Bluetooth (Basic rate/EDR)

FCC / IC Test Report

FOR:

Intel Corporation

Model Name: EP110

Product Description: Intel 4.7-inch Smartphone with GSM, GPRS, EDGE, UMTS, HSPA+, LTE, WLAN, BT and GPS radios

FCC ID: O2Z-EP110
IC ID: 1000W – EP110

47 CFR Part 15.247

RSS-210 Issue 8 & RSS-GEN Issue 4

TEST REPORT #: EMC_INTEL_054_14001_15.247_BT_Rev2
DATE: 2014-11-24

ACCREDITED
TESTING LABORATORY
Certificate #2135.01

Bluetooth Qualification Test Facility (BQTF)

CTIA Authorized Test Lab
LAB CODE 20020328-00

FCC listed
A2LA Accredited

IC recognized #
3462B

***CETECOM* Inc.**
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CETECOM Inc. is a Delaware Corporation with Corporation number: 2113686

Contents

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	Intel 4.7-inch Smartphone with GSM,GPRS,EDGE,UMTS,HSPA+,LTE, WLAN, BT and GPS radios	EP110

Responsible for Testing Laboratory:

Digitally signed by Franz Engert
DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com
Date: 2014.12.15 18:00:43 -08'00'

Date	Section	Name	Signature
2014-11-24	Compliance	Franz Engert (Compliance Manager)	

Responsible for the Report:

Jennifer Huang

Digitally signed by Jennifer Huang
DN: cn=Jennifer Huang, c=US, o=cetecom, ou=emc, email=jennifer.huang@cetecom.com
Date: 2014.12.15 16:07:51 -08'00'

Date	Section	Name	Signature
2014-11-24	Compliance	Jennifer Huang (Compliance Technician)	

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
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Compliance Manager:	Franz Engert
Responsible Project Leader:	Rami Saman

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

3.2 General specification of EUT

Marketing Name / Model No:	Intel 4.7-inch Smartphone / EP110
HW Version :	PR2
FCC-ID:	O2Z-EP110
IC-ID:	1000W- EP110
Product Description:	Intel 4.7-inch Smartphone with GSM,GPRS,EDGE,UMTS,HSPA+,LTE, WLAN, BT and GPS radios
Rated Operating Voltage / Power Supply:	3.6 Vmin/3.8 Vnom/4.2 Vmax; Rechargeable lithium-ion battery
Rated Operating temperature range:	-10oC to +55oC
Test Sample:	Prototype
Radios included in the device:	1. Cellular Radio GSM 850/900/1800/1900 MHz 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 MHz 2. WLAN ISM band, U-NII bands 3. Bluetooth BDR/EDR/LE 4. GPS

3.3 Detailed specification of EUT in scope of this report

Operating Frequency bands:	2400 – 2483.5 MHz (ISM)
Channel Bandwidths:	1MHz
Modes of Operation	Adaptive frequency hopping on 79 channels
Technology/ Type(s) of Modulation:	Bluetooth v2.0/ GFSK, π /4 DPSK, 8DPSK
Antenna info:	Internal Monopole (PCB) -3.7 dBi @ 2.4GHz
Nominal Conducted Output Powers from manufacturing process:	GFSK 8dBm π /4 DPSK 7dBm 8DPSK 7dBm
Maximum tune up tolerance in manufacturing process:	+ 2dB

3.4 Identification of the Equipment Under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	INV141400717	PR2	4.4.4 KTU84P main engineering 53181-dev-keys	Radiated and Conducted RF Sample
2	INV141401015	PR2	4.4.4 KTU84P main engineering 53181-dev-keys	RF Conducted Sample

3.5 Identification of Accessory equipment

STE #	Type	Manufacturer	Model	Serial Number
1	AC/DC Adapter	Salcomp	SC1402	1309500144736

4 Subject of Investigation

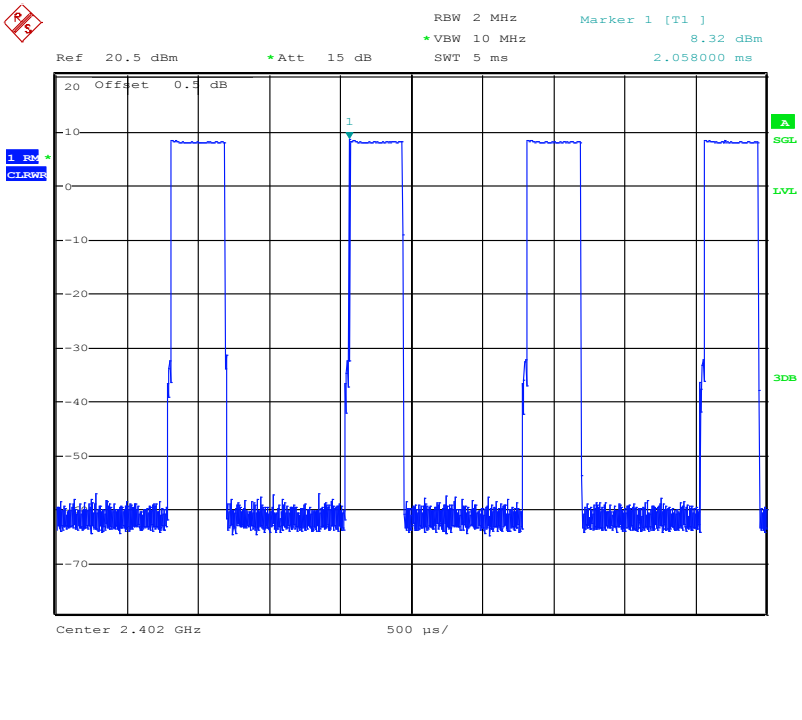
The objective of the measurements applied by CETECOM Inc. was to establish compliance of the EUT as described under Ch. 3 of this Test Report, with the applicable criteria specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-210 Issue 8 of Industry Canada.

This test report is to support a request for new equipment authorization under the FCC ID **O2Z-EP110** and IC ID **1000W-EP110.**

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

All testing against power limits has been performed for the three supported modulations except the radiated and AC power line emissions which have been tested only on the highest conducted output power modulation GFSK (see results). All testing has been performed on the longest packet type (5) only as this has influence only on the duty cycle and not on the power. See below.

1DH1 -> 8.32dBm:



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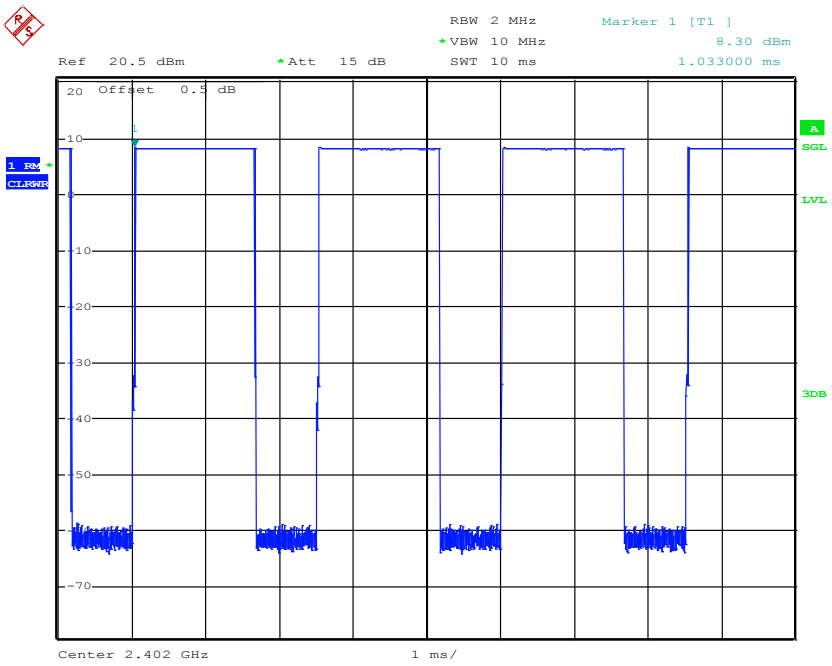
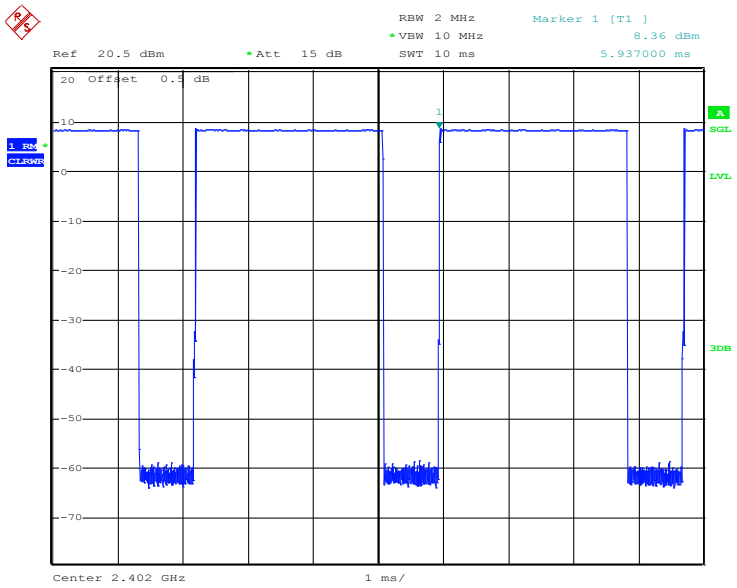


Date: 24.NOV.2014 17:18:14

1DH5 -> 8.36dBm:



Date: 24.NOV.2014 17:19:38

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 8.9	TX Spurious emissions- Radiated	Nominal	8-DFSK	■	☐	☐	☐	Complies
§15.207(a) RSS Gen 8.8	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 Measurement Uncertainty

	Uncertainty in dB radiated <30MHz	Uncertainty in in dB radiated 30MHz - 1GHz	Uncertainty in dB radiated > 1GHz	Uncertainty in dB Conducted measurement
standard deviation k=1	2.48	1.93	2.16	0.63
95% confidence interval in dB	4.86	3.79	4.23	1.24
95% confidence interval in dB in delta to Result	+-2.5 dB	+-2.0 dB	+- 2.3dB	+-0.7dB

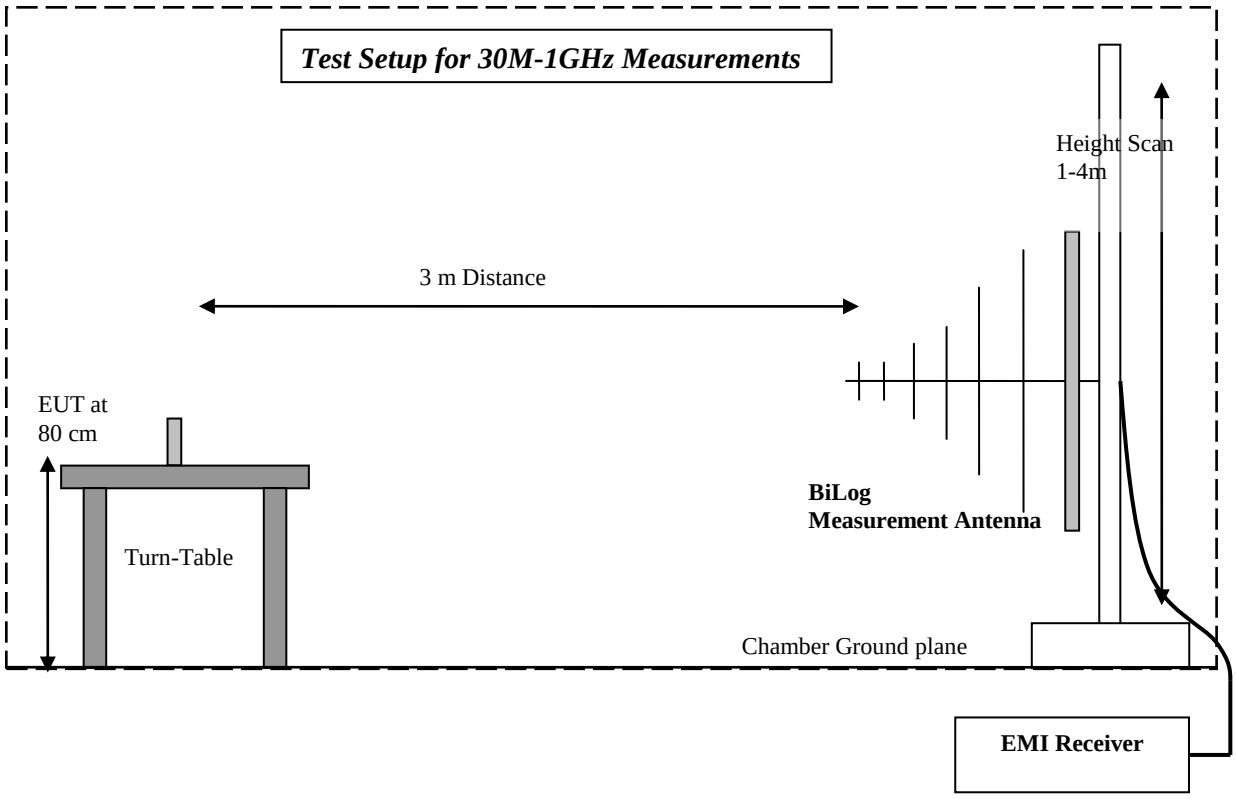
6.2 Test Conditions

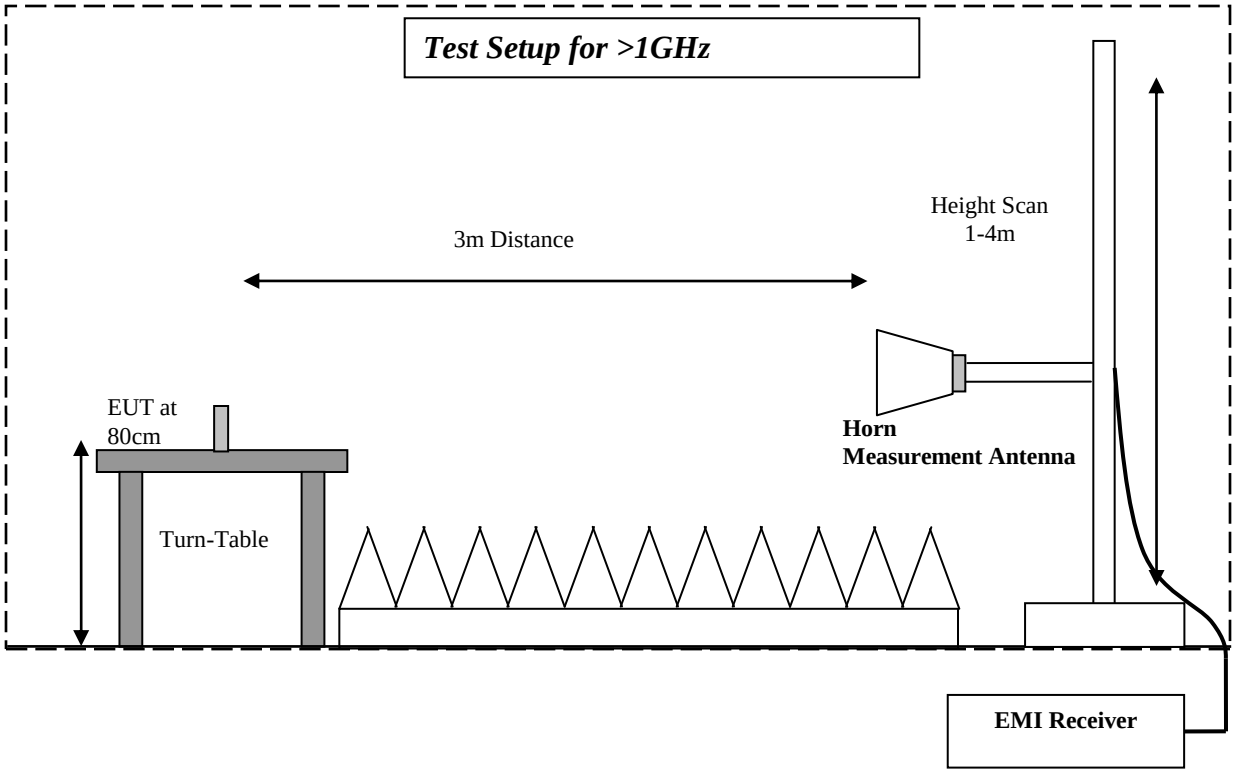
Temperature: 19°C to 25°C;
Operating Voltage: 3.8V for radio measurements;
Operating Voltage: 4.2V for emission measurements due to connected charger;
Relative Humidity 20% to 50%

6.3 Radiated Emissions Measurement Setup and Procedure

The radiated measurement is performed according to:
ANSI C63.4 (2009)
ANSI C63.10 (2009)

- 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 16 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 9kHz to 30MHz, a Biconlog antenna is used from 30MHz to 1GHz, two different horn antennas are used to cover frequencies up to 40GHz.


Test Setup for 30M-1GHz Measurements
Height Scan
1-4m
3 m Distance
EUT at
80 cm
BiLog
Measurement Antenna
Turn-Table
Chamber Ground plane
EMI Receiver


Test Setup for >1GHz
Height Scan
1-4m
3m Distance
EUT at
80cm
Horn
Measurement Antenna
Turn-Table
EMI Receiver

6.3.1 Sample Calculations for Radiated Measurements

6.3.1.1 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.

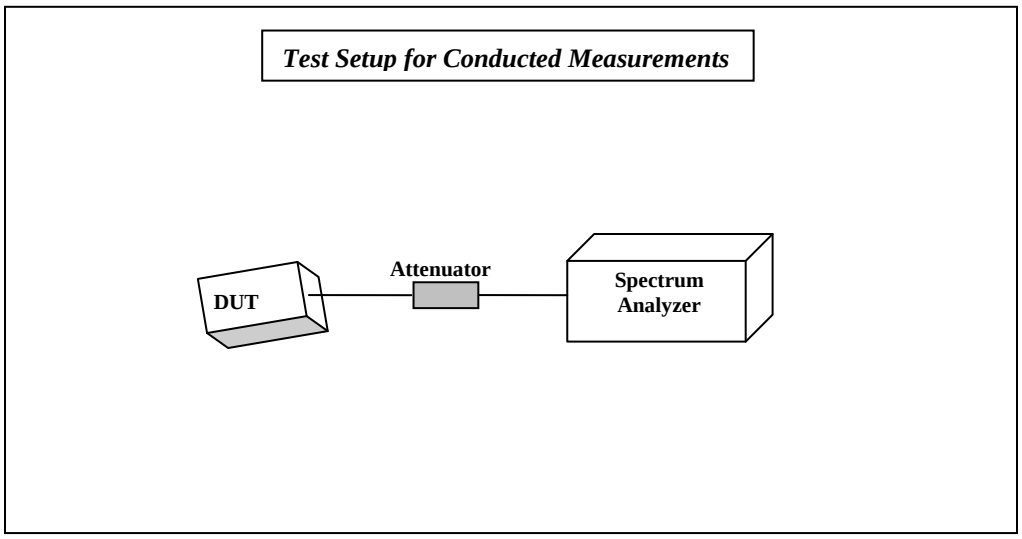
6.3.1.2 Power Measurements using Substitution Procedure:

The measurement on the Spectrum Analyzer is used as a basis for the Substitution procedure.
The EUT is replaced with a Signal Generator and an antenna. The setting on the Signal Generator is varied until the Spectrum Analyzer displays the original reading. EIRP is calculated as-

EIRP (dBm)= Signal Generator setting (dBm)- Cable Loss (dB)+ Antenna Gain (dBi)
Eg:

Frequency (MHz)	Measured SA (dBµV)	Signal Generator setting (dBm)	Antenna Gain (dBi)	Dipole Gain (dBd)	Cable Loss (dB)	EIRP (dBm)
1000	95.5	24.5	6.5	0	3.5	27.5

6.4 Conducted Measurement Setup and Procedure



7 Maximum Peak Conducted Output Power

7.1 Limits:

Maximum Peak Conducted 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

7.2 Test Procedure

Refer to DA 00-705:2000

Peak Output Power

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (see the NOTE above regarding external attenuation and cable loss). The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer.

