Bluetooth (Basic rate/EDR)

FCC Test Report

FOR:
Pearl Automation Inc.

Model Name: / Model Number:

RearVision Car Adapter / P120

Product Description:

RearVision consists of 2 main components. The "Car Adapter", which is an accessory that connects to the vehicle's OBD-II diagnostic port, and the "Camera Frame" which is an accessory that is mounted at the license plate of the vehicle. The "Car Adapter" will relay information from the "Camera Frame" and vehicle environmental and state information over Bluetooth/WiFi, and that information will be relayed to the phone over Bluetooth/WiFi and displayed to the driver via the phone app.

FCC ID: 2AG6M-P120

47 CFR Part 15.247 [DSS]

TEST REPORT #: EMC-PEARL-004-16001-15.247-P120-DSS-BT-Rev1
DATE: 2016-9-28

FCC Recognized.

A2LA Accredited

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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
No deviations were ascertained.

Company	Description	Model #
Pearl Automation Inc.	RearVision Car Adapter	P120

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2016-09-28	Compliance	Franz Engert (Compliance Manager)	Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com

Responsible for the Report:

Date	Section	Name	Signature
2016-09-28	Compliance	James Donnellan (Sr. EMC Engineer)	James Donnellan Digitally signed by James Donnellan DN: cn=James Donnellan, c=US, o=Cetecom Inc., ou=Compliance, email=james.donnellan@cetecom.com Date: 2016.09.28 20:35:46 -07'00'

The test results of this test report relate exclusively to the test item specified in Section3.
CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the 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:	Ruther Navarro

2.2 Identification of the Client

Applicant's Name:	Pearl Automation Inc.
Street Address:	100 Enterprise Way, Suite A101
City/Zip Code	Scotts Valley, CA 95066
Country	USA
Contact Person:	Hagan O'Connor / Erturk Kocalar
Phone No.	+1 408 655-3319 (Hagan) / +1 408 410-0144 (Erturk)
e-mail:	hagan@pearlauto.com / erturk@pearlauto.com.

2.3 Identification of the Manufacturer

Manufacturer's Name:	Dongguan Primax Electronic & Telecommunications Products Co. Ltd,
Manufacturers Address:	Liu Wu District, Shek Kit Town,
City/Zip Code	DongGuan City, Guang Dong,
Country	China.

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Model #:	P120
HW Version :	DVT1B
SW Version :	347
FCC-ID :	2AG6M-P120
Product Description:	RearVision Car Adapter
Frequency Range / number of channels:	Nominal band: 2400 – 2483.5 Center to center: 2402(ch 0) – 2480(ch 78), 79 channels
Type(s) of Modulation:	Bluetooth Basic/EDR: GFSK, π /4 DQPSK, 8DPSK
Modes of Operation:	Hopping
Antenna Information as declared:	Custom internal PCB Trace Antenna. For RF conducted measurements, a temporary connection was made from measurement equipment to the 50Ohm UFL port of the EUT. Documented max antenna gain: 2.4GHz = 1 dBi
Max. Output Powers:	15 dBm EIRP (Max Power per Spec 14 db plus 1dbi gain)
Power Supply/ Rated Operating Voltage Range:	CAR Battery Min. 4.0VDC, Nom. (12.0VDC -14.5VDC), Max 16VDC
operating temperature range	Tlow: -20° C/ Tnom: 25° C/ Tmax:45° C
Other Radios included in the device:	5G WLAN 2.4G WLAN BT LE
Prototype / Production unit	■Prototype; ☐Production; ☐Pre-Production

3.2 Identification of the Equipment Under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	A1A61006E4	DVT1B	347	Radiated Sample
2	A1A6100754	DVT1B	347	Conducted Sample

3.3 Identification of Ancillary equipment

STE #	Type	Manufacturer	Model	Serial Number	Notes/Comments
1	MacBook Air	A1465	Apple	C2QQ606&G4FY	Used to setup channel modes prior to test.
2	Battery	-	-	-	Supply power to EUT

3.4 EUT Sample Configuration

EUT Set-Up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE2	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected.
2	EUT#2 +AE2	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The measurement equipment was connected to the 50Ohm UFL port of the EUT.

3.5 Test mode of operation with multiple modulations:

1. The EUT was set low, mid and high channels with a Max Duty Cycle and GFSK modulation using special software that is not available to the end user.
2. The channels and modulation schemes of the EUT were set using this software.
3. Based on measurements, the GFSK modulation scheme has the highest output power followed by GFSK.
4. The GFSK and 8-DPSK modulation schemes were used in all test cases as they are considered the worst case with respect to power.
5. During tests which require Frequency Hopping, the packet length is DH3 unless otherwise noted.

4 Subject of Investigation

The objective of the evaluation documented in this report was to assess if the performance of the EUT meets the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations.

This test report is to support a request for new equipment authorization under the FCC ID: 2AG6M-P120. All testing was performed on the product referred to in Section 3 as the EUT.

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

Testing procedures are based on ANSI C63.10:2013 for FHSS systems.

A worst case evaluation for the highest power modulation has been carried out for GFSK and 8-DPSK modulation with maximum Duty Cycle.
.

5 Summary of Measurement Results

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

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

6 Measurements

6.1 Measurement Uncertainty

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

	Uncertainty in dB radiated <30MHz	Uncertainty in dB radiated 30MHz - 1GHz	Uncertainty in dB radiated > 1GHz	Uncertainty in dB Conducted measurement
standard deviation k=1	2.48	1.94	2.16	0.64
95% confidence interval in dB	4.86	3.79	4.24	1.25
95% confidence interval in dB in delta to Result (rounded up to next decimal point)	+/- 2.5 dB	+/- 2.0 dB	+/- 2.3dB	+/- 0.7dB

7 Environmental Conditions During Testing:

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

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

8 Dates of Testing:

April 22, 2016 – May 24, 2016

9 Measurement Procedures

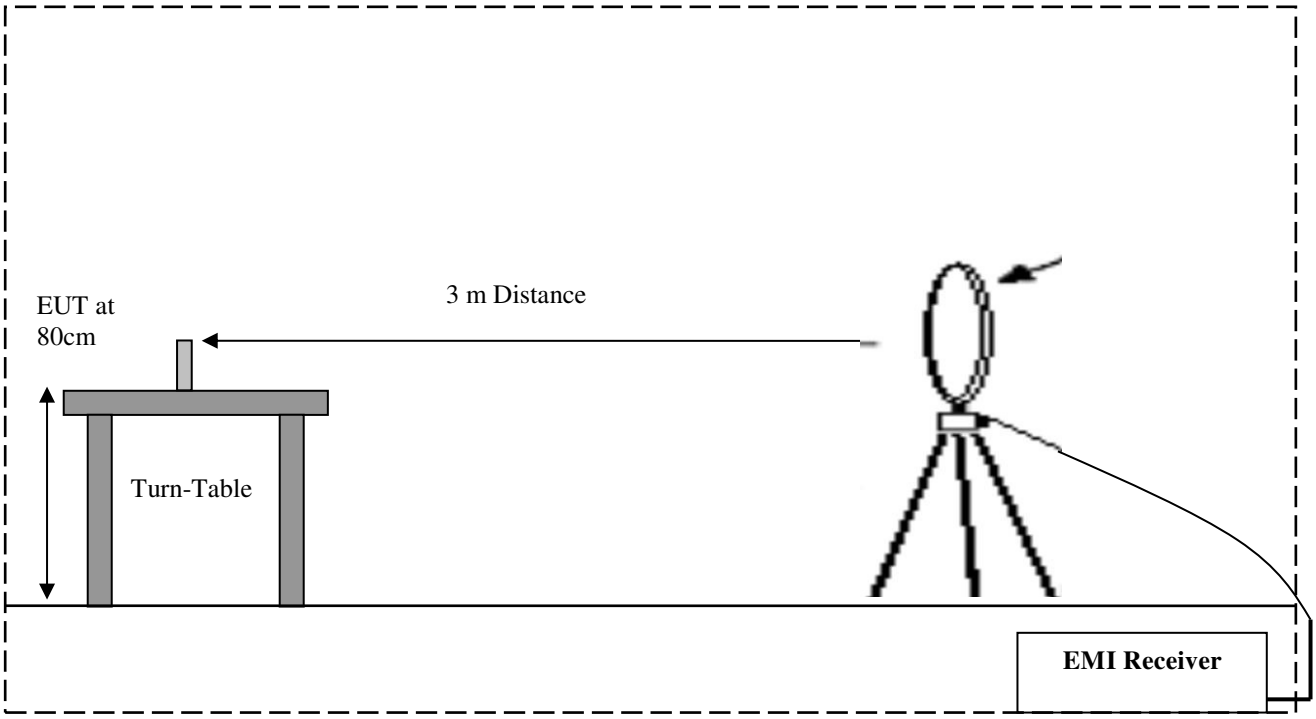
9.1 Radiated Measurement

The radiated measurement is performed according to:

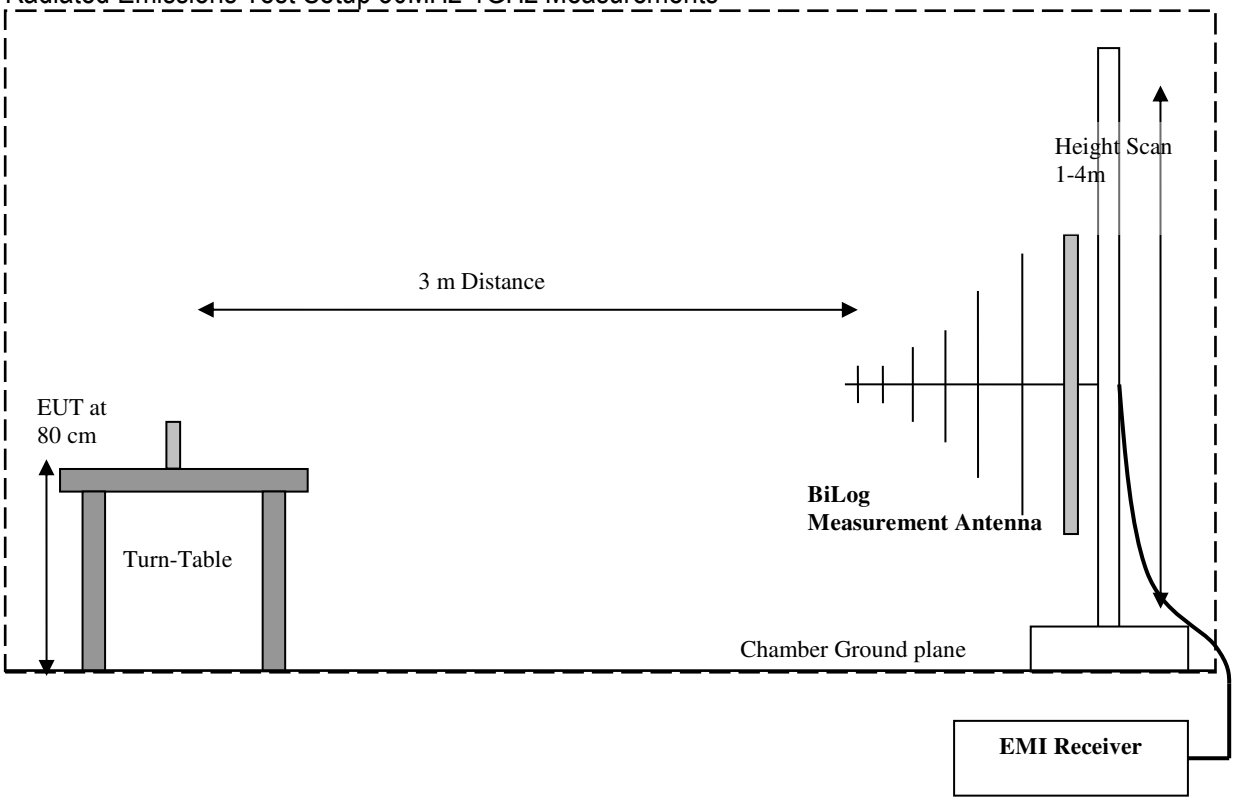
ANSI C63.10 (2013)

- The exploratory measurement is accomplished by running sweeps at 1 and 4m antenna heights over the required frequency range with R&S Test-SW EMC32 for both antenna polarizations. During each frequency scan the turntable rotates by no more than10deg.
- 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 again maximized through a fine search in frequency domain, maximized in the 360deg range of the turntable, and maximized over antenna height between 1m and 4m and for positioning of the EUT.
- The above procedure is repeated for transmission low mid and high channel.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.

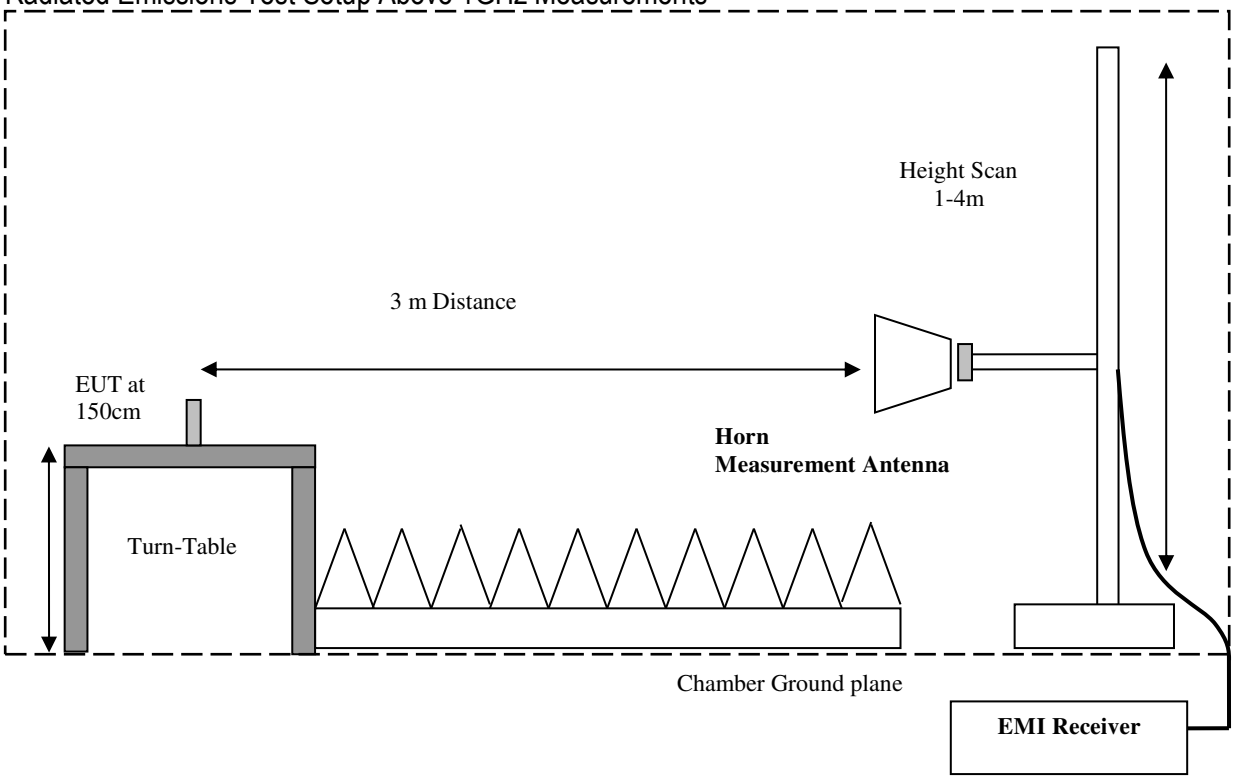
Radiated Emissions Test Setup Below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup Above 1GHz Measurements



9.2 Sample Calculations for Field Strength Measurements

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

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

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

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

Example:

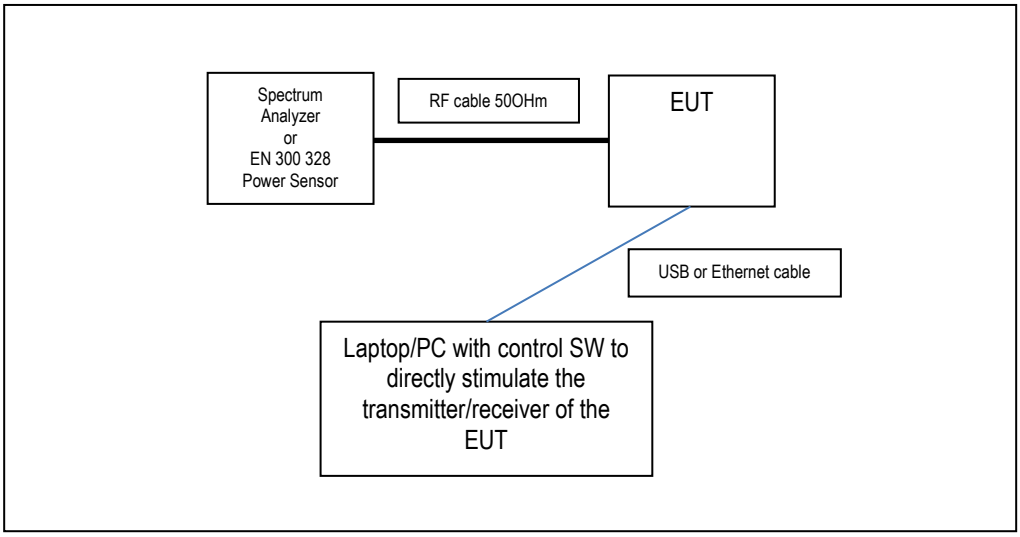
Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBµV/m)
1000	80.5	3.5	14	98.0

9.3 Power Line Conducted Measurement Procedure

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

9.4 RF Conducted Measurement Procedure

9.4.1 Conducted Measurement Setup without companion device



10 Technical Specifications Requirements

10.1 Maximum Peak Conducted Output Power

10.1.1 Limits:

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

10.1.2 Test Conditions

Tnom: 21°C; Vnom: Car Battery

10.1.3 Test Procedure

Refer to C63.10-2013 section 11.9

Hopping OFF
Spectrum Analyzer settings:
Span = ≥ 3 RBW
RBW ≥ The DTS bandwidth of the emission being measured
VBW ≥ 3 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):
2.400 – 2.48GHz: +1 dBi

10.1.4 Test Data:

Maximum Peak Conducted Output Power (dBm)			
Modulation	**Frequency (MHz)**		
	2402	**2441**	**2480**
GFSK	10.08	10.45	10.31
π/4 DQPSK	9.58	9.96	9.76
8-DPSK	9.93	10.29	10.21

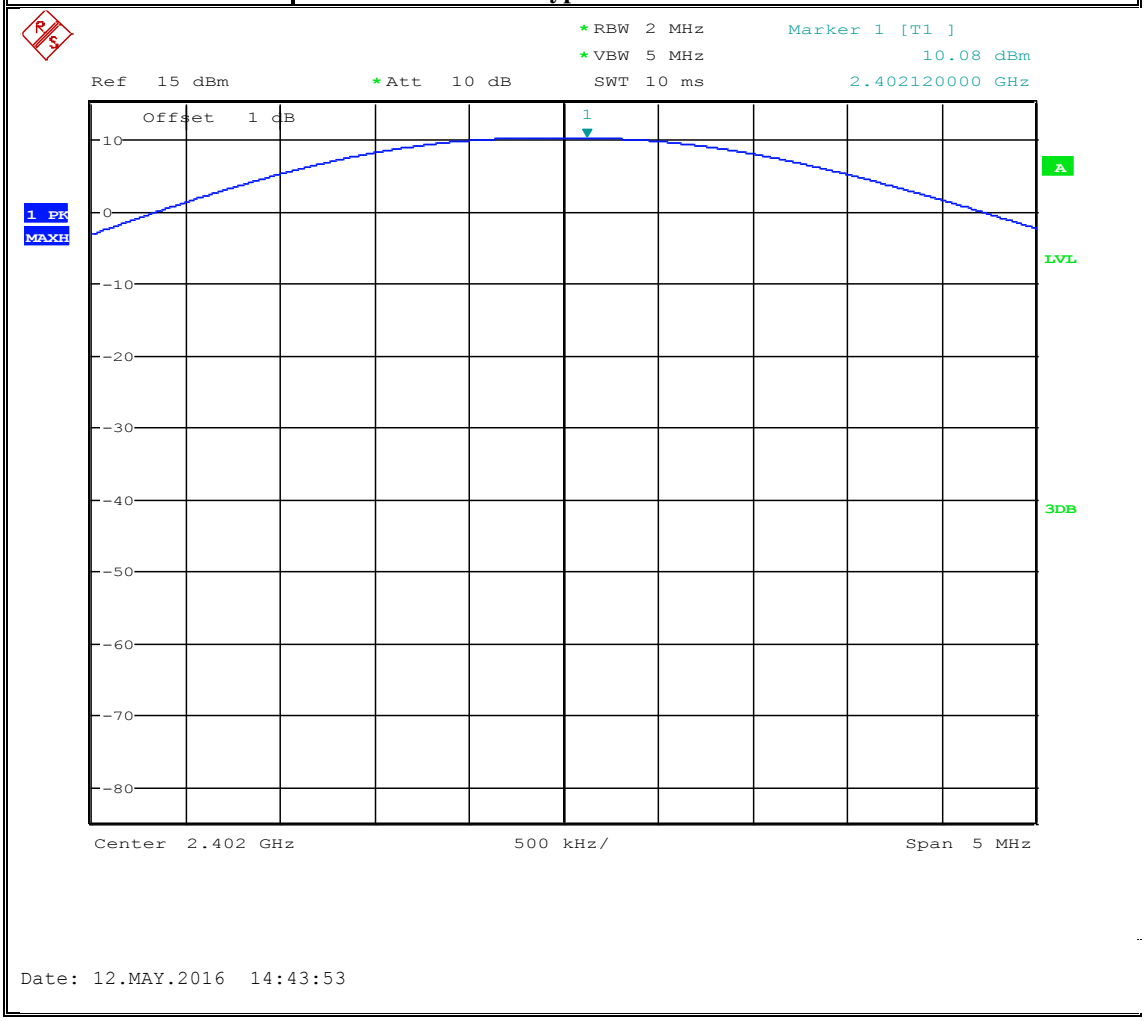
Limit: 30 dBm

10.1.5 Measurement Result

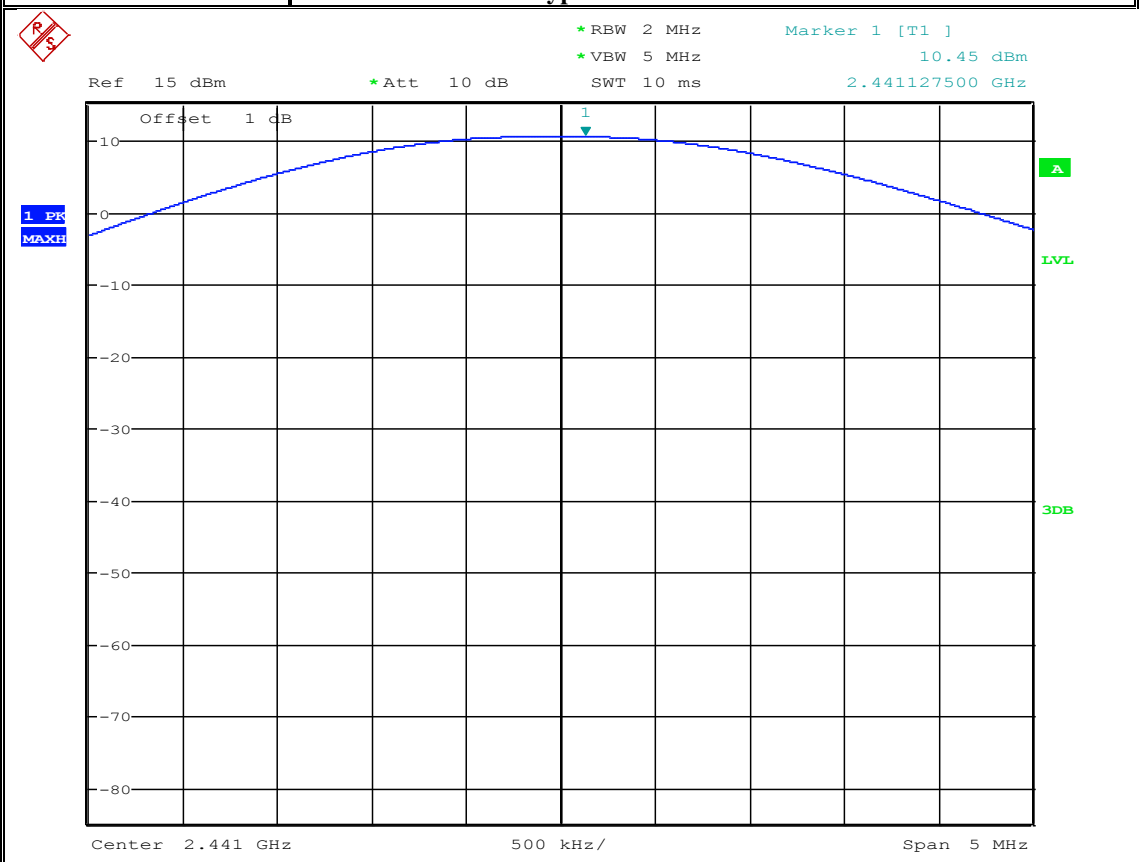
Pass.

