SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd.

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1 Cover Page

RF TEST REPORT

Application No.:	SHEM1402000360RF
Applicant:	Nocs AB
FCC ID:	A48-NS2N
Equipment Under Test (EUT): **NOTE:** The following sample(s) submitted was/were identified on behalf of the client as	
Product Name:	NS2 Air Monitors
Model No.(EUT):	NS2V2
Standards:	FCC PART 15 Subpart C: 2013
Date of Receipt:	February 21, 2014
Date of Test:	February 25, 2014 to March 03, 2014
Date of Issue:	March 04, 2014
Test Result:	**Pass***

* In the configuration tested, the EUT (Equipment under test) complied with the standards specified above.

Tony Wu

E&E Section Manager

SGS-CSTC (Shanghai) Co., Ltd.

The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards.

The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government. All test results in this report can be traceable to National or International Standards.

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2 Version

Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
00	/	March 04, 2014	/	Original

Authorized for issue by:				
Engineer		Eddy Zong **Print Name**		Eddy Zong
Clerk		Susie Liu **Print Name**		Susie Liu
Reviewer		Keny Xu **Print Name**		Keny.xu

3 Test Summary

Test Item	FCC Test Requirement	Result
Antenna Requirement	FCC Part 15, Subpart C Section 15.203/15.247 (c)	PASS
AC Power Line Conducted Emission	FCC Part 15, Subpart C Section 15.207	PASS
20dB Occupied Bandwidth	FCC Part 15, Subpart C Section 15.247 (a)(1)	PASS
Conducted Peak Output Power	FCC Part 15, Subpart C Section 15.247 (b)(1)	PASS
Carrier Frequencies Separation	FCC Part 15, Subpart C Section 15.247 (a)(1)	PASS
Hopping Channel Number	FCC Part 15, Subpart C Section 15.247 (b)	PASS
Dwell Time	FCC Part 15, Subpart C Section 15.247 (a)(1)	PASS
RF Conducted Spurious Emissions and Band-edge	FCC Part 15, Subpart C Section 15.247(d)	PASS
Radiated Spurious Emissions and Band-edge	FCC Part 15, Subpart C Section 15.209&15.205	PASS

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5 General Information

5.1 Client Information

Applicant:	Nocs AB
Address of Applicant:	Frejgatan 17, 113 49 Stockholm, Sweden
Manufacturer:	Nocs AB
Address of Manufacturer:	Frejgatan 17, 113 49 Stockholm, Sweden
Factory:	Hansong (Nanjing) Technology Ltd.
Address of Factory:	8th Kangping Road, Jiangning Economy and Technology Development Zone, Nanjing, 211106, China

5.2 General Description of E.U.T.

Product Description:	Mobile product

5.3 Technical Specifications

Operation Frequency:	2402MHz~2480MHz
Bluetooth Version:	3.0+HS
Modulation Technique:	FHSS(GFSK, π/4DQPSK, 8DPSK)
Number of Channel:	79
Antenna Type	PCB Antenna
Antenna Gain	2 dBi
Power Supply:	AC100-240V 50/60Hz 1.5A
Cable Type:	About 180cm length (2 Wires)

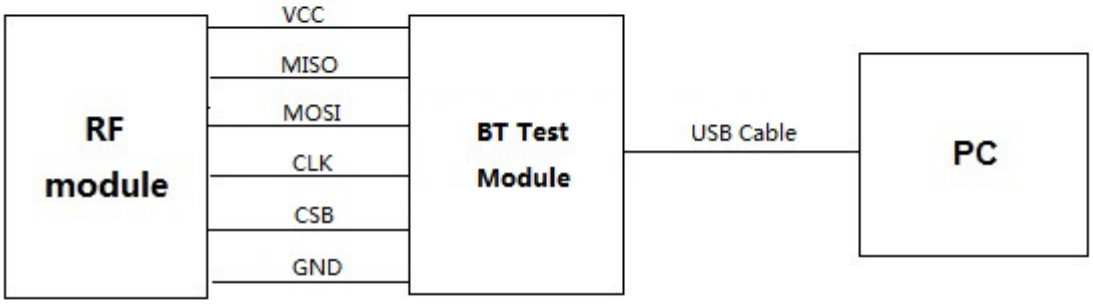
5.4 Description of Support Units

The EUT has been tested independently, or The EUT has been tested with associated equipment below.

Description	Manufacturer	Model No.	Supplied by
Laptop	Lenovo	ThinkPad X100e	SGS

Software name	Manufacturer	Supplied By
Blue Test3 (For CSR)	N/A	SGS

Description of connection:



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5.5 Test Mode

Test Mode	Description of Test Mode
Hopping disabled mode	Using test software to control EUT working in continuous transmitting, and select channel and modulation type.
Hopping enabled mode	Using test software to control EUT working in transmitting, and hopping on status.

The packet type used for the final test:

Test Item	Packet Type									Hopping Status	
	DH1	DH3	DH5	2DH1	2DH3	2DH5	3DH1	3DH3	3DH5	Disabled	Enabled
CE	-	-	√	-	-	√	-	-	√	√	√
20dB OBW	-	-	√	-	-	√	-	-	√	√	-
Peak Power	-	-	√	-	-	√	-	-	√	√	-
CFS	-	-	√	-	-	√	-	-	√	-	√
HCN	-	-	√	-	-	√	-	-	√	-	√
Dwell Time	√	√	√	√	√	√	√	√	√	-	√
CSE	-	-	√	-	-	√	-	-	√	√	-
Conducted Band-edge	-	-	√	-	-	√	-	-	√	√	√
RSE & Band-edge	-	-	√	-	-	√	-	-	√	√	-
99% OBW	-	-	√	-	-	√	-	-	√	√	-

5.6 Test Channel

Using test software was control EUT work in continuous transmitter mode. And select test channel as below:

Channel	Frequency (MHz)
Low Channel	2402
Middle Channel	2441
High Channel	2480

5.7 Test Location

All tests were performed at:

SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd.
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5.8 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **CNAS (No. CNAS L0599)**
  CNAS has accredited SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing. Date of expiry: 2014-07-26.

- **FCC – Registration No.: 402683**
  SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been registered and fully described in a report filed with the Federal Communications Commission (FCC). The acceptance letter from the FCC is maintained in our files. Registration No.: 402683, Expiry Date: 2015-02-22.

- **Industry Canada (IC) – IC Assigned Code: 8617A**
  The 3m Semi-anechoic chamber of SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 8617A-1. Expiry Date: 2017-06-18.

- **VCCI (Member No.: 3061)**
  The 3m Semi-anechoic chamber and Shielded Room of SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: R-3868 and C-4336 respectively. Date of Registration: 2012-05-29. Date of Expiry: 2015-05-28.

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5.9 Measurement Uncertainty

No.	Parameter	Measurement Uncertainty
1	Radio Frequency	< ±1 x 10^{-5}
2	Total RF power, conducted	< ±1.5 dB
3	RF power density, conducted	< ±3 dB
4	Spurious emissions, conducted	< ±3 dB
5	All emissions, radiated	< ±6 dB (30MHz – 1GHz) < ±6 dB (above 1GHz)
6	Temperature	< ±1°C
7	Humidity	< ±5 %
8	DC and low frequency voltages	< ±3 %

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6 Equipments Used during Test

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due date
1	Power meter	Rohde & Schwarz	NRP	101641	2014-02-14	2015-02-13
2	Power Sensor	Rohde & Schwarz	NRP-Z22	1137.7506.02	2013-11-21	2014-11-20
3	Spectrum Analyzer	Rohde & Schwarz	FSP-30	2705121009	2014-02-14	2015-02-13
4	EMI test receiver	Rohde & Schwarz	ESU40	100109	2014-02-14	2015-02-13
5	Horn Antenna (1GHz to 18GHz)	SCHWARZBECK	BBHA9120D	9120D-679	2014-02-14	2015-02-13
6	Horn Antenna (14GHz to 40GHz)	SCHWARZBECK	BBHA 9170	BBHA9170 373	2014-02-14	2015-02-13
7	ANTENNA (25MHz to 2GHz)	SCHWARZBECK	VULB9168	9168-313	2014-02-14	2015-02-13
8	Ultra broadband antenna (30MHz to3GHz)	Rohde & Schwarz	HL562	100227	2013-10-09	2014-10-08
9	Horn Antenna (1GHz to 18GHz)	Rohde & Schwarz	HF906	100284	2014-02-14	2015-02-13
10	Active Loop Antenna (9kHz to 30MHz)	Rohde & Schwarz	FMZB 1519	1519-034	2013-07-28	2014-07-27
11	High-low temperature cabinet	Suzhou Zhihe	TL-40	50110050	2013-04-13	2014-04-12
12	Tunable Notch Filter	Wainwright instruments Gmbh	WRCT800.0/ 880.0-0.2/40-5SSK	9	2013-06-02	2014-06-01
13	High pass Filter	FSCW	HP 12/2800-5AA2	19A45-02	2013-06-02	2014-06-01
14	Low noise amplifier	TESEQ	LNA6900	70133	2014-02-14	2015-02-13
15	AC power stabilizer	WOCEN	6100	51122	2013-06-02	2014-06-01
16	DC power	QJE	QJ30003SII	611145	2013-06-02	2014-06-01

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7 Test Results

7.1 E.U.T. test conditions

Test Power: AC 120V, 60Hz

Requirements: 15.31(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Operating Environment:

Temperature:	20.0 -25.0 °C
Humidity:	35-75 % RH
Atmospheric Pressure:	99.2 -102.0 kPa

Test frequencies: According to the 15.31(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and. if required. reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near top and 1 near bottom
More than 10 MHz	3	1 near top. 1 near middle and 1 near bottom

Pursuant to Part 15.31(c) For swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.

Test frequency is the lowest channel: 0 channel (2402MHz), middle channel: 39 channel (2441MHz) and highest channel: 78 channel (2480MHz) with fixed at channel.

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7.2 Frequency Hopping System Requirement

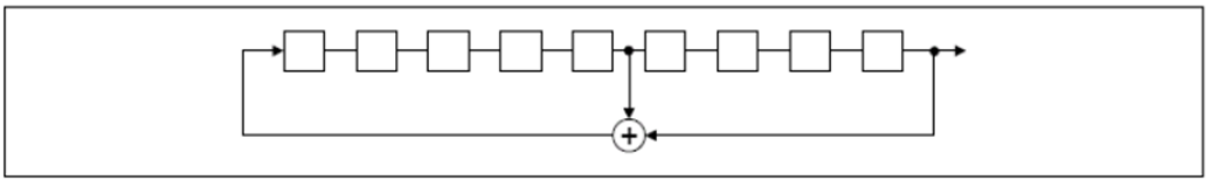
This transmitter device is frequency hopping device, and complies with Part 15.247 (g) and (h)

This device uses Bluetooth radio which operates in 2400~2483.5MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands(1MHz each; centred from 2402~2480MHz) in the range 2400~2483.5MHz. The transmitter switches hop frequencies 1600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share detail of any identified band channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

This device was tested with an Bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements

EUT Pseudorandom Frequency Hopping Sequence
The Pseudorandom sequence may be generated in a nine-shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.
Number of shift register stages: 9
Length of pseudo-random sequence:29-1=511 bits
Longest sequence of zeros: 8(non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence

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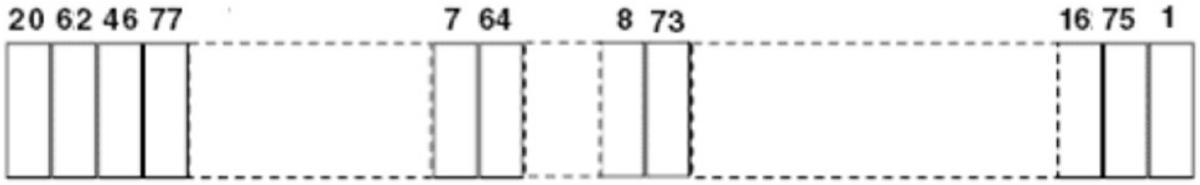

Each frequency used equally on the average by each transmitter.

The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

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7.3 Antenna Requirement

Standard requirement:

15.203 requirement:

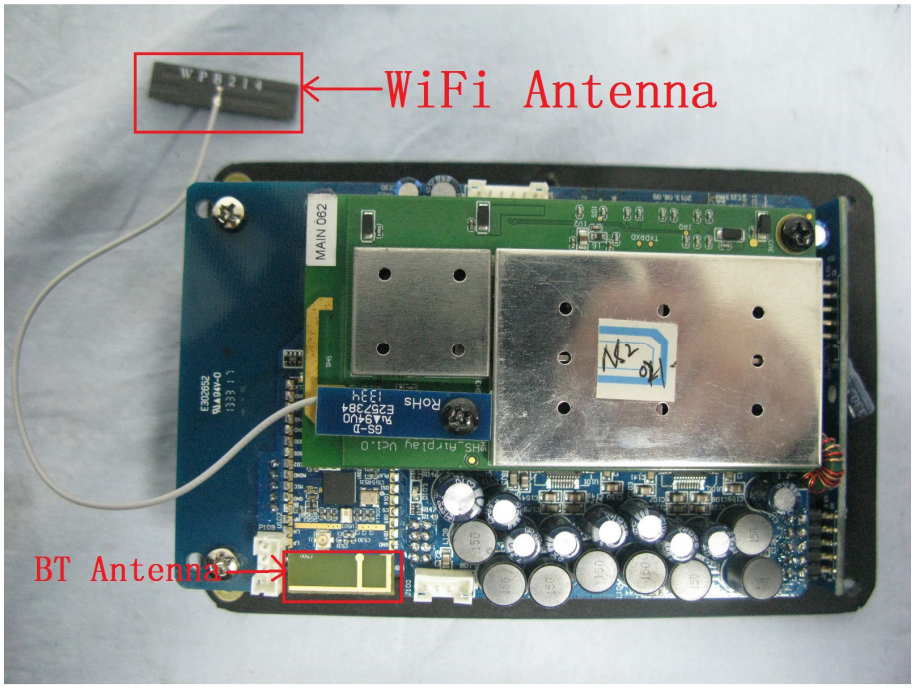
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

EUT Antenna:

The BT antenna is PCB antenna. The gain of the antenna is less than 2.0 dBi.



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7.4 Conducted Emissions on Mains Terminals

Frequency Range: 150 KHz to 30 MHz

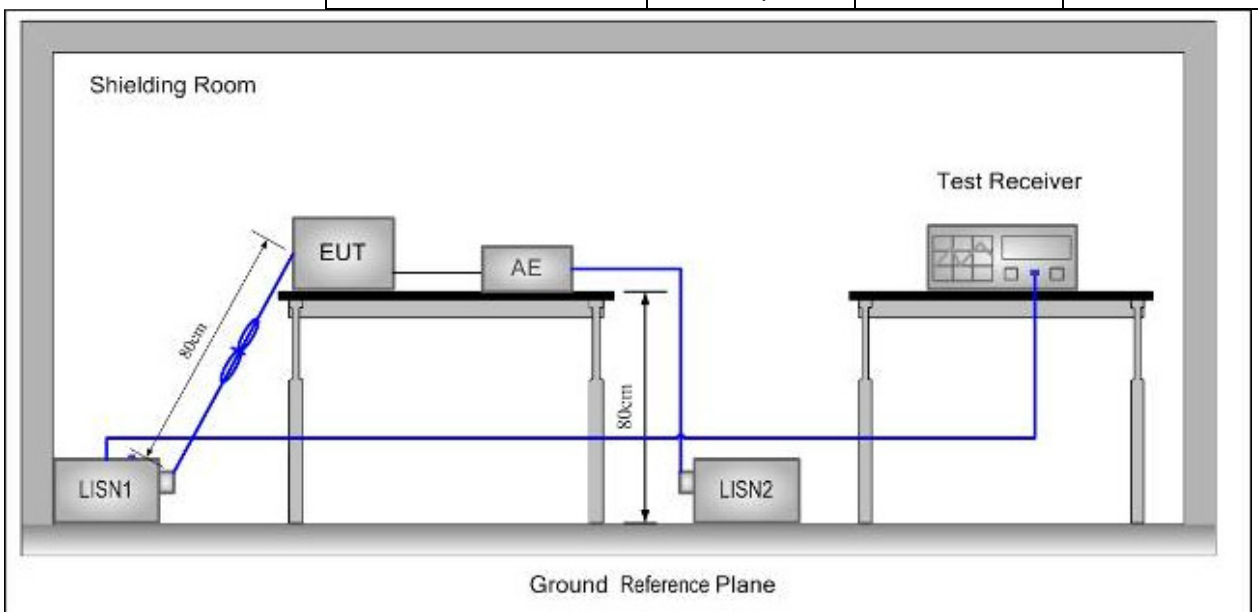
Class/Severity: Class B

Limit:

Frequency range MHz	Class B Limits: dB (μV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note1: The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50MHz. Note2: The lower limit is applicable at the transition frequency.		

Test site/setup: Test instrumentation set-up:

Frequency Range	Detector	RBW	VBW
9KHz to 150Hz	Quasi-peak	200Hz	500Hz
150KHz to 30MHz	Quasi-peak	9kHz	30kHz



Test Procedure:

1. The mains terminal disturbance voltage was measured with the EUT in a shielded room.
2. The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN, which was bonded to the ground reference plane in the same way as the LISN for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded

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3. The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane, but separated from metallic contact with the ground reference plane by 0.1m of insulation.
4. The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISN mounted on top of the ground reference plane. This distance was between the closest points of the LISN and the EUT. The mains lead of EUT excess 0.8m was folded back and forth parallel to the lead so as to form a horizontal bundle with a length between 0.3m and 0.4m. All other units of the EUT and associated equipment were at least 0.8 m from the LISN.

Remark: Pre-scan was performed with peak detected on all ports, Quasi-peak & average measurements were performed at the frequencies at which maximum peak emission level were detected. Pretest under all modes; choose the worst case mode (GFSK and Hopping enabled mode) record on the report. Please see the attached Quasi-peak and Average test results.

Test Result: Pass

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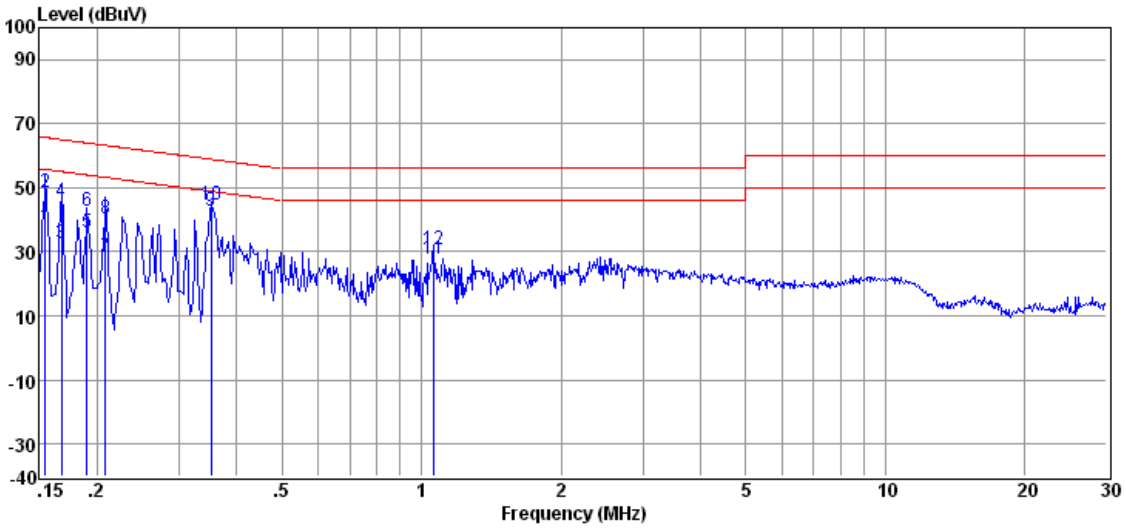
Test Data:

Test Mode: Hopping enabled mode **Test Port:** AC Live Line



Item	Freq.	Read Level	LISN Factor	Cable Loss	Level	Limit Line	Over Limit	Detector
(Mark)	(MHz)	(dBµV)	(dB)	(dB)	(dBµV)	(dBµV)	(dB)	
1	0.155	37.60	0.19	0.10	37.89	55.74	-17.85	Average
2	0.155	48.04	0.19	0.10	48.33	65.74	-17.41	QP
3	0.168	32.38	0.16	0.10	32.64	55.08	-22.44	Average
4	0.168	45.46	0.16	0.10	45.72	65.08	-19.36	QP
5	0.190	35.58	0.12	0.10	35.80	54.02	-18.22	Average
6	0.190	42.35	0.12	0.10	42.57	64.02	-21.45	QP
7	0.208	28.01	0.10	0.10	28.21	53.27	-25.06	Average
8	0.208	40.17	0.10	0.10	40.37	63.27	-22.90	QP
9	0.352	42.34	0.15	0.10	42.59	48.91	-6.32	Average
10	0.352	44.28	0.15	0.10	44.53	58.91	-14.38	QP
11	1.060	27.58	0.21	0.10	27.89	46.00	-18.11	Average
12	1.060	30.44	0.21	0.10	30.75	56.00	-25.25	QP

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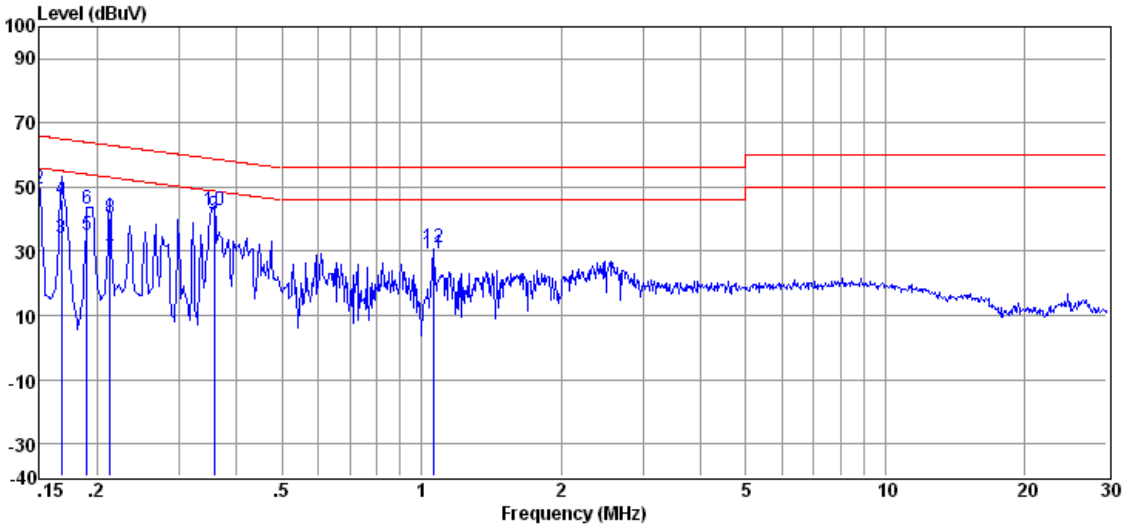
Test Mode: Hopping disabled mode **Test Port:** AC Neutral Line



Item	Freq.	Read Level	LISN Factor	Cable Loss	Level	Limit Line	Over Limit	Detector
(Mark)	(MHz)	(dBµV)	(dB)	(dB)	(dBµV)	(dBµV)	(dB)	
1	0.150	31.58	0.20	0.10	31.88	56.00	-24.12	Average
2	0.150	49.23	0.20	0.10	49.53	66.00	-16.47	QP
3	0.168	33.67	0.16	0.10	33.93	55.08	-21.15	Average
4	0.168	45.96	0.16	0.10	46.22	65.08	-18.86	QP
5	0.190	34.96	0.12	0.10	35.18	54.02	-18.84	Average
6	0.190	42.91	0.12	0.10	43.13	64.02	-20.89	QP
7	0.213	27.56	0.10	0.10	27.76	53.10	-25.34	Average
8	0.213	40.06	0.10	0.10	40.26	63.10	-22.84	QP
9	0.358	41.24	0.10	0.10	41.44	48.78	-7.34	Average
10	0.358	42.36	0.10	0.10	42.56	58.78	-16.22	QP
11	1.060	28.98	0.21	0.10	29.29	46.00	-16.71	Average
12	1.060	30.66	0.21	0.10	30.97	56.00	-25.03	QP

Remark: Level = Read Level + LISN/ISN Factor + Cable Loss.

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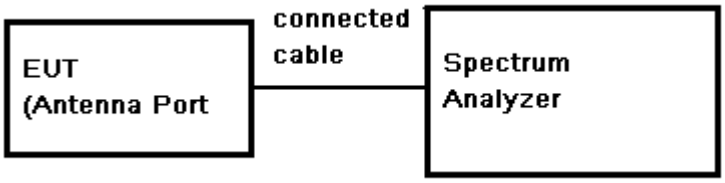
7.5 20dB Occupied Bandwidth

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: Span = approximately 2 to 3 times the 20dB bandwidth, centred on the hopping channel;
3. Set the spectrum analyzer: RBW >= 1% of the 20dB bandwidth (set 30 kHz). VBW >= RBW. Sweep = auto; Detector Function = Peak. Trace = Max Hold.
4. Mark the peak frequency and -20dB points.

Test Result: PASS

Test date:

Test Channel	Channel Frequency(MHz)	Modulation	Bandwidth(MHz)
Low	2402	GFSK	1.050
Middle	2441	GFSK	1.047
High	2480	GFSK	1.044
Low	2402	π/4DQPSK	1.068
Middle	2441	π/4DQPSK	1.164
High	2480	π/4DQPSK	1.182
Low	2402	8DPSK	1.182
Middle	2441	8DPSK	1.185
High	2480	8DPSK	1.182

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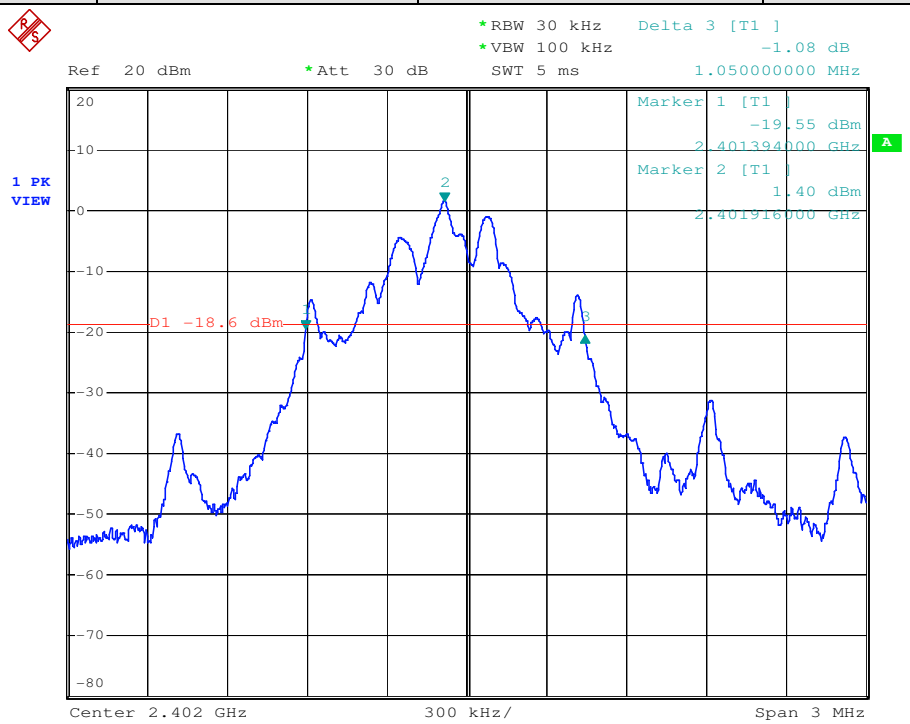
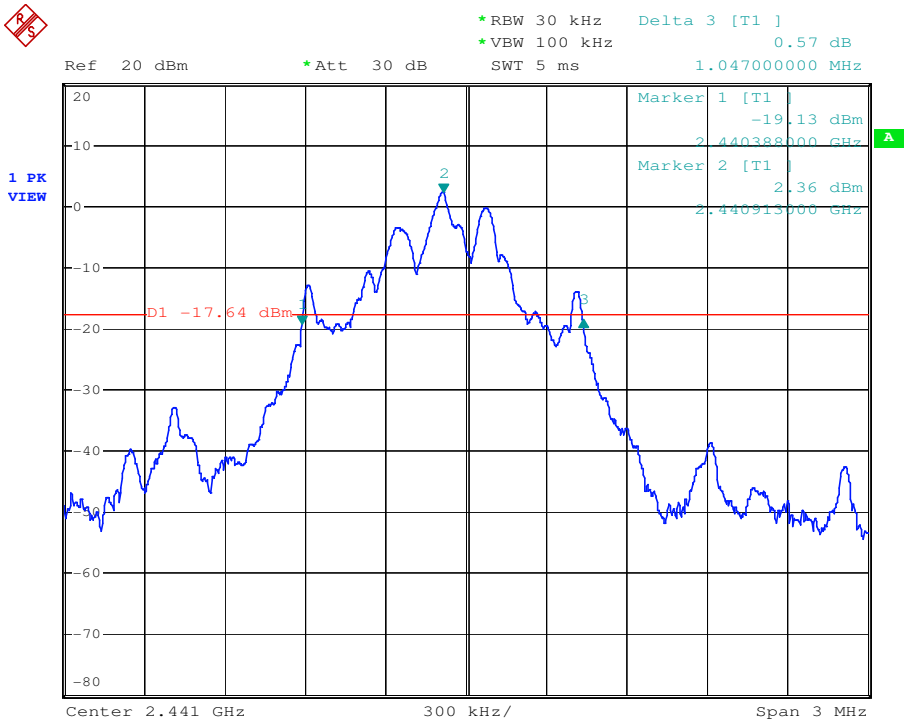
Test plot as follows:

Test mode:	GFSK	Test channel:	Lowest



Test mode:	GFSK	Test channel:	Middle



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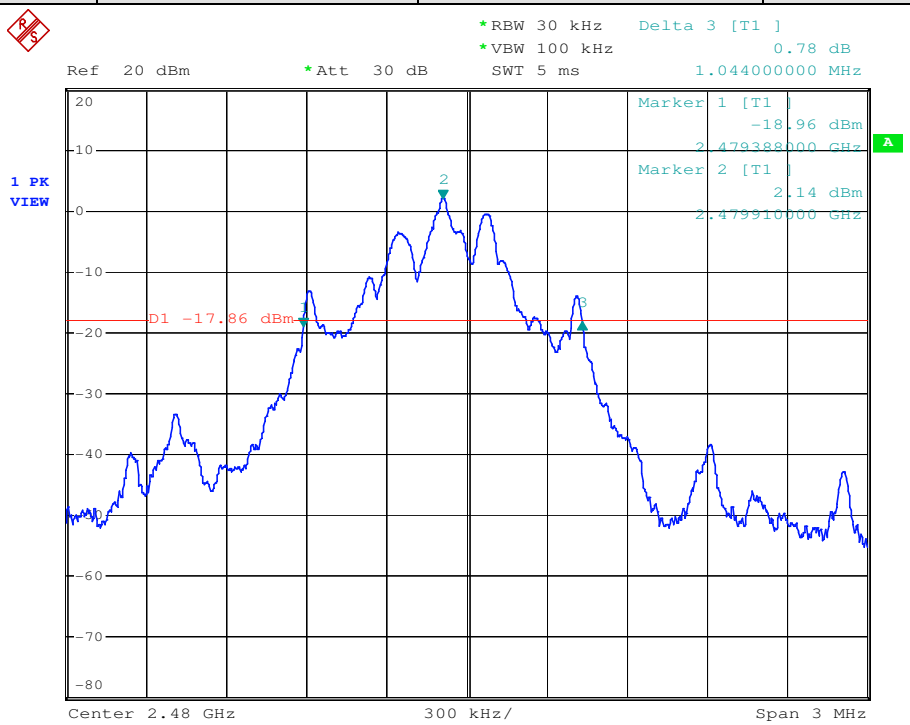
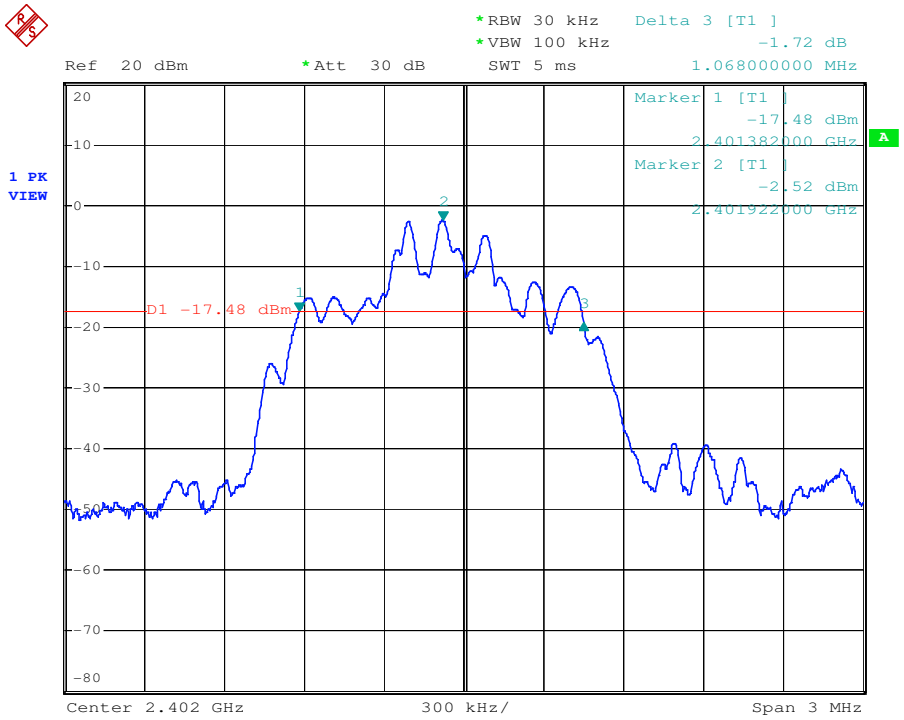
Test mode:	GFSK	Test channel:	Highest



Test mode:	π/4DQPSK	Test channel:	Lowest



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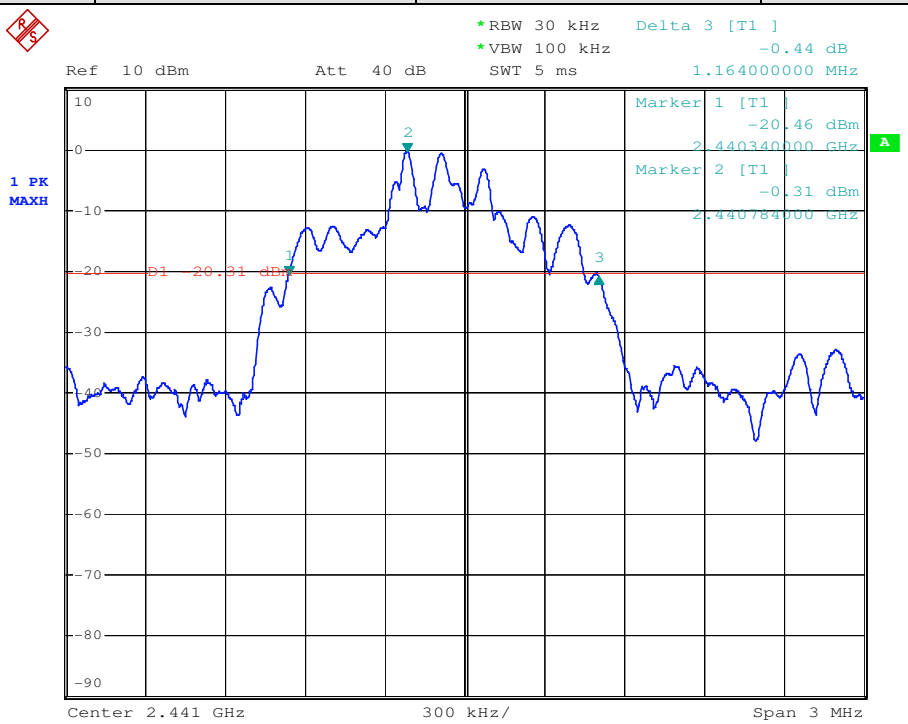
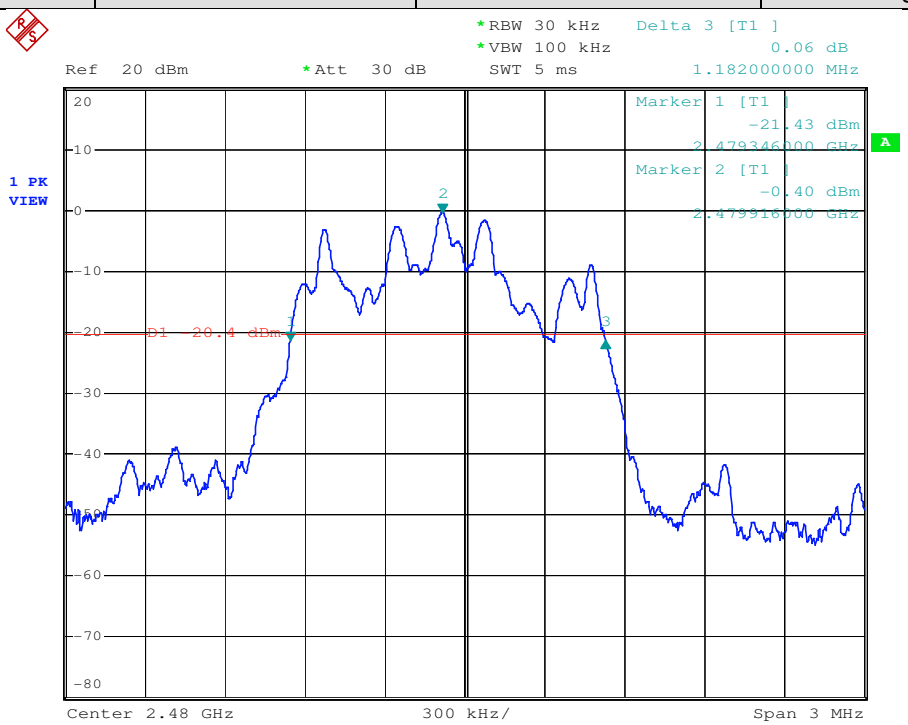
Test mode:	π/4DQPSK	Test channel:	Middle



Test mode:	π/4DQPSK	Test channel:	Highest



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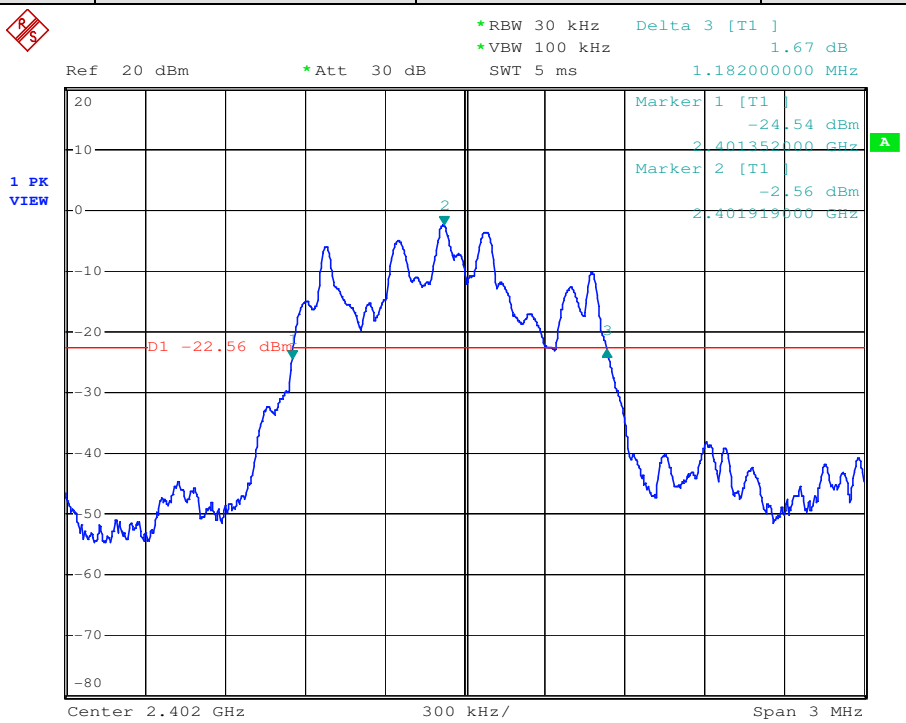
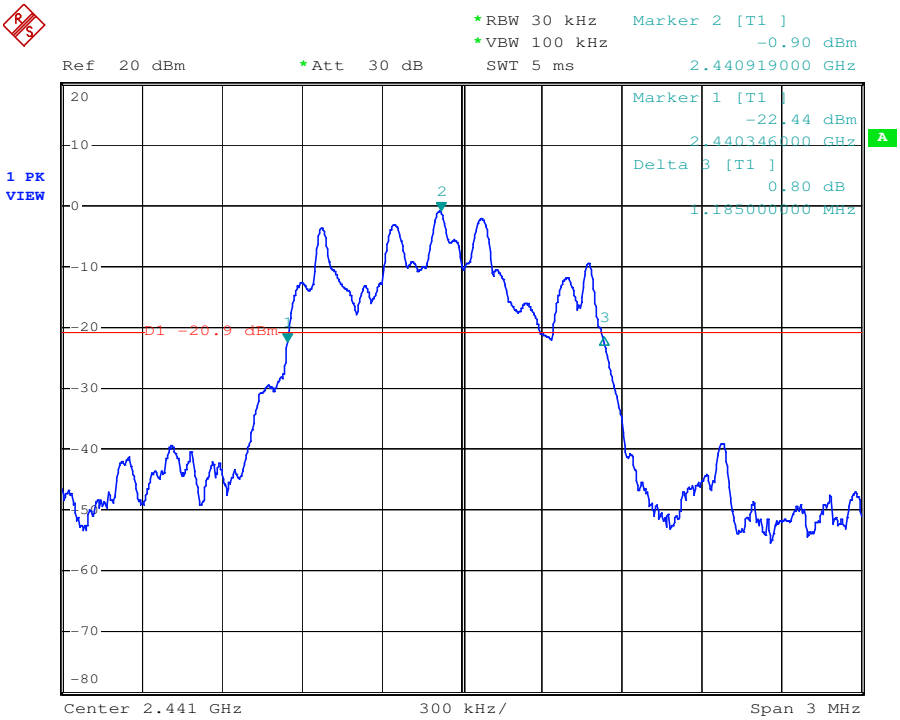
Test mode:	8DPSK	Test channel:	Lowest



Test mode:	8DPSK	Test channel:	Middle



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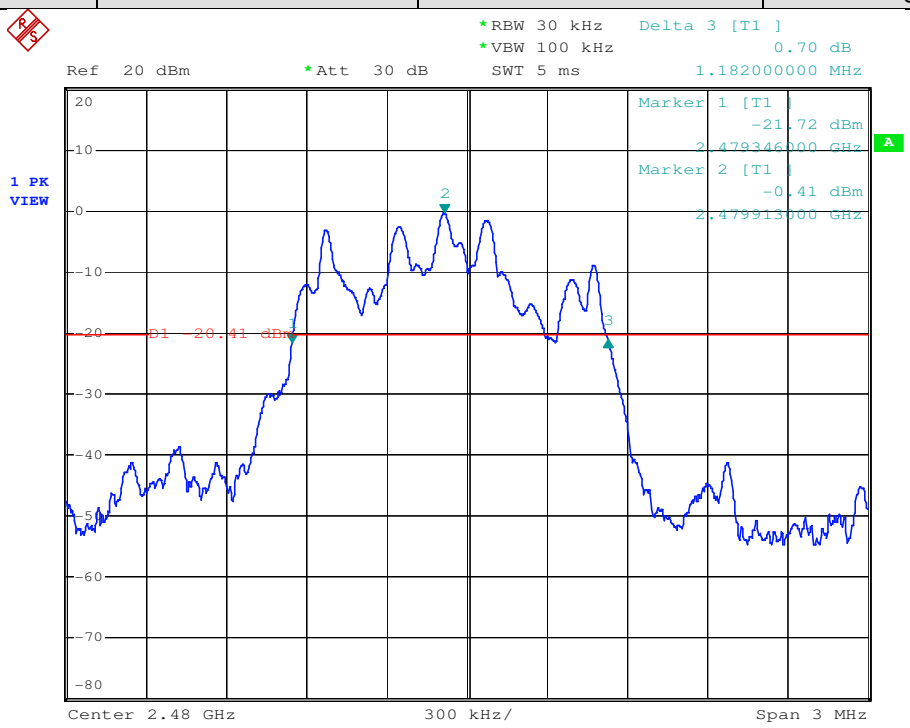
Test mode:	8DPSK	Test channel:	Highest



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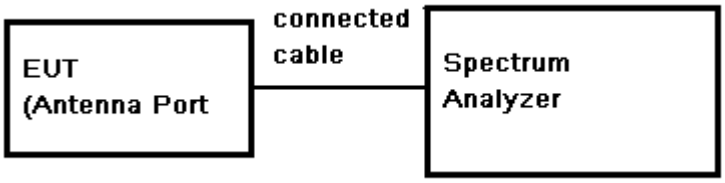
7.6 Conducted Peak Output Power

Test Limit:

Regulation 15.247 (b)(1)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.

Refer to the result "Hopping channel number" of this document. The 1 watt (30.0dBm) limit applies.

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 3 MHz, VBW = 3 MHz, Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

Test Result: Pass

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Test Data:

Modulation	Test Channel	Fundamental Frequency (MHz)	Reading Power (dBm)	Cable Loss (dB)	Output Power (dBm)	Limit (dBm)	Margin (dB)
GFSK	Lowest	2402	2.14	0.5	2.64	30	27.36
GFSK	**Middle**	**2441**	**2.55**	**0.5**	**3.05**	**30**	**26.95**
GFSK	Highest	2480	2.09	0.5	2.59	30	27.41
π/4DQPSK	Lowest	2402	0.06	0.5	0.56	30	29.44
π/4DQPSK	Middle	2441	0.60	0.5	1.10	30	28.9
π/4DQPSK	Highest	2480	-0.12	0.5	0.38	30	29.62
8DPSK	Lowest	2402	-0.24	0.5	0.26	30	29.74
8DPSK	Middle	2441	0.82	0.5	1.32	30	28.68
8DPSK	Highest	2480	0.19	0.5	0.69	30	29.31

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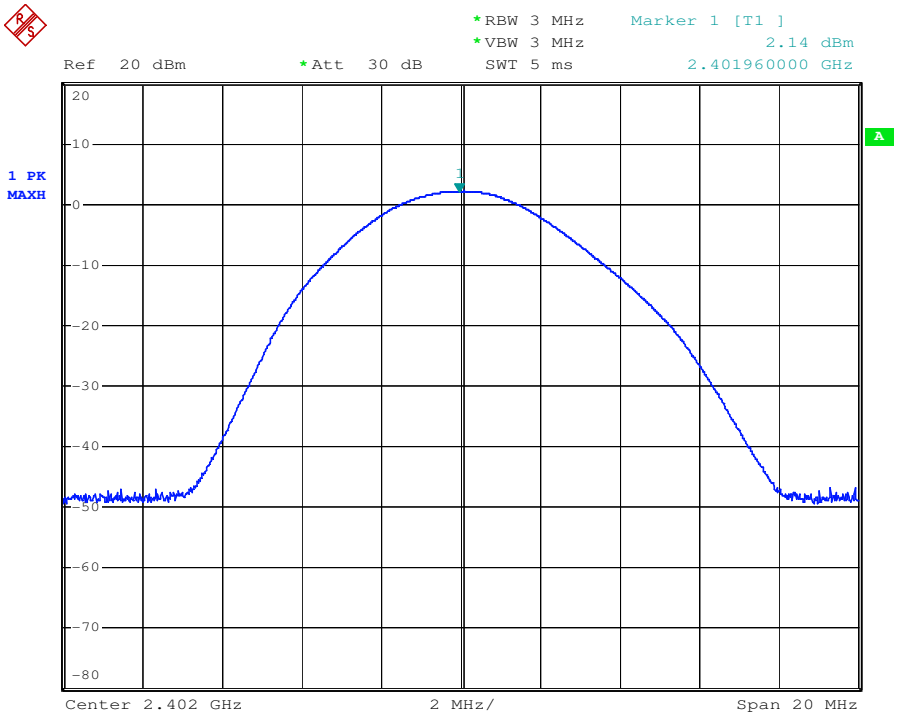
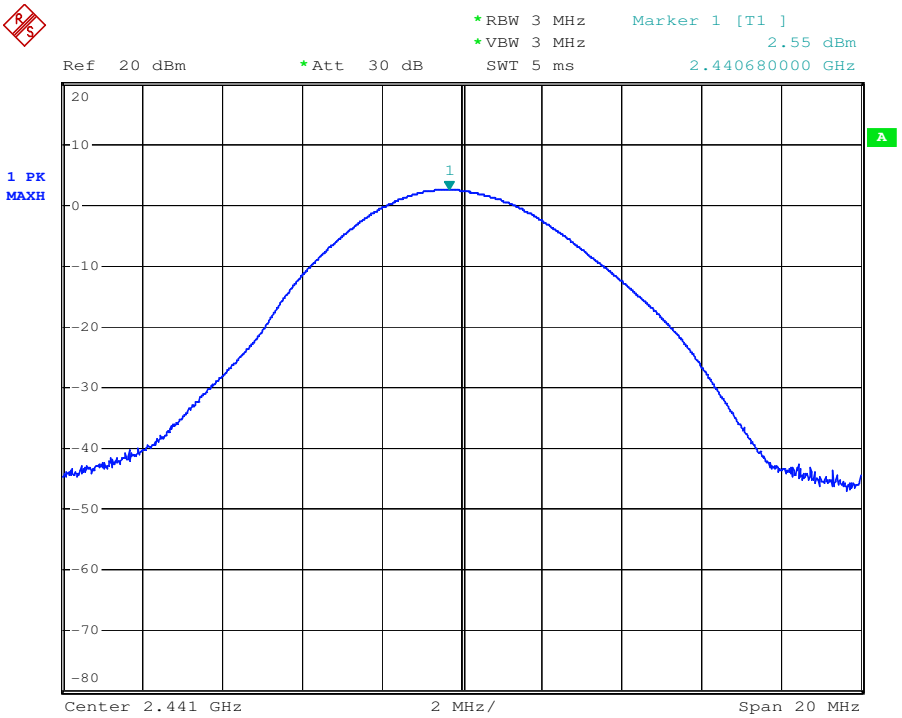
Test result plot as follows:

Test mode:	GFSK	Test channel:	Lowest



Test mode:	GFSK	Test channel:	Middle



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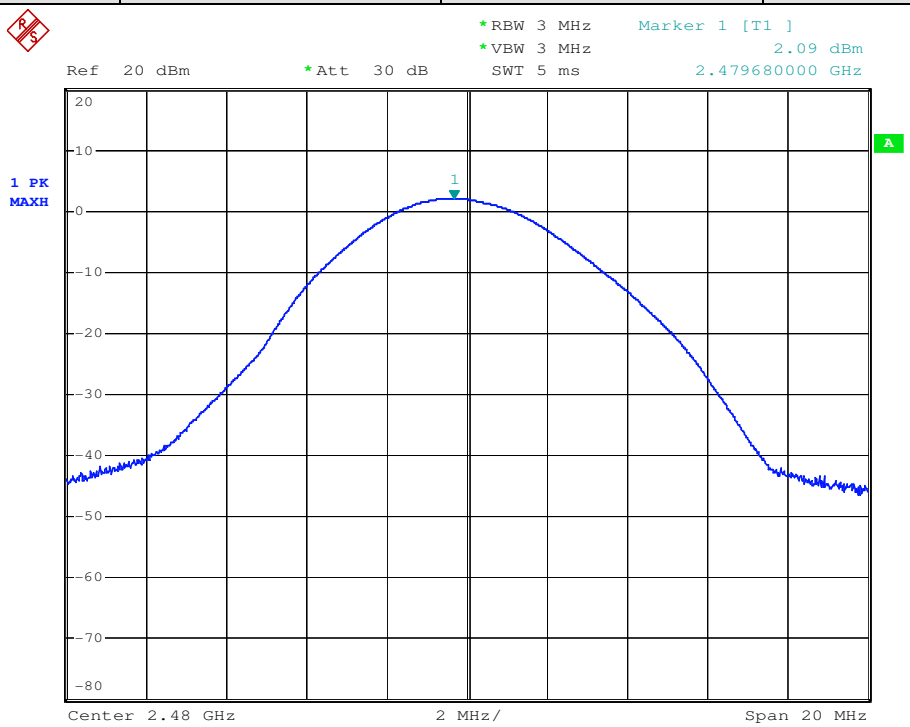
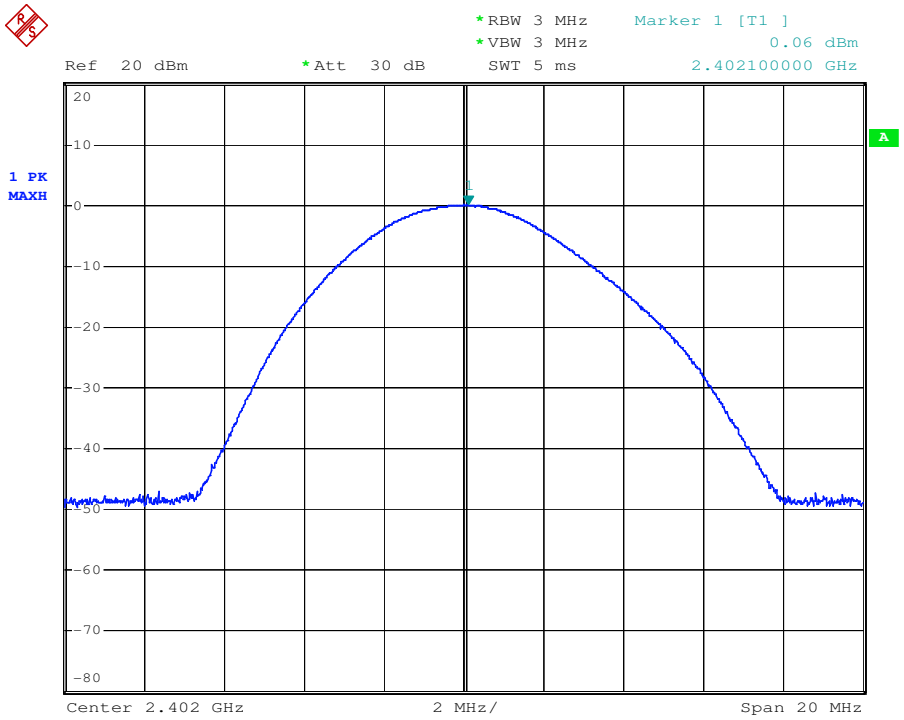
Test mode:	GFSK	Test channel:	Highest



Test mode:	π/4DQPSK	Test channel:	Lowest



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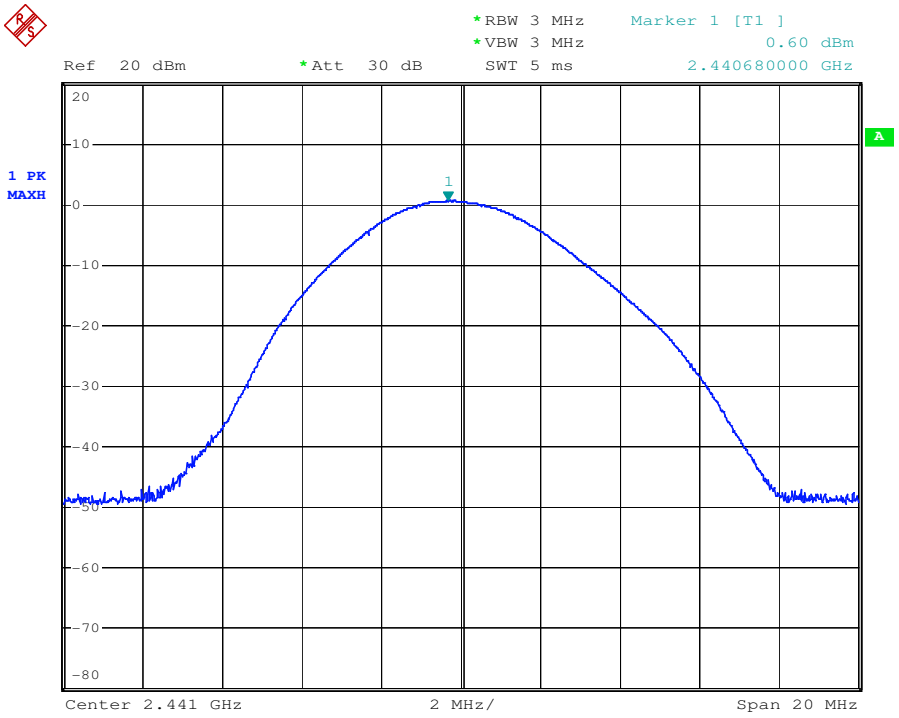
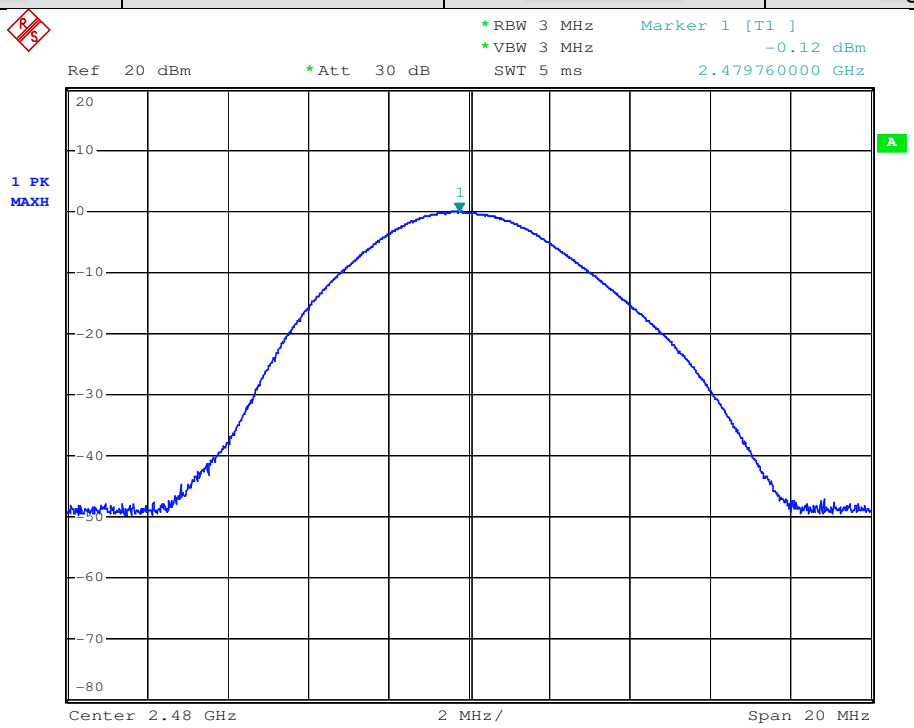
Test mode:	π/4DQPSK	Test channel:	Middle



