TEST REPORT

Test Report No. : UL-RPT-RP10056119JD05A V2.0

Manufacturer	:	UROS Ltd
Model No.	:	U100
FCC ID	:	2ACN9U100GS
Technology	:	WLAN (802.11b/g/n)
Test Standard(s)	:	FCC Parts 15.107(a), 15.109, 15.207, 15.209(a) & 15.247

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

Date of Issue: 03 October 2014

Checked by:

Ian Watch
Senior Engineer, Radio Laboratory

Issued by :

pp

John Newell
Quality Manager,
UL VS LTD

0644

This laboratory is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

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Table of Contents

1. Customer Information

Company Name:	UROS Ltd
Address:	Kirkkokatu 4 A 46 90100 OULU Finland

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.107 and 47CFR15.109
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart B (Unintentional Radiators) - Sections 15.107 and 15.109
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209
Site Registration:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	18 October 2013 to 27 June 2014

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.107(a)	Receiver/Idle Mode AC Conducted Emissions	✓
Part 15.109	Receiver/Idle Mode Radiated Spurious Emissions	✓
Part 15.207	Transmitter AC Conducted Emissions	✓
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	✓
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.247(e)	Transmitter Power Spectral Density	✓
Part 15.247(b)(3)	Transmitter Maximum Output Power	✓
Part 15.247(d) & 15.209(a)	Transmitter Radiated Emissions	✓
Part 15.247(d) & 15.209(a)	Transmitter Band Edge Radiated Emissions	✓

Key to Results

✓ = Complied ✗ = Did not comply

Note(s):

1. The measurement was performed to assist in the calculation of the level of maximum conducted output power, power spectral density and emissions. The EUT cannot transmit continuously and sweep triggering/signal gating cannot be implemented.

2.3. Methods and Procedures

Reference:	ANSI C63.4 (2009)
Title:	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
Reference:	ANSI C63.10 (2009)
Title:	American National Standard for Testing Unlicensed Wireless Devices
Reference:	KDB 558074 D01 DTS Meas Guidance v03r02 June 5, 2014
Title:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	UROS
IMEI:	353567040830508 *(Radiated sample)*
Serial Number:	DMF24462118
Hardware Version:	B2.2
Software Version:	2.0.19
Firmware Version:	6.3.5.0.99
FCC ID:	2ACN9U100GS

Brand Name:	UROS
IMEI:	353567040816341 *(Radiated sample)*
Serial Number:	XGA34461174
Hardware Version:	B2.3
Software Version:	3.0.27
Firmware Version:	6.3.10.0.133
FCC ID:	2ACN9U100GS

Brand Name:	UROS
IMEI:	353567040838337 *(Conducted sample)*
Serial Number:	XGA34461178
Hardware Version:	B2.3
Software Version:	3.0.27
Firmware Version:	6.3.10.0.133
FCC ID:	2ACN9U100GS

Brand Name:	Salcomp
Description:	USB to AC Plug Adaptor
Model Number:	SC0600
Serial Number:	121500061719

3.2. Description of EUT

The Equipment Under Test (EUT) was a 2.4 GHz WLAN device with integrated WWAN module.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	WLAN (IEEE 802.11b,g,n) / Digital Transmission System		
Type of Unit:	Transceiver		
Modulation Type:	DBPSK, DQPSK, BPSK, QPSK, 16QAM & 64QAM		
Data Rates:	802.11b	1, 2, 5.5 & 11 Mbit/s	
	802.11g	6, 9, 12, 18, 24, 36, 48 & 54 Mbit/s	
	802.11n HT20	MCS0 to MCS7 (1 spatial stream) GI = 800 ns	
Power Supply Requirement(s):	Nominal	5 VDC	
Maximum Conducted Output Power:	9.4 dBm		
Declared Antenna Gain:	1.4 dBi		
Channel Spacing:	20 MHz		
Transmit Frequency Range:	2412 MHz to 2462 MHz		
Transmit Channels Tested:	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	Bottom	1	2412
	Middle	6	2437
	Top	11	2462
Receive Frequency Range:	2412 MHz to 2462 MHz		
Receive Channels Tested:	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	Bottom	1	2412
	Middle	6	2437
	Top	11	2462

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	Test jig for production/test interface
Brand Name:	UROS
Model Name or Number:	Jig1
Serial Number:	Not marked or stated

Description:	Laptop PC
Brand Name:	Hewlett Packard
Model Name or Number:	Compaq 6510b
Serial Number:	CNU8160N87

Description:	USB to serial cable (1.8 metre length)
Brand Name:	Not marked or stated
Model Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	USB cable (0.9 metre length)
Brand Name:	Not marked or stated
Model Number:	Not marked or stated
Serial Number:	Not marked or stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):

- Continuously transmitting with a modulated carrier at maximum power on the bottom, middle and top channels as required using the supported data rates/modulation types.
- Receive/idle mode.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

- For transmitter tests the EUT was placed in the supplied test jig and connected to the laptop PC via a USB cable. The EUT was placed into a continuous transmission mode with the relevant channels and data rates selected using a test application on a laptop PC.
- All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest output power, highest power spectral density, narrowest and widest bandwidths were:
    - Highest output power
        - 802.11b – DQPSK / 2 Mbit/s
        - 802.11g – QPSK / 18 Mbit/s
        - 802.11n HT20 – 64QAM / 58.5 Mbit/s / MCS6 (GI = 800 ns)
    - Highest power spectral density
        - 802.11b – DBPSK / 1 Mbit/s
        - 802.11g – BPSK / 9 Mbit/s
        - 802.11n HT20 – QPSK / 19.5 Mbit/s / MCS2 (GI = 800 ns)
    - Narrowest bandwidth (DTS bandwidth / 6 dB)
        - 802.11b – DQPSK / 2 Mbit/s
        - 802.11g – 64QAM / 54 Mbit/s
        - 802.11n HT20 – 64QAM / 58.5 Mbit/s / MCS6 (GI = 800 ns)
- During radiated spurious emissions tests the mini USB port of the EUT was terminated using the supplied USB cable which was connected to an AC to DC power adaptor. The EUT was placed into the test jig and the relevant mode selected. Once the test mode was enabled, the EUT was removed from the jig for testing.The adaptor input was connected to a120 VAC 60 Hz single phase supply.
- Transmitter spurious emissions were performed with the EUT transmitting with a data rate of 18 Mbit/s, as this was found to have the highest power level and therefore deemed to be worst case.
- Radiated emissions tests were performed with all unused ports terminated.
- The conducted sample with IMEI 353567040838337 was used for minimum 6 dB bandwidth, duty cycle, maximum output power and power spectral density tests.
- The radiated sample with IMEI 353567040830508 was used for AC conducted and idle mode radiated spurious emissions tests.
- The radiated sample with IMEI 353567040816341 was used for all other tests.

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6. Measurement Uncertainty* for details.

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Receiver/Idle Mode AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	22 October 2013
Test Sample IMEI:	353567040830508		

FCC Reference:	Part 15.107(a)
Test Method Used:	As detailed in ANSI C63.10 Section 6.2 referencing ANSI C63.4

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	46

Results: Live / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.528	Live	37.3	56.0	18.7	Complied
2.468	Live	26.8	56.0	29.2	Complied
3.390	Live	25.0	56.0	31.0	Complied
7.458	Live	21.3	60.0	38.7	Complied
12.498	Live	25.1	60.0	34.9	Complied
17.174	Live	23.8	60.0	36.2	Complied

Results: Live / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.524	Live	30.3	46.0	15.7	Complied
2.337	Live	22.1	46.0	23.9	Complied
3.309	Live	18.6	46.0	27.4	Complied
7.314	Live	15.6	50.0	34.4	Complied
11.490	Live	17.7	50.0	32.3	Complied
18.065	Live	14.8	50.0	35.2	Complied

Receiver/Idle Mode AC Conducted Spurious Emissions (continued)

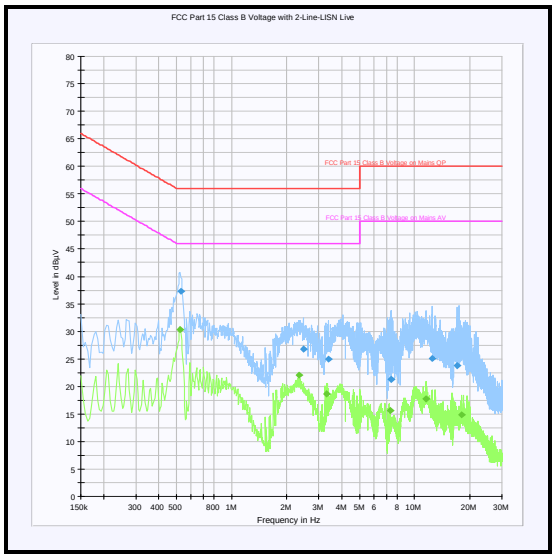
Results: Neutral / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.528	Neutral	34.0	56.0	22.0	Complied
2.337	Neutral	25.4	56.0	30.6	Complied
7.431	Neutral	18.7	60.0	41.3	Complied
12.867	Neutral	22.4	60.0	37.6	Complied
17.421	Neutral	24.2	60.0	35.8	Complied
19.145	Neutral	22.7	60.0	37.3	Complied

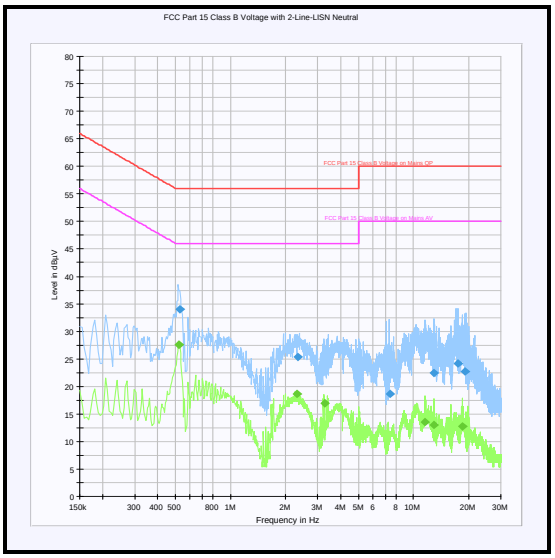
Results: Neutral / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.524	Neutral	27.6	46.0	18.4	Complied
2.306	Neutral	18.7	46.0	27.3	Complied
3.278	Neutral	16.9	46.0	29.1	Complied
11.490	Neutral	13.6	50.0	36.4	Complied
12.867	Neutral	13.0	50.0	37.0	Complied
18.438	Neutral	12.8	50.0	37.2	Complied

Receiver/Idle Mode AC Conducted Spurious Emissions (continued)



Live



Neutral

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1625	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	09 Jan 2014	12
A004	LISN	Rohde & Schwarz	ESH3-Z5	890604/027	30 Oct 2013	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	19 Feb 2014	12
M1379	Test Receiver	Rohde & Schwarz	ESIB 7	100330	15 Nov 2013	12

