



FCC / ISED Test Report

FOR:

Zonar Systems

Model Name:

V4

Product Description:

Vehicle mounted telematics device

FCC ID: SEJ-V4

IC ID: 5226A-V4

Applied Rules and Standards:

47 CFR Part 15.247 (DTS)

RSS-247 Issue 2 (DTSs) & RSS-Gen Issue 4

REPORT #: EMC_ZONAR-016-17001_15.247_DTS

DATE: 2018-03-06



A2LA Accredited

IC recognized #
3462B-2

CETECOM Inc.

411 Dixon Landing Road ♦ Milpitas, CA 95035 ♦ U.S.A.

Phone: + 1 (408) 586 6200 ♦ Fax: + 1 (408) 586 6299 ♦ E-mail: info@cetecom.com ♦ <http://www.cetecom.com>
CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations and the relevant ISSED Canada standard RSS-247.

No deviations were ascertained.

Company	Description	Model #
Zonar Systems	Vehicle mounted telematics device	V4

Responsible for Testing Laboratory:

2018-03-06	Compliance	James Donnellan (Lab Manager)	
Date	Section	Name	Signature

Responsible for the Report:

2018-03-06	Compliance	Elijah Garcia (EMC Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section 3.

CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Director Radio Com. and EMC:	Peter Nevermann
Lab Manager:	James Donnellan
Responsible Project Leader:	Ruther Navarro

2.2 Identification of the Client

Applicant's Name:	Zonar Systems
Street Address:	18200 Cascade Avenue South
City/Zip Code	Seattle, WA 98188
Country	USA
Contact Person:	David Pascoe
Phone No.	+1 (206) 878 2459
e-mail:	David.pascoe@zonarsystems.com

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as Applicant
Manufacturers Address:	-----
City/Zip Code	-----
Country	-----

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	V4
HW Version :	1
SW Version :	4
FCC-ID :	SEJ-V4
IC-ID:	5266A-V4
HVIN:	V4
Product Description:	Vehicle mounted telematics device
Frequency Range / number of channels:	Nominal band: 2400 MHz – 2483.5 MHz; Center to center: 2402 MHz (Ch. 0) – 2480 MHz (Ch. 39), 40 channels
Type(s) of Modulation:	Bluetooth version 4.0, Low Energy, using Dynamic Sequence Spread Spectrum with GFSK modulation.
Modes of Operation:	Bluetooth LE in both advertising and connected mode of operation
Antenna Information as declared:	max gain 0.5 dBi
Max. Peak Output Power:	Conducted Power 8.17 dBm (see FCC ID: SQGBT900 for Laird BT900 module report)
Power Supply/ Rated Operating Voltage Range:	Vmin: 8.0 VDC / Vnom: 12 VDC / Vmax: 30 VDC
Operating Temperature Range	-40 °C to 85 °C
Other Radios included in the device:	ublox TOBY-L200-02S-00; FCC ID: XPYTOBYL200; IC ID: 8595A-TOBYL200 ublox Ella-W131; FCC ID: PV7-WIBEAR11N-SF1; IC ID: 7738A-WB11NSF1
Sample Revision	☐ Prototype Unit; ☒ Production Unit; ☐ Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	18999166	1	4	Radiated Emissions

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	DC Power Supply	3003B	Protek	AC, 2648
2	Laptop	E5420	Dell	JYCNLQ1

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#2	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software that is not available to the end user. The measurement equipment was connected to the 50 ohm RF port of the EUT.
2	EUT#1	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software that is not available to the end user. The internal antenna was connected.
3	EUT#1 + AE#1 + AE#2	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software that is not available to the end user. The internal antenna was connected.

3.5 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low, mid and high channels, and highest possible duty cycle of 50%. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 of ISED Canada.

This test report is to support a request for new equipment authorization under the FCC ID: SEJ-V4 IC ID: 5266A-V4

Testing procedures are based on 558074 D01 DTS Meas Guidance v04 – “GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247” - April 5, 2017, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(a)(1) RSS-247 5.2(1)	Emission Bandwidth	Nominal	BTLE	☐	☐	☒	Note 2
§15.247(e) RSS-247 5.2(2)	Power Spectral Density	Nominal	BTLE	☐	☐	☒	Note 2
§15.247(b)(1) RSS-247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal	BTLE	☐	☐	☒	Note 2
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	BTLE	☐	☐	☒	Note 2
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	BTLE	☐	☐	☒	Note 2
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions- Radiated	Nominal	BTLE	☒	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	BTLE	☐	☒	☐	NA

Note: NA= Not Applicable; NP= Not Performed.

Note 2: Data leveraged from modular approval FCC ID: SQGBT900

6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

Radiated measurement

9 kHz to 30 MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

Conducted measurement

150 kHz to 30 MHz	±0.7 dB (LISN)
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RF conducted measurement	±0.5 dB
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According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: <http://physics.nist.gov/cuu/Uncertainty/typeb.html>. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

6.1 Environmental Conditions During Testing:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25° C
- Relative humidity: 40-60%

