SGS-CSTC Standards Technical Services Co., Ltd.
Shenzhen Branch

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FCC REPORT

Application No:	SZEM1604002891CR
Applicant:	S.E.M. INDUSTRIES
Manufacturer:	S.E.M. INDUSTRIES
Factory:	S.E.M. INDUSTRIES
Product Name:	Bluetooth Turntable
Model No.(EUT):	TT-9311
Add Model No.:	TT-9311-BTM3EJ, TT-9311-BTM3, TT-9511, TT-9511-BTM3EJ, TT-9511-BTM3, TTT601, TTT601-BK, TTT601-BL, TTT601-RD, TTT601-TN, TTT601S, TTT603, TTT603-BK
Trade Mark:	S.E.M., S-LOGO, NIL, S-DIGITAL, SDIGITAL, S.E.M. AUDIO LABORATORIES, TYLER
FCC ID:	2AANA-SEM-TT9311
Standards:	47 CFR Part 15, Subpart C (2015)
Date of Receipt:	2016-04-28
Date of Test:	2016-05-18 to 2016-05-19
Date of Issue:	2016-06-07
Test Result:	**PASS ***

* In the configuration tested, the EUT complied with the standards specified above.

Authorized Signature:

Jack Zhang
EMC Laboratory Manager

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. Any mention of SGS International Electrical Approvals or testing done by SGS International Electrical Approvals in connection with, distribution or use of the product described in this report must be approved by SGS International Electrical Approvals in writing.
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		*2016-06-07*		*Original*

Authorized for issue by:				
Tested By		Bill Chen **(Bill Chen) /Project Engineer**		2016-05-19 **Date**
Prepared By		Iris Zhou **(Iris Zhou) /Clerk**		2016-06-07 **Date**
Checked By		Eric Fu **(Eric Fu) /Reviewer**		2016-06-07 **Date**

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3 Test Summary

Test Item	Test Requirement	Test method	Result
Antenna Requirement	47 CFR Part 15, Subpart C Section 15.203/15.247 (c)	ANSI C63.10 (2013)	PASS
AC Power Line Conducted Emission	47 CFR Part 15, Subpart C Section 15.207	ANSI C63.10 (2013)	PASS
Conducted Peak Output Power	47 CFR Part 15, Subpart C Section 15.247 (b)(1)	ANSI C63.10 (2013)	PASS
20dB Occupied Bandwidth	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Carrier Frequencies Separation	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Hopping Channel Number	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Dwell Time	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Pseudorandom Frequency Hopping Sequence	47 CFR Part 15, Subpart C Section 15.247(b)(4)&TCB Exclusion List (7 July 2002)	ANSI C63.10 (2013)	PASS
Band-edge for RF Conducted Emissions	47 CFR Part 15, Subpart C Section 15.247(d)	ANSI C63.10 (2013)	PASS
RF Conducted Spurious Emissions	47 CFR Part 15, Subpart C Section 15.247(d)	ANSI C63.10 (2013)	PASS
Radiated Spurious emissions	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10 (2013)	PASS
Restricted bands around fundamental frequency (Radiated Emission)	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10 (2013)	PASS

Remark:

Model No.: TT-9311, TT-9311-BTM3EJ, TT-9311-BTM3, TT-9511, TT-9511-BTM3EJ, TT-9511-BTM3, TTT601, TTT601-BK, TTT601-BL, TTT601-RD, TTT601-TN, TTT601S, TTT603, TTT603-BK

Only the model TT-9311 was tested, since the electrical circuit design, layout, components used and internal wiring were identical for all above models, only different on model No., trade name, color, cosmetic outlook and silkscreen.

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5 General Information

5.1 Client Information

Applicant:	S.E.M. INDUSTRIES
Address of Applicant:	35/F., Tower A, Billion Centre, No.1 Wang Kwong Road, Kowloon Bay, Hong Kong
Manufacturer:	S.E.M. INDUSTRIES
Address of Manufacturer:	35/F., Tower A, Billion Centre, No.1 Wang Kwong Road, Kowloon Bay, Hong Kong
Factory:	S.E.M. INDUSTRIES
Address of Factory:	35/F., Tower A, Billion Centre, No.1 Wang Kwong Road, Kowloon Bay, Hong Kong

5.2 General Description of EUT

Product Name:	Bluetooth Turntable
Model No.:	TT-9311
Trade Mark:	S.E.M., S-LOGO, NIL, S-DIGITAL, SDIGITAL, S.E.M. AUDIO LABORATORIES, TYLER
Operation Frequency:	2402MHz~2480MHz
Bluetooth Version:	V2.1+EDR
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Modulation Type:	GFSK, π/4DQPSK, 8DPSK
Number of Channel:	79
Hopping Channel Type:	Adaptive Frequency Hopping systems
Antenna Type:	Integral
Antenna Gain:	1.2dBi
Power Supply:	Adapter MODEL:S24W-090200USD INPUT:100-240V50/60Hz 0.8A OUTPUT:9.0V 2A
Test Voltage:	120V 60Hz

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Operation Frequency each of channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402MHz	20	2422MHz	40	2442MHz	60	2462MHz
1	2403MHz	21	2423MHz	41	2443MHz	61	2463MHz
2	2404MHz	22	2424MHz	42	2444MHz	62	2464MHz
3	2405MHz	23	2425MHz	43	2445MHz	63	2465MHz
4	2406MHz	24	2426MHz	44	2446MHz	64	2466MHz
5	2407MHz	25	2427MHz	45	2447MHz	65	2467MHz
6	2408MHz	26	2428MHz	46	2448MHz	66	2468MHz
7	2409MHz	27	2429MHz	47	2449MHz	67	2469MHz
8	2410MHz	28	2430MHz	48	2450MHz	68	2470MHz
9	2411MHz	29	2431MHz	49	2451MHz	69	2471MHz
10	2412MHz	30	2432MHz	50	2452MHz	70	2472MHz
11	2413MHz	31	2433MHz	51	2453MHz	71	2473MHz
12	2414MHz	32	2434MHz	52	2454MHz	72	2474MHz
13	2415MHz	33	2435MHz	53	2455MHz	73	2475MHz
14	2416MHz	34	2436MHz	54	2456MHz	74	2476MHz
15	2417MHz	35	2437MHz	55	2457MHz	75	2477MHz
16	2418MHz	36	2438MHz	56	2458MHz	76	2478MHz
17	2419MHz	37	2439MHz	57	2459MHz	77	2479MHz
18	2420MHz	38	2440MHz	58	2460MHz	78	2480MHz
19	2421MHz	39	2441MHz	59	2461MHz		

Note:
In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test, and the selected channel see below:

Channel	Frequency
The Lowest channel	2402MHz
The Middle channel	2441MHz
The Highest channel	2480MHz

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5.3 Test Environment

Operating Environment:	
Temperature:	25.0 °C
Humidity:	50 % RH
Atmospheric Pressure:	1015mbar

5.4 Description of Support Units

The EUT has been tested independent unit.

5.5 Test Location

All tests were performed at:

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen Branch E&E Lab,
No. 1 Workshop, M-10, Middle Section, Science & Technology Park, Shenzhen, Guangdong, China. 518057.
Tel: +86 755 2601 2053 Fax: +86 755 2671 0594
No tests were sub-contracted.

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5.6 Test Facility

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

•CNAS (No. CNAS L2929)

CNAS has accredited SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab 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.

• A2LA (Certificate No. 3816.01)

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

• VCCI

The 10m Semi-anechoic chamber and Shielded Room of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-823, R-4188, T-1153 and C-2383 respectively.

• FCC – Registration No.: 556682

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration No.: 556682.

• Industry Canada (IC)

Two 3m Semi-anechoic chambers and the 10m Semi-anechoic chamber of SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab have been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 4620C-1, 4620C-2, 4620C-3.

5.7 Deviation from Standards

None.

5.8 Abnormalities from Standard Conditions

None.

5.9 Other Information Requested by the Customer

None.

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5.10 Equipment List

Conducted Emission						
Item	**Test Equipment**	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal. date (yyyy-mm-dd)**	**Cal.Due date (yyyy-mm-dd)**
1	Shielding Room	ZhongYu Electron	GB-88	SEM001-06	2016-05-13	2017-05-13
2	LISN	Rohde & Schwarz	ENV216	SEM007-01	2015-10-09	2016-10-09
3	LISN	ETS-LINDGREN	3816/2	SEM007-02	2016-04-25	2017-04-25
4	8 Line ISN	Fischer Custom Communications Inc.	FCC-TLISN-T8-02	EMC0120	2015-08-30	2016-08-30
5	4 Line ISN	Fischer Custom Communications Inc.	FCC-TLISN-T4-02	EMC0121	2015-08-30	2016-08-30
6	2 Line ISN	Fischer Custom Communications Inc.	FCC-TLISN-T2-02	EMC0122	2015-08-30	2016-08-30
7	EMI Test Receiver	Rohde & Schwarz	ESCI	SEM004-02	2016-04-25	2017-04-25
8	DC Power Supply	Zhao Xin	RXN-305D	SEM011-02	2015-10-09	2016-10-09

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RE in Chamber						
Item	**Test Equipment**	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal. date (yyyy-mm-dd)**	**Cal.Due date (yyyy-mm-dd)**
1	10m Semi-Anechoic Chamber	SAEMC	FSAC1018	SEM001-03	2015-08-01	2016-08-01
2	EMI Test Receiver (9k-3GHz)	Rohde & Schwarz	ESCI	SEM004-01	2016-04-25	2017-04-25
3	Trilog-Broadband Antenna(30M-1GHz)	Schwarzbeck	VULB9168	SEM003-17	2016-01-26	2017-01-26
4	Pre-amplifier	Sonoma Instrument Co	310N	SEM005-03	2016-04-25	2017-04-25
5	Loop Antenna	ETS-Lindgren	6502	SEM003-08	2015-08-14	2016-08-14

RE in Chamber						
Item	**Test Equipment**	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal. date (yyyy-mm-dd)**	**Cal.Due date (yyyy-mm-dd)**
1	3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2016-05-13	2017-05-13
2	EMI Test Receiver	Rohde & Schwarz	ESIB26	SEM004-04	2016-04-25	2017-04-25
3	BiConiLog Antenna (26-3000MHz)	ETS-Lindgren	3142C	SEM003-02	2014-11-15	2017-11-15
4	Amplifier (0.1-1300MHz)	HP	8447D	SEM005-02	2015-10-09	2016-10-09
5	Horn Antenna (1-18GHz)	Rohde & Schwarz	HF907	SEM003-07	2015-06-14	2018-06-14
6	Horn Antenna (18-26GHz)	ETS-Lindgren	3160	SEM003-12	2014-11-24	2017-11-24
7	Low Noise Amplifier	Black Diamond Series	BDLNA-0118-352810	SEM005-05	2015-10-09	2016-10-09
8	Band filter	Amindeon	Asi 3314	SEM023-01	N/A	N/A

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RF connected test						
Item	**Test Equipment**	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal. date (yyyy-mm-dd)**	**Cal.Due date (yyyy-mm-dd)**
1	DC Power Supply	ZhaoXin	RXN-305D	SEM011-02	2015-10-09	2016-10-09
2	Spectrum Analyzer	Rohde & Schwarz	FSP	SEM004-06	2015-10-17	2016-10-17
3	Signal Generator	Rohde & Schwarz	SML03	SEM006-02	2016-04-25	2017-04-25
4	Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2015-10-09	2016-10-09

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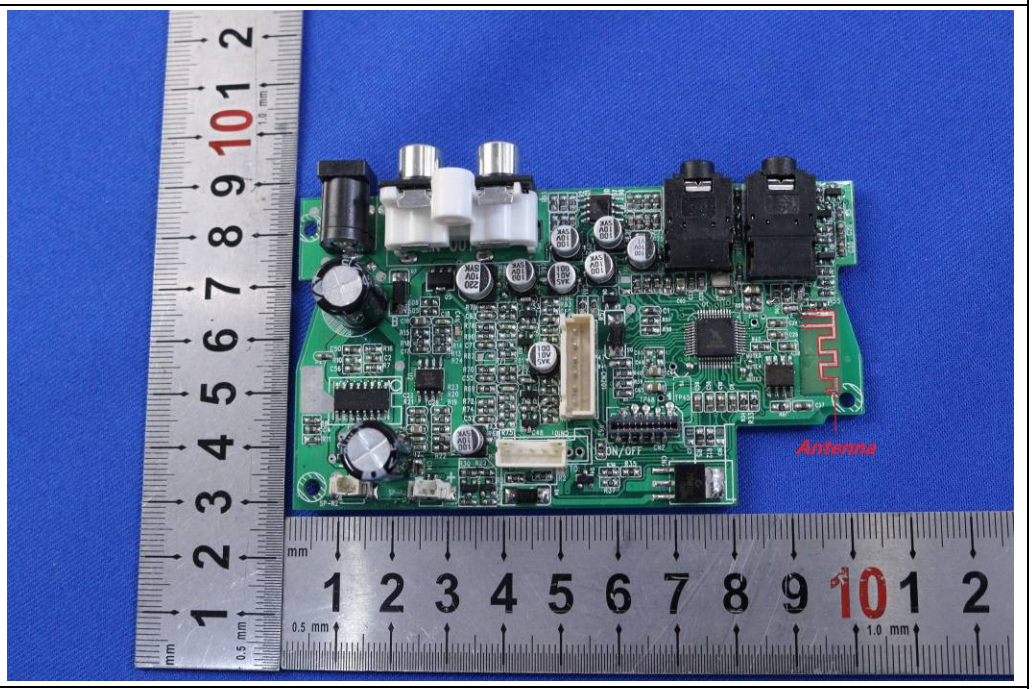
6 Test results and Measurement Data

6.1 Antenna Requirement

Standard requirement:	47 CFR Part 15C Section 15.203 /247(c)

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 antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 1.2dBi.

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6.2 Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.207
Test Method:	ANSI C63.10: 2013
Test Frequency Range:	150kHz to 30MHz
Limit:	

Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Test Procedure:

1) The mains terminal disturbance voltage test was conducted in a shielded room.
2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 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.
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,
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 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10: 2013 on conducted measurement.

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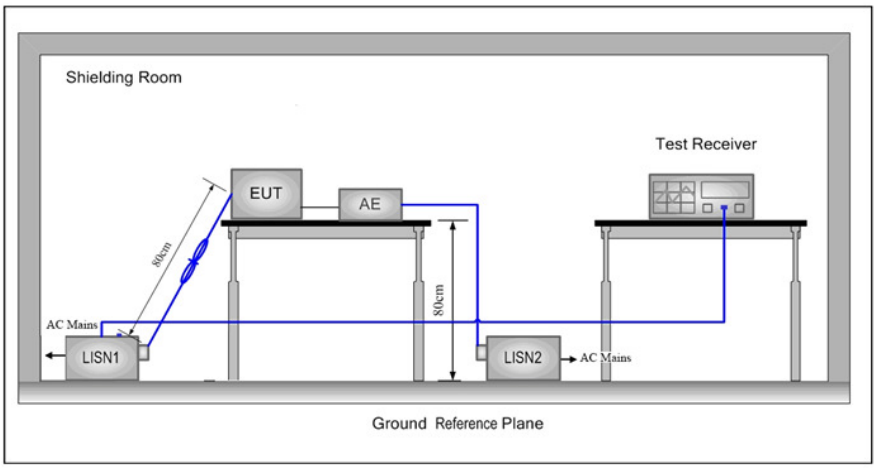
Test Setup:	
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type at the lowest, middle, high channel. Transmitting mode.
Final Test Mode:	Through Pre-scan, find the DH1 of data type and GFSK modulation at the lowest channel is the worst case. Transmitting mode Only the worst case is recorded in the report.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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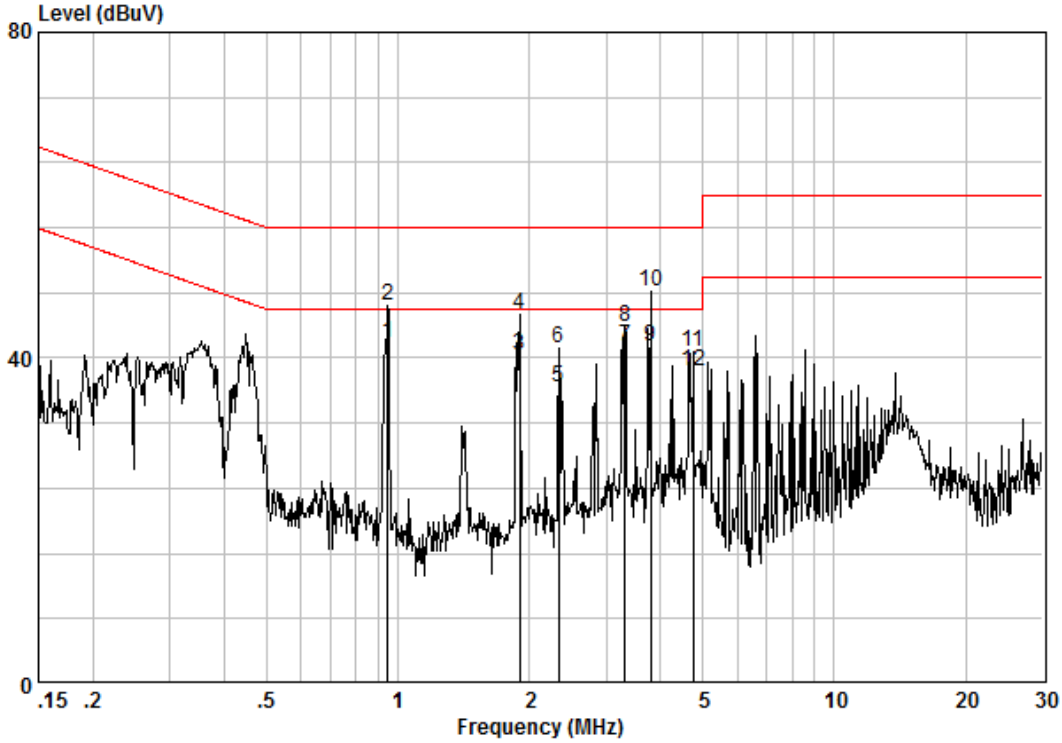
Measurement Data

An initial pre-scan was performed on the live and neutral lines with peak detector.

Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

Live line:



Site : Shielding Room
Condition : CE LINE
Job.No : 2891CR
Test Mode : TX

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.94809	0.02	9.62	32.10	41.74	46.00	-4.26	Average
2	0.94809	0.02	9.62	36.70	46.35	56.00	-9.65	QP
3	1.898	0.02	9.63	30.60	40.25	46.00	-5.75	Average
4	1.898	0.02	9.63	35.74	45.39	56.00	-10.61	QP
5	2.334	0.02	9.63	26.70	36.35	46.00	-9.65	Average
6	2.334	0.02	9.63	31.50	41.15	56.00	-14.85	QP
7	3.310	0.02	9.62	31.70	41.34	46.00	-4.66	Average
8	3.310	0.02	9.62	34.13	43.77	56.00	-12.23	QP
9	3.789	0.02	9.63	31.80	41.44	46.00	-4.56	Average
10	3.799	0.02	9.63	38.43	48.08	56.00	-7.92	QP
11	4.746	0.01	9.65	31.12	40.78	56.00	-15.22	QP
12	4.746	0.01	9.65	28.70	38.36	46.00	-7.64	Average

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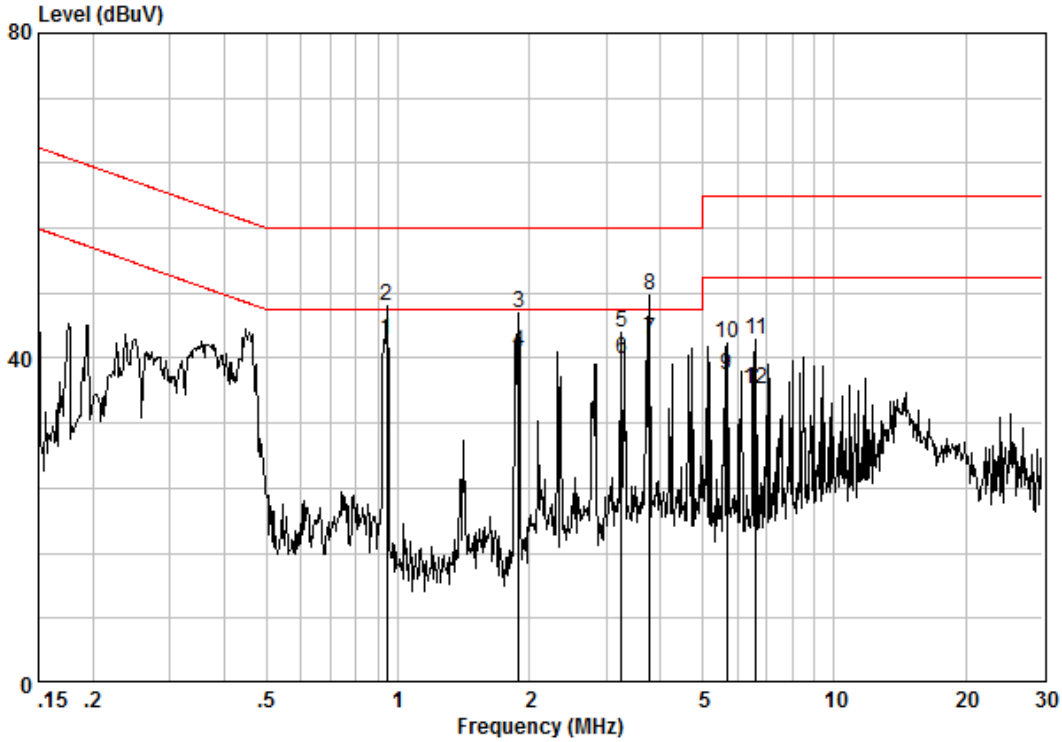
Neutral line:



Site : Shielding Room
Condition : CE NEUTRAL
Job.No : 2891CR
Test Mode : TX

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.94300	0.02	9.62	32.60	42.24	46.00	-3.76	Average
2	0.94308	0.02	9.62	36.84	46.49	56.00	-9.51	QP
3	1.888	0.02	9.63	35.87	45.51	56.00	-10.49	QP
4	1.888	0.02	9.63	31.20	40.85	46.00	-5.15	Average
5	3.258	0.02	9.62	33.48	43.12	56.00	-12.88	QP
6	3.258	0.02	9.62	30.20	39.84	46.00	-6.16	Average
7 @	3.779	0.02	9.63	32.60	42.24	46.00	-3.76	Average
8	3.779	0.02	9.63	38.06	47.71	56.00	-8.29	QP
9	5.683	0.01	9.66	28.30	37.97	50.00	-12.03	Average
10	5.683	0.01	9.66	32.21	41.88	60.00	-18.12	QP
11	6.627	0.01	9.68	32.55	42.24	60.00	-17.76	QP
12	6.627	0.01	9.68	26.40	36.09	50.00	-13.92	Average

Notes:

1. The following Quasi-Peak and Average measurements were performed on the EUT:

2. Final Test Level =Receiver Reading + LISN Factor + Cable Loss.

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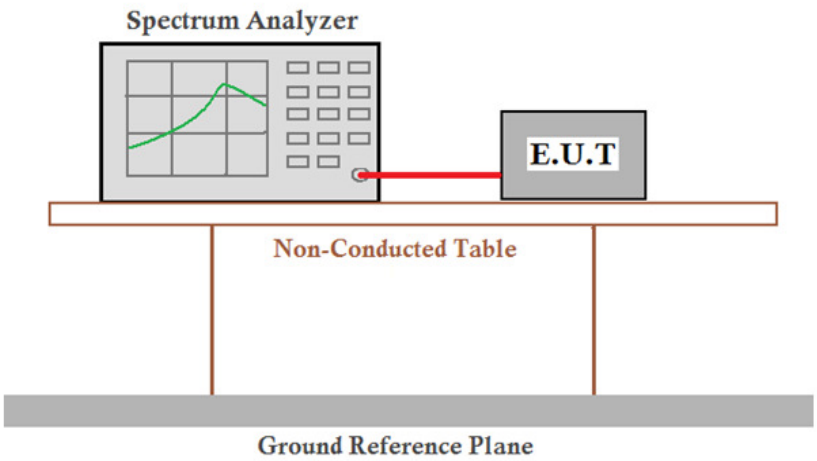
6.3 Conducted Peak Output Power

Test Requirement:	47 CFR Part 15C Section 15.247 (b)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 *Remark:* *Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer.*
Limit:	30dBm
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH1 of data type is the worst case of GFSK modulation type, 2-DH1 of data type is the worst case of π/4DQPSK modulation type, 3-DH1 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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Measurement Data

GFSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	-0.73	30.00	Pass
Middle	-0.50	30.00	Pass
Highest	-0.97	30.00	Pass
π/4DQPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	-0.68	30.00	Pass
Middle	-0.40	30.00	Pass
Highest	-0.72	30.00	Pass
8DPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	-0.20	30.00	Pass
Middle	-1.45	30.00	Pass
Highest	-1.77	30.00	Pass

