**TRaC Test Report** : 8F1631WUS1

**Applicant** : Flarm Technology GmbH

**Apparatus** : SAFEmine

**Summary:**

***The apparatus detailed above is compliant with the above standard as tested***
*(see section 1.5 of this report for full details)*

**Specification** : CFR47 Part 15.247 July 2008

**Purpose of Test** : Certification

**FCCID** : ZKSQC235A

**Authorised by** : 

: Radio Product Manager

**Issue Date** :**20th May 2011**

**Authorised Copy Number** : *PDF*

**Contents**

## 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 :

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### 1.3 Manufacturer

As Above

### 1.4 Apparatus Assessed

The following apparatus was assessed between 08/12/09 and 28/01/2010:

SAFEmine Model Number 700 018

The above equipment was a collision avoidance system, for use in industrial vehicles, consisting of central processor unit, GPS receiver and RF modem. The device periodically broadcasts its GPS position using an RF modem.

## 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 |
|---|---|---|---|
| Conducted Carrier Power | Title 47 of the CFR :2008, Part 15 Subpart (c) 15.247(b)(2) | Public Notice DA 00-705 March 30, 2000 | Pass |
| Conducted spurious emissions (Non-restricted bands) | Title 47 of the CFR: 2008, Part 15 Subpart (c) 15.247 | Public Notice DA 00-705 March 30, 2000 | Pass |
| Radiated spurious emissions (Restricted bands) | Title 47 of the CFR: 2008, Part 15 Subpart (c) 15.247 | ANSI C63.4: 2003 | Marginal |
| AC Power conducted emissions | Title 47 of the CFR: 2008, Part 15 Subpart (c) 15.207 | ANSI C63.4: 2003 | N/A |
| 20dB Bandwidth and Channel Spacing | Title 47 of the CFR :2008, Part 15 Subpart (c) 15.247(a)(1)(i) | Public Notice DA 00-705 March 30, 2000 | Pass |
| Hopping Frequencies | Title 47 of the CFR :2008, Part 15 Subpart (c) 15.247(a)(1) | Public Notice DA 00-705 March 30, 2000 | Pass |
| Frequency Occupancy | Title 47 of the CFR :2008, Part 15 Subpart (c) 15.247(a)(1)(i) | Public Notice DA 00-705 March 30, 2000 | Pass |
| Unintentional Radiated Spurious Emissions | Title 47 of the CFR: 2008, Part 15 Subpart (c) 15.109 | ANSI C63.4: 2003 | Pass |

Marginal results were recorded. See Appendix A for details and Section 2.2 (iii).

Abbreviations used in the above table:

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

The following table contains the measurement uncertainties for measurements

The following procedure is used when determining the result of a measurement :

(i) If specification limits are not exceeded by the measured result, extended by the positive component of the expanded uncertainty interval at a confidence level of 95%, then a pass result is recorded.

(ii) Where a specification limit is exceeded by the result even when the result is decreased by the negative component of the expanded uncertainty interval, a fail result is recorded.

(iii) Where measured result is below a limit, but by a margin less than the positive measurement uncertainty component, it is not possible to record a pass based on a 95% confidence level. However, the result indicates that a pass result is more probable than a fail result.

(iv) Where a measured result is above a limit, but by a margin less than the negative measurement uncertainty component, it is not possible to record a fail based on a 95% confidence level. However the result indicates that a fail is more probable than a pass.

## 2.2 Measurement Uncertainty Values

For the test data recorded in accordance with note (iii) of Section 2.1 the following measurement uncertainty was calculated :

**Hull Radio Testing – General Uncertainty Schedule**

| Test type | Quantity | Quantity frequency range | TRaC Telecoms & Radio Uncertainty |
|---|---|---|---|
| Radiated electric field emissions 3m alternative test site | Amplitude | 30MHz to 300MHz Horizontal | ±4.9dB |
| | | 30MHz to 300MHz Vertical | ±5.1dB |
| | | 300MHz to 1000MHz Horizontal | ±5.3dB |
| | | 300MHz to 1000MHz Vertical | ±5.1dB |
| | | 1GHz to 26.5GHz Horizontal and Vertical | ±4.1dB |
| Power line conducted emissions using a V mode lisn | | 150kHz to 30MHz | ±3.9dB |
| Conducted emissions | | N/A | ±0.9 dB |
| Absolute RF power (via antenna connector) | | N/A | ±0.9 dB |
| 20dB Bandwidth | Frequency | dc to 26.5GHz | 3.611kHz |

**Up Holland 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 (Equipment - TRLUH120) = **2.18dB**
Uncertainty in test result (Equipment – TRL05) = **1.08dB**
Uncertainty in test result (Equipment – TRL479) = **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 (Equipment - TRLUH120) = **119ppm**
Uncertainty in test result (Equipment – TRL05) = **0.113ppm**
Uncertainty in test result (Equipment – TRL479) = **0.265ppm**

## Up Holland Radio Testing – General Uncertainty Schedule continued:

***[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 (Equipment TRL479) Up to 8.1GHz = **3.31dB**
Uncertainty in test result (Equipment TRL479) 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result (Equipment TRL479) 15.3GHz – 21GHz = **5.34dB**
Uncertainty in test result (Equipment TRLUH120) 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%**

***[11] Power Line Conduction***

Uncertainty in test result = **3.4dB**

***[12] Spectrum Mask Measurements***

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

***[13] Adjacent Sub Band Selectivity***

Uncertainty in test result = **1.24dB**

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

Uncertainty in test result = **3.42dB**

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

Uncertainty in test result = **3.36dB**

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

Uncertainty in test result = **1.24dB**

***[17] Receiver Threshold***

Uncertainty in test result = **3.23dB**

***[18] 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 |
| Mod | : Modification |
| EUT | : Equipment Under Test |
| SE | : Support Equipment |
| L | : Live Power Line |
| N | : Neutral Power Line |
| E | : Earth Power Line |
| Pk | : Peak Detector |
| QP | : Quasi-Peak Detector |
| Av | : Average Detector |

| | |
|---|---|
| ALSR | : Absorber Lined Screened Room |
| OATS | : Open Area Test Site |
| ATS | : Alternative Test Site |
| Ref | : Reference |
| Freq | : Frequency |
| MD | : Measurement Distance |
| SD | : Spec Distance |
| Pol | : Polarisation |
| H | : Horizontal Polarisation |
| V | : Vertical Polarisation |
| CDN | : Coupling & decoupling network |

## A1 Conducted Fundamental Carrier Power

Conducted carrier power was verified using a spectrum analyser, the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

| Test Details: | |
|---|---|
| Regulation | Title 47 of the CFR 2008, Part15 Subpart (c) 15.247(b)(2) |
| EUT sample number | S01 |
| Modification state | 0 |
| SE in test environment | REF053 and Wireless Group Laptop 1 |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix C |

| Channel No | Channel Frequency (MHz) | Measured Peak Conducted Carrier Power (W) | Limit (W) ≥ 50 channels | Result |
|---|---|---|---|---|
| 301 | 905.0.0 | 0.00309 | 1 | Pass |
| 351 | 915.0.0 | 0.00325 | | Pass |
| 401 | 925.0.0 | 0.00325 | | Pass |

Note

The carrier power was measured whilst the EUT was powered by a dc power supply to simulate a lead-acid battery.
The conducted carrier power contains no correction for antenna gain.

## 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.

| **Test Details: 905.0 MHz** | |
|---|---|
| Regulation | Title 47 of the CFR 2008, Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205 |
| Measurement standard | ANSI C63.4:2003 |
| Frequency range | 9 kHz to 10 GHz |
| EUT sample number | S01 |
| Modification state | 0 |
| SE in test environment | REF053 and Wireless Group Laptop 1 |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix C |

The worst case conducted emission measurements at the antenna port are listed below:

| Ref No. | Measured Freq (MHz) | Det. | Measured Peak Conducted power (RBW =100kHz) (dBuV) | 15.247(d) Limit (dBuV) | Summary |
|---|---|---|---|---|---|
| No Significant emissions within 20 dB of the limit | | | | | |

**RF Antenna Conducted Spurious Emissions continued:**

| Test Details: 915.0 MHz | |
|---|---|
| Regulation | Title 47 of the CFR 2008, Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205 |
| Measurement standard | ANSI C63.4:2003 |
| Frequency range | 9 kHz to 10 GHz |
| EUT sample number | S01 |
| Modification state | 0 |
| SE in test environment | REF053 and Wireless Group Laptop 1 |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix C |

The worst case conducted emission measurements at the antenna port are listed below:

| Ref No. | Measured Freq (MHz) | Det. | Measured Peak Conducted power (RBW =100kHz) (dBuV) | 15.247(d) Limit (dBuV) | Summary |
|---|---|---|---|---|---|
| No Significant emissions within 20 dB of the limit | | | | | |

**RF Antenna Conducted Spurious Emissions continued:**

| Test Details: 925.0 MHz | |
|---|---|
| Regulation | Title 47 of the CFR 2008, Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205 |
| Measurement standard | ANSI C63.4:2003 |
| Frequency range | 9 kHz to 10 GHz |
| EUT sample number | S01 |
| Modification state | 0 |
| SE in test environment | REF053 and Wireless Group Laptop 1 |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix C |

The worst case conducted emission measurements at the antenna port are listed below:

| Ref No. | Measured Freq (MHz) | Det. | Measured Peak Conducted power (RBW =100kHz) (dBuV) | 15.247(d) Limit (dBuV) | Summary |
|---|---|---|---|---|---|
| No Significant emissions within 20 dB of the limit | | | | | |

**Notes:**

1. The conducted emission limit for emissions outside the restricted bands, defined in 47CFR15.205(a) are based on a transmitted carrier level of 15.247(b)(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) using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated up to the 10th harmonic in accordance15.33 (a)(1).
3. The measurements at 902 MHz and 928 MHz were made to ensure band edge compliance.
4. The carrier level was measured whilst the EUT was powered by a dc power supply to simulate a lead-acid battery. 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):

The limit in 100 kHz RBW = (Maximum Peak Conducted Carrier)-20dB

Where:

The maximum peak conducted power was measured using a peak power meter. Please refer to section A1 of this test report.

| **Limit(dBμV)** | | | | |
|---|---|---|---|---|
| Channel No. | Channel Frequency (MHz) | Measured Peak Conducted Carrier (dBμV) | Measured Peak Conducted Carrier – 20dB (dBμV) | Emission Limit 15.247(d) in 100 kHz RBW (dBμV) |
| 301 | 905.0 | 115.9 | 115.9 – 20 | 95.9 |
| 351 | 915.0 | 116.0 | 116.0 – 20 | 96.0 |
| 401 | 925.0 | 116.4 | 116.4 – 20 | 96.4 |

## A3 Radiated Electric Field Emissions Within The Restricted Bands of 15.205

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric filed emission test applies to spurious emissions and harmonics that fall within the restricted bands listed in Section 15.205. 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 at each operational data rate in turn. 2 different combinations of connector/antenna were testing in the modes described.

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: 905.0 MHz** | |
|---|---|
| Regulation | Title 47 of the CFR 2008, Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205 |
| Measurement standard | ANSI C63.4:2003 |
| Frequency range | 30MHz to 10 GHz |
| EUT sample number | S01 and S02 |
| Modification state | 0 |
| SE in test environment | None |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix 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) | Pol. | Result (dBμV/m) | Spec. Limit (dBμV/m) | Margin (dB) | Summary |
|---|---|---|---|---|---|---|
| 1. | 961.6 | V | 42.40 | 54 | -11.60 | Pass |
| 2. | 2715.008 | H | 34.02 | 54 | -19.98 | Pass |
| 3. | 3619.975 | V | 53.84 | 54 | -0.16 | Marginal |
| 4. | 4524.975 | V | 40.30 | 54 | -13.70 | Pass |
| 5. | 5429.943 | V | 49.30 | 54 | -4.70 | Pass |

[1]See section 2.1 Note (iii).

**Radiated Electric Field Emissions Within The Restricted Band 15.205 continued:**

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

| Test Details: 915.0 MHz | |
|---|---|
| Regulation | Title 47 of the CFR 2008, Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205 |
| Measurement standard | ANSI C63.4:2003 |
| Frequency range | 30MHz to 10 GHz |
| EUT sample number | S01 and S02 |
| Modification state | 0 |
| SE in test environment | None |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix 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) | Pol. | Result (dBμV/m) | Spec. Limit (dBμV/m) | Margin (dB) | Summary |
|---|---|---|---|---|---|---|
| 1. | 972.2 | V | 42.3 | 54 | -11.70 | Pass |
| 2. | 2745.032 | V | 39.59 | 54 | -14.41 | Pass |
| 3. | 3659.943 | H | 50.51 | 54 | -3.49 | Marginal |
| 4. | 4574.943 | H | 37.88 | 54 | -16.12 | Pass |

[1]See section 2.1 Note (iii).

**Radiated Electric Field Emissions Within The Restricted Band 15.205 continued:**

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

| Test Details: 925.0 MHz | |
|---|---|
| Regulation | Title 47 of the CFR 2008, Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205 |
| Measurement standard | ANSI C63.4:2003 |
| Frequency range | 30MHz to 10 GHz |
| EUT sample number | S01 and S02 |
| Modification state | 0 |
| SE in test environment | None |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix 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) | Pol. | Result (dBμV/m) | Spec. Limit (dBμV/m) | Margin (dB) | Summary |
|---|---|---|---|---|---|---|
| 1. | 982.8 | V | 42.8 | 54 | -11.20 | Pass |
| 2. | 2774.982 | V | 34.35 | 54 | -19.65 | Pass |
| 3. | 3700.003 | H | 47.71 | 54 | -6.29 | Pass |
| 4. | 4625.008 | V | 38.13 | 54 | -15.87 | Pass |

[1]See section 2.1 Note (iii).

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with 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 902 & 928 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 C63.4 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 frequency (refer to the measured frequency 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

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

The upper and lower frequency of the measurement range was decided according to 47 CFR 15:2008 Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits (47 CFR 15:2008 Clause 15.209) for emissions falling within the restricted bands defined in 15.205(a):

| Frequency of emission (MHz) | Field strength μV/m | Measurement Distance m | Field strength dBμV/m |
|---|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | 300 | 67.6/F (kHz) |
| 0.490-1.705 | 24000/F(kHz) | 30 | 87.6/F (kHz |
| 1.705-30 | 30 | 30 | 29.5 |
| 30-88 | 100 | 3 | 40.0 |
| 88-216 | 150 | 3 | 43.5 |
| 216-960 | 200 | 3 | 46.0 |
| Above 960 | 500 | 3 | 54.0 |

**Notes:**

(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:

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

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 | ✓ | | | |

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

## A4 Power Line Conducted Emissions

The EUT is a dc powered device supplied by a vehicle battery. No assessment to the 47 CFR 15:2008 Clause 15.207 has been made.

## A5 20 dB Bandwidth and Channel Spacing

Title 47 of the CFR: 2002, Part 15 Subpart (c) 15.247(a)(1)(i) 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 spacing shall be a minimum of 25 kHz or the 20 dB bandwidth, whichever is the greater. The formal measurements are detailed below:

| Test Details | |
|---|---|
| Regulation | Title 47 of the CFR: 2008, Part 15 Subpart (c) 15.247(a)(1)(i) |
| Measurement standard | ANSI C63.4:2003 |
| EUT sample number | S01 |
| Modification state | 0 |
| SE in test environment | REF053 and Wireless Group Laptop 1 |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix C |

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

| Channel No. | Measured 20 dB Bandwidth (kHz) | Limit | Result |
|---|---|---|---|
| 301 | 375 | N/A | N/A |
| 351 | 370 | N/A | N/A |
| 401 | 366 | N/A | N/A |

| Measured Channel Spacing (kHz) | Limit | Result |
|---|---|---|
| 398.000 | 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater) | Pass |

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

## A6 Hopping frequencies

Hopping frequencies were verified using a spectrum analyser, the span was set to display sub sets of the hopping channels in turn, while the EUT was operating in its normal frequency-hopping mode.

| **Test Details:** | |
|---|---|
| Regulation | Title 47 of the CFR :2008, Part 15 Subpart (c) 15.247(a)(1)(i) and 15.247 (b) (2) |
| EUT sample number | S01 |
| Modification state | 0 |
| SE in test environment | REF053 and Wireless Group Laptop 1 |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix C |

| Measured No. of Hopping Channels | Requirements | | Result |
|---|---|---|---|
| | 15.247(a)(1)(i) 20dB bandwidth $\geq$ 250kHz | 15.247 (b) (2) | |
| 50 | Shall use at least 25 hopping frequencies | For 1W conducted carrier power Limit, employing at least 50 hopping channels | Pass |

Plots showing the hopping channels are contained in Appendix B

## A7 Frequency Occupancy

Channel occupancy time was verified using a spectrum analyser in zero span mode, centred on the bottom hopping channel frequency (905.0 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 | Title 47 of the CFR2008, Part15 Subpart (c) 15.247(a)(1)(i) |
| EUT sample number | S01 |
| Modification state | 0 |
| SE in test environment | REF053 and Wireless Group Laptop 1 |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix C |

| Measured No. of Hopping Channels | Measured Frequency Occupancy time on any frequency (ms) | Measured Frequency Repetition Time (s) | Requirements | | | Result |
|---|---|---|---|---|---|---|
| | | | 15.247(a)(1)(i) 20dB bandwidth ≥ 250kHz | Frequency Occupancy Time Limit (ms) | Frequency Repetition Time (s) | |
| 50 | 393.333 | >11s | Shall use at least 25 hopping frequencies | 400 | >10s | Pass |

Plots showing the frequency occupancy time and time between successive transmissions greater than 10s, are contained in Appendix B of this test report.

## A8 Antenna Gain

The maximum antenna gain for the antenna (S02) to be used with the EUT, as declared by the client, is 2 dBi. Refer to Appendix D for antenna manufacture details.

## A9 Unintentional Radiated Electric Field Emissions - 15.109

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.109. The EUT was set to receive mode only on its lowest, centre and highest operating 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 : ☐

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

| Test Details: Lowest, Centre and Highest Operating Frequency | |
|---|---|
| Regulation | Title 47 of the CFR 2008, Part 15 Subpart (b) Clause 15.109 |
| Measurement standard | ANSI C63.4:2003 |
| Frequency range | 30MHz to 10 GHz |
| EUT sample number | S01 and S02 |
| Modification state | 0 |
| SE in test environment | None |
| SE isolated from EUT | None |
| EUT set up | Refer to Appendix C |
| Photographs (Appendix F) | Photograph 1 and 2 |

The worst case radiated emission measurements for unintentional radiated spurious emissions are listed below:

Or

| Ref No. | Freq (MHz) | Pol. | Result (dBμV/m) | Spec. Limit (dBμV/m) | Margin (dB) | Summary |
|---|---|---|---|---|---|---|
| No Significant Emissions Within 20 dB of the Limit | | | | | | |

[1]See section 2.1 Note (iii).

## Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

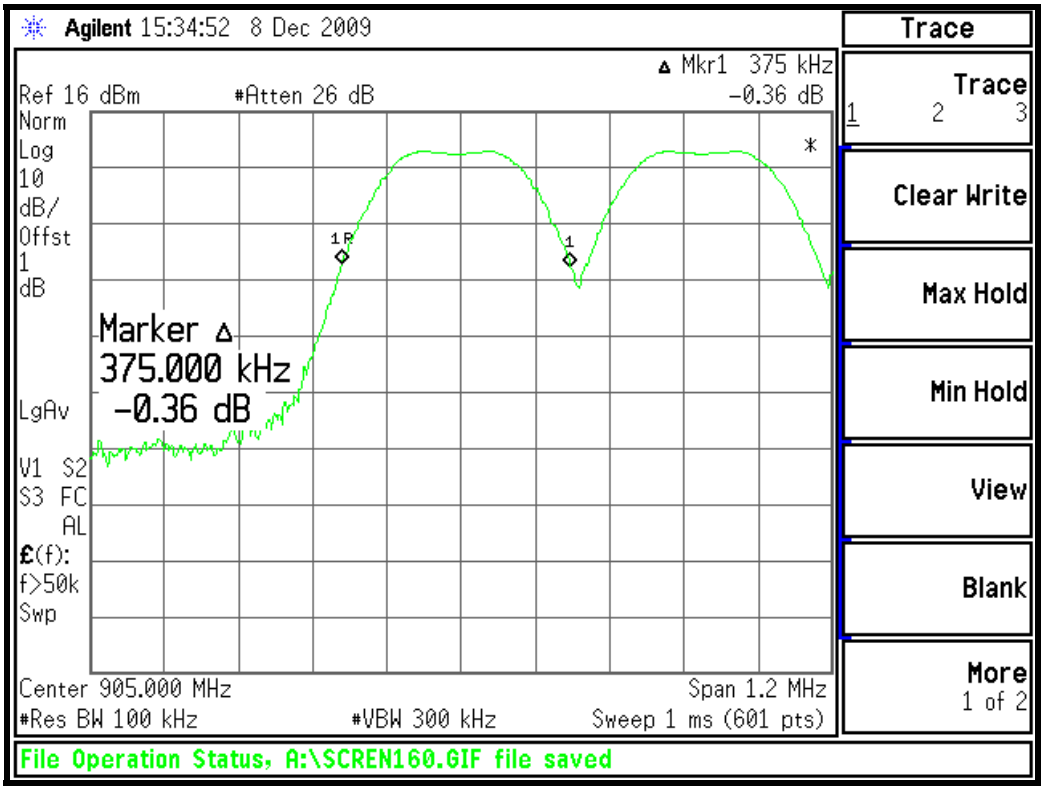
(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

(b) The time and date on the plots do not necessarily equate to the time of the test.

