

Problems with the measurement of a 5.7GHz LNA

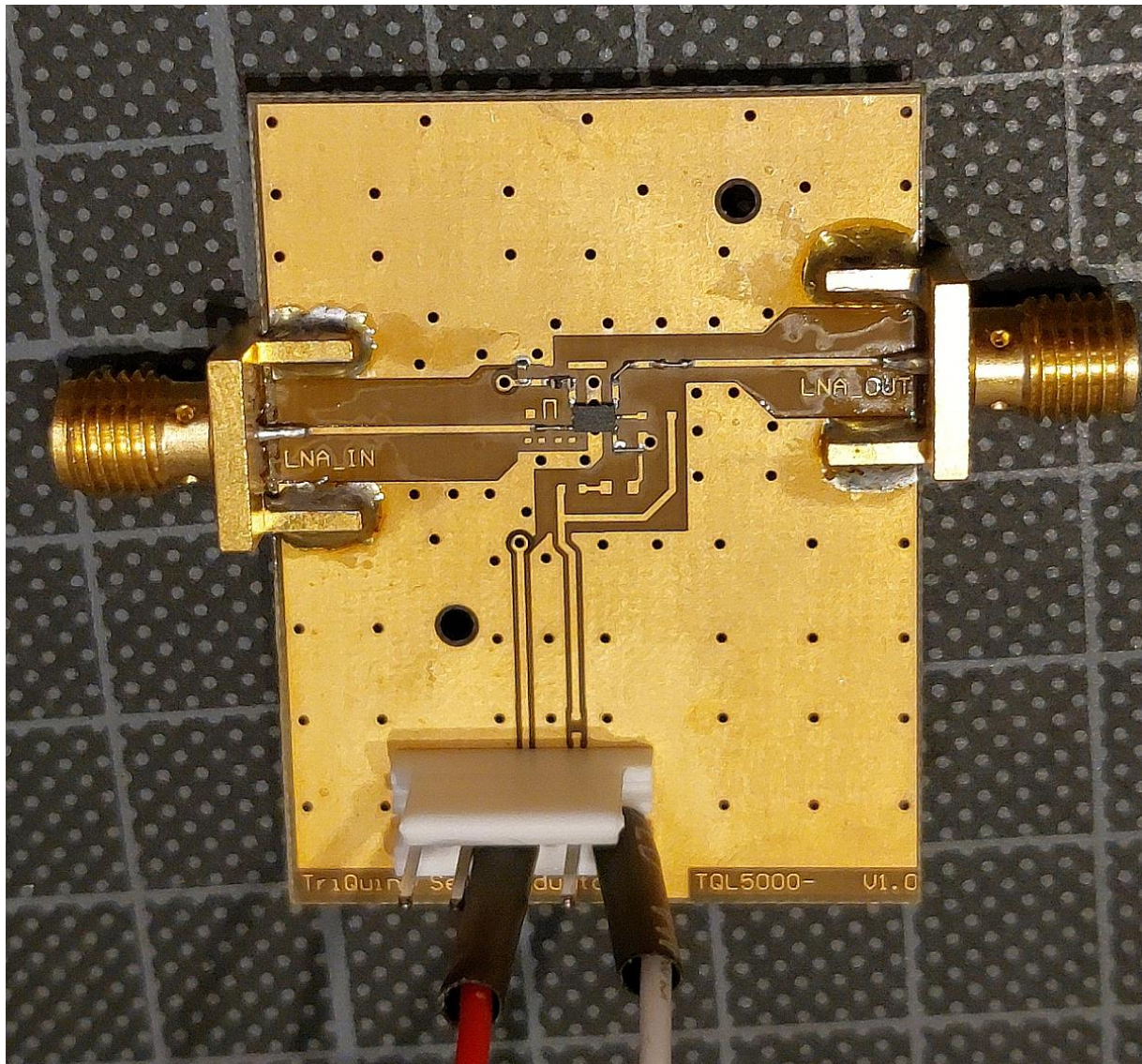
Matthias, DD1US, April 9th 2024

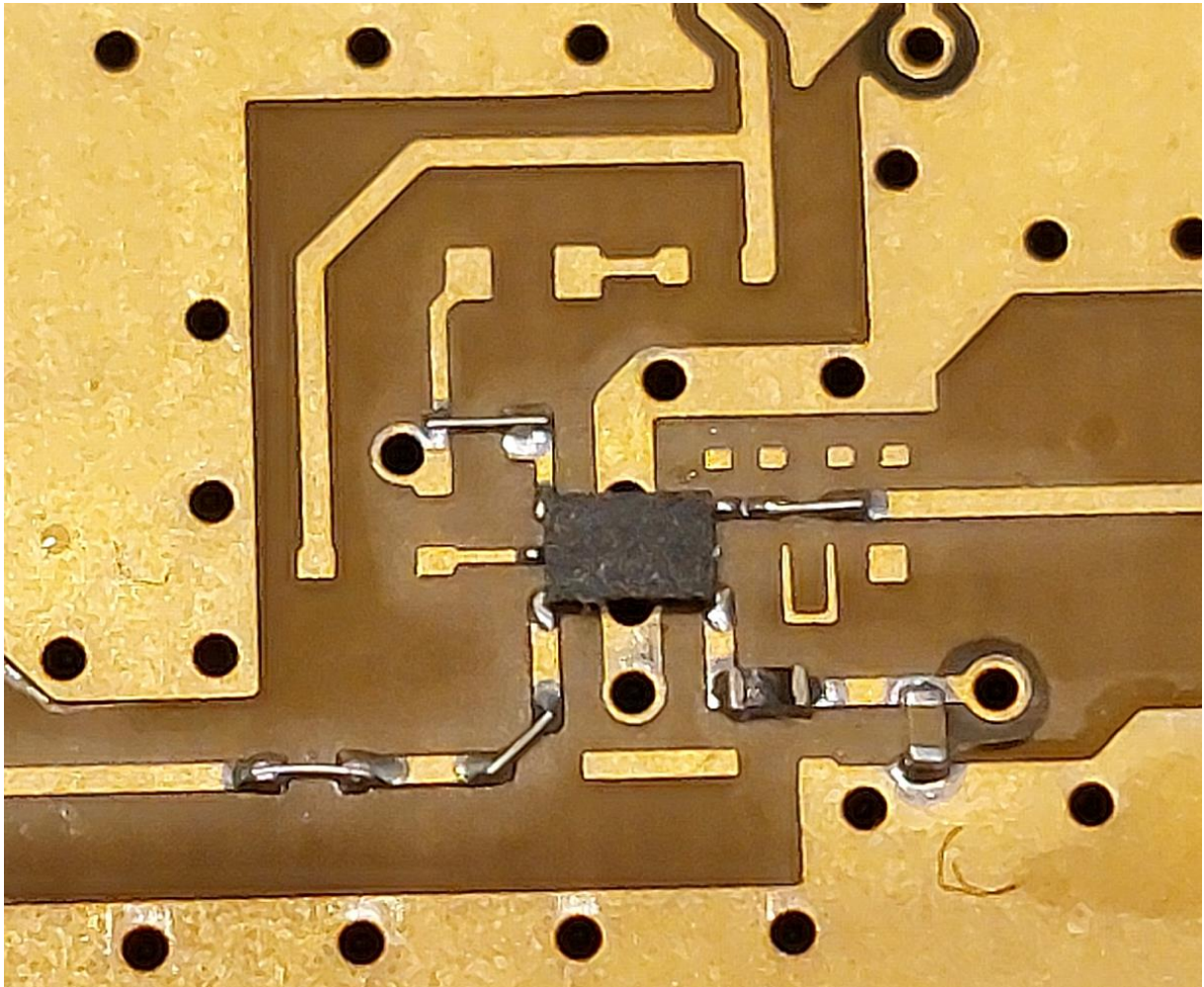
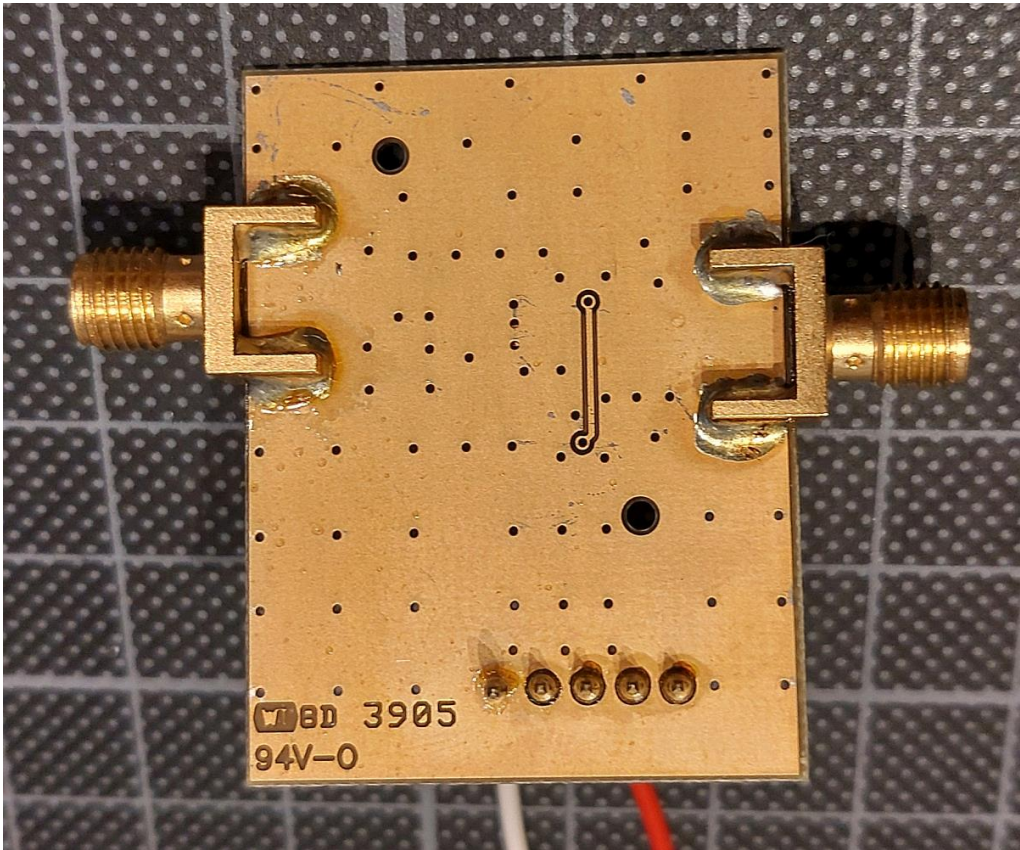
Recently I made some noise figure measurements at a 5.7GHz LNA. It is a Triquint TQL5000 MMIC on a demoboard. This MMIC is internally matched and intended for 5.8GHz WLAN 802.11 applications.

