Sulis Consultants
CE Marking and Product Approvals

RF Test Report:

Zinwave ORU

47CFR90

FCC ID: UPO302-1107

SC_TR_178_C

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1 Revision History

Revision	Originator	Date	Comment	Signature
Draft 1	C Blackham Director, Sulis Consultants Ltd	08 Dec 2015	1st release as draft	
A	C Blackham Director, Sulis Consultants Ltd	10 Jan 2016	1st release	
B	C Blackham Director, Sulis Consultants Ltd	07 Feb 2106	Typos and section 12 updated	
C	C Blackham Director, Sulis Consultants Ltd	04 May 2016	698 – 824 MHz band updated to be just 769-775 MHz	

2 Purpose

This document details the testing performed on Zinwave Optical Remote Unit, ORU, model number 302-1107 against requirements of FCC 47CFR90.

3 Reference Documents

[1]	47 CFR90	Title 47 Code of Federal Regulations Part 90: Private Land Mobile Radio Services
[2]	TIA-603-D	Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards
[3]	KDB 935210 D05 V01	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement guidance for Industrial and Non-consumer signal booster, repeater and amplifier devices
[4]	KDB971168 DO1 v02r02	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement guidance for certification of licensed digital transmitters.

4 Test Information

4.1 Client and manufacturer

Zinwave Ltd

Harston Mill

Harston

Cambridge

CB22 7GG

UK

4.2 Test Locations

Testing was performed by Charlie Blackham of Sulis Consultants Ltd on 14th September 2015 and on 3rd May 2016 at Zinwave's offices detailed in section 4.1

4.3 Test sample

The results herein only refer to sample detailed in section 5

5 Test Configuration

5.1 Test sample and Operating mode

The equipment under test (EUT) was:

Manufacturer	Name	Model Number	Serial Number
Zinwave	ORU	302-1107	310400000012

Table 1: Equipment under test

Modifications during test: None

5.2 Support equipment

The following equipment shall be used, configured as shown in Figure 1:

Name	Part Number	Label	Serial Number
Zinwave UNIhub (Primary Hub)			
Chassis		302-1001	00-17-68-00-09-B7
RF Service module		SM 1/6	030370002050
Optical module		OM 1/6	050750002036
Zinwave UNIhub (Secondary Hub)			
Chassis		302-1001	00-17-68-00-09-67
Input Optical module		OM 5/6	50750002039
Optical module		OM 3/6	50750002010

Table 2: Support Equipment

5.3 Equipment arrangement

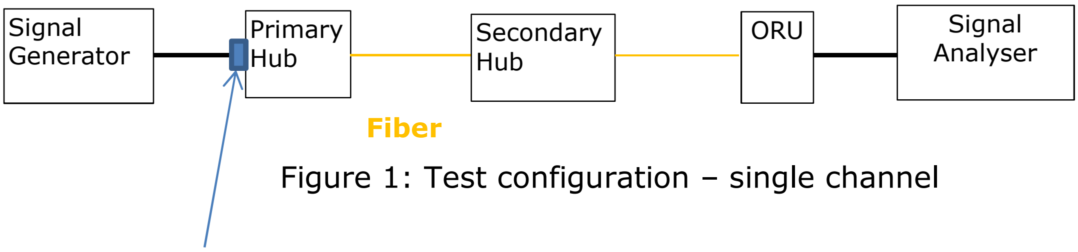


Figure 1: Test configuration – single channel

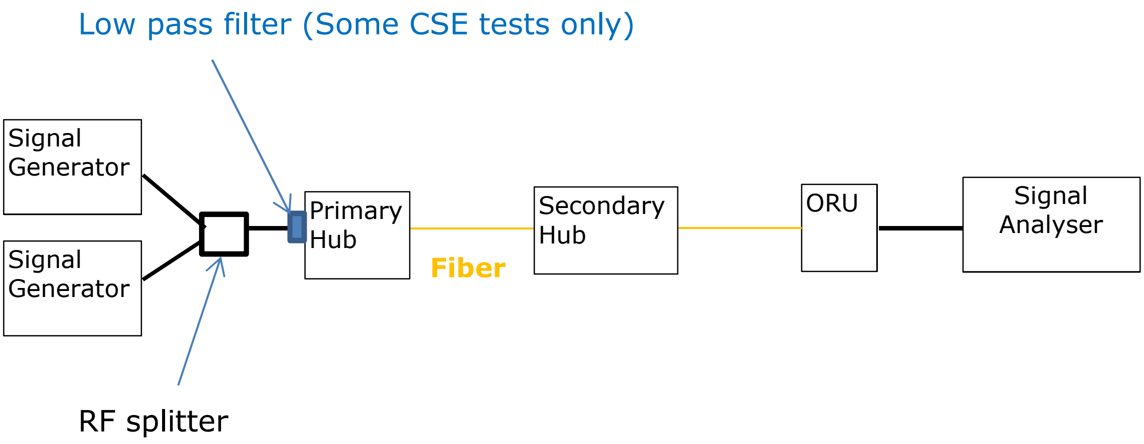


Figure 2: Test configuration – dual channel

Notes – additional connections not shown:

1. For dual channel measurements, IQ output from SMBV100A Vector Signal Generator connected to IQ input of SMJ100A signal generator
2. 10 MHz Ref Clock output of FSV40 Signal Analyser connected to Ref Clock inputs of the two signal generators

5.4 Permitted Antennas

The system is designed for operation with antennas having a maximum gain of 8.0 dBi or 5.85 dBd.

This is the value used for determining EIRP or ERP where required.

5.5 Supported Services

Frequency Band (MHz)	Service	Modulation	Channel Bandwidth	Emission designator
150 - 174	P25	C4FM (QPSK)	12.5kHz	11K2G1E
	FM	FM ±2.5kHz deviation	12.5kHz	11K2F3W
406.1 – 454.0	P25	C4FM (QPSK)	12.5kHz	11K2G1E
	FM	FM ±2.5kHz deviation	12.5kHz	11K2F3W
	FM	FM ±5.0kHz deviation	25kHz	20K0F3W
456.0 – 512.0	P25	C4FM (QPSK)	12.5kHz	11K2G1E
	FM	FM ±2.5kHz deviation	12.5kHz	11K2F3W
	FM	FM ±5.0kHz deviation	25kHz	20K0F3W
769.0 -775.0	P25	C4FM (QPSK)	6.25kHz	11K2G1E
		4kHz FM	6.25kHz	4K10F1E
851.0 – 869.0	P25	C4FM (QPSK)	12.5kHz	11K2G1E
	OpenSky	4-level GFSK	25kHz	8K10F1E
	FM & EDACS	FM ±5.0kHz deviation	25kHz	20K0F3W
	iDEN	16-QAM	25kHz	20K0W7W
935.0 – 940.0	iDEN	16-QAM	25kHz	20K0W7W
851.0 – 869.0	EVDO (QPSK+QAM)	QPSK 16QAM	1.25MHz	1M25F9W 1M25W9W
	FD-LTE	QPSK 16QAM 64QAM	5 MHz	4M20F9W 4M20W9W 4M20W9W

6 Summary of Tests performed

This report contains results for the following tests:

Test	47 CFR Part	Section	Result
Passband gain and Determination of f_0	N/A	7	N/A
Transmit Power	90.219(e)(1)	8	Pass
Noise Figure	90.219(e)(2)	Not applicable[1]	
Intermodulation spurious emission	90.219(e)(3)	9	Pass
Occupied Bandwidth	90.219(e)(4) 90.210(c) 90.210(h)	10	Pass
Conducted Spurious Emissions	90.219(e)(3)	11	Pass
Noise ERP	90.219(d)(6)(ii)	12	Pass
Emissions limitations	90.543(f)	13	

Table 3: Summary of tests performed

[1] **935210 D02 Signal Boosters Certification v03section V(j)(5)**: For the remote unit of a conventional fiber-connected host/remote DAS booster system, it is acceptable to submit compliance information and test data consistent with 90.219(d)(6)(ii) (i.e., ERP of noise ≤ −43 dBm in 10 kHz RBW) for the downlink path only, in place of 90.219(e)(2) noise figure test data (i.e., NF ≤ 9 dB for both UL and DL). Test reports must provide explicit details about instrumentation and procedure used for 90.219(d)(6)(ii) testing.

7 Pass band gain

7.1 Test method

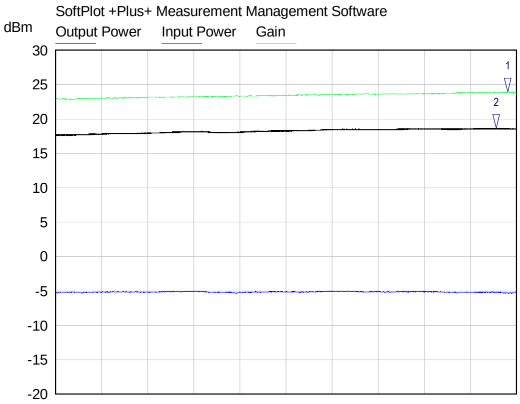
1. Connect a signal generator to the input of the Spectrum Analyser.
2. Configure a swept CW signal with the following parameters:
    a. Frequency range = the passband of the service band under investigation.
    b. Set power so that the received level to be -5dB.
    c. Dwell time = 50 ms
    d. Number of points = SPAN/(RBW/2).
3. Set the span of the spectrum analyser to the same as the frequency range of the signal generator.
4. Set the detector to Peak Max-Hold and wait for the spectrum analyser's spectral display to fill.
5. Record trace.
6. Connect Signal Generator to RF service module or Primary Hub
7. Connect a spectrum analyser to the output of the EUT using appropriate attenuation.
8. Set the detector to Peak Max-Hold and wait for the spectrum analyser's spectral display to fill.
9. Record trace.
10. Calculate and report Gain, which is difference between input and output signal.

7.2 Results

Exact power fed into Hub shown on plot as "input power" and resultant output shown as "output power". Gain calculated as "output power – input power" (as input power is –ve)

Freq range (MHz)	Maximum gain (dBm)
150 – 174	10.96
406.1 – 454	23.91
456 - 470	24.27
769.0 -775.0	25.54
851 – 869	25.44
929 – 940	24.68

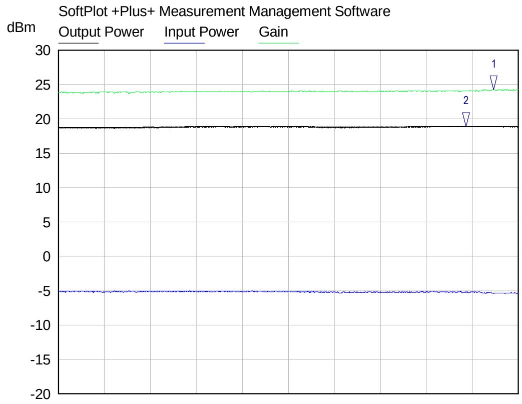
Table 4: gain variance within Land mobile service bands



Start: 406.0000 MHz Stop: 454.0000 MHz
Res BW: 100 kHz Vid BW: 100 kHz Sweep: 56.88 us
27/11/2015 15:53:17 Atten: 50 dB FSV-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Gain	453.1238 MHz	23.91 dBm	Max gain
2 ▽	Output Power	451.8875 MHz	18.66 dBm	Max output power

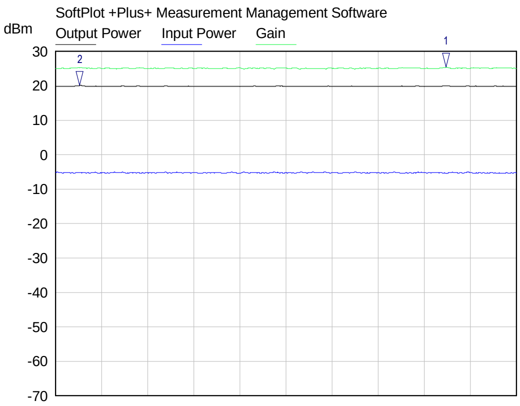
406.1 – 454 MHz



Start: 456.0000 MHz Stop: 470.0000 MHz
Res BW: 100 kHz Vid BW: 100 kHz Sweep: 18.97 us
27/11/2015 15:58:02 Atten: 50 dB FSV-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Gain	469.2508 MHz	24.27 dBm	Max gain
2 ▽	Output Power	468.4001 MHz	18.92 dBm	Max output power

