Sulis Consultants
CE Marking and Product Approvals

RF Test Report:

Altiostar Proxima AWS-3 LTE iRRH

FCC ID: NXP-4438E400

SC_TR_239_A

Prepared for:

Altiostar Inc.
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1 Revision History

Revision	Originator	Date	Comment
A	C Blackham	24 Nov 2016	1st release

2 Purpose

This document details the Altiostar Proxima AWS-3 LTE iRRH (intelligent Remote Radio Head), model number iRU4438E400D-1, designed to transmit in the 2110-2180 MHz band.

3 Reference Documents

[Ref 1]	47CFR2	Title 47 Code of Federal Regulations Part 2: frequency allocations and radio treaty matters; general rules and regulations
[Ref 2]	47 CRF27	Title 47 Code of Federal Regulations Part 27: Miscellaneous Communications Services
[Ref 3]	TIA-603-D	Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards
[Ref 4]	KDB 662911 D01 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)
[Ref 5]	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

Altiostar Inc.

100 Ames Pond Drive

Tewksbury

MA 01876

USA

4.2 Test personnel

Antenna port tests

Testing was performed by Charlie Blackham of Sulis Consultants Ltd at Altiostar UK offices on 22nd November 2016 and at Hursley EMC on and 23rd November 2016.

Radiated Spurious Emissions (section 12)

Testing was performed by Richard Pennell of Hursley EMC services Ltd, at their FCC Registered test facility, UK designation number UK0006 on 23rd November 2016 under job 16R591.

4.3 Test sample

The results herein only refer to sample detailed in section 6

5 Product Description

See Operational Description for more detail

Transmit power was set to maximum rated value of 1.5 W (31.8dBm) per port.

Channels for measurement were selected from the following channels within the band of operation:

Bandwidth (MHz)	Bottom channel (MHz)	Middle channel (MHz)	Top channel (MHz)
5	2112.5	2145.0	2177.5
10	2115.0	2145.0	2175.0
15	2117.5	2145.0	2172.5
20	2120.0	2145.0	2170.0

Testing was performed using all support modulation rates.

The test waveform has a 100% duty cycle so no gating or allowance for duty cycle is required when taking measurements

6 Test Configuration

6.1 Test sample and Operating mode

The equipment under test (EUT) was:

Manufacturer	Name	Product Code	Model Number	Serial Number
Altiostar	Proxima AWS-3	340-00-0078	iRU4438E400D-1	TEW36160012

Table 1: Equipment under test

6.2 Support equipment

The support equipment was:

Description	Manufacturer	Name	Serial Number
Laptop	HP	250	Dvt-mobile altiostar
DC PSU	Agilent	N5767A	AN00152

Table 2: Support Equipment

6.3 Equipment set-up

Equipment was configured as per figure 1:

- The Proxima system was configured used a web browser application that allowed the unit to be placed into a test mode and the required frequency, bandwidth and power to be set
- The insertion loss of the Attenuator and Co-ax cable were before testing and their combined path-loss was programmed into the analyser before testing.

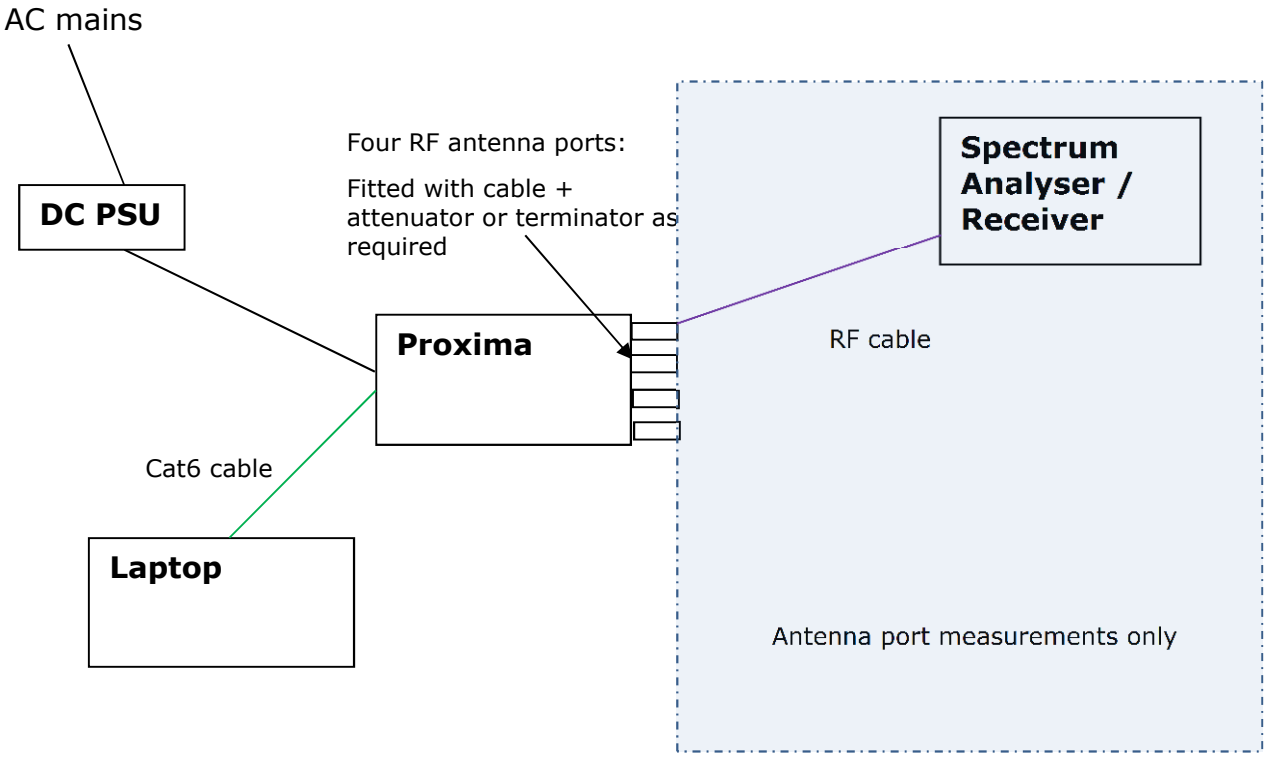


Figure 1: Configuration for test

7 Summary of Tests performed

Test	47 CFR Part	Limit	Result	Section
Transmit Power	27.50(d)(2) / 2.1046	1640 W EIRP	Pass	8
Spectral Power Density	27.50(d)(2) / 2.1046	1640 W EIRP/MHz	Pass	9
Occupied Bandwidth	2.1049	None	Pass	10
Conducted Spurious Emissions and Band Edge	27.53(h) / 2.1051	-13 dBm	Pass	11
Radiated Spurious Emissions	27.53(h) / 2.1053	-13 dBm	Pass	12
Frequency Stability	27.54 / 2.10	None	See report SC_TR_238_A	

Table 3: Summary of tests performed

8 Transmit Power

8.1 Requirement and test method

The Proxima device is designed to be installed without Geographic limits.

27.50 Power limits and duty cycle.

(d) (2) The power of each fixed or base station transmitting in the 1995-2000 MHz, the 2110-2155 MHz 2155-2180 MHz band, or 2180-2200 MHz band and situated in any geographic location other than that described in paragraph (d)(1) of this section is limited to:

(i) An equivalent isotropically radiated power (EIRP) of 1640 watts when transmitting with an emission bandwidth of 1 MHz or less;

(ii) An EIRP of 1640 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.

(d)(5) Equipment employed must be authorized in accordance with the provisions of §24.51. Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (d)(6) of this section. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

(d)(6) Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

Measurement made using KDB971168 DO1, section 5.2

Pre-testing had showed that all ports delivered the same transmit power.

The total power was summed in accordance with KDB662911D01 and the result compared against the limit. Specifically, the power was measured at Antenna port 1 and then 10log4 dB, or 6 dB, was added to show total power from all four ports.

8.2 Test results

Pre-testing had shown that highest power was on middle channel, so all measurements were made whilst transmitting at 2145.0 MHz.

Channel Bandwidth	Modulation	TX power (dBm)	Summed TX power (dBm)	TX power (W)	Limit[1] (W)	Result
5 MHz	QPSK	32.0	38.00	6.3	None	Pass
	16 QAM	32.0	38.00	6.3	None	Pass
	64 QAM	31.8	37.80	6.0	None	Pass
10 MHz	QPSK	31.9	37.90	6.2	None	Pass
	16 QAM	32.2	38.20	6.6	None	Pass
	64 QAM	32.0	38.00	6.3	None	Pass
15 MHz	QPSK	32.0	38.00	6.3	None	Pass
	16 QAM	32.1	38.10	6.5	None	Pass
	64 QAM	31.8	37.80	6.0	None	Pass
20 Mhz	QPSK	31.8	37.80	6.0	None	Pass
	16 QAM	31.9	37.90	6.2	None	Pass
	64 QAM	31.9	37.90	6.2	None	Pass

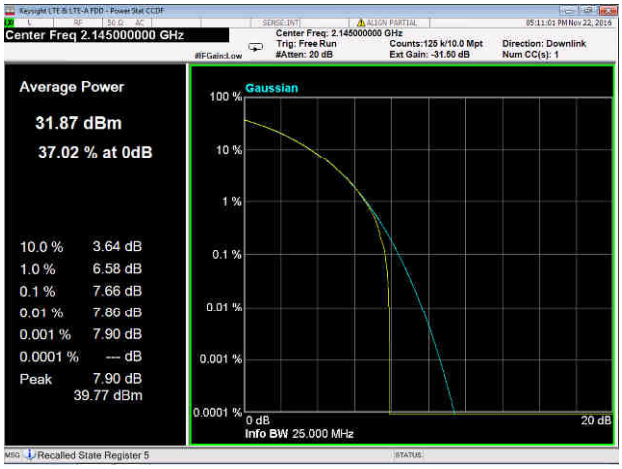
Table 4: Transmit power

Peak to average ratio is dependent on modulation type and not on channel bandwidth, so results are presented for a single channel bandwidth only.

