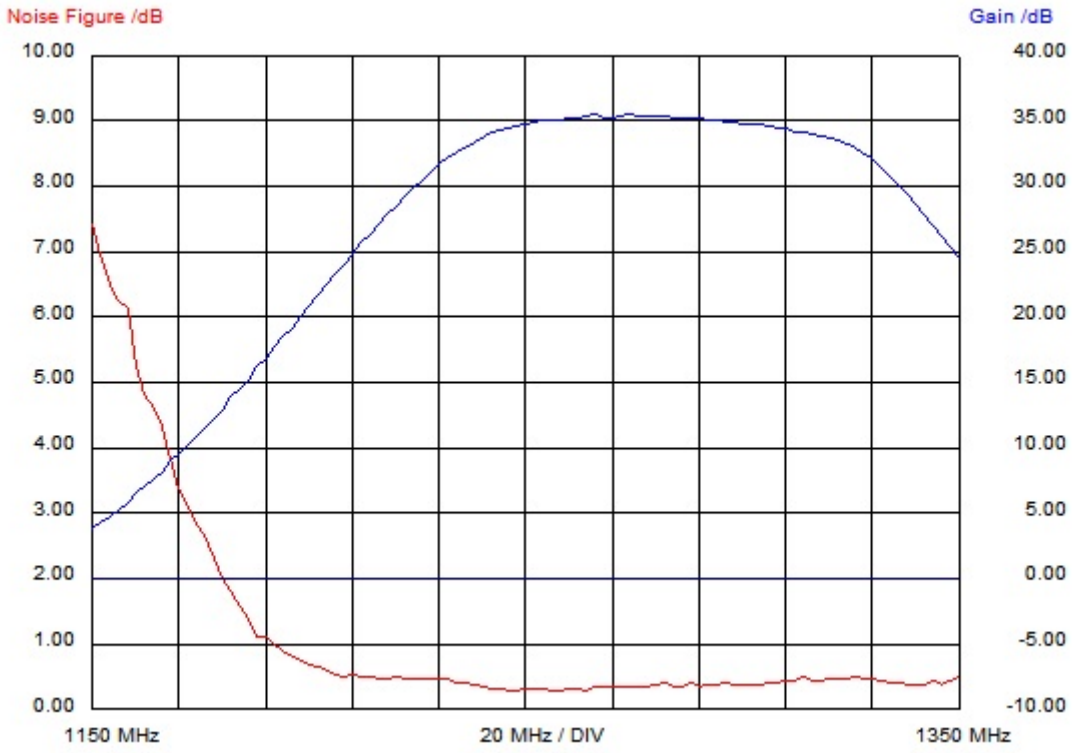


It is a 2-stage design with a Bandpass Filter with a bandwidth of 80 MHz between the first and second stage. The first stage uses a SKY67151 MMIC and the second stage is based on a PGA-103+ MMIC.

The dimensions of the amplifier are 110x43x20mm (including SMA connectors).

Detailed information can be found on the website of the supplier at www.vhfdesign.com

After I received the amplifier I made some measurements to verify its performance:



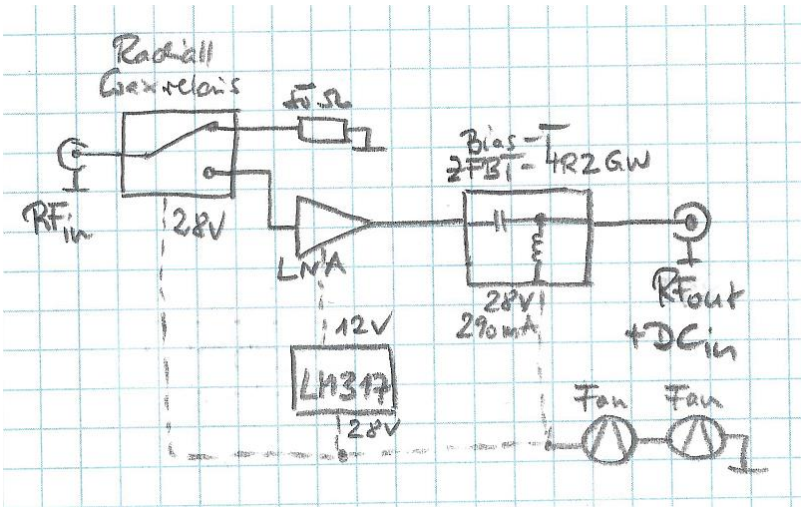
Frequency	Gain	Nf	Temp
1200 MHz	20.88 dB	0.70 dB	50.4 K
1202 MHz	21.71 dB	0.65 dB	46.9 K
1204 MHz	22.51 dB	0.60 dB	43.2 K
1206 MHz	23.26 dB	0.53 dB	37.7 K
1208 MHz	24.06 dB	0.51 dB	35.9 K
1210 MHz	24.77 dB	0.51 dB	36.4 K
1212 MHz	25.64 dB	0.51 dB	35.9 K
1214 MHz	26.33 dB	0.49 dB	34.7 K
1216 MHz	27.12 dB	0.46 dB	32.7 K
1218 MHz	27.91 dB	0.47 dB	33.5 K
1220 MHz	28.49 dB	0.48 dB	34.2 K
1222 MHz	29.28 dB	0.47 dB	33.2 K
1224 MHz	29.91 dB	0.47 dB	32.9 K
1226 MHz	30.45 dB	0.46 dB	32.1 K
1228 MHz	31.04 dB	0.47 dB	32.8 K
1230 MHz	31.73 dB	0.47 dB	32.8 K
1232 MHz	32.11 dB	0.48 dB	33.6 K
1234 MHz	32.69 dB	0.42 dB	29.4 K
1236 MHz	32.98 dB	0.41 dB	29.1 K
1238 MHz	33.43 dB	0.37 dB	25.7 K
1240 MHz	33.74 dB	0.35 dB	24.4 K
1242 MHz	34.06 dB	0.33 dB	22.6 K
1244 MHz	34.23 dB	0.32 dB	22.3 K
1246 MHz	34.51 dB	0.30 dB	20.5 K
1248 MHz	34.62 dB	0.28 dB	19.1 K
1250 MHz	34.80 dB	0.31 dB	21.2 K
1252 MHz	34.89 dB	0.30 dB	20.8 K
1254 MHz	35.08 dB	0.31 dB	21.1 K
1256 MHz	35.03 dB	0.30 dB	20.5 K
1258 MHz	35.07 dB	0.27 dB	18.8 K

