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# Amended
# FCC/ISED Test Report

**Prepared for:** **Digital Monitoring Products**

**Address:** **2500 North Partnership Blvd.**
**Springfield, MO 6582**

**Product:** **All in One (DXX - Z-wave radio)**

**Test Report No:** **R20180227-26-01B**

**Approved by:**

**Nic S. Johnson, NCE**
**Technical Manager**
**iNARTE Certified EMC Engineer #EMC-003337-NE**

**DATE:** **20 July 2018**

**Total Pages:** **38**

## REVISION PAGE

| Rev. No. | Date | Description |
|---|---|---|
| 0 | 30 May 2018 | Original – NJohnson<br>Prepared by KVepuri |
| A | 11 July 2018 | Section 4.4 was updated to show the bandwidth measurements to be 99%. A description was included under each plot to explain how the 99% occupied bandwidth was calculated. |
| B | 20 July 2018 | 99% Bandwidth measurements were replaced with measurements using ANSI C63.10-2013, Section 6.9.3, -NJ<br>Includes NCEE Labs report R2180224-26-01A and its amendment in full. |

## CONTENTS

## TABLES OF FIGURES

**Figure Number** **Page**



## TABLE OF TABLES

**Table Number** **Page**

## 1.0 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-Gen, Issue 4
(3) ISED RSS-210, Issue 9

| SUMMARY | | | |
|---|---|---|---|
| **Standard Section** | **Test Type and Limit** | **Result** | **Remark** |
| FCC 15.203 | Unique Antenna Requirement | Pass | PCB antenna |
| FCC 15.35<br>RSS-Gen, 6.10 | Duty cycle of pulsed emissions | N/A | N/A |
| FCC 15.209<br>RSS-Gen, 7.1 | Receiver Radiated Emissions | Pass | Meets the requirement of the limit. |
| FCC 15.249 | Minimum Bandwidth | N/A | Informational Purpose Only |
| FCC 15.249 | Maximum Peak Output Power | N/A | Informational Purpose Only |
| FCC 15.209<br>RSS-Gen, 8.9<br>RSS-210 A1.2<br>FCC 15.249(c),(d) | Transmitter Radiated Emissions | Pass | Meets the requirement of the limit. |
| FCC 15.209, 15.205<br>RSS-Gen, 8.9<br>RSS-247, 5.5 | Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency | Pass | Meets the requirement of the limit. |
| FCC 15.207<br>RSS-Gen. 8.8 | Conducted AC Emissions | Pass | Meets the requirement of the limit. |

# 2.0 EUT DESCRIPTION

## 2.1 EQUIPMENT UNDER TEST

**Summary**

The Equipment Under Test (EUT) was an All in One Keypad manufactured by DMP wireless devices. It has a Z-Wave radio that operates at 908.40 to 916 MHz and has transmit and receive capabilities.

| | |
|---|---|
| EUT | All in One – DXX radio |
| EUT Received | 5/23/2018 |
| EUT Tested | 5/23/2018 - 5/30/2018<br>7/20/2018 (99% BW) |
| Serial No. | NCEETEST1 (Assigned) |
| Operating Band | 900.0 – 928.0 MHz |
| Device Type | Z-wave |
| Power Supply | MH Electronics, 12 VDC ITE Power Supply<br>MN: MGT-12500-SPS |

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

## 2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

| Channel | Frequency |
|---|---|
| 1 | 908.4 MHz |
| 2 | 916 MHz |

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest and highest frequency channels.

## 2.3 DESCRIPTION OF SUPPORT UNITS

None

# 3.0 LABORATORY DESCRIPTION

## 3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

| | |
|---|---|
| A2LA Certificate Number: | 1953.01 |
| FCC Accredited Test Site Designation No: | US1060 |
| Industry Canada Test Site Registration No: | 4294A-1 |
| NCC CAB Identification No: | US0177 |

Environmental conditions varied slightly throughout the tests:
Relative humidity of 35 ± 4%
Temperature of 22 ± 3° Celsius

## 3.2 TEST PERSONNEL

| No. | PERSONNEL | TITLE | ROLE |
|---|---|---|---|
| 1 | Karthik Vepuri | EMC Test Engineer | Testing |
| 3 | Nic Johnson | Technical Manager | Review of Results |

**Notes:**
All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

## 3.3 TEST EQUIPMENT

| DESCRIPTION AND MANUFACTURER | MODEL NO. | SERIAL NO. | LAST CALIBRATION DATE | CALIBRATION DUE DATE |
|---|---|---|---|---|
| Rohde & Schwarz Test Receiver | ES126 | 100037 | 30 Jan 2018 | 30 Jan 2019 |
| EMCO Biconilog Antenna | 3142B | 1647 | 02 Aug 2017 | 02 Aug 2018 |
| EMCO Horn Antenna | 3115 | 6416 | 26 Jan 2018 | 26 Jan 2020 |
| Rohde & Schwarz Preamplifier | TS-PR18 | 3545700803 | 09 Mar 2018* | 09 Mar 2019* |
| Trilithic High Pass Filter | 6HC330 | 23042 | 09 Mar 2018* | 09 Mar 2019* |
| Rohde & Schwarz LISN | ESH3-Z5 | 836679/010 | 25 Jul 2017 | 25 Jul 2018 |
| RF Cable (preamplifier to antenna) | MFR-57500 | 01-07-002 | 09 Mar 2018* | 09 Mar 2019* |
| RF Cable (antenna to 10m chamber bulkhead) | FSCM 64639 | 01E3872 | 09 Mar 2018* | 09 Mar 2019* |
| RF Cable (10m chamber bulkhead to control room bulkhead) | FSCM 64639 | 01E3874 | 09 Mar 2018* | 09 Mar 2019* |
| RF Cable (Control room bulkhead to RF switch) | FSCM 64639 | 01E3871 | 09 Mar 2018* | 09 Mar 2019* |
| RF Cable (RF switch to test receiver) | FSCM 64639 | 01F1206 | 09 Mar 2018* | 09 Mar 2019* |
| RF switch – Rohde and Schwarz | TS-RSP | 1113.5503.14 | 09 Mar 2018* | 09 Mar 2019* |
| N connector bulkhead (10m chamber) | PE9128 | NCEEBH1 | 09 Mar 2018* | 09 Mar 2019* |
| N connector bulkhead (control room) | PE9128 | NCEEBH2 | 09 Mar 2018* | 09 Mar 2019* |

*Internal Characterization

**Notes**:
All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

# 4.0 DETAILED RESULTS

## 4.1 DUTY CYCLE

Not Applicable

## 4.2 RADIATED EMISSIONS

**Test Method**: ANSI C63.10:2013, Section 6.5, 6.6

**Limits for radiated emissions measurements:**

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

| FREQUENCIES (MHz) | FIELD STRENGTH (μV/m) | MEASUREMENT DISTANCE (m) |
|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | 300 |
| 0.490-1.705 | 24000/F(kHz) | 30 |
| 1.705-30.0 | 30 | 3 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

**NOTE:**
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

**Test procedures:**

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements form 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

**NOTE:**
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

**Deviations from test standard:**

No deviation.