10.1.6 Measurement Plots:

Maximum Peak Conducted Power	
Ch.0 / 2402 MHz	Modulation/Packet Type: GFSK / Max. DC



Ch.39 / 2441 MHz	Modulation/Packet Type: GFSK / 100% DC



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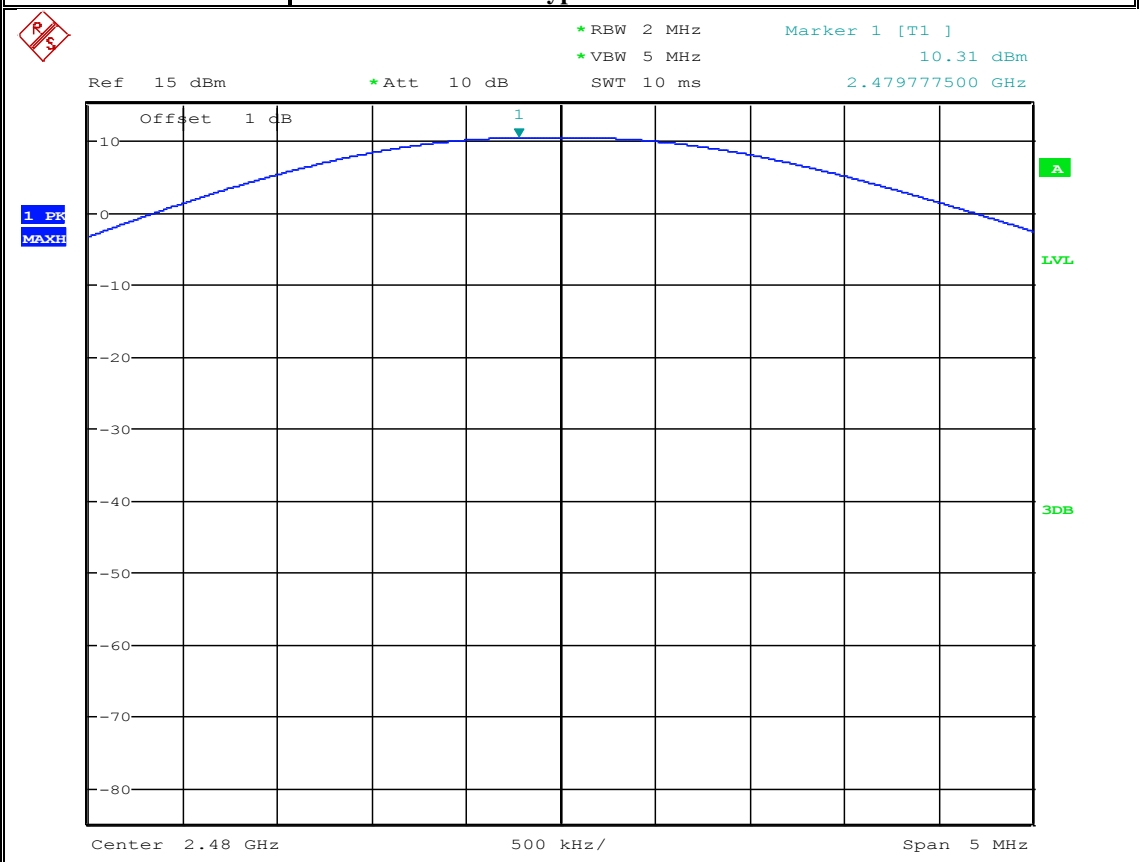
Ch.78 / 2480 MHz	Modulation/Packet Type: GFSK / Max. DC



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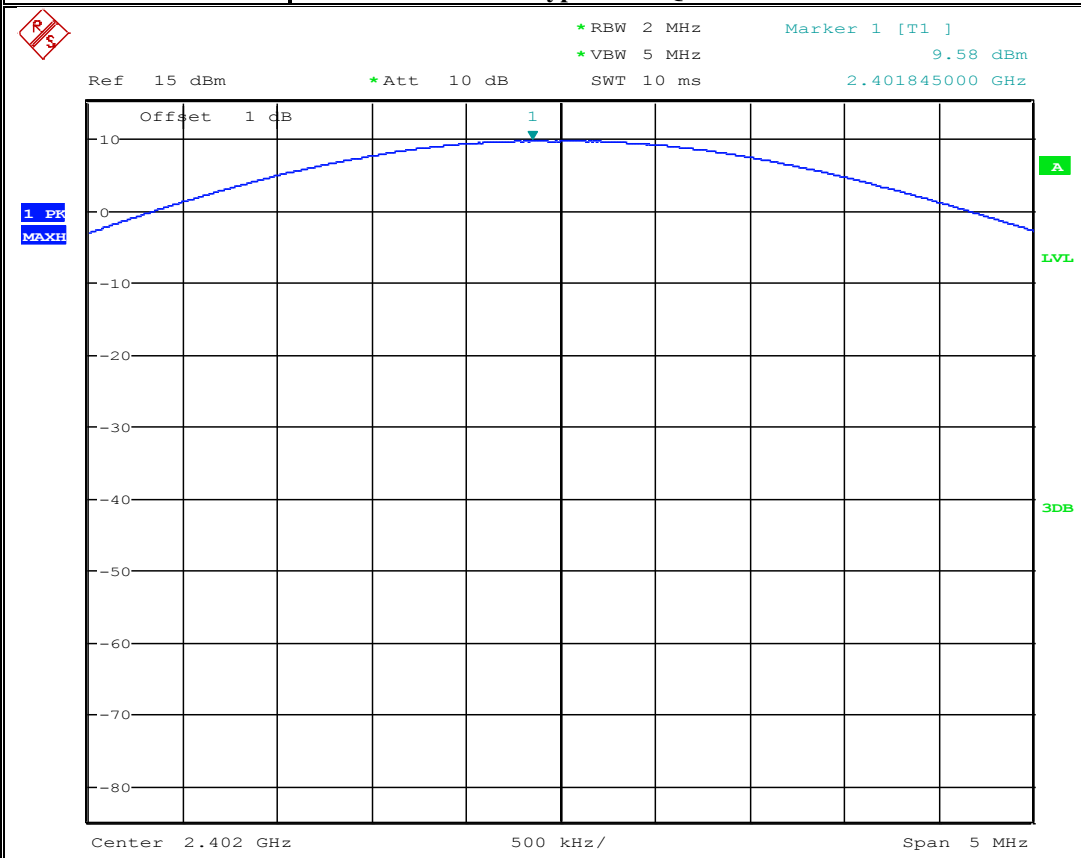
Maximum Peak Conducted Power	
Ch.0 / 2402 MHz	Modulation/Packet Type: π/4 DQPSK / Max. DC



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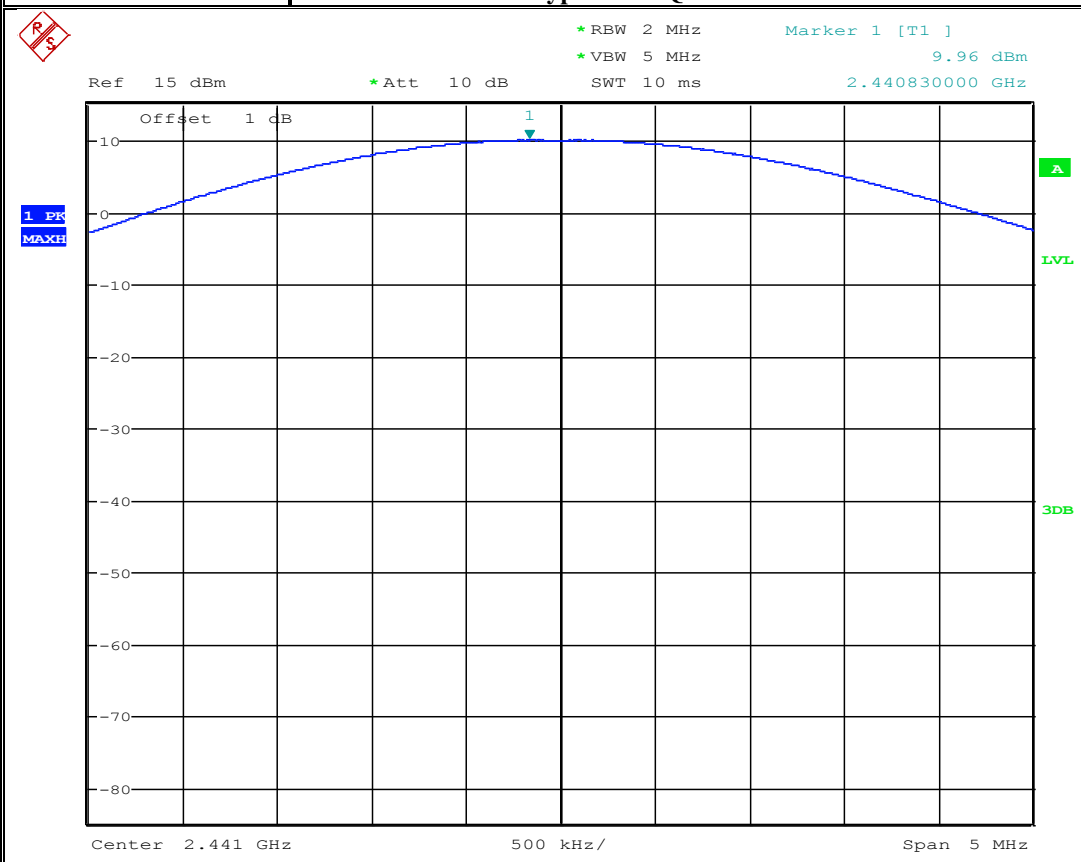
Ch.39 / 2441 MHz	Modulation/Packet Type: π/4 DQPSK / Max. DC



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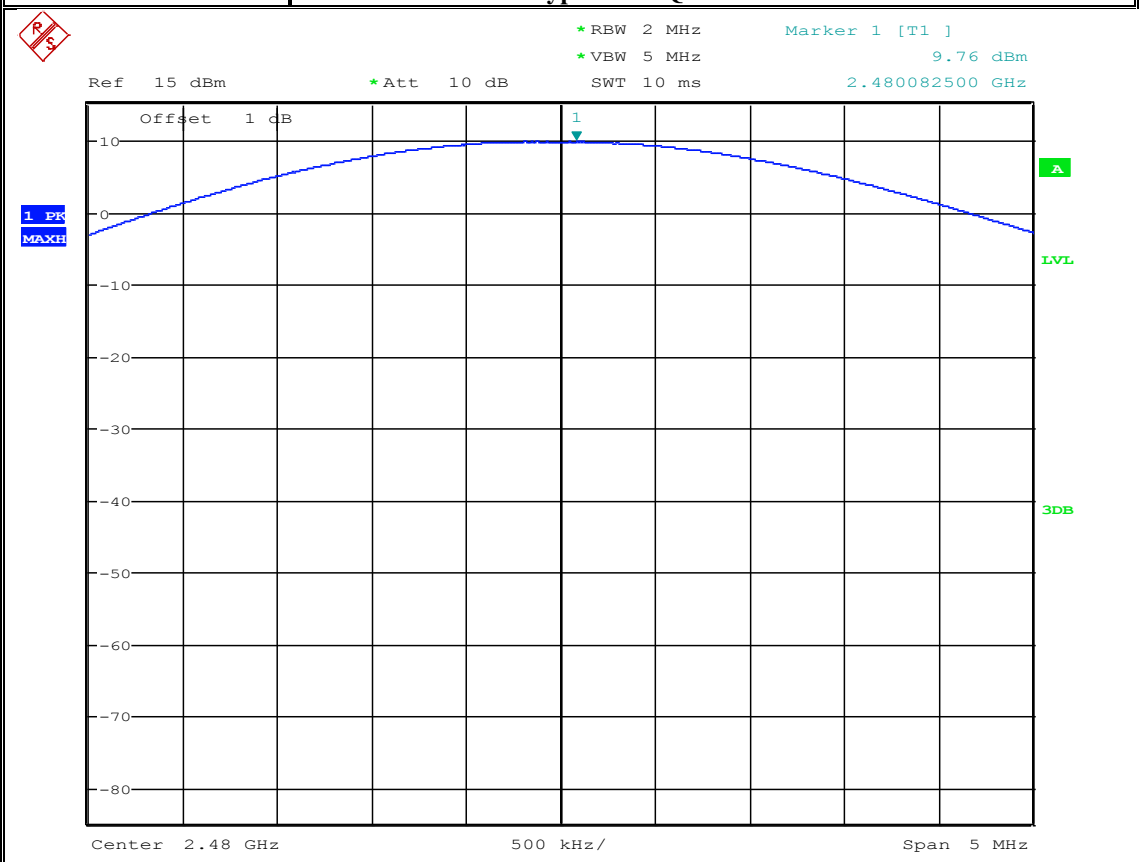
Ch.78 / 2480 MHz	Modulation/Packet Type: π/4 DQPSK / Max. DC



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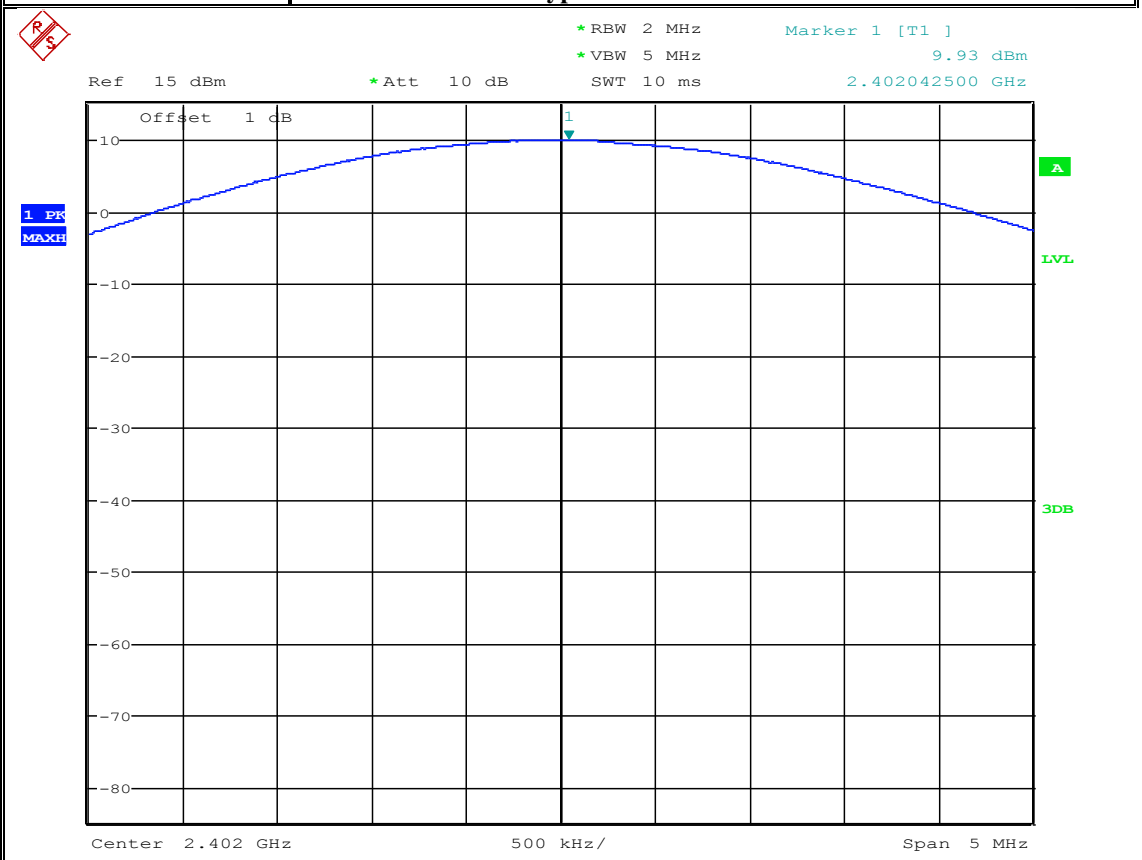
Maximum Peak Conducted Power

Ch.0 / 2402 MHz	Modulation/Packet Type: 8-DPSK / Max. DC



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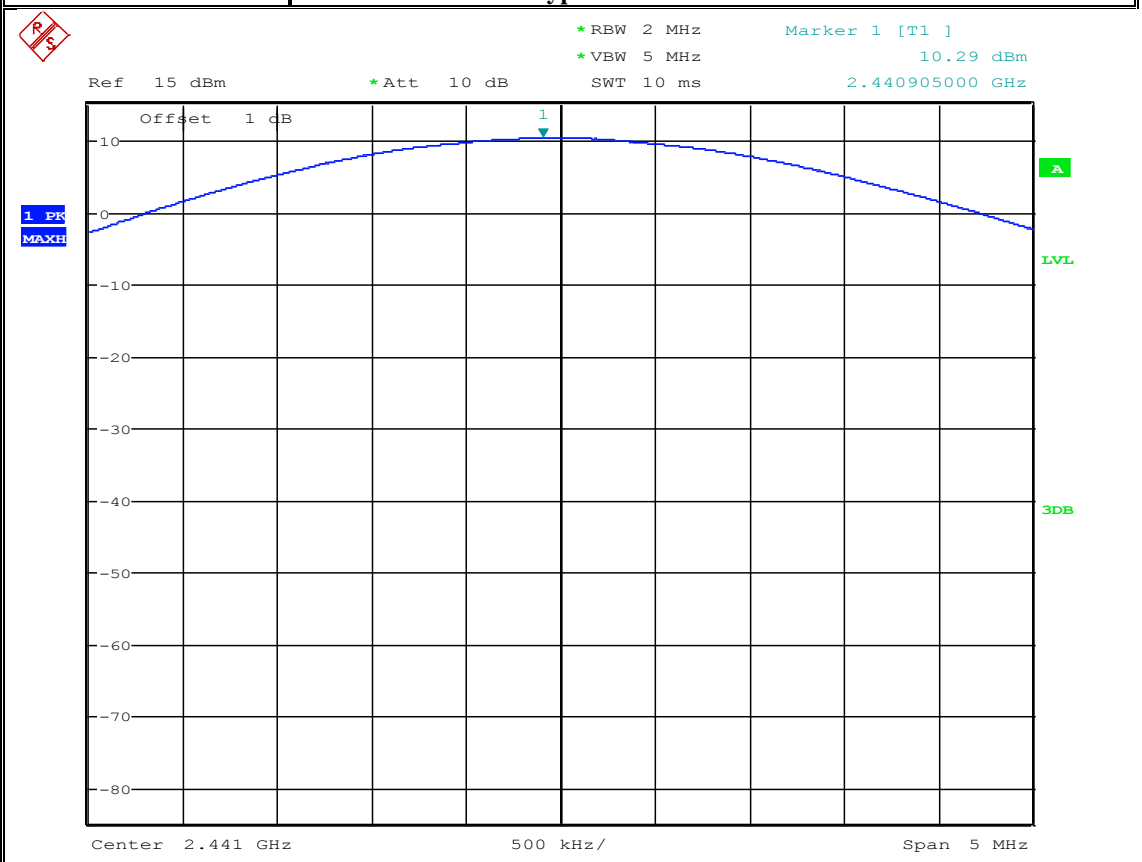
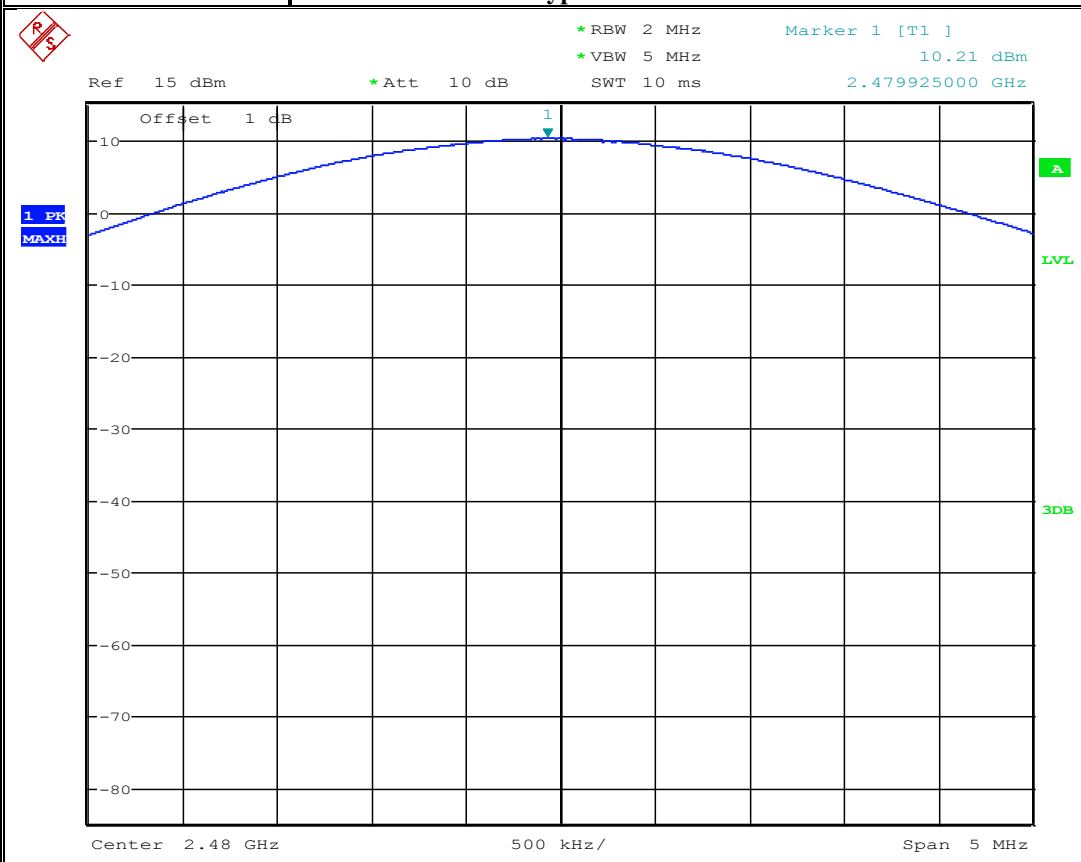
Ch.39 / 2441 MHz	Modulation/Packet Type: 8-DPSK / Max. DC



Date: 12.MAY.2016 14:49:09

Ch.78 / 2480 MHz	Modulation/Packet Type: 8-DPSK / Max. DC



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

10.2.1 Limits: §15.247/15.205

§15.205

(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)).

10.2.2 Test Conditions
Tnom: 22.4^{o}C; Vnom: Car Battery

10.2.3 Test Procedure
Refer to C63.10-2013 Section 7.8.6

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=1 MHz, VBW ≥ RBW

At 3 meter distance radiated limits are:
*PEAK LIMIT= 74dBμV/m
*AVG. LIMIT= 54dBμV/m
For conducted measurements at the antenna port:
*PEAK LIMIT= -21.2 dBm EIRP
*AVG. LIMIT= -41.2 dBm EIRP

Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205

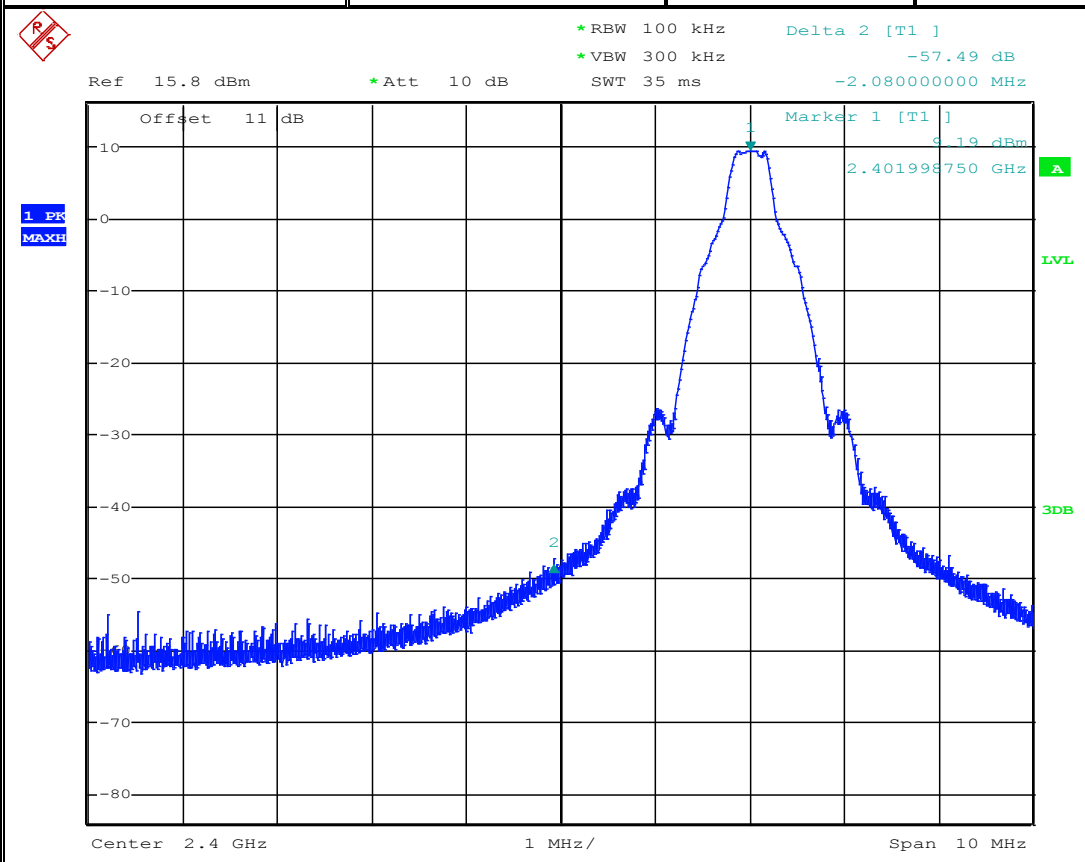
10.2.4 Measurement Result

Pass.

10.2.5 Measurement Plots:

10.2.5.1 Non Restricted Band edge

Lower Band Edge			
Ch. Low / 2402MHz	Hopping Disabled	Peak	GFSK (DH5) 98% DC



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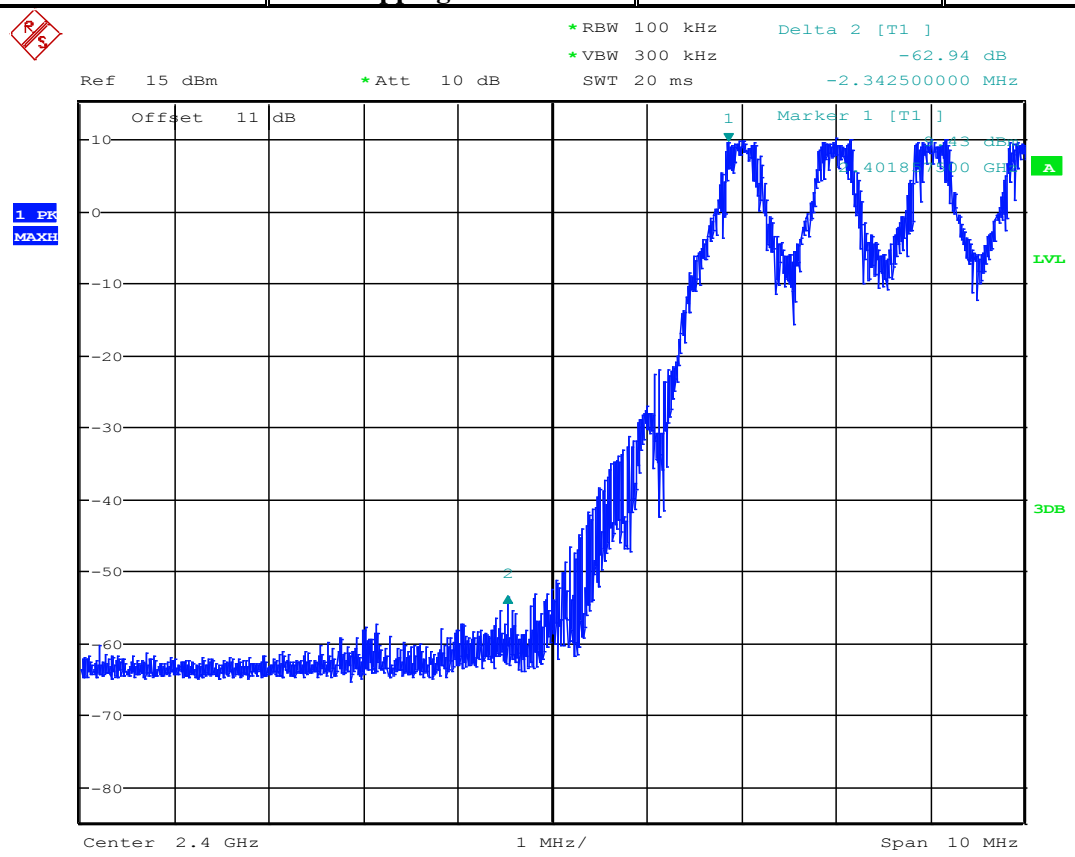
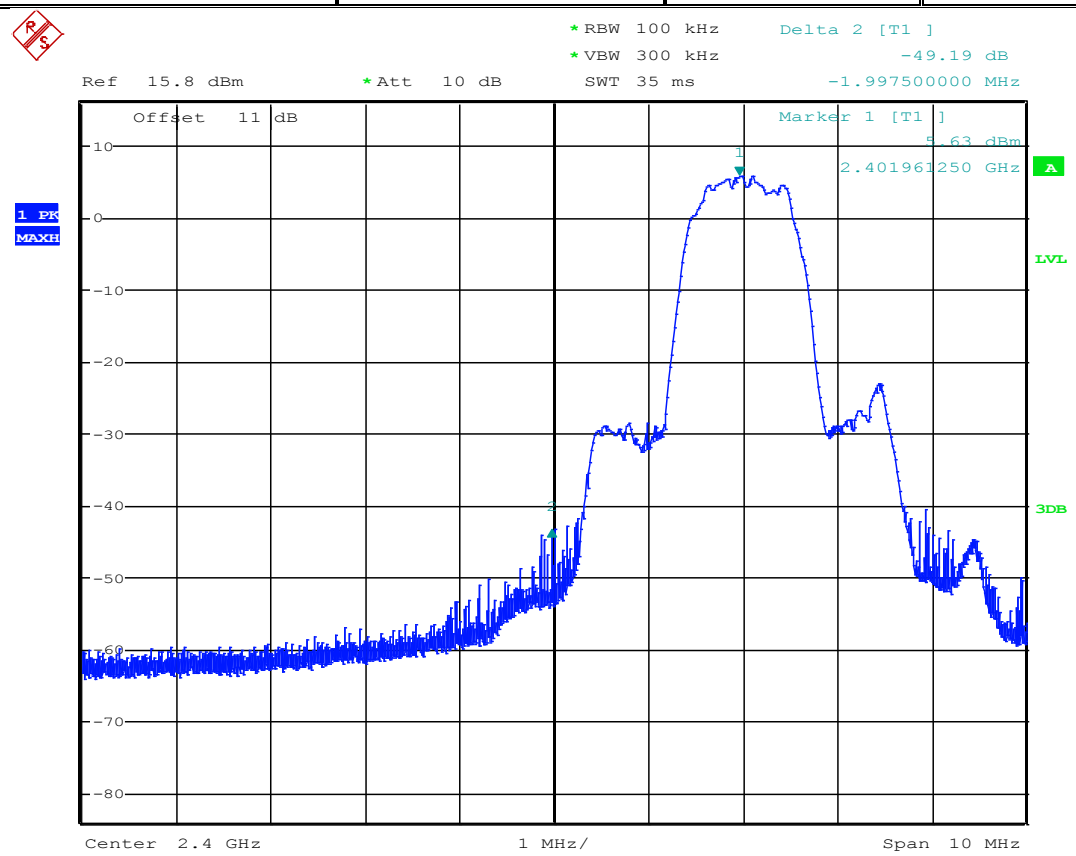
Lower Band Edge			
Ch. Low	Hopping Enabled	Peak	GFSK (DH1)



