



FCC Test Report

FOR:

HAP Innovations

Model Name:

Spencer

Product Description:

Smart In-Home Medication Dispenser

FCC ID: 2AIA7-SPN01

Per:

47 CFR Part 15.247 (DTS)

REPORT #: EMC_HAPIN-001-16501_15.247_BT_LE_rev2

DATE: 2016-08-22



A2LA Accredited

IC recognized #
3462B-1

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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.

No deviations were ascertained.

Company	Description	Model #
HAP Innovations	Smart In-Home Medication Dispenser	sp.01

Responsible for Testing Laboratory:

2016-08-22	Compliance	Franz Engert (Compliance Manager)	
Date	Section	Name	Signature

Responsible for the Report:

2016-08-22	Compliance	Douglas Antioco (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

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Department:	Compliance
Address:	411 Dixon Landing Road Milpitas, CA 95035 U.S.A.
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Compliance Manager:	Franz Engert
Responsible Project Leader:	Douglas Antioco

2.2 Identification of the Client

Applicant's Name:	Device Solutions
Street Address:	1004 Copeland Oaks Dr.
City/Zip Code	Morrisville, NC 27560
Country	USA

2.3 Identification of the Manufacturer

Manufacturer's Name:	HAP Innovations
Manufacturers Address:	4220 Apex Highway, Suite 200
City/Zip Code	Durham, NC 27713
Country	USA

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	sp.01
HW Version :	1.0
SW Version :	1.0
FCC-ID :	2AIA7-SPN01
HVIN:	Sp.01
PMN:	spencer
Product Description:	Smart In-Home Medication Dispenser
Frequency Range / number of channels:	Nominal band: 2400 – 2483.5; Center to center: 2402(ch 0) – 2480(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:	Advertising, Hopping
Integrated Module Info:	TI WL1835MOD WiLink™ 8 single band combo 2x2 MIMO Wi-Fi®, Bluetooth® & Bluetooth Smart (Low energy) module (FCC ID: Z64-WL18SBMOD / IC ID: 4511-WL18SBMO) <ul style="list-style-type: none"> • Bluetooth Low Energy with GFSK modulation • Bluetooth EDR/BDR with GFSK, $\pi/4$ DPSK, and 8 DPSK Modulations • 802.11 b/g/n (2.4GHz)
Antenna Information as declared:	PCB Trace antenna. Antenna Gain: 3.6 dBi @ 2.4 GHz.
Max. Output Power: (See Note)	Conducted Power 9.99 dBm (Peak)
Power Supply/ Rated Operating Voltage Range:	Dedicated Battery Pack (Li-ion) Vmin: 11.5V dc/ Vnom: 12.0V dc / Vmax: 16.8V dc
Operating Temperature Range	5 °C to 40 °C
Other Radios included in the device:	Bluetooth EDR/BDR 802.11 b/g/n (2.4GHz) LTE (Band 4 and 13)
Sample Revision	<input checked="" type="checkbox"/> Prototype Unit; <input type="checkbox"/> Production Unit; <input type="checkbox"/> Pre-Production

Note: Obtained from section 3.2.5 of the module report referenced in Section 6.4.



3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	010C0319160300002E	1.0	1.0	Radiated Emissions

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	N/A	N/A	N/A	N/A

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user via RS323 with a laptop utilizing a terminal emulator such as Tera Term. The EUT transmitted a modulated BT LE signal on a specified channel.



4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT per the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations.

This test report is to support a request for new equipment authorization under the FCC ID: 2AIA7-SPN01

Testing procedures are based on “GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER §15.247; April 8, 2016” 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	Fail	NA	NP	Result
§15.247(e)	Power Spectral Density	Nominal	Bluetooth LE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	See Note 1
§15.247(a)(1)	Emission Bandwidth	Nominal	Bluetooth LE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	See Note 1
§15.247(b)(1)	Maximum Conducted Output Power and EIRP	Nominal	Bluetooth LE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	See Note 1
§15.247/15.209/15.205	Band edge compliance-Restricted Band Edges	Nominal	Bluetooth LE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	See Note 1
§15.247(d)	Band edge compliance-Unrestricted Band Edges	Nominal	Bluetooth LE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	See Note 1
§15.247(d) §15.209	TX Spurious emissions-Radiated	Nominal	Bluetooth LE	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Complies
§15.207(a)	AC Conducted Emissions	Nominal	Bluetooth LE	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Complies

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

Note 1: Leveraged from module certification. See Section 6.4.



6 Measurements

6.1 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:

	Uncertainty in dB Radiated <30MHz	Uncertainty in dB Radiated 30MHz - 1GHz	Uncertainty in dB Radiated > 1GHz
Standard Deviation k=1	2.48	1.94	2.16
95% Confidence Interval in dB	4.86	3.79	4.24
95% Confidence Interval in dB in Delta to Result	+/-2.5 dB	+/-2.0 dB	+/- 2.3dB

Conducted measurement:

150 kHz to 30 MHz ±0.7 dB (LISN)

RF conducted measurement ±0.5 dB

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 3dB to the limit.

6.2 Environmental Conditions During Testing:

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

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

Deviating test conditions are indicated at individual test description where applicable.

6.3 Dates of Testing:

2016-05-09 to 2016-08-22



6.4 Inheriting Test Results from Incorporated Module Certification:

The EUT integrates the certified module TI WL1835MOD (details see EUT spec in section 3.1)

Taking into account guidance from FCC KDB 996369 (modular approval) and where relevant test procedures did not change conducted test results are leveraged from the conducted test report for the TI WL1835MOD given by Sporton International Inc., dated January 27, 2014 with Report Number: FR3N2752-02B FCC ID: Z64-WL18SBMOD

This test report contains full radiated testing as per FCC 15.247.

6.5 Additional Test Information

Testing is performed according to the guidelines provided in FCC publication (KDB) FCC KDB 558074 D01 V03R05, *GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER §15.247* and according to relevant parts of ANSI 63.10 as detailed below.