5.2.2. Receiver/Idle Mode Radiated Spurious Emissions

Test Summary:

Test Engineer:	Nick Steele	**Test Date:**	18 October 2013
Test Sample IMEI:	353567040830508		

FCC Reference:	Part 15.109
Test Method Used:	As detailed in ANSI C63.10 Sections 6.3 and 6.5 referencing ANSI C63.4
Frequency Range:	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	55

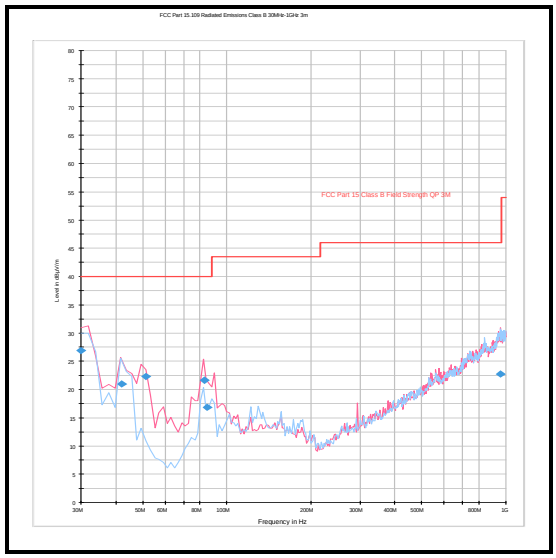
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
3. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

Results: Quasi Peak

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
30.104	Vertical	26.9	40.0	13.1	Complied
42.063	Vertical	20.9	40.0	19.1	Complied
51.214	Vertical	22.2	40.0	17.8	Complied
82.932	Vertical	21.6	40.0	18.4	Complied
84.944	Vertical	16.8	40.0	23.2	Complied
957.489	Vertical	22.7	46.0	23.3	Complied

Receiver/Idle Mode Radiated Spurious Emissions (continued)



Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1273	EMI Test Receiver	Rohde & Schwarz	ESIB 26	100275	07 Feb 2014	12
G0543	Pre-Amplifier	Sonoma	310N	230801	08 Jan 2014	3
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	24 Oct 2013	12
A490	Bi-Log Antenna	Chase	CBL6111A	1590	09 Apr 2014	12
M1622	Thermohygrometer	JM Handelspunkt	30.5015.06	0	24 May 2014	12

Receiver/Idle Mode Radiated Spurious Emissions (continued)

Test Summary:

Test Engineer:	Nick Steele	**Test Date:**	21 October 2013
Test Sample IMEI:	353567040830508		

FCC Reference:	Part 15.109
Test Method Used:	As detailed in ANSI C63.10 Sections 6.3 and 6.6 referencing ANSI C63.4
Frequency Range:	1 GHz to 12.5 GHz

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	50

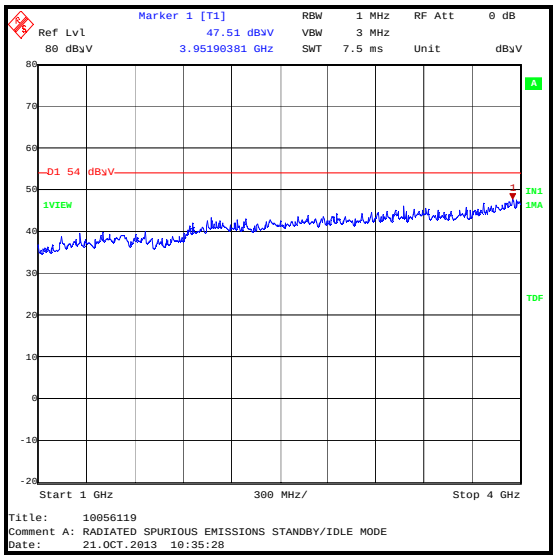
Note(s):

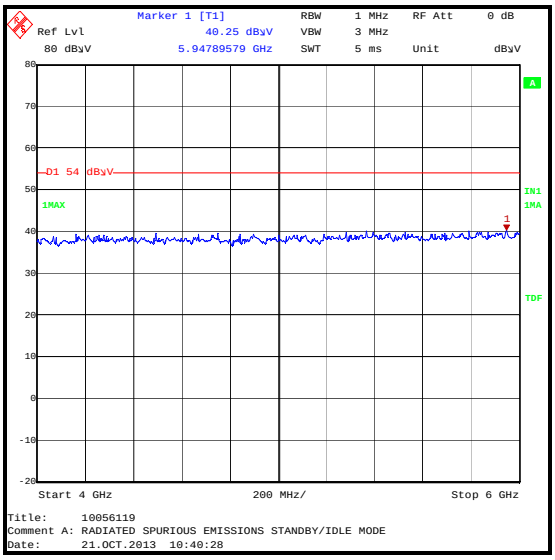
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak noise floor reading of the measuring receiver was recorded as shown in the table below. The peak level was compared to the average limit as opposed to being compared to the peak limit because this is the more onerous limit.
3. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0002) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

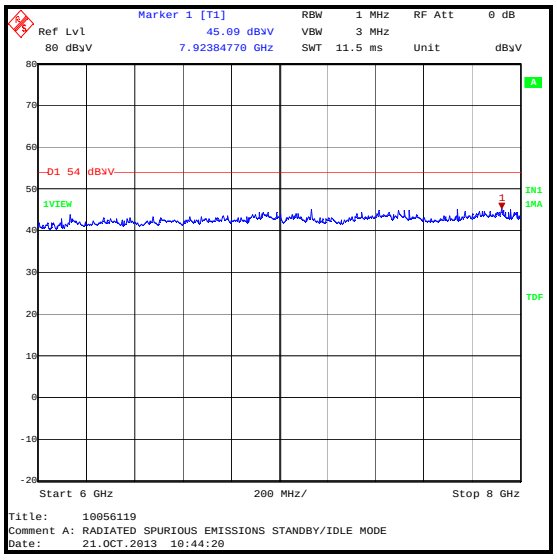
Results:

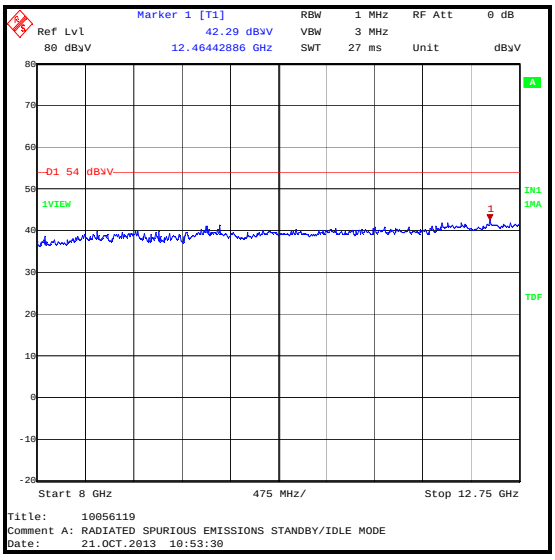
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
3951.904	Vertical	47.5	54.0	6.5	Complied

Receiver/Idle Mode Radiated Spurious Emissions (continued)









Receiver/Idle Mode Radiated Spurious Emissions (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0002	3m RSE chamber	Rainford EMC	N/A	N/A	04 Nov 2013	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046K	01 Oct 2014	12
A1534	Pre-Amplifier	Hewlett Packard	8449B	3008A00405	04 Nov 2013	12
A1818	Antenna	EMCO	3115	00075692	04 Nov 2013	12
A253	Antenna	Flann Microwave	12240-20	128	04 Nov 2013	12
A254	Antenna	Flann Microwave	14240-20	139	04 Nov 2013	12
A255	Antenna	Flann Microwave	16240-20	519	04 Nov 2013	12

5.2.3. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	22 October 2013
Test Sample IMEI:	353567040830508		

FCC Reference:	Part 15.207
Test Method Used:	As detailed in ANSI C63.10 Section 6.2 referencing ANSI C63.4

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	46

Results: Live / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.434	Live	39.2	57.2	18.0	Complied
0.443	Live	37.3	57.0	19.7	Complied
0.533	Live	41.4	56.0	14.6	Complied
7.143	Live	37.7	60.0	22.3	Complied
7.184	Live	38.8	60.0	21.2	Complied
8.084	Live	38.2	60.0	21.8	Complied

Results: Live / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.339	Live	30.9	49.2	18.3	Complied
0.398	Live	30.7	47.9	17.2	Complied
0.533	Live	33.0	46.0	13.0	Complied
2.549	Live	27.3	46.0	18.7	Complied
4.259	Live	24.0	46.0	22.0	Complied
15.896	Live	28.0	50.0	22.0	Complied
16.049	Live	28.6	50.0	21.4	Complied

Transmitter AC Conducted Spurious Emissions (continued)

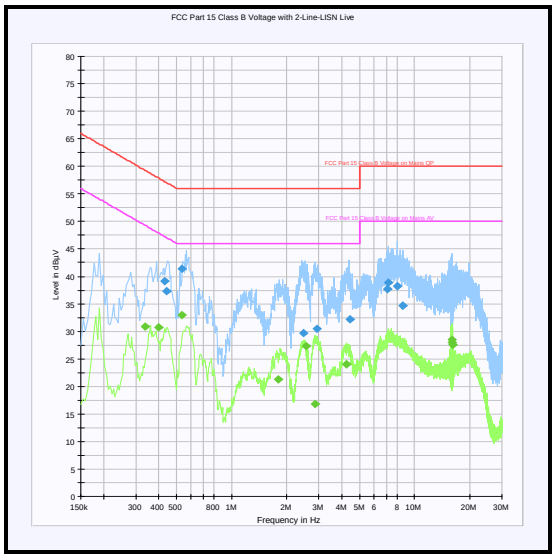
Results: Neutral / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.497	Neutral	33.6	56.1	22.5	Complied
2.499	Neutral	20.8	56.0	35.2	Complied
6.554	Neutral	32.5	60.0	27.5	Complied
7.076	Neutral	31.2	60.0	28.8	Complied
8.462	Neutral	34.7	60.0	25.3	Complied
17.826	Neutral	30.9	60.0	29.1	Complied

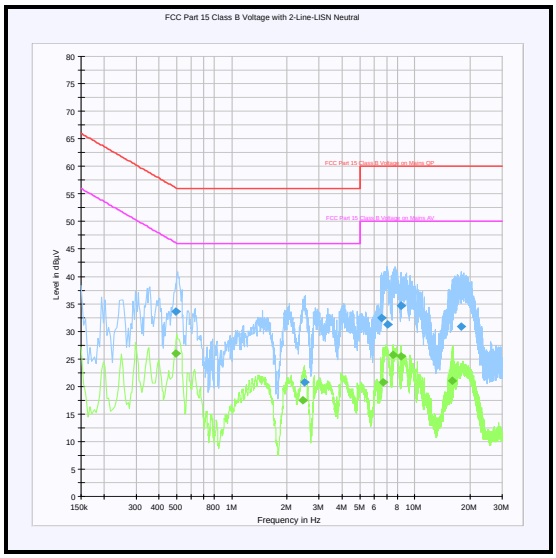
Results: Neutral / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.497	Neutral	26.0	46.1	20.1	Complied
2.450	Neutral	17.5	46.0	28.5	Complied
6.684	Neutral	20.7	50.0	29.3	Complied
7.580	Neutral	25.8	50.0	24.2	Complied
8.421	Neutral	25.5	50.0	24.5	Complied
15.986	Neutral	21.1	50.0	28.9	Complied