7.3 Test Data:

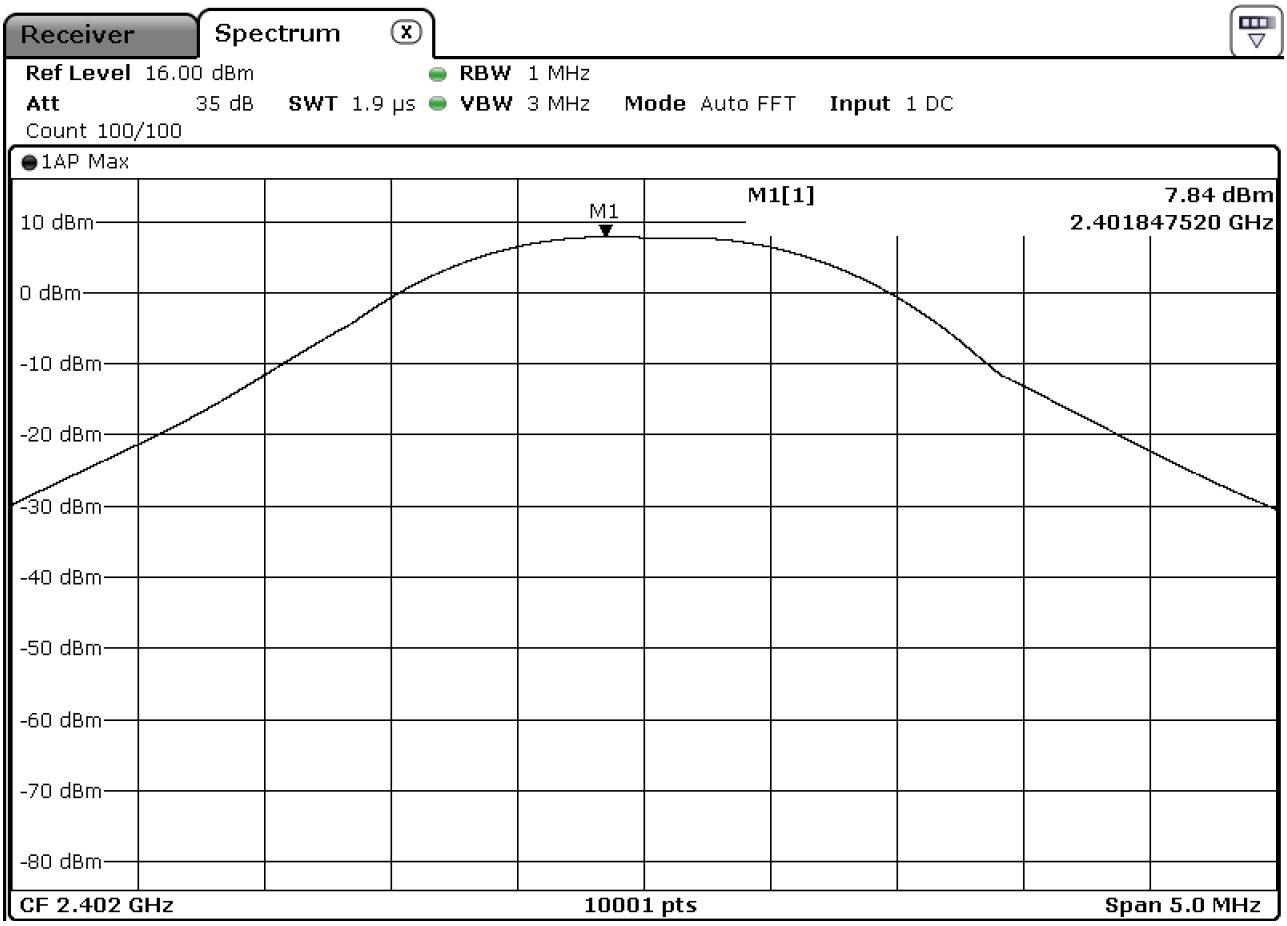
Maximum Peak Conducted Output Power for packet type DH5 (dBm)						
Modulation	**Frequency (MHz)**					
	2402	**Diagram no.**	**2441**	**Diagram no.**	**2480**	**Diagram no.**
GFSK	**7.84**	CPP_2402_gfsk_dh5	6.84	CPP_2441_gfsk_dh5	6.95	CPP_2480_gfsk_dh5
π/4 DPSK	7.18	CPP_2402_2dh5	6.77	CPP_2441_2dh5	6.09	CPP_2480_2dh5
8-DPSK	7.35	CPP_2402_3dh5	6.95	CPP_2441_3dh5	6.30	CPP_2480_3dh5

7.4 Measurement Result

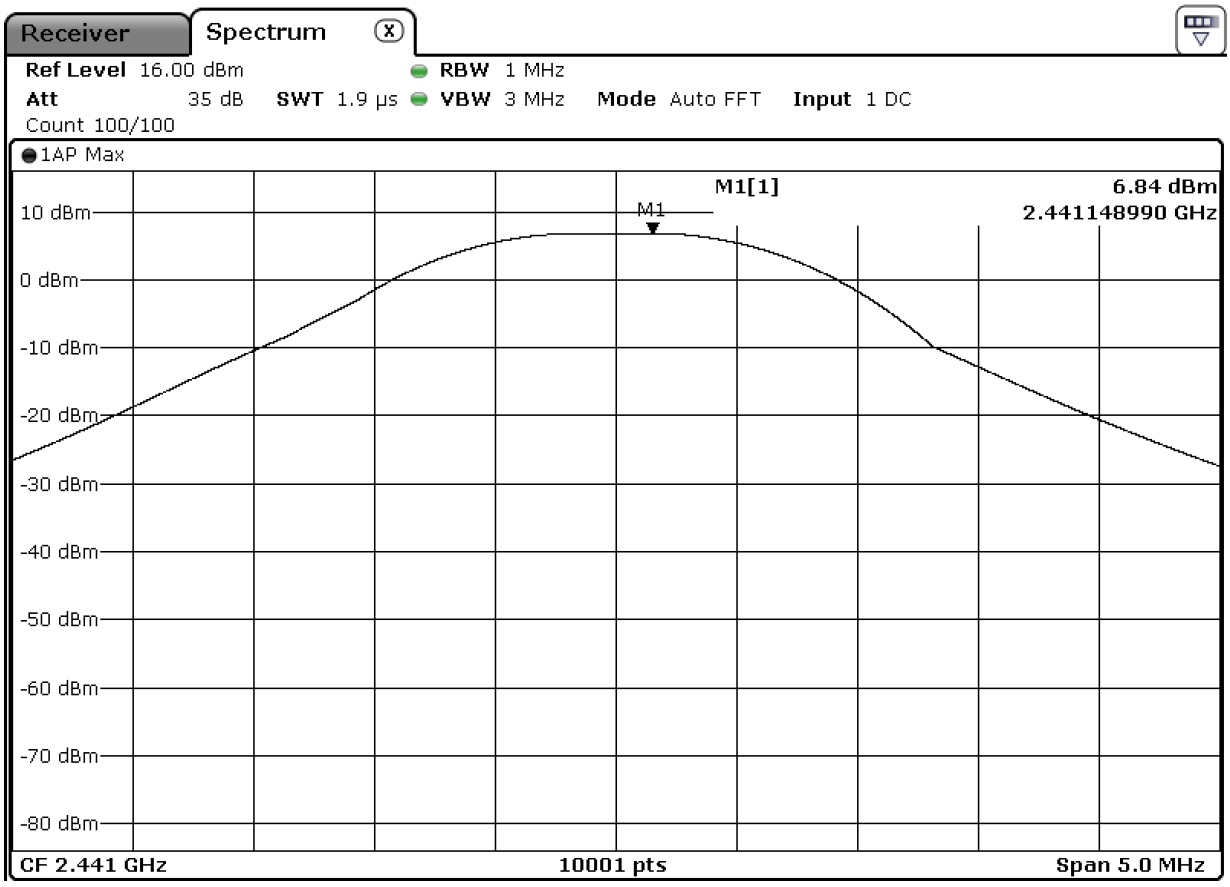
Pass.

7.5 Test Data/plots:

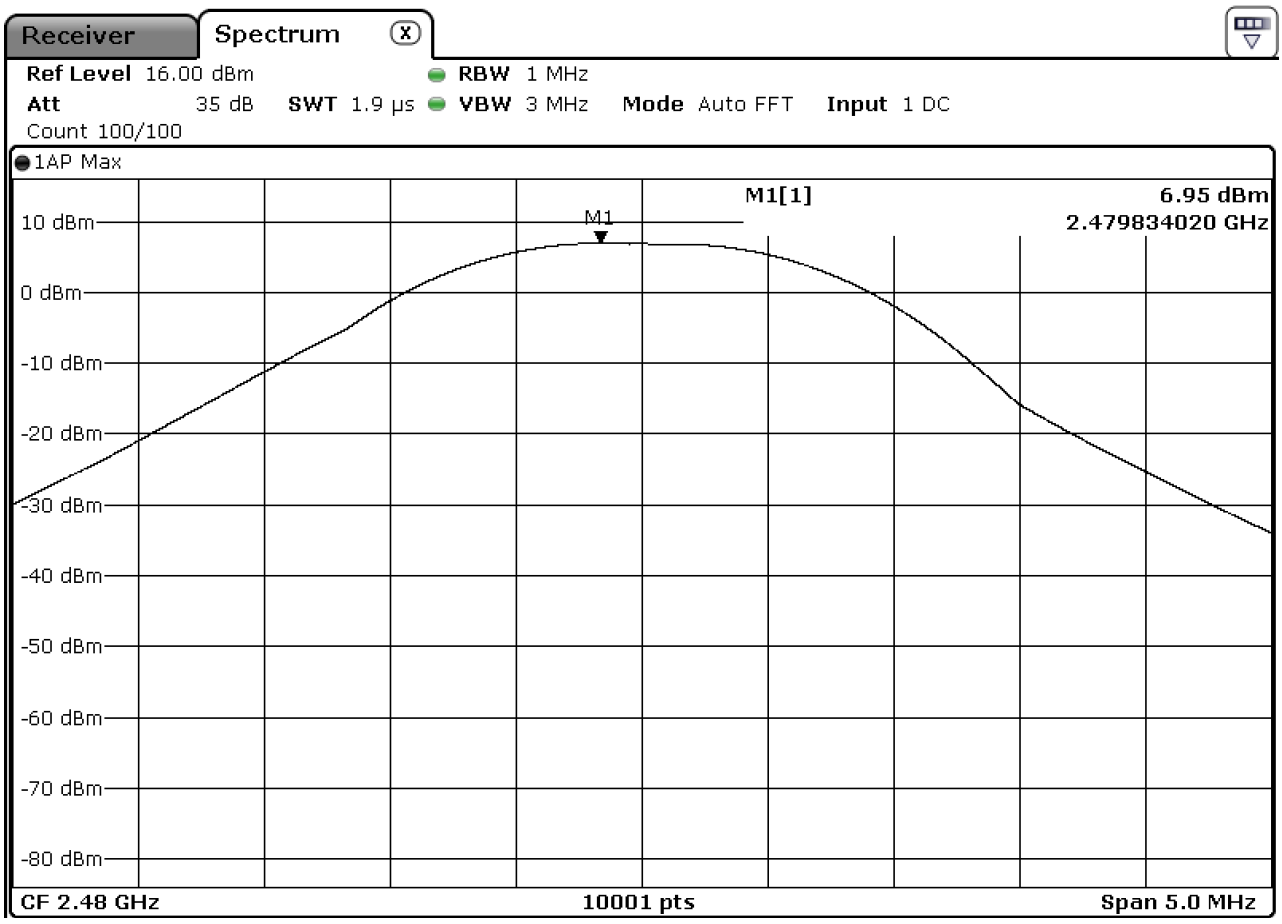
Conducted Peak Power Ch.0 /2402 MHz -GFSK (DH5)



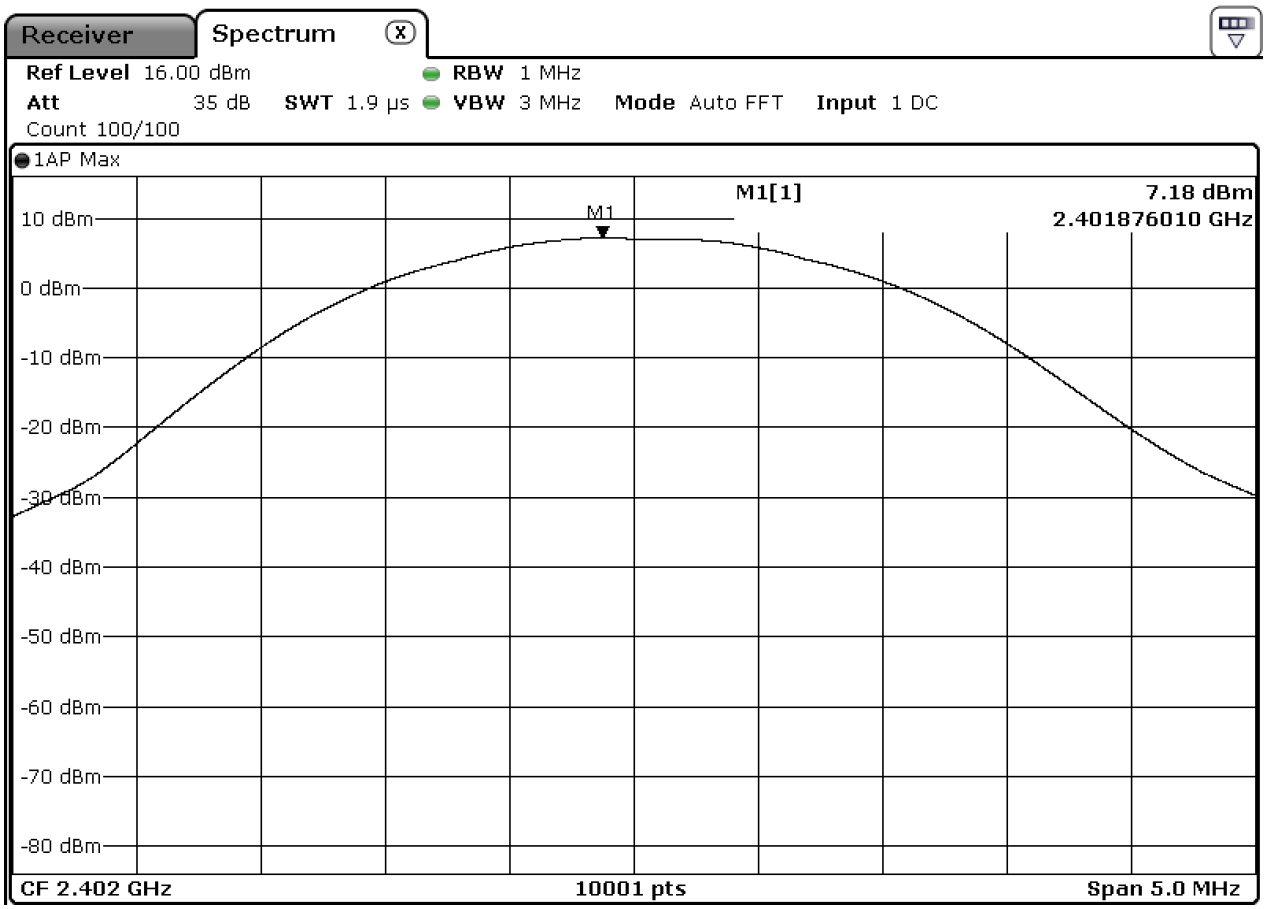
Conducted Peak Power Ch.39 /2441 MHz -GFSK (DH5)



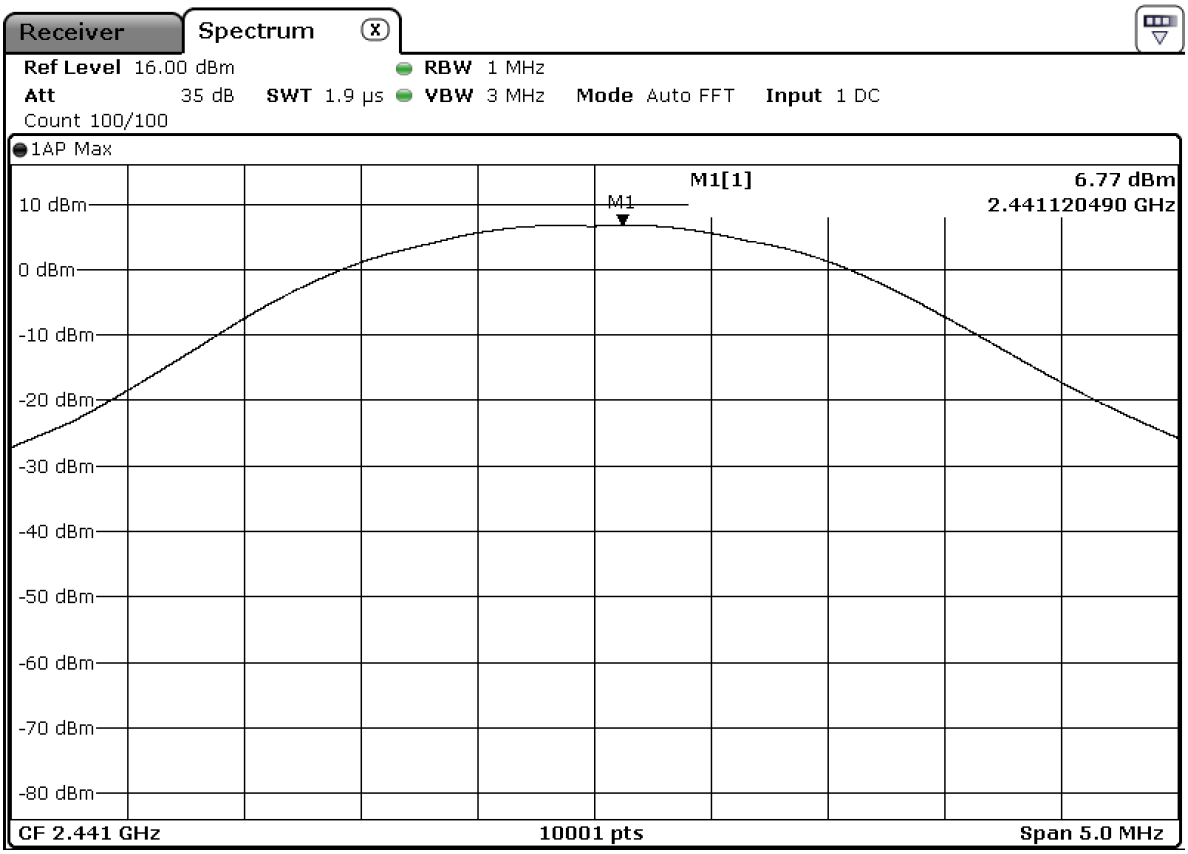
Conducted Peak Power Ch.78 /2480 MHz -GFSK (DH5)



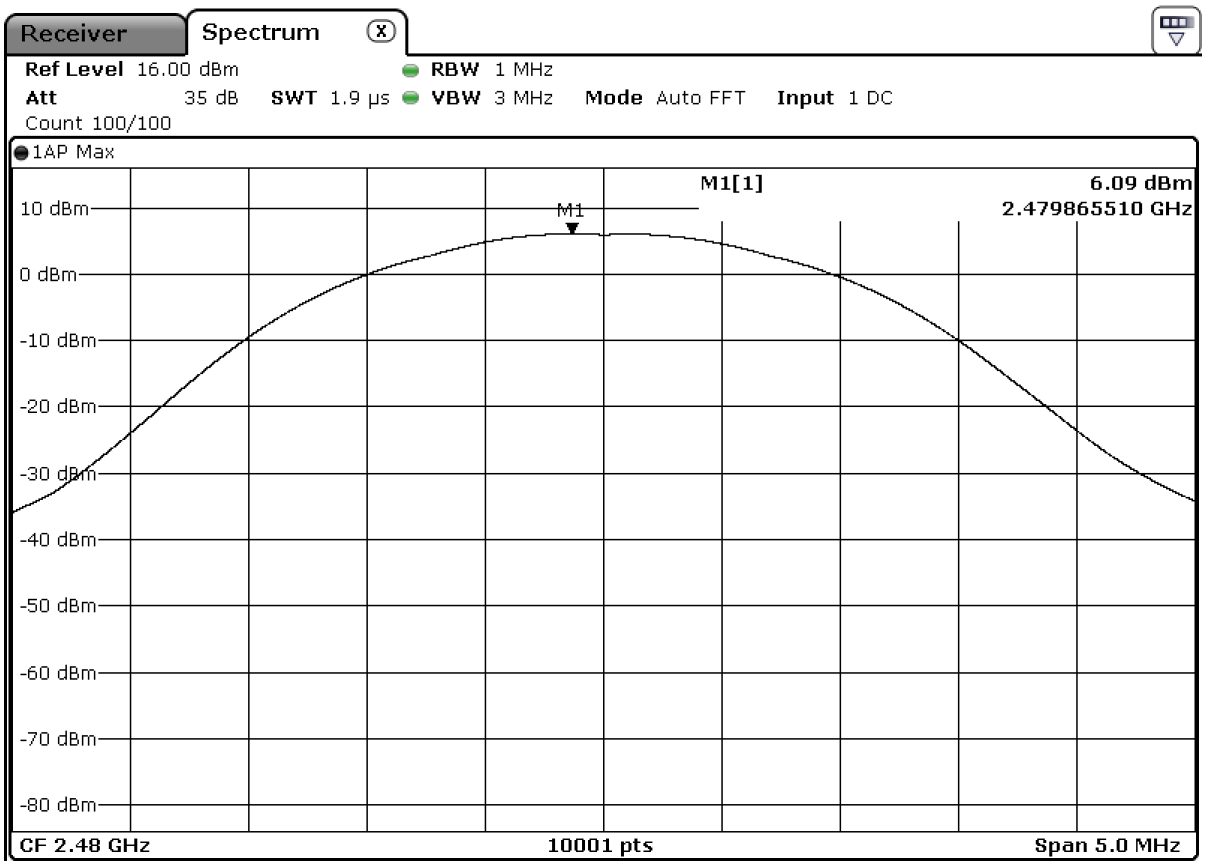
Conducted Peak Power Ch. 0 /2402 MHz -π / 4 DPSK (2-DH5)



