



TEST REPORT

Test Report No. : UL-RPT-RP10708650JD01A V3.0

Manufacturer : Bekey a/s
Model No. : ML1.1
FCC ID : 2AEPH-ML1-1
Technology : *Bluetooth – Low Energy*
Test Standard(s) : FCC Parts 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 3.0 supersedes all previous versions.

Date of Issue:

28 July 2015

Checked by:

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Engineer, Radio Laboratory

Issued by :

pp

John Newell
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1. Customer Information

Company Name:	Bekey a/s
Address:	Bredebjergvej 6 Taastrup 2630 DENMARK

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:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 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:	15 April 2015 to 30 April 2015

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	✓
Part 15.247(e)	Transmitter Power Spectral Density	Note 1
Part 15.247(b)(3)	Transmitter Maximum Peak 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. In accordance with FCC KDB 558074 Section 10.1, PSD is not required if the maximum conducted output power is less than the PSD limit of 8 dBm / 3 kHz. The PSD level is therefore deemed to be equal to the measured total output power.

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 v03r03 June 9, 2015
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:	Bekey
Model Name or Number:	ML1.1
Test Sample Serial Number:	Not marked or stated / UL ID #1 (<i>Radiated sample</i>)
Hardware Version Number:	5200
Software Version Number:	454
FCC ID:	2AEPH-ML1-1

Brand Name:	Bekey
Model Name or Number:	ML1.1
Test Sample Serial Number:	Not marked or stated / UL ID #4 (<i>Conducted sample</i>)
Hardware Version Number:	5200
Software Version Number:	454
FCC ID:	2AEPH-ML1-1

3.2. Description of EUT

The equipment under test was a door lock fitted with a *Bluetooth LE 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:	<i>Bluetooth Low Energy (Digital Transmission System)</i>				
Type of Unit:	Transceiver				
Channel Spacing:	2 MHz				
Modulation:	GFSK				
Data Rate:	1 Mbps				
Power Supply Requirement(s):	Nominal	5.4 VDC			
Maximum Conducted Output Power:	0.3 dBm				
Antenna Gain:	0.5 dBi				
Transmit Frequency Range:	2402 MHz to 2480 MHz				
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)		
	Bottom	0	2402		
	Middle	19	2440		
	Top	39	2480		

3.5. Support Equipment

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

Description:	5 V to 1.8 V converter
Brand Name:	Bekey
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	RS232 to 5V UART converter
Brand Name:	Bekey
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Laptop PC
Brand Name:	DELL
Model Name or Number:	Latitude E5410
Serial Number:	00763

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

Description:	Power supply
Brand Name:	Power Pax
Model Name or Number:	KSAS0060500100VED
Serial Number:	Not marked or stated

Description:	Power supply
Brand Name:	Cincon Electronics Co. LTD.
Model Name or Number:	TRG1505-E
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):

- Transmitting at maximum power in *Bluetooth LE* mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9.

4.2. Configuration and Peripherals

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

- Controlled using the software application 'nRFgo Studio' on the test laptop PC. The application was used to enable continuous transmission at maximum power and to select the test channels as required.
- The EUT was powered by four AA type batteries. New batteries were fitted before testing commenced and the voltage levels were monitored during testing.
- For radiated testing, once the EUT was in the correct test mode and transmitting, all support equipment was removed from the test site.
- The EUT conducted sample was used for 6 dB bandwidth and maximum peak output power.
- The EUT radiated sample was used for radiated spurious emissions 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. Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	David Doyle	Test Date:	29 April 2015
Test Sample Serial Number:	Not marked or stated / UL ID #4		

FCC Reference:	Part 15.247(a)(2)
Test Method Used:	As detailed in FCC KDB 558074 Section 8.1 Option 1

Environmental Conditions:

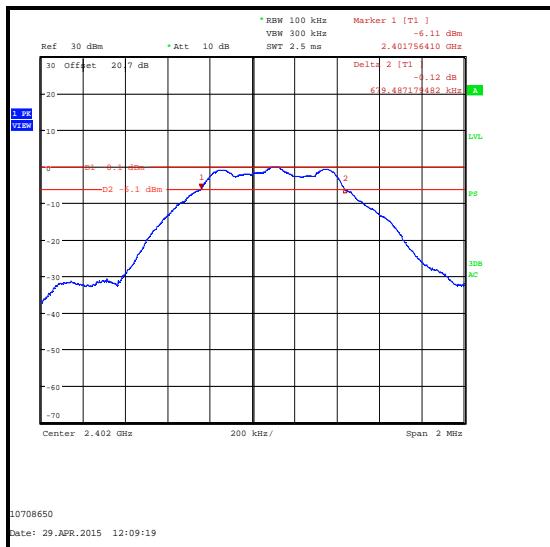
Temperature (°C):	24
Relative Humidity (%):	33