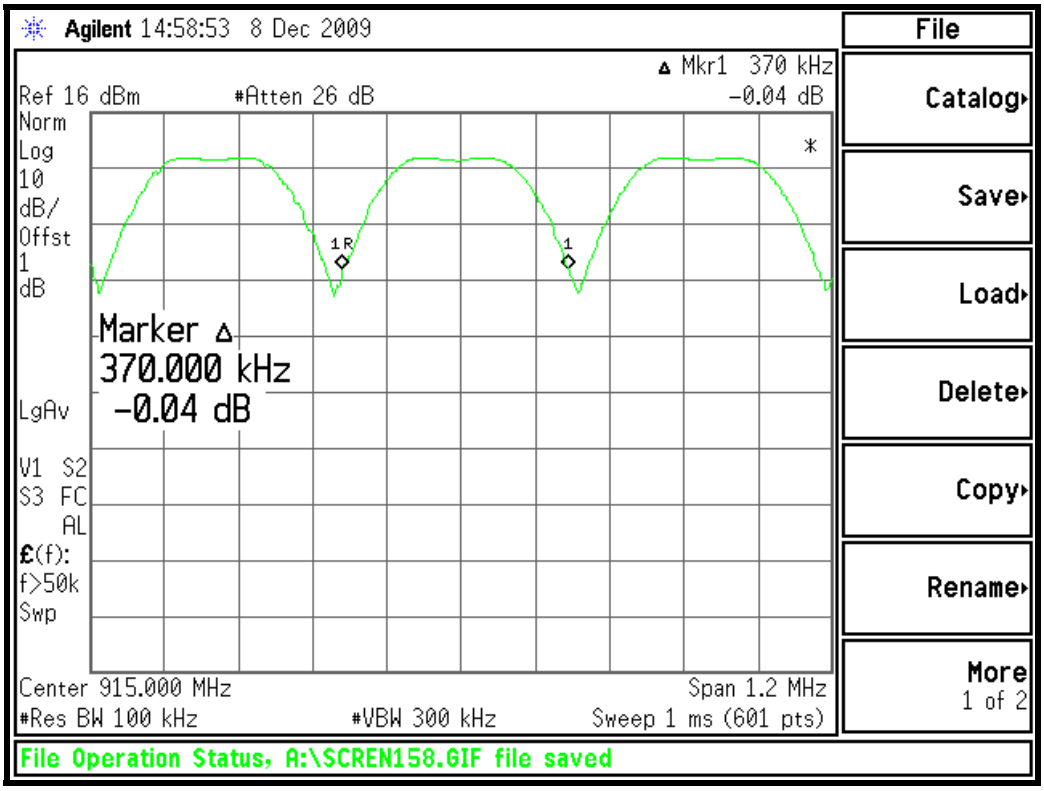
(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

(d) Appendix C details the numbering system used to identify the sample and its modification state.

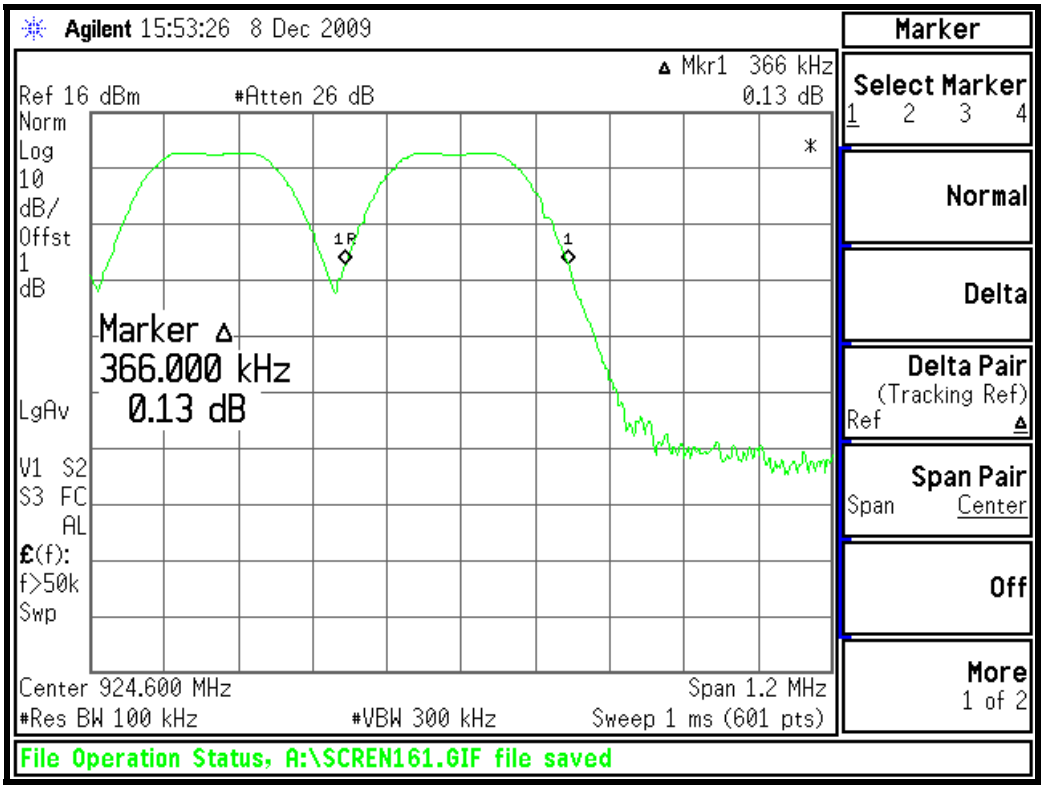
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



