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DATE: 27 April 2017

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

FCC/IC Radio Test Report

for

Cardo Systems, Inc.

Equipment under test:

Bluetooth Communication System for Motorcycles

cardo SMARTH

(2405MHz transmitter)

Tested by: _____

A. Yizhak

Approved by: _____

For: D. Shidlowsky

Measurement/Technical Report for

Cardo Systems, Inc.

Bluetooth Communication System for Motorcycles

cardo SMARTH

FCC ID: Q95ER21

IC: 4668A-ER21

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

Measurement procedure used is KDB 558074 D01 v03r05 and ANSI C63.10:2013.

Application for Certification
prepared by:
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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:	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.:	F463791254
HVIN:	3
Date of Receipt of E.U.T:	November 1, 2016
Start of Test:	November 2, 2016
End of Test:	November 20, 2016
Test Laboratory Location:	I.T.L (Product Testing) Ltd. 1 Batsheva St., Lod ISRAEL 7120101
Test Specifications:	FCC Part 15, Subpart C RSS-247, Issue 1, May 2015 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. The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) (Japan), Registration Numbers: C-3006, R-2729, T-1877, G-245.
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
Assigned Frequency Range	2405MHz
Operating Frequency Range	2405MHz
Transmit power	~13dBm
Antenna Gain	0dBi

1.4 Test Methodology

Both conducted and radiated testing was performed according to the procedures in KDB 558074 D01 v03r05 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 unit was evaluated while transmitting at 2405MHz.

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 (dBuV/m)	**2rd H** (dBuV/m)	**Band Edge** (dBuV/m)	**Field Strength** (dBuV/m)	**2rd H** (dBuV/m)	**Band Edge** (dBuV/m)	**Field Strength** (dBuV/m)	**2rd H** (dBuV/m)	**Band Edge** (dBuV/m)
2405.0	84.99	64.5	49.5	86.02	63.4	49.2	80.7	54.1	49.1
2480.0	N/A	N/A	49.4	N/A	N/A	48.1	N/A	N/A	49.3

Figure 1. Screening Results

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.