Note(s):

1. 6 dB DTS bandwidth tests were performed using a spectrum analyser in accordance with FCC KDB 558074 Section 8.1 Option 1 measurement procedure.
2. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

Results:

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	679.487	≥500	179.487	Complied
Middle	689.103	≥500	189.103	Complied
Top	682.692	≥500	182.692	Complied

Transmitter Minimum 6 dB Bandwidth (continued)**Results:**

Transmitter Minimum 6 dB Bandwidth (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	23 Apr 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	13 May 2015	12
A1998	Attenuator	Huber & Suhner	6820.17.B	07101	Calibrated before use	-
M1251	Multimeter	Fluke	175	89170179	19 May 2015	12
S0558	DC Power Supply	TTI	EL303R	395825	Calibrated before use	-
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	18 Jul 2016	36
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	08 Apr 2016	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	23 Apr 2016	24

5.2.2. Transmitter Maximum Peak Output Power**Test Summary:**

Test Engineer:	David Doyle	Test Date:	29 April 2015
Test Sample Serial Number:	Not marked or stated / UL ID #4		

FCC Reference:	Part 15.247(b)(3)
Test Method Used:	As detailed in FCC KDB 558074 Section 9.1.1

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	33

Note(s):

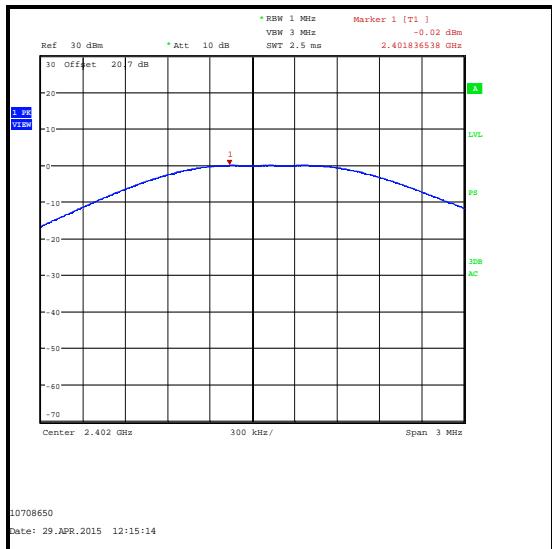
- Conducted power tests were performed using a spectrum analyser in accordance with FCC KDB 558074 Section 9.1.1 with the $RBW > DTS$ bandwidth procedure. A resolution bandwidth of 1 MHz was used and the video bandwidth was set to 3 MHz.
- A spectrum analyser was connected to the RF port on the EUT using 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.
- The declared antenna gain was added to the conducted peak power to obtain the EIRP.

Results:

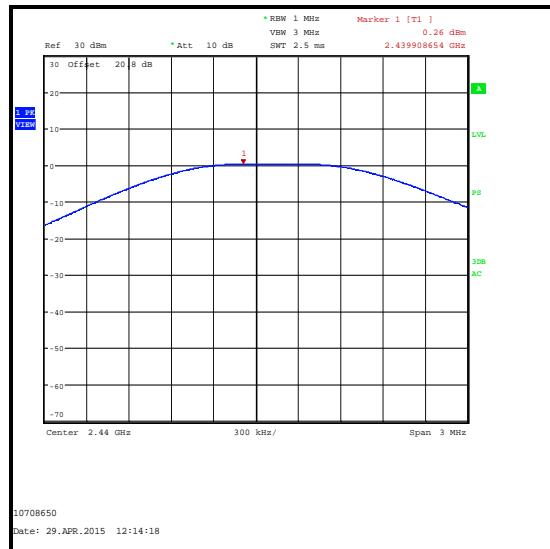
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	0.0	30.0	30.0	Complied
Middle	0.3	30.0	29.7	Complied
Top	0.1	30.0	29.9	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	0.0	0.5	0.5	36.0	35.5	Complied
Middle	0.3	0.5	0.8	36.0	35.2	Complied
Top	0.1	0.5	0.6	36.0	35.4	Complied