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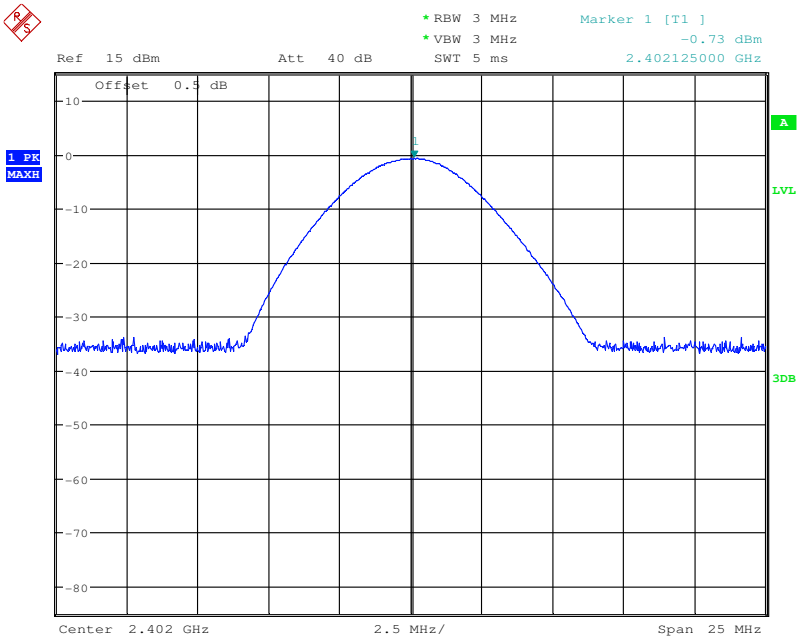
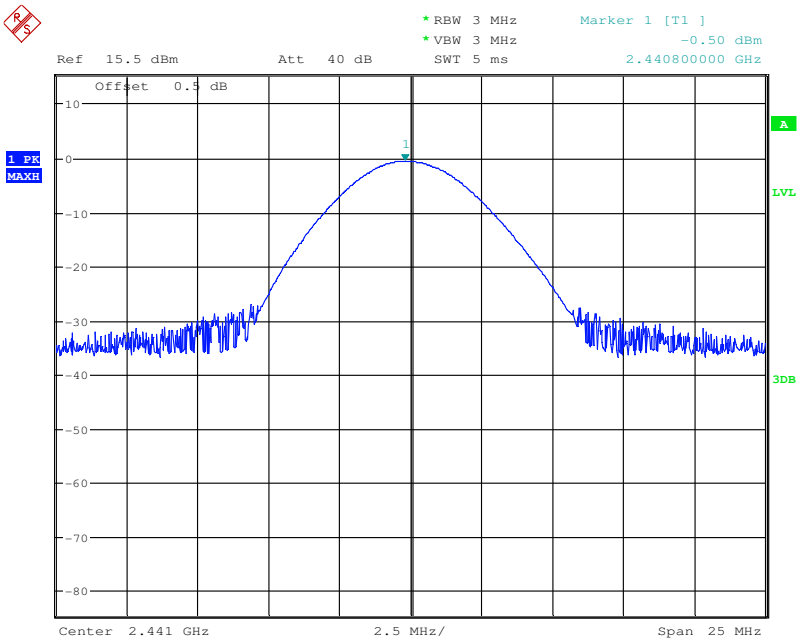
Test plot as follows:

Test mode:	GFSK	Test channel:	Lowest



Test mode:	GFSK	Test channel:	Middle



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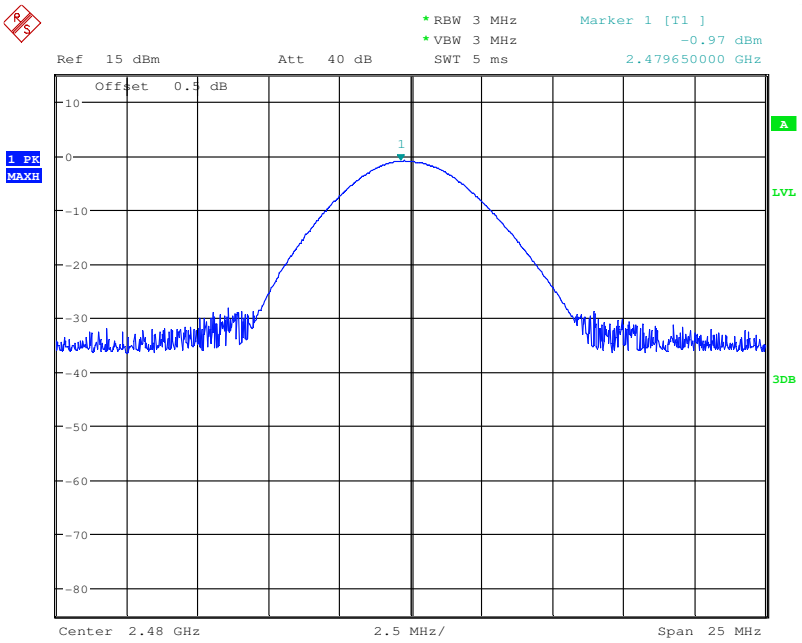
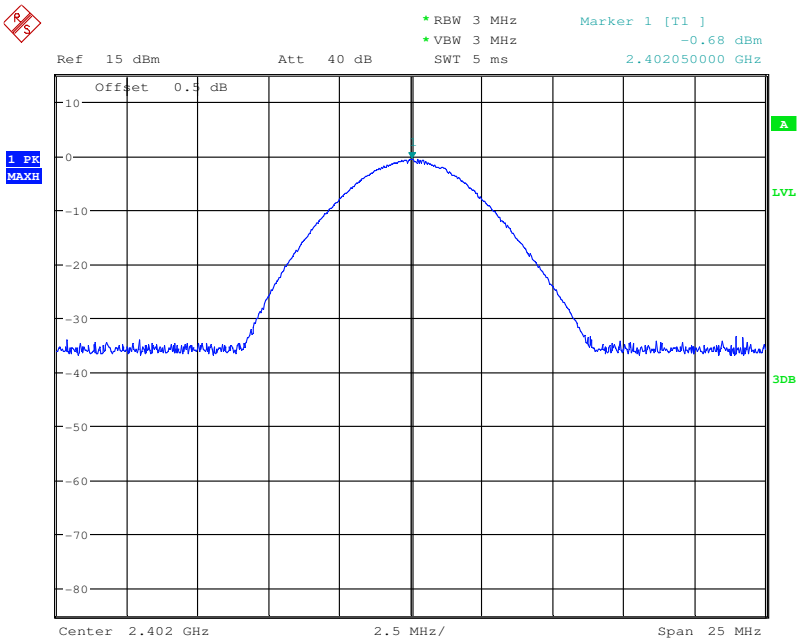
Test mode:	GFSK	Test channel:	Highest



Test mode:	π/4DQPSK	Test channel:	Lowest



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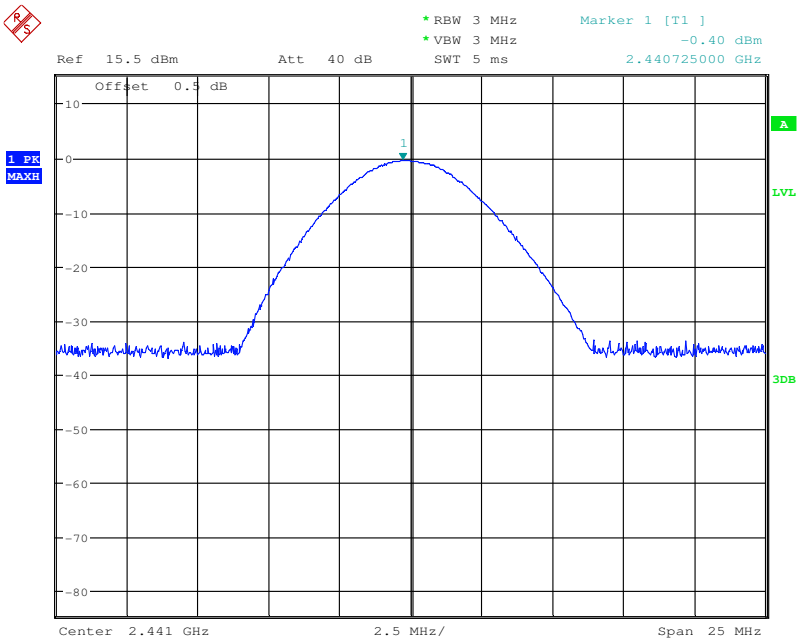
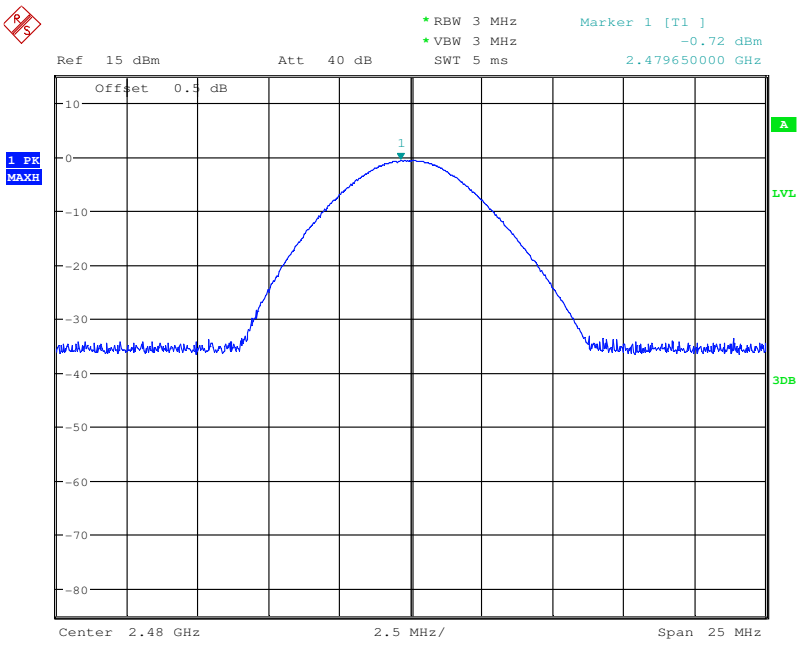
Test mode:	π/4DQPSK	Test channel:	Middle



Test mode:	π/4DQPSK	Test channel:	Highest



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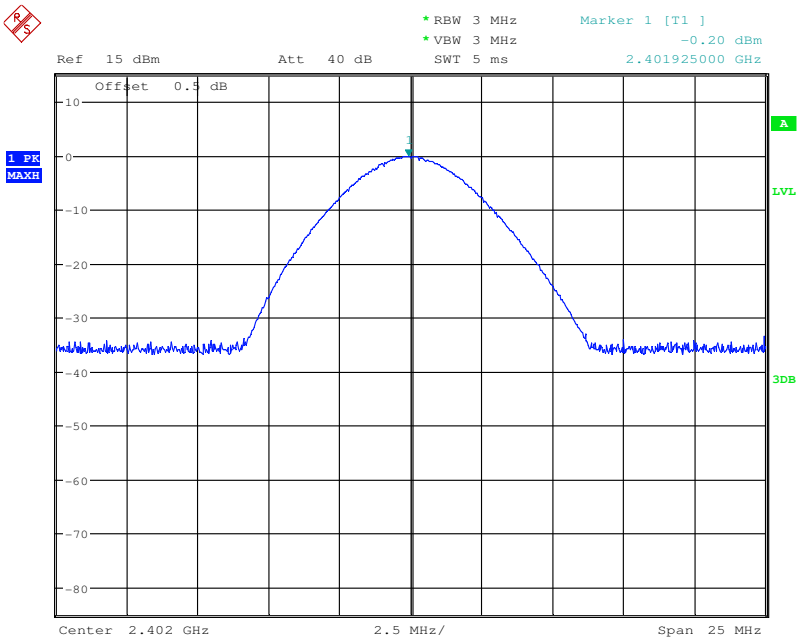
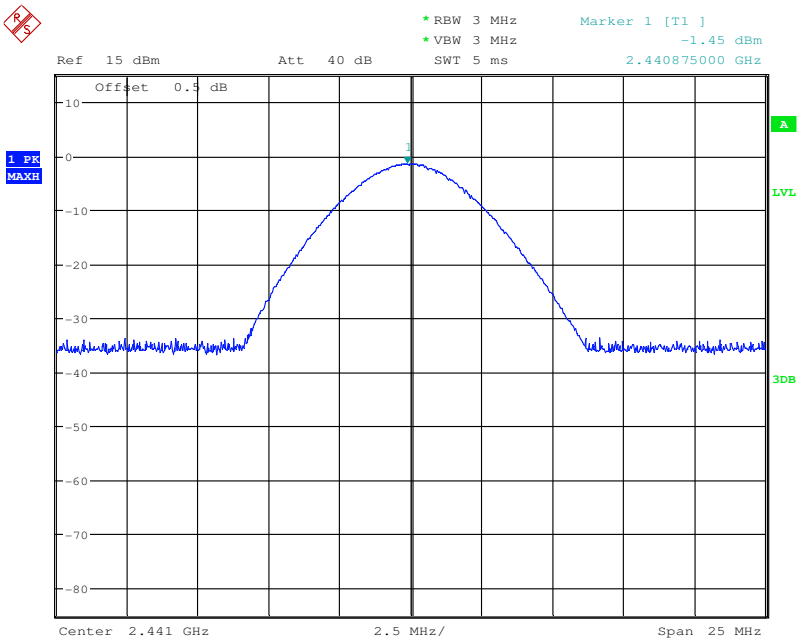
Test mode:	8DPSK	Test channel:	Lowest



Test mode:	8DPSK	Test channel:	Middle



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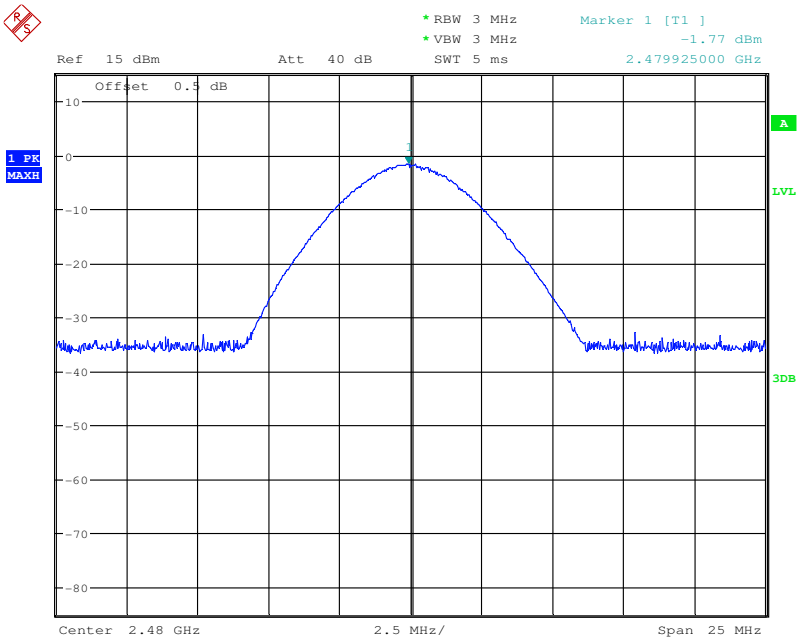
Test mode:	8DPSK	Test channel:	Highest



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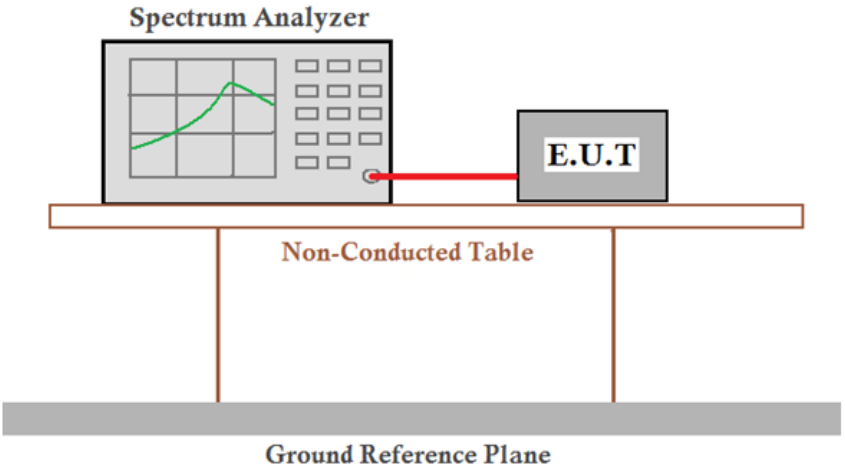
6.4 20dB Occupy Bandwidth

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	
Limit:	NA
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH1 of data type is the worst case of GFSK modulation type, 2-DH1 of data type is the worst case of π/4DQPSK modulation type, 3-DH1 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

Measurement Data

Test channel	20dB Occupy Bandwidth (kHz)		
	GFSK	π/4DQPSK	8DPSK
Lowest	902.500	1221.154	1215.385
Middle	898.885	1220.731	1230.769
Highest	899.039	1220.731	1235.577

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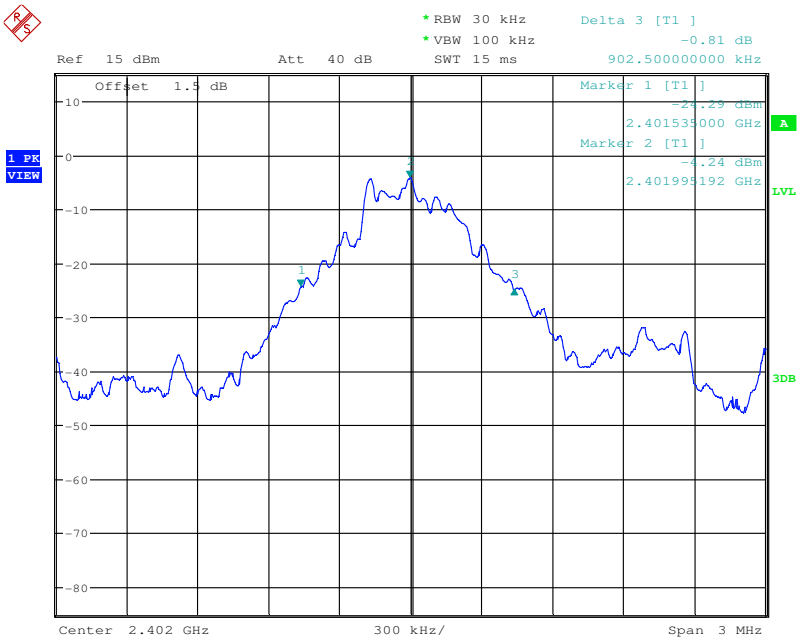
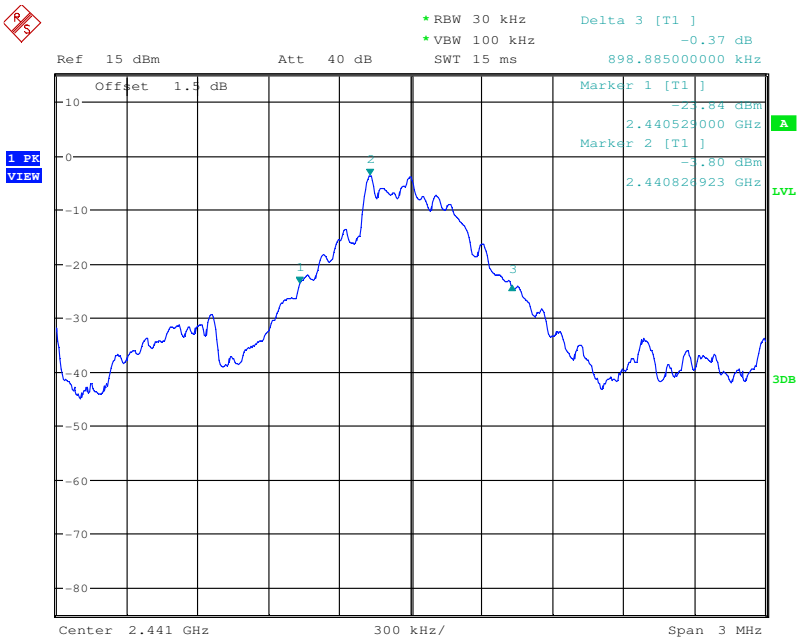
Test plot as follows:

Test mode:	GFSK	Test channel:	Lowest



Test mode:	GFSK	Test channel:	Middle



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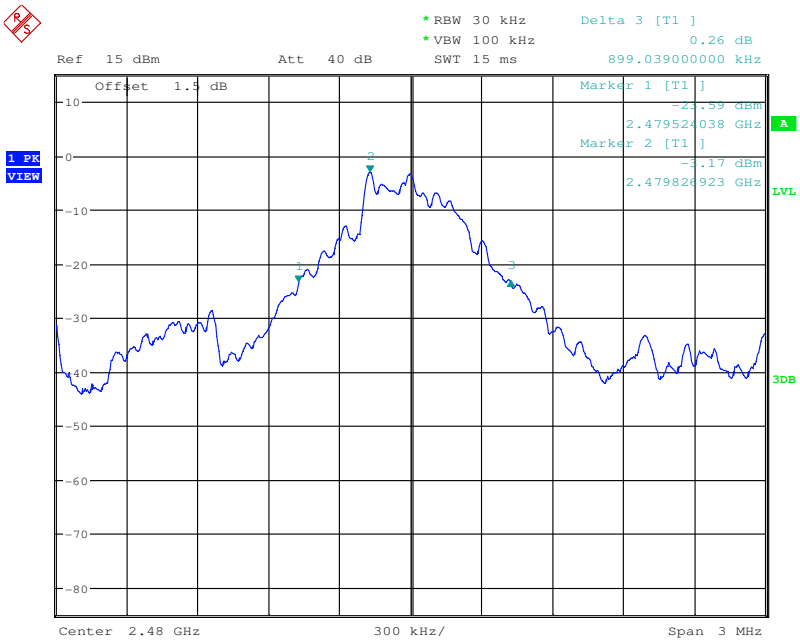
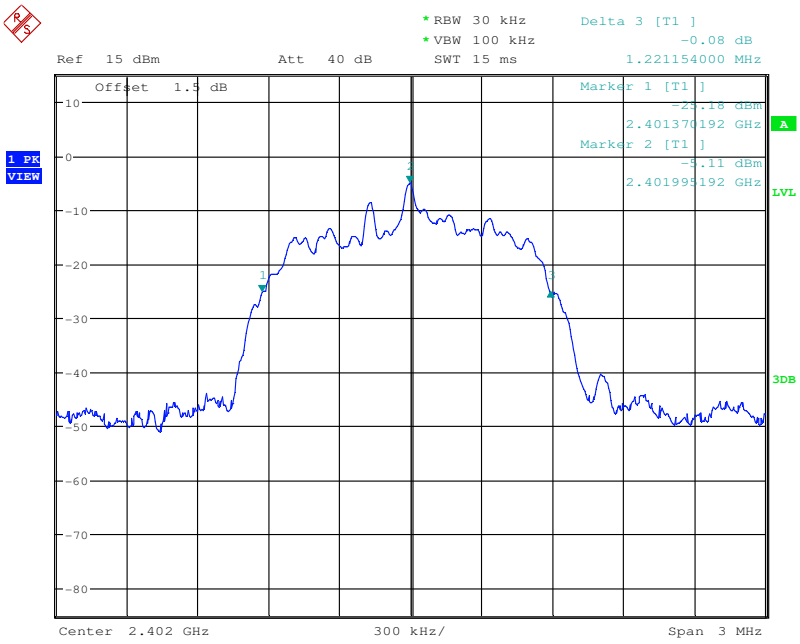
Test mode:	GFSK	Test channel:	Highest



