RF TEST REPORT

Test Equipment	:	Haptic Console
Model Name	:	JH47P
FCC ID	:	2A9ZCJH47P
Date of receipt	:	2022-12-02
Test duration	:	2022-12-27 ~ 2022-12-28
Date of issue	:	2023-01-10

Applicant : TNBTECH Co., Ltd.

3F, 4F, 92, Dongil-ro, Gwangjin-gu, Seoul, Republic of Korea

Test Laboratory : Lab-T, Inc.

2182-42 Baegok-daero, Mohyeon-eup, Cheoin-gu, Yongin-si
Gyeonggi-do, 17036, Korea

Test specification	:	FCC Part 15 Subpart C 15.247
RF Output Power	:	-4.73 dBm
Test result	:	Pass

The above equipment was tested by Lab-T Testing Laboratory for compliance with the requirements of FCC Rules and Regulations.
The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose.
This test report shall not be reproduced except in full, without the written approval of Lab-T, Inc
This test report is not related to KOLAS.

Tested by:

Engineer
HyunWoo Lee

Reviewed by:

Technical Manager
SangHoon Yu

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1. Revision history

Test Report No.	Date	Description
TRRFCC23-0001	2023-01-04	Initial issue
TRRFCC23-0001(1)	2023-01-10	FCC ID Changed

2. Information

2.1 Applicant Information

Applicant name	TNBTECH Co., Ltd.
Address	3F, 4F, 92, Dongil-ro, Gwangjin-gu, Seoul, Republic of Korea
Telephone No.	+82-2-464-5682
Person in charge	Wancheol Kim / wancheolkim@tnbtech.co.kr
Manufacturer	TNBTECH Co., Ltd.
Address	3F, 4F, 92, Dongil-ro, Gwangjin-gu, Seoul, Republic of Korea

2.2 Test Laboratory information

Corporate name	Lab-T, Inc.
Representative	Duke (Jongyoung) Kim
Address	2182-42 Baegok-daero, Mohyeon-eup, Cheoin-gu, Yongin-si, Gyeonggi-do 17036, Korea(Republic of)
Telephone	+82-31-322-6767
Fax	+82-31-322-6768
E-mail	info@lab-t.net
FCC Designation No.	KR0159

2.3 Test Site

Test Site	used	Address
Building L	☒	2182-40 Baegok-daero, Mohyeon-eup, Cheoin-gu, Yongin-si, Gyeonggi-do 17036, Korea(Republic of)
Building T	☒	2182-42 Baegok-daero, Mohyeon-eup, Cheoin-gu, Yongin-si, Gyeonggi-do 17036, Korea(Republic of)
Building A	☐	2182-44 Baegok-daero, Mohyeon-eup, Cheoin-gu, Yongin-si, Gyeonggi-do 17036, Korea(Republic of)

3. Information About Test Equipment

3.1 Equipment Information

Equipment type	Haptic Console
Model name	JH47P
Variant model name	-
Frequency range	2 402 ~ 2 480 MHz
Modulation type (Symbol rate / Bit rate)	GFSK(1 Msps / 1 Mbps), pi/4DQPSK(1 Msps / 2 Mbps)
Power supply	DC 3.7 V
H/W version	Ver 1.0
S/W version	Ver 1.0

NOTE1: The above EUT information was declared by the manufacturer.

3.2 Antenna Information

Type	Model No.	Gain	Note
PCB Antenna	2.4G ANT	3.55 dBi	-

3.3 Test Frequency

Test mode	Test frequency (MHz)		
	Lowest frequency	Middle frequency	Highest frequency
GFSK	2 402	2 441	2 480
pi/4DQPSK	2 402	2 441	2 480

3.4 Worst-Case

BDR	GFSK(DH5)
EDR	pi/4DQPSK(2-DH5)

Note:The power measurement has been conducted to determine the worst-case mode from all possible combi nations between available modulations, data rates.

3.5 Tested Companion Device Information

Type	Manufacturer	Model	Note
-	-	-	-

3.6 Operating conditions for the EUT

Firmware state		Ver 1.0
Test software name(version)		FCC_assist_1.0.1.2
Test power setting		10
Serial number (Setup mode)	EUT #1	#1 (RF conducted measurement)
	EUT #2	#2 (Radiated Emission, Conducted Emission)

4. Test Report

4.1 Summary

FCC Part 15			
FCC Rule	Parameter	Clause	Status
Transmitter Requirements			
15.203 15.247(b)(4)	Antenna Requirement	4.3.1	C
15.247(a)(1)	20 dB Channel Bandwidth	4.3.2	C
-	Occupied Bandwidth	4.3.2	-
15.247(a)(1)(iii)	Number of Hopping Frequencies	4.3.3	C
15.247(a)(1)(iii)	Time of occupancy (Dwell Time)	4.3.4	C
15.247(a)(1)	Carrier Frequencies Separation	4.3.5	C
15.247(b)(1)	Peak Output Power	4.3.6	C
15.247(d) 15.205(a) 15.209(a)	Spurious Emission, Band Edge and Restricted bands	4.3.7	C
15.207(a)	Conducted Emissions	4.3.8	C
NOTE 1 : C = Comply N/C = Not Comply N/T = Not Tested N/A = Not Applicable			

* The general test methods used to test this device is ANSI C63.10:2020
* Standard(s) : KDB 558074 D01 DTS Meas Guidance

4.2 Measurement Uncertainty

Mesurement items	Expanded Uncertainty	
RF Output Power	0.77 dB	(The confidence level is about 95 %, *k*=2)
Occupied Channel Bandwidth	6.46 kHz	(The confidence level is about 95 %, *k*=2)
Conducted Spurious Emissions	0.41 dB	(The confidence level is about 95 %, *k*=2)
Radiated Spurious Emissions (1 GHz under)	4.78 dB	(The confidence level is about 95 %, *k*=2)
Radiated Spurious Emissions (Above 1 GHz)	5.98 dB	(The confidence level is about 95 %, *k*=2)
Conducted emission	2.36 dB	(The confidence level is about 95 %, *k*=2)

4.3 Transmitter Requirements

4.3.1 Antenna Requirement

4.3.1.1 Regulation

Accoding to §15.203 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 shall be considered sufficient to comply with the provisions of this section. 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.

Accoding to §15.247(b)(4) e 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.

4.3.1.2 Result

Comply
(The transmitter has a internal PCB Antenna. The directional peak gain of the antenna is 3.55 dBi.)

4.3.2 20 dB Bandwidth and Occupied Bandwidth

4.3.2.1 Regulation

20 dB and 99% emission bandwidth reporting only, measurement is also used to determine limits for other requirements of FHSS transmitters.

4.3.2.2 Measurement Procedure

ANSI C63.10 § 6.9.2 Occupied bandwidth 20dB Relative procedure
ANSI C63.10 § 6.9.3 Occupied bandwidth 99% procedure

4.3.2.3 Result

Comply (measurement data : refer to the next page)

4.3.2.4 Measurement data

Test mode : GFSK

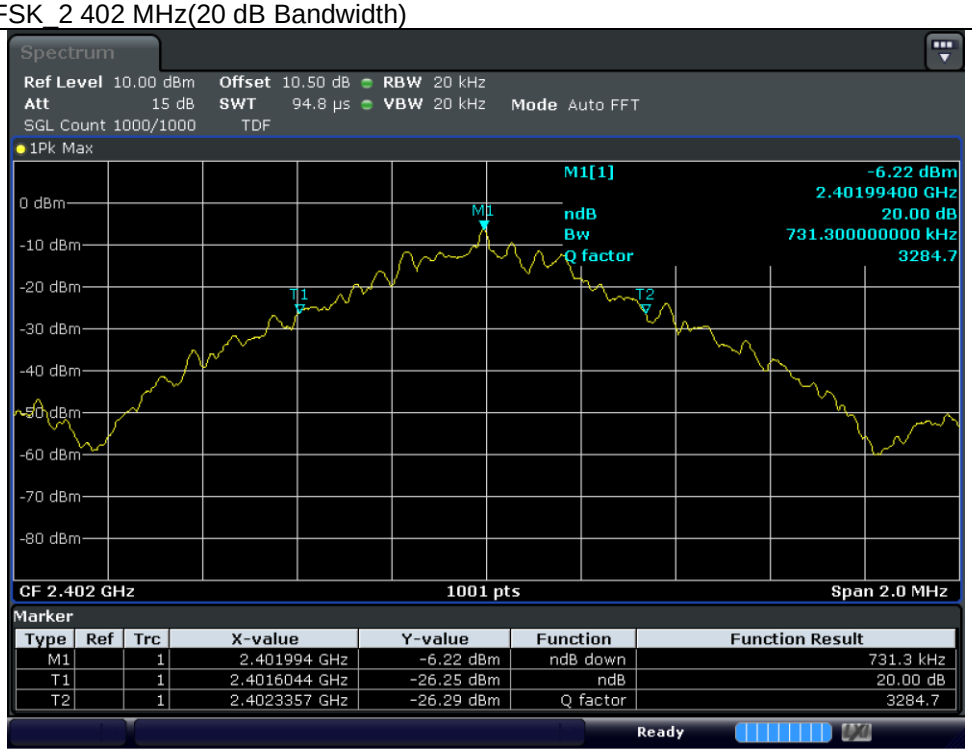
Frequency (MHz)	20 dB Bandwidth (MHz)	Min. Limit (MHz)	Occupied Bandwidth (99 % Bandwith)(MHz)
2 402	0.73	0.25	0.84
2 441	0.73	0.25	0.84
2 480	0.74	0.25	0.84

Test mode : pi/4DQPSK

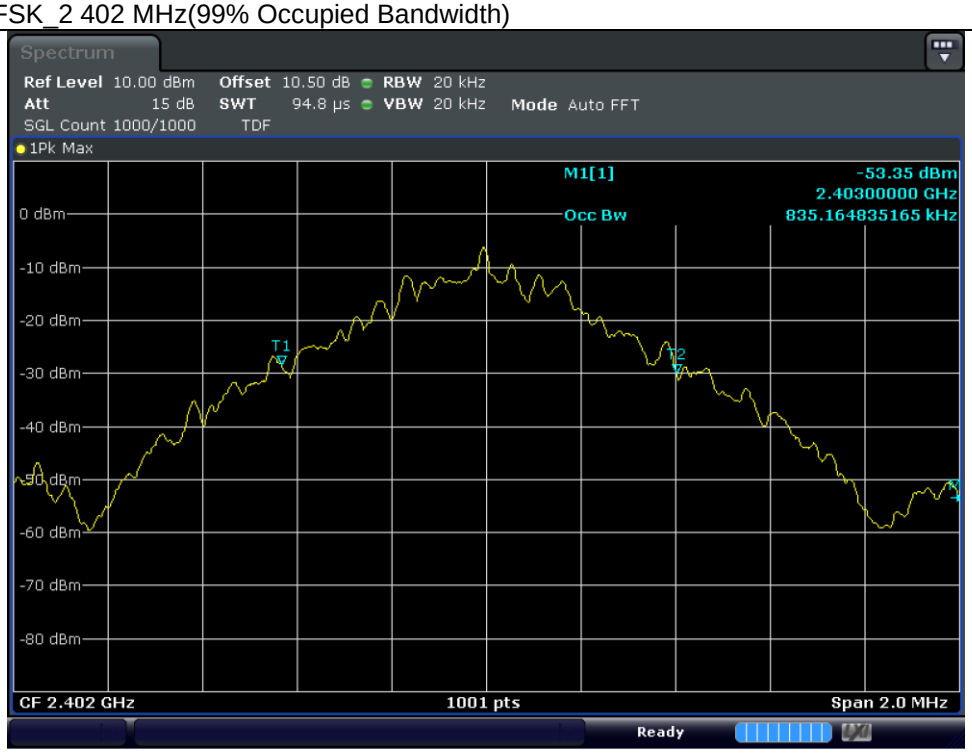
Frequency (MHz)	20 dB Bandwidth (MHz)	Min. Limit (MHz)	Occupied Bandwidth (99 % Bandwith)(MHz)
2 402	1.13	0.25	1.17
2 441	1.13	0.25	1.16
2 480	1.13	0.25	1.17

4.3.2.5 Test Plot

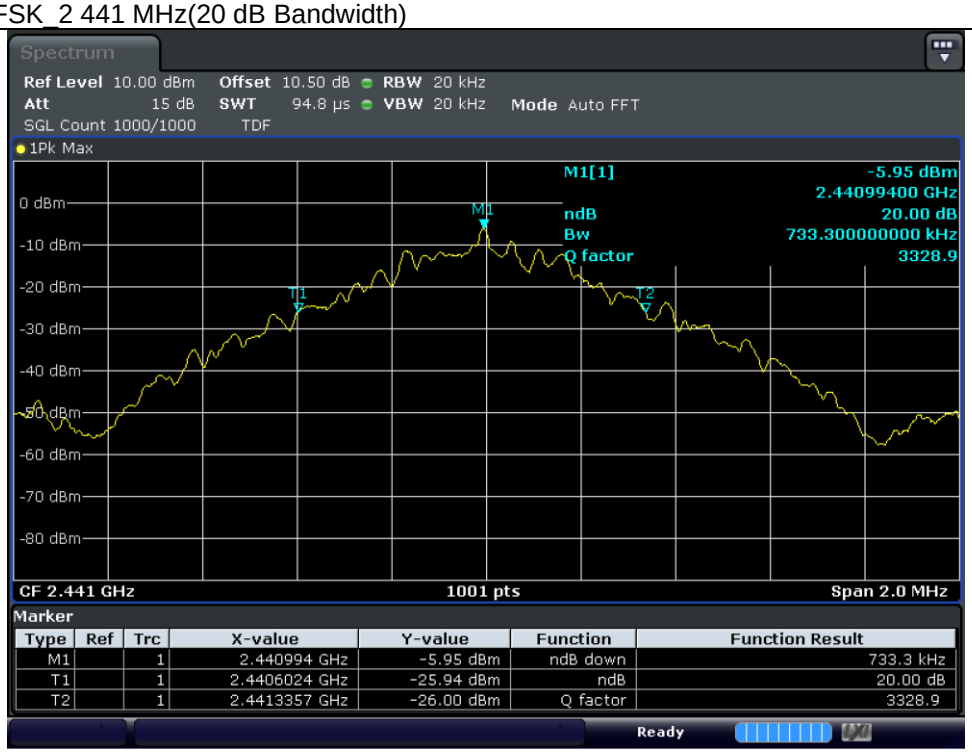
GFSK_2 402 MHz(20 dB Bandwidth)



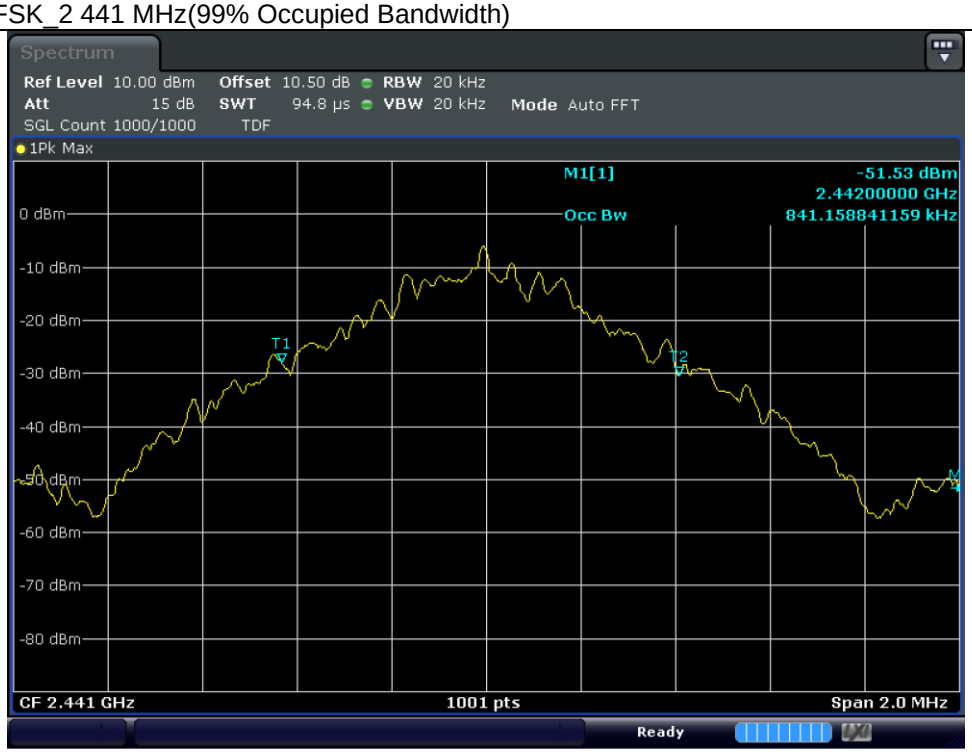
GFSK_2 402 MHz(99% Occupied Bandwidth)



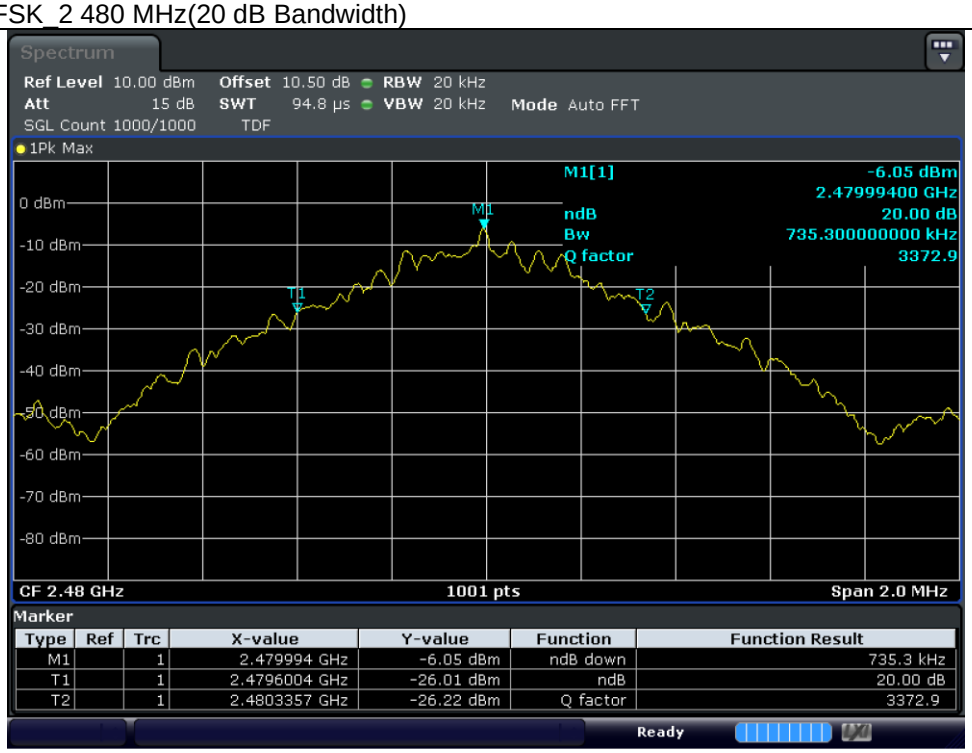
GFSK_2 441 MHz(20 dB Bandwidth)



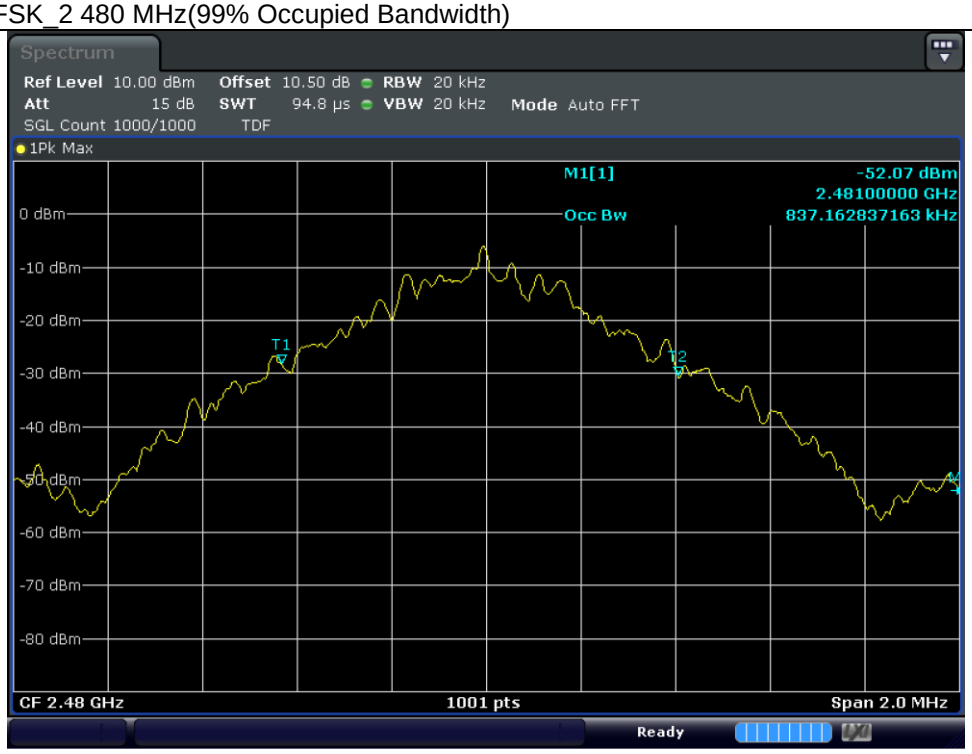
GFSK_2 441 MHz(99% Occupied Bandwidth)