7 Measurement Procedures

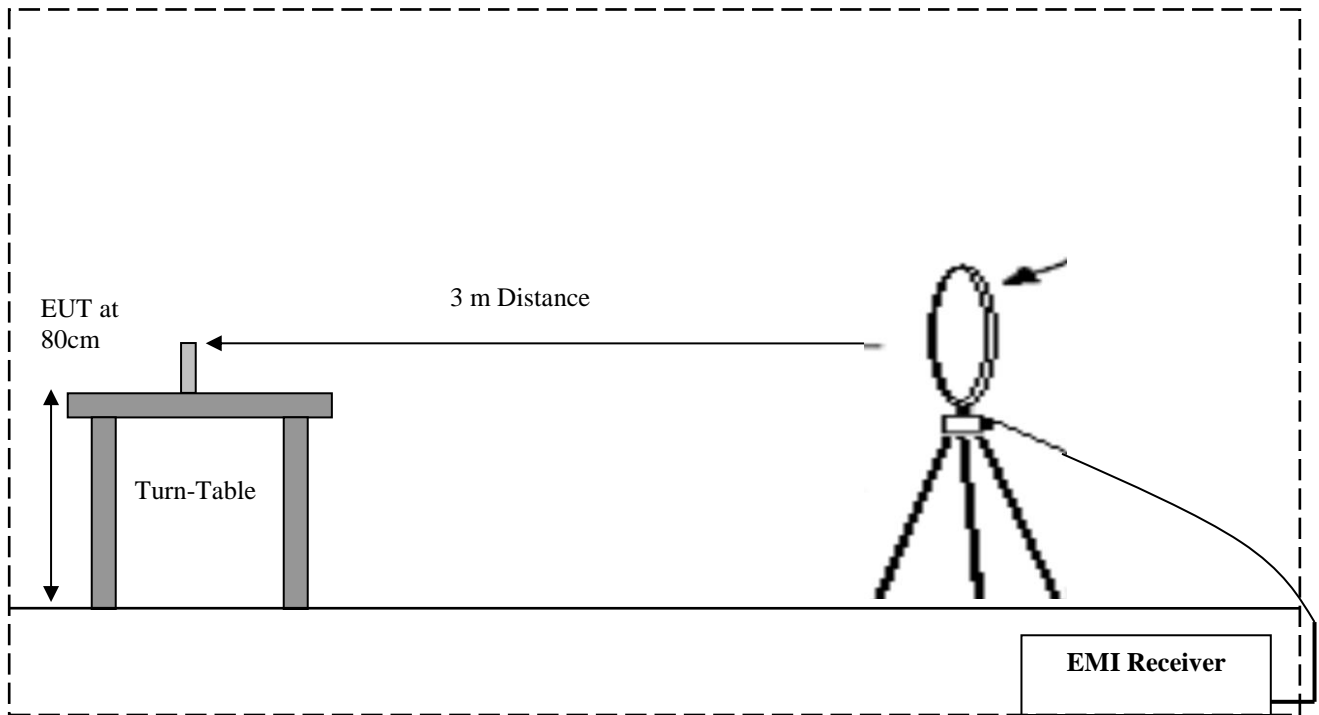
7.1 Radiated Measurement

The radiated measurement is performed according to:

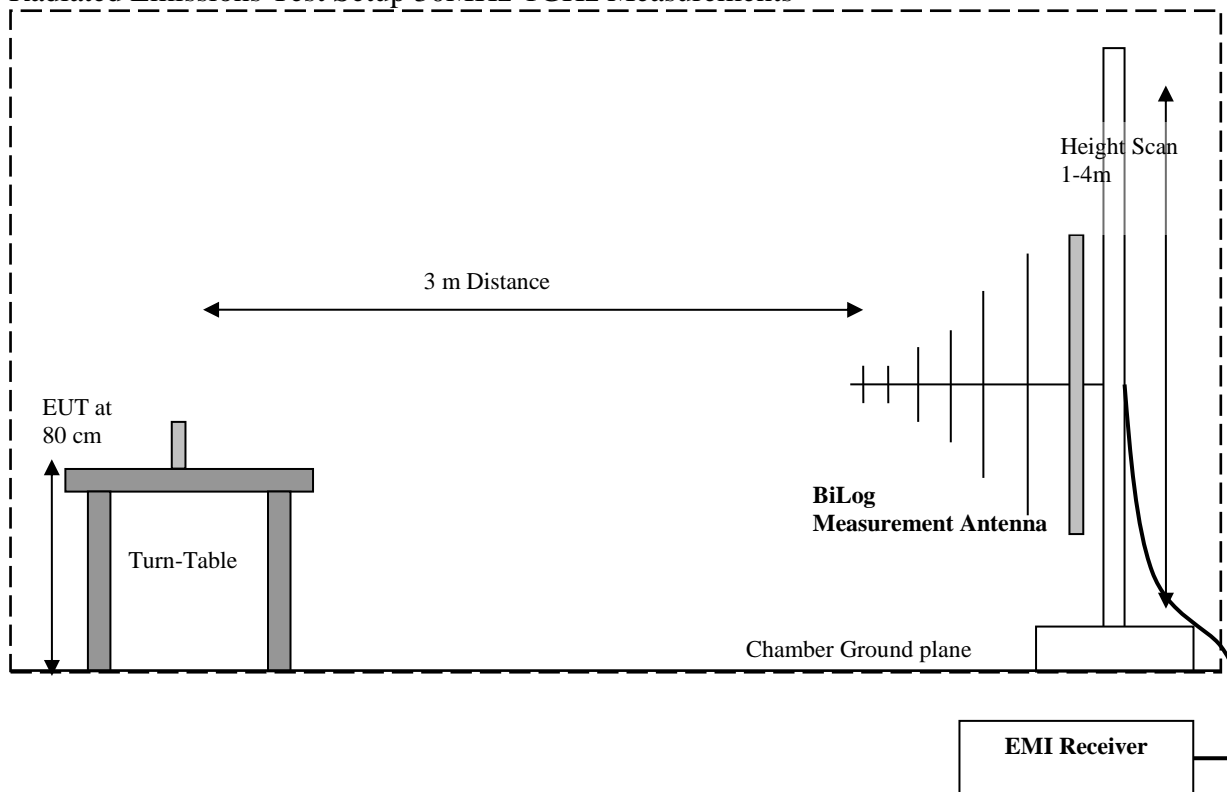
ANSI C63.10 (2013)

- 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.

