

RF Test Report:

Airspan iB440 to 47CFR15.247

FCC ID: O2J-iB440

SC_TR_150_B

Prepared for:
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1 Revision History

Revision	Originator	Date	Comment
A	C Blackham	7 April 2015	1 st issue
B	C Blackham	7 Sept 2015	Corrected typing error in section 6.5

2 Purpose

This report details testing performed on Airspan iB440 against FCC requirements.

3 Reference Documents

- [1] Title 47 CFR15 Federal Communications Commission Title 47 Code of Federal Regulations Part 15
- [2] ANSI C63.10-2009 IEEE American National Standard for Testing Unlicensed Wireless Devices Committee 63 standard 63-10 10th September 2009.
- [3] KDB 558074 D01 DTS Meas Guidance v03r02 Federal Communications Commission Office of Engineering and Technology Laboratory Division: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247. June 5, 2014
- [4] KDB 662911 D01 Multiple Transmitter Output v02r01 Federal Communications Commission Office of Engineering and Technology Laboratory Division: Emissions Testing of Transmitters with Multiple Outputs in the Same Band (e.g., MIMO, Smart Antenna, etc). October 31, 2013
- [5] SC_TR_150_plots Sulis Consultants Ltd: RF Test Report supplement - Airspan iB440 to 47CFR15.247, FCC ID: O2J-iB440

4 Test Information

4.1 Client

Airspan Communications Ltd
Capital Point,
33 Bath Road
Slough,
SL1 3UF
UK

4.2 Test personnel

4.2.1 Antenna port Conducted Emissions < 20 GHz

Testing was performed by Charlie Blackham of Sulis Consultants Ltd at Airspan Communications offices on 18 and 31 March 2015.

4.2.2 All Radiated Emissions and Antenna port Conducted Emissions > 20 GHz

Testing was performed at Hursley EMC Services Ltd by Richard Pennell on 21 March 2015 and 24 March 2015.

4.3 Test sample

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

5 Product Description

The device operates in the 5725-5850 MHz band with the following ranges of Centre Frequency for different channel bandwidths:

Channel Bandwidth	Range of Centre frequencies
20 MHz	5745 – 5830 MHz
40 MHz	5755 – 5820 MHz
80 MHz	5790 MHz only

This leaves a “guard band” of at least 10 MHz at top and bottom of the band.

As band of operation for 20 and 40 MHz channels is > 10 MHz, the device will be tested on the following channels:

Test Channel	20 MHz Channels	40 MHz channels	80 MHz channel
Bottom	5745.0	5755.0	Not applicable
Middle	5790.0	5790.0	5790.0
Top	5830.0	5820.0	Not applicable

Table 1: Test frequencies

6 Test Configuration

6.1 Test sample

The equipment under test (EUT) was:

Manufacturer	Part number	Model Number	Serial Number
Airspan	920-41-511	iB440-221-P-0	5842041AC95F

Table 2: Equipment under test

6.2 Support equipment

The support equipment was:

Description	Manufacturer	Name	Serial Number
Laptop	Dell	Latitude	AIRN006065
POE injector		MIT-09G-24H	14C006606DRC05

Table 3: Support Equipment

6.3 Test equipment

6.3.1 Conducted measurements < 20 GHZ

Description	Manufacturer	Name	Serial Number	Calibration certificate
Receiver	Rohde & Schwarz	FSQ 26	200108	R&S Ref:10-300314873 2015-02-17
Network Analyser	Rohde & Schwarz	ZVB20	100104	R&S 1400-42157 16 Dec 2014
Attenuator	MCL	BW-N10W20+	N/A	Calibrated in-situ and loaded as Transducer Factor
RF cable	Suhner	Sucoflex 104	86707/4	

Table 4: Test Equipment – Airspan

6.3.2 All Radiated Emissions and Antenna port Conducted Emissions > 20 GHz

The following equipment is all owned by Hursley EMC Services Ltd.

#ID	CP	Manufacturer	Type	Serial Nø	Description	Calibration due date
040	1	HP	8593EM	3536A00137	Spectrum analyser (9kHz-26.5GHz)	15/10/2015
050	1	HP	8447D	1937A02341	Pre-amplifier (30-1000MHz)	16//01/2016
070	1	HP	8449B	3008A00481	Pre-amplifier (1.0-26.5GHz) + 0.5m cable	05/12/2015
071	2	Q-par Angus	WBH218HN	2895	Horn antenna (2-18GHz)	29/11/2016
452	3	CHASE	CBL 6141	4013	Pink 30M-2G Antenna	02/10/2015
466	2	Schwarzbeck	BBHA 9120 571	571	1-10GHz Horn	29/01/2015
531	1	IntelliConnect	Cable	I0796	N Tpye Cable 4M yellow	21/12/2015
552	1	Rohde & Schwarz	ESCI7	1166595007	7GHz Receiver	17/04/2015
021	1	Rohde & Schwarz	ESIB	100192	Test receiver (40GHz)	24/07/2015
399	1	Q-par Angus	WBH18-40k	10300	18 to 40GHz Horn	07/08/2015

Table 5: Test Equipment – Hursley EMC

6.4 Equipment set-up

Equipment was configured as per figure 1:

- The iB440 was connected to the laptop using a USB cable so that operating mode could be configured as required for relevant test.
- The losses for the RF cables were measured and loaded into the Spectrum Analyser as a transducer factor.

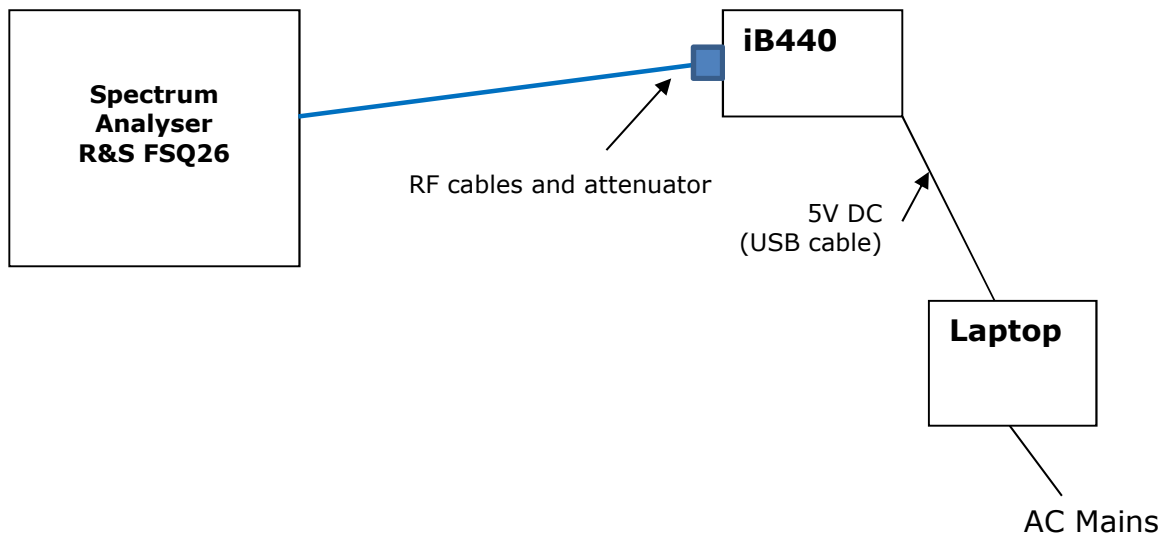


Figure 1: Test Configuration

6.5 Supported Antennas

The EUT supports operation with the following antennas:

Antenna type	Type	Gain
Integral	Flat panel	23.0 dBi
External	Dish	28.6 dBi

Table 6: EUT Antenna configurations

Note: The integral antenna is integral to the unit, but must be connected using the external SMA connectors that also allow connection to higher gain external antenna.

This is the test point used for measurements.

7 Summary of tests performed

Test	Clause	Limit / Requirement	Result
6dB bandwidth	15.247(a)(2)	> 500 kHz	Pass
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)	-30 dBc (average 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 for P2P without power reduction	Pass

Table 7: Summary of test results

8 6dB Bandwidth test

8.1 Measurement method

Test was conducted as using the automatic bandwidth measurement capability of the receiver, whilst using the following settings:

- Set resolution bandwidth to 100 kHz
- Set the video bandwidth to $\geq 3 \times \text{RBW}$
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Record measured Occupied Bandwidth reported by the analyser.

