Bluetooth (Basic rate/EDR)

FCC / IC Test Report

FOR:

Intel Corporation

Model Name: DZ110

Product Description: Smartphone with GSM/GPRS/EDGE, UMTS/HSPA+/LTE, Wi-Fi, BT, NFC and GPS Radios

FCC ID: O2Z-DZ110
IC ID: 1000W – DZ110

47 CFR Part 15.247

RSS-210 Issue 8 & RSS-Gen Issue 3

TEST REPORT #: EMC_INTEL_039_14001_15.247_BT_Rev1
DATE: 2014-06-12

ilac-MRA

A2LA ACCREDITED
TESTING LABORATORY
Certificate #2135.01

Bluetooth

Bluetooth Qualification Test Facility (BQTF)

CTIA Authorized Test Lab
LAB CODE 20020328-00

FCC listed
A2LA Accredited

IC recognized #
3462B

***CETECOM* Inc.**
411 Dixon Landing Road ◆ Milpitas, CA 95035 ◆ U.S.A.
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CETECOM Inc. is a Delaware Corporation with Corporation number: 2113686

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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 IC standard RSS-210 issue 8, Annex 8. No deviations were ascertained.

Company	Description	Model #
Intel Corporation	Smartphone with GSM/GPRS/EDGE, UMTS/HSDPA+/LTE, Wi-Fi, BT, NFC and GPS Radios	DZ110

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2014-06-12	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 Date: 2014.07.02 20:01:51 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
2014-06-12	Compliance	Danh Le (Test Engineer)	Digitally signed by Danh Le DN: cn=Danh Le, o=Cetecom, ou=Compliance, email=danh.le@cetecom.com, c=US Date: 2014.07.02 20:03:09 -07'00'

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
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:	Danh Le

2.2 Identification of the Client

Applicant's Name:	Intel Corporation
Street Address:	2200 Mission College Blvd
City/Zip Code	Santa Clara / 95054
Country	USA
Contact Person:	Christine Ryan
Phone No.	408 300 2167
Fax:	408-765-2336
e-mail:	Christine.m.ryan@intel.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 Specification of the Equipment under Test

Marketing Name / Model No:	Intel 4.5-inch Premium LTE Smartphone / DZ110
HW Version :	PR2D.2
FCC-ID :	O2Z-DZ110
IC-ID:	1000W- DZ110
Product Description:	Smartphone with GSM/GPRS/EDGE, UMTS/HSPA+/LTE, Wi-Fi, BT, NFC and GPS Radios
Frequency Range / number of channels:	Bluetooth: 2402-2480 MHz / 79
Type(s) of Modulation:	Bluetooth Basic/EDR: GFSK, π /4 DQPSK, 8DPSK
Modes of Operation:	Hopping on single channel and hopping on all channels
Antenna Information as declared:	PIFA antenna Gain (2.4GHz – 2.48GHz) = -5.5 dBi
Max. Output Powers:	Bluetooth EDR conducted: max 7.81dBm -8-DPSK
Power Supply/ Rated Operating Voltage Range:	AA lithium battery pack (dedicated) Vmin: 3.6V dc/ Vnom: 3.8V dc / Vmax: 4.35V dc
operating temperature range	-10ºC to 55ºC
Prototype / Production unit	Prototype
Other Radios included in the device:	Intel XMM 7160 Radio Module • GSM 850/900/1800/1900MHz GPRS / EDGE Multi-slot class 33 operation • WCDMA / HSPA+ 850/900/1700/1900/2100 MHz • LTE 700/800/850/900/1700/1800/1900/2100/2600 Wi-Fi, BT LE (2.4 GHz band of operation and 5GHz band of operation) GPS 1575.42 MHz NFC NXP PN547 13.56 MHz

3.2 Identification of the Equipment Under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	INV133601723	PR2D.2	SB SB JB r43-main-weekly-973 (WW46)	Radiated and Conducted RF Sample
2	INV133600961	PR2D.2	SB SB JB r43-main-weekly-973 (WW46)	RF Conducted Sample

3.3 Identification of Accessory equipment

STE #	Type	Manufacturer	Model	Serial Number
1	AC/DC Adapter	Solcomp	SC1402	12374000330319

4 Subject of Investigation

The objective of the measurements done by Cetecom Inc. was to measure the performance of the EUT as specified by requirements listed in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-210 Issue 8 of Industry Canada.

This test report is to support a request for new equipment authorization under the FCC ID **O2Z-DZ110.** All testing was performed on the product referred to in Section 3 as EUT.

- 47 CFR Part 15: Title 47 of the Code of Federal Regulations: Chapter I-Federal Communications Commission subchapter A- General, Part 15- Radio Frequency Devices.
- RSS-Gen Issue 3: General Requirements and Information for the Certification of Radio Apparatus.

According to Public Notice "DA 00-705: March 30, 2000" testing of FHSS systems shall consider modulation and packet type of the signal:

A worst case evaluation for the highest power modulation has been carried out for packet type DH5. The highest powers were found for 8-DPSK.

Further it has been determined that packet type DH5 delivers the highest output powers as compared to DH1 and DH3.

Thus all power and emission measurements have been carried out with the worst case configuration 3-DH5.

For Bandwidth and timing measurements all packet types and modulations have been tested according to DA 00-705: March 30, 2000.

Number of hopping channels is not related to modulation or packet type and has been carried out in 3-DH5.

5 Summary of Measurement Results

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§15.247(a)(1) RSS210 A8.1(b)	Carrier Frequency Separation	Nominal	GFSK	■	☐	☐	☐	Complies
§15.247(a)(1) RSS210 A8.1(d)	Number of Hopping Channels	Nominal	GFSK	■	☐	☐	☐	Complies
§15.247(a)(1)(iii) RSS210 A8.3(1)	Time of occupancy	Nominal	GFSK π/4DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(a)(1) RSS210 A8.1(a)	Spectrum Bandwidth	Nominal	GFSK π/4DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(b)(1) RSS210 A8.4(2)	Maximum Peak Conducted Output Power	Nominal	GFSK π/4DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(d) RSS210 A8.5	Band edge compliance-	Nominal	GFSK π/4DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(d) RSS210 A8.5	TX Spurious emissions- Conducted	Nominal	8-DPSK	☐	☐	☐	■	Note 1
§15.247(d) §15.209 (a) RSS210 A8.5 RSS-Gen 7.2.2	TX Spurious emissions- Radiated	Nominal	8-DFSK	■	☐	☐	☐	Complies
§15.207(a) RSS Gen 7.2.4	AC Conducted Emissions <30MHz	Nominal	8-DPSK	■	☐	☐	☐	Complies

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

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1. Conducted spurious emissions test against non-restricted band limits is NOT PERFORMED since radiated spurious emissions against more stringent restricted band limits over the complete measurement range (9kHz to 26GHz) is passed.

6 Measurements

6.1 Radiated Measurement Procedure

ANSI C63.10 (2009) Section 8.3.1.1: Exploratory radiated emission measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT. At near distances, for EUTs of comparably small size, it is relatively easy to determine the spectrum signature of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. A shielded room may be used for exploratory testing, but may have anomalies that can lead to significant errors in amplitude measurements.

Broadband antennas and a spectrum analyzer or a radio-noise meter with a panoramic display are often useful in this type of testing. It is recommended that either a headset or loudspeaker be connected as an aid in detecting ambient signals and finding frequencies of significant emission from the EUT when the exploratory and final testing is performed in an OATS with strong ambient signals. Caution should be taken if either antenna height between 1 and 4 meters or EUT azimuth is not fully explored. Not fully exploring these parameters during exploratory testing may require complete testing at the OATS or semi-anechoic chamber when the final full spectrum testing is conducted.

The EUT should be set up in its typical configuration and arrangement, and operated in its various modes. For tabletop systems, cables or wires should be manipulated within the range of likely arrangements. For floor-standing equipment, the cables or wires should be located in the same manner as the user would install them and no further manipulation is made. For combination EUTs, the tabletop and floor-standing portions of the EUT shall follow the procedures for their respective setups and cable manipulation. If the manner of cable installation is not known, or if it changes with each installation, cables or wires for floor-standing equipment shall be manipulated to the extent possible to produce the maximum level of emissions.

For each mode of operation required to be tested, the frequency spectrum shall be monitored. Variations in antenna height between 1 and 4 m, antenna polarization, EUT azimuth, and cable or wire placement (each variable within bounds specified elsewhere) shall be explored to produce the emission that has the highest amplitude relative to the limit. A step-by-step technique for determining this emission can be found in Annex C.

When measuring emissions above 1 GHz, the frequencies of maximum emission shall be determined by manually positioning the antenna close to the EUT and by moving the antenna over all sides of the EUT while observing a spectral display. It will be advantageous to have prior knowledge of the frequencies of emissions above 1 GHz. If the EUT is a device with dimensions approximately equal to that of the measurement antenna beamwidth, the measurement antenna shall be aligned with the EUT.

ANSI C63.10 (2009) Section 8.3.1.2: Final radiated emission measurements

Based on the measurement results in 8.3.1.1, the one EUT, cable and wire arrangement, and mode of operation that produces the emission that has the highest amplitude relative to the limit is selected for the final measurement. The final measurement is then performed on a site meeting the requirements of 5.3, 5.4, or 5.5 as appropriate without variation of the EUT arrangement or EUT mode of operation. If the EUT is relocated from an exploratory test site to a final test site, the highest emission shall be remaximized at the final test location before final radiated emissions measurements are performed. However, antenna height and polarity and EUT azimuth are to be varied. In addition, the full frequency spectrum (for the range to be checked for meeting compliance) shall be investigated.

This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. During the full frequency spectrum investigation, particular focus should be made on those frequencies found in exploratory testing that were used to find the final test configuration, mode of operation, and arrangement (associated with achieving the least margin with respect to the limit). This full spectrum test constitutes the compliance measurement.

For measurements above 1 GHz, use the cable, EUT arrangement, and mode of operation determined in the exploratory testing to produce the emission that has the highest amplitude relative to the limit. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the antenna in the “cone of radiation” from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response. The antenna may have to be higher or lower than the EUT, depending on the EUT’s size and mounting height, but the antenna should be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane. If the transmission line for the measurement antenna restricts its range of height and polarization, the steps needed to ensure the correct measurement of the maximum emissions, shall be described in detail in the report of measurements. Data collected shall satisfy the report requirements of Clause 10.

NOTES

1— Where limits are specified by agencies for both average and peak (or quasi-peak) detection, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.
2—Use of waveguide and flexible waveguide may be necessary at frequencies above 10 GHz to achieve usable signal-to noise ratios at required measurement distances. If so, it may be necessary to restrict the height search of the antenna, and special care should be taken to ensure that maximum emissions are correctly measured.
3—All presently known devices causing emissions above 10 GHz are physically small compared with the beam-widths of typical horn antennas used for EMC measurements. For such EUTs and frequencies, it may be preferable to vary the height and polarization of the EUT instead of the receiving antenna to maximize the measured emissions.

6.2 Sample Calculations for Radiated Measurements

6.2.1 Field Strength Measurements:

Measurements from the Spectrum Analyzer/ Receiver are used to calculate the Field Strength, taking into account the following parameters:

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

FS (dBµV/m) = Measured Value on SA (dBµV)+ Cable Loss (dB)+ Antenna Factor (dB/m)
Eg:

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

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

Measurement Uncertainty: ±3.0 dB

6.3 Conducted Emissions Procedure

ANSI C63.10 (2009) Section 6.2.5: Final AC Power-Line Conducted Emission Measurements

Based on the exploratory tests of the EUT performed in 6.2.4, the one EUT cable configuration and arrangement and mode of operation that produced the emission with the highest amplitude relative to the limit is selected for the final measurement, while applying the appropriate modulating signal to the EUT. If the EUT is relocated from an exploratory test site to a final test site, the highest emissions shall be remaximized at the final test location before final ac power-line conducted emission measurements are performed. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment in the system) is then performed for the full frequency range for which the EUT is being tested for compliance without further variation of the EUT arrangement, cable positions, or EUT mode of operation. If the EUT is comprised of equipment units that have their own separate ac power connections, e.g., floor-standing equipment with independent power cords for each shelf that are able to connect directly to the ac power network, each current-carrying conductor of one unit is measured while the other units are connected to a second (or more) LISN(s). All units shall be separately measured. If a power strip is provided by the manufacturer, to supply all of the units making up the EUT, only the conductors in the power cord of the power strip shall be measured.

If the EUT uses a detachable antenna, these measurements shall be made with a suitable dummy load connected to the antenna output terminals; otherwise, the tests shall be made with the antenna connected and, if adjustable, fully extended. When measuring the ac conducted emissions from a device that operates between 150 kHz and 30 MHz a non-detachable antenna may be replaced with a dummy load for the measurements within the fundamental emission band of the transmitter, but only for those measurements.

Record the six highest EUT emissions relative to the limit of each of the current-carrying conductors of the power cords of the equipment that comprises the EUT over the frequency range specified by the procuring or regulatory agency. Diagram or photograph the test setup that was used. See Clause 8 for full reporting requirements.

Section 6.2.5: Measurement requirements

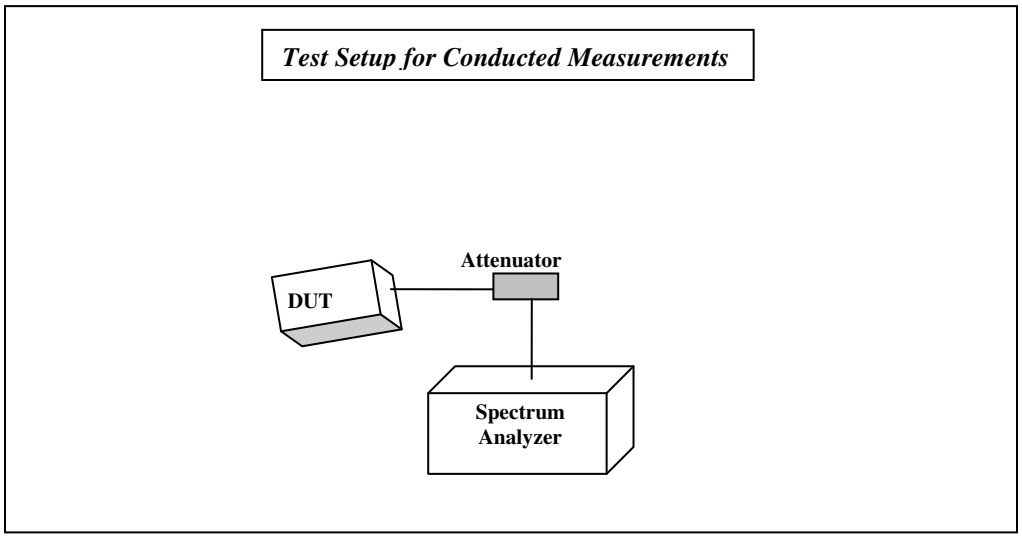
The LISN housing, measuring instrument case, reference ground plane, vertical conducting plane, if used, shall be bonded together.

Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument, or where permitted or required, the emission currents on the power line sensed by a current probe. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the manufacturer, and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements, using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having a 50 Ω input impedance. All other ports are terminated in 50 Ω loads.

Measurement Uncertainty: ±3.0dB

6.4 RF Conducted Measurement Procedure

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



1. Connect the equipment as shown in the above diagram.
2. Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
3. Measurements are to be performed with the EUT set to the low, middle and high channels and for GFSK, π/4DQPSK and 8-DPSK modulation schemes.

Measurement Uncertainty: ±0.5 dB

7 Maximum Peak Conducted Output Power

7.1.1 Limits:

Maximum Peak Output Power:
FCC §15.247 (b)(1): 1W
IC RSS-210 issue 8, annex 8.4(2): 1W
EIRP:
IC RSS-210 issue 8, annex 8.4(2): 4W

7.1.2 Test Conditions

Tnom: 21°C; Vnom: 3.8V

7.1.3 Test Procedure

Refer to DA 00-705:2000

Hopping OFF
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.

