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DATE: 13 November 2018

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

FCC/IC Radio Test Report

for

Cardo Systems Ltd.

Equipment under test:

Bluetooth Communication System for Motorcycles

Original: scala rider FREECOM 4
New: FREECOM 4+

Tested by: _____
M. Zohar

Approved by: _____
D. Shidlowsky

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Measurement/Technical Report for

Cardo Systems Ltd.

Bluetooth Communication System for Motorcycles

Original: scala rider FREECOM 4

New: FREECOM 4+

FCC ID: Q95ER22

IC: 4668A-ER22

This report concerns:	Original Grant:	
	Class I Change:	
	Class II Change:	X

Equipment type:	FCC: DTS Digital Transmission System IC: Spread Spectrum Digital Device (2400-2483.5)
Limits used:	47CFR15 Section 15.247 RSS 247, Issue 2, February 2017, Section 5 RSS-Gen, Issue 5, April 2018

Measurement procedures used are FCC Public Notice DA-00-705 and ANSI C63.10: 2013.

Application for Certification
prepared by:
R. Pinchuck
ITL (Product Testing) Ltd.
1 Bat Sheva Street
Lod 7116002
Israel
e-mail Rpinchuck@itlglobal.org

Applicant for this device:
(different from "prepared by")
Amit Davidson
Cardo Systems Ltd.
811 E. Plano Parkway, Suite 110A
Plano, Texas, USA, 75074
Tel: +1 (214) 396-1196
Fax: +1 (214) 276-7844
Email: amitd@cardosystems.com

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1. General Information

1.1 *Administrative Information*

Manufacturer:	Cardo Systems Ltd.
Manufacturer's Address:	811 E. Plano Parkway Suite 110A Plano, Texas USA, 75074 Tel: +1 (214) 396-1196 Fax: +1 (214) 276-7844
Manufacturer's Representative:	Amit Davidson
Equipment Under Test (E.U.T):	Bluetooth Communication System for Motorcycles
PMN:	Original: scala rider FREECOM 4 New: FREECOM 4+
Equipment Serial No.:	Not designated
HVIN:	1
Date of Receipt of E.U.T:	July 26, 2018
Start of Test:	July 26, 2018
End of Test:	October 7, 2018
Test Laboratory Location:	I.T.L (Product Testing) Ltd. 1 Batsheva St., Lod ISRAEL 7120101
Test Specifications:	47CFR15 Section 15.247 RSS 247, Issue 2, February 2017, Section 5 RSS-Gen, Issue 5, April 2018

1.2 *List of Accreditations*

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

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

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

1.3 *Product Description*

This product is a Bluetooth communication system, Bluetooth intercom for motorbikes and FM Radio receiver.

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

1 GHz to 6 GHz
Expanded Uncertainty (95% Confidence, K=2):
±5.19 dB

>6 GHz
Expanded Uncertainty (95% Confidence, K=2):
±5.51 dB

2. System Test Configuration

2.1 *Justification*

1. The E.U.T. was originally FCC certified on 02/14/2017 under FCC ID: Q95ER22 and IC certified on 1/31/2017 under IC: 4668A-ER22.
2. Currently, C2PC changes were made to the original E.U.T. which will now be known as the FREECOM 4+. See customer's declaration of changes on page 9.
3. A C2PC is requested based on those changes. The following tests were performed: occupied bandwidth, peak output power and spurious radiated emissions.
4. The E.U.T. met the requirements of a C2PC.
5. The E.U.T contains an IEEE 802.15.1 standard (BLE) transceiver.
6. The unit was evaluated while transmitting at the low channel (2402MHz), the mid channel (2440MHz) and the high channel (2480MHz).
7. Conducted emission method was performed with EUT connected to spectrum analyzer via 30dB attenuator.
8. Final radiated emission test for spurious emission for the new model was performed after exploratory emission testing that was performed in 3 orthogonal polarities to determine the "worst case" radiation.
9. According to the following results the worst case axis was the Y axis for all channels.