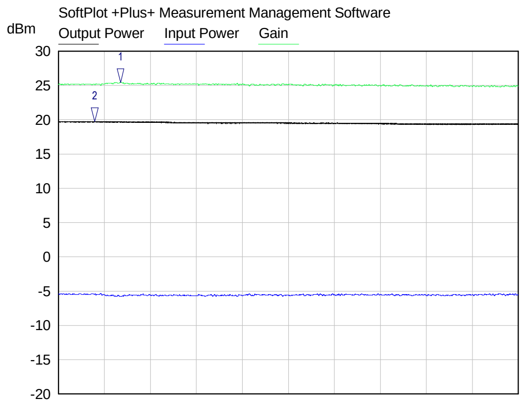
456 - 470 MHz



Start: 769.0000 MHz Stop: 775.0000 MHz
Res BW: 100 kHz Vid BW: 1 MHz Sweep: 5.00 ms
03/05/2016 16:40:31 Atten: 50 dB FSQ-8

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Gain	774.0880 MHz	25.46 dBm	Max gain
2 ▽	Output Power	769.3180 MHz	20.09 dBm	Max output power

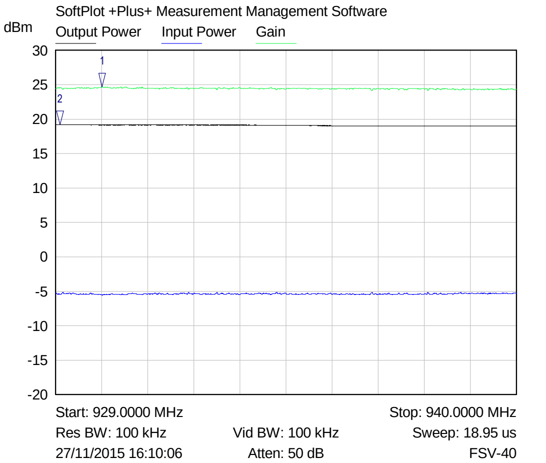
769 -775 MHz



Start: 851.0000 MHz Stop: 869.0000 MHz
Res BW: 100 kHz Vid BW: 100 kHz Sweep: 37.98 us
27/11/2015 16:07:49 Atten: 50 dB FSV-40

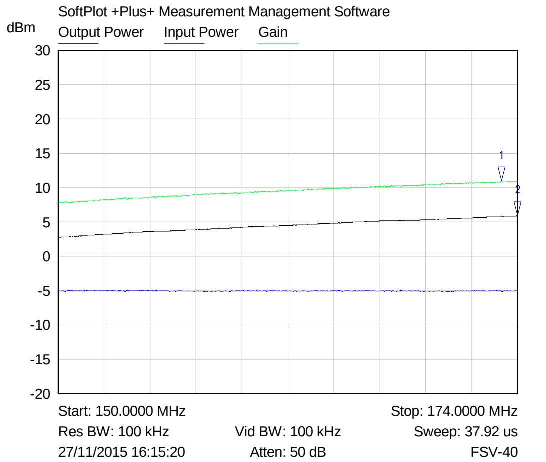
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Gain	853.4351 MHz	25.44 dBm	Max gain
2 ▽	Output Power	852.4179 MHz	19.74 dBm	Max output power

851 – 869 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Gain	930.1140 MHz	24.68 dBm	Max gain
2 ▽	Output Power	929.1073 MHz	19.19 dBm	Max output power

929 – 940 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Gain	173.1718 MHz	10.96 dBm	Max gain
2 ▽	Output Power	174.0000 MHz	5.89 dBm	Max output power

150 -174 MHz

Figure 3: gain variance within service bands

8 Transmit Power

The Maximum transmit power is determined from the maximum output power determined using a CW signal in section 7

Freq range (MHz)	Maximum conducted transmit power (dBm)	Maximum radiated power (ERP)	Limit
150 – 174	5.89		
406.1 – 454	18.66		
456 - 470	18.92		
769 -775	20.09		2W ERP 90.531
851 – 869	19.74		
929 – 940	19.19		

Table 5: Maximum transmit power within Land mobile service bands

The limit in 90.219(e)(1) is 5W ERP or 37 dBm ERP and the highest ERP obtained from this system is 26.1 dB ERP, or 406 mW ERP.

9 Intermodulation spurious emissions

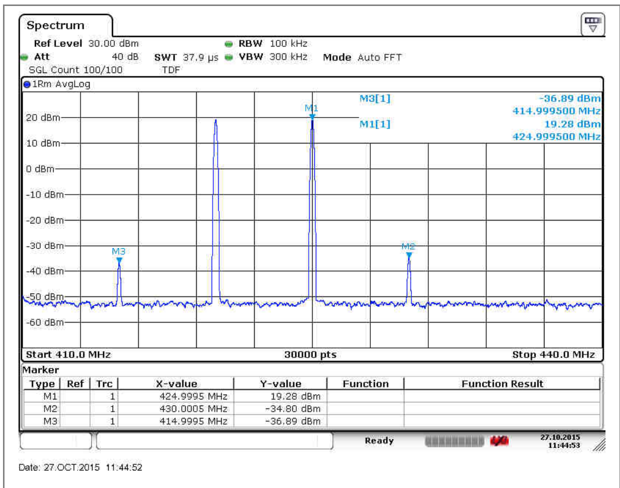
9.1 Test method

- Two signal generators were connected to the RF service input of the hub via a 2:1 splitter.
- For each band under consideration two generator frequencies f_1 and f_2 were set such that their 3rd order intermodulation products, f_3 and f_4 were also within the band under consideration.
- The input levels of the two input signals were raised until either the AGC threshold was reached or the total channel power was 3dB above that specified.
- The level of the highest CW tone was noted for
- The level of the highest intermodulation product was noted for comparison against the -13 dBm limit.

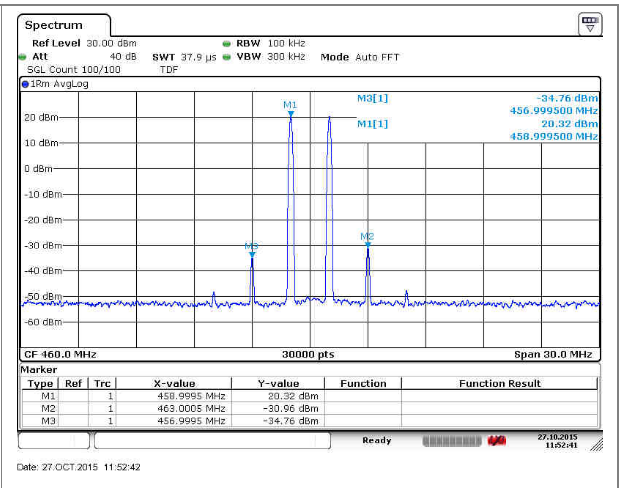
9.2 Test results

Freq range (MHz)	Highest tone, P_{o1} (dBm)	Highest intermodulation product (dBm)	Limit (dBm)	Result
150 - 174	4.07	< -50.0	-13.0	Pass
406.1 – 454	19.28	-34.8	-13.0	Pass
456 - 512	20.32	-30.96	-13.0	Pass
769 -775	20.08	-18.95	-13.0	Pass
851 – 869	20.84	-15.21	-13.0	Pass
929 – 935	20.27	-21.49	-13.0	Pass
935 – 940	20.26	-21.88	-13.0	Pass

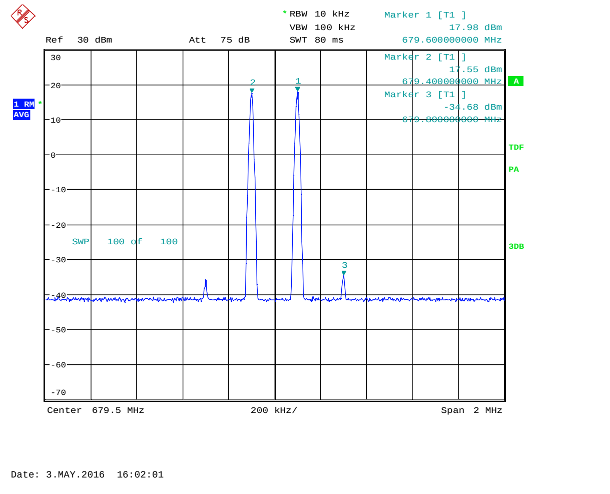
Table 6: Multi-channel transmit power and intermodulation