Date: 13.MAY.2016 19:11:16

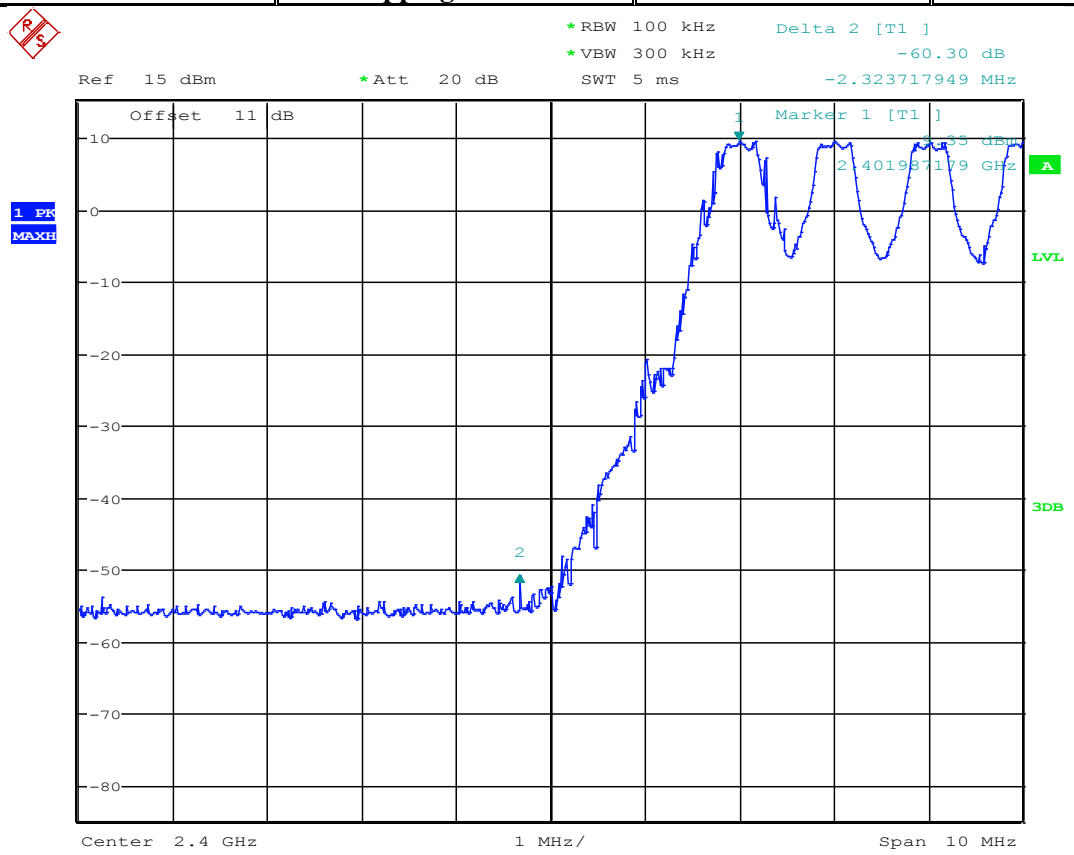
Lower Band Edge			
Ch. Low / 2402MHz	Hopping Disabled	Peak	8DPSK (3-DH5) 97% DC



Date: 12.MAY.2016 16:09:11

Lower Band Edge

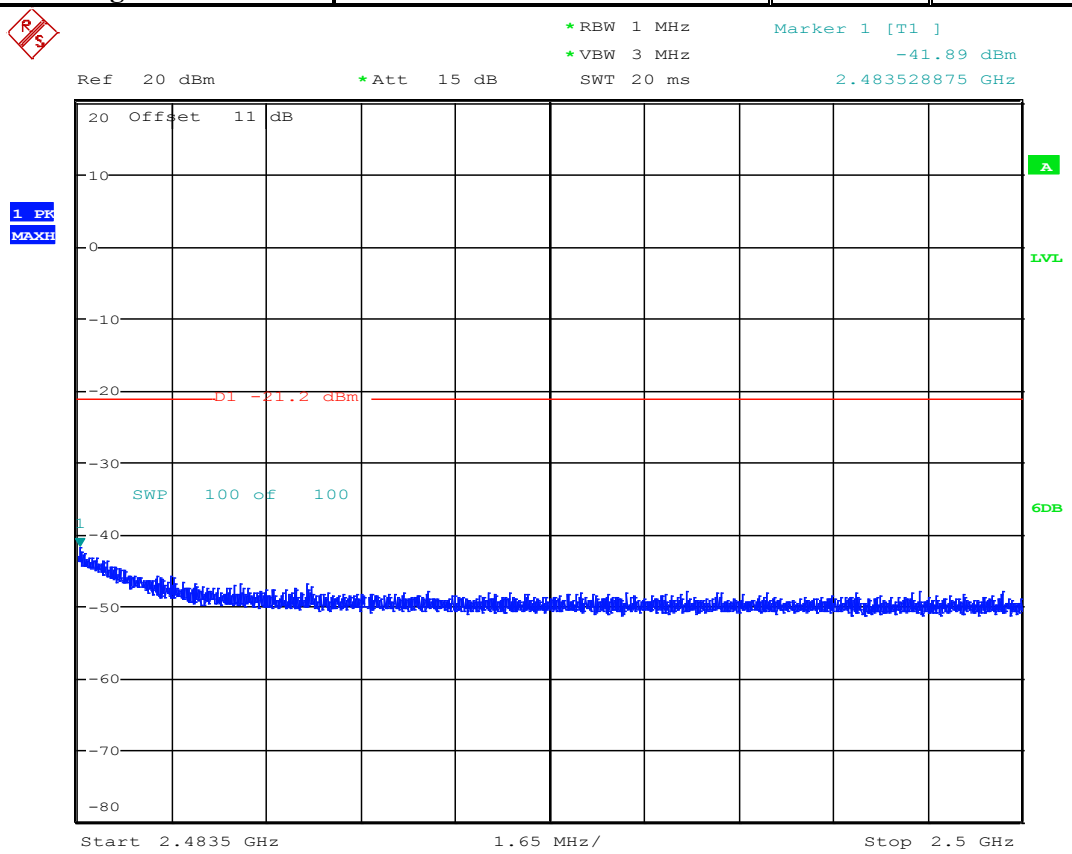
Ch. Low / 2402MHz	Hopping Enabled	Peak	8DPSK (3-DH5)



Date: 13.MAY.2016 19:01:53

10.2.5.2 Restricted Band

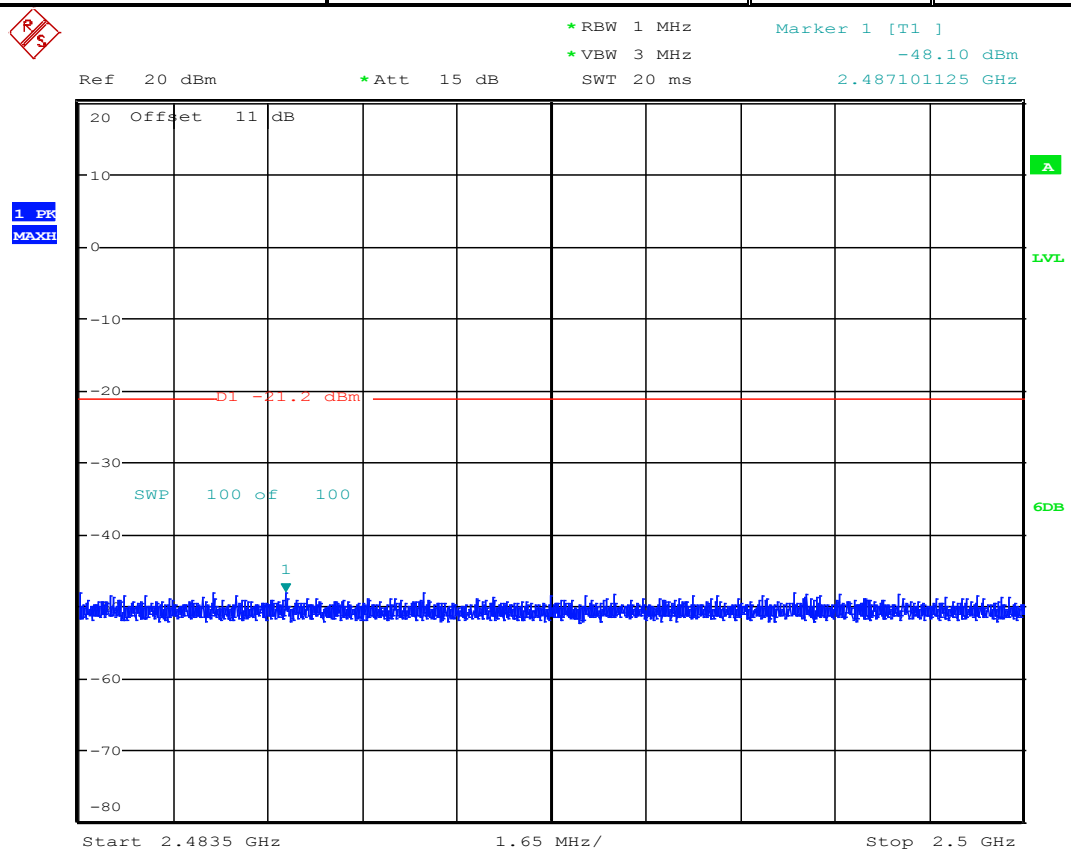
Upper Restricted Band (Hopping Mode Disabled)			
Ch. High / 2480MHz	Band: 2483.5 – 2500 MHz	Peak	GFSK (DH5)



Date: 17.MAY.2016 16:47:30

Note: Antenna gain is not in the offset.

Upper Restricted Band (Hopping Mode Enabled)			
Ch. High / 2480MHz	**Band: 2483.5 – 2500 MHz**	**Peak**	**GFSK (DH5) Max. DC**

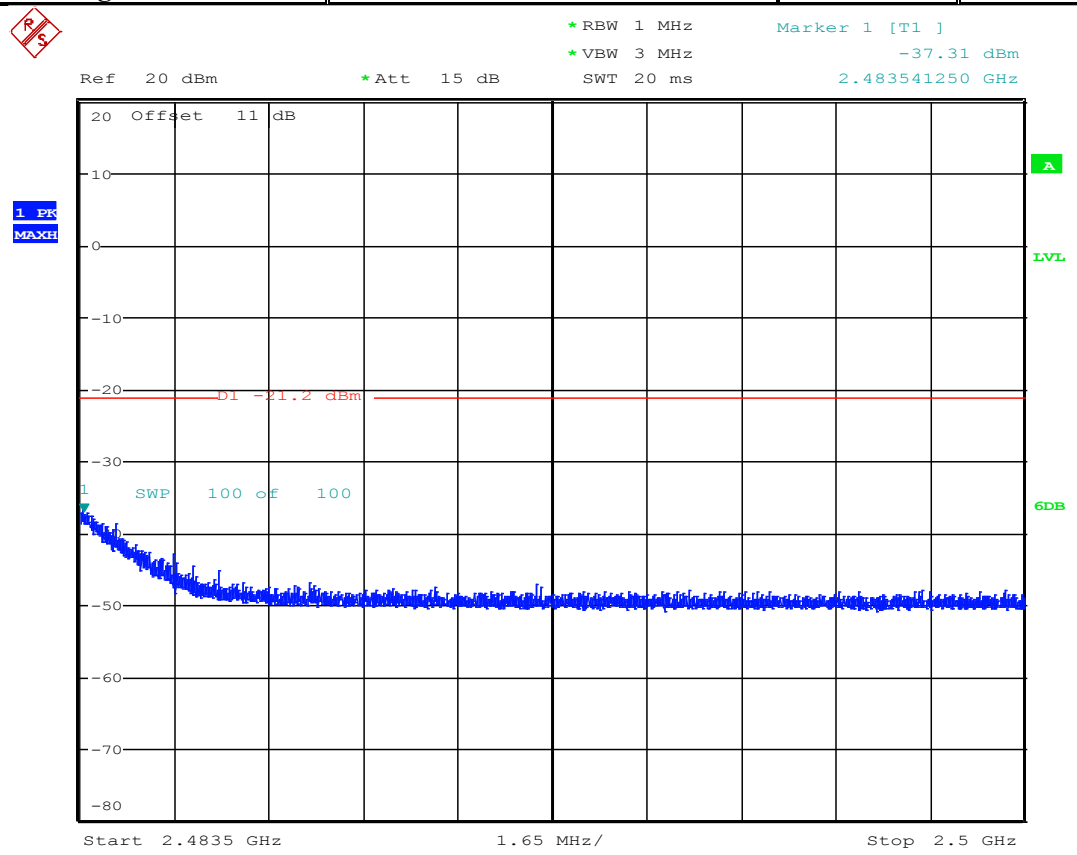


Date: 17.MAY.2016 16:23:49

Note: Antenna gain is not in the offset.

•

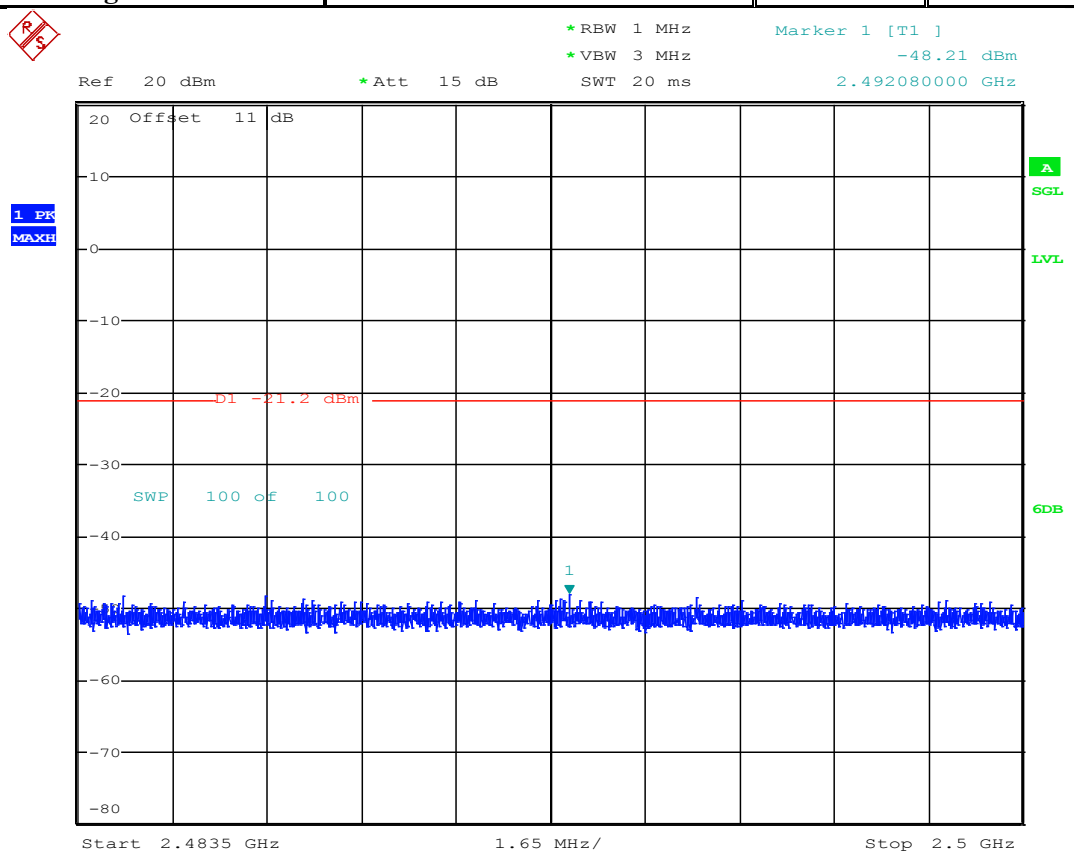
Upper Restricted Band (Hopping Mode Disabled)			
Ch. High / 2480MHz	**Band: 2483.5 – 2500 MHz**	**Peak**	**8DPSK (3-DH5)**



Date: 17.MAY.2016 16:49:30

Note: Antenna gain is not in the offset.

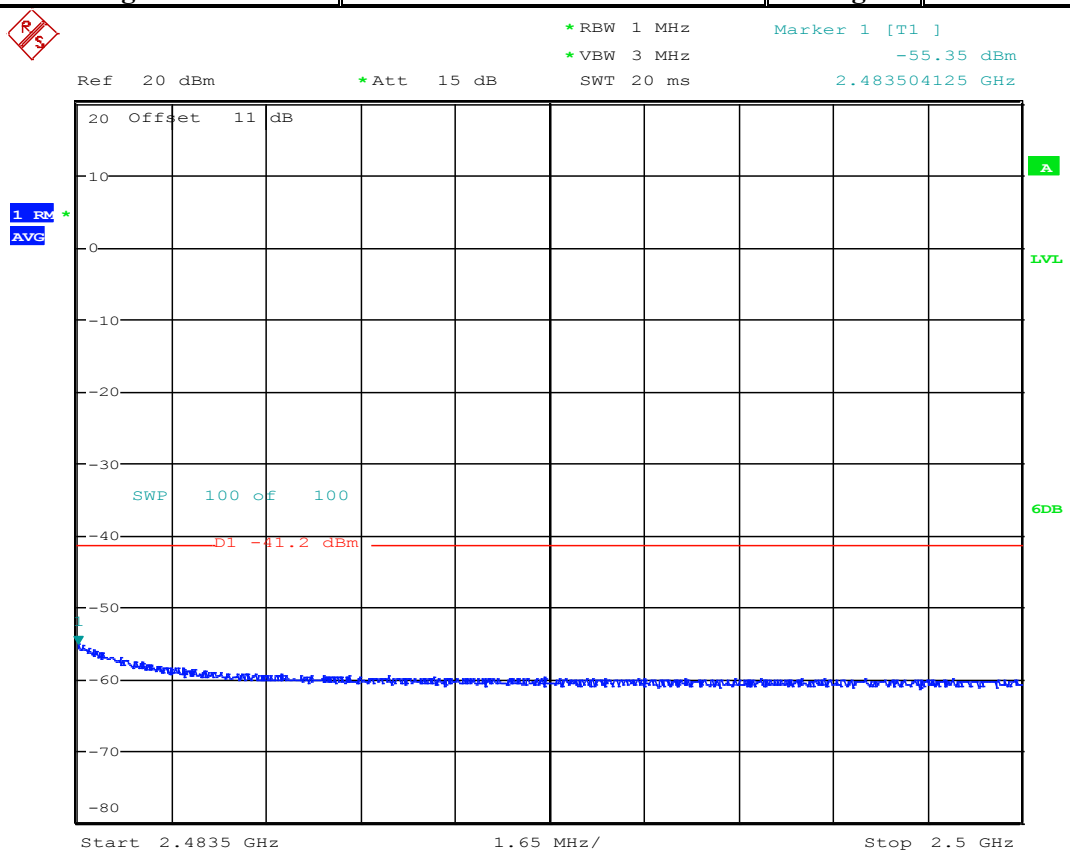
Upper Restricted Band (Hopping Mode Enabled)			
Ch. High / 2480MHz	**Band: 2483.5 – 2500 MHz**	**Peak**	**8DPSK (3-DH5)**



Date: 17.MAY.2016 16:30:58

Note: Antenna gain is not in the offset.

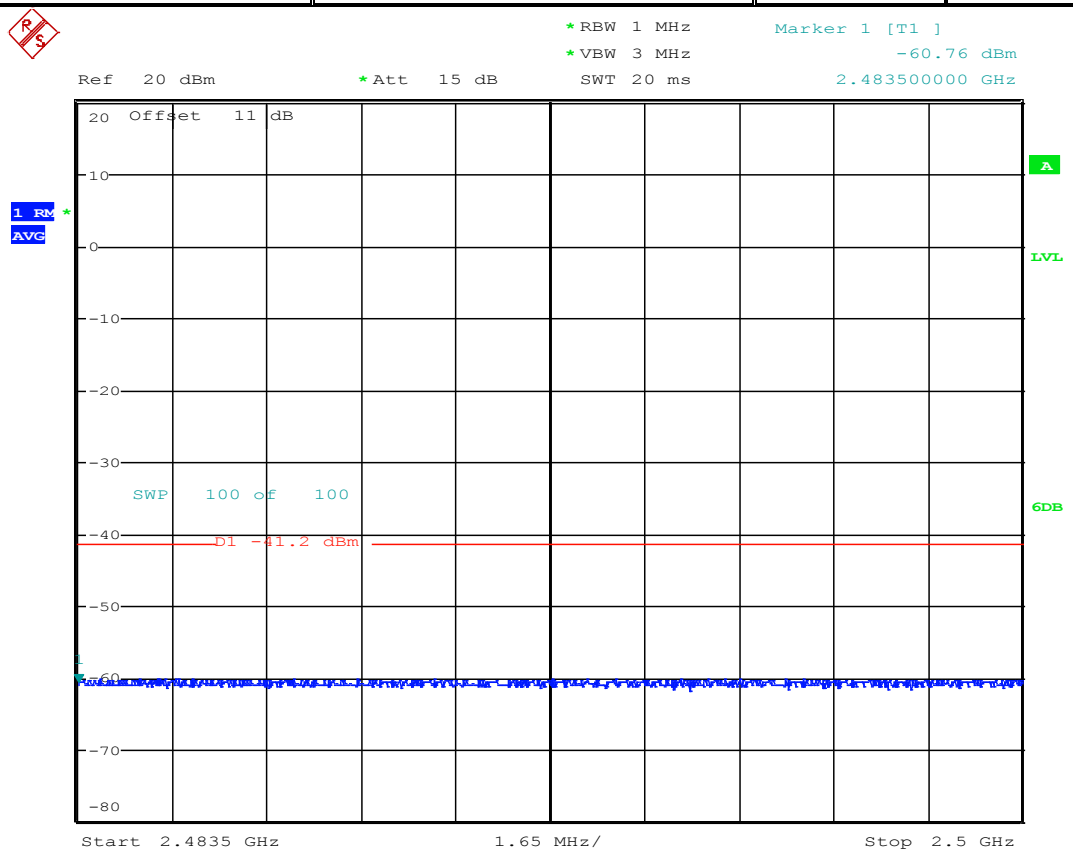
Upper Restricted Band (Hopping Mode Disabled)			
Ch. High / 2480MHz	Band: 2483.5 – 2500 MHz	Avg.	GFSK (DH5)



Date: 17.MAY.2016 16:11:01

Note: Antenna gain is not in the offset.

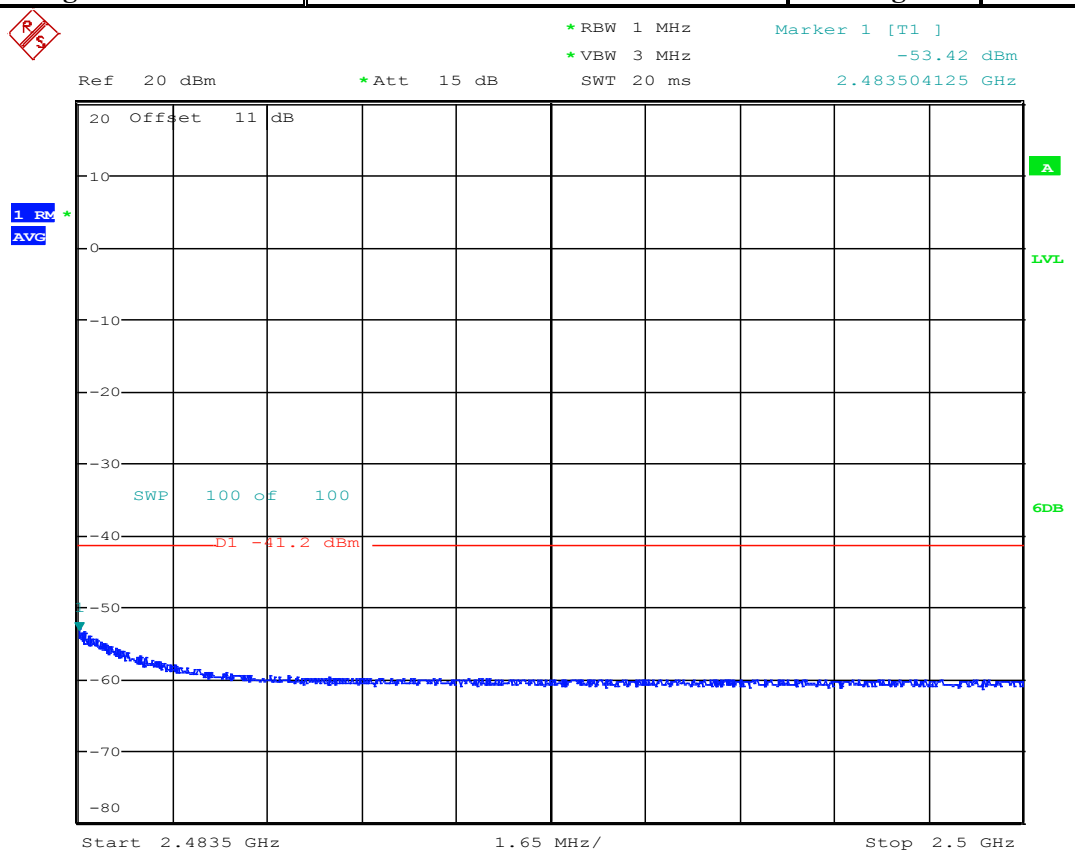
Upper Restricted Band (Hopping Mode Enabled)			
Ch. High / 2480MHz	**Band: 2483.5 – 2500 MHz**	**Avg.**	**GFSK (DH5) Max. DC**



Date: 17.MAY.2016 16:19:09

Note: Antenna gain is not in the offset.

