

TEST REPORT

CSA Group Korea Ltd.
155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si,
Gyeonggi-Do 16885 Republic of Korea
www.csagroup.org

Report No.:
CSA-26-R-0032-R1
Page (1) of (61)



1. Report No. : CSA-26-R-0032-R1

2. Customer

◦ Name : HYOLIM XE CO., LTD.

◦ Address : 89, Seongseo4chacheomdan-ro, Dalseo-gu, Daegu, 704-801, Korea

3. Use of Report : FCC Original Grant

4. Product Name / Model Name : Car AVN / DGU-12T5-J150SA-2

FCC ID : 2AE77DGU12T5J150SA2

5. FCC Regulation(s): FCC Part 15 Subpart C 15.247

Test Method used: KDB558074 D01v05r02, ANSI C63.10-2020

6. Date of Test : 2026-06-17 to 2026-06-26

7. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing
(Address: 155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 Republic of Korea)

8. Testing Environment : See appended test report.

9. Test Result : Refer to the test result in the test report

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

Affirmation	Tested by	Technical Manager
	Name : Sungjung Kim (Signature)	Name : Changwon Lee (Signature)

2026-07-09

CSA Group Korea Ltd.

As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by CSA Group Korea Ltd.

CSA Group Korea Ltd. 155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 Republic of Korea www.csagroup.org	Report No.: CSA-26-R-0032-R1 Page (2) of (61)	
---	--	---

REPORT REVISION HISTORY

Date	Revision	Page No
2026-07-06	Originally issued	-
2026-07-09	Rev.01 (1 ~ 25 GHz Spurious data added)	38 ~ 61

This report shall not be reproduced except in full, without the written approval of CSA Group Korea Ltd. This document may be altered or revised by CSA Group Korea Ltd. personnel only, and shall be noted in the revision section of the document. Any alteration of this document not carried out by CSA Group Korea Ltd. will constitute fraud and shall nullify the document. This test report is a general report that does not use the KOLAS accreditation mark and is not related to KS Q ISO/IEC 17025 and KOLAS accreditation.

General remarks for test reports

Statement concerning the uncertainty of the measurement systems used for the tests

(may be required by the product standard or client)

☐ Internal procedure used for type testing through which traceability of the measuring uncertainty has been established:

Procedure number, issue date and title:

Calculations leading to the reported values are on file with the testing laboratory that conducted the testing.

☒ Statement not required by the standard or client used for type testing

Contents

1. General Information	5
1.1. Applicant information	5
1.2. Laboratory information	5
1.3 Description of EUT	6
1.4 Declaration by the manufacturer	6
1.5 Test Equipment List	7
1.6 Summary of Test Results	8
1.7 Information about the FHSS characteristics	9
1.8 Conclusion of worst-case and operation mode	10
1.9 Measurement Uncertainty	11
2. Antenna Requirement	12
3. Maximum Peak Conducted Output Power	13
3.1. Test Setup	13
3.2. Limit	13
3.3 Test Procedure :	13
3.4 Test Results :	14
4. 20 dB BW	20
4.1. Test Setup	20
4.2. Limit	20
4.3 Test Procedure :	20
4.4 Test Results :	21
5. Carrier Frequency Separation	25
5.1. Test Setup	25
5.2. Limit	25
5.3 Test Procedure :	25
6. Number of Hopping channels	27
6.1. Test Setup	27
6.2. Limit	27
6.3 Test Procedure :	27
6.4 Test results	28
7. Time of Occupancy	31
7.1. Test Setup	31
7.2. Limit	31
7.3. Test Procedure	31
7.4. Test Results	31

8. Unwanted Emission.....	33
8.1. Test Setup.....	33
8.2. Limit	34
8.3. Test Procedures	36
8.4. Test Results	38

CSA Group Korea Ltd. 155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 Republic of Korea www.csagroup.org	Report No.: CSA-26-R-0032-R1 Page (5) of (61)	
---	---	---

1. General Information

1.1. Applicant information

Applicant: HYOLIM XE CO., LTD.
Address: 89, Seongseo4chacheomdan-ro, Dalseo-gu, Daegu, 704-801, Korea
Telephone: +82-70-4850-3322
Fax: -
E-mail: kslee@hlgroup.co.kr
Contact name: Kisuk Lee
Manufacturer: HYOLIM XE CO., LTD.
Address: 89, Seongseo4chacheomdan-ro, Dalseo-gu, Daegu, 704-801, Korea
Telephone: +82-70-4850-3322
Fax: -
E-mail: kslee@hlgroup.co.kr
Contact name: Kisuk Lee

1.2. Laboratory information

Address

CSA Group Korea Ltd. (Yongin Lab.)

155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 Republic of Korea

Telephone Number: +82-2-6371-6600

FCC&IC MRA Accredited Test Designation No. : KR0175

1.3 Description of EUT

Product	Car AVN
Model Name	DGU-12T5-J150SA-2
Add Model Name	DGU-12T5-J150SA-1, DGU-12T5-J150SA-9, DGU-12T5-J150SA-10, DGU-12T5-U110SA-1, DGU-12T5-U110SA-2
Serial Number	Identical prototype
Power Supply	DC 12 V
Frequency Range	2 402 MHz ~ 2 480 MHz(GFSK, $\pi/4$ -DQPSK, 8DPSK)
Number of Channels	79
Antenna Type	PCB antenna
Antenna Gain	-0.56 dBi

1.4 Declaration by the manufacturer

- N/A

CSA Group Korea Ltd. 155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 Republic of Korea www.csagroup.org	Report No.: CSA-26-R-0032-R1 Page (7) of (61)	
---	--	---

1.5 Test Equipment List

Type	Manufacturer	Model	S/N	Spec	Next.Cal.Date (yy/mm/dd)
Spectrum Analyzer	ROHDE & SCHWARZ	FSV40	101404	10 Hz ~ 40GHz	2026-10-02
Signal Generator	ROHDE & SCHWARZ	SMB100B	105988	8 kHz ~ 40 GHz	2026-10-02
Vector Signal Generator	ROHDE & SCHWARZ	SMM100A	102150	100 kHz ~ 7.5 GHz	2026-10-02
Temp & Humid Chamber	ESPEC	SH-241	92004648	-40 °C ~ 100 °C	2026-10-01
DC Power Supply	ROHDE & SCHWARZ	NGL201	100791	0 V ~ 20 V / 0 A ~ 6 A	2027-04-24
Digital Multimeter	HIOKI	3280-10F	2310B9354	-	2027-04-24
Digital thermometer	SATO	PC-5410TRH	545509	0.0 °C ~ 50.0 °C	2026-12-06
WIDEBAND Radio Communication Tester	ROHDE & SCHWARZ	CMW500	171215	BT,LE,GSM,WCDMA,LTE	2026-10-02
Power Splitter	HP	11667B	09436	DC to 26.5 GHz	2027-04-27
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW44	103091	1 Hz - 44 GHz	2027-04-22
Active Loop Antenna	ROHDE & SCHWARZ	HFH2-Z2E	101198	Frequency range : 8.3 kHz to 30 MHz, Nominal impedance : 50 Ω	2028-04-23
Signal Conditioning Unit	ROHDE & SCHWARZ	SCU 01	10029	9 kHz - 1 GHz, 40 dB	2027-04-22
TRILOG Broadband Antenna	SCHWARZBECK	VULB 9168	01755	30 MHz - 1 GHz, 10 W	2026-12-05
DOUBLE RIDGED HORN ANTENNA	ROHDE & SCHWARZ	HF907	100197	1-18GHz	2027-04-23
Amplifier	TESTEK	TK-PA18H	240132-L	1 GHz - 18 GHz, 45 dB	2027-04-22
HORN ANTENNA	SCHWARZBECK	BBHA 9170	1392	14 GHz - 40 GHz, 10 W	2026-10-10
Amplifier	PASTERNAK	PE7390-6	240143-L	50 dB, 18 GHz-40 GHz	2026-10-13
Highpass Filter	Wainwright Instruments	WHKX10-2838-3300-18000-60SS	12	-	2026-10-13

CSA Group Korea Ltd. 155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 Republic of Korea www.csagroup.org	Report No.: CSA-26-R-0032-R1 Page (8) of (61)	
---	--	---