2.1 *Configuration of Tested System*

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

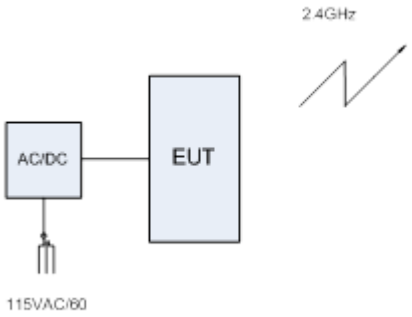

Figure 3. Configuration of Tested System – Conducted Emission on AC Line

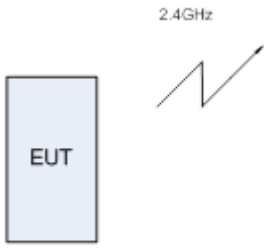

Figure 4. . Configuration of Tested System – Radiated Emission

3. Radiated and Conducted Emission Measurement Test Set-Up Photos

Figure 5. Conducted Emission From Antenna Ports Test

Figure 6. Conducted Emission From AC Mains

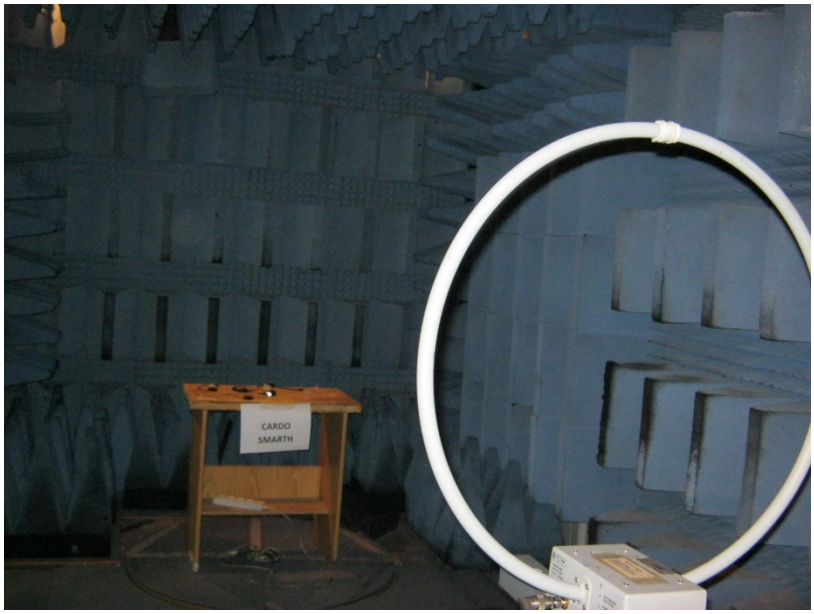

Figure 7. Radiated Emission Test

Figure 8. Radiated Emission Test

Figure 9. Radiated Emission Test

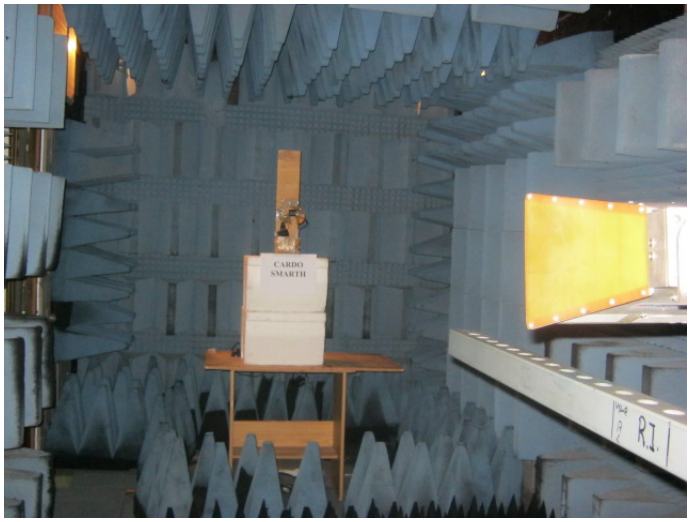

Figure 10. Radiated Emission Test Above 1GHz

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 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 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 (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 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:	F463791254

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:	F463791254

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

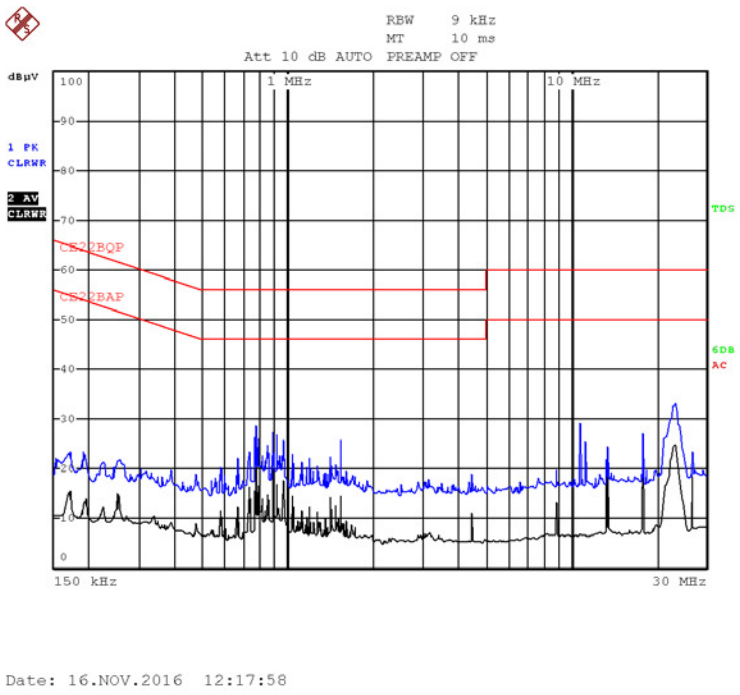

Figure 12. Detectors: Peak, Quasi-peak, Average

Conducted Emission

E.U.T Description	Bluetooth Communication System for Motorcycles
Type	cardo SMARTH
Serial Number:	F463791254