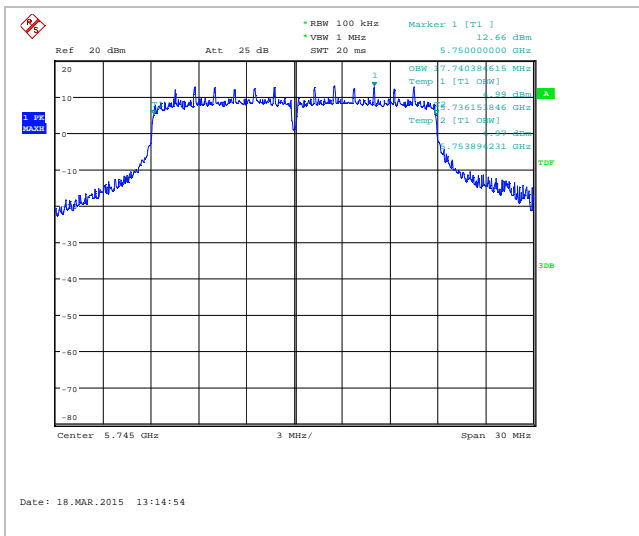
8.2 Test results

Measurements made on single port, "V".

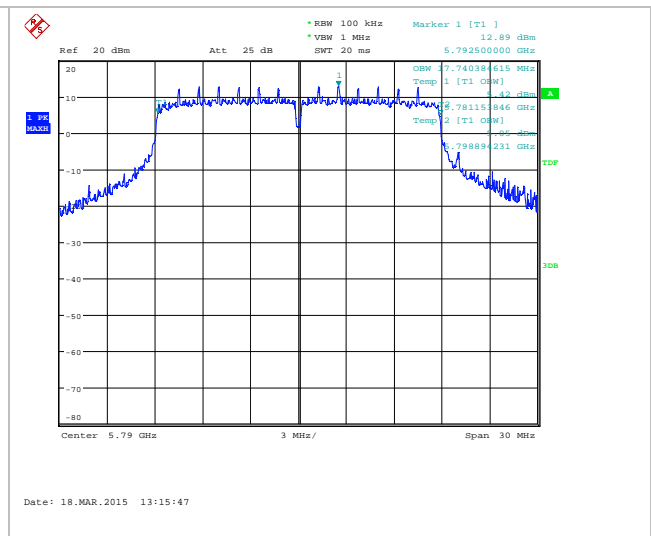
Channel Bandwidth (MHz)	Frequency (MHz)	Modulation	Occupied Bandwidth (MHz)	Requirement	Result
20	5745	BPSK	17.74	> 500 kHz	Pass
20	5790	BPSK	17.74	> 500 kHz	Pass
20	5830	BPSK	17.74	> 500 kHz	Pass
20	5745	QAM	17.71	> 500 kHz	Pass
40	5755	BPSK	36.25	> 500 kHz	Pass
40	5790	BPSK	36.22	> 500 kHz	Pass
40	5820	BPSK	36.14	> 500 kHz	Pass
40	5820	QAM	36.21	> 500 kHz	Pass
80	5790	BPSK	75.64	> 500 kHz	Pass
80	5790	QAM	75.48	> 500 kHz	Pass

Table 8: Occupied Bandwidth

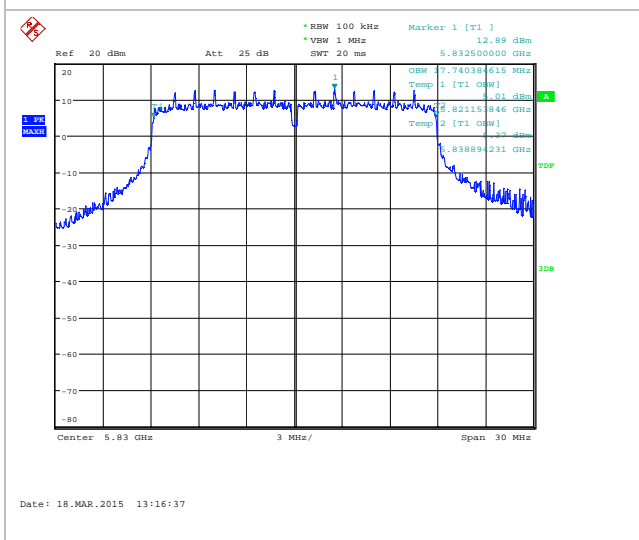
Bottom channel 20 MHz tested on all modulations.
Other channel bandwidths checked on BSPK and 16QAM