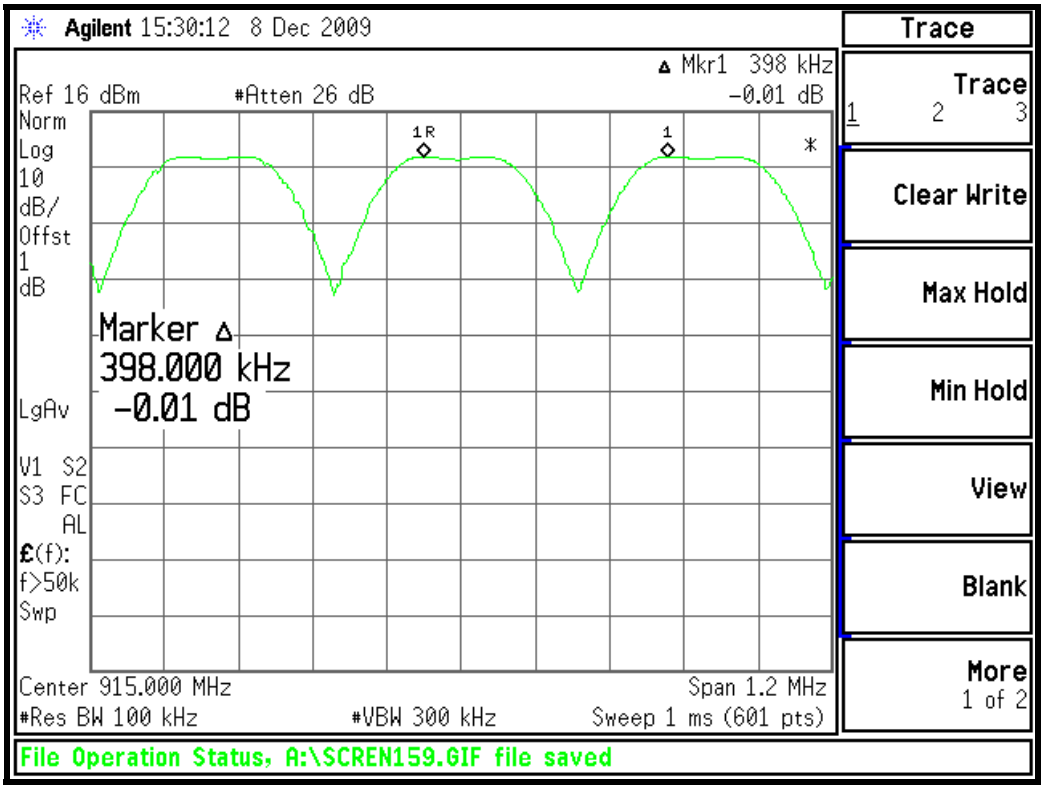

20dB Bandwidth – 905.0 MHz



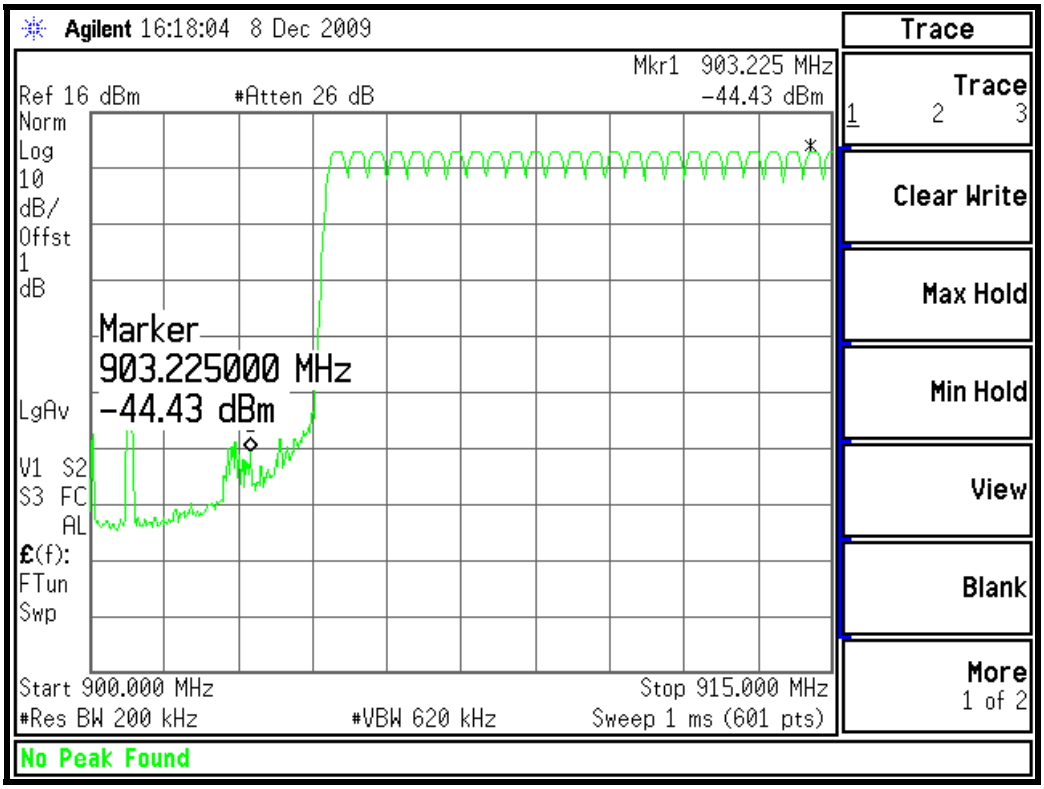

20dB Bandwidth – 915.0 MHz



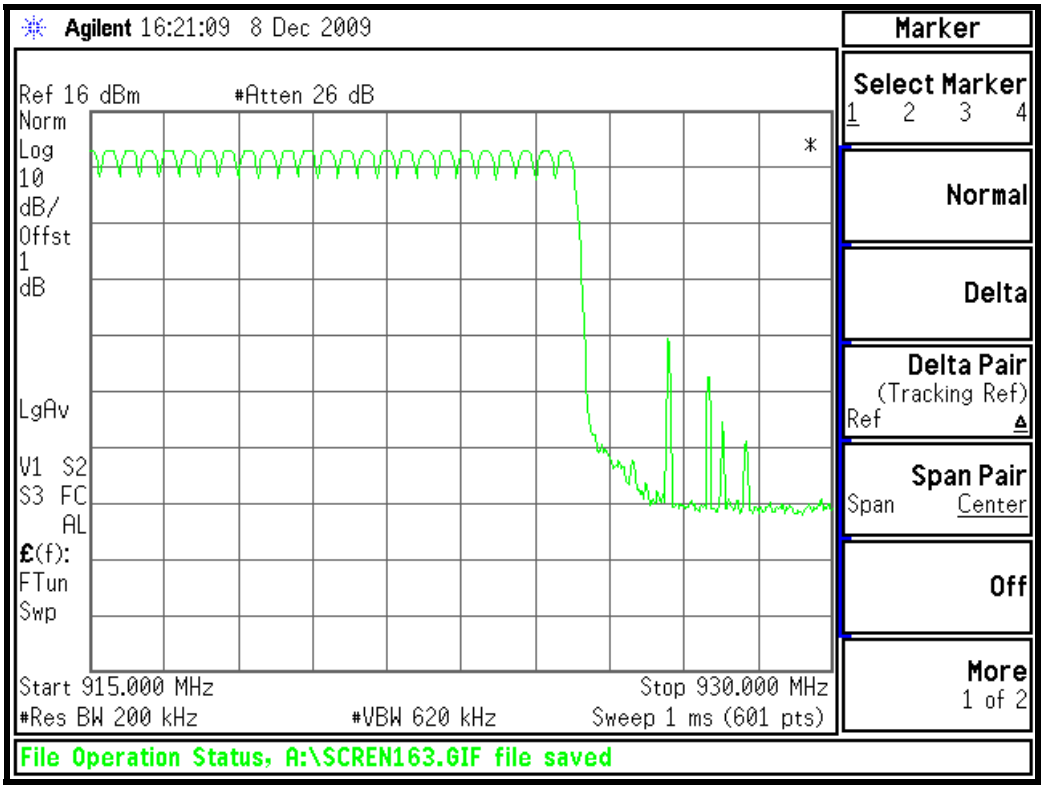

20dB Bandwidth – 925.0 MHz



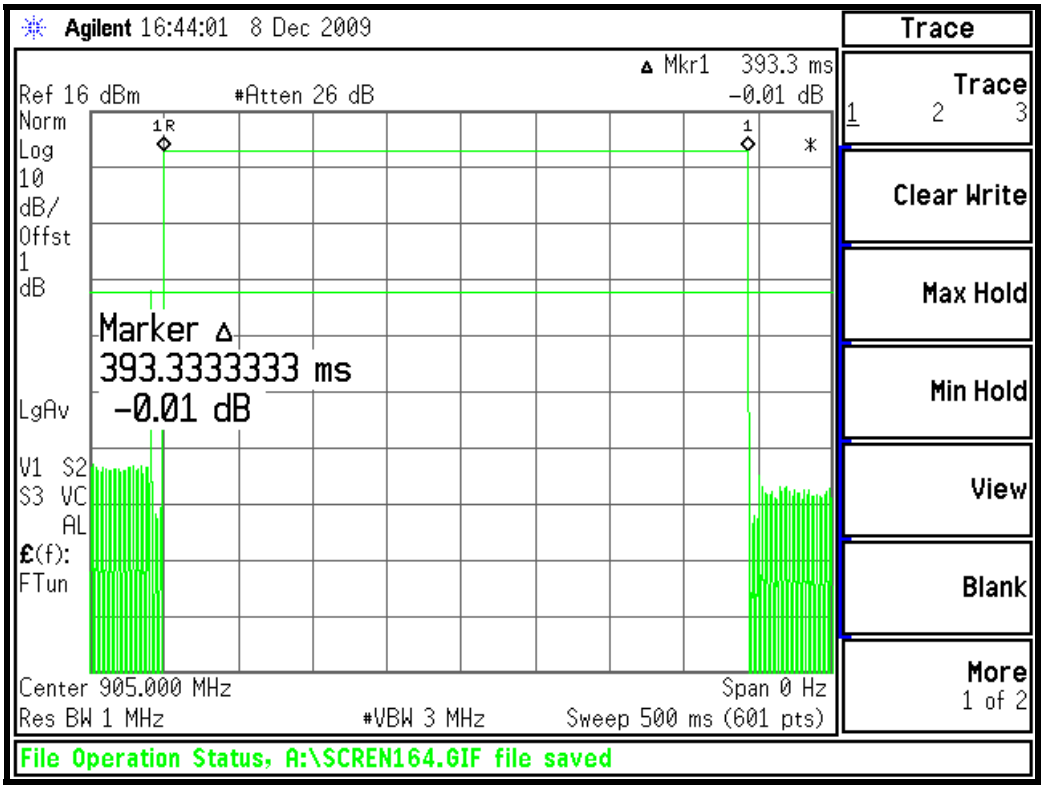

Channel Spacing



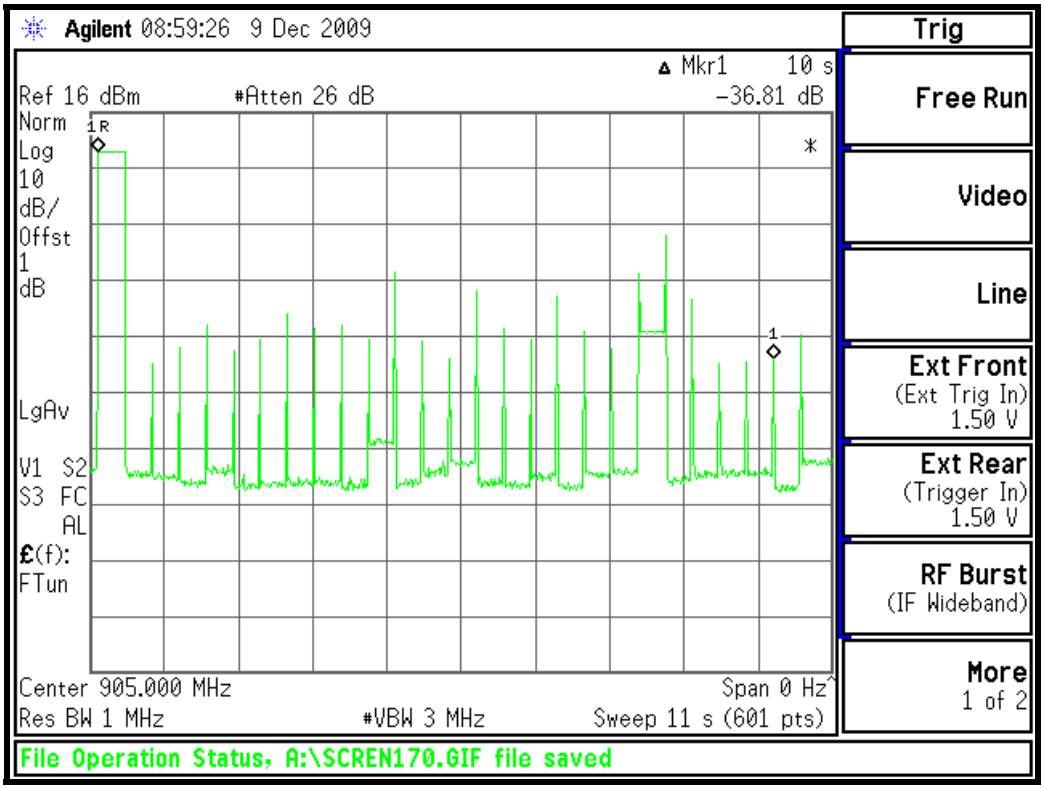

No. Of Channels 1 to 26



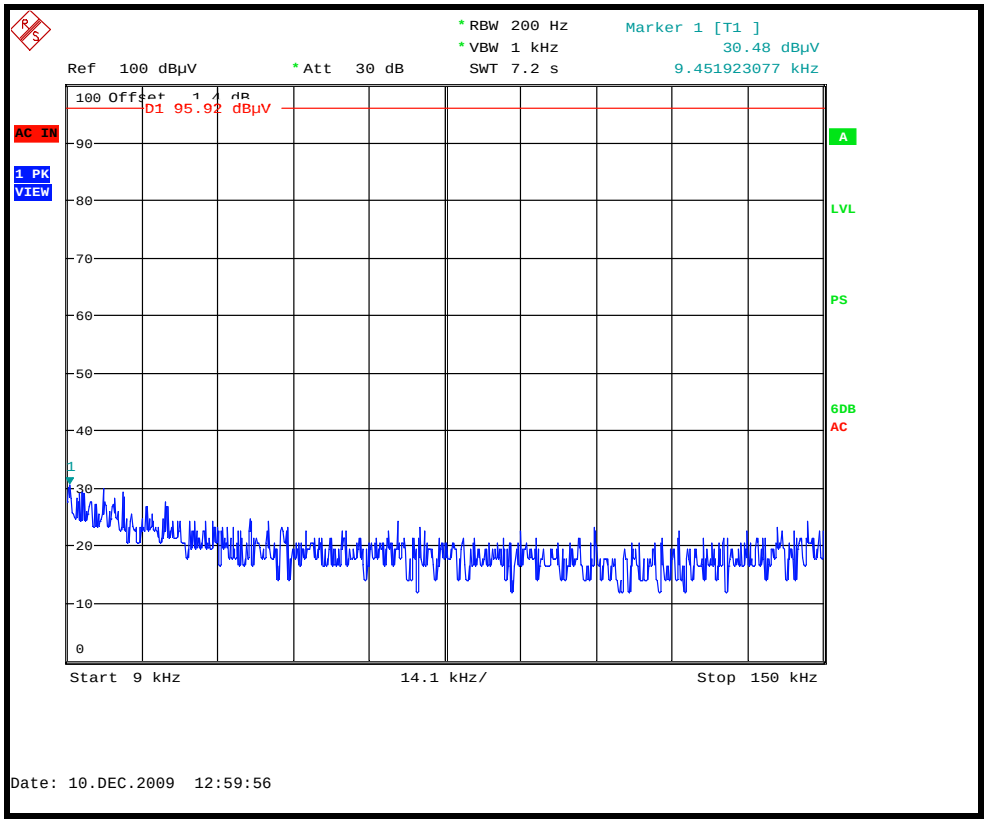

No. Of Channels 27 to 50



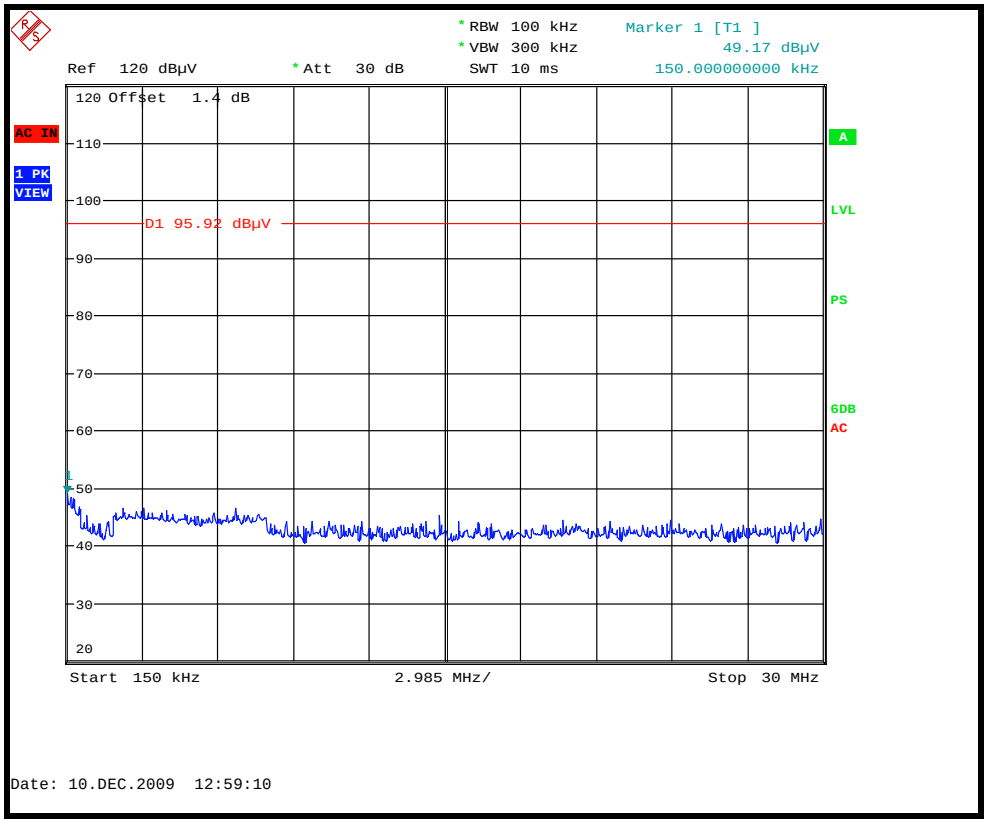

Frequency Occupancy Time



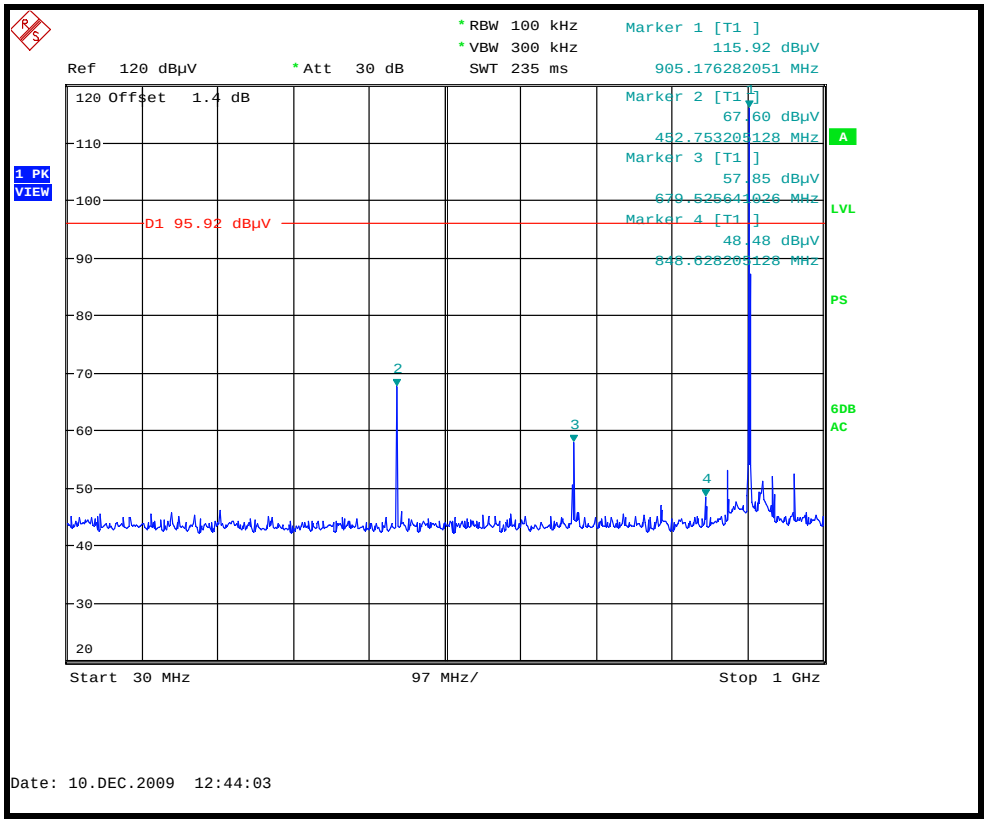

Frequency repetition time>10s



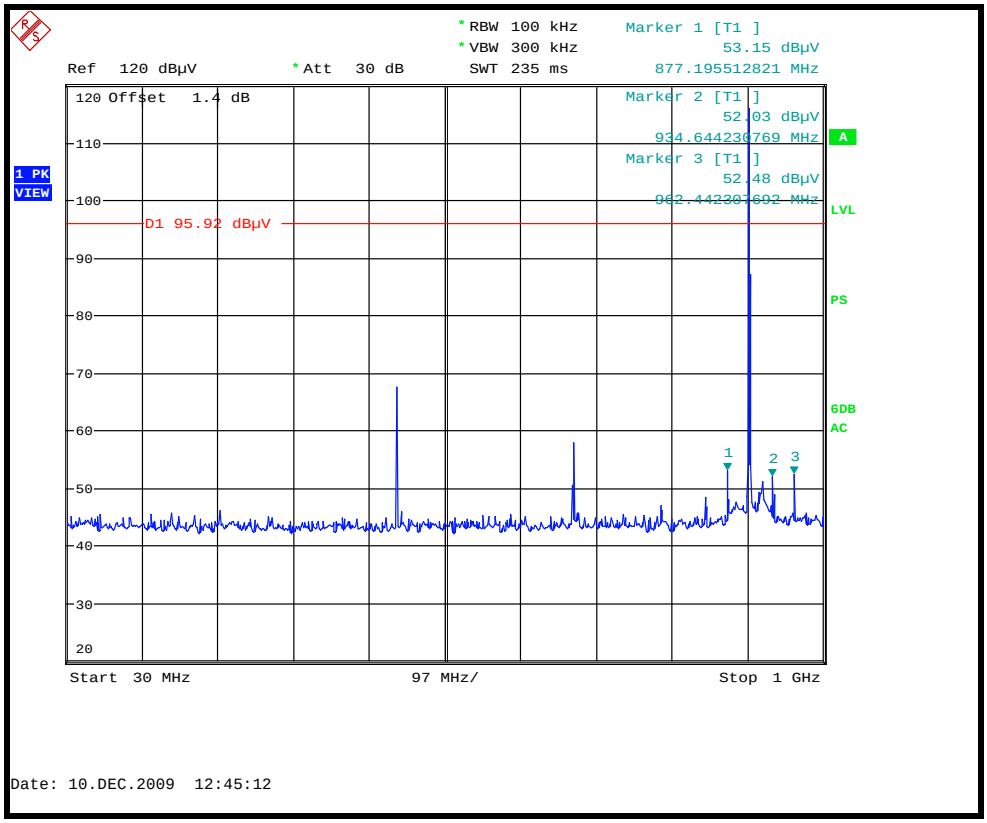

Conducted Spurious emissions 9kHz to 150kHz – 905.0 MHz



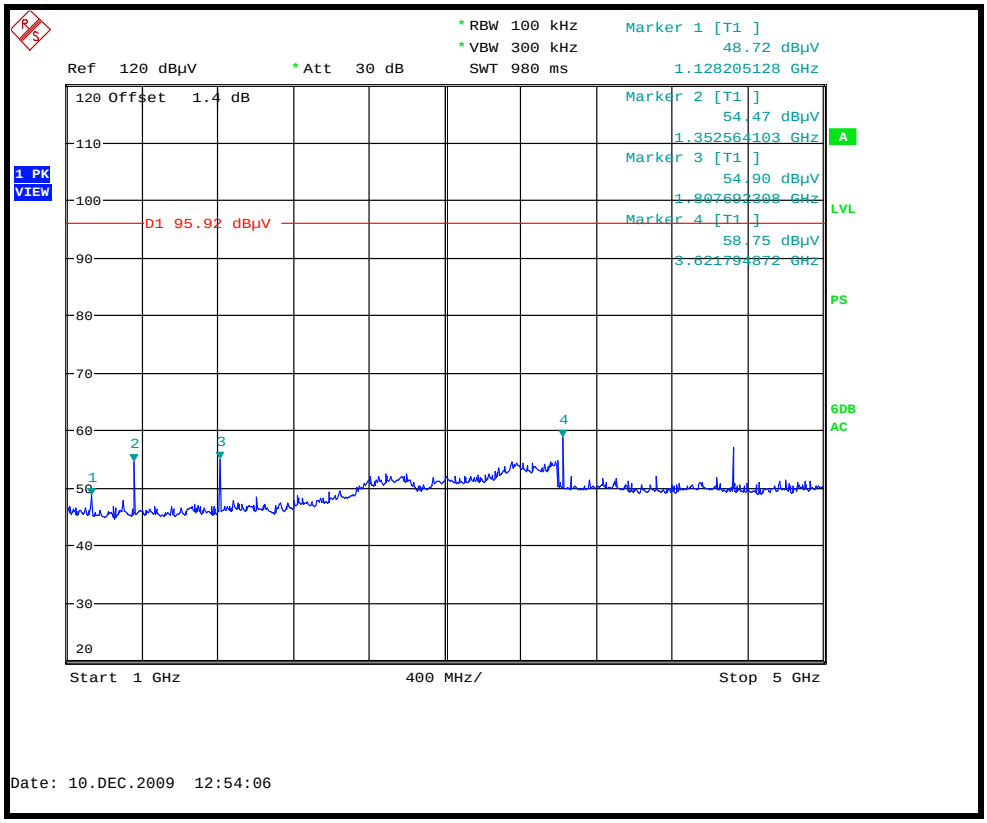

Conducted Spurious emissions 150kHz to 30MHz – 905.0 MHz



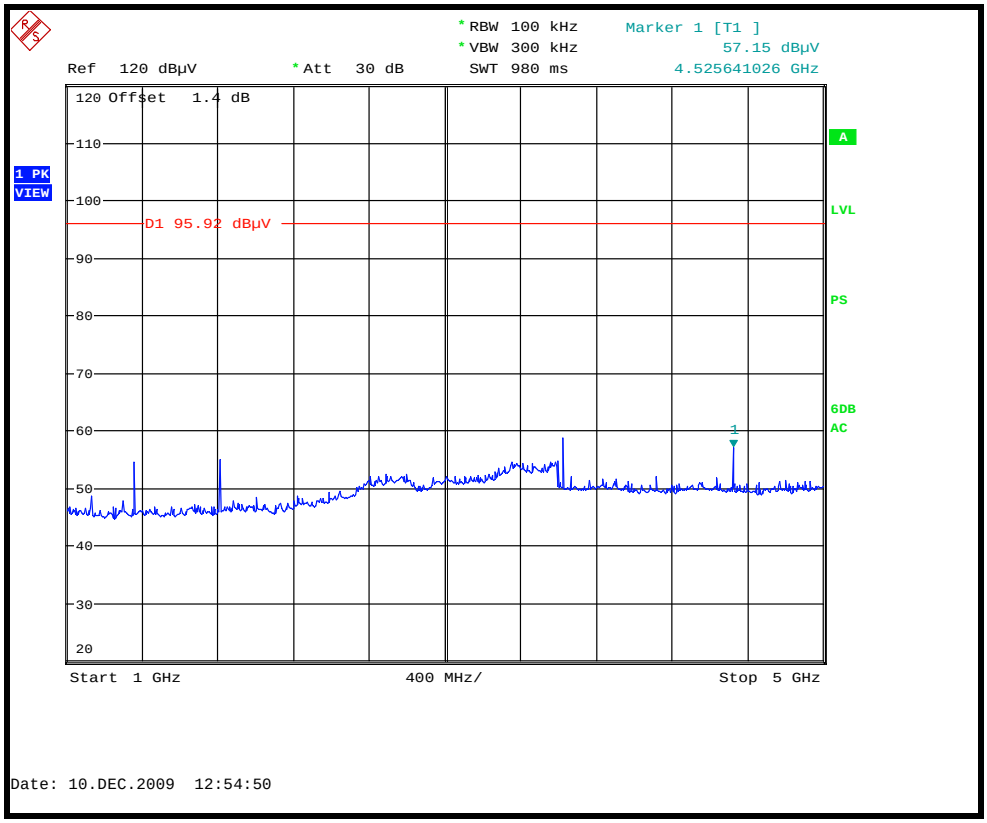

Conducted Spurious emissions 30 MHz to 1 GHz – 905.0 MHz



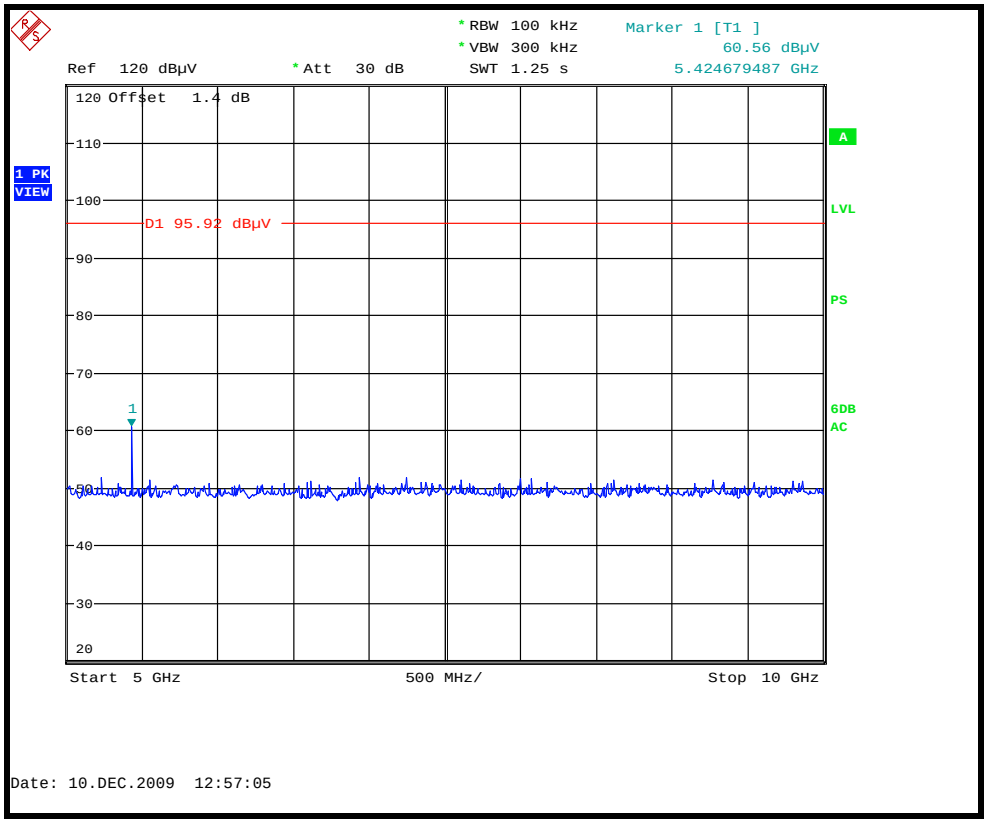