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:	F463791254

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

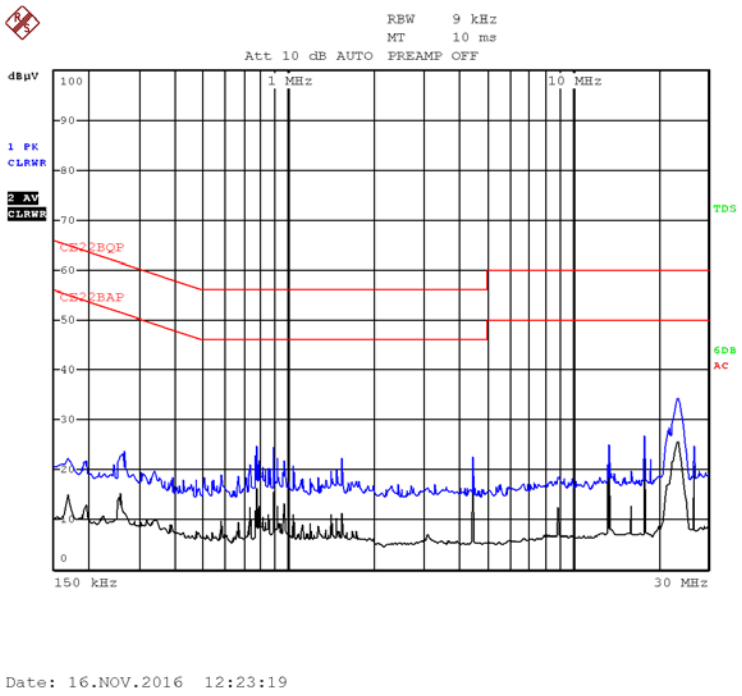

Figure 14 Detectors: Peak, Quasi-peak, Average

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. 6 dB Minimum Bandwidth

5.1 *Test Specification*

FCC Part 15, Subpart C, Section 247(a)(2)
RSS 247, Issue 1, 2015 Section 5.2

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=31.0 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.
The spectrum bandwidth of the E.U.T. at the point of 6 dB below maximum peak power was measured and recorded. The RBW was set to 100 kHz.

5.3 *Test Results*

Operation Frequency (MHz)	Reading (MHz)	Specification (MHz)
2405	1.617	>0.5

Figure 16 6 dB Minimum Bandwidth

JUDGEMENT: Passed

For additional information see *Figure 17.*

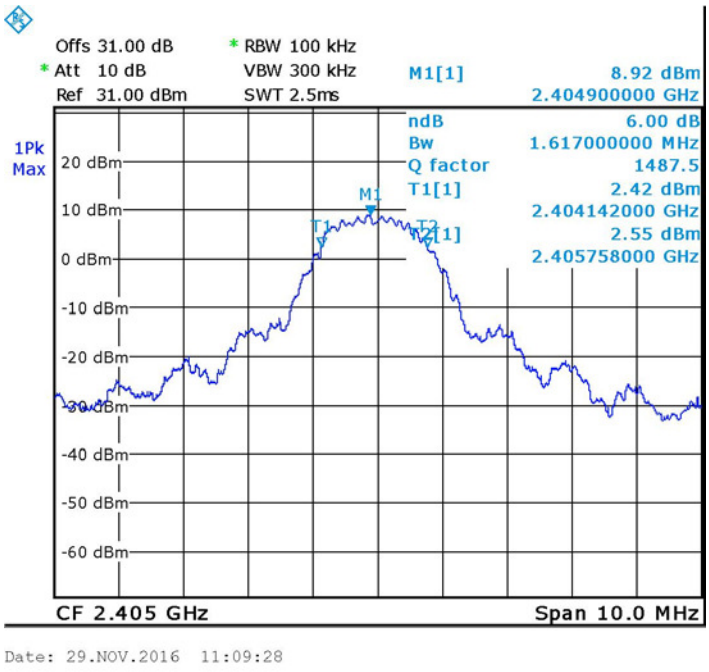

Figure 17. 2405.0 MHz - 6dB Bandwidth

5.4 *Test Equipment Used; 6dB Bandwidth*

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	FSL6	100194	February 29, 2016	March 1, 2017
30 dB attenuator	MCL	BW-S30W5	533	July 5, 2016	July 5, 2017

Figure 18. 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 2405MHz. RBW ≥ 1% of the 20 dB bandwidth.
Detector Function: Peak, Trace: Maximum Hold.
The E.U.T. was tested at 2405MHz.