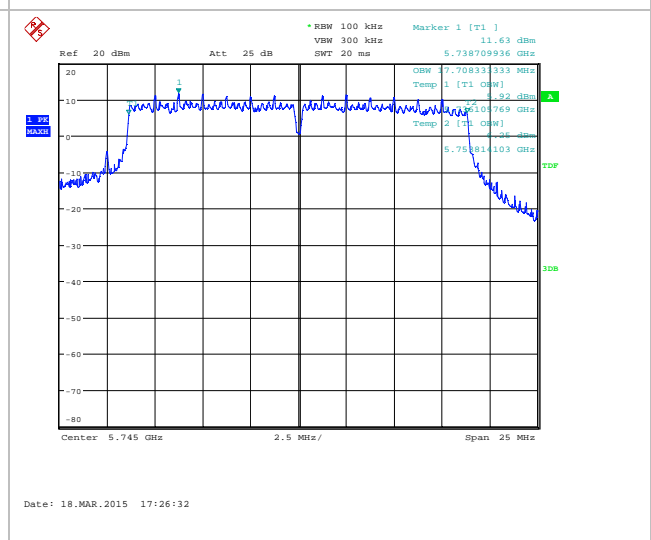
20-OCC-low BPSK



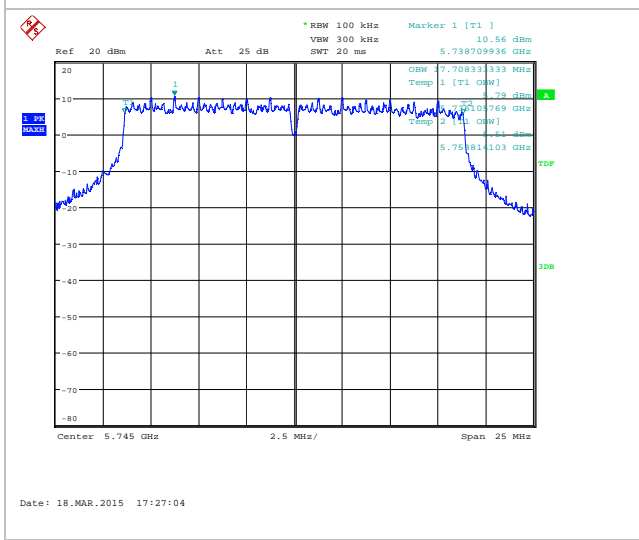
20-OCC-mid BPSK



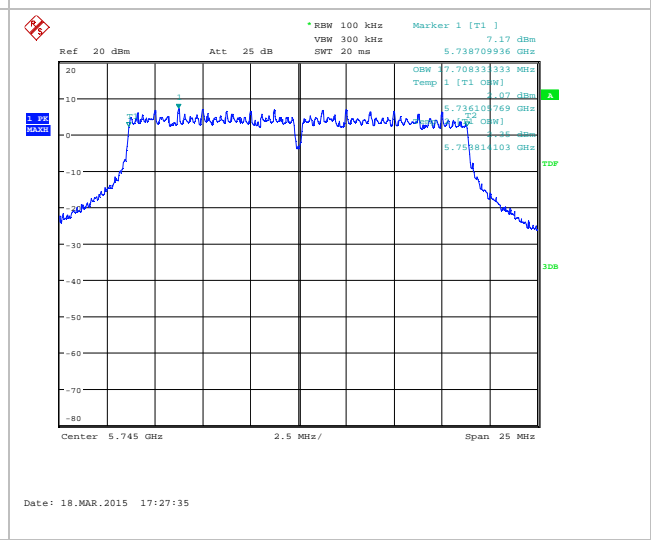
20-OCC-high BPSK



20-OBW-LOW-16QAM



20-OBW-LOW-64QAM



20-OBW-LOW-256-QAM

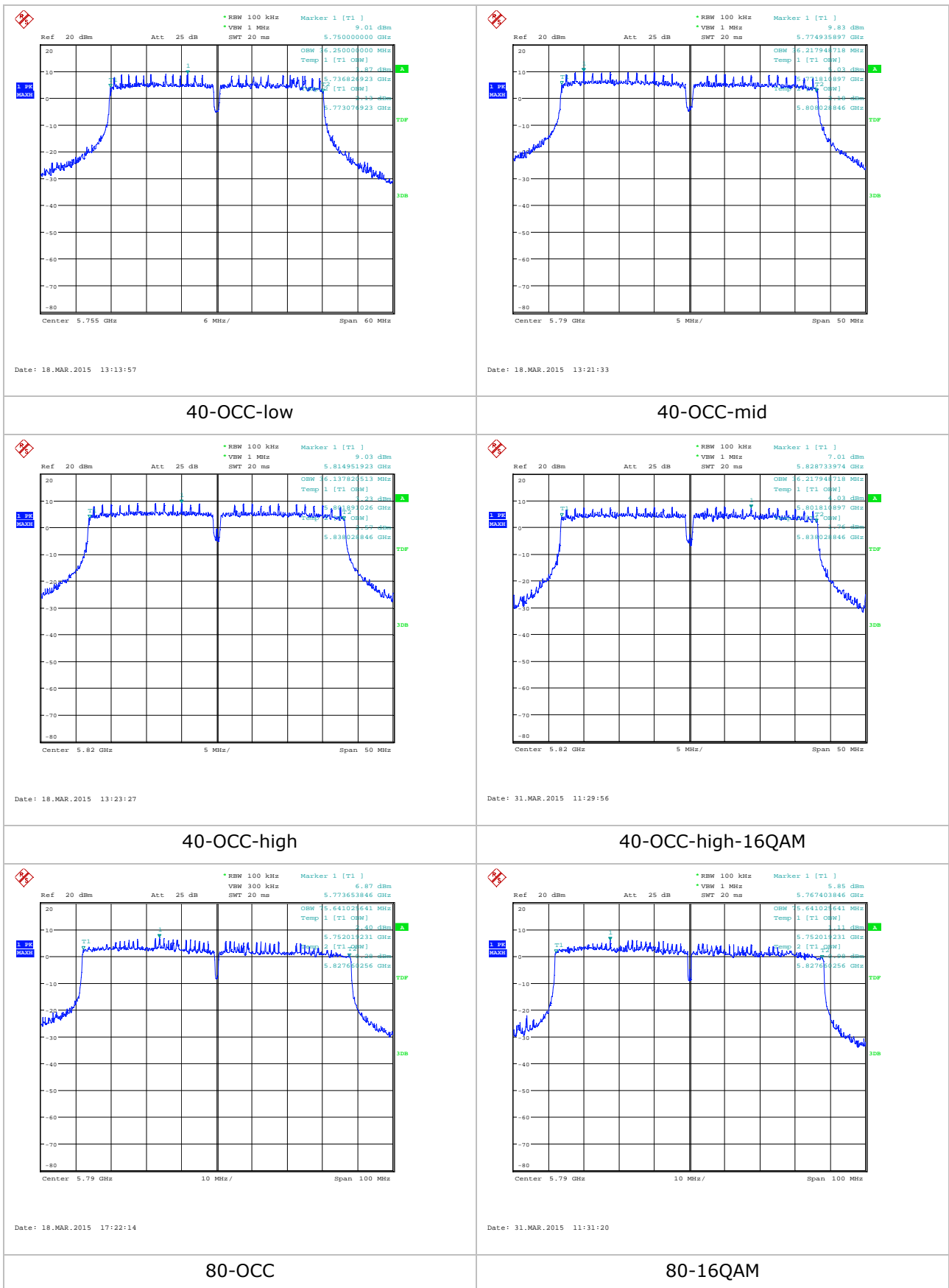


Figure 2: Occupied Bandwidth plots

9 Maximum Conducted Power

9.1 Measurement method

Test was conducted using the automatic channel power measurement capability of the receiver, whilst using the following settings:

- Set the RBW = 1 MHz
- Set the VBW = 10 MHz ($\geq 3 \times$ RBW).
- Sweep time = 5 s.
- Detector = RMS.
- Trace mode = single sweep.

9.2 Test results

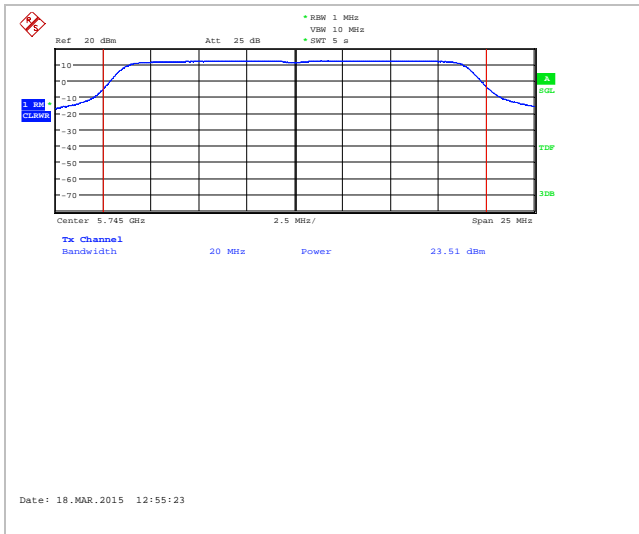
EUT set to transmit at maximum power on the required channel.

All measurements made on port V, and highest values were obtained with BPSK modulation.

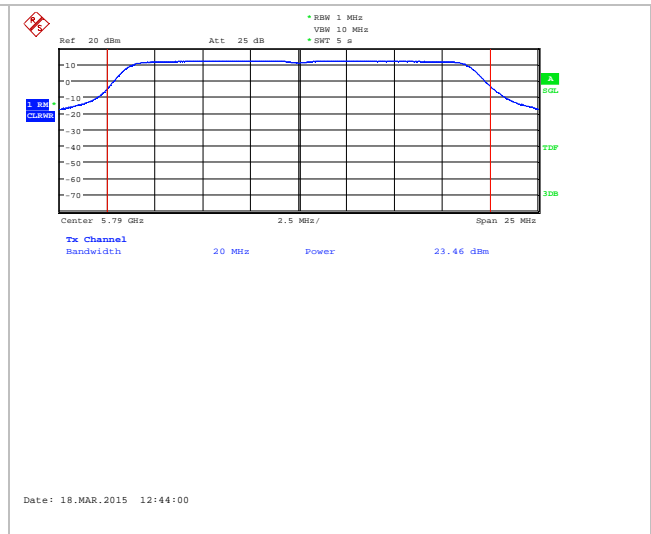
The channel with highest emission for each bandwidth was checked at all higher modulation rates – in each case the total power was lower than with BPSK and plots are in report SC_TR_150_plots.

