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**DATE: 16 August 2017**

# I.T.L. (PRODUCT TESTING) LTD.

# FCC/IC Radio Test Report

**for**

# Cardo Systems Inc.

**Equipment under test:**

## Bluetooth Communication System for Motorcycles

## Scala Rider FREECOM2 (BLE)

Tested by: _____
A. Yizhak

Approved by: _____
I. Raz

# Measurement/Technical Report for

Cardo Systems Inc.

Bluetooth Communication System for Motorcycles

Scala Rider FREECOM2

## FCC ID: Q95ER22

## IC: 4668A-ER22

| | |
|---|---|
| This report concerns: | Original Grant:<br>Class I Change:<br>Class II Change: X |
| Equipment type: | Digital Transmission System<br>IC: Spread Spectrum Digital Device<br>(2400-2483.5) |
| Limits used: | 47CFR15 Section 15.247<br>RSS-247, Issue 1, May 2015<br>RSS Gen, Issue 4, November 2014 |

Measurement procedure used is KDB 558074 D01 v03r03 and ANSI C63.10:2013.


Application for Certification
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Applicant for this device:
(different from "prepared by")
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# 1. General Information

## *1.1 Administrative Information*

| | |
|---|---|
| Manufacturer: | Cardo Systems Inc. |
| Manufacturer's Address: | 100 High Tower Blvd.<br>Pittsburgh, Pennsylvania, 15205<br>Tel: +972-3-735-3111<br>Fax: +972-3-562-3360 |
| Manufacturer's Representative: | Avi Moato |
| Equipment Under Test (E.U.T): | Bluetooth Communication System for Motorcycles |
| Product Marketing Name (PMN): | Scala Rider FREECOM2 |
| Equipment Serial No.: | Not designated |
| HVIN: | 1 |
| Date of Receipt of E.U.T: | November 1, 2016 |
| Start of Test: | November 2, 2016 |
| End of Test: | December 22, 2016 |
| Test Laboratory Location: | I.T.L (Product Testing) Ltd.<br>1 Batsheva St.,<br>Lod<br>ISRAEL 7120101 |
| Test Specifications: | FCC Part 15, Subpart C<br>RSS-247, Issue 1, May 2015<br>RSS Gen Issue 4, November 2014 |

### *1.2 List of Accreditations*

The EMC laboratory of I.T.L. is accredited by the following bodies:

1. The American Association for Laboratory Accreditation (A2LA) (U.S.A.), Certificate No. 1152.01.
2. The Federal Communications Commission (FCC) (U.S.A.), FCC Designation No. IL1005.
3. The Israel Ministry of the Environment (Israel), Registration No. 1104/01.
4. Industry Canada (Canada), IC File No.: 46405-4025; Site Nos. IC 4025A-1, IC 4025A-2.

I.T.L. Product Testing Ltd. is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this test report have been determined in accordance with I.T.L.'s terms of accreditation unless stated otherwise in the report.

### 1.3 Product Description

This product is a class 1 Bluetooth headset, Bluetooth intercom for motorbikes.

- Audio streaming via devices supporting Bluetooth Stereo A2DP and AVRCP
- profiles, Music Sharing: Rider and Passenger can enjoy the same stereo music (via A2DP)
- Built-in FM Radio with 6 station presets and automatic tuning

| | |
|---|---|
| Working voltage | 3.1-4.2V DC battery operated |
| Mode of operation | Transceiver |
| Modulations | GFSK |
| Frequency Range | 2402MHz-2480MHz |
| Transmit power | ~8dBm |
| Antenna Gain | -2.0 dBi |
| Modulation BW | >500kHz |
| Temperature (°C)/ Humidity (%RH) | 25°C/44% |

### 1.4 Test Methodology

Both conducted and radiated testing was performed according to the procedures in KDB 558074 D01 v03r03 and ANSI C63.10: 2013. Radiated testing was performed at an antenna to EUT distance of 3 meters.

### 1.5 Test Facility

Emissions tests were performed at I.T.L.'s testing facility in Lod, Israel. I.T.L.'s EMC Laboratory is accredited by A2LA, certificate No. 1152.01 and its FCC Designation Number is IL1005.

### 1.6 Measurement Uncertainty

**Conducted Emission**

(CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4)

0.15 – 30 MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 3.44 dB

**Radiated Emission**

(CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4) for open site 30-1000MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 4.98 dB

# 2. System Test Configuration

## 2.1 Justification

The EUT was FCC certified on 2/14/2017 and IC certified on 1/31/2017.

The following C2PC change was made to the EUT (Freecom2):
Via software changes, the maximum output power was reduced to ~8dBm. No other changes have been made to the EUT.

The unit was evaluated while transmitting at the low channel (2402MHz), the mid channel (2440MHz) and the high channel (2480MHz) in BLE technology.

All tests other than spurious radiated emissions, were performed conducted.

## 2.2 EUT Exercise Software

No special exercise software was used.

## 2.3 Special Accessories

No special accessories were needed to achieve compliance.

## 2.4 Equipment Modifications

No modifications were necessary in order to achieve compliance.

