2360

Radio Test Report

Roli Ltd

Seaboard Block

SBB01

47 CFR Part 15.249 Effective Date 1st October 2015
DXT: Part 15 Low Power Transceiver
Test Date: 30th March 2017 to 3rd April 2017
Report Number: 04-9523-1-17 Issue 01

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Certificate of Test 9523-1

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of 47 CFR Part 15C. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Seaboard Block
Model Number:	SBB01
Unique Serial Number:	4.5-001
Applicant:	Roli Ltd 2 Glebe Road, Dalston, London E8 4BD
Proposed FCC ID	2AFT3-SB01
Full measurement results are detailed in Report Number:	04-9523-1-17 Issue 01
Test Standards:	47 CFR Part 15.249 Effective Date 1st October 2015 DXT: Part 15 Low Power Transceiver

NOTE:
Certain tests were not performed based upon manufacturer's declarations. For details refer to section 3 of this report.

DEVIATIONS:
No deviations have been applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date Of Test: 30th March 2017 to 3rd April 2017

Test Engineer:	Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Ltd Date: 2017.04.12 13:26:24 Z
Approved By: Technical Manager	Steve Hull Digitally signed by: Steve Hull DN: CN = Steve Hull C = GB O = RN Electronics Ltd Date: 2017.04.12 14:03:03 Z
Customer Representative:	

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1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Roli Ltd 2 Glebe Road Dalston London E8 4BD	
Manufacturer of EUT	Roli Ltd	
Full Name of EUT	Seaboard Block	
Model Number of EUT	SBB01	
Serial Number of EUT	4.5-001	
Date Received	27th March 2017	
Date of Test:	30th March 2017 to 3rd April 2017	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	6th April 2017	
Main Function	Provides a playing surface for creating music in conjunction with an App running on a tablet or laptop.	
Information Specification	Height	30 mm
	Width	285 mm
	Depth	143 mm
	Weight	0.8 kg
	Voltage	3.7 V DC Internal Lithium Ion Battery
	Current	Not stated

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Desktop / Handheld
Choice of model(s) for type tests	Production prototype
Antenna details	Integral chip antenna Antenova A6111
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2483.5 MHz
Lowest Signal generated in EUT	8 MHz
Hardware Version	Not specified
Software Version	Not specified
Firmware Version	Proprietary test firmware v1.0 used for test purposes.
Type of Equipment	Portable, indoor
Technology Type	Bluetooth LE & Proprietary protocol Shockburst GFSK
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2402 - 2480 MHz
EUT Declared Modulation Parameters	Bluetooth (low energy), ShockBurst (GFSK)
EUT Declared Power level	-4 dBm
EUT Declared Signal Bandwidths	BTLE: 1 MHz Shockburst: 1 and 2 MHz
EUT Declared Channel Spacing's	2 MHz
EUT Declared Duty Cycle	BTLE approx. 66% worst case, Shockburst 15% absolute worst case
Unmodulated carrier available?	No
Declared frequency stability	40 ppm
RX Parameters	
Alignment range – receiver	2402 - 2480 MHz
EUT Declared RX Signal Bandwidth	2 MHz
Receiver Signal Level (RSL)	Not specified
Method of Monitoring Receiver BER	Not applicable
FCC equipment class	
Equipment class	DXT: Part 15 Low Power Transceiver

2.3 Functional description

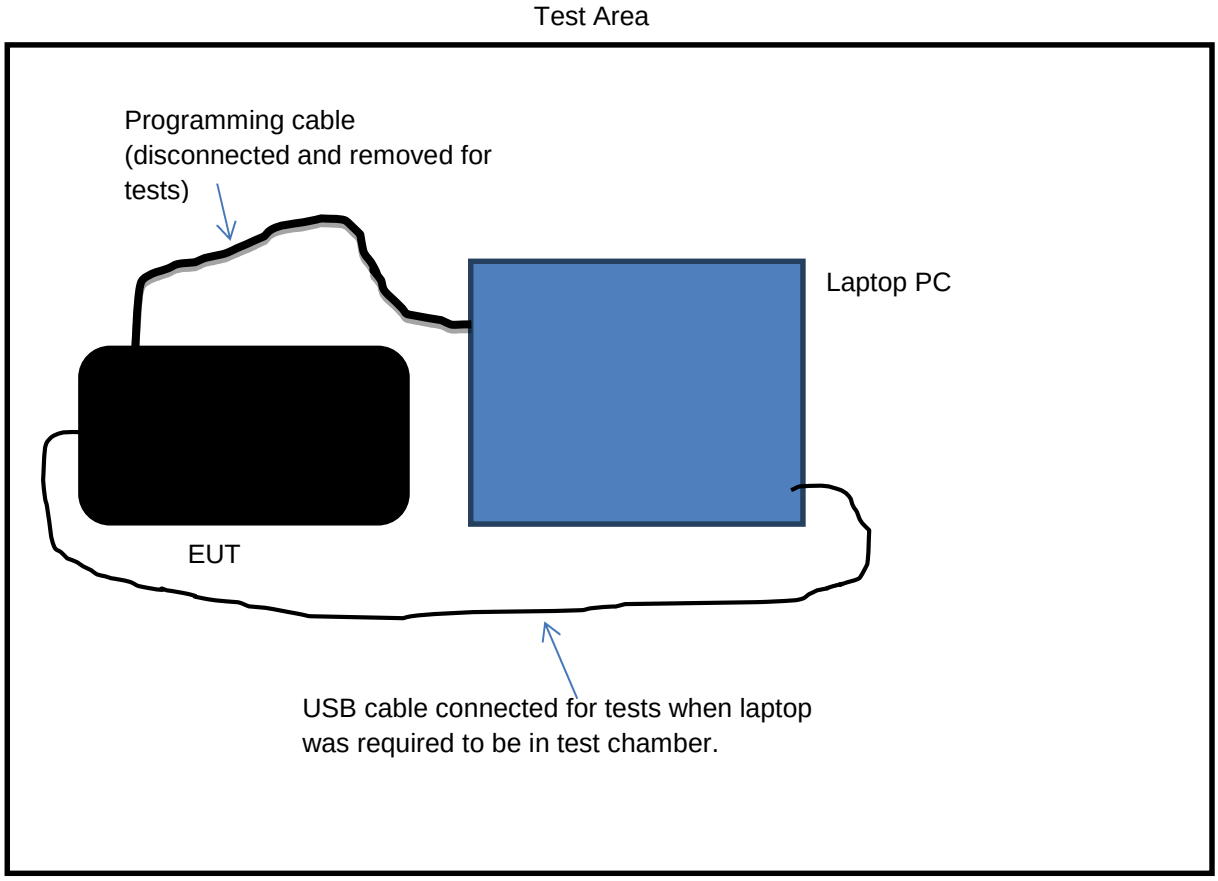
Provides a playing surface for creating music in conjunction with an App running on a tablet or laptop. The EUT incorporates a radio transceiver operating in the 2.4 GHz band. The radio operates over a frequency range of 2402 – 2480 MHz and uses either Bluetooth (Low energy) modulation or uses a proprietary modulation scheme (ShockBurst) which utilises GFSK modulation and operates at 1 MHz and 2 MHz channel bandwidths. The EUT is powered using an internal Lithium Ion battery and the antenna is integral.

2.4 Modes of operation

Mode Reference	Description	Used for testing
BTLE Low chan	Transmitting packet data repeatedly at 2402 MHz using Bluetooth low energy protocol.	Yes
BTLE Mid chan	Transmitting packet data repeatedly at 2440 MHz using Bluetooth low energy protocol.	Yes
BTLE High chan	Transmitting packet data repeatedly at 2480 MHz using Bluetooth low energy protocol.	Yes
ShockBurst 1M Low chan	ShockBurst mode 1MHz (GFSK) Transmitting packet data repeatedly at 2402 MHz.	Yes
ShockBurst 1M Mid chan	ShockBurst mode 1MHz (GFSK) Transmitting packet data repeatedly at 2440 MHz.	Yes
ShockBurst 1M High chan	ShockBurst mode 1MHz (GFSK) Transmitting packet data repeatedly at 2480 MHz.	Yes
ShockBurst 2M Low chan	ShockBurst mode 2MHz (GFSK) Transmitting packet data repeatedly at 2402 MHz.	Yes
ShockBurst 2M Mid chan	ShockBurst mode 2MHz (GFSK) Transmitting packet data repeatedly at 2440 MHz.	Yes
ShockBurst 2M High chan	ShockBurst mode 2MHz (GFSK) Transmitting packet data repeatedly at 2480 MHz.	Yes
RX Low chan (BLE)	Receiving continuously at 2402 MHz (Bluetooth low energy protocol)	Yes
RX High chan (BLE)	Receiving continuously at 2480 MHz (Bluetooth low energy protocol)	Yes
RX Low chan (ShockBurst1)	Receiving continuously at 2402 MHz (ShockBurst protocol, 1 MHz channel bandwidth)	Yes
RX High chan (ShockBurst1)	Receiving continuously at 2480 MHz (ShockBurst protocol, 1 MHz channel bandwidth)	Yes
RX Low chan (ShockBurst2)	Receiving continuously at 2402 MHz (ShockBurst protocol, 2 MHz channel bandwidth)	Yes
RX High chan (ShockBurst2)	Receiving continuously at 2480 MHz (ShockBurst protocol, 2 MHz channel bandwidth)	Yes

Note: The following duty cycles for the above modes of operation were confirmed as: BTLE 61.1%, Shockburst 1 MHz 15.9% and Shockburst 2 MHz 8.5%. Please see section 5.9 within this report

2.5 Emissions configuration



The unit was powered from its fully charged internal battery for tests. Where required the unit was also connected back to a laptop PC via its USB port for charging purposes. All tests were performed radiated. The unit was configured via a serial to USB converter lead magnetically coupled to a specific docking port on the unit, which was connected back to the ancillary laptop. This port was provided for test purposes only and allowed access to the specific engineering test modes required for tests via use of a terminal program called “cool term”. Modes set are listed in section 2.4. Low, mid and high channel frequencies were selected, along with the radio type (Bluetooth or Shockburst). Power levels for all tests were set at the -4dBm setting. The transmit modes used the following measured duty cycles, and were declared by the manufacturer to be worst case (maximum) duty cycles the equipment could use:

BTLE: 61.1%
Shockburst 1MHz: 15.9%
Shockburst 2MHz: 8.5%

Whilst a stand alone configuration without the laptop connected was checked, for the purposes of radiated emissions tests and field strength measurements highest levels / worst case emissions were with the unit connected to an ”off the shelf” laptop via its USB port. Refer to the specific test sections in section 5 for further details.
For the purposes of AC conducted emissions tests the “off the shelf” laptop was used for tests and its power supply connected to the LISN.

2.5.1 Signal leads

Port Name	Cable Type	Connected
USB charging port	Mini USB	Yes

3 Summary of test results

The Seaboard Block, SBB01 was tested for compliance to the following standard(s) :

47 CFR Part 15.249 Effective Date 1st October 2015
DXT: Part 15 Low Power Transceiver

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	PASSED
2. Radiated emissions 9 - 150 kHz		NOT APPLICABLE[1]
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209 & 15.249d	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.209 & 15.249a,d	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.209 & 15.249a,d	PASSED[2]
6. Intentional radiator field strength	47 CFR Part 15C Part 15.249a	PASSED
7. Band Edge Compliance	47 CFR Part 15C Part 15.215, 15.209,15.249a,d	PASSED
8. Occupied bandwidth	47 CFR Part 15C Part 15.215	PASSED
9. Duty cycle	47 CFR Part 15C Part 15.35 & 15.249(e)	PASSED[3]
10. Frequency stability		NOT APPLICABLE[4]

[1] EUT's lowest generated or used frequency is declared as 8MHz. Therefore tests have only been performed down to 150kHz
[2] Spectrum investigated up to a frequency of 25GHz based on 10 times the highest channel frequency used in the equipment of 2.48GHz.
[3] Test performed to confirm duty cycle of test modes. Results for duty cycle can be used to apply corrections to average emissions measurements where applicable.
[4] Test only applies to equipment intended for fixed, point-to-point operation.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 15C	2015	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
4.1.3	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

4.2 Deviations

No deviations were applied

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.2 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT and ancillary laptop were placed on a wooden table 0.8m above the ground plane and the laptop supply was connected to a LISN via a 1m mains cable.

Details of the Peripheral and Ancillary Equipment connected for this test are listed in section 10.

During the initial scan, there was no discernible difference noted in emissions between modes listed in section 2.4 of this report. Therefore final tests were performed with the EUT operating in mode **BTLE Mid chan**.

5.1.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed in the 'Test Equipment' Section. Measurements were made on the live and neutral conductors using both average and quasi-peak detection.
At least 6 signals within 20dB and/or all signals within 10dB of the limit were investigated.

Tests were performed in Test Site F.

5.1.4 Test equipment

E010, E035, E411, E465, E624, ZSW1

See Section 9 for more details

5.1.5 Test results

Temperature of test environment	15°C
Humidity of test environment	63%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Mid channel	2440 MHz

Plot refs
9523-1 Cond 1 AC Live 150k-30M Average
9523-1 Cond 1 AC Live 150k-30M Quasi-Peak
9523-1 Cond 1 AC Neutral 150k-30M Average
9523-1 Cond 1 AC Neutral 150k-30M Quasi-Peak

Table of signals measured for Cond 1 AC Live 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.155	59.2	53.8	-11.9	38.7	-17.0
2	0.179	59.2	57.5	-7.0	33.6	-20.9
3	0.217	48.5	41.7	-21.2	14.9	-38.0
4	0.250	50.4	43.6	-18.2	15.5	-36.3
5	0.271	45.9	44.7	-16.4	38.5	-12.6
6	0.315	46.0	43.2	-16.6	26.9	-22.9
7	0.542	39.8	34.4	-21.6	29.1	-16.9
8	0.607	36.1	31.7	-24.3	10.2	-35.8
9	2.964	34.5	28.9	-27.1	19.6	-26.4
10	13.926	35.8	31.0	-29.0	20.1	-29.9

Table of signals measured for Cond 1 AC Neutral 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.153	60.8	53.3	-12.5	25.6	-30.2
2	0.216	52.6	51.6	-11.4	36.4	-16.6
3	0.236	46.6	40.4	-21.8	17.7	-34.5
4	0.271	46.4	42.3	-18.8	38.8	-12.3
5	0.323	38.3	31.5	-28.1	9.5	-40.1
6	0.386	38.0	34.8	-23.3	21.5	-26.6
7	0.554	30.2	23.7	-32.3	14.8	-31.2
8	3.777	31.4	26.7	-29.3	18.1	-27.9
9	13.827	34.4	30.5	-29.5	22.4	-27.6
10	21.142	32.2	29.3	-30.7	20.9	-29.1

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.207: as given in the above tables & drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
150kHz to 30MHz ±3.6dB

5.2 Radiated emissions 9 - 150 kHz

NOT APPLICABLE: EUT's lowest generated or used frequency is declared as 8MHz. Therefore tests have only been performed down to 150kHz.

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.209/15.249(d) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes Radiated Emissions testing was performed with a fully charged battery and connected to an ancillary laptop. No discernible difference in emissions was noted between mod schemes and channels settings. The EUT was therefore connected to the laptop via the USB lead for full test and operated in **BTLE Mid chan** mode.

5.3.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment and the antenna were rotated 360 degrees to record the worst case emissions.

No emissions were observed.

Tests were performed using Test Site H.

5.3.4 Test equipment

TMS81, TMS45, ZSW1, E534, E535, E748

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	22°C
Humidity of test environment	45%
Pressure of test environment	101kPa

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Mid channel	2440 MHz

Plot refs
9523-1 Rad 1 150k-30MHz Para
9523-1 Rad 1 150k-30MHz Perp

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.249(d) other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209 whichever is the lesser attenuation.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
9kHz - 30MHz ±3.9dB

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.3 & 6.5 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.209/15.249(d) [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable along with an ancillary laptop. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery and connected to an ancillary laptop. No discernible difference in emissions was noted between mod schemes and channels settings; however, the configuration using the laptop and USB lead did provide worst case radiated emissions results in this test range. The EUT was therefore connected to the laptop via the USB lead for full test and operated in **BTLE Mid chan** mode.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below.

Measurements were made on a site listed with the FCC. The equipment was rotated 360 degrees and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site H.

5.4.4 Test equipment

LPE364, TMS45, ZSW1, E534, E535, E748

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	22°C
Humidity of test environment	48%
Pressure of test environment	101kPa

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Single channel	2440 MHz

Plot refs
9523-1 Rad 1 VHF Horiz
9523-1 Rad 1 VHF Vert
9523-1 Rad 1 UHF Horiz
9523-1 Rad 1 UHF Vert

Table of signals measured for Rad 1 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	144.005	31.6	28.6	-14.9
2	197.290	36.2	28.7	-14.8
3	225.765	40.7	32.8	-13.2
4	240.009	40.7	39.3	-6.7
5	288.002	37.9	35.4	-10.6
6	301.467	37.4	30.8	-15.2
7	456.220	37.8	34.0	-12.0
8	533.126	38.8	34.3	-11.7

Table of signals measured for Rad 1 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	48.009	31.2	29.3	-10.7
2	114.950	34.7	31.4	-12.1
3	192.017	36.1	34.8	-8.7
4	456.643	35.3	29.8	-16.2
5	480.011	42.0	39.6	-6.4
6	504.031	38.0	34.8	-11.2
7	530.810	40.1	35.0	-11.0
8	752.060	38.7	31.2	-14.8

Note: Only signals measured within 20dB of the limits have been reported. All signals within this range are generic signals and not related to channel setting or modulation/data rate setting. Therefore final measurements are presented for TX mid channel BTLE mode only for this test range.

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.249(d) other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209 whichever is the lesser attenuation.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
30MHz - 1000MHz ±6.1dB

5.5 Radiated emissions above 1 GHz

5.5.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.3 & 6.6 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.209/15.249(d) [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery. Small differences in emissions were noted between mod schemes and channels settings. The configuration using the device with the USB lead and laptop provided worst case radiated emissions results for this test range. The EUT was therefore operated in this configuration (connected to the laptop via the USB lead) and operated in all the test modes specified in section 2.4 of this report.

5.5.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. Measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. Horn antennas were used at heights where the whole of the EUT was contained within the main beam. The EUT was rotated through 360 degrees to record the worst case emissions. A measurement distance of 3m was used between the test range 1 - 6GHz, 1.2m was used in the test range 6 - 18GHz and 0.3m was used in the test range 18 - 40GHz. Max held sweeps using a Peak detector were used to determine emissions levels.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.
Tests were performed using test Site H.

5.5.4 Test equipment

E534, E535, LPE261, LPE333, TMS78, TMS79

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	18-22°C
Humidity of test environment	40-47%
Pressure of test environment	101kPa

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Low channel	2402 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1054†	43.0	-31.0	-11.0	long side upright	Horizontal
1278†	44.6	-29.4	-9.4	short side upright	Vertical
1354†	43.4	-30.6	-10.6	Flat	Vertical
1596†	48.0	-26.0	-6.0	long side upright	Vertical
1596†	42.6	-31.4	-11.4	short side upright	Horizontal
1838†	44.8	-29.2	-9.2	short side upright	Vertical
2291†	46.0	-28.0	-8.0	short side upright	Vertical
2292†	46.1	-27.9	-7.9	short side upright	Horizontal
2661†	45.5	-28.5	-8.5	short side upright	Vertical
4794†	49.5	-24.5	-4.5	short side upright	Vertical
4804	49.7	-24.3	-4.3	long side upright	Vertical
4804	47.9	-26.1	-6.1	short side upright	Horizontal
5273†	47.6	-26.4	-6.4	short side upright	Vertical

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Signals marked with a † indicate they are generic emissions and not related to channel setting.

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Mid channel	2440 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
4880	47.0	-27.0	-7.0	short side upright	Vertical
4880	48.3	-25.7	-5.7	short side upright	Horizontal

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Generic emissions (irrespective of channel setting) are included in Low channel results table only – not repeated here.

Plots for Middle channel
9523-1 Horizontal 1-2.4 GHz Mid channel BTLE, EUT short side
9523-1 Horizontal 2.4 - 2.4835 GHz Mid channel BTLE, EUT short side
9523-1 Horizontal 2.4835 - 6 GHz Mid channel BTLE, EUT short side
9523-1 Vertical 1 - 2.4 GHz Mid channel BTLE, EUT long side
9523-1 Vertical 2.4 - 2.4835 GHz Mid channel BTLE, EUT long side
9523-1 Vertical 2.4835 - 6 GHz Mid channel BTLE, EUT long side
9523-1 Horizontal 6 - 9 GHz Mid channel BTLE, EUT long side
9523-1 Horizontal 9 - 12 GHz Mid channel BTLE, EUT long side
9523-1 Vertical 6 - 9 GHz Mid channel BTLE, EUT long side
9523-1 Vertical 9 - 12 GHz Mid channel BTLE, EUT long side
9523-1 Horizontal 12-15GHz Mid chan BTLE mode
9523-1 Horizontal 15-18GHz Mid chan BTLE mode
9523-1 Vertical 12-15GHz Mid chan BTLE mode
9523-1 Vertical 15-18GHz Mid chan BTLE mode
9523-1 Horizontal 18-21.5GHz Mid chan BTLE mode
9523-1 Horizontal 21.5-25GHz Mid chan BTLE mode
9523-1 Vertical 18-21.5GHz Mid chan BTLE mode
9523-1 Vertical 21.5-25GHz Mid chan BTLE mode

Note: Whilst Low, Mid and High channels were tested in conjunction with the 3 modulation schemes, plots are for illustrative purposes only and only Mid channel BTLE plots are shown in this report.