**Test setup:**

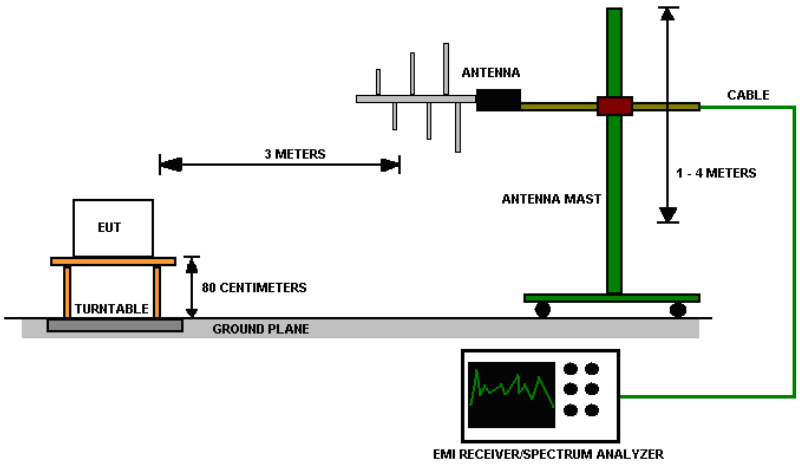


**Figure 1 - Radiated Emissions Test Setup**

**EUT operating conditions**
The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest and highest frequency channels.

**Test results:**

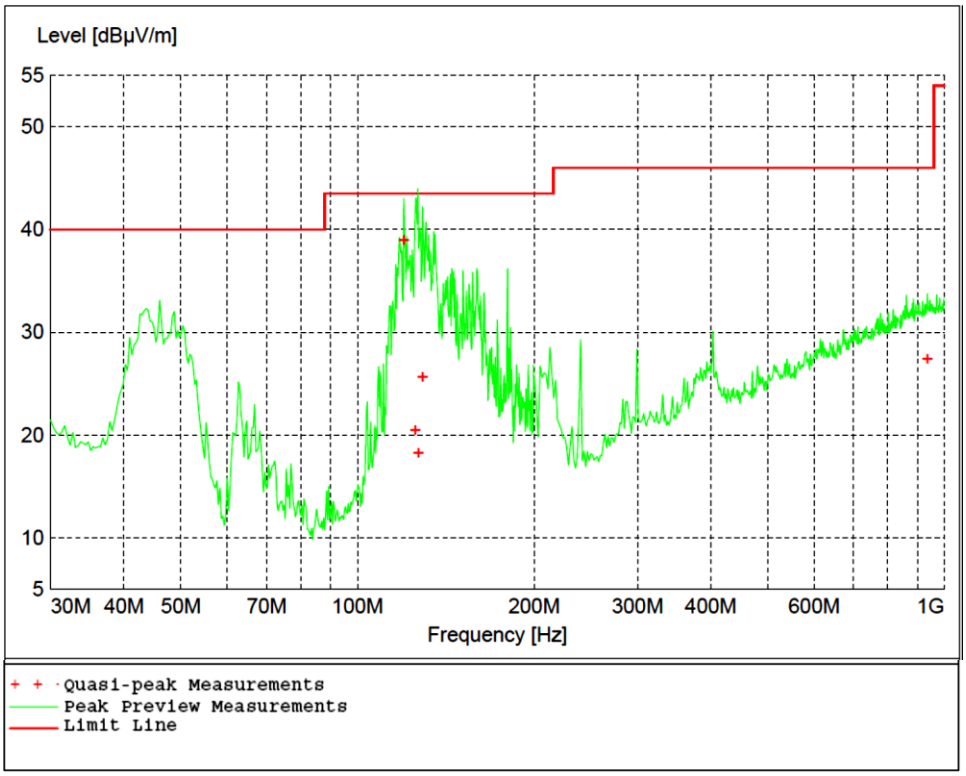


**Figure 2 - Radiated Emissions Plot, Receive**

**REMARKS**:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

**Table 1 - Radiated Emissions Quasi-peak Measurements, Receive**

| Frequency | Level | Limit | Margin | Height | Angle | Pol | Axis |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | |
| 120.000000 | 38.94 | 43.50 | 4.60 | 100 | 163 | VERT | X-axis |
| 125.520000 | 20.41 | 43.50 | 23.10 | 99 | 187 | VERT | X-axis |
| 127.080000 | 18.25 | 43.50 | 25.30 | 100 | 360 | VERT | X-axis |
| 129.180000 | 25.63 | 43.50 | 17.90 | 398 | 205 | VERT | X-axis |
| 936.840000 | 27.32 | 46.00 | 18.70 | 230 | 212 | HORI | X-axis |

**Table 2 - Radiated Emissions Peak Measurement vs Average Limits, Receive**

| Frequency | Level | Limit | Margin | Height | Angle | Pol | Axis |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | |
| 5949.000000 | 44.28 | 54.00 | 9.70 | 99 | 36 | VERT | X-axis |

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

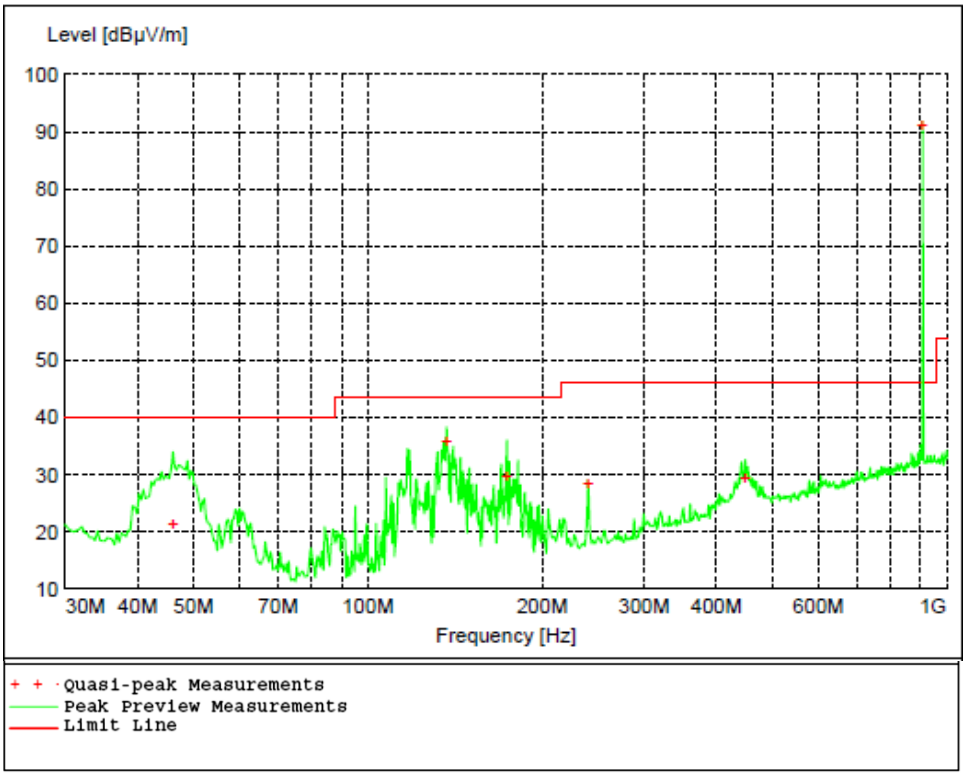


**Figure 3 - Radiated Emissions Plot, 908.4 MHz**

**REMARKS**:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

**Table 3 - Radiated Emissions Quasi-peak Measurements, 908.4 MHz**

| Frequency | Level | Limit | Margin | Height | Angle | Pol | Axis |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | |
| 46.140000 | 21.58 | 40.00 | 18.40 | 102 | 89 | VERT | Y-axis |
| 136.620000 | 35.85 | 43.50 | 7.70 | 100 | 135 | VERT | Y-axis |
| 173.460000 | 29.90 | 43.50 | 13.60 | 99 | 256 | VERT | Y-axis |
| 240.000000 | 28.47 | 46.00 | 17.50 | 186 | 339 | VERT | Y-axis |
| 447.960000 | 29.63 | 46.00 | 16.40 | 100 | 86 | HORI | Y-axis |
| 908.400000 | 91.12 | 93.98 | 2.86 | 99 | 97 | HORI | Y-axis |

**Table 4 - Radiated Emissions Peak Measurements, 908.4 MHz**

| Frequency | Level | Limit | Margin | Height | Angle | Pol | Axis |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | |
| 2725.200000 | 45.30 | 54.00 | 8.70 | 177 | 274 | VERT | X-axis |
| 3633.600000 | 40.99 | 54.00 | 13.00 | 99 | 360 | HORI | X-axis |
| 5926.800000 | 45.82 | 54.00 | 8.20 | 101 | 257 | HORI | X-axis |