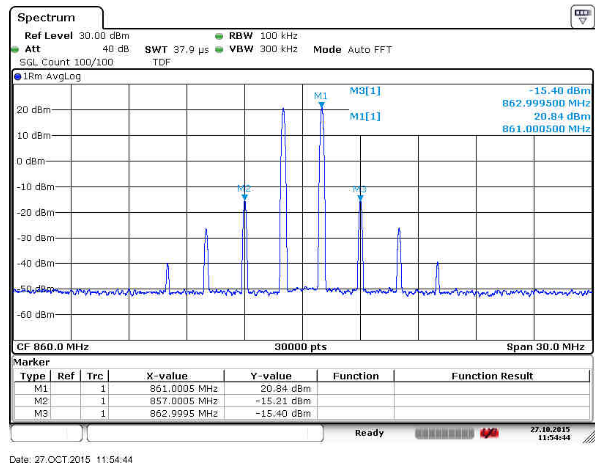
406.1 – 454 MHz



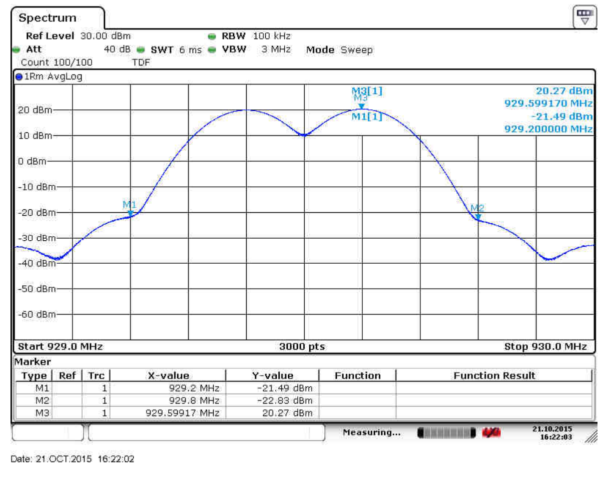
456 - 470 MHz



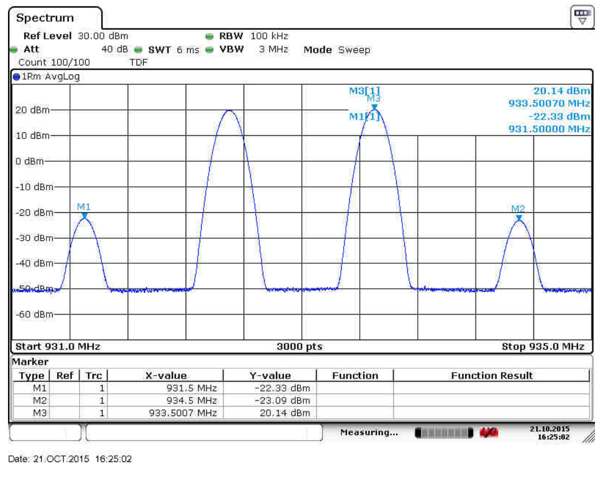
679 – 775 MHz



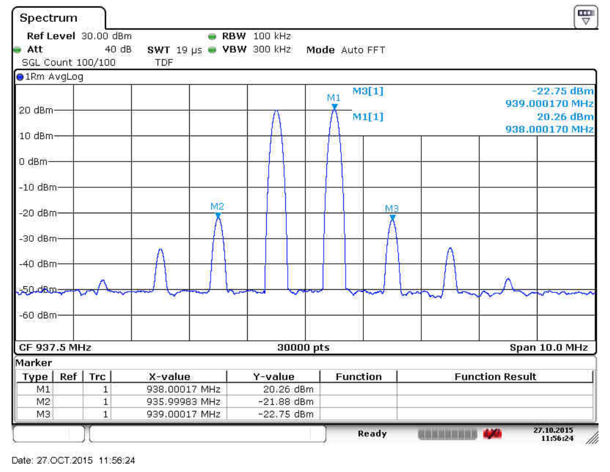
851 – 869 MHz



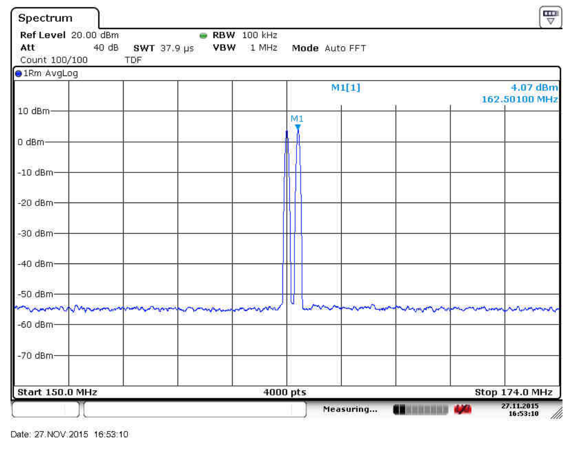
929 – 930MHz



931 – 935MHz



935 – 940MHz



150-174 MHz

Figure 4: Multi-channel transmit power and intermodulation

10 Occupied Bandwidth

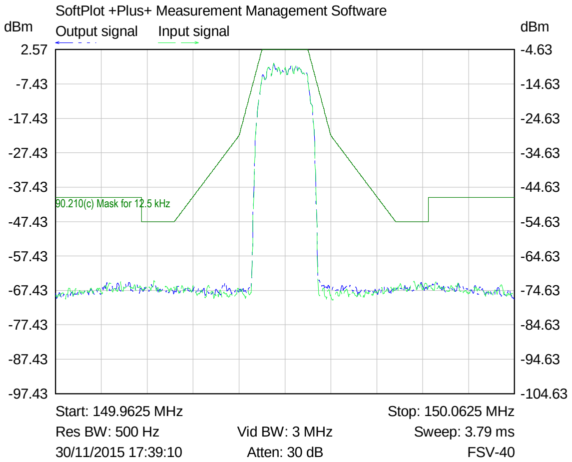
10.1 Test method

For a single channel amplifier, the 99% emission bandwidth shall be measured under the conditions described in section 4.3.2 and the spectrum analyser plots submitted in the test report.

Set the resolution bandwidth of the spectrum analyser from 1% to 3% of the 99% emission bandwidth and set the video bandwidth to 3 times the resolution bandwidth. Record both the amplifier input and set the video bandwidth to 3 times the resolution bandwidth. Record both the amplifier input and output signals.

The plot was also compared against the mask in 90.210(c) except for operation in the 851-854 MHz band where 90.210(h) was used

10.2 Test results



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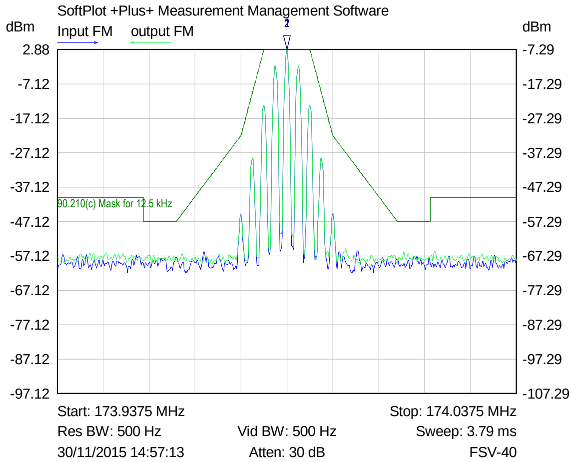
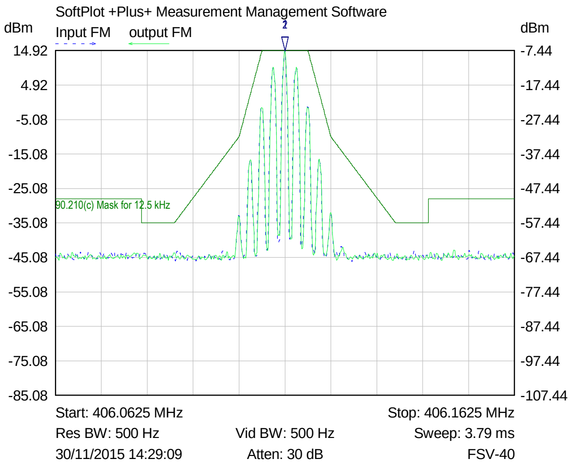


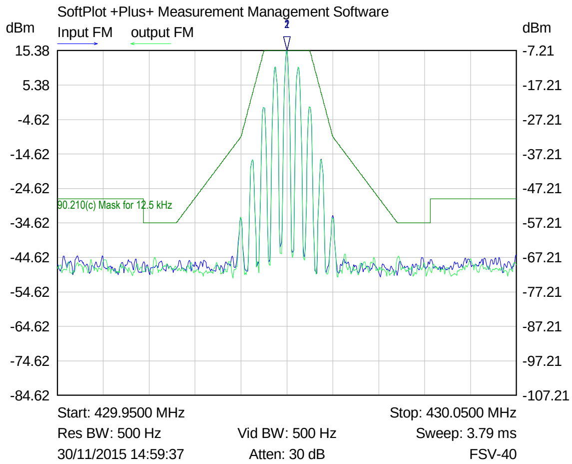
Mkr	Trace	X-Axis	Value	Notes
1 ∇	Input FM	173.9875 MHz	-7.29 dBm	max input
2 ∇	output FM	173.9875 MHz	2.88 dBm	Max level

2



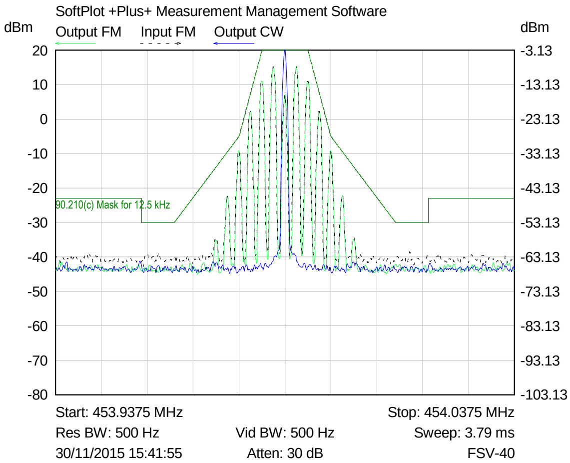
Mkr	Trace	X-Axis	Value	Notes
1 ∇	Input FM	406.1125 MHz	-7.44 dBm	max input
2 ∇	output FM	406.1125 MHz	14.82 dBm	Max level

3



Mkr	Trace	X-Axis	Value	Notes
1 ∇	Input FM	430.0000 MHz	-7.21 dBm	max input
2 ∇	output FM	430.0000 MHz	15.38 dBm	Max level

4



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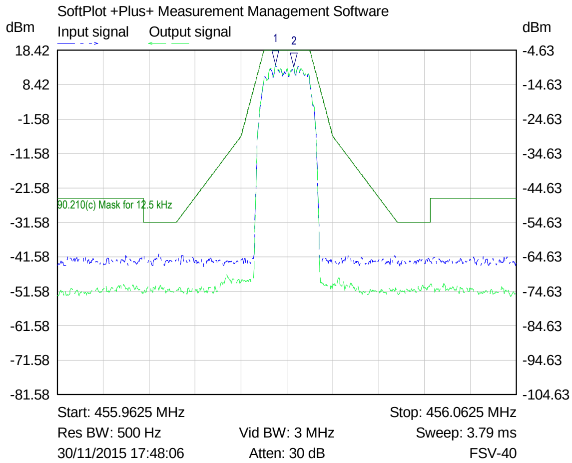
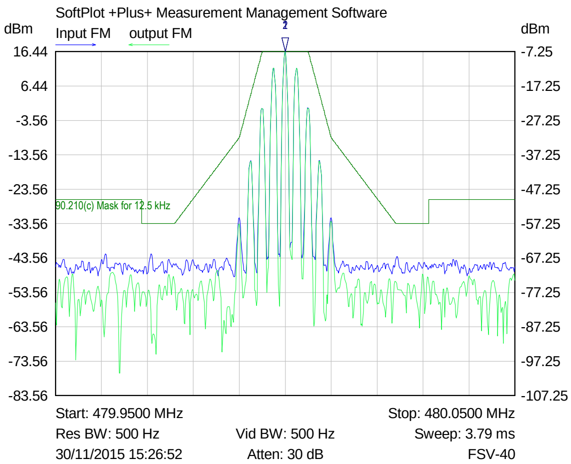


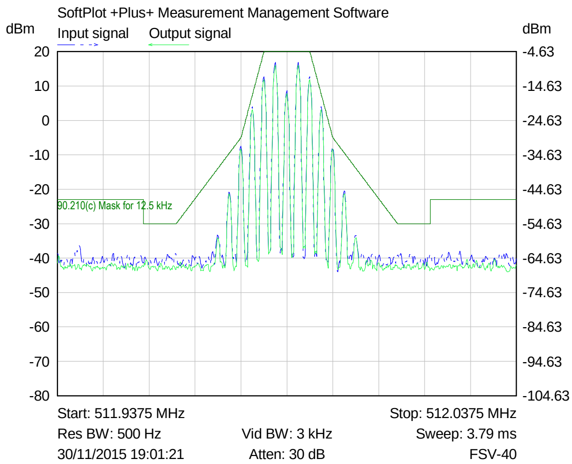
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Output signal	456.0100 MHz	14.33 dBm	
2 ▽	Input signal	456.0140 MHz	-9.47 dBm	

6



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Input FM	480.0000 MHz	-7.25 dBm	max input
2 ▽	output FM	480.0000 MHz	16.44 dBm	Max level

7



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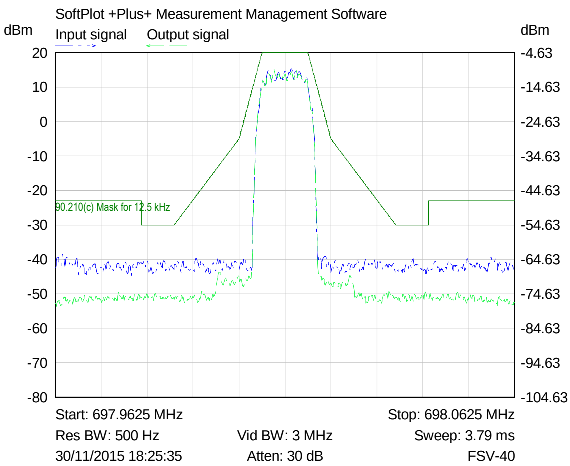

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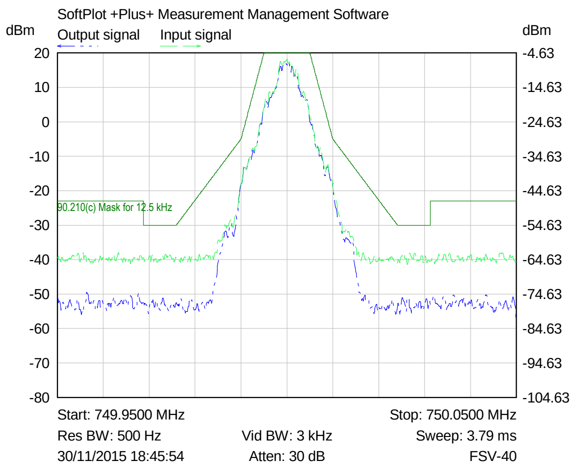