6.3 *Test Limit*

N/A

6.4 *Test Results*

Operation Frequency	Bandwidth Reading
(MHz)	(MHz)
2405	3.6

Figure 19 — Test Results

JUDGEMENT: Passed

For additional information see *Figure 20.*

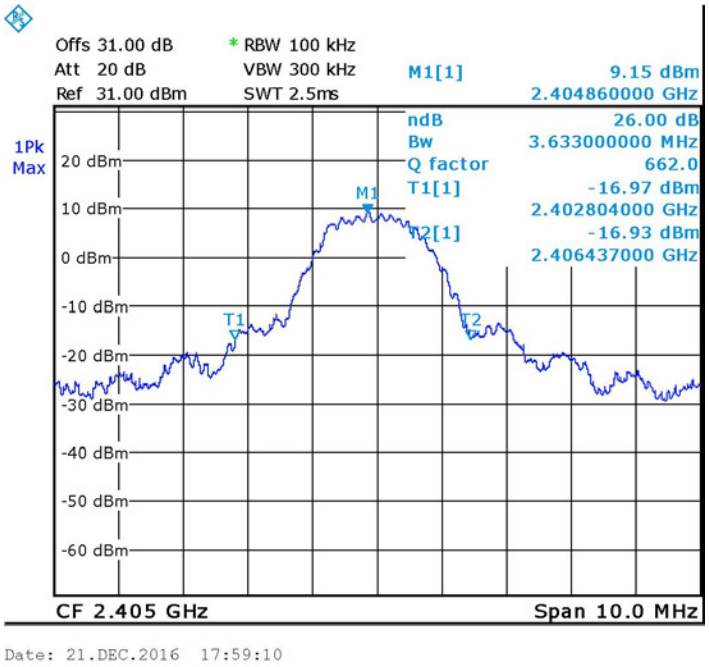

Figure 20. 2405.0 MHz - 26 dB Bandwidth

6.5 *Test Equipment Used; 26dB Bandwidth*

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	FSL6	100194	February 29, 2016	March 1, 2017
30 dB attenuator	MCL	BW-S30W5	533	July 5, 2016	July 5, 2017

Figure 21 Test Equipment Used

7. Maximum Transmitted Peak Power Output

7.1 *Test Specification*

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

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 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 at 2405MHz.

7.3 *Test Results*

Operation Frequency (MHz)	Power (dBm)	Power (mW)	Limit (mW)	Margin (mW)
2405.0	13.25	21.1	1000.0	978.9

Figure 22 Maximum Peak Power Output

JUDGEMENT: Passed by 978.9mW

For additional information see *Figure 23.*

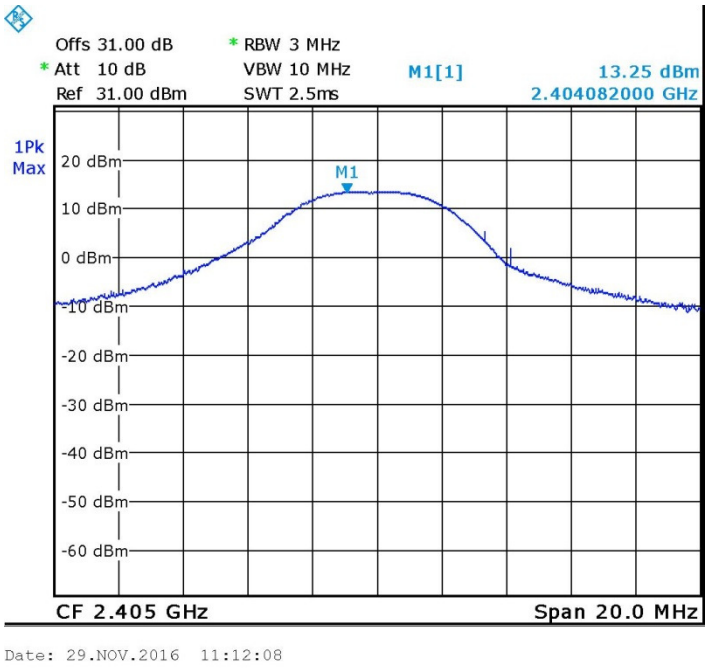

Figure 23 2405.0 MHz

7.4 *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
30 dB attenuator	MCL	BW-S30W5	533	July 5, 2016	July 5, 2017

Figure 24 Test Equipment Used

8. Band Edge Spectrum

8.1 *Test Specification*

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

8.2 *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.