Specified Antenna Gain (dBi):
2.4 – 2.48GHz: -5.5 dBi

7.1.4 Test Data:

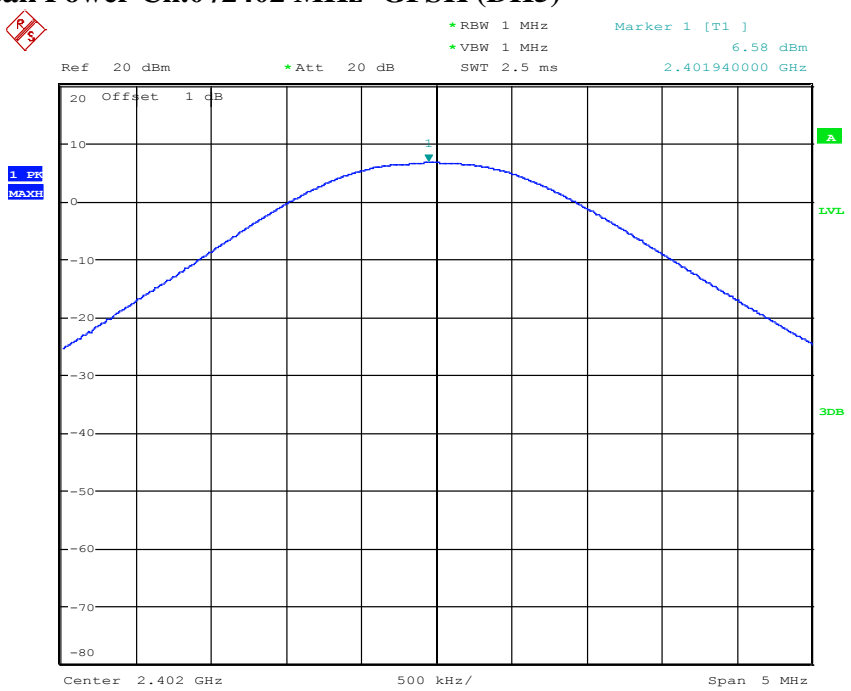
Maximum Peak Conducted Output Power for packet type DH5 (dBm)			
Modulation	**Frequency (MHz)**		
	2402	**2441**	**2480**
GFSK	6.58	7.81	6.85
π/4 DQPSK	5.46	7.86	7.52
8-DPSK	5.94	8.12	7.78

7.1.4.1 Measurement Result

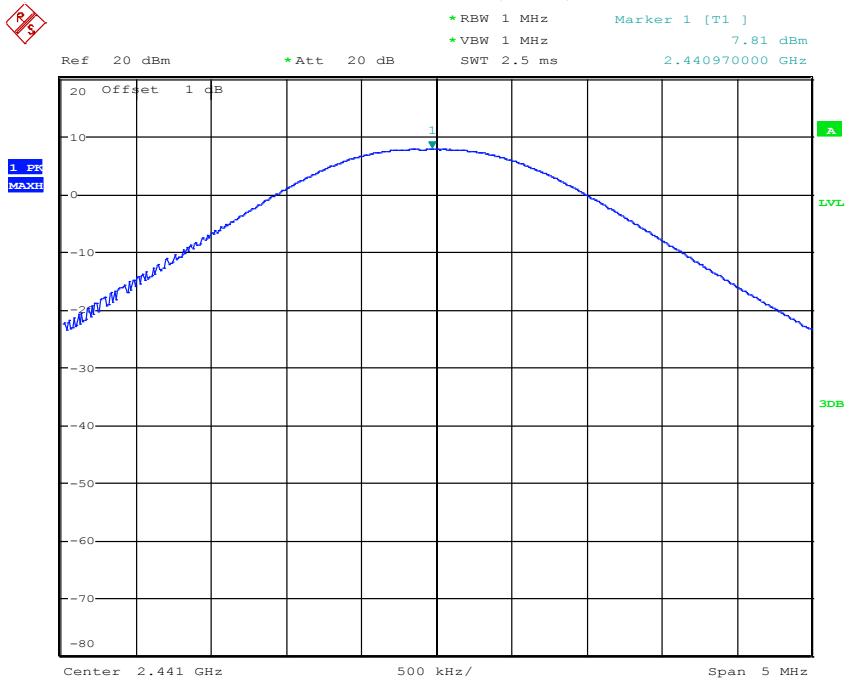
Pass.

7.1.5 Test Data/plots:

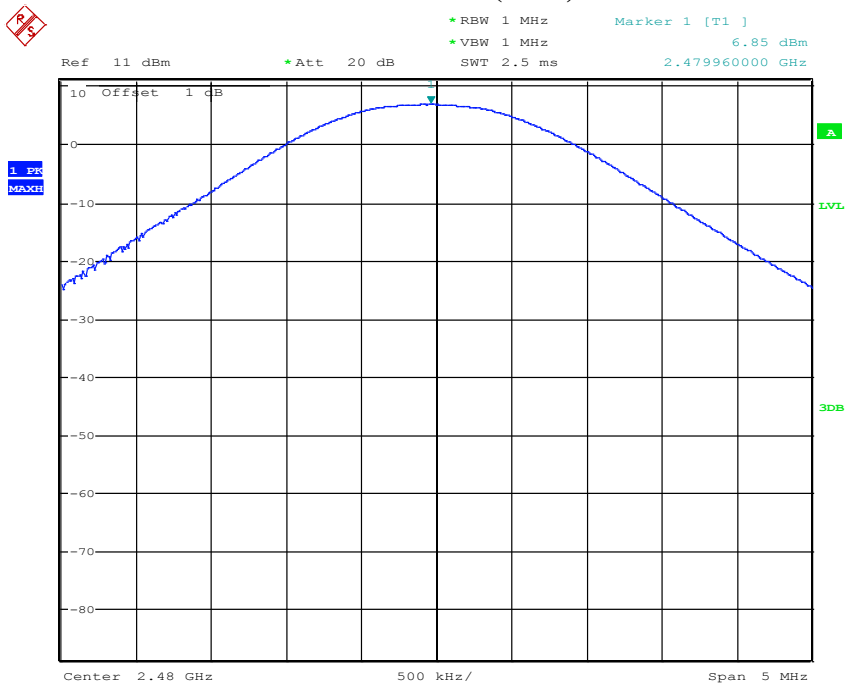
Conducted Peak Power Ch.0 /2402 MHz -GFSK (DH5)



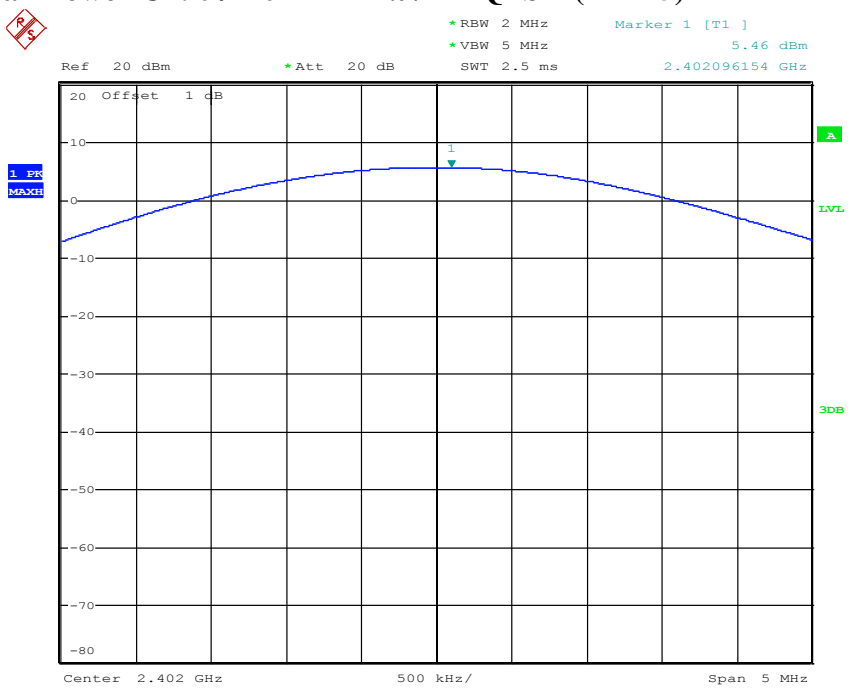
Conducted Peak Power Ch.39 /2441 MHz -GFSK (DH5)



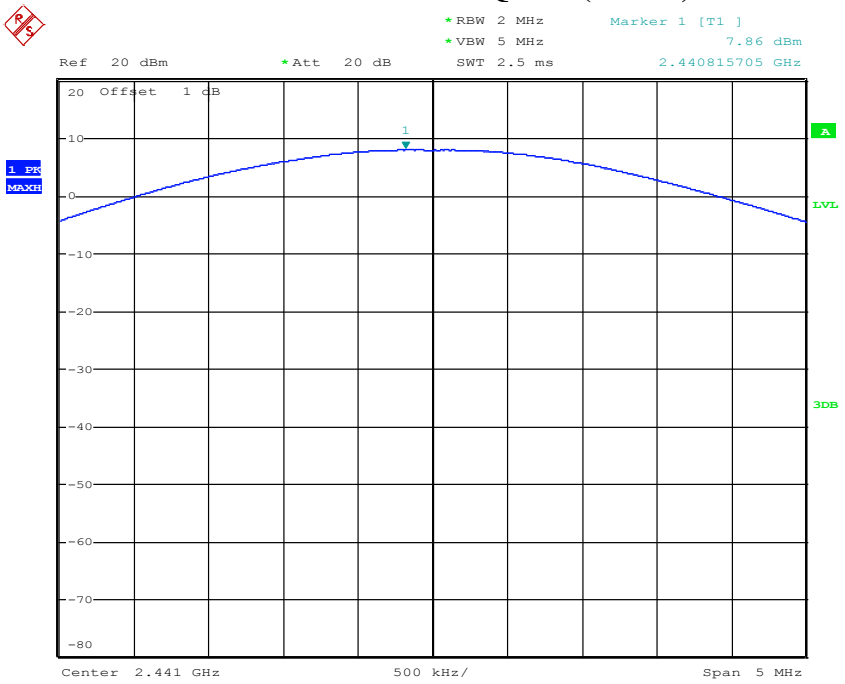
Conducted Peak Power Ch.78 /2480 MHz -GFSK (DH5)



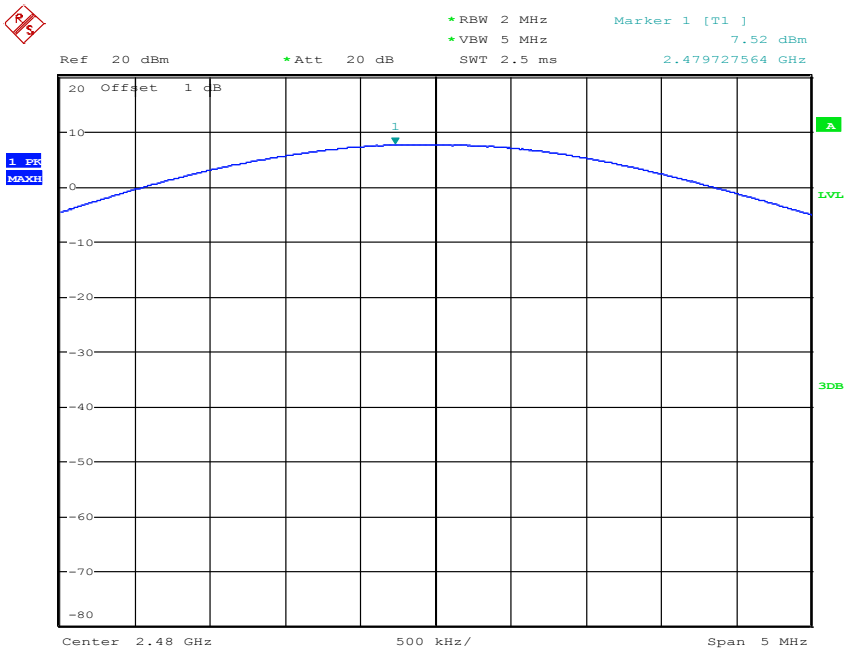
Conducted Peak Power Ch. 0 /2402 MHz -π / 4 DQPSK (2-DH5)



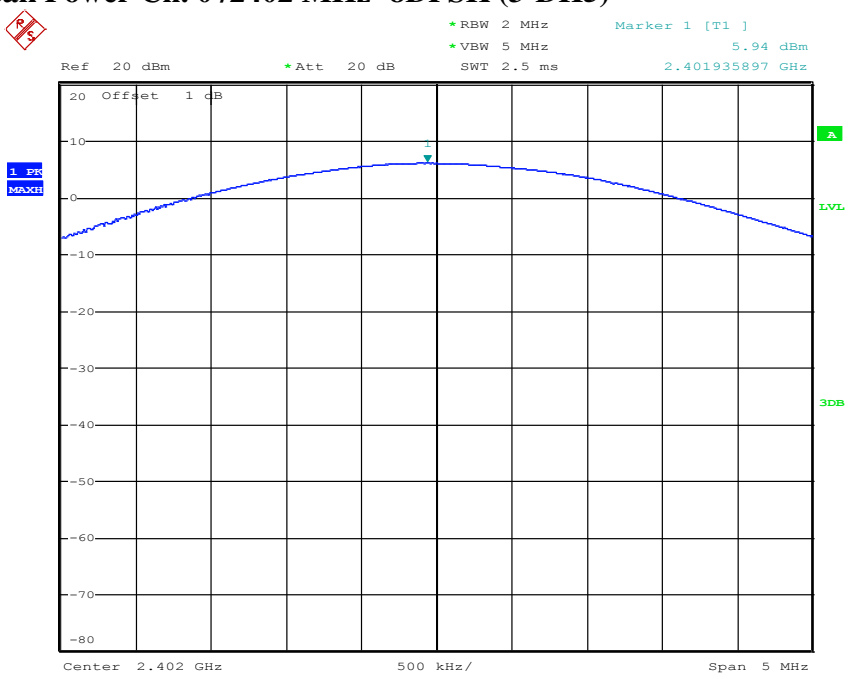
Conducted Peak Power Ch. 39 /2441 GHz -π / 4 DQPSK (2-DH5)



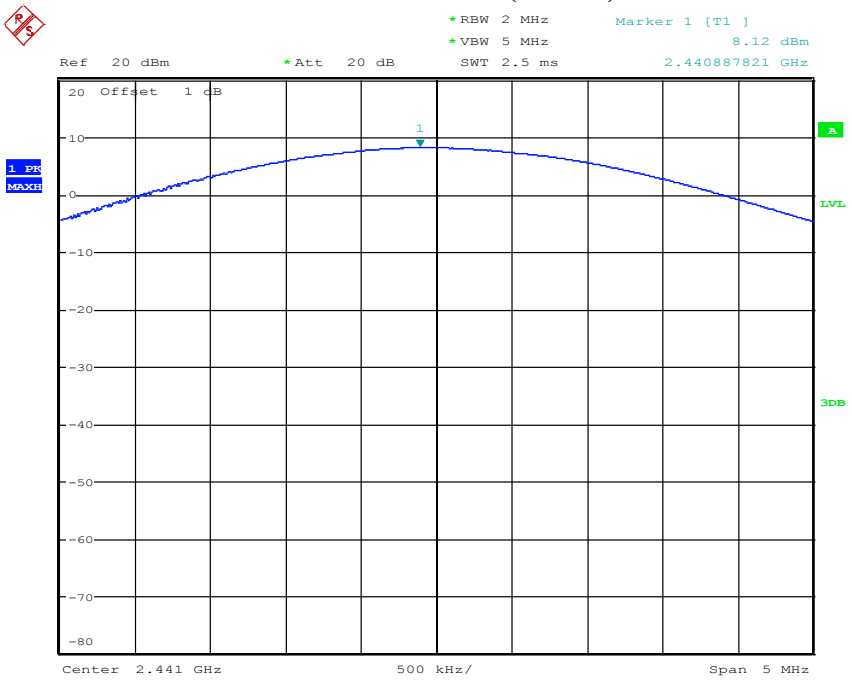
Conducted Peak Power Ch.78 /2480 MHz -π / 4 DQPSK (2-DH5)



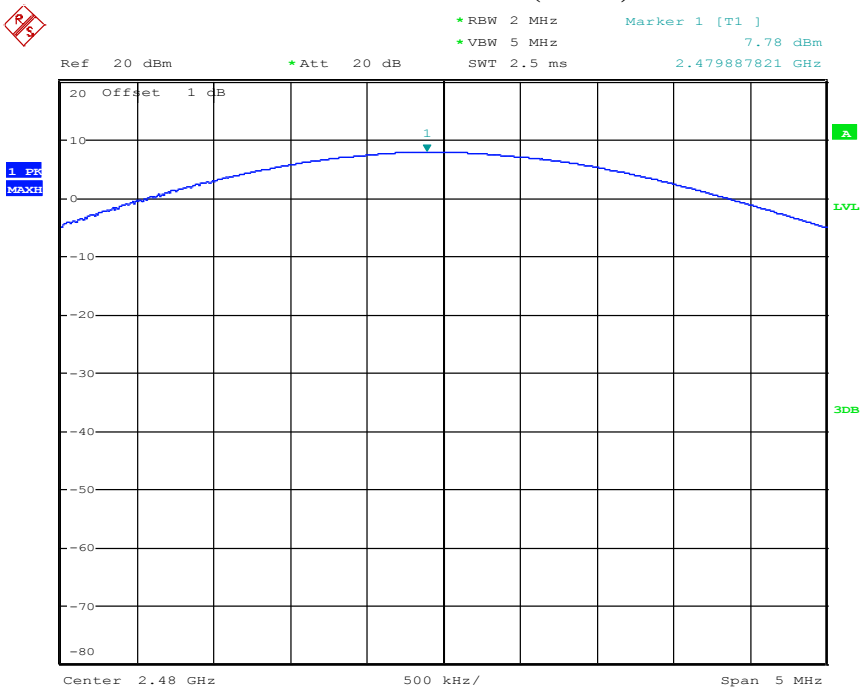
Conducted Peak Power Ch. 0 /2402 MHz -8DPSK (3-DH5)



Conducted Peak Power Ch 39 /2441 MHz -8DPSK (3-DH5)



Conducted Peak Power Ch. 78 /2480 MHz -8DPSK (3DH5)



7.2 Band Edge Compliance & Restricted and Non-restricted Band Edge

7.2.1 Limits: §15.247/15.205 & RSS-210 A8.5/RSS-Gen 7.2.2

(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			

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)).