1.6 Summary of Test Results

FCC Part Section(s)	Parameter	Limit (Using in 2400~ 2483.5MHz)	Test Condition	Status Note 1
15.247(a) 15.247(b)	Maximum Peak Conducted Output Power	=< 0.125 W(conducted)	Conducted	C
15.247(a)	20 dB Bandwidth	NA		C
	Carrier Frequency Separation	>= 25 kHz or >= Two thirds of the 20 dB BW, whichever is greater.		C
	Number of Hopping Channels	>= 15 hops		C
	Time of Occupancy	=< 0.4 seconds		C
				C
15.247(d)	Unwanted Emissions (Conducted)	The radiated emission to any 100 kHz of out-band shall be at least 20 dB below the highest in-band spectral density.		C
15.247(d) 15.205 15.209	Unwanted Emissions (Radiated)	Part 15.209 Limits (Refer to section 9)	Radiated	C
15.207	AC Power-Line Conducted Emissions	Part 15.207 Limits (Refer to section 10)	AC Line Conducted	NA ^{Note 2}
15.203	Antenna Requirement	Part 15.203 (Refer to section 2)	-	C
Note 1: C=Comply NC=Not Comply NT=Not Tested NA=Not Applicable Note 2: This device is installed in a car. Therefore the power source is a battery of car.				

CSA Group Korea Ltd. 155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 Republic of Korea www.csagroup.org	Report No.: CSA-26-R-0032-R1 Page (9) of (61)	
---	--	---

1.7 Information about the FHSS characteristics

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following :

A) The hopping sequence is pseudorandom

Note 1 : Pseudorandom Frequency Hopping Sequence Table as below:

Channel: 08, 24, 40, 56, 42, 54, 72, 09, 01, 11, 33, 41, 34, 42, 65, 73, 53, 69, 06, 22, 04, 20, 36, 52,
38, 46, 70, 78, 68, 76, 21, 29, 10, 26, 41, 58, 44, 60, 76, 13, 03, 11, 35, 43, 37, 45, 69, 77, 52, 71, 08,
24, 06, 24, 48, 56, 45, 46, 70, 01, 72, 06, 25, 33, 12, 28, 49, 60, 45, 58, 74, 13, 05, 18, 37, 49 etc

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

B) All channels are used equally on average

C) The receiver input bandwidth equals the transmit bandwidth

D) The receiver hops in sequence with the transmit signal

- 15.247(g) : In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.
- 15.247(h) : In accordance with the Bluetooth Industry Standard, the system does not coordinate its channels selection / hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

1.8 Conclusion of worst-case and operation mode

The EUT has three types of modulation (GFSK, $\pi/4$ -DQPSK and 8DPSK).

Therefore all applicable requirements were tested with all the modulations.

And packet type was tested at the worst case(DH5).

Tested frequency information,

EUT Operation test setup

Bluetooth tester was used to control the transmit parameters during test.

- Hopping Function: Enable

	Tested Frequency(MHz)
Hopping Band	2 402 ~ 2 480

- Hopping Function: Disable

	Tested Frequency(MHz)
Lowest Channel	2 402
Middle Channel	2 441
Highest Channel	2 480

1.9 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C63.4-2014 and ANSI C63.10-2020. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

Parameter	Measurement uncertainty
Antenna-port conducted emission	1.04 dB (The confidence level is about 95 %, $k = 2$)
Output Power	1.04 dB (The confidence level is about 95 %, $k = 2$)
Bandwidth	1.4×10^4 Hz (The confidence level is about 95 %, $k = 2$)
Radiated emission (1 GHz Below)	5.82 dB (The confidence level is about 95 %, $k = 2$)
Radiated emission (1 GHz Above)	5.02 dB (The confidence level is about 95 %, $k = 2$)

CSA Group Korea Ltd. 155, Osan-Ro, Mohyeon-eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 Republic of Korea www.csagroup.org	Report No.: CSA-26-R-0032-R1 Page (12) of (61)	
---	--	---

2. Antenna 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 shall be considered sufficient to comply with the provisions.

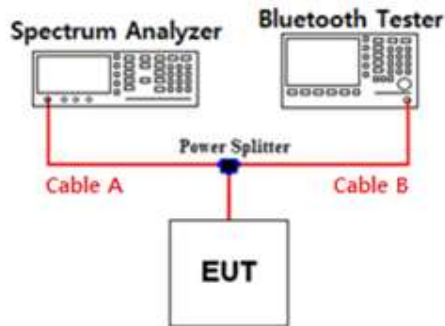
Conclusion: Comply

Uses a unique connector type. Connector type: U.FL terminal (Refer to Internal Photo file.)

Therefore this E.U.T complies with the requirement of Part 15.203

3. Maximum Peak Conducted Output Power

3.1. Test Setup



3.2. Limit

FCC Requirements

The maximum peak output power of the intentional radiator shall not exceed the following :

1. §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 2 400 MHz - 2 483.5 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.
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 MHz – 5 805 MHz band : 1 Watt. For all other frequency hopping systems in the 2 400 MHz – 2 483.5 MHz band: 0.125 watts.

3.3 Test Procedure :

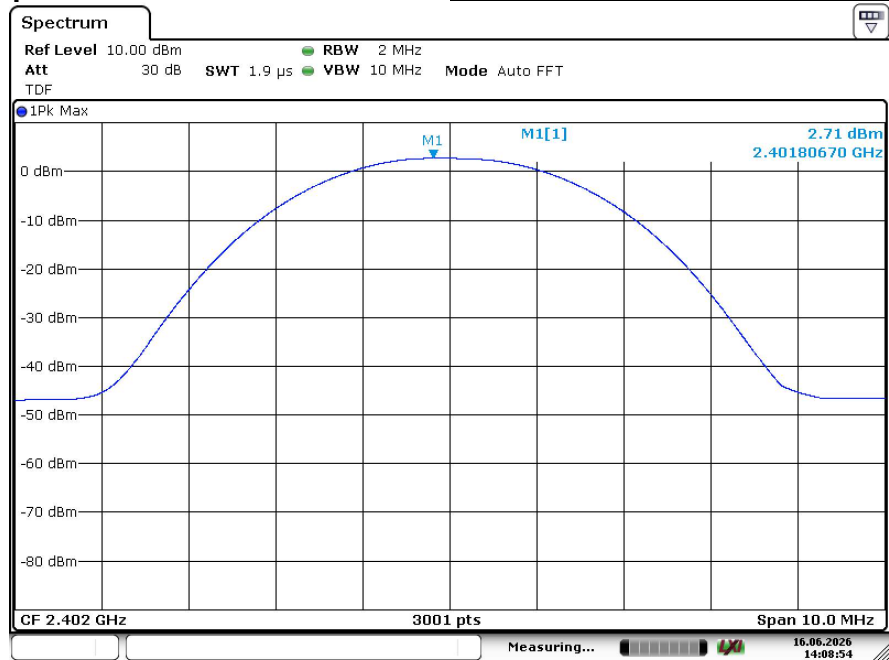
1. The RF output power was measured with a spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
2. The peak output power of the fundamental frequency was measured with the spectrum analyzer using ;Span = approximately 5 times of the 20 dB bandwidth, centered on a hopping channel, RBW ≥ 20 dB BW, VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold

3.4 Test Results :

Modulation	Tested Channel	Peak Output Power	
		dBm	mW
GFSK	Lowest	2.71	1.87
	Middle	3.25	2.11
	Highest	4.06	2.55
$\pi/4$-DQPSK	Lowest	0.98	1.25
	Middle	1.35	1.36
	Highest	1.89	1.55
8DPSK	Lowest	2.03	1.60
	Middle	1.65	1.46
	Highest	3.63	2.31

