

**A Radio Test Report**

**FOR**

**Renishaw Plc**

**ON**

**Primo Radio 3D Tool Setter**

**DOCUMENT NO.TRA-013623-47-03A**

**HULL**

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**TRaC Wireless Test Report** : TRA-013623-47-03A

**Applicant** : Renishaw Plc

**Apparatus** : Primo Radio 3D Tool Setter

**Specification(s)** : CFR47 Part 15.247 & RSS-210 Annex 8

**FCCID** :KQGPR3DTS

**ICID** :3928A-PR3DTS

**Purpose of Test** : Certification

**Authorised by**

: 

: Radio Product Manager

**Issue Date** :13<sup>th</sup> February 2014

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**Section 1:**

**Introduction**

**1.1 General**

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

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## **1.2 Tests Requested By**

This testing in this report was requested by:

Renishaw Plc  
New Mills  
Wotton Under Edge  
Gloucestershire  
GL12 8JR

## **1.3 Manufacturer**

As above

## **1.4 Apparatus Assessed**

The following apparatus was assessed between 09<sup>th</sup> January 2014 and 20<sup>th</sup> January 2014.

Primo Radio 3D Tool Setter

The above device operates in the license free 2.4GHz radio band.

## 1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

| Test Type                                              | Regulation                                  |                                     | Measurement standard | Result |
|--------------------------------------------------------|---------------------------------------------|-------------------------------------|----------------------|--------|
|                                                        | Title 47 of the CFR:<br>Part 15 Subpart (c) | RSS – 210 Issue 8,<br>December 2010 |                      |        |
| Radiated spurious emissions<br>(Restricted bands)      | 15.247                                      | Annex 8, A8.5                       | ANSI<br>C63.10:2009  | Pass   |
| Conducted spurious emissions<br>(Non-restricted bands) | 15.247                                      | Annex 8, A8.5                       | ANSI<br>C63.10:2009  | Pass   |
| AC Power conducted emissions                           | 15.207                                      | Section 7.2.2                       | ANSI<br>C63.10:2009  | N/A    |
| 20dB Bandwidth and Channel Spacing                     | 15.247(a)(1)(i)                             | Annex 8, A8.1(b)                    | ANSI<br>C63.10:2009  | Pass   |
| Conducted Carrier Power                                | 15.247(b)(2)                                | Annex 8, A8.4(2)                    | ANSI<br>C63.10:2009  | Pass   |
| Hopping Frequencies                                    | 15.247(a)(1)                                | Annex 8, A8.1(d)                    | ANSI<br>C63.10:2009  | Pass   |
| Channel Occupancy                                      | 15.247(a)(1)(i)                             | Annex 8, A8.1(d)                    | ANSI<br>C63.10:2009  | Pass   |
| Unintentional Radiated Spurious Emissions              | 15.109                                      | Section 7.2.3                       | ANSI<br>C63.10:2009  | Pass   |
| Extrapolation Factor:                                  | 15.31(f)                                    | RSS-Gen Issue 3<br>7.2.7            | -                    | -      |
| Maximum Frequency of Search:                           | 15.33                                       | RSS-Gen Issue 3<br>4.9              | -                    | -      |
| Antenna Arrangements Integral:                         | 15.203                                      | RSS-Gen Issue 3<br>7.1.2            | -                    | -      |
| Antenna Arrangements External Connector:               | 15.204                                      | RSS-Gen Issue 3<br>7.1.2            | -                    | -      |
| Restricted Bands:                                      | 15.205                                      | RSS-Gen Issue 3<br>7.2.2            | -                    | -      |

Abbreviations used in the above table:

ANSI C 63.10:2009 is outside the scope of the laboratories UKAS accreditation.

Mod : Modification  
CFR : Code of Federal Regulations  
REFE : Radiated Electric Field Emissions

RSS : Radio Standards Specification  
ANSI : American National Standards Institution  
PLCE : Power Line Conducted Emissions

## **1.6 Notes Relating To The Assessment**

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, "Pass" indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

|                     |                 |
|---------------------|-----------------|
| Temperature         | : 17 to 23 °C   |
| Humidity            | : 45 to 75 %    |
| Barometric Pressure | : 86 to 106 kPa |

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

## **1.7 Deviations from Test Standards**

There were no deviations from the standards tested to.

**Section 2:****Measurement Uncertainty****2.1 Measurement Uncertainty Values**

For the test data recorded the following measurement uncertainty was calculated :

**Radio Testing – General Uncertainty Schedule**

*All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence where no required test level exists.*

**[1] Adjacent Channel Power**

Uncertainty in test result = **1.86dB**

**[2] Carrier Power**

Uncertainty in test result (Power Meter) = **1.08dB**

Uncertainty in test result (Spectrum Analyser) = **2.48dB**

**[3] Effective Radiated Power**

Uncertainty in test result = **4.71dB**

**[4] Spurious Emissions**

Uncertainty in test result = **4.75dB**

**[5] Maximum frequency error**

Uncertainty in test result (Frequency Counter) = **0.113ppm**

Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

**[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field**

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,

Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,

Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

**[7] Frequency deviation**

Uncertainty in test result = **3.2%**

**[8] Magnetic Field Emissions**

Uncertainty in test result = **2.3dB**

**[9] Conducted Spurious**

Uncertainty in test result – Up to 8.1GHz = **3.31dB**

Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**

Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**

Uncertainty in test result – Up to 26GHz = **3.14dB**

**[10] Channel Bandwidth**

Uncertainty in test result = **15.5%**

**[11] Amplitude and Time Measurement – Oscilloscope**

Uncertainty in overall test level = **2.1dB**,  
Uncertainty in time measurement = **0.59%**,  
Uncertainty in Amplitude measurement = **0.82%**

**[12] Power Line Conduction**

Uncertainty in test result = **3.4dB**

**[13] Spectrum Mask Measurements**

Uncertainty in test result = **2.59% (frequency)**  
Uncertainty in test result = **1.32dB (amplitude)**

**[14] Adjacent Sub Band Selectivity**

Uncertainty in test result = **1.24dB**

**[15] Receiver Blocking – Listen Mode, Radiated**

Uncertainty in test result = **3.42dB**

**[16] Receiver Blocking – Talk Mode, Radiated**

Uncertainty in test result = **3.36dB**

**[17] Receiver Blocking – Talk Mode, Conducted**

Uncertainty in test result = **1.24dB**

**[18] Receiver Threshold**

Uncertainty in test result = **3.23dB**

**[19] Transmission Time Measurement**

Uncertainty in test result = **7.98%**

**Section 3:**

**Modifications**

**3.1 Modifications Performed During Assessment**

No modifications were performed during the assessment

**Appendix A:****Formal Emission Test Results**

Abbreviations used in the tables in this appendix:

|      |                                 |      |                                |
|------|---------------------------------|------|--------------------------------|
| Spec | : Specification                 | ALSR | : Absorber Lined Screened Room |
| Mod  | : Modification                  | OATS | : Open Area Test Site          |
|      |                                 | ATS  | : Alternative Test Site        |
| EUT  | : Equipment Under Test          |      |                                |
| SE   | : Support Equipment             | Ref  | : Reference                    |
|      |                                 | Freq | : Frequency                    |
| L    | : Live Power Line               |      |                                |
| N    | : Neutral Power Line            | MD   | : Measurement Distance         |
| E    | : Earth Power Line              | SD   | : Spec Distance                |
|      |                                 |      |                                |
| Pk   | : Peak Detector                 | Pol  | : Polarisation                 |
| QP   | : Quasi-Peak Detector           | H    | : Horizontal Polarisation      |
| Av   | : Average Detector              | V    | : Vertical Polarisation        |
|      |                                 |      |                                |
| CDN  | : Coupling & decoupling network |      |                                |

**A1 Transmitter Peak Output Power**

Carrier power was verified with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

| Test Details:          |                                               |
|------------------------|-----------------------------------------------|
| Regulation             | Part 15.247(b)(1) RSS – 210, Annex 8, A8.4(2) |
| Measurement standard   | ANSI C63.10:2009, RSS-GEN                     |
| EUT sample number      | S01                                           |
| Modification state     | 0                                             |
| SE in test environment | None                                          |
| SE isolated from EUT   | None                                          |
| EUT set up             | Refer to Appendix C                           |
| Temperature            | 24.8°C                                        |

| Channel Frequency (MHz) | Peak Carrier Power (W) | Limit (W) | Result |
|-------------------------|------------------------|-----------|--------|
| 2402                    | 0.00088                | 1         | Pass   |
| 2441                    | 0.00104                |           | Pass   |
| 2480                    | 0.00115                |           | Pass   |

Notes:

Number of hopping channels employed is 79

Conducted measurements were performed with a temporary antenna connector provided by the client.

**A2 RF Antenna Conducted Spurious Emissions**

Measurement of conducted spurious emissions at the antenna port was performed using a peak detector with the RBW set to 100kHz and the VBW>RBW. Frequencies were scanned up through to the 10th harmonic with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

| <b>Test Details: 2402 MHz</b> |                                                         |
|-------------------------------|---------------------------------------------------------|
| Regulation                    | Part 15.247(d) and Clause 15.205, RSS-210 Annex 8, A8.5 |
| Measurement standard          | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003            |
| Frequency range               | 9 kHz to 25 GHz                                         |
| EUT sample number             | S01                                                     |
| Modification state            | 0                                                       |
| SE in test environment        | None                                                    |
| SE isolated from EUT          | None                                                    |
| EUT set up                    | Refer to Appendix C                                     |
| Temperature                   | 24.8°C                                                  |

| Ref No. | Measured Freq (MHz)                               | Det. | Is measured Frequency within the Restricted bands (Y/N) | Measured Peak Conducted power (RBW =100kHz) (dBuV) | 15.247(d) Limit (dBuV) | Summary |
|---------|---------------------------------------------------|------|---------------------------------------------------------|----------------------------------------------------|------------------------|---------|
| 1       | No significant emissions within 20dB of the limit |      |                                                         |                                                    |                        | Pass    |

**RF Antenna Conducted Spurious Emissions continued:**

| <b>Test Details: 2441 MHz</b> |                                                         |
|-------------------------------|---------------------------------------------------------|
| Regulation                    | Part 15.247(d) and Clause 15.205, RSS-210 Annex 8, A8.5 |
| Measurement standard          | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003            |
| Frequency range               | 9 kHz to 25 GHz                                         |
| EUT sample number             | S01                                                     |
| Modification state            | 0                                                       |
| SE in test environment        | None                                                    |
| SE isolated from EUT          | None                                                    |
| EUT set up                    | Refer to Appendix C                                     |
| Temperature                   | 24.8°C                                                  |

| Ref No. | Measured Freq (MHz)                               | Det. | Is measured Frequency within the Restricted bands (Y/N) | Measured Peak Conducted power (RBW =100kHz) (dBuV) | 15.247(d) Limit (dBuV) | Summary |
|---------|---------------------------------------------------|------|---------------------------------------------------------|----------------------------------------------------|------------------------|---------|
| 1       | No significant emissions within 20dB of the limit |      |                                                         |                                                    |                        | Pass    |

**RF Antenna Conducted Spurious Emissions continued:**

| <b>Test Details: 2480 MHz</b> |                                                         |
|-------------------------------|---------------------------------------------------------|
| Regulation                    | Part 15.247(d) and Clause 15.205, RSS-210 Annex 8, A8.5 |
| Measurement standard          | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003            |
| Frequency range               | 9 kHz to 25 GHz                                         |
| EUT sample number             | S01                                                     |
| Modification state            | 0                                                       |
| SE in test environment        | None                                                    |
| SE isolated from EUT          | None                                                    |
| EUT set up                    | Refer to Appendix C                                     |
| Temperature                   | 24.8°C                                                  |

| Ref No. | Measured Freq (MHz)                               | Det. | Is measured Frequency within the Restricted bands (Y/N) | Measured Peak Conducted power (RBW =100kHz) (dBuV) | 15.247(d) Limit (dBuV) | Summary |
|---------|---------------------------------------------------|------|---------------------------------------------------------|----------------------------------------------------|------------------------|---------|
| 1       | No significant emissions within 20dB of the limit |      |                                                         |                                                    |                        | Pass    |

