



2360

## Radio Test Report

**Lumi Technologies Ltd**

**IML Connector**

**CHSv01**

47 CFR Part 15.247 Effective Date 1st October 2015

DSS: Part 15 Spread Spectrum Transmitter

Test Date: 9th June 2016 to 1st July 2016

Report Number: 07-8721-2-16 Issue 02

Supersedes report: 07-8721-2-16 Issue 01

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## Certificate of Test 8721-2

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:                                              | IML Connector                                                                                            |
| Model Number:                                           | CHSV01                                                                                                   |
| Unique Serial Number:                                   | 0110000238                                                                                               |
| Applicant:                                              | Lumi Technologies Ltd<br>Bohunt Manor, Portsmouth Road<br>Liphook, Hampshire, United Kingdom<br>GU30 7DL |
| Proposed FCC/IC ID                                      | RJO-IML-CONN-1                                                                                           |
| Full measurement results are detailed in Report Number: | 07-8721-2-16 Issue 02                                                                                    |
| Test Standards:                                         | 47 CFR Part 15.247 Effective Date 1st October 2015<br>DSS: Part 15 Spread Spectrum Transmitter           |

### 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:

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: 9th June 2016 to 1st July 2016

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Date: 2016.11.09 16:18:51 Z

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Representative:



2360

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## 2 Equipment under test (EUT)

### 2.1 Equipment specification

|                           |                                                                                                              |                        |
|---------------------------|--------------------------------------------------------------------------------------------------------------|------------------------|
| Applicant                 | Lumi Technologies Ltd<br>Bohunt Manor<br>Portsmouth Road<br>Liphook, Hampshire<br>United Kingdom<br>GU30 7DL |                        |
| Manufacturer of EUT       | Lumi Technologies Ltd                                                                                        |                        |
| Full Name of EUT          | IML Connector                                                                                                |                        |
| Model Number of EUT       | CHSv01                                                                                                       |                        |
| Serial Number of EUT      | 0110000238                                                                                                   |                        |
| Date Received             | 6th June 2016                                                                                                |                        |
| Date of Test:             | 9th June 2016 to 1st July 2016                                                                               |                        |
| Purpose of Test           | To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.     |                        |
| Date Report Created       | 20th July 2016                                                                                               |                        |
| Main Function             | Wireless data and audio audience interaction system.                                                         |                        |
| Information Specification | Height                                                                                                       | 120 mm                 |
|                           | Width                                                                                                        | 80 mm                  |
|                           | Depth                                                                                                        | 25 mm                  |
|                           | Weight                                                                                                       | 0.2 kg                 |
|                           | Voltage                                                                                                      | 3.3-4.2 Vdc            |
|                           | Current                                                                                                      | 0.2 A mean, 0.6 A peak |

## 2.2 Configurations for testing

|                                    |                                          |
|------------------------------------|------------------------------------------|
| <b>General Parameters</b>          |                                          |
| EUT Normal use position            | Handheld away from body                  |
| Choice of model(s) for type tests  | Production samples                       |
| Antenna details                    | Antenova 3030A5645                       |
| Antenna port                       | Internal U.FL                            |
| Baseband Data port (yes/no)?       | No                                       |
| Highest Signal generated in EUT    | 2477.952 MHz                             |
| Lowest Signal generated in EUT     | 864 kHz                                  |
| Hardware Version                   | CHSv01                                   |
| Software Version                   | Not specified                            |
| Firmware Version                   | 3.23.3                                   |
| Type of Equipment                  | Portable                                 |
| Technology Type                    | FHSS                                     |
| Geo-location (yes/no)              | No                                       |
| <b>TX Parameters</b>               |                                          |
| Alignment range – transmitter      | 2401.92 - 2477.952 MHz                   |
| EUT Declared Modulation Parameters | GFSK (FHSS)                              |
| EUT Declared Power level           | +20dBm                                   |
| EUT Declared Signal Bandwidths     | 1.7 MHz                                  |
| EUT Declared Channel Spacing's     | 1.728 MHz                                |
| EUT Declared Duty Cycle            | 14.18% maximum                           |
| Unmodulated carrier available?     | No                                       |
| Declared frequency stability       | +/-15ppm                                 |
| <b>RX Parameters</b>               |                                          |
| Alignment range – receiver         | 2401.92 - 2477.952 MHz                   |
| EUT Declared RX Signal Bandwidth   | 1.7 MHz                                  |
| Receiver Signal Level (RSL)        | Not Applicable                           |
| Method of Monitoring Receiver BER  | Not Applicable                           |
| <b>SRD Parameters</b>              |                                          |
| Equipment class                    | DSS: Part 15 Spread Spectrum Transmitter |
| <b>FHSS Parameters</b>             |                                          |
| Maximum No. Of hop channels        | 45                                       |
| Minimum No. Of hop channels        | 45                                       |
| Dwell time per hop channel         | 900us                                    |
| Return time to same channel        | 0.5s Approx                              |

## 2.3 Functional description

2.4 GHz transceiver using FHSS and time slots at a peak power of +20 dBm. Graphic display and keypad for data. Microphone and loudspeaker for audio. Multiple handsets connect to a handset designated as a basestation, which optionally can connect to a PC via a uSB connection.

## 2.4 Modes of operation

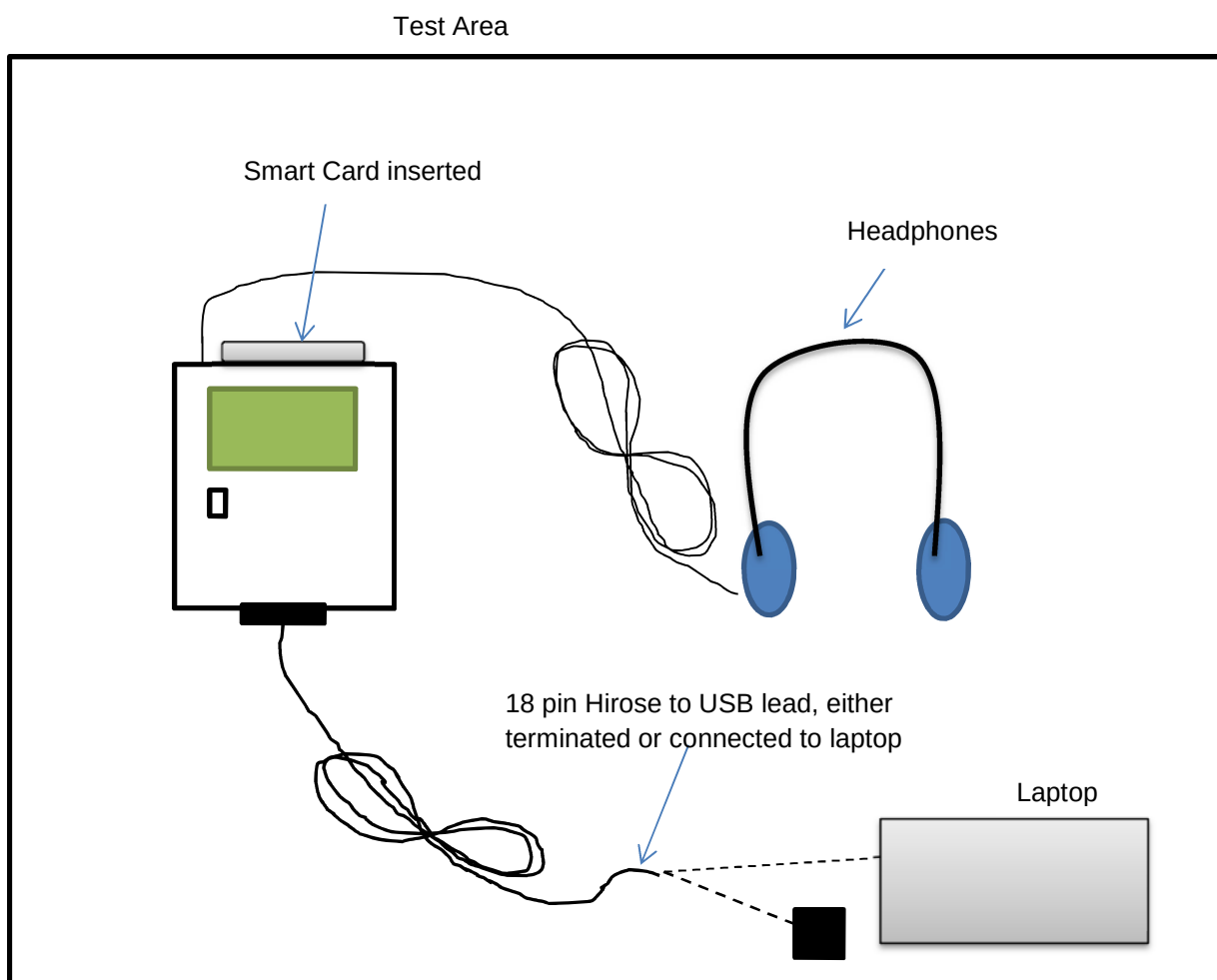
| Mode Reference | Description                                                                                                                | Used for testing |
|----------------|----------------------------------------------------------------------------------------------------------------------------|------------------|
| TX1            | EUT Transmitting @ 20 dBm on 2401.92 MHz (stand-alone config)                                                              | Yes              |
| TX2            | EUT Transmitting @ 20 dBm on 2439.936 MHz (stand-alone config)                                                             | Yes              |
| TX3            | EUT Transmitting @ 20 dBm on 2477.952 MHz (stand-alone config)                                                             | Yes              |
| TX4            | EUT hopping across all channels at Max power (+20dBm) (stand-alone config)                                                 | Yes              |
| Charging       | Unit charging in a Minidock.                                                                                               | No               |
| Base station   | Unit connected to a Laptop PC running test harness software and set into TX4 mode via the PC (Hopping across all channels) | Yes              |

Notes:

Modes TX1 to TX4 could also be set in base station mode via the connected laptop.

Charging mode was not considered for the results in this report as the transmitter is disabled when placed in the charging dock.

## 2.5 Emissions configuration



The unit was powered from its internal battery which was fully charged and monitored throughout tests. For conducted tests the internal UFL antenna connector lead was removed from the antennas board and connected via attenuation to the measuring equipment. The unit was configured with engineering test modes in software to allow transmit modes of device on the top, middle and bottom channels with and without hopping as stated within section 2.4 of this report. Single channel transmit modes were 7% duty cycle and duty cycle calculations were used where appropriate to convert results – refer to specific test sections within this report. The unit was supplied with a charging dock. The unit's transmitter is automatically switched off when placed in the dock and charging mode begins. A smart card, Headphones and 18Hirose to USB lead were provided to populate the EUT ports for worst case emissions testing. The 18 pin Hirose to USB lead could either be connected to a USB termination or a laptop for use in a "base station" mode. Worst case radiated emissions were determined with the 18 pin Hirose-USB lead connected to the unit and terminator on the lead rather than the laptop. For AC Conducted emissions tests the unit was connected to the laptop and operated in all channels hopping mode.

### 2.5.1 Signal leads

| Port Name                          | Cable Type           | Connected |
|------------------------------------|----------------------|-----------|
| Dock for power USB and audio       | Hirose 18 pin to USB | Yes       |
| Headset, microphone and headphones | 4 pin 3.5mm          | Yes       |
| Smartcard                          | Smartcard            | Yes       |

### 3 Summary of test results

The IML Connector, CHSv01 was tested for compliance to the following standard(s) :

47 CFR Part 15.247 Effective Date 1st October 2015

DSS: Part 15 Spread Spectrum Transmitter

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                     |
|--------------------------------------------|------------------------------------------|-----------------------------|
| <b>Transmitter Tests</b>                   |                                          |                             |
| 1. AC power line conducted emissions       | 47 CFR Part 15C Part 15.207              | PASSED                      |
| 2. Radiated emissions 9 - 150 kHz          |                                          | NOT APPLICABLE <sup>1</sup> |
| 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 <sup>2</sup>         |
| 6. Effective radiated power field strength | 47 CFR Part 15C Part 15.247(d)           | PASSED                      |
| 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(a)(1) 15.215 | PASSED                      |
| 9. Maximum Average conducted output power  |                                          | NOT APPLICABLE <sup>3</sup> |
| 10. Maximum Peak conducted output power    | 47 CFR Part 15C Part 15.247(b)(1)        | PASSED                      |
| 11. Maximum Power Spectral Density         |                                          | NOT APPLICABLE <sup>4</sup> |
| 12. Antenna power conducted emissions      |                                          | NOT APPLICABLE <sup>5</sup> |
| 13. Duty cycle                             | 47 CFR Part 15C Part 15.35(c)            | PASSED <sup>6</sup>         |
| 14. FHSS carrier frequency separation      | 47 CFR Part 15C Part 15.247(a1)          | PASSED                      |
| 15. Average time of occupancy              | 47 CFR Part 15C Part 15.247(a)(1)(iii)   | PASSED                      |
| 16. Number of Hop Channels                 | 47 CFR Part 15C Part 15.247(a)(1)(iii)   | PASSED                      |

<sup>1</sup> Test not required. Lowest frequency used or generated within the EUT is 864 kHz.

<sup>2</sup> Spectrum investigated started at a frequency of 30MHz up to a frequency of 25GHz based on 10 times the highest channel/ signal generated in equipment of 2478MHz.

<sup>3</sup> Not required. PK Conducted power measured.

<sup>4</sup> EUT does not employ DTS technology.

<sup>5</sup> This method only applies to equipment with a permanent external antenna connector.

<sup>6</sup> No limits apply, however duty cycle measurement performed to verify correction factors for average emissions.

## 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 |
| 4.1.4 | DA 00-705                | 2000    | PUBLIC NOTICE<br>Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems                                                                    |
| 4.1.5 | KDB 558074 D01<br>v03r03 | 2013    | Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247                                                       |

### 4.2 Deviations

No deviations have been 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 was placed on a wooden table 0.8m above the ground plane and connected to an off the shelf laptop which in turn was connected to a LISN via a 1m mains cable.

Details of the Peripheral and Ancillary Equipment connected for this test is listed in section 11.

Full tests were performed using **base station** mode.

#### 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, ZSW1, E411, E412

See Section 9 for more details

#### 5.1.5 Test results

|                                 |        |
|---------------------------------|--------|
| Temperature of test environment | 21°C   |
| Humidity of test environment    | 62%    |
| Pressure of test environment    | 102kPa |

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Mid channel     | All hopping     |

|                                              |
|----------------------------------------------|
| Plot refs                                    |
| 8721-1 Cond 2 AC Live 150k-30M Average       |
| 8721-1 Cond 2 AC Live 150k-30M Quasi-Peak    |
| 8721-1 Cond 2 AC Neutral 150k-30M Average    |
| 8721-1 Cond 2 AC Neutral 150k-30M Quasi-Peak |

**Table of signals measured for Cond 1 AC Live 150kHz-30MHz**

| Signal No. | Freq (MHz) | Peak Amp (dBuV) | QP Amp (dBuV) | QP Lim (dB) | AV Amp (dBuV) | AV Lim (dB) |
|------------|------------|-----------------|---------------|-------------|---------------|-------------|
| 1          | 0.155      | 48.6            | 42.9          | -22.8       | 24.8          | -30.9       |
| 2          | 0.197      | 47.9            | 43.4          | -20.3       | 36.6          | -17.1       |
| 3          | 0.263      | 45.4            | 43.2          | -18.1       | 39.9          | -11.4       |
| 4          | 0.328      | 42.6            | 40.8          | -18.7       | 37.6          | -11.9       |
| 5          | 0.394      | 41.3            | 39.6          | -18.4       | 35.9          | -12.1       |
| 6          | 0.459      | 37.0            | 35.0          | -21.7       | 30.3          | -16.4       |
| 7          | 0.525      | 39.0            | 37.6          | -18.4       | 34.4          | -11.6       |
| 8          | 0.591      | 38.5            | 37.8          | -18.2       | 35.0          | -11.0       |
| 9          | 0.787      | 38.0            | 37.2          | -18.8       | 34.9          | -11.1       |
| 10         | 0.984      | 37.2            | 36.6          | -19.4       | 34.8          | -11.2       |
| 11         | 1.247      | 38.2            | 37.5          | -18.5       | 34.8          | -11.2       |
| 12         | 1.444      | 38.0            | 37.3          | -18.7       | 35.3          | -10.7       |
| 13         | 1.641      | 37.6            | 37.0          | -19.0       | 34.8          | -11.2       |
| 14         | 1.706      | 37.9            | 36.5          | -19.5       | 33.5          | -12.5       |
| 15         | 1.903      | 38.0            | 37.3          | -18.7       | 34.5          | -11.5       |
| 16         | 2.297      | 37.5            | 36.6          | -19.4       | 33.7          | -12.3       |

**Table of signals measured for Cond 1 AC Neutral 150kHz-30MHz**

| Signal No. | Freq (MHz) | Peak Amp (dBuV) | QP Amp (dBuV) | QP Lim (dB) | AV Amp (dBuV) | AV Lim (dB) |
|------------|------------|-----------------|---------------|-------------|---------------|-------------|
| 1          | 0.197      | 48.7            | 44.0          | -19.7       | 38.0          | -15.7       |
| 2          | 0.262      | 46.2            | 43.5          | -17.9       | 40.2          | -11.2       |
| 3          | 0.328      | 43.7            | 41.4          | -18.1       | 38.0          | -11.5       |
| 4          | 0.394      | 41.3            | 39.6          | -18.4       | 35.6          | -12.4       |
| 5          | 0.459      | 37.7            | 35.4          | -21.3       | 30.1          | -16.6       |
| 6          | 0.525      | 39.7            | 37.9          | -18.1       | 34.6          | -11.4       |
| 7          | 0.591      | 38.8            | 37.6          | -18.4       | 34.7          | -11.3       |
| 8          | 1.247      | 38.1            | 37.1          | -18.9       | 34.7          | -11.3       |
| 9          | 2.099      | 37.5            | 36.8          | -19.2       | 34.2          | -11.8       |
| 10         | 2.821      | 37.7            | 36.6          | -19.4       | 32.3          | -13.7       |
| 11         | 3.018      | 37.6            | 36.7          | -19.3       | 32.7          | -13.3       |
| 12         | 3.674      | 37.7            | 36.7          | -19.3       | 32.6          | -13.4       |
| 13         | 4.134      | 37.9            | 36.8          | -19.2       | 32.3          | -13.7       |

No discernible difference was noted in emissions between channels (exploratory measurements); therefore the final measurements are presented for TX mid channel mode only.

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  $\pm 3.6$ dB

## 5.2 Radiated emissions 9 - 150 kHz

NOT APPLICABLE: Test not required. Lowest frequency used or generated within the EUT is 864 kHz.

## 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 fully charged battery.

The EUT was operated in all the modes listed in 2.4 and no discernible difference in emissions was observed, therefore for full test **TX2** 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 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.

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

Tests were performed using Test Site H.

### 5.3.4 Test equipment

TMS81, TMS45, ZSW1, E534, E535

See Section 9 for more details

### 5.3.5 Test results

|                                 |        |
|---------------------------------|--------|
| Temperature of test environment | 19°C   |
| Humidity of test environment    | 58%    |
| Pressure of test environment    | 101kPa |

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Mid channel     | 2439.936 MHz    |

|                              |
|------------------------------|
| Plot refs                    |
| 8721-2 Rad 1 150k-30MHz Para |
| 8721-2 Rad 1 150k-30MHz Perp |

No emissions were observed within 25dB of limits in the chamber, therefore final measurements were not required on the OATS.

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  $\pm 3.9\text{dB}$

## 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 fully charged battery.

The EUT was operated in all the modes listed in 2.4 and no discernible difference in emissions was observed, therefore for full test **TX2** 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° 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

See Section 9 for more details

### 5.4.5 Test results

Temperature of test environment 18°C  
Humidity of test environment 53%  
Pressure of test environment 101kPa

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Mid channel     | 2439.936 MHz    |

|                        |
|------------------------|
| Plot refs              |
| 8721-2 Rad 1 VHF Horiz |
| 8721-2 Rad 1 VHF Vert  |
| 8721-2 Rad 1 UHF Horiz |
| 8721-2 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          | 191.998    | 44.0              | 43.2            | -0.3        |
| 2          | 193.630    | 33.8              | 25.0            | -18.5       |
| 3          | 245.997    | 35.7              | 33.8            | -12.2       |
| 4          | 287.997    | 44.1              | 43.2            | -2.8        |
| 5          | 384.001    | 38.1              | 35.2            | -10.8       |
| 6          | 479.987    | 39.9              | 37.7            | -8.3        |

**Table of signals measured for Rad 1 Vertical Sig List**

| Signal No. | Freq (MHz) | Peak Amp<br>(dBuV/m) | QP Amp (dBuV/m) | QP Lim (dB) |
|------------|------------|----------------------|-----------------|-------------|
| 1          | 191.998    | 36.7                 | 35.7            | -7.8        |
| 2          | 287.997    | 43.8                 | 42.5            | -3.5        |
| 3          | 384.001    | 40.1                 | 37.7            | -8.3        |
| 4          | 479.988    | 40.1                 | 37.0            | -9.0        |
| 5          | 576.003    | 40.3                 | 38.2            | -7.8        |

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

No discernible difference was noted in emissions between channel settings (exploratory measurements), therefore final measurements are presented for TX mid channel mode only for these test ranges.

**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  $\pm 5.1$ dB

## 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 fully charged battery.

The EUT was operated in all the modes listed in 2.4. Worst case emissions were observed in “stand alone” configuration; therefore for full tests **TX1**, **TX2** and **TX3** modes were 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° 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 - 25 GHz.