8.3 *Test Results*

Operation Frequency (MHz)	Band Edge Frequency (MHz)	Spectrum Level (dBm)	Limit (dBm)	Margin (dB)
Low	2400.0	-28.13	-10.9	-17.23
High	2483.5	-37.39	-10.9	-26.49

Figure 25 Band Edge Spectrum

JUDGEMENT: Passed by 17.23 dB

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

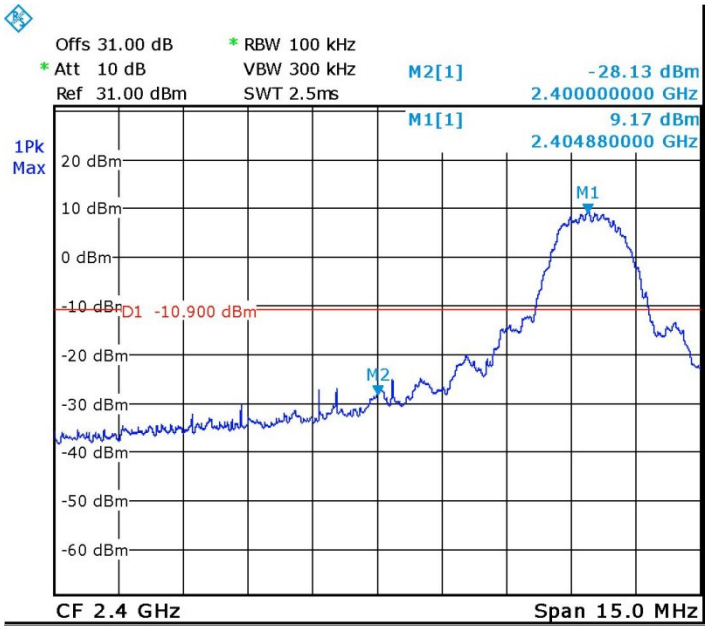

Figure 26 —Lower Band Edge

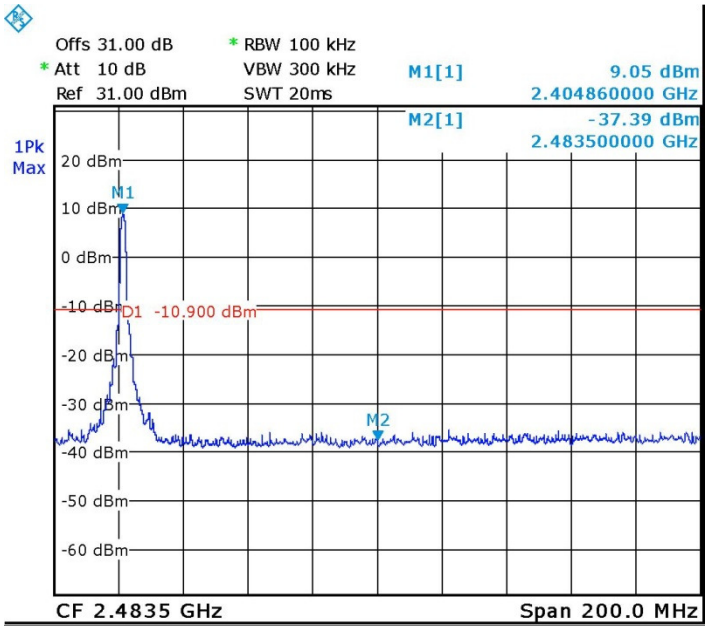

Figure 27 —Upper Band Edge

8.4 *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
30 dB attenuator	MCL	BW-S30W5	533	July 5, 2016	July 5, 2017

Figure 28 Test Equipment Used

9. Emissions in Non-Restricted Frequency Bands

9.1 *Test Specification*

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

RSS 247 Section 5.5

9.2 *Test Procedure*

(Temperature (°C)/ Humidity (%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 2405MHz. This frequency was measured using a peak detector.