**Notes:**

1. The conducted emission limit for emissions are based on a transmitted carrier level of 15.247(b) and Annex 8, A8.4(2).. With the EUT transmitting on its lowest, centre and highest carrier frequencies in turn, emissions from the EUT are required to be 20 dB below the level of the highest fundamental as measured within a 100 kHz RBW in accordance with 15.247(d) and Annex 8, A8.5 using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated in accordance with 15.33 (a)(1) and RSS – GEN 4.9.
3. The measurements at 2400 MHz and 2483.5 MHz were made to ensure band edge compliance.
4. The carrier level was measured whilst varying the supply voltage between 85% and 105% of the nominal supply voltage as required by 15.31(e). No variation in carrier level was observed.
5. The measurements at 2400 MHz and 2483.5 MHz were made to ensure band edge compliance. All other emissions were at least 20dB below the test limit

The limit outside the restricted band in 100 kHz RBW is defined using the following formula in accordance with 15.247(d) and Annex 8, A8.5:

$$\text{The limit in 100 kHz RBW} = (\text{Maximum Peak Conducted Carrier}) - 20\text{dB}$$

Where:

| Channel No. | Channel Frequency (MHz) | Measured Peak Carrier Power (W) | Measured Peak Carrier (dBm) | Measured Peak Carrier –20dB (dBm) | Emission Limit In a 100 kHz RBW (dBm) |
|-------------|-------------------------|---------------------------------|-----------------------------|-----------------------------------|---------------------------------------|
| Bottom      | 2402                    | 0.00088                         | -0.56                       | -20.56                            | -20.56                                |
| Middle      | 2441                    | 0.00104                         | 0.17                        | -19.83                            | -19.83                                |
| Top         | 2480                    | 0.00115                         | 0.59                        | -19.41                            | -19.41                                |

**A3 Radiated Electric Field Emissions**

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric field emission test applies to spurious emissions and harmonics that fall within the restricted bands. The maximum permitted field strength is listed in Section 15.209. The EUT was set to transmit on its lowest, centre and highest carrier frequency.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : ☐

3m alternative test site : ☒

The effect of the EUT set-up on the measurements is summarised in note (c) below.

| Test Details: 2402 MHz   |                                                     |
|--------------------------|-----------------------------------------------------|
| Regulation               | Part 15.247(d) and 15.205, RSS – 210, Annex 8, A8.5 |
| Measurement standard     | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003        |
| Frequency range          | 30MHz – 25GHz                                       |
| EUT sample number        | S06                                                 |
| Modification state       | 0                                                   |
| SE in test environment   | None                                                |
| SE isolated from EUT     | None                                                |
| EUT set up               | Refer to Appendix C                                 |
| Temperature              | 25.4°C                                              |
| Photographs (Appendix F) | Photograph 1 and 2                                  |

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

| Ref No. | FREQ. (MHz) | MEAS Rx (dBµV) | CABLE LOSS (dB) | ANT FACT. (dB/m) | PRE AMP (dB) | HPF Loss (dB) | FIELD ST'GH (dBµV/m) | FIELD ST'GH (µV/m) | LIMIT (µV/m) |
|---------|-------------|----------------|-----------------|------------------|--------------|---------------|----------------------|--------------------|--------------|
| 1.      | 4803.95pk   | 58.22          | 3.6             | 32.7             | 35.6         | 0.3           | 59.22                | 914.11             | 5000         |
| 2.      | 4803.95av   | 49.89          | 3.6             | 32.7             | 35.6         | 0.3           | 50.89                | 350.35             | 500          |
| 3.      | 7206.29pk   | 50.77          | 4.4             | 36.2             | 36           | 0.3           | 55.67                | 607.44             | 5000         |
| 4.      | 7206.29av   | 40.04          | 4.4             | 36.2             | 36           | 0.3           | 44.94                | 176.60             | 500          |

**Radiated Electric Field Emissions:**

The effect of the EUT set-up on the measurements is summarised in note (c) below.

| <b>Test Details: 2441 MHz</b> |                                                     |
|-------------------------------|-----------------------------------------------------|
| Regulation                    | Part 15.247(d) and 15.205, RSS – 210, Annex 8, A8.5 |
| Measurement standard          | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003        |
| Frequency range               | 30MHz to 25 GHz                                     |
| EUT sample number             | S06                                                 |
| Modification state            | 0                                                   |
| SE in test environment        | None                                                |
| SE isolated from EUT          | None                                                |
| EUT set up                    | Refer to Appendix C                                 |
| Temperature                   | 25.4°C                                              |
| Photographs (Appendix F)      | Photograph 1 and 2                                  |

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

| Ref No. | FREQ. (MHz) | MEAS Rx (dBµV) | CABLE LOSS (dB) | ANT FACT. (dB/m) | PRE AMP (dB) | HPF Loss (dB) | FIELD ST'GH (dBµV/m) | FIELD ST'GH (µV/m) | LIMIT (µV/m) |
|---------|-------------|----------------|-----------------|------------------|--------------|---------------|----------------------|--------------------|--------------|
| 1.      | 4881.98pk   | 59.06          | 3.6             | 33               | 35.6         | 0.3           | 60.36                | 1042.32            | 5000         |
| 2.      | 4881.98av   | 50.39          | 3.6             | 33               | 35.6         | 0.3           | 51.69                | 384.15             | 500          |
| 3.      | 7322.98pk   | 53.26          | 4.4             | 36.6             | 36.1         | 0.3           | 58.46                | 837.53             | 5000         |
| 4.      | 7322.98av   | 43.86          | 4.4             | 36.6             | 36.1         | 0.3           | 49.06                | 283.79             | 500          |

**Radiated Electric Field Emissions:**

The effect of the EUT set-up on the measurements is summarised in note (c) below.

| <b>Test Details: 2480 MHz</b> |                                                     |
|-------------------------------|-----------------------------------------------------|
| Regulation                    | Part 15.247(d) and 15.205, RSS – 210, Annex 8, A8.5 |
| Measurement standard          | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003        |
| Frequency range               | 30MHz to 25 GHz                                     |
| EUT sample number             | S06                                                 |
| Modification state            | 0                                                   |
| SE in test environment        | None                                                |
| SE isolated from EUT          | None                                                |
| EUT set up                    | Refer to Appendix C                                 |
| Temperature                   | 25.4°C                                              |
| Photographs (Appendix F)      | Photograph 1 and 2                                  |

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

| Ref No. | FREQ. (MHz) | MEAS Rx (dBµV) | CABLE LOSS (dB) | ANT FACT. (dB/m) | PRE AMP (dB) | HPF Loss (dB) | FIELD ST'GH (dBµV/m) | FIELD ST'GH (µV/m) | LIMIT (µV/m) |
|---------|-------------|----------------|-----------------|------------------|--------------|---------------|----------------------|--------------------|--------------|
| 1.      | 4960pk      | 58.5           | 3.6             | 33.2             | 35.7         | 0.2           | 59.80                | 977.24             | 5000         |
| 2.      | 4960av      | 50.2           | 3.6             | 33.2             | 35.7         | 0.2           | 51.50                | 375.84             | 500          |
| 3.      | 7440pk      | 50.83          | 4.3             | 36.7             | 36.1         | 0.3           | 56.03                | 633.14             | 5000         |
| 4.      | 7440av      | 39.95          | 4.3             | 36.7             | 36.1         | 0.3           | 45.15                | 180.93             | 500          |

**Notes:**

- 1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10:2009: section 4.5, Table 1 and ANSI C63.4: 2003 section 8.2.1
- 2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
- 3 Measurements at 2400 & 2483.5 MHz were made to ensure band edge compliance.
- 4 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
- 5 For Frequencies below 1 GHz, RBW= 100 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:
 

|         |               |
|---------|---------------|
| Peak    | RBW=VBW= 1MHz |
| Average | RBW=VBW= 1MHz |

These settings as per ANSI C63.10:2009 and DA 00-705.

- 6 In accordance with DA 00-705, the average level of the spurious radiated emission may be reduced by the duty cycle correction factor. If the dwell time per channel (refer to the measured channel occupancy time, section A7 of this test report) of the hopping signal is less than 100ms then the average measurement may be further adjusted by the duty cycle correction factor which is derived from

$$20\log_{10}\left(\frac{\text{dwell time}}{100\text{ms}}\right)$$

The upper and lower frequency of the measurement range was decided according to Part 15: Clause 15.33(a) and 15.33(a)(1) and RSS-GEN 4.9

Radiated emission limits for emissions falling within the restricted bands.

| Frequency of emission (MHz) | Field strength ( $\mu\text{V/m}$ ) | Measurement Distance (m) | Field strength ( $\text{dB}\mu\text{V/m}$ ) |
|-----------------------------|------------------------------------|--------------------------|---------------------------------------------|
| 30-88                       | 100                                | 3                        | 40.0                                        |
| 88-216                      | 150                                | 3                        | 43.5                                        |
| 216-960                     | 200                                | 3                        | 46.0                                        |
| Above 960                   | 500                                | 3                        | 54.0                                        |

- (a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation (dB)} = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

The results displayed take into account applicable antenna factors and cable losses.

- (b) The levels may have been rounded for display purposes.
- (c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

|                                                                                                                                                                                                                                                                                                                                                                                                           | See (i) | See (ii) | See (iii) | See (iv) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|-----------|----------|
| Effect of EUT operating mode on emission levels                                                                                                                                                                                                                                                                                                                                                           | ✓       |          |           |          |
| Effect of EUT internal configuration on emission levels                                                                                                                                                                                                                                                                                                                                                   | ✓       |          |           |          |
| Effect of Position of EUT cables & samples on emission levels                                                                                                                                                                                                                                                                                                                                             |         |          |           | ✓        |
| <div><div>(i)</div>Parameter defined by standard and / or single possible, refer to Appendix D</div> <div><div>(ii)</div>Parameter defined by client and / or single possible, refer to Appendix D</div> <div><div>(iii)</div>Parameter had a negligible effect on emission levels, refer to Appendix D</div> <div><div>(iv)</div>Worst case determined by initial measurement, refer to Appendix D</div> |         |          |           |          |

**A4 20 dB Bandwidth and Carrier Frequency Separation**

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(1)(i) and RSS-210 Annex 8, A8.1(b) requires the measurement of the bandwidth of the transmission between the -20 dB points on the transmitted spectrum. The results of this test determine the limits for channel spacing. The channel separation shall be a minimum of 25 kHz or the 2/3 of 20 dB bandwidth, whichever is the greater. The formal measurements are detailed below:

| Test Details:          |                                                |
|------------------------|------------------------------------------------|
| Regulation             | Part 15.247(a)(1)(i). RSS-210 Annex 8, A8.1(b) |
| EUT sample number      | S01                                            |
| Modification state     | 0                                              |
| SE in test environment | None                                           |
| SE isolated from EUT   | None                                           |
| Temperature            | 24.1°C                                         |
| EUT set up             | Refer to Appendix C                            |

| Channel Frequency (MHz) | Measured 20 dB Bandwidth (kHz) |
|-------------------------|--------------------------------|
| 2402                    | 1141.827                       |
| 2441                    | 1089.744                       |
| 2480                    | 1089.744                       |

| Measured Channel Spacing (kHz) | Limit                                                                       | Result |
|--------------------------------|-----------------------------------------------------------------------------|--------|
| 996.795                        | (25kHz or $\geq 2/3$ of Measured 20 dB Bandwidth kHz), whichever is greater | Pass   |

Plots of the 20 dB bandwidth and channel spacing are contained in Appendix B of this test report.