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, LPE333, LPE261, TMS78, TMS79

See Section 9 for more details

### 5.5.5 Test results

Temperature of test environment 19°C  
Humidity of test environment 58%  
Pressure of test environment 102kPa

Setup Table

|                 |             |
|-----------------|-------------|
| Band            | 2400-2483.5 |
| Power Level     | 20 dBm      |
| Channel Spacing | 1.728 MHz   |
| Mod Scheme      | GFSK        |
| Low channel     | 2401.92 MHz |

| Spurious Frequency (MHz) | Measured Peak Level (dBμV/m) | Difference to Peak Limit (dB) | Calculated Average Level (dBμV/m) | Difference to Average Limit (dB) | Antenna Polarisation | EUT Polarisation |
|--------------------------|------------------------------|-------------------------------|-----------------------------------|----------------------------------|----------------------|------------------|
| 4803.84                  | 57.8                         | -16.2                         | 40.8                              | -13.2                            | Vertical             | Flat             |
| 4803.84                  | 59.3                         | -14.7                         | 42.3                              | -11.7                            | Horizontal           | Side             |

Setup Table

|             |                 |
|-------------|-----------------|
| Band        | 2400-2483.5 MHz |
| Power Level | 20 dBm          |

|                 |              |
|-----------------|--------------|
| Channel Spacing | 1.728 MHz    |
| Mod Scheme      | GFSK         |
| Mid channel     | 2439.936 MHz |

| Spurious Frequency (MHz) | Measured Peak Level (dBμV/m) | Difference to Peak Limit (dB) | Calculated Average Level (dBμV/m) | Difference to Average Limit (dB) | Antenna Polarisation | EUT Polarisation |
|--------------------------|------------------------------|-------------------------------|-----------------------------------|----------------------------------|----------------------|------------------|
| 1536.015                 | 45.3                         | -28.7                         | 28.3                              | -15.7                            | Vertical             | side             |
| 4879.872                 | 58.0                         | -16.0                         | 41.0                              | -13.0                            | Vertical             | upright          |

| Plots                       |  |  |  |  |  |  |
|-----------------------------|--|--|--|--|--|--|
| 8721-1 Horiz 1-2 GHz        |  |  |  |  |  |  |
| 8721-1 Vert 1-2 GHz         |  |  |  |  |  |  |
| 8721-1 Horiz 2-2.4 GHz      |  |  |  |  |  |  |
| 8721-1 Vert 2-2.4 GHz       |  |  |  |  |  |  |
| 8721-1 Horiz 2.4835-2.7 GHz |  |  |  |  |  |  |
| 8721-1 Vert 2.4835-2.7 GHz  |  |  |  |  |  |  |
| 8721-1 Horiz 2.7-5 GHz      |  |  |  |  |  |  |
| 8721-1 Vert 2.7-5 GHz       |  |  |  |  |  |  |
| 8721-1 Horiz 5-6 GHz        |  |  |  |  |  |  |
| 8721-1 Vert 5-6 GHz         |  |  |  |  |  |  |
| 8721-1 Vert 6-7.8GHz        |  |  |  |  |  |  |
| 8721-1 Horiz 6-7.8GHz       |  |  |  |  |  |  |
| 8721-1 Vert 7.8-10GHz       |  |  |  |  |  |  |
| 8721-1 Horiz 7.8-10GHz      |  |  |  |  |  |  |
| 8721-1 Vert 10-12.5GHz      |  |  |  |  |  |  |
| 8721-1 Horiz 10-12.5GHz     |  |  |  |  |  |  |
| 8721-1 Vert 12-15GHz        |  |  |  |  |  |  |
| 8721-1 Horiz 12-15GHz       |  |  |  |  |  |  |
| 8721-1 Vert 15-18GHz        |  |  |  |  |  |  |
| 8721-1 Horiz 15-18GHz       |  |  |  |  |  |  |
| 8721-1 Vert 18-21.5GHz      |  |  |  |  |  |  |
| 8721-1 Horiz 18-21.5GHz     |  |  |  |  |  |  |
| 8721-1 Vert 21.5-25GHz      |  |  |  |  |  |  |
| 8721-1 Horiz 21.5-25GHz     |  |  |  |  |  |  |

Setup Table

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| High channel    | 2477.952 MHz    |

| Spurious Frequency (MHz) | Measured Peak Level (dBμV/m) | Difference to Peak Limit (dB) | Calculated Average Level (dBμV/m) | Difference to Average Limit (dB) | Antenna Polarisation | EUT Polarisation |
|--------------------------|------------------------------|-------------------------------|-----------------------------------|----------------------------------|----------------------|------------------|
| 4955.904                 | 59.1                         | -14.9                         | 42.1                              | -11.9                            | Vertical             | Flat             |
| 4955.904                 | 58.5                         | -15.5                         | 41.5                              | -12.5                            | Horizontal           | side             |

NOTE: Only middle channel plots are shown in this report to reduce report size, however, Low, middle and high channels have been fully tested and results tabulated. Only results observed within 20dB of limits have been included in results tables. Average results have been calculated from Peak measurements and corrected with duty cycle correction factor per FCC 15.35/ANSI C63.10:2013 in a 0.1second period. Correction used is -16.96dB. See section 5.13 within this report.

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  $\pm 3.5$ dB

18 – 26.5 GHz  $\pm 3.9$ dB

## 5.6 Effective radiated power field strength

### 5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(b) [Reference 4.1.1 of this report]  
Test Method: ANSI C63.10 Clause 6.5/6.6 [Reference 4.1.2 of this report]  
Limits: 47 CFR Part 15C Part 15.247(b)(1) & [Reference 4.1.1 of this report]

### 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 TX1 and TX2 and TX3 modes.

### 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. Tests were performed in test site H.

### 5.6.4 Test equipment

E534, E535, LPE333, LPE261

See Section 9 for more details

### 5.6.5 Test results

Temperature of test environment 19°C  
Humidity of test environment 58%  
Pressure of test environment 102kPa

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Low channel     | 2401.92 MHz     |
| Mid channel     | 2439.936 MHz    |
| High channel    | 2477.952 MHz    |

|                      | Low           | Mid           | High          |
|----------------------|---------------|---------------|---------------|
| Peak Level (dBμV/m)  | <b>114.80</b> | <b>116.20</b> | <b>114.90</b> |
| Antenna Polarisation | Horiz         | Horiz         | Horiz         |
| EUT Polarisation     | Upright       | Upright       | Upright       |

Note: Test performed in order to obtain the maximised EUT position and measuring antenna polarisation for radiated restricted band edge measurements (see section 5.7 within this report).

#### LIMITS:

The maximum output power in all cases is 30dBm / 1watt PK conducted (please refer to conducted PK power results section 5.10 within this report).

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

## 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 rotated through 360° in 3 orthogonal positions to find the maximum field strength per channel required. The EUT was measured at a distance of 3 metres.

The EUT was operated in TX1, TX3 and TX4 modes.

### 5.7.3 Test procedure

The emission from the EUT was maximised before taking the plots. Test modes provided by the client were only providing a 7.09% TX duty cycle, however in practice, the duty cycle maximum would be 14.18%. Therefore a duty cycle correction factor has been applied to the PK results/plots only, to determine compliance in worst case operational mode to the average limits. Please refer to section 5.13 within this report for details of the correction factor.  
Tests were performed using Test Site H.

### 5.7.4 Test equipment

E533, E534, E535, LPE261, LPE333

See Section 9 for more details

### 5.7.5 Test results

Temperature of test environment 21°C  
Humidity of test environment 58%  
Pressure of test environment 100kPa

|         |                 |
|---------|-----------------|
| Band    | 2400-2483.5 MHz |
| Power   | 20 dBm          |
| Channel | 1.728 MHz       |
| Mod     | GFSK            |
| Low     | 2401.92 MHz     |
| High    | 2477.952 MHz    |

| Restricted band edges (Non Hopping) | Low Channel                                            | High Channel                                            |
|-------------------------------------|--------------------------------------------------------|---------------------------------------------------------|
| Peak Level (dBµV/m)                 | 59.1                                                   | 70.4                                                    |
| Peak Plot reference                 | 8721-1 low channel non hopping restricted band edge PK | 8721-1 High channel non hopping restricted band edge PK |
| Average Level (dBµV/m)              | 42.1                                                   | 53.4                                                    |
| Average Plot reference              | N/A                                                    | N/A                                                     |

Note: AV results are calculated from PK results corrected for Duty cycle of 14.18% refer to 5.12 for further details

| Restricted band edges (Hopping) | Low Channel                                        | High Channel                                        |
|---------------------------------|----------------------------------------------------|-----------------------------------------------------|
| Peak Level (dBuV/m)             | 58.1                                               | 70.1                                                |
| Peak Plot reference             | 8721-1 low channel Hopping restricted band edge PK | 8721-1 High channel Hopping restricted band edge PK |
| Average Level (dBuV/m)          | 41.1                                               | 53.1                                                |

Note: AV results are calculated from PK results corrected for Duty cycle of 14.18% refer to 5.12 for further details

| Authorised band edges (Non Hopping) | Low Channel                                                    | High Channel                                                    |
|-------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------|
| Band Edge Plot reference            | 8721-1 low channel non hopping authorised band edge PK (100kHz | 8721-1 High channel non hopping authorised band edge PK (100kHz |

| Authorised band edges (Hopping) | Low Channel                               | High Channel |
|---------------------------------|-------------------------------------------|--------------|
| Band Edge Plot reference        | Radiated all hopping authorised band edge |              |

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.

\*The limit is 54dBuV/m for Average emissions. According to 15.35(c): when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. For a 10% duty cycle, the power measured would be reduced by  $20 \log(0.10) = 20\text{dB}$ . According to the declared duty cycle, therefore, the emissions observed are below the limit after averaging for pulse rate.

#### 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 showing compliance are in section 6 for radiated emissions above 1GHz, 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:  $\leq \pm 3.5 \text{ dB}$

## 5.8 Occupied bandwidth

### 5.8.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(1) & 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) [Reference 4.1.1 of this report]

### 5.8.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the internal RF port. The EUT was operated in TX1 and TX2 and TX3 modes.

### 5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A RBW between 1-5% of Occupied Bandwidth was used along with a span set between 2-5 times the OBW, 3x VBW, auto sweep time and max hold settings to measure the 20dB bandwidth.  
Tests were performed using Test Site H.

### 5.8.4 Test equipment

E534, E547

See Section 9 for more details

### 5.8.5 Test results

Temperature of test environment 18°C  
Humidity of test environment 58%  
Pressure of test environment 100kPa

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Low channel     | 2401.92 MHz     |
| Mid channel     | 2439.936 MHz    |
| High channel    | 2477.952 MHz    |

|                     | Low            | Mid         | High        |
|---------------------|----------------|-------------|-------------|
| 99% Bandwidth (MHz) | 1.316          | 1.315       | 1.311       |
| Plot reference      | Bottom channel | Mid channel | Top channel |

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.

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 APPLICABLE: Not required. PK Conducted power measured.

## 5.10 Maximum Peak conducted output power

### 5.10.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(b)(1) [Reference 4.1.1 of this report]  
Test Method: ANSI C63.10 Clause 7.8.5 [Reference 4.1.2 of this report]  
Limits: 47 CFR Part 15C Part 15.247(b)(1) [Reference 4.1.1 of this report]

### 5.10.2 Configuration of EUT

The EUT was measured on a bench using a power meter connected to the internal RF port. The EUT was set to each mode in turn (see section 2.4) and highest power levels recorded. The EUT was operated in TX1, TX2 and TX3 modes for this test.

### 5.10.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.  
Power meter reading stated is maximum power observed using a peak power head.  
Measurements were made on a test bench in site H.

### 5.10.4 Test equipment

E533, E534, E611, E547

See Section 9 for more details

### 5.10.5 Test results

Temperature of test environment 18°C  
Humidity of test environment 53%  
Pressure of test environment 102kPa

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Low channel     | 2401.92 MHz     |
| Mid channel     | 2439.936 MHz    |
| High channel    | 2477.952 MHz    |

| Test conditions                 |           | Peak Power (dBm) | Peak Power (dBm) | Peak Power (dBm) |
|---------------------------------|-----------|------------------|------------------|------------------|
| Temperature 20°C                | 3.7 Volts | Low Channel      | Mid Channel      | High Channel     |
| Maximum TX Power observed (dBm) |           | 20.60            | 20.60            | 20.90            |
| Converted to mW                 |           | 114.8            | 114.8            | 123.03           |

#### LIMITS:

For FHSS operating 2400-2483.5 MHz employing less than 75 channels 0.125 Watts.

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

NOT APPLICABLE: EUT does not employ DTS technology.

## 5.12 Antenna power conducted emissions

NOT APPLICABLE: This method only applies to equipment with a permanent external antenna connector.

## 5.13 Duty cycle

### 5.13.1 Test methods

|                    |                                                                |
|--------------------|----------------------------------------------------------------|
| Test Requirements: | 47 CFR Part 15C Part 15.35(c) [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 15.35c [Reference 4.1.1 of this report]   |

### 5.13.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the internal RF port. The EUT was operated in TX1 mode.

### 5.13.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted 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. Measurements were performed in test site H.

### 5.13.4 Test equipment

E533, E534, E535, E547

See Section 9 for more details

### 5.13.5 Test results

|                                 |        |
|---------------------------------|--------|
| Temperature of test environment | 18°C   |
| Humidity of test environment    | 58%    |
| Pressure of test environment    | 100kPa |

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Single channel  | 2041.92 MHz     |

|                                                 | Single              |
|-------------------------------------------------|---------------------|
| TX on time (mS)                                 | 0.693               |
| TX on Plot filename                             | 8721-1 Duty cycle 1 |
| TX repetition time (mS)                         | 9.77                |
| Measured TX Duty cycle (%)                      | 7.09                |
| Declared maximum number of pulses within 9.77ms | 2                   |
| Calculated maximum TX Duty cycle (%)            | 14.18               |

Based on a TX duty cycle of 14.18% and the calculation allowed in ANSI C63.10 clause 7.5 a correction factor of  $20\log(14.18/100) = -16.96\text{dB}$  can be applied to the peak results to determine the average emission compliance.

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

#### LIMITS:

No limit specified; test performed to allow calculation of emissions measured with an average detector, when the fundamental transmission is less than 0.1s in duration.

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

## 5.14 FHSS carrier frequency separation

### 5.14.1 Test methods

|                    |                                                                  |
|--------------------|------------------------------------------------------------------|
| Test Requirements: | 47 CFR Part 15C Part 15.247(a1) [Reference 4.1.1 of this report] |
| Test Method:       | ANSI C63.10 Clause 7.8.2 [Reference 4.1.2 of this report]        |
| Limits:            | 47 CFR Part 15C Part 15.247(a1) [Reference 4.1.1 of this report] |

### 5.14.2 Configuration of EUT

The EUT was tested on the bench and ambient conditions were monitored. The EUT was operated in TX4 mode.

### 5.14.3 Test procedure

Tests were made using the measuring equipment listed in the 'Test Equipment' Section. With the EUT hopping, a span was set on the spectrum analyser to show two adjacent channel peaks. The analyser was set to Peak detector and a max held trace, the trace was allowed enough sweeps to stabilise. A RBW set at approximately 30% of the channel spacing was used to best identify each channel.

Tests were performed in test site H.

### 5.14.4 Test equipment

E534, E535, E547

See Section 9 for more details

### 5.14.5 Test results

|                                 |        |
|---------------------------------|--------|
| Temperature of test environment | 18°C   |
| Humidity of test environment    | 58%    |
| Pressure of test environment    | 100kPa |

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Single channel  | All hopping     |

|                          |                                     |
|--------------------------|-------------------------------------|
|                          | Single                              |
| Separation (kHz)         | 1727.5                              |
| Plot of Separation (kHz) | 8721-1 Carrier frequency separation |

Analyser plots can be found in Section 6 of this report

#### LIMITS:

FHSS shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

These results show that the EUT has PASSED this test.

## 5.15 Average time of occupancy

### 5.15.1 Test methods

|                    |                                                                         |
|--------------------|-------------------------------------------------------------------------|
| Test Requirements: | 47 CFR Part 15C Part 15.247(a)(1)(iii) [Reference 4.1.1 of this report] |
| Test Method:       | ANSI C63.10 Clause 7.8.4 [Reference 4.1.2 of this report]               |
| Limits:            | 47 CFR Part 15C Part 15.247(a)(1)(iii) [Reference 4.1.1 of this report] |

### 5.15.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the internal RF port. Ambient conditions were monitored. The EUT was operated in TX4 mode for this test.

### 5.15.3 Test procedure

Tests were made using the measuring equipment listed in the 'Test Equipment' Section. With the EUT hopping, a suitable sweep time was set on the spectrum analyser in zero span mode centred on a hopping channel. Both the TX time period and the repetition time were measured and plotted for comparison to the limits. Tests were performed in test site H.

### 5.15.4 Test equipment

E533, E534, E535, E547

See Section 9 for more details

### 5.15.5 Test results

|                                 |        |
|---------------------------------|--------|
| Temperature of test environment | 18°C   |
| Humidity of test environment    | 58%    |
| Pressure of test environment    | 100kPa |

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK            |
| Single channel  | All hopping     |

|                                       |                    |
|---------------------------------------|--------------------|
| Measured Dwell time/pulse width (ms)  | 0.693              |
| Period time (s)                       | 18                 |
| Instances of pulse within period time | 40                 |
| Average time of occupancy (ms)        | 27.72              |
| Measured Dwell time/pulse width (ms)  | 8721-1 TX on time  |
| Period time (s)                       | 8721-1 TX rep 18 s |

Test modes provided by the manufacturer did not operate the EUT at its maximum duty cycle and as such the measured dwell time per hop needs to be multiplied by 2 to obtain the true average occupancy time per channel over the 18 second period.

Therefore actual average time of occupancy based on 40 hops per 18 second time frame and dwell per hop of 1.386ms is **55.44ms**. Analyser plots can be found in Section 6 of this report.

#### LIMITS:

FHSS operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

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

## 5.16 Number of Hop Channels

### 5.16.1 Test methods

|                    |                                                                         |
|--------------------|-------------------------------------------------------------------------|
| Test Requirements: | 47 CFR Part 15C Part 15.247(a)(1)(iii) [Reference 4.1.1 of this report] |
| Test Method:       | ANSI C63.10 Clause 7.8.3 [Reference 4.1.2 of this report]               |
| Limits:            | 47 CFR Part 15C Part 15.247(a)(1)(iii) [Reference 4.1.1 of this report] |

### 5.16.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the internal RF port. Ambient conditions were monitored. The EUT was operated in TX4 mode for this test.

### 5.16.3 Test procedure

Tests were made using the measuring equipment listed in the 'Test Equipment' Section. With the EUT hopping, a suitable span was set on the spectrum analyser to show clearly over a range of plots the number of channels being used by the EUT. The RBW was set to less than 30% of the 20dB bandwidth. The analyser was set to Peak detector and max held and the trace was allowed to stabilise for each plot. Tests were performed in test Site H.

### 5.16.4 Test equipment

E534, E535, E547

See Section 9 for more details

### 5.16.5 Test results

|                                 |        |
|---------------------------------|--------|
| Temperature of test environment | 18°C   |
| Humidity of test environment    | 58%    |
| Pressure of test environment    | 100kPa |

|                 |                 |
|-----------------|-----------------|
| Band            | 2400-2483.5 MHz |
| Power Level     | 20 dBm          |
| Channel Spacing | 1.728 MHz       |
| Mod Scheme      | GFSK MHz        |
| Single channel  | All hopping     |

|                                              |                                           |
|----------------------------------------------|-------------------------------------------|
| No of hopping Channels                       | 45                                        |
| Minimum No. Required number by specification | 15                                        |
| Plot of Hopping Channels 1-14                | 8721-1 Number of hopping channels Plot 01 |
| Plot of Hopping Channels 15-28               | 8721-1 Number of hopping channels Plot 02 |
| Plot of Hopping Channels 29-43               | 8721-1 Number of hopping channels Plot 03 |
| Plot of Hopping Channels 44-45               | 8721-1 Number of hopping channels Plot 04 |

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

#### LIMITS:

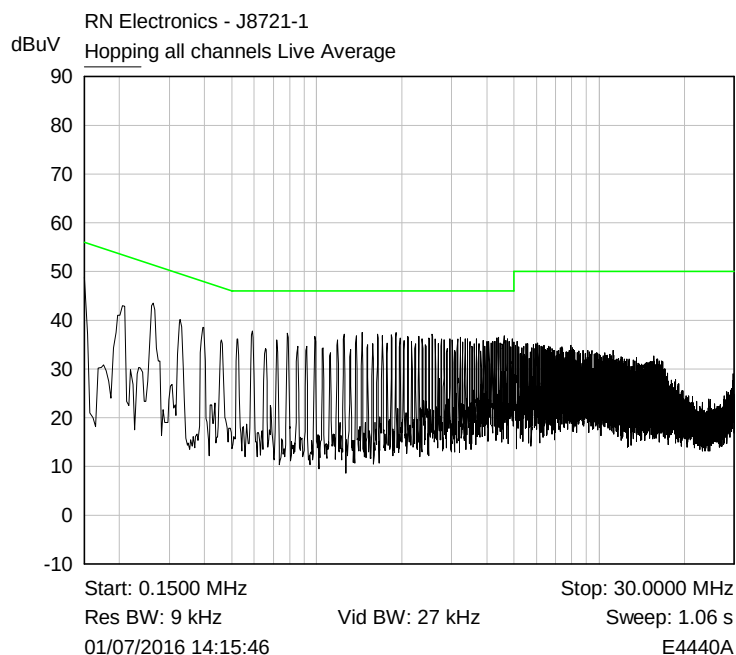
FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

These results show that the EUT has PASSED this test.

