



2360

Radio Test Report

Salunda Ltd

Latch Hawk Wireless Option E

1701E

47 CFR Part 15.247 Effective Date 1st October 2017

Test Date: 2nd July 2018 to 6th July 2018
Report Number: 07-10604-3-18 Issue 02
Supersedes report 07-10604-3-18 Issue 01

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Certificate of Test 10604-3

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:	Latch Hawk Wireless Option E
Model Number:	1701E
Unique Serial Number:	20001087 (Conducted power and Power Spectral Density tests) 20001089 (All other tests)
Applicant:	Salunda Ltd Unit 6 Avonbury Business Park, Howes Lane Bicester, Oxfordshire OX26 2UA
Full measurement results are detailed in Report Number:	07-10604-3-18 Issue 02
Test Standards:	47 CFR Part 15.247 Effective Date 1st October 2017

NOTE:

Certain tests were not performed based upon manufacturer's declarations. Certain other requirements are subject to manufacturer declaration only and have not been tested/verified. For details refer to section 3 of this report.

DEVIATIONS:

The following tests have had deviations applied: Band Edge Compliance

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: 2nd July 2018 to 6th July 2018

Test Engineer:

Approved By:
Technical Manager

Customer
Representative:



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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Salunda Ltd Unit 6 Avonbury Business Park Howes Lane Bicester Oxfordshire OX26 2UA	
Manufacturer of EUT	Salunda Ltd	
Full Name of EUT	Latch Hawk Wireless Option E	
Model Number of EUT	1701E	
Serial Number of EUT	20001087 (Conducted power and Power Spectral Density tests) 20001089 (All other tests)	
Date Received	2nd July 2018	
Date of Test:	2nd July 2018 to 6th July 2018	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	5th September 2018	
Main Function	Position sensor with NFC and 2.4 GHz connectivity.	
Information Specification	Height	30 mm
	Width	70 mm
	Depth	32 mm
	Weight	0.08 kg
	Voltage	3.6 V Li-SOCI2 battery
	Current	Not stated

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Mounted to finger board latch on a drill ship
Choice of model(s) for type tests	Sample
Antenna details	Integral coil antenna, chip part 2450AT42E010BE, -2dBi
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2.475 GHz
Lowest Signal generated in EUT	32.768 kHz
Hardware Version	D3
Software Version	V0.312
Firmware Version	V2.25
Type of Equipment	RFID
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2405 - 2475 MHz
EUT Declared Modulation Parameters	OQPSK
EUT Declared Power level	+3 dBm (conducted)
EUT Declared Signal Bandwidths	2 MHz
EUT Declared Channel Spacing's	5 MHz
EUT Declared Duty Cycle	Not stated
Unmodulated carrier available?	Yes (for test purposes)
Declared frequency stability	Not stated
RX Parameters	
Alignment range – receiver	2405 - 2475 MHz
EUT Declared RX Signal Bandwidth	2 MHz
Method of Monitoring Receiver BER	BER ratio available (for test purposes)
FCC Parameters	
FCC Transmitter Class	DTS: Digital Transmission System

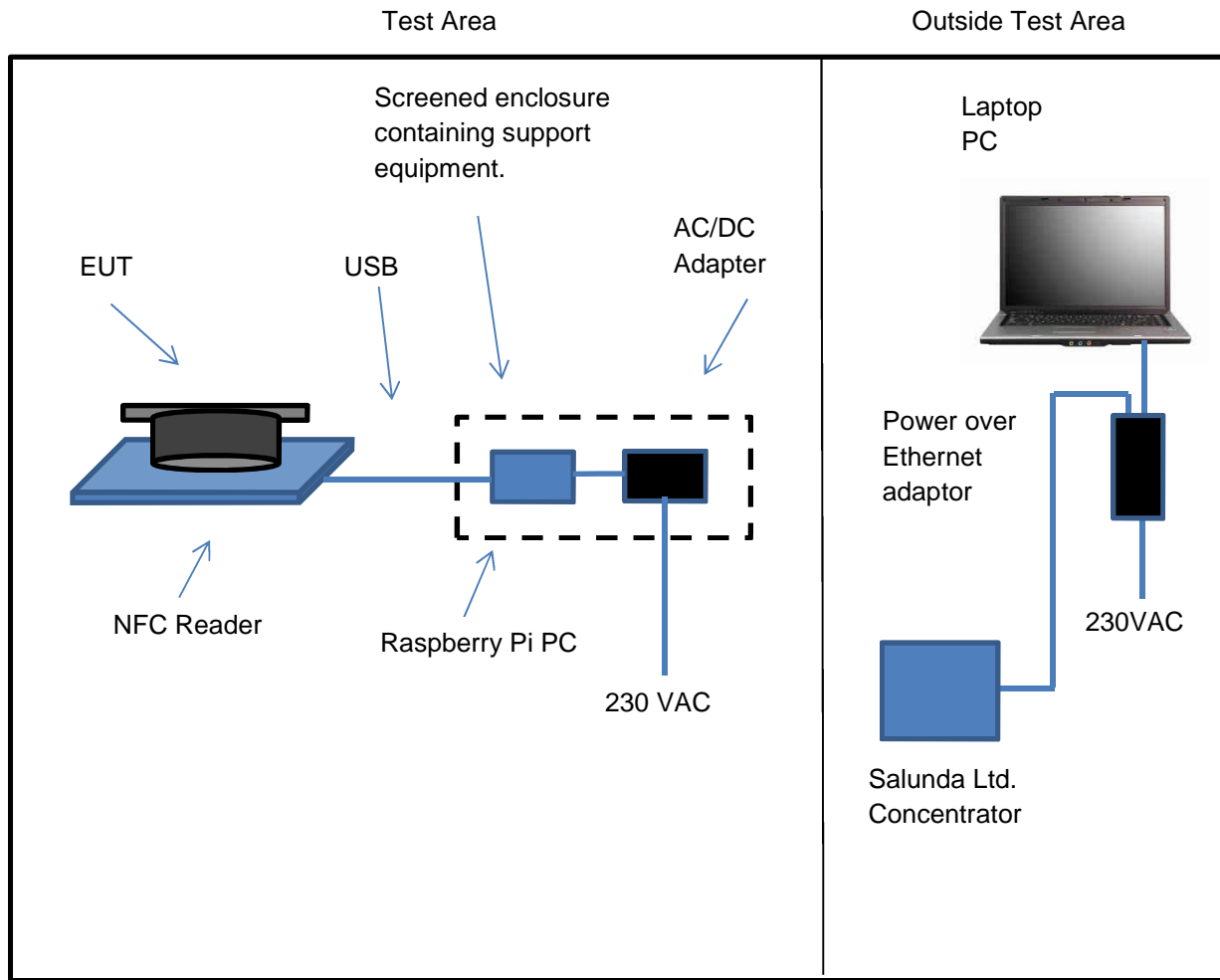
2.3 Functional description

The EUT is a wireless sensor that detects the orientation of the sensor. The EUT is powered using a long-life Li-SOCI2 battery. The EUT comprises of the battery, 13.56 MHz NFC, pressure and temperature sensors, two inductance to digital convertors, two 3 axis accelerometers and a microcontroller with 2.4 GHz transceiver. In normal use the EUT transmits using the 2.4 GHz transceiver. The 13.56 MHz NFC allows communications with the sensor via any suitable NFC enabled device.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX LOW BURST	2405 MHz, OQPSK modulation, continuous bursts of data	Yes
TX MID BURST	2440 MHz, OQPSK modulation, continuous bursts of data	Yes
TX HIGH BURST	2475 MHz, OQPSK modulation, continuous bursts of data	Yes
TX LOW CONT	2405 MHz, OQPSK modulation, continuous modulation, 100% duty cycle	Yes
TX MID CONT	2440 MHz, OQPSK modulation, continuous modulation, 100% duty cycle	Yes
TX HIGH CONT	2475 MHz, OQPSK modulation, continuous modulation, 100% duty cycle	Yes
TX LOW 1 SEC	2405 MHz, OQPSK modulation, transmitting a single message once per second	Yes
TX MID 1 SEC	2440 MHz, OQPSK modulation, transmitting a single message once per second	Yes
TX HIGH 1 SEC	2475 MHz, OQPSK modulation, transmitting a single message once per second	Yes

2.5 Emissions configuration (9 kHz – 1 GHz)



The EUT unit was powered from its internal battery. Prior to test the EUT was configured using a laptop PC which was connected to a Salunda Ltd Concentrator. This allowed the EUT to be set into continuous burst transmit modes as stated in section 2.4. The EUT was positioned in close proximity to a NFC card reader which was in turn connected to a Raspberry Pi PC running engineering test code. This code repeatedly read the stored data on the EUTs NFC tag. To minimise the emissions of the Raspberry Pi and power supply (support equipment) this equipment was placed inside a screened enclosure. This configuration was found to be worst-case for radiated emissions over the frequency range of 9 kHz to 1 GHz.

Note: Although the NFC tag is connected to the internal electronics of the EUT, it is a passive tag and does not generate its own electromagnetic field. The NFC reader was used to generate the required electromagnetic field in order to full exercise this function of the EUT.

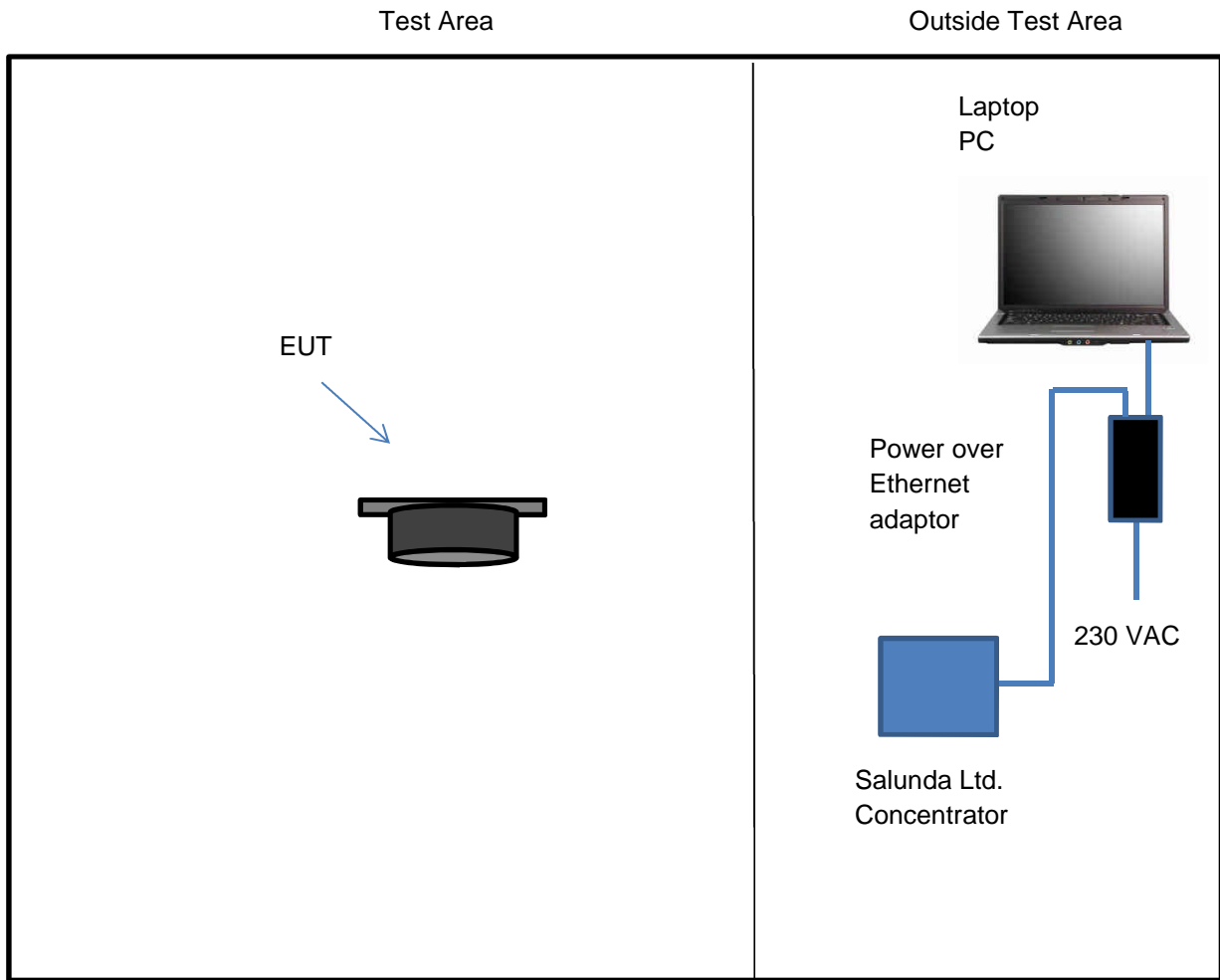
For conducted power and Power Spectral Density tests a second test unit was provided by the applicant where the 2.4 GHz chip antenna had been removed and a coax cable soldered directly to the EUT RF output.

The power level assessed during the tests detailed in this report was +3dBm (conducted) as declared by the applicant. No other power levels have been assessed.

2.5.1 Signal leads

Port Name	Cable Type	Connected
The EUT has no ports or cables		

2.6 Emissions configuration (1 GHz – 25 GHz)



The EUT unit was powered from its internal battery. Prior to test the EUT was configured using a laptop PC which was connected to a Salunda Ltd Concentrator. This allowed the EUT to be set into continuous burst transmit modes as stated in section 2.4. This configuration was found to be worst-case for radiated emissions over the frequency range of 1 GHz to 25 GHz.

For conducted power and Power Spectral Density tests a second test unit was provided by the applicant where the 2.4 GHz chip antenna had been removed and a coax cable soldered directly to the EUT RF output.

The power level assessed during the tests detailed in this report was +3dBm (conducted) as declared by the applicant. No other power levels have been assessed.

2.6.1 Signal leads

Port Name	Cable Type	Connected
The EUT has not ports or cables		

3 Summary of test results

The Latch Hawk Wireless Option E, 1701E was tested for compliance to the following standard(s) :

47 CFR Part 15.247 Effective Date 1st October 2017
DTS: Digital Transmission System

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		NOT APPLICABLE ¹
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED ²
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED
4. Radiated emissions 30 MHz - 1 GHz	47 CFR Part 15C Part 15.247(d) & 15.209	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.247(d) & 15.209	PASSED ³
6. Effective radiated power field strength	47 CFR Part 15C Part 15.247(d)	PERFORMED ⁸
7. Band Edge Compliance	47 CFR Part 15C Part 15.215 & 15.247(d)	PASSED
8. Occupied bandwidth	47 CFR Part 15C Part 15.247(2) / 15.215	PASSED
9. Maximum Average conducted output power		NOT APPLICABLE ⁴
10. Maximum Peak conducted output power	47 CFR Part 15C Part 15.247(2)(b)(3)	PASSED
11. Maximum Power Spectral Density	47 CFR Part 15C Part 15.247(e)	PASSED
12. Antenna power conducted emissions		NOT APPLICABLE ⁵
13. Duty cycle		NOT APPLICABLE ⁶
14. FHSS carrier frequency separation		NOT APPLICABLE ⁷
15. Average time of occupancy		NOT APPLICABLE ⁷
16. Number of Hop Channels		NOT APPLICABLE ⁷

¹ EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

² Spectrum below 30MHz started at a frequency of 9 kHz up to a frequency of 30MHz based on the lowest signal generated/used within the equipment as declared by the applicant.

³ Spectrum investigated up to a frequency of 25 GHz based on 10 times the highest frequency generated in equipment of 2475 MHz.

⁴ Not required. Peak Conducted power has been measured instead.

⁵ EUT does not employ FHSS technology

⁶ No limits apply

⁷ Applies to EUT's with an antenna port. The EUT has an integral antenna only.