6.2 Dates of Testing:

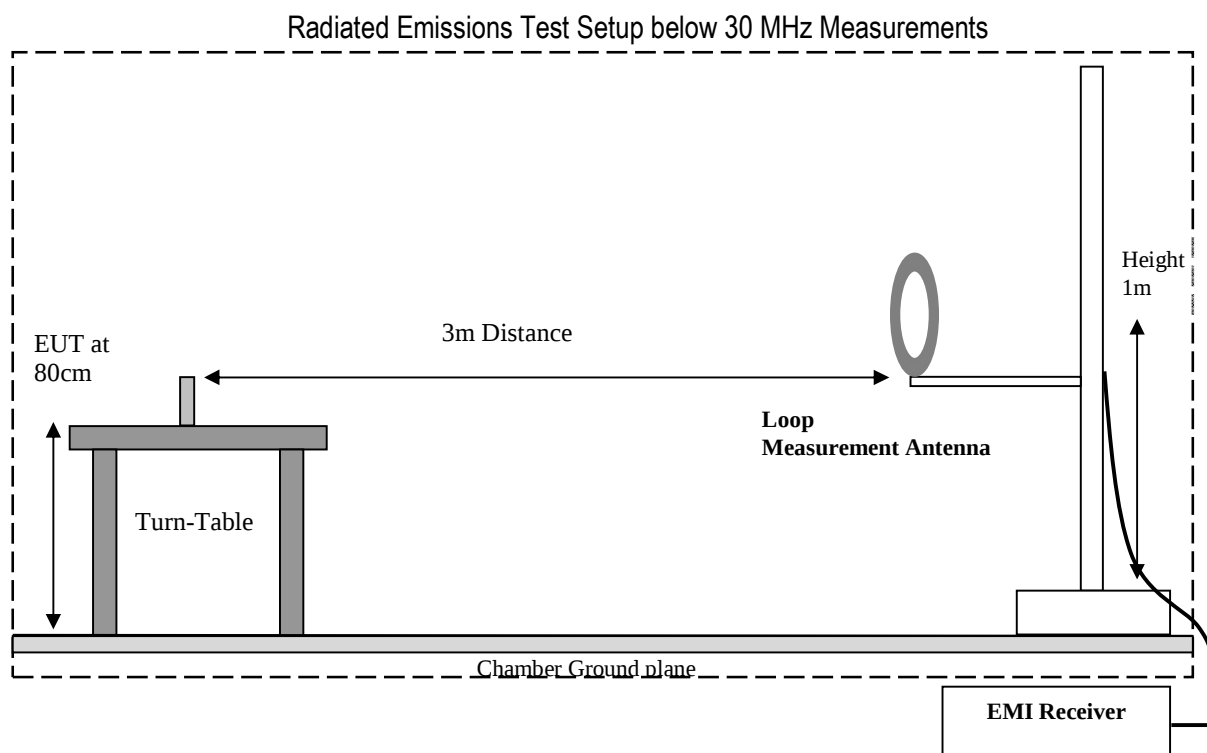
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7 Measurement Procedures

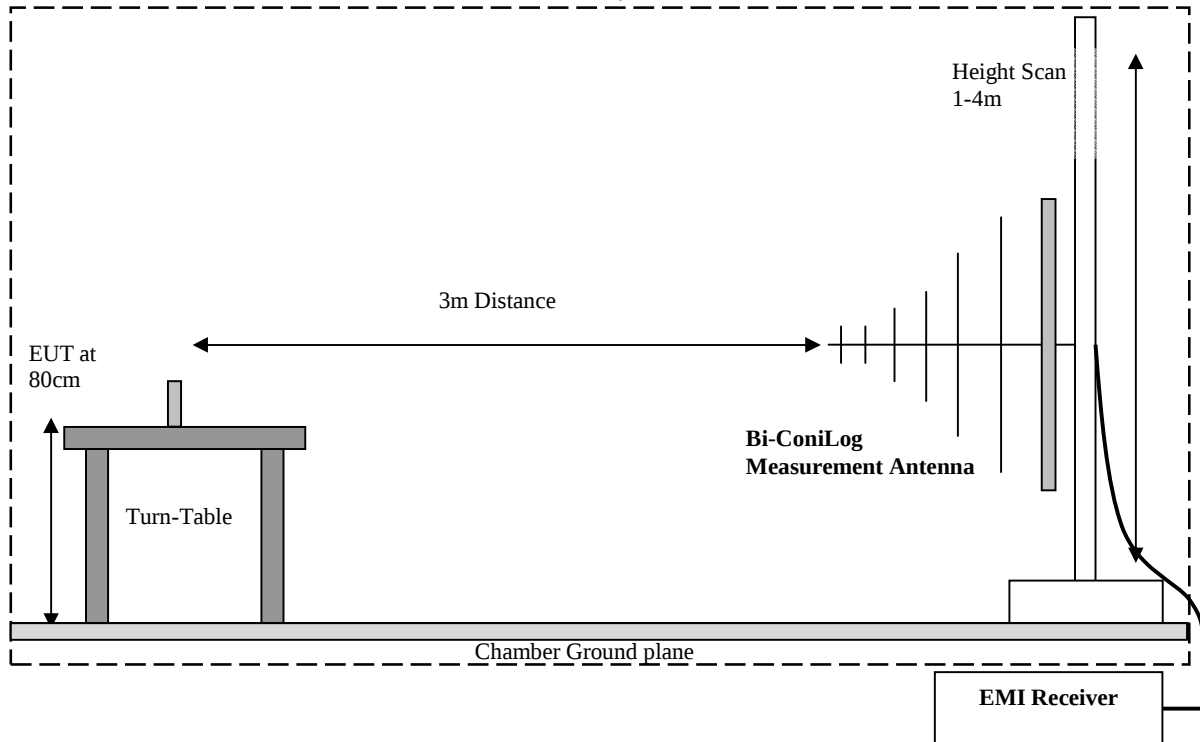
7.1 Radiated Measurement

The radiated measurement is performed according to ANSI C63.10 (2013)