Channel Bandwidth (MHz)	Frequency (MHz)	Channel Power (dBm)	Add 3dBm	Limit (dBm)	Result	Plot name
20	5745	23.51	26.51	30.0	Pass	20-CP-low
20	5790	23.46	26.46	30.0	Pass	20-CP-mid
20	5830	23.56	26.56	30.0	Pass	20-CP-high
40	5745	22.38	25.38	30.0	Pass	40-CP-low
40	5790	22.72	25.72	30.0	Pass	40-CP-mid
40	5840	22.45	25.45	30.0	Pass	40-CP-high
80	5790	21.82	24.82	30.0	Pass	80-CP

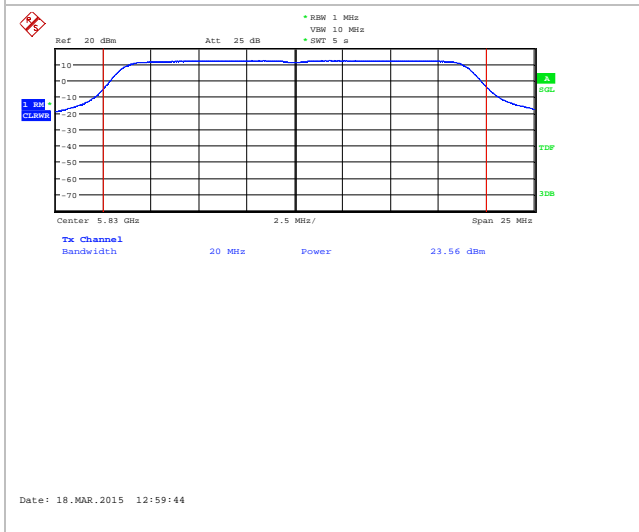
Table 9: Channel Power



20-CP-low



20-CP-mid



20-CP-high

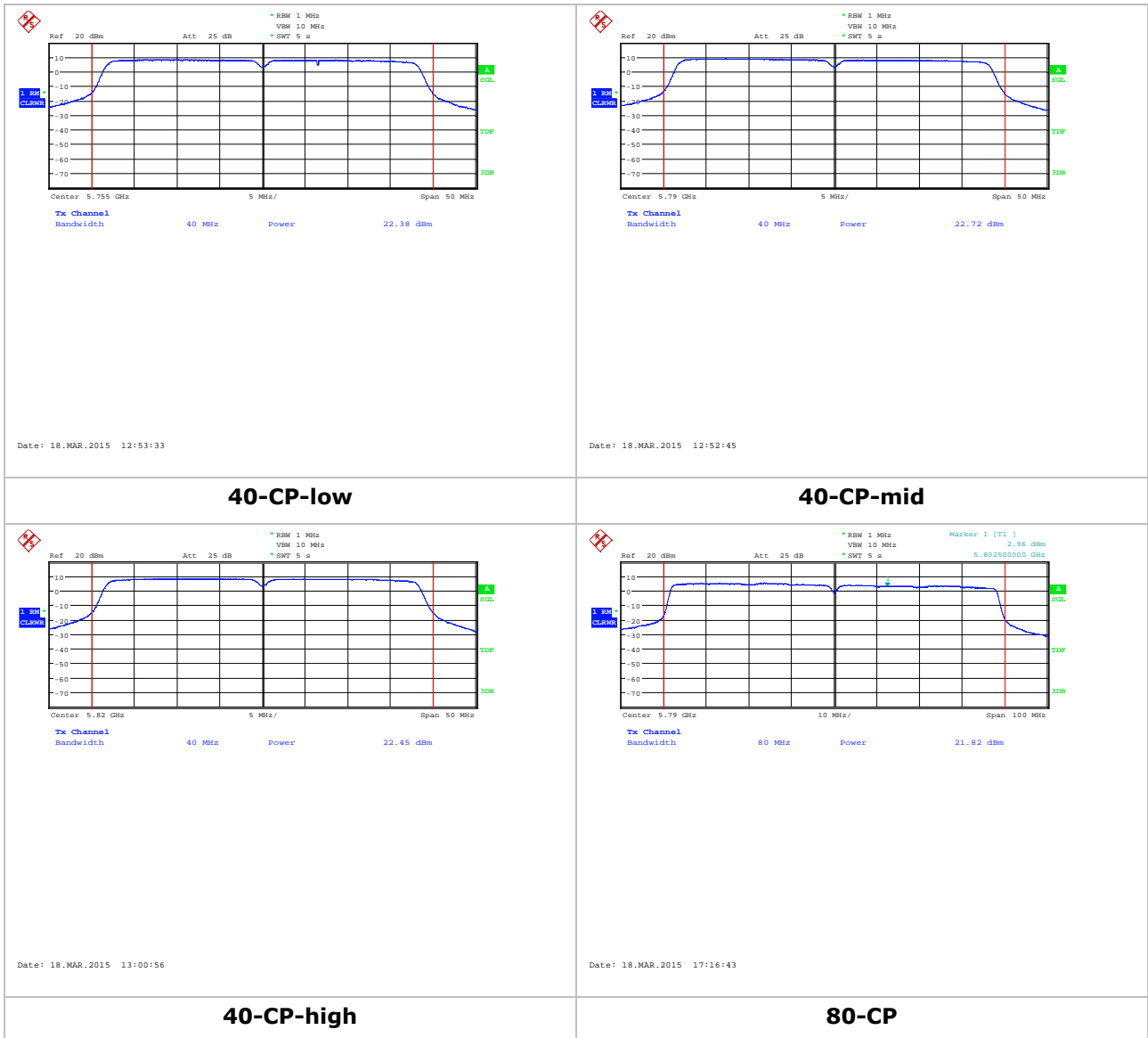


Figure 3: Peak Conducted Power plots

10 Maximum Power Spectral Density

10.1 Measurement method

Maximum Peak Conducted Power was performed according to method *Method SA-1*

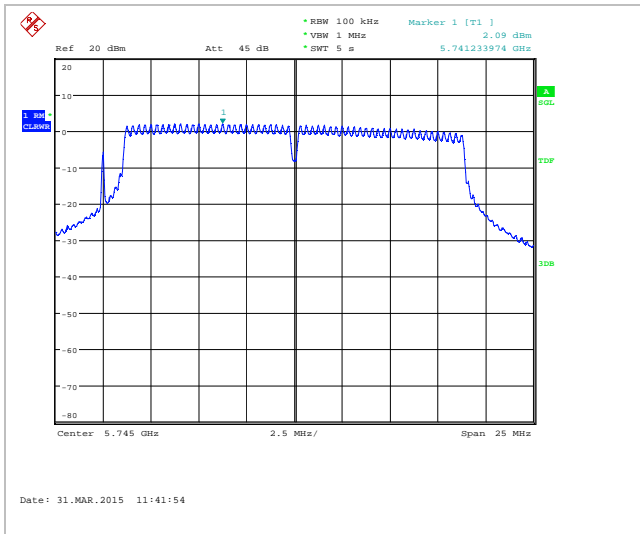
- Set the RBW = 100 kHz (Reduce if required until limit is met)
- Set the VBW = 10 MHz ($\geq 3 \times$ RBW).
- Set span = 1.2x Channel bandwidth.
- Sweep time = 5 s.
- Detector = RMS.
- Trace mode = single sweep.
- Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
- Compare resultant PSD value with maximum permitted value of 8dBm / 3kHz.

10.2 Test results

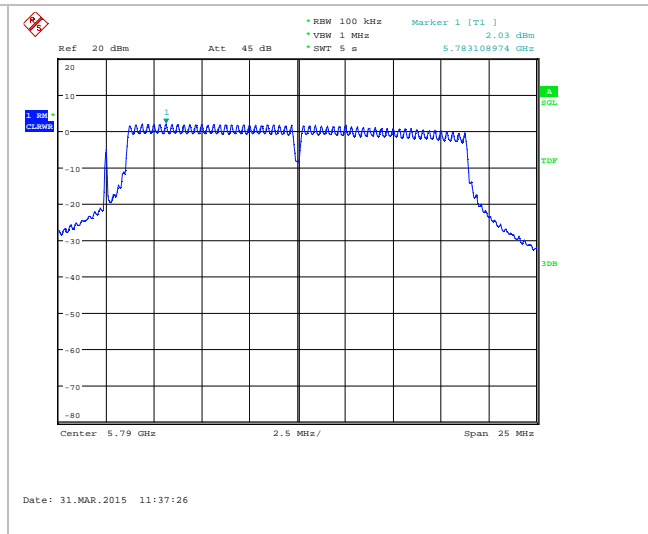
Whilst BPSK had highest total channel power, checks were also made on higher order modulation as well:

Channel Bandwidth (MHz)	Frequency (MHz)	Modulation	Peak Marker reading (dBm)	Add 3dB for 2 antennas	Limit (dBm/3kHz)	Result
20	5745	BPSK	2.09	5.09	8.0	Pass
20	5790	BPSK	2.03	5.03	8.0	Pass
20	5830	BPSK	2.02	5.02	8.0	Pass
20	5745	QAM	1.24	4.24	8.0	Pass
40	5755	BPSK	-1.20	1.80	8.0	Pass
40	5790	BPSK	-1.08	1.92	8.0	Pass
40	5820	BPSK	-1.84	1.16	8.0	Pass
40	5820	QAM	-1.65	1.35	8.0	Pass
80	5790	BPSK	-5.01	-2.01	8.0	Pass
80	5790	QAM	-6.21	-3.21	8.0	Pass