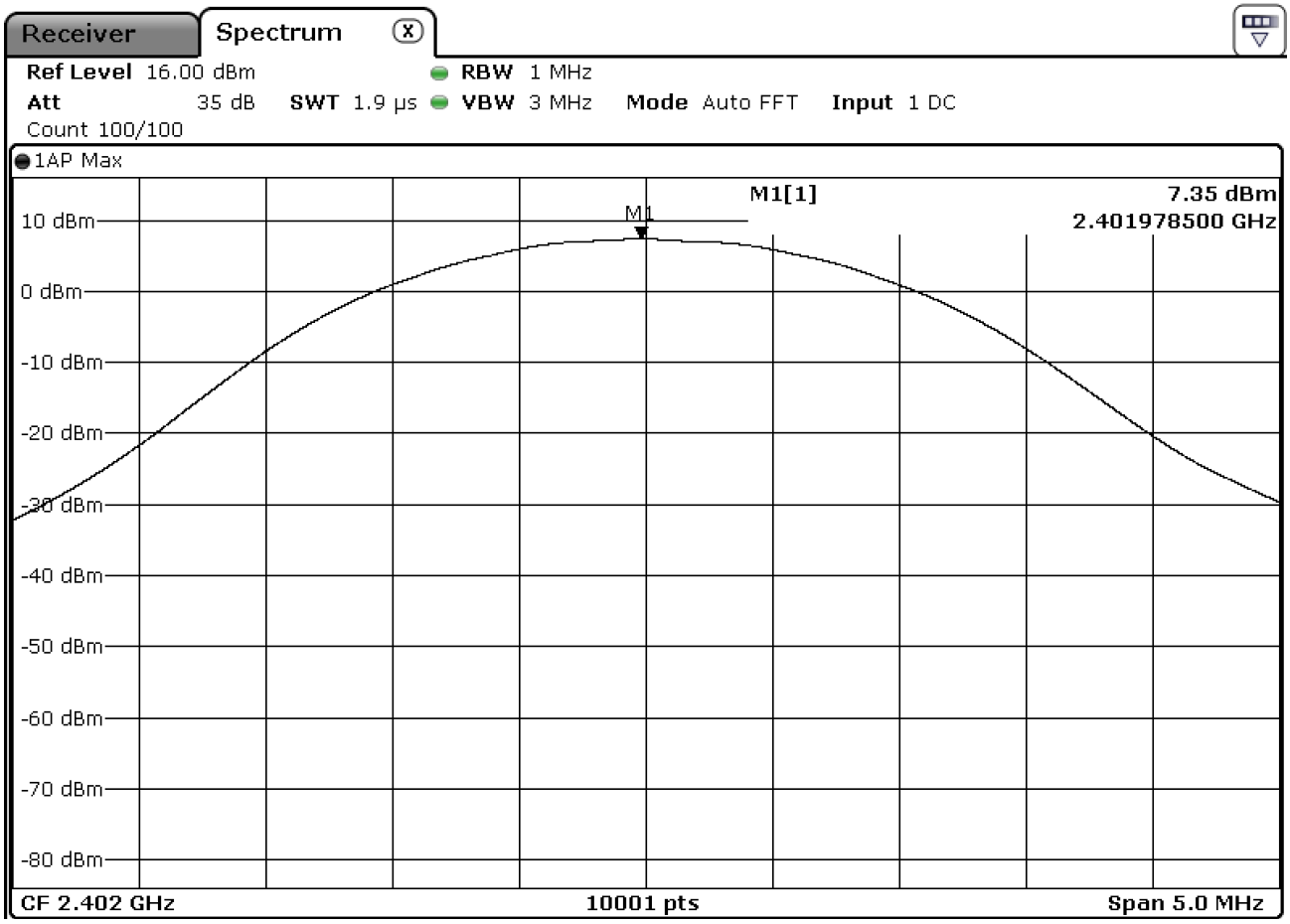
Conducted Peak Power Ch. 39 /2441 GHz -π / 4 DPSK (2-DH5)



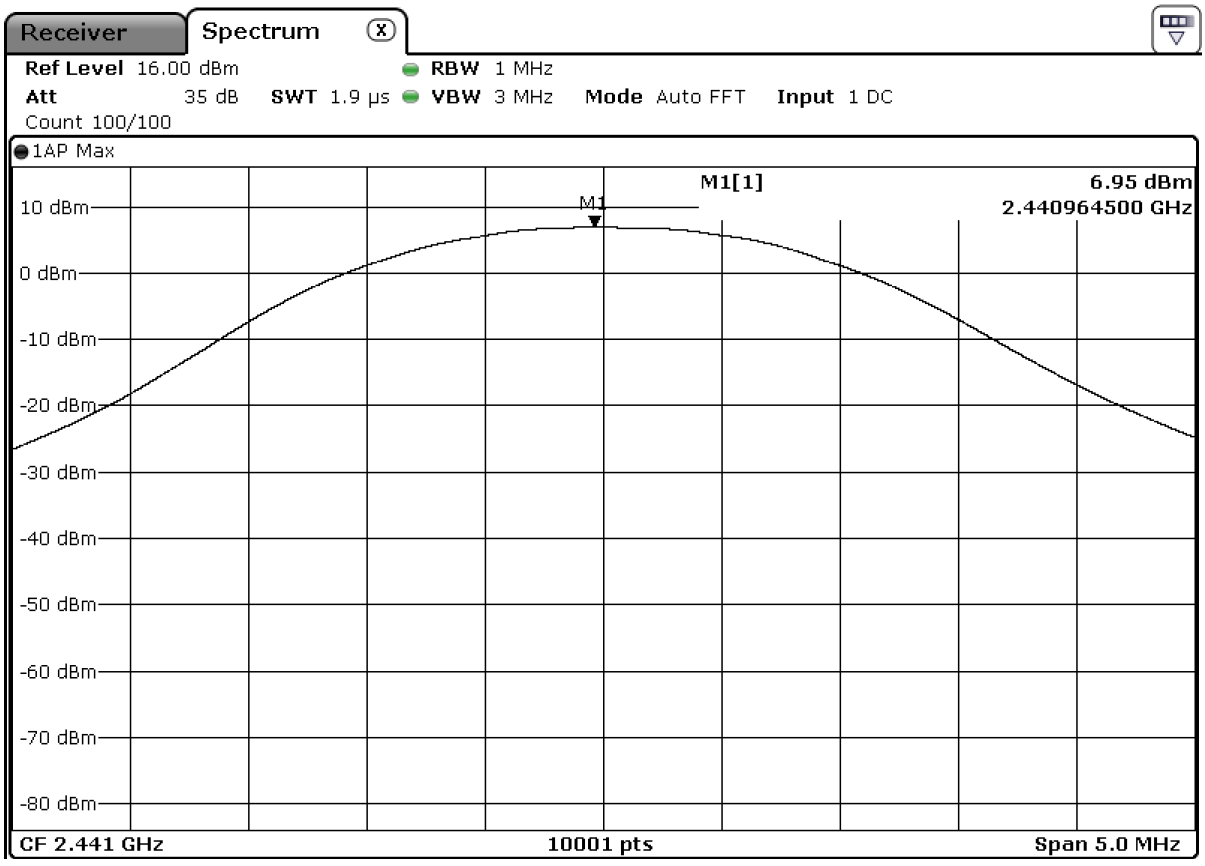
Conducted Peak Power Ch.78 /2480 MHz -π / 4 DPSK (2-DH5)



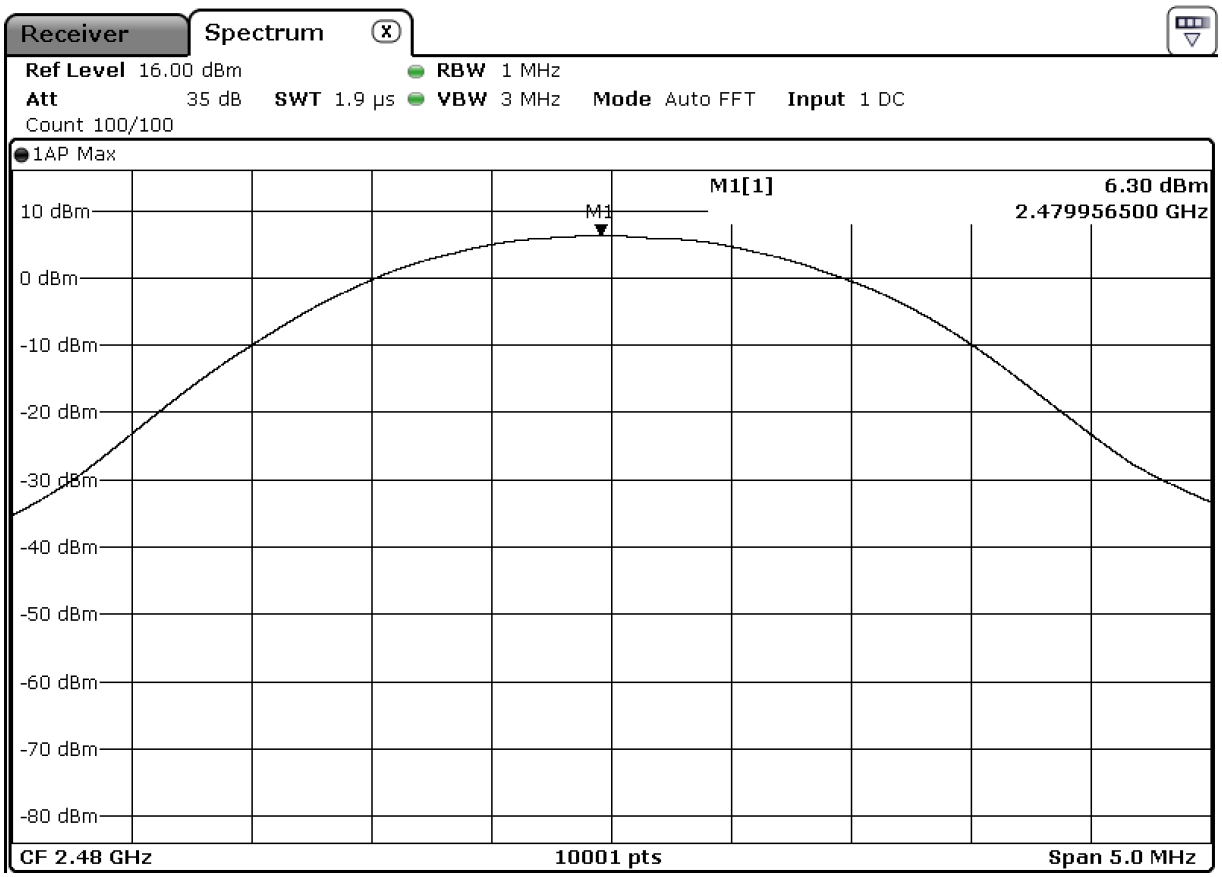
Conducted Peak Power Ch. 0 /2402 MHz -8DPSK (3-DH5)



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



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



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

8.1 Limits:

§15.247/15.205 & RSS-210 A8.5/RSS-GEN 8.9/8.10

(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			

*PEAK LIMIT= 74dBµV/m (-21.2 dBm)
*AVG. LIMIT= 54dBµV/m (-41.2 dBm)

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.

8.2 Test Procedure

8.2.1 For non-restricted bands from DA 00-705:2000

Band-edge Compliance of RF Conducted Emissions

Use the following spectrum analyzer settings:

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 = auto
Detector function = 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. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section. Submit this plot.

Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit. Submit this plot.

8.2.2 For restricted bands according to 15.35:

RBW = 1MHz (no relaxation because high channel more than 2MHz from limit line)
VBW > 3xRBW
Detector = Peak/Average

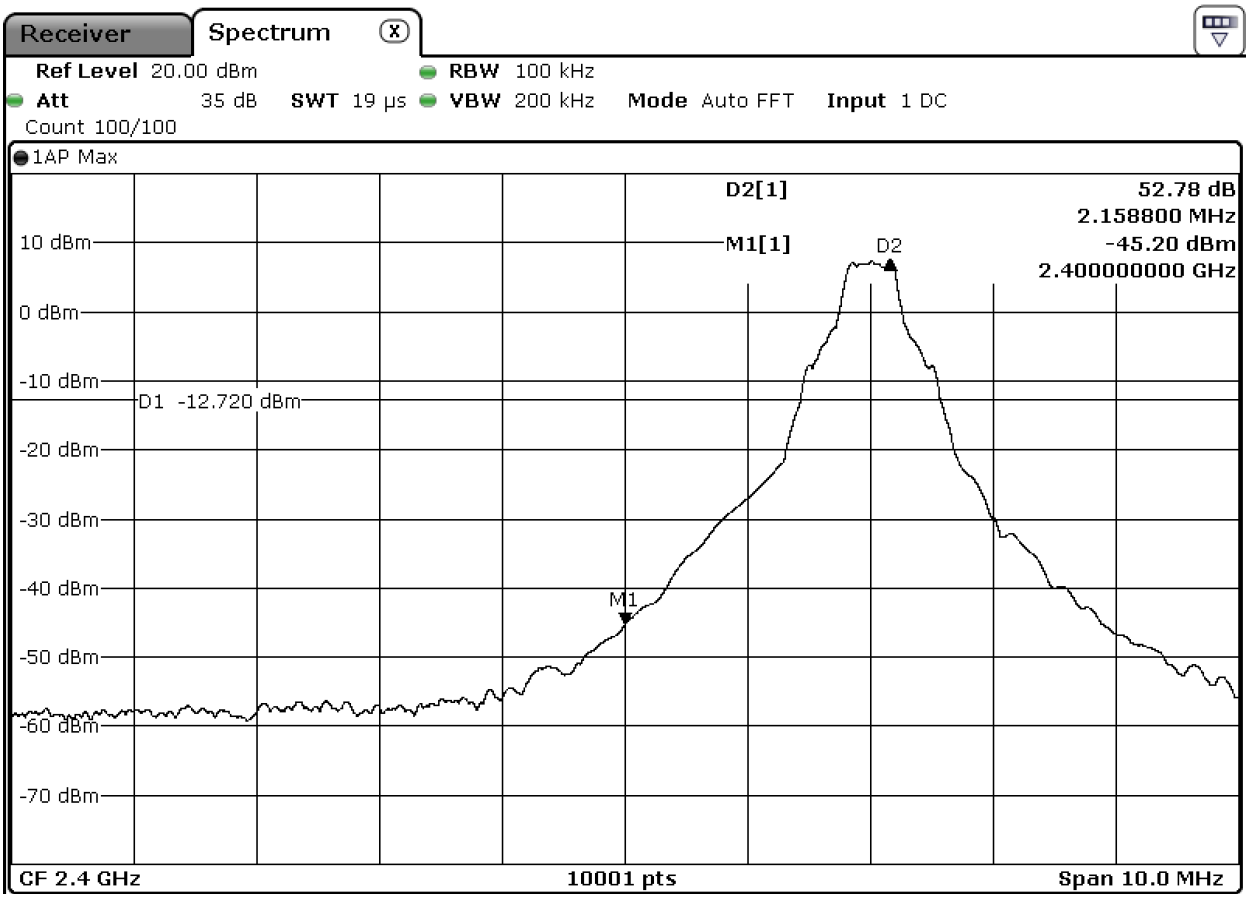
8.3 Measurement Result

Pass.

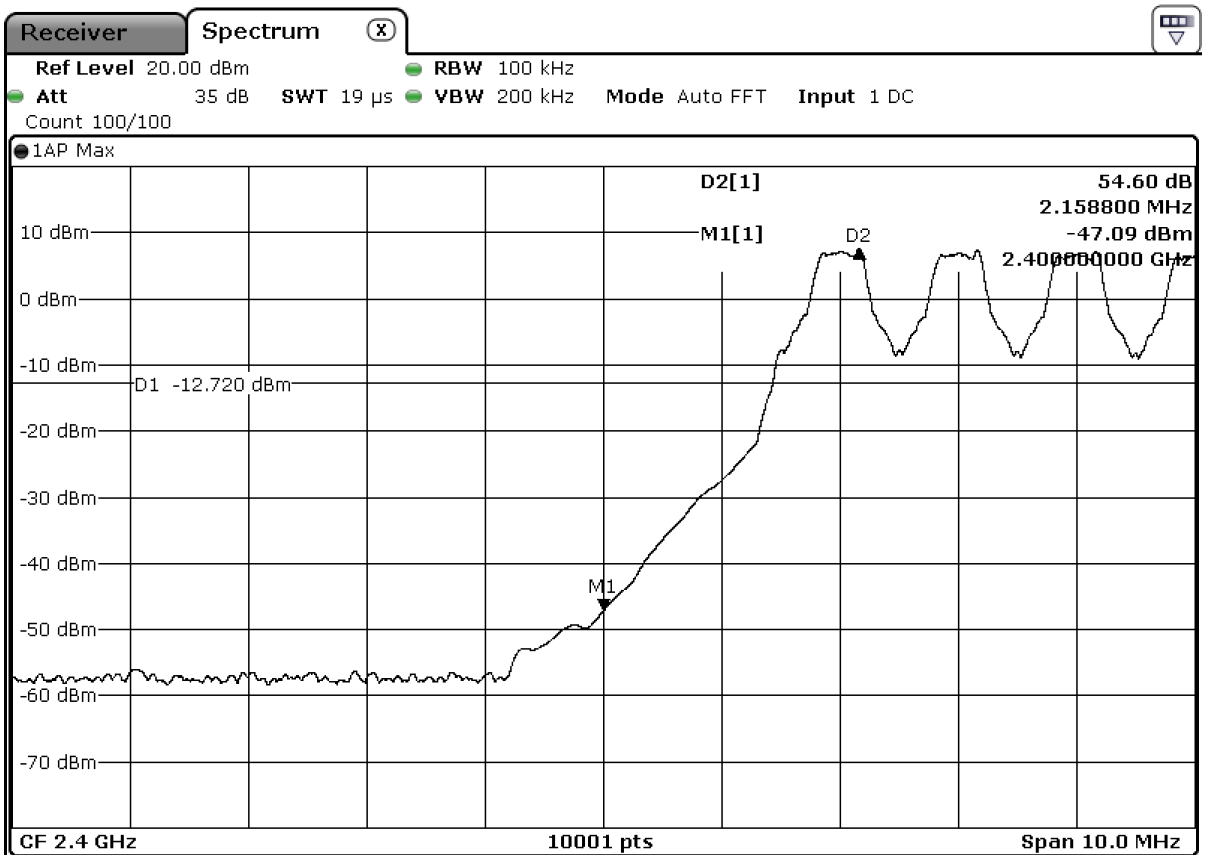
8.4 Test Data/plots:

8.4.1 Lower Band edge non restricted

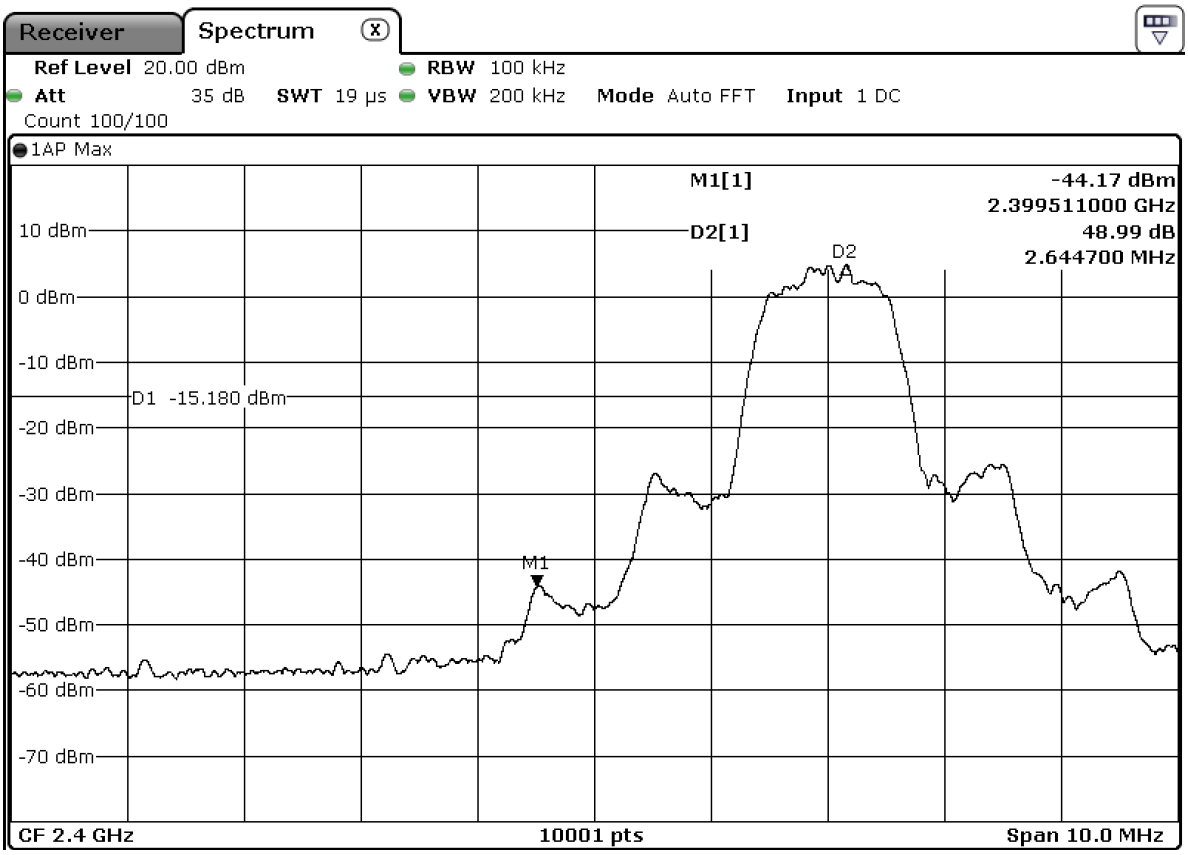
Lower band edge peak -GFSK modulation (Hopping Disable)



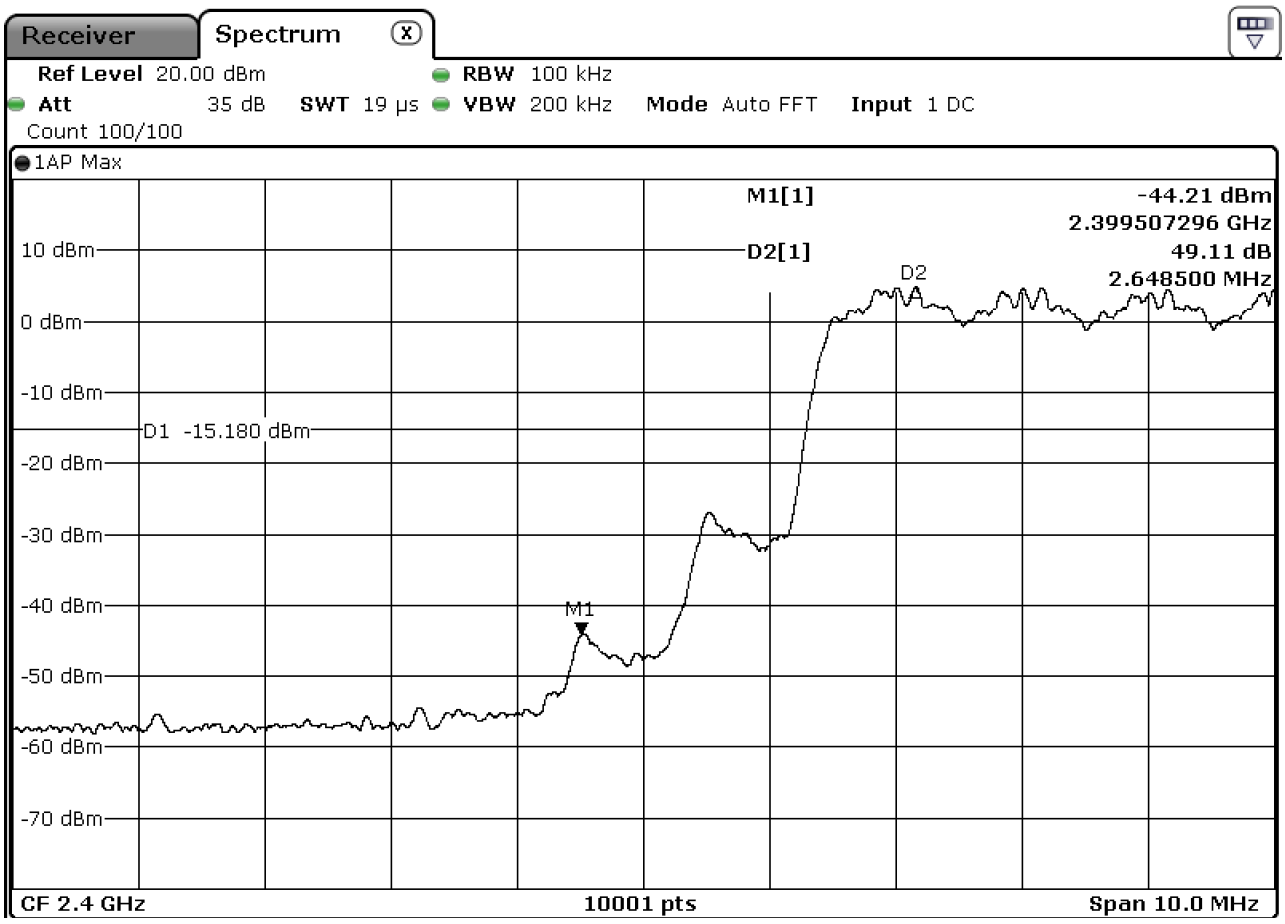
Lower band edge peak -GFSK modulation (Hopping Enable)



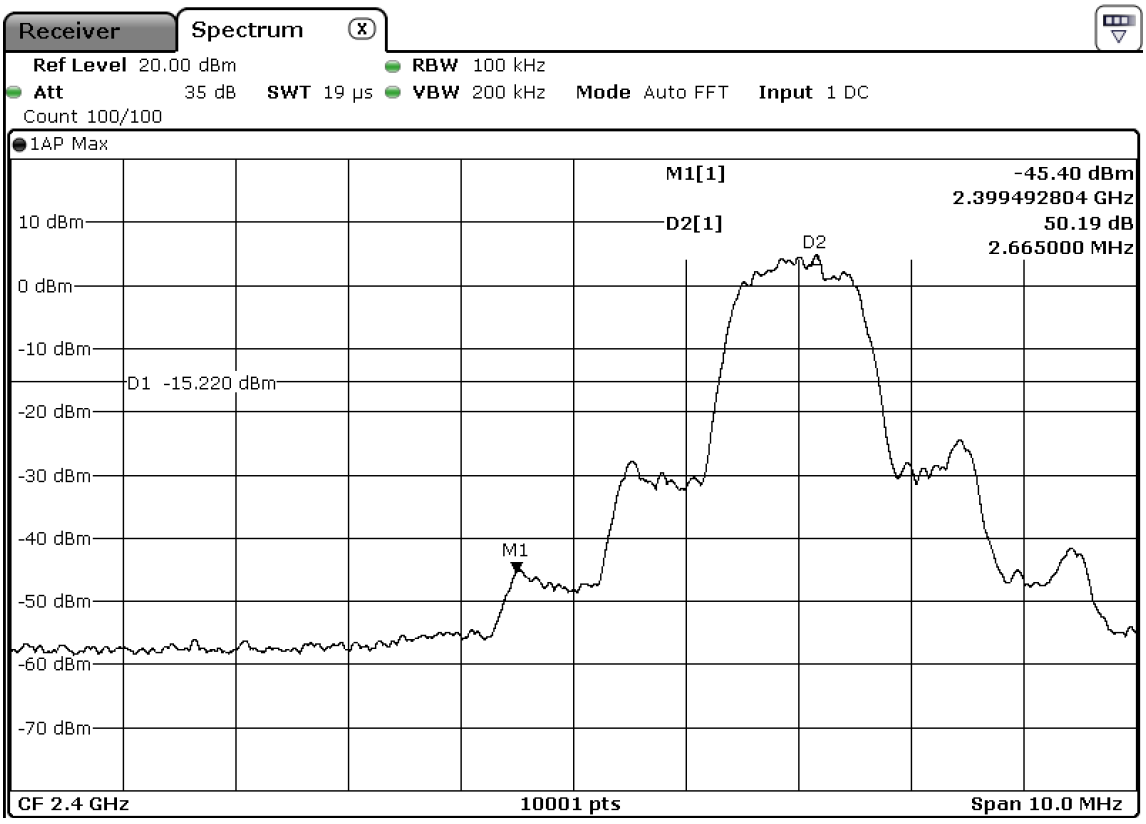
Lower band edge peak - π/4 DPSK modulation (Hopping Disable)



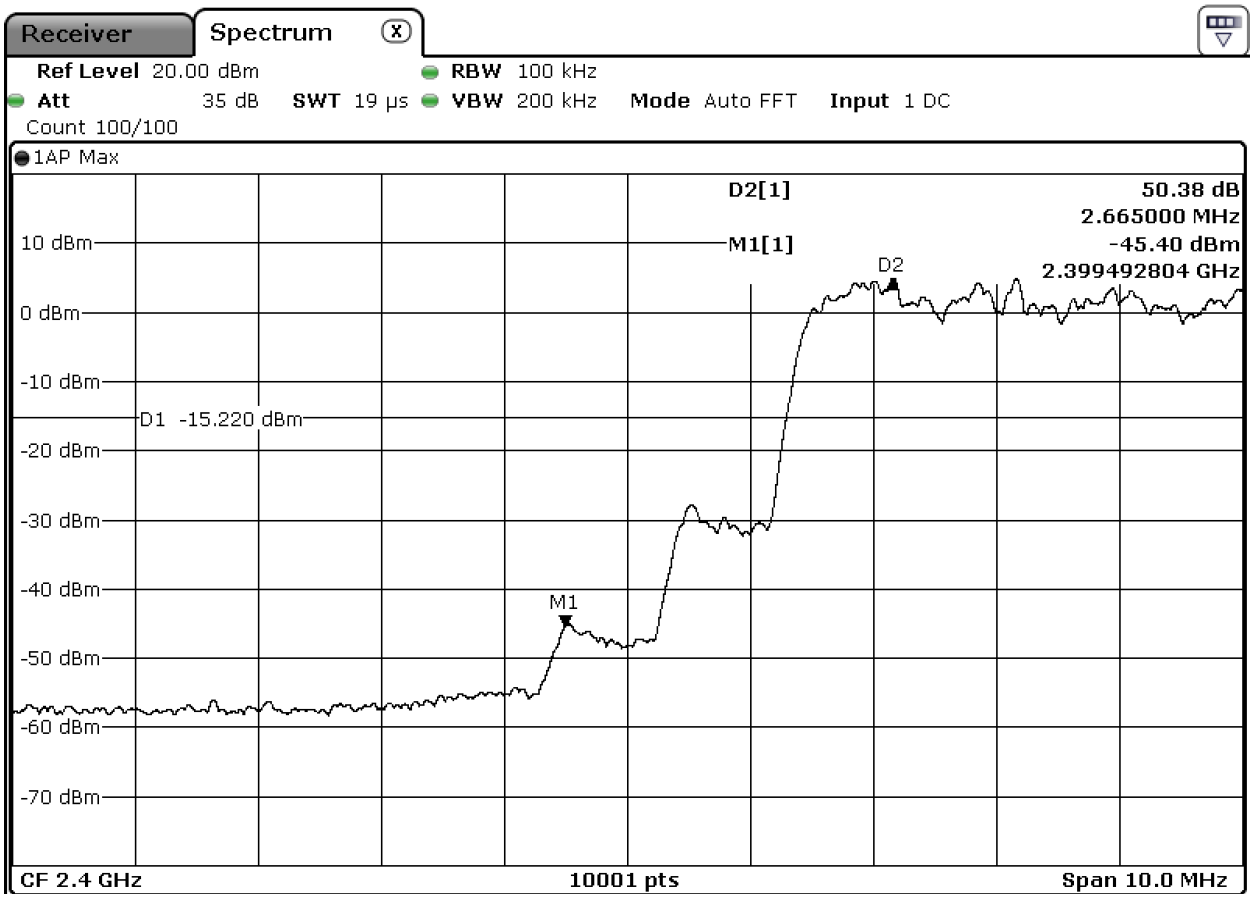
Lower band edge peak - π/4 DPSK modulation (Hopping Enable)



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

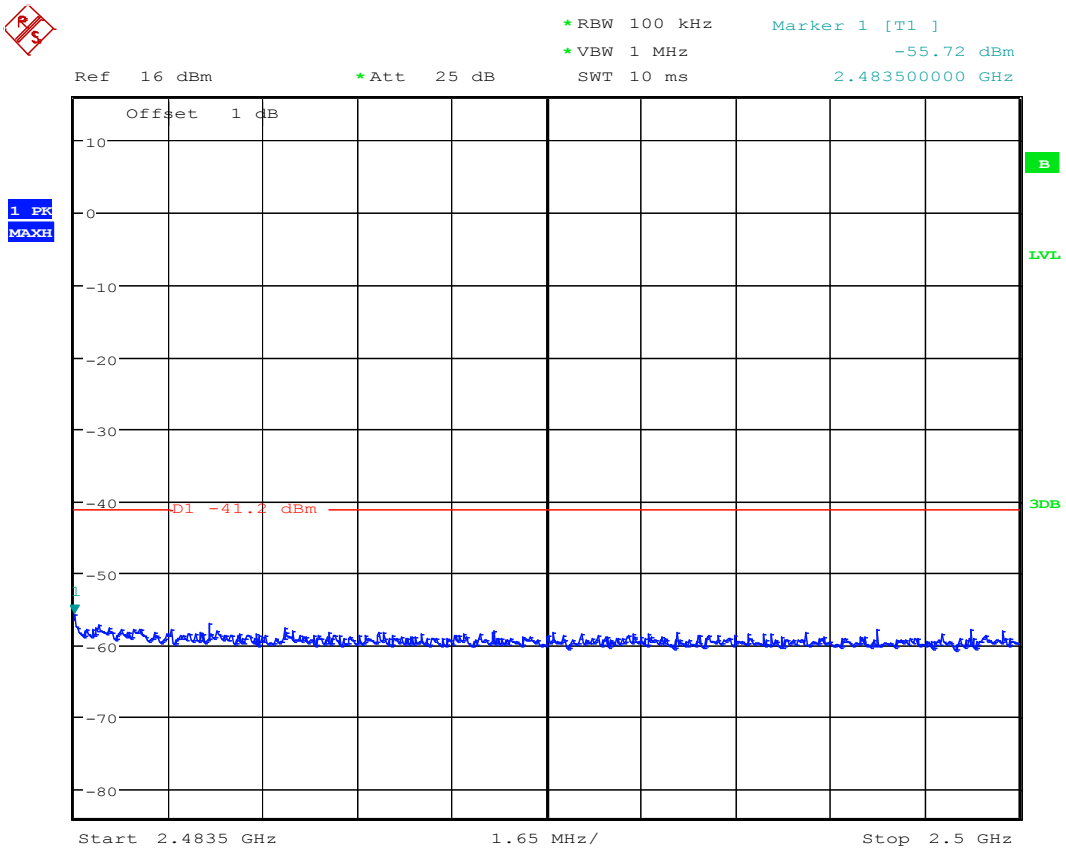


Lower band edge peak - 8DPSK modulation (Hopping Enable)



8.4.2 Upper Band edge restricted

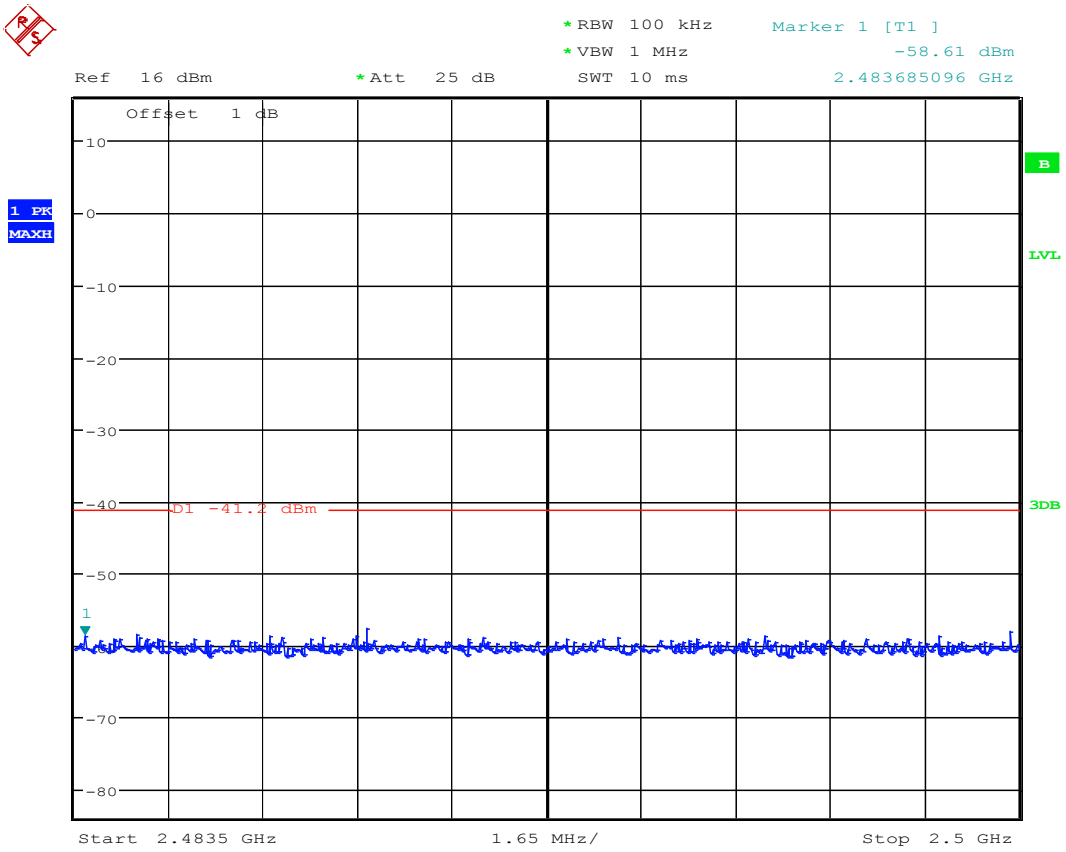
Channel 19 Restricted band peak -8-DPSK modulation -3DH5 (Hopping Disabled)



Date: 14.OCT.2014 16:26:05

Note:
The above plot passes peak measurement against the average limit (-41.2dBm). Thus average measurement is not performed.
In order to correct the limit to the specified RBW of 1MHz 10dB = 10 x log10(1000kHz/100kHz) must be subtracted. According to the DTS KDB another 2dB must be subtracted to account for a minimum gain of 2dBi. This results in a limit line at -53.2dBm.

Chennel 79 Restricted band peak -8-DPSK modulation -3DH5 (Hopping Enable)



Date: 14.OCT.2014 16:32:53

Note:
The above plot passes peak measurement against the average limit (-41.2dBm). Thus average measurement is not performed.
In order to correct the limit to the specified RBW of 1MHz 10dB = 10 x log10(1000kHz/100kHz) must be subtracted. According to the DTS KDB another 2dB must be subtracted to account for a minimum gain of 2dBi. This results in a limit line at -53.2dBm.

9 20dB Bandwidth / 99% Bandwidth

9.1 Limits:

§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.

