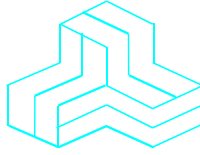


ENGINEERING TEST REPORT



**Express BLE+
Model: E04-003A
FCC ID: 2ASYW-E04003A**

Applicant:

Smart WaveTechnologies
1 Marmac Drive
Toronto, ON M9W 1E7
Canada

In Accordance With

**Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Systems (DTS) Operating in 2400 – 2483.5 MHz Band**

UltraTech's File No.: 24SMCS022_FCC15C247

This Test report is Issued under the Authority of
Tri M. Luu
Vice President of Engineering
UltraTech Group of Labs

Date: November 8, 2024

Report Prepared by: Dan Huynh

Tested by: Angus Au

Issued Date: November 8, 2024

Test Dates: June 21 – August 1, 2024

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by any agency of the US Government.*
- *This test report shall not be reproduced, except in full, without a written approval from UltraTech*

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#0685
ISO/IEC 17065
Product Certification Body

0685



APEC TEL CA0001



1309



CA 0001/2049



AT-1945



SL2-IN-E-1119R



Korea KCC-RRA
CA0001

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15 – Radio Frequency Devices
Purpose of Test:	Equipment Certification for Digital Modulation Systems (DTS) Operating Under §15.247
Test Procedures:	- ANSI C63.4 - ANSI C63.10 - FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
Environmental Classification:	☒ Commercial, industrial or business environment ☒ Residential environment

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2024	Code of Federal Regulations (CFR), Title 47 – Telecommunication
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz
ANSI C63.10	2020	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
FCC, KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02	2019	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

Applicant	
Name:	Smart WaveTechnologies
Address:	1 Marmac Drive Toronto, ON M9W 1E7 Canada

Manufacturer	
Name:	Smart WaveTechnologies
Address:	1 Marmac Drive Toronto, ON M9W 1E7 Canada

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Smart WaveTechnologies
Product Name:	Express BLE+
Model Name or Number:	E04-003A
Serial Number:	Test Sample
Firmware Version Identification Number (FVIN)	1.32
Type of Equipment:	Digital Transmission System (DTS)
Input Power Supply Type:	External DC Power Supply
Primary User Functions of EUT:	Turn on and off periodic advertising and data collection over BLE

2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Mobile Base station (fixed use)
Intended Operating Environment:	Commercial, industrial or business environment Residential environment
Power Supply Requirement:	3.6 VDC
RF Output Power Rating: maximum peak conducted power	13.94 dBm (1M Mode, 1 Mb/s) and 13.84 dBm (Coded PHY Mode, 125 kb/s)
Operating Frequency Range:	2402 - 2480 MHz
RF Output Impedance:	50 Ω
Duty Cycle:	Continuous
Modulation Type:	GFSK
Antenna Connector Types:	Integral

2.4. ASSOCIATED ANTENNA DESCRIPTIONS

Antenna Type	Maximum Gain (dBi)
¼ Wave Monopole	1.49

2.5. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	2-pin power port	1	2-pin polarized terminal connector	Non-shielded

2.6. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

No ancillary equipment.

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21 to 23 °C
Humidity:	45 to 58%
Pressure:	102 kPa
Power Input Source:	3.6 VDC nominal

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	Test configurations were manually set.
Special Hardware Used:	A modified version with external antenna connector was used for the purpose of conducted tests. As for radiated tests, test sample with intended integral was used.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment as described with the test results.

Transmitter Test Signals	
Frequency Band(s):	2402 - 2480 MHz
Frequency(ies) Tested:	2402 MHz, 2440 MHz and 2480 MHz
RF Power Output: (measured maximum peak conducted output power)	13.94 dBm (1M Mode, 1 Mb/s) and 13.84 dBm (Coded PHY Mode, 125 kb/s)
Normal Test Modulation:	GFSK
Modulating Signal Source:	Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).
- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with ANAB File No.: AT-1945.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirements	Yes*
15.207(a)	AC Power Line Conducted Emissions	Yes
15.247(a)(2)	6 dB Bandwidth	Yes
15.247(b)(3)	Peak Conducted Output Power	Yes
15.247(d)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	--
15.247(d), 15.209 & 15.205	Band-Edge and Transmitter Spurious Radiated Emissions	Yes
15.247(e)	Power Spectral Density	Yes
15.247(i), 1.1307, 1.1310, 2.1091	RF Exposure	Yes

* The EUT complies with the requirement; it employs a unique (non-standard) antenna connector or integral antenna.

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 5. TEST DATA

5.1. POWER LINE CONDUCTED EMISSIONS [§15.207(a)]

5.1.1. Limit(s)

The equipment shall meet the limits of the following table:

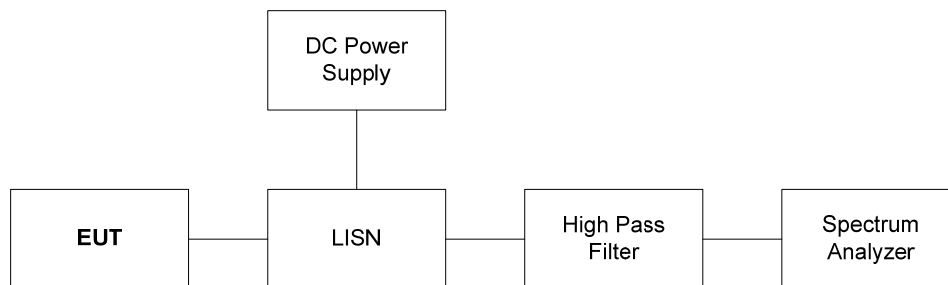
Frequency of emission (MHz)	Conducted Limits (dB μ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases linearly with the logarithm of the frequency

5.1.2. Method of Measurements

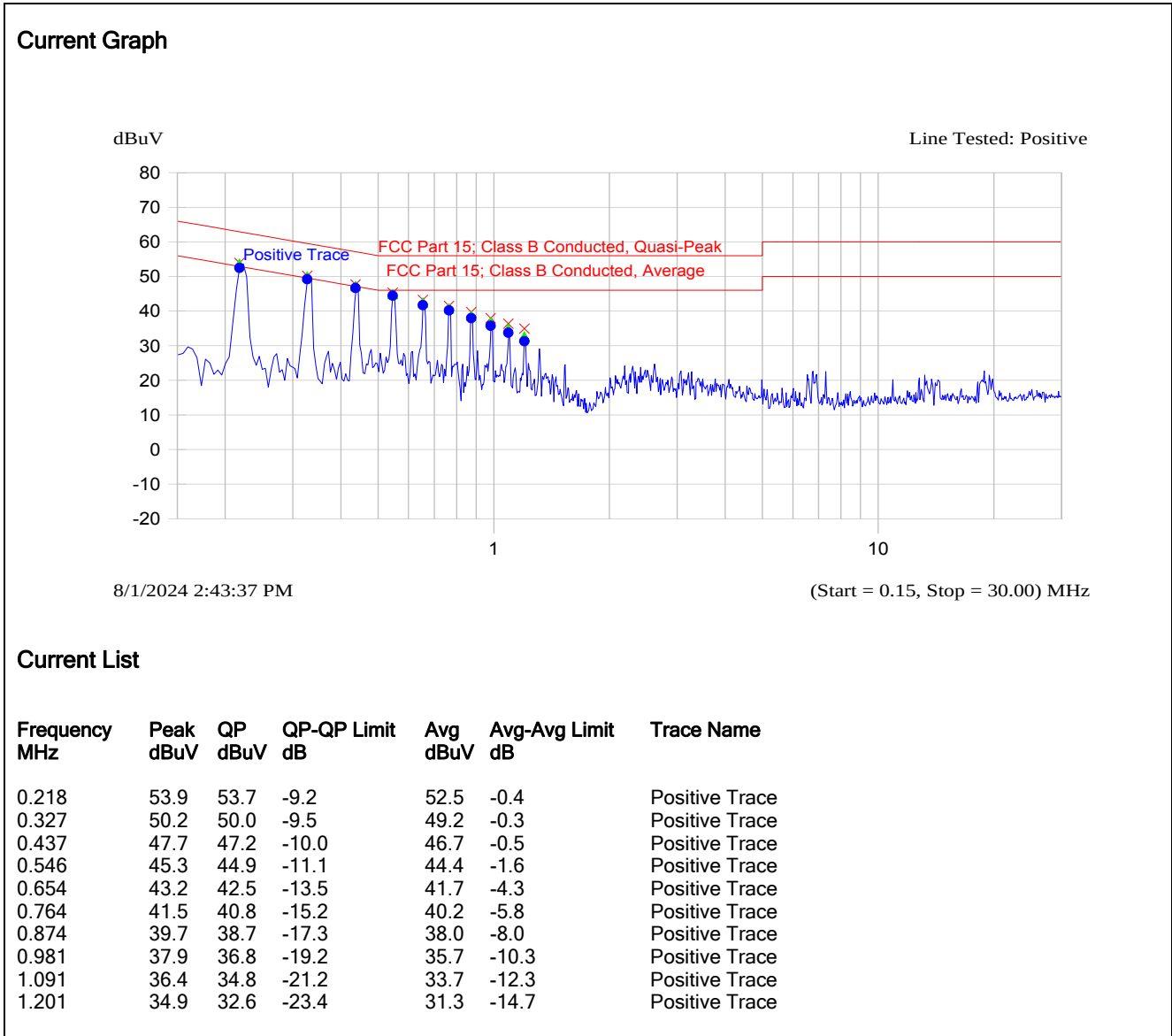
ANSI C63.4

5.1.3. Test Arrangement



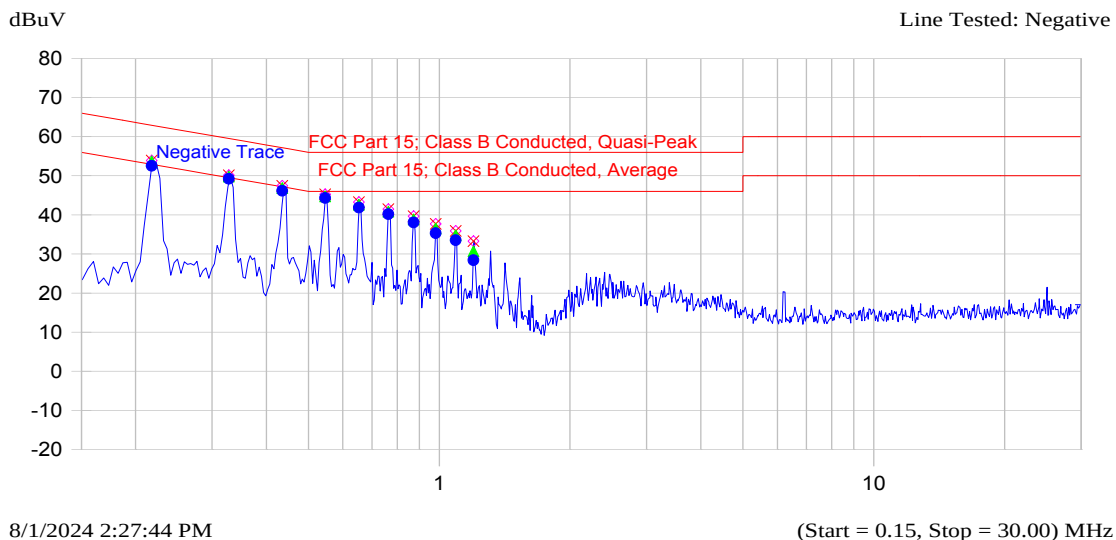
5.1.4. Test Data

Plot 5.1.4.1. Power Line Conducted Emissions (BLE Tx Mode)
Line Voltage: 3.6 VDC; Line Tested: Positive Trace



Plot 5.1.4.2. Power Line Conducted Emissions (BLE Tx Mode)
Line Voltage: 3.6 VDC; Line Tested: Negative Trace

Current Graph

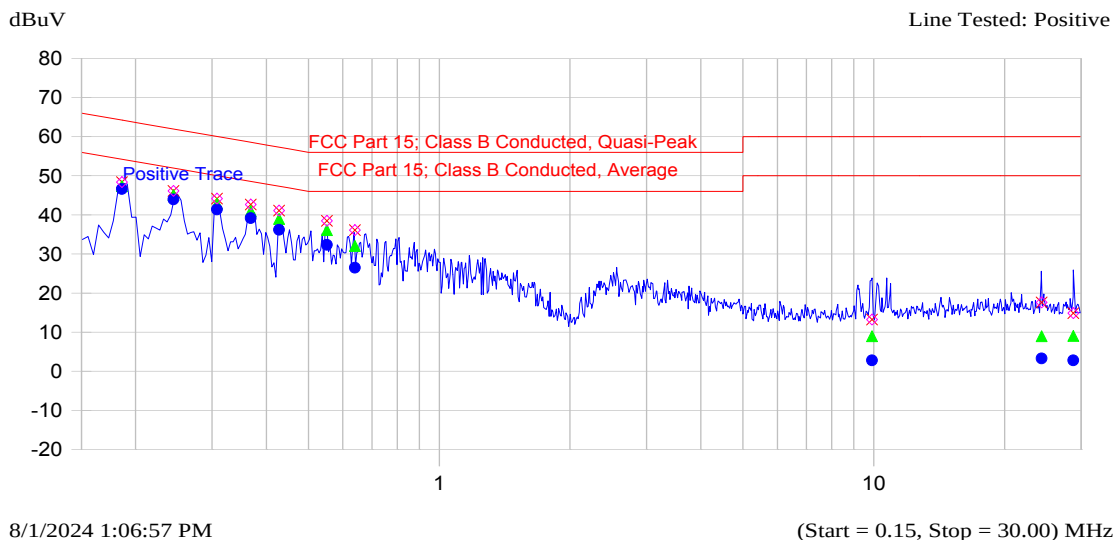


Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.218	53.9	53.7	-9.2	52.5	-0.4	Negative Trace
0.328	50.1	49.8	-9.7	49.2	-0.3	Negative Trace
0.435	47.4	46.9	-10.3	46.1	-1.0	Negative Trace
0.546	45.3	44.7	-11.3	44.3	-1.7	Negative Trace
0.653	43.3	42.6	-13.4	41.8	-4.2	Negative Trace
0.764	41.4	40.8	-15.2	40.2	-5.8	Negative Trace
0.873	39.6	38.8	-17.2	38.0	-8.0	Negative Trace
0.981	37.7	36.5	-19.5	35.3	-10.7	Negative Trace
1.091	35.9	34.8	-21.2	33.5	-12.5	Negative Trace
1.198	33.3	30.7	-25.3	28.4	-17.6	Negative Trace

Plot 5.1.4.3. Power Line Conducted Emissions (BLE Rx Mode)
Line Voltage: 3.6 VDC; Line Tested: Positive Trace