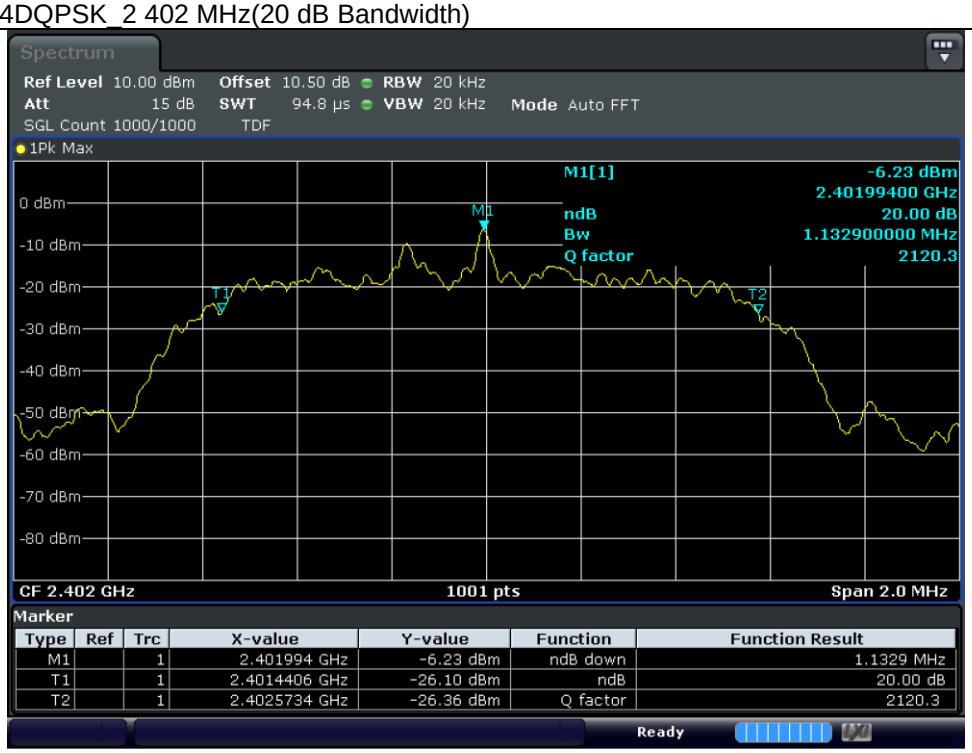
GFSK_2 480 MHz(20 dB Bandwidth)



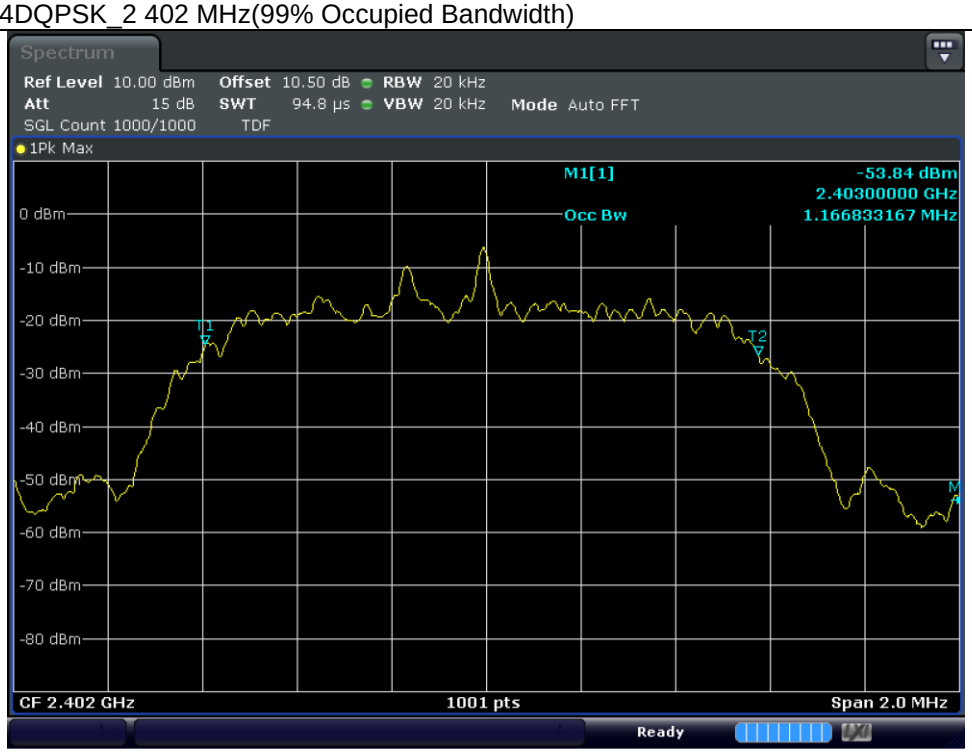
GFSK_2 480 MHz(99% Occupied Bandwidth)



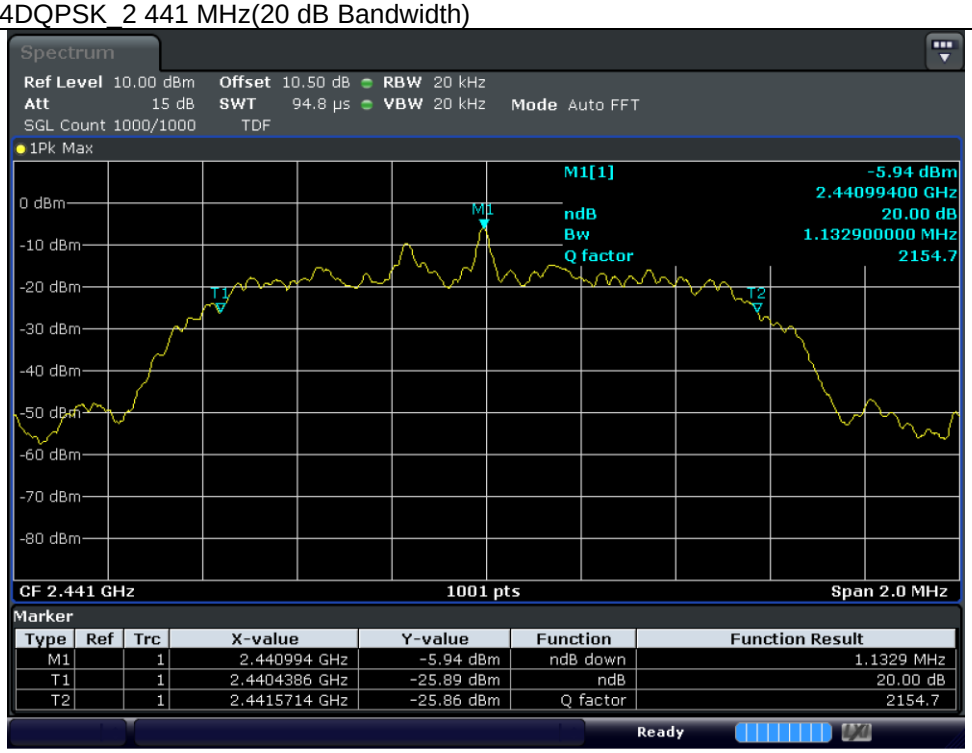
pi/4DQPSK_2 402 MHz(20 dB Bandwidth)



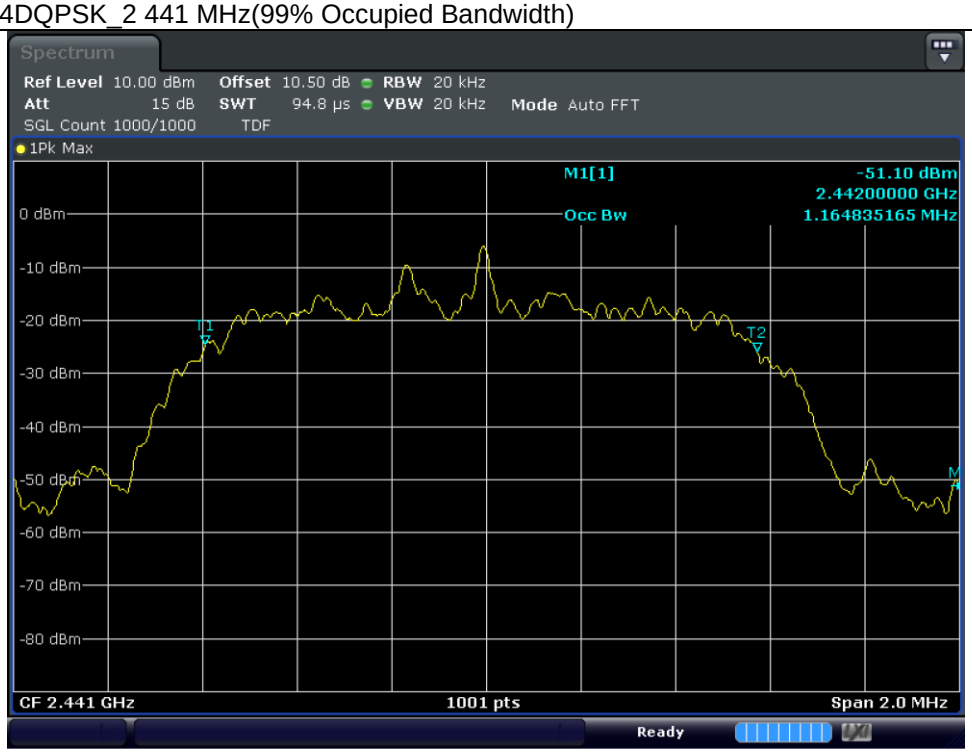
pi/4DQPSK_2 402 MHz(99% Occupied Bandwidth)



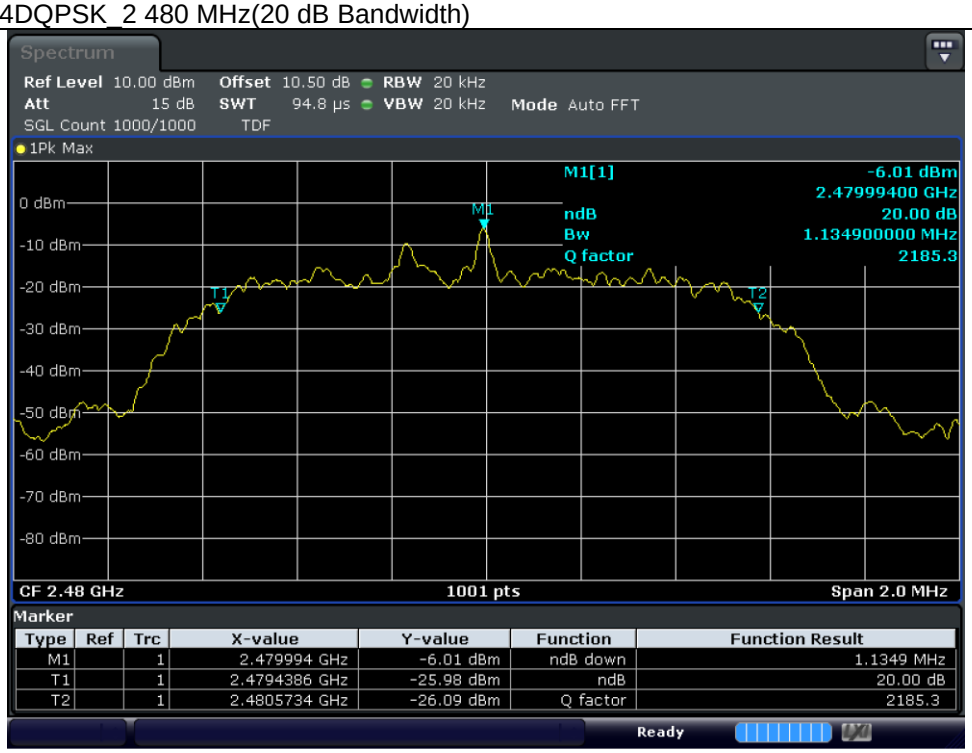
pi/4DQPSK_2 441 MHz(20 dB Bandwidth)



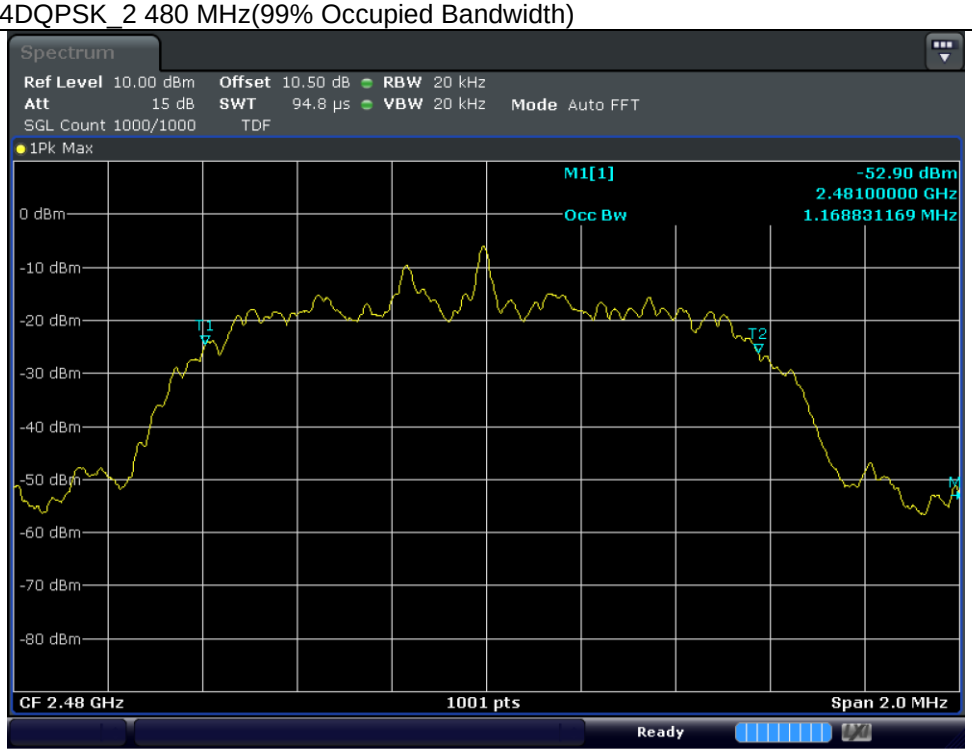
pi/4DQPSK_2 441 MHz(99% Occupied Bandwidth)



pi/4DQPSK_2 480 MHz(20 dB Bandwidth)



pi/4DQPSK_2 480 MHz(99% Occupied Bandwidth)



4.3.3 Number of Hopping Frequencies

4.3.3.1 Regulation

According to §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.

4.3.3.2 Measurement Procedure

ANSI C63.10 § 7.8.3 Number of hopping frequencies

4.3.3.3 Result

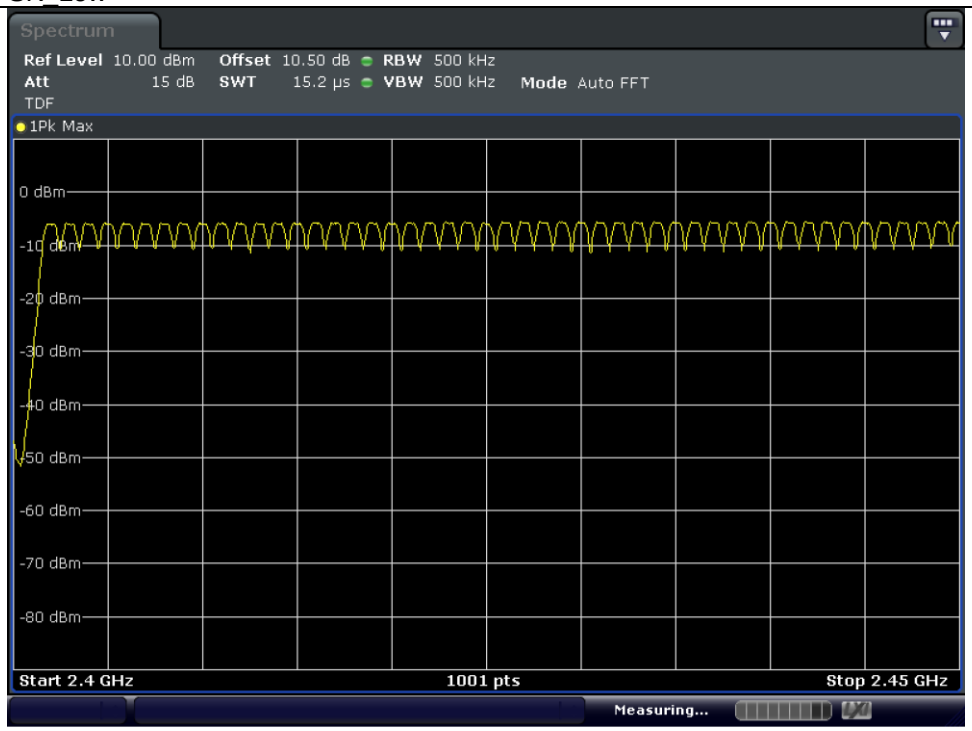
Comply (measurement data : refer to the next page)

4.3.3.4 Measurement data

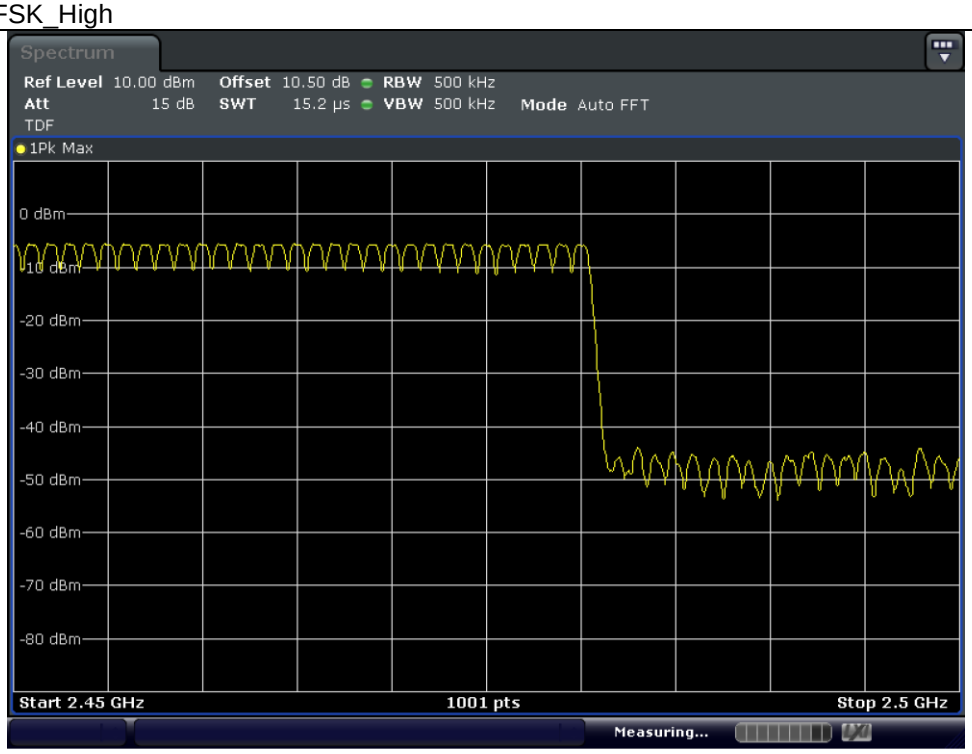
TEST MODE	Number of Hopping channels
GFSK	79
GFSK(AFH)	20
pi/4DQPSK	79
pi/4DQPSK(AFH)	20