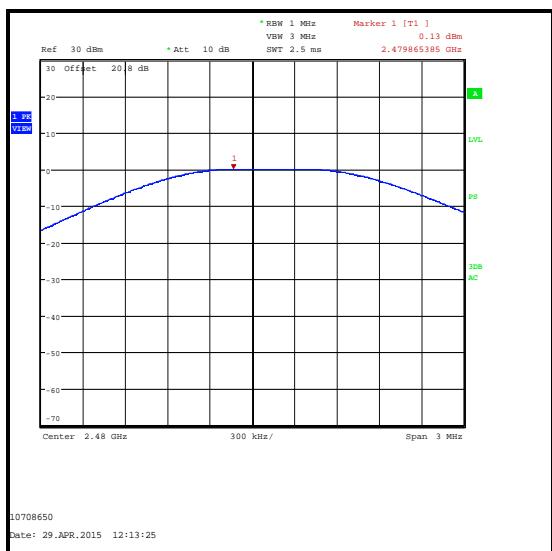
Transmitter Maximum Peak Output Power (continued)



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum Peak Output Power (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	23 Apr 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	13 May 2015	12
A1998	Attenuator	Huber & Suhner	6820.17.B	07101	Calibrated before use	-
M1251	Multimeter	Fluke	175	89170179	19 May 2015	12
S0558	DC Power Supply	TTI	EL303R	395825	Calibrated before use	-
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	18 Jul 2016	36
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	08 Apr 2016	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	23 Apr 2016	24

5.2.3. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	David Doyle	Test Date:	30 April 2015
Test Sample Serial Number:	Not marked or stated / UL ID #1		

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:

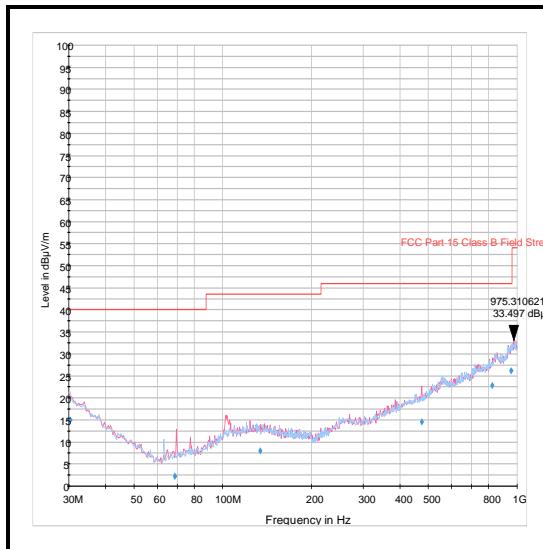
Temperature (°C):	24
Relative Humidity (%):	33

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.
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: Middle Channel

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
975.311	Horizontal	33.5	54.0	20.5	Complied

Transmitter Radiated Emissions (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1623	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	07 Jan 2016	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	19 Mar 2016	12
A259	Antenna	Chase	CBL6111	1513	09 Apr 2016	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
G0543	Amplifier	Sonoma	310N	230801	05 Jun 2015	3
A1834	Attenuator	Hewlett Packard	8491B	10444	05 Mar 2016	12

Transmitter Radiated Emissions (continued)**Test Summary:**

Test Engineer:	David Doyle	Test Dates:	15 April 2015 & 29 April 2015
Test Sample Serial Number:	Not marked or stated / UL ID #1		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	As detailed in FCC KDB 558074 Sections 11 & 12 referencing ANSI C63.10 Sections 6.3 and 6.6 and ANSI C63.4
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	33 to 37

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. The emission shown on the 1 GHz to 4 GHz plot is the EUT fundamental.
4. The reference level for the emission in the non-restricted band was established by following KDB 558074 Section 11.2 procedure.
5. 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.
6. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto.