Transmitter AC Conducted Spurious Emissions (continued)



Live



Neutral

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1625	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	09 Jan 2014	12
A004	LISN	Rohde & Schwarz	ESH3-Z5	890604/027	30 Oct 2013	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	19 Feb 2014	12
M1379	Test Receiver	Rohde & Schwarz	ESIB 7	100330	15 Nov 2013	12

5.2.4. Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Date:**	23 June 2014
Test Sample IMEI:	353567040838337		

FCC Reference:	Part 15.247(a)(2)
Test Method Used:	As detailed in FCC KDB 558074 Section 8.1

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	44

Note(s):

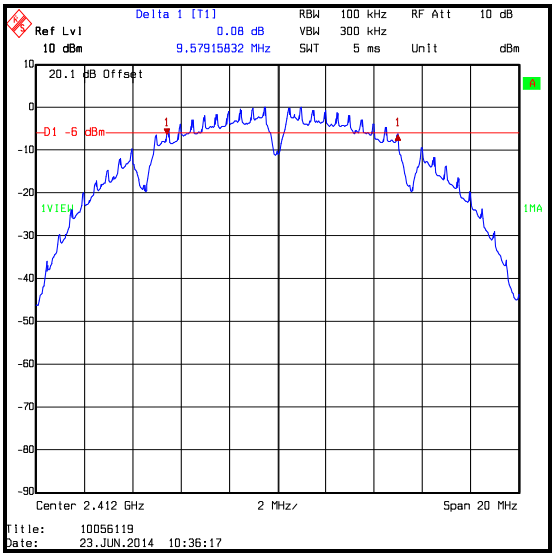
1. All configurations supported by the EUT were investigated on one channel in accordance with KDB 558074 Section 8.1 Option 1 measurement procedure. The data rates that produced the narrowest bandwidth and therefore deemed worst case were:
    - o 802.11b – DQPSK / 2 Mbit/s
    - o 802.11g – 64QAM / 54 Mbit/s
    - o 802.11n HT20 – 64QAM / 58.5 Mbit/s / MCS6 (GI = 800 ns)

    Final measurements were performed using the above configurations on the bottom, middle and top channels.
2. Plots for all data rates are archived on the UL VS LTD IT server and available for inspection upon request.
3. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

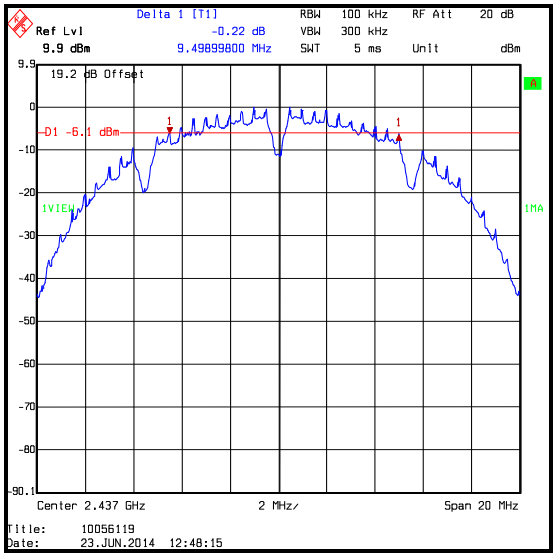
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11b / 20 MHz / DQPSK / 2 Mbit/s

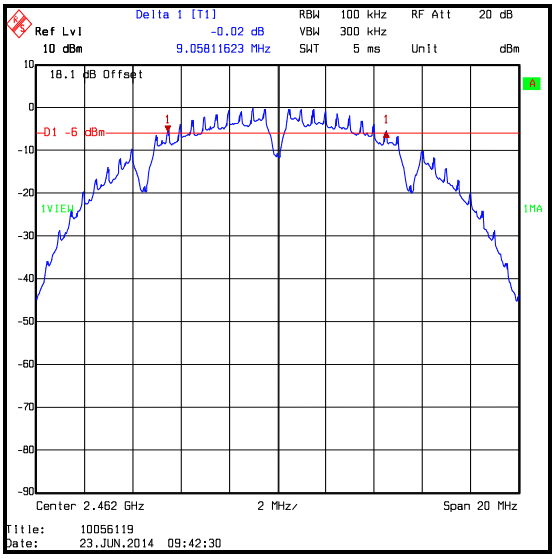
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	9579.158	≥500	9079.158	Complied
Middle	9498.998	≥500	8998.998	Complied
Top	9058.116	≥500	8558.116	Complied



Bottom Channel



Middle Channel

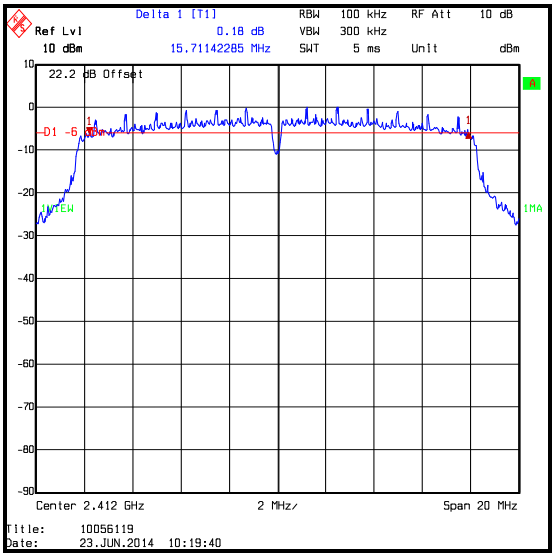


Top Channel

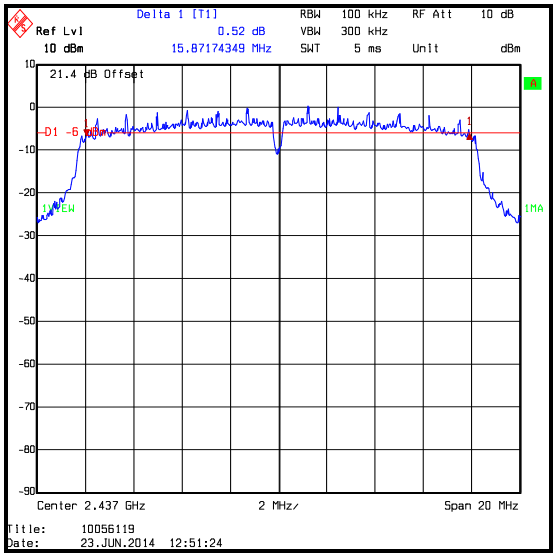
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11g / 20 MHz / 64QAM / 54 Mbit/s

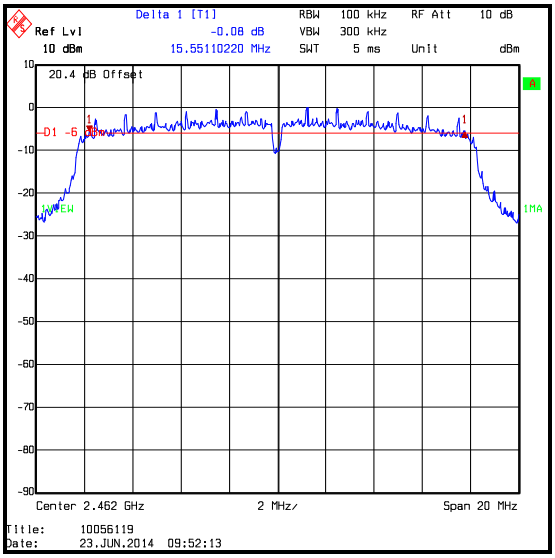
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	15711.423	≥500	15211.423	Complied
Middle	15871.743	≥500	15371.743	Complied
Top	15551.102	≥500	15051.102	Complied



Bottom Channel



Middle Channel

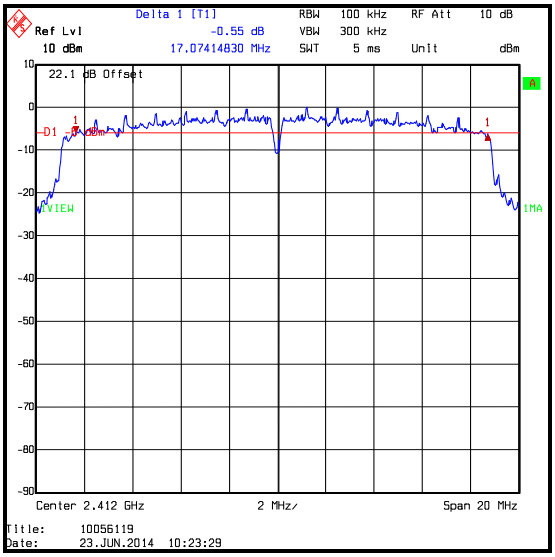


Top Channel

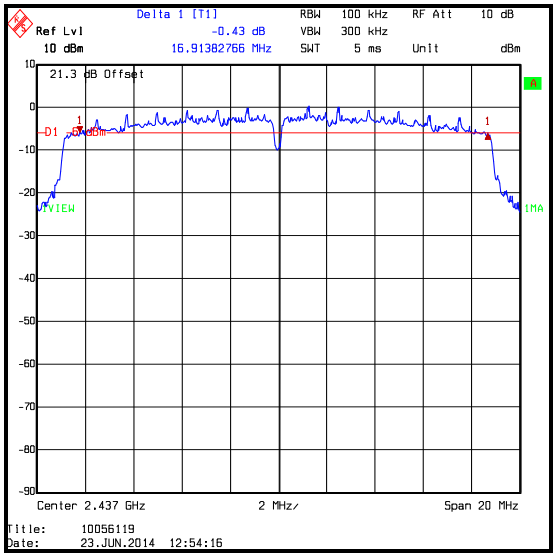
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / 20 MHz / 64QAM / 58.5 Mbit/s / MCS6

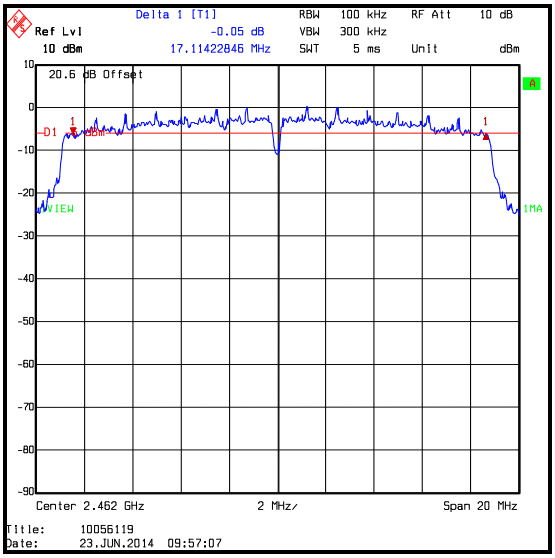
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17074.148	≥500	16574.148	Complied
Middle	16913.828	≥500	16413.828	Complied
Top	17114.228	≥500	16614.228	Complied



Bottom Channel



Middle Channel



Top Channel

Transmitter Minimum 6 dB Bandwidth (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1658	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842659/016	19 Aug 2014	12
A2142	Attenuator	AtlanTecRF	AN18-20	081120-23	25 Apr 2015	12

5.2.5. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Date:**	20 June 2014
Test Sample IMEI:	353567040838337		

FCC Reference:	Part 15.35(c)
Test Method Used:	As detailed in FCC KDB 558074 Section 6.0

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	43

Note(s):

1. In order to assist with the determination of the average level of fundamental and spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle for 802.11n mode was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

10 log (1 / (On Time / [Period or 100 ms whichever is the lesser])).

