Report on the Radio Testing

For

SmarDTV (UK) Limited

on

S55

Report no. TRA-031431-00-45-03A

20th April 2017

RFXXX

Report Number: TRA-031431-00-45-03A
Issue: A

REPORT ON THE RADIO TESTING OF A
SmarDTV (UK) Limited
S55
WITH RESPECT TO SPECIFICATION
FCC 47CFR Subpart E

TEST DATE: 25th Apr - 26th Sep 2016

Tested by:	A Longley	A Longley - A Tosif – A Wong Radio Test Engineers
Written by:	A Tosif	A Tosif Radio Test Engineer
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Date:	20th April 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	20th April 2017	Original

2 Summary

TEST REPORT NUMBER:	TRA-031431-00-45-03A
WORKS ORDER NUMBER:	TRA-029575-02
PURPOSE OF TEST:	Certification
TEST SPECIFICATION:	47CFR15 Subpart E
EQUIPMENT UNDER TEST (EUT):	S55
FCC IDENTIFIER:	DKN-AVAD1
ISED IDENTIFER:	1707A-AVAD1
MANUFACTURER/AGENT:	SmarDTV (UK) Limited
ADDRESS:	Beckside Design Centre Millennium Business Park Station Rd Steeton Keighley West Yorkshire BD20 6QW United Kingdom
CLIENT CONTACT:	Chris Wordley ☎ 01535 659000 ✉ chris.wordley@smardtv.com
ORDER NUMBER:	POR01251
TEST DATE:	25th Apr - 26th Sep 2016
TESTED BY:	A Longley - A Tosif – A Wong Element

2.1 Test Summary

Test Method and Description		*Requirement Clause* *47CFR15*	*Applicable to this equipment*	*Result / Note*
Out-of-band emissions		15.407(b)	☐	*Note 3*
AC power line conducted emissions		15.207	☐	*Note 1*
Occupied bandwidth		15.407(e)	☒	*Pass*
Output power	Conducted	15.407(a)	☒	*Pass*
	PSD		☒	
	RPE		☐	
TPC and DFS		15.407(h)	☐	*Note 2*

Notes:

1. Battery power operation only, with an internal fully charged Lithium-ion battery
2. See Test report TRA-029575-02-45-06A
3. See Test report TRA-031431-00-45-00A

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).

3 Contents

1 Revision Record 3
2 Summary 4
2.1 Test Summary 5
3 Contents 6
4 Introduction 7
5 Test Specifications 8
5.1 Normative References 8
5.2 Deviations from Test Standards 8
6 Glossary of Terms 9
7 Equipment under Test 10
7.1 EUT Identification 10
7.2 EUT Mode of Operation 10
7.2.1 Transmission 10
7.3 EUT Radio Frequency Parameters 13
7.3.1 General 13
7.3.2 Antennas 13
7.3.3 Product specific declarations 13
7.4 13
7.5 EUT Description 14
8 Modifications 15
9 EUT Test Setup 16
9.1 Block Diagram 16
10 General Technical Parameters 17
10.1 Normal Conditions 17
10.2 Varying Test Conditions 17
11 Occupied Bandwidth 18
11.1 Definition 18
11.2 Test Parameters 18
11.3 Test Method 18
11.4 Test Equipment 19
11.5 Test Results 19
12 Maximum conducted output power 27
12.1 Definition 27
12.2 Test Parameters 27
12.3 Test Method 27
12.4 Test Equipment 27
12.5 Test Limits 28
12.6 Test Results 29
13 Power spectral density 31
13.1 Definition 31
13.2 Test Parameters 31
13.3 Test Method 31
13.4 Test Equipment 31
13.5 Test Limits 33
13.6 Test Results 34
14 Measurement Uncertainty 36
15 RF Exposure 37

4 Introduction

This report TRA-031431-00-45-03A presents the results of the Radio testing on a SmarDTV (UK) Limited, S55 to specification 47CFR15 Radio Frequency Devices and RSS-247 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.

The testing was carried out for SmarDTV (UK) Limited 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
Skemersdale
West Lancashire
WN8 9PN
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.

IC 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 5470-5725 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.

5.2 Deviations from Test Standards

Only conducted emission results are included in this test report. The radiated measurements for the 5GHz WiFi module are contained within report TRA-031431-00-45-00A. The manufacturer declared that no changes to the module were made.

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
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
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: S55
- Serial Number: Sample 7
- Model Number: S55
- Software Revision: RF Test Software
- Build Level: Pre-production

7.2 EUT Mode of Operation

7.2.1 Transmission

The mode of operation for Tx tests was as follows.

Wi-Fi transmitter control was via commands sent through MTool v2.0.3.2 software. The commands provided by the manufacturer setup the device into a permanent transmit mode. For each type of test, lowest and highest date rates were investigated to find the worst case data rate. Only the worst case results are reported. The commands allowed adjustment of the following parameters of significant interest.

Modulation Scheme / Mode	Channel	Data rate	Power setting
802.11a / CDD	36	OFDM6	44
		OFDM54	44
	52	OFDM6	62
		OFDM54	56
	64	OFDM6	58
		OFDM54	56
	100	OFDM6	58
		OFDM54	56
	116	OFDM6	62
		OFDM54	56
	144	OFDM6	62
		OFDM54	56
	149	OFDM6	62
		OFDM54	56
	157	OFDM6	62
		OFDM54	56
	165	OFDM6	62
		OFDM54	56

Modulation Scheme	Channel	Data rate	Power setting
802.11n/ac 20 MHz / CDD	36	mcs0	44
		mcs8	44
	52	mcs0	62
		mcs8	56
	64	mcs0	58
		mcs8	52
	100	mcs0	62
		mcs8	56
	116	mcs0	62
		mcs8	56
	144	mcs0	62
		mcs8	56
	149	mcs0	62
		mcs8	56

	157	mcs0	62
		mcs8	56
	165	mcs0	62
		mcs8	56

Modulation Scheme	Channel	Data rate	Power setting
802.11n/ac 40 MHz / CDD	38	mcs0	44
		mcs9	44
	54	mcs0	62
		mcs9	56
	62	mcs0	54
		mcs9	52
	102	mcs0	48
		mcs9	40
	110	mcs0	62
		mcs9	56
	142	mcs0	62
		mcs9	56
	151	mcs0	62
		mcs9	56
	159	mcs0	62
		mcs9	56

