Sulis Consultants
CE Marking and Product Approvals

RF Test Report:

Senceive "FM3Node" to 47CFR15.247

FCC ID: 2AMFBFM3N

SC_TR_264_B

Sulis Consultants Limited
Mead House, Longwater Road, Eversley, Hampshire, RG27 0NW, UK
Registered in England & Wales, number 05466247
http://www.sulisconsultants.com

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1 Revision History

Revision	Originator	Date	Comment
A	C Blackham	02 July 2017	1st issue
B	C Blackham	26 July 2017	Minor corrections

2 Purpose

This report details testing performed on the Senceive FM3Node against FCC requirements.

3 Reference Documents

[1]	Title 47 CFR15	Federal Communications Commission Title 47 Code of Federal Regulations Part 15
[2]	ANSI C63.10-2013	IEEE American National Standard for Testing Unlicensed Wireless Devices Committee 63 standard 63-10. 27 June 2013.
[3]	KDB 558074 D01 DTS Meas Guidance v04[1]	Federal Communications Commission Office of Engineering and Technology Laboratory Division: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247. April 5, 2017

[1] Reference herein as "KDB 558074"

4 Test Information

4.1 Client

Senceive Ltd
Hurlingham Studios
Ranelagh Gardens
London
SW6 3PA

4.2 Test personnel

4.2.1 Antenna port tests

Testing was performed by Charlie Blackham of Sulis Consultants Ltd at their offices between 21st and 25th June 2017.

4.2.2 Radiated Emissions

Testing was performed by Hursley EMC Services Ltd test engineers at their FCC Registered test facility, UK designation number UK0006, between 26th and 29th June 2017 under job number 17R0321.

4.3 Test sample

The results herein only refer to sample detailed in section 6.

5 Product Description

The device operates inside the 2400 – 2483.5 MHz band with a single bandwidth and single modulation.
The following test frequencies were used to cover the full band of operation of the device:

Test Channel	Centre Frequency (MHz)
Bottom, channel 11	2405.0
Middle, channel 18	2440.0
Top, channel 25	2475.0

Table 1: Test frequencies

6 Test Configuration

6.1 Test sample

The equipment under test (EUT) was:

Manufacturer	Description	Model	Serial Number
Senceive	Node	FM3 Node	164870111
Soil Instruments	Vibrating Wire Spot Weldable Strain Gauge Sensor – quantity: 4.	ST1-2.1	None

Table 2: Equipment under test

6.2 Support equipment

The support equipment was:

Description	Manufacturer	Name	Serial Number
Power supply	Kenwood	PD35-10D	2080014

Table 3: Support Equipment

6.3 Equipment set-up

Equipment was configured as per figure 1:

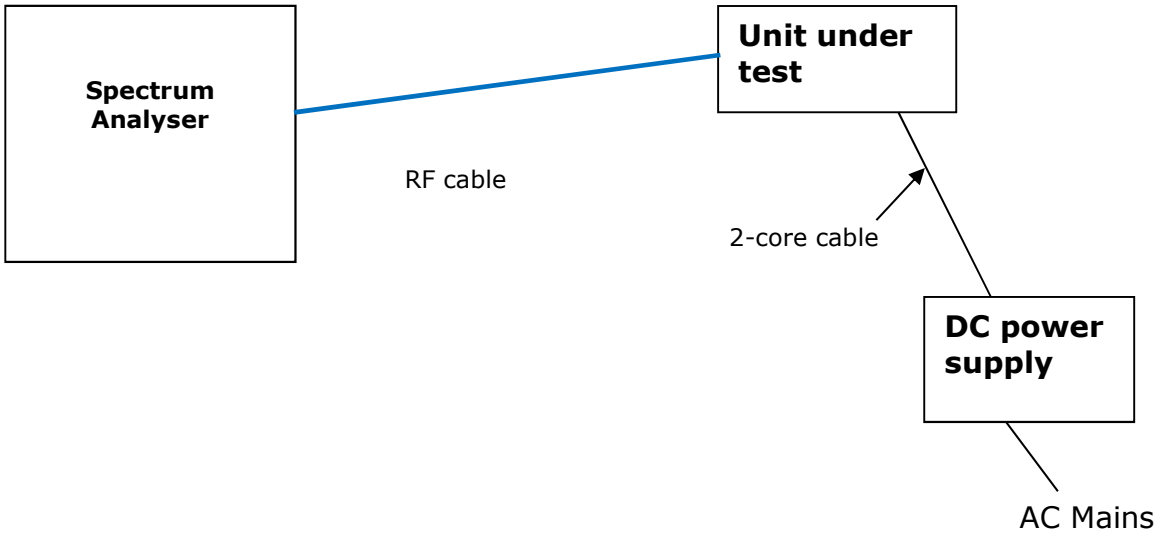


Figure 1: Test Configuration

For the purposes of testing, the EUT was configured with test firmware that transmitted continuously with a 100% duty cycle.
During bench testing, a DC power supply was used instead of the battery normally installed in the product.
The RF test cable loss was programmed into the Spectrum Analyser as a transducer factor.

6.4 Supported Antennas

The EUT supports operation with the following antennas:

Antenna type	Type	Maximum Gain
External	Connectorised	2.2 dBi (see note)

Table 4: EUT Antenna configurations

Note:
1. The antenna is external to the unit, but is connected to the main PCB via an short UFL to SMA cable. For the purposes of testing, the RF test cable was connected direct to the UFL port using a SMA-UFL adapter.
2. The maximum antenna gain that may be installed in a live installation is 2.0 dBi, but it was understood to be 2.2 dBi at time of testing and so results are worst case and acceptable for all antennas that may be used with the device as detailed in the manual.

7 Summary of tests performed

Test	Clause	Limit / Requirement	Result
6dB bandwidth	15.247(a)(2)	> 500 kHz	Pass
Occupied bandwidth		None	Noted
Max peak conducted TX power	15.247(b)(3)	1 W	Pass
Power Spectral Density	15.247(e)	8dBm / 3 kHz	Pass
Out of Band Emissions Non-restricted bands	15.247(d)	-20 dBc (peak power)	Pass
Out of Band Emissions Restricted-band: Conducted	15.247(d) / 15.205(a) and 15.209(a)	15.209(a) table	Pass
Max antenna gain	15.247(b)(4)(11)	≤ 6dBi	Pass

Table 5: Summary of test results

8 DTS Bandwidth

8.1 Measurement method

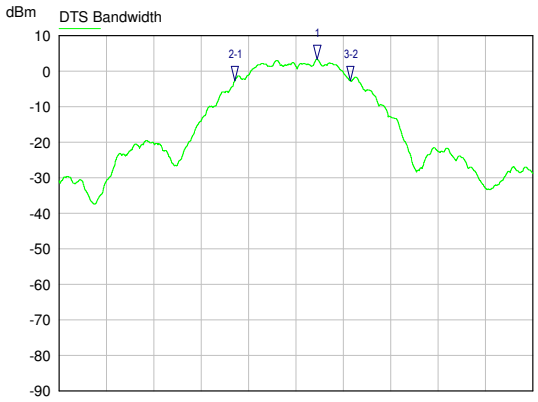
Test was conducted in accordance with KDB 558074 section 8.1 Option 1:

a) Set resolution bandwidth to 100 kHz
b) Set the video bandwidth to ≥ 3 x RBW
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

8.2 Test results

Channel	6dB DTS Bandwidth (MHz)	Requirement	Result
11	1.4595	> 500 kHz	Pass
18	1.4854	> 500 kHz	Pass
25	1.5696	> 500 kHz	Pass

Table 6: DTS Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4053 GHz	3.36 dBm	
2-1	DTS Bandwidth	-1.0395 MHz	-6.00 dB	Relative to max
3-2	DTS Bandwidth	1.4595 MHz	0.00 dB	Relative to marker 2

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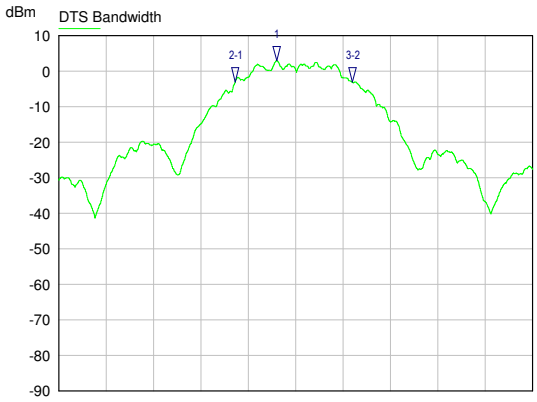
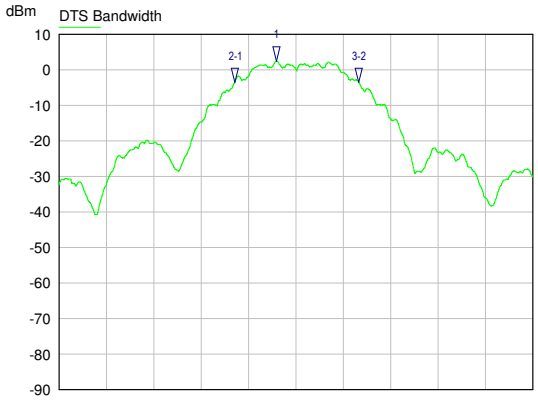


Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4398 GHz	2.95 dBm	
2-1	DTS Bandwidth	-527.8125 kHz	-6.00 dB	Relative to max
3-2	DTS Bandwidth	1.4854 MHz	-0.00 dB	Relative to marker 2

Ch 18



Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4748 GHz	2.54 dBm	
2-1	DTS Bandwidth	-527.0625 kHz	-5.99 dB	Relative to max
3-2	DTS Bandwidth	1.5696 MHz	0.00 dB	Relative to marker 2

