FCC/IC Test Report

FOR

Silver Spring Networks

Model Number: NIC 441-0702

Product Description: Network Interface Card

FCC ID: OWS-NIC441
IC ID: 5975A-NIC441

47 CFR Part 15.247 (FHSS/DTS)

IC RSS-210 Issue 8 & RSS-Gen Issue 3

TEST REPORT #: EMC_SILVE-1311-62_FCC15.247_FHSS_DTS
DATE: 2014-03-12

FCC: Accredited

IC recognized # 3462B-1

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1 Assessment

The following equipment (and as identified in Ch.3 of this test report) was evaluated against the applicable criteria specified in FCC CFR47 Part 15.247, 15.207, 15.209 and Industry Canada Radio Standard Specification RSS-210 Issue 8, Annex 8.
No deviations were ascertained during the course of the tests performed.

Company	Description	Model #
Silver Spring Networks	Network Interface Card	NIC 441-0702

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2014-03-12	Compliance	Franz Engert (Test Lab Manager)	Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com Date: 2014.03.12 21:47:11 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
2014-03-12	Compliance	Danh Le (EMC Engineer)	

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.
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Address:	411 Dixon Landing Road Milpitas, CA 95035 U.S.A.
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Test Lab Manager:	Franz Engert
Responsible Project Leader:	Danh Le

2.2 Identification of the Client

Applicant's Name:	Silver Spring Networks
Street Address:	555 Broadway Street
City/Zip Code	Redwood City, CA 94063
Country	USA
Contact Person:	Pierre Chery
Phone No.	650-839-4151
e-mail:	pchery@silverspringnet.com

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as client.
Manufacturers Address:	
City/Zip Code	
Country	

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Marketing Name:	Network Interface Card
Model Number:	NIC 441-0702
FCC-ID :	OWS-NIC441
IC ID:	5975A-NIC441
Product Description:	Network Interface Card
Technology / Type(s) of Modulation:	FHSS: FSK & GFSK; DSSS: OQPSK
Operating Frequency Ranges (MHz) / Channels:	**902 - 928 MHz** FSK@100 Kbps: 902.3(ch 0) - 926.9 MHz (ch 82); Total channels = 83 GFSK@100 Kbps: 902.2(ch 0) - 927.8 MHz (ch 128); Total channels = 129 GFSK @300 Kbps: 902.4(ch 0) - 927.6 MHz (ch 63); Total channels = 64 **2.400 - 2.4835 GHz** GFSK@250 Kbps/500 Kbps: 2.4008(ch 0) – 2.4728 (ch 90), Total channels = 91 OQPSK@250 KHz: 2.405(ch 11) – 2.480 (ch 26) Total channels = 16
Antenna info:	Omni Directional Linear Polarization 902 - 928 MHz, 2.5 - 3.0 dBi, ~ 80% Efficiency 2.400 - 2.4835 MHz, 4.0 dBi, ~ 70% Efficiency
Max. Output Powers:	**Measured Conducted output power:** **For 900MHz system** FSK@100 Kbps: 926.9 (ch 82)- Conducted Output Power = 29.82 dBm GFSK@100 Kbps: 927.8 (ch 128)- Conducted Output Power = 29.77 dBm GFSK @300 Kbps: 927.6 (ch 63)- Conducted Output Power = 29.76 dBm For 2.4 GHz system GFSK@250/500 Kbps: 2.440(ch 49)- Conducted Output Power = 24.50 dBm OQPSK@250 KHz: 2.440(ch 18)- Conducted Output Power = 22.66 dBm **Calculated EIRP:** FSK@100 Kbps: 926.9 (ch 82)- Conducted Output Power = 32.82 dBm GFSK@100 Kbps: 927.8 (ch 128)- Conducted Output Power = 32.77 dBm GFSK @300 Kbps: 927.6 (ch 63)- Conducted Output Power = 32.82 dBm **For 2.4 GHz system** GFSK@250/500 Kbps: 2.440(ch 49)- Conducted Output Power = 28.50 dBm OQPSK@250 KHz: 2.440(ch 18)- Conducted Output Power = 26.66 dBm
Rated Operating Voltage Range:	3.6 VDC (Low) / 4.0VDC (Nominal) / 4.4VDC (Max)
Rated Operating Temperature Range:	Tmin: -40°C / Tmax: +85°C

Test Sample Status:	Pre-Production
Other Radios included:	None

3.2 Identification of the Equipment Under Test (EUT)

EUT #	Serial Number	Sample	HW/SW Version
1	001350FFFE200202 & 001350FFFE2001FF	Radiated & Conducted	174-0449-00 / 83.05.8D.3D, 03.05.8D.3D

Note: Firmware version 83.05.8D.3D is for development and testing purposes; 03.05.8D.3D is operational version.

3.3 Identification of Support Test Equipment

STE #	Type	Manufacturer	Model	Serial Number
1	Laptop	DELL	Latitude E6400	27687722725
2	USB serial adaptor	Keyspan	USA-19HS	22378TRCU791101299

3.4 Identification of Accessory equipment

AE #	Type	Manufacturer	Model	Serial Number
1	Antenna	World Products LLC	WPANT30017-CA	320000056 Rev1.0

3.5 Environmental conditions during Test

Ambient Temperature: 22°C
Relative humidity: 36%

3.6 Dates of Testing

12/03/2013 – 2/13/2013

3.7 Other Testing Notes

1. The NIC 441-0702 incorporates a 900 MHz frequency hopping spread spectrum radio, 2.4 GHz frequency hopping spread spectrum radio, and 2.4 GHz direct sequence spread spectrum radio.
2. The pre-production unit was provided with serial interface connection to NIC board to send test commands.
3. The EUT was tested on low, mid and high channels in all 3 different modulation types (FSK, GFSK and OQPSK).

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 CFR47 Parts 15.247, 15.207, 15.209 and
- Industry Canada Radio Standard Specifications RSS-210 Issue 8, RSS-Gen Issue 3

5 Summary of Measurement Results

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§15.247(e) RSS-210 A8.2(b)	Power Spectral Density	Nominal	OQPSK	■	□	□	□	Passed
§15.247(a)(1) RSS-210 A8.1(b)	Carrier Frequency Separation	Nominal	Hopping	■	□	□	□	Passed
§15.247(a)(1)(i) RSS-210 A8.1(d)	Number of Hopping Channels	Nominal	Hopping	■	□	□	□	Passed
§15.247(a)(1)(iii) RSS-210 A8.3(1)	Time of occupancy (Dwell Time)	Nominal	Hopping	■	□	□	□	Passed
§15.247(a)(1) RSS-210 A8.1(a)	Channel Bandwidth	Nominal	FSK GFSK OQPSK	■	□	□	□	Passed
§15.247(b)(1) RSS-210 A8.4(2)	Maximum Peak Output Power	Nominal	FSK GFSK OQPSK	■	□	□	□	Passed
§15.247(d) RSS-210 A8.5	Band edge compliance-Conducted	Nominal	FSK GFSK OQPSK	■	□	□	□	Passed
§15.247(d) RSS-210 A8.5	Restricted Band-Radiated	Nominal	FSK GFSK OQPSK	■	□	□	□	Passed
§15.247(d) RSS-210 A8.5	TX Spurious emissions-Conducted	Nominal	-----	□	□	□	■	NA Note 1
§15.247(d) RSS-210 A8.5	TX Spurious emissions-Radiated	Nominal	FSK GFSK OQPSK	■	□	□	□	Passed
§15.209(a) RSS Gen	TX Spurious Emissions Radiated<30MHz	Nominal	FSK GFSK OQPSK	■	□	□	□	Passed
§15.109 RSS Gen	RX Spurious Emissions	Nominal	RX	■	□	□	□	Passed
§15.207(a) RSS Gen	AC Conducted Emissions <30MHz	Nominal	-----	□	□	■	□	NA Note 2

Note: NA= Not Applicable; NP= Not Performed; NR= Not Required

1. Covered by radiated emissions measurement
2. DC power source

6 Measurements

6.1 Measurement Method

ANSI C63.4 (2009) & ANSI C63.10 (2009)

6.2 Radiated Measurement Procedure

ANSI C63.4 (2009) Section 8.3.1.1: Exploratory radiated emission measurements

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

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

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

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

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

ANSI C63.4 (2009) Section 8.3.1.2: Final radiated emission measurements

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

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

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

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

Radiated Measurement Uncertainty: ±3dB

6.3 Sample Calculations for Radiated Measurements

6.3.1 Field Strength Measurements

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

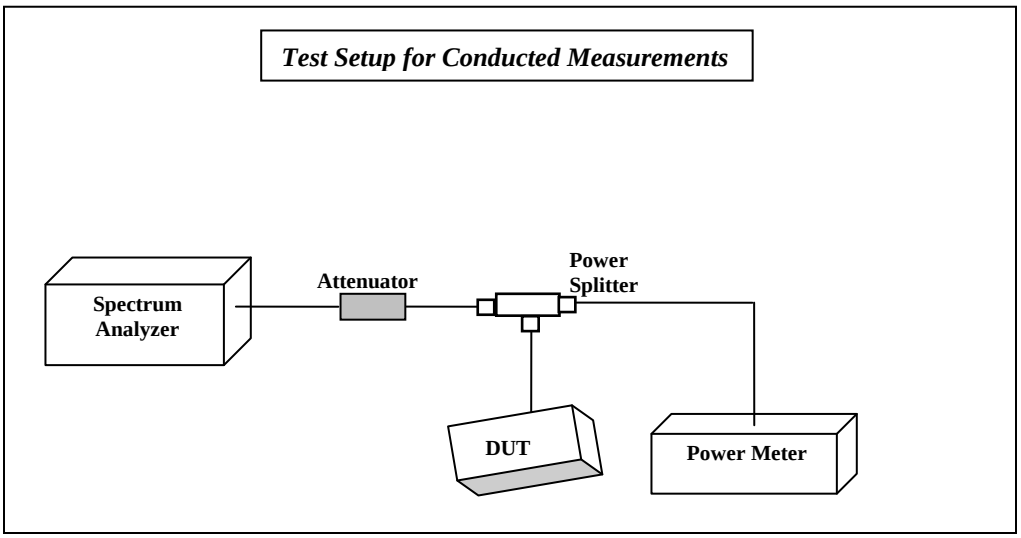
1. Measured reading in dBµV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

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.

6.4 Conducted Measurement Procedure



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

Measurement uncertainty for all conducted measurements: +/-0.5dB

7 Transmitter Measurements

7.1 Maximum Peak Output Power & Peak Power Spectral Density

7.1.1 Limits & Requirements

FCC 15.247 (a) (1), FCC.247 (2) (b) (1) (3) (4) & RSS-210-A8.4 (1) (2) (3) (4)

Peak Output Power

The maximum peak conducted output power of the intentional radiator shall not exceed the following:
For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 Watt
For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 Watts.

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

FCC 15.247 (2) (e) & RSS-210 –A-8.2 (b)

Power Spectral Density (DSSS System only)

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

7.1.2 Test Conditions

Tnom: 20°C; Vnom: 4.0 Vdc
Hopping Function Disable

7.1.3 Test Procedure

Measurement according to ANSI C63.10-2009

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

DTS system
Peak Output Power
Span = wide enough to capture the entire emission being measure
RBW ≥ 6 dB bandwidth of the emission being measured
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Use the marker-peak function to set the marker to the peak of the emission.

Conducted output power measured using Spectrum Analyzer
EIRP is calculated by applying the following formula = Conducted Power + Antenna Gain.
Rated maximum antenna Gain: 902 - 928 MHz, 2.5 - 3.0 dBi, ~ 80% Efficiency
2.400 - 2.4835 MHz, 4.0 dBi, ~ 70% Efficiency

Power Spectral Density
Peak Output Power
Span = wide enough to capture the entire emission being measure
RBW ≥ 3 KHz
VBW ≥ 3 x RBW
Sweep = auto
Detector function = peak
Trace = max hold
Use the marker-peak function to set the marker to the peak of the emission.

7.1.4 Test Data

900MHz FHSS System Modulation: FSK Data Rate = 100 kbps					
Channels/ Frequency No.	**(MHz)**	**Conducted Peak Output Power (dBm)**	**Antenna Gain (dBi)**	**Calculated EIRP (dBm)**	**Result**
0	902.3	29.39	3	32.39	Passed
43	915.2	29.79	3	32.79	Passed
82	926.9	29.82	3	32.82	Passed

900MHz FHSS System Modulation: GFSK Data Rate = 100 kbps					
Channels/ Frequency No.	**(MHz)**	**Conducted Peak Output Power (dBm)**	**Antenna Gain (dBi)**	**Calculated EIRP (dBm)**	**Result**
0	902.2	29.28	3	32.28	Passed
65	915.2	29.77	3	32.77	Passed
128	927.8	29.77	3	32.77	Passed

900MHz FHSS System Modulation: GFSK Data Rate = 300 kbps					
Channels/ Frequency No.	**(MHz)**	**Conducted Peak Output Power (dBm)**	**Antenna Gain (dBi)**	**Calculated EIRP (dBm)**	**Result**
0	902.4	29.66	3	32.66	Passed
32	915.2	29.72	3	32.72	Passed
63	927.6	29.76	3	32.76	Passed

Note: EIRP = *Conducted Measurement Result + Antenna Gain (dBi)*

2.4 GHz FHSS System Modulation: GFSK Data Rate = 250 kbps					
Channels/ Frequency No.	**(GHz)**	**Conducted Peak Output Power (dBm)**	**Antenna Gain (dBi)**	**Calculated EIRP (dBm)**	**Result**
0	2.4008	24.04	4	28.04	Passed
49	2.4400	24.50	4	28.50	Passed
90	2.4728	24.42	4	28.42	Passed

2.4 GHz FHSS System Modulation: GFSK Data Rate = 500 kbps					
Channels/Frequency No.	**(MHz)**	**Conducted Peak Output Power (dBm)**	**Antenna Gain (dBi)**	**Calculated EIRP (dBm)**	**Result**
0	2.4008	23.89	4	27.89	Passed
49	2.4400	24.43	4	28.43	Passed
90	2.4728	24.37	4	28.37	Passed

2.4 GHz DTS System Modulation: OQPSK Data Rate = 250 KHz					
Channels / Freq No.	**(MHz)**	**Conducted Peak Output Power (dBm)**	**Antenna Gain (dBi)**	**Calculated EIRP (dBm)**	**Result**
11	2.405	22.66	4	26.66	Passed
18	2.440	22.16	4	26.16	Passed
26	2.480	0.13	4	4.13	Passed

Note: EIRP = Conducted Measurement Result + Antenna Gain (dBi)

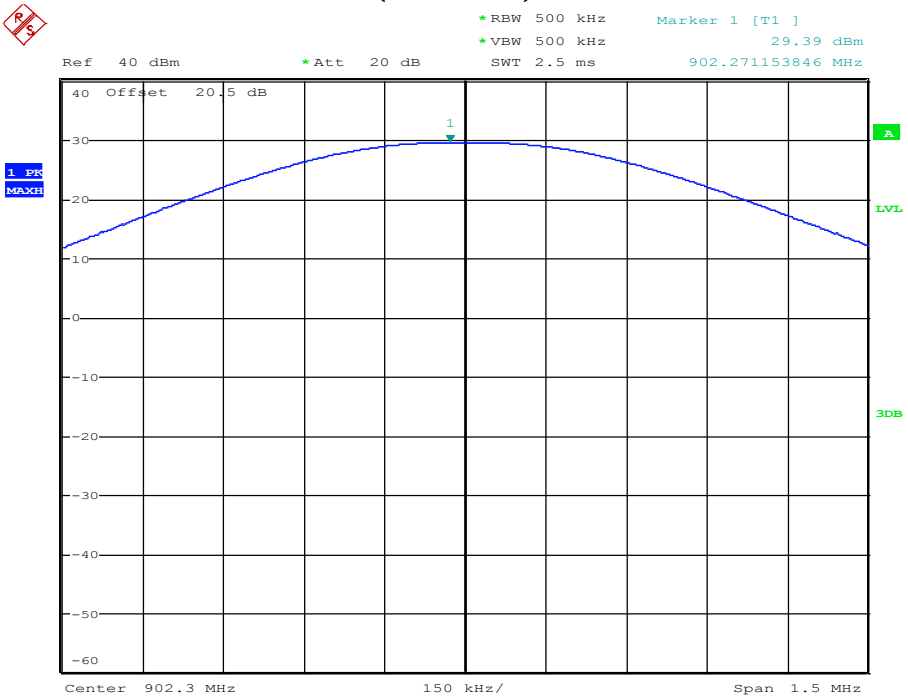
2.4 GHz DTS System Modulation: OQPSK Data Rate = 250 KHz			
Channels / Freq **No. (MHz)**	**Peak Power Spectral Density (dBm)**	**Limit (dBm)**	**Result**
11 2.405	7.72	8	Passed
18 2.440	7.45	8	Passed
26 2.480	-14.73	8	Passed

7.1.5 Measurement Verdict

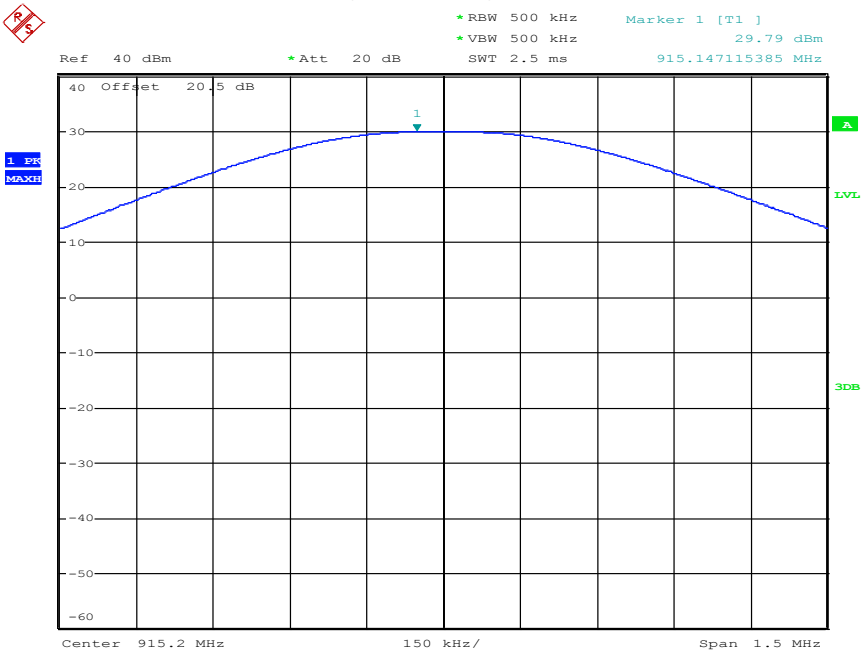
Passed

7.1.6 Data Plots

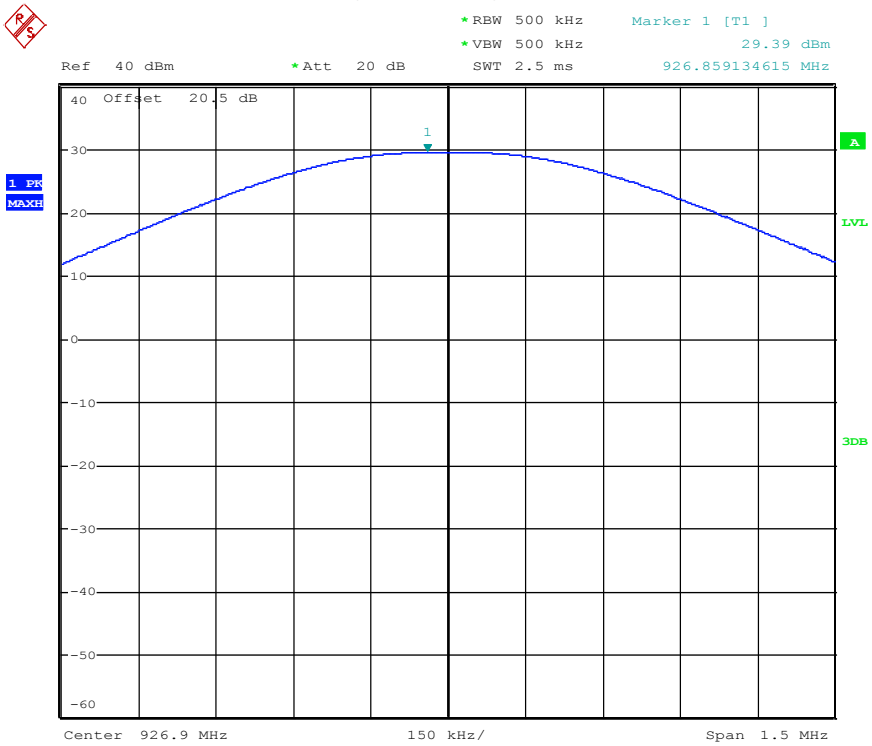
FSK: 100Kbps Conducted Peak Power Ch0 (902.3 MHz)



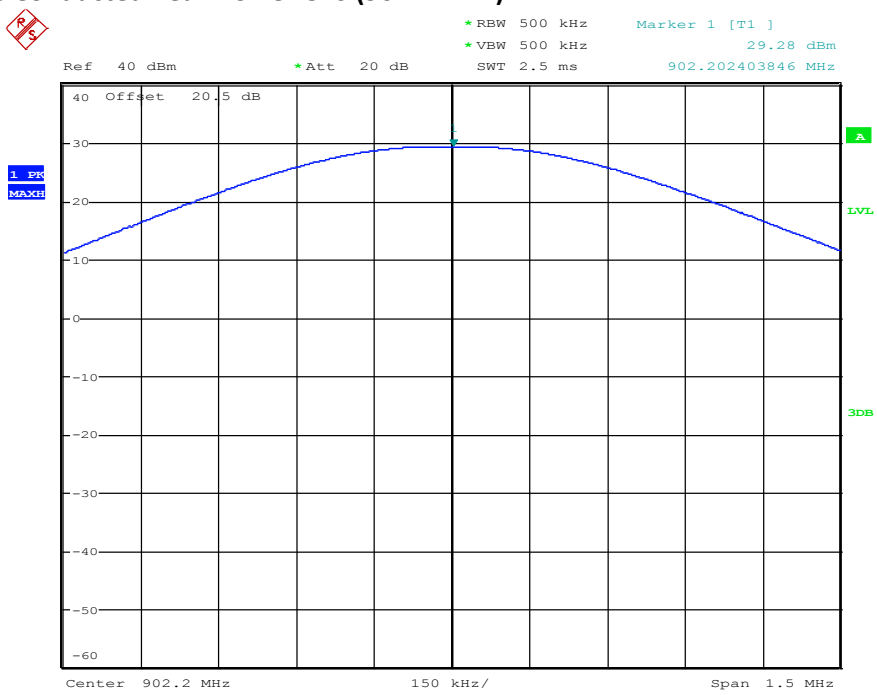
FSK: 100Kbps Conducted Peak Power Ch43 (915.2 MHz)



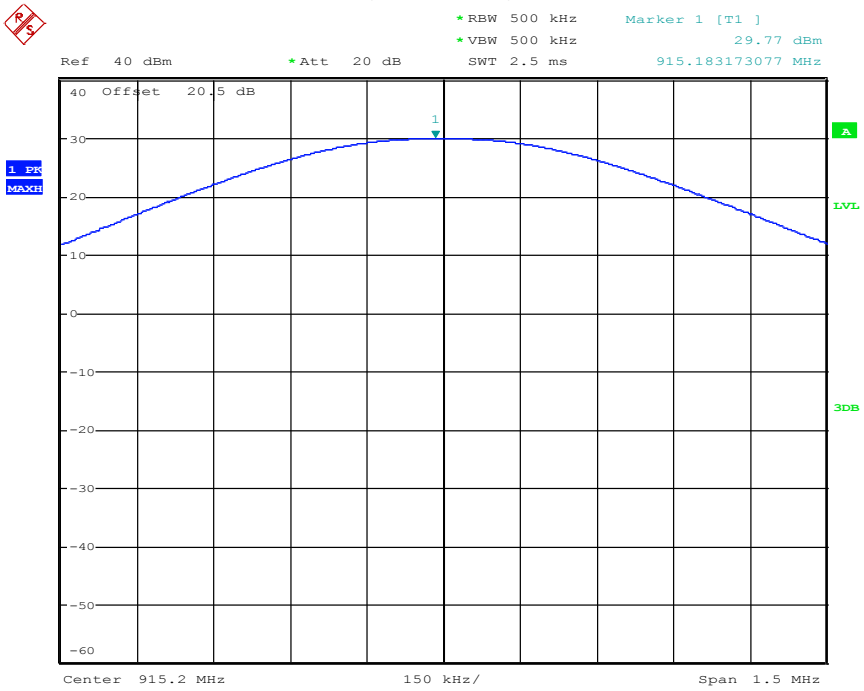
FSK: 100Kbps Conducted Peak Power Ch82 (926.9 MHz)



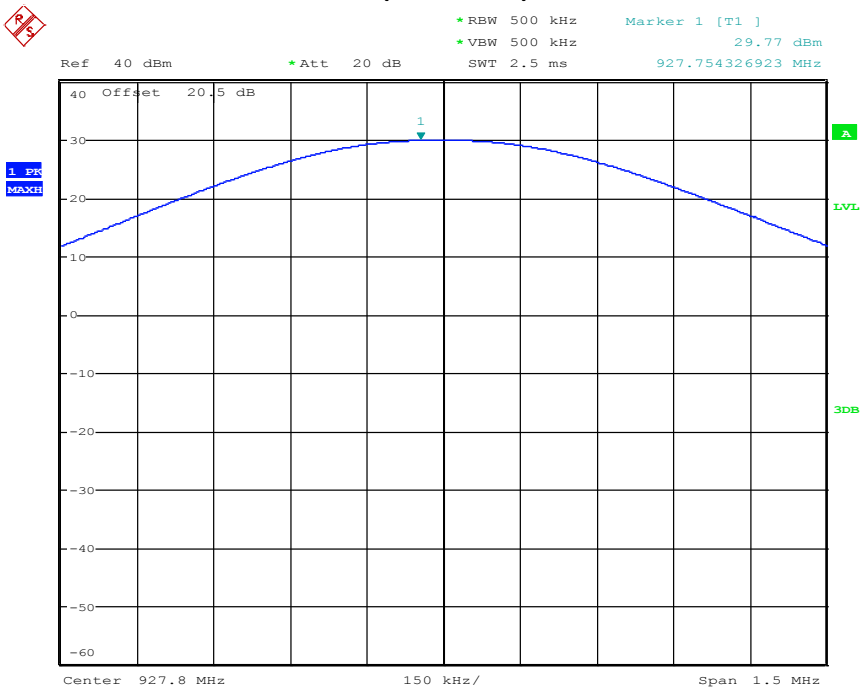
GFSK: 100Kbps Conducted Peak Power Ch0 (902.2 MHz)



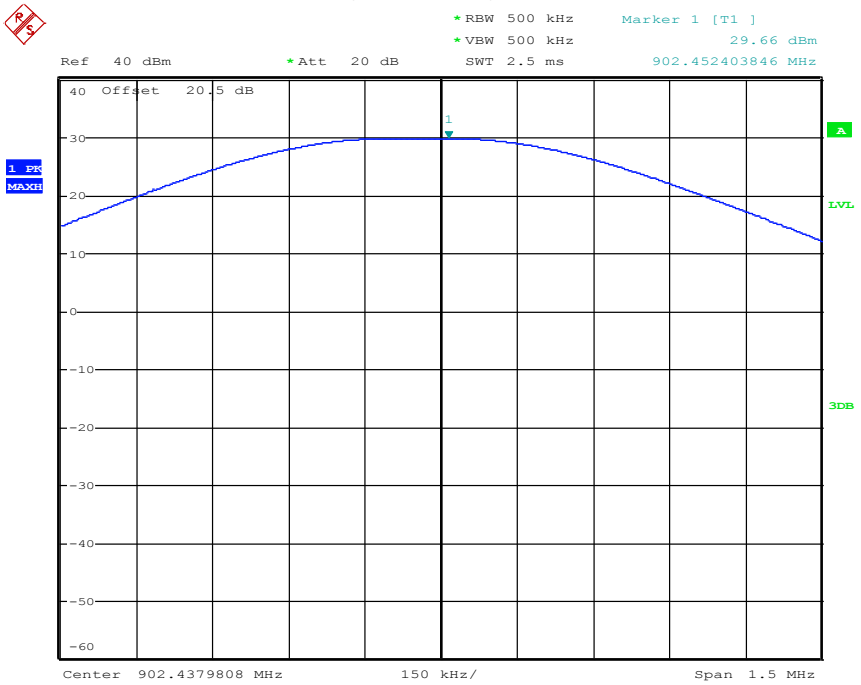
GFSK: 100Kbps Conducted Peak Power Ch65 (915.2 MHz)



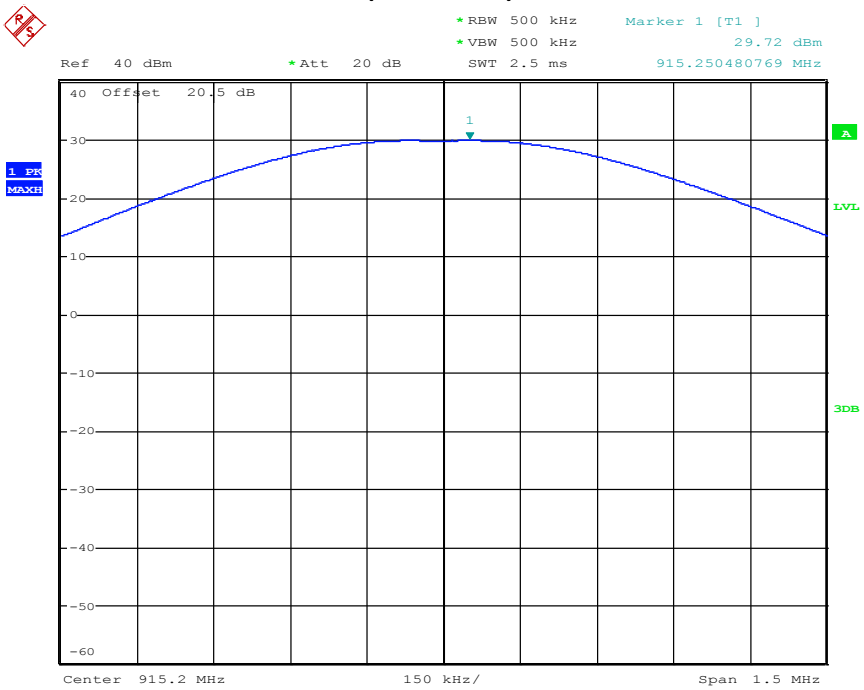
GFSK: 100Kbps Conducted Peak Power Ch128 (927.8 MHz)



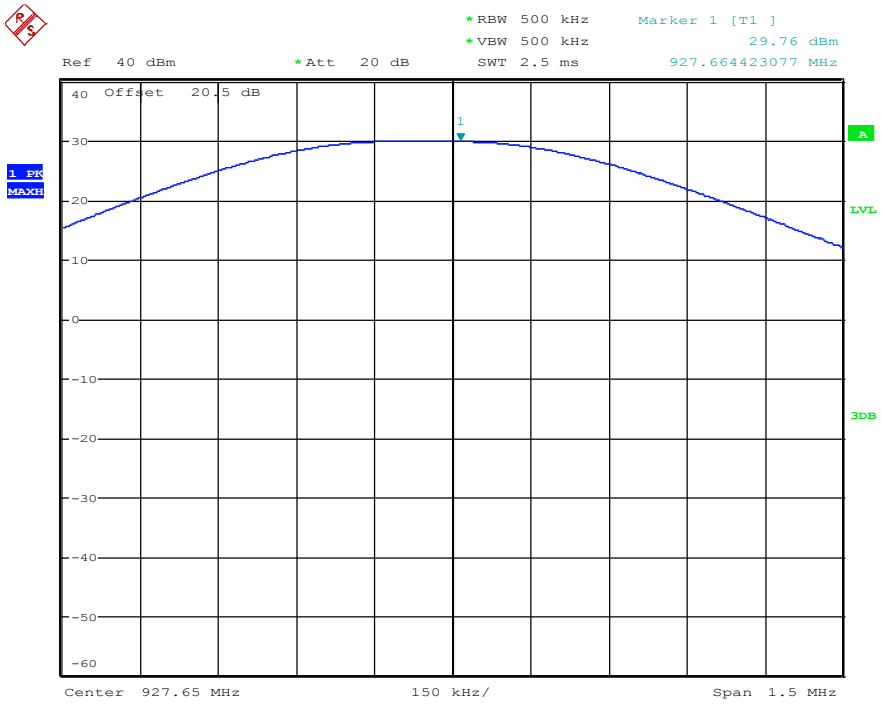
GFSK: 300Kbps Conducted Peak Power Ch0 (902.4 MHz)



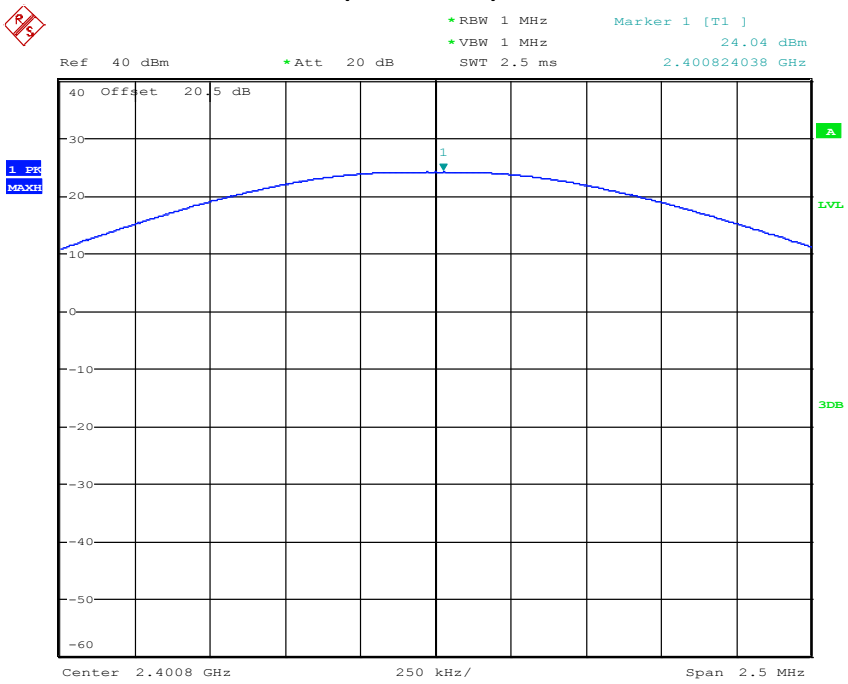
GFSK: 300Kbps Conducted Peak Power Ch32 (915.2 MHz)



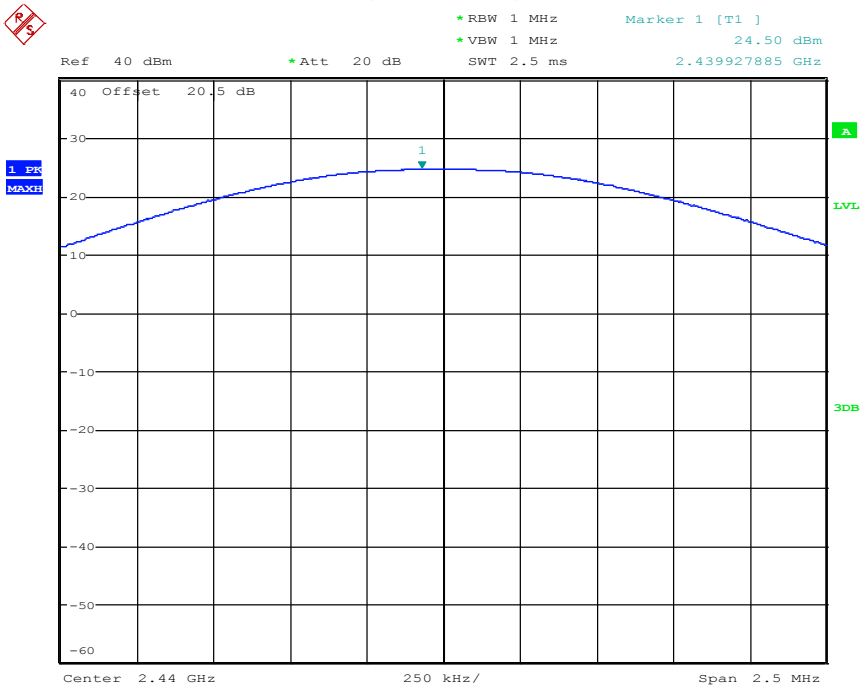
GFSK: 300Kbps Conducted Peak Power Ch63 (927.6 MHz)



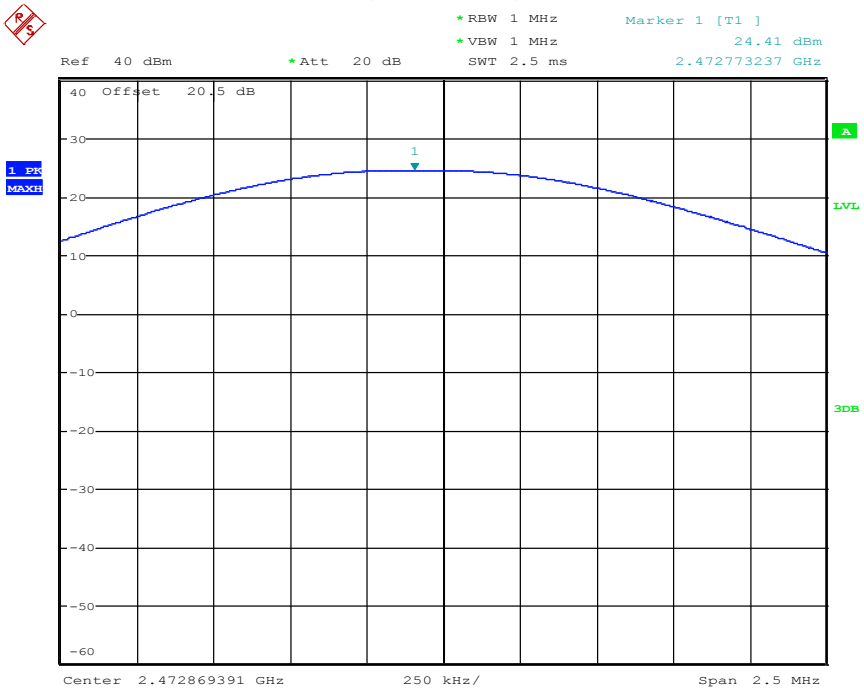
GFSK: 250Kbps Conducted Peak Power Ch0 (2.4008 GHz)



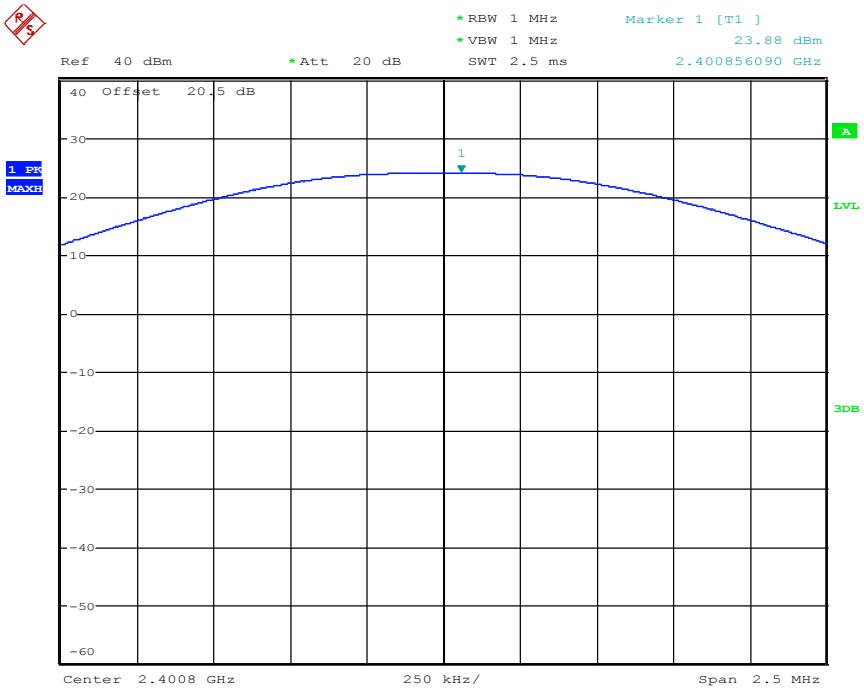
GFSK: 250Kbps Conducted Peak Power Ch49 (2.4400 GHz)



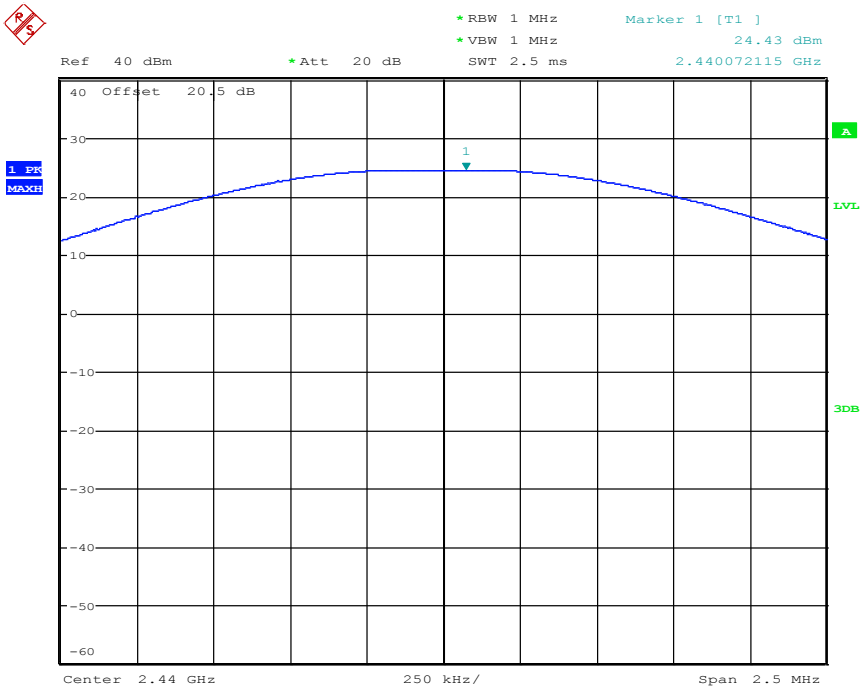
GFSK: 250Kbps Conducted Peak Power Ch90 (2.4728 GHz)



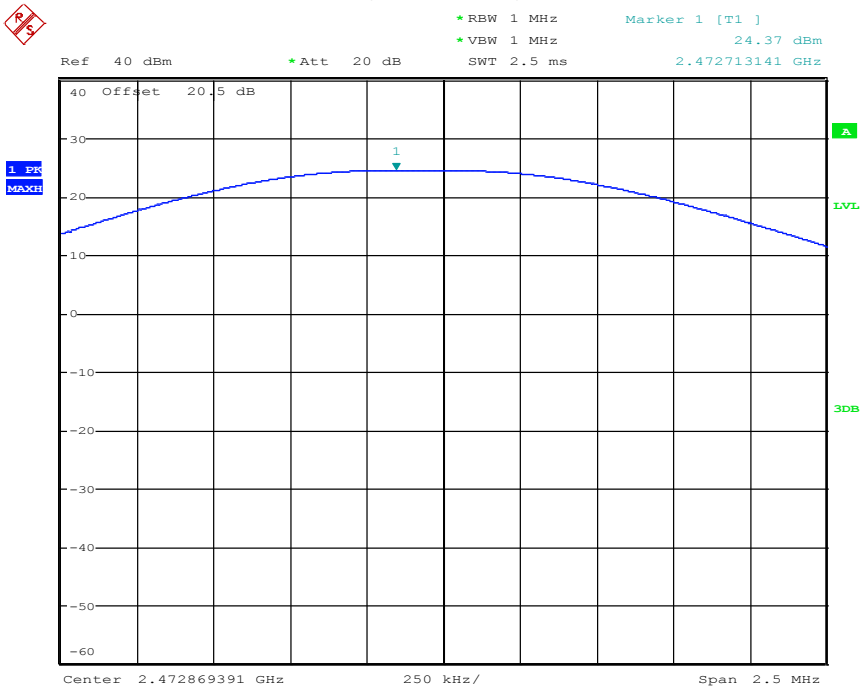
GFSK: 500Kbps Conducted Peak Power Ch0 (2.4008 GHz)