Current Graph

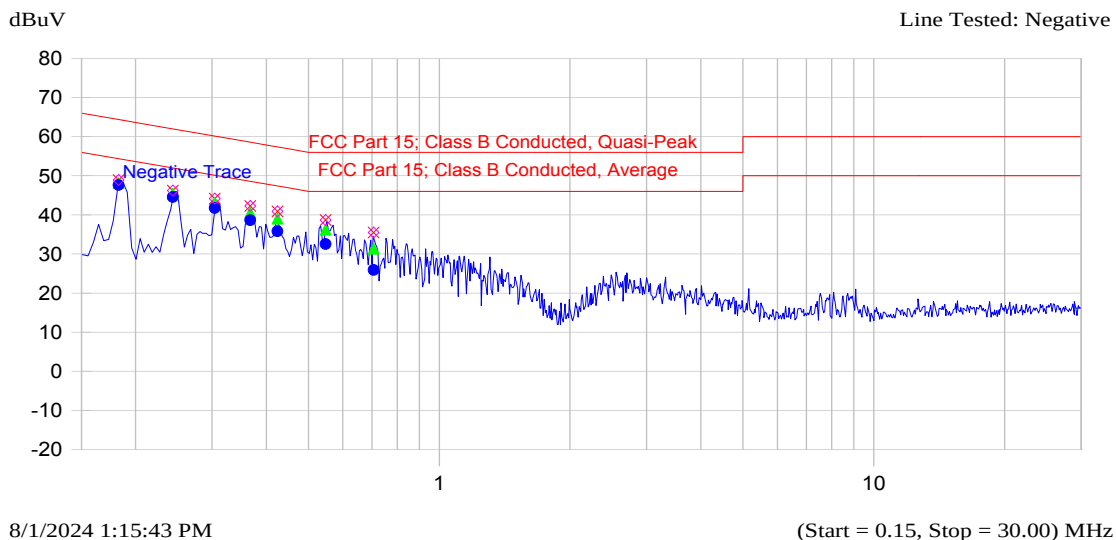


Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.186	48.4	47.4	-16.9	46.6	-7.6	Positive Trace
0.244	46.1	45.1	-16.9	43.9	-8.0	Positive Trace
0.308	44.1	42.8	-17.2	41.4	-8.6	Positive Trace
0.368	42.6	40.9	-17.6	39.2	-9.4	Positive Trace
0.428	41.1	39.0	-18.3	36.2	-11.1	Positive Trace
0.551	38.5	36.1	-19.9	32.3	-13.7	Positive Trace
0.639	36.1	32.0	-24.0	26.5	-19.5	Positive Trace
9.905	13.2	9.0	-51.0	2.8	-47.2	Positive Trace
24.319	17.6	9.0	-51.0	3.3	-46.7	Positive Trace
28.799	14.9	9.0	-51.0	2.8	-47.2	Positive Trace

Plot 5.1.4.4. Power Line Conducted Emissions (BLE Rx Mode)
Line Voltage: 3.6 VDC; Line Tested: Negative Trace

Current Graph

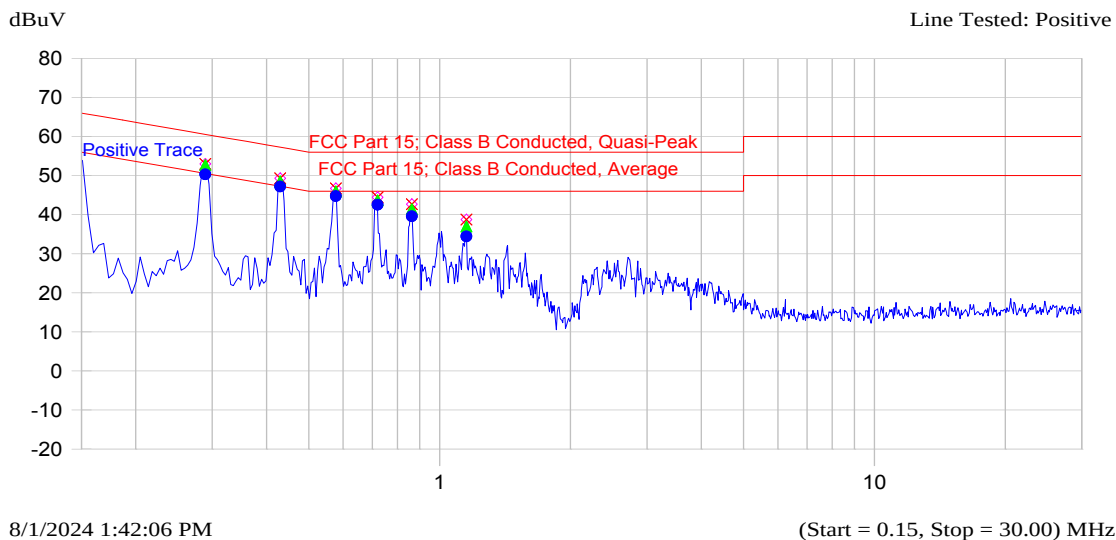


Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.183	48.9	48.1	-16.2	47.6	-6.8	Negative Trace
0.243	46.2	45.4	-16.6	44.5	-7.4	Negative Trace
0.304	44.2	43.0	-17.1	41.8	-8.4	Negative Trace
0.367	42.3	40.6	-18.0	38.6	-9.9	Negative Trace
0.424	40.9	39.0	-18.3	35.8	-11.6	Negative Trace
0.548	38.7	36.2	-19.8	32.5	-13.5	Negative Trace
0.706	35.5	31.3	-24.7	25.9	-20.1	Negative Trace

Plot 5.1.4.5. Power Line Conducted Emissions (BLE Coded PHY, Tx Mode)
Line Voltage: 3.6 VDC; Line Tested: Positive Trace

Current Graph

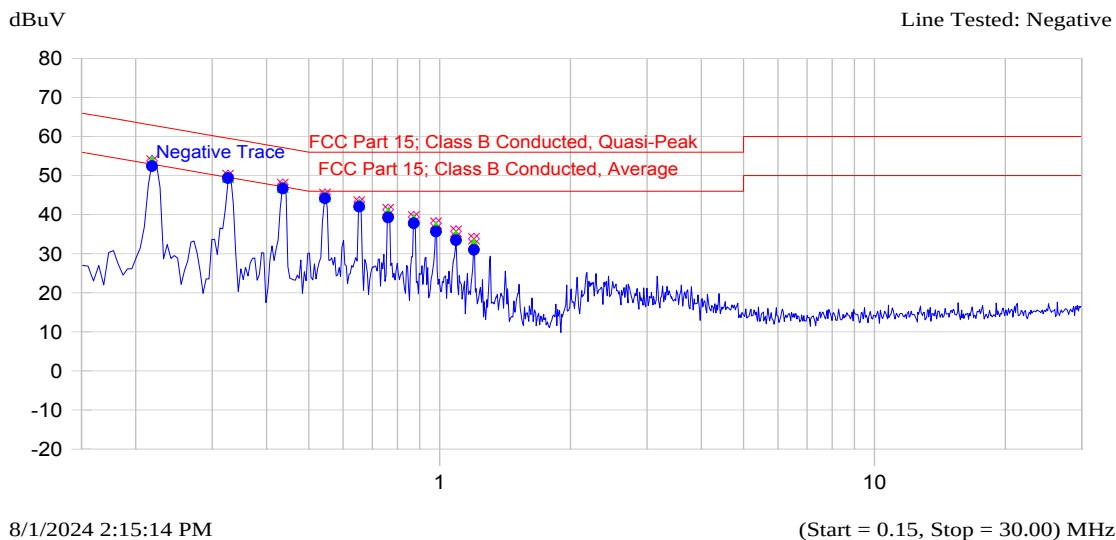


Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.289	53.0	52.7	-7.9	50.3	-0.2	Positive Trace
0.430	49.3	48.5	-8.8	47.2	-0.1	Positive Trace
0.577	46.7	46.0	-10.0	44.7	-1.3	Positive Trace
0.720	44.4	43.7	-12.3	42.5	-3.5	Positive Trace
0.863	42.6	41.4	-14.6	39.6	-6.4	Positive Trace
1.152	38.7	37.0	-19.0	34.4	-11.6	Positive Trace

Plot 5.1.4.6. Power Line Conducted Emissions (BLE Coded PHY, Tx Mode)
Line Voltage: 3.6 VDC; Line Tested: Negative Trace

Current Graph

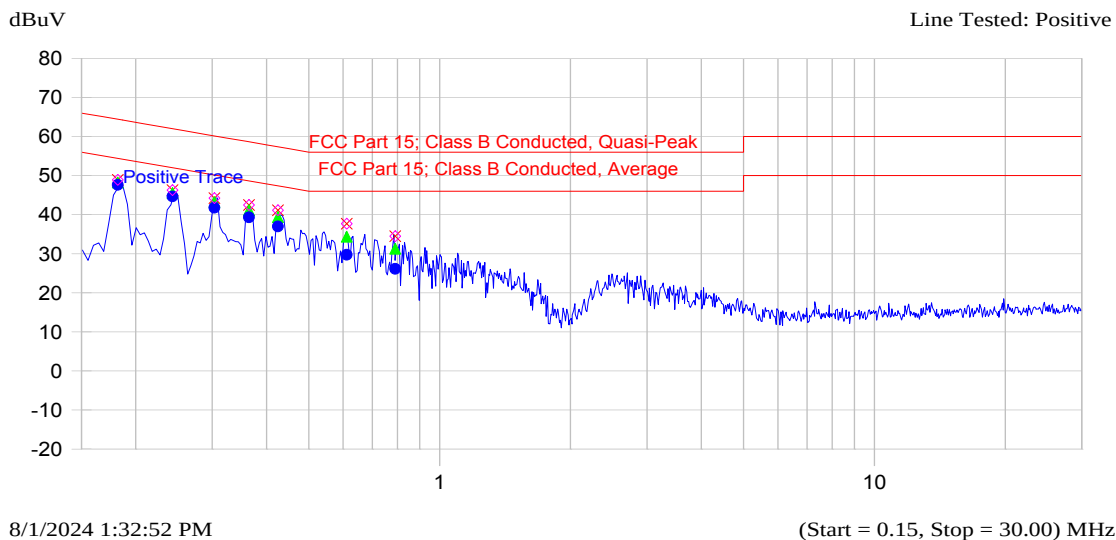


Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.218	53.7	53.6	-9.3	52.4	-0.5	Negative Trace
0.326	50.0	49.6	-9.9	49.3	-0.2	Negative Trace
0.436	47.7	47.0	-10.1	46.7	-0.5	Negative Trace
0.544	45.1	44.7	-11.3	44.1	-1.9	Negative Trace
0.654	43.2	42.6	-13.4	42.1	-3.9	Negative Trace
0.762	41.3	40.4	-15.6	39.3	-6.7	Negative Trace
0.873	39.4	38.7	-17.3	37.8	-8.2	Negative Trace
0.981	37.8	36.8	-19.2	35.7	-10.3	Negative Trace
1.091	35.8	34.5	-21.5	33.5	-12.5	Negative Trace
1.199	33.8	32.4	-23.6	31.0	-15.0	Negative Trace

Plot 5.1.4.7. Power Line Conducted Emissions (BLE Coded PHY, Rx Mode)
Line Voltage: 3.6 VDC; Line Tested: Positive Trace

Current Graph

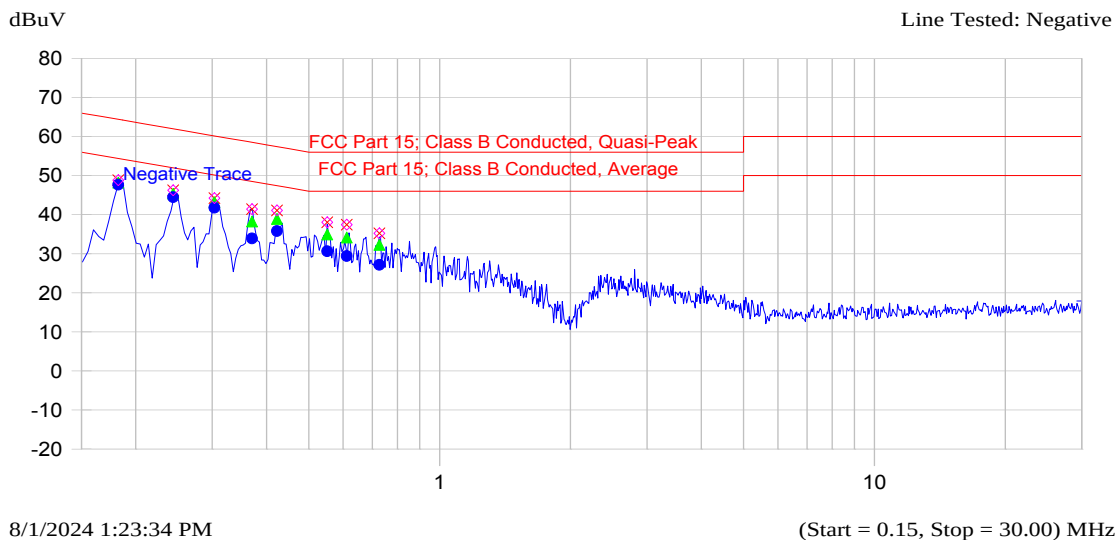


Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.182	48.9	48.3	-16.1	47.6	-6.8	Positive Trace
0.243	46.3	45.5	-16.5	44.6	-7.4	Positive Trace
0.304	44.2	43.2	-16.9	41.8	-8.4	Positive Trace
0.364	42.5	41.2	-17.5	39.3	-9.3	Positive Trace
0.425	41.1	39.4	-18.0	37.0	-10.4	Positive Trace
0.611	37.7	34.3	-21.7	29.7	-16.3	Positive Trace
0.790	34.5	31.3	-24.7	26.1	-19.9	Positive Trace

Plot 5.1.4.8. Power Line Conducted Emissions (BLE Coded PHY, Rx Mode)
Line Voltage: 3.6 VDC; Line Tested: Negative Trace

Current Graph



Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.182	48.8	48.2	-16.2	47.7	-6.7	Negative Trace
0.244	46.2	45.4	-16.6	44.5	-7.5	Negative Trace
0.304	44.2	43.1	-17.0	41.8	-8.4	Negative Trace
0.370	41.4	38.2	-20.2	33.9	-14.6	Negative Trace
0.423	41.1	38.9	-18.5	35.8	-11.6	Negative Trace
0.551	38.0	34.9	-21.1	30.6	-15.4	Negative Trace
0.611	37.4	34.2	-21.8	29.4	-16.6	Negative Trace
0.727	35.2	32.3	-23.7	27.2	-18.8	Negative Trace

5.2. OCCUPIED BANDWIDTH [§ 15.247(a)(2)]

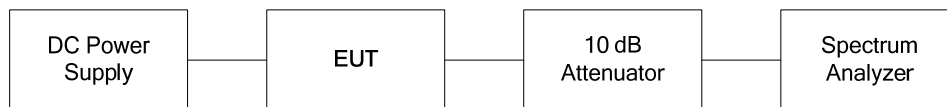
5.2.1. Limit(s)

The minimum 6 dB bandwidth shall be at least 500 kHz.

