



DATE: 27 April 2017

I.T.L. (PRODUCT TESTING) LTD. IC/FCC Radio Test Report

For

Cardo Systems, Inc.

Equipment under test:

Bluetooth Communication System for Motorcycles

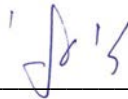
**cardo SMARTH
(2.4 GHz Bluetooth Standard/EDR)**

Tested by:



A. Yizhak

Approved by:



For: D. Shidlowsky

This report must not be reproduced, except in full, without the written
permission of I.T.L. (Product Testing) Ltd.

This report relates only to items tested.



Bluetooth Communication System for Motorcycles

FCC ID: Q95ER21

Applicant for this device:
(different from "prepared by")
Avi Moato
Cardo Systems Inc.
1204 Parkway View Drive
Pittsburgh, Pennsylvania, USA, 15205
Tel: +972-3-7353111
Fax: +972-3-5623360
Email: moato@cardosystems.com



TABLE OF CONTENTS

| | | |
|-----------|--|-----------|
| 1. | GENERAL INFORMATION | 5 |
| 1.1 | Administrative Information | 5 |
| 1.2 | List of Accreditations | 6 |
| 1.3 | Product Description | 7 |
| 1.4 | Test Methodology | 7 |
| 1.5 | Test Facility | 7 |
| 1.6 | Measurement Uncertainty | 7 |
| 2. | SYSTEM TEST CONFIGURATION | 8 |
| 2.1 | Justification | 8 |
| 2.2 | EUT Exercise Software | 8 |
| 2.3 | Special Accessories | 8 |
| 2.4 | Equipment Modifications | 8 |
| 2.5 | Configuration of Tested System | 8 |
| 3. | CONDUCTED & RADIATED MEASUREMENT TEST SET-UP PHOTOS | 10 |
| 4. | CONDUCTED EMISSION FROM AC MAINS | 13 |
| 4.1 | Test Specification | 13 |
| 4.2 | Test Procedure | 13 |
| 4.3 | Test Limit | 13 |
| 4.4 | Test Results | 14 |
| 4.5 | Test Equipment Used; Conducted Emission | 19 |
| 5. | 20DB MINIMUM BANDWIDTH | 20 |
| 5.1 | Test Specification | 20 |
| 5.2 | Test Procedure | 20 |
| 5.3 | Test Limit | 20 |
| 5.4 | Test Results | 20 |
| 5.5 | Test Equipment Used, 20 dB Minimum Bandwidth | 24 |
| 6. | 26DB MINIMUM BANDWIDTH | 25 |
| 6.1 | Test Specification | 25 |
| 6.2 | Test Procedure | 25 |
| 6.3 | Test Limit | 25 |
| 6.4 | Test Results | 25 |
| 6.5 | Test Equipment Used, 26 dB Minimum Bandwidth | 29 |
| 7. | NUMBER OF HOPPING FREQUENCIES | 30 |
| 7.1 | Test Specification | 30 |
| 7.2 | Test Procedure | 30 |
| 7.3 | Test Limit | 30 |
| 7.4 | Test Results | 30 |
| 7.5 | Test Equipment Used, Number of Hopping Frequencies | 37 |
| 8. | CHANNEL FREQUENCY SEPARATION | 38 |
| 8.1 | Test Specification | 38 |
| 8.2 | Test Procedure | 38 |
| 8.3 | Test Limit | 38 |
| 8.4 | Test Results | 38 |
| 8.5 | Test Equipment Used, Channel Frequency Separation Test | 40 |
| 9. | PEAK OUTPUT POWER | 41 |
| 9.1 | Test Specification | 41 |
| 9.2 | Test Procedure | 41 |
| 9.3 | Test Limit | 41 |
| 9.4 | Test Results | 41 |
| 9.5 | Test Equipment Used, Radiated Maximum Power Output | 45 |



| | | |
|------------|--|-----------|
| 10. | DWELL TIME ON EACH CHANNEL | 46 |
| 10.1 | Test Specification | 46 |
| 10.2 | Test Procedure | 46 |
| 10.3 | Test Limit | 46 |
| 10.4 | Test Results | 46 |
| 10.5 | Test Equipment Used, Dwell Time on Each Channel | 49 |
| 11. | BAND EDGE | 50 |
| 11.1 | Test Specification | 50 |
| 11.2 | Test Procedure | 50 |
| 11.3 | Test Limit | 50 |
| 11.4 | Test Results | 51 |
| 11.5 | Test Equipment Used, Band Edge Spectrum | 56 |
| 12. | EMISSIONS IN NON-RESTRICTED FREQUENCY BANDS | 57 |
| 12.1 | Test Specification | 57 |
| 12.2 | Test Procedure | 57 |
| 12.3 | Test Limit | 57 |
| 12.4 | Test Results | 57 |
| 12.5 | Test Equipment Used, Emissions in Non-Restricted Frequency Bands | 60 |
| 13. | EMISSIONS IN RESTRICTED FREQUENCY BANDS | 61 |
| 13.1 | Test Specification | 61 |
| 13.2 | Test Procedure | 61 |
| 13.3 | Test Limit | 62 |
| 13.4 | Test Results | 62 |
| 13.5 | Field Strength Calculation | 67 |
| 13.6 | Test Equipment Used, Emissions in Restricted Frequency Bands | 68 |
| 14. | AVG. FACTOR CALCULATION | 69 |
| 14.1 | Test Equipment Used, Average Factor | 71 |
| 15. | ANTENNA GAIN/INFORMATION | 72 |
| 16. | R.F EXPOSURE/SAFETY | 73 |
| 17. | APPENDIX A - CORRECTION FACTORS | 74 |
| 17.1 | Correction factors for RF OATS Cable 35m | 74 |
| 17.2 | Correction factors for RF OATS Cable 10m | 75 |
| 17.3 | Correction factor for RF CABLE for Semi Anechoic Chamber | 76 |
| 17.4 | Correction factors for biconical antenna – ITL # 1356 | 77 |
| 17.5 | Correction factors for log periodic antenna – ITL # 1349 | 78 |
| 17.6 | Correction factors for ACTIVE LOOP ANTENNA ITL # 1075: | 79 |
| 17.7 | Correction factors for Horn ANTENNA | 80 |



1. General Information

1.1 Administrative Information

| | |
|--------------------------------|---|
| Manufacturer: | Cardo Systems, Inc. |
| Manufacturer's Address: | 1204 Parkway View Drive Pittsburgh, Pennsylvania, 15205 USA Tel: +972-3-735-3111 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): | cardo SMARTH |
| Equipment Serial No.: | Not designated |
| HVIN: | 3 |
| Date of Receipt of E.U.T: | November 1, 2016 |
| Start of Test: | November 2, 2016 |
| End of Test: | November 23, 2016 |
| Test Laboratory Location: | I.T.L (Product Testing) Ltd. 1 Batsheva St., Lod ISRAEL 7120101 |
| Test Specifications: | FCC Part 15, Subpart C, Section 15.247 RSS 247, Issue 1: 2015 RSS Gen, Issue 4: 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. The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) (Japan), Registration Numbers: C-3006, R-2729, T-1877, G-2245.
5. 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

EUT is a class 1 Bluetooth headset, Bluetooth intercom for motorbikes and FM radio receiver.

| | |
|---------------------------|---------------------------------|
| PMN | Cardo SMARTH |
| Working voltage | Li Polymer battery 600mA 4.2V |
| Mode of operation | Transmission |
| Modulation | Bluetooth Ver. 3.0, EDR class 1 |
| Assigned Frequency Range | 2400-2483.5MHz |
| Operating Frequency Range | 2402-2480MHz |
| Transmit power | ~18dBm |
| Antenna Gain | 1.7dBi |

1.4 Test Methodology

Radiated testing was performed according to the procedures in FCC Public Notice DA 00-705 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

Conducted Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4)
0.15 – 30 MHz:

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

± 3.6 dB

Radiated Emission

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

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

± 4.96 dB

2. System Test Configuration

2.1 Justification

Exploratory emission testing was performed in 3 orthogonal polarities to determine the “worst case” polarity for full testing. (Pursuant to OET Knowledge Base Inquiry Confirmation, Tracking Number 688137.) Based on the below results the X axis was the “worst case”.

| Frequency | X | | | | Y | | | | Z | | | |
|-----------|----------------|-------------------|-------------------|-----------|----------------|-------------------|-------------------|-----------|----------------|-------------------|-------------------|-----------|
| | Field Strength | 2 rd H | 3 th H | Band Edge | Field Strength | 2 rd H | 3 th H | Band Edge | Field Strength | 2 rd H | 3 th H | Band Edge |
| | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dBuV/m) |
| 2402.0 | 103.8 | 57.7 | 62.0 | 52.2 | 100.2 | 62.4 | 58.1 | 51.9 | 99.4 | 57.4 | 60.3 | 51.9 |
| 2441.0 | 104.8 | 63.8 | 64.6 | - | 100.1 | 64.9 | 62.0 | - | 99.9 | 57.0 | 63.9 | - |
| 2480.0 | 103.5 | 68.8 | 69.0 | 50.1 | 99.5 | 64.5 | 60.0 | 50.1 | 100.2 | 66.9 | 70.5 | 50.1 |

Figure 1. Screening Results

The E.U.T. was evaluated when transmitting at the Low (2402MHz), Mid (2441MHz) and High (2480MHz) channels in the installation position. 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 in order to achieve compliance.

2.4 Equipment Modifications

No modifications were needed in order to achieve compliance.

2.5 Configuration of Tested System



Figure 2. Configuration of Tested System – Conducted Emission on Antenna Ports

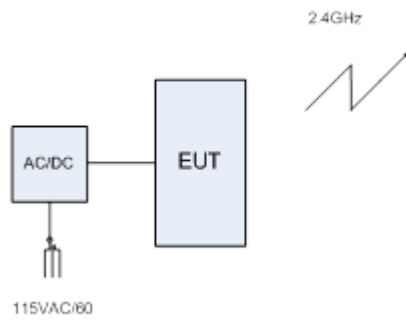


Figure 3. Configuration of Tested System – Conducted Emission on AC Line

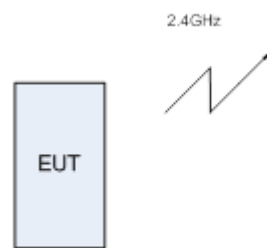


Figure 4. . Configuration of Tested System – Radiated Emission

3. Conducted & Radiated Measurement Test Set-Up Photos



Figure 5. Conducted Emission From Antenna Ports Test



Figure 6. Conducted Emission From AC Mains

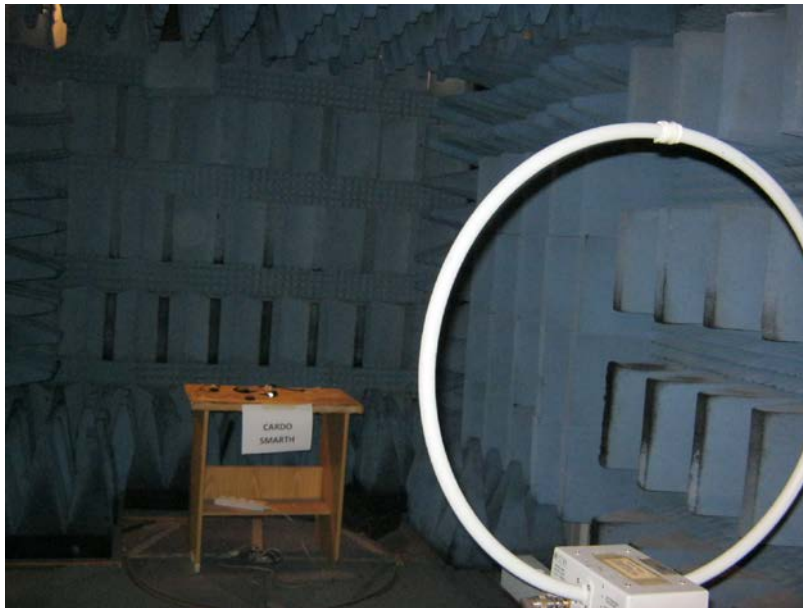


Figure 7. Radiated Emission Test



Figure 8. Radiated Emission Test



Figure 9. Radiated Emission Test

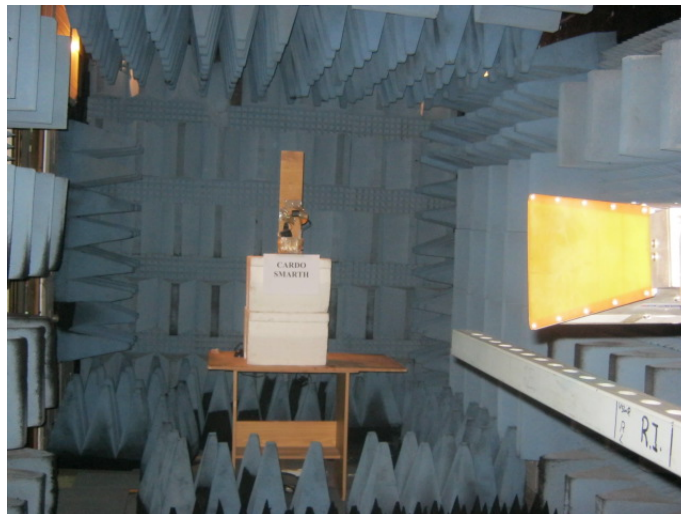


Figure 10. Radiated Emission Test Above 1GHz



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 μ Hn 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 6. 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 (dB μ V) | |
|-----------------------------|------------------------------|-----------|
| | 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 24.92 dB

The margin between the emission levels and the specification limit is, in the worst case, 24.92 dB for the phase line at 17.78 MHz and 25.35 dB at 17.78 MHz for the neutral line.

The EUT met the F.C.C. Part 15, Subpart C specification requirements.

The details of the highest emissions are given in *Figure 11* to *Figure 14*.



Conducted Emission

E.U.T Description Bluetooth
Communication
System for
Motorcycles
Type cardo SMARTH
Serial Number: Not designated

Specification: FCC Part 15, Subpart C
Lead: Phase
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 |
| 1 Quasi Peak | 770 kHz | 25.26 | -30.73 |
| 2 Average | 770 kHz | 19.10 | -26.89 |
| 1 Quasi Peak | 790 kHz | 20.75 | -35.24 |
| 2 Average | 790 kHz | 14.88 | -31.11 |
| 1 Quasi Peak | 890 kHz | 22.99 | -33.00 |
| 2 Average | 890 kHz | 18.17 | -27.82 |
| 1 Quasi Peak | 914 kHz | 21.08 | -34.91 |
| 2 Average | 914 kHz | 15.26 | -30.73 |
| 1 Quasi Peak | 962 kHz | 20.35 | -35.65 |
| 2 Average | 966 kHz | 15.71 | -30.28 |
| 1 Quasi Peak | 1.542 MHz | 20.56 | -35.43 |
| 1 Quasi Peak | 10.742 MHz | 10.71 | -49.28 |
| 2 Average | 13.334 MHz | 20.92 | -29.07 |
| 1 Quasi Peak | 17.778 MHz | 25.54 | -34.45 |
| 2 Average | 17.778 MHz | 25.07 | -24.92 |
| 2 Average | 22.222 MHz | 20.79 | -29.20 |
| 2 Average | 22.906 MHz | 23.89 | -26.10 |
| 1 Quasi Peak | 23.138 MHz | 28.93 | -31.07 |
| 1 Quasi Peak | 24.494 MHz | 19.50 | -40.49 |
| 2 Average | 26.666 MHz | 19.05 | -30.94 |

Date: 16.NOV.2016 12:19:04

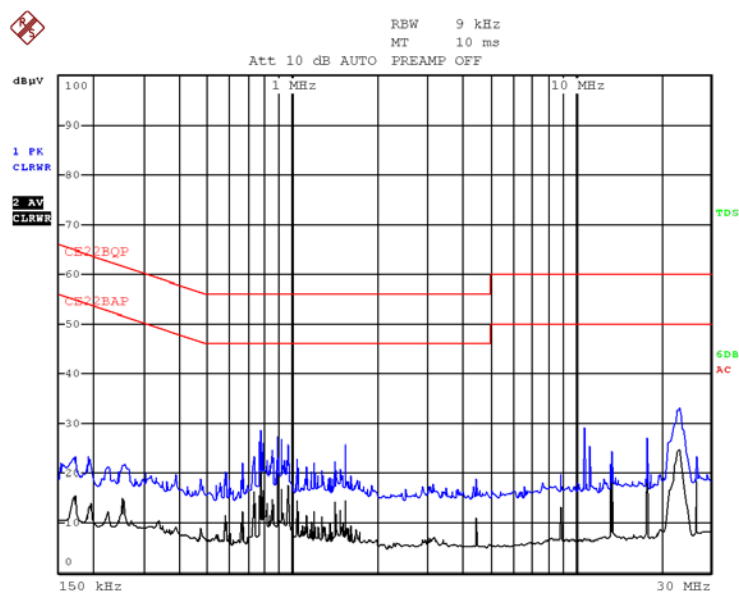
Figure 11. Detectors: Peak, Quasi-peak, Average