Orientation	Frequency	2nd Harmonic	3rd Harmonic
	(MHz)	(dBuV/m)	(dBuV/m)
X axis	2402.0	50.5	59.0
	2440.0	49.9	58.1
	2480.0	52.7	53.9
Y axis	**2402.0**	**52.4**	**62.9**
	2440.0	**51.5**	**63.1**
	2480.0	**52.9**	**57.9**
Z axis	2402.0	47.0	59.1
	2440.0	50.1	60.9
	2480.0	50.0	51.6

Figure 1. Screening Results

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*

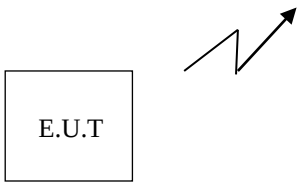


Figure 2. Configuration of Tested System, Radiated

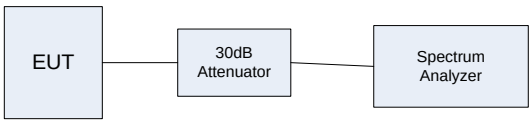


Figure 3. Configuration of Tested System, Conducted

Date: June 13, 2018

To: FCC

FCC: Q95ER22

To whom it may concern,

The previously certified device, the scala rider FREECOM2 & FREECOM4 received FCC certification on FEB 14, 2017 under FCC: Q95ER22.

Subsequently, in the new device, the FREECOM 4+, the following changes were made:

1. Added some new decorative mechanical feature to the housing.
2. Added U11 – Optimize charger protection.
3. Added SW5 – encoder for volume settings.
4. Adding the following passive for U11 component operation:
   R93,C18,C108,C116,L5,C117,C109,C110,R96,R95,C118