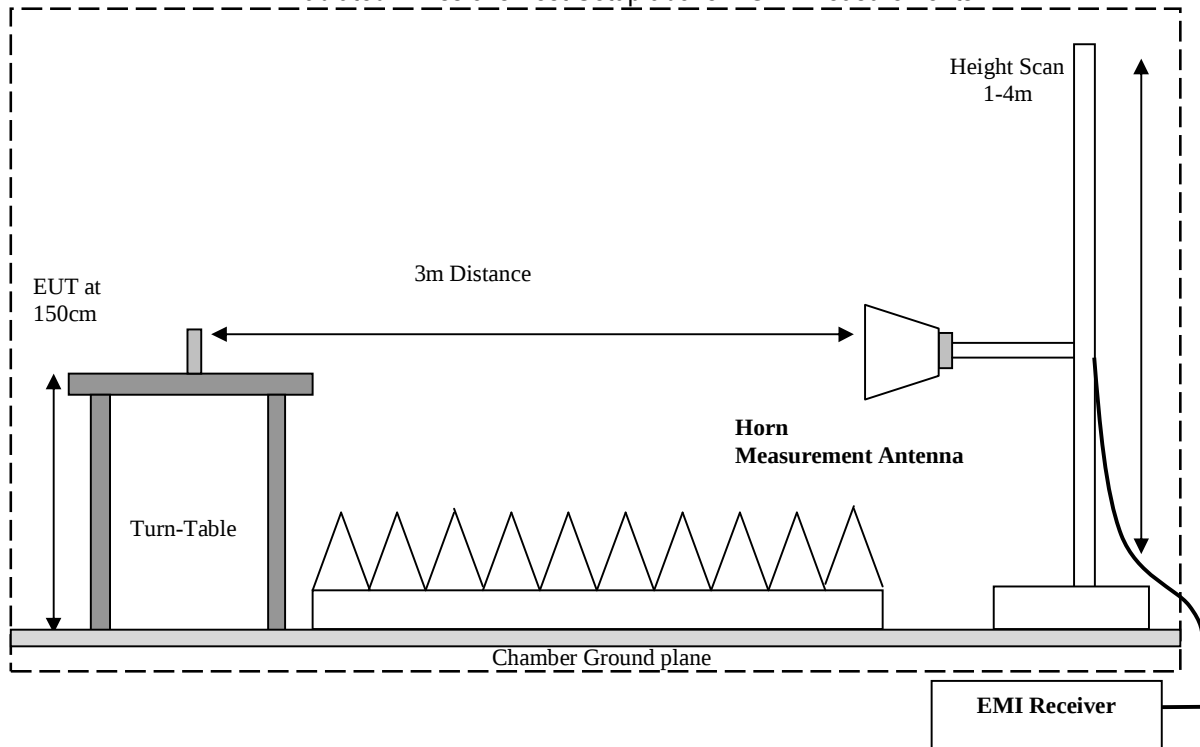
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.



Radiated Emissions Test Setup 30 MHz-1 GHz Measurements



Radiated Emissions Test Setup above 1 GHz Measurements



7.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/Receiver readings; taking into account the following parameters:

1. Measured reading in dB μ V
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} - \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

Example:

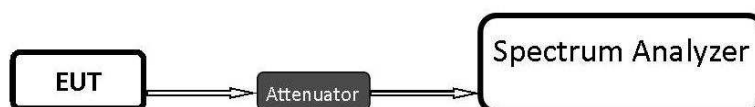
Frequency (MHz)	Measured SA (dB μ V)	Cable Loss (dB)	Antenna Factor Correction (dB/m)	Field Strength Result (dB μ V/m)
1000	80.5	3.5	14	98.0

7.2 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: ANSI C63.4 (2014)

7.3 RF Conducted Measurement Procedure

Testing procedures are based on 558074 D01 DTS Meas Guidance v04 – “GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247” - April 5, 2017, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.



- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.

8 Test Result Data

8.1 Radiated Transmitter Spurious Emissions and Restricted Bands

8.1.1 Measurement according to ANSI C63.10 (2013)

Spectrum Analyzer Settings:

- Frequency = 9 kHz – 30 MHz
- RBW = 9 kHz
- Detector: Peak

- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW= 120 kHz (<1 GHz)

- Frequency > 1 GHz
- Detector = Peak / Average
- RBW = 1 MHz

- Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements.
- The highest (or worst-case) data rate shall be recorded for each measurement.
- For testing at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow: Conversion factor (CF) = $40 \log (D/d) = 40 \log (300\text{m} / 3\text{m}) = 80\text{dB}$

8.1.2 Limits:

FCC §15.247

- In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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)).

FCC §15.209 & RSS-Gen 8.9

- Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency of emission (MHz)	Field strength (μV/m)	Measurement Distance (m)	Field strength @ 3m (dBμV/m)
0.009–0.490	2400/F(kHz) / -----	300	-
0.490–1.705	24000/F(kHz) / -----	30	-
1.705–30.0	30 / (29.5)	30	-
30–88	100	3	40 dBμV/m
88–216	150	3	43.5 dBμV/m
216–960	200	3	46 dBμV/m
Above 960	500	3	54 dBμV/m

FCC §15.205 & RSS-Gen 8.10

- Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- 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)).