9.2 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 DPSK	2-DH5
8 DPSK	3-DH5

9.3 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

9.4 Test Data:

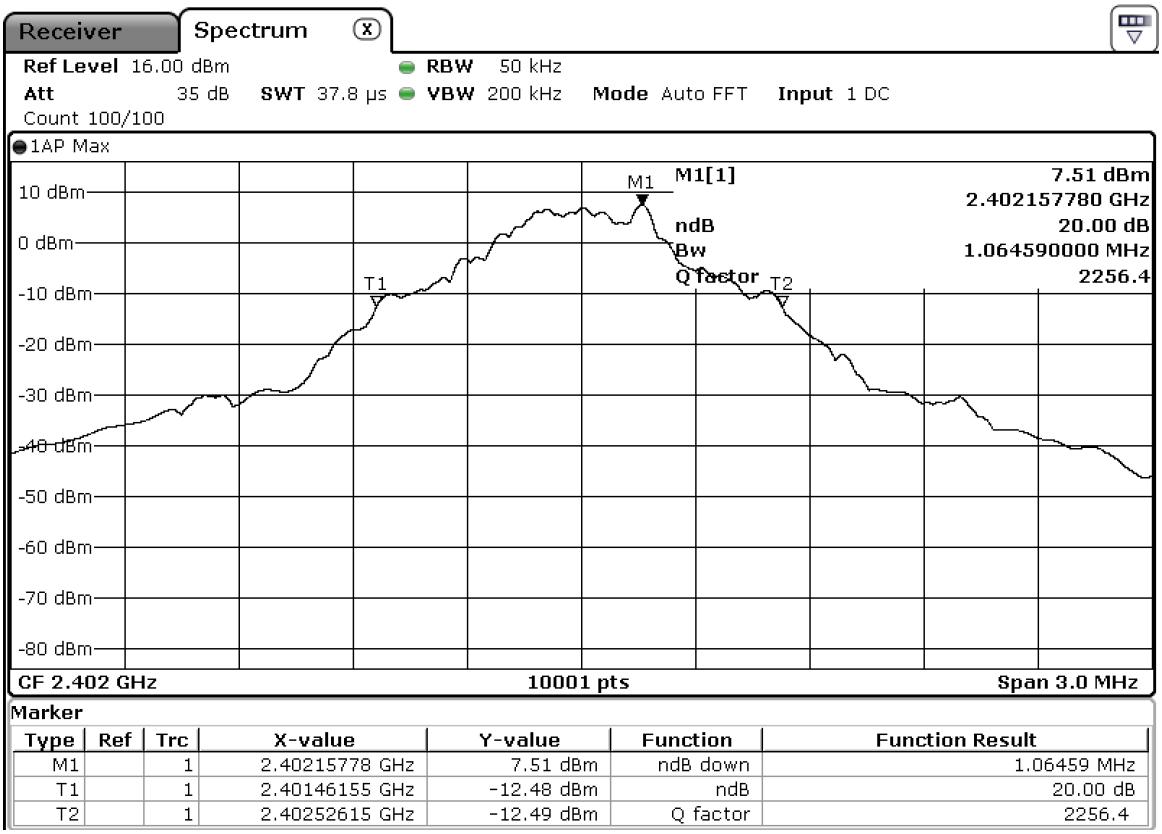
20dB Bandwidth						
Modulation (Packet Type)	**Frequency (MHz)**					
	2402	**Diagram no.**	**2441**	**Diagram no.**	**2480**	**Diagram no.**
GFSK (DH5)	1.0646	BW_2402_dh5	1.0634	BW_2441_dh5	1.634	BW_2480_dh5
π/4 DPSK (2-DH5)	1.3571	BW_2402_2dh5	1.3610	BW_2441_2dh5	1.3553	BW_2480_2dh5
8-DPSK (3-DH5)	1.3355	BW_2402_3dh5	1.3403	BW_2441_3dh5	1.3325	BW_2480_3dh5
Measurement Uncertainty: ±10 kHz						

9.5 Measurement Result

Pass.

9.6 Test Data/plots:

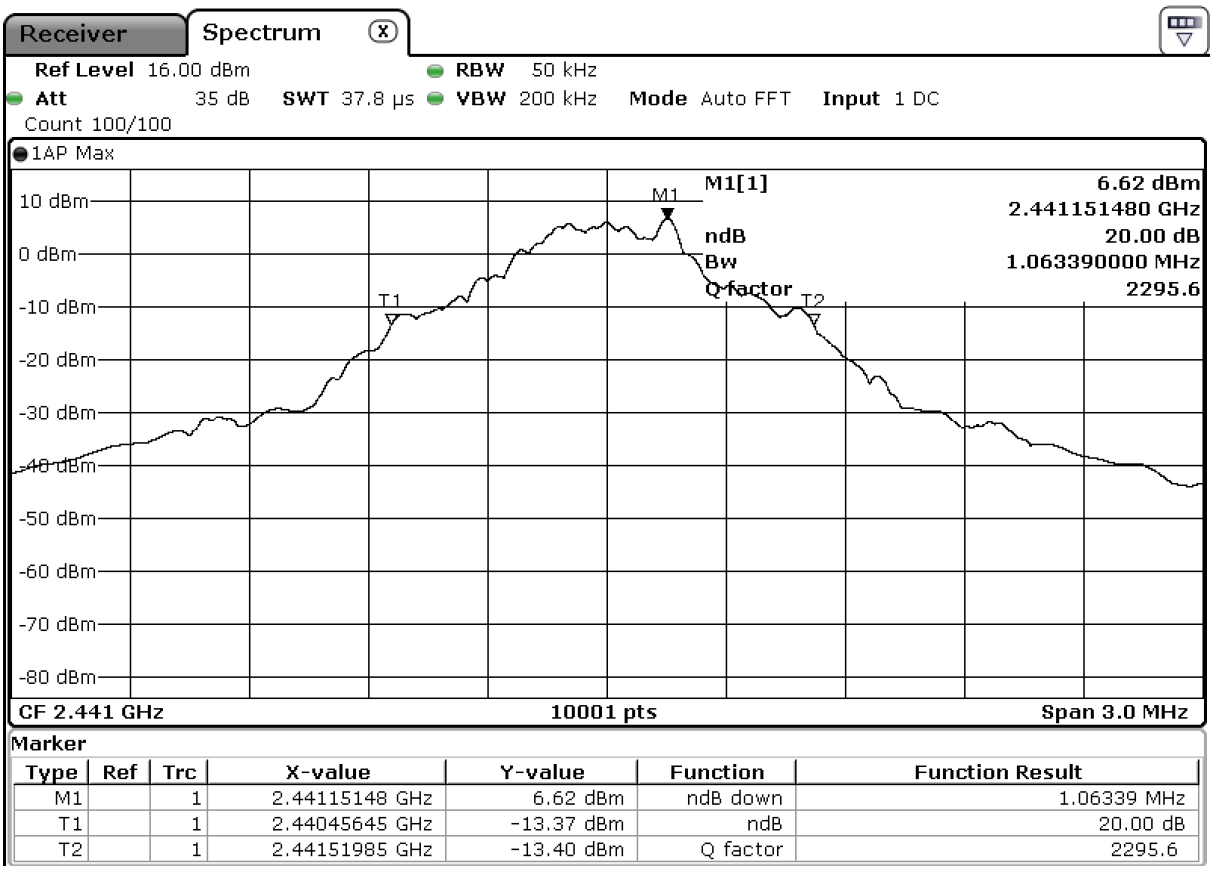
20dB Bandwidth GFSK 2402MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40215778 GHz	7.51 dBm	ndB down	1.06459 MHz
T1		1	2.40146155 GHz	-12.48 dBm	ndB	20.00 dB
T2		1	2.40252615 GHz	-12.49 dBm	Q factor	2256.4

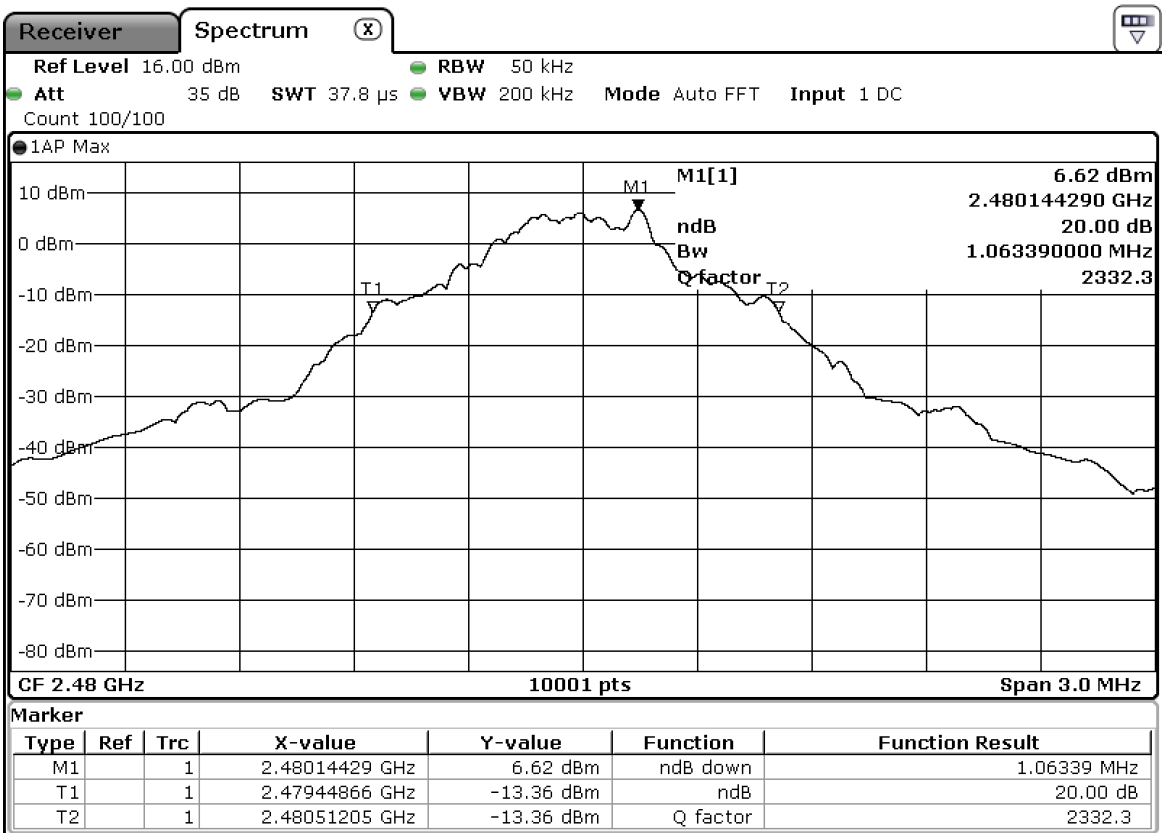
20dB Bandwidth GFSK 2441MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.44115148 GHz	6.62 dBm	ndB down	1.06339 MHz
T1		1	2.44045645 GHz	-13.37 dBm	ndB	20.00 dB
T2		1	2.44151985 GHz	-13.40 dBm	Q factor	2295.6

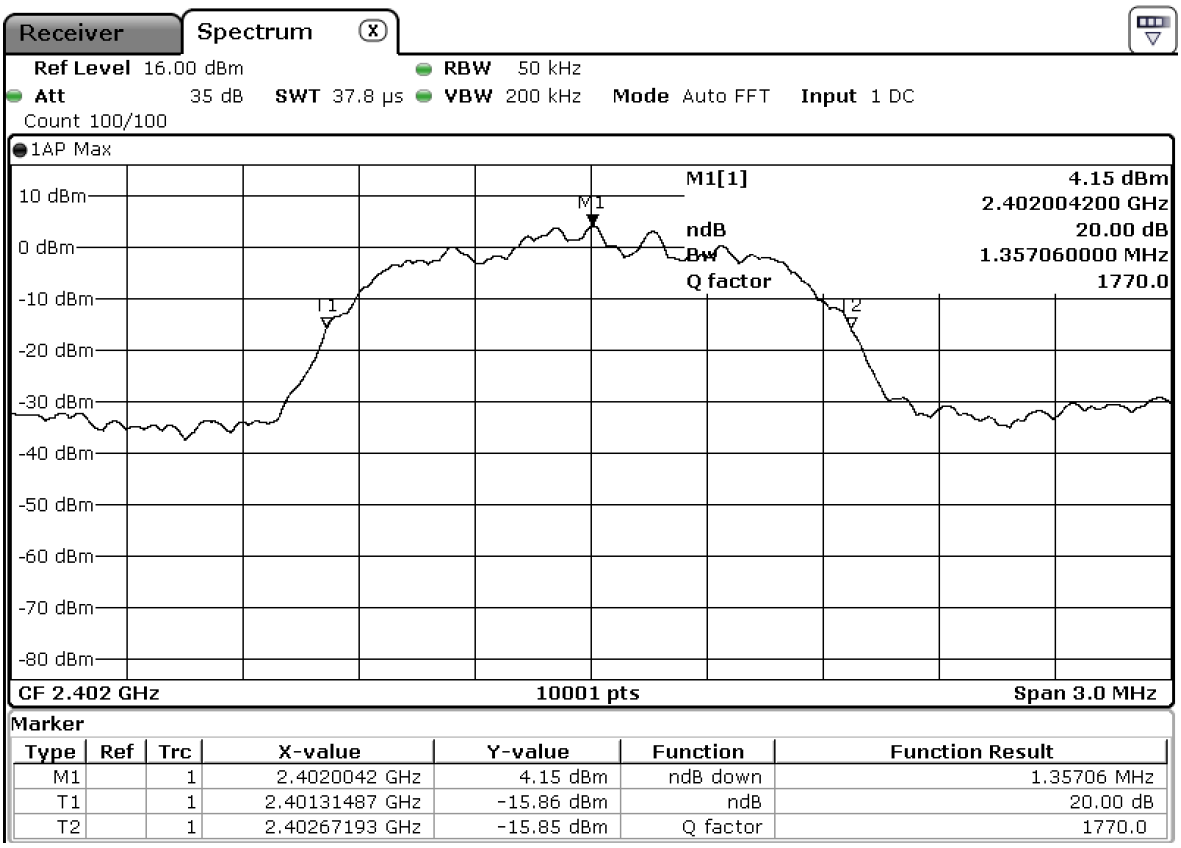
20dB Bandwidth GFSK 2480MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48014429 GHz	6.62 dBm	ndB down	1.06339 MHz
T1		1	2.47944866 GHz	-13.36 dBm	ndB	20.00 dB
T2		1	2.48051205 GHz	-13.36 dBm	Q factor	2332.3

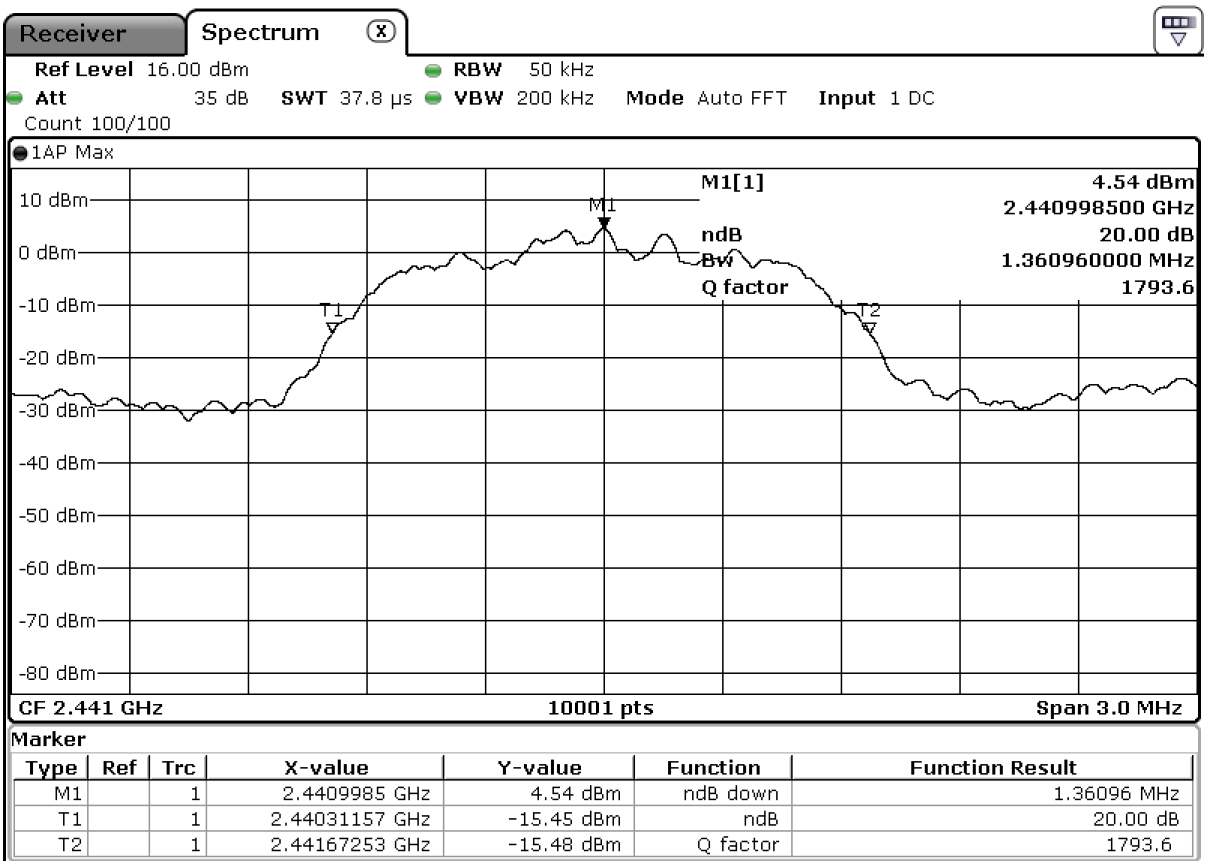
20dB Bandwidth π / 4 DPSK 2402MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4020042 GHz	4.15 dBm	ndB down	1.35706 MHz
T1		1	2.40131487 GHz	-15.86 dBm	ndB	20.00 dB
T2		1	2.40267193 GHz	-15.85 dBm	Q factor	1770.0

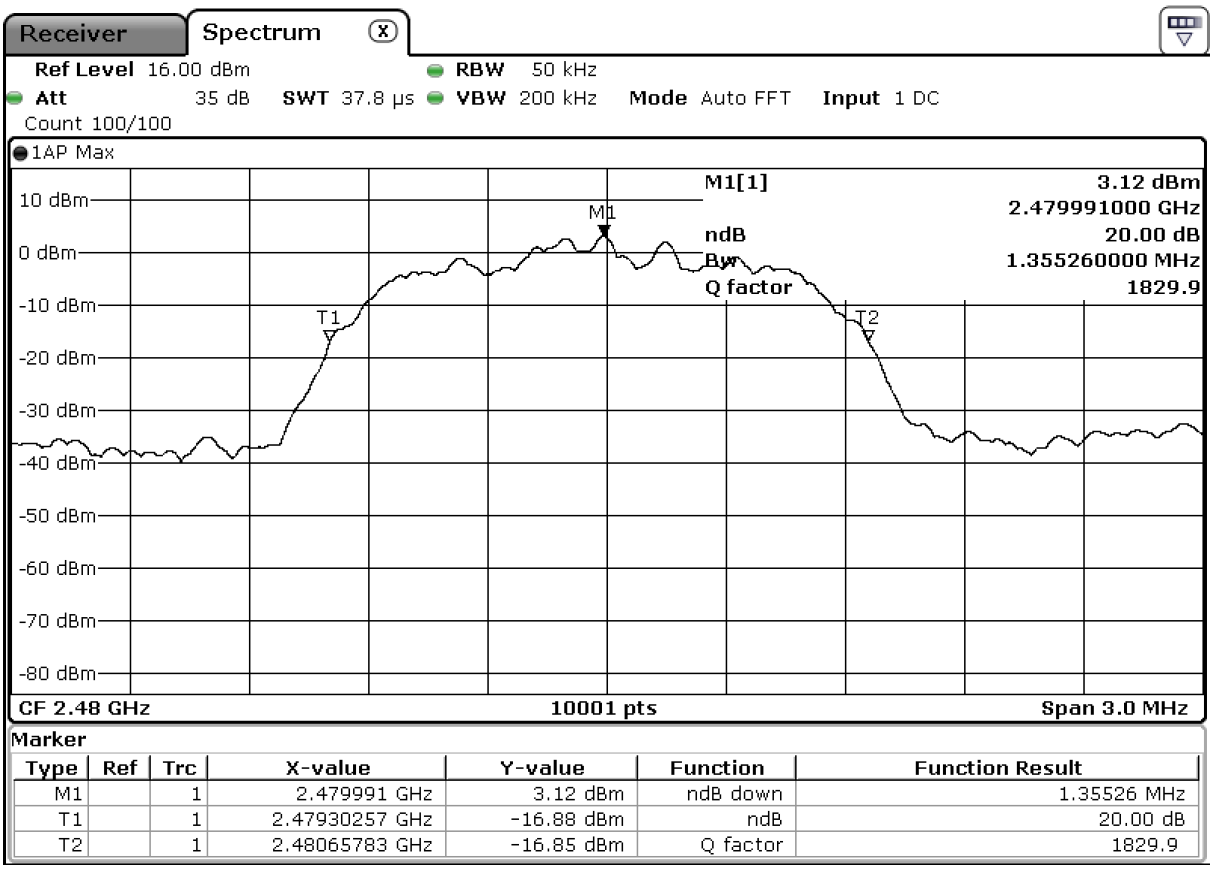
20dB Bandwidth π / 4 DPSK 2441MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4409985 GHz	4.54 dBm	ndB down	1.36096 MHz
T1		1	2.44031157 GHz	-15.45 dBm	ndB	20.00 dB
T2		1	2.44167253 GHz	-15.48 dBm	Q factor	1793.6