5.2.2. Method of Measurements

FCC KDB 558074 D01 15.247 Meas Guidance V05r02, Section 8.2, ANSI C63.10, 11.8.2 Option 2

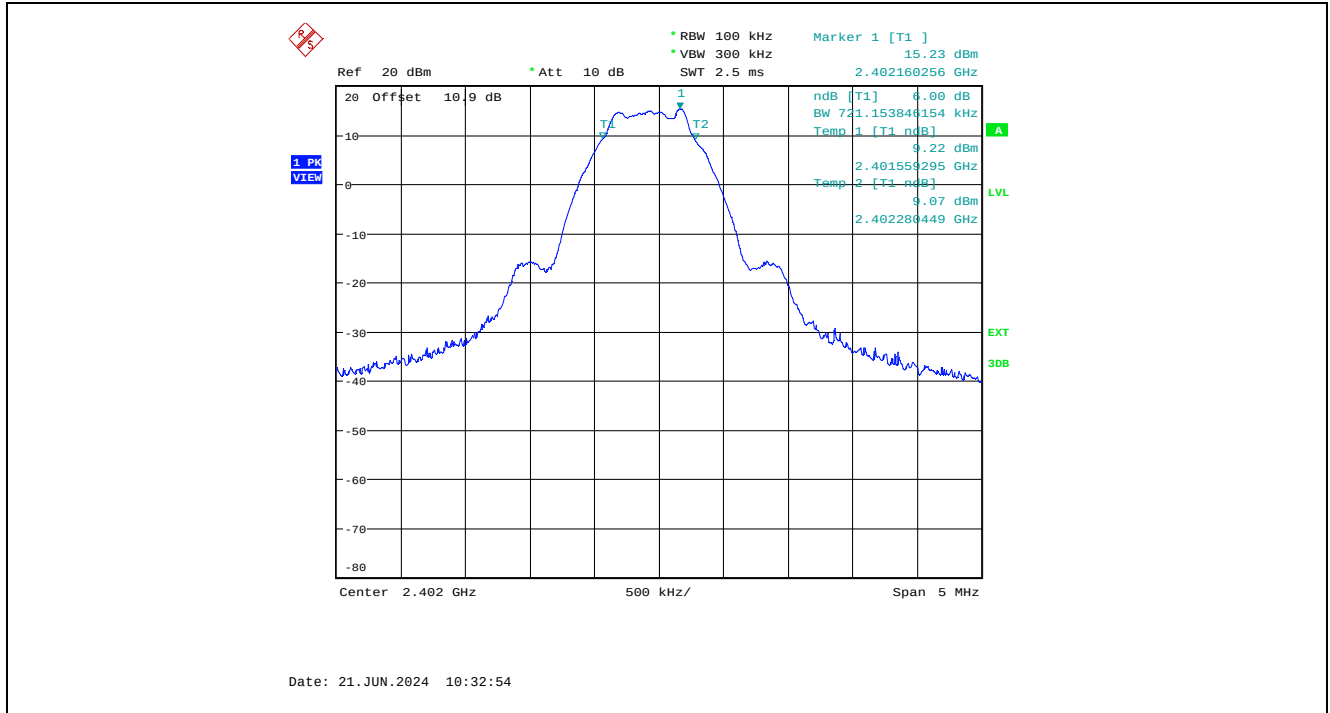
5.2.3. Test Arrangement



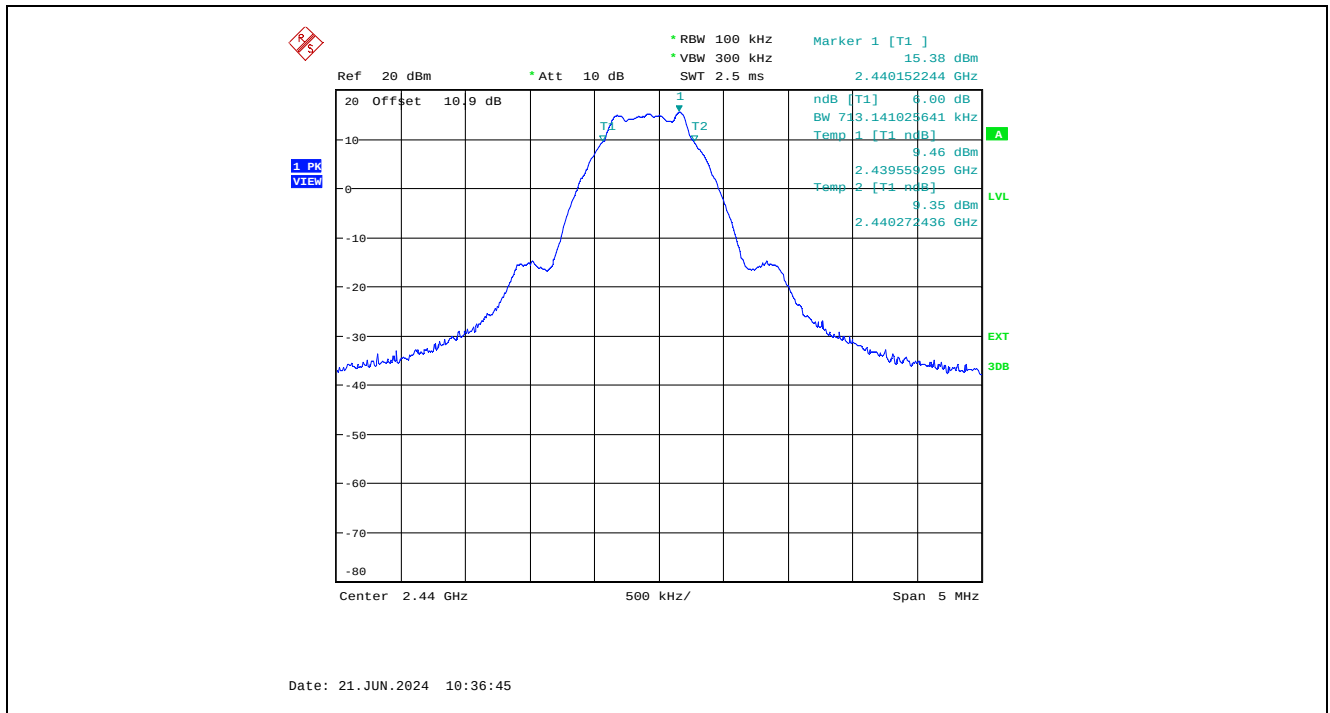
5.2.4. Test Data

Modulation	Mode	Data Rate	Frequency (MHz)	6dB BW (kHz)	Min. Limit (kHz)
GFSK	1M	1 Mb/s	2402	721.15	500
			2440	713.14	500
			2480	713.14	500
	Coded PHY	125 kb/s	2402	713.14	500
			2440	713.14	500
			2480	713.14	500

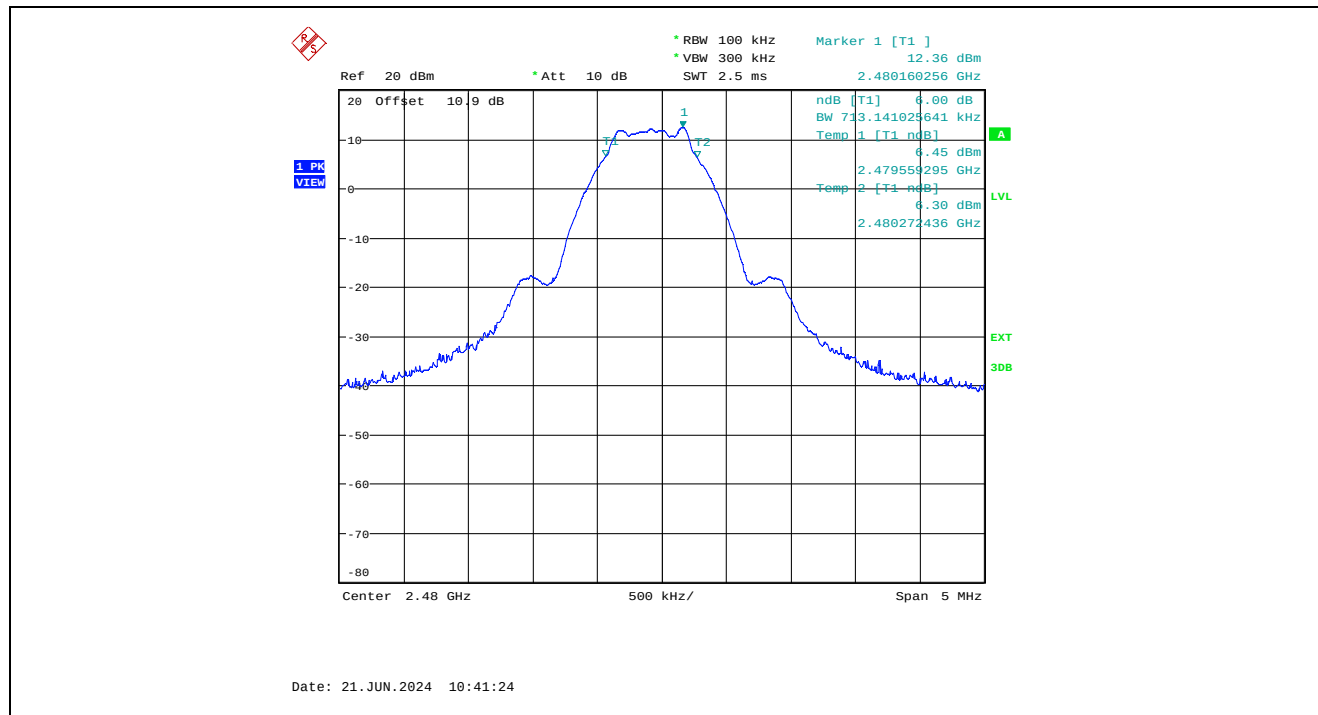
Plot 5.2.4.1. 6 dB Bandwidth, GFSK Modulation, 1M, 1 Mb/s, 2402 MHz



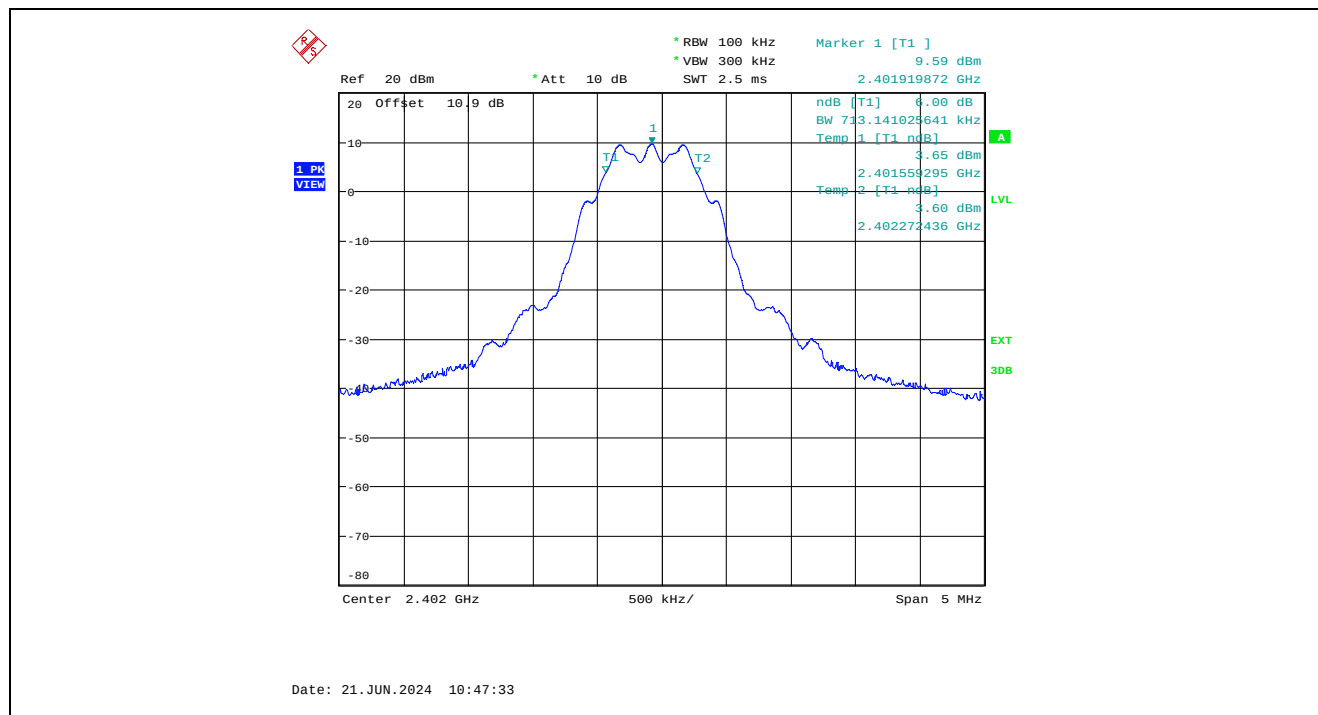
Plot 5.2.4.2. 6 dB Bandwidth, GFSK Modulation, 1M, 1 Mb/s, 2440 MHz