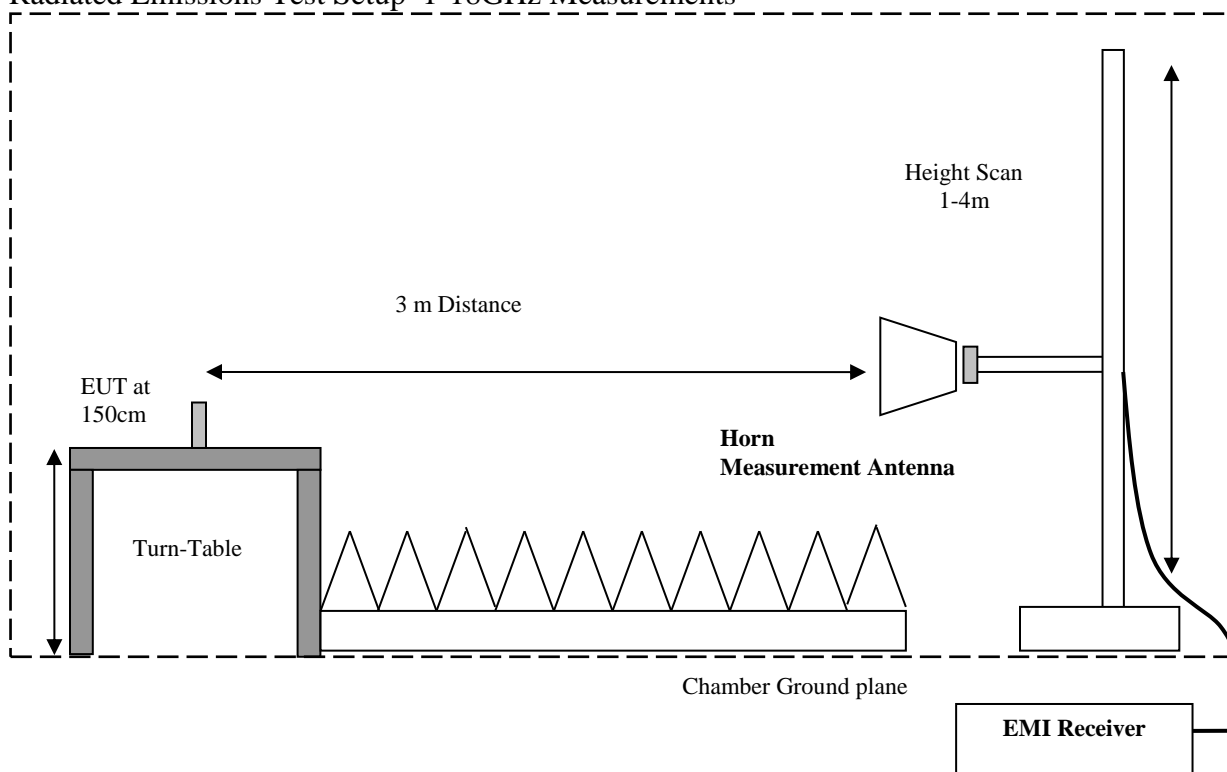
Radiated Emissions Test Setup below 30MHz Measurements



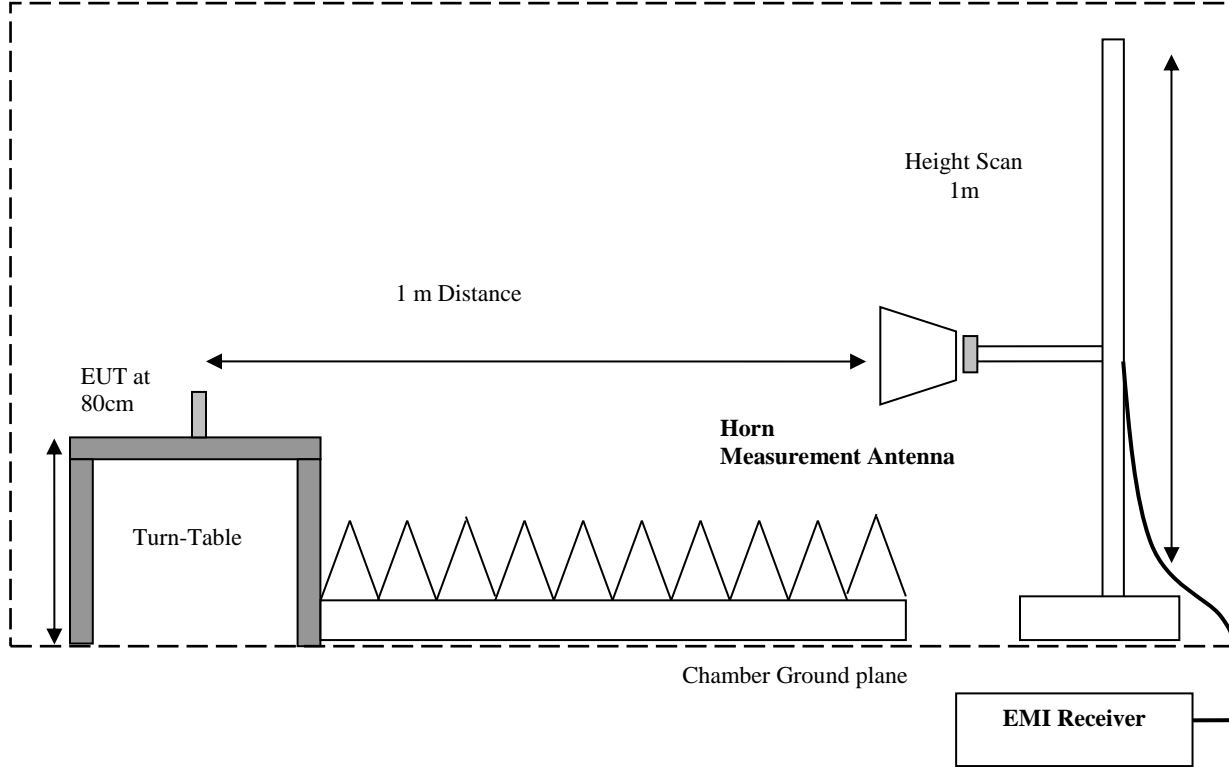
Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup 1-18GHz Measurements



Radiated Emissions Test Setup 18-26GHz 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)	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 C63.10 (2013)



8 Test Result Data

8.1 Maximum Conducted Output Peak Power Verification

8.1.1 Measurement settings

Conducted measurements were taken according to ANSI C63.10 Section 11.9.1.1 using equipment number 19 in section 9.