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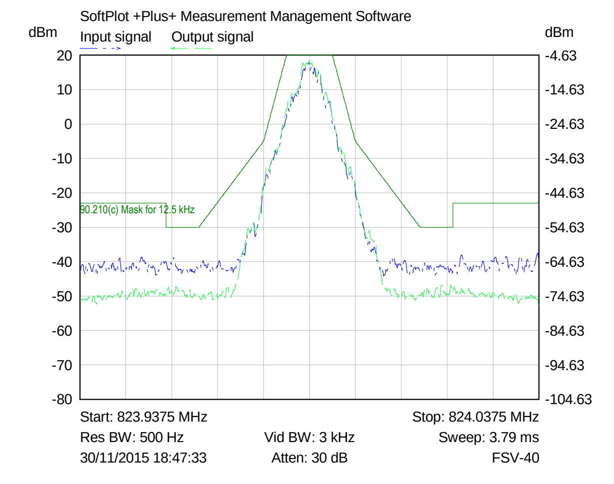

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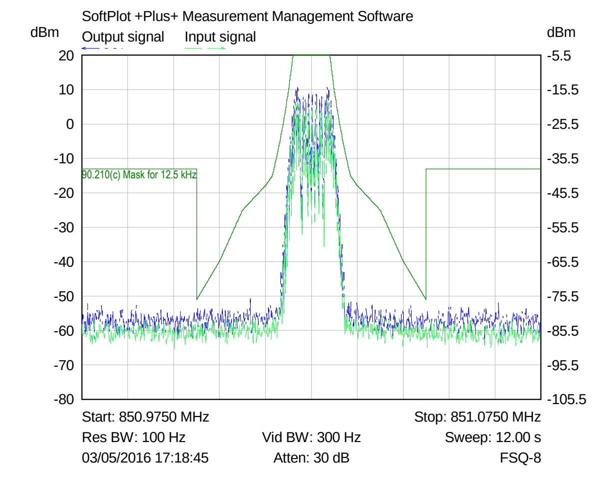
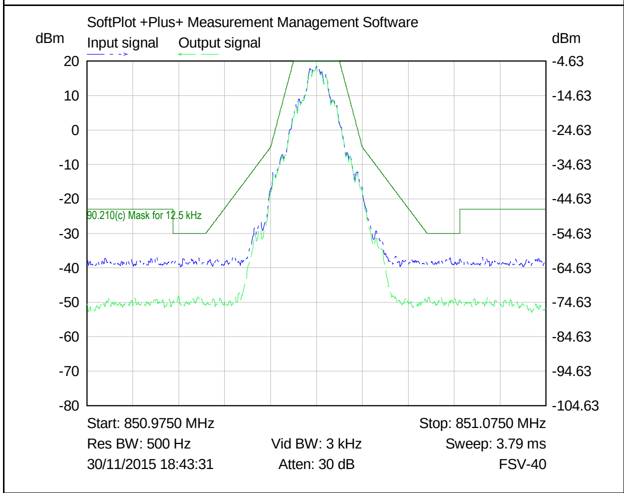


12 (mask H)



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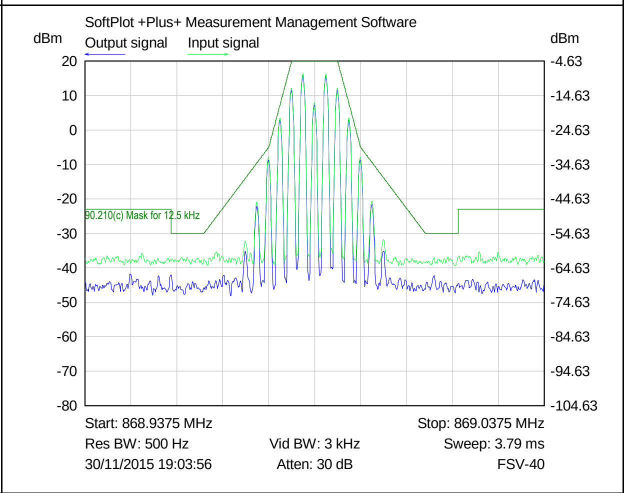

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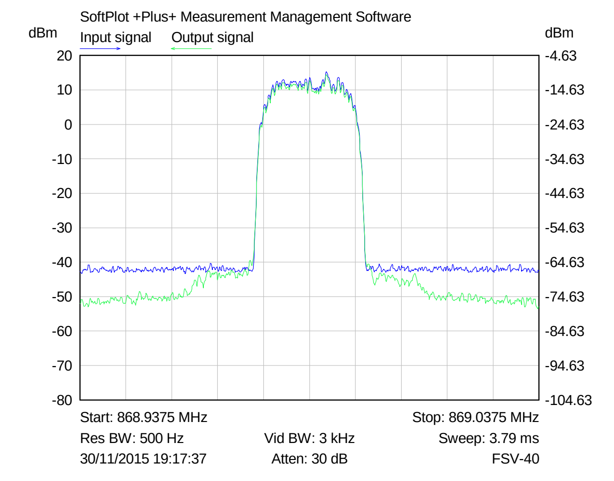

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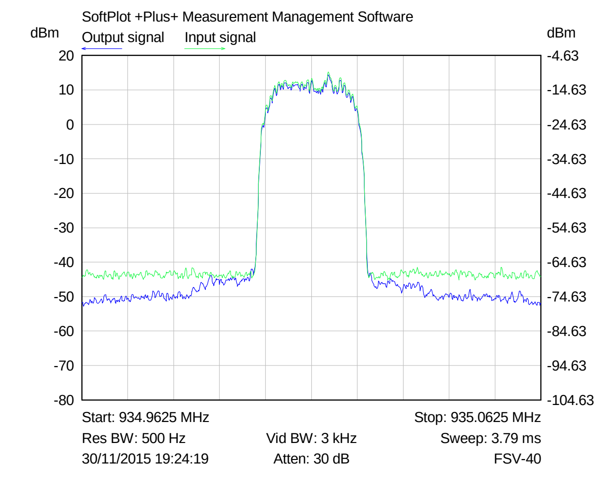

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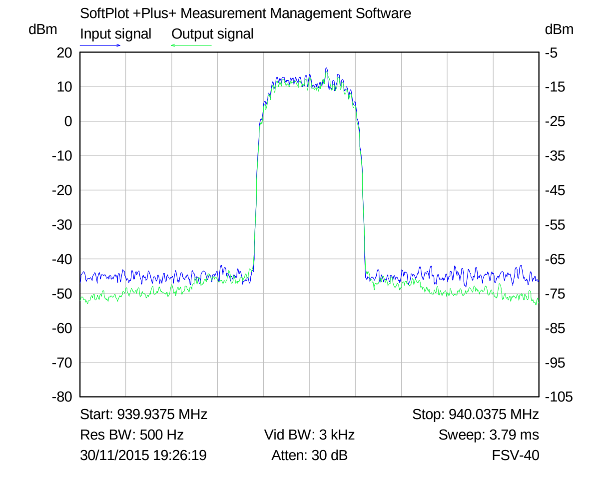

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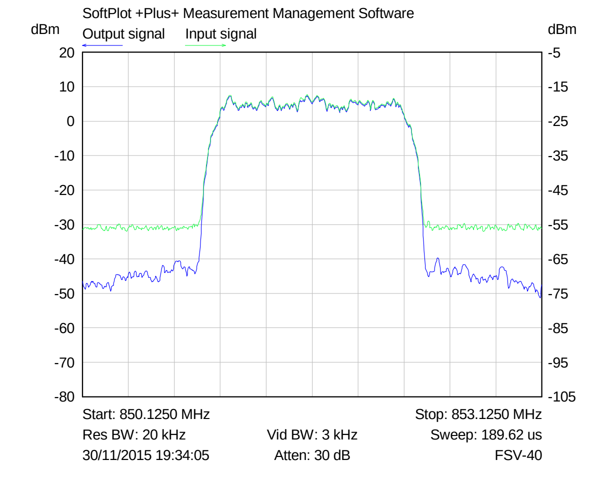

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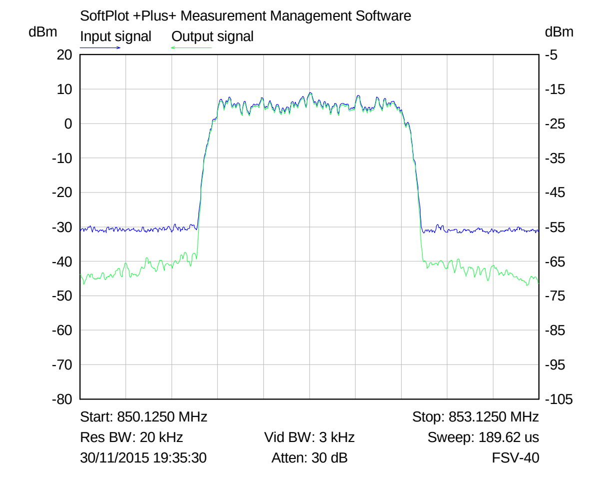

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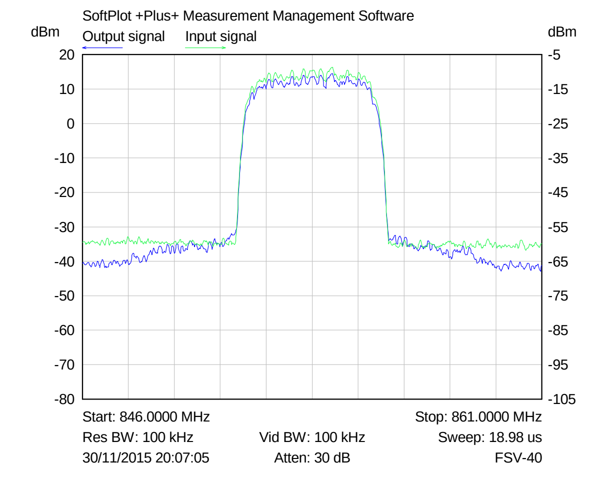

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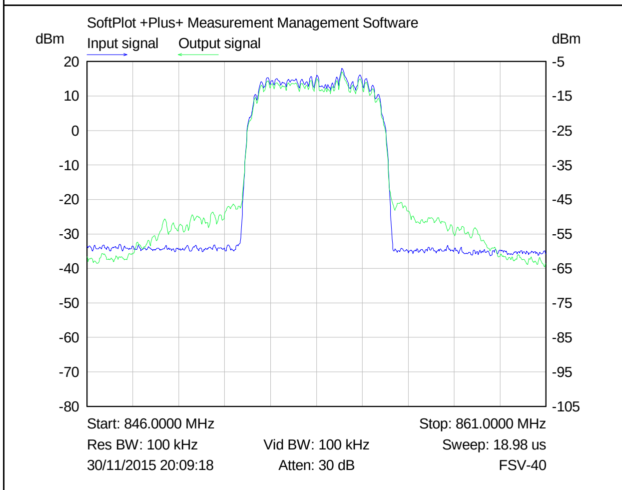

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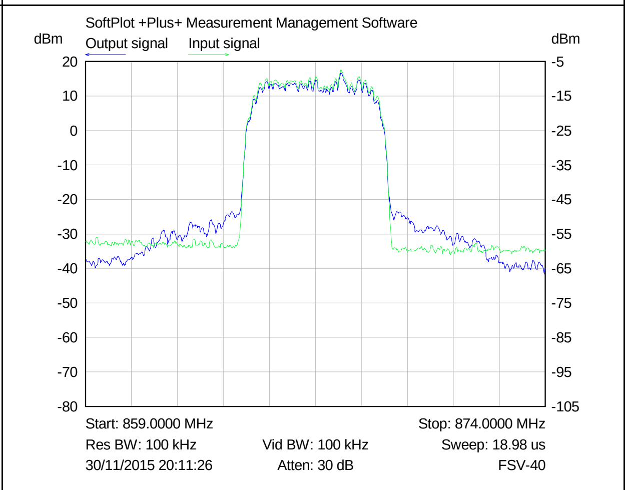

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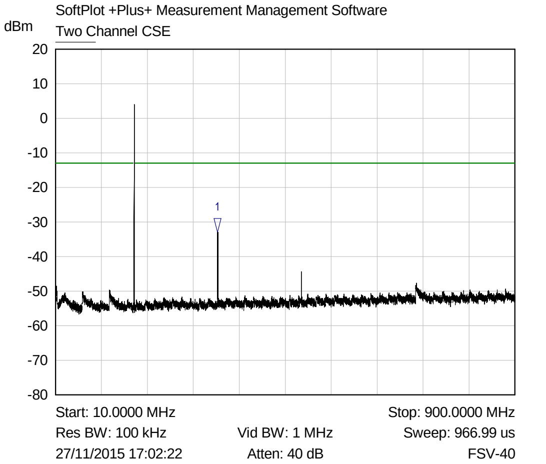
11 Spurious Emissions

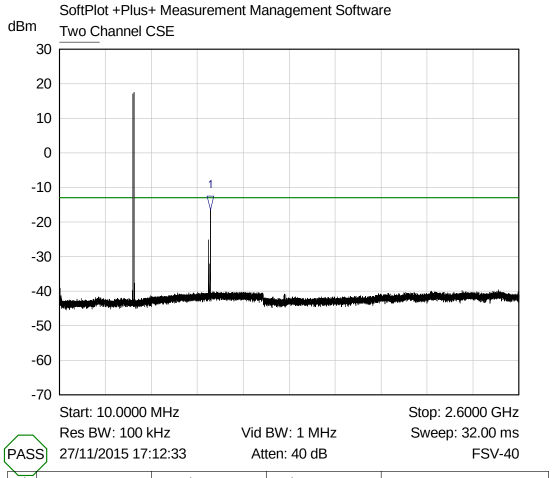
11.1 Multichannel enhancer

Measurement performed using RMS detector and sweep averaging method as for Transmit Power.