4.3.3.5 Test Plot

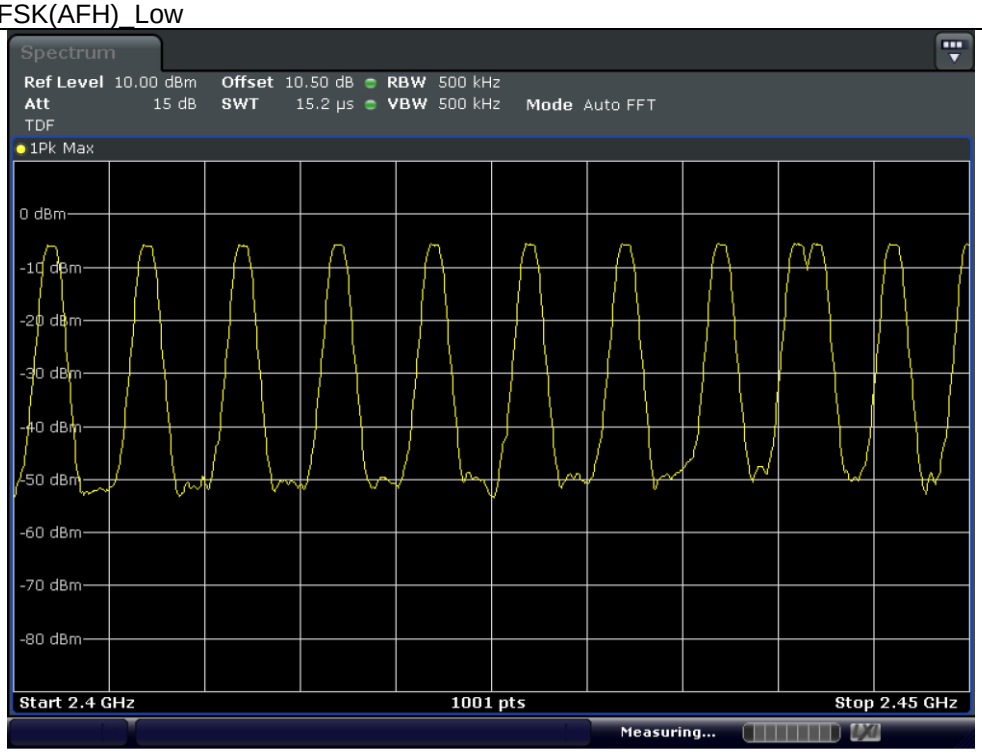
GFSK_Low



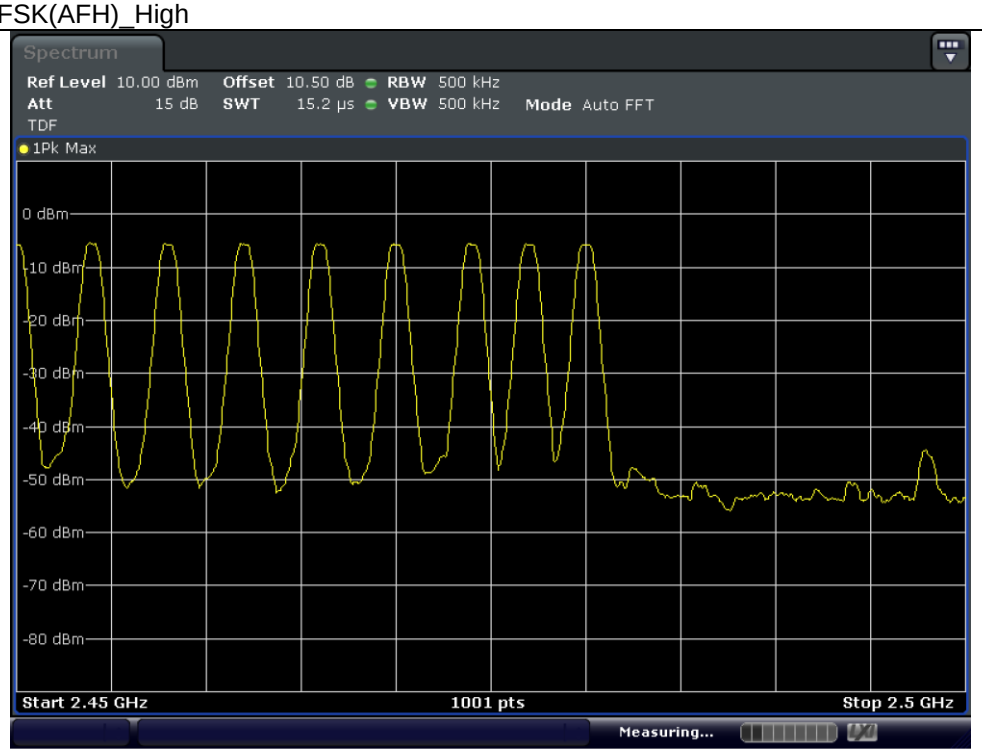
GFSK_High



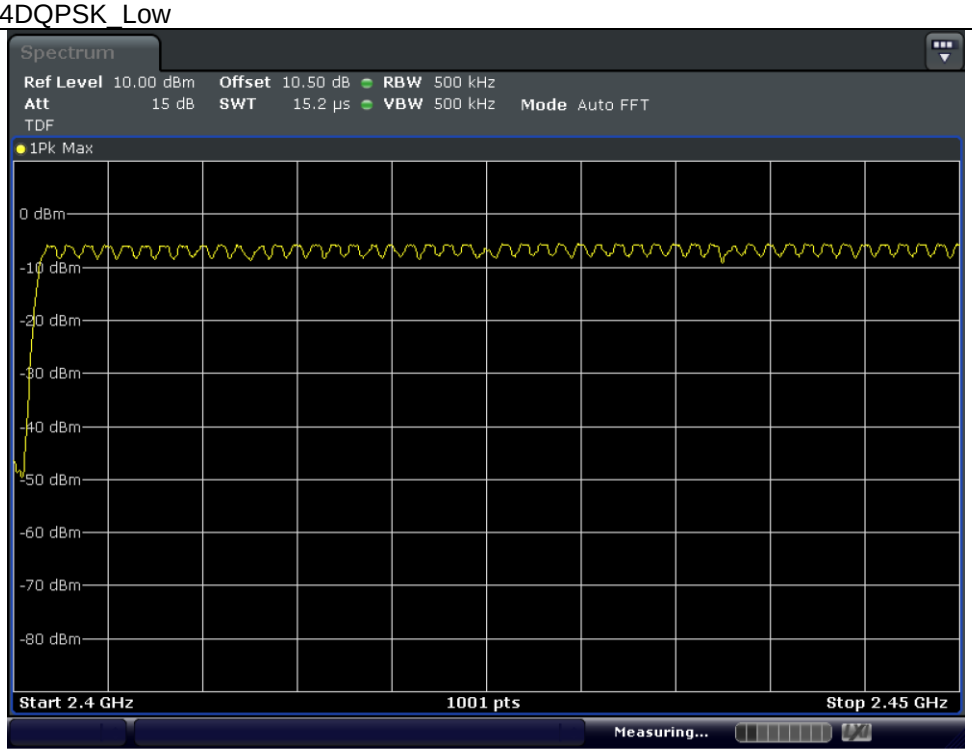
GFSK(AFH)_Low



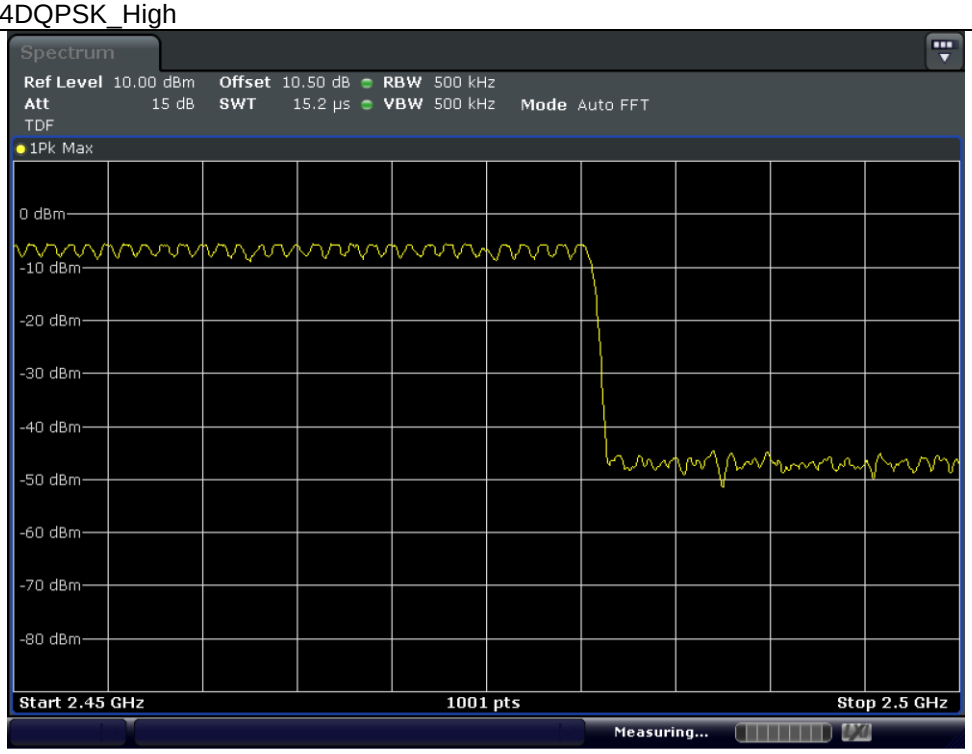
GFSK(AFH)_High



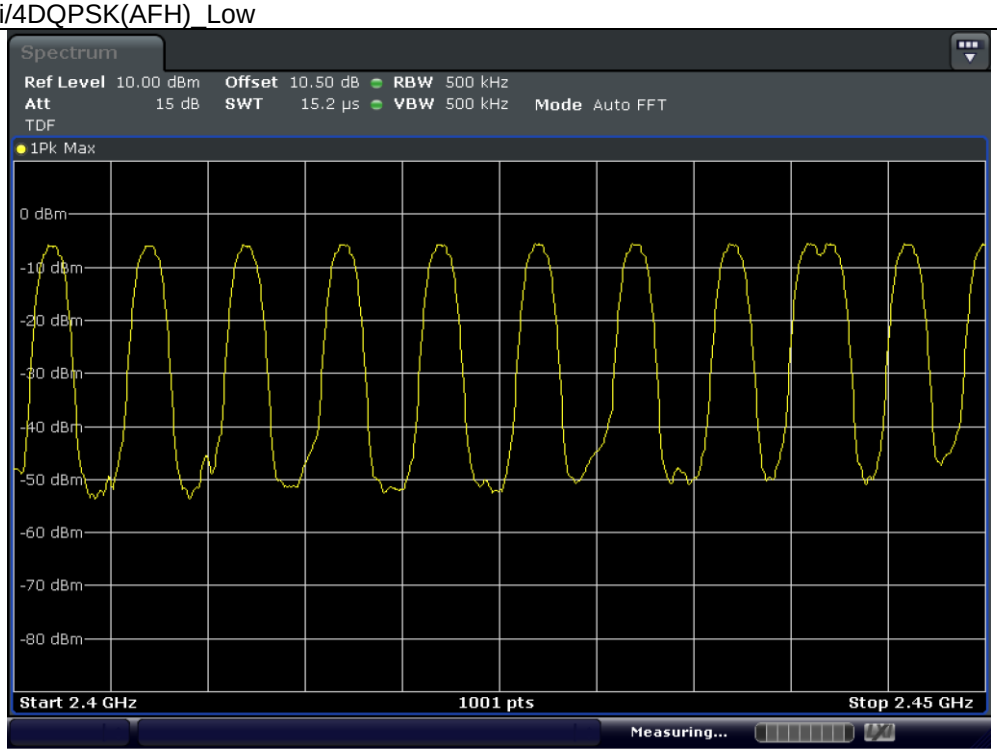
pi/4DQPSK_Low



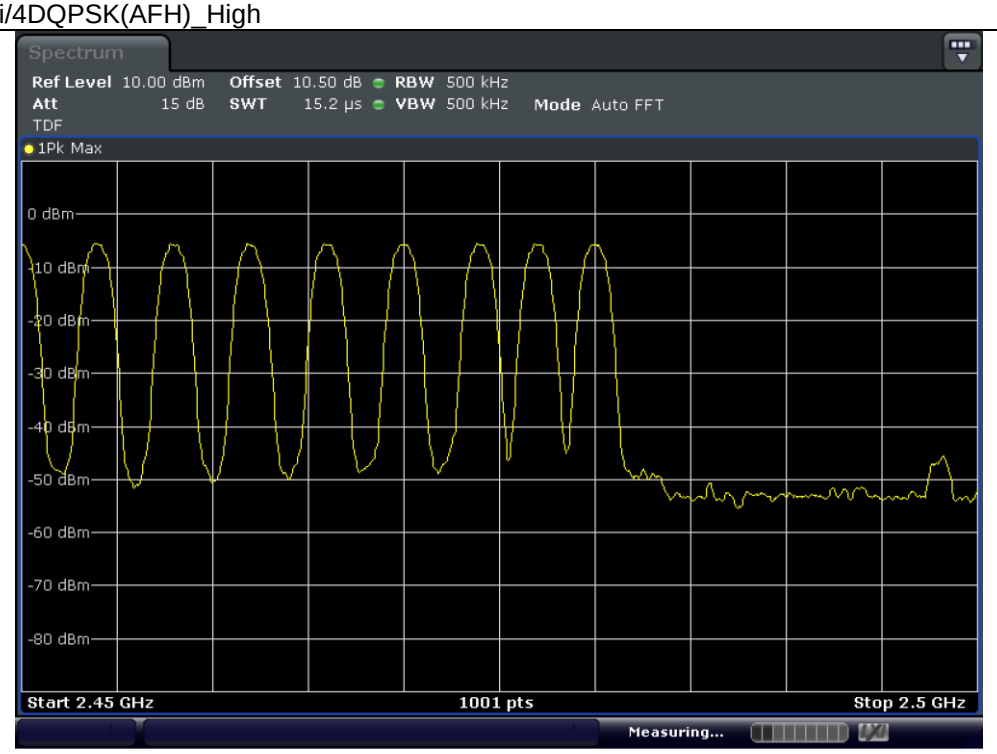
pi/4DQPSK_High



pi/4DQPSK(AFH)_Low



pi/4DQPSK(AFH)_High



4.3.4 Time of occupancy (Dwell Time)

4.3.4.1 Regulation

According to §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.

4.3.4.2 Measurement Procedure

ANSI C63.10 § 7.8.3 Time of Occupancy

4.3.4.3 Result

Comply (measurement data : refer to the next page)

4.3.4.4 Measurement data

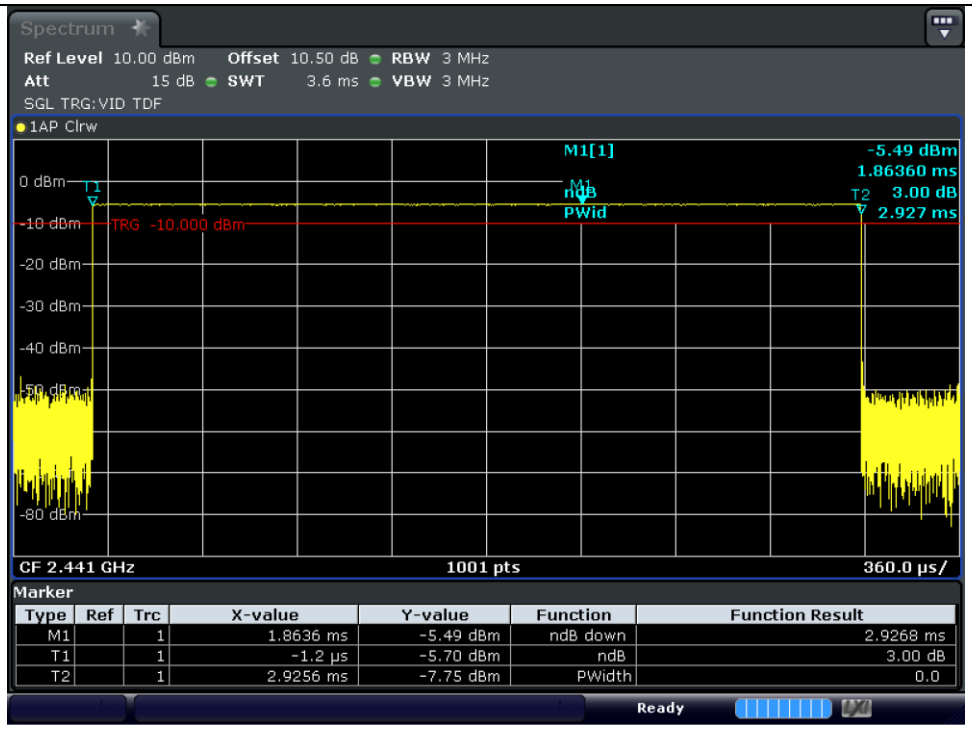
Test mode : Hopping

Time of occupancy				
Packet Type	Number of hopping Channels	Burst On Time (ms)	Result (sec)	Limit (sec)
GFSK(non-AFH)	79	2.93	0.31	0.40
GFSK(AFH)	20	2.93	0.16	0.40
pi/4DQPSK (non-AFH)	79	2.93	0.31	0.40
pi/4DQPSK(AFH)	20	2.93	0.16	0.40

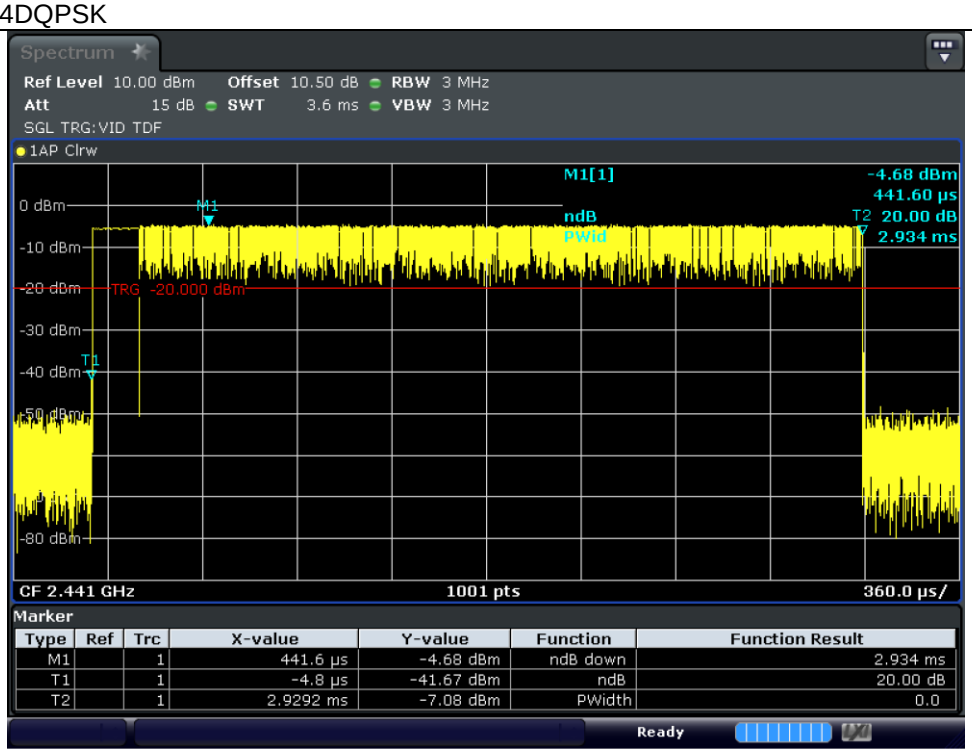
NOTE1 : Result = 0.4 * Hopping Channel * Burst On Time * ((Hopping rate/Time slots)/Hopping channel)
- Time slots for DH5 = 6 slots(TX = 5 slot, RX = 1 slot)
- Hopping Rate = 1600 for FH mode
- Hopping Rate = 800 for AFH mode

4.3.4.5 Test Plot

GFSK



pi/4DQPSK



4.3.5 Carrier Frequencies Separation

4.3.5.1 Regulation

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

4.3.5.2 Measurement Procedure

ANSI C63.10 § 7.8.2 Carrier frequency separation

4.3.5.3 Result

Comply (measurement data : refer to the next page)

4.3.5.4 Measurement data

Test mode : GFSK

Carrier Frequency Separation		
Test hopping channel No.	Result (MHz)	Min. Limit (MHz)
Channel 1 to Channel 2	1.00	0.73
Channel 39 to Channel 40	1.00	0.73
Channel 78 to Channel 79	1.00	0.74

NOTE1 : Limit(kHz) : Result of 20 dB Bandwidth

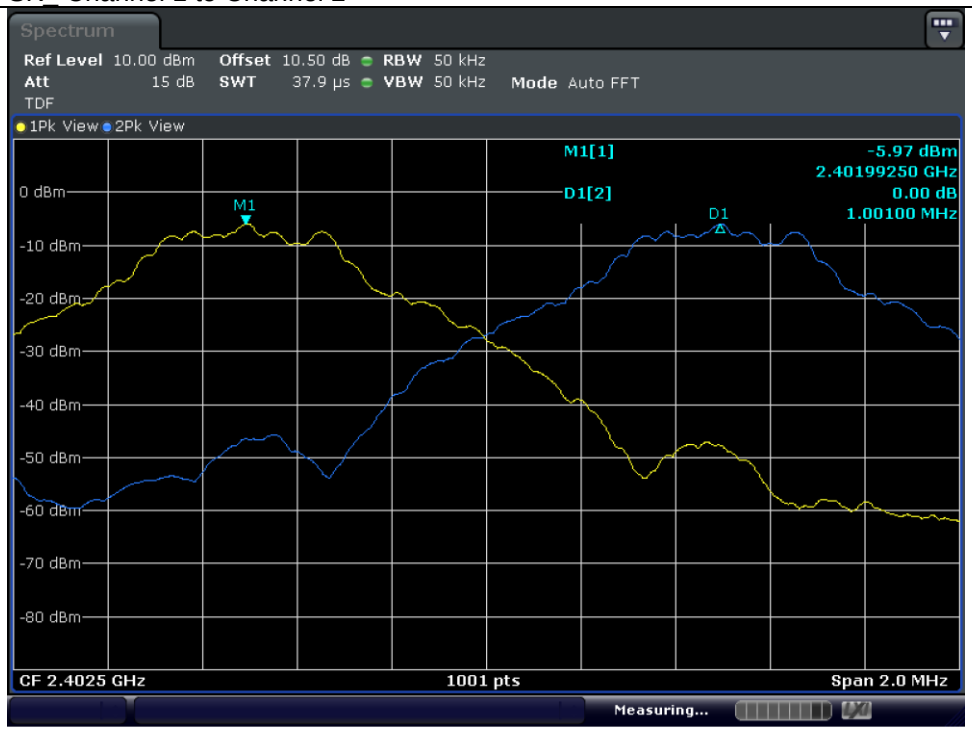
Test mode : pi/4DQPSK

Carrier Frequency Separation		
Test hopping channel No.	Result (MHz)	Min. Limit (MHz)
Channel 1 to Channel 2	1.00	0.76
Channel 39 to Channel 40	1.00	0.76
Channel 78 to Channel 79	1.00	0.76