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Figure 2: DTS Bandwidth plots

9 Maximum Peak Conducted Output Power

9.1 Measurement method

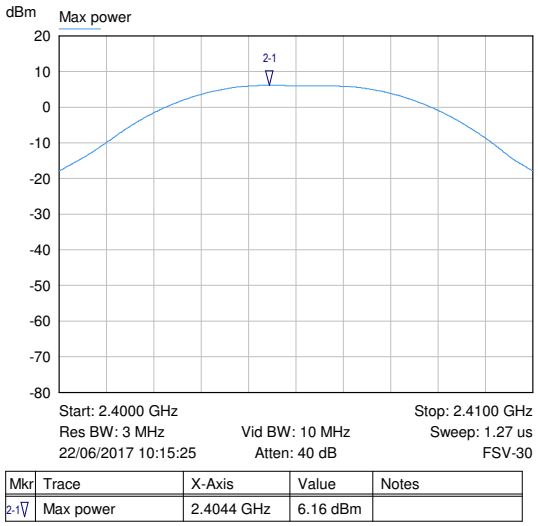
As the analyser could be set RBW ≥ DTS bandwidth, the test was conducted in accordance with KDB 558074 section 9.1.1:

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ 3 x RBW.
c) Set span ≥ 3 x RBW
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

9.2 Test results

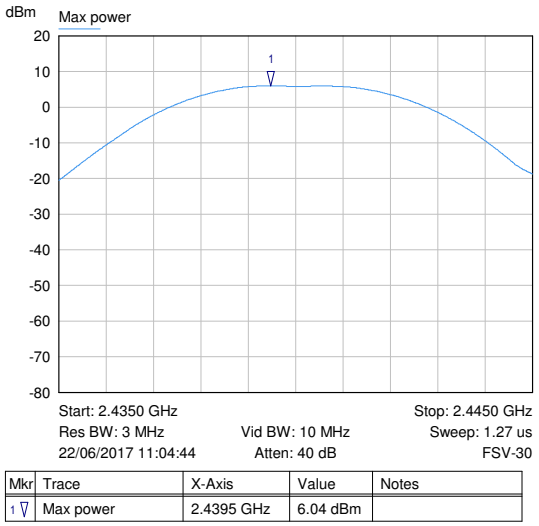
Channel	Channel Power (dBm)	Limit (dBm)	Result
11	6.16	30.0	Pass
18	6.04	30.0	Pass
25	5.71	30.0	Pass

Table 7: Channel Power



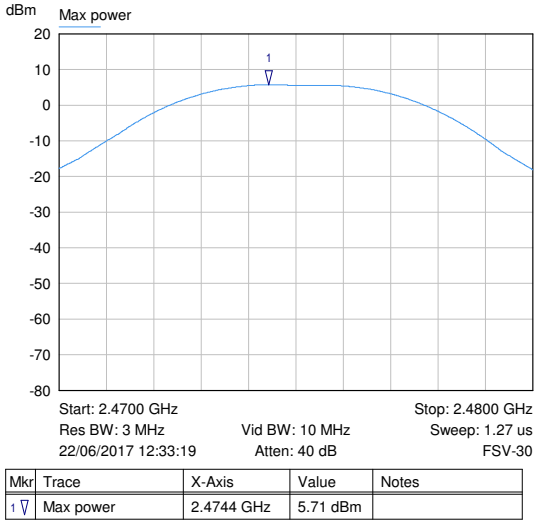
Mkr	Trace	X-Axis	Value	Notes
2-1	Max power	2.4044 GHz	6.16 dBm	

Ch 11



Mkr	Trace	X-Axis	Value	Notes
1	Max power	2.4395 GHz	6.04 dBm	

Ch 18



Mkr	Trace	X-Axis	Value	Notes
1	Max power	2.4744 GHz	5.71 dBm	

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Figure 3: Peak Conducted Power plots

10 Maximum Power Spectral Density

10.1 Measurement method

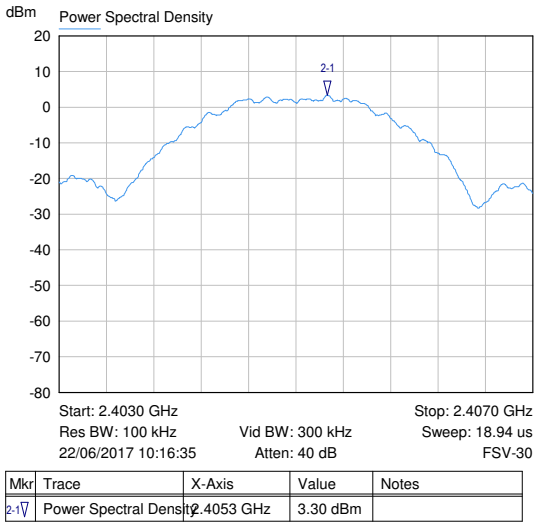
As conducted power was measured as Maximum Peak Conducted Power, measurement was performed in accordance with KDB 558074 section 10.2:

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 x DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

10.2 Test results

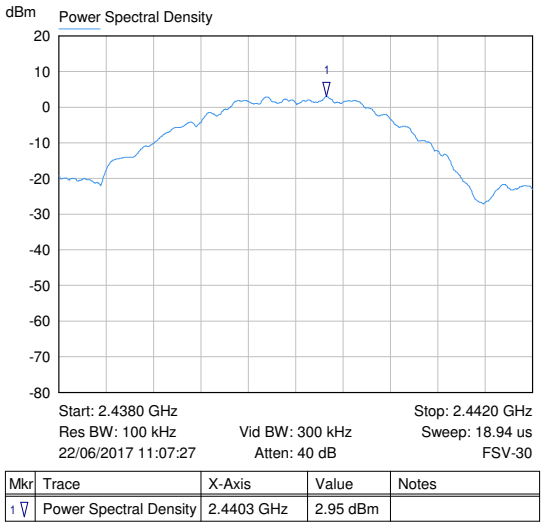
Channel	Peak Marker reading (dBm)	Limit (dBm/3kHz)	Result
11	3.30	8.0	Pass
18	2.95	8.0	Pass
25	2.94	8.0	Pass

Table 8: Spectral Density results



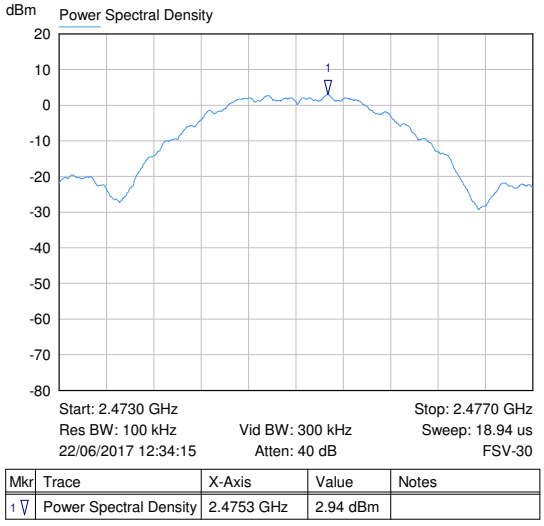
Mkr	Trace	X-Axis	Value	Notes
2-1	Power Spectral Density	2.4053 GHz	3.30 dBm	

Ch 11



Mkr	Trace	X-Axis	Value	Notes
1	Power Spectral Density	2.4403 GHz	2.95 dBm	

Ch 18



Mkr	Trace	X-Axis	Value	Notes
1	Power Spectral Density	2.4753 GHz	2.94 dBm	

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Figure 4: Spectral Density plots

11 Emissions in non-restricted frequency bands

11.1 Measurement method

Since peak power measurements were made using a peak detector, the same detector will be used for unwanted emissions. The unwanted emissions shall be at least 20dB lower than the wanted emission.

First, establish a reference level in accordance with KDB 558074 section 11.2:

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 x DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

Then measure the emission levels in accordance with KDB 558074 section 11.3

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 3 x RBW.
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.

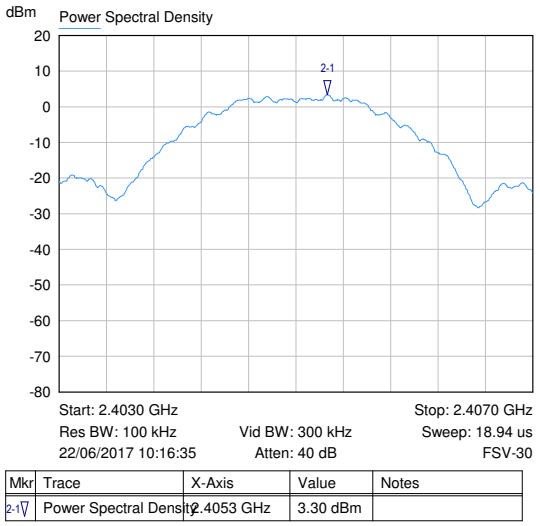
11.2 Test results

The reference trace was taken from the Power Spectral Density Measurement which used the same settings.

For ease of measurement, maximum values are reported anywhere in the frequency band of investigation, whether or not it is outside a restricted band. Further measurements in restricted bands are in the next section.