Modulation Scheme	Channel	Data rate	Power setting
802.11ac 80 MHz / CDD	42	mcs0	46
		mcs9	46
	58	mcs0	52
		mcs9	44
	106	mcs0	48
		mcs9	42
	122	mcs0	58
		mcs9	42
	138	mcs0	58
		mcs9	42
	155	mcs0	58
		mcs9	42

7.3 EUT Radio Frequency Parameters

7.3.1 General

Frequency of operation:	5.15 GHz – 5.35 GHz; 5.47 GHz – 5.725 GHz; 5.725GHz – 5.85 GHz
Occupied channel bandwidth(s):	20 MHz / 40 MHz / 80 MHz
Nominal Supply Voltage:	Lithium-ion Battery at 3.7 V d.c.
Location of notice for license exempt use:	The FCC part 15.19(a) statement is in the online user manual

7.3.2 Antennas

Type:	Embedded
Frequency range:	4.9 – 5.9 GHz
Impedance:	50 ohms
VSWR:	< 2:1
Gain:	2.7 dBi peak gain at 5.2 GHz and 2.7 dBi peak gain at 5.8 GHz
Polarisation:	Non polar
Beam width:	N/A: Not directional.
Connector type:	50 ohm, 1.13mm diameter, micro coax cable, U.FL compatible cable connector (optional), cable mounted EMI ferrites (optional)
Dimensions:	17.2 x 17.2 x 0.8 mm
Weight:	0.51 g (0.018 oz)
Environmental limits:	Operating: -40° C to +75° C (-40° F to +167° F) Storage: -40° C to +85° C (-40° F to +185° F) 0% to 95% non-condensing
Mounting:	U. FL compatible cable connector

7.3.3 Product specific declarations

Multiple antenna configuration(s), e.g. MIMO:	MIMO
Simultaneous tx (yes/no):	Yes

7.4

7.5 EUT Description

The EUT is a converter for HDMI video streams and then transmits then data over a WiFi network.

This report only covers 5 GHz Wi-Fi Client. This radio is a DFS Slave device without radar detect. It uses the following operating schemes (beamformig is not supported):

- SISO (single antenna transmission)
- SM-MIMO (multiple antenna transmission, uncorrelated)
- STBC (multiple antenna transmission, uncorrelated)
- CDD (multiple antenna transmission, correlated)

Testing is only performed in CDD mode with both antennas' active.

It uses 6 modulation schemes in the 5 GHz band:

- 802.11a (20 MHz)
- 802.11n (20 MHz)
- 802.11n (40 MHz)
- 802.11ac (20 MHz)
- 802.11ac (40 MHz)
- 802.11ac (80 MHz)

And can transmit in the following bands:

- U-NII-1
- U-NII-2A
- U-NII-2C
- U-NII-3

There are 2 antennas of known gain

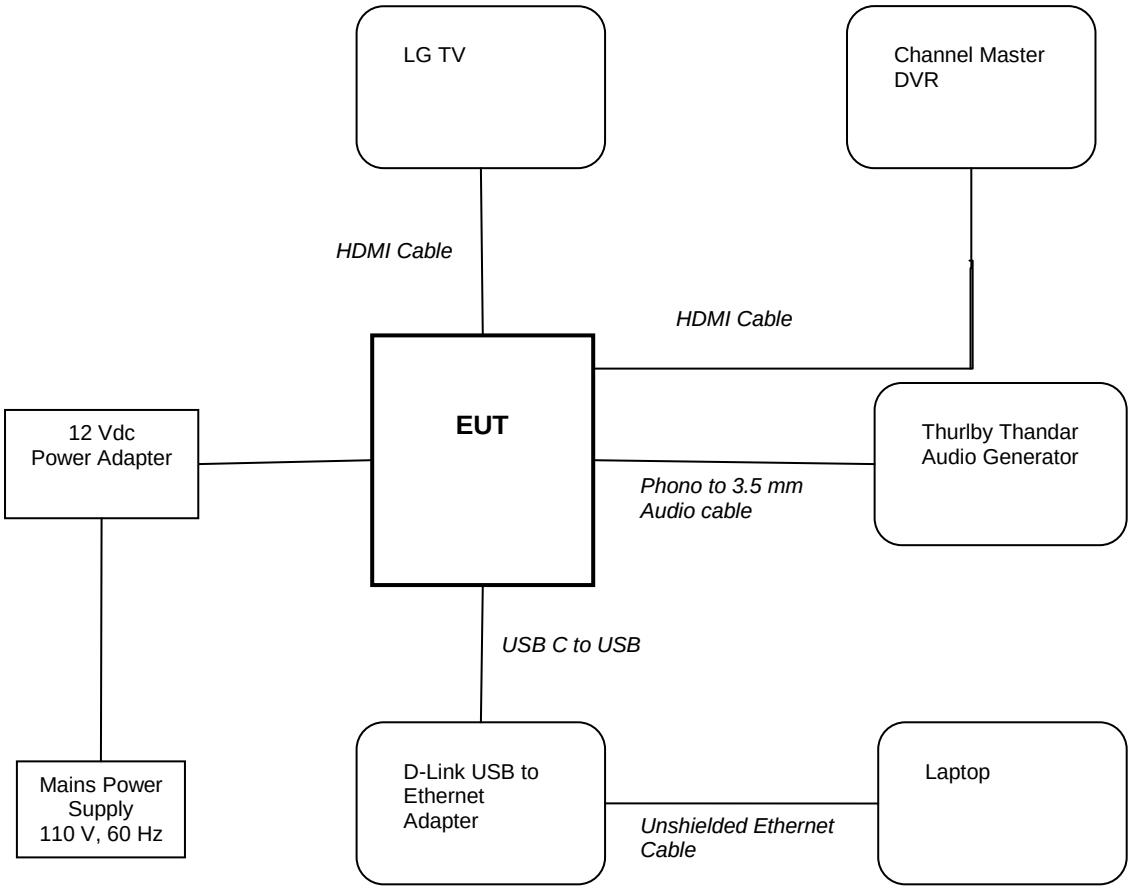
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

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



Conducted measurements were performed under with the module mounted in a N63 device. Setup relates to the N63 device in which the module was mounted during conducted testing. N63 information details.

- Serial Number: 1604210679 & 14604210698
- Model Number: TRA-029575 – S60

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.