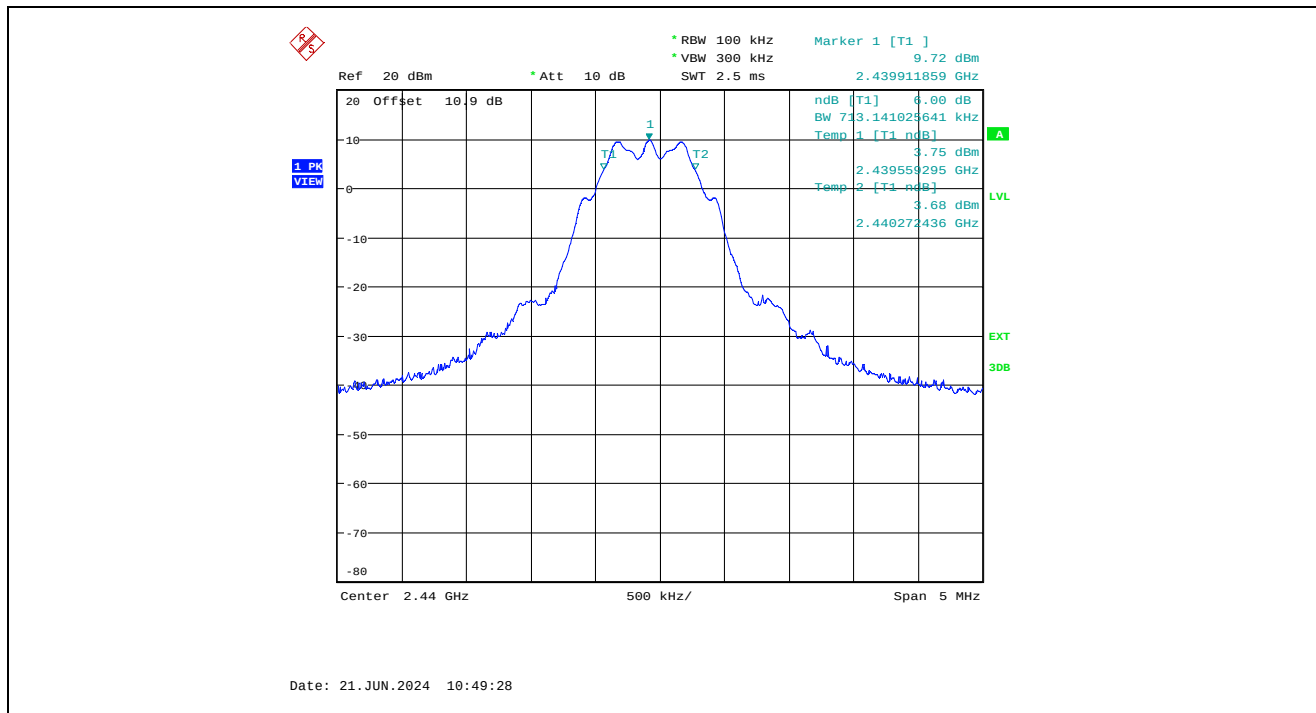
Plot 5.2.4.3. 6 dB Bandwidth, GFSK Modulation, 1M, 1 Mb/s, 2480 MHz



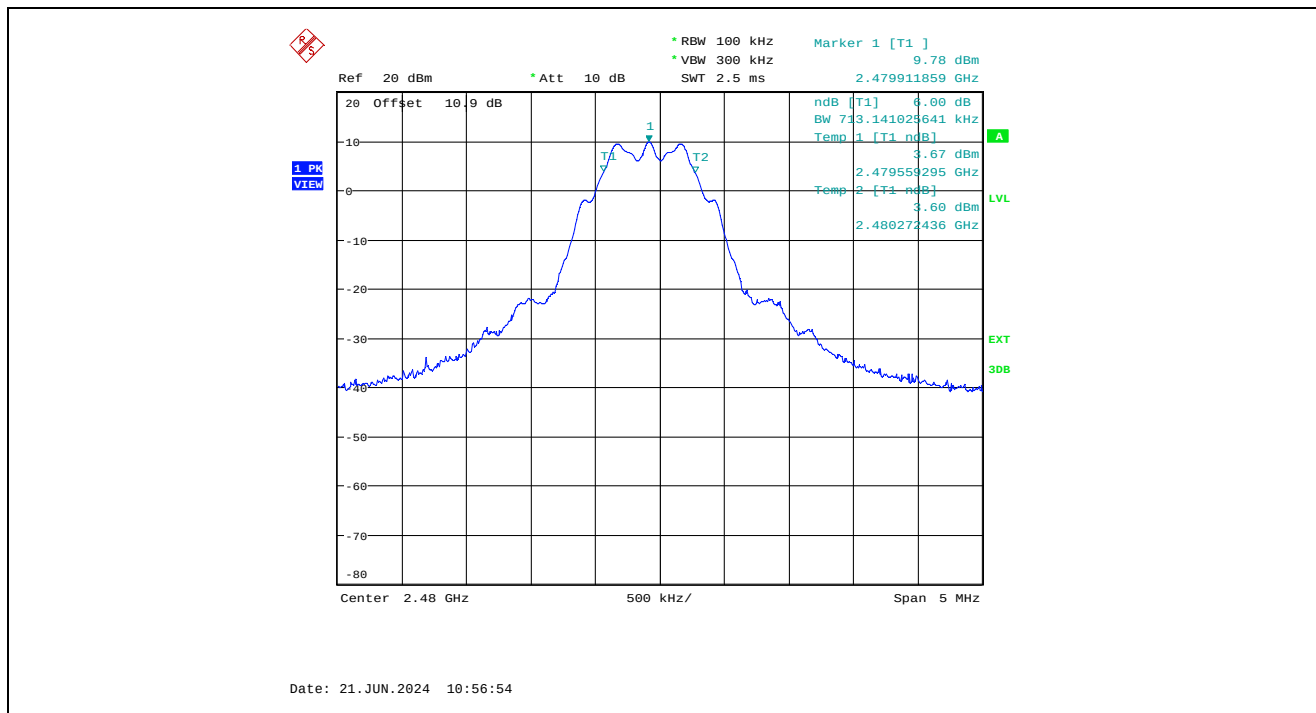
Plot 5.2.4.4. 6 dB Bandwidth, GFSK Modulation, Coded PHY, 125 kb/s, 2402 MHz



Plot 5.2.4.5. 6 dB Bandwidth, GFSK Modulation, Coded PHY, 125 kb/s, 2440 MHz



Plot 5.2.4.6. 6 dB Bandwidth, GFSK Modulation, Coded PHY, 125 kb/s, 2480 MHz



5.3. PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)(3)]

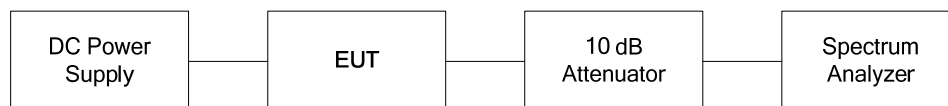
5.3.1. Limit(s)

§ 15.247(b)(3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

5.3.2. Method of Measurements

FCC KDB 558074 D01 15.247 Meas Guidance V05r02, Section 8.3.1.1 RBW $\geq$ DTS bandwidth
Subclause 11.9.1.1 of ANSI C63.10

5.3.3. Test Arrangement



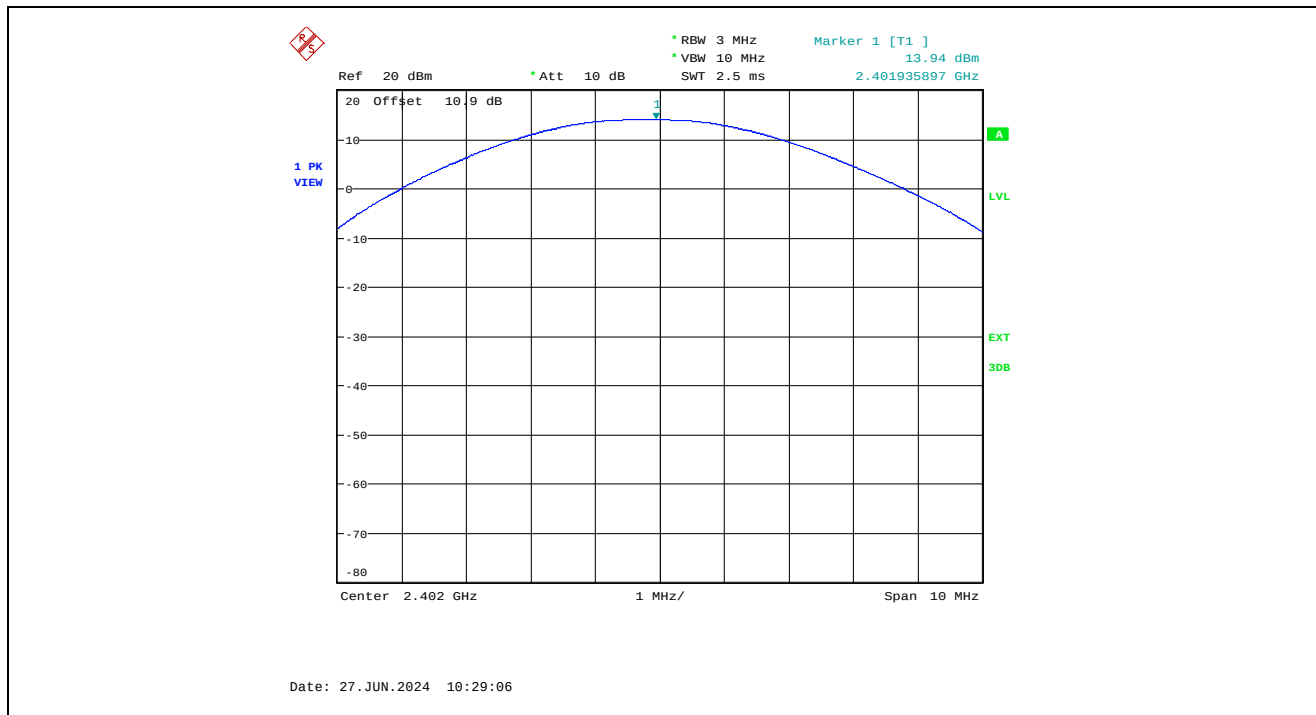
5.3.4. Test Data

Modulation	Mode	Data Rate	Frequency (MHz)	Maximum Peak Conducted Output Power (dBm)	Peak Power Limit (dBm)
GFSK	1M	1 Mb/s	2402	13.94	30
			2440	13.84	30
			2480	13.74	30
	Coded PHY	125 kb/s	2402	13.84	30
			2440	13.77	30
			2480	13.67	30

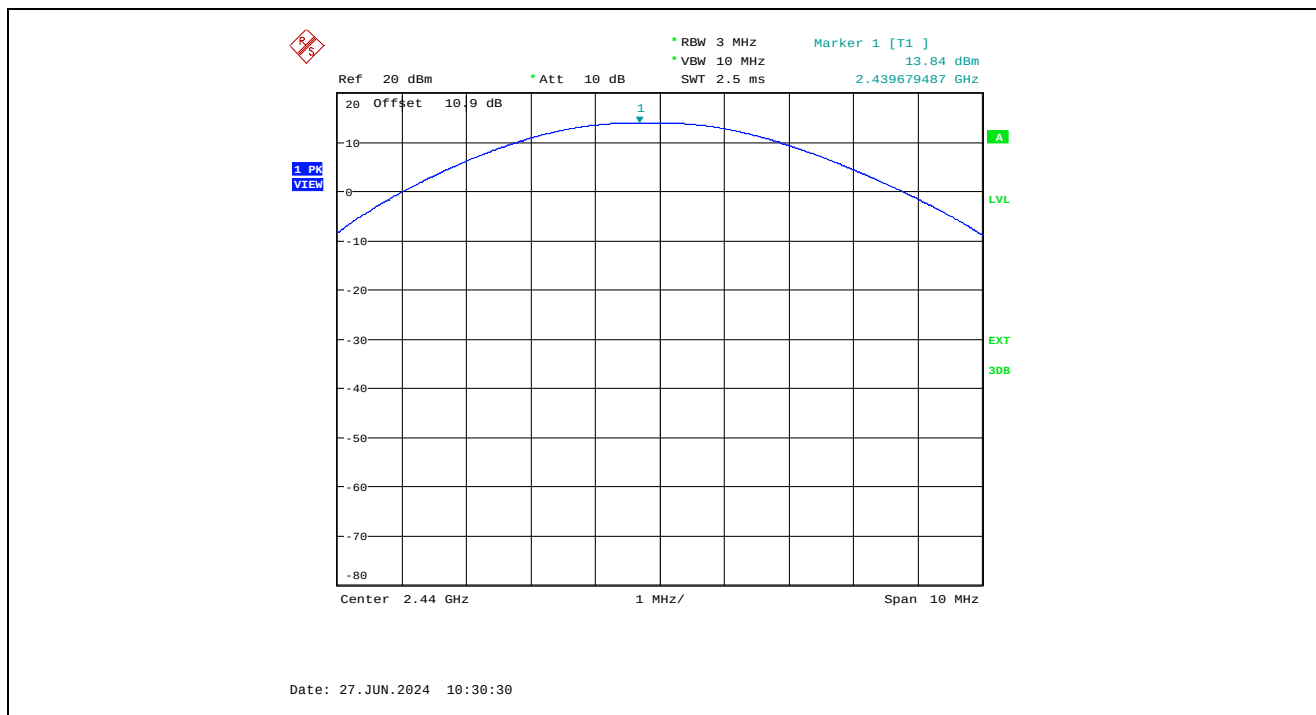
Power Level, Antenna Details and Resulting EIRP Values

Maximum Peak Conducted Output Power: 13.94 dBm					
Assembly #	Antenna Type	Maximum Gain (dBi)	Minimum Insertion / Cable Loss (dBm)	Antenna Assembly Gain (dBm)	EIRP (dBm)
1	Monopole Antenna	1.49	0	1.49	15.43

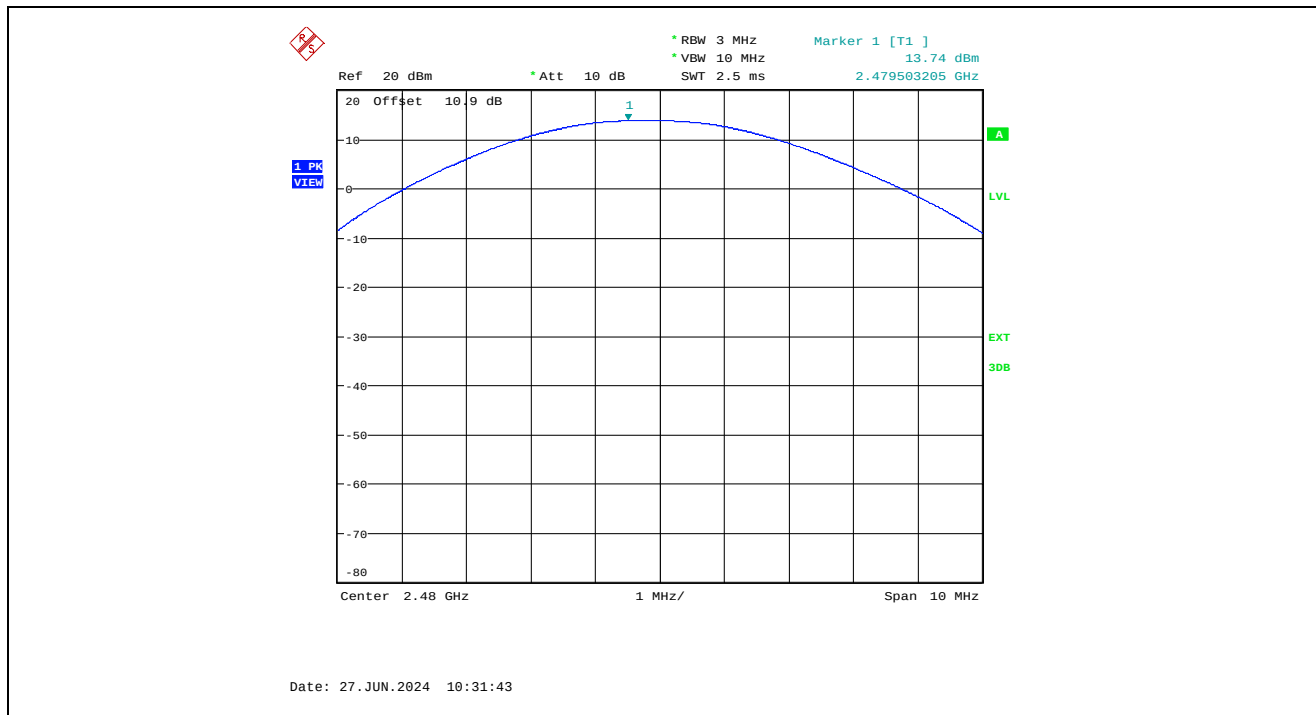
Plot 5.3.4.1. Maximum Peak Conducted Output Power, GFSK Modulation, 1M, 1 Mb/s, 2402 MHz



