Report on the Radio Testing

For

Cambium Networks Ltd

on

PMP 450m

Report no. TRA-029590-47-22B

14th December 2017

Report Number: TRA-029590-47-22B
Issue: B

REPORT ON THE RADIO TESTING OF A
Cambium Networks Ltd
PMP 450m
WITH RESPECT TO SPECIFICATION
FCC 47CFR Subpart E

TEST DATE: May - July 2017

Written by: D Winstanley

D Winstanley
Radio Senior Test Engineer

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Date: 2017.12.18 16:29:33 Z

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Date: 14th December 2017

Disclaimers:

[1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	26th October 2017	Original
B	14th December 2017	Amendments

2 Summary

TEST REPORT NUMBER:	TRA-029590-47-22B
WORKS ORDER NUMBER	TRA-029590-22
PURPOSE OF TEST:	Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION:	47CFR15 Subpart E
EQUIPMENT UNDER TEST (EUT):	PMP 450m
FCC IDENTIFIER:	QWP-50450M
MANUFACTURER/AGENT:	Cambium Networks Ltd
ADDRESS:	Unit B2 Linhay Business Park Eastern Road Ashburton Devon TQ13 7UP United Kingdom
CLIENT CONTACT:	Don Reid ☎ 01364 655667 ✉ don.reid@cambiumnetworks.com
TEST DATE:	May - July 2017
TESTED BY:	A Tosif, D Winstanley Element

2.1 Test Summary

Test Method and Description		Requirement Clause 47CFR15	Applicable to this equipment	Result / Note
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.205	☒	*Pass*
AC power line conducted emissions		15.207	☒	*Pass*
Occupied bandwidth		15.407(e)	☒	*Pass*
Output power	EIRP	15.407(a)	☒	*Pass*
	PSD		☒	
	RPE		☒	
Conducted / radiated RF power out-of-band		15.407(b)	☒	*Pass*
Duty cycle		15.35(c)	☐	*Note 1*
TPC and DFS		15.407(h)	☐	*Note 1*
U-NII detection bandwidth		15.407(h)(2)	☐	*Note 1*
CAC		15.407(h)(2)(ii)	☐	*Note 1*
In-service monitoring		15.407(h)(2)(iii) & 15.407(h)(2)(iv)	☐	*Note 1*
Statistical performance check		-	☐	*Note 1*

Notes:

Note 1 This report covers RF operation only in the 5150 MHz – 5250 MHz band and 5250 MHz – 5350 MHz, For DFS parameters see test report TRA-029590-21-45-00A.

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set-up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

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4 Introduction

This report TRA-029590-47-22B presents the results of the Radio testing on a Cambium Networks Ltd, PMP 450m to specification 47CFR15 Radio Frequency Devices

The testing was carried out for Cambium Networks Ltd by Element, at the address(es) detailed below.

☐ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☒ Element Skelmersdale
Unit 1
Pendle Place
Skelmersdale
West Lancashire
WN8 9PN
UK

☒ 30 Meter Open Area Test Site
Pershore Airfield,
Long Lane,
Throckmorton,
Worcs,
WR10 2JH
UK

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

FCC Site Listing:
The test laboratory is accredited for the above sites under the US-EU MRA, Designation number UK0009.

ISED Registration Number(s):

Element Skelmersdale	3930B
Element Hull	3483A

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.
The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- FCC KDB Publication 905462 D02 v01r02 – Compliance measurement procedures for unlicensed-national information infrastructure devices operating in the 5250-5350 MHz and 5150-5725 MHz bands incorporating dynamic frequency selection.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- KDB 789033 D02 General UNII Test Procedures
- KDB 662911 D01 Multiple Transmitter Output

5.2 Deviations from Test Standards

Maximum conducted output power

Due to the nature of the equipment it is not possible to measure the power conducted so a radiated measurement was performed. This measurement was performed at 30m to ensure the measurement was made in the antenna far field.

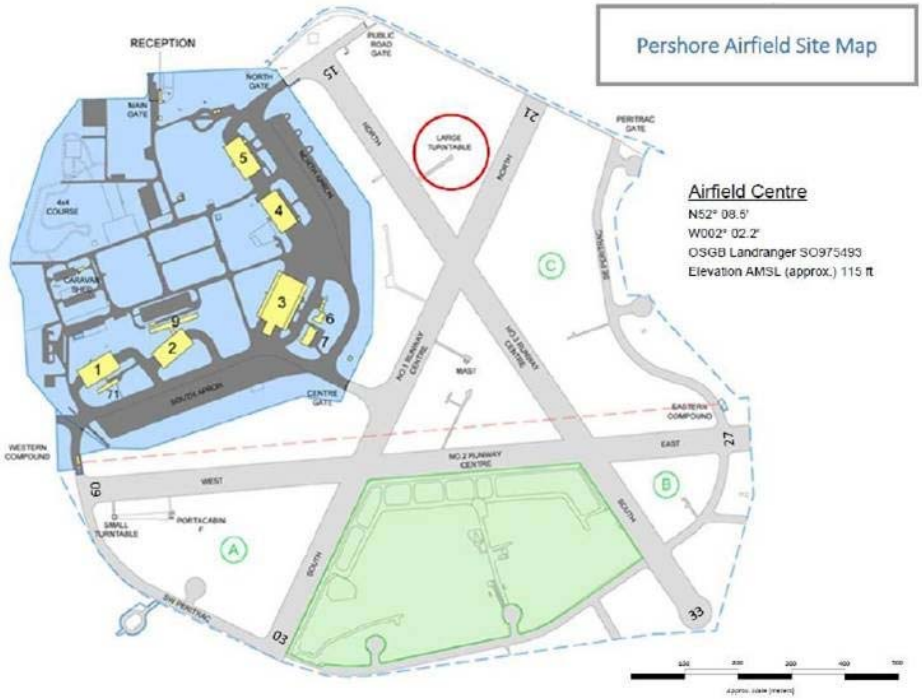
Spectral Power Density

Due to the nature of the equipment it is not possible to measure the power conducted so a radiated measurement was performed. This measurement was performed at 30m to ensure the measurement was made in the antenna far field.

5.3 Minimisation of reflections

Due to the use of a 30 meter open area test site with no RF absorbing material for the measurement of the fundamental attempts were made to minimise the influence of reflections.
To minimise the reflections the following precautions were taken.
Test performed over a grassed area to try and ensure no sub surface artefacts produce reflections.
The EUT was raised to a height of 4 meters above the ground plane to help reduce the effects of any reflected paths at 30 meters
The EUTs antennas are set with a 2 degree down tilt, and an 8 degree beam width, to negate this down tilt the EUT was rotated 180 degrees though the vertical plane (i.e. turned upside down to normal operation) and the EUT was angled so the bore sight was parallel to the grassed area.
Due to the increased height of the EUT the measurement antenna was varied between 1 and 6 meters to encompass the height of the EUT and its potential bandwidth

5.4 Open area test site information



6 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CAC	Channel Availability Check
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DFS	Dynamic Frequency Selection
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada (now ISED)
ISED	Innovation, Science and Economic Development Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
LE-LAN	Licence-Exempt Local Area Network
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
MU-MIMO	Multiuser Multiple Input and Multiple Output
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
PSD	Power Spectral Density
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
TPC	Transmitter Power Control
Tx	transmitter
UKAS	United Kingdom Accreditation Service
U-NII	Unlicensed-National Information Infrastructure
V	volt
W	watt
Ω	ohm

7 Equipment Under Test

7.1 EUT Identification

- Name: PMP 450m
- MAC Address: 0a-00-3e-60-31-83
- Model Number: C050045A102A
- Software Revision: CANOPY 15.1.3 (W) 08/24/2017 14:44 AP-None
- Build Level / Revision Number: P5

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

- Name: Cambium Networks Power Injector AC + DC
- Serial Number: 1644035834
- Model Number: E100109C G
- Build Level / Revision Number: 00

- Name: Netgear 5 port 10/100/1000M switch
- Serial Number: 2N211B3D00F3C
- Model Number: GS605 v4

- Name: Dell Latitude Laptop PC
- Serial Number:
- Model Number: E6440

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Tx tests was as follows…

EUT is set to permanently transmit on the required frequency, modulation type, operational mode and MIMO mode

Operating Frequencies
Operating frequencies tested 5170.0 MHz / 5186.5 MHz / 5200.0 MHz / 5230.0 MHz / 5270.0 MHz / 5300.0 MHz / 5325.0 MHz / 5330.0 MHz

Operating modes
There are three unique operating modes. These only affect the antenna radiation pattern.

Sector Mode
This mode produces a broad antenna radiation beam.

Beamforming Mode
This produces a narrow, focused antenna beam.

MU-MIMO mode
This produces several narrow, focused antenna beams.

Modulation Modes
Supported modulation modes are QPSK, 16QAM, 64QAM and 256QAM. Each of these four modulation mode can be configured to be MIMO A or MIMO B. The differences between these MIMO modes are described below.

MIMO A
The data streams transmitted in both horizontal and vertical antenna polarisations are identical.

MIMO B
The data streams transmitted in the horizontal and vertical polarisations are independent.

Test modes are selected through a manufactures test GUI; cambium networks regulatory RF control V4.3

Software GUI Power Setting for EIRP / PSD Recorded Levels			
Test Frequency (MHz)	EUT Operating Mode		
	SECTOR	BEAMFORMING	MU-MIMO
U-NII BAND 1			
5170	36.0	38.2	38.2
5186.5	38.2	39.5	39.5
5200	37.5	37.0	37.0
5230	39.0	39.0	39.0
U-NII BAND 2A			
5270	32.7	32.7	33.3
5300	32.0	32.0	32.0
5330	32.0	32.0	33.0

Software GUI Power Setting for spurious and out of band formal measurements		
Test Frequency (MHz)	EUT Operating Mode	
	SECTOR	BEAMFORMING / MU-MIMO
U-NII BAND 1		
5170	30.0	29.0
5186.5	33.0	33.0
5200.0	37.0	37.0
U-NII BAND 2A		
5325	32.0	32.0
5300	30.5	30.0

7.4 EUT Radio Frequency Parameters

7.4.1 General

Frequency Band of operation:	5170 – 5330 MHz
Highest/Lowest Centre Frequencies:	5152.5 – 5347.5 MHz
Modulation type(s):	QPSK, 16QAM, 64QAM, 256QAM
Modulation Mode(s):	MIMO A, MIMO B
Occupied channel bandwidth(s):	40 MHz
Channel spacing:	2.5 MHz increments
Declared output power(s):	+30 dBm eirp +36 dBm eirp
Warning against use of alternative antennas in user manual (yes/no):	Not applicable
Nominal Supply Voltage:	-48 Vdc (POE)
Location of notice for license exempt use:	Label / user manual / both.
Method of prevention of use on non-US frequencies:	Digitally signed software / licence key

7.4.2 Antennas

Type:	Integrated dual polarised seven-element adaptive array smart antenna
Frequency range:	5150 MHz – 5925 MHz
Impedance:	Not Applicable
SWR:	Not Applicable
Gain:	15 dBi
Polarisation:	Dual polarised
Beam width:	8° in Elevation 90° in azimuth
Connector type:	Integral
Length:	Not applicable
Weight:	14.2 Kg (fully assembled unit)
Environmental limits:	-40°C to +60°C
Mounting:	Pole mount

7.4.3 Product specific declarations

Multiple antenna configuration(s), e.g. MIMO:	MIMO, Beamforming, Sector
Fixed pt-pt operations (yes/no):	Yes
Software security description:	See PMP-10088.PDF
TDWR interference information in user's manual (yes/no):	Yes

7.5 EUT Description

The EUT is a point to multipoint access point with a seven-element dual-polarised adaptive array smart antenna and multi-user MIMO (MU-MIMO) capabilities

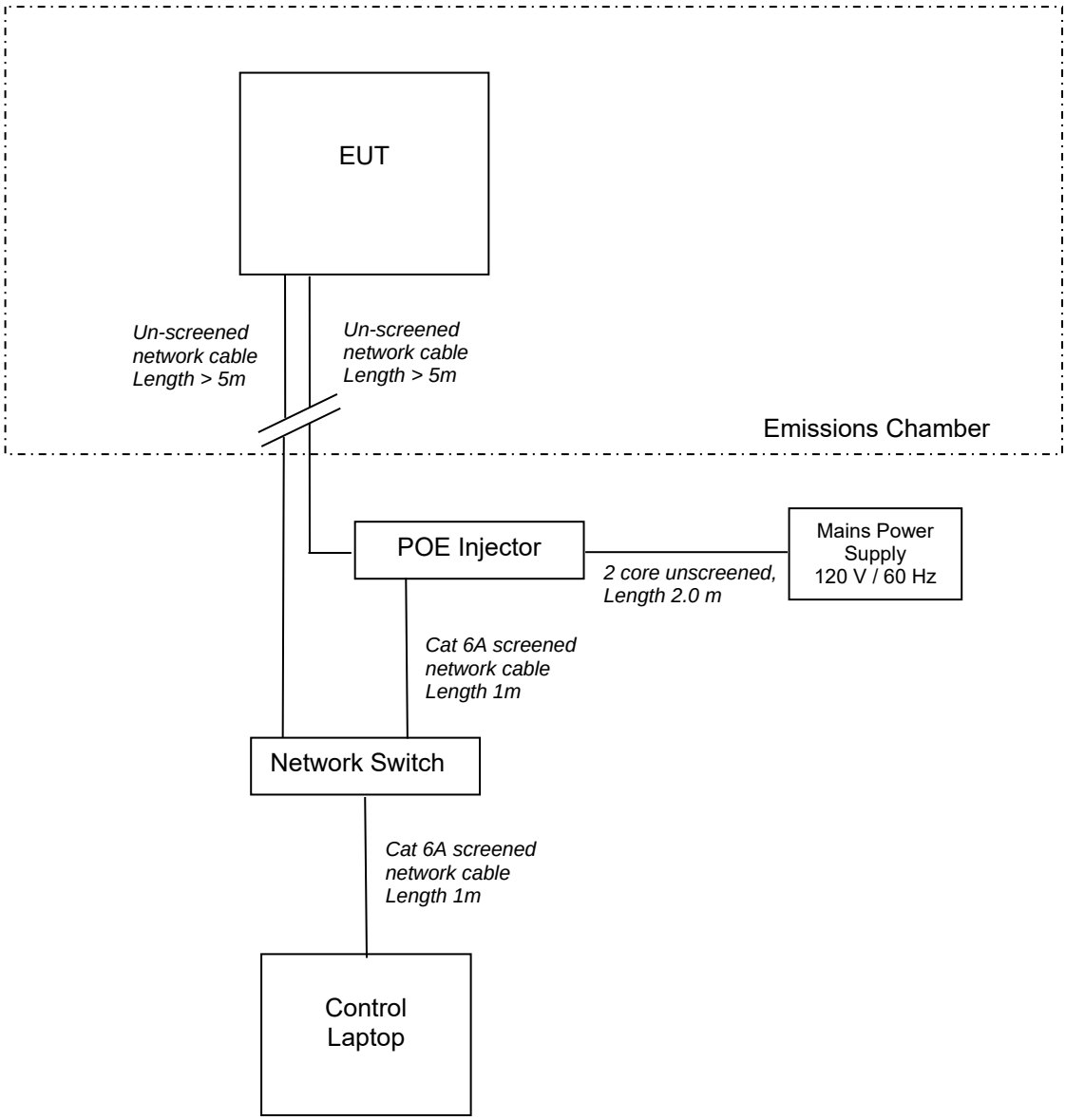
8 Modifications

Shielded cables used for radiated emissions measurements in the range 30MHz – 1GHz

9 EUT Test Setup

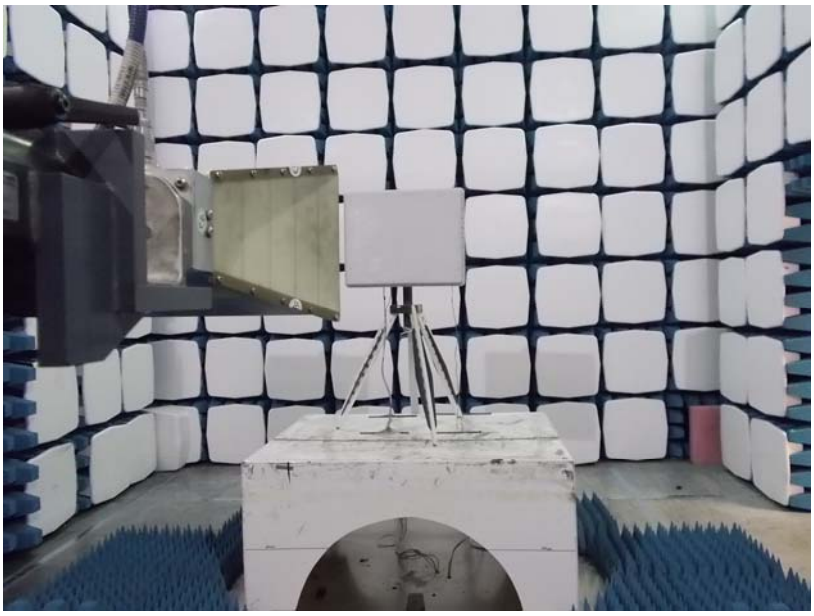
9.1 Block Diagram

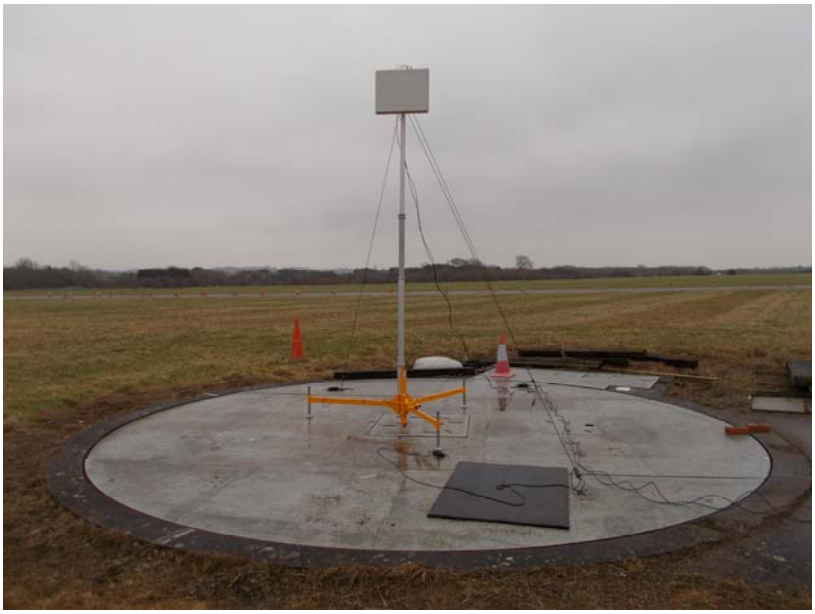
The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:





10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 48 V dc from the POE.

