Analysis of an unknow biconical omni antenna for S-band

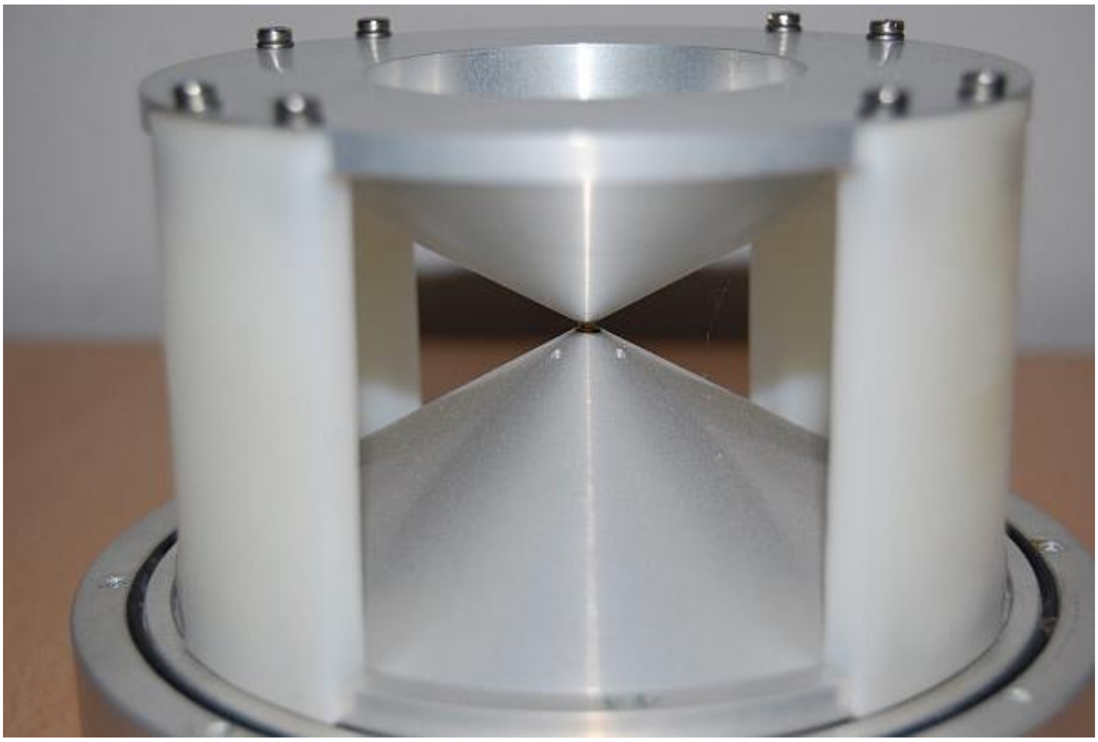
Matthias, DD1US, January 21st 2019

Recently I found some interesting omnidirectional active antennas on Ebay. I could not find out the original purpose and application. The antenna is housed in a fiberglass radome and consists of a biconical antenna a low noise amplifier with some supporting electronics, which is all housed in a massive milled aluminium encasing and gives a very professional impression.

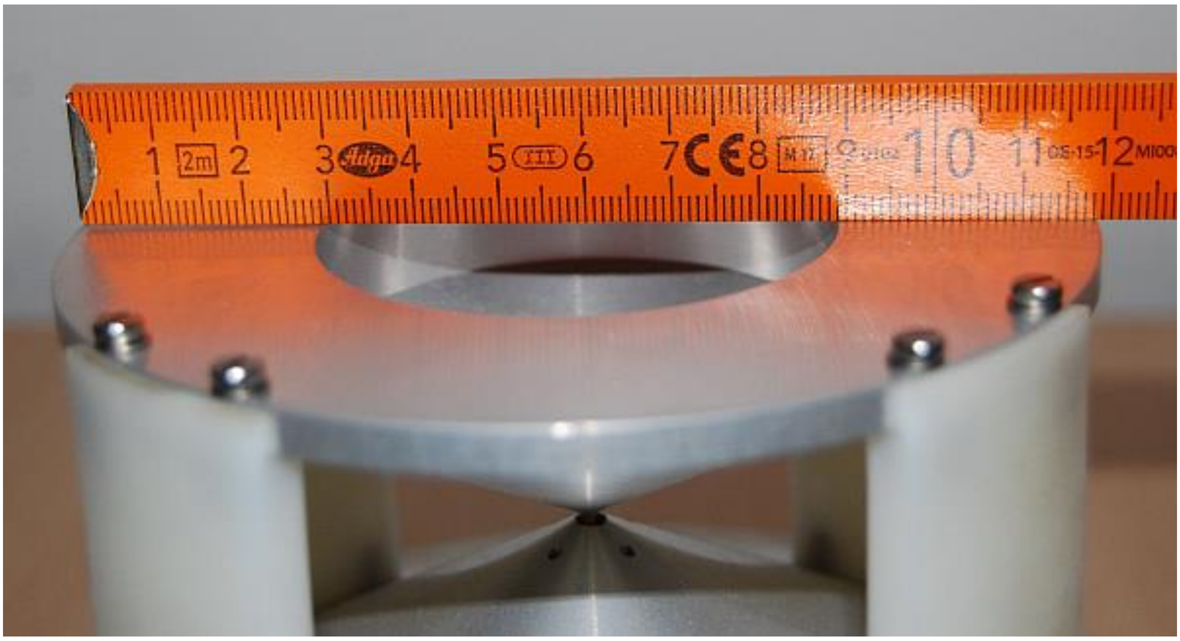
Here are some pictures of the antenna:

Complete antenna with fibre glass radome

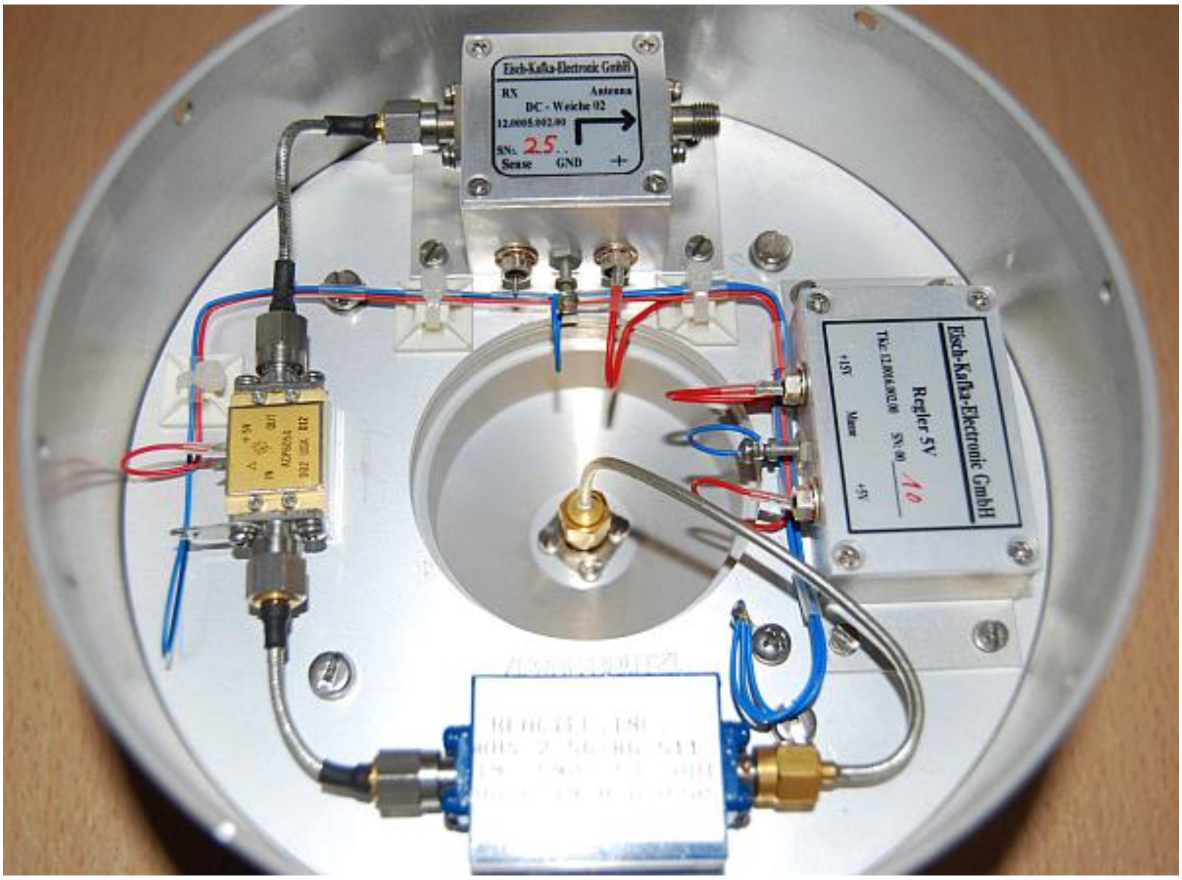
Radome and baseplate removed



Biconical antenne with Teflon holders

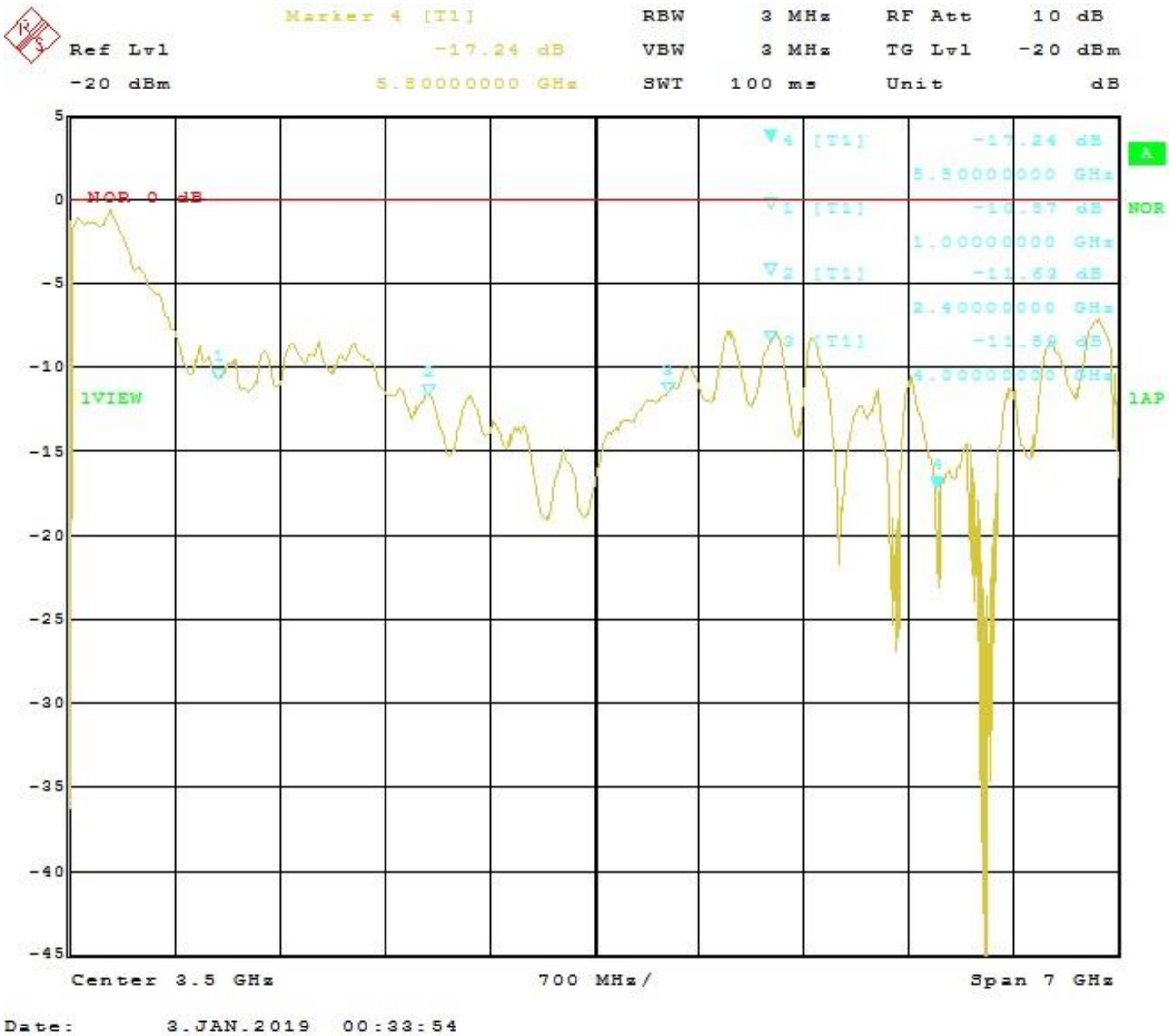


Top of biconical antenna



Electronic components mounted in a cavity under the antenna

I measured the return loss of the antenna in the frequency range 0-7 GHz:



The return loss starting already at around 700 MHz is about 10dB. This is not really very good but probably good enough for a receive-only antenna.

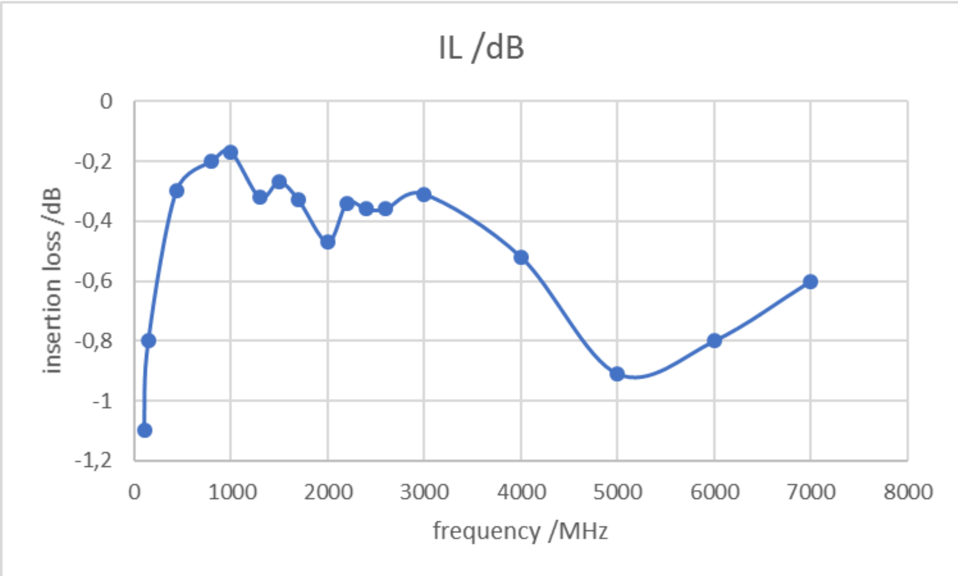
At the output of the antenna some of the antennas units feature a limiter to protect the subsequent amplifier against excess power from strong radio transmitters. In the picture which was shown before this limiter is not assembled.