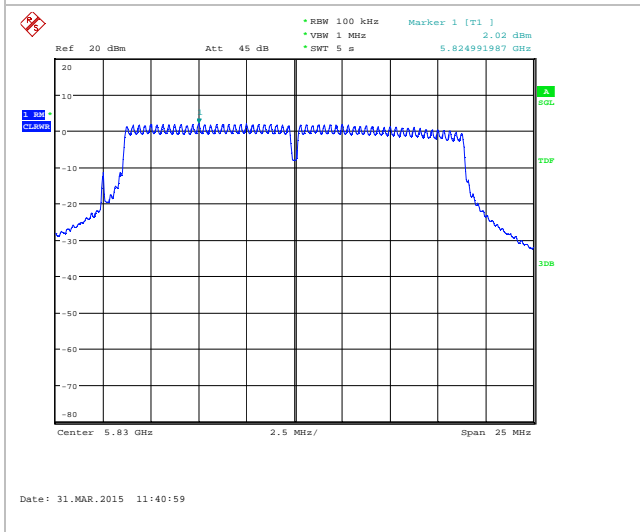
Table 10: Spectral Density results



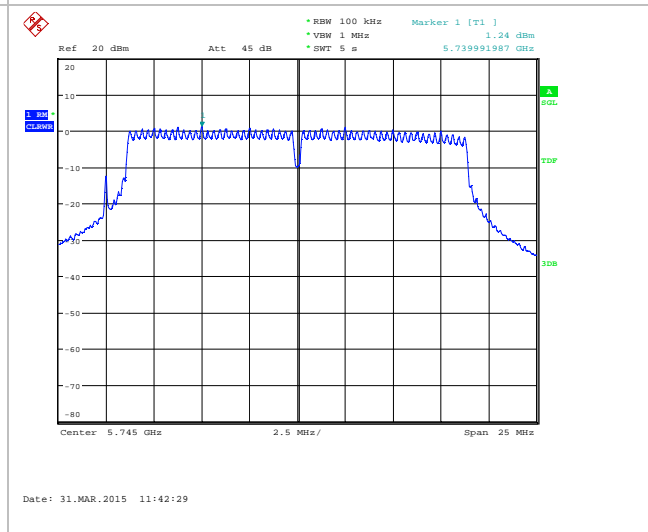
20-PSD-low



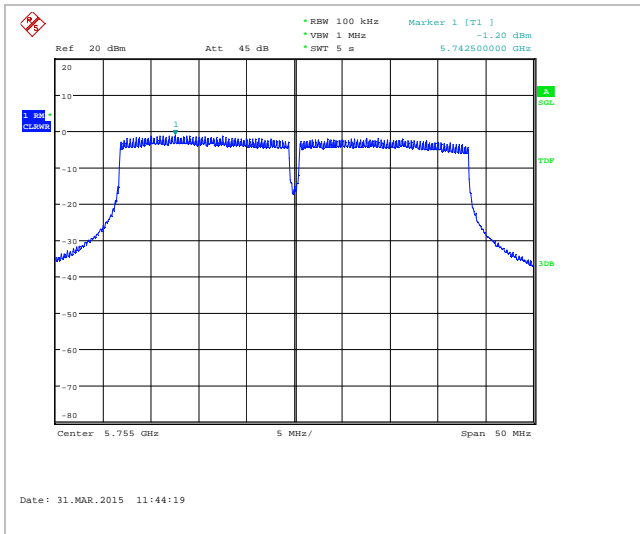
20-PSD-mid



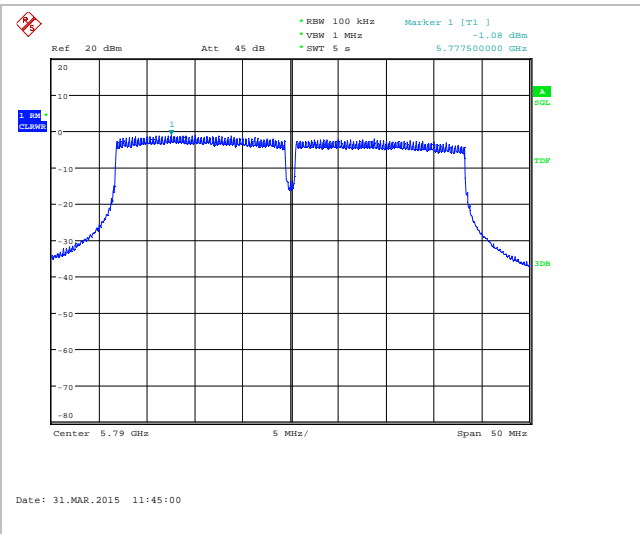
20-PSD-high



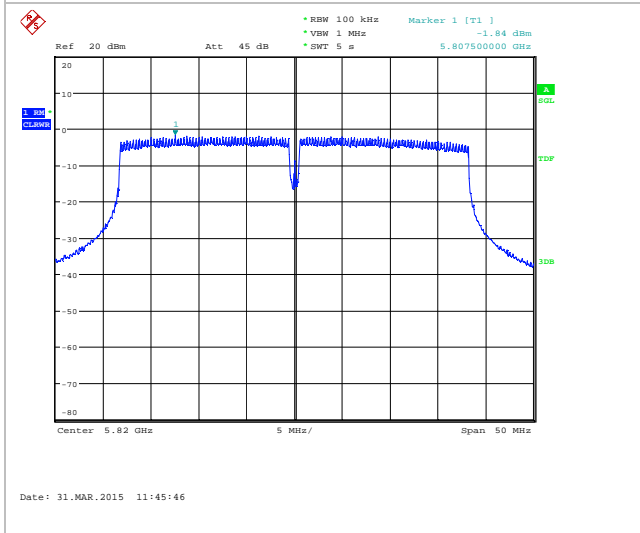
20-PSD-low-QAM



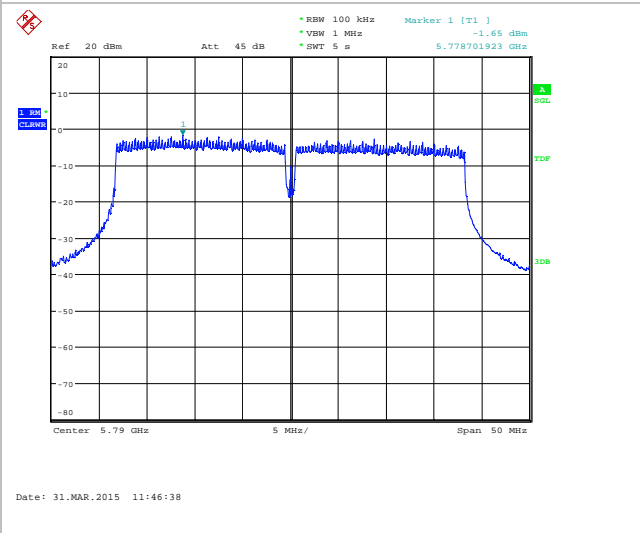
40-PSD-low



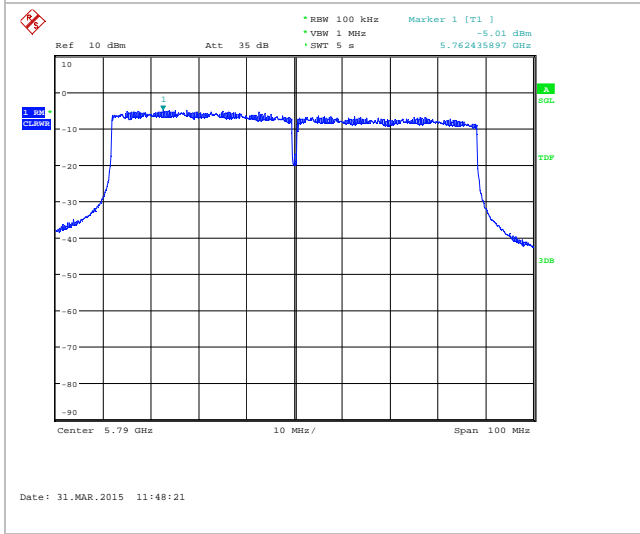
40-PSD-mid



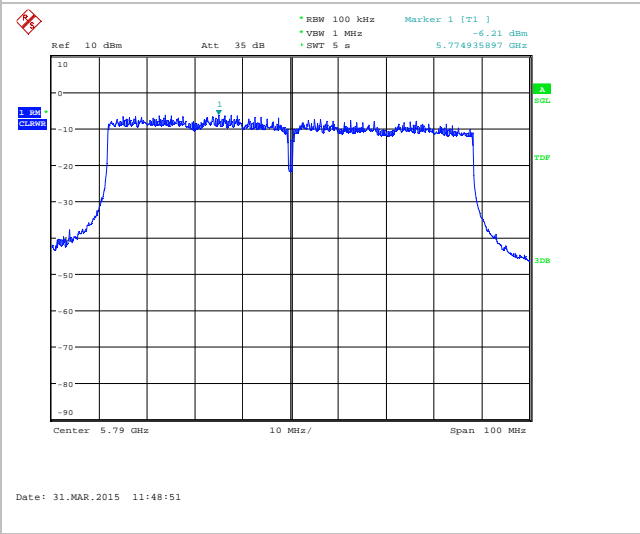
40-PSD-high



40-PSD-high-QAM



80-PSD



80-PSD-QAM

Figure 4: Spectral Density plots

11 Unwanted Emissions outside Restricted Bands

This section was only done where compliance with limits for restricted bands, in both restricted and non-restricted bands, could not be achieved or was not required. The following bands were investigated:

- 5460 – 7250 MHz
- 16.2 – 17.7 GHz.

11.1 Measurement method

Since peak power measurements were made using a RMS detector, the same detector will be used for unwanted emissions. The unwanted emissions shall be at least 30dB lower than the wanted emission.

Testing in the bands immediately adjacent to the wanted band may be done with lower than stated RBW provided the power is integrated over the required bandwidth.

First, establish a reference level by using the following procedure for measuring the peak power level in any 100 kHz bandwidth within the fundamental emission:

The measurement procedure for determining the reference level laid down in section 5.4.1.1 of KDB558074 is identical to measurement method employed in section 10, so maximum values "Peak Marker Values" obtained in section 10.0 shall be used.