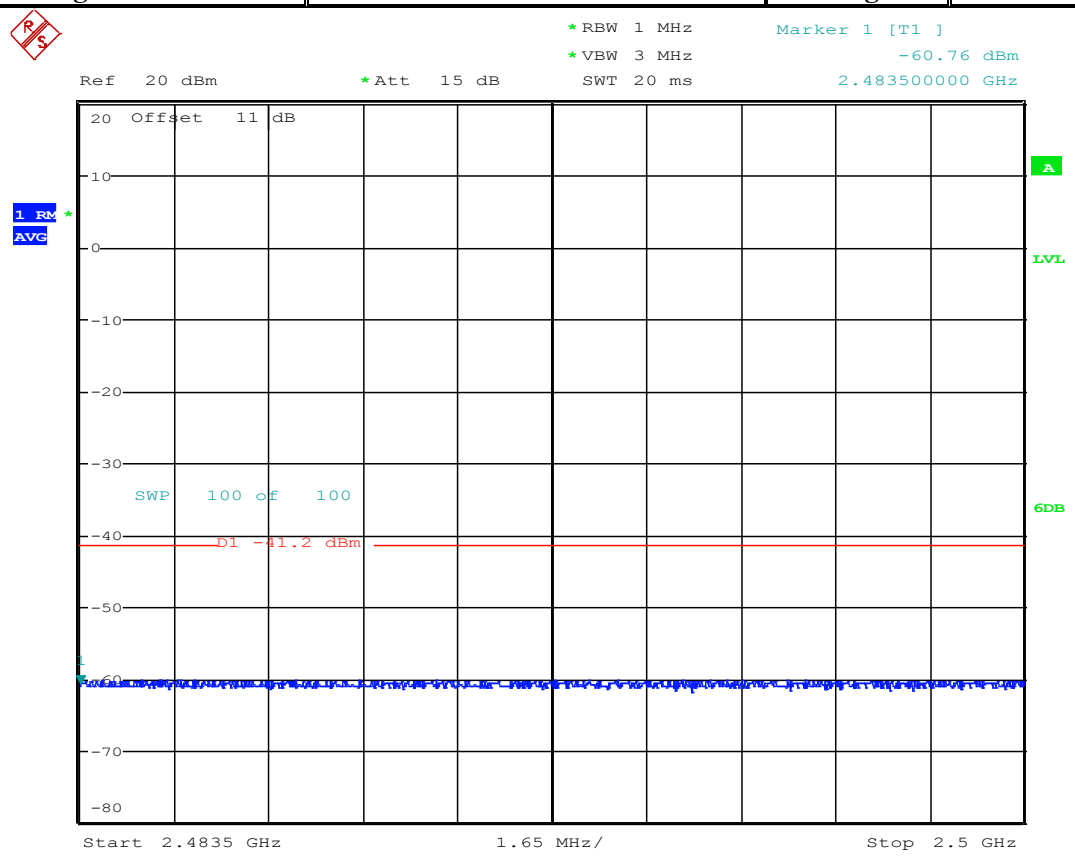
Upper Restricted Band (Hopping Mode Disabled)			
Ch. High / 2480MHz	**Band: 2483.5 – 2500 MHz**	**Avg.**	**8DPSK (3-DH5)**



Date: 17.MAY.2016 16:12:58

Note: Antenna gain is not in the offset.

Upper Restricted Band (Hopping Mode Enabled)			
Ch. High / 2480MHz	**Band: 2483.5 – 2500 MHz**	**Avg.**	**8DPSK (3-DH5)**



Date: 17.MAY.2016 16:19:09

Note: Antenna gain is not in the offset.

10.3 20dB Bandwidth / 99% Bandwidth

10.3.1 Limits:

For Reference only.

10.3.2 Test Conditions:

Tnom: 21.5 ^{o}C; Vnom: Car Battery.
Hopping OFF

Testing was done on all 3 modulations with Max. duty cycle.

10.3.3 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

10.3.4 Test Data:

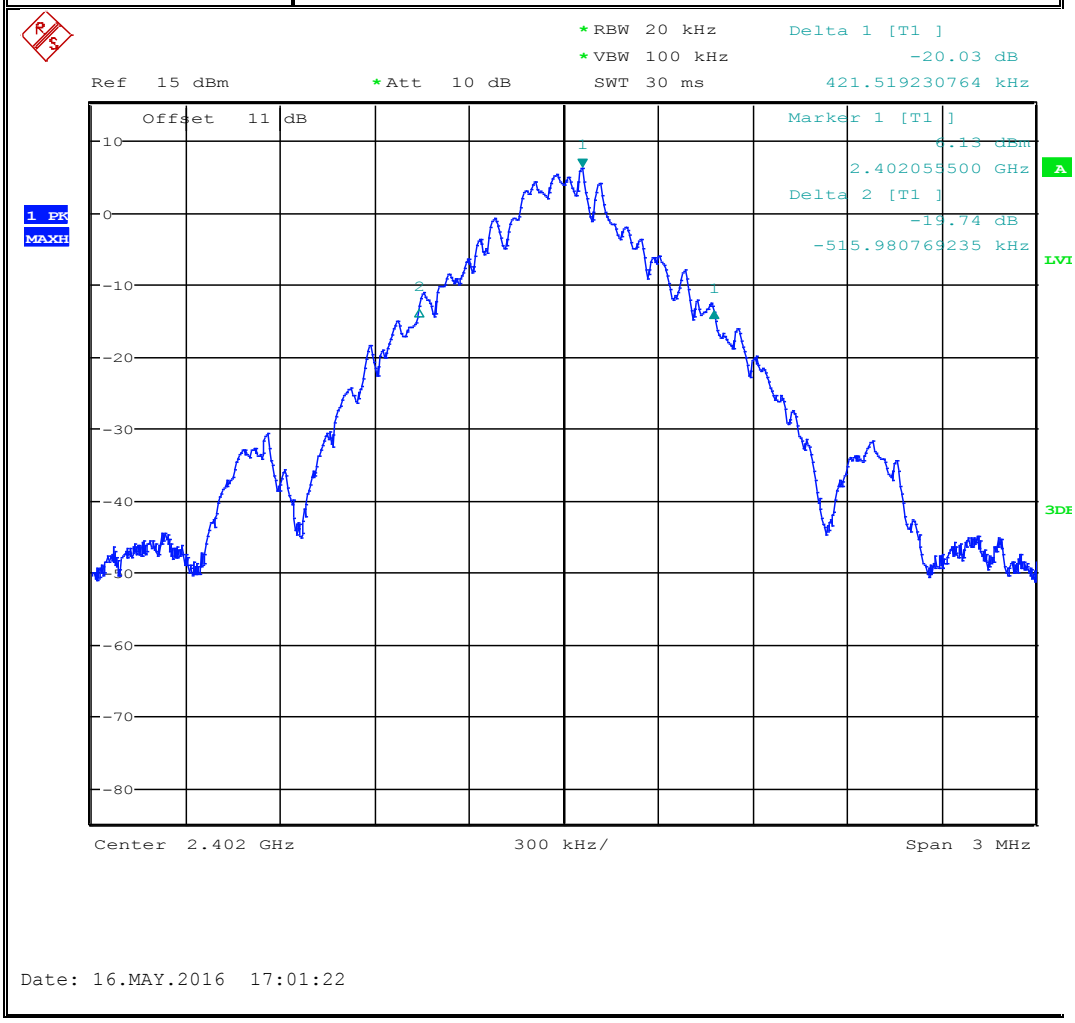
20dB Bandwidth / 99% Bandwidth			
Modulation	**Frequency (MHz)**		
	2402	**2441**	**2480**
GFSK	0.937	0.939	0.934
π/4 DQPSK	1.384	1.391	1.395
8-DPSK	1.370	1.376	1.385

10.3.5 Measurement Result

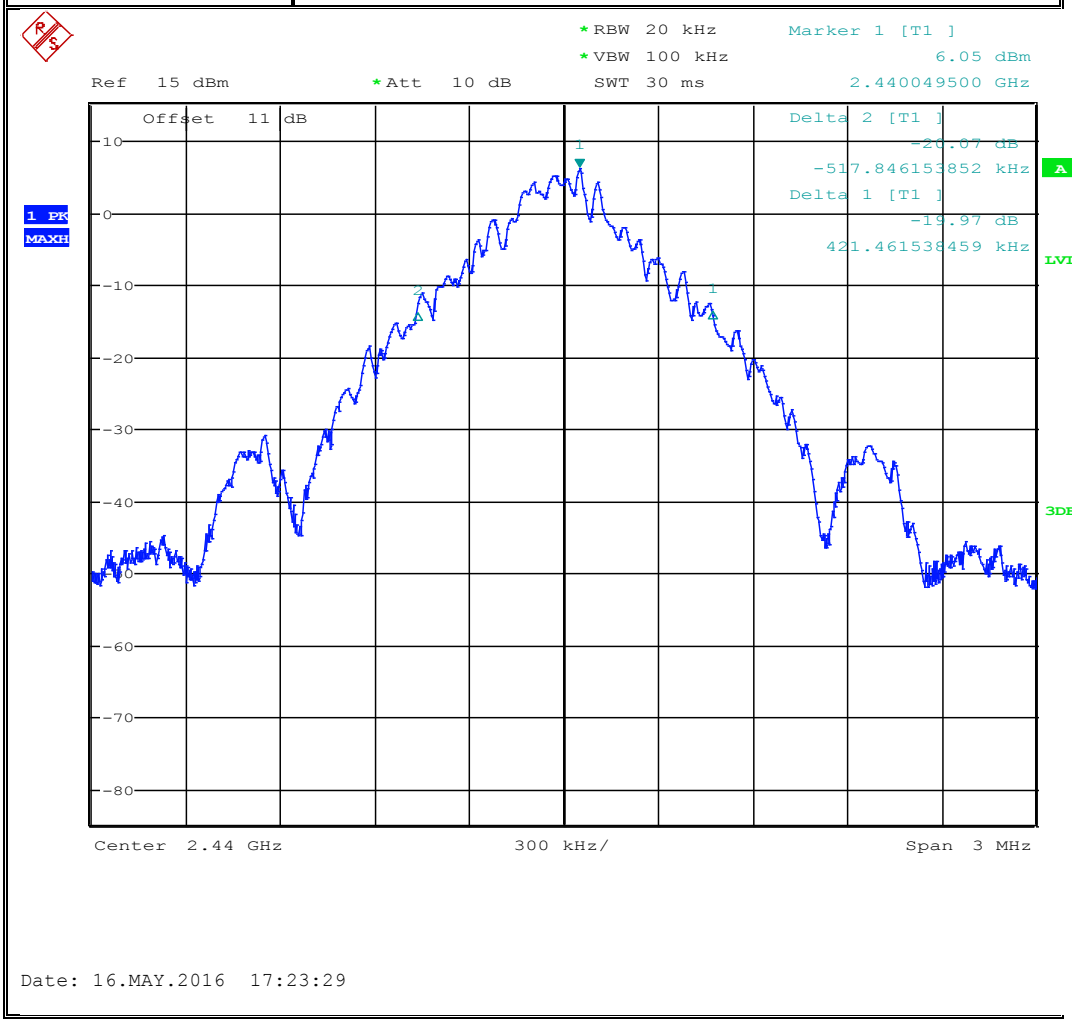
Not Applicable (for reference only)

10.3.6 Test Data/plots:

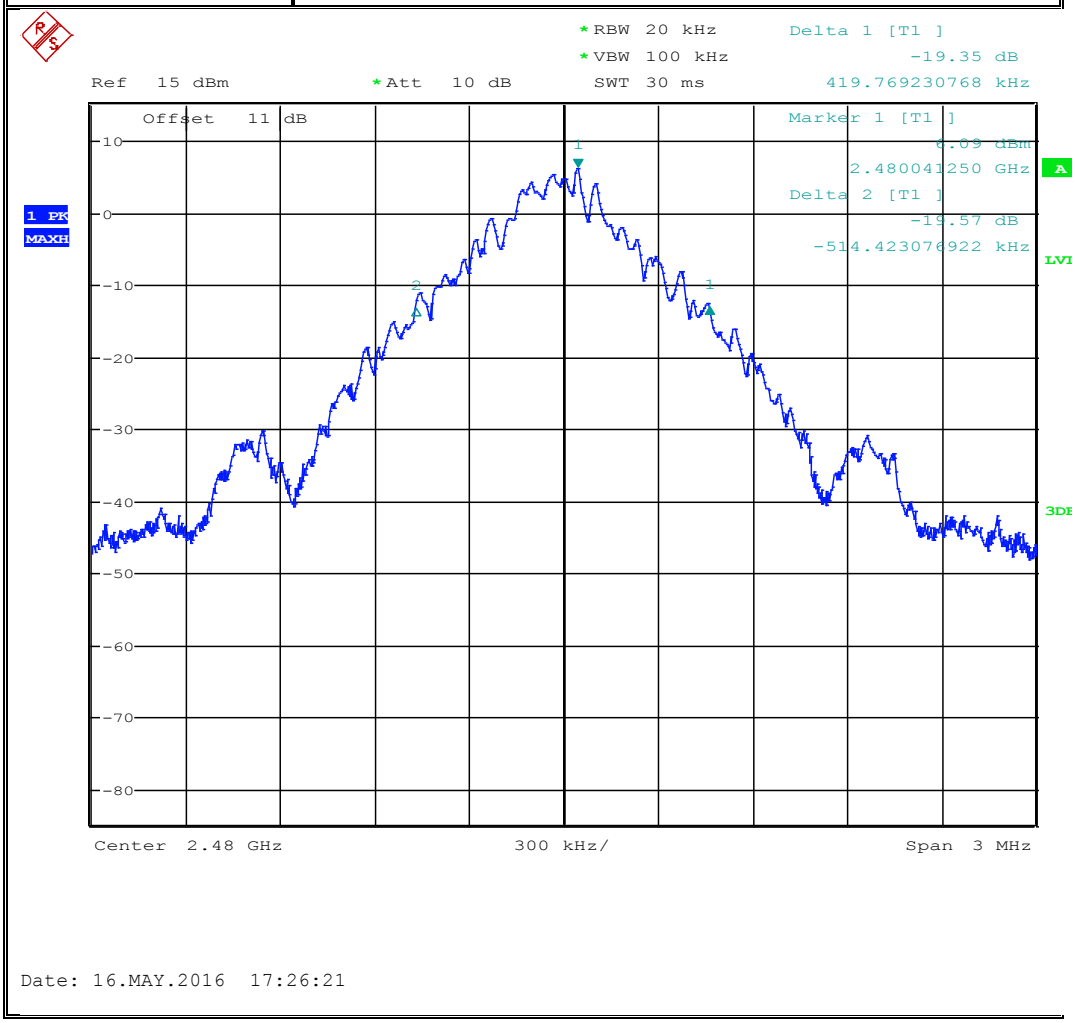
20dB Bandwidth	
Ch.0 / 2402 MHz	Modulation: GFSK / Max. DC



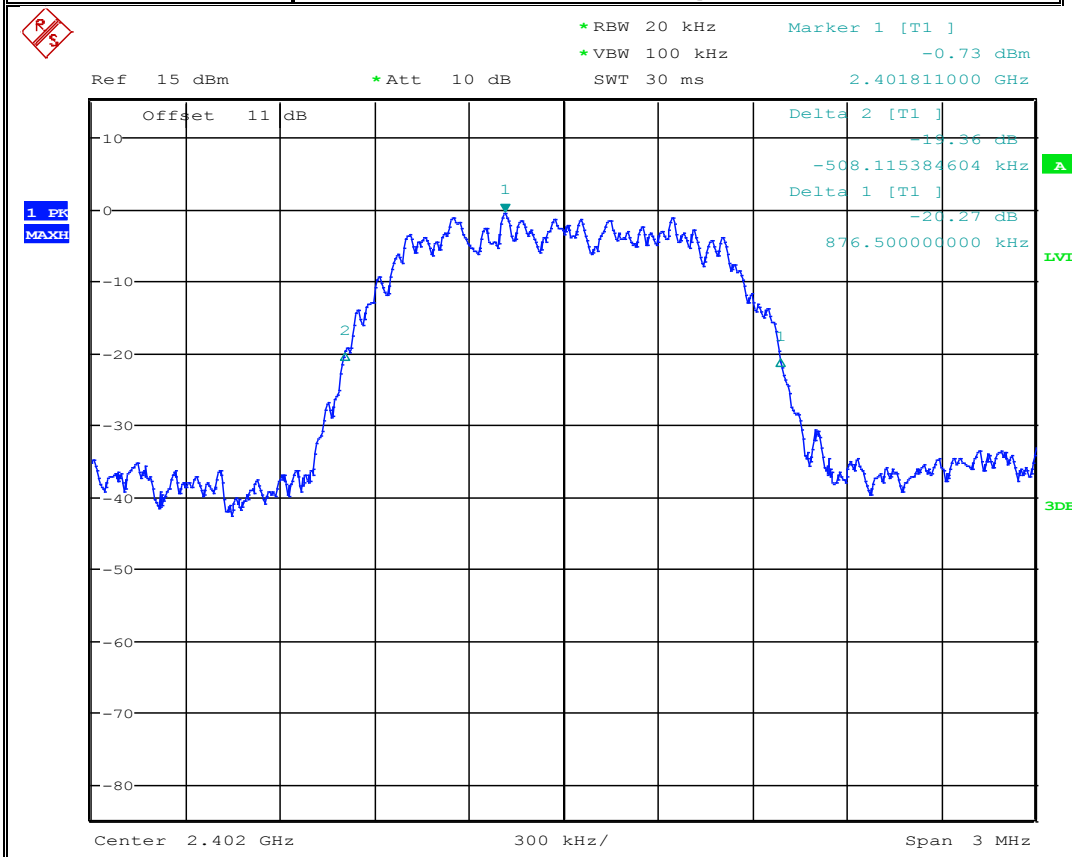
Ch.39 / 2441 MHz	Modulation: GFSK / Max. DC



Ch.78 / 2480 MHz	Modulation: GFSK / Max. DC

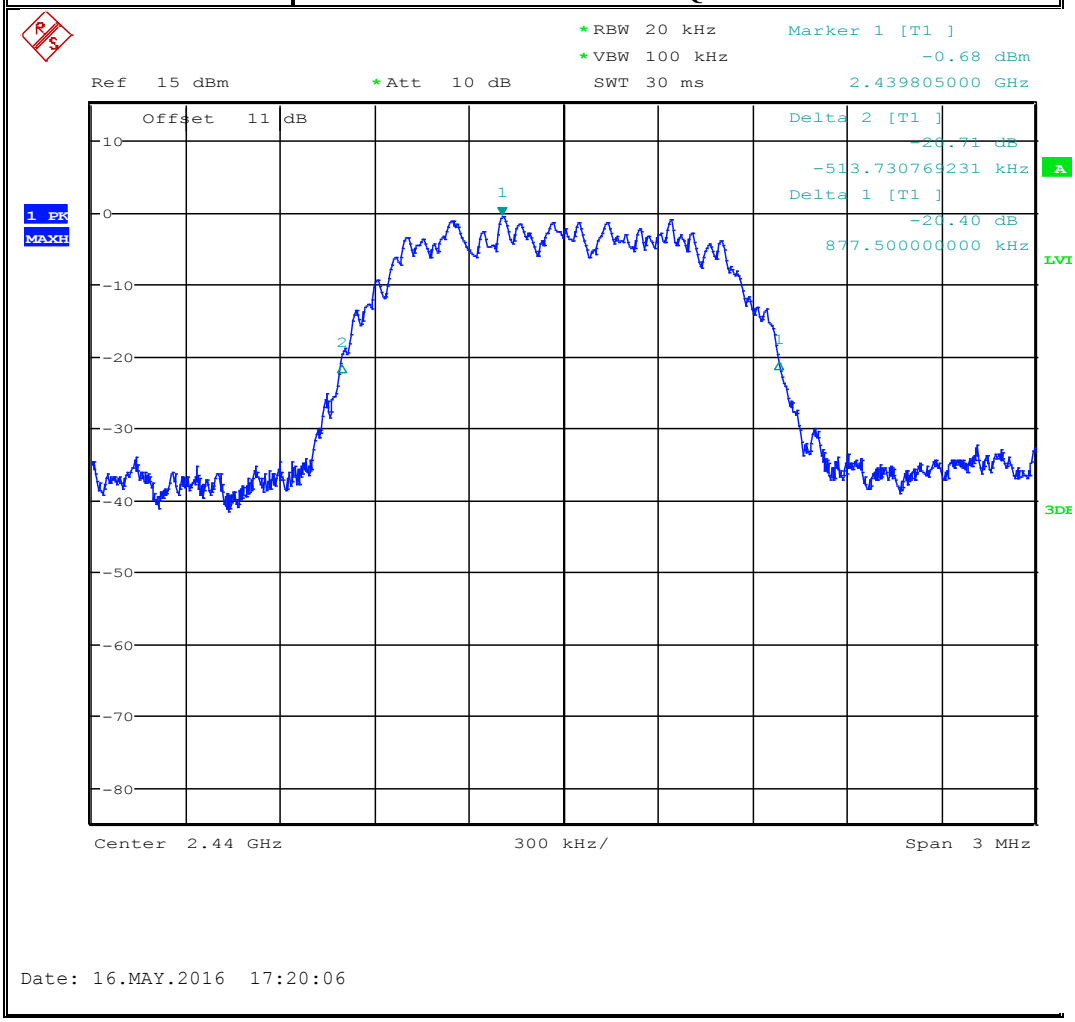


Ch.0 / 2402 MHz	Modulation: π/4 DQPSK / Max. DC

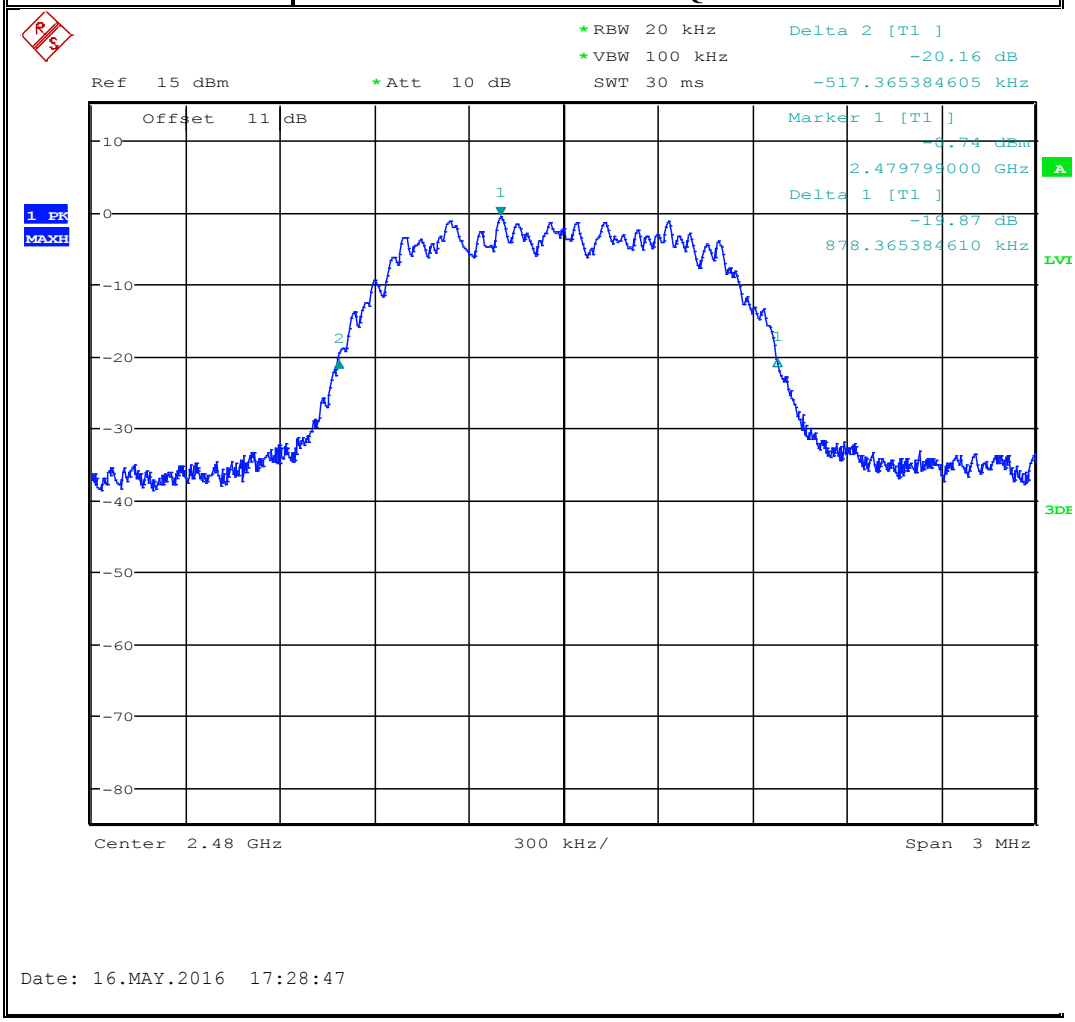


Date: 16.MAY.2016 17:05:11

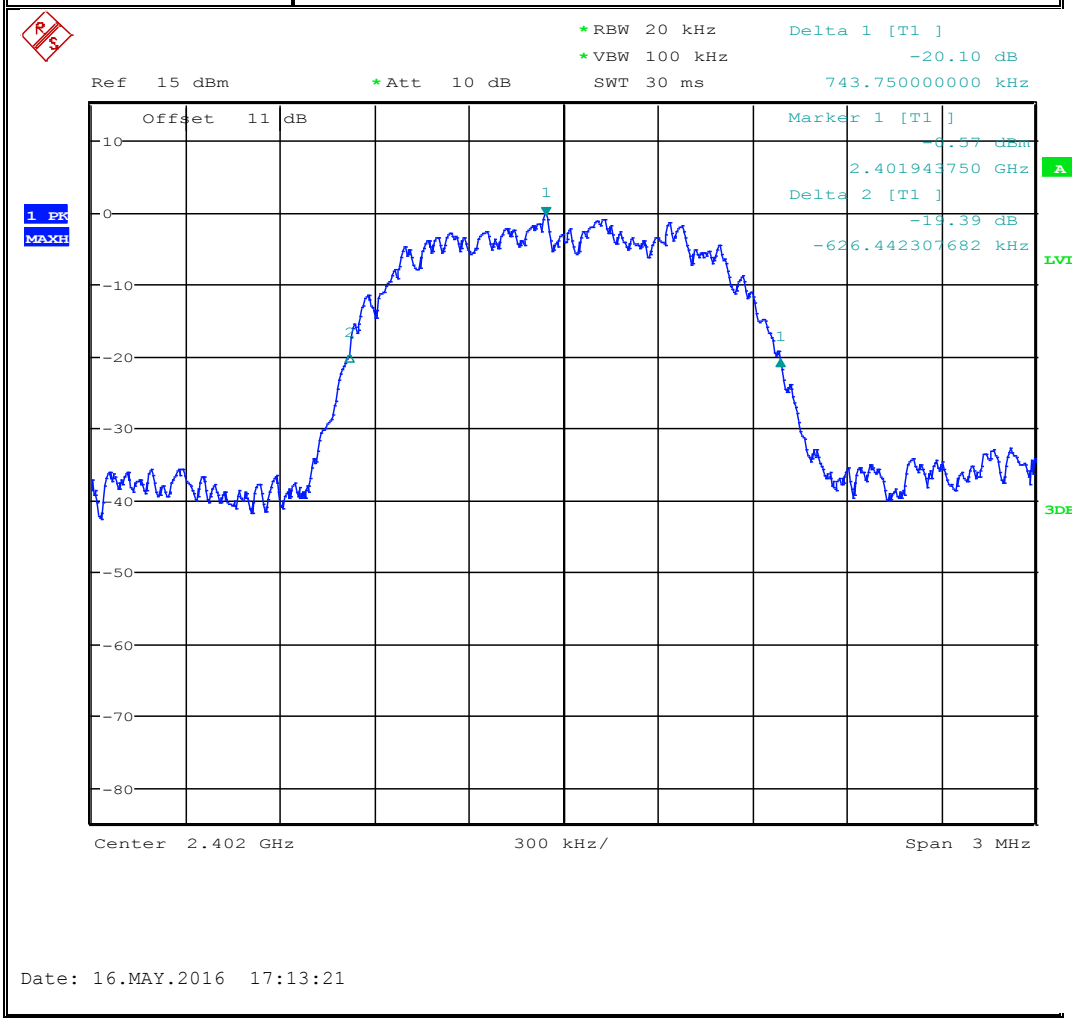
Ch.39 / 2441 MHz	Modulation: π/4 DQPSK / Max. DC