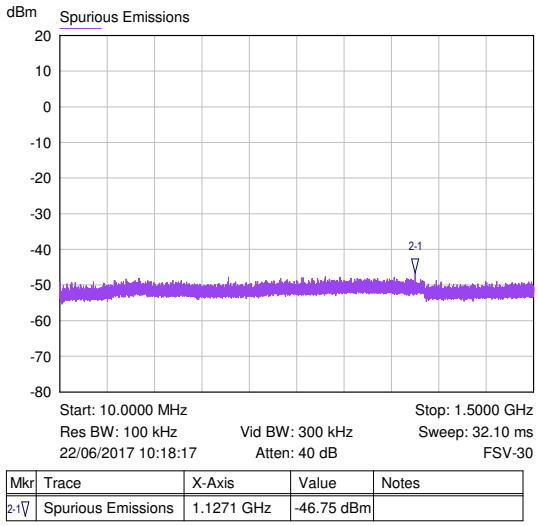
Channel	Maximum Peak level in 100 kHz RBW (dBm)	-20 dBc (dBm)	Maximum emission (dBm)	Result
11	3.30	-16.70	-38.07	Pass
18	2.95	-17.05	-39.70	Pass
25	2.94	-17.06	-40.05	Pass

Table 9: Emissions in non-restricted bands



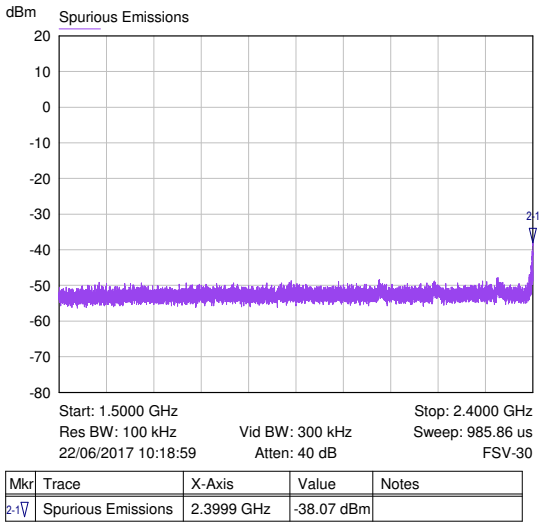
Mkr	Trace	X-Axis	Value	Notes
2-1	Power Spectral Density	2.4053 GHz	3.30 dBm	

Ch 11 reference



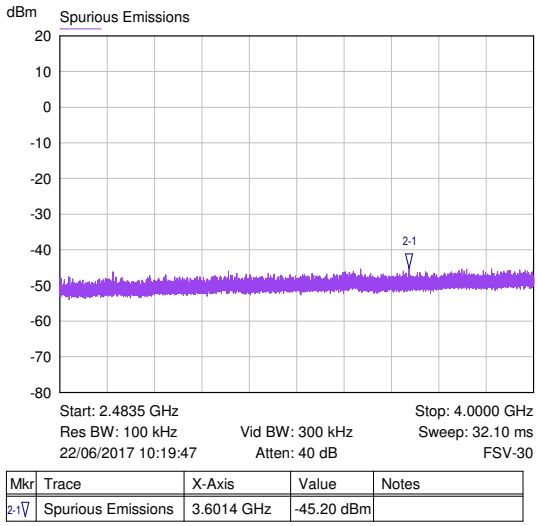
Mkr	Trace	X-Axis	Value	Notes
2-1	Spurious Emissions	1.1271 GHz	-46.75 dBm	

Ch 11: trace 1



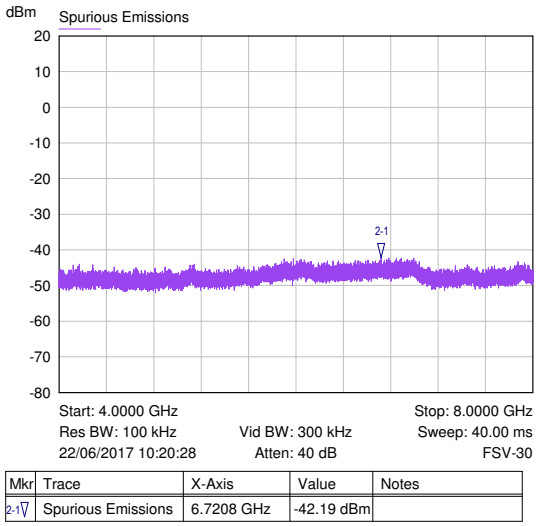
Mkr	Trace	X-Axis	Value	Notes
2-1	Spurious Emissions	2.3999 GHz	-38.07 dBm	

Ch 11: trace 2



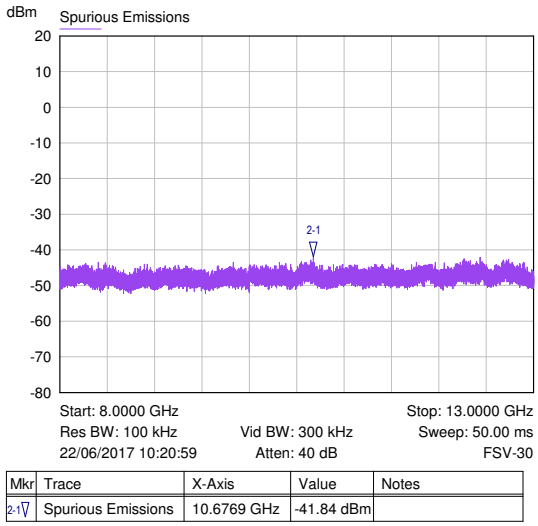
Mkr	Trace	X-Axis	Value	Notes
2-1	Spurious Emissions	3.6014 GHz	-45.20 dBm	

Ch 11: trace 3



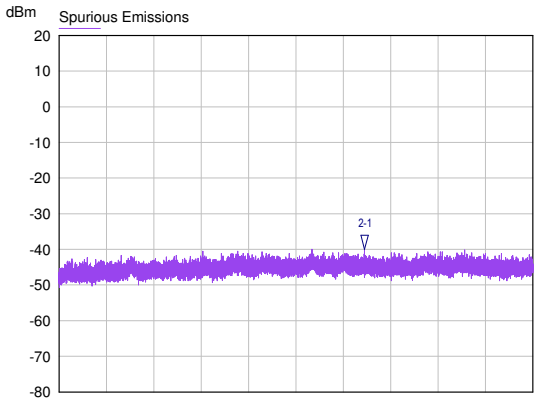
Mkr	Trace	X-Axis	Value	Notes
2-1	Spurious Emissions	6.7208 GHz	-42.19 dBm	

Ch 11: trace 4



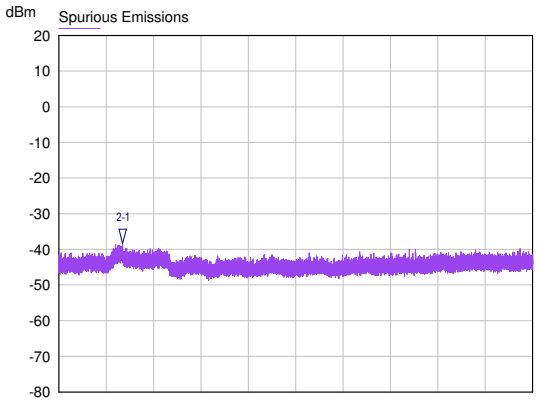
Mkr	Trace	X-Axis	Value	Notes
2-1	Spurious Emissions	10.6769 GHz	-41.84 dBm	

Ch 11: trace 5



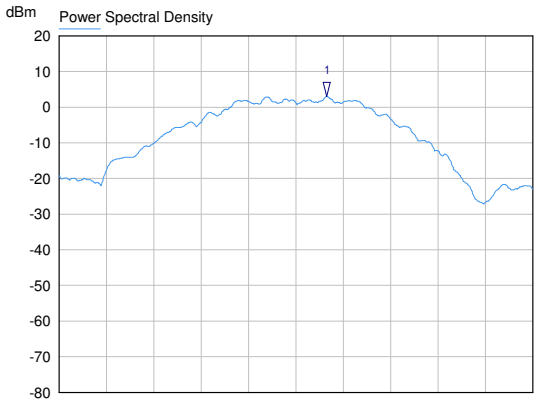
Mkr	Trace	X-Axis	Value	Notes
2-1	Spurious Emissions	16.8687 GHz	-40.05 dBm	

Ch 11: trace 6



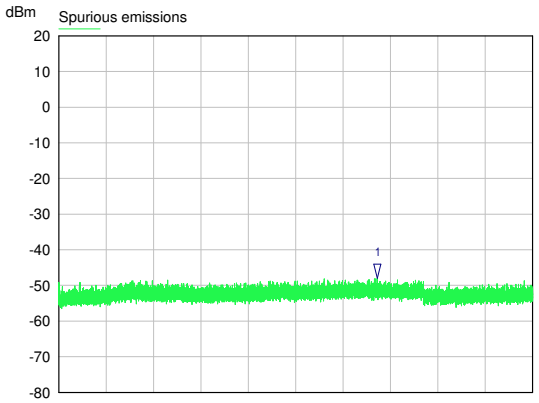
Mkr	Trace	X-Axis	Value	Notes
2-1	Spurious Emissions	19.8111 GHz	-38.27 dBm	

Ch 11: trace 7



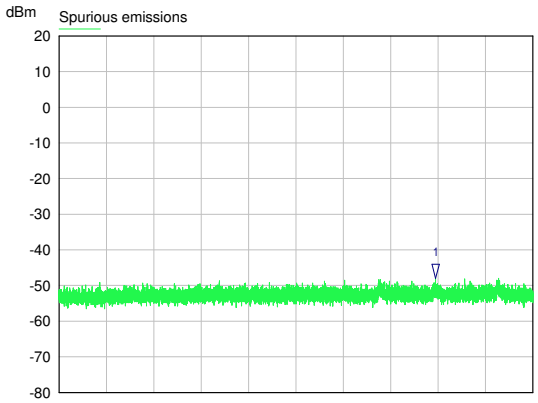
Mkr	Trace	X-Axis	Value	Notes
1	Power Spectral Density	2.4403 GHz	2.95 dBm	