Conducted Spurious emissions 30 MHz to 1 GHz – 905.0 MHz



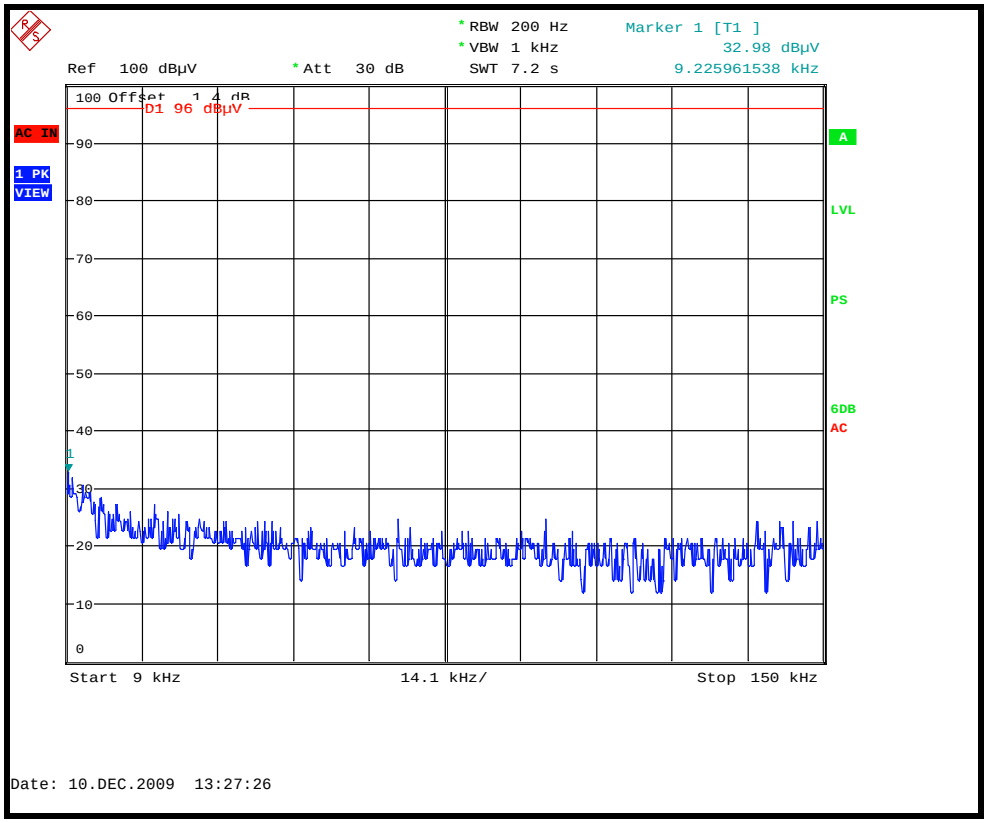

Conducted Spurious emissions 1 GHz to 5 GHz – 905.0 MHz



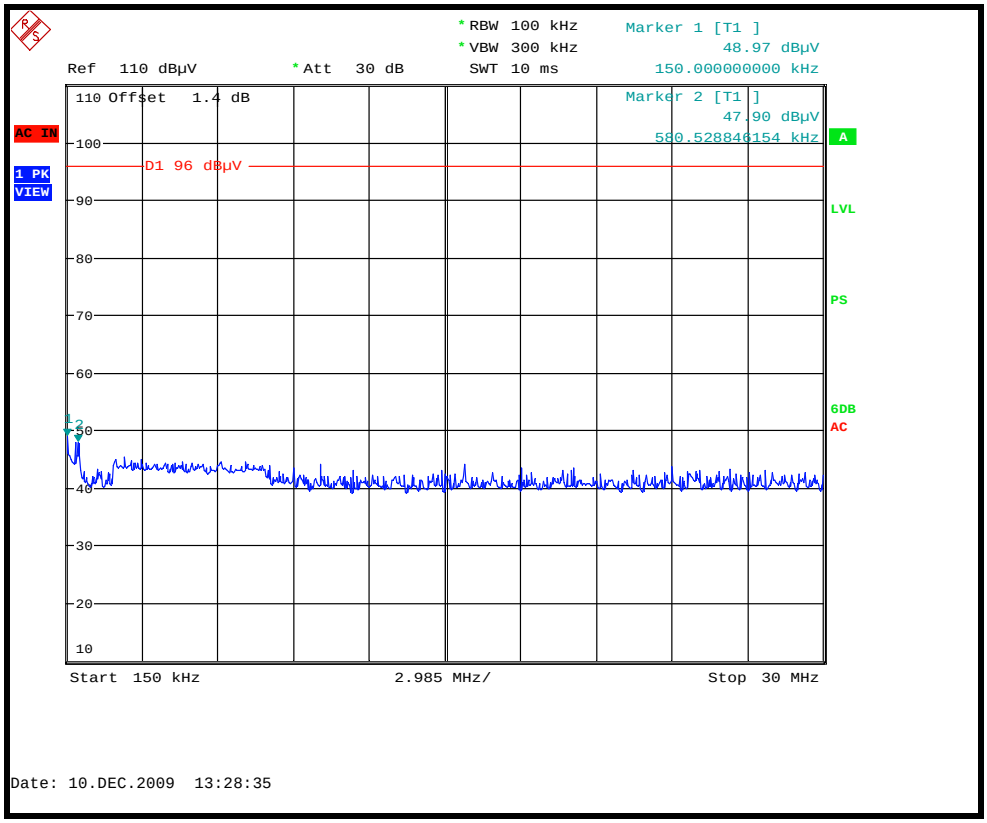

Conducted Spurious emissions 5 GHz to 10 GHz – 905.0 MHz



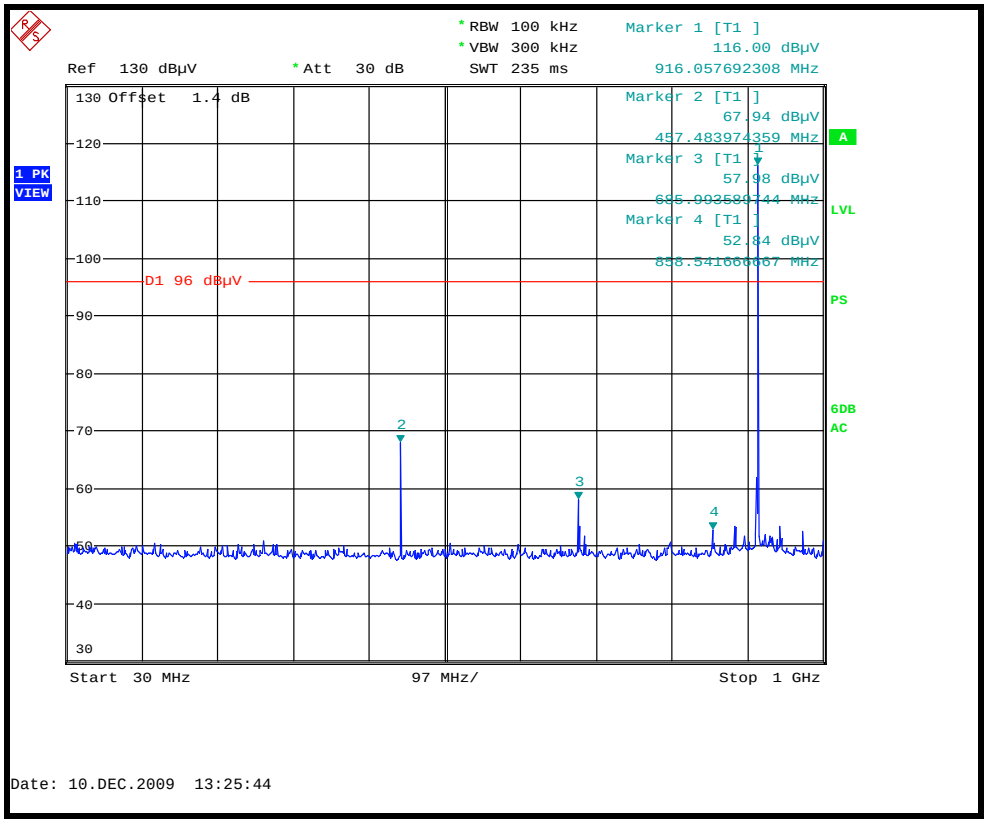

Conducted Spurious emissions 5 GHz to 10 GHz – 905.0 MHz



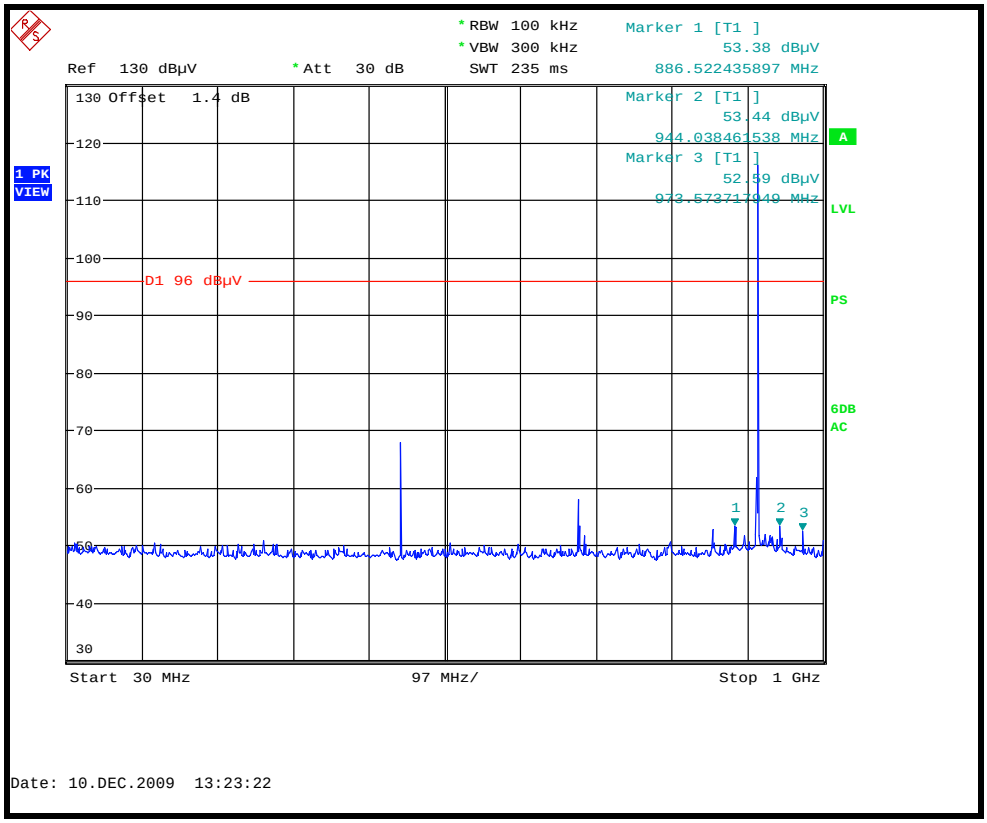

Conducted Spurious emissions 9 kHz to 150 kHz – 915.0 MHz



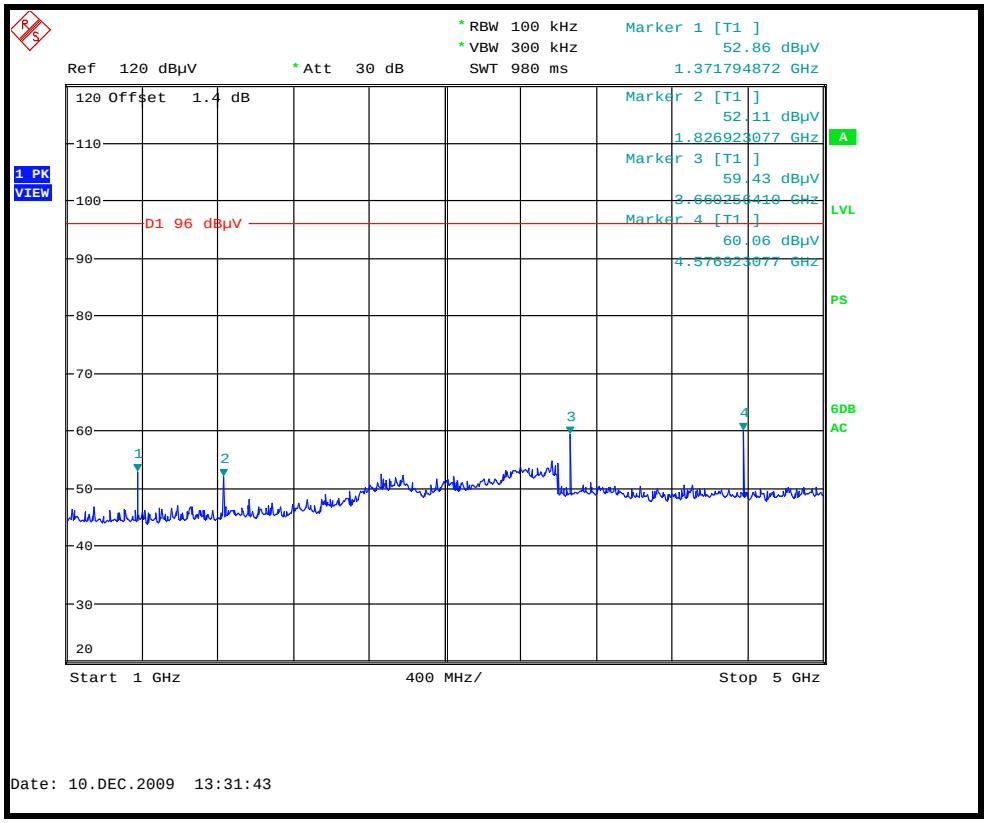

Conducted Spurious emissions 150 kHz to 30 MHz – 915.0 MHz



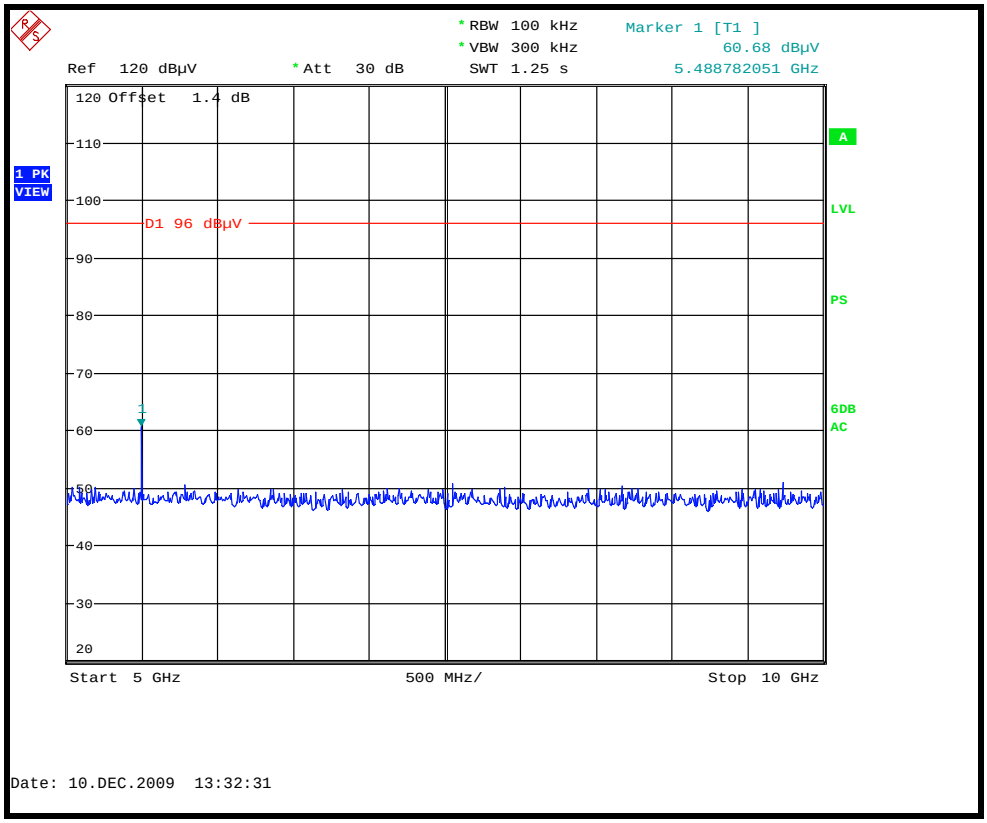

Conducted Spurious emissions 30 MHz to 1 GHz – 915.0 MHz



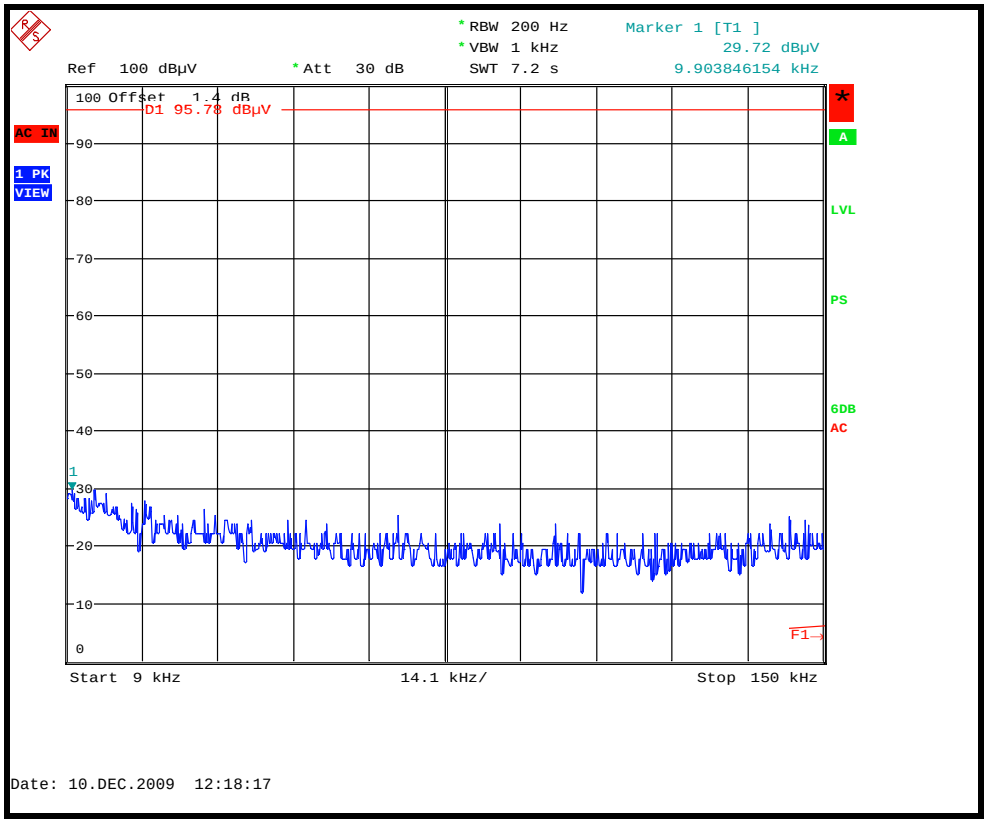

Conducted Spurious emissions 30 MHz to 1 GHz – 915.0 MHz



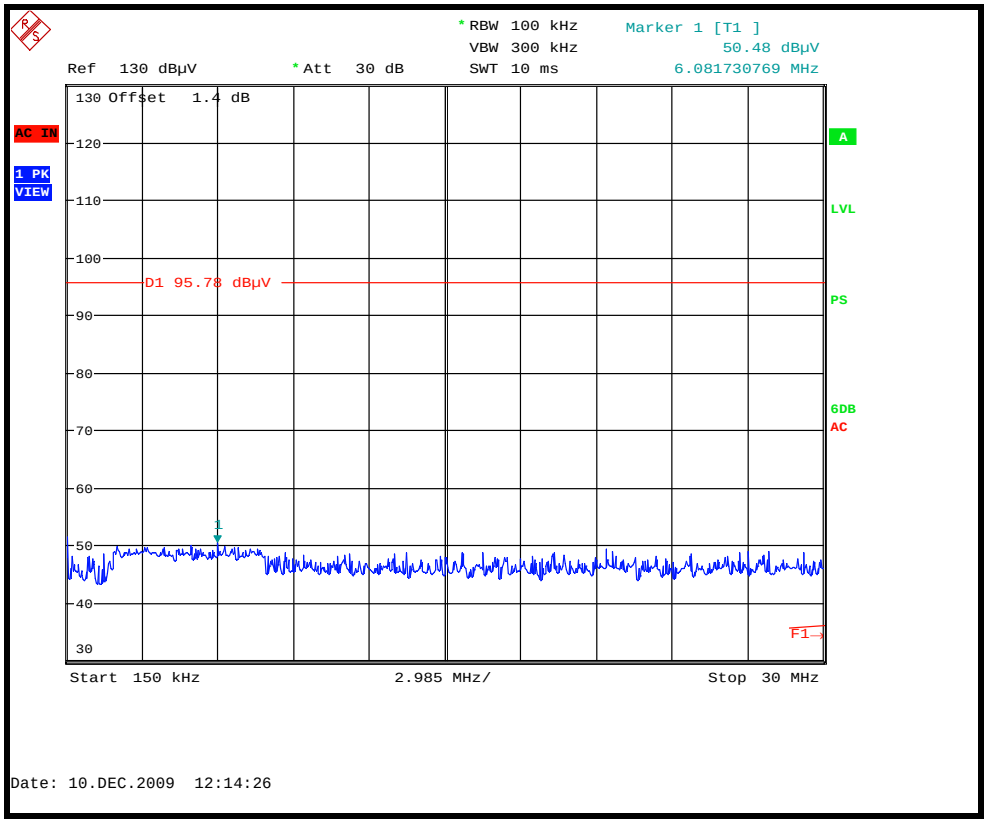

Conducted Spurious emissions 1 GHz to 5GHz – 915.0 MHz



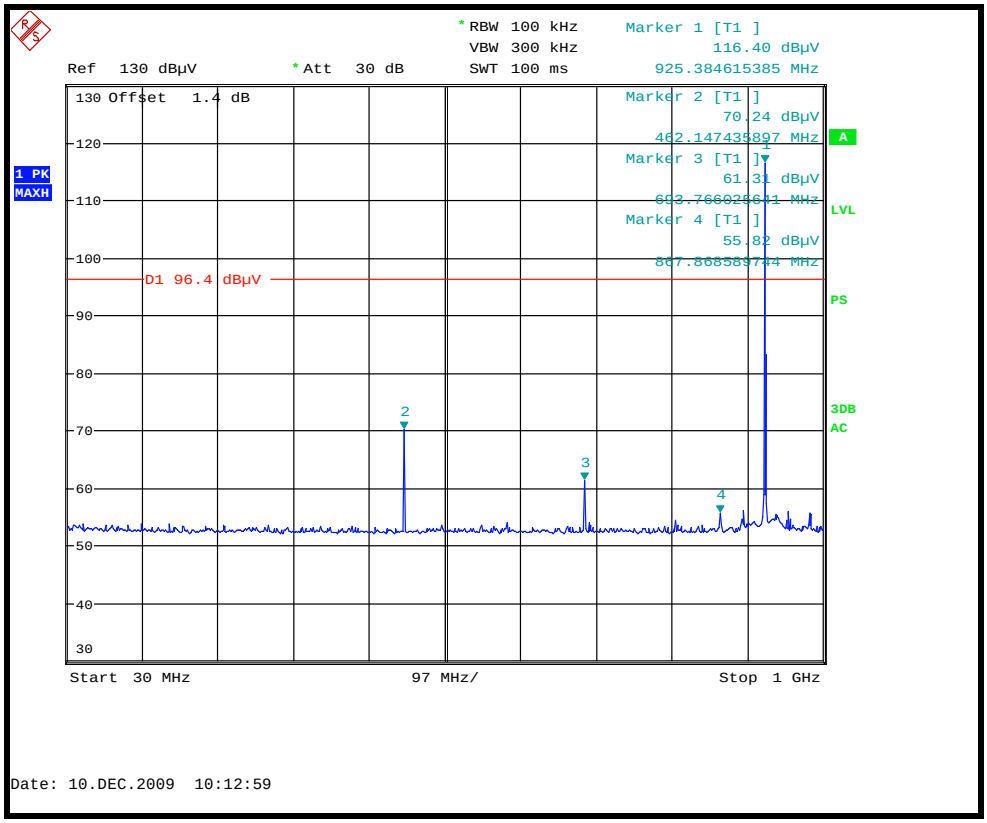