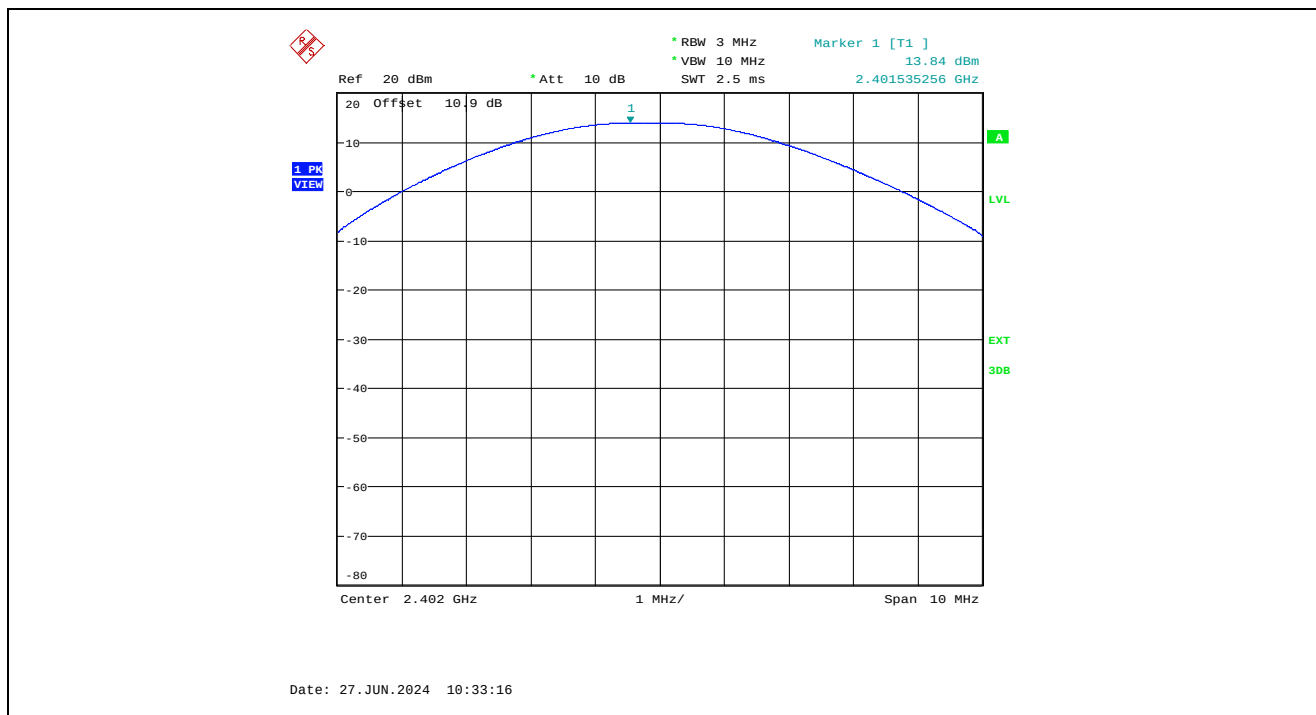
Plot 5.3.4.2. Maximum Peak Conducted Output Power, GFSK Modulation, 1M, 1 Mb/s 2440 MHz



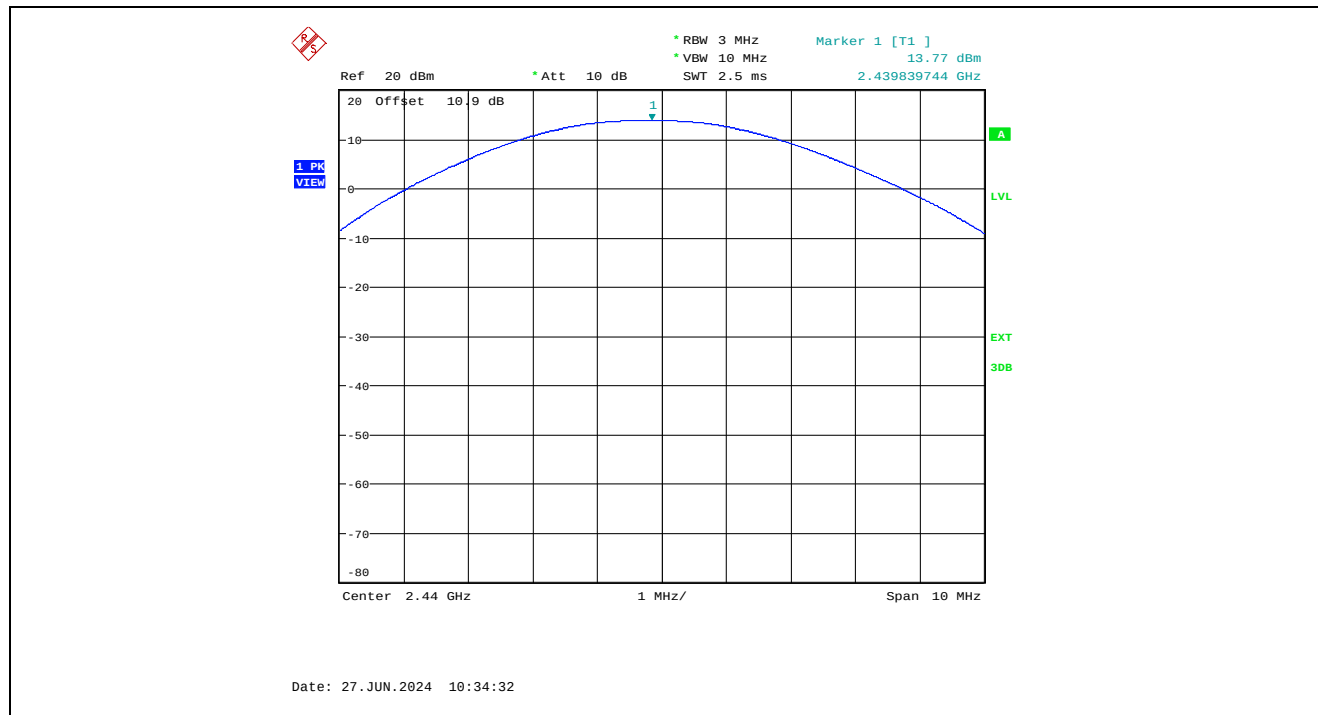
Plot 5.3.4.3. Maximum Peak Conducted Output Power, GFSK Modulation, 1M, 1 Mb/s, 2480 MHz



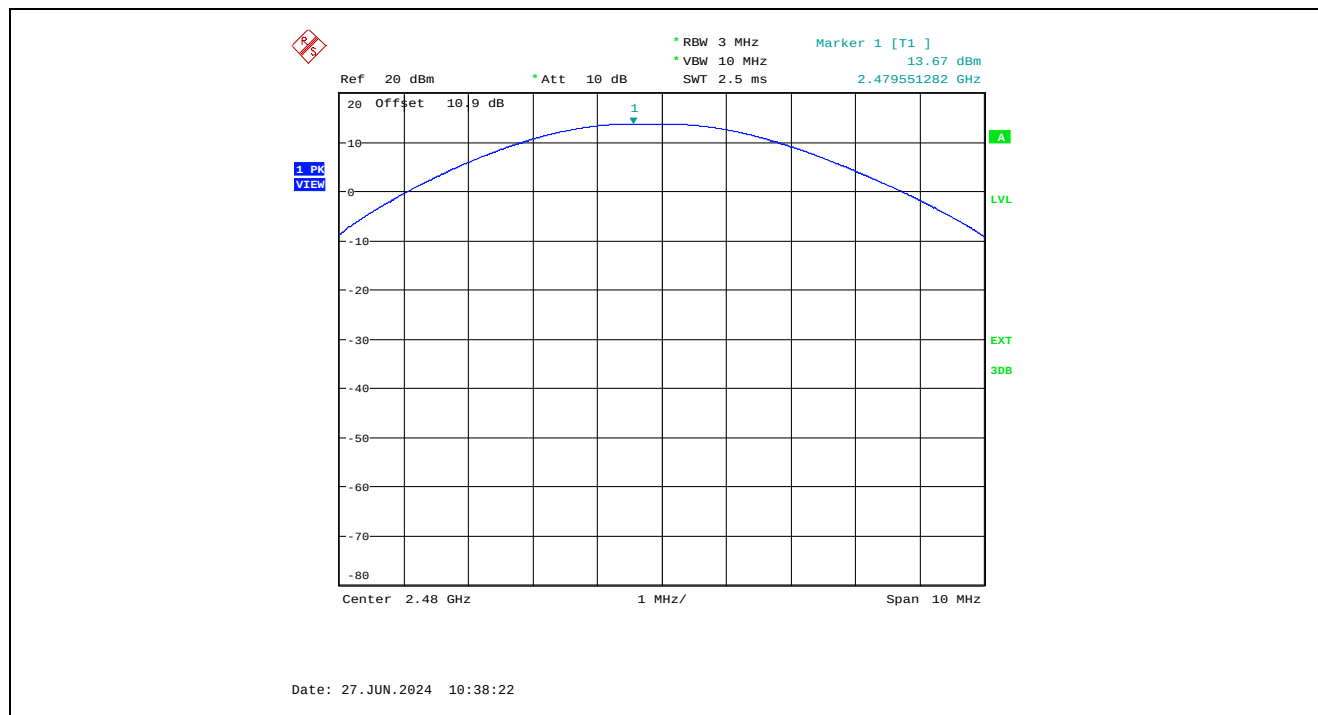
Plot 5.3.4.4. Maximum Peak Conducted Output Power, GFSK Modulation, Coded PHY, 125 kb/s, 2402 MHz



Plot 5.3.4.5. Maximum Peak Conducted Output Power, GFSK Modulation, Coded PHY, 125 kb/s, 2440 MHz



Plot 5.3.4.6. Maximum Peak Conducted Output Power, GFSK Modulation, Coded PHY, 125 kb/s, 2480 MHz



5.4. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]

5.4.1. Limit(s)

§ 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)).

Section 15.205(a) - Restricted Bands of Operation

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
¹ 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	(²)
13.36–13.41.			

¹Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.

²Above 38.6

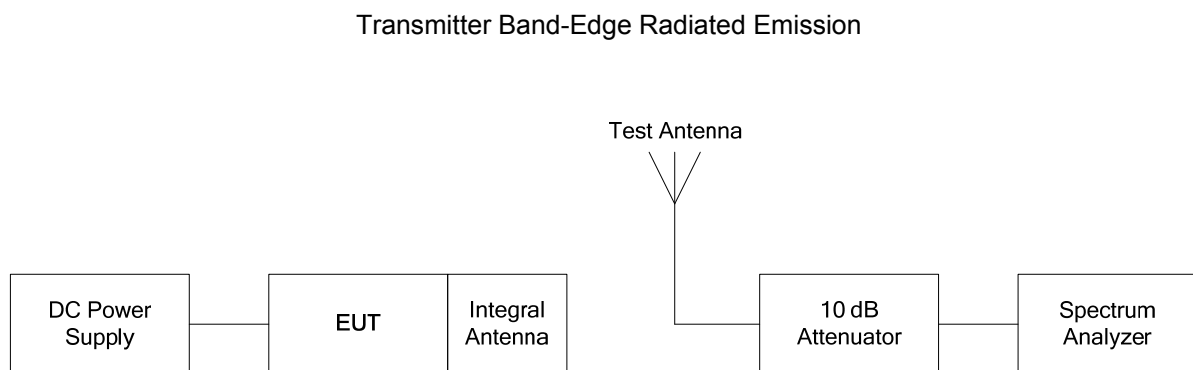
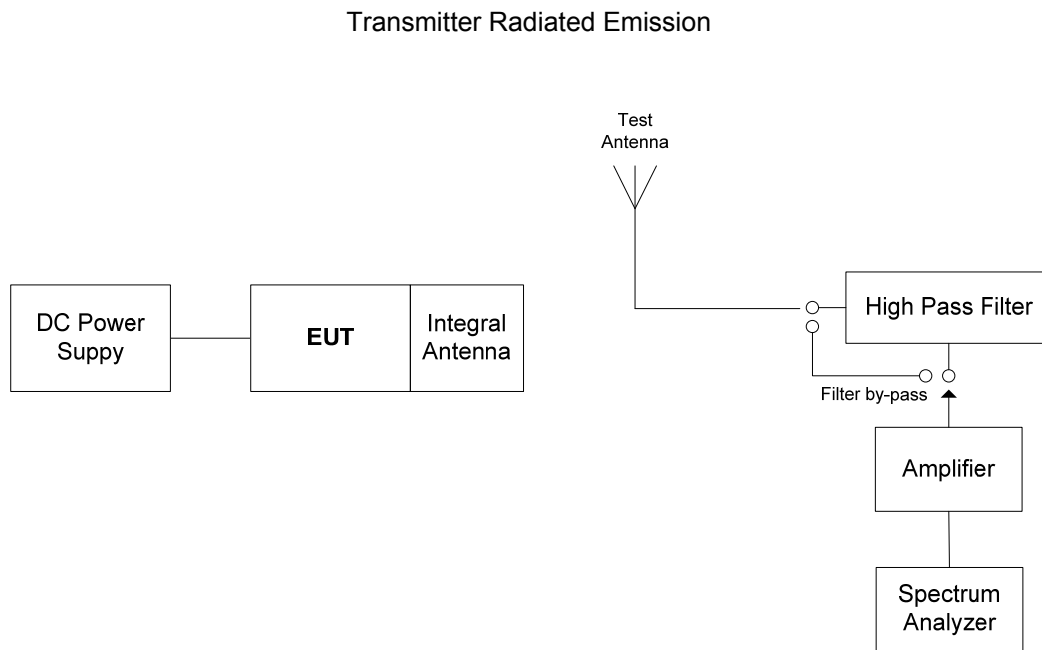
Section 15.209(a) - Field Strength Limits within Restricted Frequency Bands

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

5.4.2. Method of Measurements

KDB 558074 D01 DTS Meas Guidance v05r02 Sections 8.5 to 8.7 and ANSI C63.10.