Test mode:	π/4DQPSK	Test channel:	Highest



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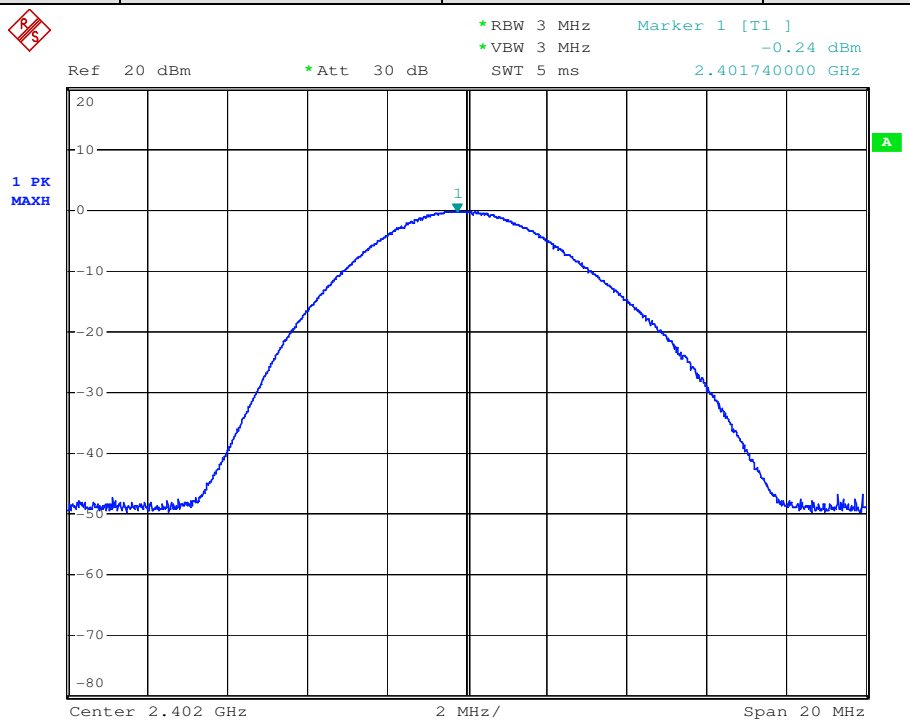
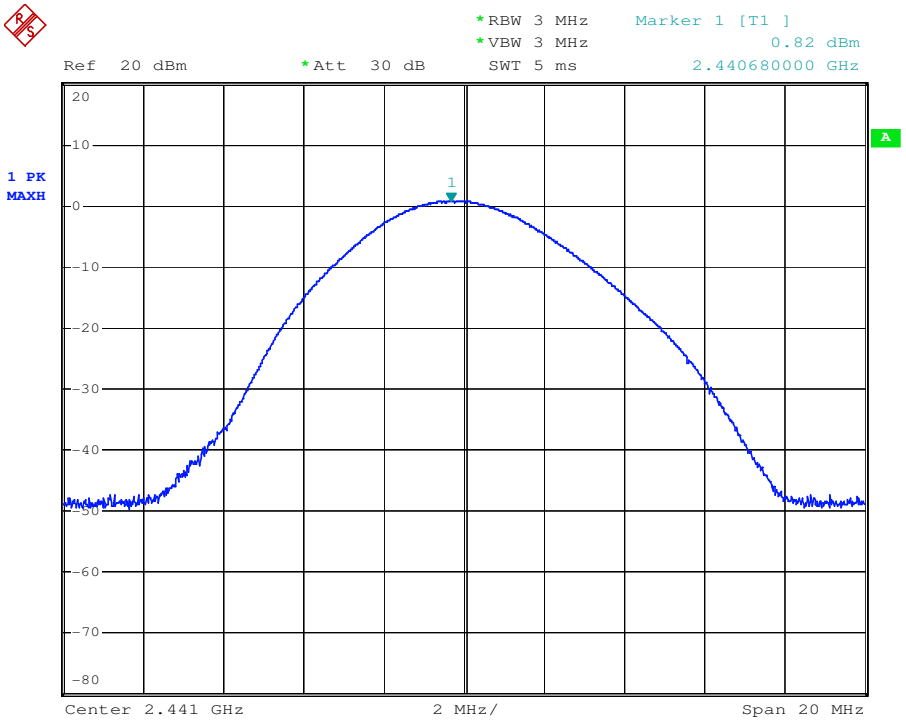
Test mode:	8DPSK	Test channel:	Lowest



Test mode:	8DPSK	Test channel:	Middle



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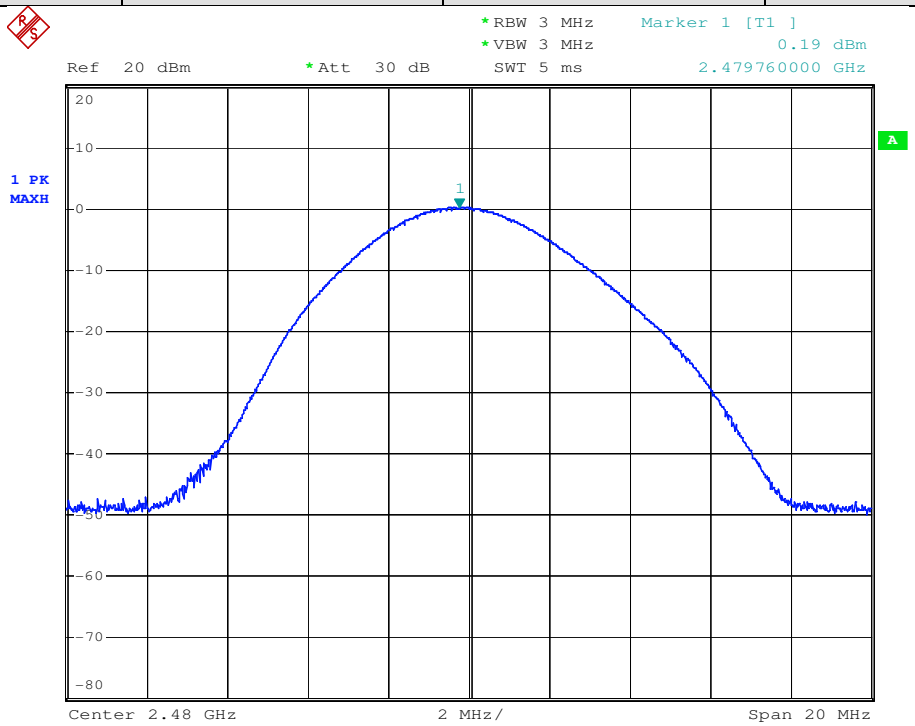
Test mode:	8DPSK	Test channel:	Highest



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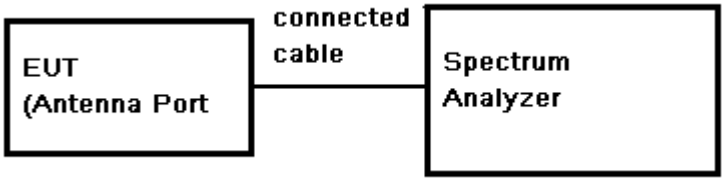
7.7 Carrier Frequencies Separated

Limit: 0.025MHz or 2/3 of the 20dB bandwidth (whichever is greater)

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW >= 1% of the span (set 30 kHz). VBW >= RBW, Span = 3MHz. Sweep = auto; Detector Function = Peak. Trace = Maxhold.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Test result: Pass

Test data:

Test Channel	Modulation	Carrier Frequencies Separated (MHz)	Limit (25kHz or two-thirds of the 20 dB bandwidth)	Results
Middle Channels (channel 39 and channel 40)	GFSK	1.002	25kHz/700kHz	PASS
Middle Channels (channel 39 and channel 40)	π/4DQPSK	1.005	25kHz/788kHz	PASS
Middle Channels (channel 39 and channel 40)	8DPSK	1.002	25kHz/790kHz	PASS

Remark: 1. According to the section 7.6, the conducted power measured is less than 125mW and 2/3 of 20dB bandwidth is used for limit.
2. 20dB bandwidth reference Section 7.5

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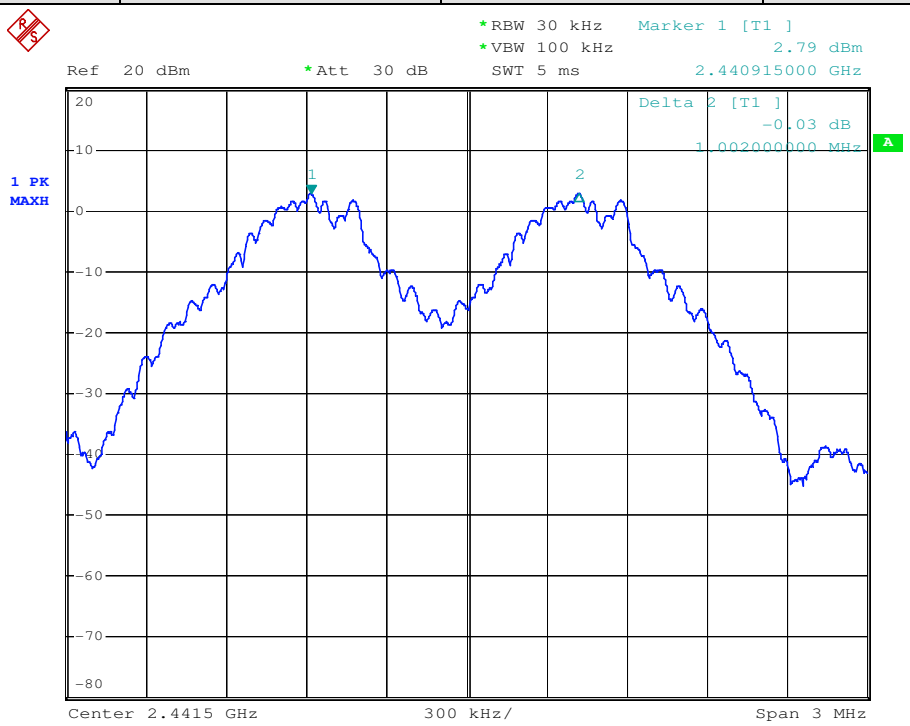
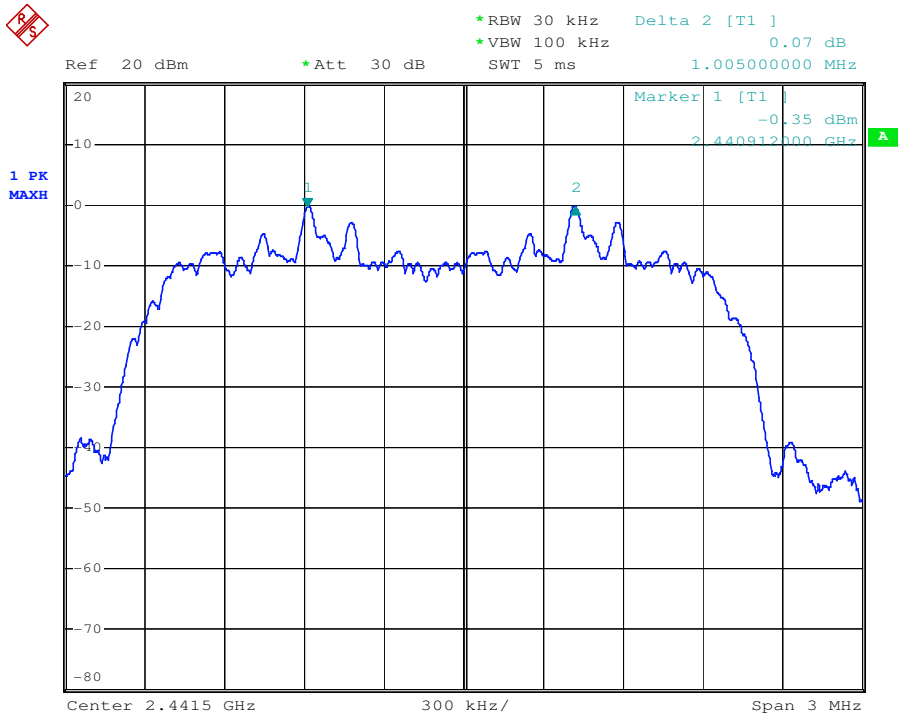
Test plot as follows:

Test mode:	GFSK	Test channel:	Middle



Test mode:	π/4DQPSK	Test channel:	Middle



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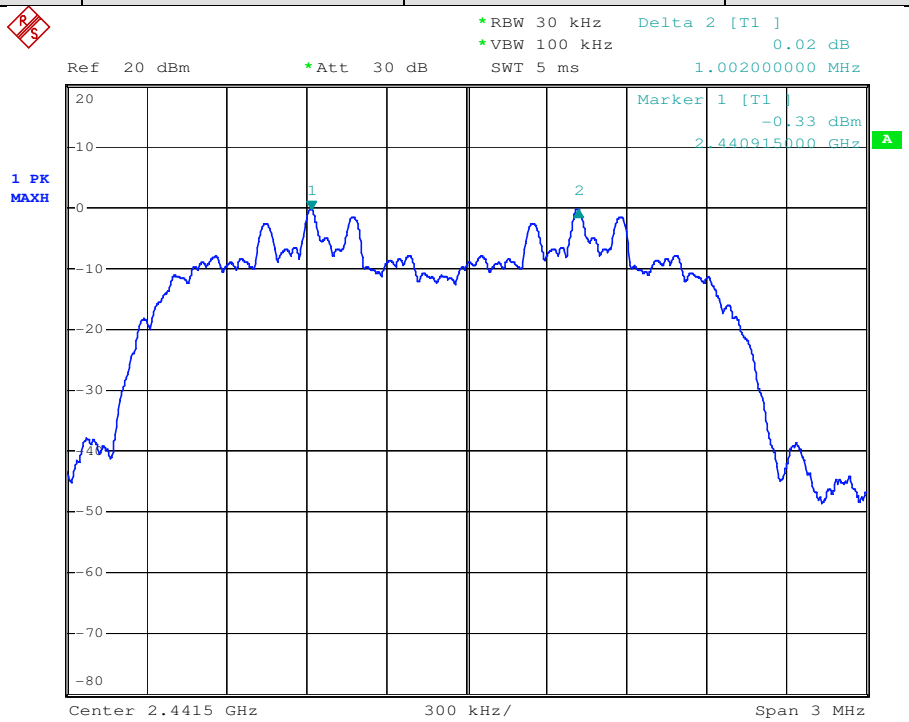
Test mode:	8DPSK	Test channel:	Middle



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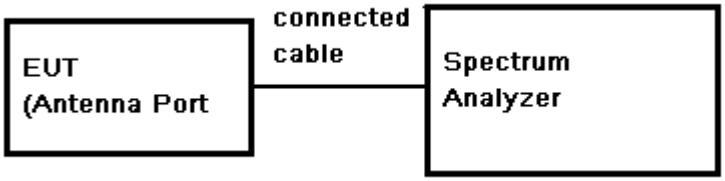
7.8 Hopping Channel Number

Limit: At least 15 channels

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100 kHz. VBW = 100 kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: start frequency = 2400MHz. stop frequency = 2483.5MHz. Submit the test result graph.

Test Result: Pass

Test Data:

Mode	Hopping channel numbers	Limit	Results
8DPSK	79	≥15	Pass
GFSK	79	≥15	Pass
π/4DQPSK	79	≥15	Pass

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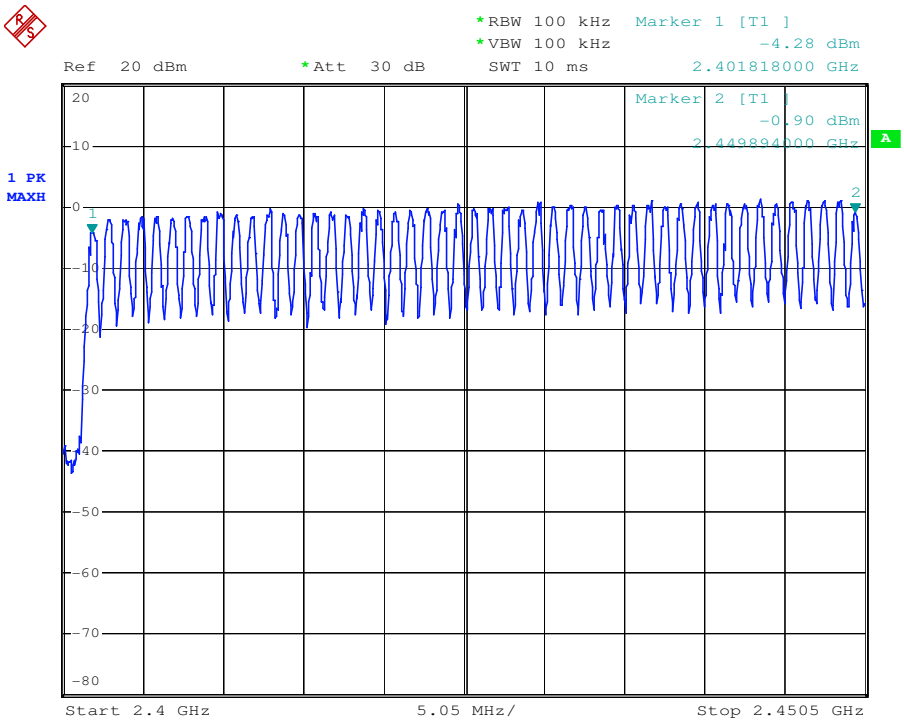
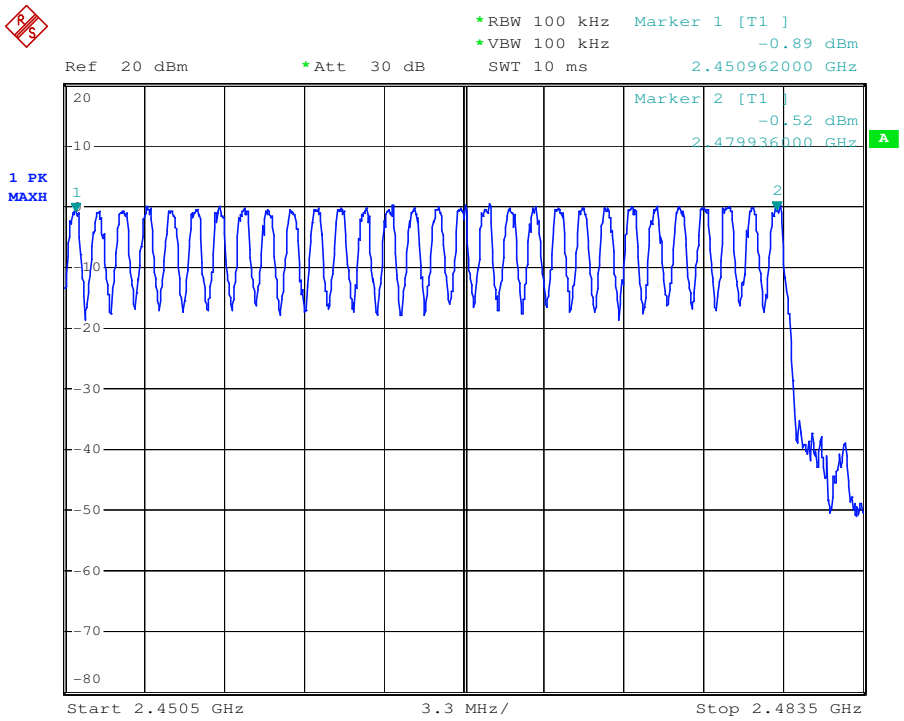
Test plot as follows:

Test mode:	GFSK	Test channel:	Middle





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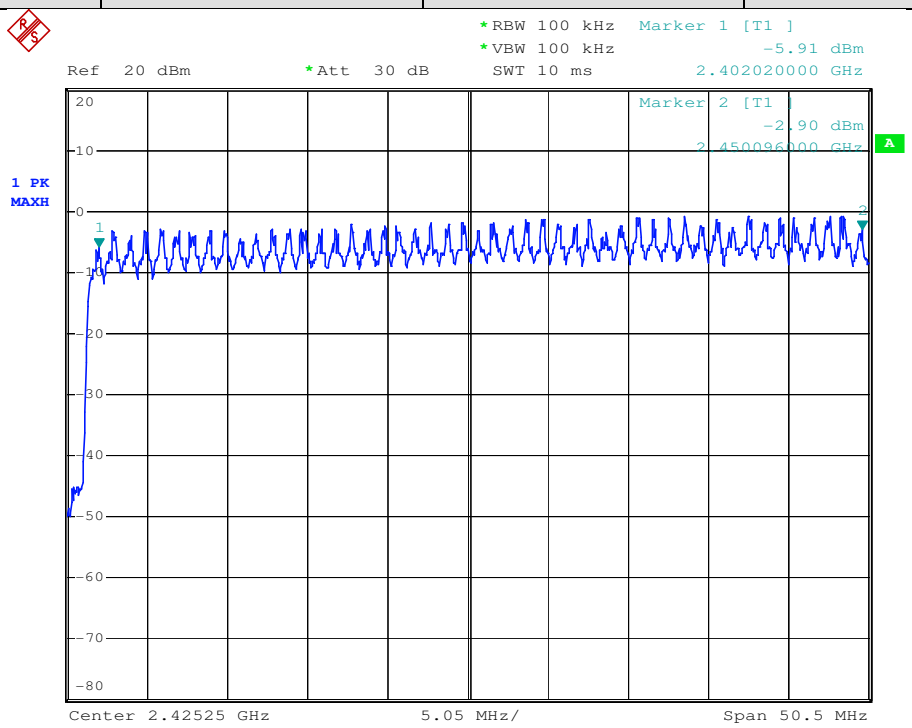
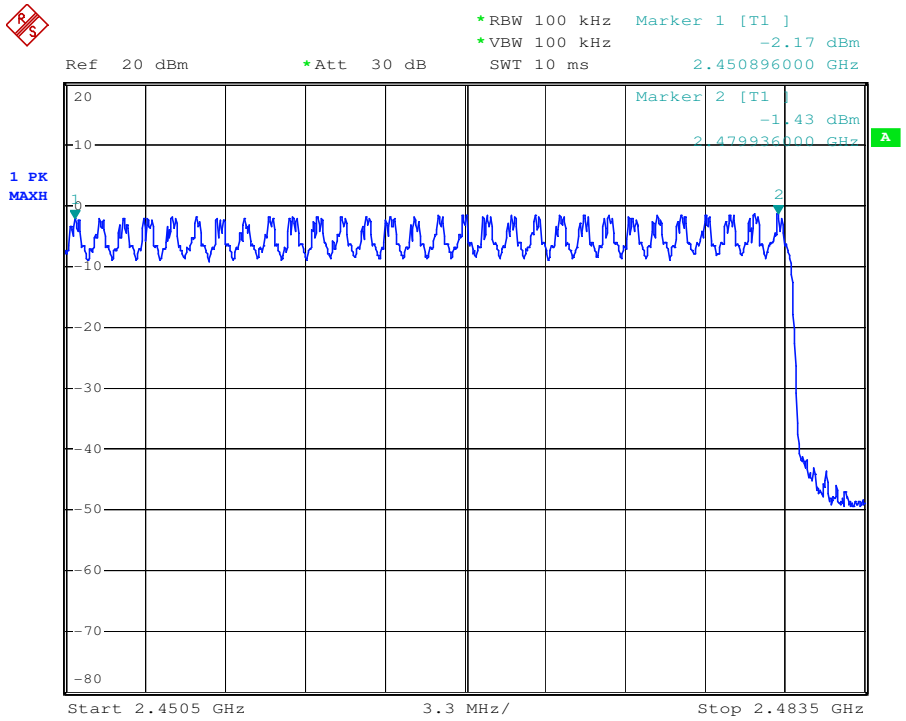
Test mode:	π/4DQPSK	Test channel:	Middle





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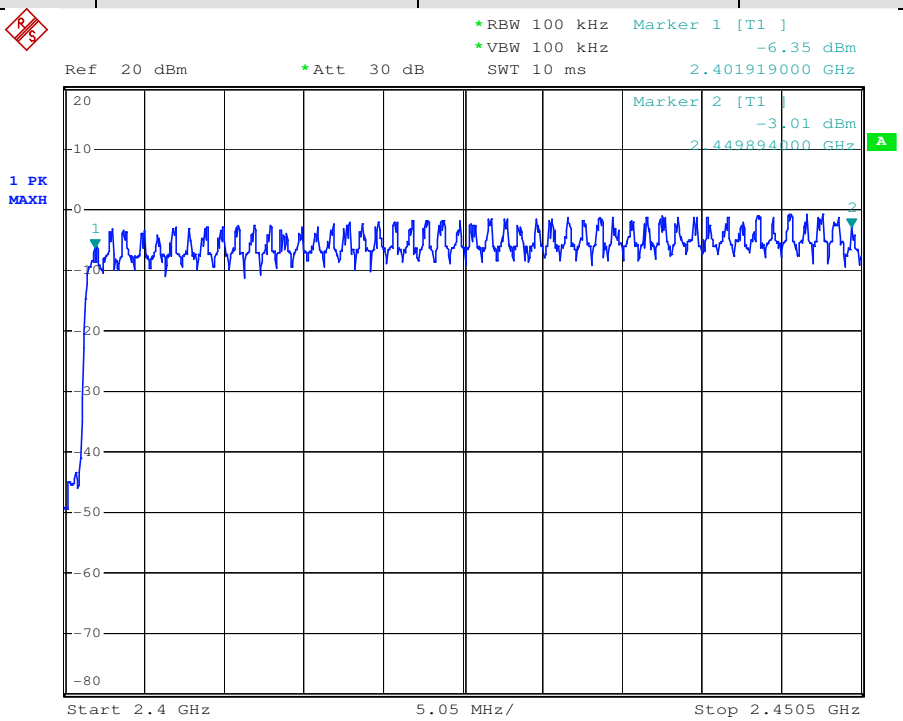
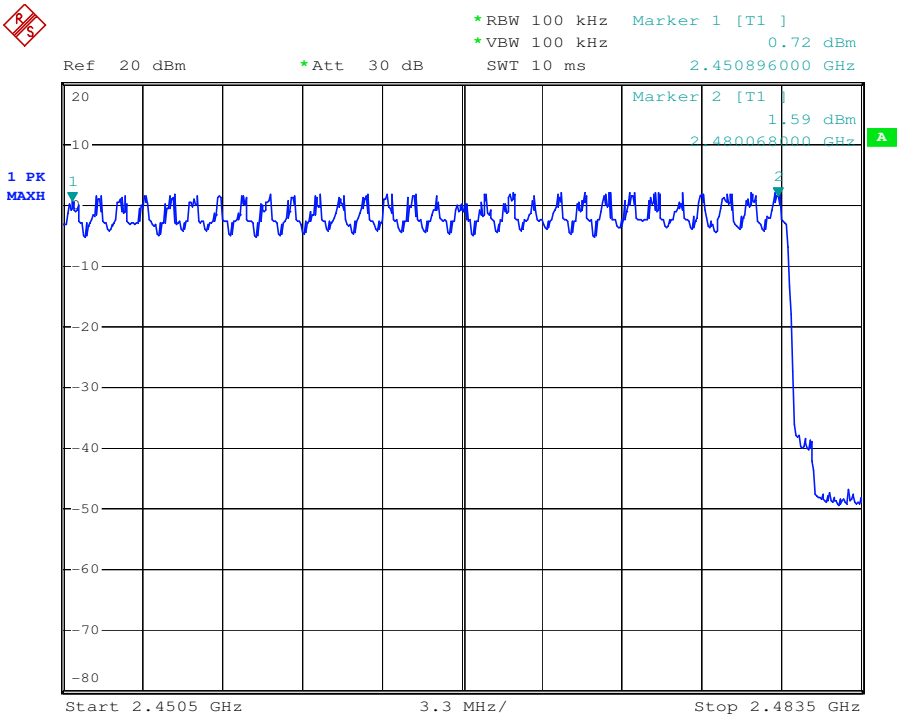
Test mode:	8DPSK	Test channel:	Middle





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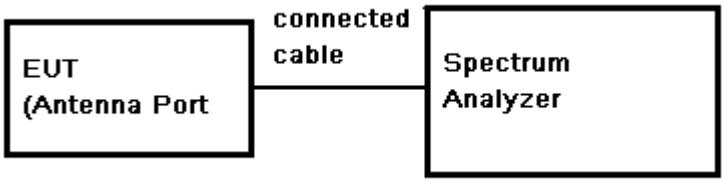
7.9 Dwell Time

Limit: Regulation 15.247(a)(1)(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.

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum. Keep EUT in Hopping transmitting with all kind of modulation.
2. Set spectrum analyzer span = 0. centered on a hopping channel;
3. Use Emission width * No. of Hopping Channels in 31.6s to determine the dwell time.