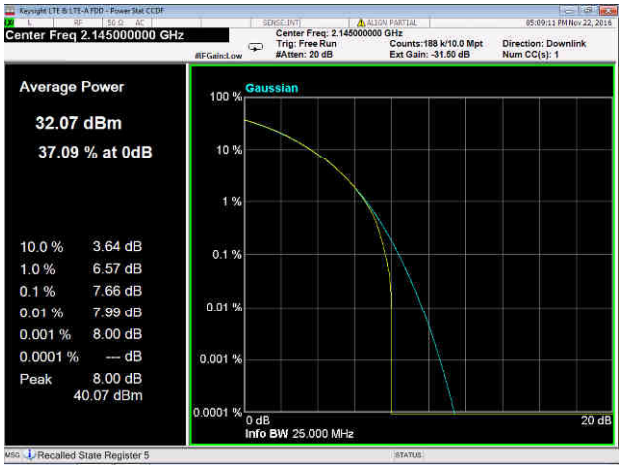
Channel Bandwidth	Modulation	Peak to Average ratio	Limit (dB)	Result
10 MHz	QPSK	7.90	13.0	Pass
	16 QAM	8.00	13.0	Pass
	64 QAM	8.05	13.0	Pass

Table 5: Peak to Average ratio

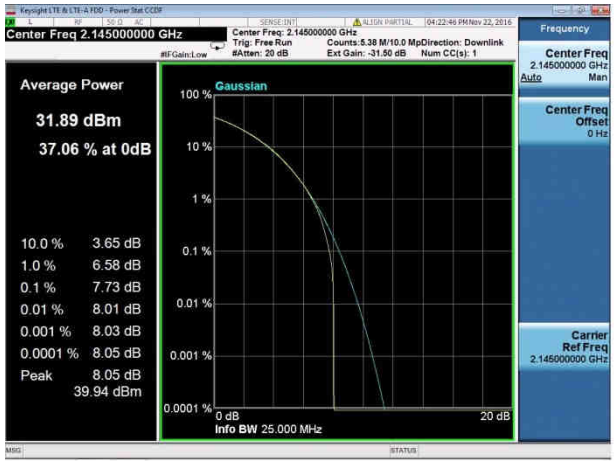
[1] Note: there is no "limit" applied during equipment authorisation as it is applied by the FCC at time of licensing.