5.4.3. Test Arrangement



5.4.4. Test Data

Remark(s):

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT shall be tested in three orthogonal positions.
- The following test data represent the worst-case derived from exploratory tests.

5.4.4.1. EUT with 1.49 dBi Monopole Antenna, 1M Mode, 1 Mb/s

5.4.4.1.1. Radiated Spurious Emission

Fundamental Frequency:		2402 MHz					
Test Frequency Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2402.0	104.18	--	V	--	--	--	--
2402.0	107.11	--	H	--	--	--	--
4804.0	46.94	34.60	V	54.0	87.1	-19.4	Pass*
4804.0	44.93	34.75	H	54.0	87.1	-19.3	Pass*
12010.0	63.19	50.95	V	54.0	87.1	-3.1	Pass*
12010.0	60.49	48.05	H	54.0	87.1	-6.0	Pass*
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.							

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:		2440 MHz					
Test Frequency Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2440.0	104.05	--	V	--	--	--	--
2440.0	107.10	--	H	--	--	--	--
4880.0	47.71	35.97	V	54.0	87.1	-18.0	Pass*
4880.0	48.46	37.15	H	54.0	87.1	-16.9	Pass*
7320.0	56.60	45.27	V	54.0	87.1	-8.7	Pass*
7320.0	57.73	46.75	H	54.0	87.1	-7.3	Pass*
12200.0	62.87	50.39	V	54.0	87.1	-3.6	Pass*
12200.0	59.00	46.62	H	54.0	87.1	-7.4	Pass*
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.							

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

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File #: 24SMCS022_FCC15C247
November 8, 2024

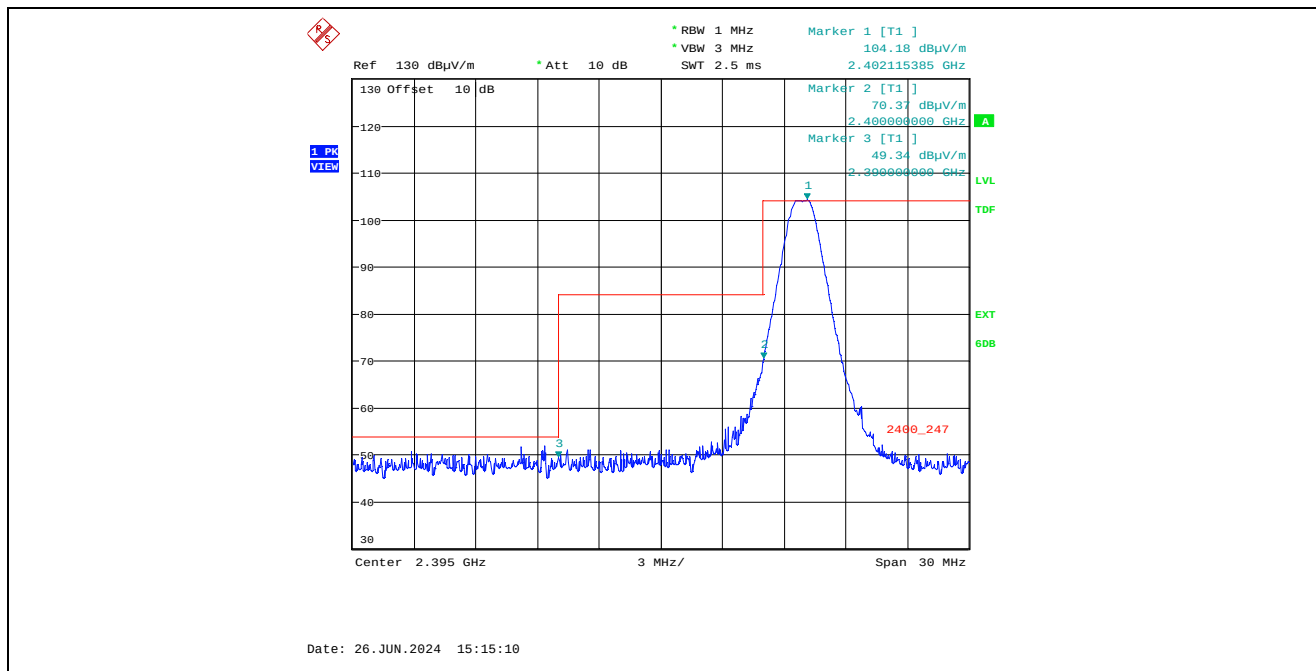
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Fundamental Frequency:		2480 MHz					
Test Frequency Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2480.0	103.55	--	V	--	--	--	--
2480.0	107.57	--	H	--	--	--	--
4960.0	47.60	39.15	V	54.0	87.6	-14.9	Pass*
4960.0	47.66	38.31	H	54.0	87.6	-15.7	Pass*
7440.0	56.01	44.39	V	54.0	87.6	-9.6	Pass*
7440.0	54.69	42.76	H	54.0	87.6	-11.2	Pass*
12400.0	60.21	47.33	V	54.0	87.6	-6.7	Pass*
12400.0	56.88	44.12	H	54.0	87.6	-9.9	Pass*
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.							

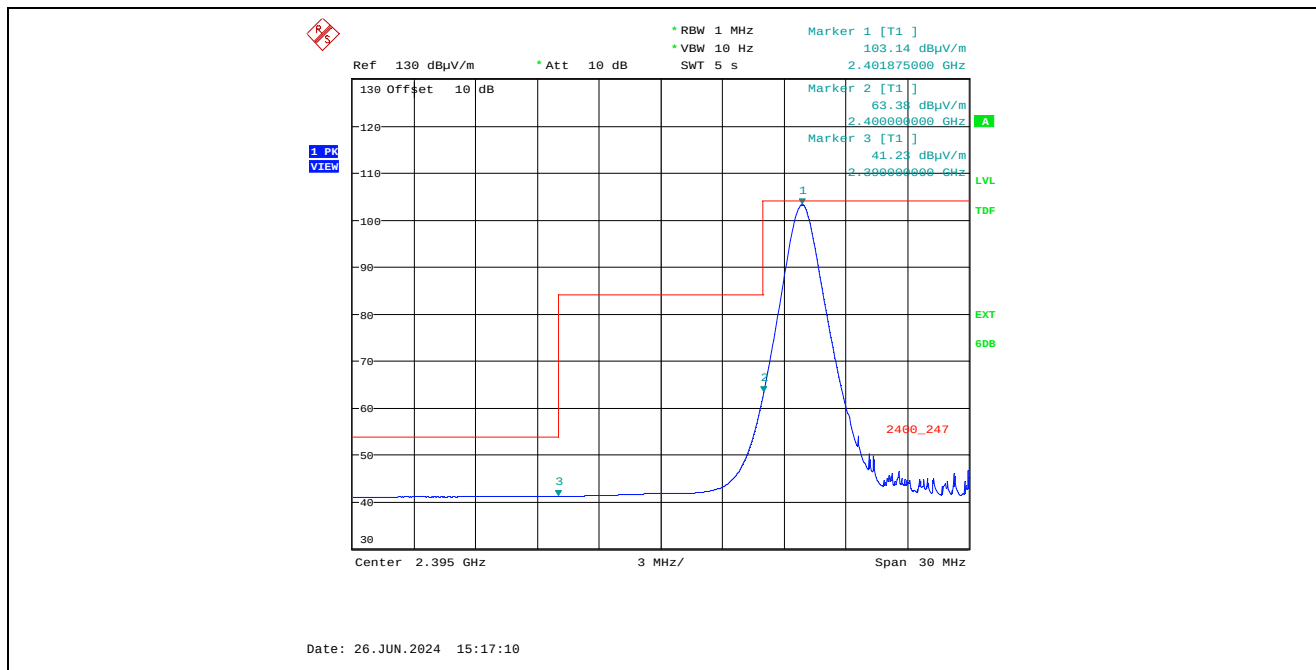
*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

5.4.4.1.2. Radiated Band-Edge Emission

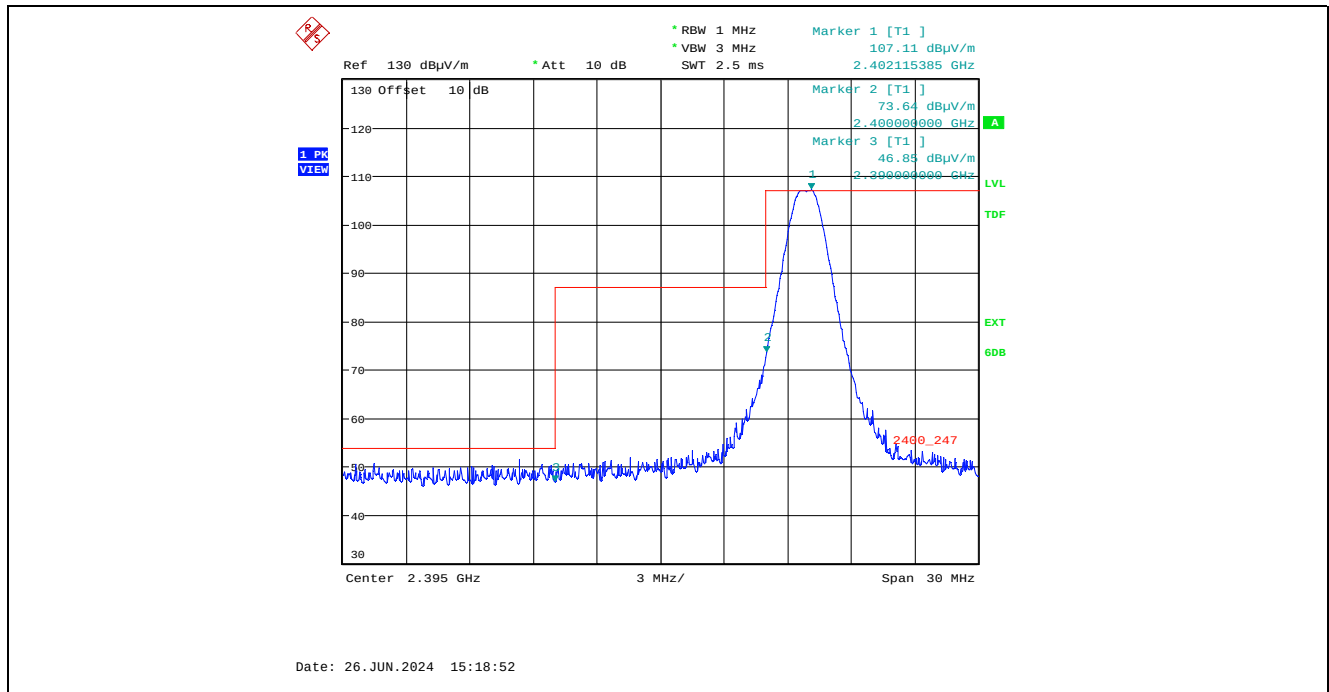
Plot 5.4.4.1.2.1. Radiated Band-Edge Emission at 3 m, Vertical Polarization, Peak
Low End of Frequency Band, 2402 MHz, GFSK Modulation, 1M, 1 Mb/s



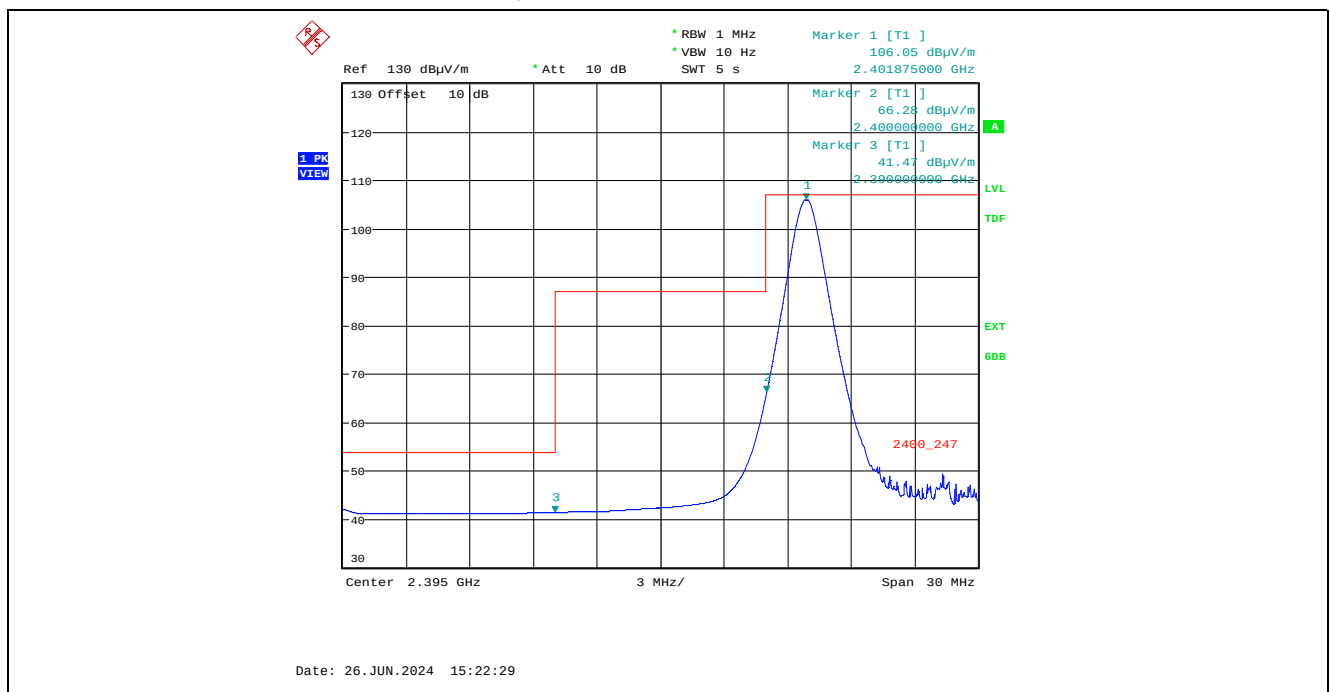
Plot 5.4.4.1.2.2. Radiated Band-Edge Emission at 3 m, Vertical Polarization, Average
Low End of Frequency Band, 2402 MHz, GFSK Modulation, 1M, 1 Mb/s



