Test Report FCC 47 CFR § 97.317 (d), EUT: QRO PA

For transmitters installed after January 1, 2003, the mean power of any spurious emission from a station transmitter or external RF power amplifier transmitting on a frequency below 30 MHz ***must be at least 43 dB below the mean power of the fundamental emission****.*

Equipment under Test:

Device:	QRO PA
Serial Number:	*#001 (Matthias Ulmann)*
	#002 (Bernd Geck)
	#003 (Adrian Helwig)
Application:	RF Amplifier, 1.8MHz to 30MHz (160m to 10m)
Address:	Bernd Geck
	Hermann-Hesse-Str. 28
	89171 Illerkirchberg
Phone	+49 7346 91 94 74

Relevant Standard: 47 CFR § 97.317 (d)

Tested: _____ Test Date: _____

Purpose

The purpose of this report is to show compliance with the 47 CFR §97.317 (d) requirements for the certification of external RF amplifiers operating in the amateur radio service.

Limits and Reservations

The test results in this test report apply only to the particular equipment under test (EUT) QRO PA #001 to #003 as declared in this report.

Test Location

Dipl. Ing. Bernd Geck
Hermann-Hesse-Str. 28
89171 Illerkirchberg

Test Temperature

Ambient temperature approximately 23c

Equipment under Test (EuT)

Name:	QRO PA
Serial Number:	#001, #002, #003
Firmware Revision:	v.1.0
Hardware Revision:	v.1.0 ALPHA
Application:	RF Amplifier
Power Supply:	230Vac +/-10%, 50Hz
Voltage for Testing:	230Vac, 50Hz
Amateur Radio Bands:	160m, 80m, 40m, 30m, 20m, 17m, 15m, 12m, 10m (TX in between 1.8MHz to 30MHz)
Output Power:	German Legal Limit 750W, tested up to 1kW
Ports:	2x TRX (exciter input HIGH 25W / exciter input LOW 5W) Antenna RF OUT PTT Power Jack 230V AC, Power ON extern CAT RS-232 12V auxiliary output, max. 4A load current

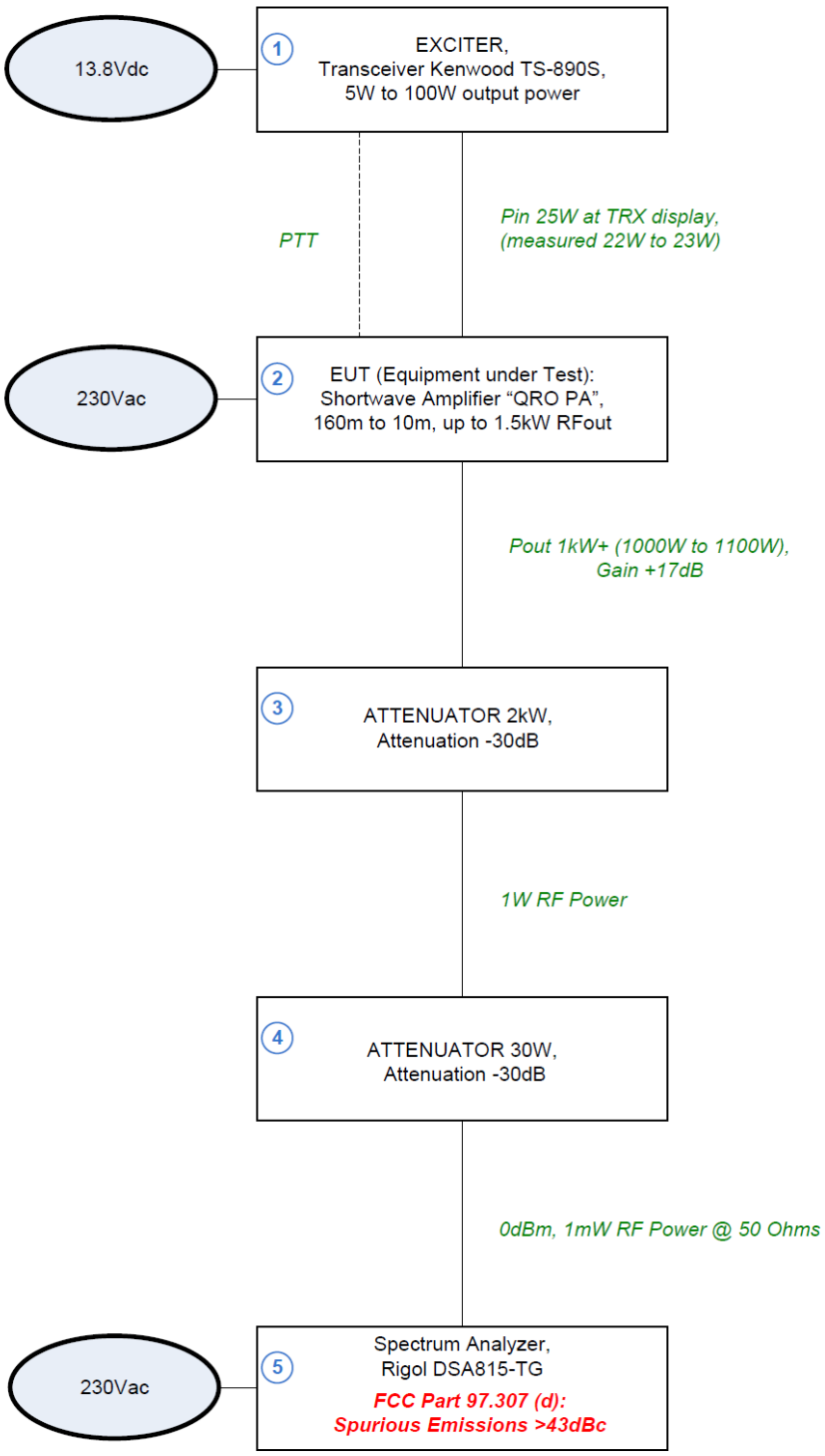
Intended Use

Amplifier for amateur radio service only

EUT Peripherals

A Kenwood TS-890S Transceiver was used as exciter at HIGH input at 25W input power to achieve 1kW+ output power (1000W to 1100W); only at 160m gain is reduced due to low input capacitor at PA module, results in less output power 800W to 900W – test setup as follows:

block diagram



title	customer	designer	project no.	date
Spurious Emissions	**n/a**	**B. Geck**	**QRO PA**	**9/16/2021**

Compliance Test QRO PA ver. ALPHA, #003 'Adrian Helwig'

Mode of Operation during Testing
The EUT was supplied with 230Vac / 50Hz and switched on. RF output was connected to the high power 2kW attenuator operating as dummy load 50 Ohms. The input of the amplifier was set to a value which equals an output power of about 1000W.

Compliance
All requirements were found to be within the limits of 47 CFR § 97.317 (d) outlined in this report. The test results in this report apply only to the particular equipment under test (EUT) QRO PA ver. ALPHA, serial number **#003** (Adrian Helwig) as declared in this report.

Test Personnel Dipl. Ing. Bernd Geck
Issuance Date: 9/16/2021

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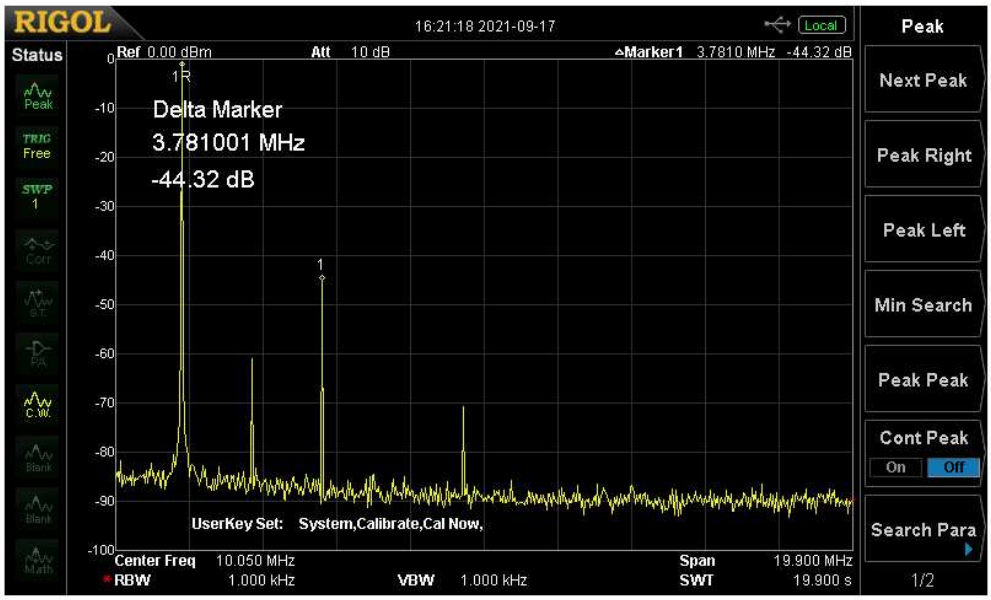
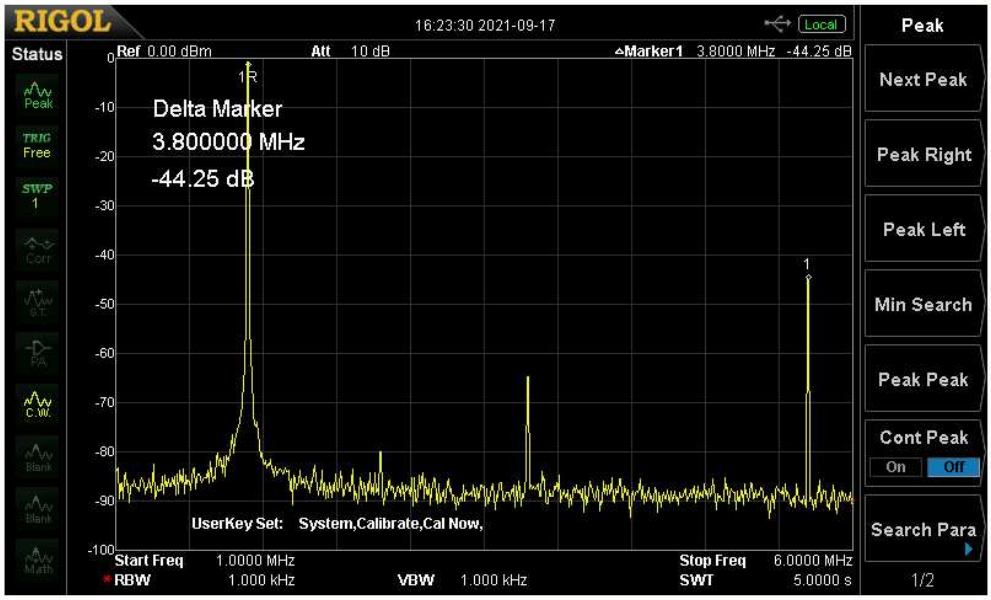
Measurements

Two measurements have been taken per band – a first orientation from 100kHz up to >10f1. Second measurement shows f1, 2f1 and 3f1, the region of major interest.
3f1 is typically dominant for a solid state RF amplifier; harmonics beyond 3f1 are damped very well (the chosen CAUER filter topology offers high attenuation >3f1).

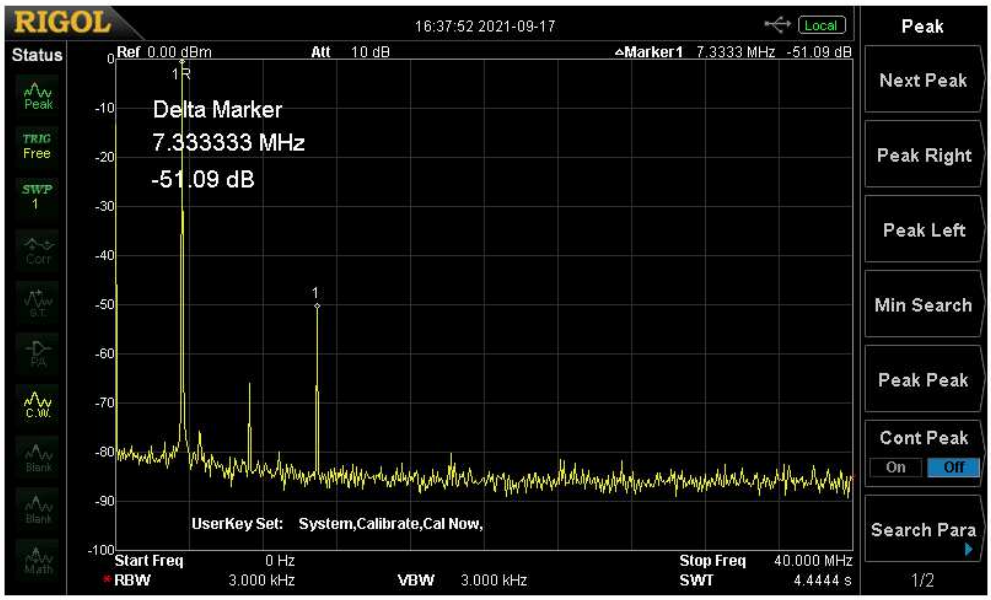
This second screenshot has been done with large sweep time to offer best resolution.



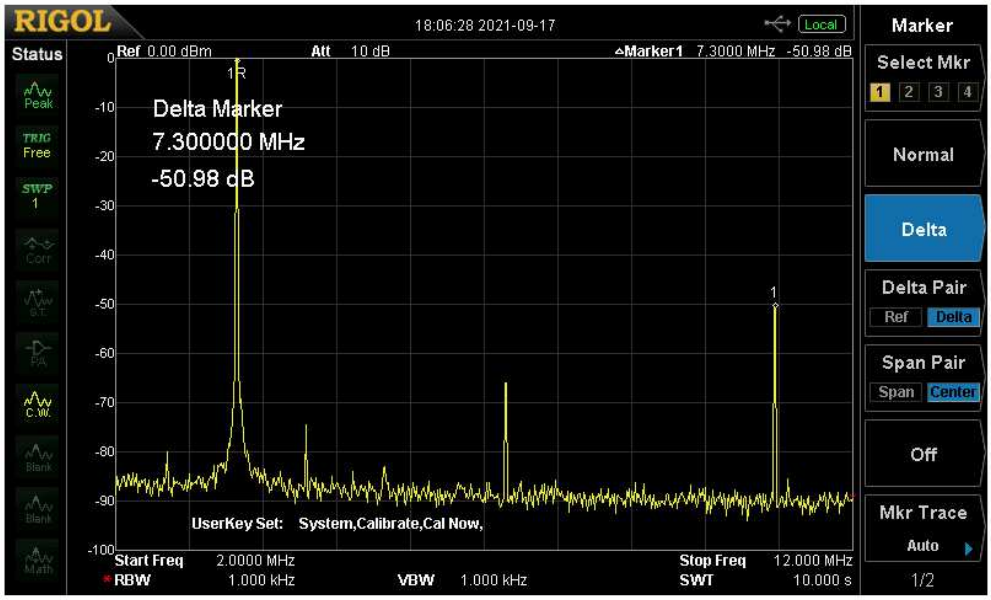
160m, 1.900MHz, approx. 900Wout, 2f1 -60.43dBc, **3f1 -44.32dBc**, 5f1 -70.19dBc