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

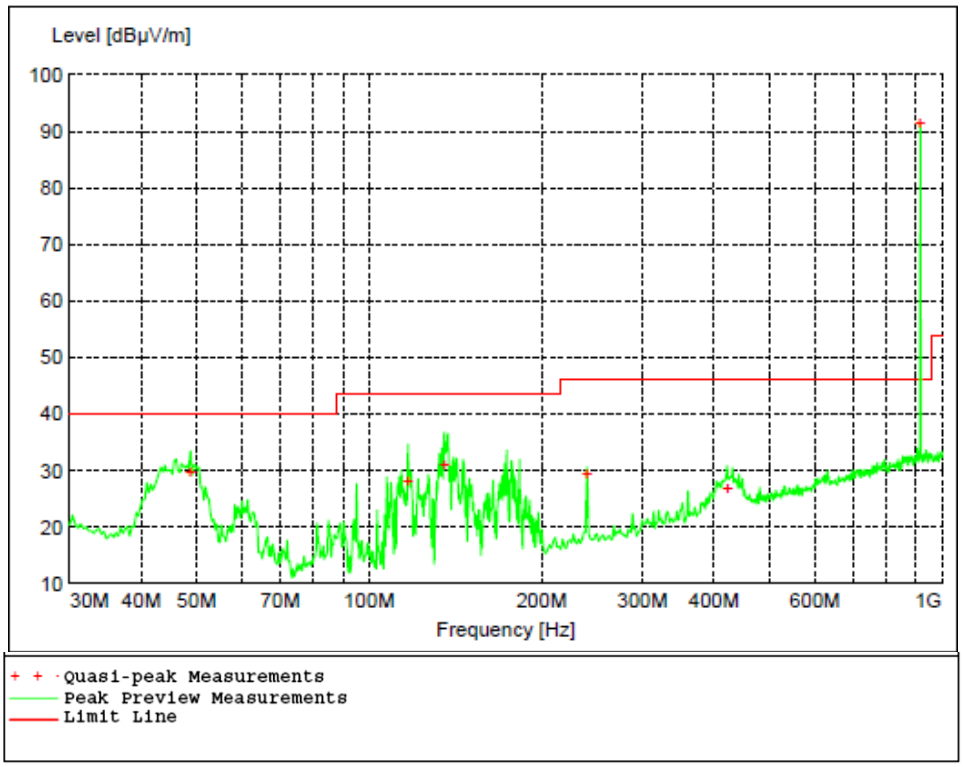


**Figure 4 - Radiated Emissions Plot, 916 MHz**

**REMARKS**:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

**Table 5 - Radiated Emissions Quasi-peak Measurements, 916 MHz**

| Frequency | Level | Limit | Margin | Height | Angle | Pol | Axis |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | |
| 48.720000 | 29.78 | 40.00 | 10.20 | 106 | 295 | VERT | Y-axis |
| 116.880000 | 28.29 | 43.50 | 15.20 | 100 | 6 | VERT | Y-axis |
| 135.300000 | 31.28 | 43.50 | 12.20 | 100 | 131 | VERT | Y-axis |
| 239.940000 | 29.51 | 46.00 | 16.50 | 176 | 360 | VERT | Y-axis |
| 422.400000 | 26.98 | 46.00 | 19.00 | 100 | 76 | HORI | Y-axis |
| 916.000000 | 90.90 | 93.98 | 3.08 | 100 | 97 | HORI | Y-axis |

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

**Table 6 - Radiated Emissions Peak Measurements, 916 MHz**

| Frequency | Level | Limit | Margin | Height | Angle | Pol | Axis |
|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | |
| 2748.000000 | 45.10 | 54.00 | 8.90 | 194 | 114 | VERT | X-axis |
| 3663.800000 | 39.52 | 54.00 | 14.50 | 99 | 72 | HORI | X-axis |

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

**Intermodulation Product:** EUT contains three separate radios modules. They were all turned ON at the same time. No intermodulation products were found to be above the noise floor.

## 4.3 PEAK OUTPUT POWER

**Test Method:** ANSI C63.10, Section(s) 7.8.5

**Limits of bandwidth measurements:**
EIRP was calculated from field strength measurements using ANSI C63.10:2013, Section 9.5, Equation (22). The field strength was measured at a 3m distance and maximized.

For Informational Purposes only

**Test procedures:**
All measurements were taken at a distance of 3m from the EUT.

The EUT was maximized in all 3 orthogonal positions in a similar manner as described in Section 4.2.

**Deviations from test standard:**
No deviation.

**Test setup:**

See Section 4.2

Measurement device used was power meter

**EUT operating conditions:**
The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest and highest frequency channel.

**Test results:**

**Peak Output Power**

| CHANNEL | CHANNEL FREQUENCY (MHz) | PEAK OUTPUT POWER (dBm) | Method | RESULT |
|---|---|---|---|---|
| 1 | 908.4 | -4.70 | EIRP | PASS |
| 2 | 916.0 | -5.36 | EIRP | PASS |