Transmitter Radiated Emissions (continued)**Results: Peak / Bottom Channel**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2313.466	Horizontal	54.9	74.0	19.1	Complied
2368.618	Horizontal	58.0	74.0	16.0	Complied

Results: Average / Bottom Channel

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2314.399	Horizontal	27.3	54.0	26.7	Complied
2370.117	Horizontal	27.5	54.0	26.5	Complied

Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2488.205	Horizontal	57.3	74.0	16.7	Complied

Results: Average / Middle Channel

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2489.039	Horizontal	27.6	54.0	26.4	Complied

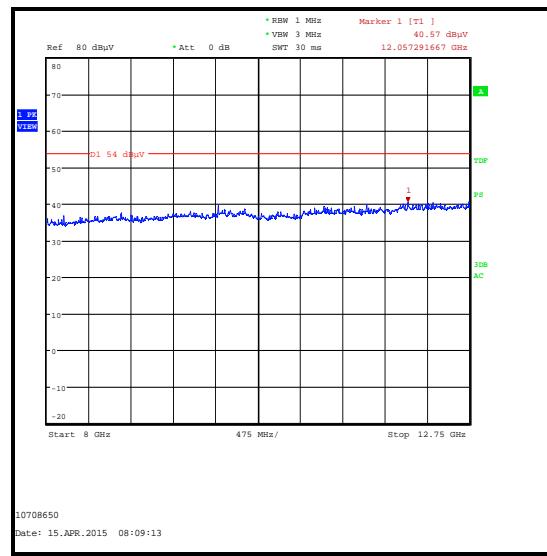
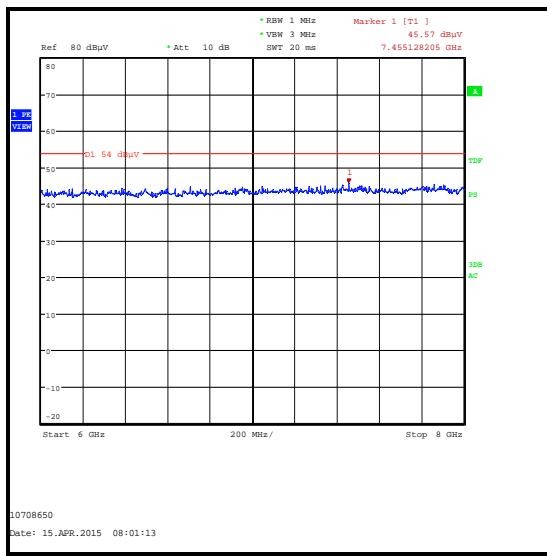
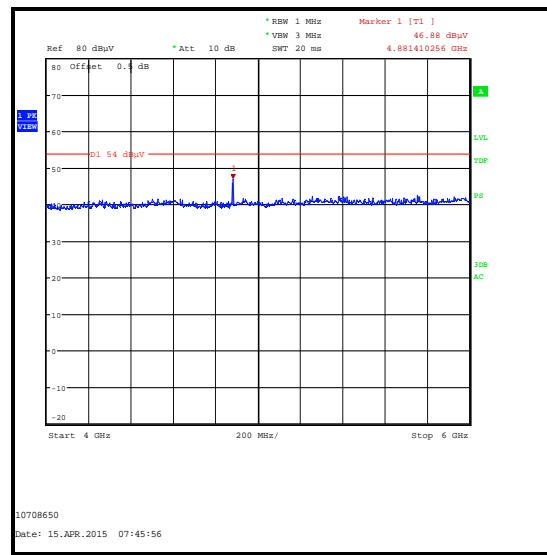
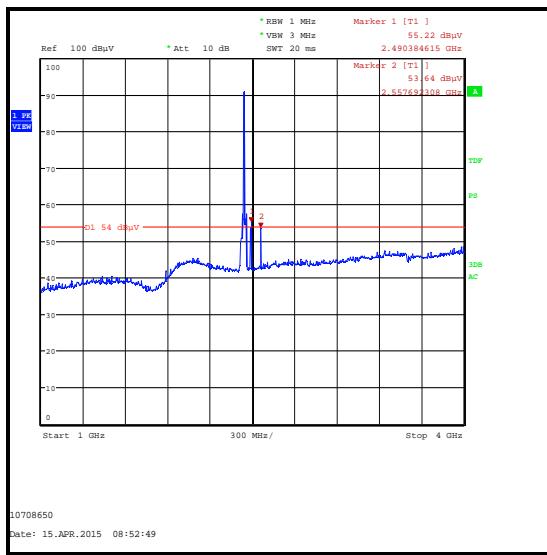
Results: Non-restricted Band / Middle Channel

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	-20 dBc Limit (dB μ V/m)	Margin (dB)	Result
2556.242	Horizontal	47.9	70.6	22.7	Complied

