FCC Test Report

For:

Verizon Telematics Inc.

Model Name:

AT-660

Product Description:

Bluetooth Hands-free Device

FCC ID: ZOQAT-660

Per:

47 CFR Part 15.247 (FHSS)

REPORT #: EMC_VERIT-010-15001_15.247_FHSS

DATE: 2015-11-09

A2LA Accredited

IC recognized # 3462B-1

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1 Assessment

The following device as further described in section 3 of this report was evaluated against the applicable criteria specified in the Code of Federal Regulations, Title 47 part 15.247.

No deviations were ascertained.

Company Name	Product Description	Model #
Verizon Telematics Inc.	Bluetooth Hands-free Device	AT-660

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2015-11-09	Compliance	Franz Engert (Compliance Manager)	Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com

Responsible for the Report:

Date	Section	Name	Signature
2015-11-09	Compliance	Kris Lazarov (EMC Engineer)	Kris Lazarov Digitally signed by Kris Lazarov DN: cn=Kris Lazarov, o, ou, email=kris.lazarov@cetecom.com, c=US

The test results of this test report relate exclusively to the test item specified in Section3.
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
Compliance Manager:	Franz Engert
Responsible Project Leader:	Kris Lazarov

2.2 Identification of the Client

Applicant's Name:	Verizon Telematics Inc.
Street Address:	2002 Summit Blvd #1800
City/Zip Code	Atlanta, GA 30319
Country	USA
Contact Person:	Chris Kang
Phone No.	1-404-573-5034
e-mail:	chris.kang@verizon.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	AT-660
HW Version	A0
SW Version	V1.0.0
FCC-ID	ZOQAT-660
Product Description	Bluetooth Hands-free Device
Frequency Range / number of channels	Nominal band: 2400 MHz to 2483.5 MHz; 79 Channels
Type(s) of Modulation	GFSK; DQPSK; 8DPSK
Modes of Operation	FHSS Bluetooth 2.1 BDR / EDR
Max. declared antenna gain	Internal antenna with maximum of 1.3 dBi gain at 2480 MHz:
Max. declared conducted output power including tune up average during continuous TX	Nominal conducted power 8 dBm + 1 dBm (positive tolerance) to the Maximum conducted power is </=9 dBm
Max. measured conducted output power average during continuous TX	9.11 dBm
Power Supply/ Rated Operating Voltage Range	Internal battery pack: Vmin: 4.75VDC; Vnom: 5VDC; Vmax: 5.25VDC
Operating Temperature Range	-30 ºC to 60 ºC
Other Radios included in the device	N/A
Sample Revision	☐Prototype ■Production ☐ Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Comments
1	Sample #1	A0	V1.0.0	Radiated measurements
2	Sample #2	A0	V1.0.0	Conducted measurements

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	USB Power Adapter	Phihong	PSAI05R-050Q	P142302633A1

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT #1	Radiated measurements
2	EUT #2	Conducted RF measurements
3	EUT #1 + AE #1	AC conducted emissions setup

3.5 Justification for Worst Case Mode of Operation

During the testing process the EUT was tested with transmitter set to low, mid and high channels. 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.

The GFSK modulation scheme produced the highest output power (worst case) and was used in all test cases during this evaluation that define limits of power or field strength.

Modulation	Timing	Peak Power (dBm)
GFSK	DH5	9.11
8DPSK	DH5	7.43
DQPSK	DH5	7.52

GFSK DH1 package type was used for all power and emission measurements with an amplitude limit as it represents the worst case. DQPSK DH5 package type peak power was tested as representative for widest occupied bandwidth mode. The occupied Bandwidth was measured with all supported modulation schemes: GFSK, 8DPSK, and DQPSK.

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 and Radio Standard Specification RSS-247 Issue 1 of Industry Canada.

This test report is to support a request for new equipment authorization under the FCC ID: ZOQAT-660

Testing procedures are based on Public Notice "DA 00-705: March 30, 2000" and ANSI C63.10:2013 for FHSS systems.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§15.247(b)(1)	Maximum Peak Conducted Output Power	Nominal	GFSK DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(d)	Band Edge Compliance	Nominal	GFSK DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(a)(1)	Spectrum Bandwidth	Nominal	GFSK DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(a)(1)	Carrier Frequency Separation	Nominal	GFSK	■	☐	☐	☐	Complies
§15.247(a)(1)	Number of Hopping Channels	Nominal	GFSK	■	☐	☐	☐	Complies
§15.247(a)(1)(iii)	Time of occupancy	Nominal	GFSK DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(d) §15.209 (a)	TX Spurious emissions-Radiated	Nominal	GFSK	■	☐	☐	☐	Complies
§15.207(a)	AC Conducted Emissions <30MHz	Nominal	GFSK	■	☐	☐	☐	Complies

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

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

9 kHz to 30MHz	±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)
RF conducted measurement	±0.5 dB

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%

6.3 Dates of Testing:

9/25/2015 - 10/13/2015

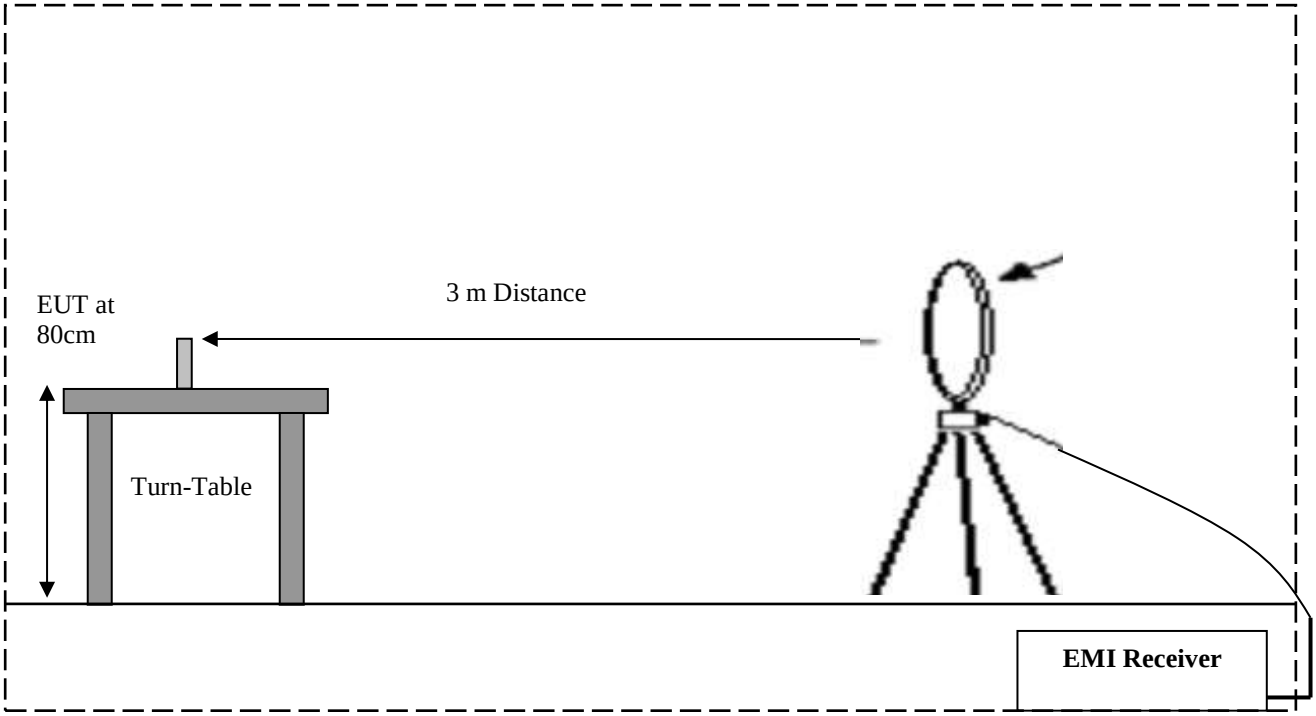
7 Measurement Procedures

7.1 Radiated Measurement

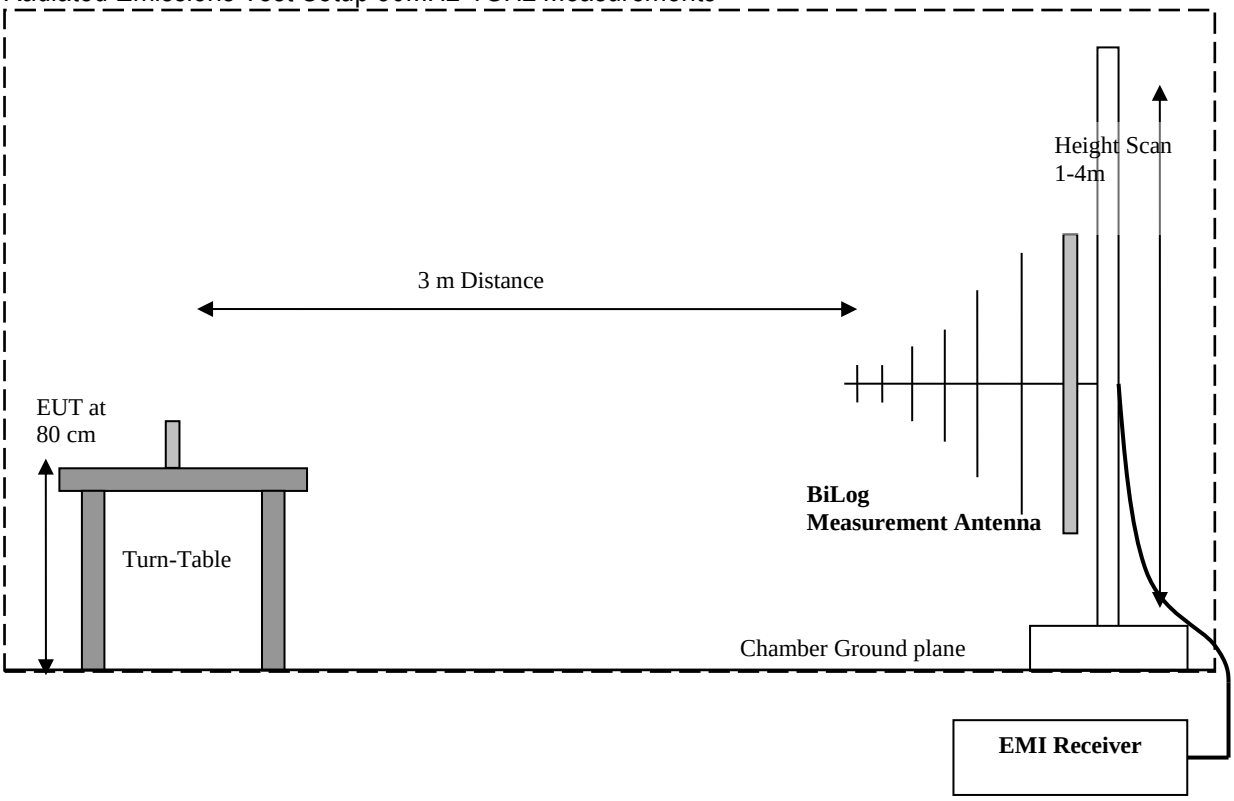
The radiated measurement is performed according to: ANSI C63.10 (2013)

- 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.

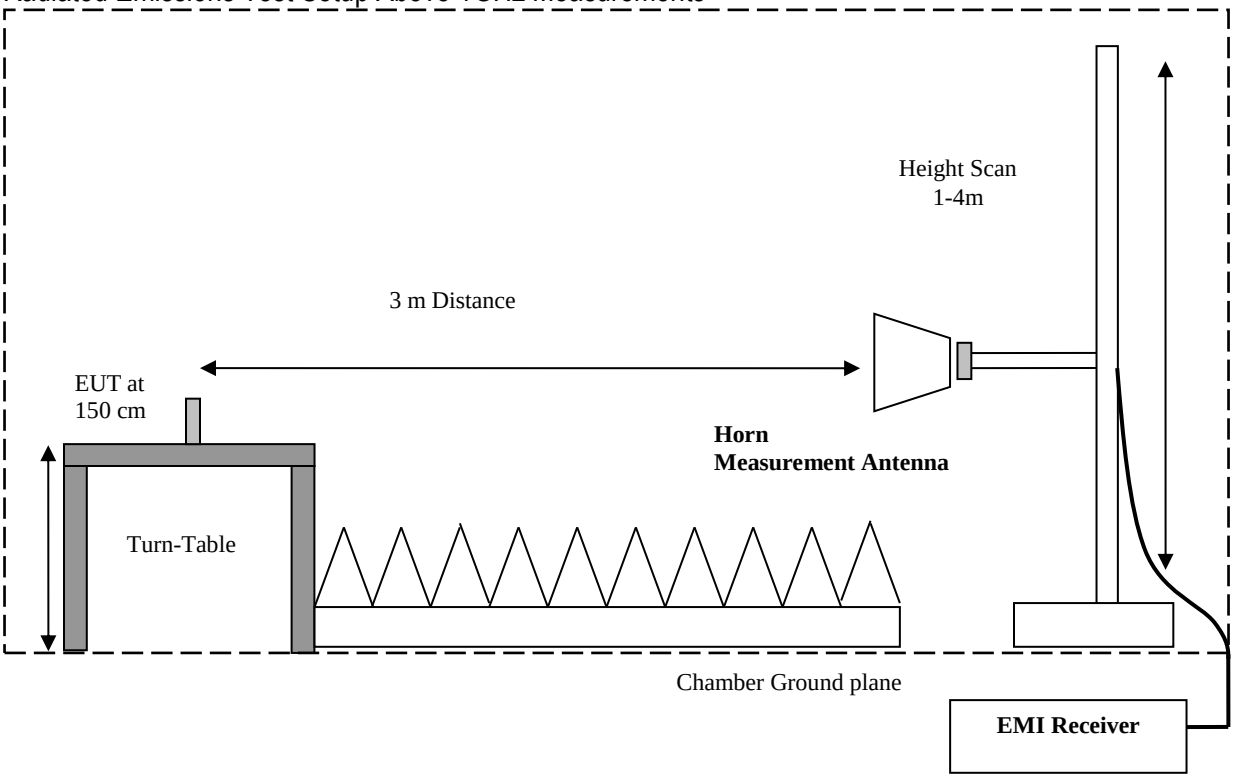
Radiated Emissions Test Setup Below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup Above 1GHz Measurements



7.2 Sample Calculations for Field Strength Measurements

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

- Measured reading in dBµV
- Cable Loss between the receiving antenna and SA in dB and
- 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 (dBµV/m) = Measured Value on SA (dBµV)- Cable Loss (dB)+ Antenna Factor (dB/m)

Example:

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

7.3 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: ANSI C63.10 (2013)

7.4 RF Conducted Measurement Procedure

Reference: FCC Public Notice DA 00-705:2000 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

- 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 20dB Bandwidth

8.1.1 Measurement according to DA 00-705:2000

Spectrum Analyzer settings:
Span: approximately 2 to 3 times the 20 dB bandwidth, centered on the hopping channel
RBW ≥ 1% of the 20 dB bandwidth
Sweep Time: Auto
Detector = peak
Trace = max hold

8.1.2 Limits: §15.247 (a) (1)

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

8.1.3 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power Input (VDC)	Antenna Gain (dBi)
22	2	GFSK / DQPSK / 8DPSK	5	1