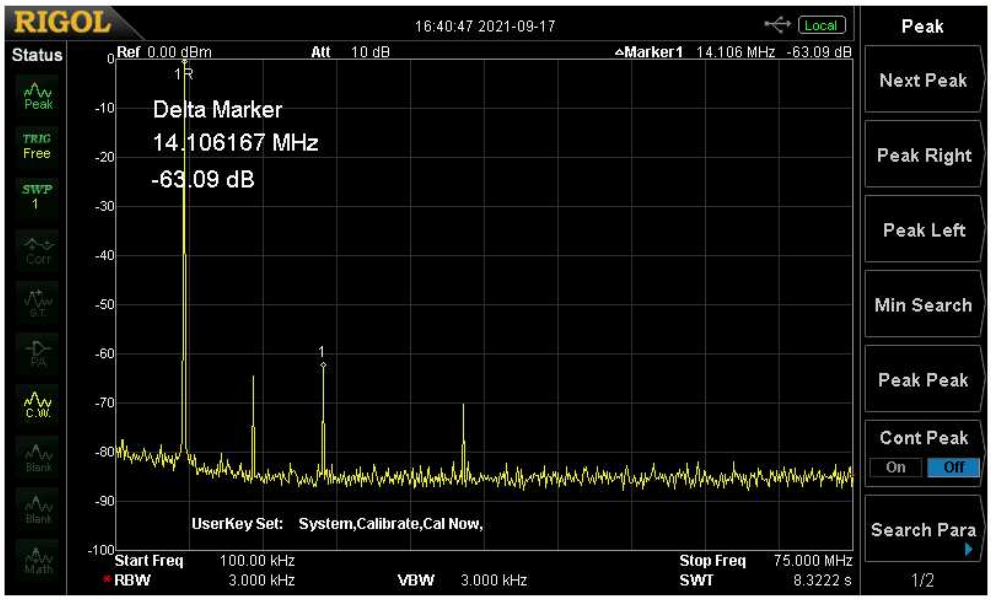
3f1 -44.25dBc - mismatch to BETA by +4.41dB (-48.66dBc)



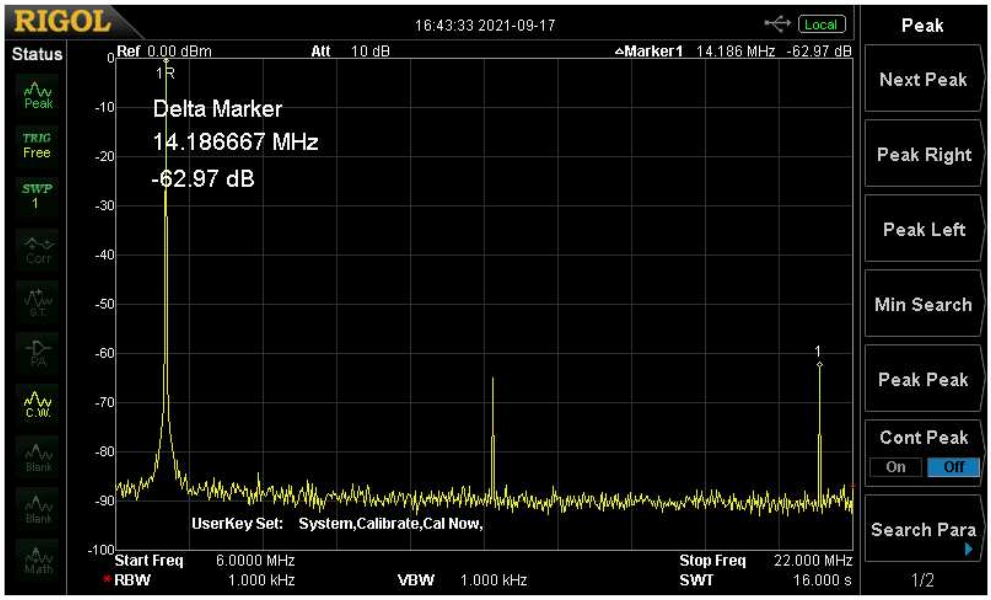
80m, 3.650MHz, 2f1 -66.36dBc, 3f1 -51.09dBc



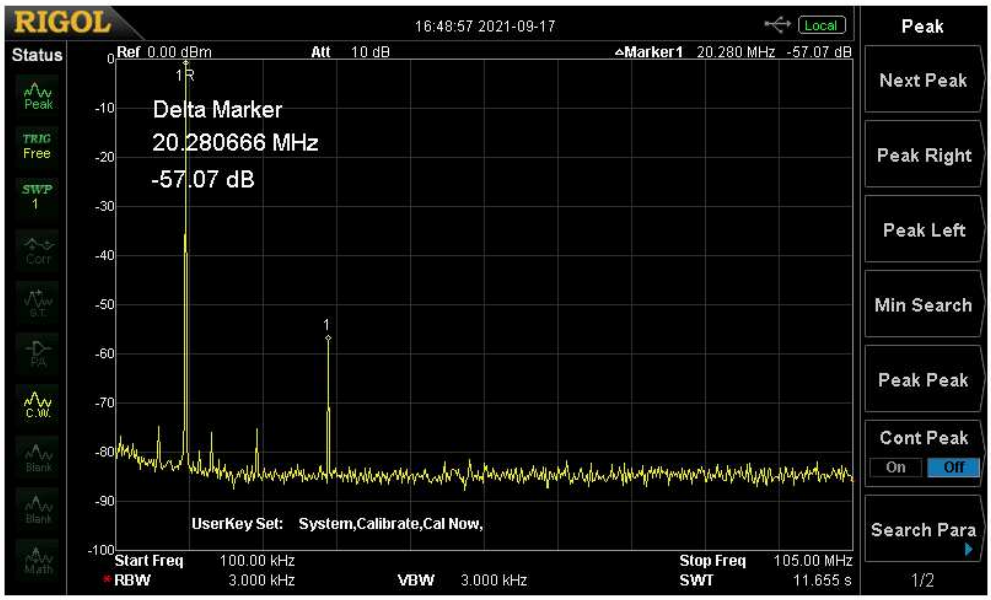
3f1 -50.98dBc



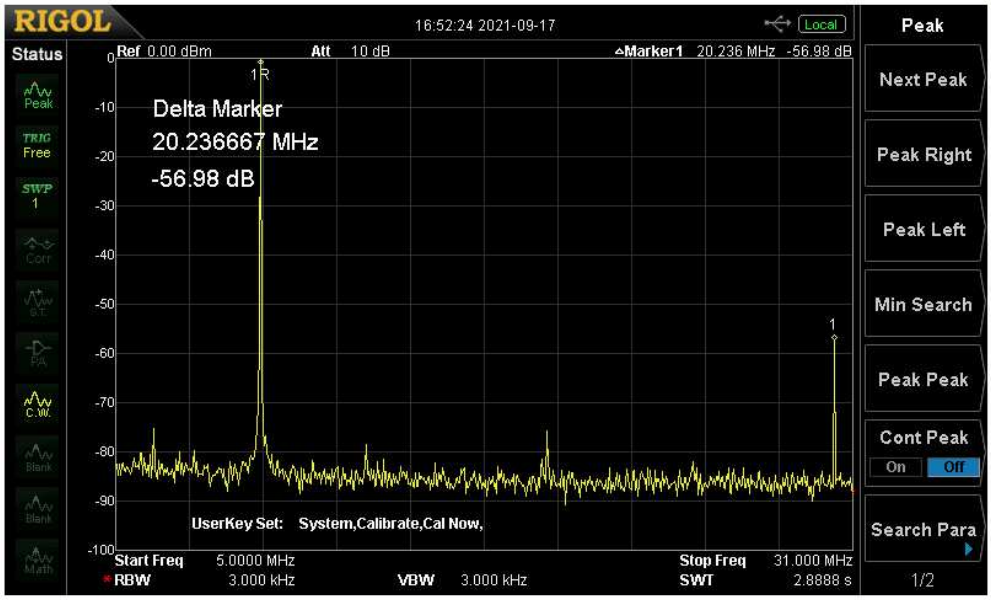
40m, 7.100MHz, 2f1 -64.73dBc, 3f1 -63.09dBc, 5f1 -70.52dBc



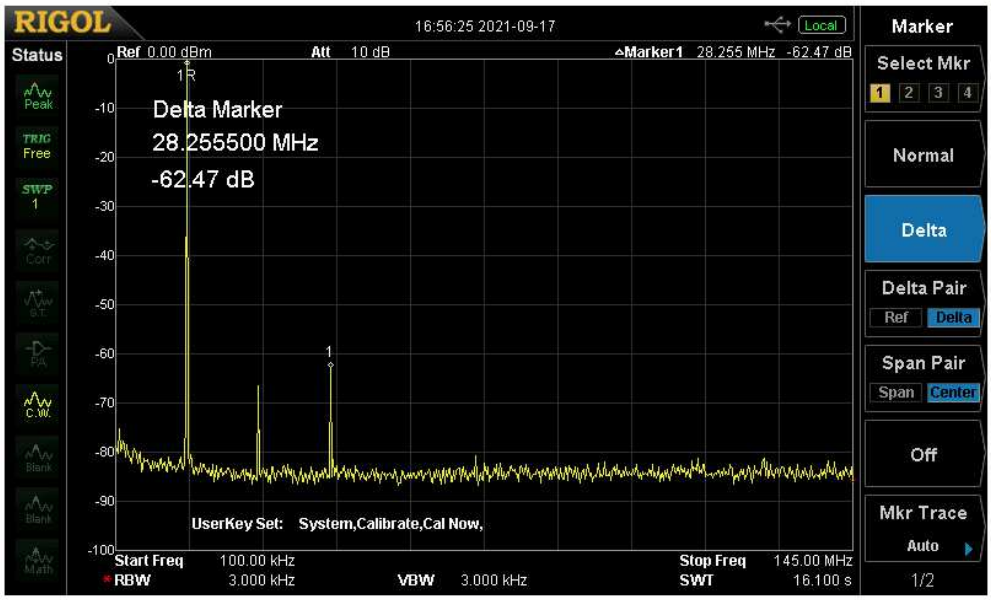
3f1 -62.97dBc



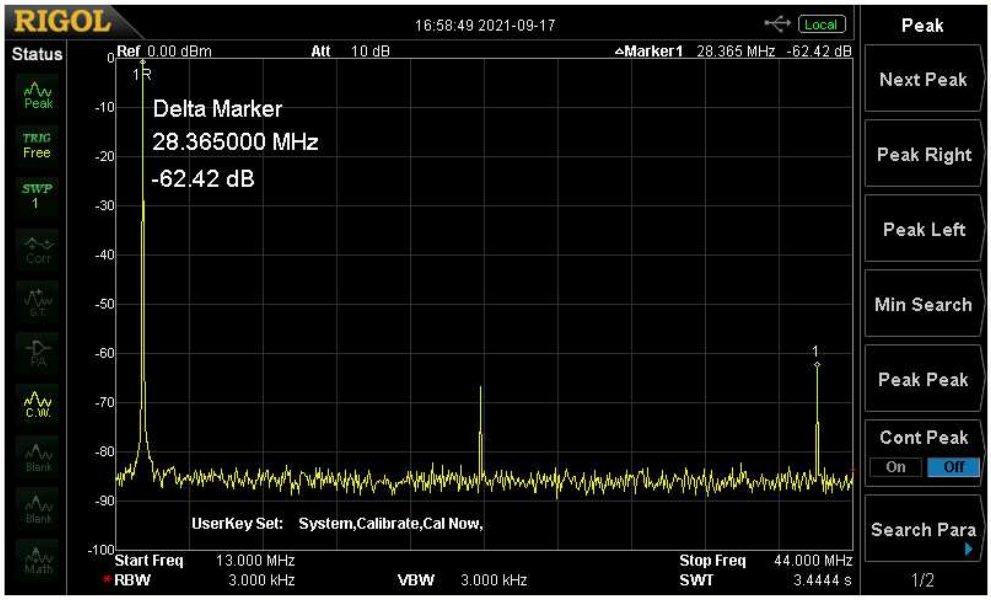
30m, 10.125MHz, 2f1 -75.02dBc, 3f1 -57.07dBc



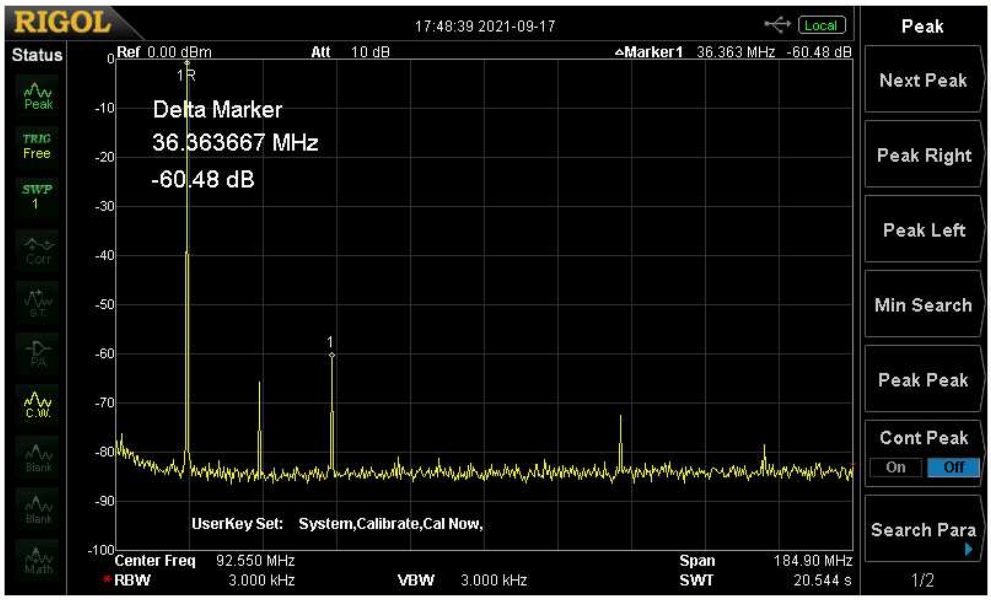
3f1 -56.98dBc



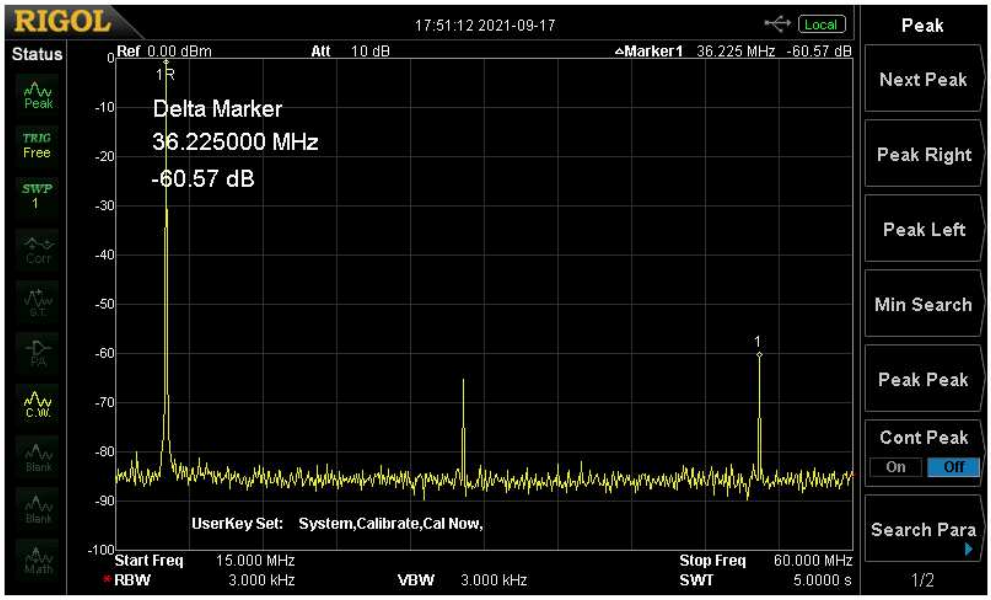
20m, 14.175MHz, 2f1 -66.25dBc, 3f1 -62.47dBc