## *2.5 Configuration of Tested System*

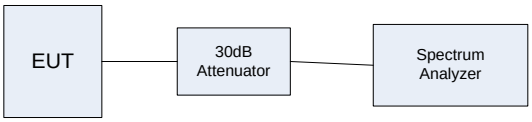



**Figure 1. Configuration of Tested System – Conducted Emission on Antenna Ports**

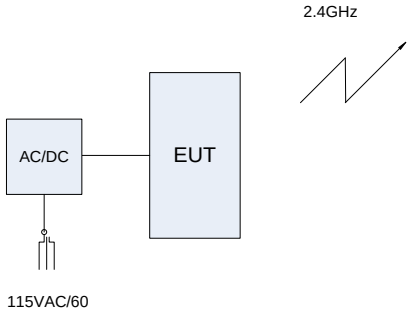



**Figure 2. Configuration of Tested System – Conducted Emission on AC Line**

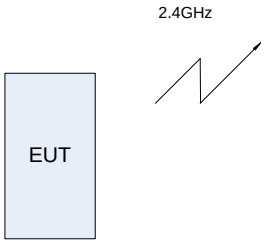



**Figure 3. Configuration of Tested System – Radiated Emission**

# 3. Conducted & Radiated Measurement Test Set-Up Photos

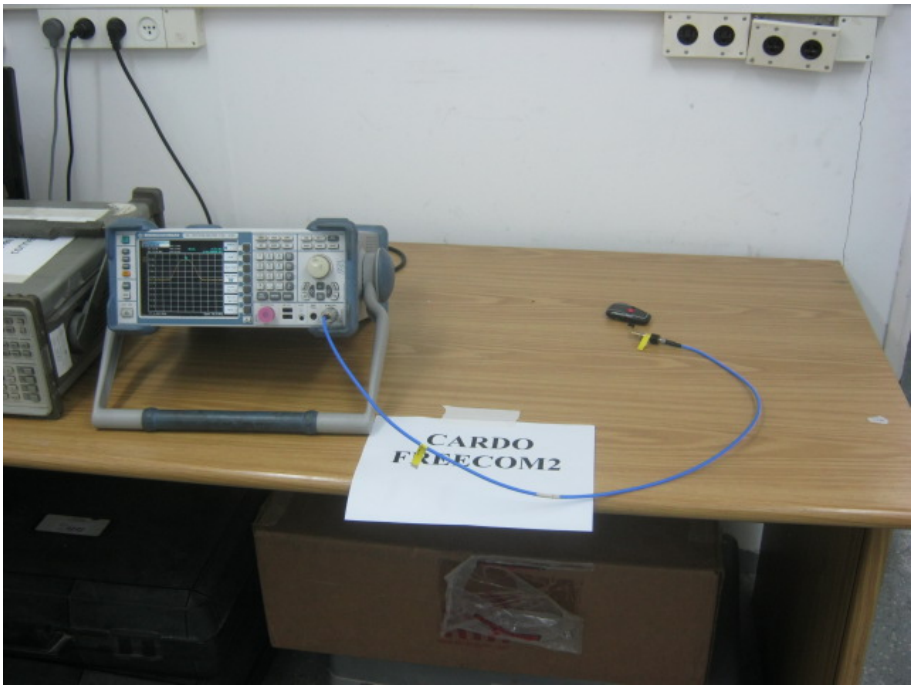



**Figure 4. Conducted Emission From Antenna Ports Test Set-Up**


**Figure 5. Conducted Emission from AC Mains**

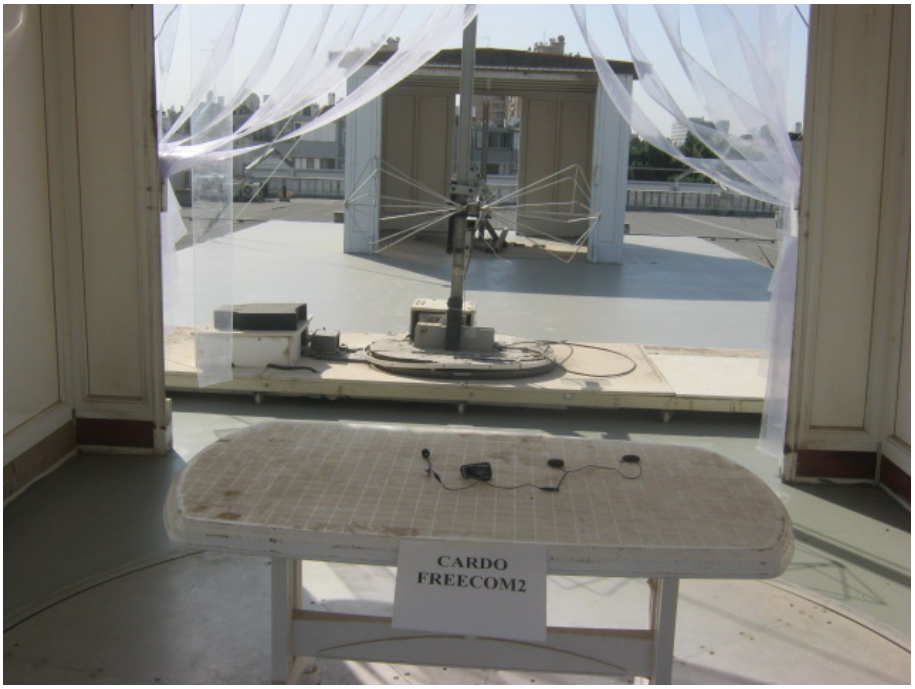



**Figure 6. Radiated Emission Test – 30MHz -200MHz**

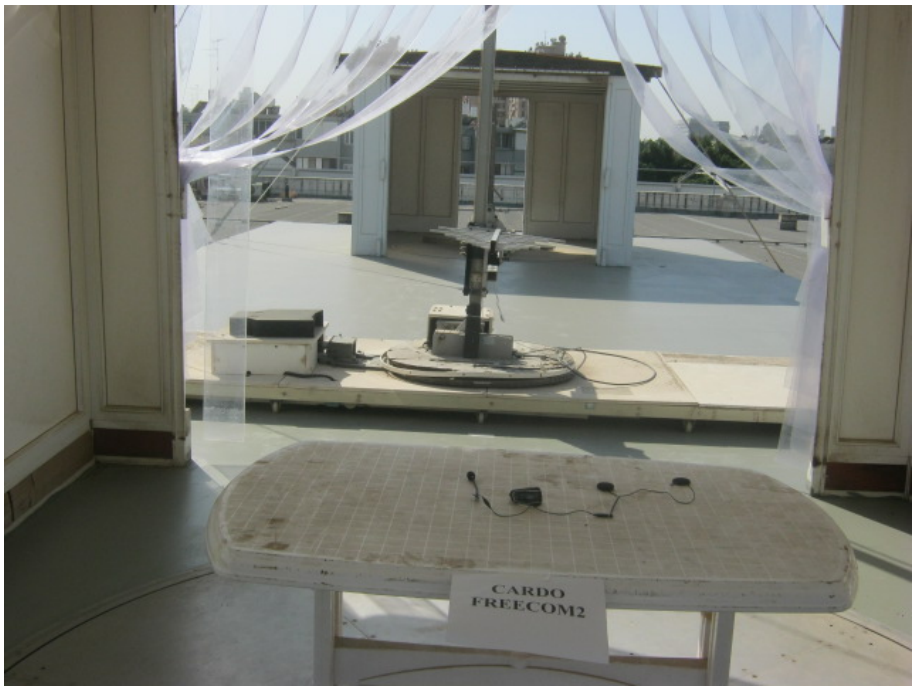



**Figure 7. Radiated Emission Test- 200MHz-1000MHz**


**Figure 8. Radiated Emission Test - 9kHz-30MHz**


**Figure 9. Radiated Emission Test - – above 1GHz**

# 4. Conducted Emission From AC Mains

## 4.1 Test Specification

FCC Part 15, Subpart C, Section 15.207
RSS Gen, Issue 4, Clause 8.8

## 4.2 Test Procedure

(Temperature (24°C)/ Humidity (40%RH))

The E.U.T operation mode and test setup are as described in Section 2 of this report. In order to minimize background noise interference, the conducted emission testing was performed inside a shielded room, with the E.U.T placed on a 0.8 meter high wooden table, 0.4 meter from the room's vertical wall. In the case of a floor-standing E.U.T., it was placed on the horizontal ground plane.

The E.U.T was powered from 115 V AC / 60 Hz via 50 Ohm / 50 µHn Line Impedance Stabilization Network (LISN) on the phase and neutral lines. The LISN's were grounded to the shielded room ground plane (floor), and were kept at least 0.8 meters from the nearest boundary of the E.U.T

The center of the E.U.T.'s AC cable was folded back and forth, in order to form a bundle less than 0.40 meters and a total cable length of 1 meter.

The effect of varying the position of the cables was investigated to find the configuration that produces maximum emission. The configuration tested is shown in the photograph, *Figure 5. Conducted Emission from AC Mains.*

The emission voltages at the LISN's outputs were measured using a computerized receiver, complying with CISPR 16 requirements. The specification limits are loaded to the receiver and are displayed on the receiver's spectrum display.

The E.U.T was evaluated in TX operation mode.

A frequency scan between 0.15 and 30 MHz was performed at 9 kHz I.F. band width, using peak detection.

The spectral components having the highest level on each line were measured using a quasi-peak and average detector.

## 4.3 Test Limit

| **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 |

* Decreases with the logarithm of the frequency.

## 4.4 Test Results

JUDGEMENT: Passed by 28.64 dB

The margin between the emission levels and the specification limit is, in the worst case, 29.31 dB for the phase line at 0.298 MHz and 28.64 dB at 27.62 MHz for the neutral line.

The EUT met the F.C.C. Part 15, Subpart C and RSS Gen, Issue 4, Clause 8.8 specification requirements.

The details of the highest emissions are given in *Figure 10* to *Figure 13*.

# Conducted Emission

| | |
|---|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | Scala Rider FREECOM2 |
| Serial Number: | Not designated |

| | |
|---|---|
| Specification: | FCC Part 15, Subpart C |
| Lead: | Phase |
| Detectors: : | Peak, Quasi-peak, Average |
| Power Operation | AC/DC adapter |


**Figure 10. Detectors: Peak, Quasi-peak, Average**

*Note: QP Delta/Av Delta refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.*

# Conducted Emission

| | |
|---|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | Scala Rider FREECOM2 |
| Serial Number: | Not designated |

| | |
|---|---|
| Specification: | FCC Part 15, Subpart C |
| Lead: | Phase |
| Detectors: | Peak, Quasi-peak, Average |
| Power Operation | AC/DC adapter |

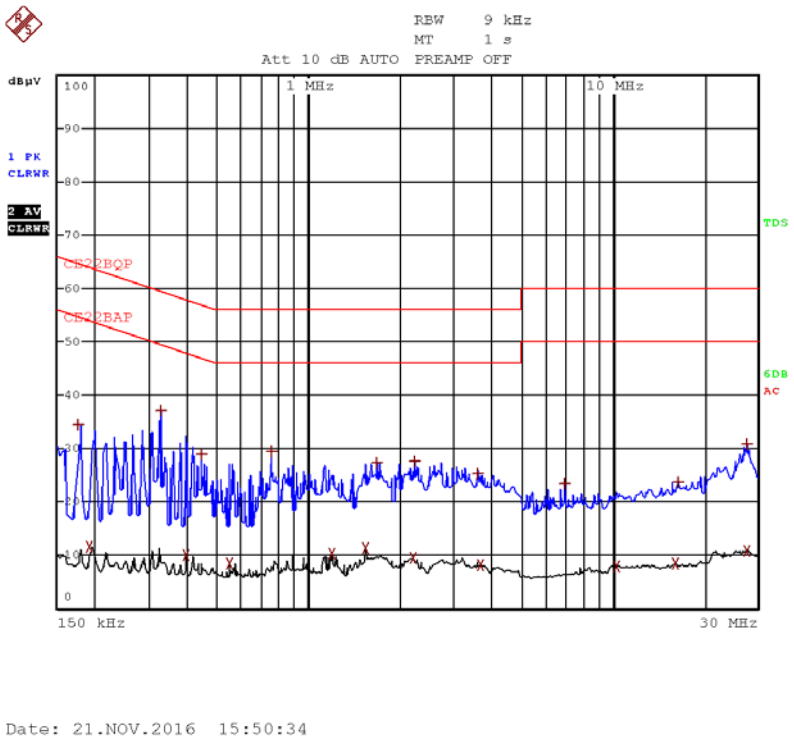



**Figure 11. Detectors: Peak, Quasi-peak, Average**

# Conducted Emission

| | |
|---|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | Scala Rider FREECOM2 |
| Serial Number: | Not designated |

| | |
|---|---|
| Specification: | FCC Part 15, Subpart C |
| Lead: | Neutral |
| Detectors: | Peak, Quasi-peak, Average |
| Power Operation | AC/DC adapter |

EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

| TRACE | | FREQUENCY | LEVEL dBµV | DELTA LIMIT dB |
|---|---|---|---|---|
| 2 | Average | 198 kHz | 13.17 | -40.52 |
| 1 | Quasi Peak | 250 kHz | 20.85 | -40.90 |
| 1 | Quasi Peak | 322 kHz | 24.08 | -35.57 |
| 2 | Average | 330 kHz | 17.00 | -32.44 |
| 1 | Quasi Peak | 438 kHz | 21.78 | -35.31 |
| 2 | Average | 734 kHz | 11.33 | -34.67 |
| 1 | Quasi Peak | 890 kHz | 18.29 | -37.71 |
| 2 | Average | 890 kHz | 10.27 | -35.72 |
| 1 | Quasi Peak | 1.422 MHz | 14.53 | -41.46 |
| 2 | Average | 1.546 MHz | 10.44 | -35.55 |
| 2 | Average | 3.122 MHz | 9.99 | -36.00 |
| 1 | Quasi Peak | 3.474 MHz | 18.84 | -37.15 |
| 1 | Quasi Peak | 3.61 MHz | 18.93 | -37.06 |
| 2 | Average | 3.61 MHz | 8.79 | -37.20 |
| 2 | Average | 9.418 MHz | 7.65 | -42.34 |
| 1 | Quasi Peak | 9.966 MHz | 15.39 | -44.60 |
| 1 | Quasi Peak | 15.53 MHz | 18.31 | -41.68 |
| 2 | Average | 17.474 MHz | 9.19 | -40.81 |
| 1 | Quasi Peak | 27.622 MHz | 31.35 | -28.64 |
| 2 | Average | 27.834 MHz | 19.34 | -30.66 |

Date: 21.NOV.2016 15:58:01

**Figure 12. Detectors: Peak, Quasi-peak, Average**

*Note: QP Delta/Av Delta refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.*

# Conducted Emission

| | |
|---|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | Scala Rider FREECOM2 |
| Serial Number: | Not designated |

| | |
|---|---|
| Specification: | FCC Part 15, Subpart C |
| Lead: | Neutral |
| Detectors: | Peak, Quasi-peak, Average |
| Power Operation | AC/DC adapter |

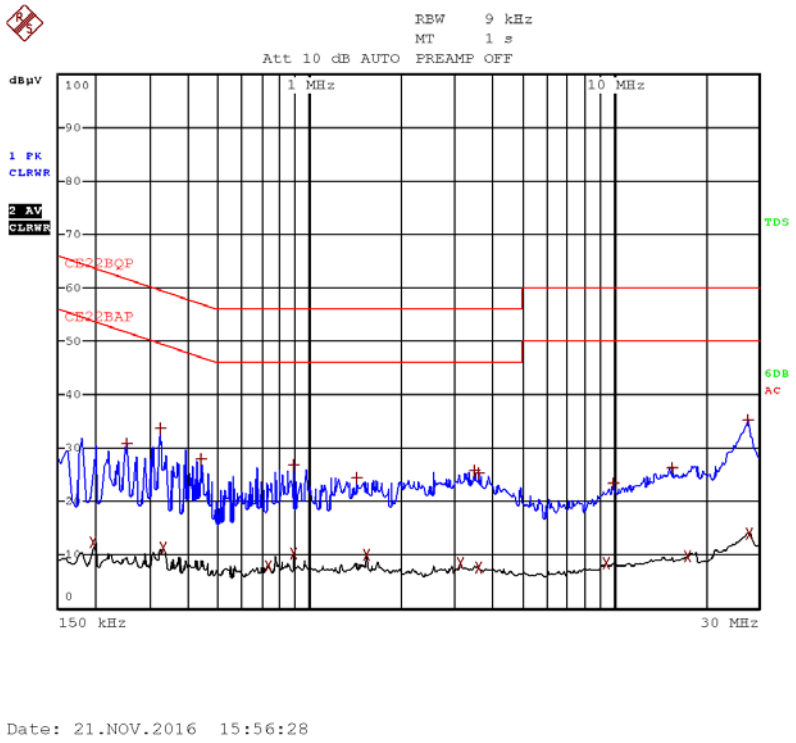



**Figure 13 Detectors: Peak, Quasi-peak, Average**

## 4.5 Test Equipment Used; Conducted Emission

| Instrument | Manufacturer | Model | Serial No. | Last Calibration Date | Next Calibration Due |
|---|---|---|---|---|---|
| LISN | Fischer | FCC-LISN-25A | 127 | June 23, 2016 | June 23, 2017 |
| Transient Limiter | HP | 11947A | 3107A03041 | June 15, 2016 | June 15, 2017 |
| EMI Receiver | Rohde & Schwarz | ESCI7 | 100724 | February 29, 2016 | March 1, 2017 |
| Low Loss Cable | Huber Suhner | - | 705A009301 EIM | May 30, 2016 | May 30, 2017 |

**Figure 14 Test Equipment Used**

# 5. Maximum Transmitted Peak Power Output

## 5.1 Test Specification

FCC, Part 15, Subpart C, Section 247(b)(3)
RSS-247, Issue 1, May 2015, Section 5.4.4

## 5.2 Test Procedure

(Temperature (23°C)/ Humidity (60%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.
The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (loss=20.5 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The E.U.T was evaluated in 3 channels: Low (2402.0 MHz), Mid (2440.0 MHz) and High (2480 MHz).

## 5.3 Test Results

| Operation Frequency (MHz) | Power (dBm) | Power (mW) | Limit (mW) | Margin (mW) |
|---|---|---|---|---|
| 2402.0 | 8.2 | 6.6 | 1000.0 | -993.4 |
| 2440.0 | 8.1 | 6.5 | 1000.0 | -993.5 |
| 2480.0 | 8.6 | 7.2 | 1000.0 | -992.8 |