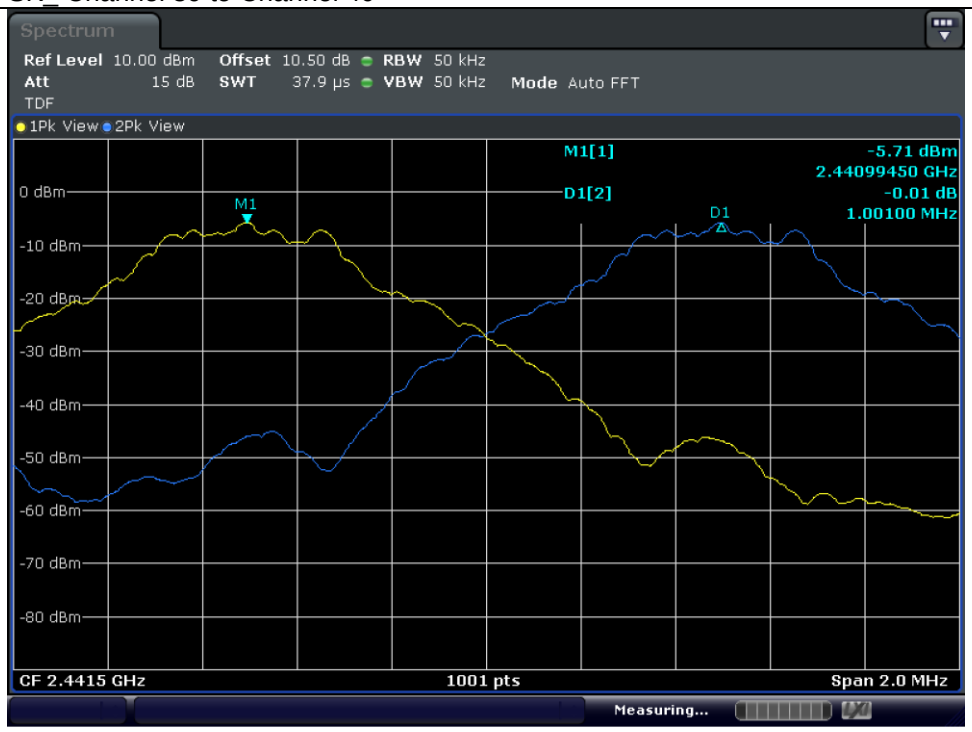
NOTE1 : Limit(kHz) : Result of 20 dB Bandwidth*2/3

4.3.5.5 Test Plot

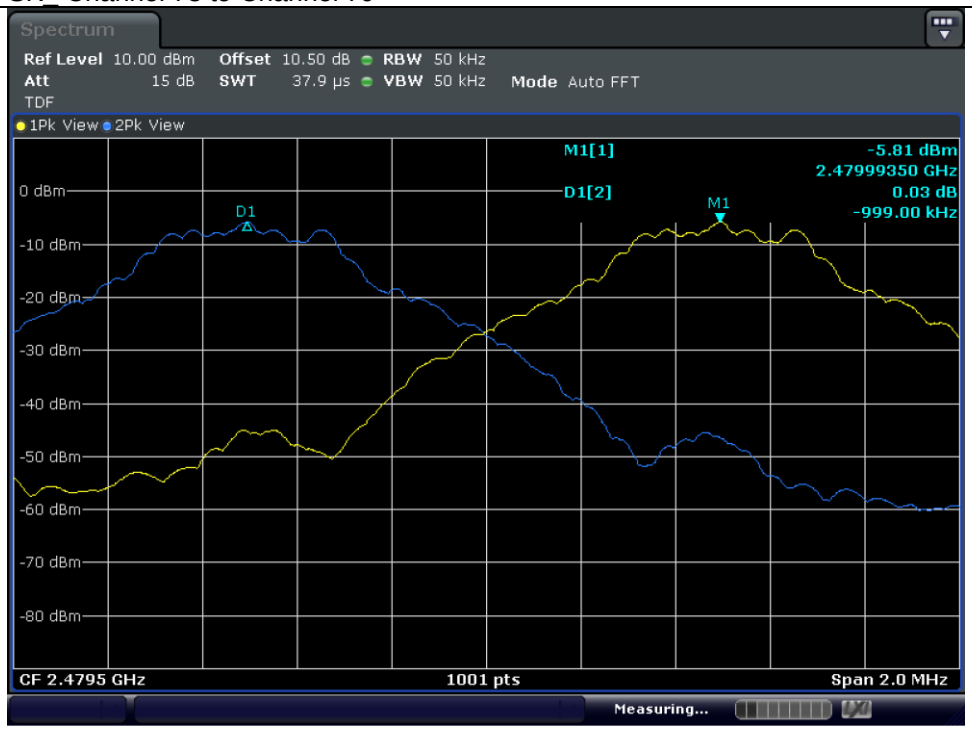
GFSK_Channel 1 to Channel 2



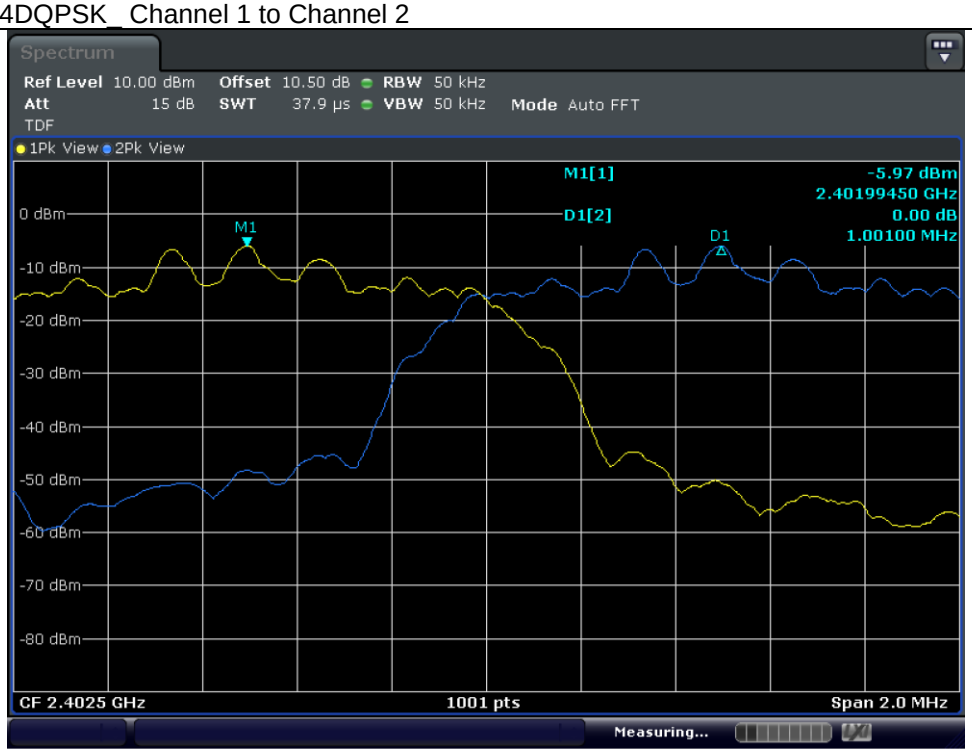
GFSK_Channel 39 to Channel 40



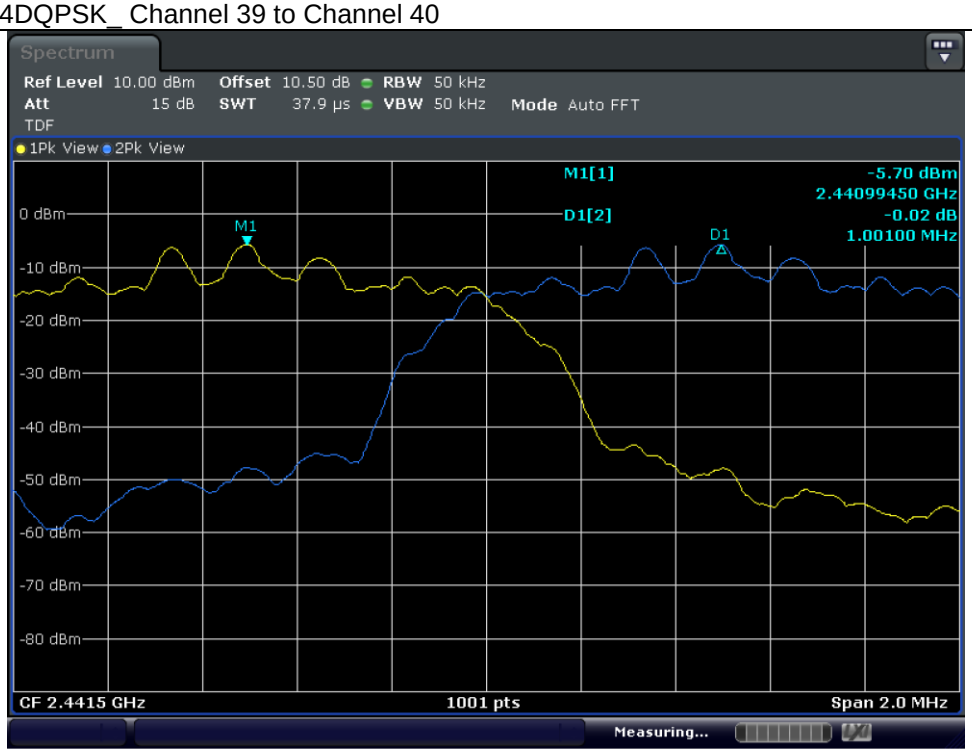
GFSK_Channel 78 to Channel 79



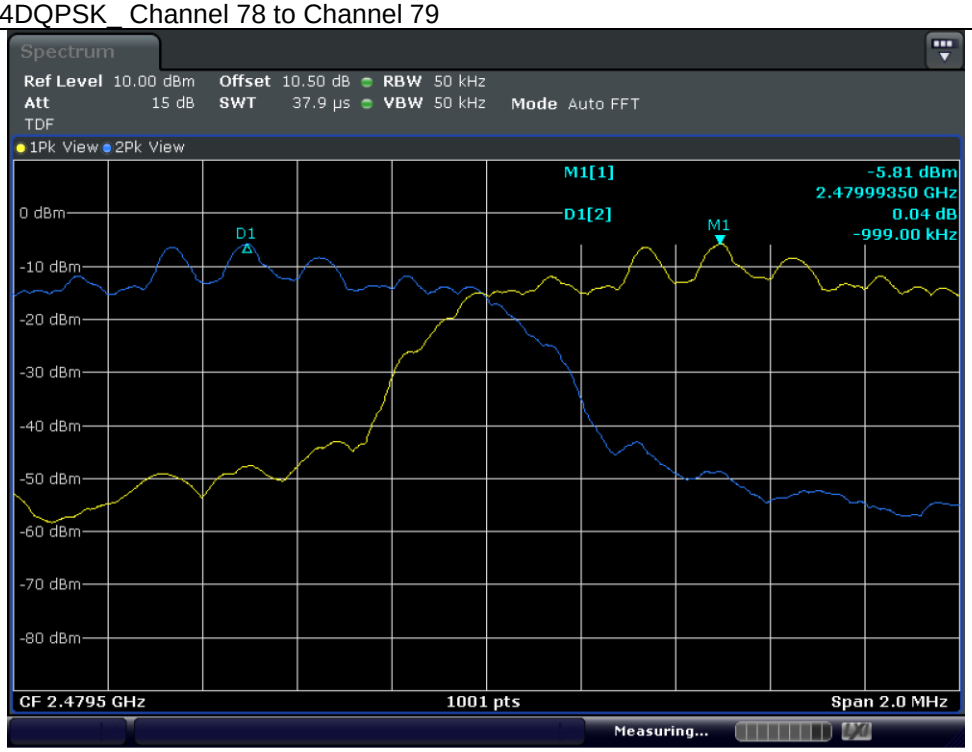
pi/4DQPSK_ Channel 1 to Channel 2



pi/4DQPSK_ Channel 39 to Channel 40



pi/4DQPSK_ Channel 78 to Channel 79



4.3.6 Peak Output Power

4.3.6.1 Regulation

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

According to §15.247(b)(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 nonoverlapping 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.

4.3.6.2 Measurement Procedure

ANSI C63.10 § 7.8.5 Output Power test procedure for FHSS

4.3.6.3 Result

Comply (measurement data : refer to the next page)

4.3.6.4 Measurement data

Test mode : GFSK

Frequency (MHz)	Peak Output Power Result (dBm)	Peak Output Power Result (mW)	Peak Output Power Limit (mW)
2 402	-5.89	0.26	1000.00
2 441	-5.63	0.27	1000.00
2 480	-5.70	0.27	1000.00

NOTE1 : Since the directional gain of the PCB Antenna declared by the manufacturer, does not exceed 6.0 dBi ,there was no need to reduce the output power.
NOTE2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.
NOTE3 : Peak Output Power Result(mW) = (10^(Peak Output Power Result(dBm)/10))
NOTE4 : In the case of AFH, the limit for peak power is 0.125W

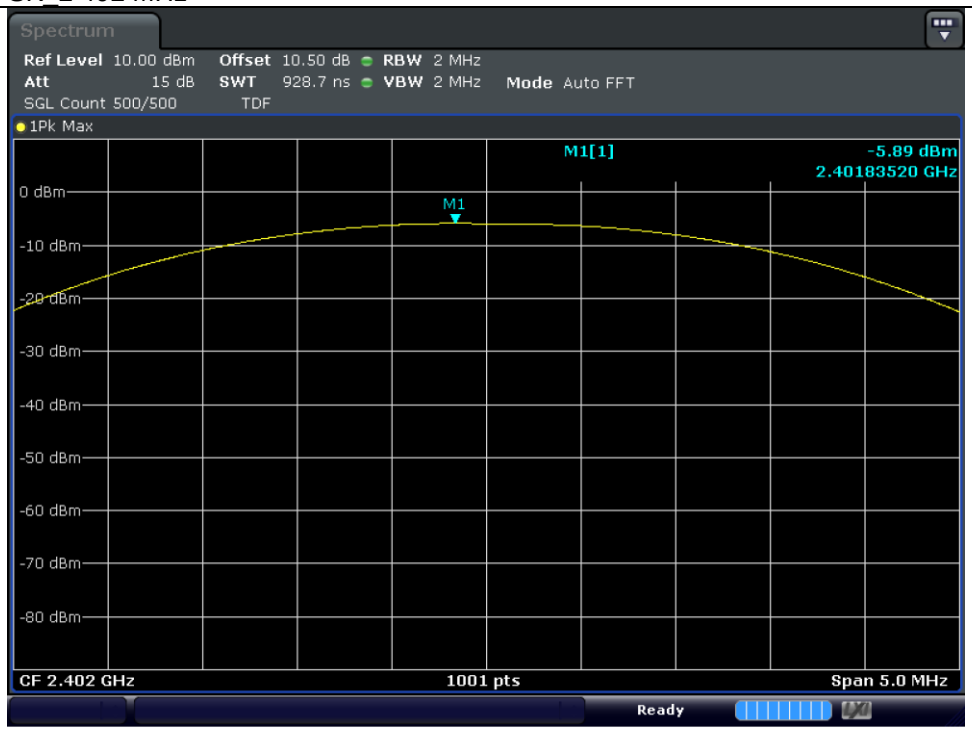
Test mode : pi/4DQPSK

Frequency (MHz)	Peak Output Power Result (dBm)	Peak Output Power Result (mW)	Peak Output Power Limit (mW)
2 402	-5.02	0.31	125.00
2 441	-4.73	0.34	125.00
2 480	-4.93	0.32	125.00

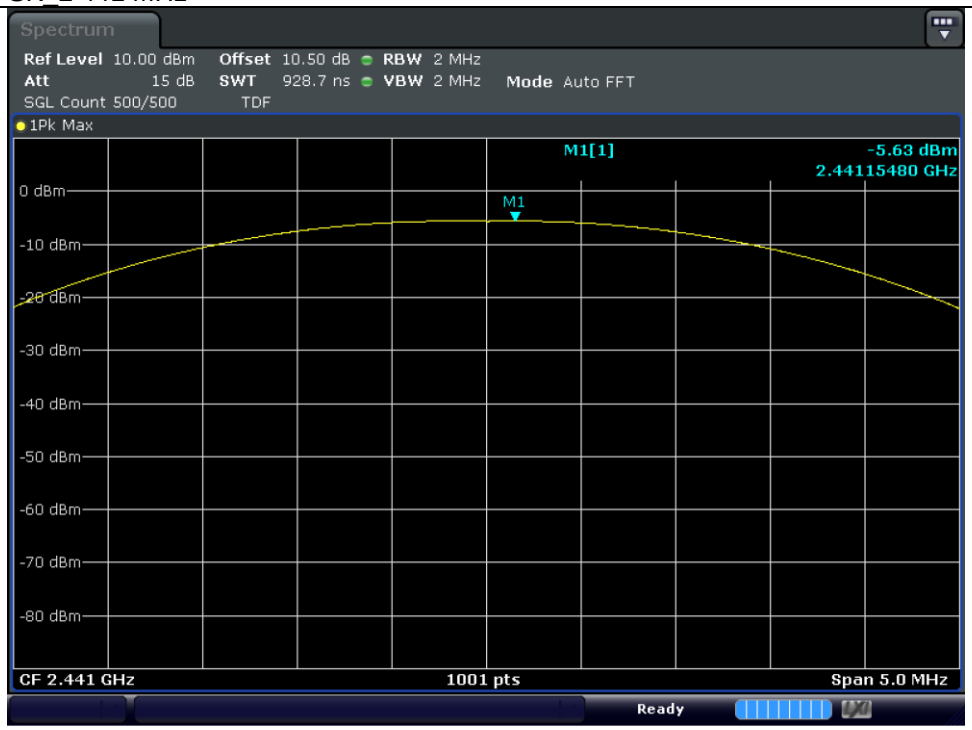
NOTE1 : Since the directional gain of the PCB Antenna declared by the manufacturer, does not exceed 6.0 dBi ,there was no need to reduce the output power.
NOTE2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.
NOTE3 : Peak Output Power Result(mW) = (10^(Peak Output Power Result(dBm)/10))
NOTE4 : In the case of AFH, the limit for peak power is 0.125W