Sample No.	*Description*	*Model No.*	*Serial No.*
TRA-029575 - S08	EUT 12 Vdc Power Adapter	EADP-40MB A	HBBD45F00A7
TRA-029575 - S11	Lenovo ThinkPad	E560	34546
TRA-029575 - S14	Thurlby Thandar Audio Generator	TF215	045441
TRA-029575 - S15	LG TV	M227WDL	002MAAK4P824
TRA-029575 - S17	Channel Master DVR	CM-7500TB1	R5YFKZ00228D
TRA-029575 - S27	Dlink USB to Ethernet adapter	DUB-E100	Q8041AA002873

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 to the N63 Host device was approx. 110 V ac, 60 Hz, from the mains.

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 was made:

	Category	***Nominal***	***Variation***
☒	Mains	110V ac +/-2%	85% and 115%
☐	Battery	New battery	N/A

11 Occupied Bandwidth

11.1 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.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9, KDB 789033 D02
EUT Channels / Frequencies Measured:	36, 38, 42, 52, 54, 58, 62, 64, 100, 102, 106, 110, 116, 122, 138, 142, 144, 149, 151, 155, 157, 159, 165
EUT Channel Bandwidths:	20 MHz / 40 MHz / 80 MHz
Deviations From Standard:	None
Measurement BW:	1% of the emission bandwidth for 26 dB BW, 100 kHz for 6 dB BW
Spectrum Analyzer Video BW:	> RBW for 26 dB BW, ≥ 3 × RBW for 6 dB BW
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 ºC to +35 ºC (as declared)
Humidity: 48 %RH	20%RH to 75%RH (as declared)
Supply: 110 Vac	

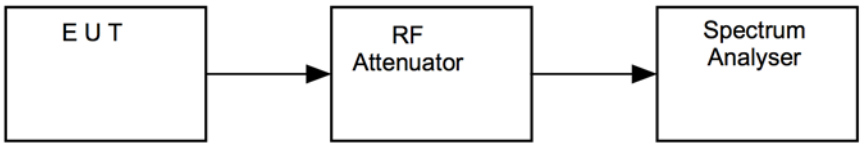
Test Limits

Within the 5.725–5.85 GHz band, the minimum 6 dB bandwidth of U–NII devices shall be at least 500 kHz.

11.3 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



11.4 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Spectrum Analyser	R&S	FSU50	U544	30/05/2016	12	29/05/2017

11.5 Test Results

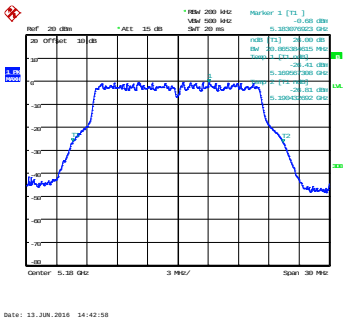
Modulation: 802.11a				
Channel Frequency (MHz)	*F_L (MHz)*	*F_H (MHz)*	*26dB Bandwidth (MHz)*	*Result*
5180	5169.567308	5190.432692	20.865	PASS
5260	5249.375000	5270.480769	21.106	PASS
5320	5309.375000	5330.480769	21.106	PASS
5500	5489.375000	5510.528846	21.154	PASS
5580	5569.375000	5590.576923	21.202	PASS
5720	5709.375000	5730.528846	21.154	PASS
5745	5734.375000	5755.528846	21.154	PASS
5785	5774.326923	5795.528846	21.202	PASS
5825	5814.326923	5835.528846	21.202	PASS

Modulation: 802.11ac-VHT20				
Channel Frequency (MHz)	*F_L (MHz)*	*F_H (MHz)*	*26dB Bandwidth (MHz)*	*Result*
5180	5169.230769	5190.721154	21.490	PASS
5260	5249.230769	5270.721154	21.490	PASS
5320	5309.230769	5330.721154	21.490	PASS
5500	5489.182692	5510.769231	21.587	PASS
5580	5569.134615	5590.721154	21.587	PASS
5720	5709.182692	5730.721154	21.538	PASS
5745	5734.230769	5755.721154	21.490	PASS
5785	5774.134615	5795.673077	21.538	PASS
5825	5814.134615	5835.721154	21.587	PASS

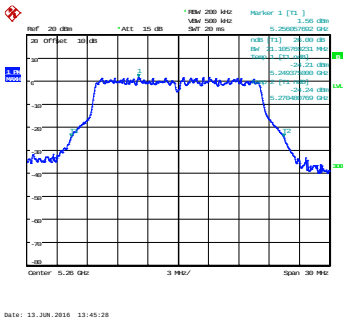
Modulation: 802.11ac-VHT40				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	26dB Bandwidth (MHz)	Result
5190	5169.903846	5210.096154	40.192	PASS
5270	5249.807692	5290.192308	40.385	PASS
5310	5289.807692	5330.192308	40.385	PASS
5510	5489.807692	5530.192308	40.385	PASS
5550	5529.807692	5570.096154	40.288	PASS
5710	5689.807692	5730.096154	40.288	PASS
5755	5734.903846	5775.096154	40.192	PASS
5795	5774.807692	5815.096154	40.288	PASS

Modulation: 802.11ac-VHT80				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	26dB Bandwidth (MHz)	Result
5210	5168.814103	5251.346154	82.532	PASS
5290	5248.814103	5331.506410	82.692	PASS
5530	5488.814103	5571.025641	82.212	PASS
5610	5568.653846	5651.506410	82.853	PASS
5690	5648.814103	5731.346154	82.532	PASS
5775	5733.814103	5816.346154	82.532	PASS