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 | cardo SMARTH |
| Serial Number: | Not designated |

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



Date: 16.NOV.2016 12:17:58

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



Conducted Emission

E.U.T Description Bluetooth
Communication System
for Motorcycles
Type cardo SMARTH
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 | 254 kHz | 14.70 | -36.92 |
| 1 | Quasi Peak | 262 kHz | 15.39 | -45.97 |
| 1 | Quasi Peak | 770 kHz | 22.94 | -33.05 |
| 2 | Average | 770 kHz | 16.96 | -29.03 |
| 1 | Quasi Peak | 890 kHz | 20.73 | -35.26 |
| 2 | Average | 890 kHz | 16.01 | -29.99 |
| 1 | Quasi Peak | 914 kHz | 18.99 | -37.00 |
| 2 | Average | 962 kHz | 13.80 | -32.19 |
| 1 | Quasi Peak | 4.446 MHz | 18.87 | -37.12 |
| 2 | Average | 4.446 MHz | 16.91 | -29.08 |
| 1 | Quasi Peak | 13.334 MHz | 22.65 | -37.34 |
| 2 | Average | 13.334 MHz | 21.65 | -28.34 |
| 1 | Quasi Peak | 17.778 MHz | 25.16 | -34.83 |
| 2 | Average | 17.778 MHz | 24.64 | -25.35 |
| 1 | Quasi Peak | 21.902 MHz | 14.86 | -45.13 |
| 2 | Average | 22.222 MHz | 21.05 | -28.94 |
| 2 | Average | 23.33 MHz | 10.31 | -39.68 |
| 1 | Quasi Peak | 23.486 MHz | 17.34 | -42.65 |
| 1 | Quasi Peak | 26.666 MHz | 22.81 | -37.18 |
| 2 | Average | 26.666 MHz | 20.53 | -29.47 |

Date: 16.NOV.2016 12:24:16

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

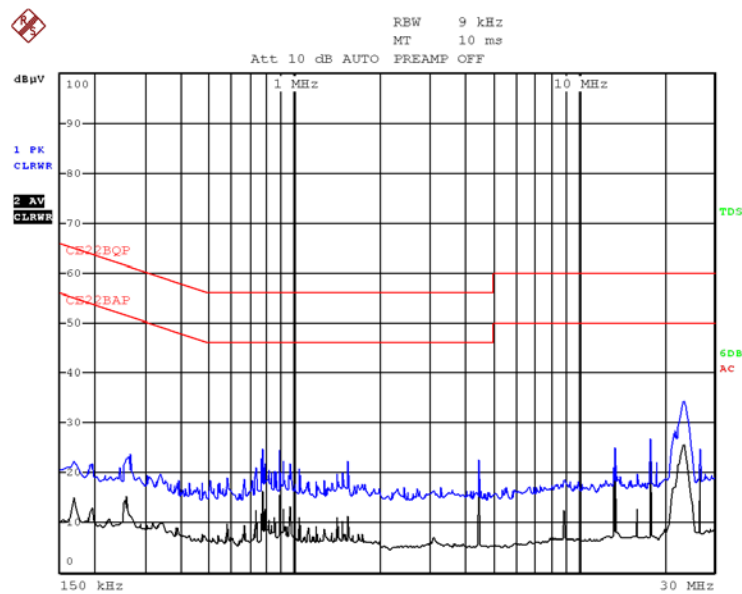
Note: QP Delta/Av Delta refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.



Conducted Emission

| | |
|-------------------|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | cardo SMARTH |
| Serial Number: | Not designated |

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



Date: 16.NOV.2016 12:23:19

Figure 14 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 Suner | | 705A009301 EIM | May 30, 2016 | May 30, 2017 |

Figure 15 Test Equipment Used



5. 20dB Minimum Bandwidth

5.1 Test Specification

F.C.C. Part 15, Subpart C: section 15.247(a)(1)
RSS 247 Section 5.1(1)

5.2 Test Procedure

(Temperature (22°C)/ Humidity (41%RH))

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable. The transmitter unit operated with normal modulation. The spectrum analyzer was set to the following parameters:

Span = ~ 2 to 3 times the 20 dB bandwidth, centered on a hopping channel RBW \geq 1% of the 20 dB bandwidth

Detector Function: Peak, Trace: Maximum Hold.

The E.U.T. was tested at Low, Mid and High channels.

5.3 Test Limit

N/A

5.4 Test Results

| Operation Frequency (MHz) | Modulation | Bandwidth Reading (MHz) |
|------------------------------|------------|----------------------------|
| 2402 | Standard | 1.114 |
| 2441 | Standard | 1.102 |
| 2480 | Standard | 1.102 |
| 2402 | EDR | 1.389 |
| 2441 | EDR | 1.389 |
| 2480 | EDR | 1.401 |

Figure 16 — Test Results

JUDGEMENT: Passed

For additional information see *Figure 17* to *Figure 22*.

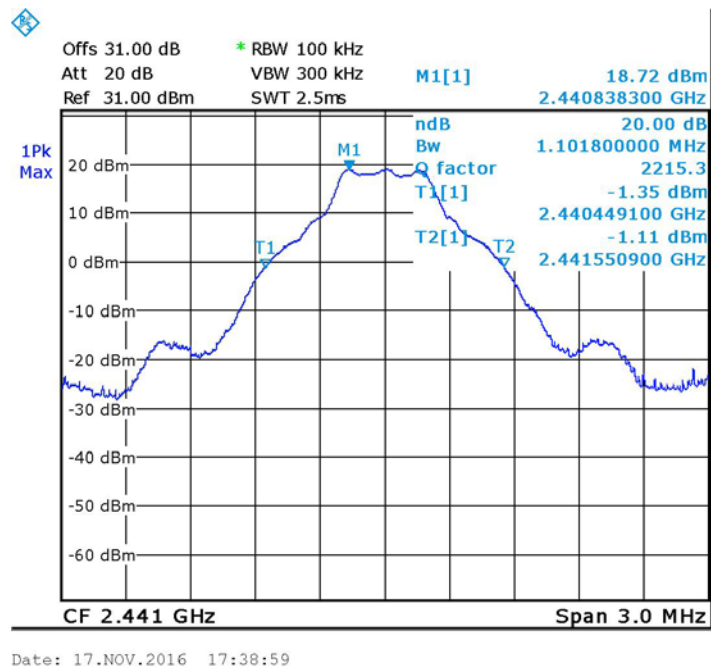


Figure 17. —2402 MHz – Low Standard Modulation

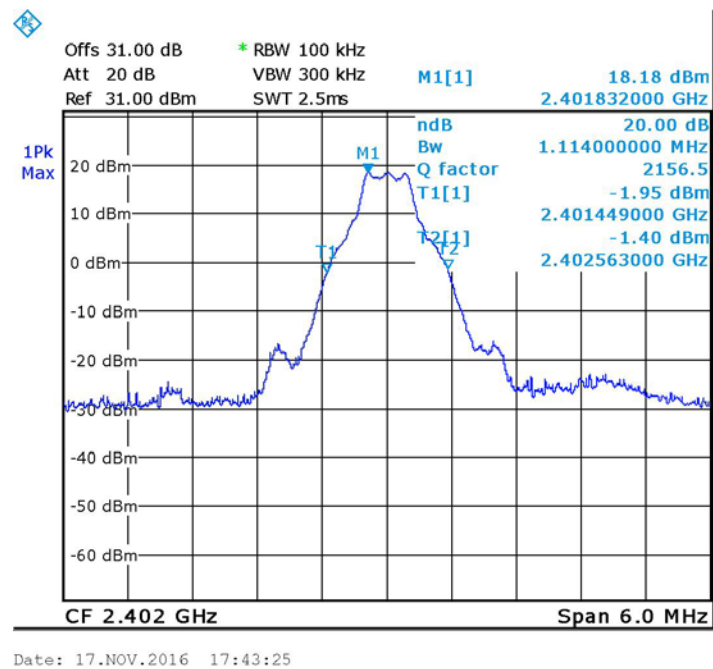


Figure 18. 2441 MHz - Mid Standard Modulation

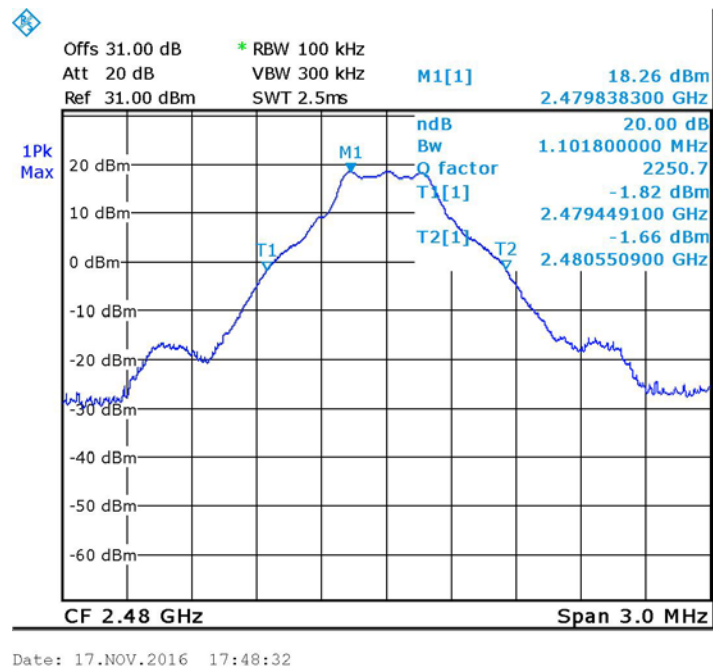


Figure 19. 2480- High Standard Modulation

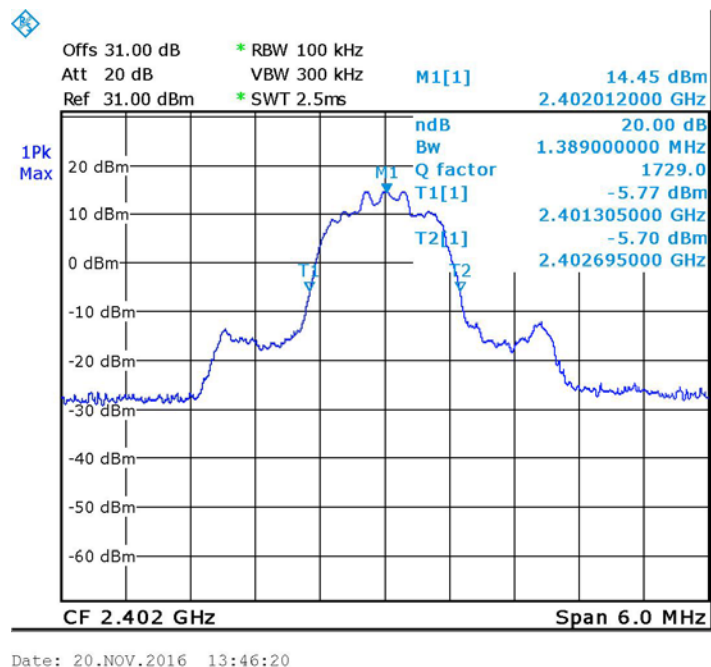


Figure 20. —2402 MHz – Low EDR Modulation

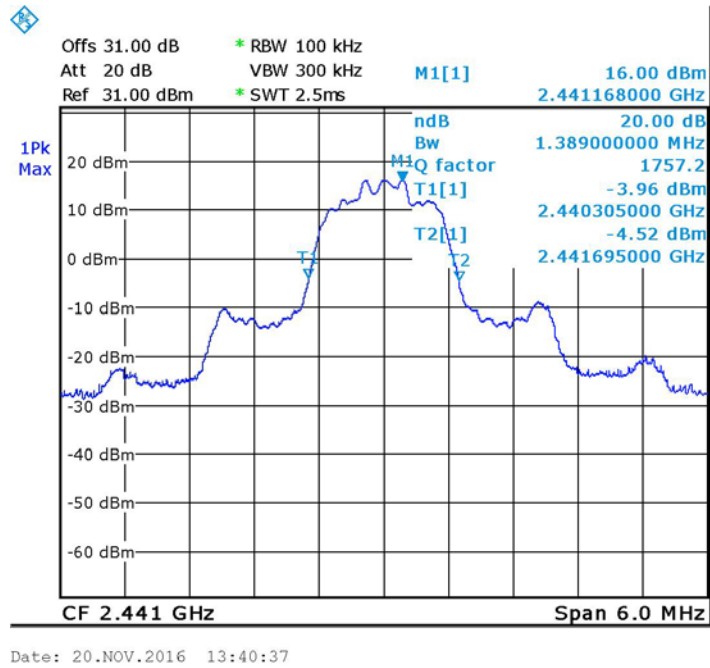


Figure 21. 2441 MHz - Mid EDR Modulation

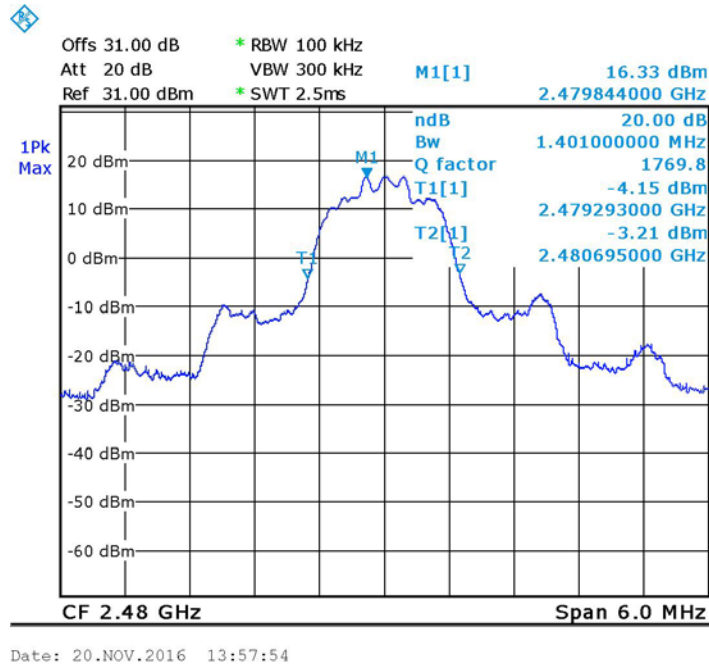


Figure 22. 2480- High EDR Modulation



5.5 Test Equipment Used, 20 dB Minimum Bandwidth

| 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 | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 23 Test Equipment Used



6. 26dB Minimum Bandwidth

6.1 Test Specification

F.C.C. Part 15, Subpart C, Section 15.247(a)
RSS Gen, Issue 4: 2014, Section 6.6

6.2 Test Procedure

(Temperature (24°C)/ Humidity (41%RH))

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable. The transmitter unit operated with normal modulation. The spectrum analyzer was set to the following parameters:

Span = ~ 2 to 3 times the 20 dB bandwidth, centered on a hopping channel RBW \geq 1% of the 20 dB bandwidth

Detector Function: Peak, Trace: Maximum Hold.

The E.U.T. was tested at Low, Mid and High channels.

6.3 Test Limit

N/A

6.4 Test Results

| Operation Frequency (MHz) | Modulation | Bandwidth Reading (MHz) |
|------------------------------|------------|----------------------------|
| 2402 | Standard | 1.281 |
| 2441 | Standard | 1.281 |
| 2480 | Standard | 1.269 |
| 2402 | EDR | 1.485 |
| 2441 | EDR | 1.533 |
| 2480 | EDR | 1.605 |

Figure 24 — Test Results

JUDGEMENT: Passed

For additional information see *Figure 25 to Figure 30*.