**Figure 15 Maximum Peak Power Output**

JUDGEMENT: Passed by 992.8mW

For additional information see *Figure 16* to *Figure 18.*

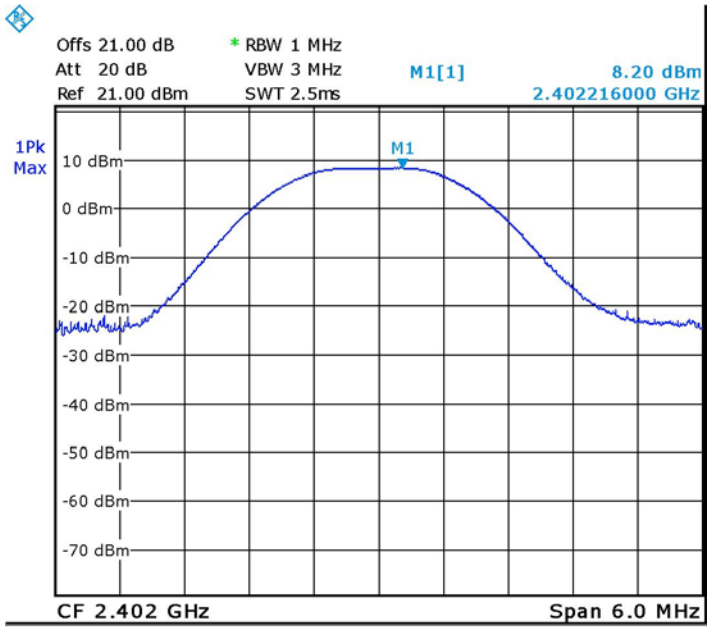



**Figure 16 2402.0 MHz**

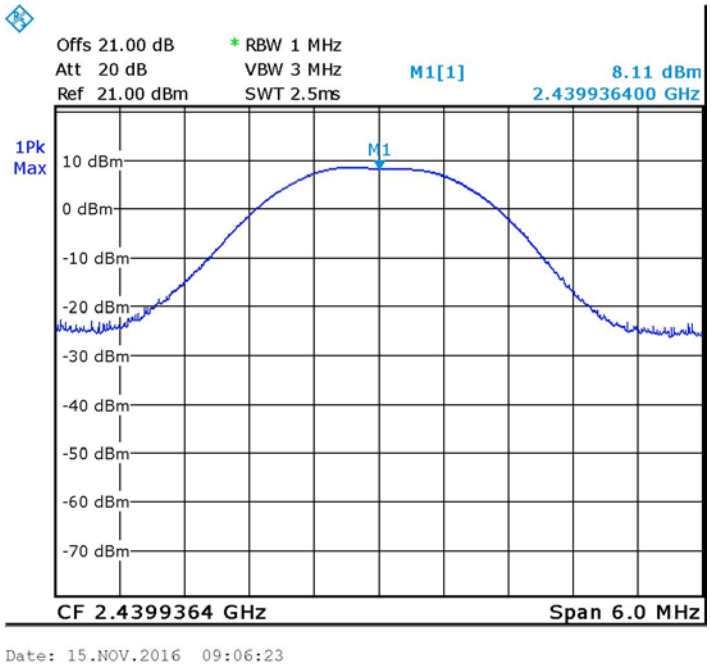



**Figure 17 2440.0 MHz**

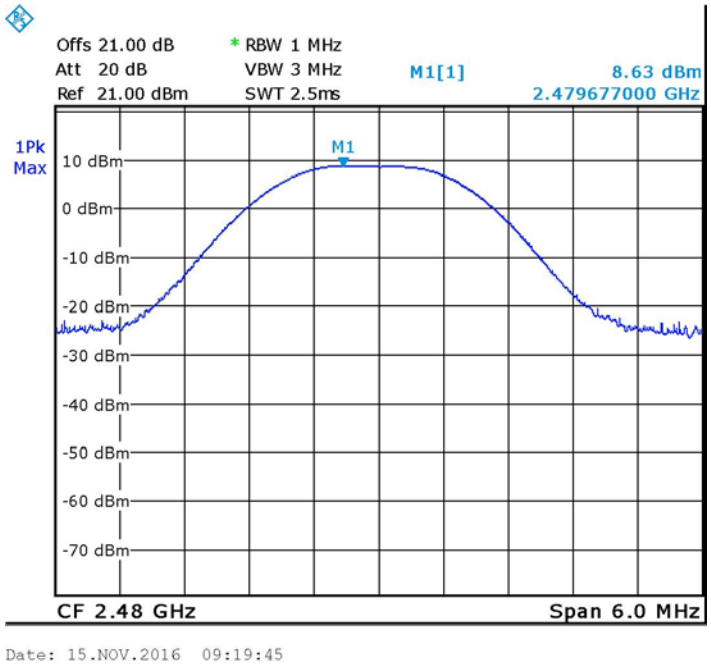



**Figure 18 2480.0 MHz**

## *5.4 Test Equipment Used; Maximum Peak Power Output*

| Instrument | Manufacturer | Model | Serial No. | Last Calibration Date | Next Calibration Due |
|---|---|---|---|---|---|
| Spectrum Analyzer | R&S | FSL6 | 100194 | February 29, 2016 | March 1, 2017 |
| 20 dB Attenuator | MCL | VAT-20W2+ | 848 | July 5, 2016 | July 5, 2017 |

**Figure 19 Test Equipment Used**

# 6. 99% Occupied Bandwidth

## 6.1 Test Specification

RSS Gen, Issue 4, Section 6.6

## 6.2 Test Procedure

(Temperature (23°C)/ Humidity (50%RH))
The E.U.T operation mode and test set-up are as described in Section 2 of this report.
The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (loss=31.0 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.
The RBW was set to 100 kHz.

## 6.3 Test Results

| Operation Frequency (MHz) | Reading (MHz) |
|---|---|
| 2402 | 0.9 |
| 2440 | 1.1 |
| 2480 | 1.4 |