Peak Output Power

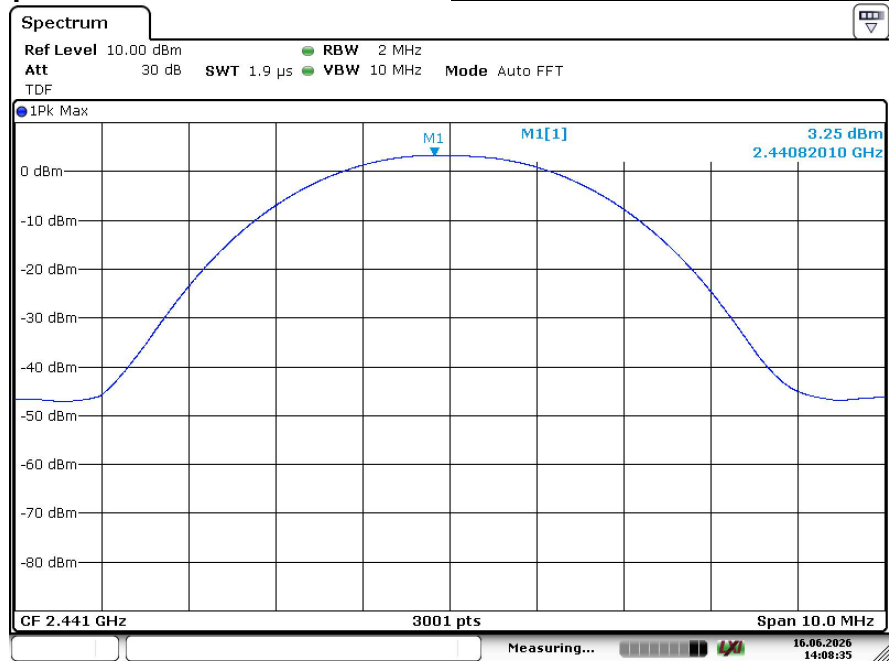
Lowest channel & Modulation : GFSK



Date: 16 JUN.2026 14:08:54

Peak Output Power

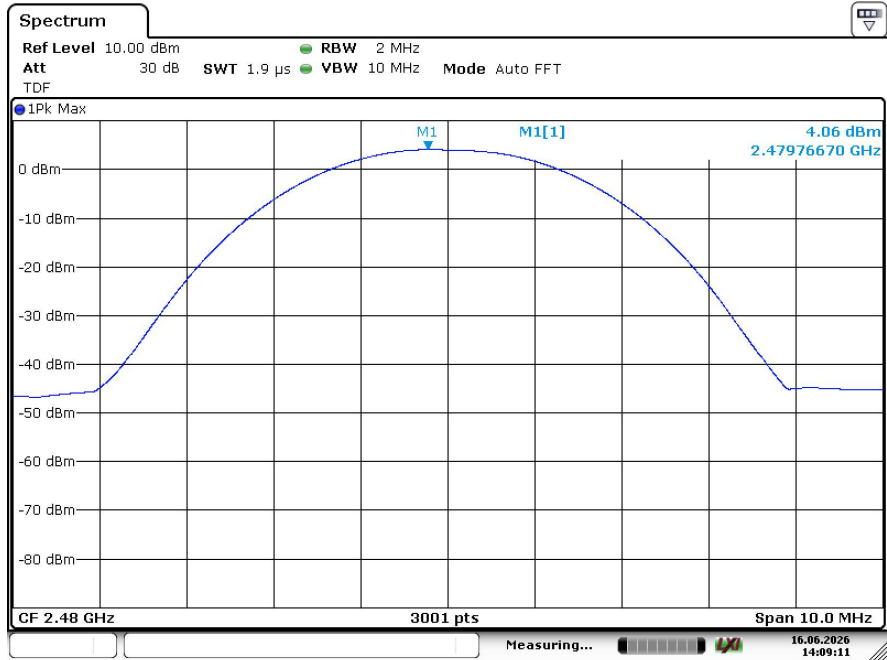
Middle channel & Modulation : GFSK



Date: 16 JUN.2026 14:08:35

Peak Output Power

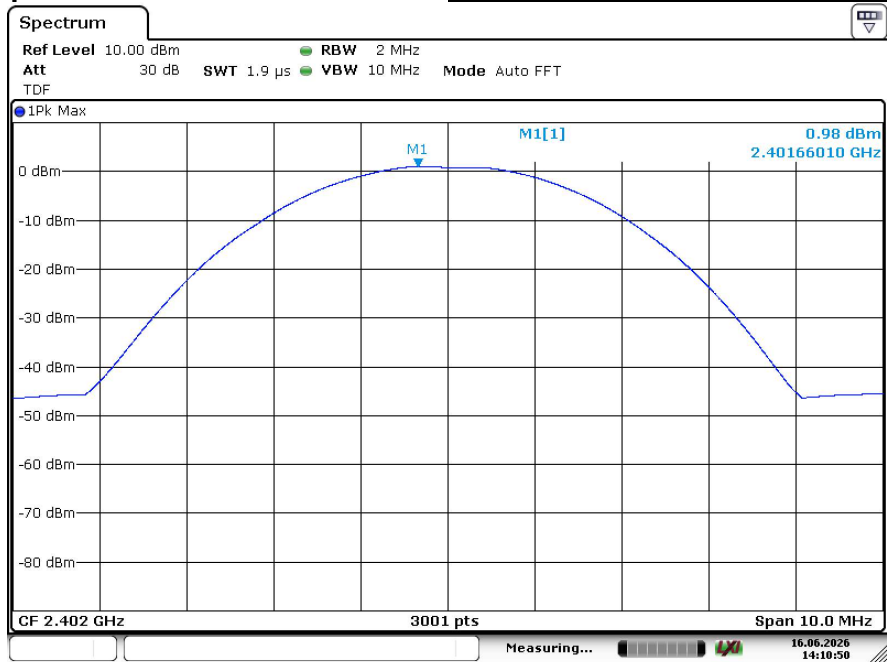
Highest channel & Modulation : GFSK



Date: 16.JUN.2026 14:09:11

Peak Output Power

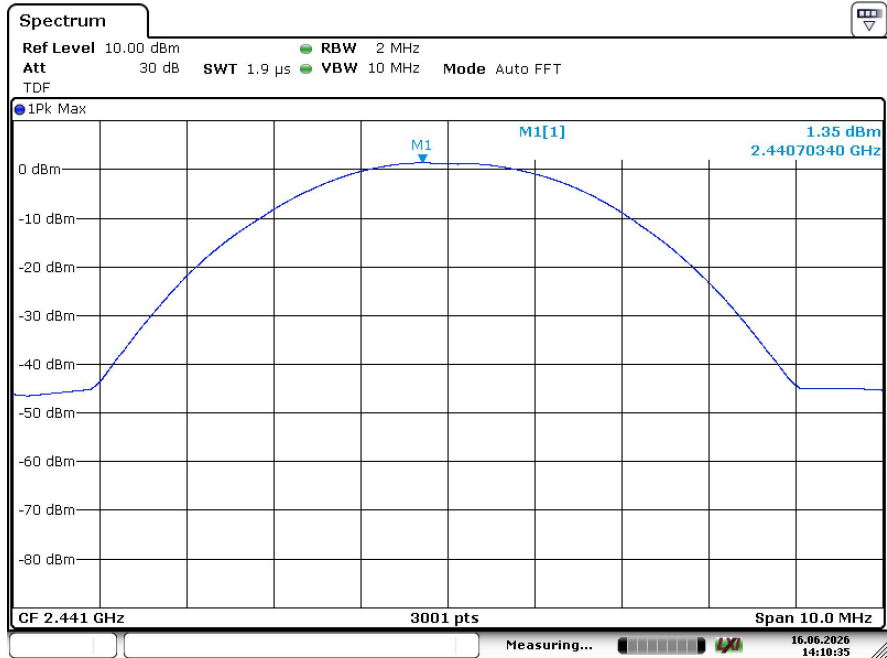
Lowest channel & Modulation : $\pi/4$ -DQPSK