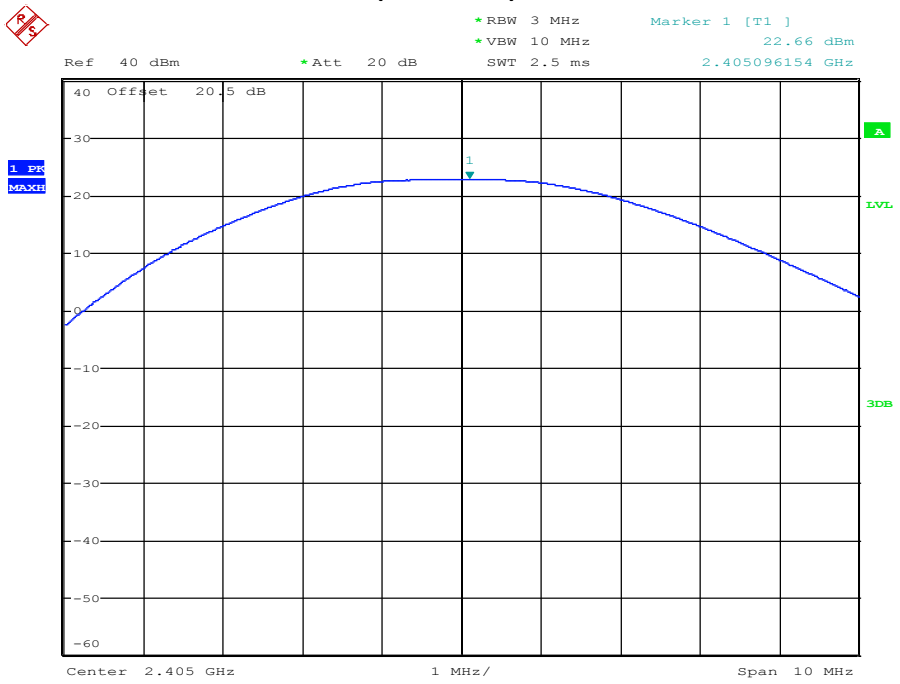
GFSK: 500Kbps Conducted Peak Power Ch49 (2.4400 GHz)



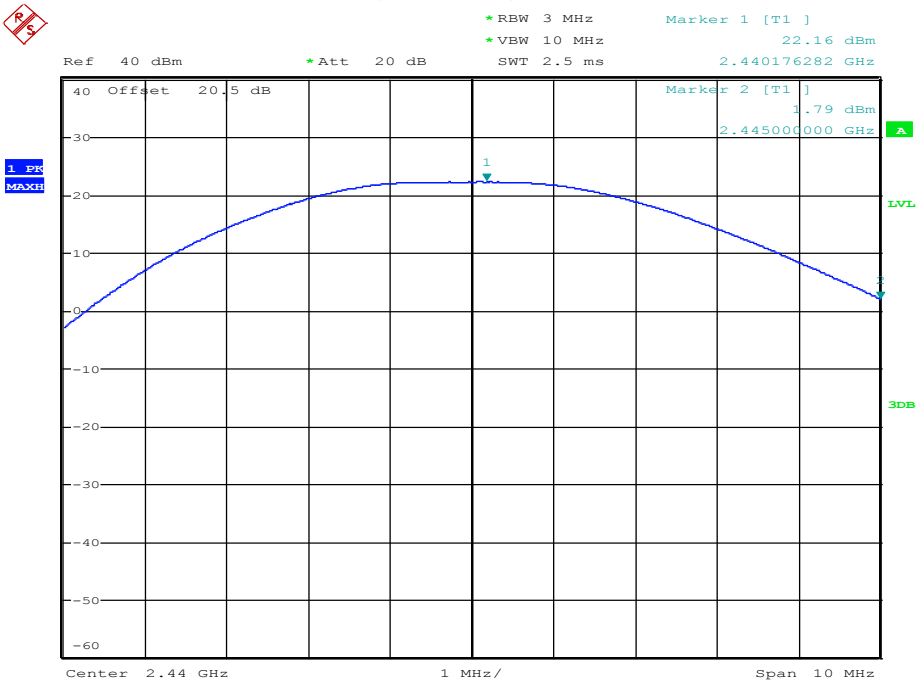
GFSK: 500Kbps Conducted Peak Power Ch90 (2.4728 GHz)



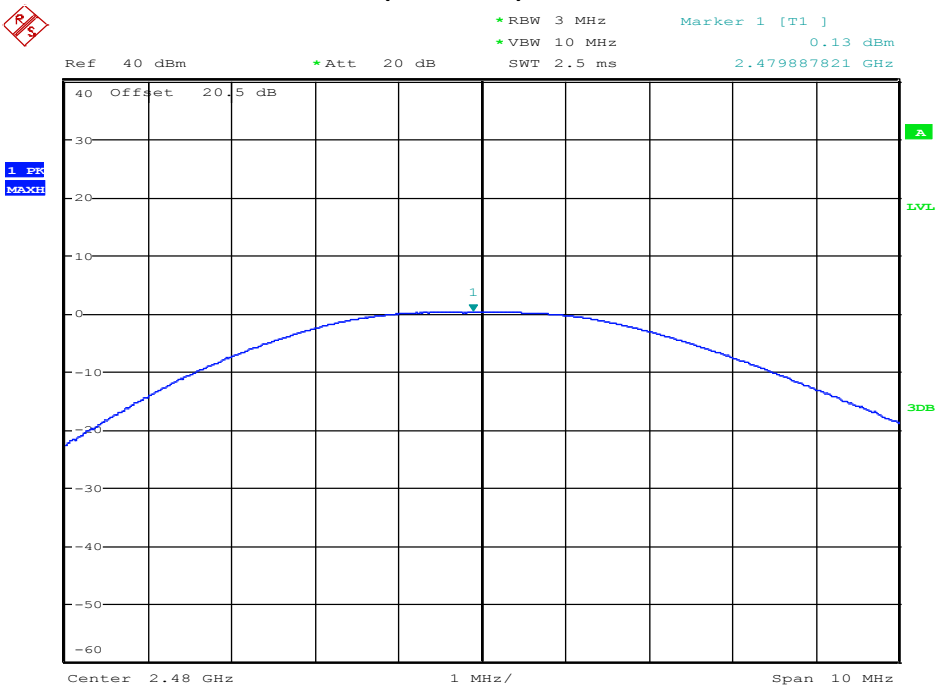
OQPSK: 250 KHz Conducted Peak Power Ch11 (2.405 GHz)



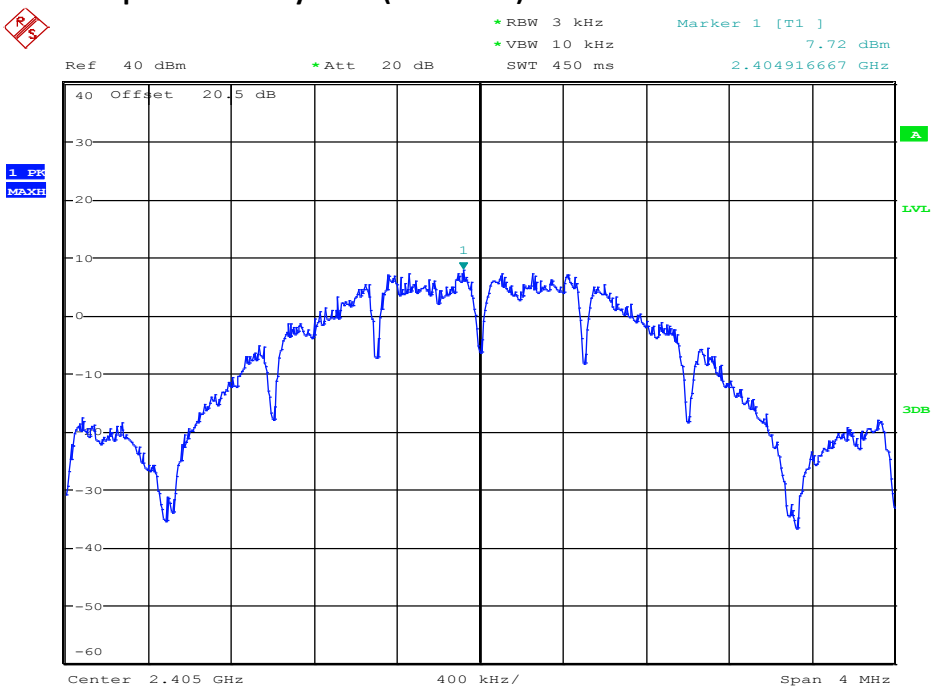
OQPSK: 250 KHz Conducted Peak Power Ch18 (2.440 GHz)



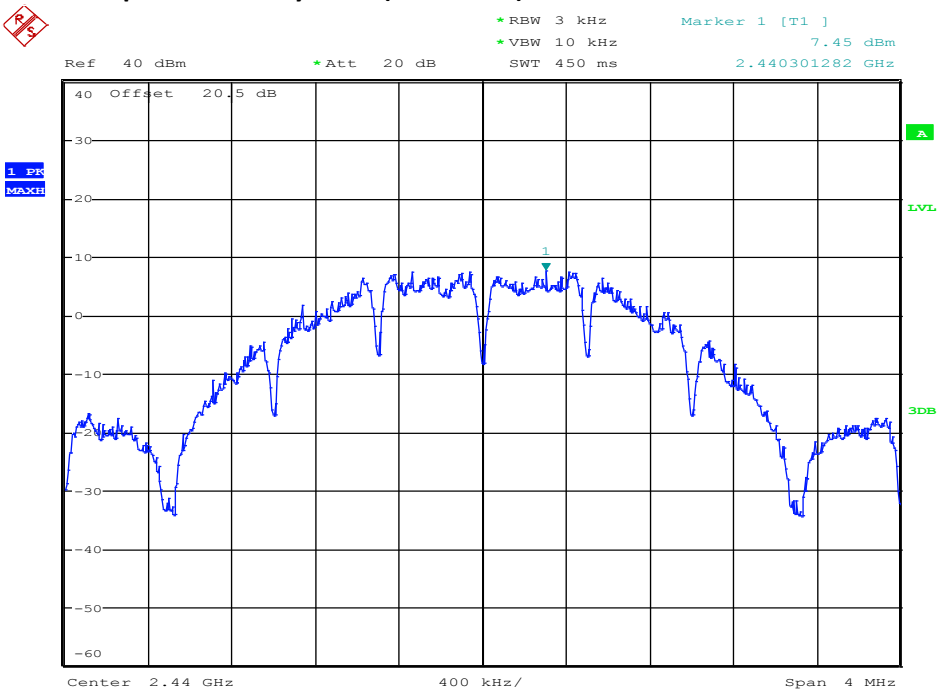
OQPSK: 250 KHz Conducted Peak Power Ch26 (2.480 GHz)



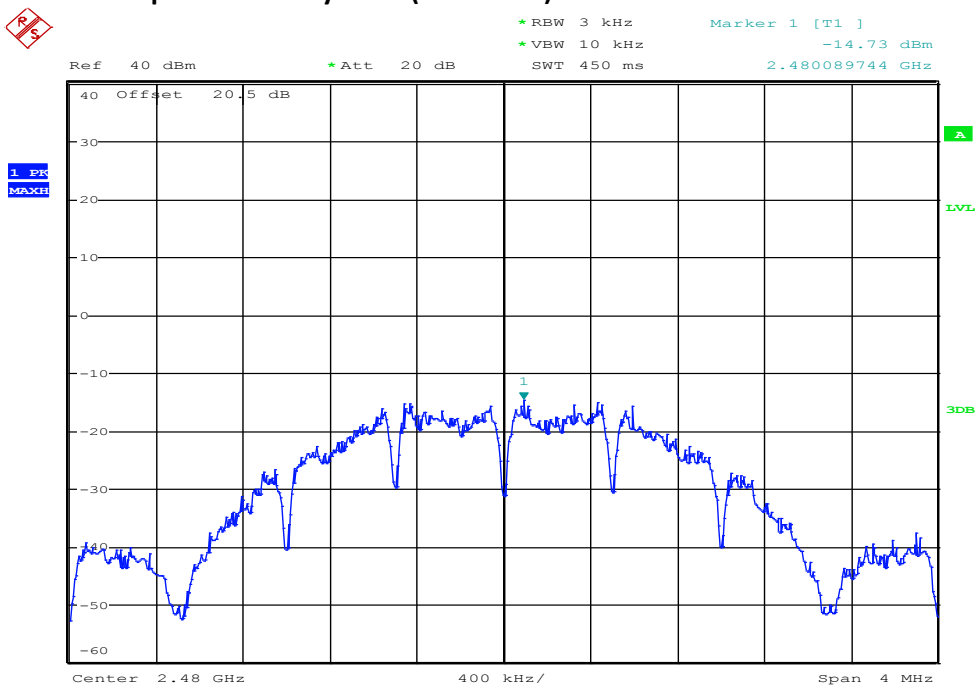
OQPSK: 250 KHz Power Spectral Density Ch11 (2.405 GHz)



OQPSK: 250 KHz Power Spectral Density Ch18 (2.440 GHz)



OQPSK: 250 KHz Power Spectral Density Ch26 (2.480 GHz)



7.2 Occupied Bandwidth & No. of Hopping Channels.

7.2.1 Limits & Requirements

FCC 15.247 (a) (i) (iii) (2) & RSS-Gen 4.6

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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.

2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

7.2.2 Test Conditions

Tnom: 20°C; Vnom: 4.0Vdc

7.2.3 Test Procedure for Occupied Bandwidth & No. of Hopping Frequencies

Measurement according to ANSI C63.10-2009 & KDB558074 D01 ver3.1:2013

Test Procedure for Occupied Bandwidth

FHSS system
20 dB BW
Spectrum Analyzer settings:
Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
RBW ≥ 1% to 5% of the occupied bandwidth
VBW ≥ RBW or 3X
Sweep = auto
Detector function = peak
Trace = max hold
Use delta function to measure the width of the fundamental emission taken between the two outer most amplitude points (upper & lower frequencies) that are 20dB below reference peak level of the frequency of interest.

DSSS system
6dB BW
Spectrum Analyzer settings:
Span = Wide enough to capture the entire emission bandwidth
RBW ≥ 100 KHz
VBW ≥ RBW or 3X
Sweep = auto
Detector function = peak
Trace = max hold
Use marker-delta function to measure the width of the fundamental emission taken between the two outer most amplitude points (upper & lower frequencies) that are 6dB below reference peak level of the frequency of interest.

For 99% occupied Bandwidth, use the occupied bandwidth measurement function with the band set equal to 99% emission bandwidth.

Test Procedure for Number of Hopping Frequencies

Spectrum Analyzer settings:
Span = the entire frequency band of operation
RBW ≥ 1% of the span
VBW ≥ RBW or 3X
Sweep = auto
Detector function = peak
Trace = max hold
The EUT must have its hopping function enabled during the test.

7.2.4 Test Data

FHSS System Modulation: FSK Date Rate: 100 Kbps					
Channel No.	**Frequency (MHz)**	**20dB BW (kHz)**	**No. of Hopping Channel**	**20 dB BW Limit (KHz)**	**Result**
0	902.3	209.1	83	≤ 250	Passed

Note: Same result for other channels with the same modulation. Only data for 1 channel shown is sufficient.

FHSS System Modulation: GFSK Date Rate: 100 Kbps					
Channel No.	**Frequency (MHz)**	**20dB BW (kHz)**	**No. of Hopping Channel**	**20 dB BW Limit (KHz)**	**Result**
0	902.2	120.2	129	≤ 250	Passed

Note: Same result for other channels with the same modulation. Only data for 1 channel shown is sufficient.

FHSS System Modulation: GFSK Date Rate: 300 Kbps					
Channel No.	**Frequency (MHz)**	**20dB BW (kHz)**	**No. of Hopping Channel**	**20 dB BW Limit (KHz)**	**Result**
0	902.4	322.1	64	≤ 500	Passed

Note: Same result for other channels with the same modulation. Only data for 1 channel shown is sufficient.

FHSS System Modulation: GFSK Date Rate: 250 Kbps					
Channel No.	**Frequency (GHz)**	**20dB BW (kHz)**	**No. of Hopping Channel**	**Occupied BW Limit**	**Result**
0	2.4008	271.6	91	None	Reference only

Note: Same result for other channels with the same modulation. Only data for 1 channel shown is sufficient.

FHSS System Modulation: GFSK Date Rate: 500 Kbps					
Channel No.	**Frequency (MHz)**	**20dB BW (kHz)**	**No. of Hopping Channel**	**Limit**	**Result**
0	2.4008	521.6	91	None	Reference only

Note: Same result for other channels with the same modulation. Only data for 1 channel shown is sufficient.

DTS System Modulation: OQPSK Date Rate: 250 KHz				
Channel No.	**Frequency (MHz)**	**6 dB BW (MHz)**	**Limit (KHz)**	**Result**
11	2.405	1.57	≥ 500	Passed
18	2.440	1.59	≥ 500	Passed
26	2.480	1.60	≥ 500	Passed

DTS System Modulation: OQPSK Date Rate: 250 KHz				
Channel No.	**Frequency (MHz)**	**99%BW (MHz)**	**Limit**	**Result**
11	2.405	2.40	None	Reference only
18	2.440	2.44	None	Reference only
26	2.480	2.48	None	Reference only

900MHz FHSS System **Modulation: FSK** **Date Rate: 100 Kbps**				
Hopping.	**Start Frequency (MHz)**	**Stop Frequency (MHz)**	**Segment #**	**No. of hopping freqs.**
ON	902	915.2	1	43.5
ON	915.2	920	2	16
ON	920	928	3	23.5
Total No. of Hopping Frequencies				83

900 MHz FHSS System **Modulation: GFSK** **Date Rate: 100 Kbps**				
Hopping.	**Start Frequency (MHz)**	**Stop Frequency (MHz)**	**Segment #**	**No. of Hopping Freqs.**
ON	902	908	1	29.5
ON	908	915	2	35
ON	915	922	3	35
ON	922	928	4	29.5
Total No. of Hopping Frequencies				129

900 MHz FHSS System **Modulation: GFSK** **Date Rate: 300 Kbps**				
Hopping.	**Start Frequency (MHz)**	**Stop Frequency (MHz)**	**Segment #**	**No. of Hopping Freqs.**
ON	**902**	**915**	1	32
ON	**915**	**928**	2	32
Total No. of Hopping Frequencies				64

2.4 GHz FHSS System Modulation: GFSK Date Rate: 250 Kbps				
Hopping.	**Start Frequency (GHz)**	**Stop Frequency (GHz)**	**Segment #**	**No. of Hopping Freqs.**
ON	2.400	2.440	1	49.5
ON	2.440	2.480	2	41.5
Total No. of Hopping Frequencies				91

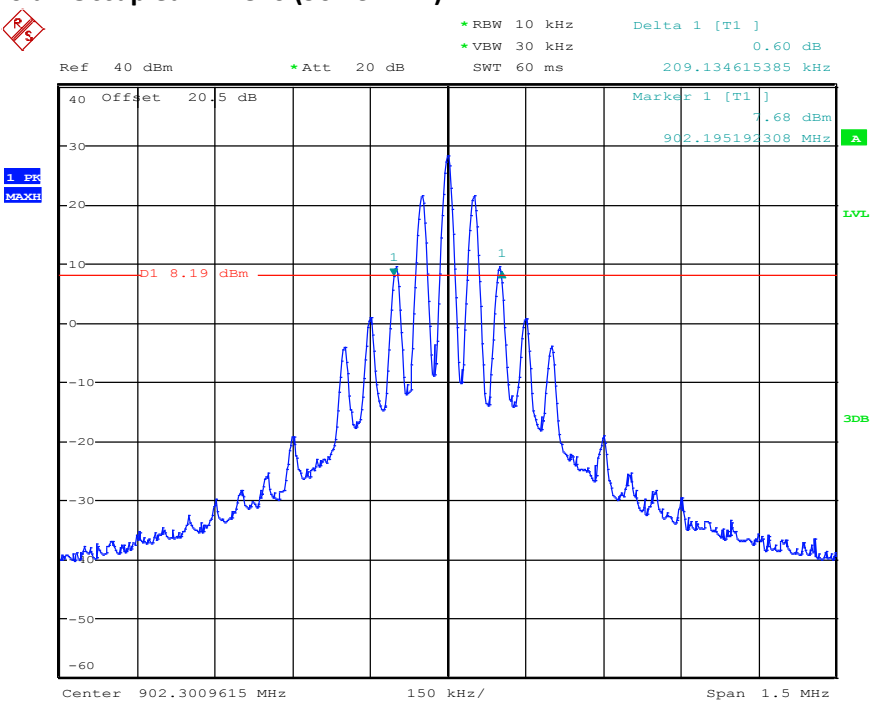
7.2.5 Measurement Verdict

Passed

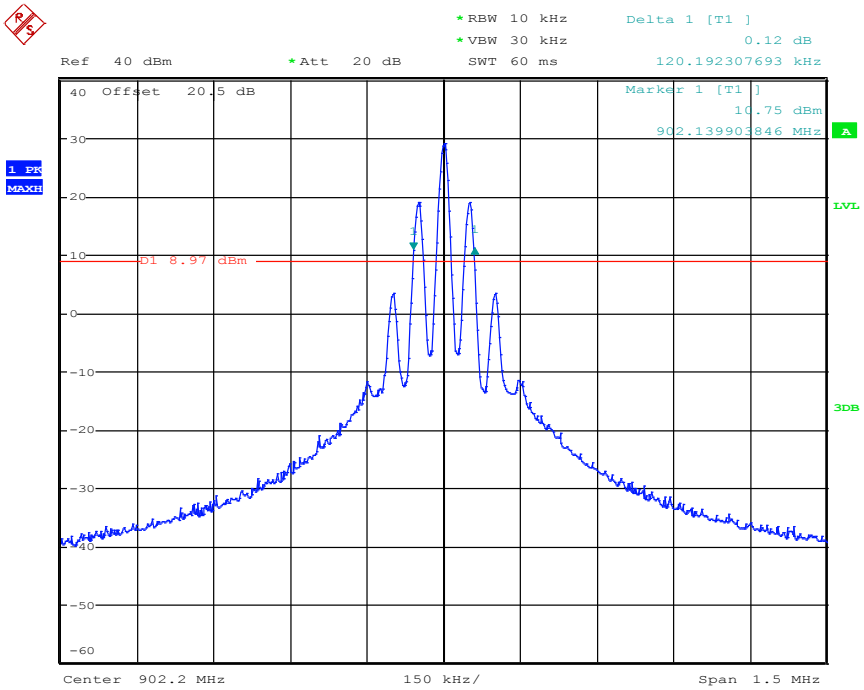
Complies to all conditions for # of hopping frequencies (FHSS)

7.2.6 Data Plots

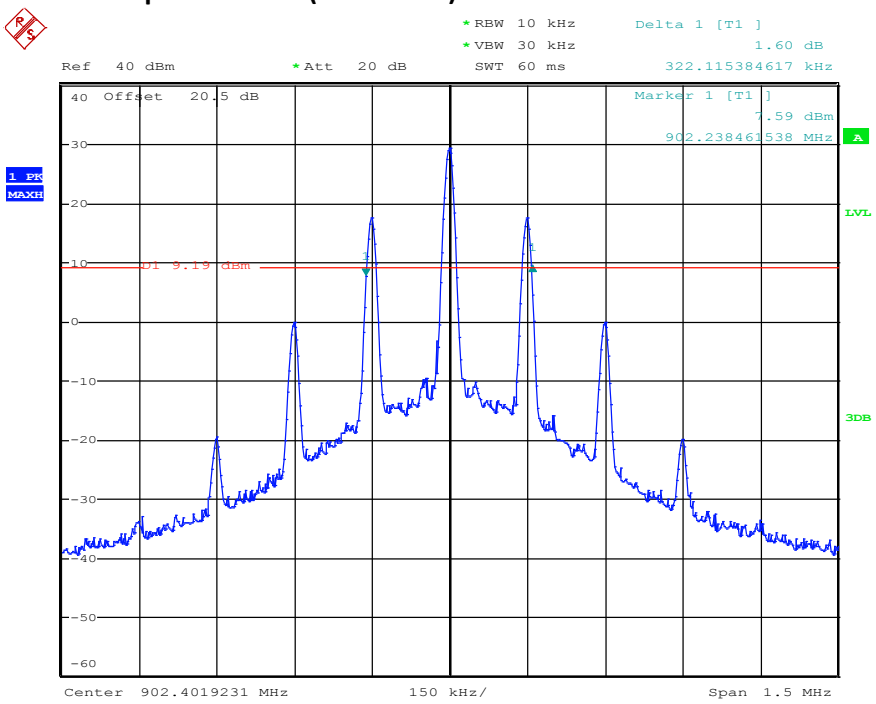
FSK: 100Kbps 20 dB Occupied BW Ch0 (902.3 MHz)



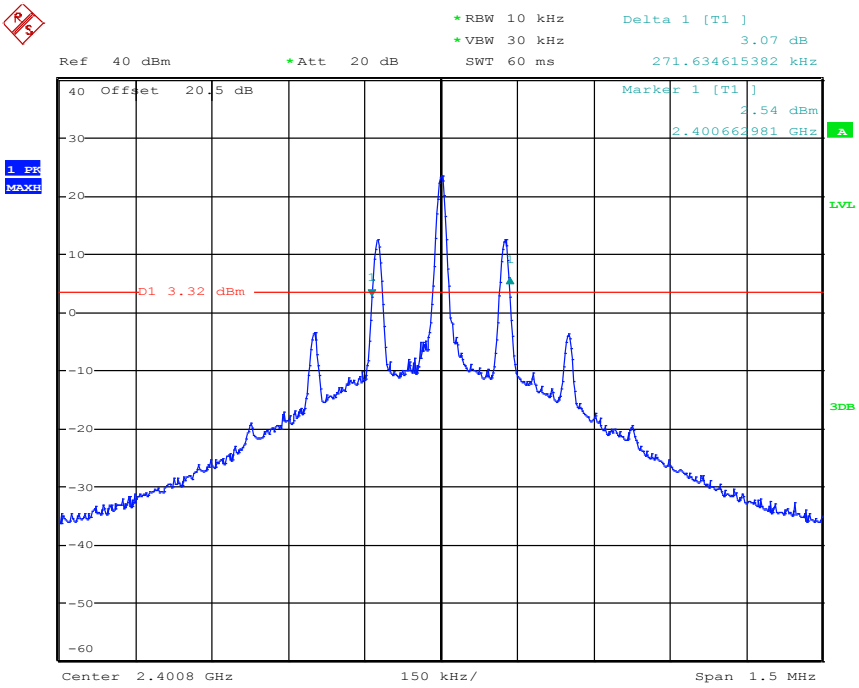
GFSK: 100Kbps 20dB Occupied BW Ch0 (902.2 MHz)



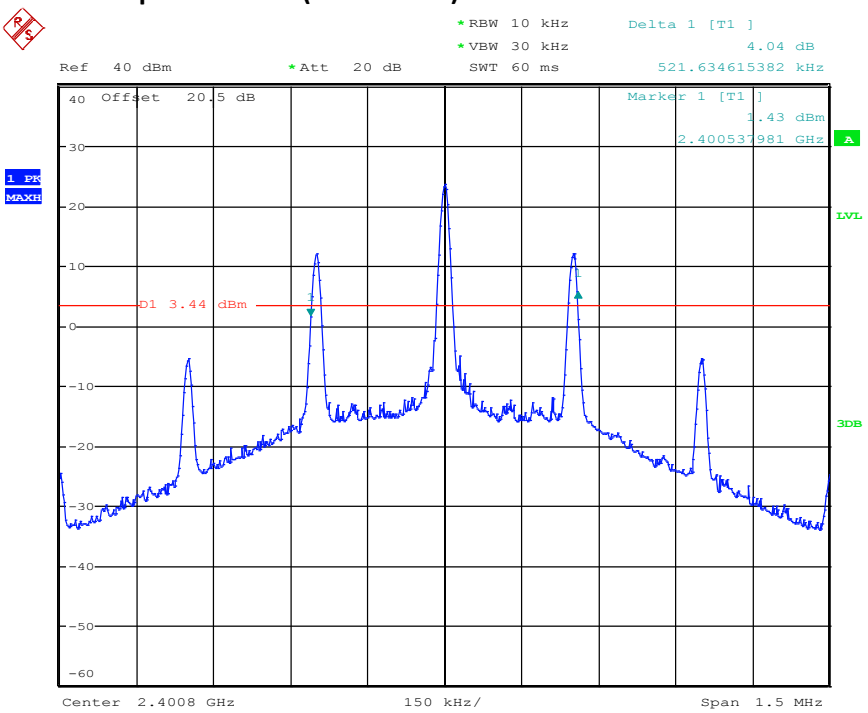
GFSK: 300Kbps 20dB Occupied BW Ch0 (902.4 MHz)



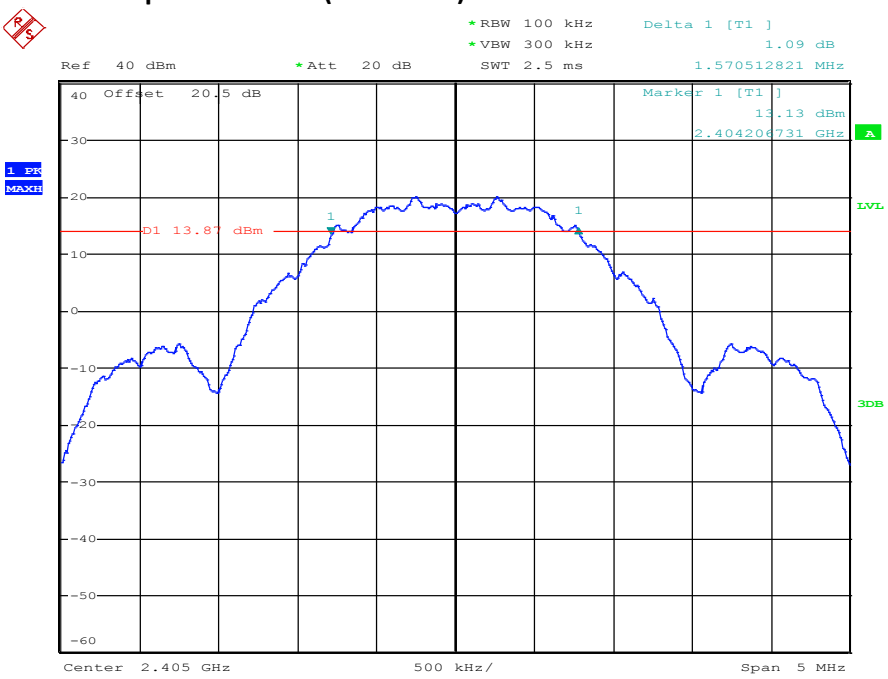
GFSK: 250Kbps 20dB Occupied BW Ch0 (2.4008 GHz)



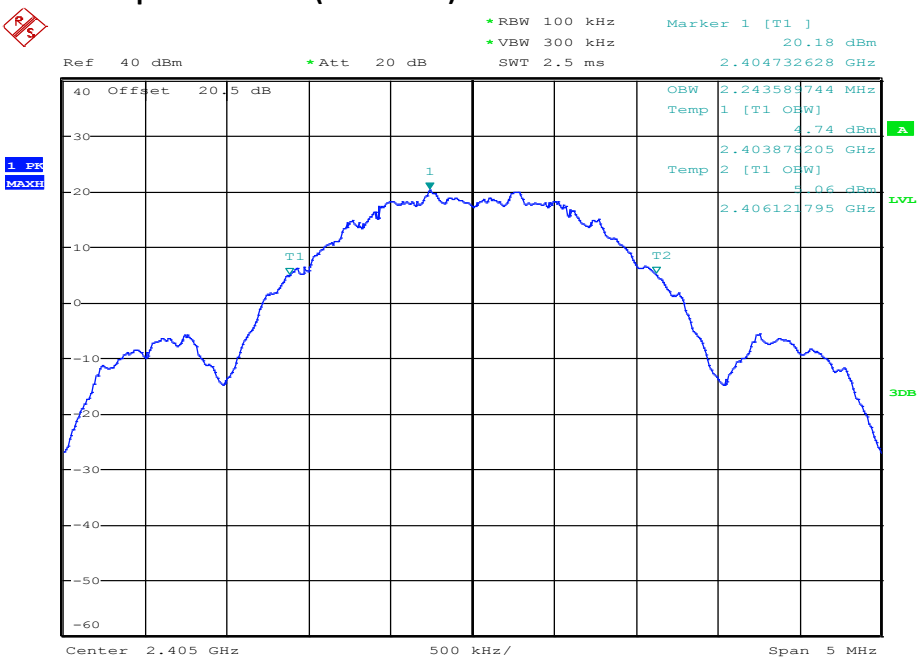
GFSK: 500Kbps 20dB Occupied BW Ch0 (2.4008 GHz)



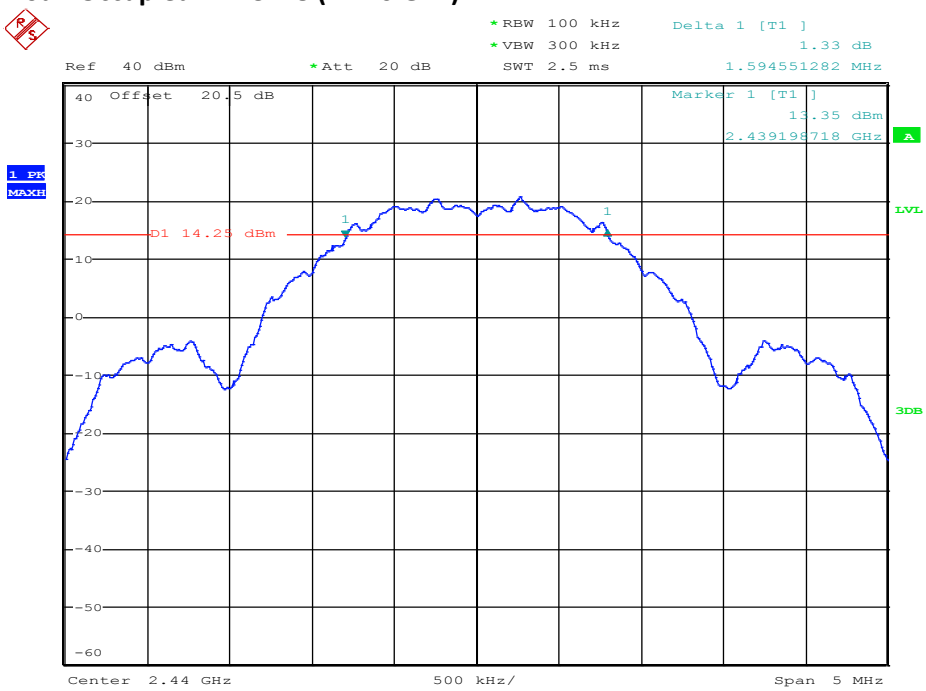
OQPSK: 250 KHz 6dB Occupied BW Ch11 (2.405 GHz)



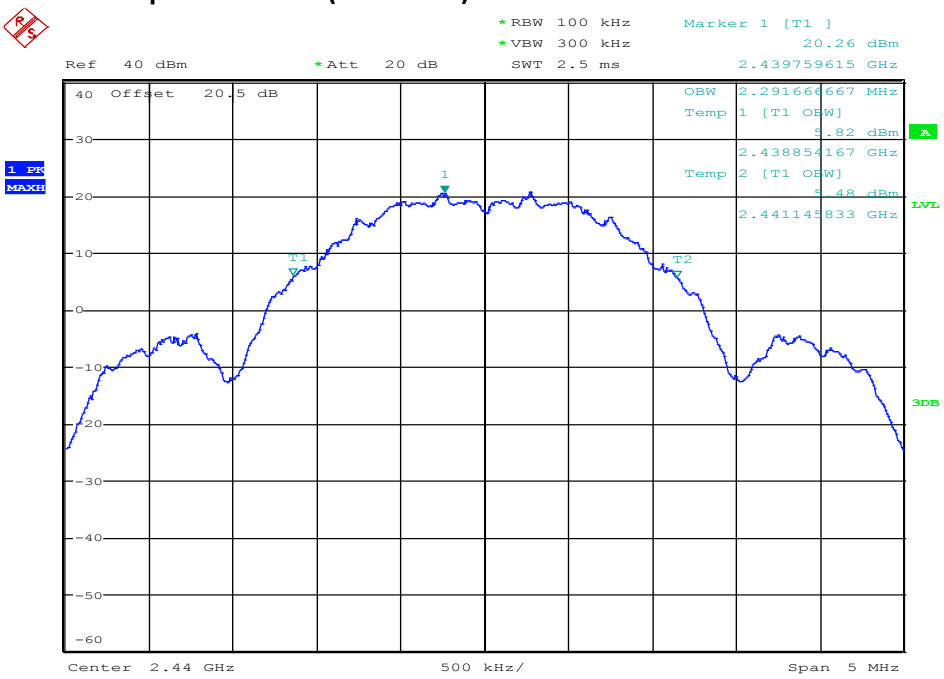
OQPSK: 250 KHz 99% Occupied BW Ch11 (2.405 GHz)



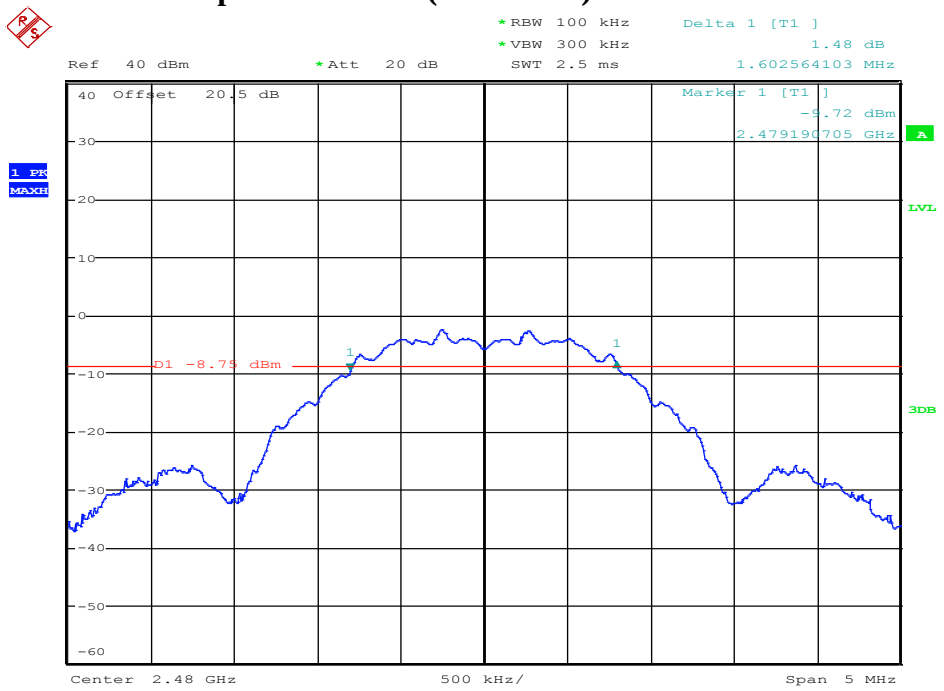
OQPSK: 250 KHz 6dB Occupied BW Ch18 (2.440 GHz)



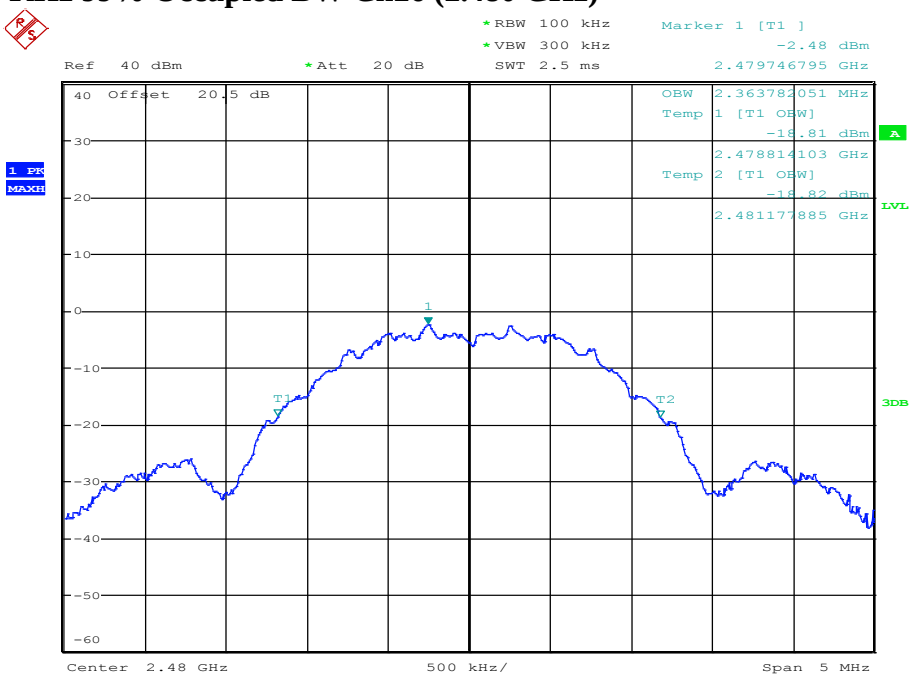
OQPSK: 250 KHz 99% Occupied BW Ch18 (2.440 GHz)



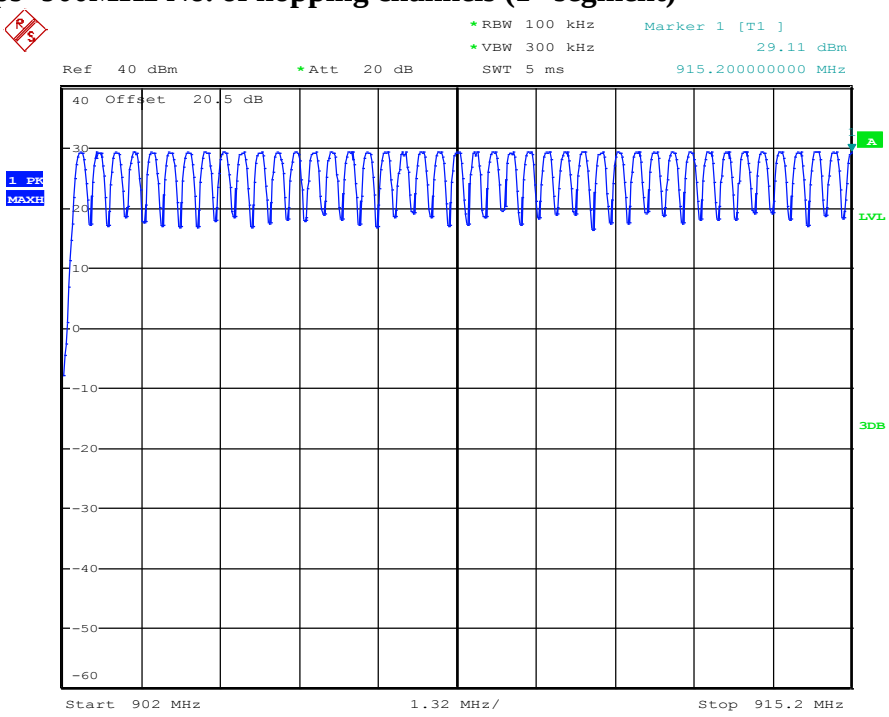
OQPSK: 250 KHz 6dB Occupied BW Ch26 (2.480 GHz)