The limiter device is from Aeroflex (previously Advanced Control Elements) and has the part number ACLM-4700FC36.

Here are its main specified parameters:
f=0.5-6GHz, P_{CW}=2W, P_{peak}=100W, IL_{max}=0.8dB, $VSWR_{max}$=1.5:1, $Leakage_{max}$=13.5dBm

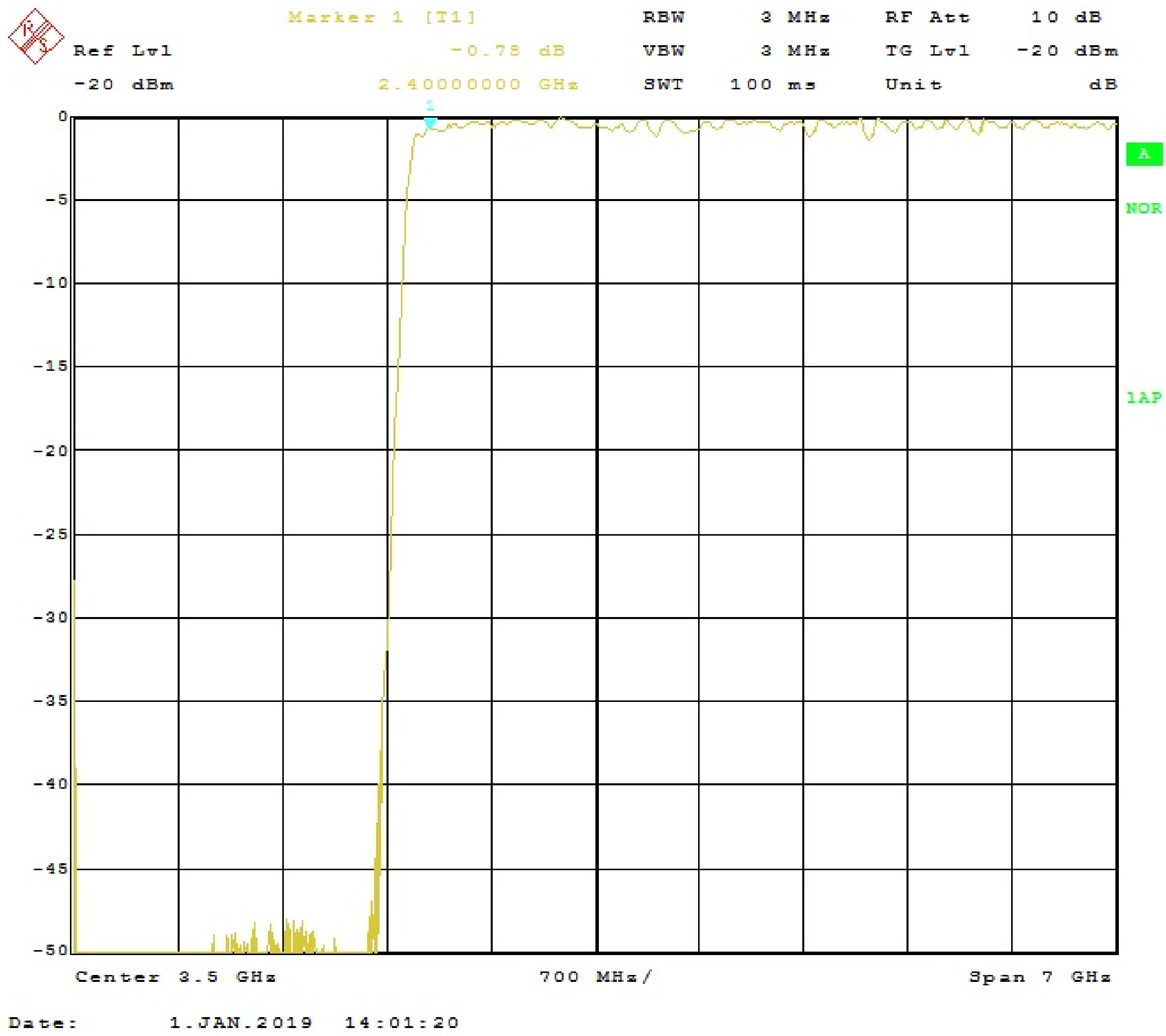
This is the insertion loss versus frequency, measured at an input power level of -20dBm:

f /MHz	IL /dB
100	-1,1
145	-0,8
435	-0,3
800	-0,2
1000	-0,17
1296	-0,32
1500	-0,27
1700	-0,33
2000	-0,47
2200	-0,34
2400	-0,36
2600	-0,36
3000	-0,31
4000	-0,52
5000	-0,91
6000	-0,8
7000	-0,6