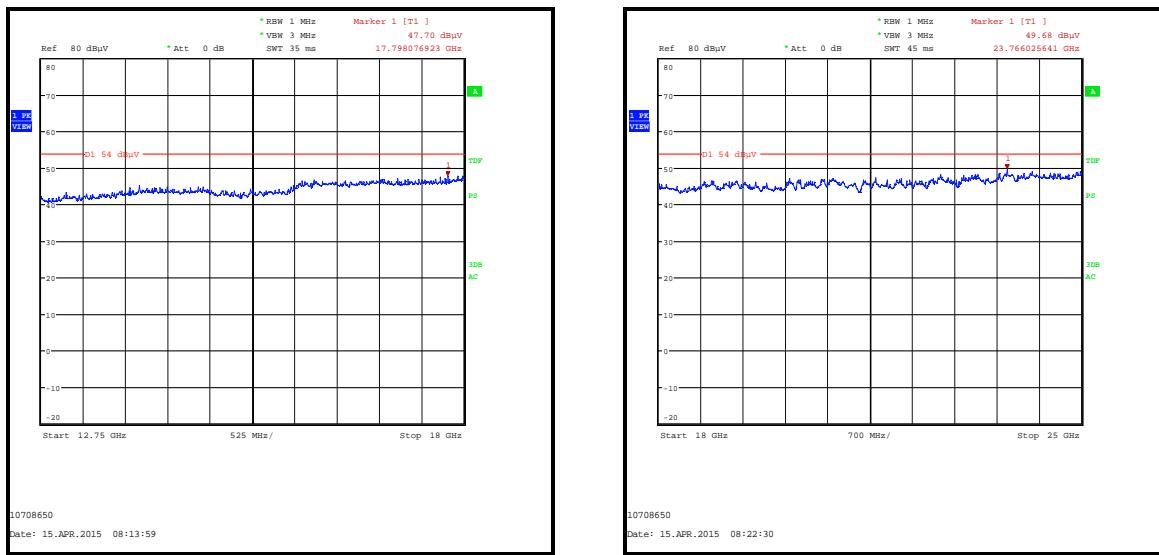
Results: Non-restricted Band / Top Channel

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	-20 dBc Limit (dB μ V/m)	Margin (dB)	Result
2556.184	Horizontal	48.1	70.6	22.5	Complied

Transmitter Radiated Emissions (continued)



Transmitter Radiated Emissions (continued)



Note: The above 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)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	30 Apr 2015	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	13 May 2015	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	21 Dec 2015	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	17 Apr 2016	12
A1818	Antenna	EMCO	3115	00075692	20 Dec 2015	12
A253	Antenna	Flann Microwave	12240-20	128	20 Dec 2015	12
A254	Antenna	Flann Microwave	14240-20	139	20 Dec 2015	12
A255	Antenna	Flann Microwave	16240-20	519	20 Dec 2015	12
A256	Antenna	Flann Microwave	18240-20	400	20 Dec 2015	12
A436	Antenna	Flann Microwave	20240-20	330	21 Dec 2015	12

5.2.4. Transmitter Band Edge Radiated Emissions**Test Summary:**

Test Engineer:	David Doyle	Test Date:	29 April 2015
Test Sample Serial Number:	Not marked or stated / UL ID #1		

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

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	33

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 maximum peak conducted output power was previously measured. In accordance with FCC KDB 558074 Section 11.1(a), the lower band edge measurement was performed with a peak detector and the -20 dBc limit applied.
3. There is a restricted band 10 MHz below the lower band edge. The test receiver was set up as follows: the RBW set to 1 MHz, the VBW set to 3 MHz, with the sweep time set to auto couple. Peak and average measurements were performed with their respective detectors. Markers were placed on the highest point on each trace.
4. * -20 dBc limit.