OQPSK: 250 KHz 99% Occupied BW Ch26 (2.480 GHz)

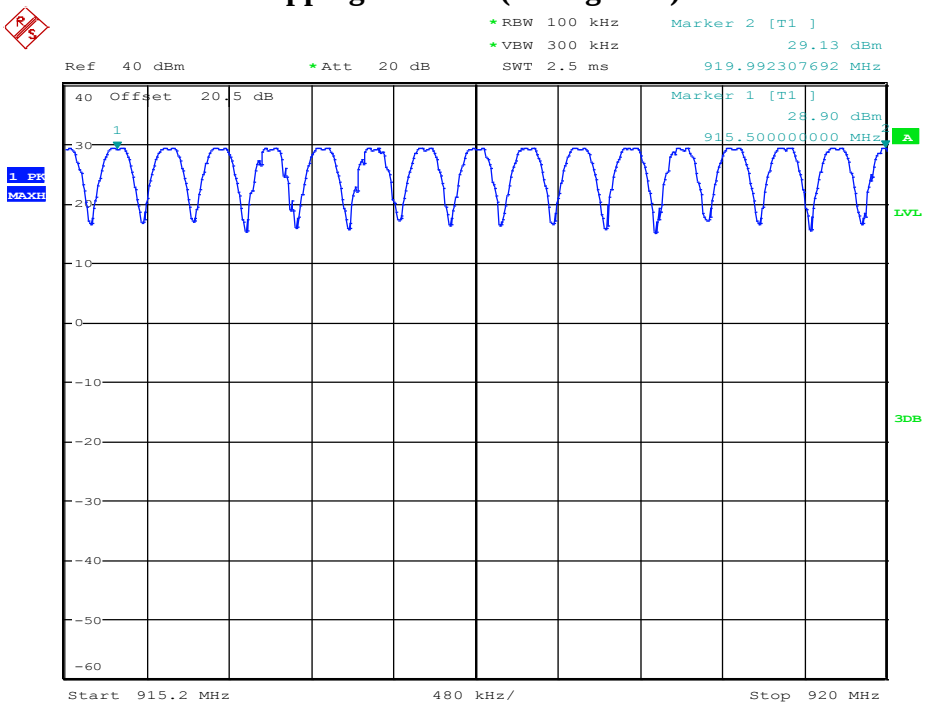


FSK: 100Kbps- 900MHz No. of hopping channels (1st segment)



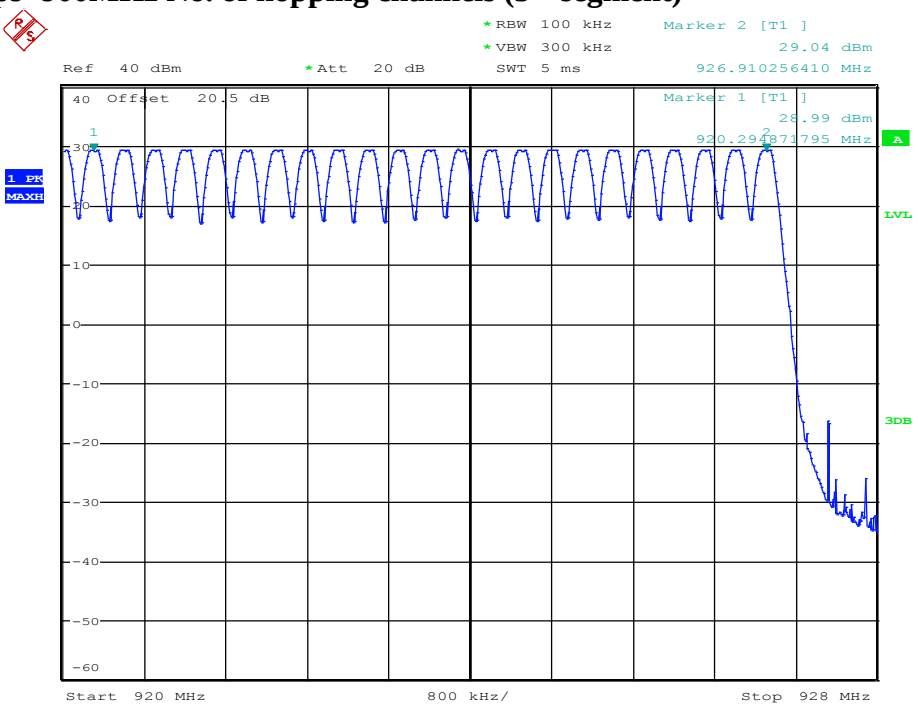
Total # of Channels = 43.5

FSK: 100Kbps- 900MHz No. of hopping channels (2nd segment)



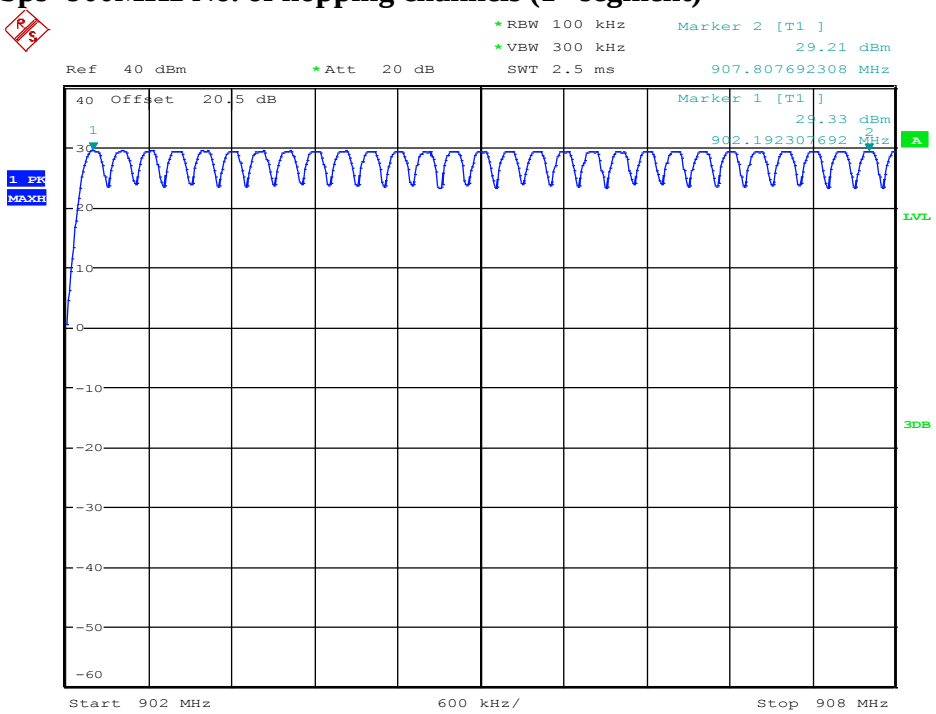
Total # of Channels = 16

FSK: 100Kbps- 900MHz No. of hopping channels (3rd segment)



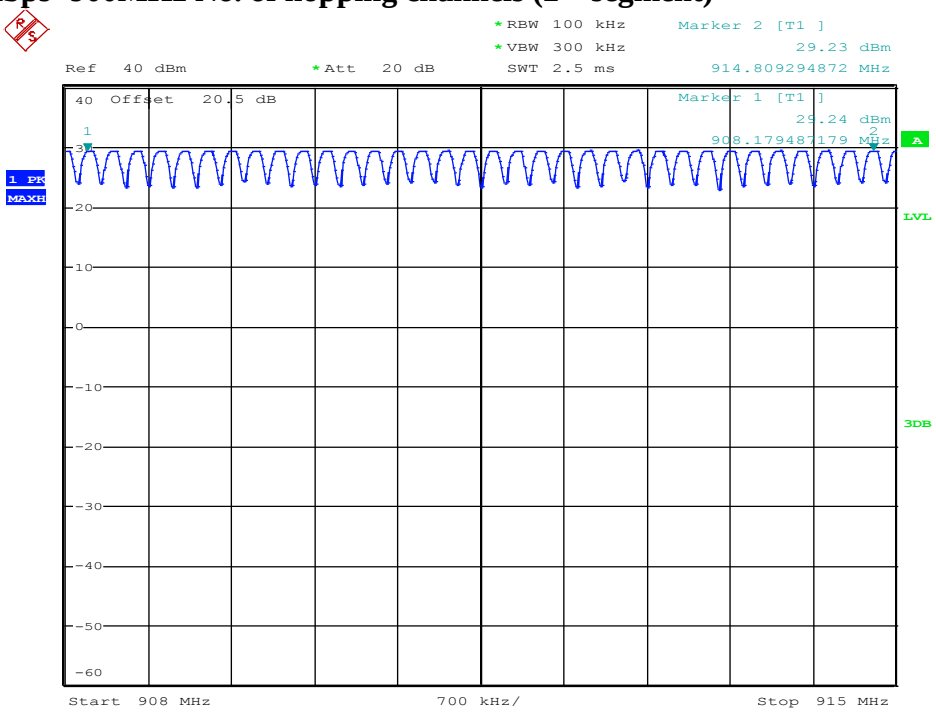
Total # of Channels = 23.5

GFSK: 100Kbps- 900MHz No. of hopping channels (1st segment)



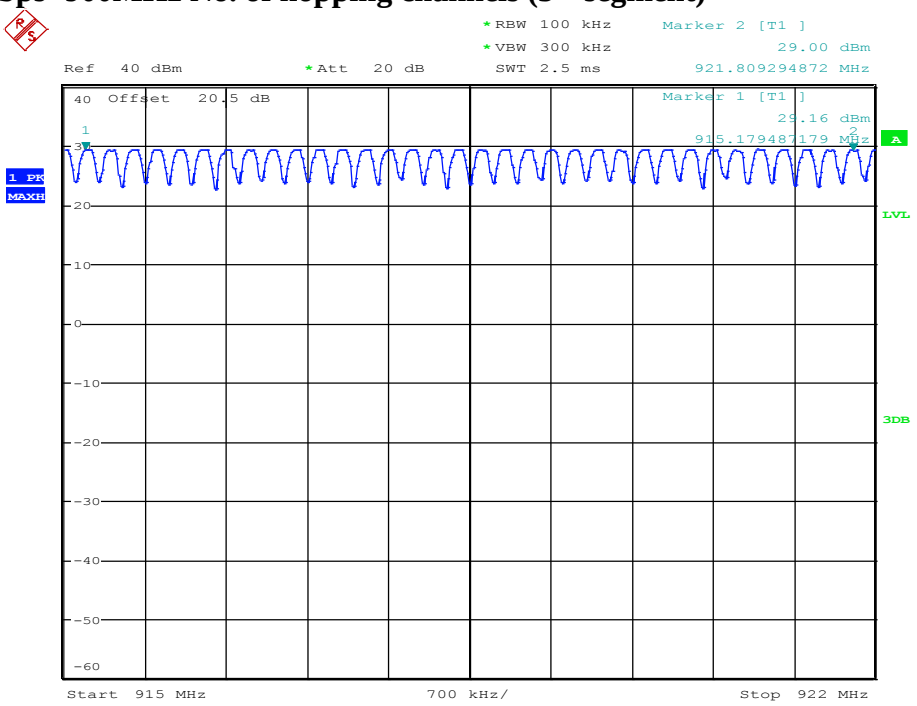
Total # of Channels = 29.5

GFSK: 100Kbps- 900MHz No. of hopping channels (2nd segment)



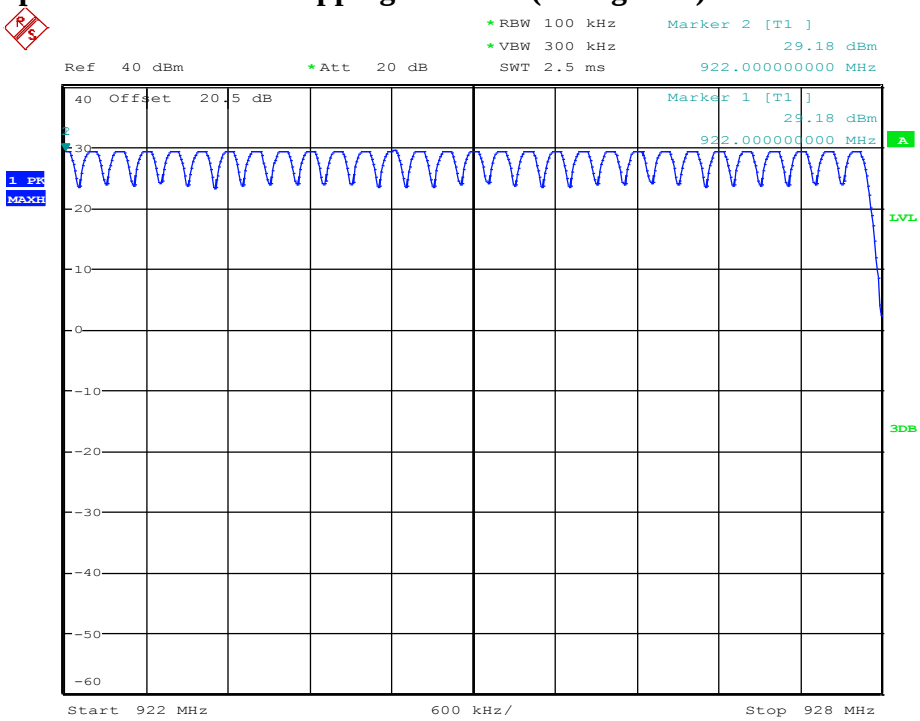
Total # of Channels = 35

GFSK: 100Kbps- 900MHz No. of hopping channels (3rd segment)



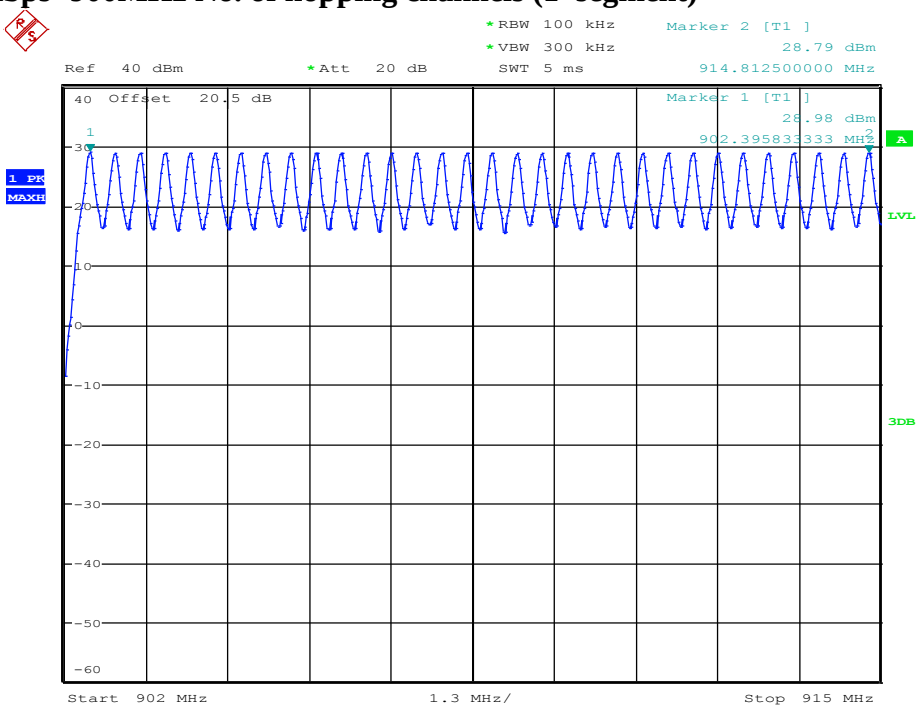
Total # of Channels = 35

GFSK: 100Kbps- 900MHz No. of hopping channels (4th segment)



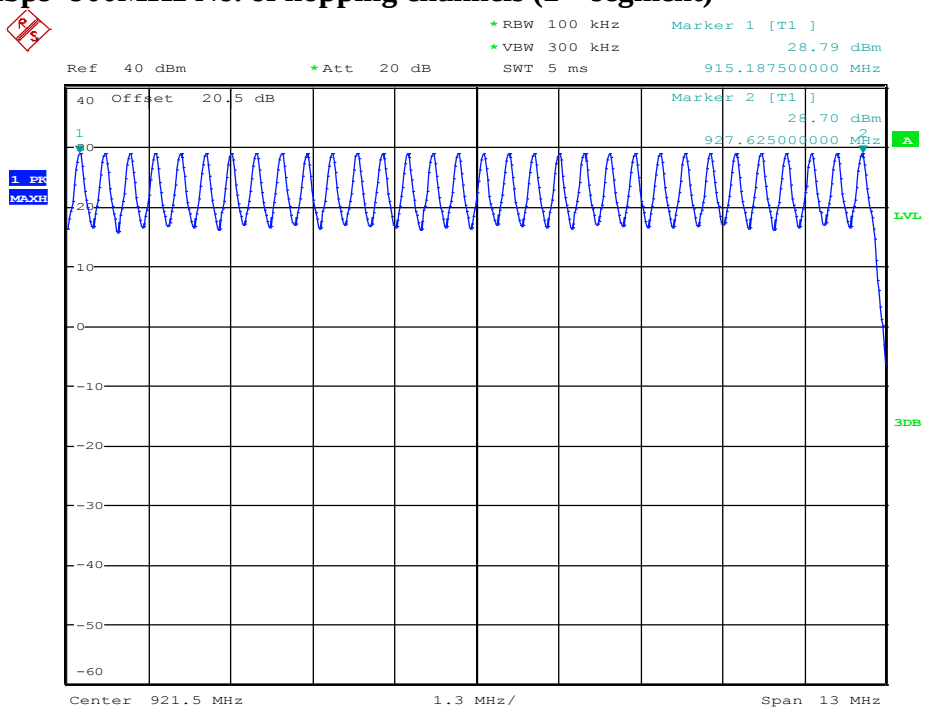
Total # of Channels = 29.5

GFSK: 300Kbps- 900MHz No. of hopping channels (1s segment)



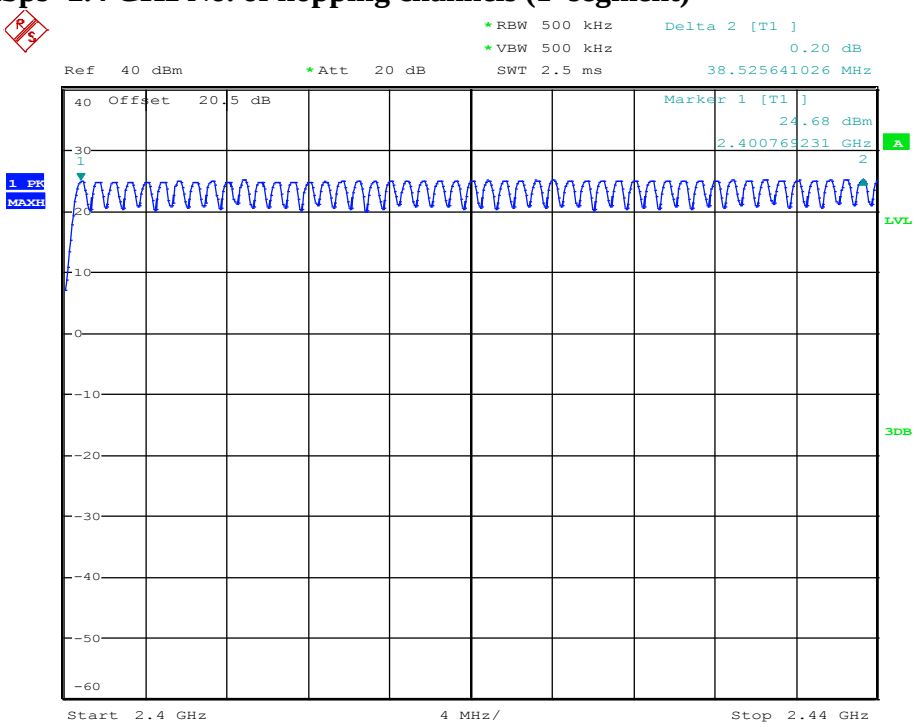
Total # of Channels = 32

GFSK: 300Kbps- 900MHz No. of hopping channels (2nd segment)



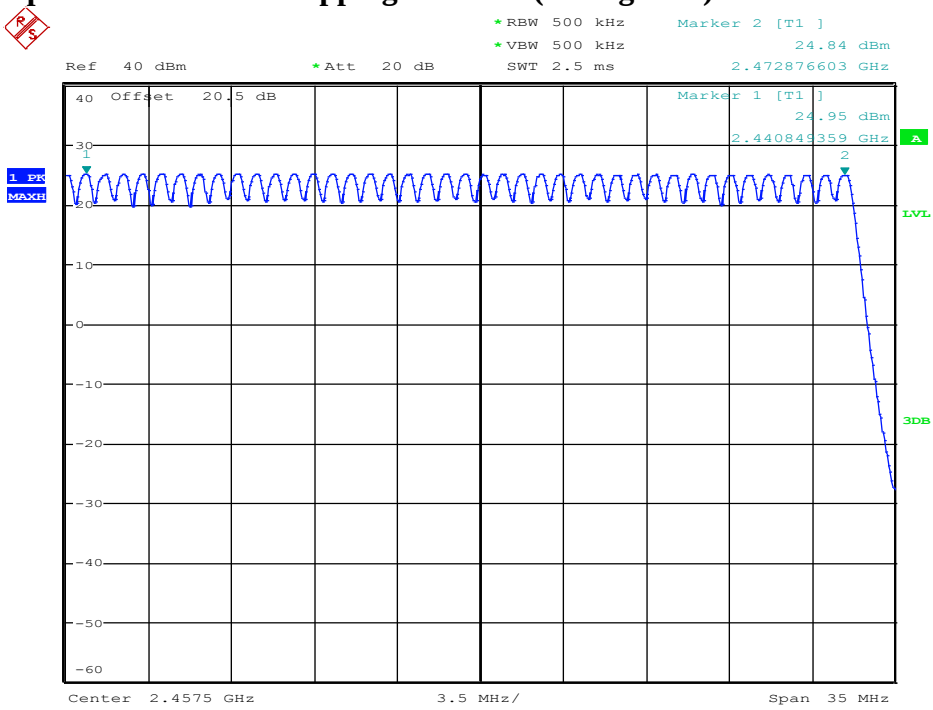
Total # of Channels = 32

GFSK: 250Kbps- 2.4 GHz No. of hopping channels (1s segment)



Total # of Channels = 49.5

GFSK: 250Kbps- 2.4 GHz No. of hopping channels (2nd segment)



Total # of Channels = 41.5

7.3 Carrier Frequency Separation

7.3.1 Limits & Requirements

FCC 15.247 (a) (1) & RSS-210 (A8.1) (b)

(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.

7.3.2 Test Conditions

Tnom: 20°C; Vnom: 4.0Vdc

7.3.3 Test Procedure

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
The EUT must have its hopping function enabled during the test.
Use marker-delta function to determine the separation between the peak of the two adjacent channels.

7.3.4 Measurement Verdict

Passed

7.3.5 Test Data

900MHz FHSS System Modulation: FSK Data Rate = 100 kbps				
Channel No.	**Frequency (MHz)**	**Measured Separation (KHz)**	**Limit ≥ 20dB BW (KHz)**	**Result (Fail/Pass)**
43 & 44	**915.2 & 915.5**	299.68	209	Passed

Note: Measured 20 dB bandwidth for 900 MHz FHSS is 209.1 KHz

900MHz FHSS System Modulation: GFSK Data Rate = 100 kbps				
Channel No.	**Frequency (MHz)**	**Measured Separation (KHz)**	**Limit ≥ 20dB BW (KHz)**	**Result (Fail/Pass)**
65 & 66	**915.2 & 915.4**	200.32	120	Passed

Note: Measured 20 dB bandwidth for 900 MHz FHSS is 120.2 KHz

900MHz FHSS System Modulation: GFSK Data Rate = 300 kbps				
Channel No.	**Frequency (MHz)**	**Measured Separation (KHz)**	**Limit ≥ 20dB BW (KHz)**	**Result (Fail/Pass)**
32 & 33	**915.2 & 915.6**	400.64	322	Passed

Note: Measured 20 dB bandwidth for 900 MHz FHSS is 322.1 KHz

2.4GHz FHSS System Modulation: GFSK Data Rate = 250 kbps				
Channel No.	**Frequency (GHz)**	**Measured Separation (KHz)**	**Limit ≥ 20dB BW (KHz)**	**Result (Fail/Pass)**
49 & 50	**2.4400 & 2.4408**	800.48	272	Passed

Note: Measured 20 dB bandwidth for 2.4 GHz FHSS @ 250 Kbps is 272 KHz

2.4 GHz FHSS System Modulation: GFSK Data Rate = 500 kbps				
Channel No.	**Frequency (MHz)**	**Measured Separation (KHz)**	**Limit ≥ 20dB BW (KHz)**	**Result (Fail/Pass)**
49 & 50	**2.4400 & 2.4408**	800.48	522	Passed

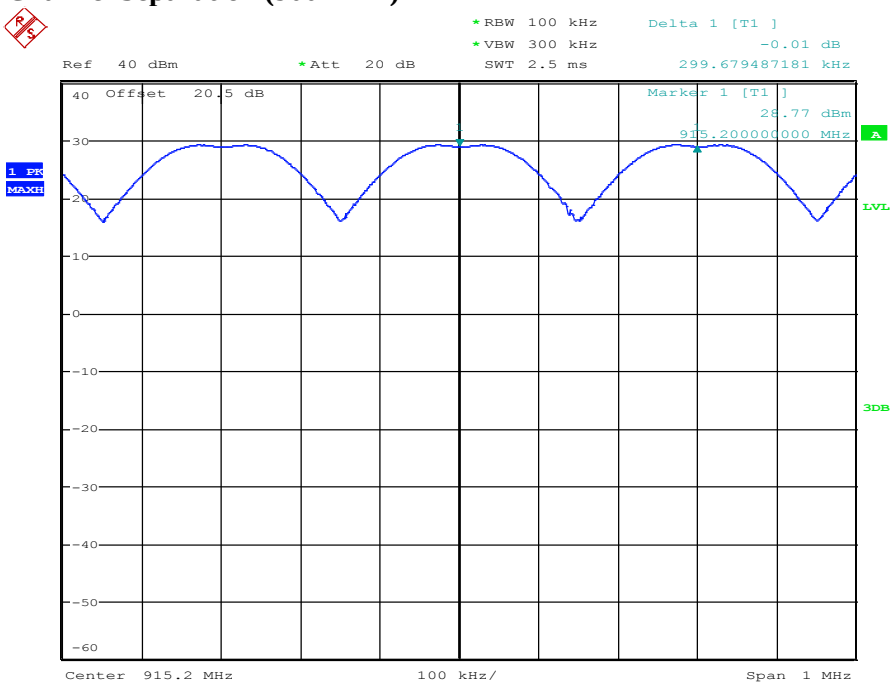
Note: Measured 20 dB bandwidth for 2.4 GHz FHSS @ 500 Kbps is 522 KHz

7.3.6 Measurement Verdict

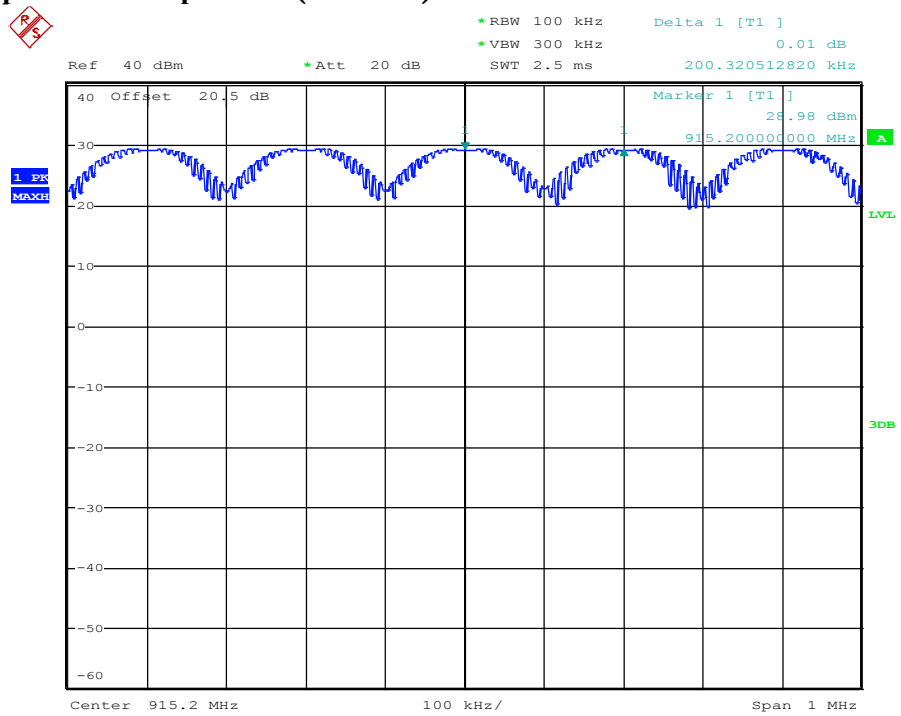
Passed

7.3.7 Data Plots

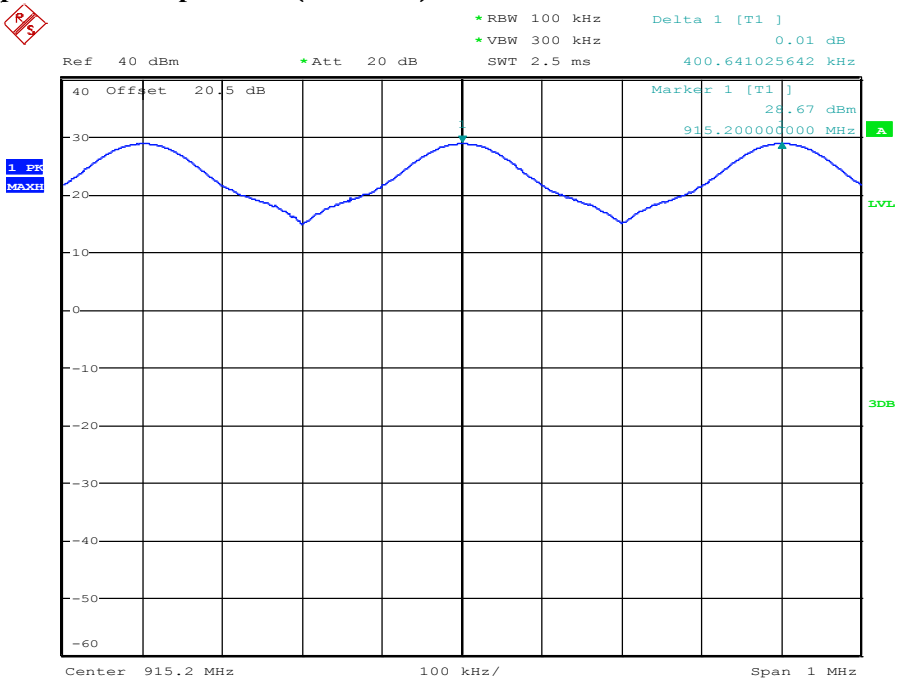
FSK: 100Kbps Channel Separation (900 MHz)



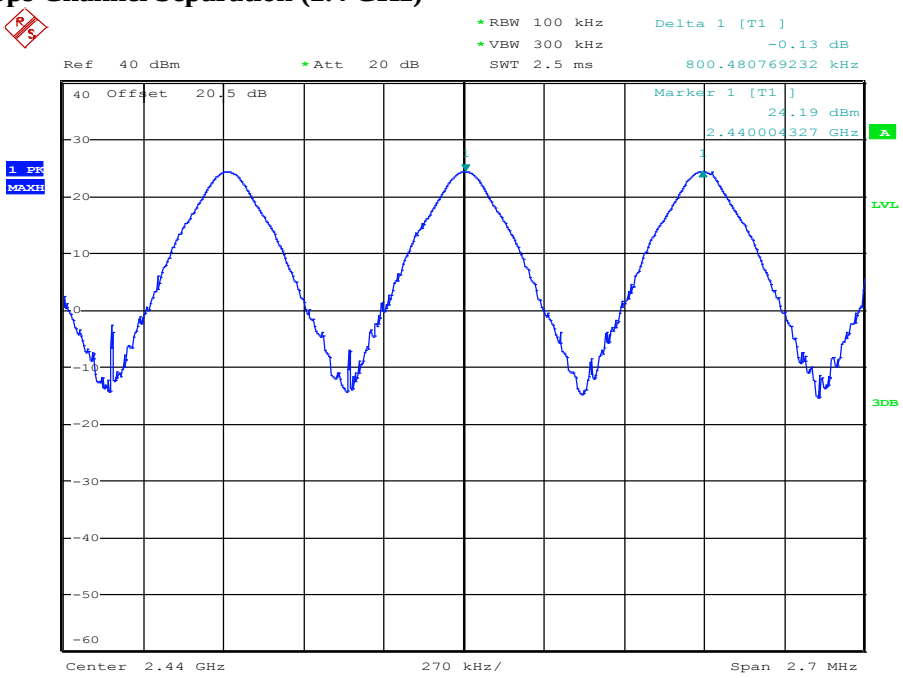
GFSK: 100Kbps Channel Separation (900 MHz)



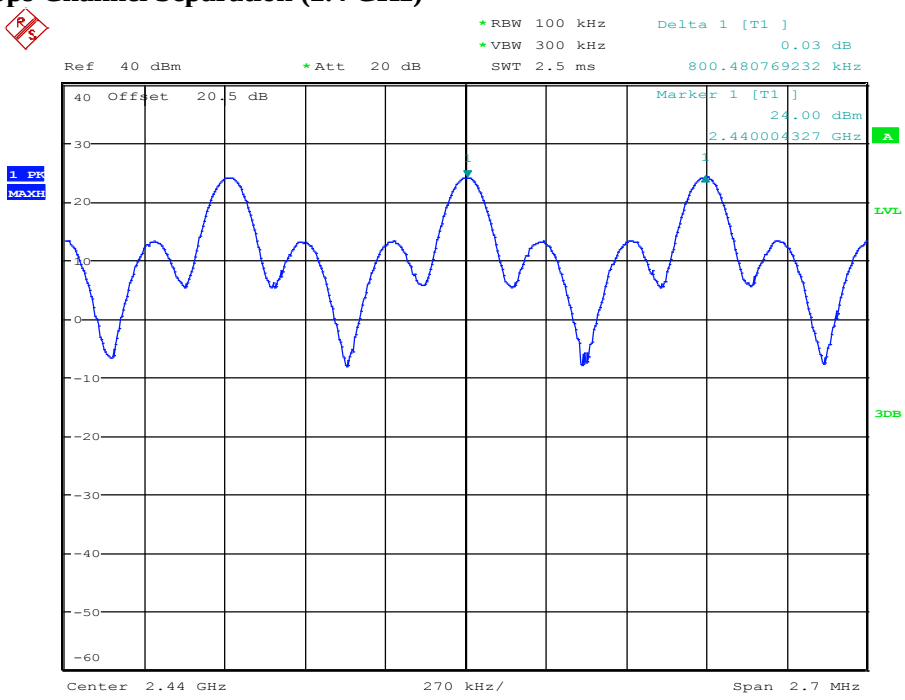
GFSK: 300Kbps Channel Separation (900 MHz)



GFSK: 250Kbps Channel Separation (2.4 GHz)



GFSK: 500Kbps Channel Separation (2.4 GHz)



7.4 Time Occupancy (Dwell Time)

7.4.1 Limits & Requirements

FCC 15.247(a) (1) (i) (iii) & RSS-210 (A8.1) (d)

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

7.4.2 Test Procedure

Spectrum Analyzer settings:
Span = 0, centered on hopping channel
RBW = 1 MHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
The EUT must have its hopping function enabled during the test.
Use the delta function marker-delta function to determine the pulse width in time domain.

7.4.3 Measurement Verdict

Passed

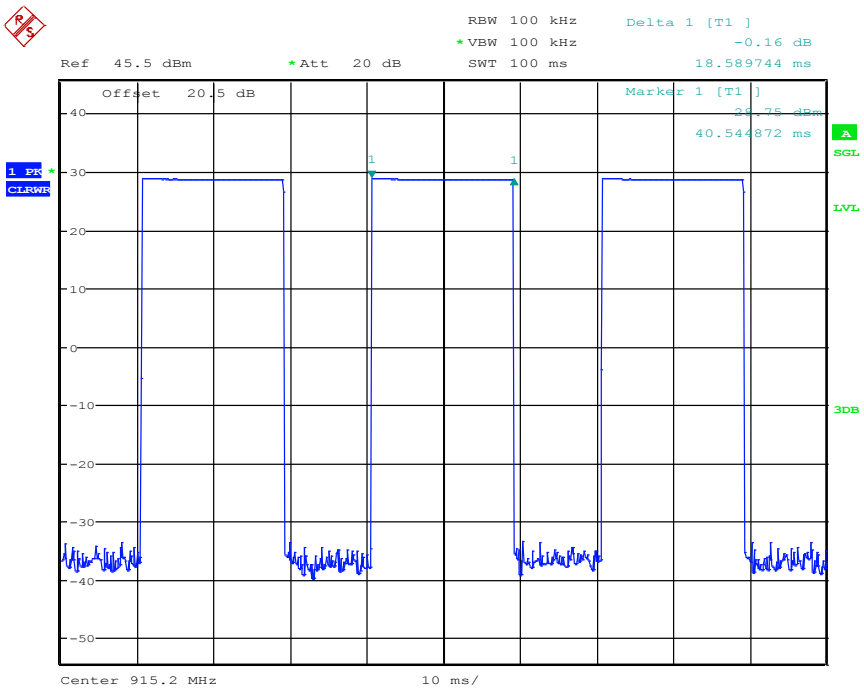
7.4.4 Test Data

900MHz FHSS System Modulation: FSK					
Data Rate (Kbps)	**Dwell Time (ms)**	**No. of Time slots**	**Time Occupancy** (Dwell * # of Time Slot) **(ms)**	**Limit (ms)**	**Result**
100	18.59	12	18.59 * 12 = 223.08	< 400 in 20s	Passed
100	18.56	8	18.11 * 8 = 144.88	< 400 in 20s	Passed
300	18.27	8	18.26 * 8 = 146.08	< 400 in 10s	Passed

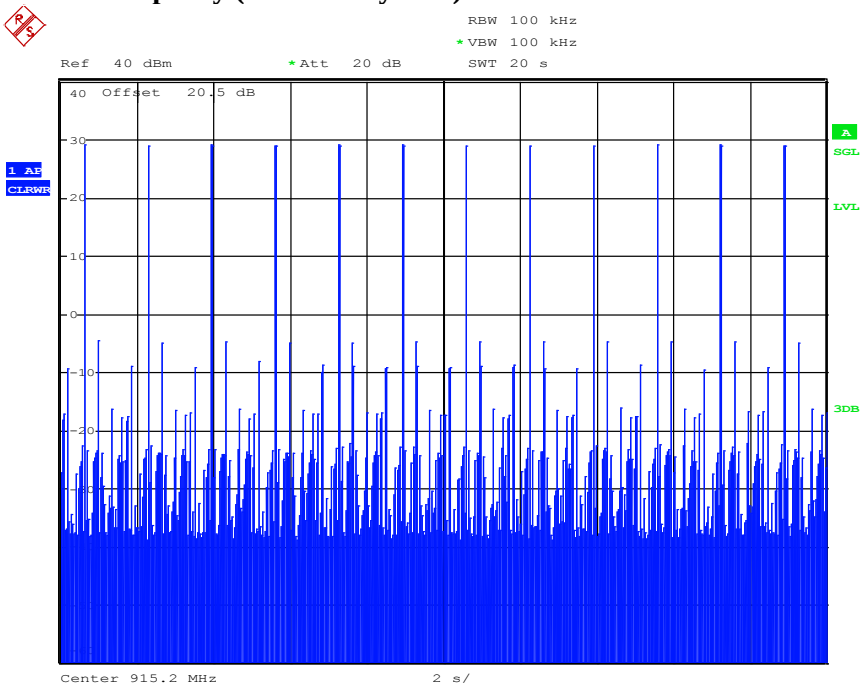
2.4 GHz FHSS System Modulation: GFSK					
Data Rate (Kbps)	**Dwell Time (ms)**	**No. of Time slots**	**Time Occupancy** (Dwell * # of Time Slot) **(ms)**	**Limit** (0.4* #of Channel) **(ms)**	**Result**
250	3.20	61	195.2	< 400 in 36.4s	Passed
500	3.01	39	117.29	< 400 in 36.4s	Passed

7.4.5 Data Plots

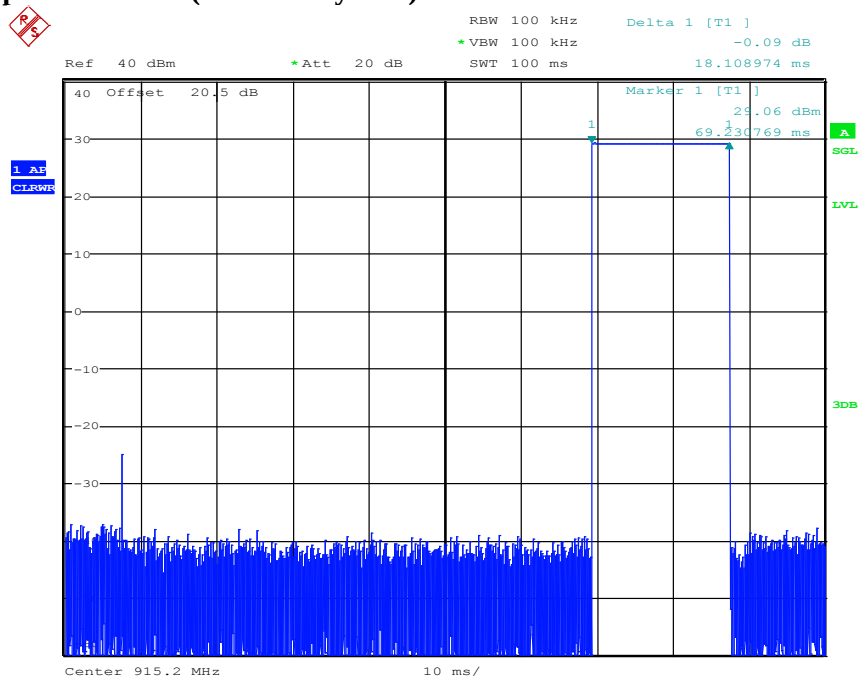
FSK: 100Kbps Dwell Time (900 MHz system)



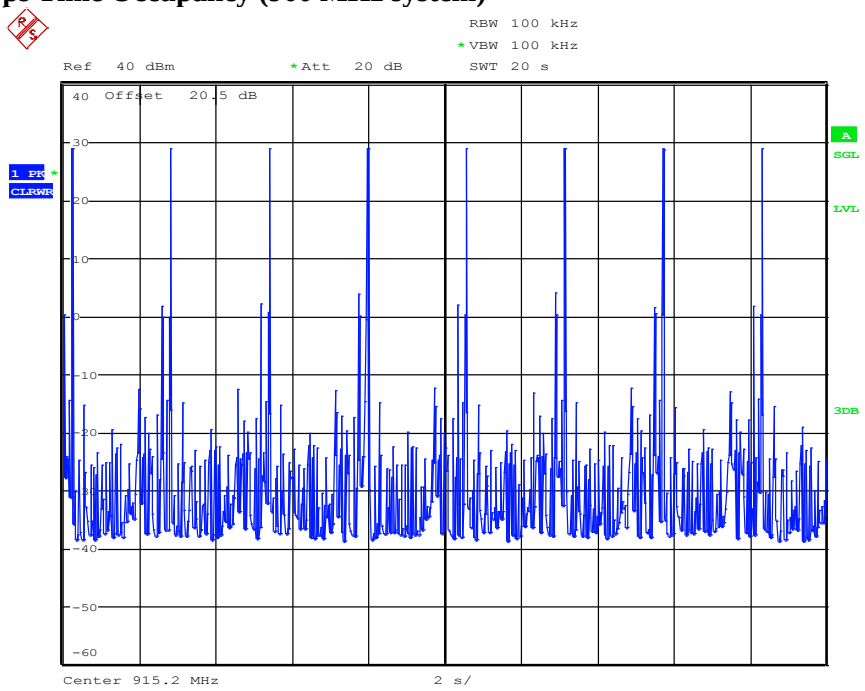
FSK: 100Kbps Time Occupancy (900 MHz system)