Ch 18 reference



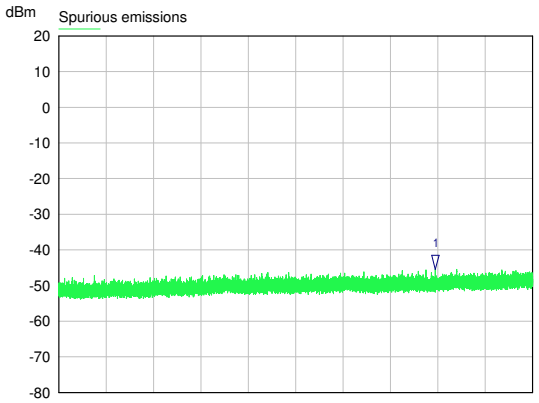
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	1.0122 GHz	-48.07 dBm	

Ch 18: trace 1



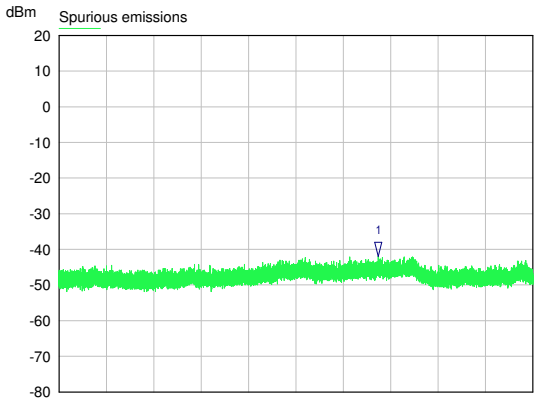
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	2.2153 GHz	-48.02 dBm	

Ch 18: trace 2



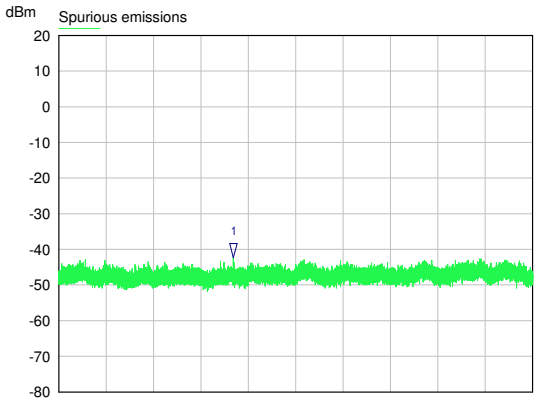
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	3.6890 GHz	-45.45 dBm	

Ch 18: trace 3



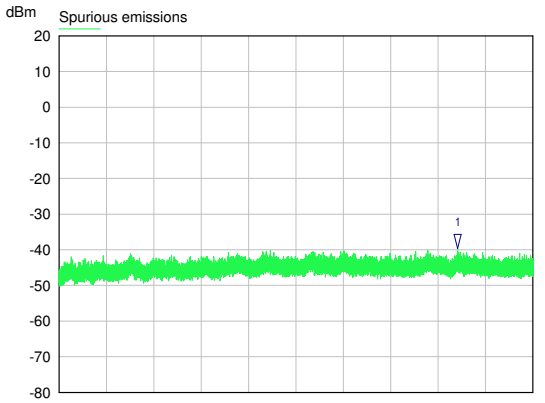
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	6.6968 GHz	-42.00 dBm	

Ch 18: trace 4



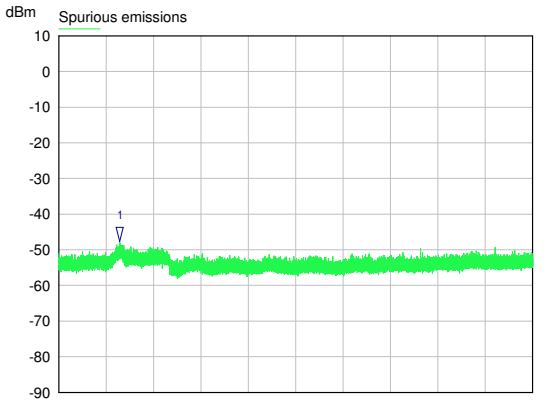
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	9.8436 GHz	-42.30 dBm	

Ch 18: trace 5



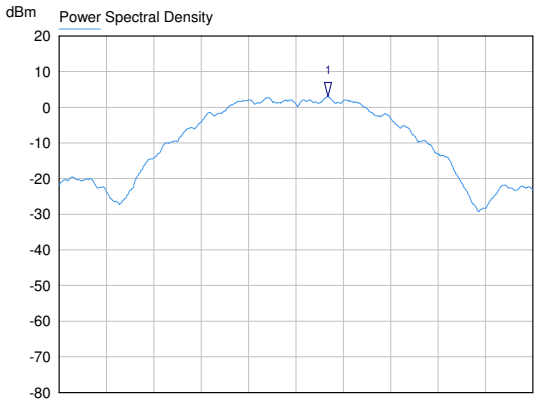
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	18.0481 GHz	-39.70 dBm	

Ch 18: trace 6



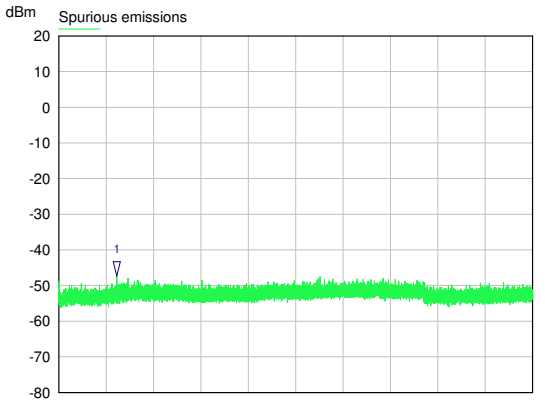
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	19.7719 GHz	-47.65 dBm	

Ch 18: trace 7



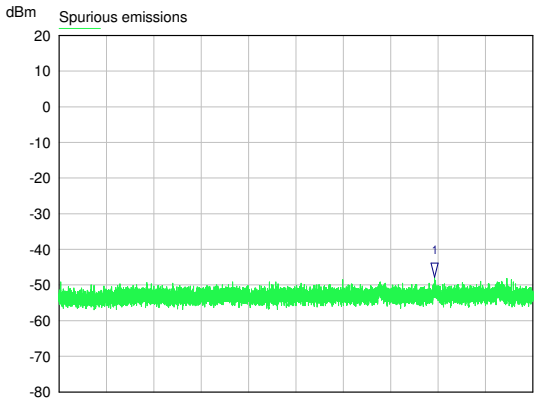
Mkr	Trace	X-Axis	Value	Notes
1	Power Spectral Density	2.4753 GHz	2.94 dBm	

Ch 25 reference



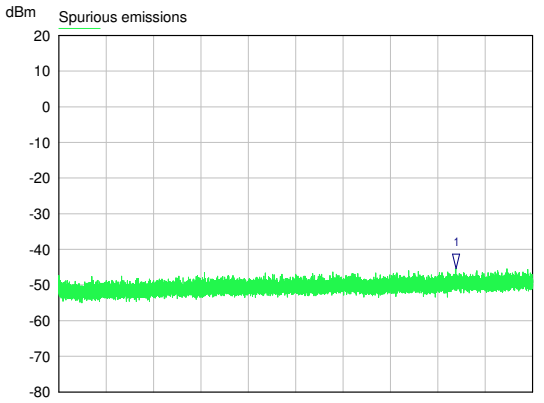
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	192.4319 MHz	-47.29 dBm	

Ch 25: trace 1



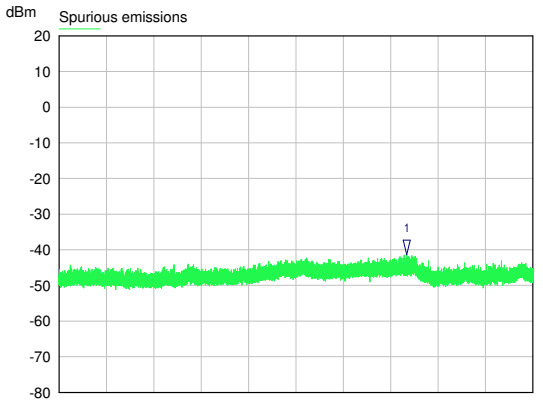
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	2.2129 GHz	-47.86 dBm	

Ch 25: trace 2



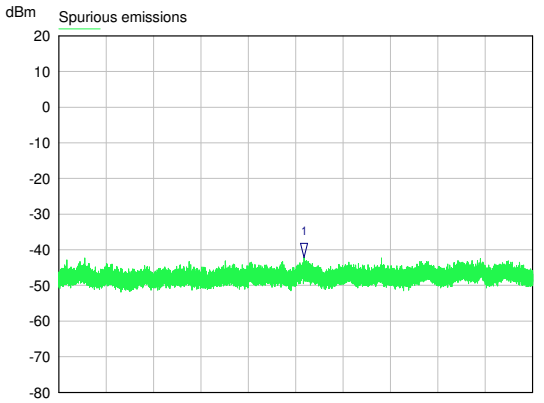
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	3.7546 GHz	-45.30 dBm	