RSS-210 A8.5

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.

7.2.2 Test Procedure

Refer to DA 00-705:2000

Spectrum Analyzer settings for band edge:
Span: wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, 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 bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge.

Spectrum Analyzer settings for restricted band:
Peak measurements are made using a peak detector and RBW=100 KHz, VBW ≥ RBW

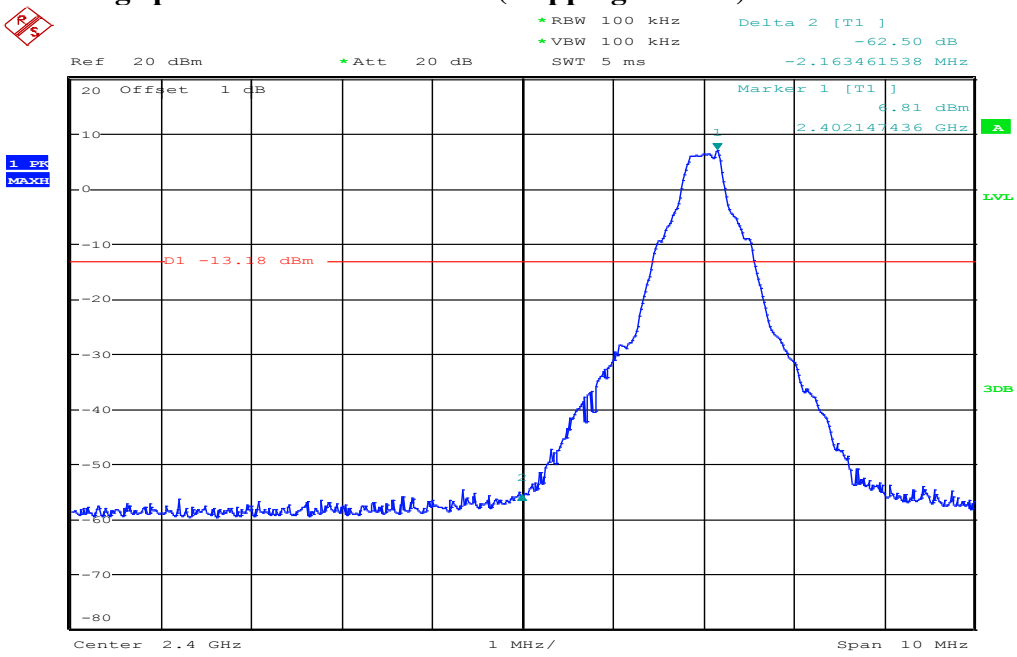
Average measurements performed using a peak detector and according to video averaging procedure with
RBW=100 KHz and VBW=10Hz.
Detector = Peak
*PEAK LIMIT= 74dBµV/m
*AVG. LIMIT= 54dBµV/m Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205 & RSS-Gen 7.2.2

Measurement Uncertainty: ±3.0dB

7.2.2.1 Measurement Result
Pass.

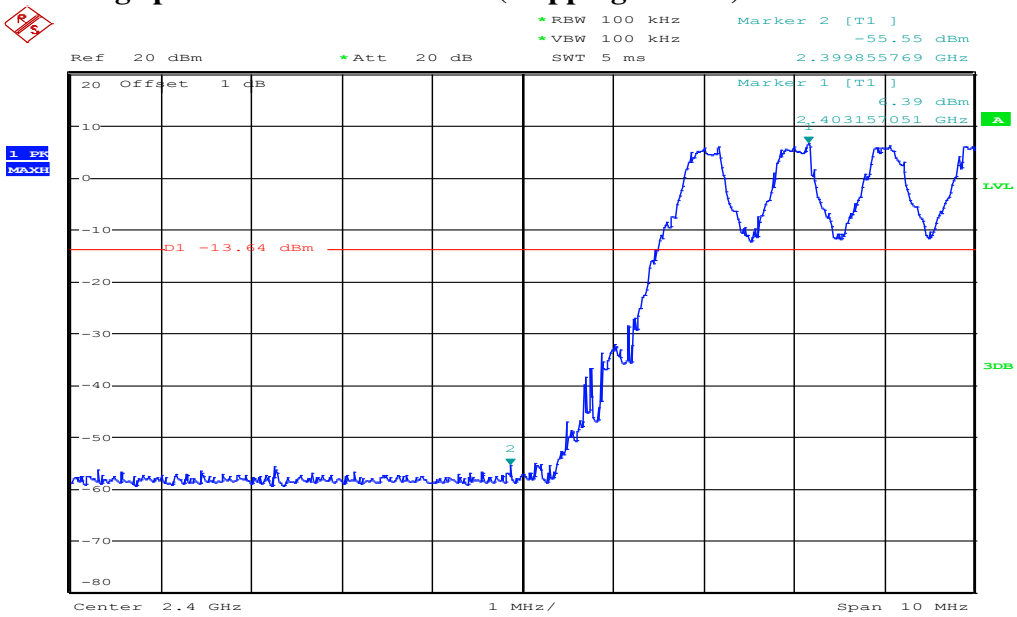
7.2.3 Test Data/plots:

Lower band edge peak -GFSK modulation (Hopping Disable)



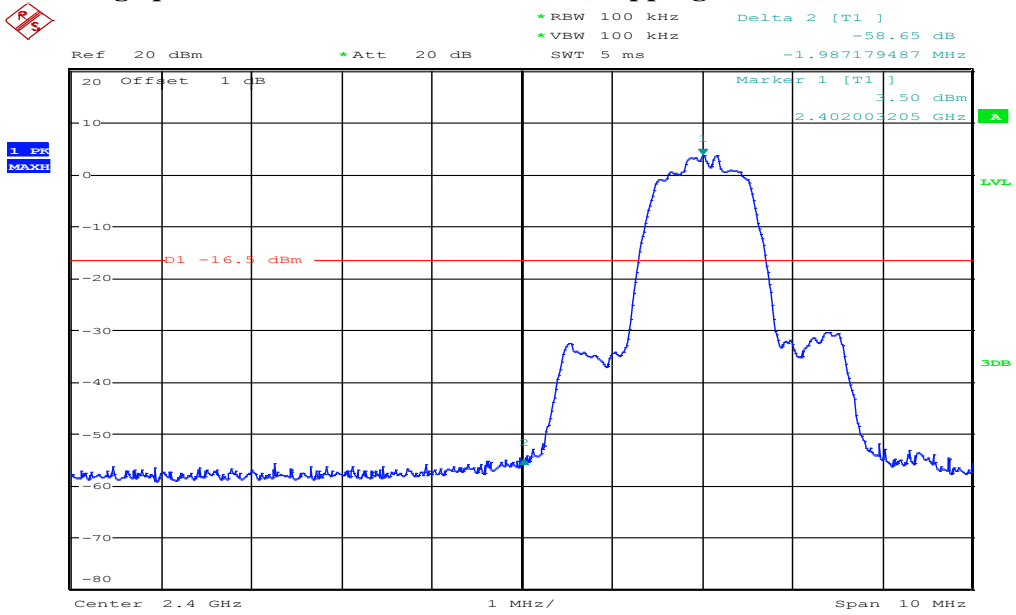
Date: 28.MAY.2014 23:03:36

Lower band edge peak -GFSK modulation (Hopping Enable)



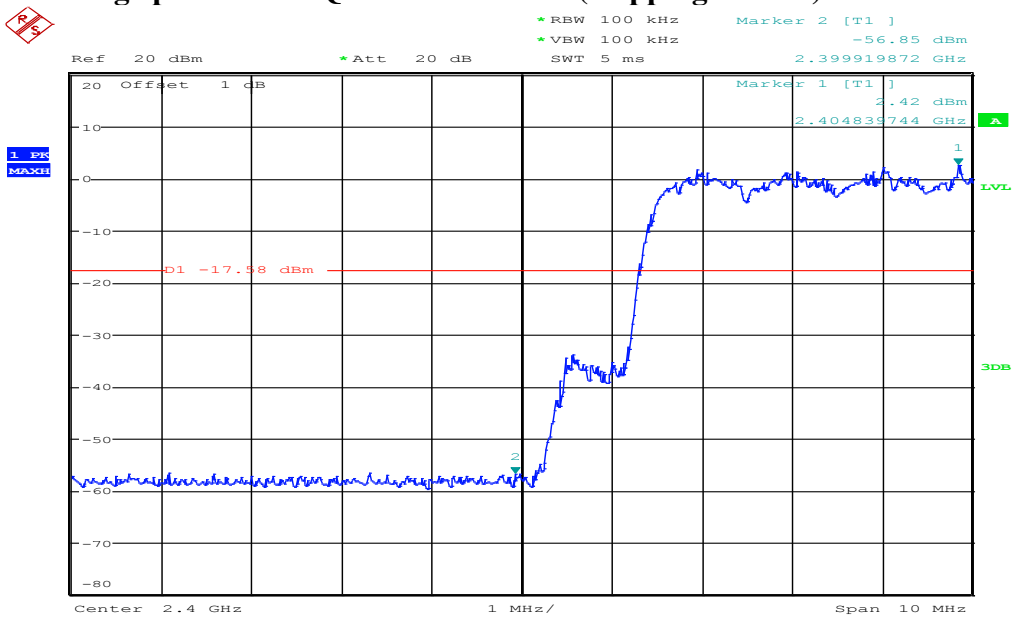
low
Date: 11.APR.2014 22:01:52

Lower band edge peak - π/4 DQPSK modulation (Hopping Disable)



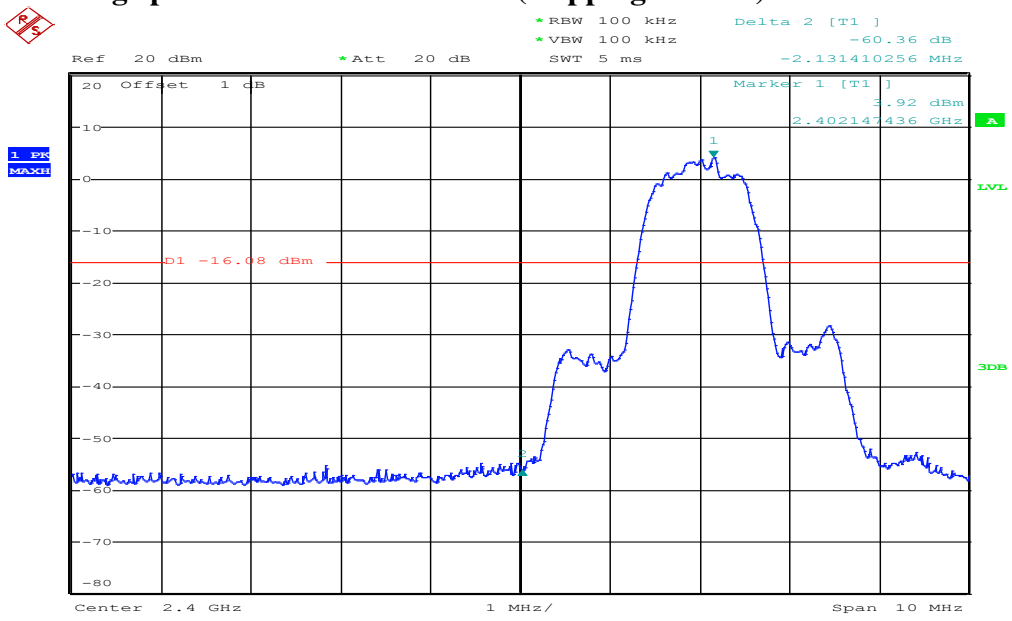
low
Date: 21.MAR.2014 17:39:53

Lower band edge peak - π/4 DQPSK modulation (Hopping Enable)



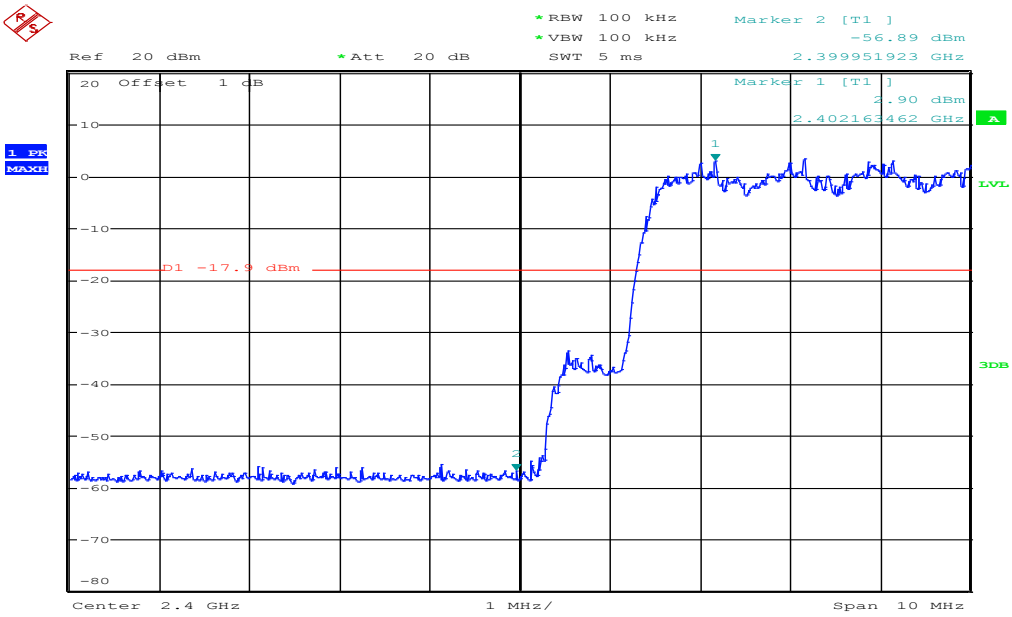
low
Date: 11.APR.2014 21:09:49

Lower band edge peak - 8DPSK modulation (Hopping Disable)



low
Date: 21.MAR.2014 17:51:06

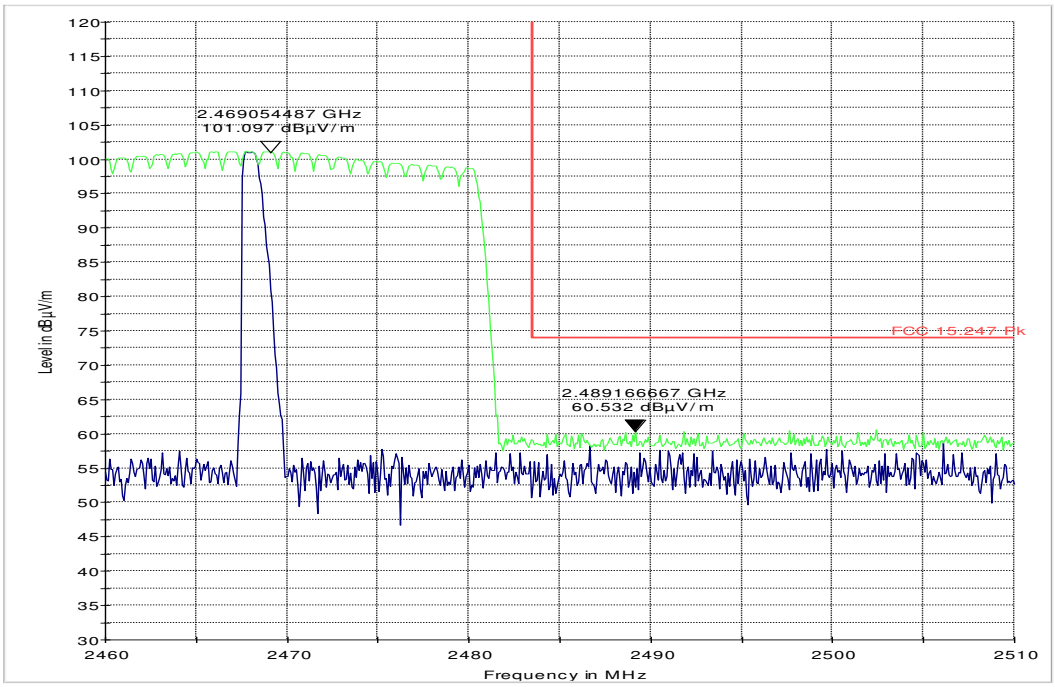
Lower band edge peak - 8DPSK modulation (Hopping Enable)