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
High channel	2480 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
4960	47.1	-26.9	-6.9	long side upright	Vertical
4960	48.8	-25.2	-5.2	short side upright	Horizontal

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Generic emissions (irrespective of channel setting) are included in Low channel results table only – not repeated here.

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (1 MHz)
Low channel	2402 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1054†	43.0	-31.0	-11.0	long side upright	Horizontal
1278†	44.6	-29.4	-9.4	short side upright	Vertical
1354†	43.4	-30.6	-10.6	Flat	Vertical
1596†	48.0	-26.0	-6.0	long side upright	Vertical
1596†	42.6	-31.4	-11.4	short side upright	Horizontal
1838†	44.8	-29.2	-9.2	short side upright	Vertical
2291†	46.0	-28.0	-8.0	short side upright	Vertical
2292†	46.1	-27.9	-7.9	short side upright	Horizontal
2661†	45.5	-28.5	-8.5	short side upright	Vertical
4794†	49.5	-24.5	-4.5	short side upright	Vertical
4804	48.0	-26.0	-6.0	long side upright	Vertical
4804	47.0	-27.0	-7.0	short side upright	Horizontal
5273†	47.6	-26.4	-6.4	short side upright	Vertical

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Signals marked with a † indicate they are generic emissions and not related to channel setting.

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (1 MHz)
Mid channel	2440 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
4880	47.0	-27.0	-7.0	long side upright	Vertical
4880	46.2	-27.8	-7.8	long side upright	Horizontal

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Generic emissions (irrespective of channel setting) are included in Low channel results table only – not repeated here.

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (1 MHz)
High channel	2480 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
4960	48.0	-26.0	-6.0	long side upright	Vertical
4960	45.0	-29.0	-9.0	long side upright	Horizontal

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Generic emissions (irrespective of channel setting) are included in Low channel results table only – not repeated here.

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (2 MHz)
Low channel	2402 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1054†	43.0	-31.0	-11.0	long side upright	Horizontal
1278†	44.6	-29.4	-9.4	short side upright	Vertical
1354†	43.4	-30.6	-10.6	Flat	Vertical
1596†	48.0	-26.0	-6.0	long side upright	Vertical
1596†	42.6	-31.4	-11.4	short side upright	Horizontal
1838†	44.8	-29.2	-9.2	short side upright	Vertical
2291†	46.0	-28.0	-8.0	short side upright	Vertical
2292†	46.1	-27.9	-7.9	short side upright	Horizontal
2661†	45.5	-28.5	-8.5	short side upright	Vertical
4794†	49.5	-24.5	-4.5	short side upright	Vertical
4804	46.7	-27.3	-7.3	long side upright	Vertical
4804	46.3	-27.7	-7.7	long side upright	Horizontal
5273†	47.6	-26.4	-6.4	short side upright	Vertical

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Signals marked with a † indicate they are generic emissions and not related to channel setting.

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (2 MHz)
Mid channel	2440 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
4880	48.2	-25.8	-5.8	long side upright	Vertical
4880	45.0	-29.0	-9.0	long side upright	Horizontal

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Generic emissions (irrespective of channel setting) are included in Low channel results table only– not repeated here.

Setup Table

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (2 MHz)
High channel	2480 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Difference in PK level to Average Limit (dB	EUT Polarisation	Antenna Polarisation
4960	44.0	-30.0	-10.0	long side upright	Vertical
4960	45.0	-29.0	-9.0	long side upright	Horizontal

Note: Average measurements were not performed as the Peak measurements made were compliant with the average limits. Generic emissions (irrespective of channel setting) are included in Low channel results table only – not repeated here.

Peak detector “Max held” Analyser plots against the Average limit line can be found in Section 6 of this report.

Note: Whilst Low, Mid and High channels were tested in conjunction with the 3 modulation schemes, plots are for illustrative purposes only and only Mid channel BTLE plots are shown in this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.249(d) other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209 whichever is the lesser attenuation.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
1 – 18 GHz ±3.5dB, 18 – 26.5 GHz ±3.9dB

5.6 Intentional radiator field strength

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.249a [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.3 & 6.6 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.249a [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was placed on a 1.5 metre high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The antenna was used in both Horizontal and Vertical polarisations. The EUT was rotated in all three orthogonal planes. Testing was performed with a fully charged battery. The configuration using the device without the USB lead and laptop provided worst case (maximum) radiated fundamental field strength results. The EUT was therefore operated in a stand-alone configuration (NOT connected to the laptop via the USB lead) for full tests and operated in all the test modes specified in section 2.4 of this report.

5.6.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below.

Maximum field strength was measured using a spectrum analyser set with the appropriate RBW & span in conjunction with a PK detector.

Measurements were made in a semi-anechoic chamber. This site is listed with the FCC. Measurements were made at site H.

5.6.4 Test equipment

E534, E535, LPE261, LPE333

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 19-22°C
Humidity of test environment 42-45%
Pressure of test environment 103kPa

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Low channel	2402 MHz
Mid channel	2440 MHz
High channel	2480 MHz

	Low	Mid	High
Peak Level (dBµV/m)	91.40	91.90	91.40
Plot reference	J9523-1 Field strength Low channel BTLE mode (Vert Ant - EUT long side upright)	J9523-1 Field strength Mid channel BTLE mode (Vert Ant - EUT long side upright)	J9523-1 Field strength High channel BTLE mode (Vert Ant - EUT long side upright)
Antenna Polarisation	Vert	Vert	Vert
EUT Polarisation	Upright long side	Upright long side	Upright long side

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Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (1 MHz)
Low channel	2402 MHz
Mid channel	2440 MHz
High channel	2480 MHz

	Low	Mid	High
Peak Level (dBµV/m)	90.90	91.80	91.60
Plot reference	J9523-1 Field strength Low channel 1MHz Shockburst mode (Vert Ant - EUT long side upright)	J9523-1 Field strength Mid channel 1MHz Shockburst mode (Vert Ant - EUT long side upright)	J9523-1 Field strength High channel 1MHz Shockburst mode (Vert Ant - EUT long side upright)
Antenna Polarisation	Vert	Vert	Vert
EUT Polarisation	Upright long side	Upright long side	Upright long side

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (2 MHz)
Low channel	2402 MHz
Mid channel	2440 MHz
High channel	2480 MHz

	Low	Mid	High
Peak Level (dBµV/m)	90.80	91.80	91.70
Plot reference	J9523-1 Field strength Low channel 2MHz Shockburst mode (Vert Ant - EUT long side upright)	J9523-1 Field strength Mid channel 2MHz Shockburst mode (Vert Ant - EUT long side upright)	J9523-1 Field strength High channel 2MHz Shockburst mode (Vert Ant - EUT long side upright)
Antenna Polarisation	Vert	Vert	Vert
EUT Polarisation	Upright long side	Upright long side	Upright long side

Analyser plots can be found in Section 6 of this report.

LIMITS:
15.249(a) 50 / 250 mV/m @ 3m (94 / 108 dBµV/m @ 3m).

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 3.5 dB (1 - 18 GHz)

5.7 Band Edge Compliance

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C Part (15.215 and 15.249d) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.10 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.209 & 15.249 [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was configured exactly the same as for the maximum fundamental field strength results measured in section 5.6.2 of this report. The EUT was operated in Low and High channel modes in modulation schemes, BTLE, Shockburst 1MHz and Shockburst 2MHz for tests.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. Appropriate RBW, VBW and spans were set on a spectrum analyser with a peak detector and a Max held display. The emission from the EUT was maximised before taking the plots.

Tests were performed using Test Site H.

5.7.4 Test equipment

E534, E535, LPE261, LPE333

See Section 9 for more details

5.7.5 Test results

Temperature of test environment 22°C
Humidity of test environment 43%
Pressure of test environment 103kPa

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Low channel	2402 MHz
High channel	2480 MHz

Restricted Band Edge	Low Channel	High Channel
Peak Level (dBµV/m)	41.3	52
Peak Plot reference	J9523-1 Restricted band edge Low channel BTLE mode	J9523-1 Restricted band edge High channel BTLE mode

Note: Average measurements have not been performed as Peak results show compliance with the Average limits.

Authorised Band Edge	Low Channel	High Channel
Authorised Band Edge Plot reference	J9523-1 Authorised band edge Low channel BTLE mode	J9523-1 Authorised band edge High channel BTLE mode

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (1 MHz)
Low channel	2402 MHz
High channel	2480 MHz

Restricted Band Edge	Low Channel	High Channel
Peak Level (dBµV/m)	41.4	51
Peak Plot reference	J9523-1 Restricted band edge Low channel Shockburst 1MHz mode	J9523-1 Restricted band edge High channel Shockburst 1MHz mode

Note: Average measurements have not been performed as Peak results show compliance with the Average limits.

Authorised Band Edge	Low Channel	High Channel
Authorised Band Edge Plot reference	J9523-1 Authorised band edge Low channel Shockburst 1MHz mode	J9523-1 Authorised band edge High channel Shockburst 1MHz mode

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (2 MHz)
Low channel	2402 MHz
High channel	2480 MHz

Restricted Band Edge	Low Channel	High Channel
Peak Level (dBµV/m)	42.6	51.6
Peak Plot reference	J9523-1 Restricted band edge Low channel Shockburst 2MHz mode	J9523-1 Restricted band edge High channel Shockburst 2MHz mode

Note: Average measurements have not been performed as Peak results show compliance with the Average limits.

Authorised Band Edge	Low Channel	High Channel
Authorised Band Edge Plot reference	J9523-1 Authorised band edge Low channel Shockburst 2MHz mode	J9523-1 Authorised band edge High channel Shockburst 2MHz mode

Analyser plots for the Band Edge Compliance can be found in Section 6 of this report. These show the 50dBc requirement of 15.249(d) are met at the band edges of 2.4 and 2.4835 GHz. Restricted band edge plots are also shown in section 6. The tables list the field strengths observed in the adjacent restricted bands, which are required to meet the tighter 15.209 limits.

LIMITS:

AV = 54dBuV/m at band edges
PK = 74dBuV/m at band edges
Emissions radiated outside of the specified frequency bands, shall be attenuated by 50dB below the level of the fundamental field strength or to the general emissions limits of 15.209, whichever is the lesser attenuation.
The restricted band edges closest to the EUT frequency band of 2.4-2.4835GHz are 2.39 & 2.4835GHz. Further wider span plots are also shown under radiated emissions above 1GHz (refer to section 5.5), these show the fact that there are no spurious emissions above the restricted limits of 15.209.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 3.5 dB (1 - 18 GHz)

5.8 Occupied bandwidth

5.8.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.215 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.9 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.215(c)/15.209 [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was placed on a 1.5 metre high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was positioned to maximise emissions. Testing was performed with a fully charged battery. No difference was observed between the configuration using the device with the USB lead and laptop and stand alone configuration without the USB connection. The EUT was therefore operated connected to the laptop via the USB lead for full tests and operated in all the test modes specified in section 2.4 of this report.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. A RBW was set between 1-5% of the emission bandwidth, with a span set to 2-5 times the emissions bandwidth. 3 times VBW, auto sweep time and max hold settings were also used. The spectrum was allowed to sweep enough times to capture the full emission. The 20dB bandwidth and 99% power measurement function on the analyser was used for each channel and scheme.
Tests were performed using test Site H.

5.8.4 Test equipment

E136, E411, E624, TMS82

See Section 9 for more details

5.8.5 Test results

Temperature of test environment 18°C
Humidity of test environment 60%
Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Low channel	2402 MHz
Mid channel	2440 MHz
High channel	2480 MHz

20dB Bandwidth (MHz)	Low	Mid	High
	1.139	1.145	1.145
Plot reference	9523-1 TX Low chan BTLE	9523-1 TX Mid chan BTLE	9523-1 TX High chan BTLE

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz

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Mod Scheme	SHOCKBURST (1 MHz)
Low channel	2402 MHz
Mid channel	2440 MHz
High channel	2480 MHz

	Low	Mid	High
20dB Bandwidth (MHz))	0.823	0.832	0.852
Plot reference	9523-1 TX Low chan Shockburst 1MHz	9523-1 TX Mid chan Shockburst 1MHz	9523-1 TX High chan Shockburst 1MHz

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (2 MHz)
Low channel	2402 MHz
Mid channel	2440 MHz
High channel	2480 MHz

	Low	Mid	High
20dB Bandwidth (MHz)	1.421	1.447	1.516
Plot reference	9523-1 TX Low chan Shockburst 2MHz	9523-1 TX Mid chan Shockburst 2MHz	9523-1 TX High chan Shockburst 2MHz

Analyser plots for the 20dB bandwidth can be found in Section 6 of this report.

LIMITS:
15.215(c) The 20dB bandwidth of the emission must be contained within the designated frequency band. The restricted band edges closest to the EUT frequency of 2400-2483.5MHz are 2390 & 2483.5MHz.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.9 Duty cycle

5.9.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.35 & 15.249(e) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 7.5 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.249(e) [Reference 4.1.1 of this report]

5.9.2 Configuration of EUT

The EUT was checked at the same time and in the same configuration as for the fundamental field strength checks performed in 5.6.2 within this report. No discernible difference in duty cycle during pre-checks were observed between channels, therefore the EUT was operated in BLTE Low chan, Shockburst 1MHz Low chan and Shockburst 2MHz Low chan modes.

5.9.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. The centre frequency of the analyser was set to that of the transmitter, and the span set to zero. The sweep time was adjusted so that either the pulse width or the periodic operation could be observed. Tests were performed using Test Site H.

5.9.4 Test equipment

E136, E411, E624, TMS82

See Section 9 for more details

5.9.5 Test results

Temperature of test environment	18°C
Humidity of test environment	58%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	Bluetooth (Low energy)
Single channel	2440 MHz

	Mid channel
TX on time (ms)	0.39
TX on Plot filename	J8523-1 TX duty ON time Mid Chan BTLE
TX repetition time (S)	0.000638
TX repetition Plot filename	J8523-1 TX duty REP time Mid Chan BTLE
Calculated TX Duty cycle (%)	61.1

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (1 MHz)
Single channel	2440 MHz

	Mid channel
TX on time (ms)	0.151
TX on Plot filename	J8523-1 TX duty ON time Mid Chan shockburst 1MHz
TX repetition time (S)	0.000952
TX repetition Plot filename	J8523-1 TX duty REP time Mid Chan shockburst 1MHz
Calculated TX Duty cycle (%)	15.9

Band	2400-2483.5 MHz
Power Level	-4 dBm
Channel Spacing	2 MHz
Mod Scheme	SHOCKBURST (2 MHz)
Single channel	2440 MHz

	Mid channel
TX on time (ms)	0.081
TX on Plot filename	J8523-1 TX duty ON time Low Chan shockburst 2MHz
TX repetition time (S)	0.000952
TX repetition Plot filename	J8523-1 TX duty REP time Low Chan shockburst 2MHz
Calculated TX Duty cycle (%)	8.5

Average duty cycle correction is not required to be applied to any measurements within this report as all Peak emissions met the required average limits, where applicable.

LIMITS:

Not applicable

Per 15.35, only devices with a TX on time of <100ms are allowed to be considered for duty cycle correction of average emissions.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
2.57 ms

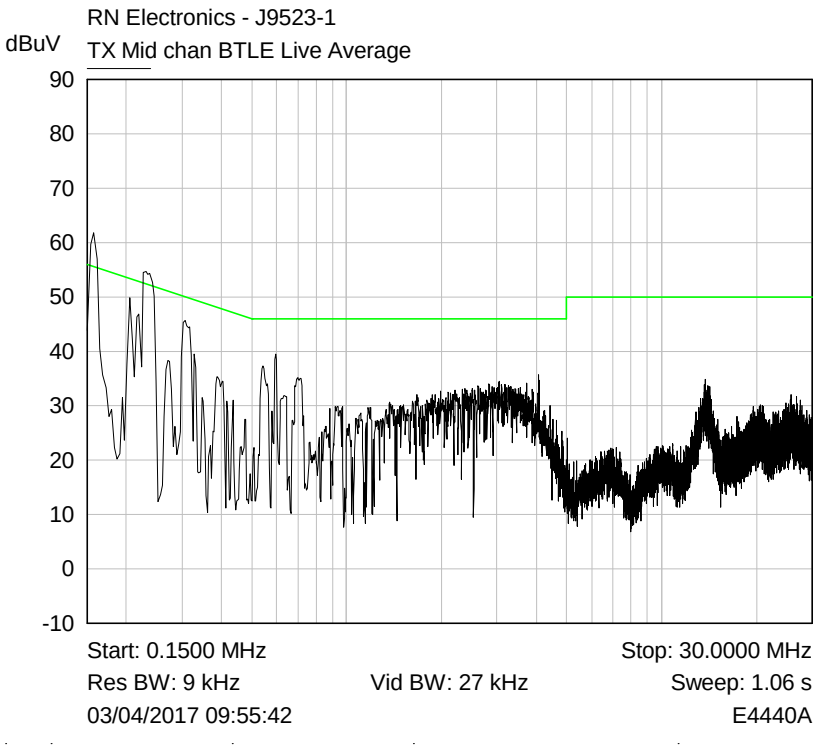
5.10 Frequency stability

NOT APPLICABLE: Test only applies to equipment intended for fixed, point-to-point operation.

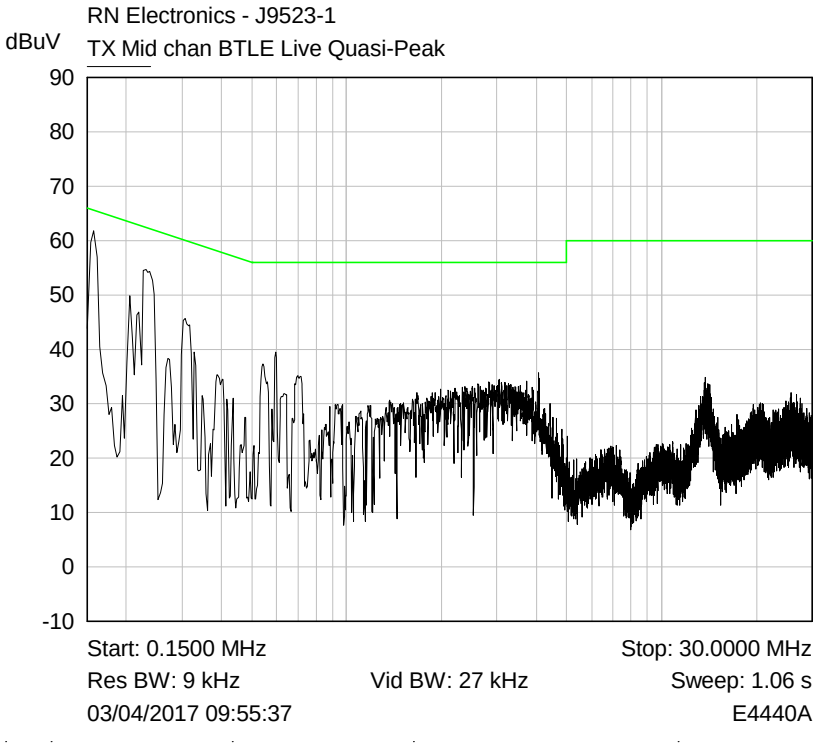
6 Plots/Graphical results

6.1 AC power line conducted emissions

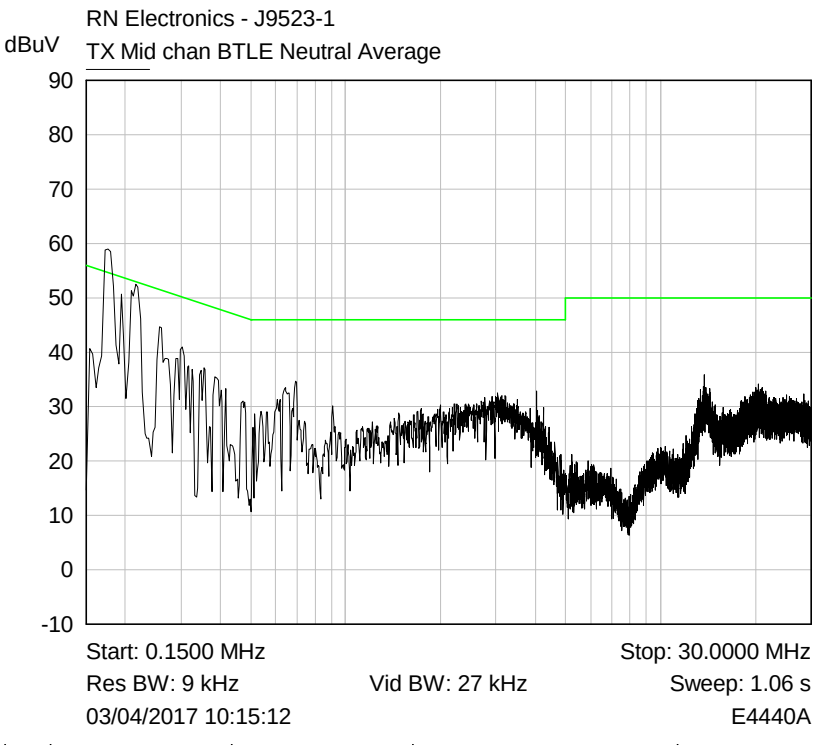
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2440 MHz