*PEAK LIMIT= 74 dBμV/m

*AVG. LIMIT= 54 dBμV/m

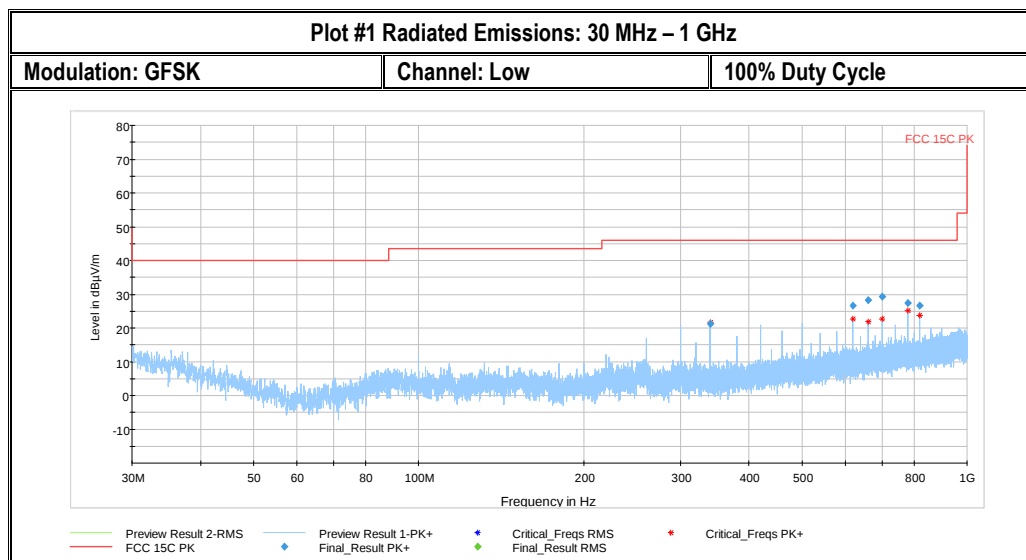
8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	2	GFSK continuous fixed channel	12VDC

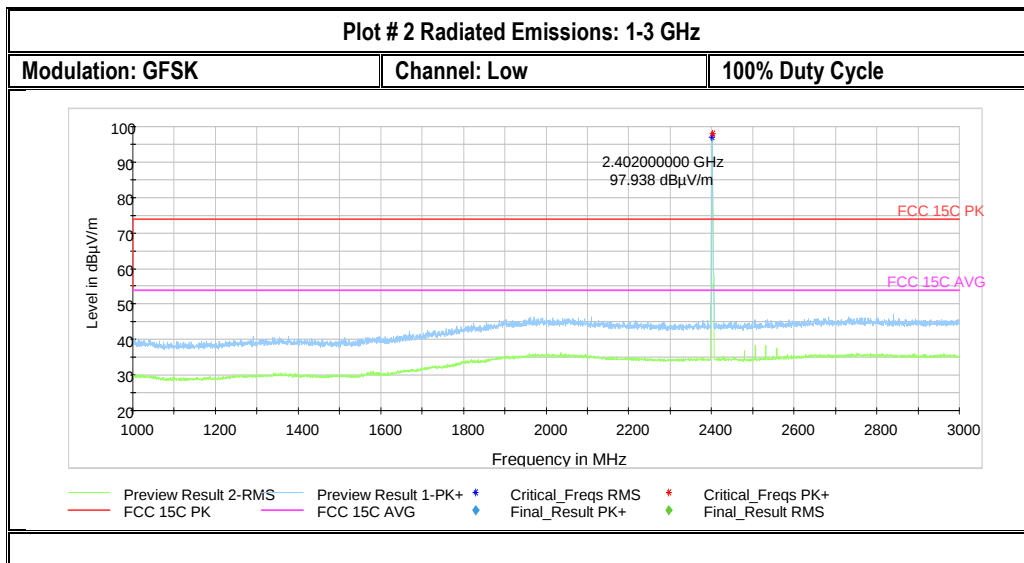
8.1.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-3	Low	30 MHz – 18 GHz	See section 8.5.2	Pass
4-8	Mid	9 kHz – 26 GHz	See section 8.5.2	Pass
9-11	High	30 MHz – 18 GHz	See section 8.5.2	Pass