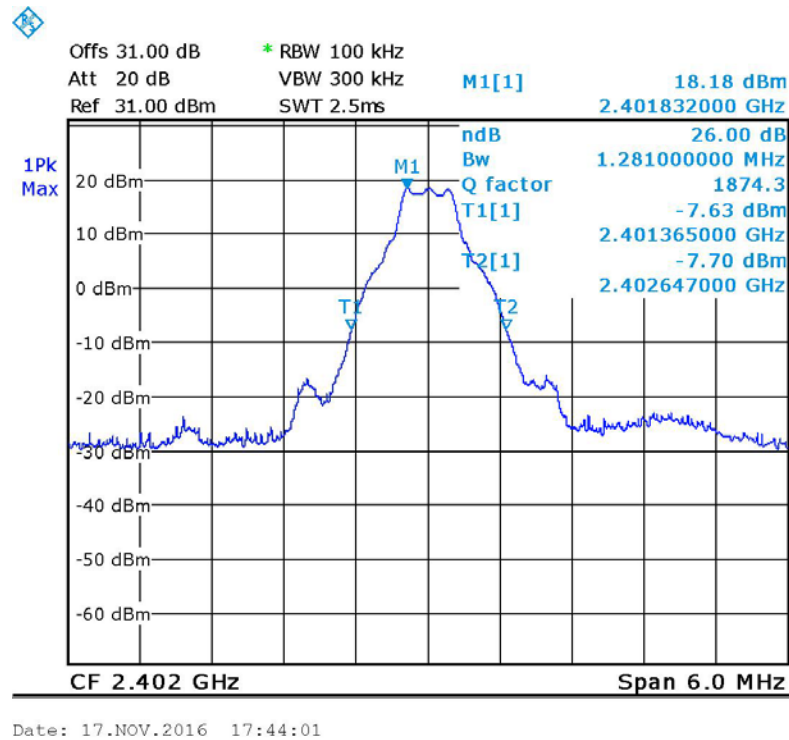


Figure 25. —2402 MHz - Low Standard Modulation

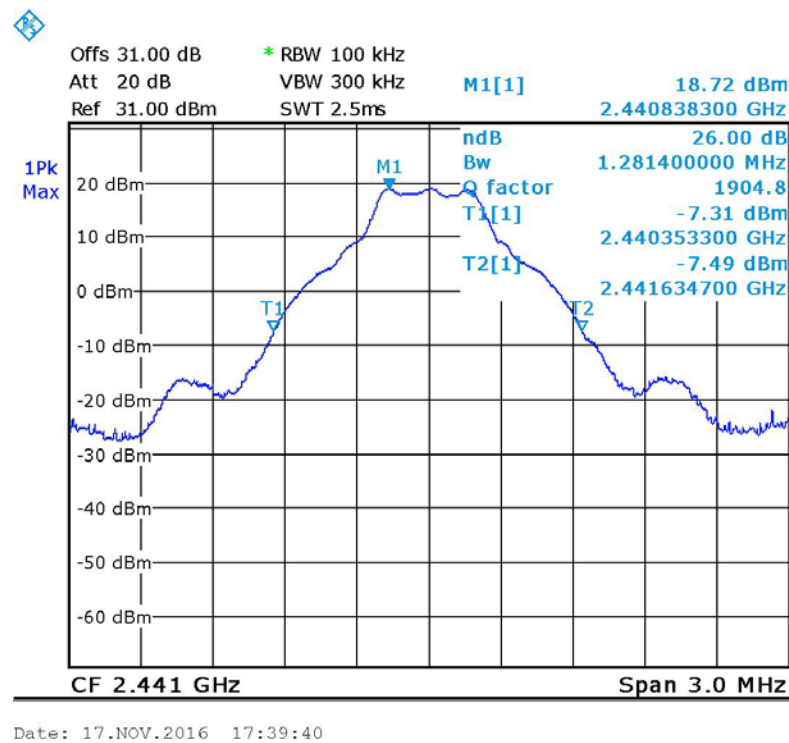


Figure 26. 2441 MHz - Mid Standard Modulation

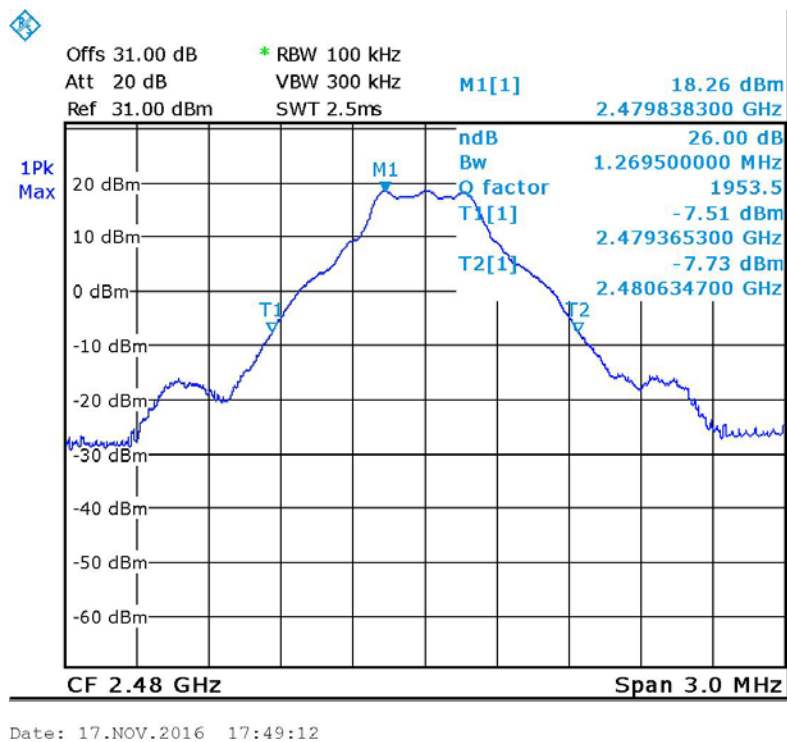


Figure 27. 2480- High Standard Modulation

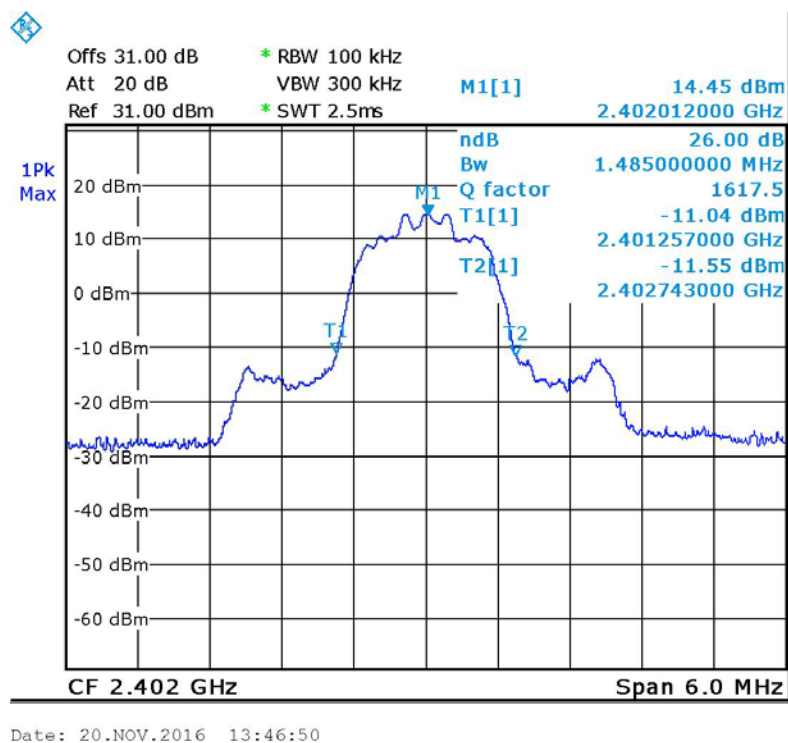


Figure 28. —2402 MHz - Low EDR Modulation

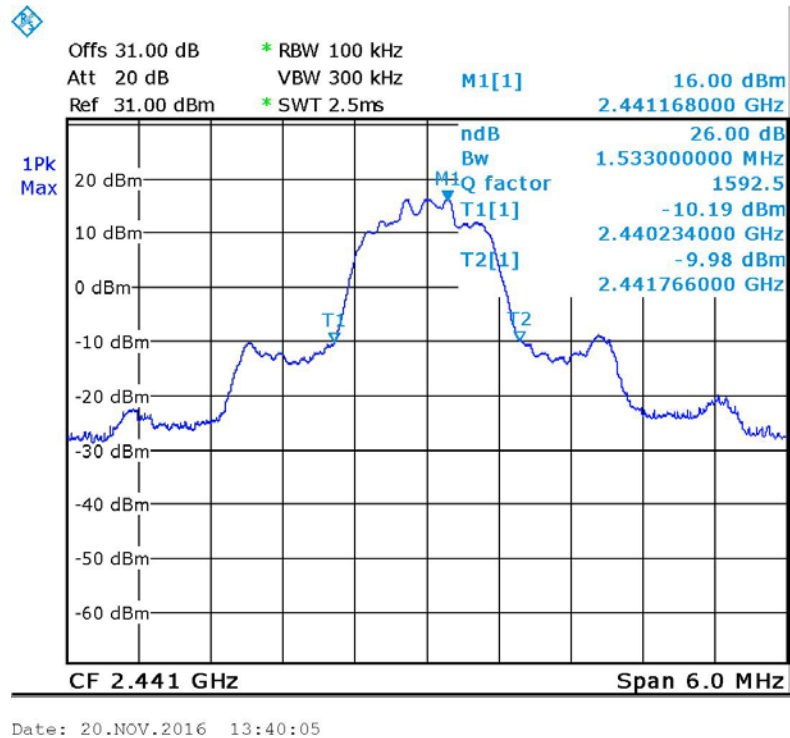


Figure 29. 2441 MHz - Mid EDR Modulation

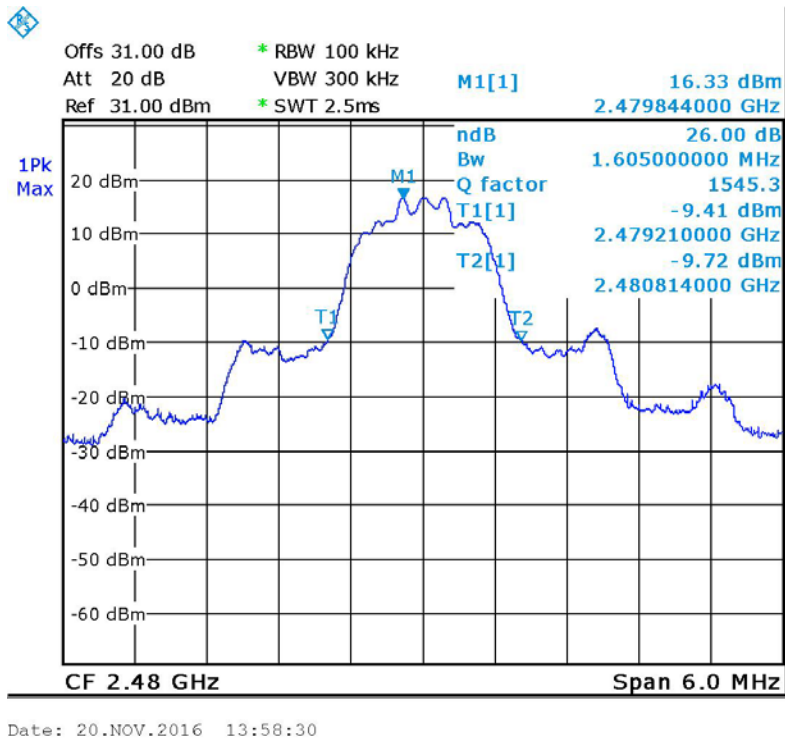


Figure 30. 2480- High EDR Modulation



6.5 Test Equipment Used, 26 dB Minimum Bandwidth

| 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 | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 31 Test Equipment Used



7. Number of Hopping Frequencies

7.1 Test Specification

F.C.C., Part 15, Subpart C Section 15.247(a)(1)(iii)

RSS Section 5.1(4)

7.2 Test Procedure

(Temperature (23°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 E.U.T. was set to hopping mode.

The spectrum analyzer was set to the following parameters:

Band of Operation: 2400M-2483.5 MHz

RBW: 30 kHz, VBW: 100 kHz

Detector Function: Peak, Trace: Maximum Hold

7.3 Test Limit

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

7.4 Test Results

| Number of Hopping Frequencies | Specification |
|-------------------------------|---------------|
| 79 | ≥ 75 |

Figure 32 Test Results

JUDGEMENT: Passed

For additional information see *Figure 33* to *Figure 38*.

Number of Hopping Frequencies

E.U.T Description Bluetooth Communication System
for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

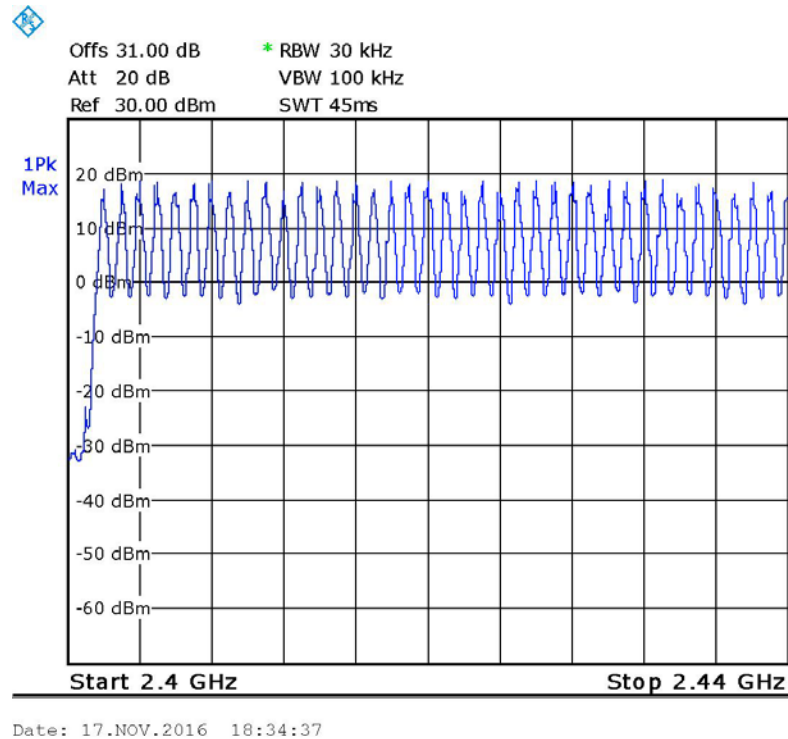


Figure 33. Number of Channels Standard Modulation = 39



Number of Hopping Frequencies

| | |
|-------------------|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | cardo SMARTH |
| Serial Number: | Not designated |

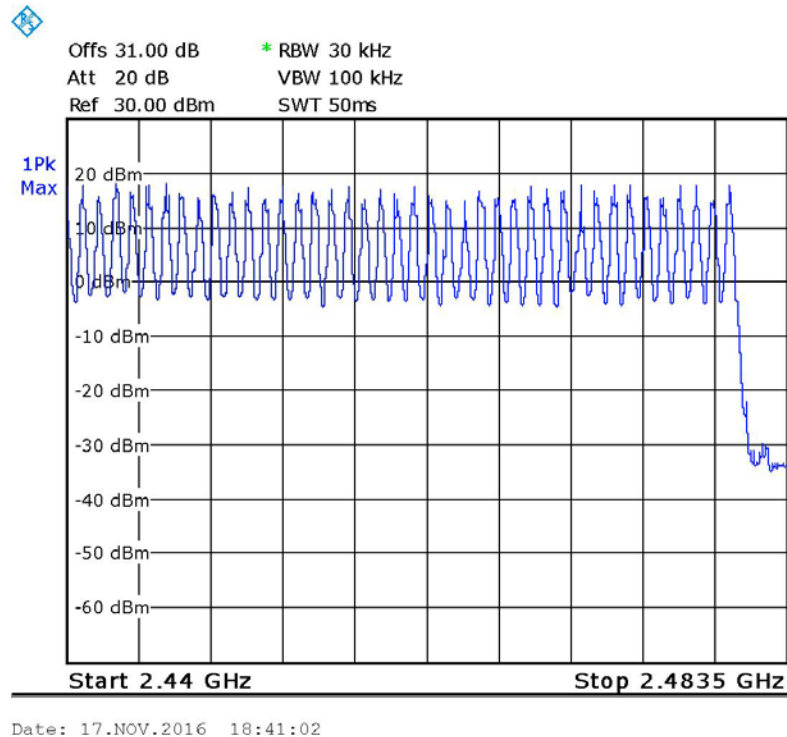


Figure 34. Number of Channels Standard Modulation=40

Number of Hopping Frequencies

E.U.T Description Bluetooth Communication System
for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