⁸ Test performed to determine maximum radiated fundamental field strength in 100 kHz RBW, for reference of the 20dBc Peak limit in 15.247(d).

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	2017	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
4.1.4	DA 00-705	2000	PUBLIC NOTICE Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
4.1.5	KDB 558074 D01 v03r03	2013	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

4.2 Deviations

Deviations have been applied on the following : Band Edge Compliance : The band edge readings were performed with a peak detector (max held plot) and with the EUT set in a constant 100% transmit state.

4.3 Test fixtures

In order to measure conducted peak power a modified unit was provided by the applicant where the integral chip-antenna was removed and a coax cable was soldered directly to the EUT RF output to create a temporary RF port. This test unit was also used for Power Spectral Density tests.

5 Tests, methods and results

5.1 AC power line conducted emissions

NOT APPLICABLE: EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

5.2 Radiated emissions 9 - 150 kHz

5.2.1 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 15.209/15.247(d) [Reference 4.1.1 of this report]

5.2.2 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 new battery.

The EUT was operated in TX LOW BURST and TX MID BURST and TX HIGH BURST mode. There was no discernible difference in emissions was observed between modes, therefore for full test TX MID BURST mode was used.

5.2.3 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 final measurements (if 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.

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

Tests were performed using Test Site M.

5.2.4 Test equipment

TMS81, ZSW1, E534, E535

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 MHz

Plot refs
10604-3 Rad 1 9k-150kHz Para
10604-3 Rad 1 9k-150kHz Perp

No signals observed on any channel during pre-scans in the chamber, therefore final measurements on an OATS were not required and only Mid channel plots are shown in this report.

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.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

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 ± 3.9 dB

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 15.209/15.247(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 new battery.

The EUT was operated in TX LOW BURST and TX MID BURST and TX HIGH BURST mode. There was no discernible difference in emissions was observed between modes, therefore for full test TX MID BURST mode was used.

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 final measurements (if 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.

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

Tests were performed using Test Site M.

5.3.4 Test equipment

TMS81, ZSW1, E534, E535

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	20°C
Humidity of test environment	60%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel channel	2440 MHz

Plot refs
10604-3 Rad 1 150k-30MHz Para
10604-3 Rad 1 150k-30MHz Perp

No spurious emissions were observed on any channel within 20 dB of the limit during pre-scans in the chamber, therefore final measurements on an OATS were not required and only Mid channel plots are shown in this report.

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.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

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 ± 3.9 dB

5.4 Radiated emissions 30 MHz - 1 GHz

5.4.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]
 Test Method: ANSI C63.10 Clause 6.5 [Reference 4.1.2 of this report]
 Limits: 47 CFR Part 15C Part 15.209/15.247(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. 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 new battery.

The EUT was operated in TX LOW BURST and TX MID BURST and TX HIGH BURST mode. There was no discernible difference in emissions was observed between modes, therefore for full test TX MID BURST mode was used.

5.4.3 Test procedure

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

5.4.4 Test equipment

LPE364, E743, NSA-M, ZSW1, E534, E535

See Section 9 for more details

5.4.5 Test results

Temperature of test environment 20°C
 Humidity of test environment 50%
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 MHz

Plot refs	
10604-3 Rad 1 VHF Horiz	
10604-3 Rad 1 VHF Vert	
10604-3 Rad 1 UHF Horiz	
10604-3 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	310.283	37.7	33.2	-12.8
2	372.487	39.7	34.0	-12.0
3	372.487	40.8	35.0	-11.0
4	378.709	42.8	37.9	-8.1
5	384.810	43.6	38.2	-7.8
6	389.220	42.0	37.7	-8.3
7	396.956	41.6	35.9	-10.1
8	406.797	37.7	35.3	-10.7
9	464.080	33.6	27.4	-18.6
10	623.754	36.7	33.8	-12.2

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	54.244	33.7	32.9	-7.1
2	305.285	32.6	26.5	-19.5
3	311.204	35.0	29.2	-16.8
4	378.056	37.5	32.3	-13.7
5	383.015	37.8	32.2	-13.8
6	389.008	37.3	32.0	-14.0

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

Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

LIMITS:

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

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 15.247(d) & 15.209 [Reference 4.1.1 of this report]
 Test Method: ANSI C63.10 Clause 6.6 [Reference 4.1.2 of this report]
 Limits: 47 CFR Part 15C Part 15.247(d) & 15.209 [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 new battery.

The EUT was operated in TX LOW BURST and TX MID BURST and TX HIGH BURST mode. There was no discernible difference in emissions was observed between modes, therefore for full test TX MID BURST modes was used.

5.5.3 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 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 - 25GHz.

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

Tests were performed using Test Site M.

5.5.4 Test equipment

E136, E535, TMS78, TMS79, TMS82, E534

See Section 9 for more details

5.5.5 Test results

Temperature of test environment 20°C
 Humidity of test environment 60%
 Pressure of test environment 102kPa

Setup Table

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
4879.058	43.6	-30.4	31.5	-22.5	Side	Horizontal
7318.598	40.9	-33.1	28.5	-25.5	Side	Horizontal
7321.576	43.0	-31.0	32.0	-22.0	Upright	Vertical

Plots
10604-3 Rad 1 1-2GHz Horiz
10604-3 Rad 1 1-2GHz Vert
10604-3 Rad 1 2-5GHz Vert
10604-3 Rad 1 2-5GHz Vert
10604-3 Rad 1 5-6GHz Horiz
10604-3 Rad 1 5-6GHz Vert
10604-3 Rad 1 6upto10GHz Horiz
10604-3 Rad 1 6upto10GHz Vert
10604-3 Rad 1 10upto12_5GHz Horiz
10604-3 Rad 1 10upto12_5GHz Vert
10604-3 Horiz 12.5 - 15 GHz
10604-3 Vert 12.5 - 15 GHz
10604-3 Horiz 15 - 18 GHz
10604-3 Vert 15 - 18 GHz
10604-3 Horiz 18 - 21 GHz
10604-3 Vert 18 - 21 GHz
10604-3 Horiz 21-25 GHz
10604-3 Vert 21-25 GHz

Peak detector "Max held" Analyser plots against the Average limit line 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.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

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 ± 3.5 dB, 18 – 25 GHz ± 3.9 dB

5.6 Effective radiated power field strength

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(d) [Reference 4.1.1 of this report]
 Test Method: ANSI C63.10 Clause 6.6 [Reference 4.1.2 of this report]
 Limits: None.

5.6.2 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 rotated in all three orthogonal planes to maximise emissions. Final measurements were taken at 3m. The EUT was operated in TX LOW BURST, TX MID BURST and TX HIGH BURST.

5.6.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment used' section. The power stated is Peak field strength. The EUT was rotated through 360° to capture maximum field strength. Tests were performed in test site M.

5.6.4 Test equipment

E136, E534, E535, TMS82

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 20°C
 Humidity of test environment 50%
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2475 MHz

	Low channel	Mid channel	High channel
Peak Level (dBµV/m) @ 3 metres	90.4	90.3	83.4
Plot reference	10604-3 FS LOW	10604-3 FS MID	10604-3 FS HIGH
Antenna Polarisation	Horiz	Horiz	Horiz
EUT Polarisation	Side	Side	Side

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

LIMITS:

Test performed to determine the maximum in band field strength in 100kHz RBW for calculating the 20dBc limit for use on non- restricted band emissions where required.

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

5.7 Band Edge Compliance

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.215 & 15.247(d) [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(a) & 15.247(d) [Reference 4.1.1 of this report]

5.7.2 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 operated in TX LOW CONT and TX MID CONT and TX HIGH CONT modes.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. The emission from the EUT was maximised before taking the plots. Due to the influence of high in-band signals when using the specified resolution bandwidth the Marker Delta method was employed for the restricted band edge tests.

Tests were performed using Test Site M.

5.7.4 Test equipment

E136, E534, E535, TMS82

See Section 9 for more details

5.7.5 Test results

Temperature of test environment 20°C
 Humidity of test environment 50%
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2475 MHz

Restricted Band Edge	Low channel	High channel
Peak Level (dBµV/m)	49.7	35.7
Peak Plot reference	10604-3 RBE LOW PEAK	10604-3 RBE HIGH PEAK
Average Level (dBµV/m)	39.2	24.8
Average Plot reference	10604-3 RBE LOW AVG	10604-3 RBE HIGH AVG

Authorised Band Edge	Low channel	High channel
Authorised Band Edge Plot reference	J10604-3 Authorised Band LOW	J10604-3 Authorised Band HIGH

Analyser plots for the Band Edge Compliance can be found in Section 6 of this report. These show the 20/30dBc requirement of 15.247(d) are met at the band edges of 2400 and 2483.5 MHz. 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

The restricted band edges closest to the EUT frequency of 2400-2483.5MHz are 2390 & 2483.5MHz.

Further wider span plots have been taken to 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:
<± 3.9 dB

5.8 Occupied bandwidth

5.8.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(2) / 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 15.247(a)(2) [Reference 4.1.1 of this report]

5.8.2 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 operated in TX LOW CONT and TX MID CONT and TX HIGH CONT modes.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 100kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 6dB bandwidth.

Tests were performed using Test Site M.

5.8.4 Test equipment

E136, E534, E535, TMS82

See Section 9 for more details

5.8.5 Test results

Temperature of test environment 20°C
 Humidity of test environment 50%
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2475 MHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz)	1.599	1.599	1.596
Plot for 6 dB Bandwidth (MHz)	10604-3 OBW LOW	10604-3 OBW MID	10604-3 OBW HIGH

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

LIMITS:

15.247(a)(2) The minimum 6dB bandwidth shall be at least 500kHz.

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 Maximum Average conducted output power

Not required. Peak Conducted power has been measured instead.

5.10 Maximum Peak conducted output power

5.10.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(3) [Reference 4.1.1 of this report]
 Test Method: ANSI C63.10 Clause [Reference 4.1.2 of this report]
 Limits: 47 CFR Part 15C Part 15.247(a)(3) [Reference 4.1.1 of this report]

5.10.2 Configuration of EUT

The EUT was powered by its internal battery. Measurements were made at the temporary RF port.

The EUT was set to each mode and test signal in turn (see section 2.4) and highest power levels recorded.

The EUT was operated in TX LOW CONT and TX MID CONT and TX HIGH CONT modes for this test.

5.10.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
 Peak stated reading is maximum power observed using a spectrum analyser RBW > 6dB BW of the EUT.
 Measurements were made in a test bench in site K.

5.10.4 Test equipment

E533, E534

See Section 9 for more details

5.10.5 Test results

Temperature of test environment 20°C
 Humidity of test environment 40%
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2475 MHz

Test conditions	Peak Power (dBm)	Peak Power (dBm)	Peak Power (dBm)
	Low channel	Mid channel	High channel
Maximum Peak conducted power (dBm)	2.8	3.9	3.4

Maximum Peak conducted power (mW)	1.91	2.46	2.19
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LIMITS:

15.247(a)(2)

For systems using digital modulation in the 902-928, 2400-2483.5 or 5725-5850 MHz bands 1 Watt.

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:
 <± 1.0 dB

5.11 Maximum Power Spectral Density

5.11.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(e) [Reference 4.1.1 of this report]
 Test Method: ANSI C63.10 Clause 10.10 [Reference 4.1.2 of this report]
 Limits: 47 CFR Part 15C Part 15.247(e) [Reference 4.1.1 of this report]

5.11.2 Configuration of EUT

The EUT was configured as for the conducted power test. The EUT was operated in TX LOW CONT and TX MID CONT and TX HIGH CONT modes for this test.

5.11.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. PEP was recorded in the required span and bandwidth. Measurements & plots were taken with the span set to 1.5 times the measured DTS bandwidth. Tests were performed on a test bench in Test Site K.

5.11.4 Test equipment

E534, E535

See Section 9 for more details

5.11.5 Test results

Temperature of test environment 20°C
 Humidity of test environment 50%
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	3 dBm
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2475 MHz

	Low channel	Mid channel	High channel
Duty Cycle (%)	100	100	100
Maximum PSD (dBm per 3 kHz)	-3.1	-2.0	-2.4
Plot reference	10604-3 Power Spectral Density Low Channel	10604-3 Power Spectral Density Mid Channel	10604-3 Power Spectral Density High Channel

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

LIMITS:

15.247(e) +8dBm/3kHz.

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 dB

5.12 Antenna power conducted emissions

NOT APPLICABLE: Applies to EUT's with an antenna port. The EUT has an integral antenna only.

5.13 Duty cycle

NOT APPLICABLE: No limits apply

5.14 FHSS carrier frequency separation

NOT APPLICABLE: EUT does not employ FHSS technology

5.15 Average time of occupancy

NOT APPLICABLE: EUT does not employ FHSS technology

5.16 Number of Hop Channels

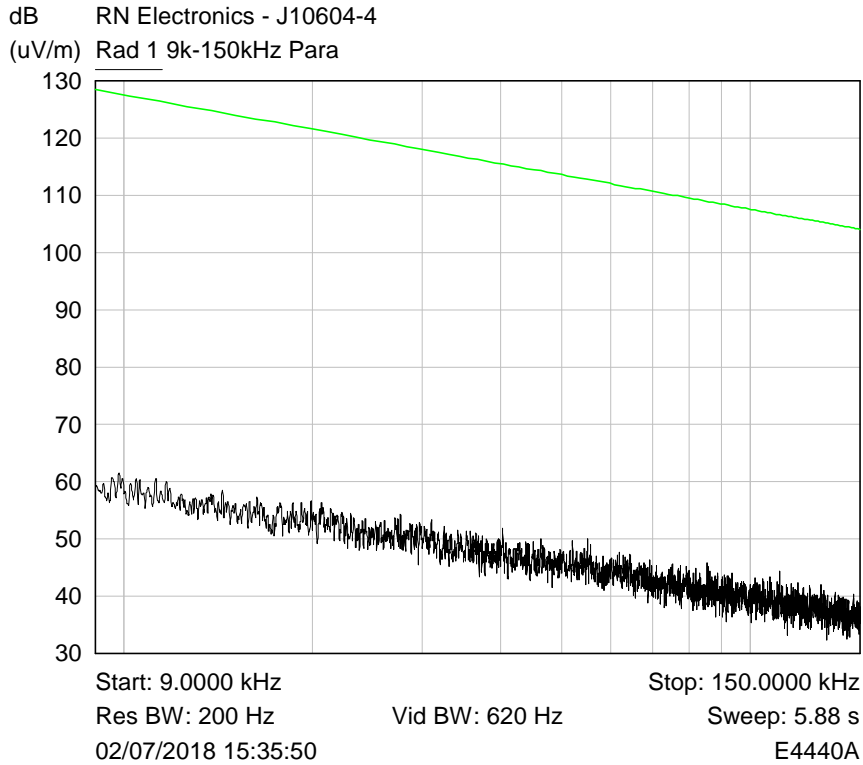
NOT APPLICABLE: EUT does not employ FHSS technology

6 Plots/Graphical results

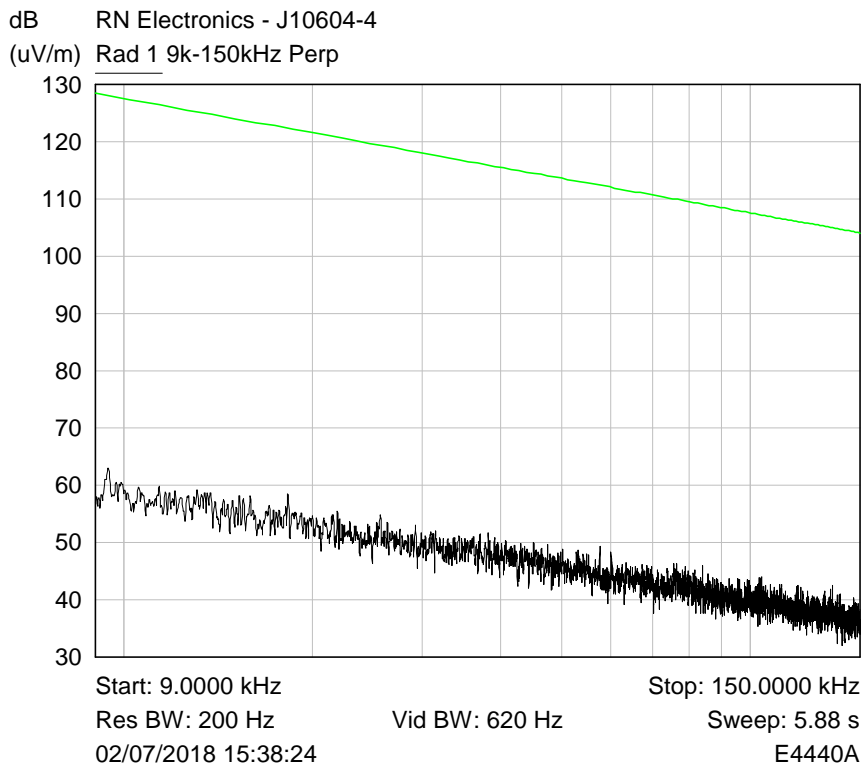
6.1 Radiated emissions 9 - 150 kHz

Note: Whilst Low, Middle and High channels have been tested, to minimise report size, only middle channel plots are shown. Plots are PK detector max held against Quasi-Peak / Average limit line.

RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



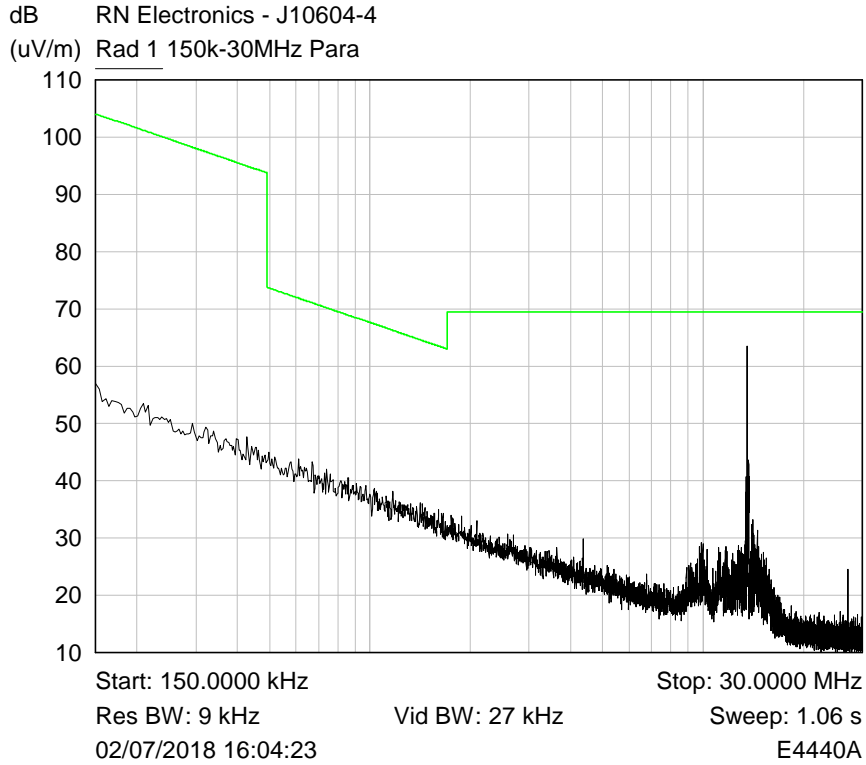
Plot of 9k-150kHz Parallel



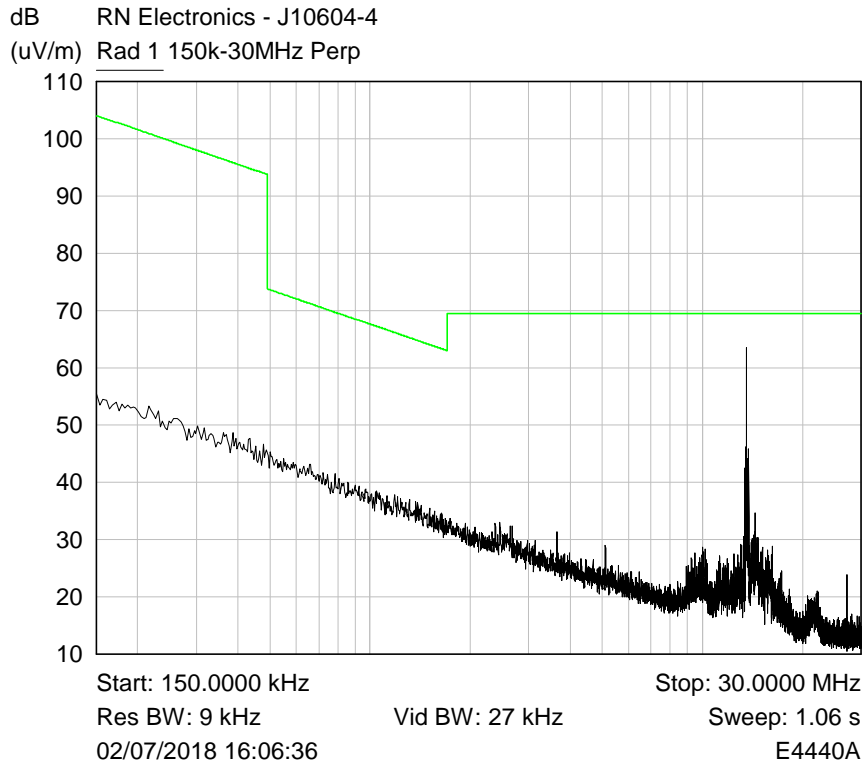
Plot of 9k-150kHz Perpendicular

6.2 Radiated emissions 150 kHz - 30 MHz

Note: Whilst Low, Middle and High channels have been tested, to minimise report size, only middle channel plots are shown. Plots are PK detector max held against Quasi-Peak / Average limit line.



Plot of 150kHz-30MHz Parallel – (shows the fundamental carrier of the 13.56 MHz NFC reader)

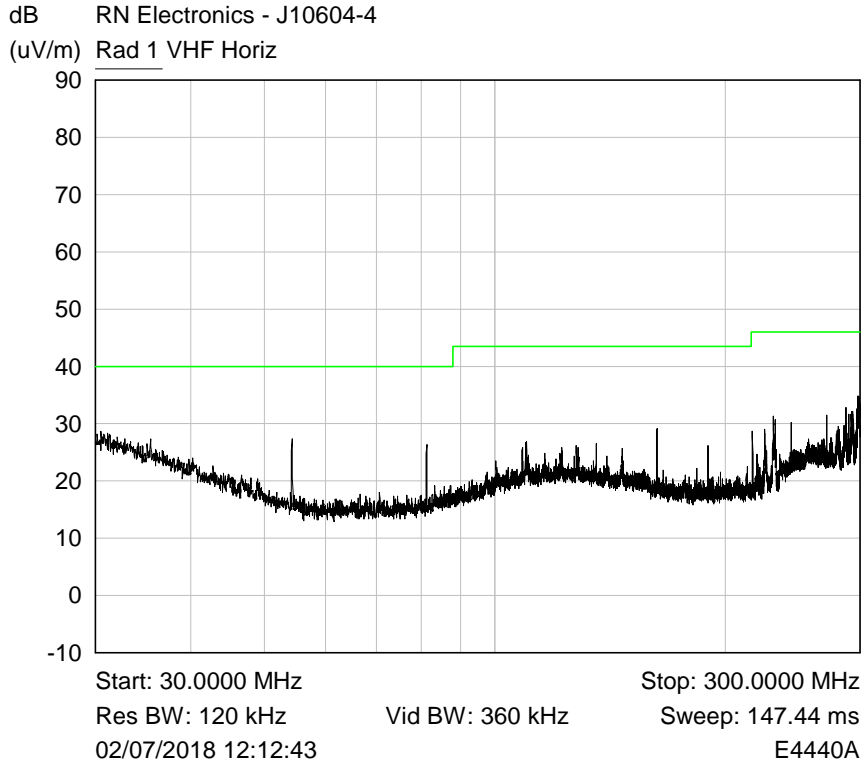


Plot of 150kHz-30MHz Perpendicular - (shows the fundamental carrier of the 13.56 MHz NFC reader)

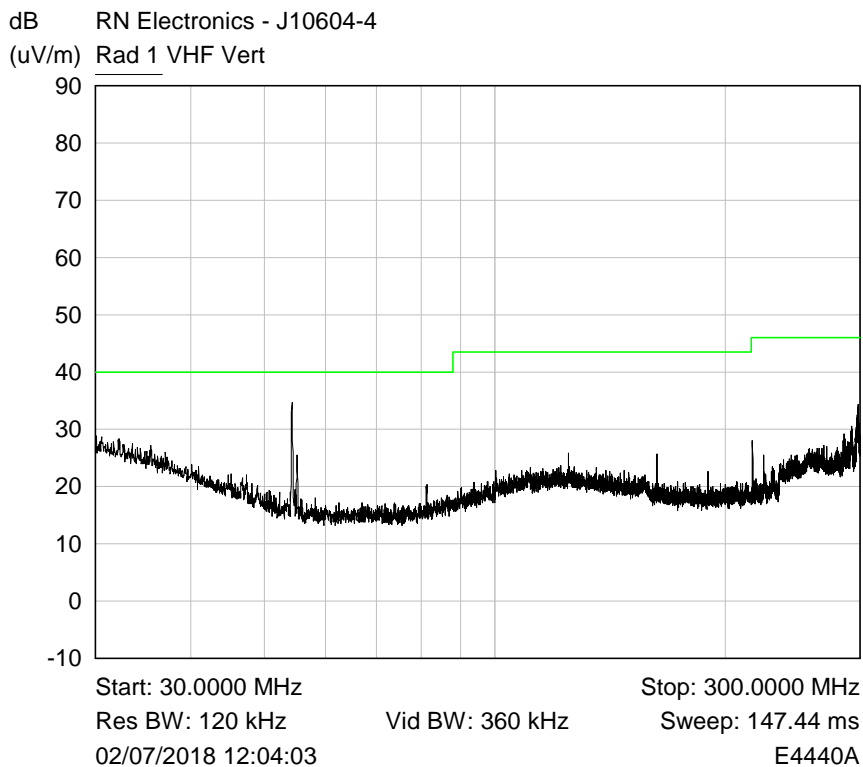
6.3 Radiated emissions 30 MHz -1 GHz

Note: Whilst Low, Middle and High channels have been tested, to minimise report size, only middle channel plots are shown. Plots are PK detector max held against QP limit line.

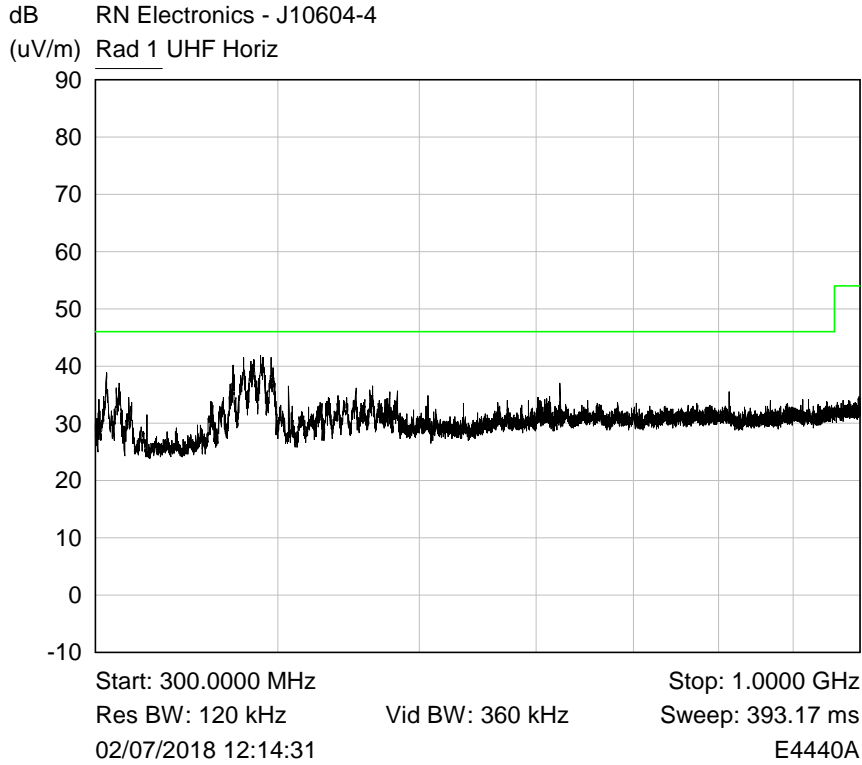
RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



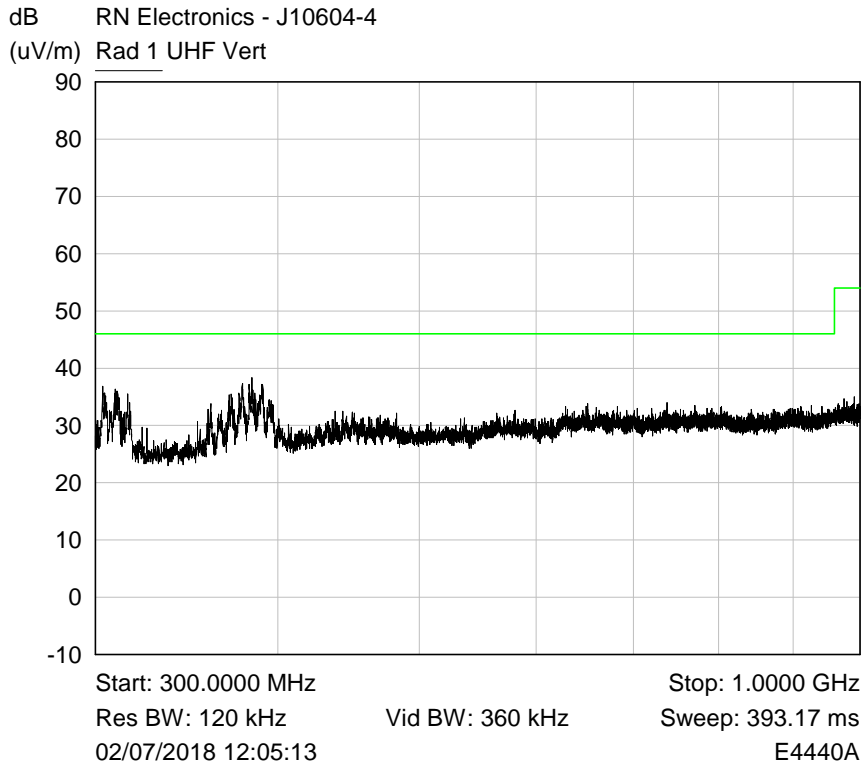
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



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

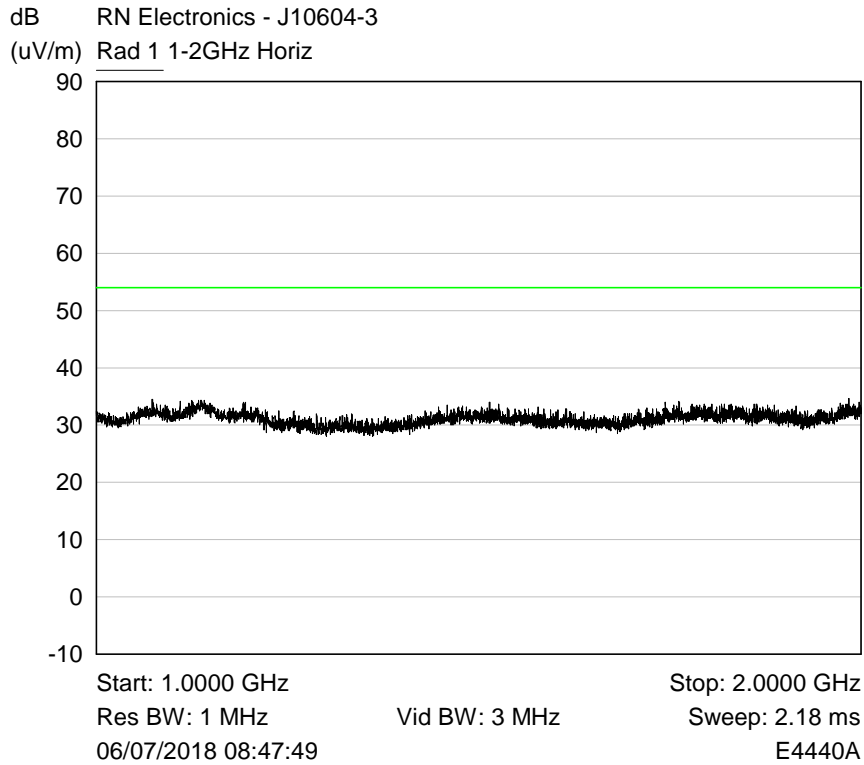


Plot of Peak emissions for UHF Vertical against the QP limit line.