10 MHz Channel, QPSK

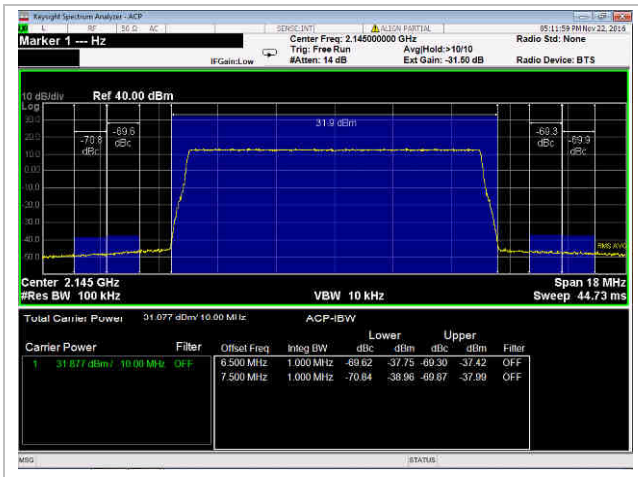


10 MHz Channel, 16 QAM

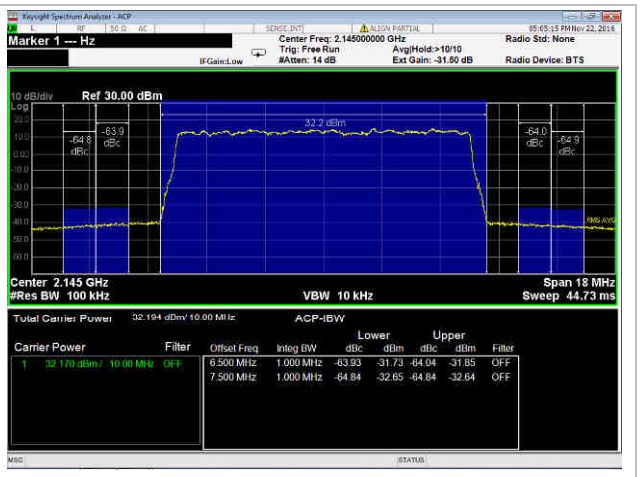


10 MHz Channel, 64 QAM

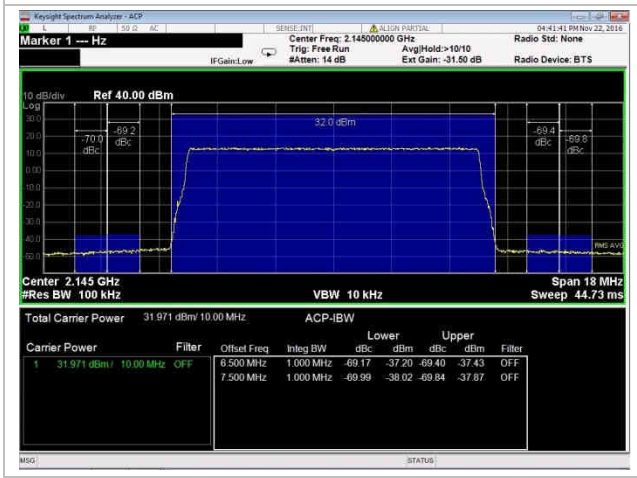
Figure 2: PAR plots



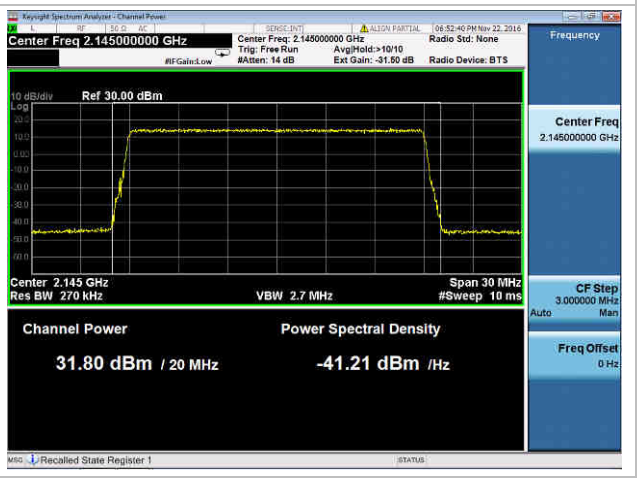
10 MHz Channel, QPSK



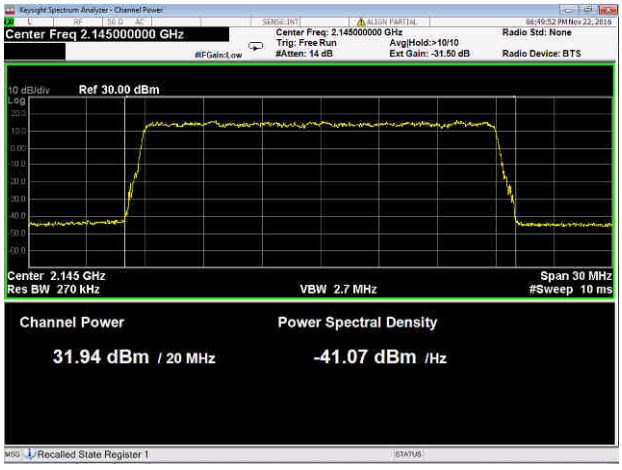
10 MHz Channel, 16 QAM



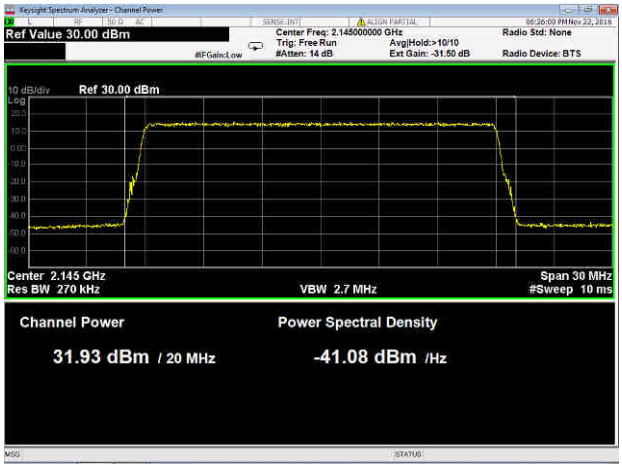
10 MHz Channel, 64 QAM



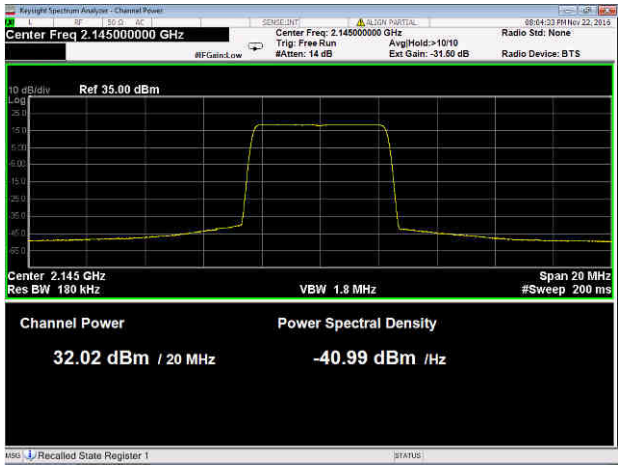
20 MHz Channel, QPSK



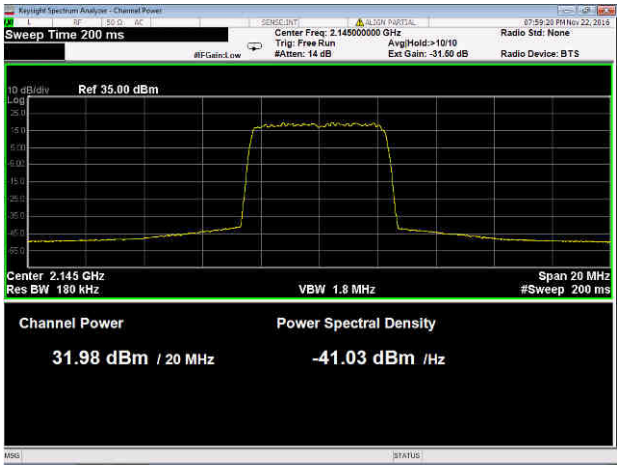
20 MHz Channel, 16 QAM



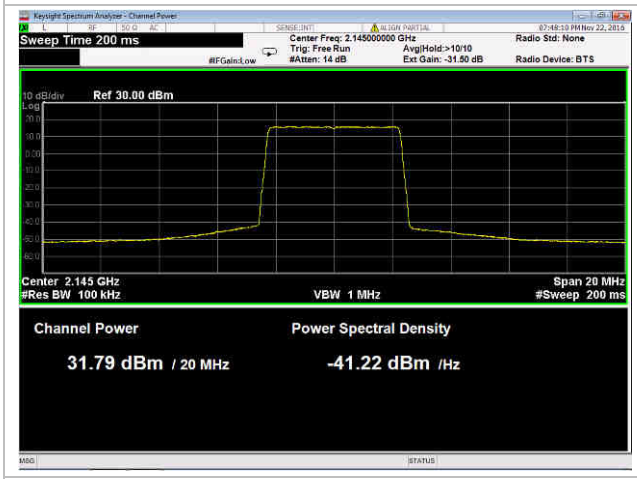
20 MHz Channel, 64 QAM



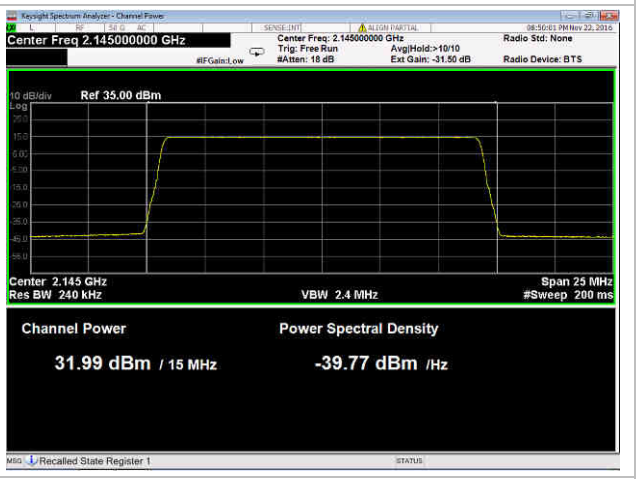
5 MHz Channel, QPSK



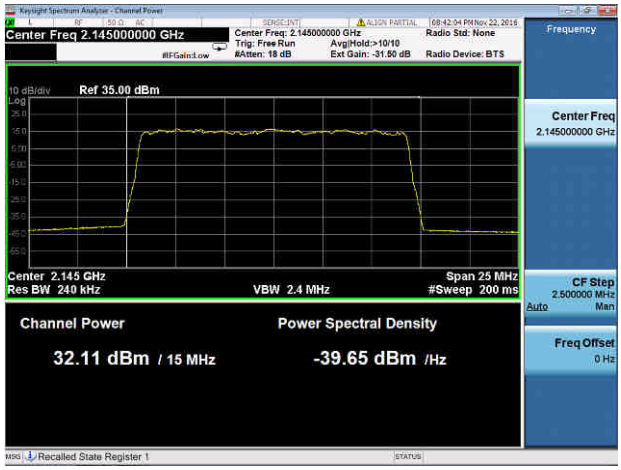
5 MHz Channel, 16 QAM



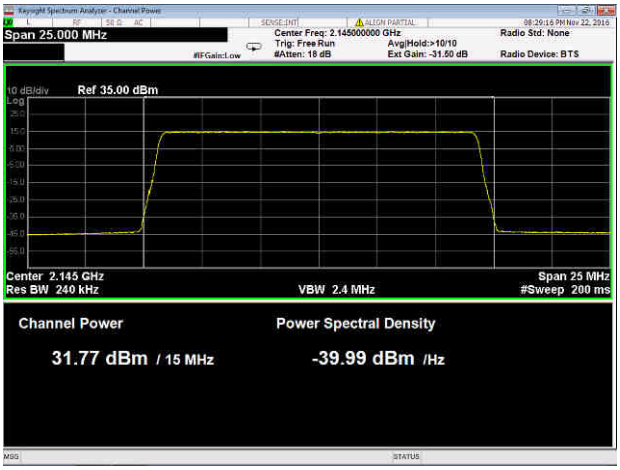
5 MHz Channel, 64 QAM



15 MHz Channel, QPSK



15 MHz Channel, 16 QAM



15 MHz Channel, 64 QAM

Figure 3: Transmit Power plots for centre channel

9 Spectral Power Density

9.1 Requirement and test method

As per section 8.1

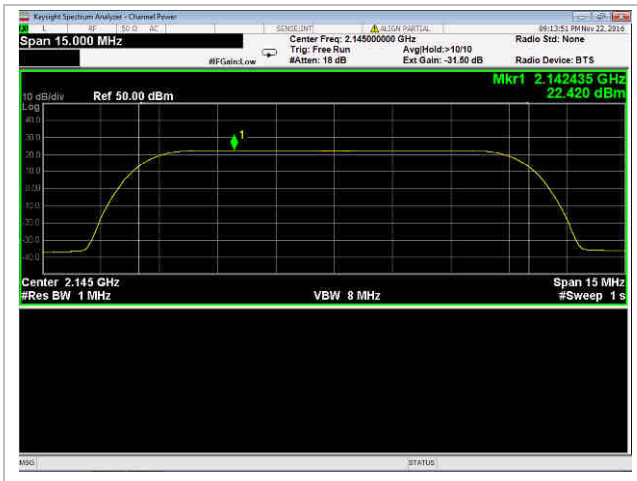
Measured using 1 MHz RBW and peak search

9.2 Test results

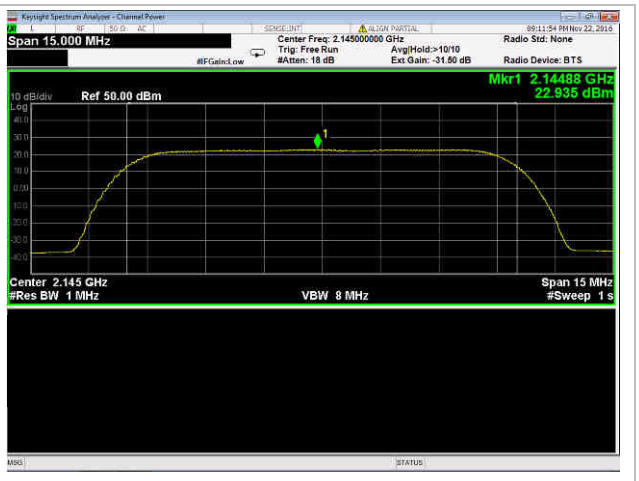
The table below shows values obtained in plots below in figure 4.

Channel Bandwidth	Modulation	TX power density (dBm/ MHz)	Summed TX power density (dBm/MHZ)	TX power density (W/MHz)	Limit (W/M Hz)	Result
5	QPSK	25.8	31.80	1.5	None	Pass
	16 QAM	25.9	31.90	1.5	None	Pass
	64 QAM	25.5	31.50	1.4	None	Pass
10	QPSK	22.4	28.40	0.7	None	Pass
	16 QAM	23.0	29.00	0.8	None	Pass
	64 QAM	22.4	28.40	0.7	None	Pass
15	QPSK	21.0	27.00	0.5	None	Pass
	16 QAM	22.1	28.10	0.6	None	Pass
	64 QAM	20.8	26.80	0.5	None	Pass
20	QPSK	19.6	25.60	0.4	None	Pass
	16 QAM	19.7	25.70	0.4	None	Pass
	64 QAM	19.7	25.70	0.4	None	Pass

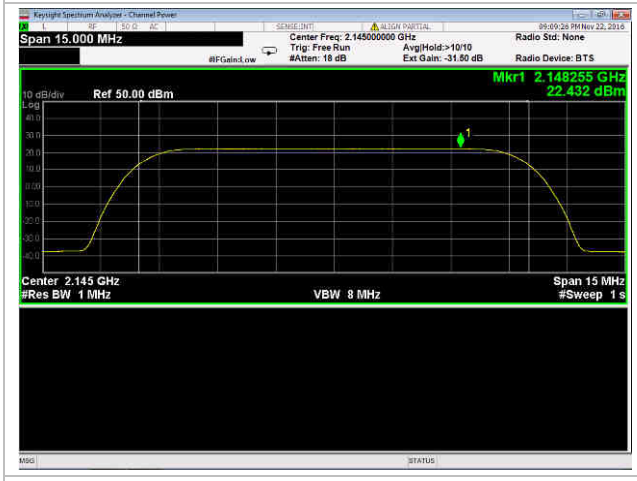
Table 6: Transmit power spectral density