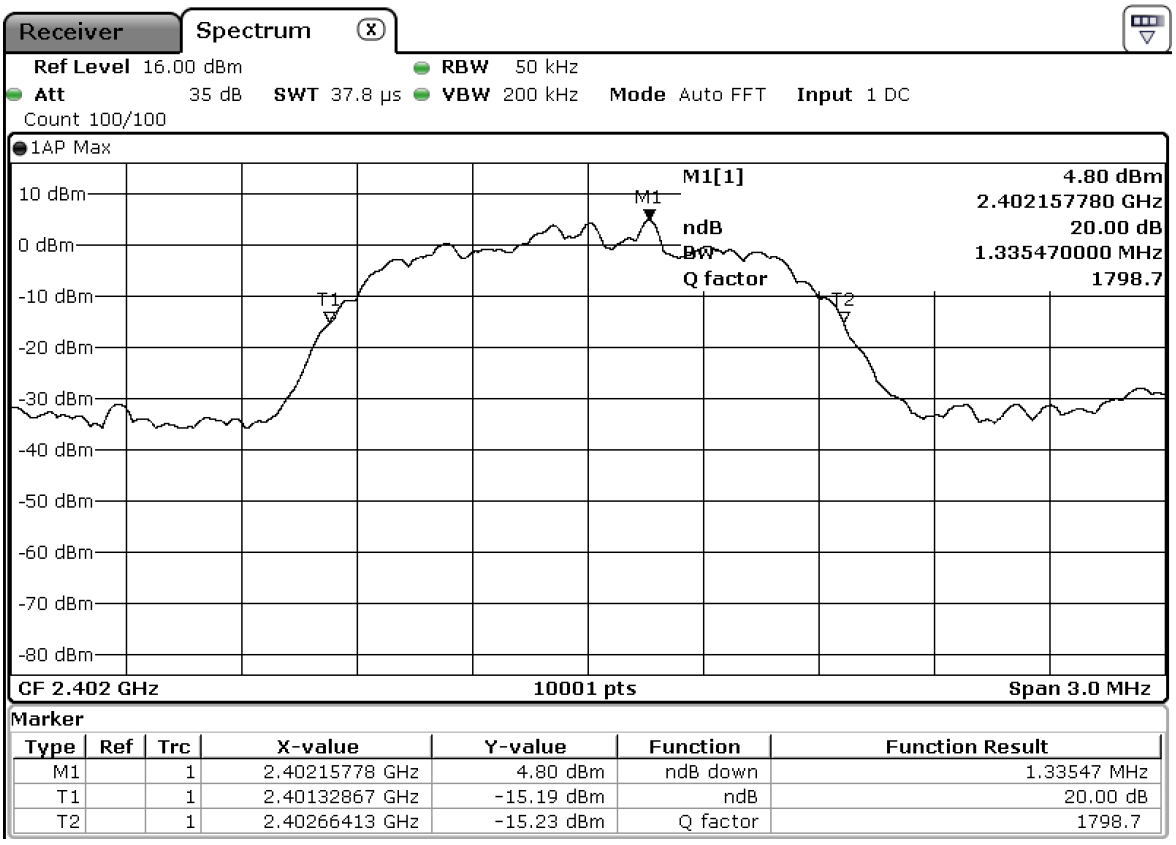
20dB Bandwidth π / 4 DPSK 2480MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.479991 GHz	3.12 dBm	ndB down	1.35526 MHz
T1		1	2.47930257 GHz	-16.88 dBm	ndB	20.00 dB
T2		1	2.48065783 GHz	-16.85 dBm	Q factor	1829.9

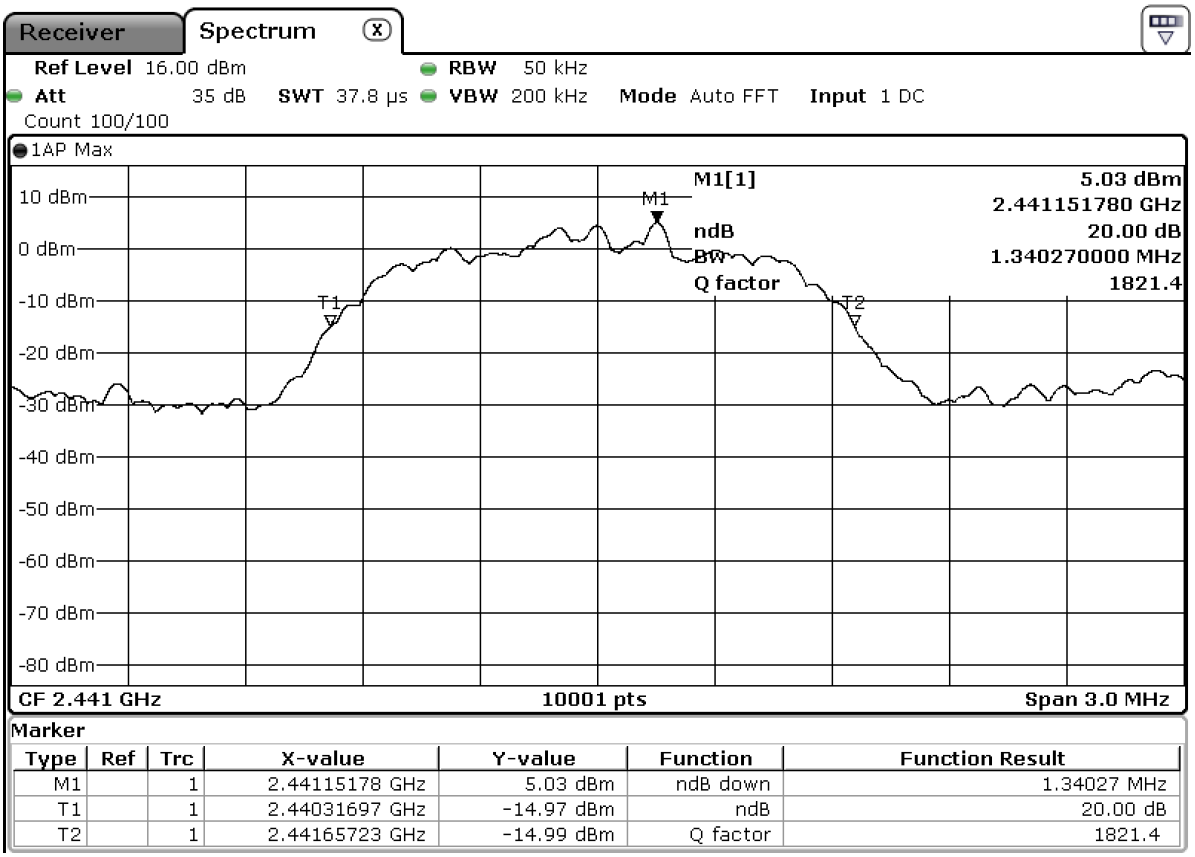
20dB Bandwidth 8PSK 2402MHz



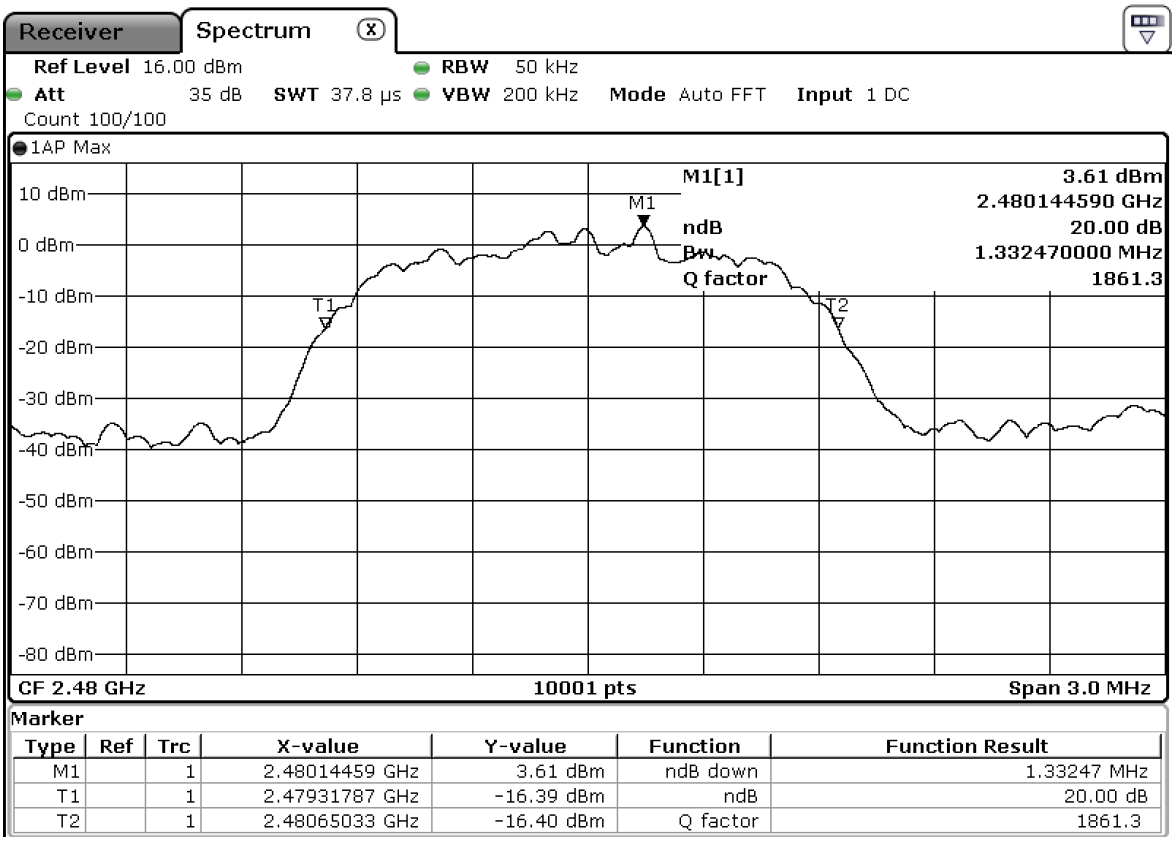
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40215778 GHz	4.80 dBm	ndB down	1.33547 MHz
T1		1	2.40132867 GHz	-15.19 dBm	ndB	20.00 dB
T2		1	2.40266413 GHz	-15.23 dBm	Q factor	1798.7

20dB Bandwidth 8PSK 2441MHz



20dB Bandwidth 8PSK 2480MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48014459 GHz	3.61 dBm	ndB down	1.33247 MHz
T1		1	2.47931787 GHz	-16.39 dBm	ndB	20.00 dB
T2		1	2.48065033 GHz	-16.40 dBm	Q factor	1861.3

10 Carrier Frequency Separation

10.1 Limits:

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

10.2 Test Conditions:

Tnom: 22°C; Vnom: 3.8 V
Hopping ON

10.3 Test Procedure:

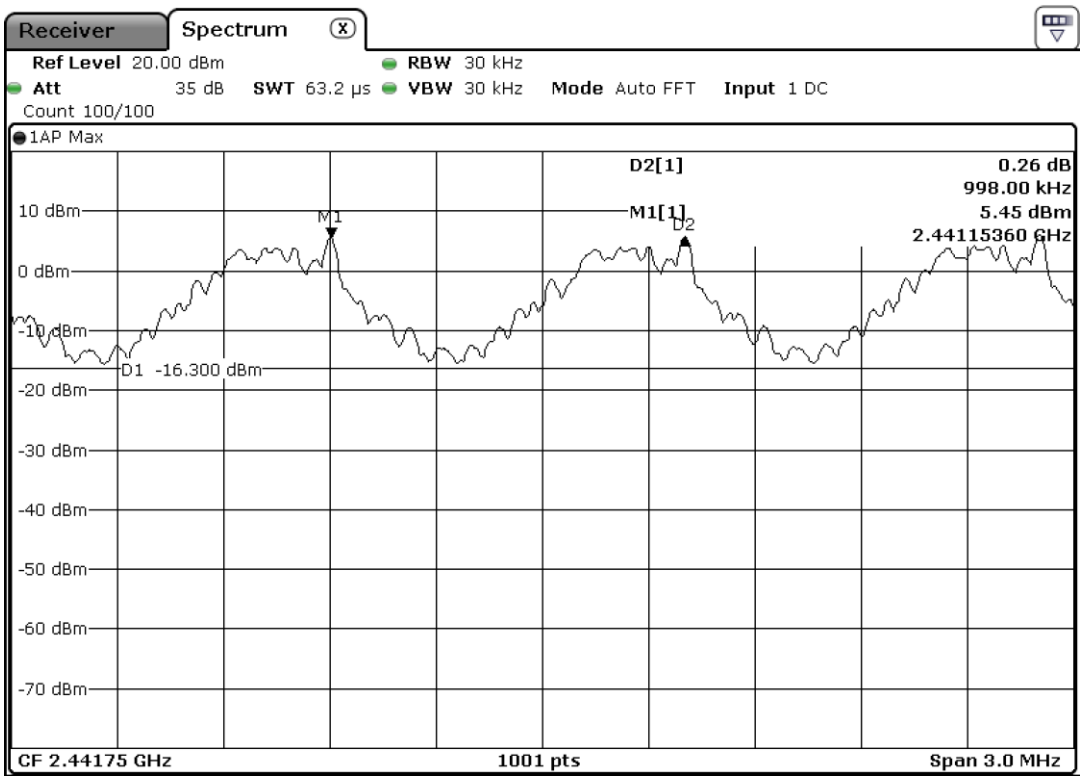
Measurement according to DA 00-705:2000

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.

10.4 Test result:

Channel Separation: 1.009 MHz
Pass

10.5 Test Data/plot:



11 Number of hopping channels

11.1 Limits:

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

11.2 Test Conditions:
Tnom: 22°C; Vnom: 3.8 V

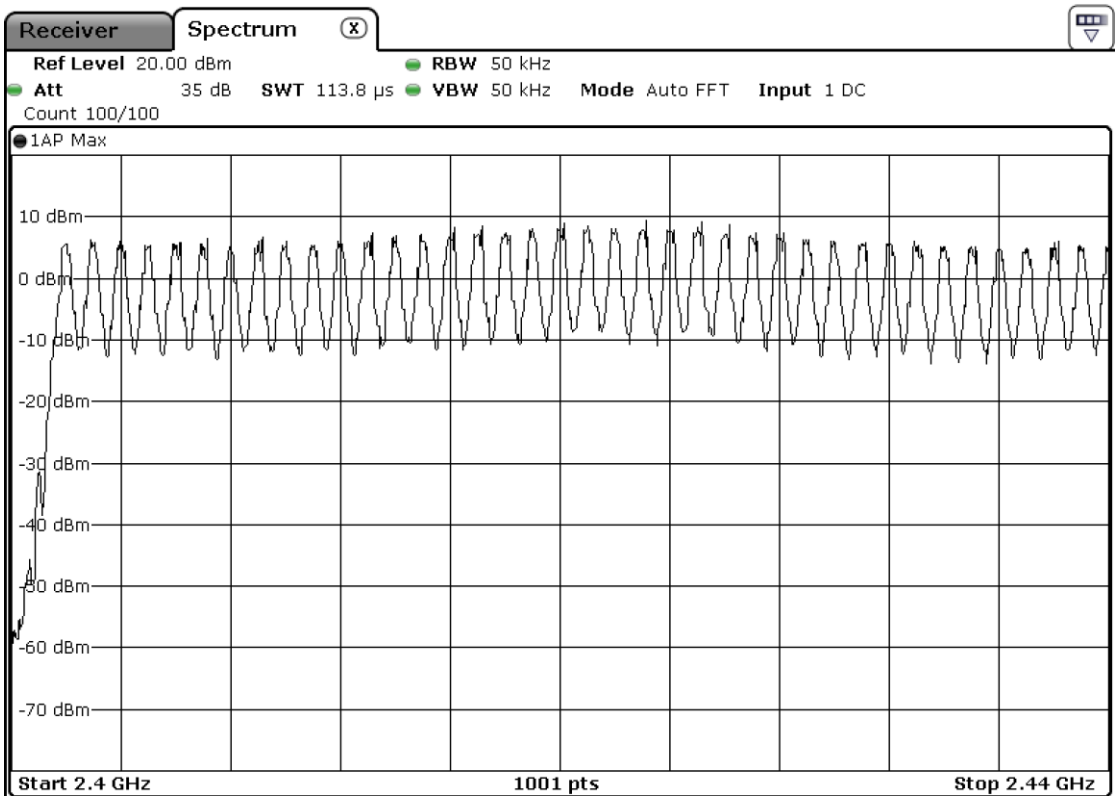
11.3 Test Procedure:
Measurement according to DA 00-705

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.

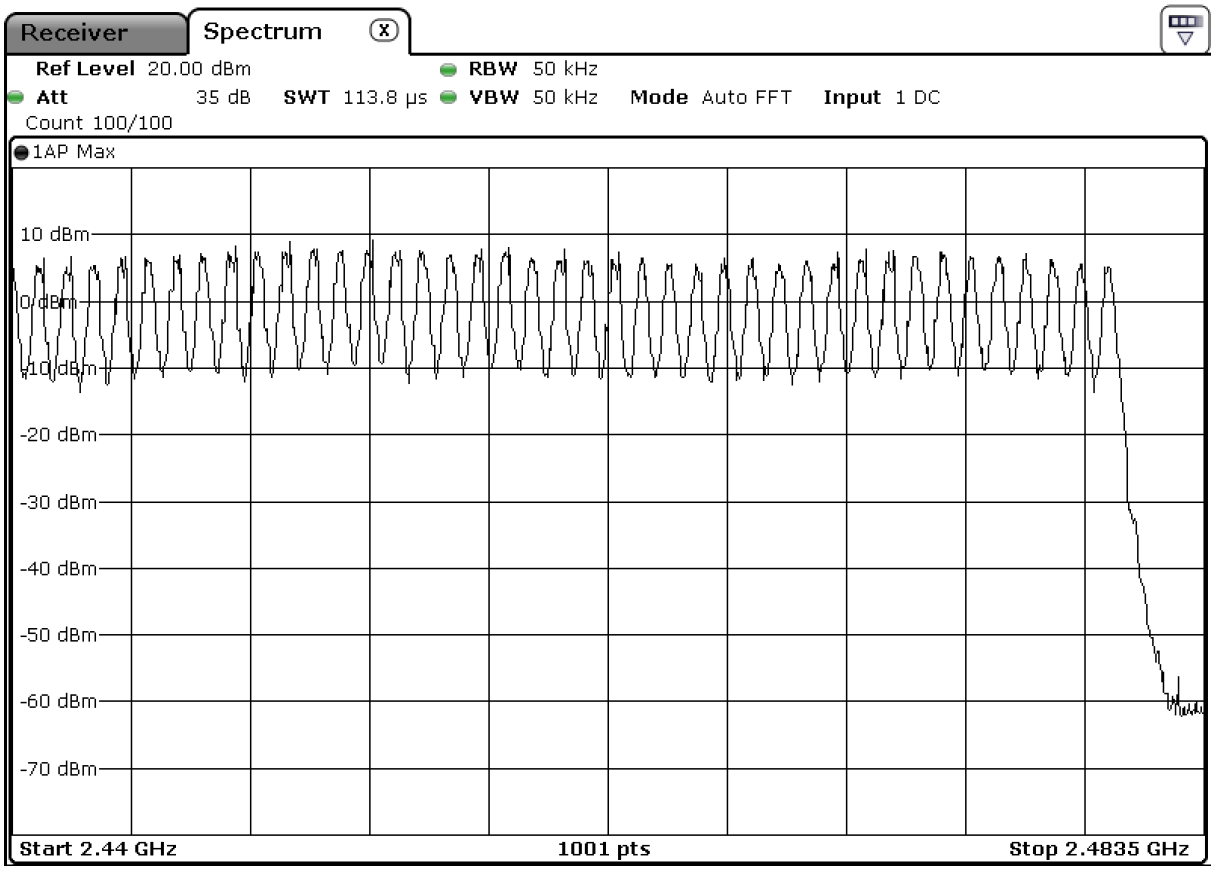
11.4 Test Result:
Number of hopping channels: 79

11.5 Test data/plot:

1st Segment (Total Hopping channels = 38.5)



2nd Segment (Total Hopping channels = 40.5)



12 Time of occupancy (Dwell time)

12.1 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.

12.2 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).

12.3 Test Result

Pass.

13 Transmitter Spurious Emissions & Restricted Bands- Radiated

13.1 Limits:

§15.247/15.205/15.209 & RSS-Gen 8.8/8.10, 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 the limits in dBuV/m are converted according to the following rule:

Below 30MHz:
acc. to FCC §15.31 (f) (2) 40dB/decade. This means that limits are relaxed by 40dB in case the measurement distance is reduced by factor 10.

Above 30MHz:
acc. to FCC §15.31 (f) (1) 20dB/decade. This means that limits are relaxed by 20dB in case the measurement distance is reduced by factor 10.