Ch 25: trace 3



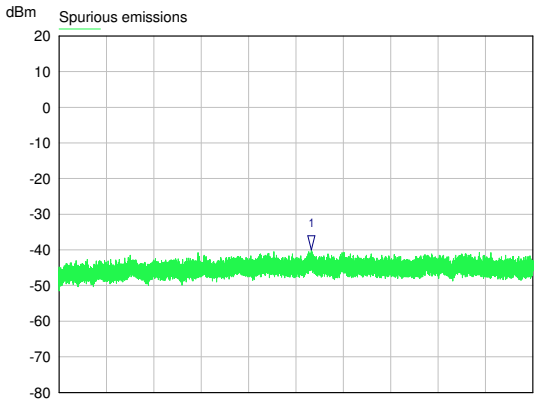
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	6.9331 GHz	-41.26 dBm	

Ch 25: trace 4



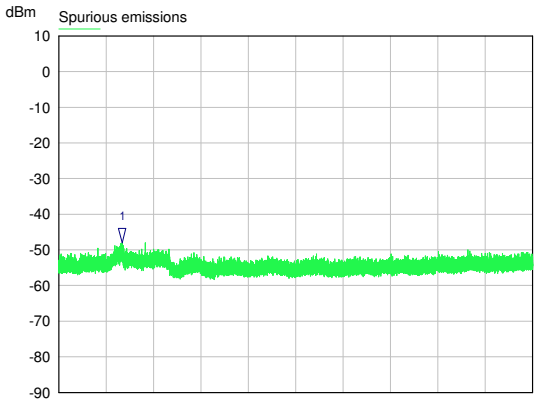
Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	10.5853 GHz	-42.25 dBm	

Ch 25: trace 5



Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	16.1946 GHz	-40.05 dBm	

Ch 25: trace 6



Mkr	Trace	X-Axis	Value	Notes
1	Spurious emissions	19.8006 GHz	-48.01 dBm	

Ch 25: trace 7

Figure 5: Emissions in non-restricted frequency bands

12 Maximum Emissions in Restricted Band

This testing is done in two parts:

- Antenna port conducted measurement
- Radiated measurement with antenna port terminated

12.1 Conducted Antenna port

12.1.1 Measurement method

The conducted antenna port power is converted to a radiated emissions field strength limit specified in 15.209(a) as per KDB 558074 12.2.2:

Electric field strength, E = EIRP – 20log D + 104.8

Which can be re-written as EIRP = E + 20logD – 104.8

Since EIRP = conducted power + antenna gain + ground reflection
This can be re-written:

Max. conducted power = E + 20logD – 104.8 - antenna gain - ground reflection

If "E" is the limit, and the measurement distance taken as 3 m, the maximum conducted power can be determined as shown in the table:

Frequency range	Limit	Field strength (µV/m)	Field Strength (dBµV/m)	20logD	Antenna gain (dBi)	Ground reflection	Limit
> 1 GHz	Average	500	54.0	9.54	2.2	0	-43.48
> 1 GHz	Peak	Average + 20dB	74.0	9.54	2.2	0	-23.46

Table 10: Restricted band limits at antenna port

Initial measurement of antenna port emissions was performed with a peak detector as per KDB 558074 section 12.2.4:

a) RBW = as specified in Table 1.
b) VBW ≥ 3 x RBW.
c) Detector = Peak.
d) Sweep time = auto.
e) Trace mode = max hold.
f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).

Where emissions above 1 GHz were close to the limit, these were re-measured using trace-averaging and RMS detector as per section 12.2.5.1:

a) RBW = 1 MHz (unless otherwise specified).
b) VBW ≥ 3 x RBW.
c) Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or

reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak. (Note: 32001 measurement points used)

d) Averaging type = power (i.e., RMS).
    1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
    2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.
e) Sweep time = auto.
f) Perform a trace average of at least 100 traces.

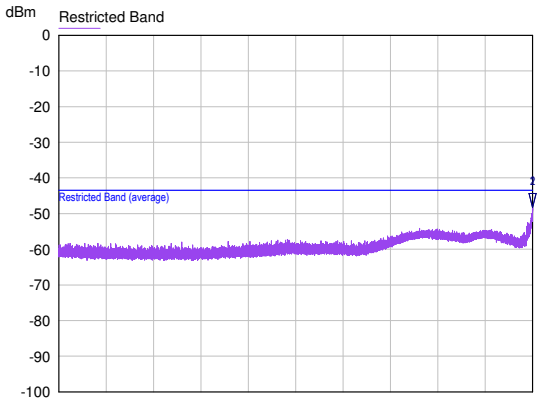
12.1.2 Test results

Maximum values for each frequency range are shown on the plots, and the worst case emissions for each channel were re-measured using RMS detector and are detailed in the table below:

Channel	Frequency (MHz)	Detector	Level (dBm)	Maximum emission relative to peak limit (dB)	Maximum emission relative to average limit (dB)	Result
11	2390.0	Peak	-48.34	-24.86	-4.86	Pass
11	4809.4	Peak	-45.94	-22.46	N/A	Pass
		RMS	-54.01	N/A	-10.53	Pass
18	4879.3	Peak	-48.08	24.60	N/A	Pass
		RMS	-55.25	N/A	-11.77	Pass
25	2483.6	Peak	-40.97	-17.49	N/A	Pass
		RMS	-49.32	N/A	-5.84	Pass
25	4949.2	Peak	-47.88	-24.4	N/A	Pass
		RMS	-55.44	N/A	-11.96	Pass

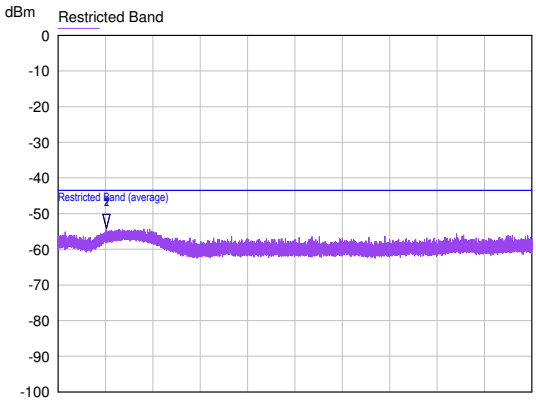
Table 11: Emissions in restricted bands

Performed radiated



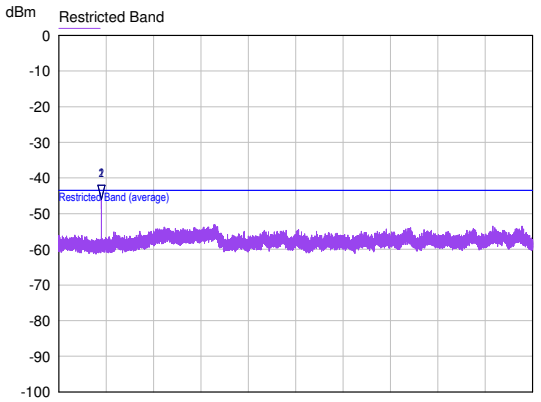
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	2.3900 GHz	-48.34 dBm	
2	Restricted Band	2.3900 GHz	-4.86 dBm	Relative to limit

Ch 11: trace 1: 30 - 1000 MHz



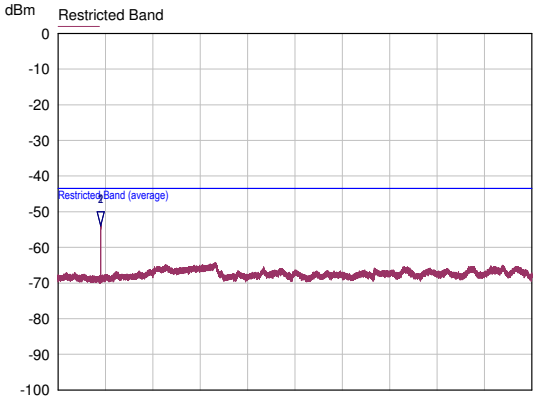
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	2.6391 GHz	-54.21 dBm	
2	Restricted Band	2.6391 GHz	-10.73 dBm	Relative to limit

Ch 11: trace 2; 1000 - 2390 MHz (Peak)



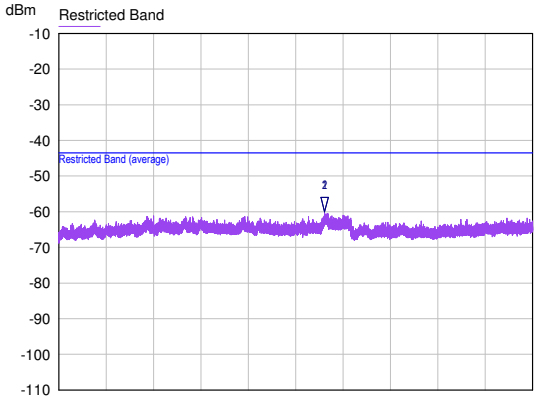
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	4.8094 GHz	-45.94 dBm	
2	Restricted Band	4.8094 GHz	-2.46 dBm	Relative to limit

Ch 11: trace 3; 2483.5 – 4000 MHz (Peak)



Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	4.8094 GHz	-54.01 dBm	
2	Restricted Band	4.8094 GHz	-10.53 dBm	Relative to limit

Ch 11: trace 4; 4000 – 13000 MHz (Peak)

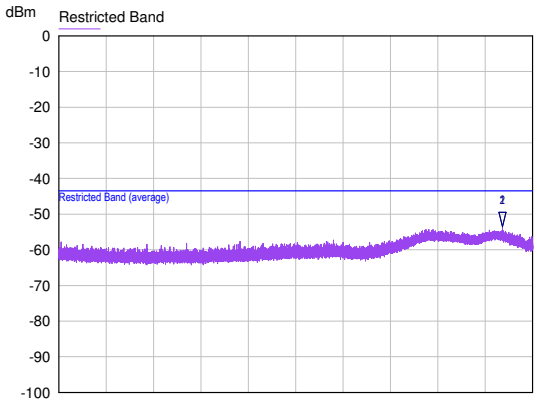


Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	19.7354 GHz	-59.98 dBm	
2	Restricted Band	19.7354 GHz	-16.50 dBm	Relative to limit