**A5 Hopping frequencies**

Hopping frequencies were verified using a spectrum analyser, while the EUT was operating in its normal frequency hopping mode.

| Test Details:          |                                                   |
|------------------------|---------------------------------------------------|
| Regulation             | Part 15.247(a)(1)(i), RSS – 210, Annex 8, A8.1(d) |
| EUT sample number      | S01                                               |
| Modification state     | 0                                                 |
| SE in test environment | None                                              |
| SE isolated from EUT   | None                                              |
| Temperature            | 24.1°C                                            |
| EUT set up             | Refer to Appendix C                               |

| No. of Hopping Channels | Requirement | Result |
|-------------------------|-------------|--------|
| 79                      | $\geq 15$   | Pass   |

Plots showing the hopping channels are contained in Appendix B

**A6 Channel Occupancy**

Channel occupancy time was verified using a spectrum analyser in zero span mode, centred on the middle hopping channel frequency (2441 MHz), while the EUT was operating in its normal frequency hopping mode. The other channels were then verified to ensure that the channel occupancy was identical for all channels.

| Test Details:          |                                                |
|------------------------|------------------------------------------------|
| Regulation             | Part 15.247(a)(1), RSS – 210, Annex 8, A8.1(d) |
| EUT sample number      | S01                                            |
| Modification state     | 0                                              |
| SE in test environment | None                                           |
| SE isolated from EUT   | None                                           |
| Temperature            | 24.1°C                                         |
| EUT set up             | Refer to Appendix C                            |

| Channel Occupancy Time (µs) | Channel Repetition Time (ms) | Calculated Average Channel retention Time (ms) | Average Channel Occupancy Time Limit (ms) | Result |
|-----------------------------|------------------------------|------------------------------------------------|-------------------------------------------|--------|
| 170.9                       | 1.024                        | 5.274                                          | 400                                       | Pass   |

Plots showing the channel occupancy time and time between successive transmissions are contained in Appendix B of this test report. These are identical for all modulation modes.

**Average Channel Retention Time Calculation:**

No. Of utilised hopping channels (N) = 79  
 Measured channel repetition time ( $T_{rep}$ ) = 1.024ms  
 Measured channel occupancy time ( $T_{occ}$ ) = 170.9µs

No. of transmission cycles in specified averaging period =

$$\frac{0.4 \times N}{T_{rep}(ms)} = \text{cycles} \quad \therefore \frac{0.4 \times 79}{1.024(ms)} = 30.859 \text{ cycles}$$

**∴ The Average Retention Time =**

Total activation time  $T_{occ}$  x No. of transmission cycles in specified averaging period

Average Channel Occupancy Time = 170.9 µs x 30.859 = 5.274 ms

**A7     Antenna Gain**

The maximum antenna gain for the antenna types to be used with the EUT, as declared by the client, is 5 dBi.

**A8 Unintentional Radiated Electric Field Emissions**

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.109 and RSS- GEN Section 7.2.3. The EUT was set to receive mode only on its lowest, centre and highest carrier frequency in turn.

The following test site was used for final measurements as specified by the standard tested to :

3m open area test site :

☐

3m alternative test site :

☒

| Test Details: 2402 MHz   |                                              |
|--------------------------|----------------------------------------------|
| Regulation               | Part 15.109, RSS – GEN, Section 7.2.3        |
| Measurement standard     | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003 |
| Frequency range          | 30MHz to 25 GHz                              |
| EUT sample number        | S06                                          |
| Modification state       | 0                                            |
| SE in test environment   | None                                         |
| SE isolated from EUT     | None                                         |
| EUT set up               | Refer to Appendix C                          |
| Temperature              | 25.4°C                                       |
| Photographs (Appendix F) | Photograph 1 and 2                           |

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

| Ref No. | FREQ. (MHz) | MEAS Rx (dBμV) | CABLE LOSS (dB) | ANT FACT. (dB/m) | PRE AMP (dB) | FIELD ST'GH (dBμV/m) | FIELD ST'GH (μV/m) | LIMIT (μV/m) |
|---------|-------------|----------------|-----------------|------------------|--------------|----------------------|--------------------|--------------|
| 1.      | 2747.43pk   | 52.26          | 3.1             | 29.1             | 36           | 48.46                | 264.85             | 5000         |
| 2.      | 2747.43av   | 46.67          | 3.1             | 29.1             | 36           | 42.87                | 139.16             | 500          |

**Unintentional Radiated Electric Field Emissions continued:**

| <b>Test Details: 2441 MHz</b> |                                              |
|-------------------------------|----------------------------------------------|
| Regulation                    | Part 15.109, RSS – GEN, Section 7.2.3        |
| Measurement standard          | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003 |
| Frequency range               | 30MHz to 25 GHz                              |
| EUT sample number             | S06                                          |
| Modification state            | 0                                            |
| SE in test environment        | None                                         |
| SE isolated from EUT          | None                                         |
| EUT set up                    | Refer to Appendix C                          |
| Temperature                   | 25.4°C                                       |
| Photographs (Appendix F)      | Photograph 1 and 2                           |

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

| Ref No. | FREQ. (MHz) | MEAS Rx (dBμV) | CABLE LOSS (dB) | ANT FACT. (dB/m) | PRE AMP (dB) | FIELD ST'GH (dBμV/m) | FIELD ST'GH (μV/m) | LIMIT (μV/m) |
|---------|-------------|----------------|-----------------|------------------|--------------|----------------------|--------------------|--------------|
| 1.      | 2792.03pk   | 53.2           | 3.2             | 29.1             | 36           | 49.50                | 298.54             | 5000         |
| 2.      | 2792.03av   | 48.9           | 3.2             | 29.1             | 36           | 45.20                | 181.97             | 500          |

**Unintentional Radiated Electric Field Emissions continued:**

| <b>Test Details: 2480 MHz</b> |                                              |
|-------------------------------|----------------------------------------------|
| Regulation                    | Part 15.109, RSS – GEN, Section 7.2.3        |
| Measurement standard          | ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003 |
| Frequency range               | 30MHz to 25 GHz                              |
| EUT sample number             | S06                                          |
| Modification state            | 0                                            |
| SE in test environment        | None                                         |
| SE isolated from EUT          | None                                         |
| EUT set up                    | Refer to Appendix C                          |
| Temperature                   | 25.4°C                                       |
| Photographs (Appendix F)      | Photograph 1 and 2                           |

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

| Ref No. | FREQ. (MHz) | MEAS Rx (dBμV) | CABLE LOSS (dB) | ANT FACT. (dB/m) | PRE AMP (dB) | FIELD ST'GH (dBμV/m) | FIELD ST'GH (μV/m) | LIMIT (μV/m) |
|---------|-------------|----------------|-----------------|------------------|--------------|----------------------|--------------------|--------------|
| 1.      | 2836.54pk   | 54.33          | 3.2             | 29.2             | 36           | 50.73                | 343.95             | 5000         |
| 2.      | 2836.54av   | 49.31          | 3.2             | 29.2             | 36           | 45.71                | 192.97             | 500          |

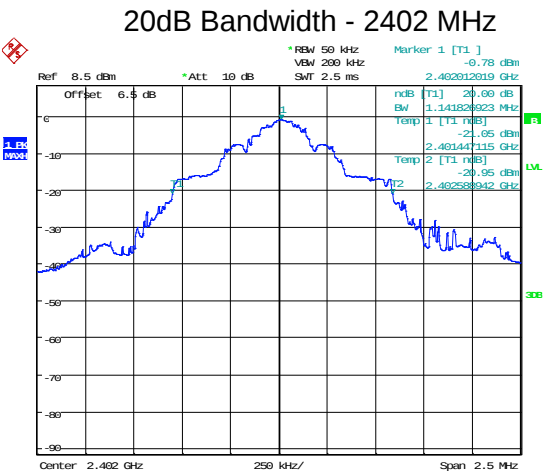
## **Appendix B:**

## **Supporting Graphical Data**

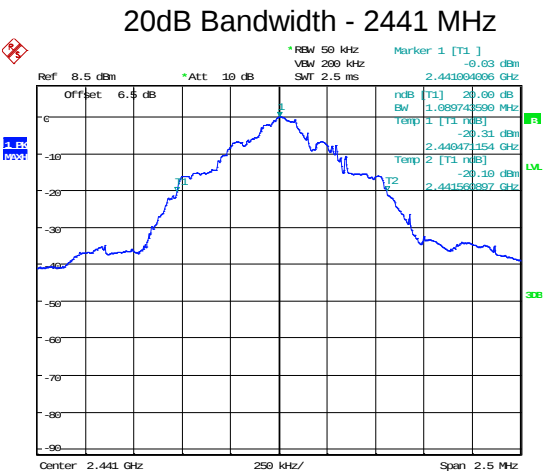
This appendix contains graphical data obtained during testing.

Notes:

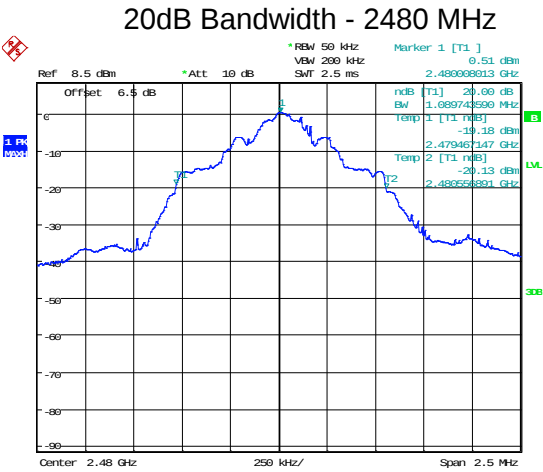
- (a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.
- (b) The time and date on the plots do not necessarily equate to the time of the test.
- (c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.
- (d) Appendix C details the numbering system used to identify the sample and its modification state.
- (e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