1260 MHz	35.21 dB	0.31 dB	21.3 K
1262 MHz	35.16 dB	0.32 dB	22.4 K
1264 MHz	35.41 dB	0.29 dB	19.7 K
1266 MHz	35.46 dB	0.34 dB	23.9 K
1268 MHz	35.25 dB	0.33 dB	22.8 K
1270 MHz	35.19 dB	0.35 dB	24.6 K
1272 MHz	35.37 dB	0.35 dB	24.4 K
1274 MHz	35.47 dB	0.34 dB	23.6 K
1276 MHz	35.34 dB	0.34 dB	23.5 K
1278 MHz	35.32 dB	0.34 dB	23.9 K
1280 MHz	35.35 dB	0.38 dB	26.7 K
1282 MHz	35.40 dB	0.40 dB	27.6 K
1284 MHz	35.22 dB	0.33 dB	23.1 K
1286 MHz	35.25 dB	0.35 dB	24.1 K
1288 MHz	35.19 dB	0.40 dB	27.7 K
1290 MHz	35.22 dB	0.33 dB	23.1 K
1292 MHz	35.05 dB	0.38 dB	26.5 K
1294 MHz	35.08 dB	0.37 dB	25.6 K
1296 MHz	34.97 dB	0.42 dB	29.4 K
1298 MHz	34.96 dB	0.37 dB	26.1 K
1300 MHz	34.80 dB	0.38 dB	26.4 K
1302 MHz	34.73 dB	0.39 dB	26.9 K
1304 MHz	34.75 dB	0.39 dB	27.1 K
1306 MHz	34.54 dB	0.40 dB	27.9 K
1308 MHz	34.50 dB	0.39 dB	27.5 K
1310 MHz	34.43 dB	0.43 dB	30.5 K
1312 MHz	34.21 dB	0.44 dB	31 K
1314 MHz	34.15 dB	0.50 dB	35.5 K
1316 MHz	33.95 dB	0.43 dB	30.1 K
1318 MHz	33.88 dB	0.43 dB	30 K
1320 MHz	33.72 dB	0.45 dB	31.8 K
1322 MHz	33.54 dB	0.46 dB	32.5 K
1324 MHz	33.18 dB	0.45 dB	32 K
1326 MHz	32.86 dB	0.49 dB	34.7 K
1328 MHz	32.45 dB	0.47 dB	33.2 K
1330 MHz	32.12 dB	0.47 dB	33 K
1332 MHz	31.39 dB	0.43 dB	30.2 K
1334 MHz	30.84 dB	0.42 dB	29.3 K
1336 MHz	30.05 dB	0.42 dB	29.2 K
1338 MHz	29.46 dB	0.37 dB	26 K
1340 MHz	28.59 dB	0.38 dB	26.8 K
1342 MHz	27.85 dB	0.39 dB	27.1 K
1344 MHz	26.96 dB	0.42 dB	29.7 K
1346 MHz	26.20 dB	0.36 dB	25.3 K
1348 MHz	25.39 dB	0.42 dB	29.5 K
1350 MHz	24.54 dB	0.49 dB	34.6 K

In the 23cm band the noise figure is between 0.3dB and 0.4dB. The respective gain is approximately 35dB.