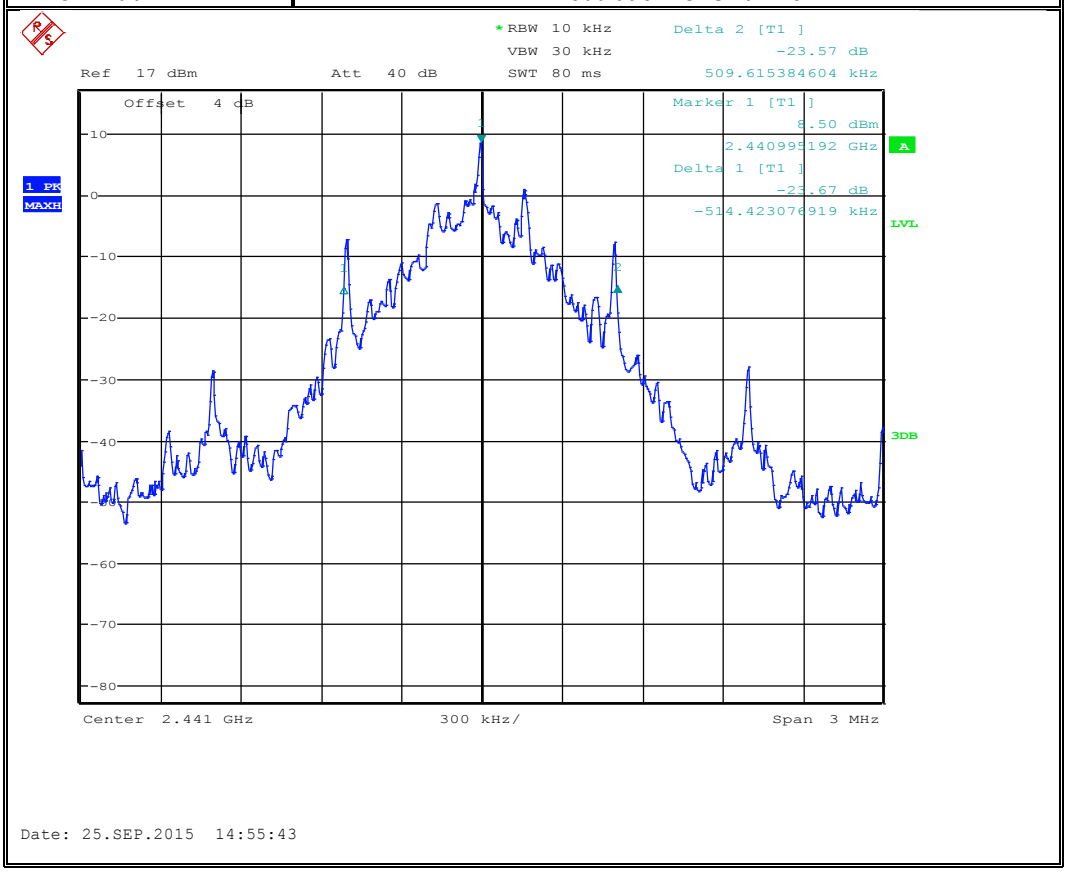
8.1.4 Measurement result:

Plot #	EUT operating mode	20 dB Bandwidth (MHz)
1	GFSK DH5 fixed channel	1.024
2	DQPSK DH5 fixed channel	1.139
3	8DPSK DH5 fixed channel	1.039

8.1.5 Measurement Plots:

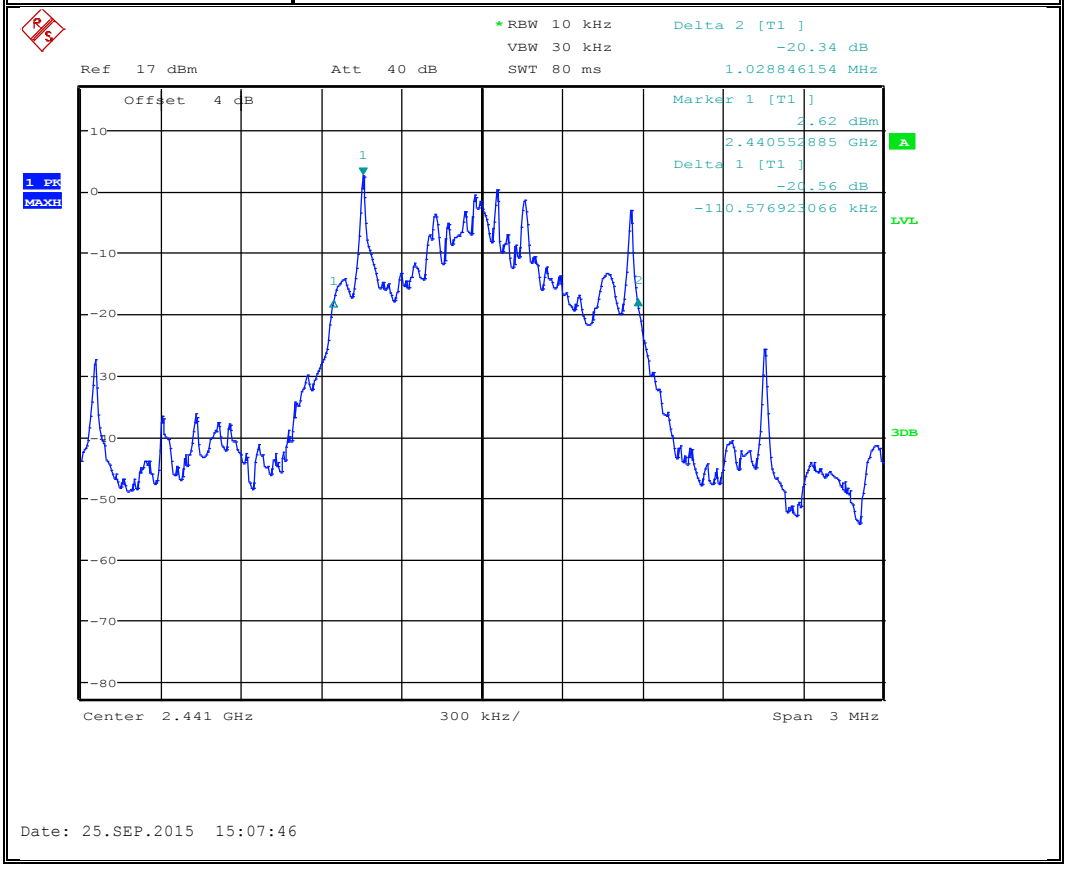
Plot #1 20dB Bandwidth

Ch Mid / 2441 MHz	Modulation: GFSK / DH5



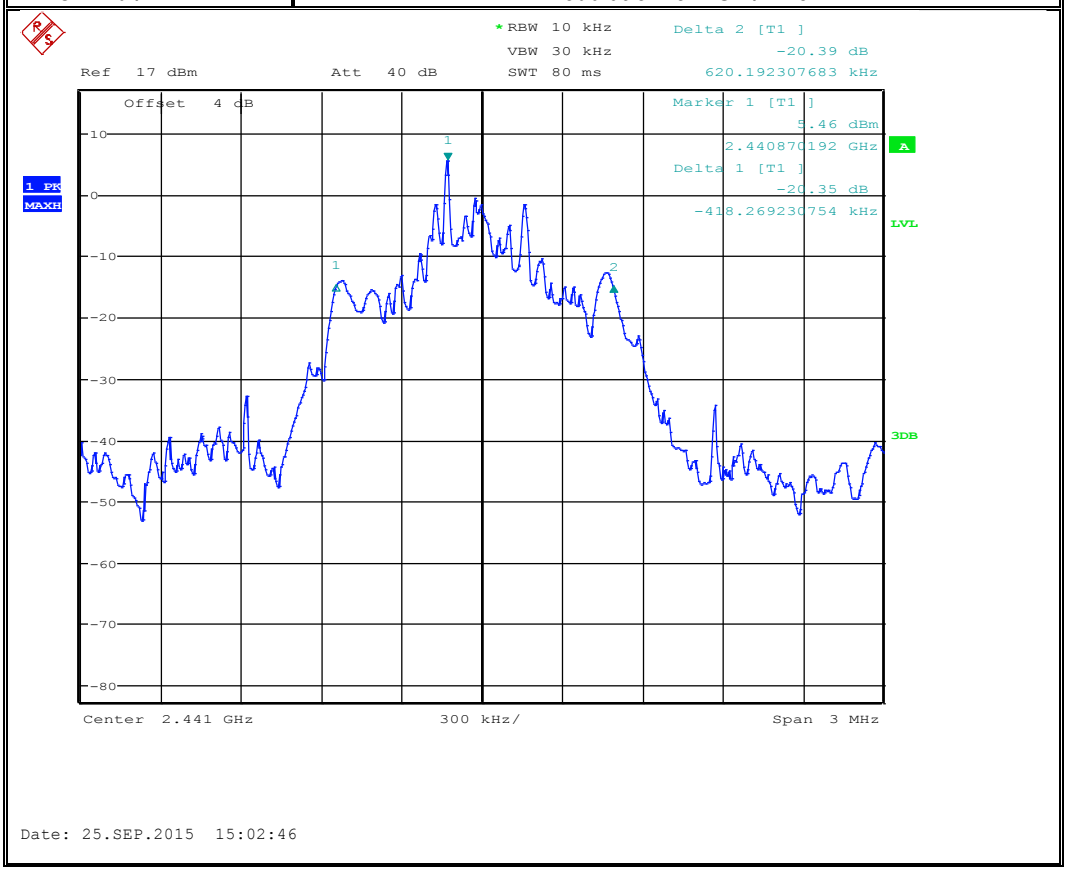
Plot #2 20dB Bandwidth

Ch Mid / 2441 MHz	Modulation: DQPSK / DH5



Plot #3 20dB Bandwidth

Ch Mid / 2441 MHz	Modulation: 8DPSK / DH5



8.2 Maximum Peak Conducted Output Power

8.2.1 Measurement according to DA 00-705:2000

Spectrum Analyzer settings:
Span = approximately 5 times the 20 dB bandwidth
RBW > the 20 dB bandwidth of the emission being measured
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Use the marker-peak function to set the marker to the peak of the emission.

8.2.2 Limits:

Maximum Peak Output Power:
FCC §15.247 (b)(1): 1W

8.2.3 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power Input (VDC)	Antenna Gain (dBi)
22	2	GFSK / DQPSK / 8DPSK	5	1.3

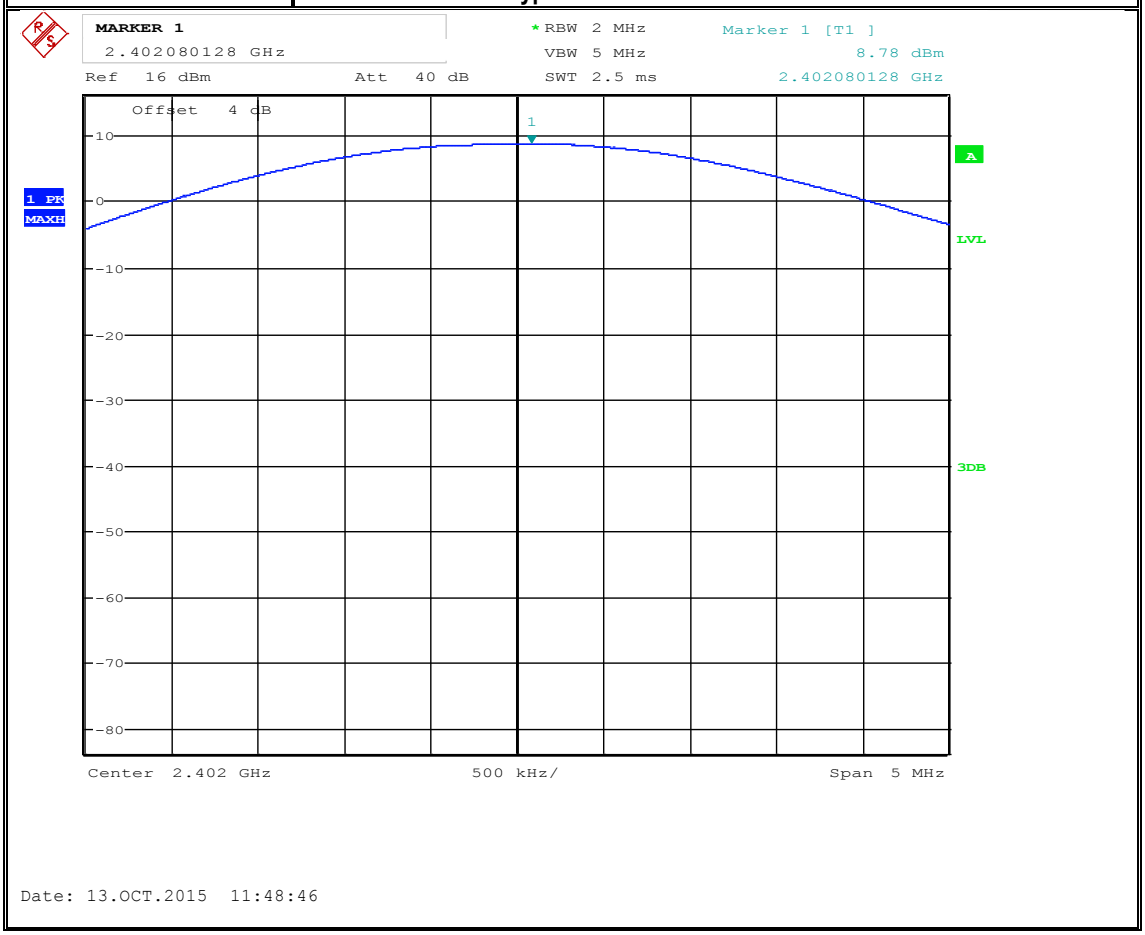
8.2.4 Measurement result:

Plot #	EUT operating mode	Frequency (MHz)	Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	GFSK DH5	2402	8.78	10.08	30(Pk) / 36(EIRP)	Pass
2	GFSK DH5	2441	9.11	10.31	30(Pk) / 36(EIRP)	Pass
3	GFSK DH5	2480	8.66	9.96	30(Pk) / 36(EIRP)	Pass
4	DQPSK DH5	2441	7.52	8.82	30(Pk) / 36(EIRP)	Pass
5	8DPSK DH5	2441	7.43	8.73	30(Pk) / 36(EIRP)	Pass

8.2.5 Measurement Plots:

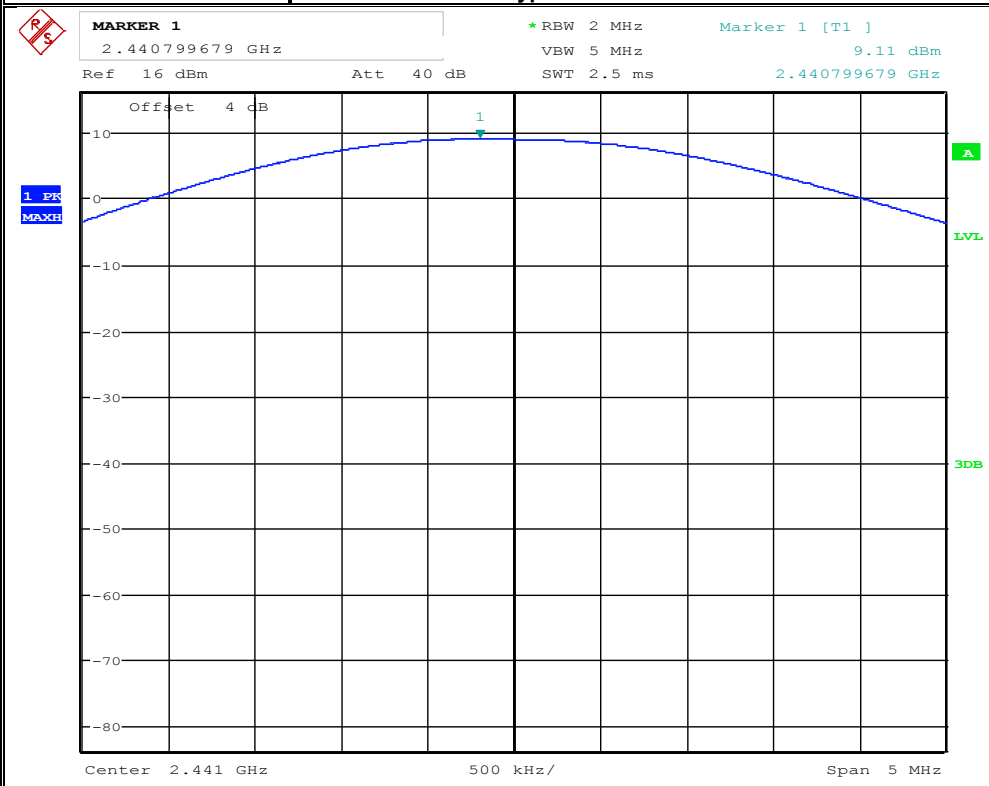
Plot #1

Ch.0 / 2402 MHz	Modulation/Packet Type: GFSK / DH5



Plot #2

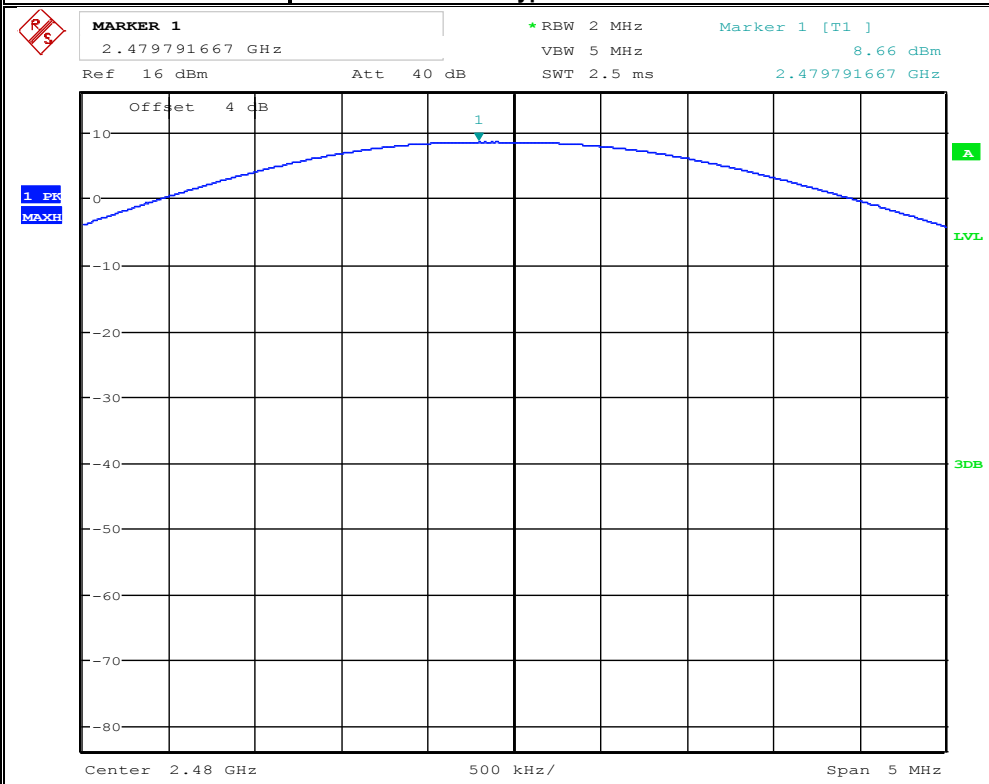
Ch.39 / 2441 MHz	Modulation/Packet Type: GFSK / DH5