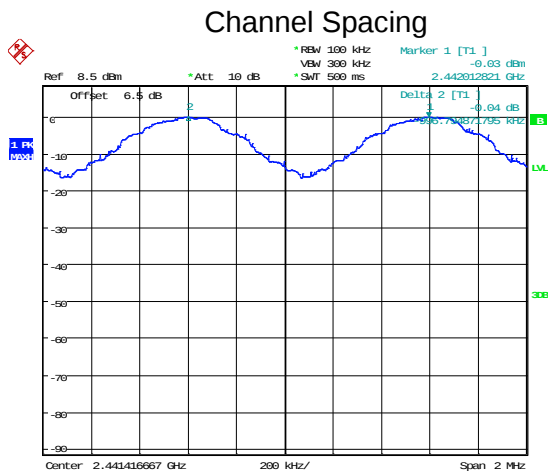
Date: 15. JAN. 2014 17:08:55



Date: 15. JAN. 2014 17:09:52

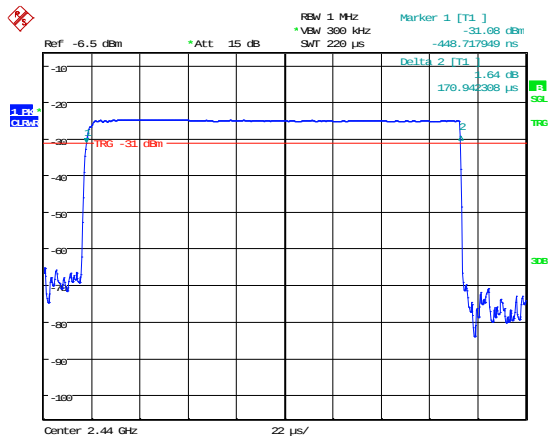


Date: 15. JAN. 2014 17:10:31



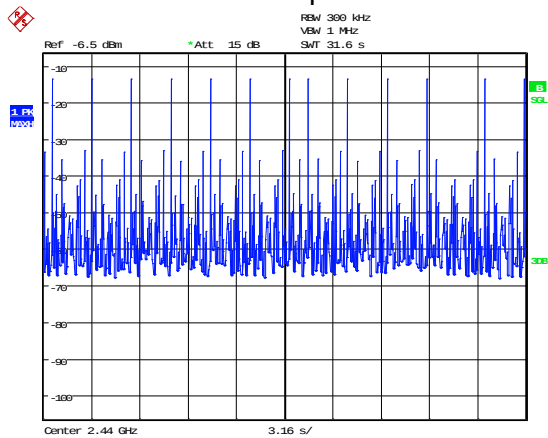
Date: 15.JAN.2014 16:54:41

### Channel Occupancy Time



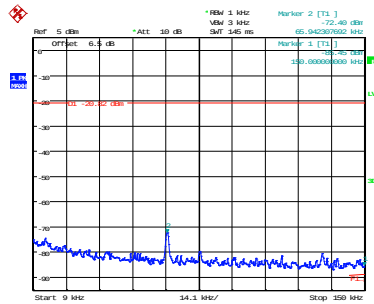
Date: 17.JAN.2014 09:41:52

### Channel repetition time



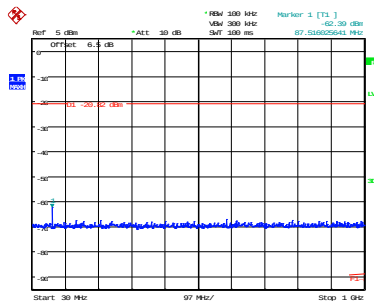
Date: 17.JAN.2014 11:02:03

## Conducted Spurious emissions– 2402 MHz



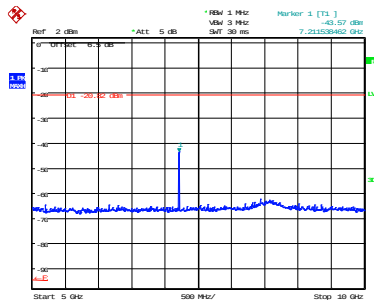
Date: 16. JAN. 2014 10:28:21

## 9kHz to 150kHz



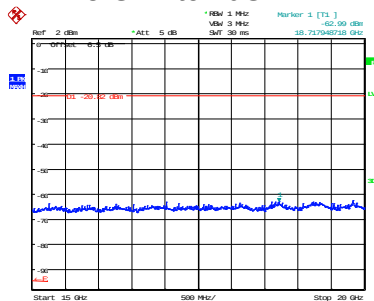
Date: 16. JAN. 2014 10:29:58

## 30 MHz to 1 GHz



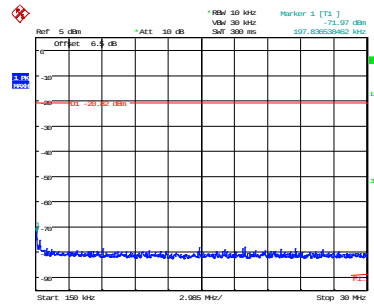
Date: 16. JAN. 2014 10:51:22

## 5 GHz to 10GHz



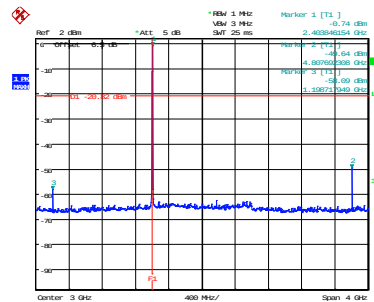
Date: 16. JAN. 2014 10:52:43

## 15 GHz to 20GHz



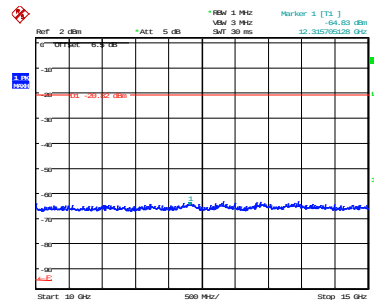
Date: 16. JAN. 2014 10:29:09

## 150kHz to 30MHz



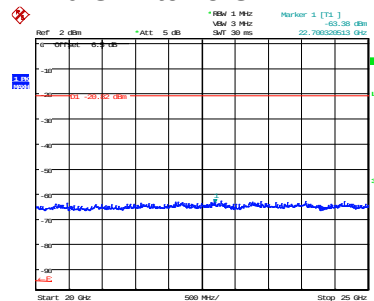
Date: 16. JAN. 2014 10:50:48

## 1 GHz to 5 GHz



Date: 16. JAN. 2014 10:52:19

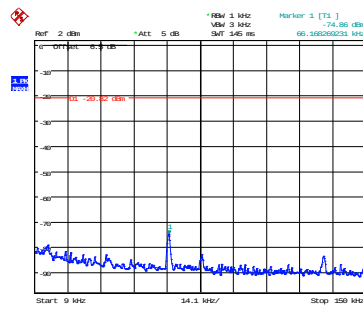
## 10 GHz to 15 GHz



Date: 16. JAN. 2014 10:53:16

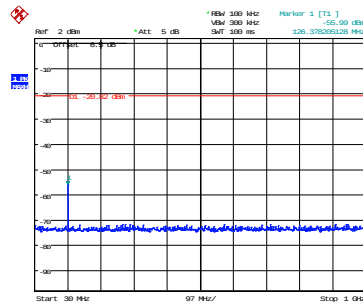
## 20 GHz to 25 GHz

## Conducted Spurious emissions– 2441 MHz



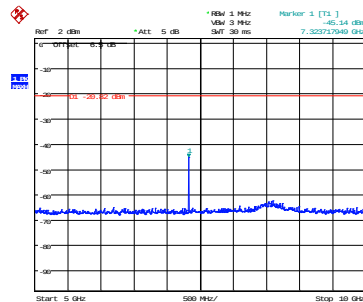
Date: 16.JAN.2014 10:56:45

## 9kHz to 150kHz



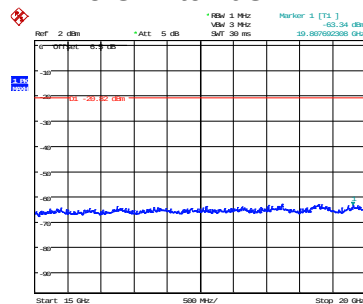
Date: 16.JAN.2014 10:57:49

## 30 MHz to 1 GHz



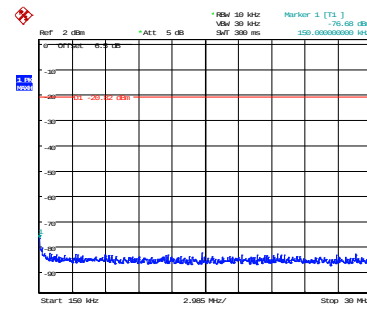
Date: 16.JAN.2014 10:54:58

## 5 GHz to 10GHz



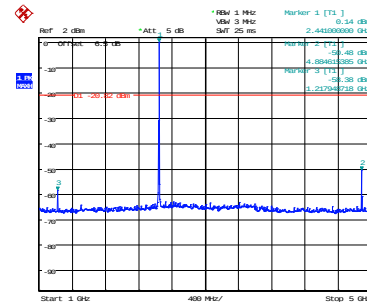
Date: 16.JAN.2014 10:55:48

## 15 GHz to 20GHz



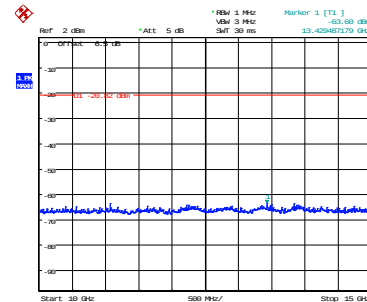
Date: 16.JAN.2014 10:57:15

## 150kHz to 30MHz



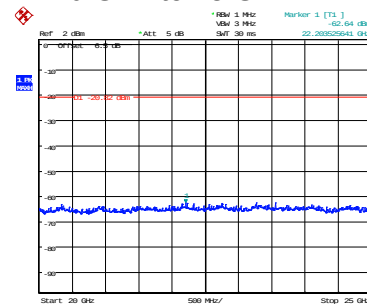
Date: 16.JAN.2014 10:54:34

## 1 GHz to 5 GHz



Date: 16.JAN.2014 10:55:25

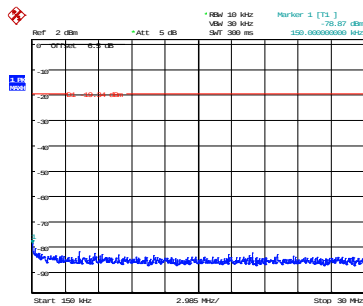
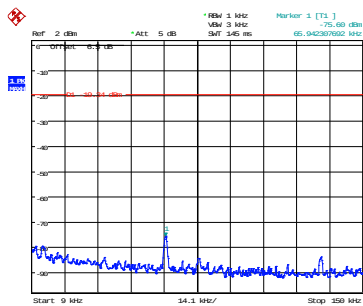
## 10 GHz to 15 GHz