Test Result: Pass

Test Data:

Frequency (MHz)	Modulation	Packet	Emission Width (ms)	Number of Hopping Channel in 31.6s	Average Time of Occupancy(s)	Limit(s)	Result
2441	GFSK	DH1	0.39	320	0.12	0.4	Pass
		DH3	1.64	160	0.26	0.4	Pass
		DH5	2.88	110	0.32	0.4	Pass
	π/4DQPSK	DH1	0.40	320	0.13	0.4	Pass
		DH3	1.64	160	0.26	0.4	Pass
		DH5	1.68	160	0.27	0.4	Pass
	8DPSK	DH1	0.40	320	0.13	0.4	Pass
		DH3	1.64	160	0.26	0.4	Pass
		DH5	2.88	110	0.32	0.4	Pass

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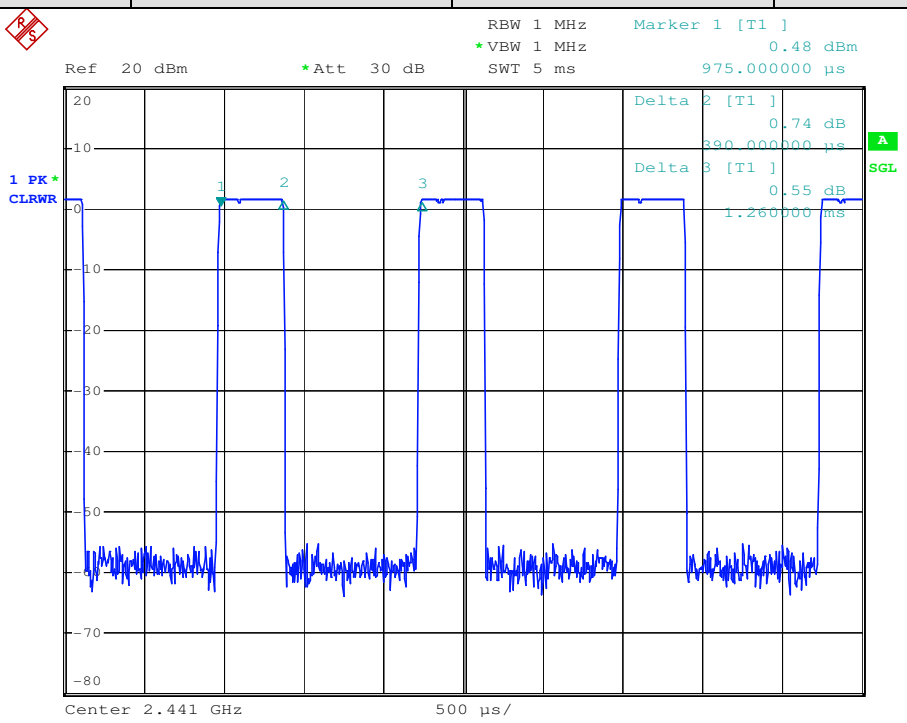
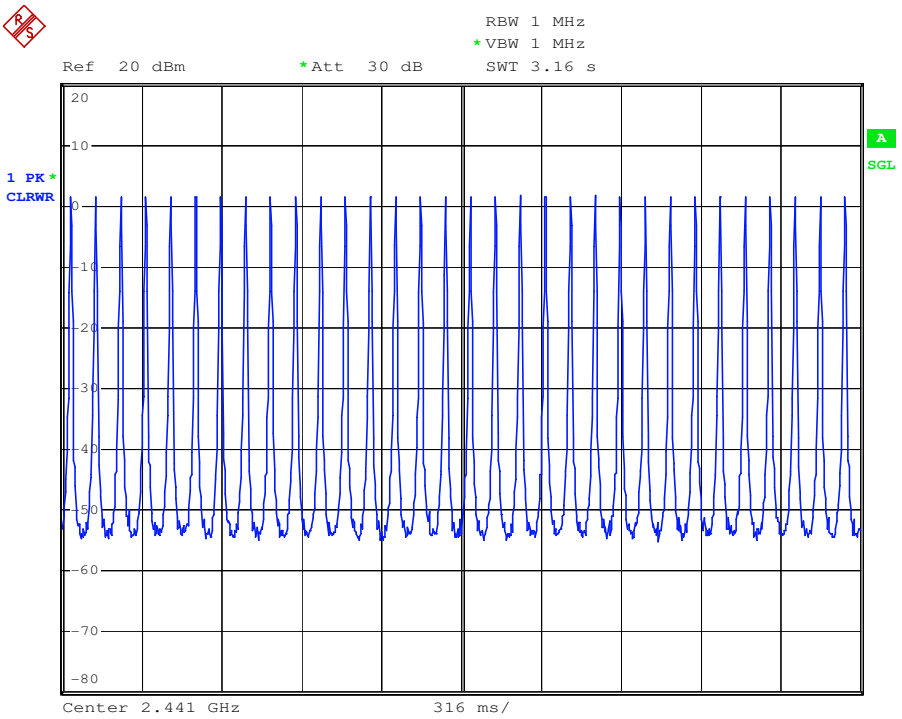
Test plot as follows:

Test mode:	GFSK-DH1	Test channel:	Middle





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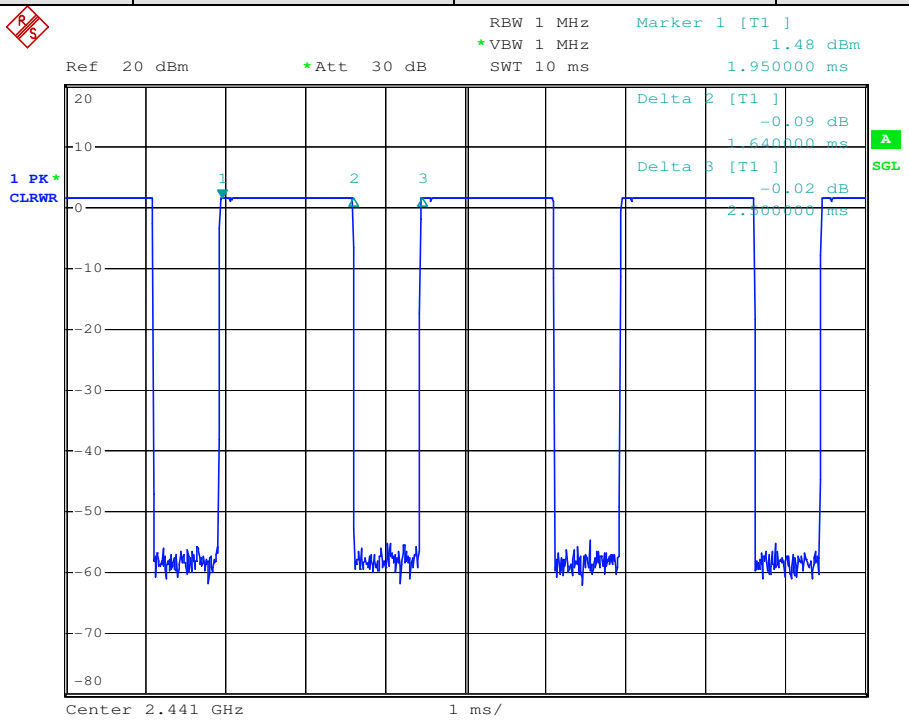
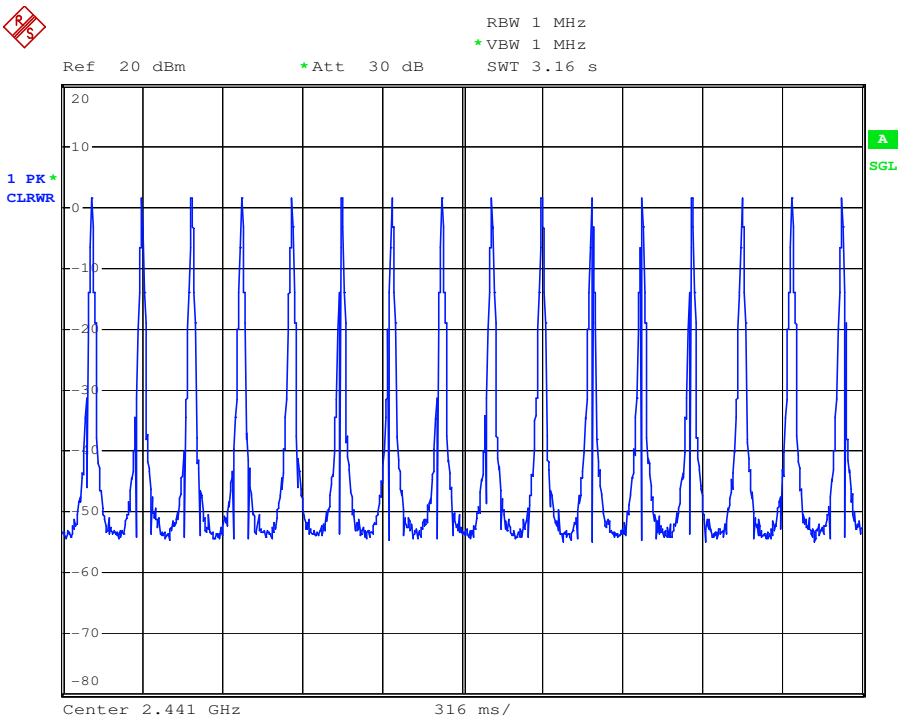
Test mode:	GFSK-DH3	Test channel:	Middle





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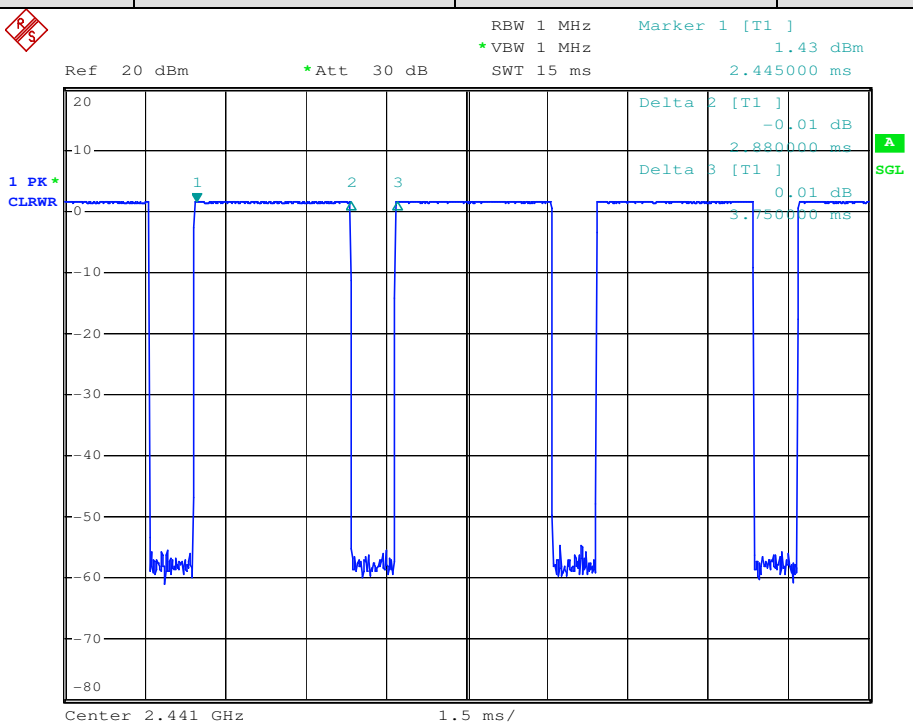
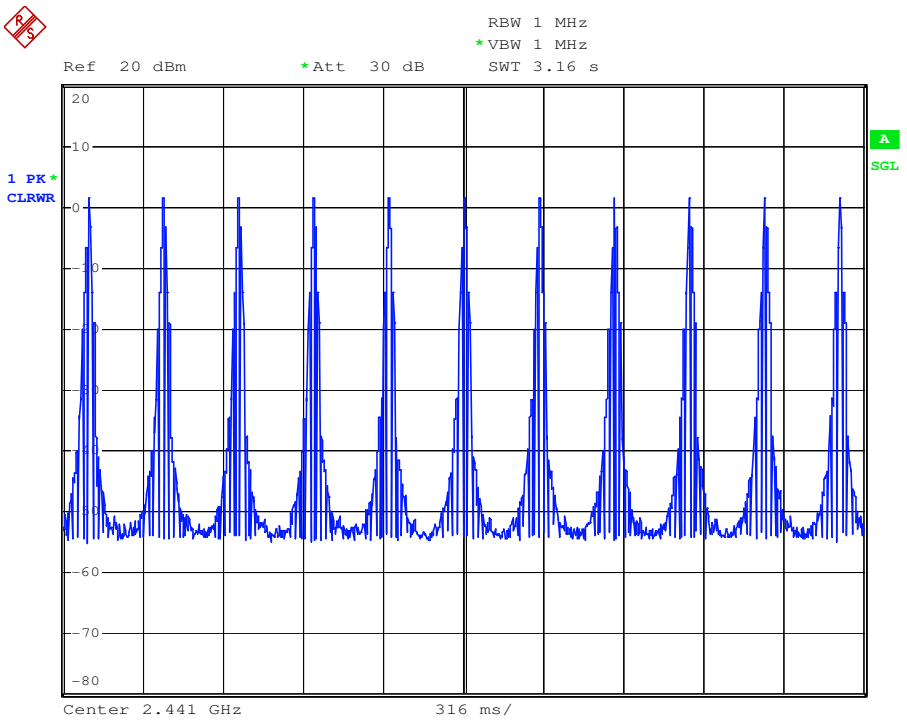
Test mode:	GFSK-DH5	Test channel:	Middle





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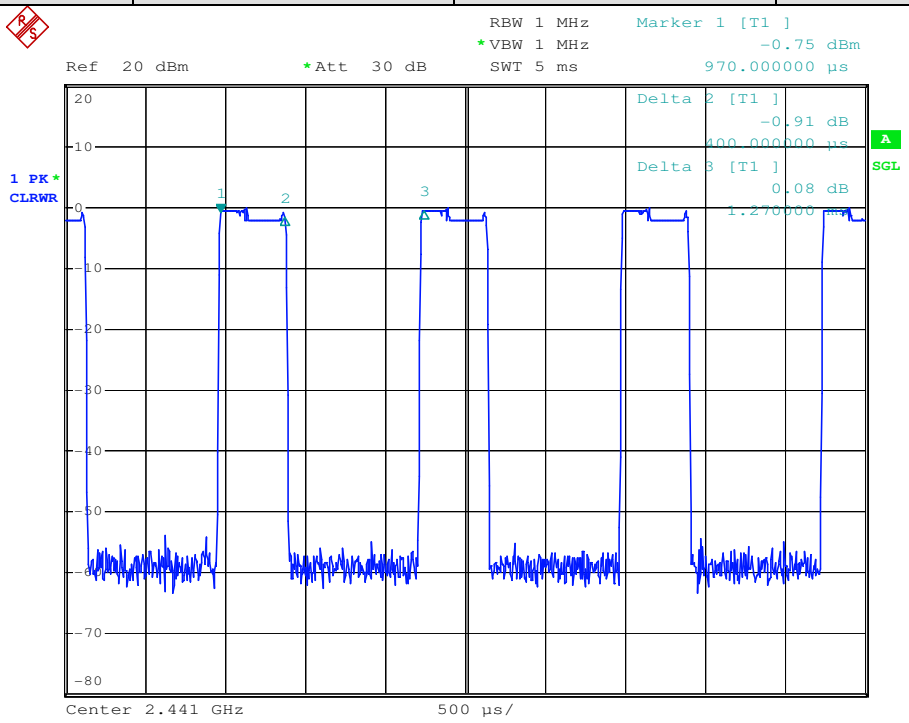
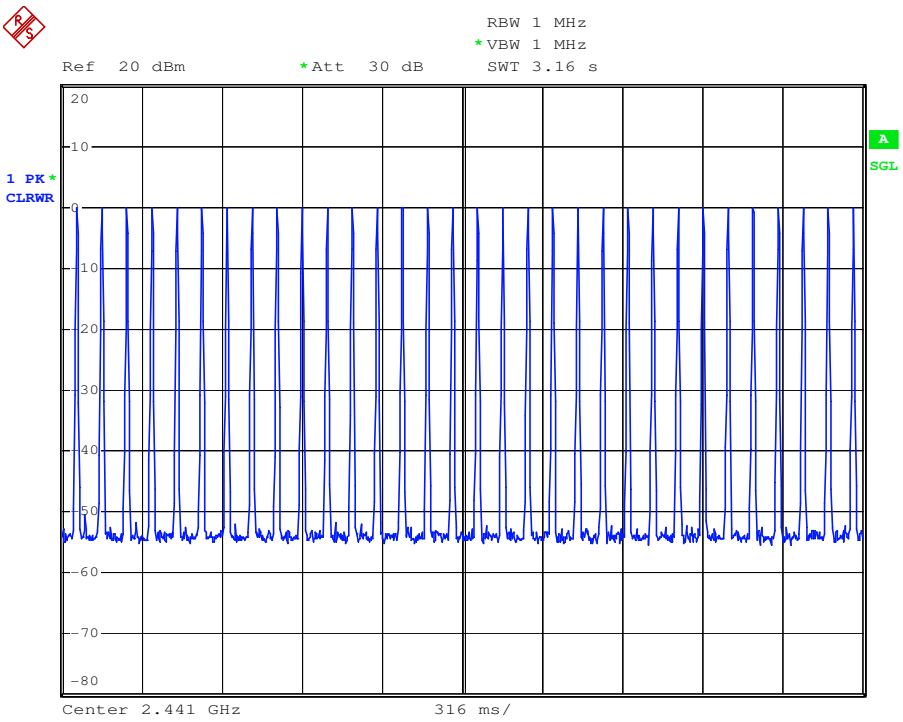
Test mode:	π/4DQPSK -DH1	Test channel:	Middle





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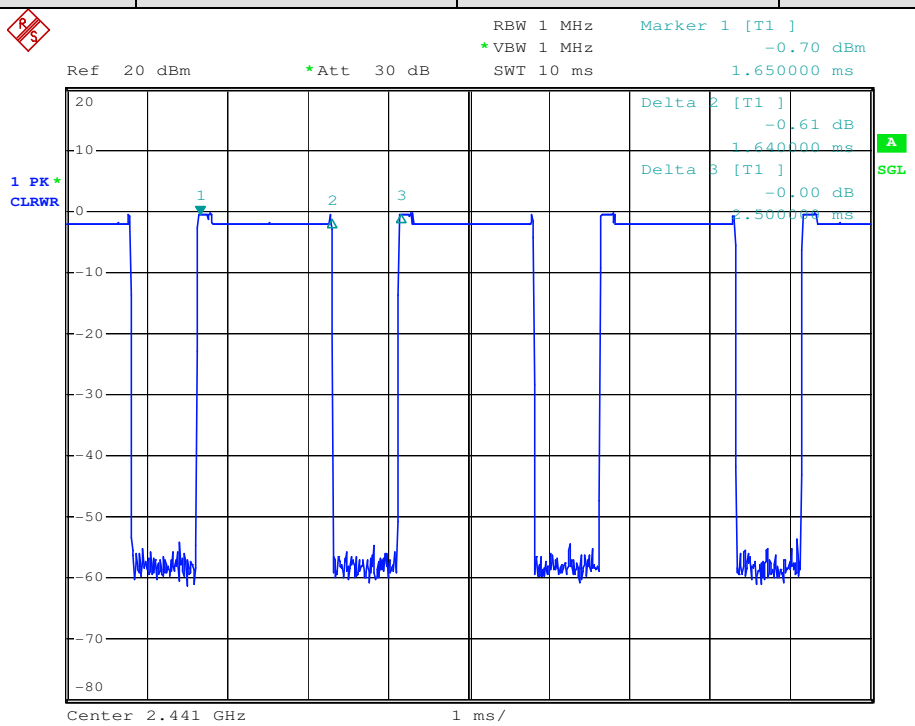
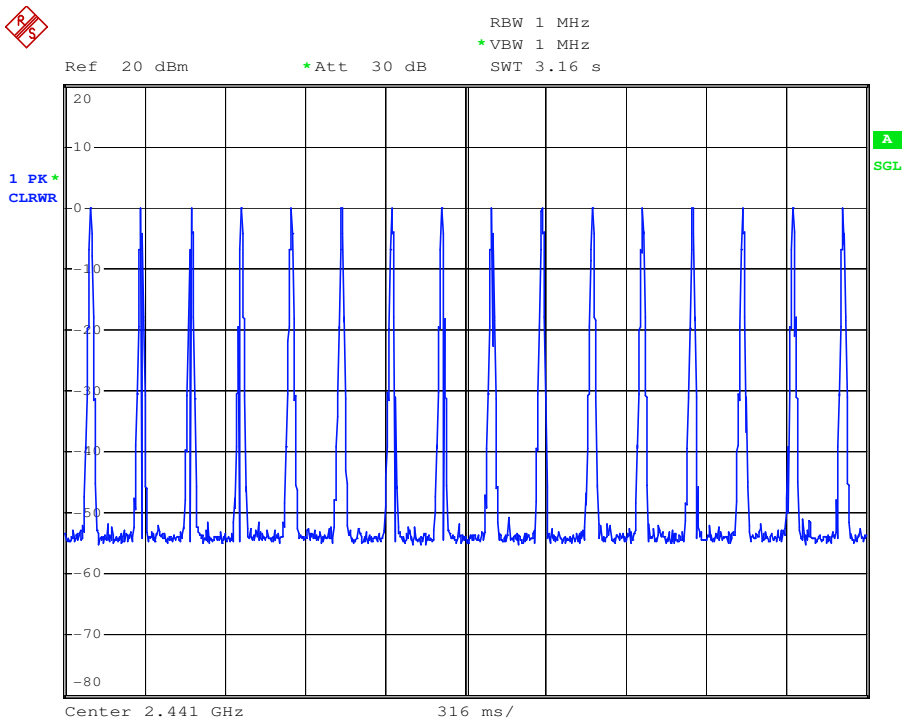
Test mode:	π/4DQPSK –DH3	Test channel:	Middle





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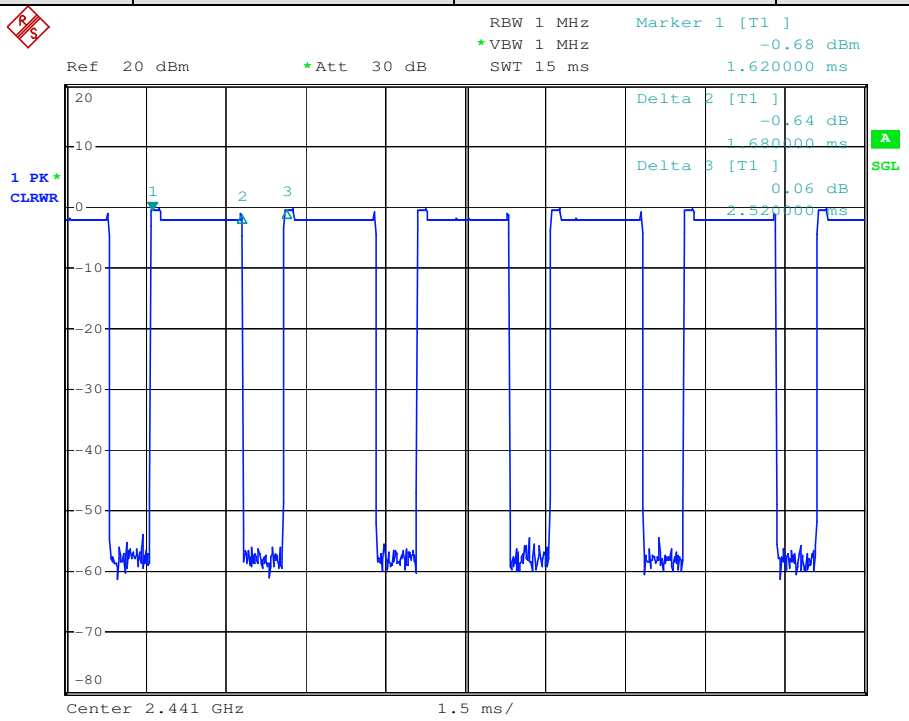
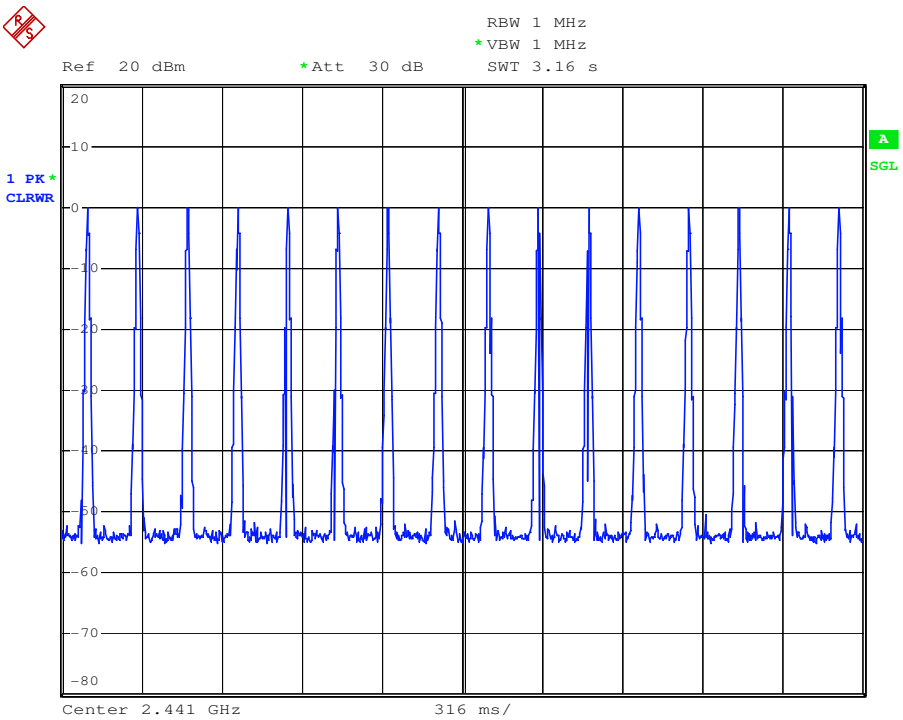
Test mode:	π/4DQPSK –DH5	Test channel:	Middle





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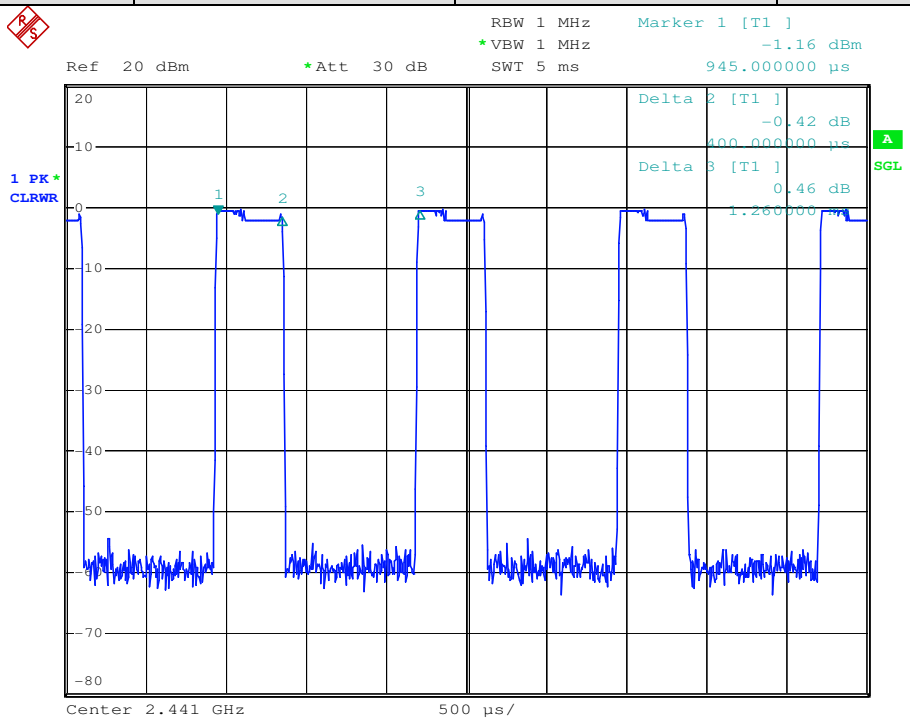
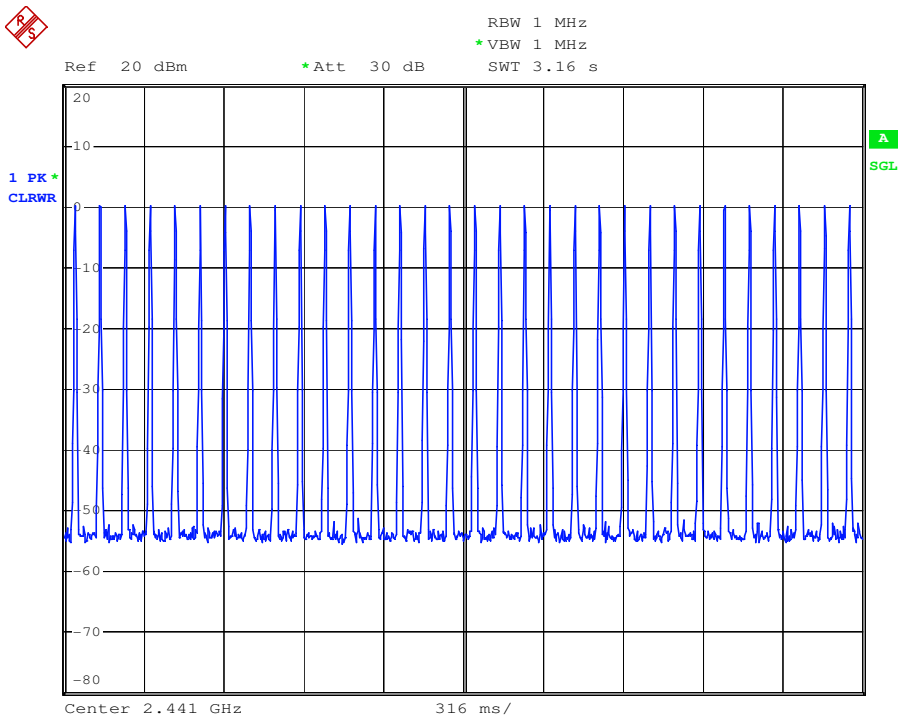
Test mode:	8DPSK -DH1	Test channel:	Middle





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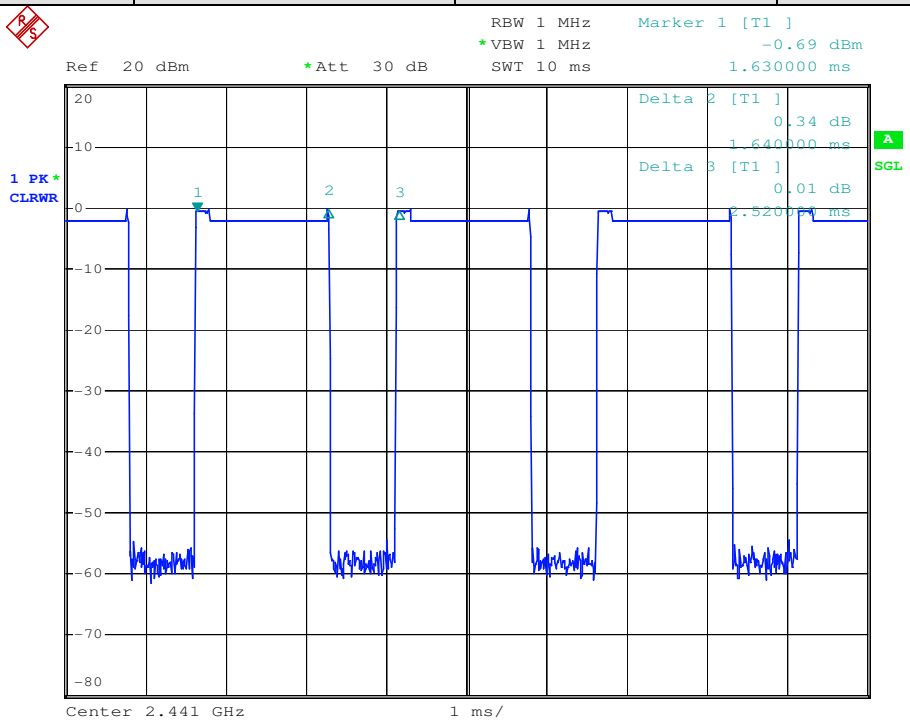
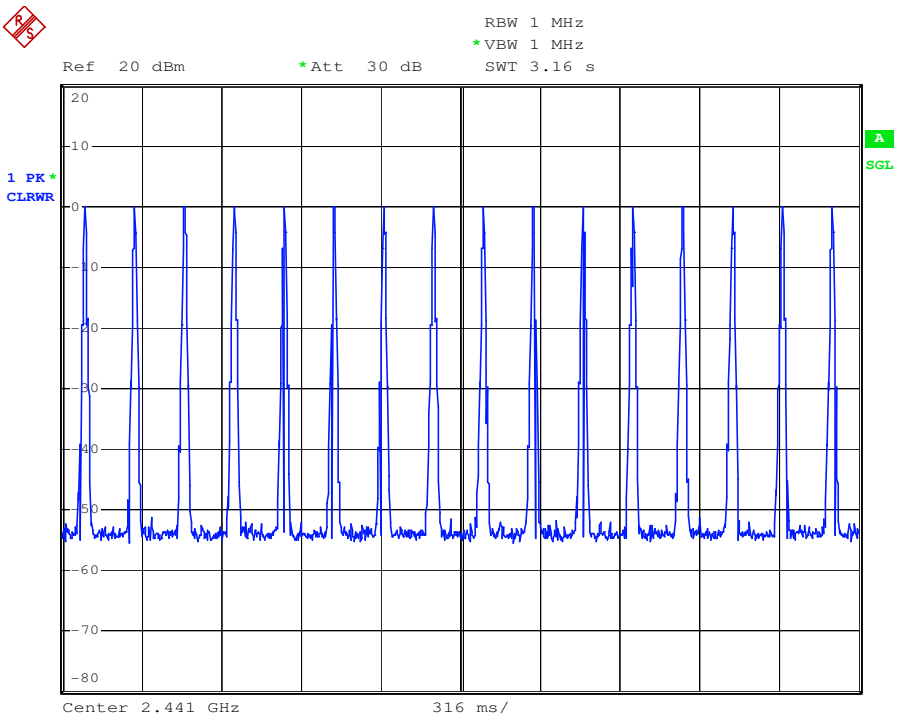
Test mode:	8DPSK –DH3	Test channel:	Middle





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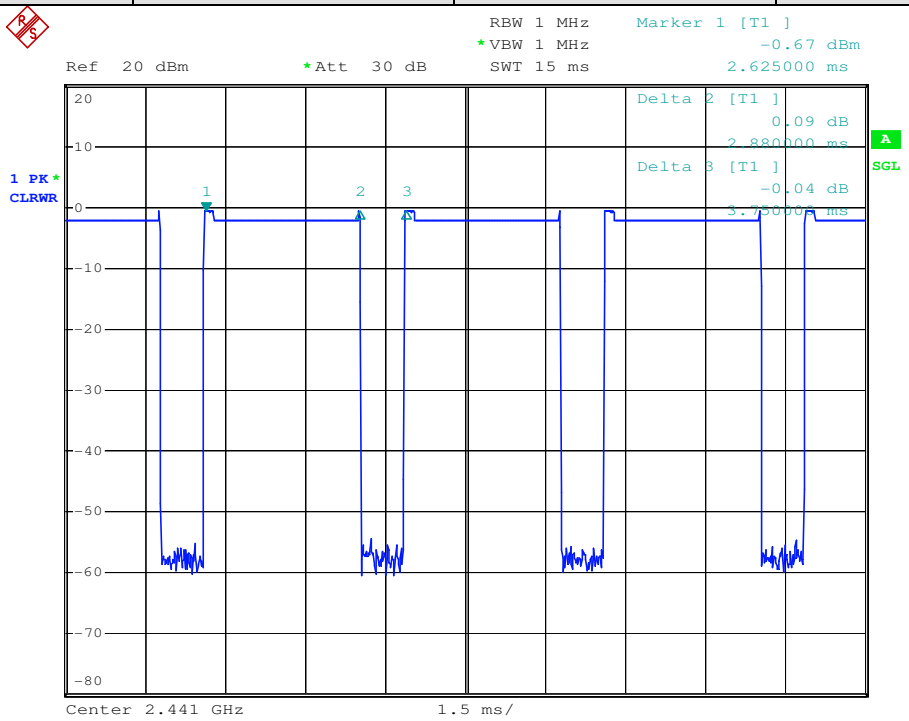
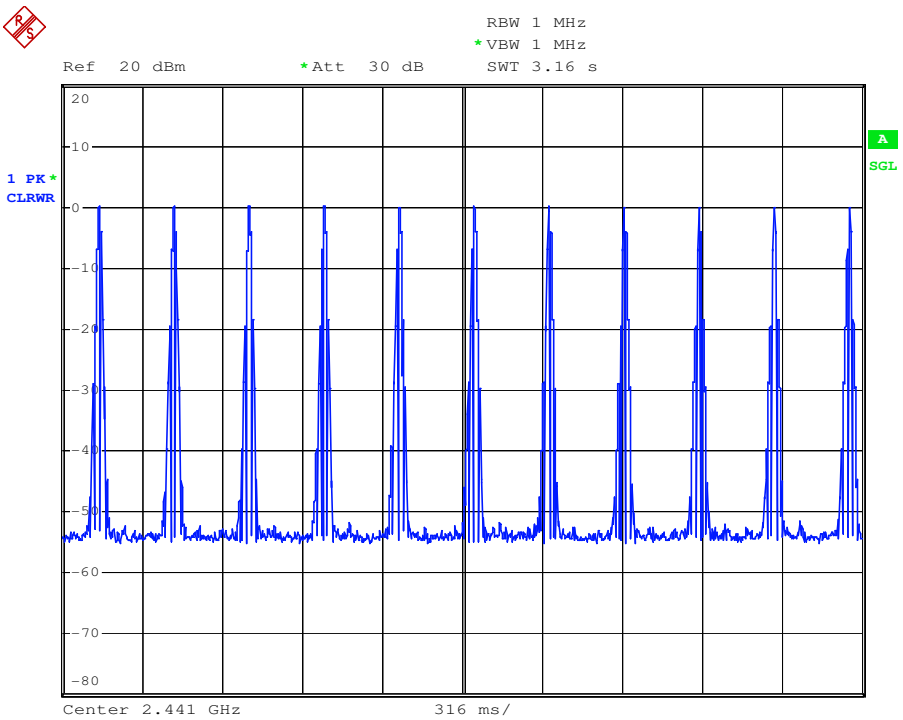
Test mode:	8DPSK –DH5	Test channel:	Middle





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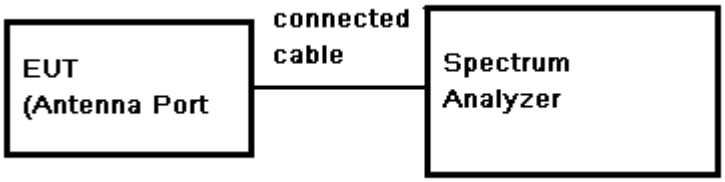
7.10 Conducted Spurious Emissions and Band-edge

Test Requirement: FCC Part 15 Section 15.247(d)

Test Method: ANSI C63.10:2009 Clause 7.7.9&7.7.10

Limit: (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.