802.11n HT20 / 19.5 Mbit/s MCS2 duty cycle: 10 log (1 / (0.801/0.818)) = 0.1 dB

802.11n HT20 / 58.5 Mbit/s MCS6 duty cycle: 10 log (1 / (0.798/0.822)) = 0.1 dB

2. For 802.11b and 802.11g, the duty cycle was measured and found to be greater than 98%.

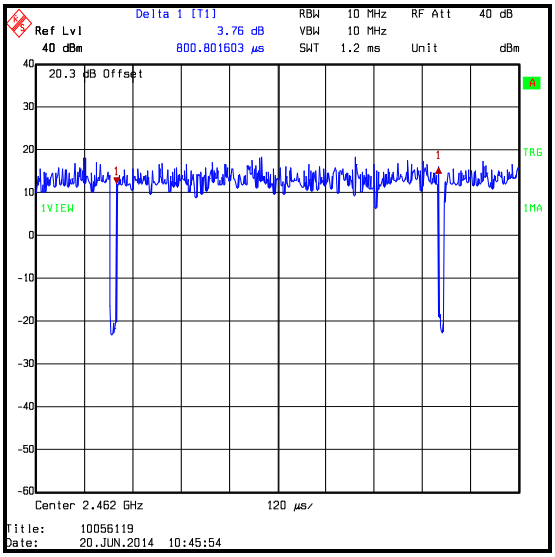
3. The spectrum analyser resolution and video bandwidths were set to 10 MHz. This is the largest available value supported by the spectrum analyser.

Transmitter Duty Cycle (continued)

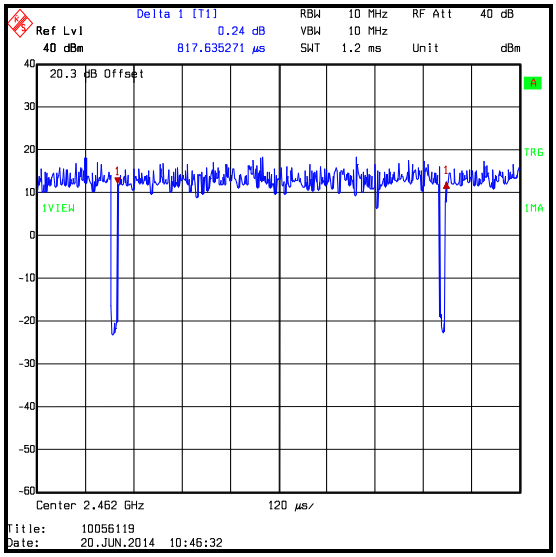
Results: 802.11n / 20 MHz / 19.5 Mbit/s / MCS2

Pulse Duration (ms)	Duty Cycle (dB)
0.801	0.1

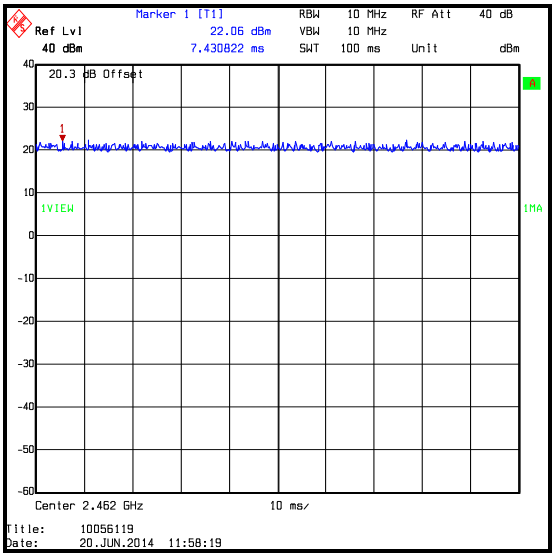
Period (ms)
0.818



TX on time



TX on + off time / period



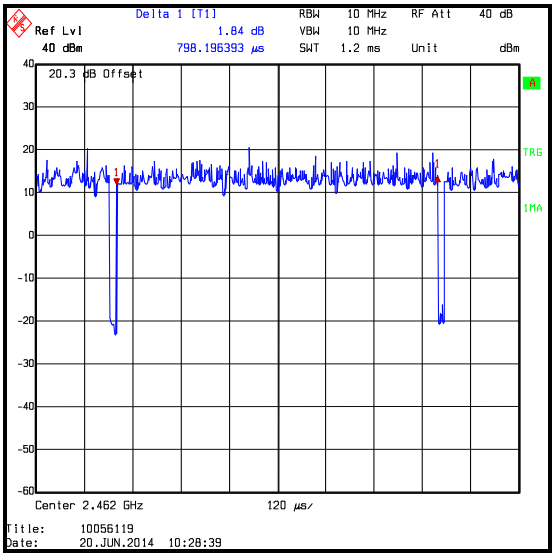
100 ms

Transmitter Duty Cycle (continued)

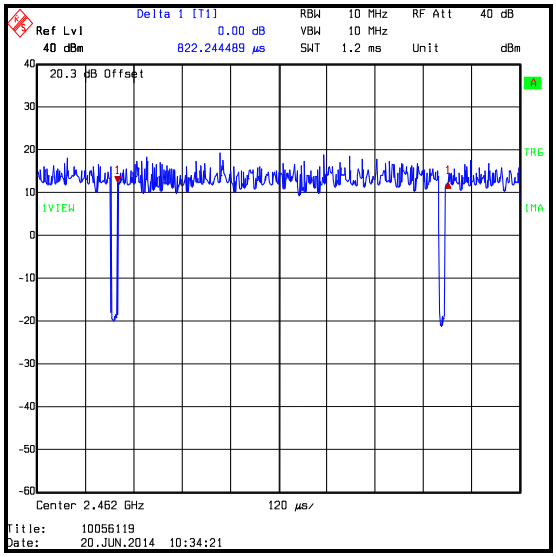
Results: 802.11n / 20 MHz / 58.5 Mbit/s / MCS6

Pulse Duration (ms)	Duty Cycle (dB)
0.798	0.1

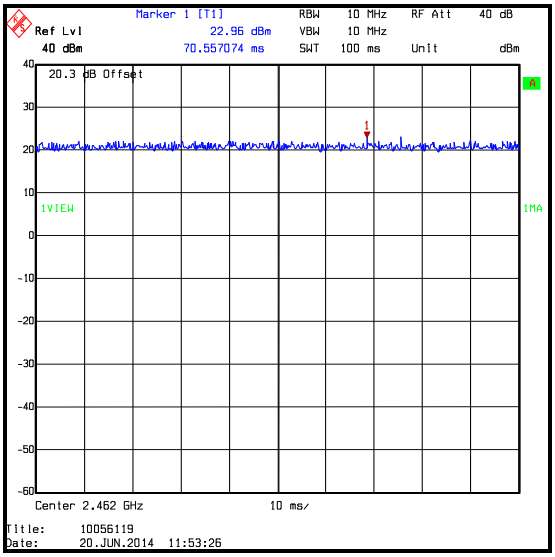
Period (ms)
0.822



TX on time



TX on + off time / period



100 ms

Transmitter Duty Cycle (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1658	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842659/016	19 Aug 2014	12
A2142	Attenuator	AtlanTecRF	AN18-20	081120-23	25 Apr 2015	12

5.2.6. Transmitter Power Spectral Density

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Date:**	23 June 2014
Test Sample IMEI:	353567040838337		

FCC Reference:	Part 15.247(e)
Test Method Used:	As detailed in FCC KDB 558074 Sections 10.3 & 10.5

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	44

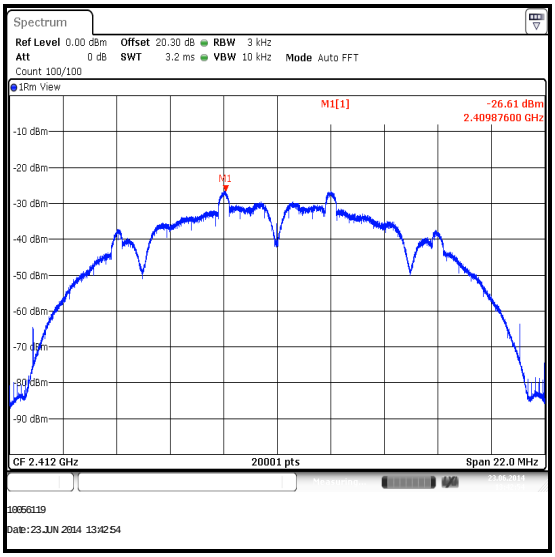
Note(s):

1. All configurations supported by the EUT were investigated on one channel in accordance with KDB 558074 Sections 10.3 and 10.5. The data rates that produced the highest power and therefore deemed worst case were:
    - 802.11b – DBPSK / 1 Mbit/s
    - 802.11g – BPSK / 9 Mbit/s
    - 802.11n HT20 – QPSK / 19.5 Mbit/s / MCS2 (GI = 800 ns)
2. Final measurements were performed using the above configurations on the bottom, middle and top channels.
3. For 802.11b and 802.11g, the EUT was transmitting at 100% duty cycle and testing was performed in accordance with KDB 558074 Section 10.3.
4. For 802.11n, the EUT was transmitting at <98% duty cycle. The calculated duty cycle in section 5.2.5 was added to the measured average power spectral density in order to compute the average power spectral density during the actual transmission time.
5. The spectrum analyser was connected to the temporary RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the spectrum analyser to compensate for the loss of the attenuator and RF cable.