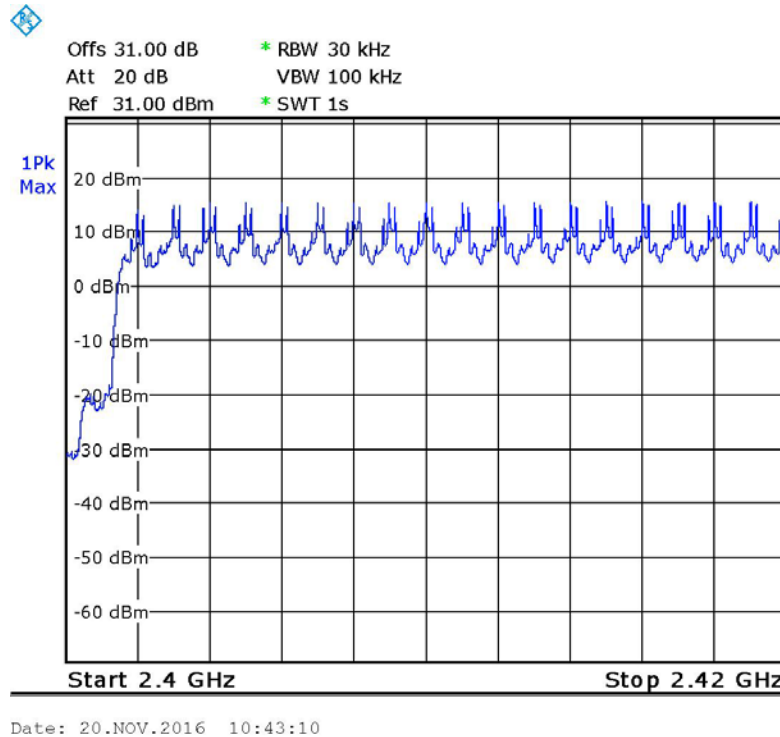
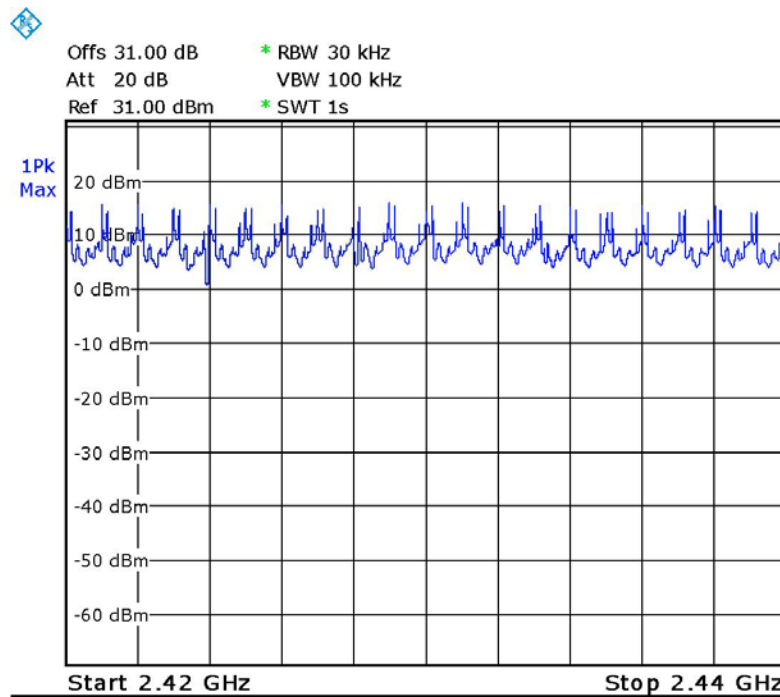


Figure 35. Number of Channels EDR Modulation=19



Number of Hopping Frequencies

| | |
|-------------------|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | cardo SMARTH |
| Serial Number: | Not designated |



Date: 20.NOV.2016 11:07:41

Figure 36. Number of Channels EDR Modulation=20



Number of Hopping Frequencies

| | |
|-------------------|---|
| E.U.T Description | Bluetooth Communication System for Motorcycles |
| Type | cardo SMARTH |
| Serial Number: | Not designated |

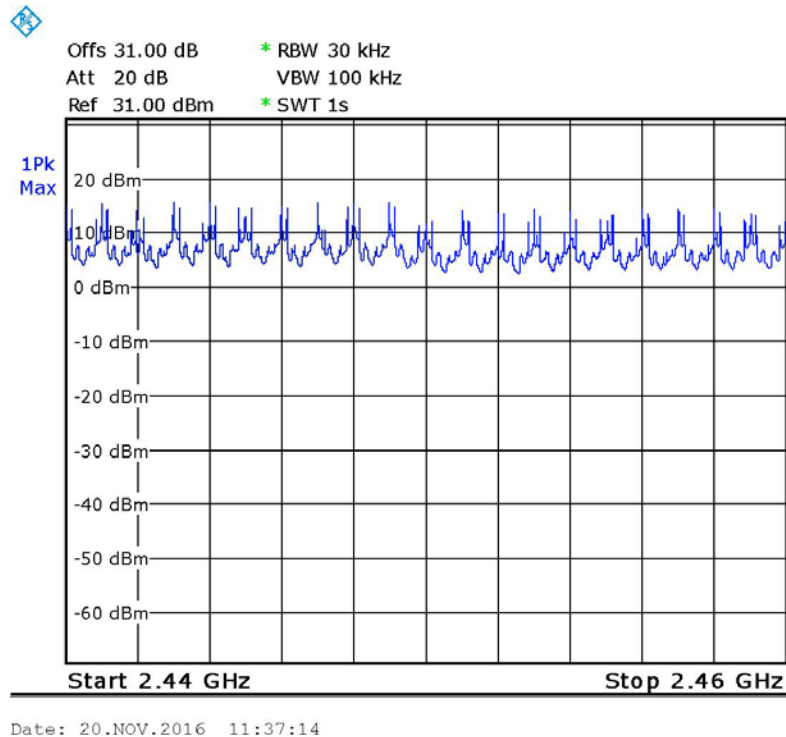
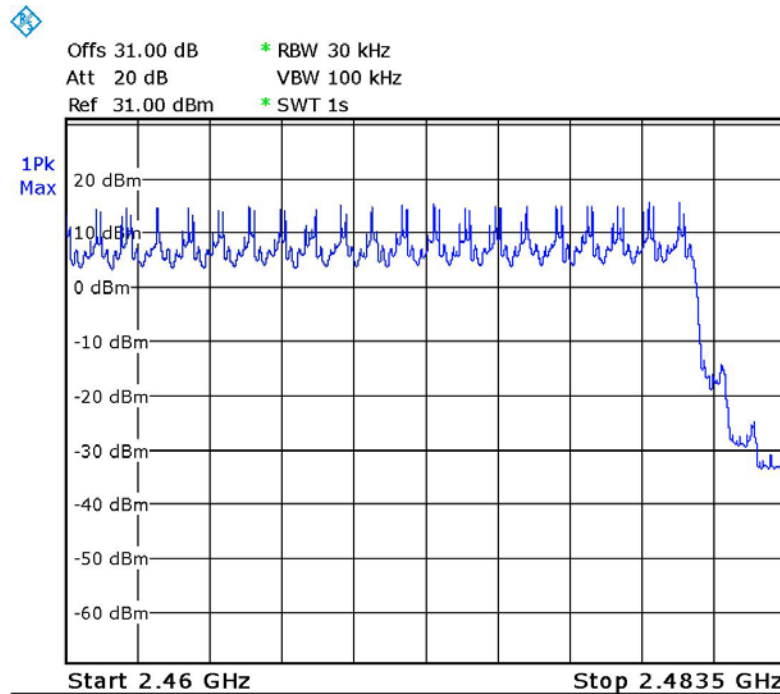


Figure 37. Number of Channels EDR Modulation=20

Number of Hopping Frequencies

E.U.T Description Bluetooth Communication System
for Motorcycles
Type cardo SMARTH
Serial Number: Not designated



Date: 20.NOV.2016 12:07:30

Figure 38. Number of Channels EDR Modulation=20



7.5 Test Equipment Used, Number of Hopping Frequencies

| 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 | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 39 Test Equipment Used

8. Channel Frequency Separation

8.1 Test Specification

FCC Part 15, Subpart C, 15.247(a) (1)

RSS 247, Issue 1, Section 5.1(2)

8.2 Test Procedure

(Temperature (25°C)/ Humidity (42%RH))

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable.

The E.U.T. was set to hopping mode.

The spectrum analyzer was set to the following parameters:

Span = wide enough to capture two adjacent channels, RBW \geq 1% of the span

Detector Function: Peak, Trace: Maximum Hold.

8.3 Test Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

8.4 Test Results

| Channel Frequency Separation | Specification | Modulation | Margin |
|------------------------------------|---------------|------------|--------|
| (MHz) | (MHz) | | (kHz) |
| 1.0 | >0.745 | Standard | -255.0 |
| 1.0 | >0.926 | EDR | -74.0 |

Figure 40 Test Results

JUDGEMENT: Passed by 74.0 kHz

For additional information see *Figure 41* to *Figure 42*.

Channel Frequency Separation

E.U.T Description Bluetooth Communication
System for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

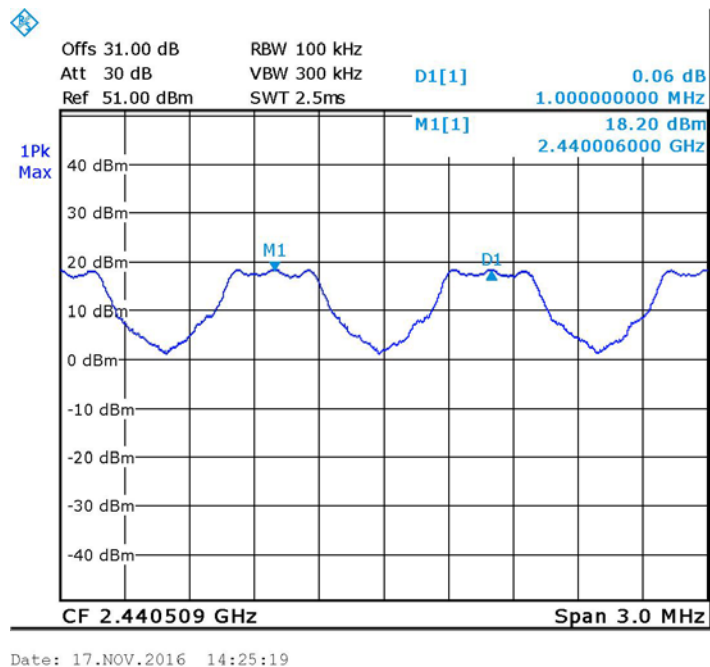


Figure 41. Channel Frequency Separation Standard Modulation

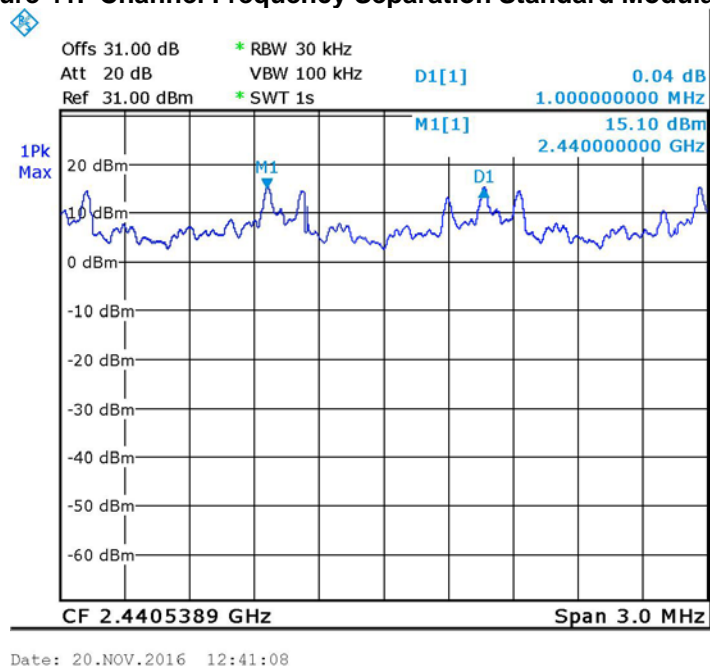


Figure 42. Channel Frequency Separation EDR Modulation



8.5 Test Equipment Used, Channel Frequency Separation Test

| Instrument | Manufacturer | Model | Serial Number | Last Calibration Date | Period Next Calibration Due |
|-------------------|---------------------|--------------|----------------------|------------------------------|------------------------------------|
| Spectrum Analyzer | Rodhe & Schwarz | FSL6 | 100194 | February 29, 2016 | March 1, 2017 |
| 30dB Attenuator | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 43 Test Equipment Used



9. Peak Output Power

9.1 Test Specification

F.C.C. Part 15, Subpart C: section 15.247(b)(1)
RSS 247, Issue 1, Section 5.4(2)

9.2 Test Procedure

(Temperature (23°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 (total loss= 31.0dB).

The spectrum analyzer was set to the following parameters:

Span = ~5 times the 20 dB bandwidth, centered on a hopping channel RBW \geq of the 20 dB bandwidth of the emission being measured

Detector Function: Peak, Trace: Maximum Hold.

The E.U.T. was tested at the Low (2402MHz), Mid (2441MHz) and High (2480 MHz) channels with modulation.

9.3 Test Limit

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt.

For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 W
(The limits above applies to antenna gain until 6dBi).

9.4 Test Results

| Operation Frequency | Power | Power | Modulation | Limit | Margin |
|---------------------|-------|-------|------------|-------|--------|
| (MHz) | (dBm) | (mW) | | (mW) | (mW) |
| 2402 | 18.40 | 69.18 | Standard | 125.0 | -55.82 |
| 2441 | 18.84 | 76.56 | Standard | 125.0 | -48.44 |
| 2480 | 18.39 | 69.02 | Standard | 125.0 | -55.98 |
| 2402 | 16.49 | 44.57 | EDR | 125.0 | -80.43 |
| 2441 | 17.67 | 58.48 | EDR | 125.0 | -66.52 |
| 2480 | 17.49 | 56.10 | EDR | 125.0 | -68.90 |

Figure 44 Radiated Power Output Test Results

JUDGEMENT: Passed by 48.44 mW

For additional information see *Figure 45 to Figure 50*.