Test mode:	π/4DQPSK	Test channel:	Lowest



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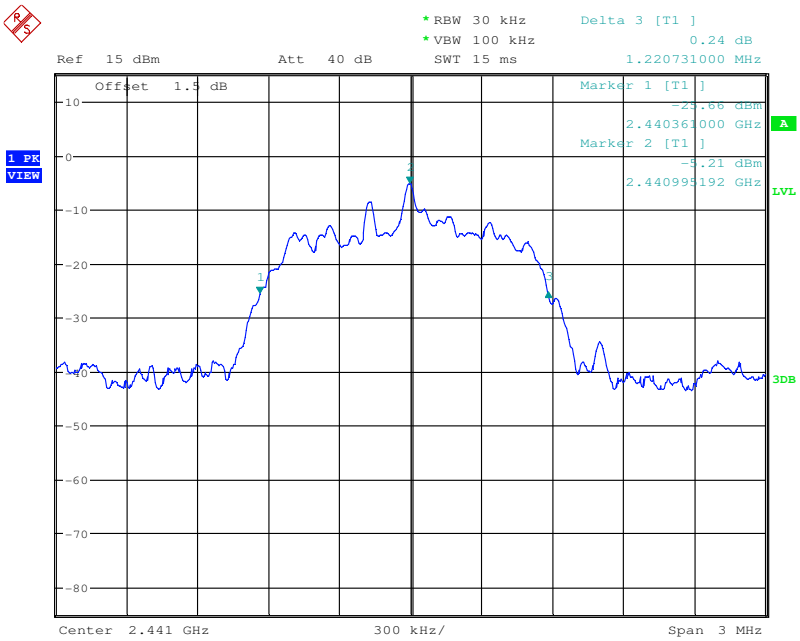
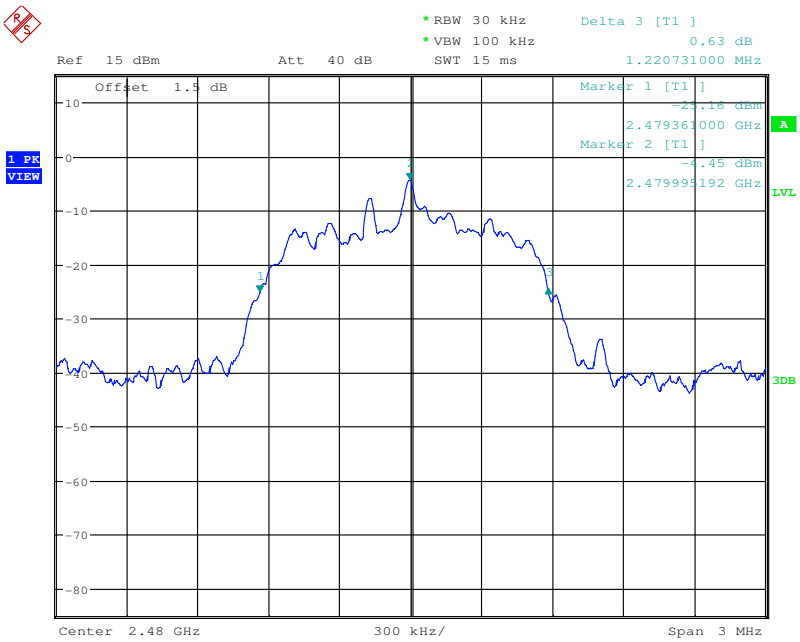
Test mode:	π/4DQPSK	Test channel:	Middle



Test mode:	π/4DQPSK	Test channel:	Highest



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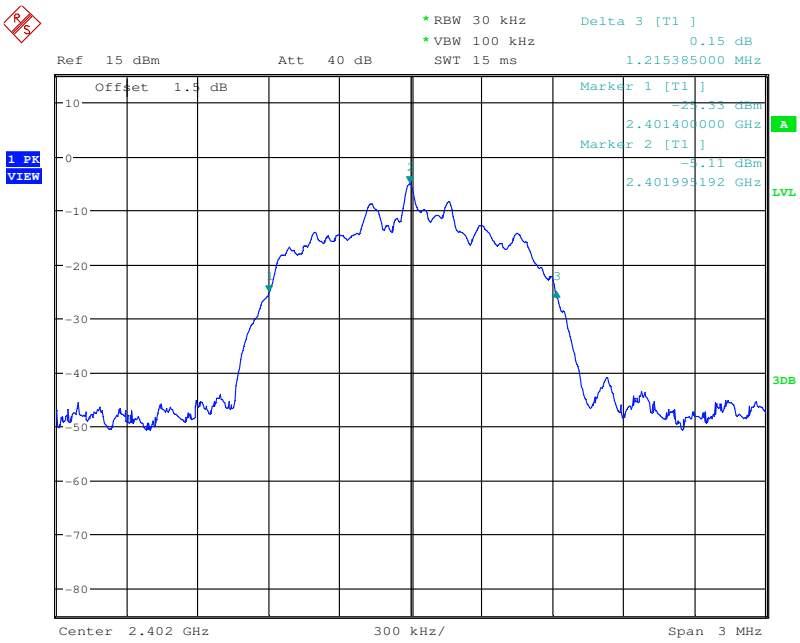
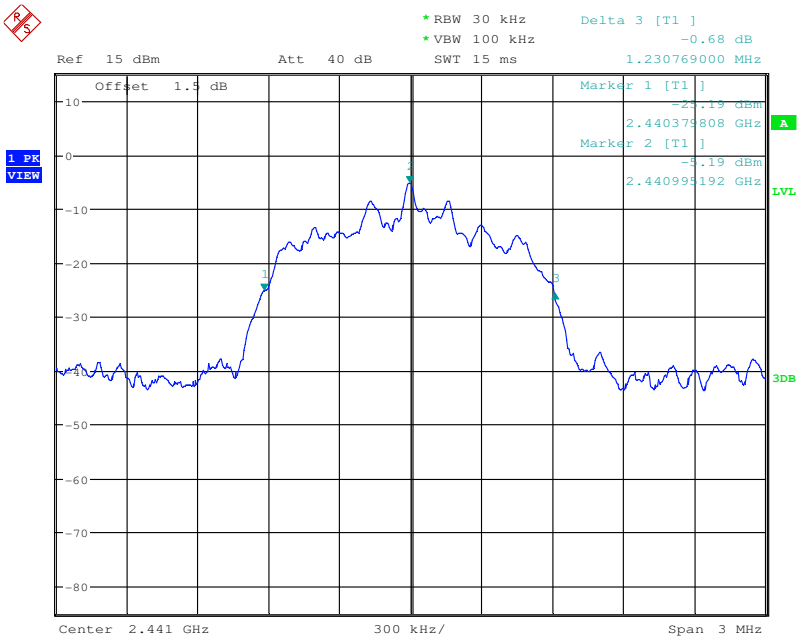
Test mode:	8DPSK	Test channel:	Lowest



Test mode:	8DPSK	Test channel:	Middle



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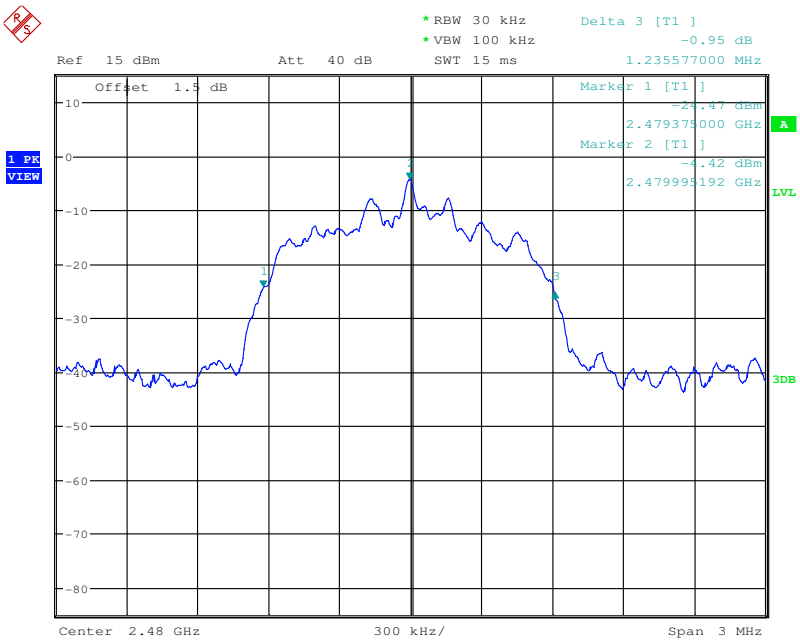
Test mode:	8DPSK	Test channel:	Highest



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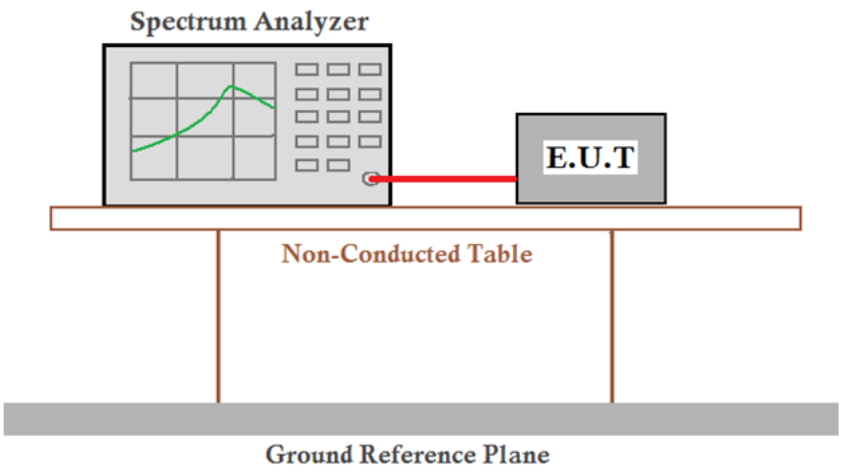
6.5 Carrier Frequencies Separation

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	
Limit:	2/3 of the 20dB bandwidth
	Remark: the transmission power is less than 0.125W.
Exploratory Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH1 of data type is the worst case of GFSK modulation type, 2-DH1 of data type is the worst case of π/4DQPSK modulation type, 3-DH1 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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Measurement Data

GFSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Middle	1023	≥599.257	Pass
π/4DQPSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Middle	990	≥820.487	Pass
8DPSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Middle	936	≥820.512	Pass

Note: According to section 6.4,

Mode	20dB bandwidth (kHz) (worse case)	Limit (kHz) (Carrier Frequencies Separation)
GFSK	898.885	599.257
π/4DQPSK	1230.731	820.487
8DPSK	1230.769	820.512

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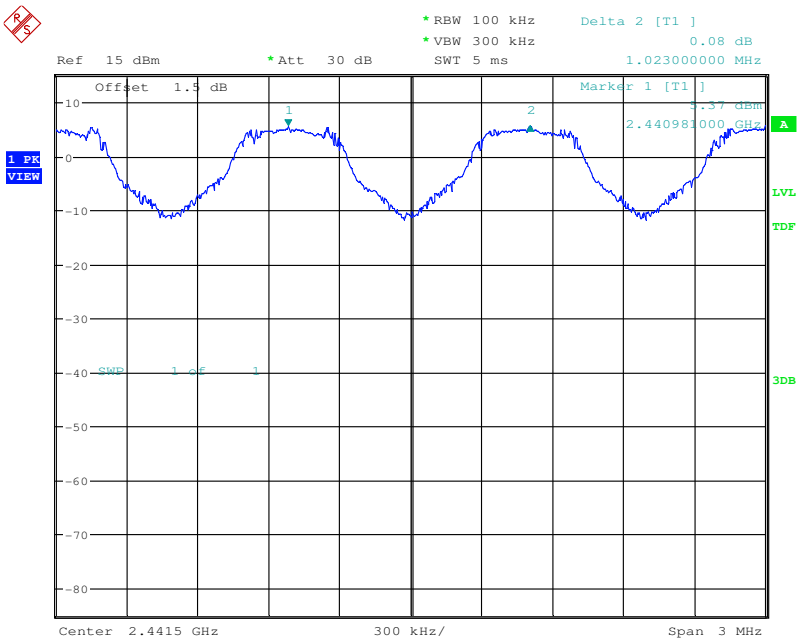
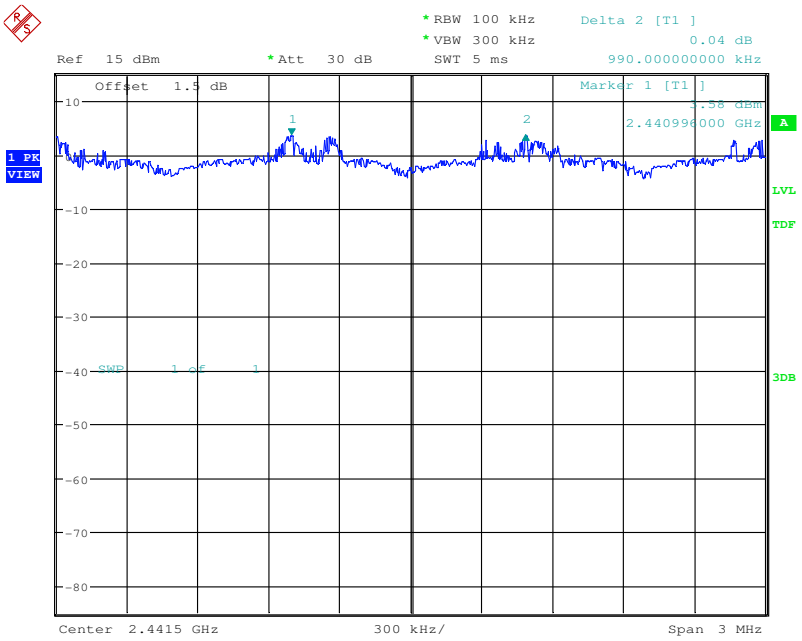
Test plot as follows:

Test mode:	GFSK	Test channel:	Middle



Test mode:	π/4DQPSK	Test channel:	Middle



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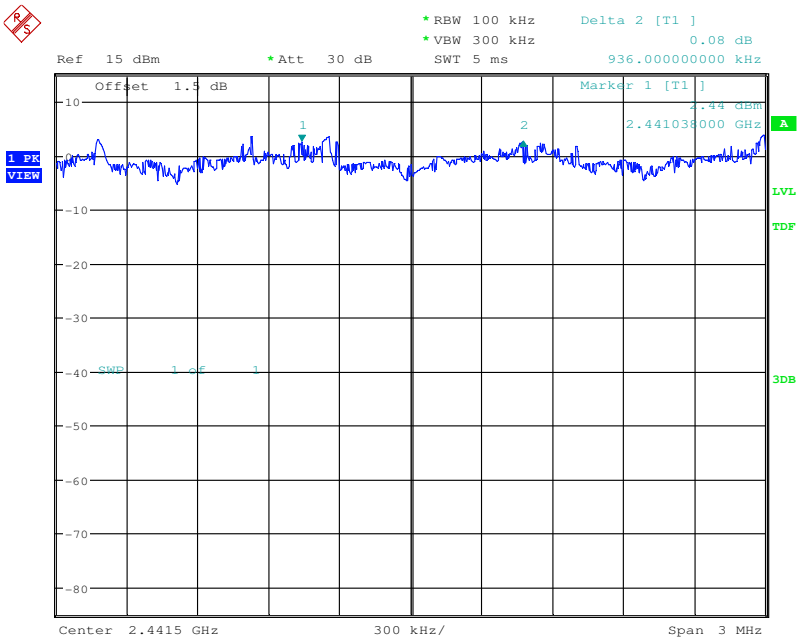
Test mode:	8DPSK	Test channel:	Middle



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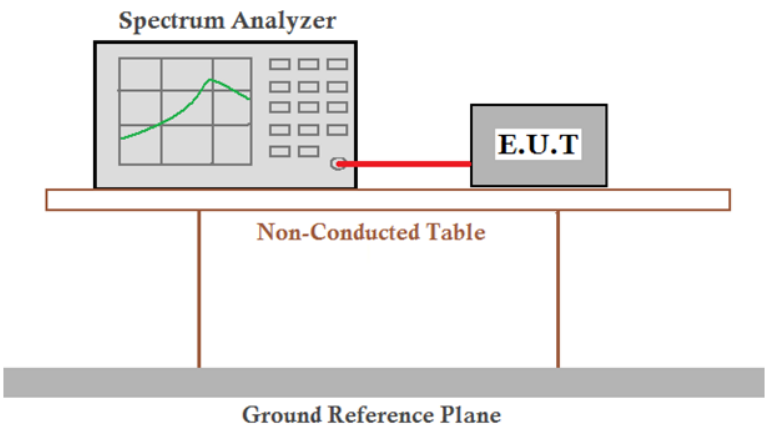
6.6 Hopping Channel Number

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	
Limit:	At least 15 channels
Test Mode:	Hopping transmitting with all kind of modulation
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

Measurement Data

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

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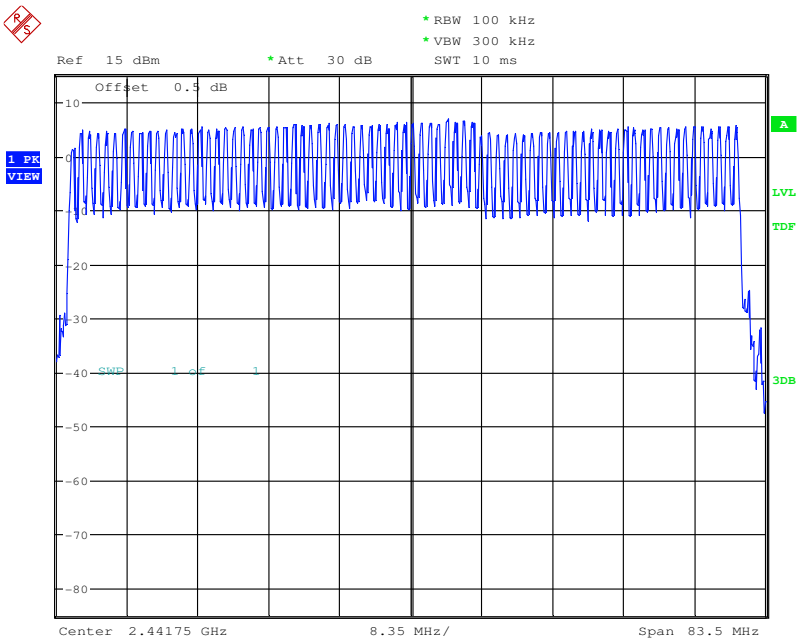
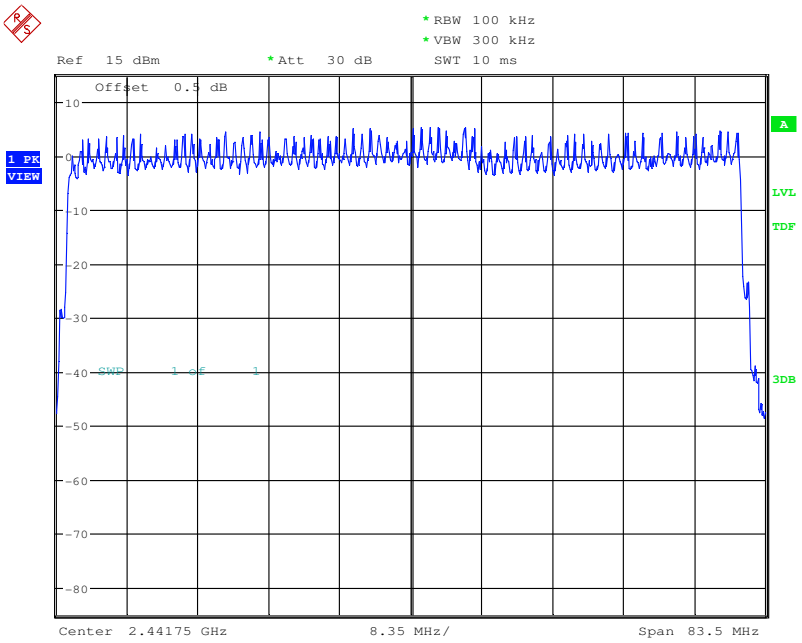
Test plot as follows:

Test mode:	GFSK



Test mode:	π/4DQPSK



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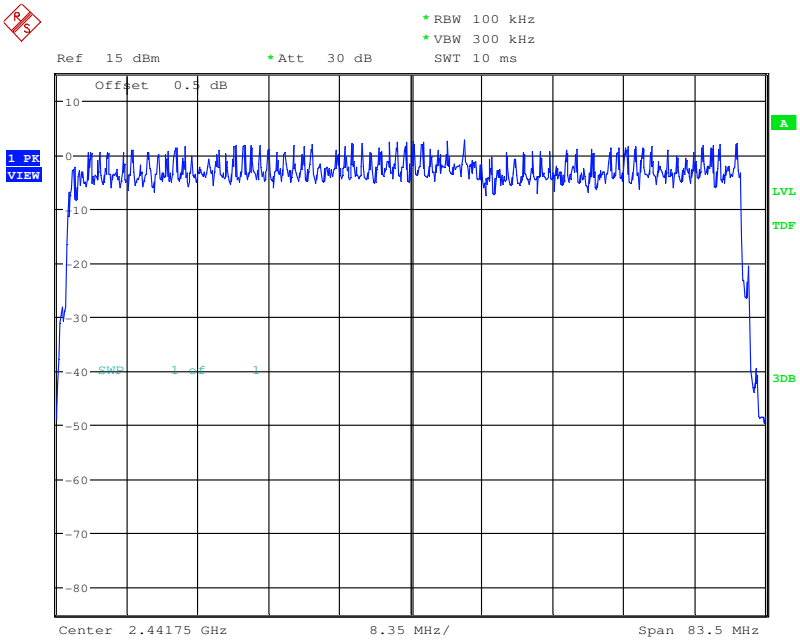
Test mode:	8DPSK



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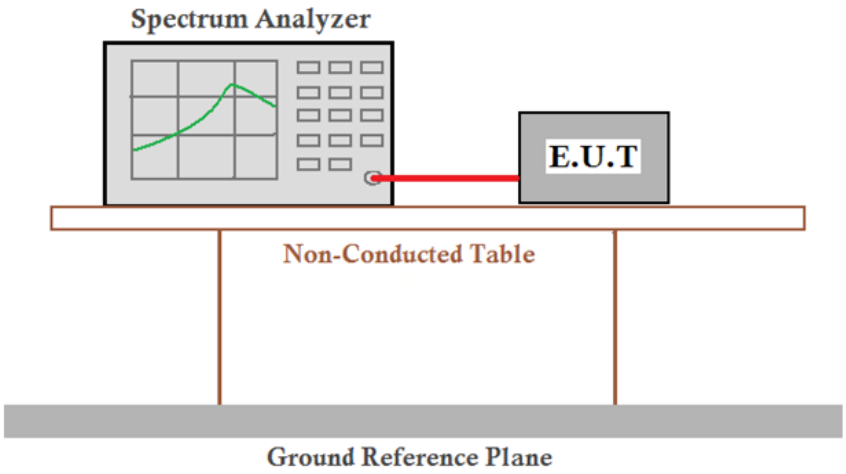
6.7 Dwell Time

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	
Instruments Used:	Refer to section 5.10 for details
Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type.
Limit:	0.4 Second
Test Results:	Pass

Measurement Data

Mode	Packet	Dwell time (second)	Limit (second)
GFSK	DH1	0.13	0.4
	DH3	0.25	0.4
	DH5	0.29	0.4
π/4DQPSK	2-DH1	0.13	0.4
	2-DH3	0.25	0.4
	2-DH5	0.29	0.4
8DPSK	3-DH1	0.13	0.4
	3-DH3	0.25	0.4
	3-DH5	0.29	0.4

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Remark:

The test period: T= 0.4 Second/Channel x 79 Channel = 31.6 s

On (ms)*total number=dwell time (ms)

The lowest channel (2402MHz), as below:

DH1 time slot=0.403 (ms)*total number x 10=128.96 (ms)

DH3 time slot=1.662 (ms)* total number x 10=249.30(ms)

DH5 time slot=2.916 (ms)* total number x 10=291.60 (ms)

2-DH1 time slot=0.420 (ms)*total number x 10=134.40 (ms)

2-DH3 time slot=1.682 (ms)* total number x 10=252.30(ms)

2-DH5 time slot=2.924 (ms)* total number x 10=292.40 (ms)

3-DH1 time slot=0.417 (ms)*total number x 10=133.44 (ms)

3-DH3 time slot=1.671 (ms)* total number x 10=250.65 (ms)

3-DH5 time slot=2.924 (ms)* total number x 10= 292.40 (ms)

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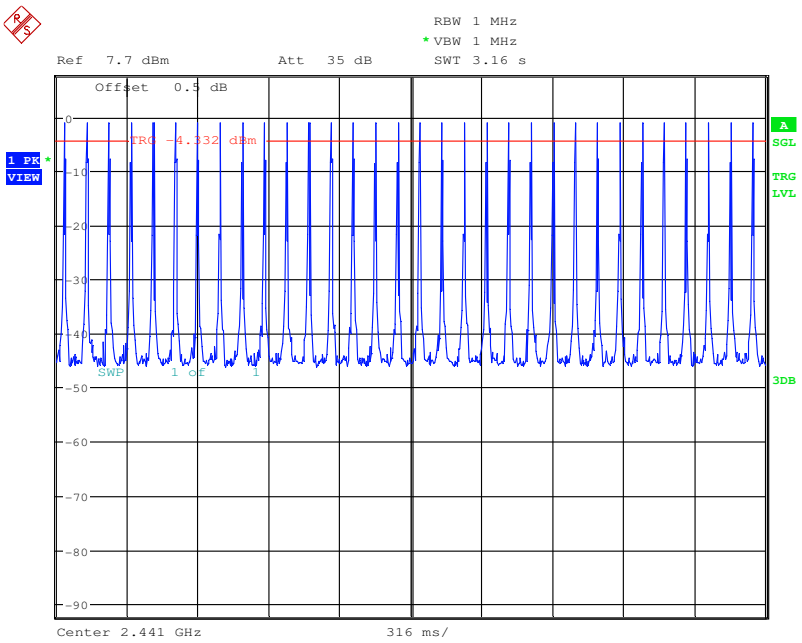
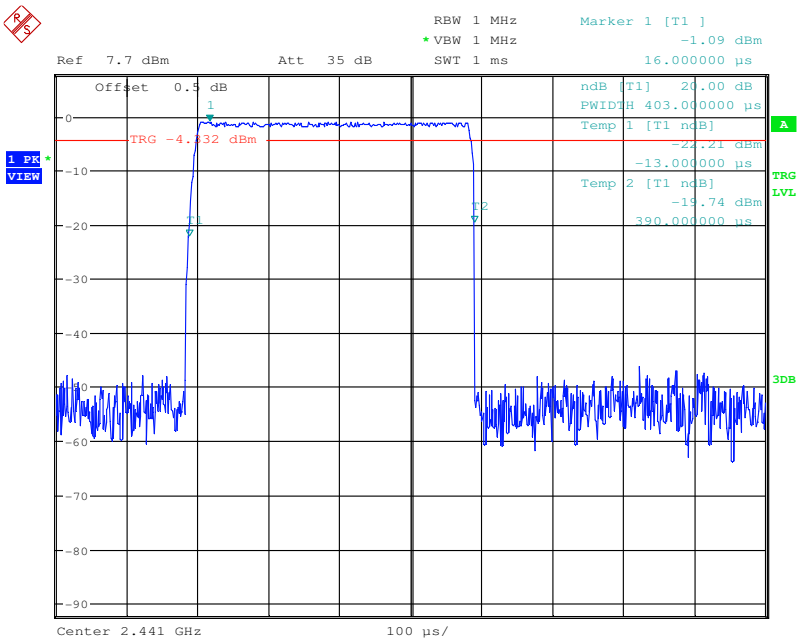
Test plot as follows:

Test Packet:	DH1





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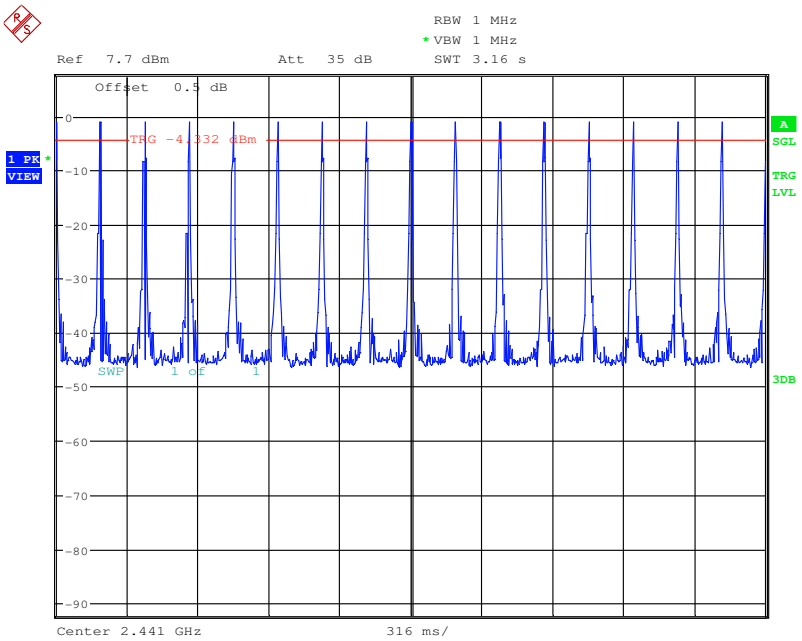
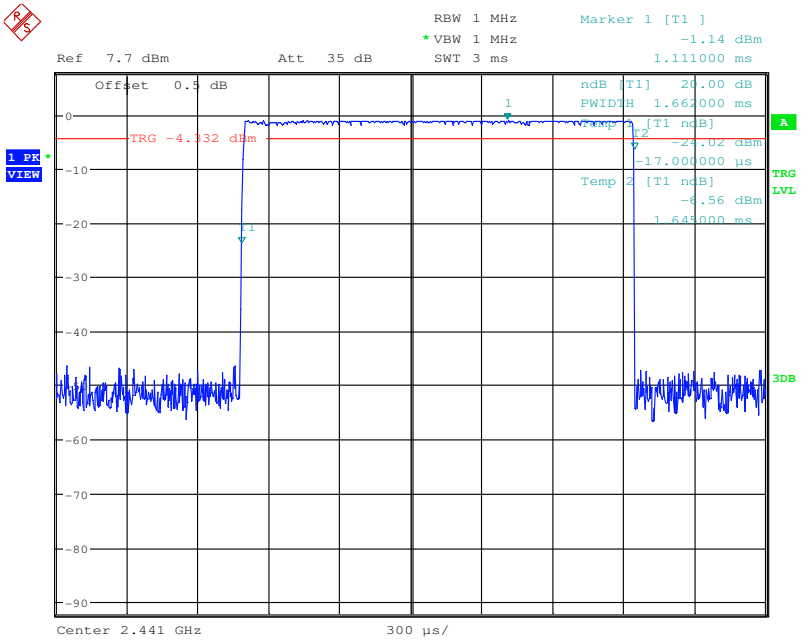
Test Packet:	DH3





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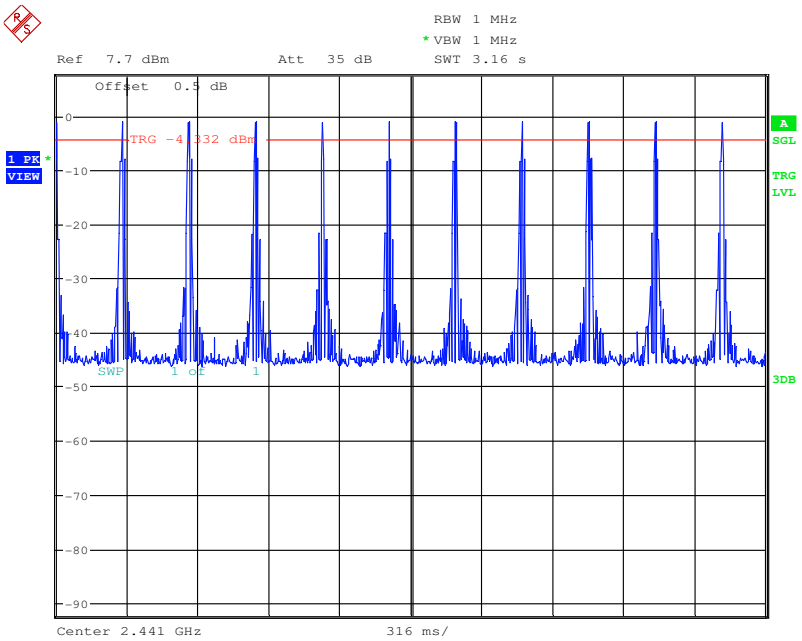
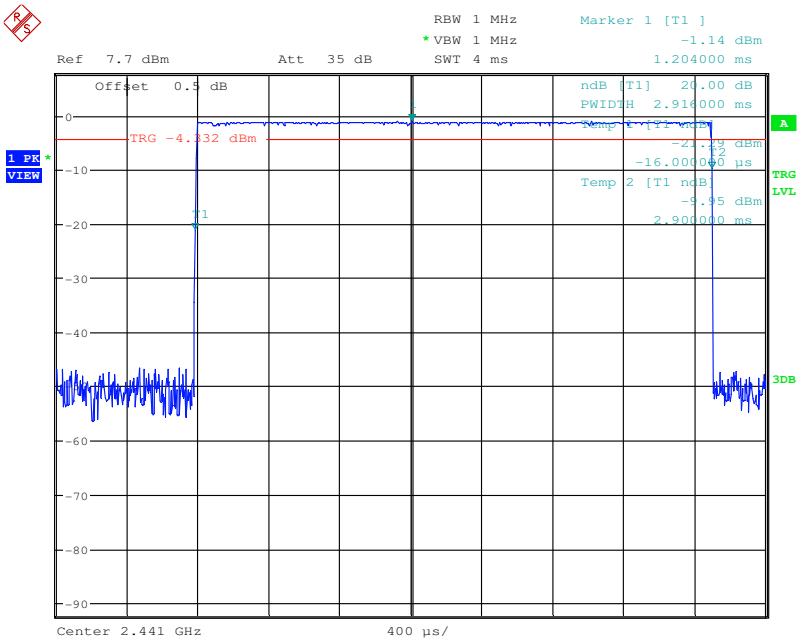
Test Packet:	DH5





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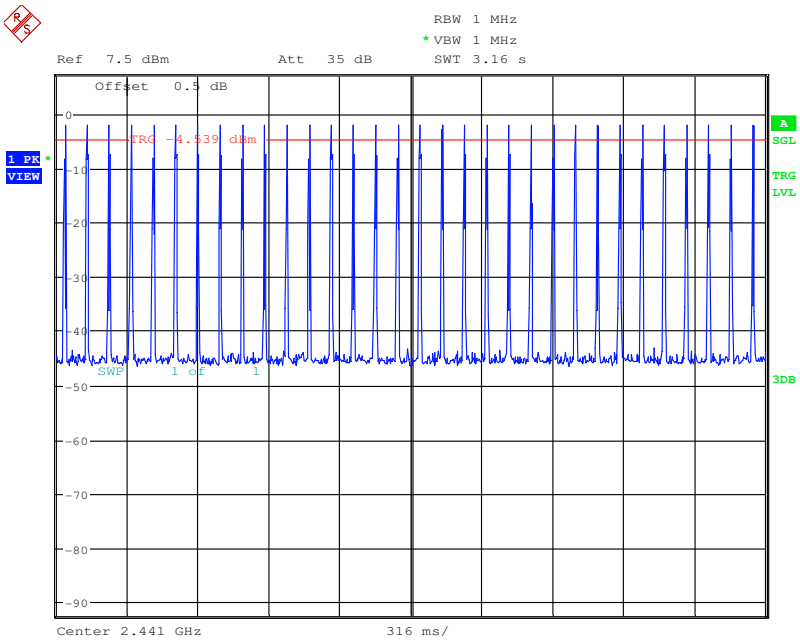
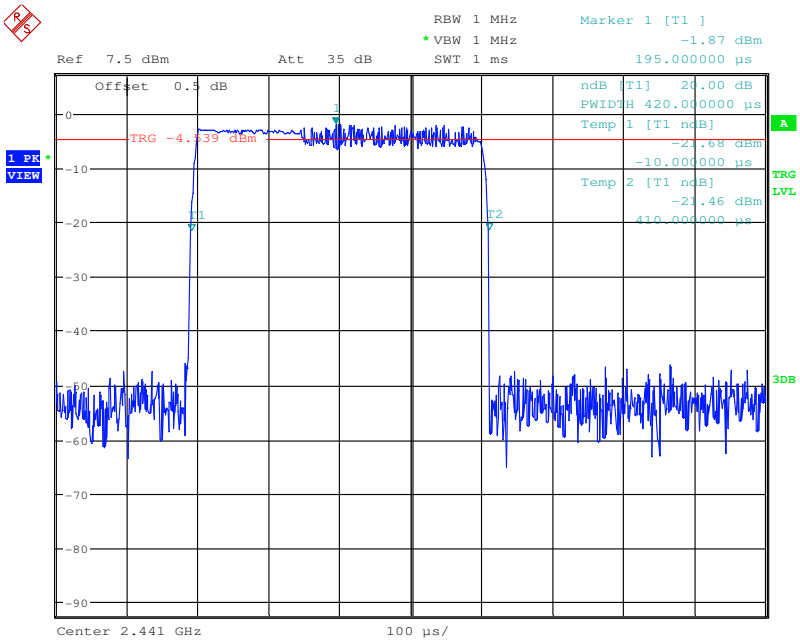
Test Packet:	2-DH1





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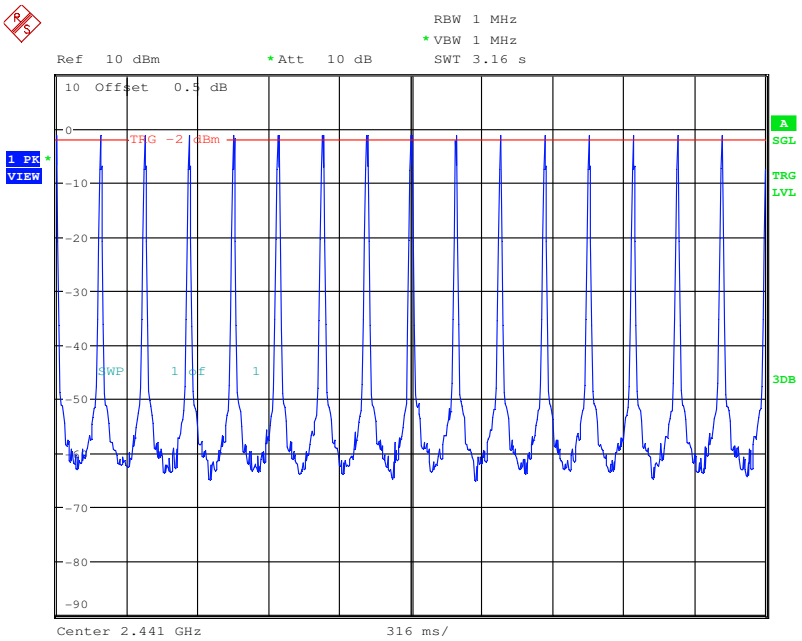
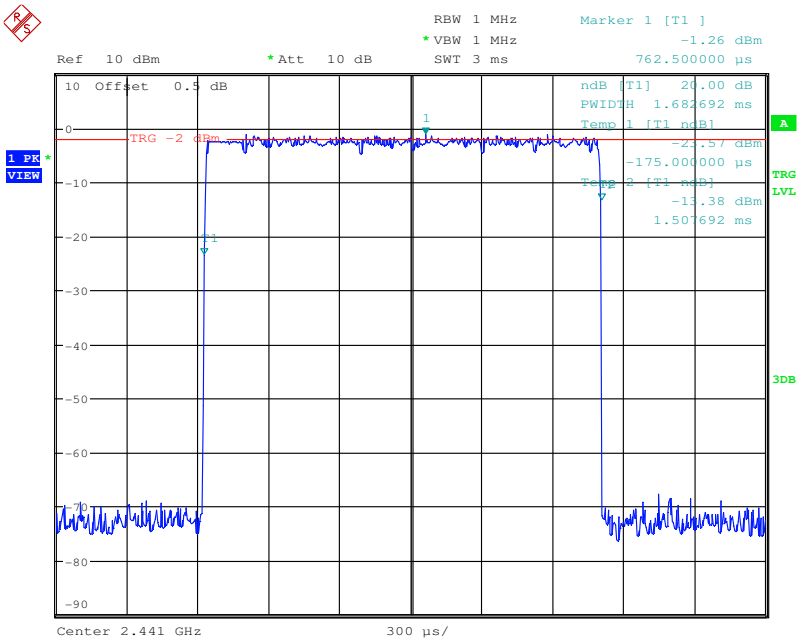
Test Packet:	2-DH3





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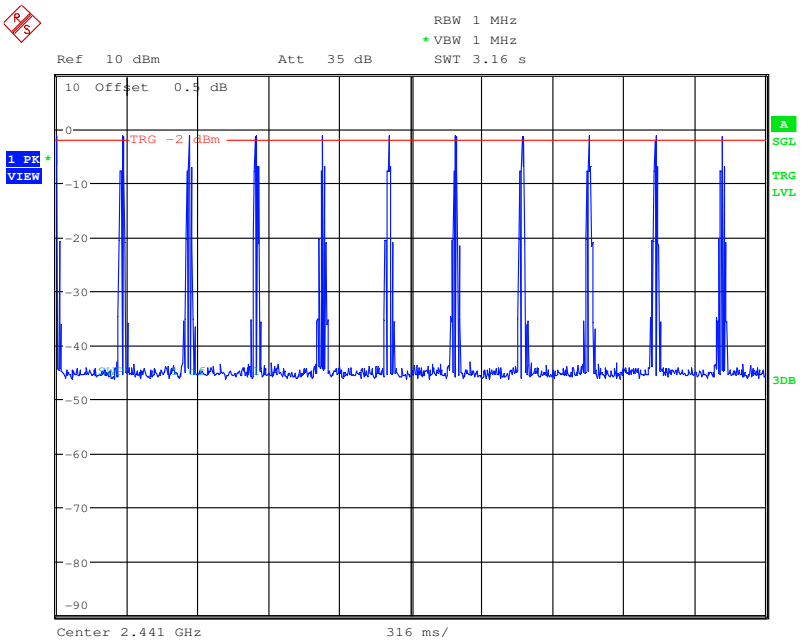
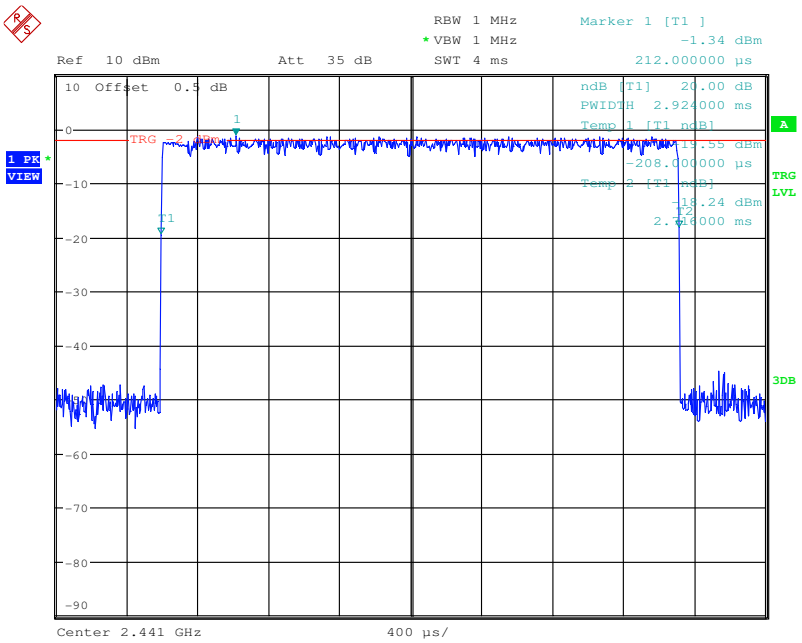
Test Packet:	2-DH5





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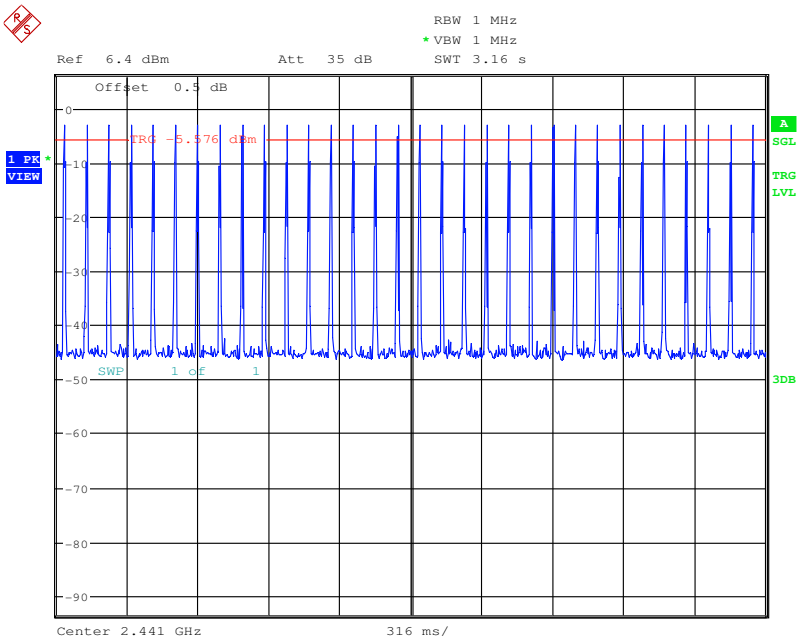
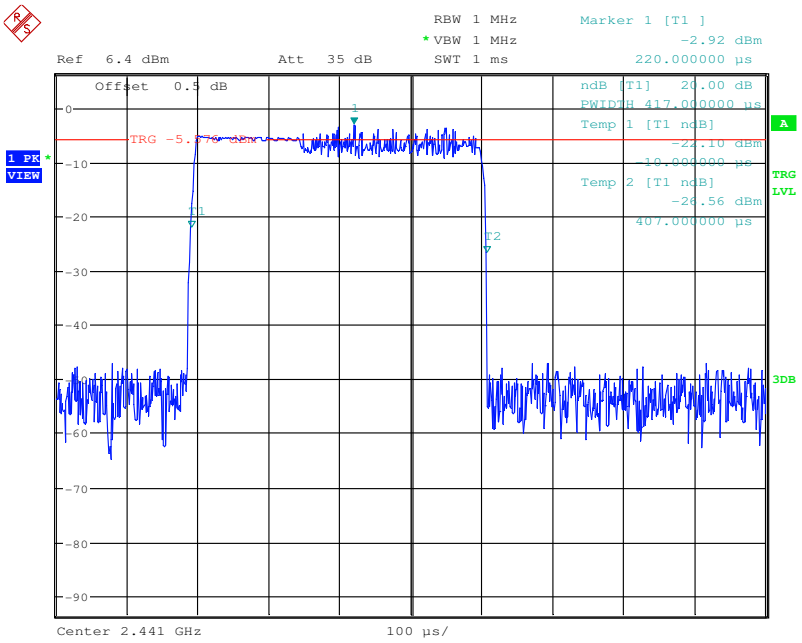
Test Packet:	3-DH1





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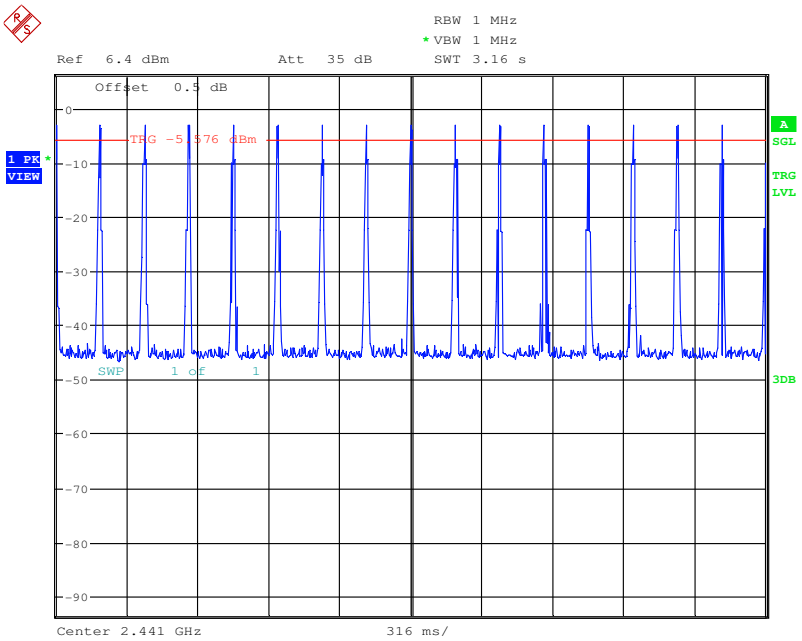
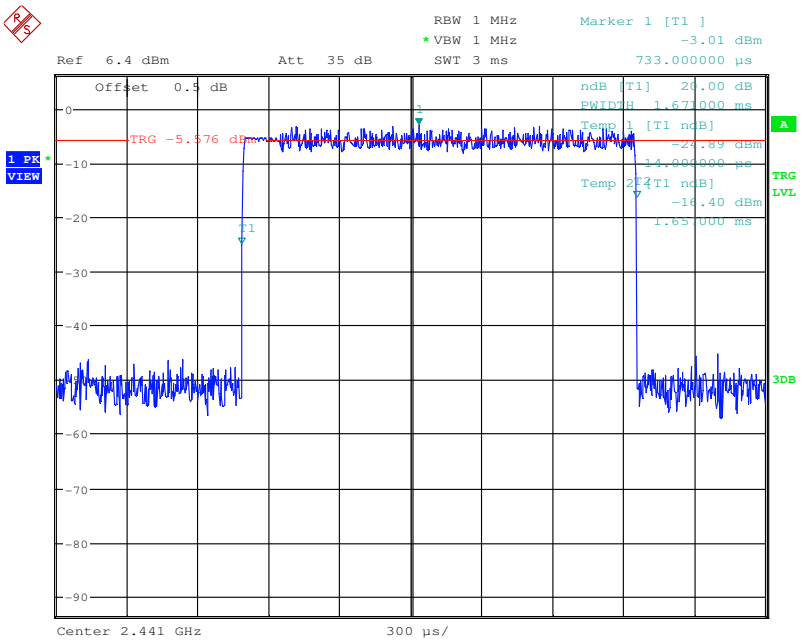
Test Packet:	3-DH3