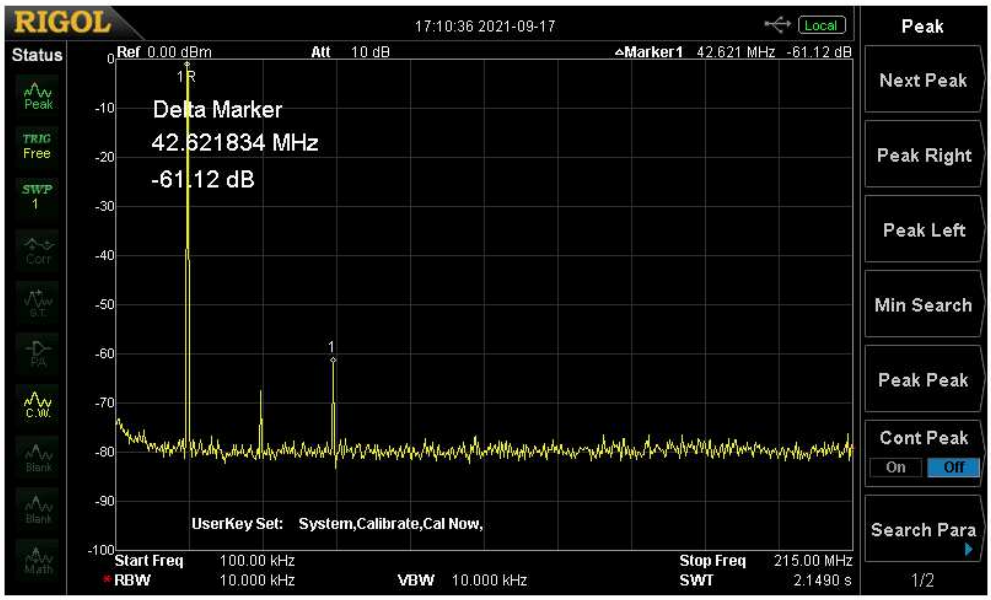
3f1 -62.42dBc



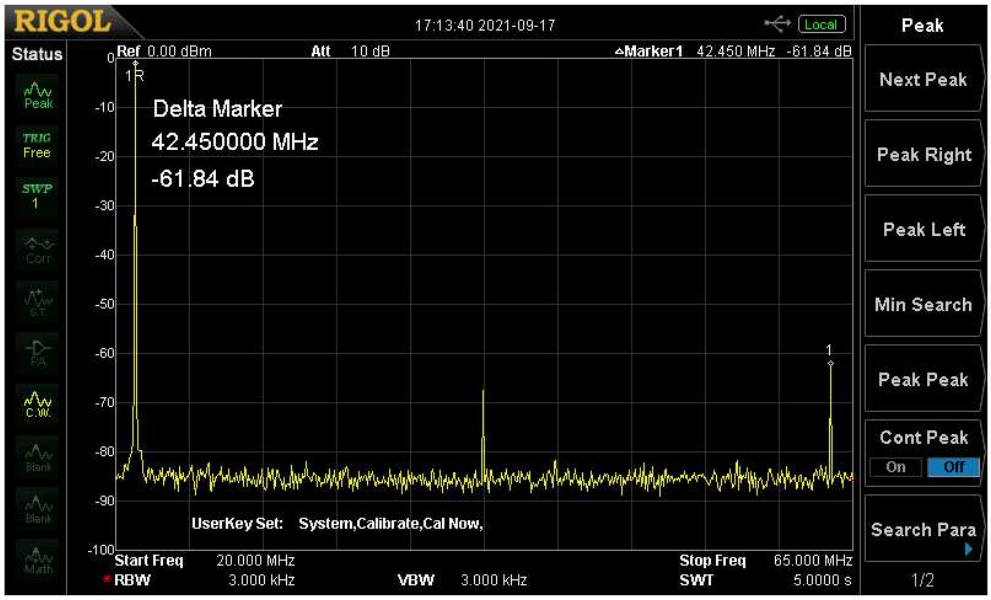
17m, 18.120MHz, 2f1 -65.54dBc, 3f1 -60.48dBc, 7f1 -72.23dB



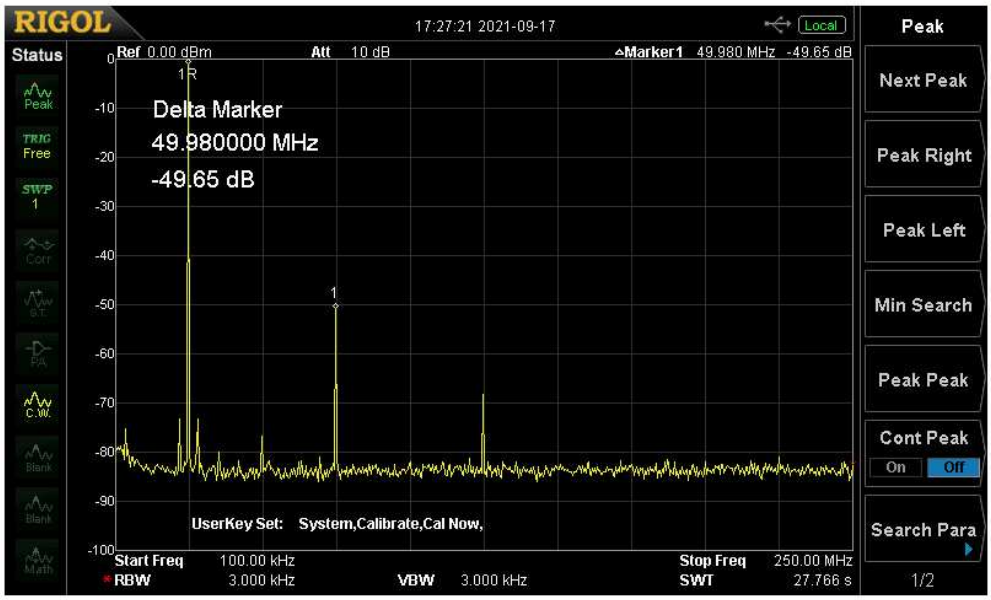
3f1 -60.57dBc



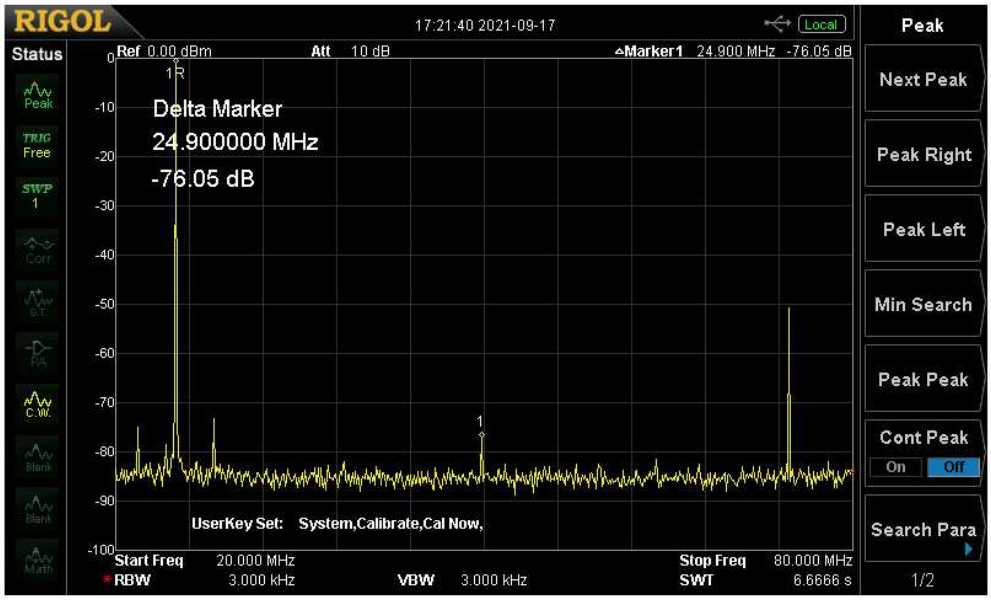
15m, 21.225MHz, 2f1 -66.88dBc, 3f1 -61.12dBc



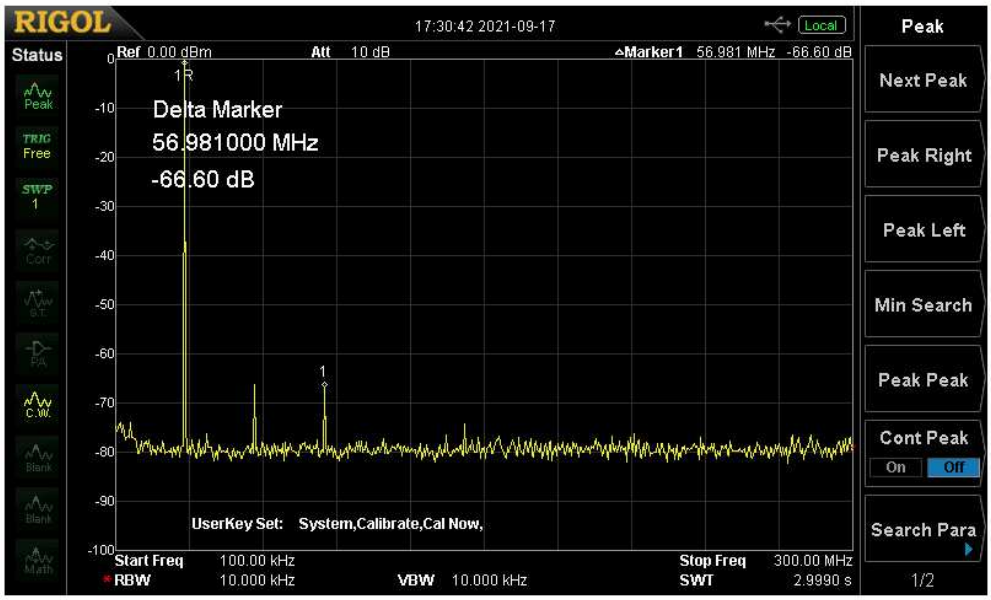
3f1 -61.84dBc



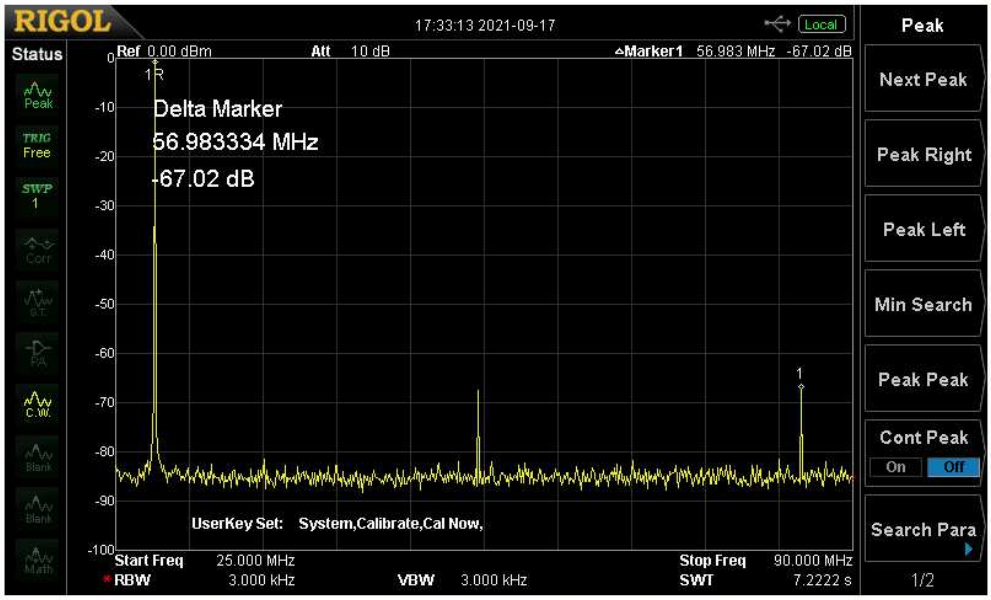
12m, 24.940MHz, approx. 800Wout*, 2f1 -75.75dBc, **3f1 -49.65dBc**, 5f1 -67.27dBc



3f1 -49.72dBc - mismatch to BETA by +6.16dB (-55.88dBc)



10m, 28.500MHz, 2f1 -66.17dBc, 3f1 -66.60dBc



2f1 -67.36dBc, 3f1 -67.02dBc

Summary for #003, Spurious Emissions § 97.307 (d) at Output Power approx. 1kW:

Band	**Frequency f1** MHz	**2f1** dBc	**3f1** dBc	**4f1** dBc	**5f1 to 10f1** dBc
160m	1.900	-60.43	**-44.25**	n/a	-70.19
80m	3.650	-66.36	**-50.98**	n/a	n/a
40m	7.100	-64.73	**-62.97**	n/a	-70.52
30m	10.125	-75.02	**-56.98**	n/a	n/a
20m	14.175	-66.25	**-62.42**	n/a	n/a
17m	18.120	-64.97	**-60.57**	n/a	-72.23
15m	21.225	-66.88	**-61.84**	n/a	n/a
12m	24.940	-76.05	**-49.72**	n/a	-67.27
10m	28.500	-67.36	**-67.02**	n/a	n/a

Compliance Test QRO PA ver. ALPHA, #001 'Matthias Ulmann'

Mode of Operation during Testing

The EUT was supplied with 230Vac / 50Hz and switched on. RF output was connected to the high power 2kW attenuator operating as dummy load 50 Ohms. The input of the amplifier was set to a value which equals an output power of about 1000W.

Compliance

All requirements were found to be within the limits of 47 CFR § 97.317 (d) outlined in this report. The test results in this report apply only to the particular equipment under test (EUT) QRO PA ver. ALPHA, serial number **#001** (Matthias Ulmann) as declared in this report.

Test Personnel Dipl. Ing. Bernd Geck
Issuance Date: 10/10/2021

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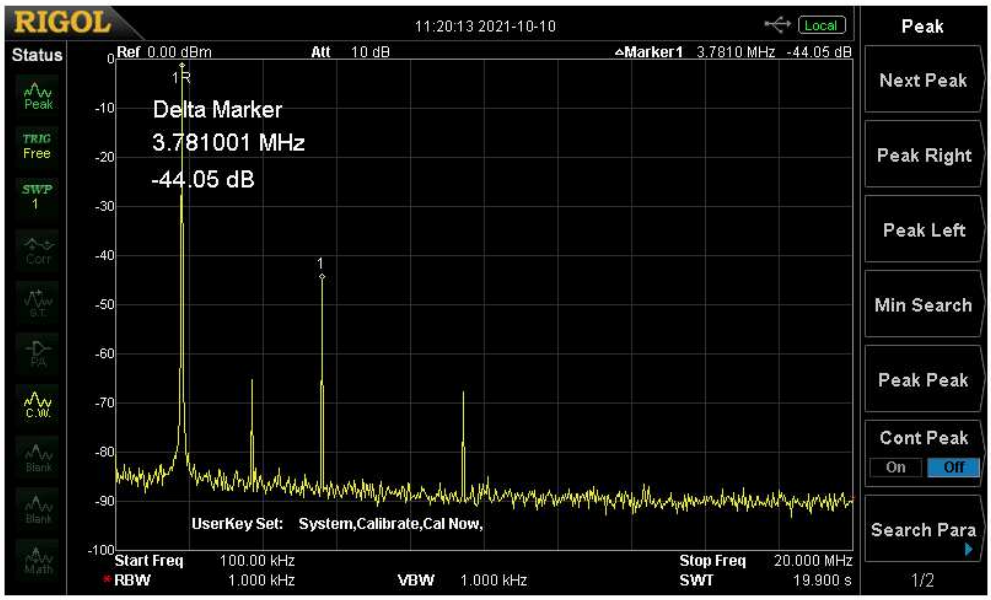
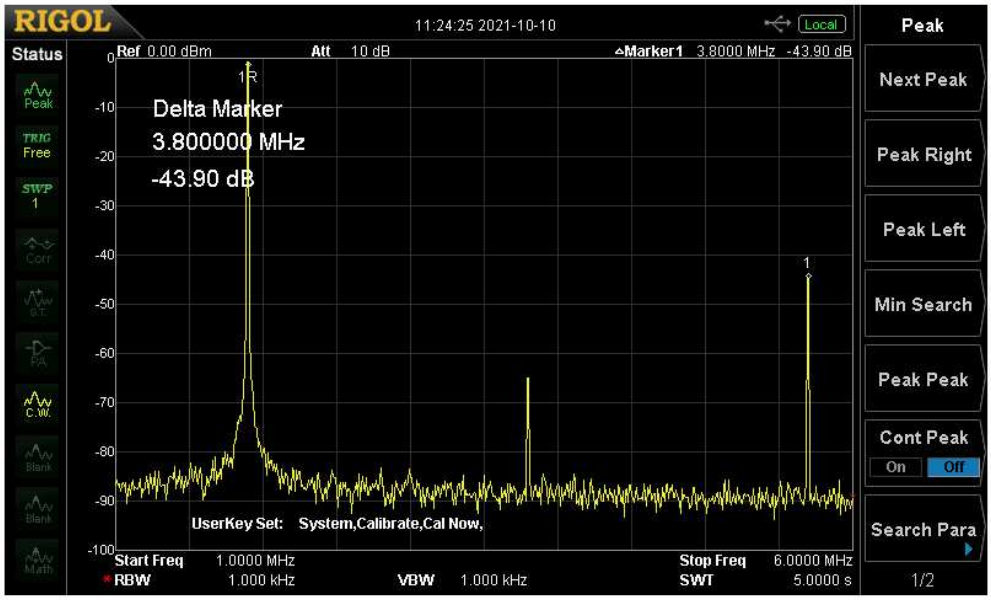
Measurements

Two measurements have been taken per band – a first orientation from 100kHz up to >10f1. Second measurement shows f1, 2f1 and 3f1, the region of major interest.
3f1 is typically dominant for a solid state RF amplifier; harmonics beyond 3f1 are damped very well (the chosen CAUER filter topology offers high attenuation >3f1).