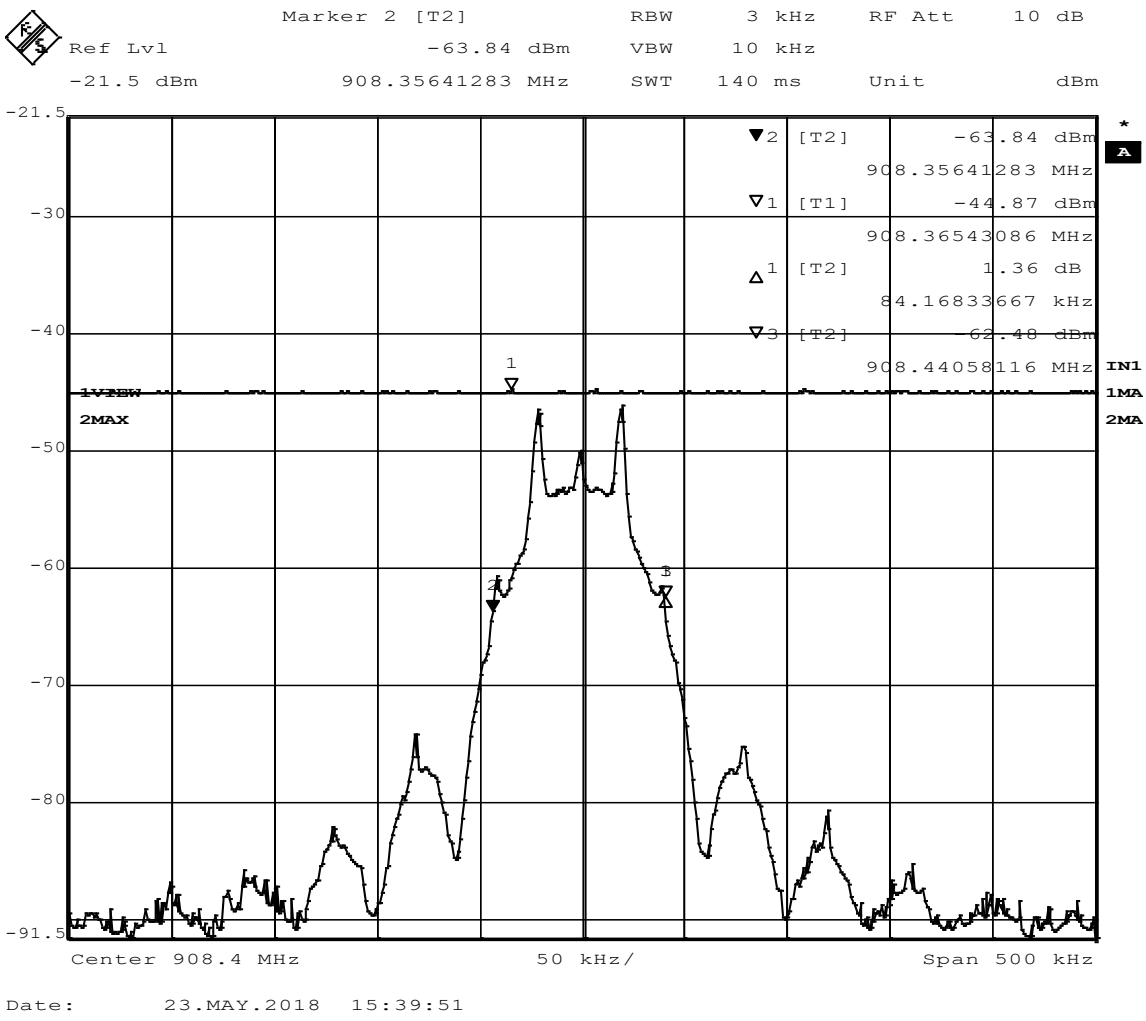


**Figure 5 – Output Power, 908.4 MHz.**

Maximum power = -44.87 dBm + 107 + CL + AF - 95.23 = -4.70 dBm*

CL = cable loss = 4.80 dB

AF = antenna factor = 23.60 dB

107 = conversion from dBm to dBµV on a 50Ω measurement system

-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance.

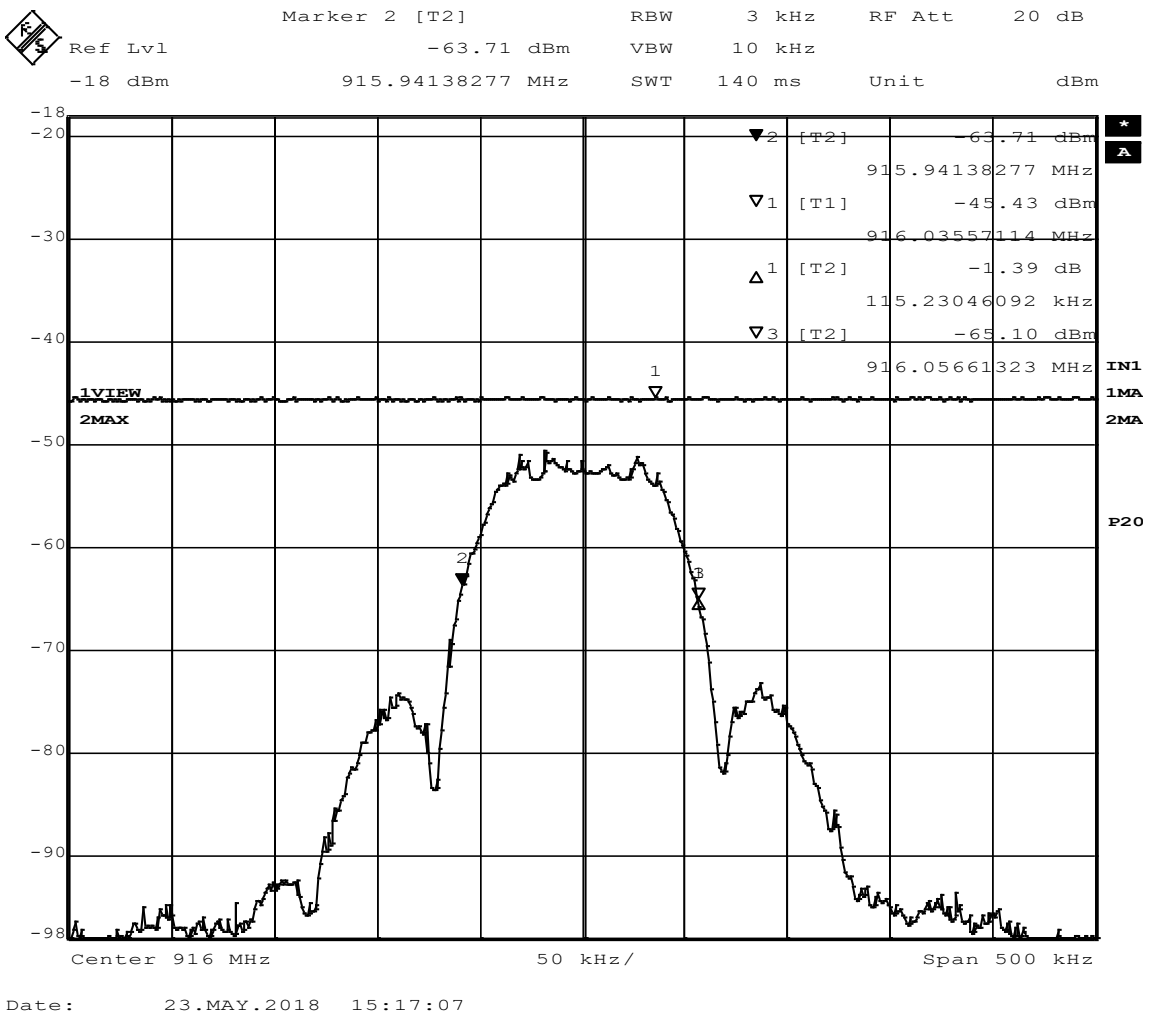


**Figure 6 – Output Power, 916 MHz**

Maximum power = -45.43 dBm + 107 + CL + AF - 95.23 = -5.36 dBm*

CL = cable loss = 4.80 dB

AF = antenna factor = 23.50 dB

107 = conversion from dBm to dBµV on a 50Ω measurement system

-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance.

## 4.4 BANDWIDTH

**Test Method:** ANSI C63.10, Section(s) 6.9.2 (20 dB BW)
ANSI C63.10, Section(s) 6.9.3 (99% BW)

**Limits of bandwidth measurements:**
From FCC Part 15.247 (1) (i) and RSS-247 5.1(c)

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

**Test procedures:**
Bandwidth measurement was taken at a distance of 3m from the EUT. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW and 10 kHz VBW.

The 20dB bandwidth is defined as the bandwidth of which is higher than peak power minus 20dB.

The 99% occupied bandwidth was measured using the test receiver's occupied bandwidth function.

**Test setup:**

All the measurements were done at 3m test distance while an operator was trying to activate the hopping sequence manually. See Section 4.3 for more details.

**Deviations from test standard:**
No deviation.

**Test setup:**

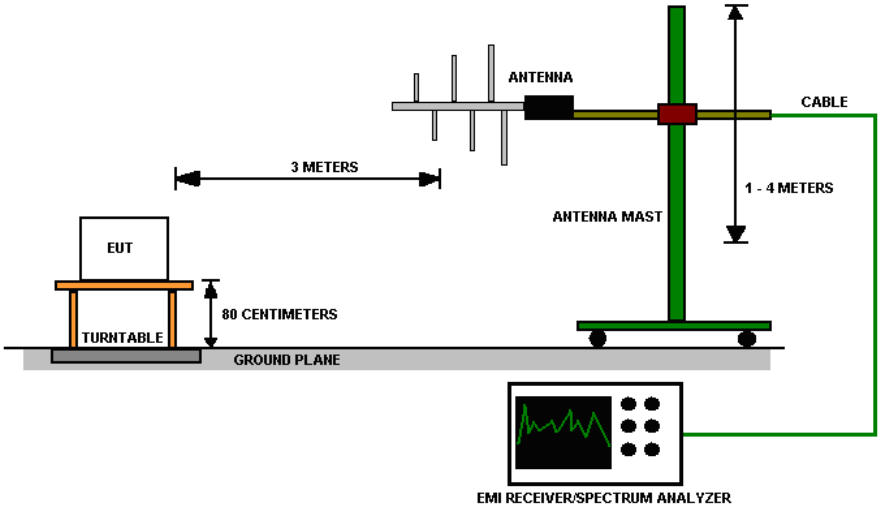


**Figure 7 - Bandwidth Measurements Test Setup**

**EUT operating conditions:**

The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest and highest frequency channel.