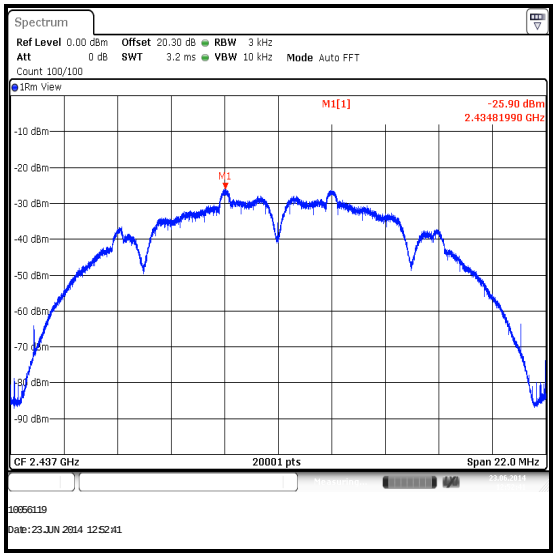
Transmitter Power Spectral Density (continued)

Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s

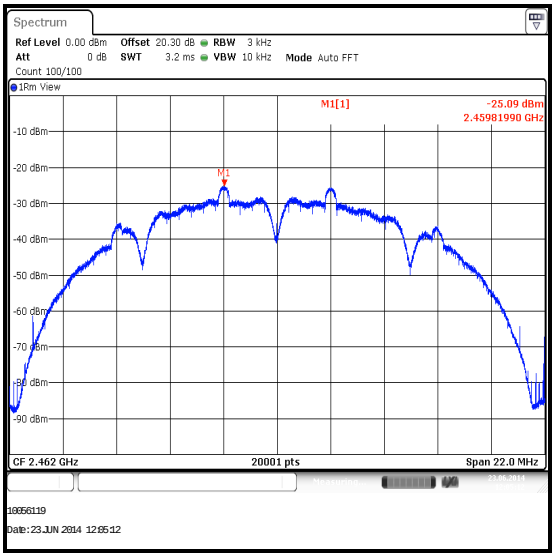
Channel	Output Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-26.6	8.0	34.6	Complied
Middle	-25.9	8.0	33.9	Complied
Top	-25.1	8.0	33.1	Complied



Bottom Channel



Middle Channel

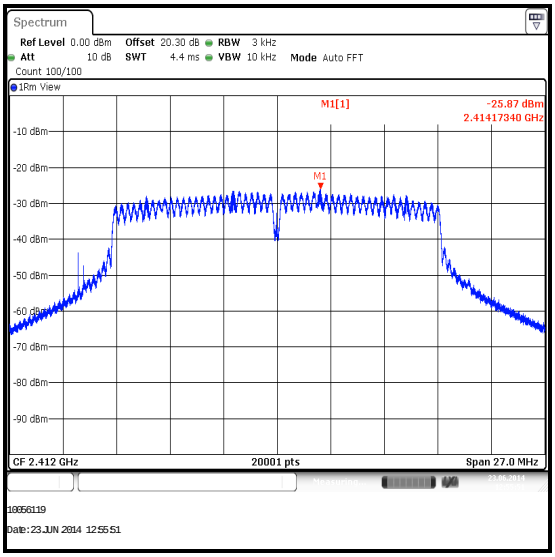


Top Channel

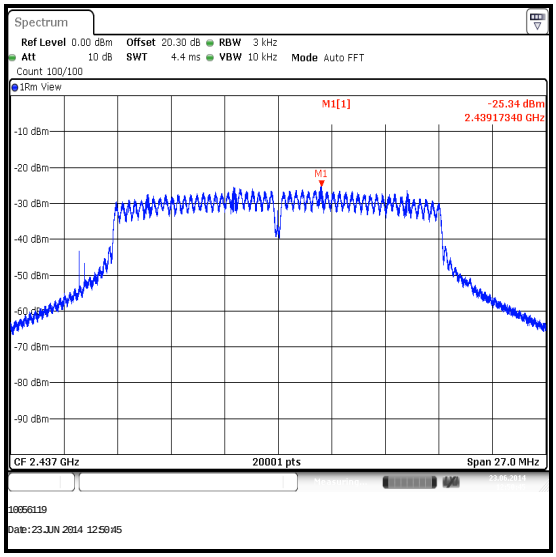
Transmitter Power Spectral Density (continued)

Results: 802.11g / 20 MHz / BPSK / 9 Mbit/s

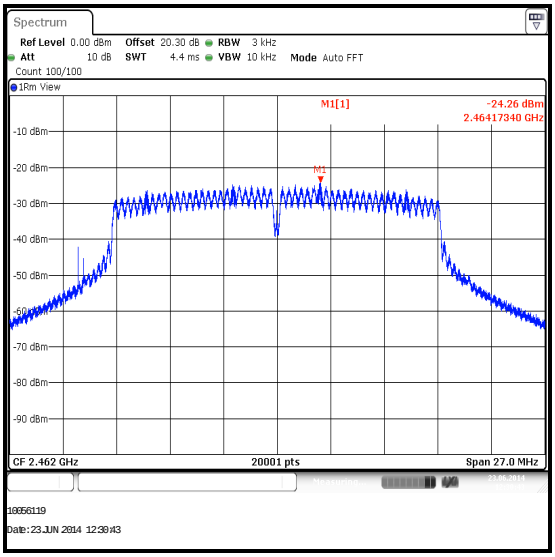
Channel	Output Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-25.9	8.0	33.9	Complied
Middle	-25.3	8.0	33.3	Complied
Top	-24.3	8.0	32.3	Complied



Bottom Channel



Middle Channel

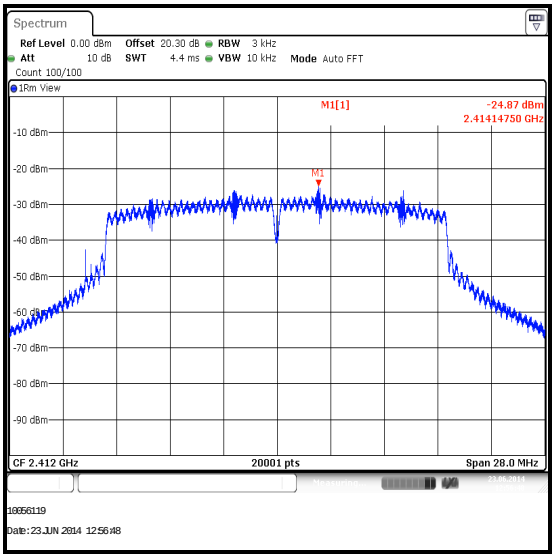


Top Channel

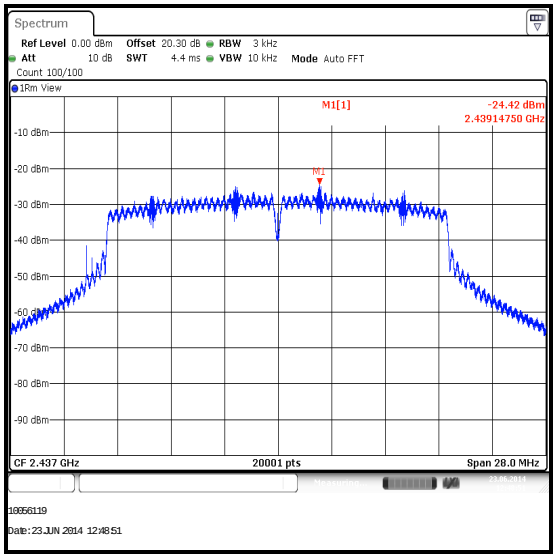
Transmitter Power Spectral Density (continued)

Results: 802.11n / 20 MHz / QPSK / 19.5 Mbit/s / MCS2

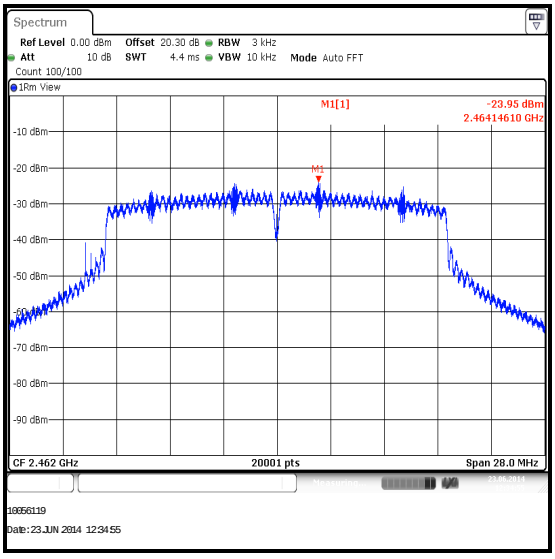
Channel	Output Power (dBm/3 kHz)	Duty cycle correction (dB)	Corrected Output Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-24.9	0.1	-24.8	8.0	32.8	Complied
Middle	-24.4	0.1	-24.3	8.0	32.3	Complied
Top	-24.0	0.1	-23.9	8.0	31.9	Complied



Bottom Channel



Middle Channel



Top Channel

Transmitter Power Spectral Density (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1658	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
M1873	Signal Analyser	Rohde & Schwarz	FSV 30	103074	15 May 2015	12
A2142	Attenuator	AtlanTecRF	AN18-20	081120-23	25 Apr 2015	12

5.2.7. Transmitter Maximum Output Power

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Date:**	20 June 2014
Test Sample IMEI:	353567040838337		

FCC Reference:	Part 15.247(b)(3)
Test Method Used:	As detailed in FCC KDB 558074 Sections 9.2.2.2 & 9.2.2.5

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	43

Note(s):

1. All configurations supported by the EUT were investigated on one channel in accordance with KDB 558074 Sections 9.2.2.2 and 9.2.2.5. The data rates that produced the highest power and therefore deemed worst case were:
    - 802.11b – DQPSK / 2 Mbit/s
    - 802.11g – QPSK / 18 Mbit/s
    - 802.11n HT20 – 64QAM / 58.5 Mbit/s / MCS6 (GI = 800 ns)
2. Final measurements were performed using the above configurations on the bottom, middle and top channels.
3. For 802.11b and 802.11g modes, the EUT was transmitting at 100% duty cycle and testing was performed in accordance with KDB 558074 Section 9.2.2.2.
4. For 802.11n mode, the EUT was transmitting at <98% duty cycle. The calculated duty cycle in section 5.2.5 of this test report was added to the measured power in order to compute the average power during the actual transmission time.
5. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the spectrum analyser to compensate for the loss of the attenuator and RF cable.