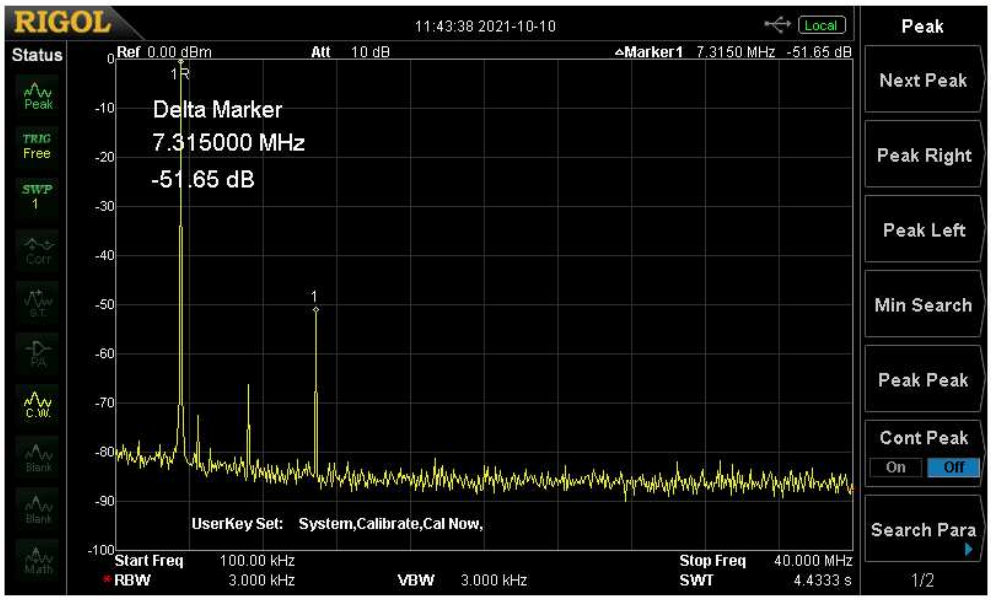
This second screenshot has been done with large sweep time to offer best resolution.



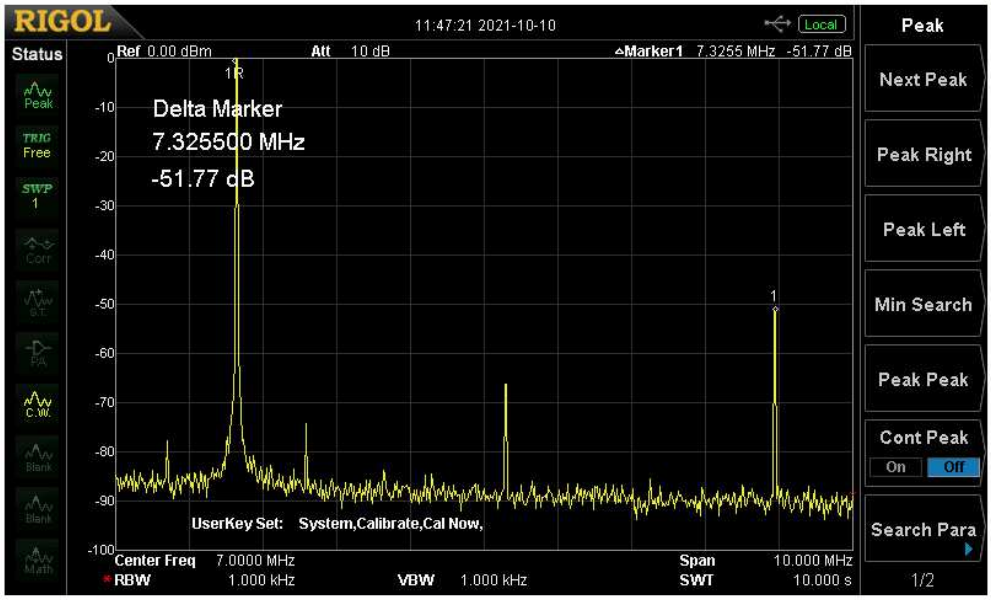
160m, 1.900MHz, approx. 900Wout, 2f1 -64.54dBc, **3f1 -44.05dBc**, 5f1 -67.11dBc



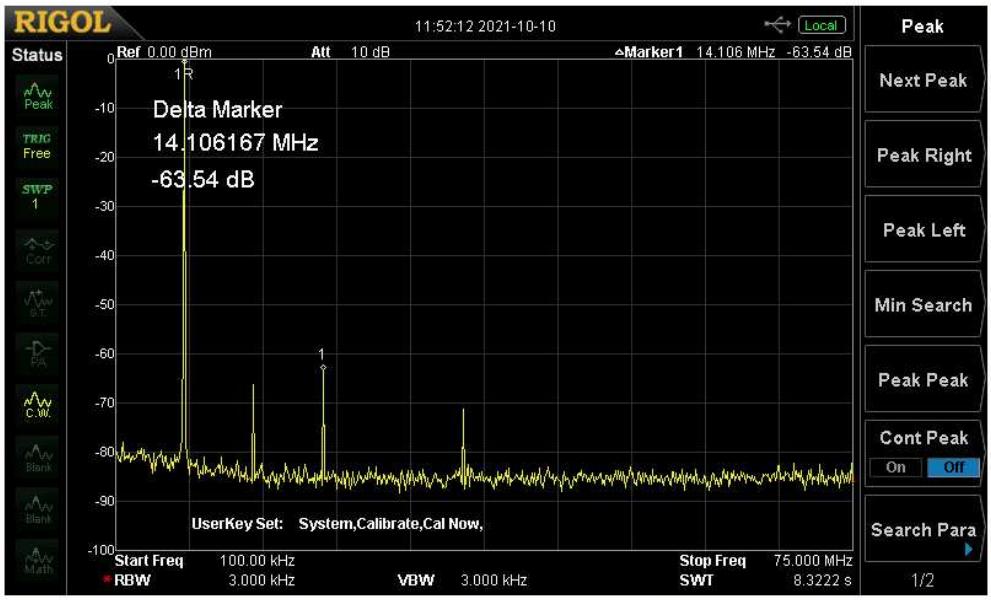
3f1 -43.90dBc - mismatch to BETA by +4.76dB (-48.66dBc)



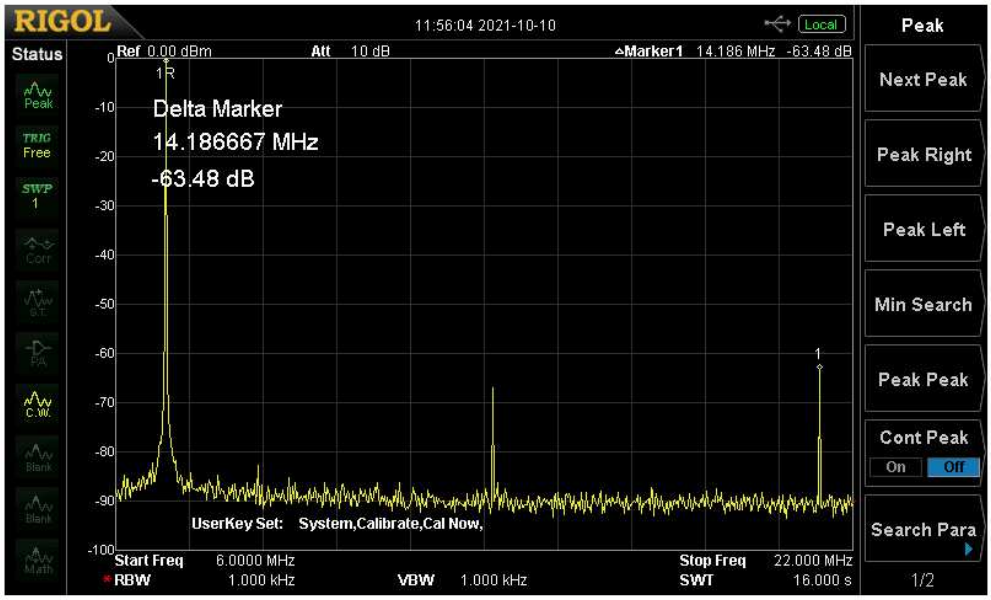
80m, 3.650MHz, 2f1 -66.31dBc, 3f1 -51.65dBc



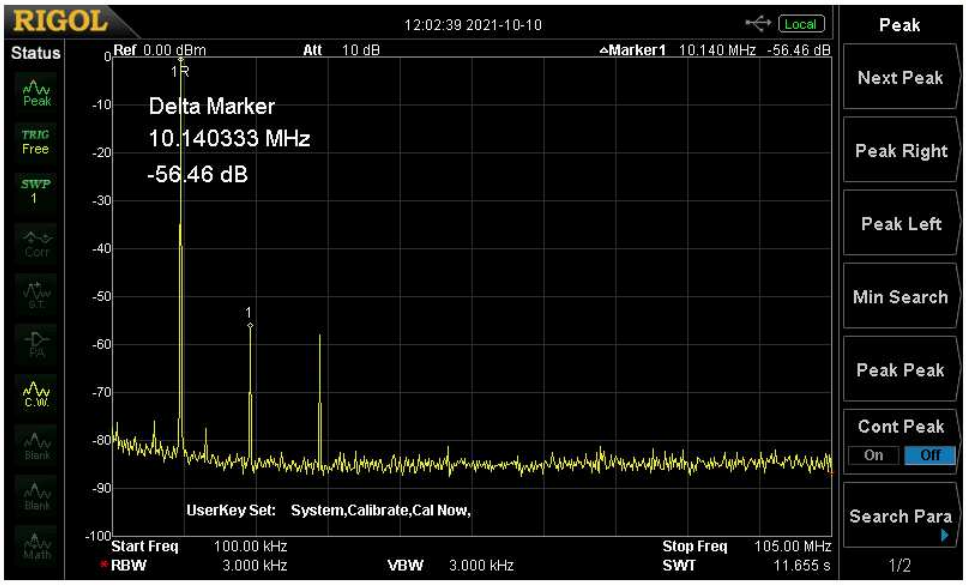
3f1 -51.77dBc



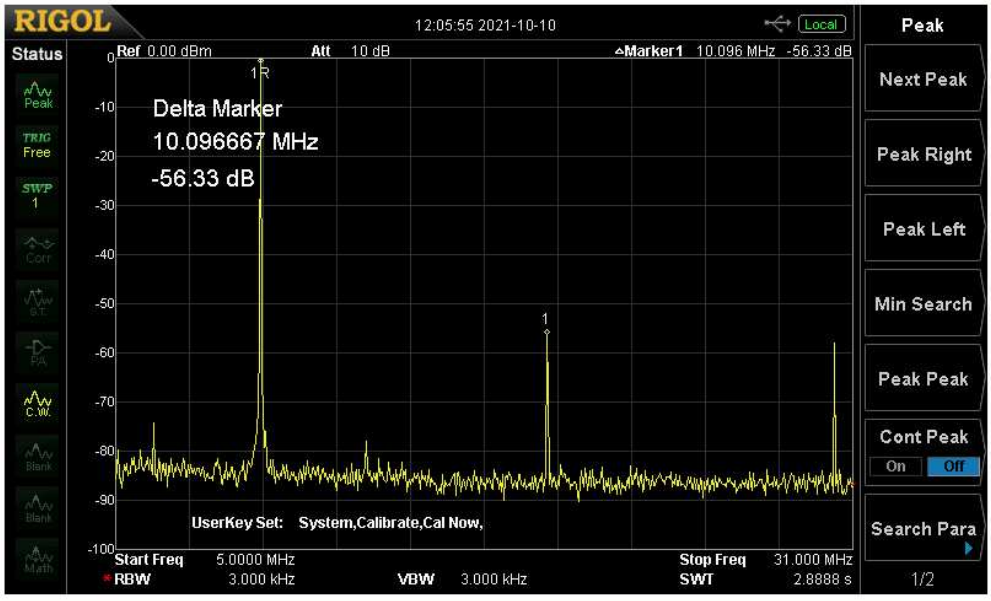
40m, 7.100MHz, 2f1 -66.59dBc, 3f1 -63.54dBc, 5f1 -71.59dBc



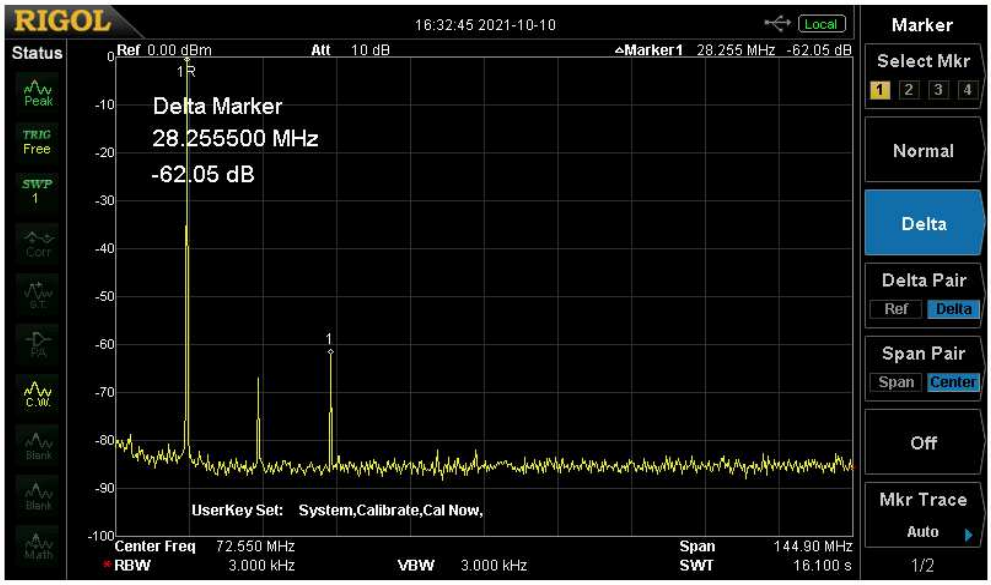
3f1 -63.48dBc



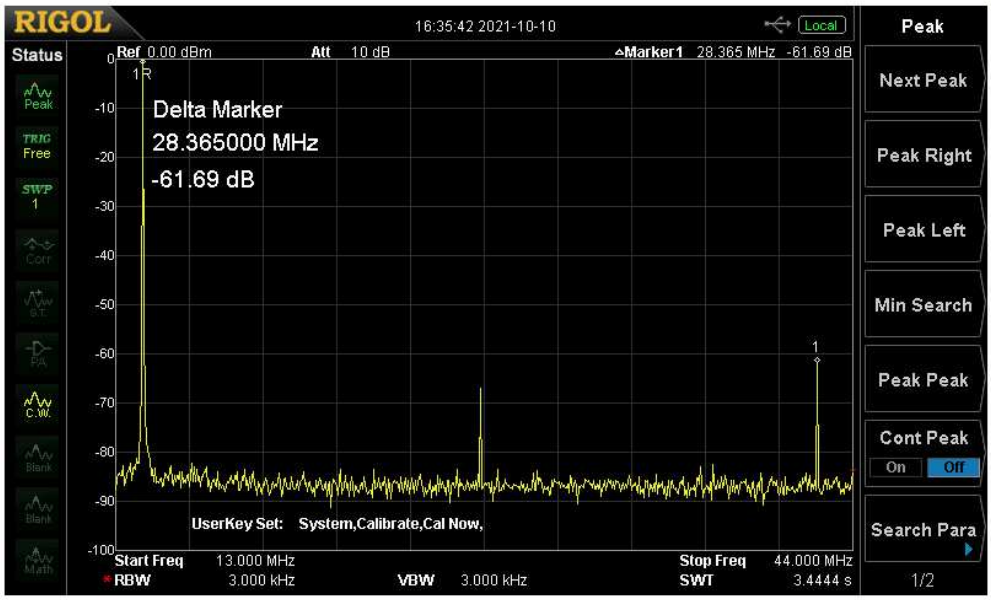
30m, 10.125MHz, 2f1 -56.46dBc, 3f1 -57.92dBc – 2f1 differs from #003