Ch.78 / 2480 MHz	Modulation: π/4 DQPSK / Max. DC

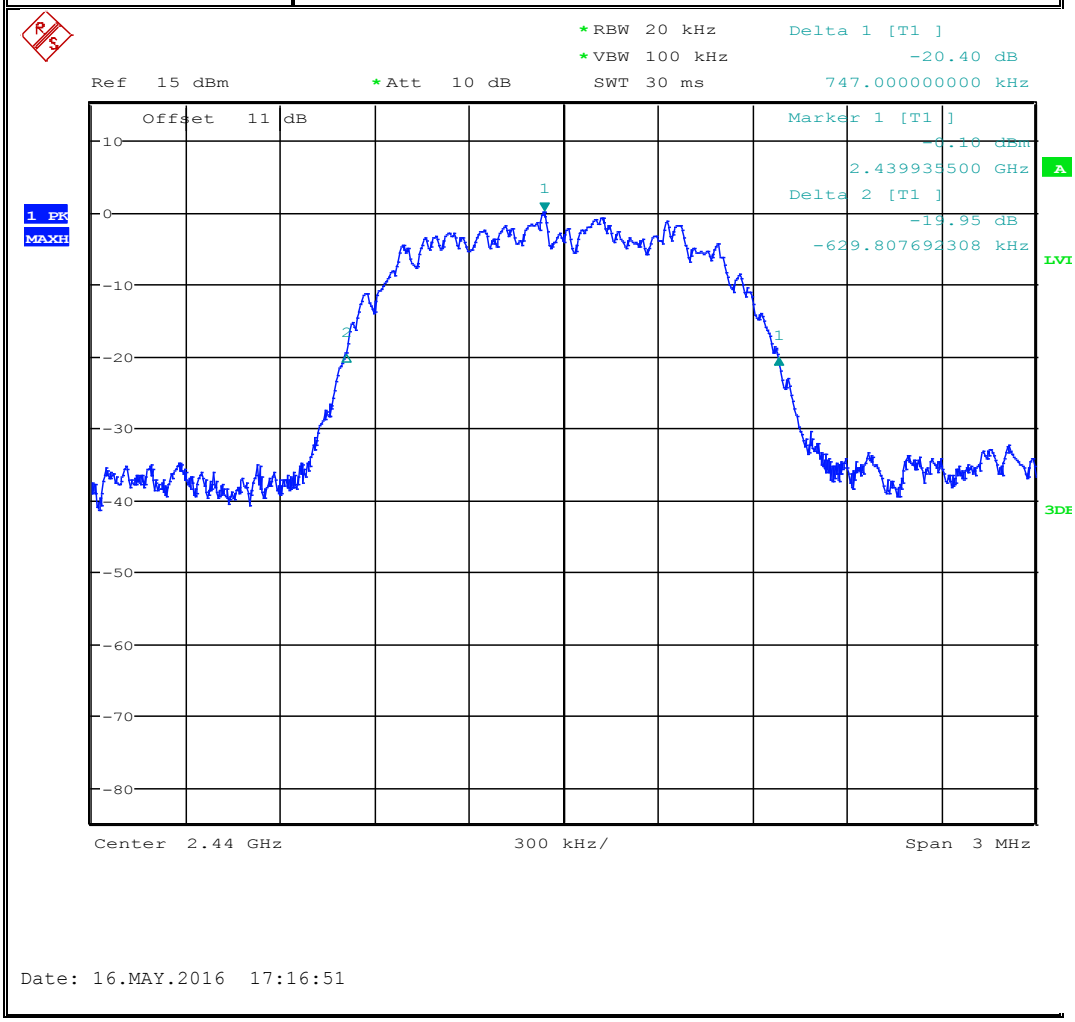


Ch.0 / 2402 MHz	Modulation: 8-DPSK / Max. DC



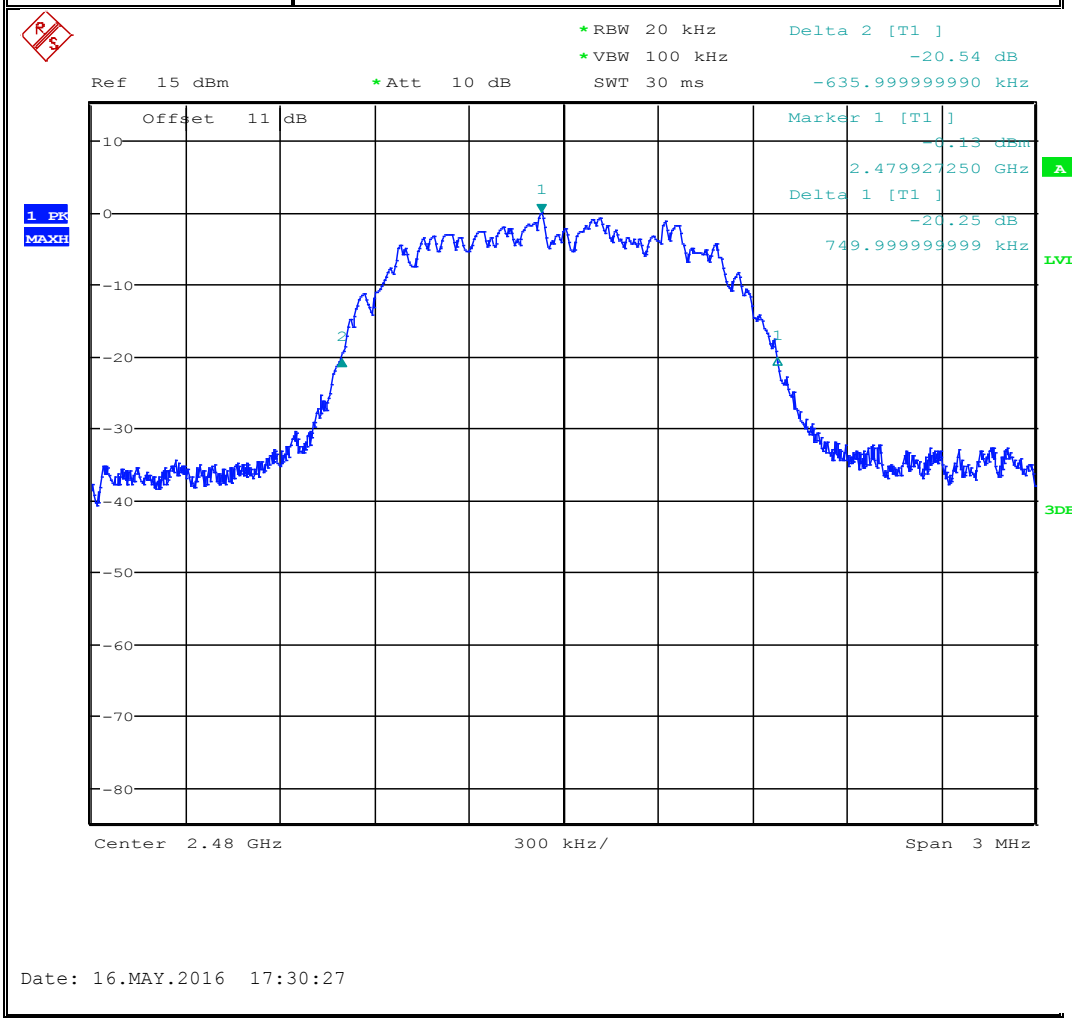
Date: 16.MAY.2016 17:13:21

Ch.39 / 2441 MHz	Modulation: 8-DPSK / Max. DC



Date: 16.MAY.2016 17:16:51

Ch.78 / 2480 MHz	Modulation: 8-DPSK / Max. DC



10.4 Carrier Frequency Separation

10.4.1 Limits:

§ 15.247 (a) (1)
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Considering the maximum 20 dB bandwidth measured of each modulation, the minimum carrier frequency separation is:

GFSK
$\frac{2}{3}(20\ dB\ Bandwidth)$ **= 0.626 MHz**

For 8PSK:
$\frac{2}{3}(20\ dB\ Bandwidth)$ **= 0.923 MHz**

10.4.2 Test Conditions:

Tnom: 21.3^{o}C; Vnom: Car Battery

10.4.3 Test Procedure:

Measurement according to ANSI C63.10-2013Section 7.8.2
The EUT shall have its hopping function enabled.
a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.
Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

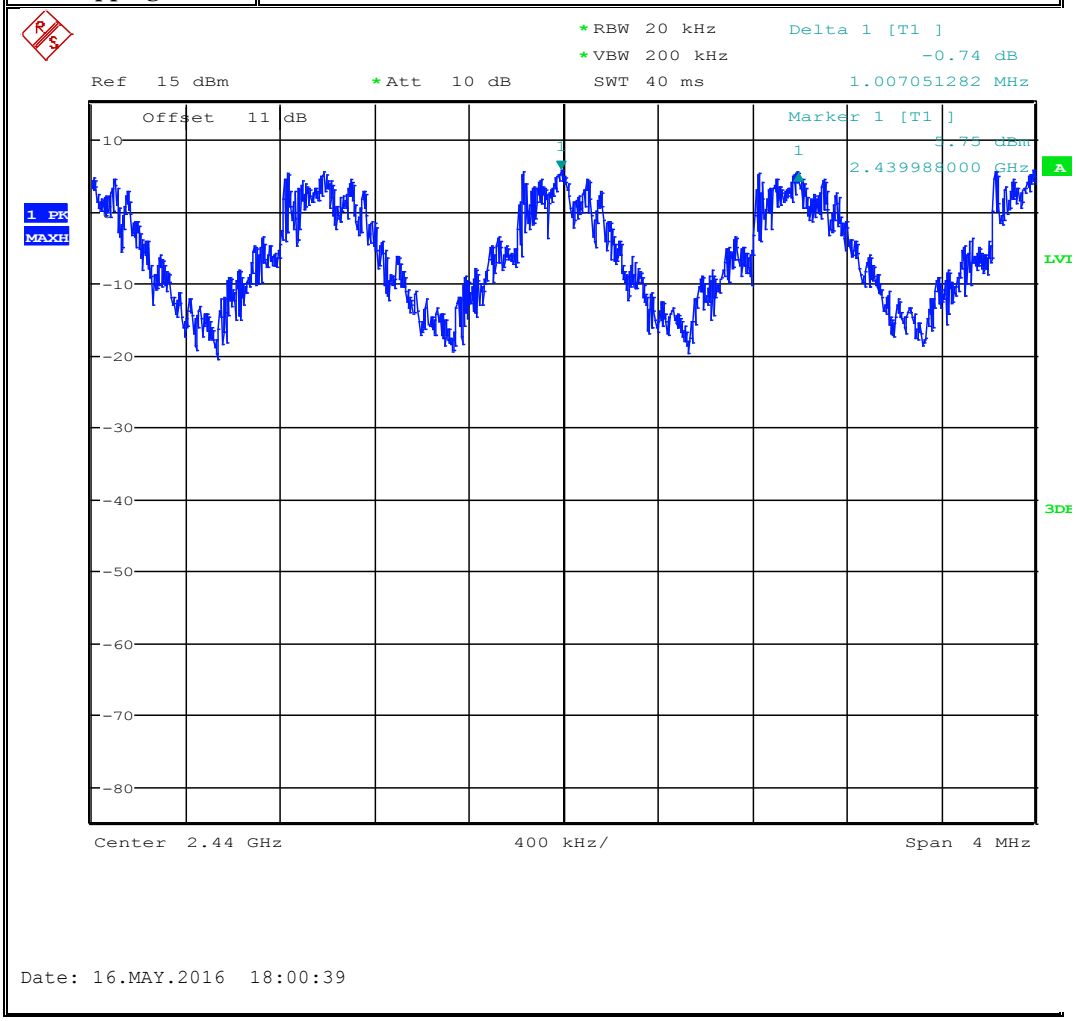
10.4.4 Measurement result:

Channel Separation: GFSK: 1.007 MHz
8-DPSK: 1.006 MHz

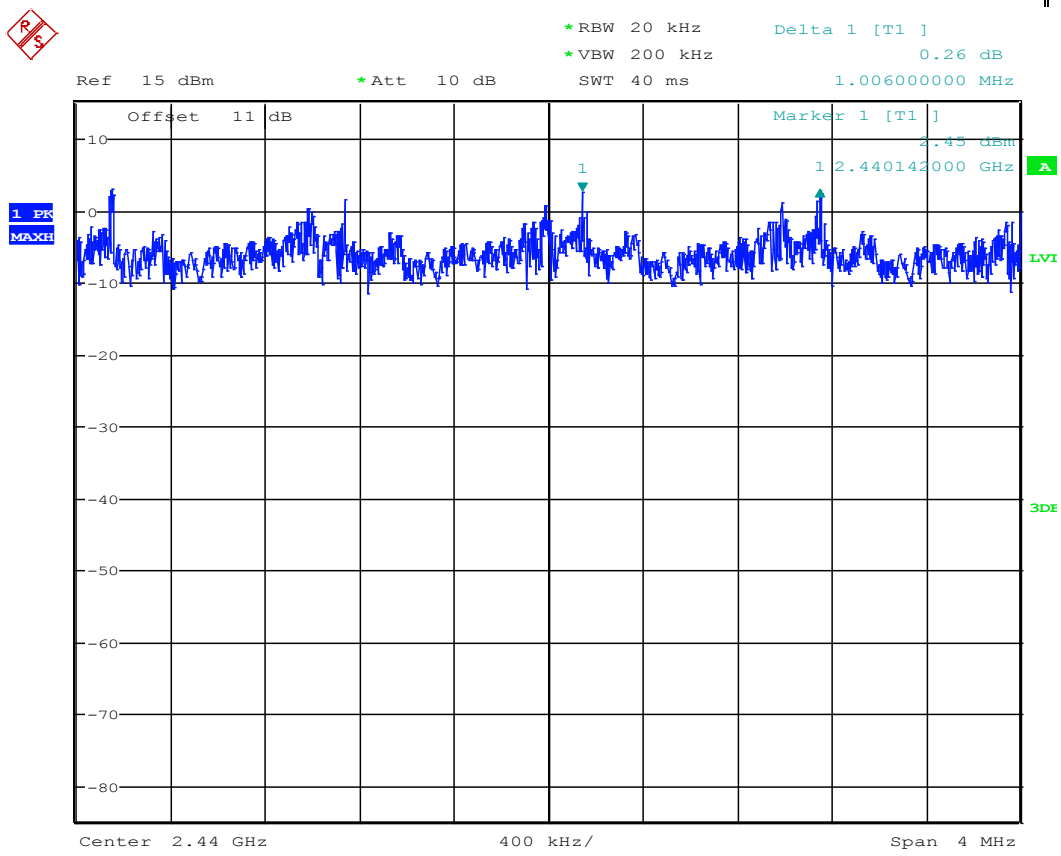
Pass

10.4.5 Measurement plots:

Channel Separation	
Packet Type: DH5	**Modulation: GFSK**
Hopping On	**Channel 39 & Channel 40**



Channel Separation	
Packet Type: DH5	**Modulation: 8-DPSK**
Hopping On	**Channel 39 & Channel 40**



Date: 16.MAY.2016 18:08:44

10.5 Number of hopping channels

10.5.1 Limits:

§ 15.247 (a) (1) (ii) (iii)
At least 15 non-overlapping channels

10.5.2 Test Conditions:

Tnom: 22°C; Vnom: Car Battery.

10.5.3 Test Procedure:

Measurement according to ANSI C63.10-2013 Section 7.8.3

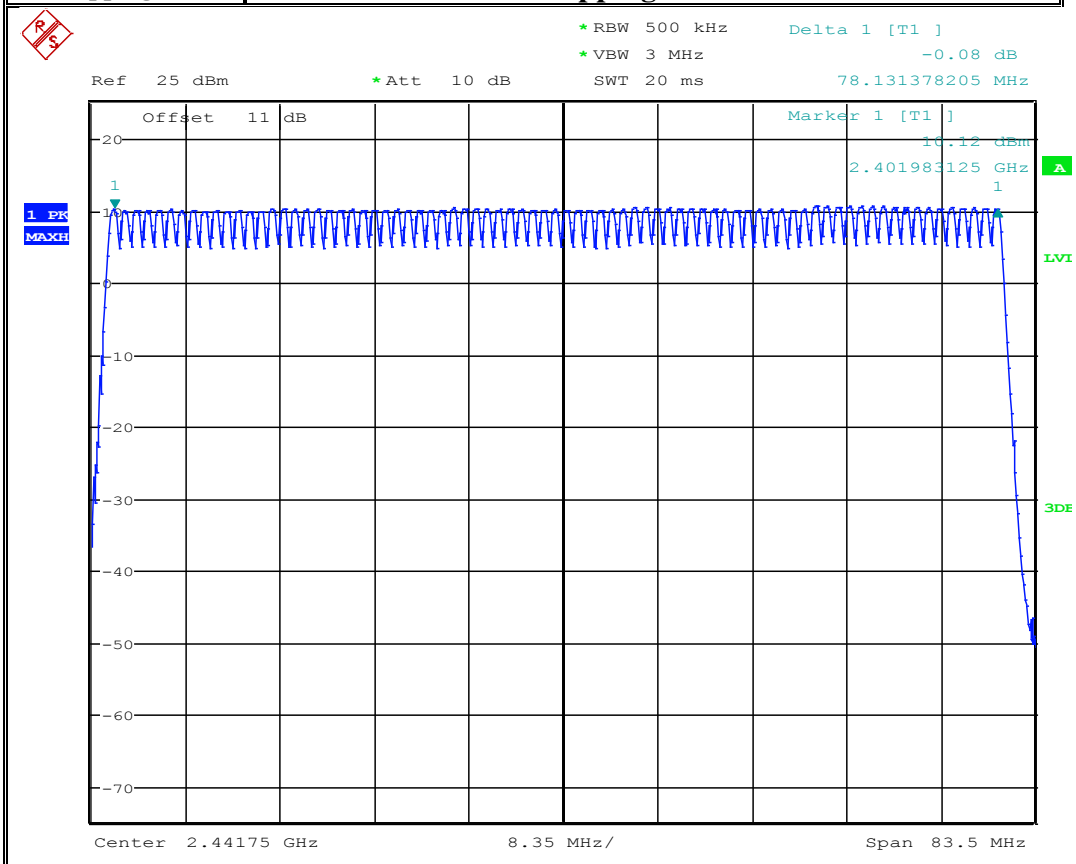
Hopping function: enabled
Spectrum Analyzer settings:
Span = the entire frequency band of operation
Set RBW to capture the peaks.
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
The EUT must have its hopping function enabled during the test.

10.5.4 Measurement Result:

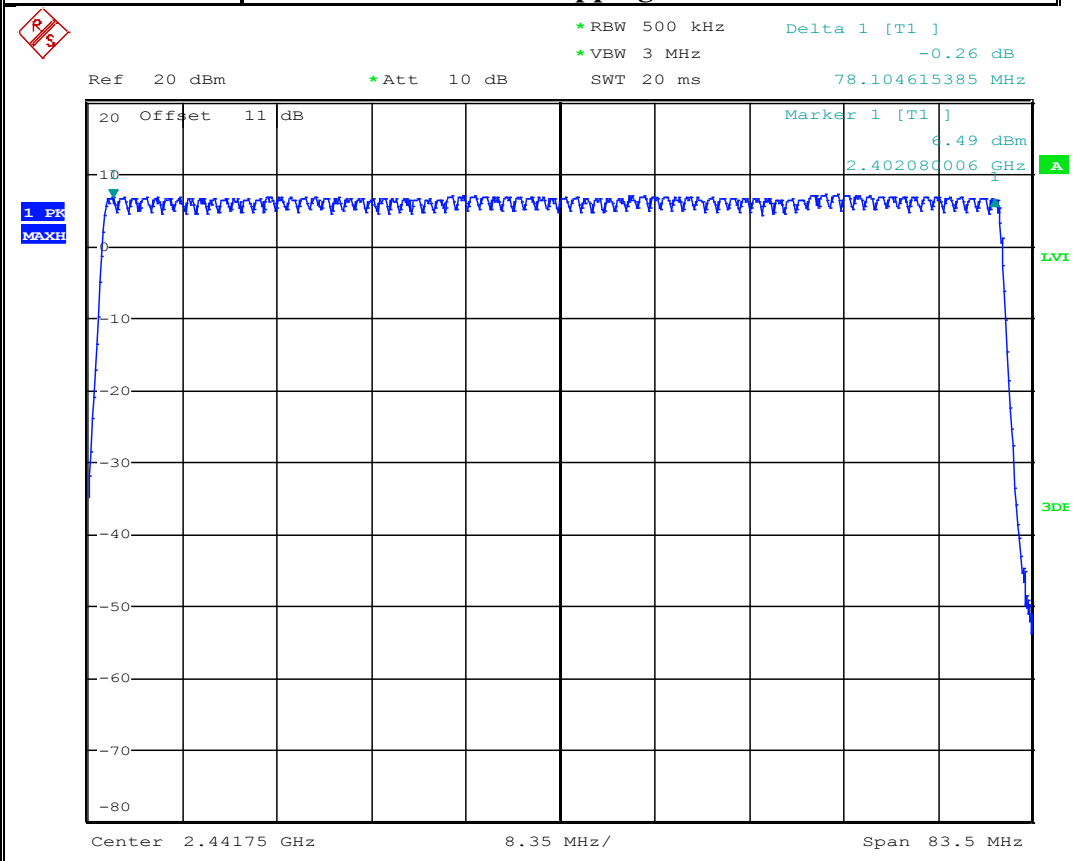
Number of hopping channels: 79
Pass

10.5.5 Measurement Plots:

No. of Hopping frequencies	
Packet Type: DH5	**Modulation: GFSK**
Hopping On	**Total Hopping channels = 79**



No. of Hopping frequencies	
Packet Type: 3-3-3-DH5	Modulation: 8-DPSK
Hopping On	Total Hopping channels = 79



Date: 16.MAY.2016 18:17:30

10.6 Time of occupancy / Dwell time

10.6.1 Limits:

§ 15.247 (a) (1) (iii)

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

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

10.6.2 Test Conditions

Tnom: 23°C; Vnom: Car Battery

10.6.3 Test Procedure:

Duration of Pulse Measurement

Spectrum Analyser Settings:
RBW= 1MHz
VBW= 3MHz
Sweep Time= 10 ms
Sweep Mode= Single
Detector=Peak
Trigger= Video

Observation Period

Spectrum Analyser Settings:
RBW= 1MHz
VBW= 3MHz
Sweep Time= 31.6 s
Sweep Mode= Single
Detector=Peak
Trigger= Free Run

A 31.6 second sweep was performed for each test case. The trace data was saved and the number of Tx pulses were computed by applying a threshold. The time of occupancy was calculated by multiplying the number of Tx pulses by the duration of the pulse.

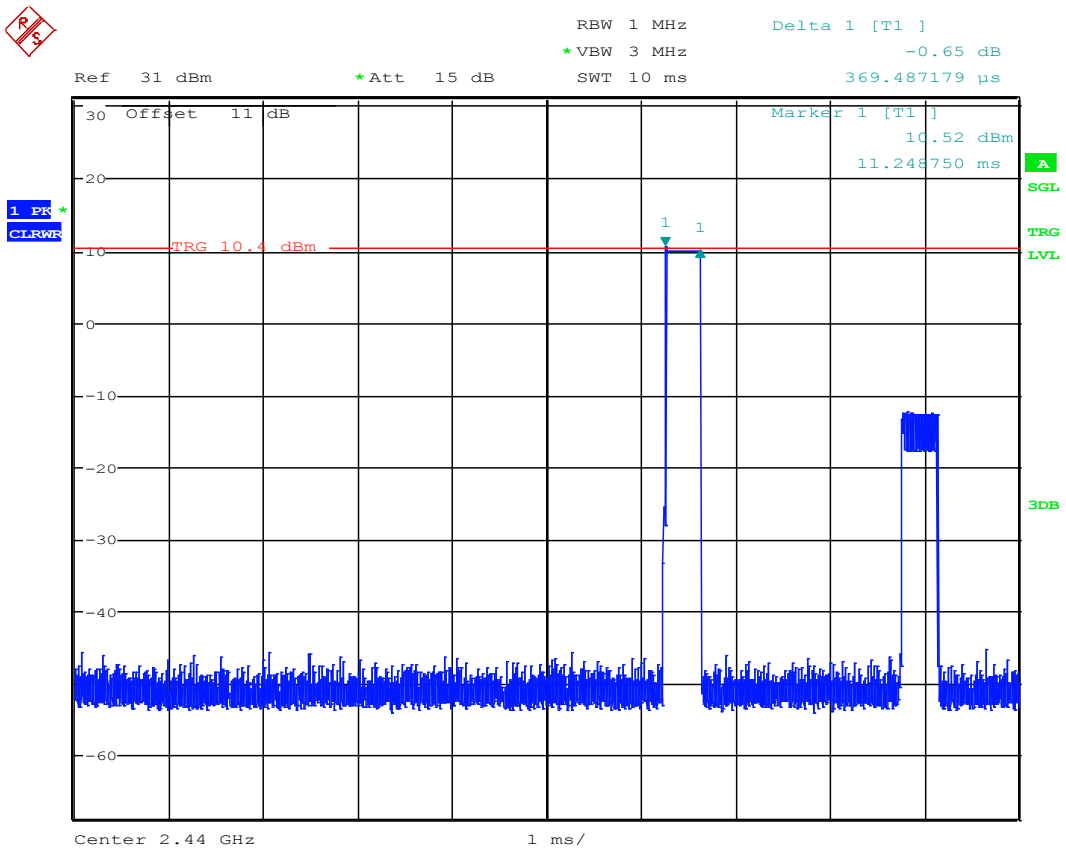
10.6.4 Measurement Result:

Channel	Timing	Modulation	Pulse Duration (ms)	# hops 31.6s	total dwell time in 31.6s (ms)	Limit	Result
38	DH1	GFSK	0.396	316	125.136	< 400 in 31.6s	Pass
38	DH3	GFSK	1.63	166	270.58	< 400 in 31.6s	Pass
38	DH5	GFSK	2.869	92	263.948	< 400 in 31.6s	Pass
38	2-DH3	π/4 DQPSK	2.85	82	233.7	< 400 in 31.6s	Pass
38	3-DH5	8-DPSK	2.89	98	283.22	< 400 in 31.6s	Pass