13.2 Test Conditions

Tnom: 23°C; Vnom: 3.8V

13.3 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)

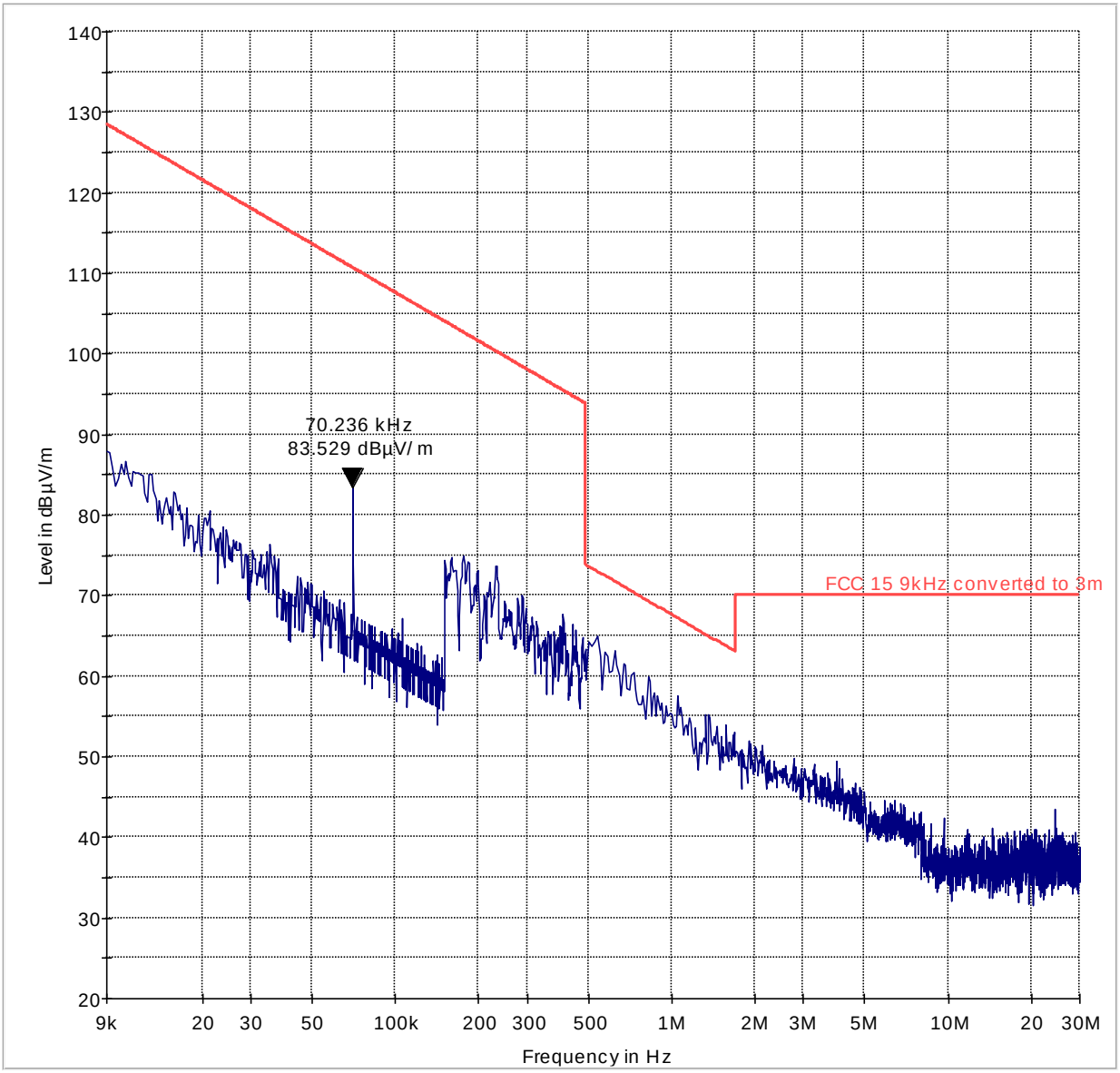
Above 1 GHz
Detector = Peak / Average
RBW= 1MHz

Test mode: *Modulation:* GFSK (DM5) used due to 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.

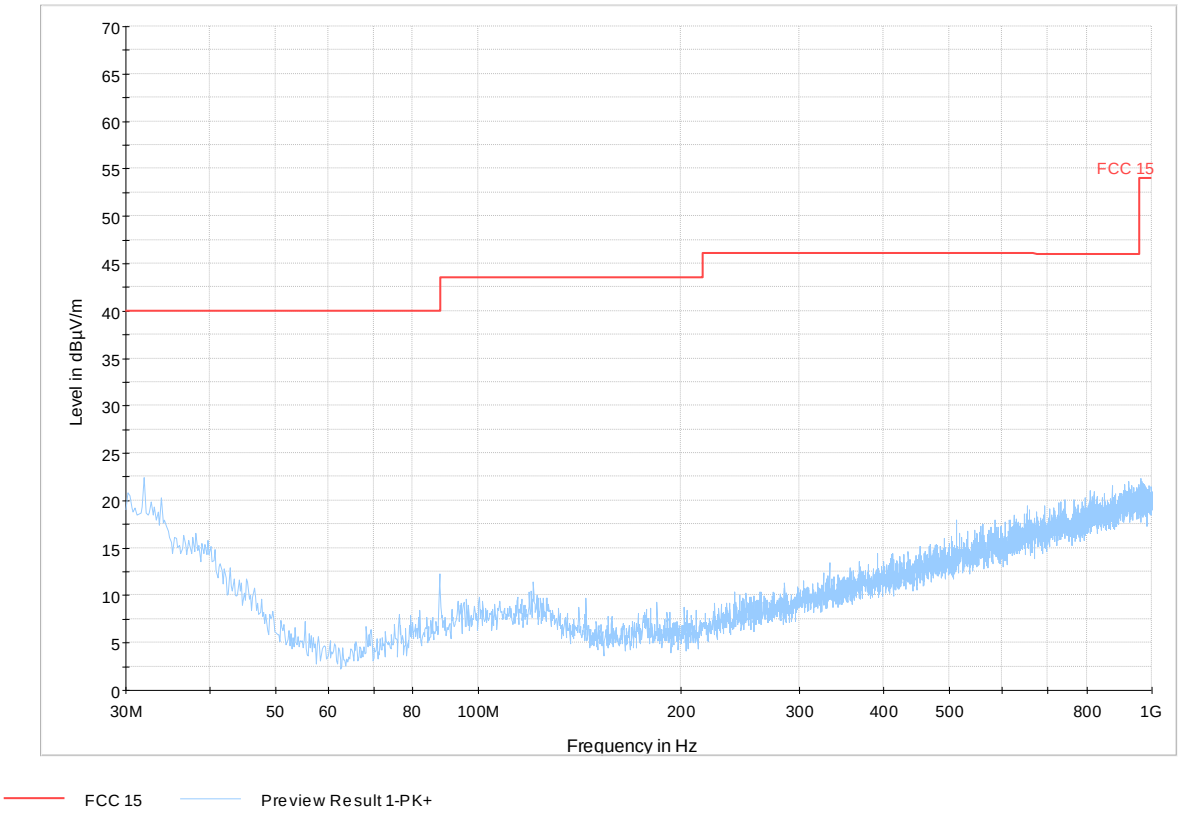
13.4 Test Result:

Pass.

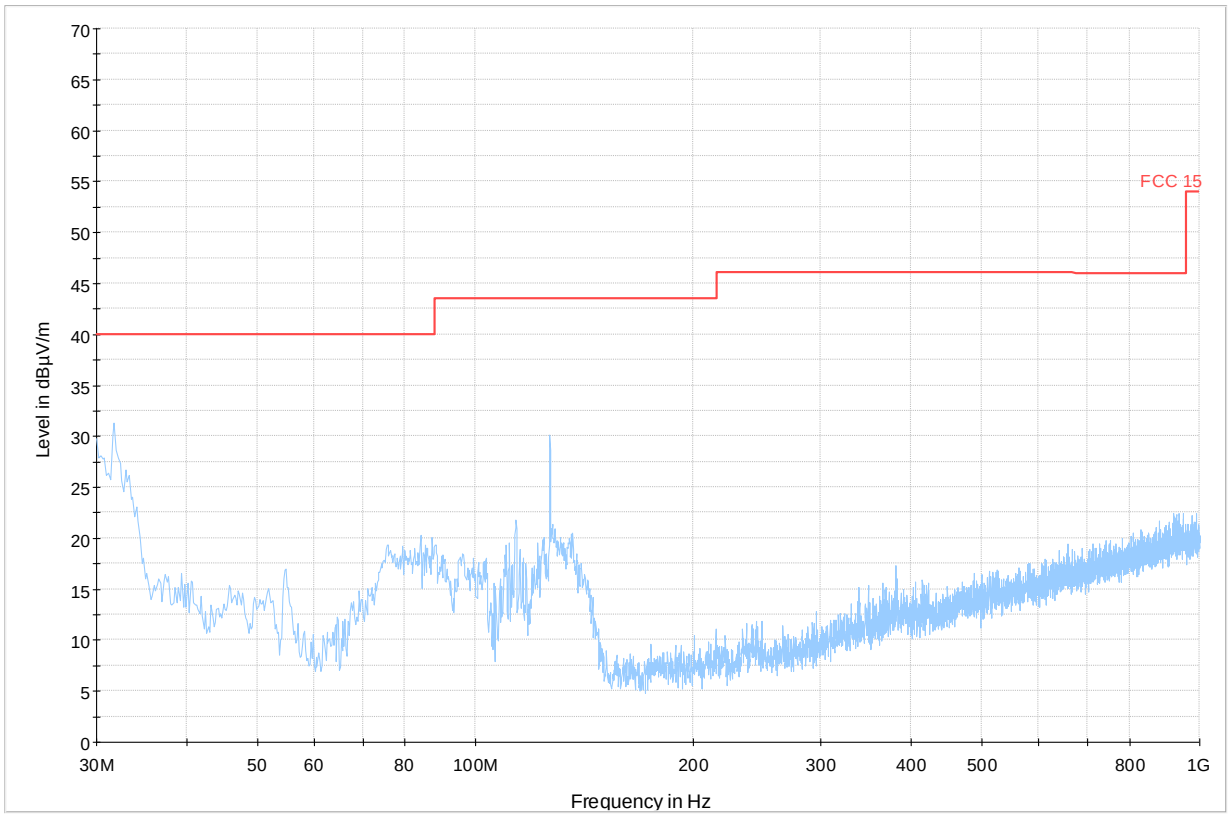
TX Radiated Spurious Emission- < 30 MHz– GFSK modulation –Mid CH



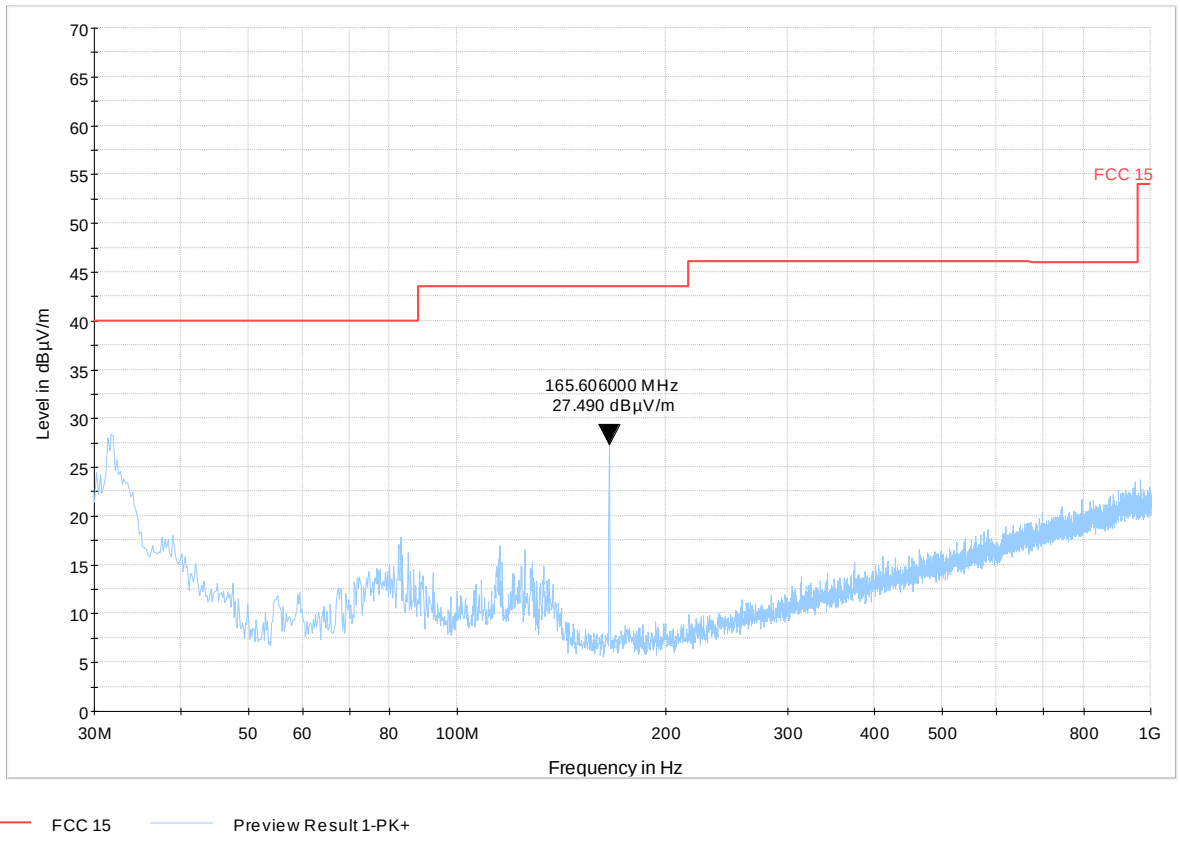
TX Radiated Spurious Emission- 30 MHz-1GHz GFSK modulation –Low CH



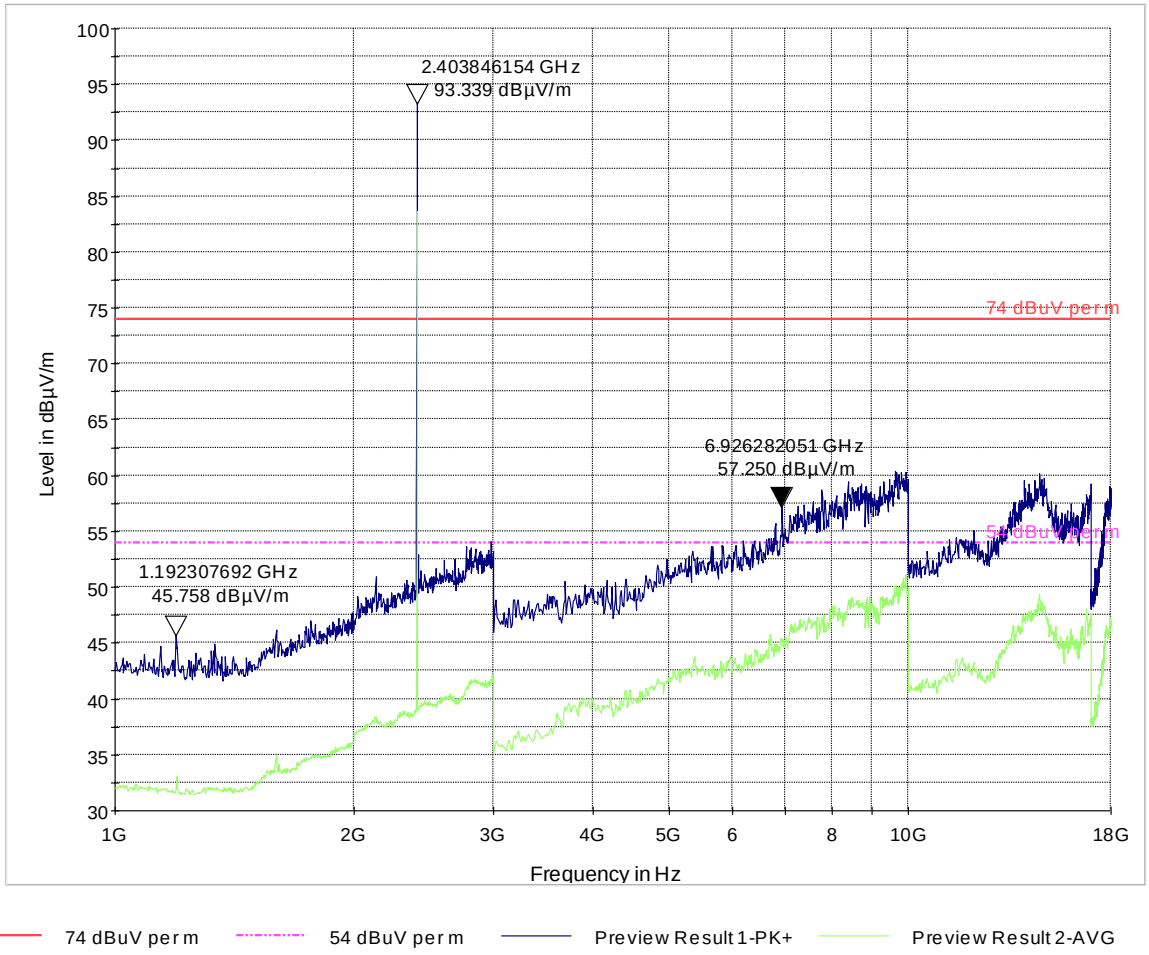
TX Radiated Spurious Emission-– 30 MHz-1GHz – GFSK modulation –Mid CH



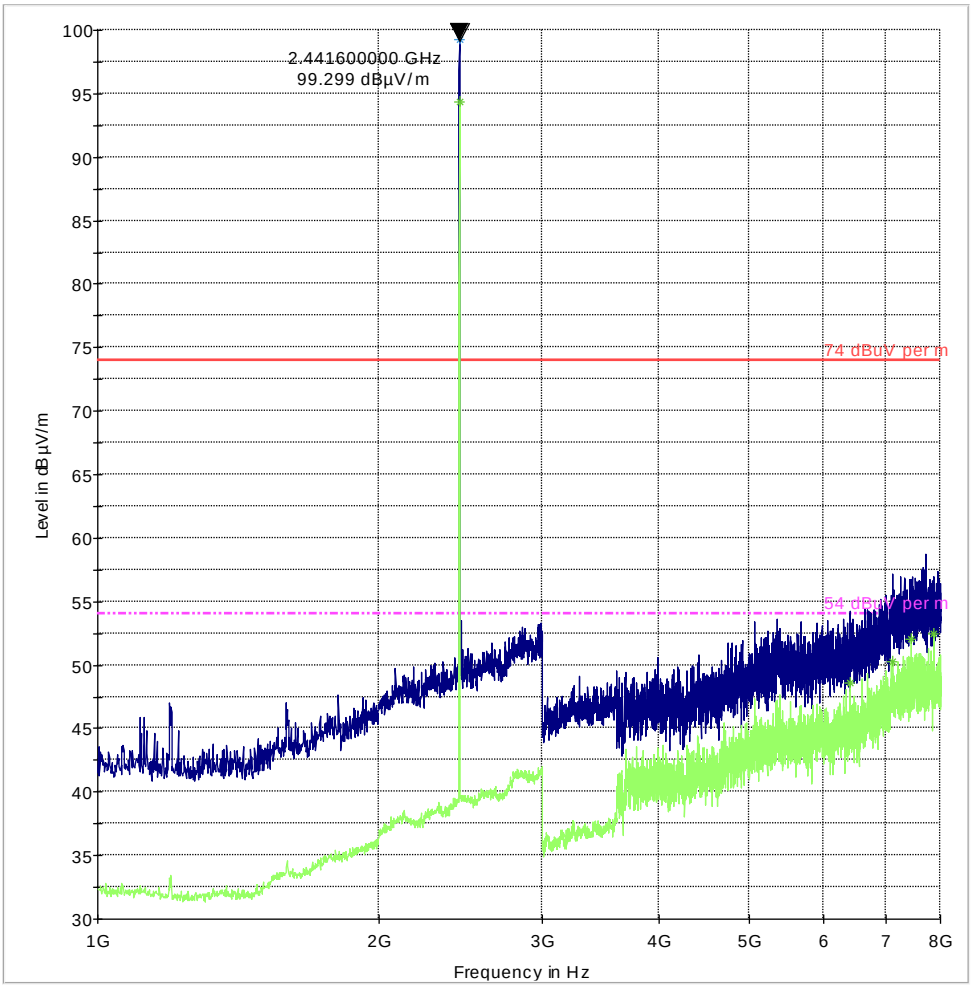
TX Radiated Spurious Emission– 30 MHz-1GHz– GFSK modulation –High CH