Date: 16.JUN.2026 14:10:51

Peak Output Power

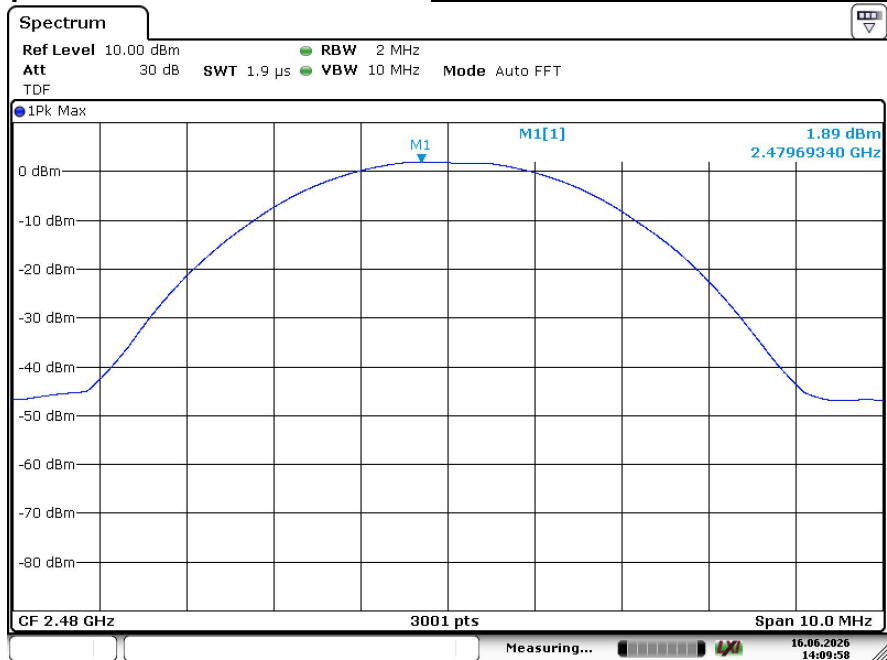
Middle channel & Modulation : $\pi/4$ -DQPSK



Date: 16. JUN. 2026 14:10:35

Peak Output Power

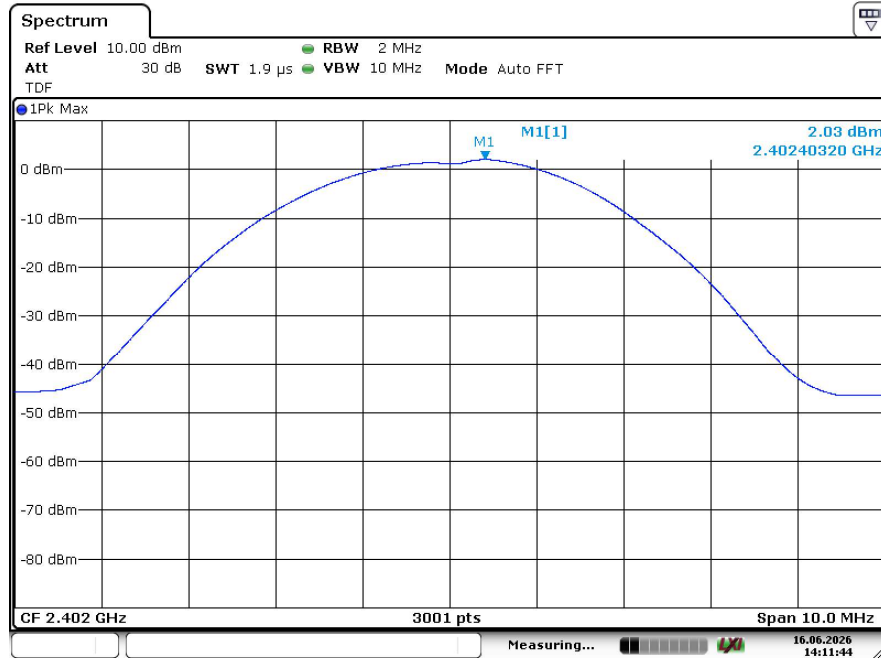
Highest channel & Modulation : $\pi/4$ -DQPSK



Date: 16. JUN. 2026 14:09:58

Peak Output Power

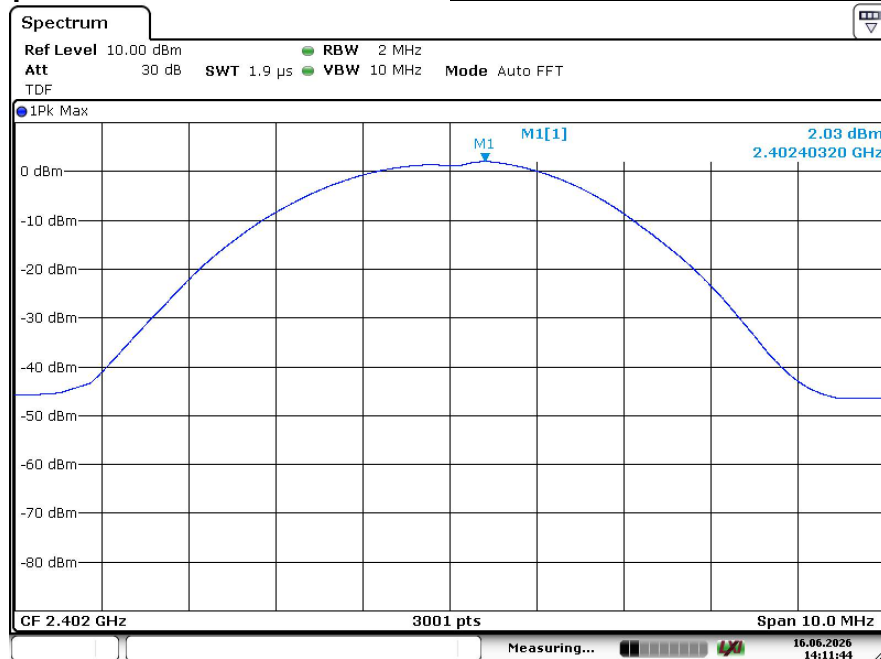
Lowest channel & Modulation : 8DPSK



Date: 16.JUN.2026 14:11:44

Peak Output Power

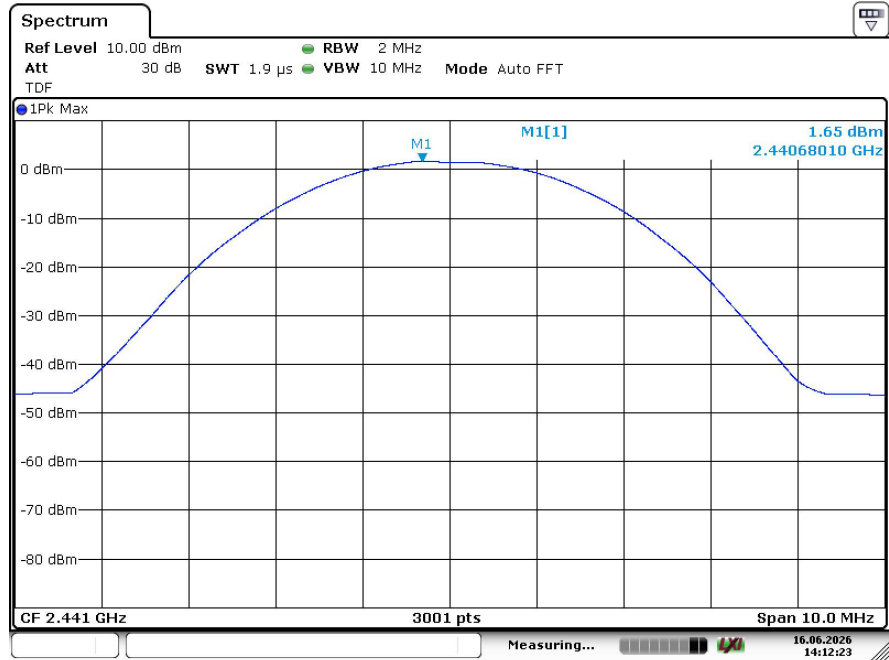
Middle channel & Modulation : 8DPSK



Date: 16.JUN.2026 14:11:44

Peak Output Power

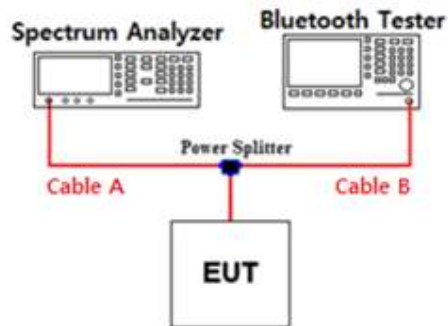
Highest channel & Modulation : 8DPSK



Date: 16.JUN.2026 14:12:23

4. 20 dB BW

4.1. Test Setup



4.2. Limit

Limit : Not Applicable

4.3 Test Procedure :

1. The 20 dB bandwidth was measured with a spectrum analyzer connected to RF antenna Connector (conducted measurement) while EUT was operating in transmit mode. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using below setting:

RBW = 1 % to 5 % of the 20 dB BW

VBW $\geq 3 \times$ RBW

Span = between two times and five times the 20 dB bandwidth

Sweep = auto

Detector function = peak

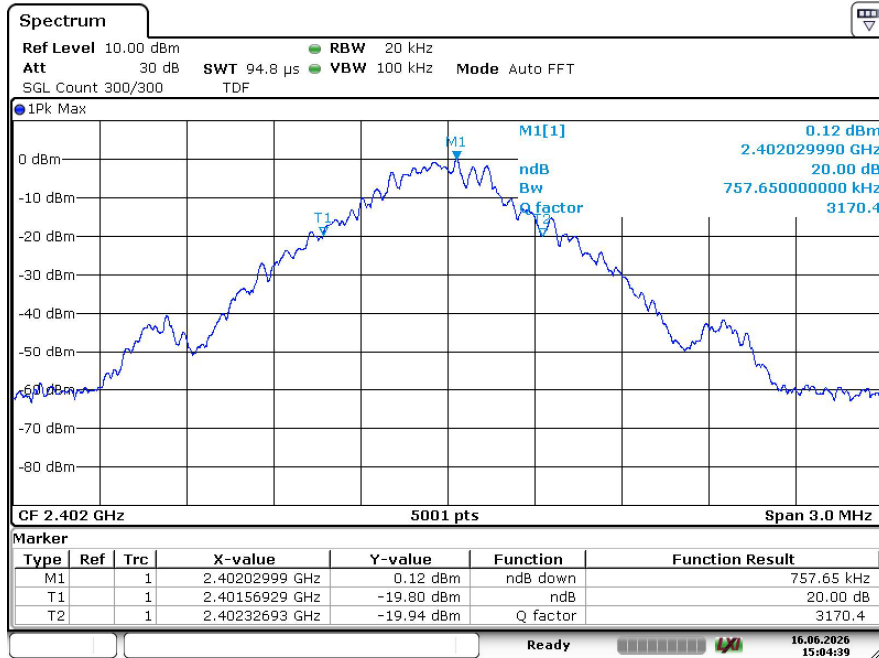
Trace = max hold

4.4 Test Results :

Hopping mode	Test Channel	20 dB BW (MHz)
GFSK	Lowest	0.758
	Middle	0.806
	Highest	0.806
8DPSK	Lowest	1.284
	Middle	1.272
	Highest	1.287