9.3 *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.

9.4 *Test Results*

JUDGEMENT: Passed

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

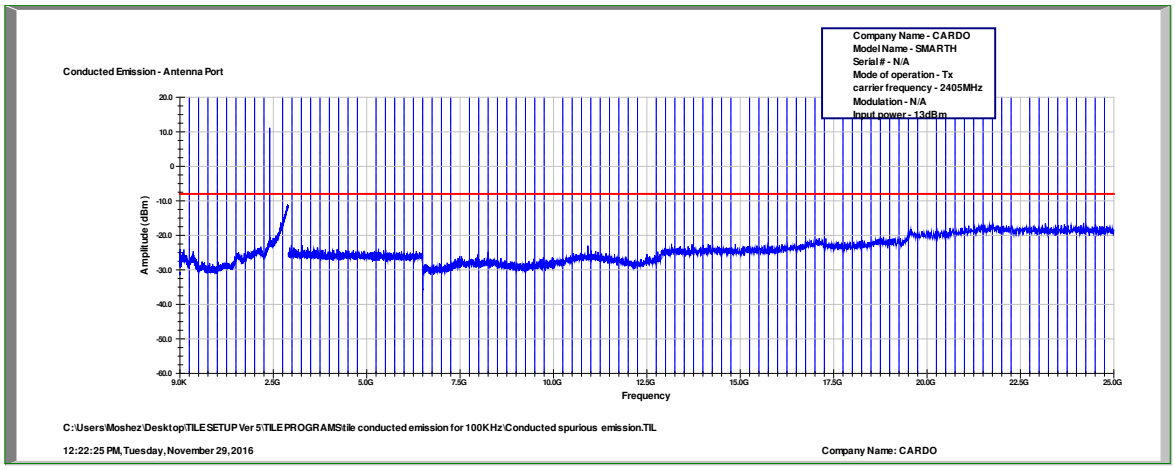

Figure 29 Conducted Spurious Emission – 2405 MHz

9.5 *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
30 dB attenuator	MCL	BW-S30W5	533	July 5, 2016	July 5, 2017

Figure 30 Test Equipment Used

10. Emissions in Restricted Frequency Bands

10.1 *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

10.2 *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, 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 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 4*.

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 2405MHz.

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 31 Table of Limits

10.3 *Test Results*

JUDGEMENT: Passed by 3.1 dB

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

The details of the highest emissions are given in *Figure 32* to *Figure 33.*

Radiated Emission

E.U.T Description	Bluetooth Communication System for Motorcycles
Type	cardo SMARTH
Serial Number:	F463791254

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			Peak Limit	Peak Margin
(MHz)	(MHz)	(H/V)	(dBµV/m)			(dB µV/m)	(dB)
			X axis	Y axis	Z axis		
2405.0	2390.0	H	**49.5**	49.2	49.1	74.0	-24.5
2405.0	2390.0	V	48.3	**49.7**	48.1	74.0	-24.3
2405.0	4810.0	H	**64.5**	63.36	54.1	74.0	-9.5
2405.0	4810.0	V	60.3	**64.2**	54.8	74.0	-9.8
2405.0	7215.0	H	**55.94**	53.86	51.93	74.0	-18.16
2405.0	7215.0	V	54.95	54.74	**56.93**	74.0	-17.17
2405.0	2483.5	H	48.2	47.2	**48.8**	74.0	-25.2
2405.0	2483.5	V	**49.4**	48.1	49.3	74.0	-24.6

Figure 32. 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

Radiated Emission

E.U.T Description: Bluetooth Communication System for Motorcycles
Type: cardo SMARTH
Serial Number: F463791254