10.2 Varying Test Conditions

Variation of supply voltage is required to ensure stability of the declared output power and frequency. During carrier power testing the following variations were made:

	Category	***Nominal***	***Variation***
☐	Mains		85% and 115%
☐	Battery	New battery	N/A
☒	Other	-48Vdc	POE

11 Radiated emissions

11.1 Definitions

Spurious emissions
Emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands
A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6 KDB 789033 D02 II G
EUT Channels / Frequencies Measured:	5170 MHz / 5270 MHz / 5330 MHz
EUT Channel Bandwidths:	40 MHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Det:	Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 48 %RH	20%RH to 75%RH (as declared)
Supply: -48 Vdc POE	-48 Vdc POE

Test Limits
Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

General Field Strength Limits for License-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	*Field Strength (µV/m at 3m)*
30-88	100
88-216	150
216-960	200
Above 960	500

11.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak Det and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak Det and 100kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and Det type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dBµV/m at the regulatory distance, using:

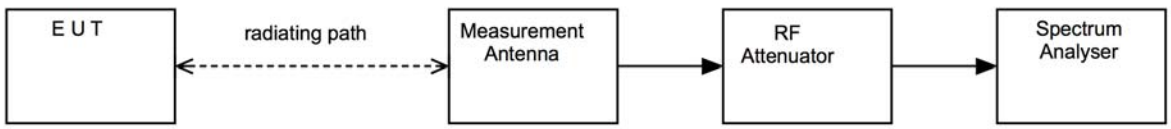
$$FS = PR + CL + AF – PA + DC – CF$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB (where used, e.g. where average Det on pulsed harmonic understates the power);
CF is the distance factor in dB (where measurement distance different to limit distance);

This field strength value is then compared with the regulatory limit.

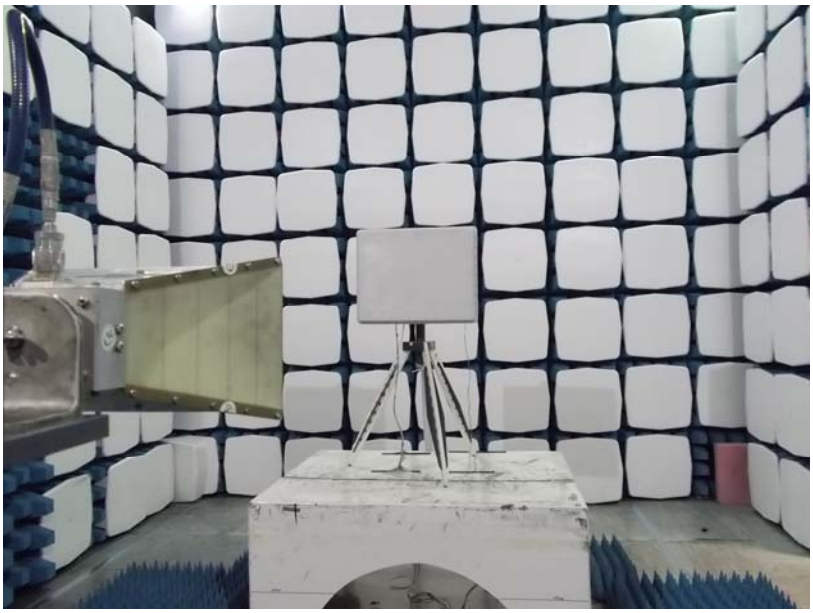
Figure i Test Setup



Measurements are made at 5170 MHz, 5270 and at 5330 MHz.

Measurement made at 5170 MHz; 5270 and at 5330 MHz are at a power setting lower than the setting used for maximum EIRP and are set to the highest level whilst still achieving compliance with the requirements.

Test Setup Photograph(s)

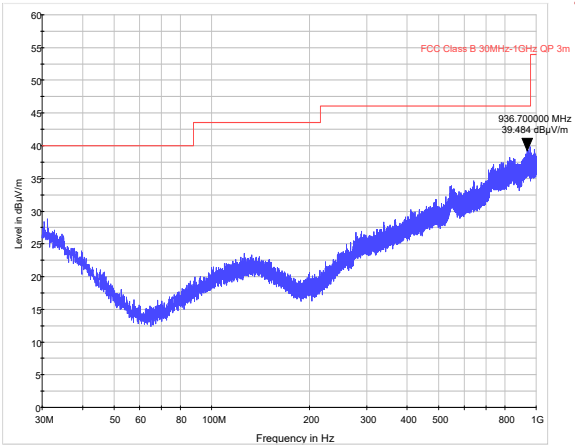


11.4 Test Equipment

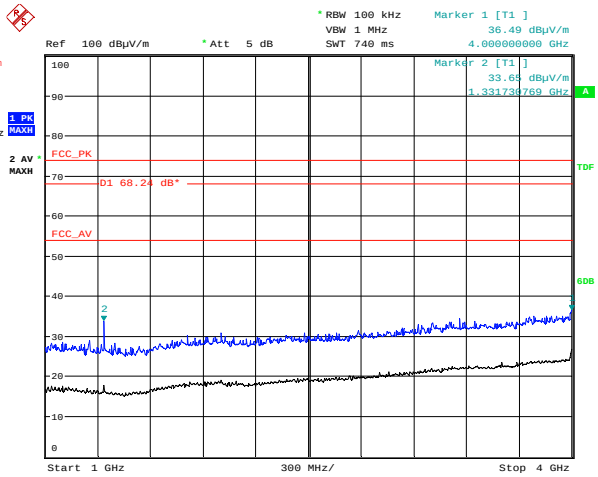
Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Bilog	Chase	CBL611/A	L290	02/12/2014	24	12/12/2018
ESVS10	R&S	ESVS10	L352	18/07/2016	12	18/07/2017
Spectrum Analyser	R&S	FSU46	U281	07/06/2016	12	07/06/2017
Horn Antenna	EMCO	3115	L139	25/09/2015	24	25/09/2017
Pre-Amplifier	Agilent	8449B	L572	07/02/2017	12	07/02/2018
Horn Antenna	Flann	20240-20	L300	07/04/2016	24	07/04/2018
Horn Antenna	Flann	22240-20	L301	11/07/2016	12	11/07/2017
6 dB Attenuator	Bird	8304-060-N	U376	Calibrate in Use		
10 dB Attenuator	Bird	8304-100-N	L222	Calibrate in Use		
High Pass Filter	Atlantic Microwave Ltd	AFH-0700	U558	Calibrate in Use		

11.5 Test Results

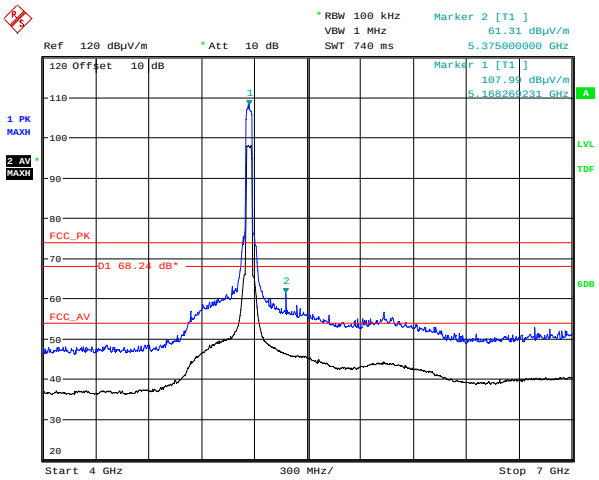
Channel: 5170 MHz, Sector Mode; 256QAM; MIMO A



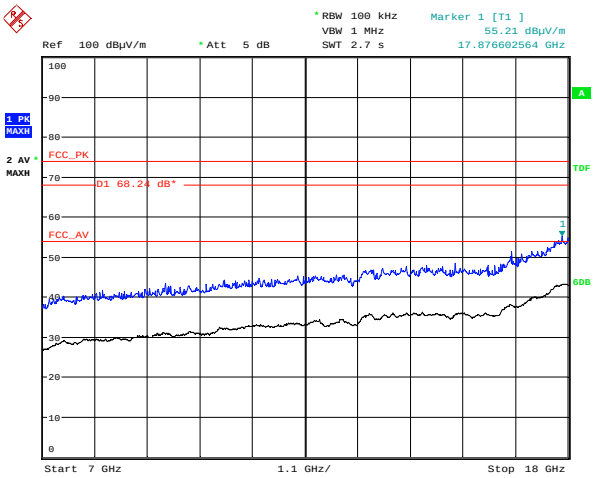
30 MHz – 1 GHz



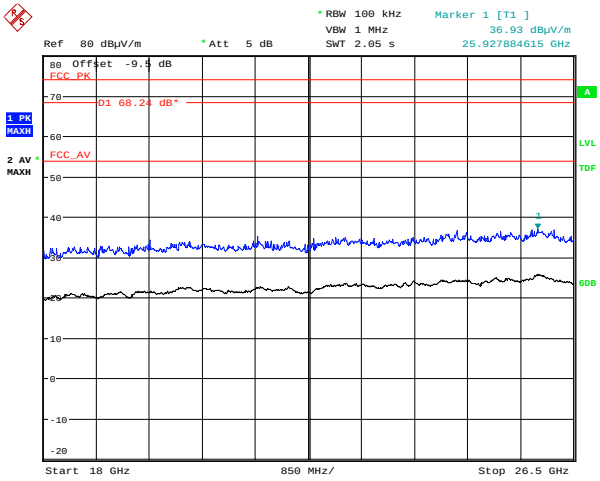
1 GHz – 4 GHz



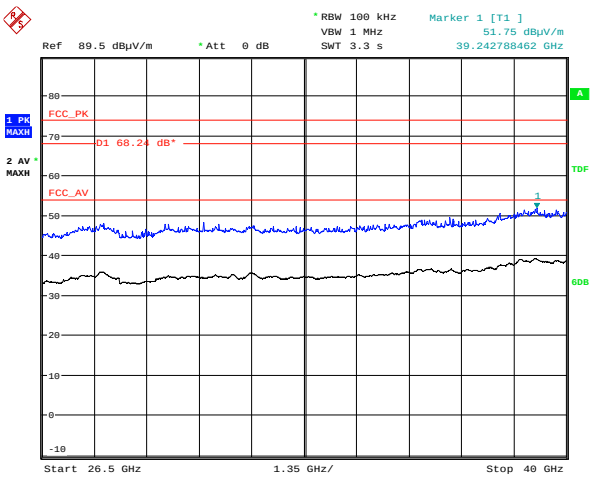
4 GHz – 7 GHz



7 GHz – 18 GHz



18 GHz – 26.5 GHz



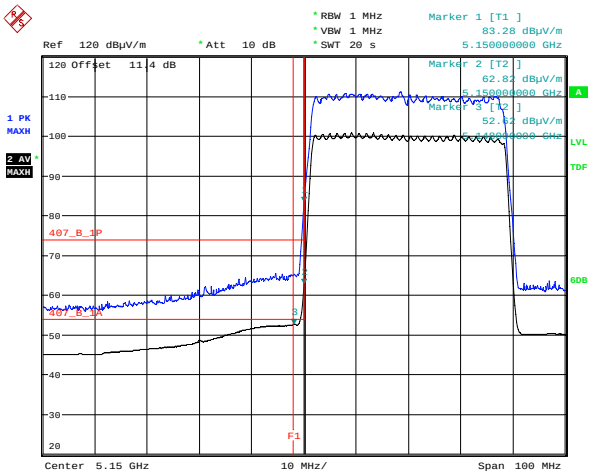
26.5 GHz – 40 GHz

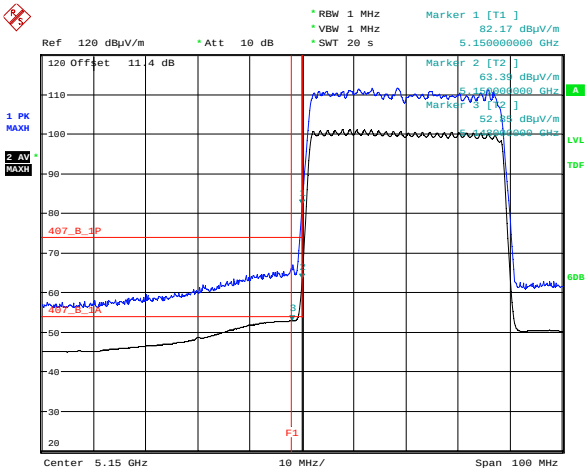
Channel:* 5170 *MHz, Beamforming & MU-Mimo Mode; QPSK; MIMO A										
Det	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	5376.00	59.26	4.50	33.90	35.97	0.00	0.00	61.69	1214.79	5000
Av	5376.00	50.88	4.50	33.90	35.97	0.00	0.00	53.31	462.91	500

Channel:* 5170 *MHz, Sector Mode; QPSK; MIMO A										
Det	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	5376.00	59.96	4.50	33.90	35.97	0.00	0.00	62.39	1316.74	5000
Av	5376.00	50.85	4.50	33.90	35.97	0.00	0.00	53.28	461.32	500

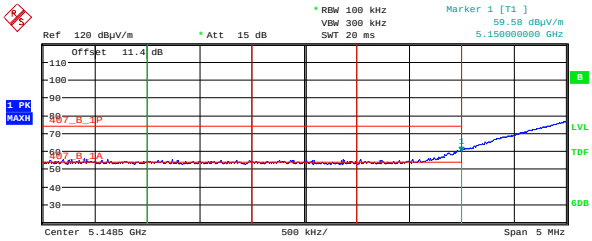
Variation in 5376MHz Emission Level due to variation in output power setting

BEAMFORMING QPSK

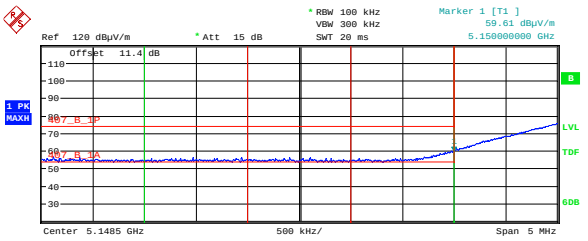




MIMO A > 2 MHz from Bandedge MIMO B

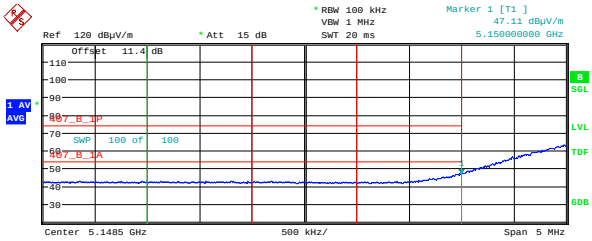


Tx Channel			
Bandwidth	1 MHz	Power	63.17 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	63.20 dBµV/m
Spacing	1 MHz	Upper	65.06 dBµV/m

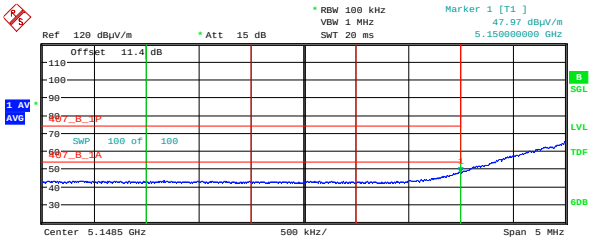


Tx Channel			
Bandwidth	1 MHz	Power	64.21 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	64.28 dBµV/m
Spacing	1 MHz	Upper	65.56 dBµV/m

MIMO A Integration Method - Peak Level MIMO B



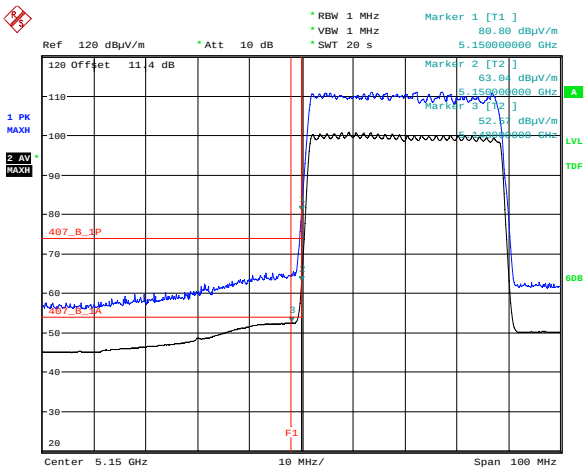
Tx Channel			
Bandwidth	1 MHz	Power	51.70 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	51.83 dBµV/m
Spacing	1 MHz	Upper	53.09 dBµV/m