Date: 13.OCT.2015 11:51:09

Plot #3

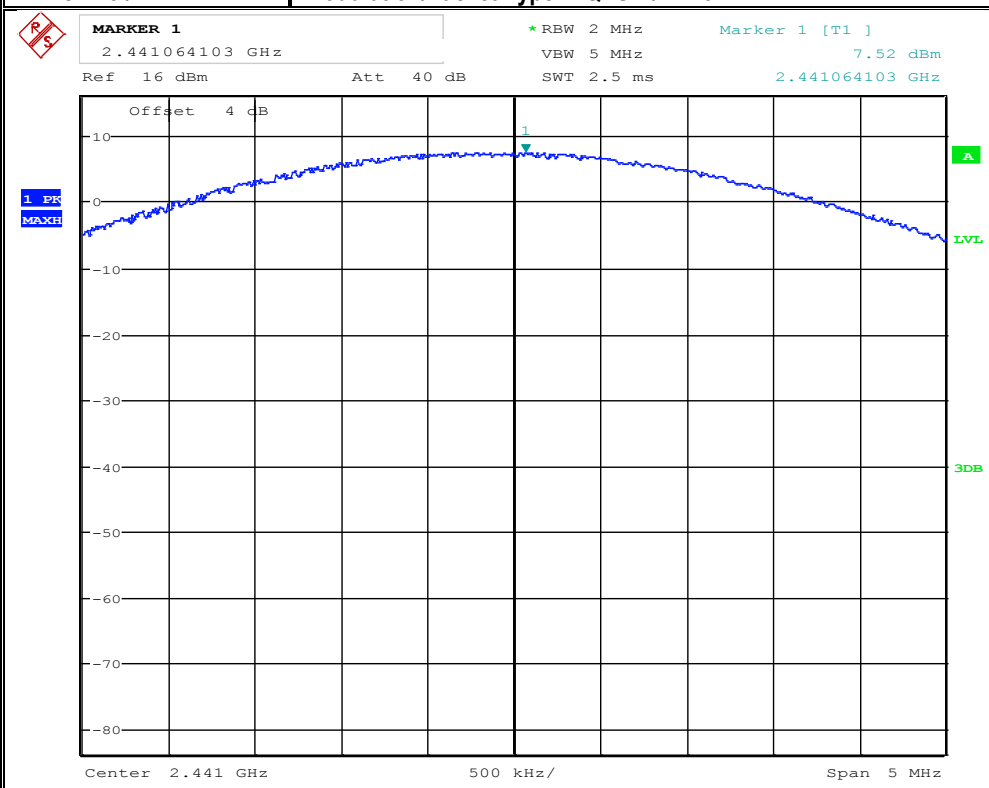
Ch.78 / 2480 MHz	Modulation/Packet Type: GFSK / DH5



Date: 13.OCT.2015 11:52:51

Plot #4

Ch.78 / 2441 MHz	Modulation/Packet Type: DQPSK / DH5



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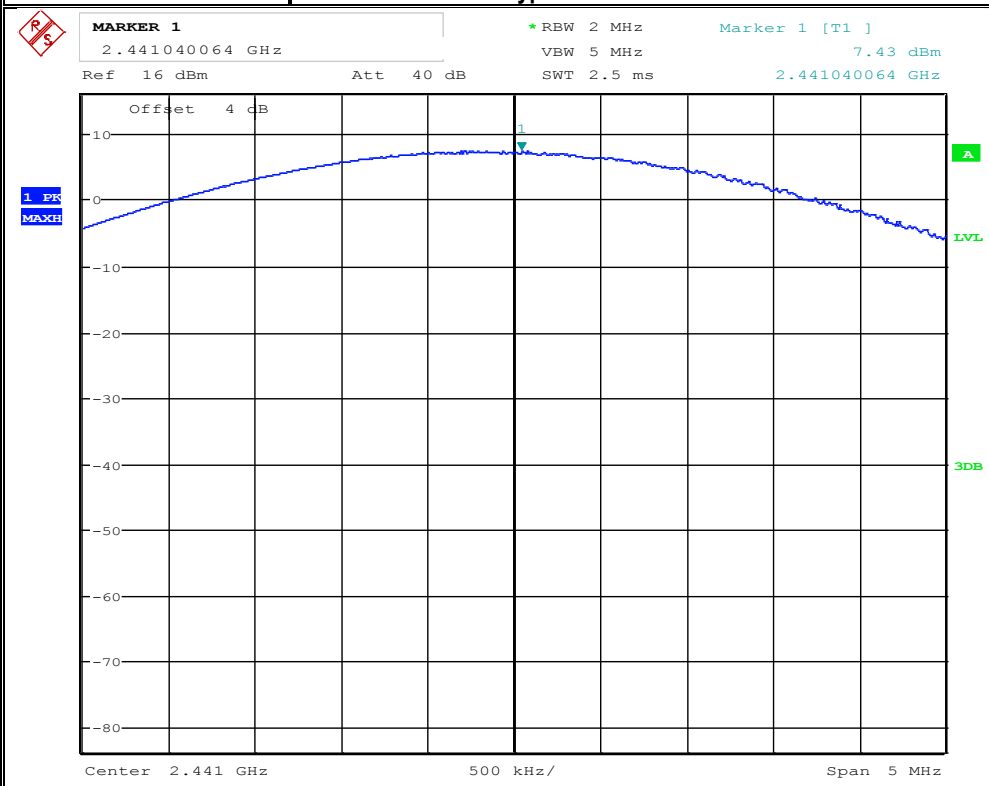
Plot #5

Ch.78 / 2441 MHz	Modulation/Packet Type: 8DPSK / DH5



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8.3 Band Edge and Restricted Band Compliance

8.3.1 Measurement according to DA 00-705:2000

Spectrum Analyzer settings for non-restricted band edge:

- Span: wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
- RBW ≥ 1% of the span
- VBW ≥ RBW
- Sweep Time: Auto
- Detector = peak
- Trace = max hold
- Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge.

Spectrum Analyzer settings for restricted band:

- Peak measurements are made using a peak detector and RBW=1 MHz, VBW ≥ RBW

8.3.2 Limits restricted band §15.205

- PEAK LIMIT= 74dBµV/m @3m =-21.23dBm
- AVG. LIMIT= 54dBµV/m @3m =-41.23dBm
- Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205

Restricted bands of operation:

- Except as shown in CFR 47 Part 15.205 paragraph (d), 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	Above 38.6
13.36-13.41			

8.3.3 Limits non restricted band §15.247(d)

FCC15.247 (d)
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).

8.3.4 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power Input (VDC)
22	2	GFSK / DQPSK / 8DPSK	5

8.3.5 Measurement result:

Plot #	EUT operating mode	Lower Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
1	GFSK Fix Chan.	Non-restricted	-48.54	20	Pass
2	GFSK Hopping	Non-restricted	-48.23	20	Pass
3	DQPSK Fix Chan.	Non-restricted	-39.65	20	Pass
4	DQPSK Hopping	Non-restricted	-38.85	20	Pass

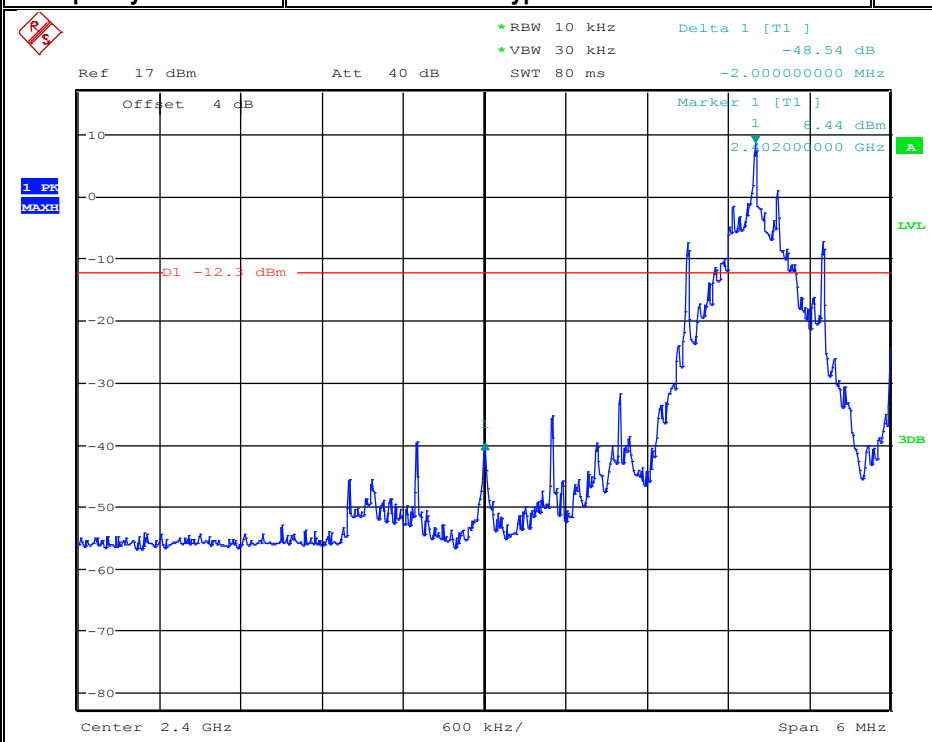
Plot #	EUT operating mode	Upper Band Edge	Measured value	Corrected by duty cycle	Corrected for Antenna gain	limit [dBm/MHz]	Result
5	GFSK Fix Chan.	Restricted	-34.7	NA due to peak detector	-32.7	-21.23 PEAK	Pass
6	GFSK Hopping	Restricted	-35.66	NA due to peak detector	-33.66	-21.23 PEAK	Pass
7	GFSK Fix Chan.	Restricted	-48.42	NA due to max hold	-46.42	-41.23 AVG	Pass
8	GFSK Hopping	Restricted	-48.77	NA due to max hold	-46.77	-41.23 AVG	Pass
9	DQPSK Fix Chan.	Restricted	-33.61	NA due to peak detector	-31.61	-21.23 PEAK	Pass
10	DQPSK Hopping	Restricted	-34.68	NA due to peak detector	-32.68	-21.23 PEAK	Pass
11	DQPSK Fix Chan.	Restricted	-48.68	NA due to max hold	-46.68	-41.23 AVG	Pass
12	DQPSK Hopping	Restricted	-48.58	NA due to max hold	-46.58	-41.23 AVG	Pass

Note: Added 2dBi gain for the antenna

8.3.6 Measurement Plots:

Plot #1 Lower Band Edge

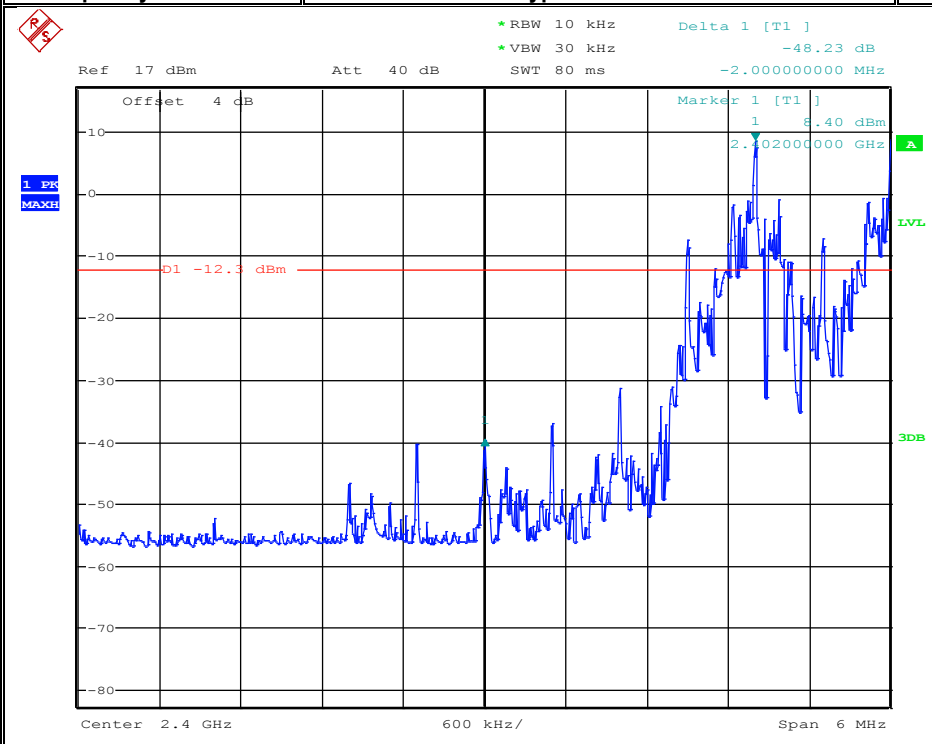
Frequency = 2402MHz	Modulation/Packet Type: GFSK DH5	Fixed Channel