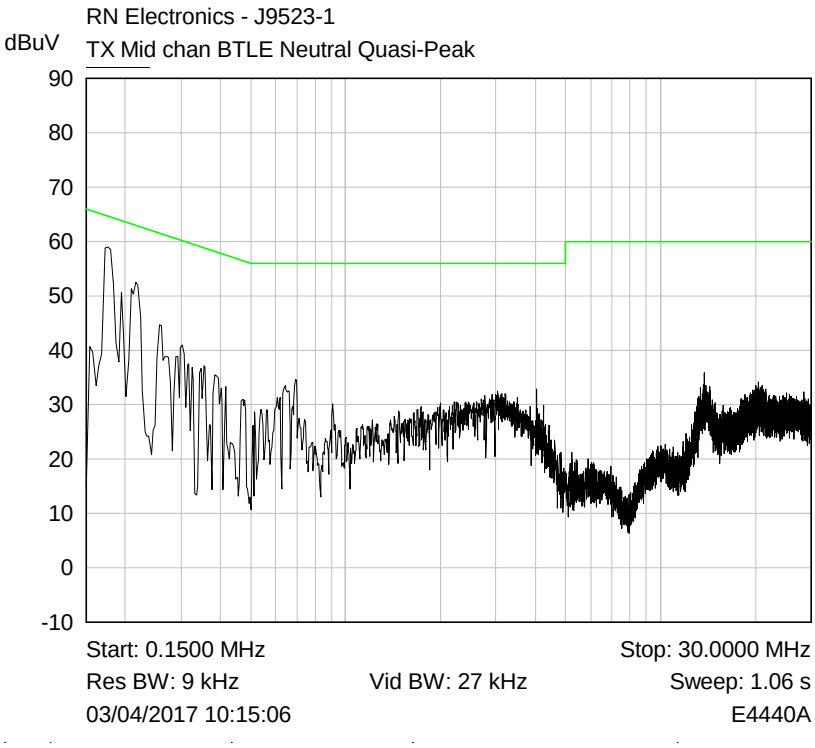
Plot of Live150k-30M Average



Plot of Live150k-30M Quasi-Peak



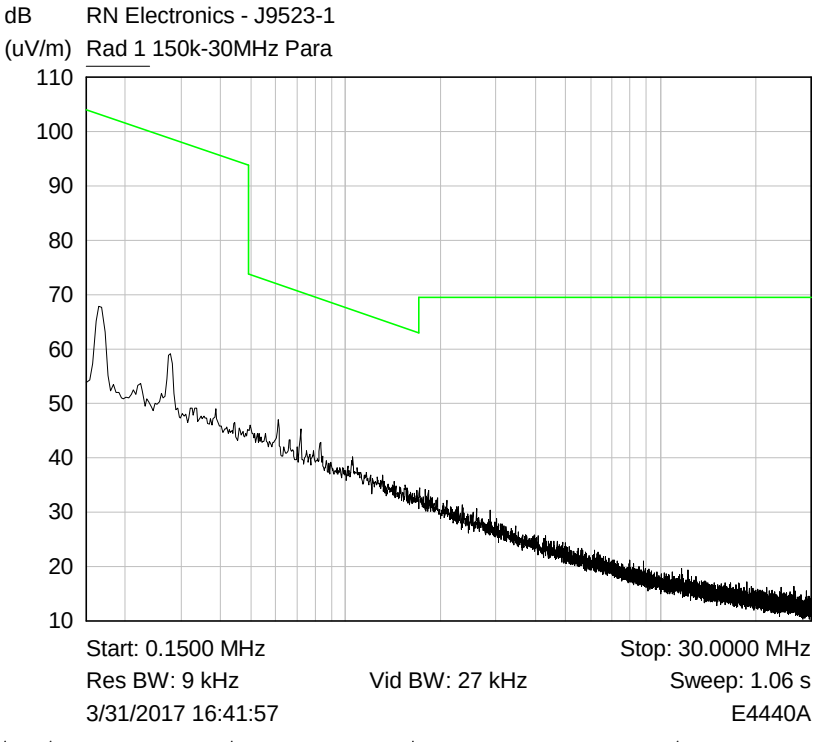
Plot of Neutral150k-30M Average



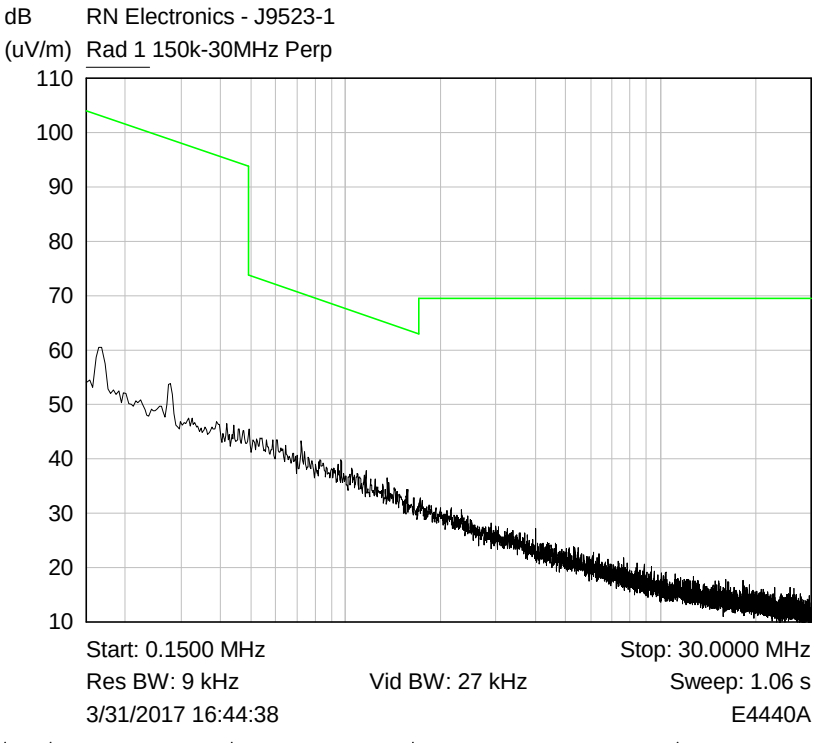
Plot of Neutral150k-30M Quasi-Peak

6.2 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2440 MHz



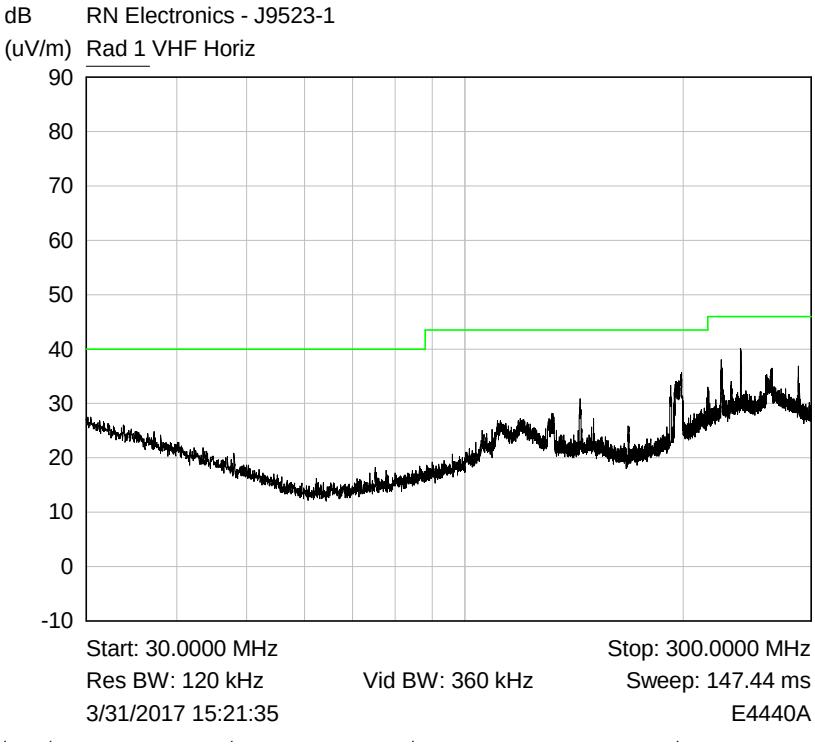
Plot of 150kHz-30MHz Parallel



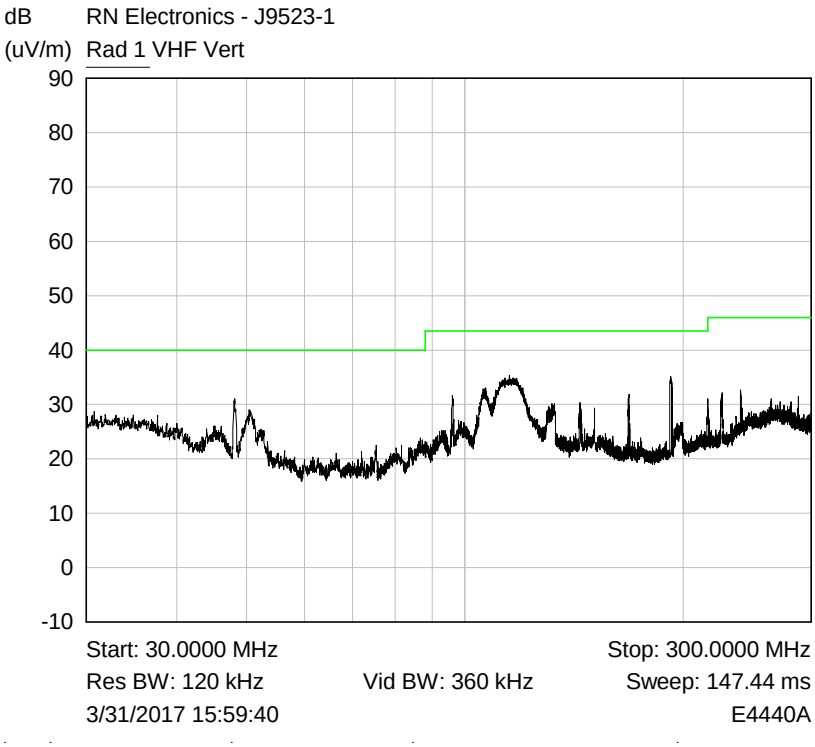
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

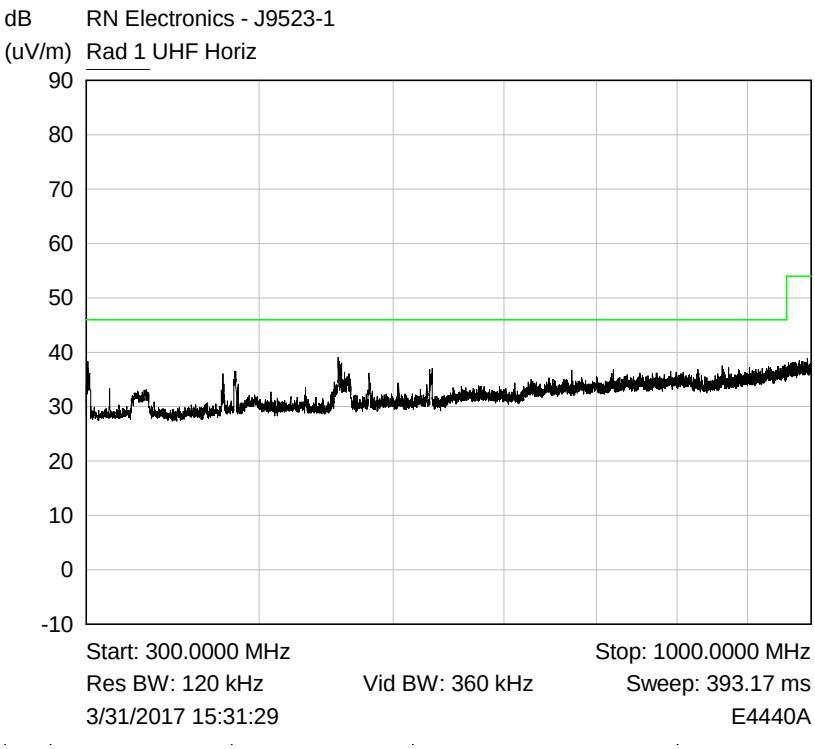
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2440 MHz



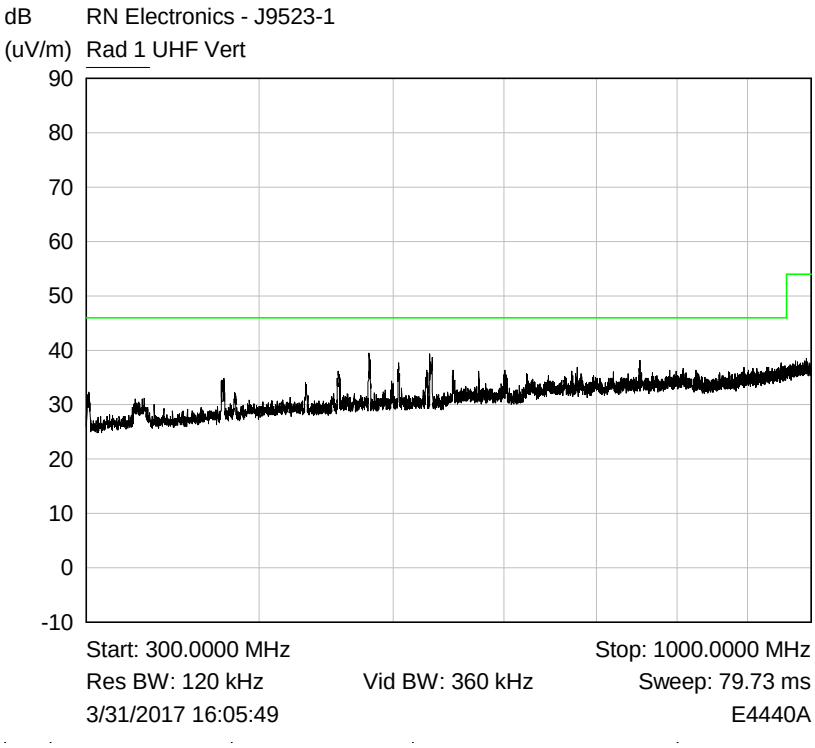
Plot of Peak emissions for VHF Horizontal against the QP limit line.



Plot of Peak emissions for VHF Vertical against the QP limit line.



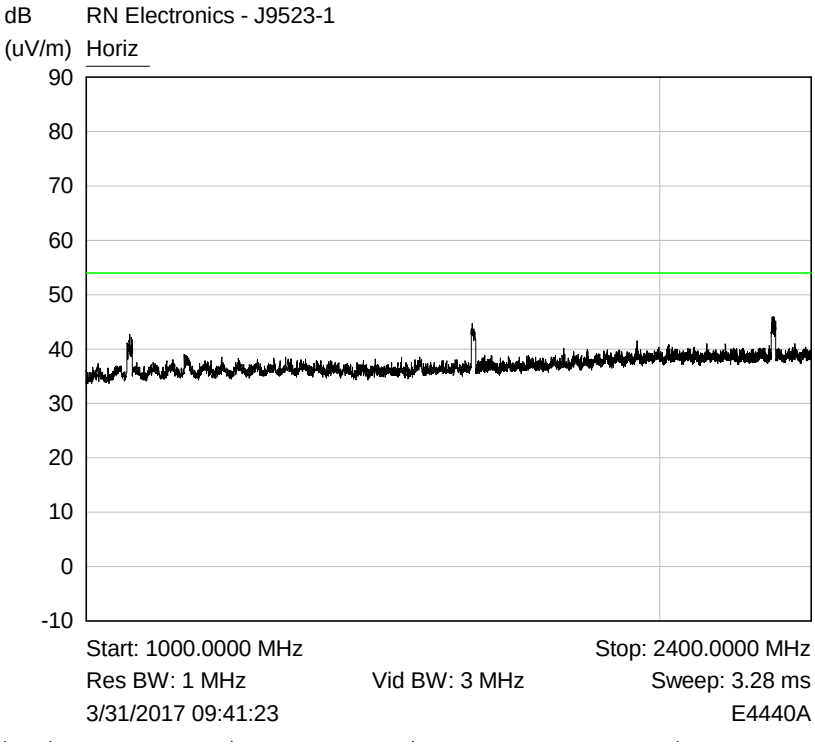
Plot of Peak emissions for UHF Horizontal against the QP limit line.



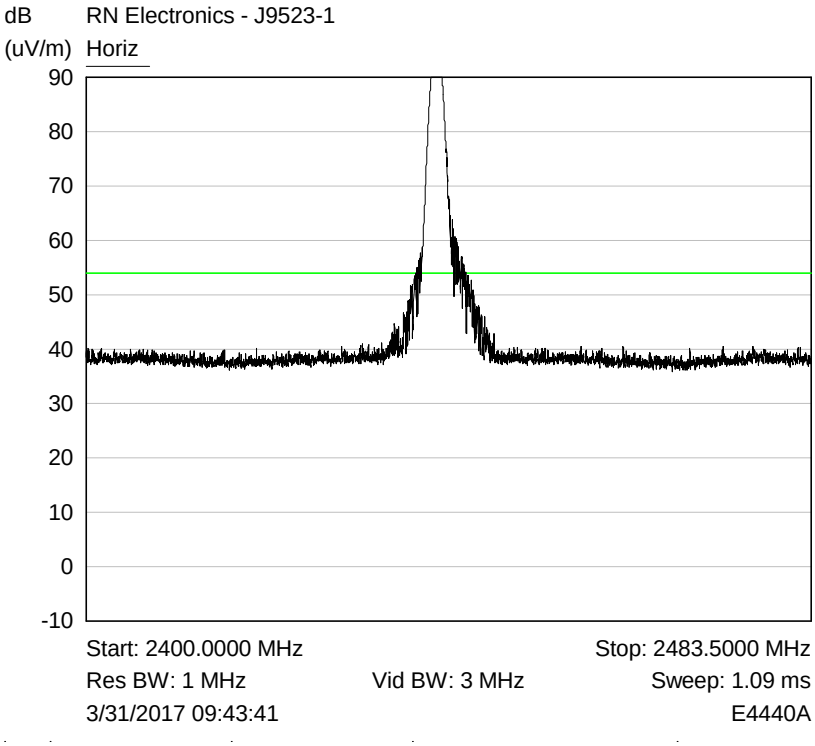
Plot of Peak emissions for UHF Vertical against the QP limit line.

6.4 Radiated emissions above 1 GHz

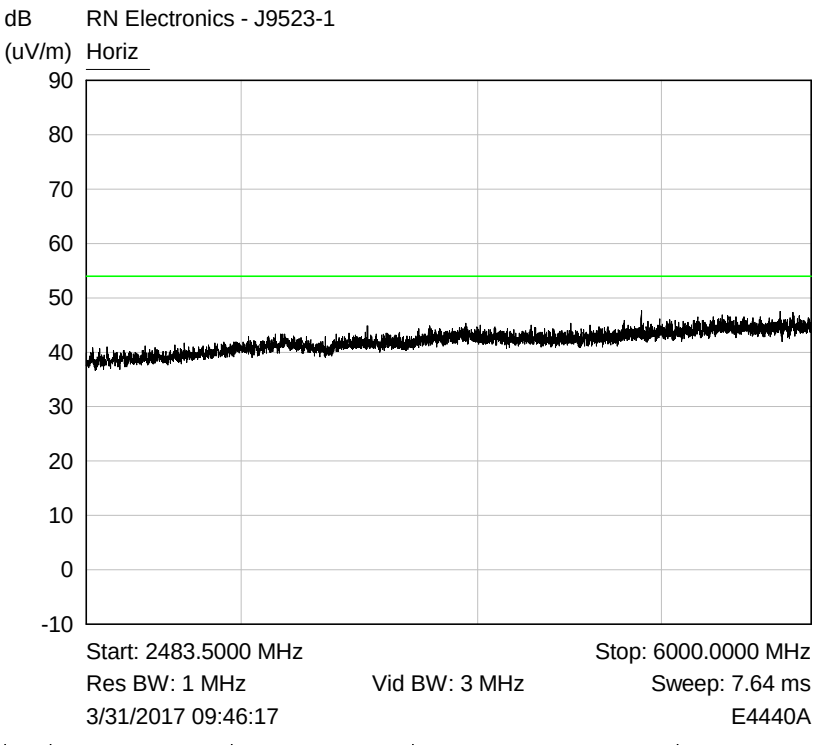
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2440 MHz



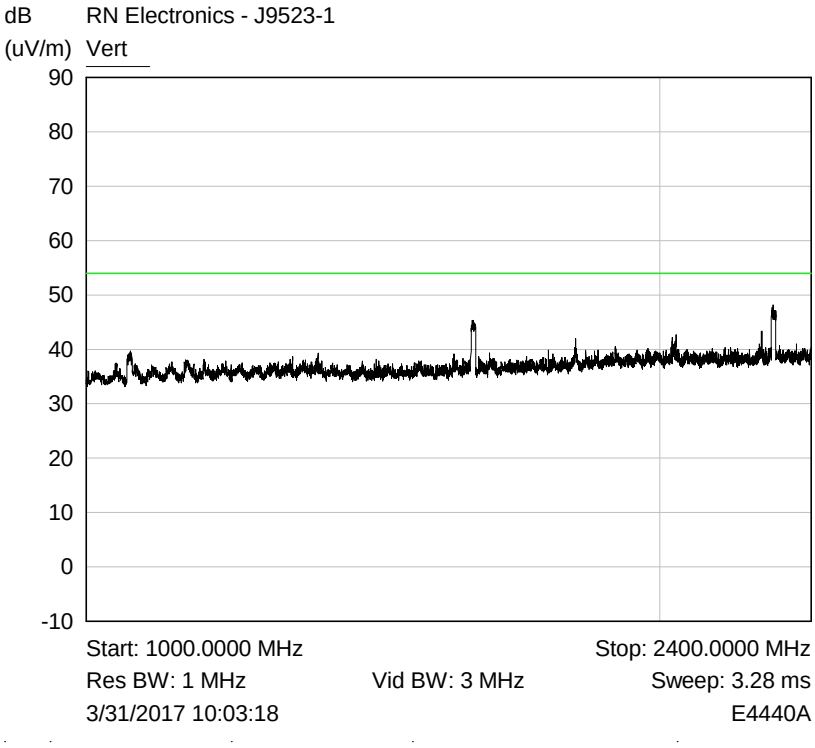
Plot of Peak emissions for 1-2.4 GHz Horizontal against the AV limit line