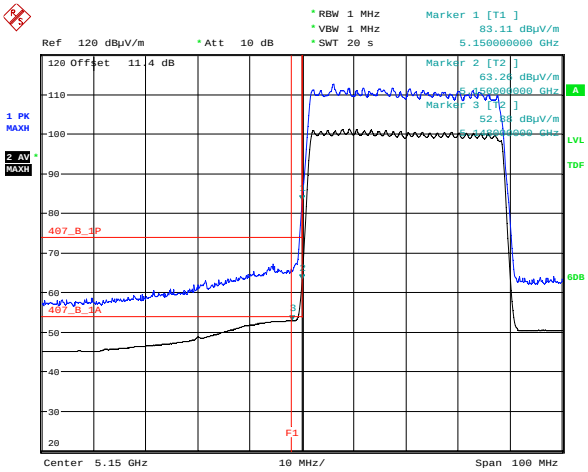


Tx Channel			
Bandwidth	1 MHz	Power	51.91 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	52.03 dBµV/m
Spacing	1 MHz	Upper	53.45 dBµV/m

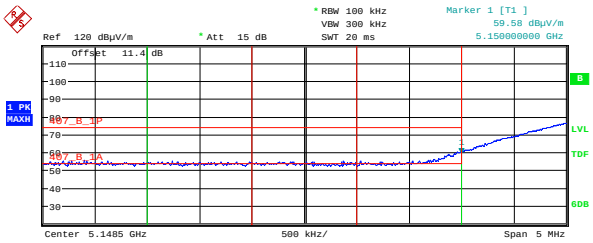
MIMO A Integration Method - Average Level MIMO B

BEAMFORMING 256QAM

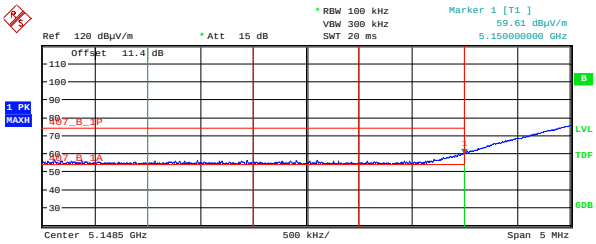




MIMO A > 2 MHz from Bandedge MIMO B

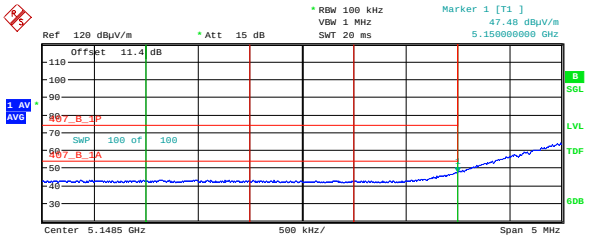


Tx Channel			
Bandwidth	1 MHz	Power	63.17 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	63.20 dBµV/m
Spacing	1 MHz	Upper	65.06 dBµV/m

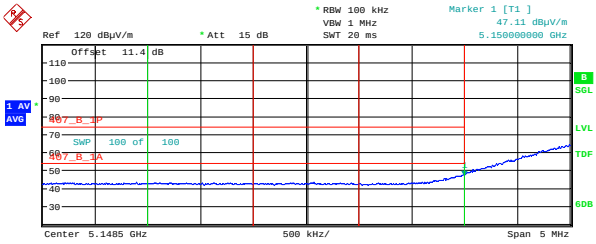


Tx Channel			
Bandwidth	1 MHz	Power	64.21 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	64.28 dBµV/m
Spacing	1 MHz	Upper	65.56 dBµV/m

MIMO A Integration Method - Peak Level MIMO B



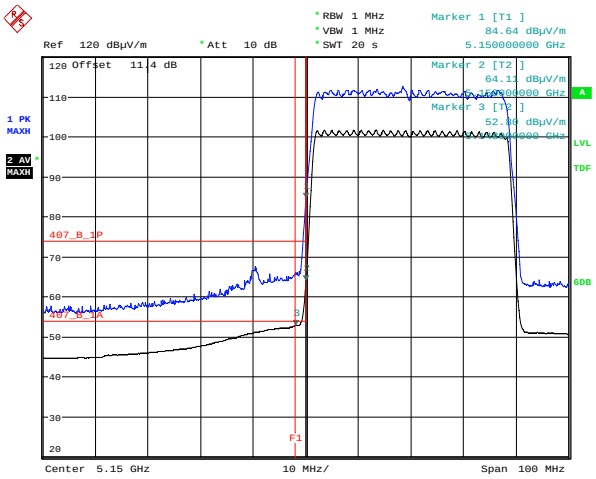
Tx Channel			
Bandwidth	1 MHz	Power	51.67 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	51.89 dBµV/m
Spacing	1 MHz	Upper	53.07 dBµV/m

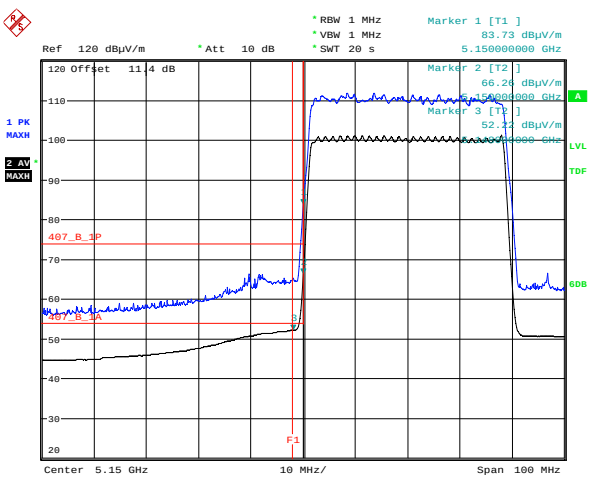


Tx Channel			
Bandwidth	1 MHz	Power	51.90 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	51.96 dBµV/m
Spacing	1 MHz	Upper	53.23 dBµV/m

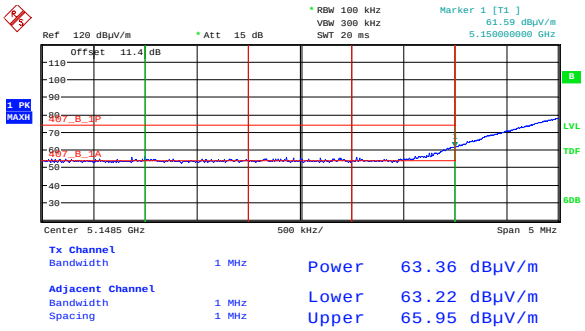
MIMO A Integration Method - Average Level MIMO B

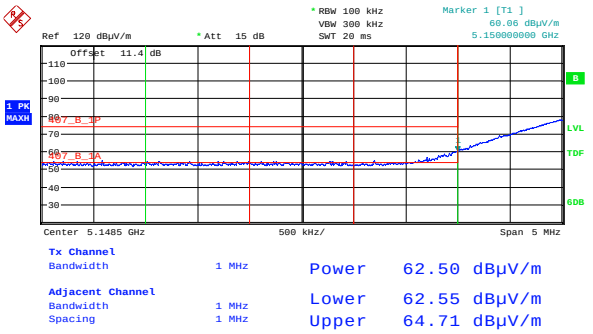
SECTOR QPSK



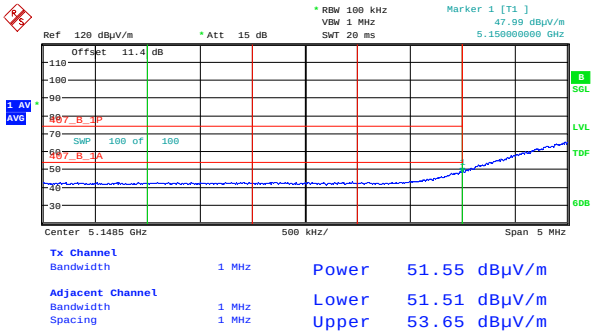


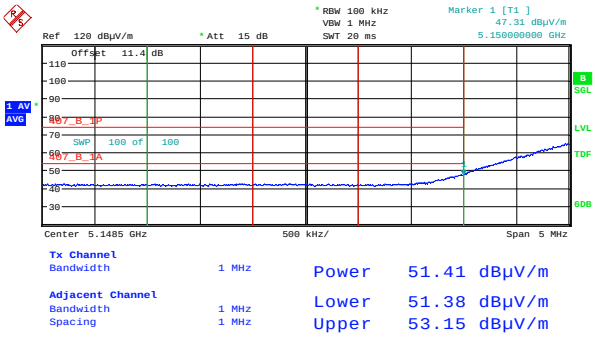
MIMO A > 2 MHz from Bandedge MIMO B





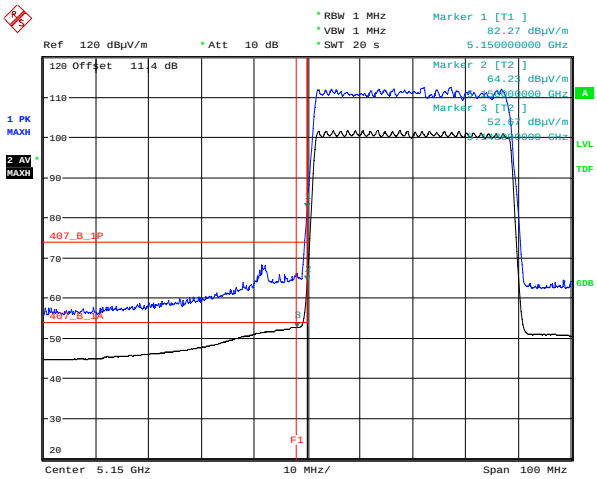
MIMO A Integration Method - Peak Level MIMO B

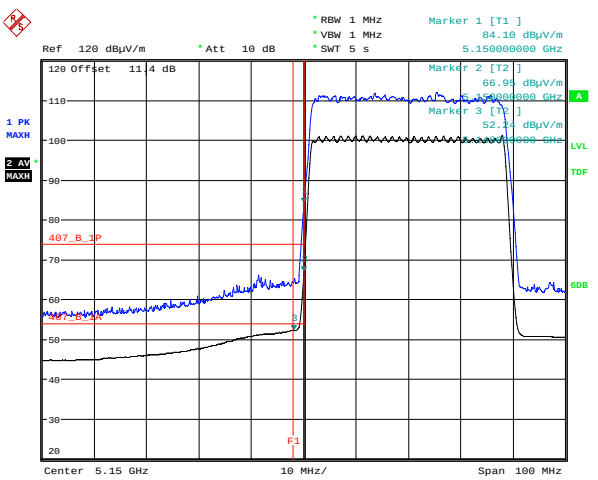




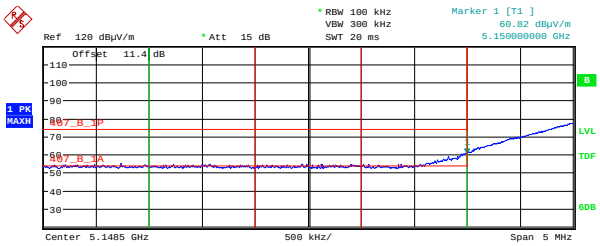
MIMO A Integration Method - Average Level MIMO B

SECTOR 256QAM

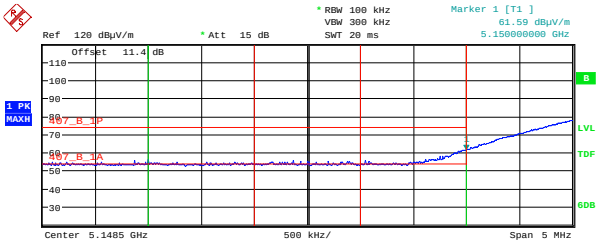




MIMO A > 2 MHz from Bandedge MIMO B

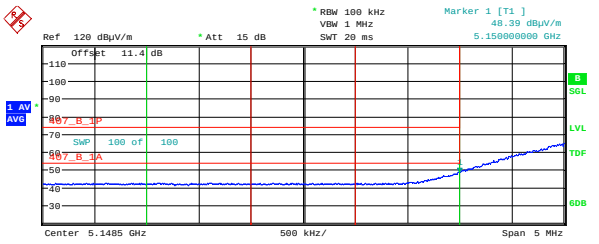


Tx Channel			
Bandwidth	1 MHz	Power	62.98 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	62.93 dBµV/m
Spacing	1 MHz	Upper	65.27 dBµV/m

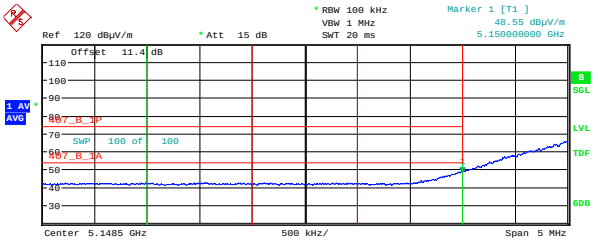


Tx Channel			
Bandwidth	1 MHz	Power	63.36 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	63.22 dBµV/m
Spacing	1 MHz	Upper	65.95 dBµV/m

MIMO A Integration Method - Peak Level MIMO B



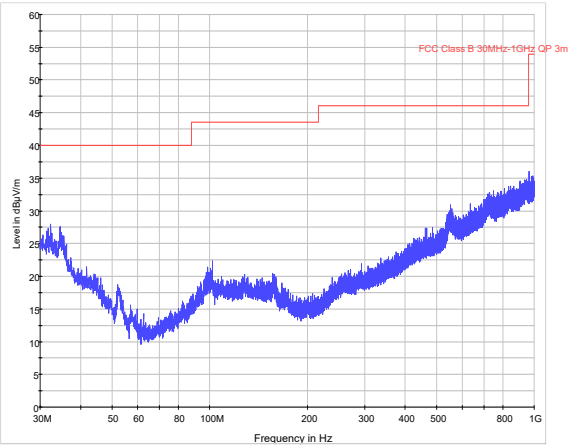
Tx Channel			
Bandwidth	1 MHz	Power	51.51 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	51.54 dBµV/m
Spacing	1 MHz	Upper	53.53 dBµV/m



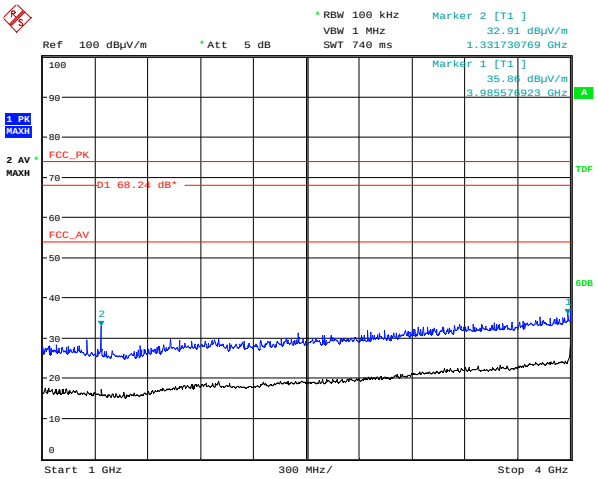
Tx Channel			
Bandwidth	1 MHz	Power	51.37 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	51.39 dBµV/m
Spacing	1 MHz	Upper	53.58 dBµV/m

MIMO A Integration Method - Average Level MIMO B

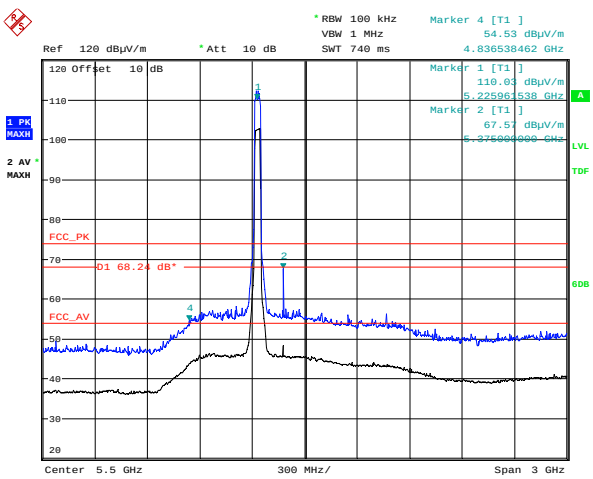
Channel: 5270 MHz, Sector Mode; 256QAM; MIMO A