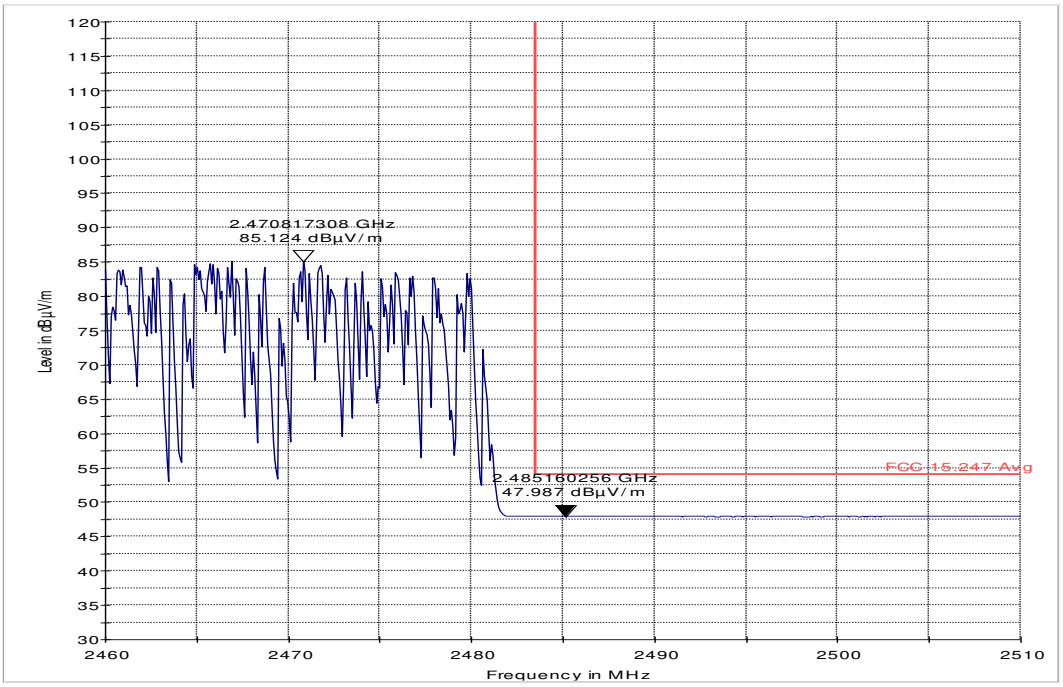
low
Date: 11.APR.2014 21:07:12

Restricted Band

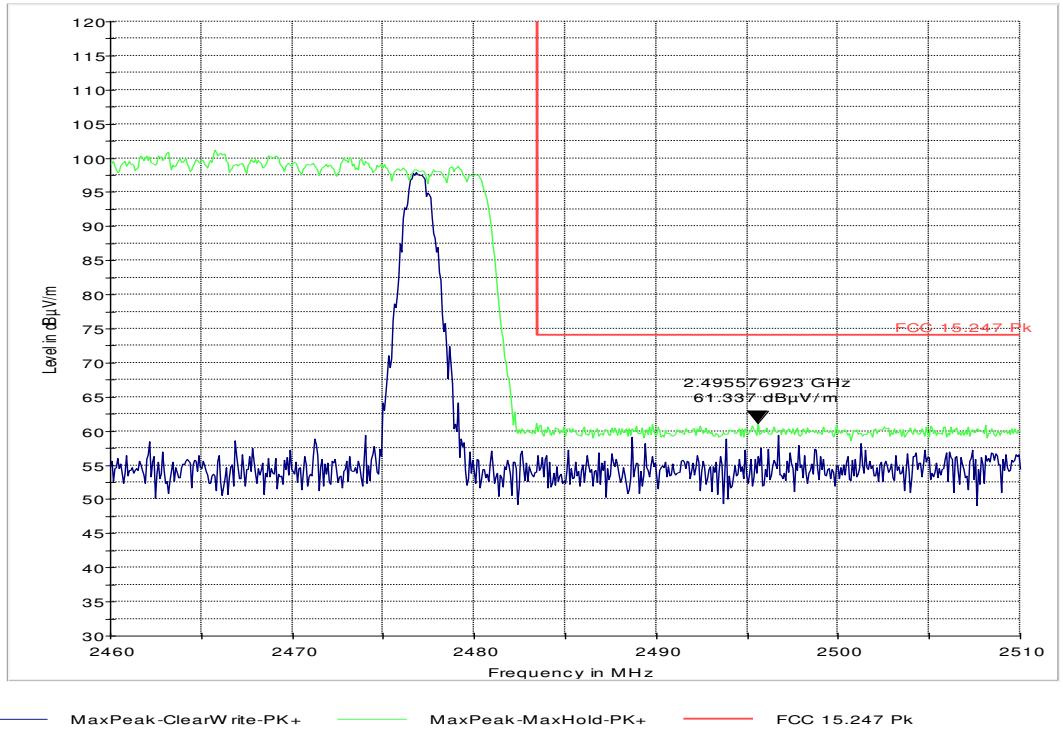
Restricted band peak -GFSK –DH5 modulation (Hopping Enable)



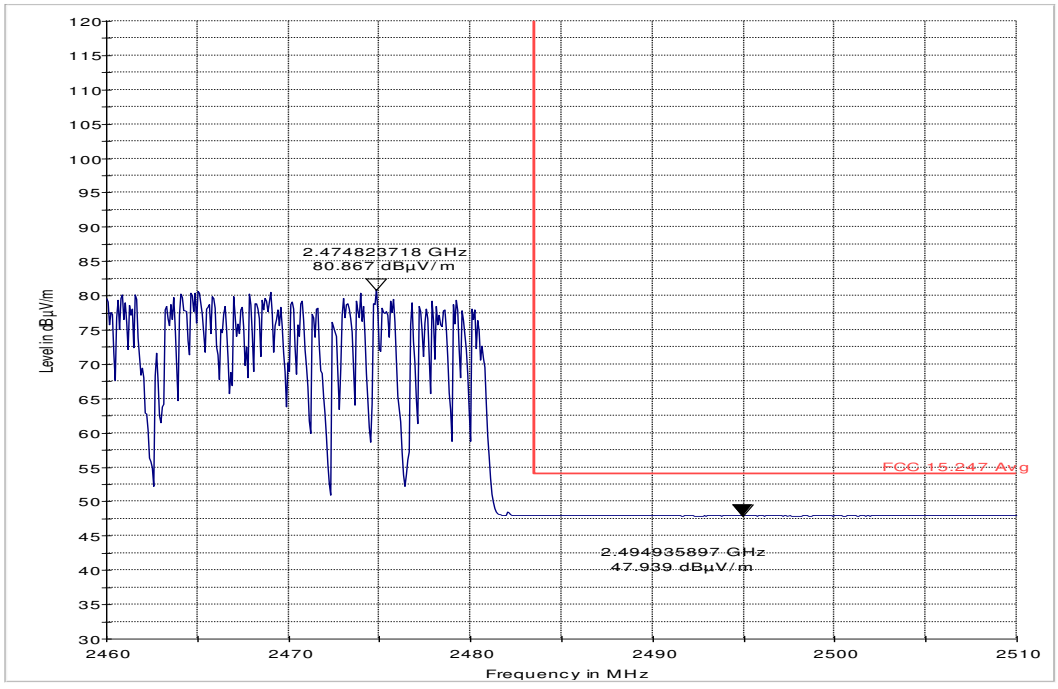
Restricted band average -GFSK –DH5 modulation (Hopping Enable)



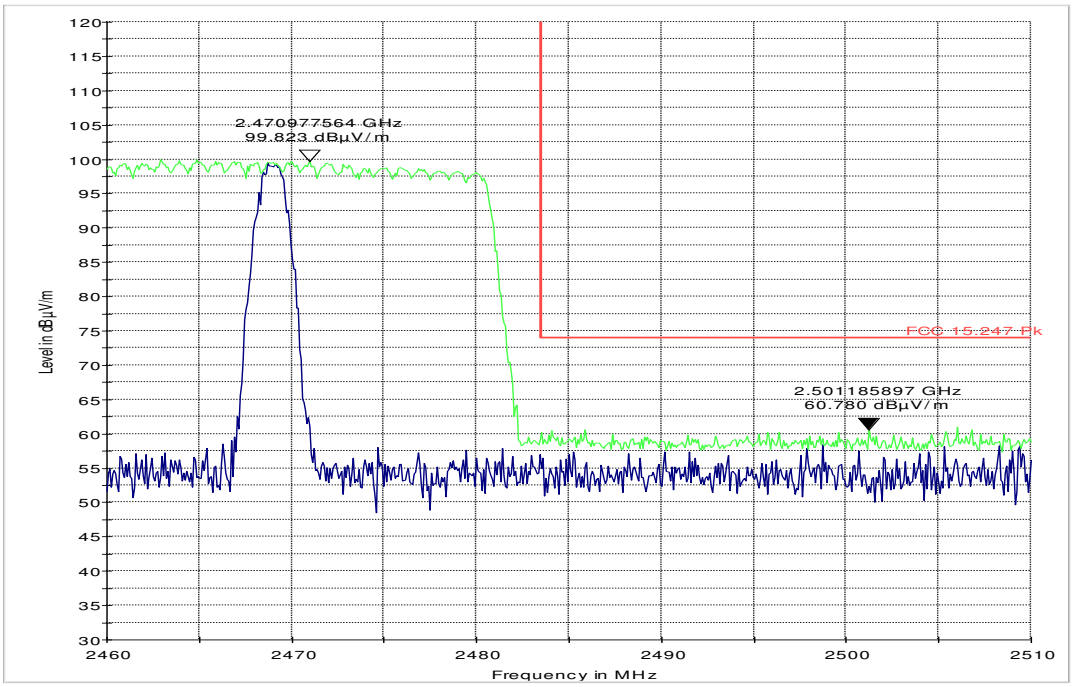
Restricted band peak -π/4 DQPSK modulation -2DH5 (Hopping Enable)



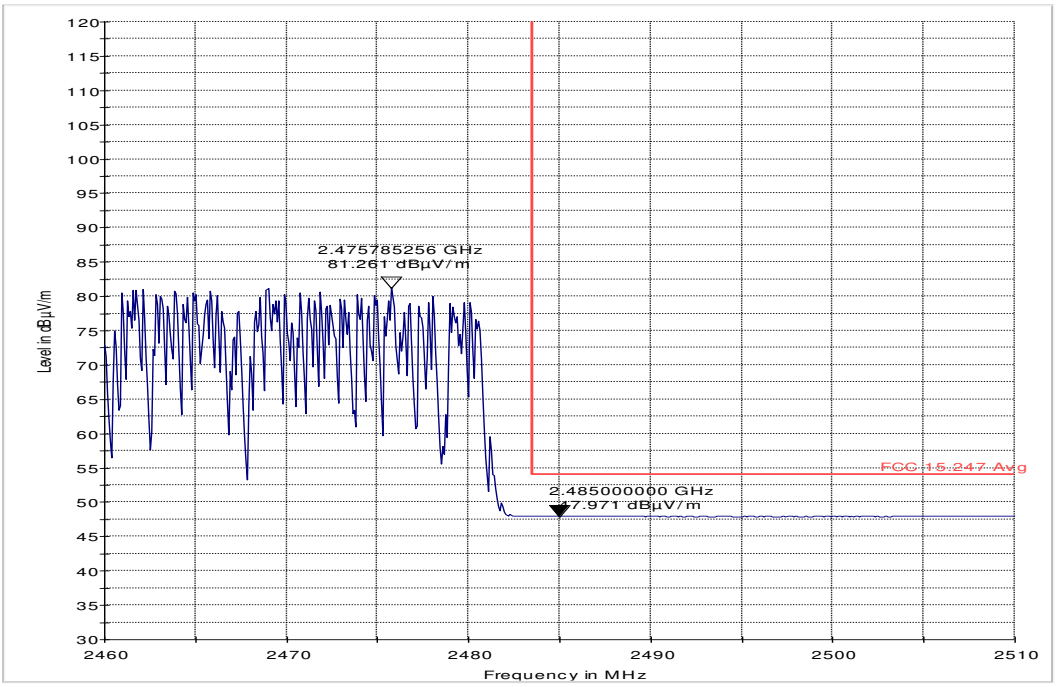
Restricted band average -π/4 DQPSK modulation -2DH5 (Hopping Enable)



Restricted band peak -8-DPSK modulation -3DH5 (Hopping Enable)



Restricted band average -8-DPSK modulation -3DH5 (Hopping Enable)



7.3 20dB Bandwidth / 99% Bandwidth

7.3.1 Limits:

7.3.1.1 §15.247 (a) (1), RSS-210 A8.1 (d)
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.

7.3.2 Test Conditions:

Tnom: 21°C; Vnom: 3.8 V
Hopping OFF

Testing was done on all 3 modulations with different packet types as described in the table below.

Modulation	Packet Type
GFSK	DH5
π / 4 DQPSK	2-DH5
8 DPSK	3-DH5

7.3.3 Test Procedure
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

7.3.4 Test Data:

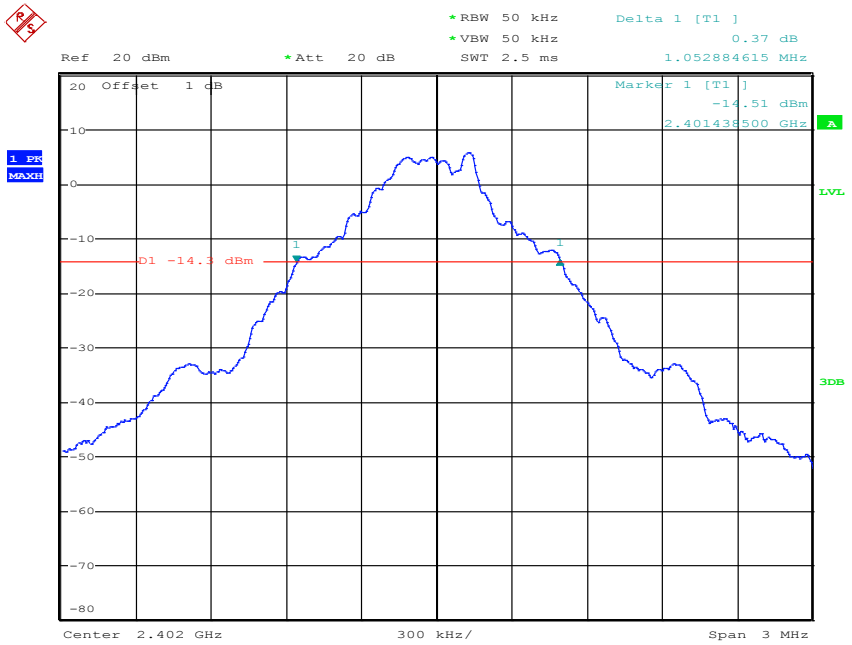
20dB Bandwidth			
Modulation (Packet Type)	**Frequency (MHz)**		
	2402	**2441**	**2480**
GFSK (DH5)	1.0528	1.0541	1.0528
π/4 DQPSK (2-DH5)	1.3653	1.3606	1.3702
8-DPSK (3-DH5)	1.3317	1.3461	1.3413
Measurement Uncertainty: ±10 kHz			

7.3.4.1 Measurement Result

Pass.