**Figure 20 Occupied Bandwidth**

JUDGEMENT: Passed

For additional information see *Figure 21* to *Figure 23*

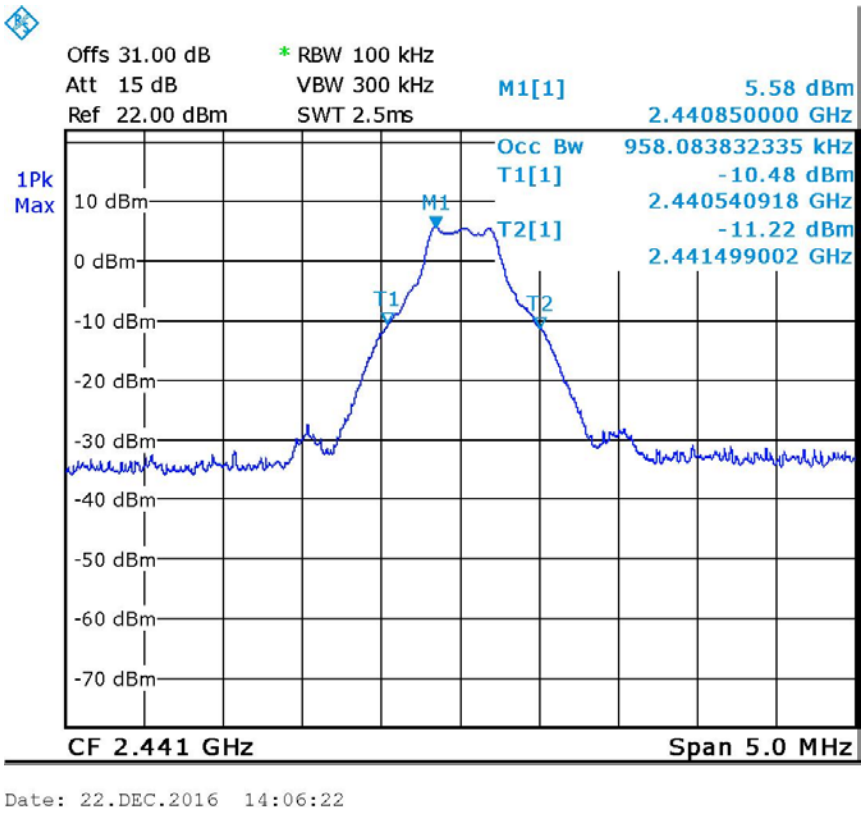



**Figure 21. 2402.0 MHz – Occupied Bandwidth**

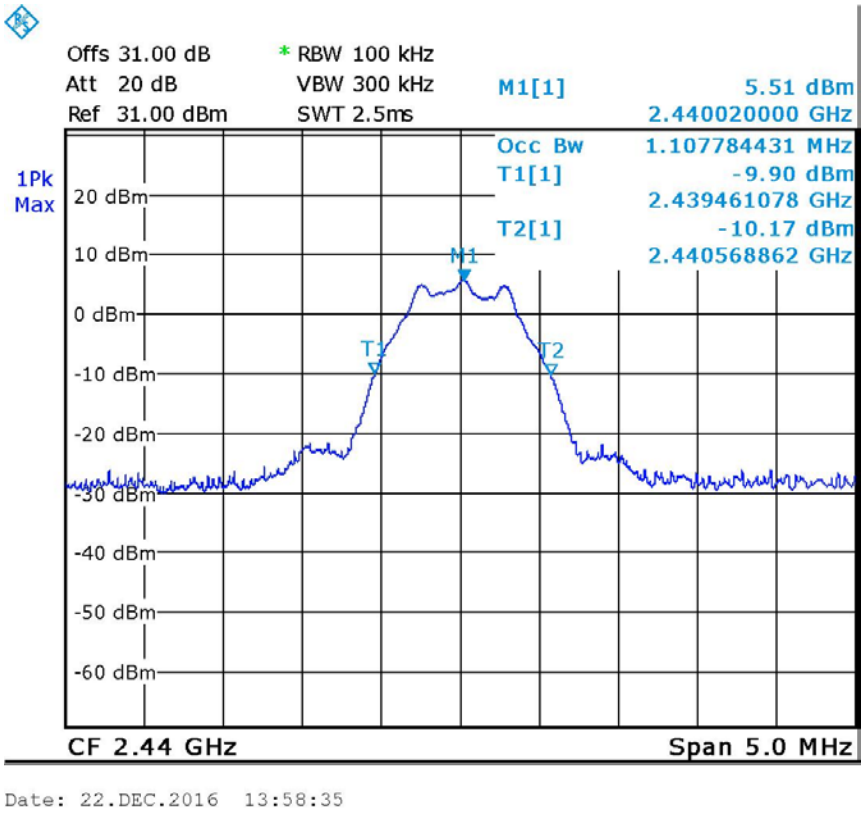



**Figure 22. 2440.0 MHz - Occupied Bandwidth**

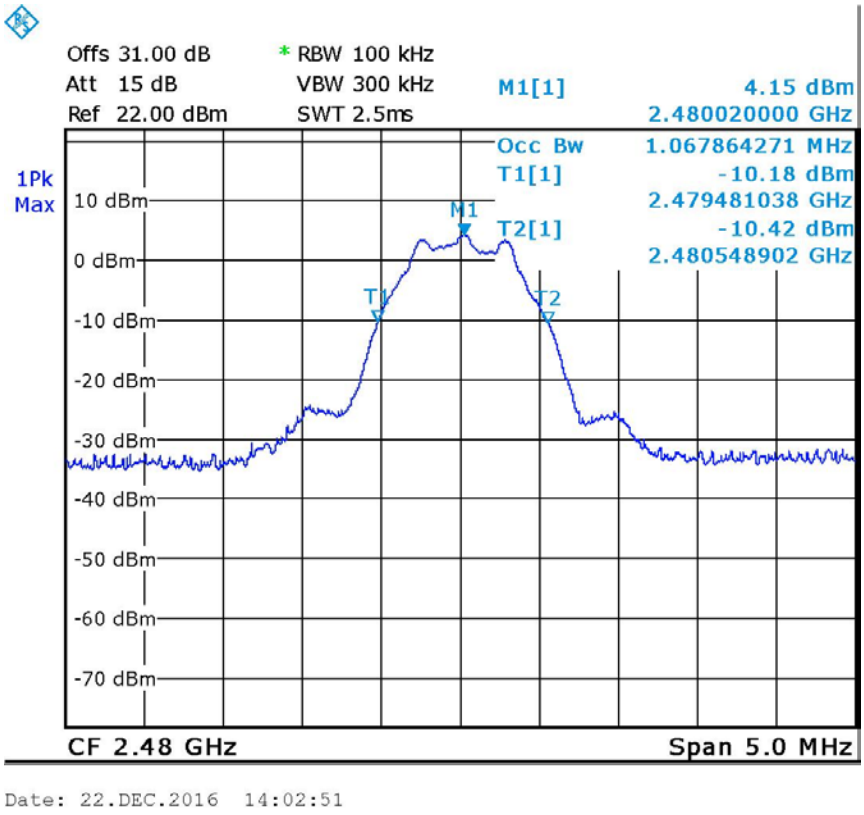



**Figure 23. 2480.0 MHz – Occupied Bandwidth**

## *6.4 Test Equipment Used; Occupied Bandwidth*

| Instrument | Manufacturer | Model | Serial No. | Last Calibration Date | Next Calibration Due |
|---|---|---|---|---|---|
| Spectrum Analyzer | R&S | FSL6 | 100194 | February 29, 2016 | March 1, 2017 |
| 30dB Attenuator | Bird | 8304-N30DB | 533 | June 1, 2016 | June 1, 2017 |

**Figure 24 Test Equipment Used**

# 7. Band Edge Spectrum

## 7.1 Test Specification

FCC, Part 15, Subpart C, Section 247(d)
RSS-247, Issue 1, May 2015, Section 5.5

## 7.2 Test Procedure

(Temperature (23°C)/ Humidity (60%RH))

The E.U.T operation mode and test set-up are as described in Section 2.
The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (loss=20.5 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The E.U.T was evaluated in 2 channels: Low and High.

The RBW was set to 100 kHz.

## 7.3 Test Results

| Operation Frequency (MHz) | Modulation | Band Edge Frequency (MHz) | Spectrum Level (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|
| Low | BLE | 2400.0 | -32.6 | -12.1 | -20.5 |
| High | BLE | 2483.5 | -39.7 | -11.6 | -28.1 |

**Figure 25 Band Edge Spectrum**

JUDGEMENT: Passed by 20.5 dB

For additional information see *Figure 26* and *Figure 27*.

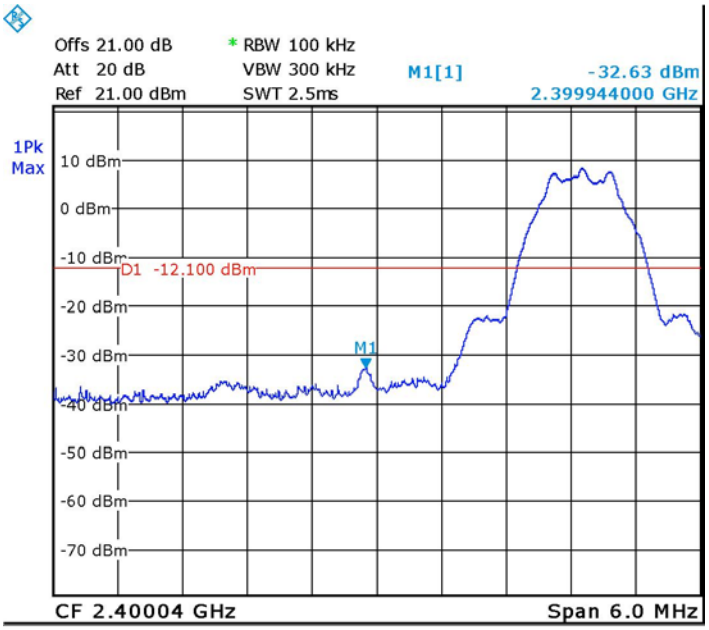



**Figure 26 —Lower Band Edge**

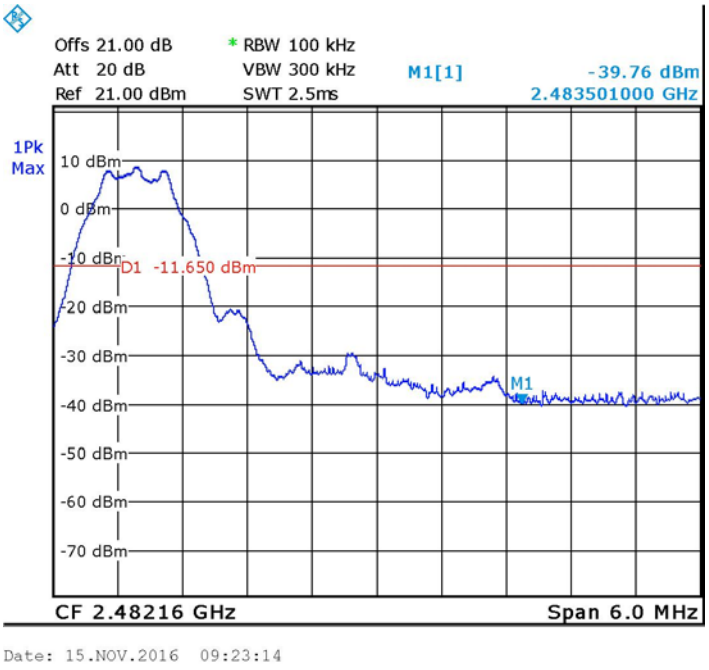



**Figure 27 —Upper Band Edge**

## *7.4 Test Equipment Used; Band Edge Spectrum*

| Instrument | Manufacturer | Model | Serial No. | Last Calibration Date | Next Calibration Due |
|---|---|---|---|---|---|
| Spectrum Analyzer | R&S | FSL6 | 100194 | February 29, 2016 | March 1, 2017 |
| 20 dB Attenuator | MCL | VAT-20W2+ | 848 | July 5, 2016 | July 5, 2017 |

**Figure 28 Test Equipment Used**

# 8. Emissions in Non-Restricted Frequency Bands

## 8.1 Test Specification

FCC, Part 15, Subpart C, Section 247(d)

RSS 247, Issue 1, Section 5.5

## 8.2 Test Procedure

(Temperature (24°C)/ Humidity (40%RH))
The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable.

The frequency range 0.009-25,000.0 MHz was scanned to find other emissions that don't fall in the restricted band
RBW was set to 100 kHz, detector set to max peak and trace to "max hold"

The E.U.T. was operated at the following frequencies: Low (2402 MHz), Mid (2440 MHz) and High (2480 MHz).
These frequencies were measured using a peak detector.

## 8.3 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

## 8.4 Test Results

JUDGEMENT: Passed

The EUT met the requirements of the F.C.C. Part 15, Subpart C, Section 247 (d) specification.

For additional information see *Figure 29* to *Figure 31*.