Transmitter Maximum Output Power (continued)

Results: 802.11b / 20 MHz / DQPSK / 2 Mbit/s

Conducted Limit Comparison

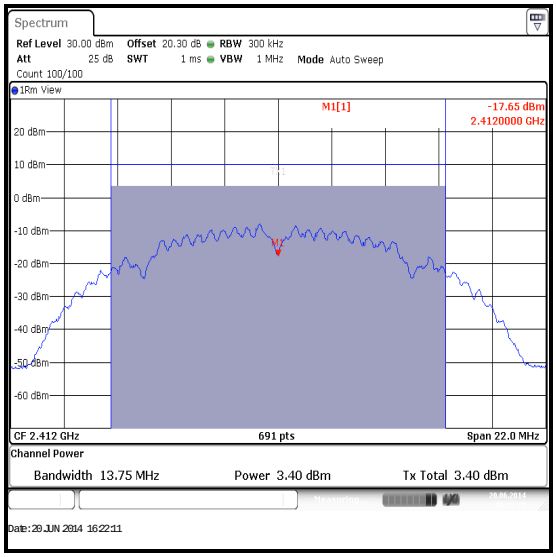
Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	3.4	30.0	26.6	Complied
Middle	3.7	30.0	26.3	Complied
Top	4.9	30.0	25.1	Complied

De Facto EIRP Limit Comparison

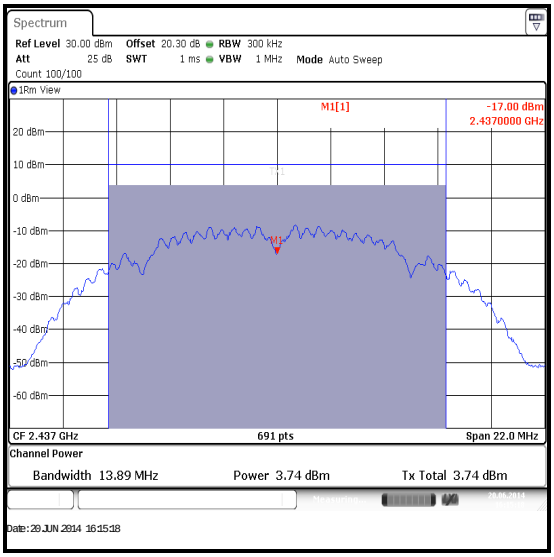
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	3.4	1.4	4.8	36.0	31.2	Complied
Middle	3.7	1.4	5.1	36.0	30.9	Complied
Top	4.9	1.4	6.3	36.0	29.7	Complied

Transmitter Maximum Output Power (continued)

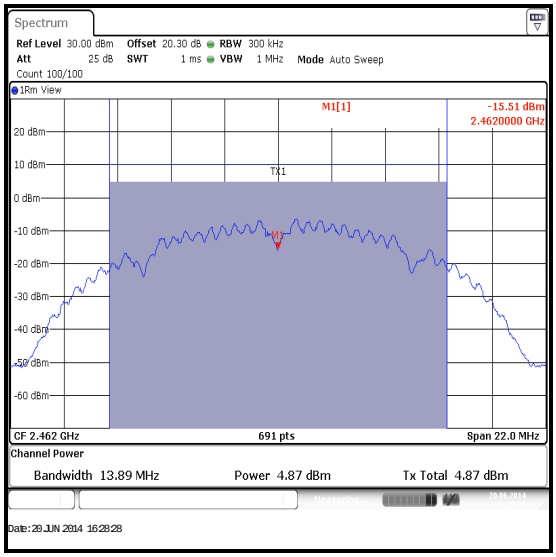
Results: 802.11b / 20 MHz / DQPSK / 2 Mbit/s



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum Output Power (continued)

Results: 802.11g / 20 MHz / QPSK / 18 Mbit/s

Conducted Limit Comparison

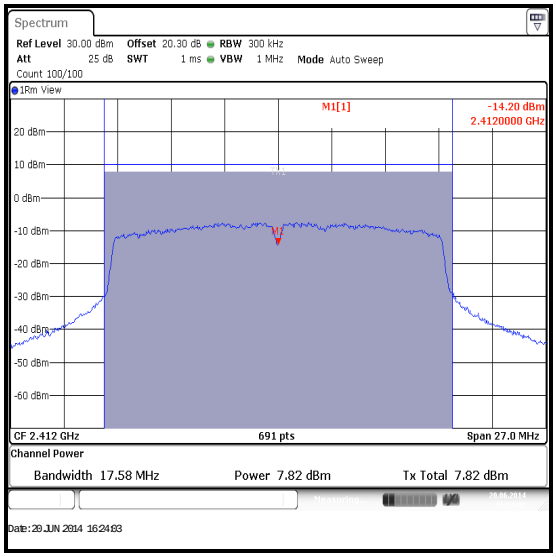
Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	7.8	30.0	22.2	Complied
Middle	8.7	30.0	21.3	Complied
Top	9.4	30.0	20.6	Complied

De Facto EIRP Limit Comparison

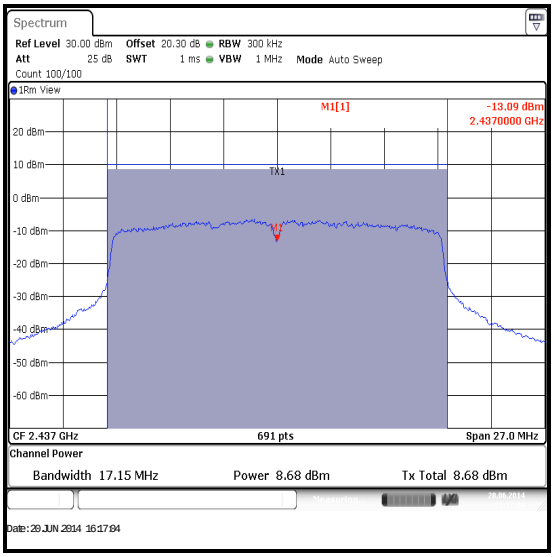
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	7.8	1.4	9.2	36.0	26.8	Complied
Middle	8.7	1.4	10.1	36.0	25.9	Complied
Top	9.4	1.4	10.8	36.0	25.2	Complied

Transmitter Maximum Output Power (continued)

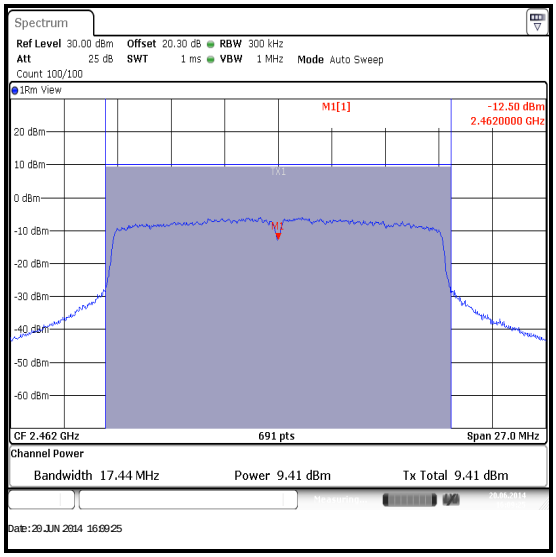
Results: 802.11g / 20 MHz / QPSK / 18 Mbit/s



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum Output Power (continued)

Results: 802.11n / 20 MHz / 64QAM / 58.5 Mbit/s / MCS6

Conducted Limit Comparison

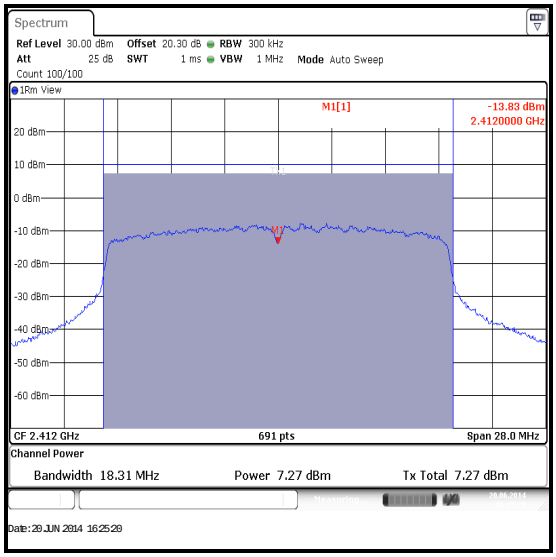
Channel	Conducted Power (dBm)	Duty cycle correction (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	7.3	0.1	7.4	30.0	22.6	Complied
Middle	8.0	0.1	8.1	30.0	21.9	Complied
Top	8.8	0.1	8.9	30.0	21.1	Complied

De Facto EIRP Limit Comparison

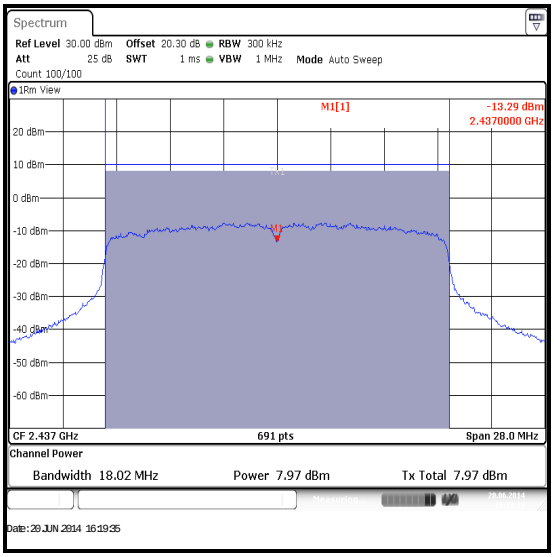
Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	7.4	1.4	8.8	36.0	27.2	Complied
Middle	8.1	1.4	9.5	36.0	26.5	Complied
Top	8.9	1.4	10.3	36.0	25.7	Complied

Transmitter Maximum Output Power (continued)

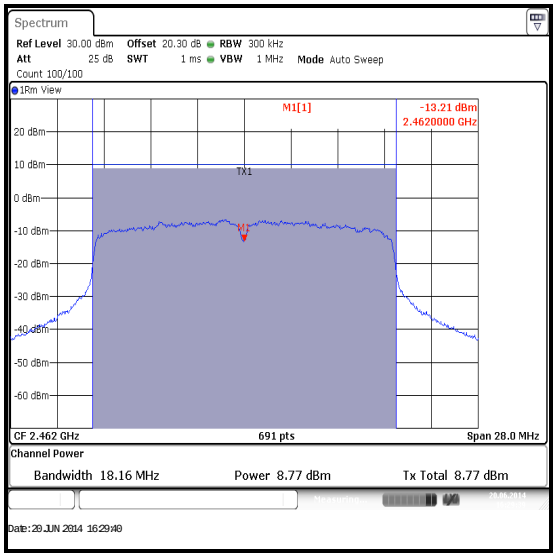
Results: 802.11n / 20 MHz / 64QAM / 58.5 Mbit/s / MCS6



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum Output Power (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1658	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
M1873	Signal Analyser	Rohde & Schwarz	FSV 30	103074	15 May 2015	12
A2142	Attenuator	AtlanTecRF	AN18-20	081120-23	25 Apr 2015	12

5.2.8. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Date:**	27 June 2014
Test Sample IMEI:	353567040816341		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	As detailed in ANSI C63.10 Sections 6.3 and 6.5 referencing ANSI C63.4
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	25
Relative Humidity (%):	32