20 dB BW

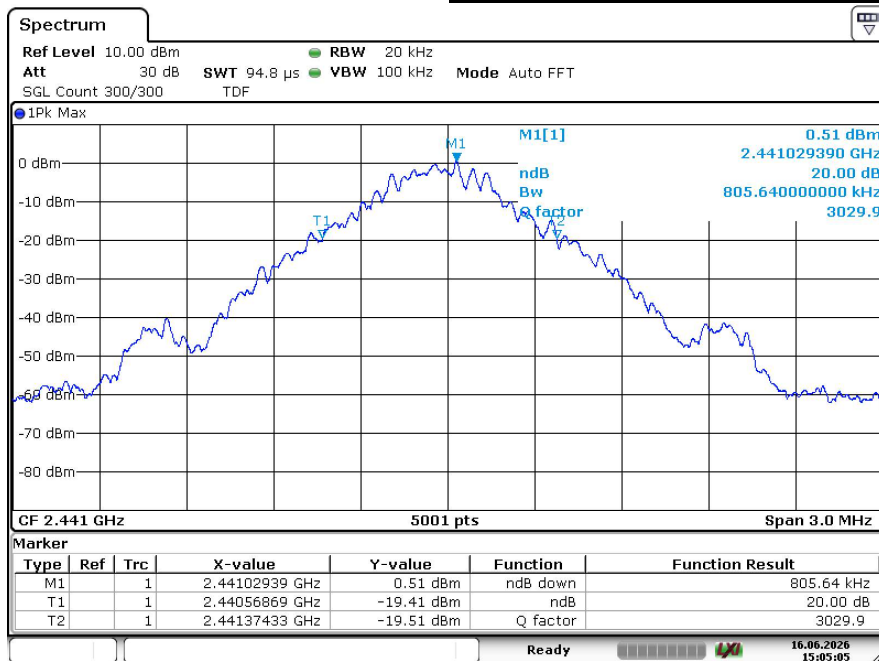
Lowest channel & Modulation : GFSK



Date: 16 JUN.2026 15:04:39

20 dB BW

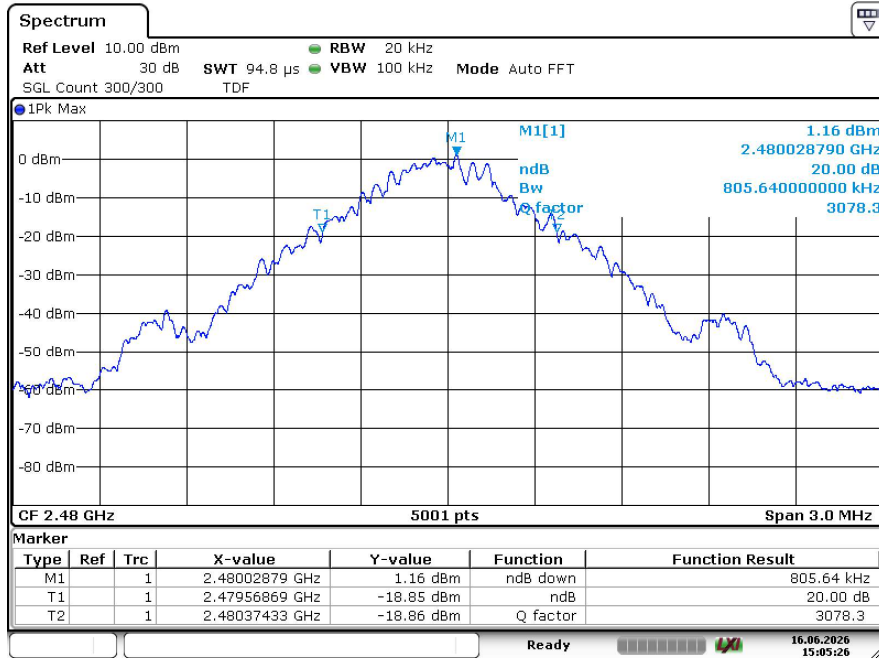
Middle channel & Modulation : GFSK



Date: 16 JUN.2026 15:05:06

20 dB BW

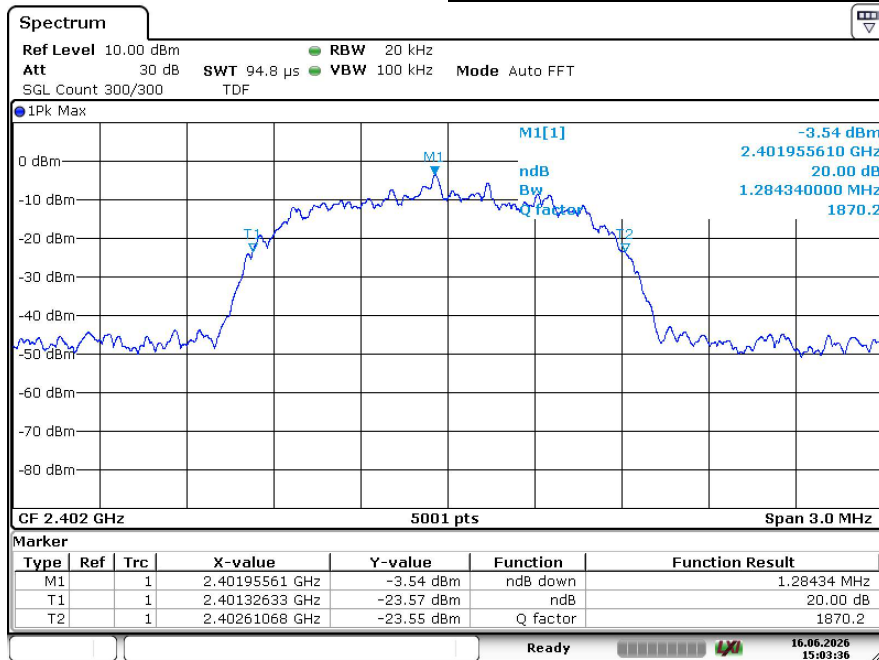
Highest channel & Modulation : GFSK



Date: 16 JUN.2026 15:05:26

20 dB BW

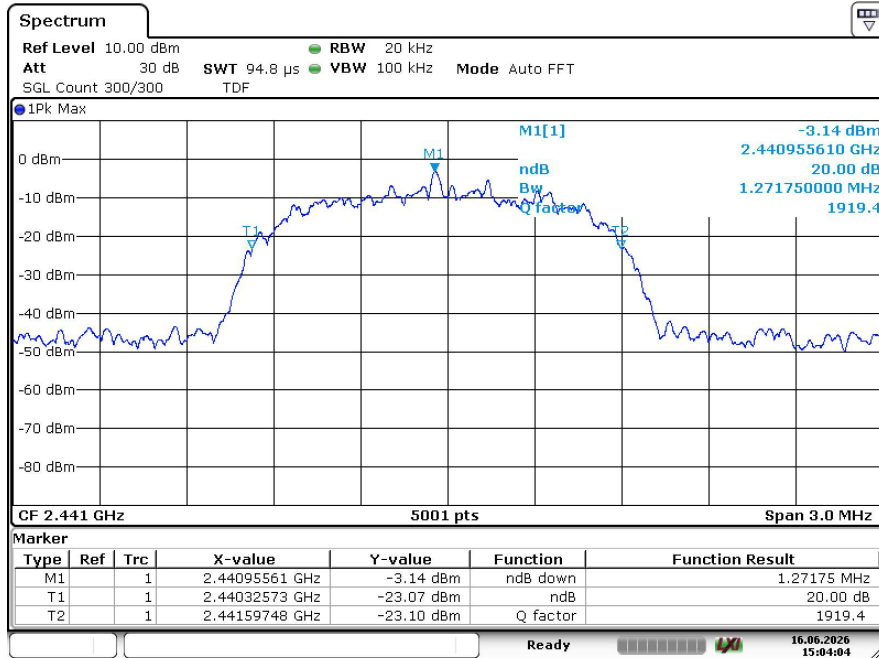
Lowest channel & Modulation : 8DPSK



Date: 16 JUN.2026 15:03:36

20 dB BW

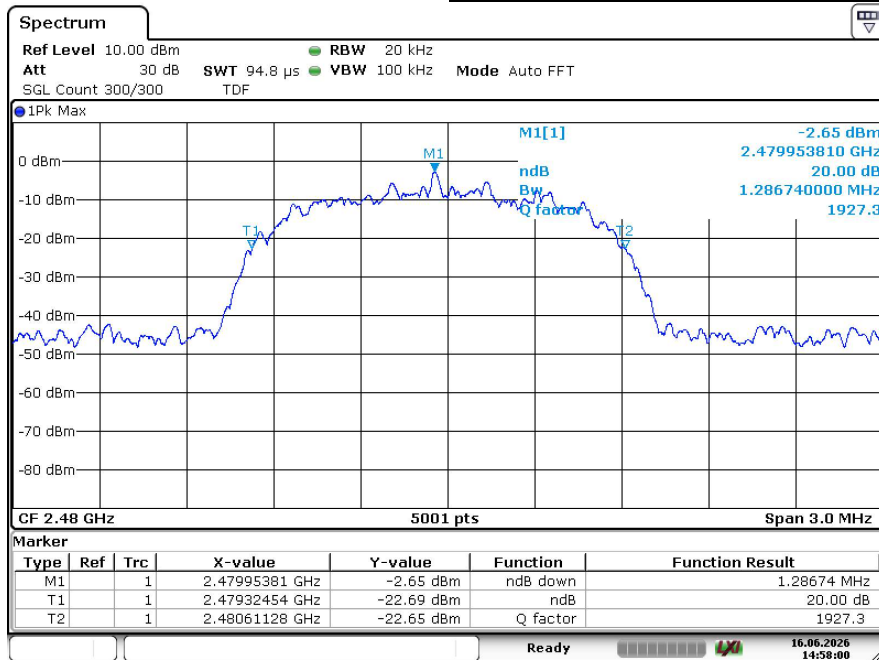
Middle channel & Modulation : 8DPSK



Date: 16 JUN.2026 15:04:04

20 dB BW

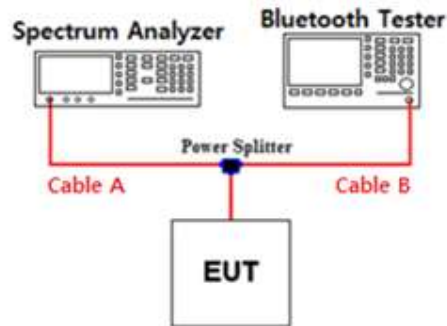
Highest channel & Modulation : 8DPSK



Date: 16 JUN.2026 14:58:01

5. Carrier Frequency Separation

5.1. Test Setup



5.2. Limit

Limit : ≥ 25 kHz or $\geq$ Two-Thirds of the 20 dB BW whichever is greater.

5.3 Test Procedure :

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

After the trace being stable, the reading value between the peaks of the adjacent channels using the marker-delta function was recorded as the measurement results.

The spectrum analyzer is set to :

Span = wide enough to capture the peaks of two adjacent channels

RBW = Start with the RBW set to approximately 30 % of the channel spacing; adjust as necessary to best identify the center of each individual channel.

VBW $\geq$ RBW

Sweep = auto

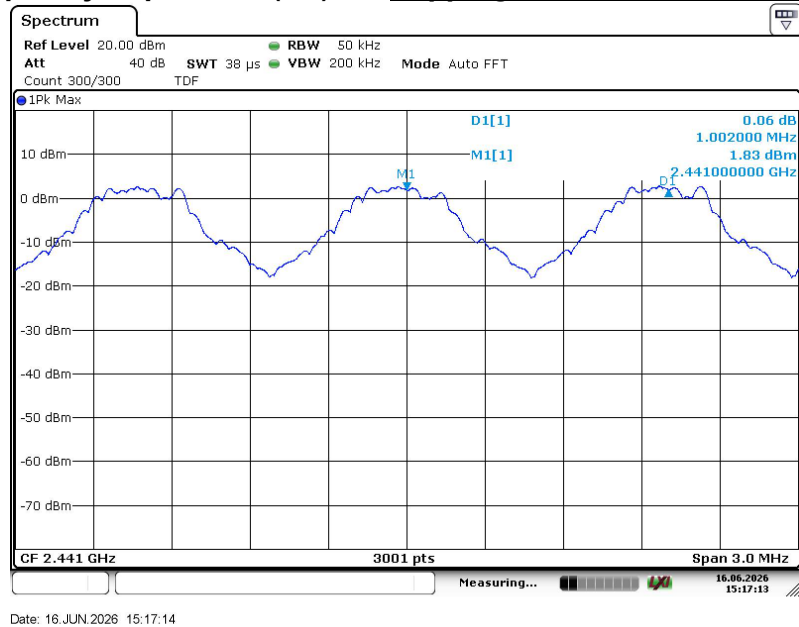
Detector function = peak

Trace = max hold

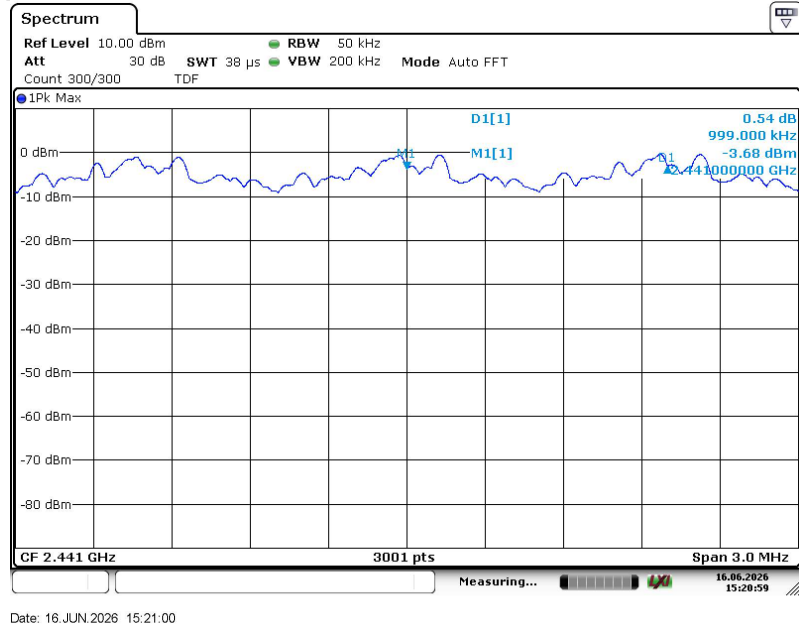
5.4 Test results

Hopping Mode	Modulation	Peak of reference channel(MHz)	Peak of adjacent Channel(MHz)	Test Result (MHz)
Enable	GFSK	2 441.000	2 442.002	1.002
	8DPSK	2 441.000	2 441.999	0.999