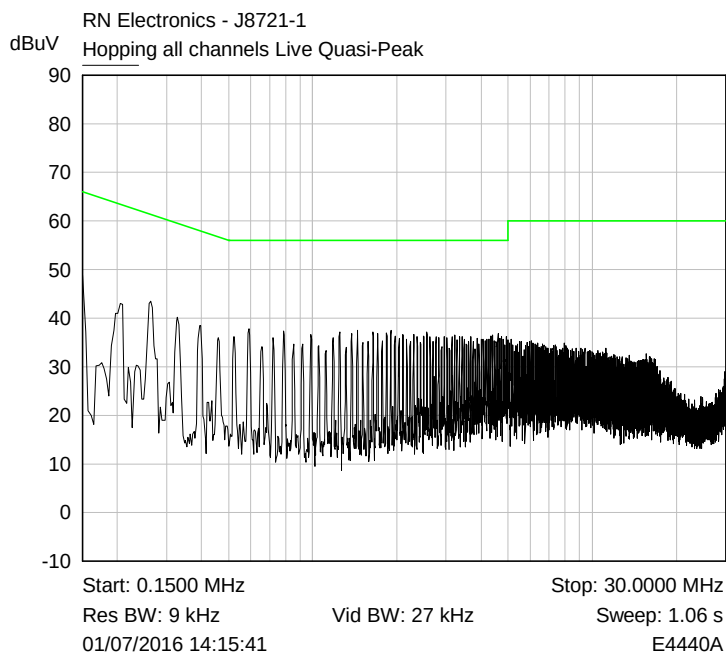
## 6 Plots/Graphical results

### 6.1 AC power line conducted emissions

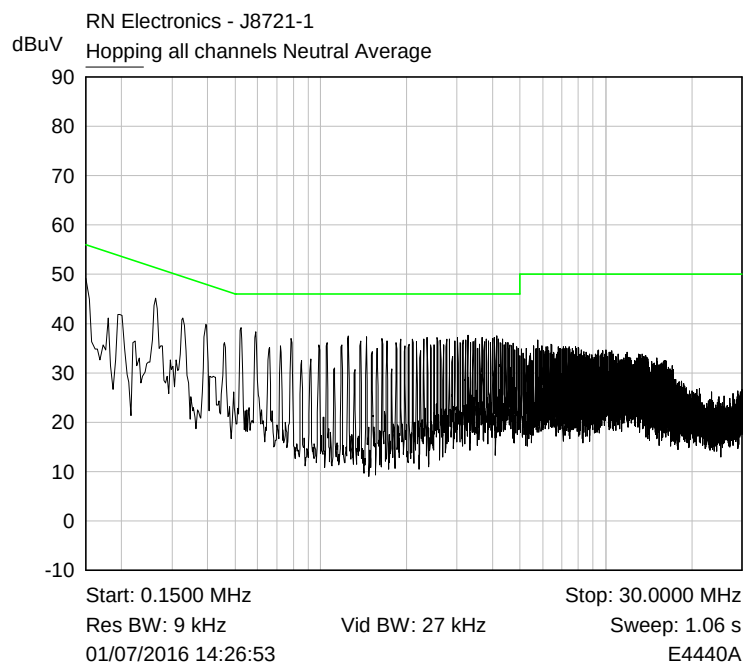
RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, Channel All hopping



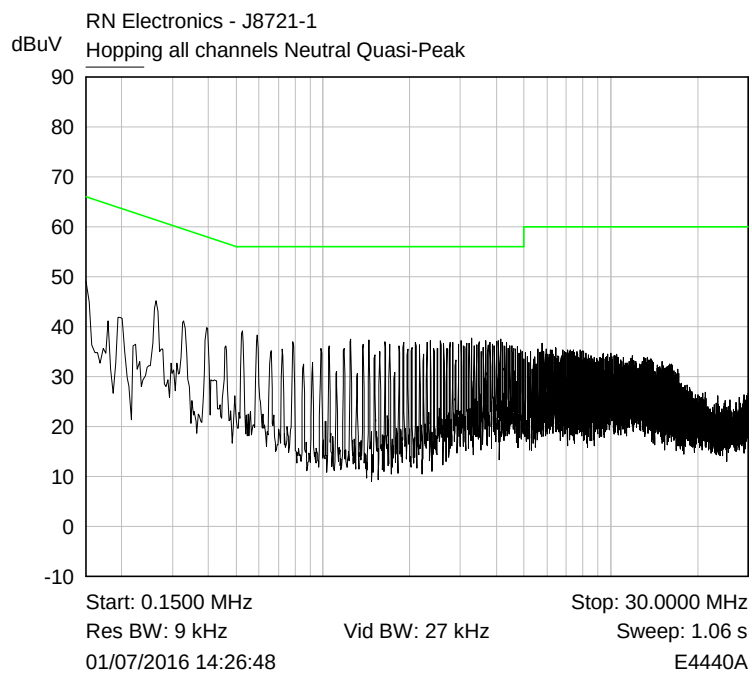
Plot of Live 150kHz-30MHz Average



Plot of Live 150kHz-30MHz Quasi-Peak



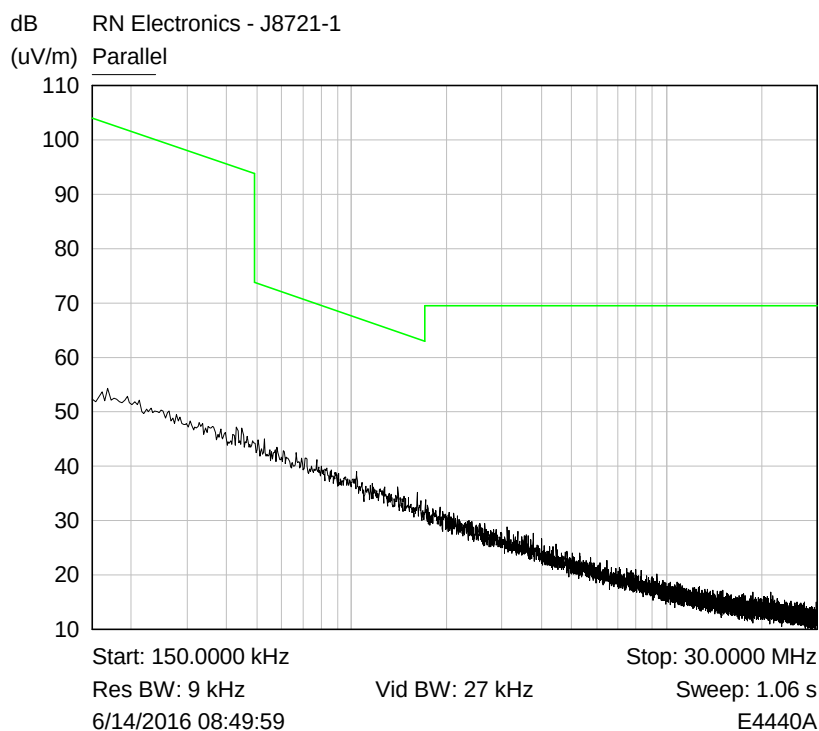
Plot of Neutral150kHz-30MHz Average



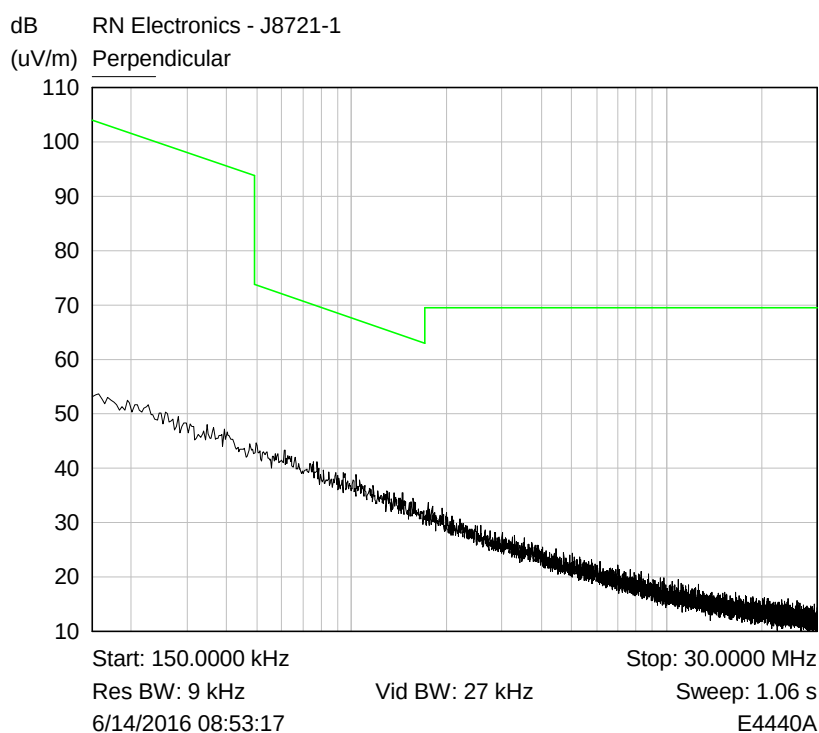
Plot of Neutral150kHz-30MHz Quasi-Peak

## 6.2 TX Unwanted radiated emissions 150kHz-30MHz

RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, Channel 2439.936 MHz



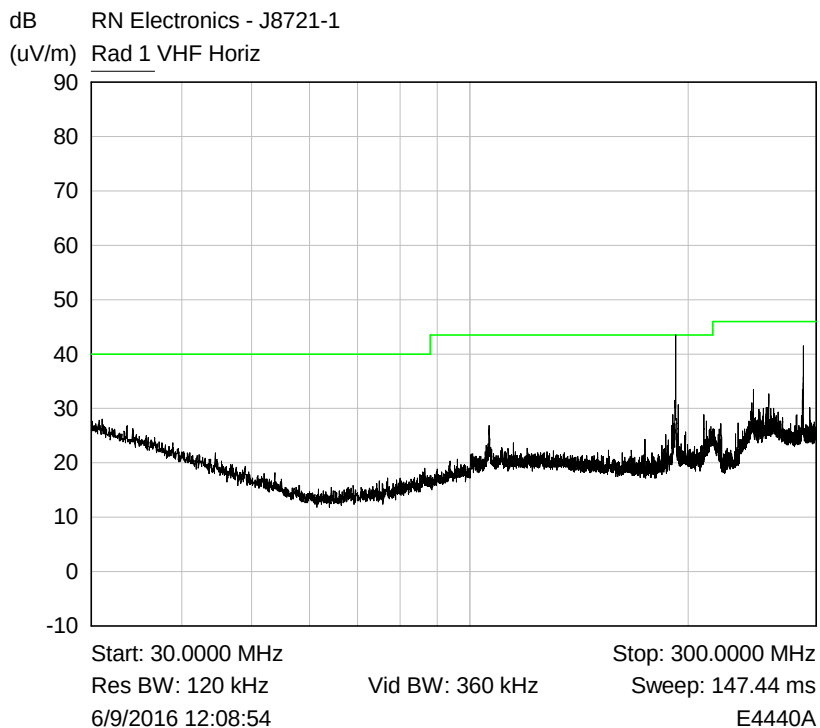
Plot of 150kHz-30MHz Parallel



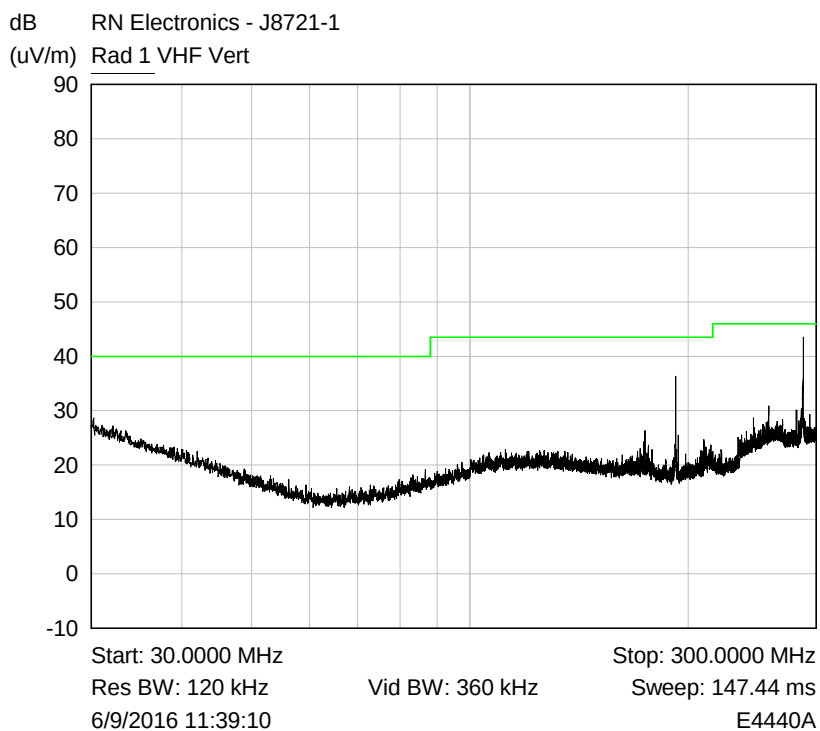
Plot of 150kHz-30MHz Perpendicular

### 6.3 TX Unwanted radiated emissions 30MHz-1GHz

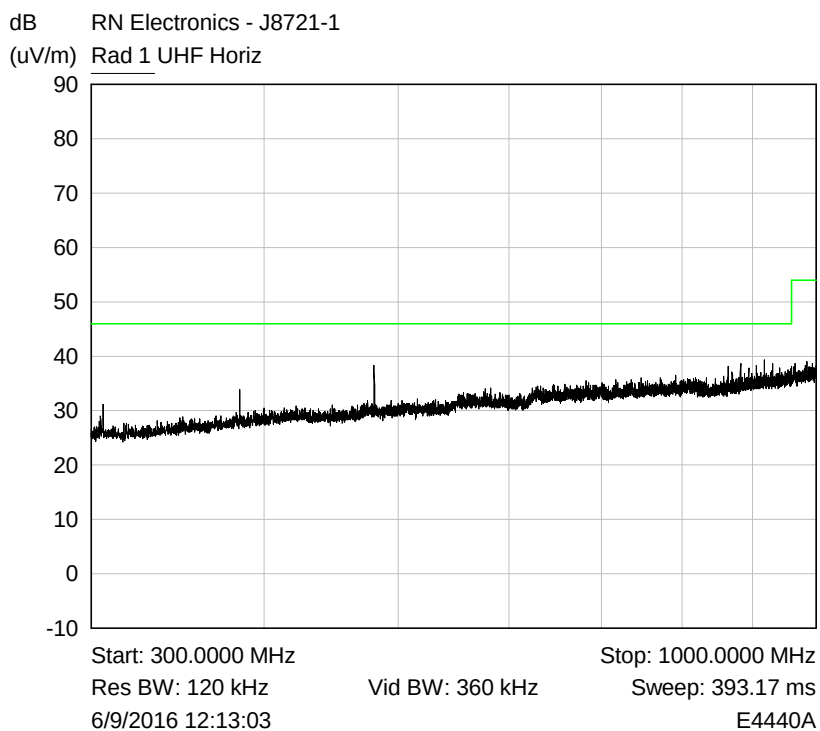
RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, Channel 2439.936 MHz



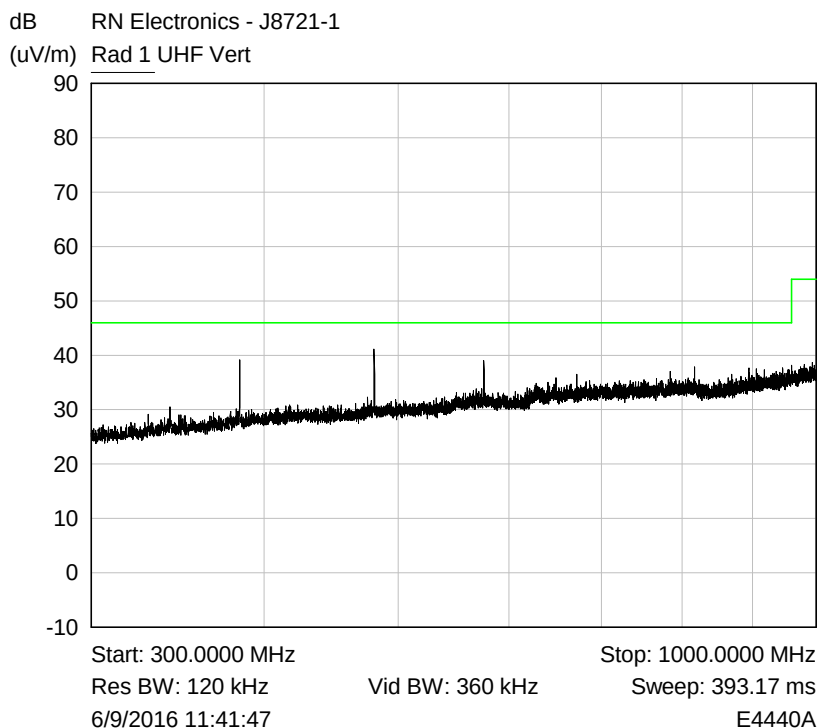
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



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

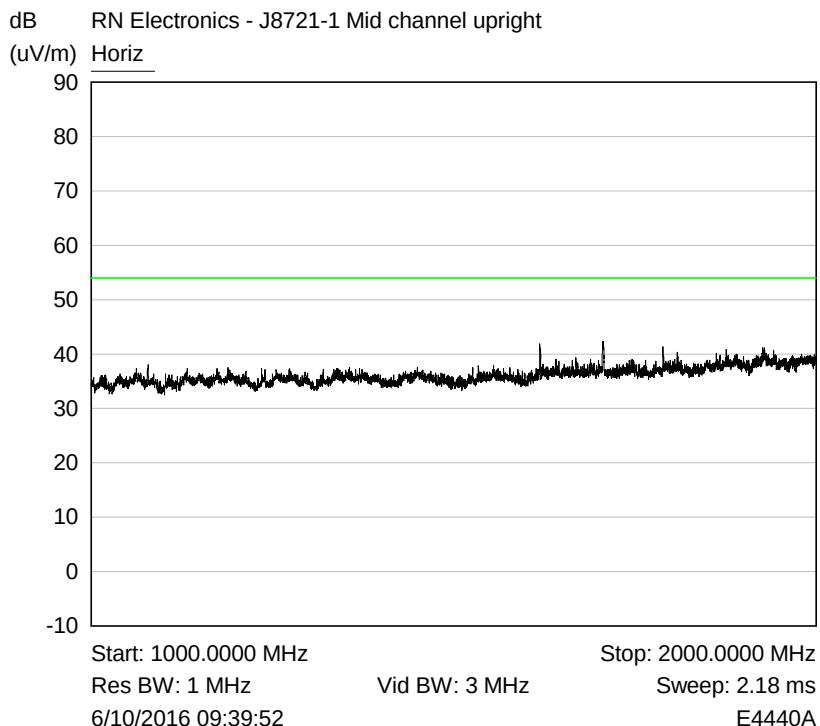


Plot of Peak emissions for UHF Vertical against the QP limit line.

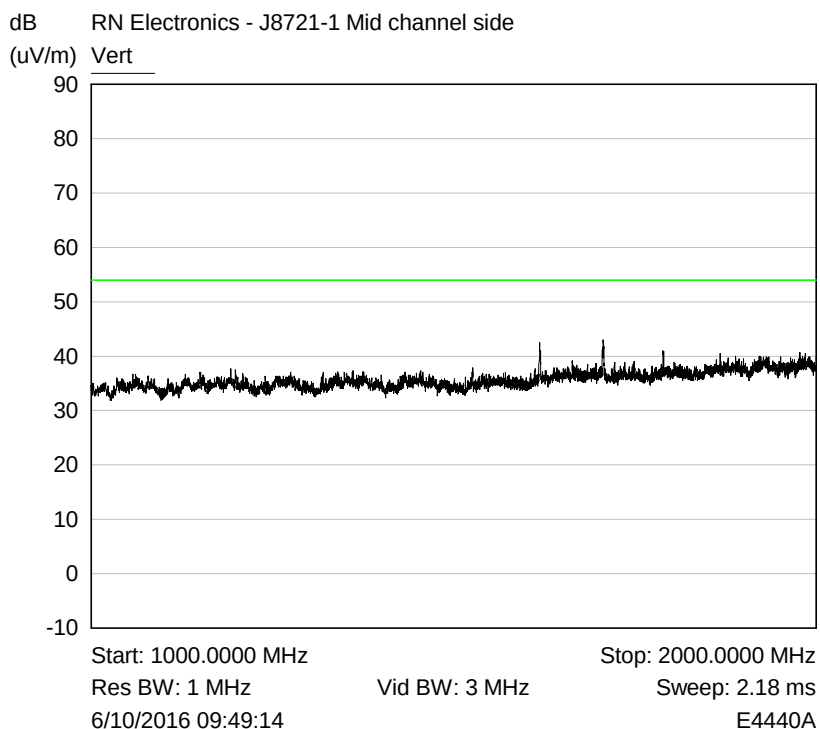
## 6.4 Radiated emissions above 1 GHz

Note: only middle plots shown to minimise size of report, low, mid and high channels were tested as required.

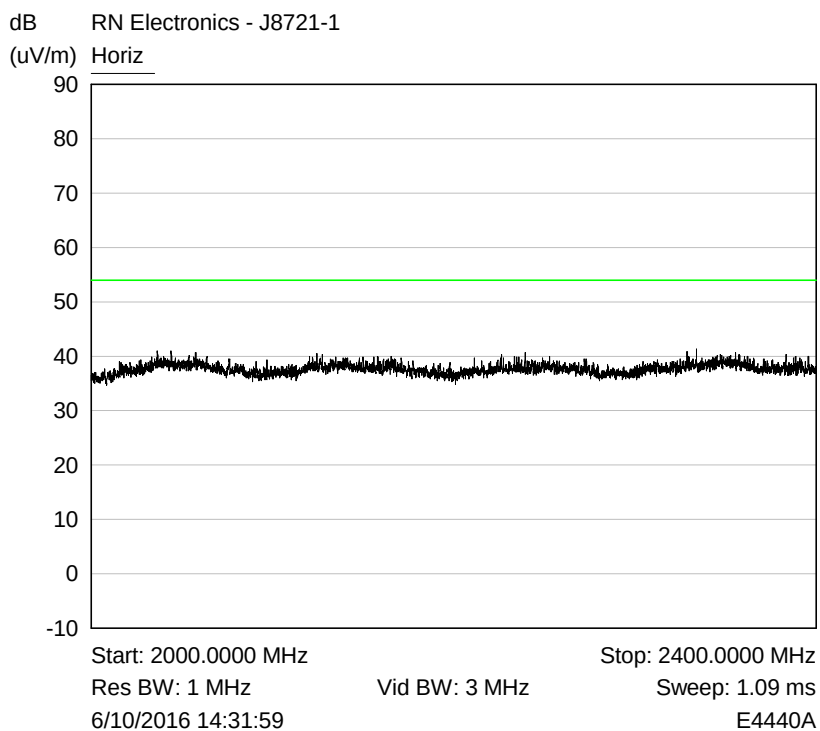
RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, Channel 2439.936 MHz



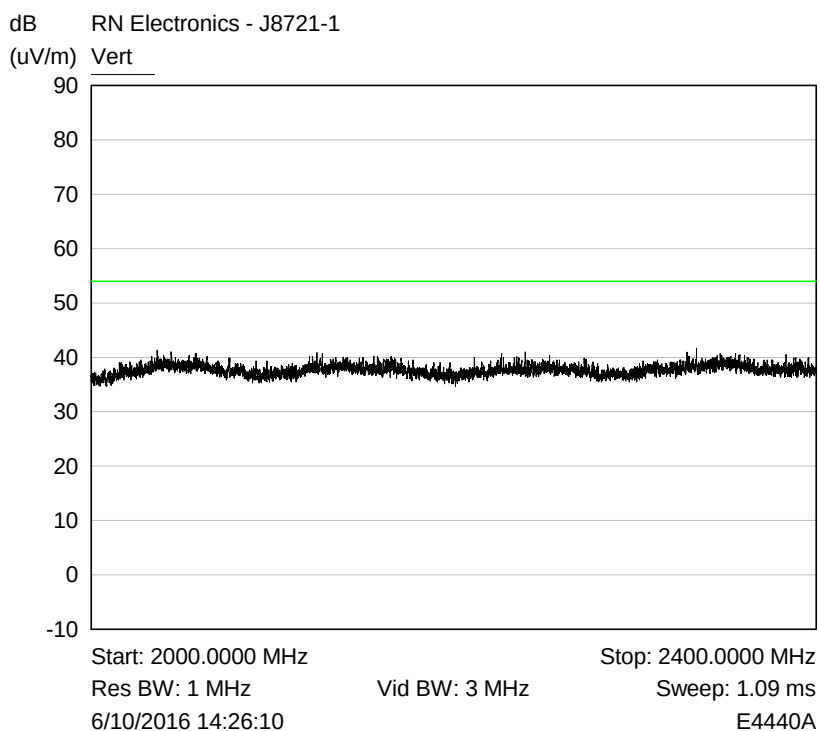
Plot of Peak horizontal (max held) emissions 1-2 GHz against the AV limit line.