Date: 28.SEP.2015 13:33:52

Plot #2 Lower Band Edge

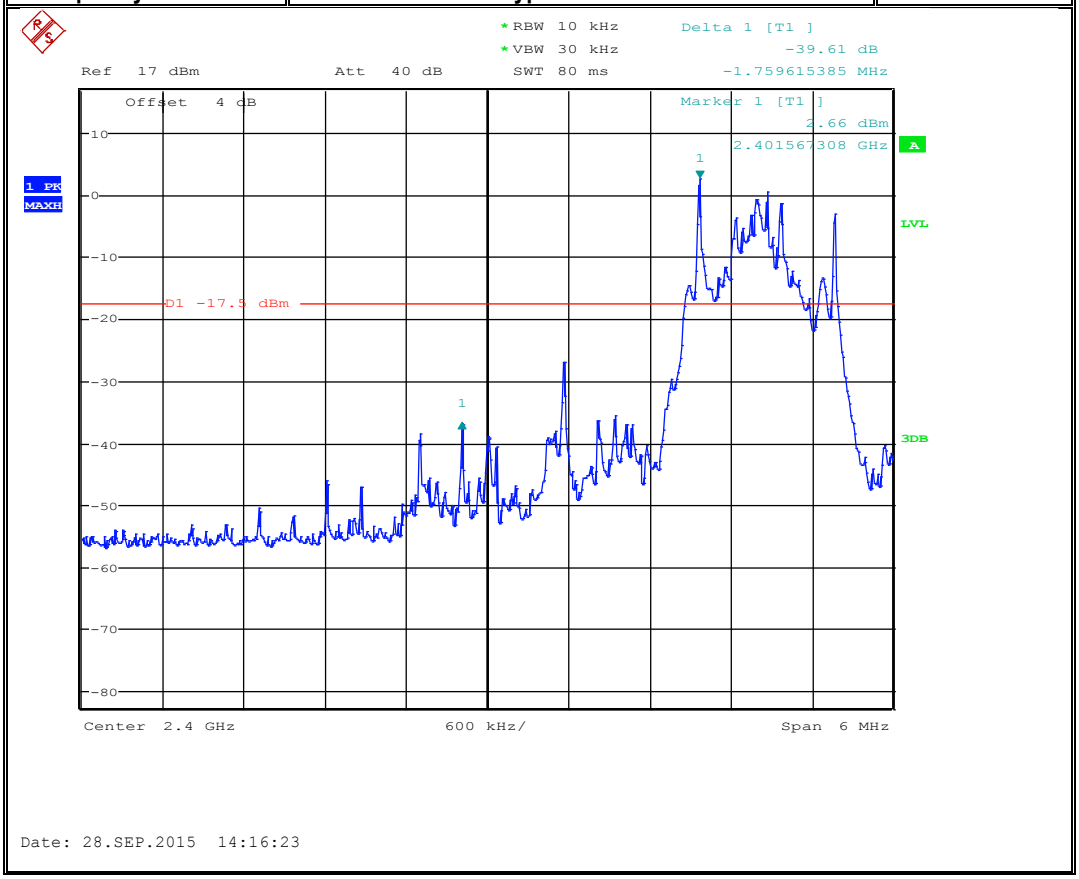
Frequency = 2402MHz	Modulation/Packet Type: GFSK DH5	Hopping



Date: 28.SEP.2015 13:39:04

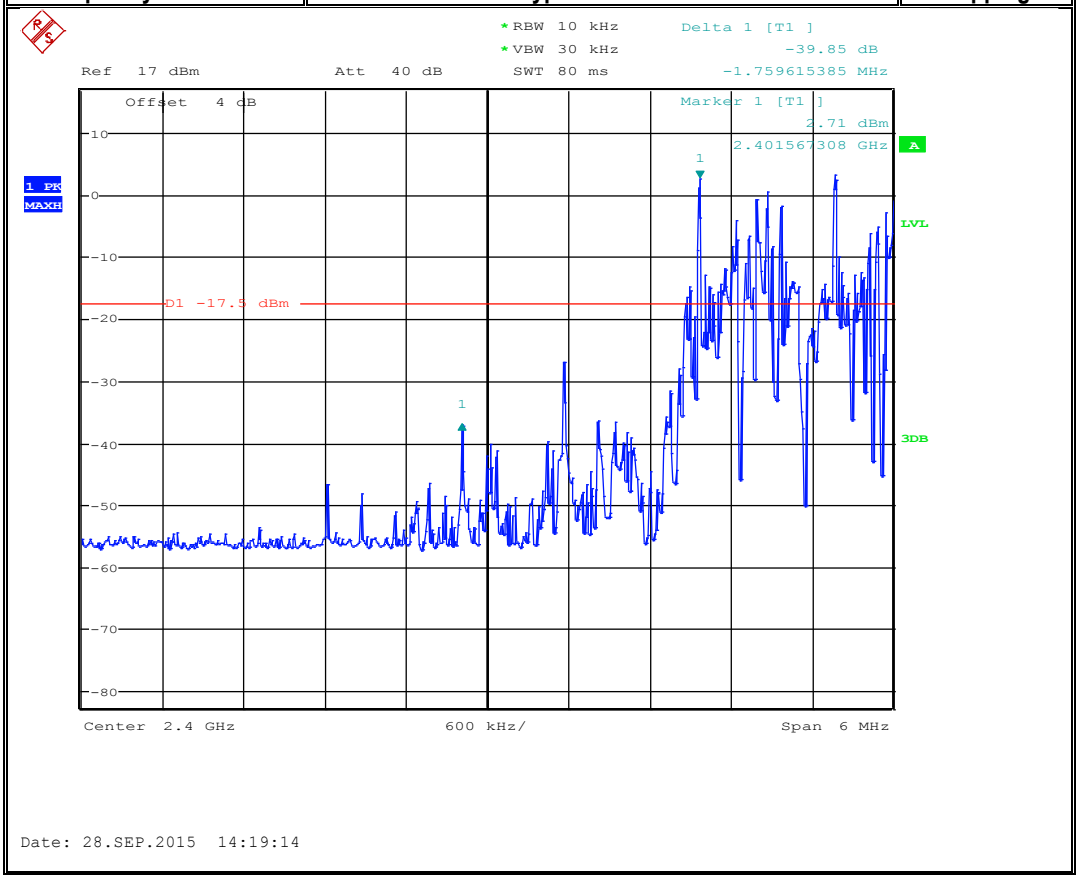
Plot #3 Lower Band Edge

Frequency = 2402MHz	Modulation/Packet Type: DQPSK DH5	Fixed Channel



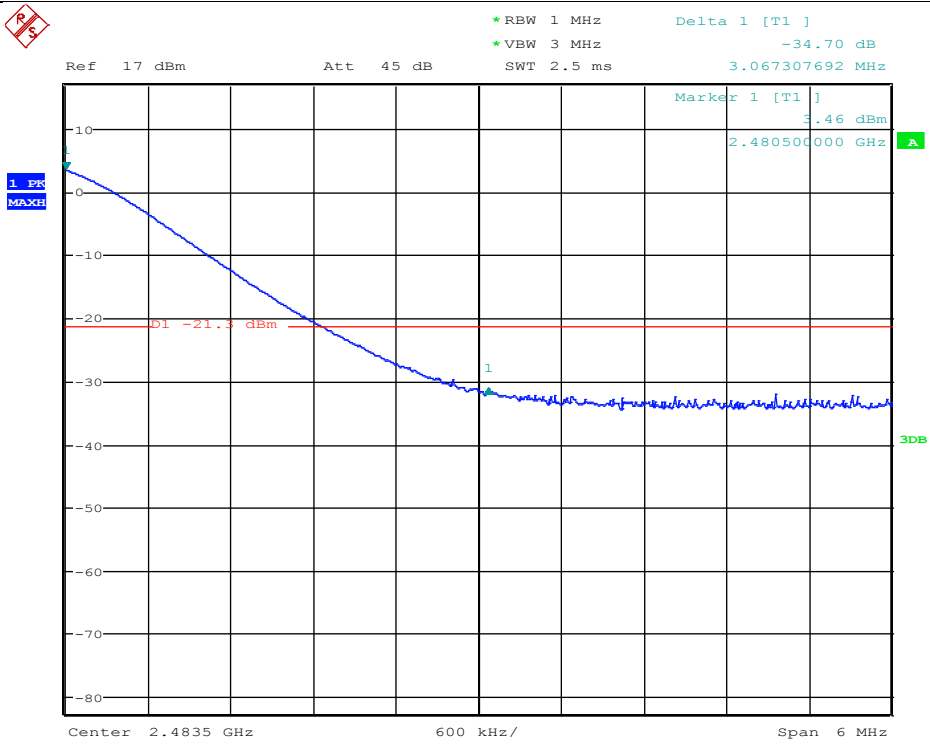
Plot #4 Lower Band Edge

Frequency = 2402MHz	Modulation/Packet Type: DQPSK DH5	Hopping



Plot #5 Upper Band Edge Peak

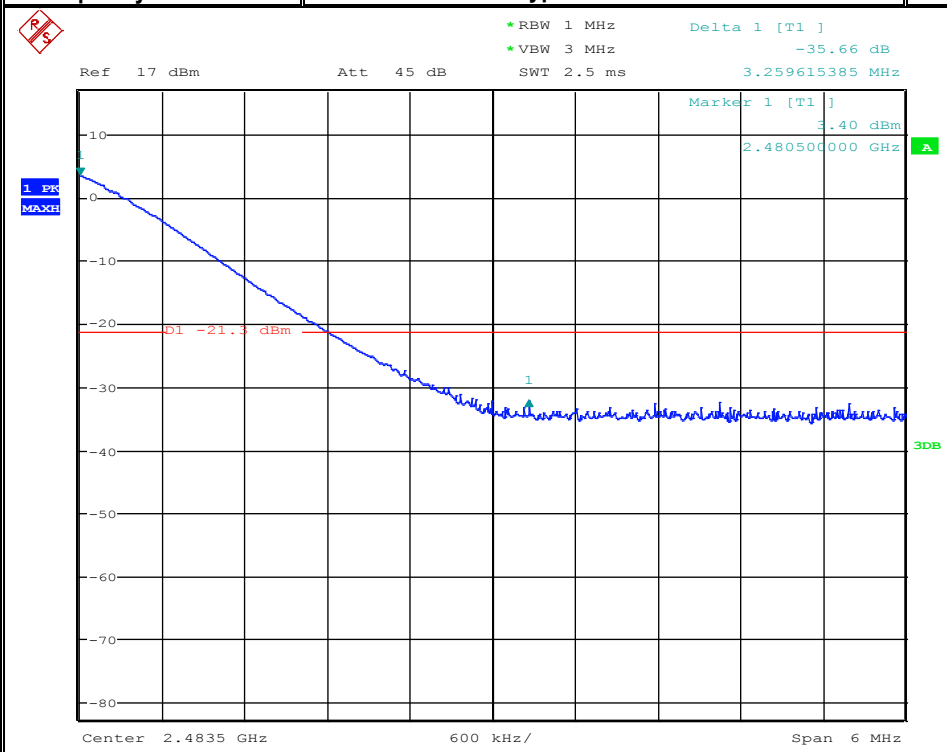
Frequency = 2480MHz	Modulation/Packet Type: GFSK DH5	Fixed Channel



Date: 28.SEP.2015 14:53:19

Plot #6 Upper Band Edge Peak

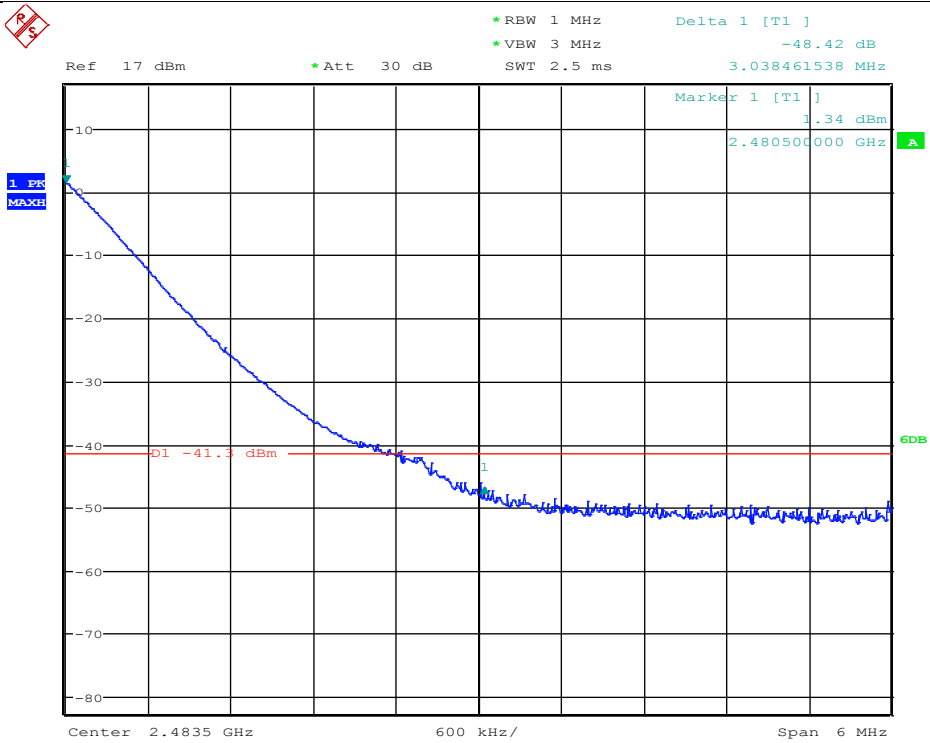
Frequency = 2480MHz	Modulation/Packet Type: GFSK DH5	Hopping



Date: 28.SEP.2015 14:55:32

Plot #7 Upper Band Edge AVG

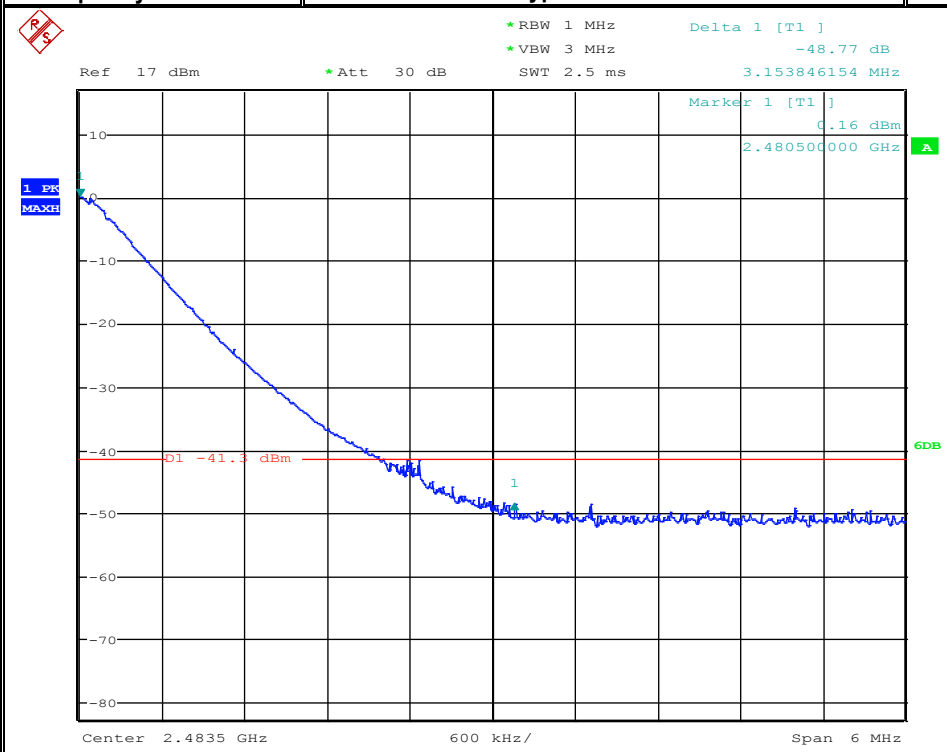
Frequency = 2480MHz	Modulation/Packet Type: GFSK DH5	Fixed Channel



Date: 28.SEP.2015 15:29:46

Plot #8 Upper Band Edge AVG

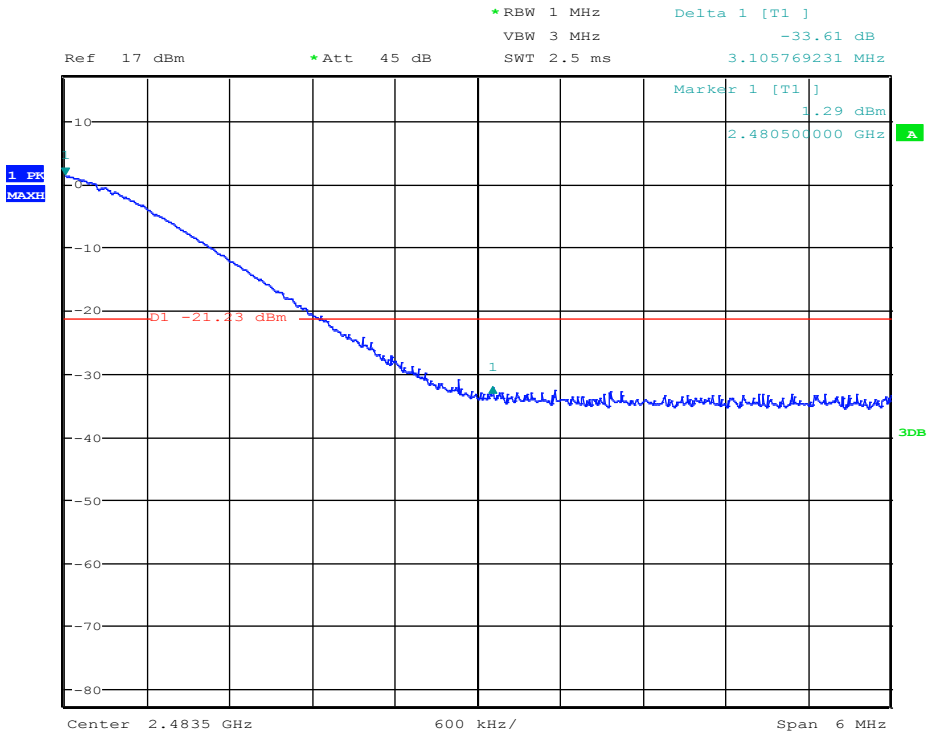
Frequency = 2480MHz	Modulation/Packet Type: GFSK DH5	Hopping