Peak Output Power

E.U.T Description Bluetooth Communication
System for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

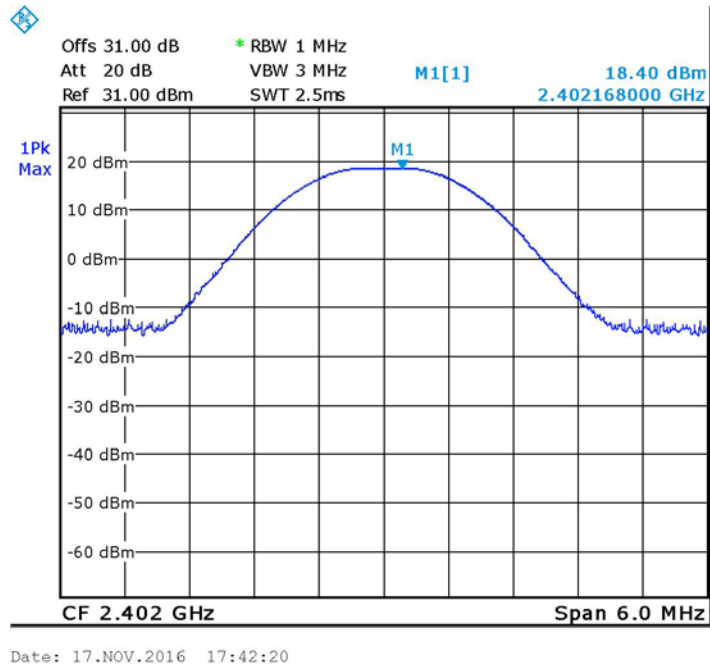


Figure 45 — 2402 MHz - Low Standard Modulation

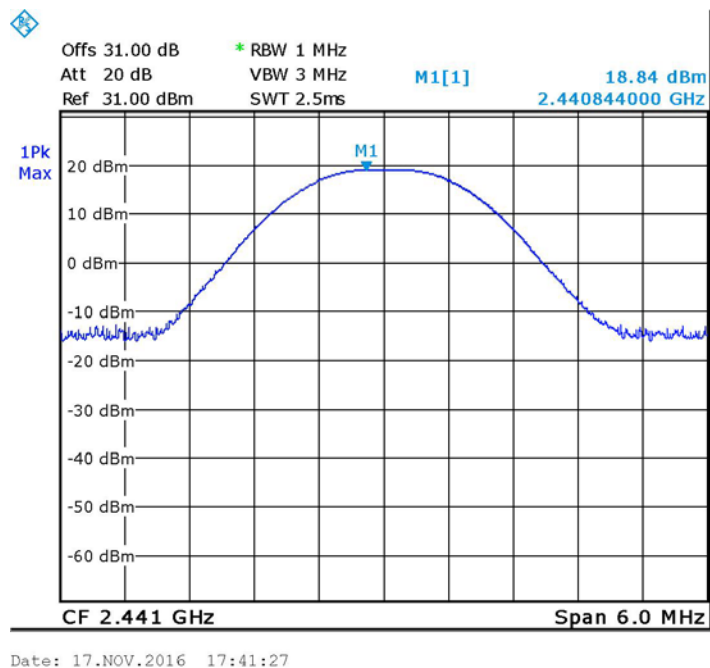


Figure 46 — 2441 - Mid Standard Modulation



Peak Output Power

E.U.T Description Bluetooth Communication
System for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

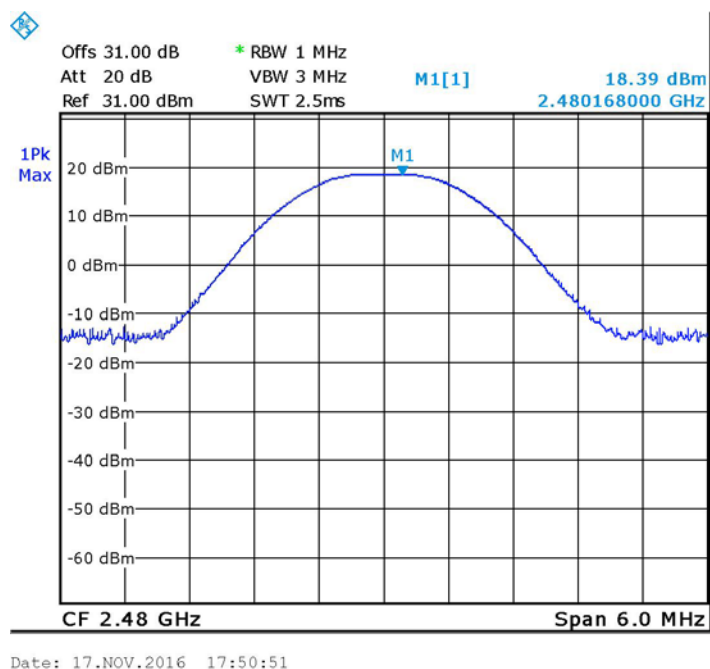


Figure 47 — 2480MHz - High Standard Modulation



Peak Output Power

E.U.T Description Bluetooth Communication
System for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

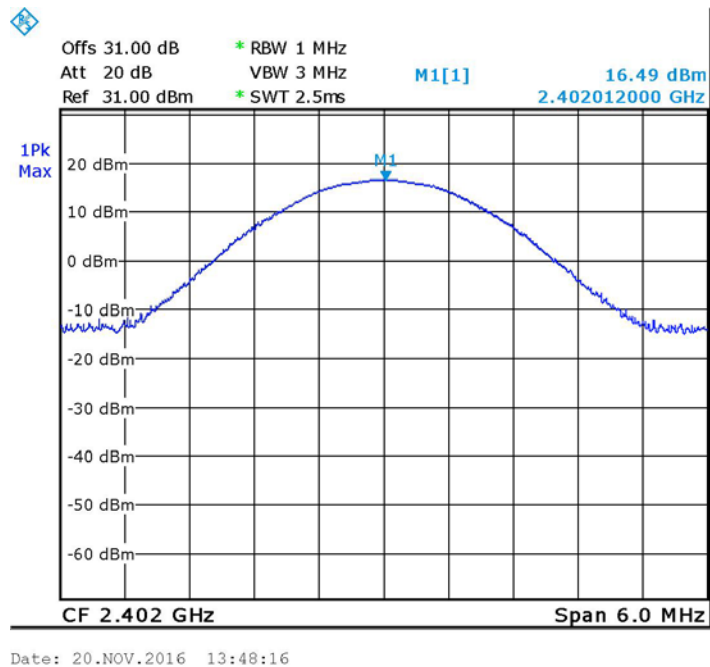


Figure 48 — 2402 MHz - Low EDR Modulation

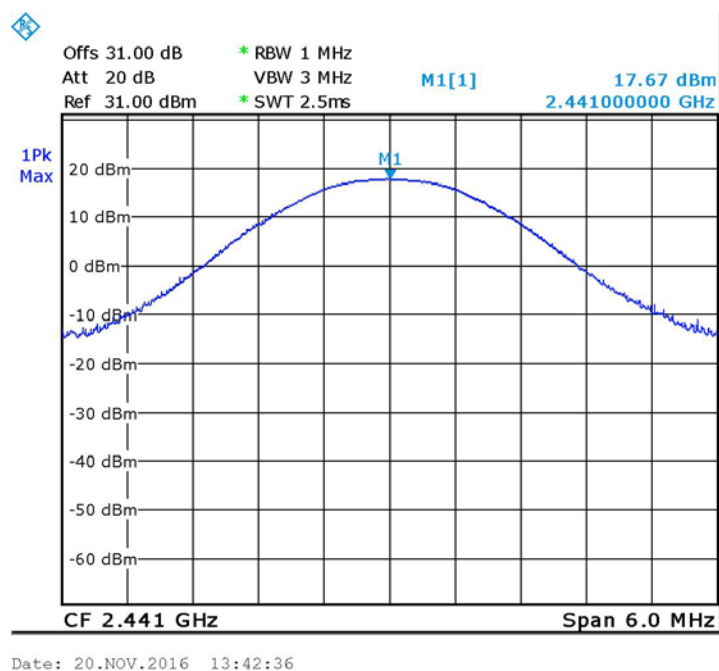


Figure 49 — 2441 - Mid EDR Modulation



Peak Output Power

E.U.T Description Bluetooth Communication
System for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

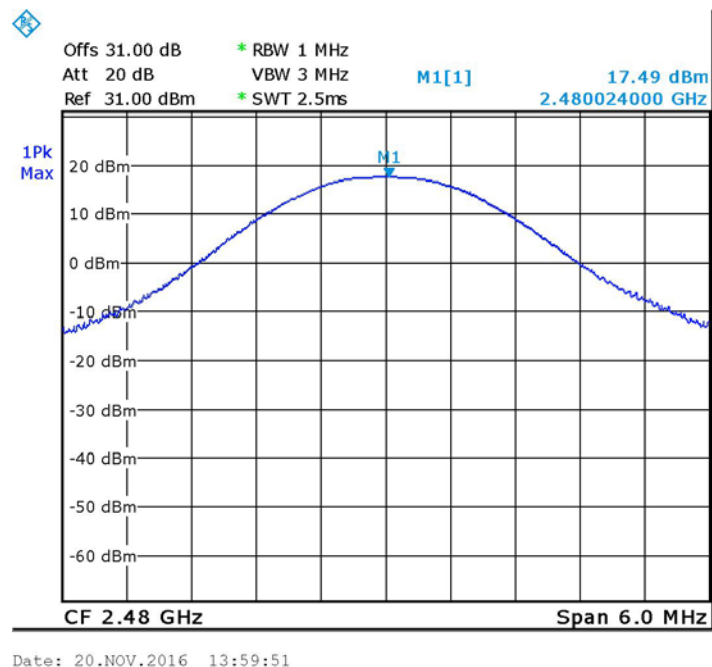


Figure 50 — 2480MHz - High EDR Modulation

9.5 Test Equipment Used, Radiated Maximum Power Output

| 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 | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 51 Test Equipment Used



10. Dwell Time on Each Channel

10.1 Test Specification

FCC Part 15, sub part C, Section 15.247(a)(1)(iii)

RSS-247, Issue 1, Section 5.1(4)

10.2 Test Procedure

(Temperature (25°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 spectrum analyzer was set to the following parameters:

Span = zero span, centered on a hopping channel, RBW \geq 1MHz.

Detector Function: Peak, Trace: Maximum Hold

10.3 Test Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

10.4 Test Results

JUDGEMENT: Passed

The E.U.T met the requirements of the FCC Part 15, Section 15.247(a)(1)(i).

Additional information of the results is given in *Figure 52* to *Figure 55*.

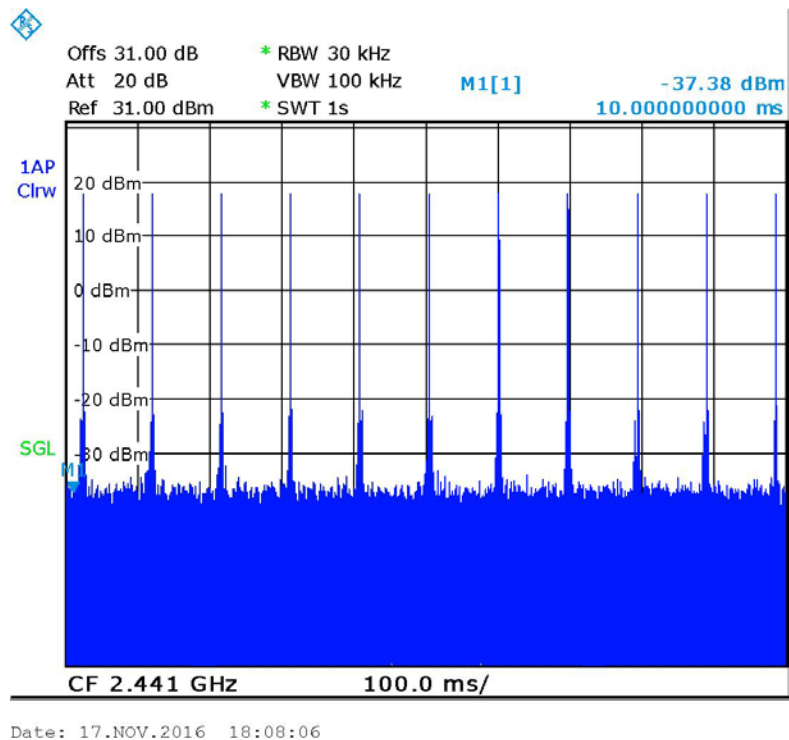


Figure 52 — Number of Bursts in 1 sec = 11 standard modulation

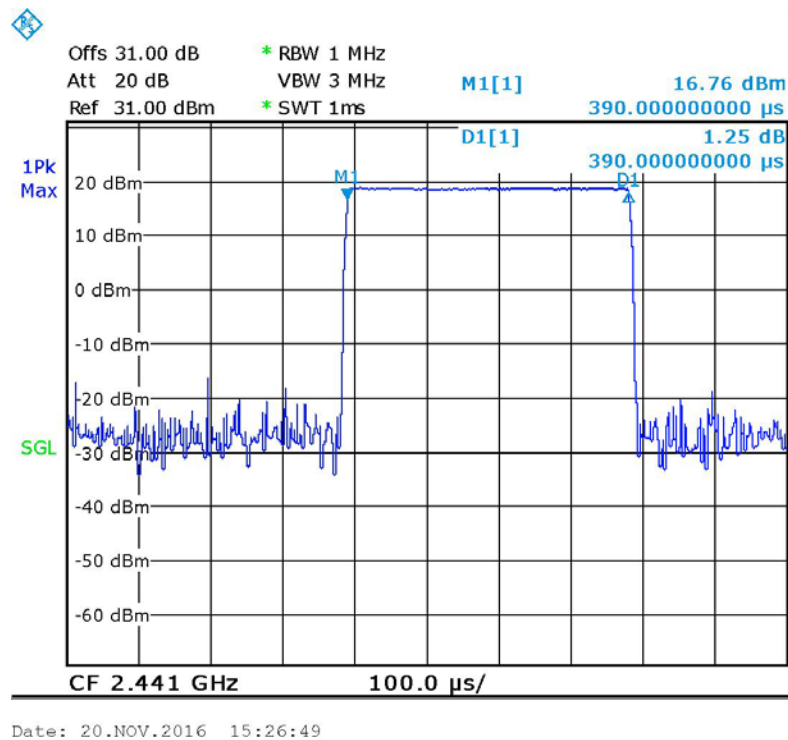


Figure 53 — Burst Duration =.390mS standard modulation

$$\text{DWELL TIME} = 0.390\text{m} * 11 * 31.6 = 135.56\text{msec} = 0.136\text{s} < 0.4\text{s}$$

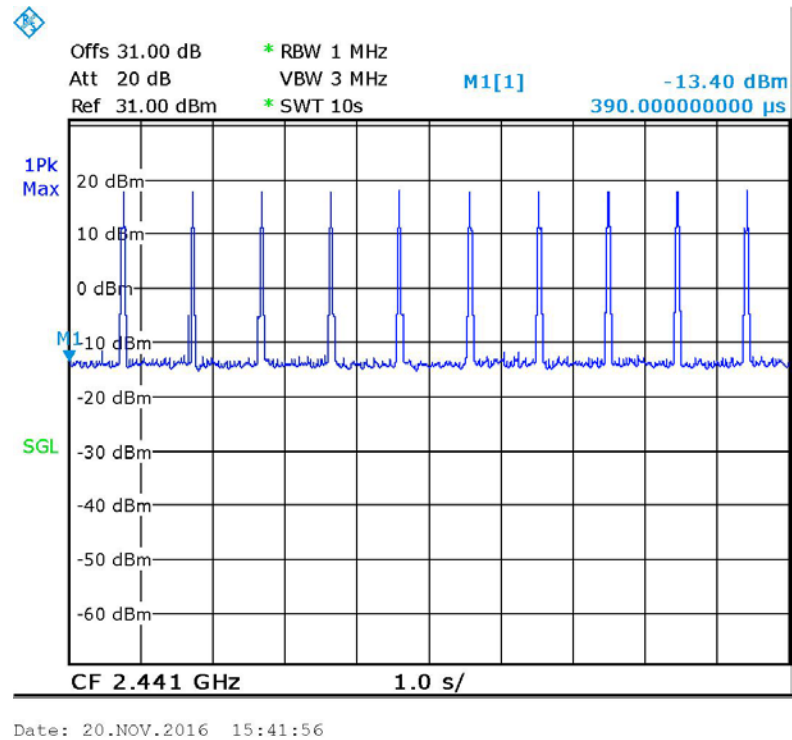


Figure 54 — Number of Bursts in 10 sec=10 EDR modulation

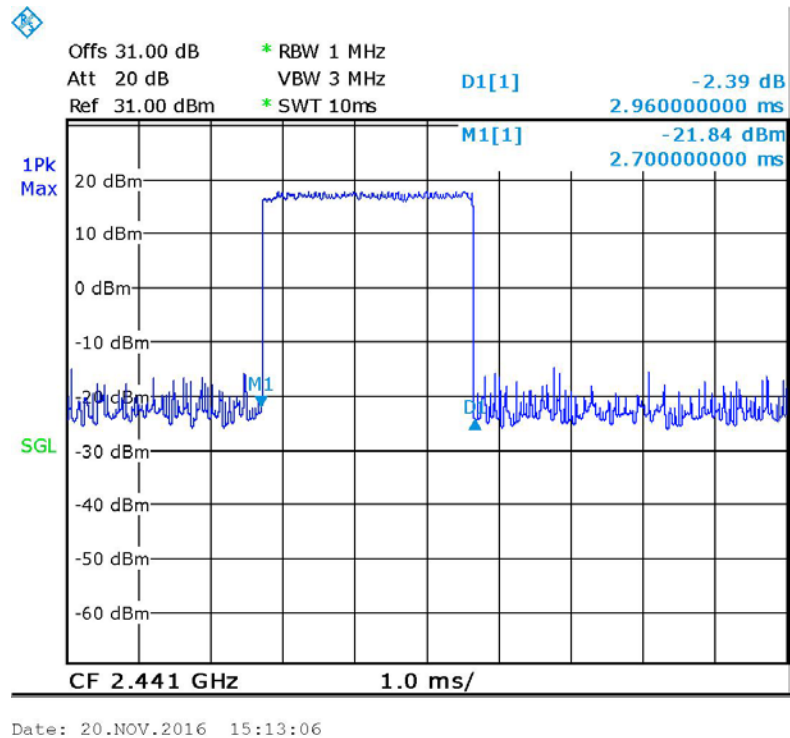


Figure 55 — Burst Duration =2.960ms EDR modulation

DWELL TIME =2.960ms *1*31.6=93.536msec=0.094s<0.4s



10.5 Test Equipment Used, Dwell Time on Each Channel

| Instrument | Manufacturer | Model | Serial Number | Last Calibration Date | Next Calibration Due |
|-------------------|---------------------|--------------|----------------------|------------------------------|-----------------------------|
| Spectrum Analyzer | HP | 8564E | 3442A00275 | March 11, 2016 | March 10, 2017 |
| 30dB Attenuator | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 56 Test Equipment Used



11. Band Edge

11.1 Test Specification

FCC Part 15, Section 15.247(d)

RSS-247, Issue 1, Section 5.5

11.2 Test Procedure

(Temperature (23°C)/ Humidity (41%RH))

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable.