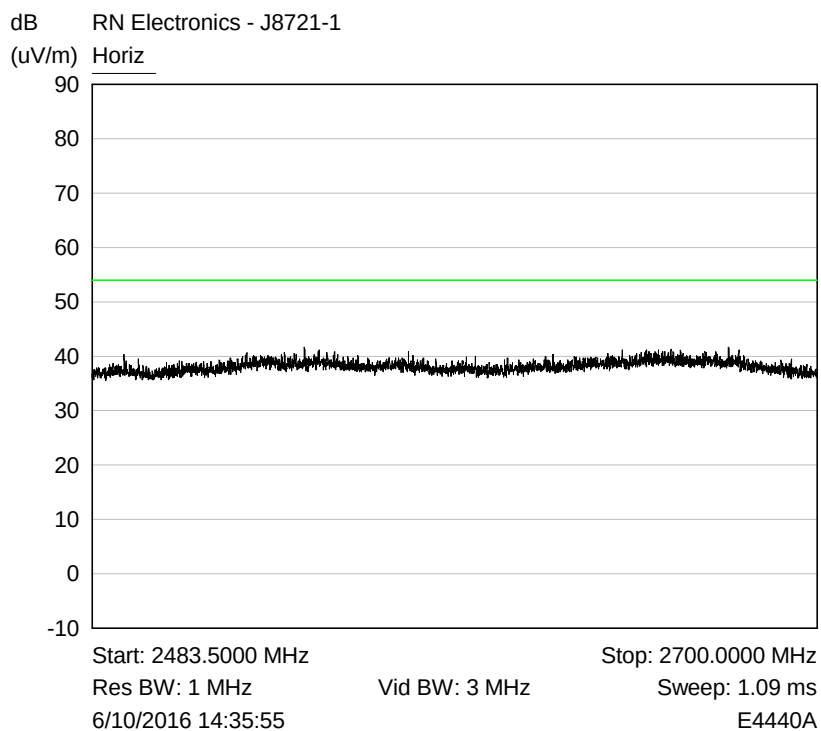
Plot of Peak vertical (max held) emissions 1-2 GHz against the AV limit line.



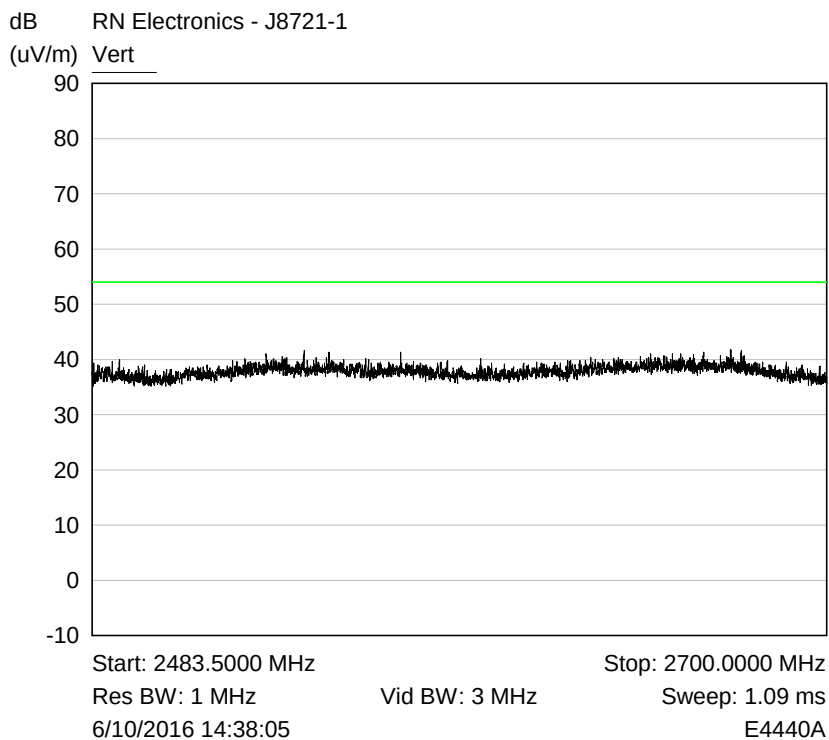
Plot of Peak horizontal (max held) emissions 2-2.4 GHz against the AV limit line.



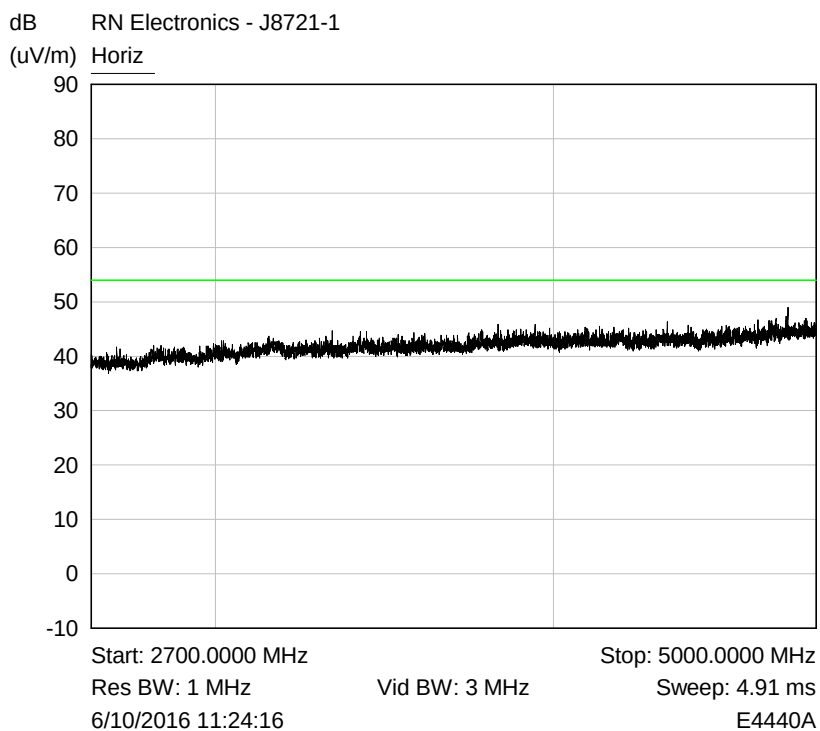
Plot of Peak vertical (max held) emissions 2-2.4 GHz against the AV limit line.



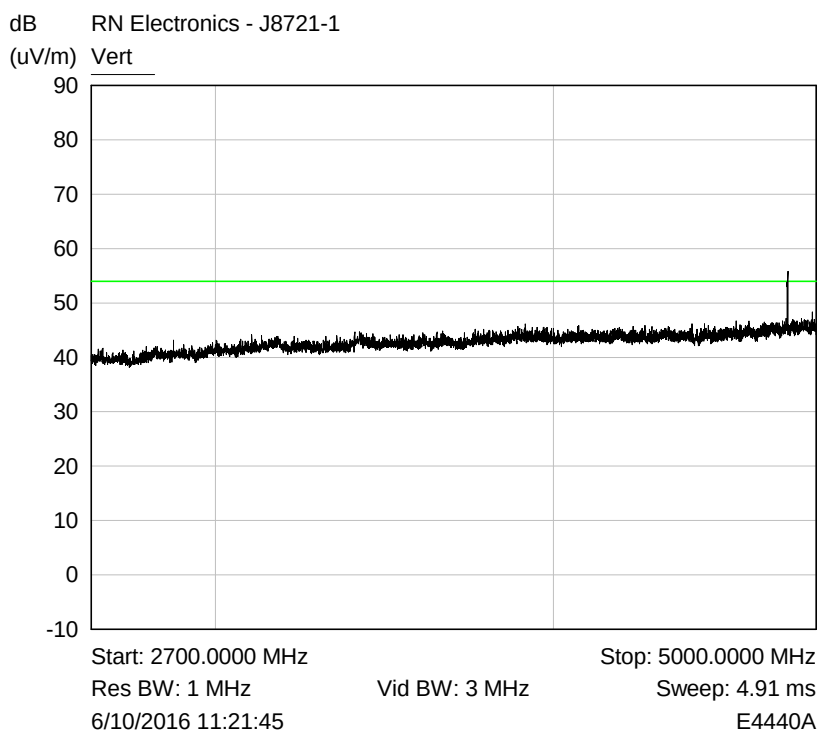
Plot of Peak horizontal (max held) emissions 2.4835-2.7 GHz against the AV limit line.



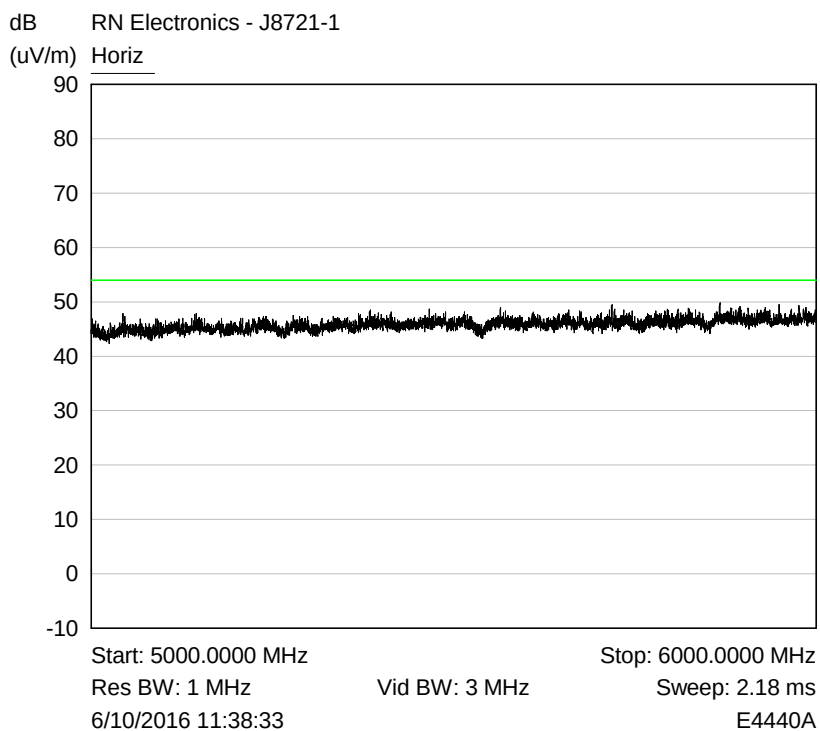
Plot of Peak vertical (max held) emissions 2.4835-2.7 GHz against the AV limit line.



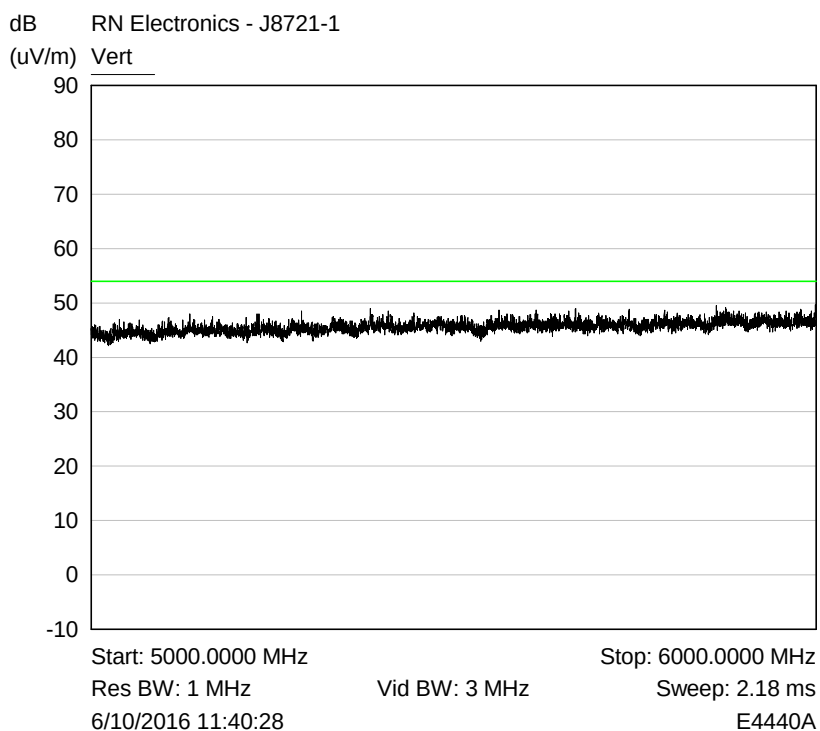
Plot of Peak horizontal (max held) emissions 2.7-5 GHz against the AV limit line.



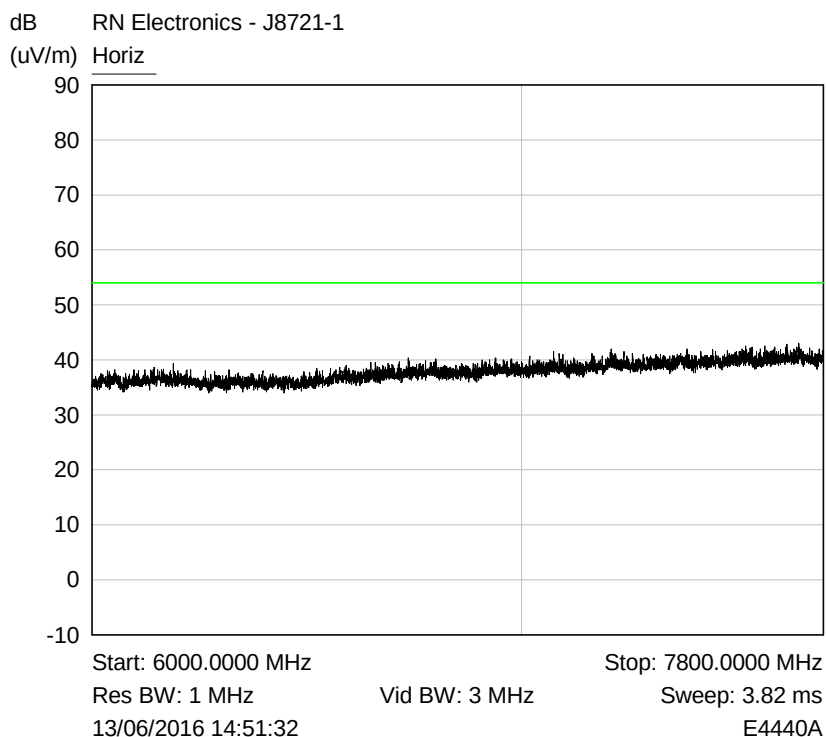
Plot of Peak vertical (max held) emissions 2.7-5 GHz against the AV limit line.



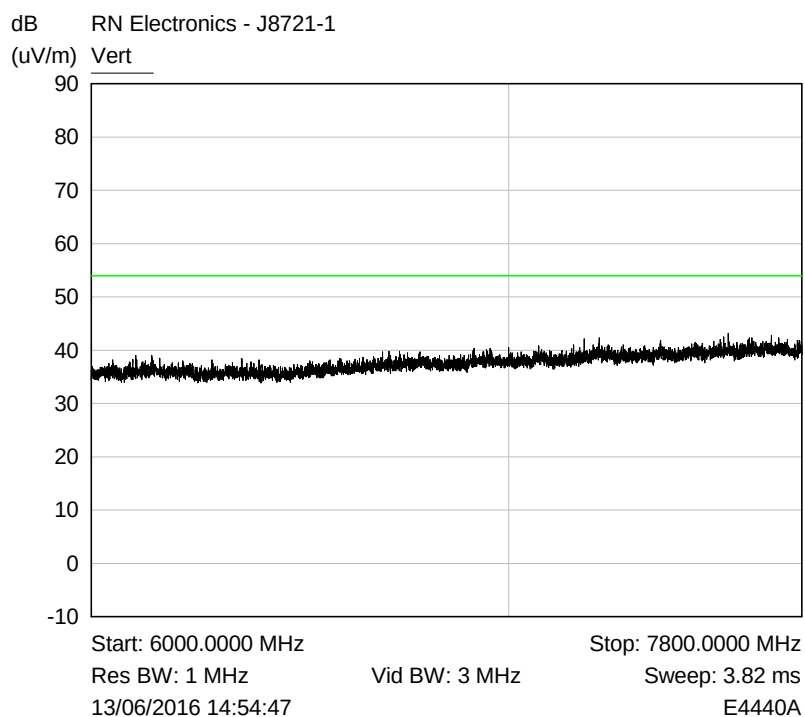
Plot of Peak horizontal (max held) emissions 5-6 GHz against the AV limit line.



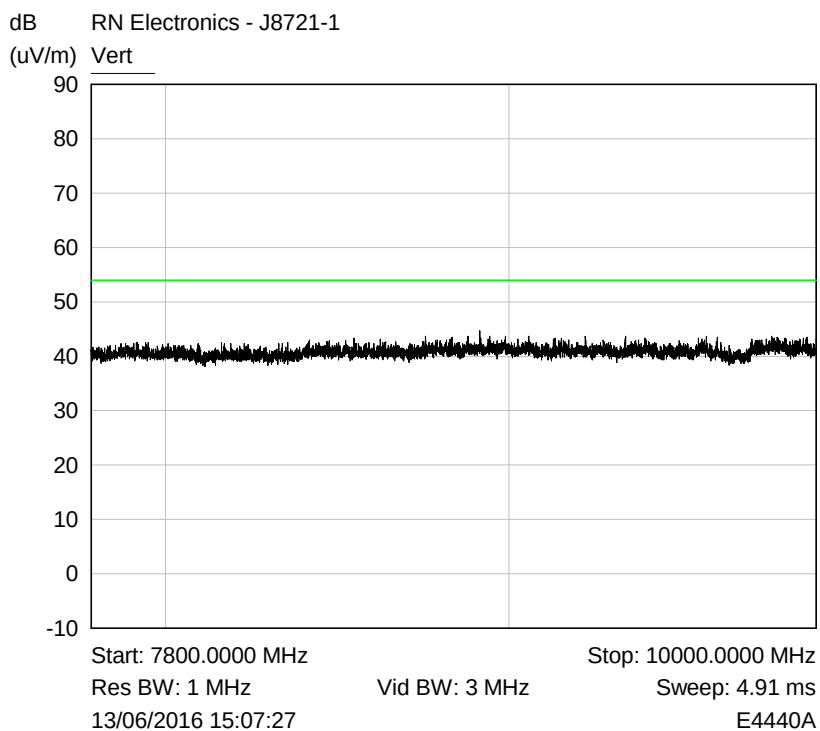
Plot of Peak vertical (max held) emissions 5-6 GHz against the AV limit line.



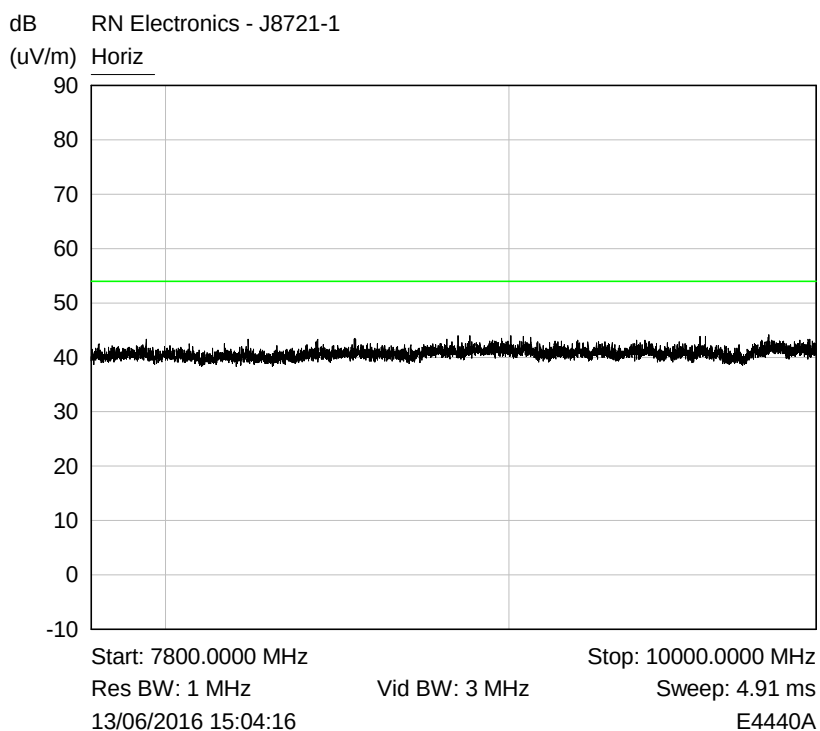
Plot of Peak horizontal (max held) emissions 6-7.8 GHz against the AV limit line.



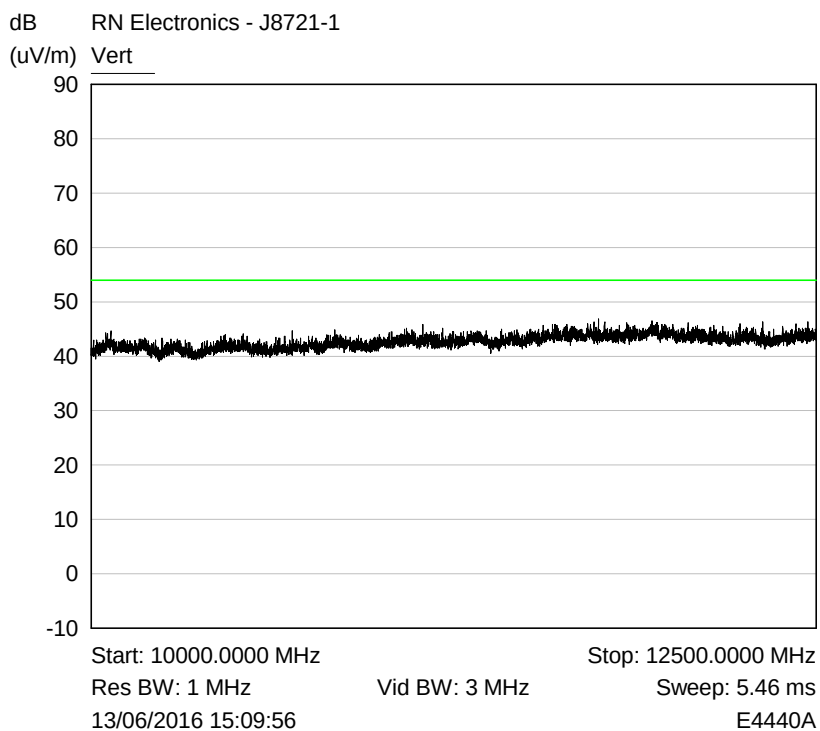
Plot of Peak vertical (max held) emissions 6-7.8 GHz against the AV limit line.



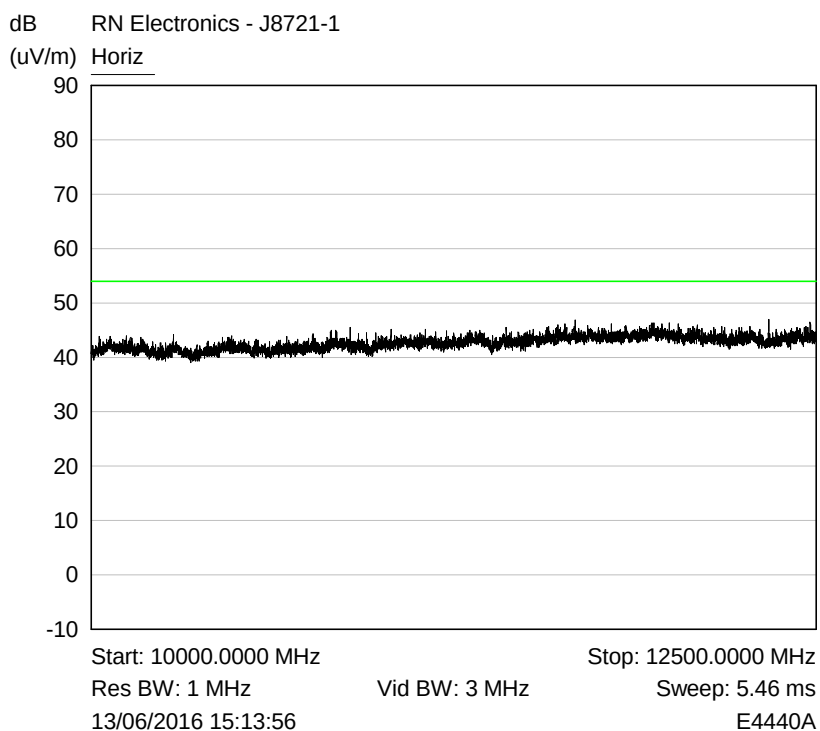
Plot of Peak vertical (max held) emissions 7.8-10 GHz against the AV limit line.