The Maximum out of Band Emissions values are determined by subtracting 30dB from the values obtained in section 10 and detailed in table 9 which gives the resultant maximum permitted out-of-band emissions levels detailed in table 10:

Next, determine the power in 100 kHz band segments outside of the authorized frequency band using the following measurement:

Measurement Procedure - Unwanted Emissions

- Set RBW = 100 kHz.
- Set VBW = 300 kHz.
- Set span to encompass the spectrum to be examined.
- Detector = peak.
- Trace Mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize (this may take some time, depending on the extent of the span).

11.2 Test results for 5460 – 7250 MHz band

Channel Bandwidth (MHz)	Frequency (MHz)	Maximum RMS level in 100 kHz RBW (dBm) (section 10)	-30 dBc (dBm)	Maximum emission in 5460 – 7250 MHz (dBm)	Result
20	5745	2.09	-27.91	-40.42	Pass
20	5790				
20	5830				
40	5755	-1.2	-31.2	-39.48	Pass
40	5790				
40	5820				
80	5790	-5.01	-35.01	-42.42	Pass

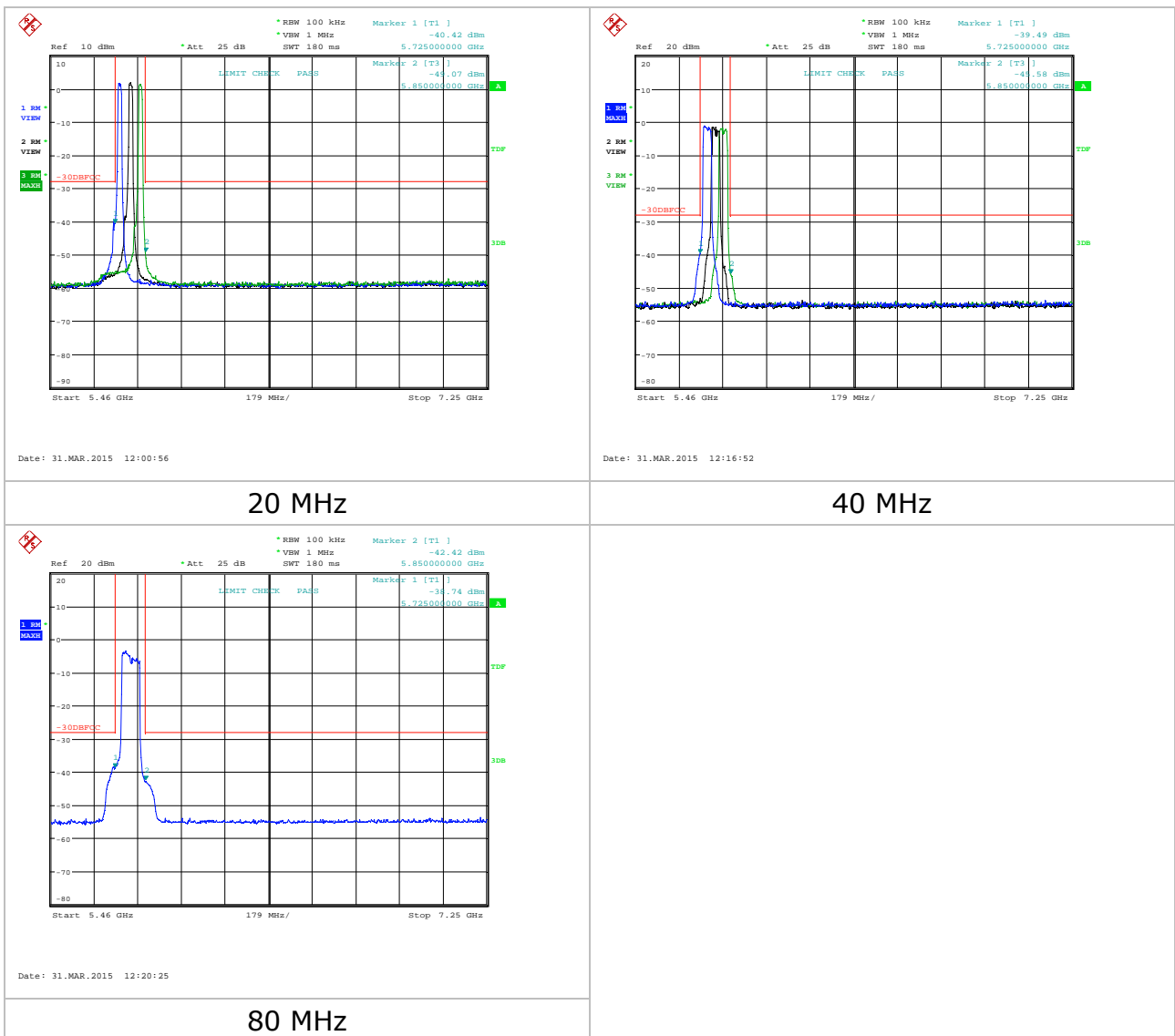


Figure 5: CSE 5460 – 7250 MHz, BPSK

11.3 Test results for 16.2 – 17.7 GHz

The plots are in section 7 of SC_TR_150_plots

Frequency band	Channel Bandwidth (MHz)	Frequency (MHz)	Maximum RMS level in 100 kHz RBW (dBm) (section 10)	-30 dBc (dBm)	Maximum emission in 16.2 – 17.7 GHz band (dBm)	Result
16.2 – 17.7 GHz	20	5745	2.09	-27.91	-47.58	Pass
	20	5790			-56.35	Pass
	20	5830			-57.11	Pass
	40	5755	-1.2	-31.2	-51.19	Pass
	40	5790			-58.02	Pass
	40	5820			-74.22	Pass
	80	5790			-5.01	-35.01

12 Maximum Emissions in Restricted Band

Compliance with this section was demonstrated in more than one method:

Either Radiated with antenna port terminated

Or Conducted from antenna port and Radiated with antenna port terminated.