Next, I integrated the LNA together with the necessary components in an encasing. I have chosen an ABS plastic box with the dimensions 115x90x55mm as I wanted to minimize the size and weight of the complete amplifier unit, which needs to attached directly to the septum feed. The complete amplifier includes:
- the LNA 23cm - EME from vhfdesign
- 1 coaxial relay from Radiall to protect the LNA during TX periods (insertion loss 0.02dB, isolation 80dB)
- 1 50 Ohm absorber which is connected during TX periods to the antenna input of the LNA by the coaxial relay
- 1 Bias-T to allow phantom feed through the coaxial cable from the Transceiver
- 1 linear voltage regulator to generate the 12V supply for the LNA from the 28V supplied through the Bias-T
- 2 fans, one blowing air into the encasing and the other sucking air out of the encasing.

Here is sketch of the block diagram:



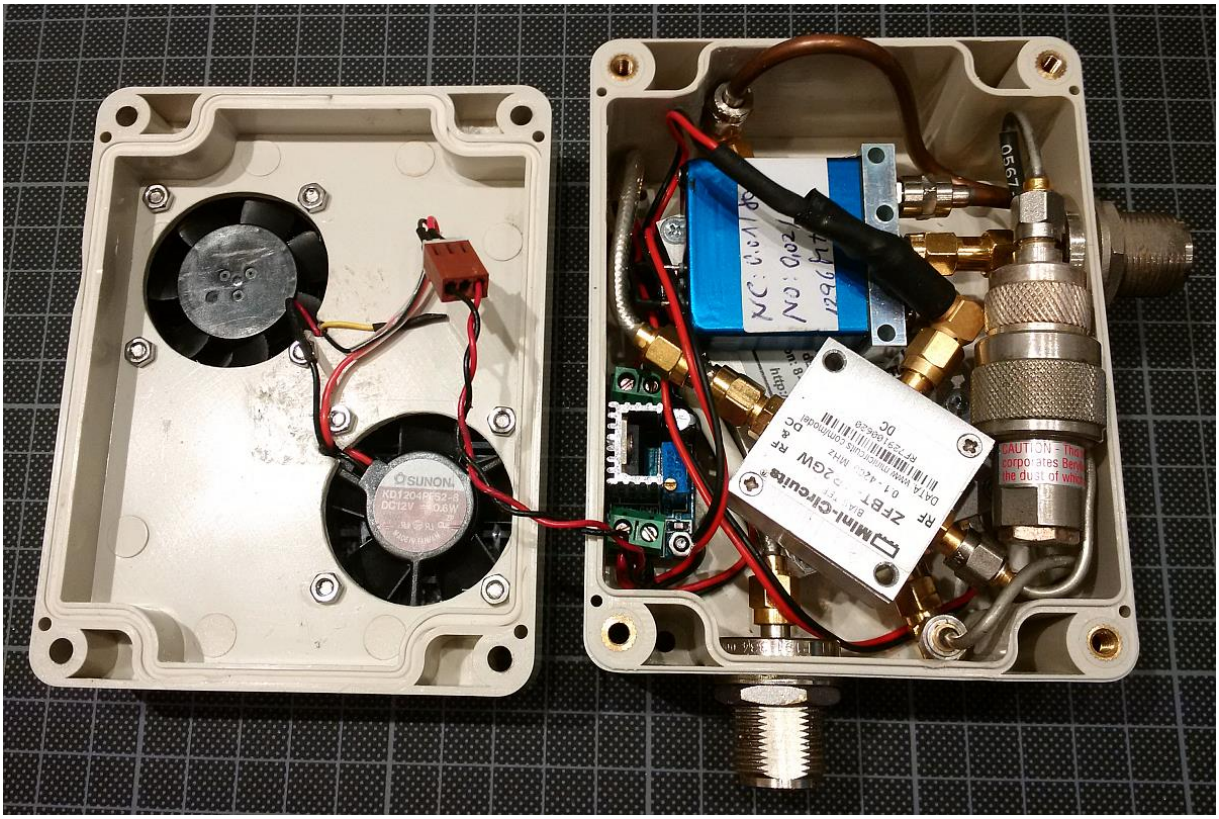
Some remarks on the setup: all RF connections are done either with high quality adapters or semi-rigid-cables with low loss and high isolation. High quality feedthrough adapters Nfemale-SMAfemale were mounted into the plastic encasing to provide the ports for RF input and RF output. Inside all RF connectors are SMA. The coaxial relay from Radiall was selected from some I had available for minimum insertion loss. I have chosen a linear voltage regulator based on an LM317 to avoid any generation of EMI noise by a switched power supply. The total power consumption of the LNA is 8W. Thus, I decided to add two small fans, one blowing in cool air and the other exhausting warm air out of the encasing. Using a DC-DC-converter would have reduced the total power consumption from 8W to approx. 6W. However, that would not have avoided the need for cooling fans.