**Test results:**

**Occupied Bandwidth**

| CHANNEL | CHANNEL FREQUENCY (MHz) | Occupied BW (kHz) | RESULT |
|---|---|---|---|
| 1 | 908.4 | 87.17 | PASS |
| 2 | 916.0 | 108.22 | PASS |

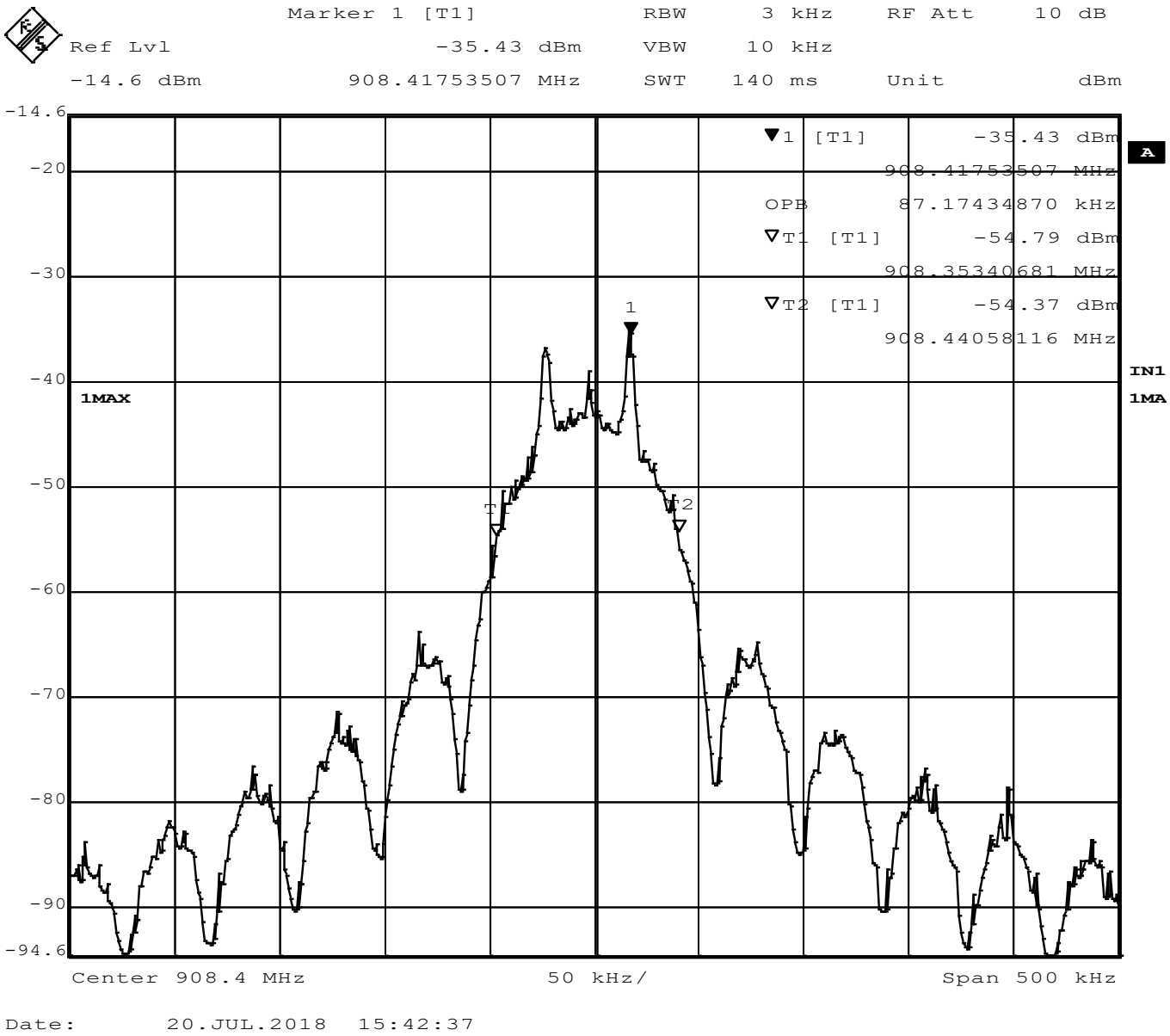


**Figure 8 – Occupied Bandwidth, 908.4 MHz**

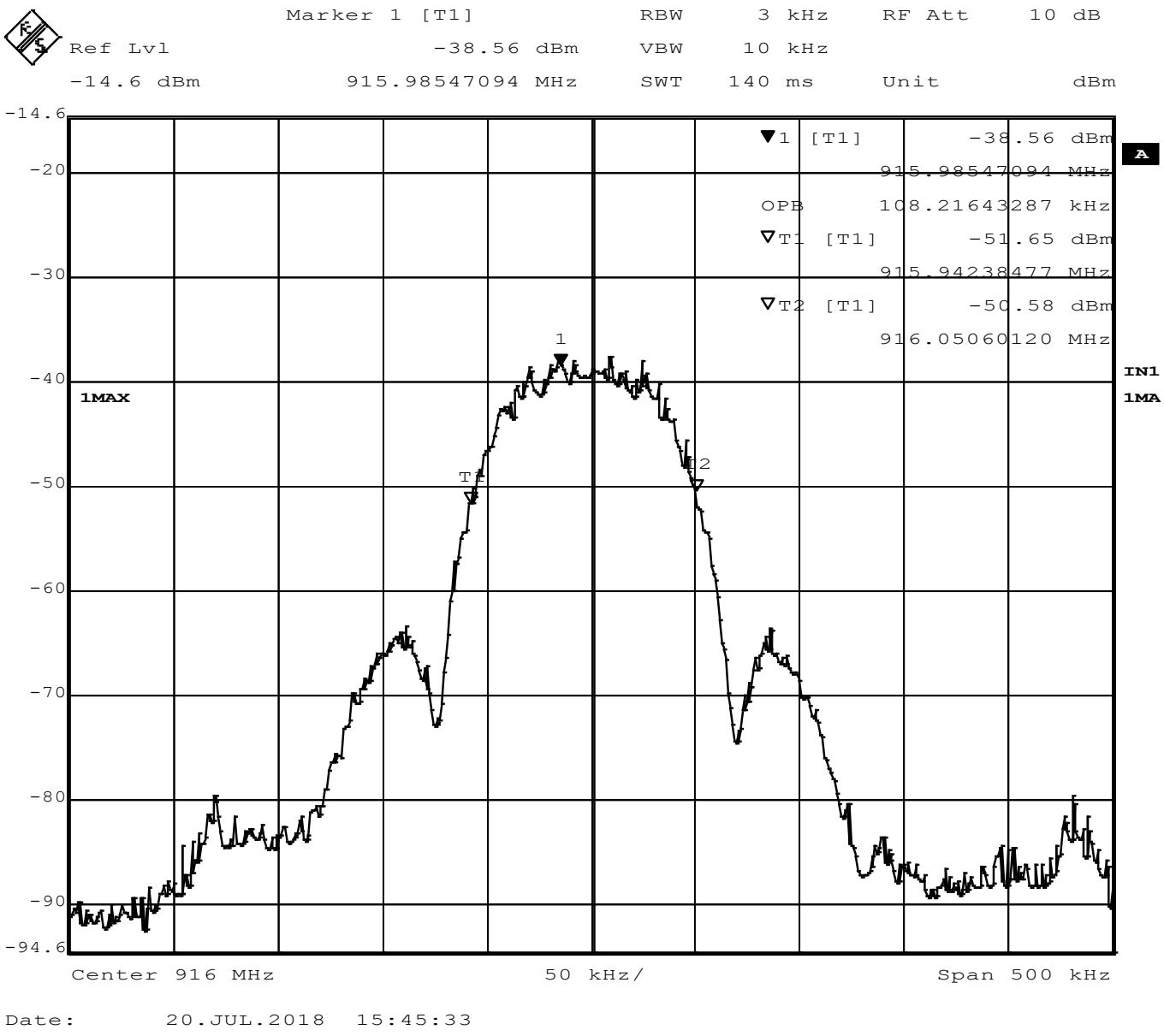


**Figure 9 - Occupied Bandwidth, 916 MHz**

## 4.5 BANDEDGES

**Test Method**: ANSI C63.10, Section(s) 6.10.6

**Limits of bandedge measurements:**
For emissions outside of the allowed band of operation (902 – 928MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

**Test procedures:**
The EUT was tested in the same method as described in section *4.4 - Bandwidth*. The EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 30kHz and the EMI receiver was used to scan from the bandedge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the bandedge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209.