Frequency band	Measurement method	Section
30 – 1000 MHz	Radiated with antenna fitted	12.2
1000 – 5460 MHz	Conducted	12.3
	Radiated with antenna port terminated	12.4
5460 – 7250 MHz	No requirement (no restricted bands)	N/A
7250-10000 MHz	Conducted	12.3
	Radiated with antenna port terminated	12.4
10000 – 16200	Conducted	12.3
	Radiated with antenna port terminated.	12.4
	2 nd Harmonic: radiated with antenna port fitted	12.5
17700 - 20000	Conducted	12.3
	Radiated with antenna port terminated	12.4
20 – 40 GHz	Radiated with antenna fitted	12.6

12.1 Measurement method

12.1.1 Conducted measurements

The radiated emissions field strength limit specified in 15.209(a) is converted to a conducted power at the antenna port as per section 5.4.2 of KDB 558074-d01.

Frequency range	Limit	Field strength ($\mu\text{V/m}$)	Measurement distance (m)	Field Strength ($\text{dB}\mu\text{V/m}$)	EIRP (dBm)	3dB for MIMO antennas	Antenna port assuming 28.6 dBi antenna
> 1 GHz	Average	500	3	54.0	-41.2	-44.2	-72.8
> 1 GHz	Peak	Average + 20dB	3	74.0	-21.2	-24.2	-52.8

Table 11: Out of band emissions limits above 1 GHz

Measurements above 1 GHz, so the following test method was used as per section 12.2.5.1 of the KDB:

- Set the RBW = 1 MHz
- Set the VBW $\geq 3 \times$ RBW
- Sweep time = auto
- Detector = RMS.
- Trace mode = Averaging (power) over 100 sweeps.

Emissions were measured:

- 1,000 – 5,460 MHz including all Restricted and Non-restricted Bands
- 7,250 – 20,000 MHz including all Restricted and Non-restricted Bands

12.1.2 Radiated measurements

Testing was performed according to procedures in ANSI C63.4:2009. Final radiated testing was performed at a EUT to antenna distance of three metres below 18 GHz and a one metre above 18 GHz.

Instrumentation, including receiver and spectrum analyser bandwidth, comply with the requirements of ANSI C63.2.

12.2 Test results for frequencies below 1 GHz

This test was performed as a radiated emissions test at Hursley EMC with antenna fitted to the unit.

Worst case emissions were with 20 MHz channels.

Restricted Band	Frequency	Maximum emission Quasi-Peak (dB μ V/m)	Limit	Margin
37.5 – 38.25	37.9	22.95	29.54	-6.59
73 – 74.6	Peak emission > 10 dB below limit			
74.8 – 75.2	Peak emission > 10 dB below limit			
All other below 1 GHz	Peak emission > 15 dB below limit			

Table 12: Restricted band emissions 30 - 1000 MHz

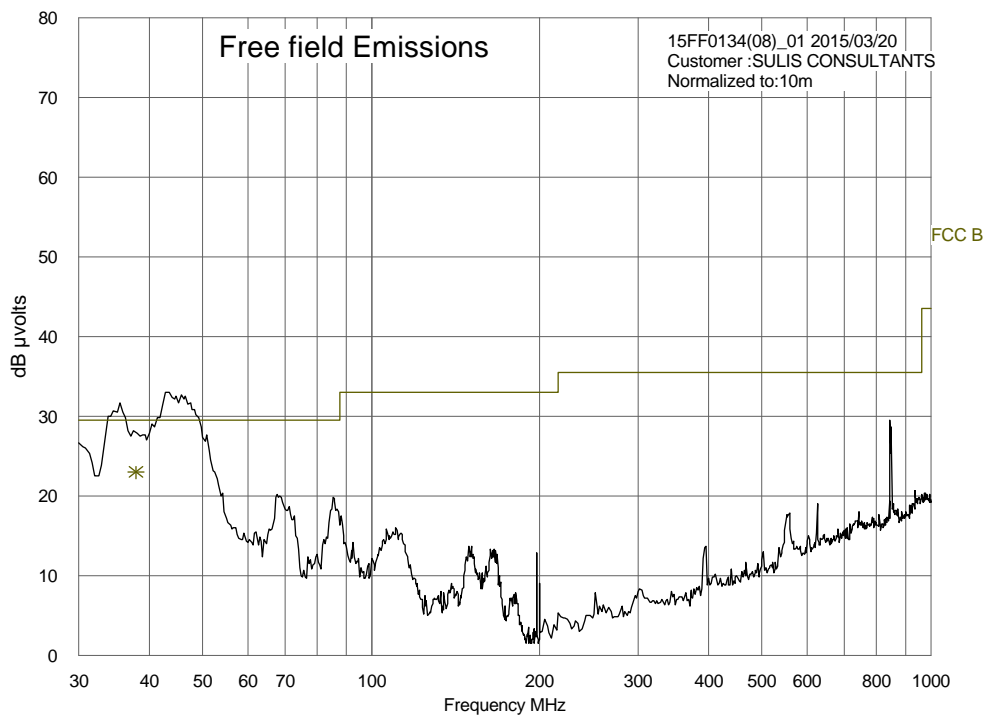


Figure 6: 30-1000 MHz RSE; 20 MHz channel at 5790 MHz

12.3 Test results for 1 – 20 GHz conducted

12.3.1 20 MHz Channels

Frequency Range (MHz)	Detector	TX Frequency	Maximum emission (dBm)	Limit (dBm)	Result	Plots in SC_TR_150_plots
1000 – 5460	Peak	5745	-59.86	-52.8	Pass	Figure 2
		5790	-60.60	-52.8	Pass	
		5830	-60.28	-52.8	Pass	
	Average	5745	-76.18	-72.8	Pass	
		5790	-76.13	-72.8	Pass	
		5830	-76.13	-72.8	Pass	
7250-10000	Peak	5745	-59.84	-52.8	Pass	Figure 3
		5790	-60.57	-52.8	Pass	
		5830	-60.05	-52.8	Pass	
	Average	5745	-86.21	-72.8	Pass	
		5790	-85.57	-72.8	Pass	
		5830	-86.31	-72.8	Pass	
10000 – 16200 And 17700 - 20000 ¹	Peak	5745	All passed except 2 nd Harmonic which was measured radiated in section 12.4 and 12.5			Figure 4
		5790				
		5830				
	Average	5745	All passed except 2 nd Harmonic which was measured radiated in section 12.4 and 12.			
		5790				
		5830				

Table 13: Restricted Band CSE results for 20 MHz channels

¹ Note: There are several “non-restricted” bands in this region, but the only one not being complied with using conducted method is the 16.2 to 17.7 GHz band, which is complied with as a radiated test.

12.3.2 40 MHz Channels

Frequency Range (MHz)	Detector	TX Frequency	Maximum emission (dBm)	Limit (dBm)	Result	Plots in SC_TR_150_plots
1000 – 5460	Peak	5745	-63.7	-52.8	Pass	Figure 5
		5790	-64.9	-52.8	Pass	
		5830	-63.8	-52.8	Pass	
	Average	5745	-76.2	-72.8	Pass	
		5790	-76.2	-72.8	Pass	
		5830	-76.2	-72.8	Pass	
7250-10000	Peak	5745	-65.0	-52.8	Pass	Figure 6
		5790	-65.1	-52.8	Pass	
		5830	-64.7	-52.8	Pass	
	Average	5745	-85.7	-72.8	Pass	
		5790	-78.6	-72.8	Pass	
		5830	-78.6	-72.8	Pass	
10000 – 16200 And 17700 - 20000 ²	Peak	5745	All passed except 2 nd Harmonic which was measured radiated in section 12.4 and 12.5			Figure 7
		5790				
		5830				
	Average	5745	All passed except 2 nd Harmonic which was measured radiated in section 12.4 and 12.			
		5790				
		5830				

Table 14: Restricted Band CSE results for 40 MHz channels

12.3.3 80 MHz Channels

Frequency Range (MHz)	Detector	TX Frequency	Maximum emission (dBm)	Limit (dBm)	Result	Plot name
1000 – 5460	Peak	5790	-64.5	-52.8	Pass	Figure 8
	Average	5790	-76.1	-72.8	Pass	
7250-10000	Peak	5790	-65.2	-52.8	Pass	
	Average	5790	-86.3	-72.8	Pass	
10000 – 16200 And 17700 – 20000 ²	Peak	5790	-55.93	-52.8	Pass	
	Average	5790	All passed except 2 nd Harmonics which were measured radiated in section 12.4 and 12.5			

Table 15: Restricted Band CSE results for 80 MHz channels

² Note: There are several “non-restricted” bands in this region, but the only one not being complied with using conducted method is the 16.2 to 17.7 GHz band, which is complied with as a radiated test.