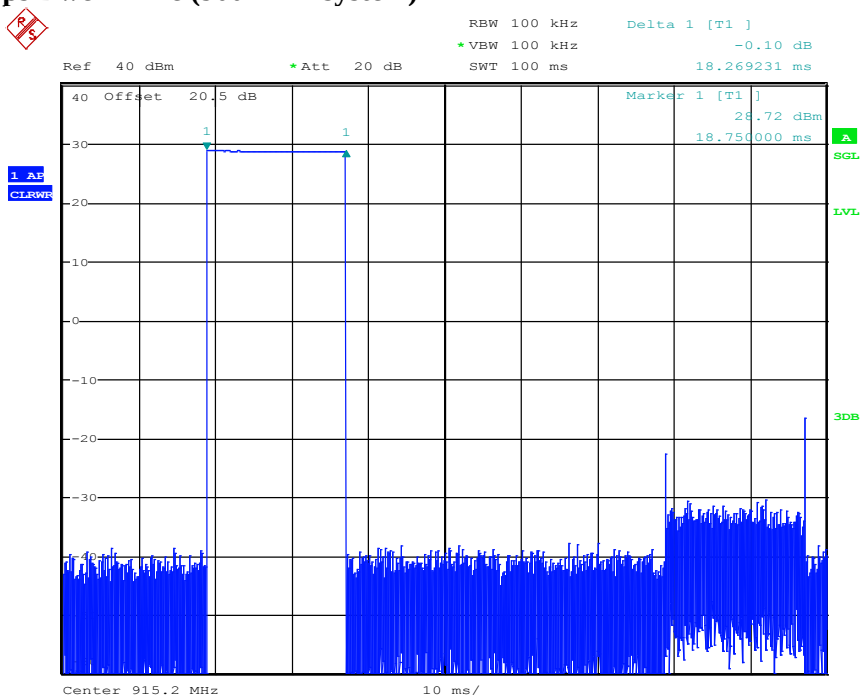
GFSK: 100Kbps Dwell Time (900 MHz system)



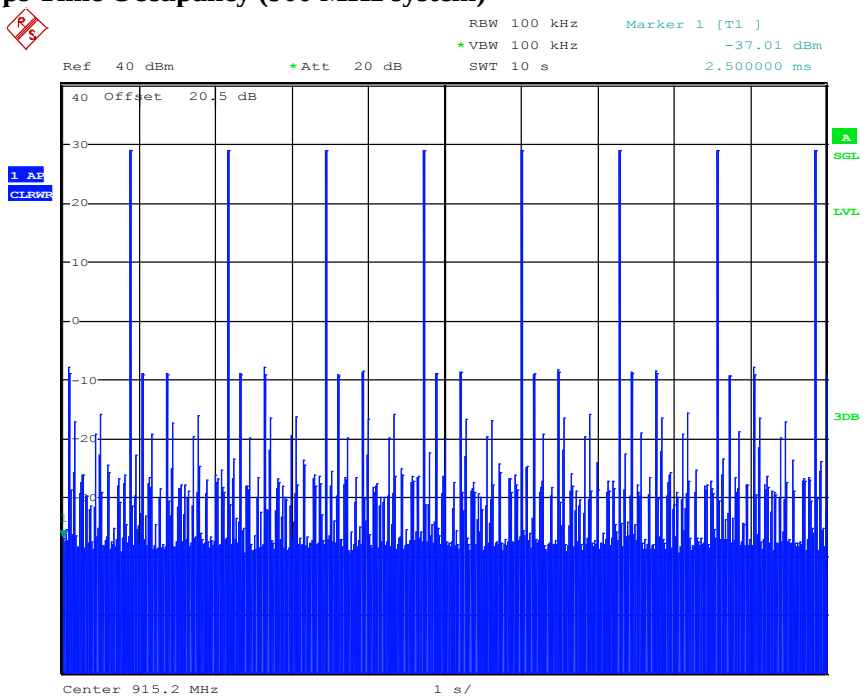
GFSK: 100Kbps Time Occupancy (900 MHz system)



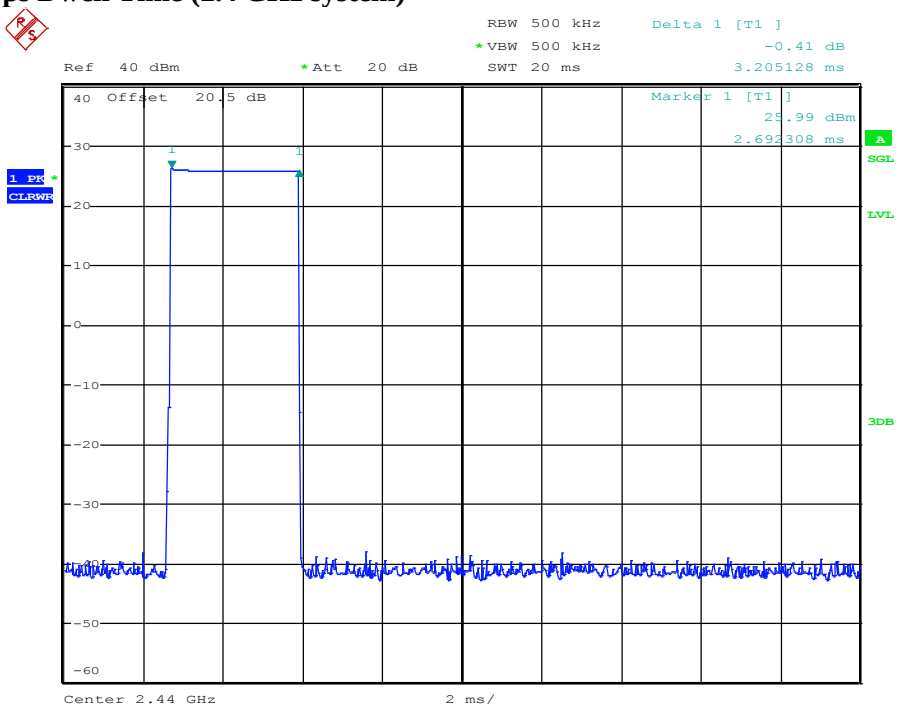
GFSK: 300Kbps Dwell Time (900 MHz system)



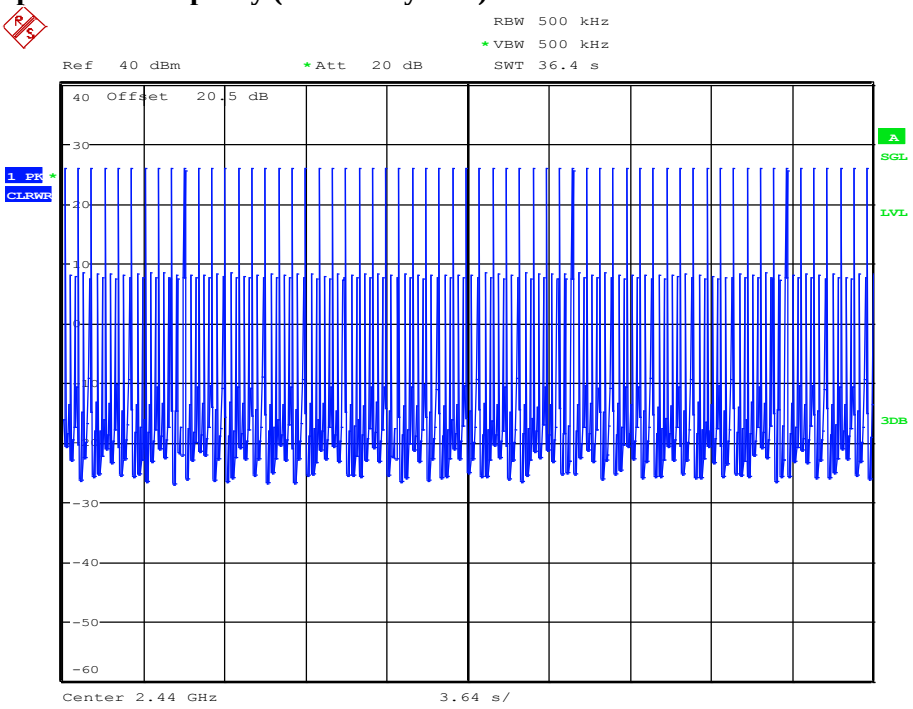
GFSK: 300Kbps Time Occupancy (900 MHz system)



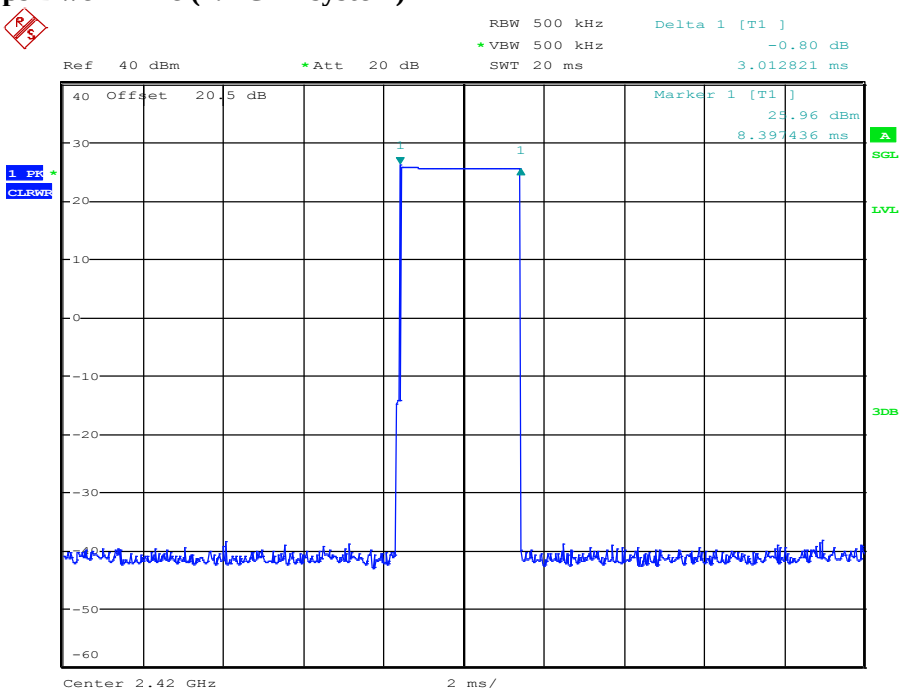
GFSK: 250Kbps Dwell Time (2.4 GHz system)



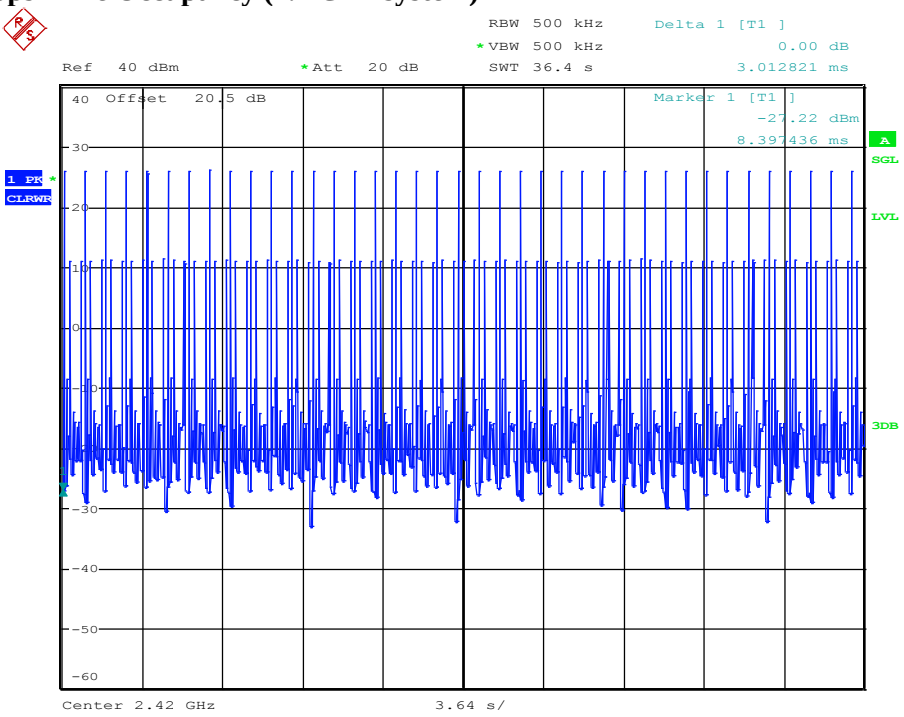
GFSK: 250Kbps Time Occupancy (2.4 GHz system)



GFSK: 500Kbps Dwell Time (2.4 GHz system)



GFSK: 500Kbps Time Occupancy (2.4 GHz system)



7.5 Band Edge & Restricted Band Compliance

7.5.1 Limits & Requirements

FCC 15.247 (d), 15.205, RSS-210 A8.5 & RSS-Gen 7.2.2

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

7.5.2 Test Conditions

Tnom: 20°C; Vnom: 4.0Vdc
Hopping Function Disable

7.5.3 Measurement Procedure

Peak measurements are made using a peak detector and RBW=1MHz.
*PEAK LIMIT= 74dBµV/m

Average measurements performed using a peak detector and according to video averaging procedure with RBW=1MHz and VBW=10Hz.
*AVG. LIMIT= 54dBµV/m

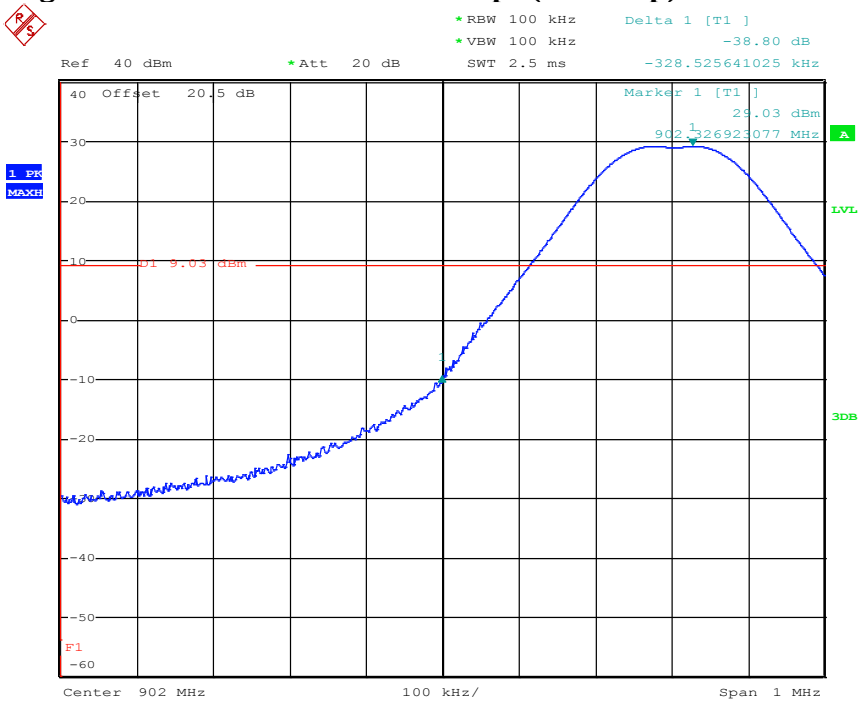
7.5.4 Measurement Verdict

Pass.

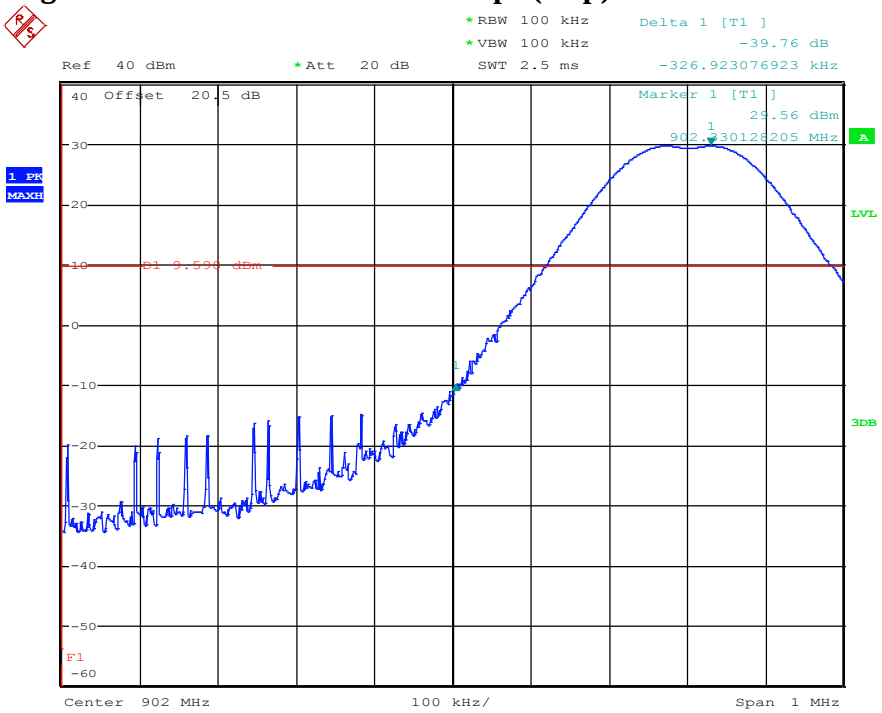
Note: Restricted band measurements were determined for worst case scenario at the data rate of 250Kbps for 2.4GHz (FHSS).

7.5.5 Test Data/plots

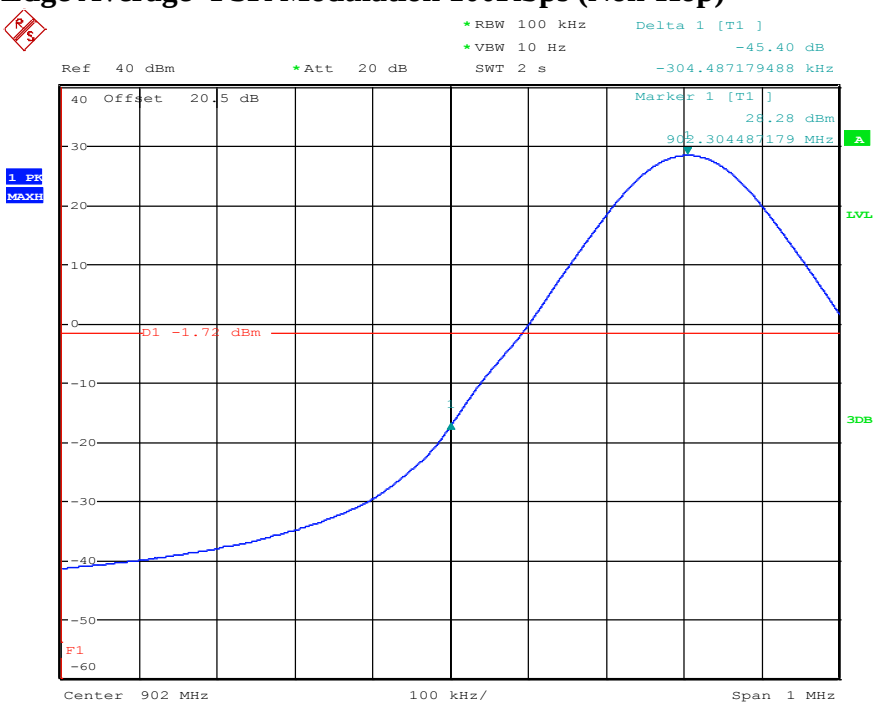
Lower Band-Edge Peak -FSK Modulation 100Kbps (Non-Hop)



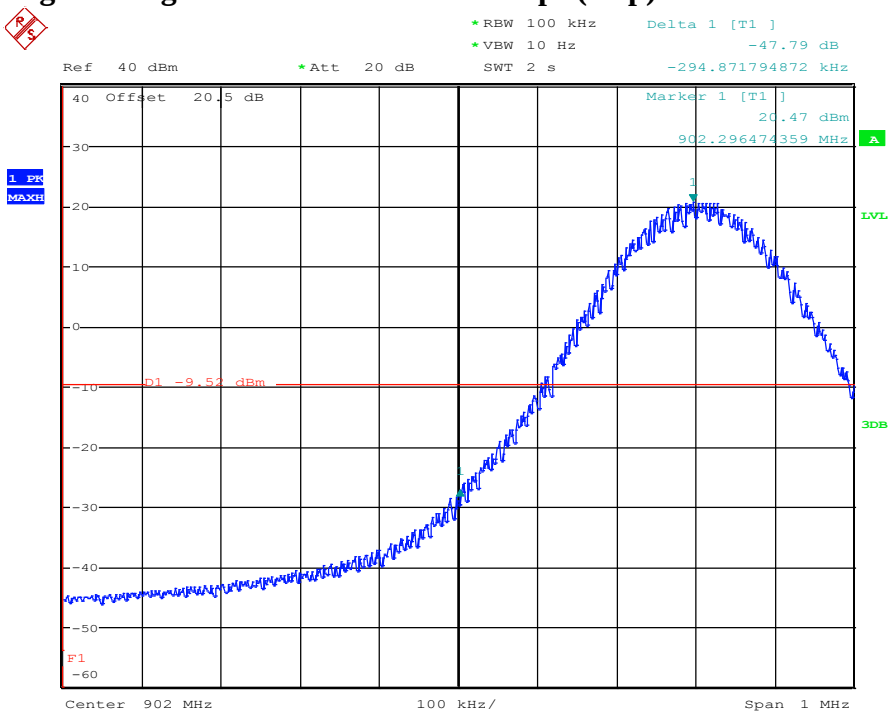
Lower Band-Edge Peak -FSK Modulation 100Kbps (Hop)



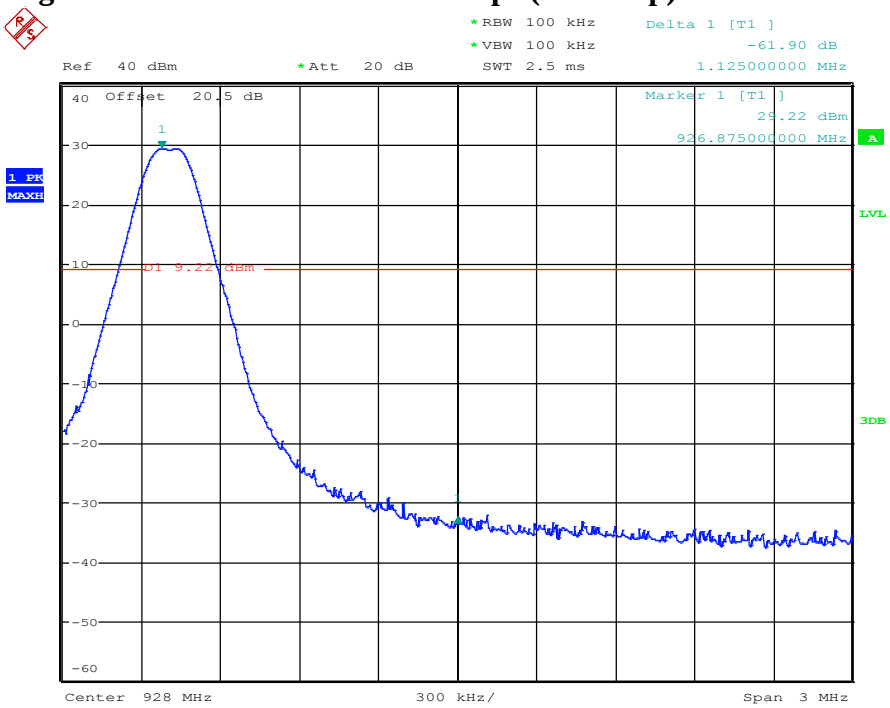
Lower Band-Edge Average -FSK Modulation 100Kbps (Non-Hop)



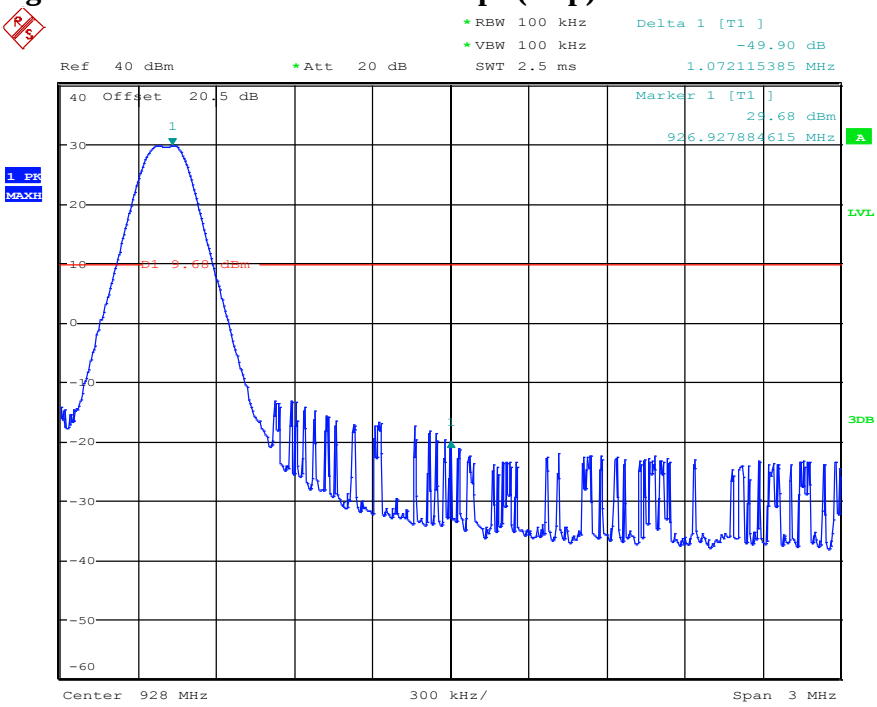
Lower Band-Edge Average -FSK Modulation 100Kbps (Hop)



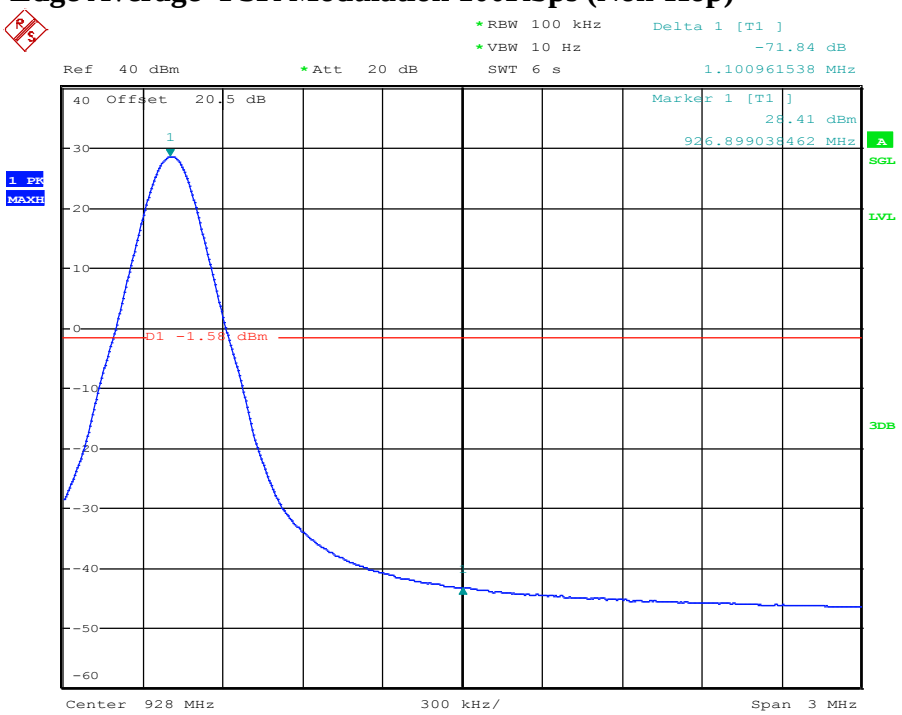
Upper Band-Edge Peak -FSK Modulation 100Kbps (Non-Hop)



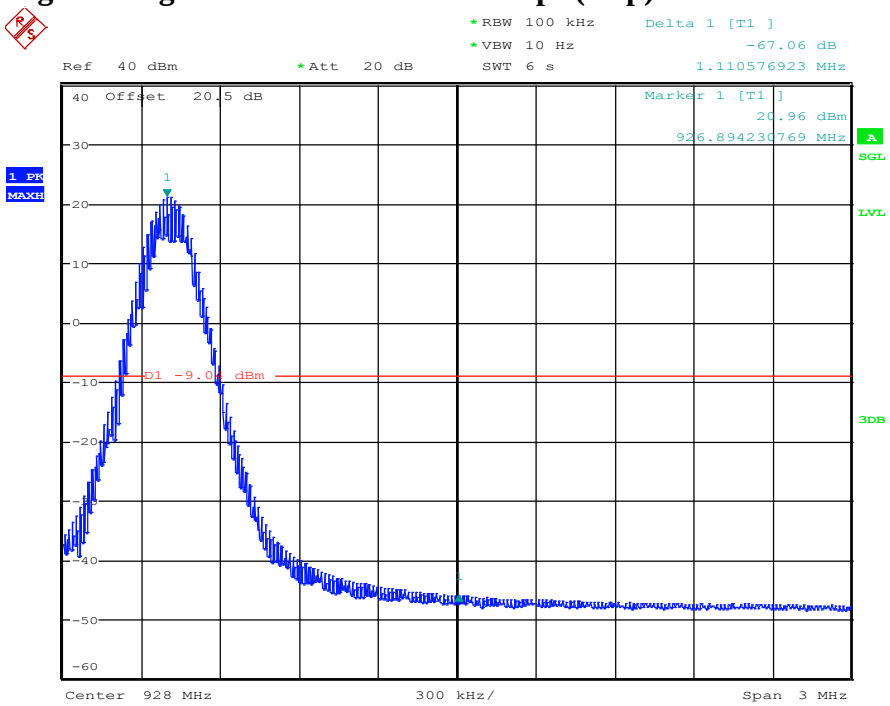
Upper Band-Edge Peak -FSK Modulation 100Kbps (Hop)



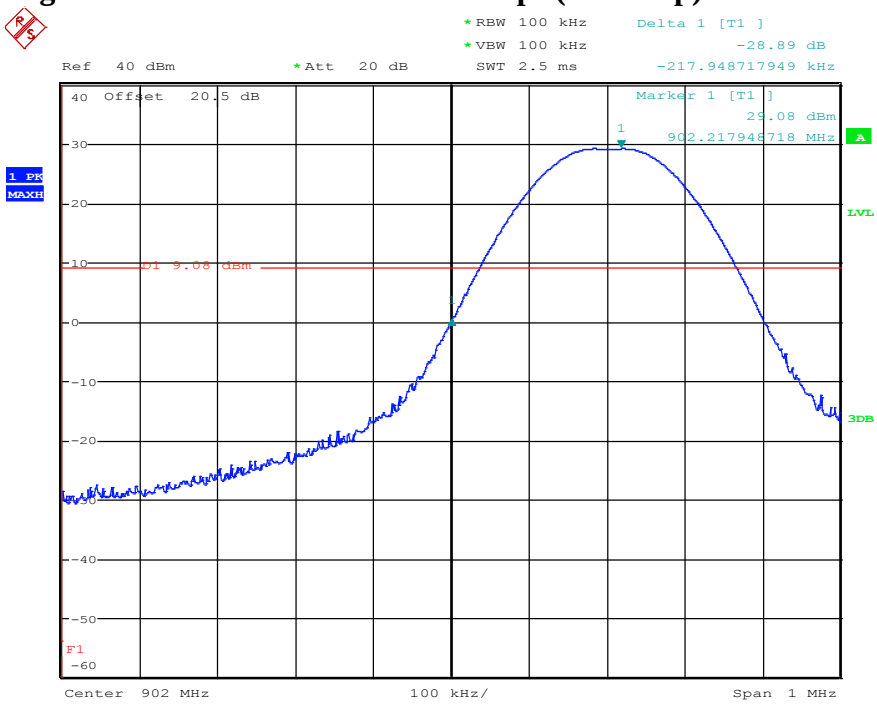
Upper Band-Edge Average -FSK Modulation 100Kbps (Non-Hop)



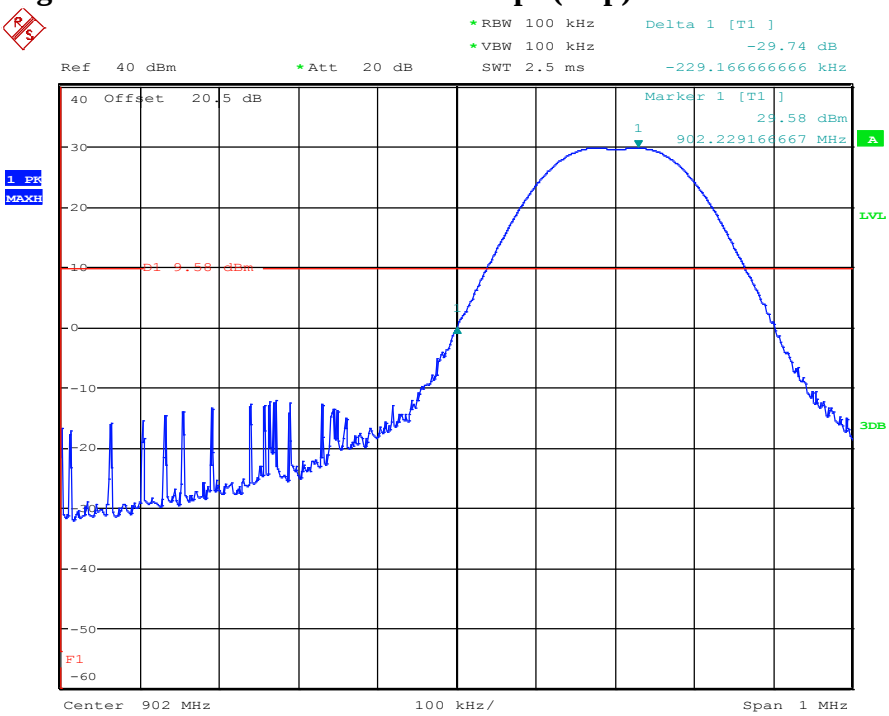
Upper Band-Edge Average -FSK Modulation 100Kbps (Hop)



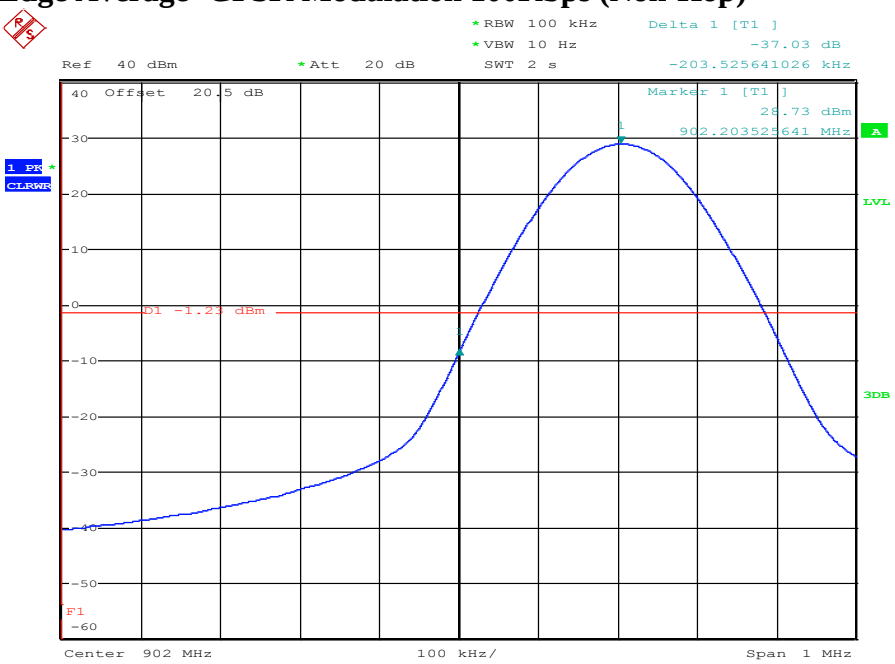
Lower Band-Edge Peak -GFSK Modulation 100Kbps (Non-Hop)



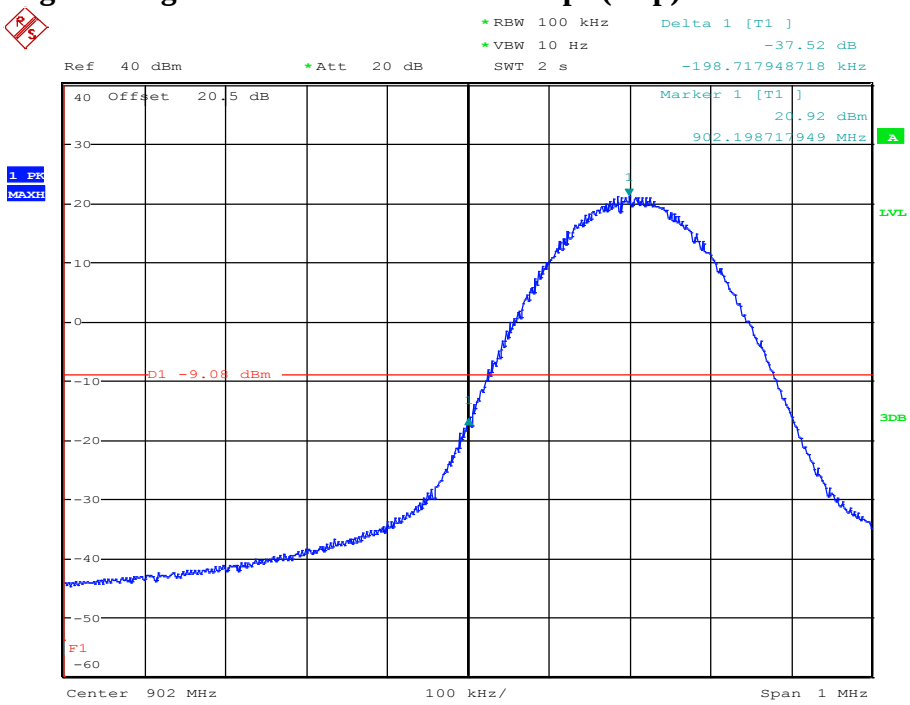
Lower Band-Edge Peak -GFSK Modulation 100Kbps (Hop)



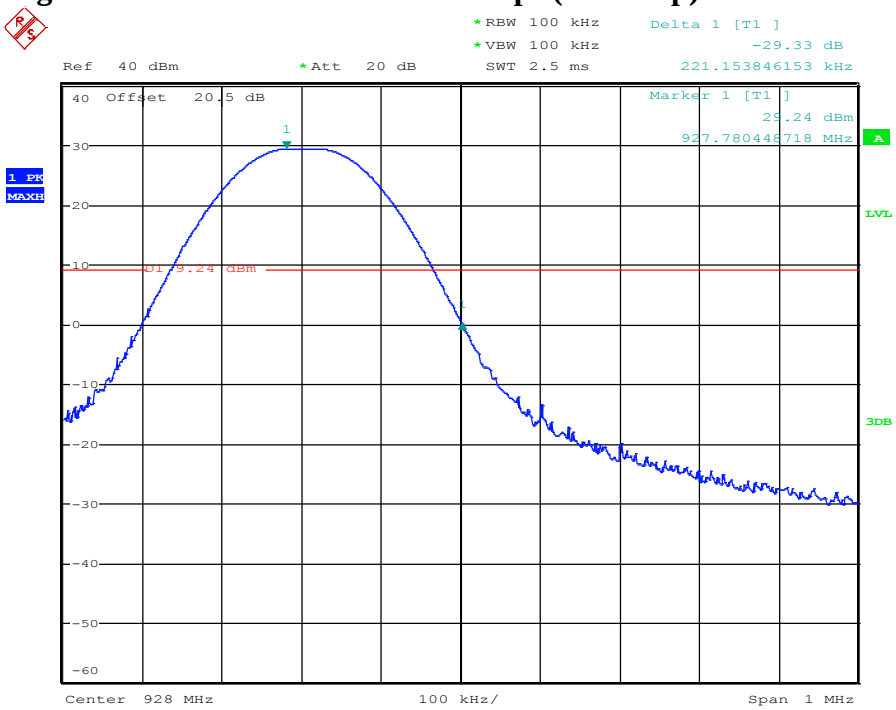
Lower Band-Edge Average -GFSK Modulation 100Kbps (Non-Hop)



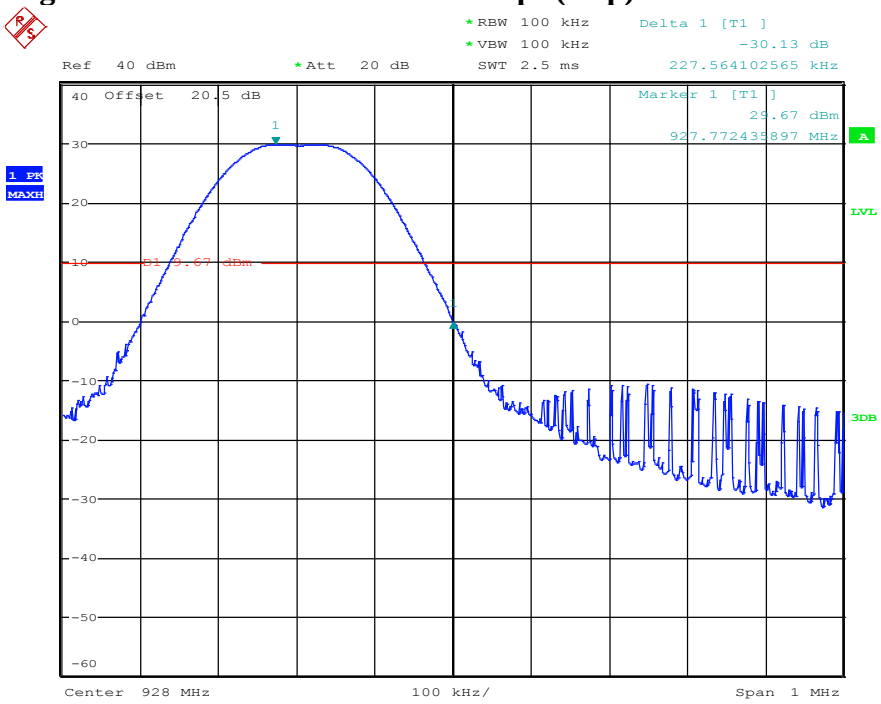
Lower Band-Edge Average -GFSK Modulation 100Kbps (Hop)