**Deviations from test standard:**
No deviation.

**Test setup:**
All the measurements were done at 3m test distance while an operator was trying to activate the hopping sequence manually.

**EUT operating conditions:**
The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest frequency channel, and the highest frequency channel.

**Test results:**

Highest Out of Band Emissions

| CHANNEL | Band edge /Measurement Frequency (MHz) | Relative Highest out of band level dBm | Relative Fundamental Level (dBm) | Delta | Min (dBc) | Result |
|---|---|---|---|---|---|---|
| Low, Continuous | 614.0 (Restricted) | -101.33 | -45.73 | 55.60 | 45.12 | PASS |
| High, Continuous | 960.0 (Restricted) | -101.79 | -46.07 | 55.72 | 44.90 | PASS |
| Low, Continuous | 902 (Un-Restricted) | -81.43 | -45.73 | 35.70 | 20.00 | PASS |
| High, Continuous | 928 (Un-Restricted) | -79.88 | -46.07 | 33.81 | 20.00 | PASS |

*Minimum delta = [highest fundamental peak field strength from Section 4.2 ] – [ Part 15.209 radiated emissions limit. ]

From Section 4.2

Fundamental average field strength at 908.4 MHz = 91.12 dBµV/m
Fundamental average field strength at 916 MHz = 90.10 dBµV/m

908.4 MHz minimum delta = 91.12 – 46.0 dBµV/m = 45.12 dBc
916 MHz minimum delta = 90.90– 46.0 dBµV/m = 44.90 dBc

Measurements do not include correction factors and are intended to be relative measurements only.

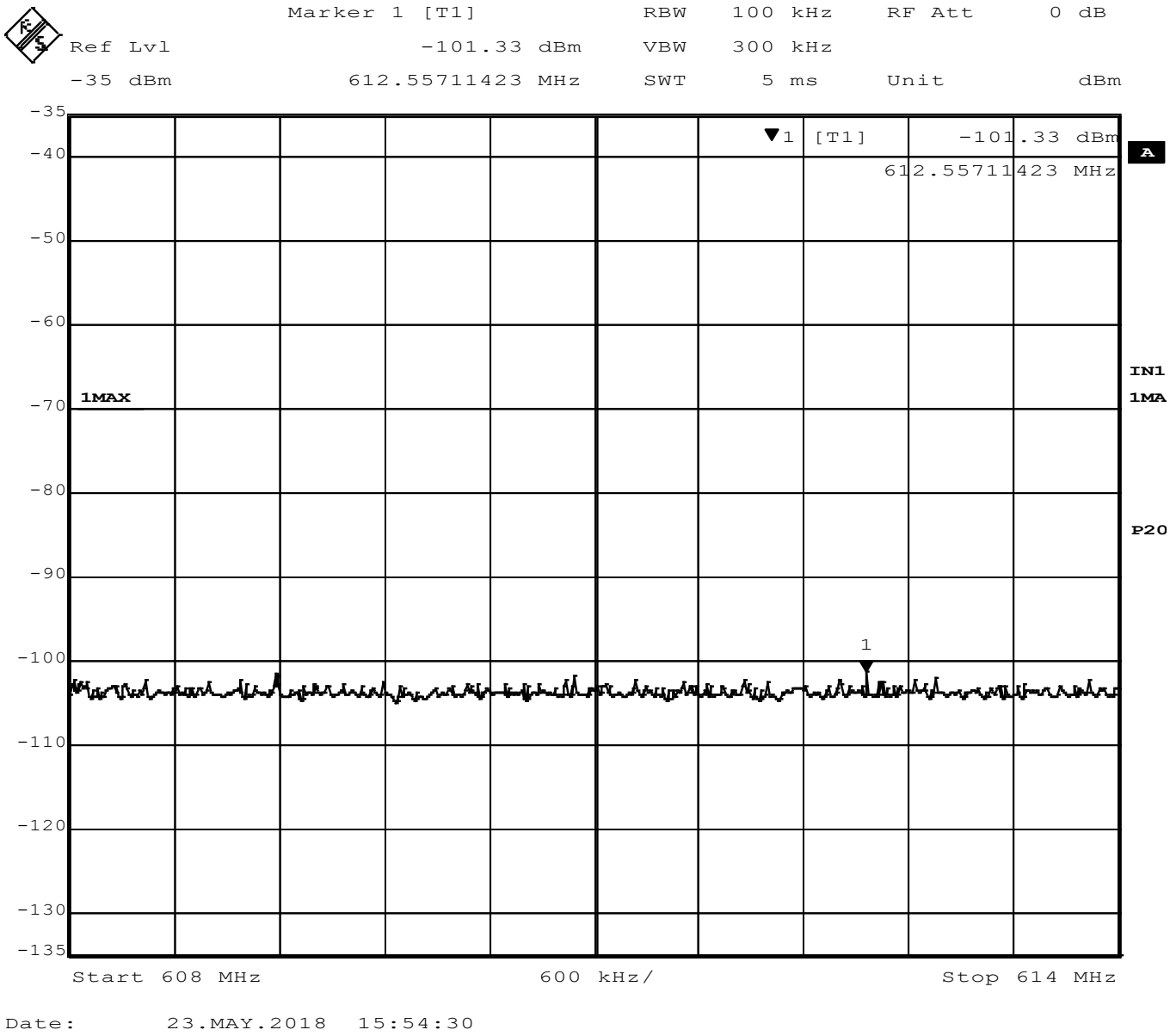


**Figure 10 - Band-edge Measurement, 908.4 MHz, Restricted Frequency, Continuous Transmit**

The plot shows an uncorrected measurement, used for relative measurements only.