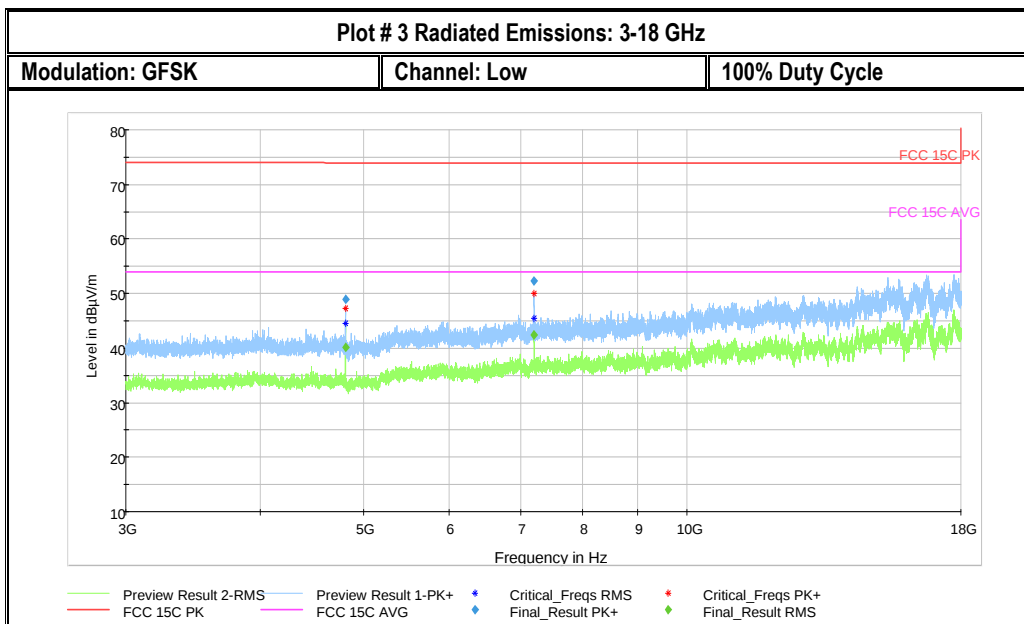
8.1.5 Measurement Plots:



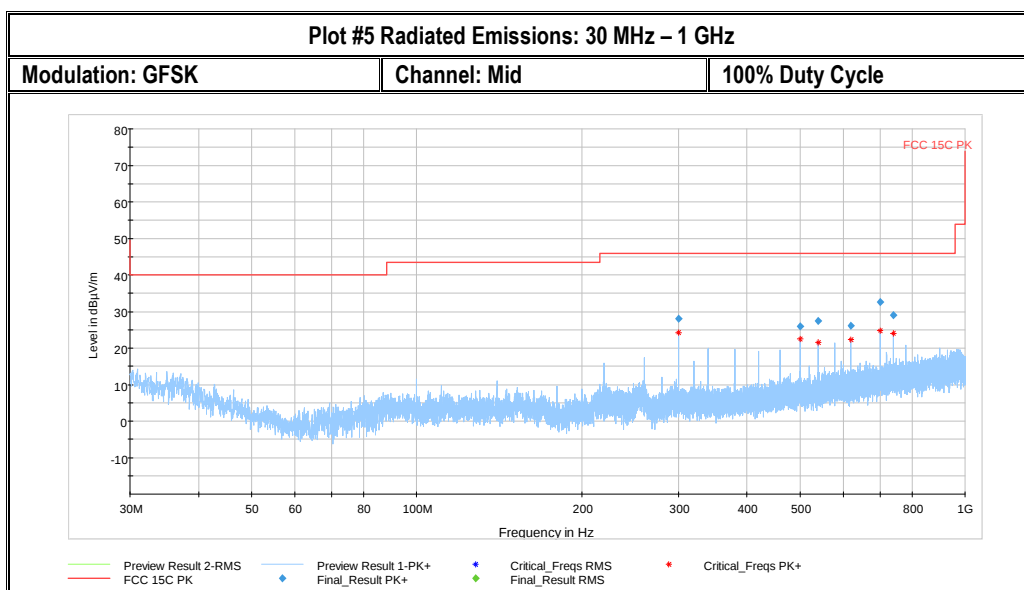
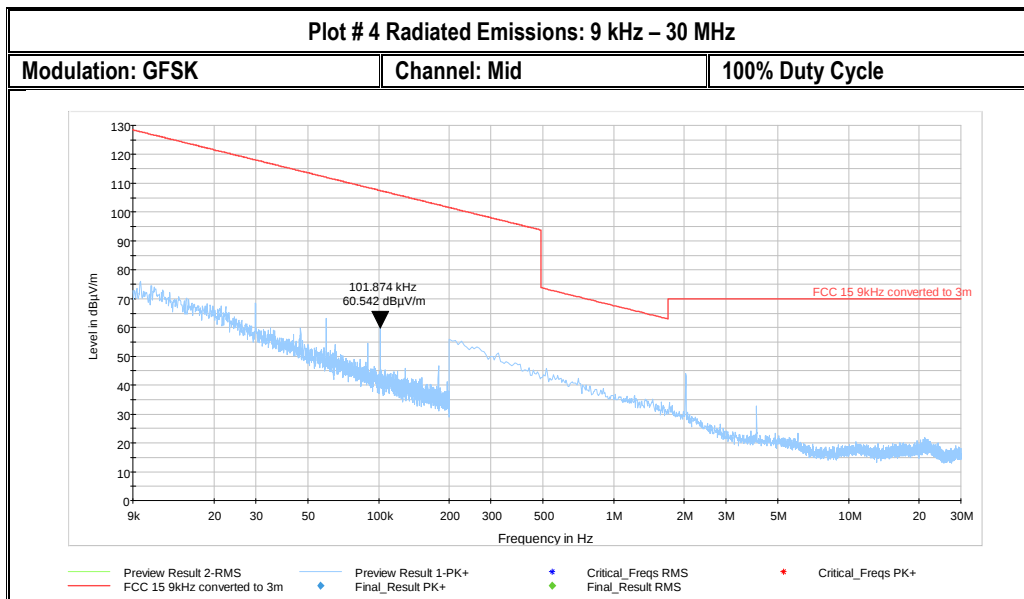
Frequency (MHz)	Max Peak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
340.001505	21.31	---	46.00	24.69	100.0	120.000	151.0	H	100.0
620.005609	26.59	---	46.00	19.41	100.0	120.000	100.0	V	260.0
660.003220	28.27	---	46.00	17.73	100.0	120.000	100.0	V	-16.0
700.012936	29.18	---	46.00	16.82	100.0	120.000	116.0	H	-23.0
780.013619	27.51	---	46.00	18.49	100.0	120.000	100.0	H	13.0
820.002294	26.67	---	46.00	19.33	100.0	120.000	177.0	H	-12.0