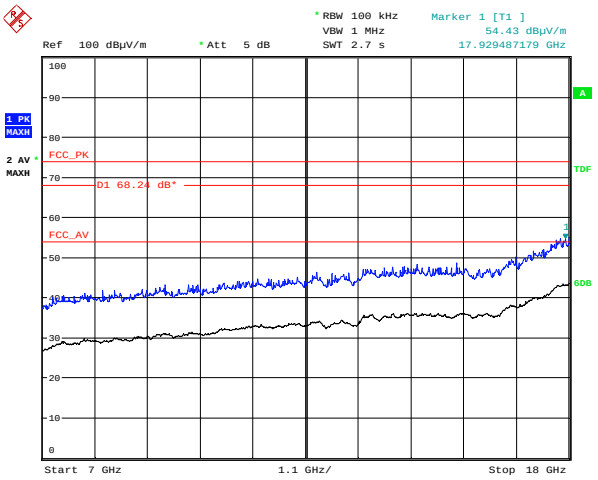
30 MHz – 1 GHz



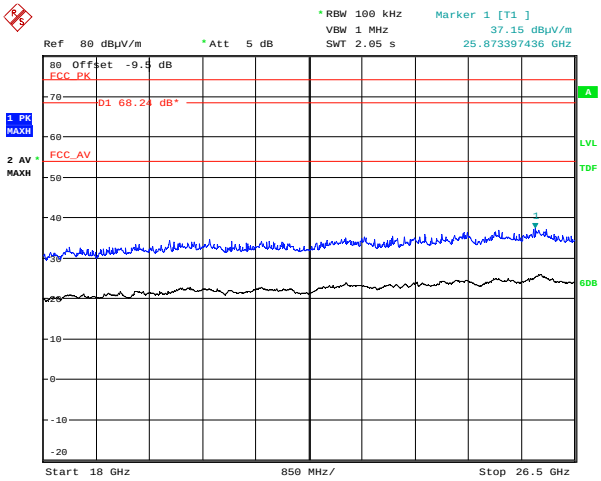
1 GHz – 4 GHz



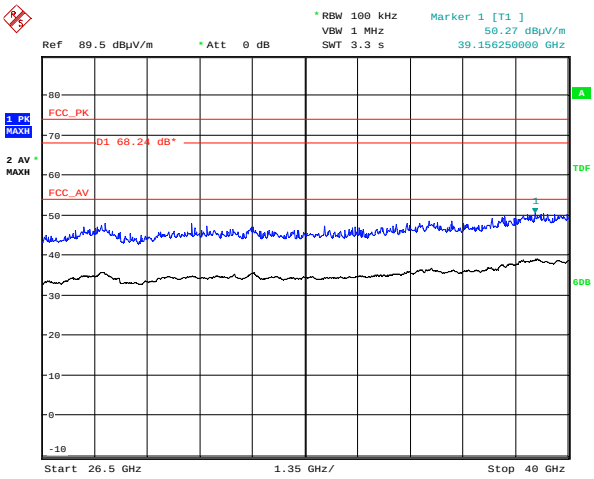
4 GHz – 7 GHz



7 GHz – 18 GHz



18 GHz – 26.5 GHz



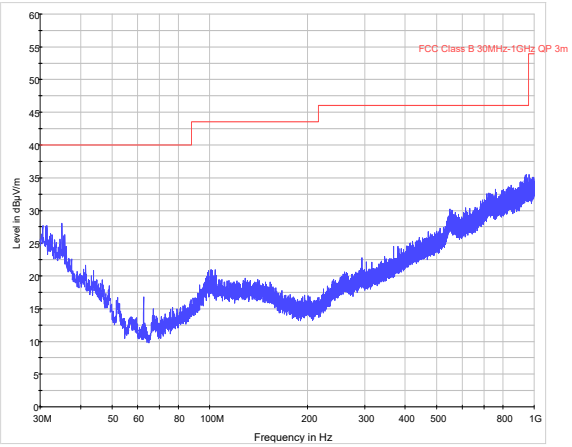
26.5 GHz – 40 GHz

Channel: 5270 MHz, Beamforming Mode; QPSK; MIMO A										
Det	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	5376.00	59.92	4.50	33.90	35.97	0.00	0.00	62.35	1310.69	5000
Av	5376.00	47.57	4.50	33.90	35.97	0.00	0.00	50.00	316.23	500

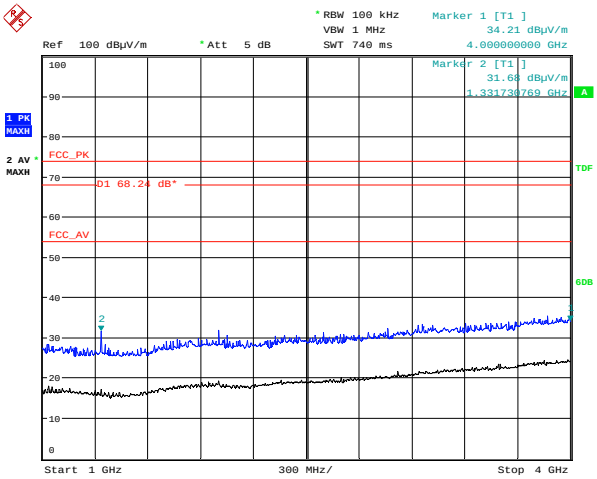
Channel: 5270 MHz, Sector Mode; 256QAM; MIMO A										
Det	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	5376.00	61.07	4.50	33.90	35.97	0.00	0.00	63.50	1496.24	5000
Av	5376.00	48.63	4.50	33.90	35.97	0.00	0.00	51.06	357.27	500

Variation in 5376MHz Emission Level due to variation in output power setting

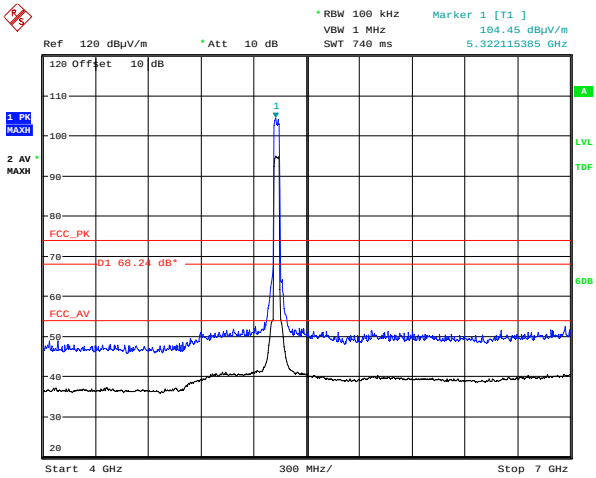
Channel: 5330 MHz, Sector Mode; 256QAM; MIMO A



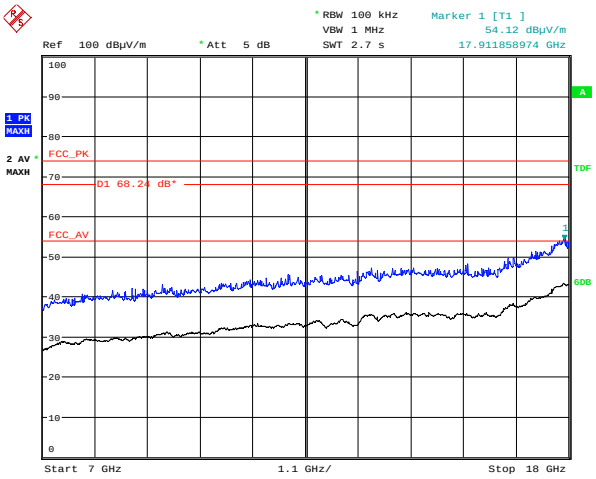
30 MHz – 1 GHz



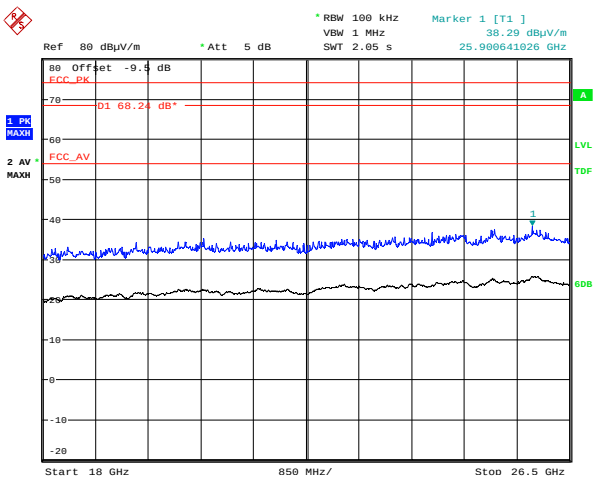
1 GHz – 4 GHz



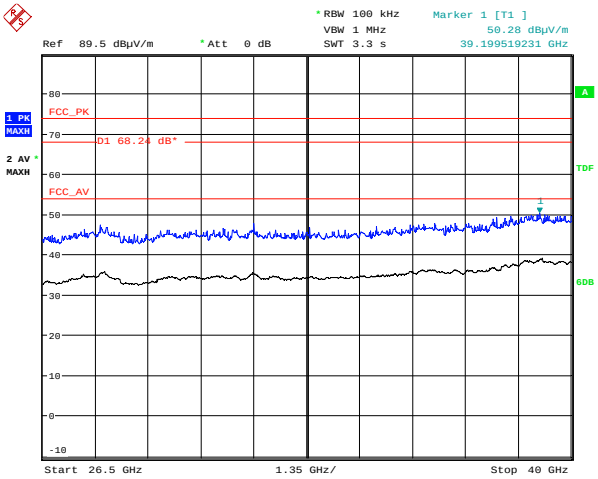
4 GHz – 7 GHz



7 GHz – 18 GHz



18 GHz – 26.5 GHz



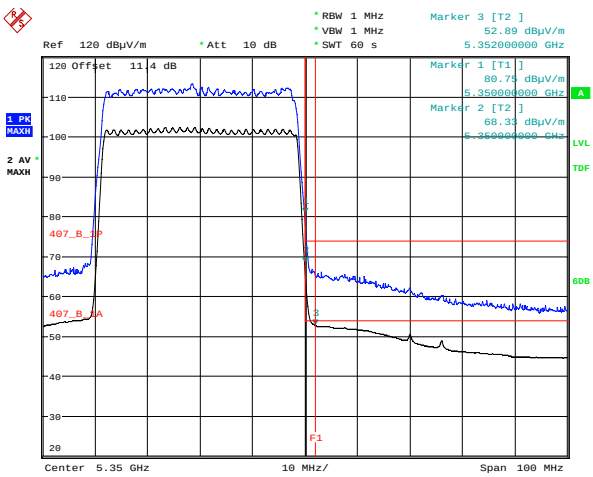
26.5 GHz – 40 GHz

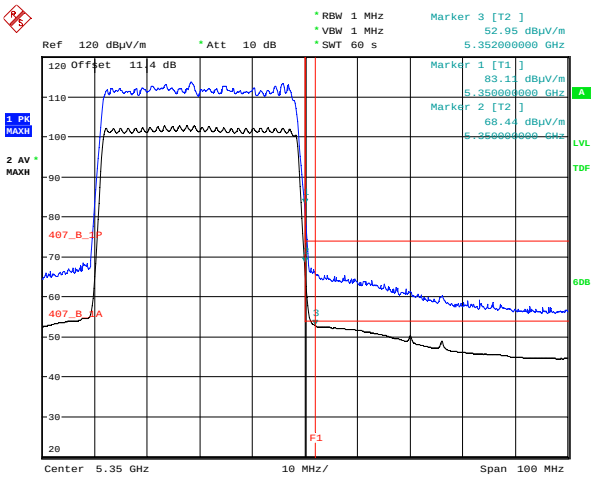
Channel: 5330 MHz, Beamforming & MU-Mimo Mode; QPSK; MIMO A										
Det	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	5376.00	63.12	4.50	33.90	35.97	0.00	0.00	65.55	1894.52	5000
Av	5376.00	50.65	4.50	33.90	35.97	0.00	0.00	53.08	450.82	500

Channel: 5330 MHz, Sector Mode; QPSK; MIMO A										
Det	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	5376.00	62.01	4.50	33.90	35.97	0.00	0.00	64.44	1667.25	5000
Av	5376.00	50.00	4.50	33.90	35.97	0.00	0.00	52.43	418.31	500

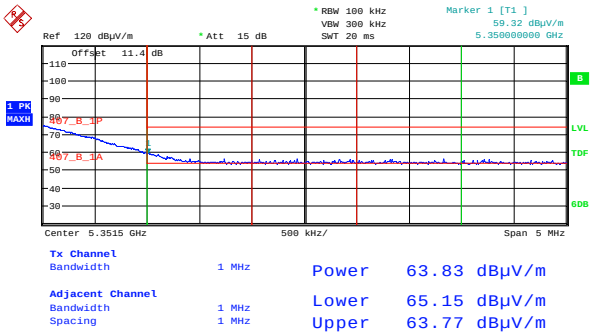
Variation in 5376MHz Emission Level due to variation in output power setting

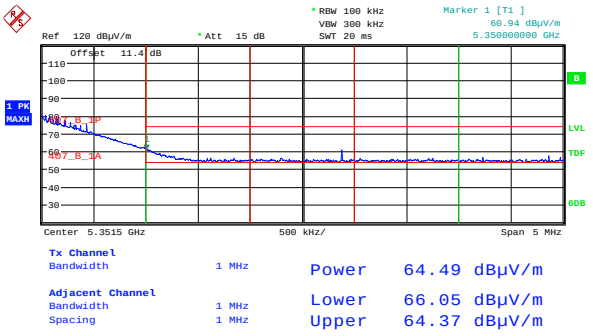
BEAMFORMING QPSK



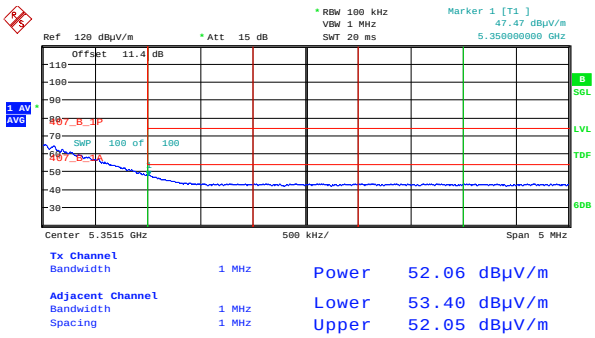


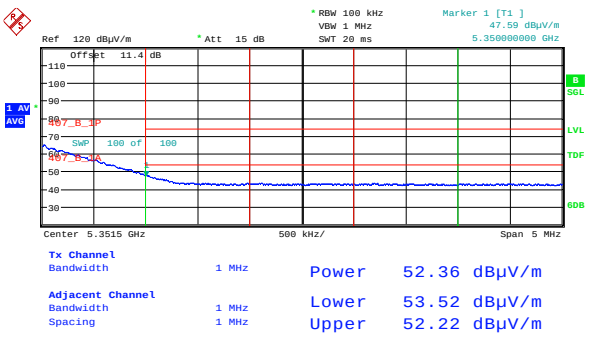
MIMO A > 2 MHz from Bandedge MIMO B





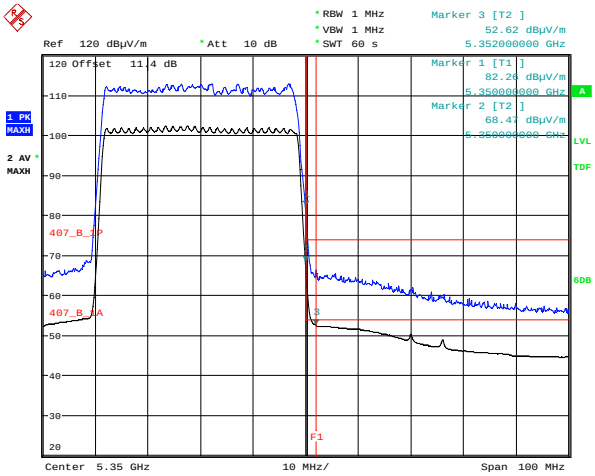
MIMO A Integration Method - Peak Level MIMO B

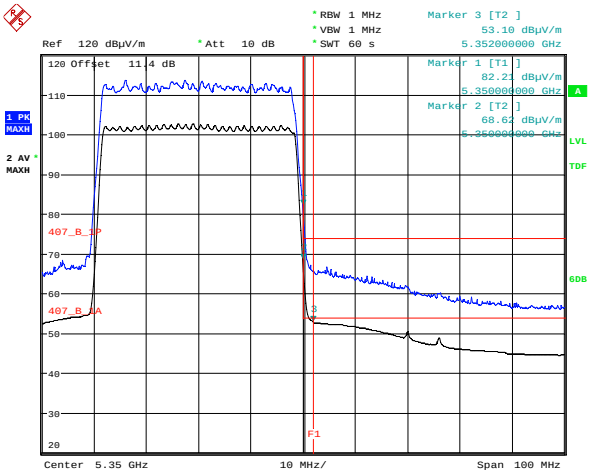




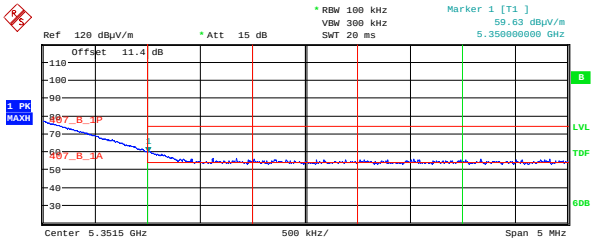
MIMO A Integration Method - Average Level MIMO B

BEAMFORMING 256QAM

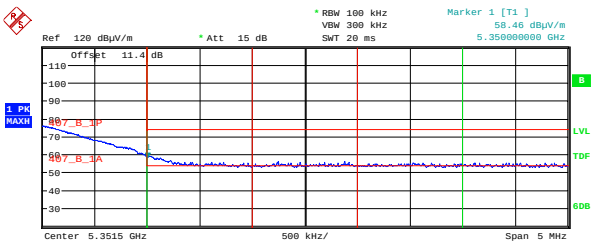




MIMO A > 2 MHz from Bandedge MIMO B

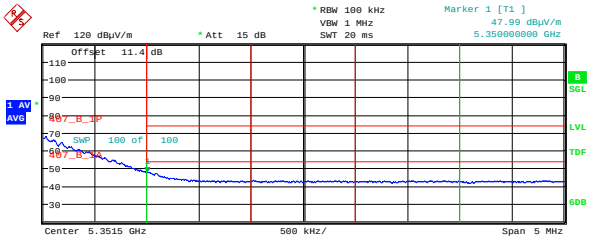


Tx Channel			
Bandwidth	1 MHz	Power	63.55 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	65.21 dBµV/m
Spacing	1 MHz	Upper	63.54 dBµV/m