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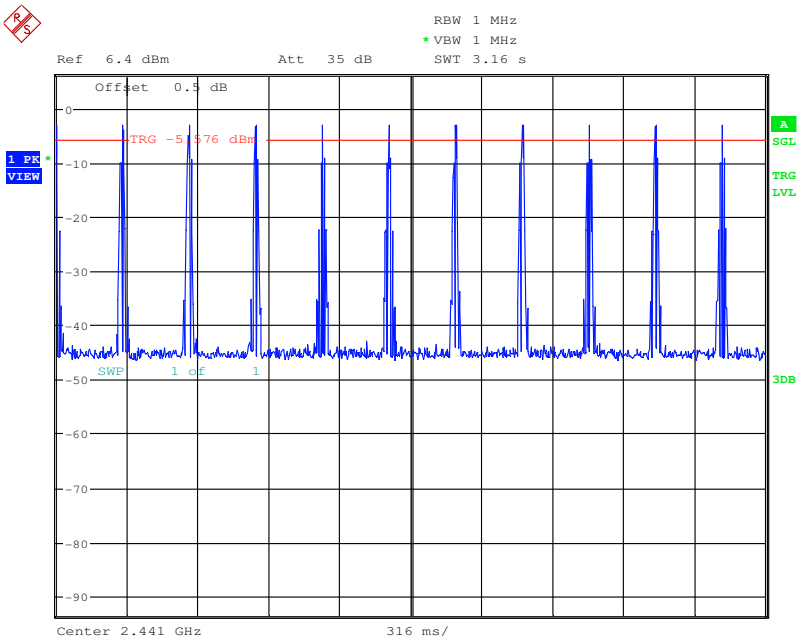
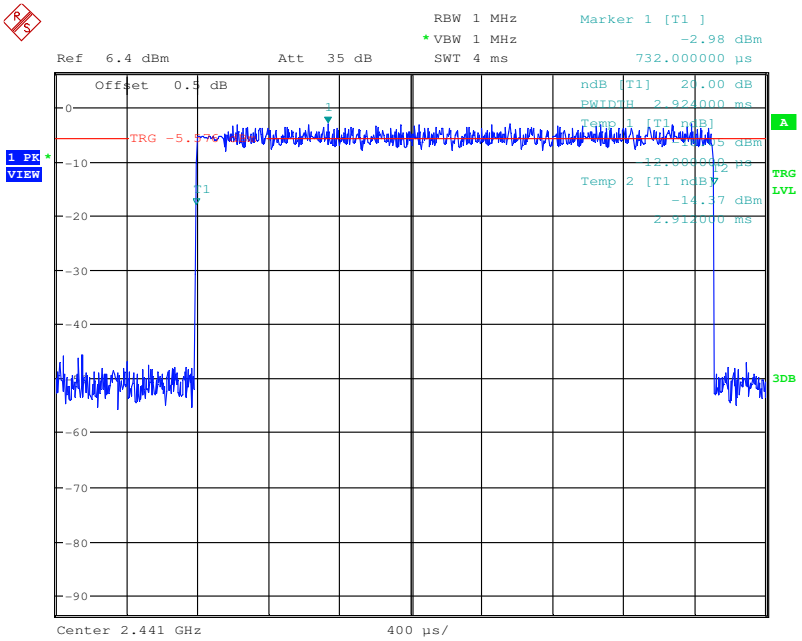
Test Packet:	3-DH5





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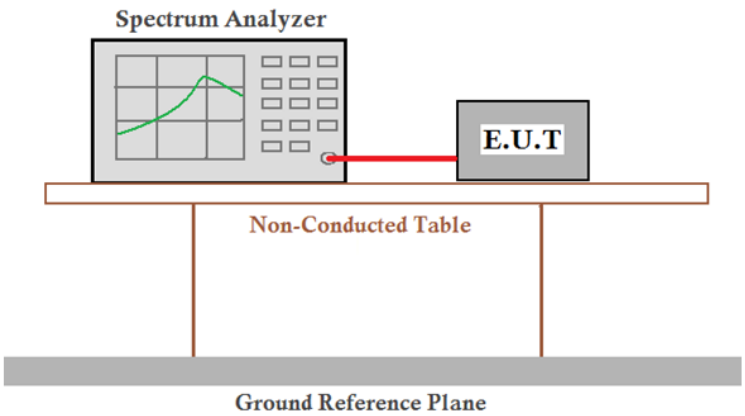
6.8 Band-edge for RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer.
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.
Exploratory Test Mode:	Hopping and Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH1 of data type is the worst case of GFSK modulation type, 2-DH1 of data type is the worst case of π/4DQPSK modulation type, 3-DH1 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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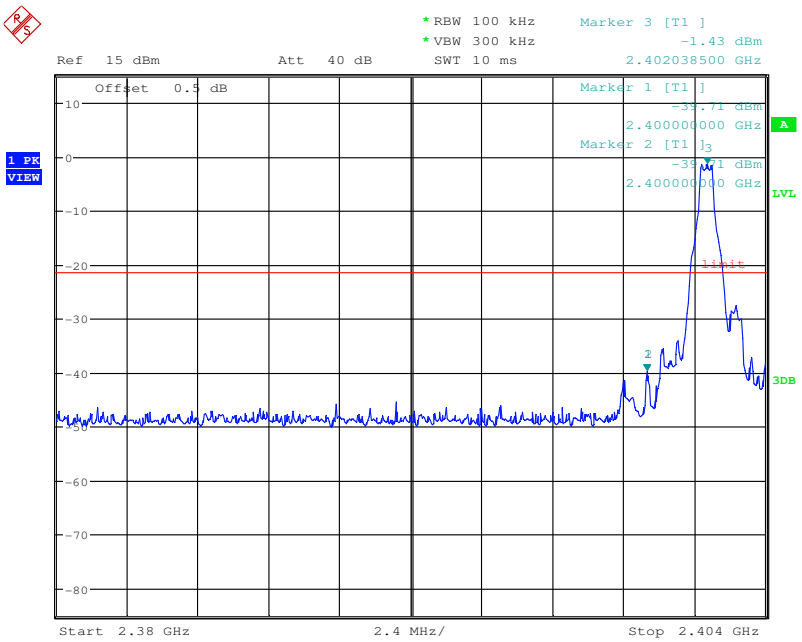
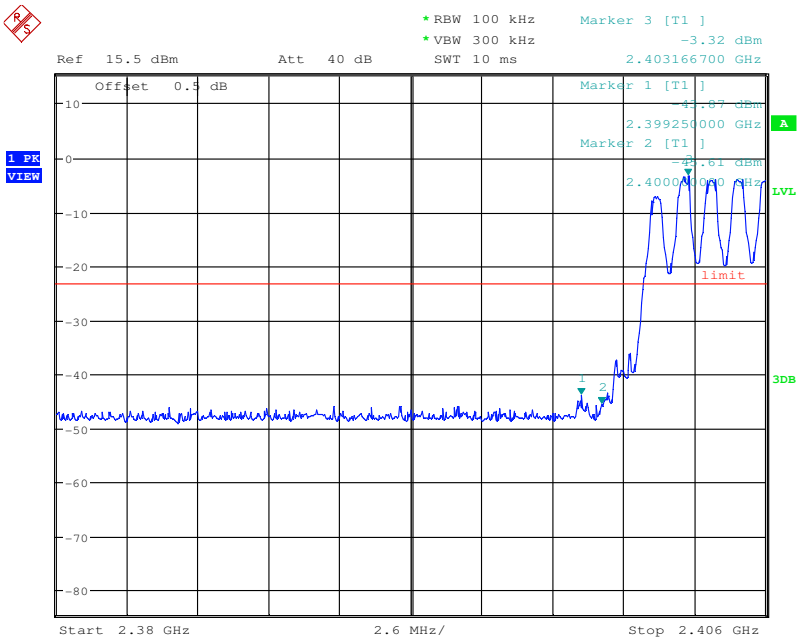
Test plot as follows:

Test mode:	GFSK	Test channel:	Lowest





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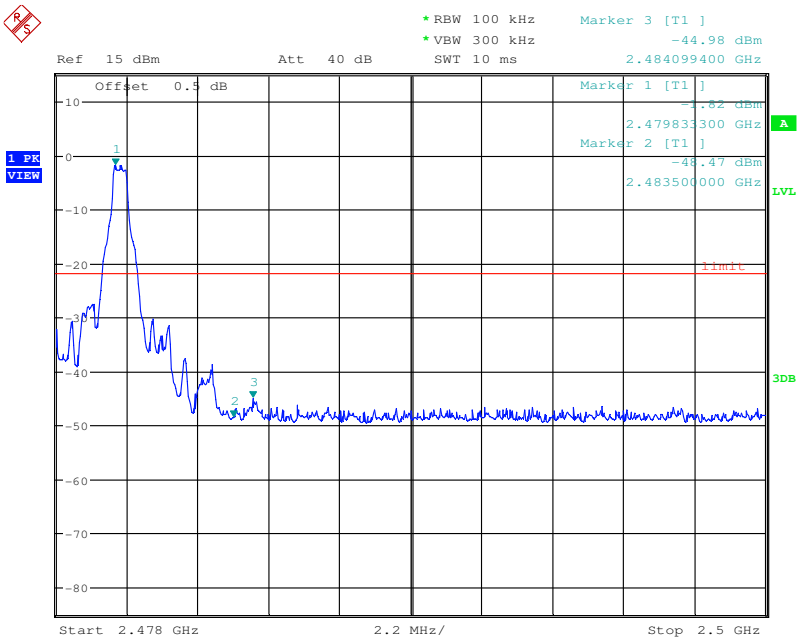
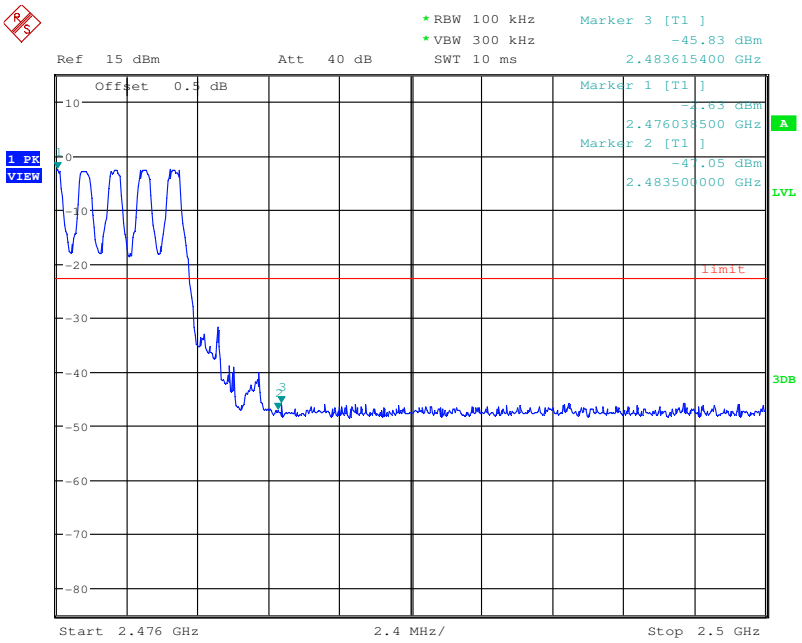
Test mode:	GFSK	Test channel:	Highest





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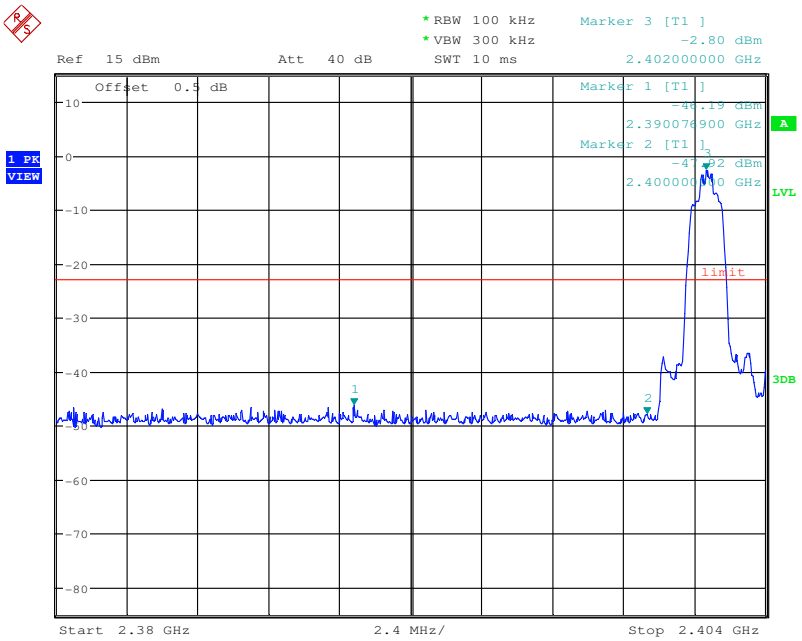
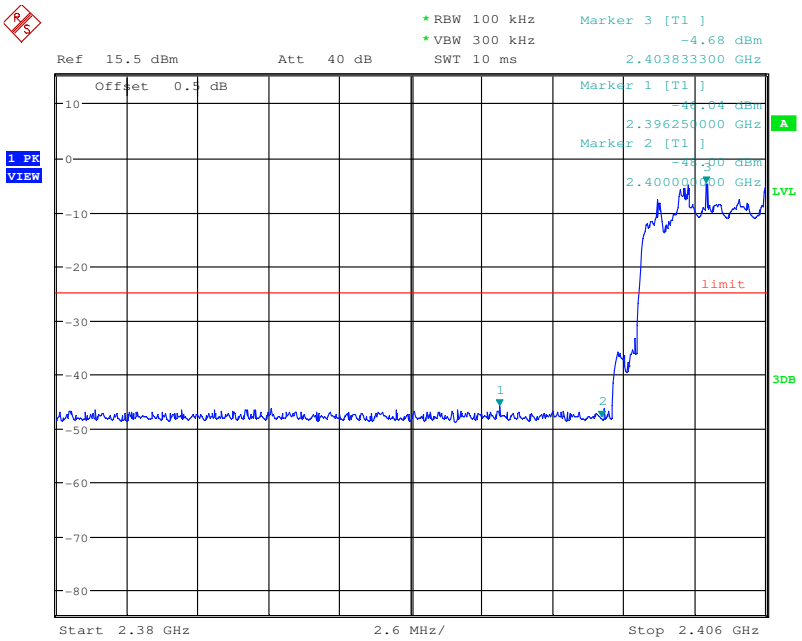
Test mode:	π/4DQPSK	Test channel:	Lowest





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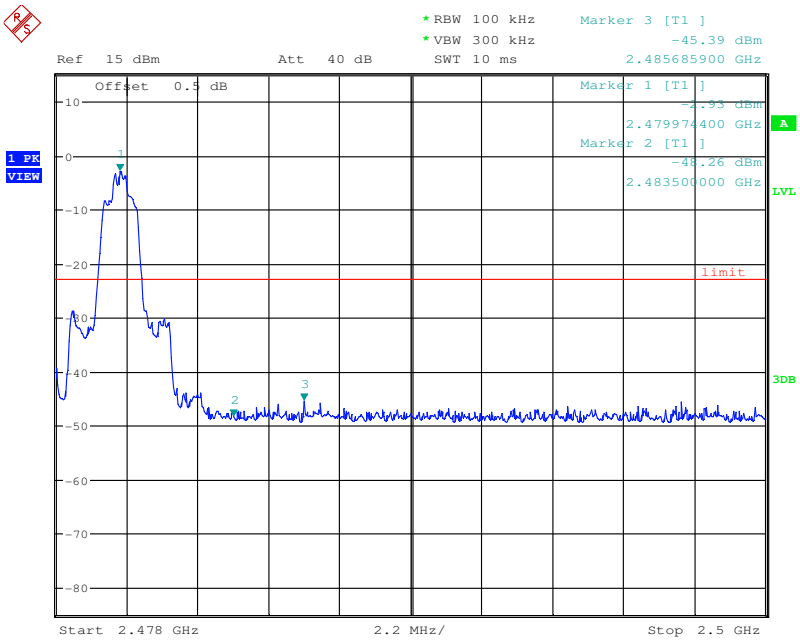
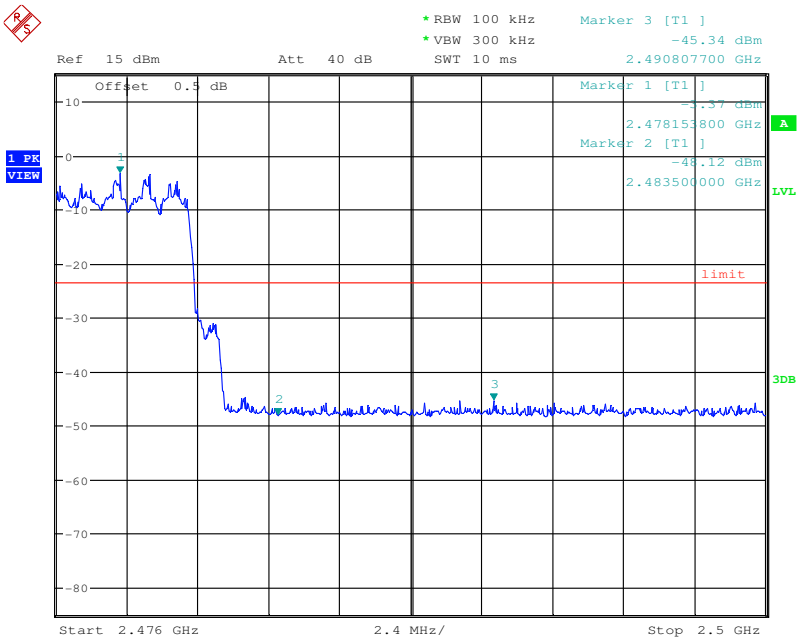
Test mode:	π/4DQPSK	Test channel:	Highest





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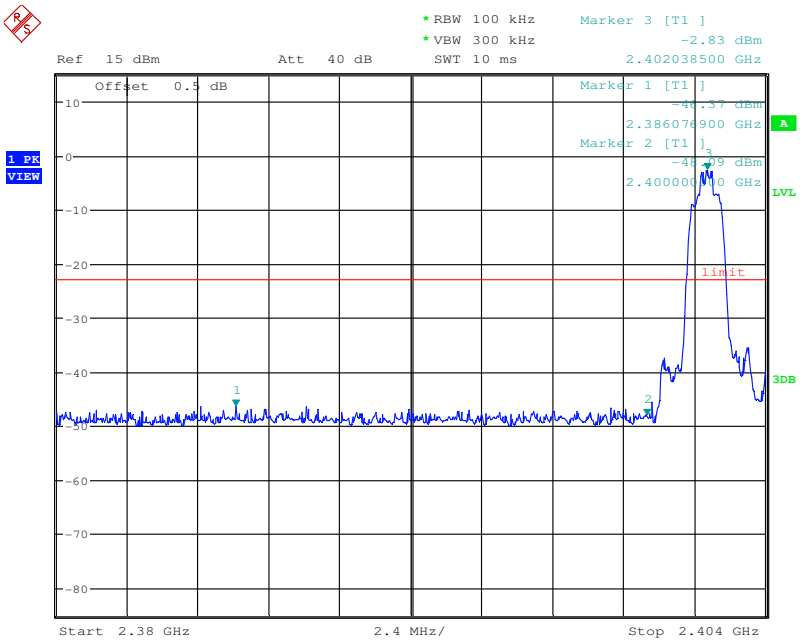
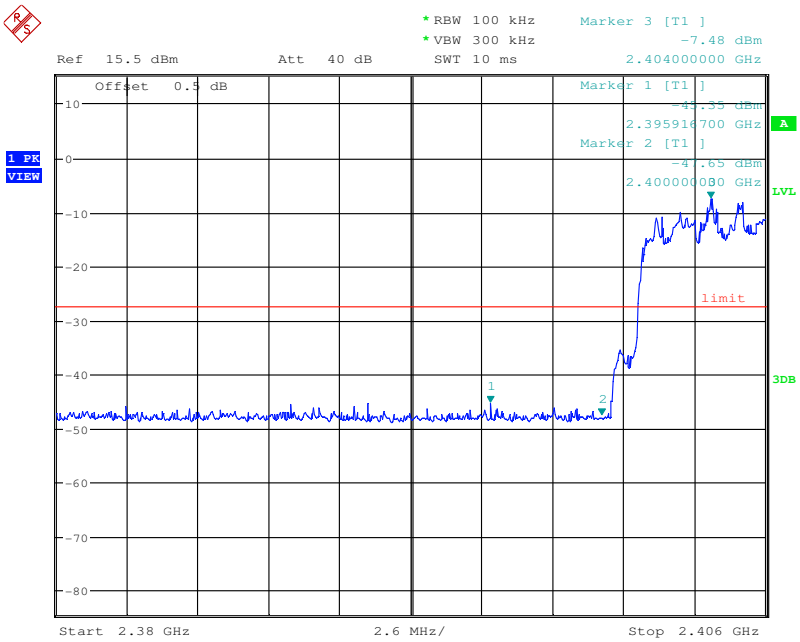
Test mode:	8DPSK	Test channel:	Lowest





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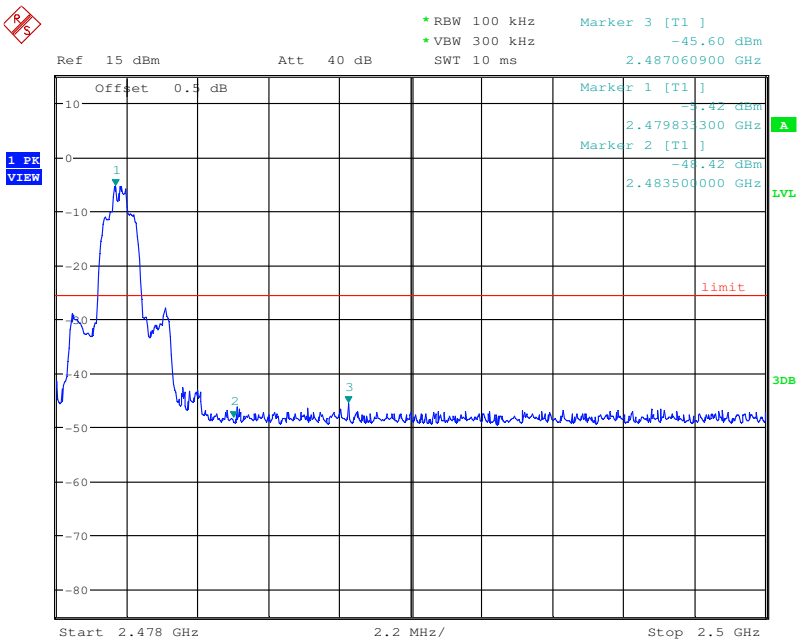
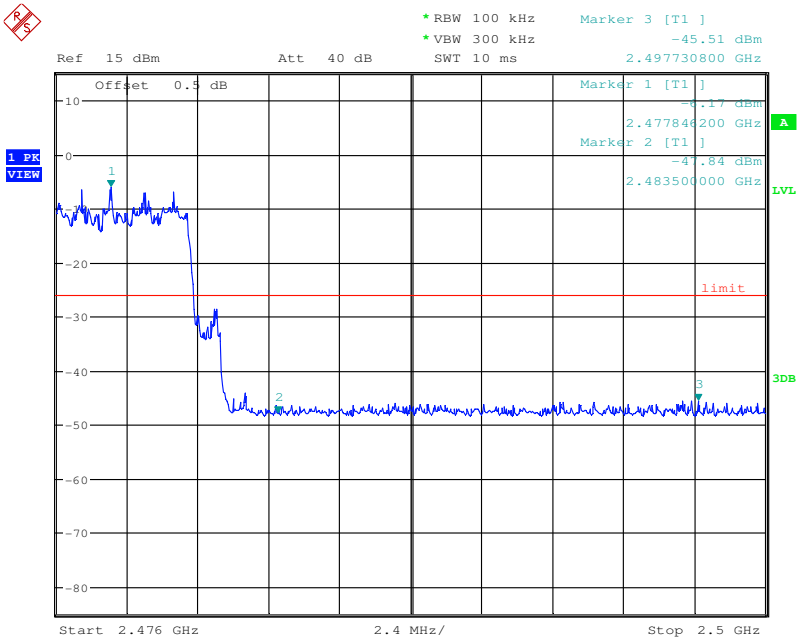
Test mode:	8DPSK	Test channel:	Highest