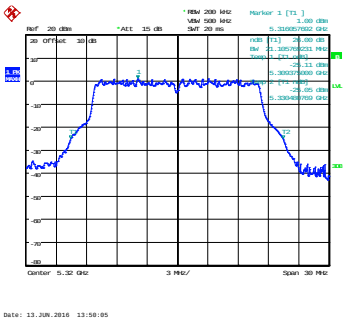
802.11a



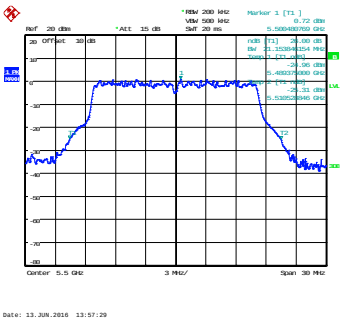
5180 MHz



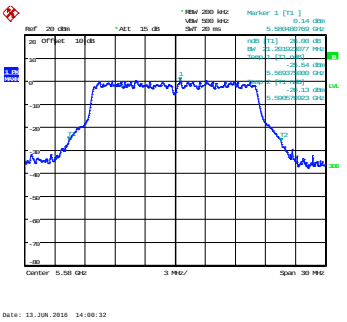
5260 MHz



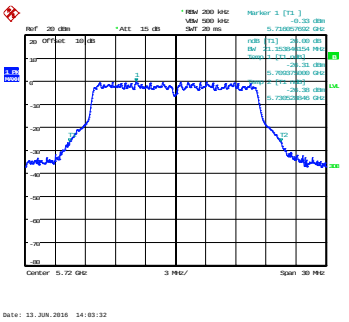
5320 MHz



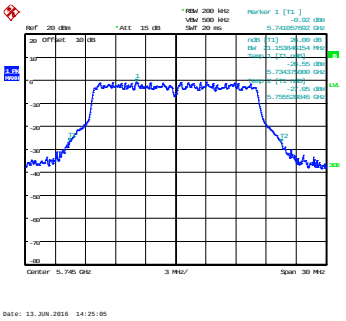
5500 MHz



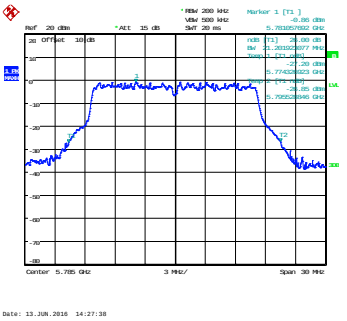
5580 MHz



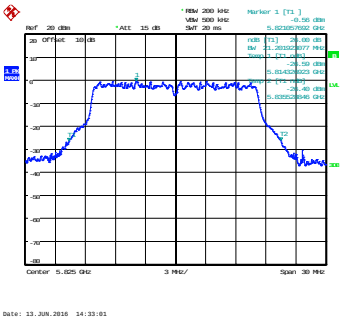
5720 MHz



5745 MHz

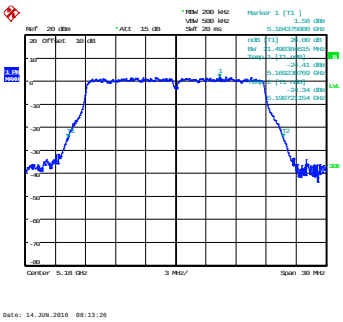


5785 MHz

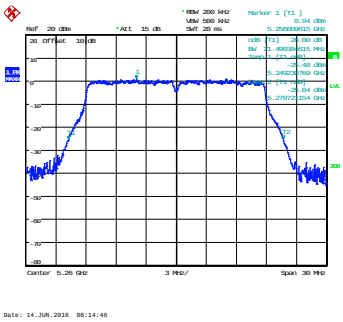


5825 MHz

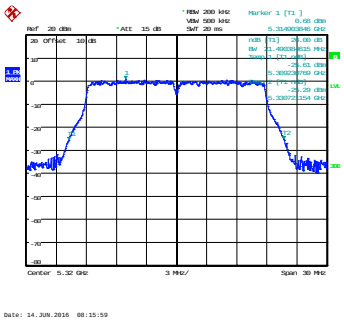
802.11ac VHT20



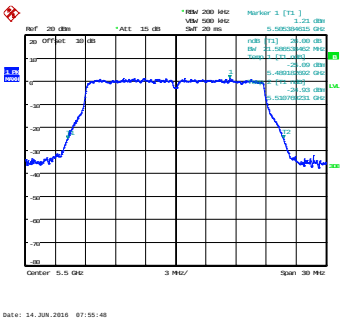
5180 MHz



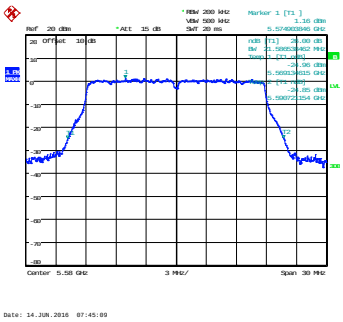
5260 MHz



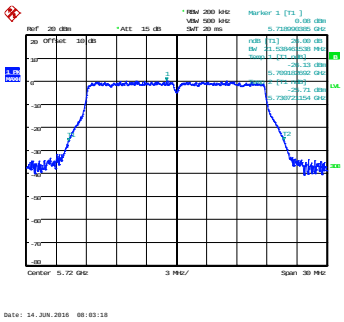
5320 MHz



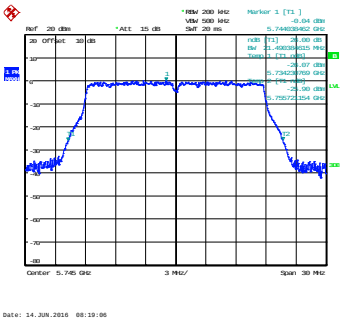
5500 MHz



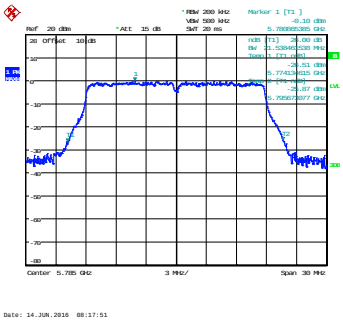
5580 MHz



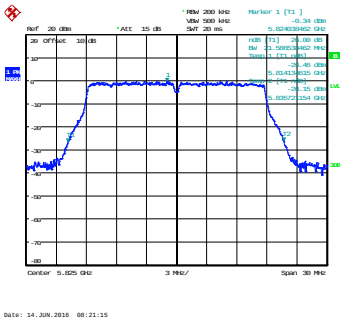
5720 MHz



5745 MHz

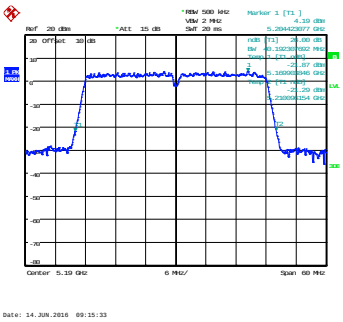


5785 MHz

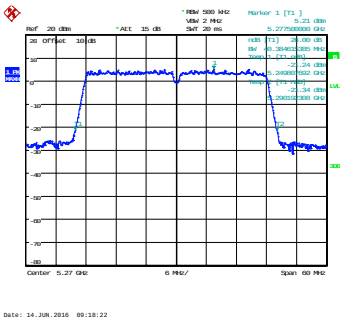


5825 MHz