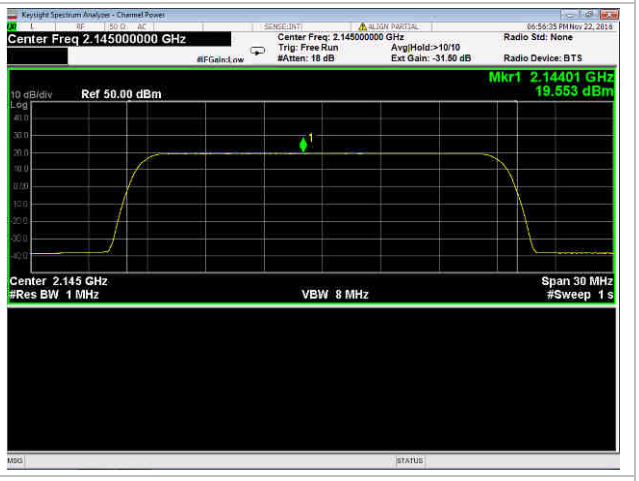
10 MHz Channel, QPSK



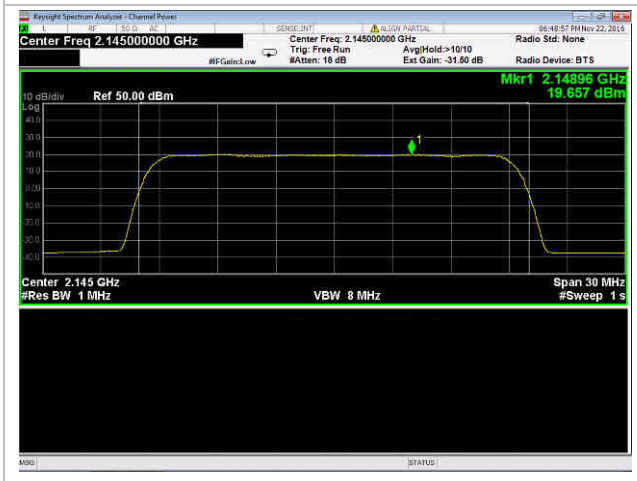
10 MHz Channel, 16 QAM



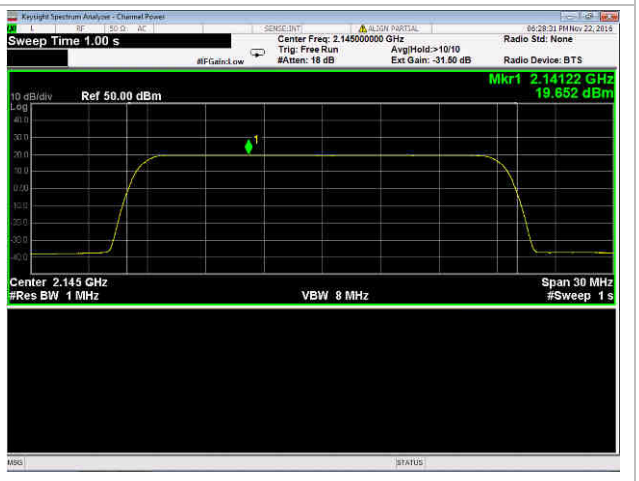
10 MHz Channel, 64 QAM



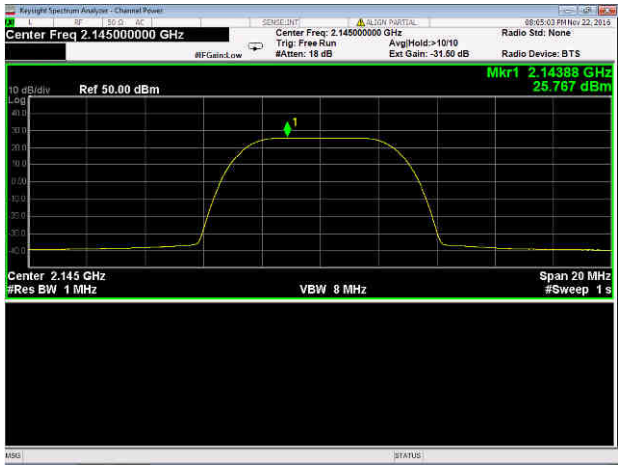
20 MHz Channel, QPSK



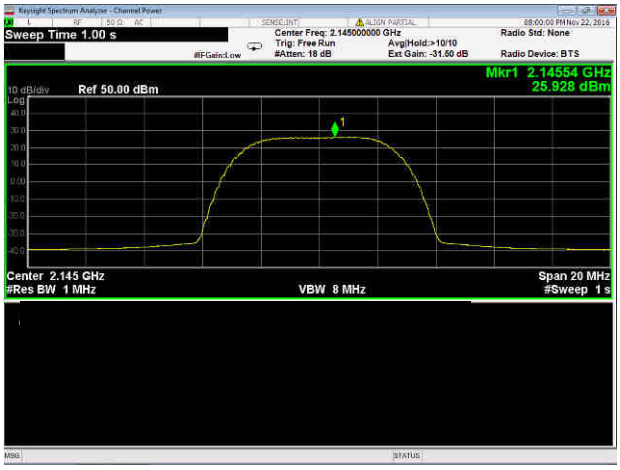
20 MHz Channel, 16 QAM



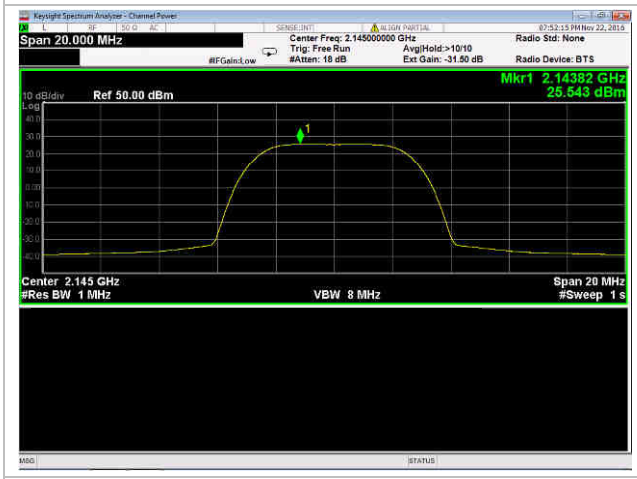
20 MHz Channel, 64 QAM



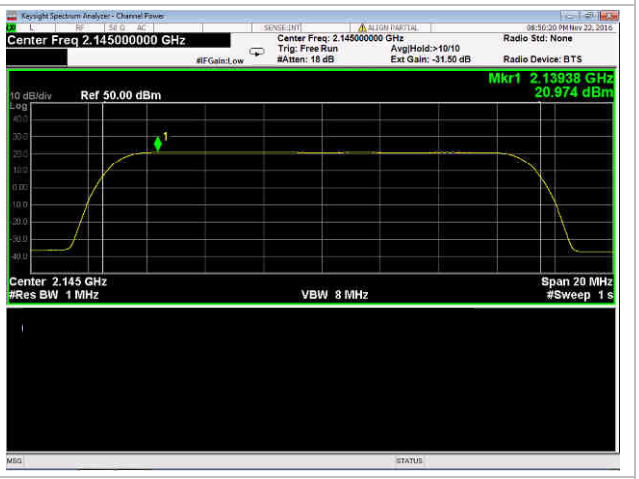
5 MHz Channel, QPSK



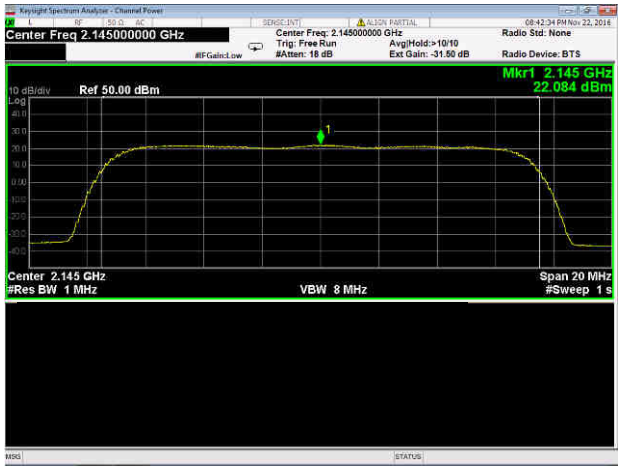
5 MHz Channel, 16 QAM



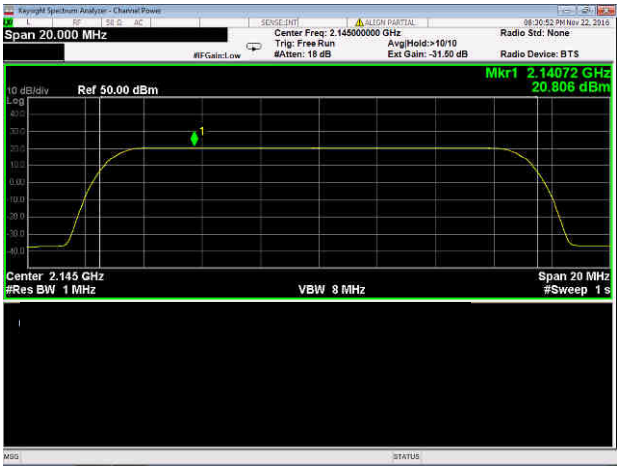
5 MHz Channel, 64 QAM



15 MHz Channel, QPSK



15 MHz Channel, 16 QAM



15 MHz Channel, 64 QAM

Figure 4: Transmit Power Spectral Density plots

10 Occupied Bandwidth

10.1 Requirement and test method

The Occupied Bandwidth is defined in 2.1049 as:

> The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission

The occupied bandwidth was measured using the inbuilt function on the Signal Analyser set to measure the 99% emission bandwidth. Measurement was made using peak detector.

There is no pass/fail criterion so measurement results are reported without reference to a limit for measurements on antenna port 1.

The table below shows worst case results for plots in figure 6.

10.2 Test results: Occupied Bandwidth

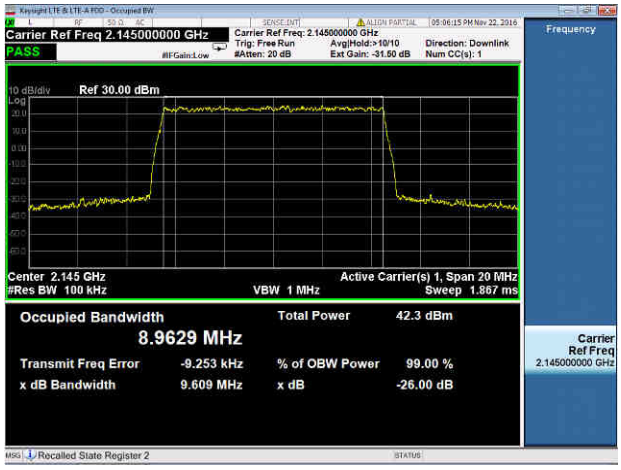
The table below shows results for plots below in figure 5.

Channel Bandwidth	Modulation	99% Occupied Bandwidth (MHz)	Limit (MHz)	Result
5	QPSK	4.496	5.0	Pass
	16 QAM	4.498	5.0	Pass
	64 QAM	4.515	5.0	Pass
10	QPSK	8.954	10.0	Pass
	16 QAM	8.963	10.0	Pass
	64 QAM	8.974	10.0	Pass
15	QPSK	13.470	15.0	Pass
	16 QAM	13.482	15.0	Pass
	64 QAM	13.486	15.0	Pass
20	QPSK	17.908	20.0	Pass
	16 QAM	17.956	20.0	Pass
	64 QAM	17.904	20.0	Pass

Table 7: Occupied Bandwidth test results

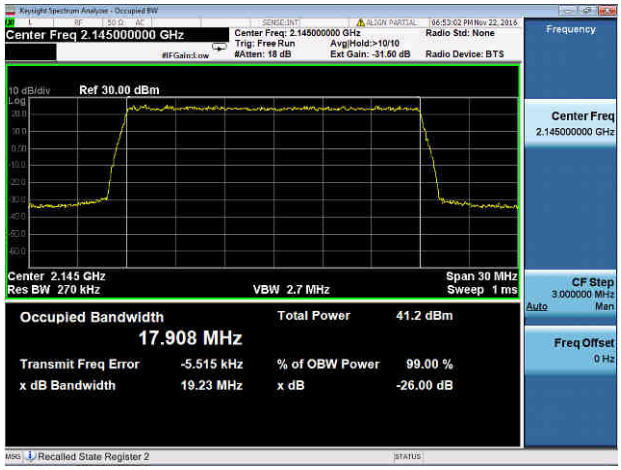
Note: the PXA Signal analyser presents results for both "Occupied Bandwidth", which is the 99% measurement, and "-X dB Bandwidth", which is the -26 dB bandwidth as X is set to 26.