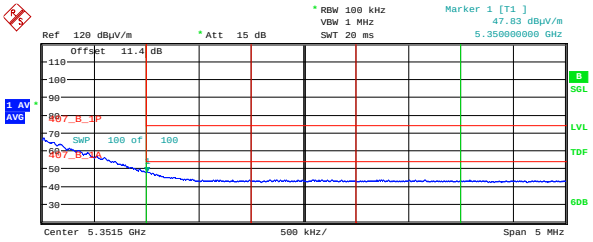


Tx Channel			
Bandwidth	1 MHz	Power	63.61 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	64.90 dBµV/m
Spacing	1 MHz	Upper	63.47 dBµV/m

MIMO A Integration Method - Peak Level MIMO B



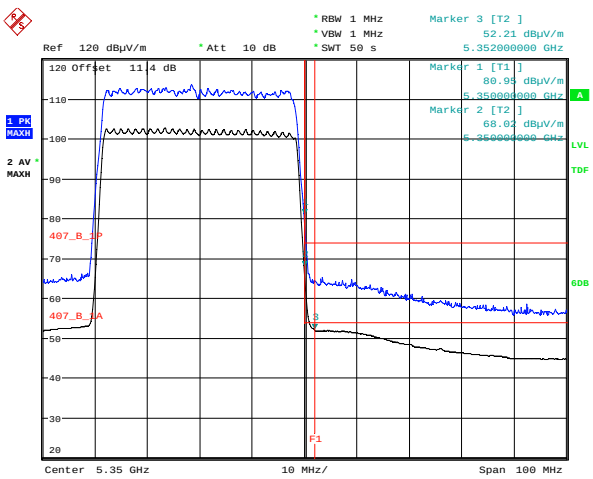
Tx Channel			
Bandwidth	1 MHz	Power	52.12 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	53.54 dBµV/m
Spacing	1 MHz	Upper	52.07 dBµV/m

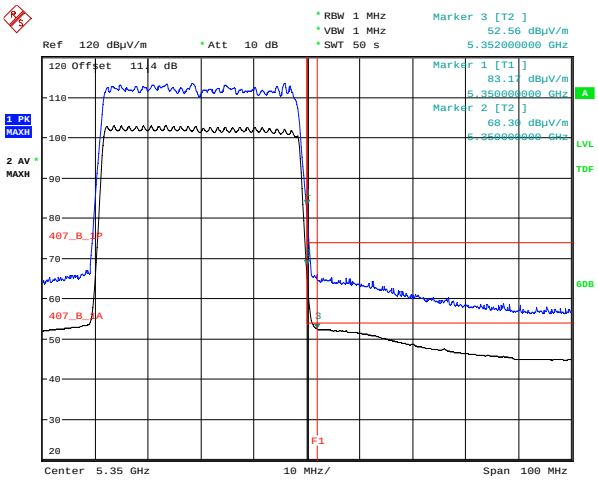


Tx Channel			
Bandwidth	1 MHz	Power	52.50 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	53.70 dBµV/m
Spacing	1 MHz	Upper	52.42 dBµV/m

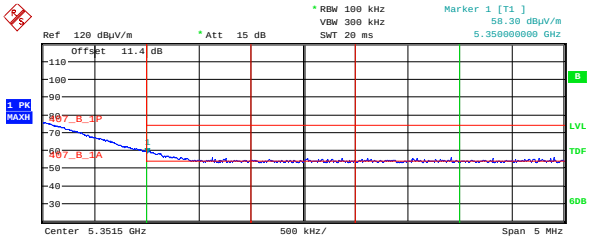
MIMO A Integration Method - Average Level MIMO B

SECTOR QPSK

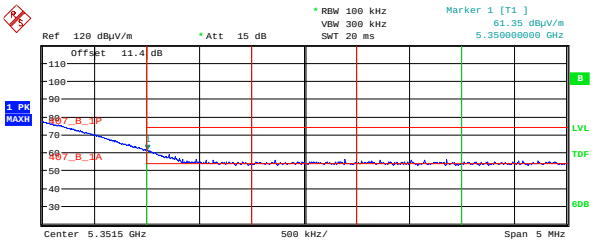




MIMO A > 2 MHz from Bandedge MIMO B

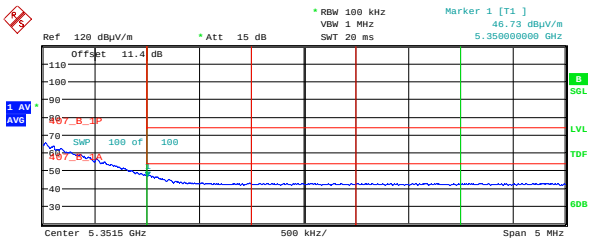


Tx Channel			
Bandwidth	1 MHz	Power	63.38 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	64.91 dBµV/m
Spacing	1 MHz	Upper	63.48 dBµV/m

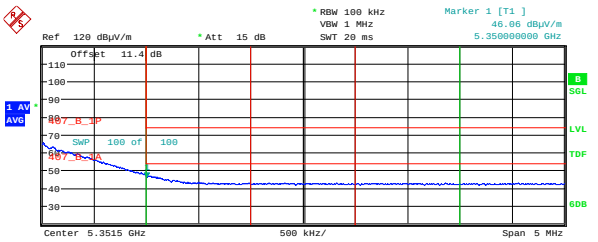


Tx Channel			
Bandwidth	1 MHz	Power	63.55 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	65.71 dBµV/m
Spacing	1 MHz	Upper	63.60 dBµV/m

MIMO A Integration Method - Peak Level MIMO B



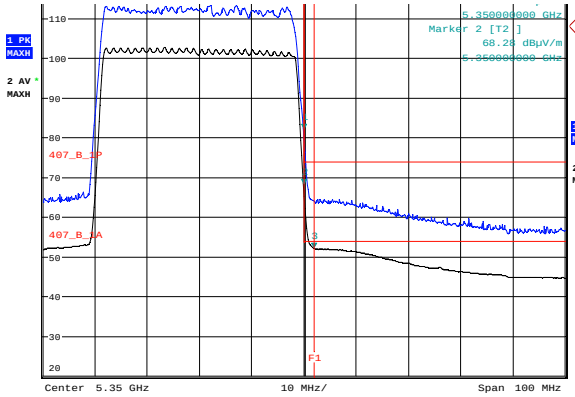
Tx Channel			
Bandwidth	1 MHz	Power	51.73 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	53.08 dBµV/m
Spacing	1 MHz	Upper	51.71 dBµV/m



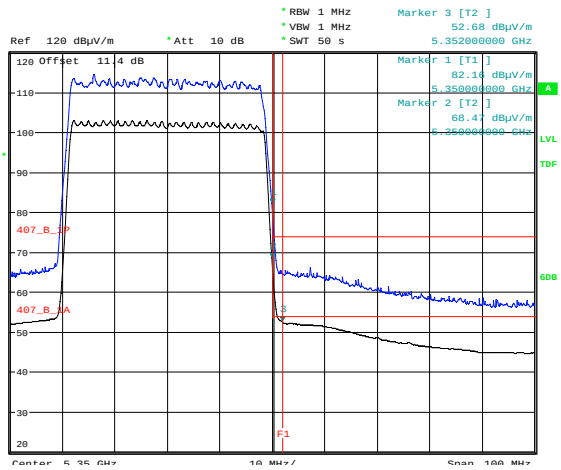
Tx Channel			
Bandwidth	1 MHz	Power	51.91 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	53.24 dBµV/m
Spacing	1 MHz	Upper	51.83 dBµV/m

MIMO A Integration Method - Average Level MIMO B

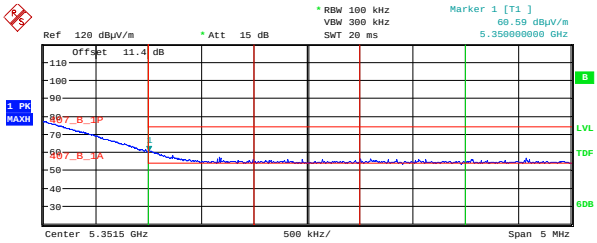
SECTOR 256QAM



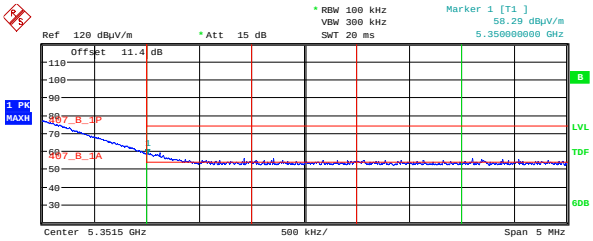
Date: 21.SEP.2017 12:33:20



MIMO A > 2 MHz from Bandedge MIMO B

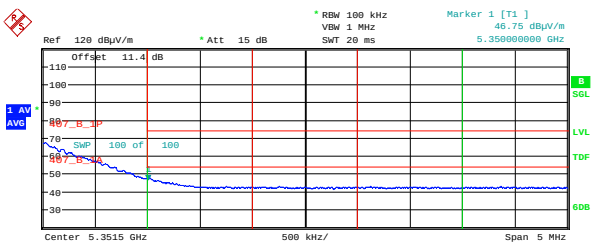


Tx Channel			
Bandwidth	1 MHz	Power	63.97 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	65.74 dBµV/m
Spacing	1 MHz	Upper	64.06 dBµV/m

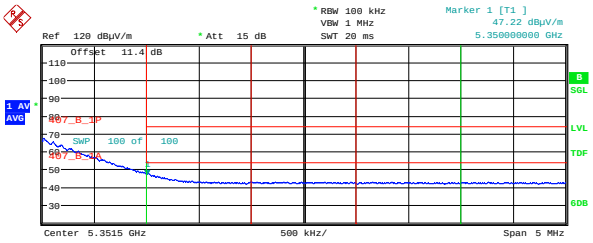


Tx Channel			
Bandwidth	1 MHz	Power	62.98 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	64.52 dBµV/m
Spacing	1 MHz	Upper	62.84 dBµV/m

MIMO A Integration Method - Peak Level MIMO B



Tx Channel			
Bandwidth	1 MHz	Power	51.74 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	53.16 dBµV/m
Spacing	1 MHz	Upper	51.74 dBµV/m



Tx Channel			
Bandwidth	1 MHz	Power	51.98 dBµV/m
Adjacent Channel			
Bandwidth	1 MHz	Lower	53.29 dBµV/m
Spacing	1 MHz	Upper	51.85 dBµV/m

MIMO A Integration Method - Average Level MIMO B

12 AC power-line conducted emissions

12.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Transient Lab (U390)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	5200 MHz
EUT Channel Bandwidths:	40 MHz
EUT Modulation:	QPSK MIMO A
Deviations From Standard:	None
Measurement BW:	10 kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 ºC to +35 ºC (as declared)
Humidity: 40 %RH	20%RH to 75%RH (as declared)
Supply: -48Vdc POE	-48Vdc POE

Test Limits

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz-30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	*Conducted limit (dBµV)*	
	Quasi-Peak	*Average***
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5.0	56	46
5.0 – 30.0	60	50

* The level decreases linearly with the logarithm of the frequency.
** A linear average detector is required.

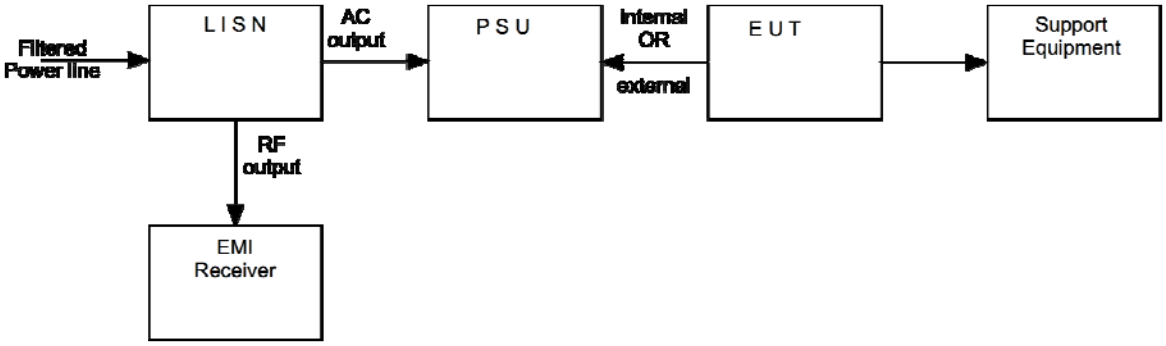
12.3 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit mode.

Figure ii Test Setup



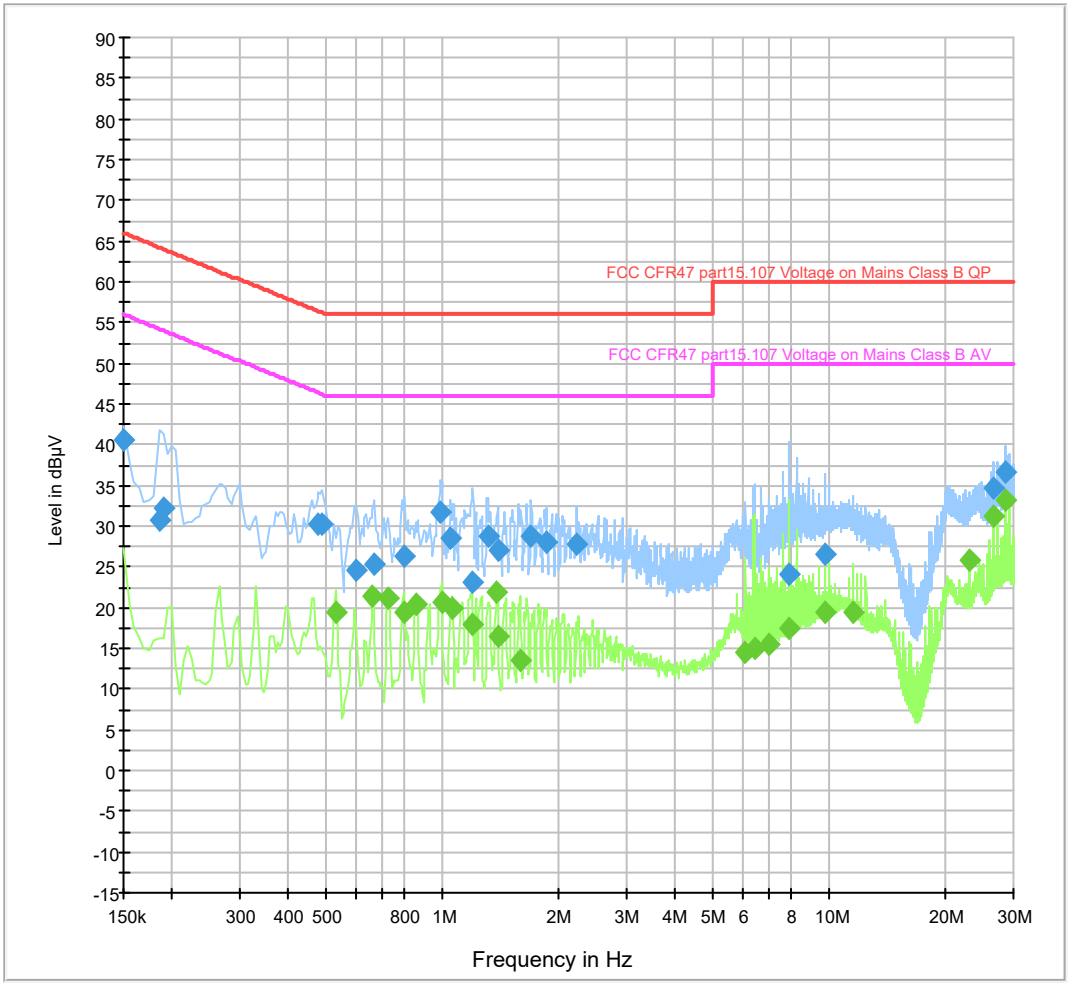
Test Setup Photograph(s)

12.4 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Lisn	R&S	ESH3-Z5.831.5	U195	16/08/2017	12	16/08/2018
Receiver	R&S	ESHS10	U003	25/06/2016	12	25/06/2017
Pulse Limiter	R&S	ESH3-Z2	U559	28/07/2015	24	28/07/2017