8.1.2 Limits:

Maximum Output Power:

- The measured output power shall be within +0.2dB and -1dB from the modular report power.
- The power measured on the mid channel of each RF band of operation will be compared to the Max. Output Power from the modular report referenced in section 6.4.

8.1.3 Test conditions and setup:

Equipment number 19 in section 9 of this report was used for this test case.

Ambient Temperature	EUT Set-Up #	EUT operating mode	Antenna Gain
22° C	1	GFSK continuous fixed channel	3.6

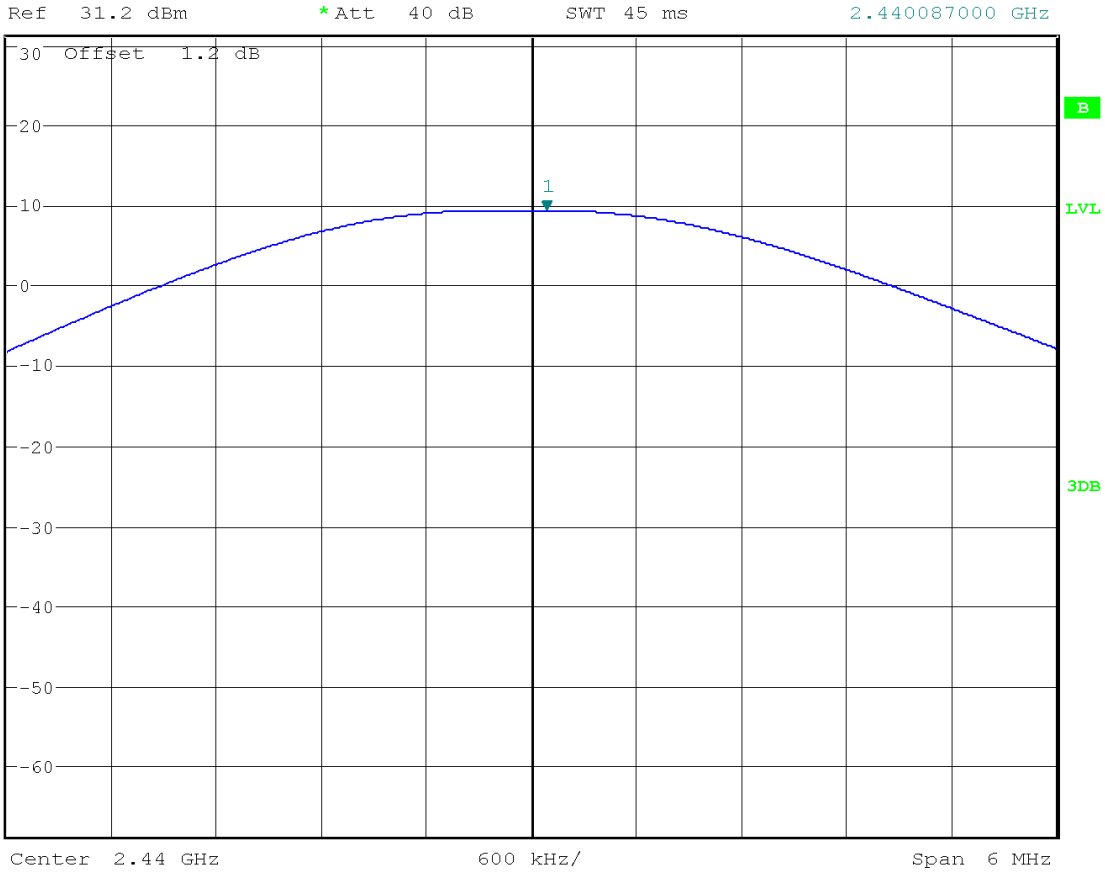
8.1.4 Measurement result:

Frequency (MHz)	Conducted Peak Output Power (dBm)	Conducted Output Peak Power From Modular Report (dBm)	Output Power Delta (dB)	Result
2440	9.3	9.6	-0.3	Pass

8.1.5 Measurement Plots:



*RBW 2 MHz Marker 1 [T1]
*VBW 10 MHz 9.29 dBm
SWT 45 ms 2.440087000 GHz



Date: 22.AUG.2016 17:18:11



8.2 Radiated Transmitter Spurious Emissions and Restricted Bands

8.2.1 Measurement according to ANSI C63.10 (2013)

Analyzer Settings:

Frequency = 9 KHz – 30 MHz

RBW = 9 KHz

Detector: Peak

Frequency = 30 MHz – 1 GHz

Detector = Peak / Quasi-Peak

RBW=120 KHz (<1GHz)

Frequency > 1 GHz

Detector = Peak / Average

RBW= 1MHz

Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT. Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.

8.2.2 Limits: §15.247/15.205/15.209

(a) 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
¹ 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	(²)
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= 74dBµV/m



*AVG. LIMIT= 54dBμV/m

Table 1:

Frequency of emission (MHz)	Field strength @ 3m (μV/m)	Field strength @ 3m (dBμV/m)
30–88	100	40dBμV/m
88–216	150	43.5 dBμV/m
216–960	200	46 dBμV/m
Above 960	500	54 dBμV/m

Table 2:

Frequency of emission (MHz)	Field strength (μV/m) / (dBuV/m)	Measurement Distance (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

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 described in 5.4.

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:

$$\text{Conversion factor (CF)} = 40 \log (D/d) = 40 \log (300\text{m} / 3\text{m}) = 80\text{dB}$$

8.2.3 Test conditions and setup:

Please see section 7.1 for detailed test setup. Equipment numbers 1-16 in section 9 of this report were used for this test case in a semi-anechoic chamber.

Only mid channel was tested as the difference in output power between the mid channel and low and high channels of the module certification report referenced in section 6.4 is within the measurement uncertainty for conducted measurements.