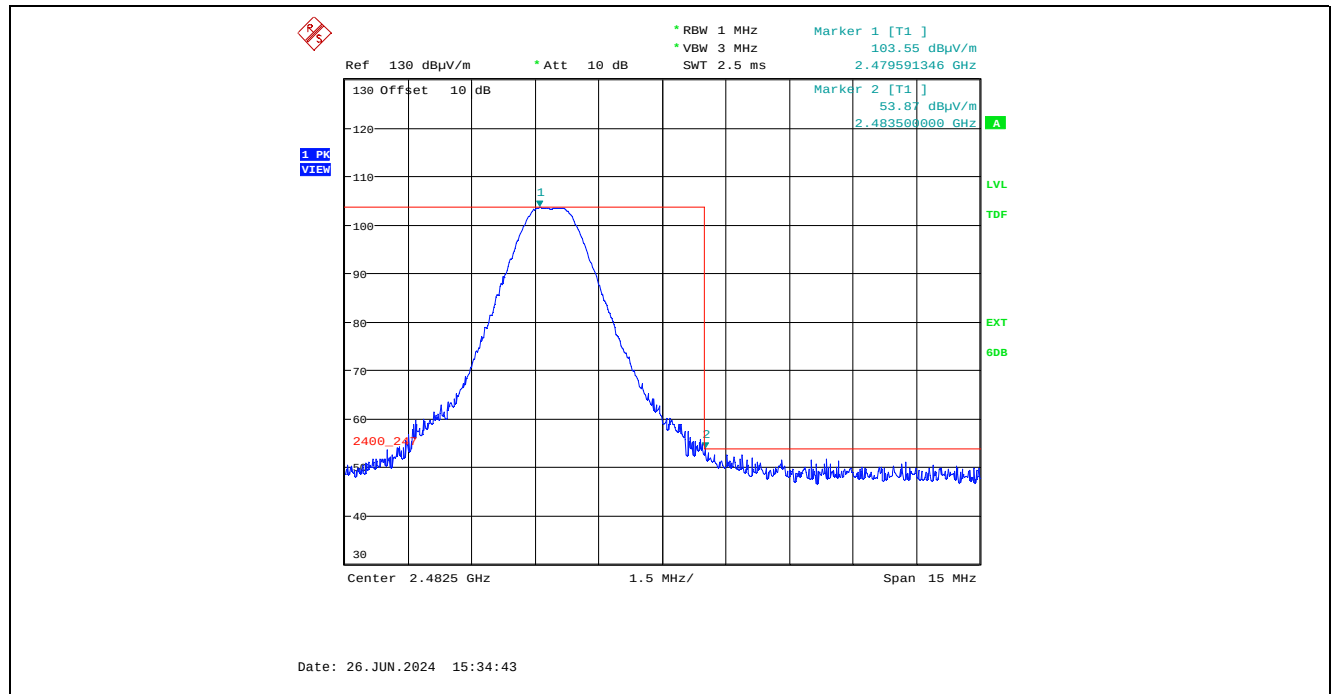
Plot 5.4.4.1.2.3. Radiated Band-Edge Emission at 3 m, Horizontal Polarization, Peak
Low End of Frequency Band, 2402 MHz, GFSK Modulation, 1M, 1 Mb/s



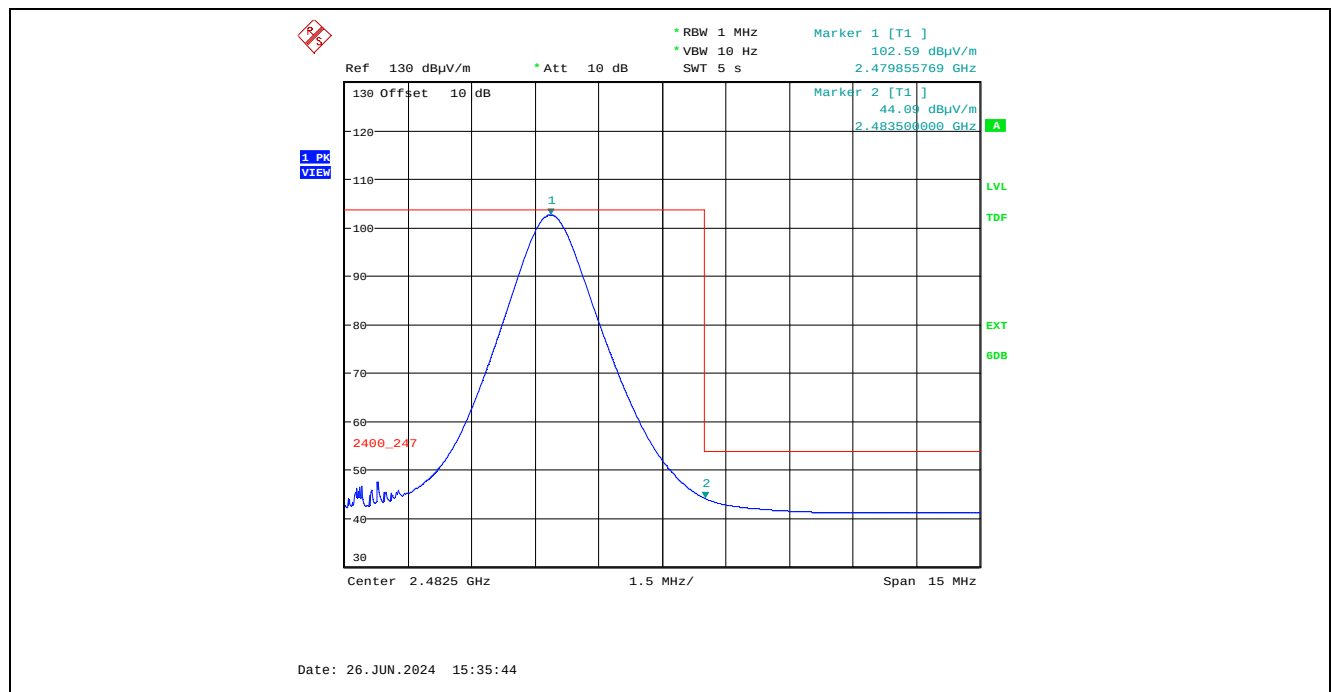
Plot 5.4.4.1.2.4. Radiated Band-Edge Emission at 3 m, Horizontal Polarization, Average
Low End of Frequency Band, 2402 MHz, GFSK Modulation, 1M, 1 Mb/s



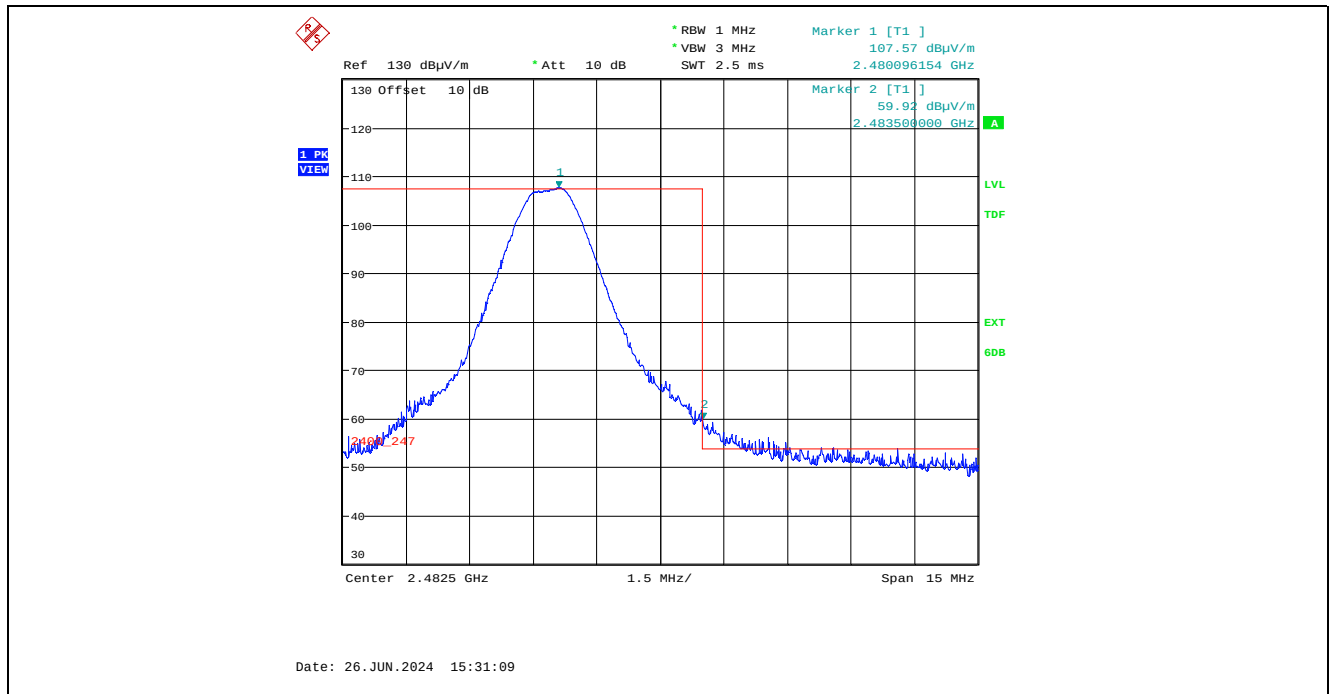
Plot 5.4.4.1.2.5. Radiated Band-Edge Emission at 3 m, Vertical Polarization, Peak
High End of Frequency Band, 2480 MHz, GFSK Modulation, 1M, 1 Mb/s



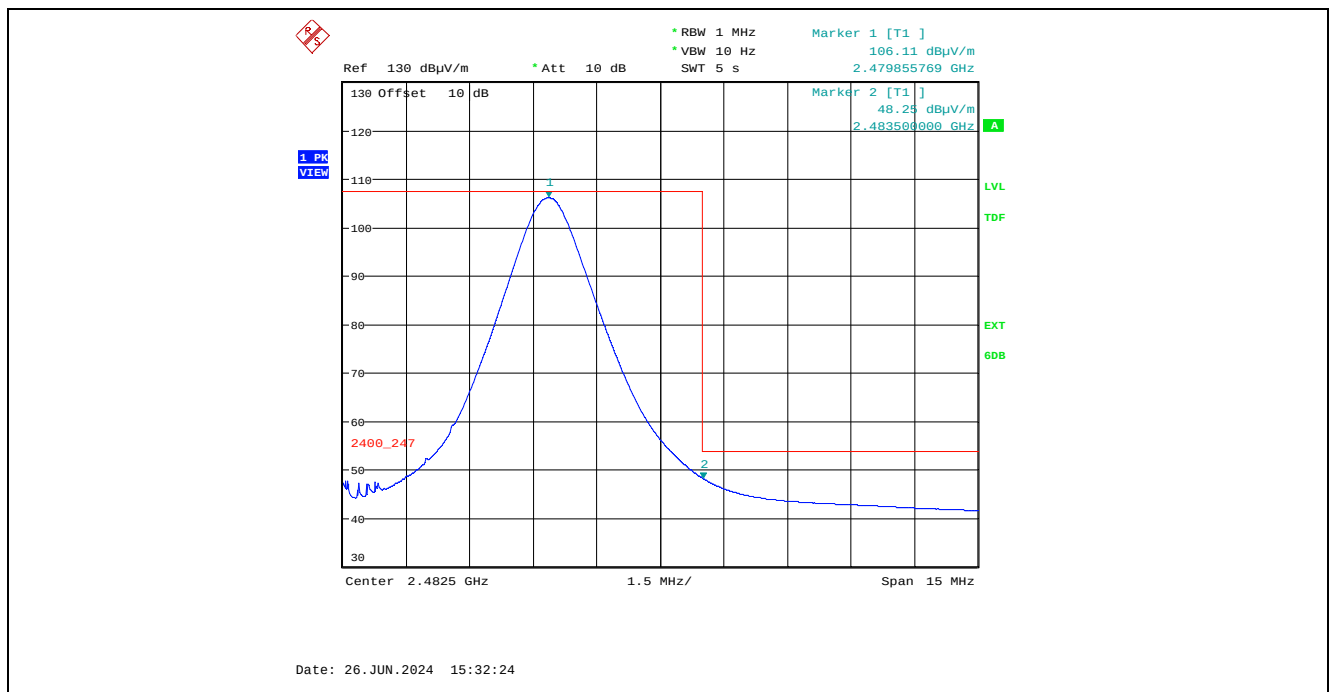
Plot 5.4.4.1.2.6. Radiated Band-Edge Emission at 3 m, Vertical Polarization, Average
High End of Frequency Band, 2480 MHz, GFSK Modulation, 1M, 1 Mb/s



Plot 5.4.4.1.2.7. Radiated Band-Edge Emission at 3 m, Horizontal Polarization, Peak
High End of Frequency Band, 2480 MHz, GFSK Modulation, 1M, 1 Mb/s



Plot 5.4.4.1.2.8. Radiated Band-Edge Emission at 3 m, Horizontal Polarization, Average
High End of Frequency Band, 2480 MHz, GFSK Modulation, 1M, 1 Mb/s



5.4.4.2. EUT with 1.49 dBi Monopole Antenna, Coded PHY Mode, 125 kb/s

5.4.4.2.1. Radiated Spurious Emission

Fundamental Frequency:		2402 MHz					
Test Frequency Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2402.0	104.17	--	V	--	--	--	--
2402.0	107.84	--	H	--	--	--	--
4804.0	45.42	34.23	V	54.0	87.8	-19.8	Pass*
4804.0	46.18	34.94	H	54.0	87.8	-19.1	Pass*
12010.0	64.55	51.68	V	54.0	87.8	-2.3	Pass*
12010.0	60.58	48.33	H	54.0	87.8	-5.7	Pass*
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.							

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:		2440 MHz					
Test Frequency Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2440.0	103.74	--	V	--	--	--	--
2440.0	107.63	--	H	--	--	--	--
4880.0	47.71	36.05	V	54.0	87.6	-18.0	Pass*
4880.0	48.64	38.03	H	54.0	87.6	-16.0	Pass*
7320.0	57.09	45.94	V	54.0	87.6	-8.1	Pass*
7320.0	57.82	46.38	H	54.0	87.6	-7.6	Pass*
12200.0	63.53	50.97	V	54.0	87.6	-3.0	Pass*
12200.0	59.77	47.23	H	54.0	87.6	-6.8	Pass*
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.							