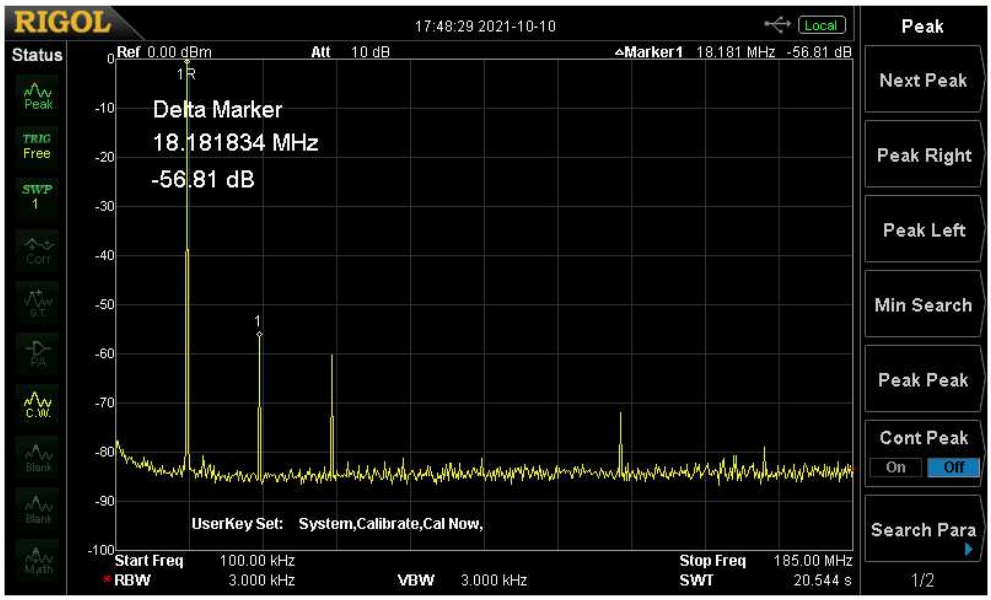
2f1 -56.33dBc, 3f1 -57.83dBc



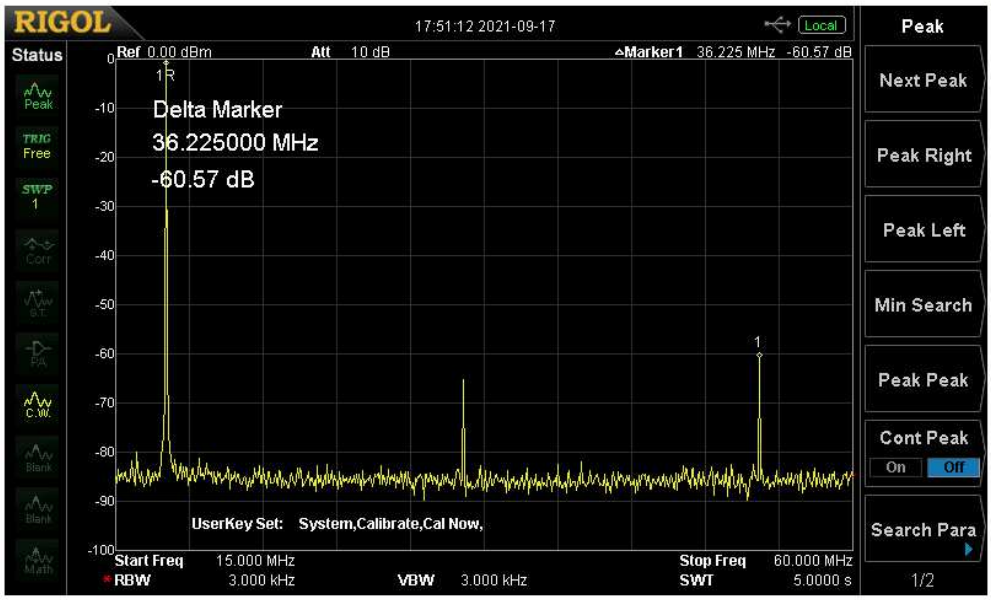
20m, 14.175MHz, 2f1 -66.97dBc, 3f1 -62.05dBc



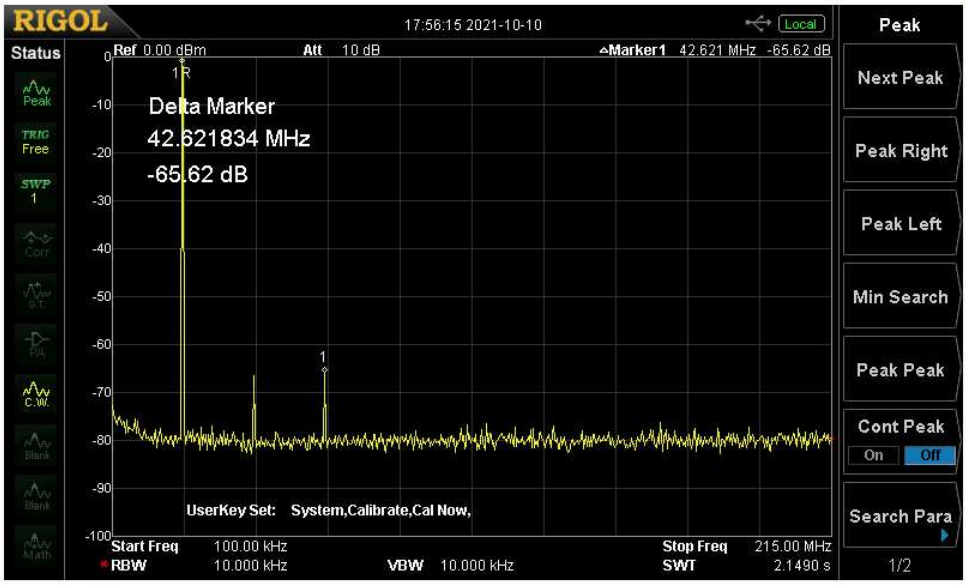
2f1 -66.84dBc, 3f1 -61.69dBc



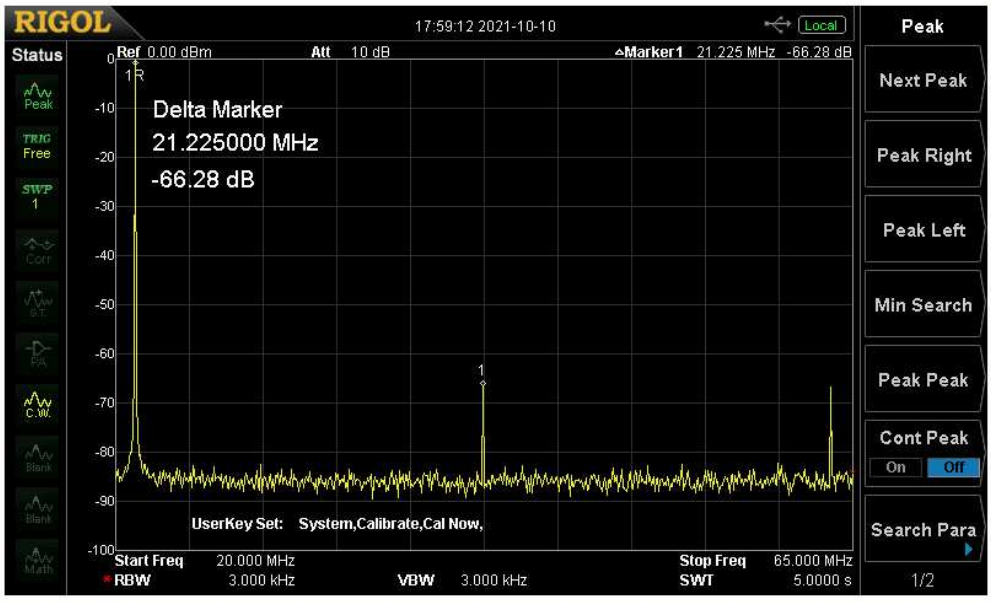
17m, 18.120MHz, 2f1 -56.81dBc, 3f1 -60.61dBc, 7f1 -72.37dB – 2f1 differs from #003



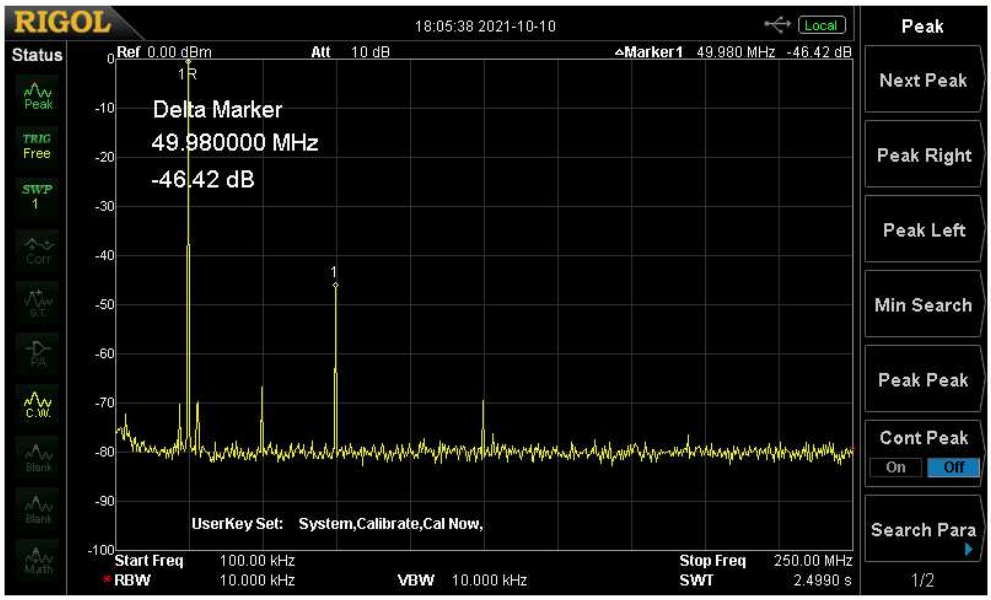
2f1 -57.34dBc



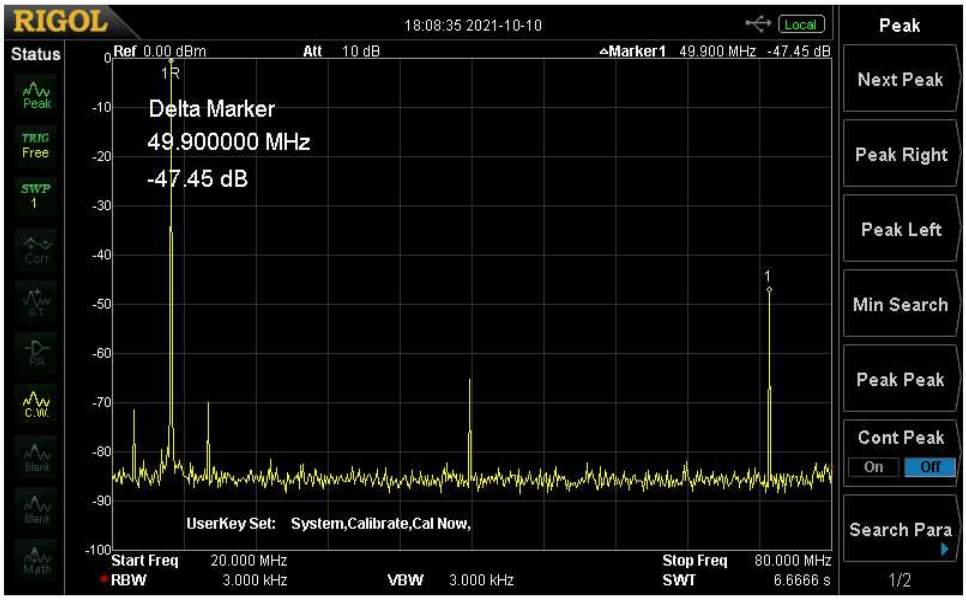
15m, 21.225MHz, 2f1 -66.30dBc, 3f1 -65.62dBc



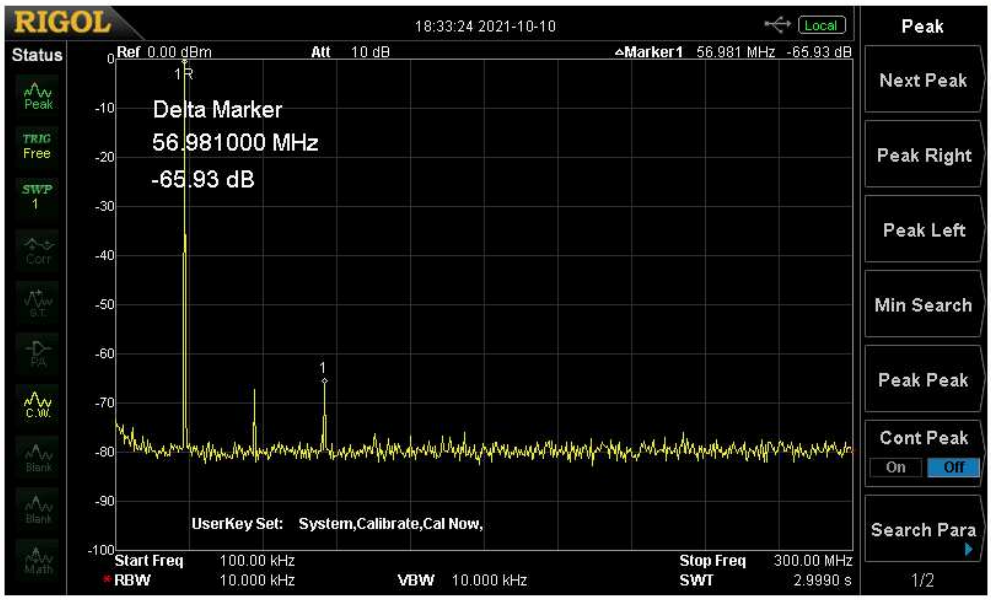
2f1 -66.28, 3f1 -66.65dBc



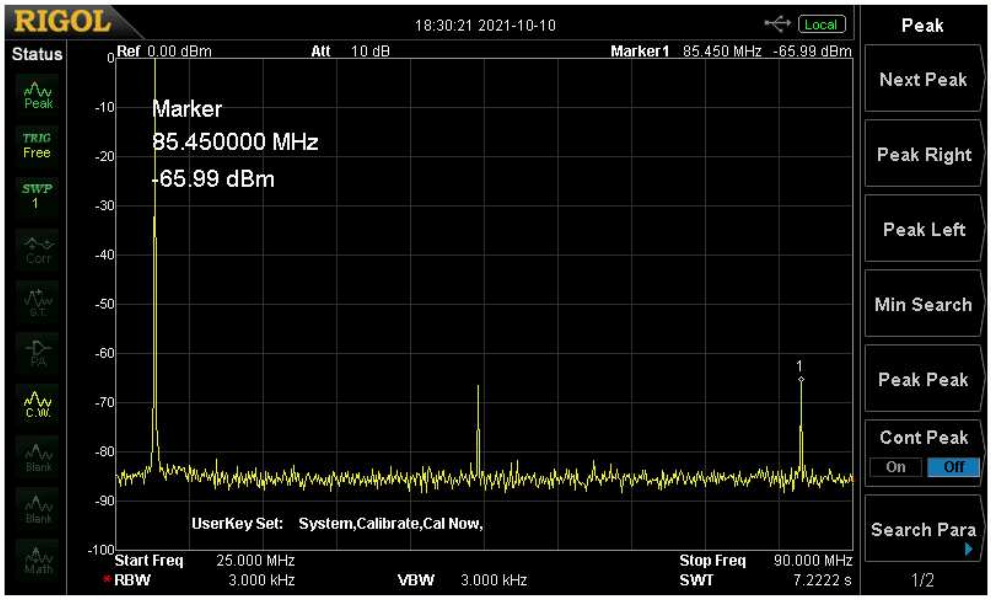
12m, 24.940MHz, 2f1 -66.70dBc, **3f1 -46.42dBc**, 5f1 -69.62dBc – 2f1 differs to #003