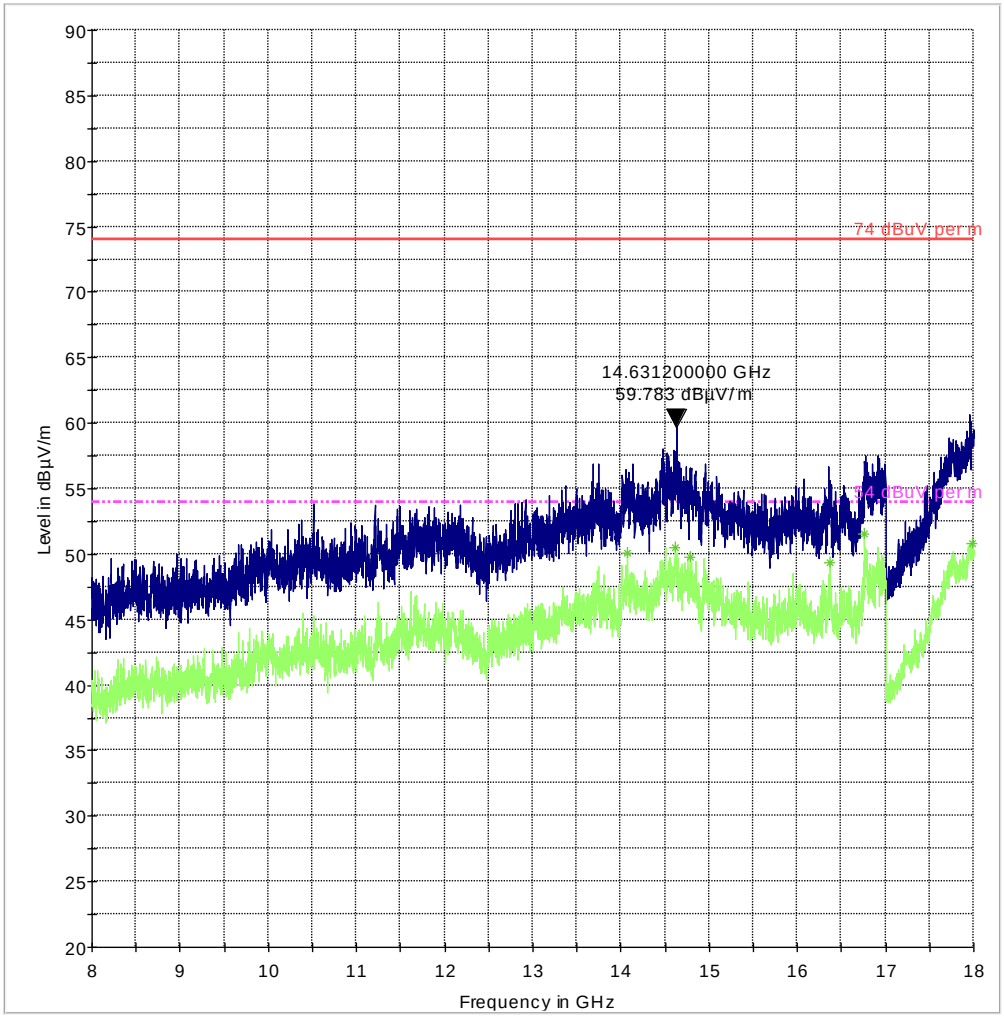
TX Radiated Spurious Emission– 1GHz - 18GHz – GFSK modulation –Low CH



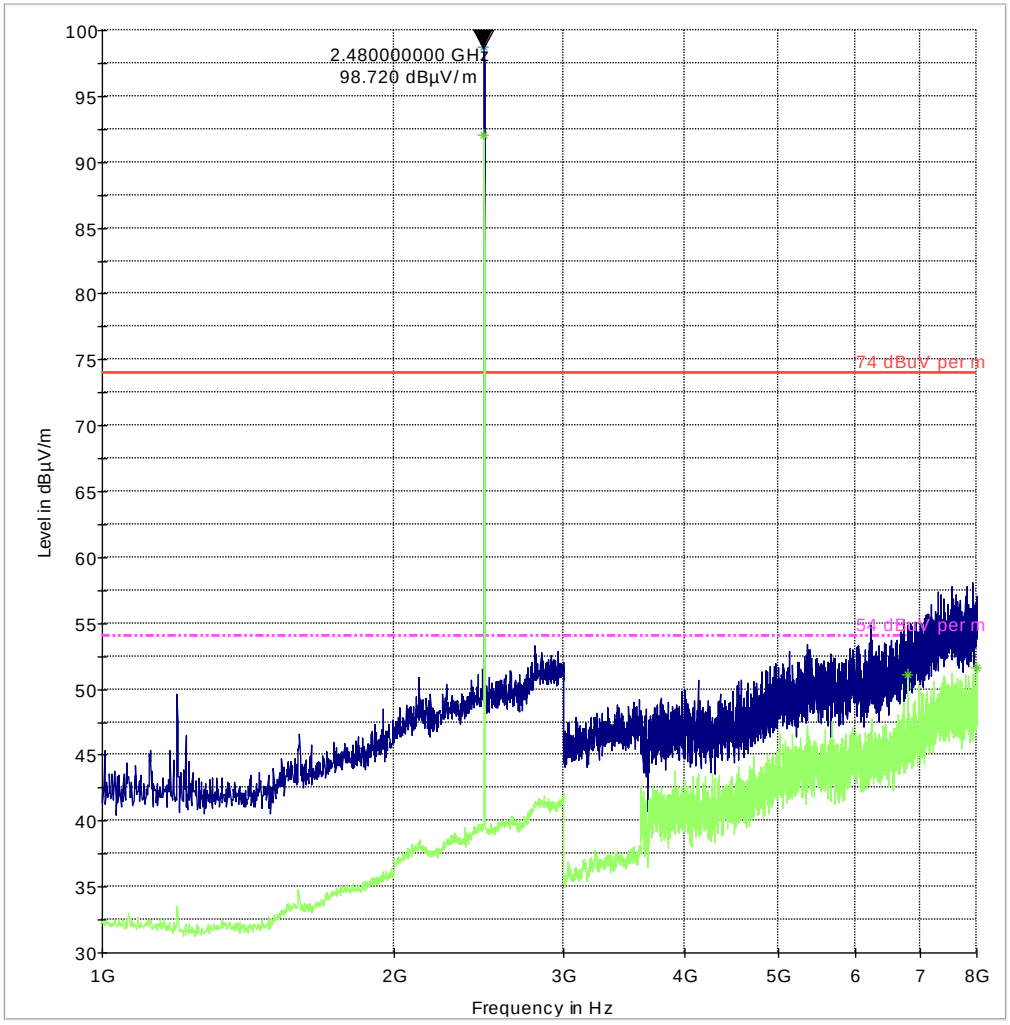
TX Radiated Spurious Emission-– 1GHz - 8GHz - GFSK modulation –Mid CH



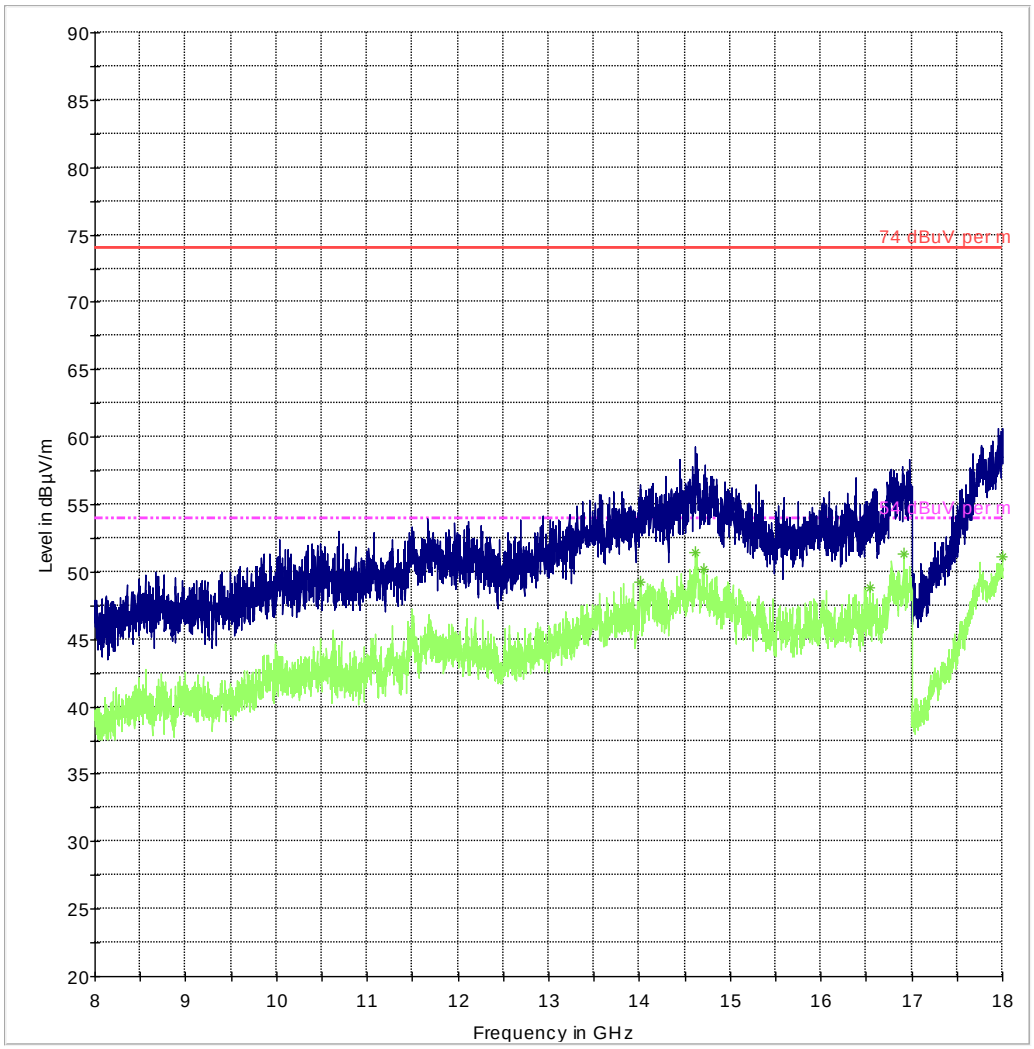
TX Radiated Spurious Emission-– 8GHz - 18GHz - GFSK modulation –Mid CH



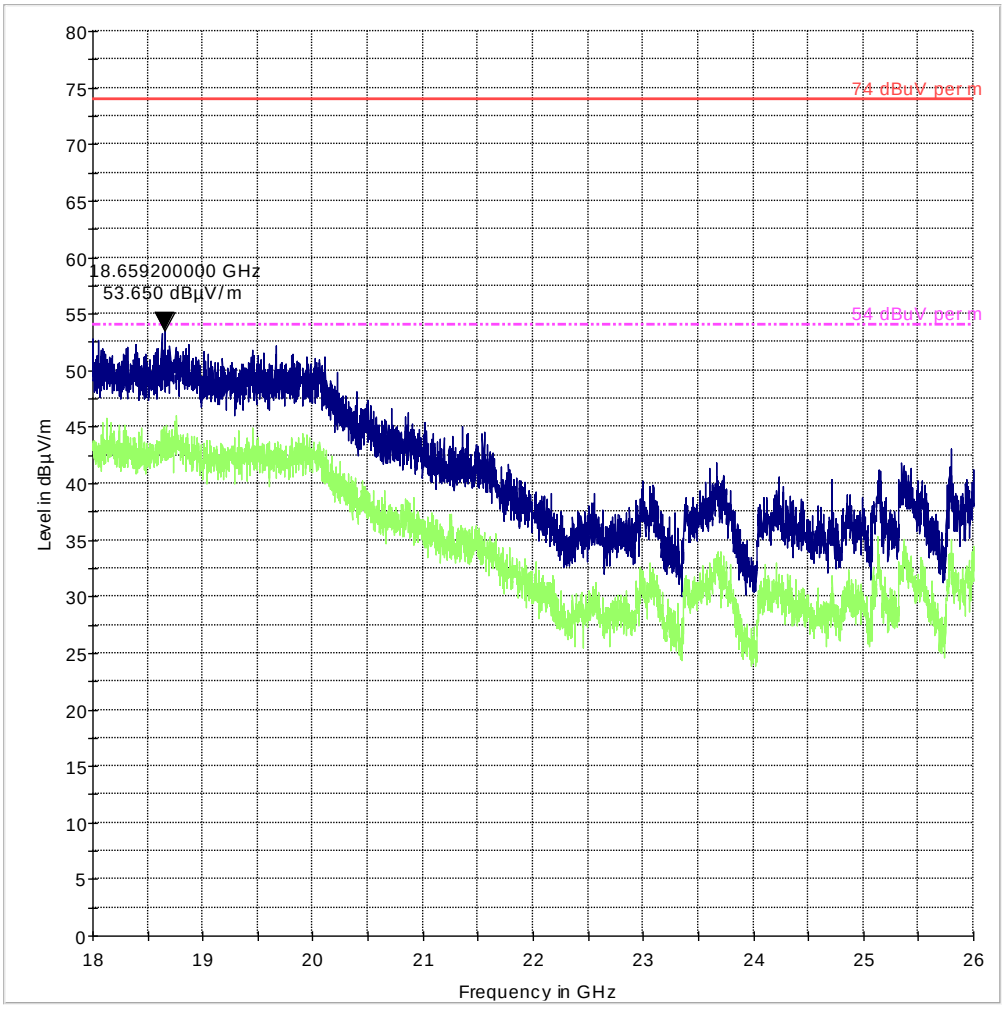
TX Radiated Spurious Emission– 1GHz - 8GHz – GFSK modulation –High CH



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



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



14 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.

14.1 Limits:

§15.207 & RSS-Gen 8.8
(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.

14.2 Test Conditions:

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

14.2.1 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

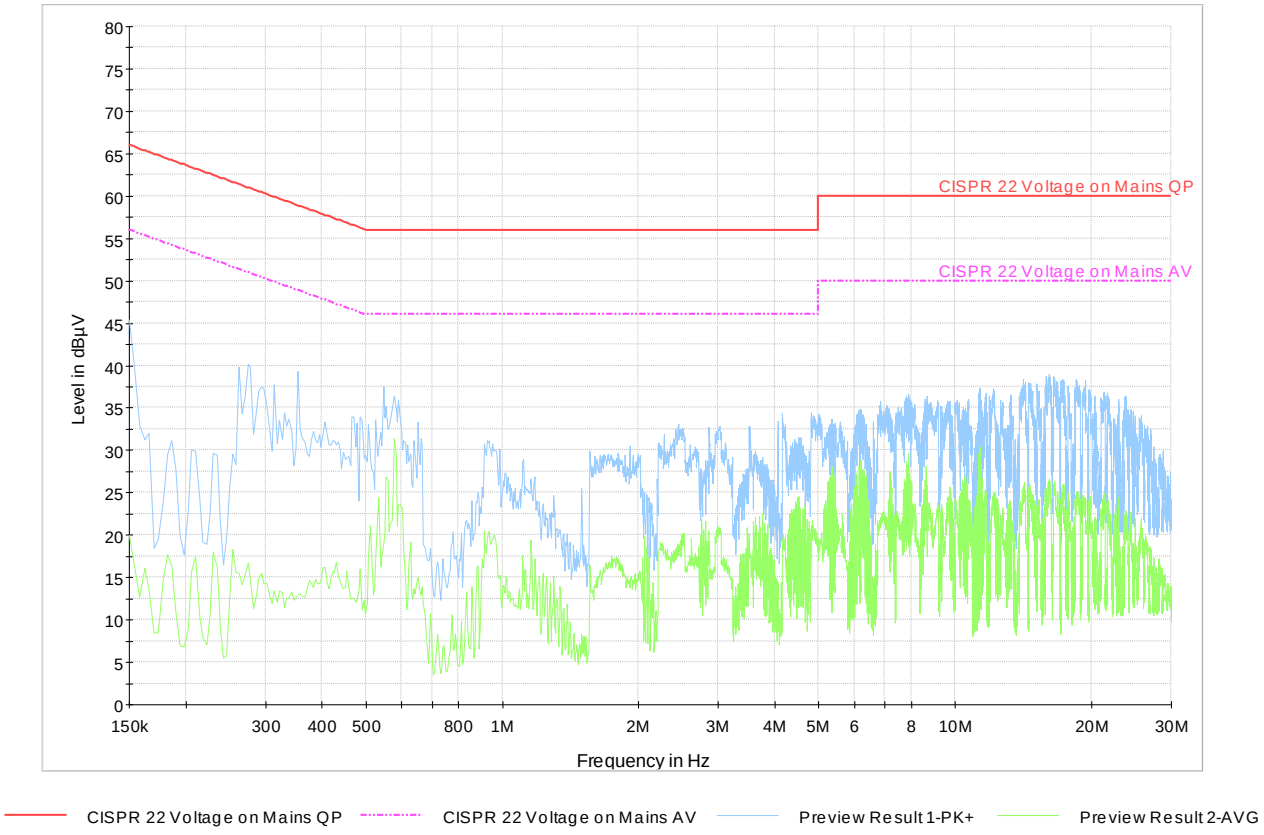
14.3 Results

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

14.4 Measurement Plots:

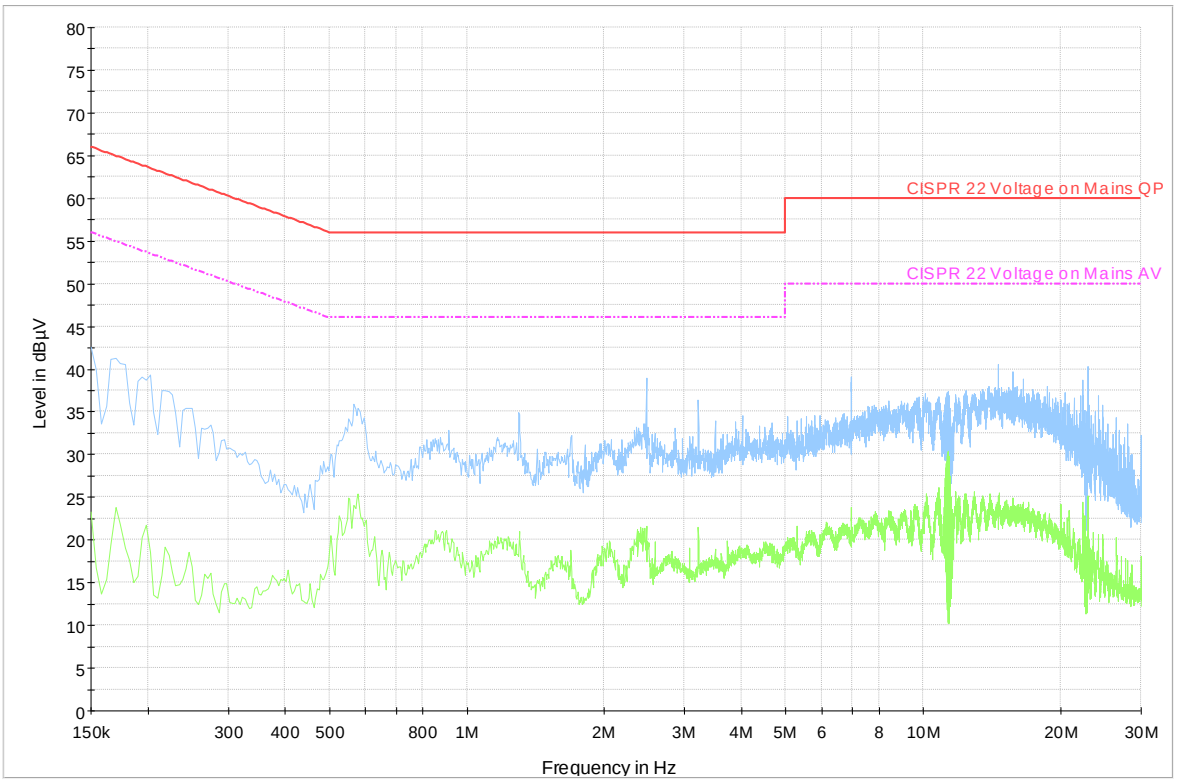
Conducted Emissions: 150 KHz – 30 MHz

TX Mode: GFSK modulation



Conducted Emissions: 150 KHz – 30 MHz

RX Mode:



15 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
	Climatic Chamber	Votsch	VT4004	G1115	N/A	N/A

16 Revision History

Date	Report Name	Changes to report	Report prepared by
2014-10-16	EMC_INTEL_054_14001_15.247_BT	First official version	Jennifer Huang
2014-11-24	EMC_INTEL_054_14001_15.247_BT_Rev1	Add documentation for choice of test modes.	Franz Engert
2014-12-15	EMC_INTEL_054_14001_15.247_BT_Rev2	Add information on measurement distances below 30MHz.	Jennifer Huang