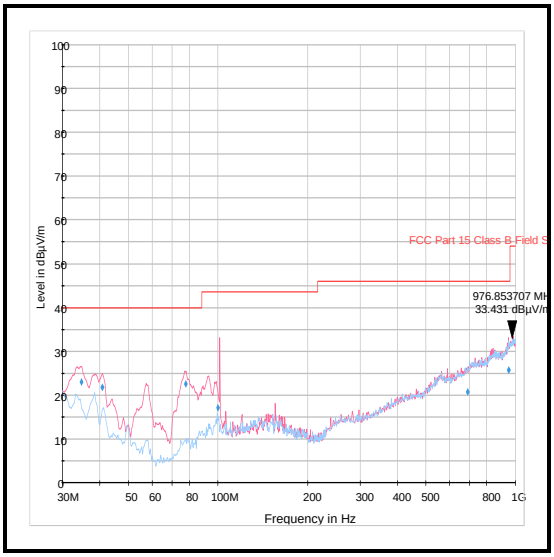
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the top channel only.
3. All emissions shown on the pre-scan plots were investigated and found to be ambient, or >20 dB below the applicable limit or below the measurement system noise floor. Therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
4. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

Results: Top Channel / 802.11g / 20 MHz / 18 Mbit/s

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
976.854	Vertical	33.4	54.0	20.6	Complied

Transmitter Radiated Emissions (continued)



Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1622	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	31 Dec 2014	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	26 Nov 2014	12
A1834	Attenuator	Hewlett Packard	8491B	10444	15 Nov 2014	12
G0543	Amplifier	Sonoma	310N	230801	19 Aug 2014	3
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	15 Feb 2015	12
A490	Antenna	Chase	CBL6111A	1590	29 Apr 2015	12

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Date:**	23 June 2014
Test Sample IMEI:	353567040816341		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	As detailed in ANSI C63.10 Sections 6.3 and 6.6 referencing ANSI C63.4
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	45

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak and average noise floor readings of the measuring receiver were recorded as shown in the tables below.
3. The emission shown approximately at 2462 MHz on the 1 GHz to 4 GHz plots is the EUT fundamental.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0002) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

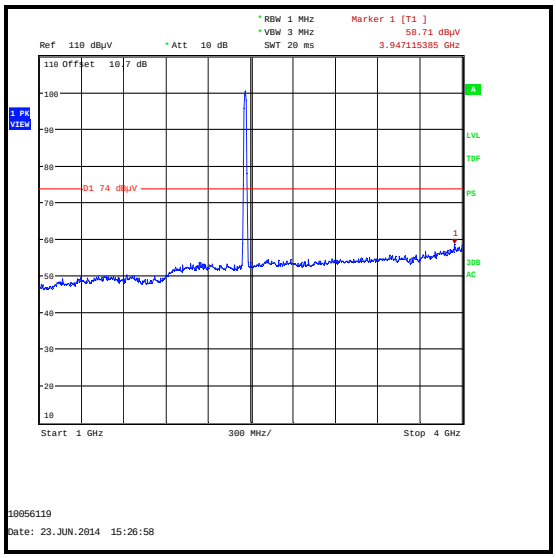
Results: Peak

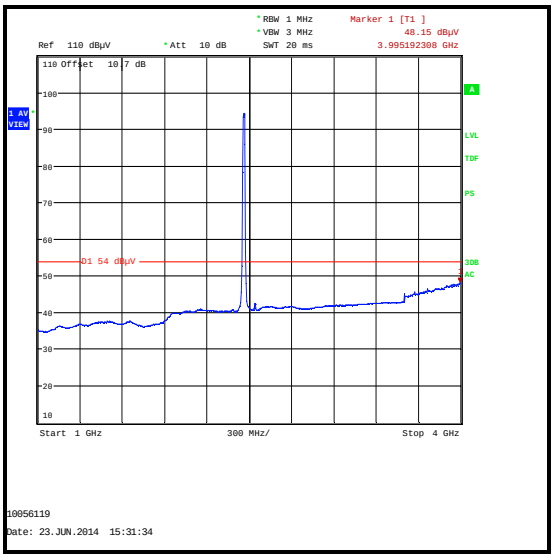
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
3947.115	Vertical	58.7	74.0	15.3	Complied

Results: Average

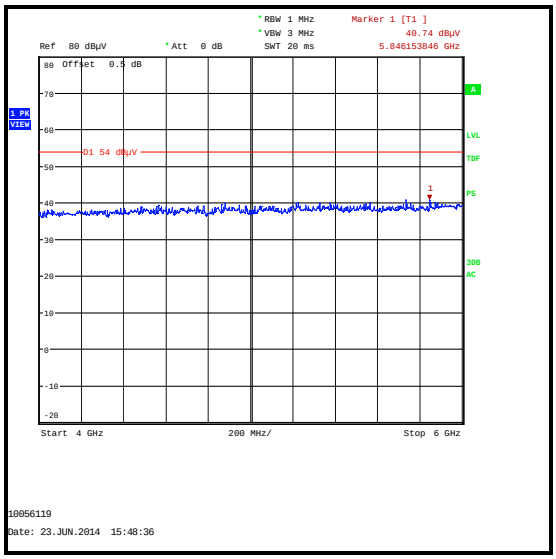
Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
3995.192	Vertical	48.2	54.0	5.8	Complied

Transmitter Radiated Emissions (continued)

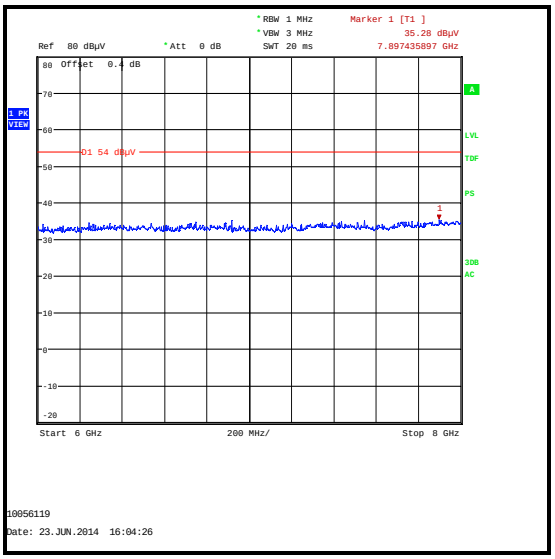




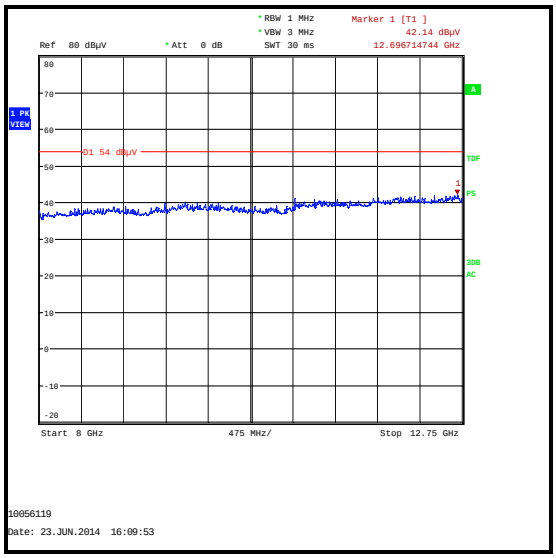
Peak detector

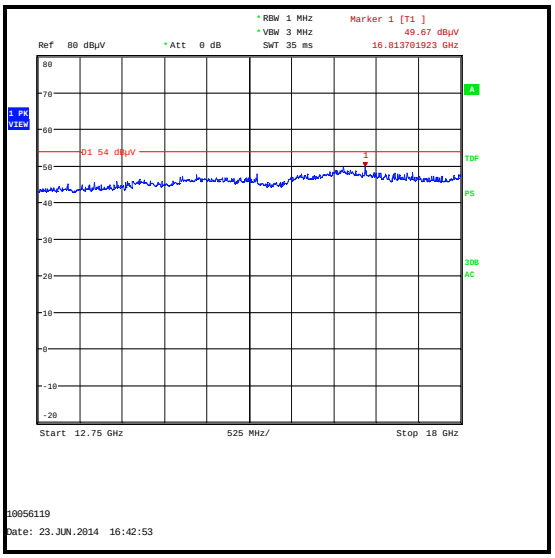


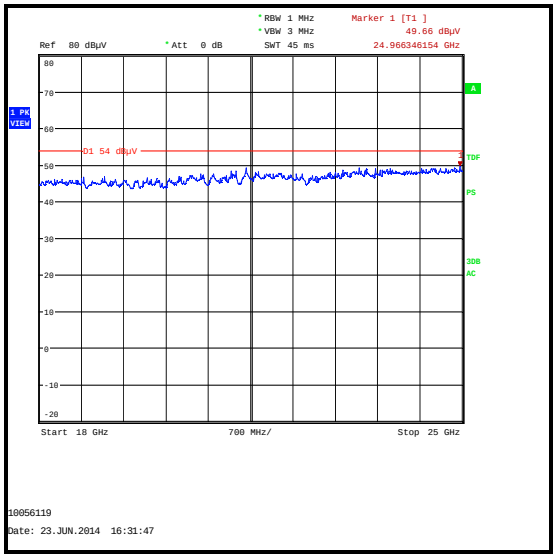
Average detector



Transmitter Radiated Emissions (continued)







Transmitter Radiated Emissions (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Nov 2014	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	13 May 2015	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	18 May 2015	12
A1818	Antenna	EMCO	3115	00075692	14 Nov 2014	12
A253	Antenna	Flann Microwave	12240-20	128	14 Nov 2014	12
A254	Antenna	Flann Microwave	14240-20	139	14 Nov 2014	12
A255	Antenna	Flann Microwave	16240-20	519	14 Nov 2014	12
A256	Antenna	Flann Microwave	18240-20	400	14 Nov 2014	12
A436	Antenna	Flann Microwave	20240-20	330	14 Nov 2014	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	02 May 2015	12

5.2.9. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Date:**	26 June 2014
Test Sample IMEI:	353567040816341		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	As detailed in ANSI C63.10 Section 6.9.2 & FCC KDB 558074 Section 11

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	40

Note(s):

1. All configurations supported by the EUT were investigated on one channel. The data rates that produced the highest power and widest bandwidth were therefore deemed worst case :
    - 802.11b – DQPSK / 2 Mbit/s
    - 802.11g – QPSK / 18 Mbit/s
    - 802.11n HT20 – 64QAM / 58.5 Mbit/s / MCS6 (GI = 800 ns)
2. Final measurements were performed with the above configurations.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
4. The maximum conducted (average) output power was previously measured. In accordance with FCC KDB 558074 Section 11.1(b), the lower band edge measurement should be performed with a peak detector and the -30 dBc limit applied.
5. * -30 dBc limit.