Test Configuration:



Test Procedure: 1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW = 100KHz. VBW >= RBW. Sweep = auto; Detector Function = Peak (Max. hold).

Test Result: Pass

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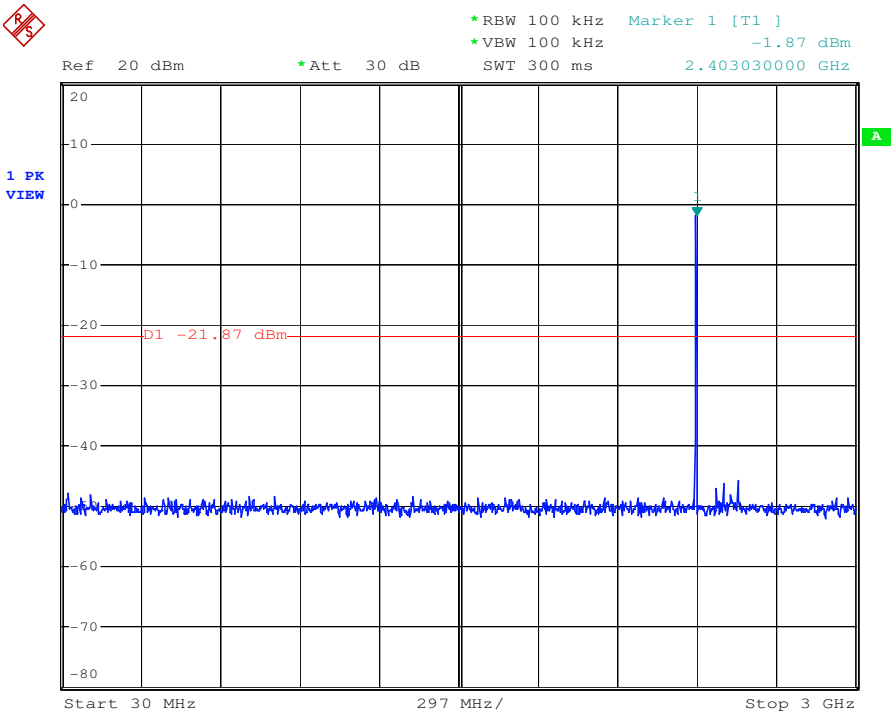
7.10.1 Conducted spurious emission

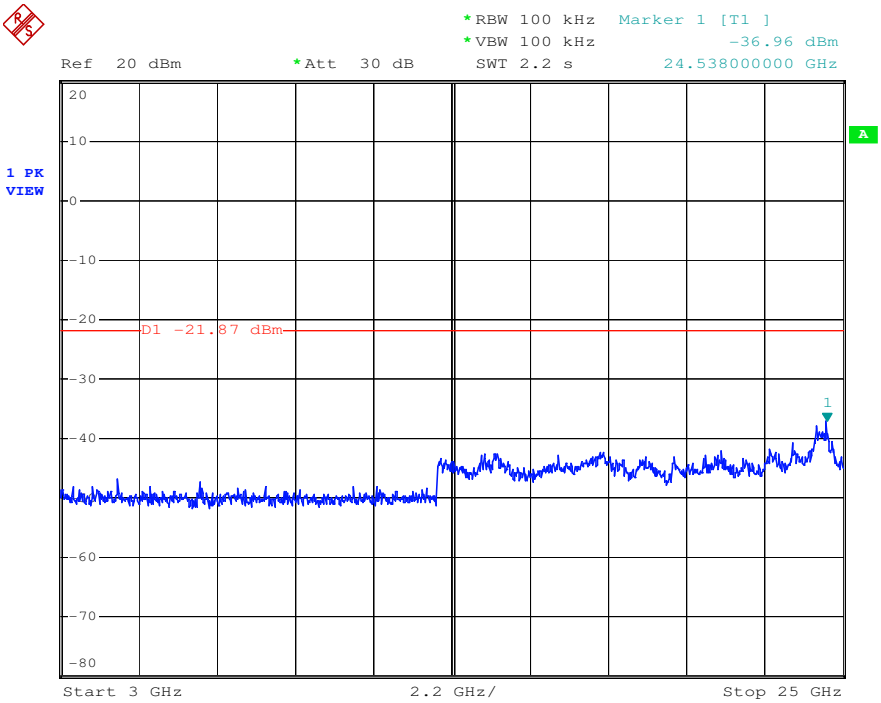
Test plot as follows:

Test mode:	GFSK	Test channel:	Lowest

30MHz-3GHz:



3GHz-25GHz:



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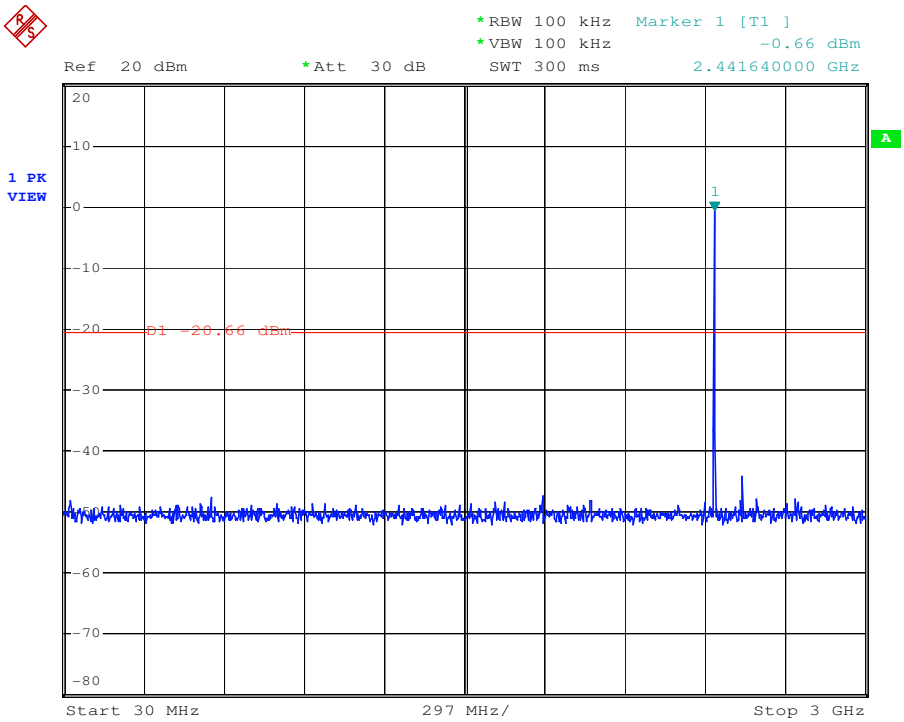
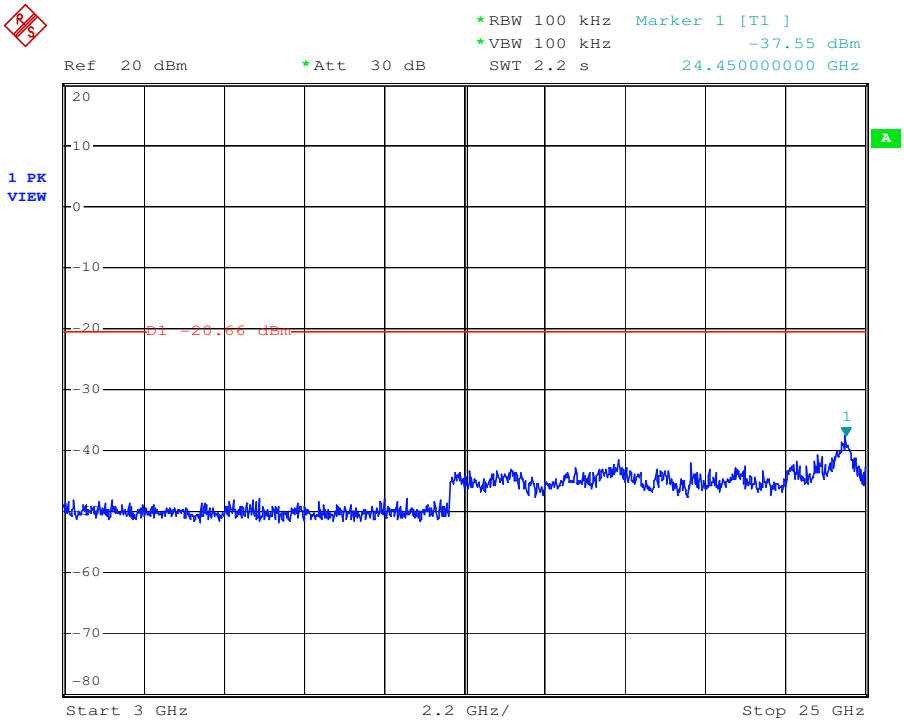
Test mode:	GFSK	Test channel:	Middle

30MHz-3GHz:



3GHz-25GHz:



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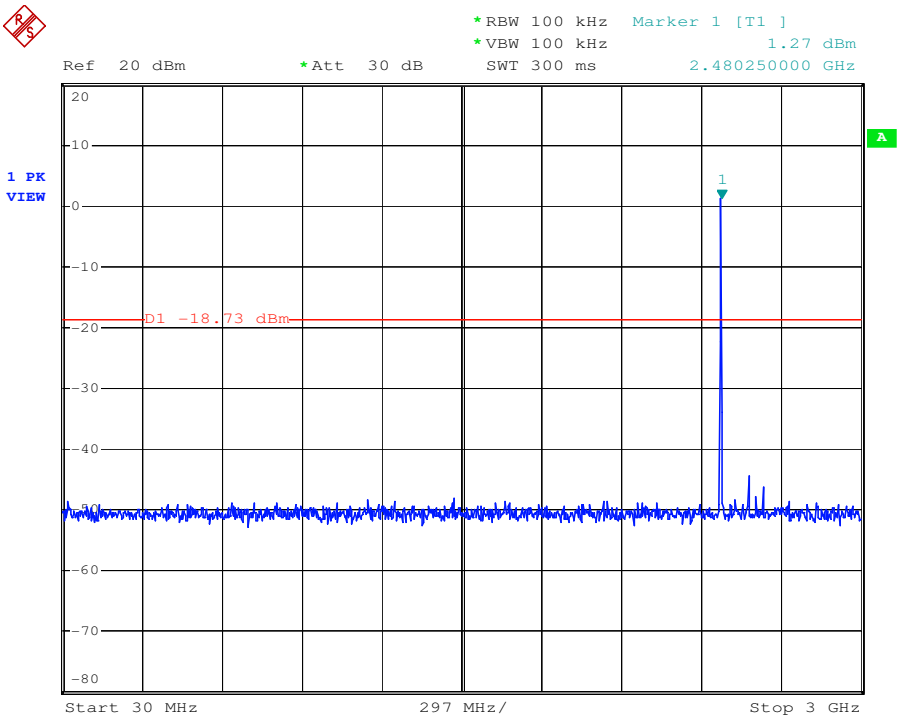
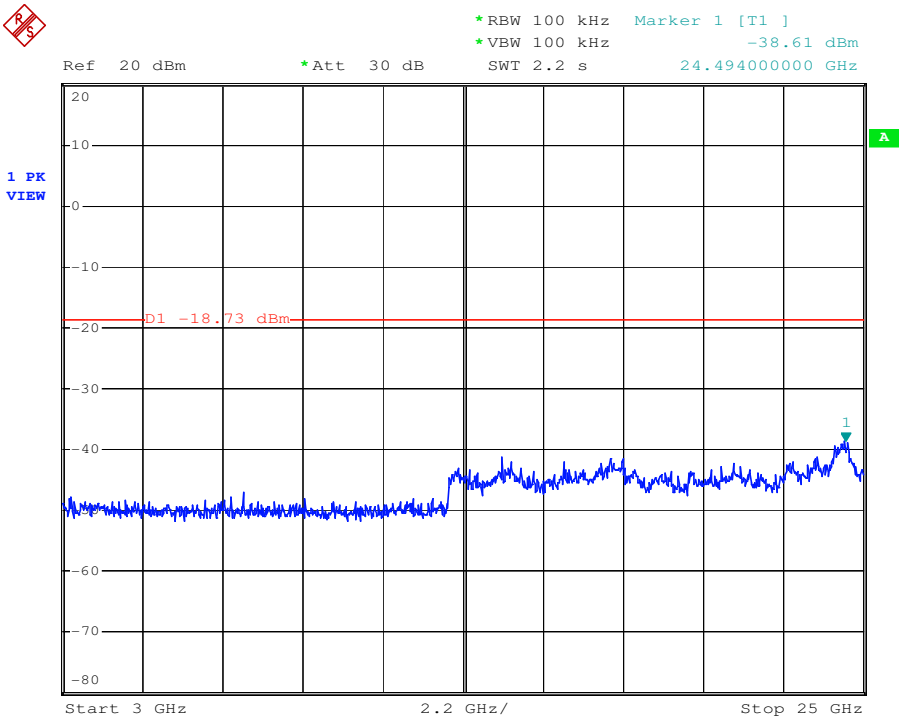
Test mode:	GFSK	Test channel:	Highest

30MHz-3GHz:



3GHz-25GHz:



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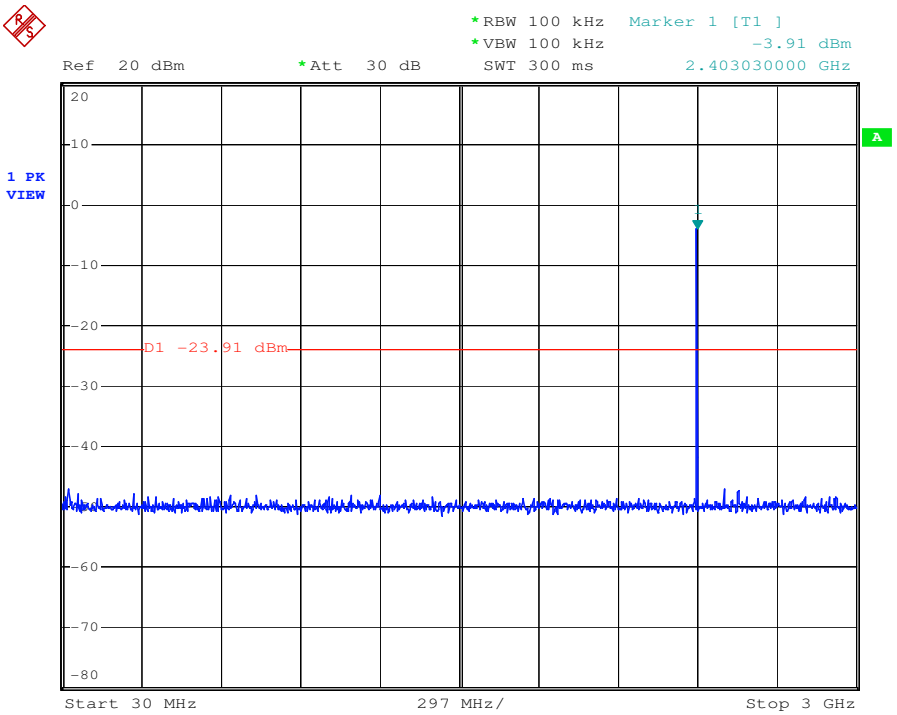
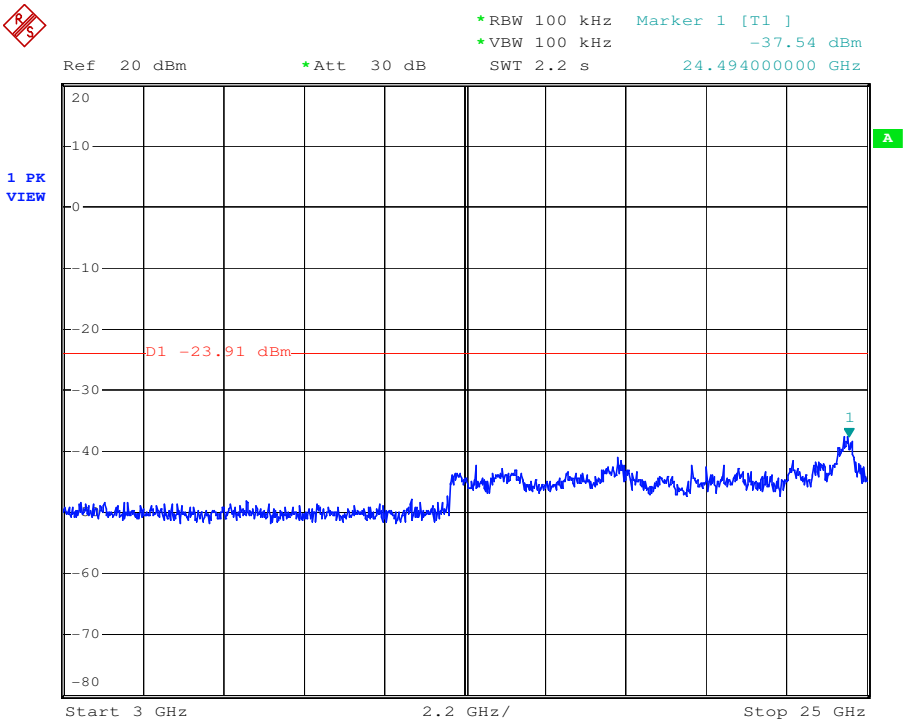
Test mode:	π/4DQPSK	Test channel:	Lowest

30MHz-3GHz:



3GHz-25GHz:



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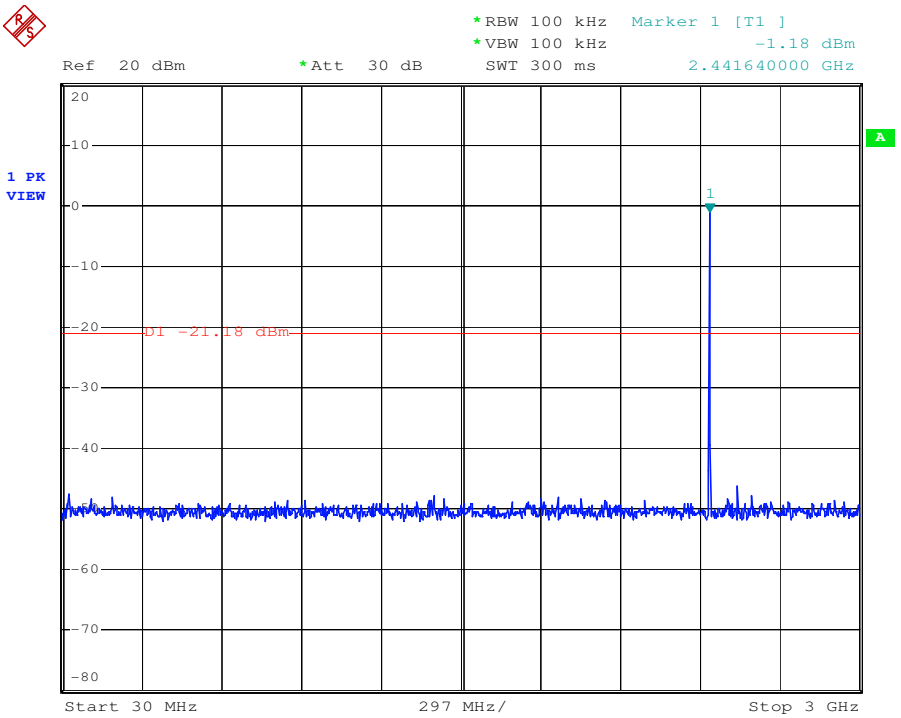
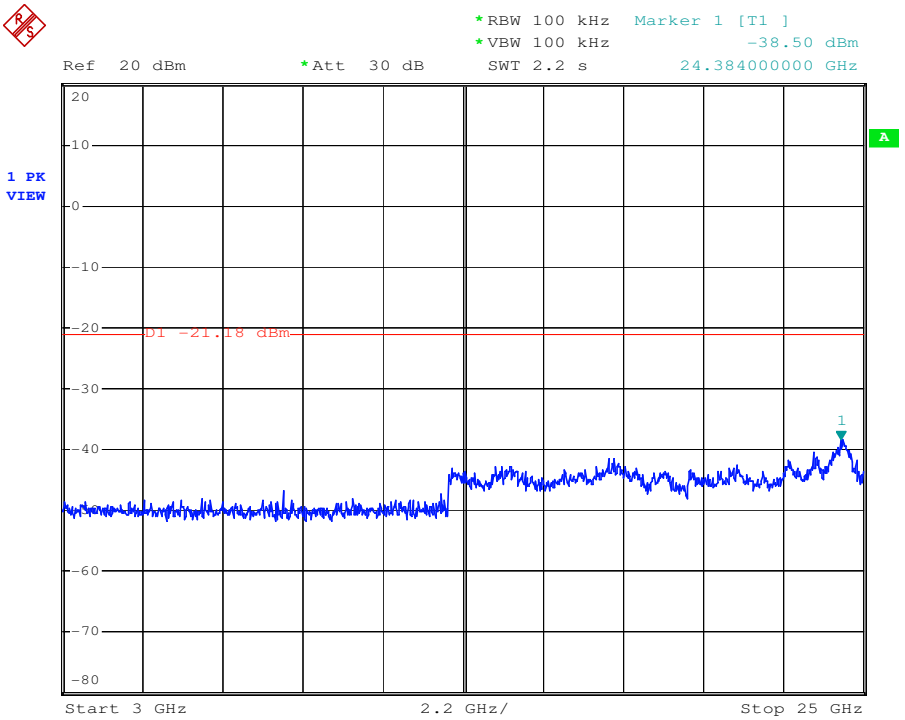
Test mode:	π/4DQPSK	Test channel:	Middle

30MHz-3GHz:



3GHz-25GHz:



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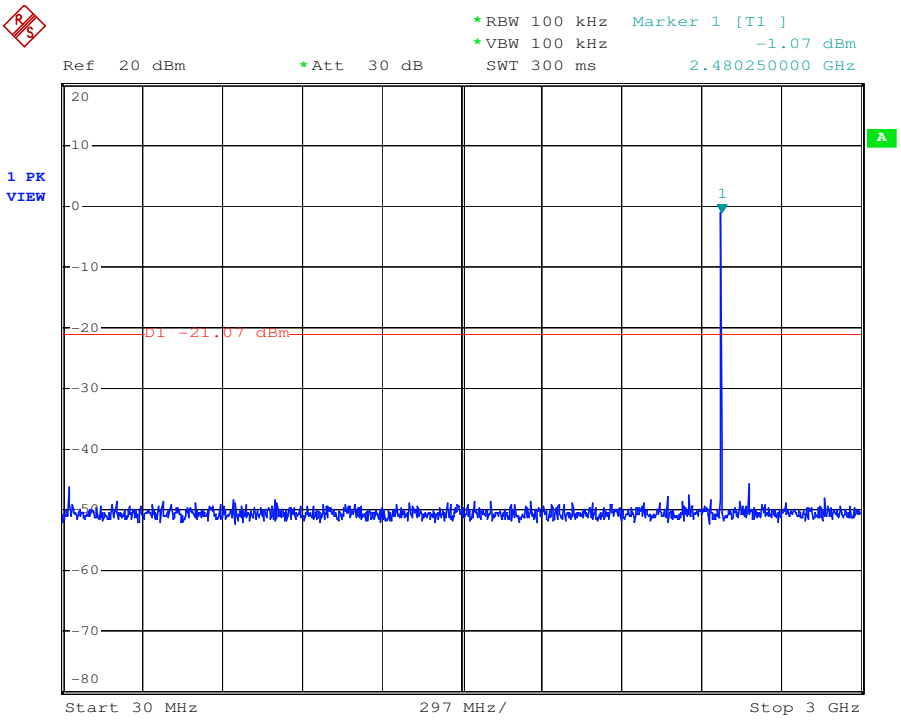
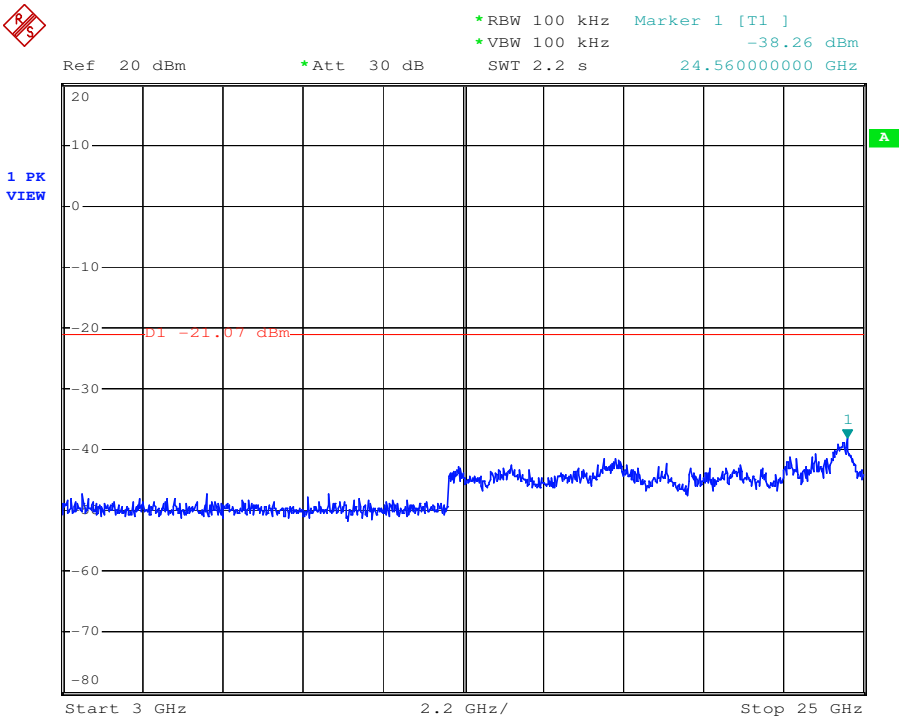
Test mode:	π/4DQPSK	Test channel:	Highest

30MHz-3GHz:



3GHz-25GHz:



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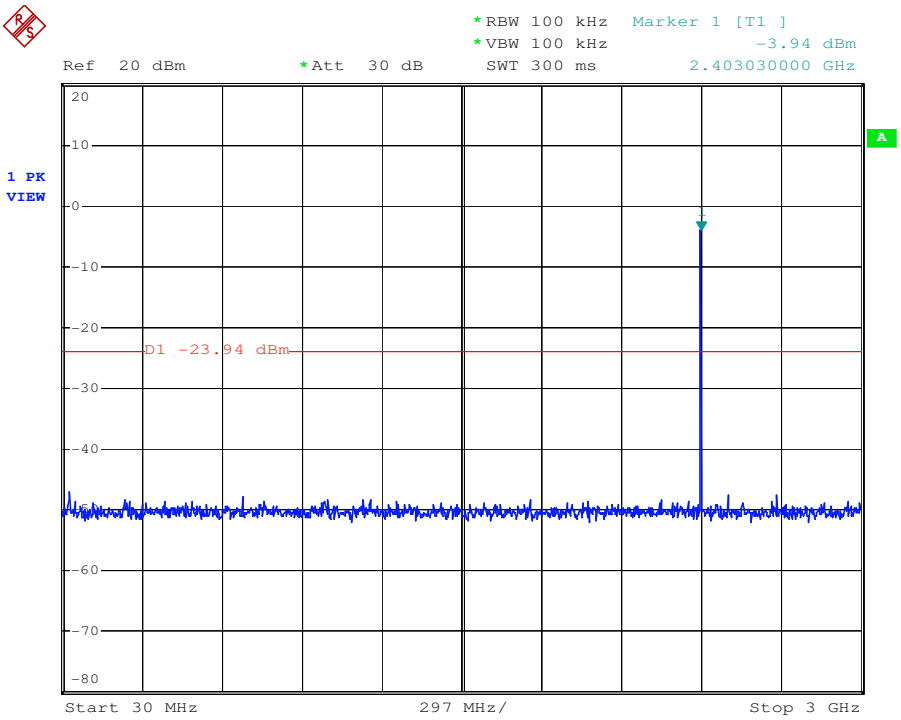
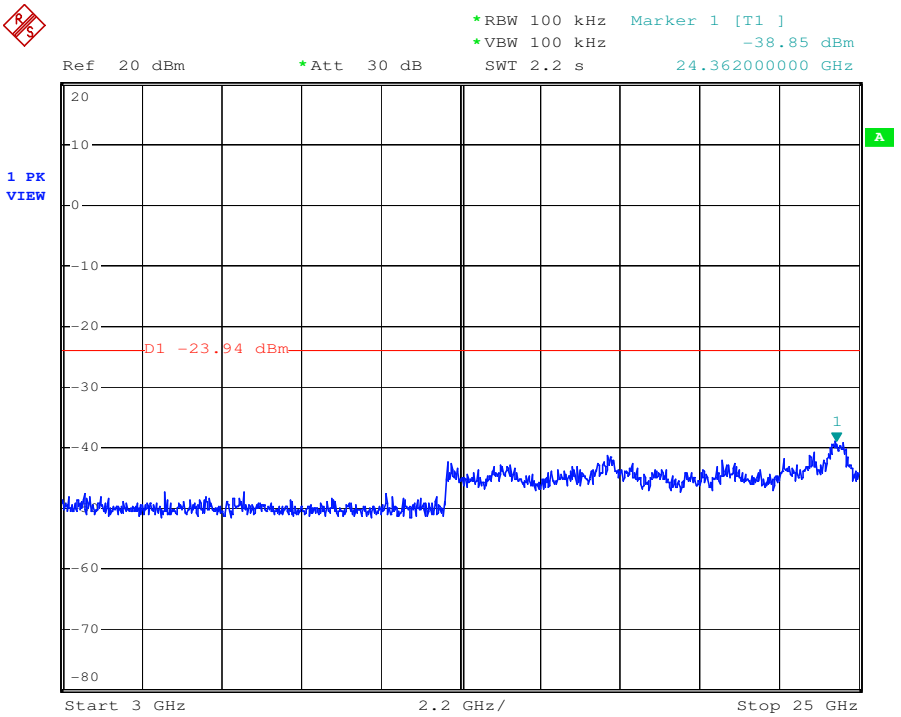
Test mode:	8DPSK	Test channel:	Lowest

30MHz-3GHz:



3GHz-25GHz:



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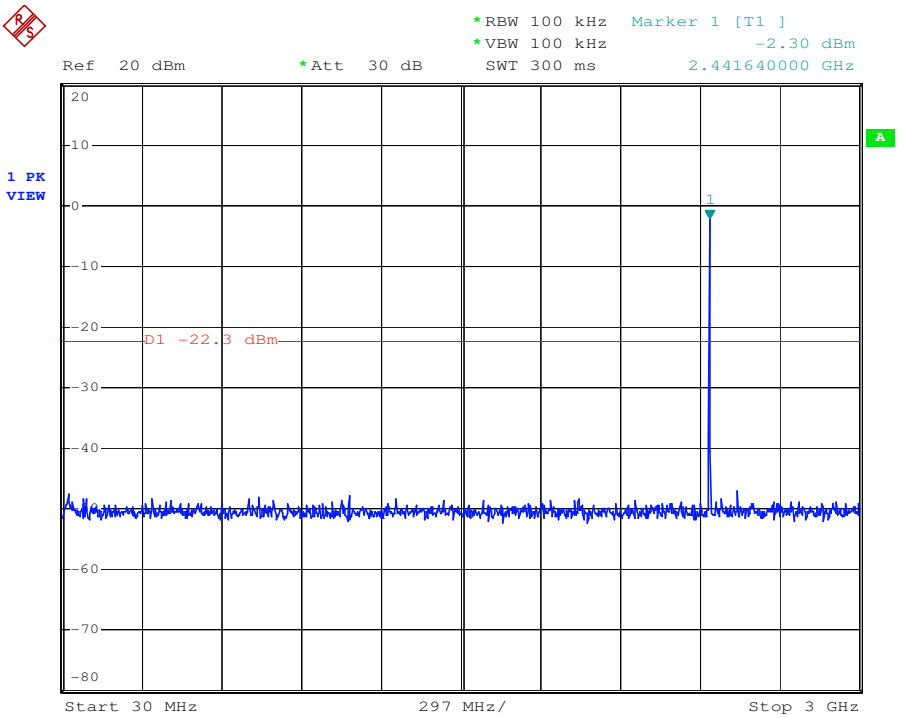
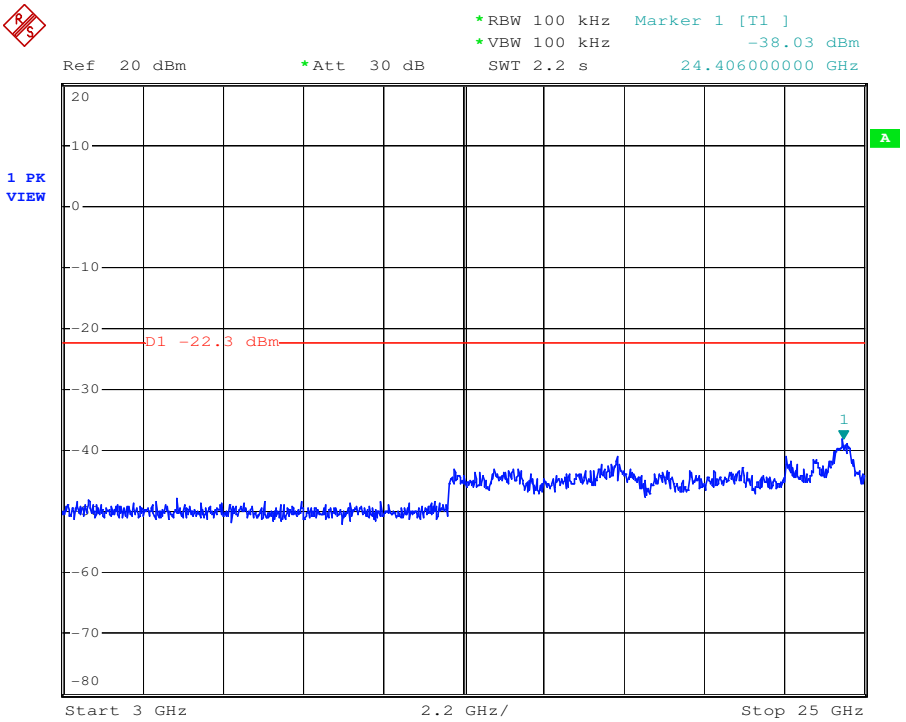
Test mode:	8DPSK	Test channel:	Middle

30MHz-3GHz:



3GHz-25GHz:



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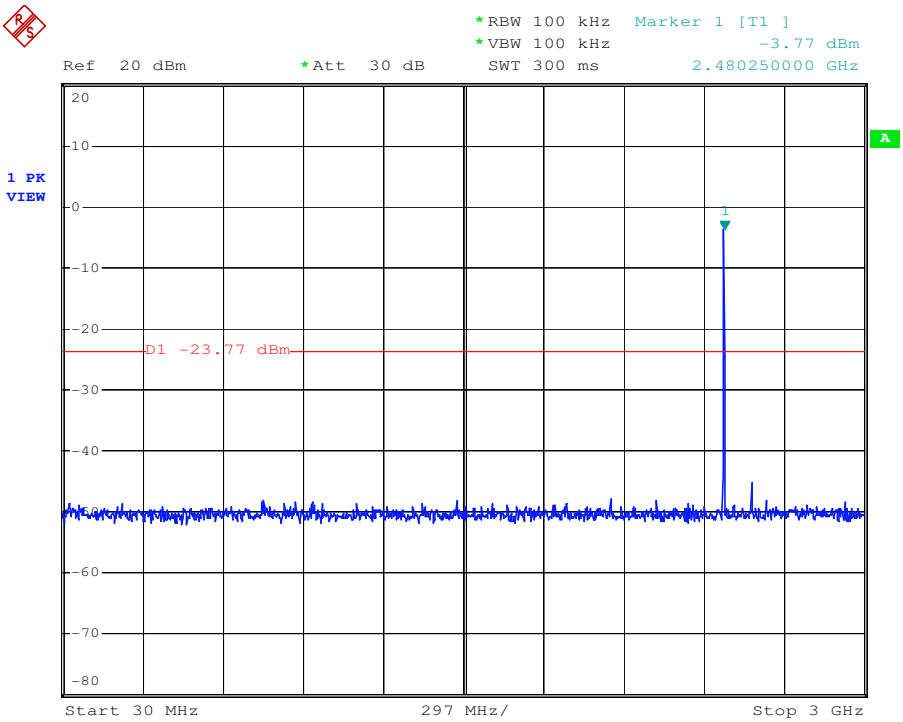
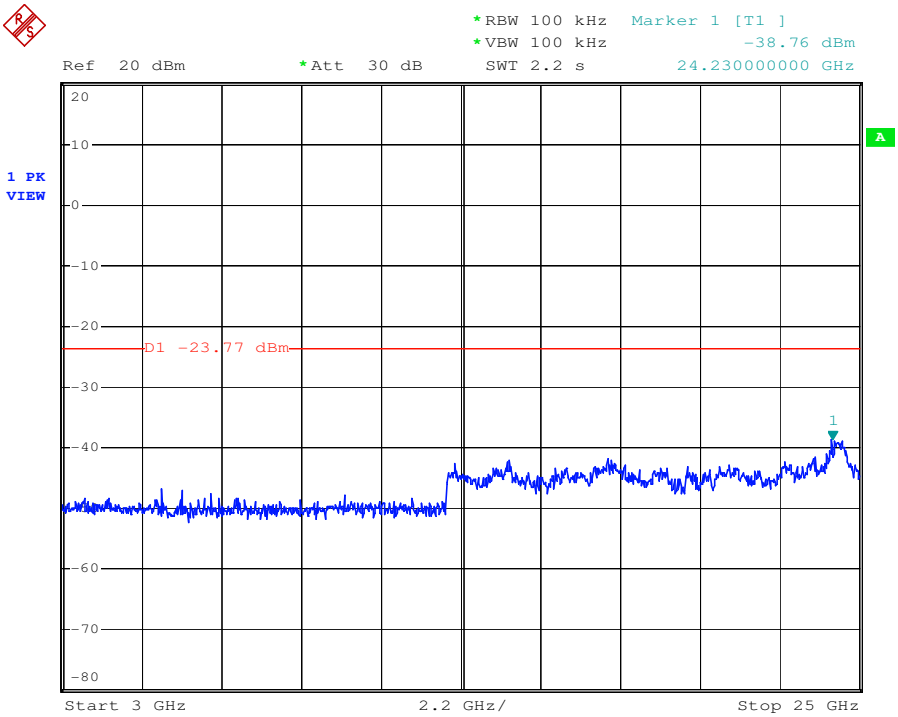
Test mode:	8DPSK	Test channel:	Highest

30MHz-3GHz:



3GHz-25GHz:



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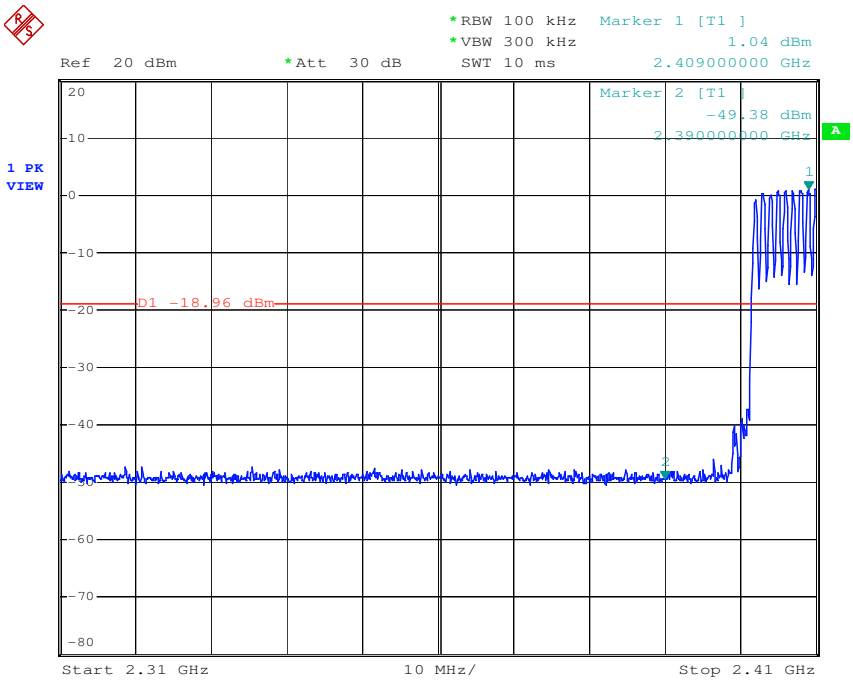
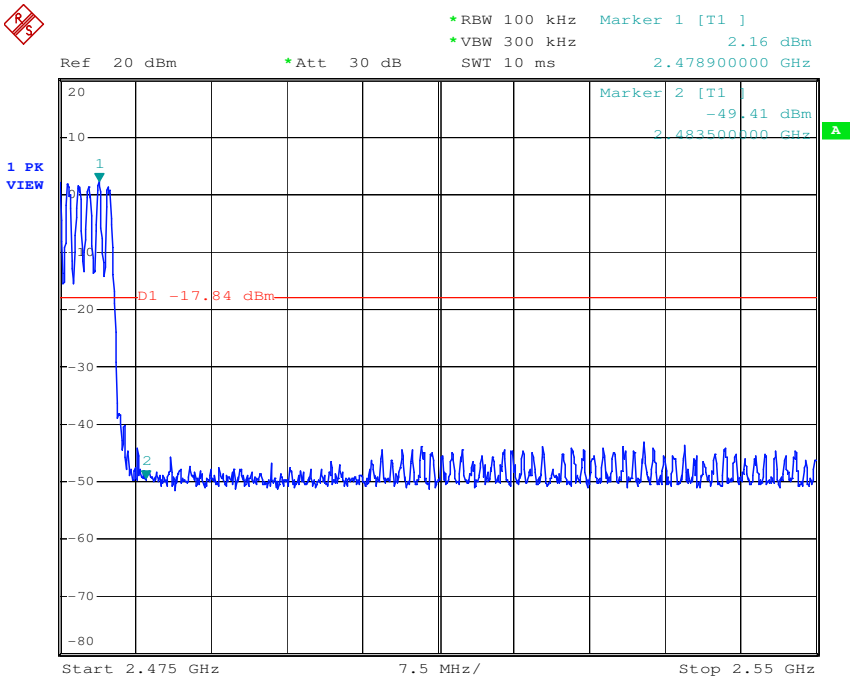
7.10.2 Conducted Band-edge

Test plot as follows:

Test mode:	GFSK	Test channel:	Hopping enabled





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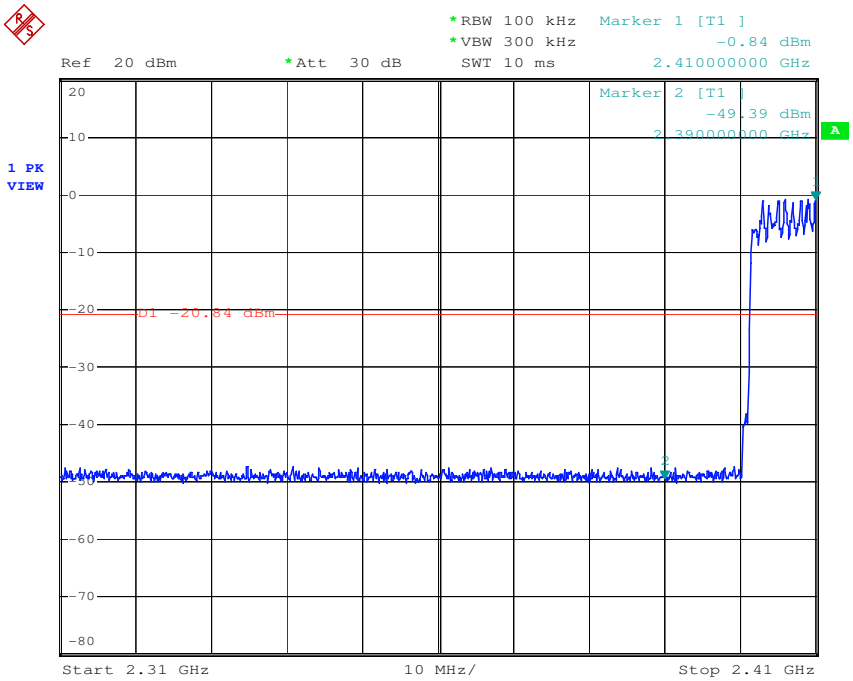
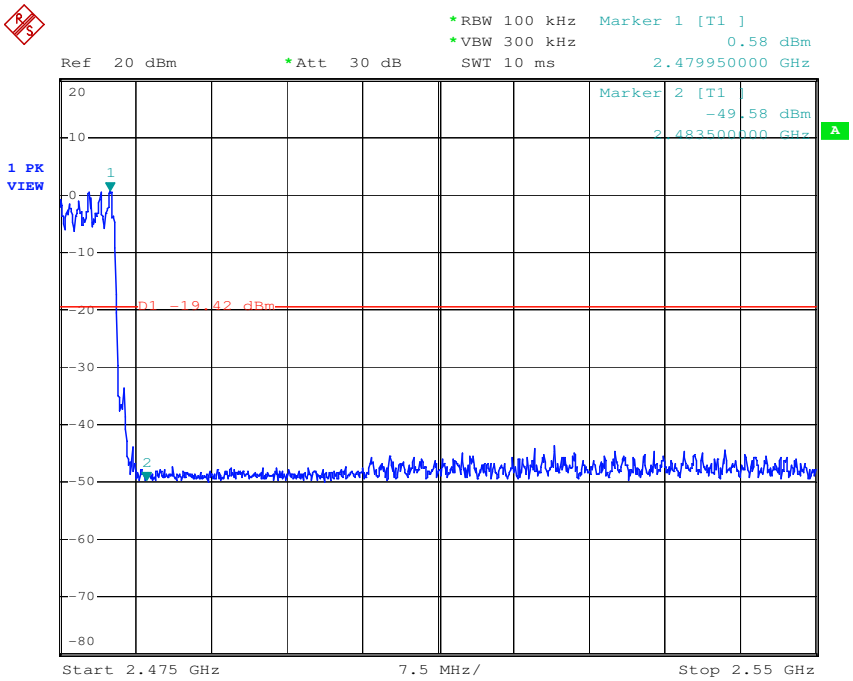
Test mode:	π/4DQPSK	Test channel:	Hopping enabled





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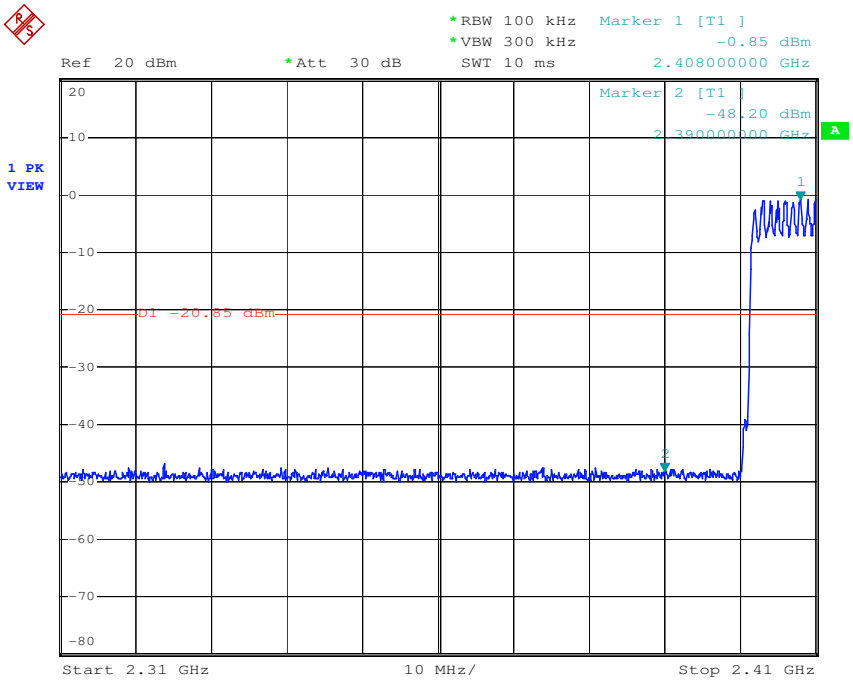
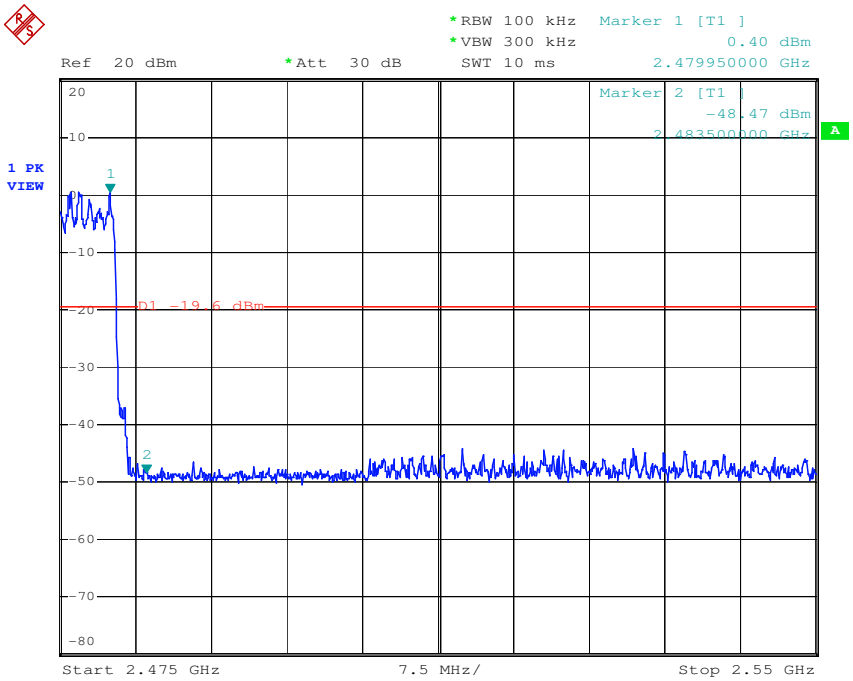
Test mode:	8DPSK	Test channel:	Hopping enabled





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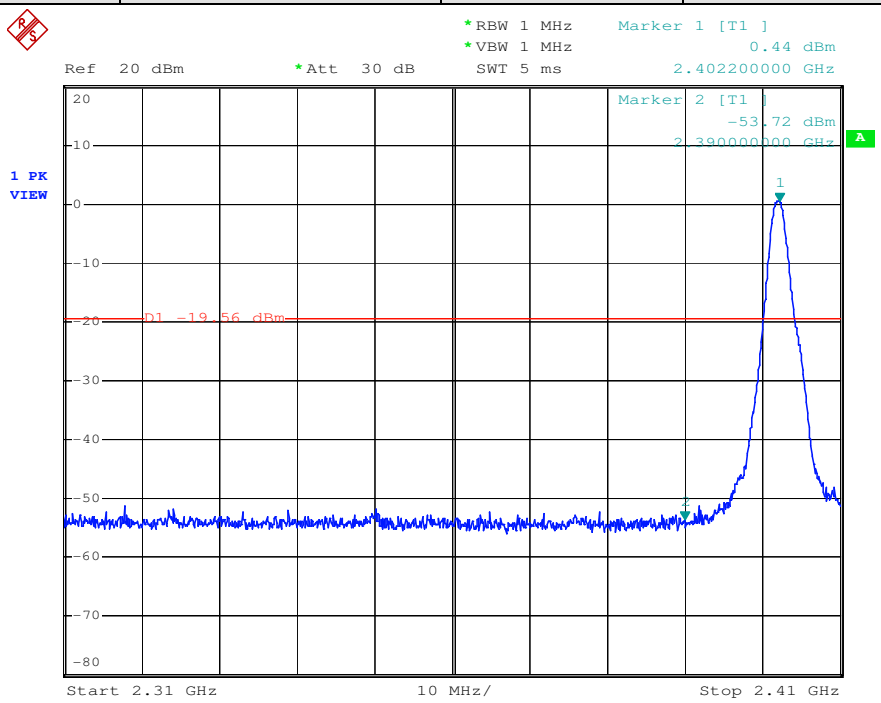
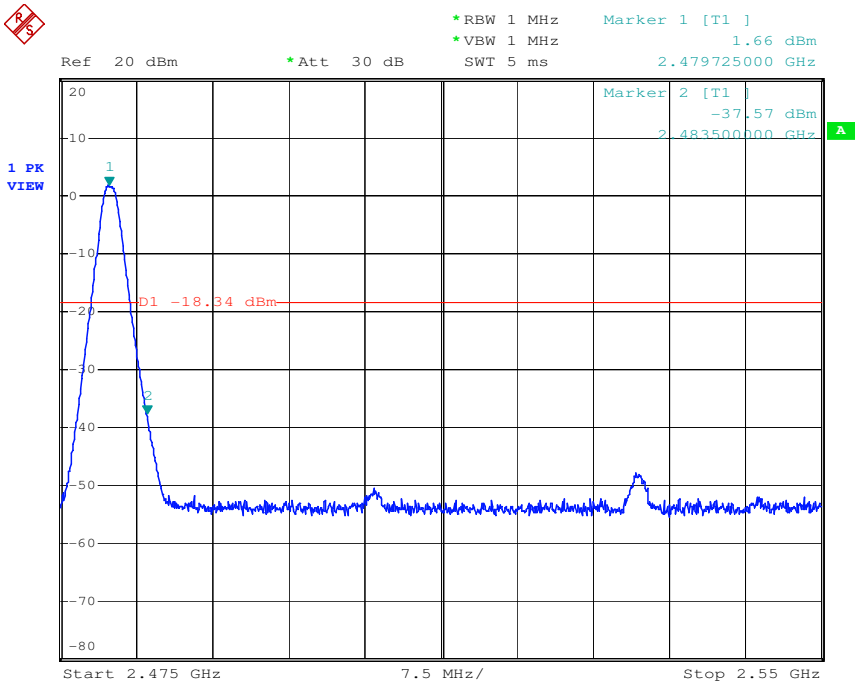
Test mode:	GFSK	Test channel:	Hopping disabled- Lowest



Test mode:	GFSK	Test channel:	Hopping disabled- Highest



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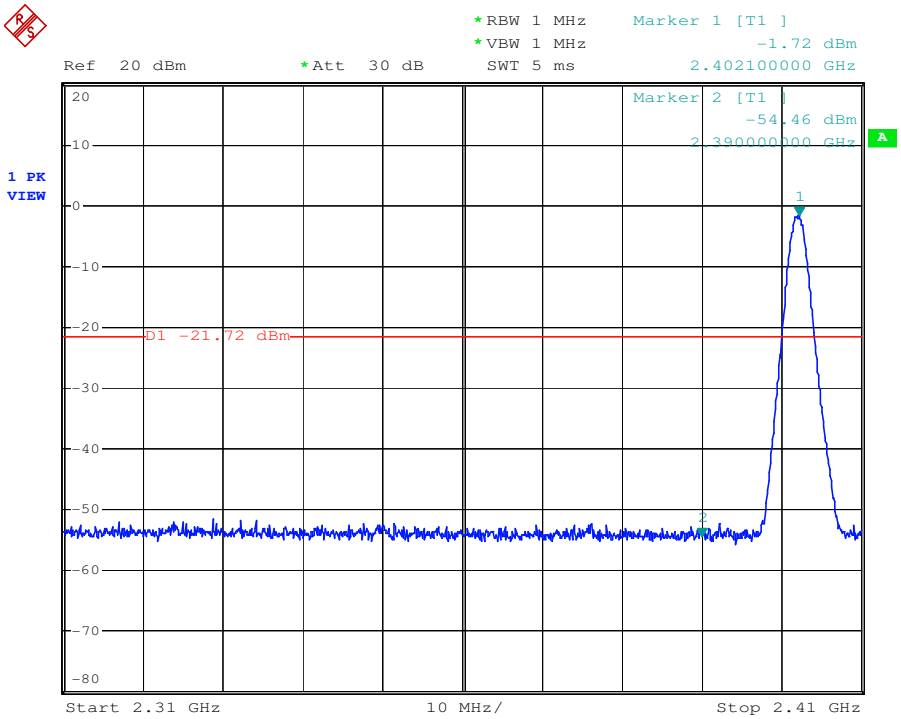
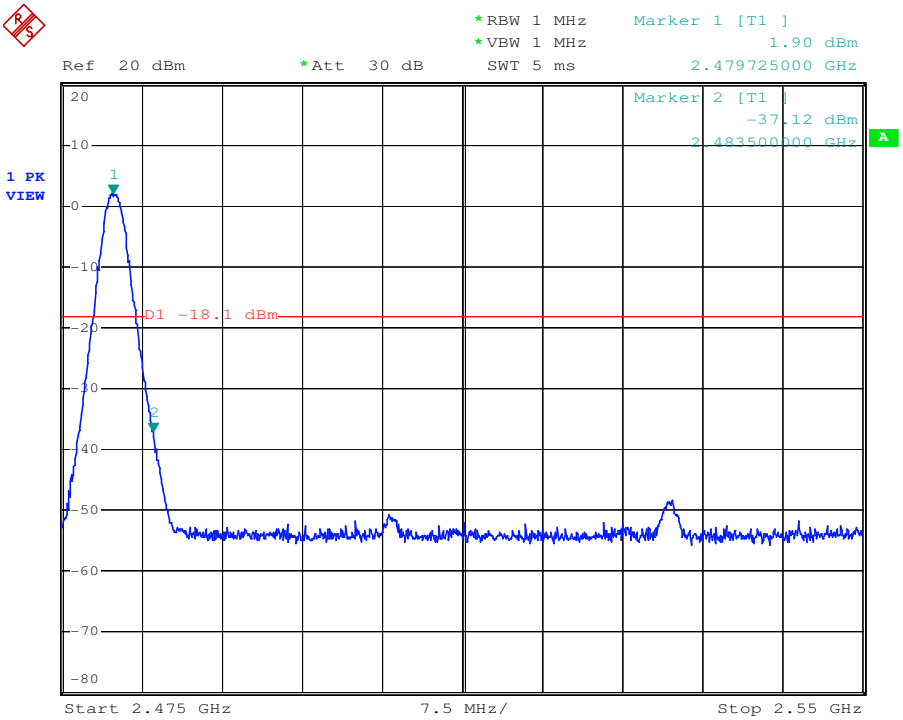
Test mode:	π/4DQPSK	Test channel:	Hopping disabled- Lowest