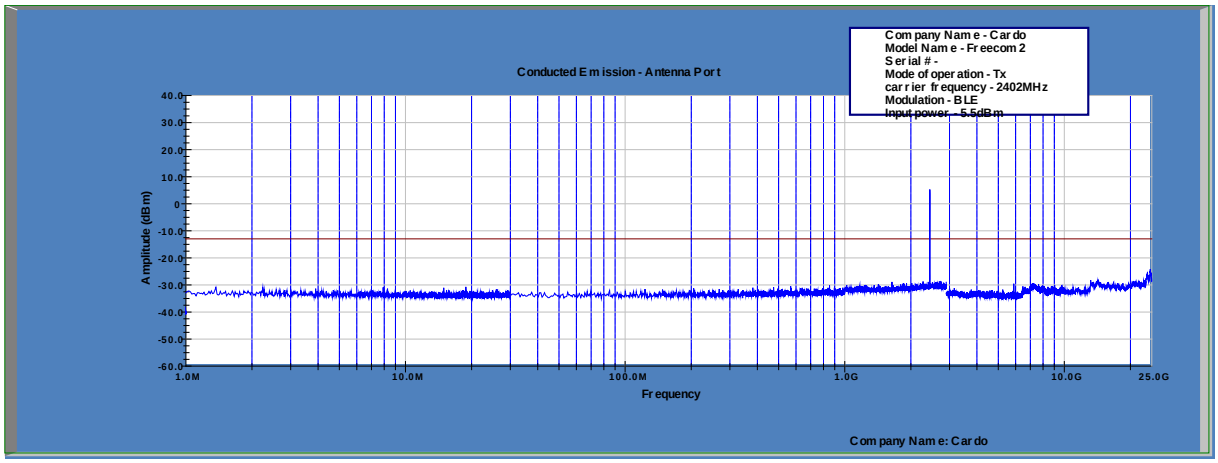



**Figure 29 Conducted Spurious Emission – 2402 MHz**

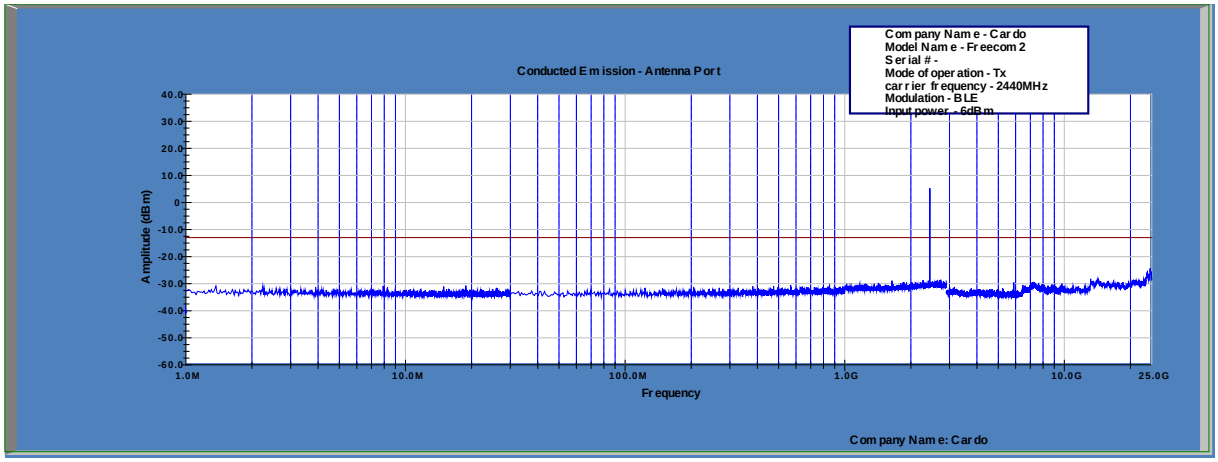



**Figure 30 Conducted Spurious Emission - 2440 MHz**

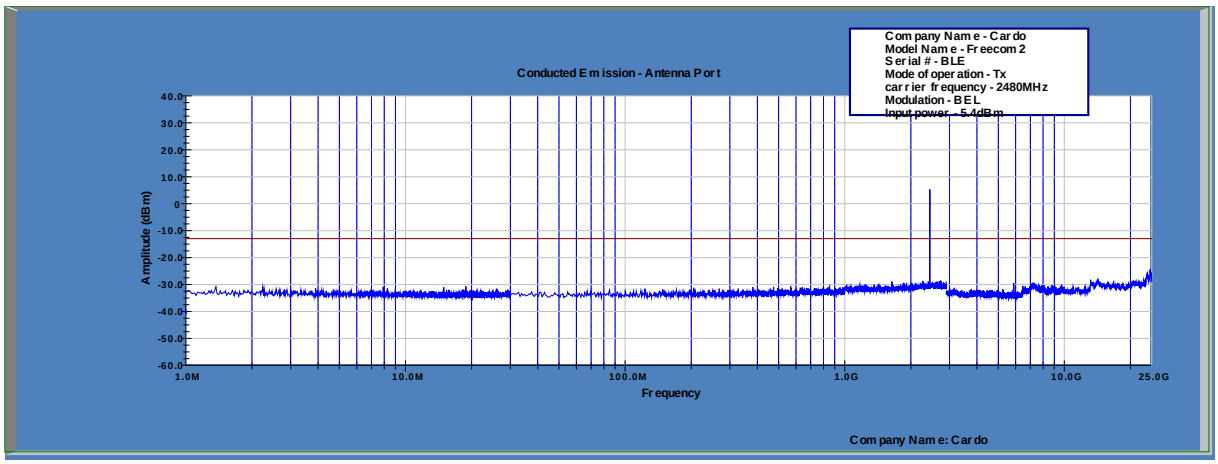



**Figure 31 Conducted Spurious Emission – 2480 MHz**

## 8.5 Test Equipment Used, Emissions in Non-Restricted Frequency Bands

| Instrument | Manufacturer | Model | Serial Number | Last Calibration Date | Next Calibration Due |
|---|---|---|---|---|---|
| Spectrum Analyzer | Rodhe & Schwarz | FSL6 | 100194 | February 29, 2016 | March 1, 2017 |
| 30dB Attenuator | Bird | 8304-N30DB | 533 | June 1, 2016 | June 1, 2017 |

**Figure 32 Test Equipment Used**

# 9. Emissions in Restricted Frequency Bands

## 9.1 Test Specification

FCC, Part 15, Subpart C, Sections 15.209, 15.205, 15.247(d)
RSS GEN, Issue 4: 2014, Clause 8.9; 8.10

## 9.2 Test Procedure

(Temperature (23°C)/ Humidity (60%RH))

**For measurements between 0.009MHz-30.0MHz:**

The E.U.T was tested inside the chamber at a distance of 3 meters and the E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The frequency range 0.009MHz-30MHz was scanned. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

**For measurements between 30.0MHz-1.0GHz**:
A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The frequency range 30.0MHz -1.0GHz was scanned and the list of the highest emissions was verified and updated accordingly.
The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

**For 1000.0MHz-25,000.0MHz range:**

The E.U.T was placed in the chamber and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The configuration tested is shown in *Figure 3.*

The frequency range 1000 MHz-25000 MHz was scanned.

The readings were maximized by adjusting the turntable azimuth between 0-360°, and the antenna polarization.

The emissions were measured at a distance of 3 meters.

The E.U.T. was operated at the low, mid and high channels.
(2402, 2440, 2480 MHz).

The levels of the emissions within the frequency ranges of the restricted bands (Section 15.205 of FCC Part 15) were compared to the limits of the table in Section 15.209 (a), General Requirements.
Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

| Frequency (MHz) | Field strength (microvolts/meter) | Measurement distance (meters) | Field strength* (dBµV/m) | Field strength* (dBµV/m)@3m |
|---|---|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | 300 | 48.5-13.8 | 128.5-73.8 |
| 0.490-1.705 | 24000/F(kHz) | 30 | 33.8-23.0 | 73.8-63.0 |
| 1.705-30.0 | 30 | 30 | 29.5 | 69.5 |
| 30-88 | 100 | 3 | 40.0 | 40.0 |
| 88-216 | 150 | 3 | 43.5 | 43.5 |
| 216-960 | 200 | 3 | 46.0 | 46.0 |
| Above 960 | 500 | 3 | 54.0 | 54.0 |

*The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector. For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

**Figure 33 Table of Limits**

## *9.3 Test Results*

JUDGEMENT: PASSED

The EUT met the requirements of the F.C.C. Part 15, Subpart C, 209 specifications.

The details of the highest emissions are given in *Figure 34*

# Radiated Emission

| | |
|---|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | Scala Rider FREECOM2 |
| Serial Number: | Not designated |

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical
Frequency range: 9KHz to 25.0 GHz
Test Distance: 3 meters
Detector: Peak

| Operation Frequency | Freq. | Polarity | Peak Reading | Average Limit | Peak Margin |
|---|---|---|---|---|---|
| (MHz) | (MHz) | (H/V) | (dBµV/m) | (dBµV/m) | (dB) |
| 2402.0 | 2390.0 | H | 36.7 | 54.0 | -17.3 |
| 2402.0 | 2390.0 | V | 37.2 | 54.0 | -16.8 |
| 2402.0 | 4804.0 | H | 42.0 | 54.0 | -12.0 |
| 2402.0 | 4804.0 | V | 43.0 | 54.0 | -11.0 |
| 2440.0 | 4880.0 | H | 43.6 | 54.0 | -10.4 |
| 2440.0 | 4880.0 | V | 43.1 | 54.0 | -10.9 |
| 2480.0 | 4960.0 | H | 44.0 | 54.0 | -10.0 |
| 2480.0 | 4960.0 | V | 42.2 | 54.0 | -11.8 |
| 2480.0 | 7440.0 | H | 50.0 | 54.0 | -4.0 |
| 2480.0 | 7440.0 | V | 49.6 | 54.0 | -4.4 |
| 2480.0 | 2483.5 | H | 34.3 | 54.0 | -19.7 |
| 2480.0 | 2483.5 | V | 34.0 | 54.0 | -20.0 |

**Figure 34. Radiated Emission. Antenna Polarization: HORIZONTAL / VERTICAL. Detector: Peak**

Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

"Peak Amp" includes correction factor.