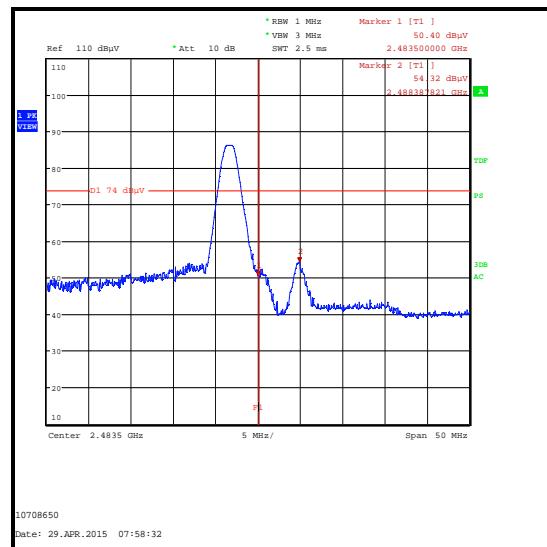
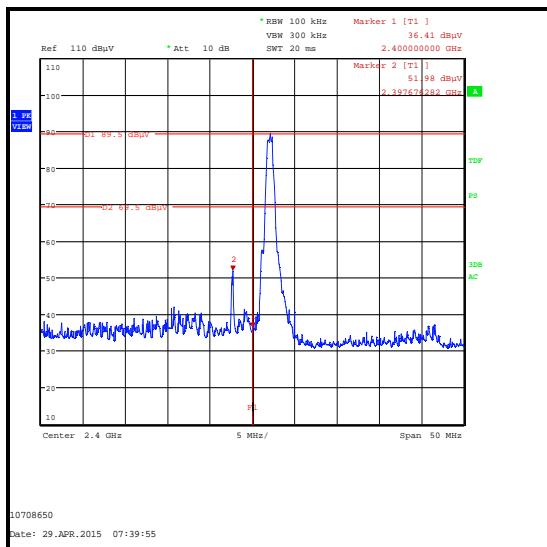
Results: Peak

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2368.718	54.8	74.0	19.2	Complied
2397.676	52.0	69.5*	17.5	Complied
2400.0	36.4	69.5*	33.1	Complied
2483.5	50.4	74.0	23.6	Complied
2488.388	54.3	74.0	19.7	Complied

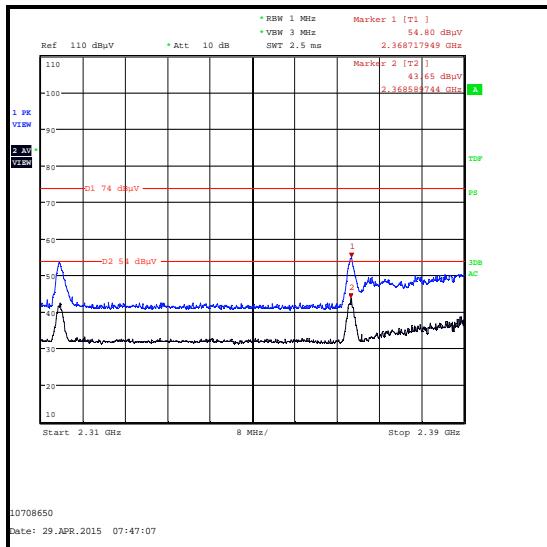
Results: Average

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2368.590	43.7	54.0	10.3	Complied
2483.5	36.7	54.0	17.3	Complied

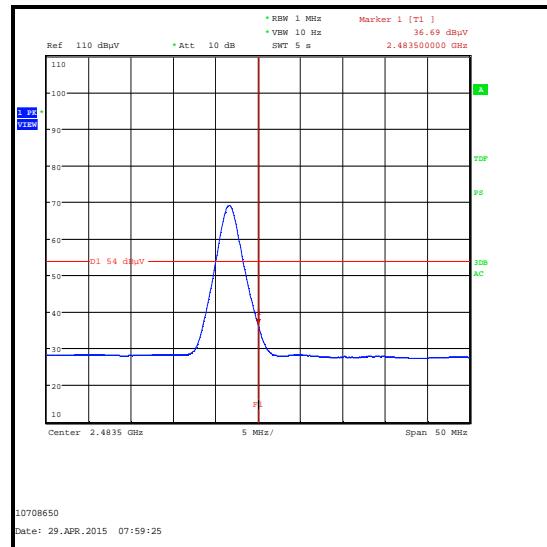
Transmitter Band Edge Radiated Emissions (continued)



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



2310 MHz to 2390 MHz Restricted Band Plot

Upper Band Edge Average Measurement

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	30 Apr 2015	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	13 May 2015	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	21 Dec 2015	12
A1818	Antenna	EMCO	3115	00075692	20 Dec 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 measured (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
Conducted Maximum Peak Output Power	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 26.5 GHz	95%	±2.94 dB

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	-	-	FCC ID updated
3.0	-	-	FCC ID & Section 2.3 updated

--- END OF REPORT ---