10.6.5 Test Data/Plots:

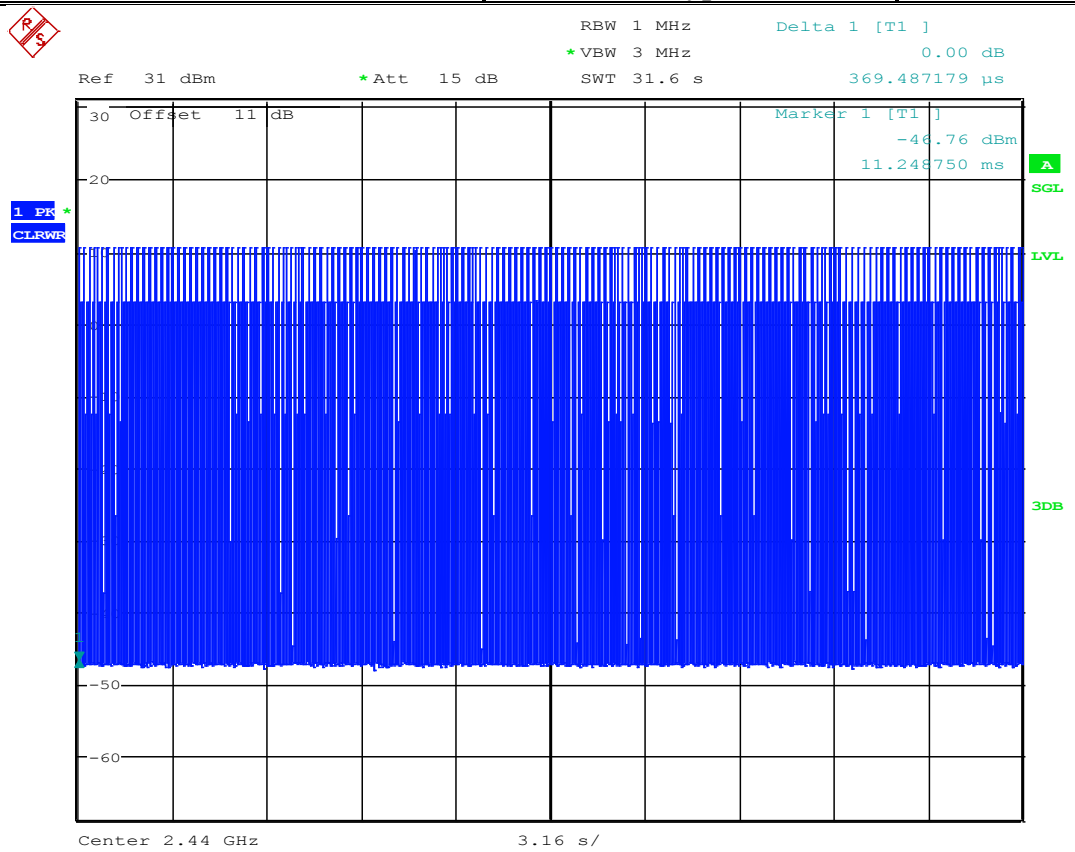
10.6.5.1 GFSK DH1

Duration of Pulse



Date: 16.MAY.2016 19:52:07

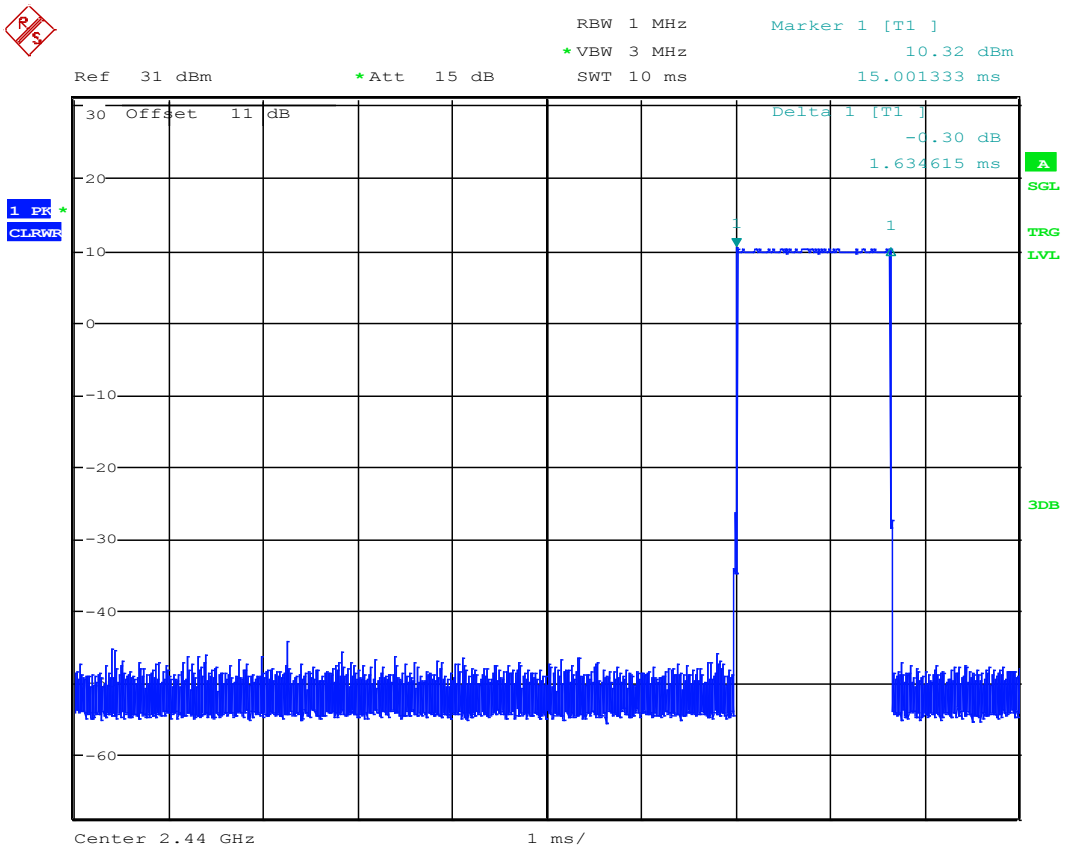
Transmission on Time in Observation Period (31.6s)		
Modulation: GFSK	**Packet Type: DH1**	**Number of Tx Bursts = 312**



Date: 16.MAY.2016 20:08:11

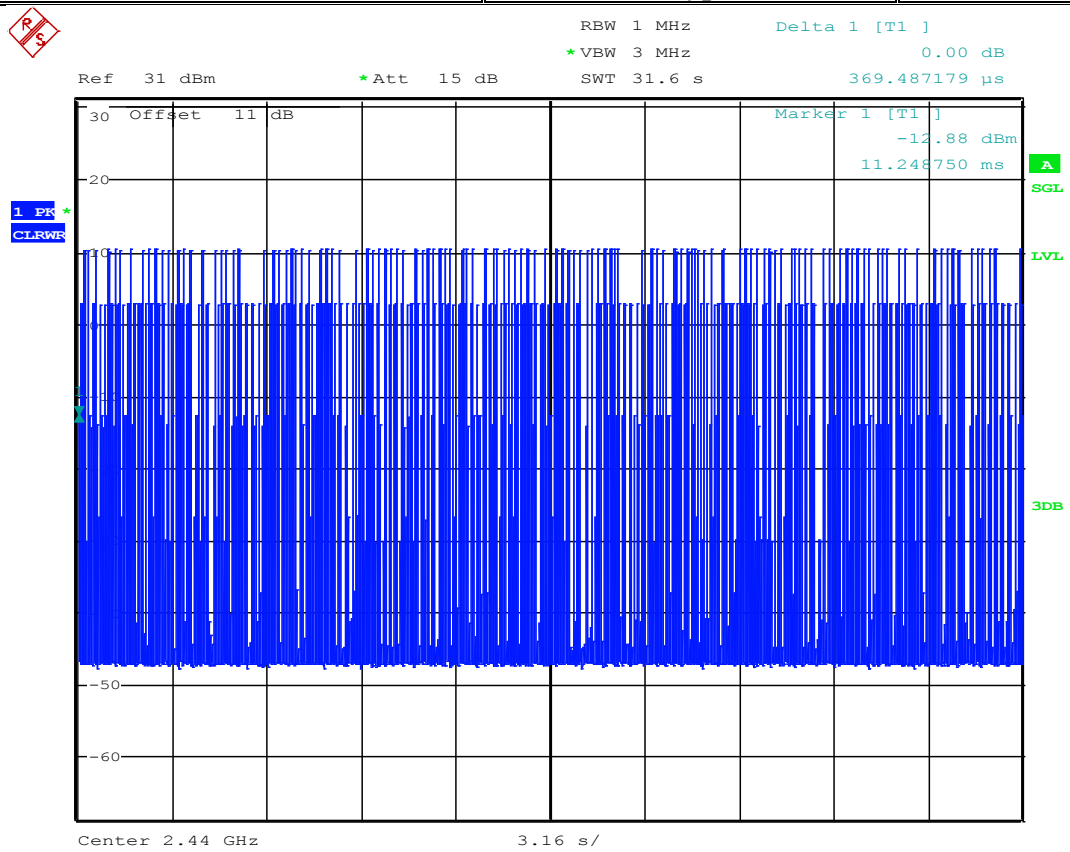
10.6.5.2 GFSK DH3

Duration of Pulse



Date: 16.MAY.2016 21:02:56

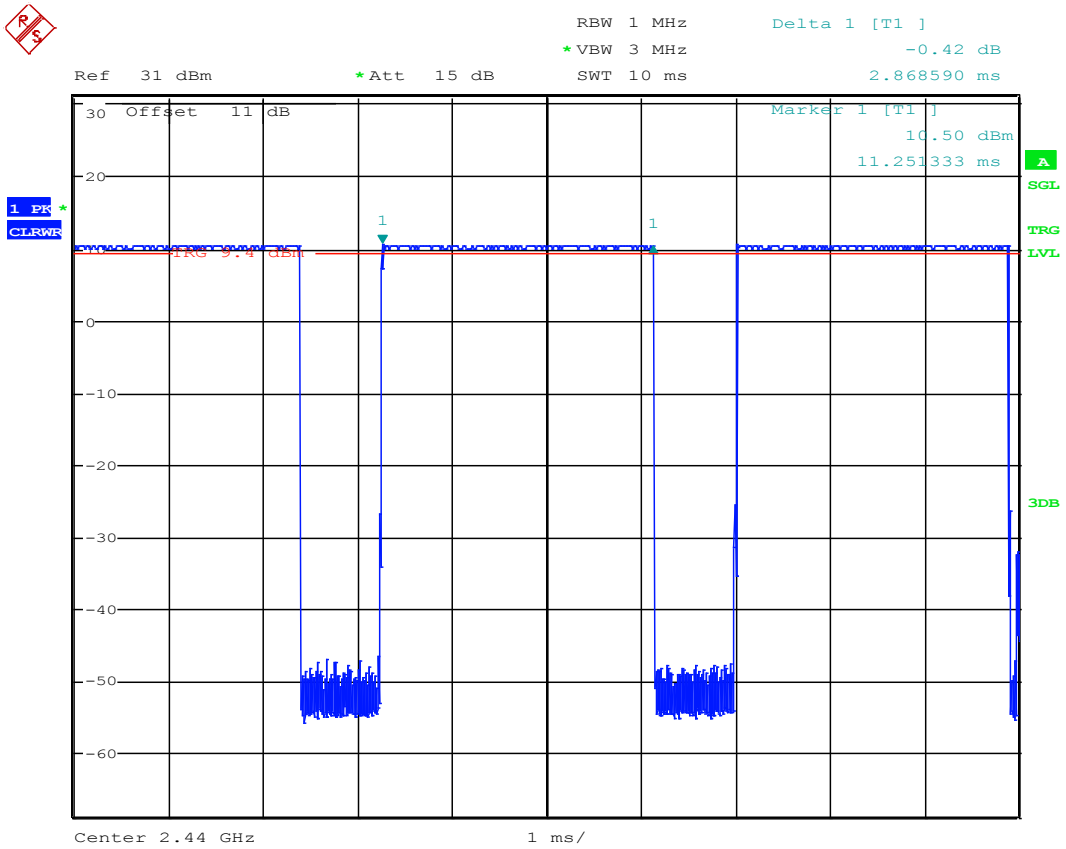
Transmission on Time in Observation Period (31.6s)		
Modulation: GFSK	**Packet Type: DH3**	**Number of Tx Bursts =155**



Date: 16.MAY.2016 20:50:04

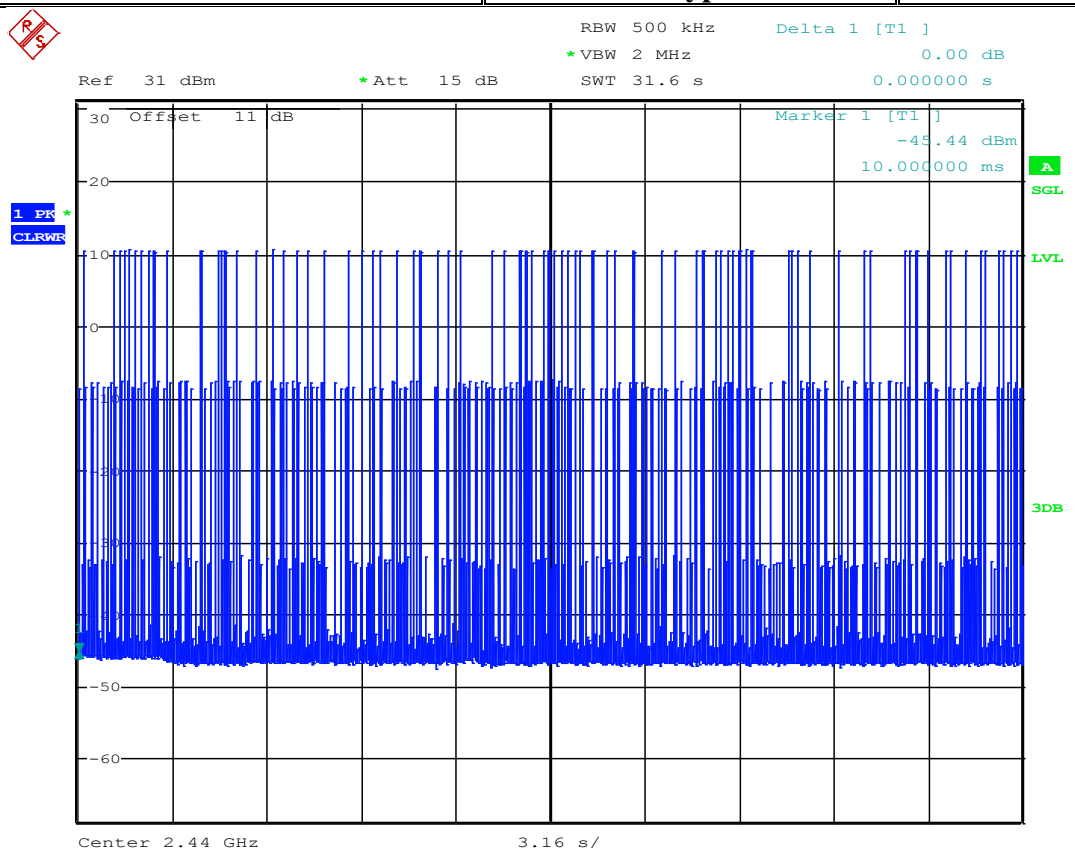
10.6.5.3 GFSK DH5

Duration of Pulse



Date: 17.MAY.2016 09:05:26

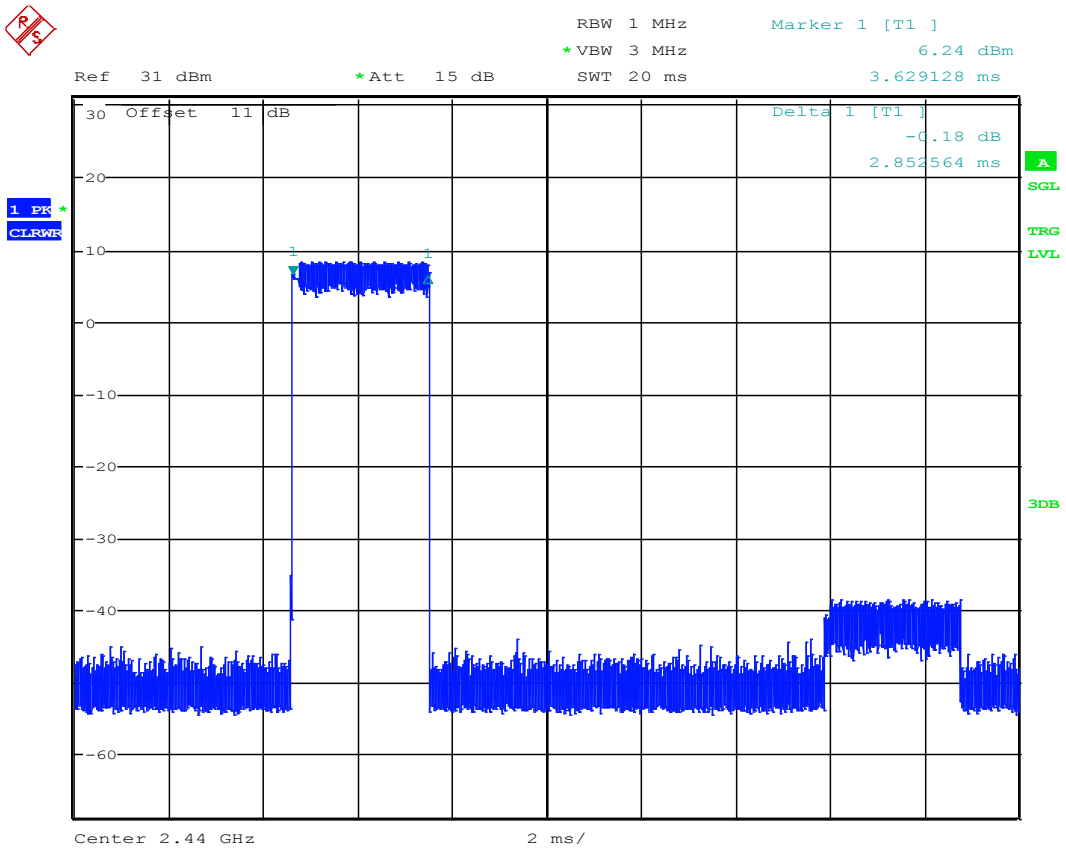
Transmission on Time in Observation Period (31.6s)		
Modulation: GFSK	**Packet Type: DH5**	**Number of Tx Bursts =95**



Date: 17.MAY.2016 09:12:22

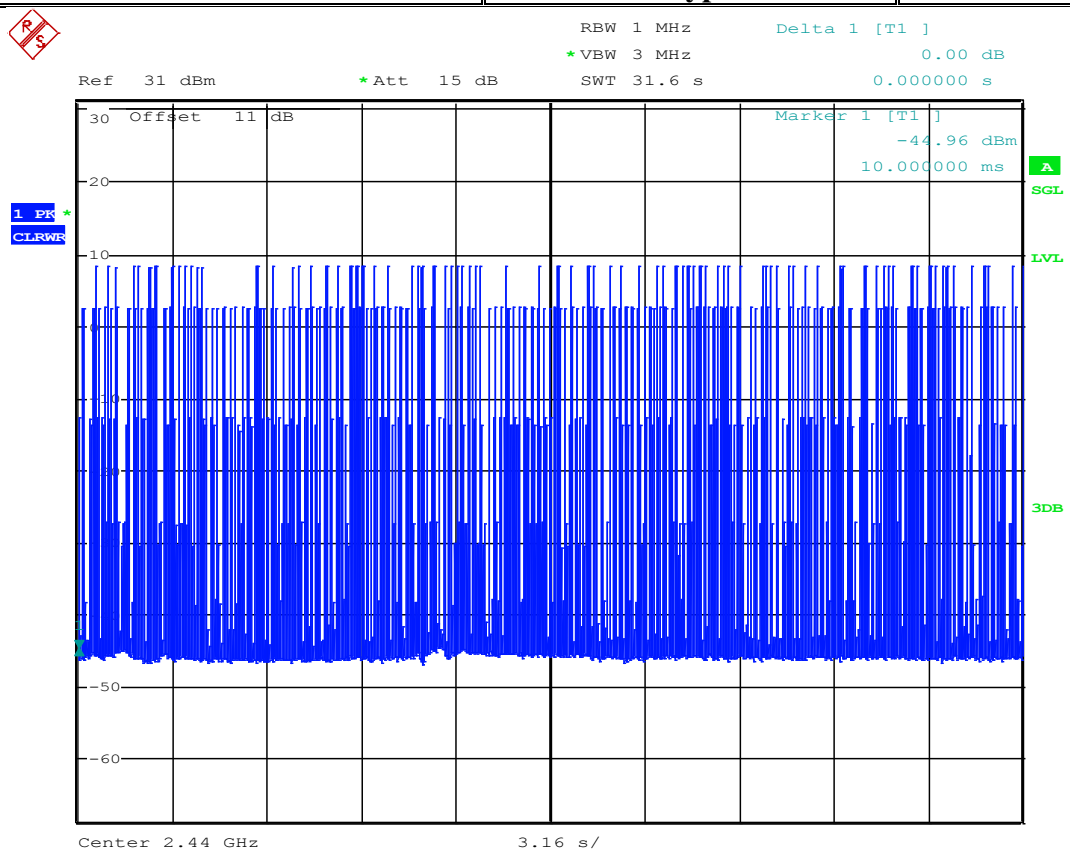
10.6.5.4 π/4 DQPSK 2-DH3

Duration of Pulse



Date: 17.MAY.2016 10:34:27

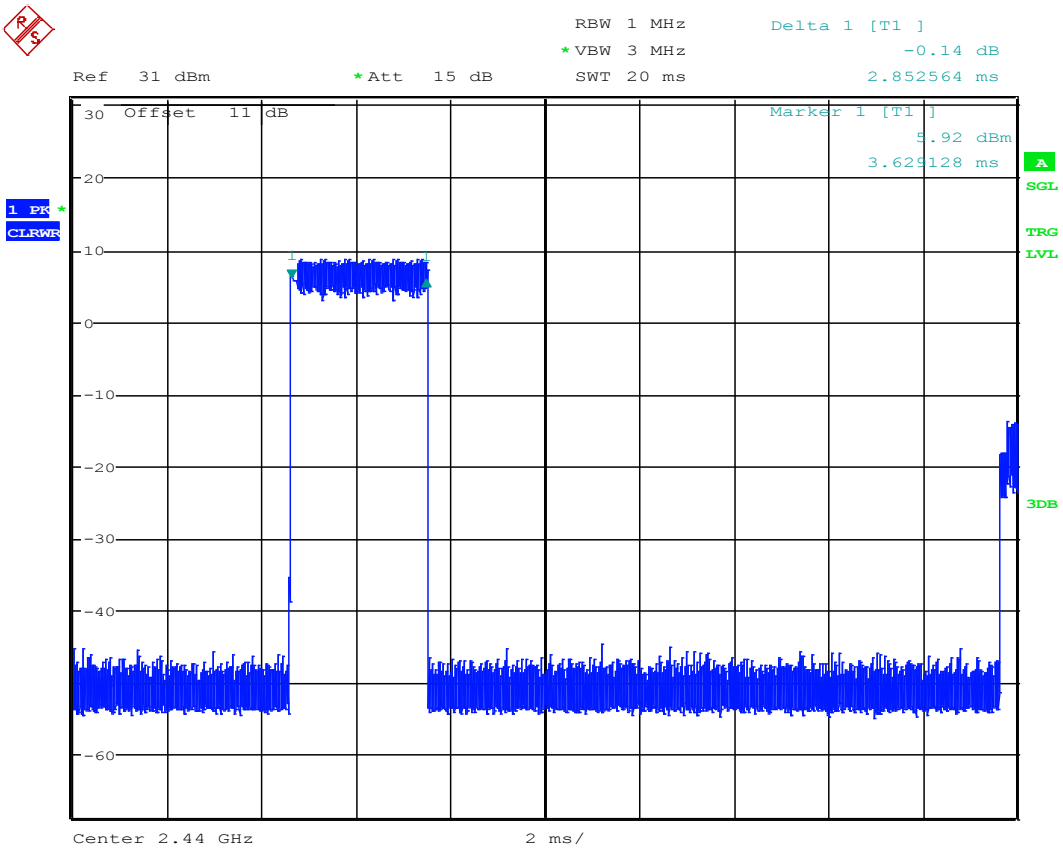
Transmission on Time in Observation Period (31.6s)		
Modulation: 8-DPSK	**Packet Type: DH5**	**Number of Tx Bursts =113**



Date: 17.MAY.2016 09:47:43

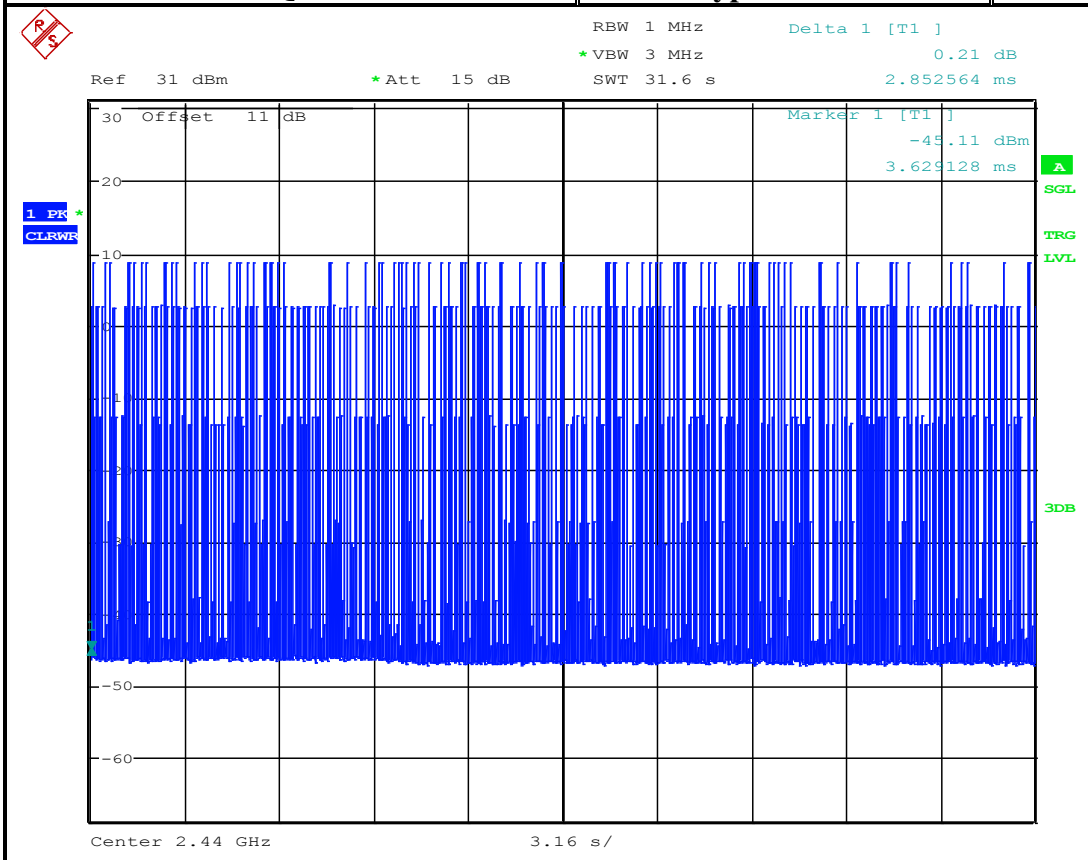
10.6.5.5 8-DPSK 3-DH5

Duration of Pulse



Date: 17.MAY.2016 10:38:35

Transmission on Time in Observation Period (31.6s)		
Modulation: π/4 DQPSK	**Packet Type: DH5**	**Number of Tx Bursts =105**



Date: 17.MAY.2016 10:39:58

10.7 Transmitter Spurious Emissions & Restricted Bands- Radiated

10.7.1 Limits:

§15.247/15.205/15.209 & RSS-Gen 8.9/ 8.10 (restricted bands)
(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 40 dB/decade extrapolation factor equation (4) as follow:

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

10.7.2 Test Conditions

Tnom: 23°C; Vnom: Car Battery

10.7.3 Test Procedure

Measurement according to:
ANSI C63.10 (2013)

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 and 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.

10.7.4 Measurement Result:

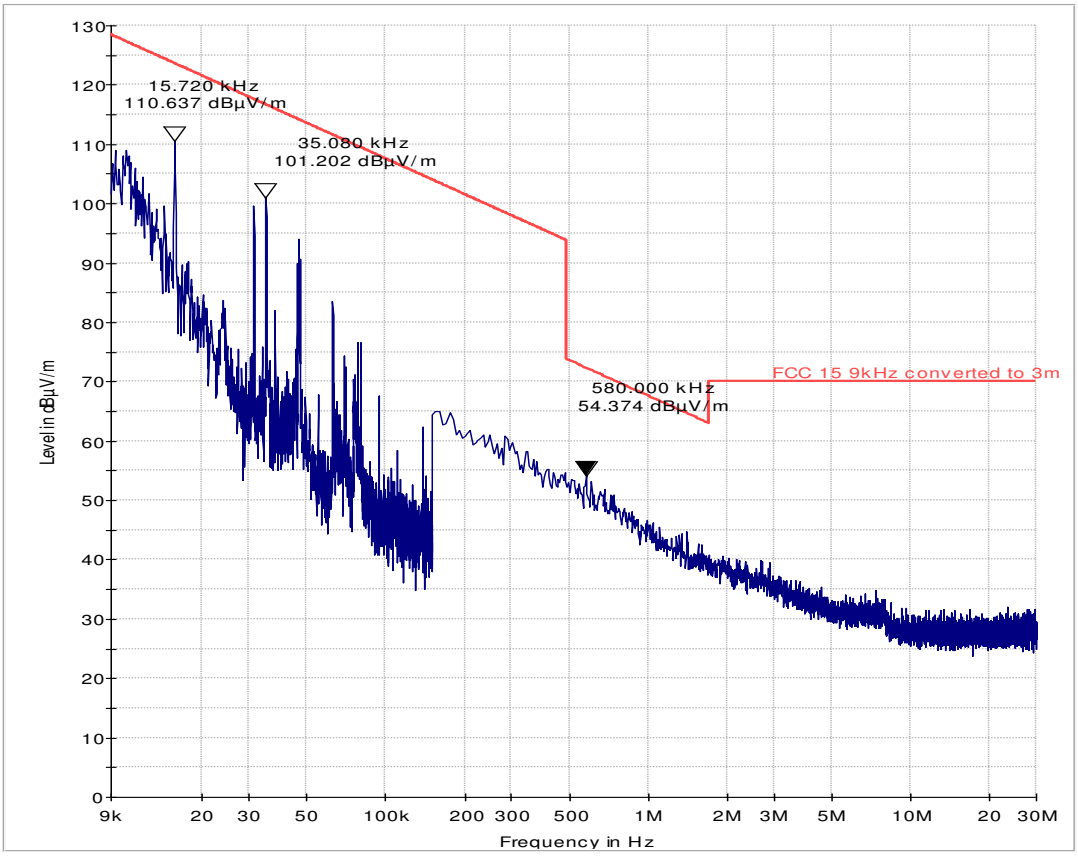
Pass.