* "Correction Factor" = Antenna Factor + Cable Loss- Low Noise Amplifier Gain

## 9.4 Test Instrumentation Used; Emissions in Restricted Frequency Bands

| Instrument | Manufacturer | Model | Serial No. | Last Calibration Date | Next Calibration Due |
|---|---|---|---|---|---|
| EMI Receiver | R&S | ESCI7 | 100724 | February 29, 2016 | March 1, 2017 |
| Spectrum Analyzer | HP | 8592L | 3826A01204 | March 13, 2016 | March 13, 2017 |
| EMI Receiver | HP | 8542E | 3906A00276 | March 3, 2016 | March 3, 2017 |
| RF Filter Section | HP | 85420E | 3705A00248 | March 3, 2016 | March 3, 2017 |
| Spectrum Analyzer | HP | 8564E | 3442A00275 | March 10, 2016 | March 10, 2017 |
| Biconical Antenna | EMCO | 3110B | 9912-3337 | March 24, 2016 | March 24, 2018 |
| Log Periodic Antenna | EMCO | 3146 | 9505-4081 | April 23, 2016 | April 23, 2017 |
| Horn Antenna | ETS | 3115 | 29845 | May 19, 2015 | May 19, 2018 |
| Active Loop Antenna | EMCO | 6502 | 9506-2950 | November 4, 2015 | November 30, 2016 |
| Low Noise Amplifier | Narda | DBS-0411N313 | 13 | August 8, 2016 | August 8, 2017 |
| Low Noise Amplifier | Sophia Wireless | LNA28-B | 232 | August 8, 2016 | August 8, 2017 |
| Spectrum Analyzer | HP | 8593EM | 3536A00120 ADI | March 10, 2016 | March 10, 2017 |
| Semi Anechoic Civil Chamber | ETS | S81 | SL 11643 | N/A | N/A |
| Antenna Mast | ETS | 2070-2 | 9608-1497 | N/A | N/A |
| Turntable | ETS | 2087 | - | N/A | N/A |
| Mast & Table Controller | ETS/EMCO | 2090 | 9608-1456 | N/A | N/A |

**Figure 35 Test Equipment Used**

# 10. AVG. Factor Calculation

1. Pulse period = 1msec (worst scenario)
2. Pulse duration = 1msec (worst scenario)
3. Burst duration = 0.3971msec
4. Time between bursts = 0.24msec
5. $$\text{Average Factor} = 20\log\left[\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{burst duration}}{100\text{msec}} \times \text{Num of burst within } 100\text{msec}\right]$$

$$\text{Average Factor} = 20\log\left[1 * \frac{0.397}{100} * 150\right] = -4.5dB$$

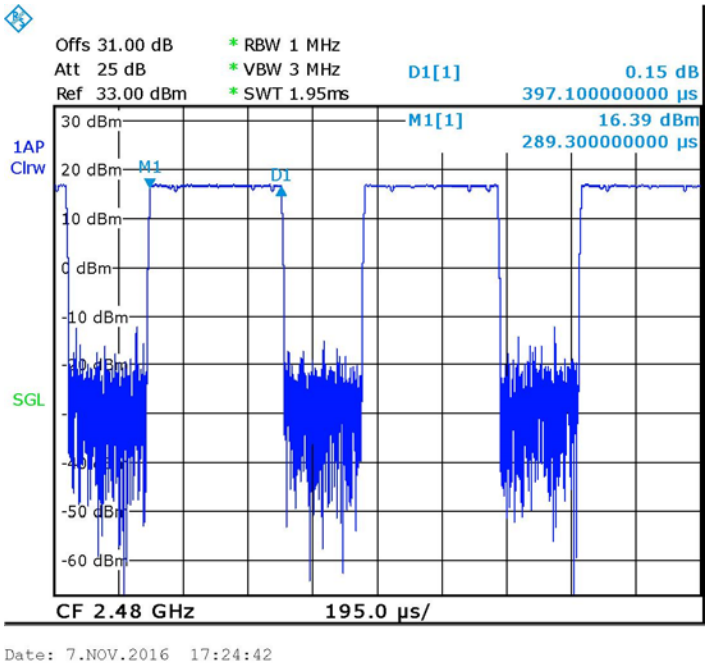



**Figure 36. Burst Duration**

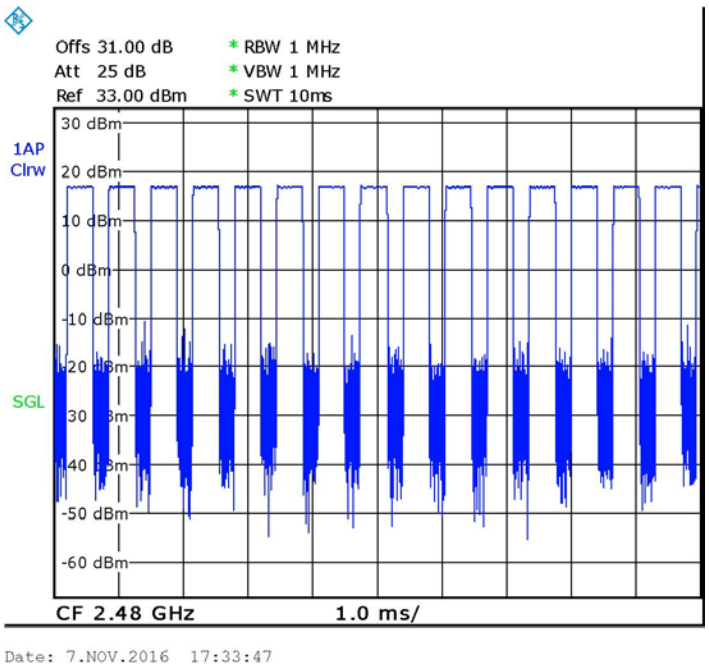



**Figure 37. Number of bursts in 10msec=15**

# 11. Antenna Gain/Information

The antenna gain is -2.0 dBi, integral.

# 12. R.F Exposure/Safety

The typical placement of the E.U.T. is on a motorcycle helmet. The typical distance between the E.U.T. and the user is 4cm. See photo on following page.

SAR Testing Exclusion Based on Section 4.3.1 and Appendix A of KDB447498 D01 V06 (Oct 23, 2015) and RSS 102, Issue 5, Section 2.5.2 Requirements

**For FCC**

Section 4.3.1 and Appendix A of KDB447498 D01 V06 was used as the guidance as follows:

Peak power output (standard) = 8.6 dBm=7.2mW.

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] *· [√f(GHz)]

=7.2/40 * 1.55=0.279 this value is less than 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR.

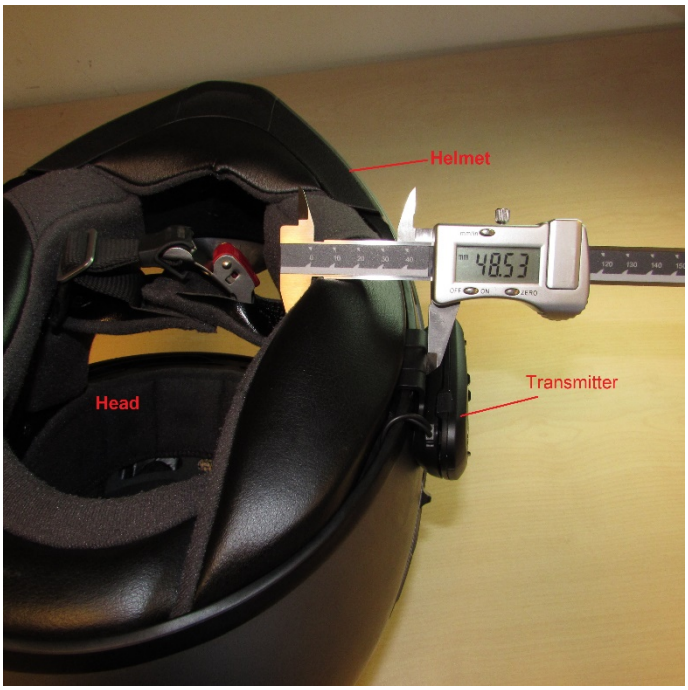
The SAR measurement is not necessary.

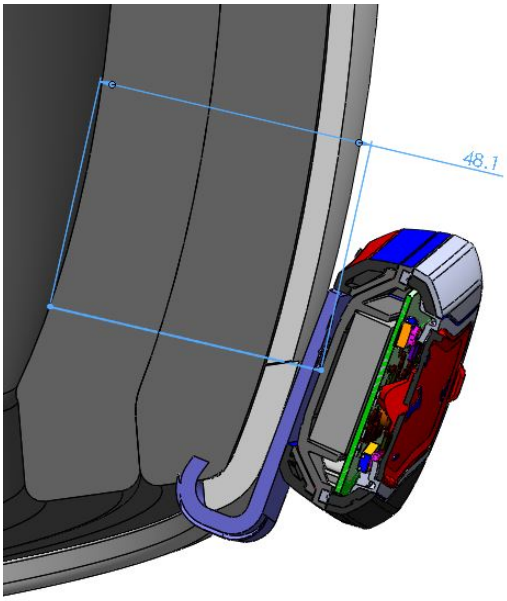
**For IC**

For IC per Table 1 of RSS 102 Issue 5, SAR exemption based on IC limit of 173.0mW at a separation distance of 40mm= 4.0cm at 2450 MHz.
EUT power transmission is 8.6 dBm=7.2mW.