Thank you,

Amit Davidson, HW manager

Cardo Systems, Ltd.
811 E. Plano Parkway, Ste. 110a
Plano, TX. 75074, USA

3. Conducted & Radiated Measurement Test Set-Up Photos

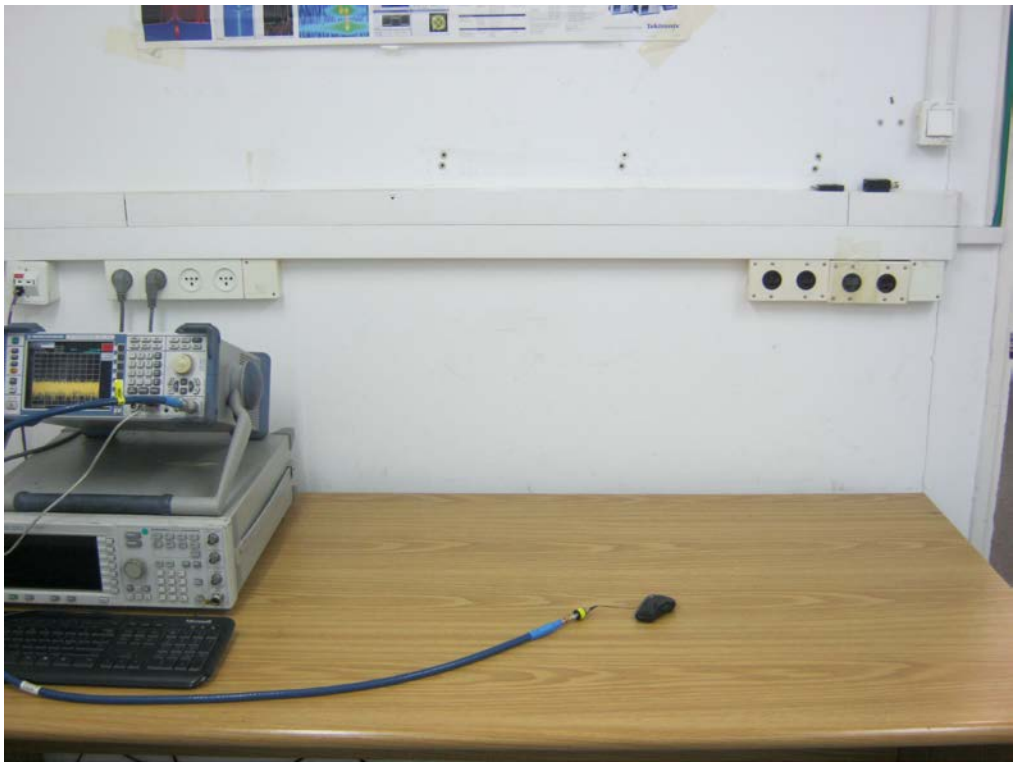


Figure 4. Conducted Emission Test

Figure 5. Radiated Emission Test, 30-200MHz

Figure 6. Radiated Emission Test, 200-1000MHz

Figure 7. Radiated Emission Test, 1-18GHz

4. Occupied Bandwidth

4.1 *Test Specification*

F.C.C. Part 15, Subpart C: section 2.1048

RSS Gen, Issue 4, November 2014

4.2 *Test Procedure*

(Temperature (22°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. The spectrum analyzer was set to the following parameters:
Span = ~ 1.5 to 5 times the OBW
RBW = between 1% to 5% of the OBW
Detector Function: Peak, Trace: Maximum Hold.

4.3 *Test Limit*

N/A

4.4 *Test Results*

Unit type	Modulation	Operation Frequency	Bandwidth Reading
		(MHz)	(kHz)
4+	BLE	2402.0	1029.9
		2440.0	1029.9
		2480.0	1029.9

Figure 8 Test Results

JUDGEMENT: Passed

For additional information see *Figure 9* to *Figure 11*.