Date: 16.JAN.2014 10:56:13

## 20 GHz to 25 GHz

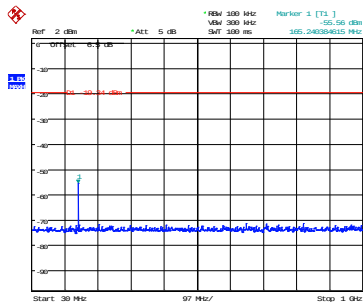
Conducted Spurious emissions– 2480 MHz



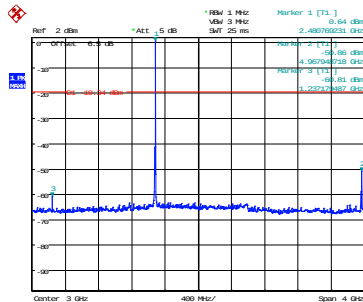
Date: 16 JAN 2014 11:24:01

Date: 16 JAN 2014 11:24:25

9kHz to 150kHz



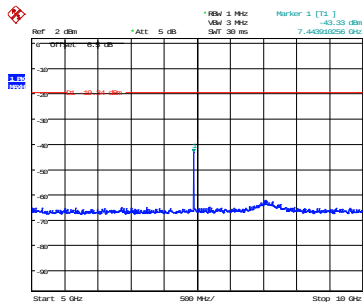
150kHz to 30MHz



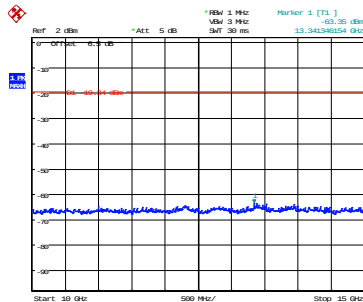
Date: 16 JAN 2014 11:24:54

Date: 16 JAN 2014 11:22:01

30 MHz to 1 GHz



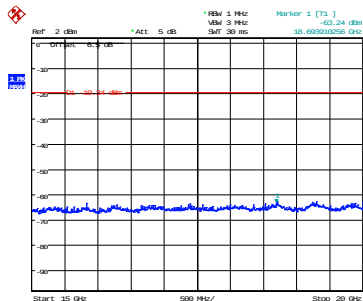
1 GHz to 5 GHz



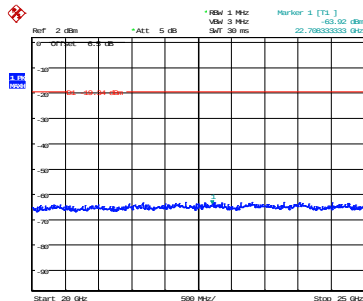
Date: 16 JAN 2014 11:22:32

Date: 16 JAN 2014 11:22:55

5 GHz to 10GHz



10 GHz to 15 GHz



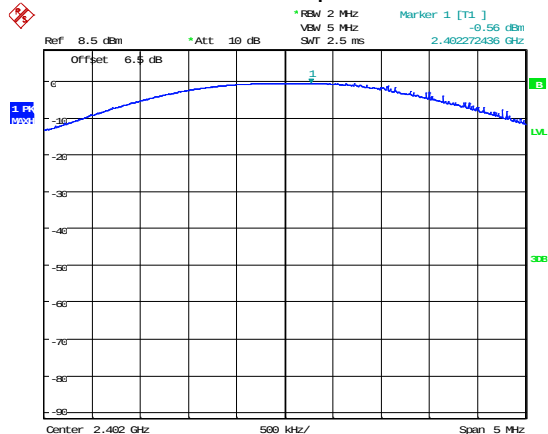
Date: 16 JAN 2014 11:23:17

Date: 16 JAN 2014 11:23:37

15 GHz to 20GHz

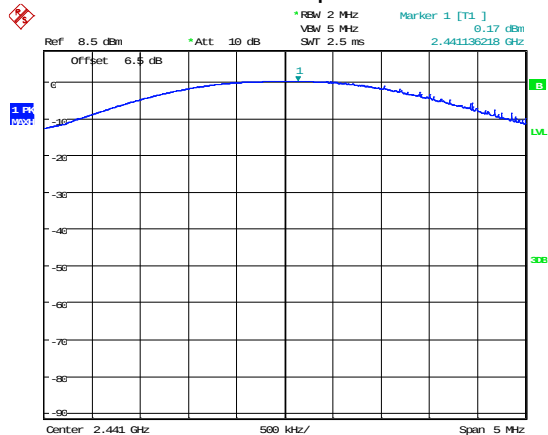
20 GHz to 25 GHz

Conducted carrier power - 2402 MHz



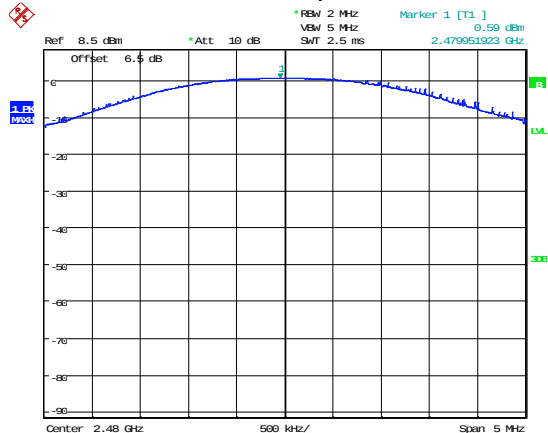
Date: 15.JAN.2014 17:22:41

Conducted carrier power - 2441 MHz



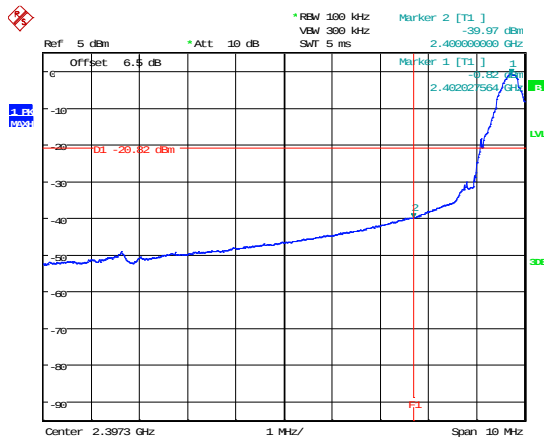
Date: 15.JAN.2014 17:23:21

Conducted carrier power - 2408 MHz

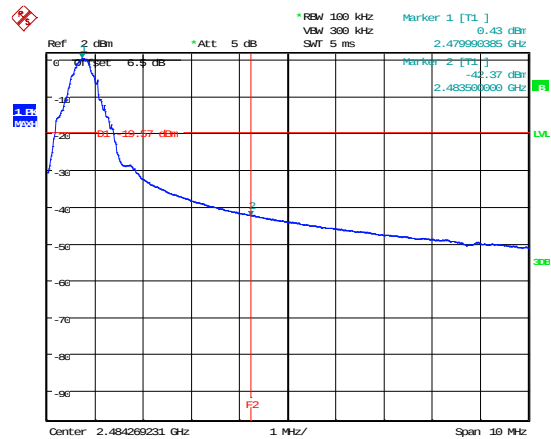


Date: 15.JAN.2014 17:24:03

## Bandedge Compliance

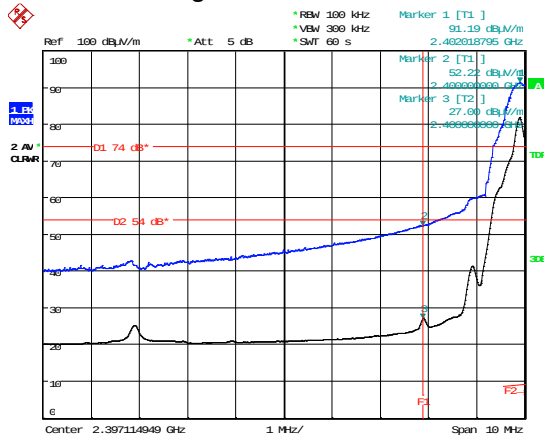


Date: 16.JAN.2014 10:27:43



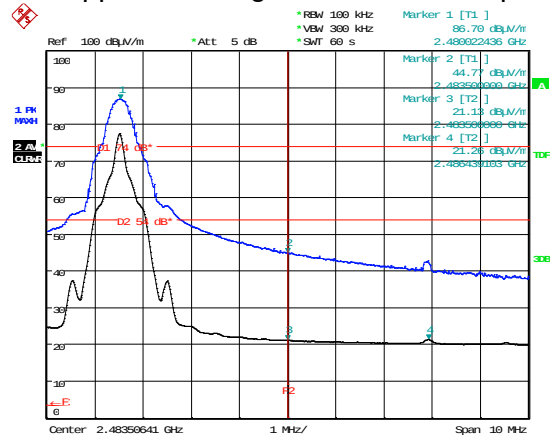
Date: 16.JAN.2014 11:02:20

## Lower Bandedge Conducted – Bottom Channel



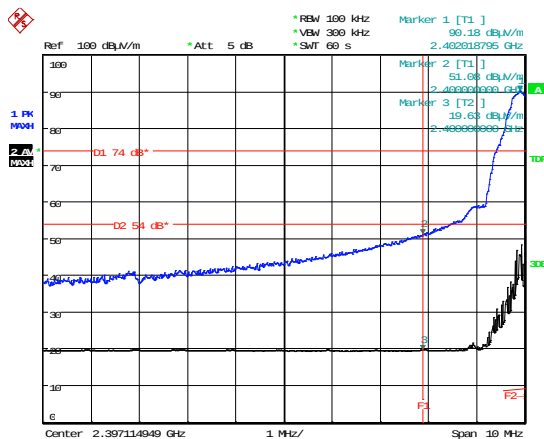
Date: 14.JAN.2014 13:28:02

## Upper Bandedge Conducted – Top Channel



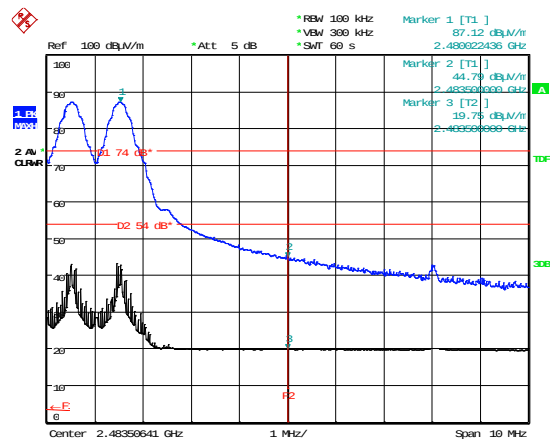
Date: 14.JAN.2014 13:51:19

## Lower Bandedge Radiated – Bottom Channel



Date: 14.JAN.2014 13:31:19

## Upper Bandedge Radiated – Top Channel

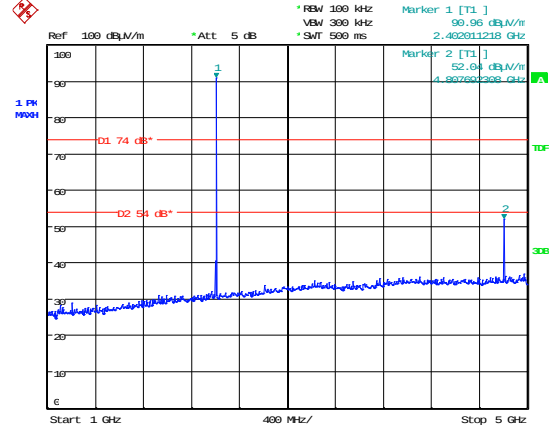
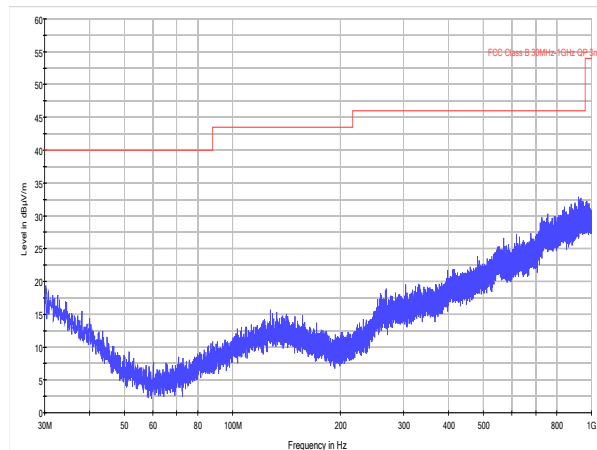