The key specification of this LNA, which is using a GaAs pHEMT technology are:

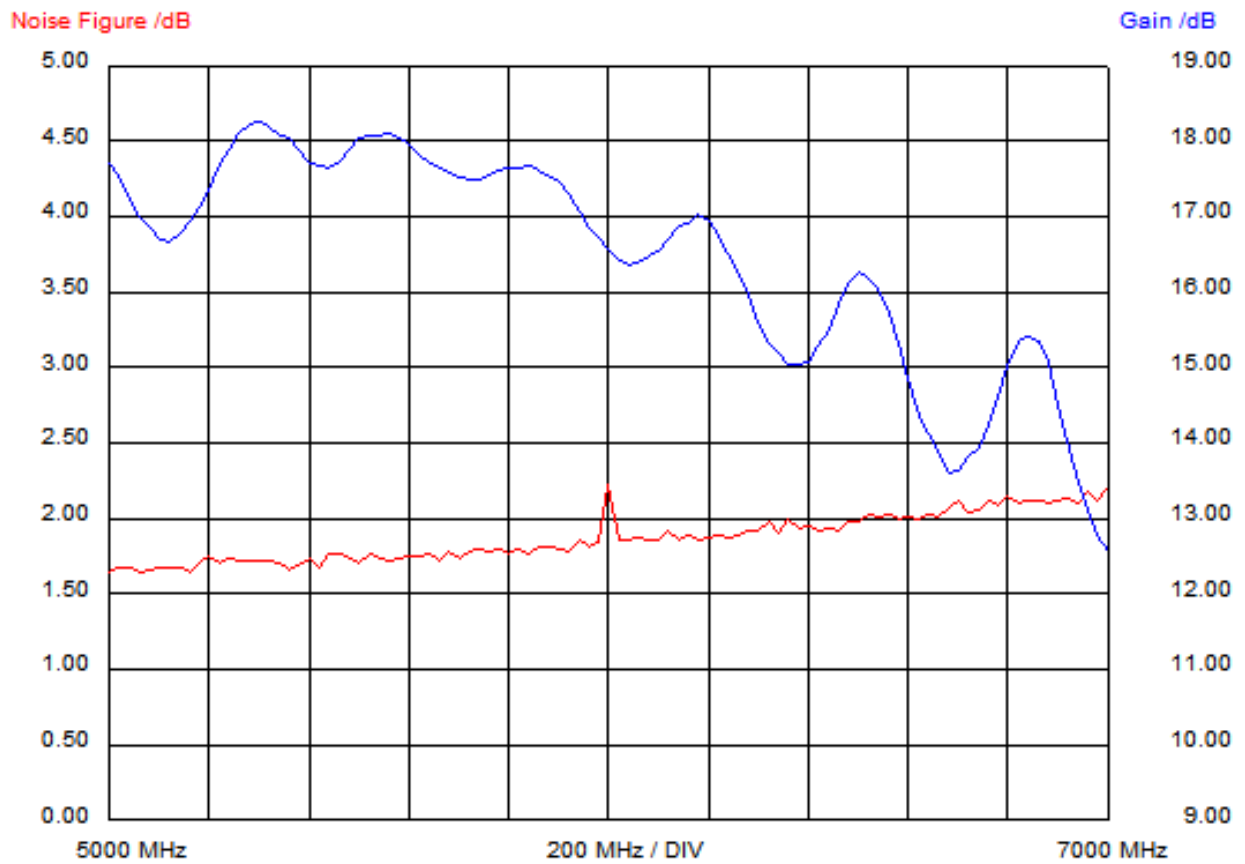
Frequency range:	4.9-5.9GHz
Noise figure:	1.3dB
Gain:	18dB
P1dB:	-13dBm
IIP3:	-3dBm
Vs:	3.0V
Is:	8mA