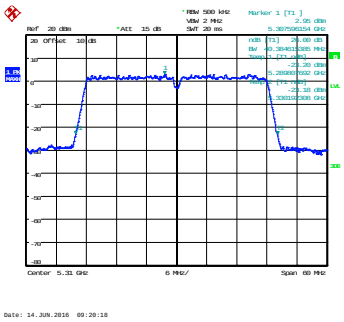
802.1ac VHT40



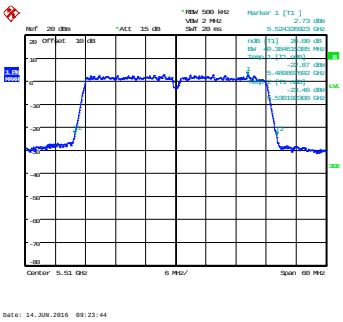
5190 MHz



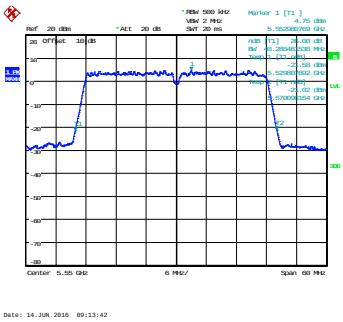
5270 MHz



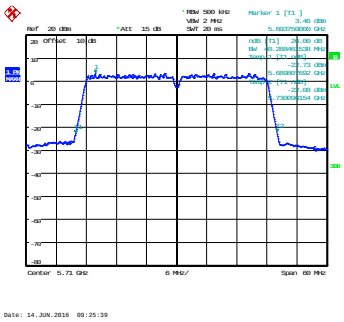
5310 MHz



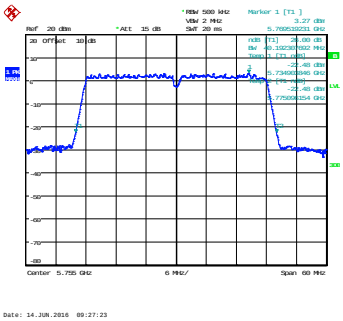
5510 MHz



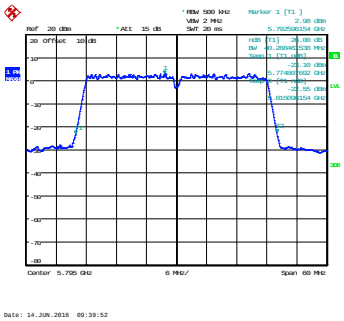
5550 MHz



5710 MHz

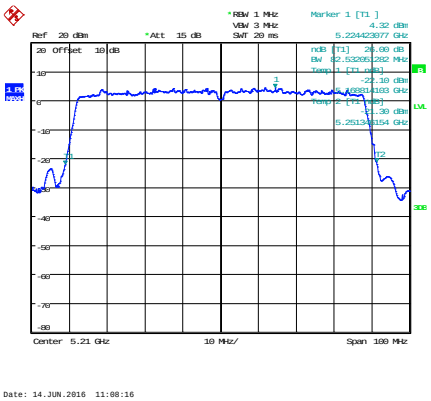


5755 MHz

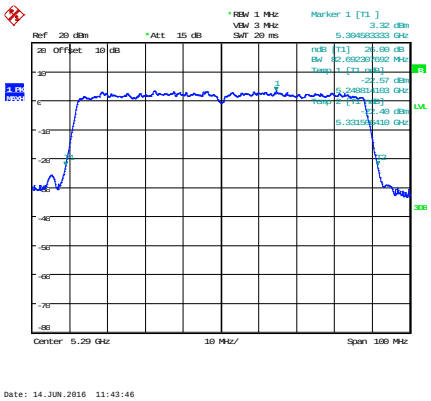


5795 MHz

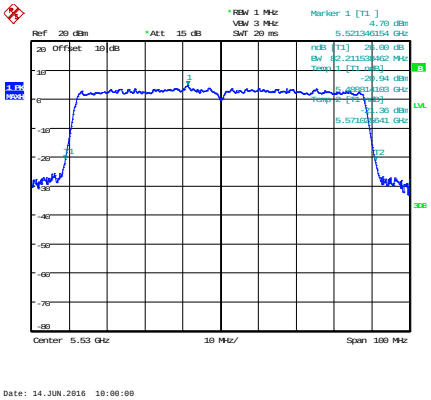
802.1ac VHT80



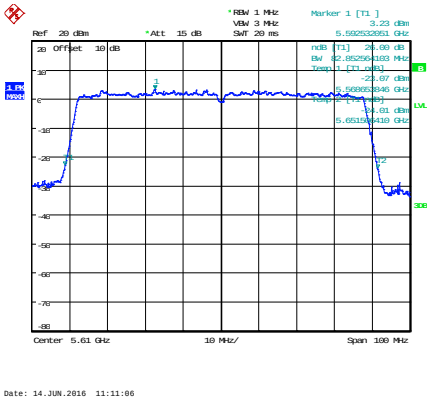
5210 MHz



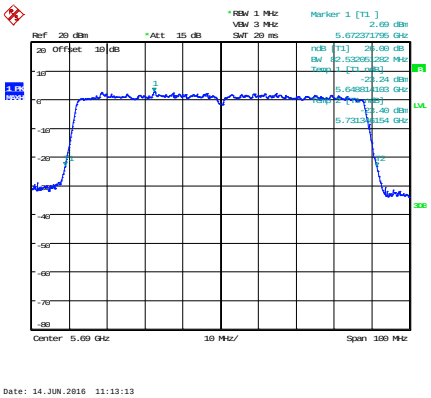
5290 MHz



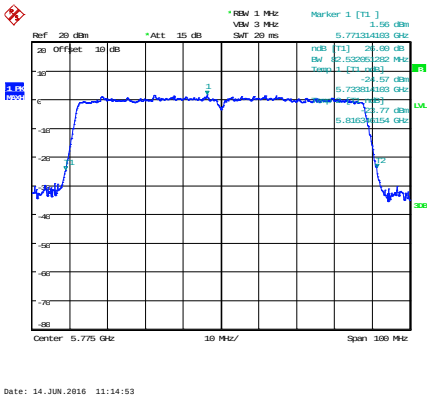
5530 MHz



5610 MHz



5690 MHz



5775 MHz

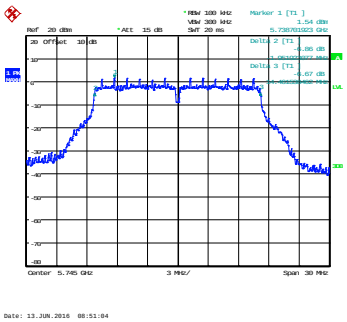
Modulation: 802.11a				
Channel Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***6dB Bandwidth (kHz)***	***Result***
5745	5736.750000	5753.163461	16413.5	PASS
5785	5776.721154	5793.182692	16461.5	PASS
5825	5816.721154	5833.182692	16461.5	PASS