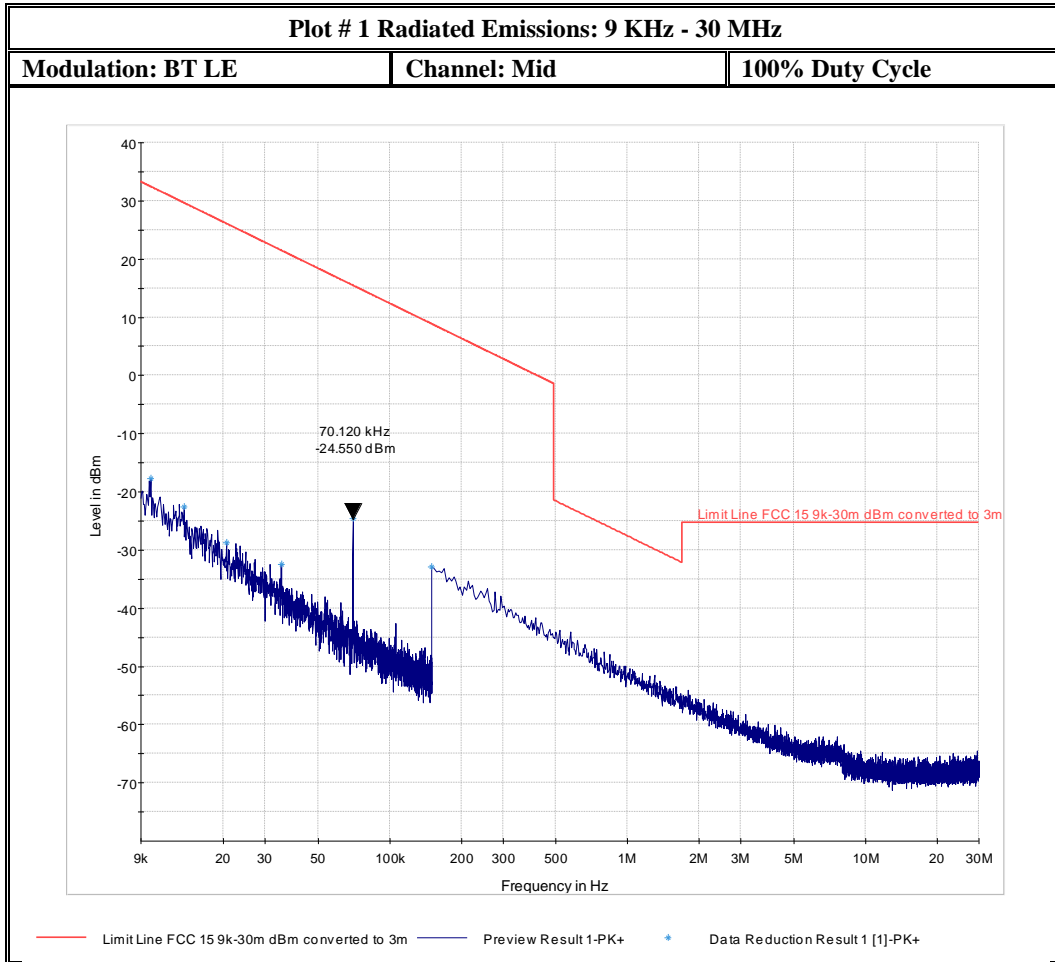
Ambient Temperature	EUT Set-Up #	EUT operating mode
22° C	1	GFSK continuous fixed channel