12.5 Test Results

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH195 +UH559



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	40.6	2000.0	10.000	GND	N	10.0	25.4	66.0
0.185000	30.7	2000.0	10.000	GND	L1	10.0	33.6	64.3
0.190000	32.2	2000.0	10.000	GND	L1	10.0	31.9	64.0
0.480000	30.4	2000.0	10.000	GND	L1	10.1	26.0	56.3
0.490000	30.1	2000.0	10.000	GND	L1	10.1	26.0	56.2
0.600000	24.7	2000.0	10.000	GND	L1	10.1	31.3	56.0
0.670000	25.3	2000.0	10.000	GND	L1	10.1	30.7	56.0
0.800000	26.3	2000.0	10.000	GND	N	10.1	29.7	56.0
0.990000	31.7	2000.0	10.000	GND	L1	10.1	24.3	56.0
1.050000	28.5	2000.0	10.000	GND	L1	10.1	27.5	56.0
1.200000	23.2	2000.0	10.000	GND	L1	10.1	32.8	56.0
1.310000	28.8	2000.0	10.000	GND	N	10.1	27.2	56.0
1.395000	27.0	2000.0	10.000	GND	N	10.1	29.0	56.0
1.700000	28.7	2000.0	10.000	GND	N	10.2	27.3	56.0
1.855000	28.2	2000.0	10.000	GND	N	10.2	27.8	56.0
2.225000	27.7	2000.0	10.000	GND	N	10.2	28.3	56.0
7.920000	24.2	2000.0	10.000	GND	N	10.5	35.8	60.0
9.740000	26.6	2000.0	10.000	GND	N	10.6	33.4	60.0
26.485000	34.6	2000.0	10.000	GND	N	11.8	25.4	60.0
28.685000	36.6	2000.0	10.000	GND	N	11.9	23.4	60.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.530000	19.4	2000.0	10.000	GND	L1	10.1	26.6	46.0
0.660000	21.3	2000.0	10.000	GND	L1	10.1	24.7	46.0
0.725000	21.2	2000.0	10.000	GND	L1	10.1	24.8	46.0
0.795000	19.4	2000.0	10.000	GND	L1	10.1	26.6	46.0
0.860000	20.3	2000.0	10.000	GND	L1	10.1	25.7	46.0
0.995000	20.5	2000.0	10.000	GND	L1	10.1	25.5	46.0
1.060000	20.0	2000.0	10.000	GND	L1	10.1	26.0	46.0
1.195000	18.0	2000.0	10.000	GND	L1	10.1	28.0	46.0
1.380000	21.8	2000.0	10.000	GND	L1	10.2	24.2	46.0
1.395000	16.5	2000.0	10.000	GND	L1	10.2	29.5	46.0
1.595000	13.6	2000.0	10.000	GND	L1	10.2	32.4	46.0
6.095000	14.6	2000.0	10.000	GND	N	10.4	35.4	50.0
6.400000	15.1	2000.0	10.000	GND	N	10.5	34.9	50.0
6.960000	15.4	2000.0	10.000	GND	N	10.5	34.6	50.0
7.920000	17.6	2000.0	10.000	GND	N	10.5	32.4	50.0
9.740000	19.4	2000.0	10.000	GND	N	10.6	30.6	50.0
11.565000	19.3	2000.0	10.000	GND	N	10.8	30.7	50.0
23.130000	25.7	2000.0	10.000	GND	N	11.8	24.3	50.0
26.610000	31.1	2000.0	10.000	GND	N	11.8	18.9	50.0
28.685000	33.2	2000.0	10.000	GND	N	11.9	16.8	50.0

13 Emission Bandwidth

13.1 Definition

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	5170 MHz / 5230MHz / 5330 MHz
EUT Channel Bandwidths:	40 MHz
EUT Test Modulations:	QPSK / 16 QAM / 64QAM / 256QAM
EUT Data Mode:	MIMO A / MIMO B
Deviations From Standard:	None
Measurement BW: (approx. 1% of EBW)	500kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	2 MHz
Measurement Span: (requirement 2 to 5 times OBW)	100MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 ºC to +35 ºC (as declared)
Humidity: 35 %RH	20%RH to 75%RH (as declared)
Supply: -48Vdc POE	-48Vdc POE

Test Limits

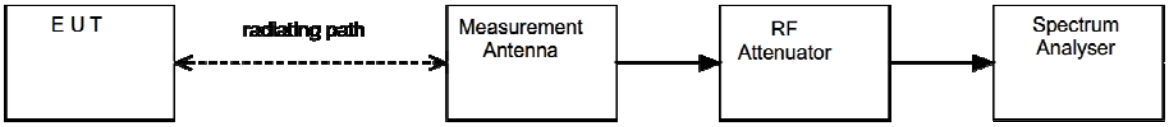
Emission bandwidth. The emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier centre frequency and one above the carrier centre frequency, that are 26 dB down relative to the maximum level of the modulated carrier.

13.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the bandwidth of the EUT was measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iii Test Setup

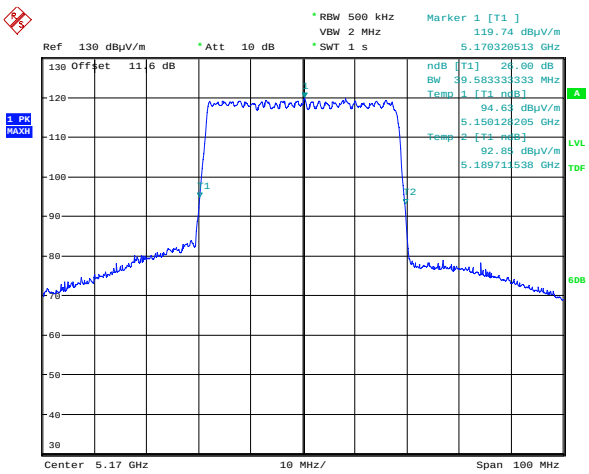


13.4 Test Equipment

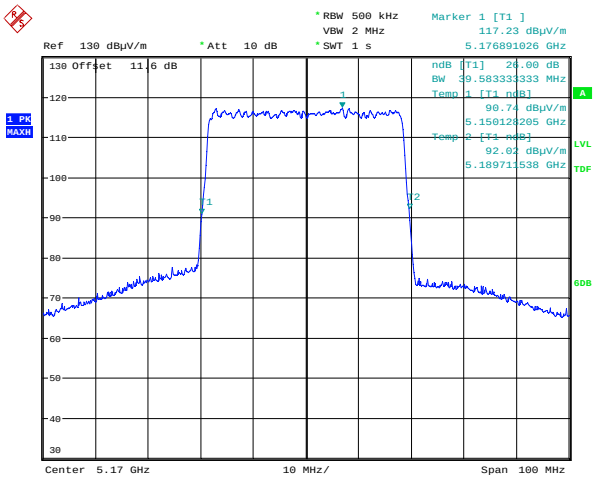
Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Spectrum Analyser	R&S	FSU46	U281	19/06/2017	12	19/06/2018
1-18GHz Horn	EMCO	3115	L139	25/09/2017	24	25/09/2019

13.5 Test Results

5170 MHz					
Modulation Mode	**MIMO Mode**	***F_L (MHz)***	***F_H (MHz)***	***26dB Bandwidth (MHz)***	***Result***
QPSK	A	5150.128205	5189.711538	39583.333	PASS
16QAM	A	5150.128205	5189.711538	39583.333	PASS
64QAM	A	5150.128205	5189.711538	39583.333	PASS
256QAM	A	5150.128205	5189.711538	39583.333	PASS
QPSK	B	5150.128205	5189.711538	39583.333	PASS
16QAM	B	5150.128205	5189.871795	39743.590	PASS
64QAM	B	5150.128205	5189.711538	39583.333	PASS
256QAM	B	5150.288462	5189.551282	39262.820	PASS

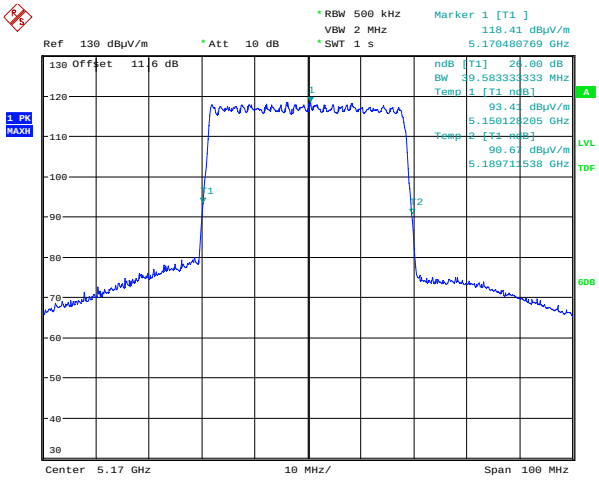


MIMO A

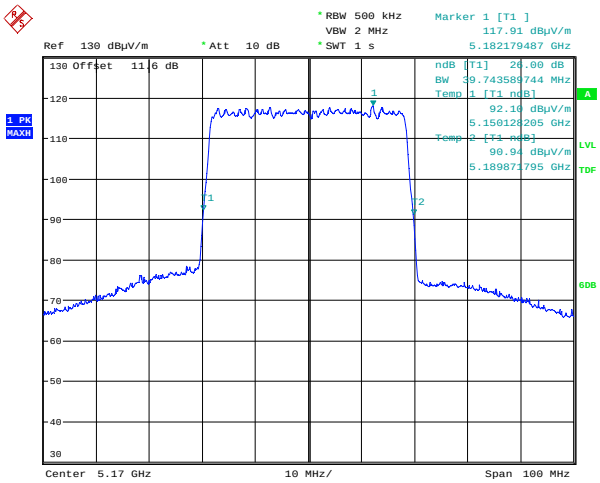


QPSK 5170 MHz

MIMO B

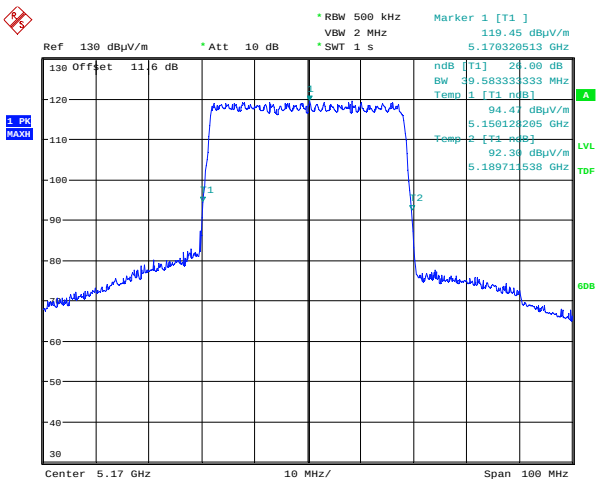


MIMO A

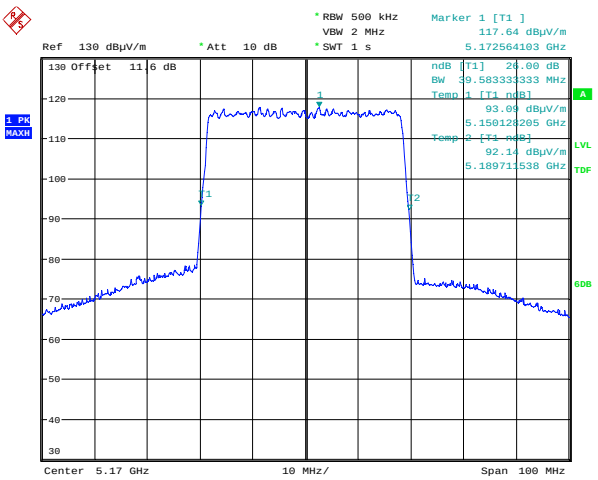


16QAM 5170 MHz

MIMO B

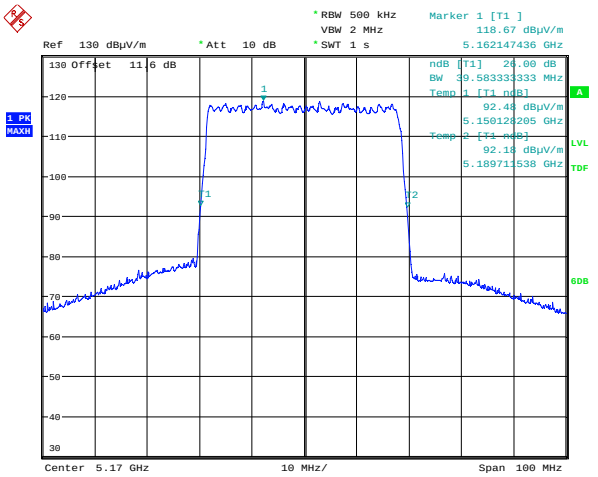


MIMO A

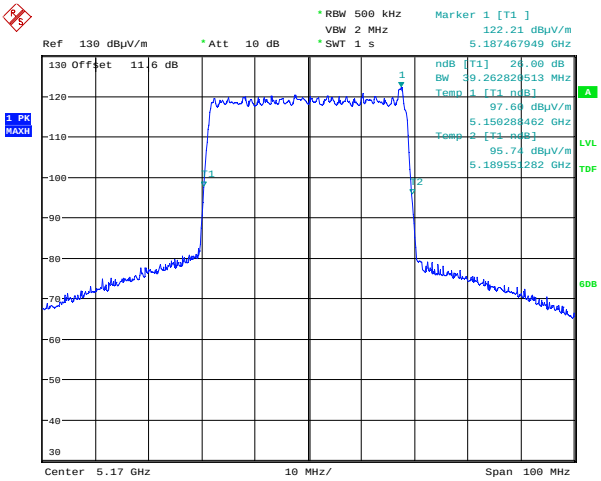


64QAM 5170 MHz

MIMO B



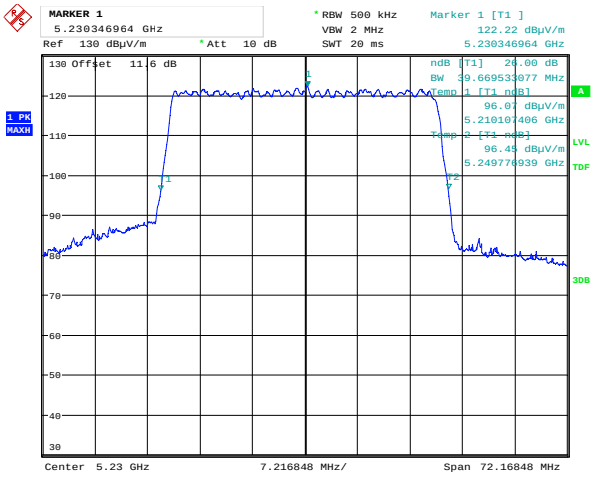
MIMO A



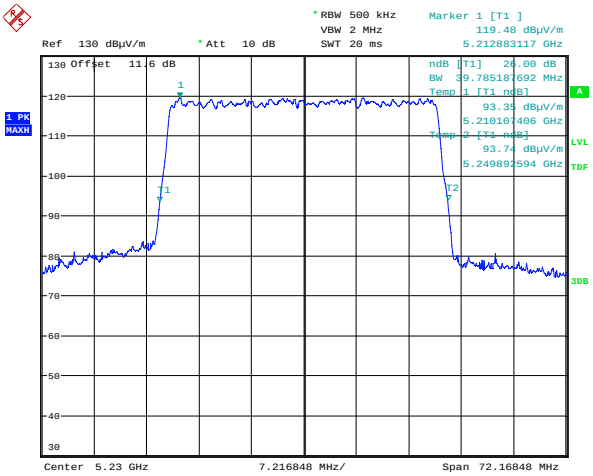
256QAM 5170 MHz

MIMO B

5230MHz					
Modulation Mode	**MIMO Mode**	***F_L (MHz)***	***F_H (MHz)***	***26dB Bandwidth (kHz)***	***Result***
QPSK	A	5210.107406	5249.776939	39669.533	PASS
16QAM	A	5210.223061	5249.776939	39553.878	PASS
64QAM	A	5210.223061	5249.776939	39553.878	PASS
256QAM	A	5210.448718	5249.711538	39262.821	PASS
QPSK	B	5210.107406	5249.892594	39785.188	PASS
16QAM	B	5210.288462	5249.711538	39423.077	PASS
64QAM	B	5210.288462	5249.711538	39423.076	PASS
256QAM	B	5210.288462	5249.551282	39262.820	PASS