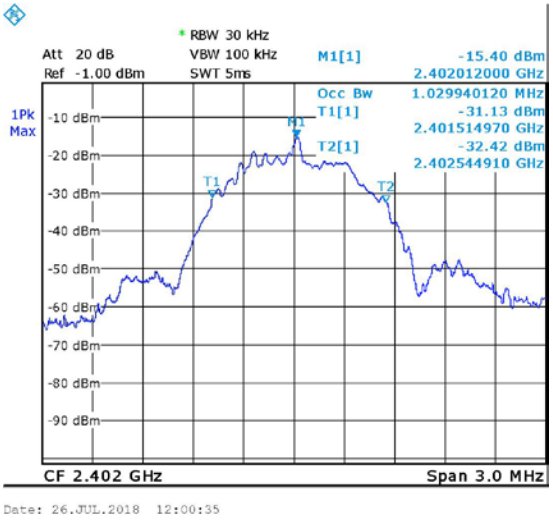


Figure 9. BLE, Low

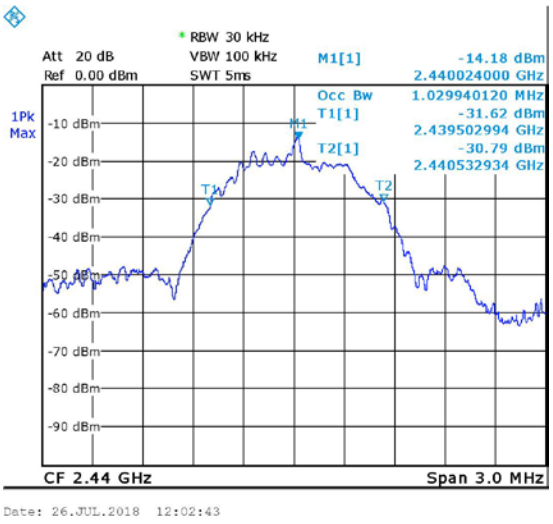


Figure 10. BLE, Mid

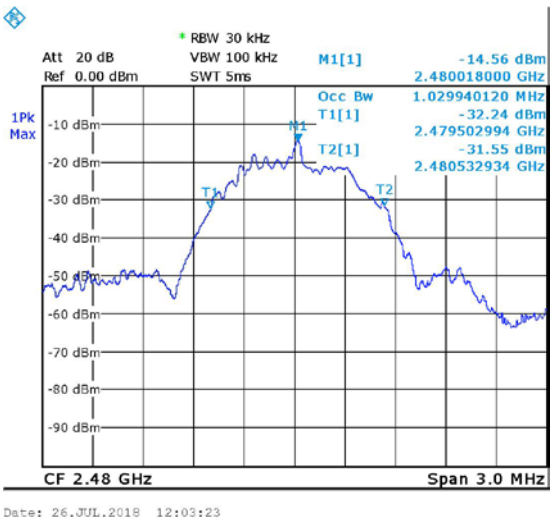


Figure 11. BLE, High

4.5 *Test Equipment Used, Occupied Bandwidth*

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
RF Cable	Commscope ORS	0623 WBC-400	G020132-	October 1, 2017	October 31, 2018
30dB Attenuator	MCL	BW-S30W5	533	October 1, 2017	October 31, 2018
Spectrum Analyzer	Rohde & Schwarz	FSL6	100194	February 19, 2018	February 19, 2019
RF Cable (OATS)	EIM	RG214-11N(X2)	-	August 13, 2018	August 31, 2019

Figure 12 Test Equipment Used

5. Peak Output Power

5.1 *Test Specification*

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

5.2 *Test Procedure*

(Temperature (22°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.

5.3 *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 watts. (The limits above applies to antenna gain until 6dBi).

5.4 *Test Results*

JUDGEMENT: Passed by 932.4 mW

Unit	Modulation	Operation Frequency	Power	Power	Limit	Margin
(Original/New)		(MHz)	(dBm)	(mW)	(mW)	(mW)
Original	BLE	2402.0	17.4	55.0	1000.0	-945.0
		2440.0	18.3	67.6	1000.0	-932.4
		2480.0	17.5	56.2	1000.0	-943.8
New	BLE	2402.0	16.9	49.0	1000.0	-951.0
		2440.0	18.0	63.1	1000.0	-936.9
		2480.0	17.4	55.0	1000.0	-945.0

Figure 13 Radiated Power Output Test Results

5.5 *Test Equipment Used, Radiated Maximum Power Output*

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
RF Cable	Huber Suner	Sucofelex	27502/4PEA	October 1, 2017	October 31, 2018
30dB Attenuator	MCL	BW-S30W5	533	October 1, 2017	October 31, 2018
Spectrum Analyzer	Rohde & Schwarz	FSL6	100194	February 19, 2018	February 19, 2019

Figure 14 Test Equipment Used

6. Spurious Radiated Emissions

6.1 *Test Specification*

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

6.2 *Test Procedure*

(Temperature (22°C)/ Humidity (60%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 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.

6.3 *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.

6.4 *Test Results*

JUDGEMENT: Passed

The EUT met the requirements of the F.C.C. Part 15, Subpart C 209 and RSS Gen, Issue 4, Section 8.10 specification.

For additional information see *Figure 15.*

Spurious Radiated Emission

Specification: FCC, Part 15, Subpart C; Sections 15.209, 15.205, 15.247(d);
RSS Gen, Issue 4, Section 8.10

Antenna Polarization: Horizontal/Vertical
Frequency range: 9 kHz to 25.0 GHz
Protocol type: BLE
Detectors: Peak