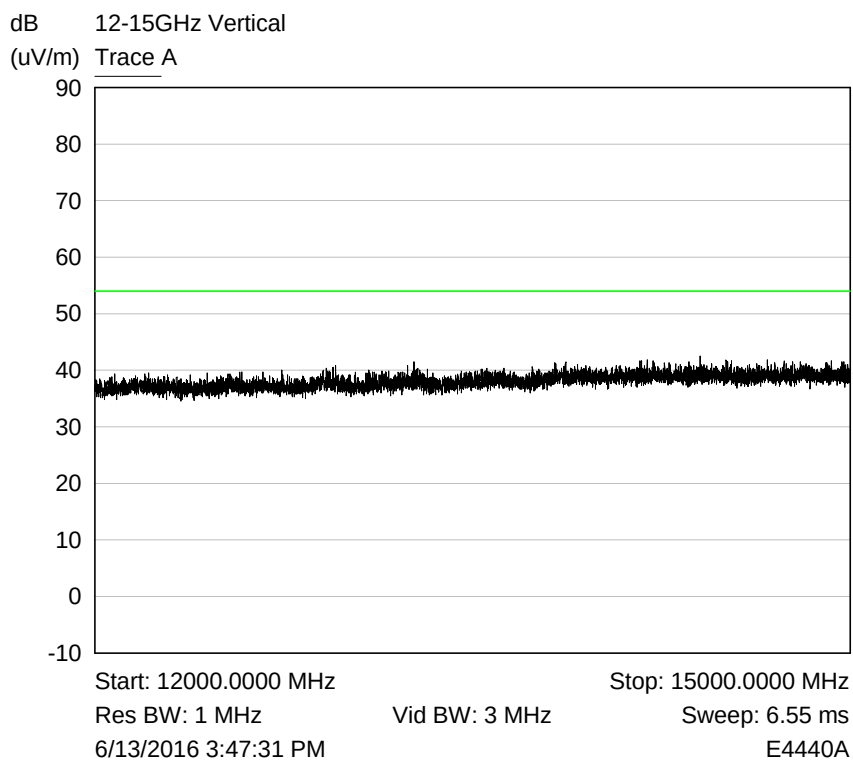
Plot of Peak horizontal (max held) emissions 7.8-10 GHz against the AV limit line.



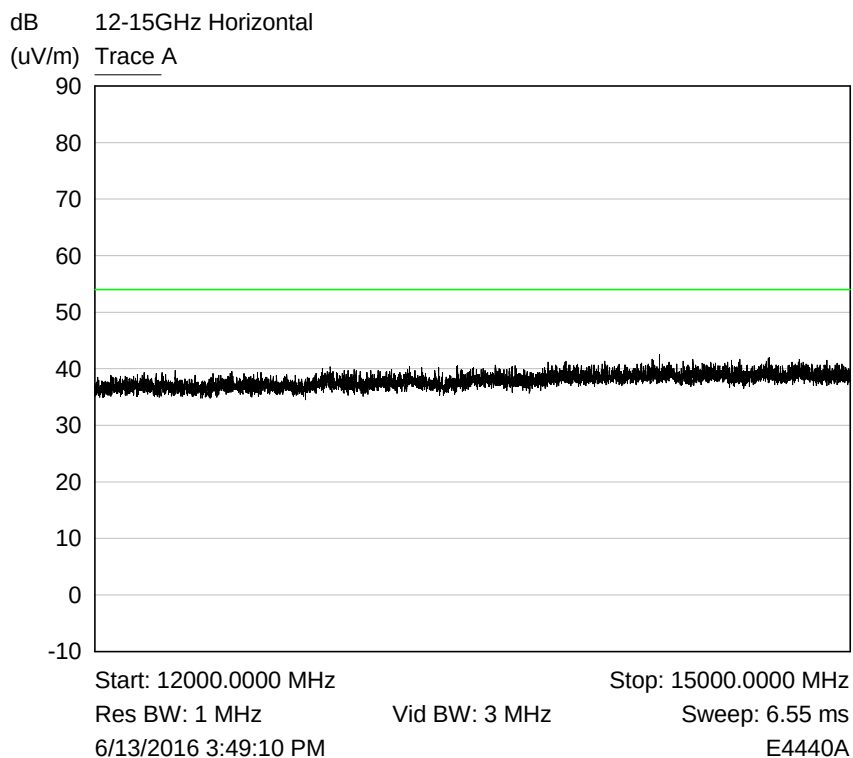
Plot of Peak vertical (max held) emissions 10-12.5 GHz against the AV limit line.



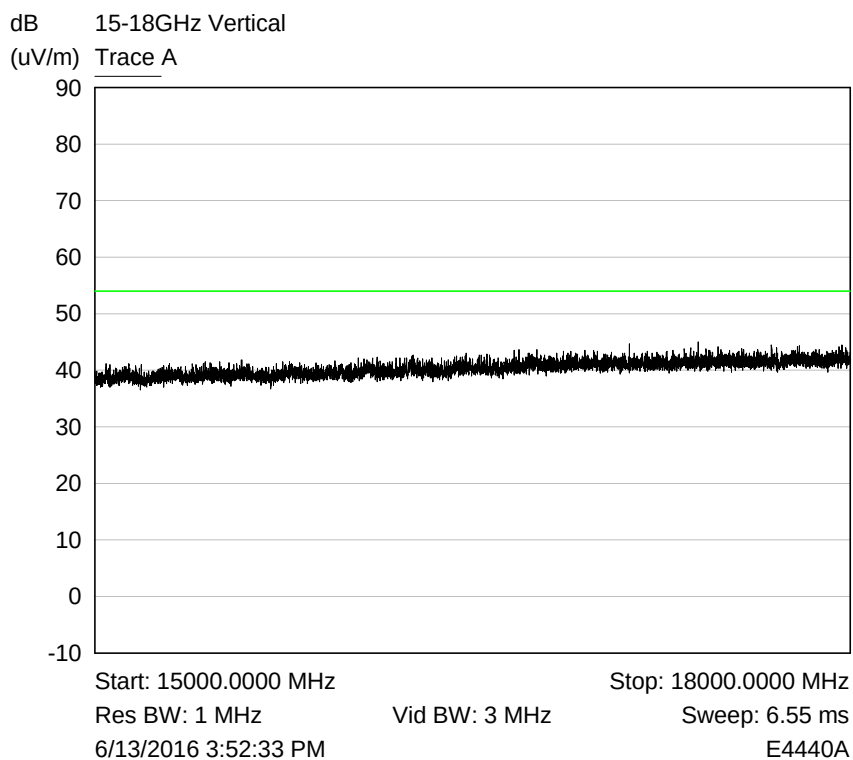
Plot of Peak horizontal (max held) emissions 10-12.5 GHz against the AV limit line.



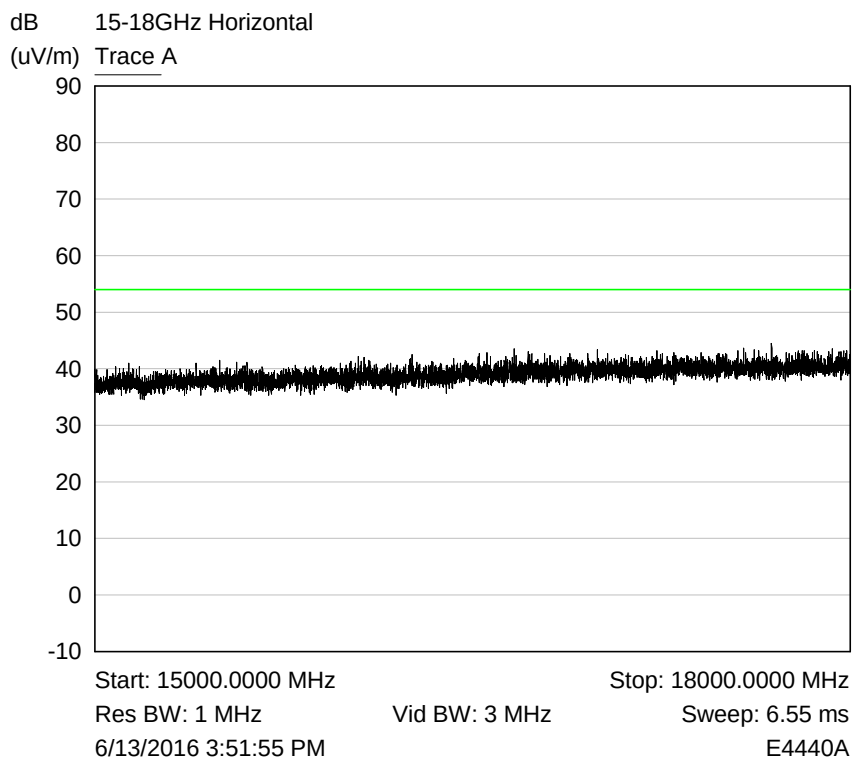
Plot of Peak vertical (max held) emissions 12-15 GHz against the AV limit line.



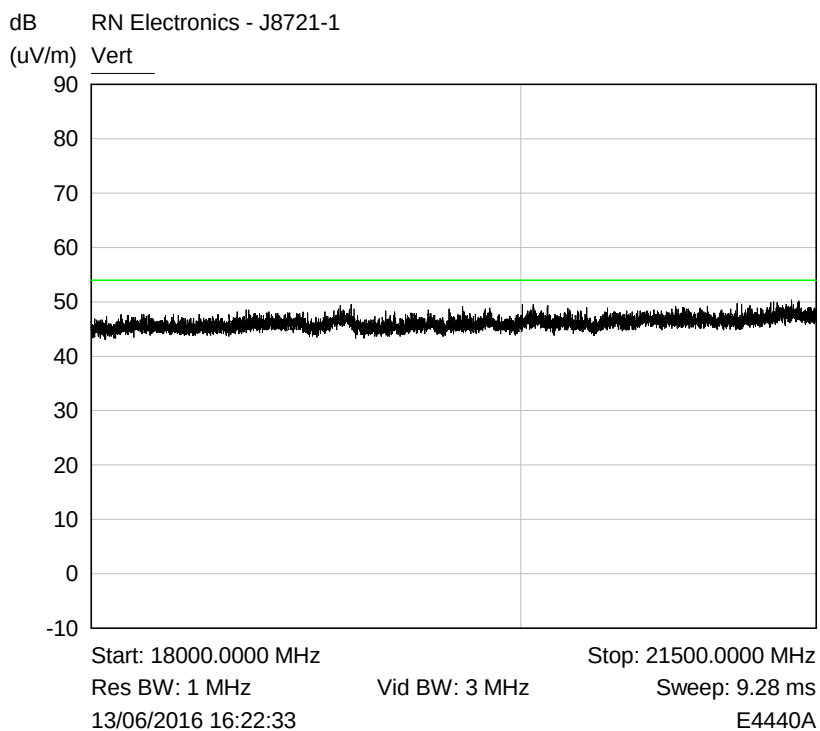
Plot of Peak horizontal (max held) emissions 12-15 GHz against the AV limit line.



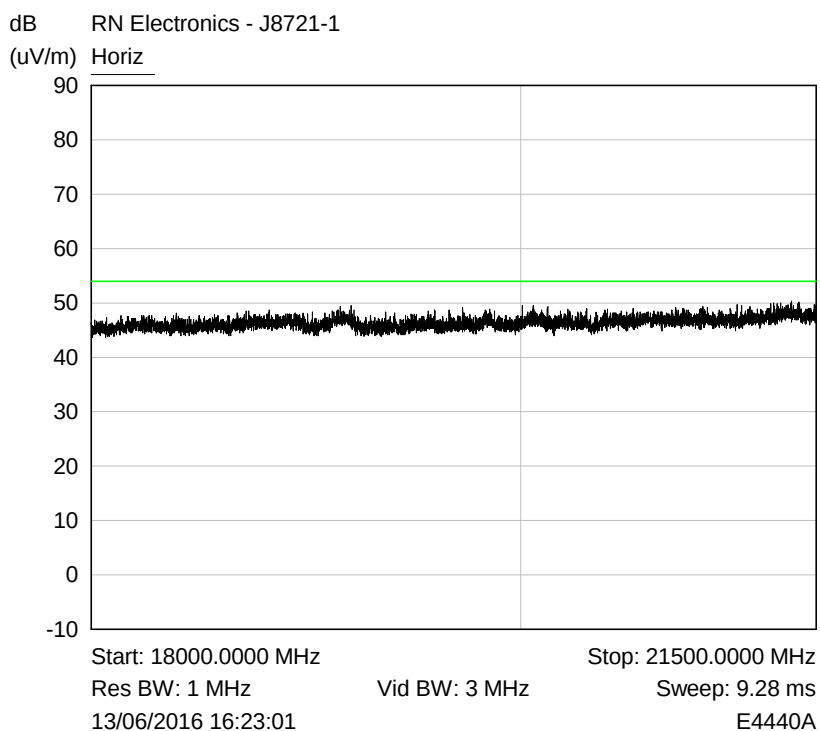
Plot of Peak vertical (max held) emissions 15-18 GHz against the AV limit line.



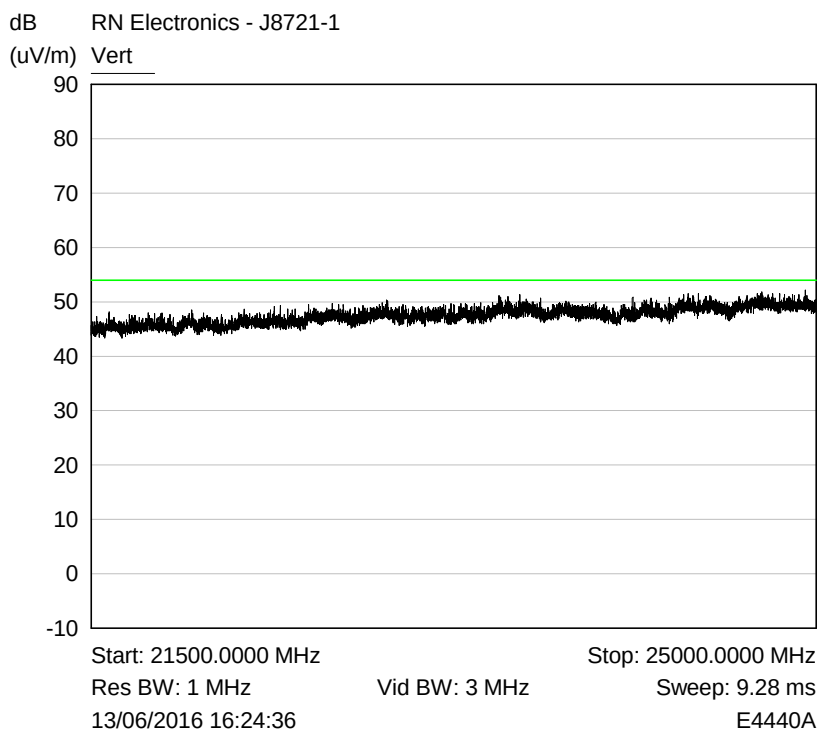
Plot of Peak horizontal (max held) emissions 15-18 GHz against the AV limit line.



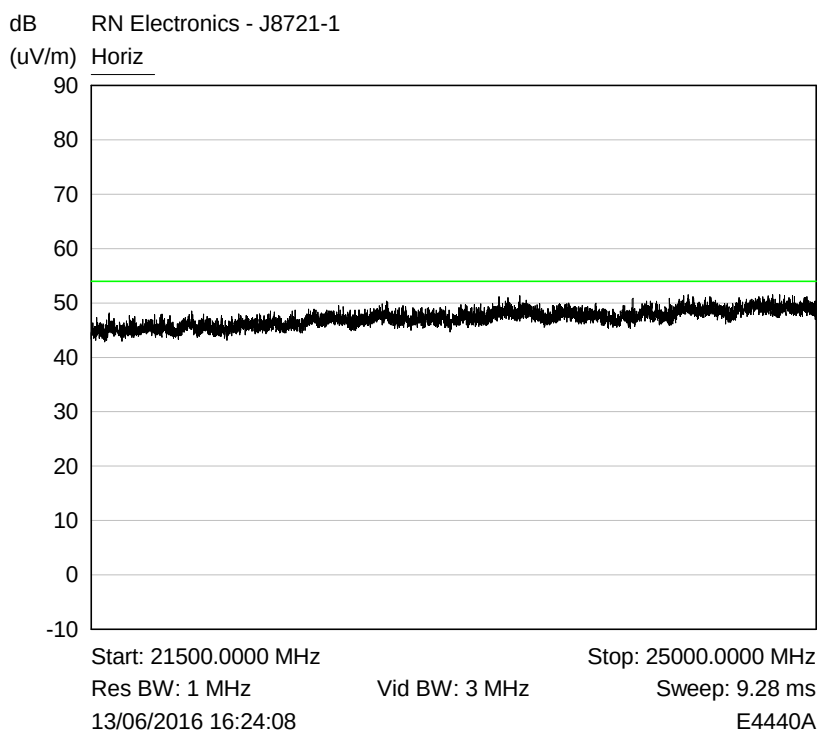
Plot of Peak vertical (max held) emissions 18-21.5 GHz against the AV limit line.



Plot of Peak horizontal (max held) emissions 18-21.5 GHz against the AV limit line.



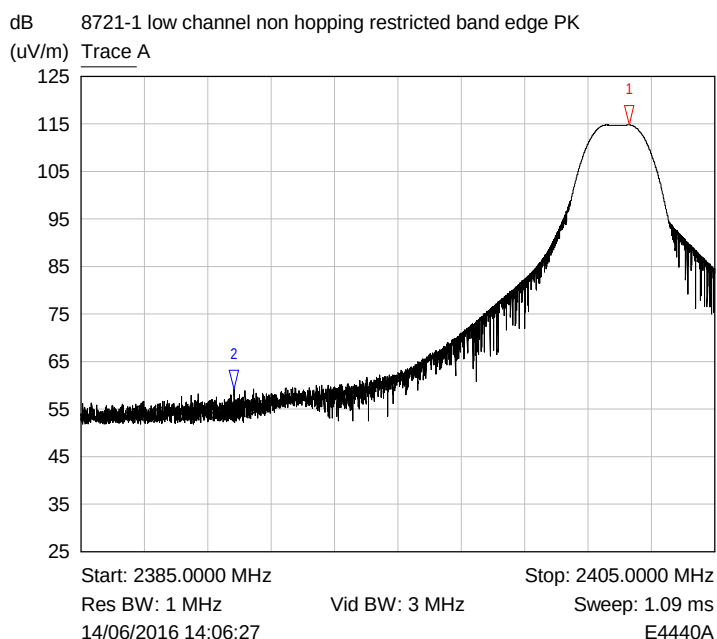
Plot of Peak vertical (max held) emissions 21.5-25 GHz against the AV limit line.



Plot of Peak horizontal (max held) emissions 21.5-25 GHz against the AV limit line.

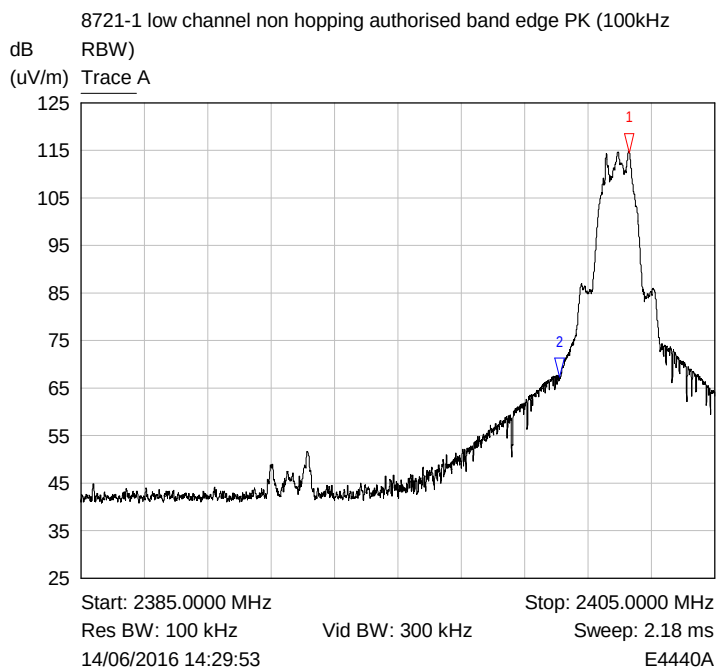
## 6.5 Band Edge Compliance

RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz, Modulation GFSK, Channel 2401.92 MHz



| Mkr | Trace   | X-Axis        | Value           | Notes |
|-----|---------|---------------|-----------------|-------|
| 1 ▽ | Trace A | 2402.3117 MHz | 114.78 dB(uV/m) |       |
| 2 ▽ | Trace A | 2389.8346 MHz | 59.12 dB(uV/m)  |       |

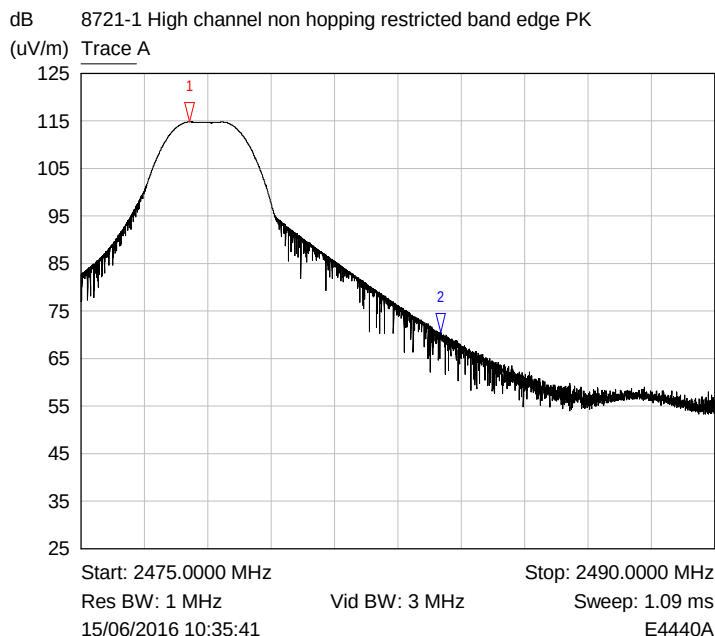
### Peak Plot



| Mkr | Trace   | X-Axis        | Value           | Notes |
|-----|---------|---------------|-----------------|-------|
| 1 ▽ | Trace A | 2402.3117 MHz | 114.44 dB(uV/m) |       |
| 2 ▽ | Trace A | 2400.0995 MHz | 67.27 dB(uV/m)  |       |