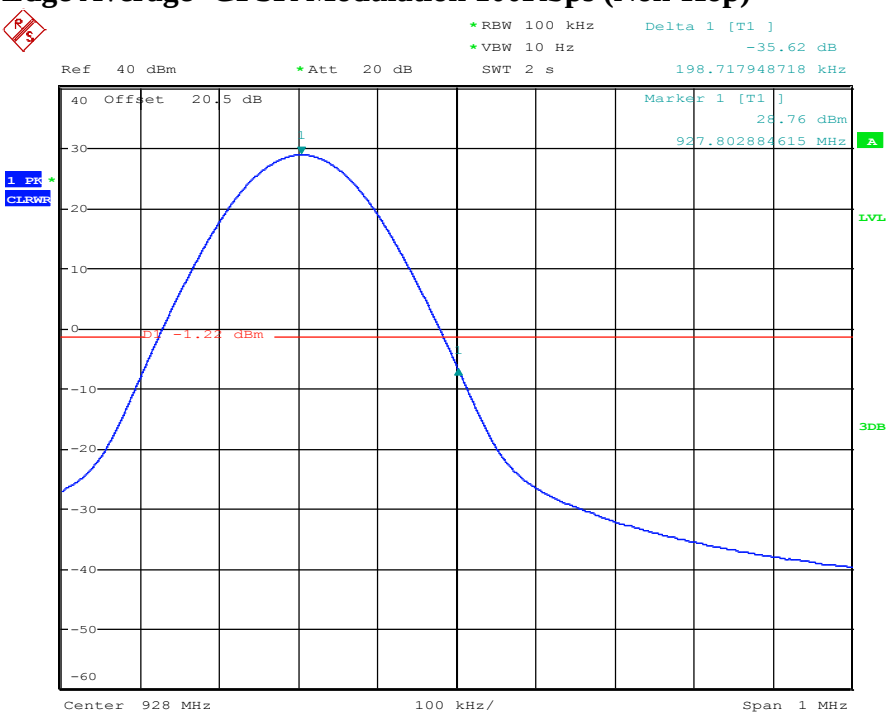
Upper Band-Edge Peak -GFSK Modulation 100Kbps (Non-Hop)



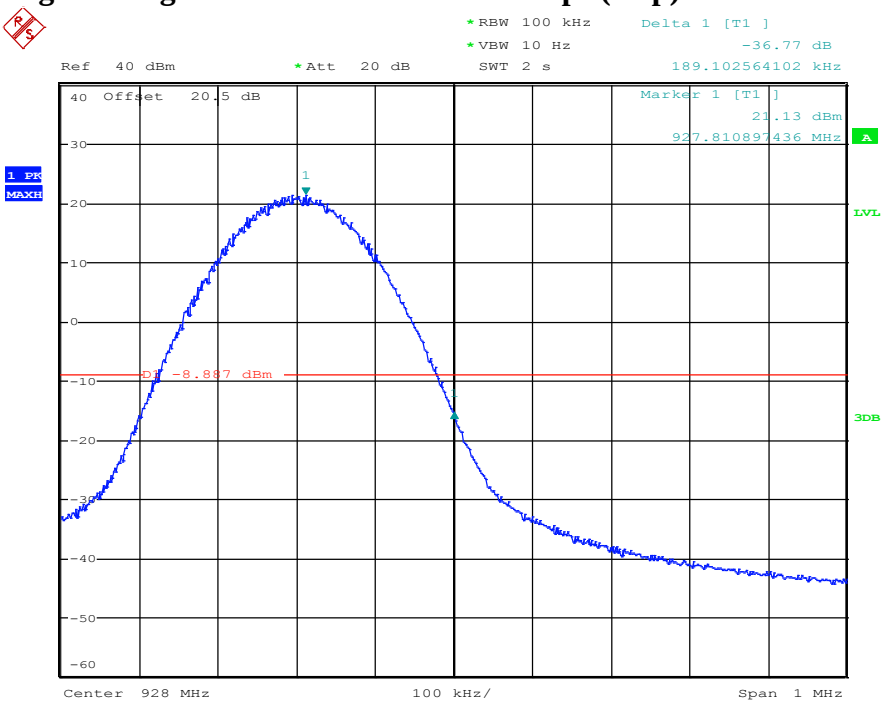
Upper Band-Edge Peak -GFSK Modulation 100Kbps (Hop)



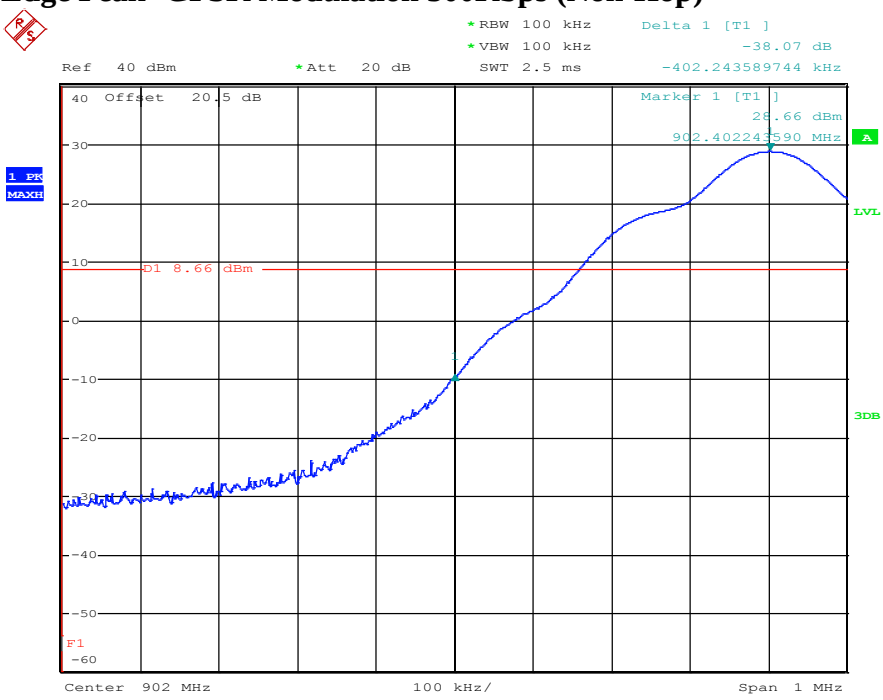
Upper Band-Edge Average -GFSK Modulation 100Kbps (Non-Hop)



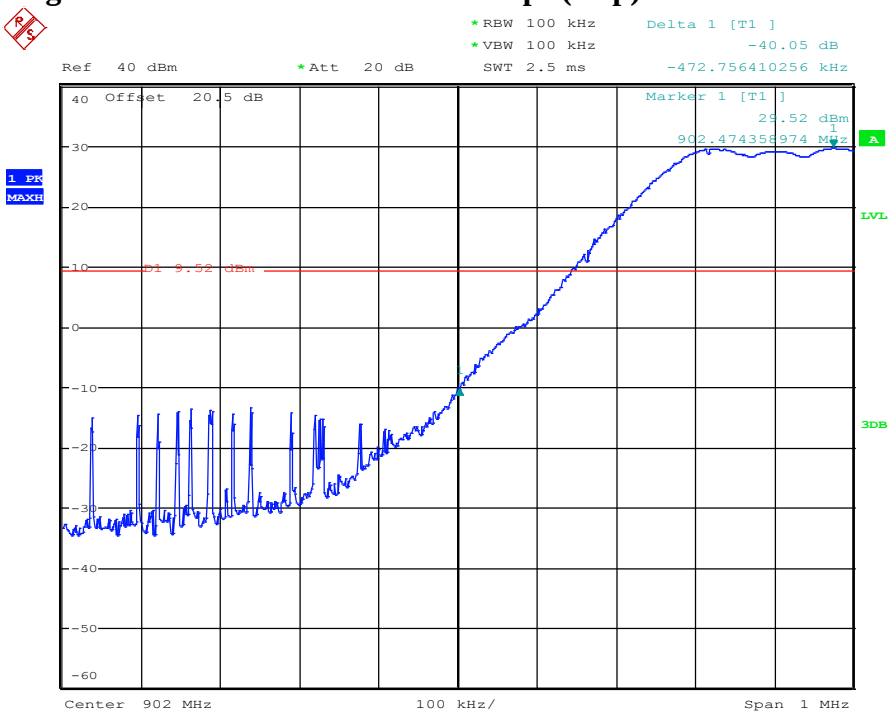
Upper Band-Edge Average -GFSK Modulation 100Kbps (Hop)



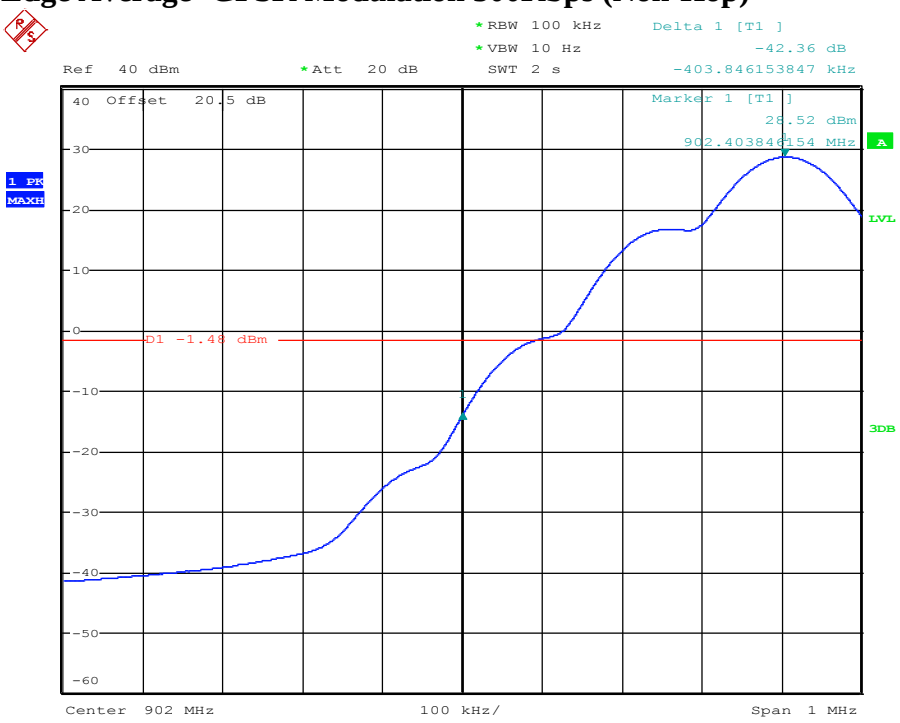
Lower Band-Edge Peak -GFSK Modulation 300Kbps (Non-Hop)



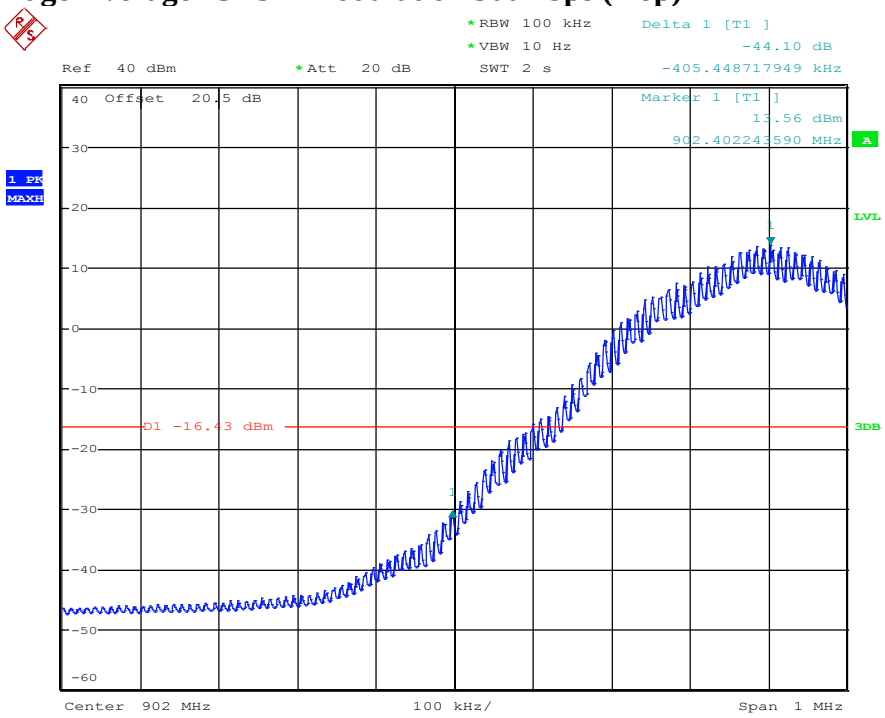
Lower Band-Edge Peak -GFSK Modulation 300Kbps (Hop)



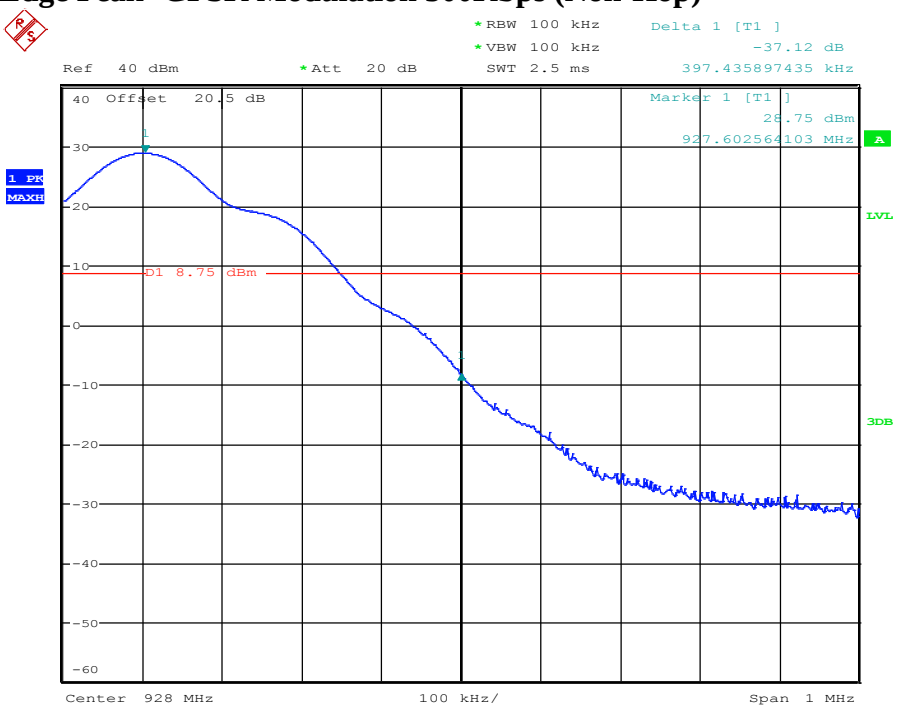
Lower Band-Edge Average -GFSK Modulation 300Kbps (Non-Hop)



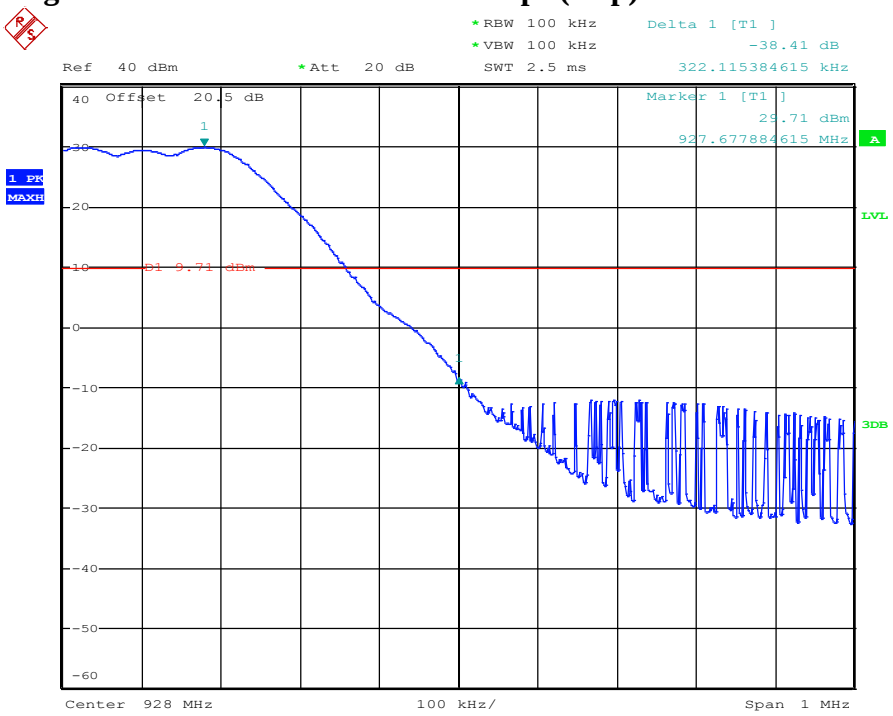
Lower Band-Edge Average -GFSK Modulation 300Kbps (Hop)



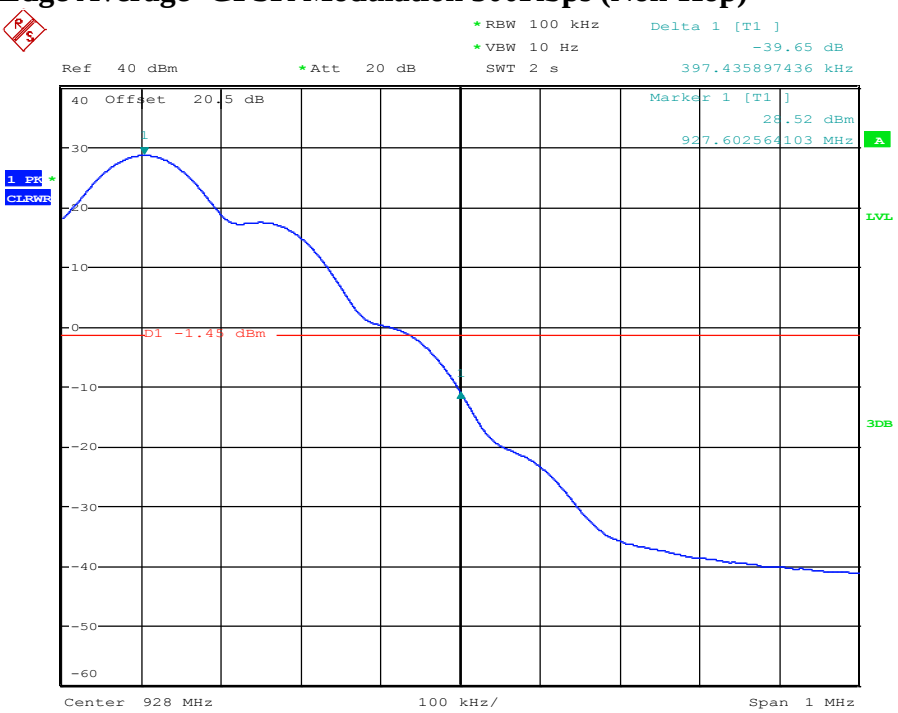
Upper Band-Edge Peak -GFSK Modulation 300Kbps (Non-Hop)



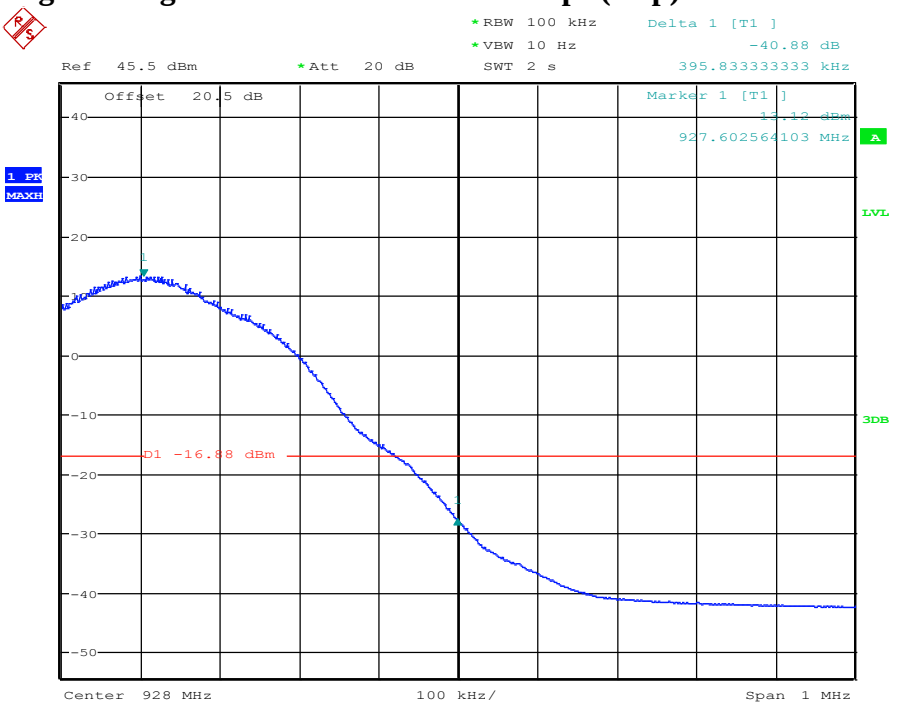
Upper Band-Edge Peak -GFSK Modulation 300Kbps (Hop)



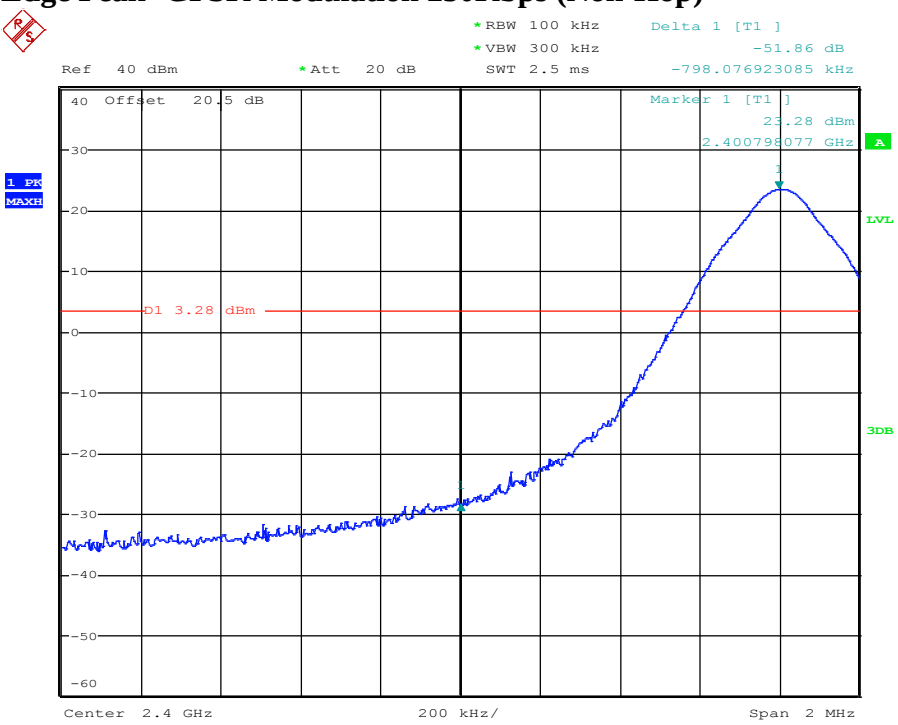
Upper Band-Edge Average -GFSK Modulation 300Kbps (Non-Hop)



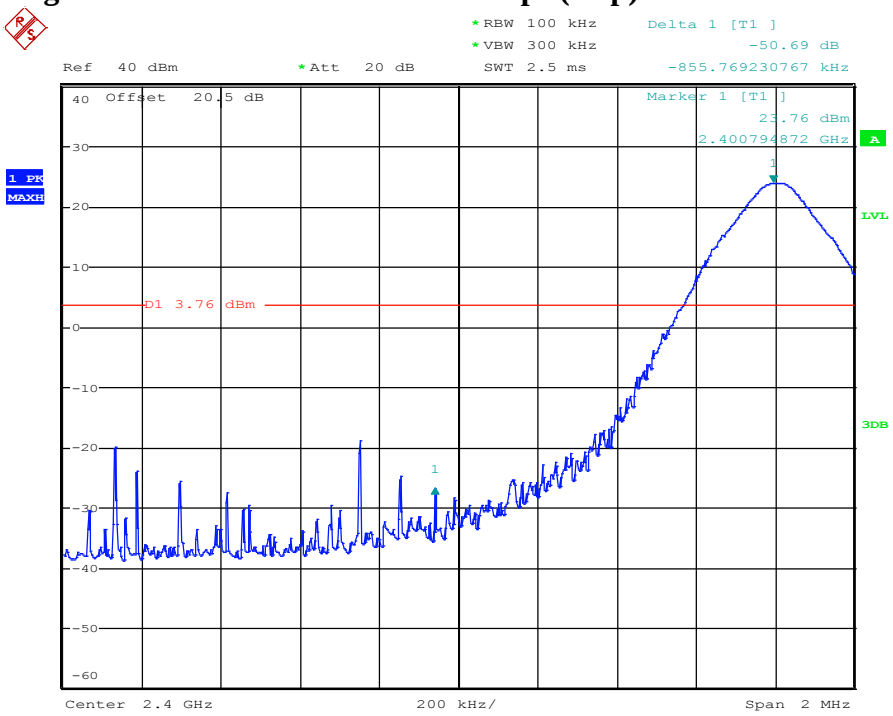
Upper Band-Edge Average -GFSK Modulation 300Kbps (Hop)



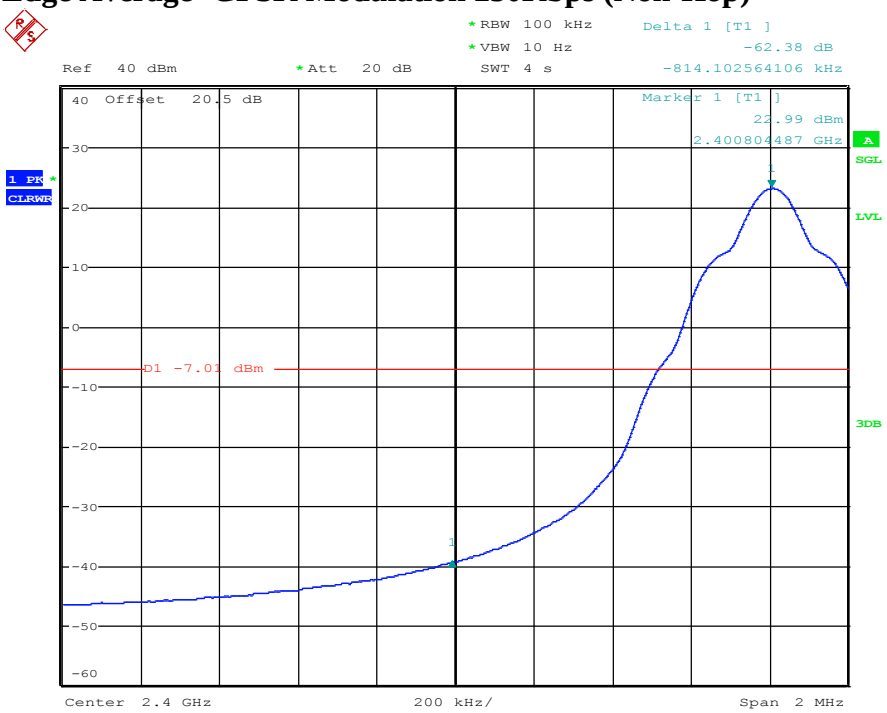
Lower Band-Edge Peak -GFSK Modulation 250Kbps (Non-Hop)



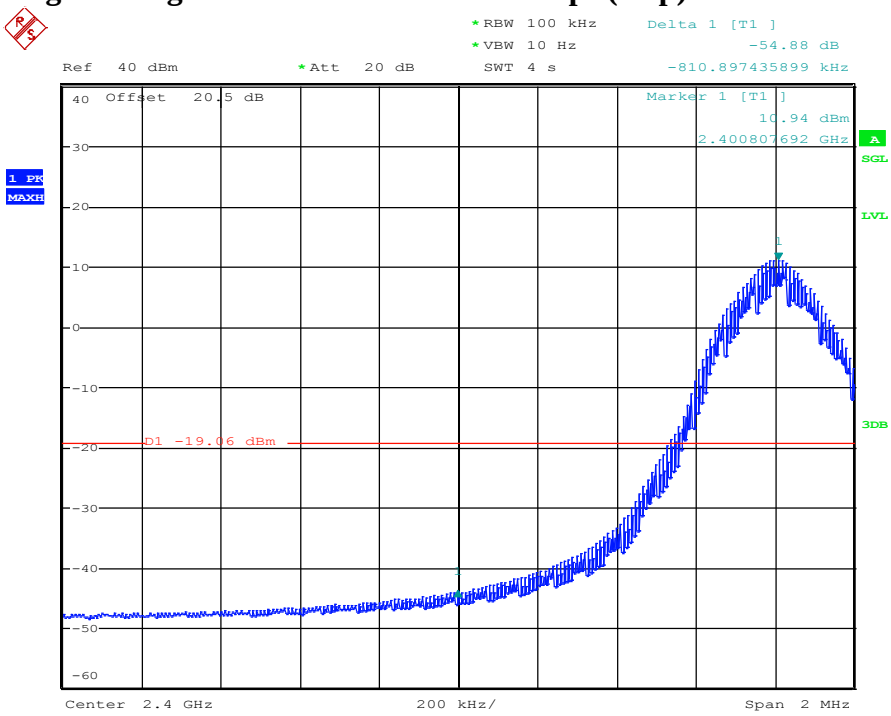
Lower Band-Edge Peak -GFSK Modulation 250Kbps (Hop)



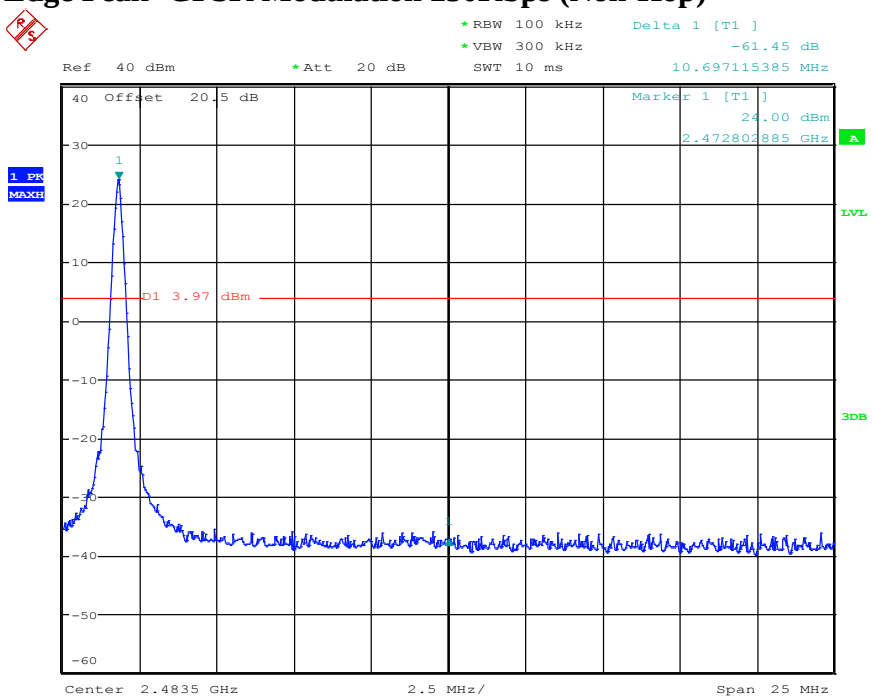
Lower Band-Edge Average -GFSK Modulation 250Kbps (Non-Hop)



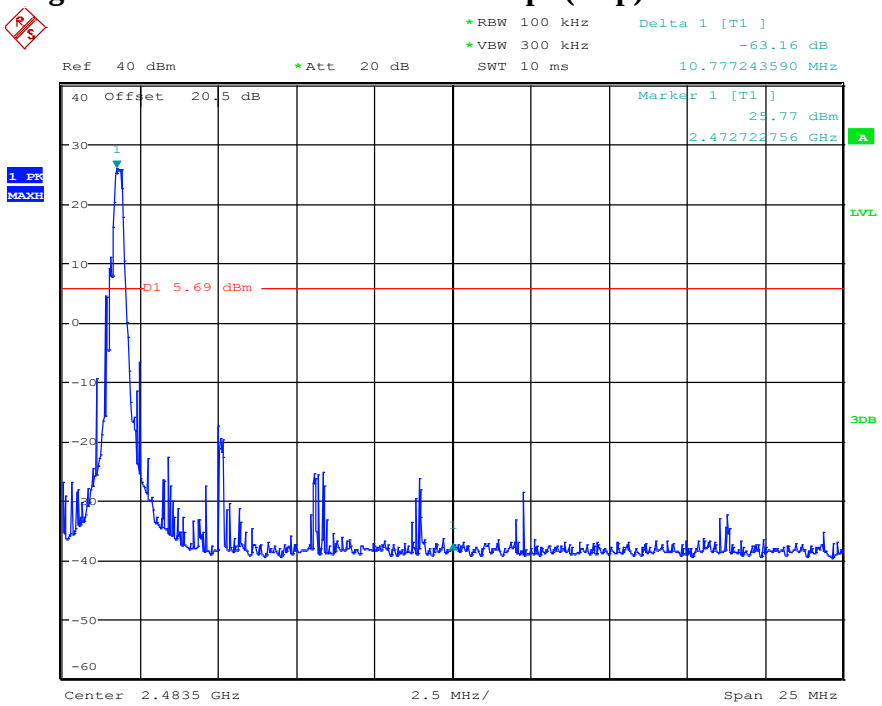
Lower Band-Edge Average -GFSK Modulation 250Kbps (Hop)



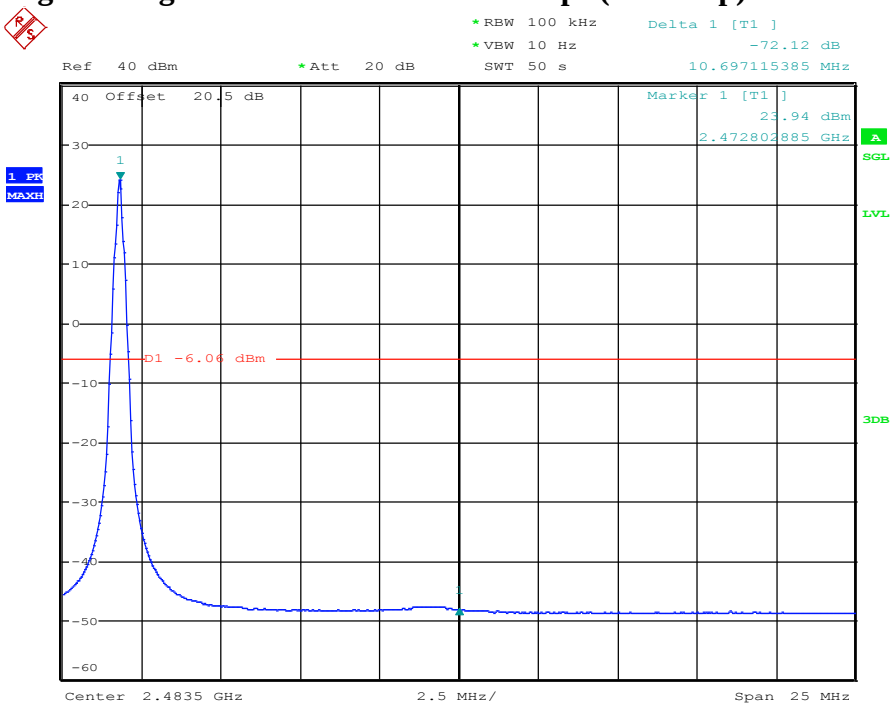
Upper Band-Edge Peak -GFSK Modulation 250Kbps (Non-Hop)



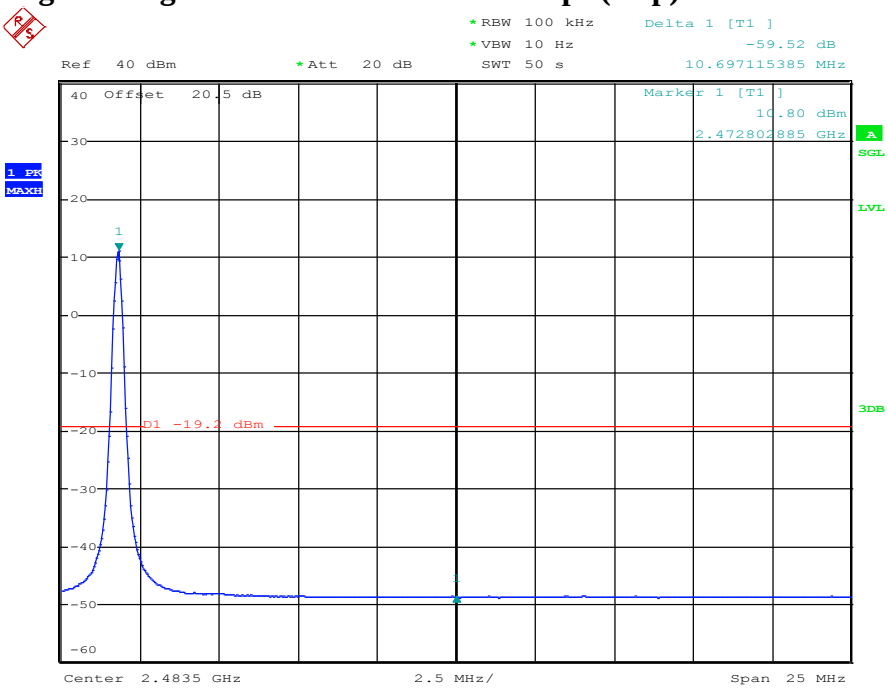
Upper Band-Edge Peak -GFSK Modulation 250Kbps (Hop)



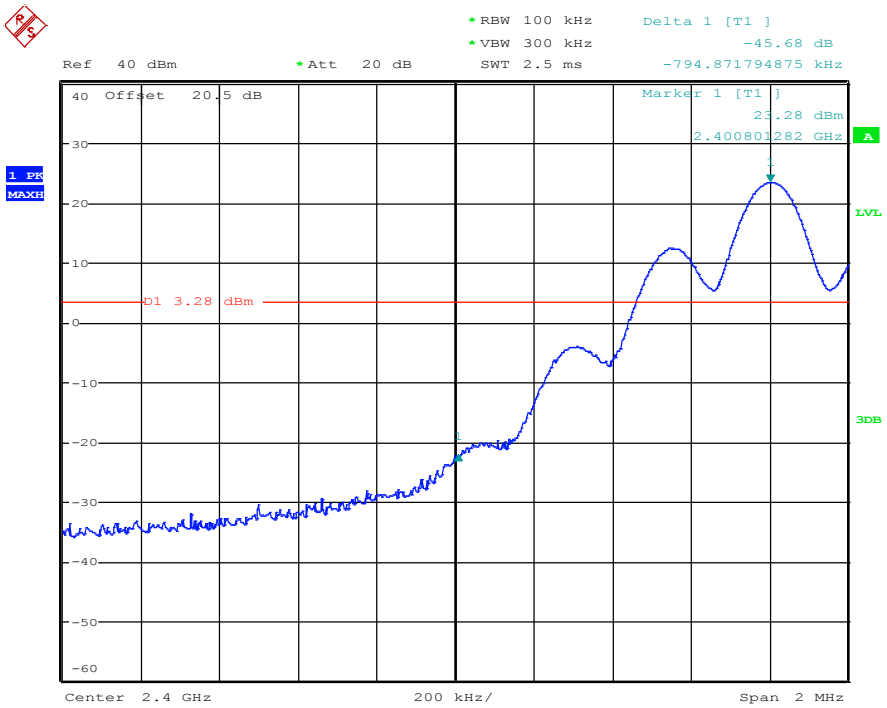
Upper Band-Edge Average -GFSK Modulation 250Kbps (Non-Hop)



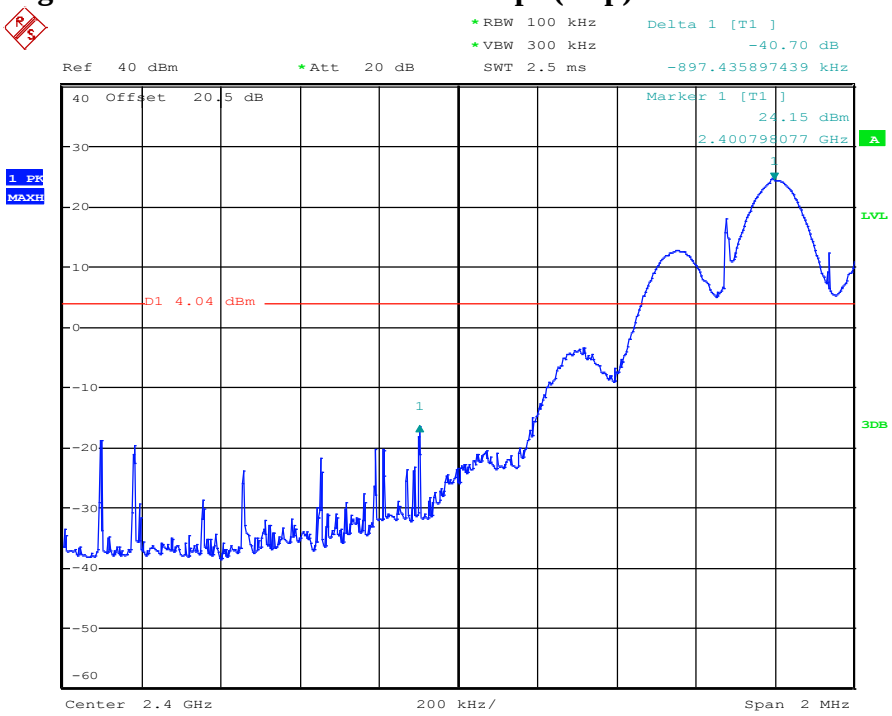
Upper Band-Edge Average -GFSK Modulation 250Kbps (Hop)



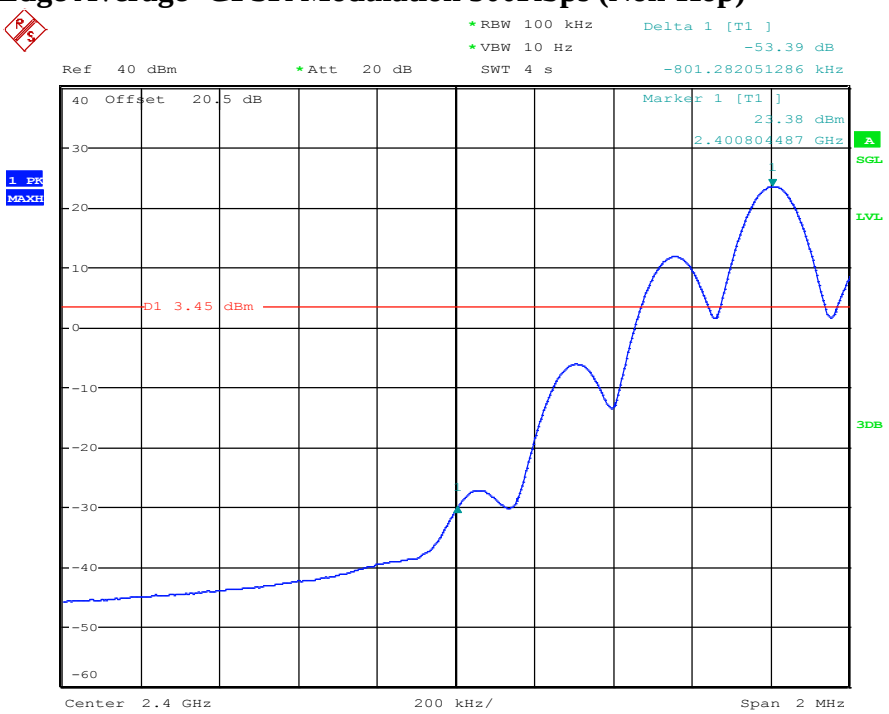
Lower Band-Edge Peak -GFSK Modulation 500Kbps (Non-Hop)