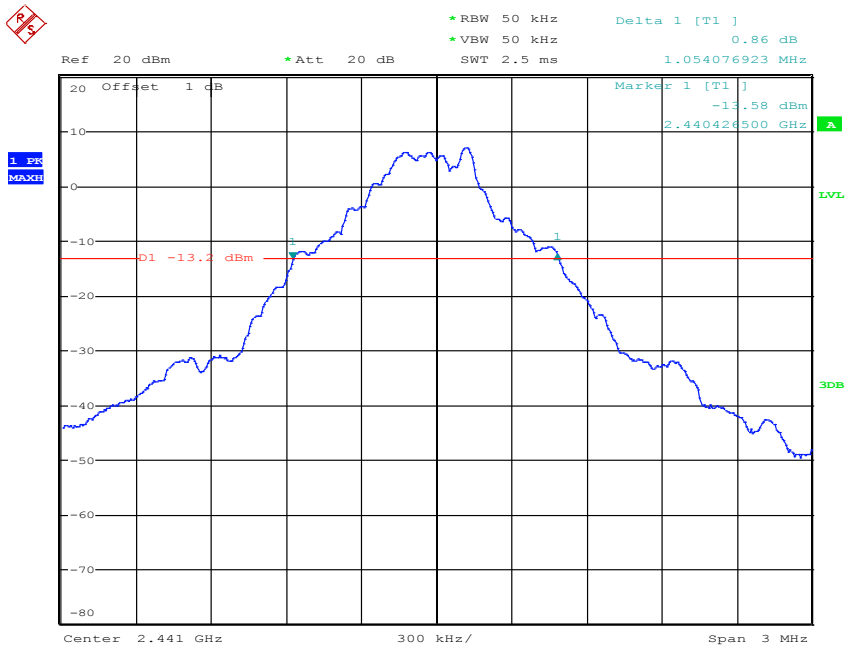
7.3.5 Test Data/plots:

20dB Bandwidth GFSK 2402MHz



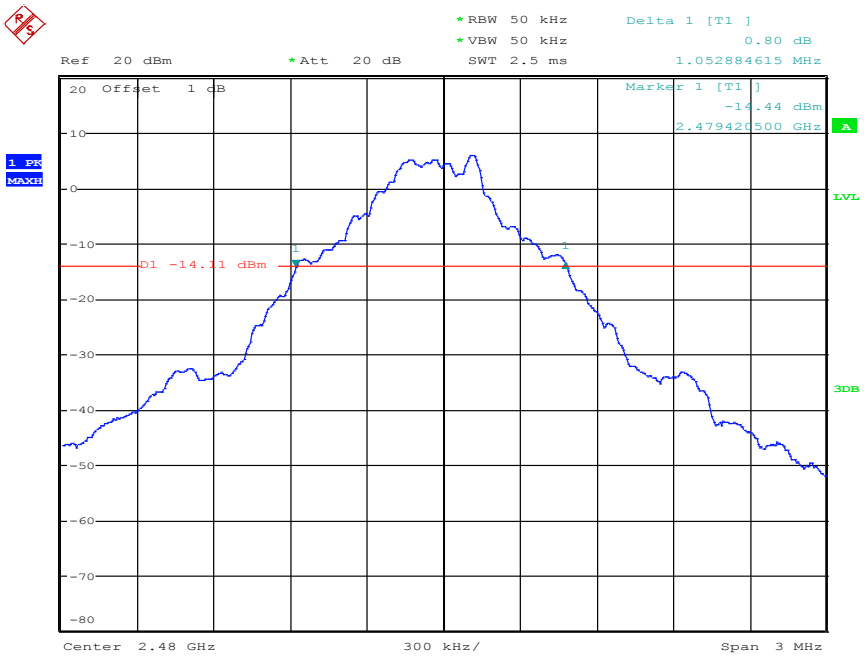
Date: 18.FEB.2014 22:28:13

20dB Bandwidth GFSK 2441MHz



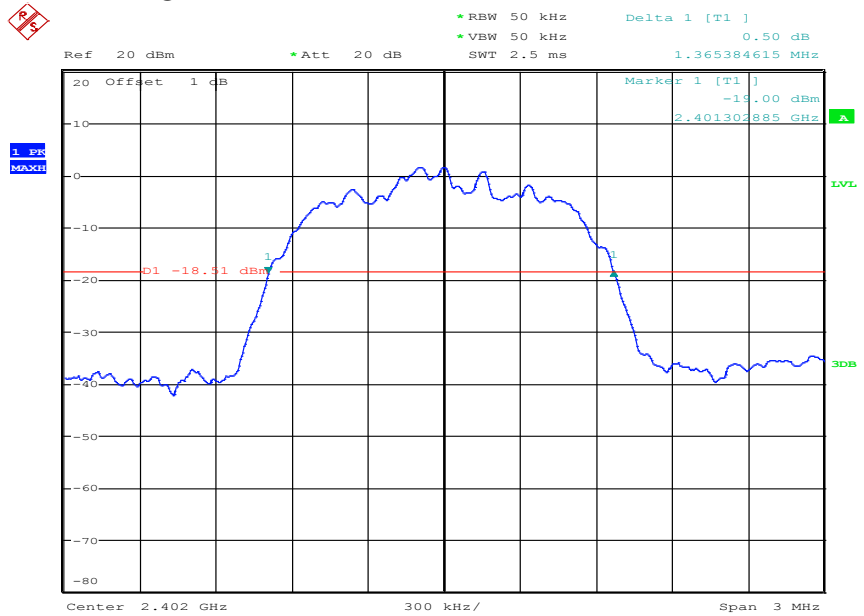
Date: 18.FEB.2014 22:31:18

20dB Bandwidth GFSK 2480MHz



Date: 18.FEB.2014 22:33:16

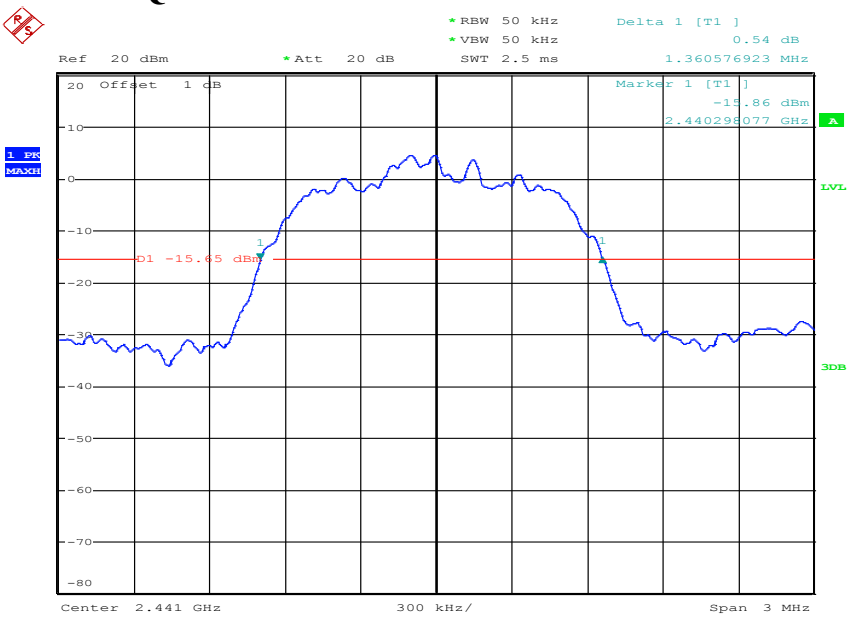
20dB Bandwidth π / 4 DQPSK 2402MHz



low

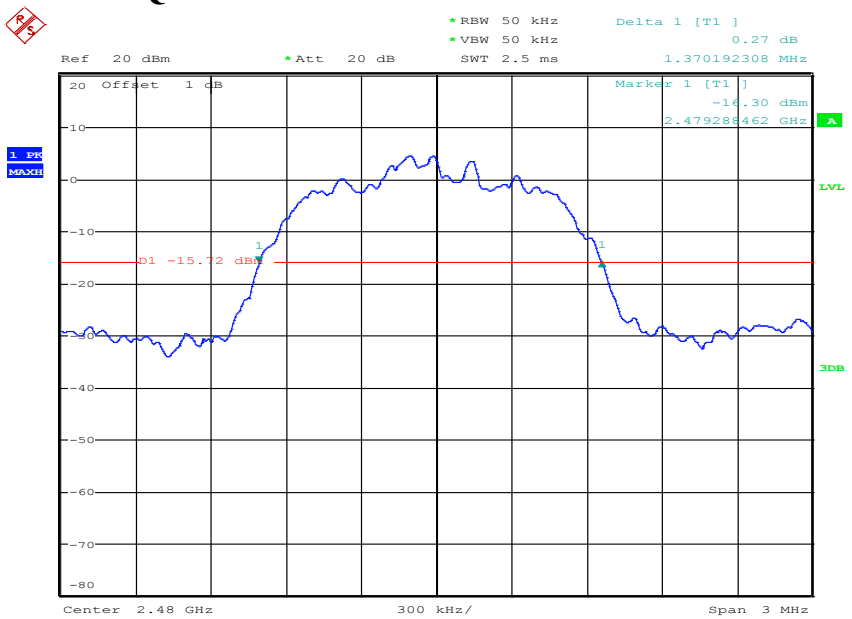
Date: 20.MAR.2014 14:08:42

20dB Bandwidth π / 4 DQPSK 2441MHz



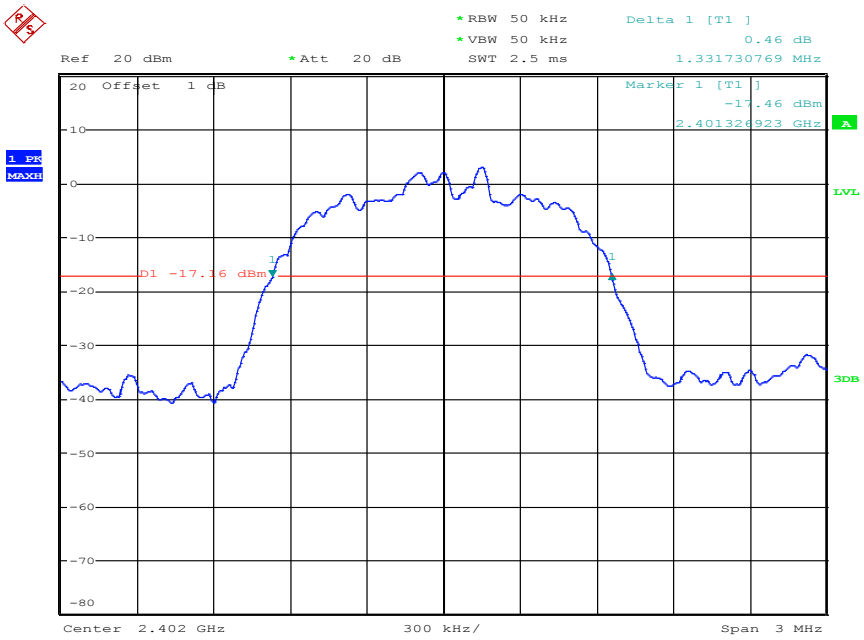
low
Date: 20.MAR.2014 14:12:50

20dB Bandwidth π / 4 DQPSK 2480MHz



low
Date: 20.MAR.2014 14:15:24

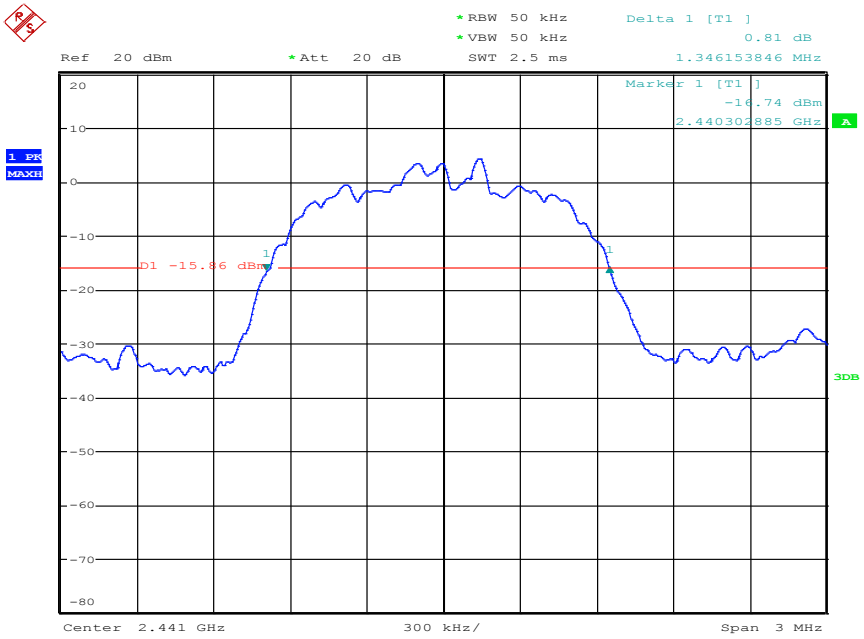
20dB Bandwidth 8PSK 2402MHz



low

Date: 20.MAR.2014 14:18:41

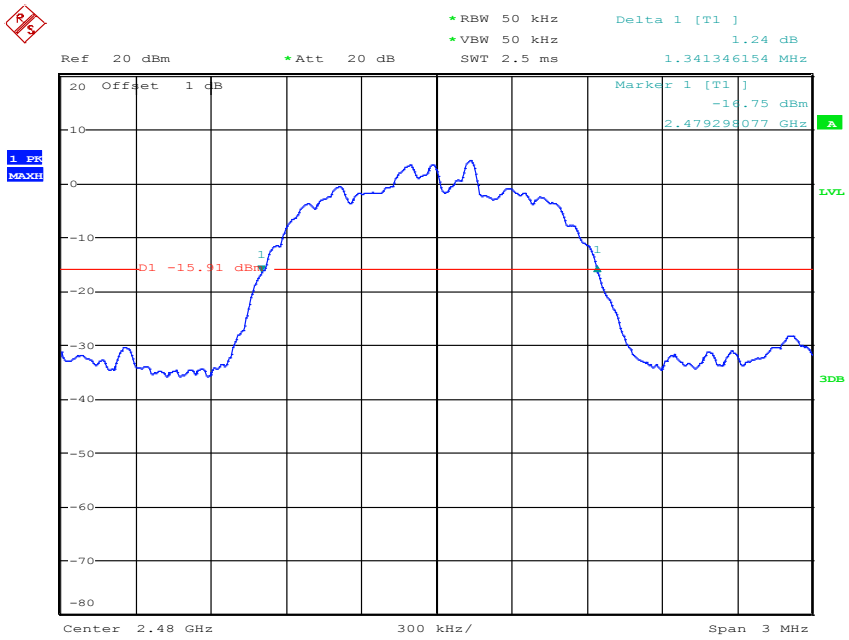
20dB Bandwidth 8PSK 2441MHz



low

Date: 10.APR.2014 23:59:31

20dB Bandwidth 8PSK 2480MHz



low

Date: 19.MAR.2014 21:07:10

7.4 Carrier Frequency Separation

7.4.1 Limits:

§ 15.247 (a) (1) & RSS-210 (A8.1) (b)
Minimum 25 kHz or 2/3 of the 20dB bandwidth of the hopping system

7.4.2 Test Conditions:

Tnom: 22°C; Vnom: 3.8 V
Hopping ON

7.4.3 Test Procedure:

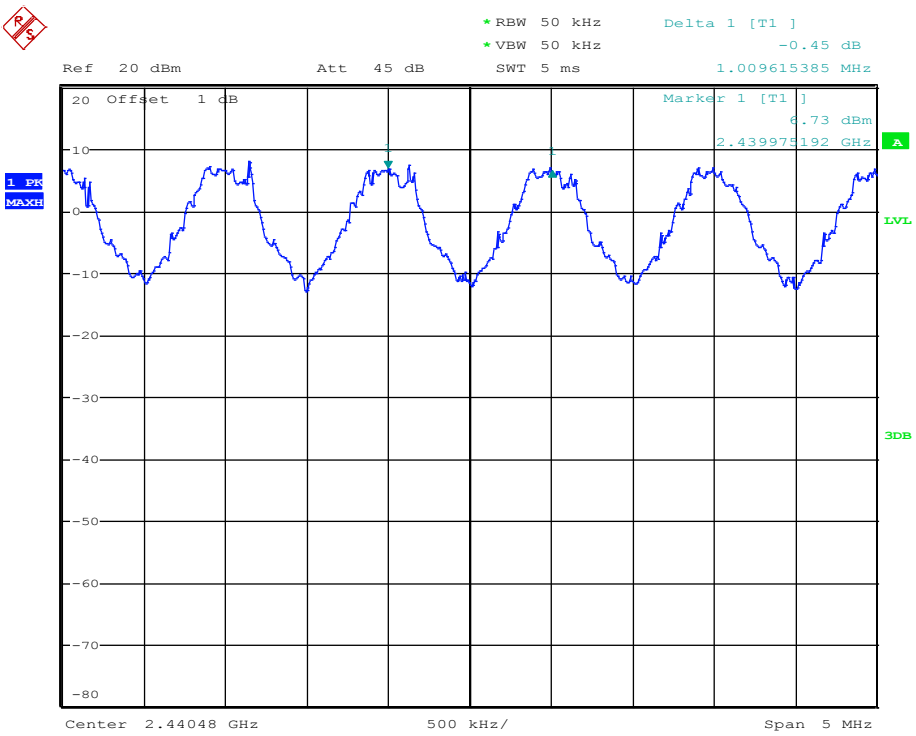
Measurement according to DA 00-705:2000

Hopping function: enabled
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 peak of the two adjacent channels.

7.4.4 Test result:

Channel Separation: 1.009 MHz
Pass

7.4.5 Test Data/plot:



Date: 19.FEB.2014 22:10:17

7.5 Number of hopping channels

7.5.1 Limits:

§ 15.247 (a) (1) (ii) (iii) & RSS-210 A8.1 (d) (e)
At least 15 non-overlapping channels

7.5.2 Test Conditions:

Tnom: 22°C; Vnom: 3.8 V

7.5.3 Test Procedure:

Measurement according to DA 00-705

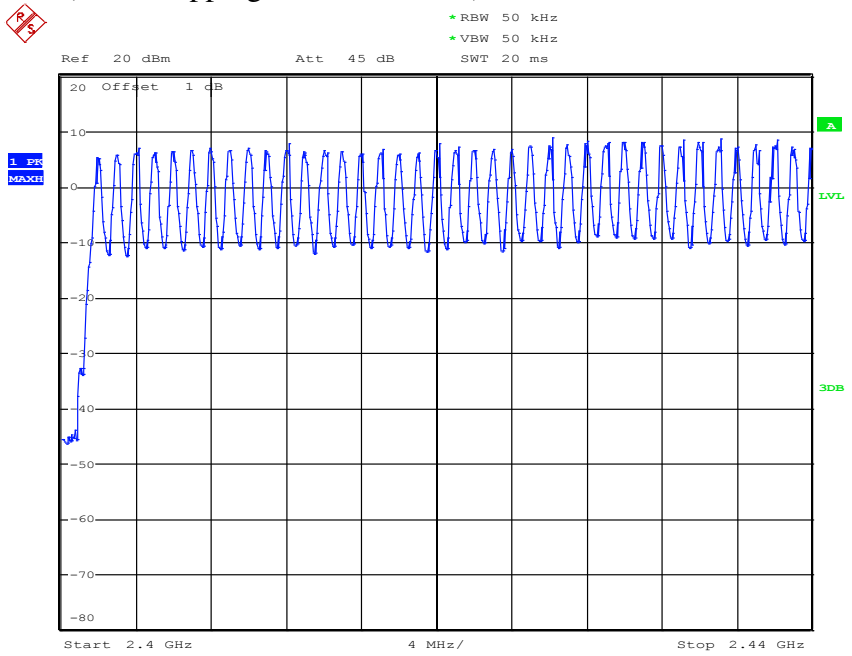
Hopping function: enabled
Spectrum Analyzer settings:
Span = the entire frequency band of operation
RBW ≥ 50 KHz
VBW ≥ RBW or 3X
Sweep = auto
Detector function = peak
Trace = max hold
The EUT must have its hopping function enabled during the test.