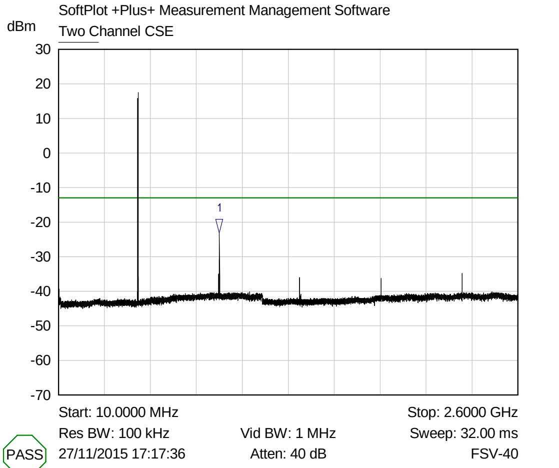
Mkr	Trace	X-Axis	Value	Notes
1 ∇	Two Channel CSE	323.9851 MHz	-20.07 dBm	Relative to limit

150 – 174 MHz



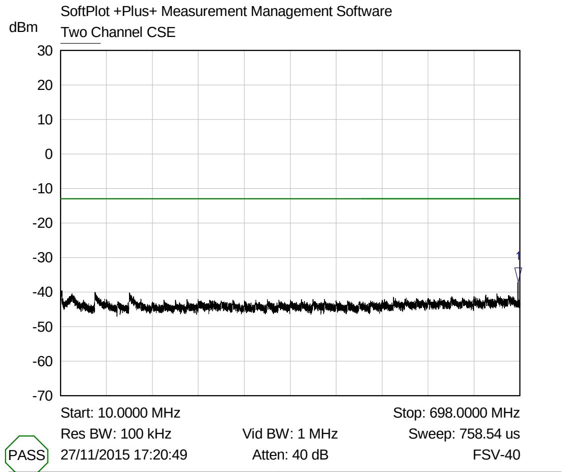
Mkr	Trace	X-Axis	Value	Notes
1 ∇	Two Channel CSE	860.0322 MHz	-3.45 dBm	Relative to limit

406 – 454 MHz



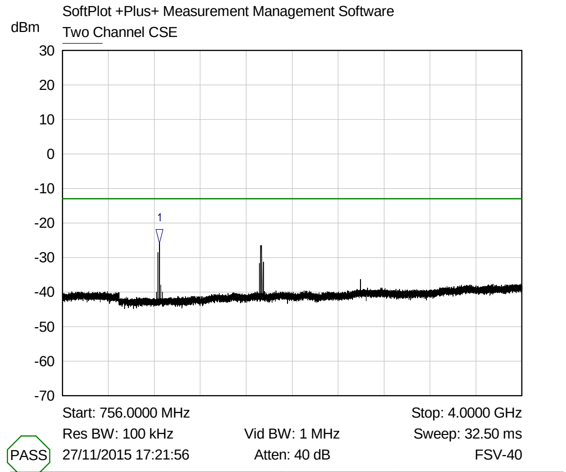
Mkr	Trace	X-Axis	Value	Notes
1 ∇	Two Channel CSE	917.9852 MHz	-10.24 dBm	Relative to limit

456 – 470 MHz



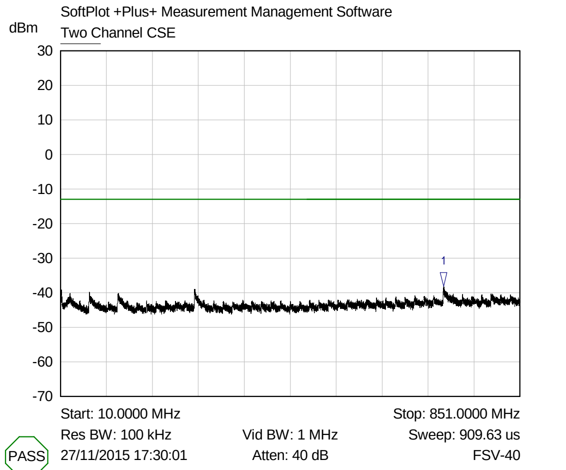
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	695.0114 MHz	-24.06 dBm	Relative to limit

769 -775 MHz



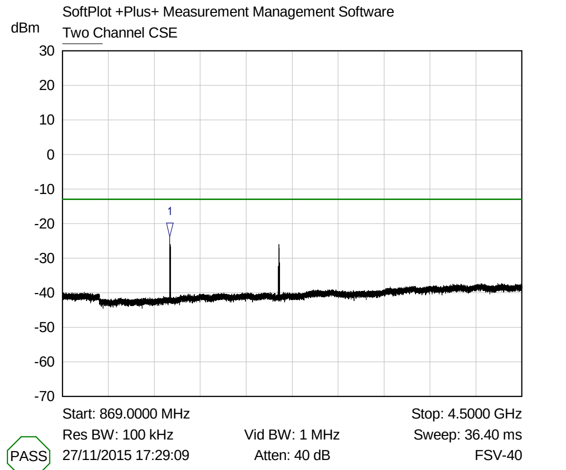
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	1.4400 GHz	-12.78 dBm	Relative to limit

769 -775 MHz pt 2



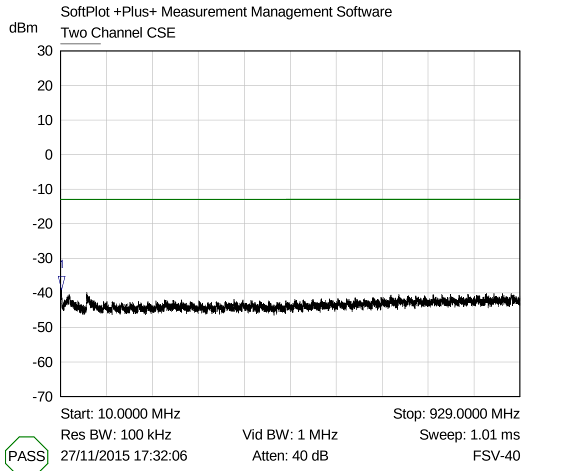
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	711.1268 MHz	-25.15 dBm	Relative to limit

851 – 869 MHz



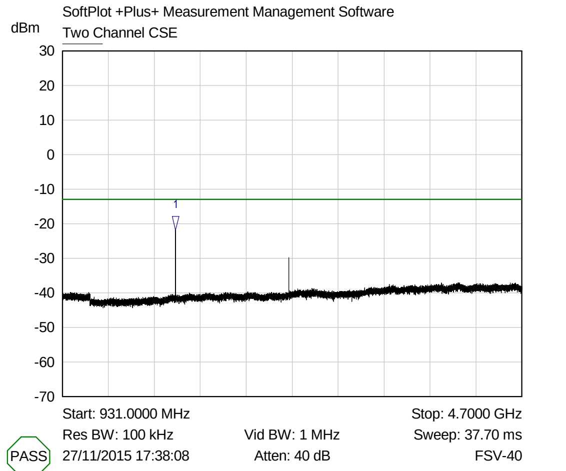
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	1.7180 GHz	-10.91 dBm	Relative to limit

851 – 869 MHz pt 2



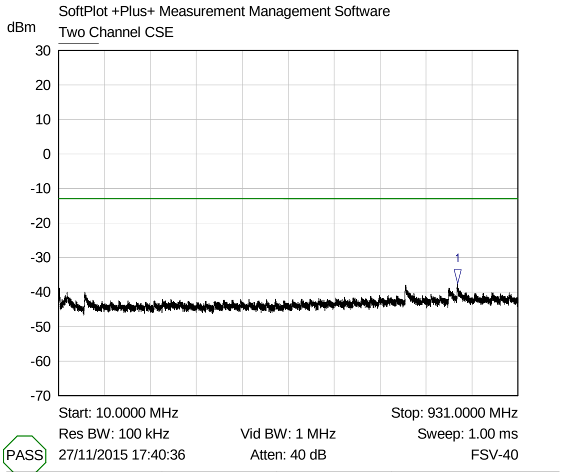
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	11.8381 MHz	-26.16 dBm	Relative to limit

929 – 930MHz



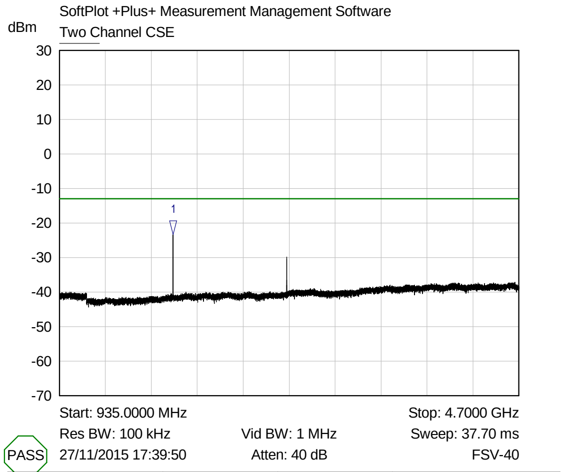
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	1.8590 GHz	-8.87 dBm	Relative to limit

929 – 930MHz pt 2



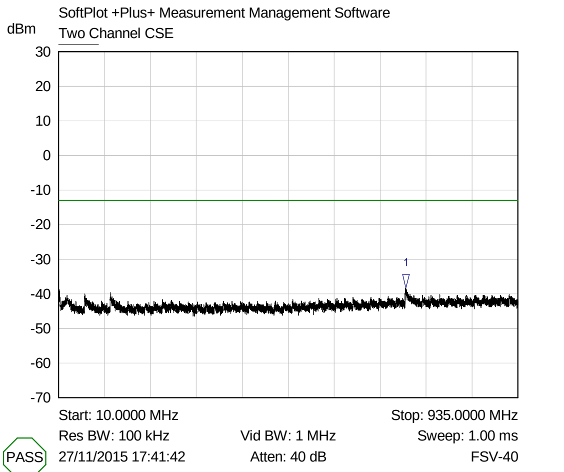
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	809.8847 MHz	-24.42 dBm	Relative to limit

931 – 935MHz



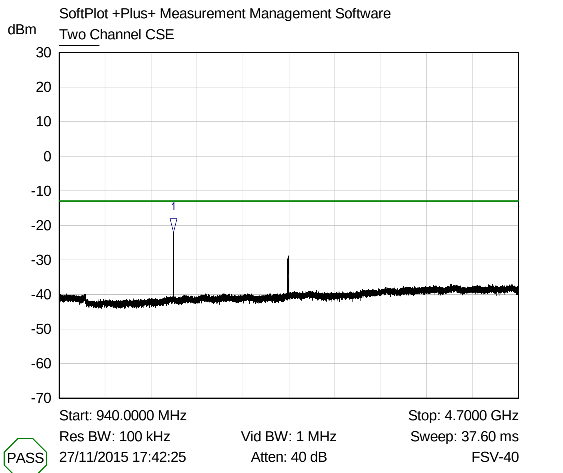
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	1.8660 GHz	-10.30 dBm	Relative to limit

931 – 935MHz pt 2



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	708.9750 MHz	-25.28 dBm	Relative to limit

935 – 940MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Two Channel CSE	1.8750 GHz	-9.02 dBm	Relative to limit

935 – 940MHz pt 3

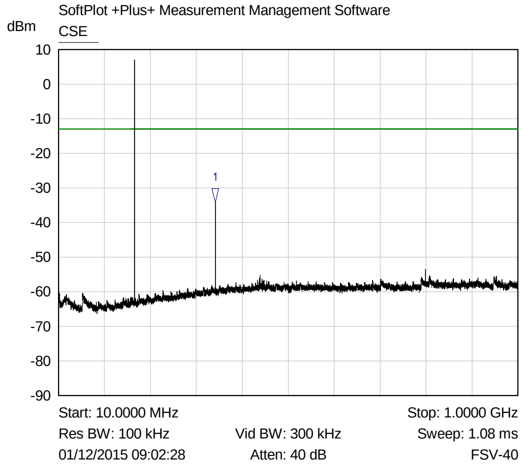
11.2 Single channel enhancer

The level of Harmonic emissions from transmit frequencies at bottom, middle and top channels for each band were investigated.