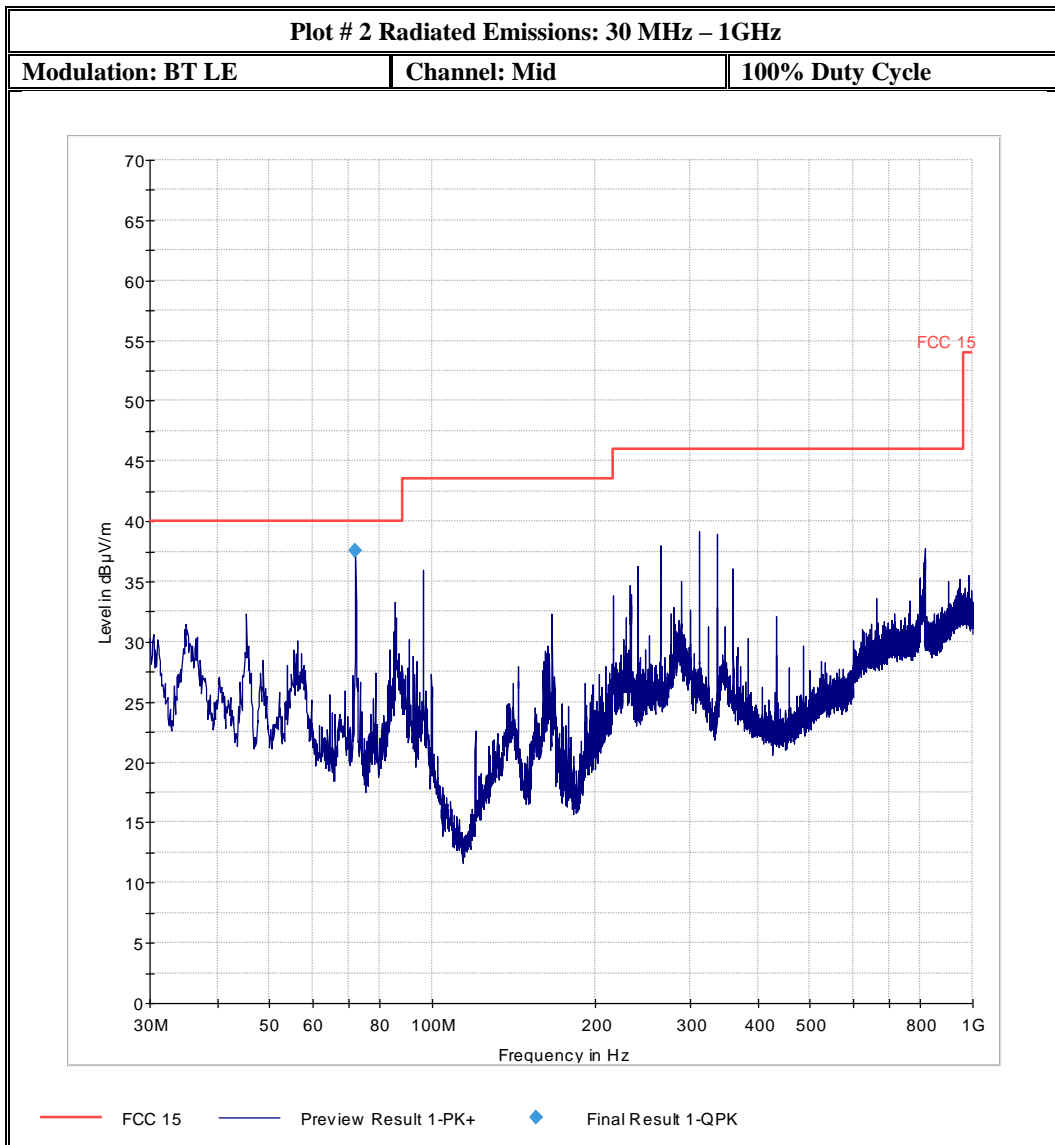


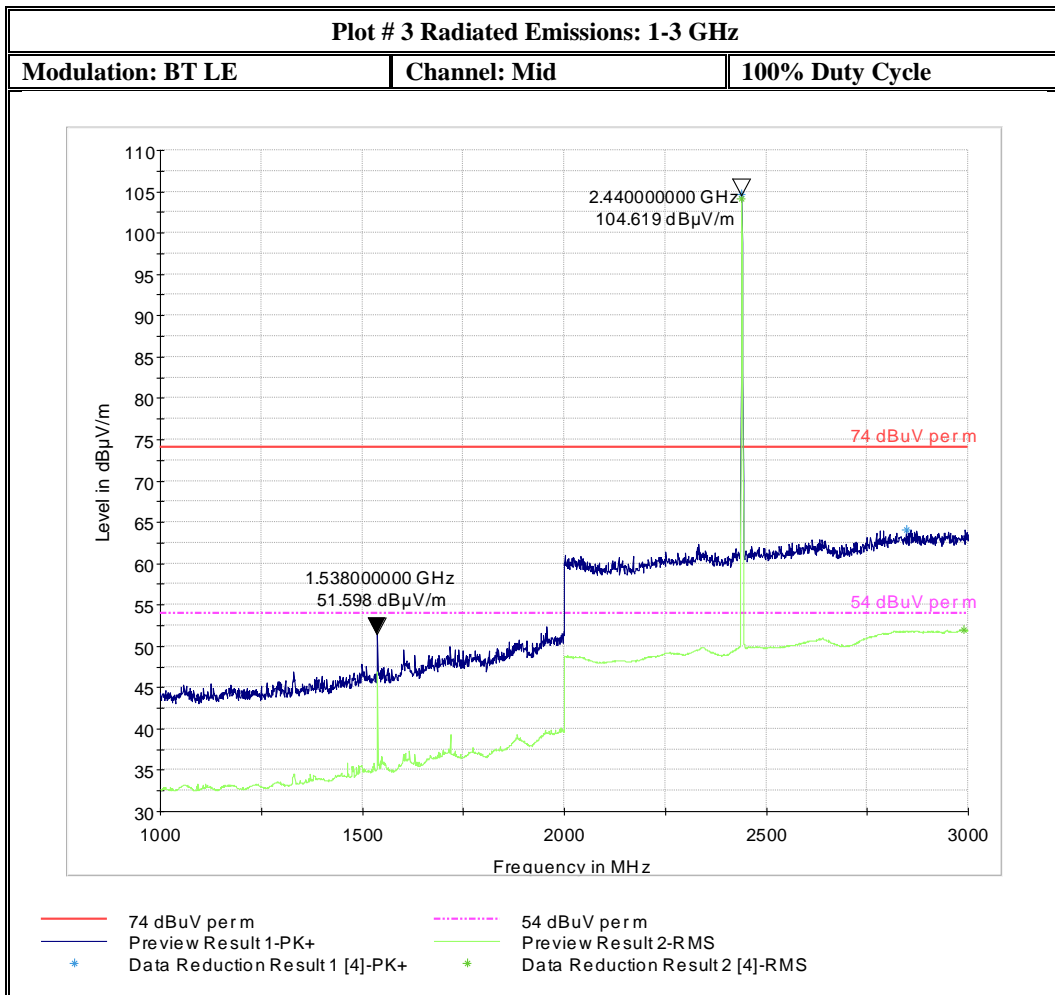
8.2.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-5	Mid (19)	9 kHz – 26 GHz	See section 8.1.2	Pass