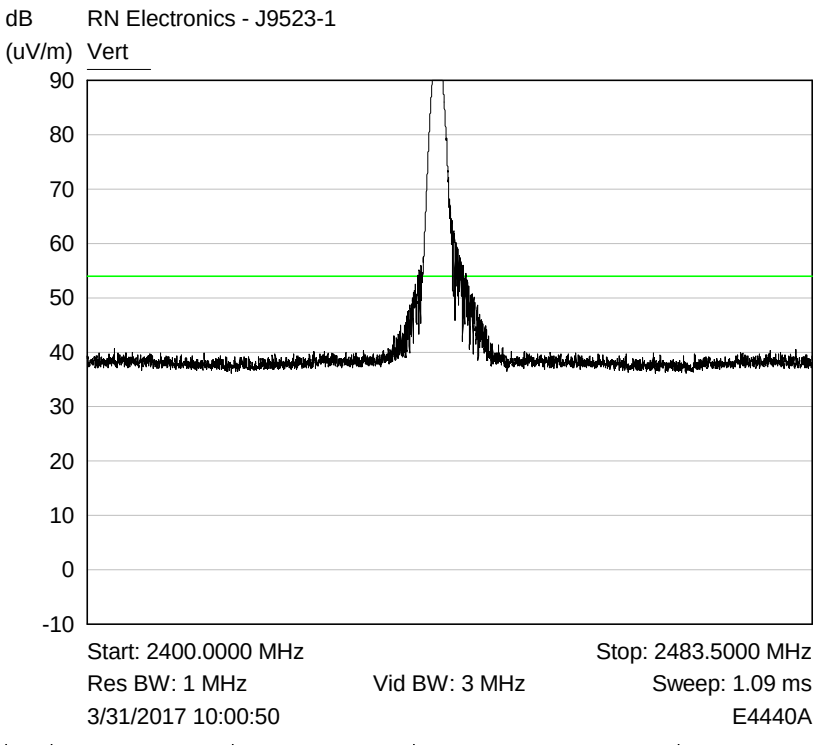
Plot of Peak emissions for 2.4 - 2.4835 GHz Horizontal against the AV limit line
(Note: plot shows fundamental)



Plot of Peak emissions for 2.4835 - 6 GHz Horizontal against the AV limit line

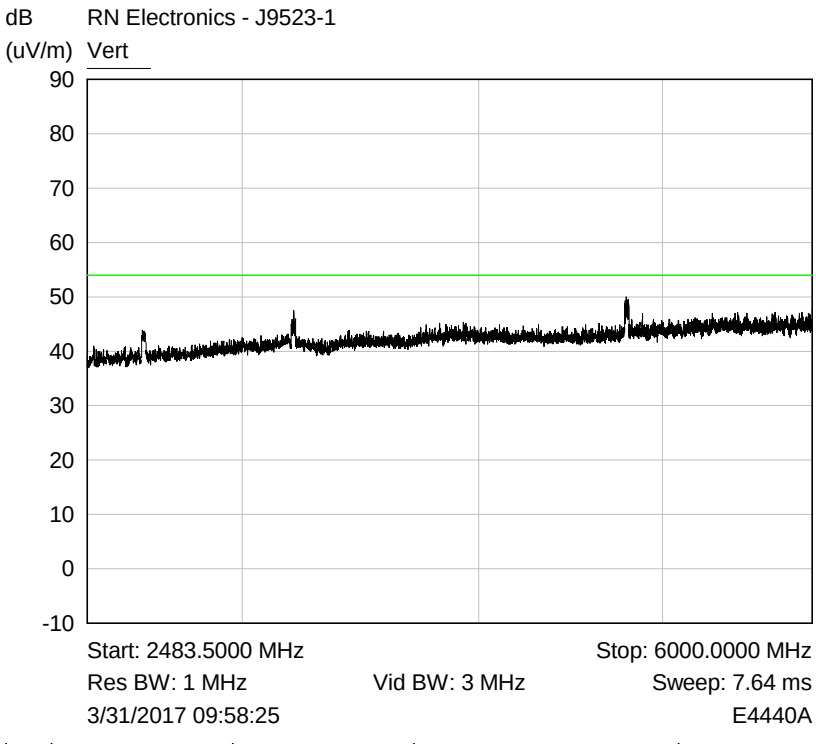


Plot of Peak emissions for 1-2.4 GHz Vertical against the AV limit line

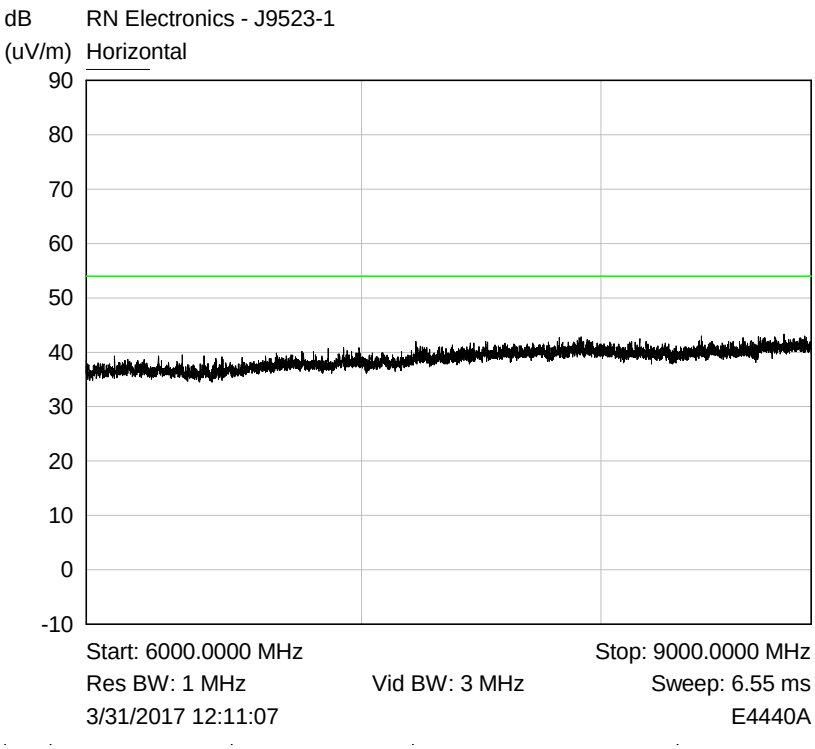


Plot of Peak emissions for 2.4 - 2.4835 GHz Vertical against the AV limit line

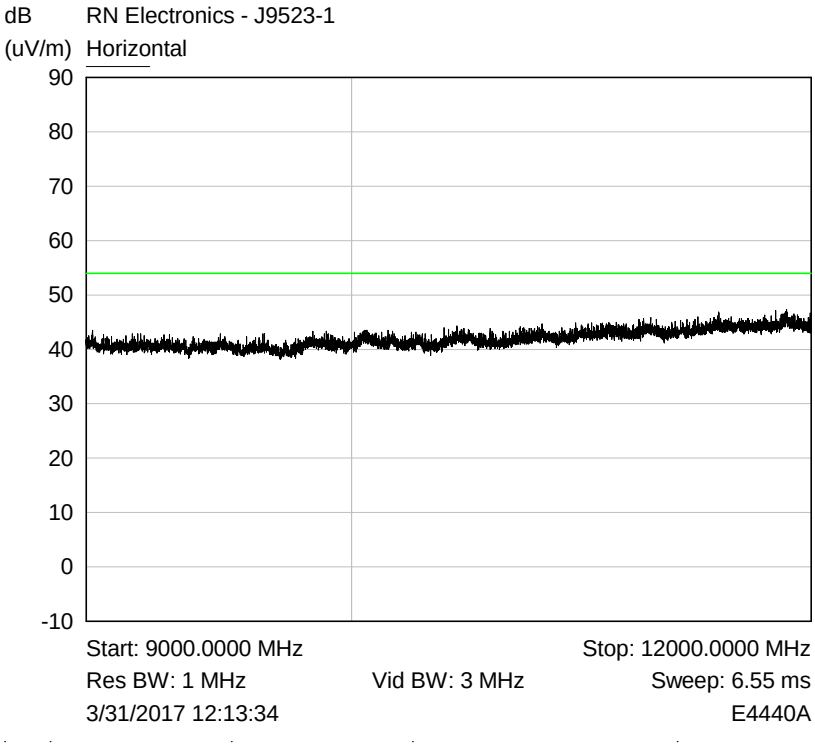
(Note: plot shows fundamental)



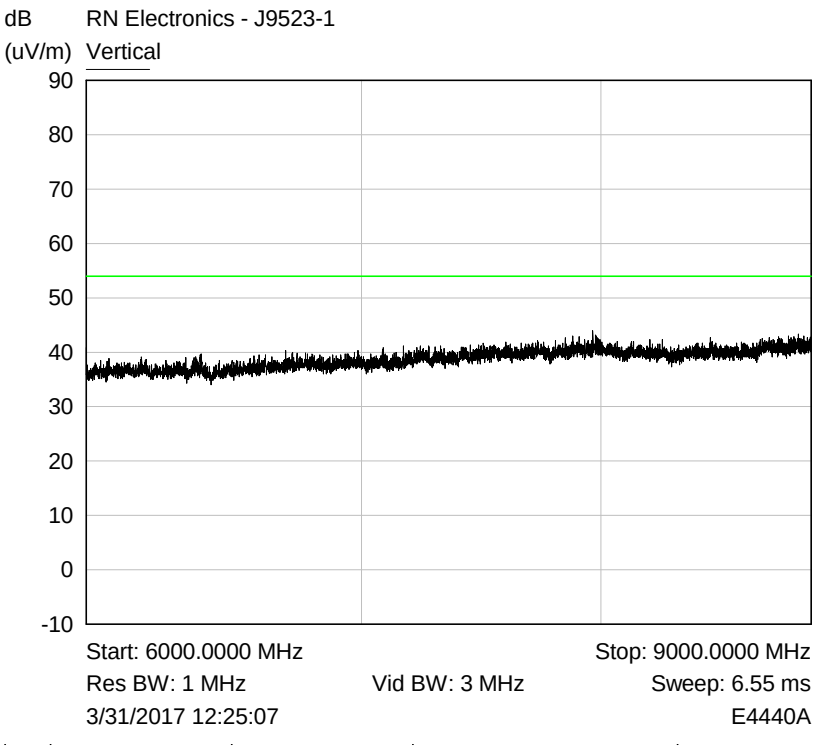
Plot of Peak emissions for 2.4835 - 6 GHz Vertical against the AV limit line



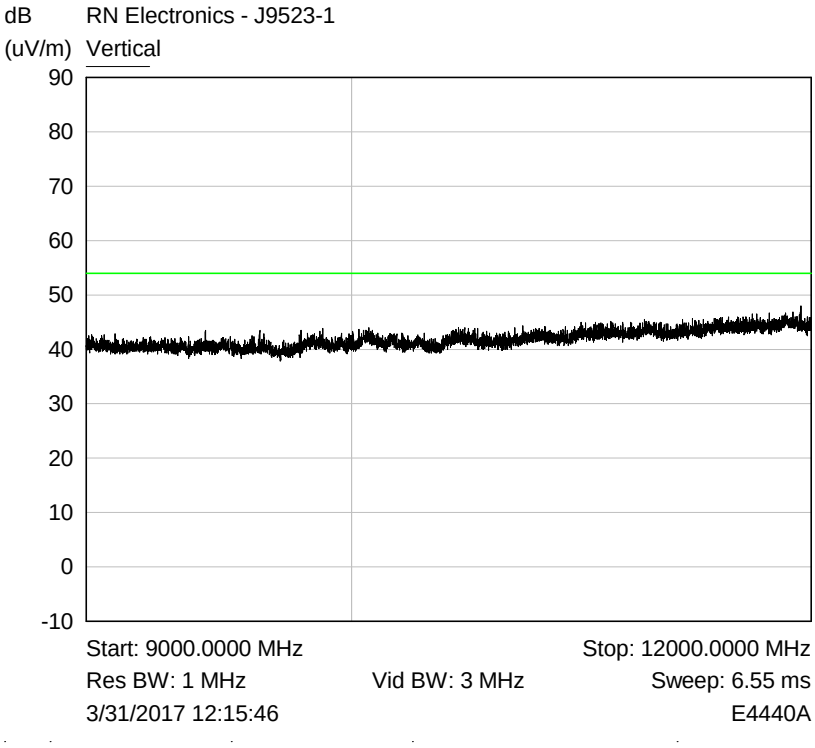
Plot of Peak emissions for 6 - 9 GHz Horizontal against the AV limit line



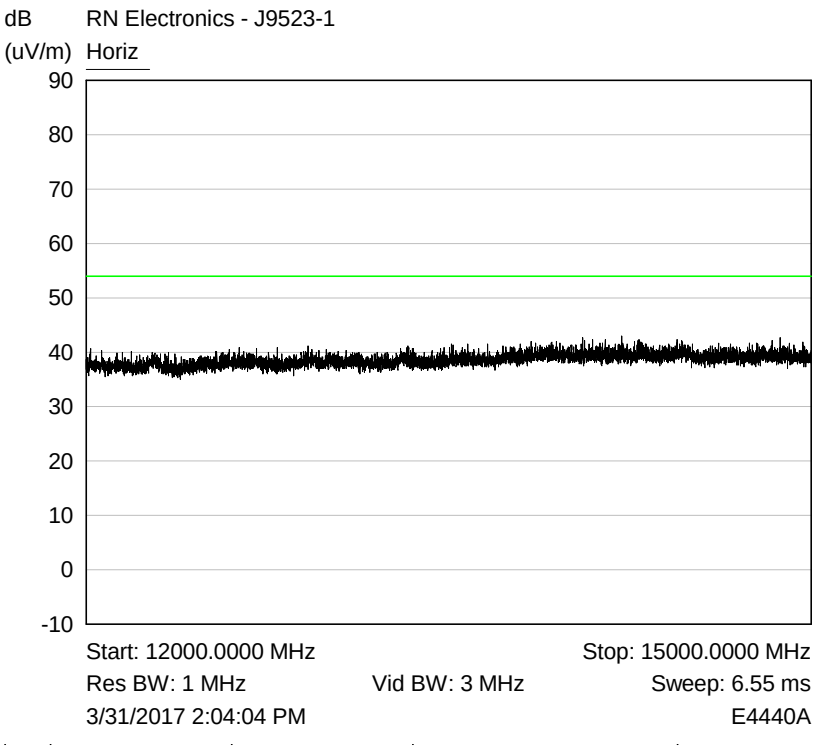
Plot of Peak emissions for 9 - 12 GHz Horizontal against the AV limit line



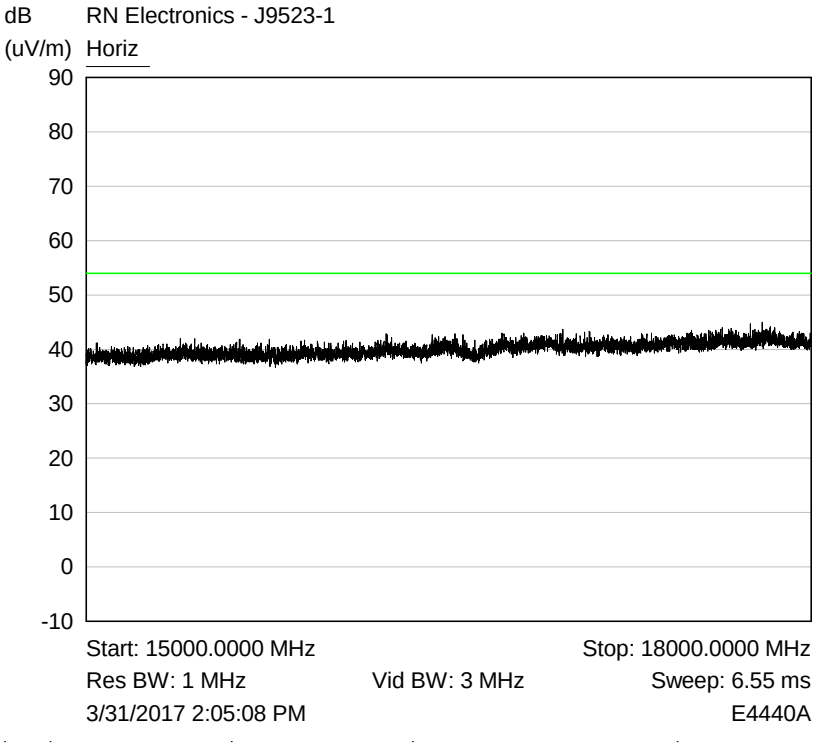
Plot of Peak emissions for 6 - 9 GHz Vertical against the AV limit line



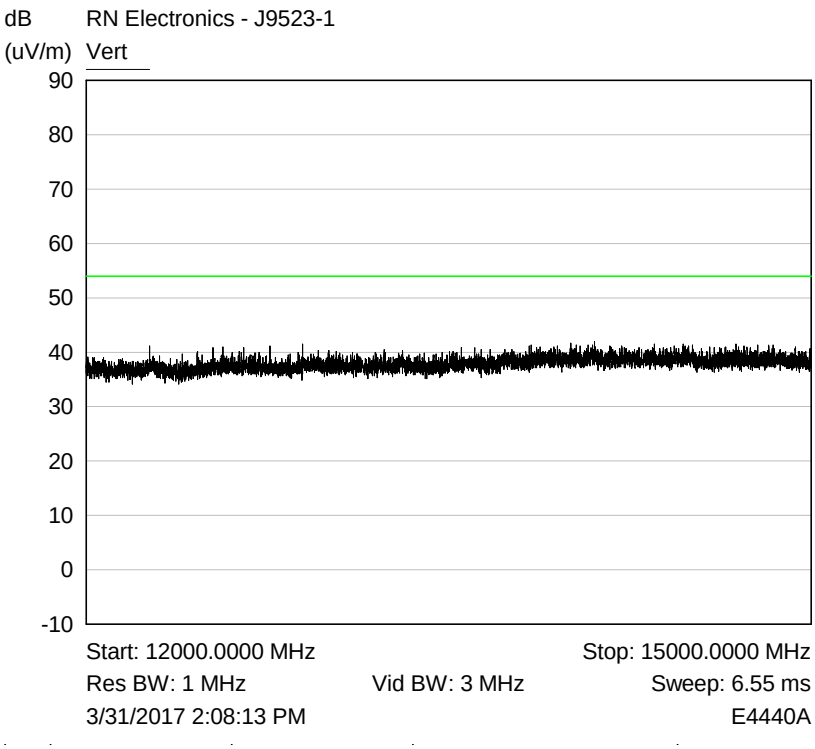
Plot of Peak emissions for 9 - 12 GHz Vertical against the AV limit line



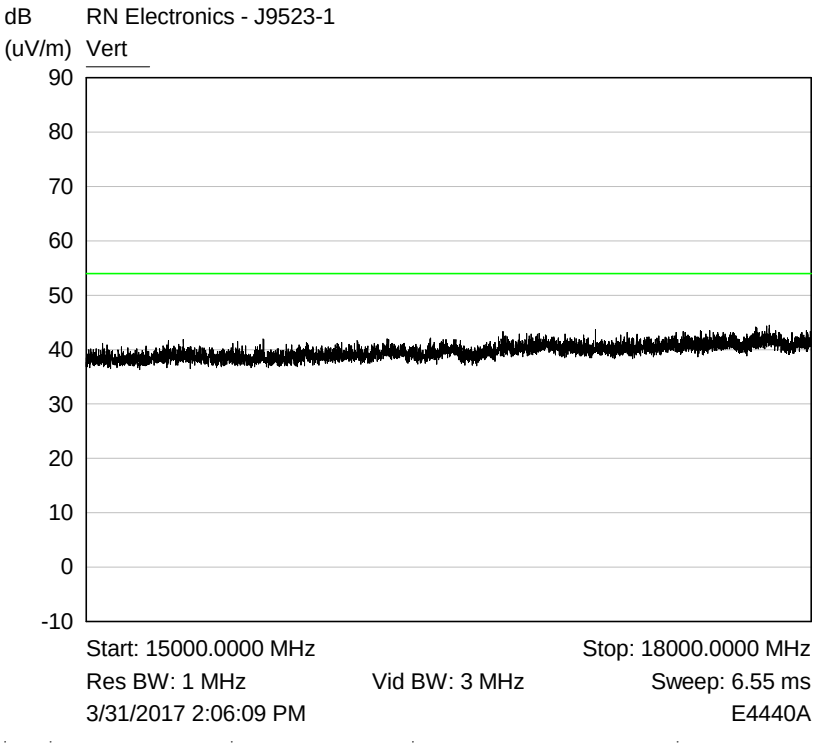
Plot of Peak emissions for 12 - 15 GHz Horizontal against the AV limit line