Here are some pictures of the device mounted on an original evaluation board from Triquint:





Here are the measurement results of gain (blue) and noise figure (red) versus frequency in the range 5 to 6GHz:



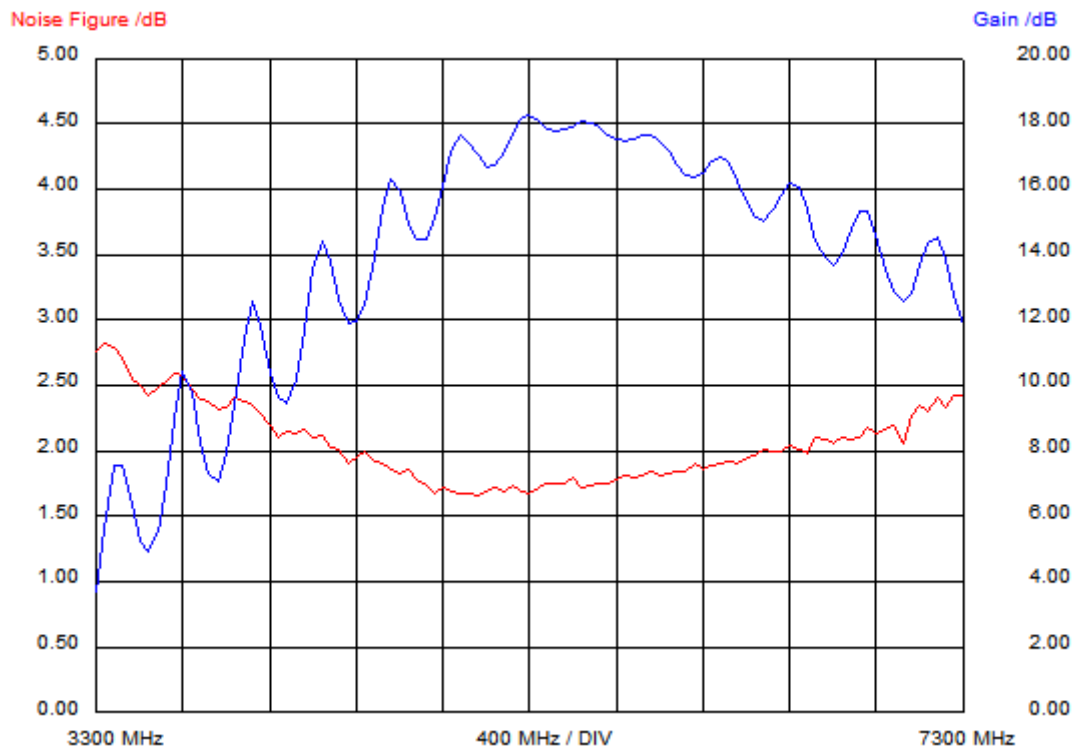
Frequency	Gain /dB	NF /dB	Frequency	Gain /dB	NF /dB
5000 MHz	17.71	1.65	5340 MHz	18.08	1.71
5020 MHz	17.54	1.67	5360 MHz	18.03	1.66
5040 MHz	17.23	1.67	5380 MHz	17.89	1.68
5060 MHz	17.00	1.65	5400 MHz	17.70	1.73
5080 MHz	16.85	1.66	5420 MHz	17.69	1.68
5100 MHz	16.70	1.67	5440 MHz	17.64	1.76
5120 MHz	16.67	1.67	5460 MHz	17.72	1.76
5140 MHz	16.78	1.67	5480 MHz	17.88	1.73
5160 MHz	16.94	1.64	5500 MHz	18.04	1.70
5180 MHz	17.12	1.71	5520 MHz	18.08	1.76
5200 MHz	17.34	1.75	5540 MHz	18.08	1.74
5220 MHz	17.70	1.71	5560 MHz	18.11	1.72
5240 MHz	17.88	1.73	5580 MHz	18.04	1.74
5260 MHz	18.10	1.72	5600 MHz	17.95	1.75
5280 MHz	18.23	1.72	5620 MHz	17.83	1.74
5300 MHz	18.24	1.71	5640 MHz	17.70	1.77
5320 MHz	18.20	1.72	5660 MHz	17.66	1.72