12.4 Radiated test results for 1 – 40 GHz - antenna terminated

Worst case values are shown below:

Frequency range (GHz)	Detector	Maximum emission (dB μ V/m)	Limit (dB μ V/m)	Result
1-6	Peak	< 48	74	Pass
	Average	< 48	54	Pass
6 – 18	Peak	< 60	74	Pass
	Average	46.64	54	Pass
18 - 40	Peak	50.49	84 (1m)	Pass
	Average	<50.49	64 (1m)	Pass

Table 16: Restricted Band RSE results with antenna terminated

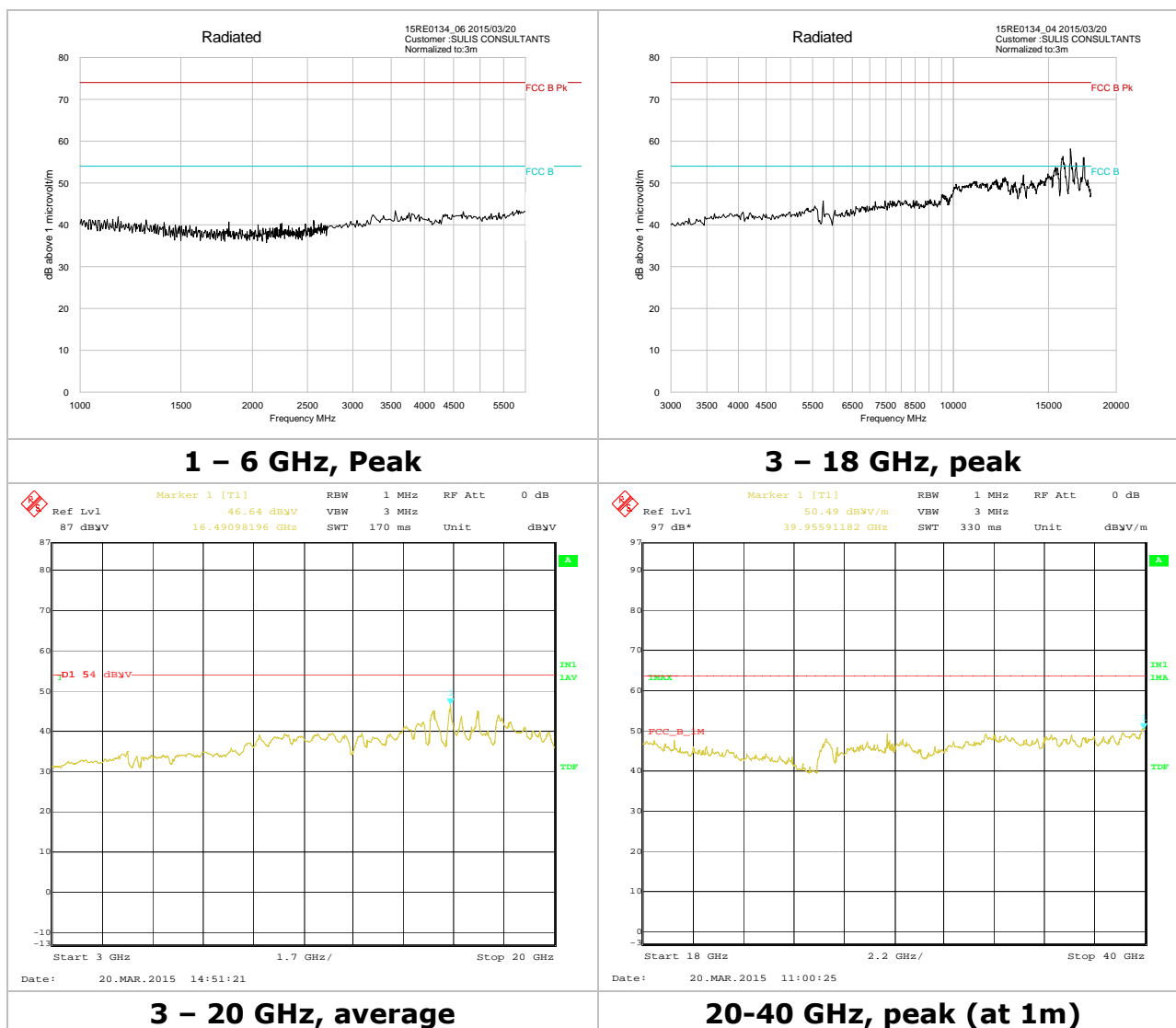


Figure 7: 1 – 40 GHz RSE; antenna port terminated

12.5 Radiated test results – antenna fitted

Worst case was 2nd Harmonic with 20 MHz channels:

Frequency Range (MHz)	Detector	TX Frequency	Maximum measured emission (dB μ V/m)	Limit (dB μ V/m)	Result
10000 – 16200	Peak	5745	61.56	74.0	Pass
		5790	64.34	74.0	Pass
		5830	58.82	74.0	Pass
	Average	5745	49.36	54.0	Pass
		5790	52.73	54.0	Pass
		5830	47.74	54.0	Pass
20000 - 40000	No emissions above the noise floor which was over 10dB below limit line			54.0	Pass

Table 17: Restricted Band RSE results with antenna fitted

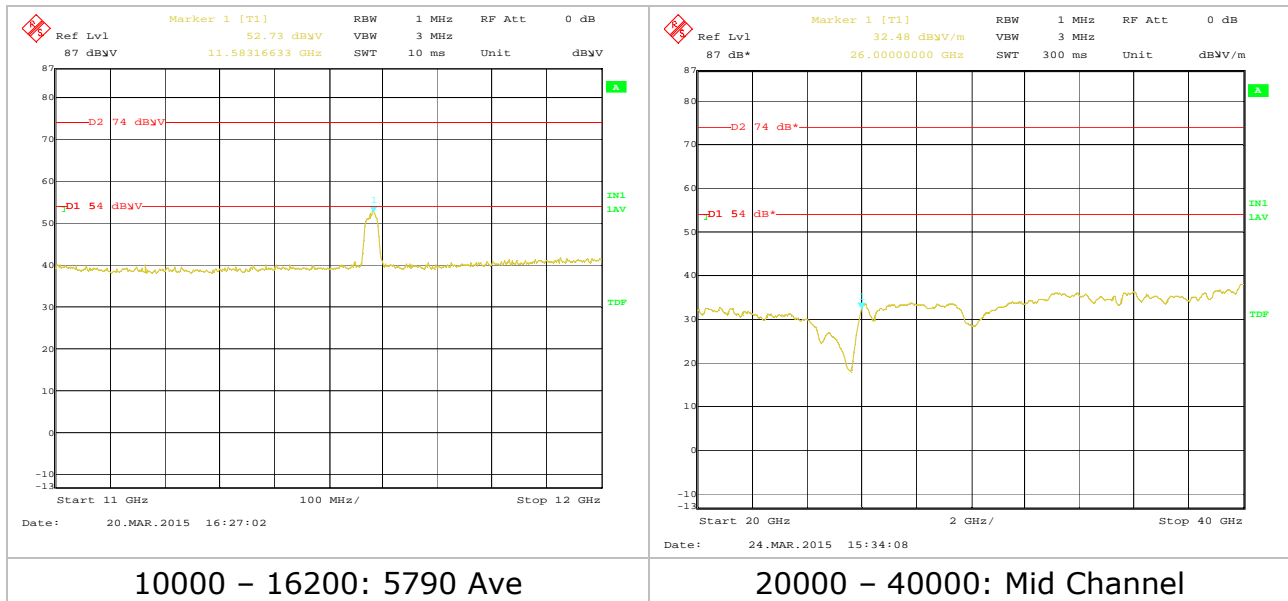


Figure 8: 10 – 40 GHz RSE; antenna fitted