Date: 14.JAN.2014 14:01:40

## Lower Bandedge Radiated – Hopping

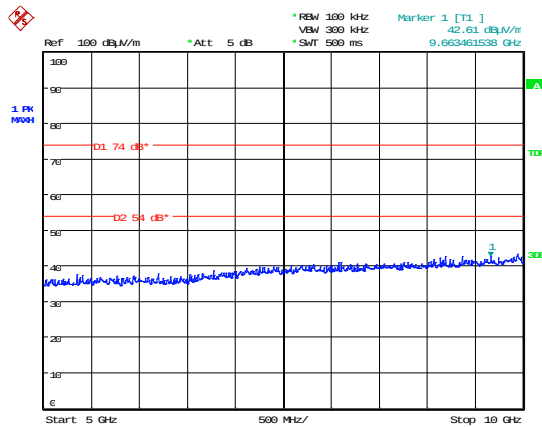
## Upper Bandedge Radiated – Hopping

## Radiated Spurious Emissions – 2402 MHz



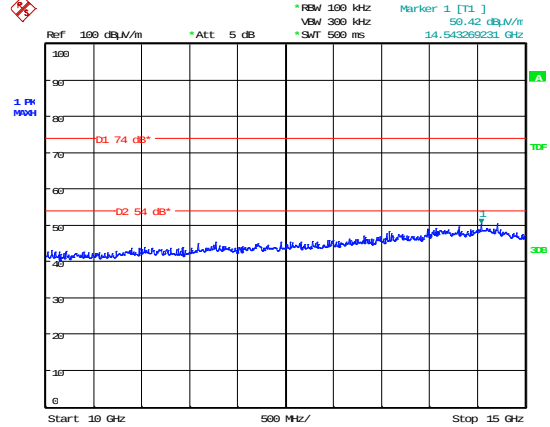
Date: 9. JAN. 2014 13:13:02

## 30 MHz to 1 GHz



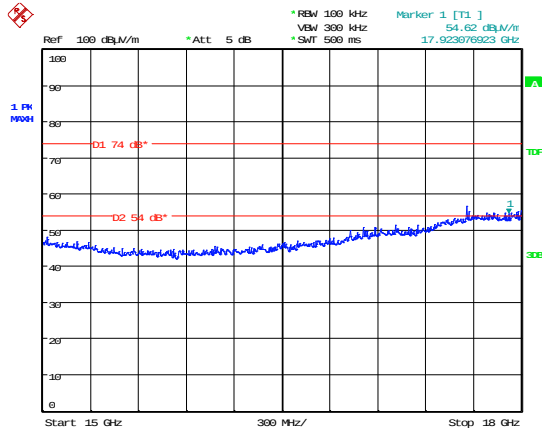
Date: 9. JAN. 2014 13:13:44

## 1 GHz to 5 GHz



Date: 9. JAN. 2014 13:14:36

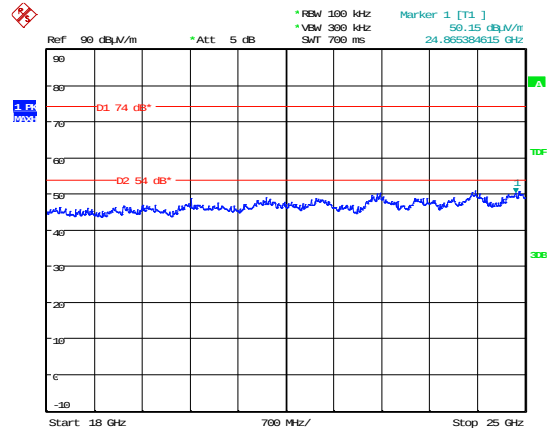
## 5GHz to 10 GHz



Date: 9. JAN. 2014 13:15:07

## 15 GHz to 18 GHz

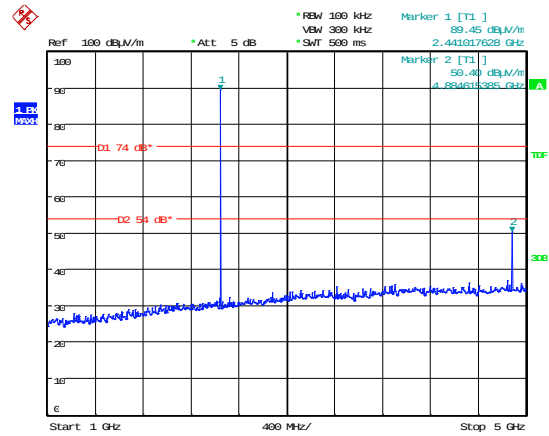
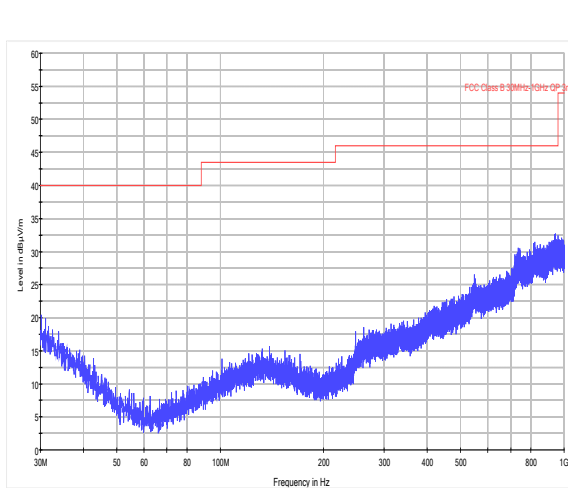
## 10 GHz to 15 GHz



Date: 14. JAN. 2014 11:12:31

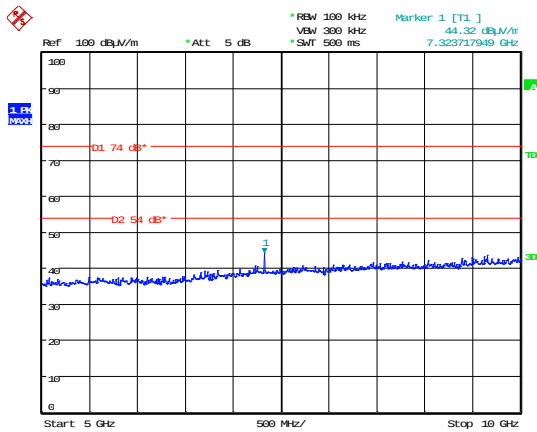
## 18 GHz to 25 GHz

## Radiated Spurious Emissions – 2441 MHz



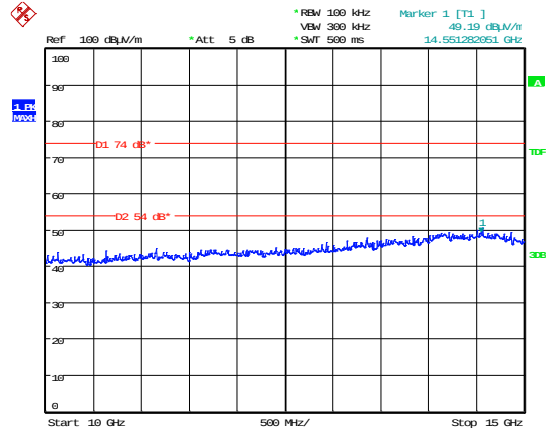
Date: 9.JAN.2014 13:25:56

## 30 MHz to 1 GHz



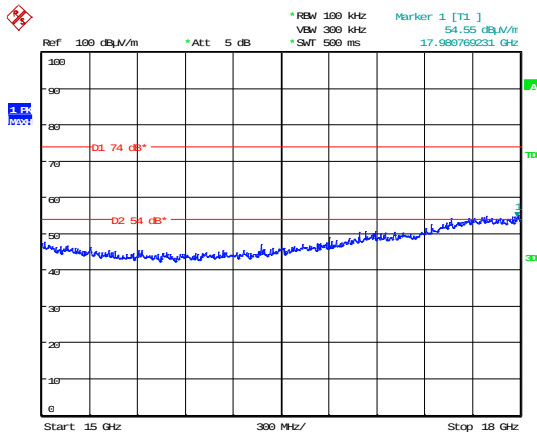
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## 1 GHz to 5 GHz



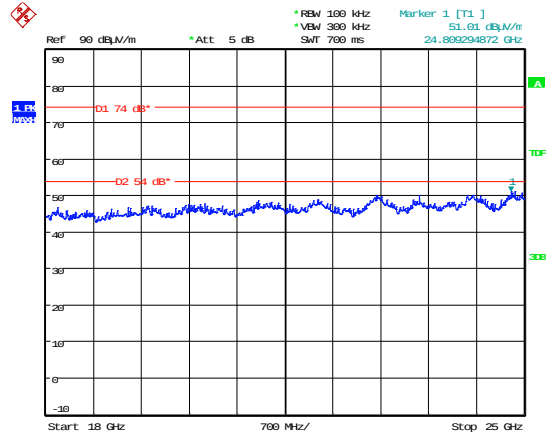
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## 5GHz to 10 GHz



Date: 9.JAN.2014 13:28:46

## 10 GHz to 15 GHz

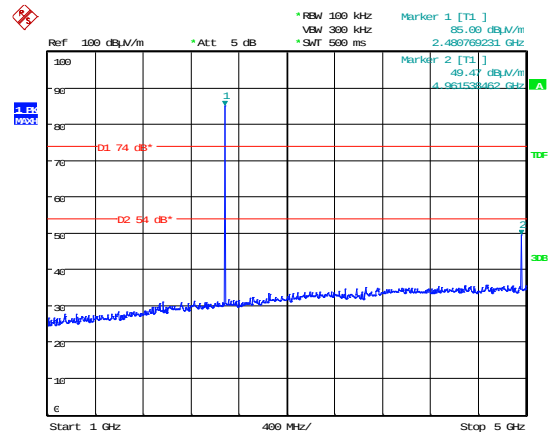
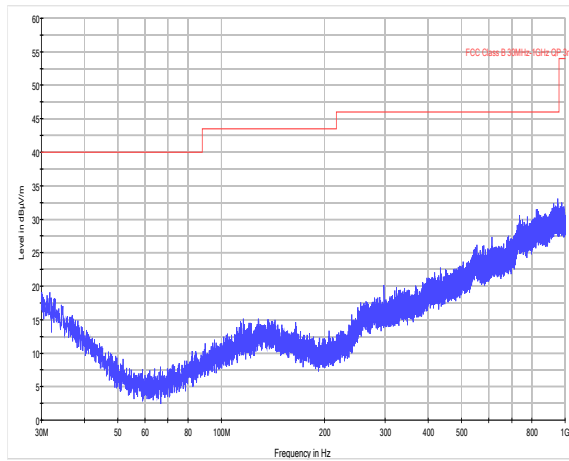


Date: 14.JAN.2014 11:14:03

## 15GHz to 18 GHz

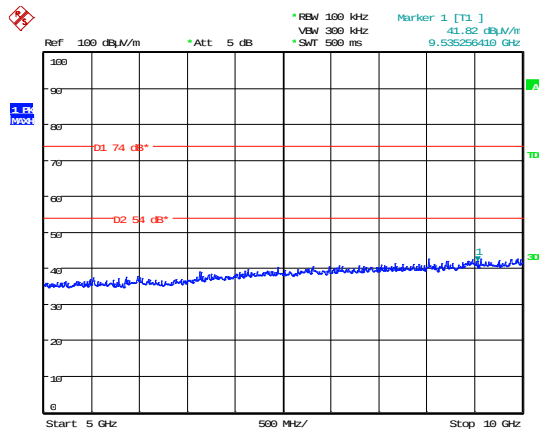
## 18 GHz to 25 GHz

## Radiated Spurious Emissions – 2480 MHz



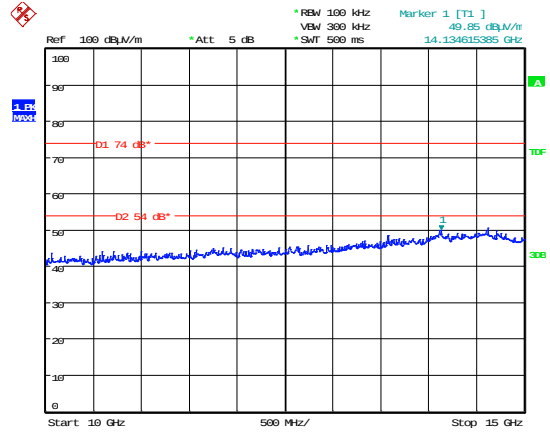
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## 30 MHz to 1 GHz



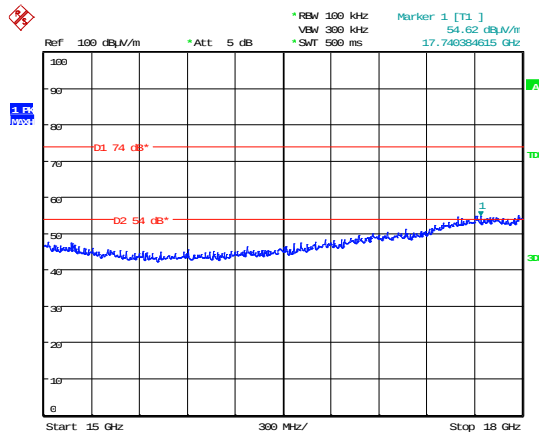
Date: 9.JAN.2014 13:38:39

## 1 GHz to 5 GHz



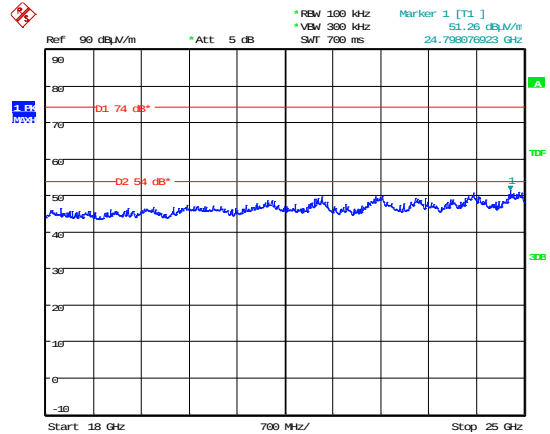
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## 5GHz to 10 GHz