4.3.6.5 Test Plot

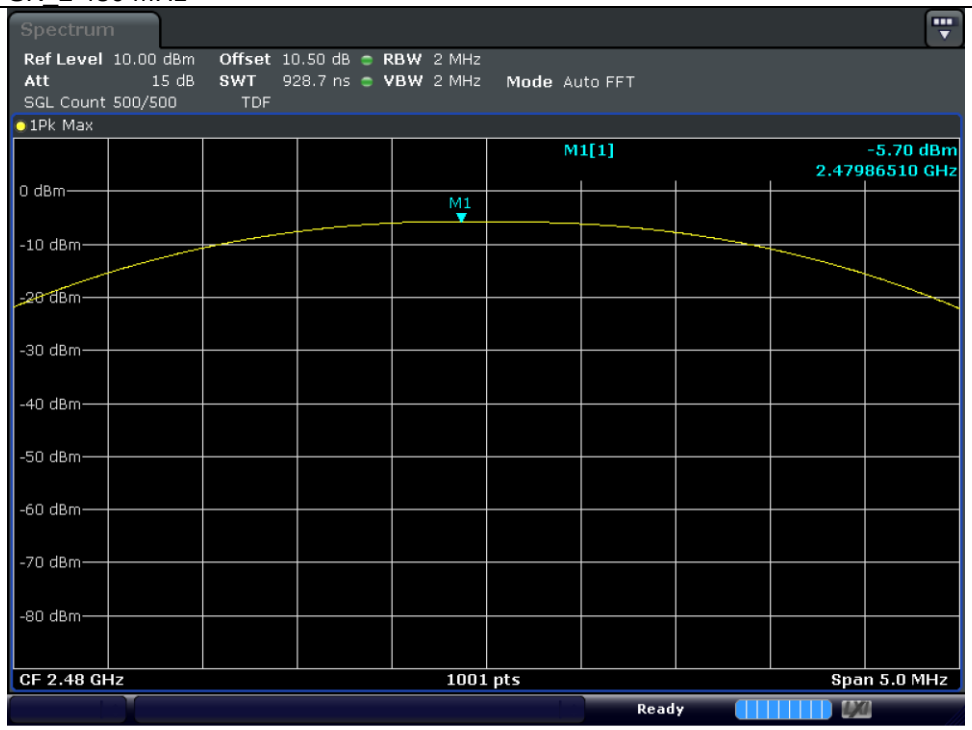
GFSK_2 402 MHz



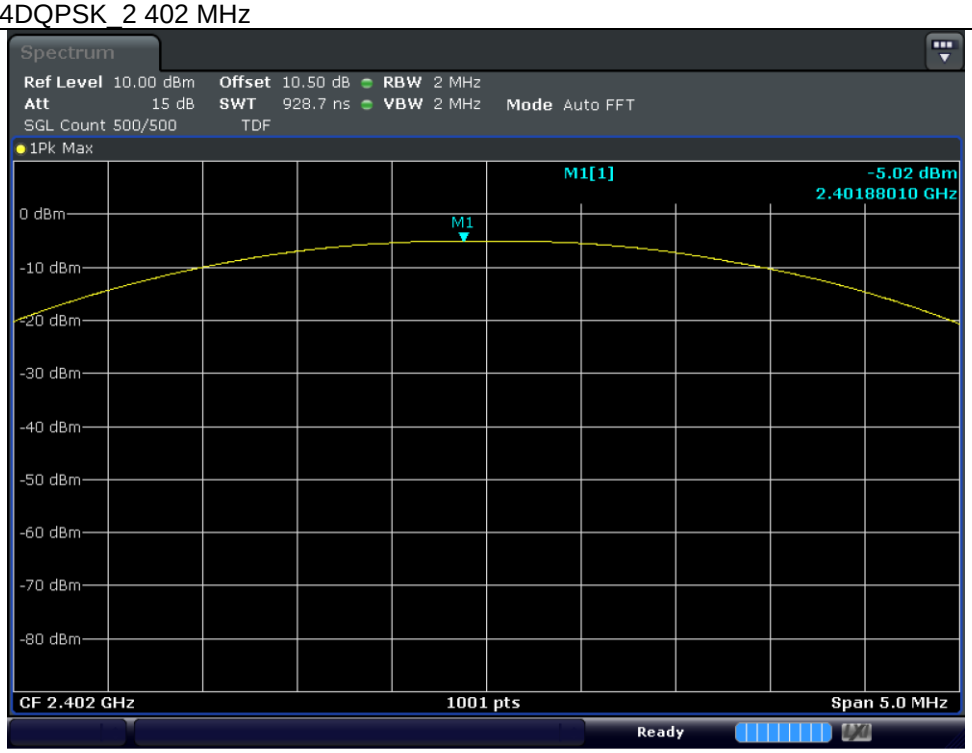
GFSK_2 441 MHz



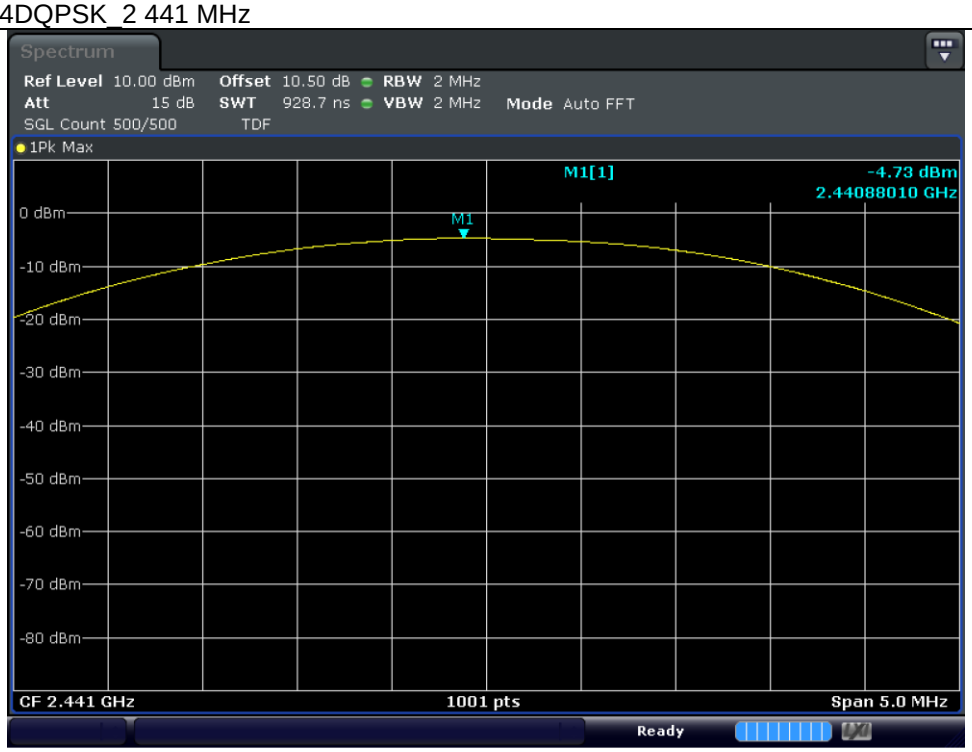
GFSK_2 480 MHz



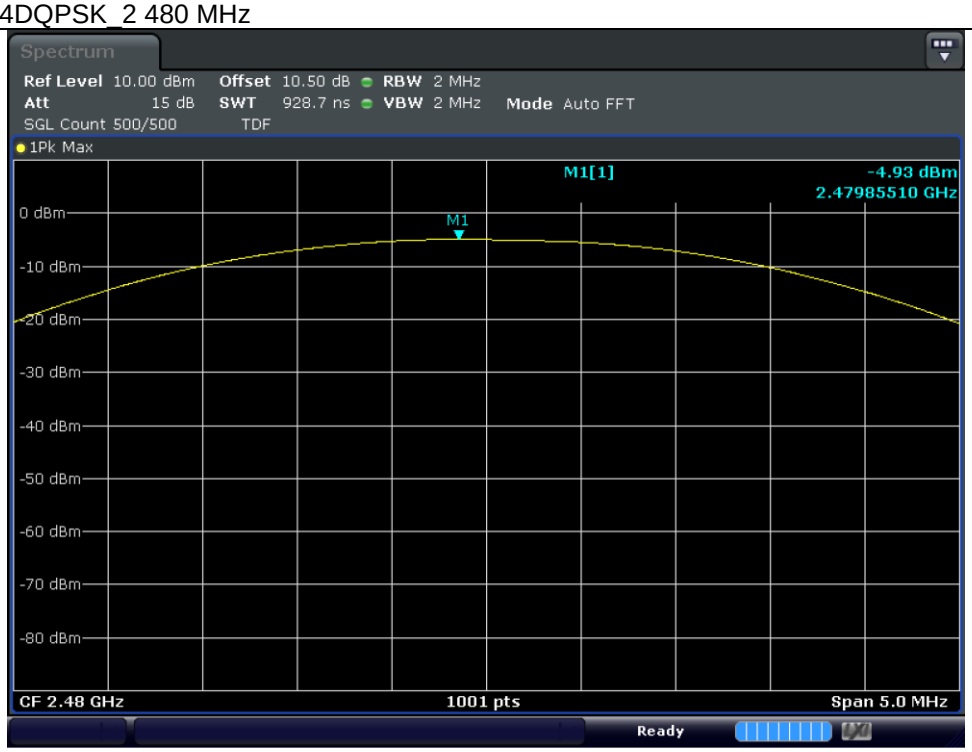
pi/4DQPSK_2 402 MHz



pi/4DQPSK_2 441 MHz



pi/4DQPSK_2 480 MHz



4.3.7 Spurious Emission, Band Edge, and Restricted bands

4.3.7.1 Regulation

According to §15.247(d) in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

According to §15.209(a) and RSS-GEN §8.9 Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall notexceed the field strength levels specified in the following table:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009 - 0.490	2 400/F(kHz)	300
0.490 - 1.705	24 000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shallnot be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permItted under other sections of this part, e.g., §§15.231 and 15.241.

According to §15.205(a),(b) only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 – 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 – 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 – 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 – 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 – 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 – 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 – 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 – 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525 25	2 483.5 – 2 500	17.7 - 21.4
8.376 25 - 8.386 75	156.7 - 156.9	2 690 – 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 – 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 – 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 – 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 – 4 400	Above 38.6
13.36 - 13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurement

4.3.7.2 Measurement Procedure

ANSI C63.10 § 6.10.4 Authorized band-edge relative method (lower bandedge)
ANSI C63.10 § 6.10.6 Marker Delta Method (upper restricted bandedge)
ANSI C63.10 § 11.11.1 General Information
ANSI C63.10 § 11.11.3 Emission level measurement

4.3.7.2.1 Band-edge Compliance of RF Conducted Emissions

Span : wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
RBW : ≥ 1% of the span
VBW : ≥ RBW
Sweep : Auto
Detector : Peak
Trace : Max hold

Allow the trace to stabilize. Set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section. Submit this plot.

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

4.3.7.2.2 Conducted Spurious Emissions

Span : wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
RBW : ≥ 1% of the span
VBW : ≥ RBW
Sweep : Auto
Detector : Peak
Trace : Max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section. Submit these plots.

4.3.7.2.3 Radiated Spurious Emissions

1) The preliminary and final rdiated measurements were performed to determine the frequency producing the maximum emissions in at a 10m anechoic chamber. The EUT was tested at a distance 3 m(Below 1 GHz) and 1 m(Above 1 GHz).
2) The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.
3) The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1 000 MHz using the BILOG broadband antenna, and from 1 000 MHz to 10 000 MHz using the horn antenna.
4) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

Span : wide enough to fully capture the emission being measured
RBW : ≥ 1 MHz for f ≥1 GHz, 100 kHz for f < 1 GHz
VBW : ≥ RBW
Sweep : Auto
Detector : Peak
Trace : Max hold

Follow the guidelines in ANSI C63.4 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.

set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a “duty cycle correction factor”, derived from 20log(dwell time/100 ms), in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

NOTE1 : The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 GHz.
NOTE2 : The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
NOTE3 : The 0.8 m height is for below 1 GHz testing, and 1.5 m is for above 1 GHz testing

4.3.7.3 Note

- Below 1GHz

Note 1 : Measured the worst case.
Note 2 : Loss : Cable loss - Amp gain
Note 3 : Result : Reading + Ant Factor + Loss
Note 4 : Measured distance : 3 m

- Above 1GHz

Note 1 : Factor : Ant Factor + Cable loss - Amp gain + Distance Factor
Note 2 : Peak Result : Reading + Factor
Note 3 : Average Reasult : Average Reading + Factor + DCCF
Note 4 : DCCF(Duty Cyle Correction Factor) : 20 x Log(worst case dwell time / 100 ms) dB, refer to 4.3.7.8
Note 5 : Measured distance : 1 m, Distance Factor = 20log(1 / 3) = -9.54
Note 6 : Not Detected means that peak data does not exceed the average limit.

4.3.7.4 Result

Comply (measurement data : refer to the next page)

4.3.7.5 Measurement data_Radiated Spurious Emissions

Test mode : Below 1 GHz (Worst case : pi/4DQPSK_2 441 MHz)

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Ant Factor (dB)	Loss (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1.00	QP	H	45.90	11.80	0.10	57.80	67.60	9.80
1.00	QP	V	38.60	11.80	0.10	50.50	67.60	17.10
143.97	QP	H	44.90	19.40	-27.90	36.40	43.50	7.10
167.98	QP	H	38.40	18.80	-27.70	29.50	43.50	14.00
191.99	QP	H	42.40	16.70	-27.60	31.50	43.50	12.00
240.00	QP	H	41.70	17.70	-27.40	32.00	46.00	14.00
287.89	QP	H	42.70	19.40	-27.00	35.10	46.00	10.90
452.30	QP	V	30.20	23.50	-26.50	27.20	46.00	18.80

Test mode : Above 1 GHz_GFSK_2 402

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Factor (dB)	DCCF (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2 354.05	PK	H	49.10	-4.04	-	45.06	74.00	28.94
2 354.05	PK	V	46.40	-4.04	-	42.36	74.00	31.64
4 799.95	PK	H	44.20	1.76	-	45.96	74.00	28.04
4 799.95	PK	V	40.80	1.76	-	42.56	74.00	31.44

Test mode : Above 1 GHz_GFSK_2 441

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Factor (dB)	DCCF (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4 878.81	PK	H	45.40	2.06	-	47.46	74.00	26.54
4 878.81	PK	V	42.30	2.06	-	44.36	74.00	29.64

Test mode : Above 1 GHz_GFSK_2 480

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Factor (dB)	DCCF (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2 528.11	PK	H	53.30	-3.34	-	49.96	74.00	24.04
2 528.11	PK	V	46.30	-3.34	-	42.96	74.00	31.04
4 955.61	PK	H	43.50	2.26	-	45.76	74.00	28.24
4 955.61	PK	V	44.10	2.26	-	46.36	74.00	27.64

Test mode : Above 1 GHz_ pi/4DQPSK _2 402

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Factor (dB)	DCCF (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2 353.75	PK	V	46.50	-4.04	-	42.46	74.00	31.54
2 353.95	PK	H	50.20	-4.04	-	46.16	74.00	27.84
4 800.02	PK	H	44.50	1.76	-	46.26	74.00	27.74
4 800.02	PK	V	41.20	1.76	-	42.96	74.00	31.04

Test mode : Above 1 GHz_ pi/4DQPSK _2 441

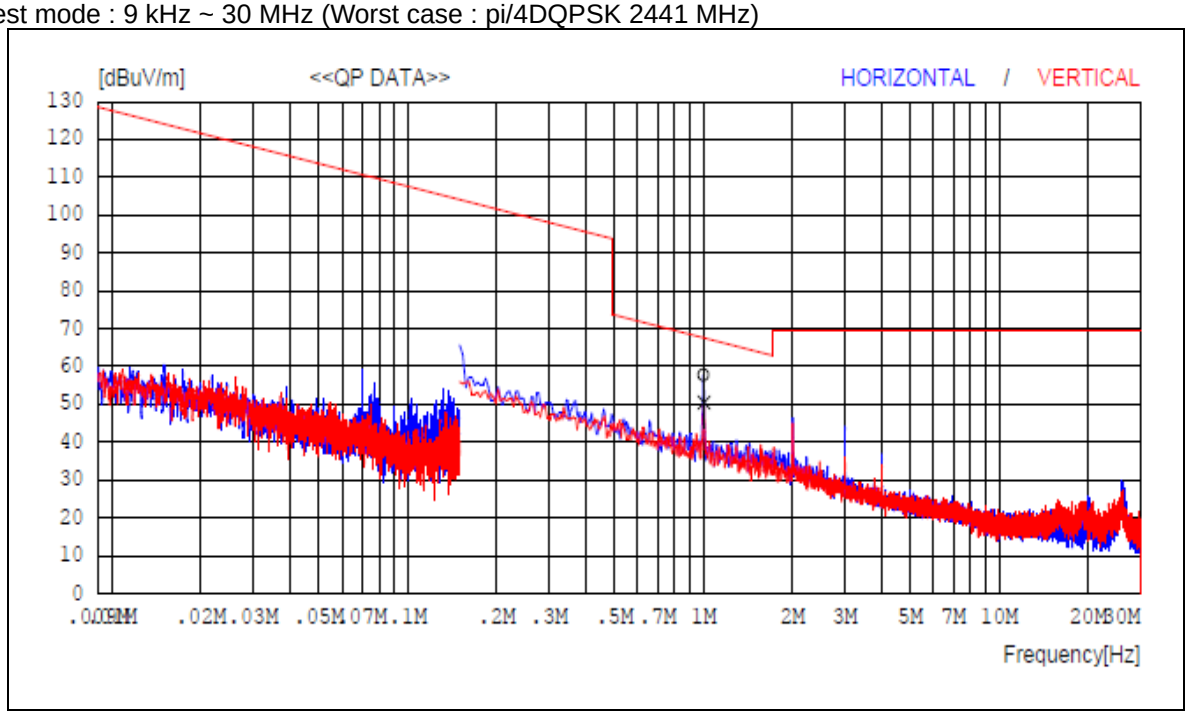
Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Factor (dB)	DCCF (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4 878.87	PK	H	46.10	2.06	-	48.16	74.00	25.84
4 878.87	PK	V	42.70	2.06	-	44.76	74.00	29.24

Test mode : Above 1 GHz_ pi/4DQPSK _2 480

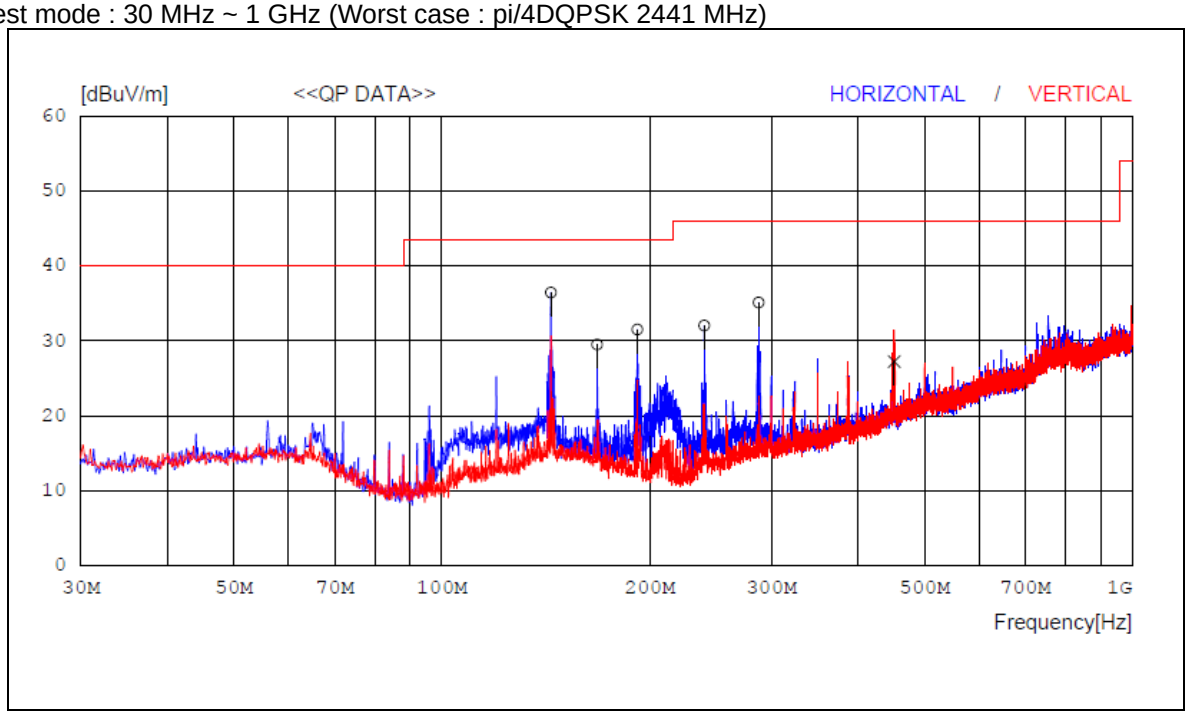
Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Factor (dB)	DCCF (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2 527.74	PK	H	52.20	-3.44	-	48.76	74.00	25.24
2 528.17	PK	V	49.60	-3.34	-	46.26	74.00	27.74
4 955.61	PK	H	43.90	2.26	-	46.16	74.00	27.84
4 955.61	PK	V	43.00	2.26	-	45.26	74.00	28.74

4.3.7.6 Measurement Plot_Radiated Spurious Emissions

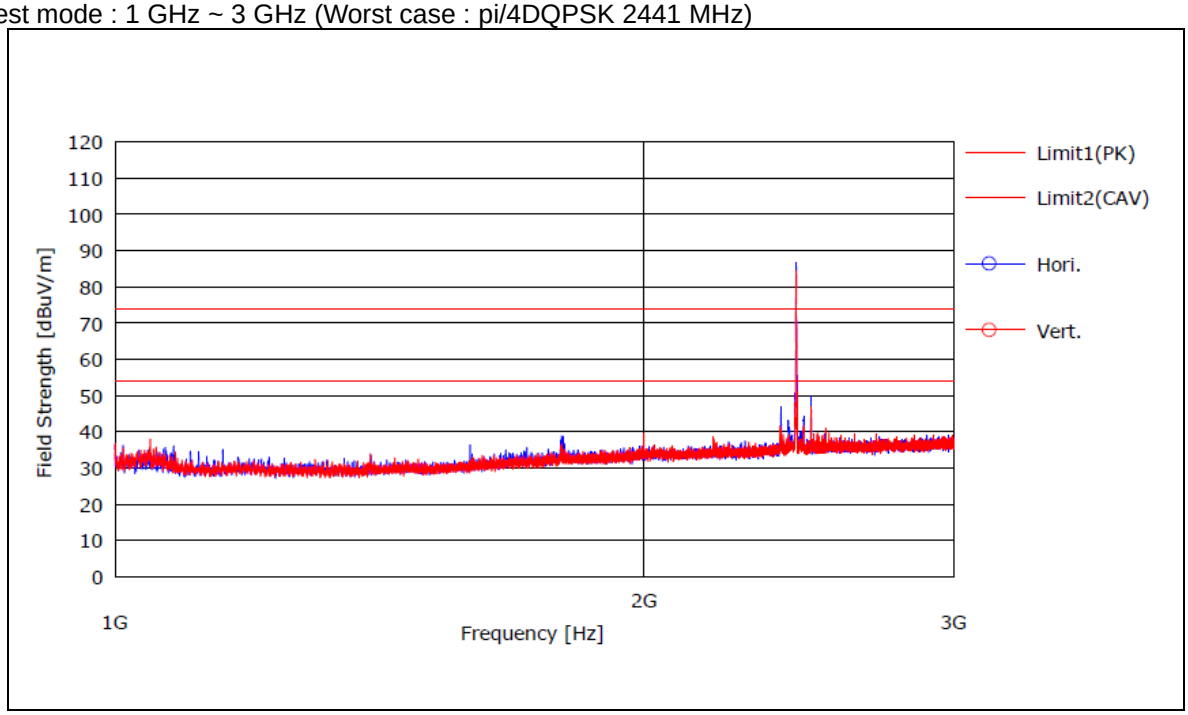
Test mode : 9 kHz ~ 30 MHz (Worst case : pi/4DQPSK 2441 MHz)