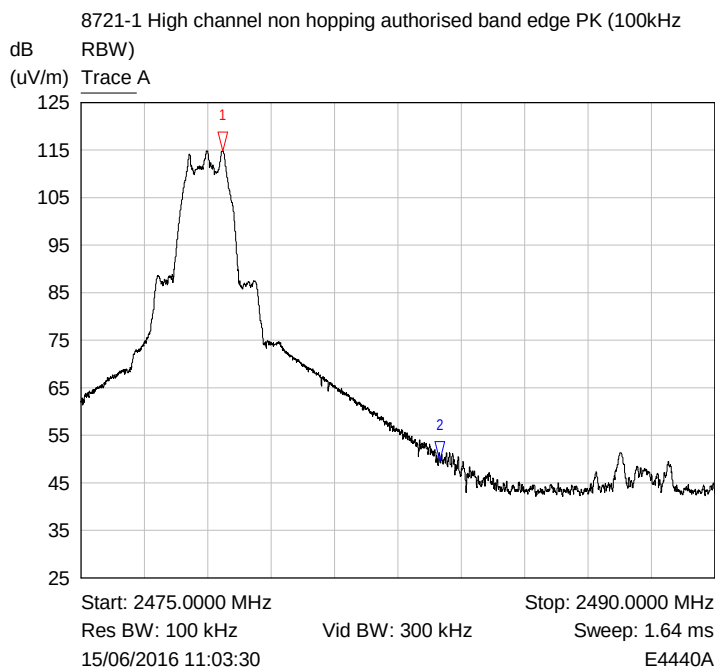
### Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, Channel 2477.952 MHz



| Mkr | Trace   | X-Axis        | Value           | Notes |
|-----|---------|---------------|-----------------|-------|
| 1 ▾ | Trace A | 2477.5656 MHz | 114.78 dB(uV/m) |       |
| 2 ▾ | Trace A | 2483.5081 MHz | 70.44 dB(uV/m)  |       |

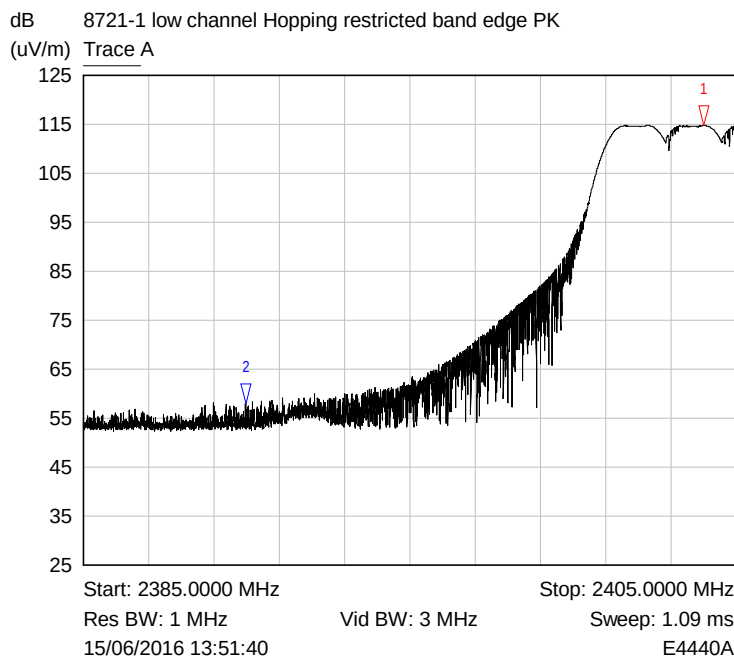
Peak Plot



| Mkr | Trace   | X-Axis        | Value           | Notes |
|-----|---------|---------------|-----------------|-------|
| 1 ▾ | Trace A | 2478.3531 MHz | 114.91 dB(uV/m) |       |
| 2 ▾ | Trace A | 2483.5008 MHz | 49.61 dB(uV/m)  |       |

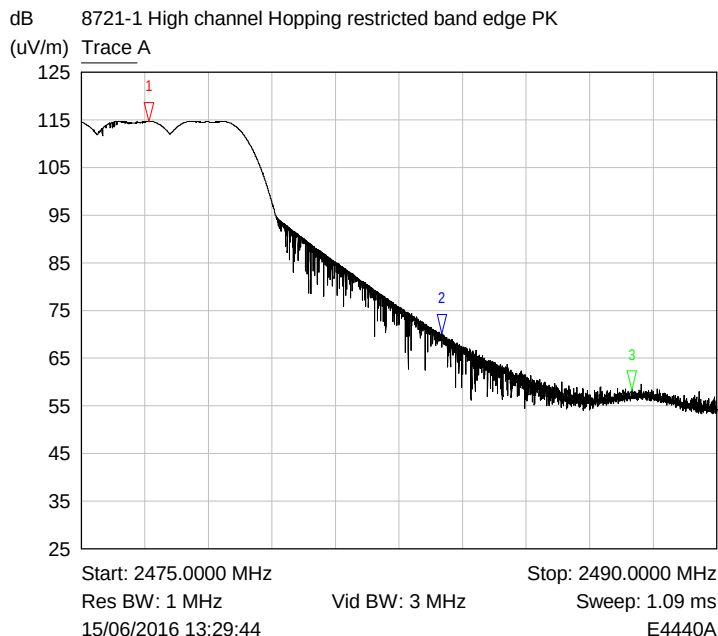
Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, Channel All Hopping



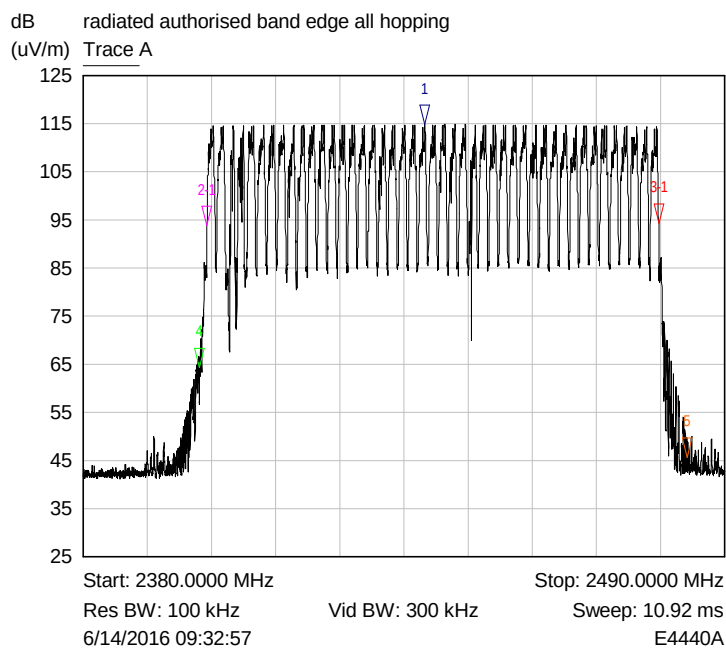
| Mkr | Trace   | X-Axis        | Value           | Notes |
|-----|---------|---------------|-----------------|-------|
| 1 ▽ | Trace A | 2403.9965 MHz | 114.80 dB(uV/m) |       |
| 2 ▽ | Trace A | 2389.9640 MHz | 58.07 dB(uV/m)  |       |

Peak restricted Plot Low band edge – Hopping



| Mkr | Trace   | X-Axis        | Value           | Notes |
|-----|---------|---------------|-----------------|-------|
| 1 ▽ | Trace A | 2476.5987 MHz | 114.68 dB(uV/m) |       |
| 2 ▽ | Trace A | 2483.5063 MHz | 70.11 dB(uV/m)  |       |
| 3 ▽ | Trace A | 2488.0021 MHz | 58.36 dB(uV/m)  |       |

Peak restricted Plot High band edge – Hopping

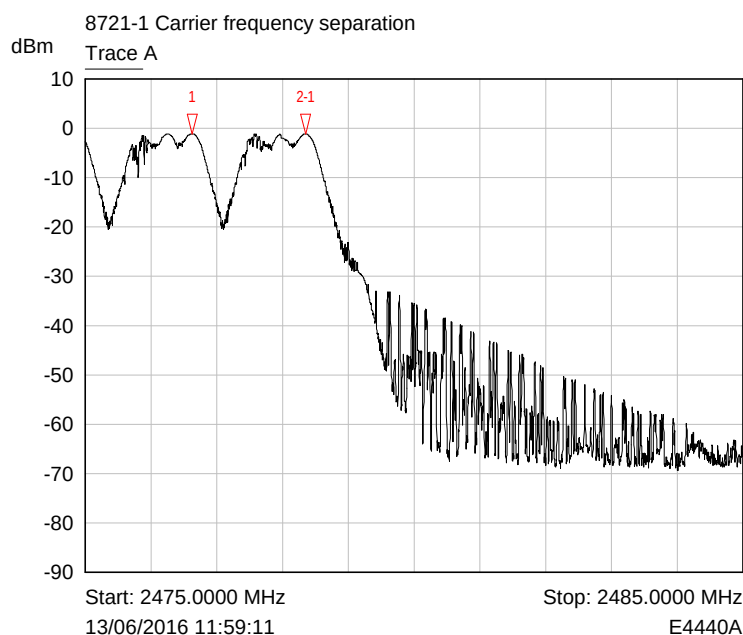


| Mkr   | Trace   | X-Axis        | Value           | Notes |
|-------|---------|---------------|-----------------|-------|
| 1 ▽   | Trace A | 2438.5924 MHz | 114.77 dB(uV/m) |       |
| 2-1 ▽ | Trace A | -37.3605 MHz  | -20.95 dB       |       |
| 3-1 ▽ | Trace A | 40.0733 MHz   | -20.45 dB       |       |
| 4 ▽   | Trace A | 2399.9963 MHz | 64.37 dB(uV/m)  |       |
| 5 ▽   | Trace A | 2483.5002 MHz | 45.72 dB(uV/m)  |       |

Band Edge Plot (Whole band) – Hopping

## 6.6 FHSS carrier frequency separation

RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz, Modulation GFSK

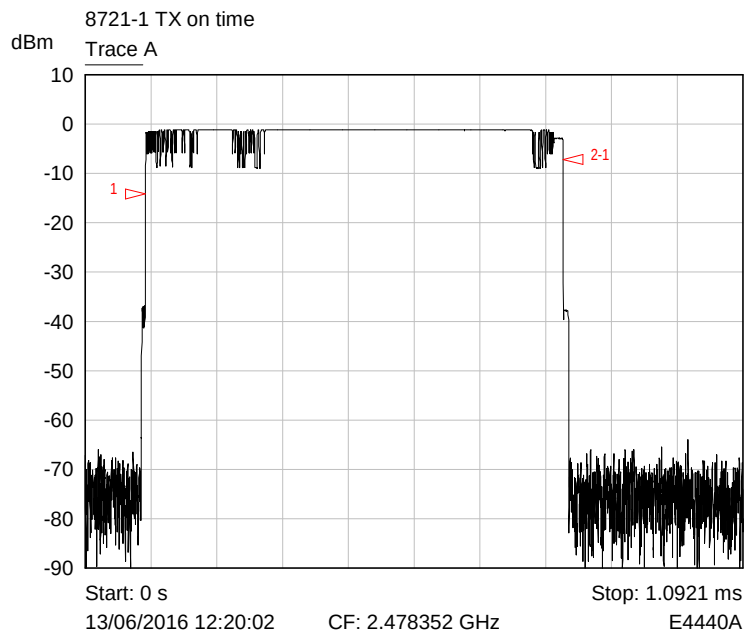


| Mkr   | Trace   | X-Axis        | Value     | Notes |
|-------|---------|---------------|-----------|-------|
| 1 ▽   | Trace A | 2476.6237 MHz | -1.11 dBm |       |
| 2-1 ▽ | Trace A | 1.7275 MHz    | -0.03 dB  |       |

Plot of Separation (kHz)

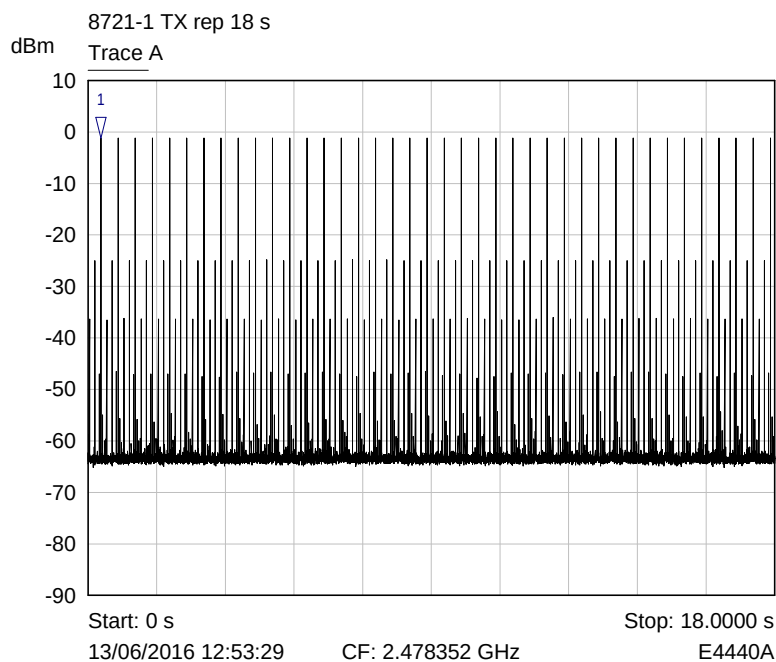
## 6.7 Average time of occupancy

RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, Channel All hopping



| Mkr   | Trace   | X-Axis      | Value      | Notes |
|-------|---------|-------------|------------|-------|
| 1 ▽   | Trace A | 100.0000 us | -14.12 dBm |       |
| 2-1 ▽ | Trace A | 693.0667 us | 6.90 dB    |       |

Measured Dwell time/pulse width (ms)

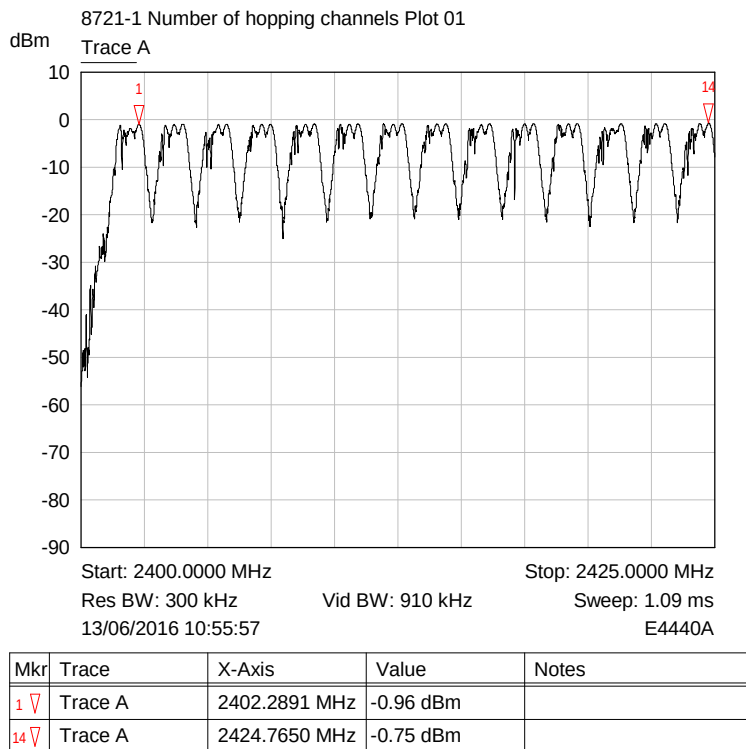


| Mkr | Trace   | X-Axis      | Value     | Notes |
|-----|---------|-------------|-----------|-------|
| 1 ▽ | Trace A | 336.2226 ms | -1.20 dBm |       |

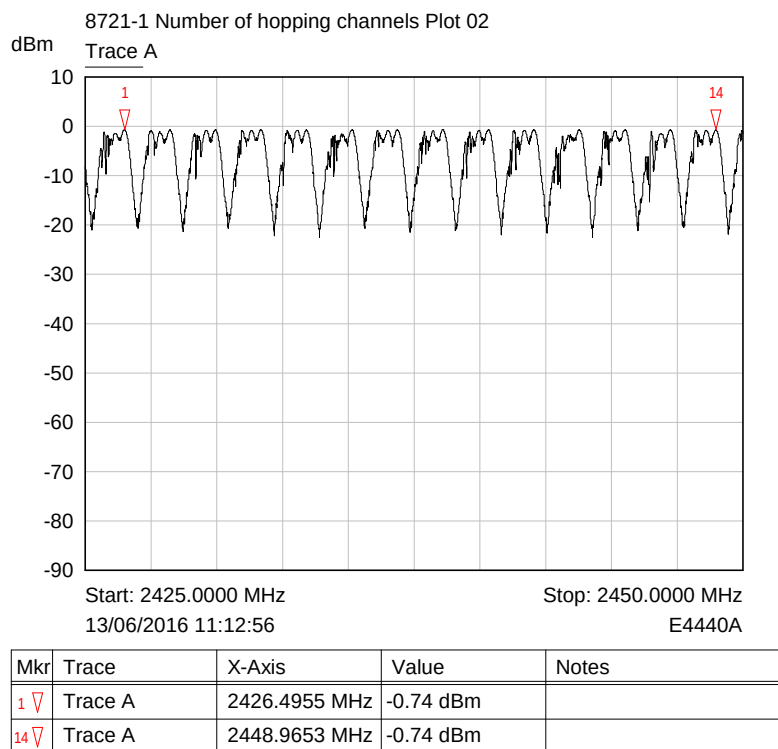
Period time (s)

## 6.8 Number of Hop Channels

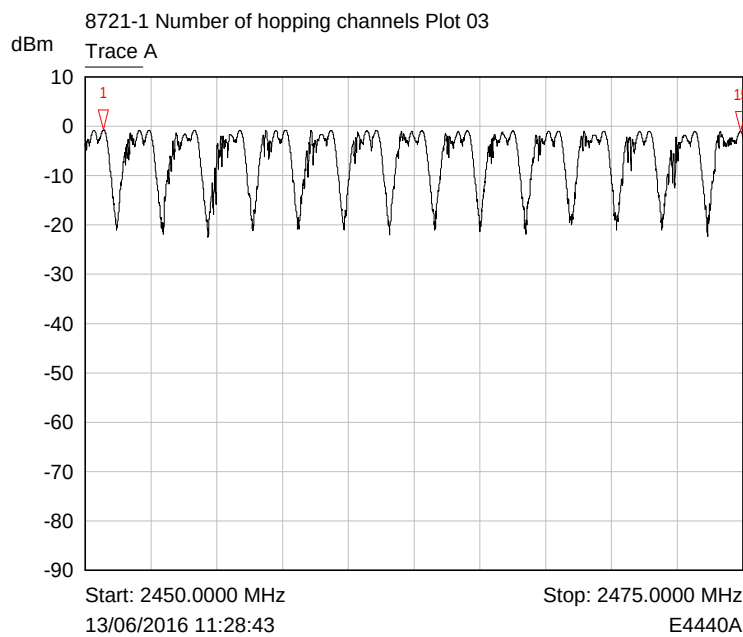
RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, Channel All hopping



Plot of Hopping Channels 1-14

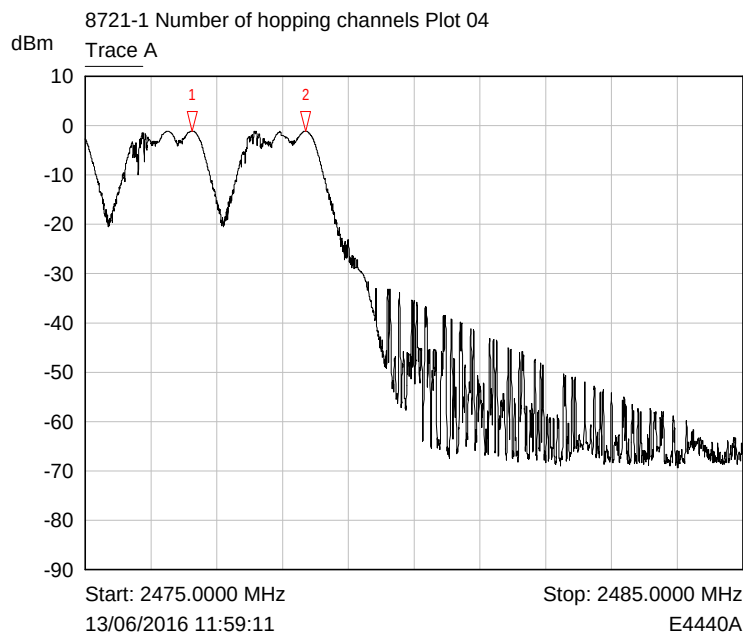


Plot of Hopping Channels 15-28



| Mkr  | Trace   | X-Axis        | Value     | Notes |
|------|---------|---------------|-----------|-------|
| 1 ▽  | Trace A | 2450.6989 MHz | -0.74 dBm |       |
| 15 ▽ | Trace A | 2474.9023 MHz | -1.05 dBm |       |

Plot of Hopping Channels 29-43

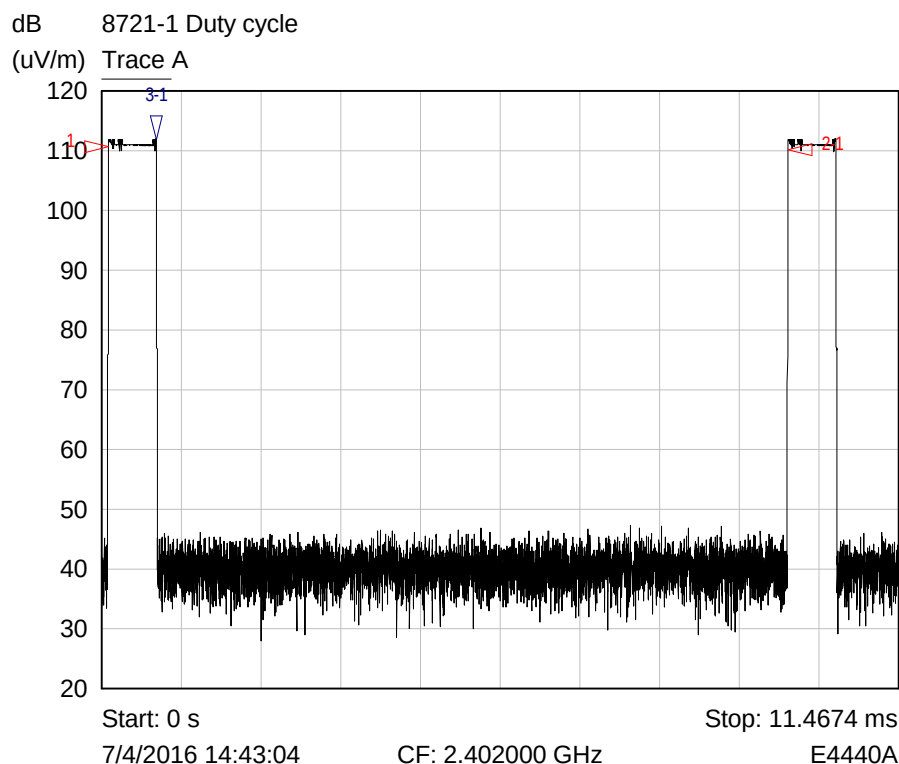


| Mkr | Trace   | X-Axis        | Value     | Notes |
|-----|---------|---------------|-----------|-------|
| 1 ▽ | Trace A | 2476.6237 MHz | -1.11 dBm |       |
| 2 ▽ | Trace A | 2478.3512 MHz | -1.14 dBm |       |

Plot of Hopping Channels 44-45

## 6.9 TX Duty cycle

RF Parameters: Band 2400-2483.5 MHz, Power 20 dBm, Channel Spacing 1.728 MHz,  
Modulation GFSK, All hopping



| Mkr   | Trace   | X-Axis      | Value           | Notes |
|-------|---------|-------------|-----------------|-------|
| 1 ▽   | Trace A | 98.0000 us  | 110.61 dB(uV/m) |       |
| 2-1 ▽ | Trace A | 9.7776 ms   | -0.46 dB        |       |
| 3-1 ▽ | Trace A | 693.0000 us | 1.22 dB         |       |

Plot EUT test mode duty cycle.