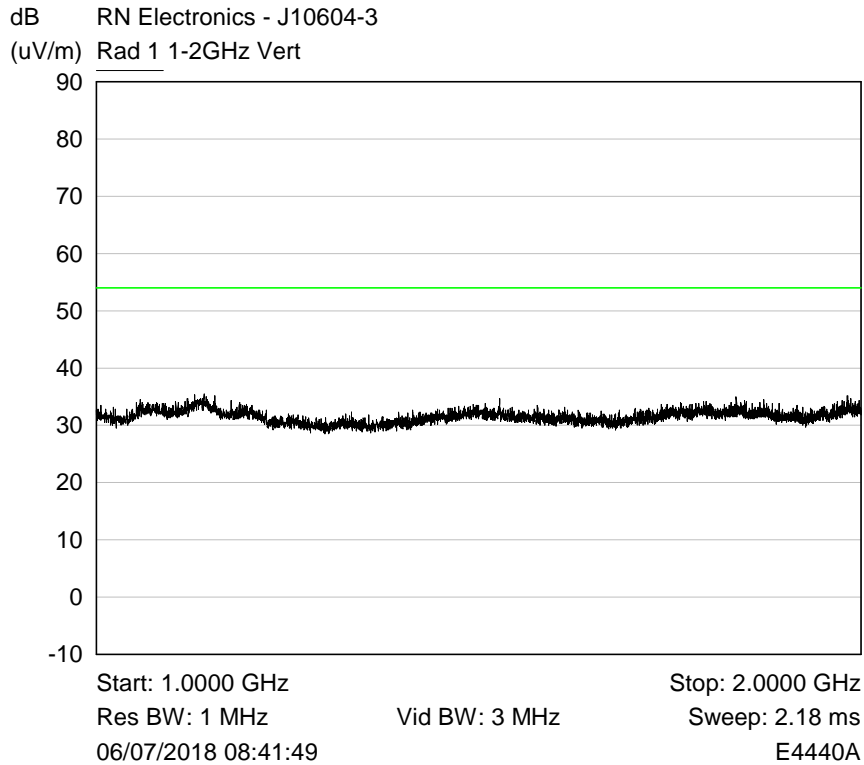
6.4 Radiated emissions above 1 GHz

Note: Whilst Low, Middle and High channels have been tested, to minimise report size, only middle channel plots are shown. Plots are PK detector max held against Average limit line.

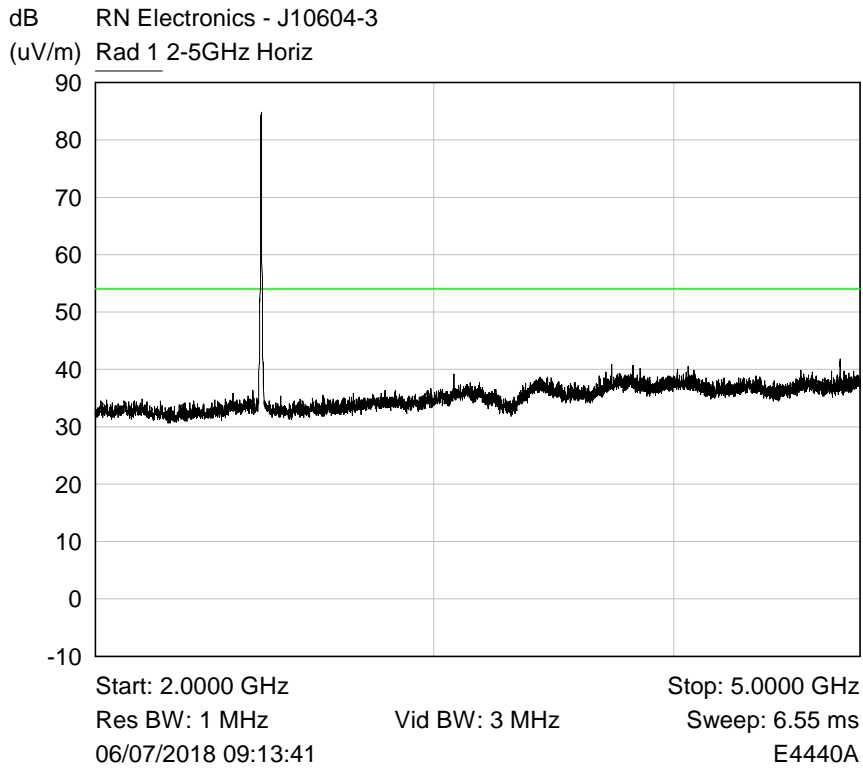
RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



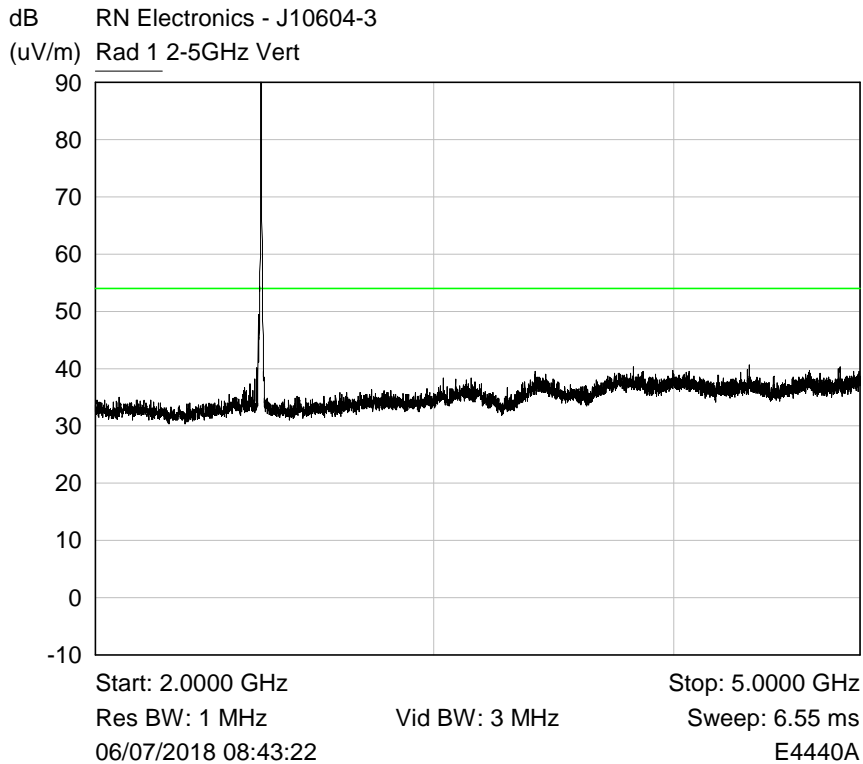
Plot of Horizontal 1 – 2 GHz emissions



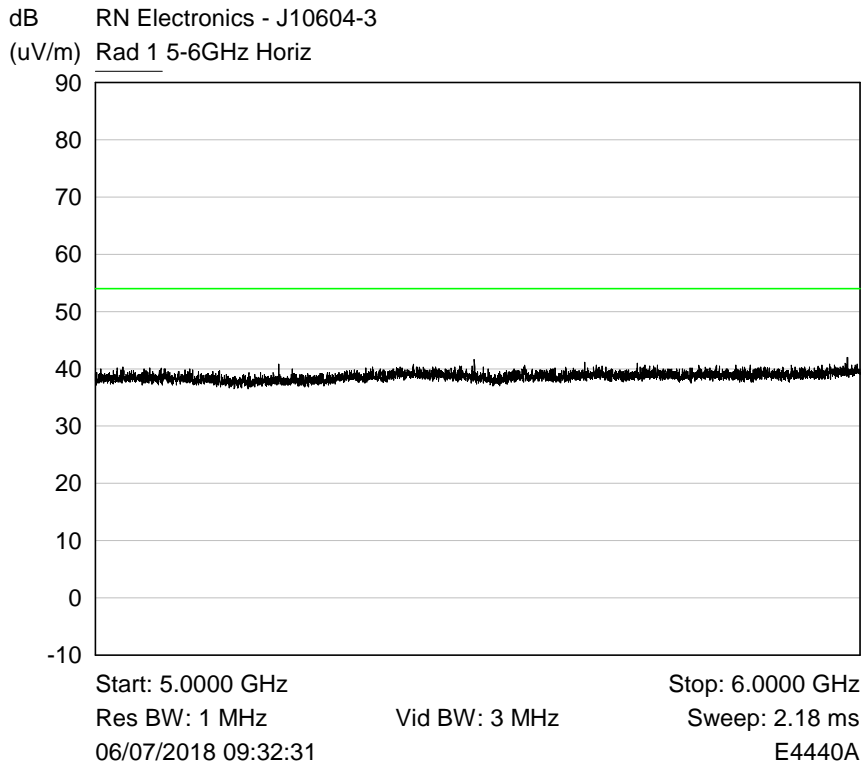
Plot of Vertical 1 – 2 GHz emissions



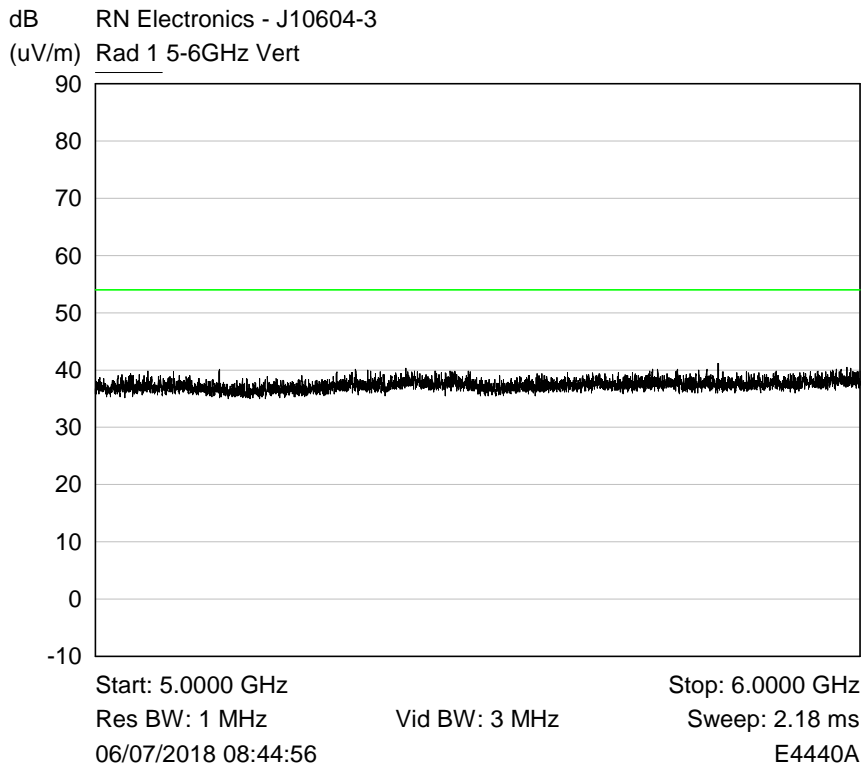
Plot of Horizontal 2 – 5 GHz emissions. Note: The emissions that exceeds the limit line is the EUT’s fundamental carrier at 2440 MHz.



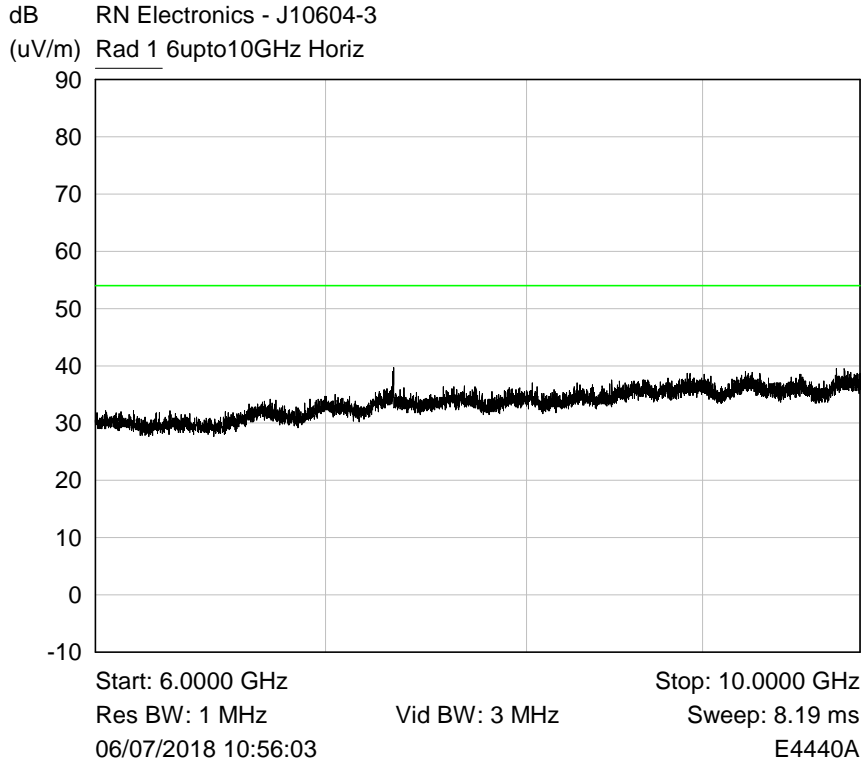
Plot of Vertical 2 – 5 GHz emissions. Note: The emissions that exceeds the limit line is the EUT’s fundamental carrier at 2440 MHz.



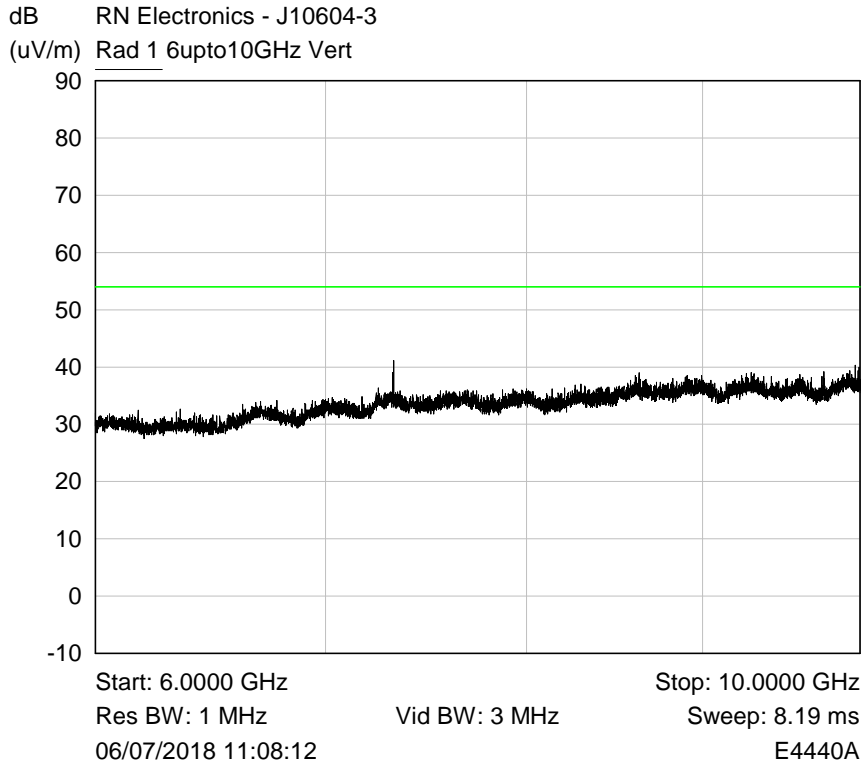
Plot of Horizontal 5 – 6 GHz emissions.