Ch 11: trace 4; 4000 – 13000 MHz (RMS)

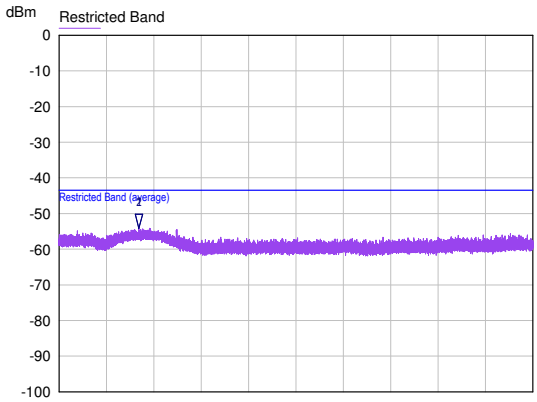
Performed radiated

Ch 11: trace 6; 13 – 25 GHz (peak)



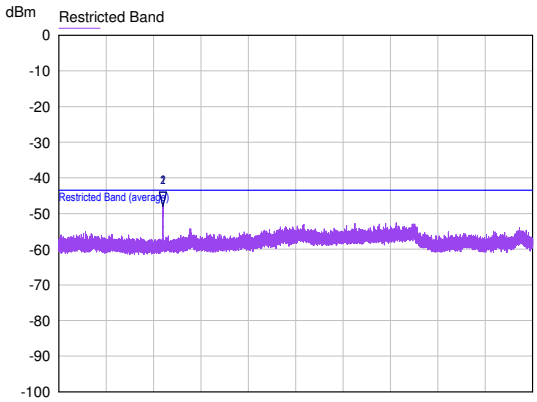
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	2.3011 GHz	-53.47 dBm	
2	Restricted Band	2.3011 GHz	-9.99 dBm	Relative to limit

Ch 18: trace 1; 30 - 1000 MHz



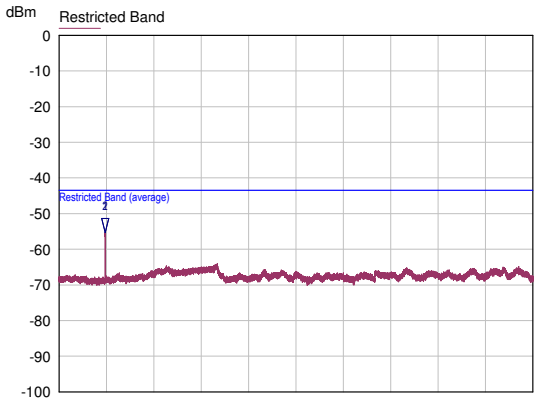
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	2.7396 GHz	-54.17 dBm	
2	Restricted Band	2.7396 GHz	-10.69 dBm	Relative to limit

Ch 18: trace 2; 1000 – 2390 MHz (peak)



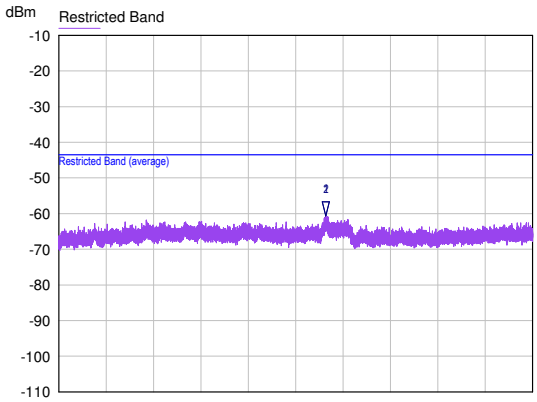
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	4.8793 GHz	-48.08 dBm	
2	Restricted Band	4.8793 GHz	-4.60 dBm	Relative to limit

Ch 18: trace 3; 2483.5 – 4000 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	4.8795 GHz	-55.25 dBm	
2	Restricted Band	4.8795 GHz	-11.77 dBm	Relative to limit

Ch 18: trace 4; 4000 – 13000 MHz

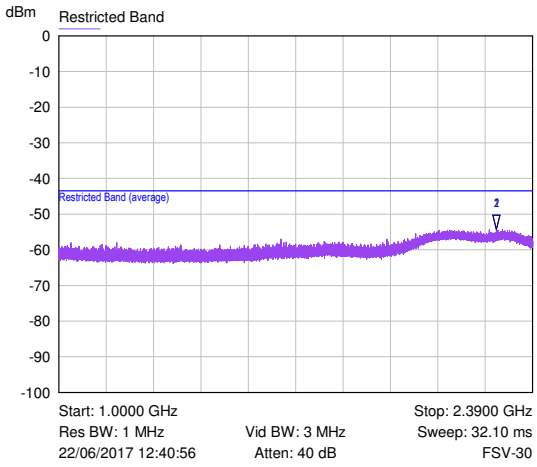


Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	19.7691 GHz	-60.59 dBm	
2	Restricted Band	19.7691 GHz	-17.11 dBm	Relative to limit

Ch 18: trace 4; 4000 – 13000 MHz (RMS)

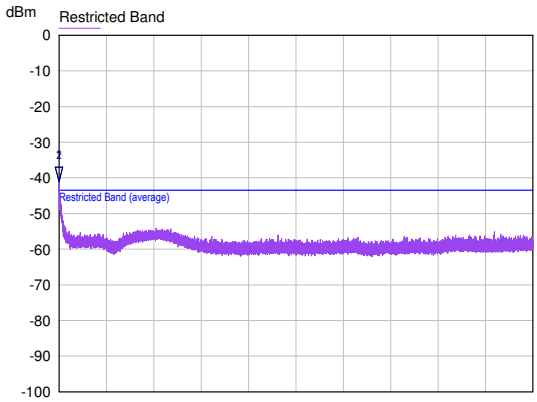
Performed radiated

Ch 18: trace 6; 13 – 25 GHz (peak)



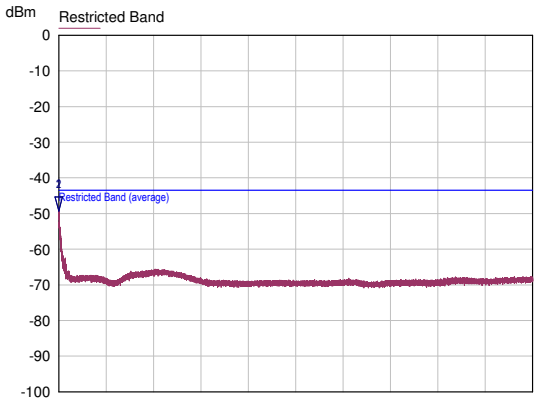
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	2.2844 GHz	-54.31 dBm	
2	Restricted Band	2.2844 GHz	-10.83 dBm	Relative to limit

Ch 25: trace 1; 30 - 1000 MHz



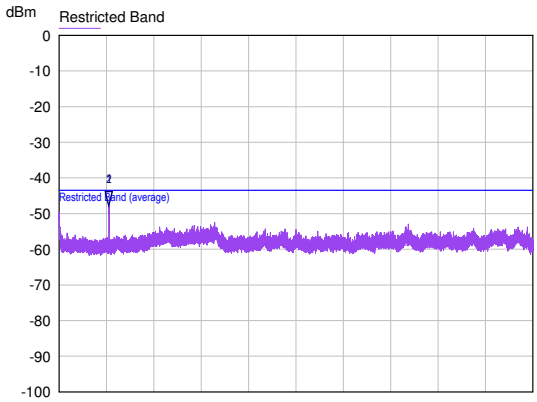
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	2.4836 GHz	-40.97 dBm	
2	Restricted Band	2.4836 GHz	2.51 dBm	Relative to limit

Ch 25: trace 2; 1000 – 2390 MHz



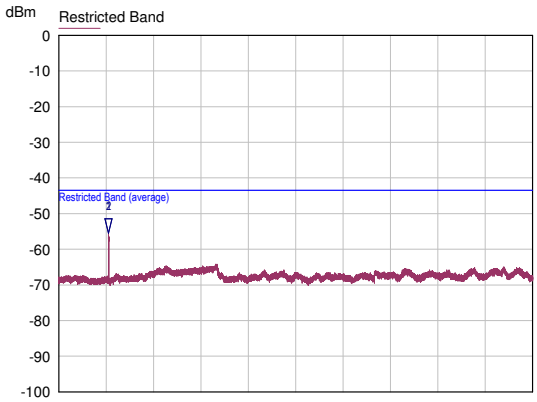
Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	2.4835 GHz	-49.32 dBm	
2	Restricted Band	2.4835 GHz	-5.84 dBm	Relative to limit

Ch 25: trace 3; 2483.5 – 4000 MHz (Peak)

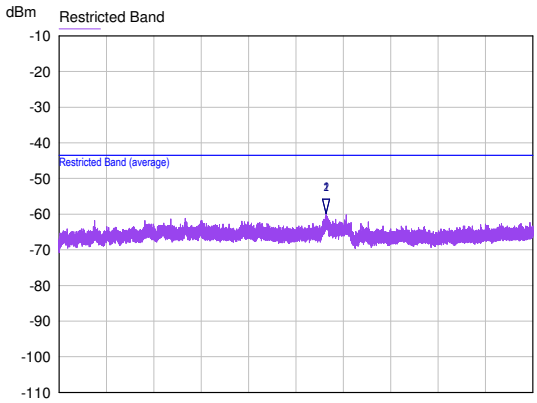


Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	4.9492 GHz	-47.88 dBm	
2	Restricted Band	4.9492 GHz	-4.40 dBm	Relative to limit

Ch 25: trace 3; 2483.5 – 4000 MHz (RMS)



Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	4.9489 GHz	-55.44 dBm	
2	Restricted Band	4.9489 GHz	-11.96 dBm	Relative to limit

Ch 25: trace 5; 4000 – 13000 MHz (Peak)	Ch 25: trace 5; 4000 – 13000 MHz (RMS)
	
Ch 18: trace 6; 13 – 25 GHz (peak)	

Mkr	Trace	X-Axis	Value	Notes
1	Restricted Band	19.7703 GHz	-59.83 dBm	
2	Restricted Band	19.7703 GHz	-16.35 dBm	Relative to limit

Figure 6: Emissions in restricted frequency bands

12.2 Radiated test results

12.2.1 Measurement method

Measurements were made in a semi-anechoic chamber and the EUT was positioned:

- On a 0.8m polystyrene table for emissions below 1 GHz
- On a 1.5m polystyrene support for emissions above 1 GHz

Measurements of emissions from battery powered node were made with and without external sensors connected.