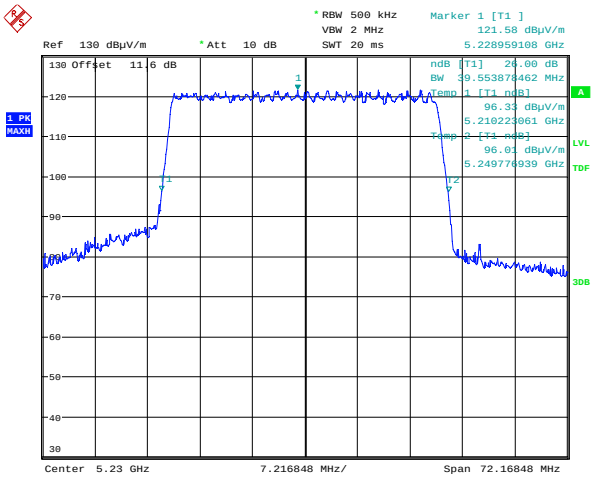


MIMO A

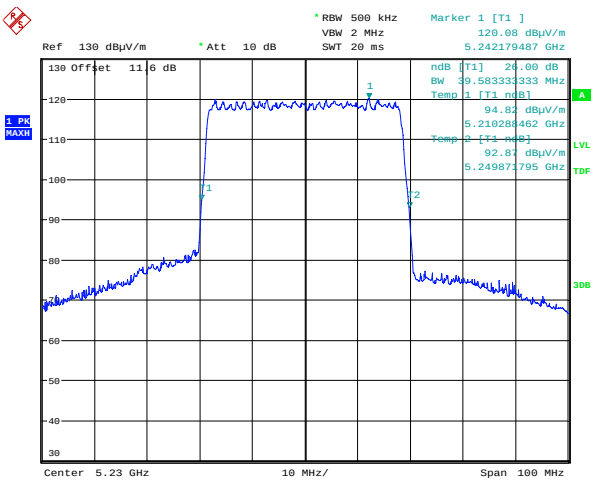


QPSK 5230MHz

MIMO B

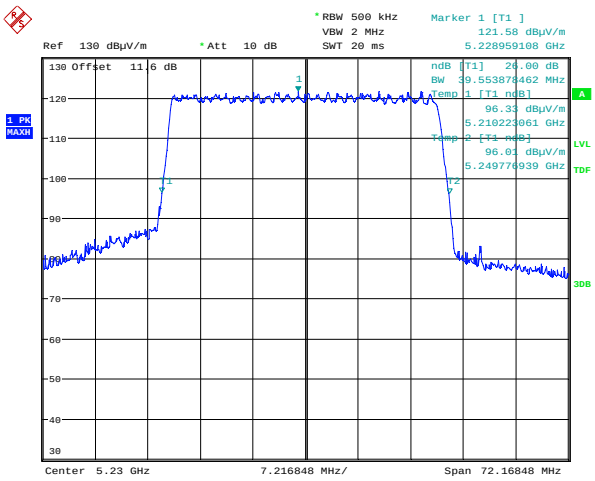


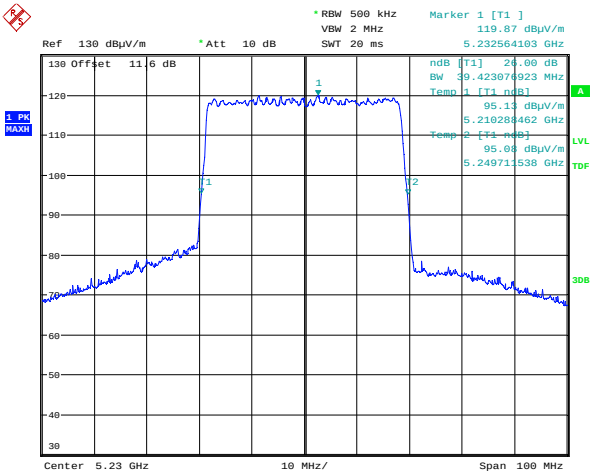
MIMO A



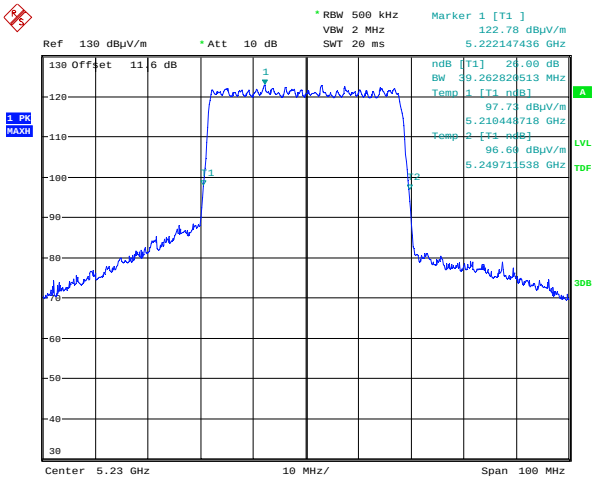
16QAM 5230MHz

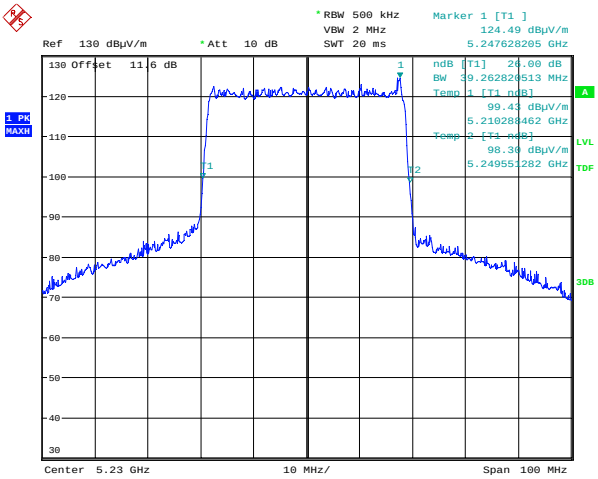
MIMO B





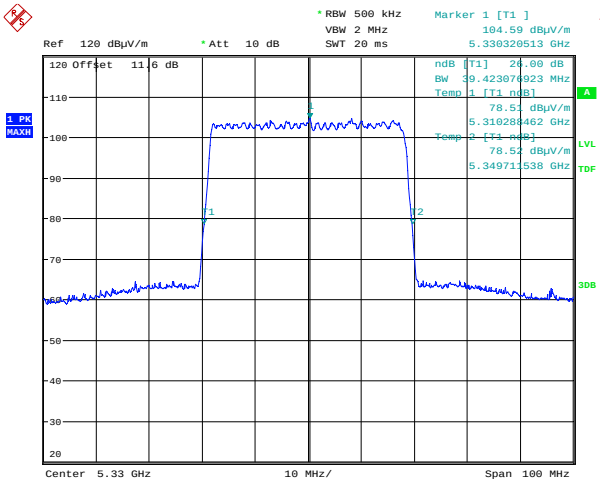
MIMO A 64QAM 5230MHz MIMO B



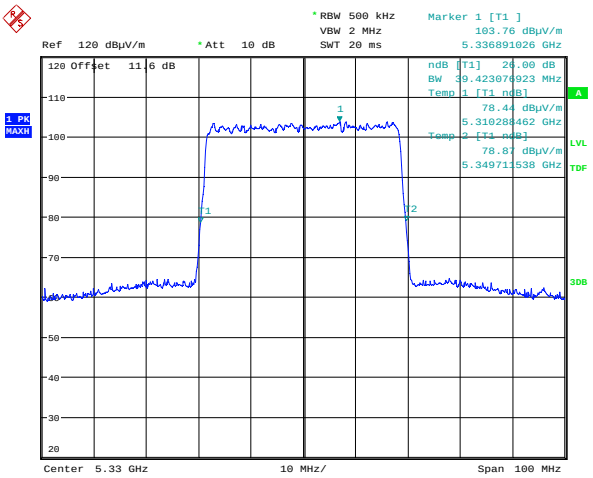


MIMO A 256QAM 5230MHz MIMO B

Modulation Mode: 5330 MHz					
Modulation Mode	**MIMO Mode**	***F_L (MHz)***	***F_H (MHz)***	***26dB Bandwidth (kHz)***	***Result***
QPSK	A	5310.288462	5349.711538	39423.076	PASS
16QAM	A	5310.288462	5349.711538	39423.076	PASS
64QAM	A	5310.128205	5349.551282	39423.077	PASS
256QAM	A	5310.288462	5349.711538	39423.076	PASS
QPSK	B	5310.288462	5349.711538	39423.076	PASS
16QAM	B	5310.288462	5349.711538	39423.076	PASS
64QAM	B	5310.128205	5349.711538	39583.333	PASS
256QAM	B	5310.288462	5349.551282	39262.820	PASS

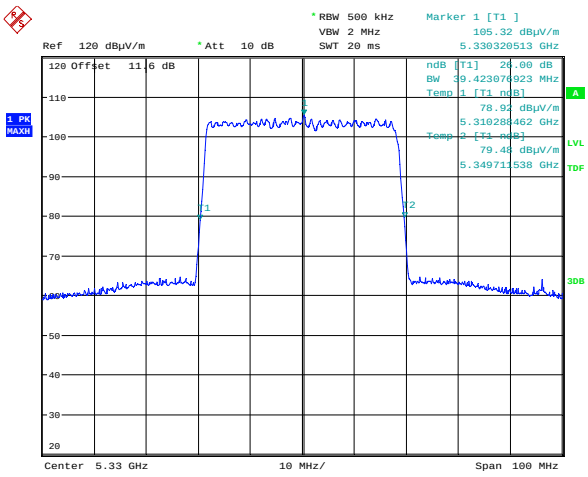


MIMO A

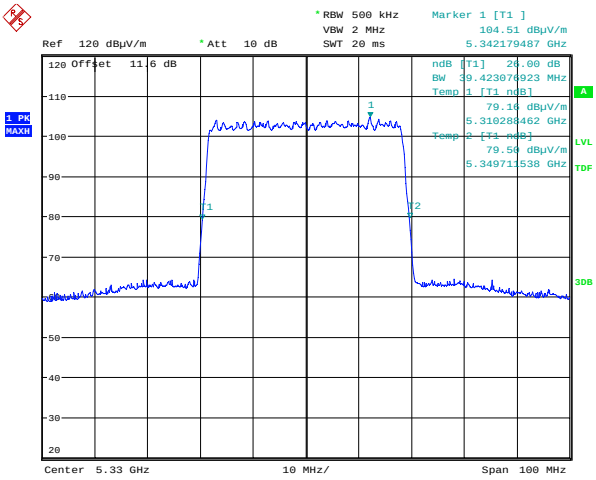


QPSK 5330 MHz

MIMO B

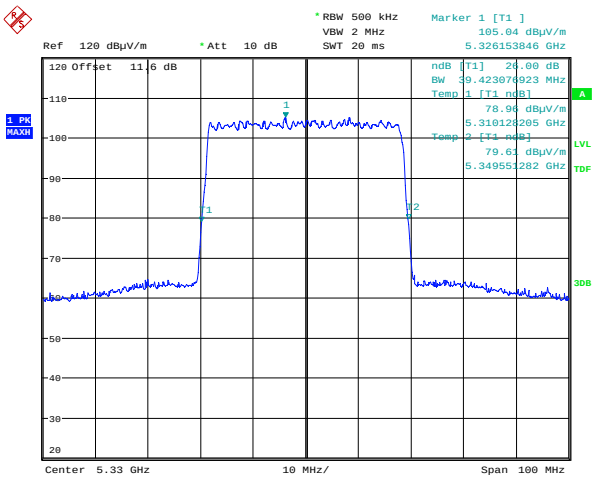


MIMO A

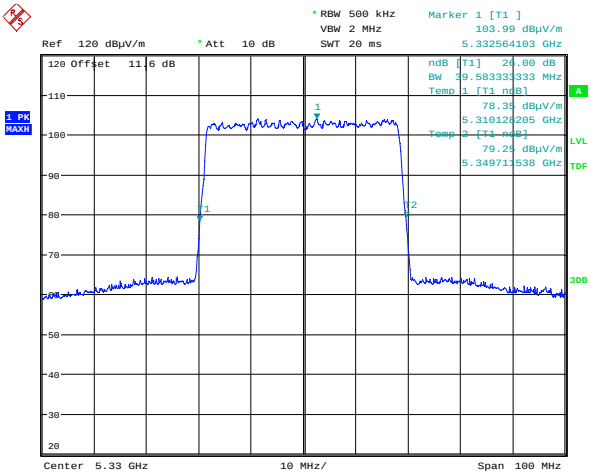


16QAM 5330 MHz

MIMO B

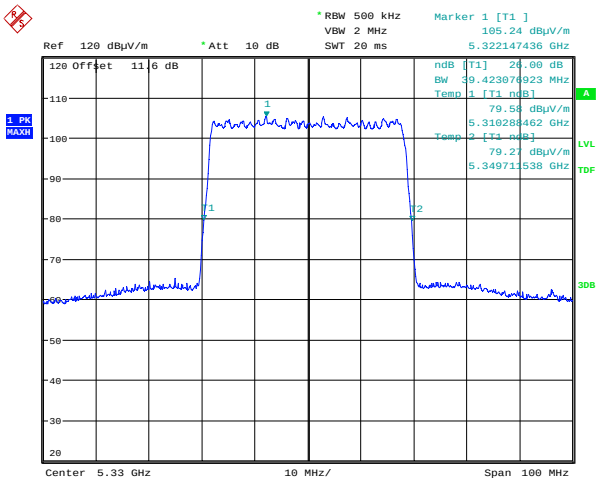


MIMO A

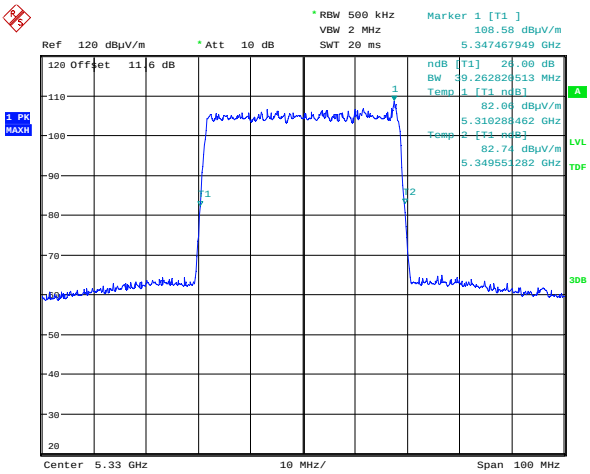


64QAM 5330 MHz

MIMO B



MIMO A



256QAM 5330 MHz

MIMO B

14 Maximum conducted output power

14.1 Definition

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

14.2 Test Parameters

Test Location:	30 Meter Open Area Test Site
Test Chamber:	Not Applicable
Test Standard and Clause:	ANSI C63.10-2013, Clause 12.3 KDB 789033 D02 Clauses II A1 and E3 KDB 662911 D01 Clause E
EUT Channels / Frequencies Measured:	5170 MHz / 5186.5 MHz / 5200 MHz / 5270 MHz 5300 MHz / 5330 MHz
EUT Occupied Bandwidths:	40 MHz
EUT Duty Cycle:	100%
Deviations From Standard:	None
Measurement BW:	Not Applicable
Measurement Span:	Not Applicable
Measurement Points:	Not Applicable
Measurement Detector:	RMS
Measurement Distance:	30 meters
Voltage Extreme Environment Test Range:	-48 Vdc POE

Environmental Conditions (Normal Environment)

Temperature: 8 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 %RH	20%RH to 75%RH (as declared)

Test Limits

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

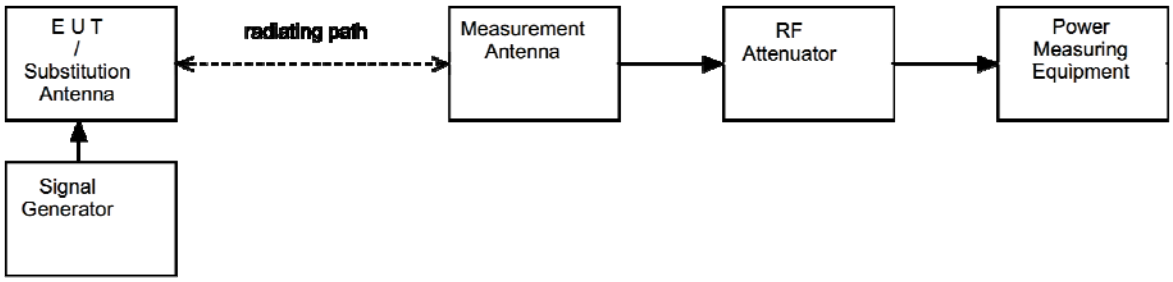
(2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

14.3 Test Method

The EUT was setup as per section 9 of this report and, as per Figure iv, once maximised for a particular polarisation the power meter was used to measure each polarisation in turn.
The results were summed to determine total power for both polarisations at the maximised angle as shown in the tables below to ensure compliance with the limit.
The measurement was repeated by maximising in the other polarisation and summing
The measurements were performed with EUT set at its maximum duty cycle.
All modulation schemes, data rates and EUT operating modes were used on one frequency to determine worst case.
Worst case modes used on all frequencies
Results recorded for highest total power orientation only
EIRP was determined using substitution method.

Software GUI Power Setting for Recorded Levels			
Test Frequency	***EUT Operating Mode***		
	SECTOR	***BEAMFORMING***	***MU-MIMO***
N-NII BAND 1			
5170.0	36.0	38.2	38.2
5186.5	38.2	39.5	39.5
5200.0	37.5	37.0	37.0
U-NII BAND 2A			
5270	32.7	32.7	33.3
5300.0	32.0	32.0	32.0
5330.0	32.0	32.0	32.0

Figure iv Test Setup



14.4 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Signal Generator	Agilent	E4438C	REF844	13/01/2016	24	13/01/2018
Spectrum Analyser	R&S	FSU46	REF910	13/07/2017	12	13/07/2018
Power Meter	Dare	RPR3006W	REF2112	27/03/2017	12	27/03/2018
Pre Amp	Agilent	8449B	L572	07/02/2017	12	07/02/2018
1-18GHz Horn	EMCO	3115	L138	13/04/2016	24	13/04/2018
Octave Horn Antenna	EMCO	3161-03	N/A*	18/02/15	36	18/02/18

* Not applicable, hired equipment

14.5 Test Results – U-NII-Band 1

Channel: 5170 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	2630.27	34.20	35.96
H	1318.26	31.20	
Result:		PASS	

Channel: 5170 MHz ; Modulation: 256QAM ; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	1778.28	32.50	35.51
V	1778.28	32.50	
Result:		PASS	

Channel: 5170 MHz ; Modulation: 256QAM A ; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	1659.59	32.20	35.41
V	1819.70	32.60	
Result:		PASS	

Channel: 5186.5 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	2344.23	33.70	35.53
H	1230.27	30.90	
Result:		PASS	

Channel: 5186.5 MHz ; Modulation: 256QAM ; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	1778.28	32.50	35.93
V	2137.96	33.30	
Result:		PASS	

Channel: 5186.5 MHz ; Modulation: 256QAM ; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	1737.80	32.40	35.36
H	1698.24	32.30	
Result:		PASS	

Channel: 5200 MHz ; Modulation: QPSK ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
H	1995.26	33.00	35.37
V	1445.44	31.60	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 16QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
H	1698.24	32.30	35.07
V	1513.56	31.80	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 64 QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
H	1905.46	32.80	35.96
V	2041.74	33.10	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
H	1819.70	32.60	35.81
V	1995.26	33.00	
Result:		PASS	

Channel: 5200 MHz ; Modulation: QPSK ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
H	1905.46	32.80	35.91
V	1995.26	33.00	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 16QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
H	1995.26	33.00	35.96
V	1949.84	32.90	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 64 QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
H	1949.84	32.90	35.91
V	1949.84	32.90	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
H	1995.26	33.00	35.96
V	1949.84	32.90	
Result:		PASS	