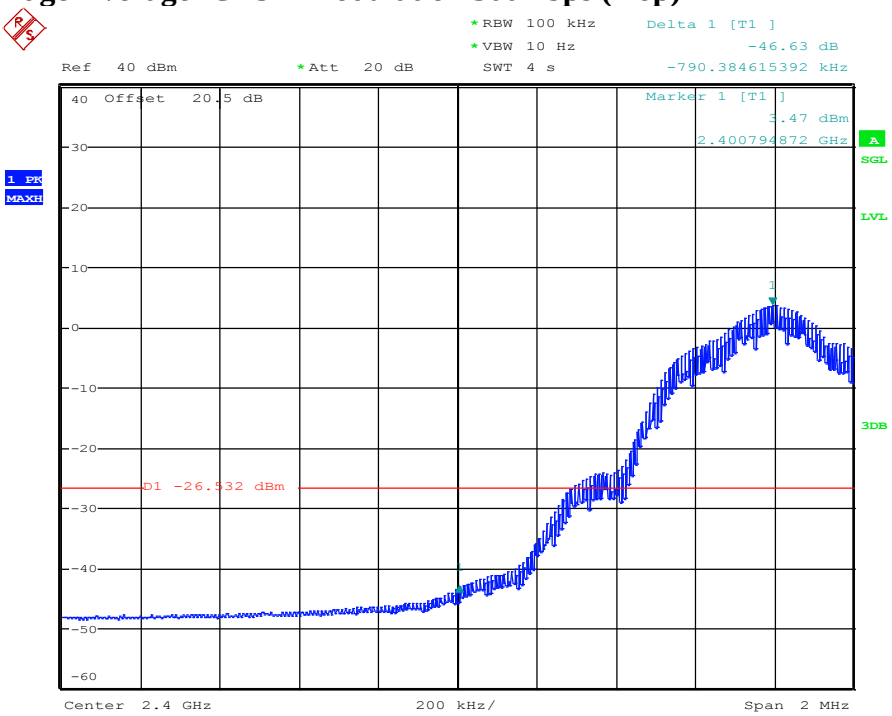
Lower Band-Edge Peak -GFSK Modulation 500Kbps (Hop)



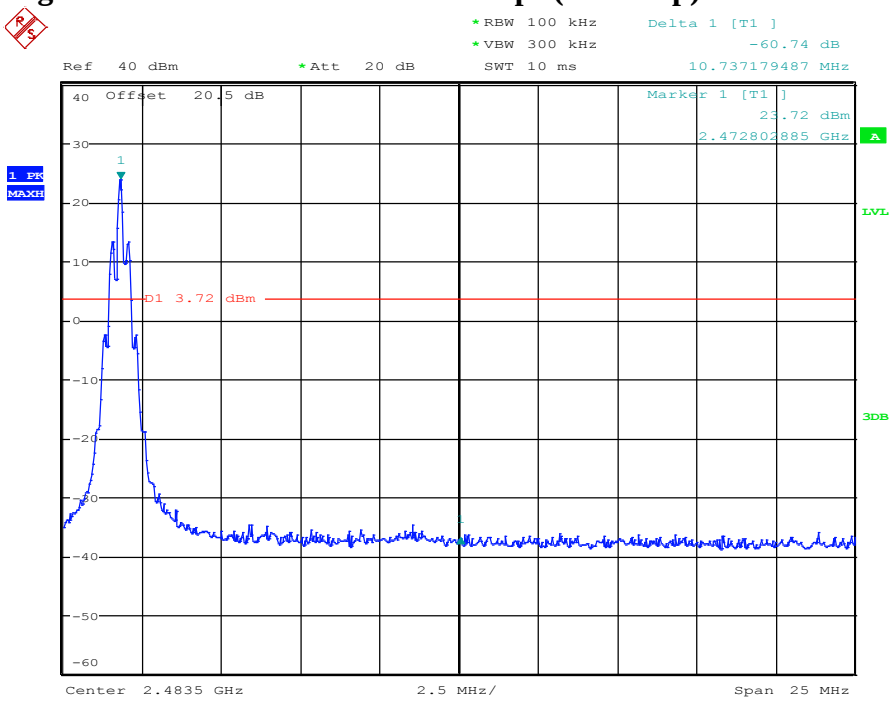
Lower Band-Edge Average -GFSK Modulation 500Kbps (Non-Hop)



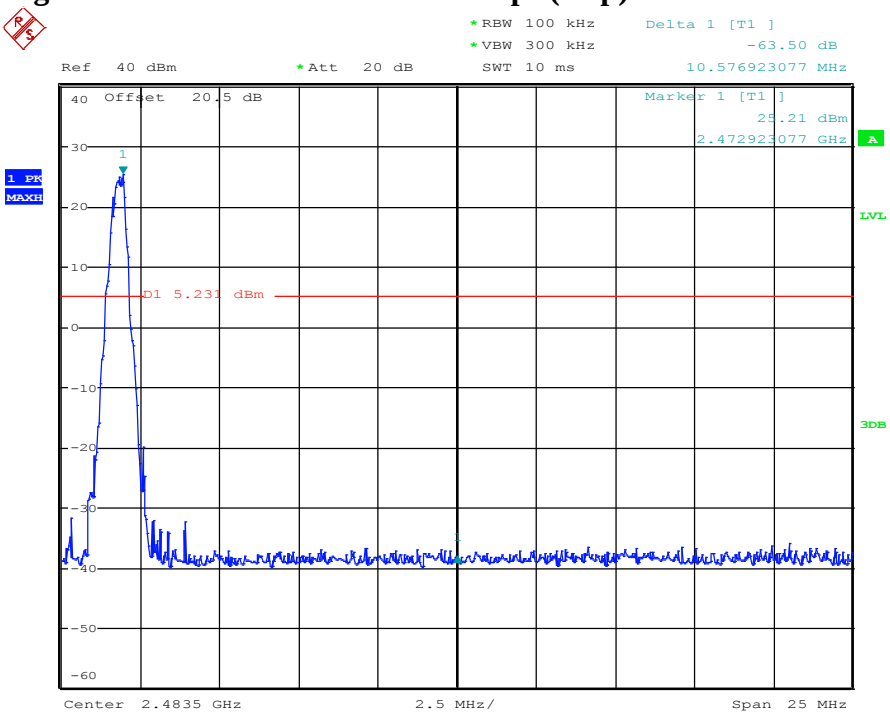
Lower Band-Edge Average -GFSK Modulation 500Kbps (Hop)



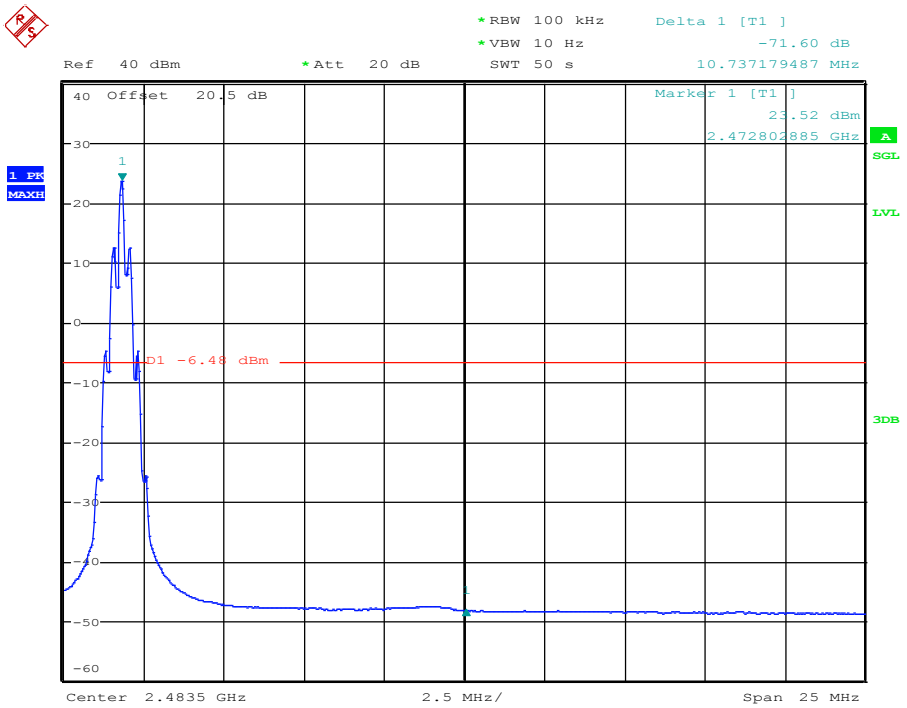
Upper Band-Edge Peak -GFSK Modulation 500Kbps (Non-Hop)



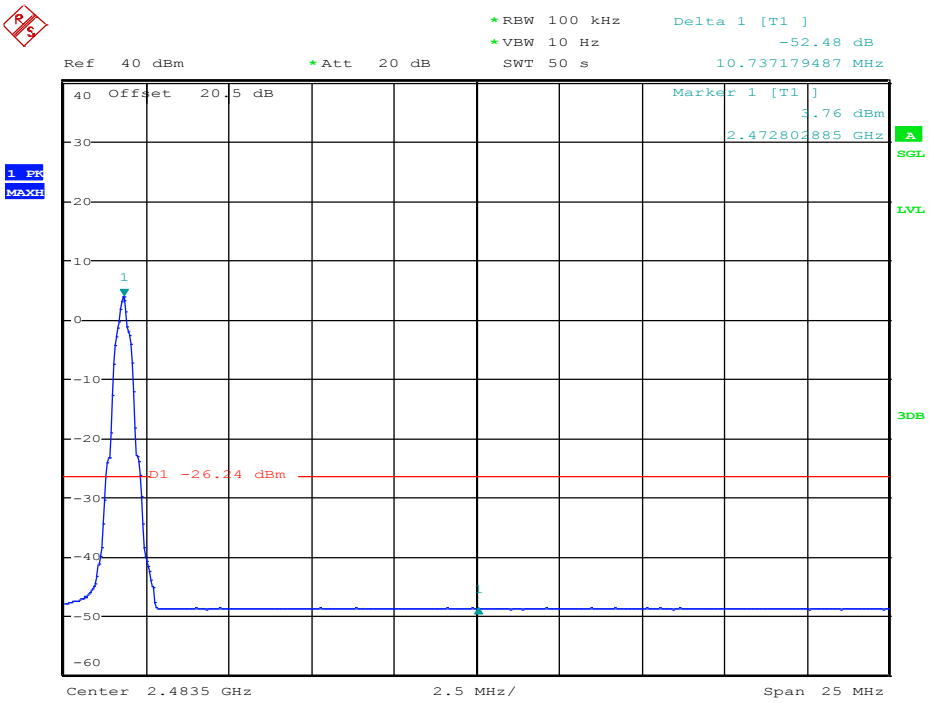
Upper Band-Edge Peak -GFSK Modulation 500Kbps (Hop)



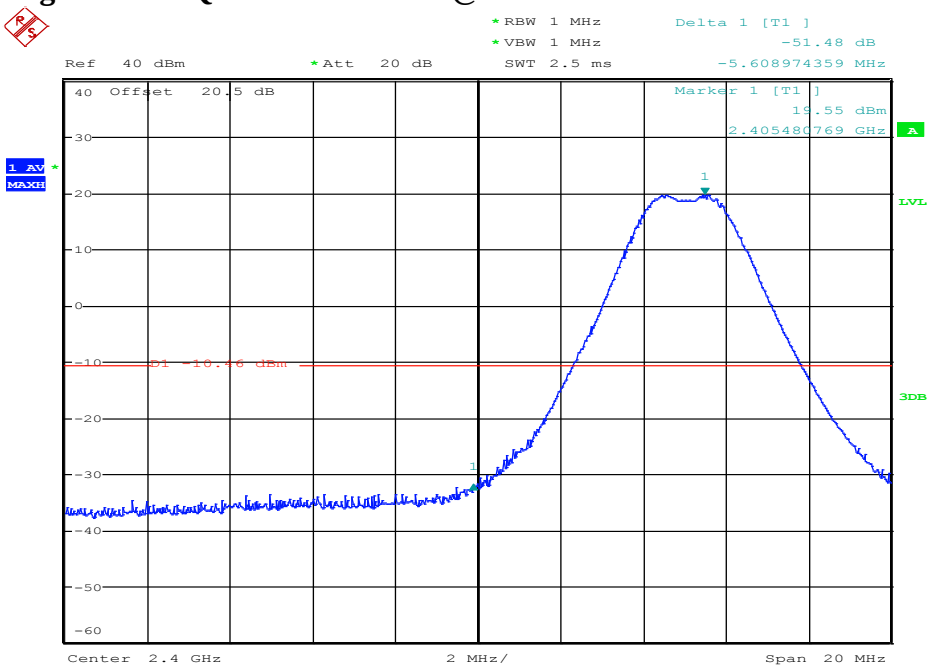
Upper Band-Edge Average -GFSK Modulation 500Kbps (Non-Hop)



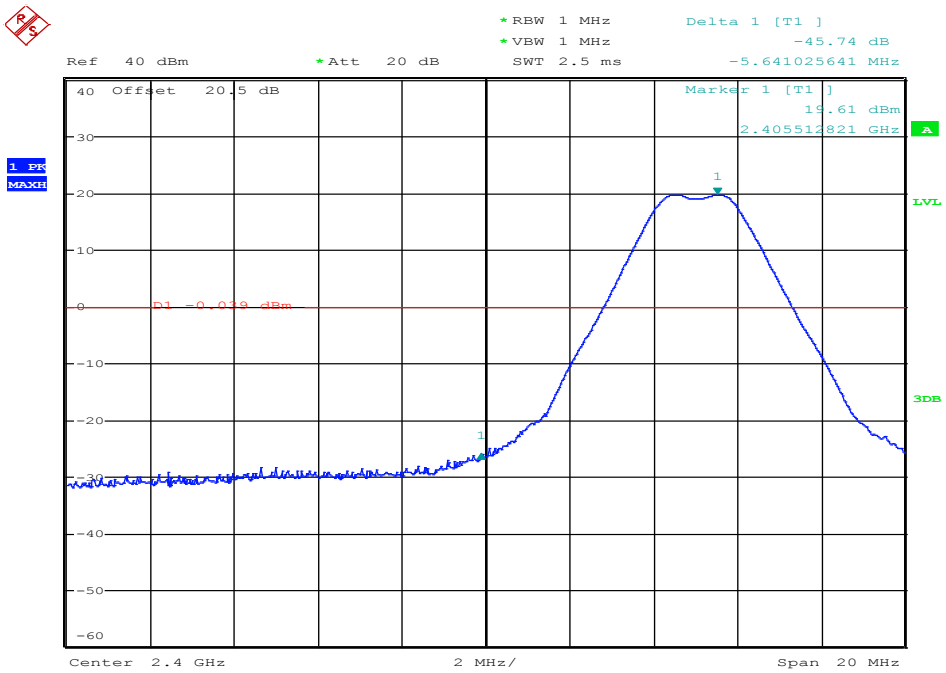
Upper Band-Edge Average -GFSK Modulation 500Kbps (Hop)



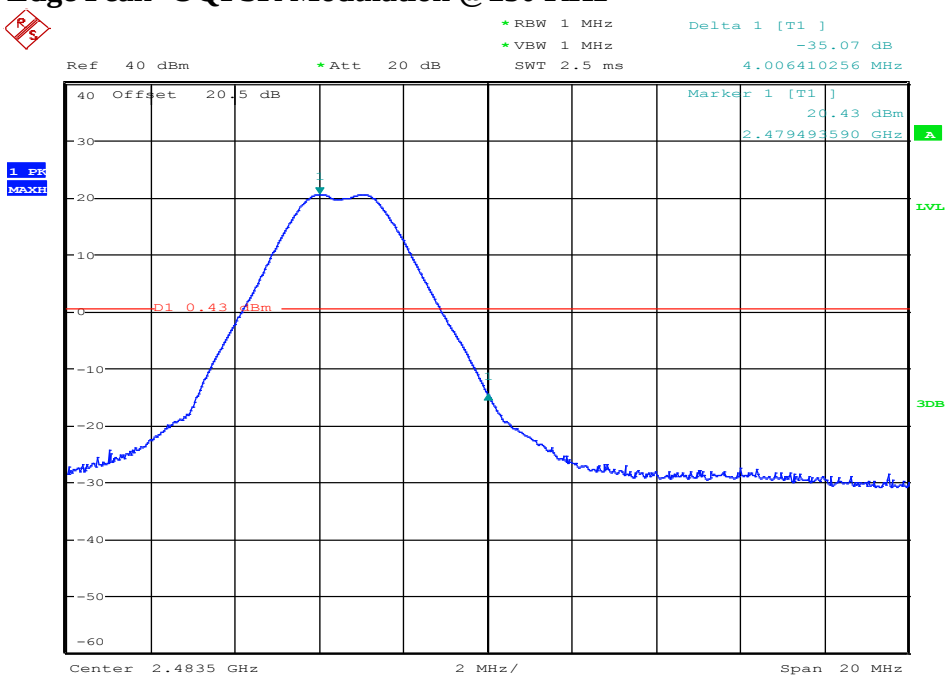
Lower Band-Edge Peak -OQPSK Modulation @250 KHz



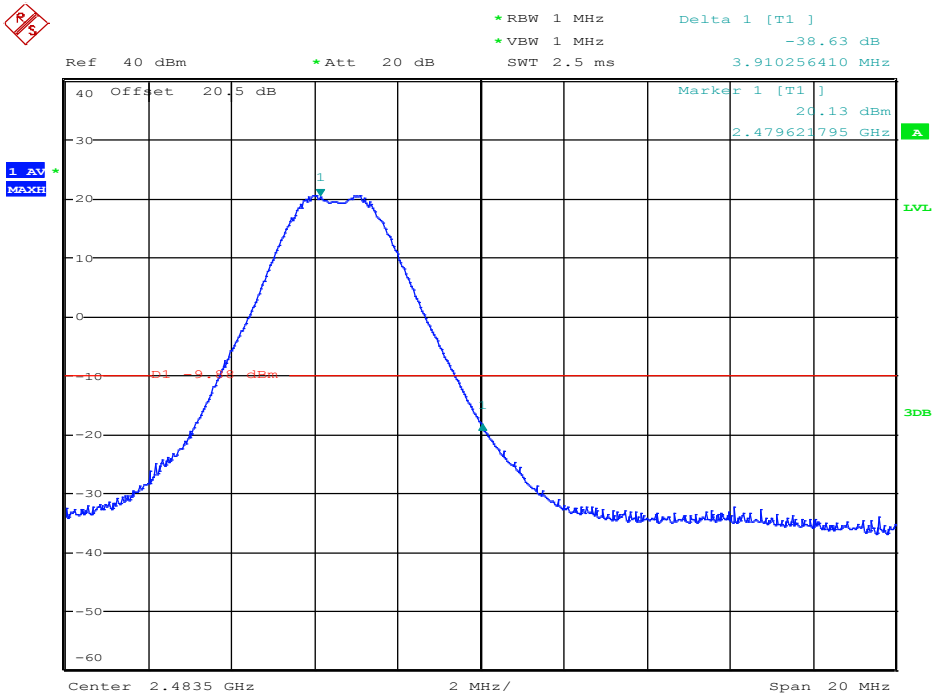
Lower Band-Edge Average -OQPSK Modulation @250 KHz



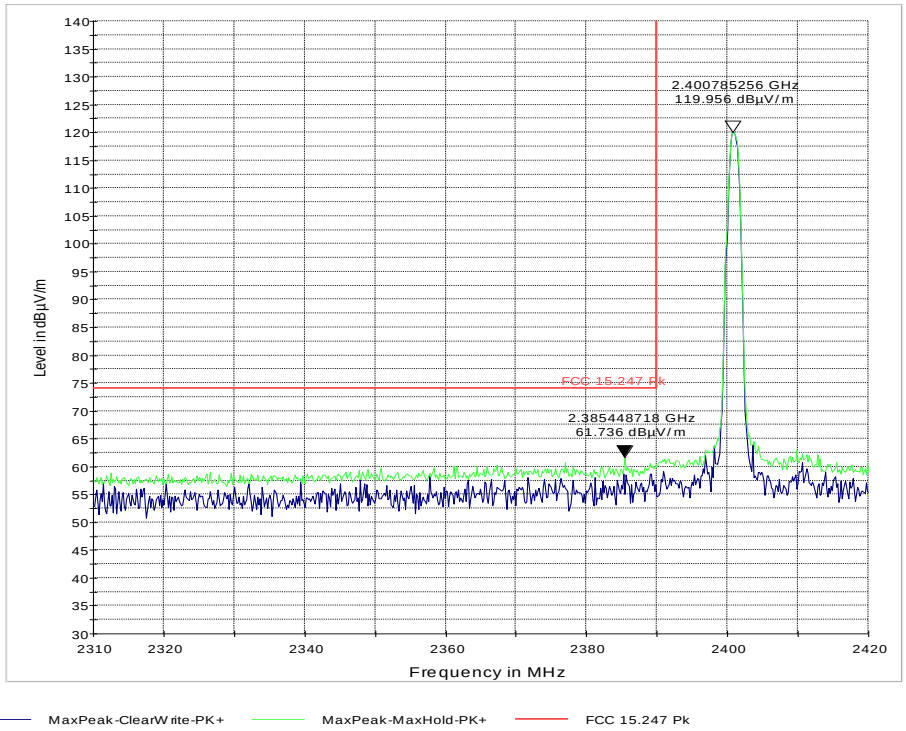
Upper Band-Edge Peak -OQPSK Modulation @250 KHz



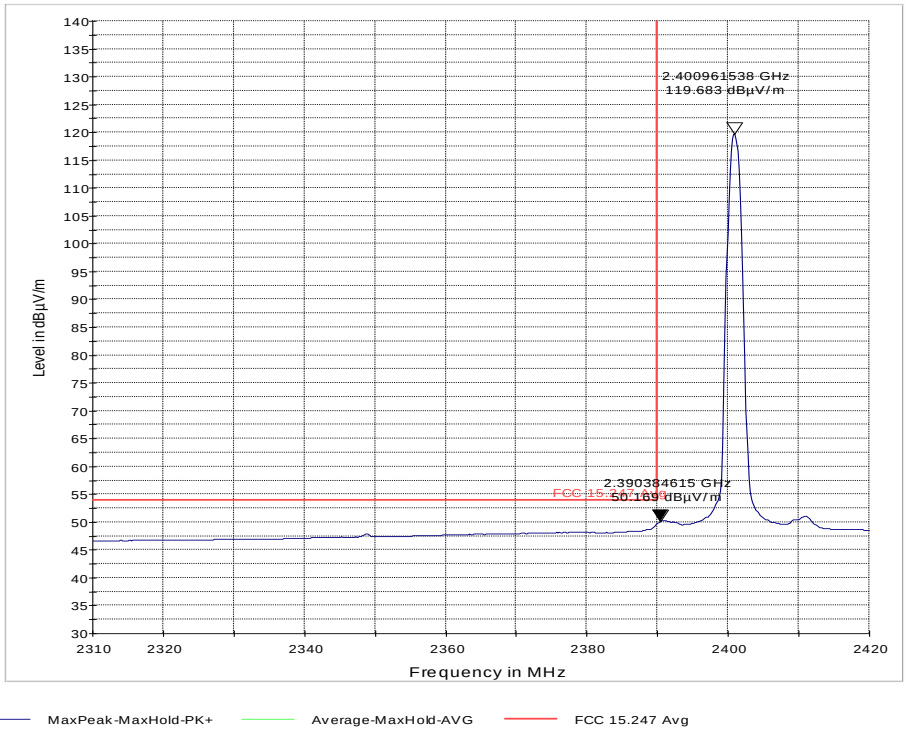
Upper Band-Edge Average -OQPSK Modulation @250 KHz



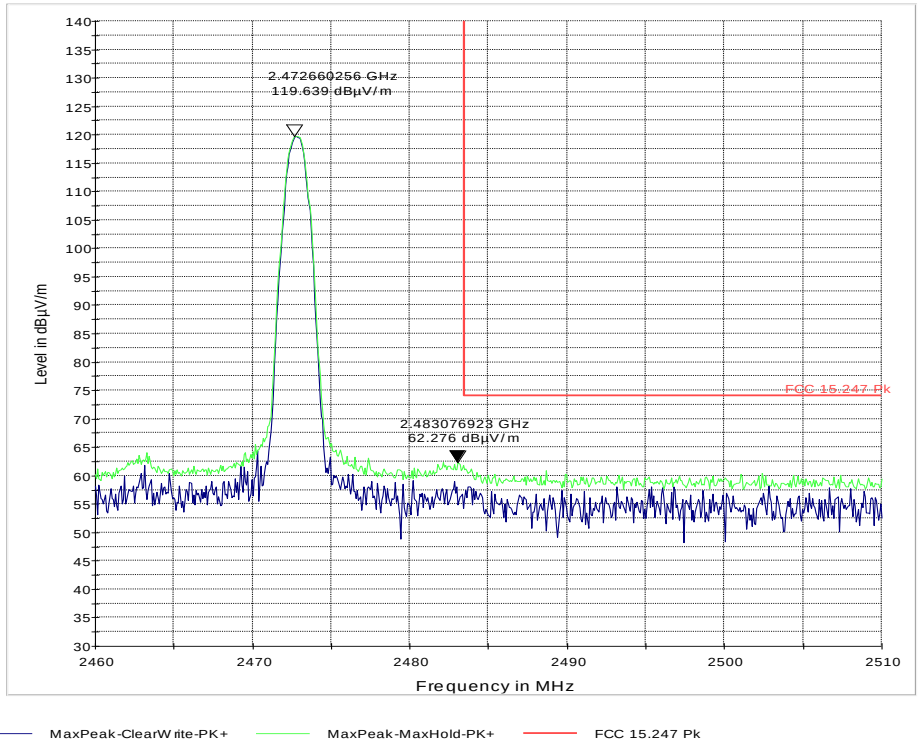
Lower Restricted Band Peak – 2.4008 MHz GFSK Modulation @ 250Kbps



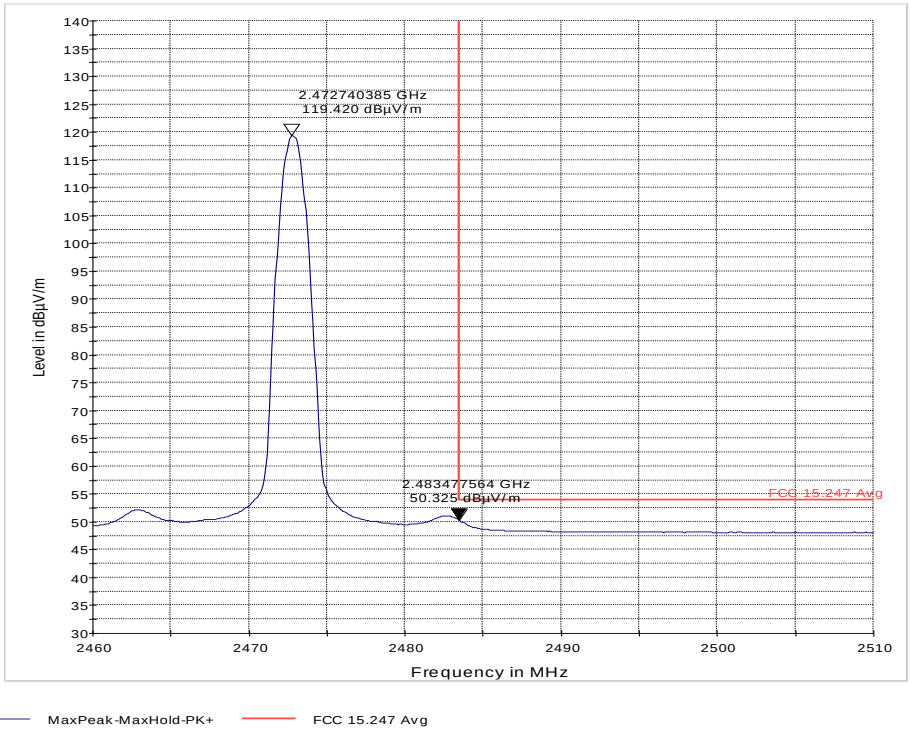
Lower Restricted Band Average – 2.4008 MHz GFSK Modulation @250Kbps



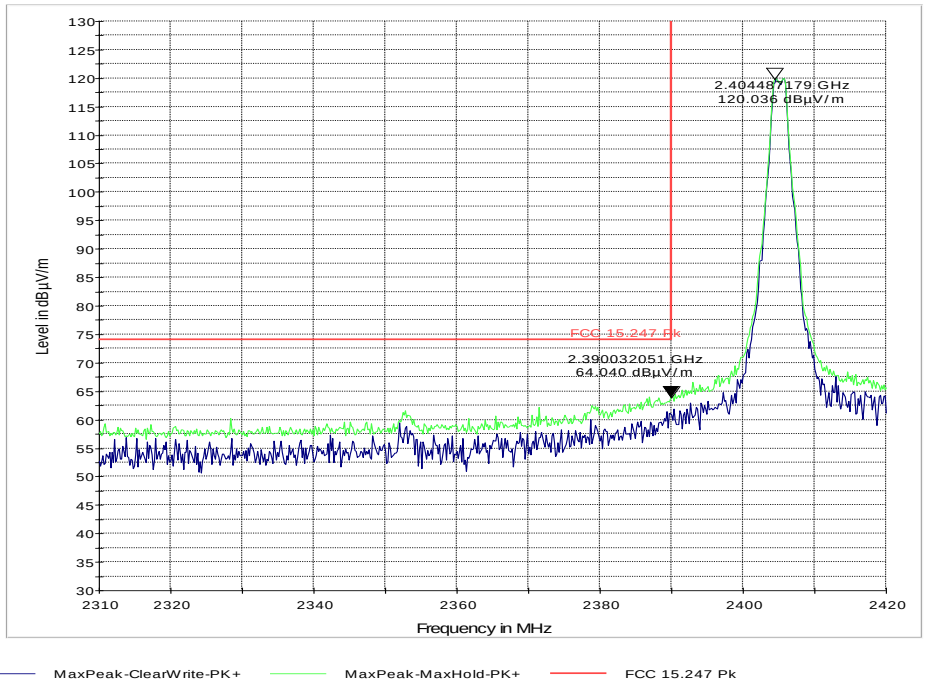
Upper Restricted Band Peak – 2.472 MHz GFSK Modulation @ 250Kbps



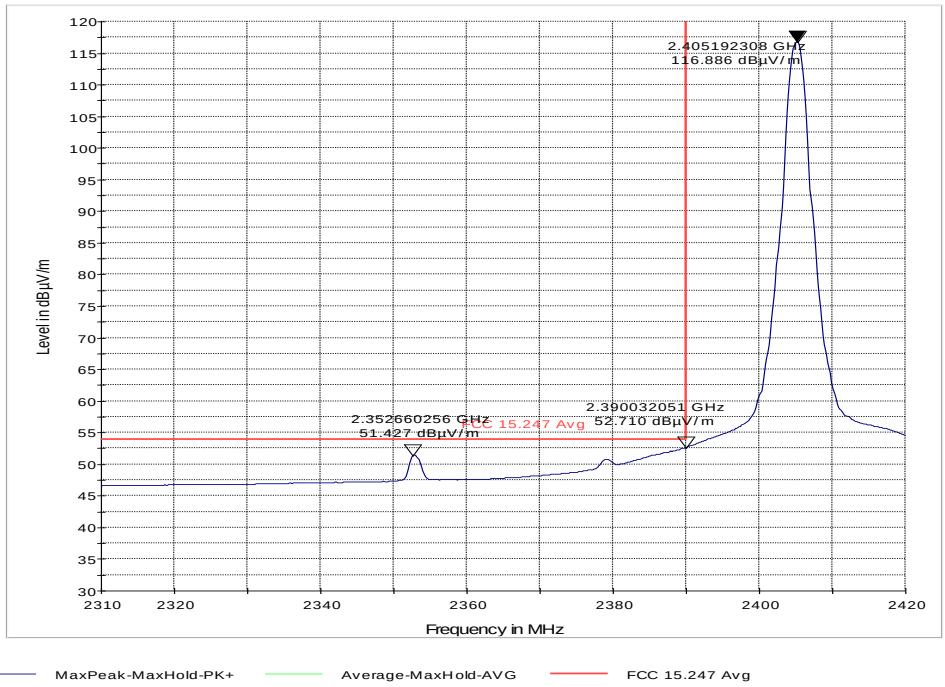
Upper Restricted Band Average – 2.472 MHz GFSK Modulation @ 250Kbps



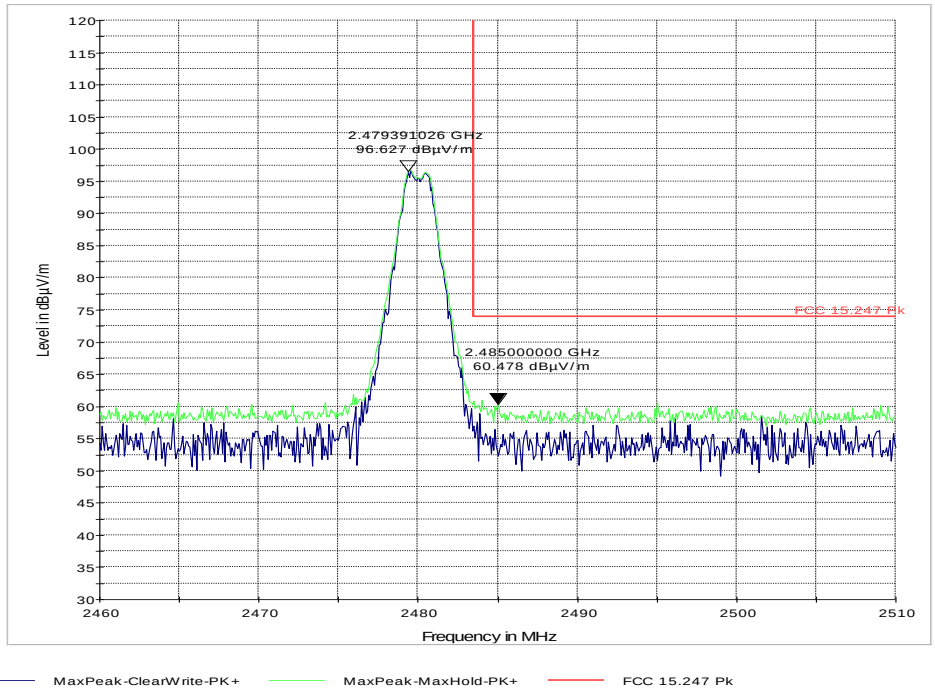
Lower Restricted Band Peak – 2.405 MHz OQPSK Modulation @ 250 Kbps



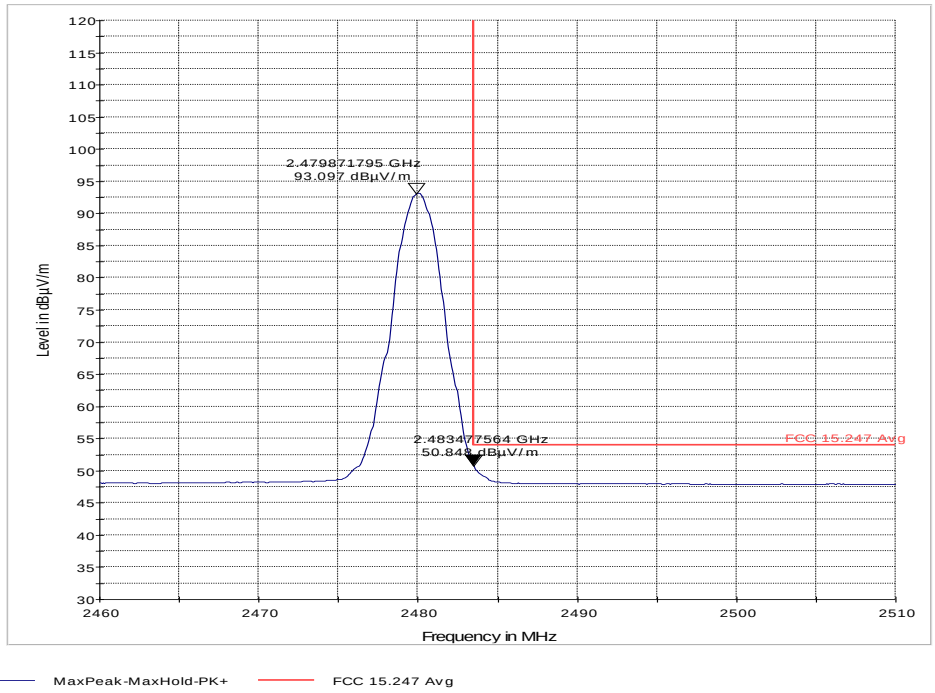
Lower Restricted Band Average – 2.405 MHz OQPSK Modulation @ 250 Kbps



Upper Restricted Band Peak – 2.480 MHz OQPSK Modulation @ 250 KHz



Upper Restricted Band Average – 2.480 MHz OQPSK Modulation @ 250 KHz



7.6 Transmitter Spurious Emissions- Radiated

7.6.1 Limits & Requirements

FCC 15.247/15.205/15.209 & RSS-Gen Section 7.2.5

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

7.6.2 Test Result

The device was set to operate in variation of test modes (highest output power, low/mid/high channel & FSK/GFSK/OQPSK modulation). The measurement results as reported here, represents the worst case radiated spurious emissions.
Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.
For radiated measurements, all data in this report shows the worst case emissions data between H/V antenna polarizations and for all 3 orthogonal orientations of the EUT.

7.6.3 Test Conditions

Tnom: 20°C; Vnom: 4.0 Vdc

7.6.4 Measurement Procedure

Peak measurements are made using a peak detector and RBW=120kHz (<1GHz) and RBW= 1MHz (>1GHz)

7.6.5 Testing Notes:

The following plots show the worst case per frequency range out of all tested modes of operation.
For the measurement range up to 30 MHz in the following plots the field strength results from 3m distance measurement are extrapolated to 300m and 30m distance respectively, by 40dB/decade, according to part 15.31(f)(2), per antenna factor scaling. The red limit line shows the 300 m limit up to 490 kHz, the 30m limit up to 30 MHz and 3m limit above 30MHz.