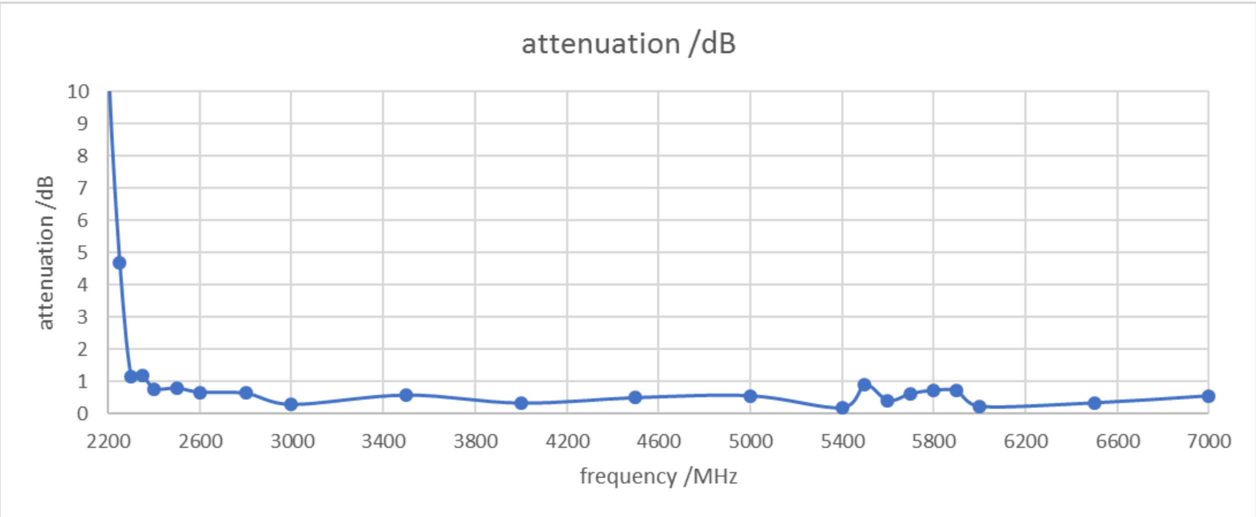


The limiter is followed by a bandpass filter from Reactel Inc. The part number is 8HS 2.5G/8G S11. This filter has a specified pass band from 2.5 to 8 GHz.

Here is the insertion loss of this filter measured in the frequency range DC to 7 GHz (which is the limit of my setup):



Here is a graph of the passband insertion loss and a table of the measured insertion loss.