10 MHz Channel, QPSK

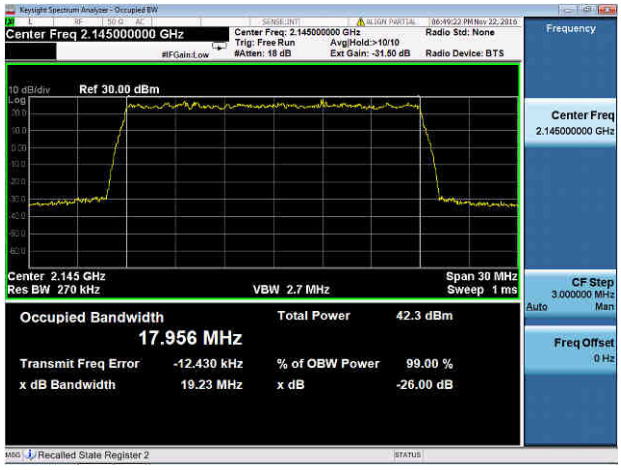


10 MHz Channel, 16 QAM

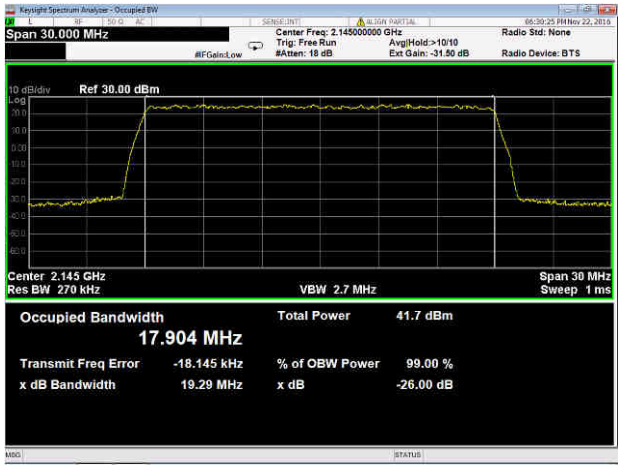
10 MHz Channel, 64 QAM



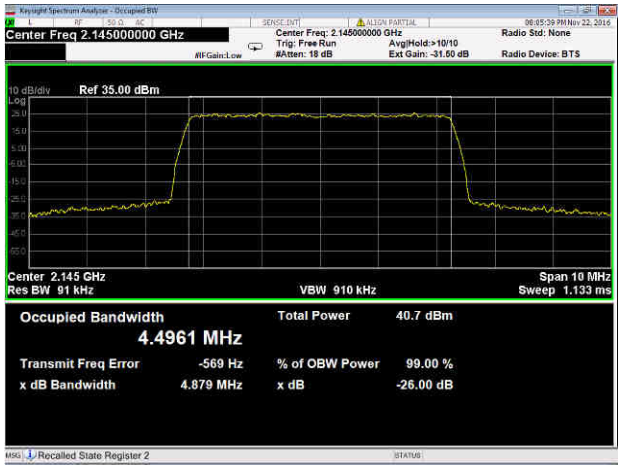
20 MHz Channel, QPSK



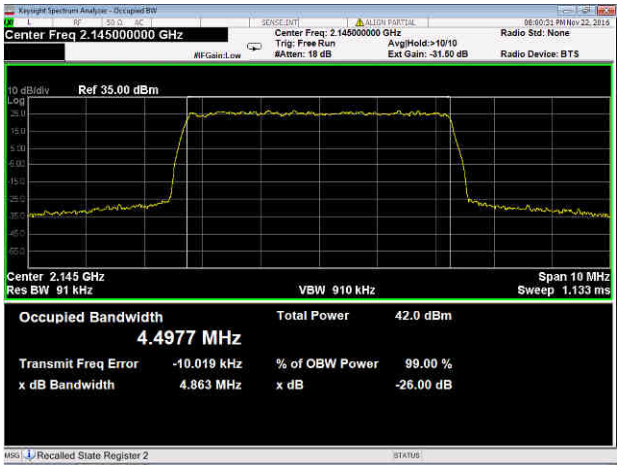
20 MHz Channel, 16 QAM



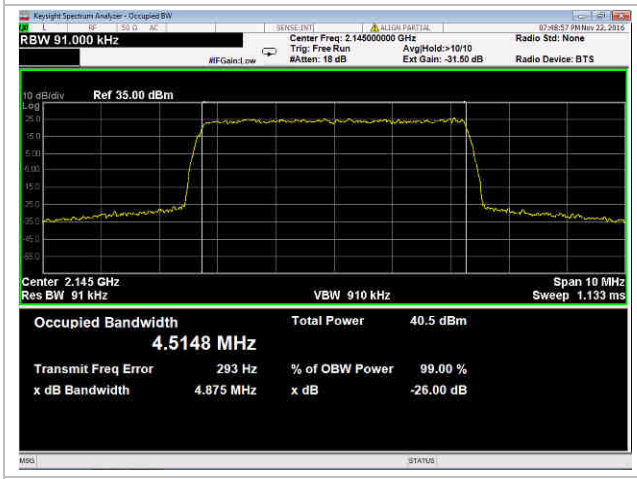
20 MHz Channel, 64 QAM



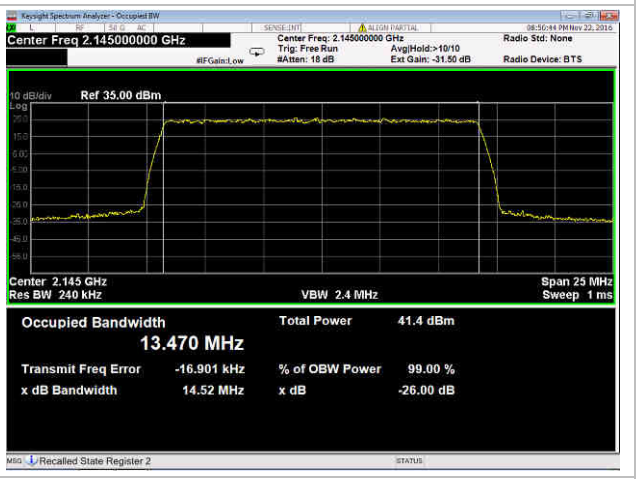
5 MHz Channel, QPSK



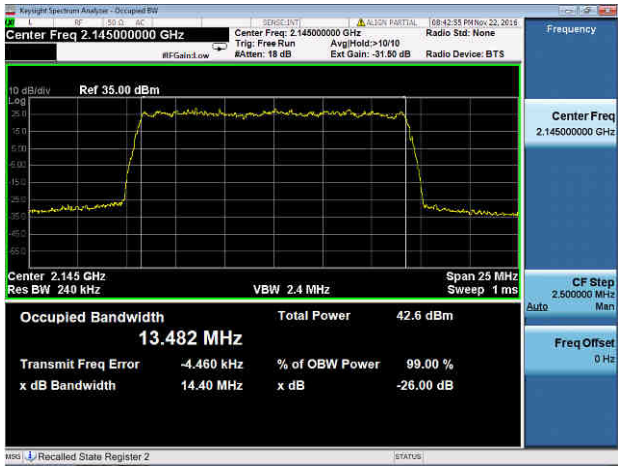
5 MHz Channel, 16 QAM



5 MHz Channel, 64 QAM



15 MHz Channel, QPSK



15 MHz Channel, 16 QAM

15 MHz Channel, 64 QAM

Figure 5: Occupied Bandwidth plots

11 Conducted Spurious Emissions inc. Band Edge

11.1 Requirement and test method

27.53(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

(3) *Measurement procedure.* (i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power

The licensed band of operation was considered to be a single 5MHz channel for 5MHz operation, a single 10MHz channel for 10MHz operation, etc.

Band edge emissions were performed on bottom and top channels using RBW ≥ 1% EBW and Adjacent Channel Power Function for emissions 1-3 MHz from bandedge.

Emissions were measured using RMS detector and trace averaging.

CSE scans were performed on middle channel and -19dBm limit line was placed on the graph. Determination of total spurious emission was done by adding 10 log (4), or 6.0 dB to the emission level measured on port Ant1 and this was compares with limit of -13dBm as per KDB 662911 section 3(a)(iii).

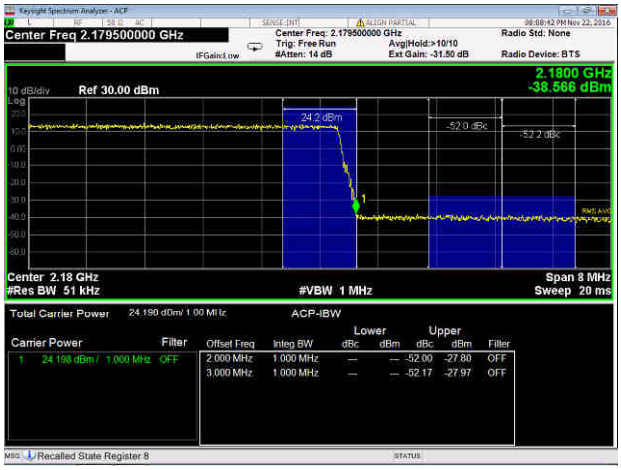
11.2 Bandedge Results

The table below lists the worst case values for plots shown below in figures 6 - 9.

Channel Bandwidth	Modulation	Band-edge (dBm)	Summed Band-edge (dBm)	Limit (dBm)	Result
5	QPSK	-27.8	-21.80	-13.0	Pass
	16 QAM	-33.5	-27.50	-13.0	Pass
	64 QAM	-32.8	-26.80	-13.0	Pass
10	QPSK	-36.7	-30.70	-13.0	Pass
	16 QAM	-34.1	-28.10	-13.0	Pass
	64 QAM	-35.8	-29.80	-13.0	Pass
15	QPSK	-38.4	-32.40	-13.0	Pass
	16 QAM	-38.1	-32.10	-13.0	Pass
	64 QAM	-38.7	-32.70	-13.0	Pass
20	QPSK	-38.9	-32.90	-13.0	Pass
	16 QAM	-39.3	-33.30	-13.0	Pass
	64 QAM	-38.3	-32.30	-13.0	Pass