Carrier Frequency Separation (FH) Hopping mode : Enable & GFSK

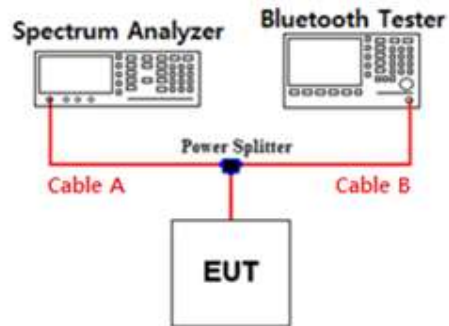


Carrier Frequency Separation (FH) Hopping mode : Enable & 8DPSK



6. Number of Hopping channels

6.1. Test Setup



6.2. Limit

Limit : ≥ 15 hops.

6.3 Test Procedure :

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

To get higher resolution, two frequency ranges for FH mode within the 2 400 MHz ~ 2 483.5 MHz were examined.

The spectrum analyzer is set to :

Span for FH mode = 50 MHz Start Frequency = 2 391.5 MHz, Stop Frequency = 2 441.5 MHz

Start Frequency = 2 441.5 MHz, Stop Frequency = 2 491.5 MHz

RBW = To identify clearly the individual channels, set the RBW to less than 30 % of the channel spacing or the 20 dB bandwidth, whichever is smaller.

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

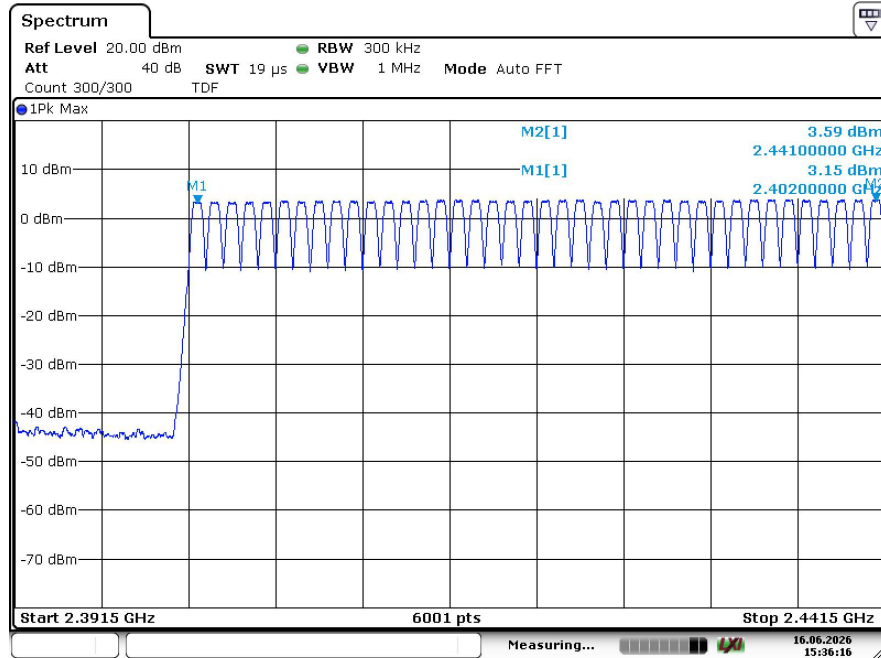
Trace = max hold

6.4 Test results

Hopping mode	Modulation	Test Result (Total Hops)
Enable	GFSK	79
	8DPSK	79

Number of Hopping Channels 1(FH)

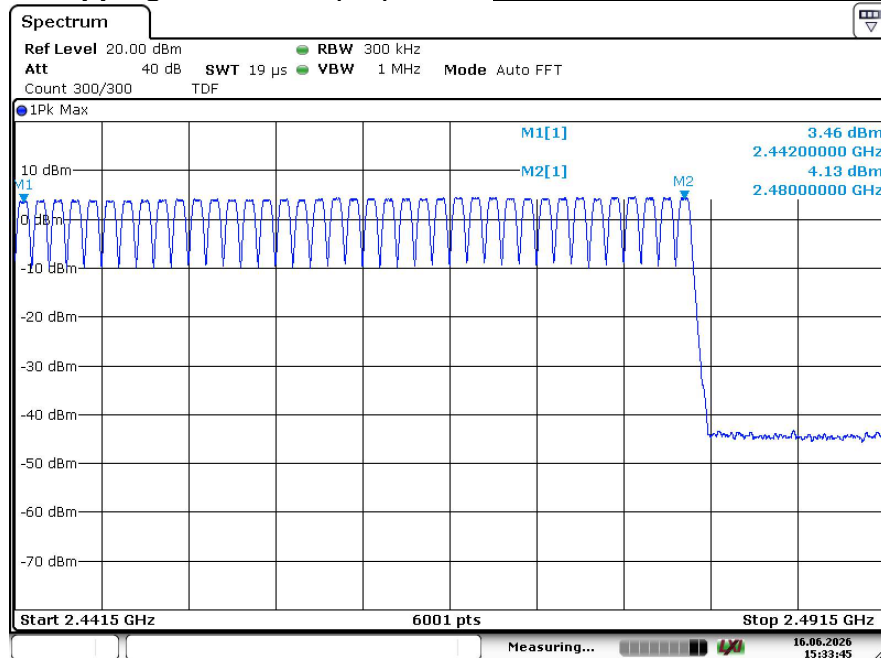
Hopping mode : Enable & GFSK



Date: 16.JUN.2026 15:36:16

Number of Hopping Channels 2(FH)

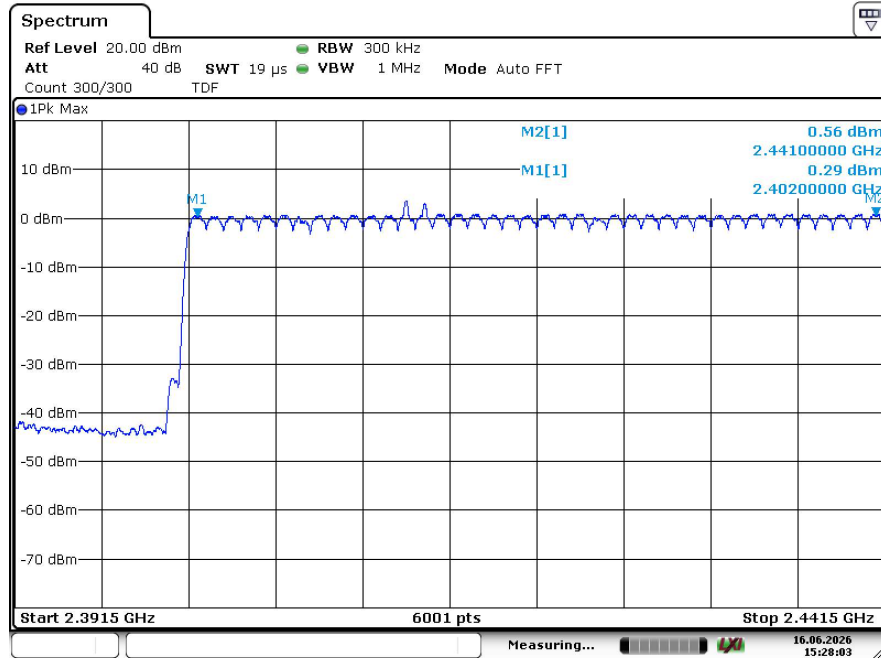
Hopping mode : Enable & GFSK



Date: 16.JUN.2026 15:33:46

Number of Hopping Channels 1(FH)