7.5.4 Test Result:

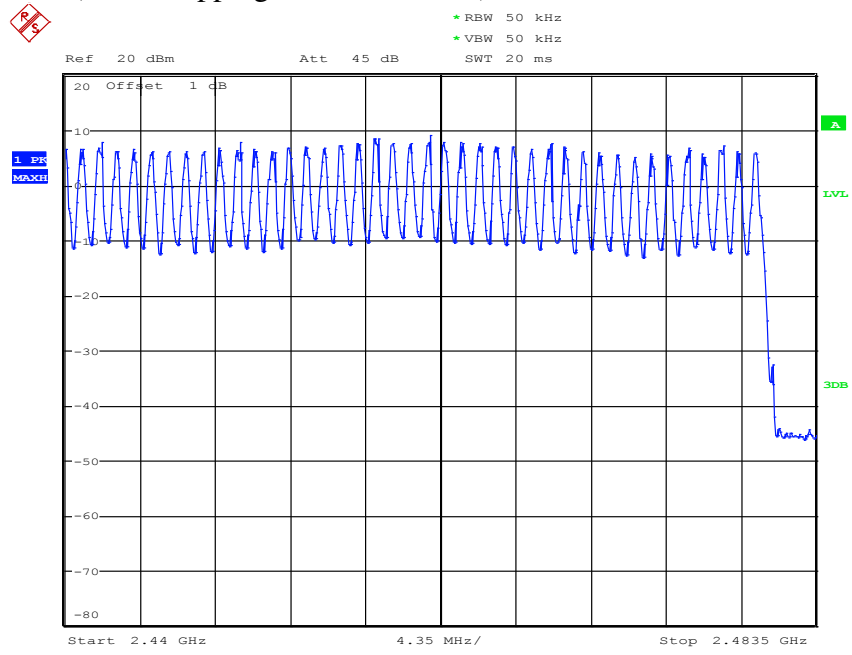
Number of hopping channels: 79

7.5.5 Test data/plot:

1st Segment (Total Hopping channels = 38.5)



2nd Segment (Total Hopping channels = 40.5)



7.6 Time of occupancy (Dwell time)

7.6.1 Limits:

§ 15.247 (a) (1) (iii) & RSS-210 A8.1 (d) (e)

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.

7.6.2 Time occupancy calculation

For Bluetooth devices

The dwell time of 0.4 s within a 31.6 second period in data mode is independent from the packet type (packet length). The calculation for a 31.6 second period is a follows:

Dwell time = time slot length * hop rate / number of hopping channels *31.6 s

Example for a DH1 packet (with a maximum length of one time slot)
Dwell time = 625 µs * 1600 1/s / 79 * 31.6 s = 0.4 s (in a 31.6 s period)

For multi-slot packet the hopping is reduced according to the length of the packet.
Example for a DH5 packet (with a maximum length of five time slots)
Dwell time = 5 * 625 µs * 1600 * 1/5 *1/s / 79 * 31.6 s = 0.4 s (in a 31.6 s period)

This is according to Bluetooth Core Specification for all Bluetooth devices. Therefore all qualified Bluetooth devices satisfy the FCC requirement on time of occupancy (dwell time).

7.6.2.1 Test Result

Pass.

7.7 Transmitter Spurious Emissions & Restricted Bands- Radiated

7.7.1 Limits:

§15.247/15.205/15.209 & RSS-Gen 7.2.2/7.2.5, RSS-210 A8.5

(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.

When testing at other than specified distance in the standard, the approach calculation by using 20 dB/decade extrapolation factor equation (4) as follow:

Conversion factor (CF) = 20 log (D/d) = 20 log (3m / 30 m) = -20dB

Therefore, 20 dB shall be added to the specified limit @ 30 m to convert to actual test limit @ 3m or shall be subtracted from the actual readings if the specified limit @ 30 m remains the same.

7.7.2 Test Conditions

Tnom: 23°C; Vnom: 3.8V

7.7.3 Test Procedure

Measurement according to ANSI C63.10:2009
Refer to section 6, 6.1 in this test report

Analyzer Settings:
From 9 KHz – 30 MHz
RBW = 9 KHz
Detector: Peak

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

Above 1 GHz
Detector = Peak / Average
RBW= 1MHz

Test mode: *Modulation:* 8-DPSK- the highest conducted output power
Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.
Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT.

Measurement Uncertainty: ±3.0dB

7.7.4 Test Result:

Pass.

7.7.5 Test data/ plots:

Note: Worst case representation for all modes of operation in this frequency range.
Limits adjusted for 3m measurement.

Modulation: 8-DPSK
Data Rate: 3DH5 packet
Channel: Low
Frequency range: 30 MHz – 1 GHz

Frequency (MHz)	Peak (dBuV/m)	Quasi-Peak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
63.20	----	26.8	120	123	V	159	7.3	40	13.2
67.27	----	28.6	120	123	V	270	7.7	40	11.4
214.5	----	31.6	120	100	V	22	12.1	43.5	11.9
239.9	----	33.1	120	100	V	179	14	46	12.9
846.9	----	26.7	120	123	V	180	26.6	46	19.4

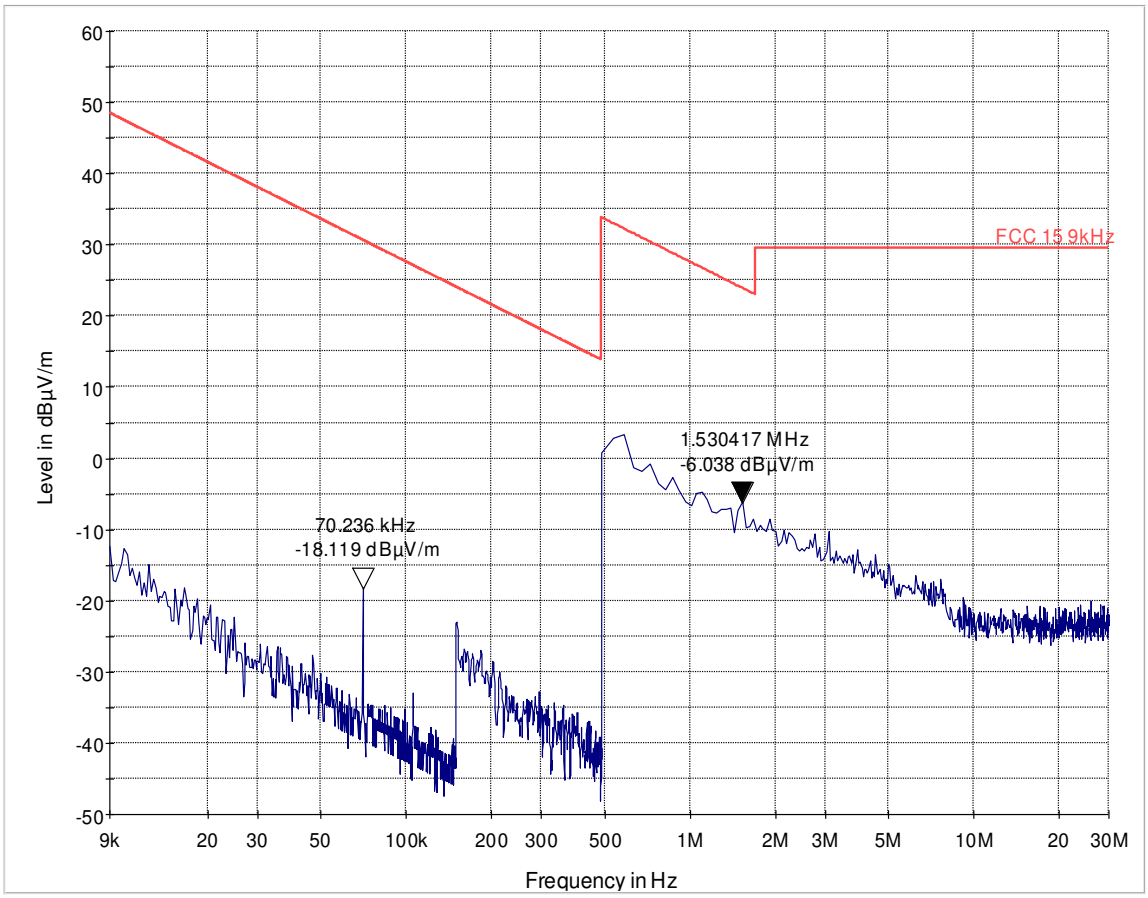
Modulation: 8-DPSK
Data Rate: 3DH5 packet
Channel: Mid
Frequency range: 30 MHz – 1 GHz

Frequency (MHz)	Peak (dBuV/m)	Quasi-Peak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
63.20	----	**28.4**	120	123	V	202	7.3	40	11.6
63.60	----	29.6	120	123	V	0	7.3	40	10.4
66.05	----	30.8	120	123	V	200	7.6	40	9.2
215.3	----	23.2	120	100	V	185	12.1	20.3	43.5
863.0	----	26.1	120	123	V	179	26.4	19.9	46.0

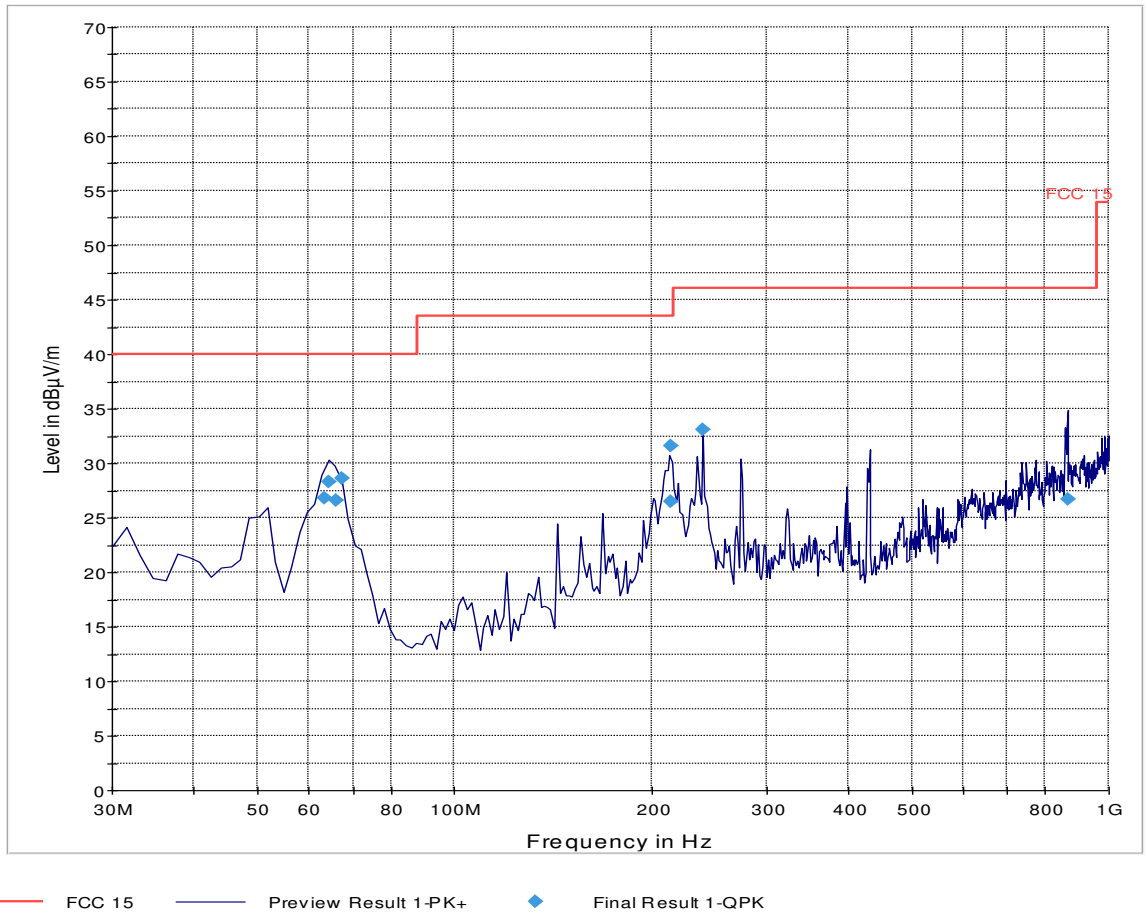
Modulation: 8-DPSK
Data Rate: 3DH5 packet
Channel: High
Frequency range: 30 MHz – 1 GHz

Frequency (MHz)	Peak (dBuV/m)	Quasi-Peak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
63.37	----	**23.8**	120	123	V	292	7.1	40	16.2
64.01	----	29.5	120	123	V	255	7.3	40	10.5
65.20	----	27.5	120	123	V	270	7.5	40	12.5
214.45	----	32.1	120	100	V	159	12.1	43.5	11.4
856.86	----	34.1	120	123	V	193	25.8	46	12.0
956.5	----	27.1	120	123	V	269	27.1	46	18.9

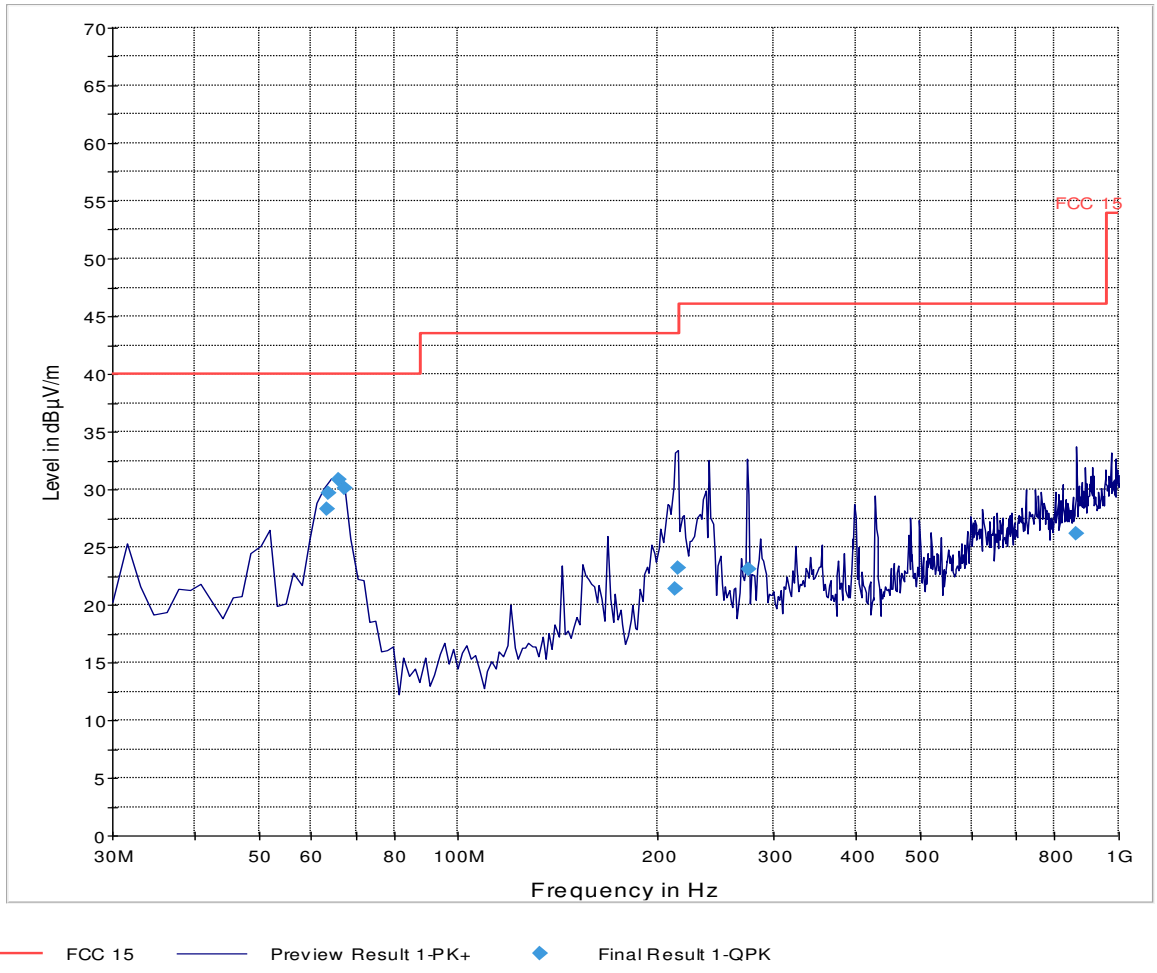
TX Radiated Spurious Emission- < 30 MHz– 8-DPSK modulation –Mid CH