Conducted Spurious emissions 5 GHz to 10 GHz – 915.0 MHz



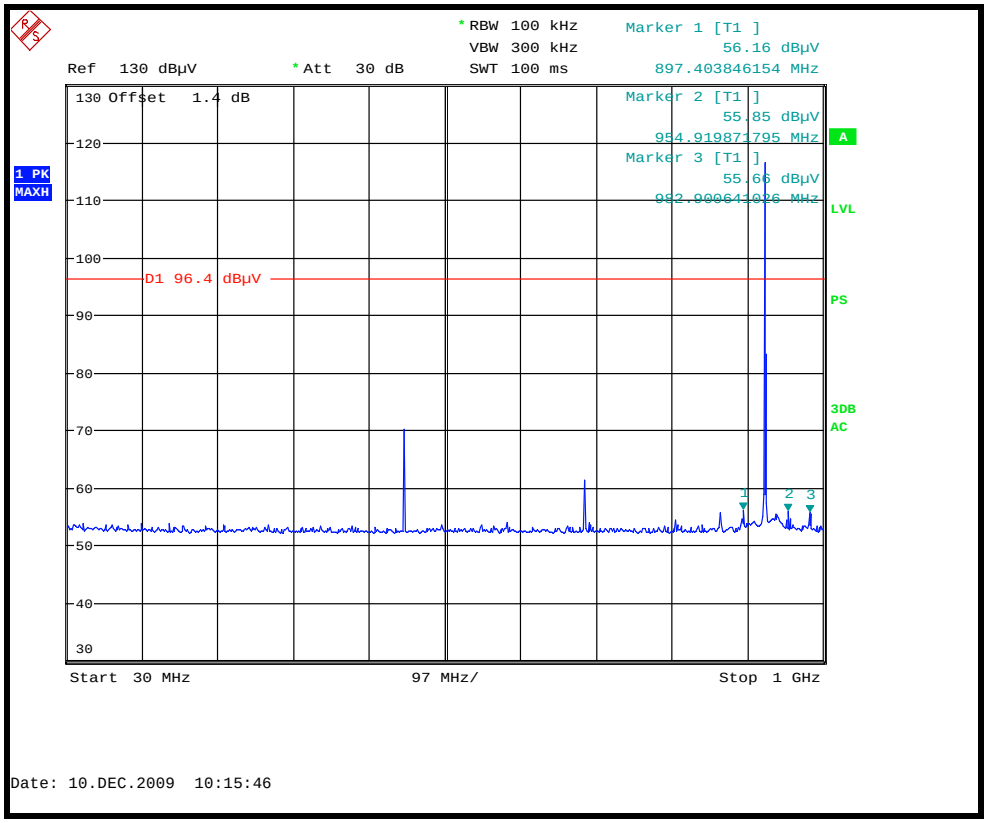

Conducted Spurious emissions 9 kHz to 150 kHz – 925.0 MHz



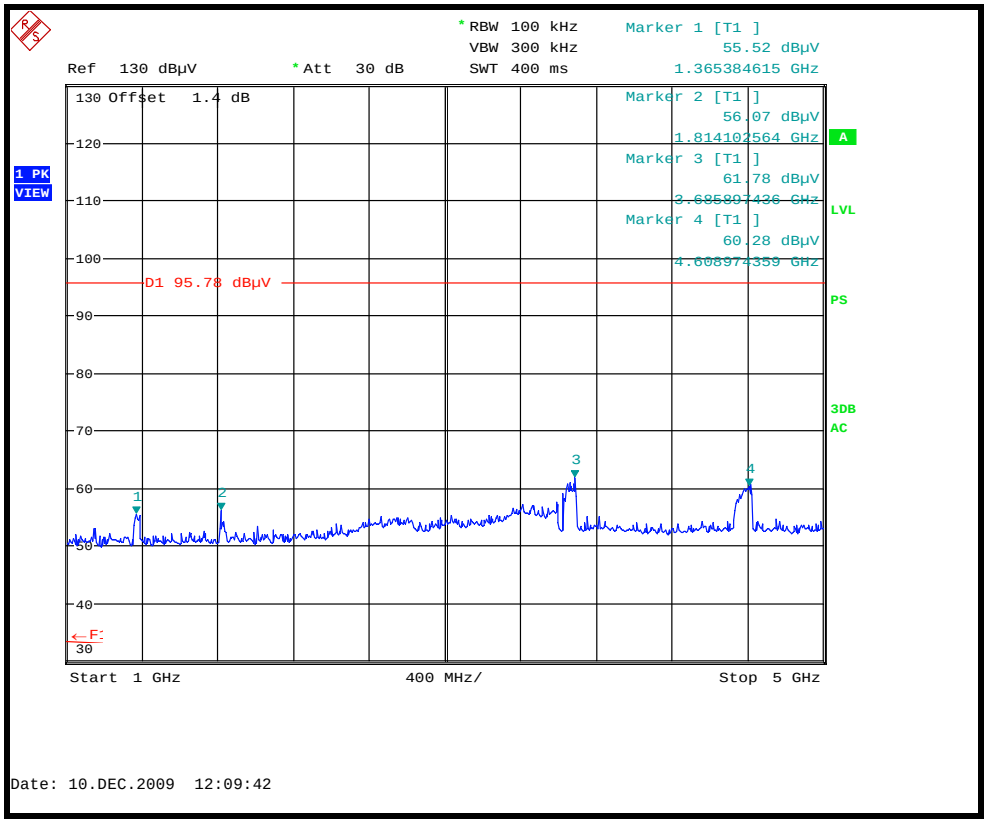

Conducted Spurious emissions 150 kHz to 30 MHz – 925.0 MHz



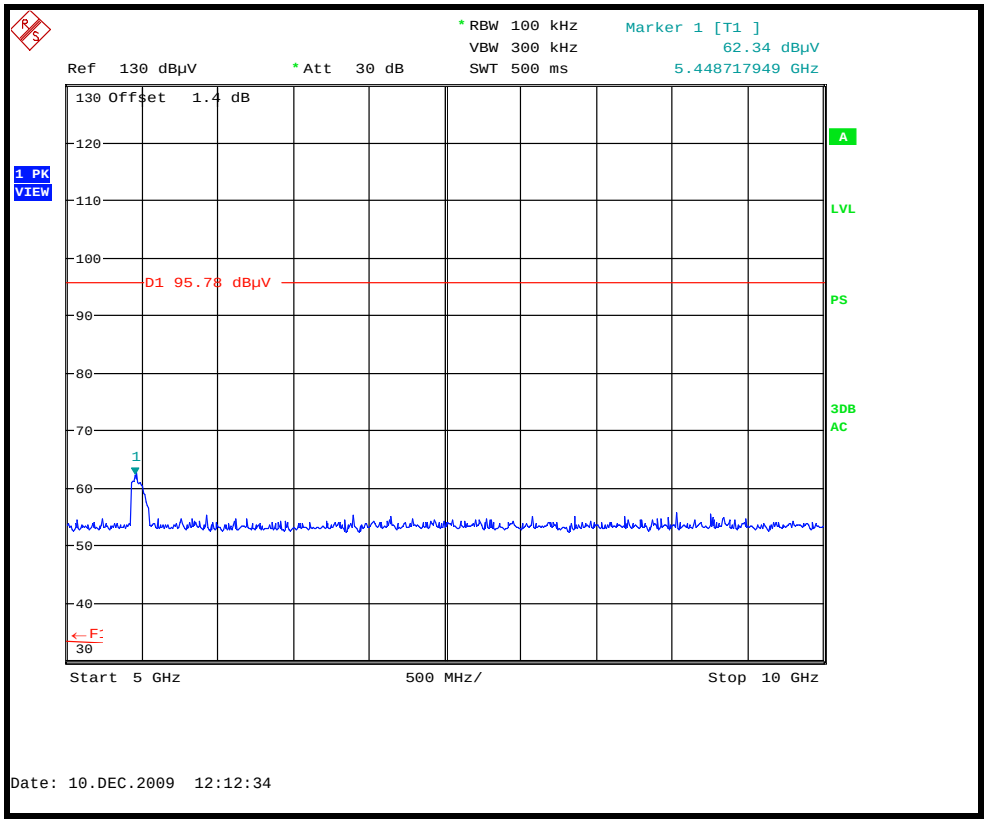

Conducted Spurious emissions 30 MHz to 1 GHz – 925.0 MHz



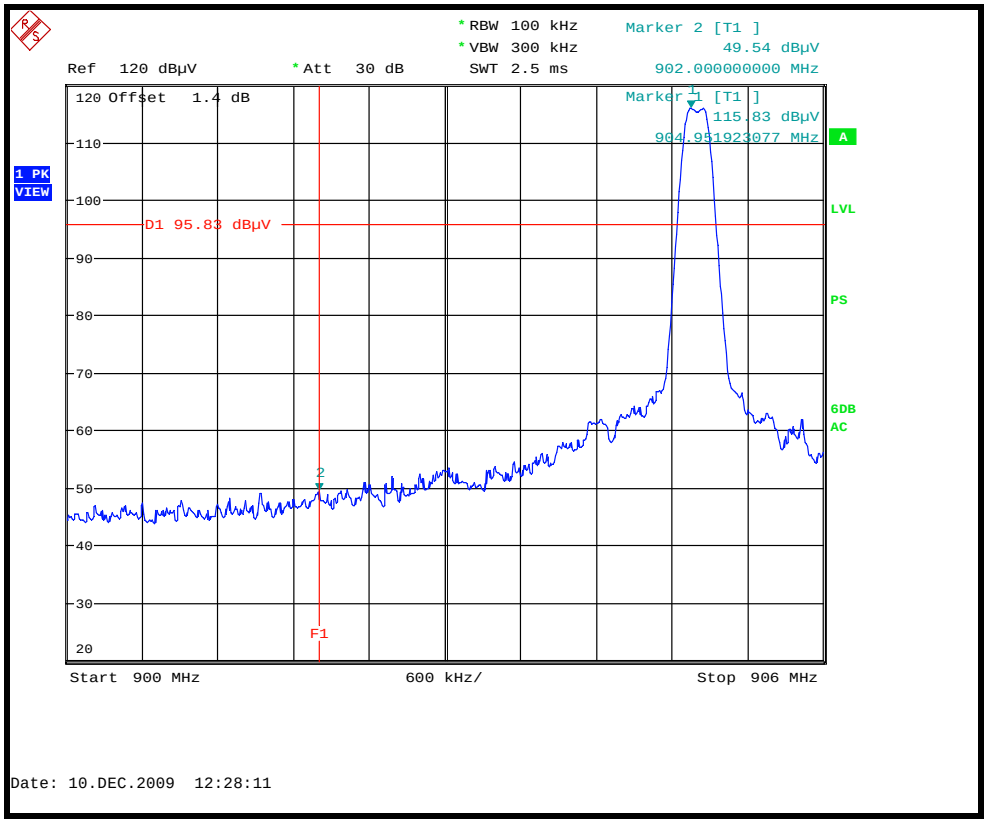

Conducted Spurious emissions 30 MHz to 1 GHz – 925.0 MHz



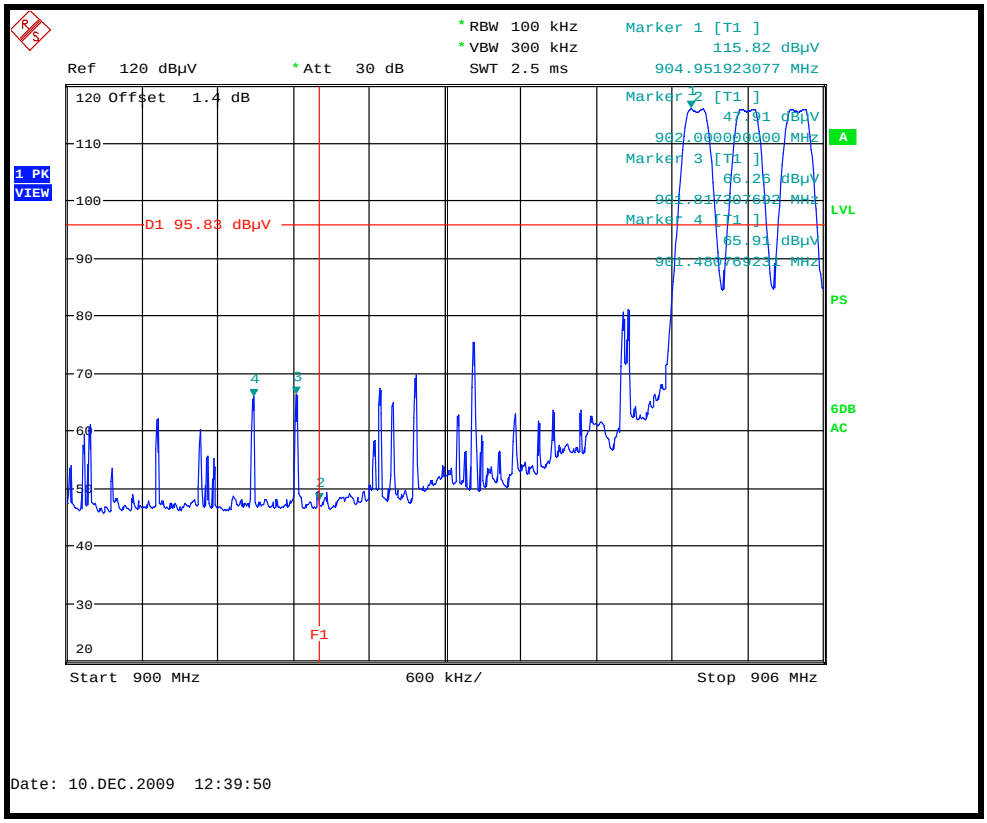

Conducted Spurious emissions 1 GHz to 5GHz – 925.0 MHz



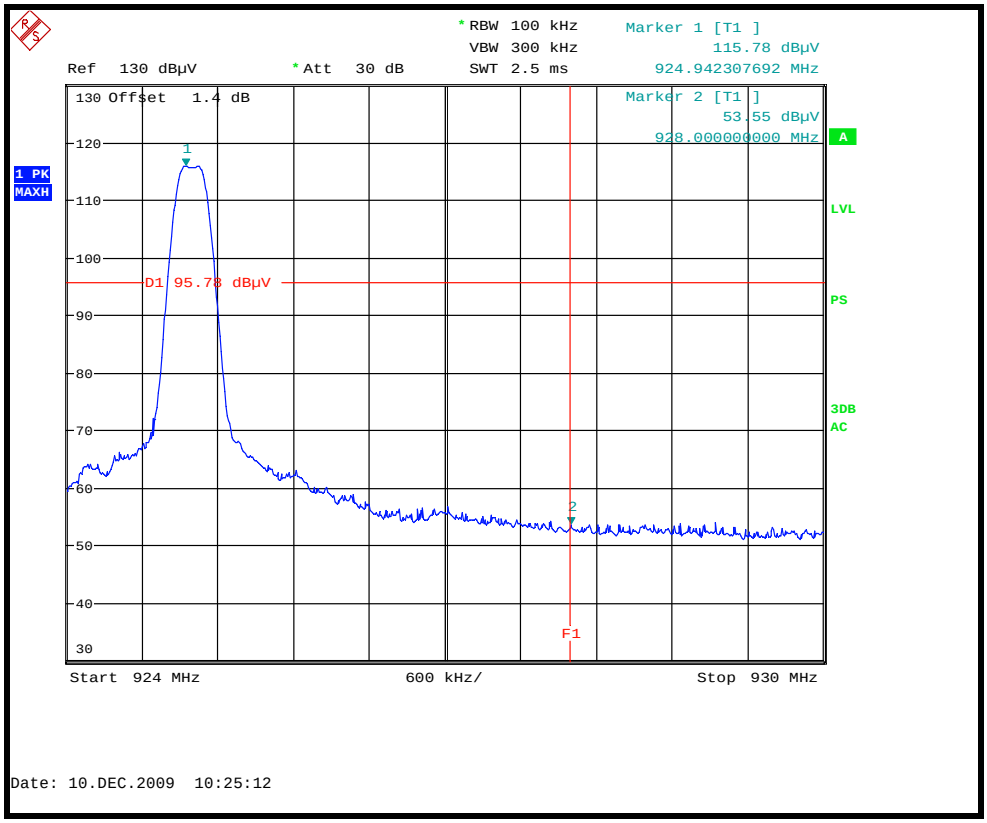

Conducted Spurious emissions 5 GHz to 10 GHz – 925.0 MHz



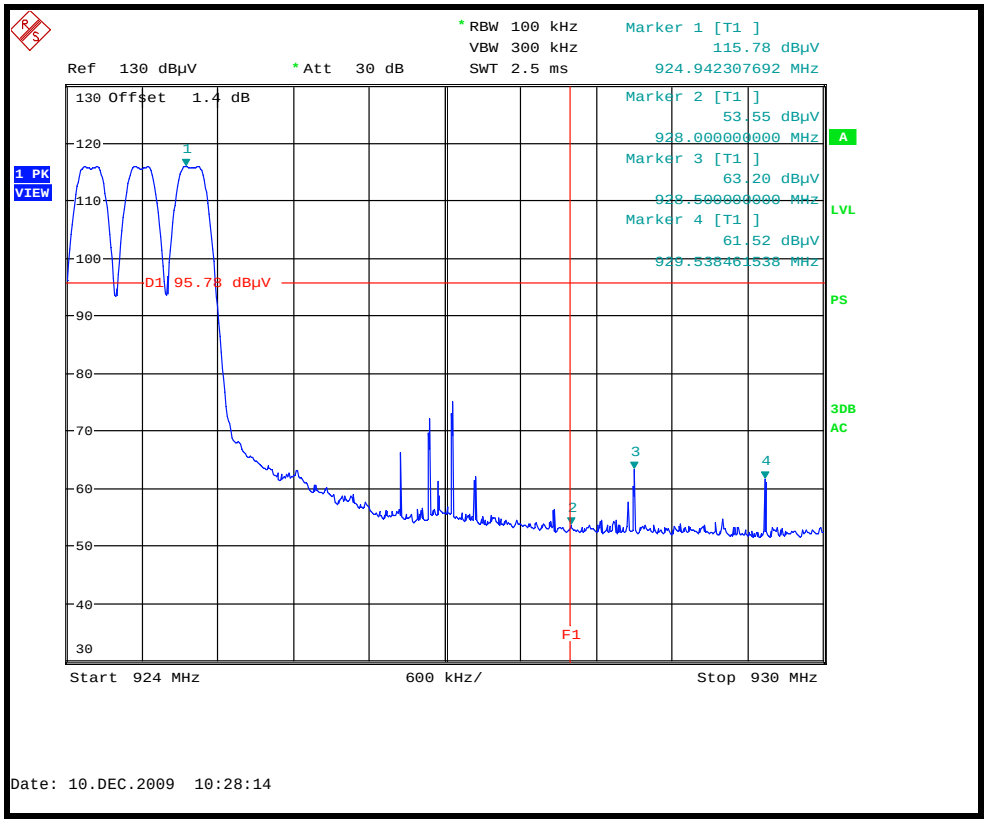

Conducted Lower band-edge Compliance - Non Hopping - 905.0MHz



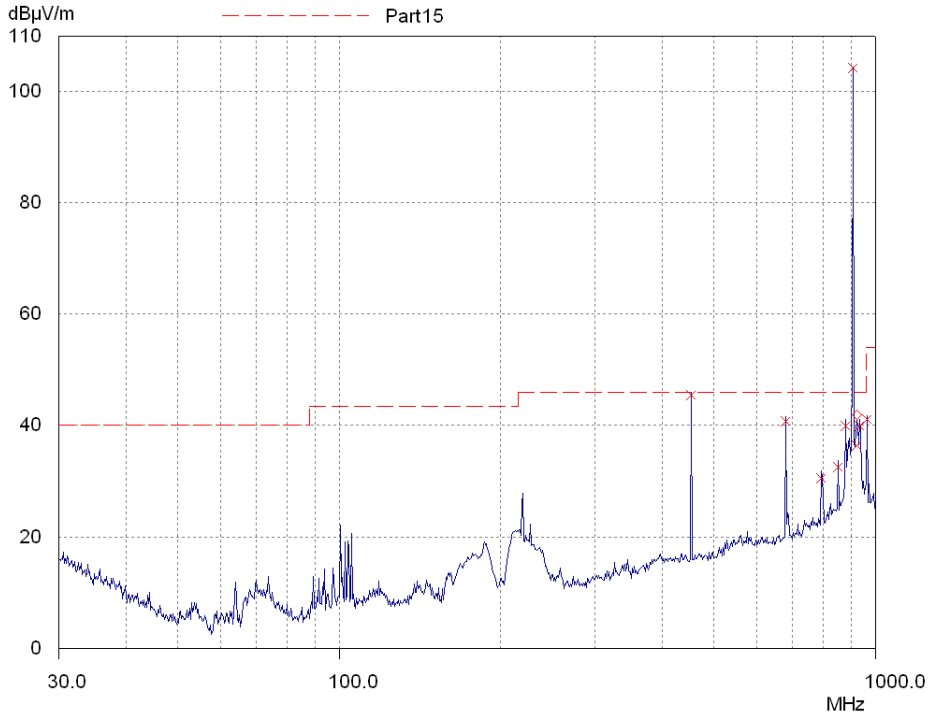

Conducted Lower band-edge Compliance - Hopping - 905.0MHz