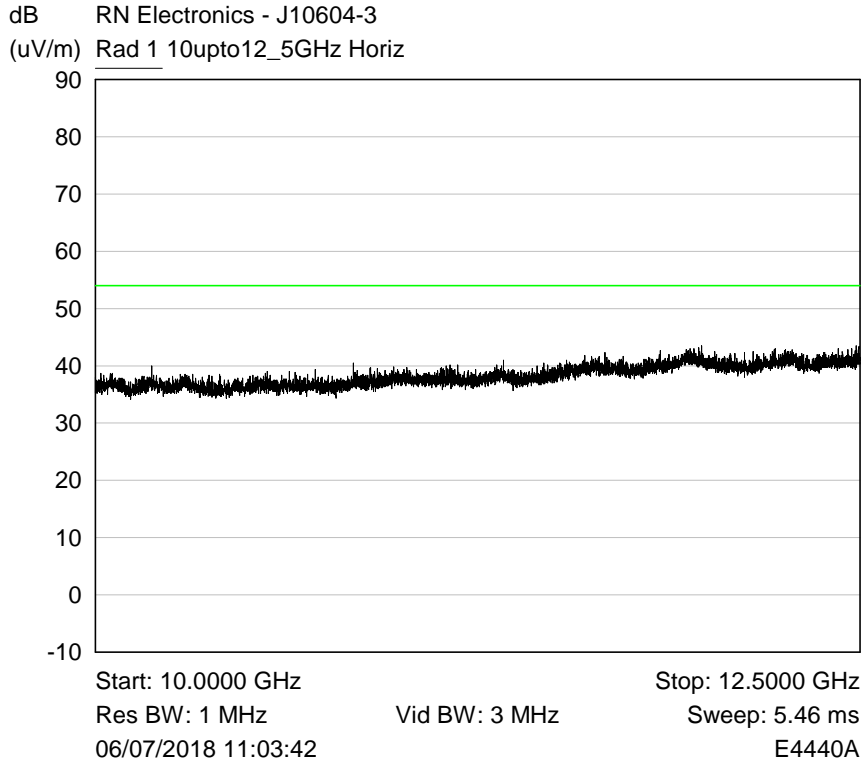
Plot of Vertical 5 – 6 GHz emissions.



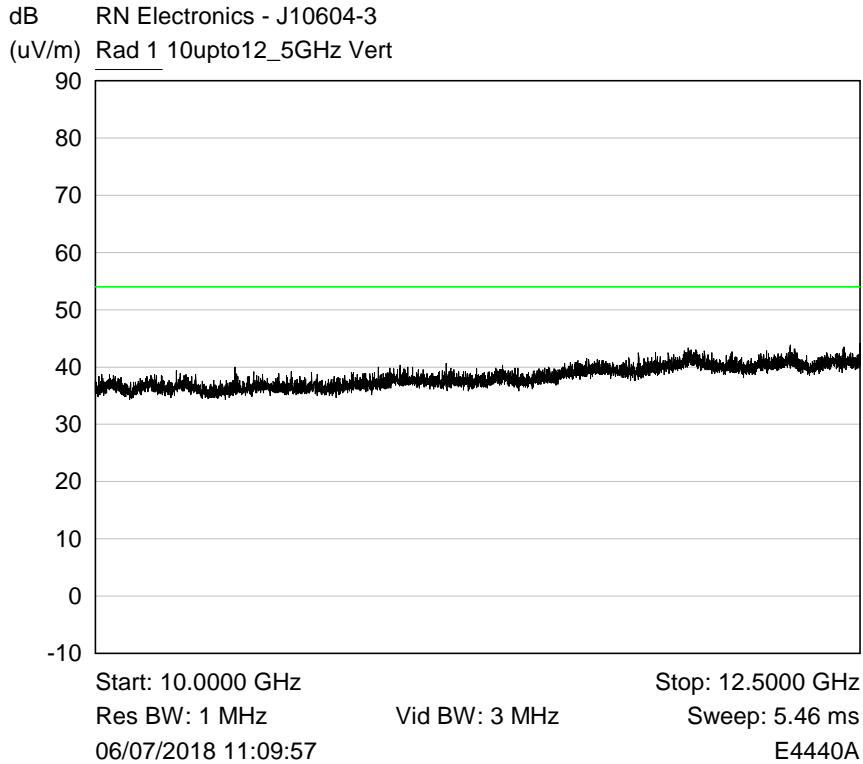
Plot of Horizontal 6 – 10 GHz emissions.



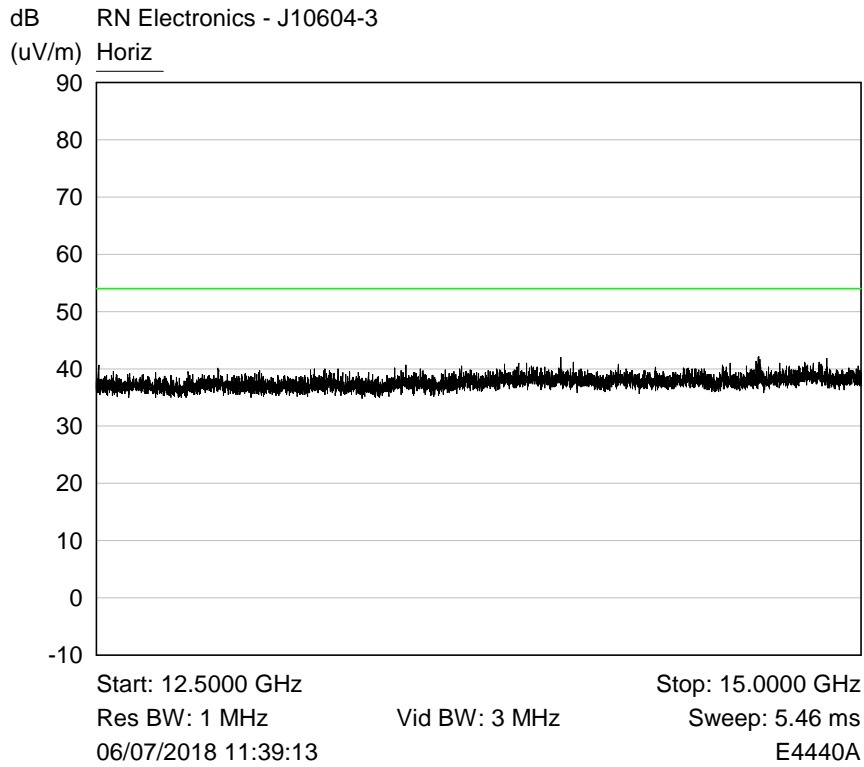
Plot of Vertical 6 – 10 GHz emissions.



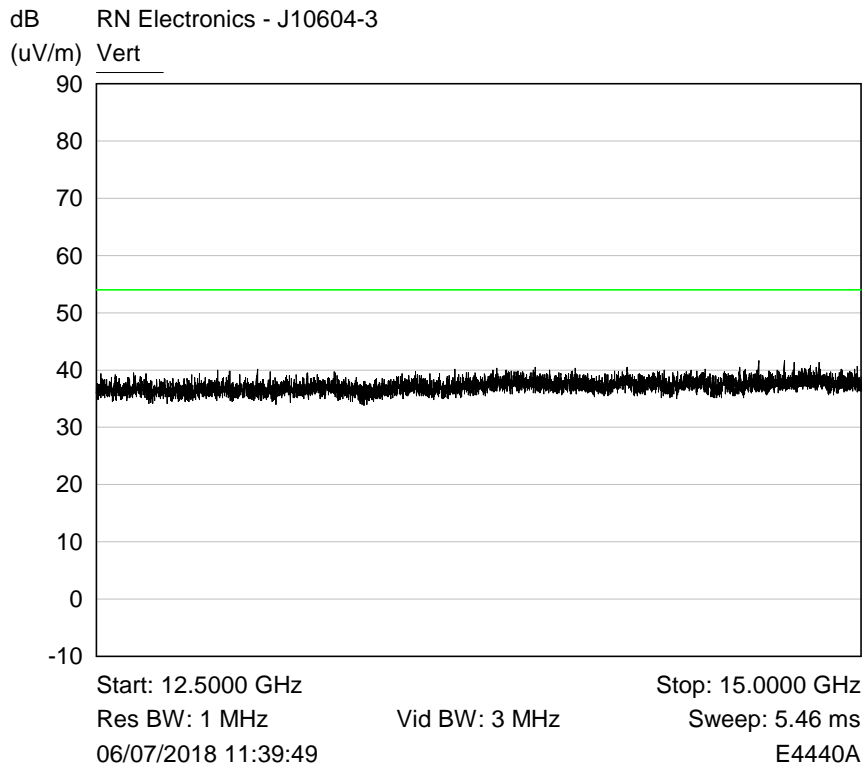
Plot of Horizontal 10 – 12.5 GHz emissions.



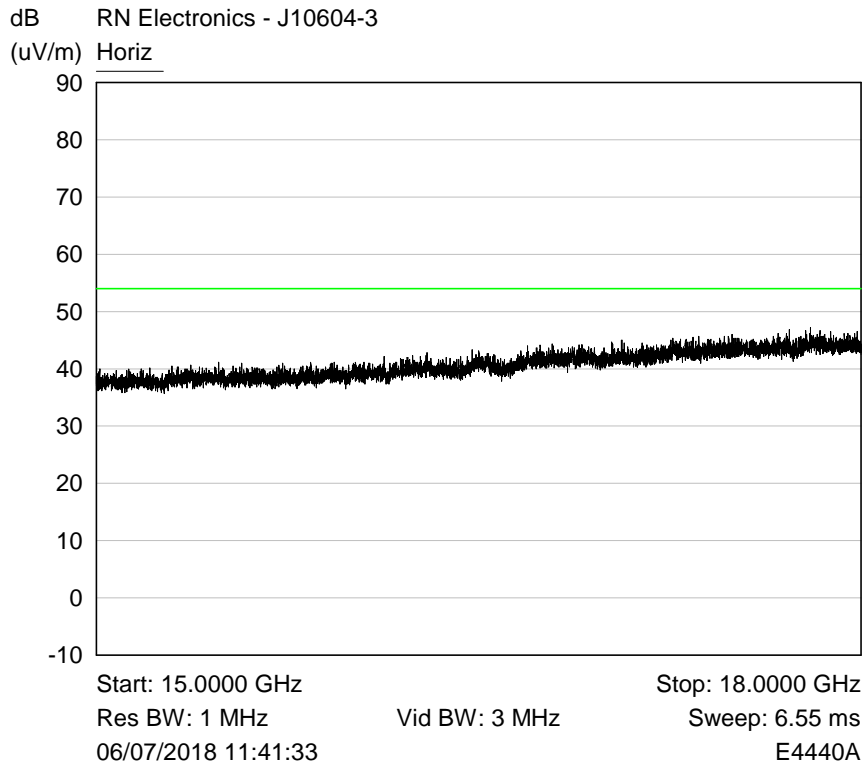
Plot of Vertical 10 – 12.5 GHz emissions.



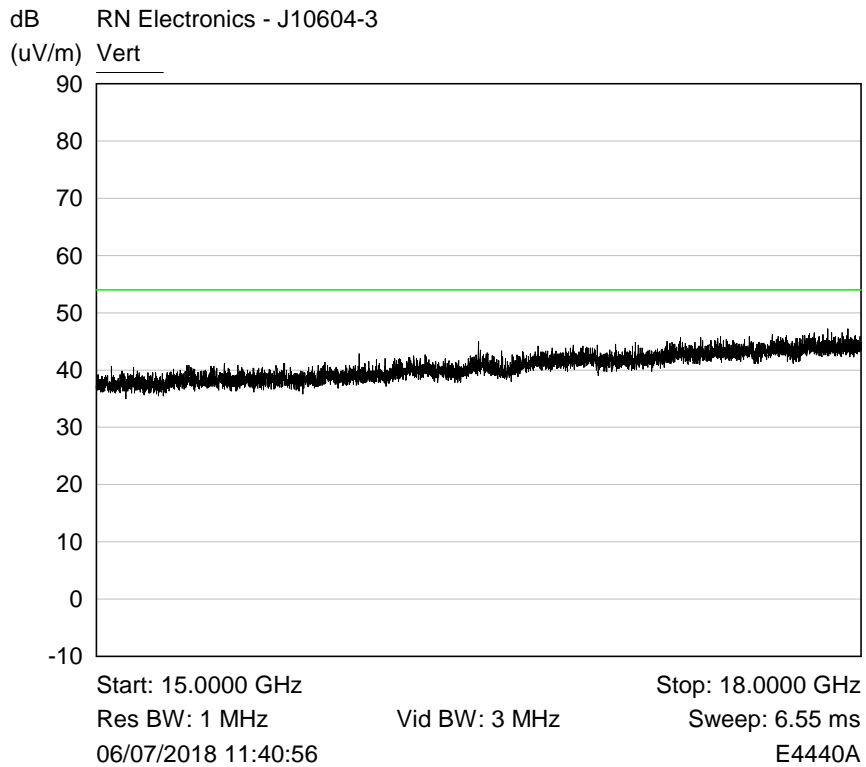
Plot of Horizontal 12.5 – 15 GHz emissions.



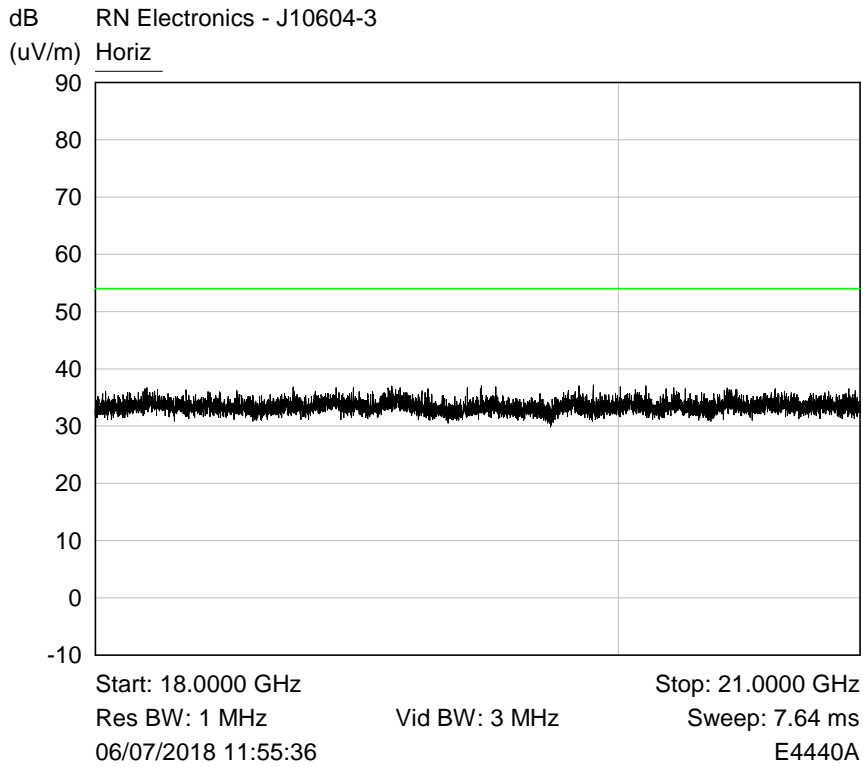
Plot of Vertical 12.5 – 15 GHz emissions.