The plots below show worst case emissions levels for each band.

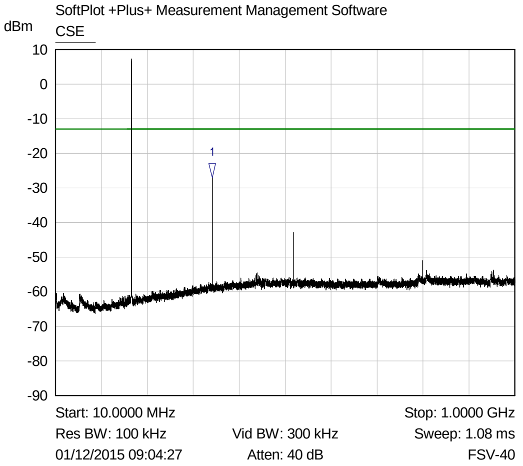
Measurement performed using RMS detector and sweep averaging method as for Transmit Power.

There were no emissions within 10 dB of the limit.



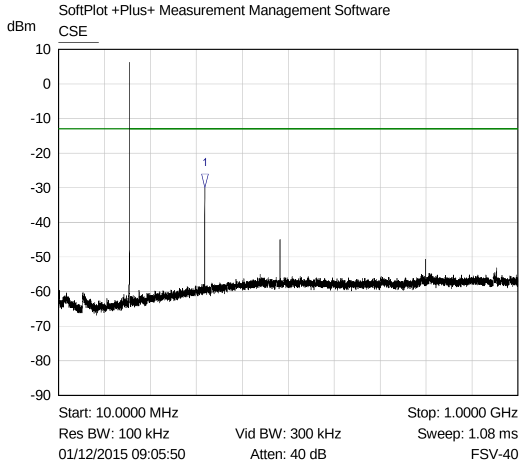
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	347.9613 MHz	-21.22 dBm	Relative to limit

150 – 174 MHz Top QPSK



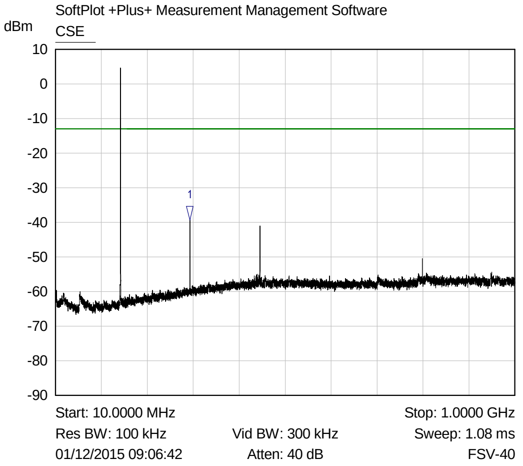
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	347.9718 MHz	-14.02 dBm	Relative to limit

150 – 174 MHz Top FM



Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	325.0155 MHz	-17.07 dBm	Relative to limit

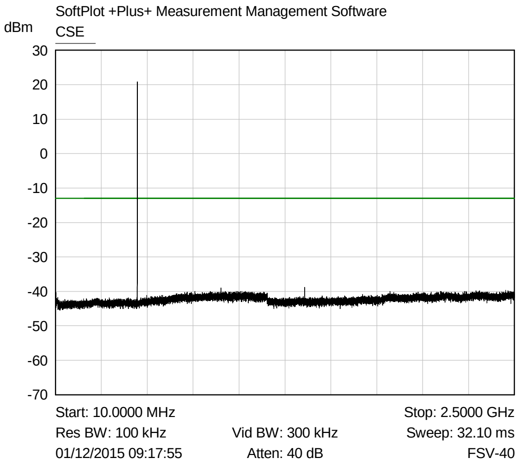
150 – 174 MHz middle FM



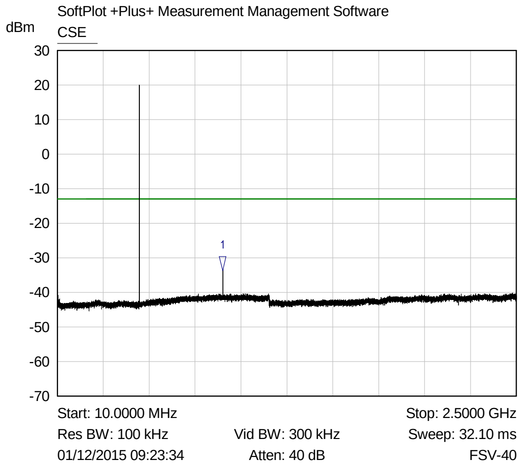
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	300.0172 MHz	-26.37 dBm	Relative to limit

150 – 174 MHz bottom FM

Sulis Consultants
CE Marking and Product Approvals

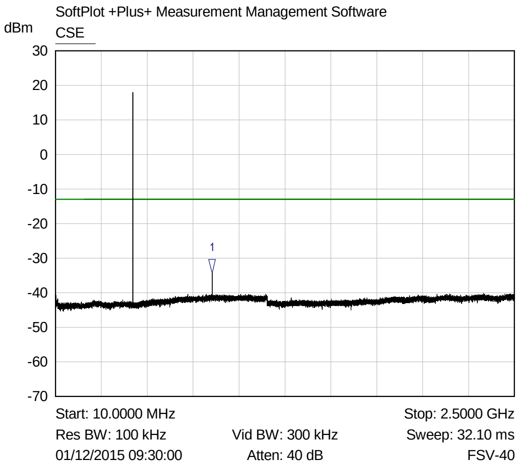


406 – 454 MHz Top FM



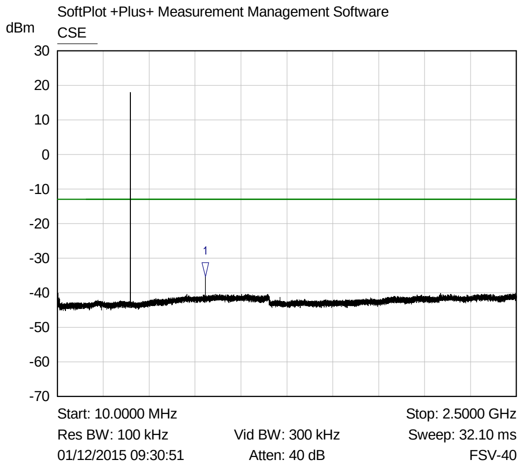
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	907.9563 MHz	-20.61 dBm	Relative to limit

406 – 454 MHz Top QPSK



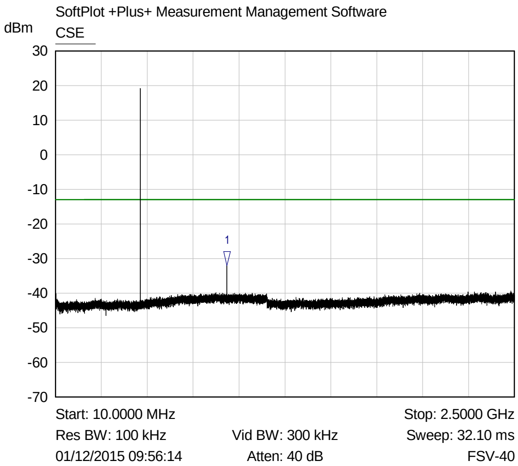
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	860.0238 MHz	-21.30 dBm	Relative to limit

406 – 454 MHz Middle QPSK



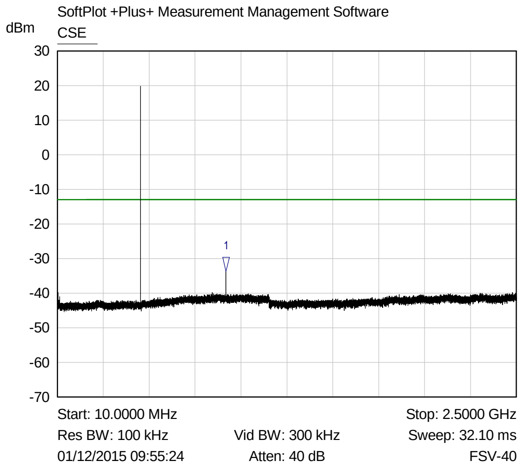
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	812.0134 MHz	-22.35 dBm	Relative to limit

406 – 454 MHz Bottom QPSK



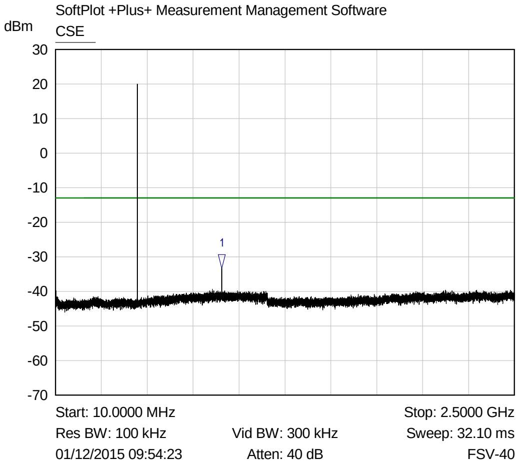
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	940.0150 MHz	-18.92 dBm	Relative to limit

456 – 470 MHz top QPSK



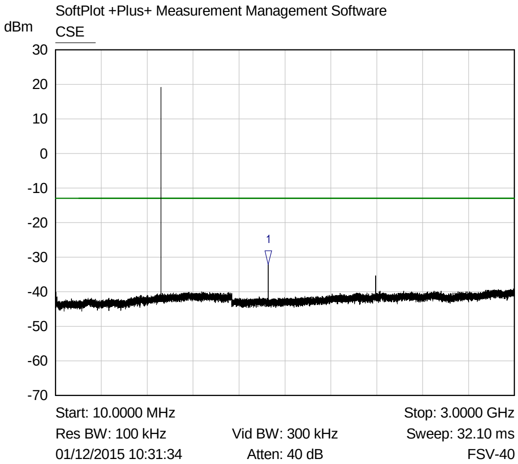
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	923.9856 MHz	-20.60 dBm	Relative to limit

456 – 470 MHz middle QPSK



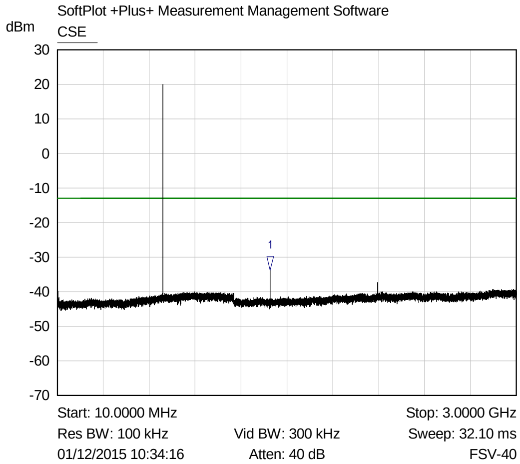
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	912.0803 MHz	-20.39 dBm	Relative to limit