Table 8: Band edge emissions

5 MHz Channel, QPSK, Low



5 MHz Channel, QPSK, high

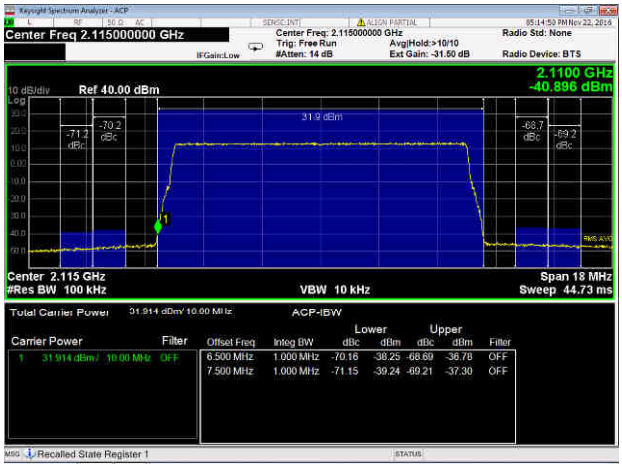
5 MHz Channel, 16 QAM, low

5 MHz Channel, 16 QAM, high

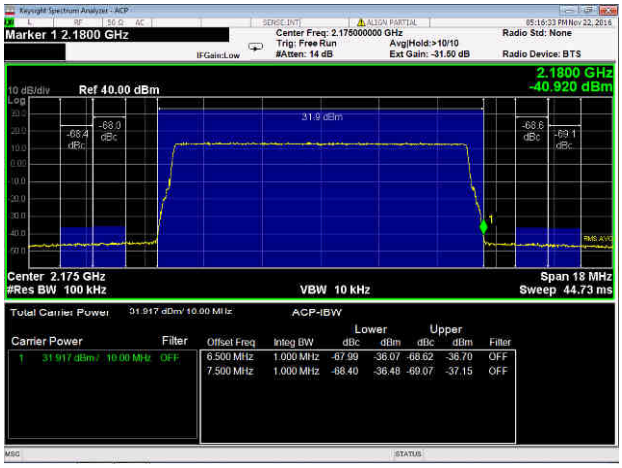
5 MHz Channel, 64 QAM, low

5 MHz Channel, 64 QAM, high

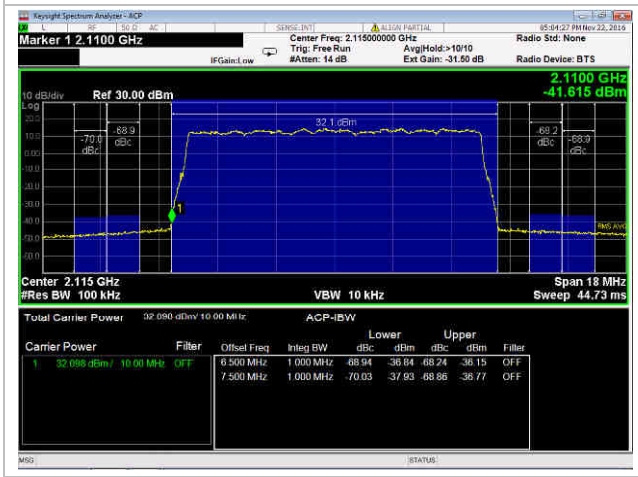
Figure 6: Band-edge emissions for 5 MHz channels