Date: 28.SEP.2015 15:30:53

Plot #9 Upper Band Edge Peak

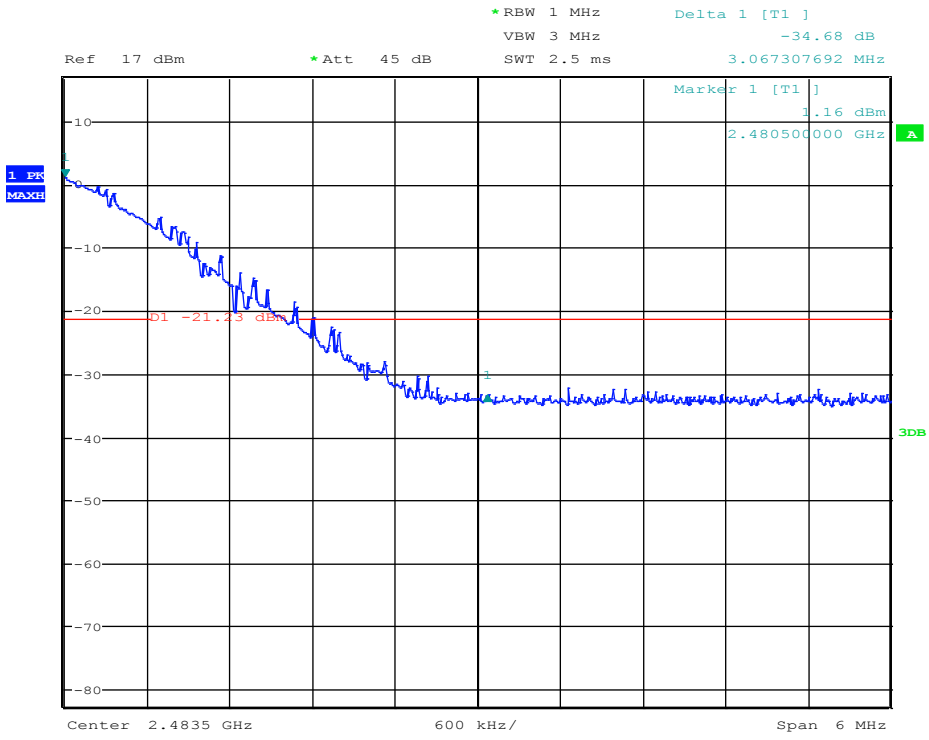
Frequency = 2480MHz	Modulation/Packet Type: DQPSK DH5	Fixed Channel



Date: 13.OCT.2015 11:32:15

Plot #10 Upper Band Edge Peak

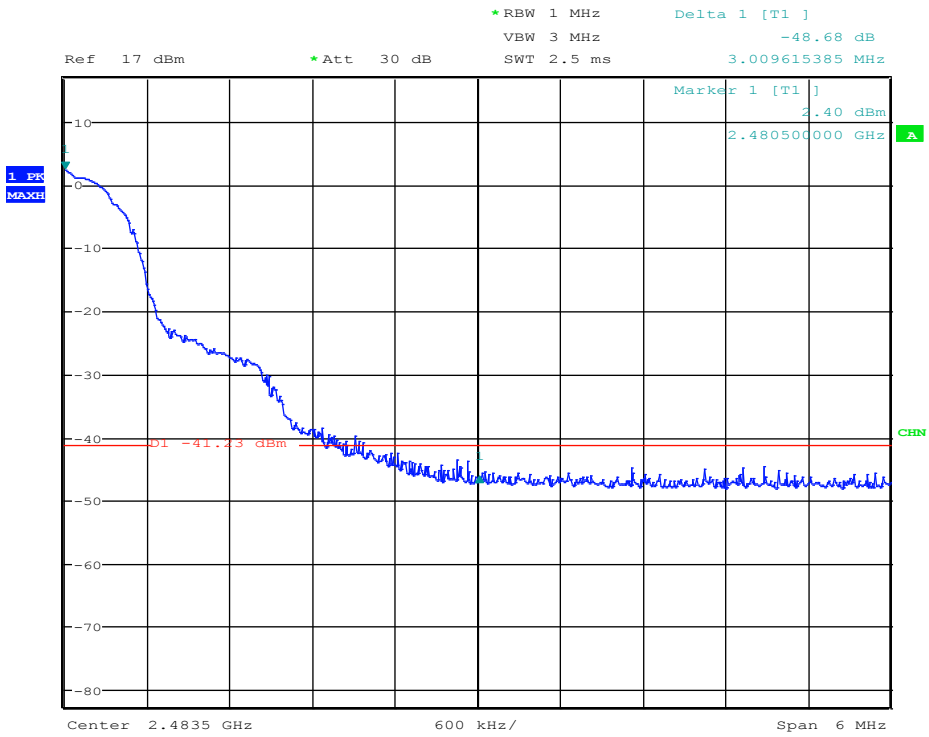
Frequency = 2480MHz	Modulation/Packet Type: DQPSK DH5	Hopping



Date: 13.OCT.2015 11:34:24

Plot #11 Upper Band Edge AVG

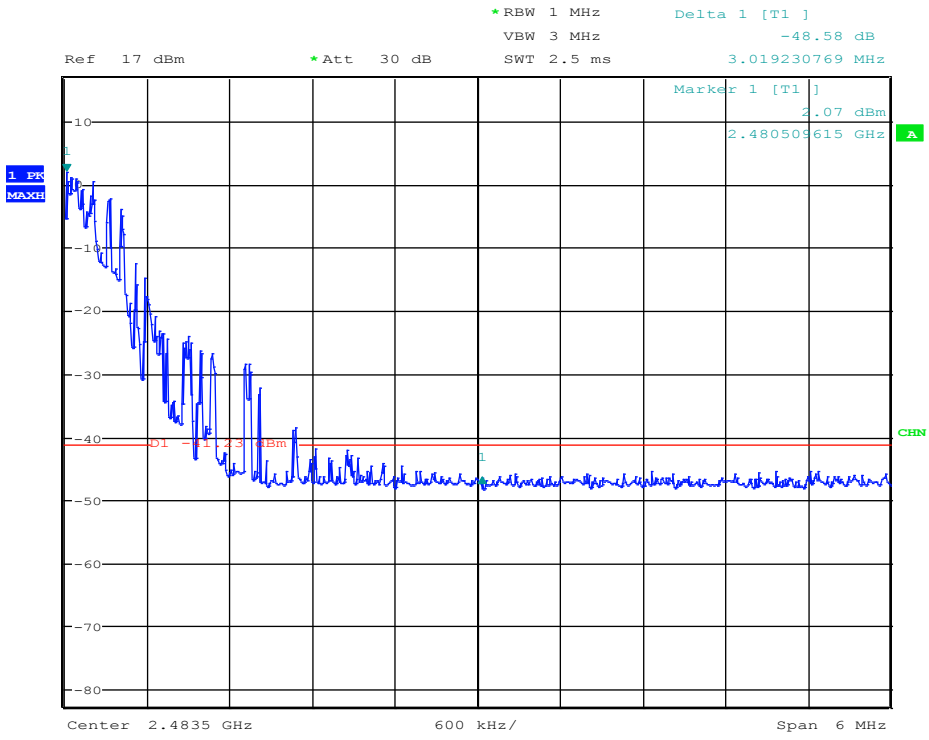
Frequency = 2480MHz	Modulation/Packet Type: DQPSK DH5	Fixed Channel



Date: 13.OCT.2015 11:25:15

Plot #12 Upper Band Edge AVG

Frequency = 2480MHz	Modulation/Packet Type: DQPSK DH5	Hopping



Date: 13.OCT.2015 11:28:40

8.4 Carrier Frequency Separation

8.4.1 Measurement according to DA 00-705:2000

Spectrum Analyzer settings:

- Span = Wide enough to capture the peaks of the two adjacent channels
- RBW ≥ 1% of the span
- VBW ≥ RBW or 3X
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Use marker-delta function to determine the separation between the peaks of the two adjacent channels.

8.4.2 Limits: § 15.247 (a) (1)

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

8.4.3 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power Input (VDC)
22	2	GFSK	5

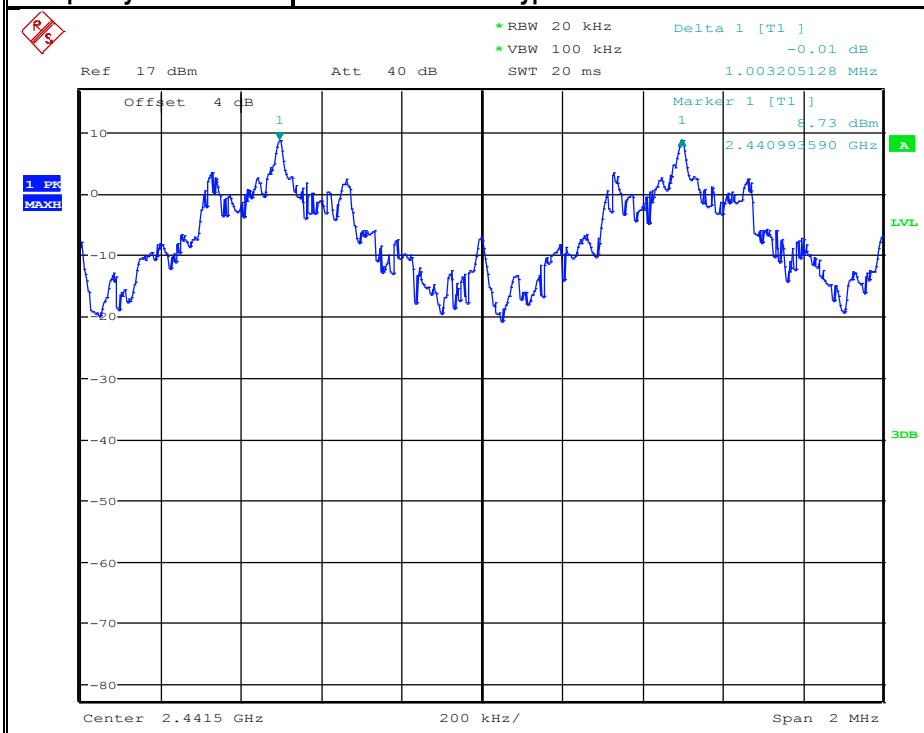
8.4.4 Measurement result:

Plot #	Carrier Frequency Separation (MHz)	Limit (MHz)	Result
1	1.003	> (2/3 * OBW) = 0.76	Pass

8.4.5 Measurement Plots:

Plot #1 Carrier Frequency Separation

Frequency = 24415 MHz	Modulation/Packet Type: GFSK DH5



8.5 Number of hopping channels

8.5.1 Measurement according to DA 00-705:2000

Spectrum Analyzer settings:

- Span = the entire frequency band of operation
- RBW ≥ 50 KHz
- VBW ≥ RBW or 3X
- Sweep = auto
- Detector function = peak
- Trace = max hold

8.5.2 Limits: § 15.247 (a) (1) (ii) (iii)

- At least 15 non-overlapping channels

8.5.3 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power Input (VDC)
22	2	GFSK	5

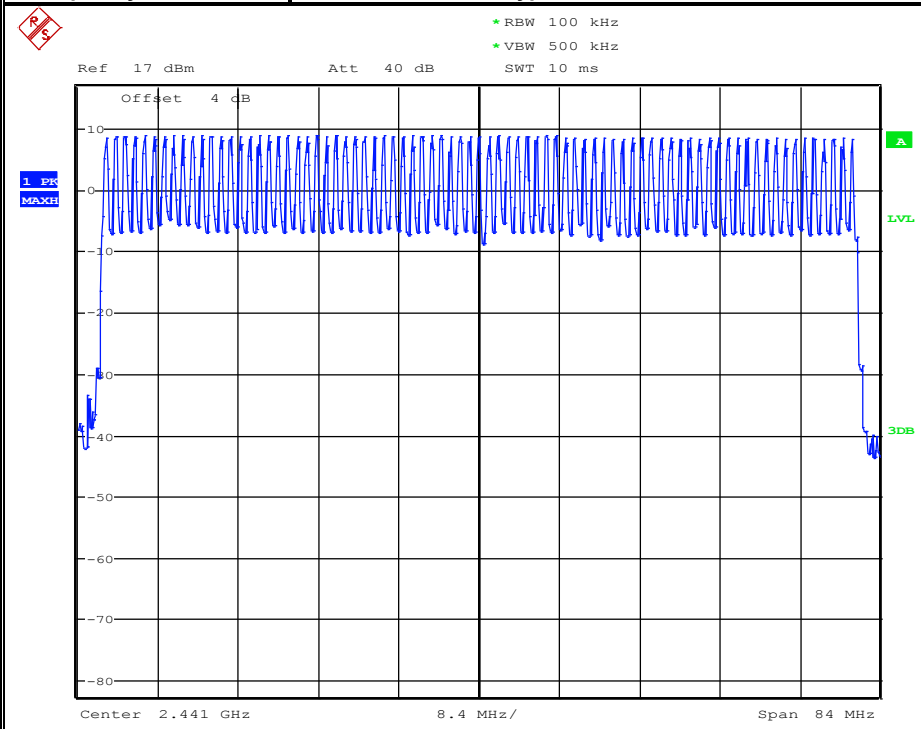
8.5.4 Measurement result:

Plot #	Number of Hopping Frequencies	Limit	Result
1	79	Minimum 15 non-overlapping channels	Pass

8.5.5 Measurement Plots:

Plot #1 Number of Hopping Frequencies

Frequency = 2441 MHz	Modulation/Packet Type: GFSK DH5



Date: 28.SEP.2015 11:00:51

8.6 Time of Occupancy (Dwell Time)

8.6.1 Measurement according to DA 00-705:2000

Spectrum Analyzer settings:

Duration of Pulse Measurement
- RBW= 1MHz
- VBW= 3MHz
- Sweep Time= 10 ms
- Sweep Mode= Single
- Detector=Peak
- Trigger= Video

Observation Period
- RBW= 1MHz
- VBW= 3MHz
- Sweep Time= 31.6 s
- Sweep Mode= Single
- Detector=Peak
- Trigger= Free Run

Observation Period = 0.4s x No. of hopping channels = 0.4 x 79 = 31.6 s

8.6.2 Limits: § 15.247 (a) (1) (iii)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

8.6.3 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power Input (VDC)
22	2	GFSK / DQPSK / 8DPSK	5