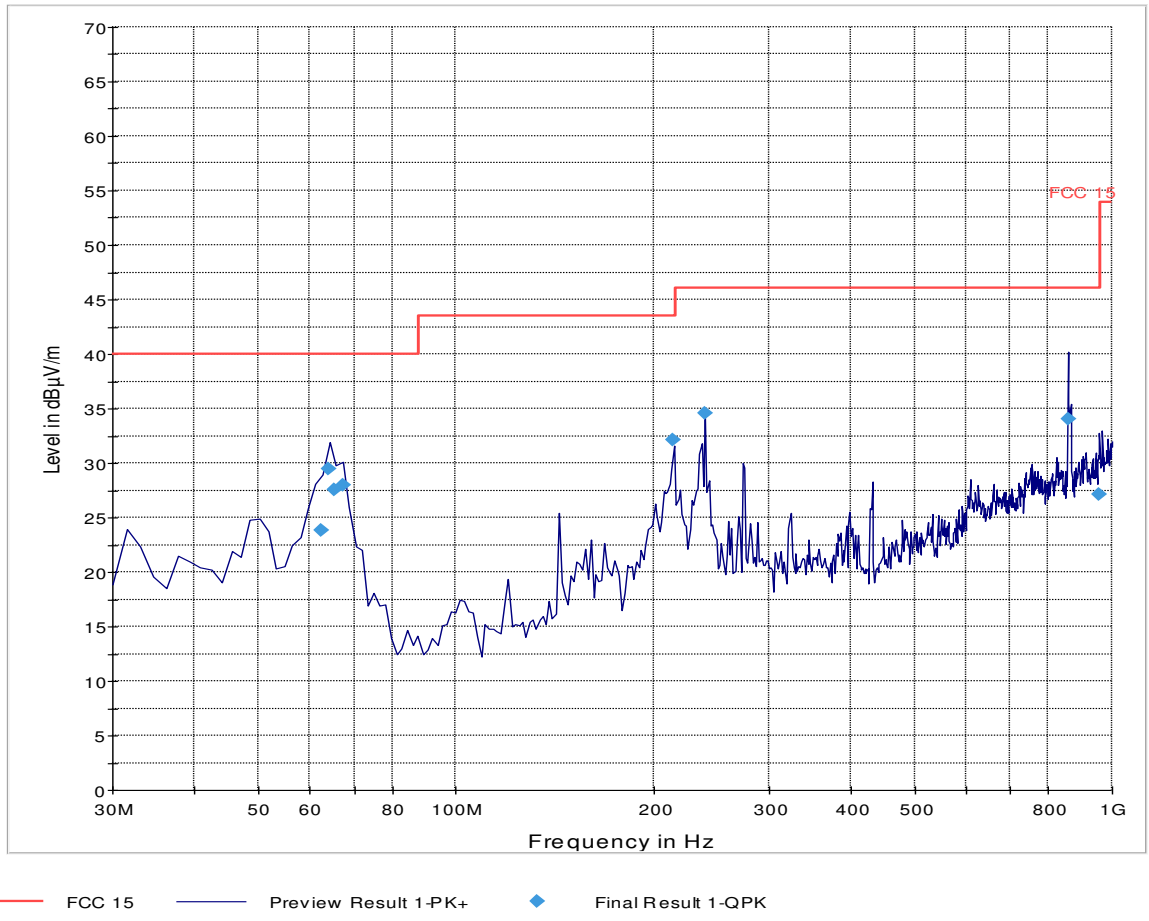
TX Radiated Spurious Emission- 30 MHz-1GHz – 8-DPSK modulation –Low CH



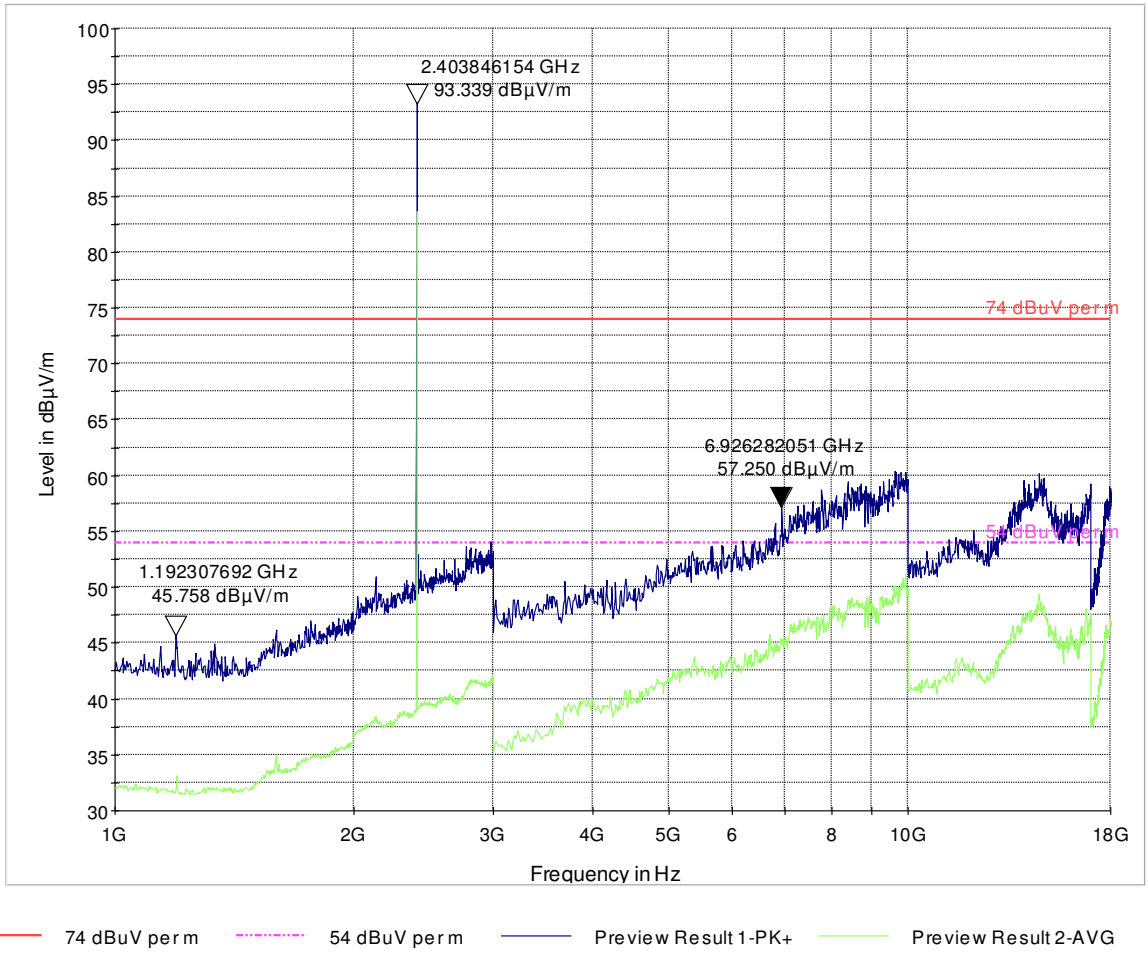
TX Radiated Spurious Emission-– 30 MHz-1GHz – 8-DPSK modulation –Mid CH



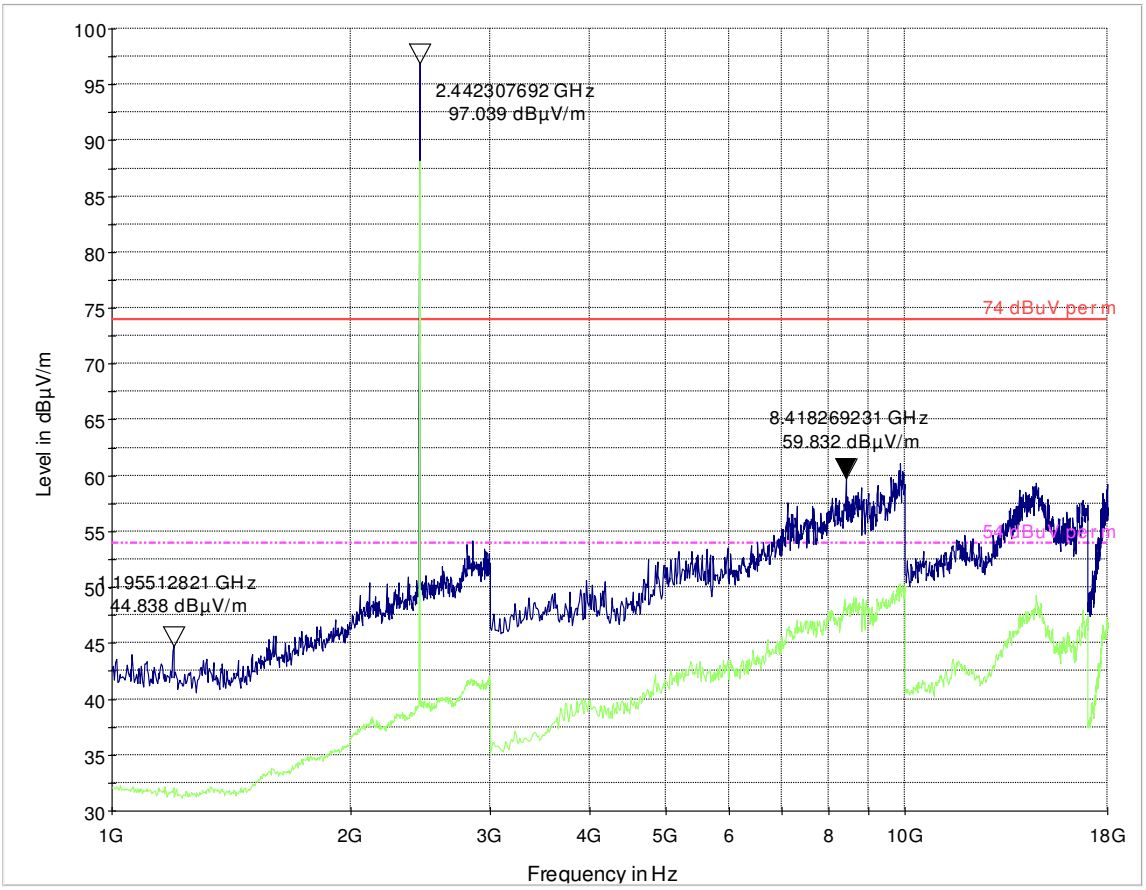
TX Radiated Spurious Emission– 30 MHz-1GHz– 8-DPSK modulation –High CH



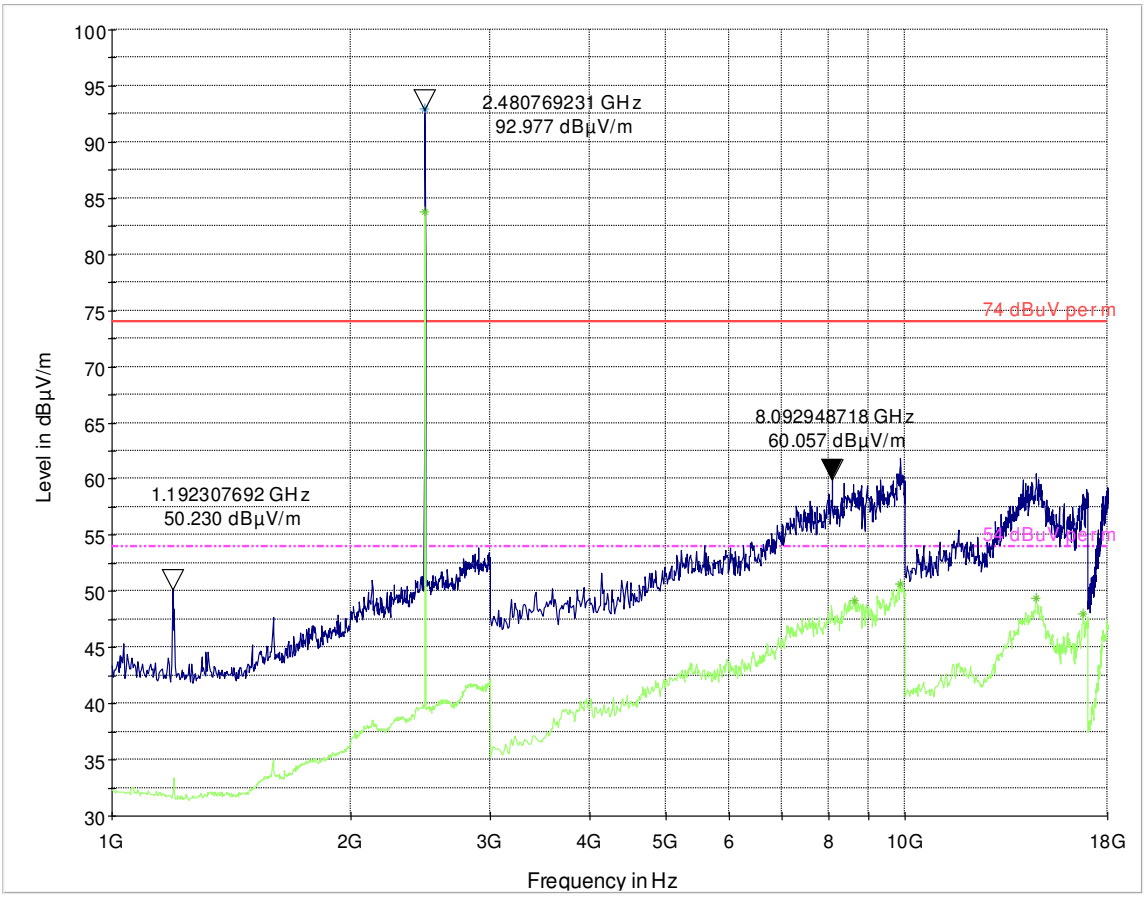
TX Radiated Spurious Emission– 1GHz - 18GHz – 8-DPSK modulation –Low CH



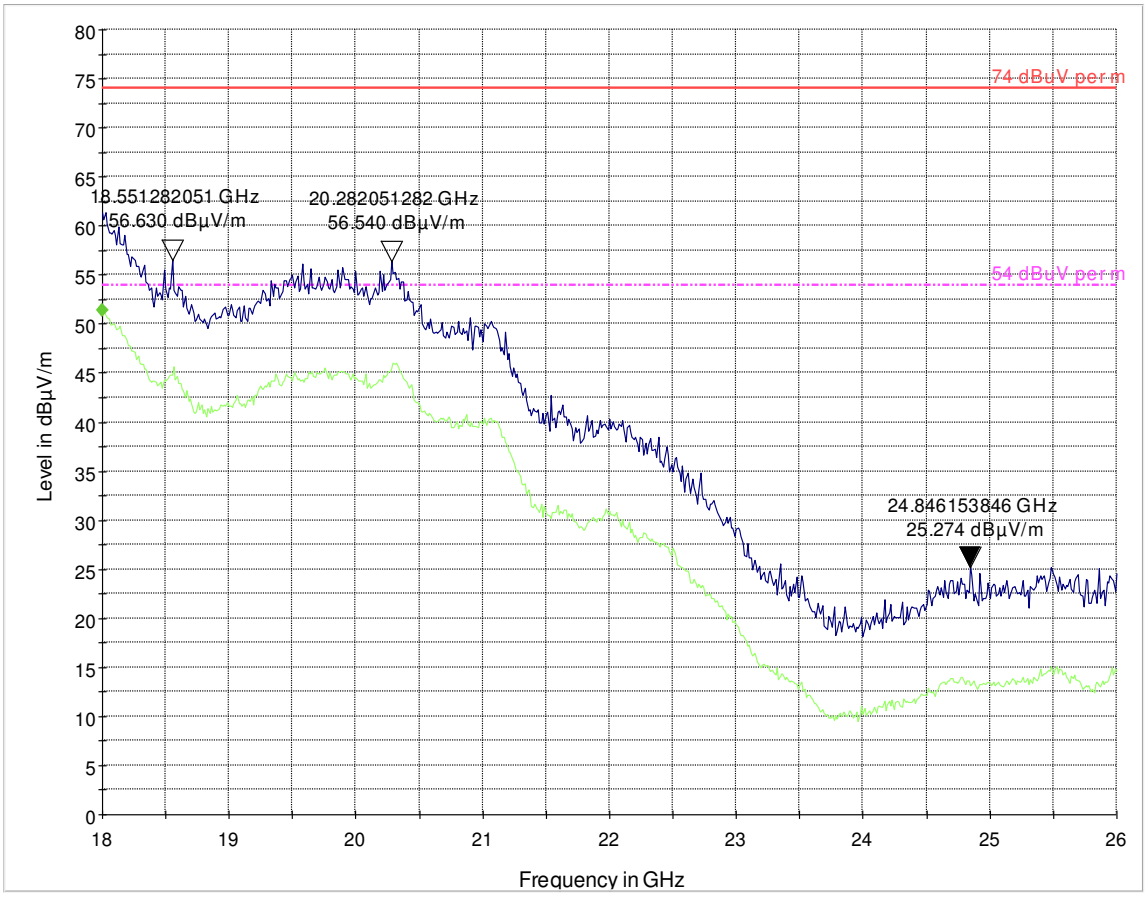
TX Radiated Spurious Emission-– 1GHz - 18GHz - 8-DPSK modulation –Mid CH



TX Radiated Spurious Emission– 1GHz - 18GHz – 8-DPSK modulation –High CH



TX Radiated Spurious Emission– 18GHz - 26GHz – 8-DPSK modulation –Mid CH



7.8 AC Power Line Conducted Emissions

The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

7.8.1 Limits:

§15.207 & RSS-Gen 7.2.4

(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 the 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.