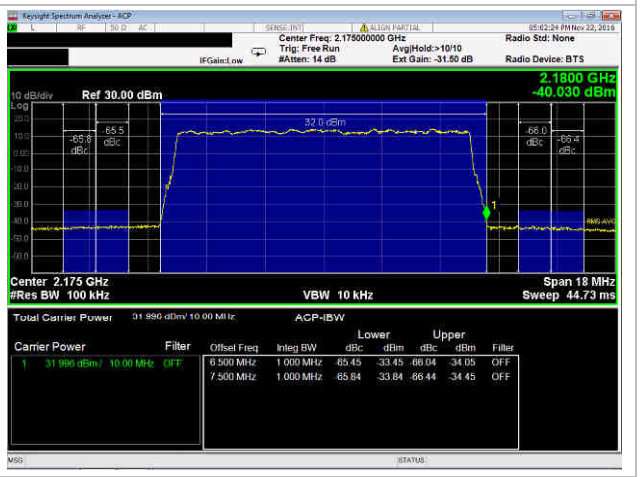
10 MHz Channel, QPSK, Low



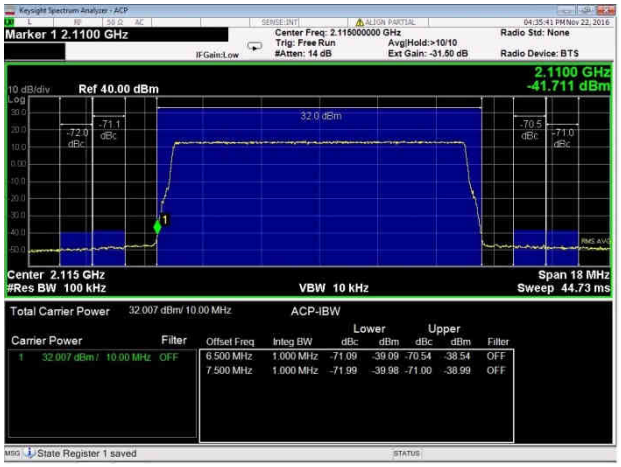
10 MHz Channel, QPSK, high



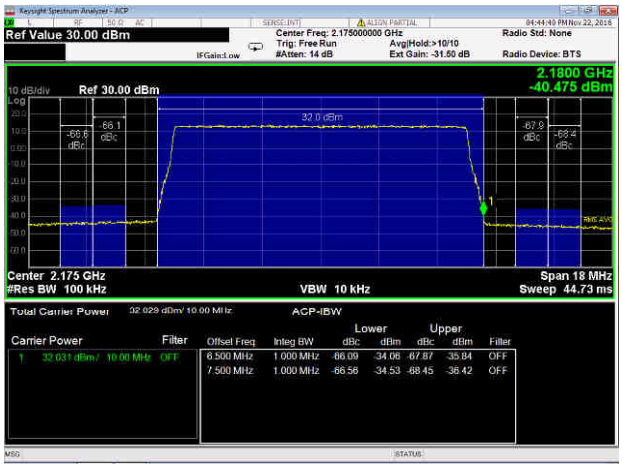
10 MHz Channel, 16 QAM, low



10 MHz Channel, 16 QAM, high

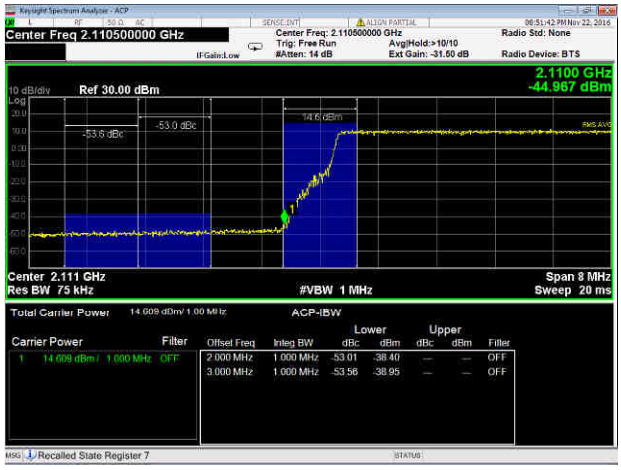


10 MHz Channel, 64 QAM, low



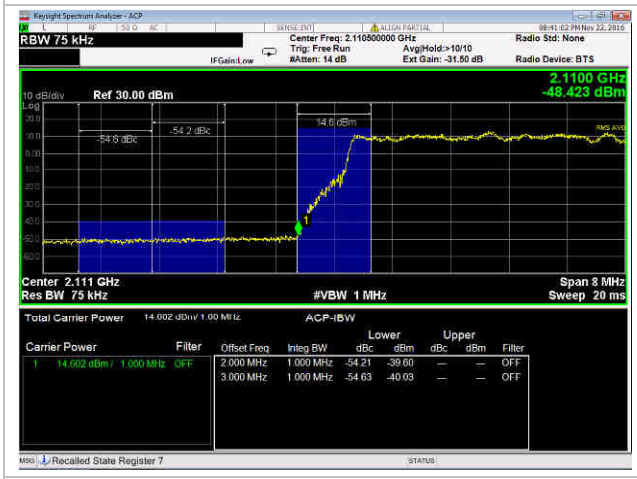
10 MHz Channel, 64 QAM, high

Figure 7: Band-edge emissions for 10 MHz channels



15 MHz Channel, QPSK, Low

15 MHz Channel, QPSK, high



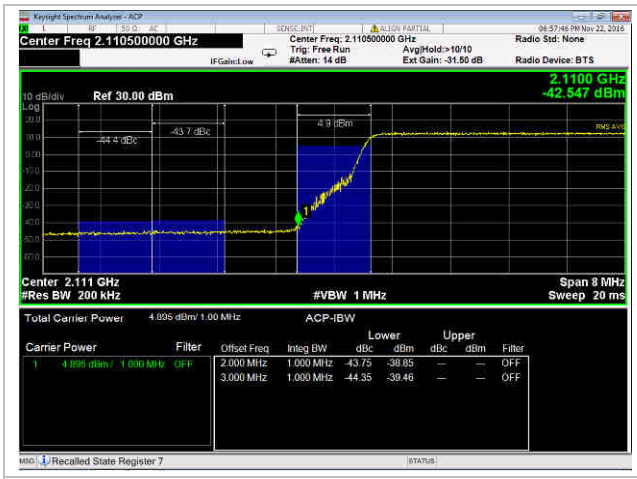
15 MHz Channel, 16 QAM, low

15 MHz Channel, 16 QAM, high

15 MHz Channel, 64 QAM, low

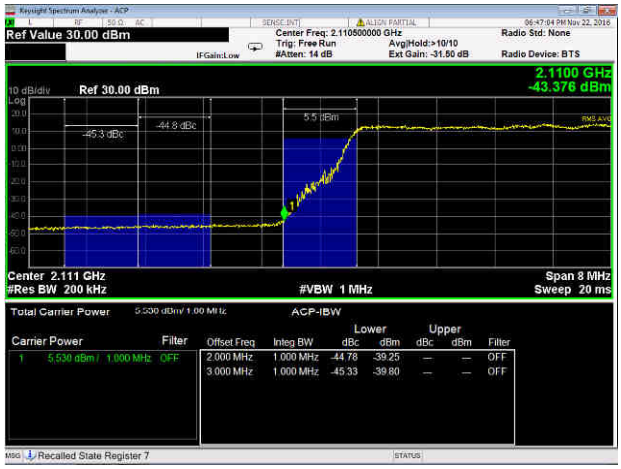
15 MHz Channel, 64 QAM, high

Figure 8: Band-edge emissions for 15 MHz channels



20 MHz Channel, QPSK, Low

20 MHz Channel, QPSK, high



20 MHz Channel, 16 QAM, low

20 MHz Channel, 16 QAM, high

20 MHz Channel, 64 QAM, low

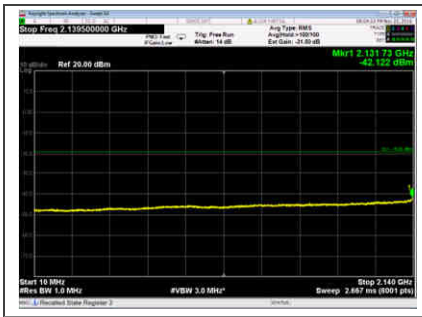
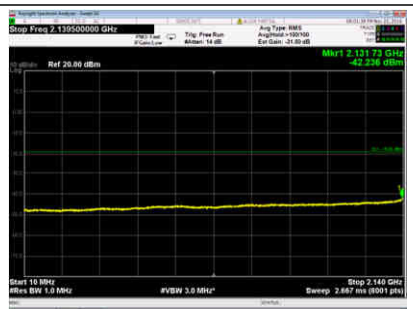
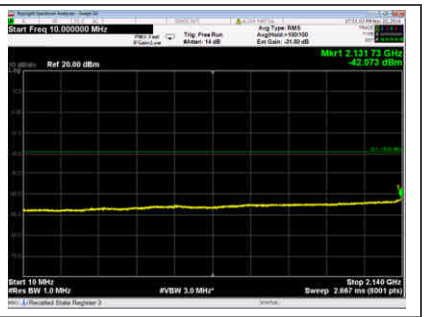
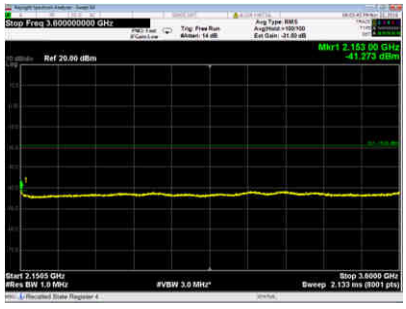
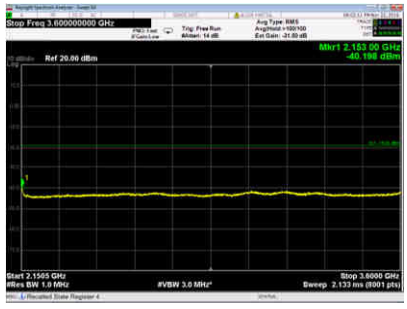
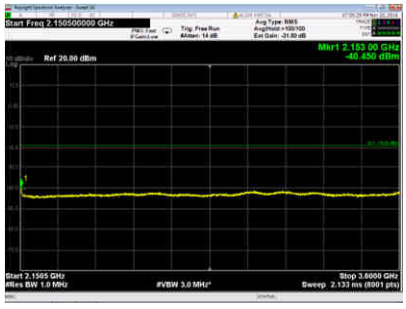
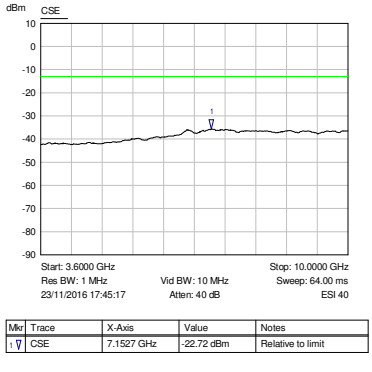
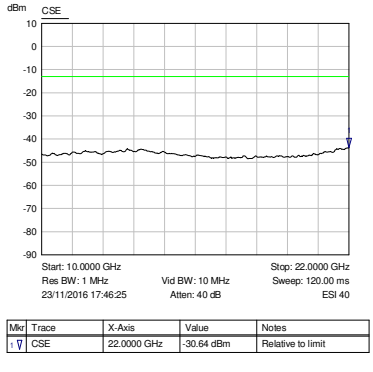
20 MHz Channel, 64 QAM, high

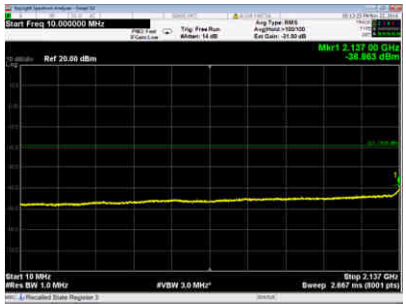
Figure 9: Band-edge emissions for 20 MHz channels

11.3 Conducted Spurious Emissions Results

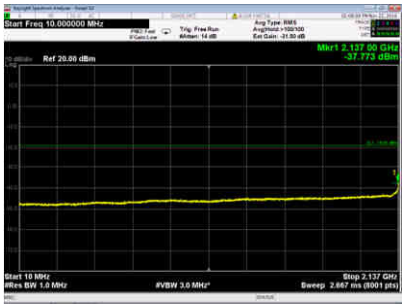
The plots below show:

- CSE results for all modes 10 MHz to 3600 MHz:
  - All emissions were at least 18 dB below the display line at -19dBm per antenna port
  - The worst case emission of -37.1 dBm equates to a total 4-port spurious emission of -31.1 dBm which is 18.1 dB below the limit of -13 dBm.
- CSE results for worst case modes 3600 MHz to 22000 MHz:
  - All emissions were > 20 dB below the limit

		
5 MHz QPSK	5 MHz 16 QAM	5 MHz 64QAM
		
5 MHz QPSK	5 MHz 16 QAM	5 MHz 64QAM
 Mkr | Trace | X-Axis | Value | Notes 1 | CSE | 7.1527 GHz | -22.72 dBm | Relative to limit	 Mkr | Trace | X-Axis | Value | Notes 1 | CSE | 22.0000 GHz | -30.64 dBm | Relative to limit	
5 MHz QPSK	5 MHz QPSK	

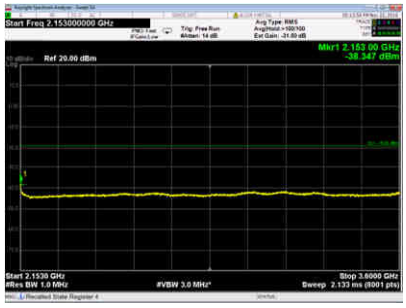


10 MHz QPSK

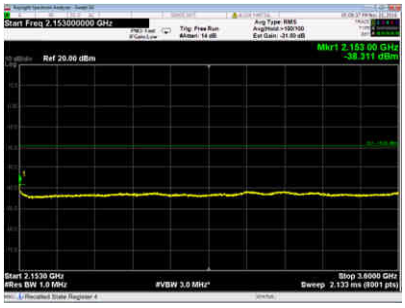


10 MHz 16 QAM

10 MHz 64QAM

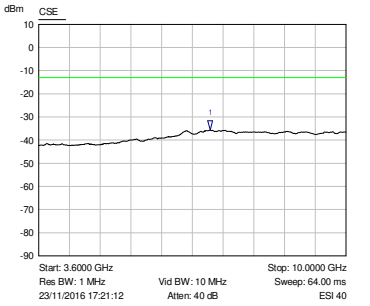


10 MHz QPSK



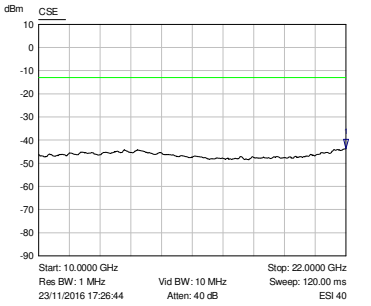
10 MHz 16 QAM

10 MHz 64QAM



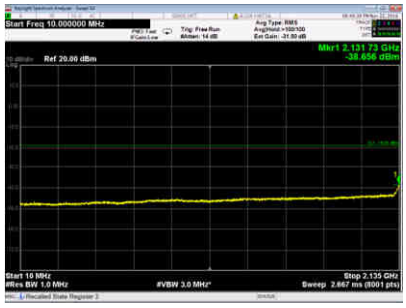
Mkr	Trace	X-Axis	Value	Notes
1	CSE	7.1655 GHz	-22.69 dBm	Relative to limit