The transmitter unit operated in 2 modes: hopping enabled and hopping disabled.

The RBW was set to 100 kHz.

The EMI receiver was adjusted to the transmission channel at the maximum level.

The display line was set to 20 dBc and the EMC analyzer was set to the band edge frequencies.

The E.U.T. was tested at the lower and the upper channels.

11.3 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 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.



11.4 Test Results

| Mode | Operation Frequency | Band Edge Frequency | Spectrum Level | Limit | Margin |
|-------------|---------------------|---------------------|----------------|-------|--------|
| | (MHz) | (MHz) | (dBm) | (dBm) | (dB) |
| Hopping | Low | 2400.0 | -27.74 | -4.2 | -23.5 |
| | High | 2483.49 | -29.06 | -4.0 | -25.1 |
| Non-Hopping | Low | 2400.0 | -26.05 | -1.2 | -24.9 |
| | High | 2483.5 | -28.67 | -1.7 | -27.0 |
| Hopping | Low | 2400.0 | -27.07 | -4.1 | -23.0 |
| | High | 2483.49 | -27.98 | -3.7 | -24.3 |
| Non-Hopping | Low | 2400.0 | -26.64 | -4.5 | -22.1 |
| | High | 2483.5 | -29.25 | -3.6 | -25.7 |

Figure 57 Band Edge Test Results

JUDGEMENT: Passed by 22.1 dB

For additional information see *Figure 58* to *Figure 65*.

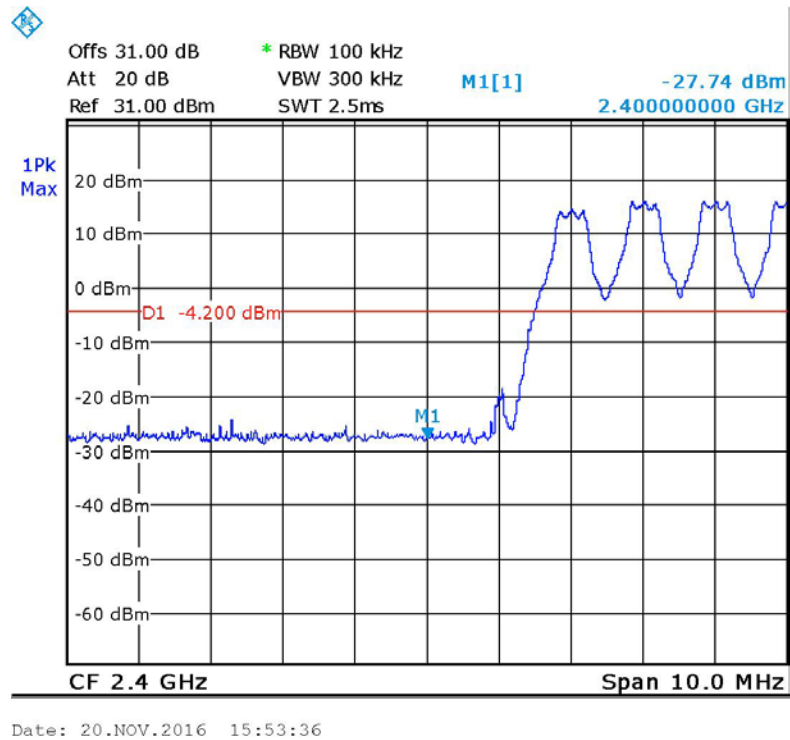


Figure 58 — Hopping - Low Standard Modulation

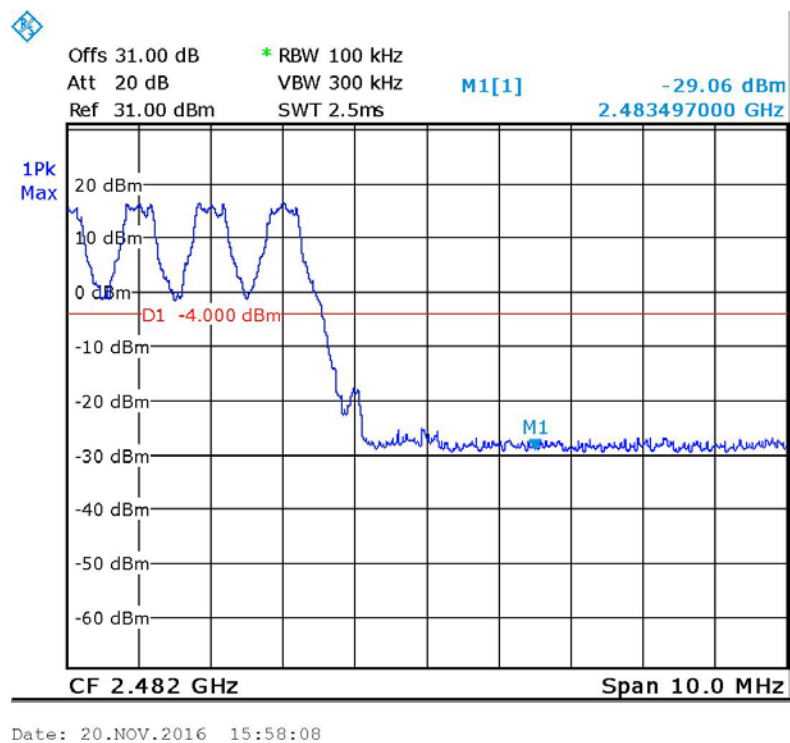


Figure 59 — Hopping - High Standard Modulation

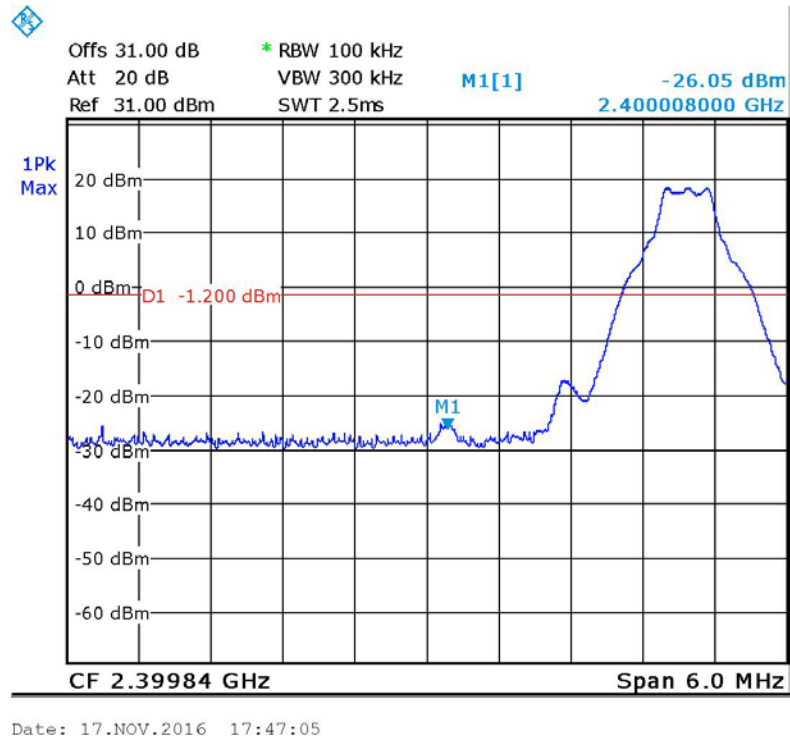


Figure 60 — Non-Hopping - Low Standard Modulation

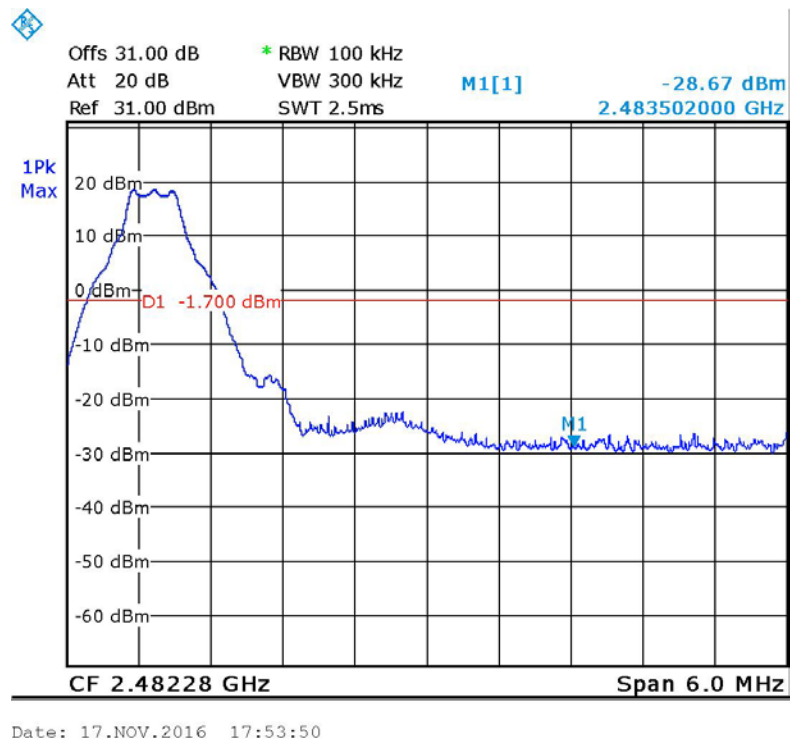


Figure 61 — Non-Hopping – High Standard Modulation

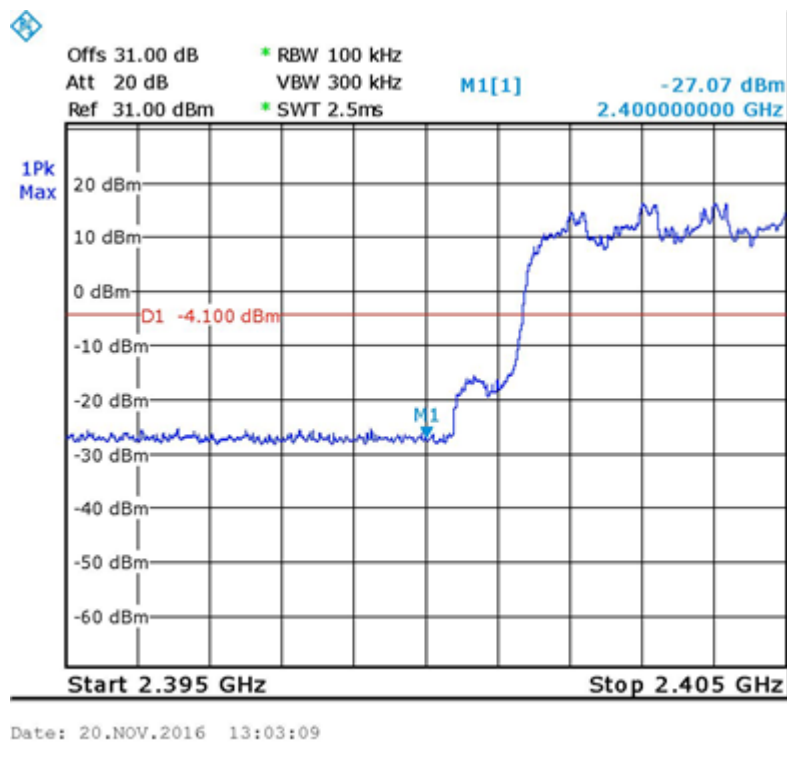


Figure 62 — Hopping - Low EDR Modulation

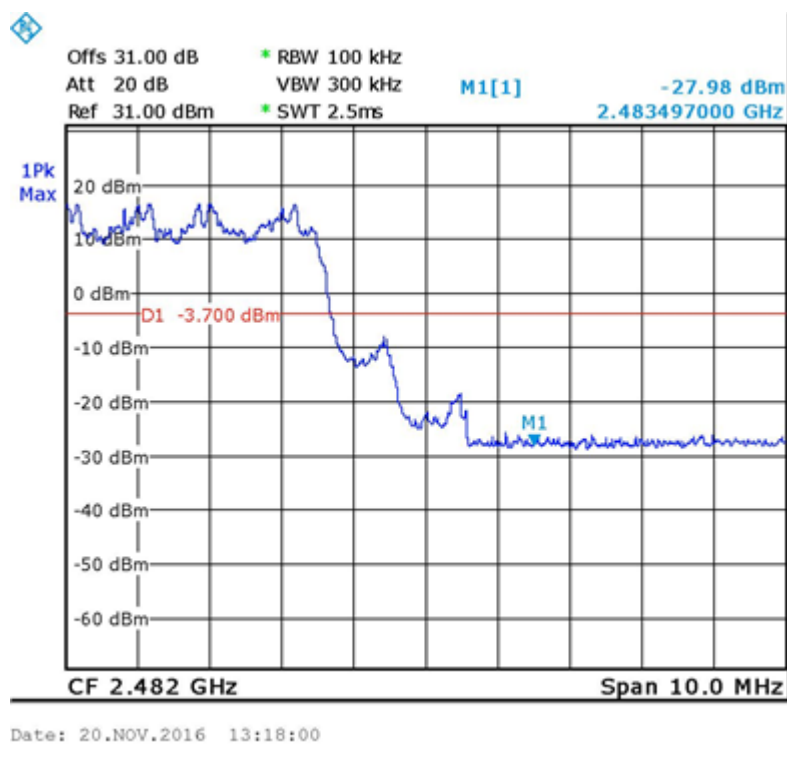


Figure 63 — Hopping - High EDR Modulation

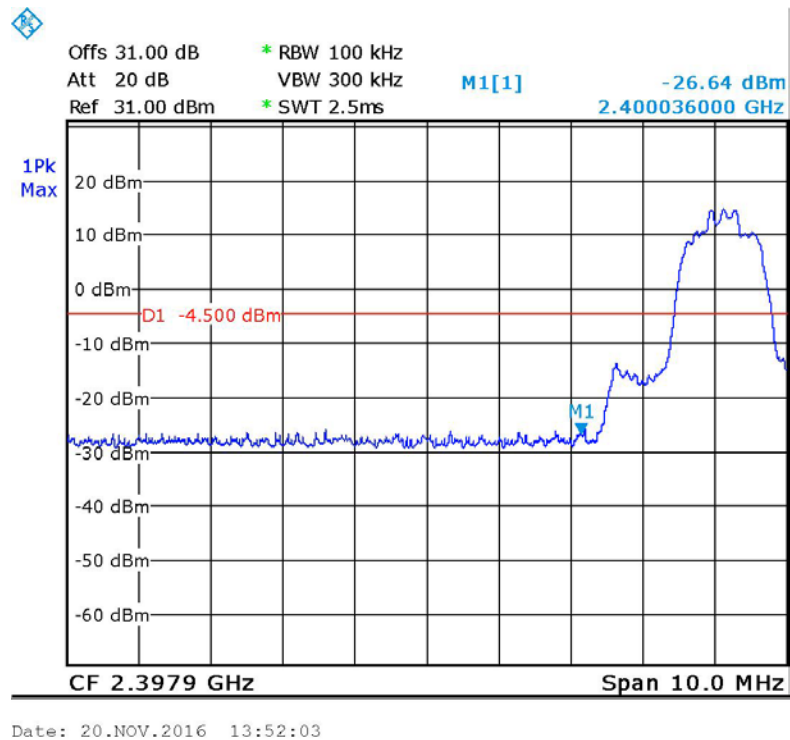


Figure 64 — Non-Hopping - Low EDR Modulation

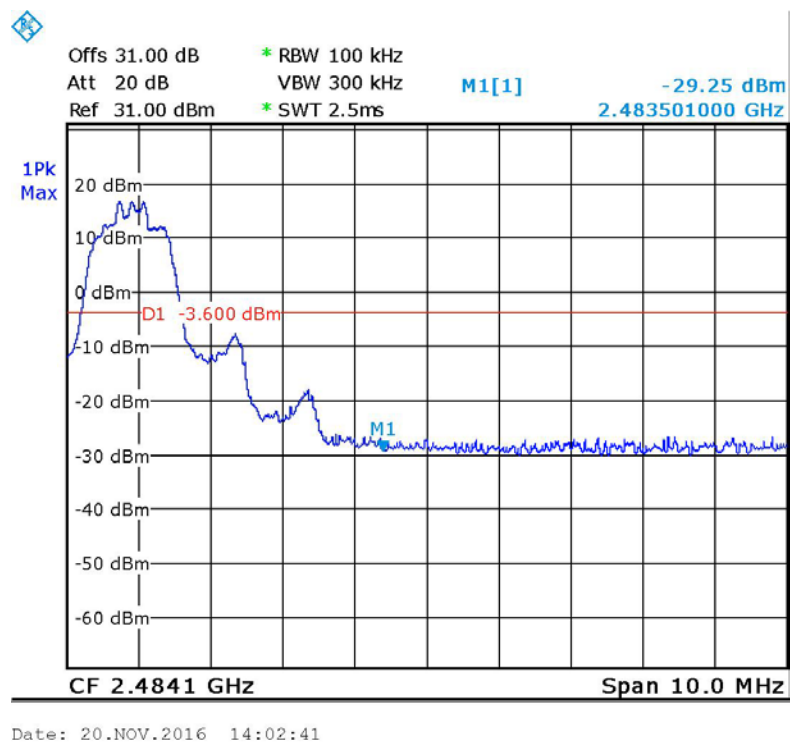


Figure 65 — Non-Hopping – High EDR Modulation



11.5 Test Equipment Used, Band Edge Spectrum

| 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 | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 66 Test Equipment Used



12. Emissions in Non-Restricted Frequency Bands

12.1 Test Specification

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

RSS 247, Issue 1, Section 5.5

12.2 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.