Here are pictures of the completed amplifier:

Completed 23cm EME low noise amplifier (115x90x55mm, 620g)

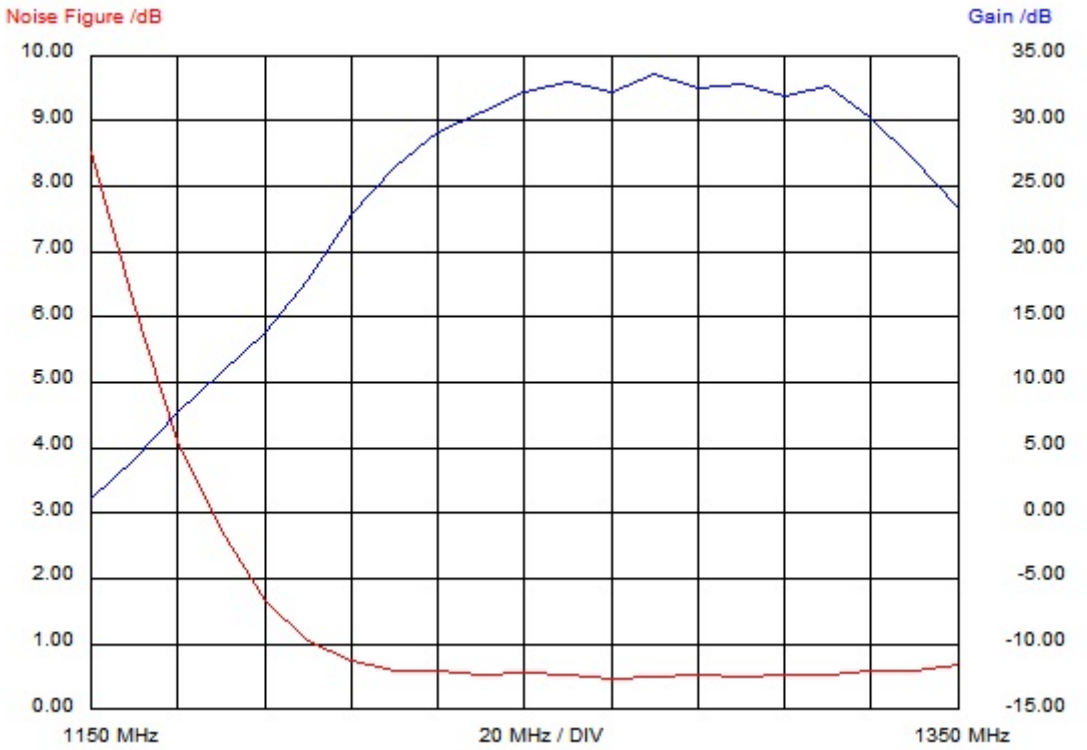
23cm EME low noise amplifier attached to RX port of Septum Feed

The Septum Feed needs a fare to make its beamwidth narrower to match my dish



As can be seen on the next picture the plastic box is pretty full

Here is the measured data of the complete amplifier as it was shown above:



Frequency	Gain	Nf	Temp
1150 MHz	1.07 dB	8.51 dB	1767.3 K
1160 MHz	4.12 dB	6.13 dB	899.5 K
1170 MHz	7.71 dB	4.11 dB	456.3 K
1180 MHz	10.81 dB	2.74 dB	254.7 K
1190 MHz	13.89 dB	1.66 dB	135.4 K
1200 MHz	17.87 dB	1.05 dB	79.6 K
1210 MHz	22.82 dB	0.74 dB	53.8 K
1220 MHz	26.62 dB	0.60 dB	42.8 K
1230 MHz	29.20 dB	0.59 dB	41.9 K
1240 MHz	30.71 dB	0.53 dB	37.6 K
1250 MHz	32.20 dB	0.56 dB	40.3 K
1260 MHz	32.93 dB	0.52 dB	37.1 K
1270 MHz	32.14 dB	0.48 dB	33.8 K
1280 MHz	33.58 dB	0.51 dB	36.1 K
1290 MHz	32.55 dB	0.53 dB	38 K
1300 MHz	32.89 dB	0.49 dB	34.7 K
1310 MHz	31.85 dB	0.51 dB	36.5 K
1320 MHz	32.61 dB	0.52 dB	36.8 K
1330 MHz	30.28 dB	0.59 dB	42.5 K
1340 MHz	27.00 dB	0.59 dB	42.5 K
1350 MHz	23.28 dB	0.67 dB	48.3 K

I always appreciate feedback. Please send it to the Email address below.

Best regards

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