Unit	Operation Frequency	Freq.	Pol	Peak Reading	Peak Limit	Peak Margin
(Original/New)	(MHz)	(MHz)	(H/V)	(dBµV/m)	(dBµV/m)	(dB)
Original	2402.0	4804.0	V	50.5	74.0	-23.5
		4804.0	H	53.9	74.0	-20.1
		7206.0	V	51.3	74.0	-22.7
		7206.0	H	63.4	74.0	-10.6
	2440.0	4880.0	V	50.5	74.0	-23.5
		4880.0	H	52.9	74.0	-21.1
		7320.0	V	50.6	74.0	-23.4
		7320.0	H	60.7	74.0	-13.3
	2480.0	4960.0	V	52.2	74.0	-21.8
		4960.0	H	53.5	74.0	-20.5
		7440.0	V	50.8	74.0	-23.2
		7440.0	H	58.0	74.0	-16.0
New (4+)	2402.0	4804.0	V	49.9	74.0	-24.1
		4804.0	H	55.1	74.0	-18.9
		7206.0	V	50.1	74.0	-23.9
		7206.0	H	62.7	74.0	-11.3
	2440.0	4880.0	V	51.8	74.0	-22.2
		4880.0	H	55.0	74.0	-19.0
		7320.0	V	52.5	74.0	-21.5
		7320.0	H	62.8	74.0	-11.2
	2480.0	4960.0	V	54.0	74.0	-20.0
		4960.0	H	55.0	74.0	-19.0
		7440.0	V	51.0	74.0	-23.0
		7440.0	H	60.7	74.0	-13.3

Figure 15. Radiated Emission Results - BLE

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

6.5 *Test Equipment Used, Spurious Radiated Emissions*

Instrument	Manufacturer	Model	Serial Number	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	February 19, 2018	February 19, 2019
Spectrum Analyzer	HP	8592L	3826A01204	February 19, 2018	February 19, 2019
EMI Receiver	HP	8542E	3906A00276	February 19, 2018	February 19, 2019
RF Filter Section	HP	85420E	3705A00248	February 19, 2018	February 19, 2019
Horn Antenna	ETS	3115	29845	May 31, 2018	May 31 2021
Horn Antenna	ARA	SWH-28	1007	December 13, 2017	December 13, 2020
Log Periodic Antenna	EMCO	3146	9505-4081	May 31, 2018	May 31, 2019
Biconical Log Antenna	EMCO	3110B	9912-3337	May 15, 2017	May 15, 2019
Active Loop Antenna	EMCO	6502	9506-2950	October 19, 2017	October 31, 2018
Low Noise Amplifier	DBS MICROWAVE	LNA-DBS-0411N313	013	October 1, 2017	October 31, 2018
Low Noise Amplifier	Sophia Wireless	LNA 28-B	232	October 1, 2017	October 31, 2018
RF Cable	Commscope ORS	0623 WBC-400	G020132-	October 1, 2017	October 31, 2018
RF Cable (OATS)	EIM	RG214-11N(X2)	-	August 13, 2018	August 31, 2019
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR
Antenna Mast	ETS	2070-2	9608-1497	NCR	NCR
Turntable	ETS	2087	-	NCR	NCR
Mast & Table Controller	ETS/EMCO	2090	9608-1456	NCR	NCR

Figure 16 Test Equipment Used

7. R.F Exposure/Safety

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

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 =18.0 dBm =63.1mW

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

63.1/40 * 1.55=2.45 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.