10 MHz QPSK

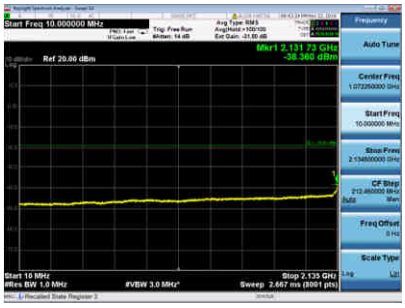


Mkr	Trace	X-Axis	Value	Notes
1	CSE	22.0000 GHz	-30.69 dBm	Relative to limit

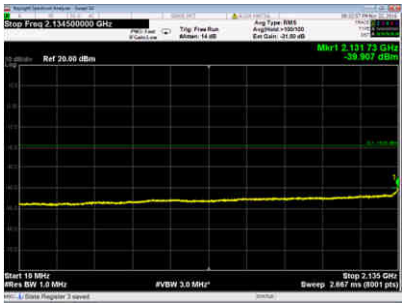
10 MHz QPSK



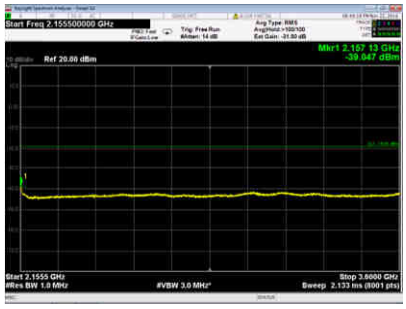
15 MHz QPSK

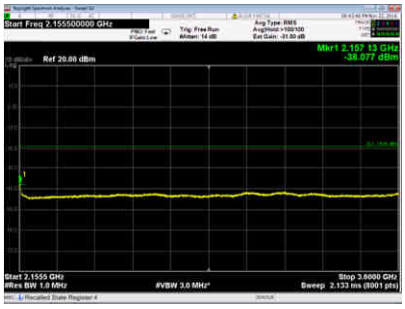


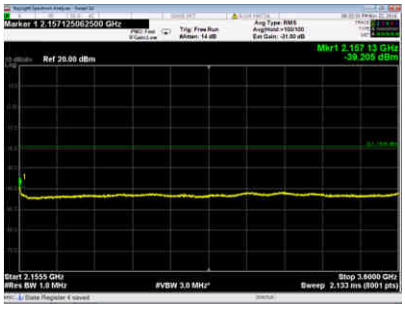
15 MHz 16 QAM



15 MHz 64QAM







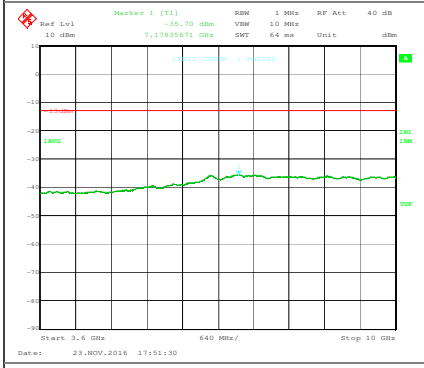
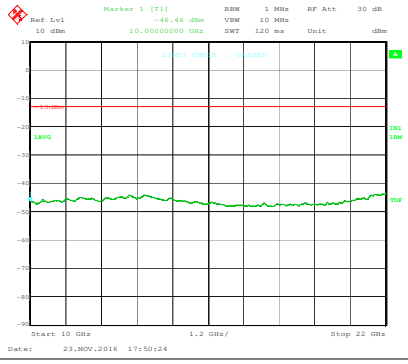
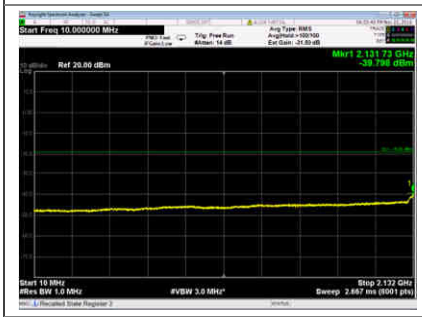
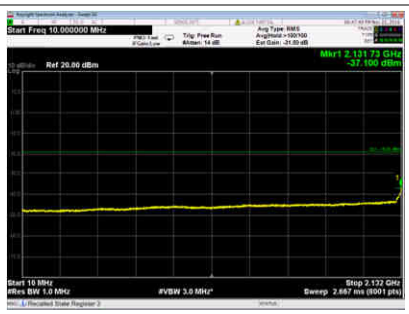
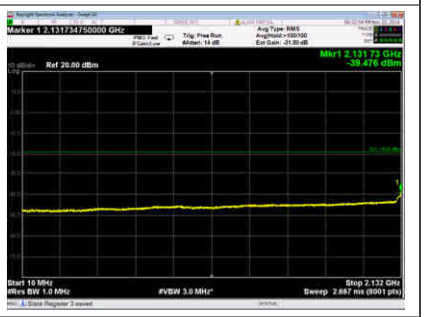
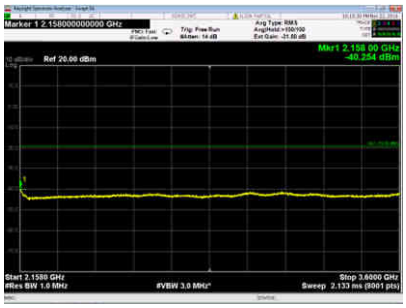
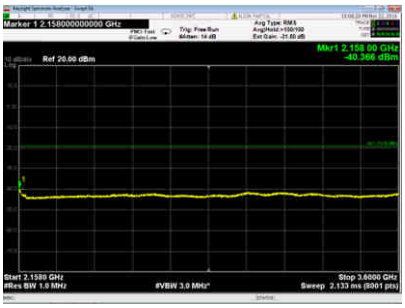
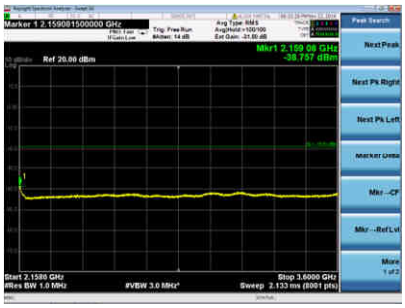
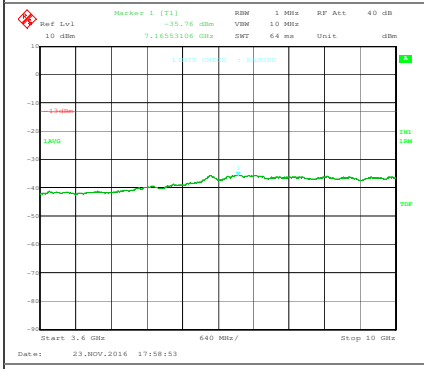
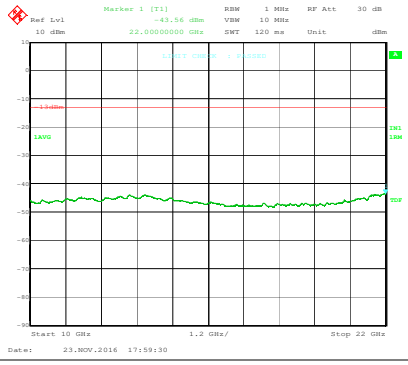
15 MHz QPSK	15 MHz 16 QAM	15 MHz 64QAM
		
15 MHz QPSK	15 MHz QPSK	
		
20 MHz QPSK	20 MHz 16 QAM	20 MHz 64QAM
		
20 MHz QPSK	20 MHz 16 QAM	20 MHz 64 QAM
		
20 MHz QPSK	20 MHz QPSK	

Figure 10: Conducted Spurious Emissions plots

12 Radiated Spurious Emissions

12.1 Requirement and test method

> 27.53(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

Attenuation of 43+10log(P) dBm equates to an absolute limit of -13dBm.

All measurements below 18 GHz were performed at 3m distance

Emissions above 18 GHz were measured at 1m and checked by sniffing over the whole device with device hand-held at approximately 30 cm.

Pre-scan measurements were performed with a spectrum analyser, using a peak detector with 100 kHz RBW for frequencies below 1 GHz and 1 MHz for frequencies above 1 GHz.

The cabinet radiation was performed while antenna ports were terminated with 50Ω load.

Initial pre-scan measurements were performed with limit determined by

$E = EIRP - 20\log D + 104.8$

Where pre-scans showed emissions within 20dB of the limit, final measurement was made using substitution method.

12.2 Results

Initial pre-scans were performed using peak detector.

No emissions were found within 20dB of the limit.

Worst case plots for 10 MHz channels are included below in figure 14 for information.

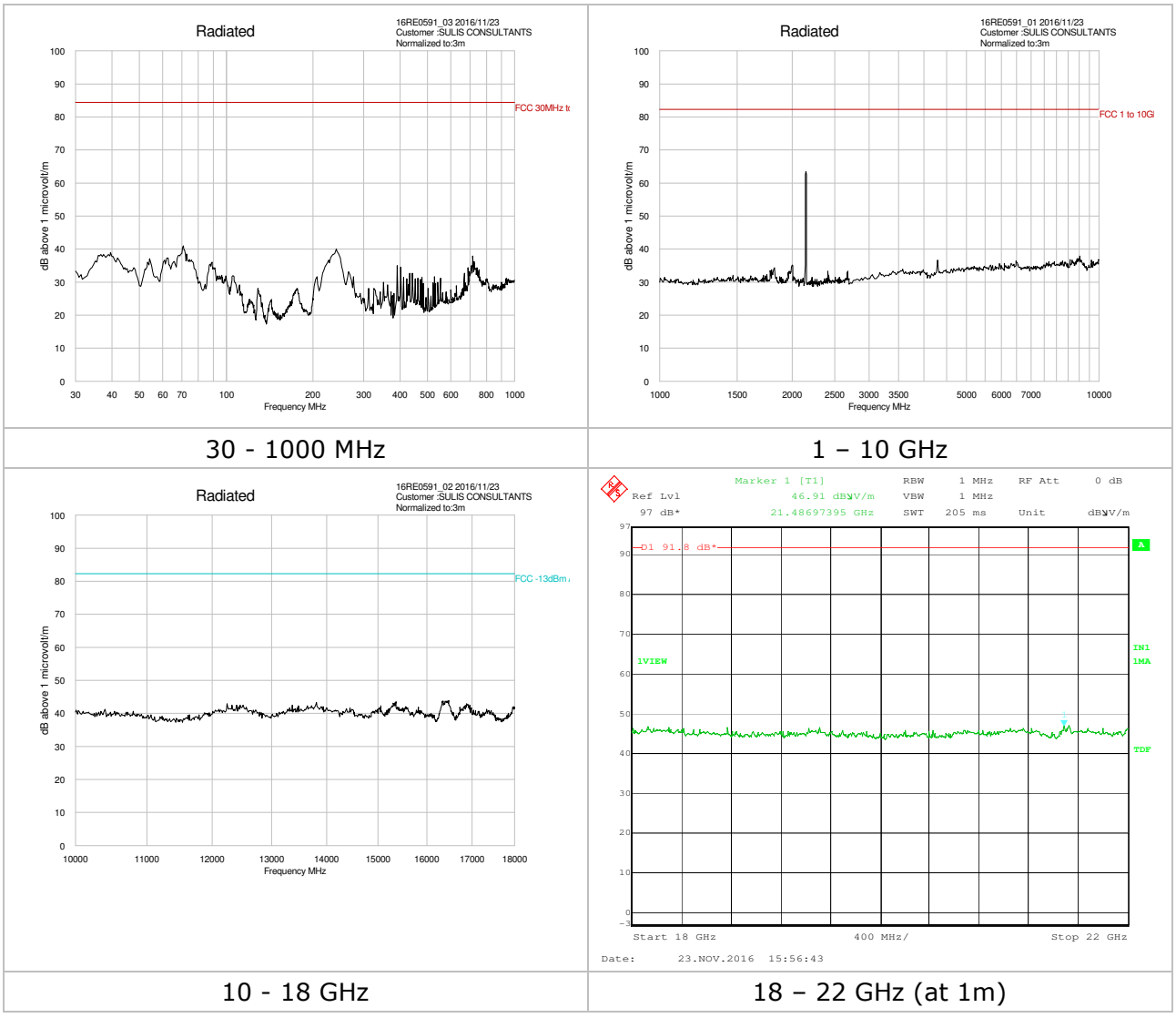


Figure 11: RSE pre-scans, 10 MHz channel

13 Test equipment

Description	Manufacturer	Name	Serial Number	Calibration certificate
Testing at Altiostar				
PXA Signal Analyser	Agilent	N9030A	MY541702228	4105006-4886110-1
Network Analyser	HP	8719D	US38110410	Electroservices T385943C
Attenuator	Fairview Microwave	SA18N25WA-30	None	Calibrated before test using Network Analyser
RF cable	Times Microwave	SLU18-SMNM-01.75m	3716	
Testing at Hursley				
Pre-amplifier (30-1000MHz)	HP	8447D	1937A02341	14/09/2017
Pre-amp, 1-18GHz 55dB	HEMCS	PA XVIII	001	internal
1-10GHz Horn	Schwarzbeck	BBHA 9120 571	571	24/02/2019
Horn antenna (2-18GHz)	Q-par Angus	WBH218HN	5367	22/06/2019
18 to 40GHz Horn	Q-par Angus	WBH18-40k	10300	23/01/2019
40GHz receiver	Rohde & Schwarz	ESIB 40 no.2	100262	11/03/2017
7GHz Receiver	Rohde & Schwarz	ESCI7	1166595007	20/05/2017
Spectrum analyser (9kHz-26.5GHz)	HP	8593EM	3536A00137	17/12/2016
Pink 30M-2G Antenna	CHASE	CBL 6141	4013	01/10/2018

Table 9: Test Equipment