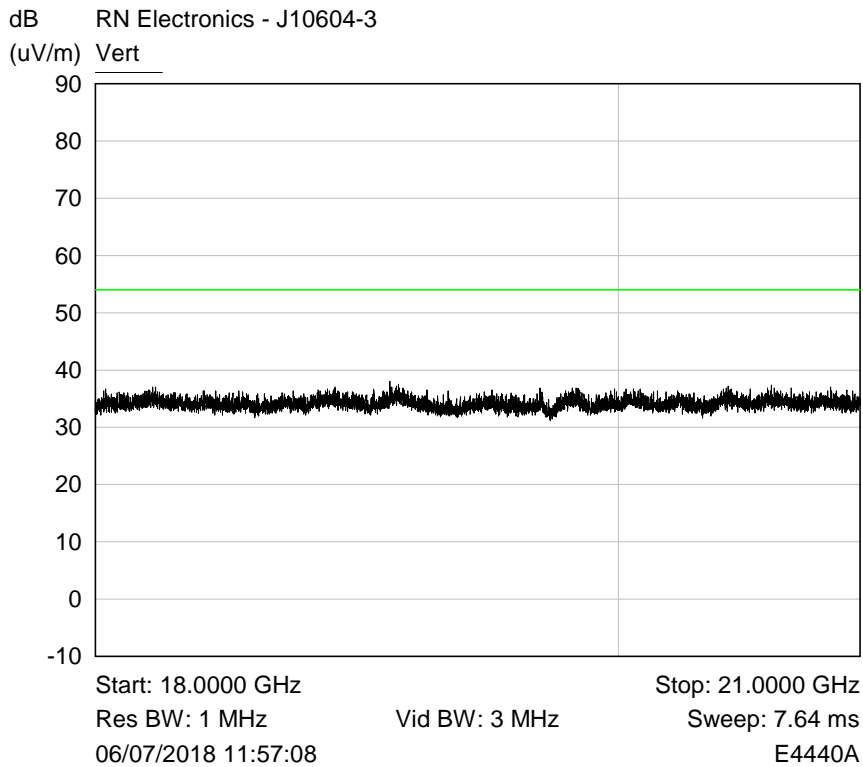
Plot of Horizontal 15 – 18 GHz emissions.



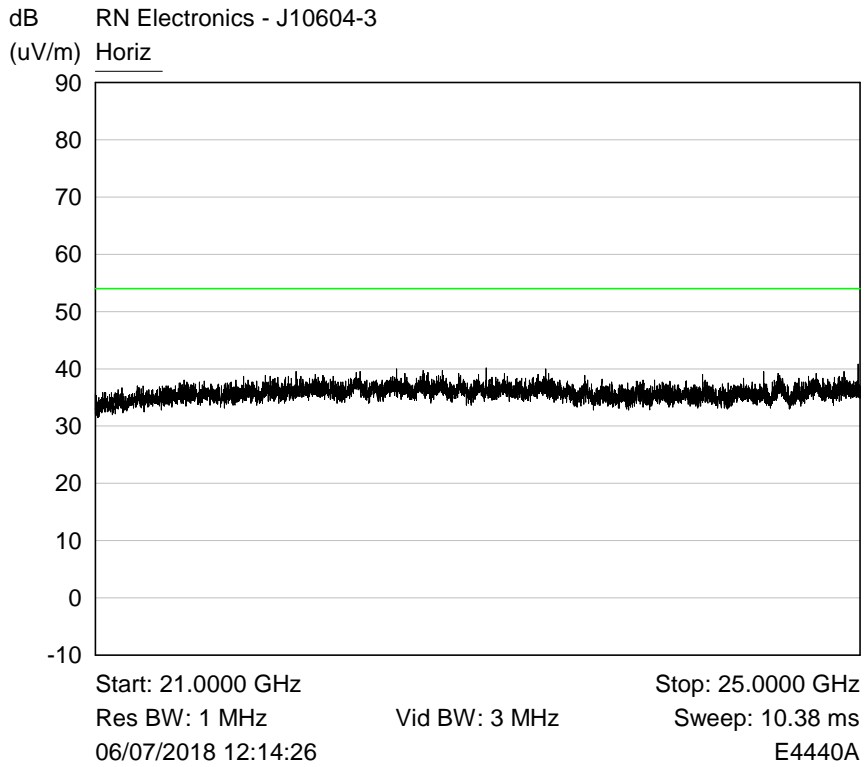
Plot of Vertical 15 – 18 GHz emissions.



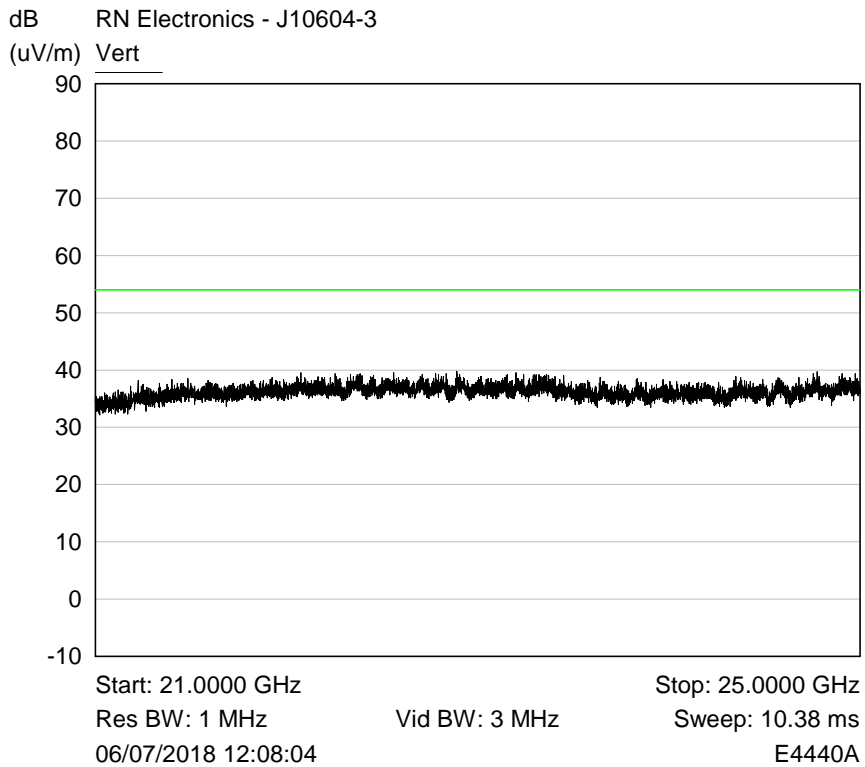
Plot of Horizontal 18 – 21 GHz emissions.



Plot of Vertical 18 – 21 GHz emissions.



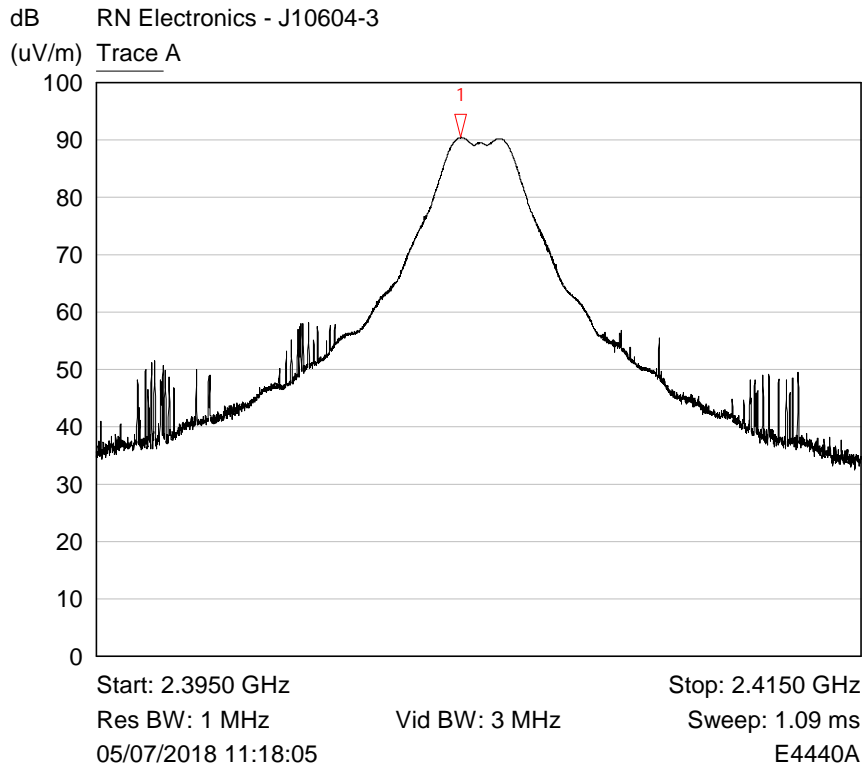
Plot of Horizontal 21 – 25 GHz emissions.



Plot of Vertical 21 – 25 GHz emissions.

6.5 Effective radiated power field strength

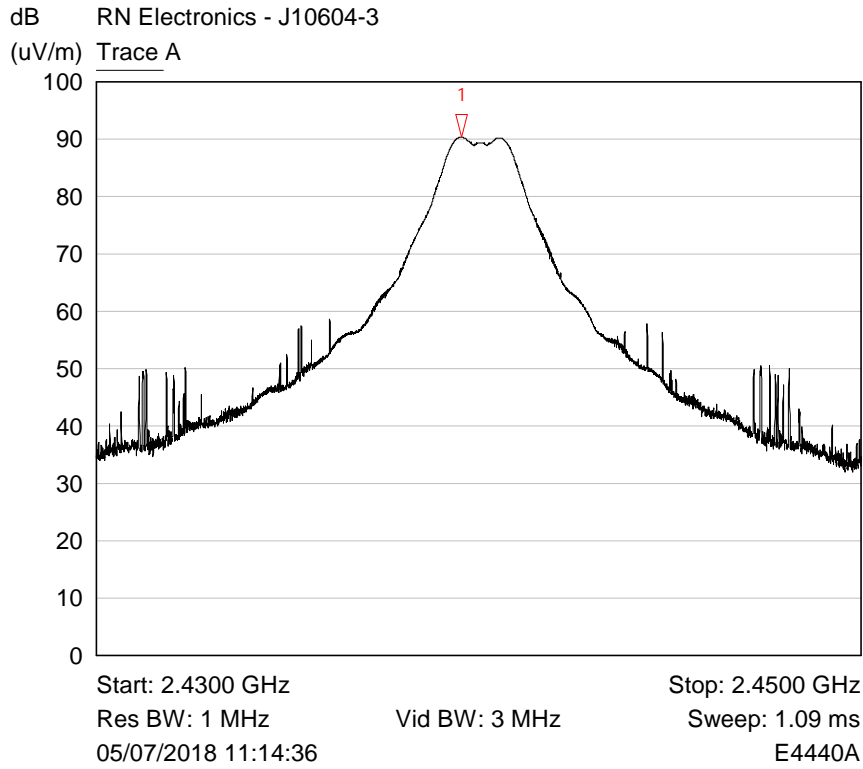
RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4045 GHz	90.42 dB(uV/m)	

Plot of Horiz polarisation and EUT in Side position

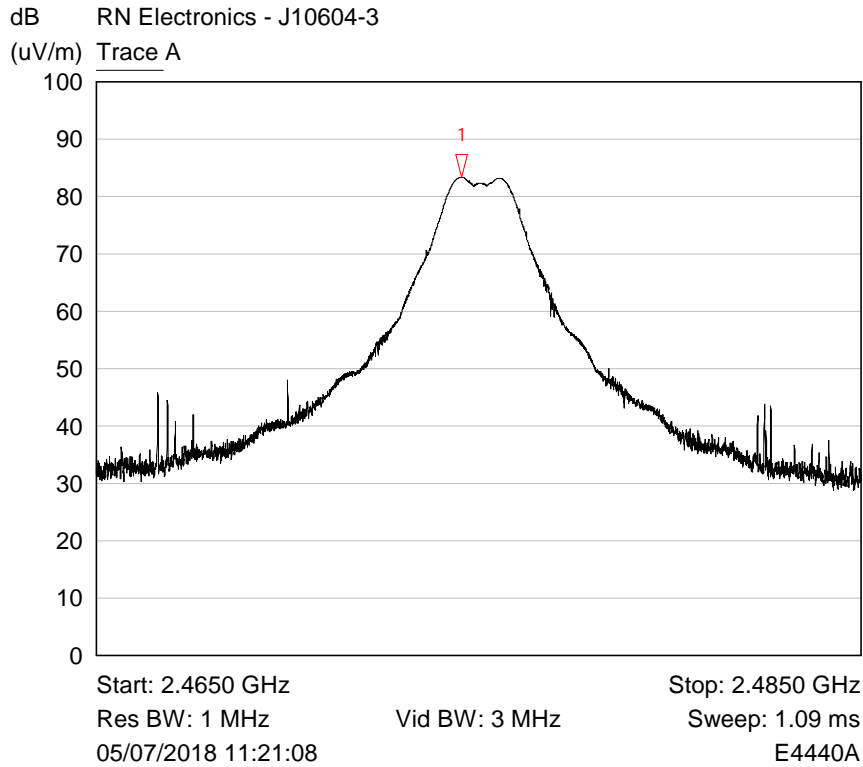
RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4395 GHz	90.36 dB(uV/m)	

Plot of Horiz polarisation and EUT in Side position

RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2475 MHz

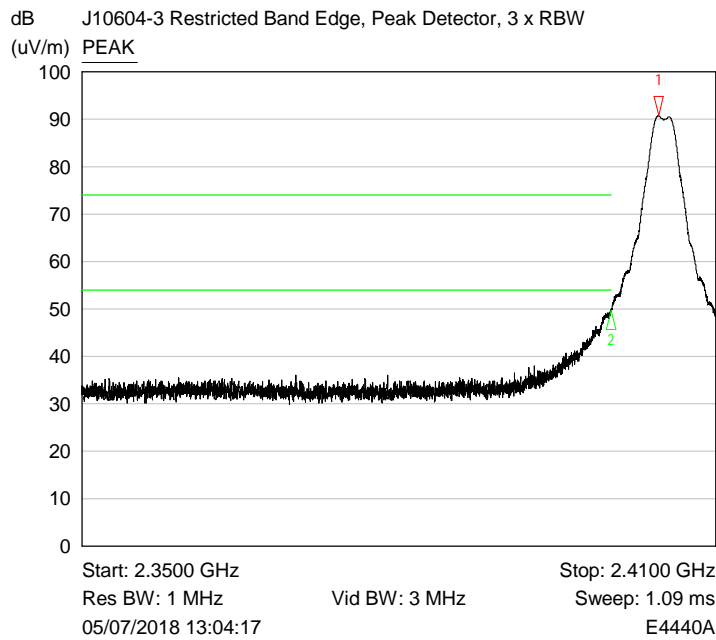


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4745 GHz	83.36 dB(uV/m)	