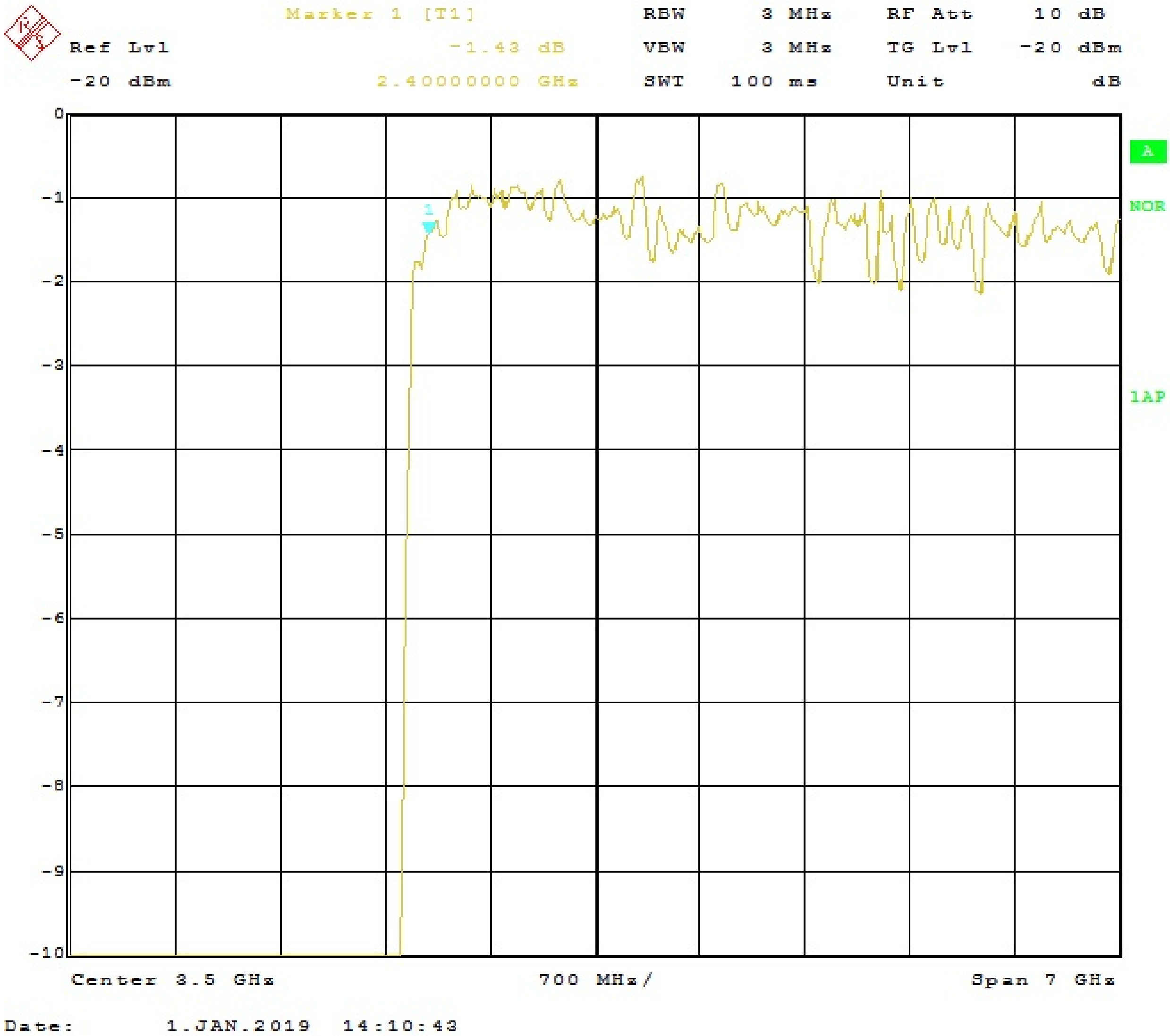


f /MHz	att /dB
1950	50
2000	46
2050	40
2100	31
2150	22
2200	11
2250	4,7
2300	1,15
2350	1,19
2400	0,78
2500	0,8
2600	0,67
2800	0,64
3000	0,29
3500	0,58
4000	0,33
4500	0,5
5000	0,56
5400	0,19
5500	0,9
5600	0,41
5700	0,63
5800	0,73
5900	0,71
6000	0,23
6500	0,34
7000	0,56

The 13cm ham radio band and the 2.4 GHz WLAN band are passed with low insertion loss but right below the 13cm ham radio band the filter shows a rather steep slope. Thus, cellular phone signals between 800 MHz and 2200 MHz are effectively attenuated, which is very nice.

What I do not understand is, why the limiter is placed between the antenna and the filter. I would rather put the limiter behind the filter as the passive filter should be able to withstand high power levels without problems and the filter might already reject some strong RF signals which would otherwise trigger the limiter and thus cause intermodulation. Inputs are appreciated.

I also measured the insertion loss of the combination of limiter and filter. This is shown in the next diagram. Please note that the vertical scaling has been changed to 1dB / div.



The output of the filter is connected to the input of a wideband amplifier. This amplifier is from Teledyne and has the part number ACP6054.

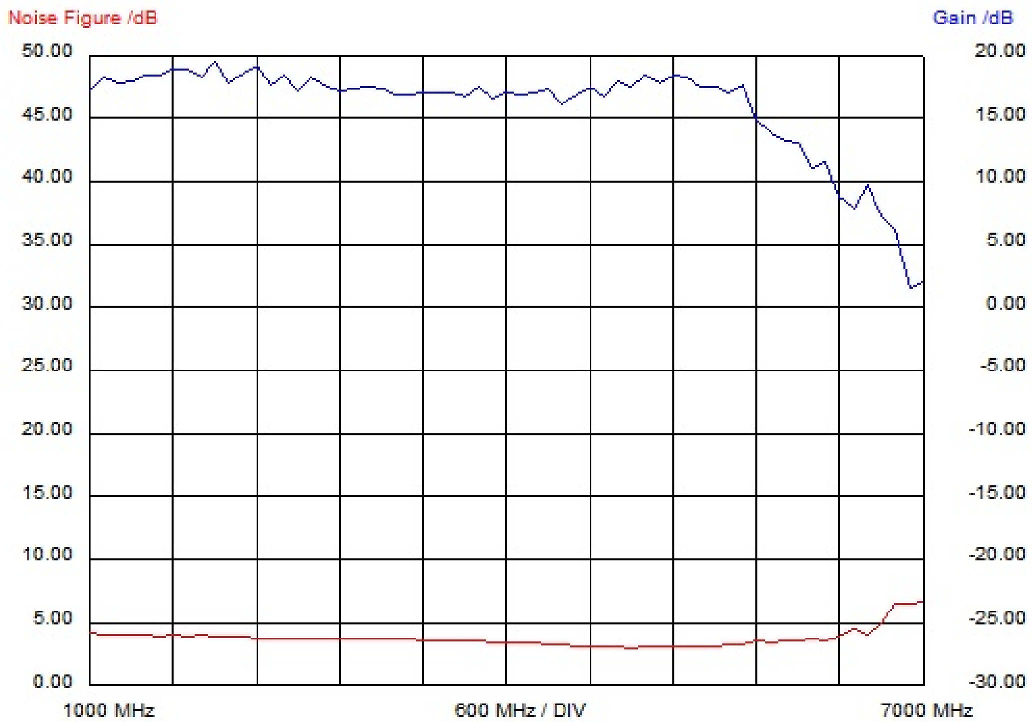
I have not found specification data of the LNA ACP6054, however I assume it is actually an AS6054 device in a special module type package with SMA connectors.