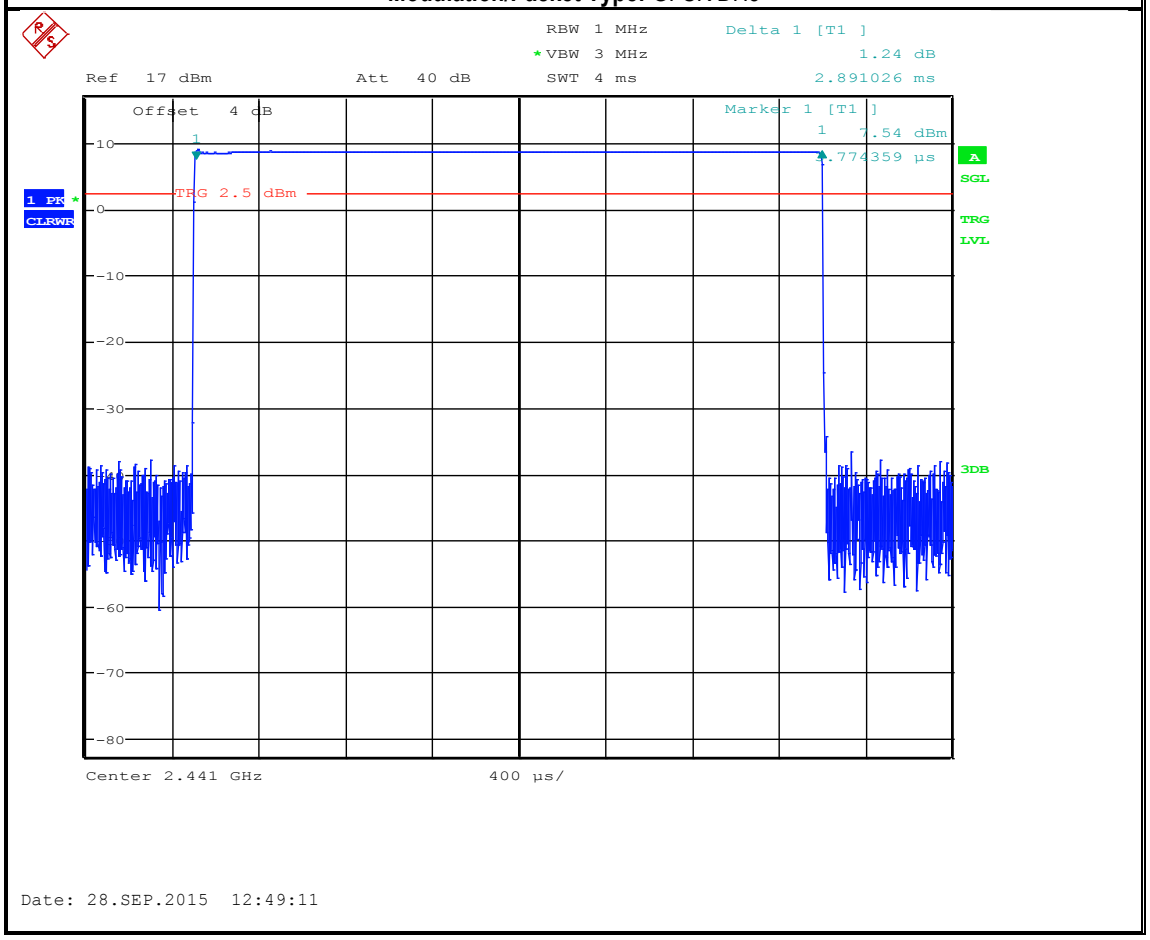
8.6.4 Measurement result:

Plot #	Modulation	Timing	Number of hops 31.6s	Pulse Width (ms)	Total Dwell Time in 31.6s (ms)	Limit (ms)	Result
1	GFSK	DH5	110	2.89	318	< 400 in 31.6s	Pass
2	DQPSK	DH5	102	2.89	295	< 400 in 31.6s	Pass
3	8DPSK	DH5	119	2.89	343	< 400 in 31.6s	Pass

8.6.5 Measurement Plots:

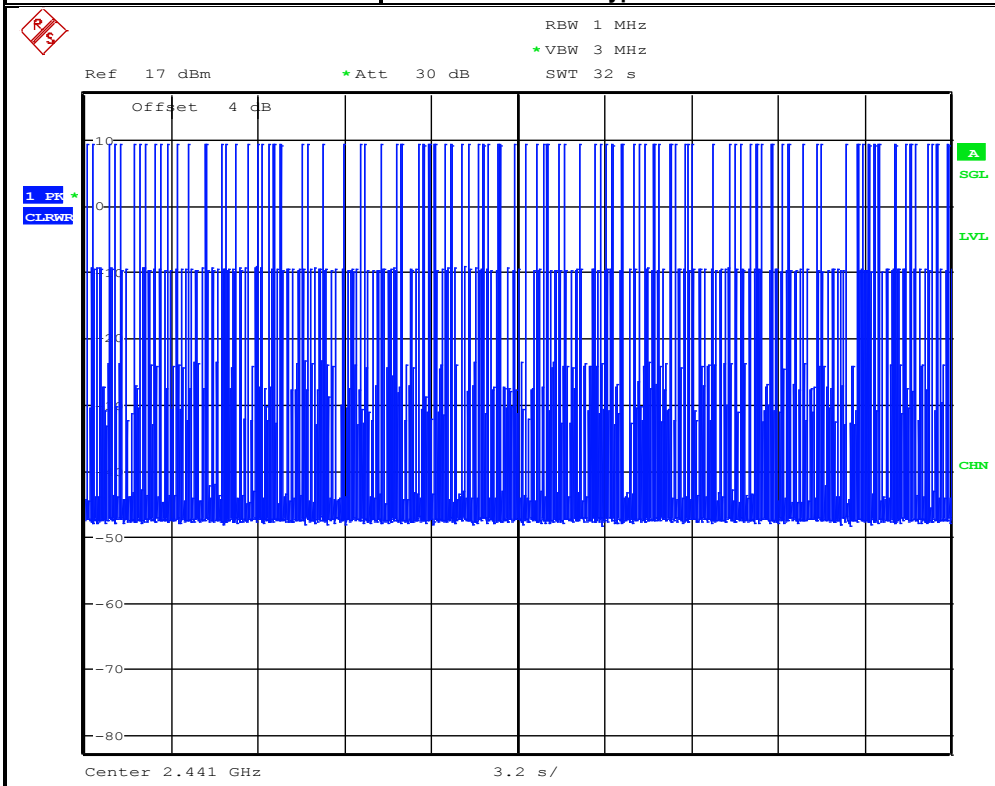
Sample Pulse Width Plot

Modulation/Packet Type: GFSK DH5



Plot #1 Transmission in Observation Period (31.6s)

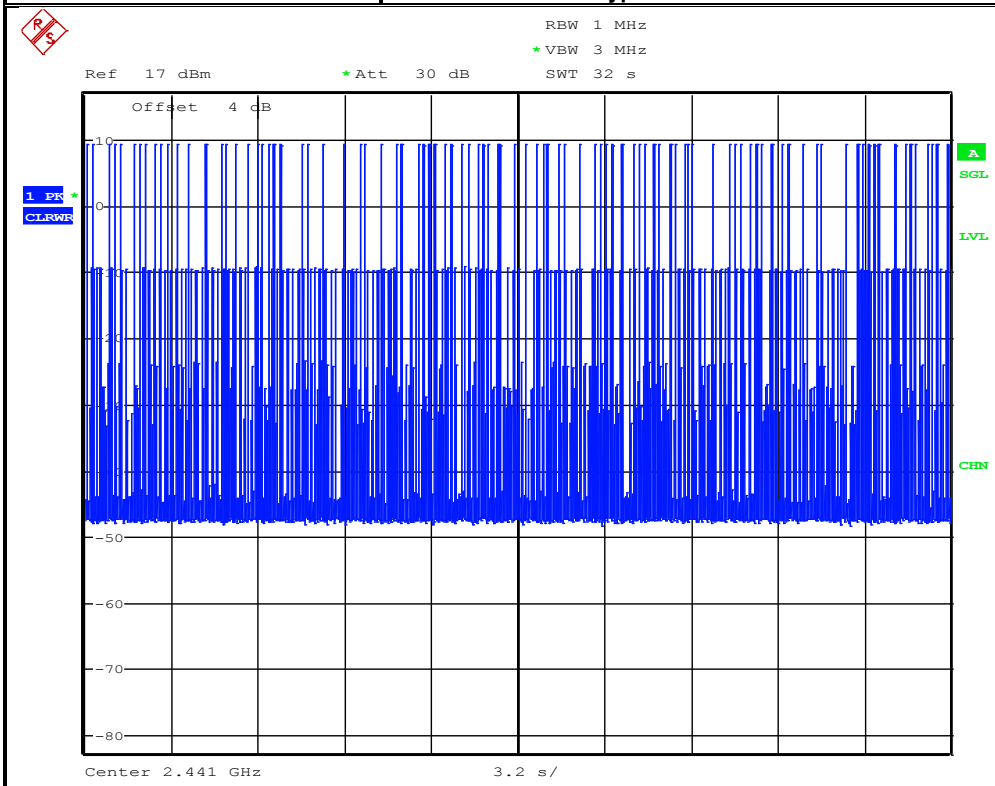
Number Bursts = 110	Modulation/Packet Type: GFSK



Date: 29.SEP.2015 10:13:07

Plot #2 Transmission in Observation Period (31.6s)

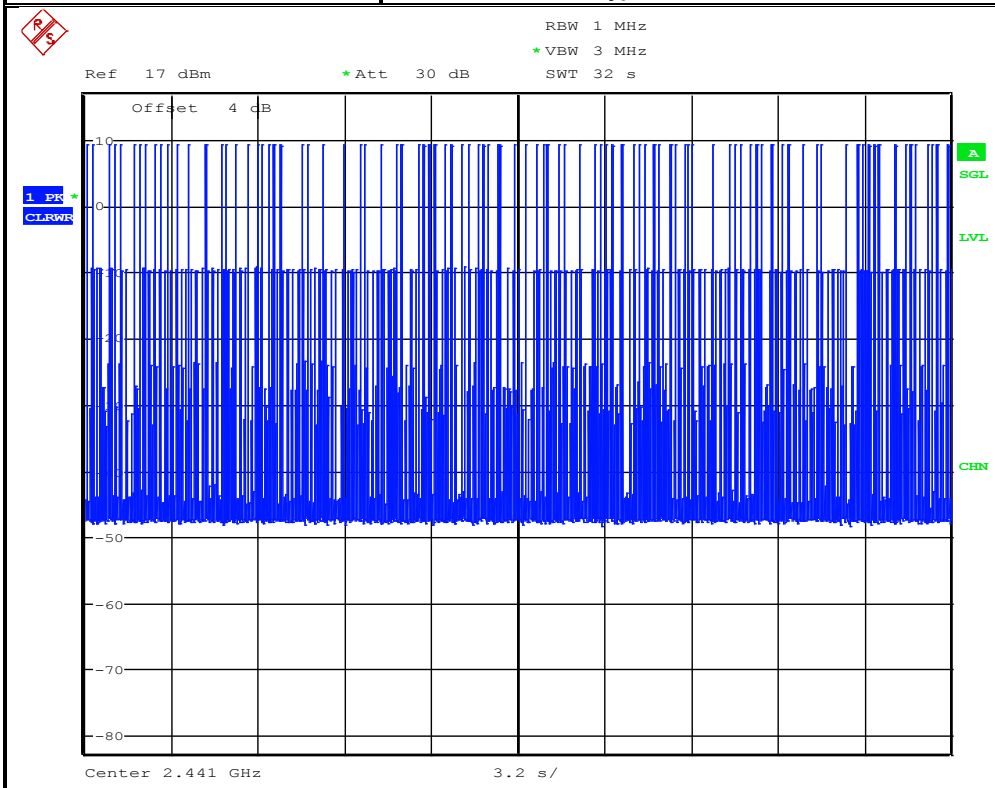
Number Bursts = 102	Modulation/Packet Type: DQPSK



Date: 29.SEP.2015 10:13:07

Plot #3 Transmission in Observation Period (31.6s)

Number Bursts = 119	Modulation/Packet Type: 8QPSK



Date: 29.SEP.2015 10:13:07

8.7 Transmitter Spurious Emissions

8.7.1 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.

8.7.2 Limits: §15.247(d)/15.209(a)

- Except as shown in CFR 47 Part 15.205 paragraph (d), 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	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= 74dBµV/m
- AVG. LIMIT= 54dBµV/m

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

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 as follow:

Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

8.7.3 Test conditions and setup:

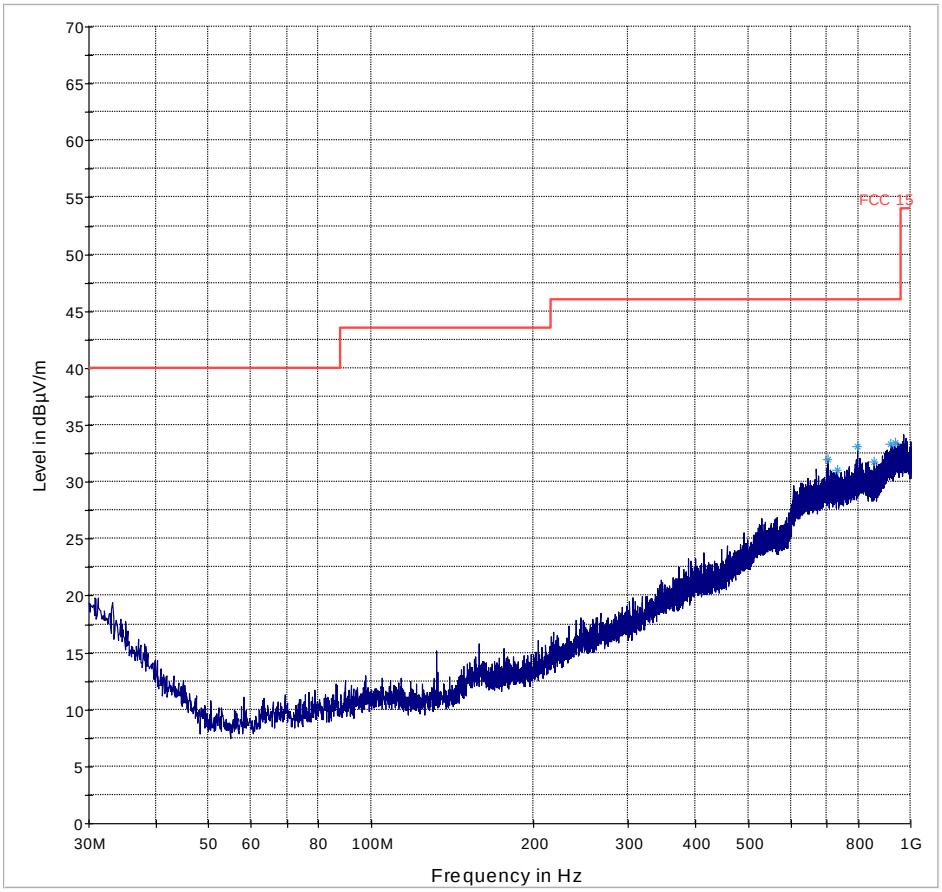
Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power Input (VDC)
22	1	GFSK	5

8.7.4 Measurement result:

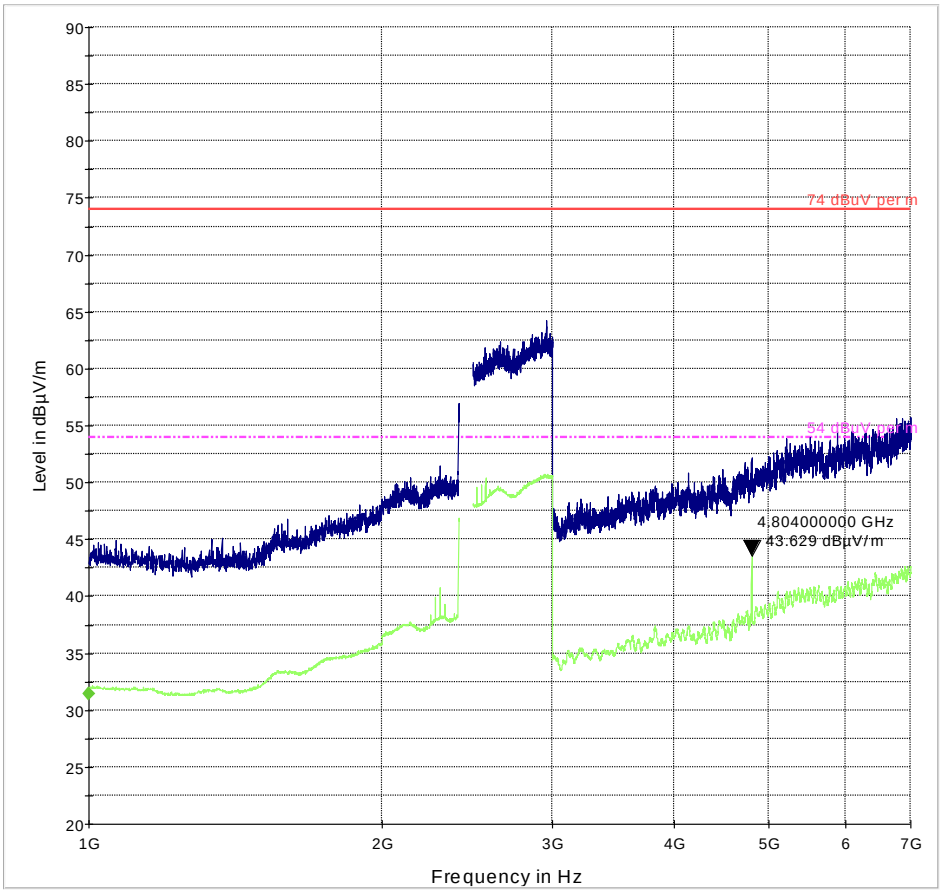
Plot #	Channel #	EUT operating mode	Scan Frequency	Limit	Result
1-3	Low	GFSK	30 MHz – 18 GHz	See section 8.7.2	Pass
4-8	Mid	GFSK	9 kHz – 26 GHz	See section 8.7.2	Pass
9-12	High	GFSK	30 MHz – 18 GHz	See section 8.7.2	Pass