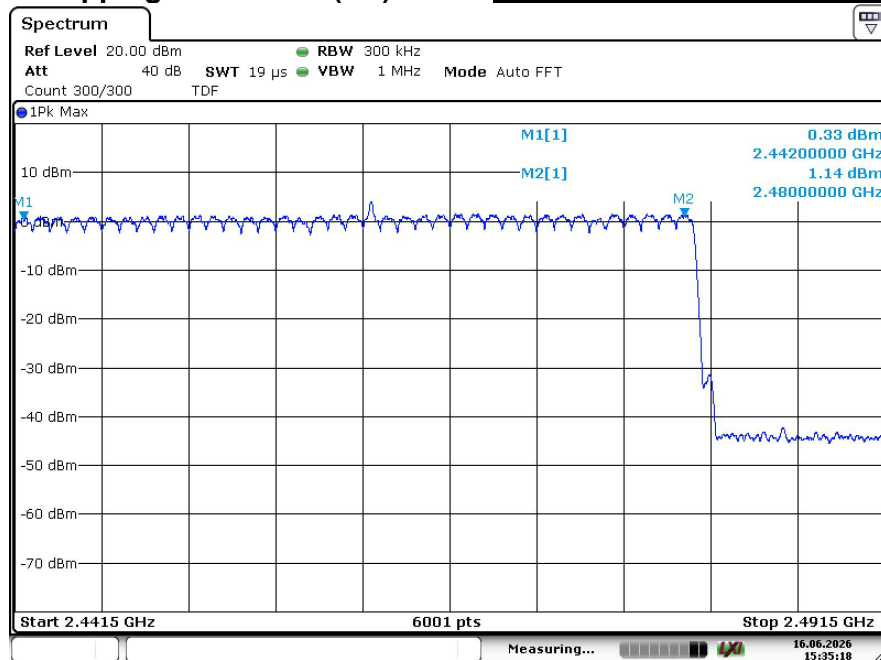
Hopping mode : Enable & 8DPSK



Date: 16 JUN.2026 15:28:03

Number of Hopping Channels 2(FH)

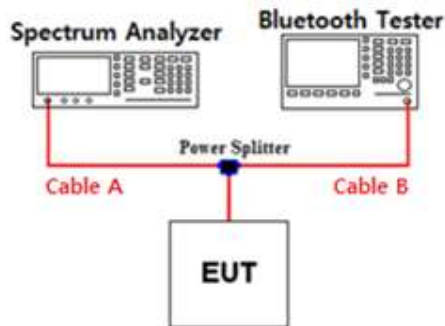
Hopping mode : Enable & 8DPSK



Date: 16 JUN.2026 15:35:19

7. Time of Occupancy

7.1. Test Setup



7.2. Limit

The maximum permissible time of occupancy is 400 ms within a period of 400 ms multiplied by the number of hopping channels employed.

7.3. Test Procedure

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to :

Center frequency = 2 441 MHz

Span = zero

RBW = 1 MHz (RBW shall be $\leq$ channel spacing and where possible RBW should be set $\gg 1 / T$, where T is the expected dwell time per channel)

VBW $\geq$ RBW

Detector function = peak

Trace = max hold

7.4. Test Results

Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
Enable	DH5	79	2.880	3.743	0.307
	3-DH5	79	2.880	3.747	0.307

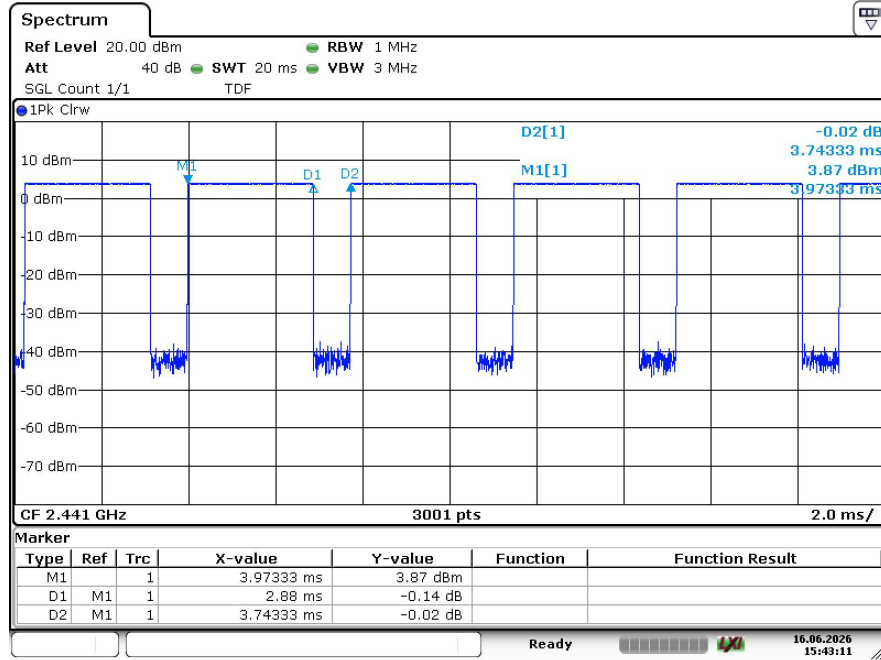
Note 1 : Dwell Time = $0.4 \times \text{Hopping channel} \times \text{Burst ON time} \times$

$((\text{Hopping rate} \div \text{Time slots}) \div \text{Hopping channel})$

- Time slots for DH 5 = 6 slots (TX = 5 slots / RX = 1 slot)
- Hopping Rate = 1 600 for FH mode

Time of Occupancy

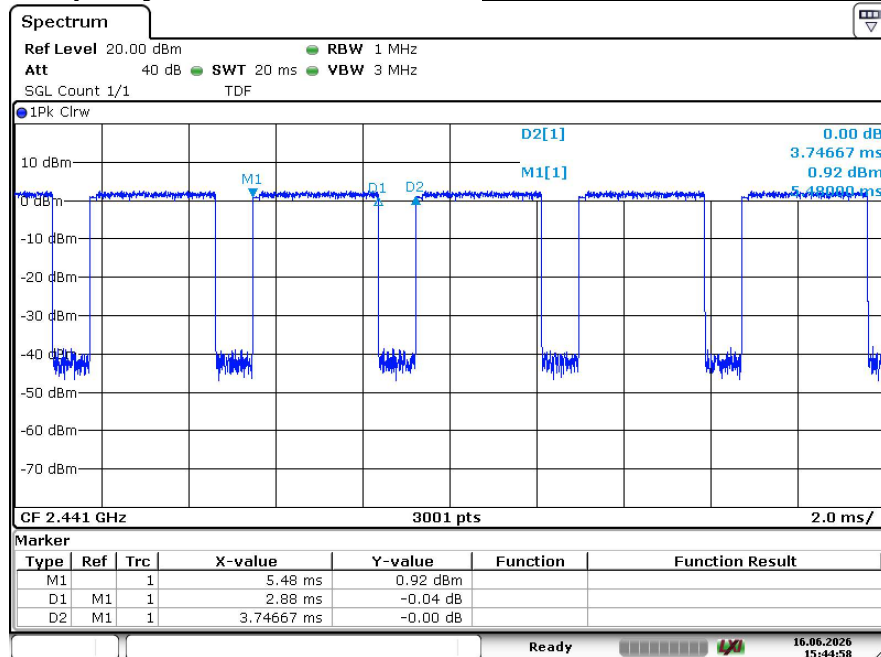
Hopping mode : Enable & DH5



Date: 16.JUN.2026 15:43:11

Time of Occupancy

Hopping mode : Enable & 3-DH5



Date: 16.JUN.2026 15:44:59