Here are the electrical specifications for the AS6054 amplifier (@ 1.0-6.0 GHz):

Gain:	17.5dB
Gain flatness:	±0.8db
Noise figure:	<4.3dB
P1dB:	+19dBm
OIP2:	+58dBm
OIP3:	+30dBm
Output impedance:	50 Ohms
Supply voltage:	5.0 VDC (max. 8V)
Supply current:	110 mA

The output of the amplifier is connected to a bias-t, which extracts the DC voltage supplied via the coaxial cable connecting the antenna to the receiver. This voltage is regulated using a 5V linear regulator to the necessary +5V supply of the LNA. The supply voltage range of the phantom feed is approximately +6.5V to +20V. Bias-T and 5V regulator unit are from Eisch-Kafka-Elektronik GmbH in Germany, who also developed the whole active antenna unit.

Here is the measured gain and noise figure between 1 and 7 GHz.

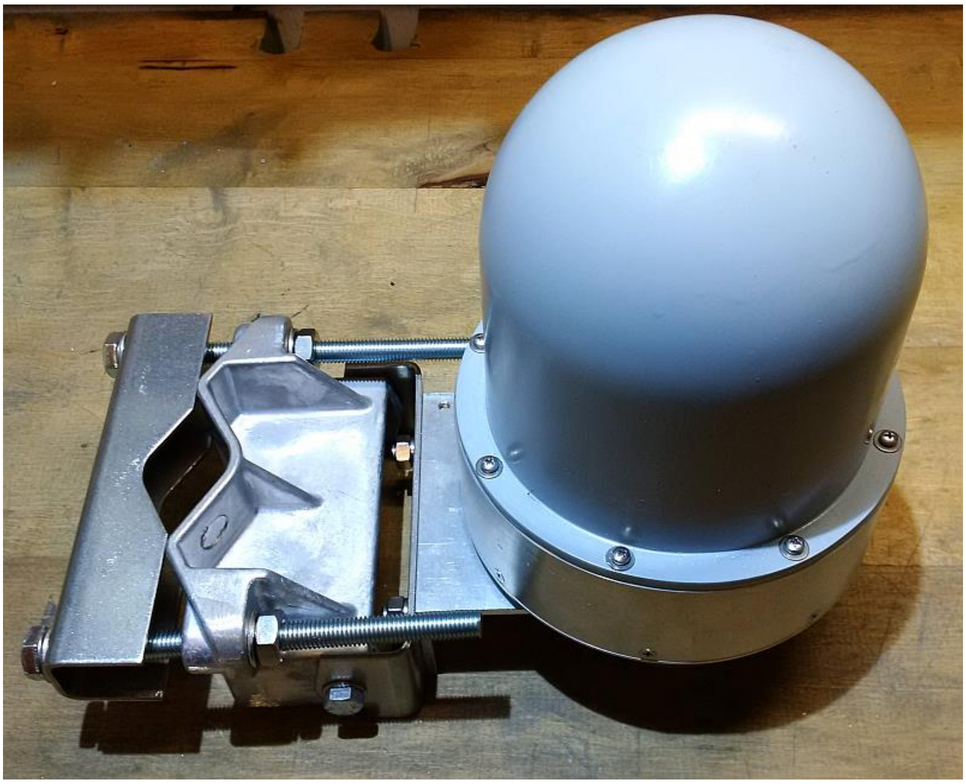


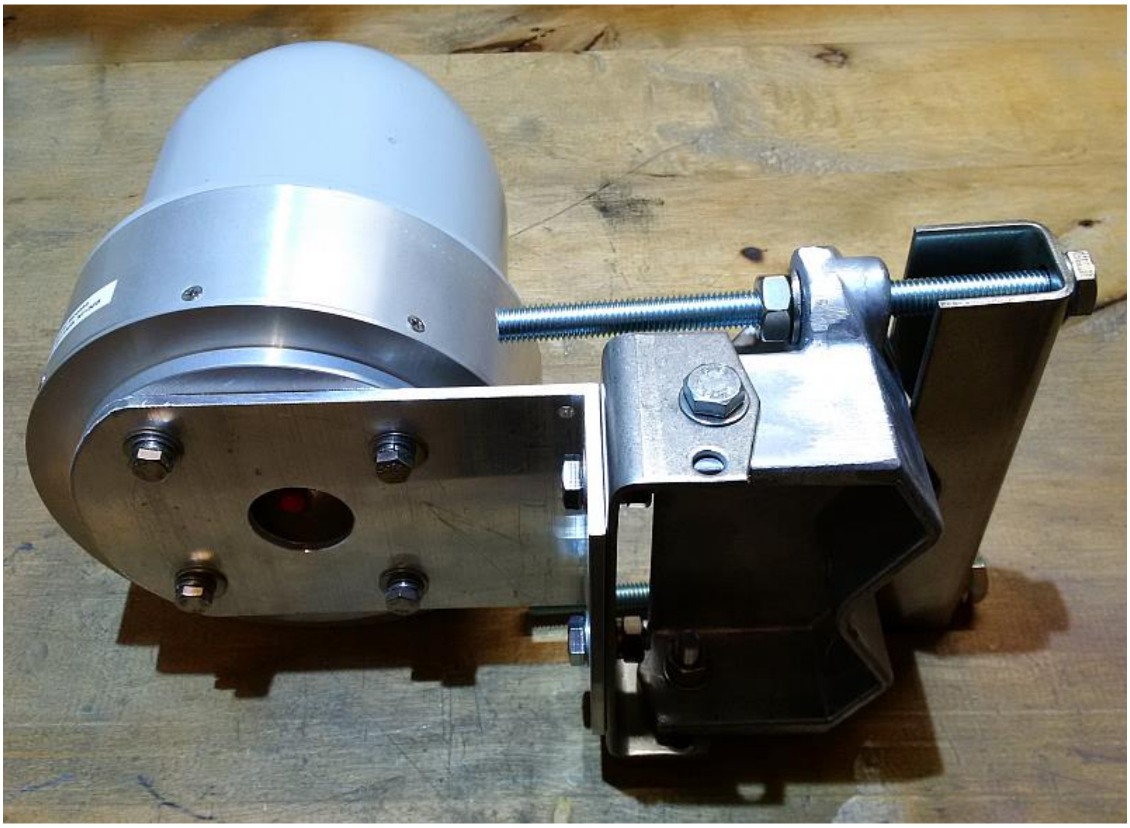
The measured current consumption including the voltage regulator is 120mA. As the current consumption of the voltage regulator is about 6mA this fits quite well with specification of the AS6054. Also, the measured RF data corresponds very well with the above specification. The measured noise figure is actually better than specified.