2f1 -65.25dBc, 3f1 -47.45dBc - mismatch to BETA by +8.43dB (-55.88dBc)



10m, 28.500MHz, 2f1 -67.26dBc, 3f1 -65.93dBc



2f1 -66.51dBc, 3f1 -65.99dBc

Summary for #001, Spurious Emissions § 97.307 (d) at Output Power approx. 1kW:

Band	**Frequency f1** MHz	**2f1** dBc	**3f1** dBc	**4f1** dBc	**5f1 to 10f1** dBc
160m*	1.900	-64.54	**-43.90**	n/a	-67.11
80m	3.650	-66.31	**-51.77**	n/a	n/a
40m	7.100	-66.59	**-63.48**	n/a	-71.59
30m	10.125	**-56.33 (?)**	-57.83	n/a	n/a
20m	14.175	-66.84	**-61.69**	n/a	n/a
17m	18.120	**-57.34 (?)**	-60.61	n/a	-72.37
15m	21.225	**-66.28**	-66.65 (?)	n/a	n/a
12m	24.940	-65.25 (?)	**-47.45**	n/a	-69.62
10m	28.500	-66.51	**-65.99**	n/a	n/a

Compliance Test QRO PA ver. ALPHA, #002 'Bernd Geck'

Mode of Operation during Testing
The EUT was supplied with 230Vac / 50Hz and switched on. RF output was connected to the high power 2kW attenuator operating as dummy load 50 Ohms. The input of the amplifier was set to a value which equals an output power of about 1000W.

Compliance
All requirements were found to be within the limits of 47 CFR § 97.317 (d) outlined in this report. The test results in this report apply only to the particular equipment under test (EUT) QRO PA ver. ALPHA, serial number **#002** (Bernd Geck) as declared in this report.

Test Personnel	Dipl. Ing. Bernd Geck
Issuance Date:	11/04/2021

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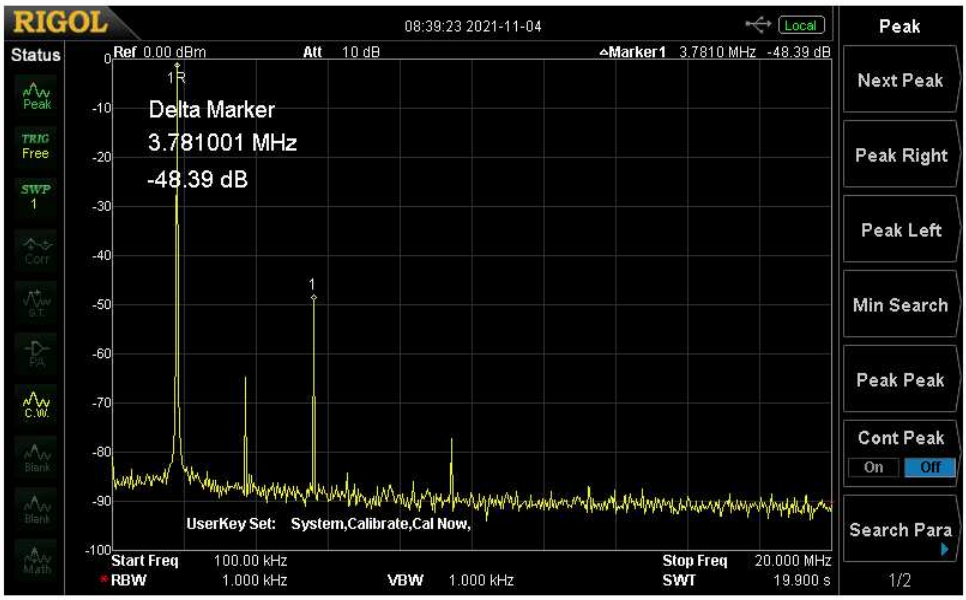
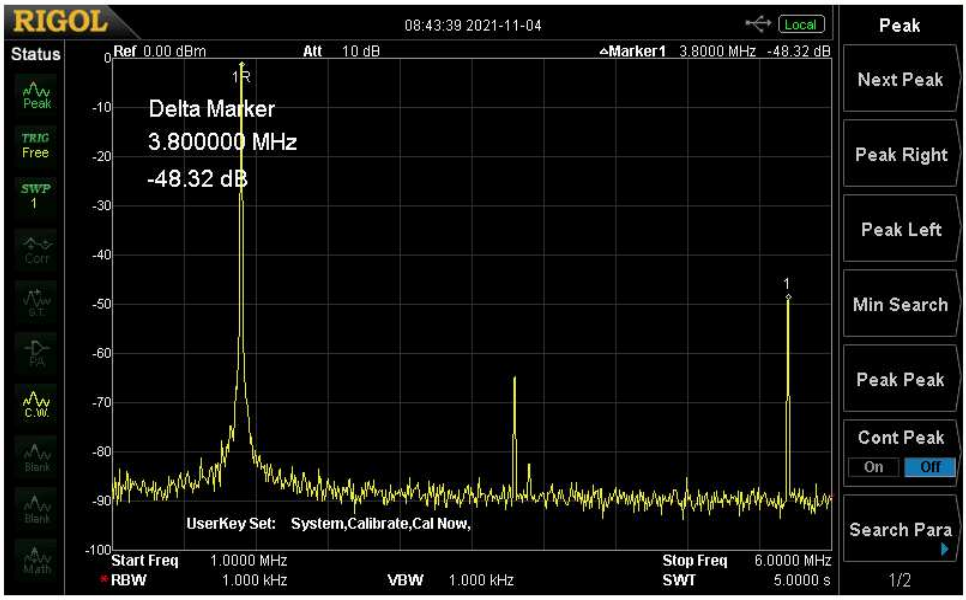
Measurements

Two measurements have been taken per band – a first orientation from 100kHz up to >10f1. Second measurement shows f1, 2f1 and 3f1, the region of major interest.
3f1 is typically dominant for a solid state RF amplifier; harmonics beyond 3f1 are damped very well (the chosen CAUER filter topology offers high attenuation >3f1).

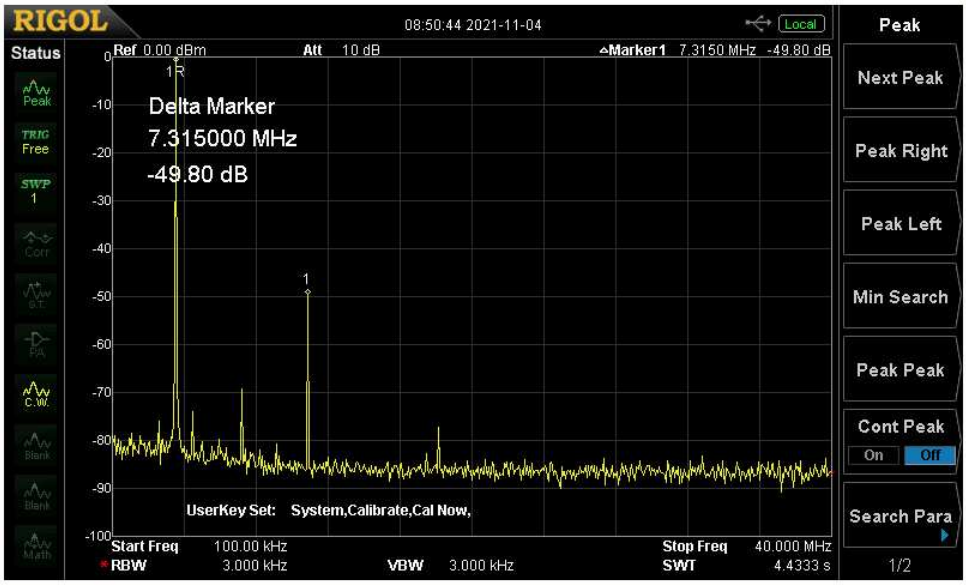
This second screenshot has been done with large sweep time to offer best resolution.



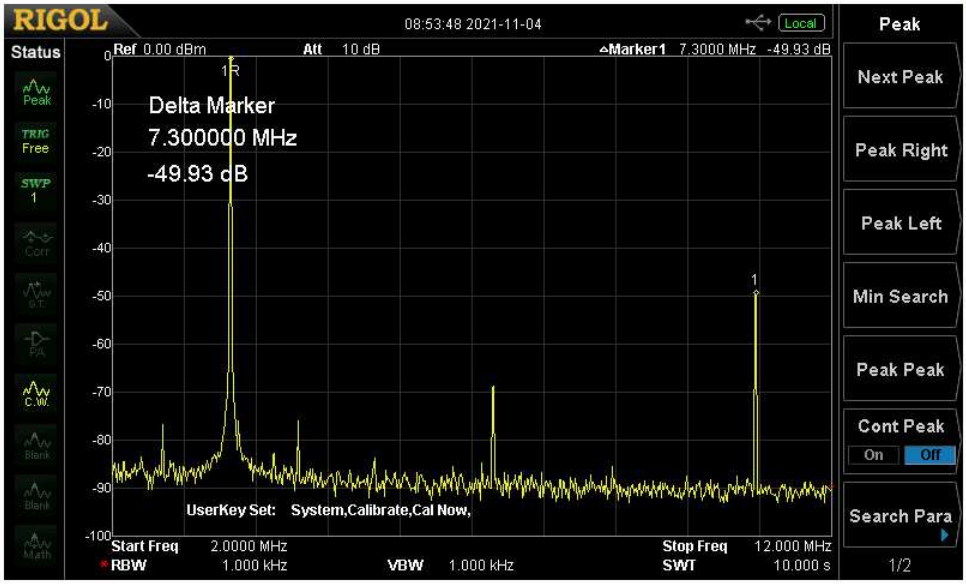
160m, 1.900MHz, approx. 900Wout, 2f1 -64.12dBc, **3f1 -48.39dBc**, 5f1 -76.58dBc



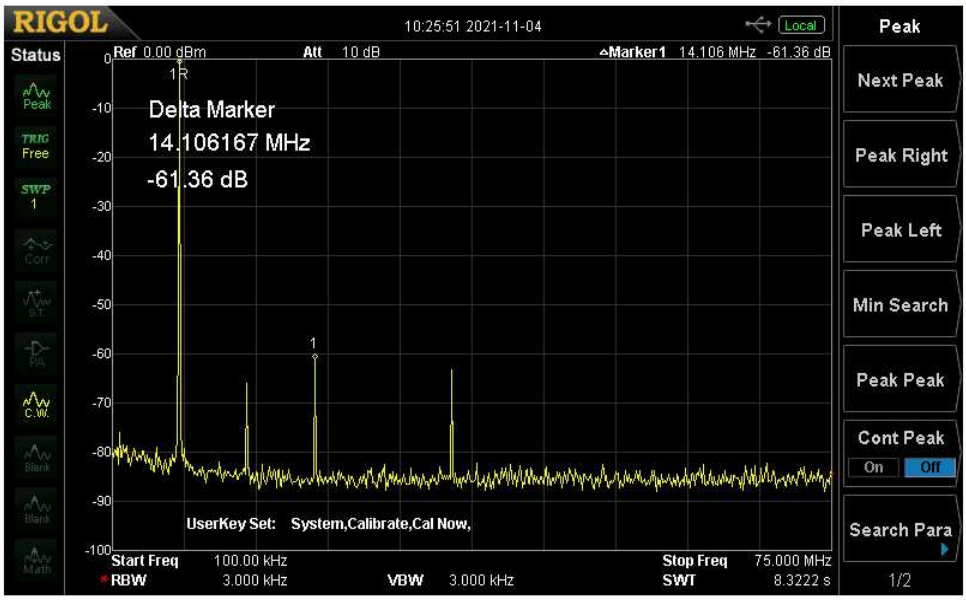
2f1 -64.01dBc, **3f1 -48.32dBc** - meets BETA (-48.66dBc)



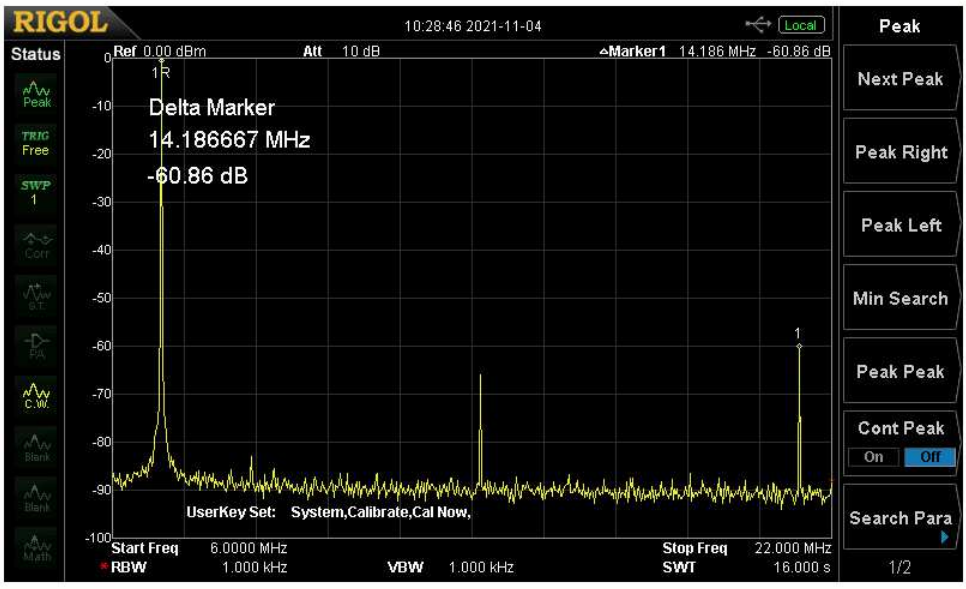
80m, 3.650MHz, 2f1 -69.38dBc, **3f1 -49.80dBc**, 5f1 -77.54dBc