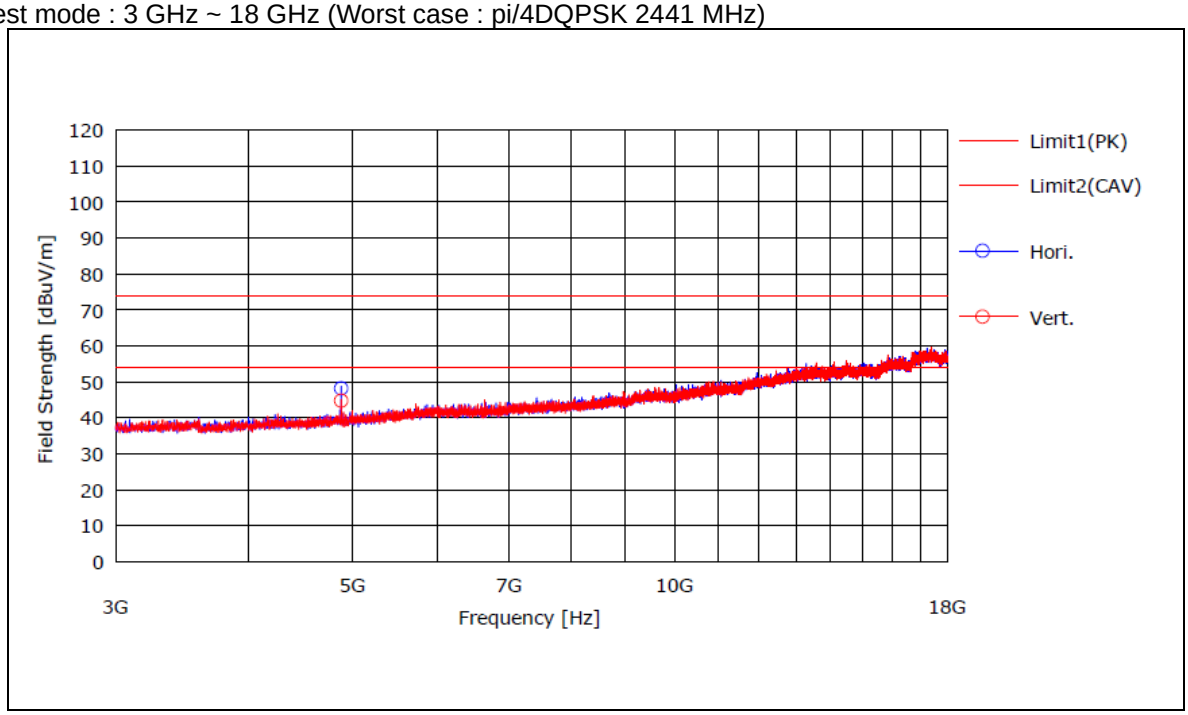
Test mode : 30 MHz ~ 1 GHz (Worst case : pi/4DQPSK 2441 MHz)



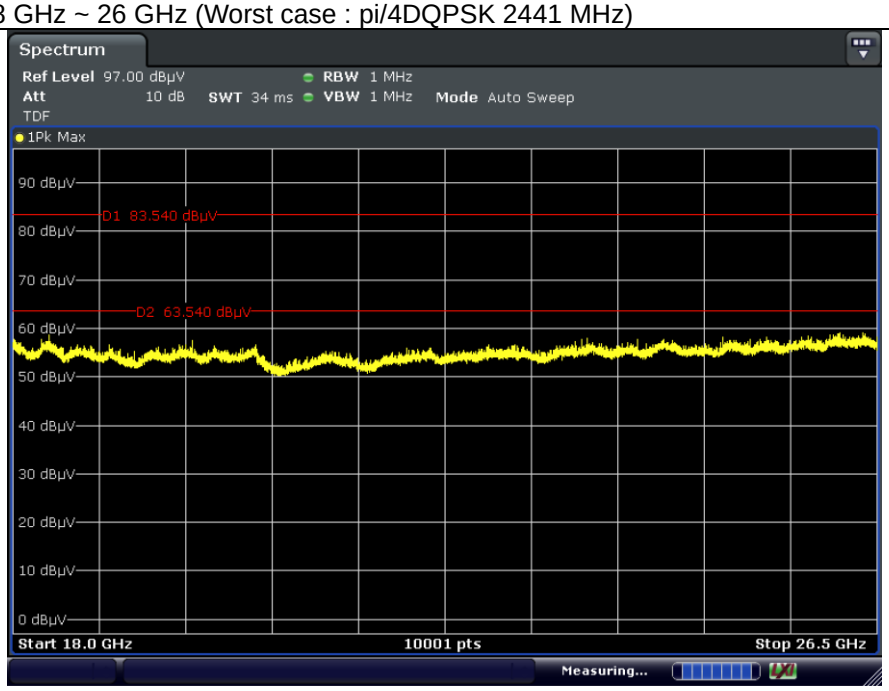
Test mode : 1 GHz ~ 3 GHz (Worst case : pi/4DQPSK 2441 MHz)



Test mode : 3 GHz ~ 18 GHz (Worst case : pi/4DQPSK 2441 MHz)



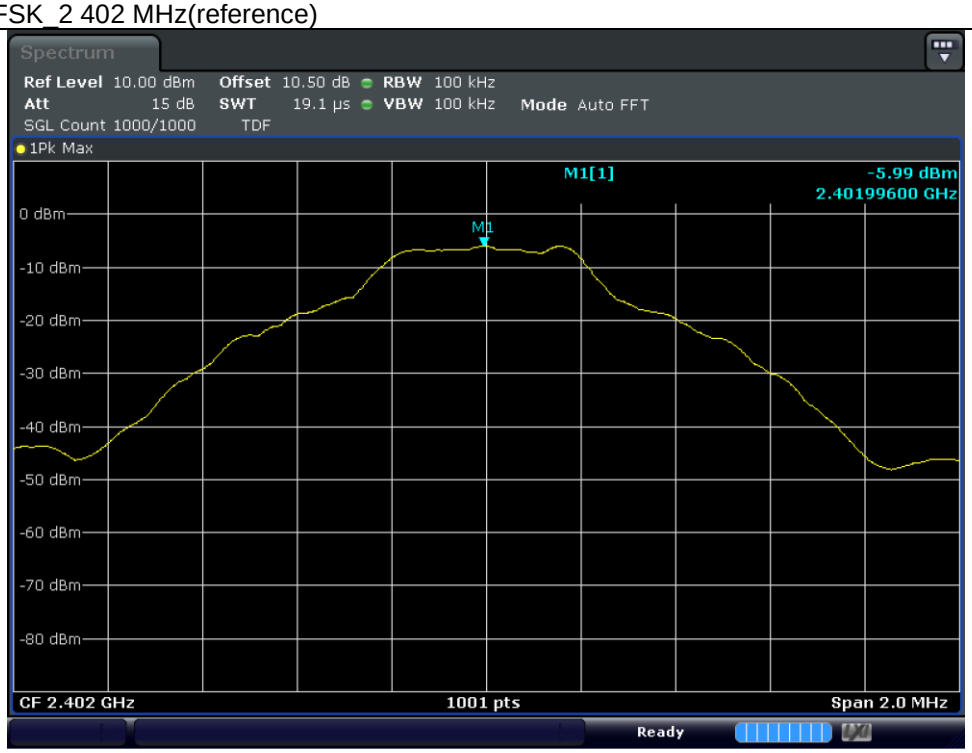
Test mode : 18 GHz ~ 26 GHz (Worst case : pi/4DQPSK 2441 MHz)



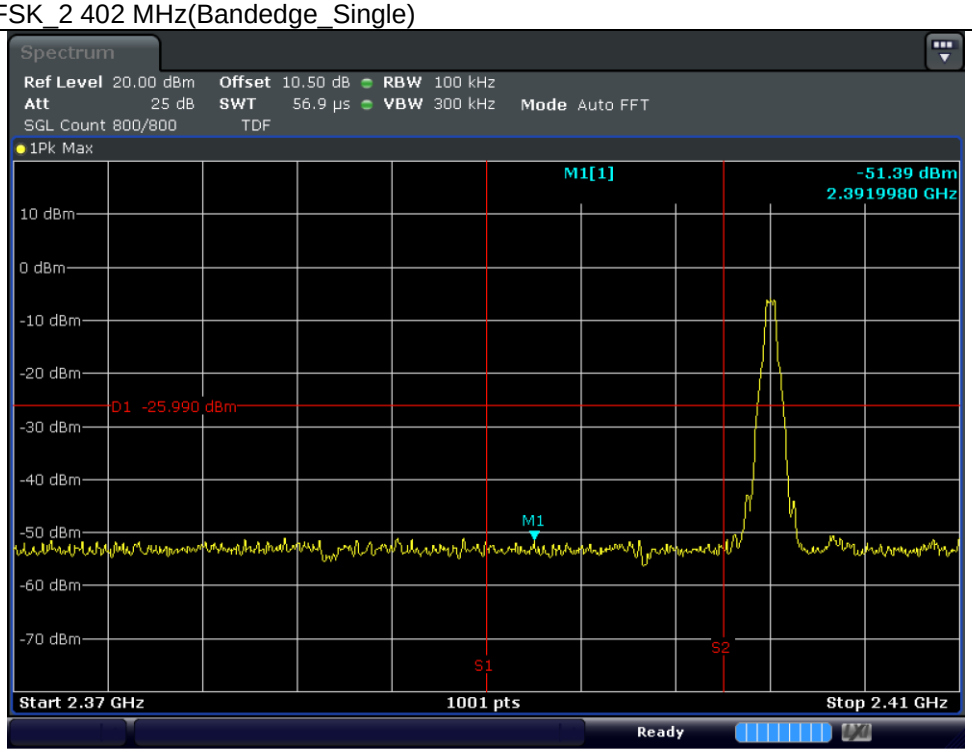
Note 1 : Limit : Peak : 83.54 dBµV/m, Average : 63.54 dBµV/m

4.3.7.7 Measurement data_Conducted Spurious Emissions

GFSK_2 402 MHz(reference)

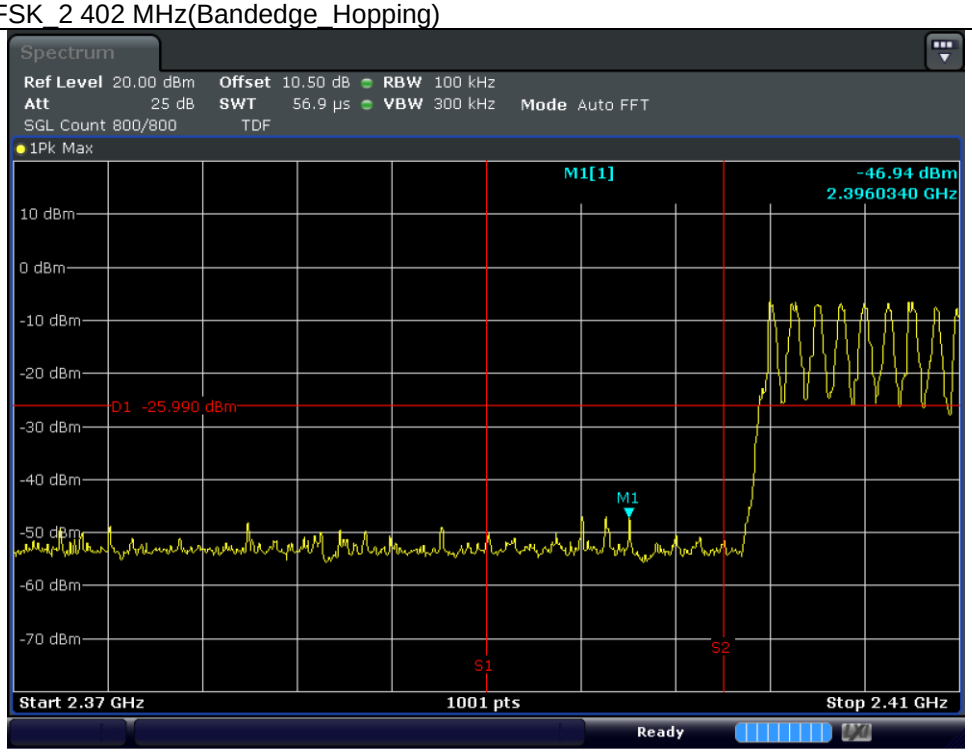


GFSK_2 402 MHz(Bandedge_Single)



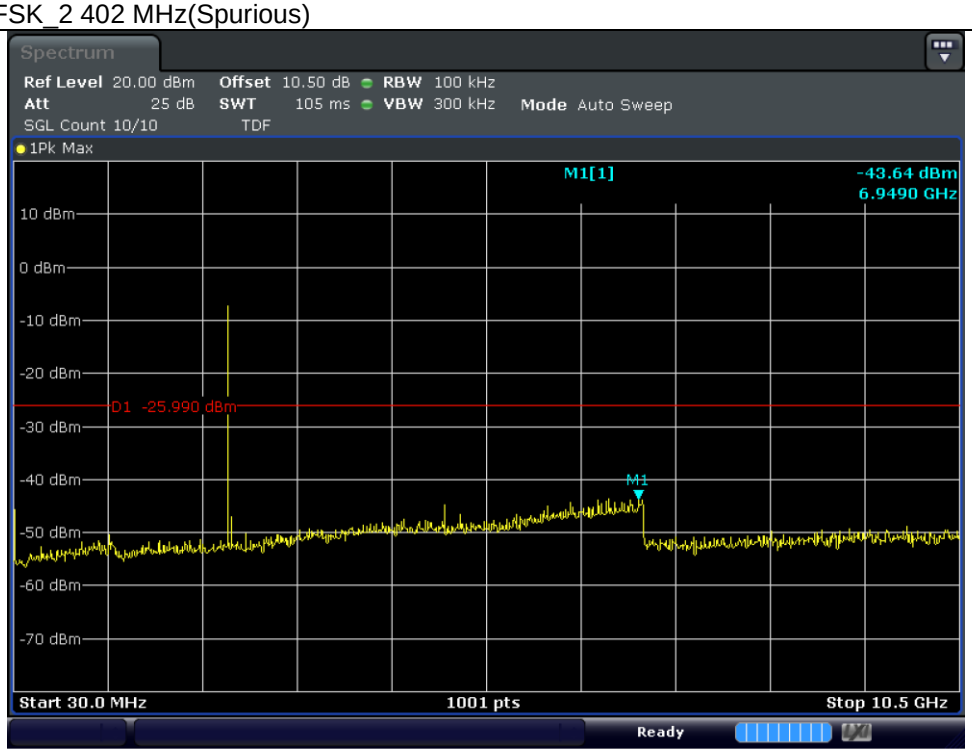
NOTE: F1 : 2 390 MHz, F2 : 2 400 MHz

GFSK_2 402 MHz(Bandedge_Hopping)

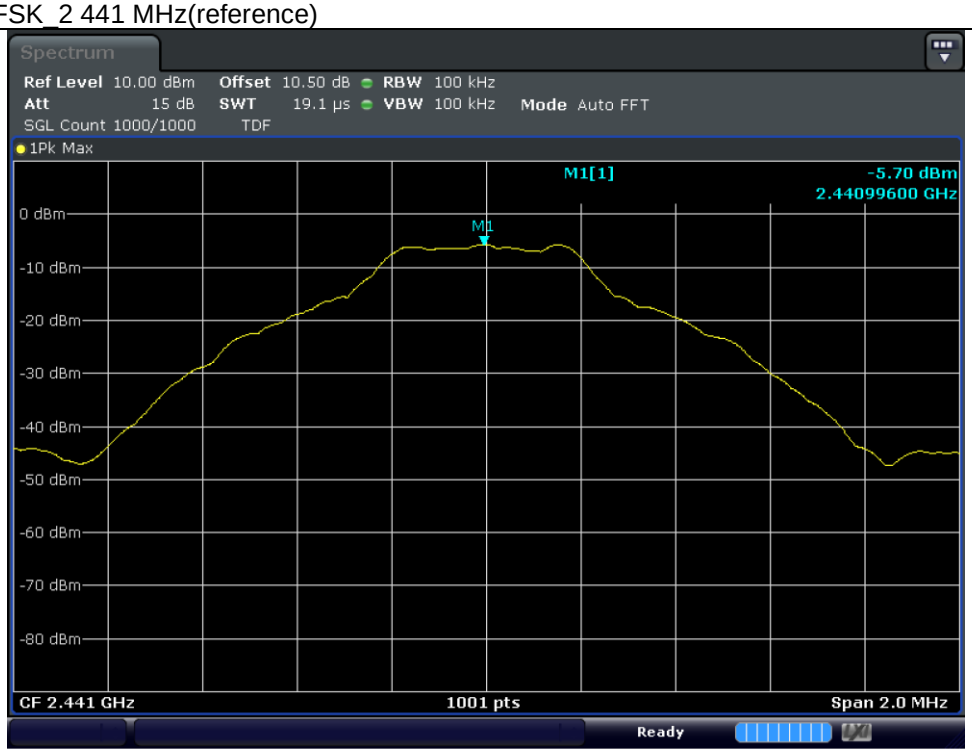


NOTE: F1 : 2 390 MHz, F2 : 2 400 MHz

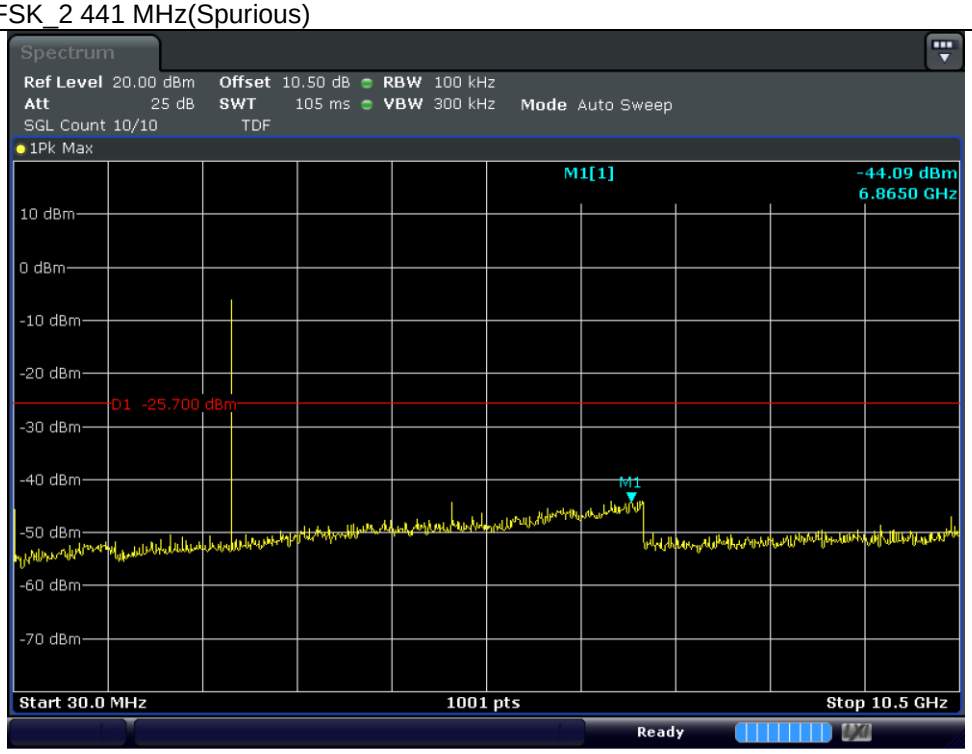
GFSK_2 402 MHz(Spurious)



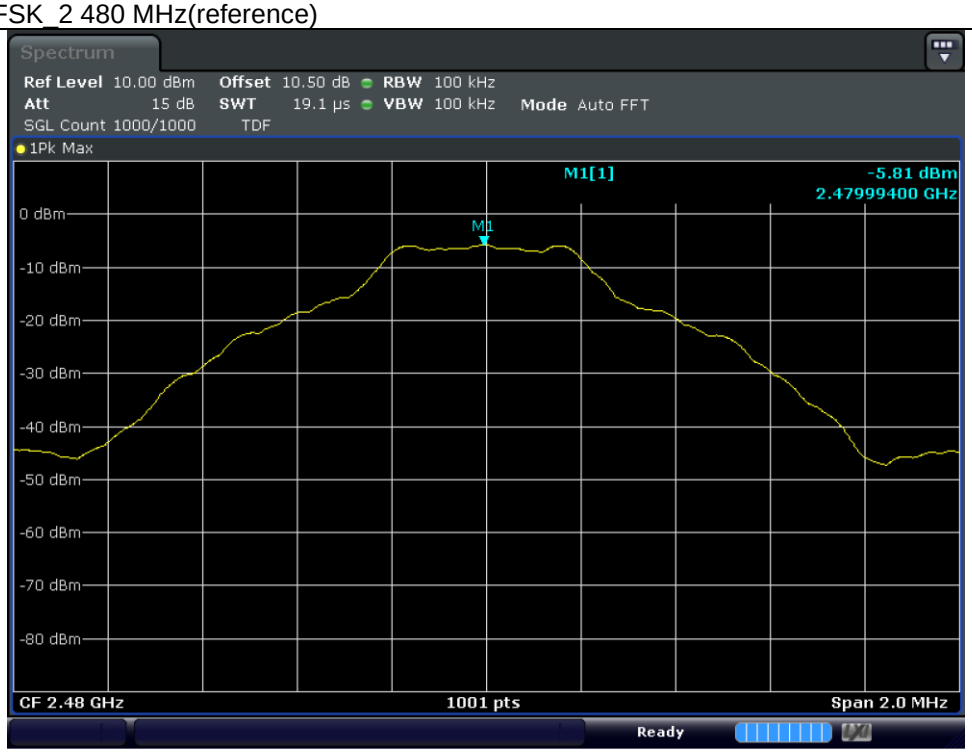
GFSK_2 441 MHz(reference)