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical

Frequency range: 9KHz to 25.0 GHz

Test Distance: 3 meters

Detector: Average
RBW=1MHz,VBW=10Hz

Operation Frequency	Freq.	Polarity	Average Reading			Average Limit	Average Margin
(MHz)	(MHz)	(H/V)	(dBµV/m)			(dB µV/m)	(dB)
			X axis	Y axis	Z axis		
2405.0	2390.0	H	**40.2**	39.1	39.4	54.0	-13.8
2405.0	2390.0	V	39.7	39.5	**40.2**	54.0	-13.8
2405.0	4810.0	H	**50.9**	50.2	45.4	54.0	-3.1
2405.0	4810.0	V	47.3	**49.1**	44.6	54.0	-4.9
2405.0	7215.0	H	**48.9**	47.4	40.5	54.0	-5.1
2405.0	7215.0	V	45.1	**46.6**	43.7	54.0	-7.4
2405.0	2483.5	H	**45.4**	42.4	42.8	54.0	-8.6
2405.0	2483.5	V	**44.0**	43.9	41.9	54.0	-10.0

Figure 33. 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

Intermodulation Radiated Emission

E.U.T Description	Bluetooth Communication System for Motorcycles
Type	cardo SMARTH
Serial Number:	F463791254

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 (MHz)	Polarity (H/V)	Peak Reading (dBµV/m)	Peak Limit (dB µV/m)	Peak Margin (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 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

Intermodulation Radiated Emission

E.U.T Description	Bluetooth Communication System for Motorcycles
Type	cardo SMARTH
Serial Number:	F463791254

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 (MHz)	Polarity (H/V)	AVG. Reading (dBµV/m)	AVG. Limit (dB µV/m)	AVG. Margin (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 35. 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

10.4 *Field Strength Calculation*

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

$$[dB\mu v/m]\ FS = RA + AF + CF$$

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

Example: FS = 30.7 dBμV (RA) + 14.0 dB (AF) + 0.9 dB (CF) = 45.6 dBμV

No external pre-amplifiers are used.

10.5 *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	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 36 Test Equipment Used

11. Transmitted Power Density

11.1 *Test Specification*

FCC, Part 15, Subpart C, Section 247(e)
RSS-247, Issue 1:2015, Clause 5.2(2)

11.2 *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 spectrum analyzer was set to 3 kHz RBW and VBW to 10 kHz.

The E.U.T was evaluated at 2405 MHz.

11.3 *Test Results*

Operation Frequency (MHz)	Reading Spectrum Analyzer (dBm)	Antenna Gain (dBi)	Total PSD (dBm)	Limit (dBm)	Margin (dB)
2405.0	7.13	0	7.13	8.0	-0.9

Figure 37 Test Results

JUDGEMENT: Passed by 0.9dB

For additional information see *Figure 38*.

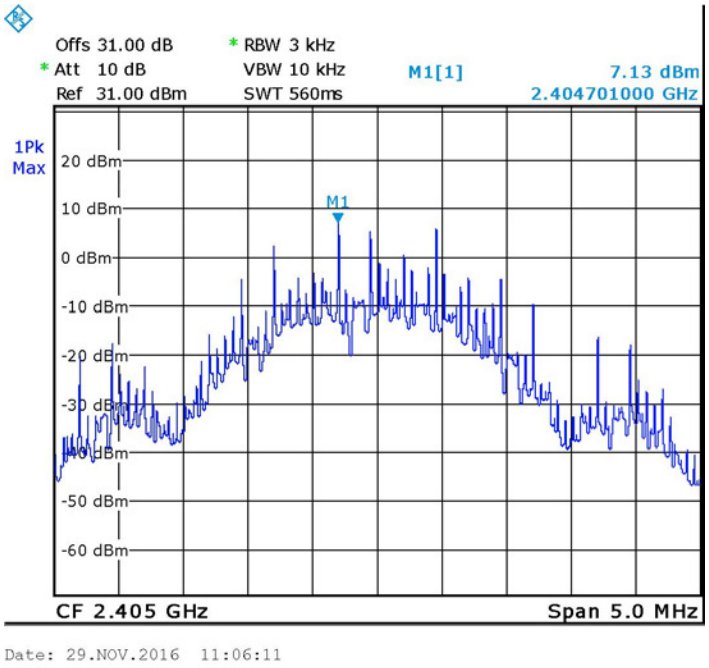

Figure 38 — 2405.0 MHz

11.4 *Test Equipment Used; Transmitted Power Density*

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	FSL6	100194	February 29, 2016	March 1, 2017
30 dB attenuator	MCL	BW-S30W5	533	July 5, 2016	July 5, 2017