Modulation: 802.11acVHT20				
Channel Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***6dB Bandwidth (kHz)***	***Result***
5745	5736.096154	5753.807692	17711.5	PASS
5785	5776.096154	5793.807692	17711.5	PASS
5825	5816.096154	5833.807692	17711.5	PASS

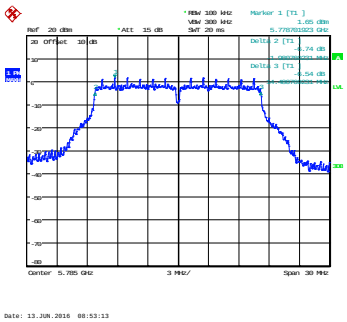
Modulation: 802.11acVHT40				
Channel Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***6dB Bandwidth (kHz)***	***Result***
5755	5736.737179	5773.166667	36429.5	PASS
5795	5776.762820	5813.166667	36403.8	PASS

Modulation: 802.11acVHT80				
Channel Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***6dB Bandwidth (kHz)***	***Result***
5775	5736.692308	5812.734308	76042.0	PASS

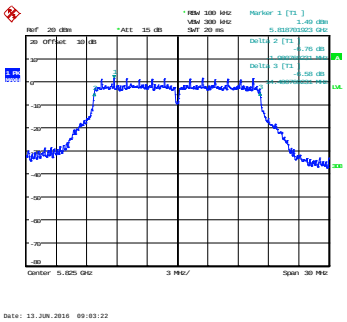
802.11a



5745 MHz

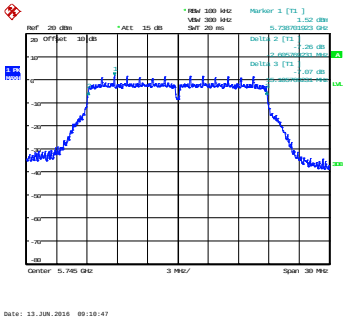


5785 MHz

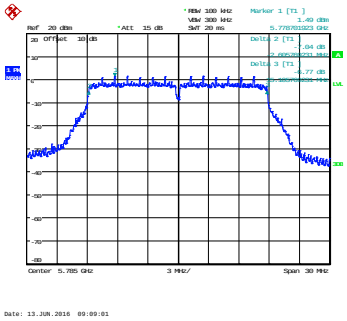


5825 MHz

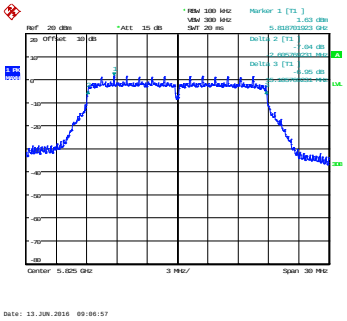
802.11ac VHT20



5745 MHz

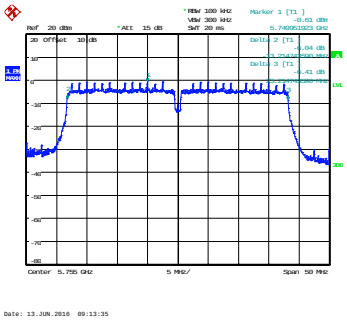


5785 MHz

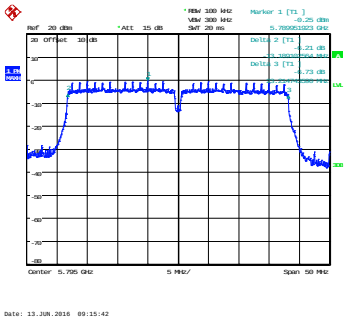


5825 MHz

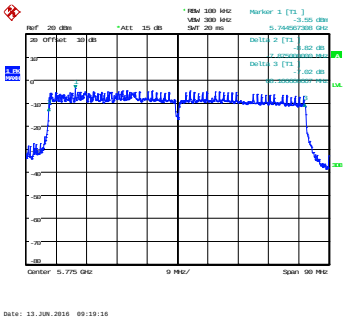
802.11ac VHT40/80



5755 MHz – VHT40



5795 MHz - VHT40



5775 MHz – VHT80

12 Maximum conducted output power

12.1 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.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 12.3, KDB 789033 D02, KDB 662911 D01
EUT Channels / Frequencies Measured:	36, 38, 42, 52, 54, 58, 62, 64, 100, 102, 106, 110, 116, 122, 138, 142, 144, 149, 151, 155, 157, 159, 165
EUT Channel Bandwidths:	20 MHz / 40 MHz / 80 MHz
Deviations From Standard:	None
Measurement Detector:	RMS
Voltage Extreme Environment Test Range:	Mains Power = 85% and 115% of Nominal (FCC only requirement);

Environmental Conditions (Normal Environment)

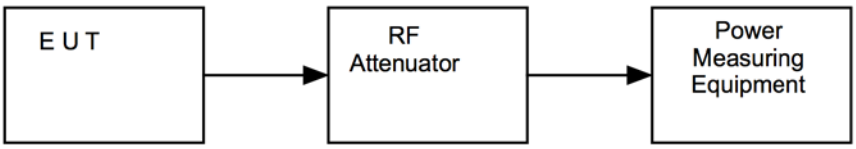
Temperature:	22 °C	+15 ºC to +35 ºC (as declared)
Humidity:	44%RH	20%RH to 75%RH (as declared)

12.3 Test Method

The EUT was setup as per section 9 of this report and, as per Figure iv, the power meter was used to measure each antenna output in turn, having taken account of all path losses. The results were summed as in the tables below.

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 iv Test Setup



12.4 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Power Meter	Dare	RPR3006W	REF2111	09/03/2016	12	09/03/2017

12.5 Test Limits

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.

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.

For the band 5.725–5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W.