12.2.2 Results

Channel	Frequency (MHz)	Antenna Polarisation	Detector	Level (dBµV/m)	Limit (dBµV/m)	Result
11	30-1000 MHz	Vertical and Horizontal	No frequencies needed final measurement			Pass
18	30-1000 MHz	Vertical and Horizontal	No frequencies needed final measurement			Pass
25	30-1000 MHz	Vertical and Horizontal	No frequencies needed final measurement			Pass

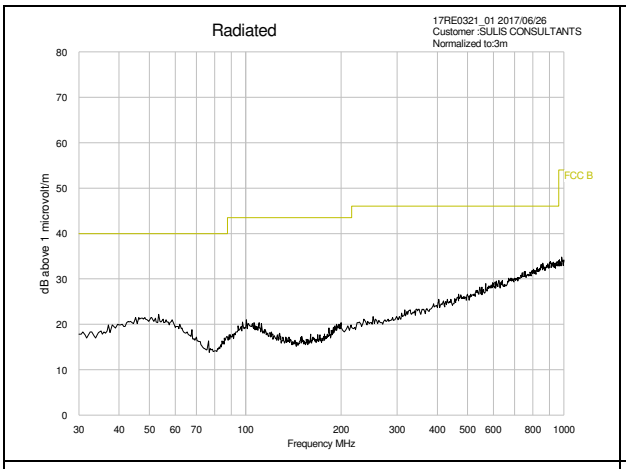
Table 12: 30-1000 MHz Restricted Band RSE results with antenna terminated

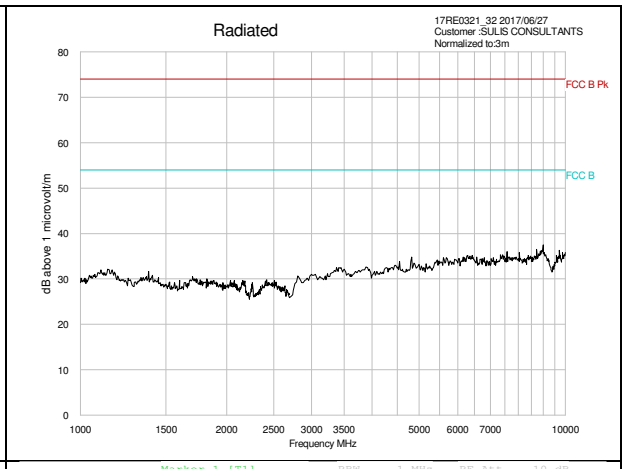
Channel	Frequency (MHz)	Detector	Level (dBµV/m)	Peak limit (dBµV/m)	Average limit (dBµV/m)	Result
11	2483.5	RMS	No emissions to measure			Pass
19	2483.5	RMS	No emissions to measure			Pass
25	2483.5	Peak	40.16	74.0	-	Pass
		RMS	27.78	-	54.0	Pass
18	4881.1	Peak	46.82	74.0	-	Pass
		RMS	34.85	-	54.0	Pass
25	4949.1	Peak	47.81	74.0	-	Pass
		RMS	38.09	-	54.0	Pass

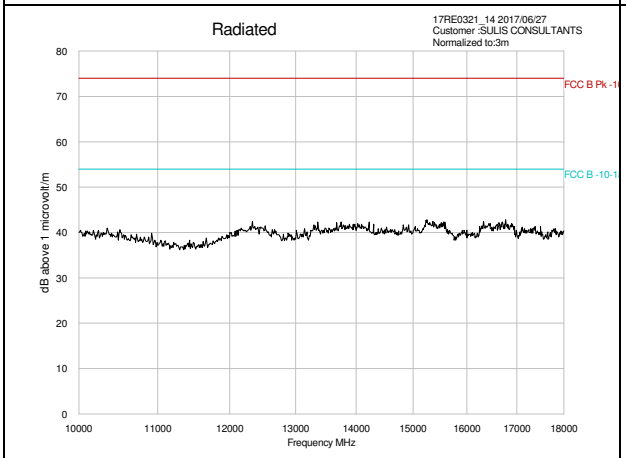
Table 13: 1-25 GHz Restricted Band RSE results with antenna terminated

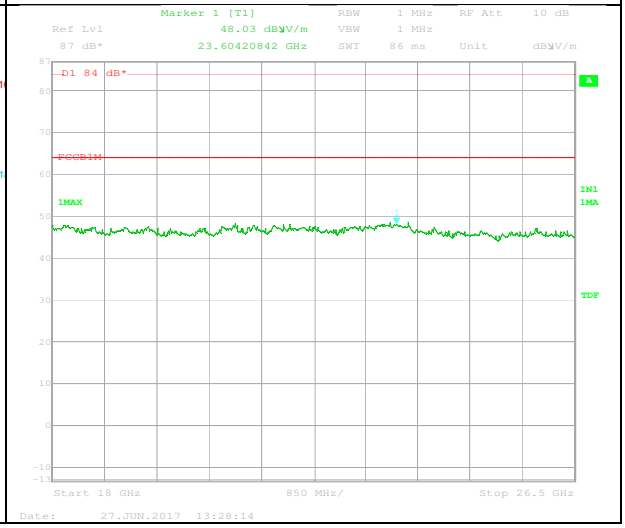
Emissions were investigated on bottom, middle and top channels and worst case plots are included below.