Here is a table of the measurement data:

Frequency	Gain	NF
1000 MHz	17.19 dB	4.11 dB
1100 MHz	18.23 dB	4.09 dB
1200 MHz	17.83 dB	4.07 dB
1300 MHz	17.94 dB	4.03 dB
1400 MHz	18.43 dB	3.98 dB
1500 MHz	18.42 dB	3.94 dB
1600 MHz	18.91 dB	3.96 dB
1700 MHz	18.92 dB	3.90 dB
1800 MHz	18.22 dB	3.97 dB
1900 MHz	19.45 dB	3.88 dB
2000 MHz	17.81 dB	3.89 dB
2100 MHz	18.56 dB	3.83 dB
2200 MHz	19.15 dB	3.77 dB
2300 MHz	17.67 dB	3.73 dB
2400 MHz	18.50 dB	3.77 dB
2500 MHz	17.24 dB	3.75 dB
2600 MHz	18.32 dB	3.70 dB
2700 MHz	17.56 dB	3.71 dB
2800 MHz	17.21 dB	3.71 dB
2900 MHz	17.39 dB	3.63 dB
3000 MHz	17.45 dB	3.64 dB
3100 MHz	17.40 dB	3.67 dB
3200 MHz	16.95 dB	3.66 dB
3300 MHz	16.86 dB	3.64 dB
3400 MHz	17.12 dB	3.58 dB
3500 MHz	17.08 dB	3.62 dB
3600 MHz	17.03 dB	3.54 dB
3700 MHz	16.80 dB	3.51 dB
3800 MHz	17.44 dB	3.50 dB
3900 MHz	16.59 dB	3.47 dB
4000 MHz	17.03 dB	3.37 dB
4100 MHz	16.87 dB	3.35 dB
4200 MHz	17.04 dB	3.33 dB
4300 MHz	17.31 dB	3.25 dB
4400 MHz	16.10 dB	3.22 dB
4500 MHz	16.92 dB	3.14 dB
4600 MHz	17.48 dB	3.09 dB
4700 MHz	16.69 dB	3.12 dB
4800 MHz	18.01 dB	3.04 dB
4900 MHz	17.58 dB	2.99 dB
5000 MHz	18.40 dB	3.04 dB
5100 MHz	17.76 dB	3.07 dB
5200 MHz	18.37 dB	3.06 dB
5300 MHz	18.34 dB	3.07 dB
5400 MHz	17.52 dB	3.14 dB
5500 MHz	17.46 dB	3.16 dB
5600 MHz	17.11 dB	3.24 dB
5700 MHz	17.72 dB	3.26 dB
5800 MHz	14.94 dB	3.50 dB
5900 MHz	13.81 dB	3.36 dB
6000 MHz	13.25 dB	3.62 dB
6100 MHz	13.12 dB	3.51 dB
6200 MHz	11.04 dB	3.65 dB
6300 MHz	11.59 dB	3.60 dB
6400 MHz	8.80 dB	3.78 dB
6500 MHz	7.86 dB	4.51 dB
6600 MHz	9.69 dB	3.99 dB
6700 MHz	7.24 dB	4.97 dB
6800 MHz	6.19 dB	6.48 dB
6900 MHz	1.66 dB	6.45 dB
7000 MHz	2.09 dB	6.62 dB
7100 MHz	-0.38 dB	7.65 dB

As my antenna had some dents in the radome I repaired and repainted it. Also I attached a solid bracket in order to be able to mount it to a mast. Here are some pictures of the final setup:





As a summary I it is a very nice active antenna to monitor the 2.4 GHz and 5.8 GHz WLAN bands and anything in between. The system noise figure will be between 4 and 5dB and the large signal capability is quite high.

If anyone has more information about these antennas and especially where they were used for I appreciate your feedback.

I am always happy to answer questions. Please direct them to my Email address given below.

Best regards

Matthias Email: dd1us@amsat.org Homepage: www.dd1us.de