Note: EUT would use as a maximum two time slots within a 10ms period, therefore total TX on time in 10ms would be 1.386ms

## 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 (dBμV) | Pk – Lim 1 (dB) | QP Amp (dBμV) | QP - Lim1 (dB) | Av Amp (dBμV) | 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  $\mu\text{V/m}$  equates to  $20.\log(500) = 54 \text{ dB } \mu\text{V/m}$ .

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

(c) limit of 30  $\mu\text{V/m}$  at 30m, but below 30MHz, equates to  $20.\log(30) + 40.\log(30/3) = 69.5 \text{ dB}\mu\text{V/m}$  at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

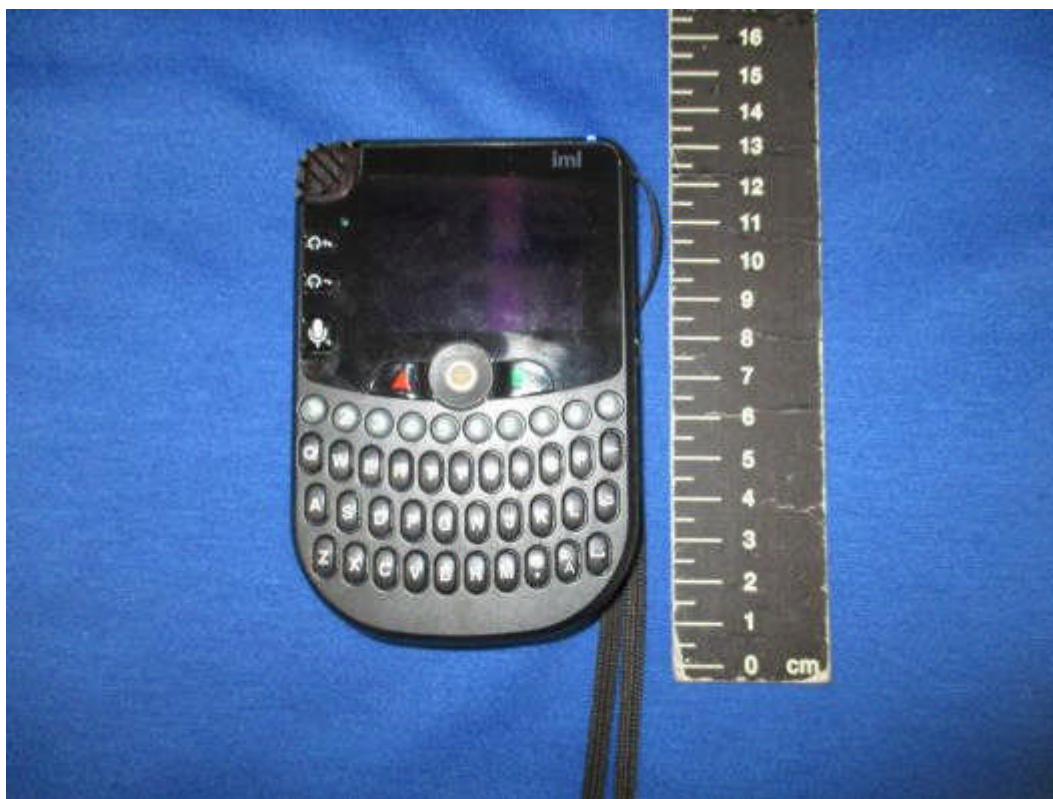
The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically. The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

Example calculation: -  $\text{FS} = \text{RA} + \text{AF} + \text{CL}$ .

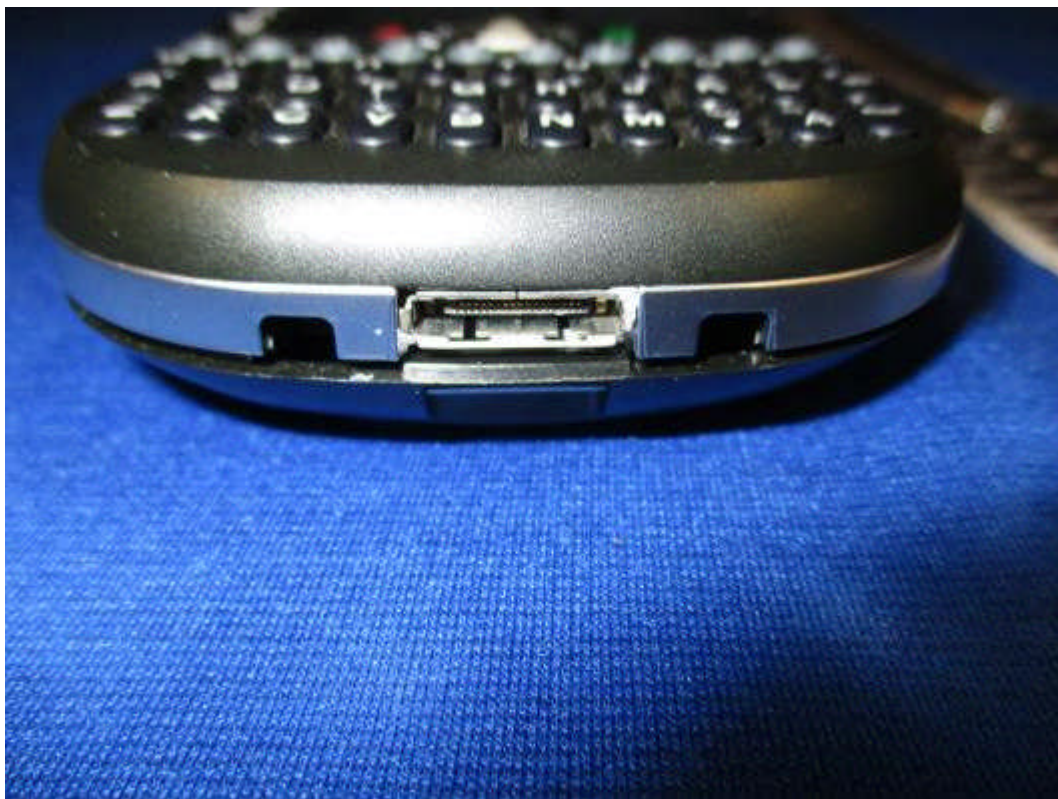
| Receiver amplitude (RA) | Antenna factor (3m)<br>(AF) | Cable loss (CL) | Field strength result (3m) (FS) |
|-------------------------|-----------------------------|-----------------|---------------------------------|
| 20dBuV                  | 25 dB                       | 3 dB            | 48dBuV/m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

## 8 Photographs

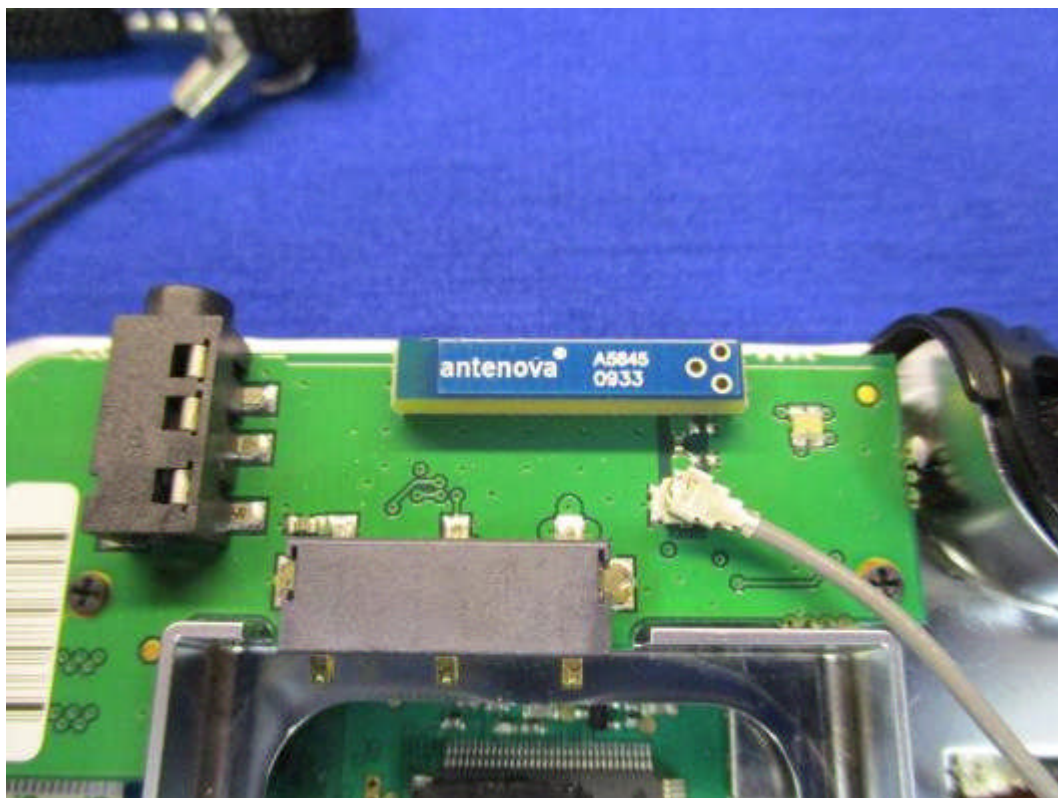
### 8.1 EUT Front View



## 8.2 EUT Reverse Angle



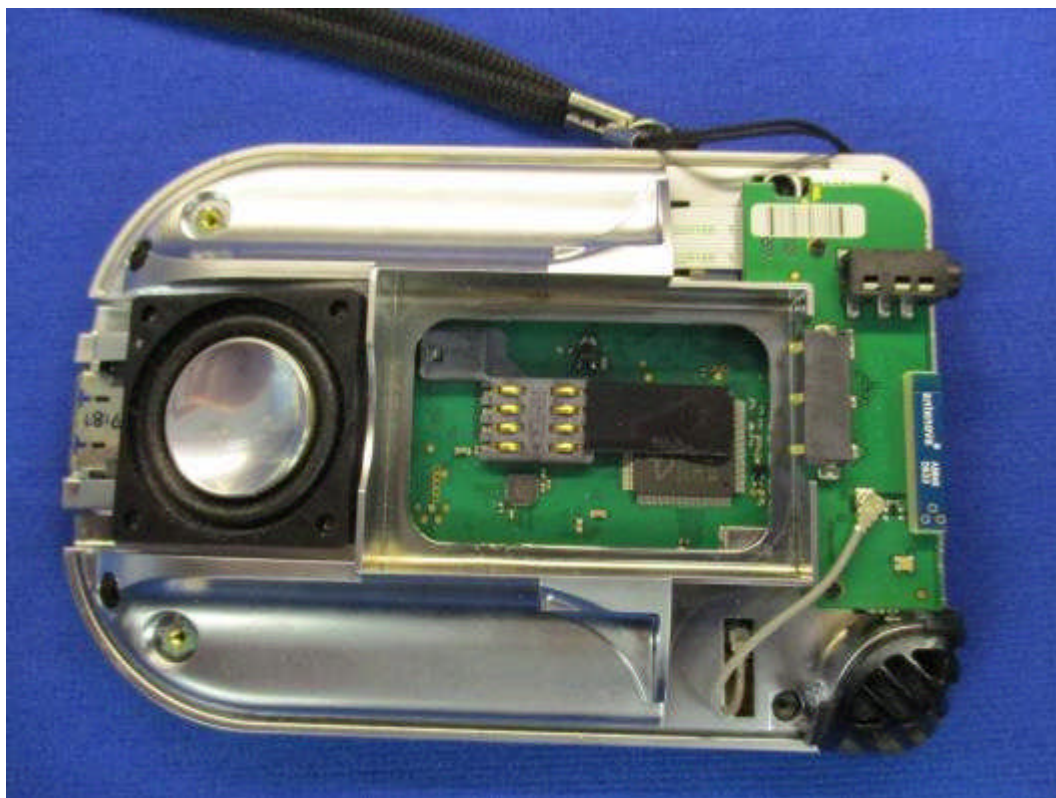
### 8.3 EUT Antenna Port

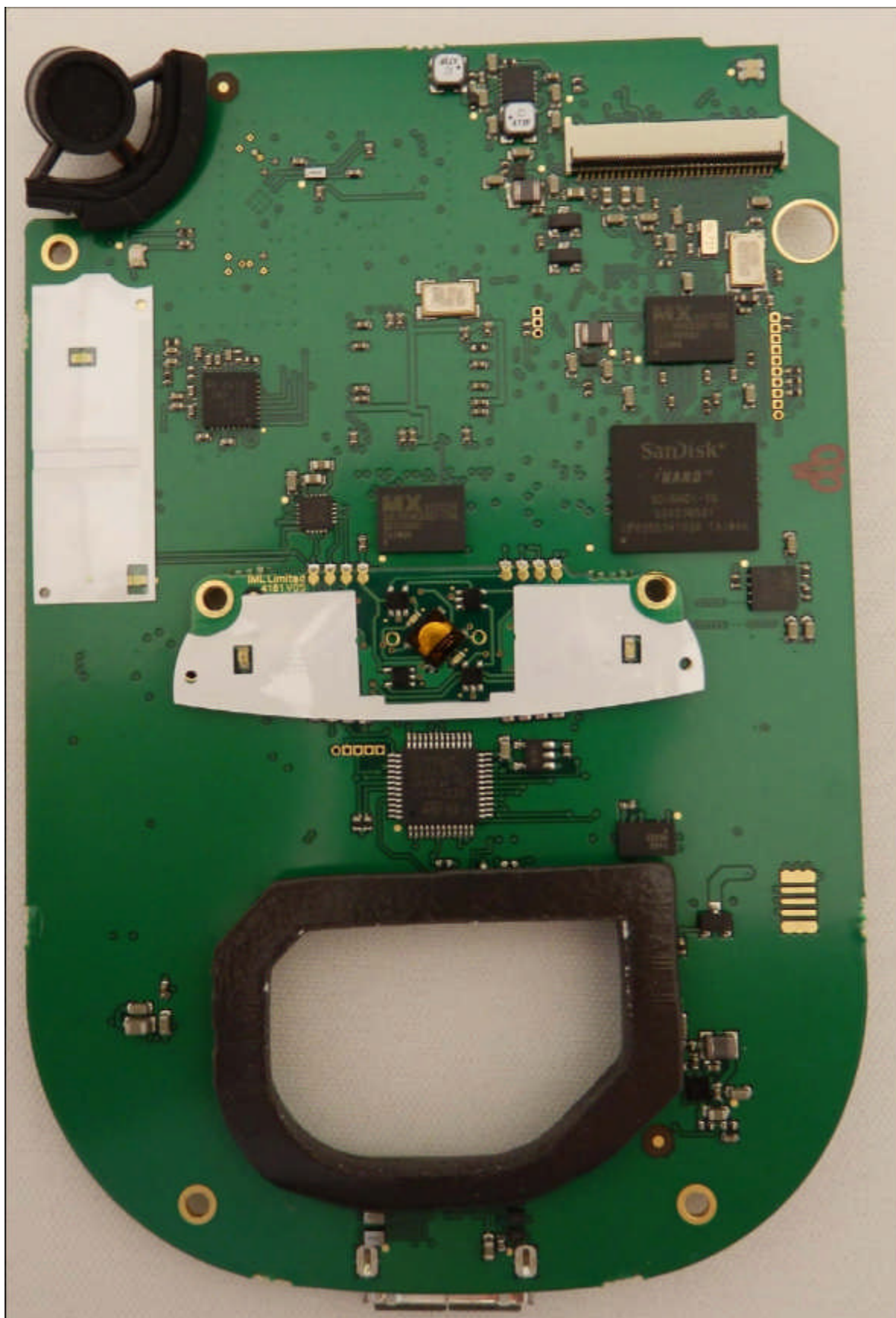


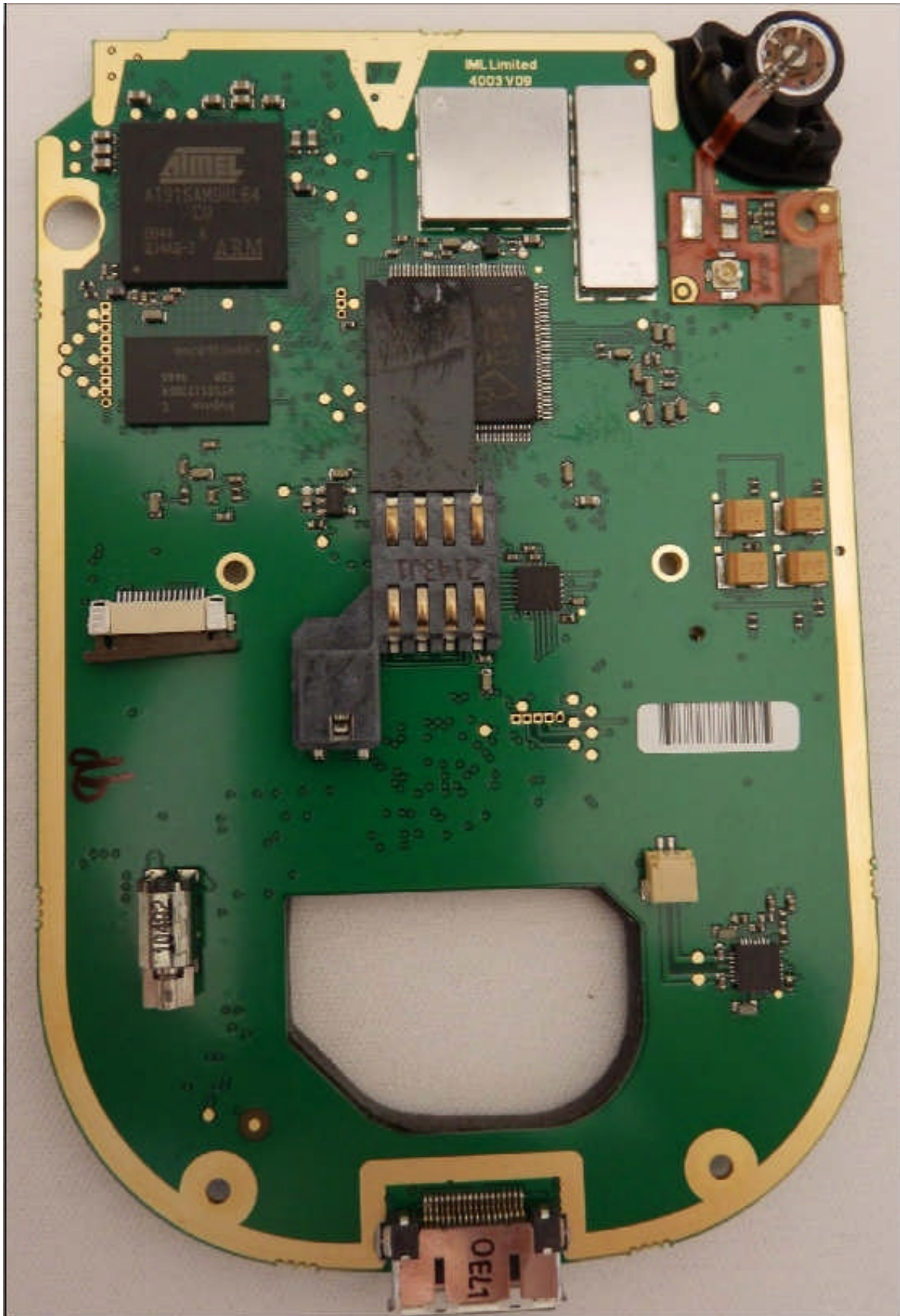
## 8.4 EUT Display & Controls



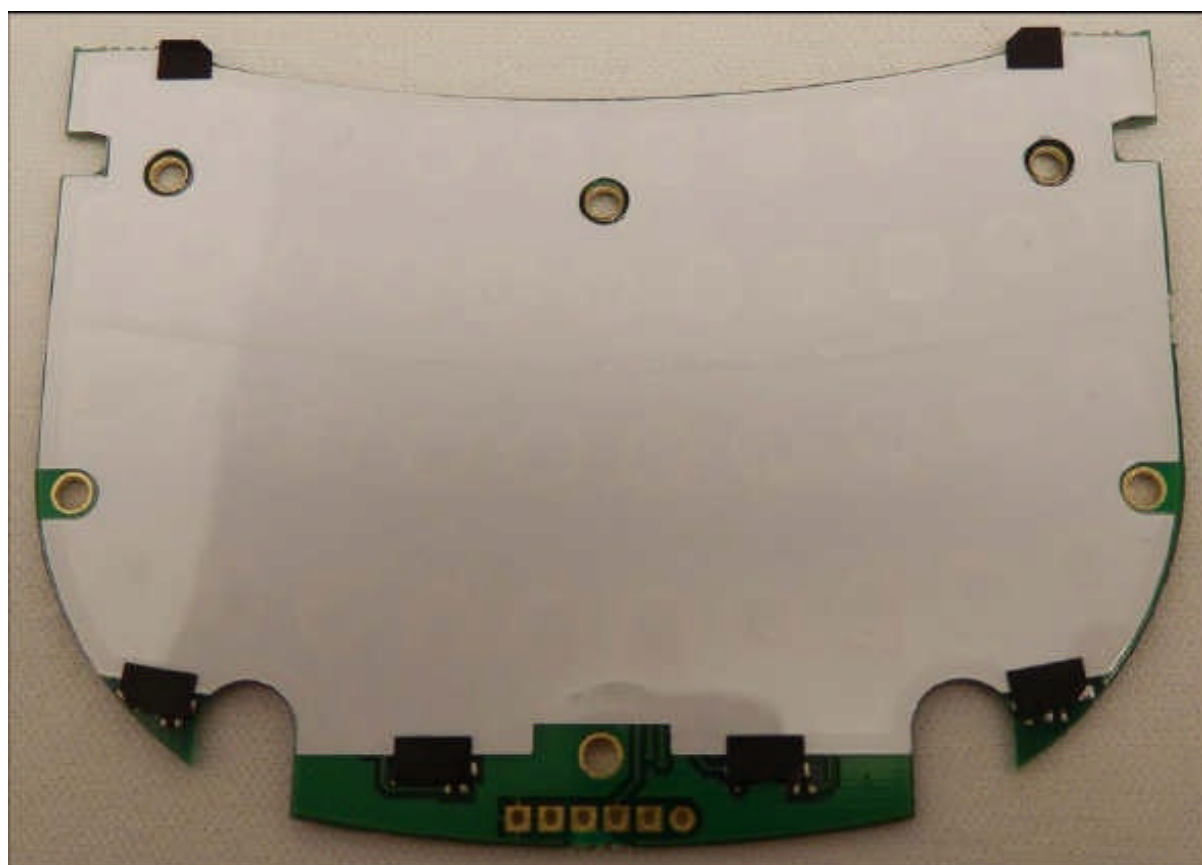
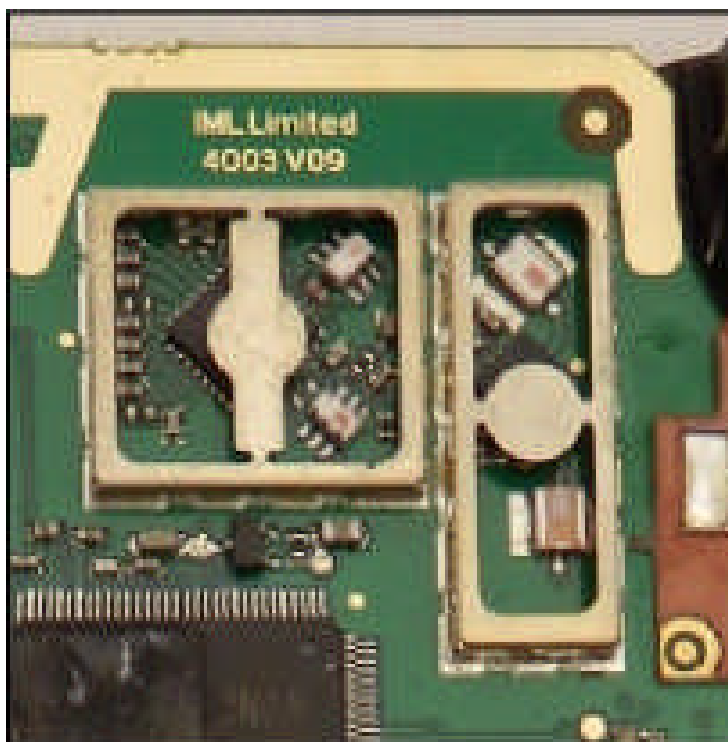
## 8.5 EUT Internal photos