7.6.6 Measurements Verdict

Passed

7.6.7 Test Data

900 MHz FHSS System Modulation: FSK Data Rate: 100 Kbps Channel: Mid Frequency range: 9 KHz – 30 MHz									
Frequency (KHz)	**Peak (dBuV/m)**	**Quasi-Peak (dBµV/m)**	**Bandwidth (kHz)**	**Height (cm)**	**Antenna Polarity**	**Azimuth (deg)**	**Corr. (dB)**	**Limit (dBµV/m)**	**Margin (dB)**
632.87	23.3	----	10	200	V	270	-10.27	34	- 10.7

900 MHz FHSS System Modulation: FSK Data Rate: 100 Kbps Channel: Low Frequency range: 30 MHz – 1 GHz									
Frequency (MHz)	**Peak (dBuV/m)**	**Quasi-Peak (dBµV/m)**	**Bandwidth (kHz)**	**Height (cm)**	**Antenna Polarity**	**Azimuth (deg)**	**Corr. (dB)**	**Limit (dBµV/m)**	**Margin (dB)**
160.6	27.3	----	120	101	V	45	13.7	43.5	-16.2
799.5	35.4	----	120	101	V	90	25.7	46	-10.6
824.3	39.0	----	120	101	V	45	25.9	46	-7.0

900 MHz FHSS System Modulation: FSK Data Rate: 100 Kbps Channel: Mid Frequency range: 30 MHz – 1 GHz									
Frequency (MHz)	**Peak (dBuV/m)**	**Quasi-Peak (dBµV/m)**	**Bandwidth (kHz)**	**Height (cm)**	**Antenna Polarity**	**Azimuth (deg)**	**Corr. (dB)**	**Limit (dBµV/m)**	**Margin (dB)**
707.7	36.9	----	120	101	V	270	24.2	46	-9.1
755.9	37.4	----	120	101	V	135	24.9	46	-8.6
799.5	36.6	----	120	101	V	0	25.5	46	-9.4
811.9	38.1	----	120	101	V	0	25.7	46	-7.9
894.3	42.9	----	120	101	V	315	26.5	46	-3.4

900 MHz FHSS System Modulation: FSK Data Rate: 100 Kbps Channel: High Frequency range: 30 MHz – 1 GHz									
Frequency (MHz)	**Peak (dBuV/m)**	**Quasi-Peak (dBµV/m)**	**Bandwidth (kHz)**	**Height (cm)**	**Antenna Polarity**	**Azimuth (deg)**	**Corr. (dB)**	**Limit (dBµV/m)**	**Margin (dB)**
693.8	34.2	----	120	101	V	0	23.7	46	-11.8
763.7	40.1	----	120	101	V	135	25.6	46	-5.9
822.8	41.7	----	120	101	V	135	25.9	46	-4.3

900 MHz FHSS System
Modulation: FSK
Data Rate: 100 Kbps
Channel: Mid
Frequency range: 1 GHz – 18 GHz

Frequency (GHz)	Peak (dBuV/m)	Average (dBµV/m)	Bandwidth (MHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
9.85	61.4	51.8	1	100	H	90	32.5	74 Pk / 54 Av	-12.6 Pk -2.20 Av
16.91	60.3	49.1	1	100	V	90	25.2	74 Pk / 54 Av	-13.7 Pk / -4.90 Av

2.4 GHz FHSS System
Modulation: GFSK
Data Rate: 250 Kbps
Channel: Mid
Frequency range: 9 KHz – 30 MHz

Frequency (KHz)	Peak (dBuV/m)	Quasi-Peak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
679.17	23.8	----	10	200	V	0	-10.7	34	- 10.2

2.4 GHz FHSS System
Modulation: GFSK
Data Rate: 250 Kbps
Channel: Low
Frequency range: 30 MHz – 1 GHz

Frequency (MHz)	Peak (dBuV/m)	Quasi-Peak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
155.9	21.8	----	120	100	V	315	21.3	43.5	-21.7

2.4 GHz FHSS System
Modulation: GFSK
Data Rate: 250 Kbps
Channel: Mid
Frequency range: 30 MHz – 1 GHz

Frequency (MHz)	Peak (dBuV/m)	Quasi-Peak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
31.55	20.6	----	120	100	V	45	11.7	40	-19.4
96.84	22.2	----	120	100	V	180	10.1	43.5	-21.3
207.2	21.8	----	120	100	V	270	7.34	43.5	-21.7

2.4 GHz FHSS System
Modulation: GFSK
Data Rate: 250 Kbps
Channel: High
Frequency range: 30 MHz – 1 GHz

Frequency (MHz)	Peak (dBuV/m)	Quasi-Peak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
145.0	22.6	----	120	100	V	45	9.38	43.5	-20.9

2.4 GHz DSSS System Modulation: OQPSK Data Rate: 250 Kbps Channel: Low Frequency range: 30 MHz – 1 GHz									
Frequency (MHz)	**Peak (dBuV/m)**	**Quasi-Peak (dBµV/m)**	**Bandwidth (kHz)**	**Height (cm)**	**Antenna Polarity**	**Azimuth (deg)**	**Corr. (dB)**	**Limit (dBµV/m)**	**Margin (dB)**
50.2	23.6	----	120	100	V	270	5.3	40.0	-16.4

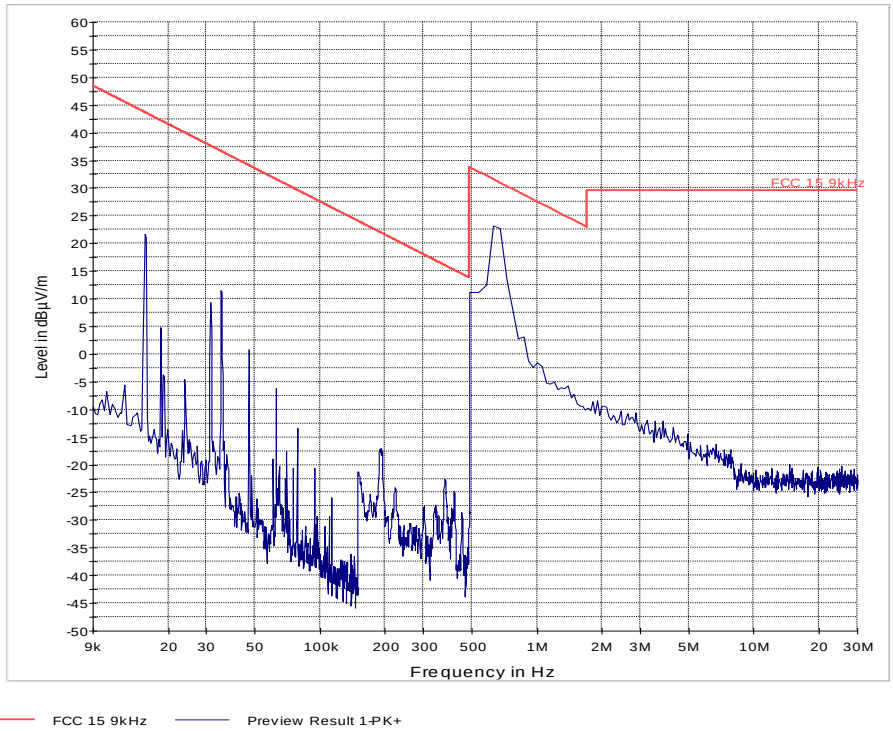
2.4 GHz DSSS System Modulation: OQPSK Data Rate: 250 Kbps Channel: High Frequency range: 30 MHz – 1 GHz									
Frequency (MHz)	**Peak (dBuV/m)**	**Quasi-Peak (dBµV/m)**	**Bandwidth (kHz)**	**Height (cm)**	**Antenna Polarity**	**Azimuth (deg)**	**Corr. (dB)**	**Limit (dBµV/m)**	**Margin (dB)**
135.7	25.6	----	120	101	V	180	8.9	43.5	-17.9

2.4 GHz DSSS System Modulation: OQPSK Data Rate: 250 Kbps Channel: Low Frequency range: 1 GHz – 18 GHz									
Frequency (GHz)	**Peak (dBuV/m)**	**Average (dBµV/m)**	**Bandwidth (MHz)**	**Height (cm)**	**Antenna Polarity**	**Azimuth (deg)**	**Corr. (dB)**	**Limit (dBµV/m)**	**Margin (dB)**
7.12	57.6	45.9	1	100	H	0	19.1	74Pk 54Av	-16.4Pk -8.10Av
14.5	59.12	47.5	1	100	H	270	31.5	74Pk 54Av	-14.0Pk -6.50Av

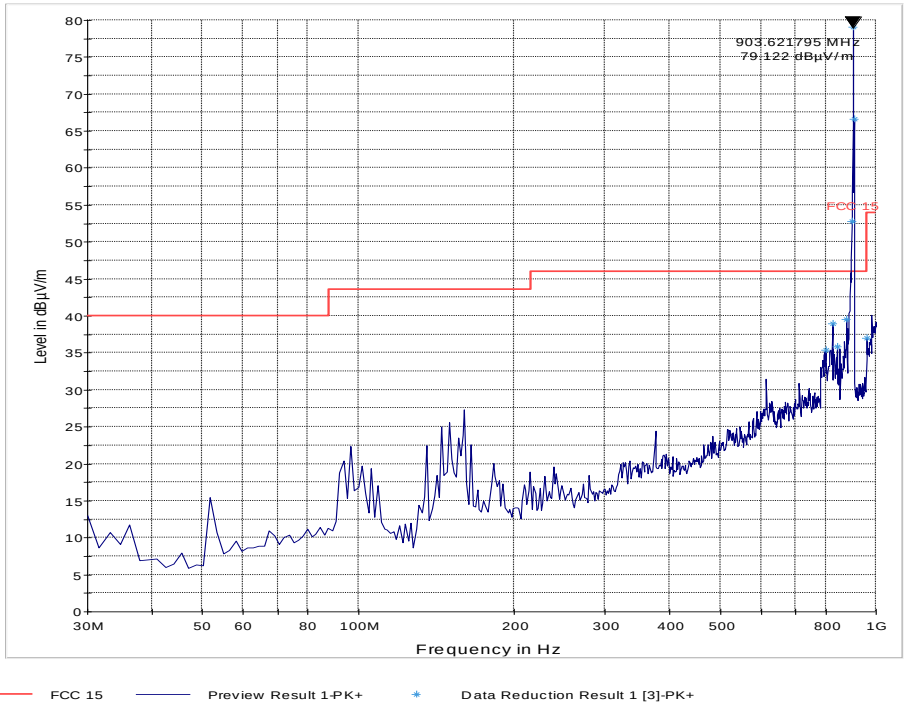
2.4 GHz DSSS System Modulation: OQPSK Data Rate: 250 Kbps Channel: Mid Frequency range: 1 GHz – 18 GHz									
Frequency (GHz)	**Peak (dBuV/m)**	**Average (dBµV/m)**	**Bandwidth (MHz)**	**Height (cm)**	**Antenna Polarity**	**Azimuth (deg)**	**Corr. (dB)**	**Limit (dBµV/m)**	**Margin (dB)**
9.94	61.5	50.8	1	100	V	90	24.8	74Pk 54Av	-12.5Pk -3.20Av
14.8	60.0	46.8	1	100	V	270	31.1	74Pk 54Av	-14.0Pk -7.2Av

7.6.8 Measurement Plots

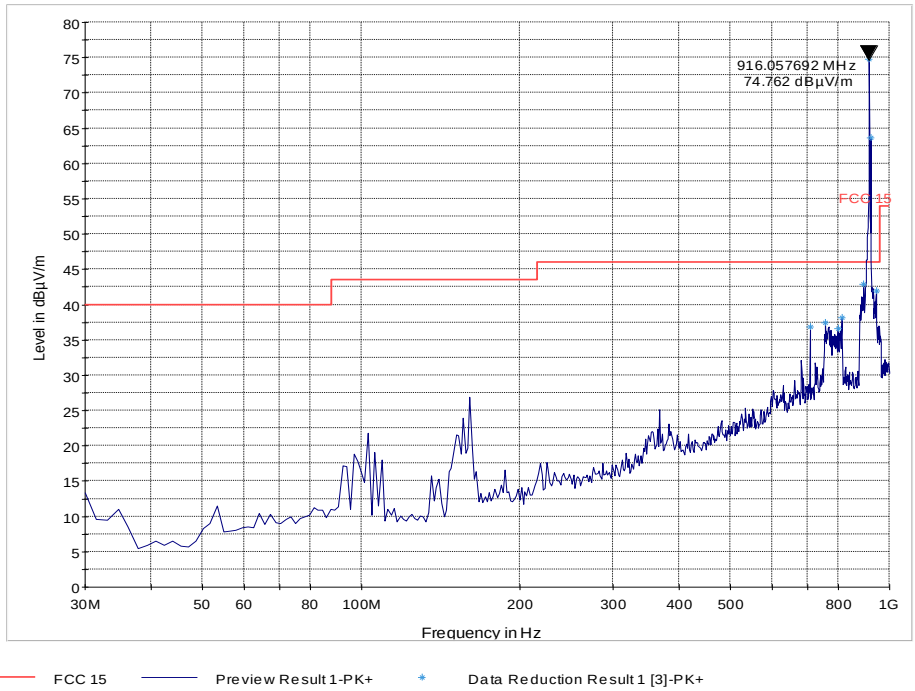
TX Radiated Spurious Emission- Ch Mid- 9 KHz-30MHz; 900 MHz FSK Modulation @100 Kbps



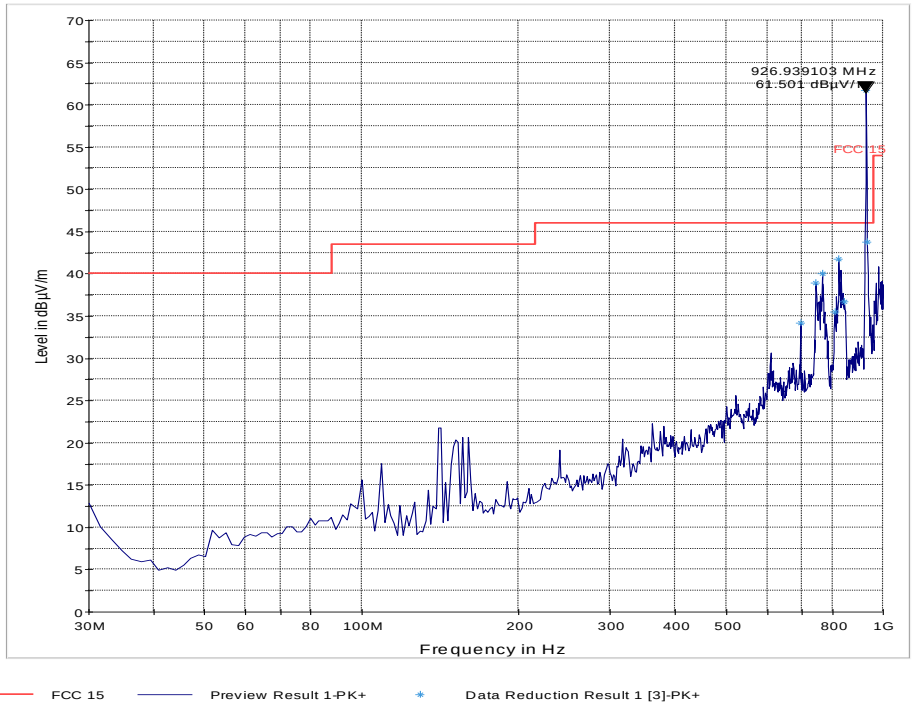
TX Radiated Spurious Emission- Ch Low - 30 MHz-1GHz; 900 MHz FSK Modulation @100 Kbps



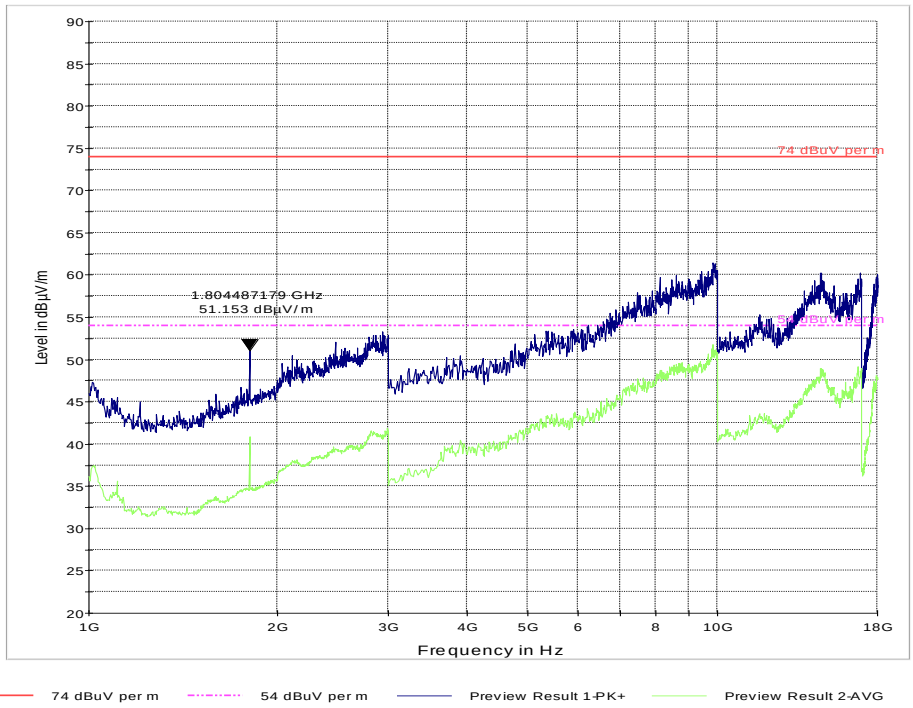
TX Radiated Spurious Emission- Ch Mid - 30 MHz-1GHz; 900 MHz FSK Modulation @100 Kbps



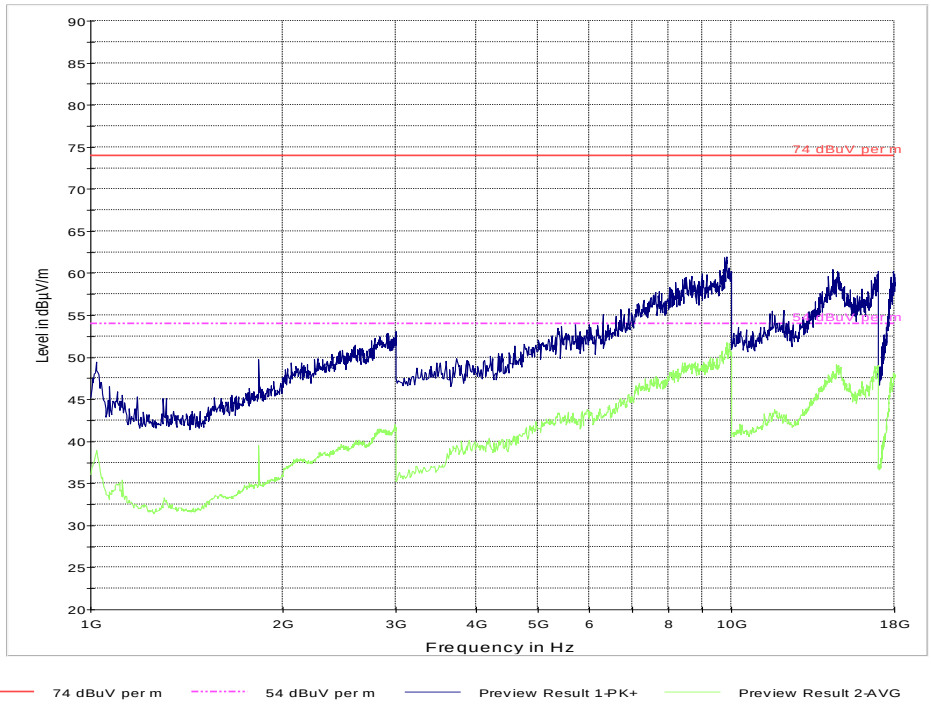
TX Radiated Spurious Emission- Ch High- 30 MHz-1GHz; 900 MHz FSK Modulation @100 Kbps



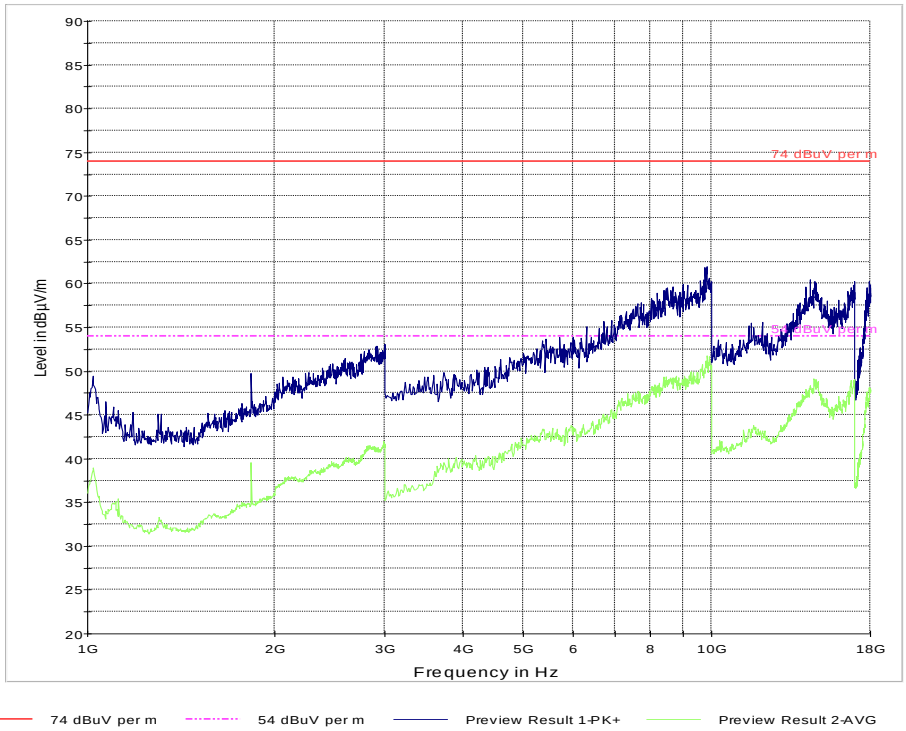
TX Radiated Spurious Emission- Ch Low- 1GHz -18 GHz; 900 MHz FSK Modulation @100 Kbps



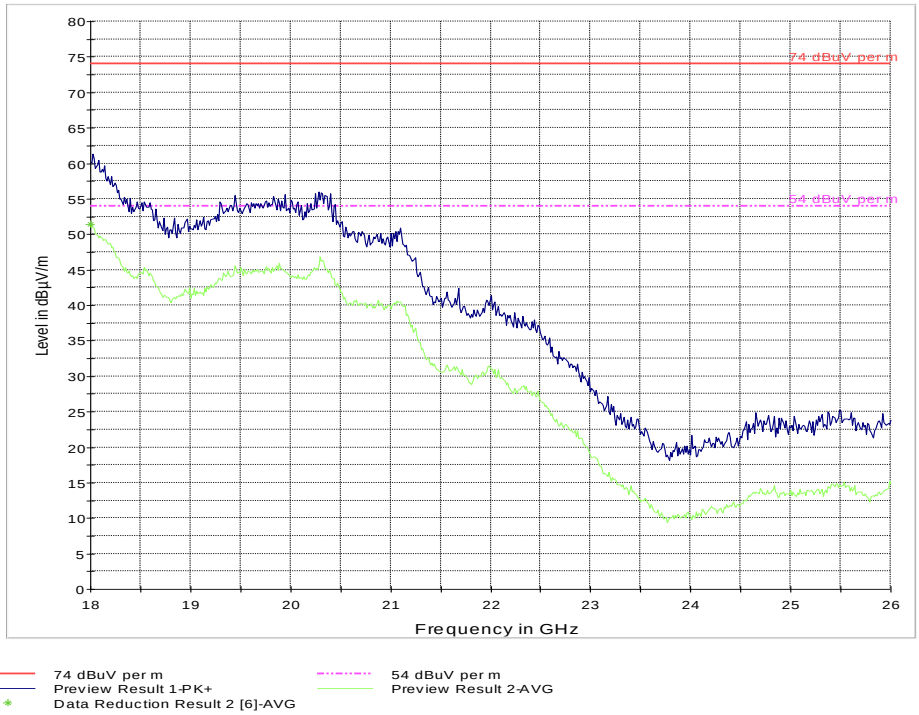
TX Radiated Spurious Emission- Ch Mid- 1GHz -18 GHz; 900 MHz FSK Modulation @100 Kbps



TX Radiated Spurious Emission- Ch High- 1GHz-18 GHz; 900 MHz FSK Modulation @100 Kbps

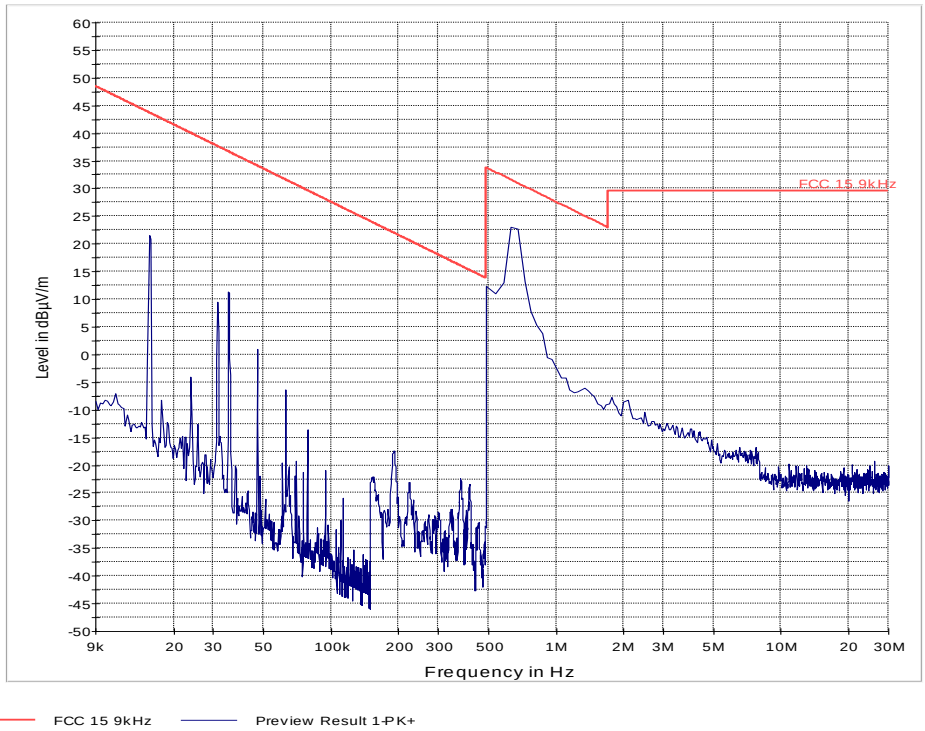


TX Radiated Spurious Emission- Ch Mid 18 GHz-26 GHz, 900 MHz FSK Modulation @100 Kbps

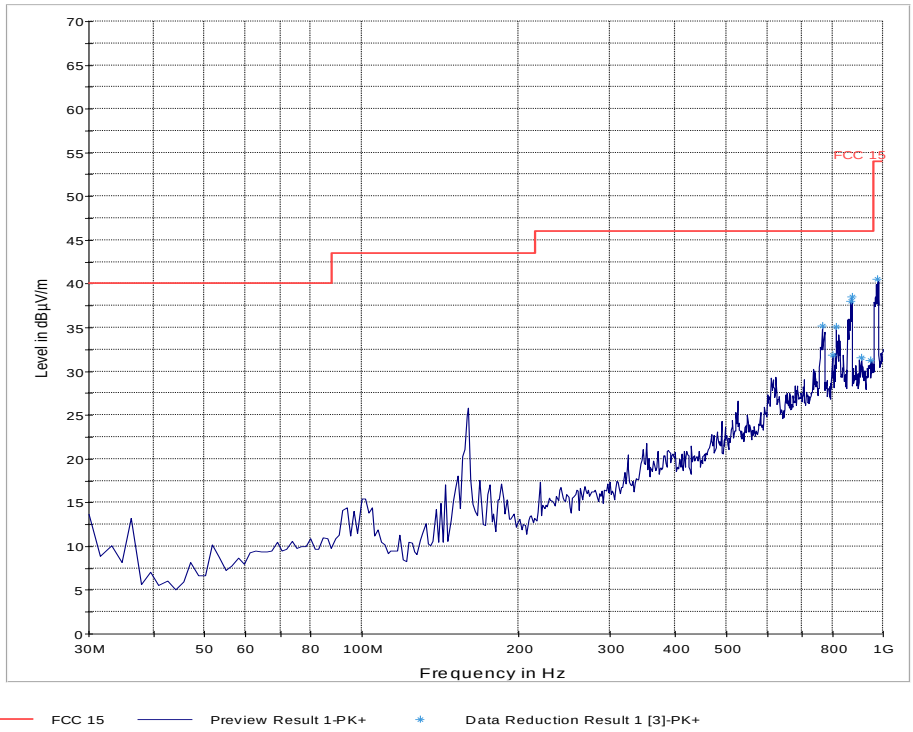


NOTE: Worst case representation for all modes of operation in this range of test.

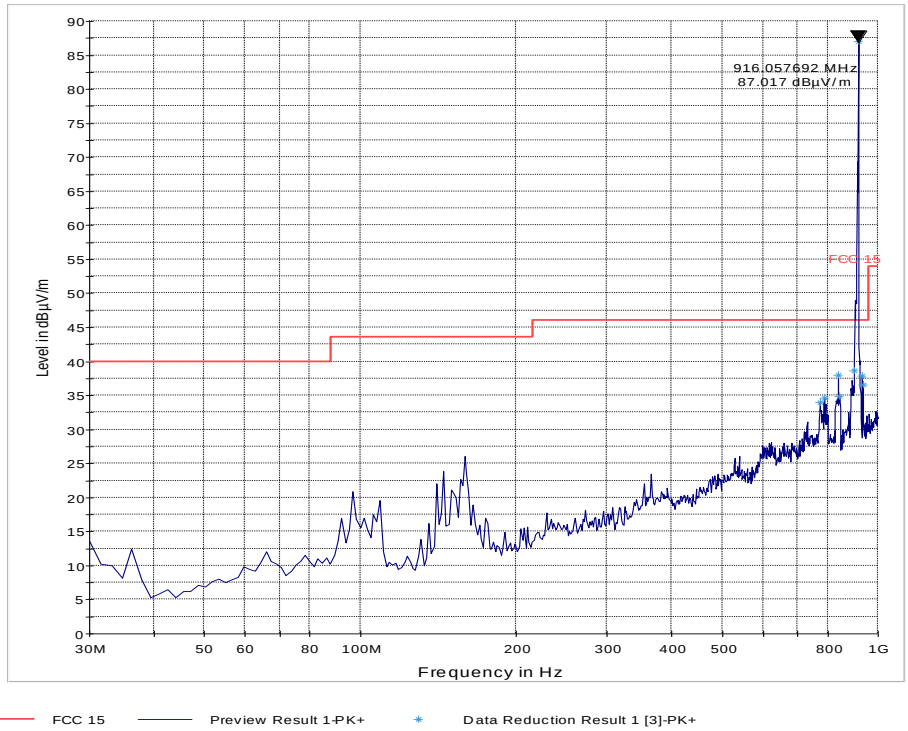
TX Radiated Spurious Emission Ch Mid- 9 KHz-30MHz, 900 MHz GFSK Modulation @300Kbps



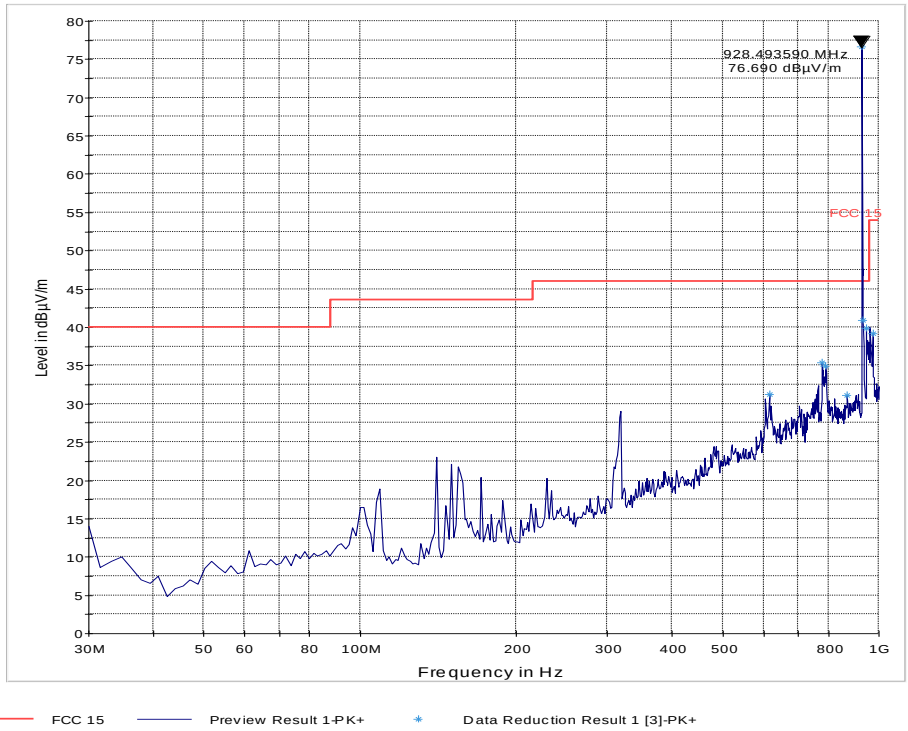
TX Radiated Spurious Emission- Ch Low- 30 MHz-1GHz, 900 MHz GFSK Modulation @300KHz



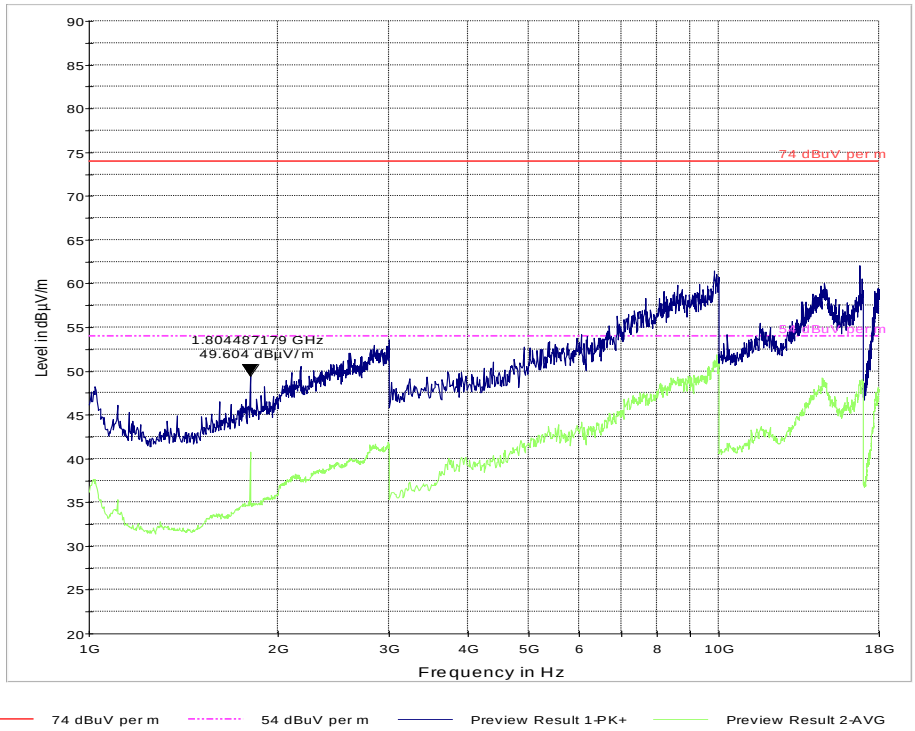
TX Radiated Spurious Emission- Ch Mid- 30 MHz-1GHz; 900 MHz GFSK Modulation @300KHz



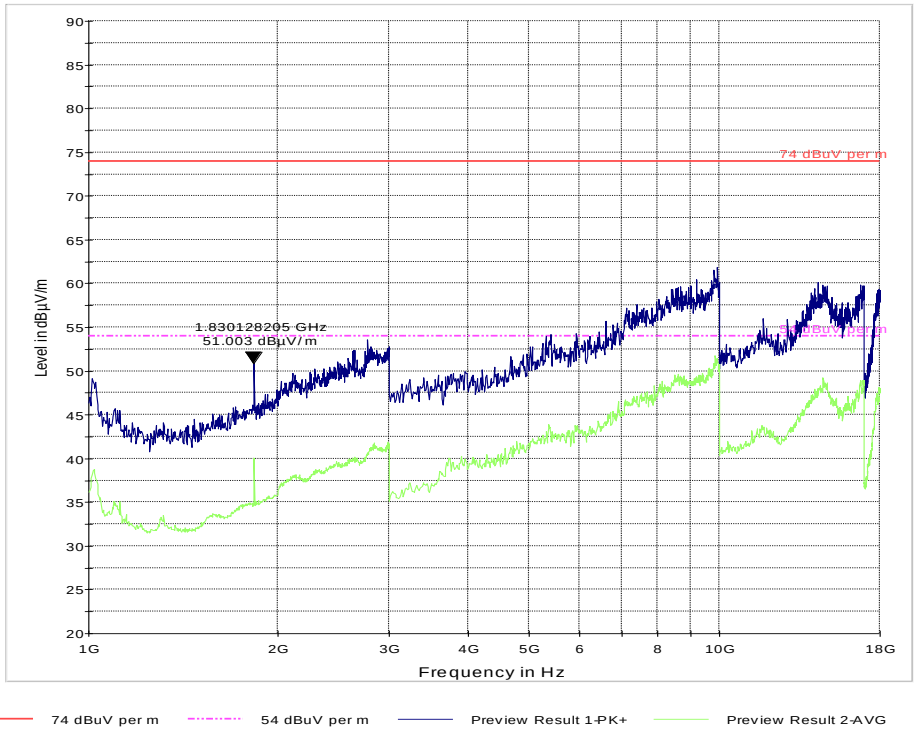
TX Radiated Spurious Emission- Ch High 30 MHz-1GHz 900 MHz GFSK Modulation @300Kbps



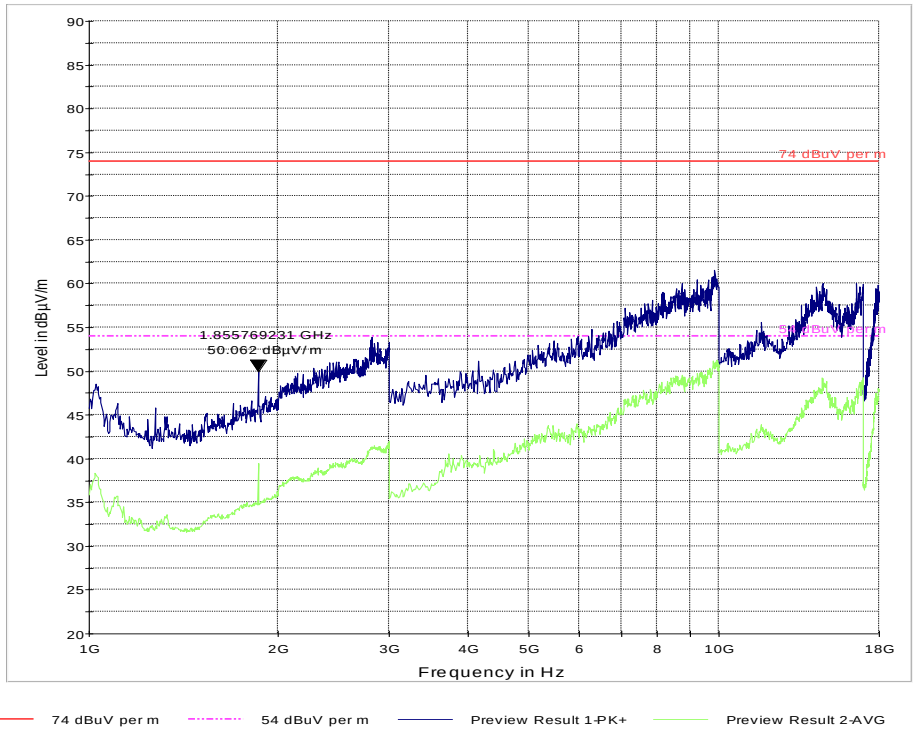
TX Radiated Spurious Emission- Ch Low 1 GHz- 18GHz, 900 MHz GFSK Modulation @300Kbps



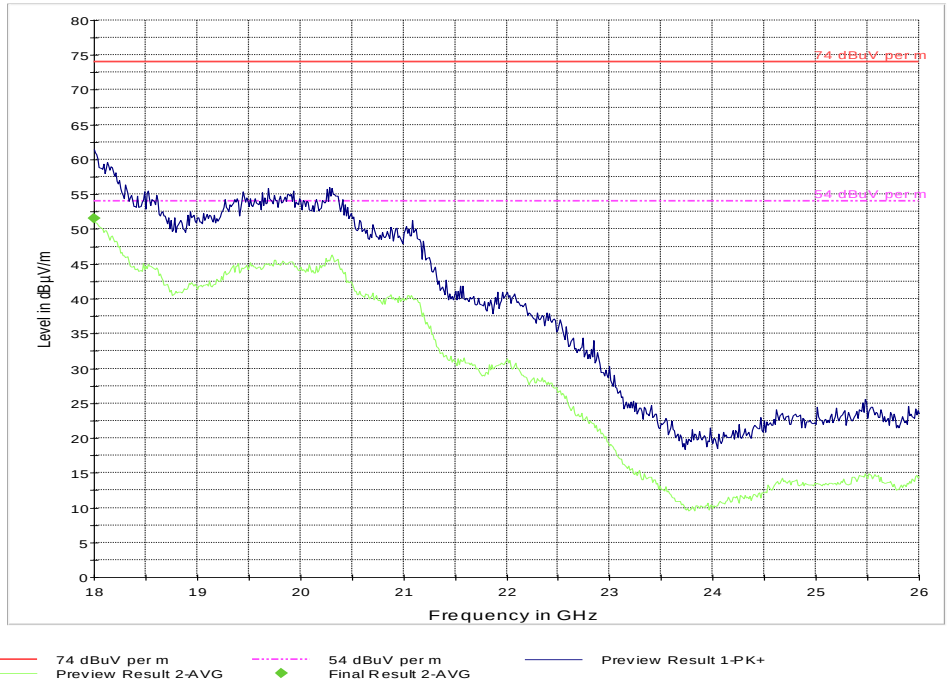
TX Radiated Spurious Emission- Ch Mid 1GHz-18GHz, 900 MHz GFSK Modulation @300Kbps



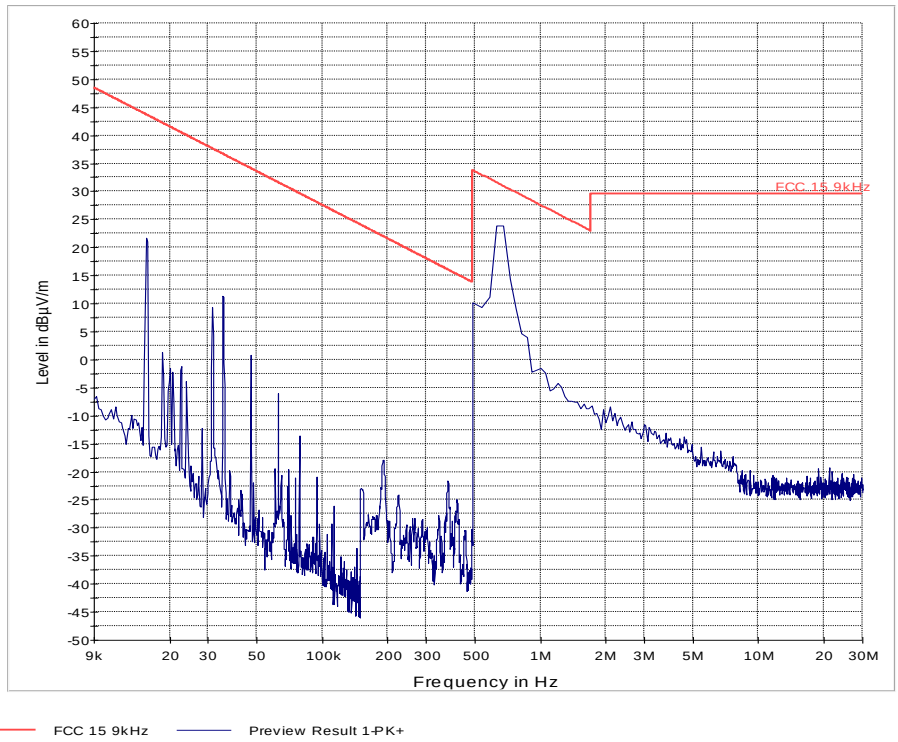
TX Radiated Spurious Emission- Ch High 1GHz-18GHz, 900 MHz GFSK Modulation @300Kbps



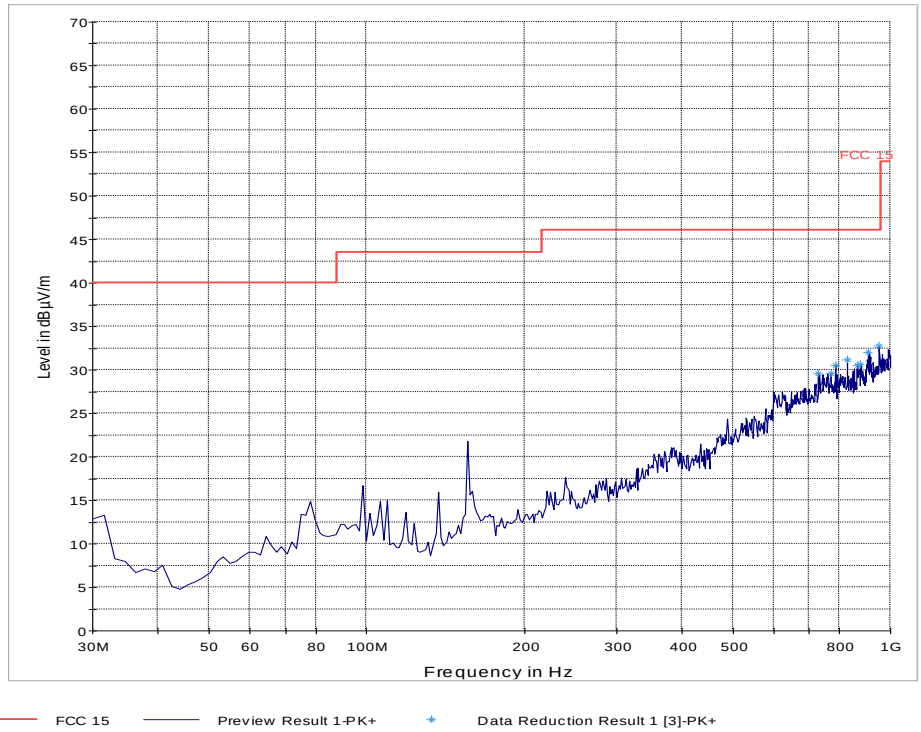
TX Radiated Spurious Emission- Ch Mid 18GHz-26GHz, 900 MHz GFSK Modulation @300Kbps



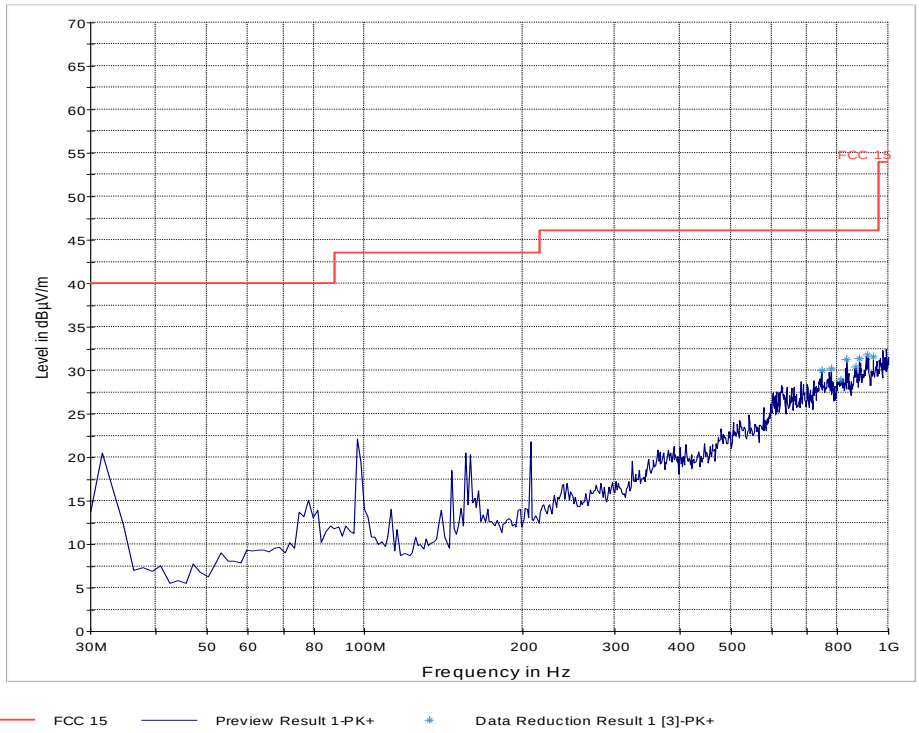
TX Radiated Spurious Emission- Ch Mid 9 KHz-30 MHz, 2.4 GHz GFSK Modulation @250Kbps