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

802.11n/ac 20 MHz									
Frequency (MHz)	5180	5260	5320	5500	5580	5720	5745	5785	5825
Gain	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Array Gain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direction Gain of Antenna*	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Exceeds 6 dBi?	No	No	No	No	No	No	No	No	No
Spec limit (dBm)	24	24	24	24	24	24	30	30	30
Number Of Antennas	2	2	2	2	2	2	2	2	2

802.11n/ac 40 MHz								
Frequency (MHz)	5190	5270	5310	5510	5550	5710	5755	5795
Gain	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Array Gain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direction Gain of Antenna*	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Exceeds 6 dBi?	No	No	No	No	No	No	No	No
Spec limit (dBm)	24	24	24	24	24	24	30	30
Number Of Antennas	2	2	2	2	2	2	2	2

802.11ac 80 MHz						
Frequency (MHz)	5210	5290	5530	5610	5690	5775
Gain	2.7	2.7	2.7	2.7	2.7	2.7
Array Gain	0.0	0.0	0.0	0.0	0.0	0.0
Direction Gain of Antenna*	2.7	2.7	2.7	2.7	2.7	2.7
Exceeds 6 dBi?	No	No	No	No	No	No
Spec limit (dBm)	24	24	24	24	24	30
Number Of Antennas	2	2	2	2	2	2

* Directional Gain of antenna Calculated as per KDB 662911 D01 Multiple Transmitter Output v02r01
Directional gain = G_{ANT} + Array Gain
Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$

12.6 Test Results

Modulation: 802.11a				
Channel (MHz)	***Power setting***	***Power Chain 0 (dBm)***	***Power Chain 1 (dBm)***	***Total Power (dBm)***
5180	44	10.40	10.80	13.61
5260	62	14.00	14.50	17.27
5320	58	13.10	13.60	16.37
5500	58	13.40	13.70	16.56
5580	62	14.00	14.70	17.37
5720	62	13.40	13.90	16.67
5745	62	13.20	13.80	16.52
5785	62	13.30	13.50	16.41
5825	62	13.40	13.50	16.46

Modulation: 802.11n HT20				
Channel (MHz)	***Power setting***	***Power Chain 0 (dBm)***	***Power Chain 1 (dBm)***	***Total Power (dBm)***
5180	44	10.50	11.30	13.93
5260	62	14.00	14.50	17.27
5320	58	12.80	13.40	16.12
5500	62	14.10	14.50	17.31
5580	62	13.80	14.30	17.07
5720	62	13.70	13.80	16.76
5745	62	13.30	13.60	16.46
5785	62	13.40	13.50	16.46
5825	62	13.40	13.40	16.41

Modulation: 802.11n HT40				
Channel (MHz)	***Power setting***	***Power Chain 0 (dBm)***	***Power Chain 1 (dBm)***	***Total Power (dBm)***
5190	44	10.70	11.30	14.02
5270	62	14.50	14.90	17.71
5310	54	12.40	13.00	15.72
5510	48	11.40	11.60	14.51
5550	62	14.50	15.10	17.82
5710	62	14.10	14.20	17.16
5755	62	13.50	14.20	16.87
5795	62	13.60	14.00	16.81

Modulation: 802.11ac VHT80				
Channel (MHz)	***Power setting***	***Power Chain 0 (dBm)***	***Power Chain 1 (dBm)***	***Total Power (dBm)***
5210	46	10.60	11.60	14.14
5290	52	11.70	12.20	14.97
5530	48	10.70	11.10	13.91
5610	58	12.90	13.40	16.17
5690	58	12.60	13.00	15.81
5775	58	12.50	12.90	15.71

13 Power spectral density

13.1 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.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 12.5, KDB 789033 D02, KDB 662911 D01
EUT Channels / Frequencies Measured:	36, 38, 42, 52, 54, 58, 62, 64, 100, 102, 106, 110, 116, 122, 138, 142, 144, 149, 151, 155, 157, 159, 165
EUT Channel Bandwidths:	20 MHz / 40 MHz / 80 MHz
Deviations From Standard:	None
Measurement BW:	1 MHz, 500 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	10 MHz, 5 MHz
Measurement Detector:	RMS

Environmental Conditions (Normal Environment)

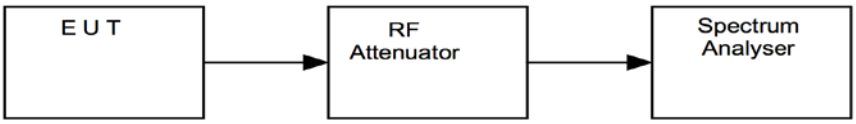
Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44%RH	20%RH to 75%RH (as declared)
Supply: 110 Vac	110 Vac +/-10% (as declared)

13.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the peak emission of the EUT was measured on a spectrum analyser, with path losses taken into account. 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.

Measurements were performed as per KDB 662911 D01 Multiple Transmitter Output v02r01 2) In-Band Power Spectral Density (PSD) Measurements b) Measure and sum spectral maxima across the outputs.

Figure v 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	FSU50	U544	30/05/2016	12	29/05/2017

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Spectrum Analyser	R&S	FSW26	-	01/05/2015	24	01/05/2017
Spectrum Analyser	R&S	FSV13	-	14/07/2015	12	14/07/2016

13.5 Test Limits

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.

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.

For the band 5.725–5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band.

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

802.11a/n/ac 20 MHz									
Frequency (MHz)	5180	5260	5320	5500	5580	5720	5745	5785	5825
Gain	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Array Gain	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Direction Gain of Antenna*	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Exceeds 6 dBi by	0	0	0	0	0	0	0	0	0
Spec limit (dBm/MHz)	11	11	11	11	11	11	30	30	30
Number Of Antennas	2	2	2	2	2	2	2	2	2
Correlated Signals	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Limit (dBm/MHz)	11	11	11	11	11	11	30	30	30

802.11n/ac 40 MHz								
Frequency (MHz)	5190	5270	5310	5510	5550	5710	5755	5795
Gain	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Array Gain	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Direction Gain of Antenna*	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Exceeds 6 dBi by	0	0	0	0	0	0	0	0
Spec limit (dBm/MHz)	11	11	11	11	11	11	30	30
Number Of Antennas	2	2	2	2	2	2	2	2
Correlated Signals	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Limit (dBm/MHz)	11	11	11	11	11	11	30	30

802.11ac 80 MHz						
Frequency (MHz)	5210	5290	5530	5610	5690	5775
Gain	2.7	2.7	2.7	2.7	2.7	2.7
Array Gain	3.0	3.0	3.0	3.0	3.0	3.0
Direction Gain of Antenna*	5.7	5.7	5.7	5.7	5.7	5.7
Exceeds 6 dBi by	0	0	0	0	0	0
Spec limit (dBm/MHz)	11	11	11	11	11	30
Number Of Antennas	2	2	2	2	2	2
Correlated Signals	Yes	Yes	Yes	Yes	Yes	Yes
Limit (dBm/MHz)	11	11	11	11	11	30