10.7.5 Measurement plots:

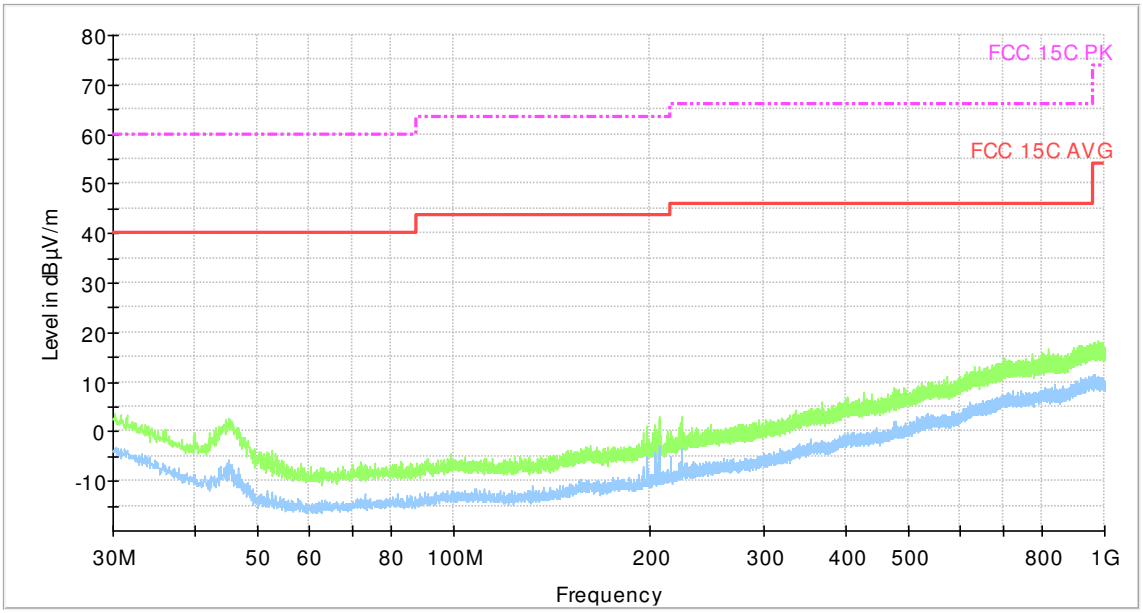
Note: Worst case representation for all modes of operation in this frequency range. Limits adjusted for 3m measurement.

10.7.5.1 GFSK

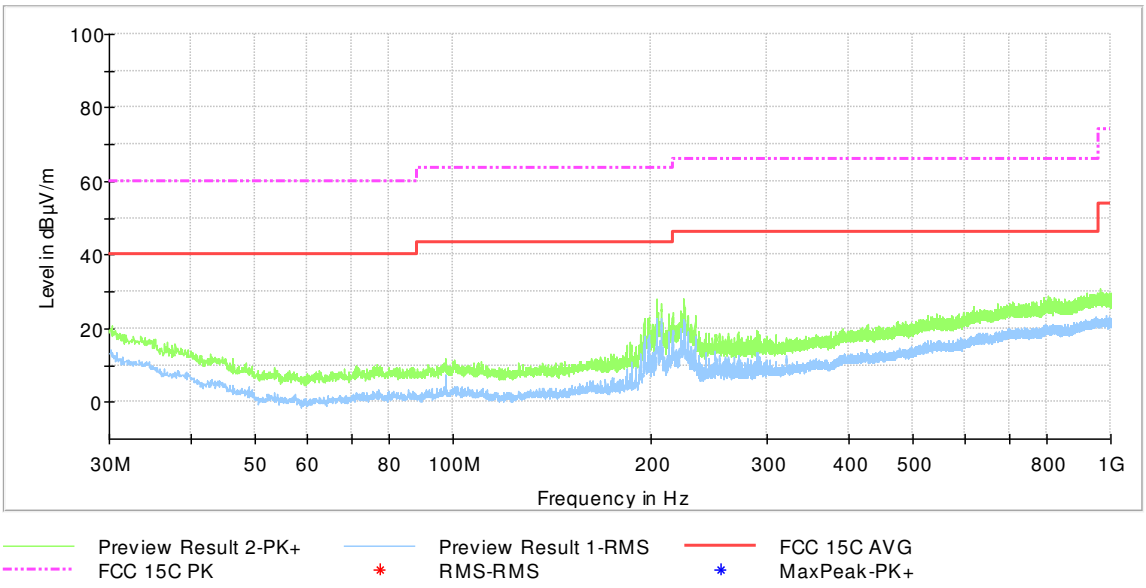
Radiated Emissions: 9 KHz - 30 MHz		
Modulation: GFSK	**Channel: 39**	**Max. Duty Cycle**



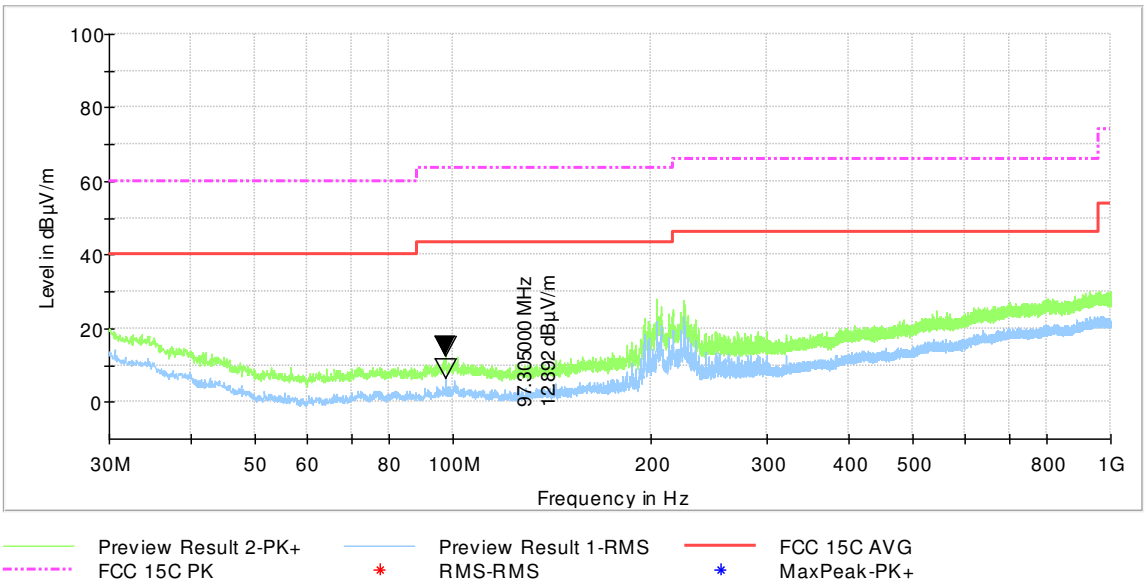
Radiated Emissions: 30 MHz – 1GHz		
Modulation: GFSK	**Channel: 0**	**Max. Duty Cycle**



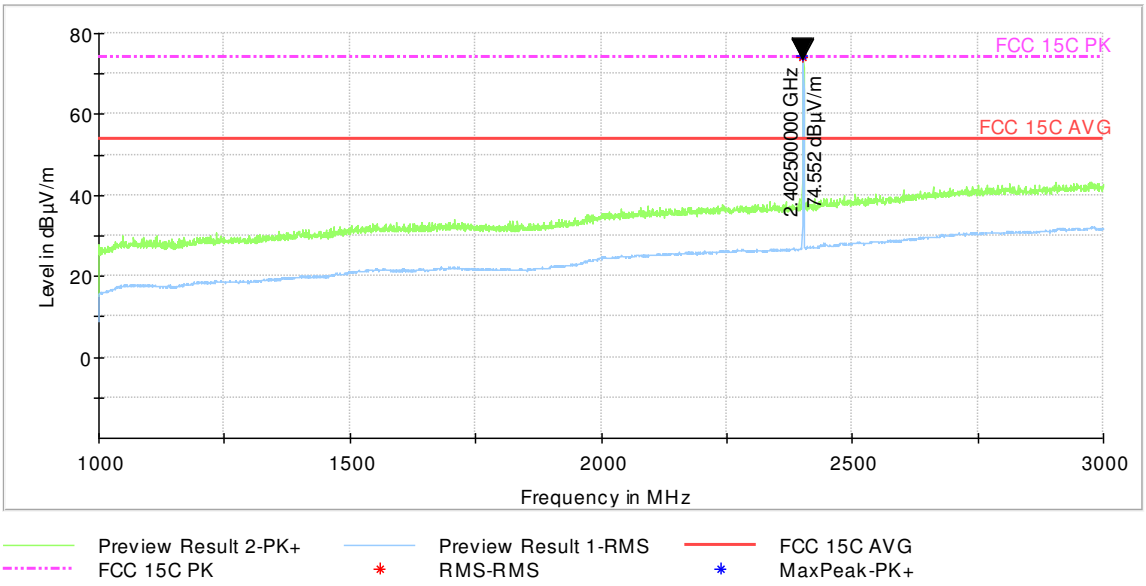
Radiated Emissions: 30 MHz – GHz		
Modulation: GFSK	**Channel: 39**	**Max. Duty Cycle**



Radiated Emissions: 30 MHz – 1GHz		
Modulation: GFSK	**Channel: 78**	**Max. Duty Cycle**

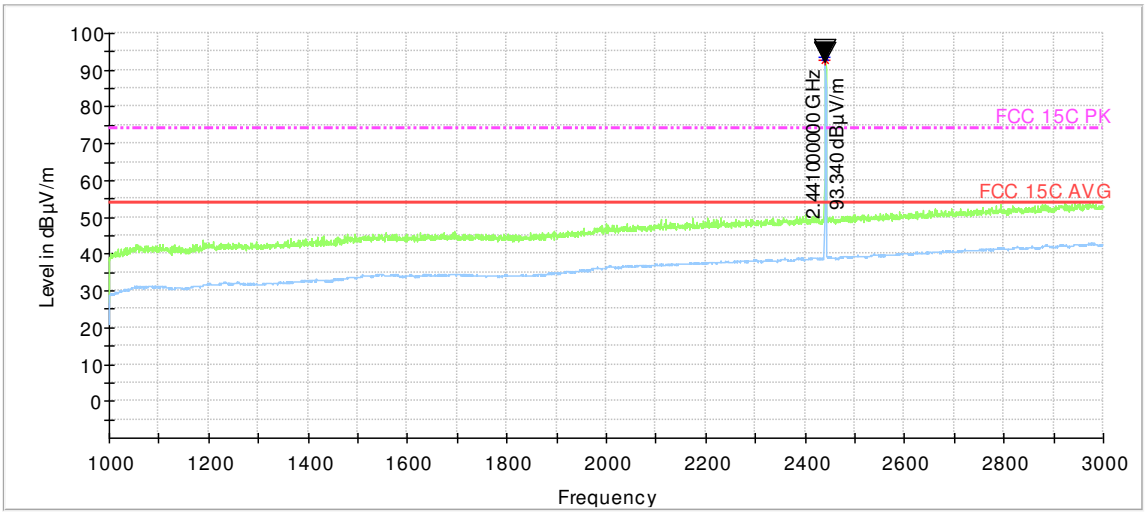


Radiated Emissions: 1GHz – 3GHz		
Modulation: GFSK	**Channel: 0**	**Max. Duty Cycle**



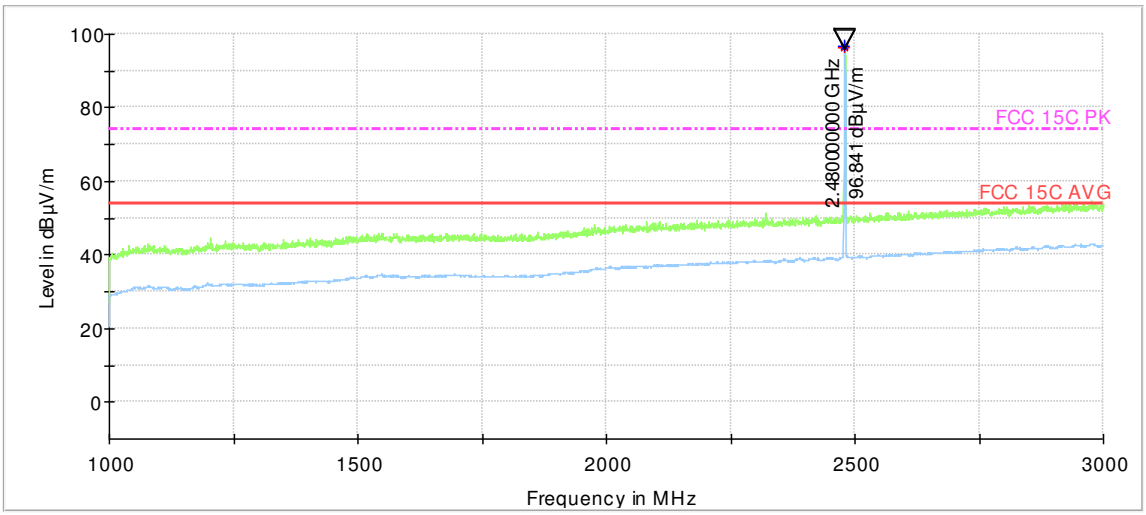
Note: Emission above limit is the Tx Signal

Radiated Emissions: 1GHz – 3GHz		
Modulation: GFSK	**Channel: 78**	**Max. Duty Cycle**



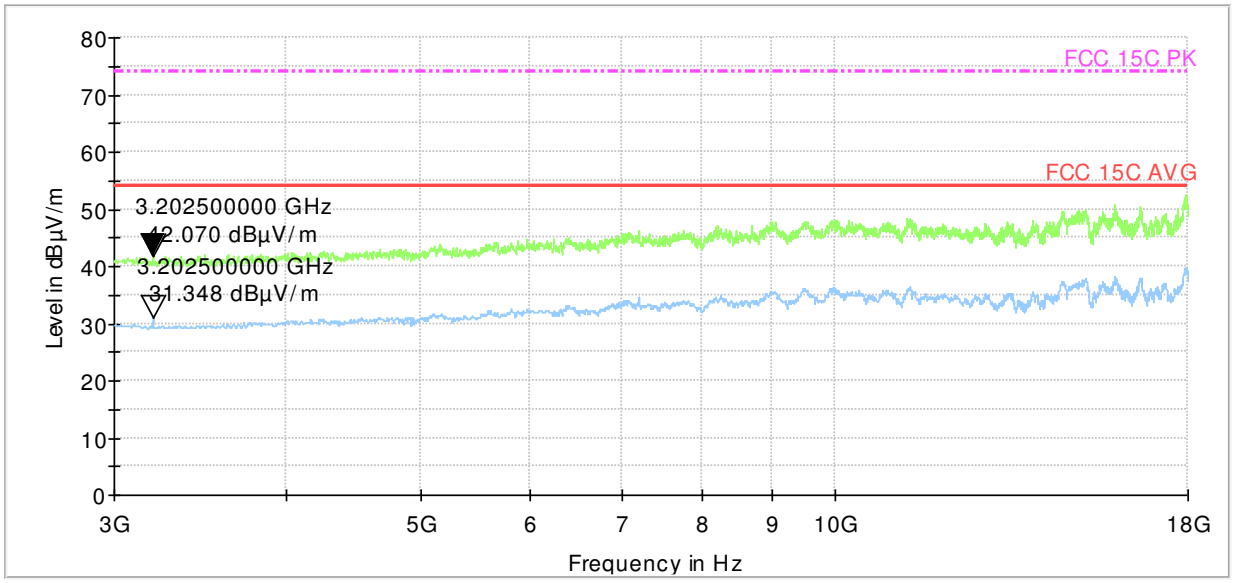
Note: Emission above limit is the Tx Signal

Radiated Emissions: 1GHz – 3GHz		
Modulation: GFSK	**Channel: 78**	**Max. Duty Cycle**

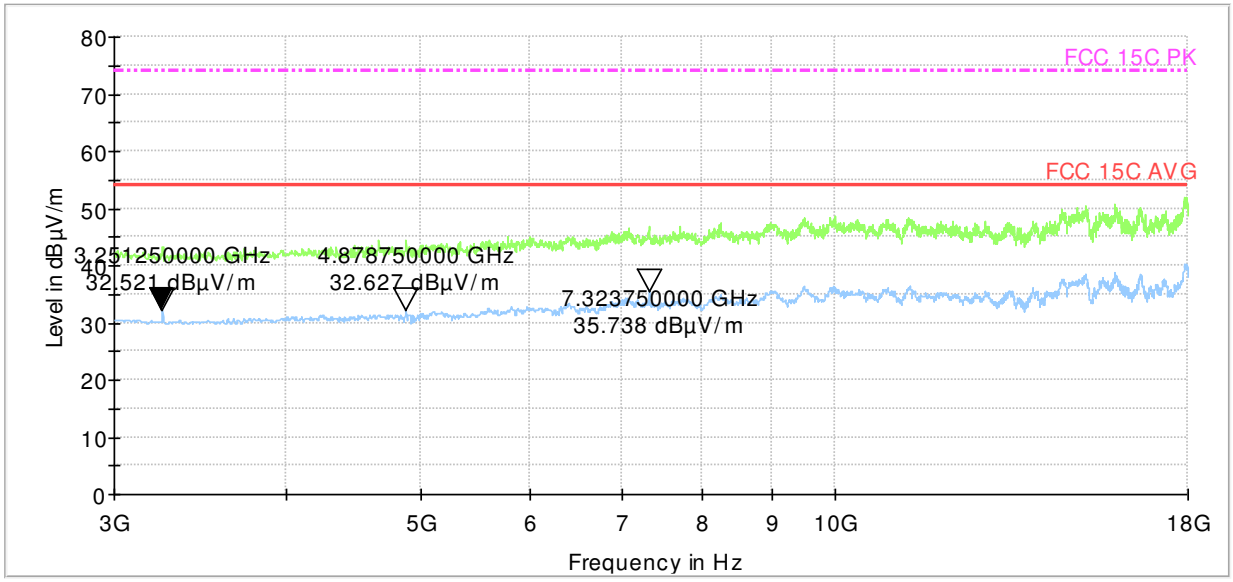


Note: Emission above limit is the Tx Signal

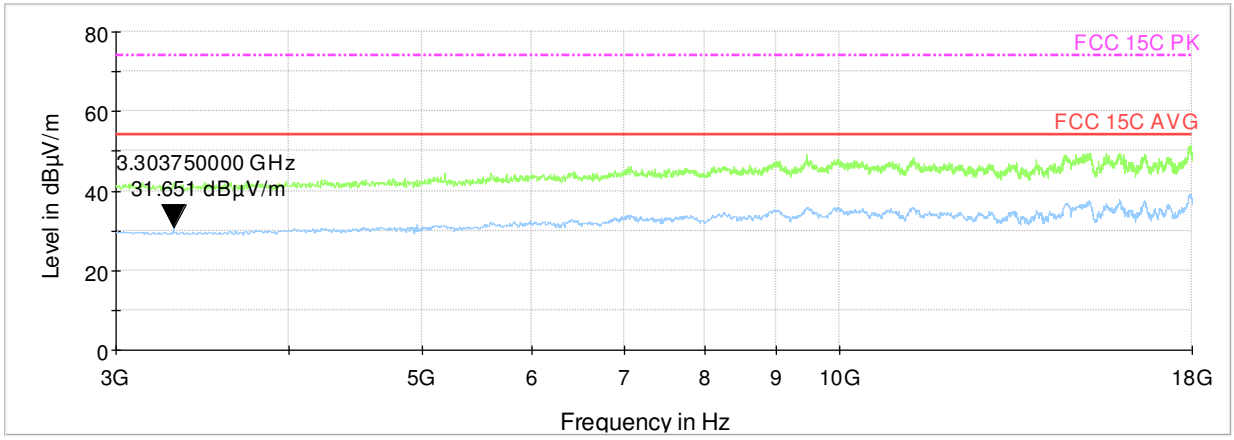
Radiated Emissions: 3-18 GHz		
Modulation: GFSK	**Channel: 0**	**Max. Duty Cycle**



Radiated Emissions: 3-18 GHz		
Modulation: GFSK	**Channel: 39**	**Max. Duty Cycle**

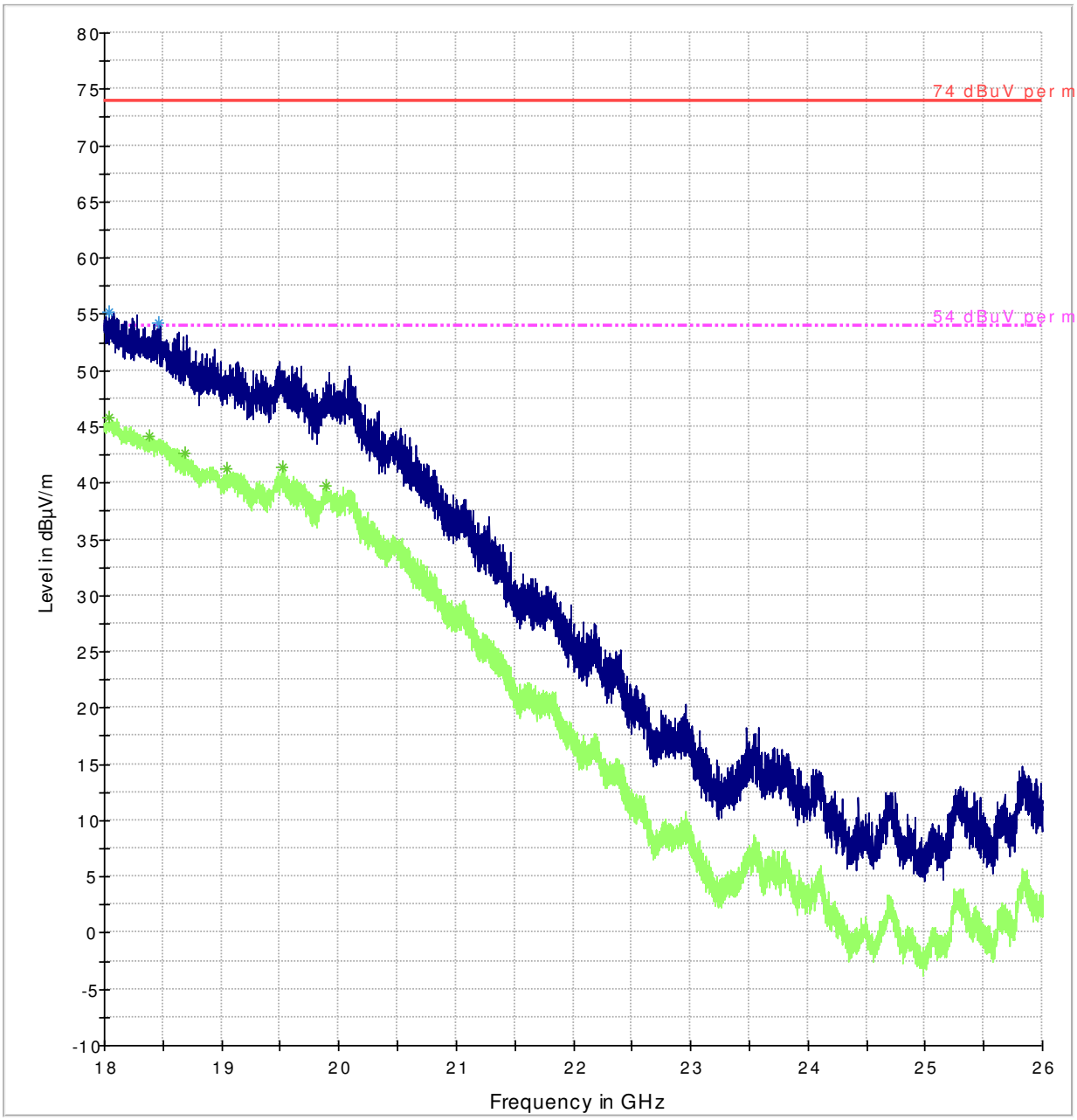


Radiated Emissions: 6-18 GHz		
Modulation: GFSK	**Channel: 78**	**Max. Duty Cycle**



Preview Result 2-PK+ | Preview Result 1-RMS | FCC 15C AVG
FCC 15C PK | RMS-RMS | MaxPeak-PK+

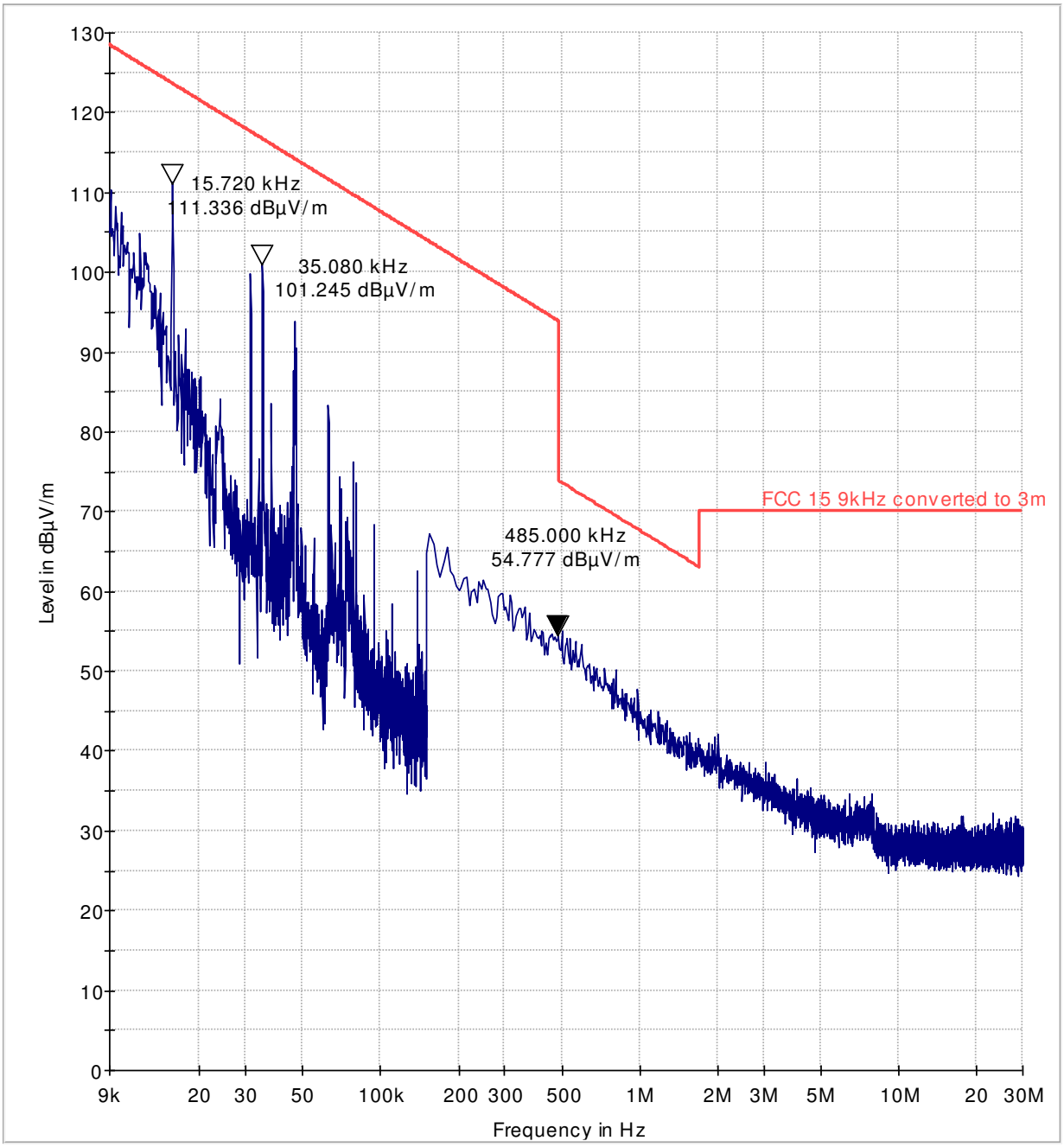
Radiated Emissions: 18-26 GHz		
Modulation: GFSK	**Channel: 39**	**Max. Duty Cycle**