8.7.5 Measurement Plots:

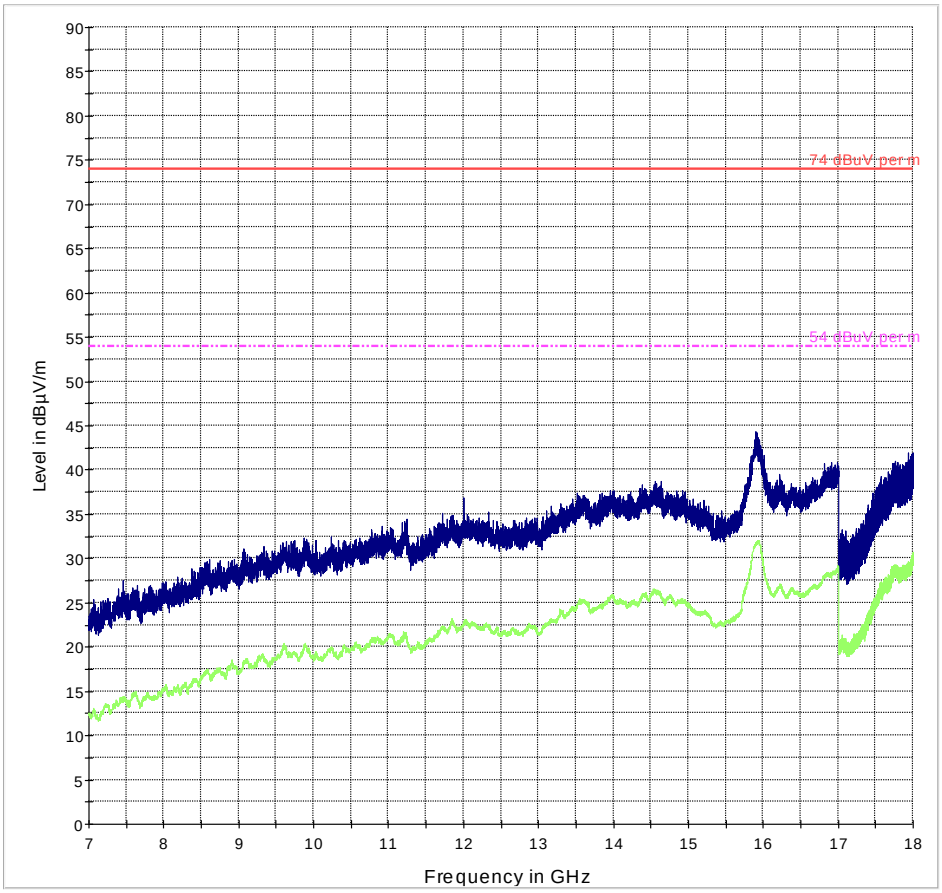
Plot #1 Radiated Emissions: 30 MHz – 1GHz		
Modulation: GFSK	Channel: Low	DH5



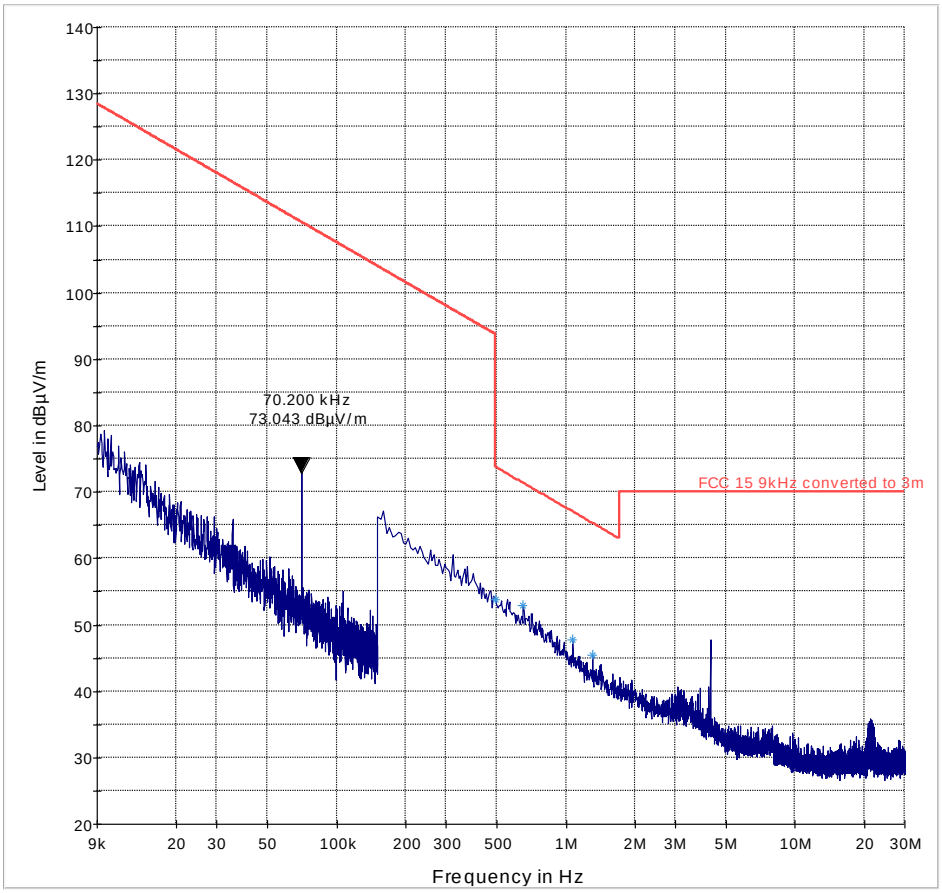
Plot # 2 Radiated Emissions: 1-7 GHz		
Modulation: GFSK	**Channel: Low**	**DH5**



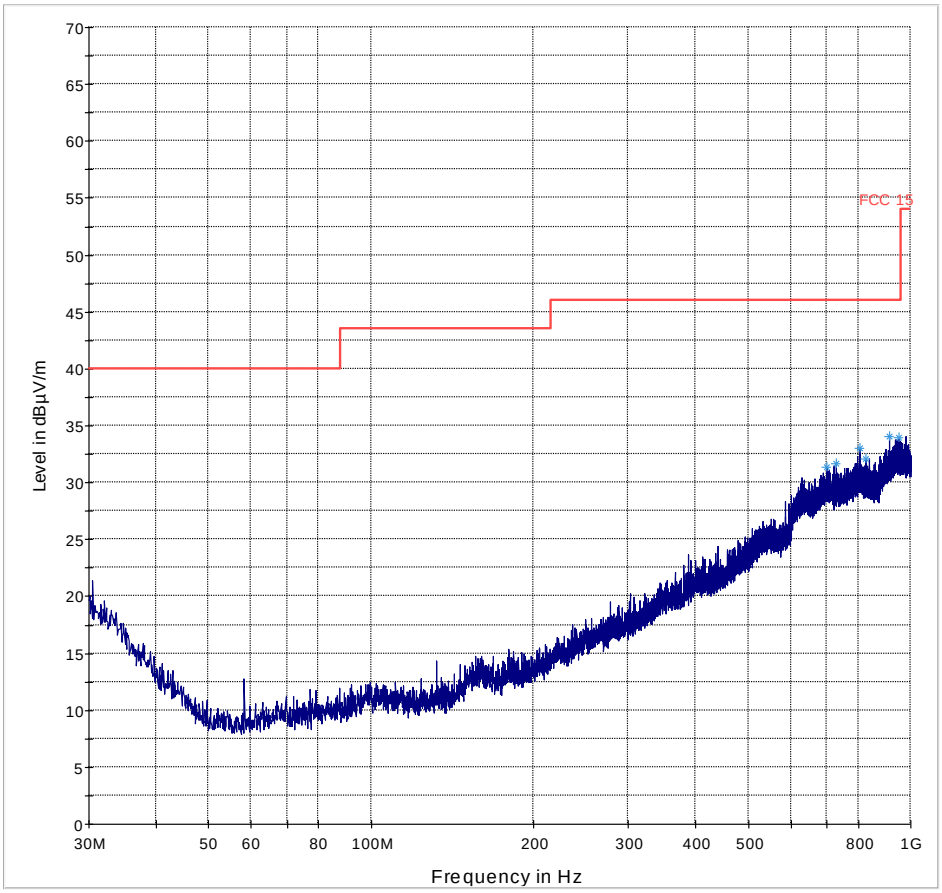
Plot # 3 Radiated Emissions: 7-18 GHz		
Modulation: GFSK	**Channel: Low**	**DH5**



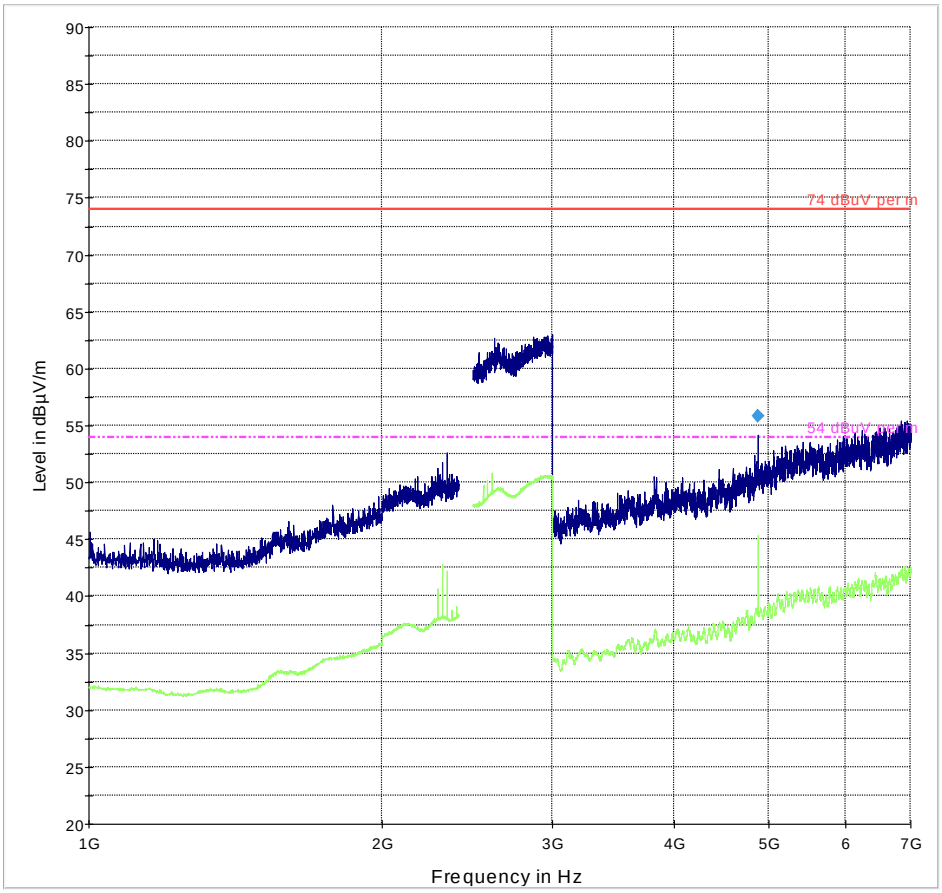
Plot # 4 Radiated Emissions: 9 KHz - 30 MHz		
Modulation: GFSK	**Channel: Mid**	**DH5**



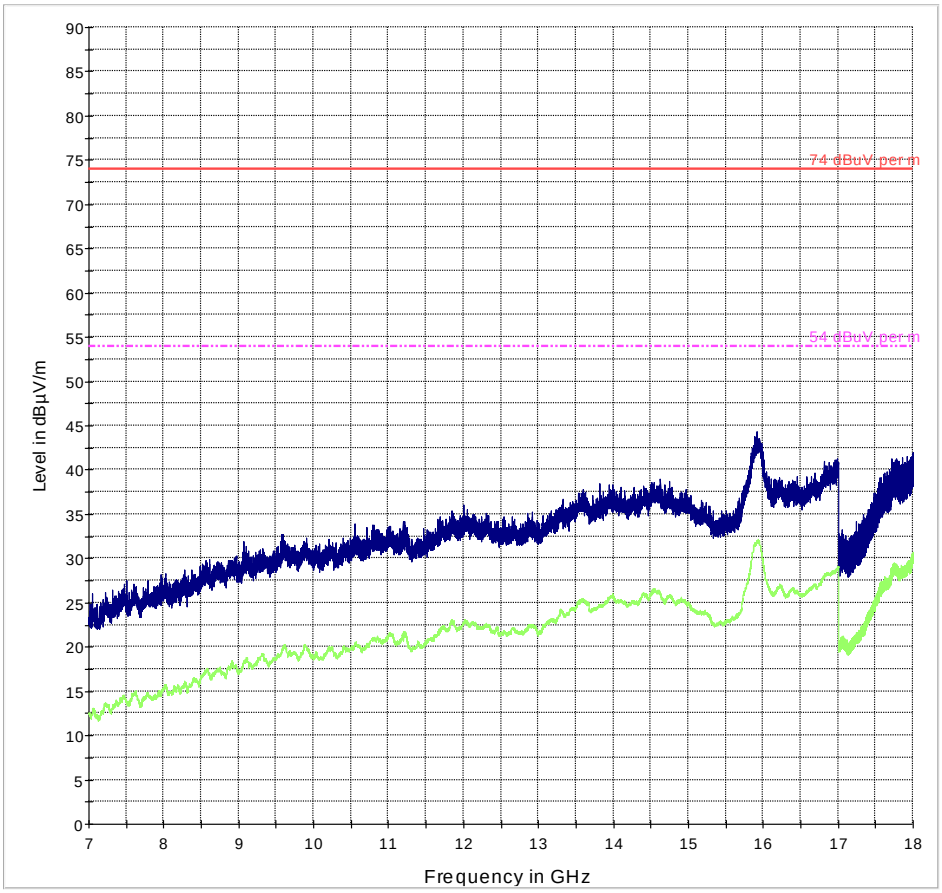
Plot #5 Radiated Emissions: 30 MHz – 1GHz		
Modulation: GFSK	**Channel: Mid**	**DH5**



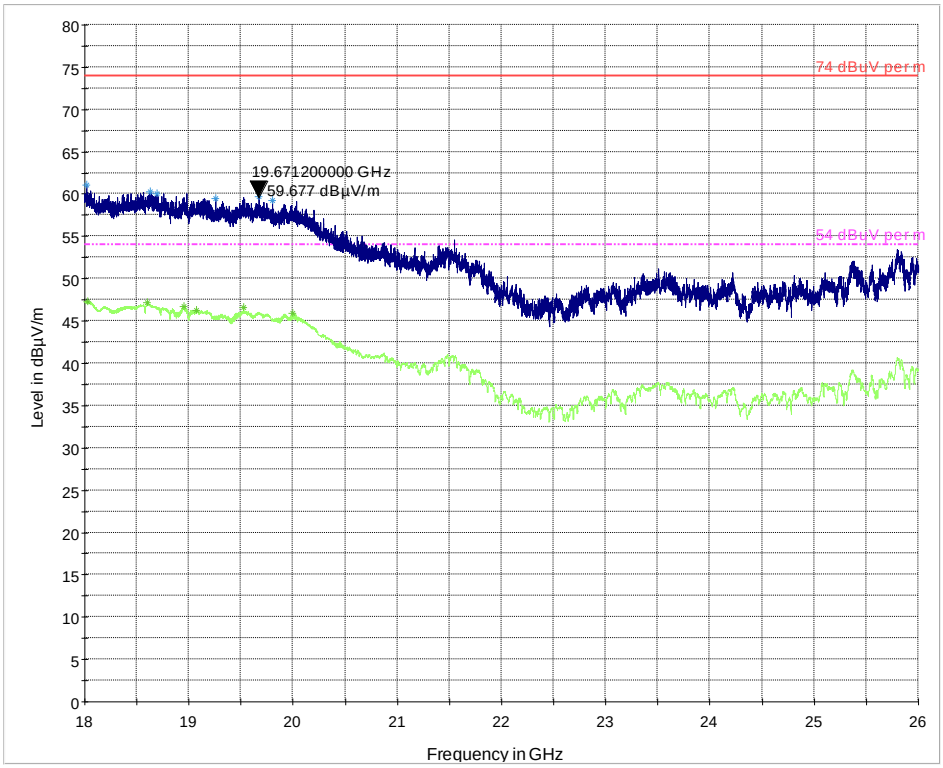
Plot #6 **Radiated Emissions: 1-7 GHz**		
Modulation: GFSK	**Channel: Mid**	**DH5**