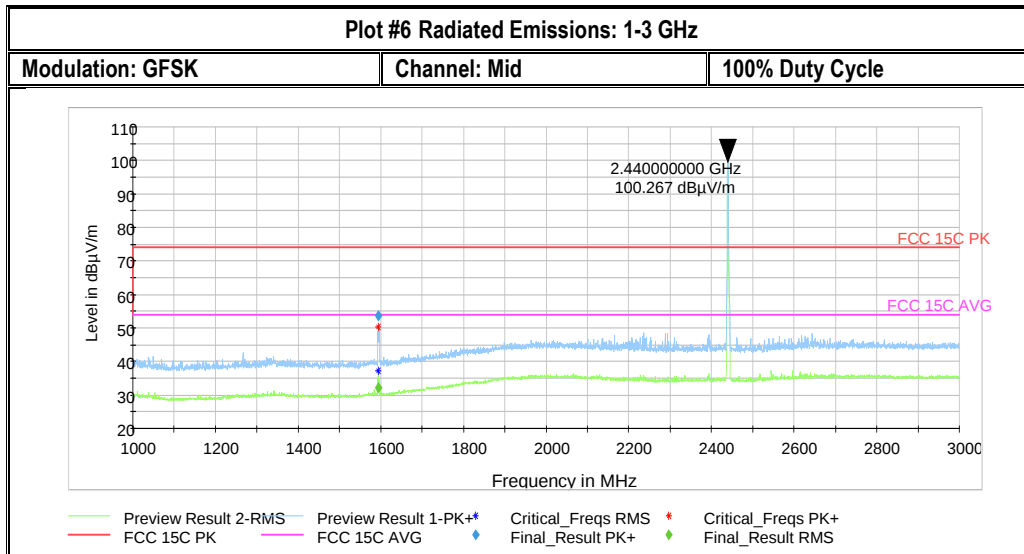
Note: Intentional Transmission occurring on Bluetooth low channel: 2402 MHz



Frequency (MHz)	Max Peak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4804.387667	48.94	---	73.99	25.04	200.0	1000.000	124.0	V	84.0
4804.401867	---	40.16	53.98	13.82	200.0	1000.000	190.0	H	261.0
7205.255200	---	42.47	53.98	11.51	200.0	1000.000	141.0	V	253.0
7206.421033	52.30	---	73.99	21.68	200.0	1000.000	100.0	V	-77.0

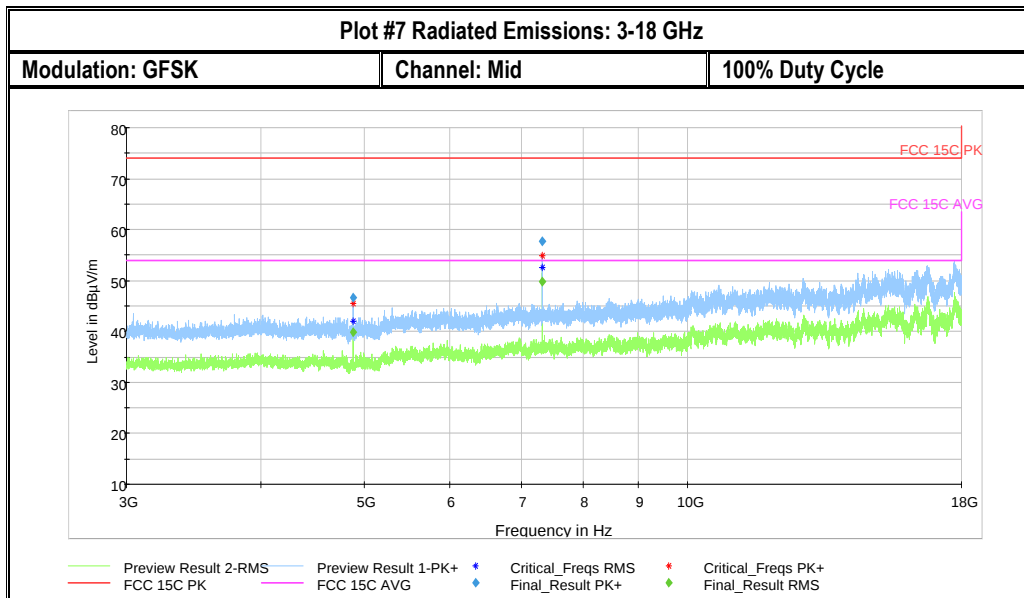


Frequency (MHz)	Max Peak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
299.995333	28.02	---	46.00	17.98	100.0	120.000	100.0	H	299.0
500.003022	25.98	---	46.00	20.02	100.0	120.000	100.0	V	103.0
540.002028	27.52	---	46.00	18.48	100.0	120.000	100.0	V	237.0
620.005860	26.11	---	46.00	19.89	100.0	120.000	100.0	V	5.0
700.004430	32.55	---	46.00	13.45	100.0	120.000	108.0	H	289.0
739.994756	28.99	---	46.00	17.01	100.0	120.000	117.0	H	-38.0