12.3 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 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

12.4 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 67* to *Figure 72*.

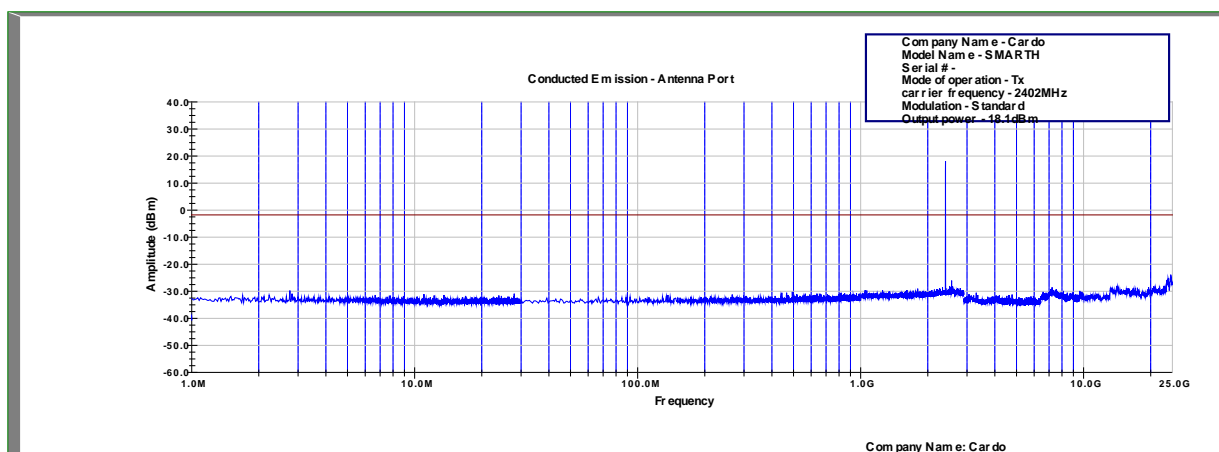


Figure 67 Conducted Spurious Emission – 2402 MHz Standard modulation

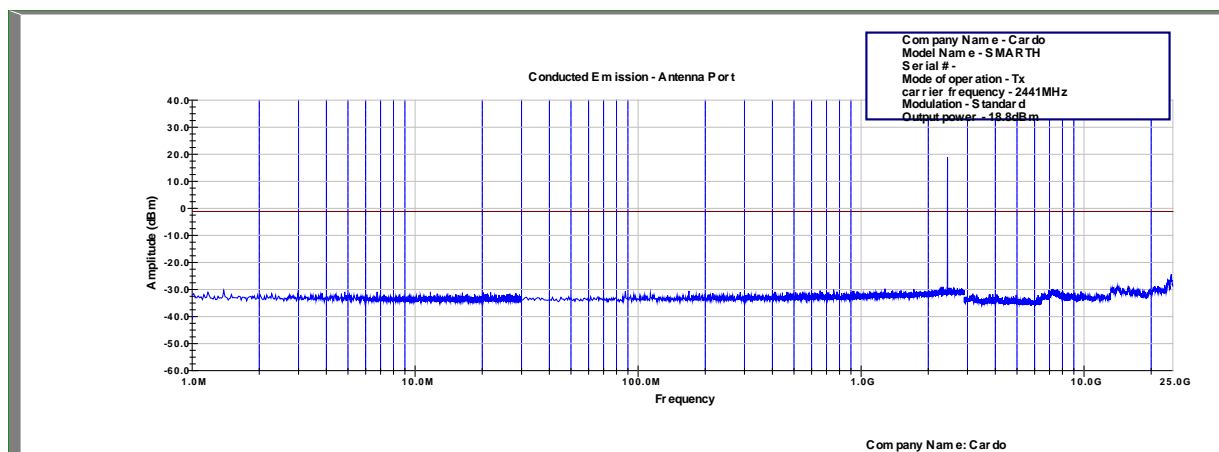


Figure 68 Conducted Spurious Emission - 2441 MHz Standard modulation

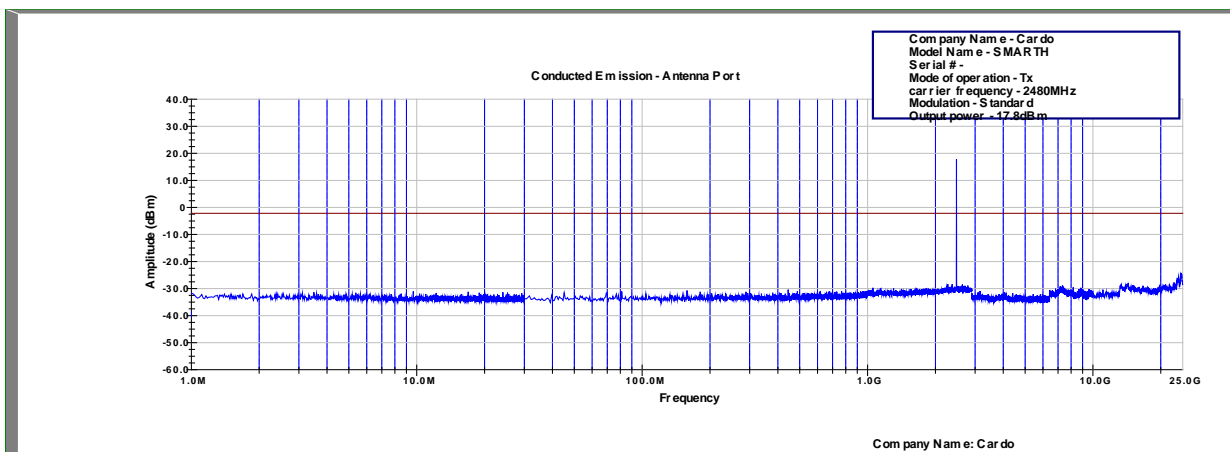


Figure 69 Conducted Spurious Emission – 2480 MHz Standard modulation

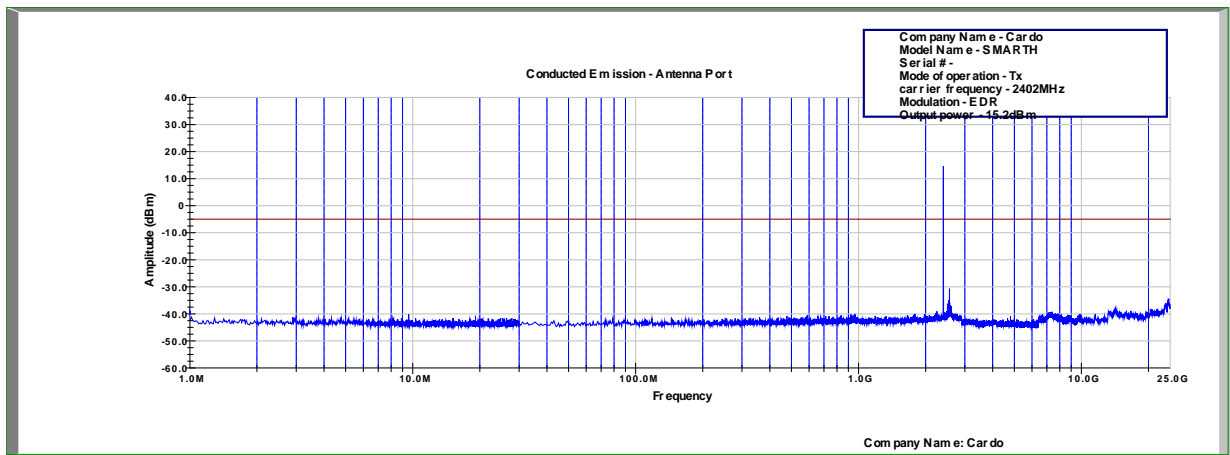


Figure 70 Conducted Spurious Emission – 2402 MHz EDR modulation

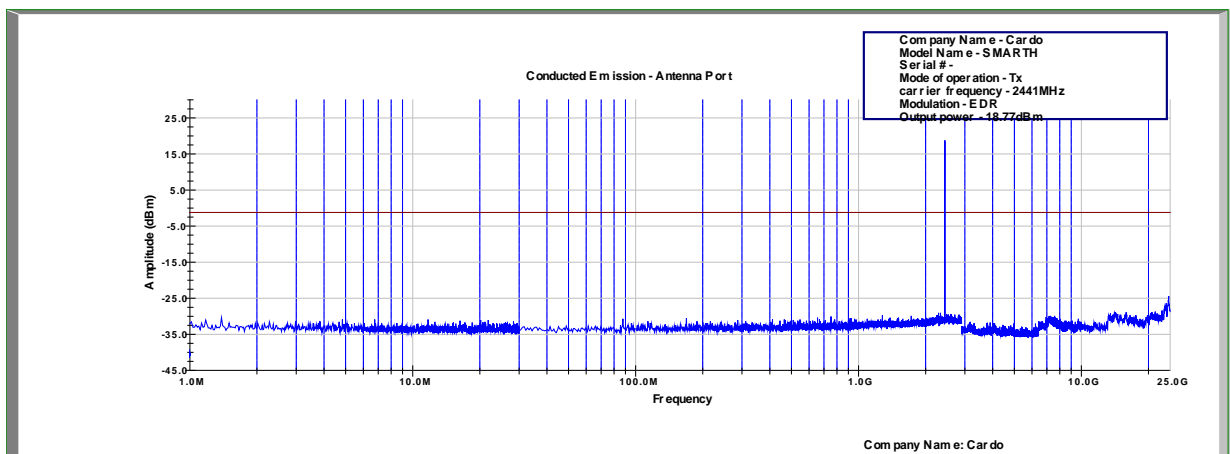


Figure 71 Conducted Spurious Emission - 2441 MHz EDR modulation

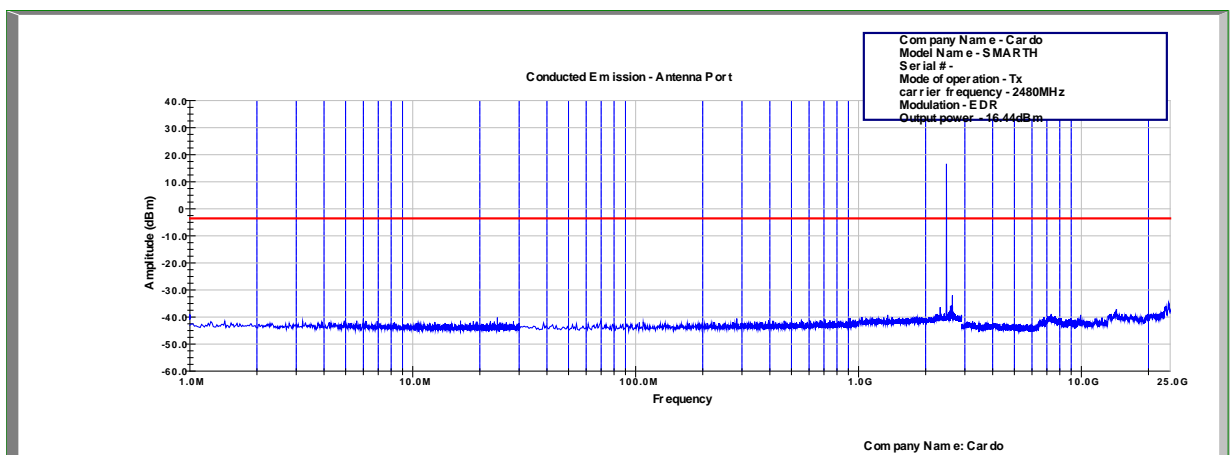


Figure 72 Conducted Spurious Emission – 2480 MHz EDR modulation



12.5 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 | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 73 Test Equipment Used



13. Emissions in Restricted Frequency Bands

13.1 Test Specification

FCC, Part 15, Subpart C, Sections 247(d), 15.205, 15.209
RSS Gen, Issue 4: 2014 Section 8.9, 8.10

13.2 Test Procedure

(Temperature (23°C)/ Humidity (40%RH))

For measurements between 0.009MHz-30MHz:

The E.U.T was tested inside the shielded room at a distance of 3 meters and the E.U.T was placed on a non-metallic table, 0.8 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 measurements between 1.0GHz-25.0GHz:

The E.U.T was tested inside the shielded room 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 1.0GHz -25.0GHz 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.

The E.U.T. was operated at the low, mid and high channels. (2402, 2441, 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.



13.3 Test Limit

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.

13.4 Test Results

JUDGEMENT: Passed

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

For additional information see *Figure 74* and *Figure 75*.



Radiated Emission

E.U.T Description Bluetooth Communication System for Motorcycles

Type cardo SMARTH

Serial Number: Not designated

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical Frequency range: 9 kHz to 25.0 GHz

Test Distance: 3 meters

Detector: Peak

| Operation Frequency (MHz) | Freq. (MHz) | Polarity (H/V) | Peak Reading (dBμV/m) | | | Peak Limit (dB μV/m) | Peak Margin (dB) |
|---------------------------------|----------------|-------------------|--------------------------|-------------|-------------|----------------------------|------------------------|
| | | | X axis | Y axis | Z axis | | |
| 2402.0 | 2390.0 | H | 51.9 | 51.9 | 51.9 | 74.0 | -22.1 |
| 2402.0 | 2390.0 | V | 52.2 | 52.2 | 52.2 | 74.0 | -21.8 |
| 2402.0 | 4804.0 | H | 53.7 | 62.4 | 57.4 | 74.0 | -11.6 |
| 2402.0 | 4804.0 | V | 57.7 | 53.7 | 57.7 | 74.0 | -16.3 |
| 2402.0 | 7206.0 | H | 60.5 | 54.4 | 63.6 | 74.0 | -10.4 |
| 2402.0 | 7206.0 | V | 62.0 | 58.1 | 60.3 | 74.0 | -12.0 |
| 2402.0 | 9608.0 | H | 56.7 | 52.3 | 59.4 | 74.0 | -14.6 |
| 2402.0 | 9608.0 | V | 56.6 | 55.9 | 56.5 | 74.0 | -17.4 |
| 2441.0 | 4882.0 | H | 54.4 | 54.9 | 57.0 | 74.0 | -17.0 |
| 2441.0 | 4882.0 | V | 63.8 | 64.9 | 53.6 | 74.0 | -9.1 |
| 2441.0 | 7323.0 | H | 60.9 | 65.9 | 63.9 | 74.0 | -8.1 |
| 2441.0 | 7323.0 | V | 64.6 | 61.2 | 63.5 | 74.0 | -9.4 |
| 2441.0 | 9766.0 | H | 63.4 | 62.0 | 63.9 | 74.0 | -10.1 |
| 2441.0 | 9766.0 | V | 58.9 | 58.0 | 54.0 | 74.0 | -15.1 |
| 2480.0 | 4960.3 | H | 61.0 | 66.1 | 66.9 | 74.0 | -7.1 |
| 2480.0 | 4960.0 | V | 68.8 | 57.3 | 61.4 | 74.0 | -5.2 |
| 2480.0 | 7439.2 | H | 69.6 | 64.5 | 70.0 | 74.0 | -4.0 |
| 2480.0 | 7439.4 | V | 69.0 | 62.9 | 70.5 | 74.0 | -3.5 |
| 2480.0 | 9920.0 | H | 62.4 | 60.8 | 60.0 | 74.0 | -11.6 |
| 2480.0 | 9920.0 | V | 66.0 | 59.4 | 65.4 | 74.0 | -8.0 |
| 2480.0 | 2483.5 | H | 49.2 | 49.0 | 49.5 | 74.0 | -24.5 |
| 2480.0 | 2483.5 | V | 50.1 | 50.1 | 50.1 | 74.0 | -23.9 |

Figure 74. Radiated Emission, 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 Reading” includes correction factor.