* Directional Gain of antenna Calculated as per KDB 662911 D01 Multiple Transmitter Output v02r01
Directional gain = G_{ANT} + Array Gain
Array Gain = 10 log (N_{ANT}/N_{SS}) dBi, Where N_{ANT} = 2 & N_{SS} =1

13.6 Test Results

Modulation: 802.11a				
Channel (MHz)	***Power setting***	***PSD Chain 0 (dBm)***	***PSD Chain 1 (dBm)***	***Total PSD (dBm)***
5180	44	-1.13	-0.37	2.28
5260	62	3.03	3.27	6.17
5320	58	1.72	2.11	4.93
5500	58	1.98	2.15	5.08
5580	62	2.73	3.23	6.00
5720	62	2.46	2.31	5.40
5745	62	-0.88	-0.30	2.43
5785	62	-0.84	-0.39	2.41
5825	62	-0.66	-0.58	2.40

Modulation: 802.11n HT20				
Channel (MHz)	***Power setting***	***PSD Chain 0 (dBm)***	***PSD Chain 1 (dBm)***	***Total PSD (dBm)***
5180	44	-1.33	-0.47	2.13
5260	62	2.32	2.76	5.56
5320	58	1.19	1.83	4.53
5500	62	2.42	2.66	5.55
5580	62	2.24	2.74	5.51
5720	62	1.98	2.06	5.03
5745	62	-1.28	-0.70	2.03
5785	62	-1.17	-0.99	1.93
5825	62	-1.10	-0.84	2.04

Modulation: 802.11n HT40				
Channel (MHz)	***Power setting***	***PSD Chain 0 (dBm)***	***PSD Chain 1 (dBm)***	***Total PSD (dBm)***
5190	44	-3.86	-3.20	-0.51
5270	62	-0.19	0.45	3.15
5310	54	-2.17	-1.69	1.09
5510	48	-3.15	-2.77	0.06
5550	62	0.06	0.62	3.36
5710	62	-0.10	0.05	2.99
5755	62	-3.70	-3.00	-0.32
5795	62	-3.34	-3.12	-0.22

Modulation: 802.11ac VHT80				
Channel (MHz)	***Power setting***	***PSD Chain 0 (dBm)***	***PSD Chain 1 (dBm)***	***Total PSD (dBm)***
5210	46	-5.19	-4.58	-1.86
5290	52	-5.60	-5.26	-2.42
5530	48	-6.29	-6.10	-3.19
5610	58	-4.15	-3.74	-0.93
5690	58	-4.37	-4.26	-1.31
5775	58	-7.91	-7.65	-4.77

14 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**

15 RF Exposure

KDB 447498

Prediction of MPE limit at a given distance

Equation from IEEE C95.1

$$S = \frac{EIRP}{4\pi R^2}$$

Where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

The EIRP was calculated by addition of the maximum conducted carrier power plus the maximum directional antenna gain. The directional gain of antenna was calculated as per KDB 662911 D01 Multiple Transmitter Output v02r01

Directional gain = GANT + Array Gain
Array Gain = 0 dB (i.e., no array gain) for NANT ≤ 4

Results:

Modulation: 802.11a						
Frequency (MHz)	Maximum Conducted Power (dBm)	Antenna Gain (dBi)	Maximum EIRP (mW)	Minimum Distance (cm)	Power density at distance (mW/cm^2)	Power density limit (S) (mW/cm^2)
5180	13.61	4.2	60.4	20.0	0.012	1
5260	17.27	4.0	134.0	20.0	0.027	1
5320	16.37	3.8	104.0	20.0	0.021	1
5500	16.56	4.3	121.9	20.0	0.024	1
5620	17.37	4.3	146.9	20.0	0.029	1
5720	16.67	4.1	119.4	20.0	0.024	1
5745	16.52	4.6	129.4	20.0	0.026	1
5785	16.41	4.6	126.2	20.0	0.025	1
5825	16.46	4.9	136.8	20.0	0.027	1

Modulation: 802.11n HT20						
Frequency (MHz)	Maximum Conducted Power (dBm)	Antenna Gain (dBi)	Maximum EIRP (mW)	Minimum Distance (cm)	Power density at distance (mW/cm^2)	Power density limit (S) (mW/cm^2)
5180	13.93	4.2	65.0	20.0	0.013	1
5260	17.27	4.0	134.0	20.0	0.027	1
5320	16.12	3.8	98.2	20.0	0.020	1
5500	17.31	4.3	144.9	20.0	0.029	1
5620	17.07	4.3	137.1	20.0	0.027	1
5720	16.76	4.1	121.9	20.0	0.024	1
5745	16.46	4.6	127.6	20.0	0.025	1
5785	16.46	4.6	127.6	20.0	0.025	1
5825	16.41	4.9	135.2	20.0	0.027	1

Modulation: 802.11n HT40						
Frequency (MHz)	Maximum Conducted Power (dBm)	Antenna Gain (dBi)	Maximum EIRP (mW)	Minimum Distance (cm)	Power density at distance (mW/cm^2)	Power density limit (S) (mW/cm^2)
5190	14.02	4.2	66.4	20.0	0.013	1
5270	17.71	4.0	148.3	20.0	0.029	1
5310	15.72	4.0	93.8	20.0	0.019	1
5510	14.51	4.3	76.0	20.0	0.015	1
5630	17.82	4.3	162.9	20.0	0.032	1
5710	17.16	4.1	133.7	20.0	0.027	1
5755	16.87	4.6	140.3	20.0	0.028	1
5795	16.81	4.9	148.3	20.0	0.029	1

Modulation: 802.11ac VHT80						
Frequency (MHz)	Maximum Conducted Power (dBm)	Antenna Gain (dBi)	Maximum EIRP (mW)	Minimum Distance (cm)	Power density at distance (mW/cm^2)	Power density limit (S) (mW/cm^2)
5210	14.14	4.2	68.2	20.0	0.014	1
5290	14.97	4.0	78.9	20.0	0.016	1
5530	13.91	4.3	66.2	20.0	0.013	1
5610	16.17	4.3	111.4	20.0	0.022	1
5690	15.81	4.1	97.9	20.0	0.019	1
5775	15.71	4.9	115.1	20.0	0.023	1