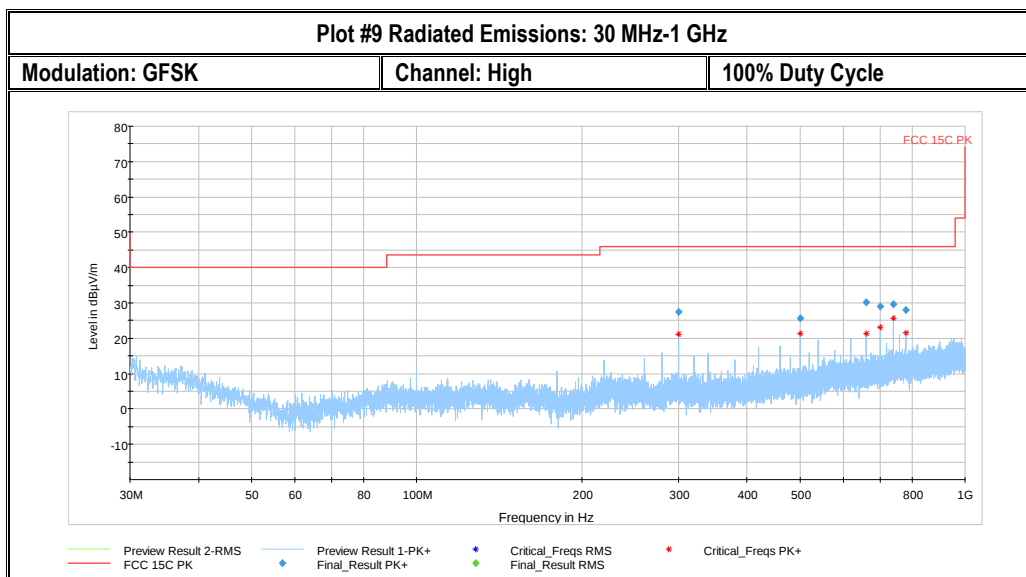
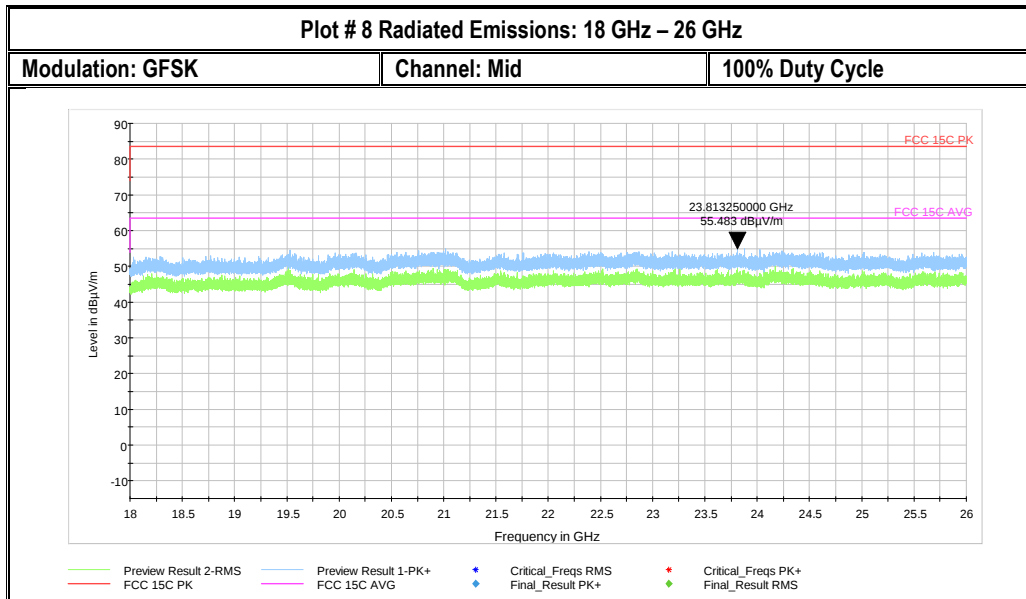


Frequency (MHz)	Max Peak (dBμV/m)	RMS (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1593.040000	---	32.22	53.98	21.76	10.0	1000.000	156.0	H	222.0
1593.350000	53.66	---	74.00	20.33	10.0	1000.000	154.0	V	320.0

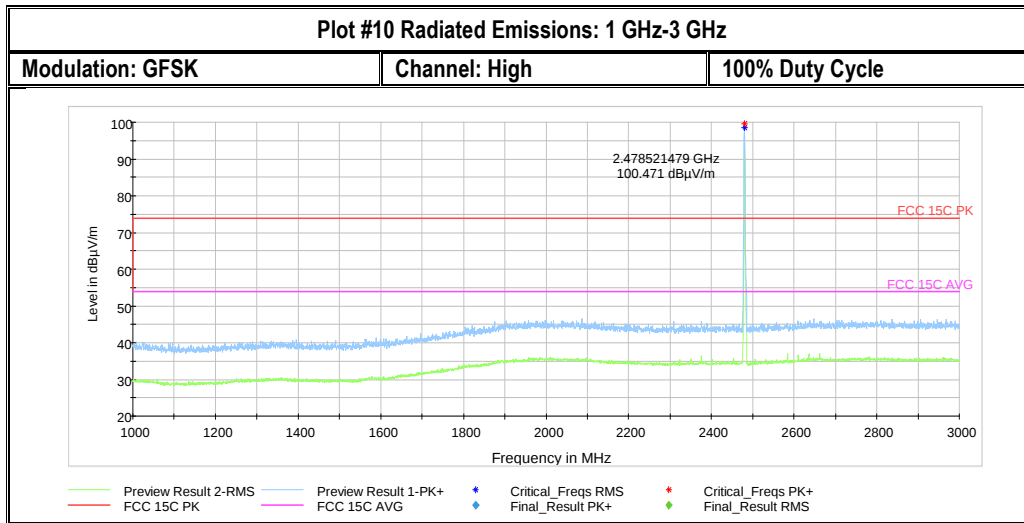
Note: Intentional Transmission occurring on Bluetooth mid channel: 2440 MHz