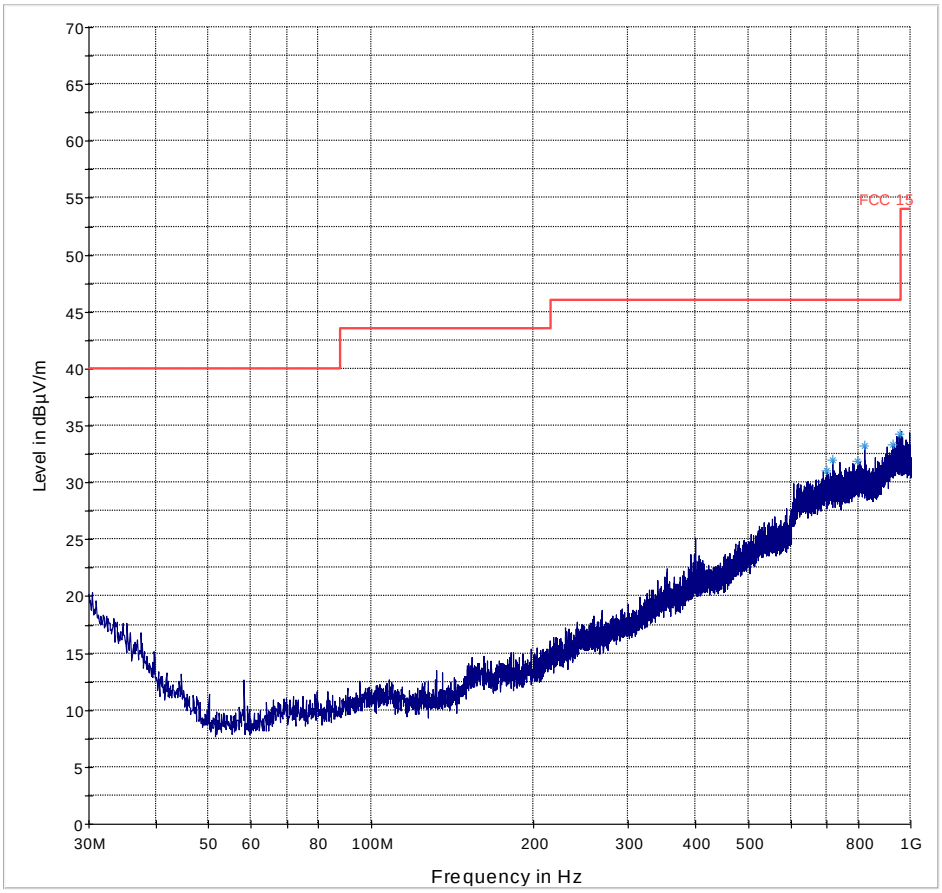
Plot #7 Radiated Emissions: 7-18 GHz		
Modulation: GFSK	**Channel: Mid**	**DH5**



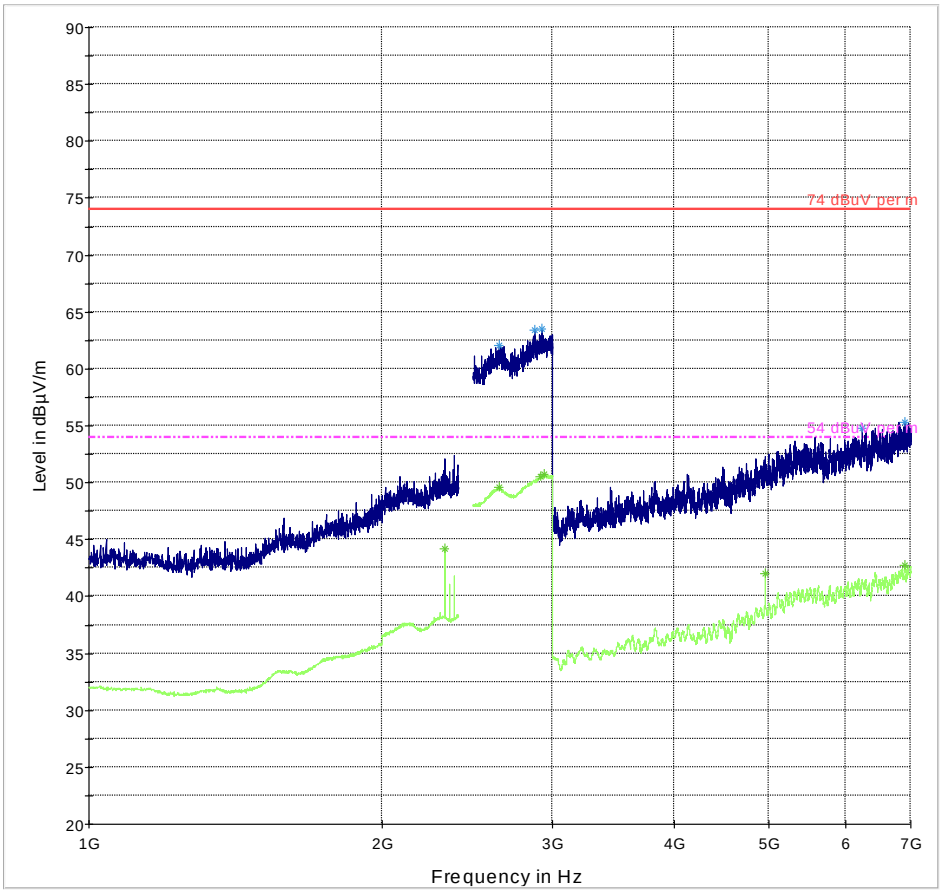
Plot #8 Radiated Emissions: 18-26 GHz		
Modulation: GFSK	**Channel: Mid**	**DH5**



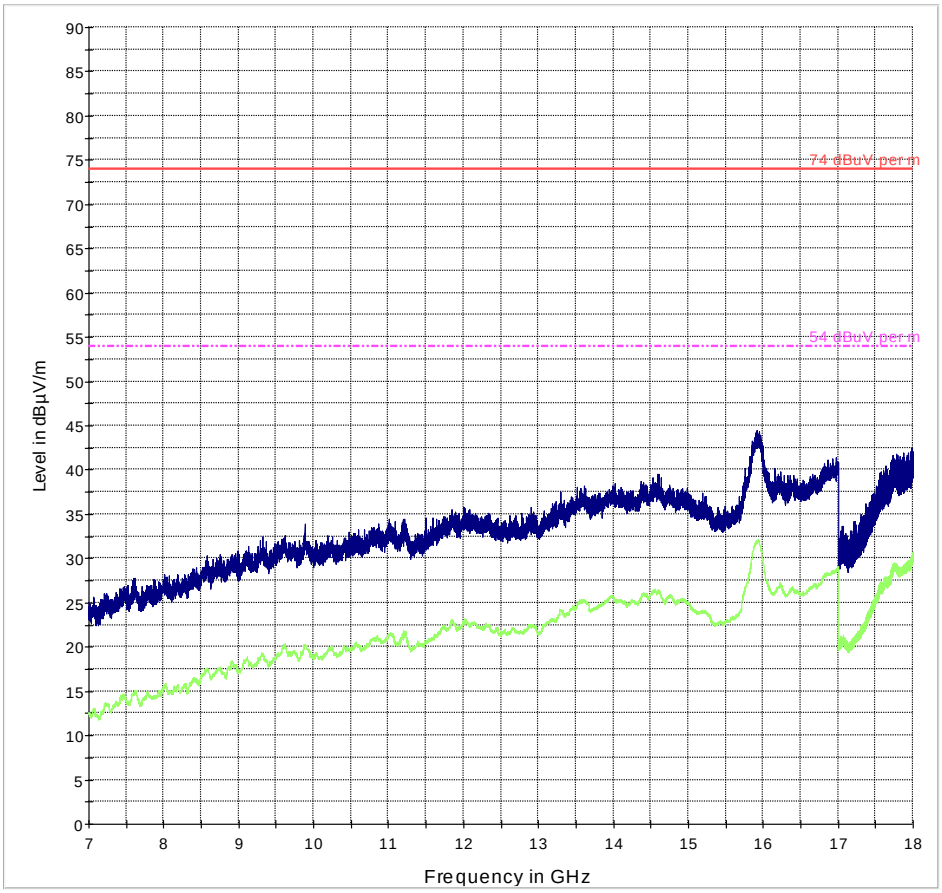
Plot #9 Radiated Emissions: 30 MHz – 1GHz		
Modulation: GFSK	**Channel: High**	**DH5**



Plot # 10 Radiated Emissions: 1-7 GHz		
Modulation: GFSK	**Channel: High**	**DH5**



Plot #11 Radiated Emissions: 7-18 GHz		
Modulation: GFSK	**Channel: High**	**DH5**



8.8 AC Power Line Conducted Emissions

8.8.1 Measurement according to ANSI C63.10 (2013)

Analyzer Settings:

- RBW = 9 KHz (CISPR Bandwidth)
- Pre-scan Detector = Peak / Average for
- Final Measurements Detector = Quasi-Peak / Average

8.8.2 Limits: §15.207

Except as shown in CFR 47 Part 15.207 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.

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.

8.8.3 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power line (L1, L2, L3, N)	Power Input
22	3	GFSK	Line & Neutral	110V / 60Hz

8.8.4 Measurement Result:

Plot #	Port	EUT Set-Up #:	EUT operating mode	Scan Frequency	Limit	Result
1	AC Mains	3	GFSK DH5	150 kHz – 30 MHz	See section 8.8.2	Pass

8.8.5 Measurement Plots:

Plot #1

EUT Information

EUT Name: AT-660
Manufacturer: Verizon Telematics
Serial Number: #1
Comment: AC

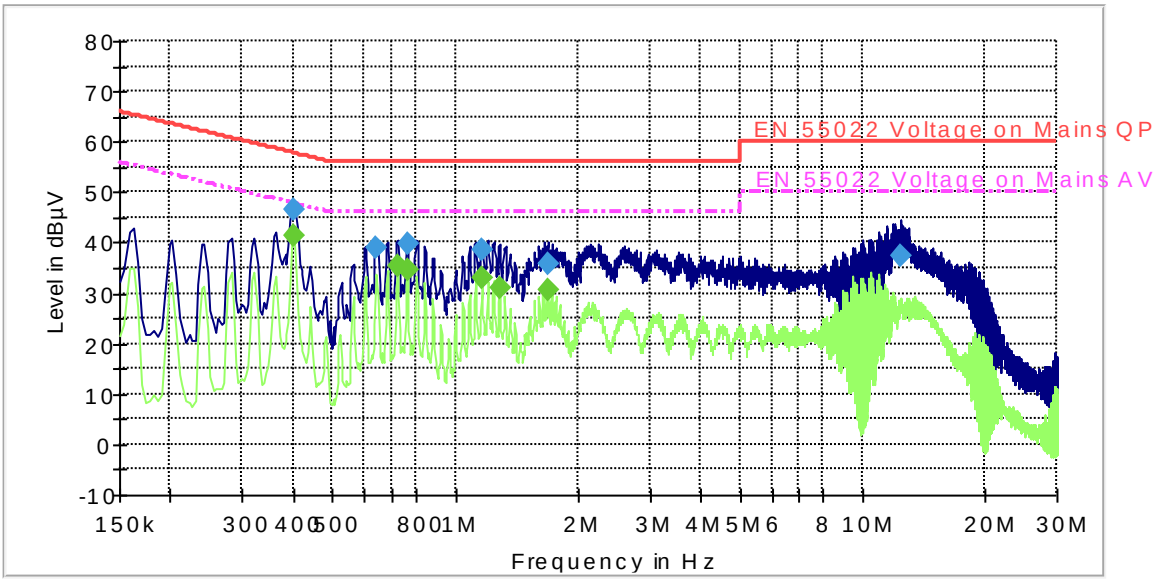
Final QP Result

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.402000	46.6	20.0	9.000	GND	N	0.5	11.2	57.8	Pass
0.642000	39.0	20.0	9.000	GND	N	0.4	17.0	56.0	Pass
0.762000	39.7	20.0	9.000	GND	N	0.4	16.3	56.0	Pass
1.162000	38.5	20.0	9.000	GND	N	0.4	17.5	56.0	Pass
1.690000	36.0	20.0	9.000	GND	N	0.5	20.0	56.0	Pass
12.342000	37.5	20.0	9.000	GND	N	0.9	22.5	60.0	Pass

Final AVG Result

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.402000	41.4	20.0	9.000	GND	N	0.5	6.5	47.8	Pass
0.722000	35.3	20.0	9.000	GND	N	0.4	10.7	46.0	Pass
0.762000	34.8	20.0	9.000	GND	N	0.4	11.2	46.0	Pass
1.162000	32.9	20.0	9.000	GND	N	0.4	13.1	46.0	Pass
1.282000	31.2	20.0	9.000	GND	N	0.5	14.8	46.0	Pass
1.682000	30.6	20.0	9.000	GND	N	0.5	15.4	46.0	Pass

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

Test Date:10/8/2015 11:26:41 Test Engineer:EMC32

9 Test setup photos

Setup photos are included in supporting file name: “EMC_VERIT-010-15001_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 3149	Biconilog Antenna	EMCO	3149	63983	3 years	9-Apr-14
Antenna Binconical 3110B SN 0004-3356	Binconical Antenna	EMCO	3110B	0004-3356	3 years	10/4/2011
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	7/22/2015
Antenna Loop 6512	Loop Antenna	ETS Lindgren	6512	49838	3 years	3/13/2014
Audio Analyzer UPL16	Audio Analyzer	R&S	UPL16	838205/0005	3 years	5/25/2013
Bluetooth Comm. Tester CBT	Bluetooth Comm. Tester	R&S	CBT	100212	3 years	7/1/2015
Current Probe EZ-17 Immunity	RF Current Probe Conducted Emissions	R&S	EZ-17	834613/007	3 years	6/17/2013
DFS Generator PXI-5421 AWG	DFS Generator / PXI-5421 card	National Instruments	NI PXI-1042	E965F1	3 years	7/3/2012
DFS Generator PXI-5610 Upconverter	DFS Upconverter PXI-5610 card	National Instruments	NI PXI-1042	E93740	3 years	6/29/2012
Digital Barometer	Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	4/7/2015
LISN FCC-LISN-50-25-2-08	LISN	FCC	FCC-LISN-50-25-2-08	8014	2 Years	3/26/2015
Receiver ESU40	EMI Receiver	R&S	ESU40	100251	3 years	6/29/2015
Signal Generator SME03	Signal Generator	Amplifier Research	SME 03	1038-6002-03	3 years	6/13/2013
Signal Generator SMP04	Signal Generator	R&S	SMP04	100151	3 years	6/17/2013
Spectrum Analyzer FSU08	Spectrum Analyzer	R&S	FSU-8	200256	2 Years	7/5/2015
Spectrum Analyzer FSU26 #2	Spectrum Analyzer	R&S	FSU26	200065	3 years	7/4/2015
Thermometer Humidity TM320	Thermometer Humidity	Dickson	TM320	5280063	1 Year	7/29/2015

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.

12 Revision History

Date	Report Name	Changes to report	Report prepared by
2015-11-03	EMC_VERIT-010-15001_15.247_FHSS	Initial Version	Kris Lazarov