Test mode:	π/4DQPSK	Test channel:	Hopping disabled- Highest



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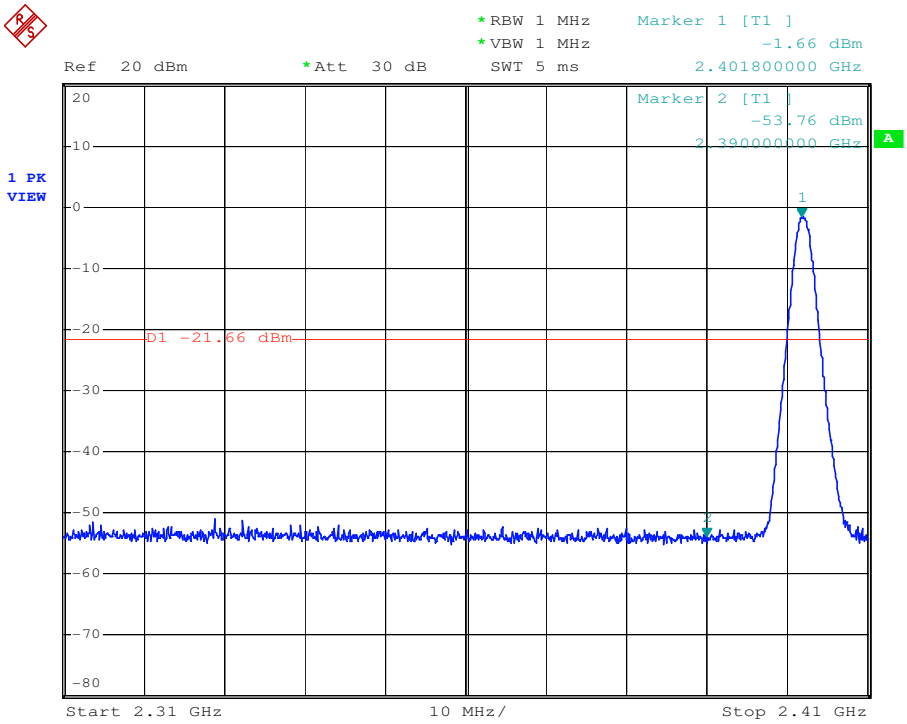
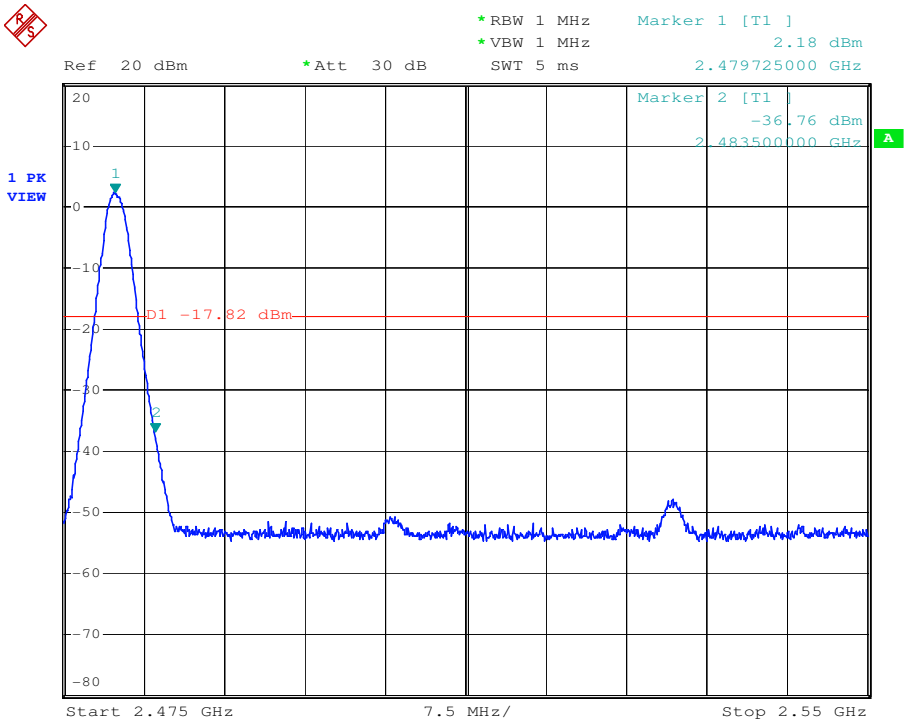
Test mode:	8DPSK	Test channel:	Hopping disabled- Lowest



Test mode:	8DPSK	Test channel:	Hopping disabled- Highest



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7.11 Radiated Spurious Emissions and Band-edge

Frequency Range: 9KHz to 25GHz

Test site/setup:

Measurement Distance: 3m (Semi-Anechoic Chamber)
Test instrumentation set-up:

Frequency Range	Detector	RBW	VBW
0.009MHz-0.090MHz	Peak	10kHz	30kHz
0.009MHz-0.090MHz	Average	10kHz	30kHz
0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz
0.110MHz-0.490MHz	Peak	10kHz	30kHz
0.110MHz-0.490MHz	Average	10kHz	30kHz
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz
30MHz-1GHz	Quasi-peak	100kHz	300kHz
Above 1GHz	Peak	RBW=1MHz	VBW≥RBW
	Average		VBW=10Hz

Sweep=Auto

15.209 Limit:

Frequency	Limit (dBuV/m)
0.009MHz-0.490MHz	128.5 ~ 93.8
0.490MHz-1.705MHz	73.8 ~63.0
1.705MHz-30MHz	69.5
30MHz-88MHz	40.0
88MHz-216MHz	43.5
216MHz-960MHz	46.0
960MHz-1GHz	54.0
Above 1GHz	54.0

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

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Test Configuration: Receive antenna scan height 1 m - 4 m. polarization Vertical / Horizontal

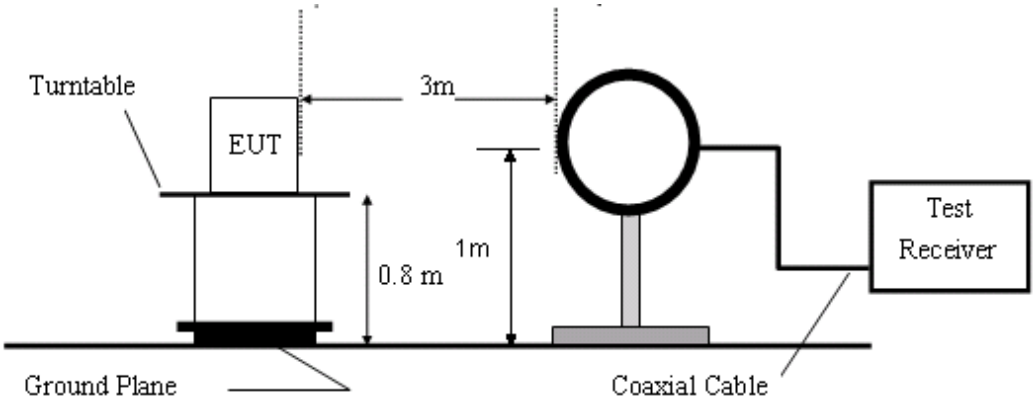

Figure1. 30MHz to 1GHz radiated emissions test configuration

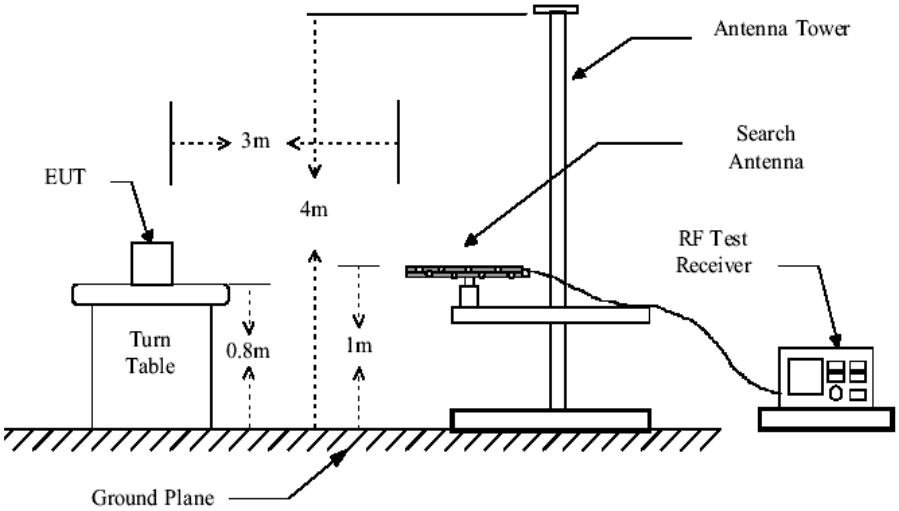

Figure2. 30MHz to 1GHz radiated emissions test configuration

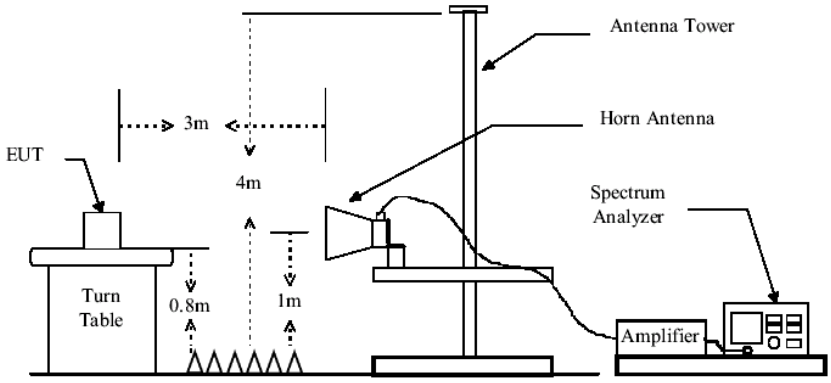

Figure3. Above 1GHz radiated emissions test configuration

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Test Procedure: The procedure used was ANSI Standard C63.10:2009. The receiver was scanned from 9KHz to 25GHz.When an emission was found, the table was rotated to produce the maximum signal strength. An initial pre-scan was performed for in peak detection mode using the receiver. The EUT was measured for both the Horizontal and Vertical polarities and performed a pre-test three orthogonal planes. For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. The worst case emissions were reported.

Low noise amplifier was used below 1GHz, High pass Filter was used above 3GHz.

Between 1G and 3GHz, we did not use any amplifier or filter.

Pre-test was performed on GFSK and HS mode, Compliance test was performed on worse case (8DPSK mode).

Test were performed for their spatial orthogonal(X, Y, Z), the worst test data (X orthogonal) was submitted.

1) For this intentional radiator operates below 25 GHz. the spectrum shall be investigated to the tenth harmonic of the highest fundamental frequency. And above the third harmonic of this intentional radiator, the disturbance is very low. So the test result only displays to 5rd harmonic.
2) As shown in Section, for frequencies above 1000MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

The test only perform the EUT in transmitting status since the test frequencies were over 1GHz only required transmitting status.

Test Result: Pass

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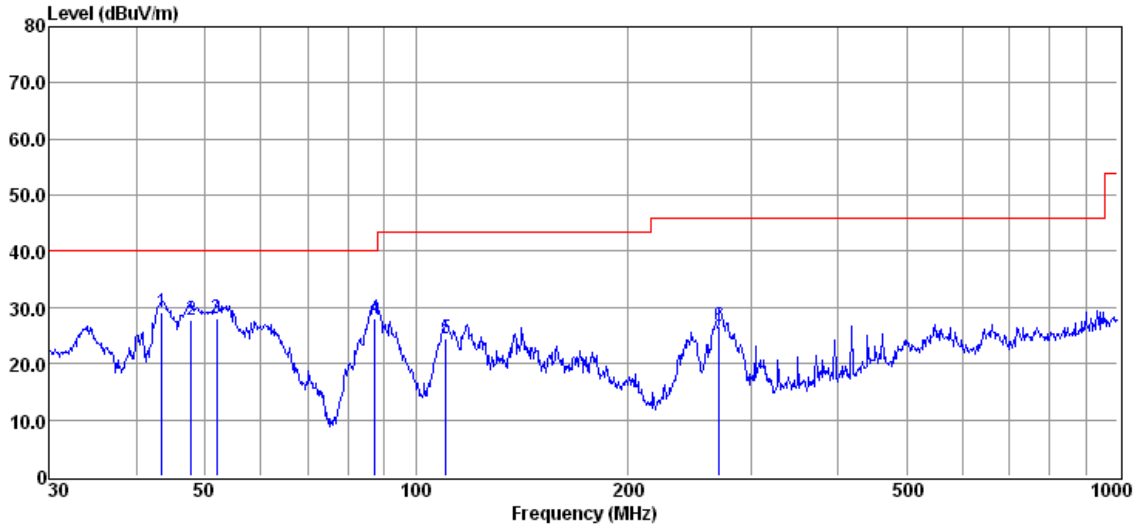
7.11.1 Radiated Spurious Emissions:

30MHz-1GHz:
Vertical:



Item	Freq.	Read Level	Antenna Factor	Preamp Factor	Cable Loss	Result Level	Limit Line	Over Limit	Detector
(Mark)	(MHz)	(dBµV)	(dB/m)	(dB)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	
1	78.97	32.80	9.01	24.70	0.86	17.97	40.00	-22.03	QP
2	183.20	33.63	10.65	24.60	1.43	21.11	43.50	-22.39	QP
3	248.55	38.86	10.49	24.50	1.72	26.57	46.00	-19.43	QP
4	271.33	37.32	11.52	24.50	1.82	26.16	46.00	-19.84	QP
5	304.61	37.26	12.53	24.50	1.97	27.26	46.00	-18.74	QP
6	372.00	33.90	14.22	24.41	2.20	25.91	46.00	-20.09	QP

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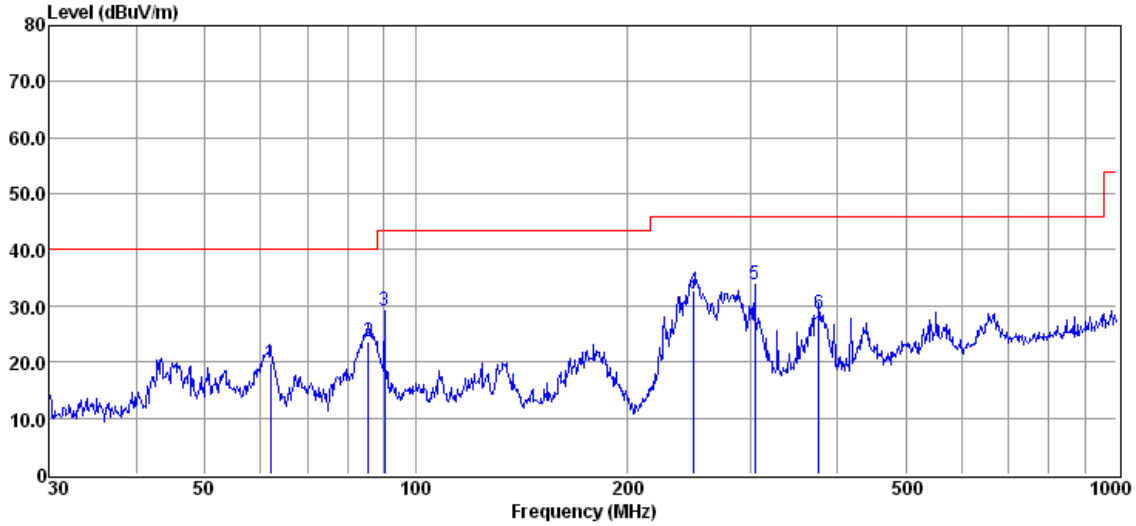
Horizontal:



Item	Freq.	Read Level	Antenna Factor	Preamp Factor	Cable Loss	Result Level	Limit Line	Over Limit	Detector
(Mark)	(MHz)	(dBµV)	(dB/m)	(dB)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	
1	43.05	41.00	13.18	24.70	0.58	30.06	40.00	-9.94	QP
2	46.50	39.69	13.01	24.70	0.62	28.62	40.00	-11.38	QP
3	53.69	40.70	12.58	24.70	0.68	29.26	40.00	-10.74	QP
4	61.56	39.16	11.98	24.70	0.74	27.18	40.00	-12.82	QP
5	86.81	42.00	8.60	24.70	0.92	26.82	40.00	-13.18	QP
6	270.38	38.79	11.48	24.50	1.82	27.59	46.00	-18.41	QP

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Above 1GHz:

Lowest Channel(2402MHz)

Mark	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	4818.75	43.49	8.46	51.95	54	-2.05	peak	Horizontal
2	7192.25	43.00	10.60	53.60	54	-0.40	peak	Horizontal
3	9612.75	42.52	14.24	53.76	54	-0.24	peak	Horizontal
4	4818.75	41.79	8.46	50.25	54	-3.75	peak	Vertical
5	7192.25	41.94	10.60	52.54	54	-1.46	peak	Vertical
6	9612.75	41.39	14.24	53.63	54	-0.37	peak	Vertical

Middle Channel(2441MHz)

Mark	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	4877.50	44.49	8.83	53.32	54	-0.68	peak	Horizontal
2	7333.25	44.54	10.93	53.47	54	-0.53	peak	Horizontal
3	9777.25	43.12	14.45	52.57	54	-1.43	peak	Horizontal
4	4877.50	41.45	8.83	50.28	54	-3.72	peak	Vertical
5	7333.25	42.12	10.93	53.05	54	-0.95	peak	Vertical
6	9777.25	39.77	14.45	52.22	54	-1.78	peak	Vertical

Highest Channel(2480MHz)

Mark	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	4971.50	46.77	8.94	52.71	54	-1.29	peak	Horizontal
2	7427.25	45.73	11.14	53.87	54	-0.13	peak	Horizontal
3	9918.25	43.55	14.69	52.24	54	-1.76	peak	Horizontal
4	4971.50	42.22	8.94	51.16	54	-2.84	peak	Vertical
5	7427.25	41.46	11.14	52.60	54	-1.40	peak	Vertical
6	9918.25	41.79	14.69	53.48	54	-0.52	peak	Vertical

Remark: 1. Test Level =Receiver Reading + Antenna Factor + Cable Loss –Preamplifier Factor.

2. If the Peak value below the AV Limit, the AV test doesn't perform for this submission.

3. No any other emissions level which are attenuated less than 20dB below the limit. According to 15.31(o), the amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this Part. Hence there no other emissions have been reported.

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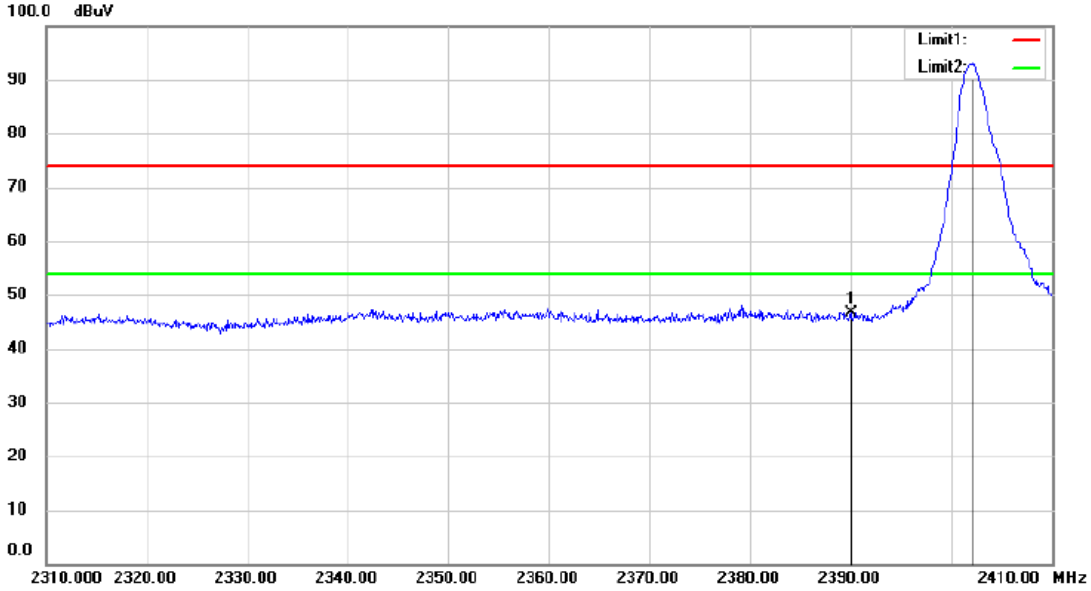
7.11.2 Radiated Band edge

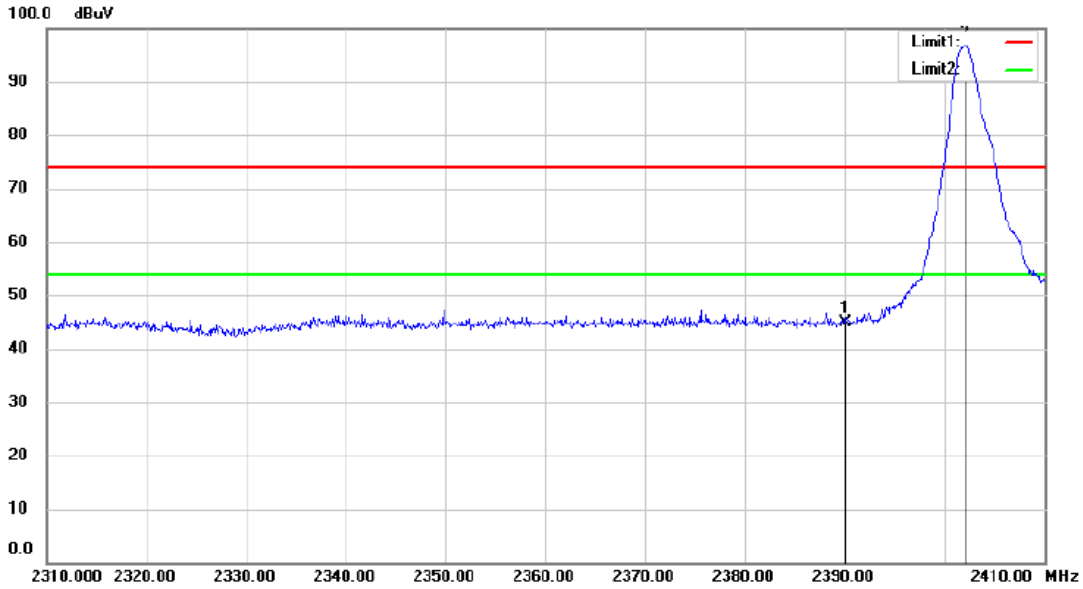
Lowest Channel(2402MHz) **Modulation: GFSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2390.00	47.26	-0.56	46.70	54	-7.30	Peak	Horizontal
2	2402.10	93.63	-0.63	93.00	54	39.00	Peak	Horizontal
1	2390.00	45.10	-0.56	44.84	54	-9.16	Peak	Vertical
2	2402.10	97.37	-0.63	96.74	54	42.74	Peak	Vertical

Horizontal:



Vertical:



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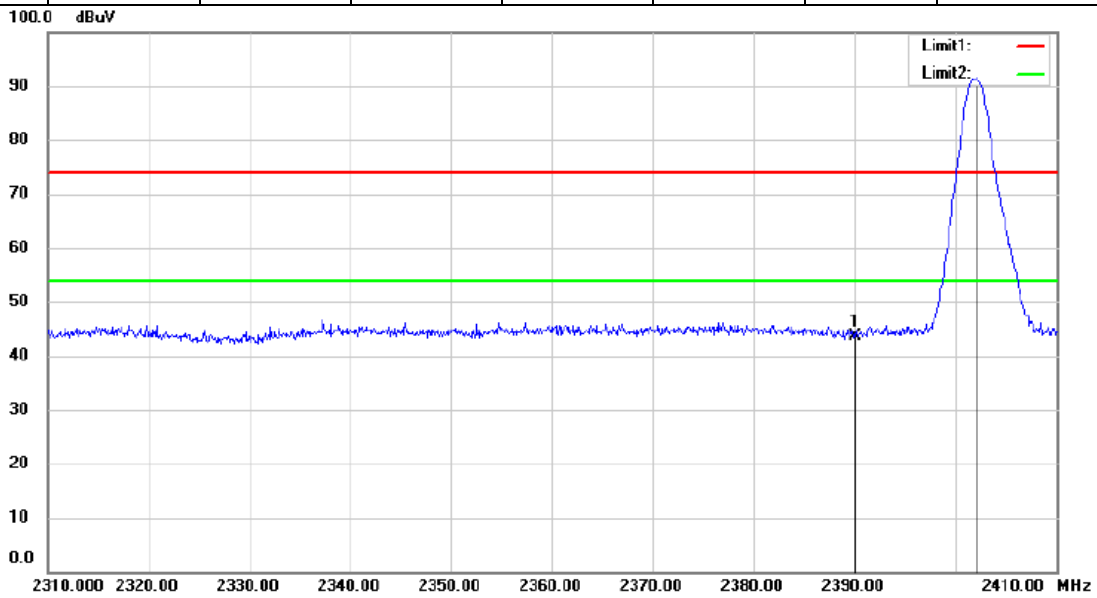
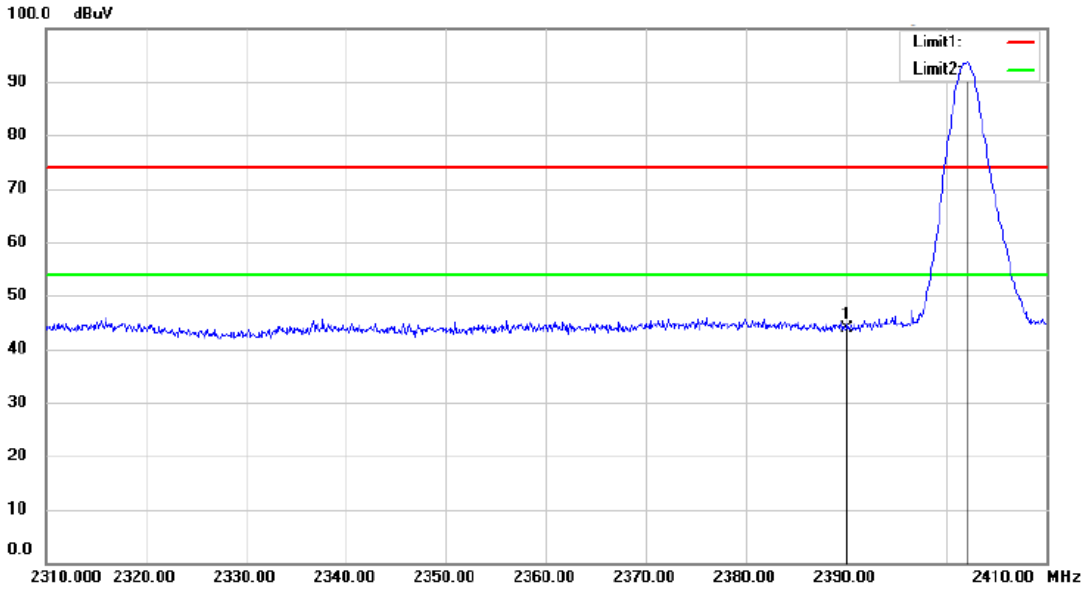
Lowest Channel(2402MHz) **Modulation: π/4DQPSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2390.00	44.20	-0.56	43.64	54	-10.36	Peak	Horizontal
2	2402.00	92.26	-0.62	91.63	54	37.63	Peak	Horizontal
1	2390.00	44.34	-0.56	43.78	54	-10.22	Peak	Vertical
2	2402.00	94.35	-0.63	93.72	54	39.72	Peak	Vertical

Horizontal:



Vertical:



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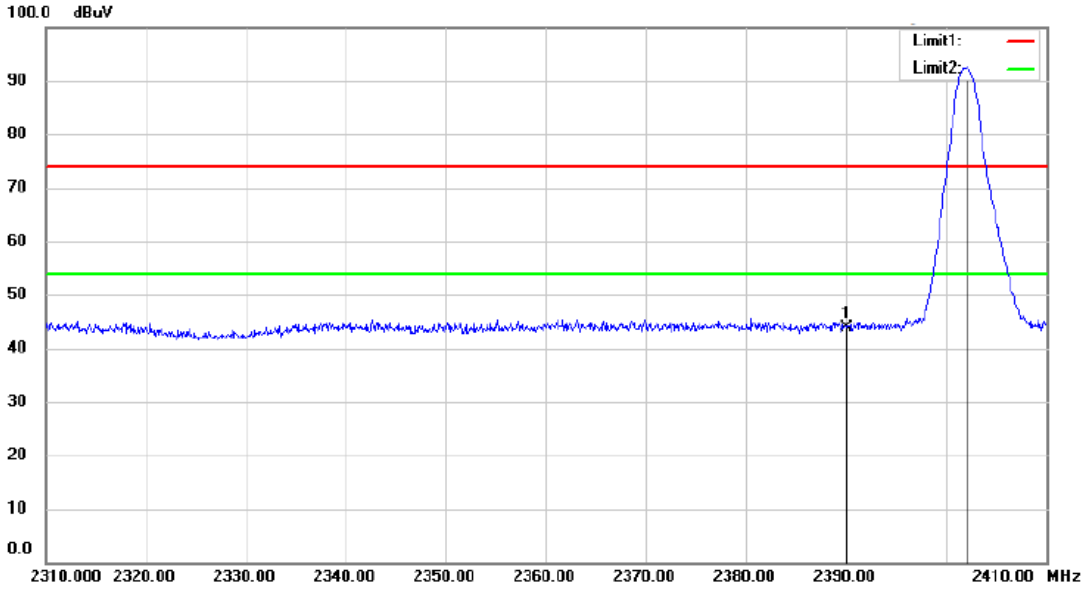
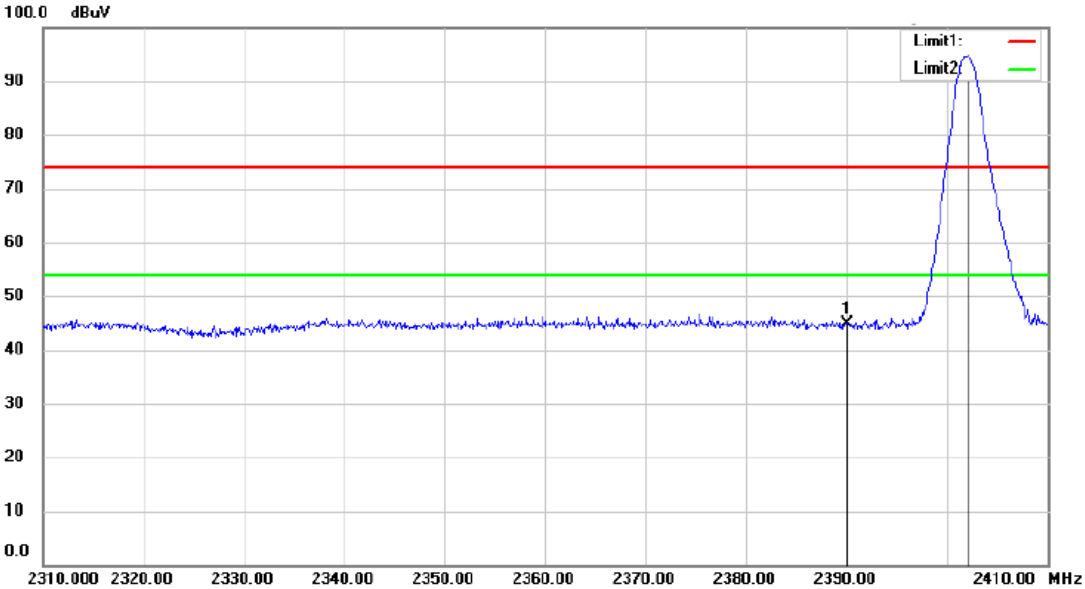
Lowest Channel(2402MHz) **Modulation: 8DPSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2390.00	44.36	-0.56	43.80	54	-10.20	Peak	Horizontal
2	2402.10	93.24	-0.63	92.61	54	28.61	Peak	Horizontal
1	2390.00	45.46	-0.56	44.90	54	-9.10	Peak	Vertical
2	2402.10	95.45	-0.63	94.82	54	40.82	Peak	Vertical

Horizontal:



Vertical:



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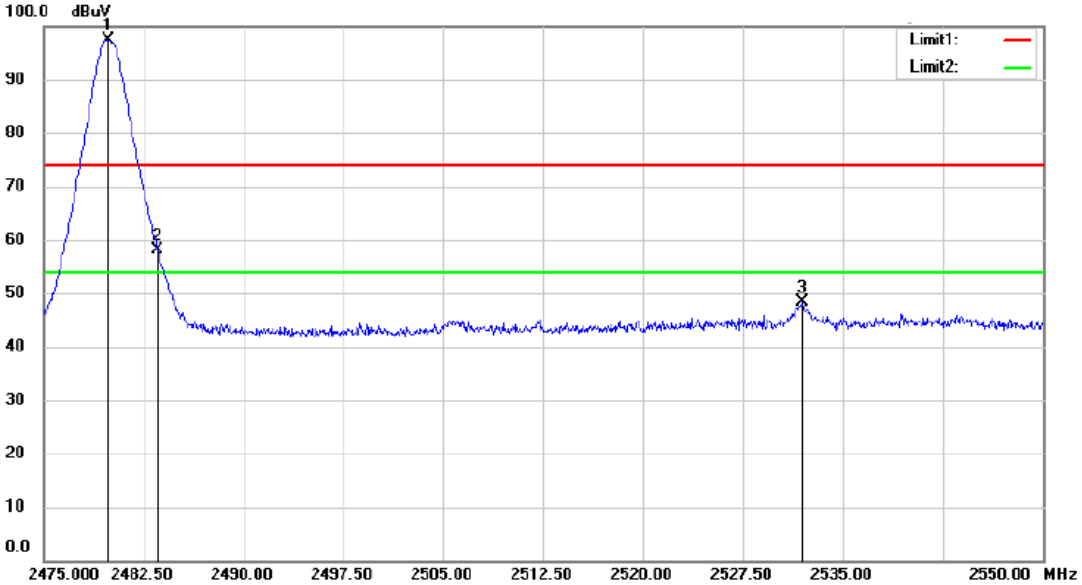
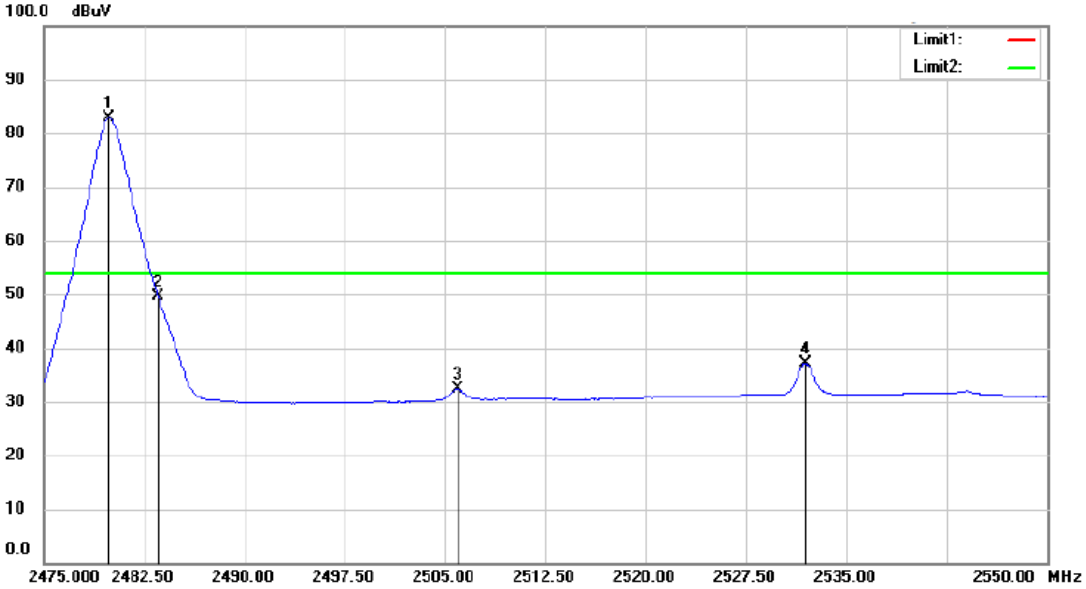
CH Low 2480MHz **Modulation: GFSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2479.80	98.41	-0.99	97.42	74	23.42	Peak	Horizontal
2	2483.50	59.18	-1.01	58.17	74	-15.83	Peak	Horizontal
3	2531.923	49.14	-0.75	48.39	74	-25.61	Peak	Horizontal
1	2479.88	83.83	-0.99	82.84	54	28.84	Average	Horizontal
2	2483.50	50.63	-1.01	49.62	54	-4.38	Average	Horizontal
3	2505.90	33.38	-1.02	32.36	54	-21.64	Average	Horizontal
4	2531.93	37.92	-0.75	37.17	54	-16.83	Average	Horizontal

Detector Peak:



Detector Average:



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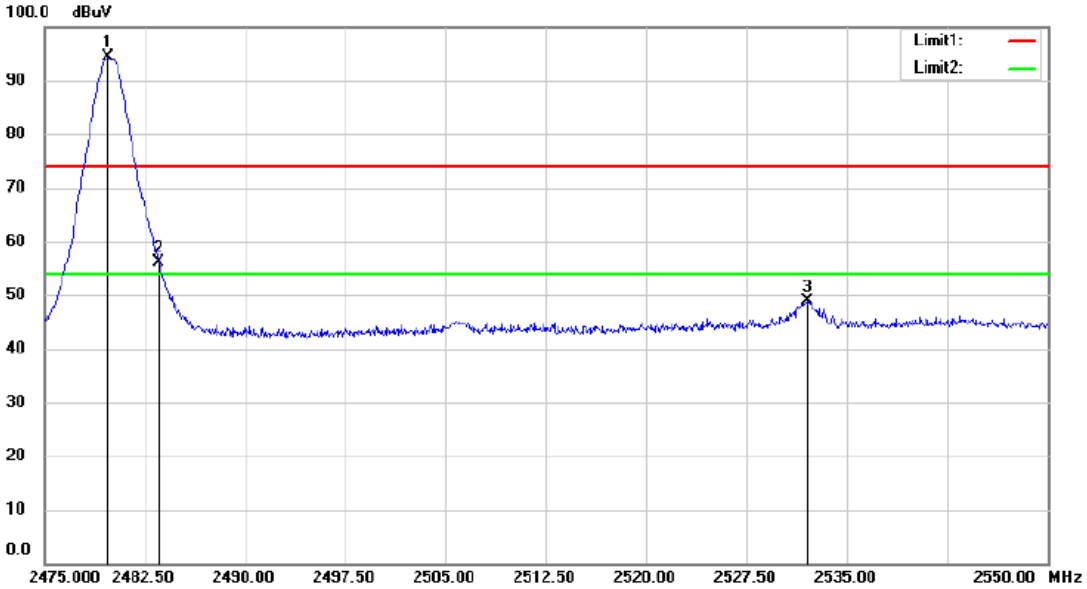
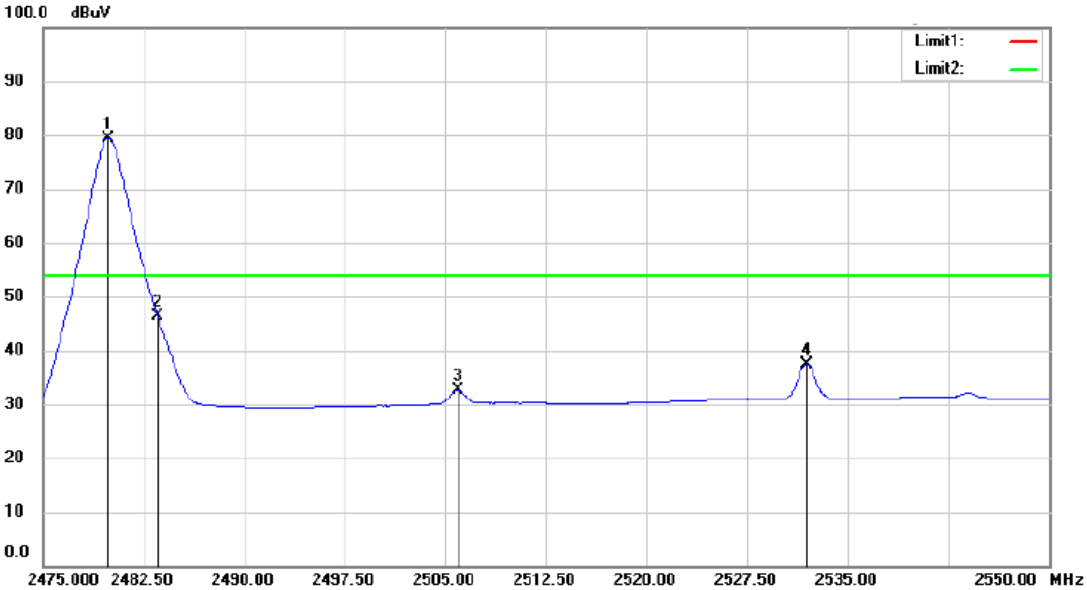
CH Low 2480MHz **Modulation: GFSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2479.73	95.25	-0.99	94.26	74	20.26	Peak	Vertical
2	2483.50	57.17	-1.01	56.16	74	-17.84	Peak	Vertical
3	2532.08	49.51	-0.74	48.77	74	-25.23	Peak	Vertical
1	2479.88	80.46	-0.99	79.47	54	25.47	Average	Vertical
2	2483.50	47.37	-1.01	46.36	54	-7.64	Average	Vertical
3	2505.90	33.71	-1.02	32.69	54	-21.31	Average	Vertical
4	2531.93	38.22	-0.75	37.47	54	-16.53	Average	Vertical

Detector Peak:



Detector Average:



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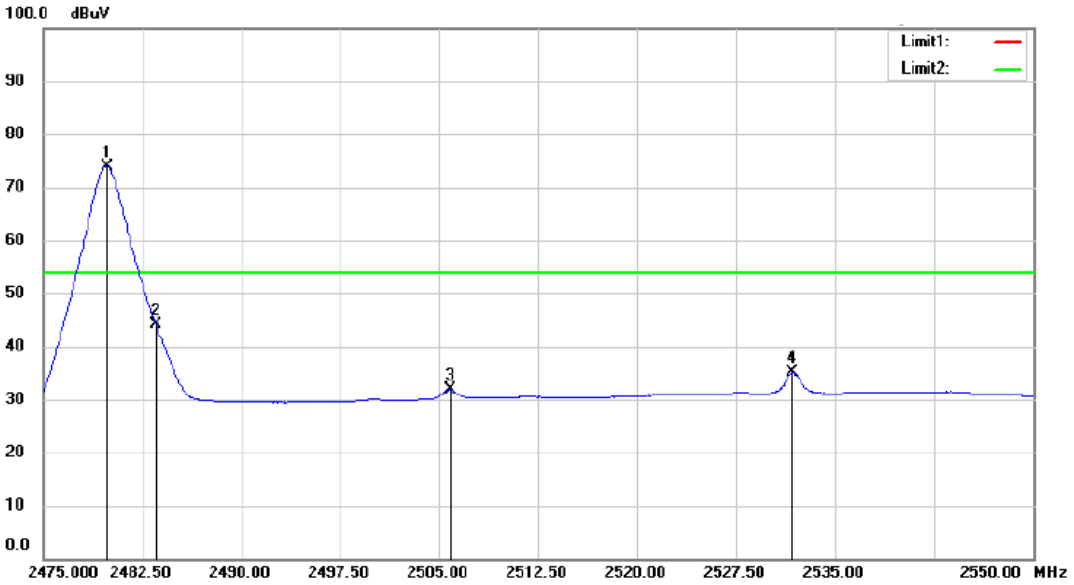
CH Low 2480MHz **Modulation: π/4DQPSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2479.73	95.92	-0.99	94.93	74	20.93	Peak	Horizontal
2	2483.50	57.68	-1.01	56.67	74	-17.33	Peak	Horizontal
3	2531.55	47.65	-0.76	46.89	74	-27.11	Peak	Horizontal
1	2479.80	74.96	-0.99	73.97	54	19.97	Average	Horizontal
2	2483.50	45.11	-1.01	44.10	54	-9.90	Average	Horizontal
3	2505.83	32.85	-1.02	31.83	54	-22.17	Average	Horizontal
4	2531.78	35.86	-0.75	35.11	54	-18.89	Average	Horizontal

Detector Peak:

Detector Average:



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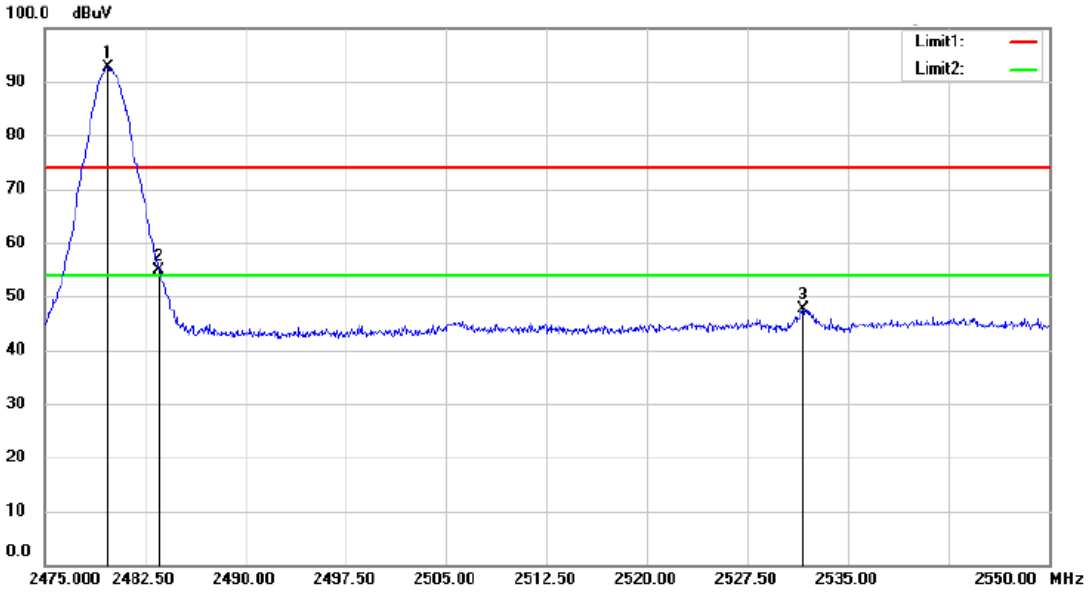
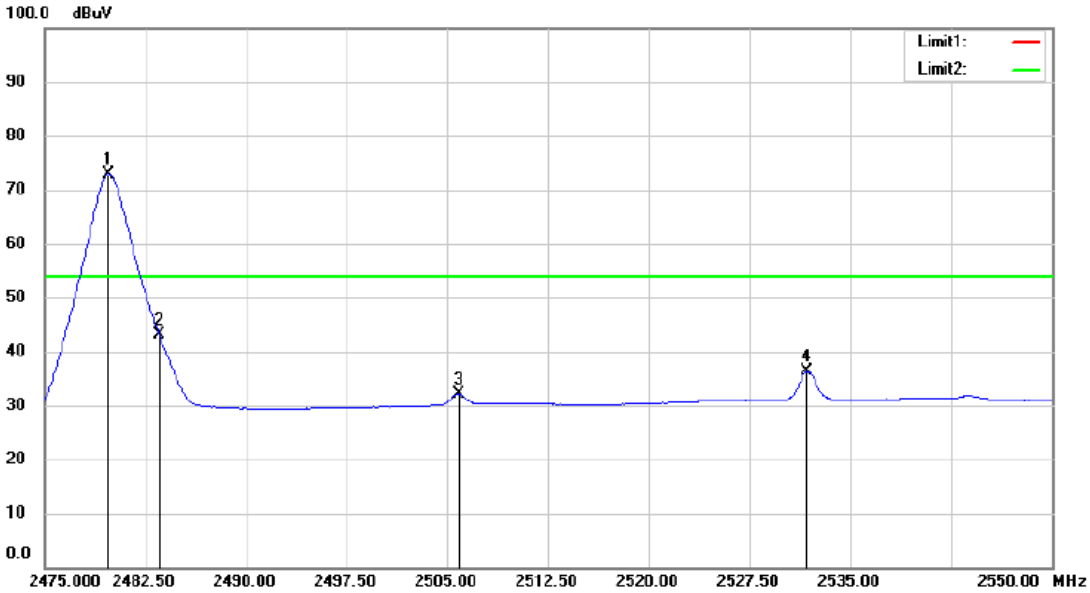
CH Low 2480MHz **Modulation: π/4DQPSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2479.73	93.55	-0.99	92.56	74	18.56	Peak	Vertical
2	2483.50	55.91	-1.01	54.90	74	-19.10	Peak	Vertical
3	2531.63	48.37	-0.76	47.61	74	-26.39	Peak	Vertical
1	2479.73	73.99	-0.99	73.00	54	19.00	Average	Vertical
2	2483.50	44.17	-1.01	43.16	54	-10.84	Average	Vertical
3	2505.83	33.22	-1.02	32.20	54	-21.80	Average	Vertical
4	2531.78	37.01	-0.75	36.26	54	-17.74	Average	Vertical

Detector Peak:



Detector Average:



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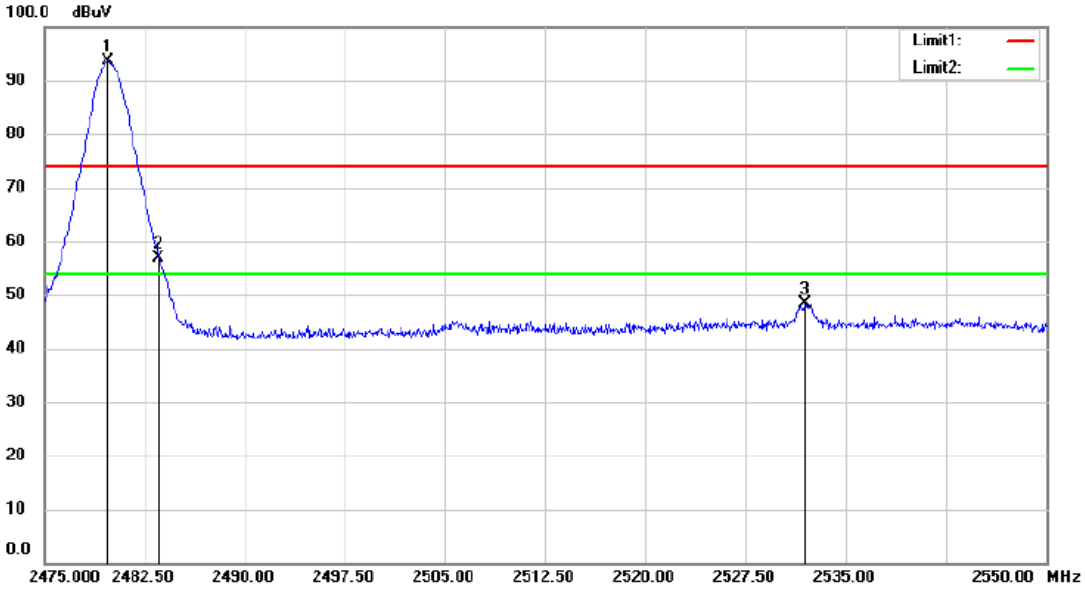
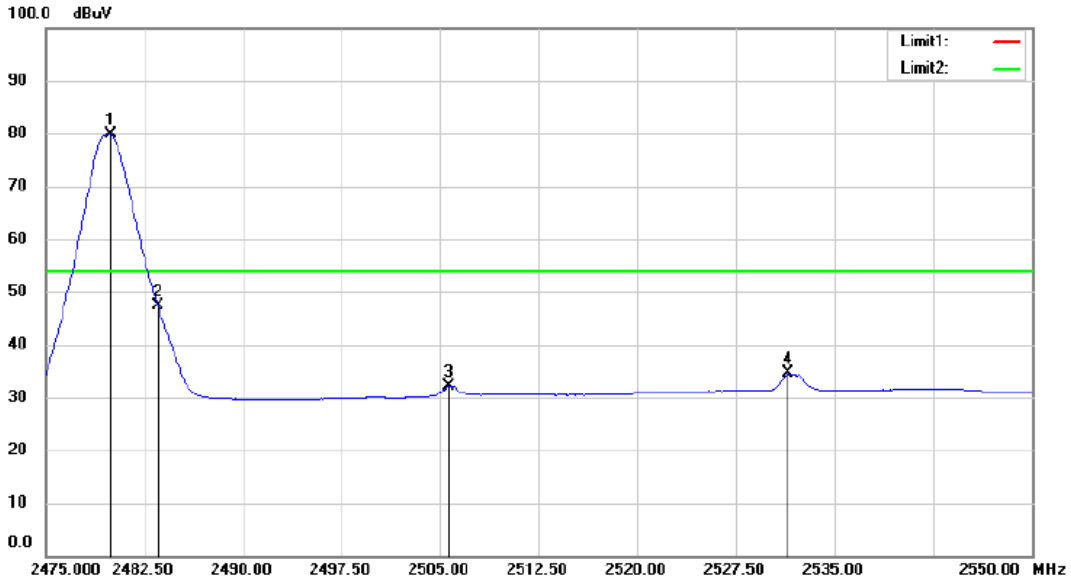
CH Low 2480MHz **Modulation: 8DPSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2479.73	94.50	-0.99	93.51	74	19.51	Peak	Horizontal
2	2483.50	57.95	-1.01	56.94	74	-17.06	Peak	Horizontal
3	2531.93	49.12	-0.75	48.37	74	-25.63	Peak	Horizontal
1	2479.95	80.98	-0.99	79.99	54	25.99	Average	Horizontal
2	2483.50	48.30	-1.01	47.29	54	-6.71	Average	Horizontal
3	2505.68	33.27	-1.02	32.24	54	-21.76	Average	Horizontal
4	2531.40	35.39	-0.76	34.63	54	-19.37	Average	Horizontal

Detector Peak:



Detector Average:



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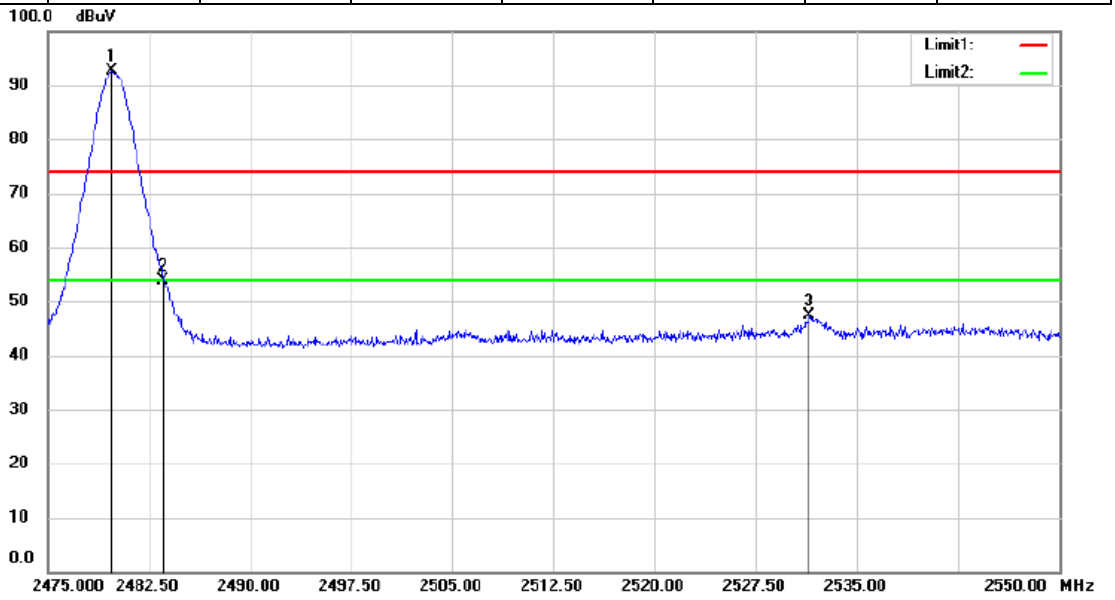
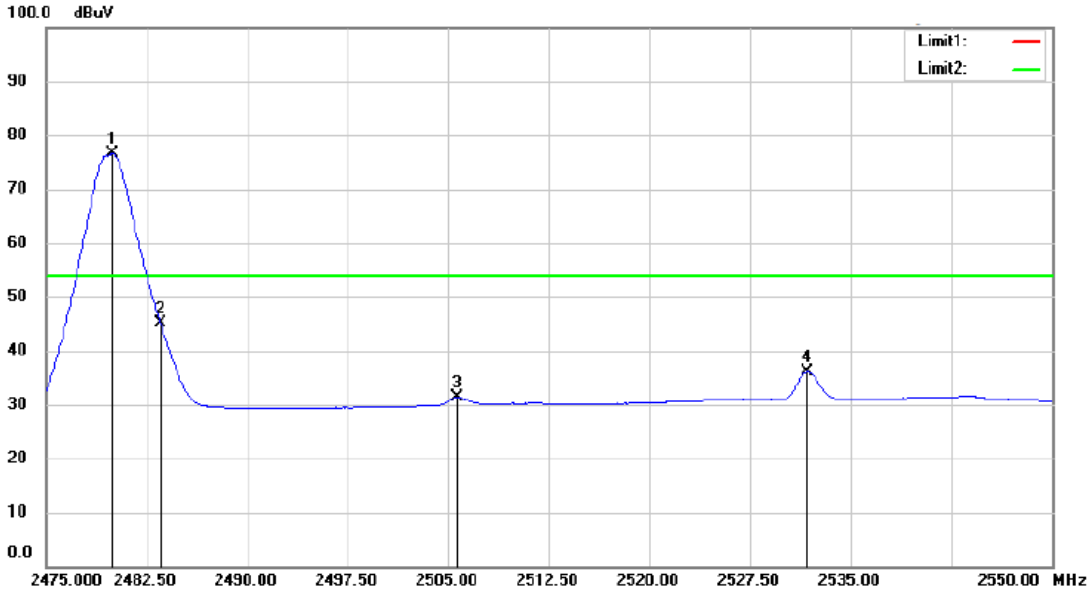
CH Low 2480MHz **Modulation: 8DPSK**

MK.	Frequency (MHz)	Reading (dBuV/m)	Corrected factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Polarization
1	2479.73	93.50	-0.99	92.51	74	18.51	Peak	Vertical
2	2483.50	54.94	-1.01	53.93	74	-20.07	Peak	Vertical
3	2531.48	48.07	-0.76	47.31	74	-26.69	Peak	Vertical
1	2479.95	77.60	-0.99	76.61	54	22.61	Average	Vertical
2	2483.53	46.02	-1.01	45.01	54	-8.99	Average	Vertical
3	2505.60	32.39	-1.03	31.36	54	-22.64	Average	Vertical
4	2531.78	36.77	-0.75	36.02	54	-17.98	Average	Vertical

Detector Peak:



Detector Average:



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Remark: 1. Test Level =Receiver Reading + Antenna Factor + Cable Loss –Preamplifier Factor.

2. No any other emissions level which are attenuated less than 20dB below the limit. According to 15.31(o), the amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this Part. Hence there no other emissions have been reported.

3. If the Peak value below the AV Limit, the AV test doesn't perform for this submission.

All frequencies within the "Restricted bands" have been evaluated to compliance. Section 15.205 Restricted bands of operation.

Except as shown in paragraph 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	10.5 - 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	2655 - 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	
13.36 - 13.41			

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8 Test Setup Photographs

Refer to the < NS2V2 _Test Setup photos-FCC>.

9 EUT Constructional Details

Refer to the < NS2V2 _External Photos-FCC > & < NS2V2 _Internal Photos-FCC>.

--End of the Report--

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