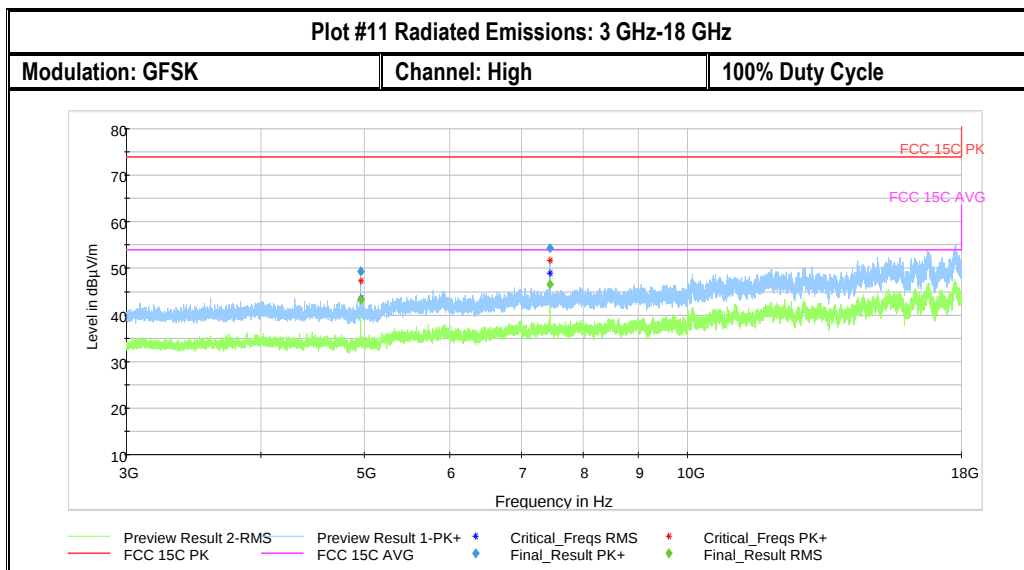
Frequency (MHz)	Max Peak (dBμV/m)	RMS (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4879.822333	46.72	---	73.99	27.27	200.0	1000.000	165.0	V	88.0
4880.047300	---	39.85	53.98	14.13	200.0	1000.000	108.0	V	87.0
7319.195000	57.64	---	73.99	16.34	200.0	1000.000	108.0	V	277.0
7320.070633	---	49.85	53.98	4.13	200.0	1000.000	125.0	V	272.0



Frequency (MHz)	Max Peak (dBμV/m)	RMS (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
299.998265	27.41	---	46.00	18.59	100.0	120.000	100.0	H	-51.0
500.003936	25.64	---	46.00	20.36	100.0	120.000	117.0	V	211.0
660.005783	30.25	---	46.00	15.75	100.0	120.000	135.0	H	-7.0
700.014958	28.96	---	46.00	17.04	100.0	120.000	123.0	H	165.0
740.006249	29.70	---	46.00	16.30	100.0	120.000	100.0	H	-2.0
780.007348	27.93	---	46.00	18.07	100.0	120.000	108.0	H	-24.0



Note: Intentional Transmission occurring on Bluetooth high channel: 2480 MHz



Frequency (MHz)	Max Peak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4959.687200	49.34	---	73.99	24.65	200.0	1000.000	195.0	V	67.0
4959.957700	---	43.22	53.98	10.76	200.0	1000.000	199.0	V	100.0
7439.190567	54.24	---	73.99	19.75	200.0	1000.000	124.0	V	131.0
7439.928367	---	46.56	53.98	7.42	200.0	1000.000	173.0	V	252.0

9 Test setup photos

Setup photos are included in supporting file name: "EMC_ZONAR-016-17001_15.247_DTS_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Antenna Biconilog 3142E	BiConiLog Antenna	EMCO	3142E	166067	3 years	06/27/2017
Magnetic Loop Antenna	Loop Antenna	ETS Lindgren	6512	49838	3 years	07/28/2017
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	10/31/2017
Antenna Horn 3115	Horn Antenna	ETS Lindgren	3115	35111	3 years	07/24/2015
Digital Barometer	Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	06/08/2017
Thermometer Humidity	Thermometer Humidity	Dickson	TM323	16253651	1 Year	11/02/2017
Receiver ESU40	EMI Receiver	R&S	ESU40	100251	3 years	07/01/2017
Digital Radio Comm. Tester CMU 500	Digital Radio Comm. Tester	R&S	CMW500	127068	2 Years	7/01/2017

Note:

1. Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels.

Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

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11 History

Date	Report Name	Changes to report	Report prepared by
2018-03-06	EMC_ZONAR-016-17001_15.247_DTS	Initial Version	Elijah Garcia