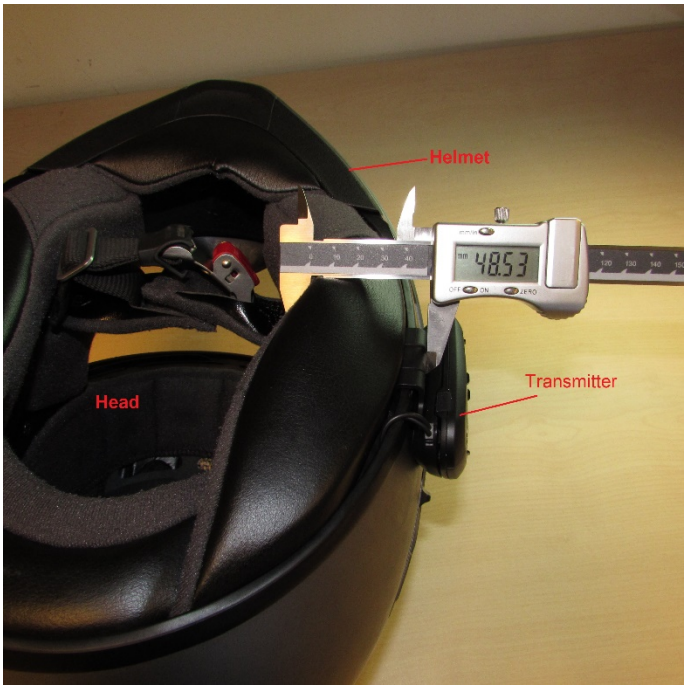
For IC

(a) For IC per Table 1 of RSS 102 Issue 5, SAR exemption based on IC limit of 173.0mW at a separation distance of 40mm= 4.0cm at 2450 MHz.

EUT power transmission is 18.0dBm =63.1mW

This is below the 173.0mW SAR exemption limits.

See photos on following page.


Helmet
48.53
Transmitter
Head

8. APPENDIX A - CORRECTION FACTORS

8.1 *Correction factors for RF OATS Cable 35m ITL #1879*

Frequency (MHz)	Cable loss (dB)
30.0	1.1
50.0	1.1
100.0	1.7
150.0	2.1
200.0	2.5
250.0	2.7
300.0	2.9
350.0	3.1
400.0	3.5
450.0	3.7
500.0	3.9
550.0	4.0
600.0	4.2
650.0	4.4
700.0	4.9
750.0	5.0
800.0	5.0
850.0	4.9
900.0	5.0
950.0	5.1
1000.0	5.4

8.2 *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

8.3 *Correction factors for Active Loop Antenna*

Model 6502 S/N 9506-2950

ITL # 1075:

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

8.4 *Correction factors for biconical antenna – ITL # 1356*

Model: EMCO 3110B

Serial No.:9912-3337

Frequency	**ITL 1356 AF**
[MHz]	**[dB/m]**
30	13.00
35	10.89
40	10.59
45	10.63
50	10.12
60	9.26
70	7.74
80	6.63
90	8.23
100	11.12
120	13.16
140	13.07
160	14.80
180	16.95
200	17.17

8.5 *Correction factors for log periodic antenna – ITL # 1349*

Model: EMCO 3146

Serial No.:9505-4081

Frequency	**ITL 1349 AF**
[MHz]	**[dB/m]**
200	11.58
250	12.04
300	14.76
400	15.55
500	17.85
600	18.66
700	20.87
800	21.15
900	22.32
1000	24.22

8.6 *Correction factors for Double –Ridged Waveguide Horn ANTENNA*

Model: 3115
Serial number:29845
3 meter range; ITL # 1352

FREQUENCY (GHz)	AFE (dB/m)	FREQUENCY (GHz)	AFE (dB/m)
0.75	25	9.5	38
1.0	23.5	10.0	38.5
1.5	26.0	10.5	38.5
2.0	29.0	11.0	38.5
2.5	27.5	11.5	38.5
3.0	30.0	12.0	38.0
3.5	31.5	12.5	38.5
4.0	32.5	13.0	40.0
4.5	32.5	13.5	41.0
5.0	33.0	14.0	40.0
5.5	35.0	14.5	39.0
6.0	36.5	15.0	38.0
6.5	36.5	15.5	37.5
7.0	37.5	16.0	37.5
7.5	37.5	16.5	39.0
8.0	37.5	17.0	40.0
8.5	38.0	17.5	42.0
9.0	37.5	18.0	42.5

8.7 *Correction factors for* *Horn Antenna*

Model: SWH-28
at 3 meter range.
ITL #:1353

CALIBRATION DATA

3 m distance

Frequency, MHz	Measured antenna factor, dB/m [1]
18000	32.4
18500	32.0
19000	32.3
19500	32.4
20000	32.3
20500	32.8
21000	32.8
21500	32.7
22000	33.1
22500	33.0
23000	33.1
23500	33.8
24000	33.5
24500	33.5
25000	33.8
25500	33.9
26000	34.2
26500	34.7

[1] The antenna factor shall be added to receiver reading in dBµV to obtain field strength in dBµV/m.