Transmitter Band Edge Radiated Emissions (continued)

Results: Peak / 802.11b / 20 MHz / DQPSK / 2 Mbit/s

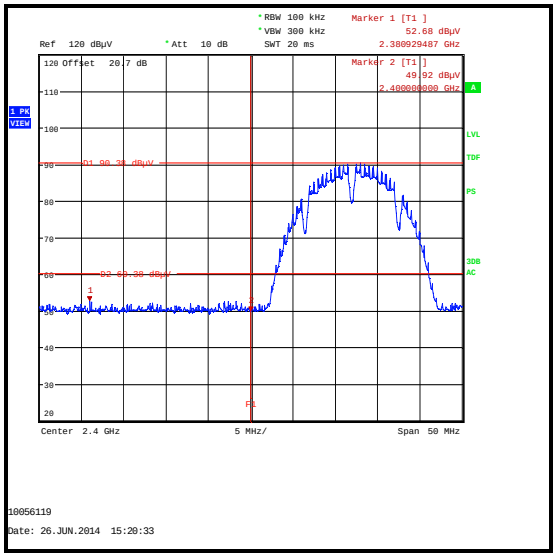
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2400.0	49.9	60.4*	10.5	Complied
2483.5	62.3	74.0	11.7	Complied
2489.429	63.7	74.0	10.3	Complied

Results: Average / 802.11b / 20 MHz / DQPSK / 2 Mbit/s

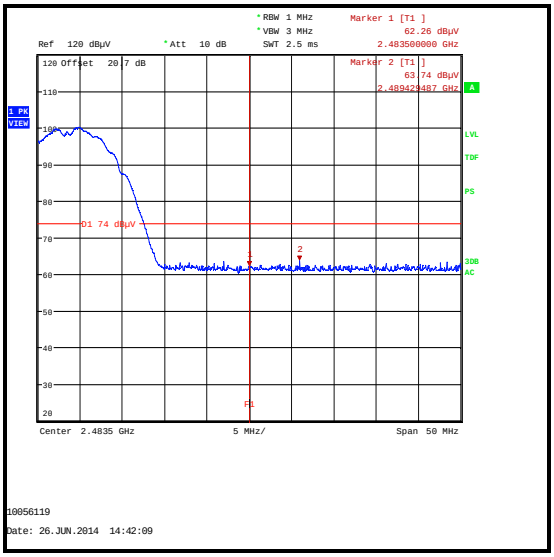
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	48.8	54.0	5.2	Complied

Transmitter Band Edge Radiated Emissions (continued)

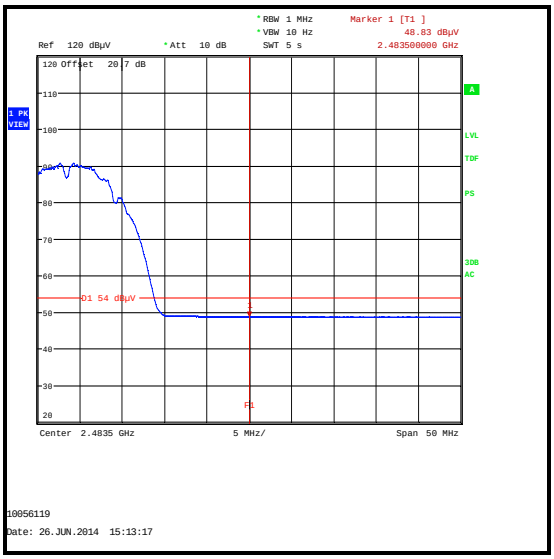
Results: 802.11b / 20 MHz / DQPSK / 2 Mbit/s



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



Upper Band Edge Average Measurement

Transmitter Band Edge Radiated Emissions (continued)

Results: Peak / 802.11g / 20 MHz / QPSK / 18 Mbit/s

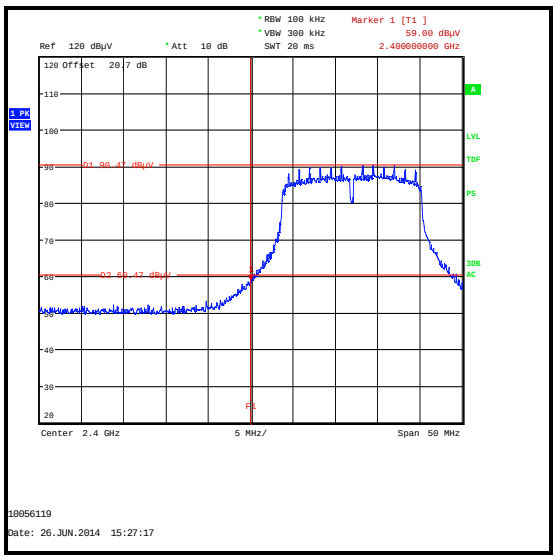
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2400.0	59.0	60.5*	1.5	Complied
2483.5	61.5	74.0	12.5	Complied
2503.853	63.3	74.0	10.7	Complied

Results: Average / 802.11g / 20 MHz / QPSK / 18 Mbit/s

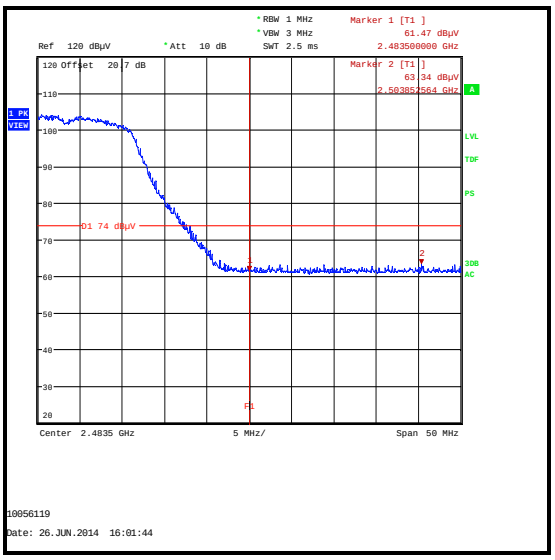
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	49.0	54.0	5.0	Complied

Transmitter Band Edge Radiated Emissions (continued)

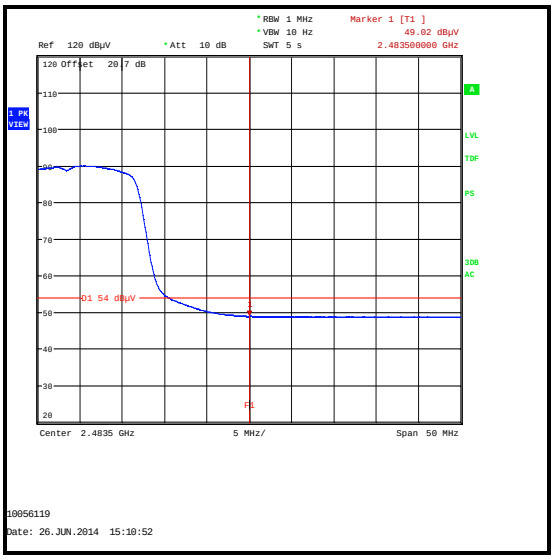
Results: 802.11g / 20 MHz / QPSK / 18 Mbit/s



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



Upper Band Edge Average Measurement

Transmitter Band Edge Radiated Emissions (continued)

Results: Peak / 802.11n / 20 MHz / 64QAM / 58.5 Mbit/s / MCS6

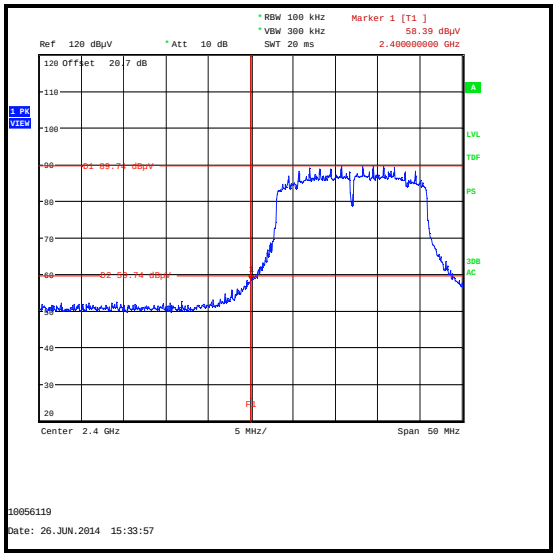
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2400.0	58.4	59.7*	1.3	Complied
2483.5	61.4	74.0	12.6	Complied
2490.872	63.1	74.0	10.9	Complied

Results: Average / 802.11n / 20 MHz / 64QAM / 58.5 Mbit/s / MCS6

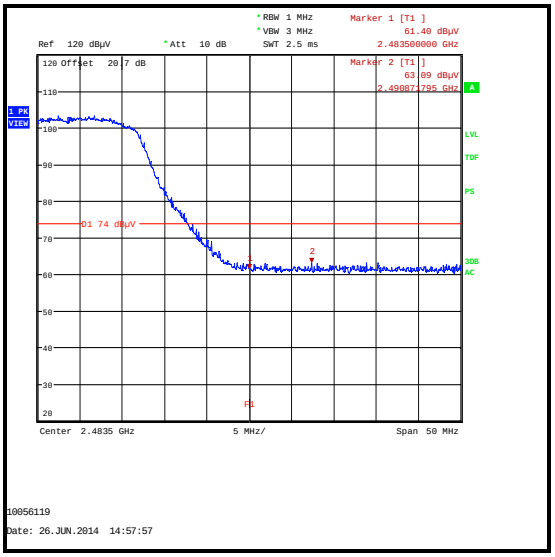
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	49.1	54.0	4.9	Complied

Transmitter Band Edge Radiated Emissions (continued)

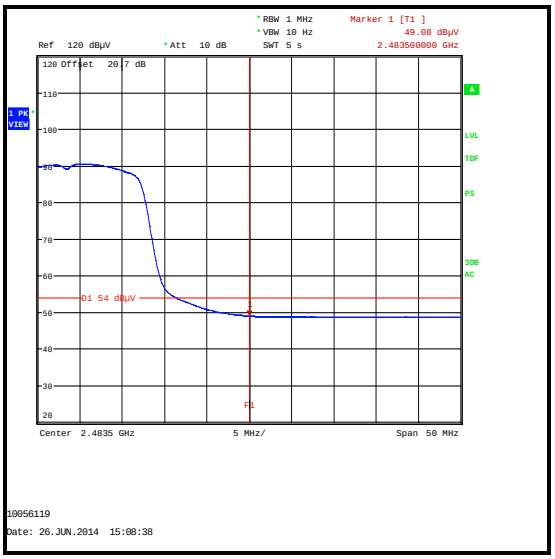
Results: Peak / 802.11n / 20 MHz / 64QAM / 58.5 Mbit/s / MCS6



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



Upper Band Edge Average Measurement

Transmitter Band Edge Radiated Emissions (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	14 Mar 2015	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Nov 2014	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	13 May 2015	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	18 May 2015	12
A1818	Antenna	EMCO	3115	00075692	14 Nov 2014	12
A1393	Attenuator	Huber & Suhner	6820.17.B	757456	02 May 2015	12

6. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±4.69 dB
Conducted Maximum Output Power	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Spectral Power Density	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±3.92 %
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 dB
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version
2.0	7	-	Corrected brand name of USB to AC plug adaptor
	8	-	Section 3.2. Changed description of EUT at the request of the TCB
	29	-	Inserted Note 3 at the request of the TCB

---END OF REPORT---