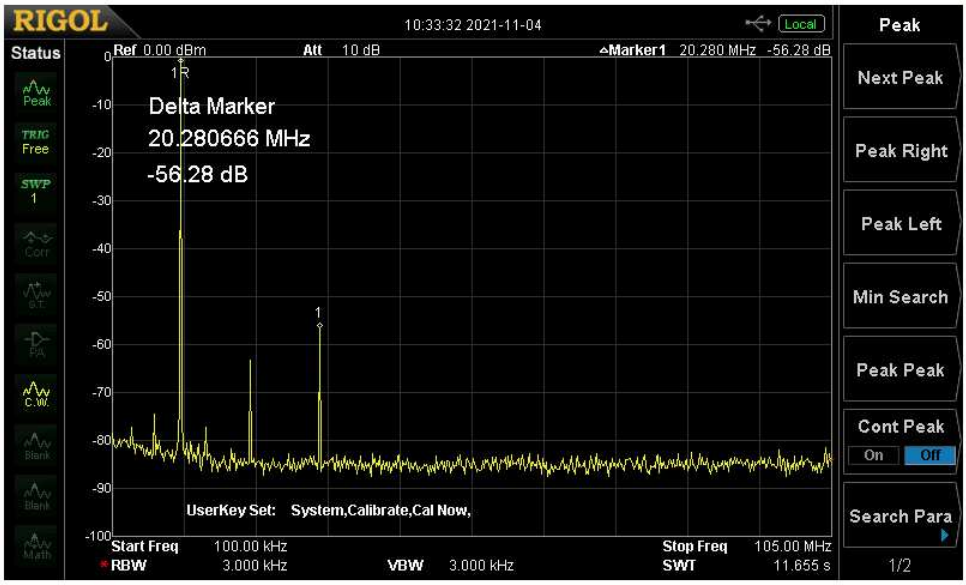
2f1 -69.06dBc, **3f1 -49.93dBc**



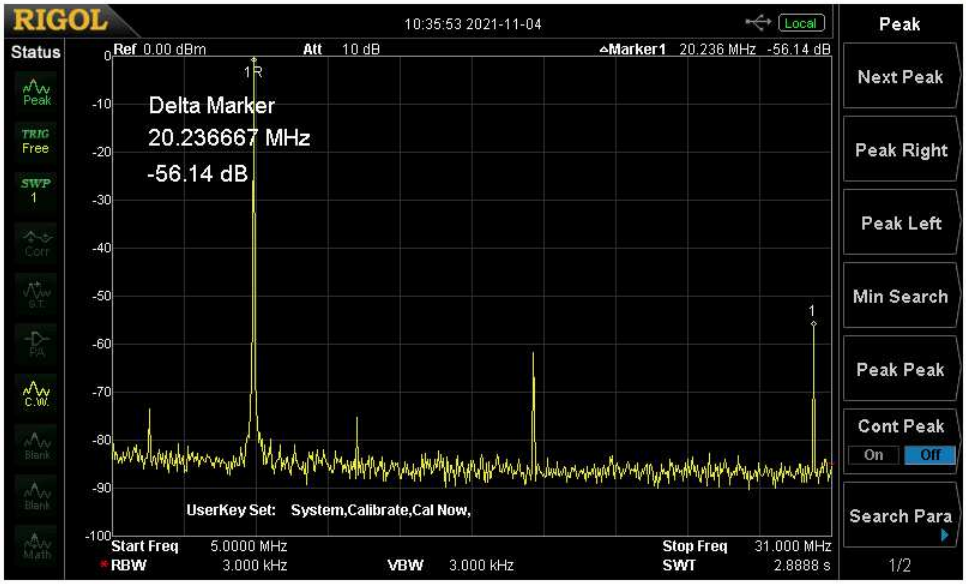
40m, 7.100MHz, 2f1 -66.43dBc, **3f1 -61.36dBc**, 5f1 -63.65dBc



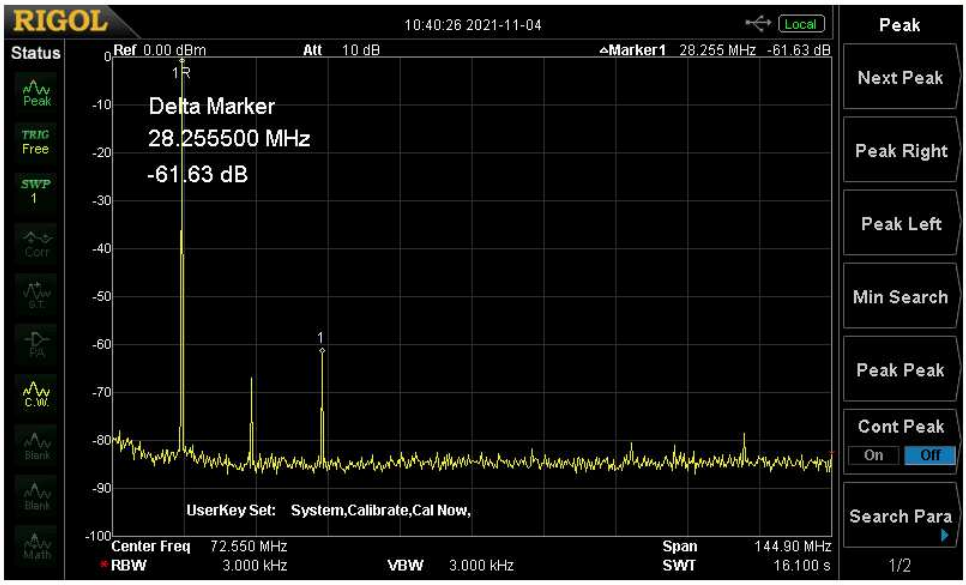
2f1 -66.26dBc, **3f1 -60.86dBc**



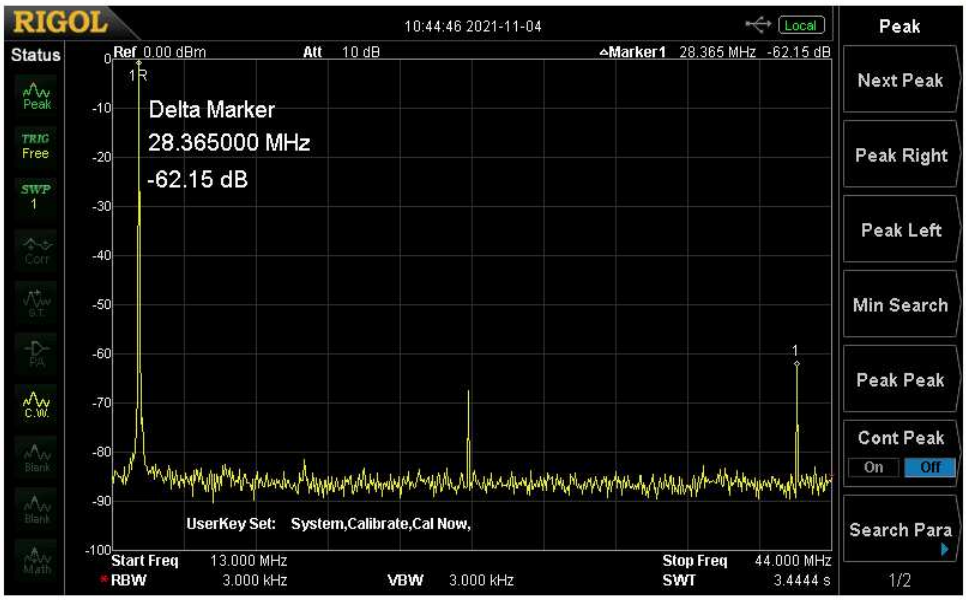
30m, 10.125MHz, 2f1 -62.97dBc, **3f1 -56.28dBc**



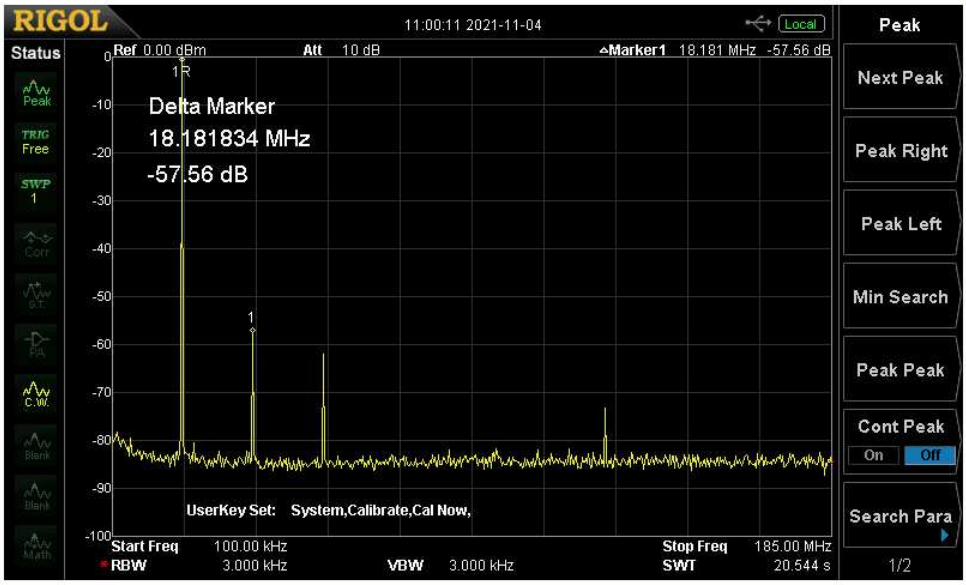
2f1 -61.50dBc, **3f1 -56.14dBc**



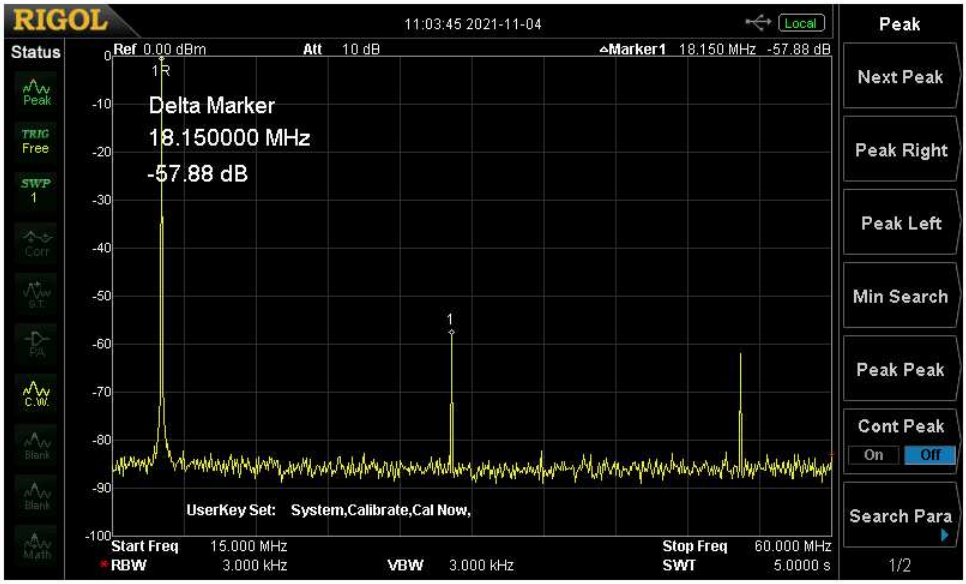
20m, 14.175MHz, 2f1 -66.66dBc, **3f1 -61.63dBc**



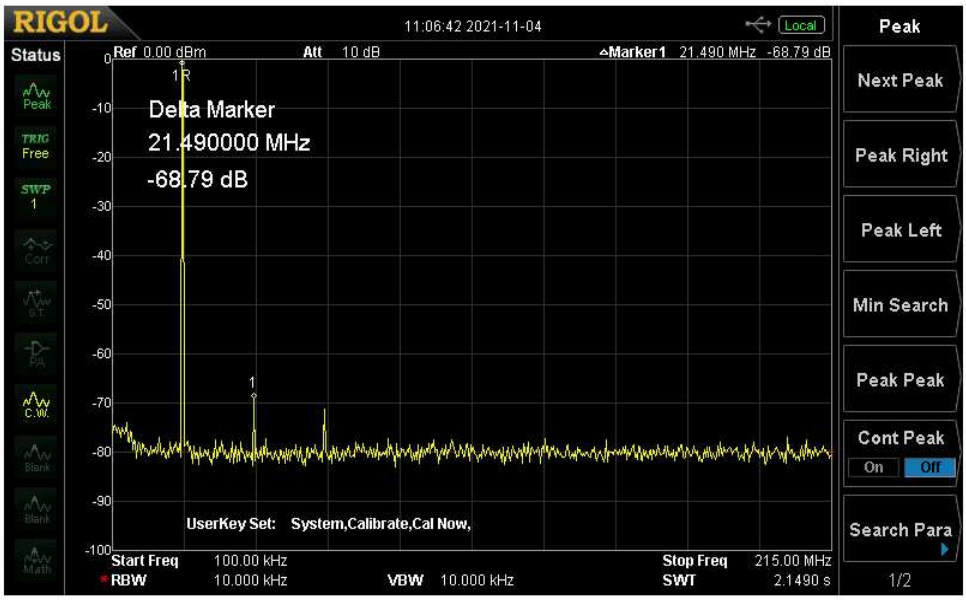
2f1 -67.22dBc, **3f1 -62.15dBc**



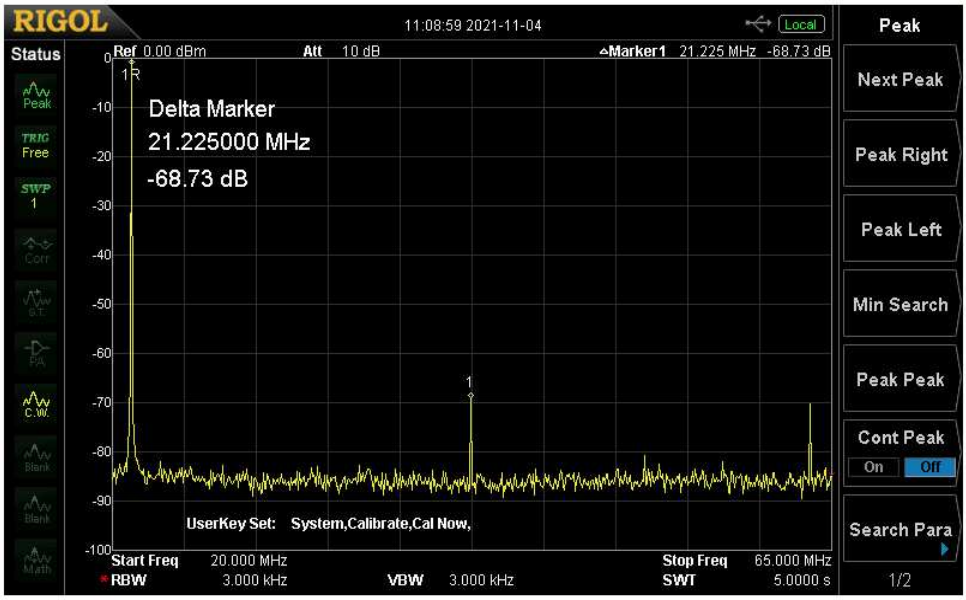
17m, 18.120MHz, **2f1 -57.56dBc**, 3f1 -62.05dBc, 7f1 -73.29dBc



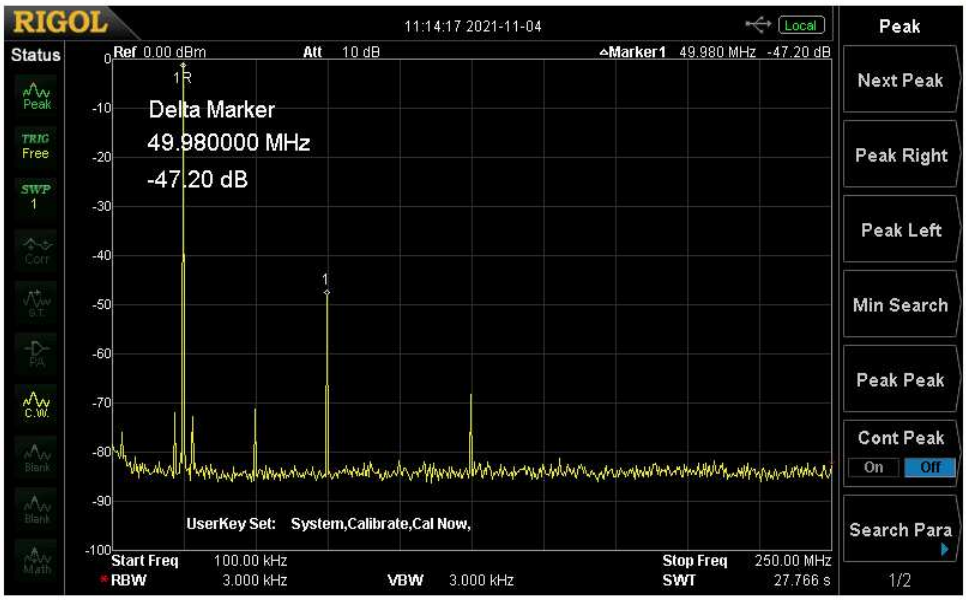
2f1 -57.88dBc, 3f1 -62.01dBc



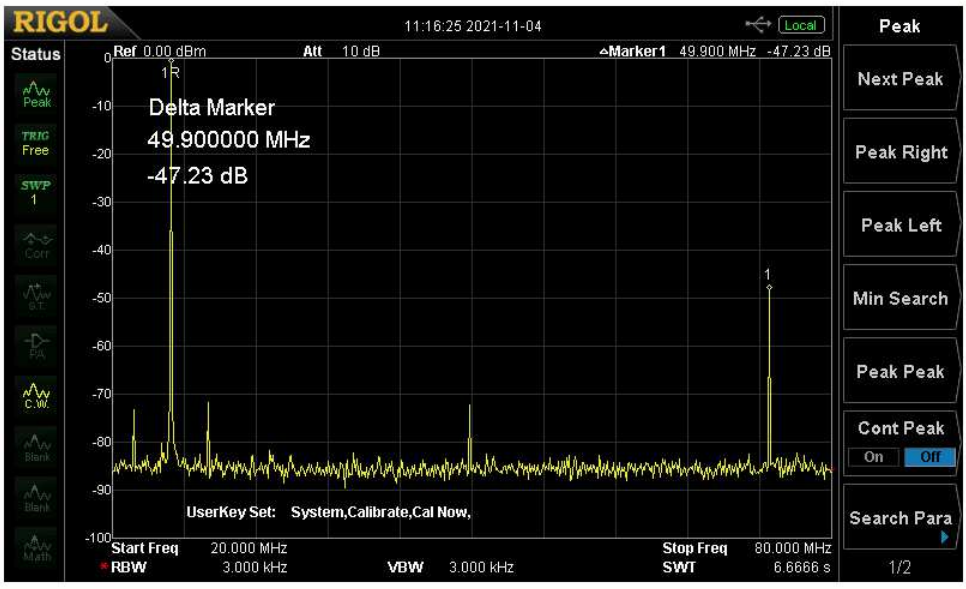
15m, 21.225MHz, **2f1 -68.79dBc**, 3f1 -71.03dBc