74 dBuV per m
54 dBuV per m
Preview Result 1-PK+
Preview Result 2-RMS
Data Reduction Result 1 [6]-PK+
Data Reduction Result 2 [6]-RMS

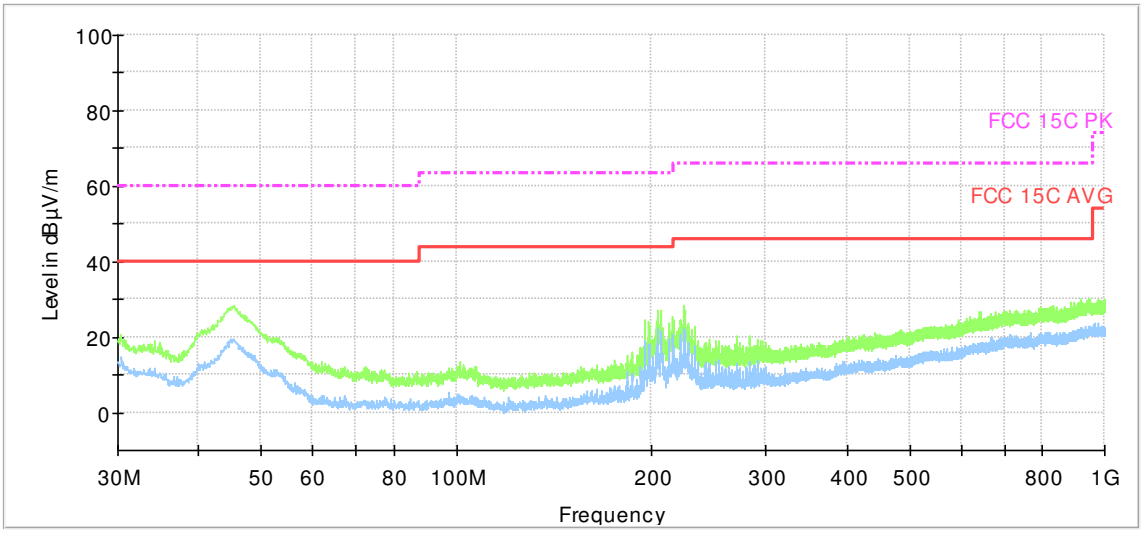
10.7.5.2 8-DPSK

Radiated Emissions: 9 KHz - 30 MHz		
Modulation: 8-DPSK	**Channel: 39**	**Max. Duty Cycle**



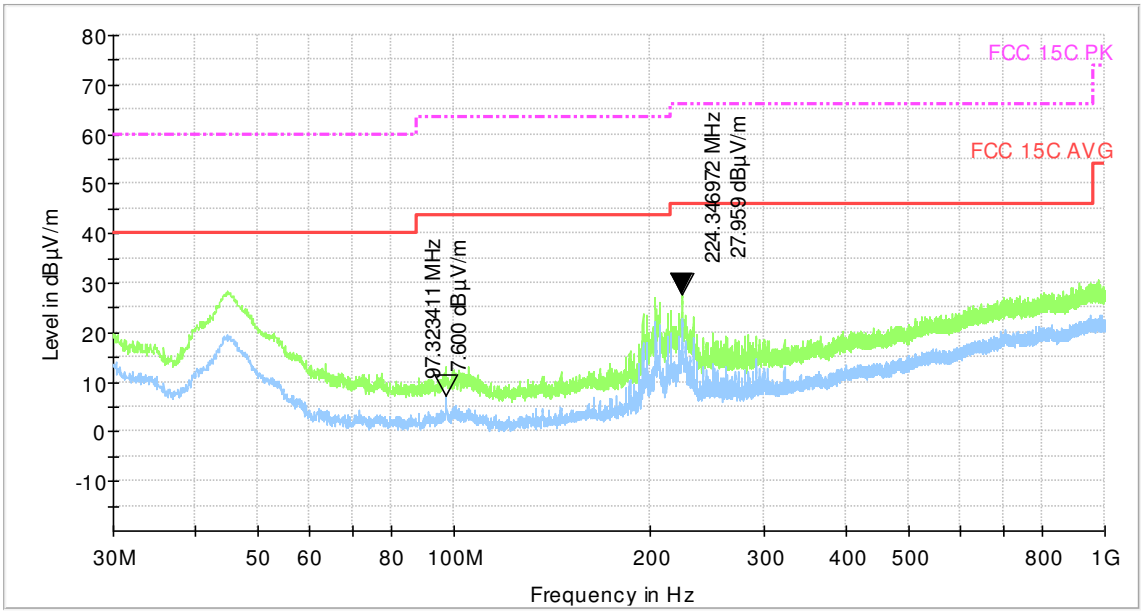
FCC 15 9kHz converted to 3m — Preview Result 1-PK+

Radiated Emissions: 30 MHz – 1GHz		
Modulation: 8-DPSK	**Channel: 0**	**Max. Duty Cycle**

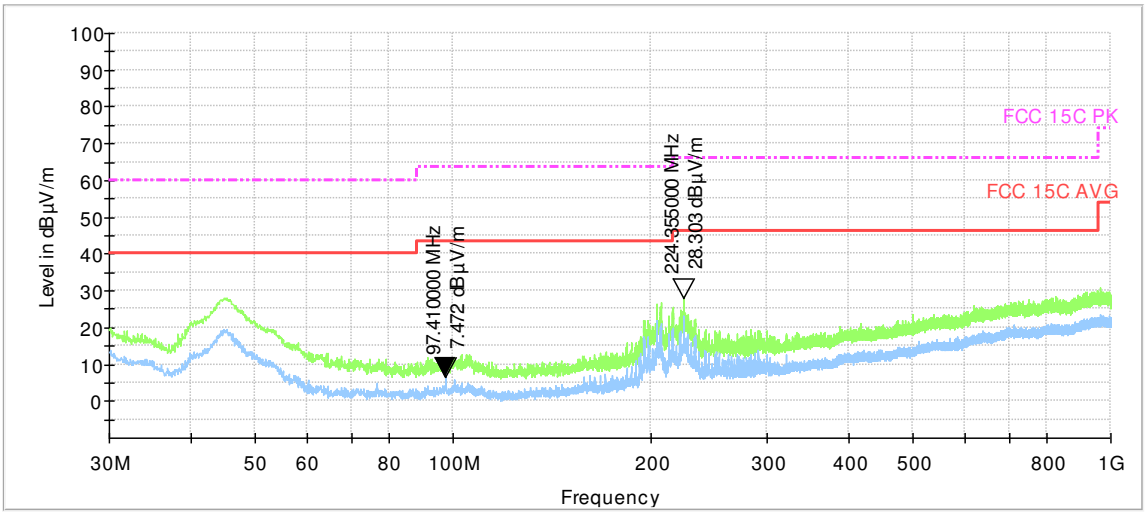


Preview Result 2-PK+ [Preview Result 2.Result:2]
Preview Result 1-RMS [Preview Result 1.Result:1]
FCC 15C AVG [..\]

Radiated Emissions: 30 MHz – 1GHz		
Modulation: 8-DPSK	**Channel: 39**	**Max. Duty Cycle**

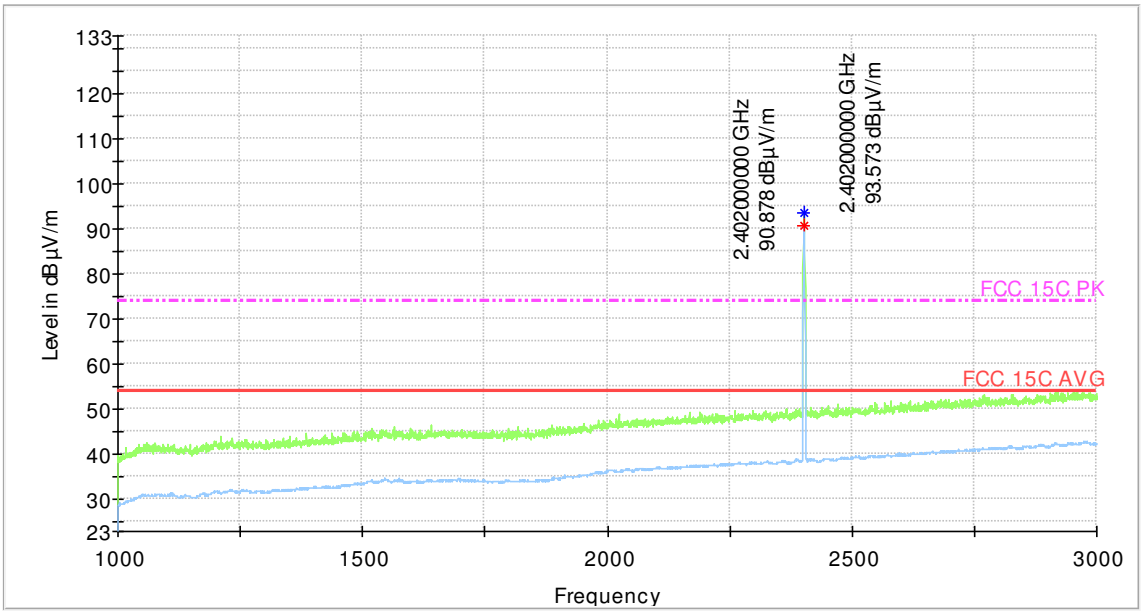


Radiated Emissions: 30 MHz – 1GHz		
Modulation: 8-DPSK	**Channel: 78**	**Max. Duty Cycle**



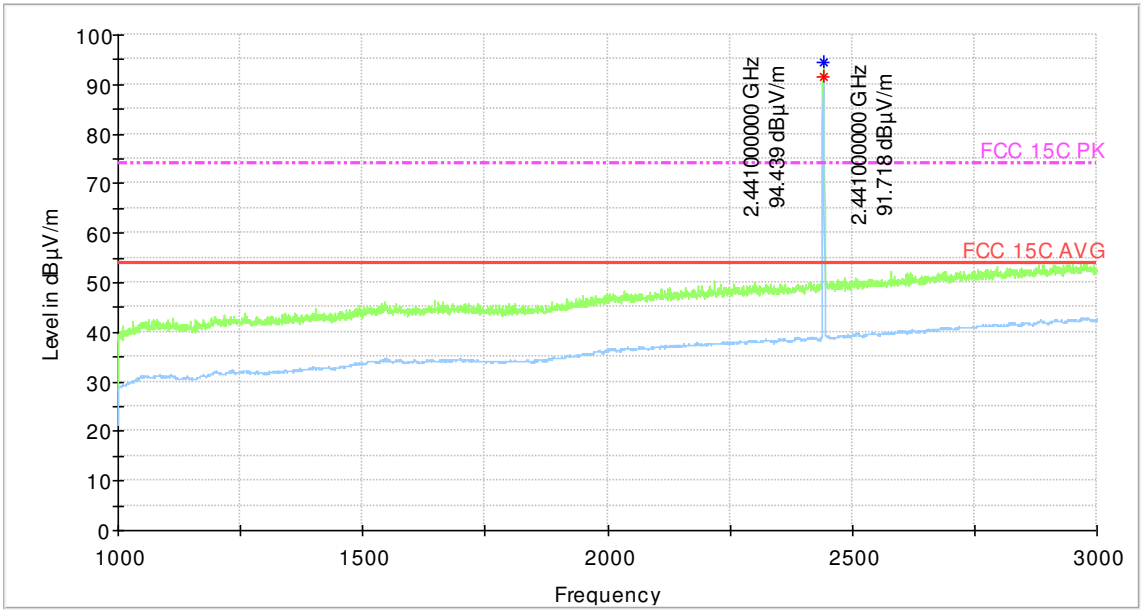
Preview Result 2-PK+ [Preview Result 2.Result:2] Preview Result 1-RMS [Preview Result 1.Result:1]
FCC 15C AVG [..\]

Radiated Emissions: 1GHz – 3GHz		
Modulation: 8-DPSK	**Channel: 0**	**Max. Duty Cycle**



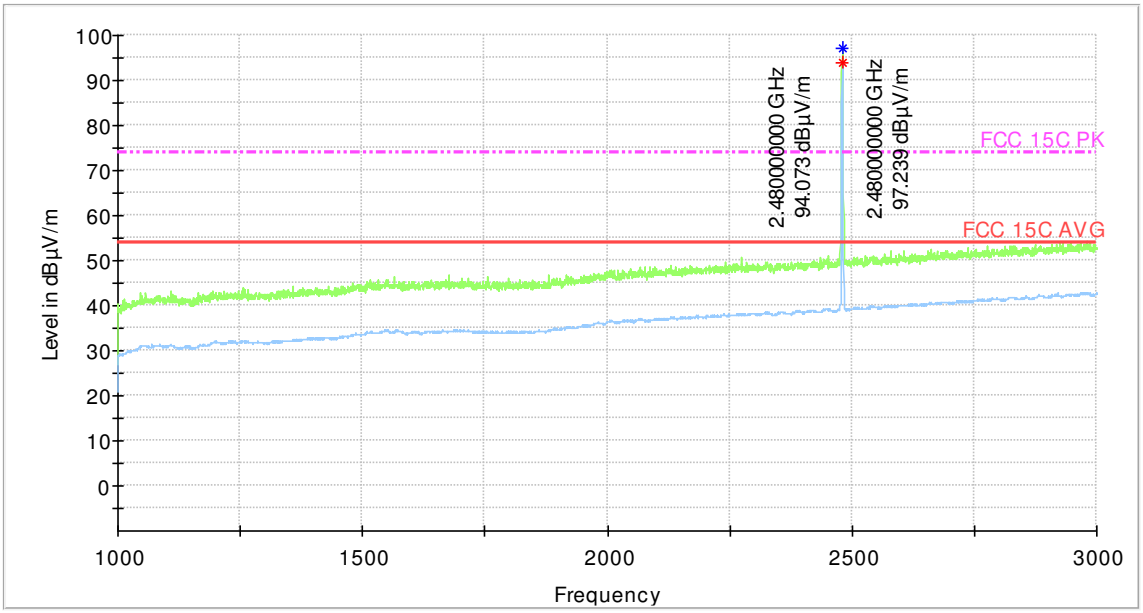
Note: Emission above limit is the Tx Signal

Radiated Emissions: 1GHz – 3GHz		
Modulation: 8-DPSK	**Channel: 39**	**Max. Duty Cycle**



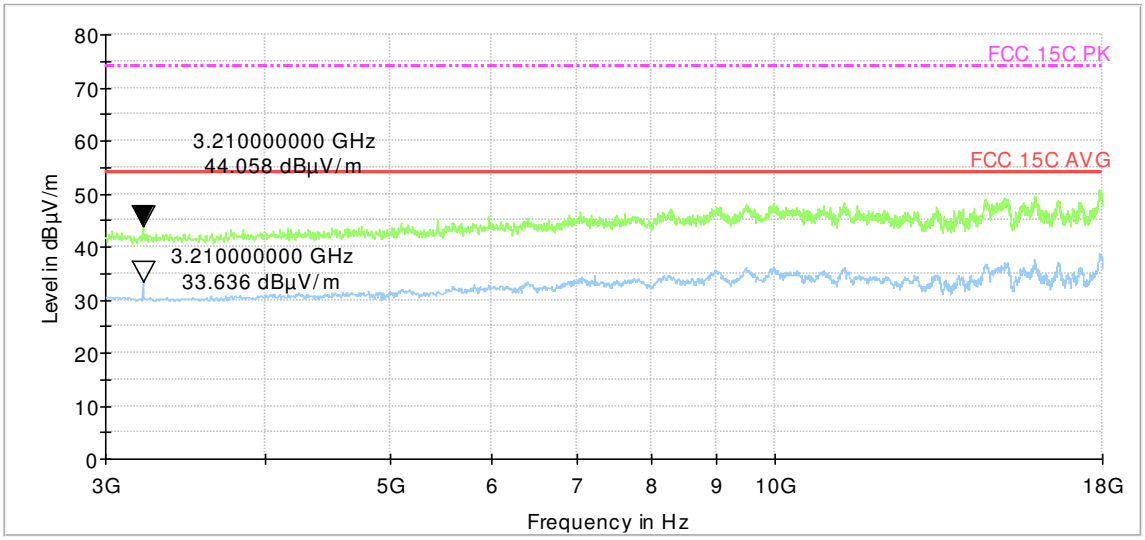
Note: Emission above limit is the Tx Signal

Radiated Emissions: 1GHz – 3GHz		
Modulation: 8-DPSK	**Channel: 78**	**Max. Duty Cycle**



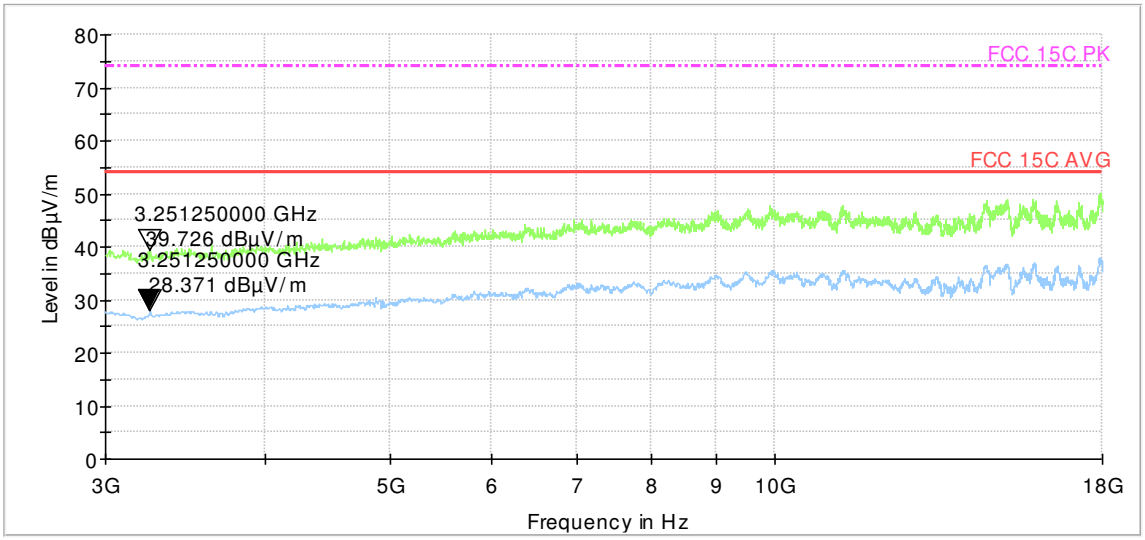
Note: Emission above limit is the Tx Signal

Radiated Emissions: 3 – 18 GHz		
Modulation: 8-DPSK	**Channel: 0**	**Max. Duty Cycle**



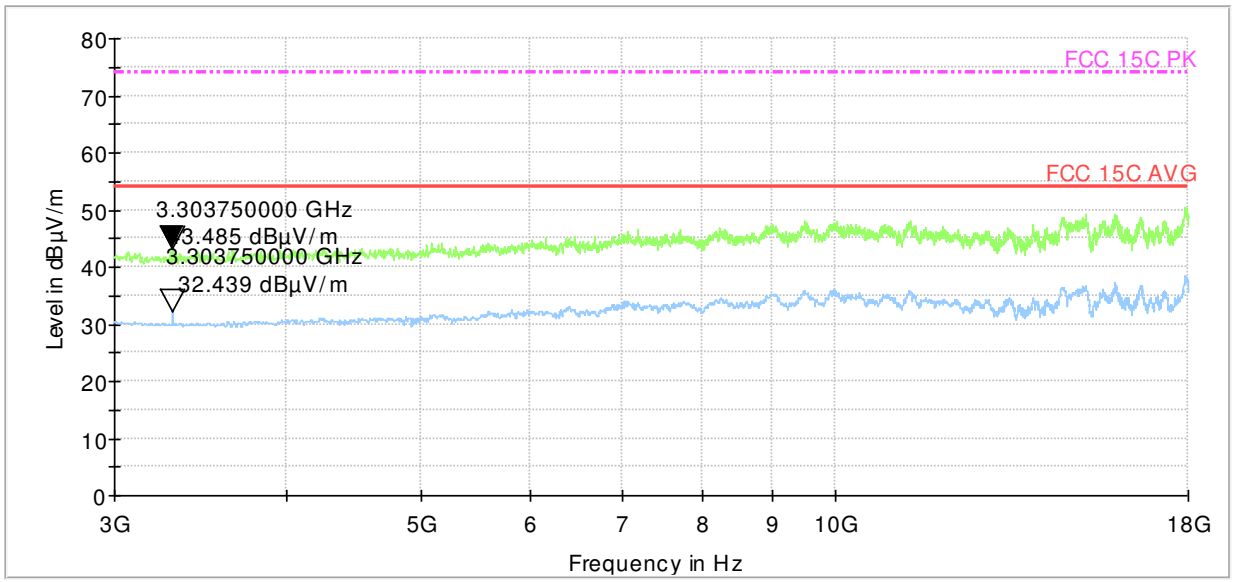
Preview Result 2-PK+ | Preview Result 1-RMS | FCC 15C AVG
FCC 15C PK | RMS-RMS | MaxPeak-PK+

Radiated Emissions: 3 – 18 GHz		
Modulation: 8-DPSK	**Channel: 39**	**Max. Duty Cycle**



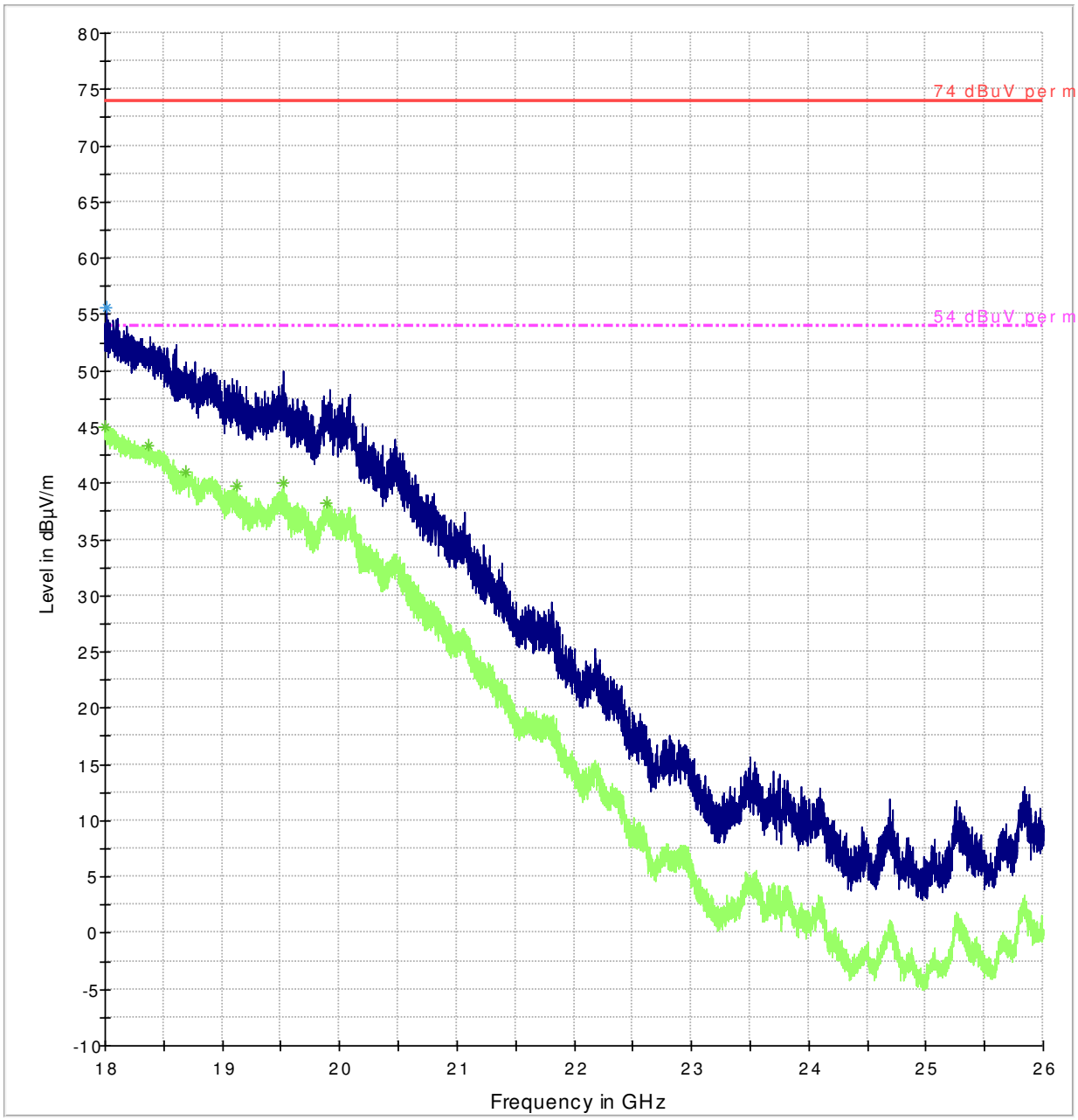
Preview Result 2-PK+ | Preview Result 1-RMS | FCC 15C AVG
FCC 15C PK | RMS-RMS | MaxPeak-PK+

Radiated Emissions: 3 – 18 GHz		
Modulation: 8-DPSK	**Channel: 78**	**Max. Duty Cycle**



Preview Result 2-PK+ | Preview Result 1-RMS | FCC 15C AVG
FCC 15C PK | RMS-RMS | MaxPeak-PK+

Radiated Emissions: 18-26 GHz		
Modulation: 8-DPSK	**Channel: 39**	**Max. Duty Cycle**



74 dBuV per m
54 dBuV per m
Preview Result 1-PK+
Preview Result 2-RMS
Data Reduction Result 1 [6]-PK+
Data Reduction Result 2 [6]-RMS

11 EUT Setup Pictures

Please refer to EMC-PEARL-004-16001-P120-TestSetupPhotos.pdf

12 Test Equipment and Ancillaries used for tests

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Turn table	Turn table	EMCO	2075	N/A	N/A	N/A
MAPS Position Controller	Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
Antenna Mast	Antenna Mast	EMCO	2075	N/A	N/A	N/A
High Pass Filter	Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
High Pass Filter	Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
6GHz High Pass Filter	Filter	HPM50106	Microtronics	001	Part of system calibration	
Pre-Amplifier	Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
Relay Switch Unit	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
Spectrum Analyzer	Analyzer	Rohde&Schwarz	FSU	200302	3 Years	Jun 2013
Antenna Biconilog 3142E	Biconlog Antenna	EMCO	3142E	166067	3 years	6/14/2014
Antenna Loop 6512	Loop Antenna	ETS Lindgren	6512	49838	3 years	3/13/2014
Antenna Horn 3115 SN 35111	Horn Antenna	EMCO	3115	35111	3 years	7/24/2015
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	7/22/2015
LISN FCC-LISN-50-25-2-08	LISN	FCC	FCC-LISN-50-25-2-08	8014	2 Years	3/26/2015
Digital Barometer	Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	4/7/2015
Digital Radio Comm. Tester CMU 200 #1	Digital Radio Comm. Tester	R&S	CMU 200 #1	101821	2 Years	7/4/2015
ESU 40	Receiver	R&S	ESU 40	100251	2 years	6/29/2015
Thermometer Humidity TM320	Thermometer Humidity	Dickson	TM320	5280063	1 Year	7/29/2015

13 Revision History

Date	Report Name	Changes to report	Prepared by
2016-09-27	EMC-PEARL-004-16001-15.247-P120-DSS-BT	First Version	James Donnellan
2016-09-28	EMC-PEARL-004-16001-15.247-P120-DSS-BT-Rev1	Corrected Cal cycle FSU	James Donnellan