7.2mW is below the 173.0mW SAR exemption limits.

See next page for photos.


Helmet
48.53
Head
Transmitter


48.1


48.1

# 13. APPENDIX A - CORRECTION FACTORS

## *13.1 Correction factors for CABLE from EMI receiver to test antenna at 3 meter range.*

| Frequency (MHz) | Cable Loss (dB) | Frequency (MHz) | Cable Loss (dB) |
|---|---|---|---|
| 0.010 | 0.4 | 50.00 | 1.2 |
| 0.015 | 0.2 | 100.00 | 0.7 |
| 0.020 | 0.2 | 150.00 | 2.1 |
| 0.030 | 0.3 | 200.00 | 2.3 |
| 0.050 | 0.3 | 300.00 | 2.9 |
| 0.075 | 0.3 | 500.00 | 3.8 |
| 0.100 | 0.2 | 750.00 | 4.8 |
| 0.150 | 0.2 | 1000.00 | 5.4 |
| 0.200 | 0.3 | 1500.00 | 6.7 |
| 0.500 | 0.4 | 2000.00 | 9.0 |
| 1.00 | 0.4 | 2500.00 | 9.4 |
| 1.50 | 0.5 | 3000.00 | 9.9 |
| 2.00 | 0.5 | 3500.00 | 10.2 |
| 5.00 | 0.6 | 4000.00 | 11.2 |
| 10.00 | 0.8 | 4500.00 | 12.1 |
| 15.00 | 0.9 | 5000.00 | 13.1 |
| 20.00 | 0.8 | 5500.00 | 13.5 |
| | | 6000.00 | 14.5 |

*NOTES:*

*1. The cable type is SPUMA400 RF-11N(X2) and 39m long*

*2. The cable is manufactured by Huber + Suhner*

## 13.2 Correction factor for RF CABLE for Semi Anechoic Chamber

| FREQ (MHz) | LOSS (dB) |
|---|---|
| 1000.0 | 1.5 |
| 2000.0 | 2.1 |
| 3000.0 | 2.7 |
| 4000.0 | 3.1 |
| 5000.0 | 3.5 |
| 6000.0 | 4.1 |
| 7000.0 | 4.6 |
| 8000.0 | 4.9 |
| 9000.0 | 5.7 |
| 10000.0 | 5.7 |
| 11000.0 | 6.1 |
| 12000.0 | 6.1 |
| 13000.0 | 6.2 |
| 14000.0 | 6.7 |
| 15000.0 | 7.4 |
| 16000.0 | 7.5 |
| 17000.0 | 7.9 |
| 18000.0 | 8.1 |
| 19000.0 | 8.8 |
| 20000.0 | 9.1 |

*NOTES:*

1. *The cable is manufactured by Commscope*
2. *The cable type is 0623 WBC-400, serial # G020132 and 10m long*
3. *ITL # 1840*

## *13.3 Correction factors for Low Loss CABLE*

### *Huber Suner #1696*
### *Serial No. 705A009301 EIM*

| FREQ (MHz) | INPUT (dBm) | OUTPUT (dBm) | LOSS (dB) |
|---|---|---|---|
| 1000.0 | -10 | -10.7 | 0.7 |
| 2000.0 | -10 | -10.7 | 0.7 |
| 3000.0 | -10 | -10.6 | 0.6 |
| 4000.0 | -10 | -10.5 | 0.5 |
| 5000.0 | -10 | -10.7 | 0.7 |
| 6000.0 | -10 | -10.8 | 0.8 |
| 7000.0 | -10 | -10.8 | 0.8 |
| 8000.0 | -10 | -11.0 | 1.0 |
| 9000.0 | -10 | -10.5 | 0.5 |
| 10000.0 | -10 | -10.3 | 0.3 |
| 11000.0 | -10 | -10.5 | 0.5 |
| 12000.0 | -10 | -11.3 | 1.3 |
| 13000.0 | -10 | -11.6 | 1.6 |
| 14000.0 | -10 | -11.8 | 1.8 |
| 15000.0 | -10 | -11.0 | 1.0 |
| 16000.0 | -10 | -10.6 | 0.6 |
| 17000.0 | -10 | -12.0 | 2.0 |
| 18000.0 | -10 | -11.6 | 1.6 |

## *13.4 Correction factors for ACTIVE LOOP ANTENNA*

## Model 6502
## S/N 9506-2950

| f(MHz) | MAF(dBs/m) | AF(dB/m) |
|---|---|---|
| 0.01 | -33.1 | 18.4 |
| 0.02 | -37.2 | 14.3 |
| 0.03 | -38.2 | 13.3 |
| 0.05 | -39.8 | 11.7 |
| 0.1 | -40.1 | 11.4 |
| 0.2 | -40.3 | 11.2 |
| 0.3 | -40.3 | 11.2 |
| 0.5 | -40.3 | 11.2 |
| 0.7 | -40.3 | 11.2 |
| 1 | -40.1 | 11.4 |
| 2 | -40 | 11.5 |
| 3 | -40 | 11.5 |
| 4 | -40.1 | 11.4 |
| 5 | -40.2 | 11.3 |
| 6 | -40.4 | 11.1 |
| 7 | -40.4 | 11.1 |
| 8 | -40.4 | 11.1 |
| 9 | -40.5 | 11 |
| 10 | -40.5 | 11 |
| 20 | -41.5 | 10 |
| 30 | -43.5 | 8 |

## *13.5 Correction factors for Biconical Antenna EMCO, Model 3110B, Serial #9912-3337*

| Frequency [MHz] | AF [dB/m] |
|---|---|
| 30.0 | 14.18 |
| 35.0 | 13.95 |
| 40.0 | 12.84 |
| 45.0 | 11.23 |
| 50.0 | 11.10 |
| 60.0 | 10.39 |
| 70.0 | 9.34 |
| 80.0 | 9.02 |
| 90.0 | 9.31 |
| 100.0 | 8.95 |
| 120.0 | 11.53 |
| 140.0 | 12.20 |
| 160.0 | 12.56 |
| 180.0 | 13.49 |
| 200.0 | 15.27 |

## *13.6 Correction factors for Log Periodic Antenna EMCO, Model 3146, Serial #9505-4081*

| Frequency [MHz] | AF [dB/m] |
|---|---|
| 200.0 | 11.47 |
| 250.0 | 12.06 |
| 300.0 | 14.77 |
| 400.0 | 15.77 |
| 500.0 | 18.01 |
| 600.0 | 18.84 |
| 700.0 | 20.93 |
| 800.0 | 21.27 |
| 900.0 | 22.44 |
| 1000.0 | 24.10 |

## *13.7 Correction factors for Horn ANTENNA.*

***Model: 3115***

***Antenna serial number: 29845***

**3 meter range**

| f(GHz) | AF(dB/m) | GA(dB) |
|---|---|---|
| 0.75 | 25 | 3 |
| 1G | 23.5 | 7 |
| 1.5G | 26 | 8 |
| 2G | 29 | 7 |
| 2.5G | 27.5 | 10 |
| 3G | 30 | 10 |
| 3.5G | 31.5 | 10 |
| 4G | 32.5 | 9.5 |
| 4.5G | 32.5 | 10.5 |
| 5G | 33 | 10.5 |
| 5.5G | 35 | 10.5 |
| 6G | 36.5 | 9.5 |
| 6.5G | 36.5 | 10 |
| 7G | 37.5 | 10 |
| 7.5G | 37.5 | 10 |
| 8G | 37.5 | 11 |
| 8.5G | 38 | 11 |
| 9G | 37.5 | 11.5 |
| 9.5G | 38 | 11.5 |
| 10G | 38.5 | 11.5 |
| 10.5G | 38.5 | 12 |
| 11G | 38.5 | 12.5 |
| 11.5G | 38.5 | 13 |
| 12G | 38 | 13.5 |
| 12.5G | 38.5 | 13 |
| 13G | 40 | 12 |
| 13.5G | 41 | 12 |
| 14G | 40 | 13 |
| 14.5G | 39 | 14 |
| 15G | 38 | 15.5 |
| 15.5G | 37.5 | 16 |
| 16G | 37.5 | 16 |
| 16.5G | 39 | 15 |
| 17G | 40 | 15 |
| 17.5G | 42 | 13.5 |
| 18G | 42.5 | 13 |