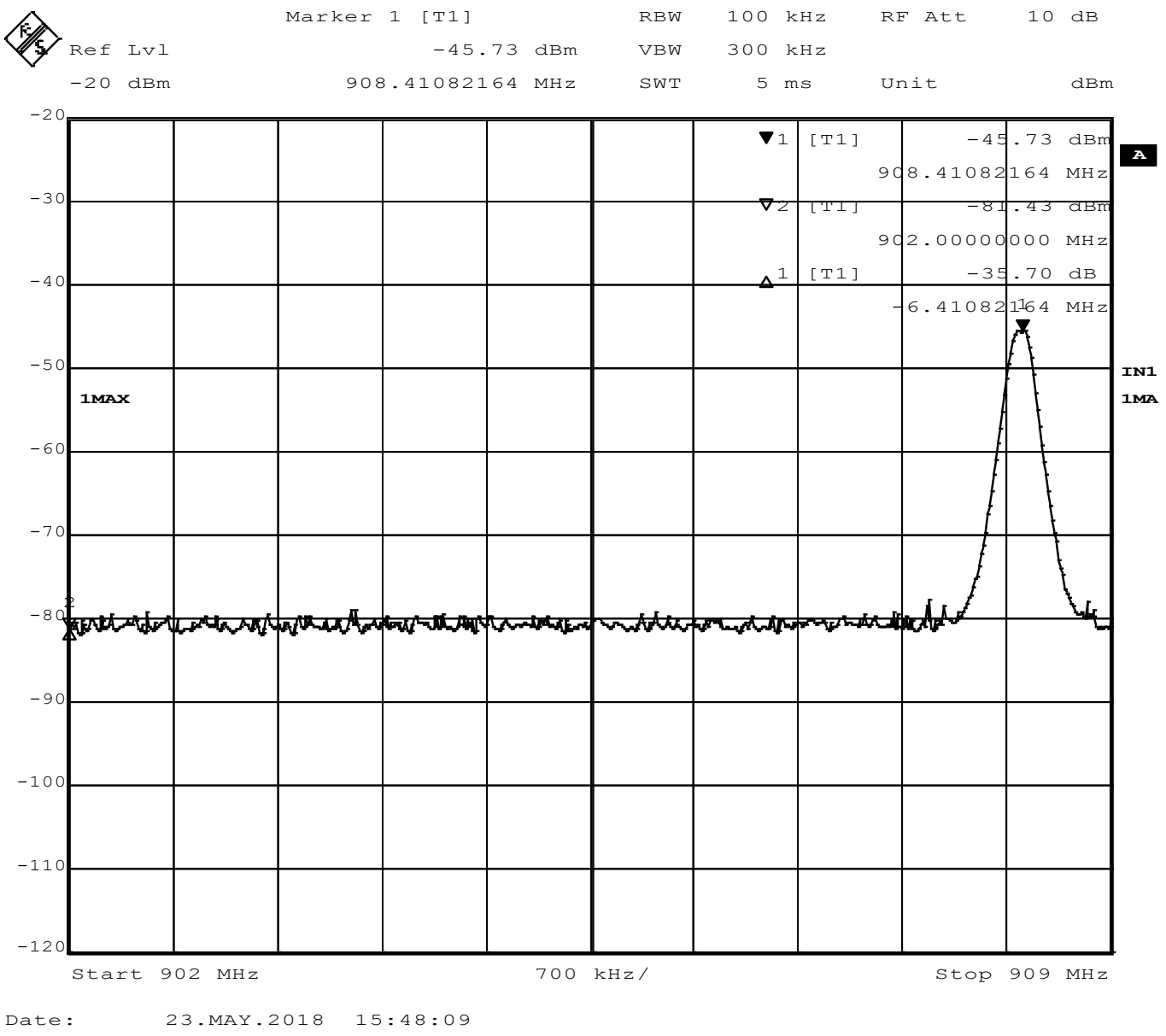


**Figure 11 - Band-edge Measurement, 908.4 MHz, Fundamental, Continuous Transmit**

The plot shows an uncorrected measurement, used for relative measurements only.

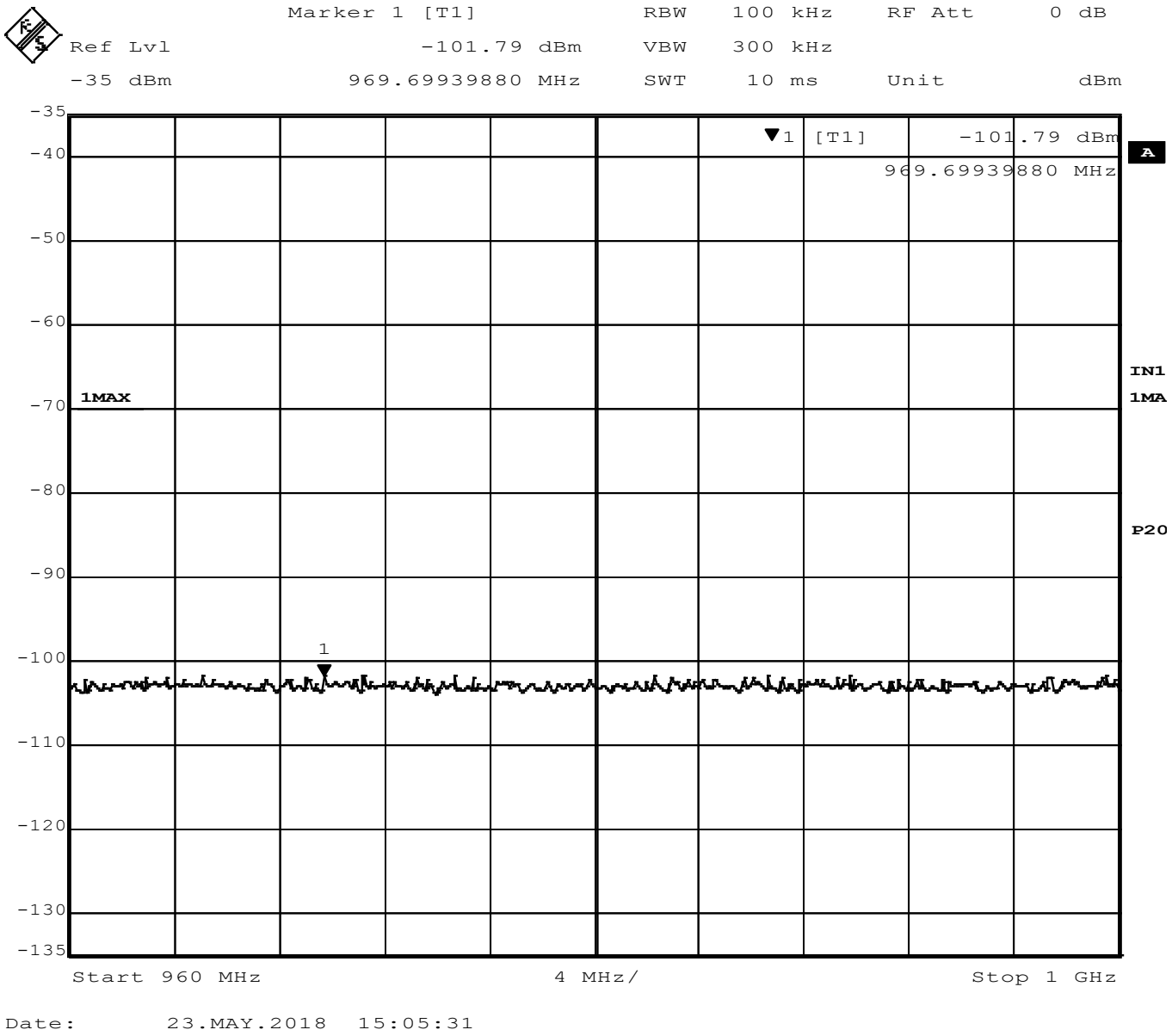


**Figure 12 - Band-edge Measurement, 916 MHz, Restricted Frequency, Continuous Transmit**

The plot shows an uncorrected measurement, used for relative measurements only.