Channel: 5200 MHz; Modulation: QPSK; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	2187.76	33.40	35.56
V	1412.54	31.50	
Result:		PASS	

Channel: 5200 MHz; Modulation: 16QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	2137.96	33.30	35.54
H	1445.44	31.60	
Result:		PASS	

Channel: 5200 MHz; Modulation: 64QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	1737.80	32.40	35.83
V	2089.30	33.20	
Result:		PASS	

Channel: 5200 MHz; Modulation: 256QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	1445.44	31.60	33.80
H	954.99	29.80	
Result:		PASS	

Channel: 5200 MHz; Modulation: QPSK; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	1905.46	32.80	35.17
H	1380.38	31.40	
Result:		PASS	

Channel: 5200 MHz; Modulation: 16QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	1819.70	32.60	35.01
H	1348.96	31.30	
Result:		PASS	

Channel: 5200 MHz; Modulation: 64QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	1778.28	32.50	34.95
H	1348.96	31.30	
Result:		PASS	

Channel: 5200 MHz; Modulation: 256QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	1202.26	30.80	34.86
V	1862.09	32.70	
Result:		PASS	

14.6 Test Results – U-NII-Band 2a

Channel: 5270 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	660.69	28.20	29.44
H	218.78	23.40	
Result:		PASS	

Channel: 5270 MHz ; Modulation: 256QAM ; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	288.40	24.60	29.10
V	524.81	27.20	
Result:		PASS	

Channel: 5270 MHz ; Modulation: 256QAM ; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	537.03	27.30	29.27
H	309.03	24.90	
Result:		PASS	

Channel: 5300 MHz ; Modulation: QPSK ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
V	645.65	28.10	29.80
H	309.03	24.90	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 16QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
V	645.65	28.10	29.77
H	302.00	24.80	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 64QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
V	630.96	28.00	29.70
H	302.00	24.80	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
V	616.60	27.90	29.70
H	316.23	25.00	
Result:		PASS	

Channel: 5300 MHz ; Modulation: QPSK ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
V	645.65	28.10	29.97
H	346.74	25.40	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 16QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
V	630.96	28.00	29.97
H	363.08	25.60	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 64QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
V	645.65	28.10	29.90
H	331.13	25.20	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**EIRP (mW)**	**EIRP (dBm)**	**Total EIRP (dBm)**
V	645.65	28.10	30.00
H	354.81	25.50	
Result:		PASS	

Channel: 5300 MHz; Modulation: QPSK; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	426.58	26.30	29.84
V	537.03	27.30	
Result:		PASS	

Channel: 5300 MHz; Modulation: 16QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	398.11	26.00	29.37
V	467.74	26.70	
Result:		PASS	

Channel: 5300 MHz; Modulation: 64QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	398.11	26.00	29.43
V	478.63	26.80	
Result:		PASS	

Channel: 5300 MHz; Modulation: 256QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	398.11	26.00	29.37
V	467.74	26.70	
Result:		PASS	

Channel: 5300 MHz; Modulation: QPSK; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	354.81	25.50	28.41
V	338.84	25.30	
Result:		PASS	

Channel: 5300 MHz; Modulation: 16QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	389.05	25.90	28.44
H	309.03	24.90	
Result:		PASS	

Channel: 5300 MHz; Modulation: 64QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	380.19	25.80	28.38
H	309.03	24.90	
Result:		PASS	

Channel: 5300 MHz; Modulation: 256QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	389.05	25.90	28.40
H	302.00	24.8	
Result:		PASS	

Channel: 5330 MHz ; Modulation: 64QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	691.83	28.40	29.52
H	204.17	23.10	
Result:		PASS	

Channel: 5330 MHz ; Modulation: 64QAM ; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
H	269.15	24.30	29.00
V	524.81	27.20	
Result:		PASS	

Channel: 5330 MHz ; Modulation: 64QAM ; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***EIRP (mW)***	***EIRP (dBm)***	***Total EIRP (dBm)***
V	562.34	27.50	29.33
H	295.12	24.70	
Result:		PASS	

15 Power spectral density

15.1 Definition

The power spectral density is the total energy output per unit bandwidth from a pulse or sequence of pulses for which the transmit power is at its maximum level, divided by the total duration of the pulses.

15.2 Test Parameters

Test Location:	30 Meter Open Area Test Site
Test Chamber:	Not Applicable
Test Standard and Clause:	ANSI C63.10-2013, Clause 12.5 KDB 789033 D02 Clauses II A1 and F KDB 662911 D01 Clause E
EUT Channels / Frequencies Measured:	5170 MHz / 5186.5 MHz / 5200 MHz / 5270 MHz 5300 MHz / 5330 MHz
EUT Channel Bandwidths:	40 MHz
Deviations From Standard:	None
Measurement BW:	1 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	2MHz
Measurement Span: (requirement 1.5 times Channel BW)	>30MHz
Measurement Detector:	RMS

Environmental Conditions (Normal Environment)

Temperature: 8 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 %RH	20%RH to 75%RH (as declared)
Supply: -48 Vdc POE	-48 Vdc POE

Test Limits

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

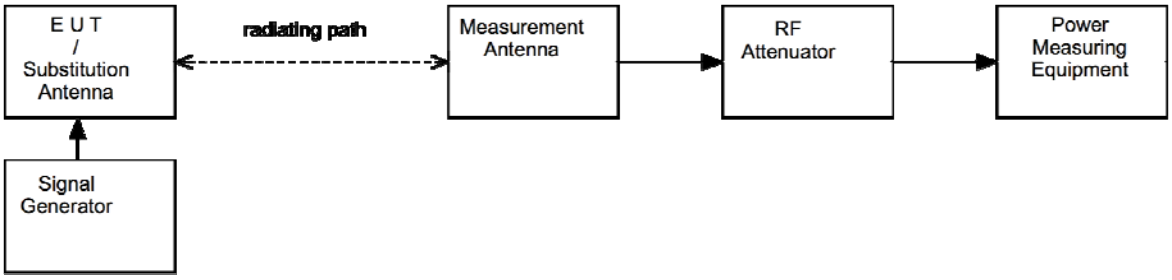
(iv) For client devices in the 5.15-5.25 GHz band, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

15.3 Test Method

The EUT was setup as per section 9 of this report and, as per Figure iv, once maximised for a particular polarisation the spectrum analyser was used to measure each polarisation in turn.
The results were summed to determine total power for both polarisations at the maximised angle as shown in the tables below to ensure compliance with the limit.
The measurement was repeated by maximising in the other polarisation and summing
The measurements were performed with EUT set at its maximum duty cycle.
All modulation schemes, data rates and EUT operating modes were used on one frequency to determine worst case.
Worst case modes used on all frequencies
Results recorded for highest PSD orientation only
PSD was determined using substitution method.

Figure v Test Setup



15.4 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Signal Generator	Agilent	E4438C	REF844	13/01/2016	24	13/01/2018
Spectrum Analyser	R&S	FSU46	REF910	13/07/2017	12	13/07/2018
Power Meter	Dare	RPR3006W	REF2112	27/03/2017	12	27/03/2018
Pre Amp	Agilent	8449B	L572	07/02/2017	12	07/02/2018
1-18GHz Horn	EMCO	3115	L138	13/04/2016	24	13/04/2018
Octave Horn Antenna	EMCO	3161-03	N/A*	18/02/15	36	18/02/18

* Not applicable, hired equipment

15.5 Test Results – U-NII-Band 1

Channel: 5170 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	64.71	18.11	19.79
H	30.62	14.86	
Result:		PASS	

Channel: 5170 MHz ; Modulation: 256QAM ; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	61.52	17.89	21.68
V	85.70	19.33	
Result:		PASS	

Channel: 5170 MHz ; Modulation: 256QAM A ; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	61.52	17.89	21.04
V	65.61	18.17	
Result:		PASS	

Channel: 5186.5 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	91.41	19.61	21.41
H	47.10	16.73	
Result:		PASS	

Channel: 5186.5 MHz ; Modulation: 256QAM ; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	73.28	18.65	21.98
V	84.53	19.27	
Result:		PASS	

Channel: 5186.5 MHz ; Modulation: 256QAM ; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	69.66	18.43	21.56
H	73.62	18.67	
Result:		PASS	

Channel: 5200 MHz ; Modulation: QPSK ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	74.30	18.71	21.02
V	52.24	17.18	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 16QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	54.95	17.40	20.26
V	51.29	17.10	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 64 QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	60.26	17.80	21.02
V	66.07	18.20	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	44.67	16.50	19.70
V	48.75	16.88	
Result:		PASS	

Channel: 5200 MHz ; Modulation: QPSK ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
H	60.67	17.83	20.90
V	62.37	17.95	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 16QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	69.02	18.39	20.27
H	37.41	15.73	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 64 QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
H	48.31	16.84	19.79
V	46.88	16.71	
Result:		PASS	

Channel: 5200 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
H	49.66	16.96	19.90
V	47.97	16.81	
Result:		PASS	

Channel: 5200 MHz; Modulation: QPSK; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	49.32	16.93	21.07
V	78.52	18.95	
Result:		PASS	

Channel: 5200 MHz; Modulation: 16QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	67.76	18.31	20.48
H	43.85	16.42	
Result:		PASS	

Channel: 5200 MHz; Modulation: 64QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	55.08	17.41	20.80
V	65.01	18.13	
Result:		PASS	

Channel: 5200 MHz; Modulation: 256QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	42.66	16.30	18.59
H	29.65	14.72	
Result:		PASS	

Channel: 5200 MHz; Modulation: QPSK; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	68.39	18.35	20.75
H	50.35	17.02	
Result:		PASS	

Channel: 5200 MHz; Modulation: 16QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	58.61	17.68	20.08
H	43.35	16.37	
Result:		PASS	

Channel: 5200 MHz; Modulation: 64QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	57.41	17.59	20.07
H	44.16	16.45	
Result:		PASS	

Channel: 5200 MHz; Modulation: 256QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	37.15	15.70	19.58
V	53.58	17.29	
Result:		PASS	

Test Results – U-NII-Band 2a

Channel: 5270 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	24.66	13.92	15.21
H	8.55	9.32	
Result:		PASS	

Channel: 5270 MHz ; Modulation: 256QAM ; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	11.19	10.49	15.05
V	20.80	13.18	
Result:		PASS	

Channel: 5270 MHz ; Modulation: 256QAM ; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	20.80	13.18	15.18
H	12.13	10.84	
Result:		PASS	

Channel: 5300 MHz ; Modulation: QPSK ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	21.38	13.30	14.99
H	10.14	10.06	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 16QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	20.84	13.19	14.86
H	9.77	9.90	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 64QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	21.23	13.27	14.98
H	10.26	10.11	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	20.80	13.18	14.93
H	10.33	10.14	
Result:		PASS	

Channel: 5300 MHz ; Modulation: QPSK ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	21.13	13.25	15.17
H	11.75	10.70	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 16QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	20.65	13.15	15.17
H	12.22	10.87	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 64QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	21.23	13.27	15.09
H	11.02	10.42	
Result:		PASS	

Channel: 5300 MHz ; Modulation: 256QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO B			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	20.42	13.10	15.13
H	12.13	10.84	
Result:		PASS	

Channel: 5300 MHz; Modulation: QPSK; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	14.55	11.63	15.12
V	17.99	12.55	
Result:		PASS	

Channel: 5300 MHz; Modulation: 16QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	13.65	11.35	14.67
V	15.63	11.94	
Result:		PASS	

Channel: 5300 MHz; Modulation: 64QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	14.44	11.60	14.81
V	15.81	11.99	
Result:		PASS	

Channel: 5300 MHz; Modulation: 256QAM; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
H	13.74	11.38	14.70
V	15.74	11.97	
Result:		PASS	

Channel: 5300 MHz; Modulation: QPSK; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	14.00	11.46	14.00
H	11.09	10.45	
Result:		PASS	

Channel: 5300 MHz; Modulation: 16QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	14.96	11.75	14.20
H	11.32	10.54	
Result:		PASS	

Channel: 5300 MHz; Modulation: 64QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	14.45	11.60	14.06
H	11.02	10.42	
Result:		PASS	

Channel: 5300 MHz; Modulation: 256QAM; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	***PSD (mW)***	***PSD (dBm)***	***Total PSD (dBm)***
V	14.86	11.72	14.17
H	11.27	10.52	
Result:		PASS	

Channel: 5330 MHz ; Modulation: 64QAM ; EUT Mode: SECTOR; EUT Data Mode: MIMO A			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	29.17	14.65	15.78
H	8.65	9.37	
Result:		PASS	

Channel: 5330 MHz ; Modulation: 64QAM ; EUT Mode: BEAMFORMING; EUT Data Mode: MIMO A			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
H	11.09	10.45	15.37
V	23.33	13.68	
Result:		PASS	

Channel: 5330 MHz ; Modulation: 64QAM ; EUT Mode: MU-MIMO; EUT Data Mode: MIMO A			
Antenna Pol	**PSD (mW)**	**PSD (dBm)**	**Total PSD (dBm)**
V	24.15	13.83	15.58
H	12.02	10.80	
Result:		PASS	

16 Out-of-band spurious emissions

16.1 Definition

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Spurious emission.
Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude out-of-band emissions.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 12.7.3 KDB 789033 D02 II G
EUT Channels / Frequencies Measured: (requirement as close to upper and lower frequency band edges as the design of the equipment permits).	5170 MHz / 5270 MHz / 5330 MHz
EUT Channel Bandwidths:	40 MHz
Deviations From Standard:	None
Measurement BW:	1 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	3 MHz
Measurement Detector:	Peak
Measurement Range:	1 GHz to 40 GHz
Antenna Gain: (required if conducted measurement made)	Not Applicable

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 48 %RH	20%RH to 75%RH (as declared)
Supply: +48 Vdc POE	+48 Vdc POE

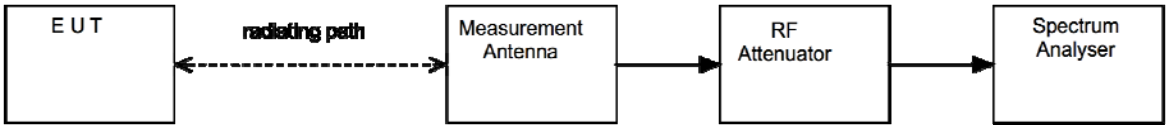
Test Limits
15.407(b):
(1) For transmitters operating in the 5.15–5.25 GHz band: All emissions outside of the 5.15–5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.
(2) For transmitters operating in the 5.25–5.35 GHz band: All emissions outside of the 5.15–5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.
(3) For transmitters operating in the 5.47–5.725 GHz band: All emissions outside of the 5.47–5.725 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.
(4)(i) For transmitters operating in the 5.725–5.85 GHz band: All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

The provisions of §15.205 apply to intentional radiators operating under this section

16.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vii, the emissions from the EUT were measured on a spectrum analyser.
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

Figure vii Test Setup



16.4 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Spectrum Analyser	R&S	FSU46	U281	19/06/2017	12	19/06/2018
1-18GHz Horn	EMCO	3115	L139	25/09/2017	24	25/09/2019
Pre Amp	Agilent	8449B	L572	07/02/2017	12	07/02/2018
6 dB Attenuator	Bird	8304-060-N	U376	Calibrate in Use		
10 dB Attenuator	Bird	8304-100-N	L222	Calibrate in Use		

Conversion from field strength to eirp is as follows:

$$EIRP = E + 20\log(d) - 104.77, \text{ where}$$

EIRP is the equivalent isotropically radiated power in dBm;
E is field strength in dBμV/m;
d is the measurement distance in meters.

Measurements are made at 5170 MHz, 5270 and at 5330 MHz.

Measurement made at 5170 MHz; 5270 and at 5330 MHz are at a power setting used for maximum EIRP and are set to the highest level whilst still achieving compliance with the requirements.

These frequencies are determined as the lowest middle and highest high power operating frequencies based on power setting required to achieve compliance with the requirements.

16.5 Test Results

Channel: 5170 MHz						
Emission Frequency (MHz)	***Peak Field Strength (dBµV/m)***	***Distance (m)***	***Power (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
*The provisions of §15.205 apply in restricted bands (See Section 11)						PASS
No Significant Emissions >10 MHz from Band edge						PASS

Channel: 5270 MHz						
Emission Frequency (MHz)	***Peak Field Strength (dBµV/m)***	***Distance (m)***	***Power, eirp (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
*The provisions of §15.205 apply in restricted bands (See Section 11)						PASS
10495	56.21	3	-39.02	-27	-12.02	PASS

Channel: 5330 MHz						
Emission Frequency (MHz)	***Peak Field Strength (dBµV/m)***	***Distance (m)***	***Power, eirp (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
*The provisions of §15.205 apply in restricted bands (See Section 11)						PASS
No Significant Emissions >10 MHz from Band edge						PASS

* Emissions close to the Bandedges fall into restricted bands (4.5-5.15 GHz and 5.35 – 5.46 GHz) listed in 15.205 and are therefore subject to the general radiated spurious emission limits of 15.209

17 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence:

[1] Radiated spurious emissions

Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[2] AC power line conducted emissions

Uncertainty in test result = **3.4dB**

[3] Occupied bandwidth

Uncertainty in test result = **15.5%**

[4] Conducted carrier power

Uncertainty in test result (Power Meter) = **1.08dB**

[5] Conducted / radiated RF power out-of-band

Uncertainty in test result – Up to 8.1GHz = **3.31dB**
Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[6] Power spectral density

Uncertainty in test result (Spectrum Analyser) = **2.48dB**