456 – 470 MHz bottom QPSK



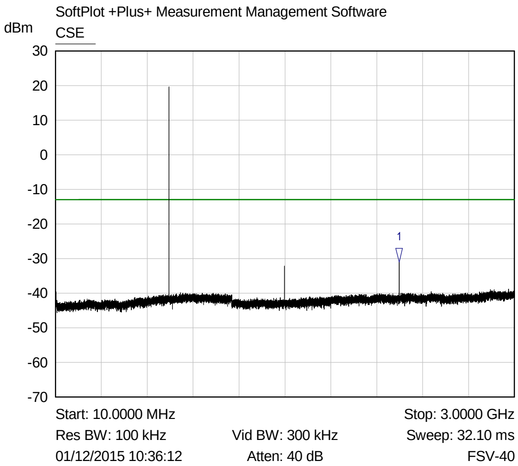
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.3961 GHz	-19.15 dBm	Relative to limit

698 – 824 MHz Bottom 12.5 kHz QPSK



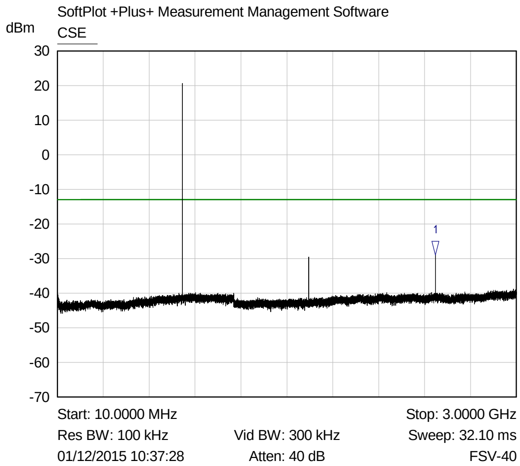
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.3961 GHz	-20.86 dBm	Relative to limit

698 – 824 MHz pt 2 Bottom 12.5 kHz 4FSK



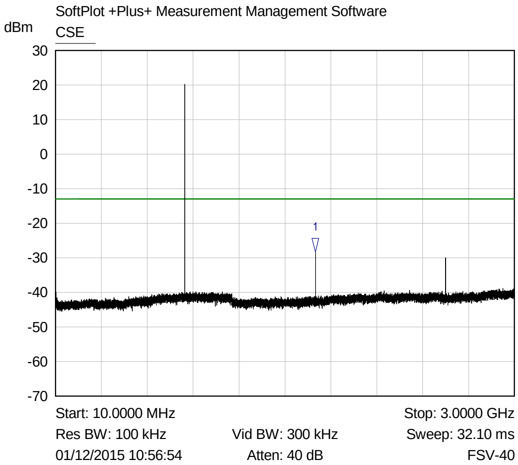
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	2.2501 GHz	-18.00 dBm	Relative to limit

698 – 824 MHz Middle 12.5 kHz QPSK



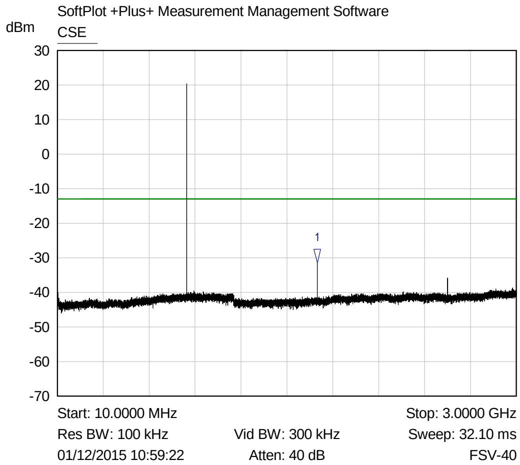
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	2.4720 GHz	-15.96 dBm	Relative to limit

698 – 824 MHz Top 12.5 kHz QPSK



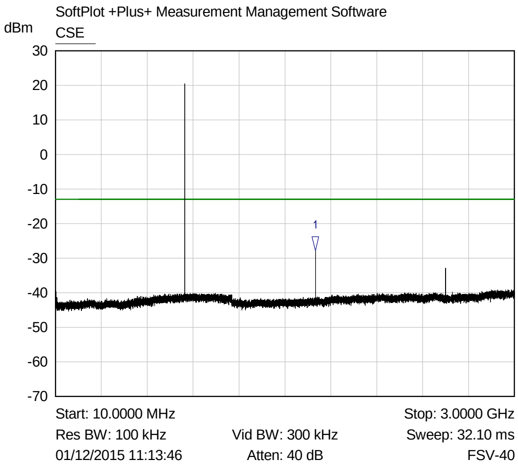
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.7021 GHz	-15.34 dBm	Relative to limit

851 – 869 MHz 12.5 kHz QPSK bottom



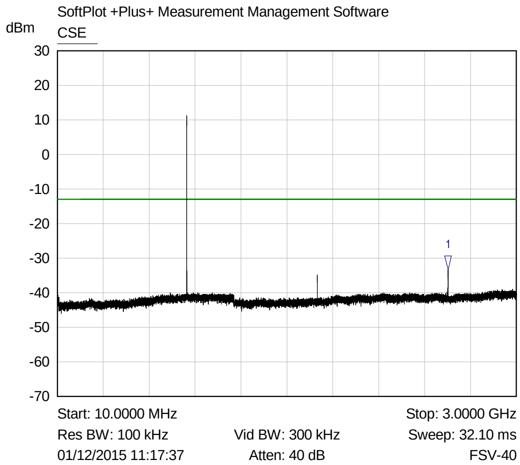
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.7021 GHz	-18.43 dBm	Relative to limit

851 – 869 MHz 25 kHz FM bottom



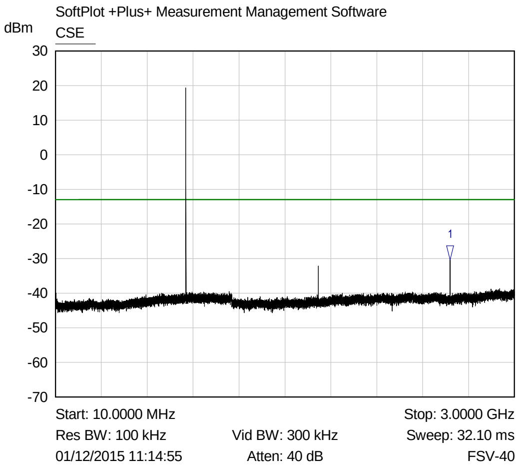
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.7021 GHz	-14.92 dBm	Relative to limit

851 – 869 MHz 25 kHz 16-QAM bottom



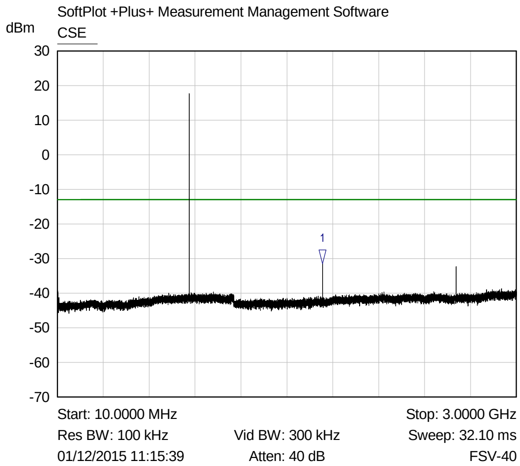
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	2.5548 GHz	-20.37 dBm	Relative to limit

851 – 869 MHz 1.25 MHz 16-QAM bottom



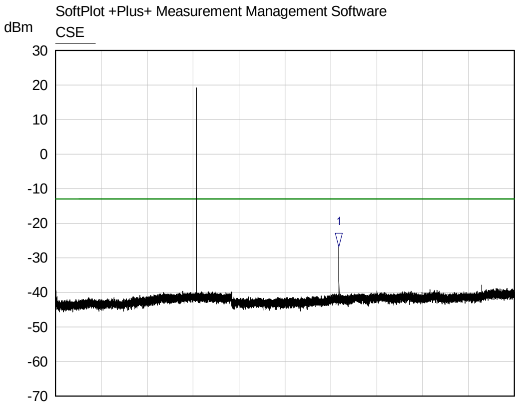
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	2.5801 GHz	-17.41 dBm	Relative to limit

851 – 869 MHz 25 kHz 16-QAM middle



Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.7380 GHz	-18.51 dBm	Relative to limit

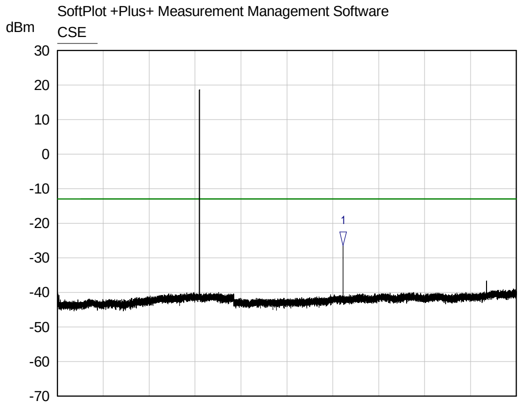
851 – 869 MHz 25 kHz 16-QAM top



Start: 10.0000 MHz | Stop: 3.0000 GHz
Res BW: 100 kHz | Vid BW: 300 kHz | Sweep: 32.10 ms
01/12/2015 11:40:00 | Atten: 40 dB | FSV-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.8581 GHz	-13.84 dBm	Relative to limit

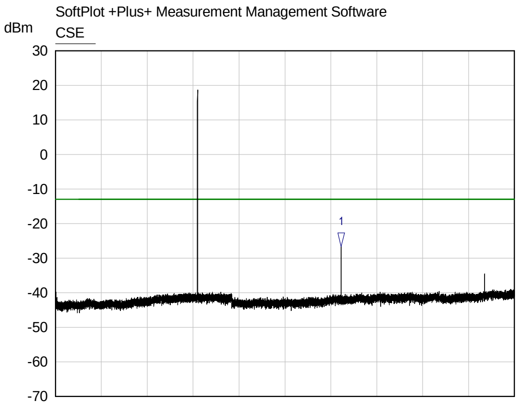
929 – 935MHz bottom FSK



Start: 10.0000 MHz | Stop: 3.0000 GHz
Res BW: 100 kHz | Vid BW: 300 kHz | Sweep: 32.10 ms
01/12/2015 11:40:50 | Atten: 40 dB | FSV-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.8701 GHz	-13.45 dBm	Relative to limit

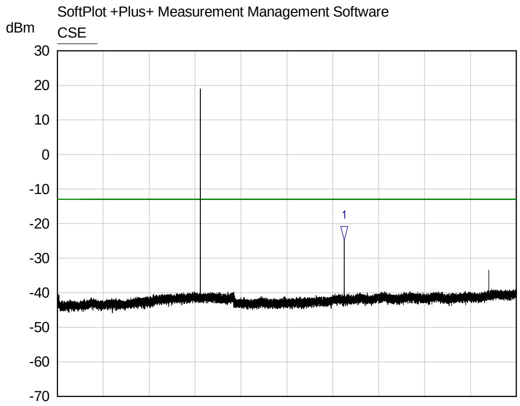
929 – 935MHz top FSK



Start: 10.0000 MHz | Stop: 3.0000 GHz
Res BW: 100 kHz | Vid BW: 300 kHz | Sweep: 32.10 ms
01/12/2015 11:41:41 | Atten: 40 dB | FSV-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.8701 GHz	-13.68 dBm	Relative to limit