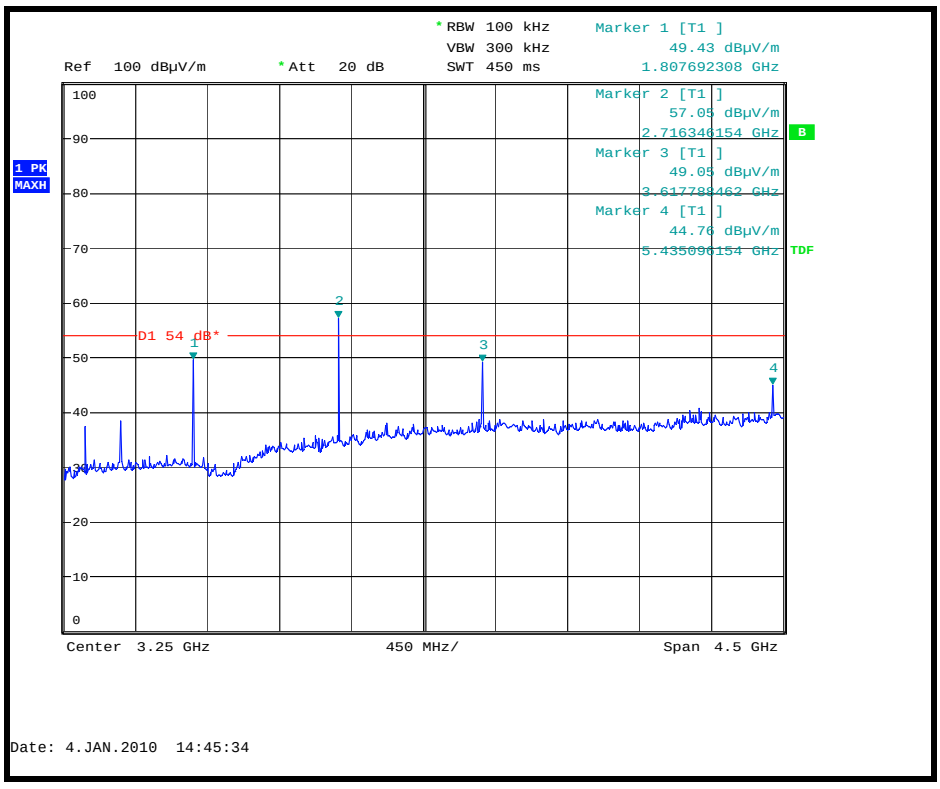

Conducted Upper band-edge Compliance - Non Hopping - 925.0MHz



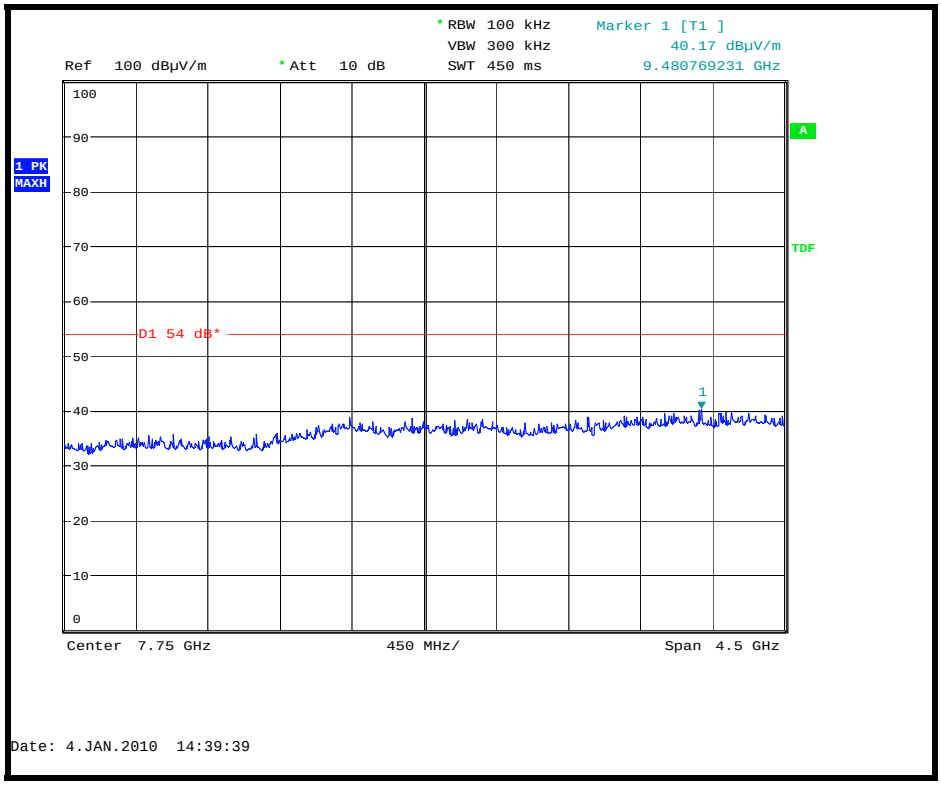

Conducted Upper band-edge Compliance - Hopping - 925.0MHz



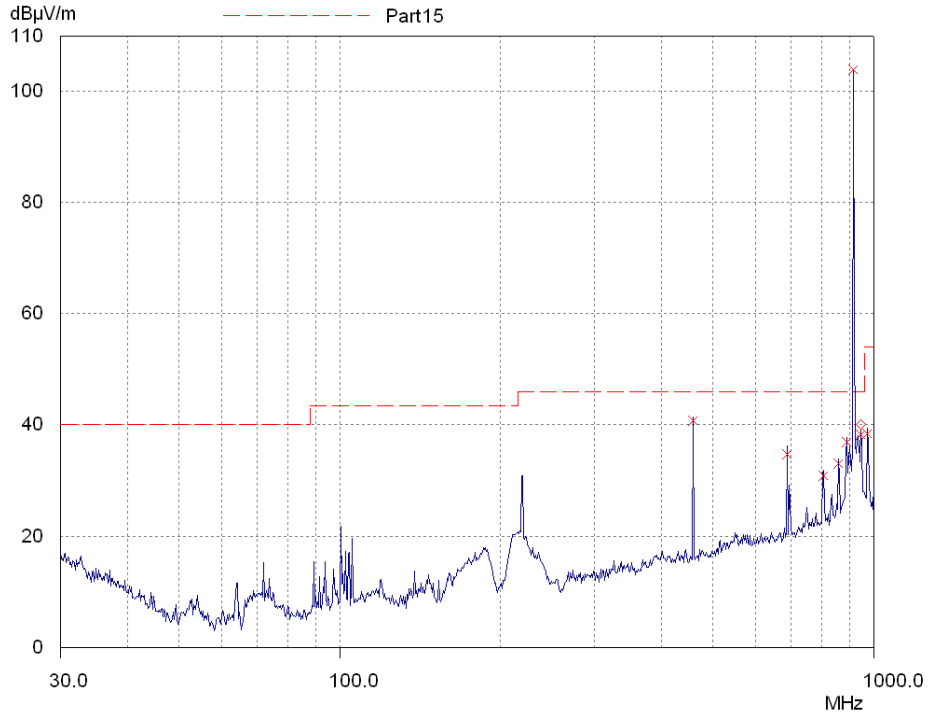

Radiated Spurious emissions 30 MHz to 1 GHz – 905.0 MHz



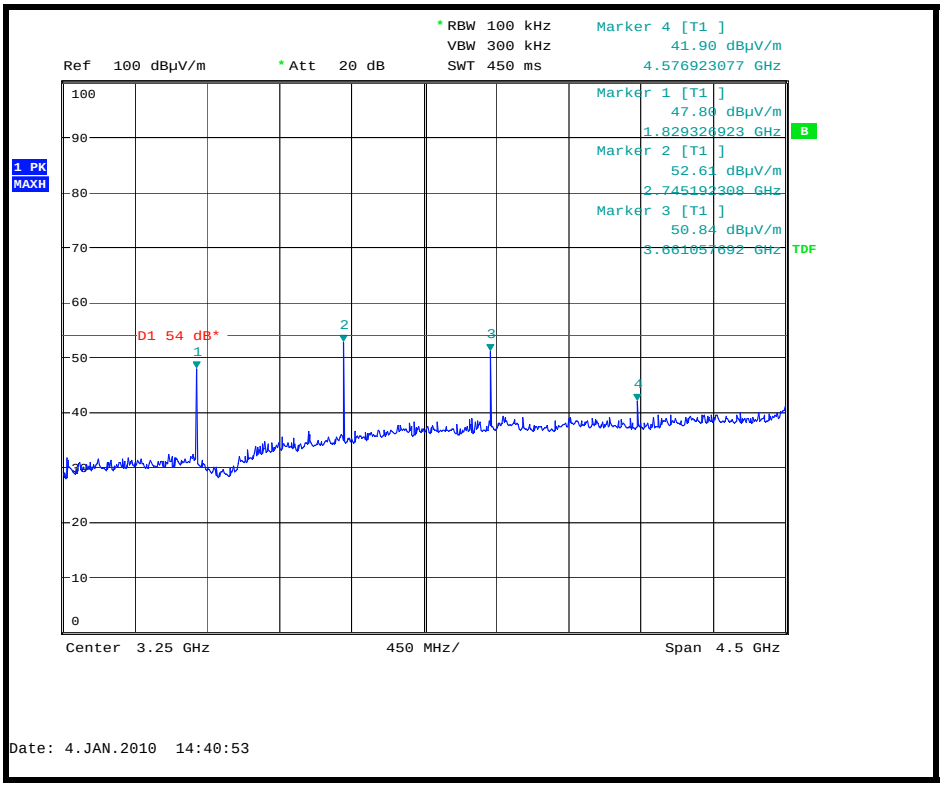

Radiated Spurious emissions 1 GHz to 5 GHz – 905.0 MHz



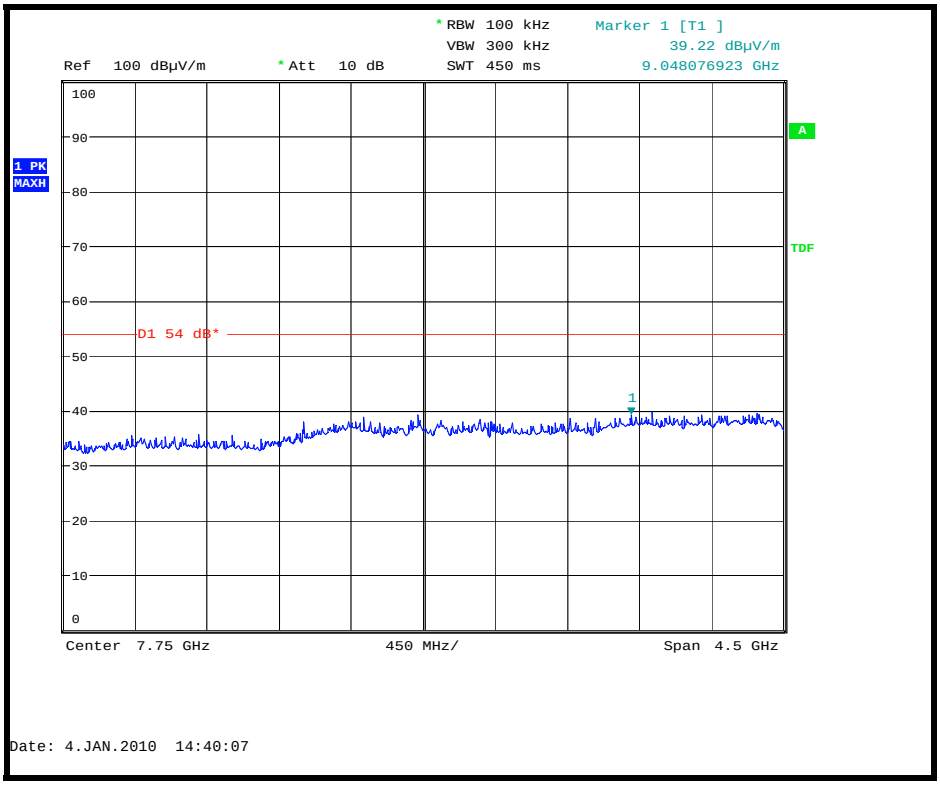

Radiated Spurious emissions (15.209) 5 GHz to 10 GHz – 905.0 MHz




Radiated Spurious emissions (15.209) 30 MHz to 1 GHz – 915.0 MHz

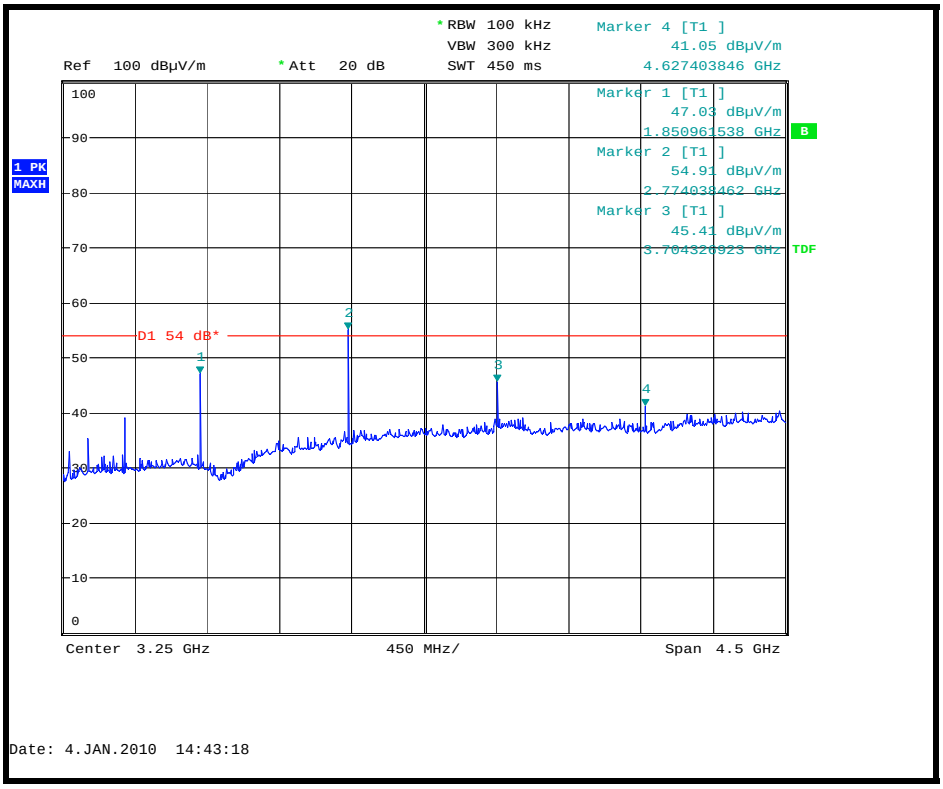



Radiated Spurious emissions (15.209) 1 GHz to 5 GHz – 915.0 MHz

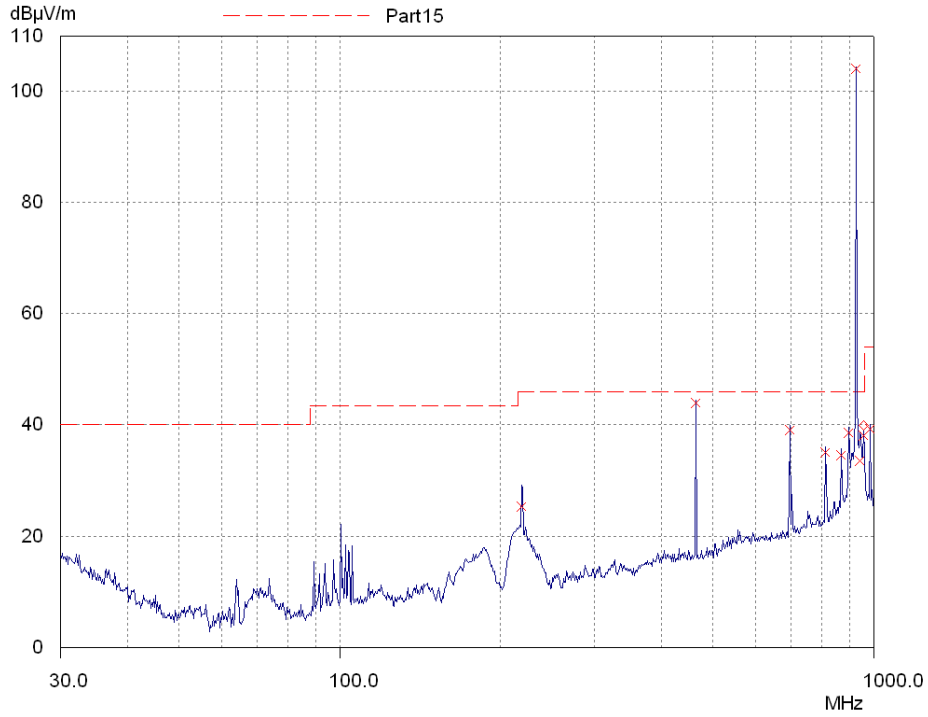



Radiated Spurious emissions (15.209) 5 GHz to 10 GHz – 915.0 MHz

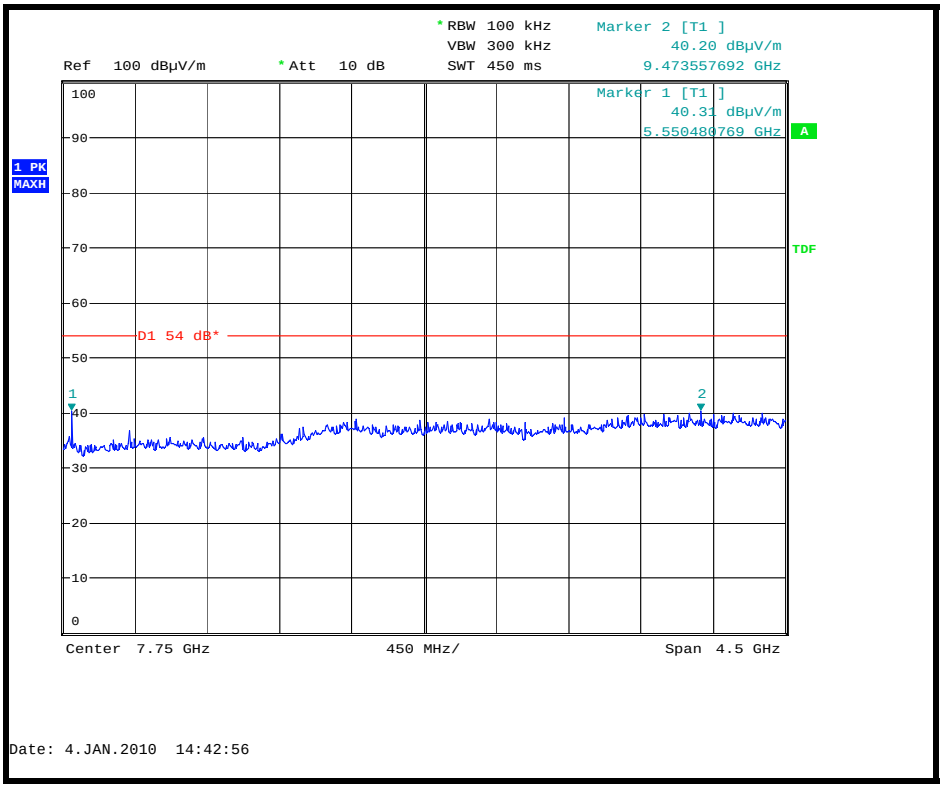
Radiated Spurious emissions (15.209) 30 MHz to 1 GHz – 915.0 MHz