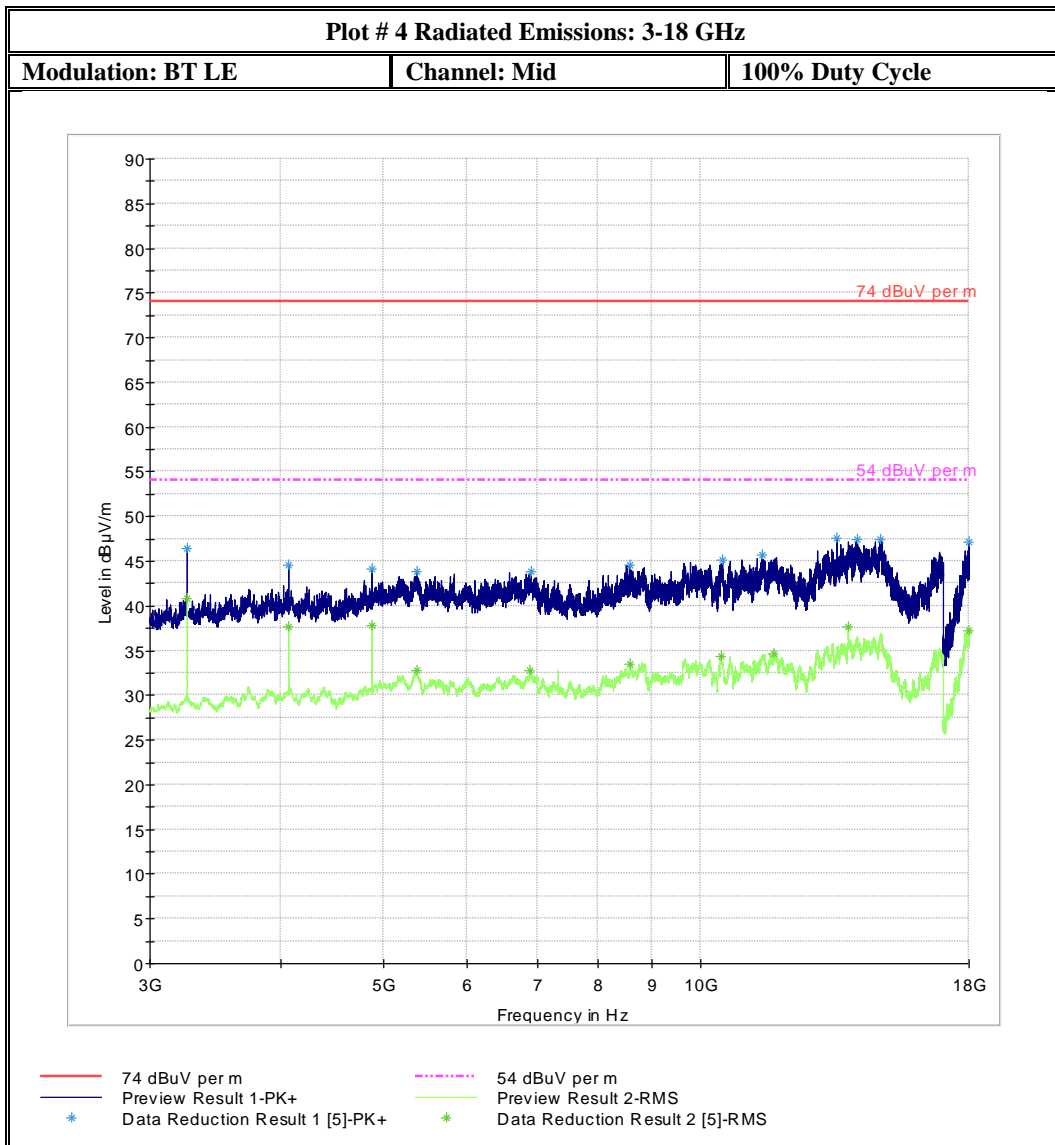
8.2.5 Measurement Plots:

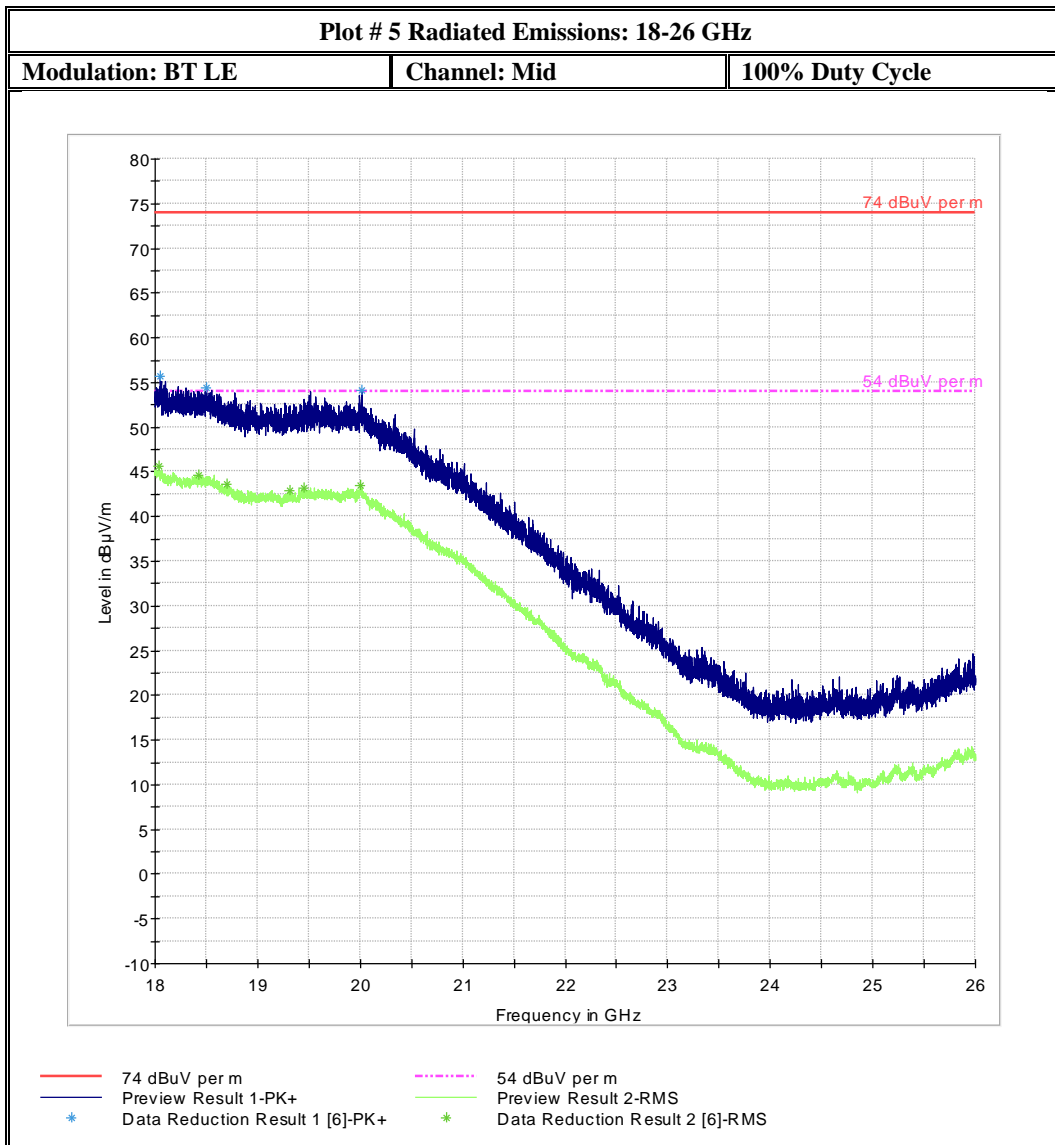






Note: Emission above limit is transmitter.