Plot of Horiz polarisation and EUT in Side position

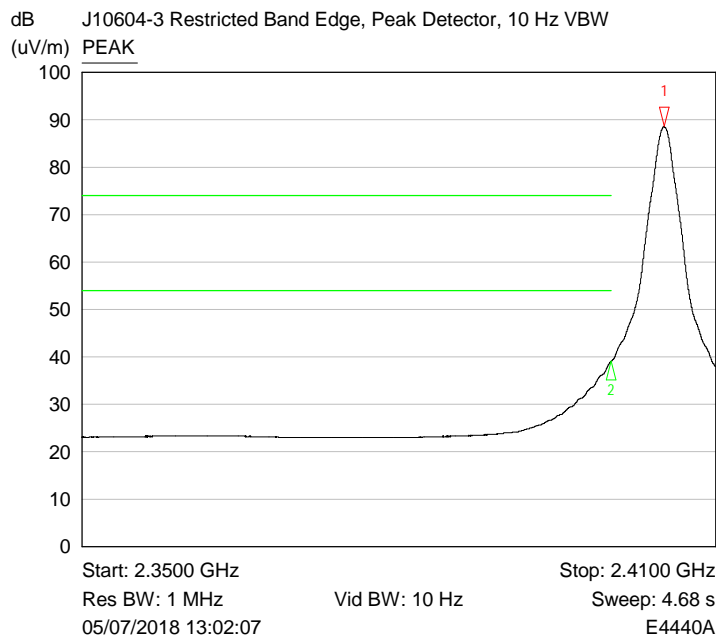
6.6 Band Edge Compliance

RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz



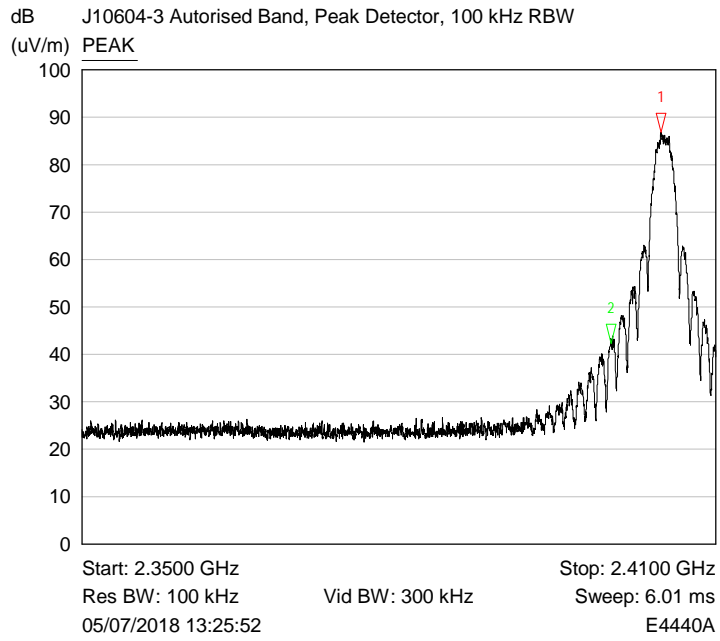
Mkr	Trace	X-Axis	Value	Notes
1 ▽	PEAK	2.4045 GHz	90.77 dB(uV/m)	
2 ▽	PEAK	2.4000 GHz	49.72 dB(uV/m)	

Restricted band edge Peak Plot (Low channel)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	PEAK	2.4050 GHz	88.59 dB(uV/m)	
2 ▽	PEAK	2.4000 GHz	39.16 dB(uV/m)	

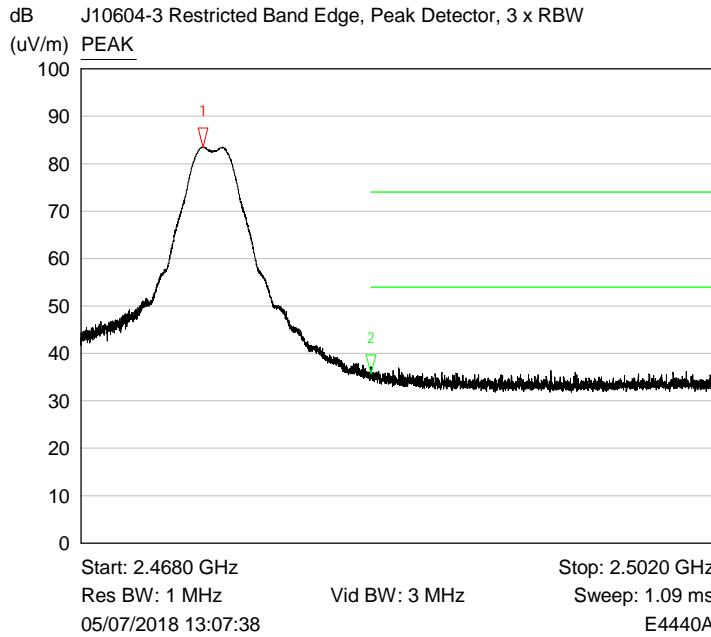
Restricted band edge Average Plot (Low channel)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	PEAK	2.4047 GHz	86.75 dB(uV/m)	
2 ▽	PEAK	2.4000 GHz	42.34 dB(uV/m)	

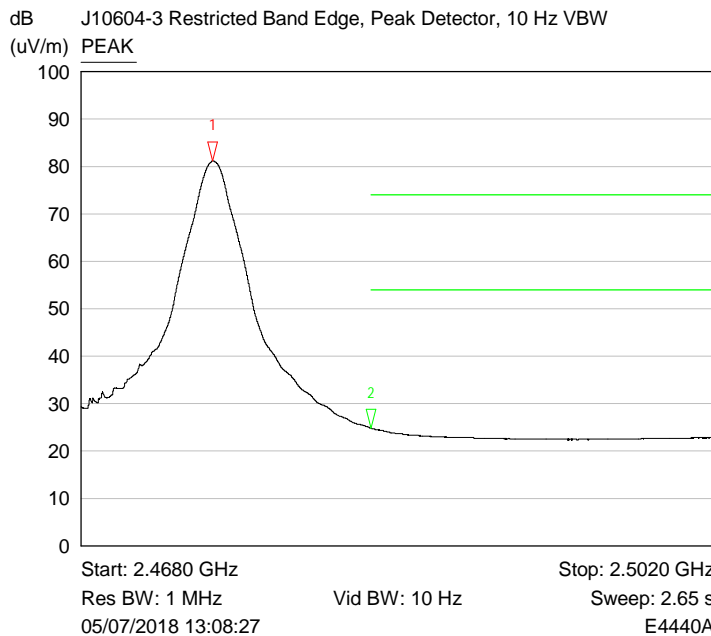
Authorised Band Edge Plot (Low channel)

RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2475 MHz



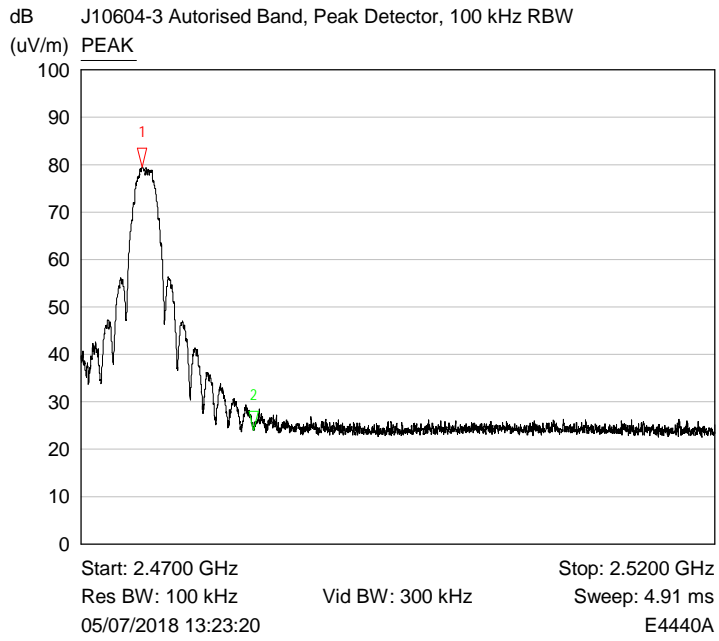
Mkr	Trace	X-Axis	Value	Notes
1 ▾	PEAK	2.4745 GHz	83.55 dB(uV/m)	
2 ▾	PEAK	2.4835 GHz	35.67 dB(uV/m)	

Restricted band edge Peak Plot (High channel)



Mkr	Trace	X-Axis	Value	Notes
1 ▾	PEAK	2.4750 GHz	81.09 dB(uV/m)	
2 ▾	PEAK	2.4835 GHz	24.80 dB(uV/m)	

Restricted band edge Average Plot (High channel)

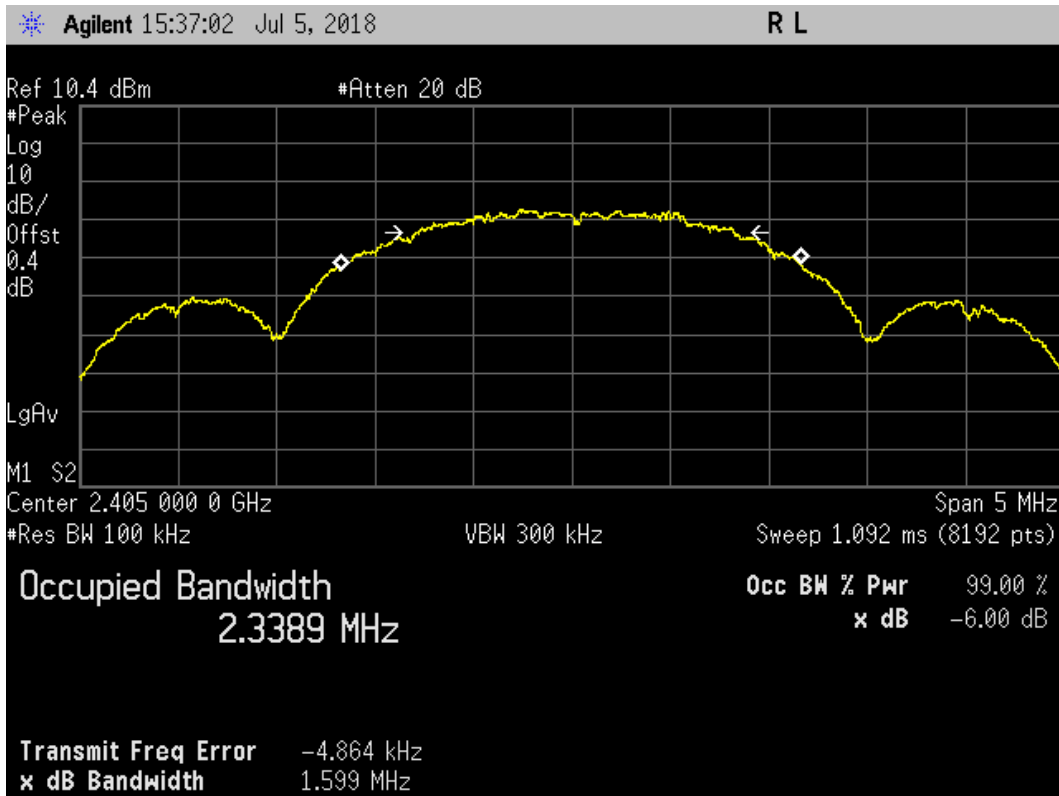


Mkr	Trace	X-Axis	Value	Notes
1 ▾	PEAK	2.4748 GHz	79.50 dB(uV/m)	
2 ▾	PEAK	2.4835 GHz	23.93 dB(uV/m)	

Authorised Band Edge Plot (High channel)

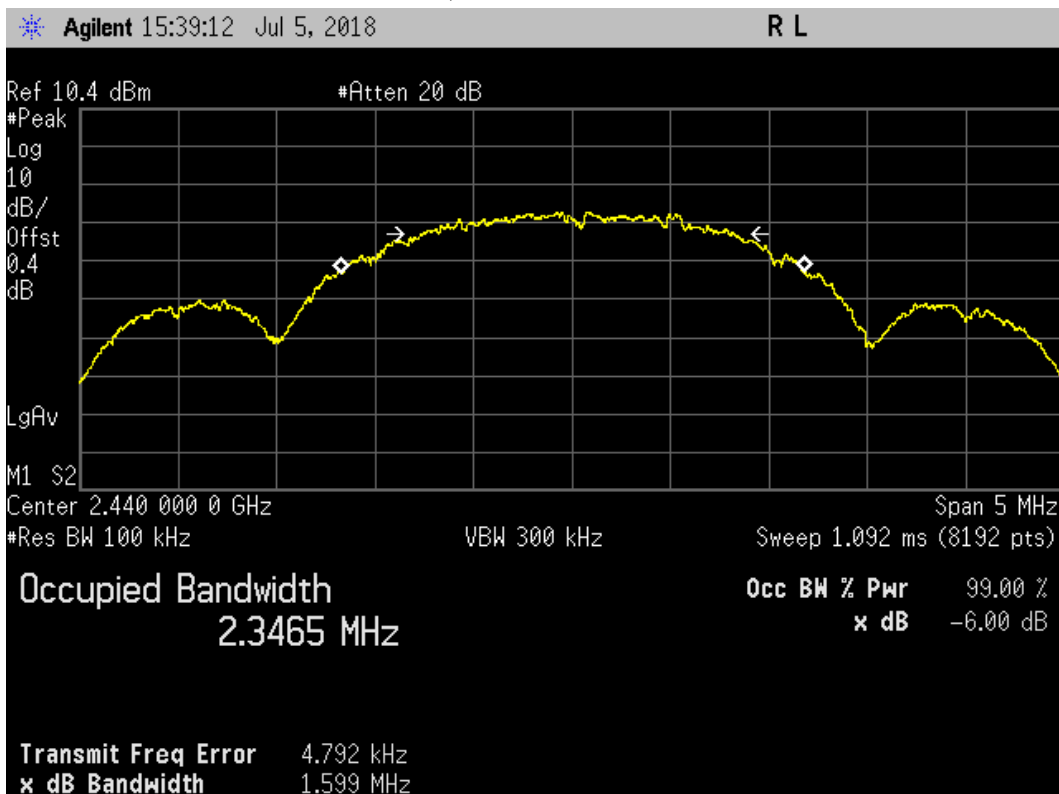
6.7 Occupied bandwidth

RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz



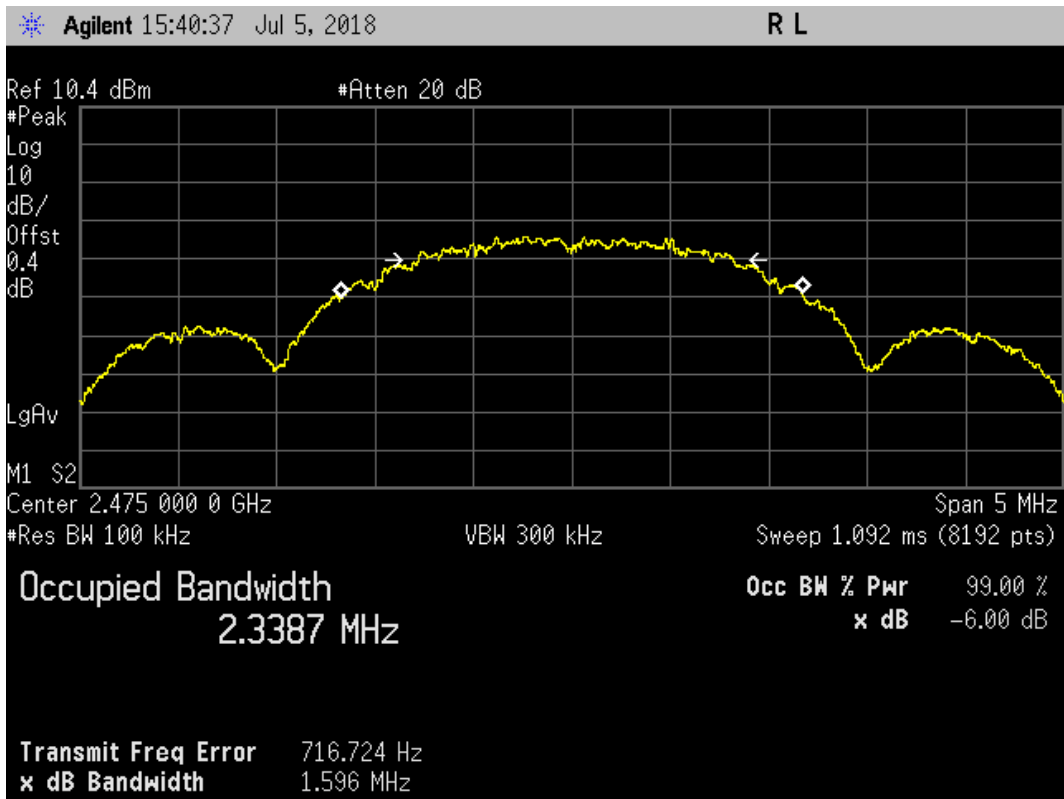
Plot for 6 dB Bandwidth (Low channel)

RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



Plot for 6 dB Bandwidth (Mid channel)

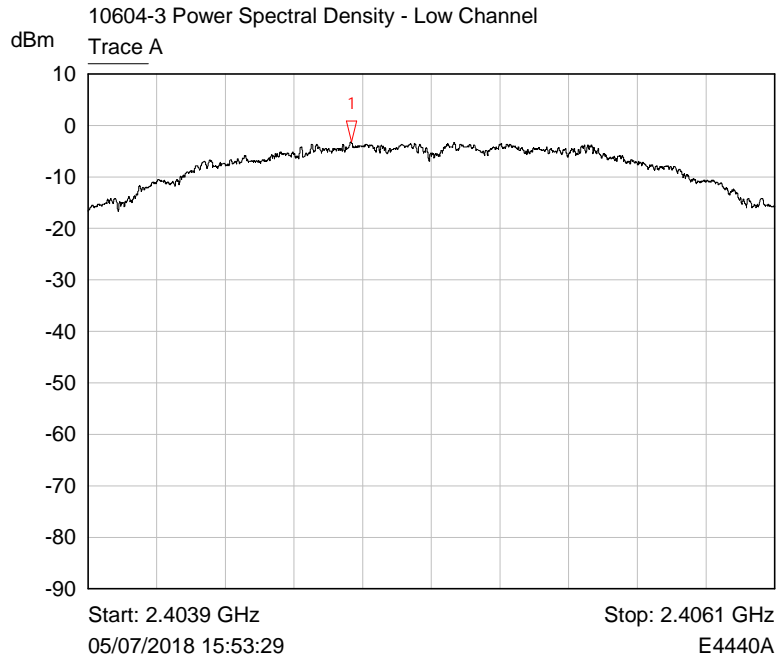
RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2475 MHz



Plot for 6 dB Bandwidth (High channel)

6.8 Maximum Power Spectral Density

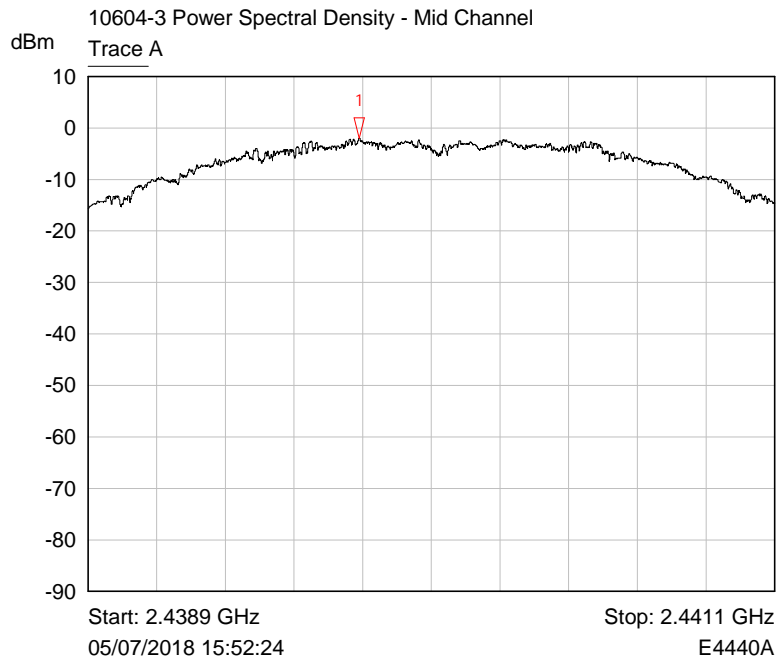
RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4047 GHz	-3.14 dBm	

Power Spectral Density (Low channel)

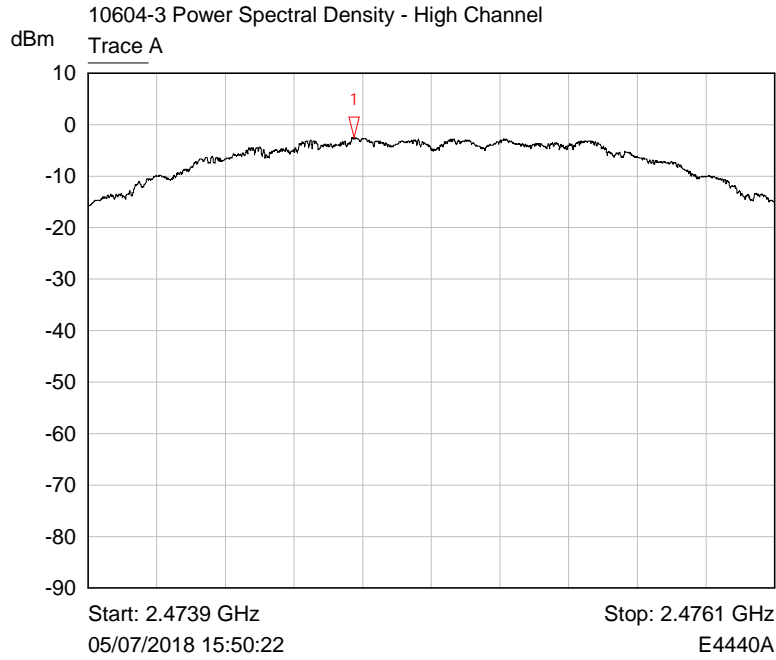
RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4398 GHz	-2.01 dBm	

Power Spectral Density (Mid channel)

RF Parameters: Band 2400-2483.5 MHz, Power 3 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2475 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4747 GHz	-2.44 dBm	

Power Spectral Density (High channel)

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 (dB μ V)	Pk - Lim 1 (dB)	QP Amp (dB μ V)	QP - Lim1 (dB)	Av Amp (dB μ V)	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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 $\mu\text{V}/\text{m}$ at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in $\text{dB}\mu\text{V}/\text{m}$ 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 $500 \mu\text{V}/\text{m}$ equates to $20.\log(500) = 54 \text{ dB } \mu\text{V}/\text{m}$.

(b) limit of $300 \mu\text{V}/\text{m}$ at 10m equates to $20.\log(300 \cdot 10/3) = 60 \text{ dB } \mu\text{V}/\text{m}$ at 3m

(c) limit of $30 \mu\text{V}/\text{m}$ at 30m, but below 30MHz, equates to $20.\log(30) + 40.\log(30/3) = 69.5 \text{ dB}\mu\text{V}/\text{m}$ 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: - $\text{FS} = \text{RA} + \text{AF} + \text{CL}$.

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

8 Photographs

Photographs not included in test report due to long term confidentiality request in conjunction with FCC certification of device.

8.1 Radiated emission diagrams

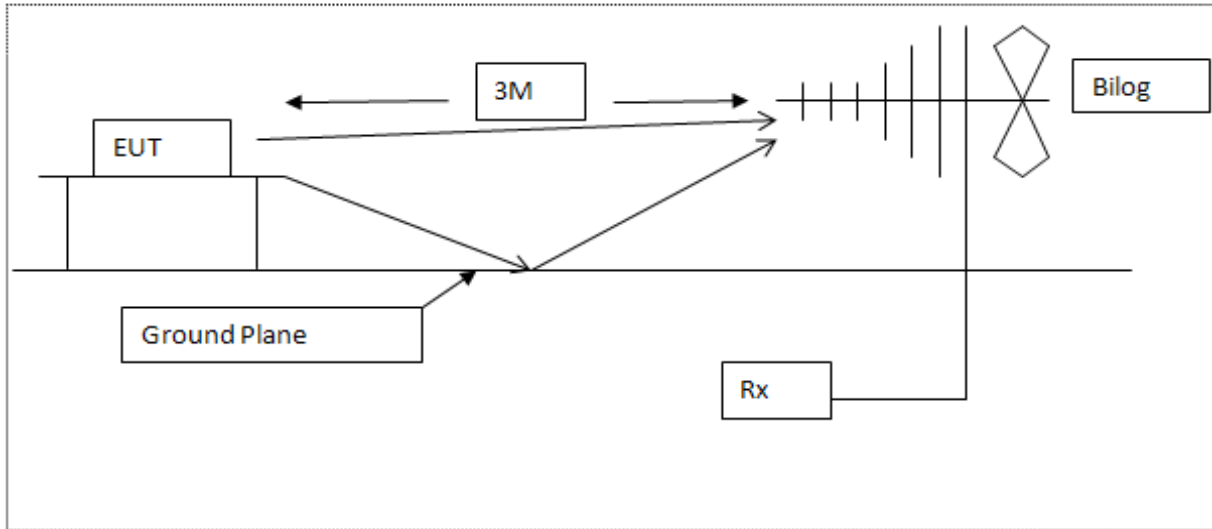


Diagram of the radiated emissions test setup 30 - 1000 MHz

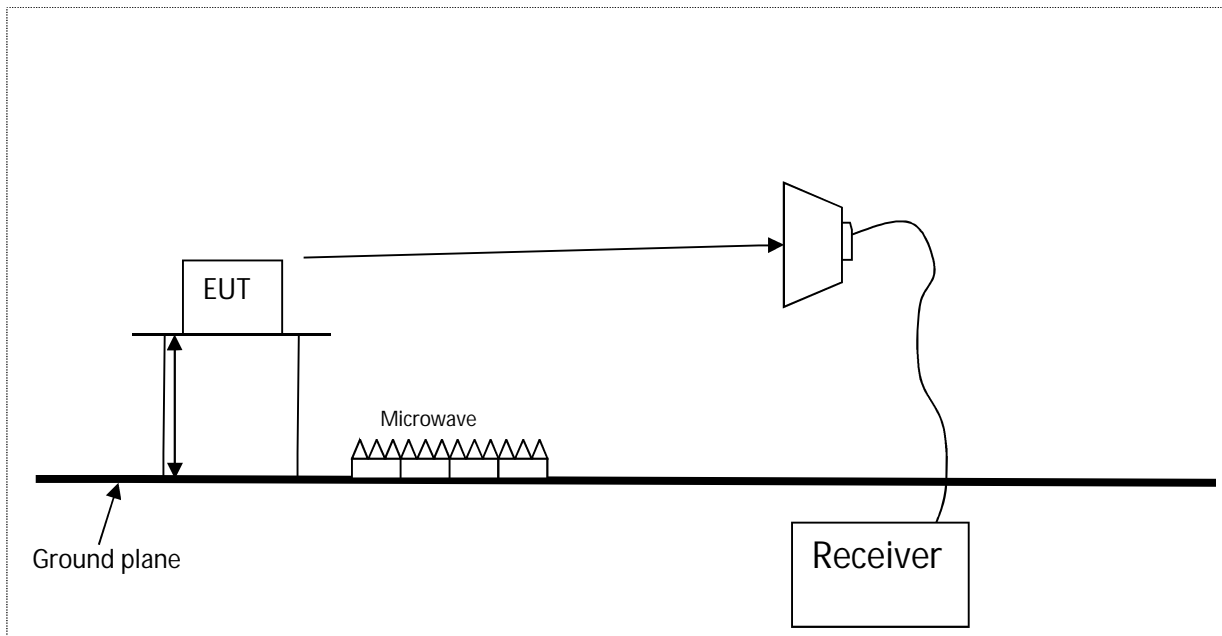


Diagram of the radiated emissions test setup above 1GHz

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
E136	3105	Horn Antenna 12.5GHz	EMCO	24-Apr-2018	12 months
E291-2	6960B	RF Power Meter	Marconi Instruments	17-Apr-2018	24 months
E533	N5182A	Signal Generator 6 GHz MXG	Agilent Technologies	18-Jan-2017	36 months
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	07-Feb-2018	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	07-Feb-2018	12 months
E700	6914	Power Sensor 10MHz - 40GHz	IFR	18-Oct-2017	12 months
E743	RR2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	12-Feb-2018	12 months
LPE364	CBL6112A	Antenna Bilog 30MHz - 2GHz	Chase Electronics Ltd	21-Mar-2018	24 months
NSA-M	NSA - M	NSA - Site M	RN Electronics	20-Feb-2018	36 months
TMS78	3160-08	Horn Std Gain 12.4-18 GHz	ETS Systems	25-Jul-2017	12 months
TMS79	3160-09	Horn Std Gain 18-26.5 GHz	ETS Systems	25-Jul-2017	12 months
TMS81	6502	Antenna Active Loop	EMCO	08-Jun-2017	24 months
TMS82	8449B	Pre-amplifier 1GHz - 26.5GHz	Agilent Technologies	19-Dec-2017	12 months
ZSW1	V2.2	Measurement Software Suite	RN Electronics	Not applicable	

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	1702	Wireless Gateway/Concentrator	Salunda Ltd	Not stated
2	PSA16U-480(POE)	POE Injector	Phihong	P64301317B1
3	Latitude 3570	Laptop PC	DELL	2354494142

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
N557	RC-S380	NFC Reader / Writer	Sony	207904
-	1505FP	Monitor	DELL	CN-0Y4287-71618-55H-C943
-	KT800U1	USB Keyboard	KeyTronic	C071001532
-	T6090DV	PSU	Stontronics	DSA-13PFC-05
-	RP13-MODB UVSK	Raspberry Pi 3	Raspberry Pi	RP13-MODB UVSK

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 FCC Registration No. 293246 IC Registration No. 5612A-4
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 IC Registration No. 5612A-3
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	LBT	Listen Before Talk
µA/m	microAmps per metre	LO	Local Oscillator
µV	microVolts	mA	milliAmps
µW	microWatts	max	maximum
AC	Alternating Current	kPa	Kilopascal
ALSE	Absorber Lined Screened Enclosure	Mbit/s	MegaBits per second
AM	Amplitude Modulation	MHz	MegaHertz
Amb	Ambient	mic	Microphone
ATPC	Automatic Transmit Power Control	min	minimum
BER	Bit Error Rate	mm	milliMetres
°C	Degrees Celsius	ms	milliSeconds
C/I	Carrier / Interferer	mW	milliWatts
CEPT	European Conference of Postal and Telecommunications Administrations	NA	Not Applicable
COFDM	Coherent OFDM	nom	Nominal
CS	Channel Spacing	nW	nanoWatt
CW	Continuous Wave	OATS	Open Area Test Site
dB	deciBels	OFDM	Orthogonal Frequency Division Multiplexing
dBµA/m	deciBels relative to 1µA/m	ppm	Parts per million
dBµV	deciBels relative to 1µV	PRBS	Pseudo Random Bit Sequence
dBc	deciBels relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	deciBels relative to 1mW	QPSK	Quadrature Phase Shift Keying
DC	Direct Current	R&TTE	Radio and Telecommunication Terminal Equipment
DTA	Digital Transmission Analyser	Ref	Reference
EIRP	Equivalent Isotropic Radiated Power	RF	Radio Frequency
ERP	Effective Radiated Power	RFC	Remote Frequency Control
EU	European Union	RSL	Received Signal Level
EUT	Equipment Under Test	RTP	Room Temperature and Pressure
FM	Frequency Modulation	RTPC	Remote Transmit Power Control
FSK	Frequency Shift Keying	Rx	Receiver
g	Grams	s	Seconds
GHz	GigaHertz	SINAD	Signal to Noise And Distortion
Hz	Hertz	Tx	Transmitter
IF	Intermediate Frequency	V	Volts
kHz	kiloHertz		