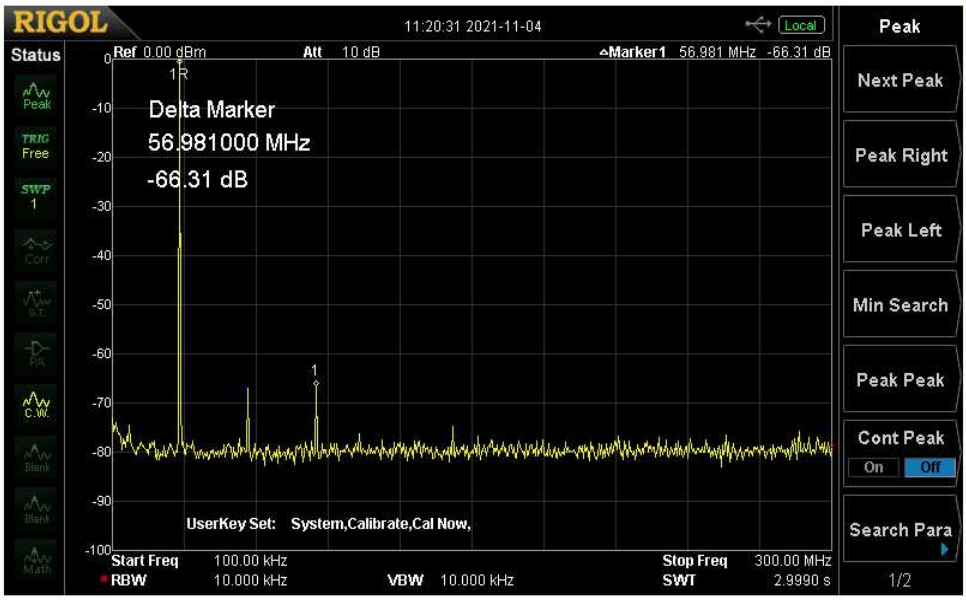
2f1 -68.73dBc, 3f1 -69.92dBc



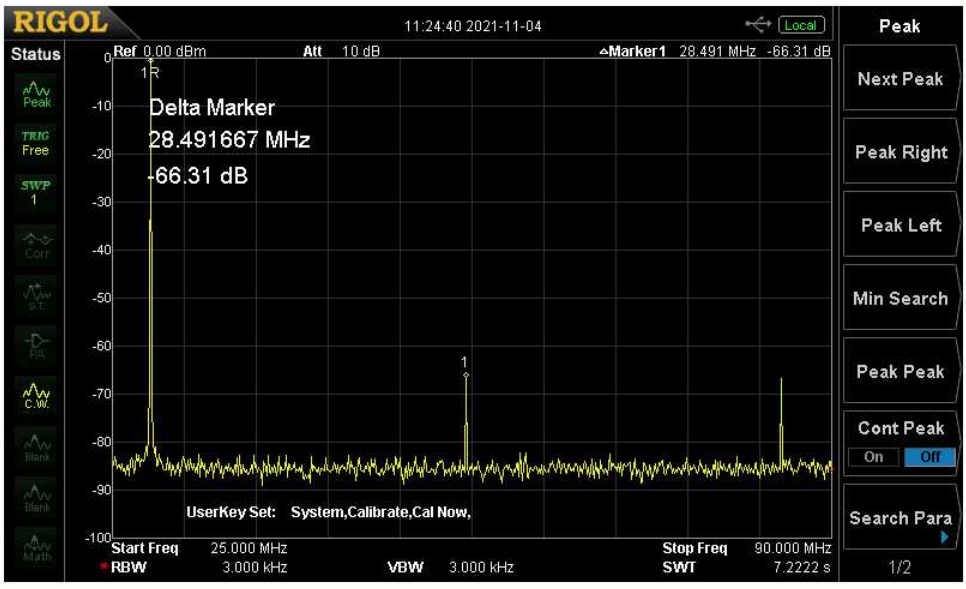
12m, 24.940MHz, approx. 900Wout*, 2f1 -70.51dBc, **3f1 -47.20dBc**, 5f1 -67.30dBc



2f1 -71.27dBc, **3f1 -47.23dBc** - mismatch to BETA by +8.65dB (-55.88dBc, TRX TS-570DG)



10m, 28.500MHz, 2f1 -67.01dBc, **3f1 -66.31dBc**



2f1 -66.31dBc, 3f1 -66.65dBc

Summary for #002, Spurious Emissions § 97.307 (d) at Output Power approx. 1kW:

Band	**Frequency f1** MHz	**2f1** dBc	**3f1** dBc	**4f1** dBc	**5f1 to 10f1** dBc
160m (900W)	1.900	-64.01	**-48.32**	n/a	-76.58
80m	3.650	-69.06	**-49.93**	n/a	-77.54
40m	7.100	-66.26	**-60.86**	n/a	-63.65
30m	10.125	-61.50	**-56.14**	n/a	n/a
20m	14.175	-67.22	**-62.15**	n/a	n/a
17m	18.120	**-57.88**	-62.01	n/a	-73.29
15m	21.225	**-68.73**	-69.92	n/a	n/a
12m (900W)	24.940	-71.27	**-47.23**	n/a	-67.30
10m	28.500	**-66.31**	-66.65	n/a	n/a

==========

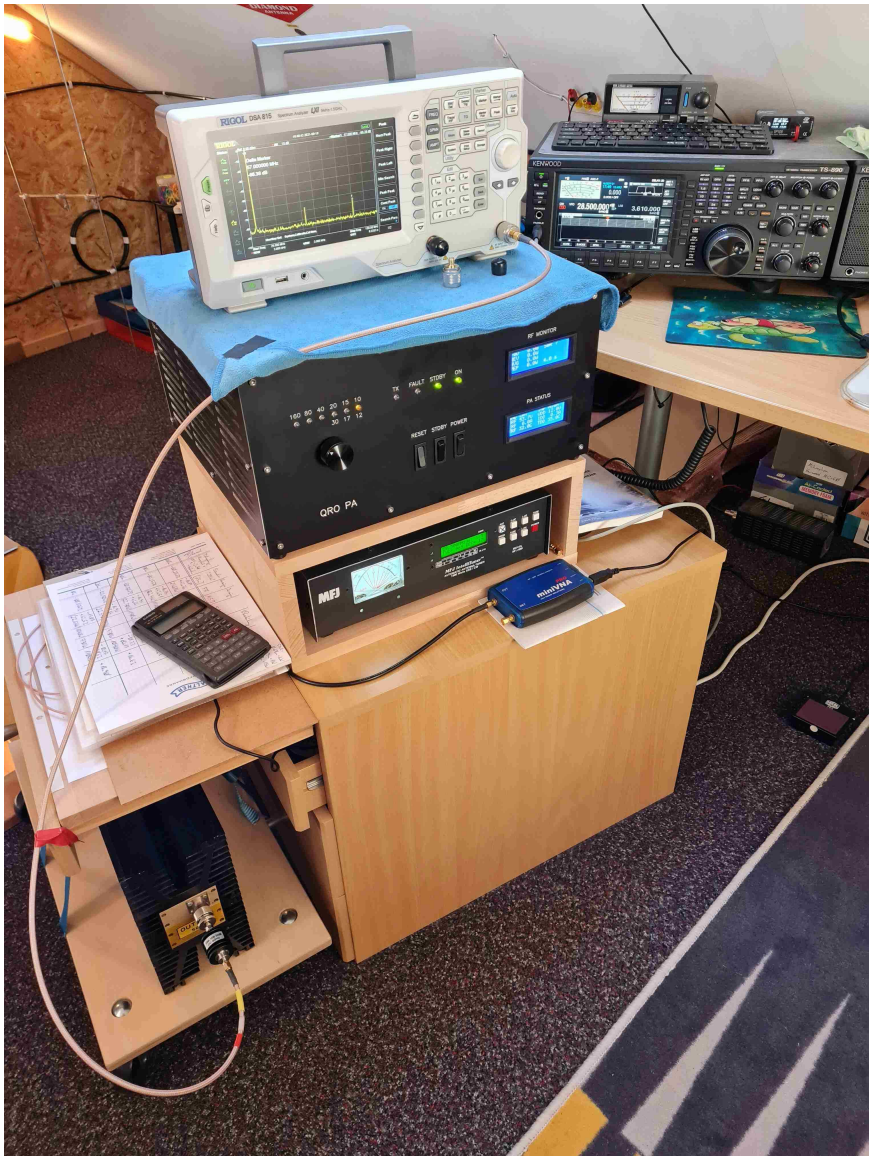
Power & Gain in Depth, measured for #003 only – achieved gain around +17dB at HIGH input:

Band m	**Att** "-60dB"	**TX** "25W"	**PA mtr**	**MFJ mtr**	**SA** "1kW"	**Gain** dB	**Drain** Ampere
160m **-44.3dBc**	-60.25	-16.89 +43.36 = 21.7W	930W	840W	-0.58 +59.67 **= 927W**	+16.3	42
80m **-51.0dBc**	-60.35	-16.84 +43.51 = 22.4W	1100W	1060W	+0.27 +60.62 = 1153W	+17.1	42.5
40m **-64.0dBc**	-60.50	-16.94 +43.56 = 22.7W	1140W	1110W	+0.34 +60.84 = 1213W	+17.3	40.5
20m **-62.4dBc**	-60.50	-16.96 +43.54 = 22.6W	990W	970W	-0.33 +60.17 = 1040W	+16.6	40.5
10m **-67.0dBc**	-60.6	-17.07 +43.53 = 22.5W	1040W	970W	-0.17 +60.43 = 1104W	+16.9	43.0

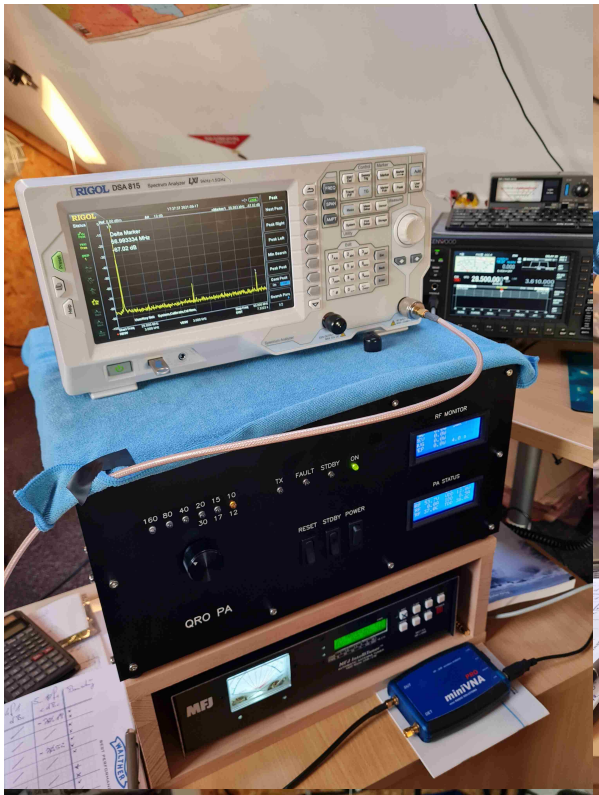
For use at the United States of America maximum gain needs to be less than 15dB,
see FCC 47 CFR §97.317 (a) (2);
furthermore the amplifier must not operate in the frequency range 26MHz to 28MHz,
see FCC 47 CFR §97.317 (b) (2);

FOR USE AT US
- *exciter input LOW needs to be blocked*
- *input attenuator at exciter input HIGH needs to be modified, >48W input power to 1.5kW output power*
- *at 10m band and 12m band amplifier has to stay in STAND BY (no gain), input power to be bypassed to PA output*

Photos Test Setup:



- Exciter Kenwood TS-890S to
  - **QRO PA** to
    - MF J-998 (ATU bypassed) to
      - Attenuator -30dB (3kW) to
        - Attenuator -30dB (10W) to
          - Spectrum Analyzer Rigol DSA-815 TG


RIGOL DSA 815
RF MONITOR
160 80 40 20 15 10
30 17 12
TX FAULT STDBY ON
PA STATUS
RESET STDBY POWER
QRO PA
MFJ
miniVNA


RIGOL DSA 815
RF MONITOR
160 80 40 20 15 10
30 17 12
TX FAULT STDBY ON
RESET STDBY POWER
PA STATUS
QRO PA
MFJ
MFJ IntelliTuner™
AUTOMATIC ANTENNA TUNER
miniVNA


RF MONITOR
160 80 40 20 15 10
TX FAULT STDBY ON
RESET STDBY POWER
PA STATUS
QRO PA
miniVNA

dBc Vergleichswerte zu BETA, diese Vorserie jedoch gemessen mit Knwd TS-570DG:

Band	BETA	ALPHA #001	ALPHA #002	ALPHA #003	Differenz
160m	-48.66	-43.90	**-48.32**	-44.25	**4.42 dB**
80m	-49.14	**-51.77**	-49.93	-50.98	1.84 dB
40m	-57.41	**-63.48**	-60.86	-62.97	2.62 dB
30m*	-58.34 (pwr)	-56.33	-56.14	**-56.98**	0.84 dB
20m	-65.11	-61.69	-62.15	**-62.42**	0.73 dB
17m	-60.25	-57.34	-57.88	**-60.58**	3.24 dB
15m	-60.38	-66.28	**-68.73**	-61.84	**6.89 dB**
12m*	-55.88 (pwr)	-47.45	-47.23 (pwr)	**-49.72** (pwr)	2.49 dB
10m	-70.25	-65.99	-66.31	**-67.02**	1.03 dB

*Bestwerte des Cauer Filters in **Gruen***

Abweichungen von bis zu 3dB sind bei der Abstimmung des Filters zu erwarten und zu akzeptieren; die Abweichung von #003 auf 15m kann nicht erklaert werden, jedoch der absolute Wert von fast -62dBc ist mehr als ausreichend.

Hardware ALPHA #002 geht aus BETA Version hervor:
- HW Aenderungen „Rotstrich“ aus der Erprobung eingepflegt
- Verkabelung optimiert
- EMV Problem CAT-Arduino durch Abblockung mit Ferritkernen geloest
- professionelles Gehaeuse von HK Mechanik aus Wilhelmshaven
- aktuelle FW Version mit Ansteuerung Piezo Signalgeber