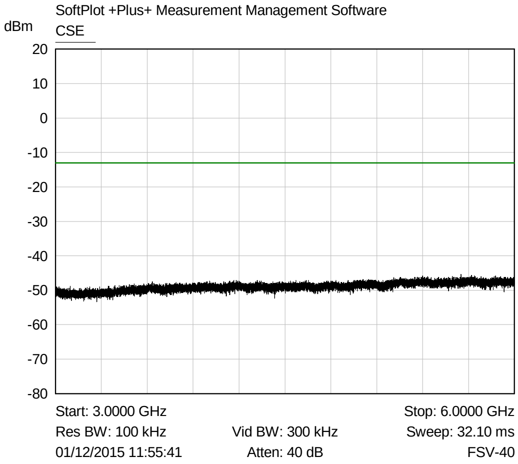
935 – 940MHz bottom 16-QAM

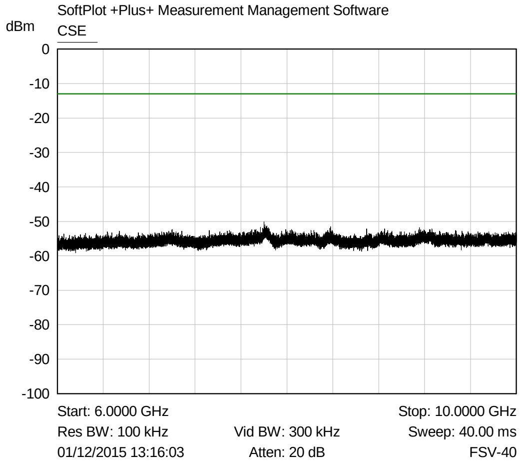


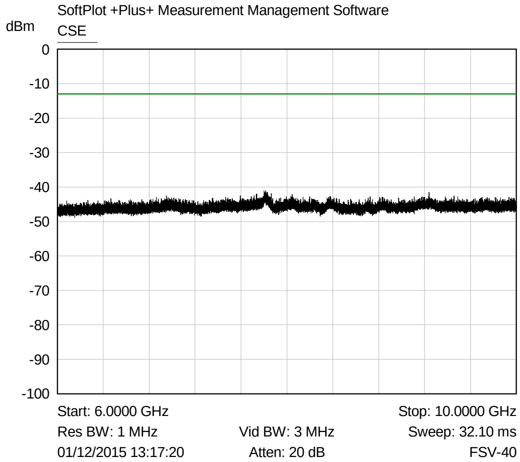
Start: 10.0000 MHz | Stop: 3.0000 GHz
Res BW: 100 kHz | Vid BW: 300 kHz | Sweep: 32.10 ms
01/12/2015 11:42:30 | Atten: 40 dB | FSV-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE	1.8801 GHz	-11.89 dBm	Relative to limit

935 – 940MHz top 16-QAM







No emissions of note above 3 GHz for any frequency of operation	6 – 10 GHz with peak detector and max hold for all operating bands 500-1000 MHz

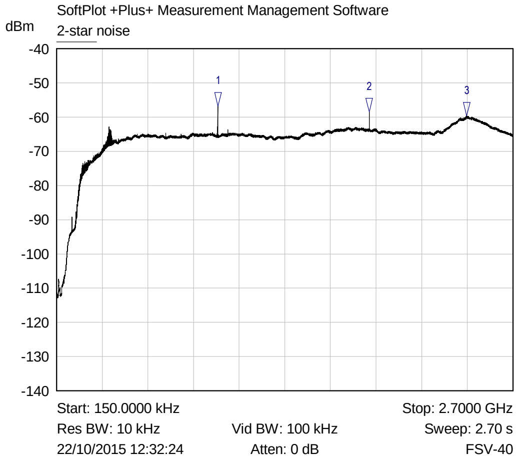
12 Noise Figure

The equipment was connected as shown in Figure 1, but the input to the hub was terminated with 50 ohm load.

The noise was measured using an RMS detector and 100 sweep averaging and the analyser set to measure 32000 sweep points.

Two plots were made of the noise from the system:

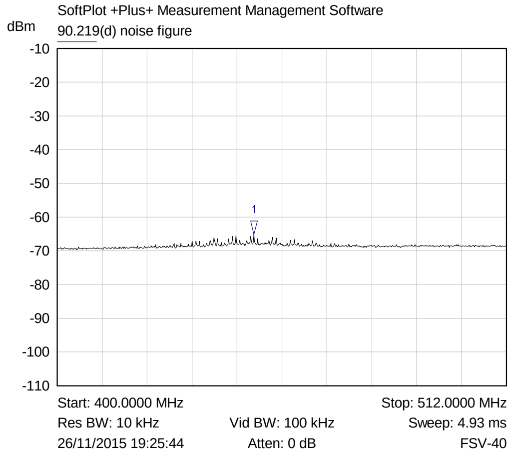
- Capture of the whole passband at once (80 kHz steps)
- Capture of the 400-512 MHz UHF radio bands (3.5 kHz steps)



Mkr	Trace	X-Axis	Value	Notes
1 ∇	2-star noise	953.5888 MHz	-56.79 dBm	
2 ∇	2-star noise	1.8510 GHz	-58.56 dBm	
3 ∇	2-star noise	2.4262 GHz	-59.65 dBm	

2-star noise 1Rm AvgLog Count 100/100

2-star (standard FCC/IC config)



Mkr	Trace	X-Axis	Value	Notes
1 ∇	90.219(d) noise figure	449.0203 MHz	-65.24 dBm	Maximum

Two-star specific band: 400-512 MHz

The following are noted:

- A maximum noise figure of -43 dBm ERP corresponds to a maximum antenna port noise figure of -48.85 dBm (-43.0 - 8.0 dBi + 2.15[2])
- The maximum noise figure for the system was over 7 dB below this.
- The system is typically used to provide both cellular and non-cellular services.
- Further discussion of noise mitigation is included in operation exhibit “noise discussion”.

[2] 8 dBi exceeds the maximum antenna gain in any band of operation and the 2.15 dB is to convert EIRP to ERP

13 Additional noted for 769-775 MHz

Clause	Requirement	Comment
90.531(a)	The 763-775 MHz band may be used for base, mobile or fixed (repeater) transmissions	Device certified for operation in the 769 – 775 MHz band only
90.531(b)	band plan, narrowband segments	Device certified for operation in the 769 – 775 MHz band only. Exact channel dependant on end license
90.531(d)(1)	band plan, combining channels;	Channels may be combined subject to license
90.535(a)	All transmitters in the 769-775 MHz and 799-805 MHz frequency bands must use digital modulation	Digital modulation supported
90.541	(a) The transmitting power and antenna height of base stations must not exceed the limits given in paragraph (a) of §90.635. (b) The transmitting power of a control station must not exceed 200 watts ERP	Transmit power 100 mW Results available via reference to section 6
90.543	emission limitations, first paragraph [for booster with multi-carriers, use 90.543(c) not 90.543(a)-(b)];	See dual channel test results in section 11
90.543(f)	emission limitations, emissions in 1559-1610 MHz from 758-775/788-805 MHz devices.	See section 13.1 below

Table 7: Additional noted for 769-775 MHz

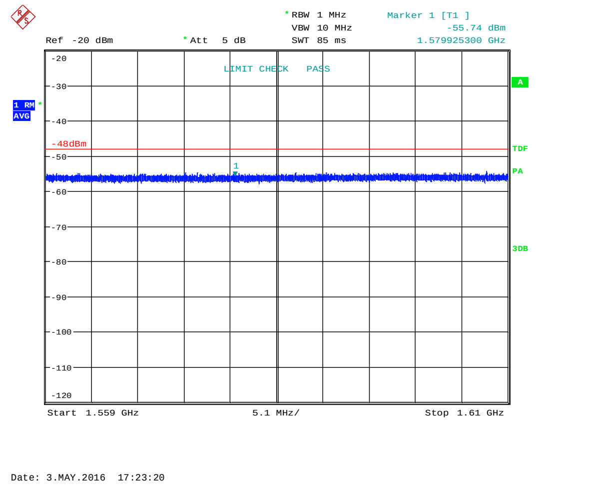
13.1 §90.543 Emission limitations

(f) For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation

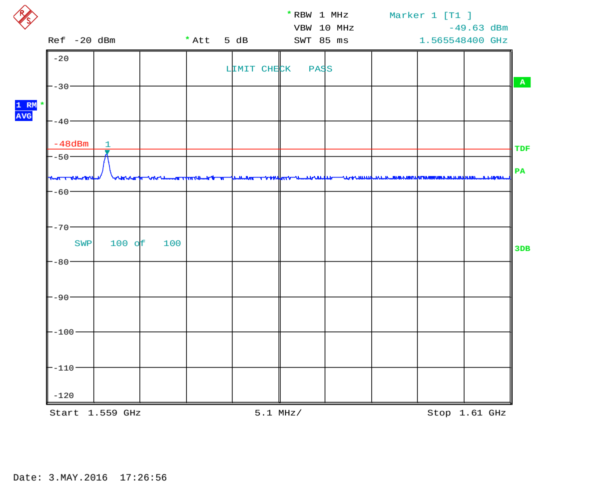
note:

-70dBW EIRP equates to a limit of -78 dBW conduced for 8dBi antenna, which is -48dBm

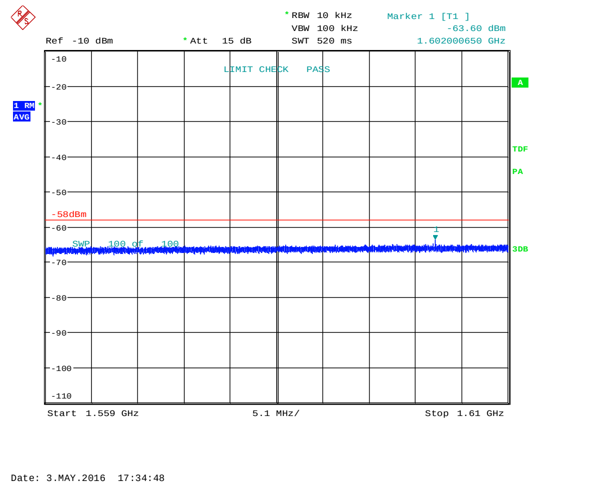
-80dBW EIRP equates to a limit of -88 dBW conduced for 8dBi antenna, which is -58dBm for narrowband)



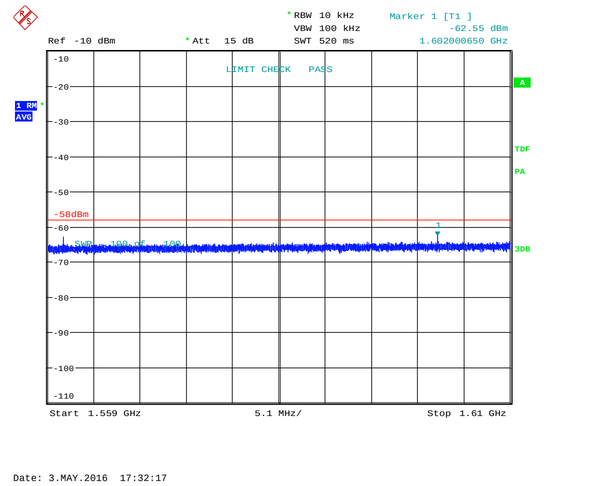
Bottom channel wideband



Top channel wideband



Bottom channel narrowband



Top channel narrowband

14 Test equipment

Description	Manufacturer	Model	Serial Number	Calibration
Signal Analyser	Rohde & Schwarz	FSV 40	Livingston Hire asset X479651	Code: 161467 Due 19 May 16
Signal Analyser	Rohde & Schwarz	FSQ8	100152	Ref: 1-7510563598-1 Due 23 Dec 16
Signal Generator	Rohde & Schwarz	SMBV100A	Microlease asset 45440	Ref: 45440 Due 19 Nov 15
Cable	Utiflex	BUA01G	FA210A0009M30309	ABEX UK. Ref: green bua01g Due 08 Oct 17
Signal Generator	Rohde & Schwarz	SMJ100A	100156	Verified as part of system test
Signal Generator	Rohde & Schwarz	SM300	100320	
Attenuator	Mini-circuits	VAT 10	3 0433	
Cable (input)	Mini-circuits	CBL-1M-SMNM+	120274	
Cable (input)	Mini-circuits	CBL-1M-SMNM+	120295	
2-way splitter (input)	Mini-circuits	ZN2PD2-63-S+	UU21401232	
Low pass filter DC-600 MHz	Mini-circuits	SLP-600+	R8636400710	
Low pass filter DC-1000 MHz	Mini-circuits	15542	UU14401231	

Table 8: Test Equipment

Measurement uncertainty for test equipment

Analyser ±0.5 dB