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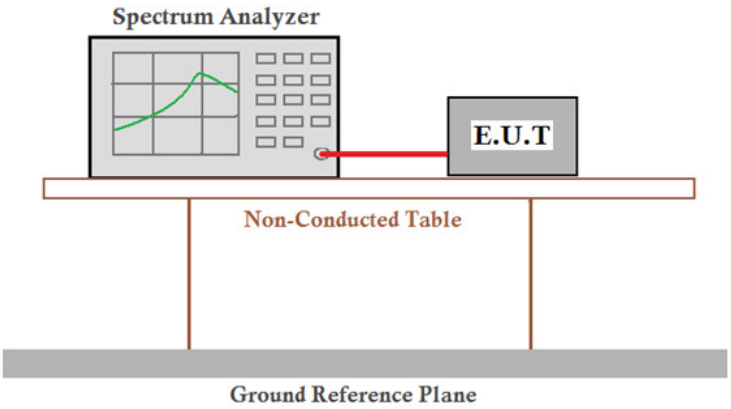
6.9 Spurious RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer.
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH1 of data type is the worst case of GFSK modulation type, 2-DH1 of data type is the worst case of π/4DQPSK modulation type, 3-DH1 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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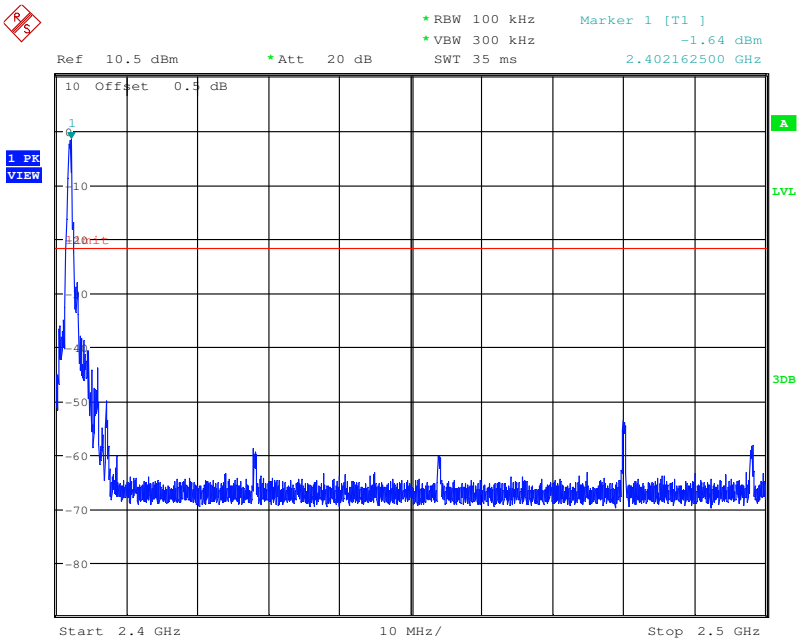
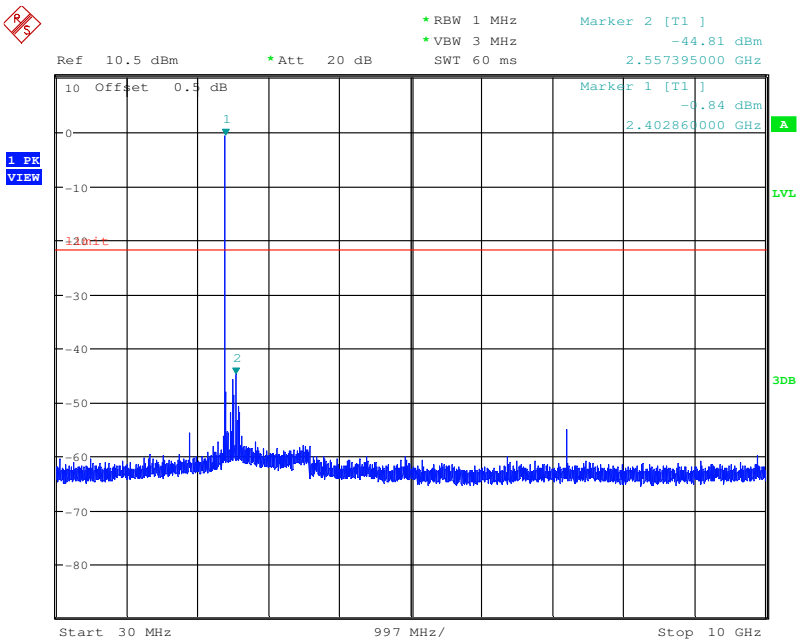
Test mode:	GFSK	Test channel:	Lowest





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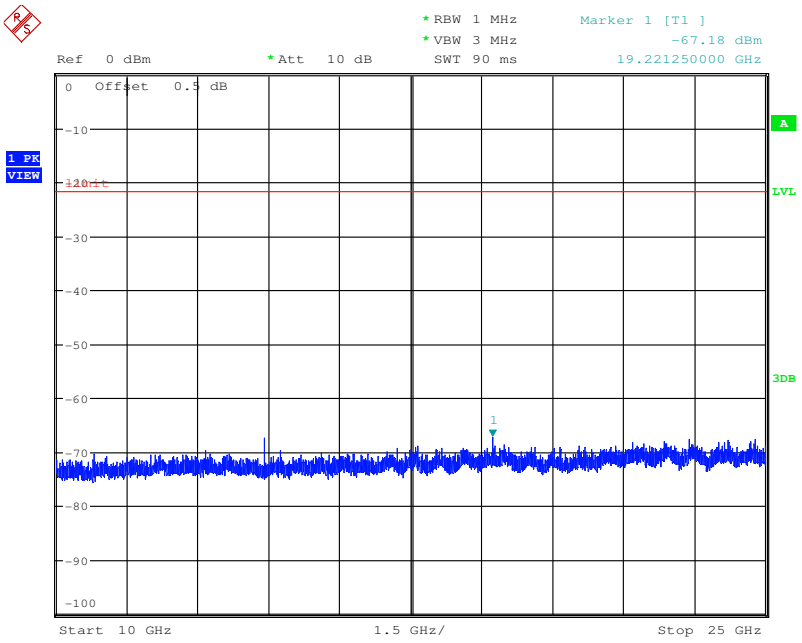
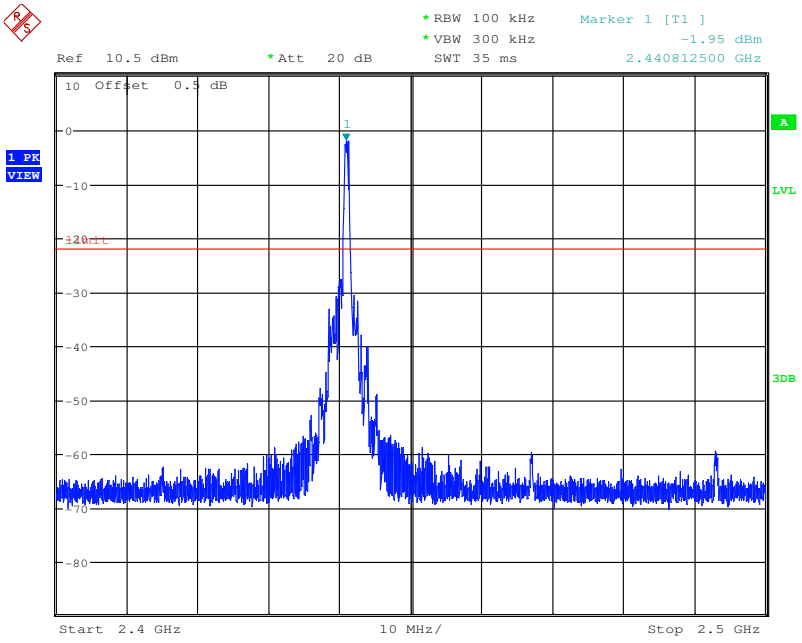


Test mode:	GFSK	Test channel:	Middle



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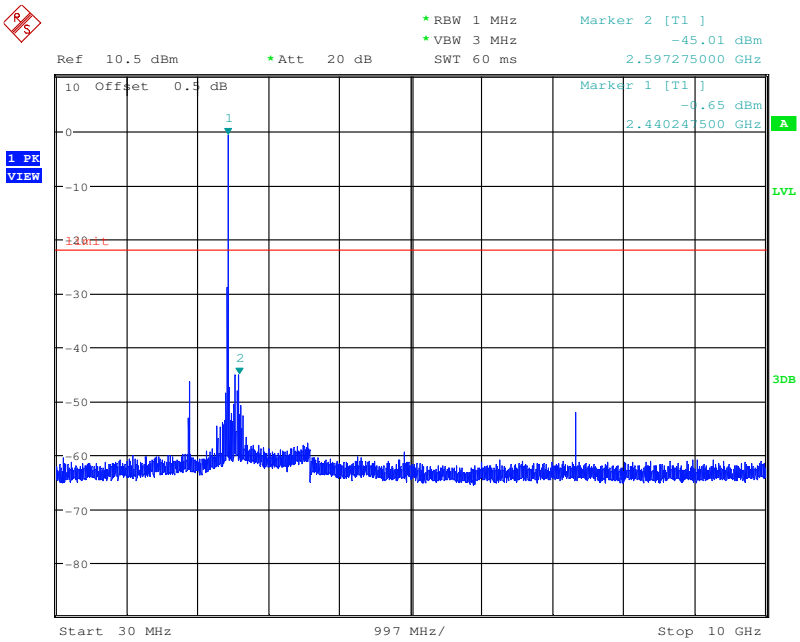

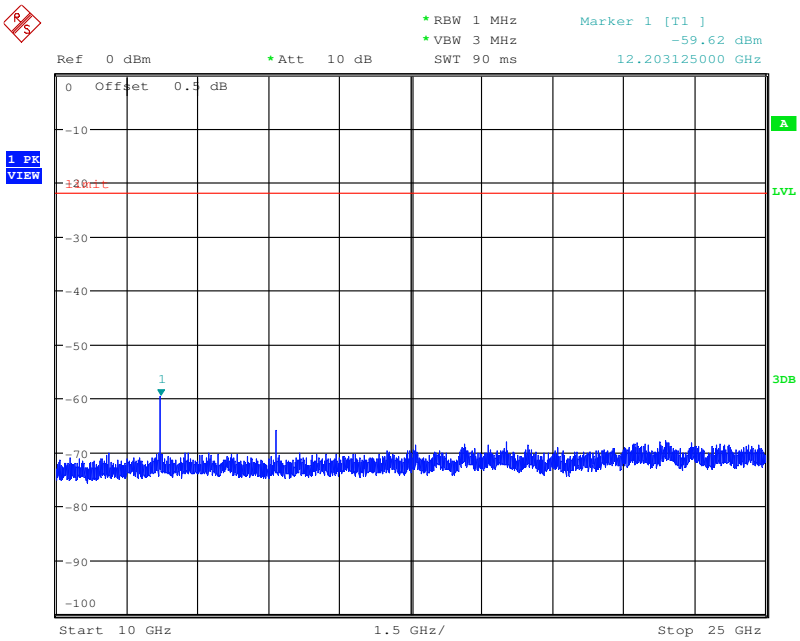

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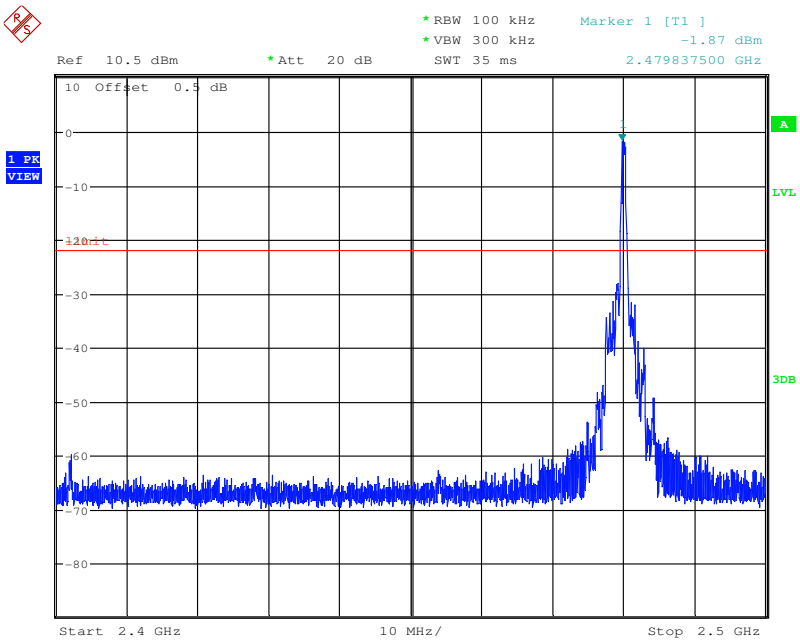
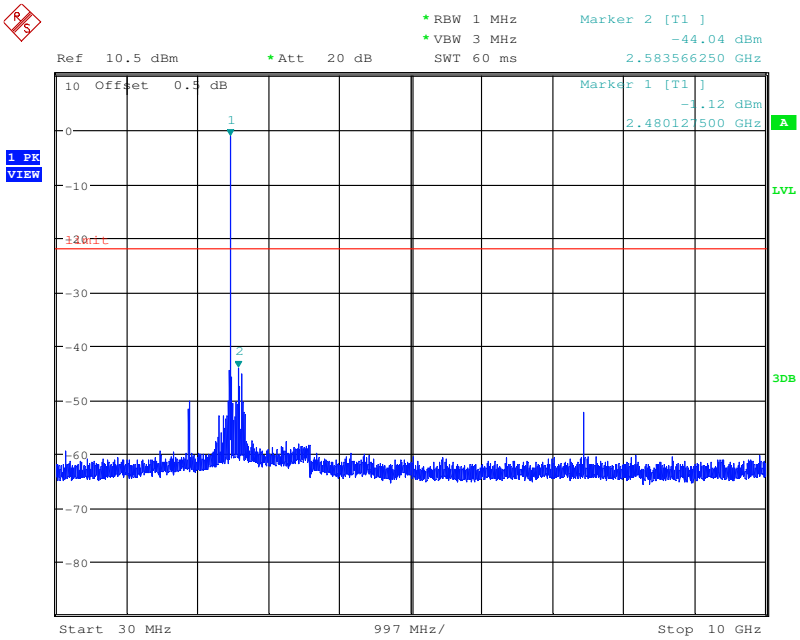
Test mode:	GFSK	Test channel:	Highest





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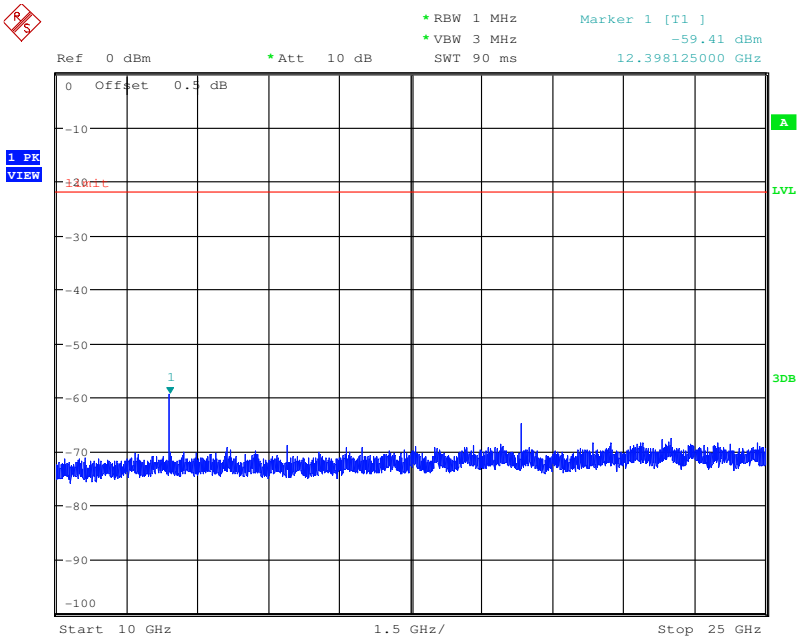
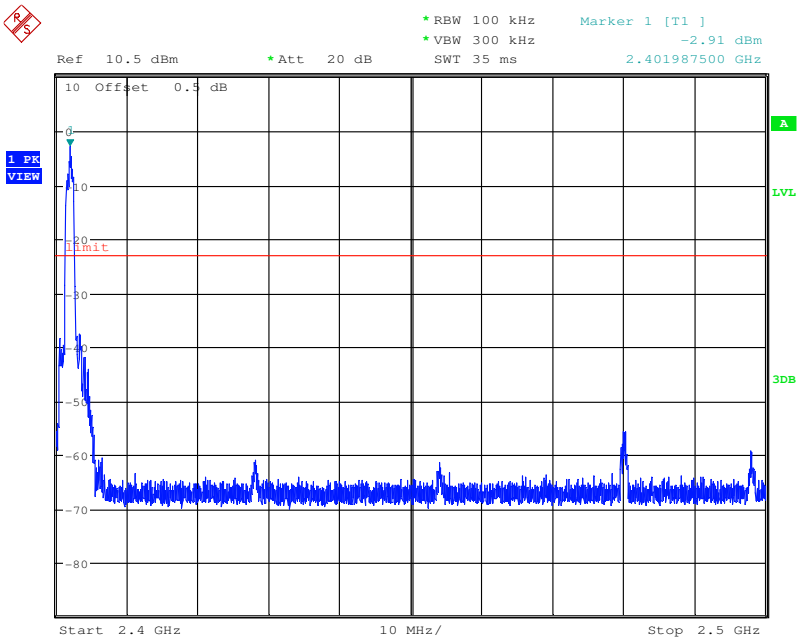


Test mode:	π/4DQPSK	Test channel:	Lowest



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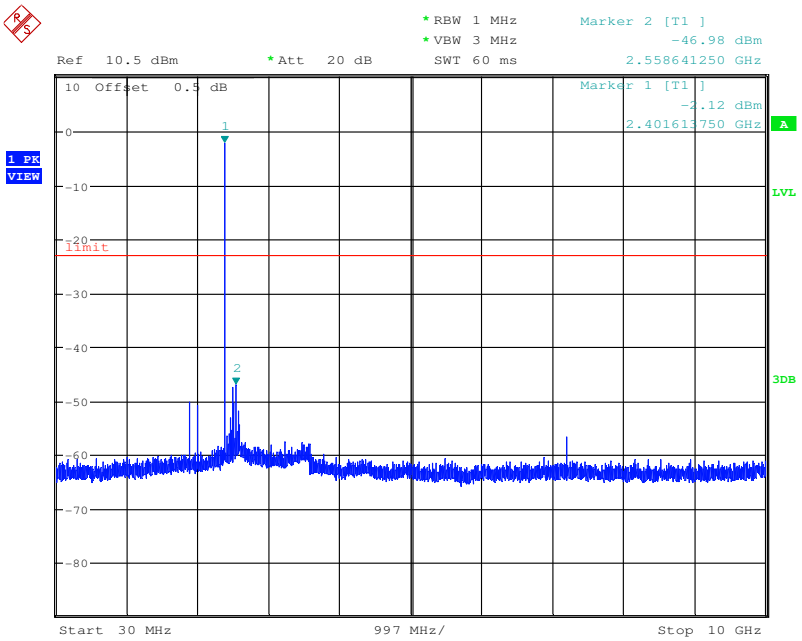

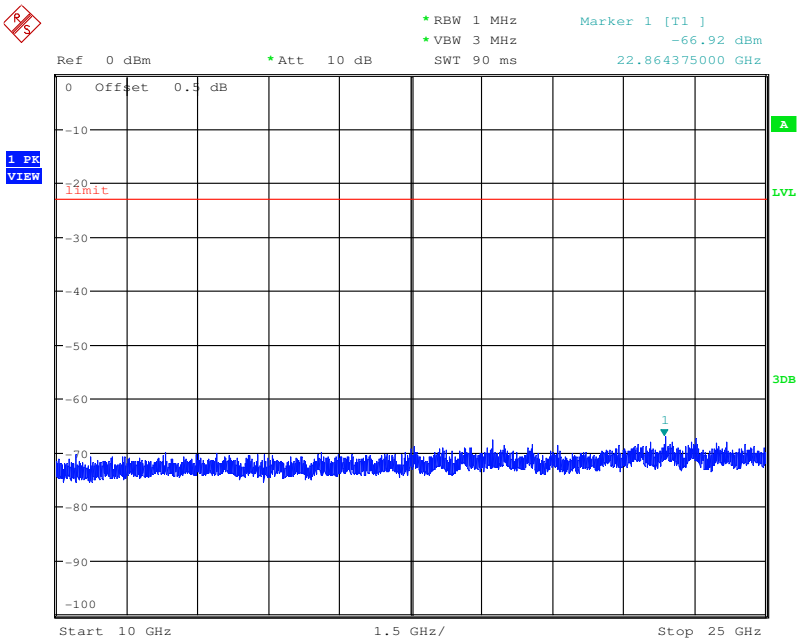

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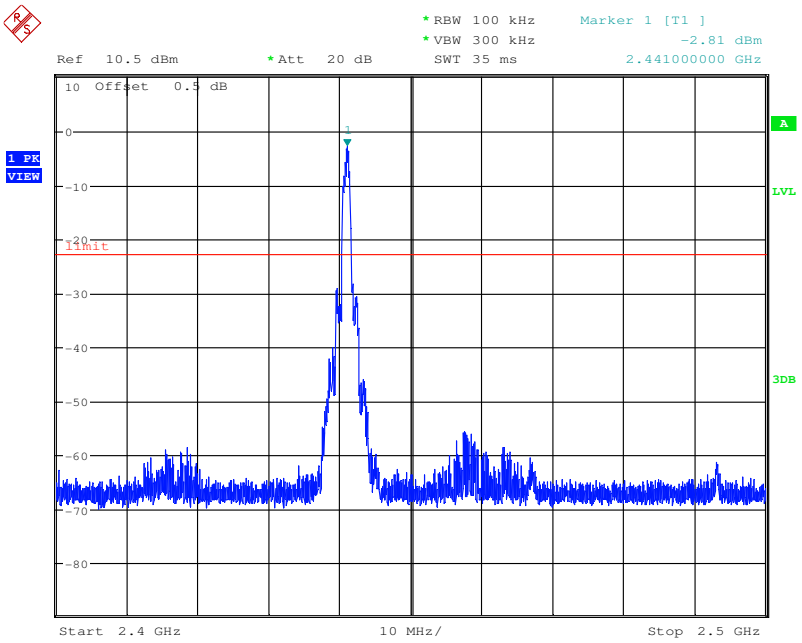
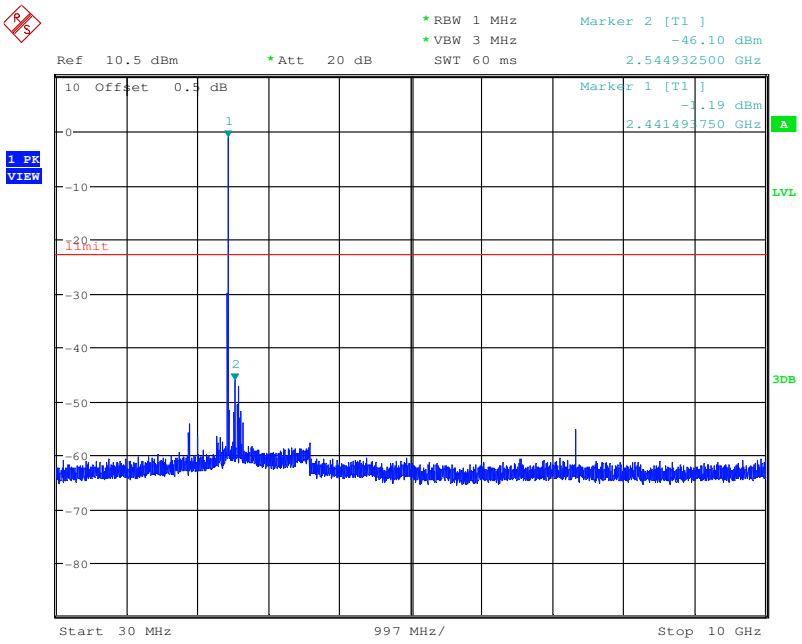
Test mode:	π/4DQPSK	Test channel:	Middle





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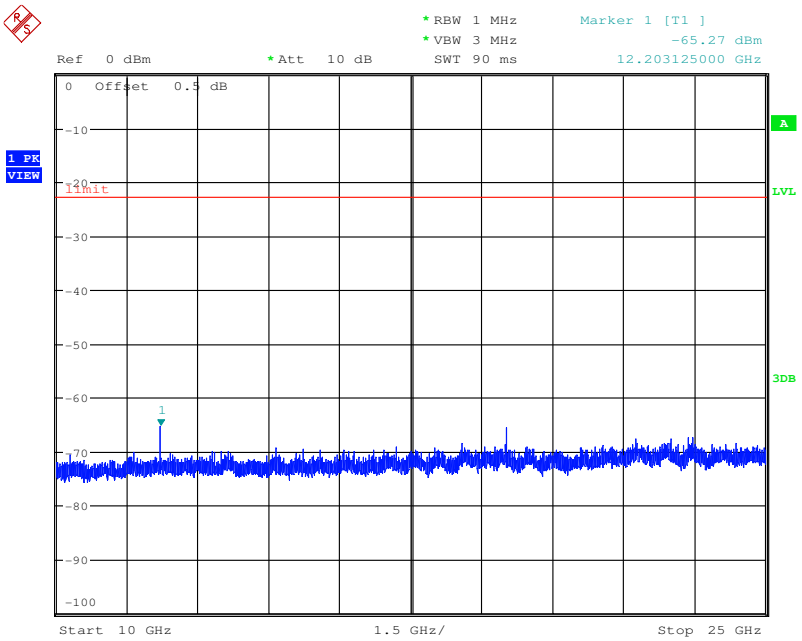
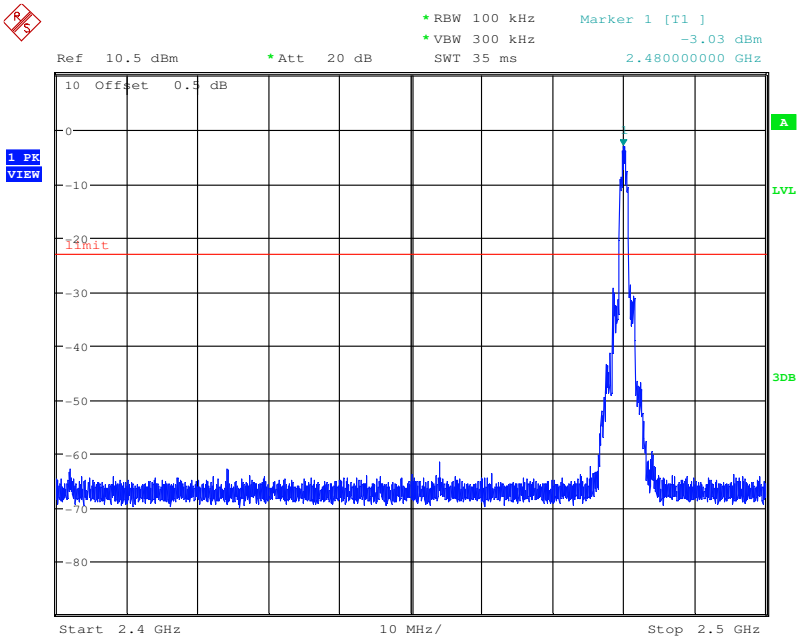