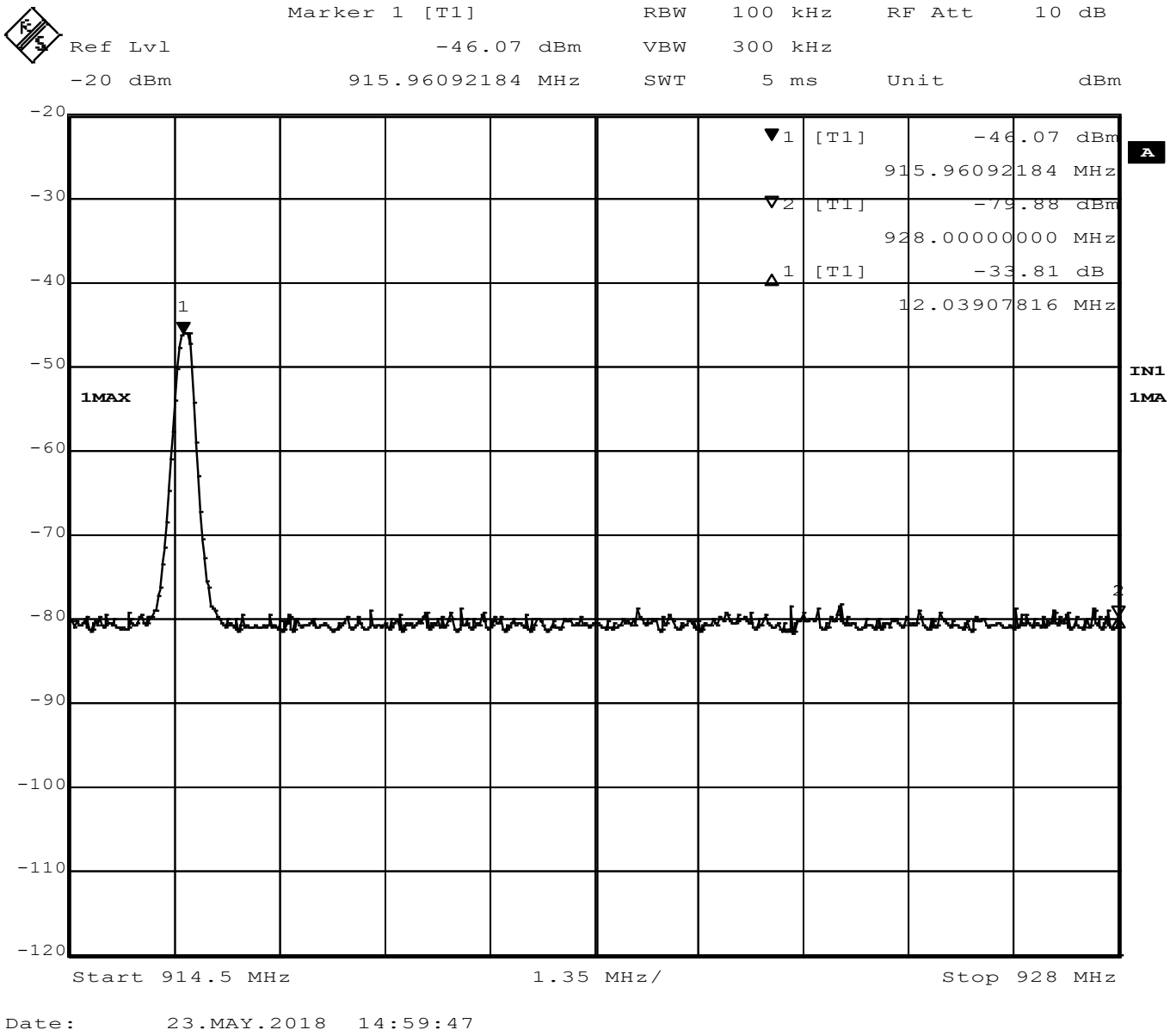


**Figure 13 - Band-edge Measurement, 916 MHz, Fundamental, Continuous Transmit**

The plot shows an uncorrected measurement, used for relative measurements only.

## 4.7 CONDUCTED AC MAINS EMISSIONS

**Test Method**: ANSI C63.10-2013, Section(s) 6.2

**Limits for conducted emissions measurements:**

| FREQUENCY OF EMISSION (MHz) | CONDUCTED LIMIT (dBµV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56 | 56 to 46 |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

**Notes:**
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

**Test Procedures:**

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
d. Results were compared to the 15.207 limits.

**Deviation from the test standard:**
No deviation

**EUT operating conditions:**
The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest and highest frequency channels.

**Test Results:**

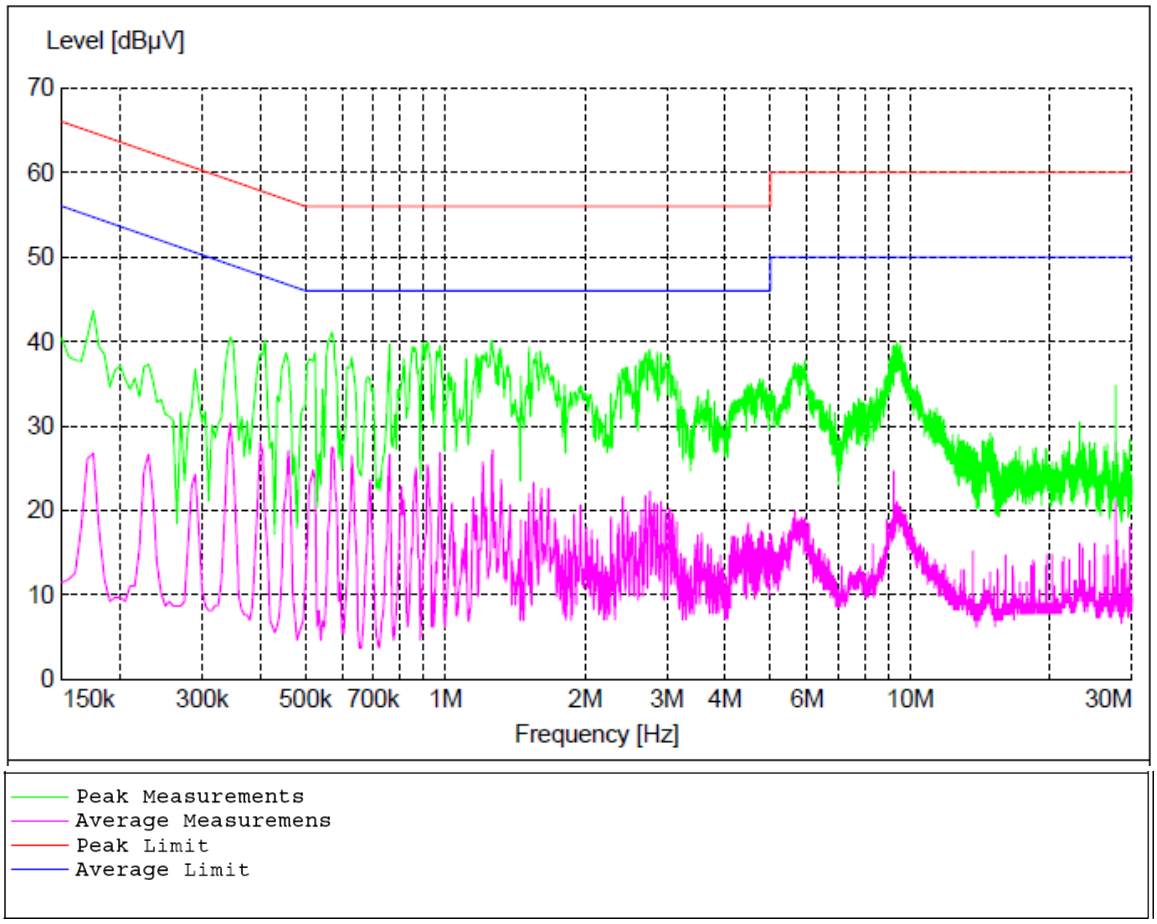


Figure 14 - Conducted Emissions Plot

All measurements were found to be at least 10dB below the applicable limit.

## APPENDIX A: SAMPLE CALCULATION

**Field Strength Calculation**

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log($T_{on}$/100) where $T_{on}$ is the maximum transmission time in any 100ms window.

**EIRP Calculations**

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

*EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]$^2$ / 30*

*Power (watts) = 10^[Power (dBm)/10] / 1000*

*Voltage (dBµV) = Power (dBm) + 107 (for 50Ω measurement systems)*

*Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6*

*Gain = 1 (numeric gain for isotropic radiator)*

*Conversion from 3m field strength to EIRP (d=3):*

*EIRP = [FS(V/m) x d^2]/30 = FS [0.3]  for d = 3*

*EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBµV/m) - 95.23*

*10log( 10^9) is the conversion from micro to milli*

## APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

| Test | Frequency Range | Uncertainty Value (dB) |
|---|---|---|
| Radiated Emissions, 3m | 30MHz - 1GHz | 3.82 |
| Radiated Emissions, 3m | 1GHz - 18GHz | 4.44 |
| Emissions limits, conducted | 30MHz – 18GHz | ±3.30 dB |

Expanded uncertainty values are calculated to a confidence level of 95%.

REPORT END