Date: 9.JAN.2014 13:40:26

## 10 GHz to 15 GHz

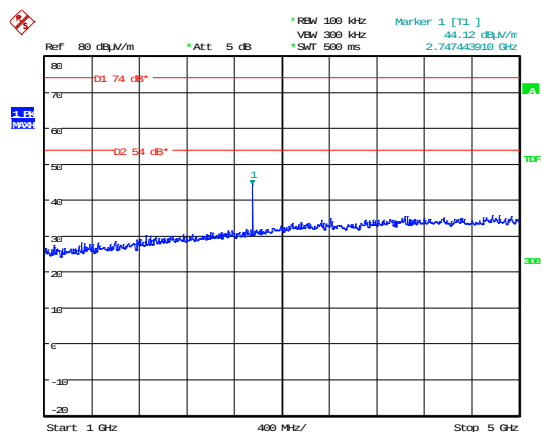
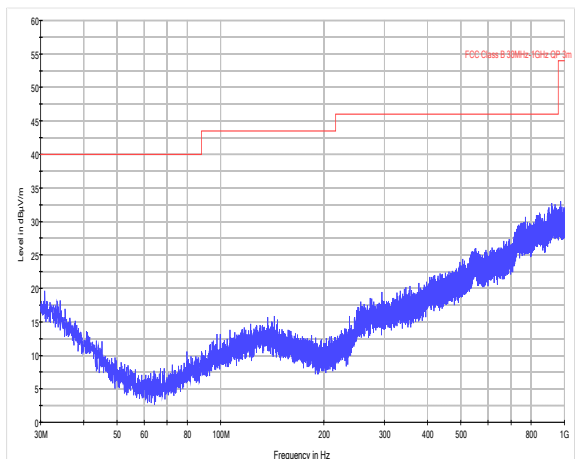


Date: 14.JAN.2014 11:15:56

## 15GHz to 18 GHz

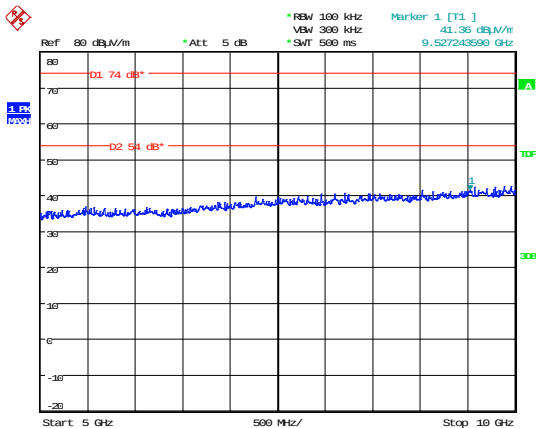
## 18 GHz to 25 GHz

Unintentional Radiated Spurious Emissions – 2402 MHz



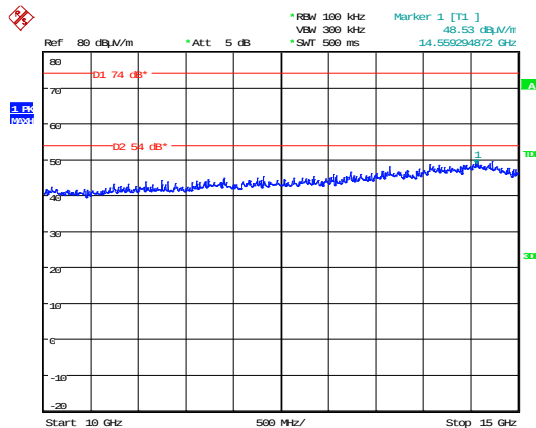
Date: 9.JAN.2014 14:01:27

30 MHz to 1 GHz



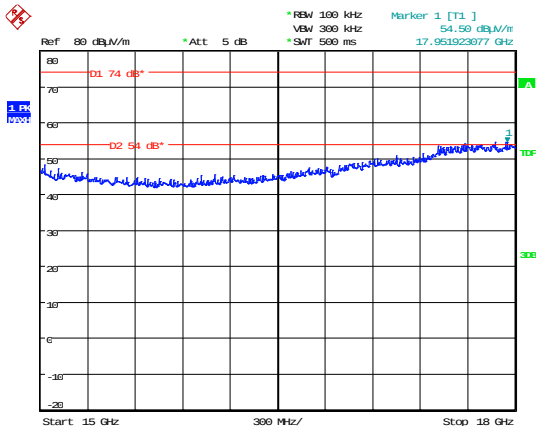
Date: 9.JAN.2014 14:02:04

1 GHz to 5 GHz



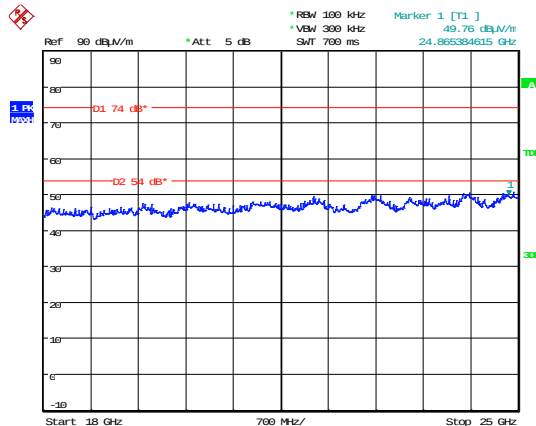
Date: 9.JAN.2014 14:02:36

5GHz to 10 GHz



Date: 9.JAN.2014 14:03:06

10 GHz to 15 GHz

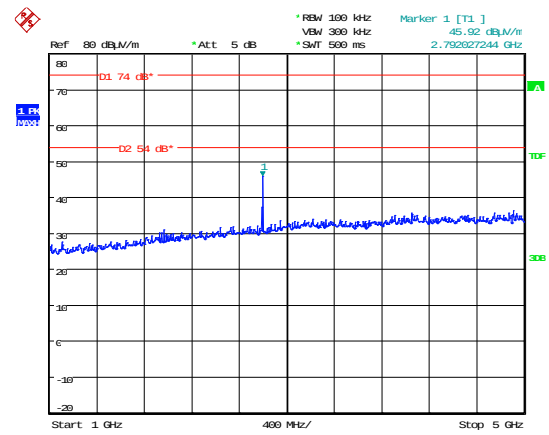
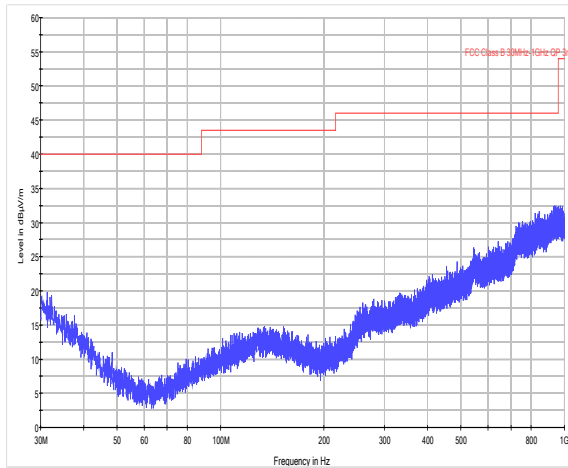


Date: 14.JAN.2014 11:17:31

15 GHz to 18 GHz

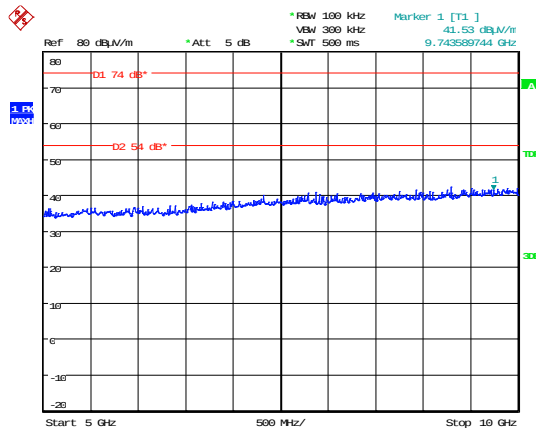
18 GHz to 25 GHz

## Unintentional Radiated Spurious Emissions – 2441 MHz



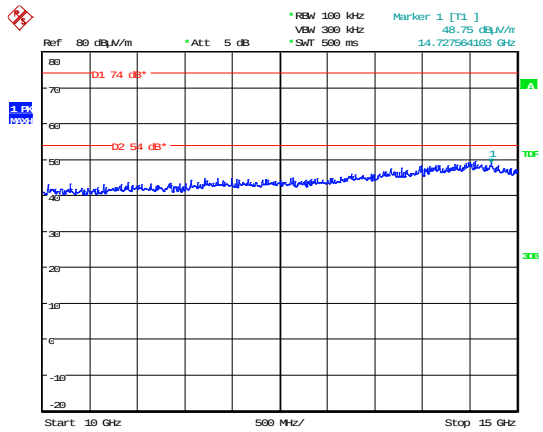
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## 30 MHz to 1 GHz



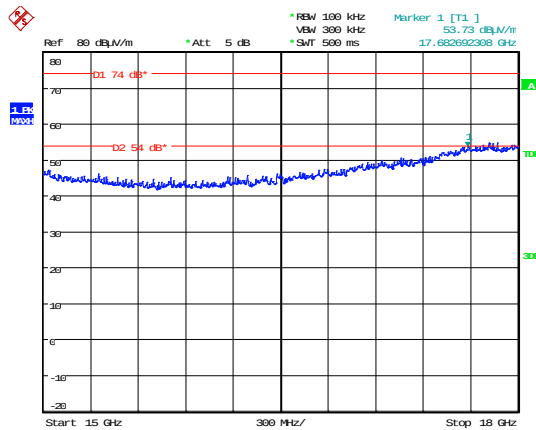
Date: 9.JAN.2014 14:33:53

## 1 GHz to 5 GHz



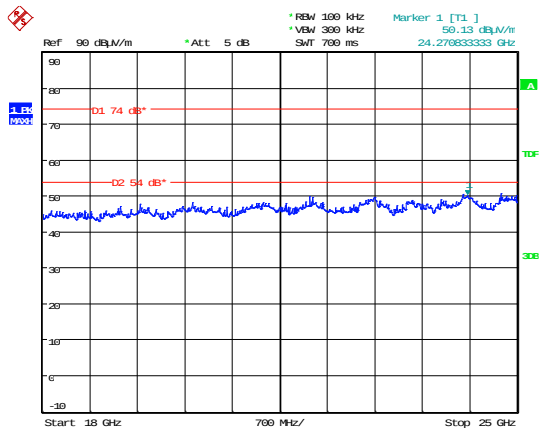
Date: 9.JAN.2014 14:34:27

## 5GHz to 10 GHz



Date: 9.JAN.2014 14:34:56

## 10 GHz to 15 GHz

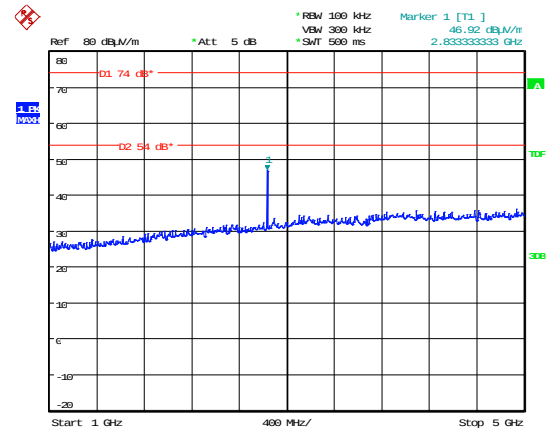
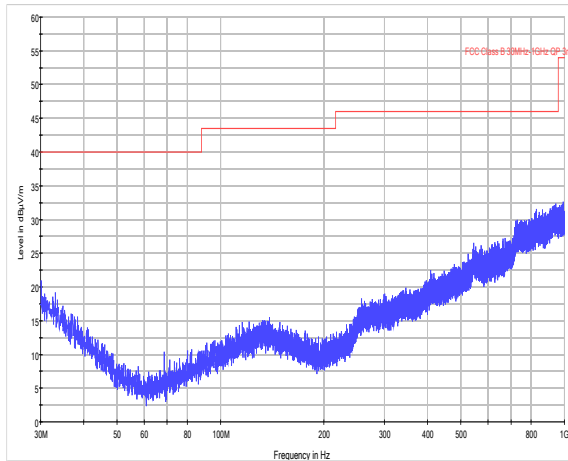