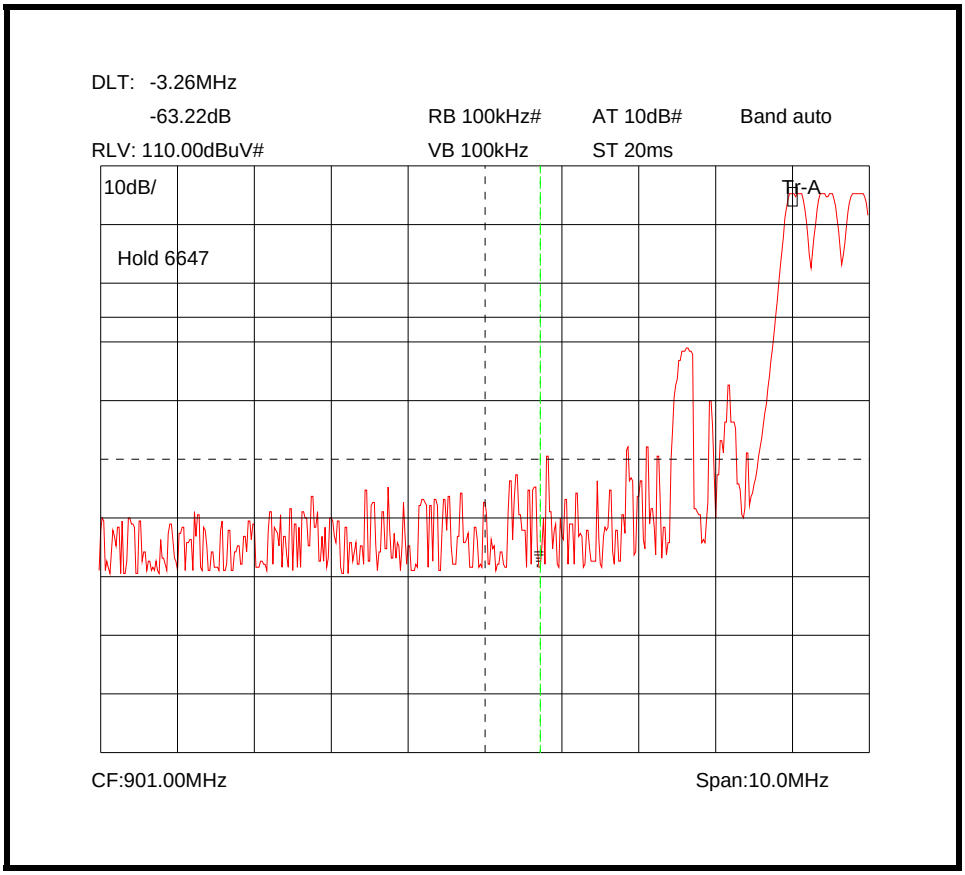



Radiated Spurious emissions (15.209) 1 GHz to 5 GHz – 925.0 MHz

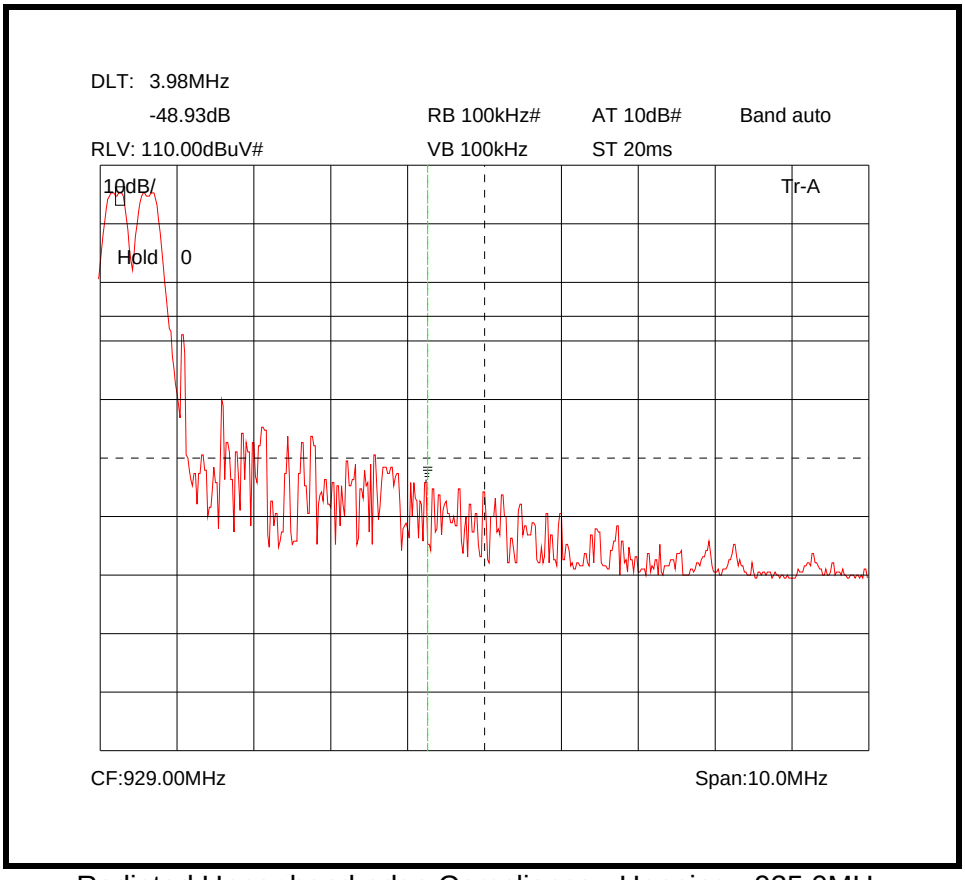



Radiated Spurious emissions (15.209) 5 GHz to 10 GHz – 925.0 MHz

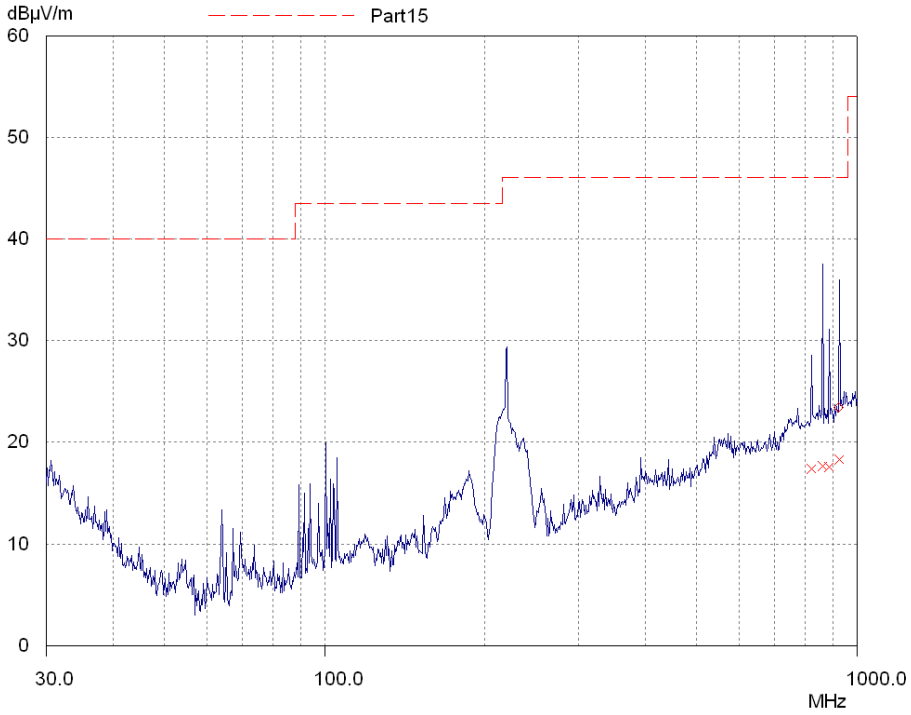




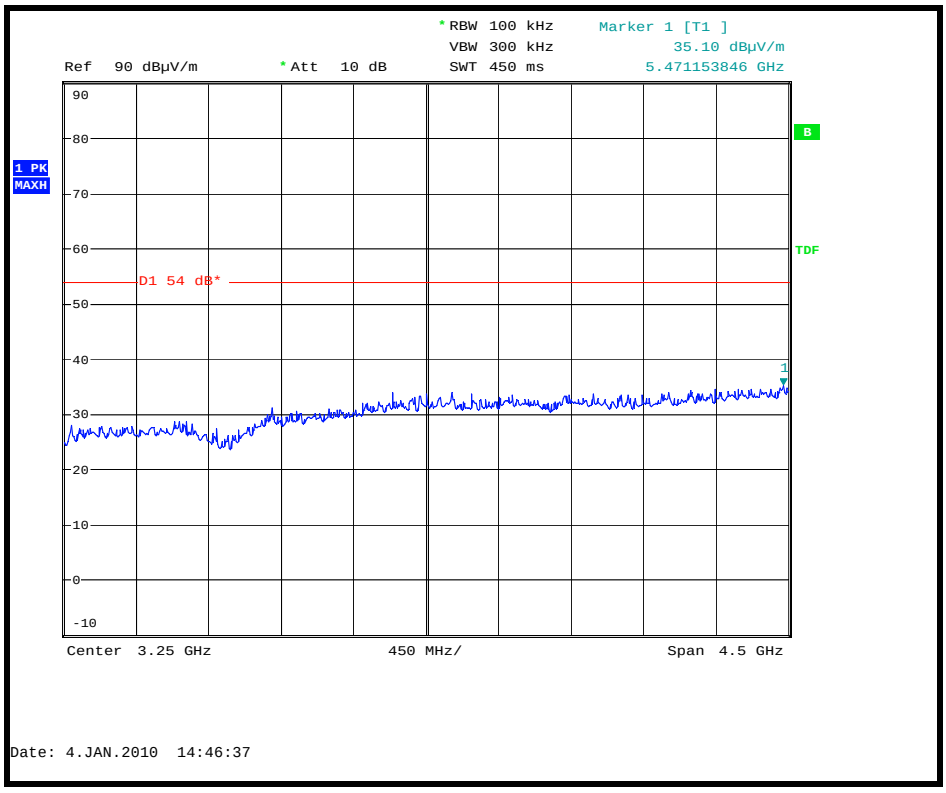

Radiated Lower band-edge Compliance - Hopping - 905.0MHz



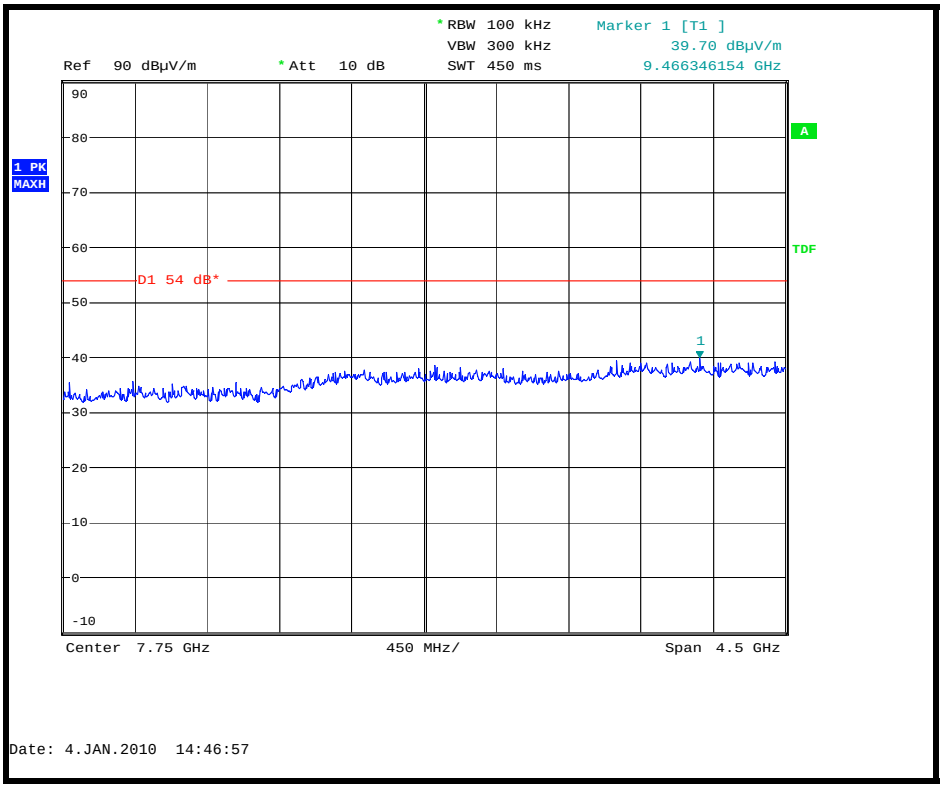

Radiated Upper band-edge Compliance - Hopping - 925.0MHz



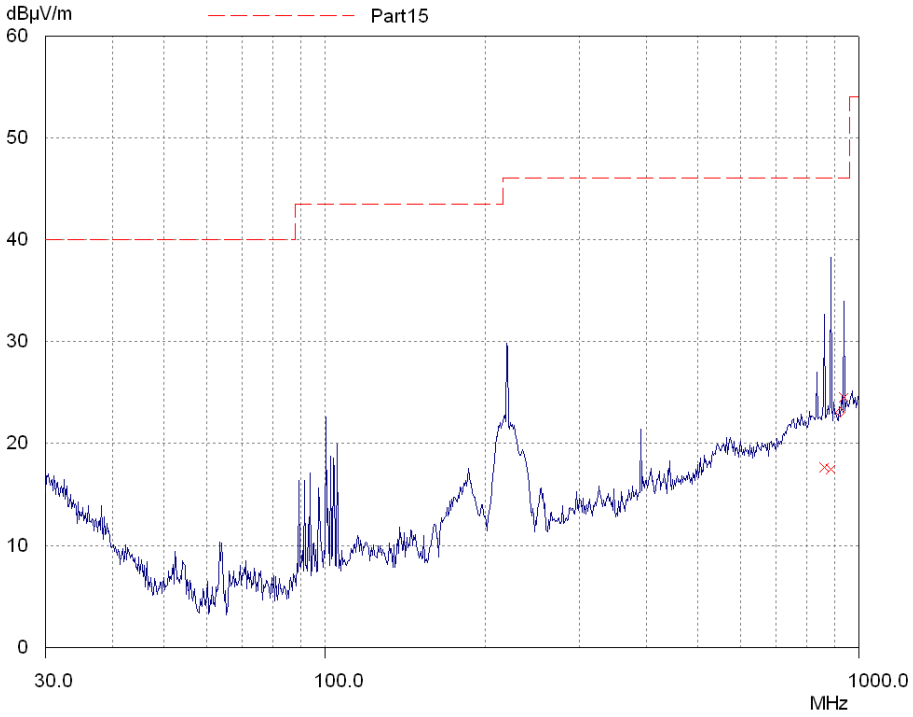

Radiated Spurious emissions (15.109) 30 MHz to 1 GHz – 905.0 MHz



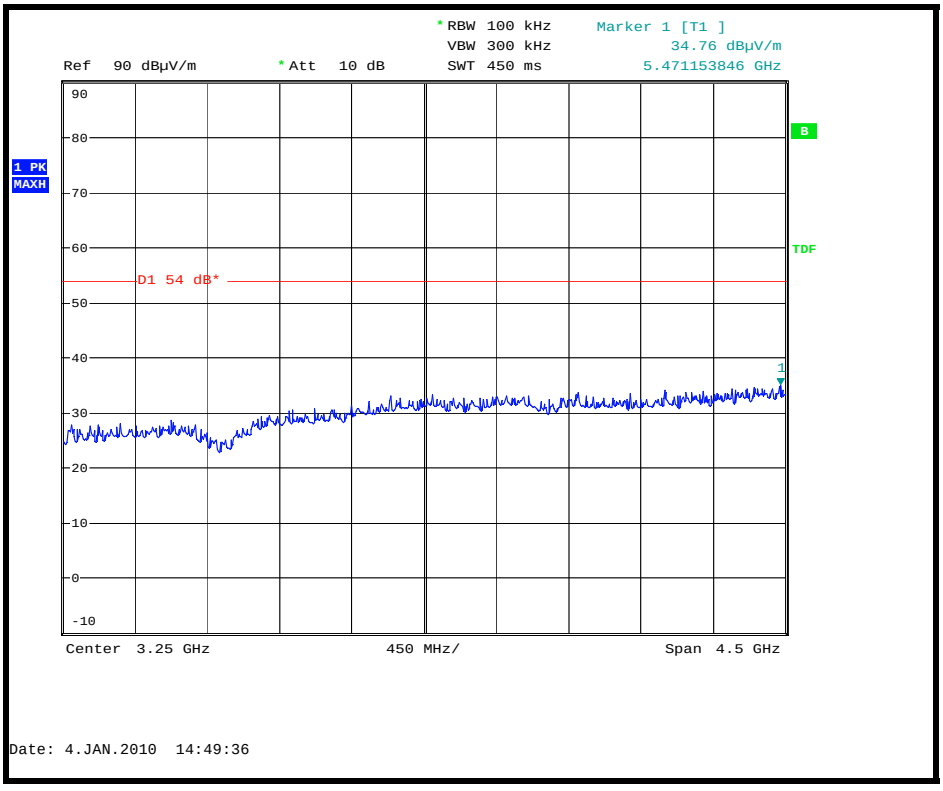

Radiated Spurious emissions (15.109) 1 GHz to 5 GHz – 905.0 MHz



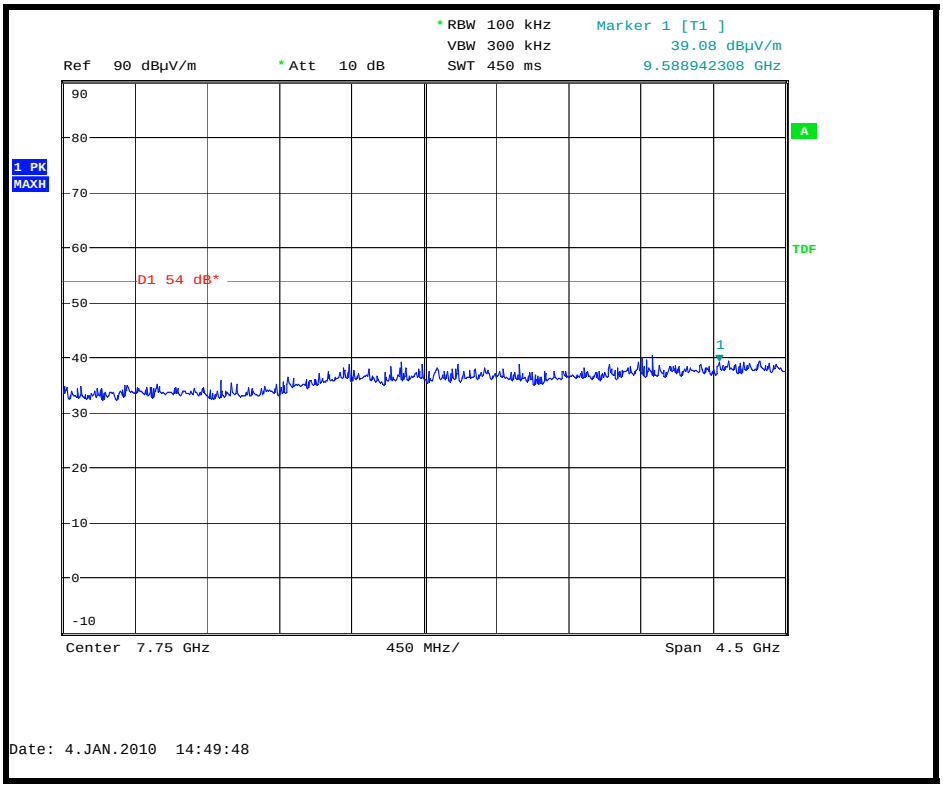

Radiated Spurious emissions (15.109) 5 GHz to 10 GHz – 905.0 MHz



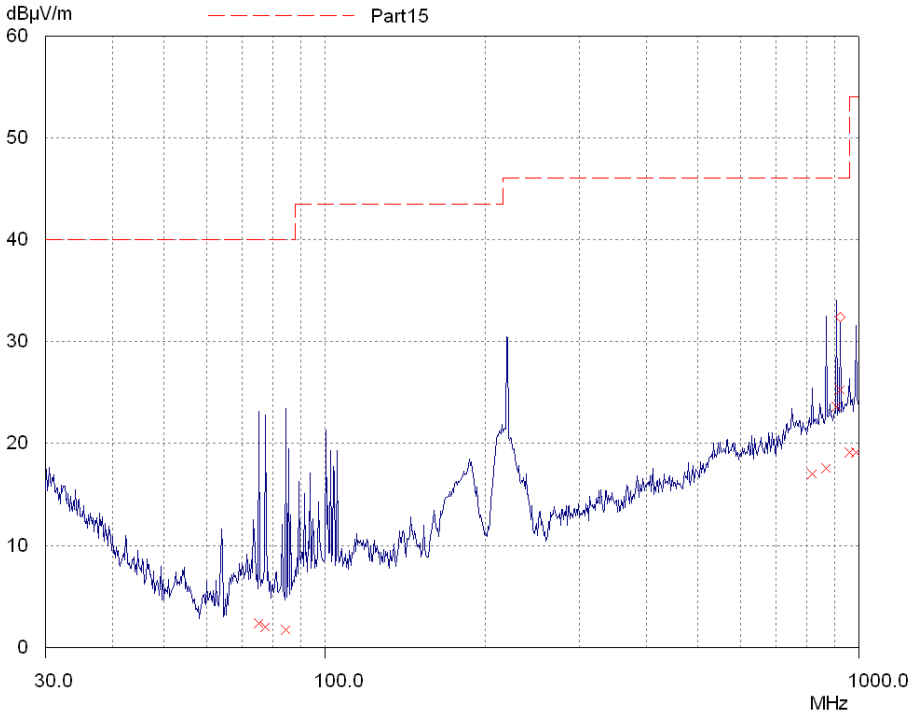

Radiated Spurious emissions (15.109) 30 MHz to 1 GHz – 915.0 MHz



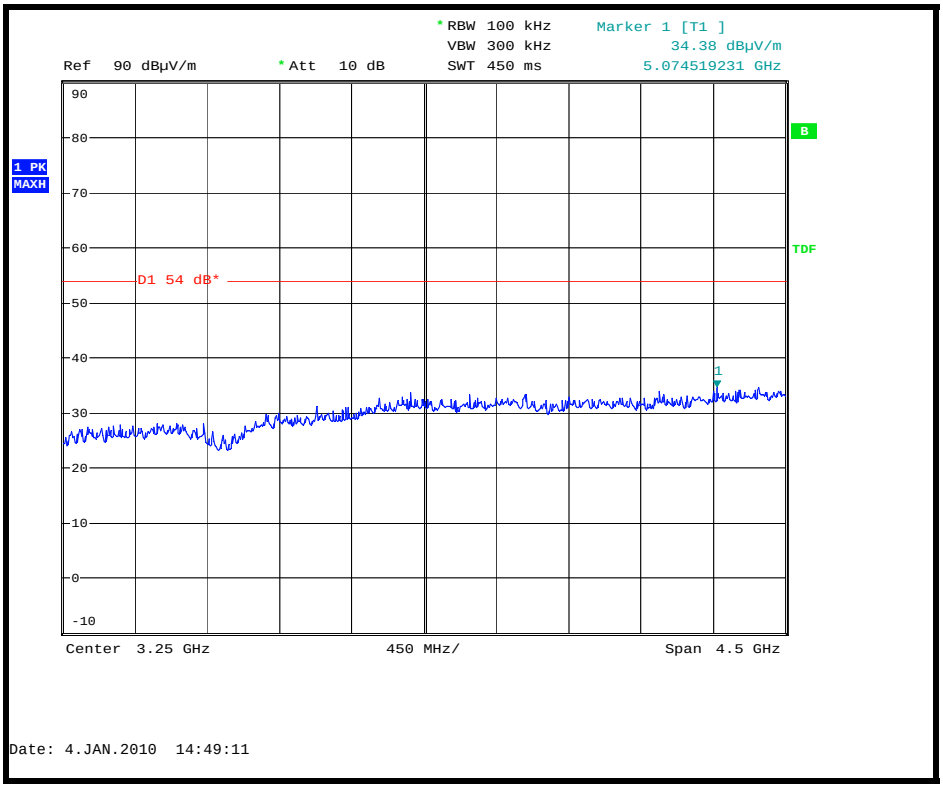

Radiated Spurious emissions (15.109) 1 GHz to 5 GHz – 915.0 MHz



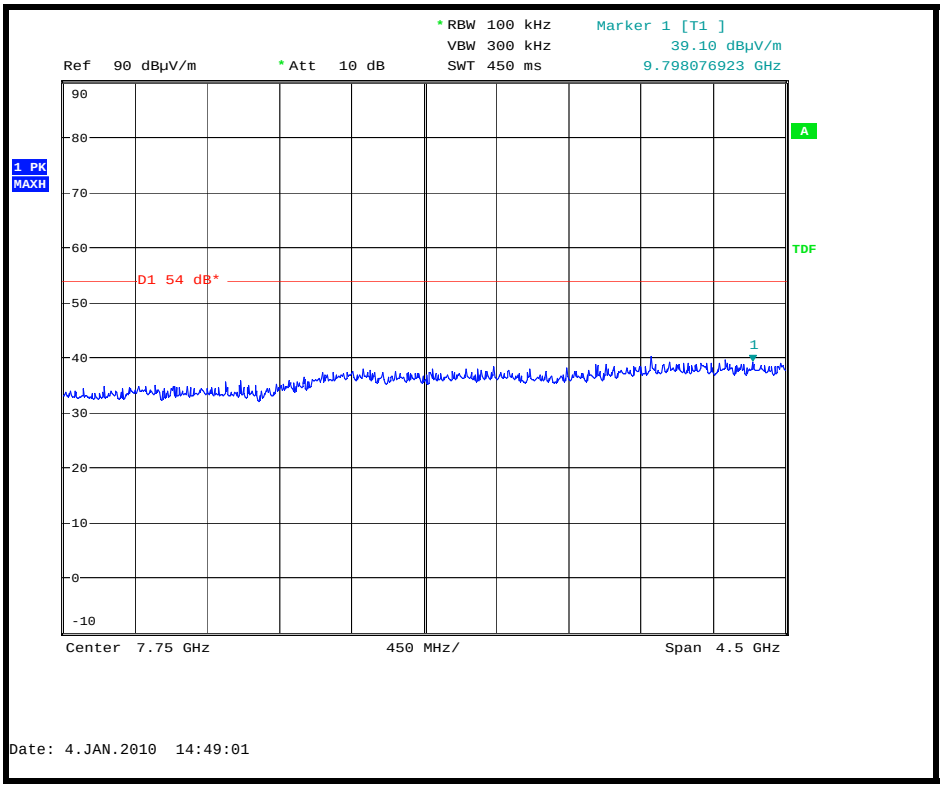

Radiated Spurious emissions (15.109) 5 GHz to 10 GHz – 915.0 MHz




Radiated Spurious emissions (15.109) 30 MHz to 1 GHz – 925.0 MHz




Radiated Spurious emissions (15.109) 1 GHz to 5 GHz – 925.0 MHz




Radiated Spurious emissions (15.109) 5 GHz to 10 GHz – 925.0 MHz

## 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 Telecoms & Radio upon request.

## C1) Test samples

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

| Sample No. | Description | Identification |
|---|---|---|
| S01 | SAFEmine model number 700 018 | |
| S02 | SMW: Surface Mount Multiband Antenna with GPS | |