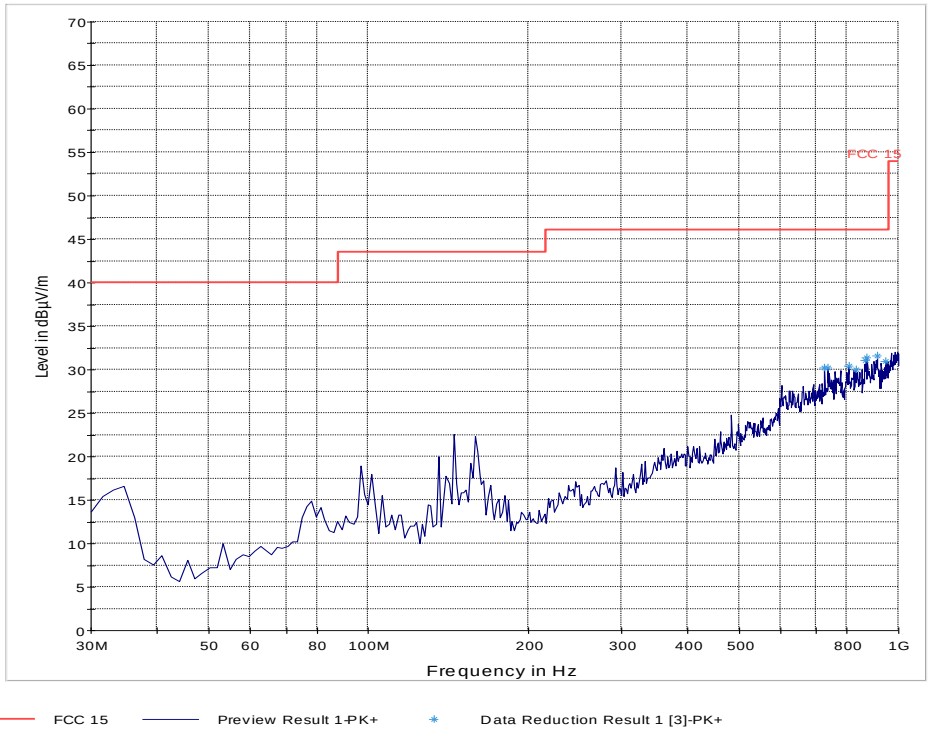
TX Radiated Spurious Emission- Ch Low 30MHz -1GHz, 2.4 GHz GFSK Modulation @250Kbps



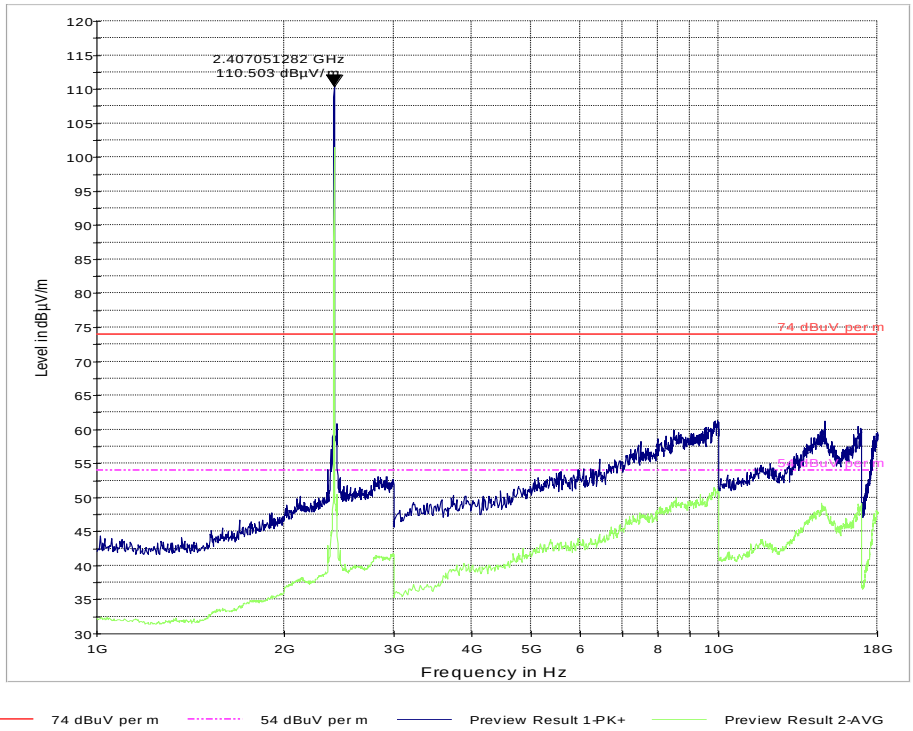
TX Radiated Spurious Emission- Ch Mid 30MHz -1GHz, 2.4 GHz GFSK Modulation @250Kbps



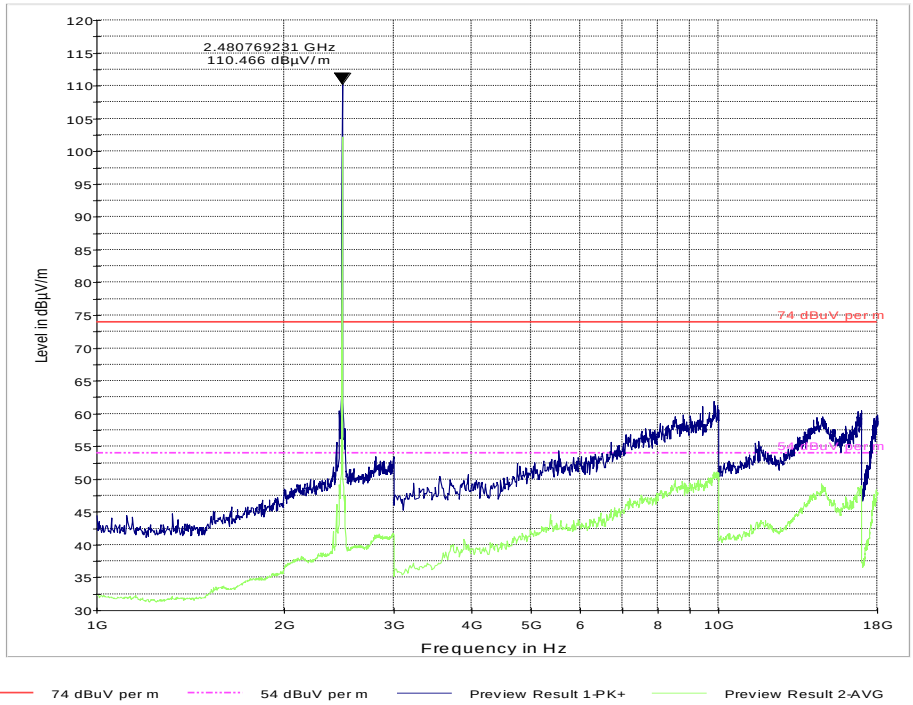
TX Radiated Spurious Emission- Ch High 30MHz -1GHz, 2.4 GHz GFSK Modulation @250Kbps



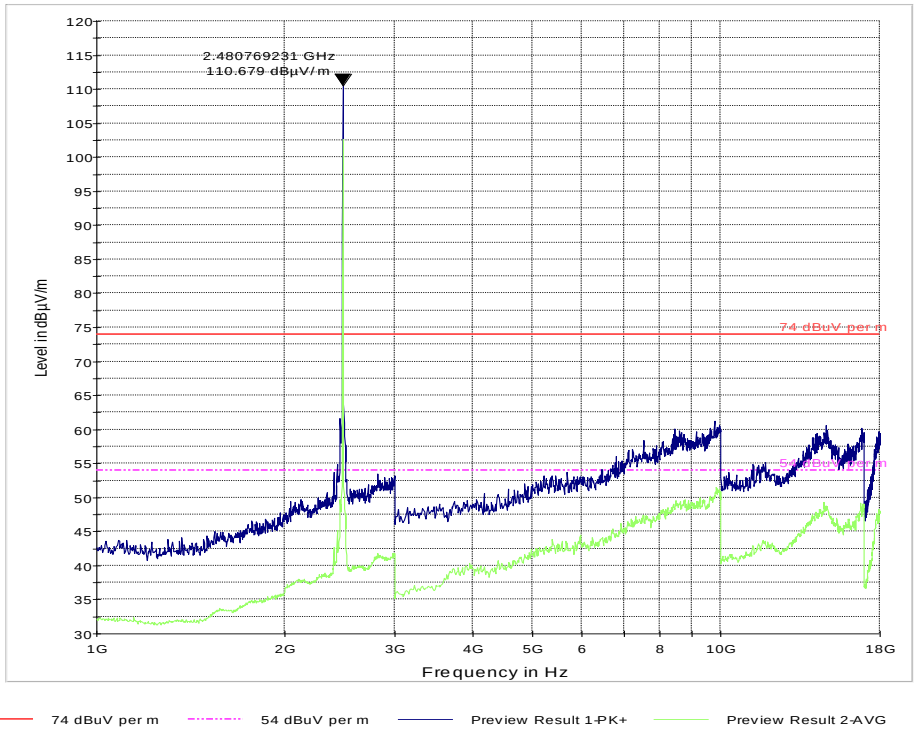
TX Radiated Spurious Emission Ch Low- 1GHz -18GHz, 2.4 GHz GFSK Modulation @250Kbps



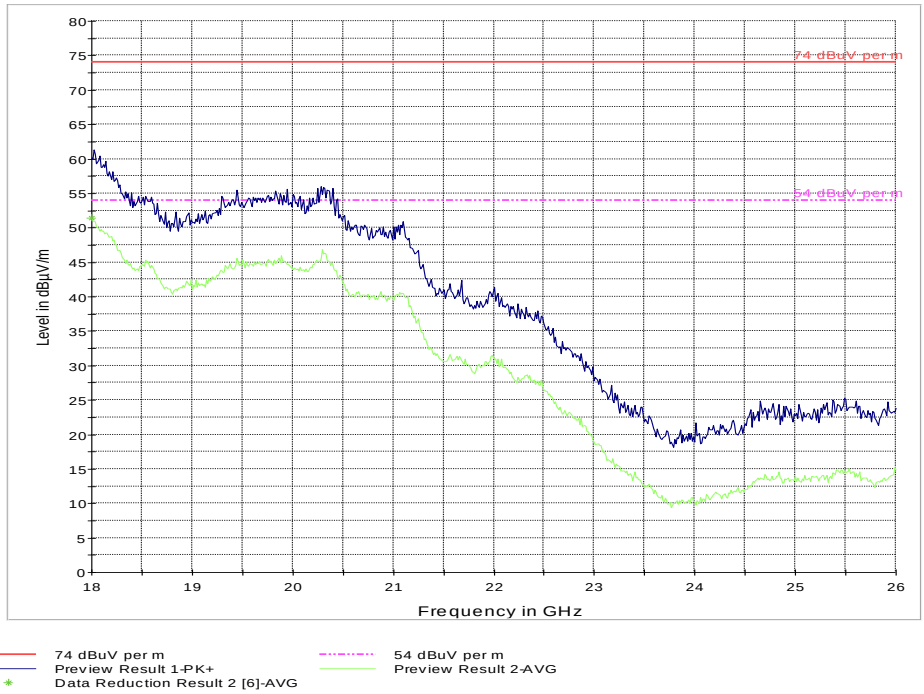
TX Radiated Spurious Emission Ch Mid- 1GHz -18GHz, 2.4 GHz GFSK Modulation @250Kbps



TX Radiated Spurious Emission Ch High- 1GHz -18GHz, 2.4 GHz GFSK Modulation @250Kbps

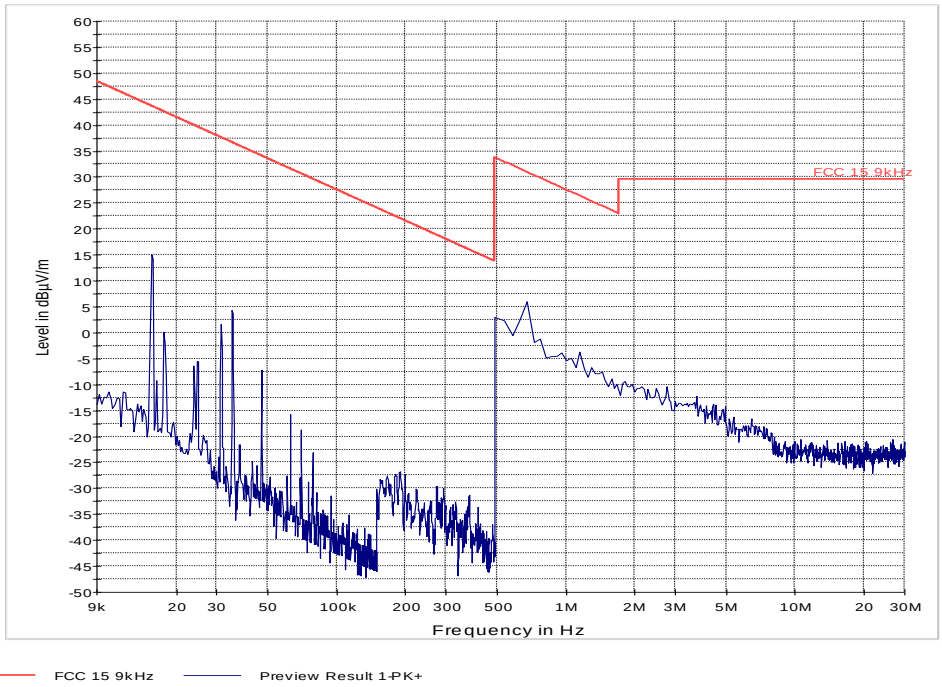


TX Radiated Spurious Emission Ch Mid 18GHz-26GHz, 2.4 GHz GFSK Modulation @250 Kbps

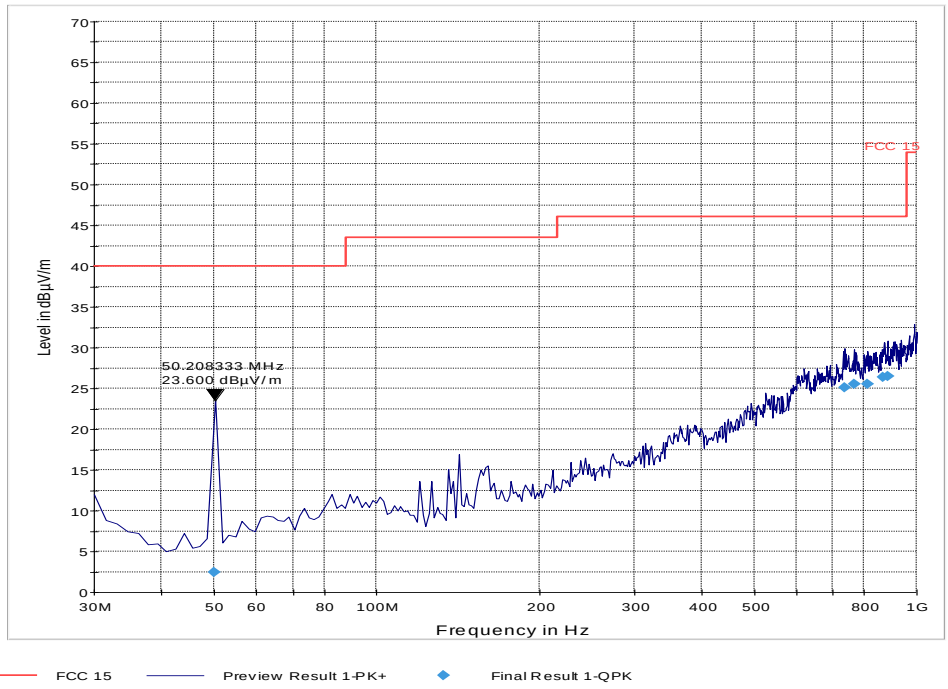


NOTE: Worst case representation for all modes of operation in this range of test.

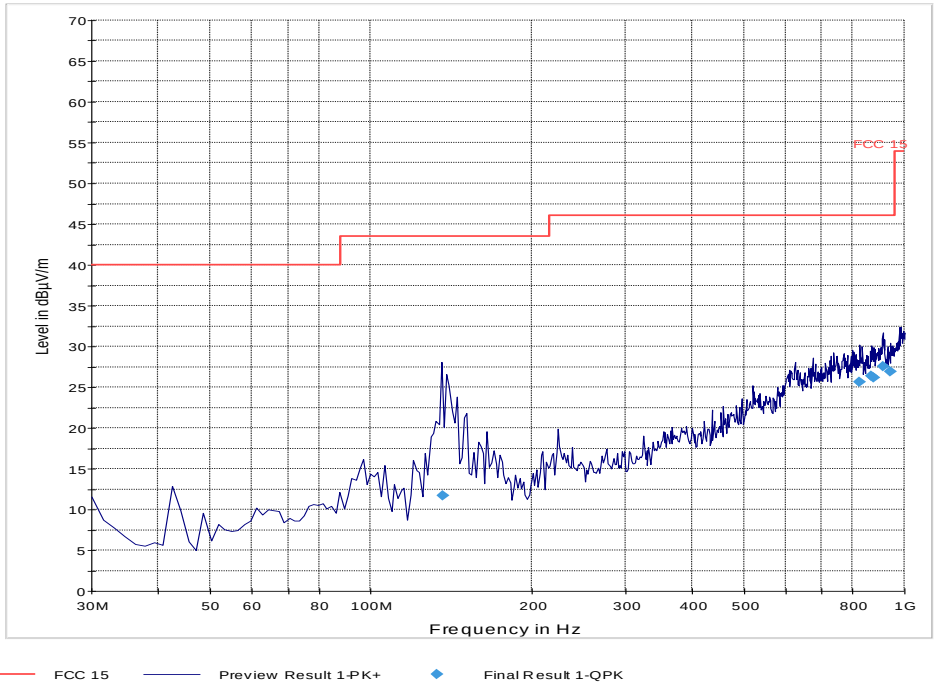
TX Radiated Spurious Emission Ch Mid- 9KHz-30MHz, 2.4 GHz OQPSK Modulation @250 KHz



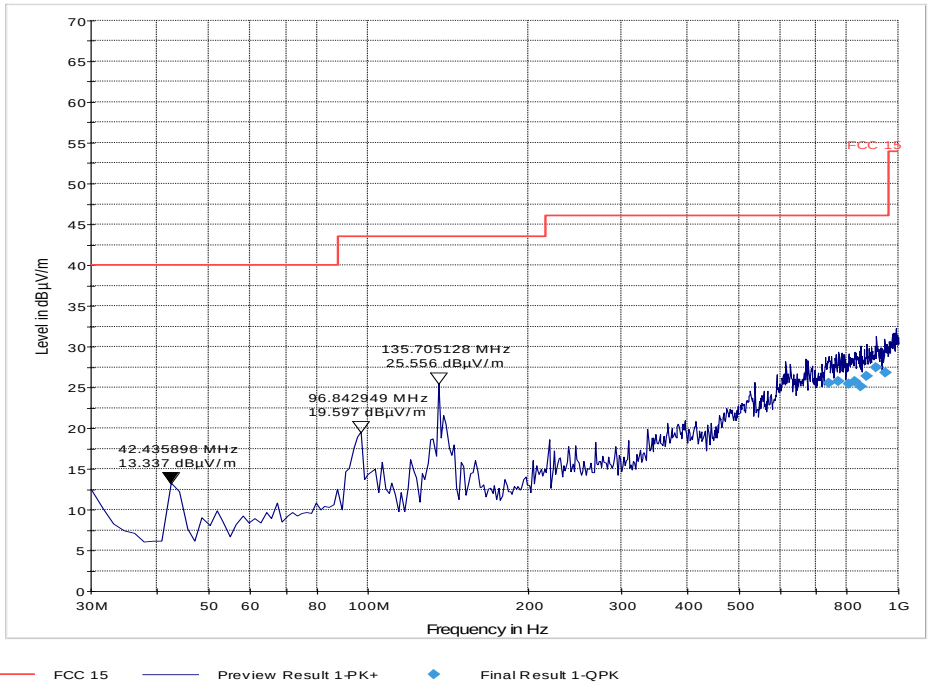
TX Radiated Spurious Emission Ch Low- 30MHz-1GHz, 2.4 GHz OQPSK Modulation @250 KHz



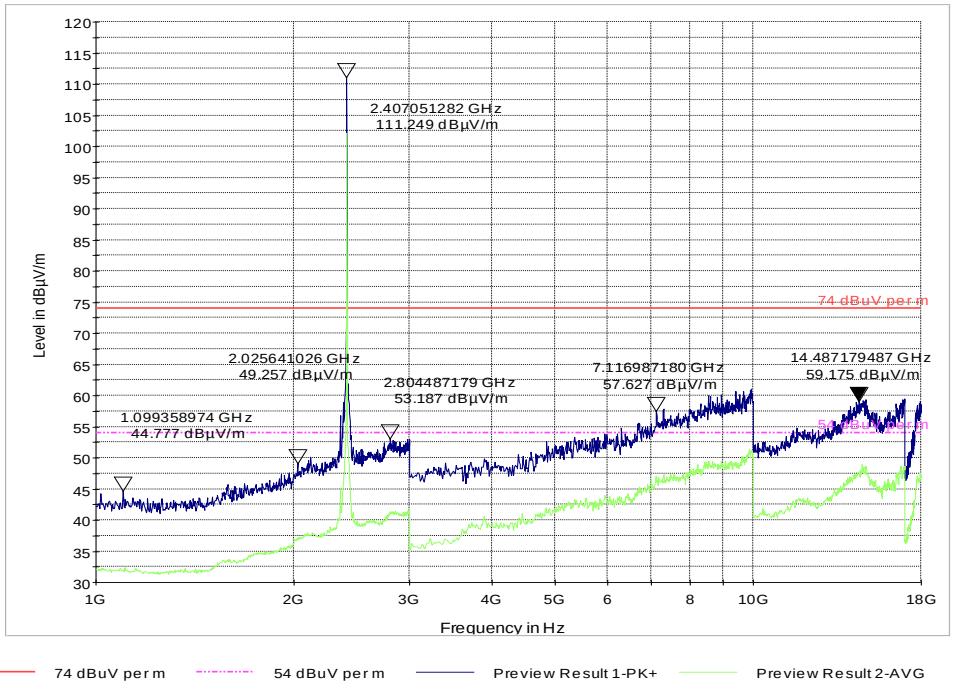
TX Radiated Spurious Emission Ch Mid- 30MHz-1GHz, 2.4 GHz OQPSK Modulation @250 KHz



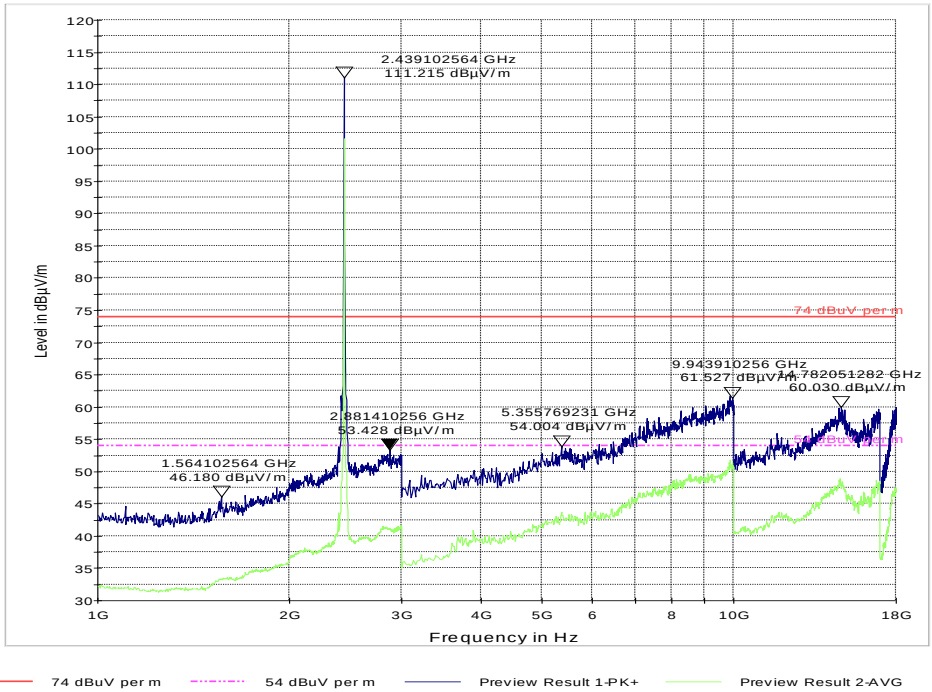
TX Radiated Spurious Emission Ch High 30MHz-1GHz, 2.4 GHz OQPSK Modulation @250 KHz



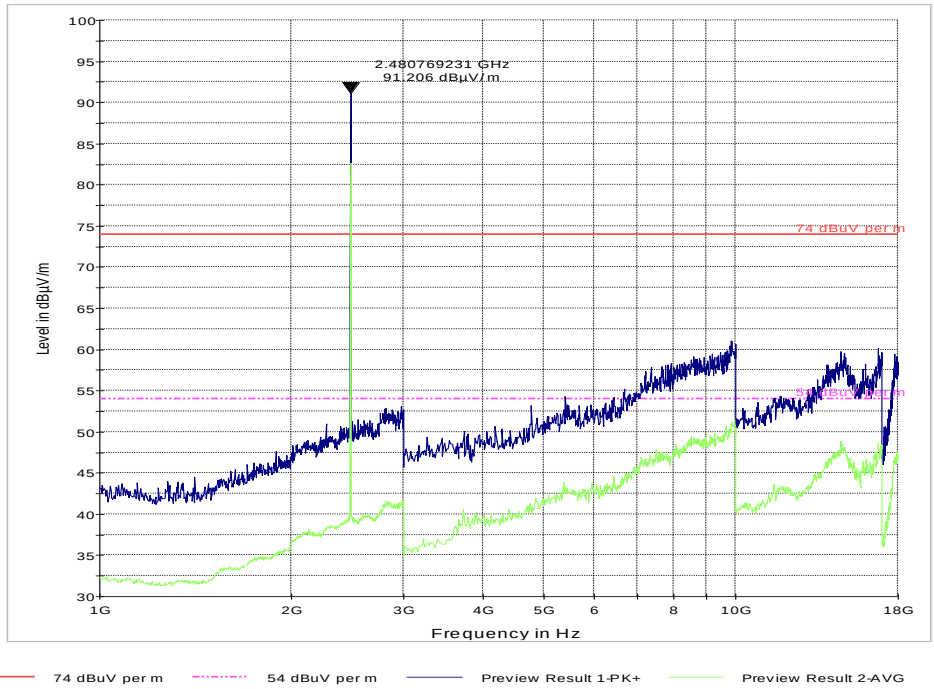
TX Radiated Spurious Emission Ch Low- 1GHz-18 GHz, 2.4 GHz OQPSK Modulation @250 KHz



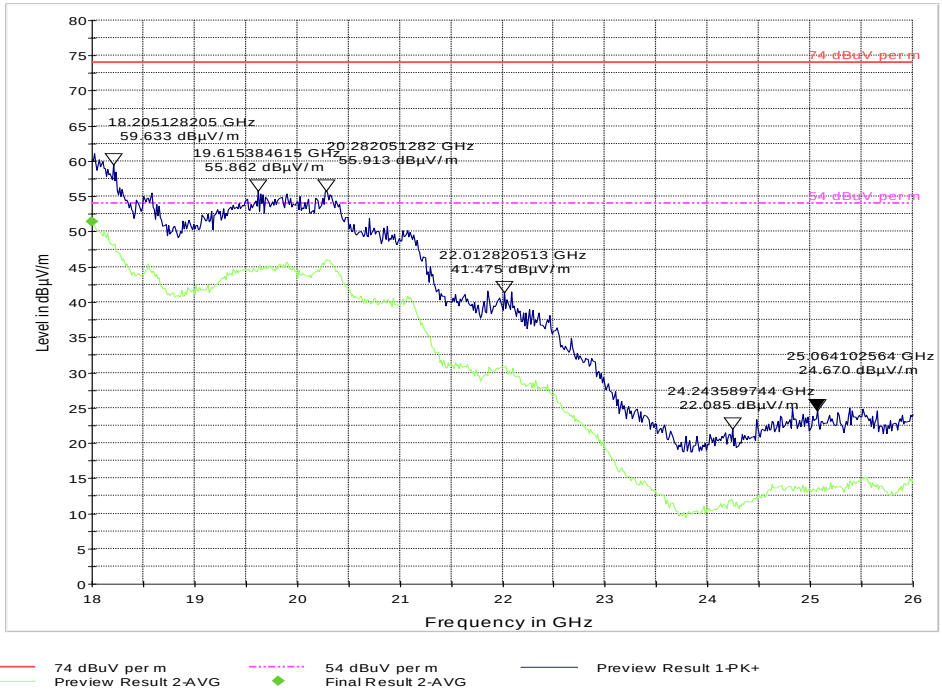
TX Radiated Spurious Emission Ch Mid- 1GHz-18 GHz, 2.4 GHz OQPSK Modulation @250 KHz



TX Radiated Spurious Emission Ch High-1GHz-18 GHz, 2.4 GHz OQPSK Modulation @250 KHz



TX Radiated Spurious Emission Ch Mid 18GHz-26GHz, 2.4 GHz OQPSK Modulation @250 KHz



NOTE: Worst case representation for all modes of operation in this range of test.

8 Receiver Spurious Emissions- Radiated

8.1 Limits & Requirements

FCC 15.109 & RSS-Gen 6.1 - Unintentional Radiators

(a) Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of emission (MHz)	Field strength (µV/m)
30–88	100
88–216	150
216–960	200
Above 960	500

(b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the following:

Frequency of emission (MHz)	Field strength (µV/m)
30–88	90
88–216	150
216–960	210
Above 960	300

8.4 Test Conditions

Tnom: 20°C; Vnom: 4.0Vdc
Hopping Function Disable

8.5 Measurement Procedure

Refer to section 6

8.6 Measurements Verdict

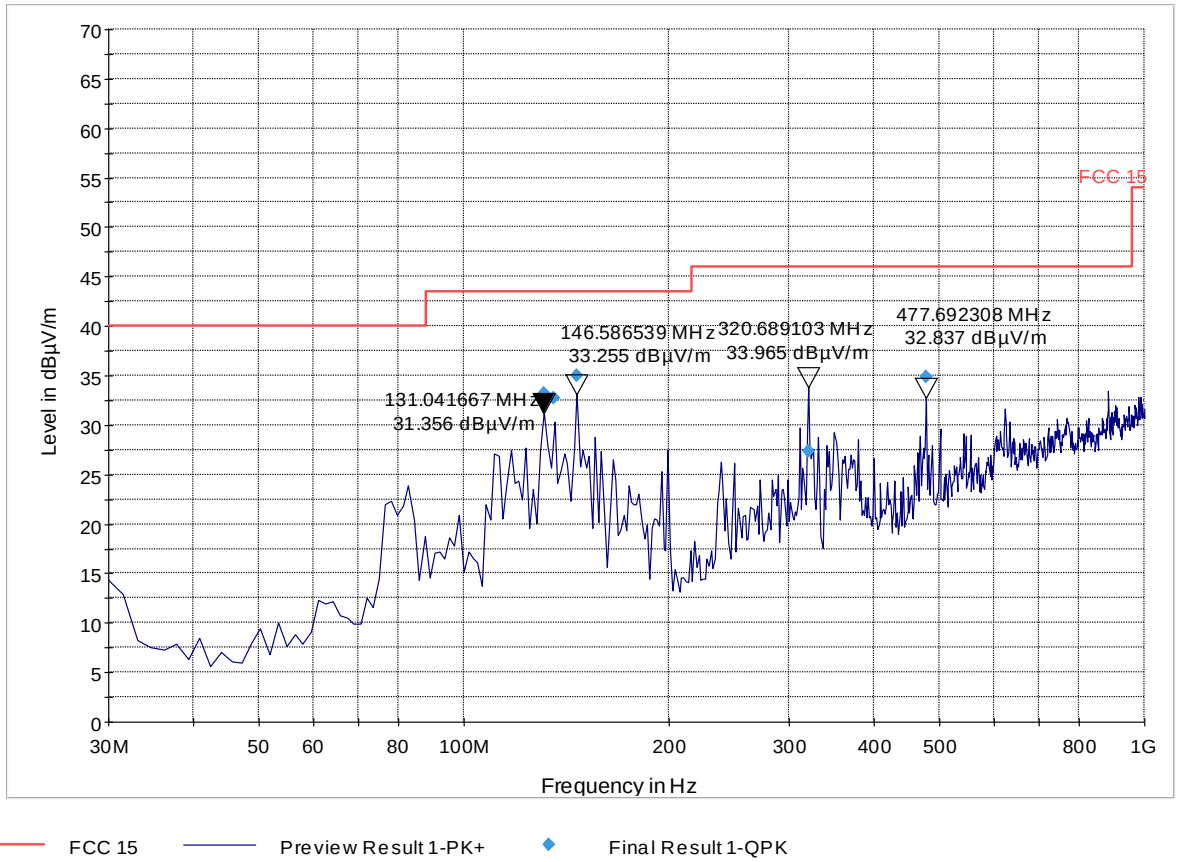
Passed

8.7 Test Data

Frequency (MHz)	Peak (dBuV/m)	Quasi-Peak (dBµV/m)	Bandwidth (kHz)	Height (cm)	Antenna Polarity	Azimuth (deg)	Corr. (dB)	Limit (dBµV/m)	Margin (dB)
130.905129	31.4	33.2	120.000	124.0	H	242.0	8.5	43.5	10.3 Qp
135.653205	30.2	32.7	120.000	124.0	H	256.0	8.9	43.5	10.8 Qp
146.496154	33.3	35.0	120.000	124.0	H	262.0	9.5	43.5	8.5 Qp
320.129488	33.8	27.3	120.000	101.0	H	1.0	15.6	46.0	18.7 Qp
477.490385	32.8	34.9	120.000	101.0	H	308.0	20.6	46.0	11.2 Qp
623.814487	31.6	----	120.000	101.0	V	332.0	23.5	46.0	14.4 Pk

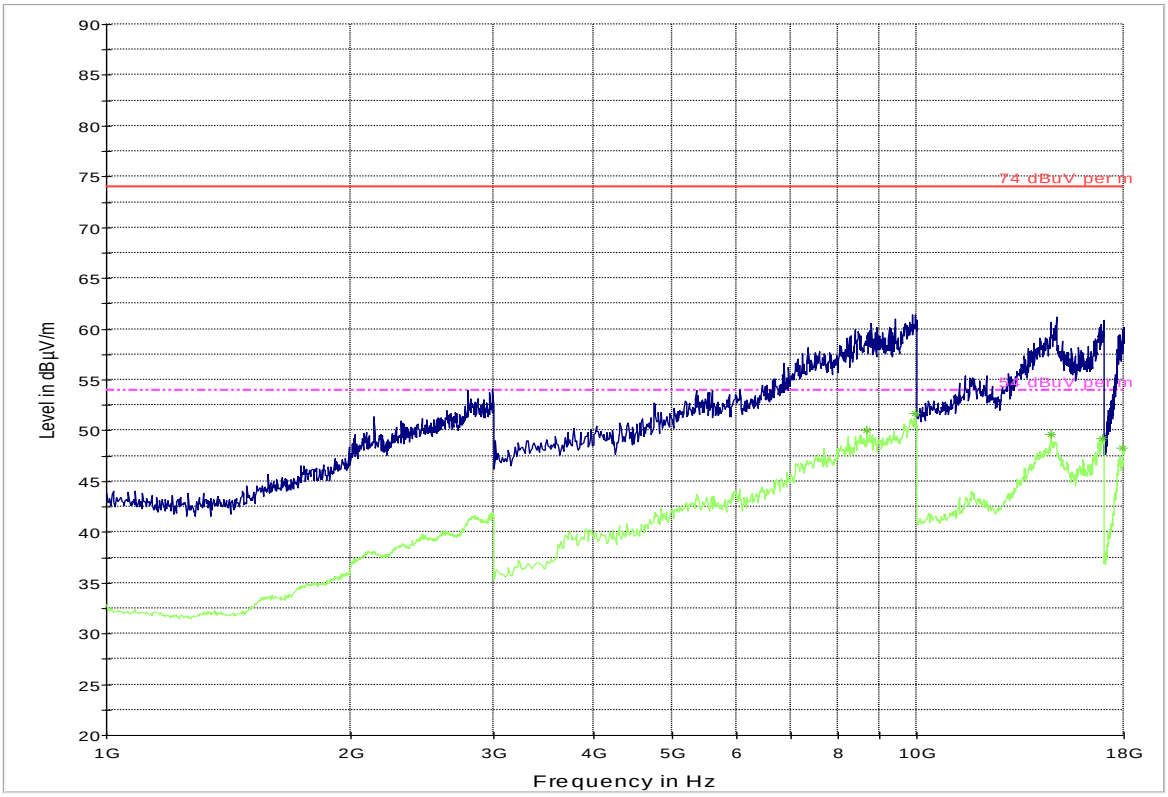
8.8 Measurement Plots

RX Radiated Emissions: 30M- 1GHz



NOTE: Diamond symbols represent quasi-peak readings, triangle symbols represent peak readings.

RX Radiated Emissions: 1GHz – 18 GHz

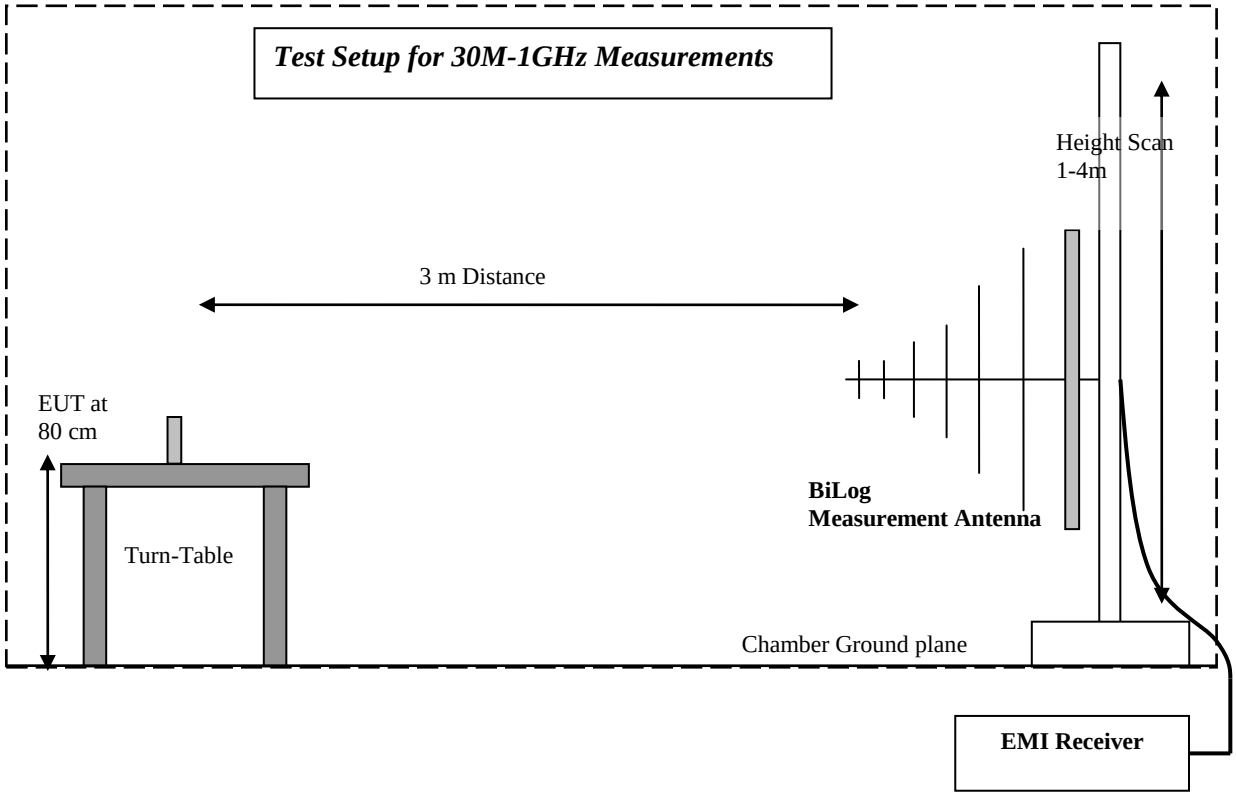


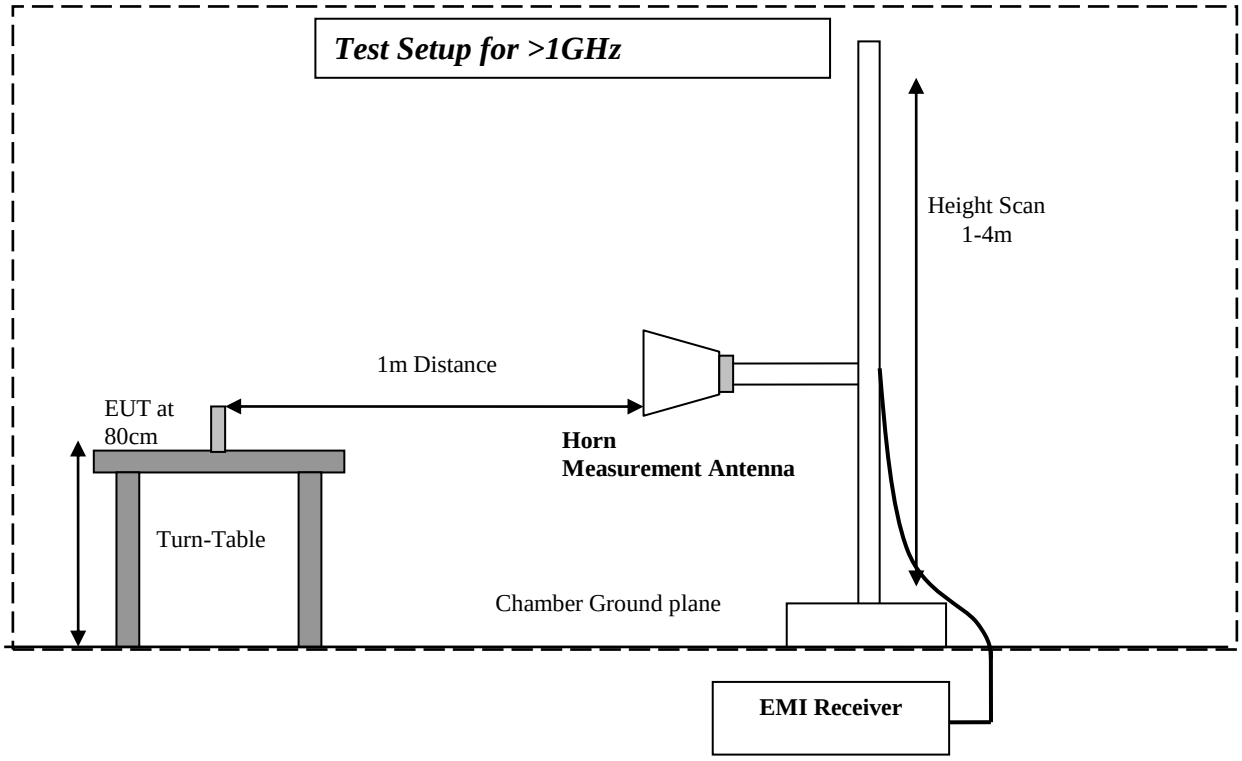
9 Test Equipment and Ancillaries used for tests

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
3m Semi- Anechoic Chamber:						
	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	1 Year
	Spectrum Analyzer	Rohde&Schwarz	FSU	200302	Jun 2013	2 Years
	Notch Filter	Wainwright Instrument	WRCT700/100-0.2	013	N/A	N/A
	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
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

Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels.
Calibration due dates, unless defined specifically, falls on the last day of the month.
tems indicated “N/A” for cal status either do not specifically require calibration or is internally characterized before use.

10 Test Setup Diagrams:





11 Revision History

Date	Report Name	Changes to report	Report prepared by
3/12/2014	1st revision		Danh Le