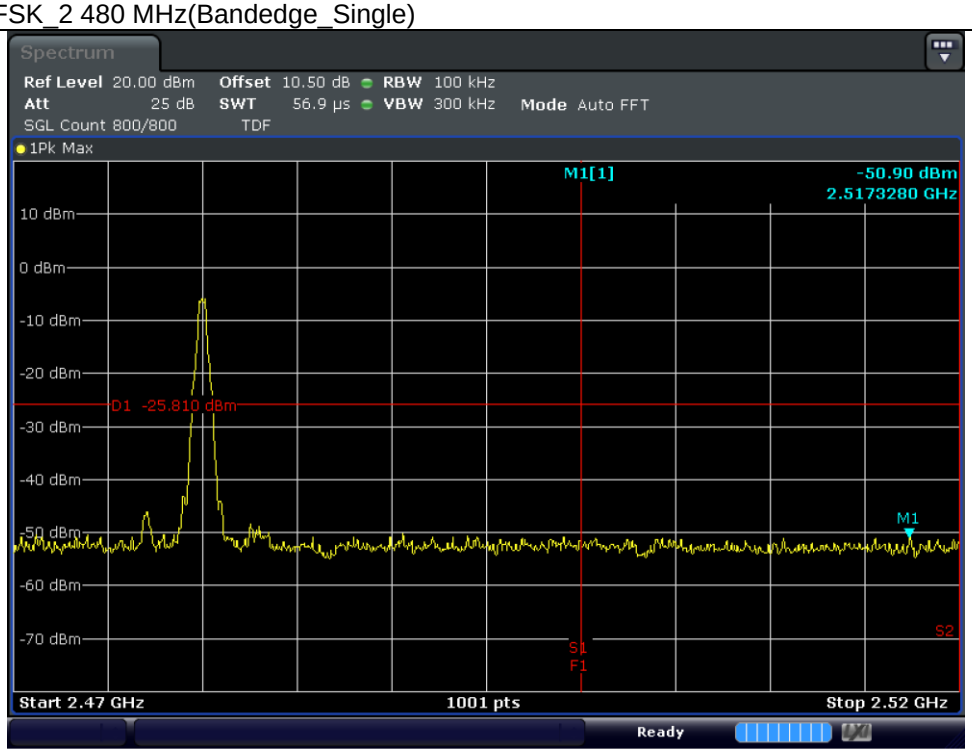
GFSK_2 441 MHz(Spurious)



GFSK_2 480 MHz(reference)

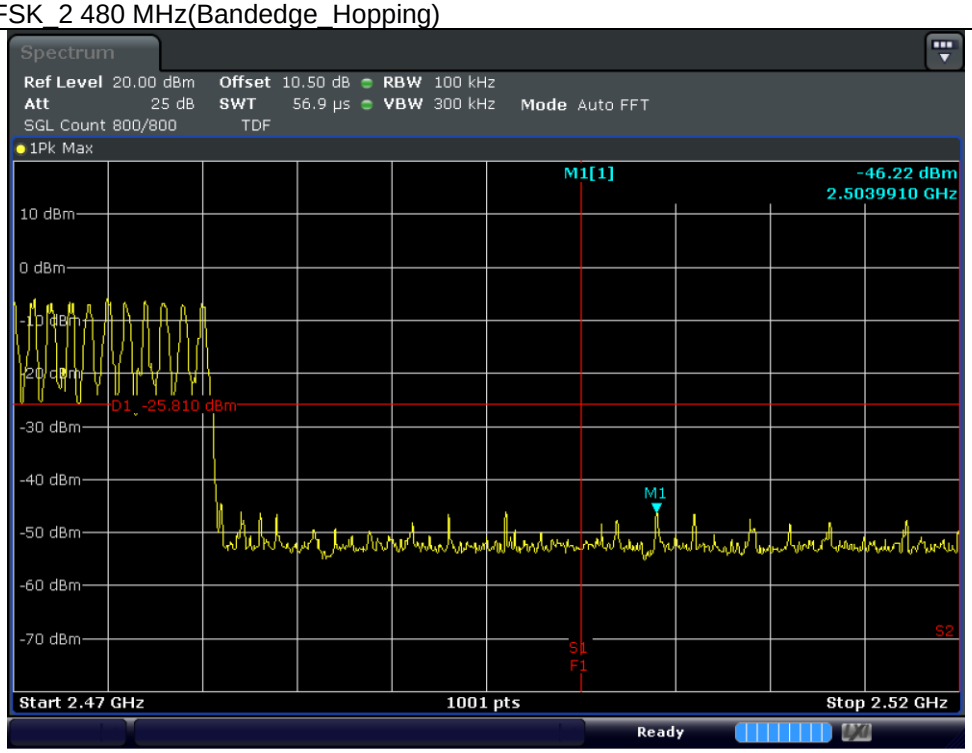


GFSK_2 480 MHz(Bandedge_Single)



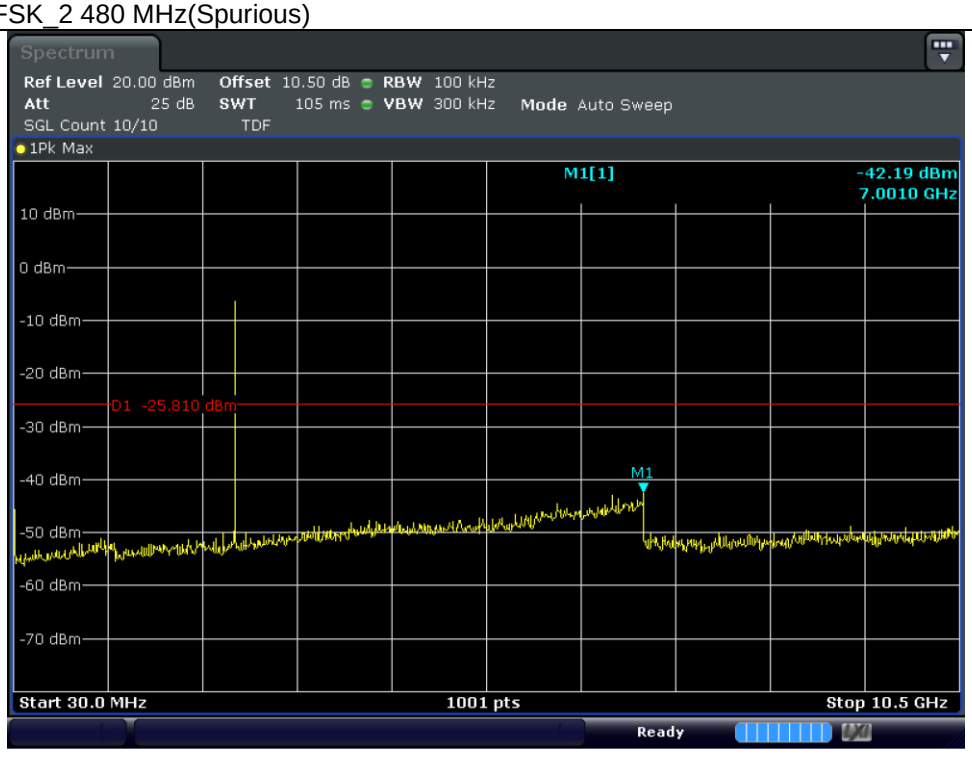
NOTE: F1 : 2 500 MHz

GFSK_2 480 MHz(Bandedge_Hopping)

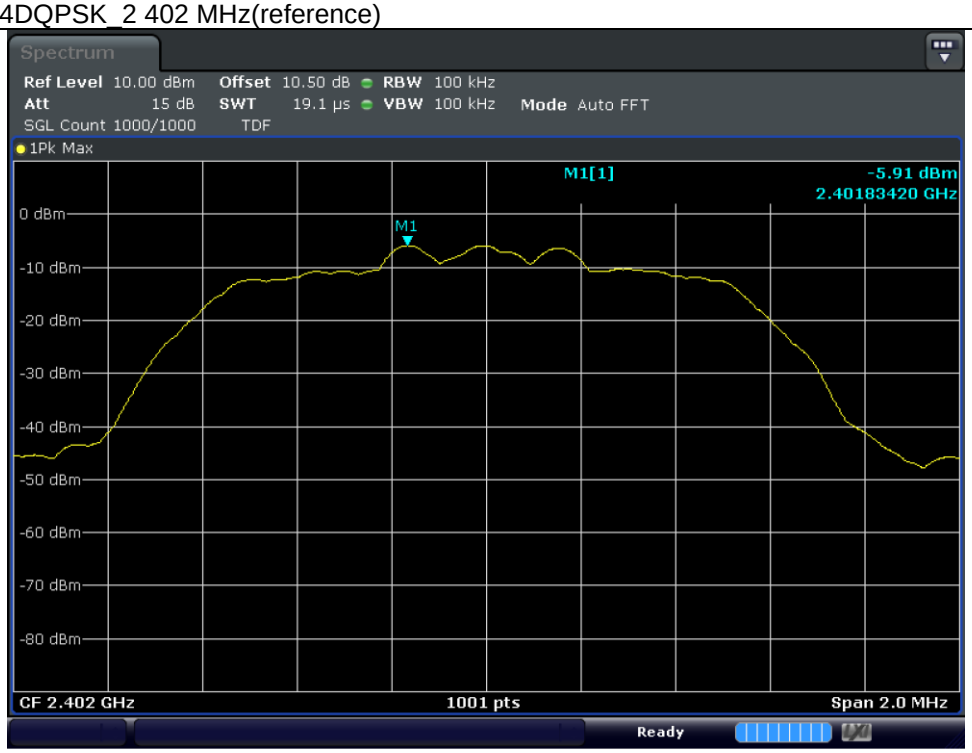


NOTE: F1 : 2 500 MHz

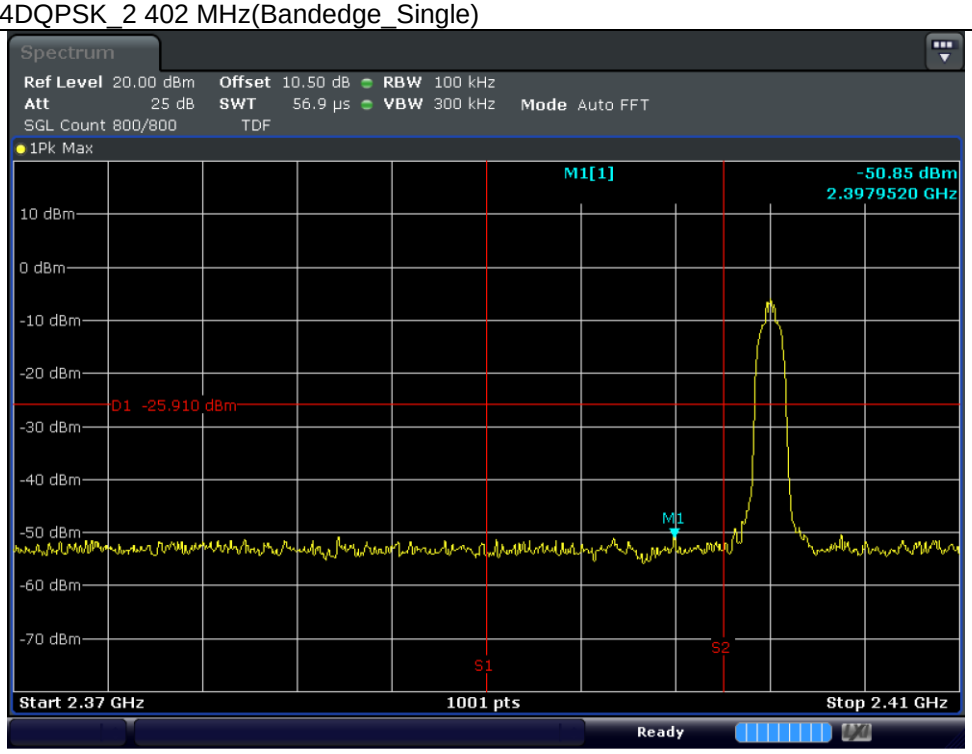
GFSK_2 480 MHz(Spurious)



pi/4DQPSK_2 402 MHz(reference)

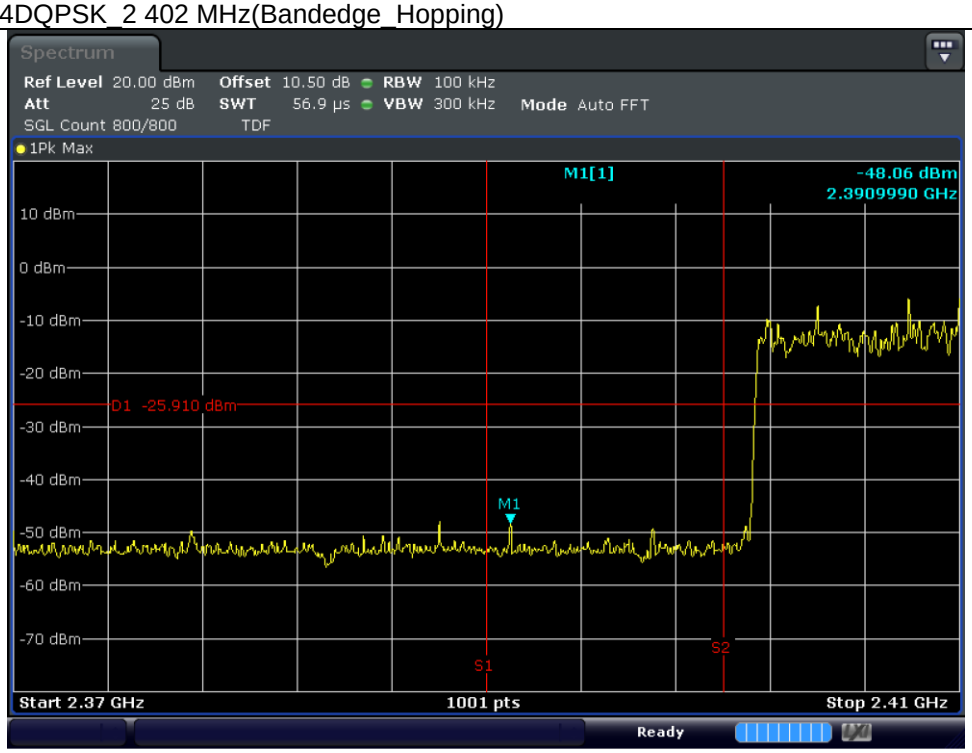


pi/4DQPSK_2 402 MHz(Bandedge_Single)



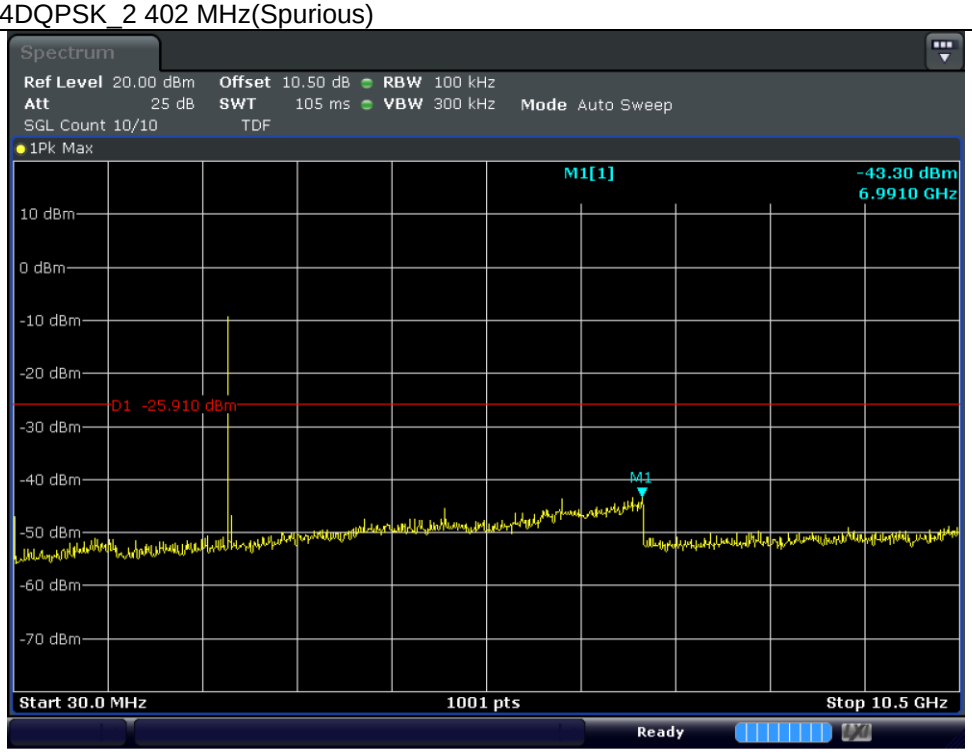
NOTE: F1 : 2 390 MHz, F2 : 2 400 MHz

pi/4DQPSK_2 402 MHz(Bandedge_Hopping)

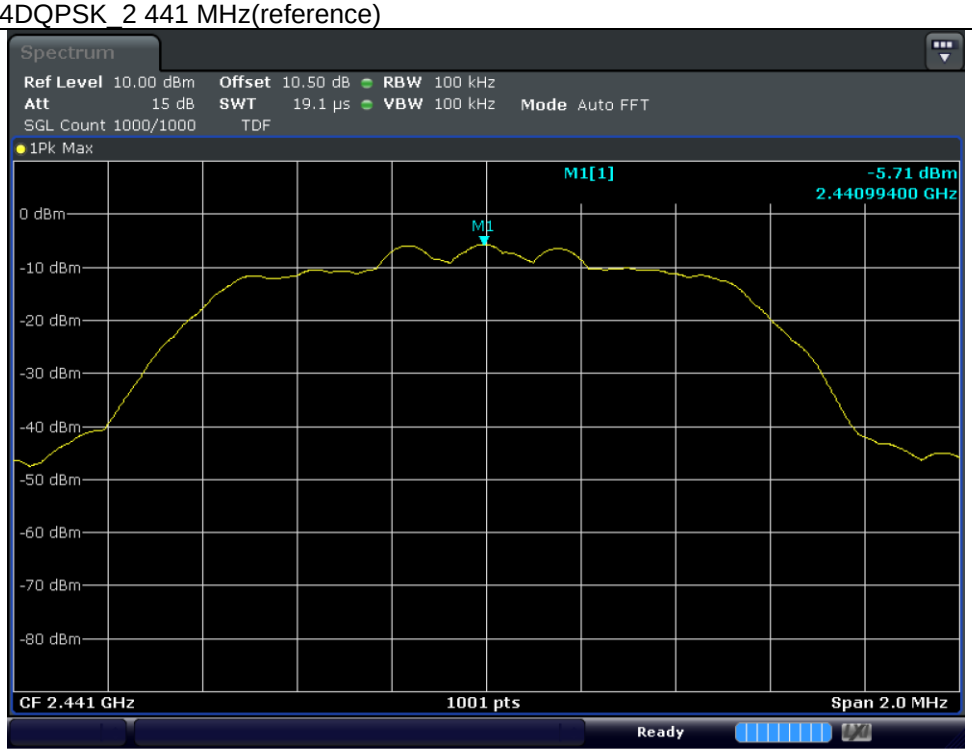


NOTE: F1 : 2 390 MHz, F2 : 2 400 MHz

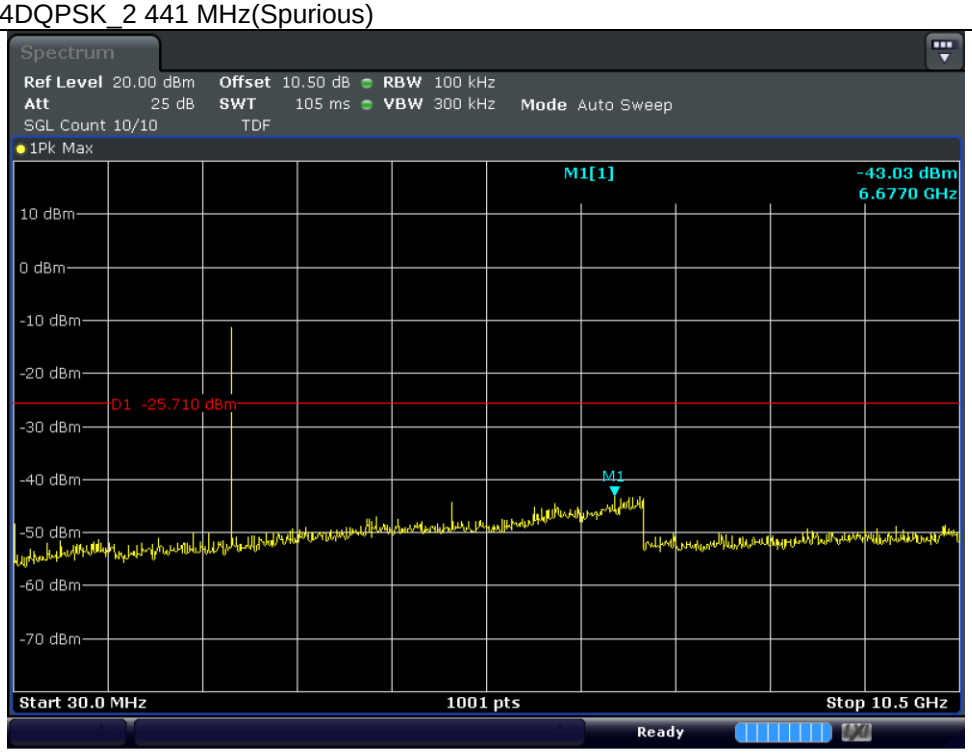
pi/4DQPSK_2 402 MHz(Spurious)