7.8.2 Test Conditions:

Modulation: 8-DPSK modulation - Transmit and Receive modes of operation
Tnom: 22°C; Vnom: 3.8V

7.8.3 Test Procedure

Measurement according to ANSI C63.10:2009 section 6.2 (also refer to section 6, 6.3 in this test report)

Analyzer Settings:
RBW = 9 KHz (CISPR Bandwidth)
Detector: Qusi-Peak / Average

Measurement Uncertainty: ±3.0dB

7.8.4 Results

Plots shown here represent the combined worse case emissions for power lines (phases and neutral line).
Pass.

7.8.5 Test Data

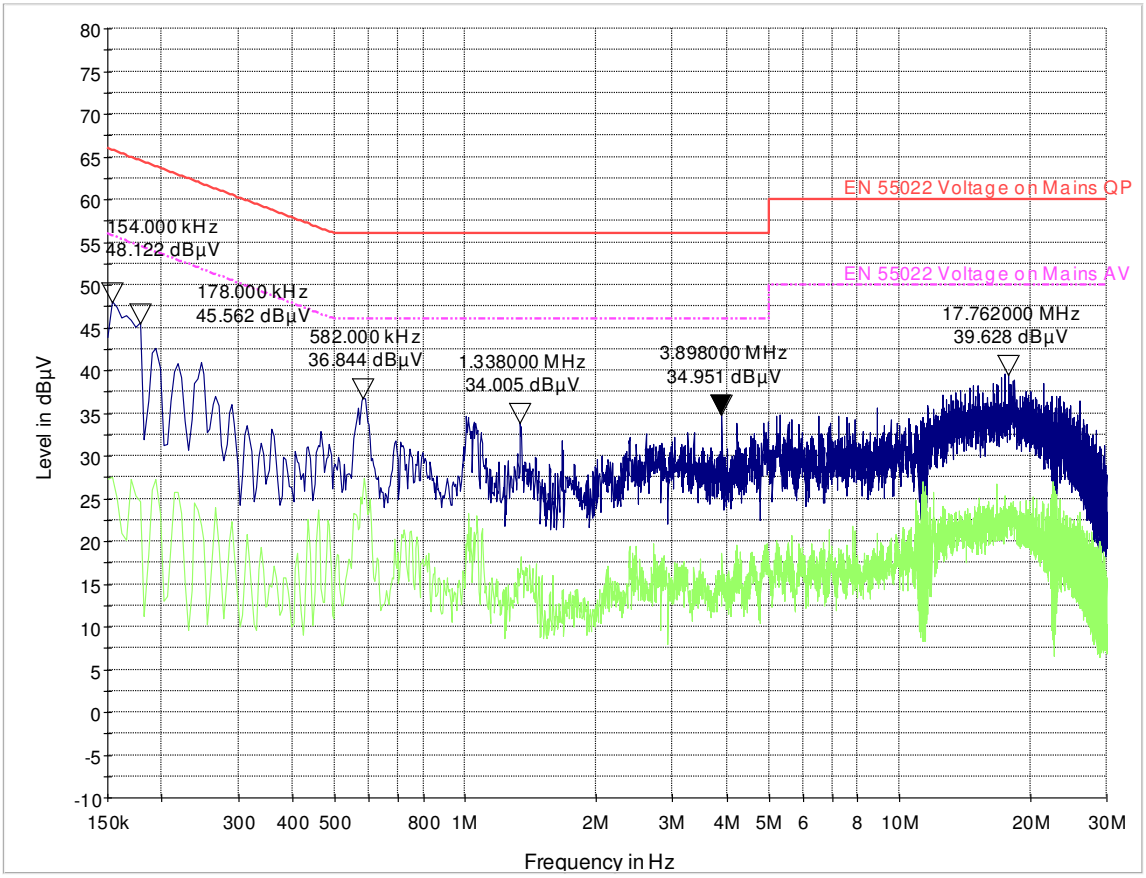
Conducted Emissions: 150 KHz – 30 MHz

Frequency (MHz)	Peak /Quasi-Pk (dBuV	Average (dBuV)	BW (kHz)	C F (dB)	Line (L1/N)	Limit (dBµV/m)	Margin (dB)	Results
0.154	48.1	27.5	9	0.3	L1	65.7Pk/55.7Av	-17.6Pk/ -28.2Av	Pass
0.178	45.6	24.7	9	0.2	L1	64.7Pk / 54.7Av	-40.0Pk/ -30.0Av	Pass
582.0	36.8	25.9	9	0.1	L1	56Pk / 46Av	-19.2Pk/ -20.1Av	Pass
1.338	34.0	15.8	9	0.2	L1	56Pk / 46Av	-22Pk / -30.2Av	Pass
3.89	35.0	18.6	9	0.3	L1	56Pk / 46Av	-21Pk / -27.4Av	
17.76	39.6	23.2	9	0.7	L1	60Pk / 50Av	-20.4Pk/ -26.5Av	Pass

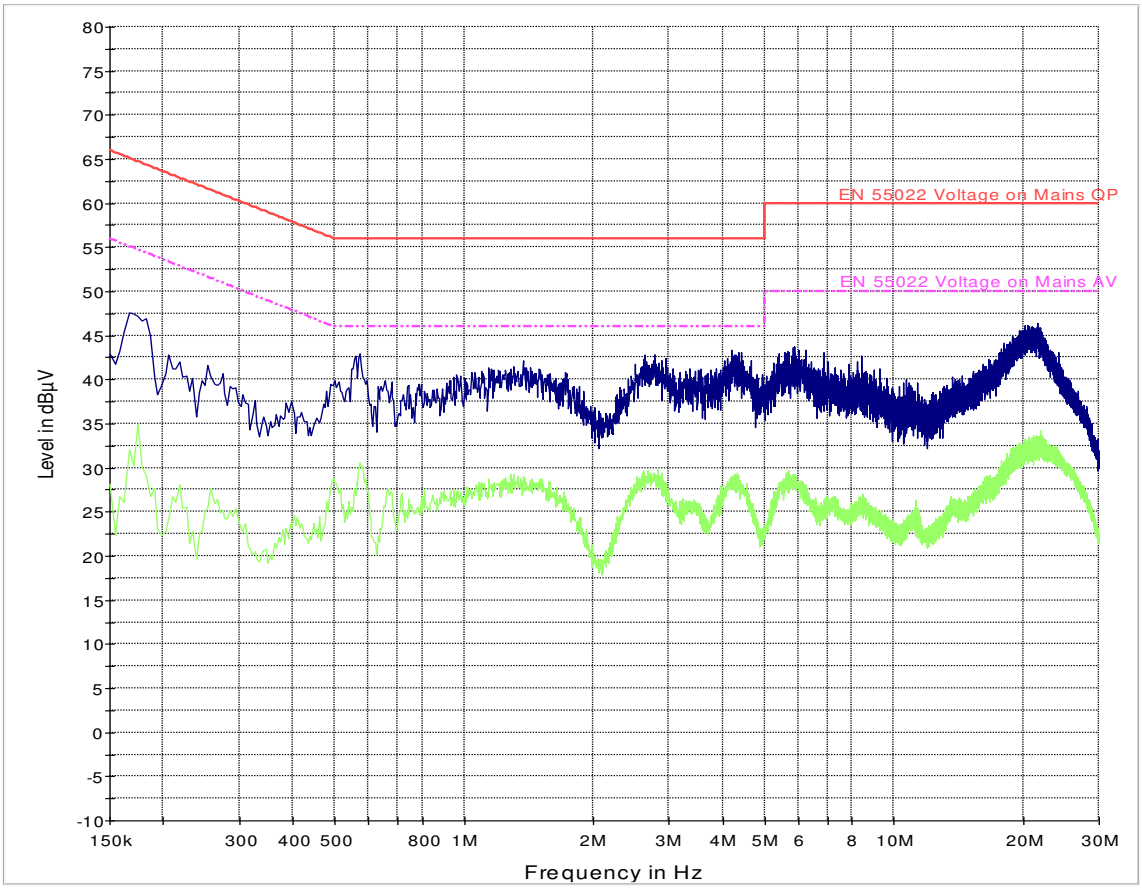
Note: Test voltage used was 120 Vac / 60Hz

7.8.6 Measurement Plots:

Conducted Emissions: 150 KHz – 30 MHz
TX Mode: 8-DPSK modulation



Conducted Emissions: 150 KHz – 30 MHz
RX Mode:

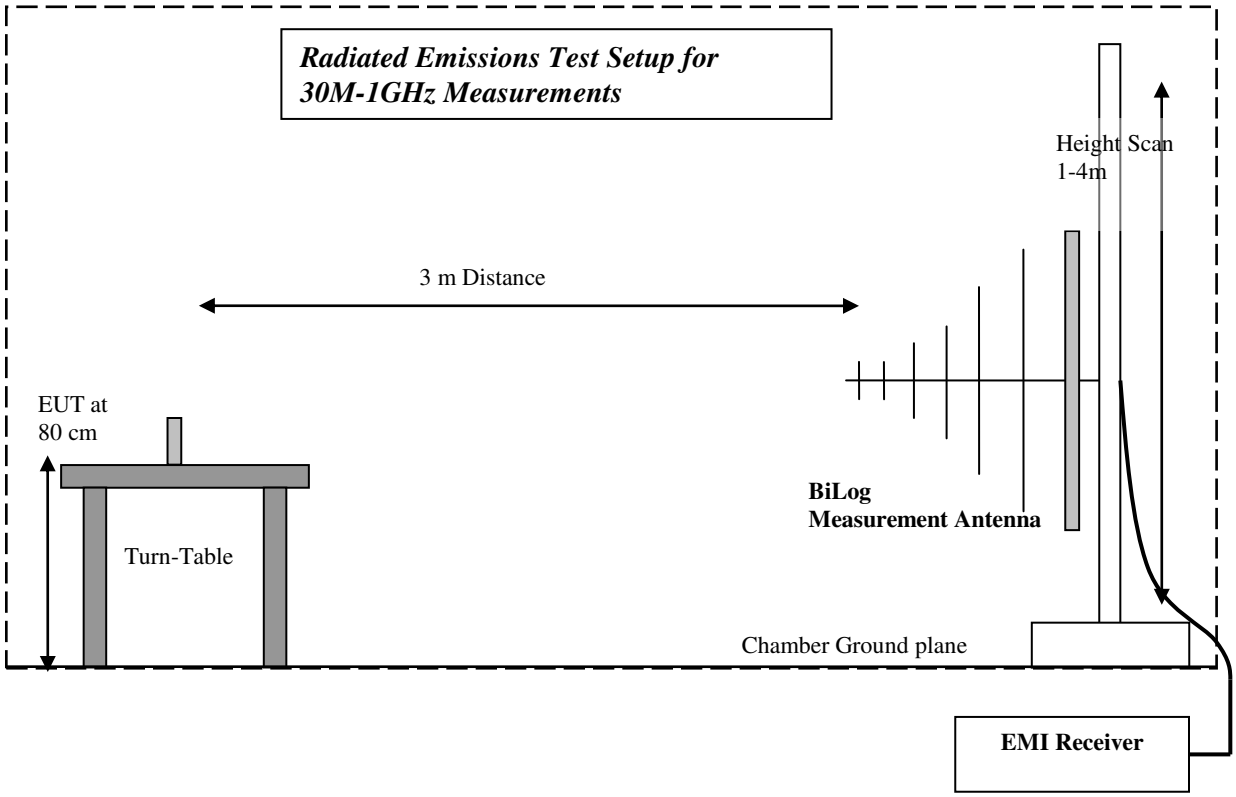


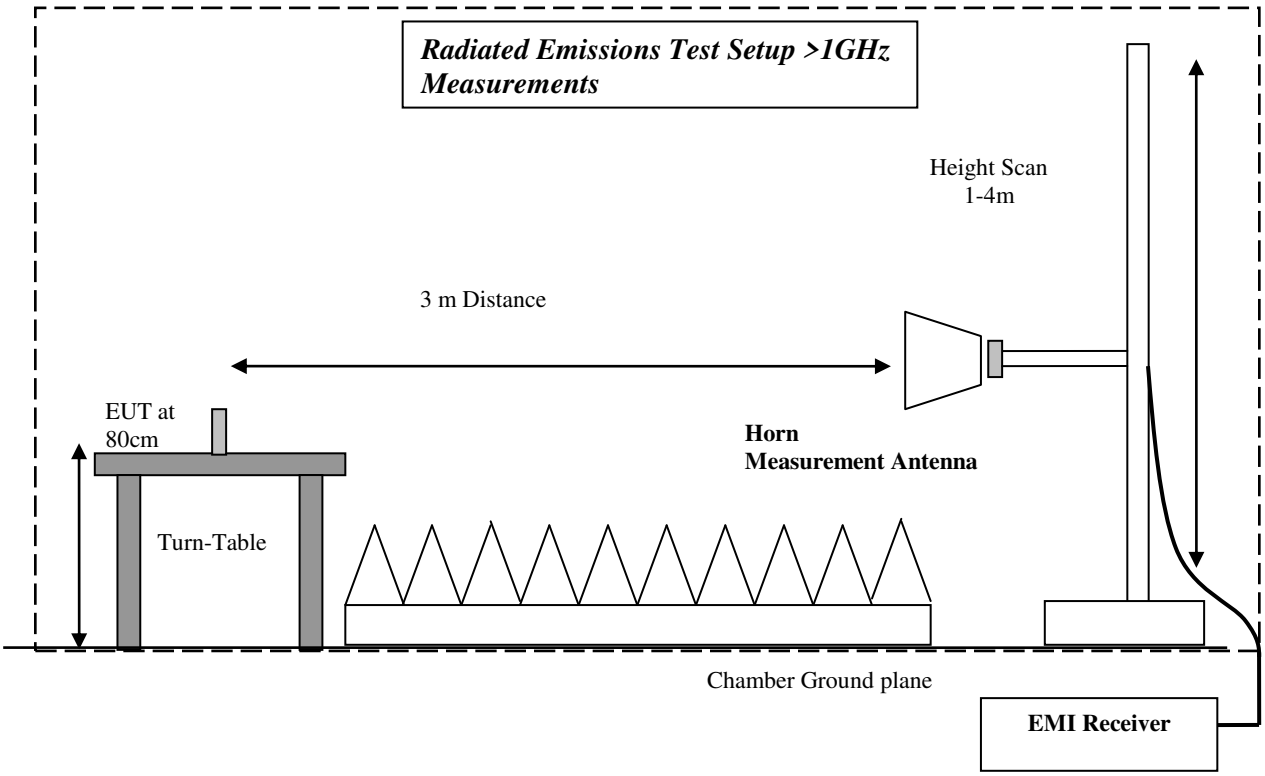
EN 55022 Voltage on Mains QP
Preview Result 1-PK+
EN 55022 Voltage on Mains AV
Preview Result 2-AVG

8 Test Equipment and Ancillaries used for tests

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
	Turn table	EMCO	2075	N/A	N/A	N/A
	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
	Antenna Mast	EMCO	2075	N/A	N/A	N/A
	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	Sept 2013	2 Year
	Spectrum Analyzer	Rohde&Schwarz	FSU	200302	Jun 2013	2 Years
	1500MHz HP Filter	Filtek	HP12/1700	14c48	N/A	N/A
	2800 MHZ HP Filter	Filtek	HP12/2800	14C47	N/A	N/A
	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
	Binconilog Antenna	EMCO	3141	0005-1186	Apr 2012	3 Years
	Binconilog Antenna	ETS	3149	J000123908	Feb 2012	3 years
	Horn Antenna	EMCO	3115	35114	Mar 2012	3 Years
	LISN	Rohde and Schwarz	ESV 216	101129	Mar 2013	2 years
Ancillary equipment						
	DC Power Supply	HP	E3610A	KR83023316	N/A	N/A
	Communication Antenna	IBP5-900/1940	Kathrein	N/A	N/A	N/A
	Signal Generator	Agilent	83712B	US37101255	N/A	N/A
	Power Splitter	Agilent	11667B	52565	N/A	N/A
	Temp Hum Logger	TM325	Dickson	5285354	Apr 2014	1 Year
	Climatic Chamber	Votsch	VT4004	G1115	N/A	N/A

9 Test Setup Diagram:





10 Revision History

Date	Report Name	Changes to report	Report prepared by
2014-06-12	**EMC_INTEL_039_14001_15.247_BT_Rev1**	Product description corrected	Danh Le