Test mode:	π/4DQPSK	Test channel:	Highest



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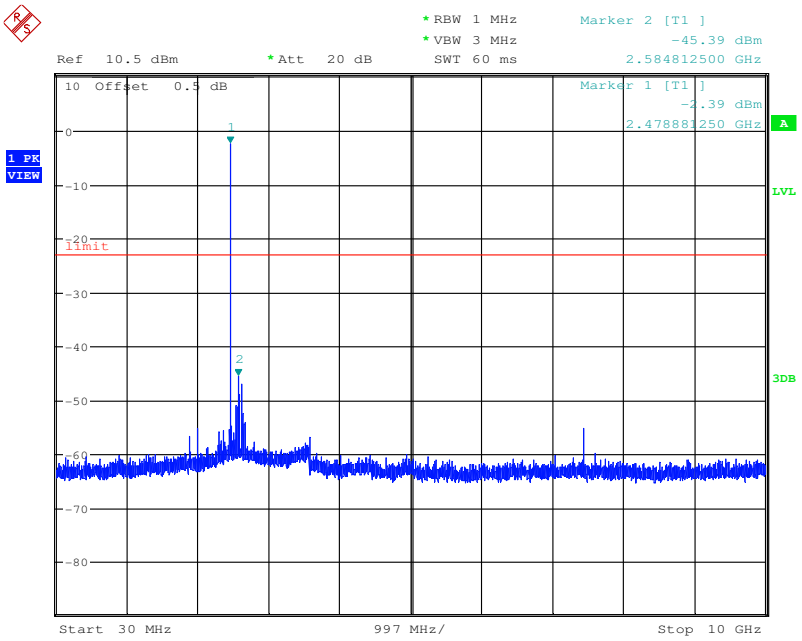

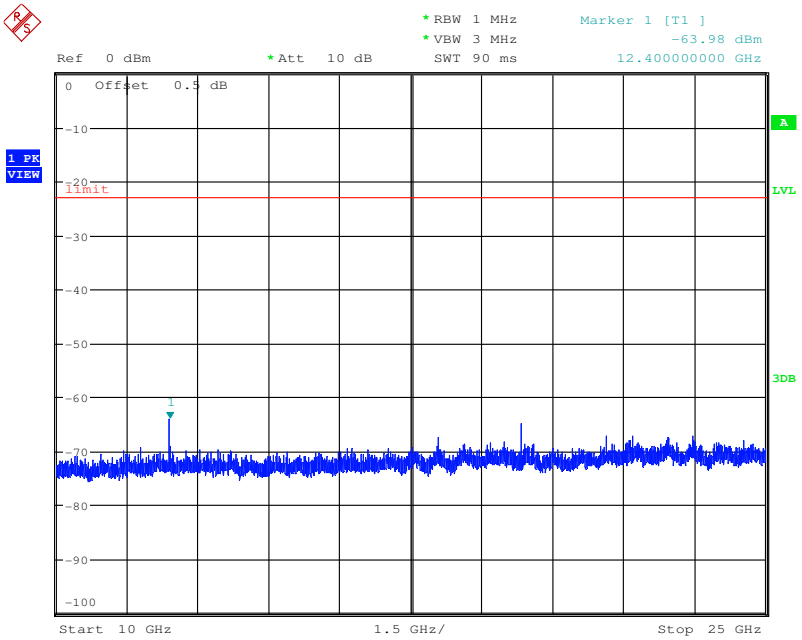

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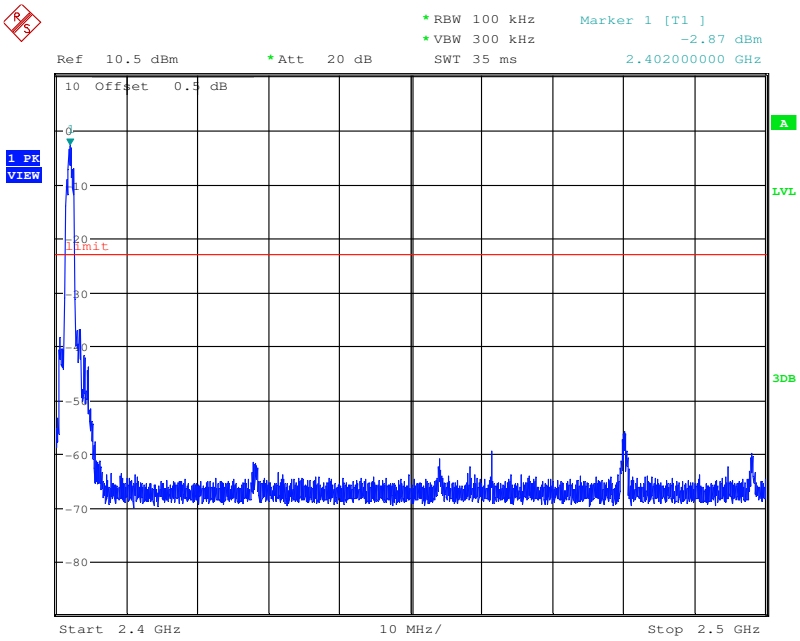
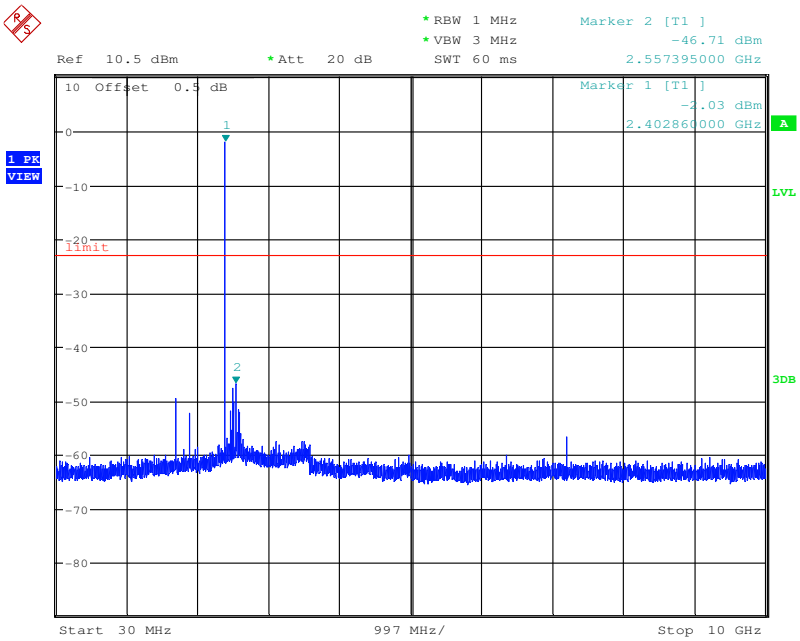
Test mode:	8DPSK	Test channel:	Lowest





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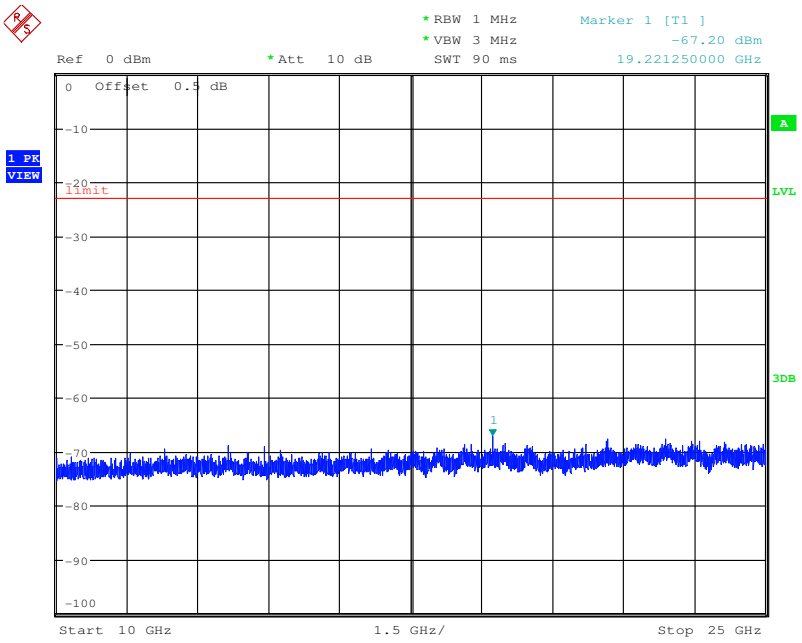
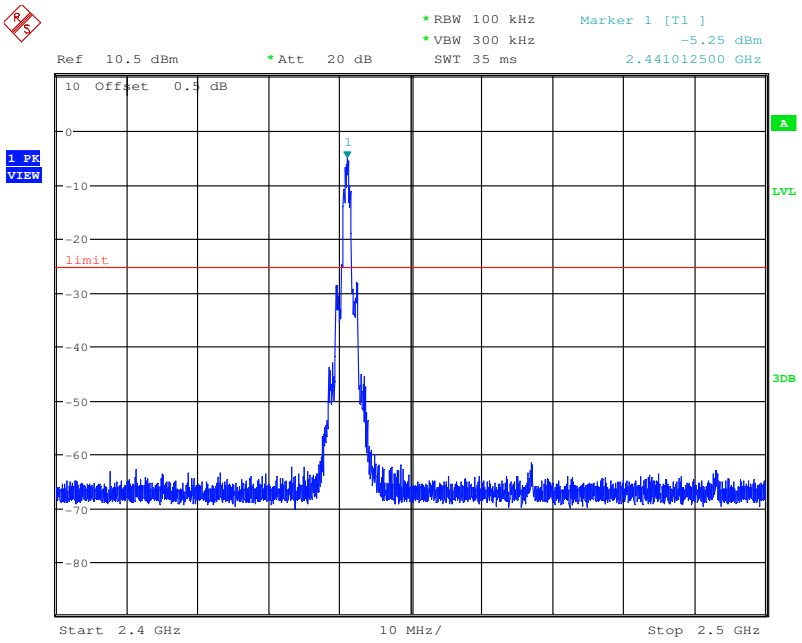


Test mode:	8DPSK	Test channel:	Middle



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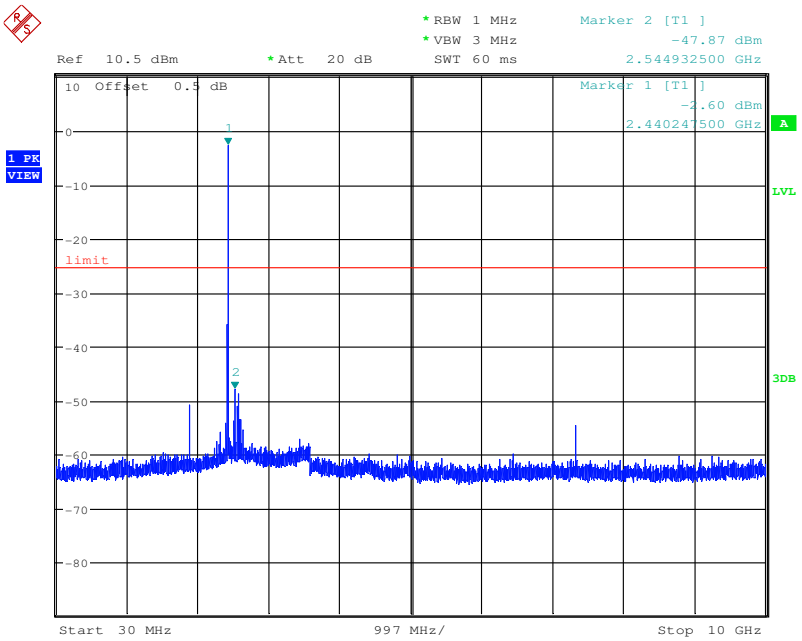

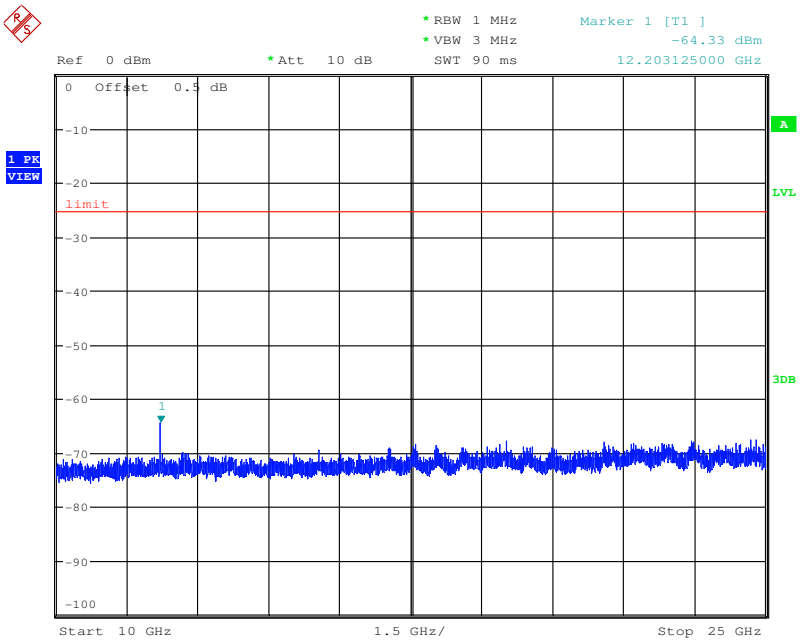

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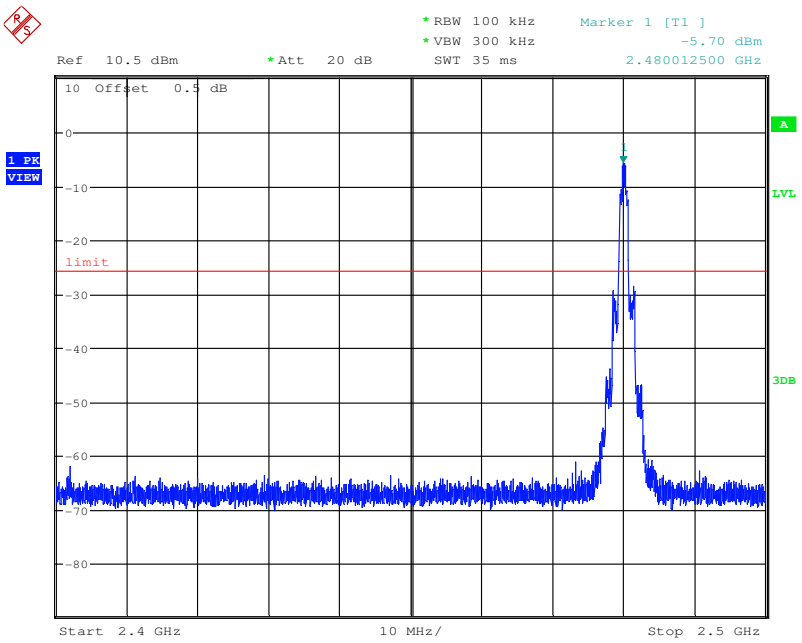
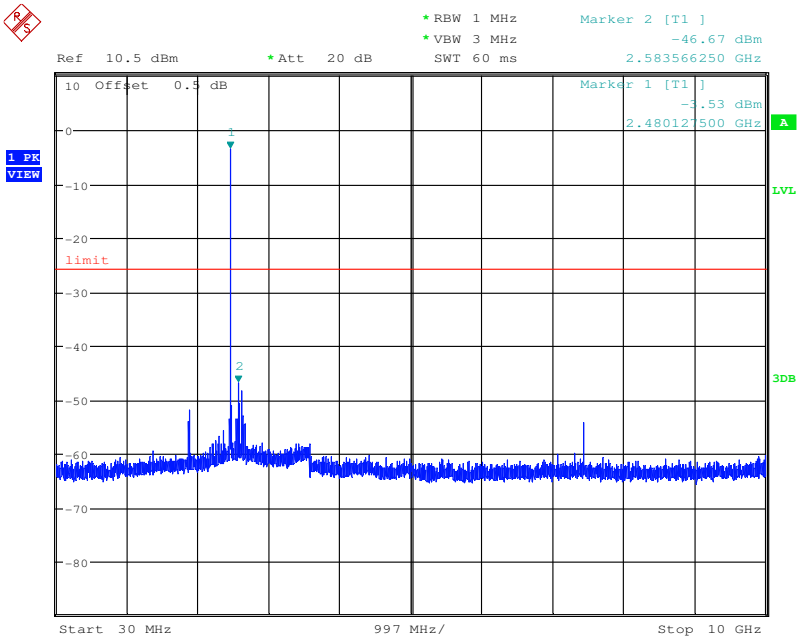
Test mode:	8DPSK	Test channel:	Highest





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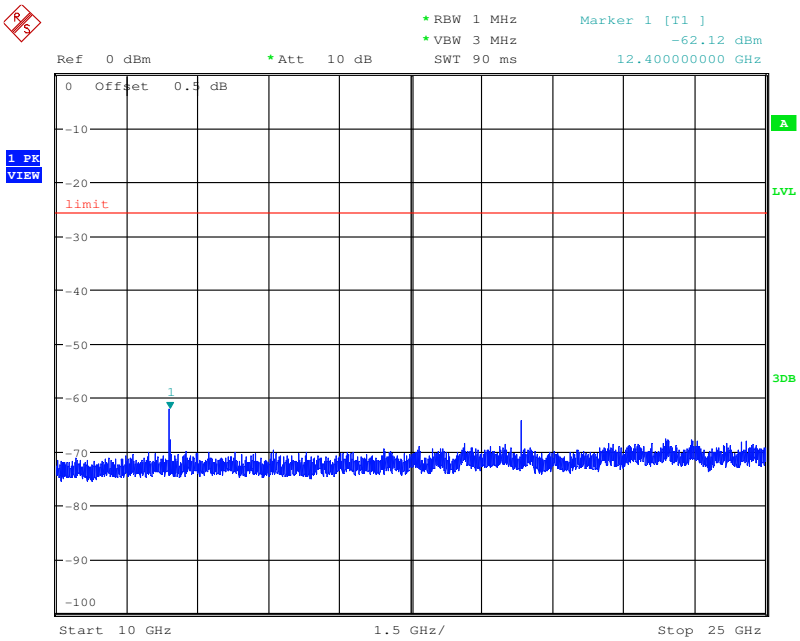

Remark:

Use 100kHz RBW to determine the relative limit in the band 2.4GHz to 2.5GHz, and Use 1MHz RBW to measure spurious emissions in the band 30MHz to 10GHz and 10GHz to 25GHz. The sweep points set to 30001.

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6.10 Other requirements Frequency Hopping Spread Spectrum System

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1), (h) requirement:

The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

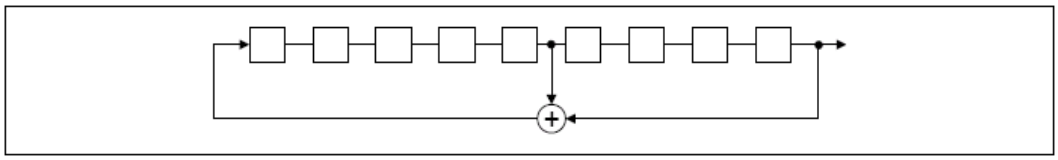
Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Compliance for section 15.247(a)(1)

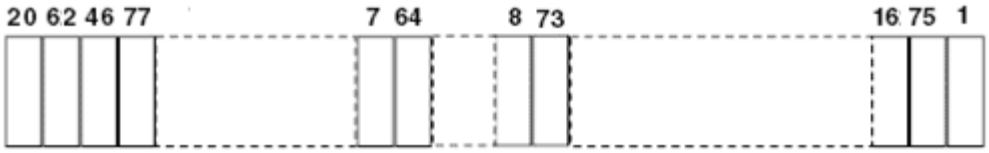
According to Bluetooth Core Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage
outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: 2^9 -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 as follow:



Each frequency used equally on the average by each transmitter.

According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift frequencies in synchronization with the transmitted signals.