Date: 14.JAN.2014 11:19:10

## 15 GHz to 18 GHz

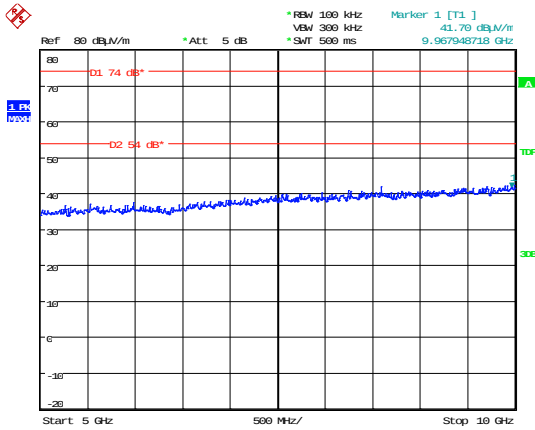
## 18 GHz to 25 GHz

## Unintentional Radiated Spurious Emissions – 2480 MHz



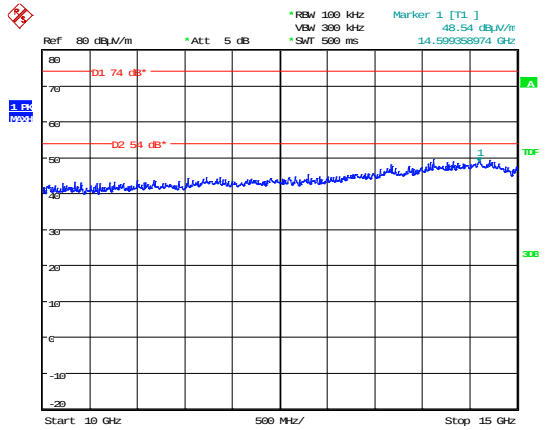
Date: 9.JAN.2014 14:49:10

## 30 MHz to 1 GHz



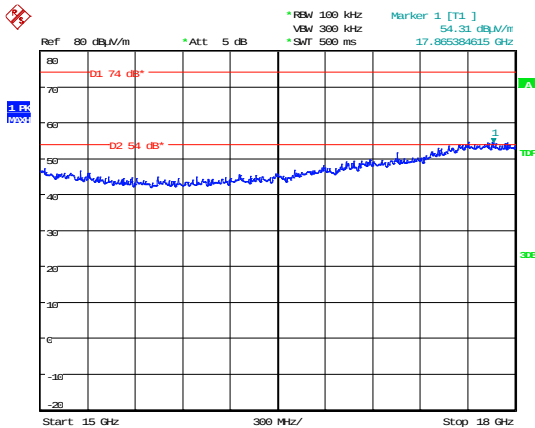
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## 1 GHz to 5 GHz



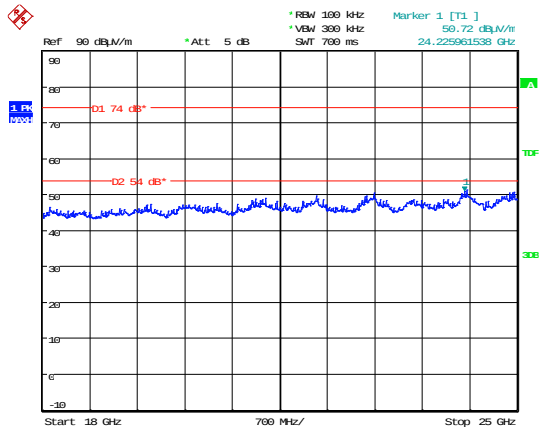
Date: 9.JAN.2014 14:50:43

## 5GHz to 10 GHz



Date: 9.JAN.2014 14:51:24

## 10 GHz to 15 GHz



Date: 14.JAN.2014 11:20:38

## 15 GHz to 18 GHz

## 18 GHz to 25 GHz

**Appendix C:****Additional Test and Sample Details**

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and it's modification state:

**Sample No:** Sxx Mod w

where:

|    |                       |           |
|----|-----------------------|-----------|
| xx | = sample number       | eg. S01   |
| w  | = modification number | eg. Mod 2 |

The following terminology is used throughout the test report:

**Support Equipment (SE)** is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

**EUT configuration** refers to the internal set-up of the EUT. It may include for example:

- Positioning of cards in a chassis.
- Setting of any internal switches.
- Circuit board jumper settings.
- Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as "single possible configuration".

**EUT arrangement** refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by TRaC Global upon request.

**C1) Test samples**

The following samples of the apparatus were submitted by the client for testing :

| Sample No. | Description                | Identification |
|------------|----------------------------|----------------|
| S01        | Primo Radio 3D Tool Setter | 232C93         |
| S06        | Primo Radio 3D Tool Setter | 232C90         |
|            |                            |                |

**C2) EUT Operating Mode During Testing.**

During testing, the EUT was exercised as described in the following tables :

| Test                              | Description of Operating Mode : Transmit                                                                          |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------|
| All tests detailed in this report | Unless Specified as set to a specific frequency the EUT transmitting on maximum power using FHSS over 79 channels |

| Test                                                     | Description of Operating Mode: Receive |
|----------------------------------------------------------|----------------------------------------|
| Receiver conducted and radiated (ERP) spurious emissions | EUT active but non-transmitting.       |

**C3) EUT Configuration Information.**

The EUT was submitted for testing in one single possible configuration.

**C4) List of EUT Ports**

EUT is battery powered equipment with no external ports.

**C5     Details of Equipment Used**

| <b>TRAC Ref</b> | <b>Type</b> | <b>Description</b> | <b>Manufacturer</b> | <b>Date Calibrated.</b> |
|-----------------|-------------|--------------------|---------------------|-------------------------|
| UH004           | ESVS10      | Receiver           | R&S                 | 11/02/2013              |
| UH191           | CBL611/A    | Bilog              | Chase               | 13/12/2012              |
| UH281           | FSU46       | Spectrum Analyser  | R&S                 | 06/03/2013              |
| UH405           | FSU26       | Spectrum Analyser  | R&S                 | 20/03/2013              |
| L138            | 3115        | 1-18GHz Horn       | EMCO                | 17/10/2013              |
| L572            | 8449B       | Pre Amp            | Agilent             | 12/12/2012              |
| REF940          | ATS         | Radio Chamber - PP | Rainford EMC        | 09/07/2013              |
| REF977          | SH4141      | High Pass Filter   | BSC                 | 25/02/2013              |

**Appendix D:****Additional Information**

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New Mills, Wotton-under-Edge,  
Gloucestershire GL12 8JR  
United Kingdom

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**Email** uk@renishaw.com  
[www.renishaw.com](http://www.renishaw.com)



15 January 2014

**DECLARATION**Primo system details

The Primo products (Interface, Part Setter and 3D Tool Setter) all use a Nordic Semiconductor nRF24L01+ transceiver. This transceiver provides automatic packet handling with an on-air transmission rate of 1Mbps. In addition to the payload, each transmission consists of 8 bits of preamble, 40 bits of address header, 9 bits of packet control data and finally 16 bits of CRC (covering the entire packet). The data payload can vary in length (depending on mode) from 48 bits to 144 bits for the probes and from 32 bits to 208 bits for the interface. The transceiver has a synthesiser settling time of approximately 130µs before it is ready to send the data over the air. The repetition rate under normal circumstances varies from between 1.024ms and 32.768ms (i.e. 976 transmissions per second to 30 transmissions per second) depending on whether the probe (Part Setter or 3D Tool Setter) receives an acknowledgement from the Primo Interface.

It should be noted that the test modes used within the individual Primo elements use Pseudorandom Noise modulated data (256µs) with a repetition rate of 1.024ms. The actual 'on-air' period starts 57µs before the PN data is transmitted and finishes 18µs after it, therefore giving a total time of 329µs.

Signed by

A handwritten signature in blue ink that reads "John Styles". The signature is written in a cursive, flowing style.

John Styles CEng MIET

Principal Design Engineer

## **Appendix E:**

## **Photographs and Figures**

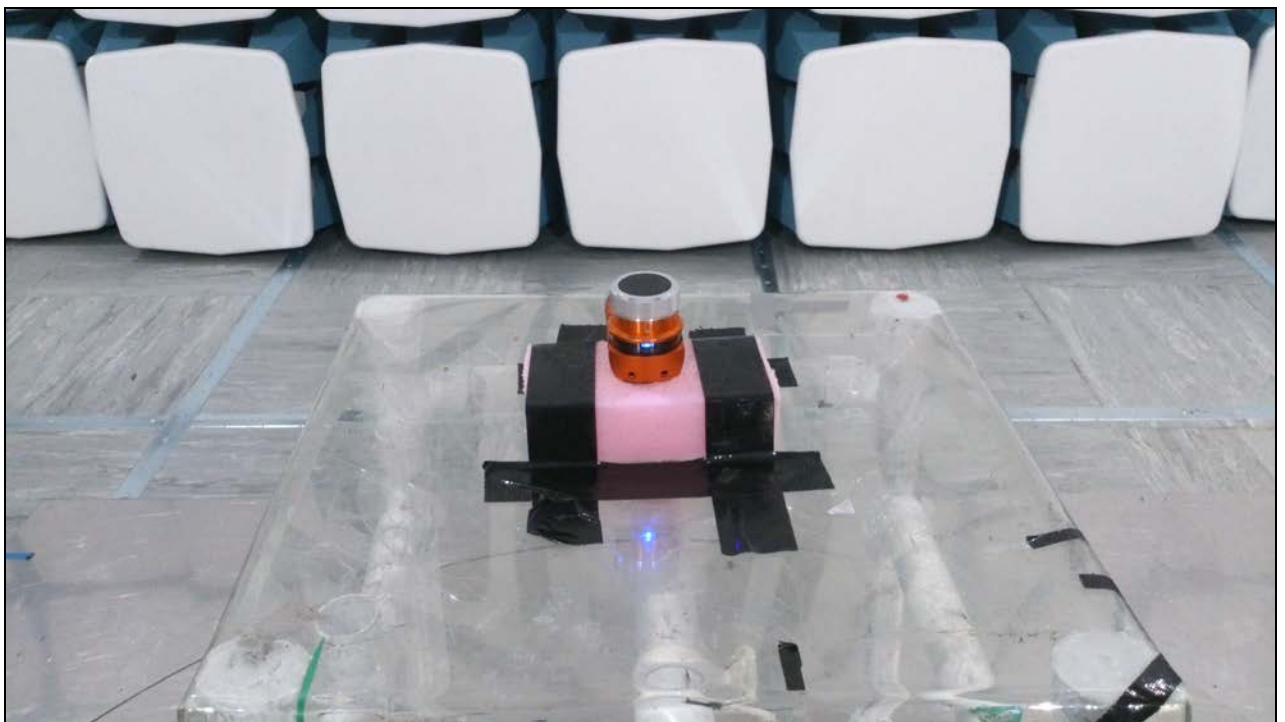
The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: Overview.
2. Radiated electric field emissions arrangement: close up.

Photograph 1



Photograph 2



**Appendix F:****MPE Calculation**

OET Bulletin No. 65, Supplement C 01-01, RSS-102

**47 CFR §§1.1307 and 2.1091**

Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC and IC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimetres is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC and IC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than power the density limit, as required.

**Prediction of MPE limit at a given distance**

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{EIRP}{4\pi R^2} \text{ re - arranged } R = \sqrt{\frac{EIRP}{S 4\pi}}$$

where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Note:

The EIRP measurement was calculated from the peak conducted carrier power plus the antenna gain.

Result:

| Prediction Frequency (MHz) | Maximum EIRP (mW) | Power density limit (S) (mW/m <sup>2</sup> ) | Distance (R) required to be less than (S) |
|----------------------------|-------------------|----------------------------------------------|-------------------------------------------|
| 2480                       | 3.62              | 1                                            | 0.54                                      |

IC limit: 10mW/m<sup>2</sup>1mW/cm<sup>2</sup> ≡ 10W/m<sup>2</sup>