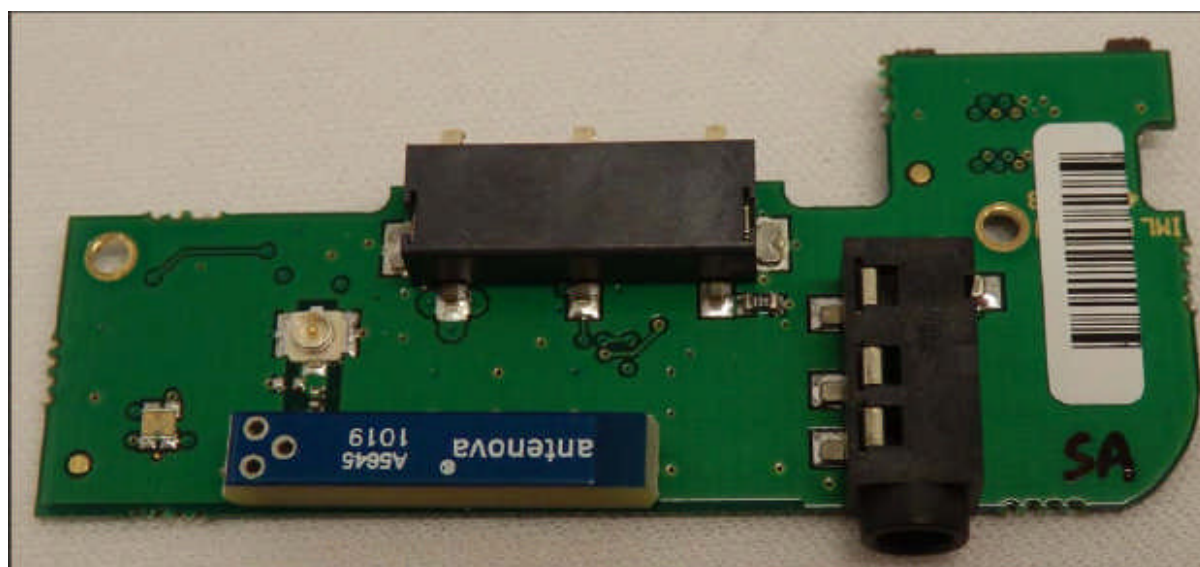
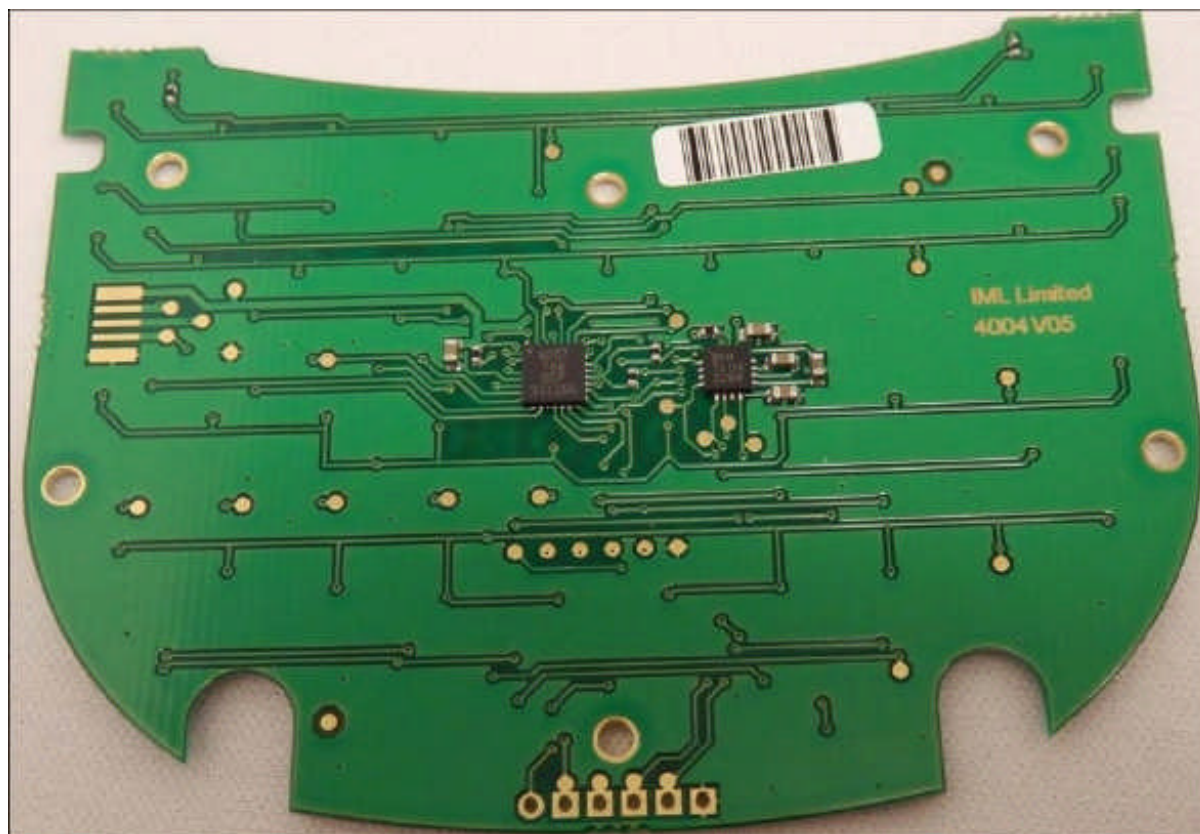


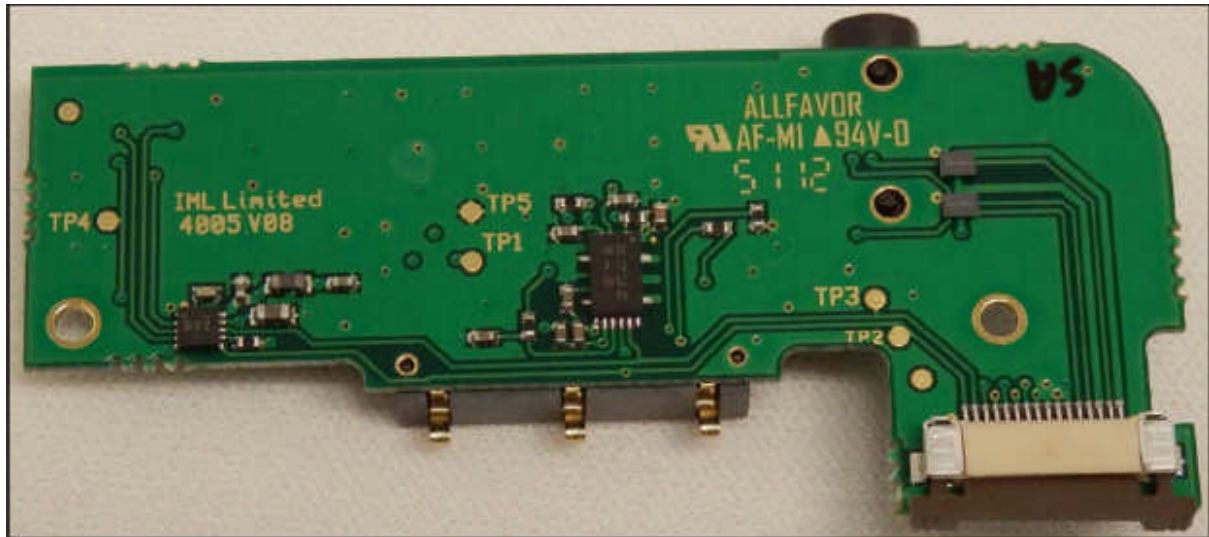




RF cans removed







## 8.6 EUT ID Label

Not provided at time of test.

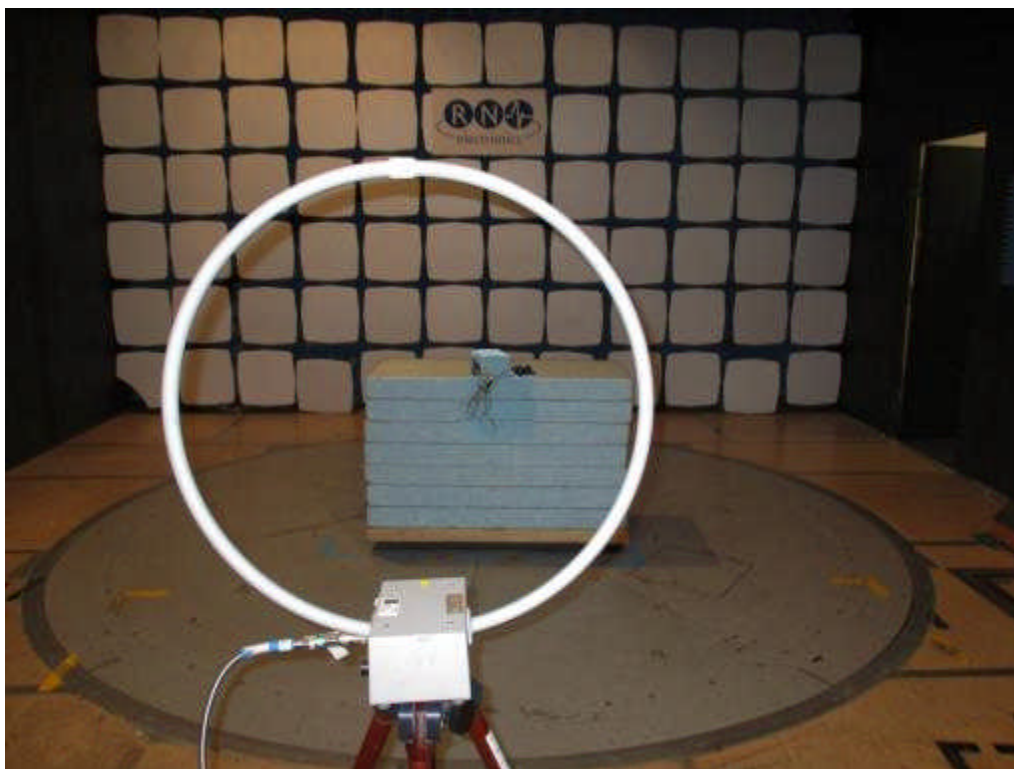
## 8.7 EUT Chassis



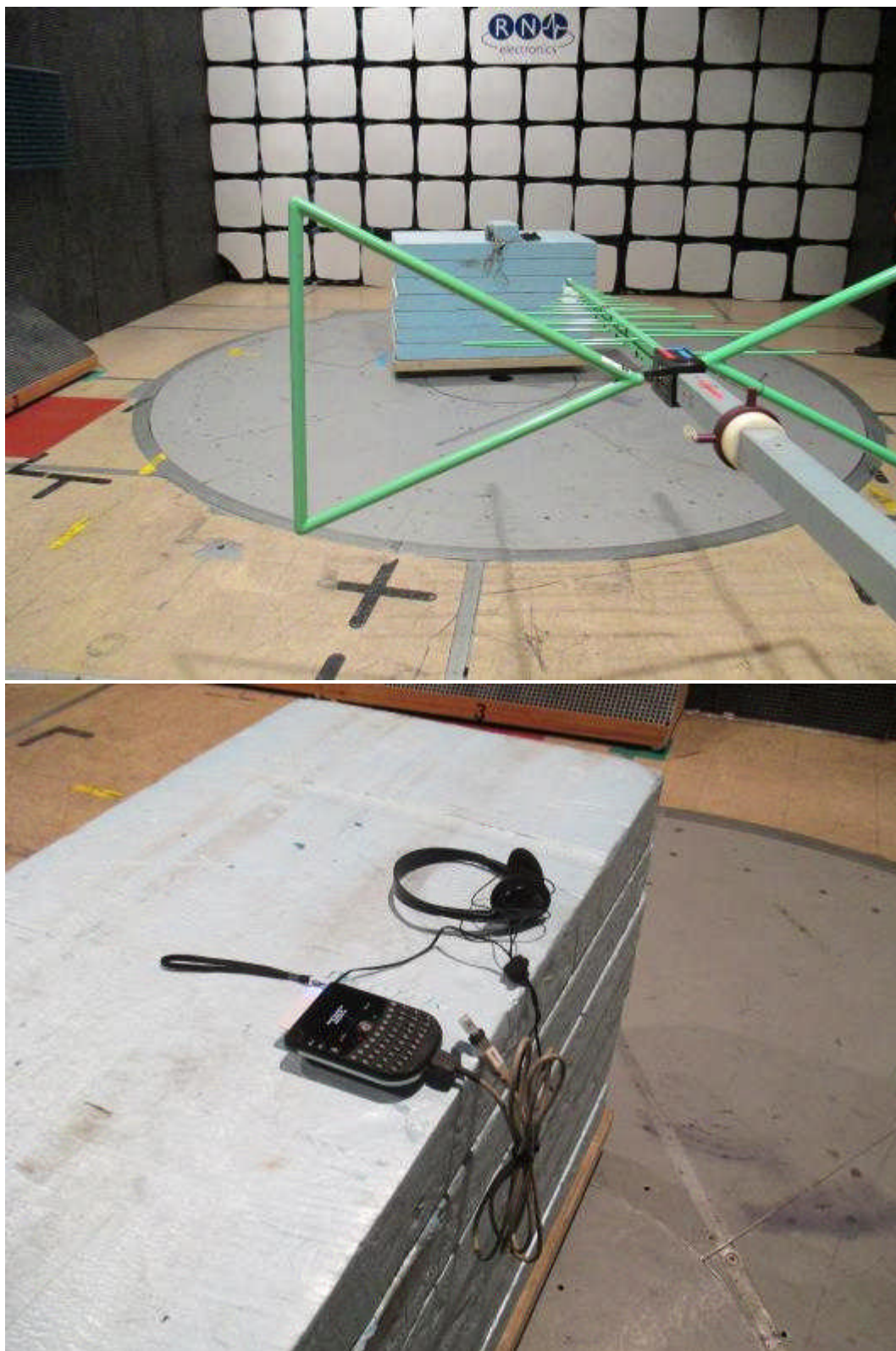
## 8.8 AC power line conducted emissions



## 8.9 TX Unwanted radiated emissions 150 kHz – 30 MHz



## 8.10 Radiated emissions 30 MHz - 1 GHz





## 8.11 Radiated emissions above 1 GHz



## 8.12 Radiated emission diagram

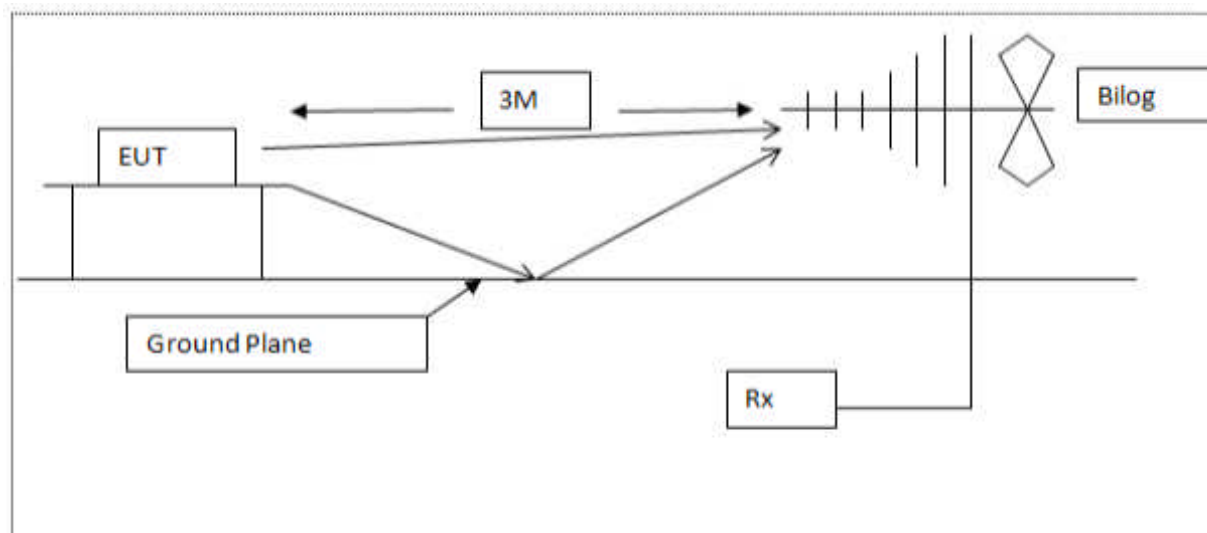


Diagram of the radiated emissions test setup 30 - 1000 MHz

### 8.13 AC powerline conducted emission diagram

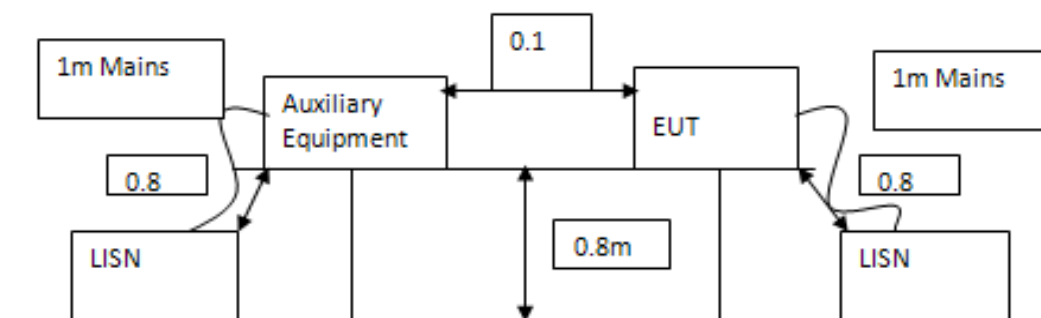


Diagram of the AC conducted emissions test setup

## 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       | 01-Jun-2016      | 6 months   |
| E411   | N9039A    | 9 kHz - 1 GHz RF Filter Section   | Agilent Technologies  | 29-Apr-2016      | 12 months  |
| E412   | E4440A    | PSA 3Hz – 26.5 GHz                | Agilent Technologies  | 29-Apr-2015      | 24 months  |
| E533   | N5182A    | Signal Generator 6 GHz MXG        | Agilent Technologies  | 26-Feb-2016      | 36 months  |
| E534   | E4440A    | PSA 3 Hz - 26.5 GHz               | Agilent Technologies  | 26-Feb-2015      | 24 months  |
| E535   | N9039A    | 9 kHz - 1 GHz RF Filter Section   | Agilent Technologies  | 25-Feb-2016      | 12 months  |
| E547   | 8493A     | Attenuator 20dB 12.4GHz           | Hewlett Packard       | 16-Oct-2015      | 12 months  |
| E611   | RPR3006W  | USB RF Power Sensor 10MHz - 6GHz  | DARE Instruments      | 21-Apr-2016      | 12 months  |
| LPE261 | 3115      | 1-18GHz Horn                      | EMCO                  | 04-Apr-2016      | 24 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             | 07-Jul-2015      | 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  |
| ZSW1   | V2.0      | Measurement Software Suite        | RN Electronics        | N/A              | N/A        |

## 10 Auxiliary and peripheral equipment

### 10.1 Customer supplied equipment

| Item No. | Model No. | Description                                 | Manufacturer | Serial No. |
|----------|-----------|---------------------------------------------|--------------|------------|
| 1        | PX30      | Headphones                                  | Sennheiser   | IML08      |
| 2        | -         | Smartcard                                   | IML          | -          |
| 3        | -         | 2m USB to Hirose 18 pin with USB terminator | -            | -          |

### 10.2 RN Electronics supplied equipment

| RN No. | Model No.     | Description | Manufacturer    | Serial No  |
|--------|---------------|-------------|-----------------|------------|
| I039   | compaq nx9010 | Laptop      | Hewlett Packard | CNF41315YS |

## 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)<br>VCCI Registration No. C-2823                                  |
| Site G                                   | Screened Room (Control Room for Site H)                                                              |
| Site H                                   | 3m Semi-anechoic chamber (indoor OATS)<br>FCC Registration No. 293246<br>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)<br>FCC Registration No. 293246                                |
| Site Q                                   | Fully-anechoic chamber                                                                               |
| Site OATS 3m and 10m Open Area Test Site | FCC Registration No. 293246<br>IC Registration No. 5612A-1<br>VCCI Registration No. R-2580           |
| 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                                                            |        |                                                |