Frequency	Gain /dB	NF /dB	Frequency	Gain /dB	NF /dB
5680 MHz	17.58	1.78	6360 MHz	15.03	1.99
5700 MHz	17.54	1.74	6380 MHz	15.05	1.93
5720 MHz	17.48	1.78	6400 MHz	15.07	1.95
5740 MHz	17.48	1.80	6420 MHz	15.28	1.92
5760 MHz	17.55	1.78	6440 MHz	15.50	1.93
5780 MHz	17.60	1.80	6460 MHz	15.82	1.91
5800 MHz	17.64	1.77	6480 MHz	16.10	1.98
5820 MHz	17.64	1.79	6500 MHz	16.28	1.98
5840 MHz	17.67	1.77	6520 MHz	16.17	2.02
5860 MHz	17.60	1.81	6540 MHz	16.05	2.01
5880 MHz	17.54	1.81	6560 MHz	15.71	2.03
5900 MHz	17.46	1.79	6580 MHz	15.32	1.99
5920 MHz	17.30	1.78	6600 MHz	14.87	2.01
5940 MHz	17.06	1.85	6620 MHz	14.36	1.99
5960 MHz	16.86	1.82	6640 MHz	14.11	2.02
5980 MHz	16.73	1.84	6660 MHz	13.91	2.01
6000 MHz	16.57	2.22	6680 MHz	13.60	2.08
6020 MHz	16.43	1.86	6700 MHz	13.62	2.11
6040 MHz	16.37	1.86	6720 MHz	13.80	2.04
6060 MHz	16.40	1.87	6740 MHz	13.93	2.05
6080 MHz	16.47	1.85	6760 MHz	14.23	2.12
6100 MHz	16.53	1.85	6780 MHz	14.63	2.09
6120 MHz	16.68	1.92	6800 MHz	15.01	2.15
6140 MHz	16.88	1.86	6820 MHz	15.34	2.11
6160 MHz	16.91	1.89	6840 MHz	15.40	2.11
6180 MHz	17.02	1.85	6860 MHz	15.35	2.11
6200 MHz	16.95	1.87	6880 MHz	15.07	2.11
6220 MHz	16.77	1.89	6900 MHz	14.50	2.12
6240 MHz	16.50	1.88	6920 MHz	14.03	2.13
6260 MHz	16.24	1.89	6940 MHz	13.48	2.11
6280 MHz	15.95	1.91	6960 MHz	13.10	2.17
6300 MHz	15.58	1.92	6980 MHz	12.78	2.12
6320 MHz	15.30	1.99	7000 MHz	12.55	2.21
6340 MHz	15.18	1.91			

When looking at the results I notice, that the noise figure measurement is pretty much spot on with the specifications. Please note that Triquint did some de-embedding of the losses on the evaluation board and determined a loss from the input connector to the input of the MMIC of 0.3dB, which adds directly to the noise figure. Subtracting 0.3dB from the measured value gets the noise figure quite close to the specified value of 1.3dB.

However there gain curve is quite “wobbly”. I assume that this is a problem in my measurement setup. I am using a wideband preamplifier in front of my spectrum analyzer in order to improve the sensitivity of my measurement setup. I do not know the input match of this preamplifier and suspect it might be rather poor. As there is also a low loss 50Ω cable with a length of about 20cm between the output of the device under test (DUT) and the preamplifier this might also contribute to the measurement problem.

The problem of the “wobbly” gain curve is even more apparent when measuring gain and noise figure over a wider frequency range:



I am always grateful to get feedback and appreciate any hints on the problem I am encountering.

Please direct them to the Email address, which you will find at the end of this page.

Best regards

Matthias DD1US

Email: DD1US@AMSAT.ORG

Homepage: <http://www.dd1us.de>