8.3 AC Power Line Conducted Emissions

8.3.1 Measurement according to ANSI C63.10 (2013)

Analyzer Settings:

RBW = 9 KHz (CISPR Bandwidth)

Detector: Peak / Average for Pre-scan

Quasi-Peak/Average for Final Measurements

8.3.2 Limits: §15.207

(a) Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between frequency ranges.

Table 1:

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.

8.3.3 Test conditions and setup:

Equipment numbers 9, 17 in section 9 of this report were used for this test case.

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power line (L1, L2, L3, N)	Power Input
22.5	1	GFSK continuous fixed channel	Line & Neutral	110V / 60Hz

8.3.4 Measurement Result:

Plot #	Port	EUT Set-Up #:	EUT operating mode	Scan Frequency	Limit	Result
1	AC Mains	1	BT LE	150 kHz – 30 MHz	See section 8.2.2	Pass

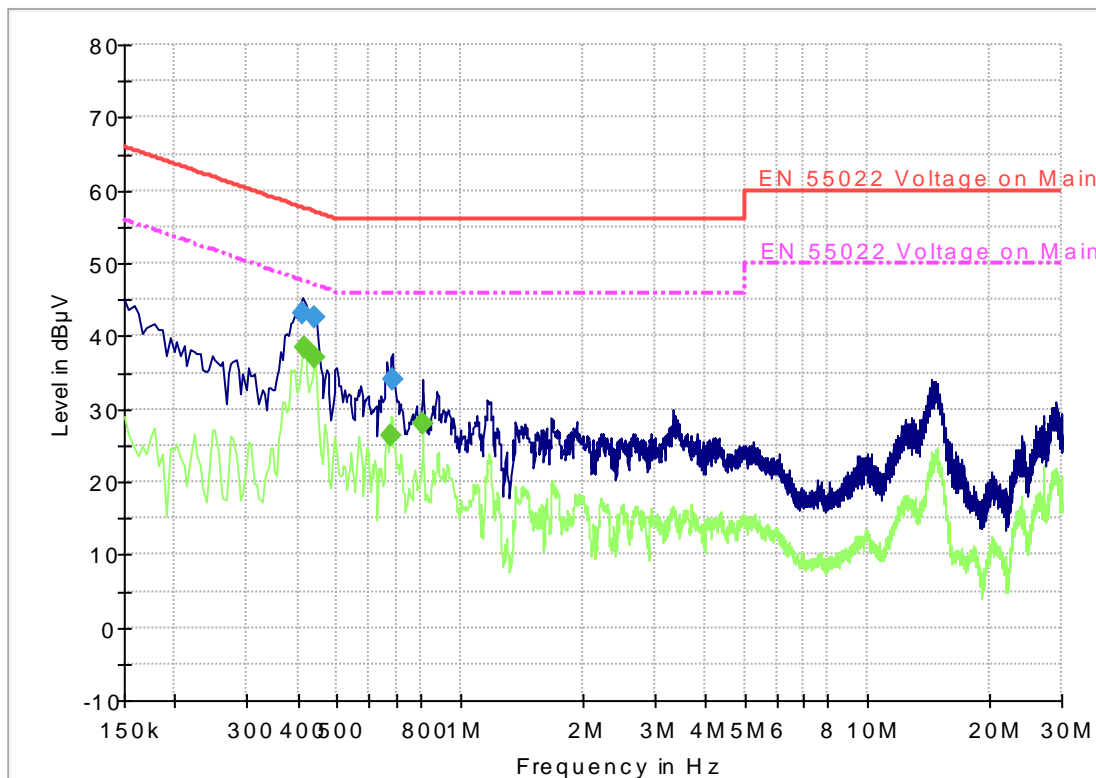
8.3.5 Measurement Plots:

Plot #1

Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.410000	43.2	500.0	9.000	GN	L1	2.8	14.4	57.6	
0.438000	42.6	500.0	9.000	GN	N	2.5	14.5	57.1	
0.682000	34.1	500.0	9.000	GN	N	1.5	21.9	56.0	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL, due to measurement uncertainty considerations.

CISPR 22 Mains Conducted FCC_LISN



- EN 55022 Voltage on Mains QP
- EN 55022 Voltage on Mains AV
- Preview Result 1-PK+
- Preview Result 2-AVG
- ◆ Final Result 1-QPK
- ◆ Final Result 2-AVG



9 Test Equipment And Ancillaries Used For Testing

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
1	Turn table	EMCO	2075	N/A	N/A	N/A
2	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
3	Antenna Mast	EMCO	2075	N/A	N/A	N/A
4	High Pass Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
5	High Pass Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
6	6GHz High Pass Filter	HPM50106	Microtronics	001	Part of system calibration	
7	Pre-Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
8	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
9	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	June 2015	3 Years
10	1500MHz HP Filter	Filtek	HP12/1700	14c48	N/A	N/A
11	2800 MHZ HP Filter	Filtek	HP12/2800	14C47	N/A	N/A
12	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
13	Binconilog Antenna	ETS	3142E	166067	Jun 2014	3 years
14	Horn Antenna	EMCO	3115	35111	Jul 2015	3 Years
15	Horn Antenna	EMCO	3116	00070497	Jul 2015	3 Years
16	Loop Antenna	EMCO	6512	00049838	Mar 2014	3 years
17	LISN	R&S	ESH3-Z5	836679/003	Jun 2013	3 Years
18	Spectrum Analyzer	Rohde&Schwarz	FSU	100189	June 2013	3 Years
19	Spectrum Analyzer	Rohde&Schwarz	FSU-8	200256	Jul 2015	2 Years

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.



10 Revision History

Date	Report Name	Changes to report	Report prepared by
2016-07-27	EMC_HAPIN-001-16501_15.247_BT_LE	Initial Version	Douglas Antioco
2016-08-18	EMC_HAPIN-001-16501_15.247_BT_LE_rev1	Replaces Previous version. Added Conducted Output Power Measurement Verification (Section 8.1), Updated Sections 3.1, 6.4, 8.2.3, 8.3.3, and 9.	Douglas Antioco
2016-08-22	EMC_HAPIN-001-16501_15.247_BT_LE_rev2	Replaces Previous version. Updated Section 8.1	Douglas Antioco