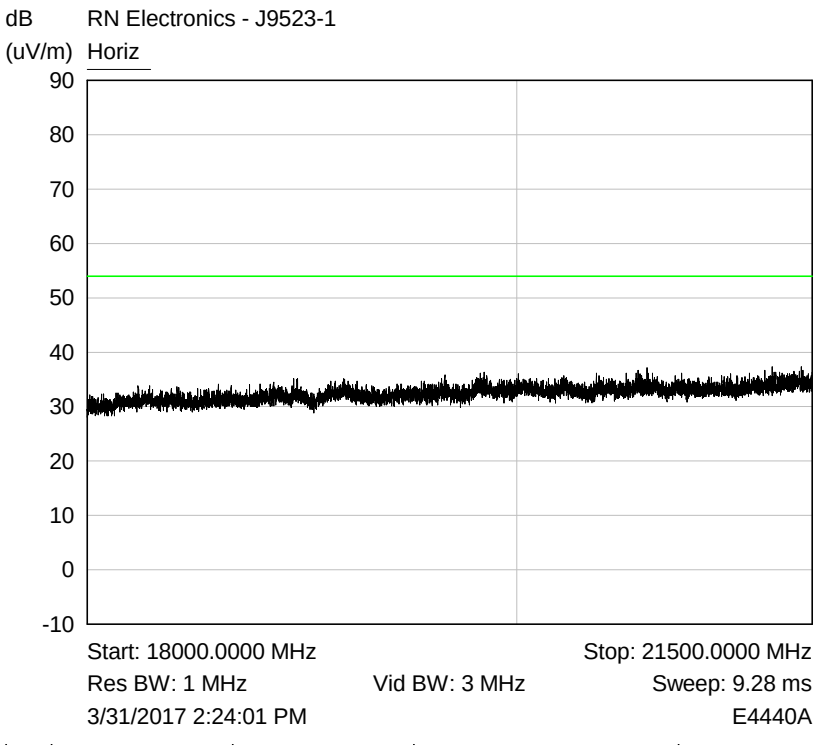
Plot of Peak emissions for 15 - 18 GHz Horizontal against the AV limit line



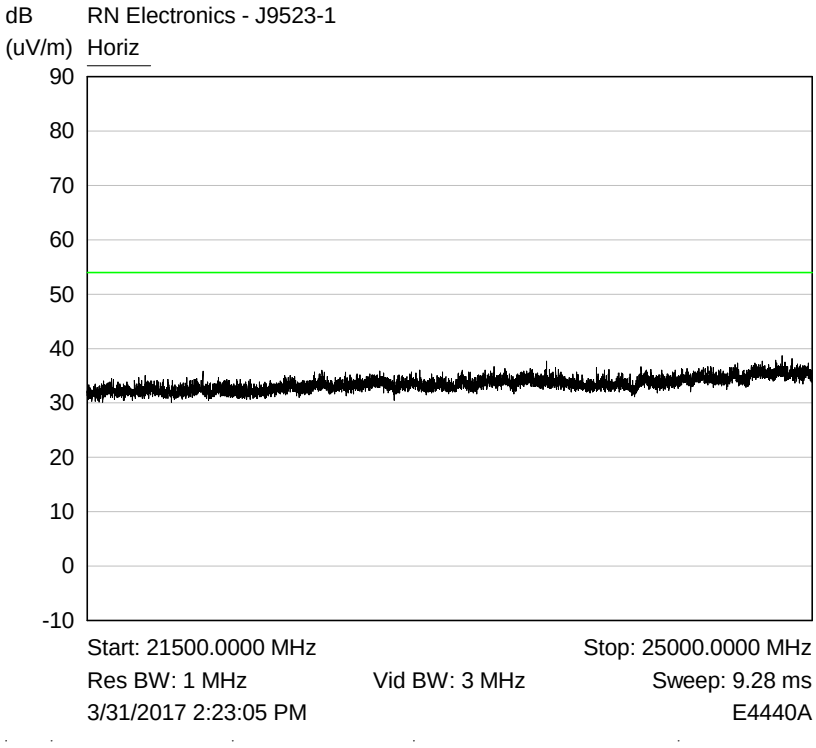
Plot of Peak emissions for 12 - 15 GHz Vertical against the AV limit line



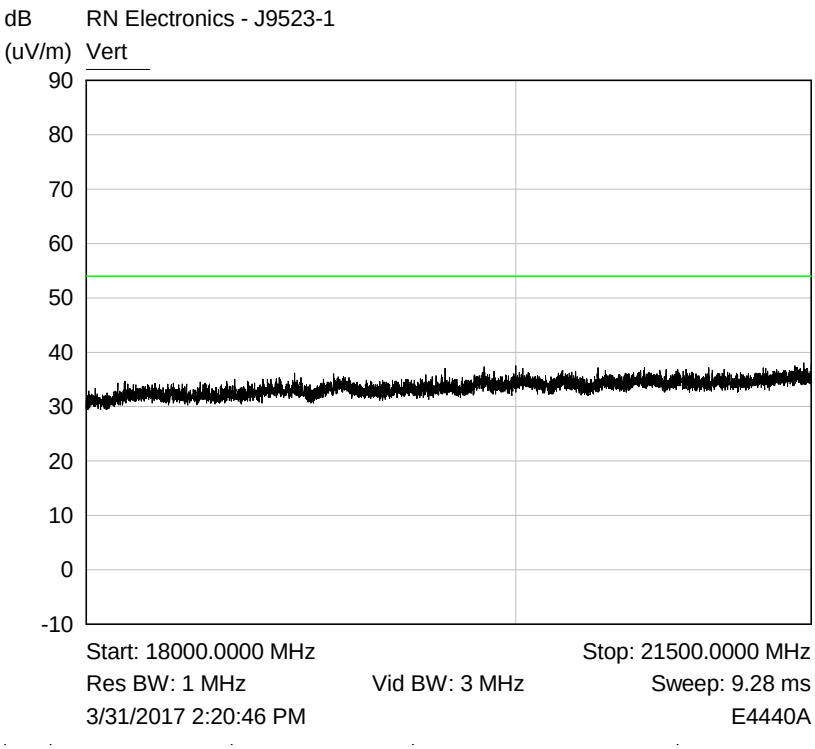
Plot of Peak emissions for 15 - 18 GHz Vertical against the AV limit line



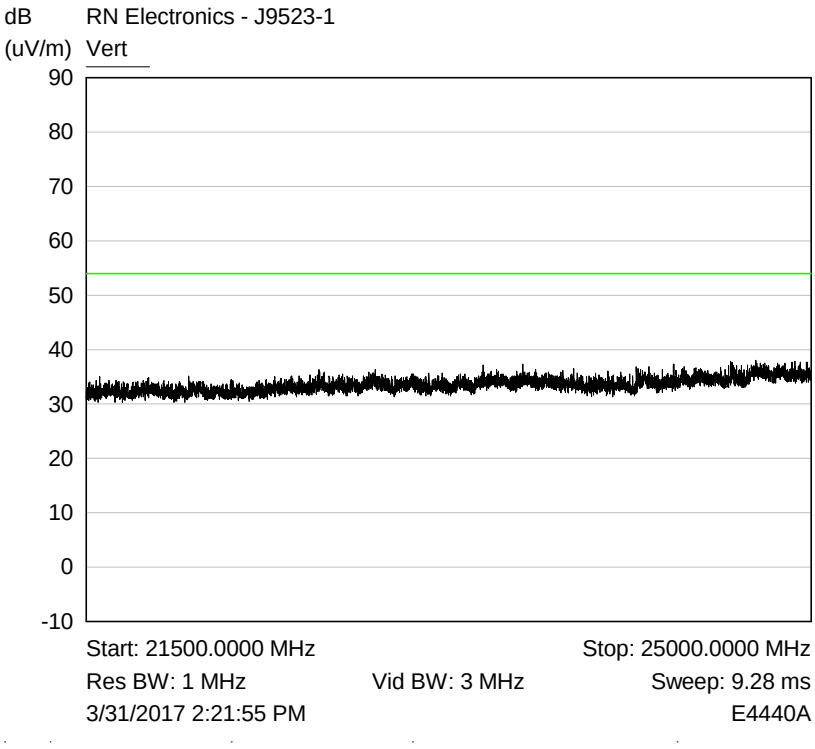
Plot of Peak emissions for 18 – 21.5 GHz Horizontal against the AV limit line



Plot of Peak emissions for 21.5 - 25 GHz Horizontal against the AV limit line



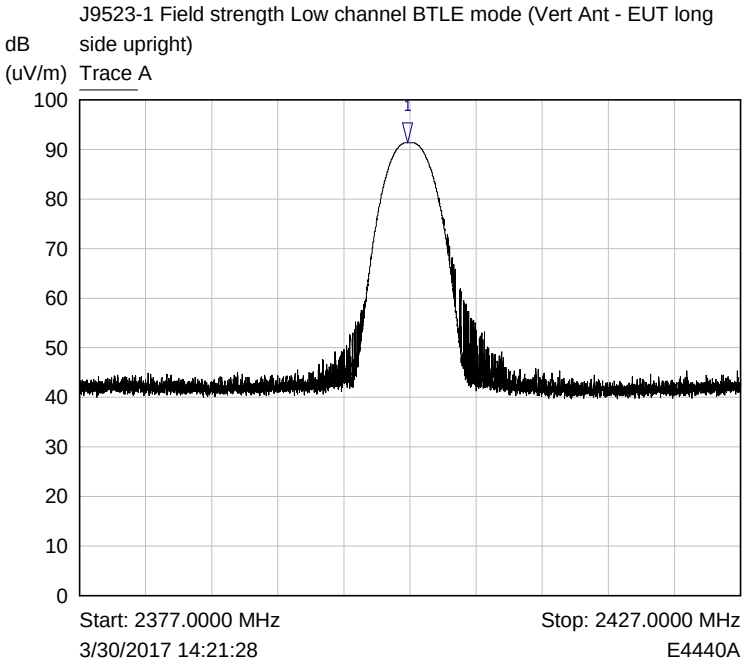
Plot of Peak emissions for 18 – 21.5 GHz Vertical against the AV limit line



Plot of Peak emissions for 21.5 - 25 GHz Vertical against the AV limit line

6.5 Intentional radiator field strength

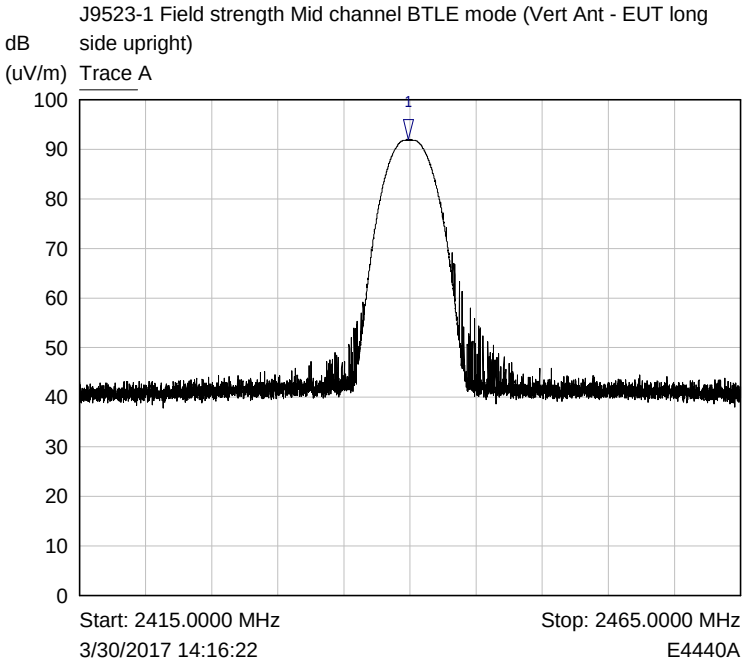
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2401.8382 MHz	91.38 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

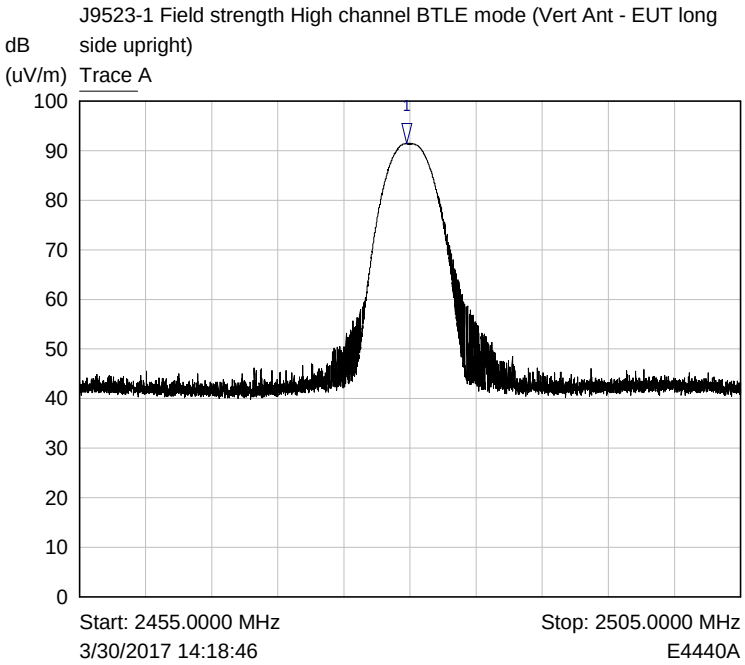
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2440 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2439.8443 MHz	91.92 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

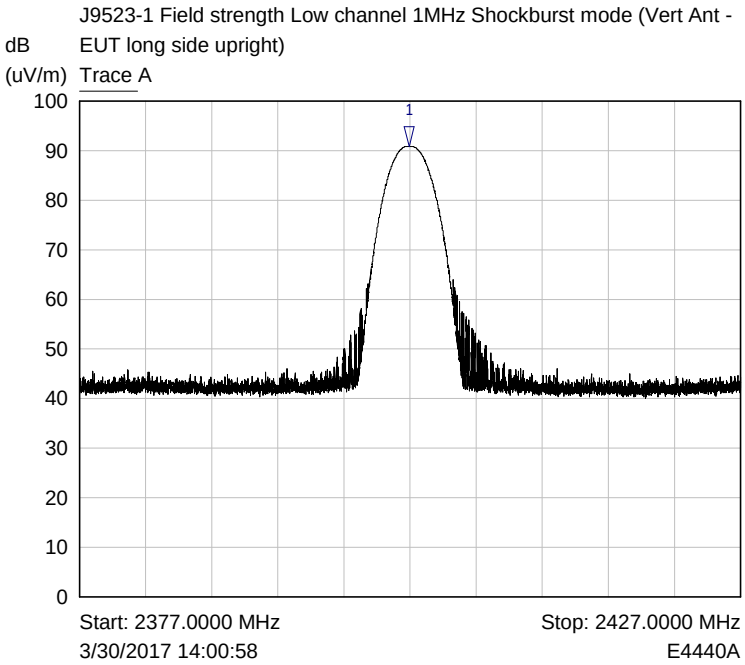
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2479.7711 MHz	91.44 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

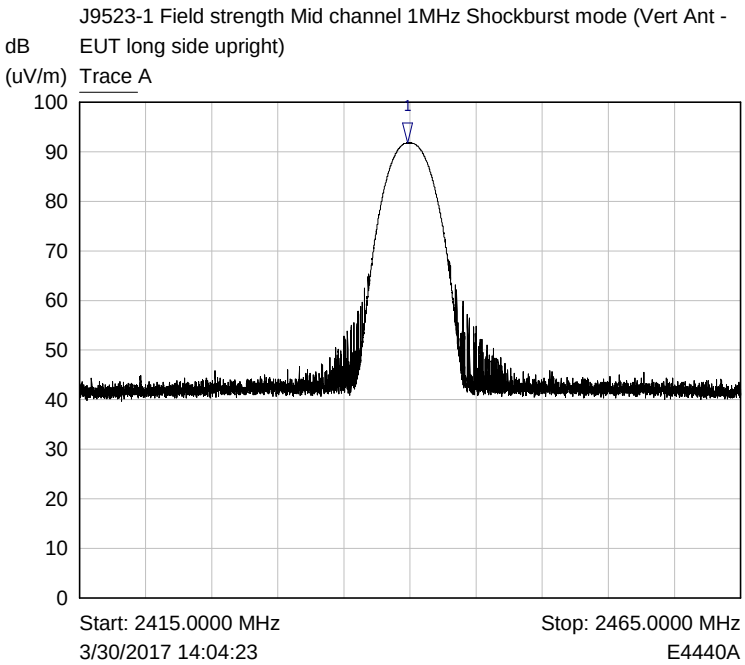
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz), Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2401.9237 MHz	90.89 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

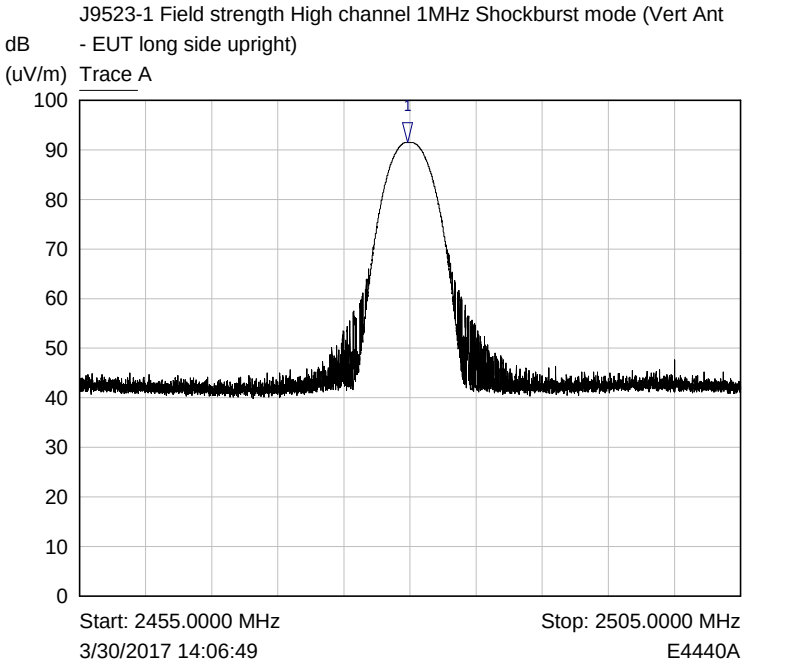
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz), Channel 2440 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2439.8077 MHz	91.77 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

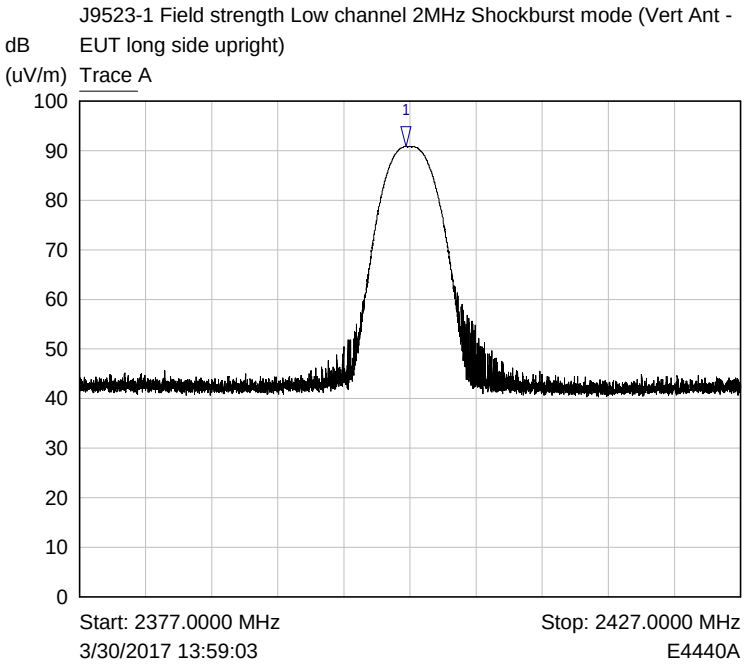
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz), Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2479.8138 MHz	91.57 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

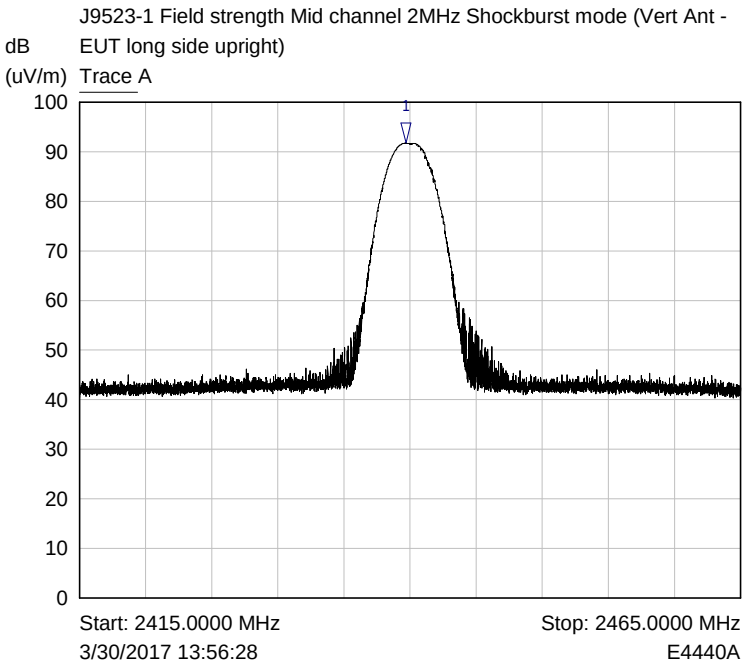
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz), Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2401.7039 MHz	90.78 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