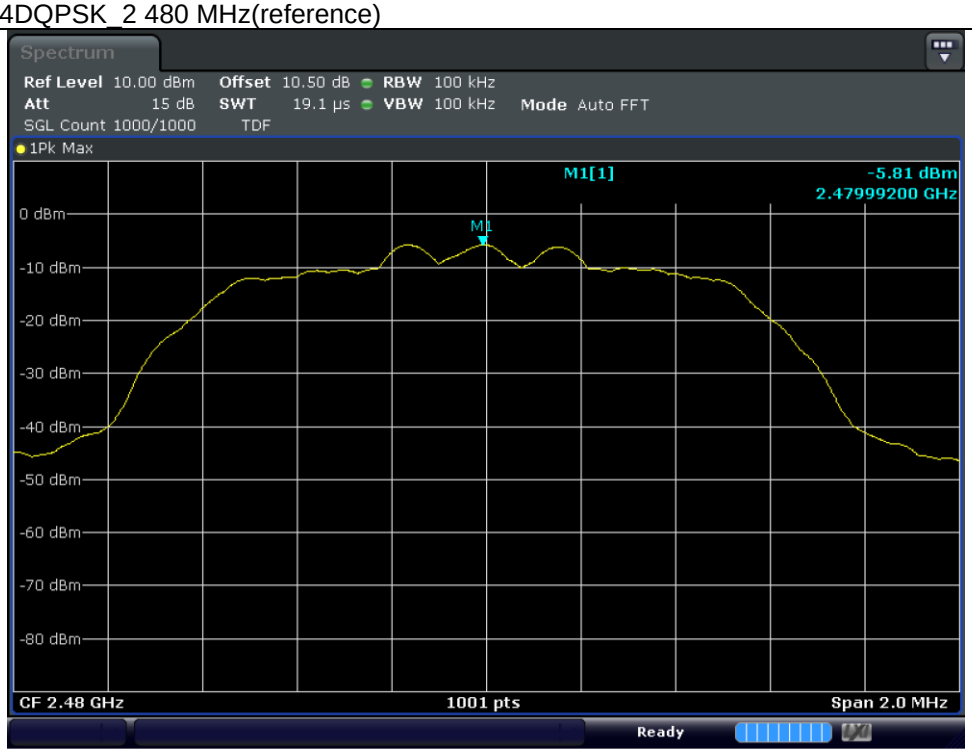
pi/4DQPSK_2 441 MHz(reference)



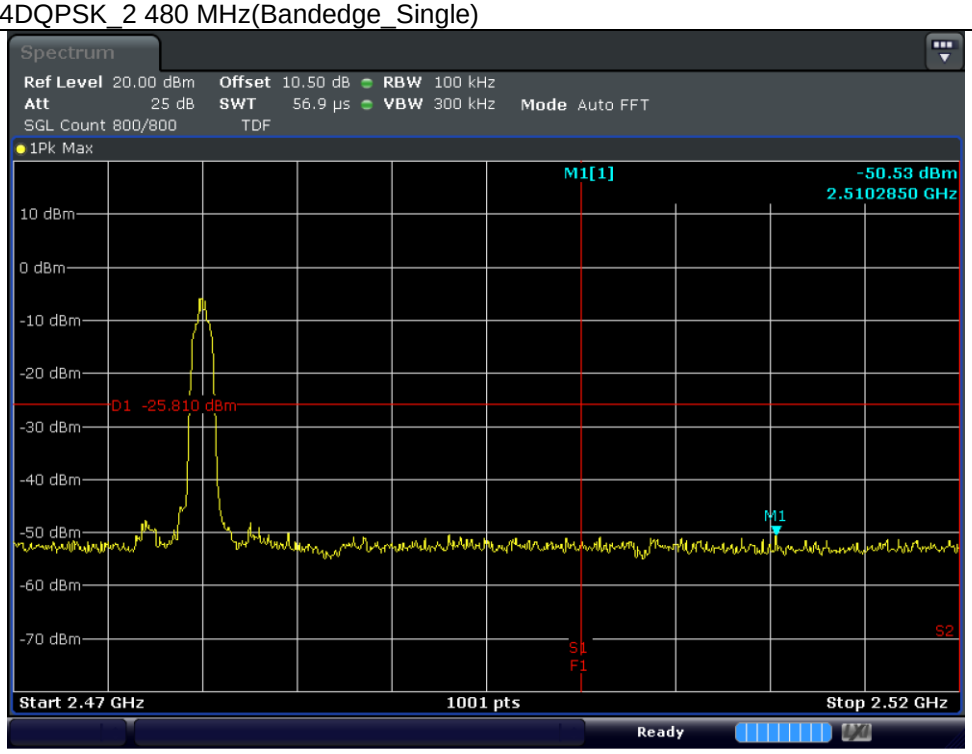
pi/4DQPSK_2 441 MHz(Spurious)



pi/4DQPSK_2 480 MHz(reference)

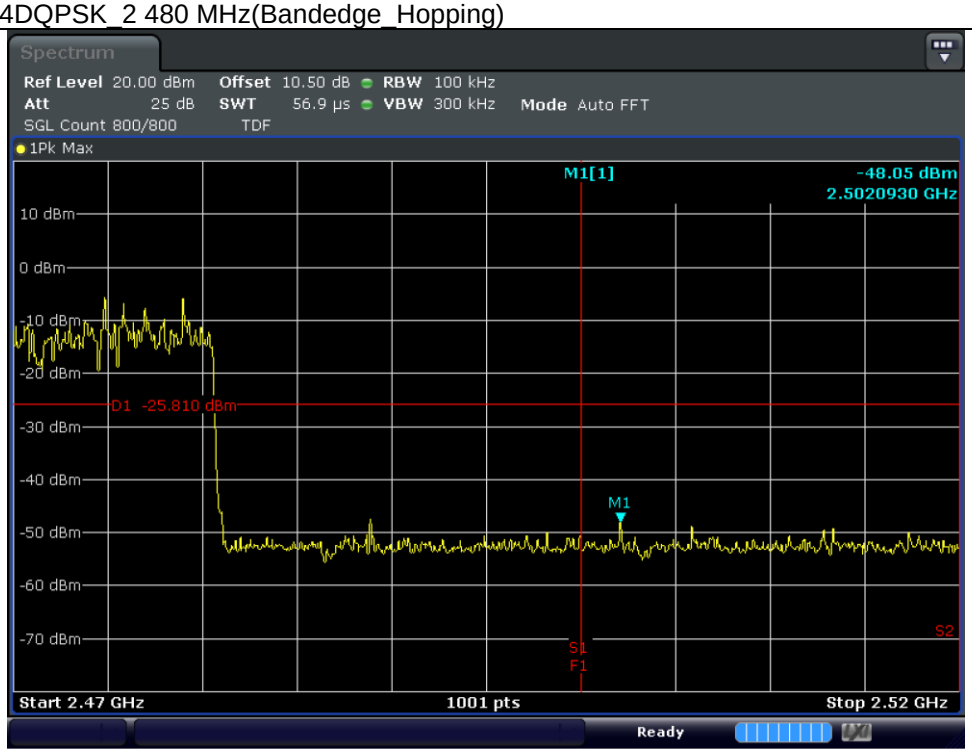


pi/4DQPSK_2 480 MHz(Bandedge_Single)



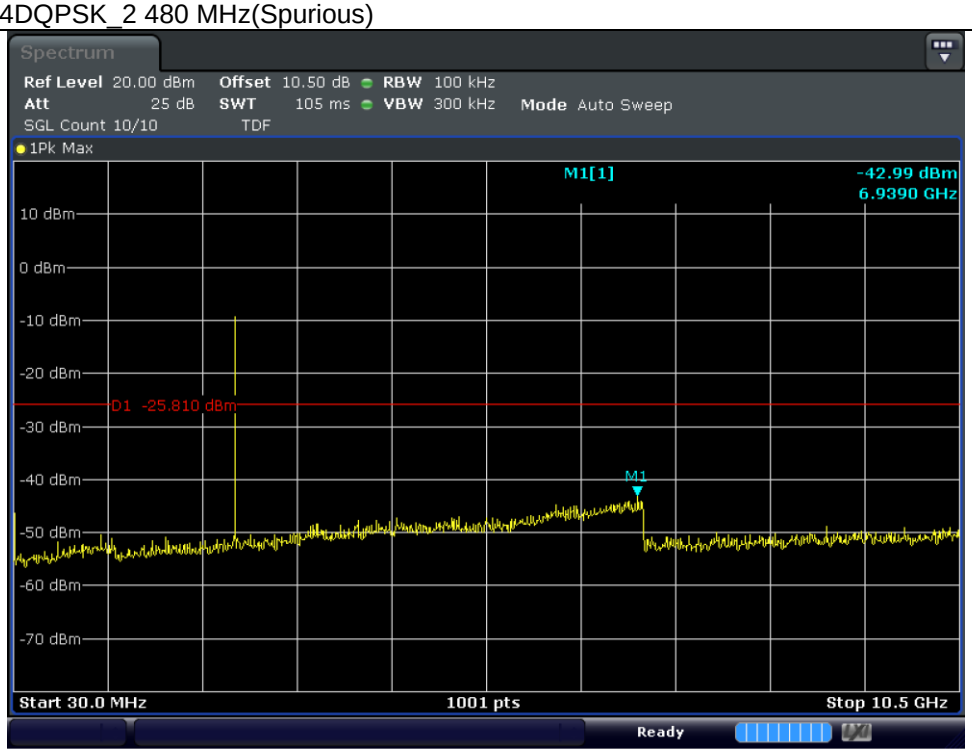
NOTE: F1 : 2 500 MHz

pi/4DQPSK_2 480 MHz(Bandedge_Hopping)



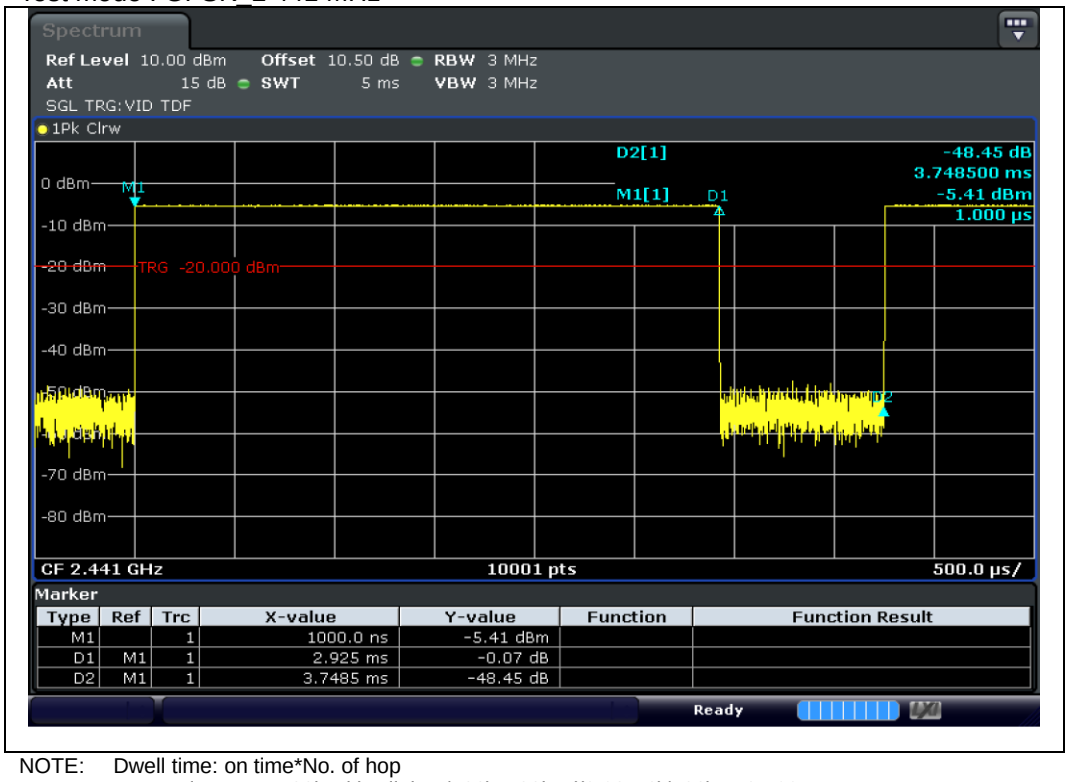
NOTE: F1 : 2 500 MHz

pi/4DQPSK_2 480 MHz(Spurious)



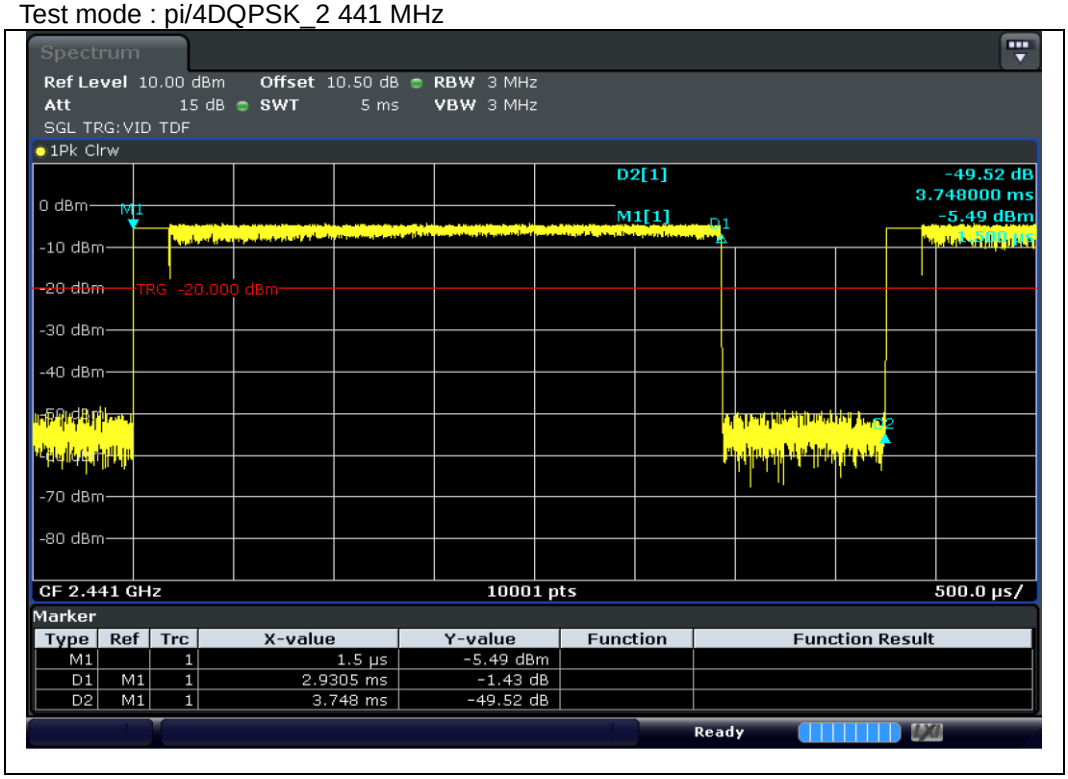
4.3.7.8 Measurement Plot_Dutycycle

Test mode : GFSK_2 441 MHz



NOTE: Dwell time: on time*No. of hop
Dutycycle Factor : 20log(dwell time/100) = 20log((2.925*2)/100) = -24.66

Test mode : pi/4DQPSK_2 441 MHz



NOTE: Dwell time: on time*No. of hop
Dutycycle Factor : 20log(dwell time/100) = 20log((2.9305*2)/100) = -24.64

4.3.8 Conducted Emission

4.3.8.1 Regulation

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN).
Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Qausi-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.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

4.3.8.2 Measurement Procedure

1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5 m away from the side wall of the shielded room.

2) Each current-carrying conductor of the EUT power cord was individually connected through a 50 Ω/50 μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.

3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.

4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.

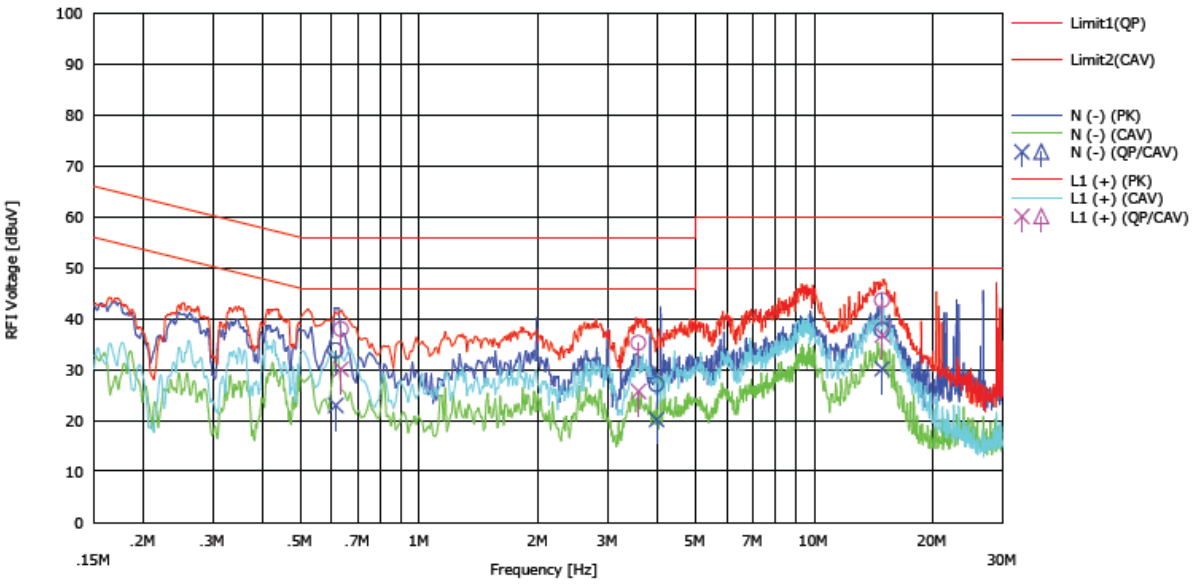
5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASIPEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

4.3.8.3 Result

Comply (measurement data : refer to the next page)

4.3.8.4 Measurement data

Test mode : GFSK_2 402 MHz



NO	FREQ [MHz]	READING QP [dBuV]	READING CAV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT CAV [dBuV]	LIMIT QP [dBuV]	LIMIT CAV [dBuV]	MARGIN QP [dBuV]	MARGIN CAV [dBuV]	PHASE
1	0.61465	13.8	3.0	19.9	33.7	22.9	56.0	46.0	22.3	23.1	N (-)
2	3.99523	7.3	0.4	19.8	27.1	20.2	56.0	46.0	28.9	25.8	N (-)
3	14.88242	17.6	10.0	20.1	37.7	30.1	60.0	50.0	22.3	19.9	N (-)
4	0.63387	18.0	10.2	19.9	37.9	30.1	56.0	46.0	18.1	15.9	L1 (+)
5	3.59536	15.4	6.0	19.8	35.2	25.7	56.0	46.0	20.8	20.3	L1 (+)
6	14.89015	23.5	16.7	20.1	43.6	36.8	60.0	50.0	16.4	13.2	L1 (+)

APPENDIX I

TEST EQUIPMENT USED FOR TESTS

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment.

Equipment	Manufacturer	Model	Serial No.	Cal. Date (yy.mm.dd)	Next Cal.Date (yy.mm.dd)
FSV Signal Analyzer	ROHDE&SCHWARZ	FSV30	103370	2022-10-11	2023-10-11
Power Sensor	KEYSIGHT	U2022XA	MY55320008	2022-08-16	2023-08-16
DC Power Supply	AGILENT	E3632A	MY51160055	2022-04-14	2023-04-14
Digital MultiMeter	HP	34401A	US36025428	2022-01-10	2023-01-10
ATTENUATOR	WEINSCHEL	54A-10	69672	2022-10-11	2023-10-11
Signal Generator	ROHDE&SCHWARZ	SMB100A	178384	2022-10-11	2023-10-11
EMI Test Receiver	ROHDE&SCHWARZ	ESU40	100445	2022-09-05	2023-09-05
BiLog Antenna	Schwarzbeck	VULB9168	00821	2021-03-31	2023-03-31
ATTENUATOR	JFW	50F-006	6 dB-3	2022-04-13	2023-04-13
Preamplifier	TSJ	MLA-10k01-b01-27	1870367	2022-04-13	2023-04-13
Antenna Mast(10 m)	TOKIN	5977	-	-	-
Antenna Mast(10 m)	Innco	MA4640-XPET-0800	578	-	-
Controller(10 m)	TOKIN	5909L	141909L-1	-	-
Controller(10 m)	Innco	CO3000	40040217	-	-
Turn Table(10 m)	TOKIN	5983-1.5	-	-	-
10 m Semi-Anechoic Chamber	SY CORPORATION	-	-	-	-
Active Loop H-Field	ETS	6502	00150598	2022-06-02	2023-06-02
Double Ridege Horn Antenna	ETS	3117	00168719	2022-08-16	2023-08-16
Double Ridege Horn Antenna	A.H Systems, Inc	SAS-574	465	2021-04-26	2023-04-26
PREAMPLIFIER	Agilent	8449B	3008A02110	2022-01-10	2023-01-10
PREAMPLIFIER	A.H Systems, Inc	PAM-1840VH	166	2022-01-10	2023-01-10
EMI Test Receiver	ROHDE&SCHWARZ	ESR7	101440	2022-09-05	2023-09-05
LISN	ROHDE&SCHWARZ	ENV216	101883	2022-04-13	2023-04-13
Pulse Limiter	Schwarzbeck	VTSD 9561-F	00189	2022-04-13	2023-04-13
Band Reject Filter	wainwright instruments gmbh	WRCGV10-2363.5-2400-2483.5-2520--60SS	7	2022-04-14	2023-04-14