The following samples of apparatus were supplied by TRaC Telecoms & Radio as support or drive equipment (auxiliary equipment):

| Identification | Description |
|---|---|
| REF053 | HP 6634A dc Power Supply |
| Wireless Group Laptop 1 | HP Compaq 6715s Laptop |
| N/A | Battery |

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

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

| Test | Description of Operating Mode |
|---|---|
| All tests detailed in this report excluding Radiated Electric Field Emissions 15.109 digital circuitry | The EUT was powered via an external dc power supply, REF053 and Battery. The EUT was transmitting on maximum power using Gaussian Frequency Shift Keying (GFSK) with a data rate of 100kbps. Deviation is ±50kHz modulation at centre frequencies<br>Fc = = ((422.4+(CH/10)) x 2<br><br>Where Fc =<br><br>905.0 MHz<br>915.0 MHz<br>925.0 MHz<br><br>Or rearranged to determine the channel number<br><br>Channel = CH = ((F/2)-422.4) x 10 |

| Test | Description of Operating Mode: |
|---|---|
| Radiated Electric Field Emissions 15.109 digital circuitry | EUT active but non-transmitting. |

**C3) EUT Configuration Information**.

| Sample | Internal Configuration Details |
|---|---|
| S01 | Single possible internal configuration |
| S02 | Single possible internal configuration |

### C4) List of EUT Ports

The tables below describe the termination of EUT ports:

Sample : S01
Tests : RF Antenna Conducted Spurious Emissions measurement

| Port | Description of Cable Attached | Cable length | Equipment Connected |
|---|---|---|---|
| dc power port | 6 core unscreened | 2m | REF053 |
| GPS | None | N/A | 50Ohm Terminating load |
| RF | 50 Ohm Coax | 2m | REF847 |
| Serial | 9 way screened serial cable | 2m | Wireless Group Laptop 1 |

Sample : S01
Tests : RF Antenna Conducted Spurious Emissions measurement Conducted Fundamental Carrier Power measurement

| Port | Description of Cable Attached | Cable length | Equipment Connected |
|---|---|---|---|
| dc power port | 6 core unscreened | 2m | REF053 |
| GPS | None | N/A | 50Ohm Terminating load |
| RF | 50 Ohm Coax | 2m | REF835/836 |
| Serial | 9 way screened serial cable | 2m | Wireless Group Laptop 1 |

Sample : S01
Tests : RF Antenna Conducted Spurious Emissions measurement 20dB Bandwidth and Channel Spacing, Hopping Frequencies, Frequency Occupancy measurement

| Port | Description of Cable Attached | Cable length | Equipment Connected |
|---|---|---|---|
| dc power port | 6 core unscreened | 2m | REF053 |
| GPS | None | N/A | 50Ohm Terminating load |
| RF | 50 Ohm Coax | 2m | REF837 |
| Serial | 9 way screened serial cable | 2m | Wireless Group Laptop 1 |

Sample : S01
Tests : : Radiated Electric Field Emissions Restricted band 15.205 and 15.109 digital circuitry

| Port | Description of Cable Attached | Cable length | Equipment Connected |
|---|---|---|---|
| dc power port | 6 core unscreened | 2m | +24Vdc (Battery) |
| GPS | 50 Ohm Coax | N/A | S02 |
| RF | 50 Ohm Coax | 2m | S02 |
| Serial | 9 way screened serial cable | 2m | Test Laptop |

## C5 Details of Equipment Used

**For Conducted Measurements:**

RF Antenna Conducted Spurious Emissions measurement

| RFG No | Type | Description | Manufacturer | Date Calibrated |
|---|---|---|---|---|
| REF847 | ESU | EMI Test Receiver (Spectrum analyser) | R&S | 08/05/09 |
| RFG476 | - | 3m 50 Ohm coax | Semflex | 22/04/09 |
| RFG422 | 34401A | Multi-meter | HP | 19/12/08 |
| REF053 | 6634A | dc power supply | HP | CAL date N/A |

Conducted Fundamental Carrier Power measurement

| RFG No | Type | Description | Manufacturer | Date Calibrated |
|---|---|---|---|---|
| REF835<br>REF836 | N1911A<br>N1922A | P-Series Power Meter and Power Head | Agilent | 03/08/09 |
| RFG476 | - | 3m 50 Ohm coax | Semflex | 22/04/09 |
| RFG422 | 34401A | Multi-meter | HP | 19/12/08 |
| REF053 | 6634A | dc power supply | HP | CAL date N/A |

20dB Bandwidth and Channel Spacing, Hopping Frequencies, Frequency Occupancy measurement

| RFG No | Type | Description | Manufacturer | Date Calibrated |
|---|---|---|---|---|
| REF837 | E4440A | P-Series Spectrum analyser | Agilent | 30/01/09 |
| RFG476 | - | 3m 50 Ohm coax | Semflex | 22/04/09 |
| RFG422 | 34401A | Multi-meter | HP | 19/12/08 |
| REF053 | 6634A | dc power supply | HP | CAL date N/A |

**For Radiated Measurements**: Radiated Electric Field Emissions Restricted band 15.205 and 15.109 digital circuitry

| TRAC Ref | Type | Description | Manufacturer | Date Calibrated. |
|---|---|---|---|---|
| TRLUH377 | ESU26 | Spectrum Analyser | Rhode & Schwarz | 11/09/2009 |
| TRL139 | 3115 | 1-18GHz Horn Antenna | EMCO | 17/08/2009 |
| TRL572 | 8499B | 1 – 26.5 GHz Pre Amplifier | Agilent | 15/07/2009 |
| TRLUH186 | ESHS10 | Receiver | Rhode & Schwarz | 10/12/2009 |
| TRLUH191 | CBL611/A | BiLog Periodic Antenna | York | 10/10/2008 |

## Appendix D: Additional Information

### Antenna specification:

**Product Specifications**

MOBILE MARK® COMMUNICATIONS ANTENNAS

# Surface Mount GPS Antenna (Pat.Pnd.)

## GSM/CDMA, WiFi, WiMAX & GPS

MultiBand with GPS
3 separate coaxes

New!
Magnet Mount
Version
(series MGW)

- Mounts easily to roof, trunk or bulkhead
- MultiBand covers all popular worldwide frequency systems from 800 MHz - 6 GHz
- 3 Separate RF coax feeds; for radio comm channel (800-2.7 GHz), 2.4/5 GHz & GPS
- High performance GPS with 26 dB active amplifier

For maximum communications capability and ultimate versatility, this is the antenna of choice. This Wide Band antenna provides high performance operation on all cellular bands, all PCS bands and 2.4 GHz 802.11 bands along with GPS. An optional version can operate dual band on 2.4 & 5 GHz for 802.11 a/b/g. Three separate RF feeds allow communication with the voice/data channel, the WiFi radio, as well as GPS. The antennas can be mounted to any vehicle, cargo container or trailer.

The design uses a 3/4" feed thru (19 mm) for securing to the vehicle. Access to the underside of the body surface is required to complete the installation. Note, for best performance, the antenna should be mounted on a metal surface/groundplane.

For the GPS interface, the antennas are typically outfitted with 15 feet of RG-174 cable (4.5 meters). The communications channel cables are 15 feet of low loss RF-195. All connectors are male unless requested otherwise.

GPS performance is 26 dB, with 5 dBi antenna gain. The GPS circuit has a low noise figure (2.0 dB max) with excellent filter characteristics.

The antennas are enclosed in a 4.2"D x 3.2"H ASA radome (107 mm x 81 mm), and supplied with all mounting hardware and sealing gasket. The SMW radome color is white standard, black optional. The MGW mag mount is available in white (standard) or optional black.

**Antenna Model Configurator**

**SMW-❑❑❑-❑❑-❑❑ -❑❑**

example - SMW-UMB-3A3A2C
Mag Mount - MGW-UMB-3A3A2C

Combo Configuration

| Code | Description |
|---|---|
| SMW-UMB | Cable 1 = 800 - 2.7 GHz<br>Cable 2 = 2.4 GHz (WiFi)<br>Cable 3 = GPS |
| SMW-301 | Cable 1 = 800 - 2.7 GHz<br>Cable 2 = 2.4 & 5+ GHz (WiFi)<br>Cable 3 = GPS |

**Note: For Mag mount, substitute MGW for SMW in model**

Cable #1 / Cable #2

| Code | Description |
|---|---|
| 3A | RF-195/TNC |
| 3B | RF-195/MiniUHF |
| 3C | RF-195/SMA |
| 3J | RF-195/RevPol SMA |
| 3K | RF-195/RevPol TNC |

GPS Interface

| Code | Description |
|---|---|
| 2C | RG-174/SMA |
| 2D | RG-174/SMB |
| 2E | RG-174/MCX |
| 2F | RG-174/MMCX |
| 2H | RG-174/Fakra |
| 2L | RG-174/SMC |

**Specifications**

| | |
|---|---|
| **Frequency:** | |
| Cable #1 | 800 - 2700 MHz |
| Cable #2 | 2400 - 2485 MHz or dual band 2.4-2.5/4.9 - 6.0 GHz |
| GPS | 1575.42 +/- 2 MHz |
| **Comm Channel Gain:** | |
| 800 - 1GHz | 2 dBi |
| 1700 - 2700 | 5 dBi (peak) |
| 2.4 - 2.5 GHz | 5 dBi (peak) |
| 5.2 - 5.8 GHz Band | 5 dBi (peak) |
| **GPS Gain:** | 26 dB, 5 dBi Antenna |
| **VSWR:** | 2:1 max over range |
| **Noise Figure:** | 2.0 dB max, 1.7 dB typical |
| **Operating Temp:** | -40° to +85° C |
| **Nominal Impedance:** | 50 ohms |
| **Amplifier Bias:** | 3.3 or 5 VDC +/- 10% |
| **Maximum Power:** | |
| 800 - 1900 MHz | 20 Watts |
| 1900 - 5800 MHz | 10 Watts |
| **Current:** | 20 mA max, 10 mA typical |
| **Cable:** | |
| GPS | RG-174, 15 ft (4.5 meters) |
| CABLE #1 & #2 | Separate RF-195 Cables, 15 ft (4.5 meters) |
| **Case:** | 4.2"D x 3.2"H (107 mm x 81 mm) |
| **Case Material:** | White ASA, black optional |
| **Mounting:** | 3/4" dia.x 1/2" long (19 mm x13 mm) for 3/16" thick (4.7 mm) metal |
| **Hardware:** | Nut and gasket included |
| **Option:** | Mag Mount MGW, 15 ft cables |

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Antenna details continued:

MOBILE MARK®
COMMUNICATIONS ANTENNAS

# SMW Multi-Band Series Antennas

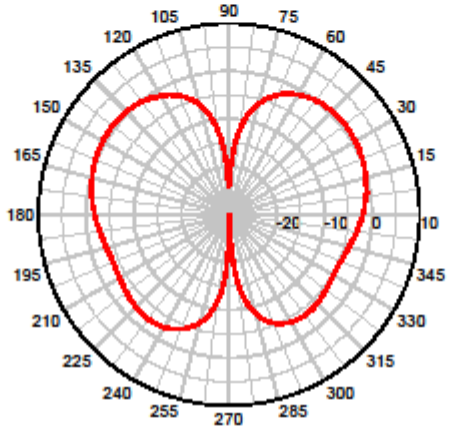
Surface Mount Multi-Band Antenna
2 dBi Gain, Com #1 Frequency (800-960 MHz)
(Nextel/Cellular/EU GSM)

**These plots can be used for the following models:**

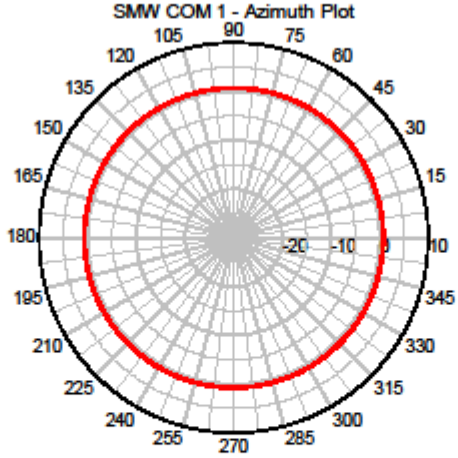
**SMW-UMB-3X3X2X**

**Note:**
**SMW model consists 3 Patterns**
Com #1 (800-960 MHz)
Com #2 (1710-1990 MHz)
2.4 GHz (2400-2500 MHz)

SMW COM 1 - Elevation Plot




SMW COM 1 - Azimuth Plot




Note: Azimuth Plot is at an elevation angle of 35° for the coordinate system shown above.

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## Appendix E: Calculation of the duty cycle correction factor

Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time was set accordingly to capture the pulse train. The transmit pulsewidths and period was measured. A plots of the pulse train is contained in Appendix B of this test report.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulsewidths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was calculated by averaging the sum of the pulsewidths over the 100ms width with the highest average value. (The duty cycle is the value of the sum of the pulse widths in one period (or 100ms), divided by the length of the period (or 100ms). The duty cycle correction factor was then expressed in dB and the peak emissions adjusted accordingly to give an average value of the emission.

Correction factor dB = 20 x ($Log_{10}$ Calculated Duty Cycle)

Therefore the calculated duty cycle was determined:

The pulse train period was greater than >100ms and in as shown from the plots in contained in appendix B of this test report.

Duty cycle = $\frac{\text{the sum of the highest average value pulsewidths over 100ms}}{\text{100ms}}$

e.g

$$= \frac{7.459ms}{100ms} = 0.07459$$

0.07459 or 7.459%

Correction factor (dB) = 20 x ($Log_{10}$ 0.07459) = -22.54dB

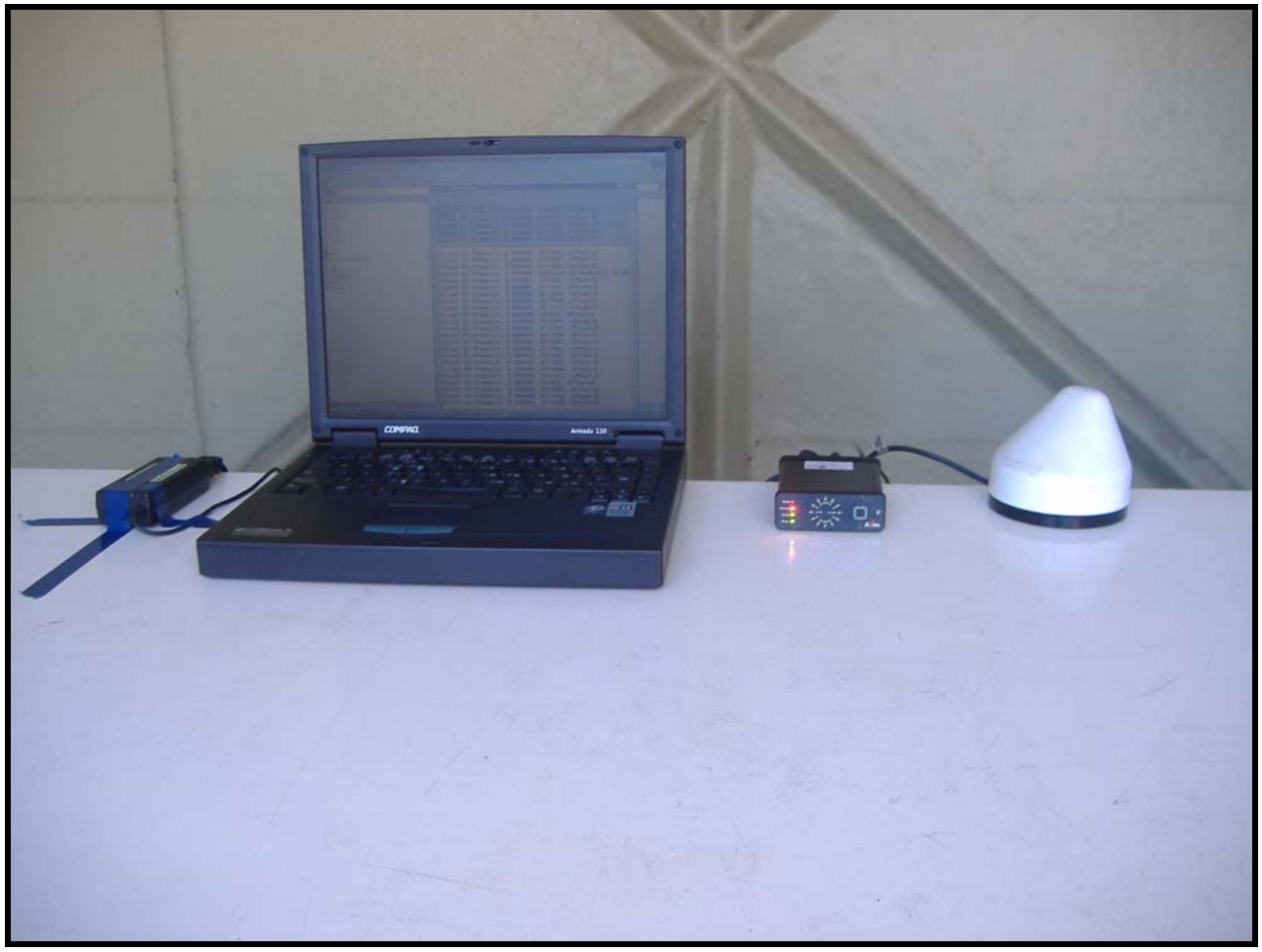
## Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: front view.
2. Radiated electric field emissions arrangement: close up.
3. Photo of the S01 Overview
4. Photo of the S01 Overview

Photograph 1

Photograph 2



Photograph 3

Photograph 4

## Appendix G: MPE Calculation

OET Bulletin No. 65, Supplement C 01-01

**47 CFR §§1.1307 and 2.1091**

2.1091 Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC 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 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 0.6mW/cm$^2$ power density limit, as required under FCC rules.

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

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

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

where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Note:

The EIRP measurement was performed using a signal substitution method.

Result

| Prediction Frequency (MHz) | Maximum EIRP | Power density limit (S) (mW/cm$^2$) | Distance (R) cm required to be less than 0.6 mW/cm$^2$ |
|---|---|---|---|
| 915 MHz | 5.15 mW | 0.505 mW/cm$^2$ | 0.9 cm |

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