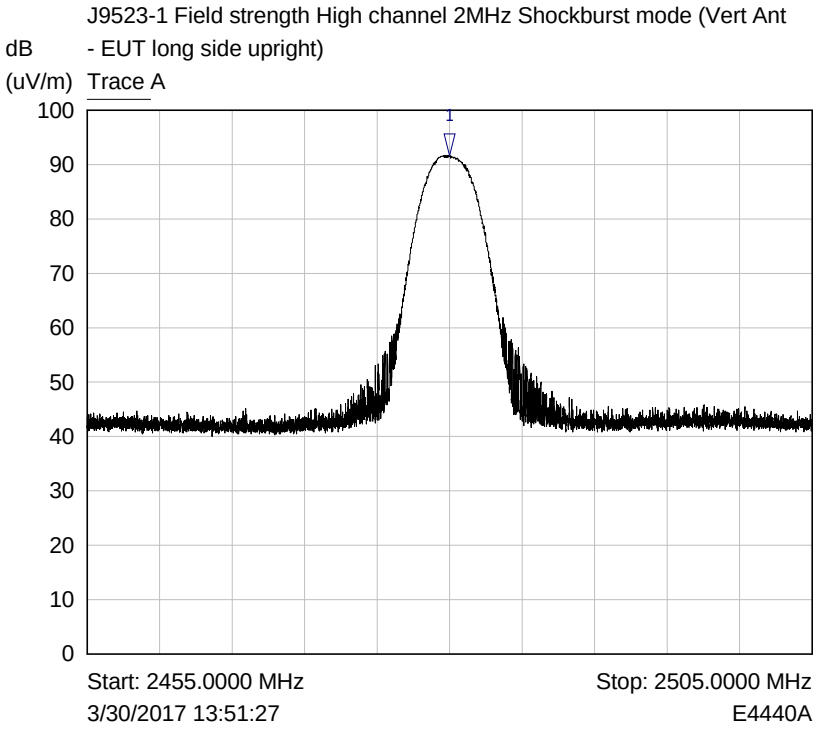
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz), Channel 2440 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2439.7039 MHz	91.76 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz), Channel 2480 MHz

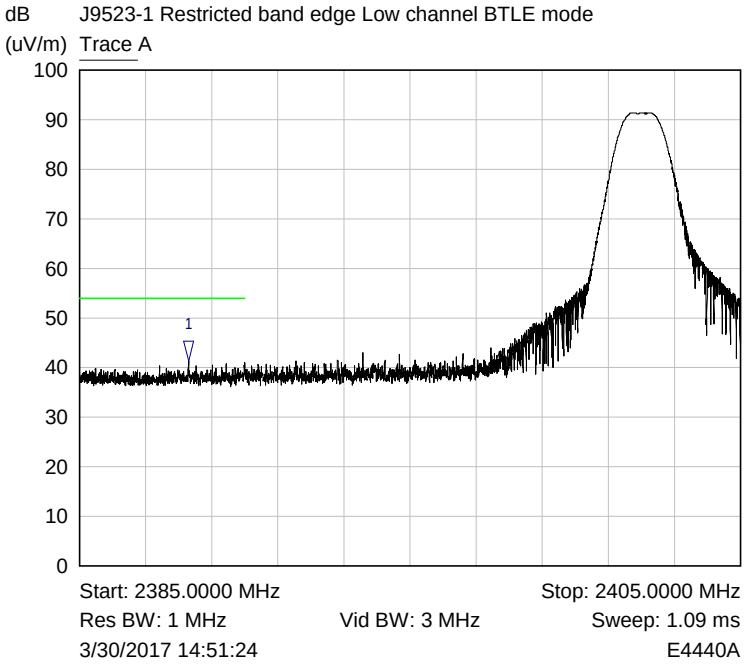


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2480.0275 MHz	91.65 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright long side position

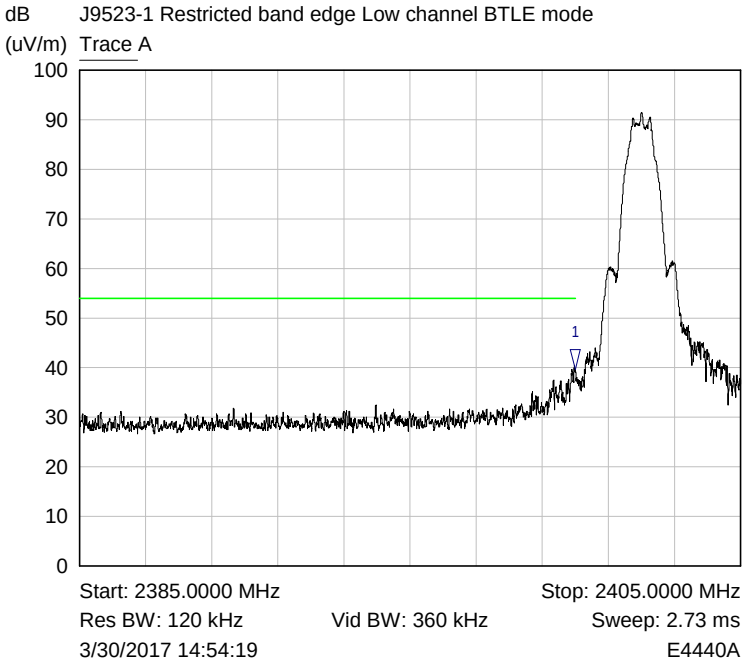
6.6 Band Edge Compliance

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2388.2987 MHz	41.29 dB(uV/m)	

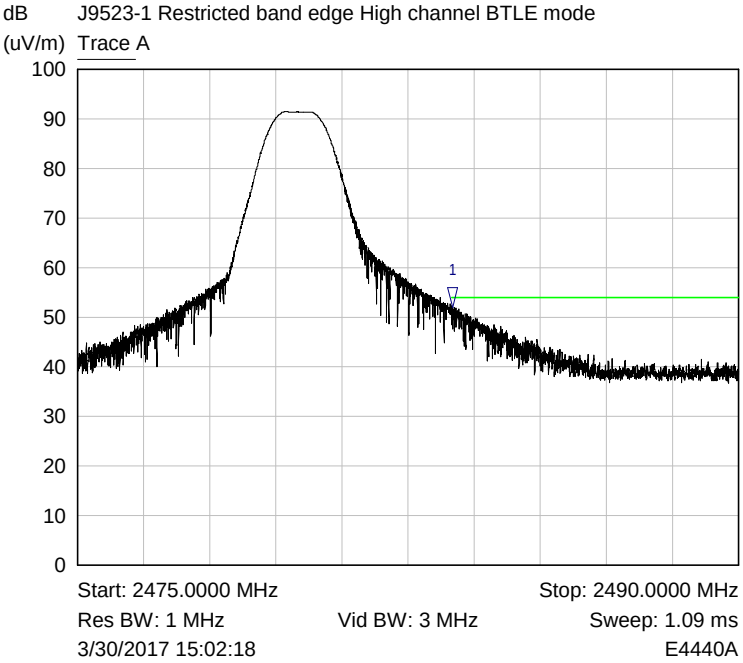
Lower Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2399.9994 MHz	39.60 dB(uV/m)	

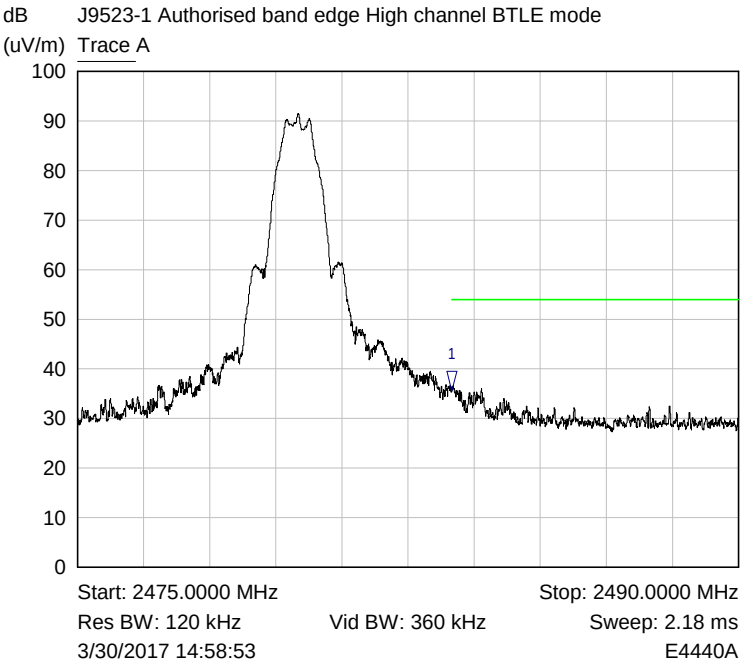
Lower Authorised Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2483.5063 MHz	51.96 dB(uV/m)	

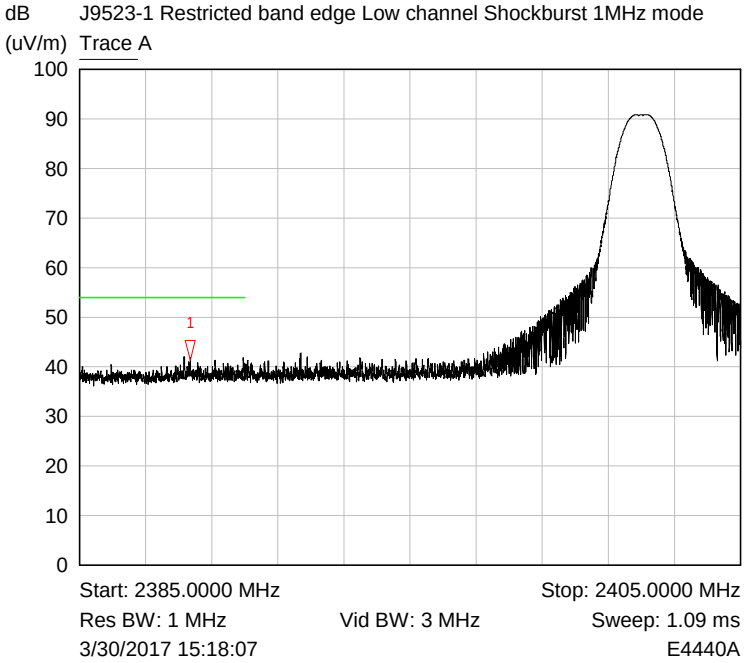
Upper Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2483.5008 MHz	35.56 dB(uV/m)	

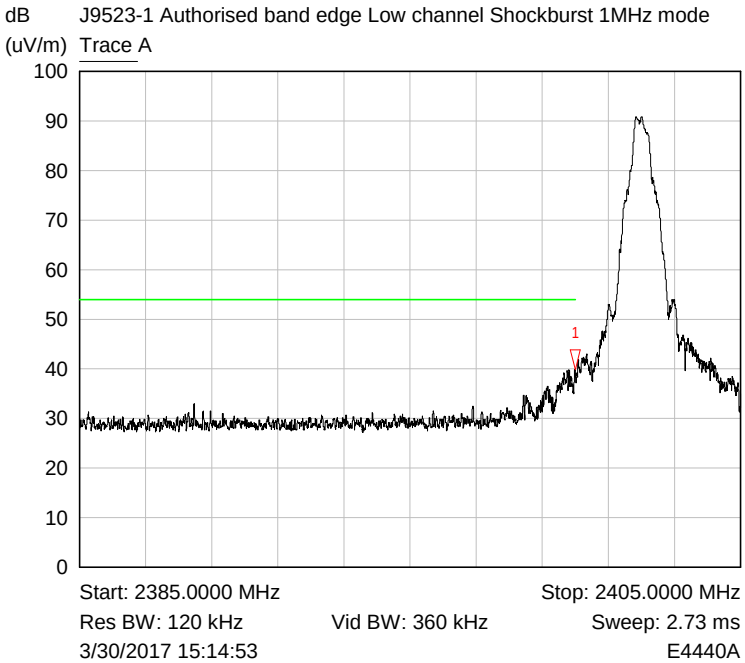
Upper Authorised Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz), Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2388.3403 MHz	41.35 dB(uV/m)	

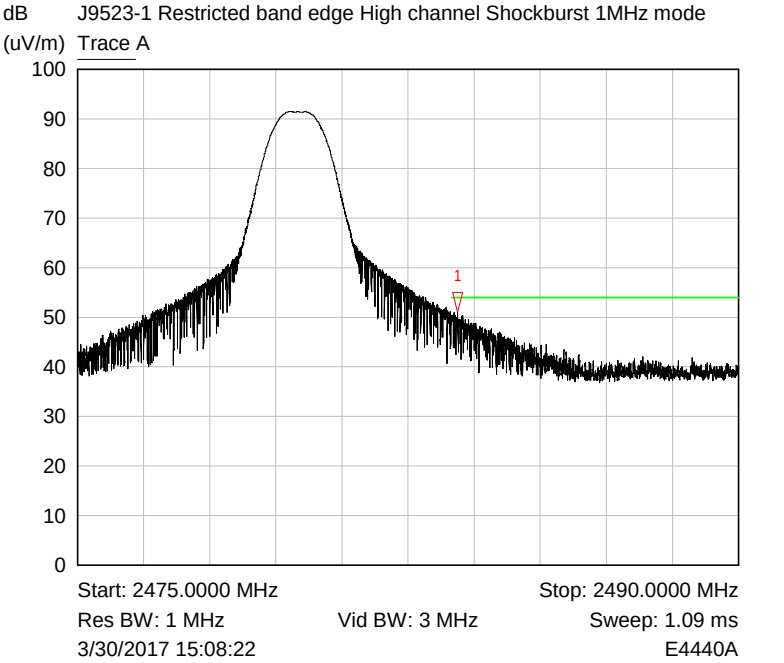
Lower Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2399.9994 MHz	39.75 dB(uV/m)	

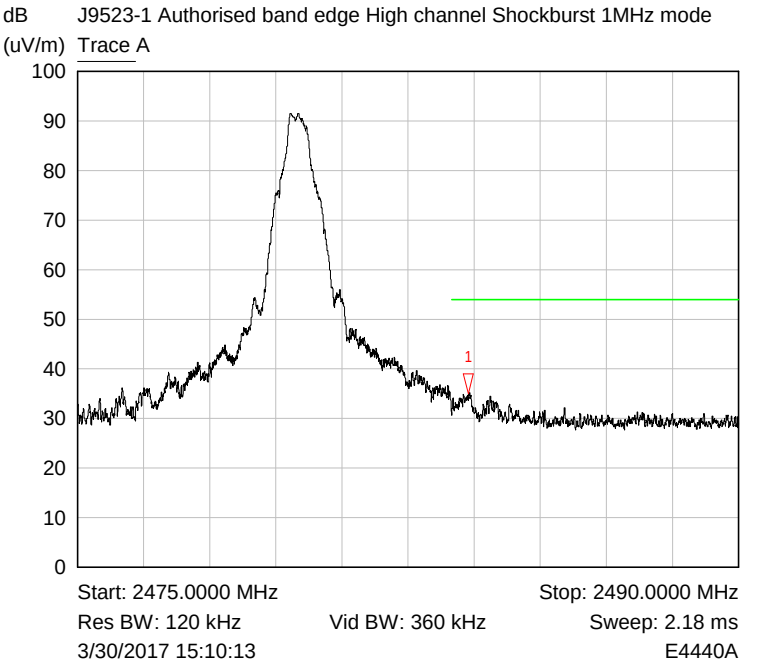
Lower Authorised Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz), Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2483.6272 MHz	51.02 dB(uV/m)	

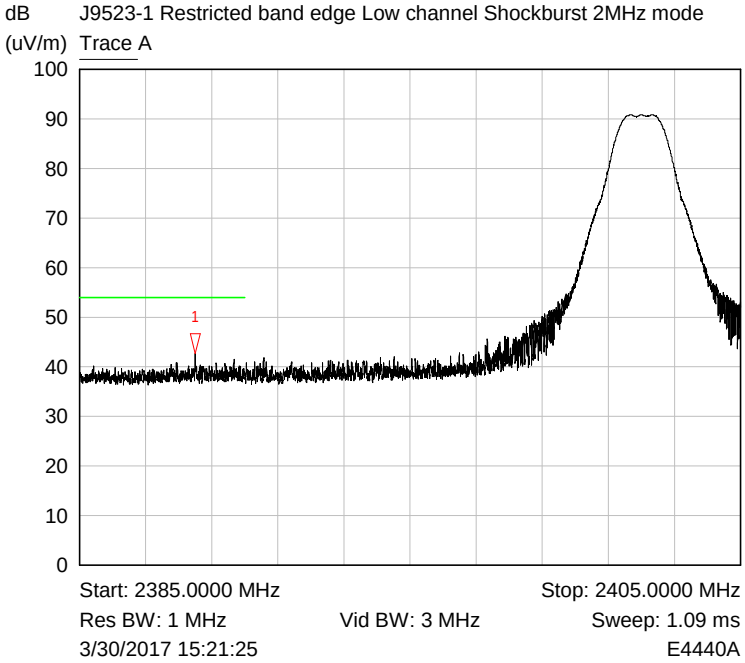
Upper Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2483.8780 MHz	35.06 dB(uV/m)	

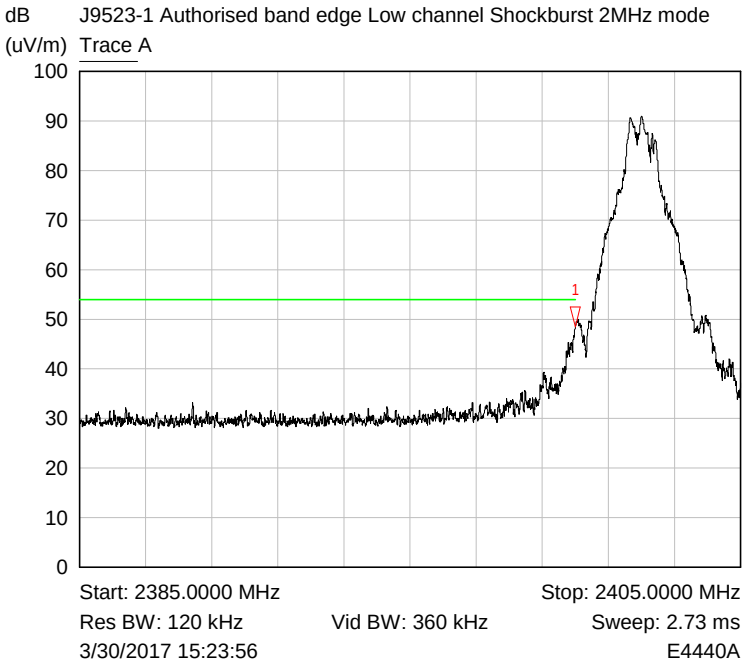
Upper Authorised Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz), Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2388.5014 MHz	42.61 dB(uV/m)	

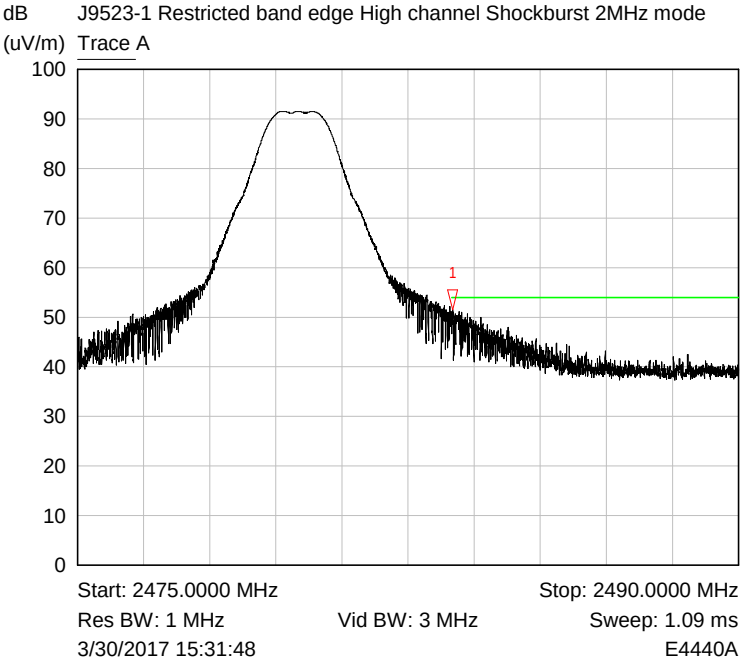
Lower Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2399.9994 MHz	48.52 dB(uV/m)	

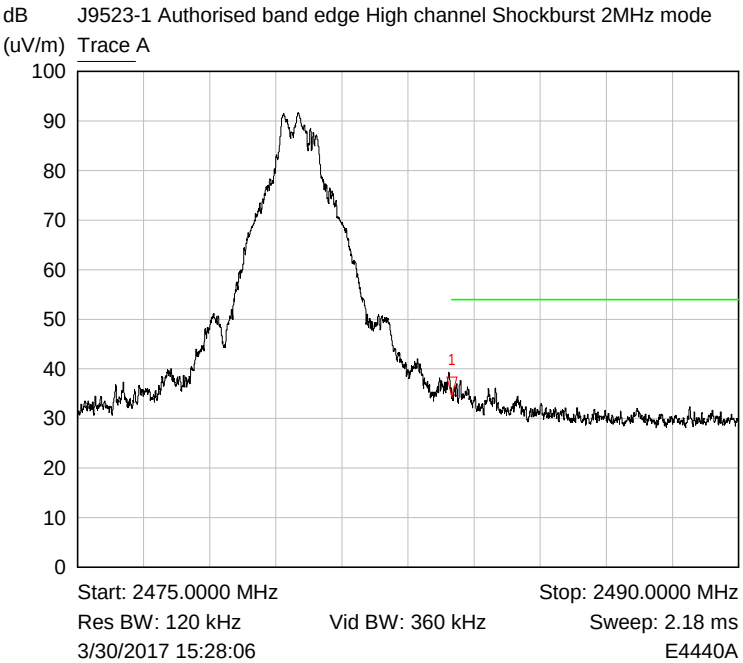
Lower Authorised Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz), Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2483.5081 MHz	51.55 dB(uV/m)	