Channel 11

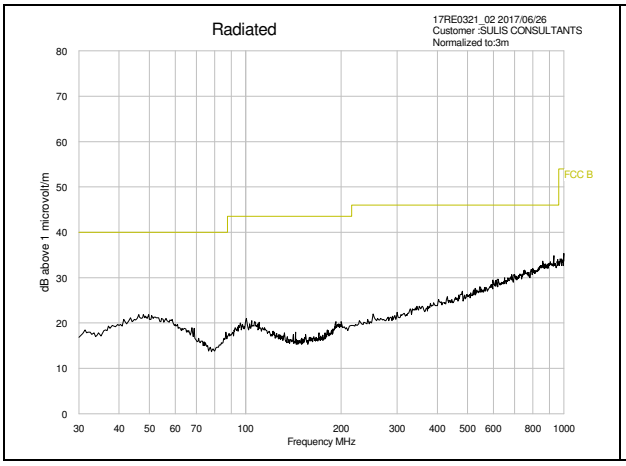


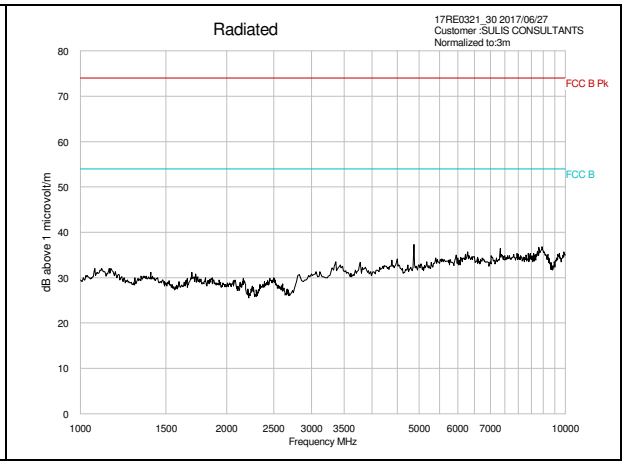


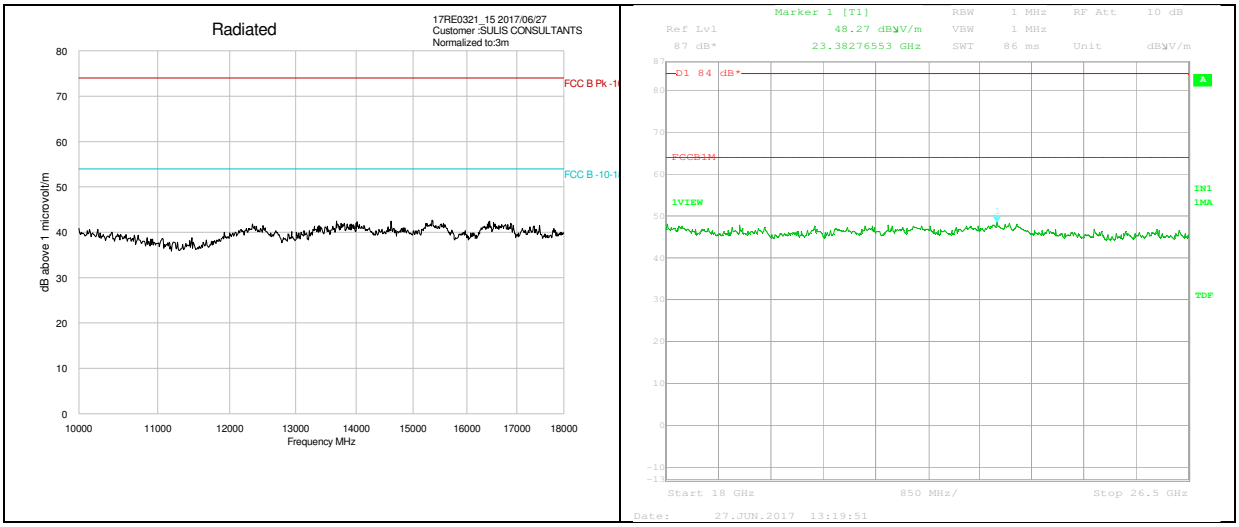




Channel 18







Channel 25

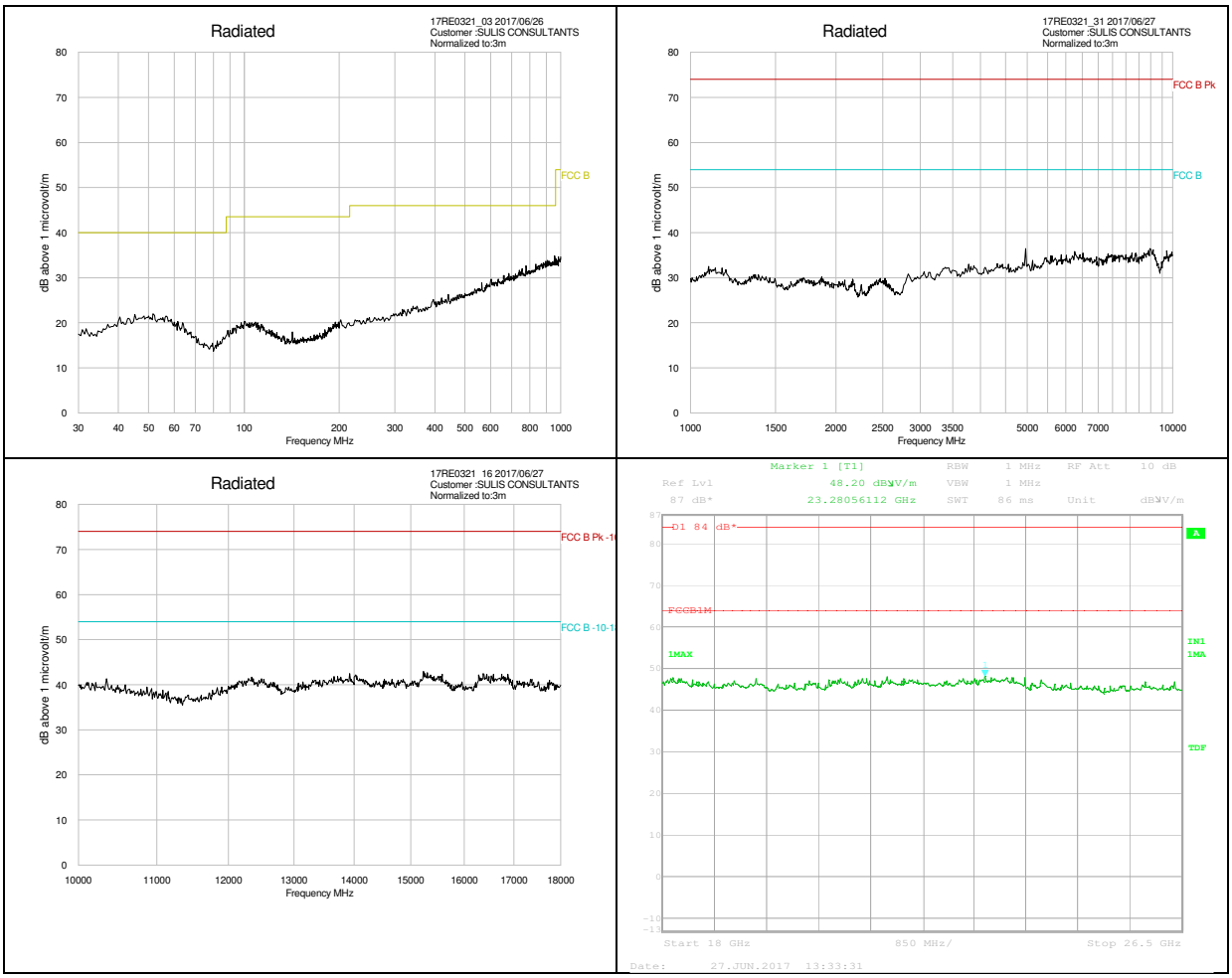


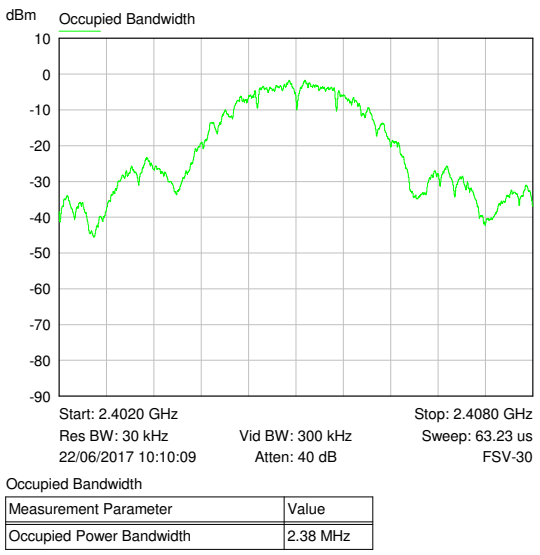
Figure 7: Radiated Spurious emissions

13 Occupied bandwidth

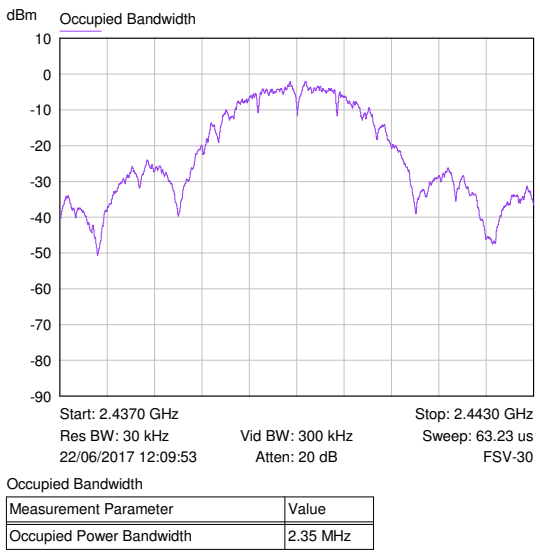
99% occupied bandwidth measured using the inbuilt function in the spectrum analyser

Channel	Occupied Bandwidth (MHz)	Requirement	Result
11	2.38	None	For information
18	2.35	None	For information
25	2.38	None	For information

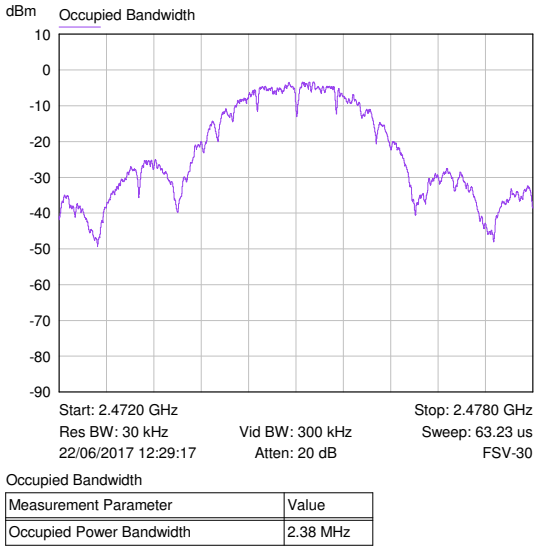
Table 14: Occupied Bandwidth



Channel 11



Channel 18



Channel 25

Figure 8: Occupied Bandwidth

14 Test equipment

Description	Manufacturer	Name	Serial Number	Calibration certificate Or Calibration due
Receiver	Rohde & Schwarz	FSV30	101389	R&S 1400-59078 Cal date: 07 June 2017
RF test cable	Utiflex	BUA01G	FA210A0009M30309	ABEX UK. Ref: green bua01g Due 08 Oct 17
Antenna	Schwarzbeck	VULB9162	129	Due 07/04/2019
Spectrum analyser	HP	8593EM	3726U00203	Due 11/10/2017
7GHz Receiver	Rohde & Schwarz	ESCI7	1166595007	Due 30/05/2018
Pre-amplifier (30-1000MHz)	HP	8447D	1937A02341	Due 14/09/2017
1-10GHz Horn	Schwarzbeck	BBHA 9120 571	571	Due 24/02/2019
Pre-amp, 1-18GHz 55dB	HEMCS	PA XVIII	001	Internal
Horn antenna (2-18GHz)	Q-par Angus	WBH218HN	5367	Due 22/06/2019
18 to 40GHz Horn	Q-par Angus	WBH18-40k	10300	Due 23/01/2019
40GHz receiver	Rohde & Schwarz	ESIB 40 no.2	100262	Due 11/03/2018
Pre-amp, 1-26.5 GHz	HP	8449B	3008A01077	Due 13/07/2017

Table 15: Test Equipment

Note: Where only a calibration due date is listed, the calibration certificate is held by Hursley EMC Services Ltd under their UKAS accreditation, no. 1871