Figure 39 Test Equipment Used

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

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

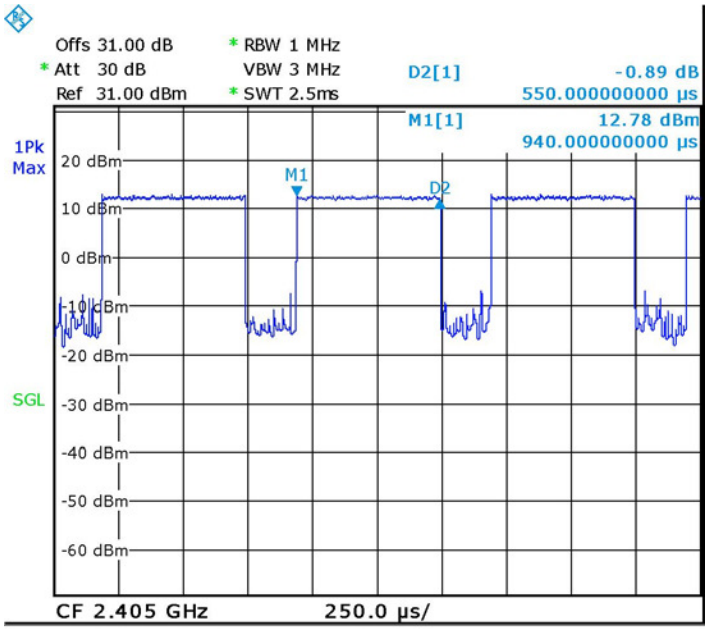

Figure 40. Burst Duration

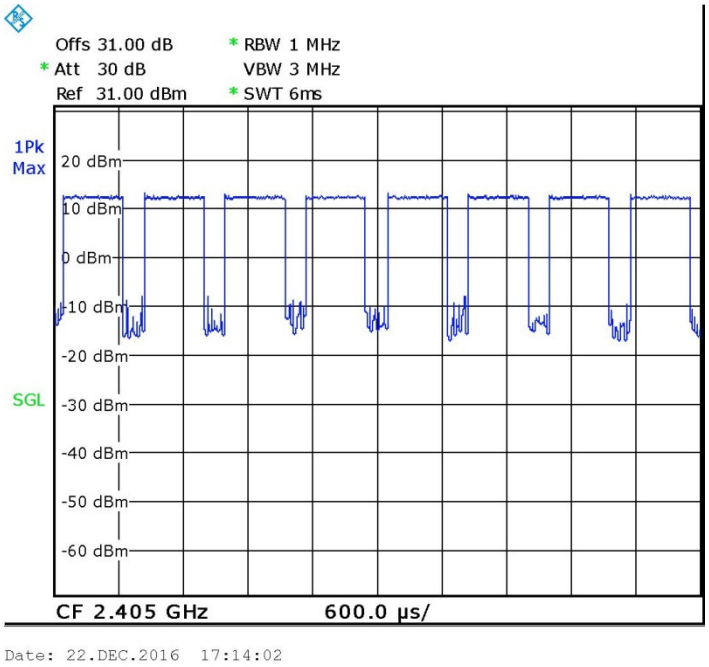

Figure 41. Number of bursts in 6msec=8

13. Antenna Gain/Information

The antenna gain is 0 dBi, integral.

14. 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) = 13.25 dBm=21.1mW.

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

=21.1/20 * 1.55= 1.635 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= 20cm at 2405 MHz.
EUT power transmission is 13.25 dBm=21.1mW.

Taking into account the -4.5dB AVG factor (page 29)
peak power = 13.25- 4.2= 9.05dBm =8.04mW

This is below the 30mW SAR exemption limits.

EUT

15. APPENDIX A - CORRECTION FACTORS

15.1 *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

15.2 *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

15.3 *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*

15.4 *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

15.5 *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

15.6

15.6 *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

15.7 *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