“Correction Factor” = Antenna Factor + Cable Loss- Low Noise Amplifier Gain



Radiated Emission

E.U.T Description Bluetooth Communication System for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical
Test Distance: 3 meters

Frequency range: 9 kHz to 25.0 GHz
Detector: Average

| Operation Frequency (MHz) | Freq. (MHz) | Polarity (H/V) | Average Reading (dBμV/m) | | | Average Limit (dB μV/m) | Average Margin (dB) |
|---------------------------------|----------------|-------------------|--------------------------------|-------------|-------------|-------------------------------|---------------------------|
| | | | X axis | Y axis | Z axis | | |
| 2402.0 | 2390.0 | H | 39.8 | 39.8 | 39.8 | 54.0 | -14.2 |
| 2402.0 | 2390.0 | V | 39.6 | 39.6 | 39.6 | 54.0 | -14.4 |
| 2402.0 | 4804.0 | H | 42.7 | 48.3 | 47.0 | 54.0 | -5.7 |
| 2402.0 | 4804.0 | V | 47.9 | 41.0 | 45.4 | 54.0 | -6.1 |
| 2402.0 | 7206.0 | H | 49.5 | 52.5 | 51.7 | 54.0 | -1.5 |
| 2402.0 | 7206.0 | V | 50.1 | 49.0 | 50.3 | 54.0 | -3.7 |
| 2402.0 | 9608.0 | H | 49.0 | 47.5 | 48.1 | 54.0 | -5.0 |
| 2402.0 | 9608.0 | V | 47.1 | 44.0 | 45.3 | 54.0 | -6.9 |
| 2440.0 | 4882.0 | H | 46.4 | 50.6 | 49.7 | 54.0 | -3.4 |
| 2440.0 | 4882.0 | V | 50.9 | 43.9 | 44.1 | 54.0 | -3.1 |
| 2441.0 | 7323.0 | H | 50.9 | 50.8 | 50.8 | 54.0 | -3.1 |
| 2441.0 | 7323.0 | V | 49.1 | 52.6 | 51.4 | 54.0 | -1.4 |
| 2480.0 | 4960.3 | H | 51.7 | 50.3 | 51.0 | 54.0 | -2.3 |
| 2480.0 | 4960.0 | V | 50.0 | 49.6 | 50.6 | 54.0 | -3.4 |
| 2480.0 | 7440. | H | 49.7 | 50.5 | 47.8 | 54.0 | -3.5 |
| 2480.0 | 7440. | V | 51.5 | 51.9 | 50.5 | 54.0 | -2.1 |
| 2480.0 | 9920.0 | H | 48.8 | 51.5 | 50.5 | 54.0 | -2.5 |
| 2480.0 | 9920.0 | V | 47.5 | 49.3 | 48.1 | 54.0 | -4.7 |
| 2480.0 | 2483.5 | H | 38.7 | 38.7 | 38.7 | 54.0 | -15.3 |
| 2480.0 | 2483.5 | V | 38.7 | 38.7 | 38.7 | 54.0 | -15.3 |

Figure 75. Radiated Emission, Detector: Average

Notes:

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.

“Avg Reading” includes Avg factor.



Intermodulation Radiated Emission

E.U.T Description Bluetooth Communication
System for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical Frequency range: 1.0 GHz to 25.0 GHz
Test Distance: 3 meters Detector: Peak
Frequency: 2405 MHz + 2402 MHz

| Frequency | Polarity | Peak Reading | Peak Limit | Peak Margin |
|-----------|----------|--------------|------------|-------------|
| (MHz) | (H/V) | (dBμV/m) | (dB μV/m) | (dB) |
| 2399 | H | 38.7 | 74.0 | -35.3 |
| 2399 | V | 36.5 | 74.0 | -37.5 |
| 2396 | H | 34.1. | 74.0 | -39.9 |
| 2396 | V | 32.0 | 74.0 | -42.0 |
| 2393 | H | 31.0 | 74.0 | -43.0 |
| 2393 | V | 35.0 | 74.0 | -39.0 |
| 2390 | H | 35.9 | 74.0 | -38.1 |
| 2390 | V | 33.0 | 74.0 | -41.0 |

**Figure 76. 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



Intermodulation Radiated Emission

E.U.T Description Bluetooth Communication
System for Motorcycles
Type cardo SMARTH
Serial Number: Not designated

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical

Frequency range: 1.0 GHz to 25.0 GHz

Test Distance: 3 meters

Detector: Average

Frequency: 2405 MHz + 2402 MHz

| Frequency | Polarity | AVG. Reading | AVG. Limit | AVG. Margin |
|-----------|----------|-----------------|---------------|----------------|
| (MHz) | (H/V) | (dBμV/m) | (dB μV/m) | (dB) |
| 2399 | H | N/A | 54.0 | N/A |
| 2399 | V | N/A | 54.0 | N/A |
| 2396 | H | N/A | 54.0 | N/A |
| 2396 | V | N/A | 54.0 | N/A |
| 2393 | H | N/A | 54.0 | N/A |
| 2393 | V | N/A | 54.0 | N/A |
| 2390 | H | 45.9 | 54.0 | -8.1 |
| 2390 | V | 43.0 | 54.0 | -11.0 |

**Figure 77. Radiated Emission. Antenna Polarization: HORIZONTAL / VERTICAL.
Detector: Average**

Notes:

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.

“Average Amp” includes correction factor.

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



13.5 **Field Strength Calculation**

The field strength is calculated directly by the EMI Receiver software, and a "Correction Factors" data disk, using the following equation:

$$[\text{dB}\mu\text{V}/\text{m}] \text{ FS} = \text{RA} + \text{AF} + \text{CF}$$

FS: Field Strength [dB μ V/m]
RA: Receiver Amplitude [dB μ V]
AF: Receiving Antenna Correction Factor [dB/m]
CF: Cable Attenuation Factor [dB]

Example: $\text{FS} = 30.7 \text{ dB}\mu\text{V (RA)} + 14.0 \text{ dB (AF)} + 0.9 \text{ dB (CF)} = 45.6 \text{ dB}\mu\text{V}$

No external pre-amplifiers are used.



13.6 Test Equipment Used, Emissions in Restricted Frequency Bands

| Instrument | Manufacturer | Model | Serial Number | 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 |
| Horn Antenna | ETS | 3115 | 29845 | May 19, 2015 | May 19, 2018 |
| Log Periodic Antenna | EMCO | 3146 | 9505-4081 | April 23, 2016 | April 23, 2017 |
| Biconical Antenna | EMCO | 3110B | 9912-3337 | March 24, 2016 | March 24, 2018 |
| Active Loop Antenna | EMCO | 6502 | 9506-2950 | November 4, 2015* | November 30, 2016* |
| Low Noise Amplifier | DBS MICROWAVE | LNA-DBS-0411N313 | 013 | August 8, 2016 | August 8, 2017 |
| Low Noise Amplifier | Sophia Wireless | LNA 28-B | 232 | August 8, 2016 | August 8, 2017 |
| Spectrum Analyzer | HP | 8593EM | 3536A00120ADI | 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 |

*Calibration dates for April 26, 2017 re-testing of radiated emissions measurements below 30MHz: September 12, 2016 to September 12, 2017.

**Calibration dates for April 26, 2017 re-testing of radiated emissions measurements below 30MHz: February 28, 2017 to February 28, 2018.

Figure 78 Test Equipment Used

14. Avg. Factor Calculation

1. Pulse period = 1msec (worst scenario)
2. Pulse duration = 1 msec (worst scenario)
3. Burst duration of Standard modulation =.390msec
4. Burst duration of EDR modulation =2.93msec

$$5. \text{ Average Factor} = 20 \log \left[\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{burst duration}}{100\text{msec}} \times \text{Num of burst within 100msec} \right]$$

$$\text{Average Factor} = 20 \log \left[1 * \frac{.390}{100} * 2 \right] = -42.2\text{dB for Standard modulation}$$

$$\text{Average Factor} = 20 * \log \left[\frac{2.96}{100} * 1 \right] = -30.57\text{dB for EDR modulation}$$

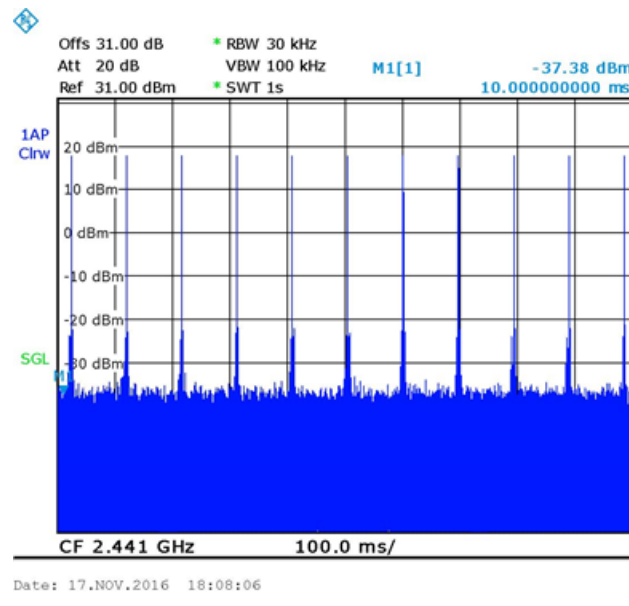


Figure 79 — Number of Bursts in 100m sec=2 standard modulation

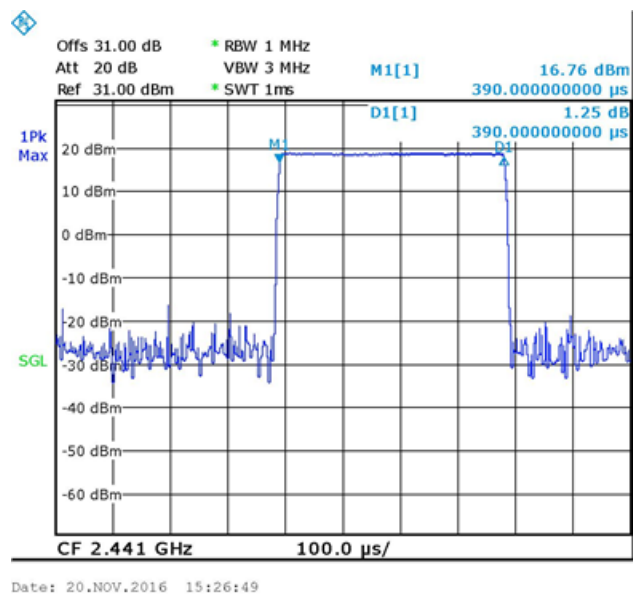


Figure 80 — Burst Duration =.390mS standard modulation

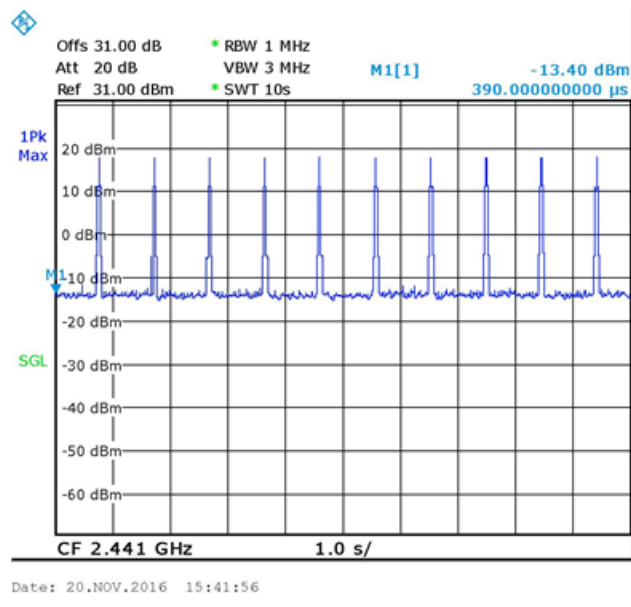


Figure 81 — Number of Bursts in 10 sec=10 EDR modulation

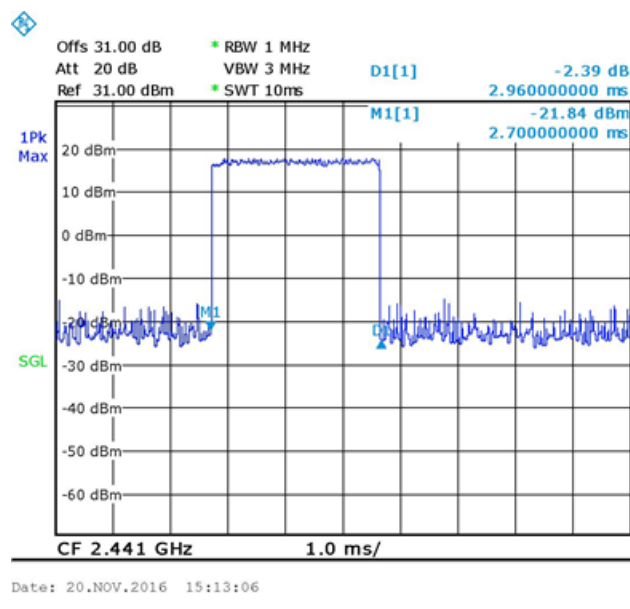


Figure 82 — Burst Duration =2.96ms EDR modulation

14.1 Test Equipment Used, Average Factor

| 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 | MCL | BW-S30W5 | 533 | July 5, 2016 | July 5, 2017 |

Figure 83 Test Equipment Used



15. Antenna Gain/Information

The antenna gain is 1.7 dBi.

Fractus Compact Reach Xtend™

Bluetooth® , 802.11b/g WLAN

Chip Antenna



16. R.F Exposure/Safety

The typical placement of the E.U.T. is on a motorcycle helmet. The minimal distance between the E.U.T. and the user is 2.0cm. See photos below.

SAR Testing Exclusion Based on Section 4.3.1 and Appendix A of KDB447498 D01 V05 and RSS 102, Issue 5, Section 2.5.2 Requirements

For FCC

Section 4.3.1 and Appendix A of KDB447498 D01 V05 was used as the guidance as follows:

Peak power output (standard) = 18.84 dBm=76.56mW.

Taking into account the -42.2dB AVG factor (page 69)

peak power = 18.84- 42.2= -23.36dBm =0.005mW

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] * [\sqrt{f(\text{GHz})}]$$

$$=0.005/15 * 1.55= 5.166 \times 10^{-4}$$
 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 30mW at a separation distance of 20mm= 2.0cm at 2450 MHz.

EUT power transmission is 18.84 dBm=76.56mW.

Taking into account the -42.2dB AVG factor (page 69)

peak power = 18.84- 42.2= -23.36dBm =0.005mW

This is below the 30mW SAR exemption limits.





17. APPENDIX A - CORRECTION FACTORS

17.1 Correction factors for RF OATS Cable 35m ITL #1784

| Frequency (MHz) | Cable loss (dB) |
|------------------|-----------------|
| 10.0 | 0.3 |
| 20.0 | 0.2 |
| 50.0 | -0.1 |
| 100.0 | -0.6 |
| 200.0 | -1.2 |
| 500.0 | -2.3 |
| 1000.0 | -3.6 |



17.2 Correction factors for RF OATS Cable 10m
ITL #1794

| Frequency(MHz) | Cable loss(dB) |
|----------------|----------------|
| 10.0 | -0.3 |
| 20.0 | -0.3 |
| 50.0 | -0.5 |
| 100.0 | -0.7 |
| 200.0 | -1.1 |
| 500.0 | -1.8 |
| 1000.0 | -2.7 |



17.3 Correction factor for RF CABLE for Semi Anechoic Chamber

ITL # 1841

| 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*



17.4 Correction factors for biconical antenna – ITL # 1356

Model: EMCO 3110B

Serial No.: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 |



17.5 Correction factors for log periodic antenna – ITL # 1349

Model: EMCO 3146

Serial No.: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 |



17.6 Correction factors for ACTIVE LOOP ANTENNA ITL # 1075:

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 |



17.7

Correction factors for Horn ANTENNA

Model: 3115 ITL # 1352

Antenna serial number: 6142

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 |