Upper Restricted band edge Peak Plot

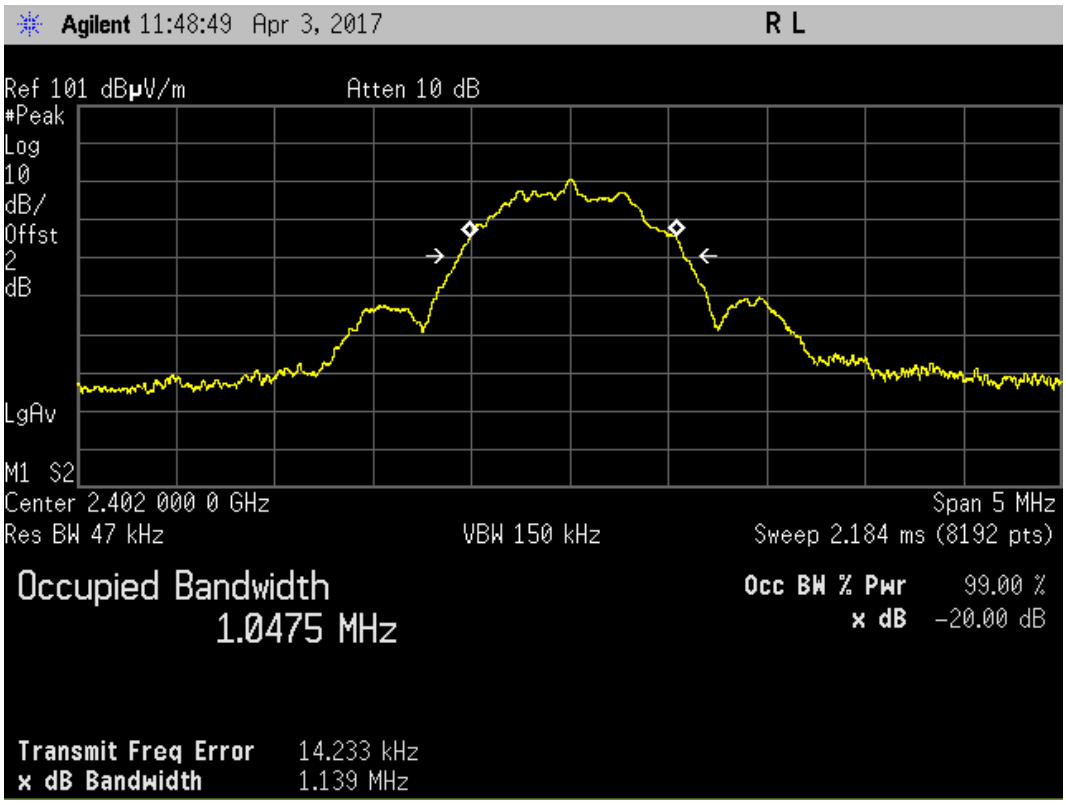


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2483.5008 MHz	34.41 dB(uV/m)	

Upper Authorised Band Edge Plot

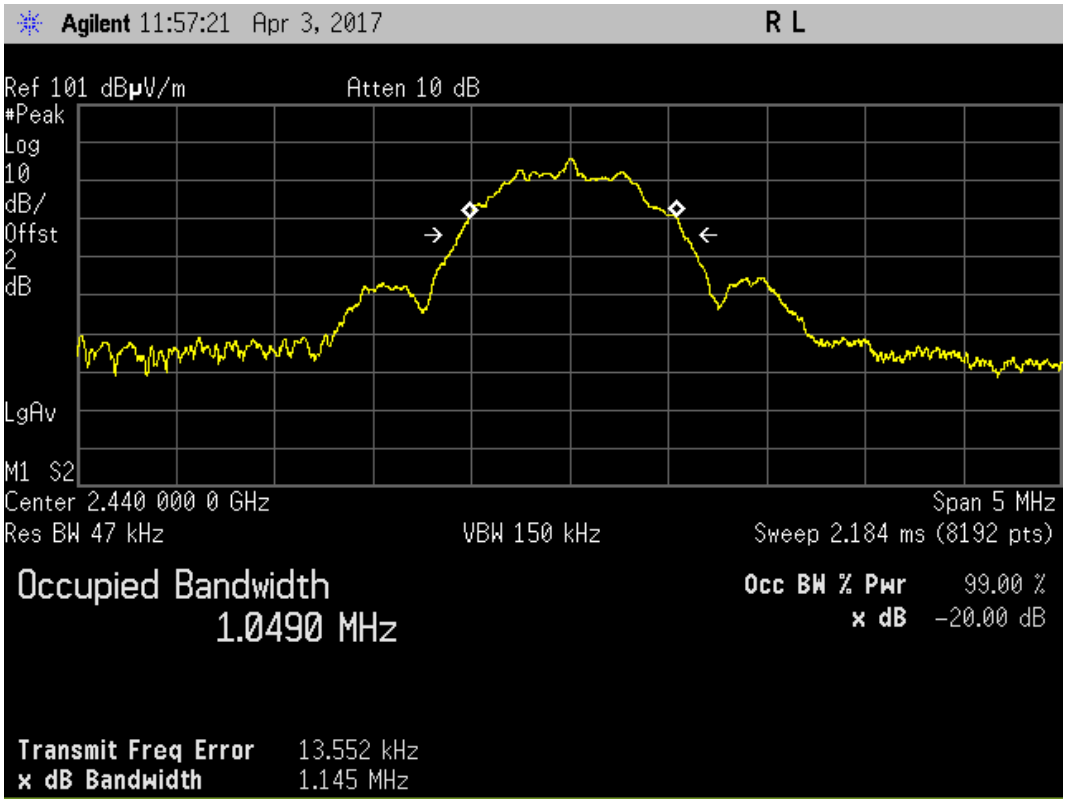
6.7 Occupied bandwidth

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2402 MHz



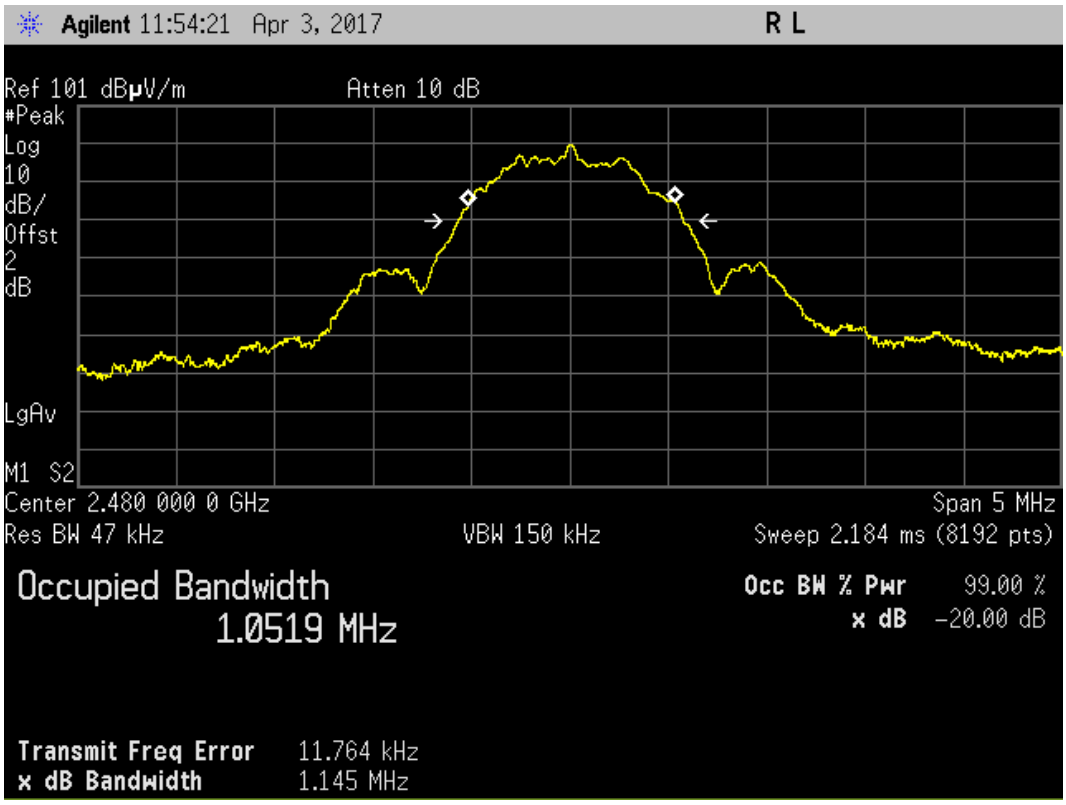
Plot for 20dB Bandwidth (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2440 MHz



Plot for 20dB Bandwidth (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy), Channel 2480 MHz

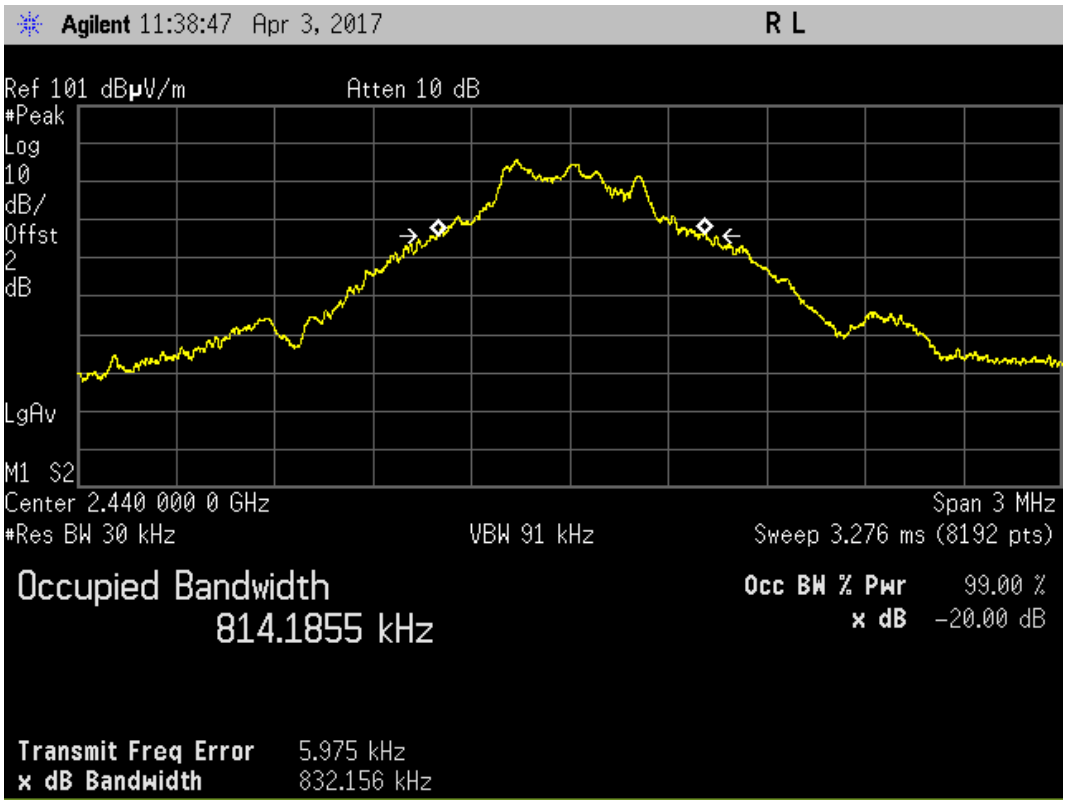


Plot for 20dB Bandwidth (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz), Channel 2402 MHz

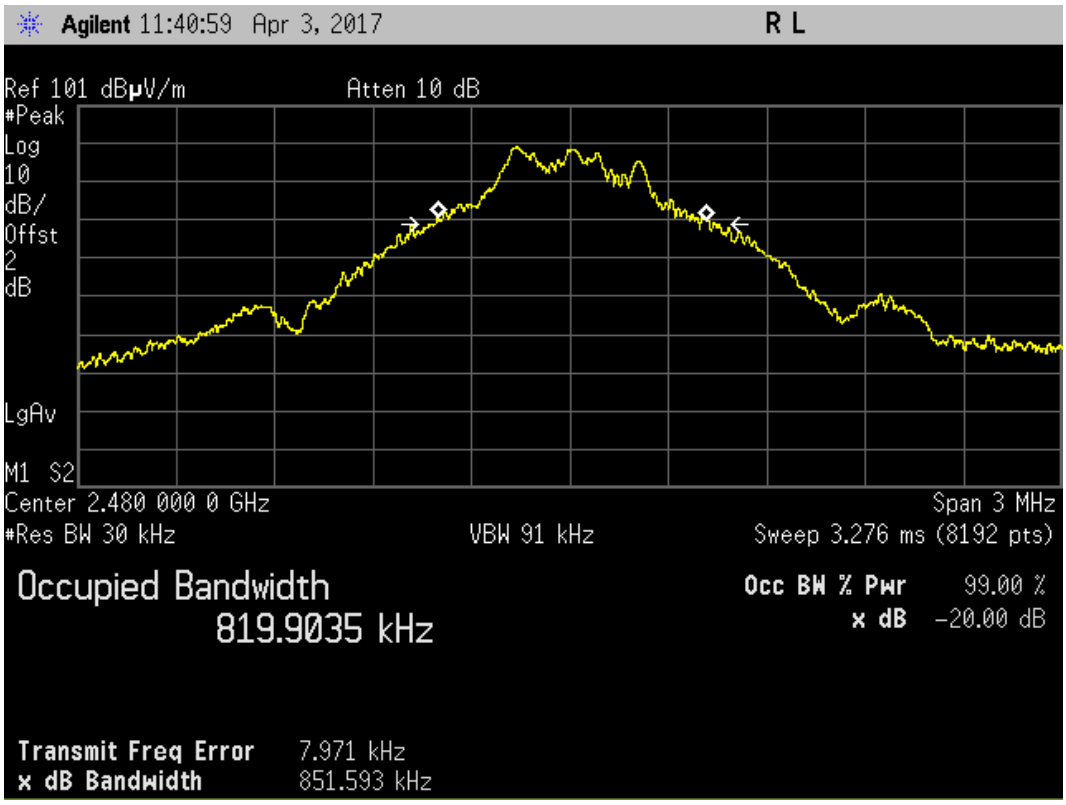
Plot for 20dB Bandwidth (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz), Channel 2440 MHz



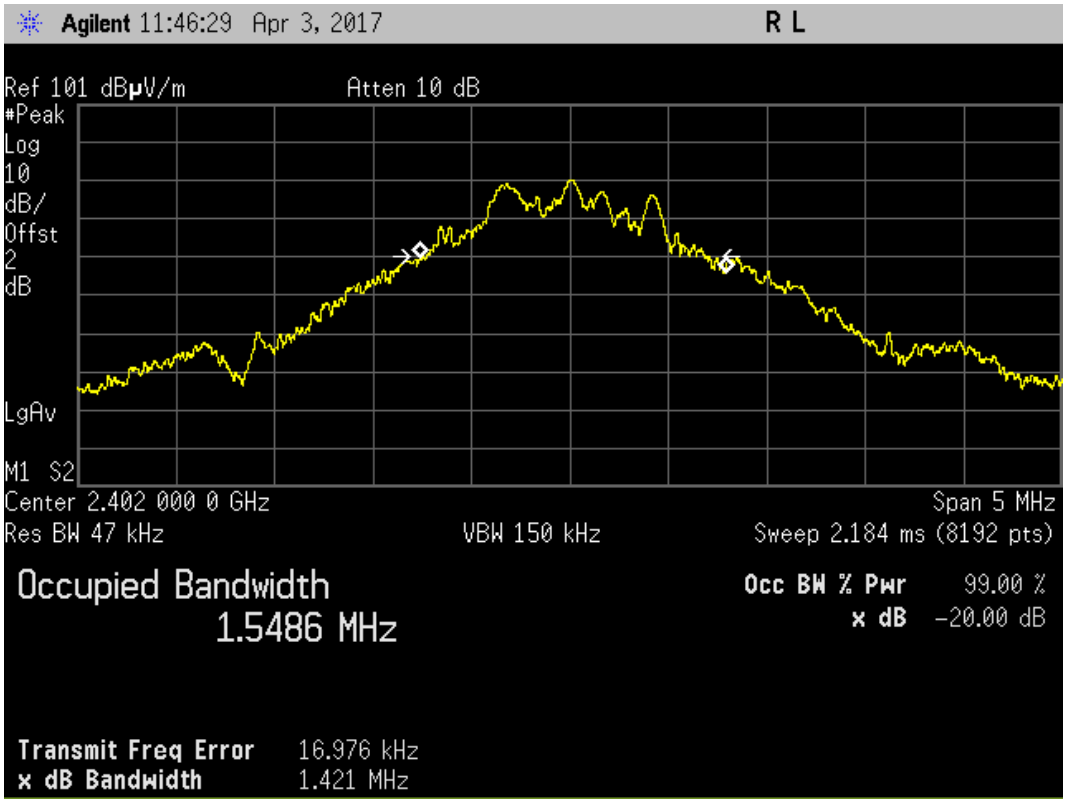
Plot for 20dB Bandwidth (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz), Channel 2480 MHz



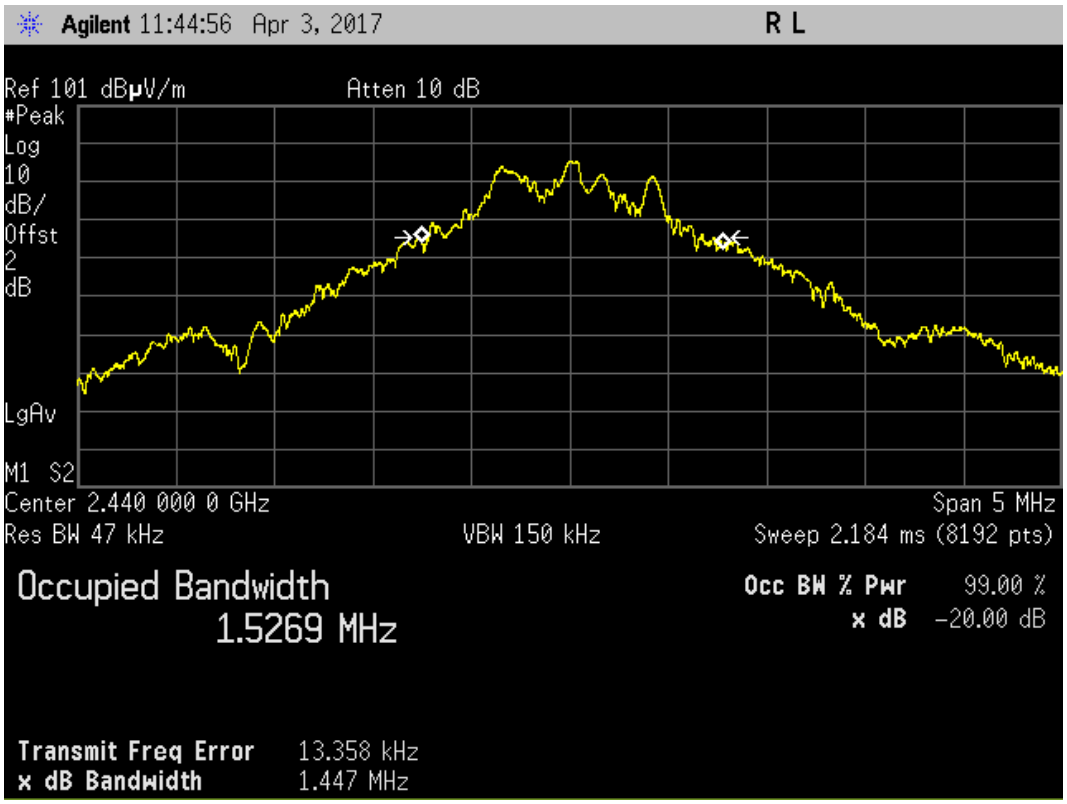
Plot for 20dB Bandwidth (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz), Channel 2402 MHz



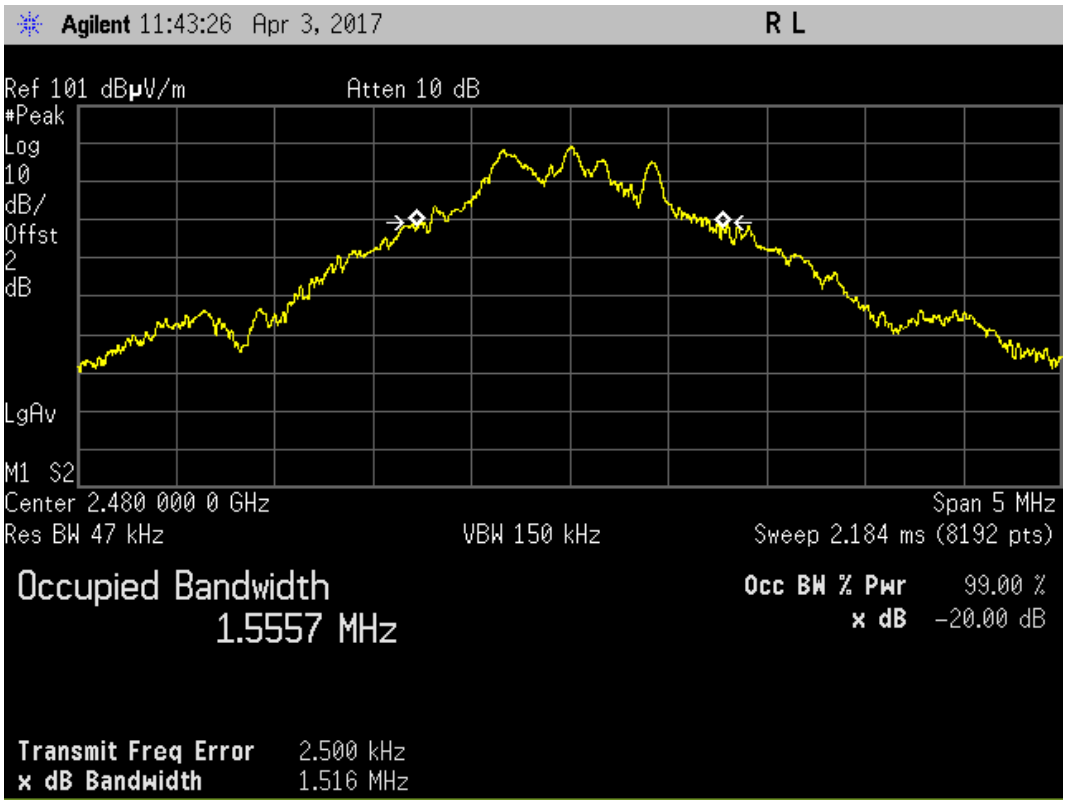
Plot for 20dB Bandwidth (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz), Channel 2440 MHz