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Compliance for section 15.247(g)
According to Bluetooth Core Specification, the Bluetooth system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.
Compliance for section 15.247(h)
According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels. According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

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6.11 Radiated Spurious Emission

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205
Test Method:	ANSI C63.10: 2013
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber) Measurement Distance: 10m (Semi-Anechoic Chamber)
Receiver Setup:	

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Quasi-peak	100 kHz	300kHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

Limit:

Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	29.9	40.0	Quasi-peak	10
88MHz-216MHz	44.7	43.5	Quasi-peak	10
216MHz-960MHz	60.3	46.0	Quasi-peak	10
960MHz-1GHz	100	54.0	Quasi-peak	10
Above 1GHz	500	54.0	Average	3

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 Setup:	

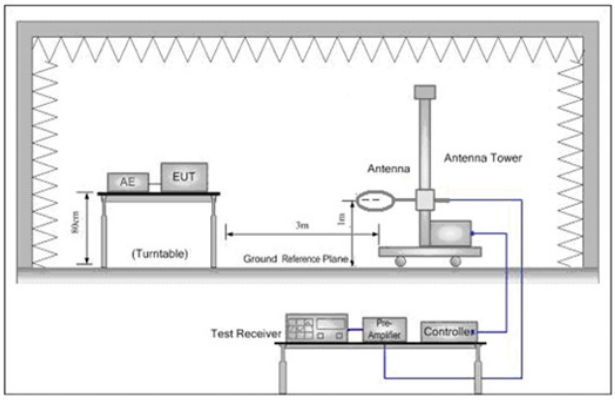

Figure 1. Below 30MHz

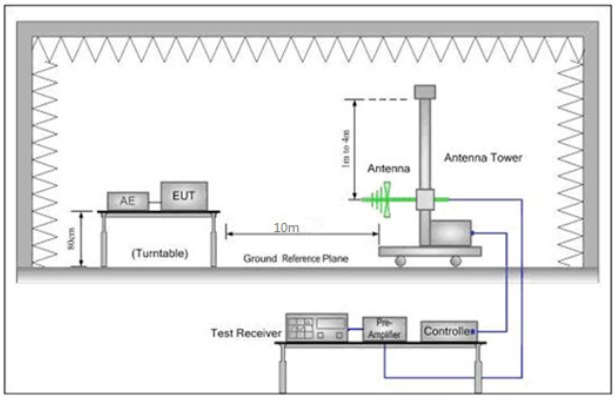

Figure 2. 30MHz to 1GHz

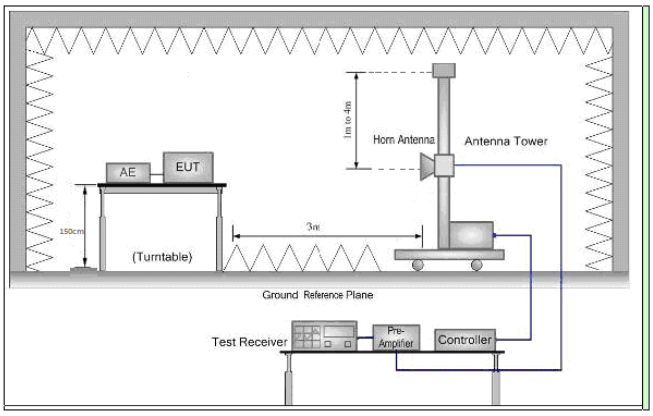

Figure 3. Above 1 GHz

Test Procedure:	a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 and 10 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

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	g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet. h. Test the EUT in the lowest channel (2402MHz),the middle channel (2441MHz),the Highest channel (2480MHz) i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. j. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type Transmitting mode
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation is the worst case. Transmitting mode Only the worst case is recorded in the report.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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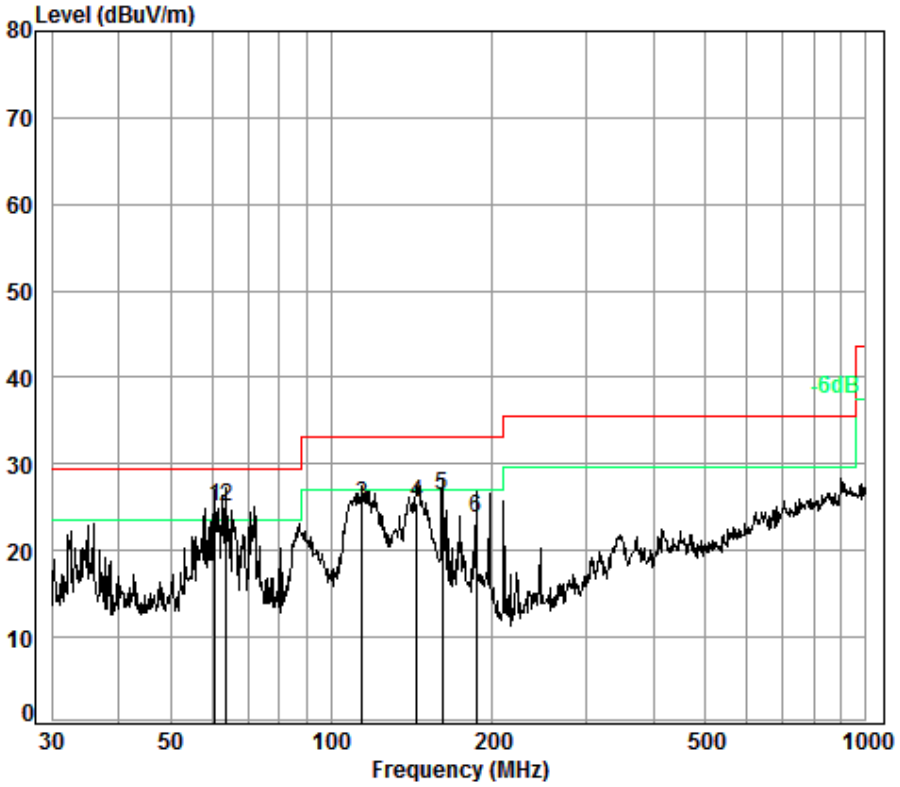
6.11.1 Radiated Emission below 1GHz

30MHz~1GHz (QP)		
Test mode:	Transmitting	Vertical



Condition: 10m Vertical
Job No. : 2891CR
Test Mode: TX mode

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	60.70	7.00	11.85	32.94	39.22	25.13	29.50	-4.37
2 pp	63.54	7.00	11.28	32.93	39.79	25.14	29.50	-4.36
3	114.11	7.27	10.84	32.78	40.03	25.36	33.10	-7.74
4	144.84	7.43	13.08	32.75	37.78	25.54	33.10	-7.56
5	161.47	7.50	13.24	32.73	38.38	26.39	33.10	-6.71
6	186.44	7.53	10.19	32.71	38.77	23.78	33.10	-9.32

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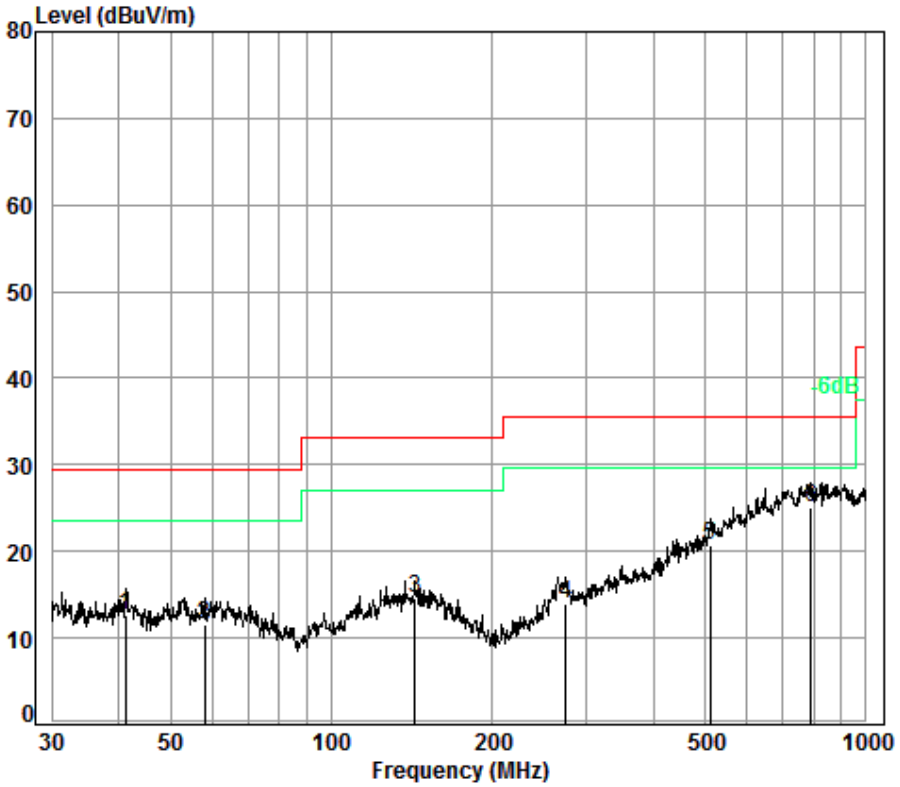
Test mode:	Transmitting	Horizontal



Condition: 10m Horizontal
Job No. : 2891CR
Test Mode: TX mode

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	41.28	6.80	13.21	32.99	25.58	12.60	29.50	-16.90
2	58.00	7.00	12.15	32.96	25.42	11.61	29.50	-17.89
3	143.33	7.42	12.98	32.75	26.88	14.53	33.10	-18.57
4	274.19	7.97	11.98	32.62	26.67	14.00	35.60	-21.60
5	511.84	8.66	17.02	32.60	27.73	20.81	35.60	-14.79
6 pp	787.85	9.27	21.15	32.60	27.18	25.00	35.60	-10.60

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6.11.2 Transmitter Emission above 1GHz

Test mode:	GFSK(DH1)		Test channel:	Lowest	Remark:		Peak
Frequency (MHz)	Antenna Factor (dB/m)	Cable loss (dB)	Preamp Factor (dB)	Read Level (dBuV)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4804.000	34.10	8.87	38.75	49.53	53.75	74.00	-20.25	Vertical
7206.000	35.60	10.68	37.64	40.62	49.26	74.00	-24.74	Vertical
9608.000	37.10	12.50	36.35	36.15	49.40	74.00	-24.60	Vertical
4804.000	34.10	8.87	38.75	49.44	53.66	74.00	-20.34	Horizontal
7206.000	35.60	10.68	37.64	40.70	49.34	74.00	-24.66	Horizontal
9608.000	37.10	12.50	36.35	35.85	49.10	74.00	-24.90	Horizontal

Test mode:	GFSK(DH1)		Test channel:	Middle	Remark:		Peak
Frequency (MHz)	Antenna Factor (dB/m)	Cable loss (dB)	Preamp Factor (dB)	Read Level (dBuV)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4882.000	34.18	8.98	38.77	48.77	53.16	74.00	-20.84	Vertical
7323.000	35.54	10.72	37.59	41.94	50.61	74.00	-23.39	Vertical
9764.000	37.10	12.58	36.14	39.47	53.01	74.00	-20.99	Vertical
4882.000	34.18	8.98	38.77	48.95	53.34	74.00	-20.66	Horizontal
7323.000	35.54	10.72	37.59	41.70	50.37	74.00	-23.63	Horizontal
9764.000	37.10	12.58	36.14	39.08	52.62	74.00	-21.38	Horizontal

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Test mode:	GFSK(DH1)	Test channel:	Highest	Remark:	Peak

Frequency (MHz)	Antenna Factor (dB/m)	Cable loss (dB)	Preamp Factor (dB)	Read Level (dBuV)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4960.000	34.26	9.09	38.78	47.82	52.39	74.00	-21.61	Vertical
7440.000	35.60	10.77	37.54	37.02	45.85	74.00	-28.15	Vertical
9920.000	37.22	12.67	35.93	37.87	51.83	74.00	-22.17	Vertical
4960.000	34.26	9.09	38.78	48.80	53.37	74.00	-20.63	Horizontal
7440.000	35.60	10.77	37.54	38.71	47.54	74.00	-26.46	Horizontal
9920.000	37.22	12.67	35.93	35.91	49.87	74.00	-24.13	Horizontal

Remark:

1) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
   Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

2) Scan from 9kHz to 25GHz, the disturbance above 13GHz and below 30MHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

3) As shown in this section, for frequencies above 1GHz, the 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. So, only the above measurement data were shown in the report.

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6.12 Restricted bands around fundamental frequency

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205
Test Method:	ANSI C63.10: 2013
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)
Limit:	

Frequency	Limit (dBuV/m @3m)	Remark
30MHz-88MHz	40.0	Quasi-peak Value
88MHz-216MHz	43.5	Quasi-peak Value
216MHz-960MHz	46.0	Quasi-peak Value
960MHz-1GHz	54.0	Quasi-peak Value
Above 1GHz	54.0	Average Value
	74.0	Peak Value

Test Setup:

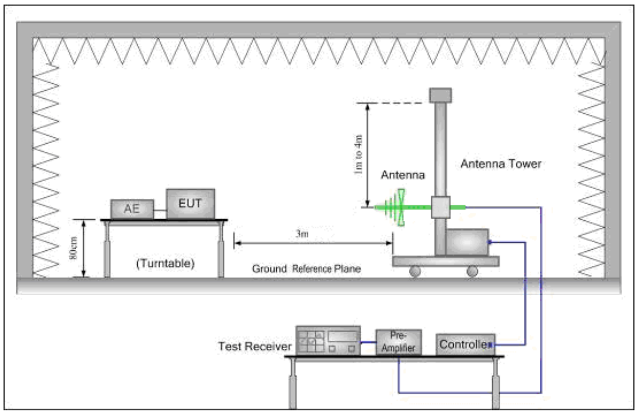

Figure 1. 30MHz to 1GHz

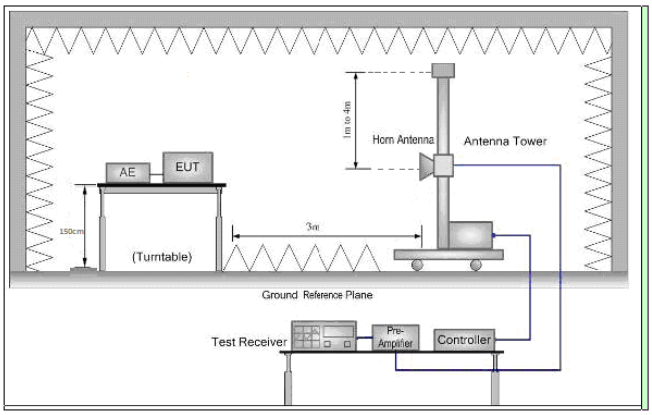

Figure 2. Above 1 GHz

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Test Procedure:	a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. c. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. g. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel h. Test the EUT in the lowest channel , the Highest channel i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. j. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type Transmitting mode
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation is the worst case. Transmitting mode Only the worst case is recorded in the report.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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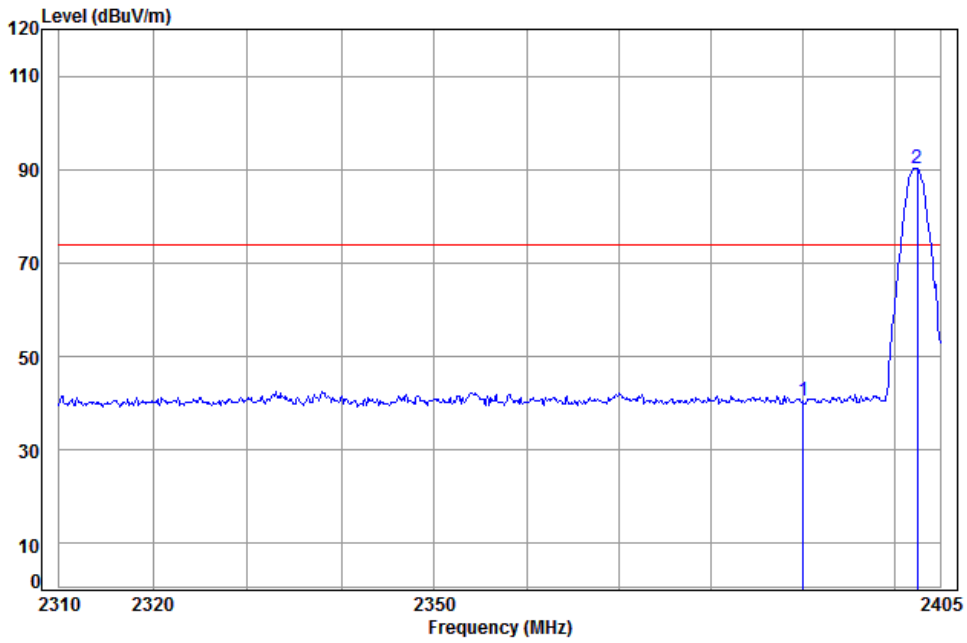
Test plot as follows:

Worse case mode:	GFSK (DH5)	Test channel:	Lowest	Remark:	Peak	Vertical



Condition: 3m Vertical
Job No: : 2891CR
Mode: : 2402 Band edge

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	2390.000	5.34	28.57	38.11	44.79	40.59	74.00	-33.41
2 pp	2402.481	5.35	28.61	38.11	94.47	90.32	74.00	16.32

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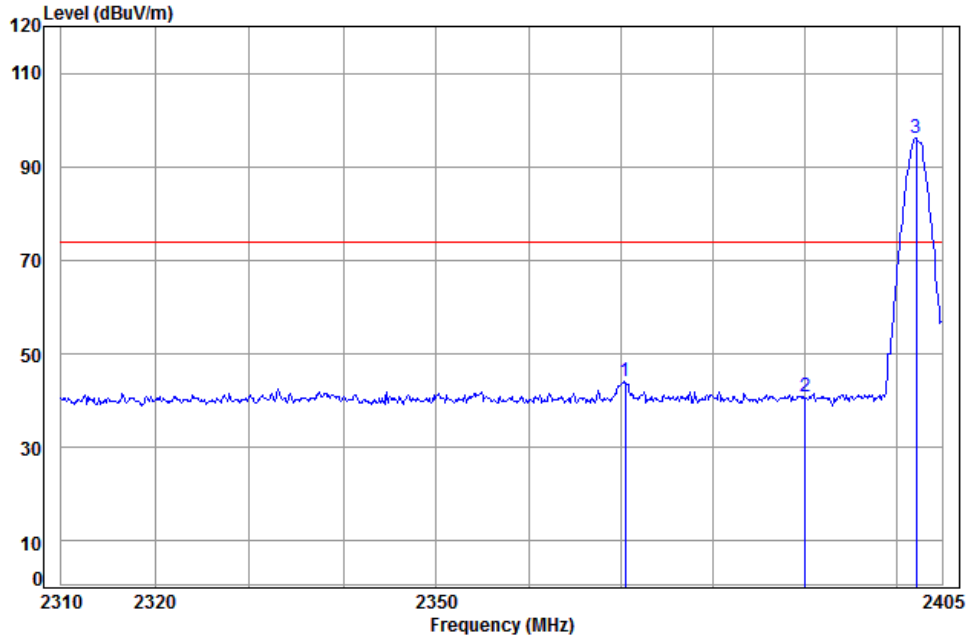
Worse case mode:	GFSK (DH5)	Test channel:	Lowest	Remark:	Peak	Horizontal



Condition: 3m Horizontal
Job No: : 2891CR
Mode: : 2402 Band edge

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	2370.358	5.32	28.51	38.11	48.27	43.99	74.00	-30.01
2	2390.000	5.34	28.57	38.11	45.12	40.92	74.00	-33.08
3 pp	2402.191	5.35	28.61	38.11	100.30	96.15	74.00	22.15

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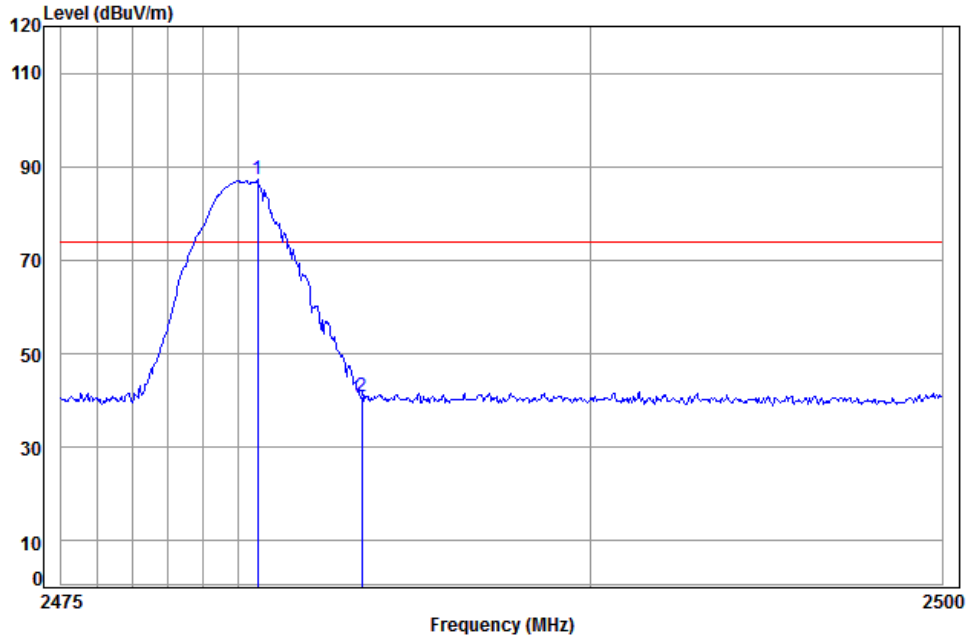
Worse case mode:	GFSK (DH5)	Test channel:	Highest	Remark:	Peak	Vertical



Condition: 3m Vertical
Job No: : 2891CR
Mode: : 2480 Band edge

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1 pp	2480.553	5.41	28.97	38.12	90.91	87.17	74.00	13.17
2	2483.500	5.41	28.98	38.12	44.65	40.92	74.00	-33.08

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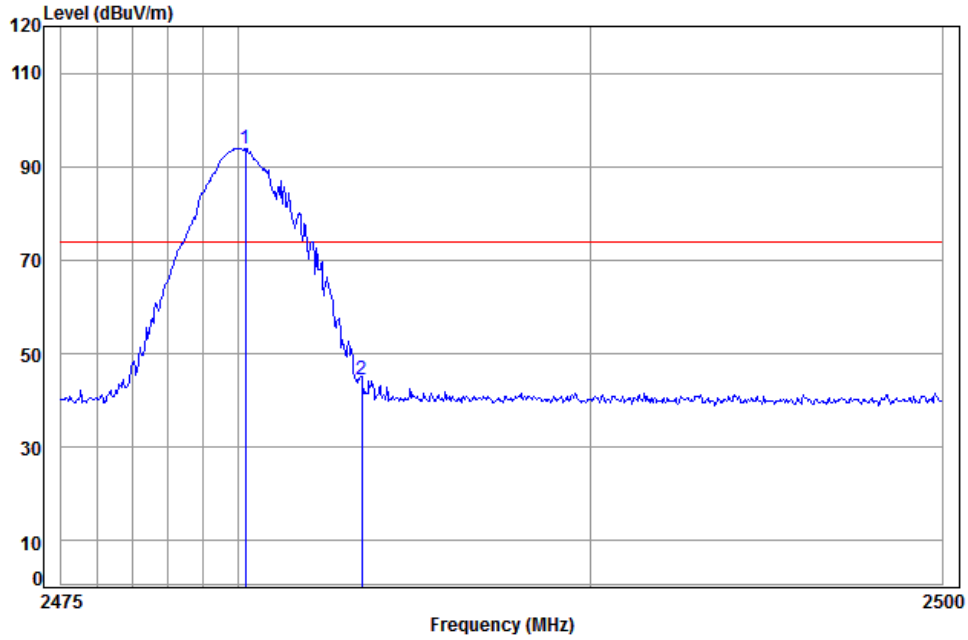
Worse case mode:	GFSK (DH5)	Test channel:	Highest	Remark:	Peak	Horizontal



Condition: 3m Horizontal
Job No: : 2891CR
Mode: : 2480 Band edge

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1 pp	2480.204	5.41	28.97	38.12	97.68	93.94	74.00	19.94
2	2483.500	5.41	28.98	38.12	48.33	44.60	74.00	-29.40

Note:
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

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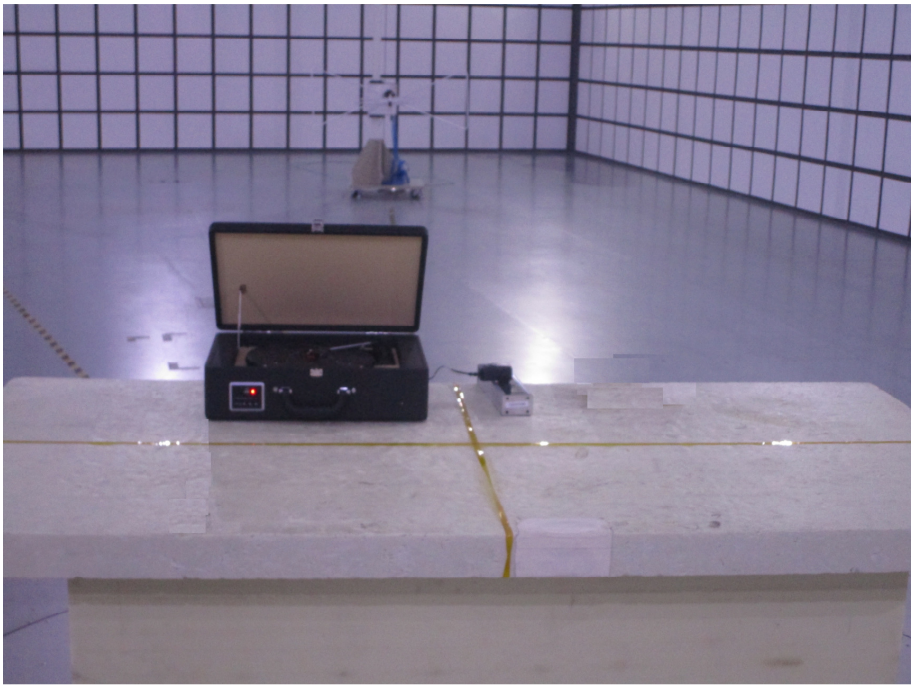
7 Photographs - EUT Test Setup

Test model No.: TT-9311

7.1 Conducted Emission

7.2 Radiated Emission



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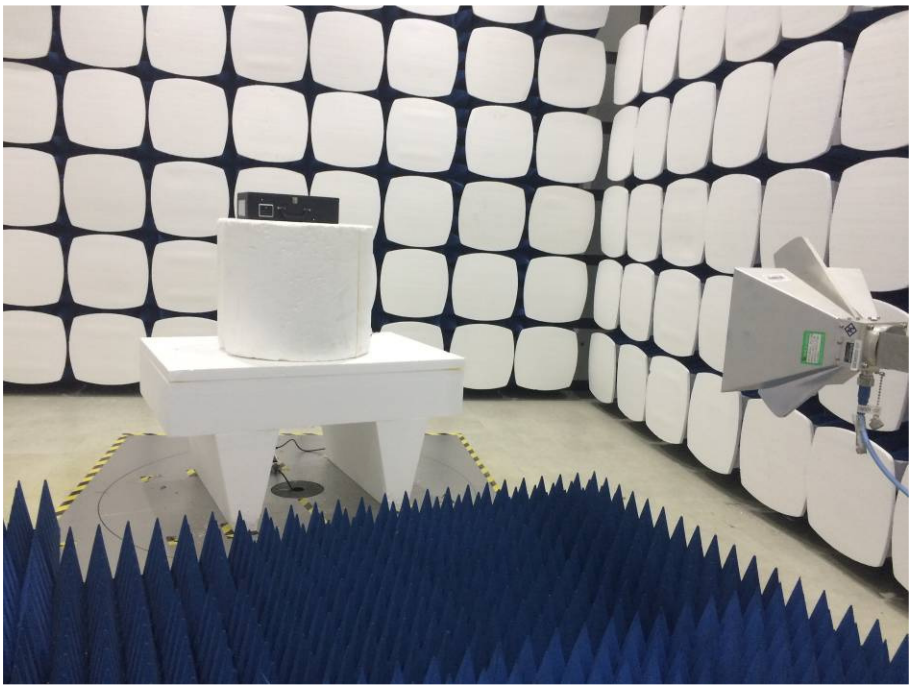
7.3 Radiated Spurious Emission



8 Photographs - EUT Constructional Details

Refer to Appendix A - Photographs of EUT Constructional Details for SZEM1604002891CR.

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