Plot for 20dB Bandwidth (MHz)

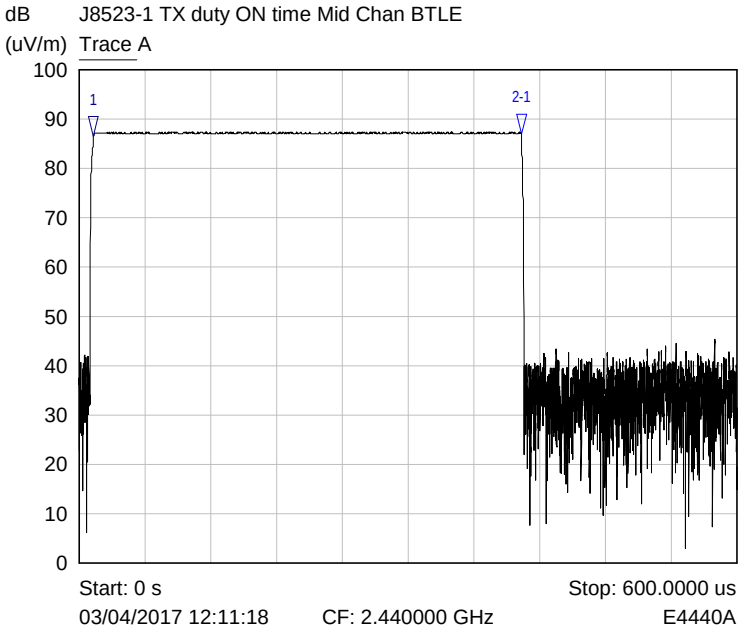
RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz), Channel 2480 MHz



Plot for 20dB Bandwidth (MHz)

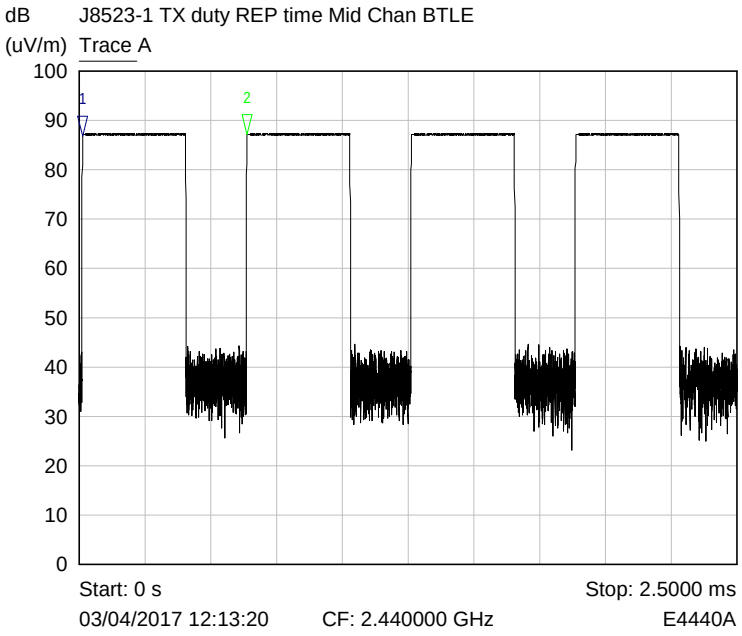
6.8 Duty cycle

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation Bluetooth (Low energy)



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	13.0387 us	86.43 dB(uV/m)	
2-1	Trace A	390.4285 us	0.53 dB	

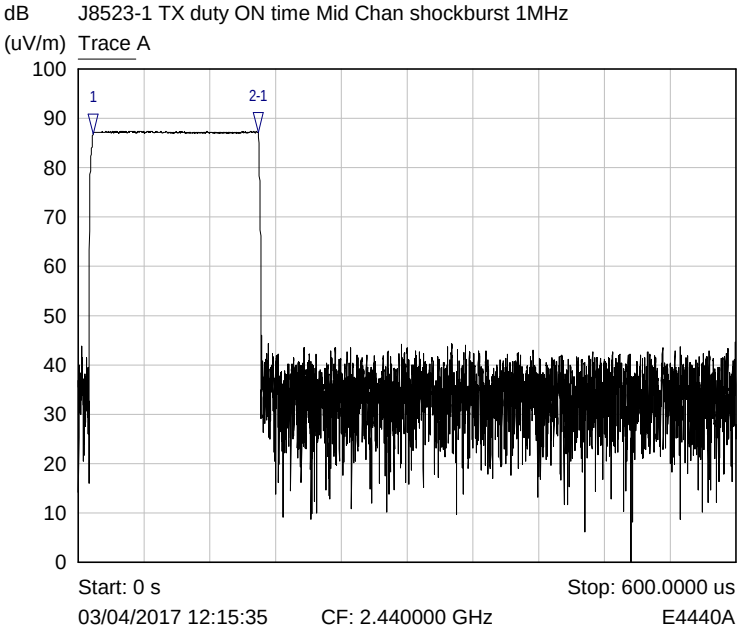
TX on time (us)



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	13.1242 us	86.84 dB(uV/m)	
2	Trace A	638.5057 us	87.10 dB(uV/m)	

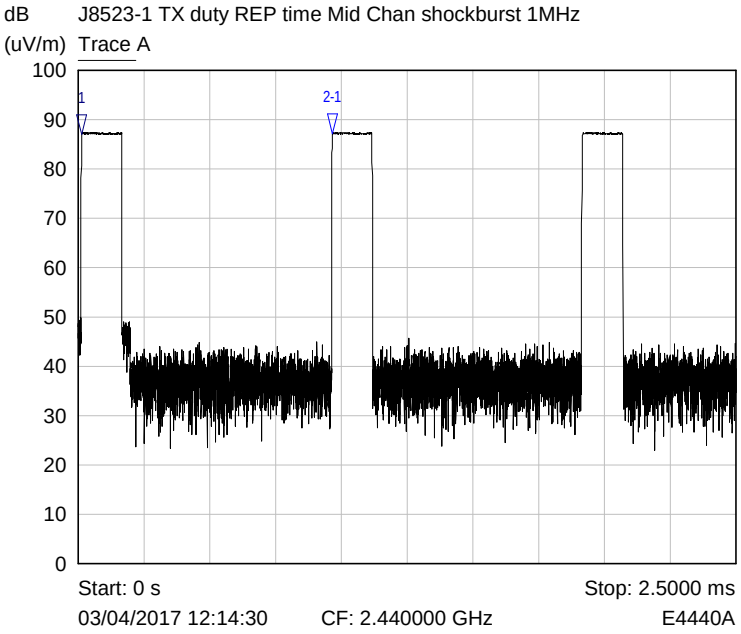
TX repetition time (ms)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (1 MHz)



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	13.2585 us	86.84 dB(uV/m)	
2-1	Trace A	151.1171 us	0.37 dB	

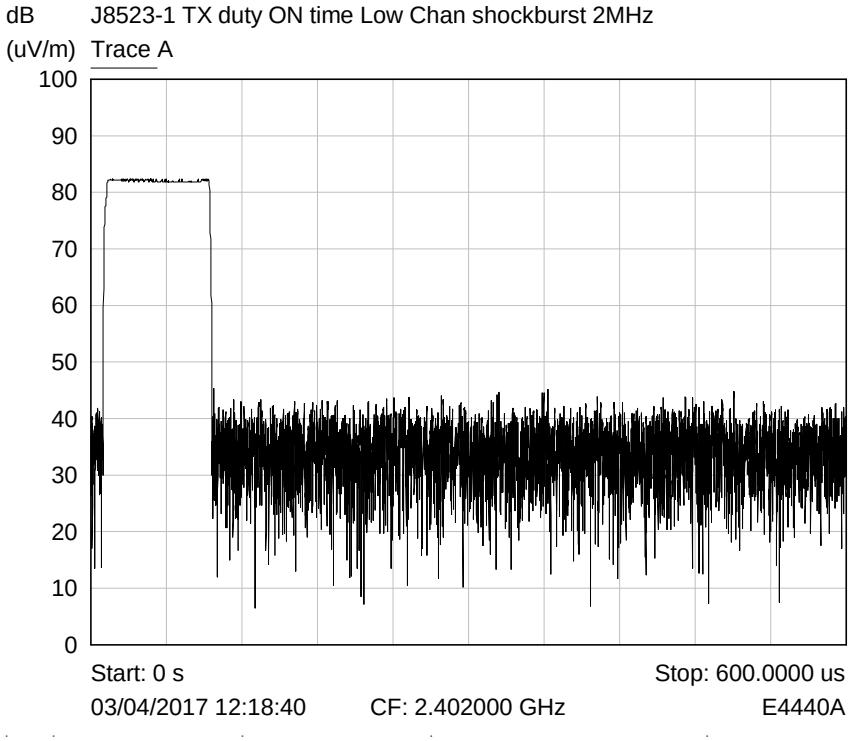
TX on time (us)



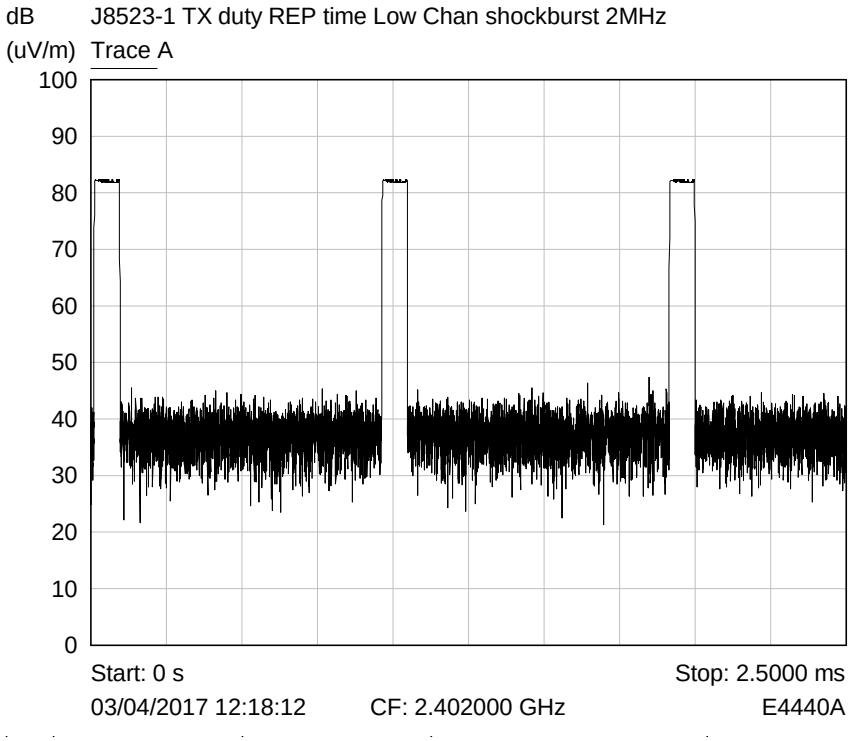
Mkr	Trace	X-Axis	Value	Notes
1	Trace A	13.4294 us	87.05 dB(uV/m)	
2-1	Trace A	951.9595 us	0.06 dB	

TX repetition time (ms)

RF Parameters: Band 2400-2483.5 MHz, Power -4 dBm, Channel Spacing 2 MHz, Modulation SHOCKBURST (2 MHz)



TX on time (us)



TX repetition time (ms)

7 Explanatory Notes

7.1 Explanation of Table of Signals Measured

Measurements are made as required by the standard. These measurements are made and recorded using detectors, either peak, quasi peak or average dependant on the test. A table of results has been given following the relevant plots. This table looks similar to the one illustrated below dependant on the measurements required by the test: -

Signal No.	Freq (MHz)	Peak Amp (dBuV)	Pk – Lim 1 (dB)	QP Amp (dBuV)	QP - Lim1 (dB)	Av Amp (dBuV)	Av - Lim1 (dB)
1	12345	54.9	-10.5	48	-12.6	37.6	-14.4

Column One - Labelled Signal No. is an incremental number that the receiver has given to each signal that has been measured.

Column Two - Labelled Freq (MHz) is the approximate frequency of the signal received.

Column Three - Labelled Peak Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the peak detector.

Column Four - Labelled Pk - Lim1 (dB) is the difference in level from the peak signal given to the active limit line. If this column appears in the table the peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Five - Labelled QP Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the quasi-peak detector.

Column Six - Labelled QP - Lim1 (dB) is the difference in level from the quasi-peak signal given to the active limit line. If this column appears in the table the quasi-peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Seven - Labelled Av Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the average detector.

Column Eight - Labelled Av - Lim1 (dB) is the difference in level from the average signal given to the active limit line. If this column appears in the table the average detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Only signals highlighted in red are deemed to exceed the limit of the detector required.

7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in μV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBμV/m referenced to the measuring instrument inputs. RN Electronics calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

(a) limit of 500 μV/m equates to 20.log (500) = 54 dB μV/m.

(b) limit of 300 µV/m at 10m equates to 20.log (300 . 10/3) = 60 dB µV/m at 3m
(c) limit of 30 µV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBµV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically. The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

Example calculation: - FS = RA + AF + CL.

Receiver amplitude (RA)	Antenna factor (3m) (AF)	Cable loss (CL)	Field strength result (3m) (FS)
20dBuV	25 dB	3 dB	48dBuV/m

8 Photographs

Short term confidentiality required, therefore all photographs removed at the manufacturer's request.

8.1 Radiated emission diagram

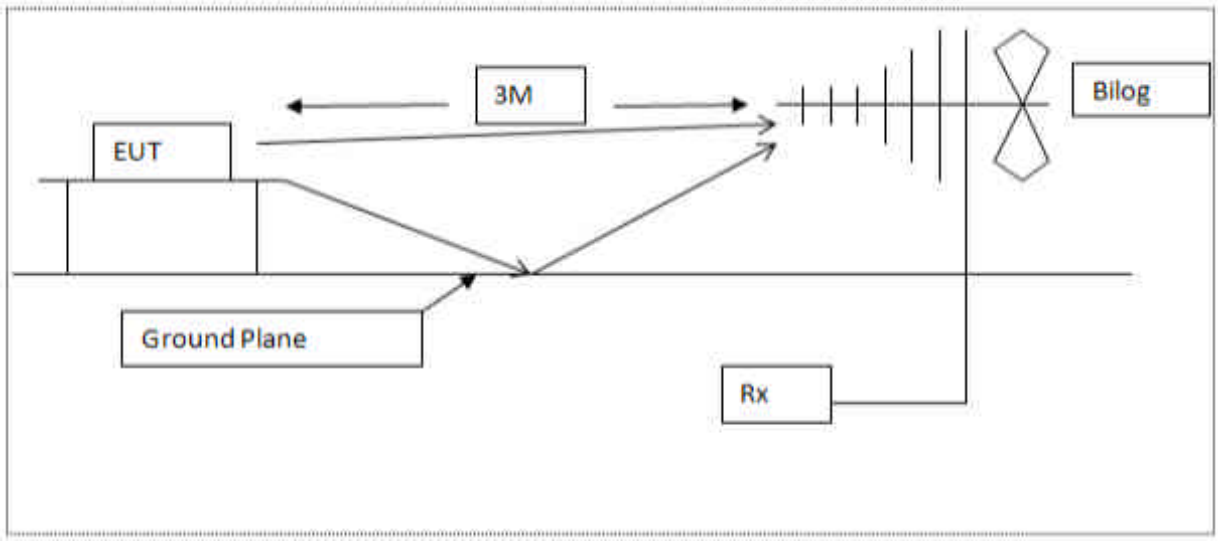


Diagram of the radiated emissions test setup 30 - 1000 MHz

8.2 AC powerline conducted emission diagram

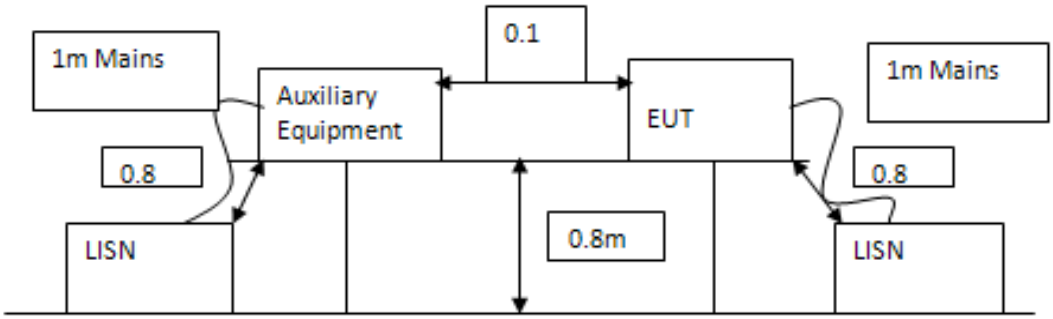


Diagram of the AC conducted emissions test setup

9 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E010	MN2050	LISN 13A	Chase	28-Apr-2016	12 months
E035	11947A	Transient Limiter + 10dB Atten.	Hewlett Packard	28-Nov-2016	6 months
E136	3105	Horn Antenna 12.5GHz	EMCO	03-Apr-2017*	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	06-Jul-2016	12 months
E465	PCR2000LA	AC Power Supply	Kikusui	10-May-2016	12 months
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	18-Jan-2017	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	18-Jan-2017	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	22-Dec-2015	24 months
E748	3001iM	AC Power Source 3kVA	California Instruments	N/A	N/A
LPE261	3115	Horn Antenna 1-18 GHz	EMCO	03-Apr-2017*	12 months
LPE333	8449B	Pre-amplifier 1GHz - 26.5GHz	Hewlett Packard	18-Apr-2016	24 months
LPE364	CBL6112A	30MHz - 2GHz Bilog Antenna	Chase Electronics Ltd	22-Jan-2016	24 months
TMS45	Model1	Attenuator 3dB 12.4GHz	Weinschel	02-Sep-2016	12 months
TMS78	3160-08	Std Gain Horn Antenna 12.4-18 GHz	ETS Systems	03-Jun-2016	12 months
TMS79	3160-09	Std Gain Horn Antenna 18-26.5 GHz	ETS Systems	03-Jun-2016	12 months
TMS81	6502	Active Loop Antenna	EMCO	27-Apr-2015	24 months
TMS82	8449B	Pre Amplifier 1 - 26 GHz	Agilent Technologies	19-Dec-2016	12 months
ZSW1	V2.1	Measurement Software Suite	RN Electronics	N/A	N/A

* Equipment was in calibration for tests and has been re-calibrated during or since testing dates.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	TTL-232R-3V3	USB to serial programming lead	FTDI	-

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
H25	E442 series	Laptop PC	Dell	LXNBF020020410623C1

11 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

11.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 Description of test sites

Site A Radio / Calibration Laboratory and anechoic chamber

Site B Semi-anechoic chamber

Site B1 Control Room for Site B

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

Site H 3m Semi-anechoic chamber (indoor OATS)
FCC Registration No. 293246
IC Registration No. 5612A-2

Site J Screened Room

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-anechoic chamber (indoor OATS)
FCC Registration No. 293246

Site Q Fully-anechoic chamber

Site OATS 3m and 10m Open Area Test Site
FCC Registration No. 293246
IC Registration No. 5612A-1

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

13 Abbreviations and units

%	Percent
µA/m	microAmps per metre
µV	microVolts
µW	microWatts
AC	Alternating Current
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ATPC	Automatic Transmit Power Control
BER	Bit Error Rate
ºC	Degrees Celsius
C/I	Carrier / Interferer
CEPT	European Conference of Postal and Telecommunications Administrations
COFDM	Coherent OFDM
CS	Channel Spacing
CW	Continuous Wave
dB	deciBels
dBµA/m	deciBels relative to 1µA/m
dBµV	deciBels relative to 1µV
dBc	deciBels relative to Carrier
dBm	deciBels relative to 1mW
DC	Direct Current
DTA	Digital Transmission Analyser
EIRP	Equivalent Isotropic Radiated Power
ERP	Effective Radiated Power
EU	European Union
EUT	Equipment Under Test
FM	Frequency Modulation
FSK	Frequency Shift Keying
g	Grams
GHz	GigaHertz
Hz	Hertz
IF	Intermediate Frequency
kHz	kiloHertz
LBT	Listen Before Talk
LO	Local Oscillator
mA	milliAmps
max	maximum
kPa	Kilopascal
Mbit/s	MegaBits per second
MHz	MegaHertz
mic	Microphone
min	minimum
mm	milliMetres
ms	milliSeconds
mW	milliWatts
NA	Not Applicable
nom	Nominal
nW	nanoWatt
OATS	Open Area Test Site
OFDM	Orthogonal Frequency Division Multiplexing
ppm	Parts per million
PRBS	Pseudo Random Bit Sequence
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
R&TTE	Radio and Telecommunication Terminal Equipment
Ref	Reference
RF	Radio Frequency
RFC	Remote Frequency Control
RSL	Received Signal Level
RTP	Room Temperature and Pressure
RTPC	Remote Transmit Power Control
Rx	Receiver
s	Seconds
SINAD	Signal to Noise And Distortion
Tx	Transmitter
V	Volts