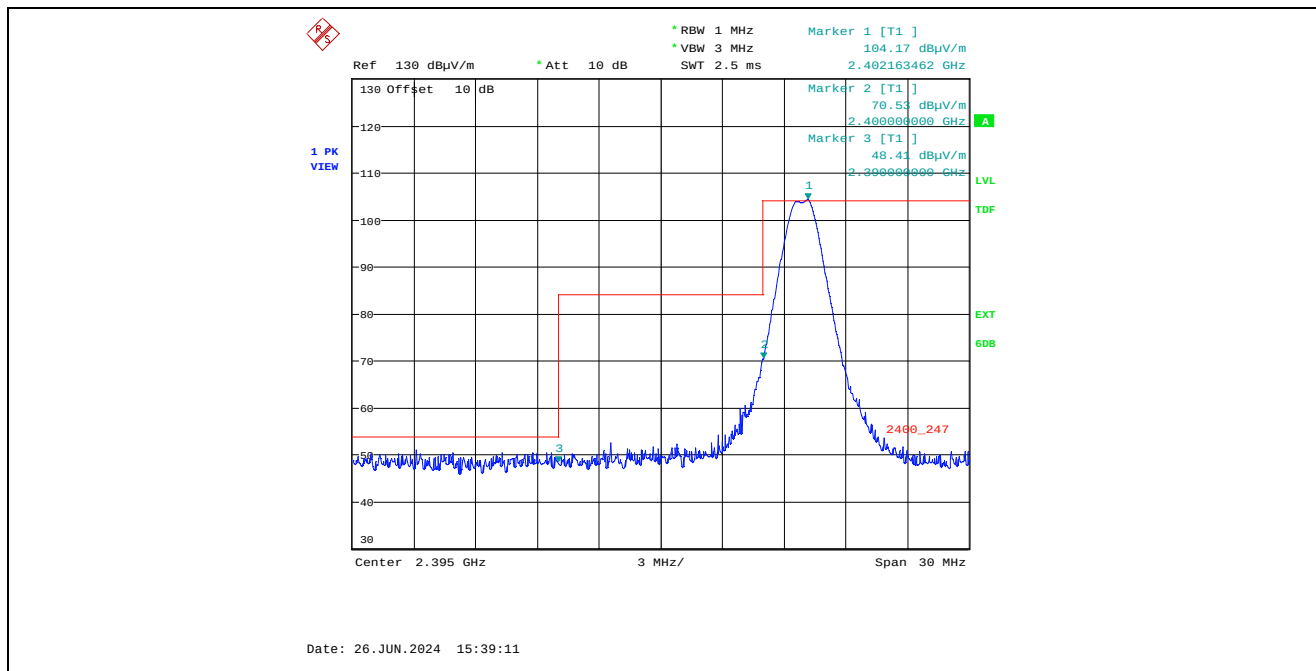
*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:		2480 MHz					
Test Frequency Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2480.0	103.60	--	V	--	--	--	--
2480.0	107.55	--	H	--	--	--	--
4960.0	47.90	38.30	V	54.0	87.6	-15.7	Pass*
4960.0	48.74	39.10	H	54.0	87.6	-14.9	Pass*
7440.0	55.66	44.06	V	54.0	87.6	-9.9	Pass*
7440.0	55.57	43.89	H	54.0	87.6	-10.1	Pass*
12400.0	60.79	48.50	V	54.0	87.6	-5.5	Pass*
12400.0	57.83	44.12	H	54.0	87.6	-9.9	Pass*
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.							

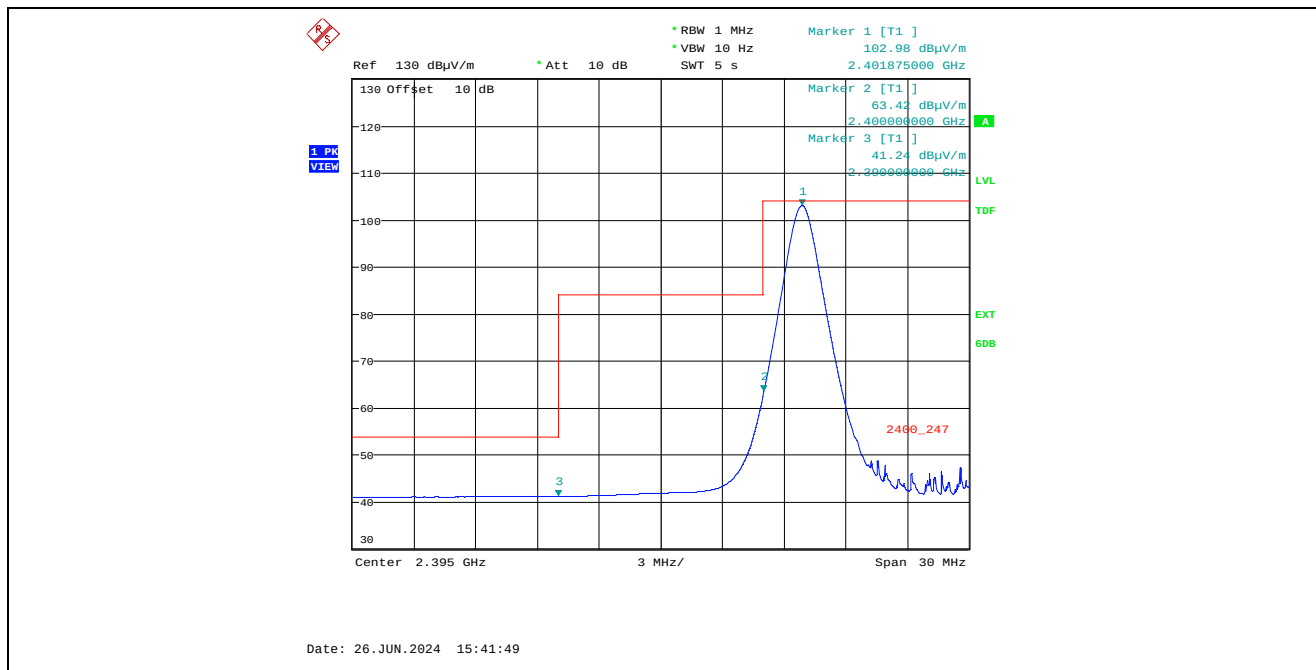
*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

5.4.4.2.2. Radiated Band-Edge Emission

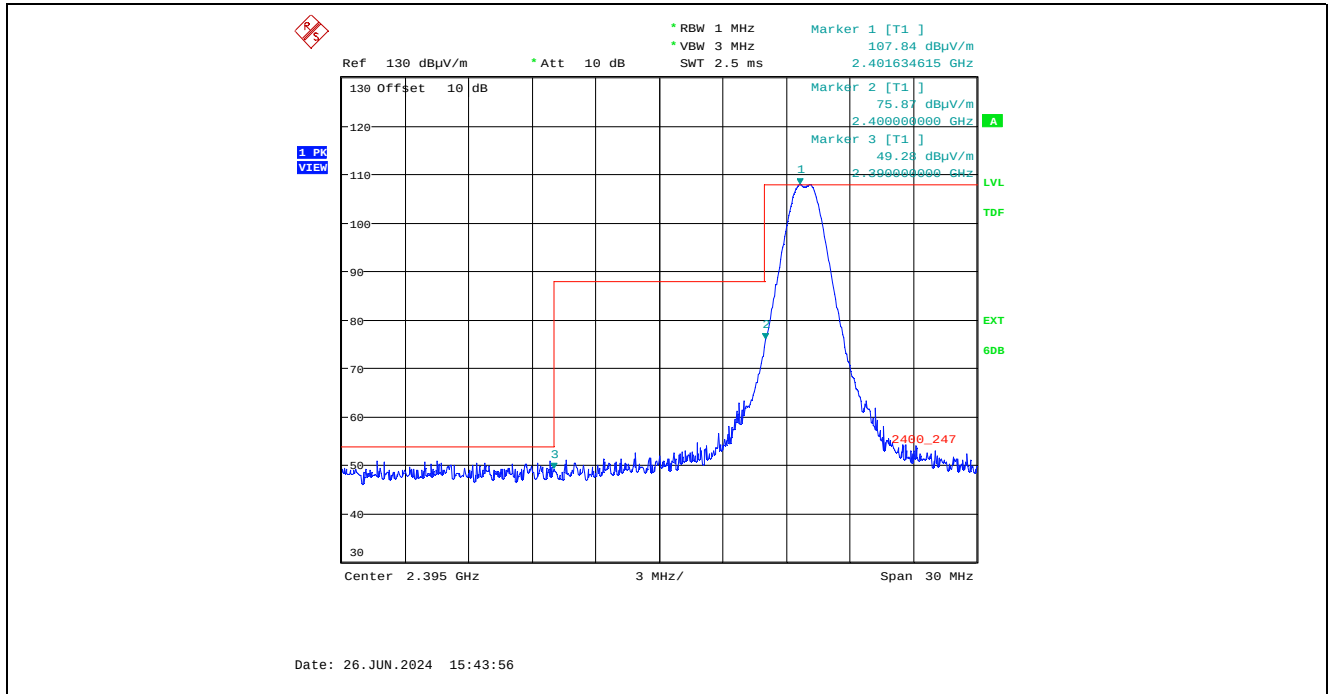
Plot 5.4.4.2.2.1. Radiated Band-Edge Emission at 3 m, Vertical Polarization, Peak Low End of Frequency Band, 2402 MHz, GFSK Modulation, Coded PHY, 125 kb/s



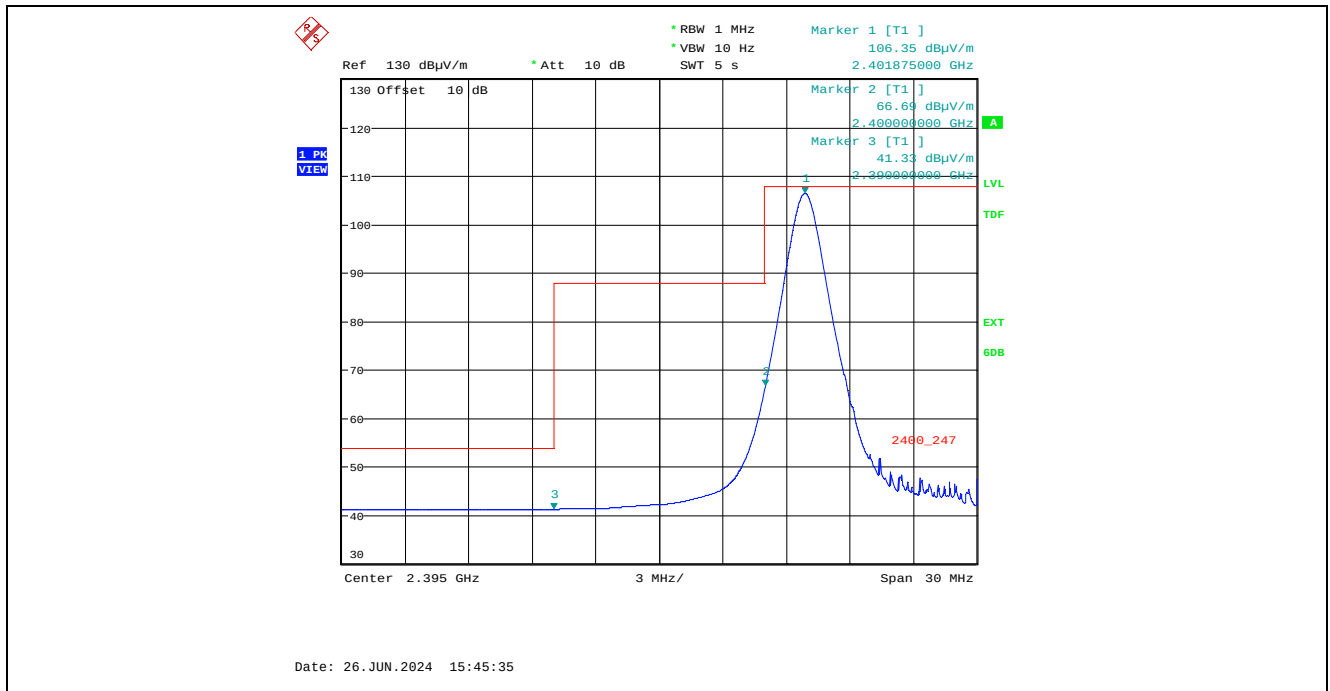
Plot 5.4.4.2.2.2. Radiated Band-Edge Emission at 3 m, Vertical Polarization, Average Low End of Frequency Band, 2402 MHz, GFSK Modulation, Coded PHY, 125 kb/s



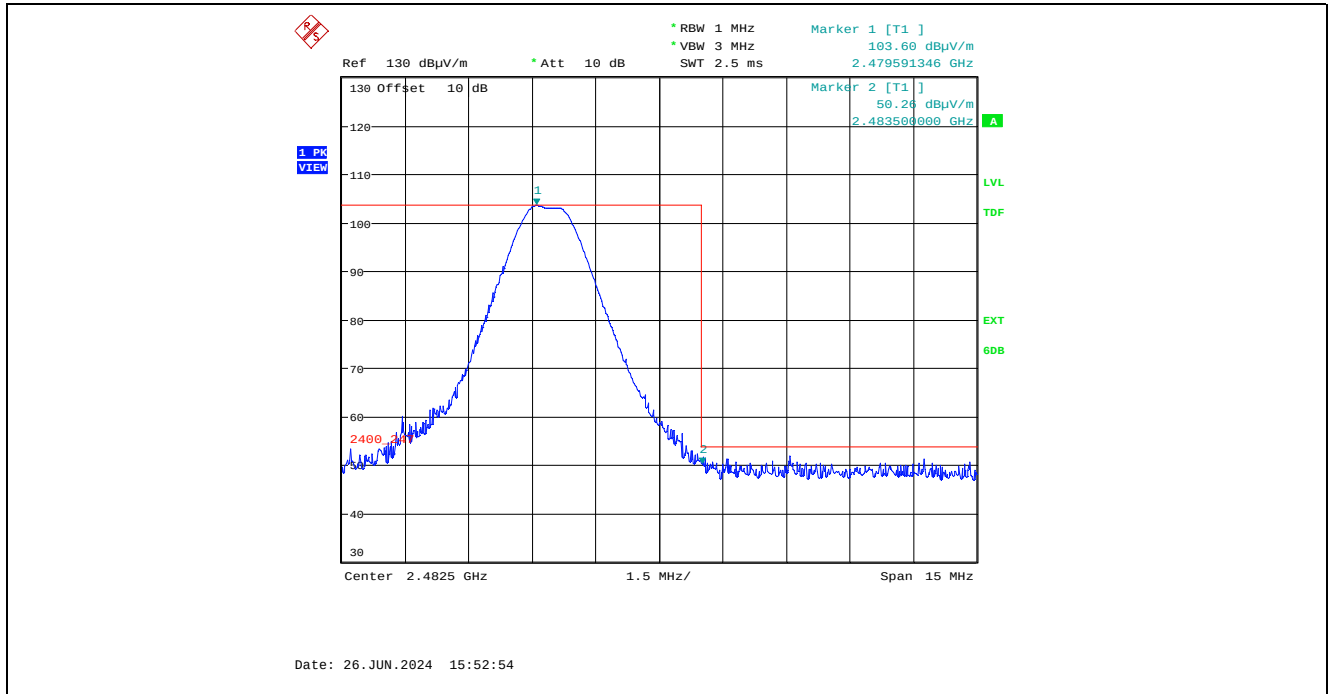
Plot 5.4.4.2.2.3. Radiated Band-Edge Emission at 3 m, Horizontal Polarization, Peak
Low End of Frequency Band, 2402 MHz, GFSK Modulation, Coded PHY, 125 kb/s



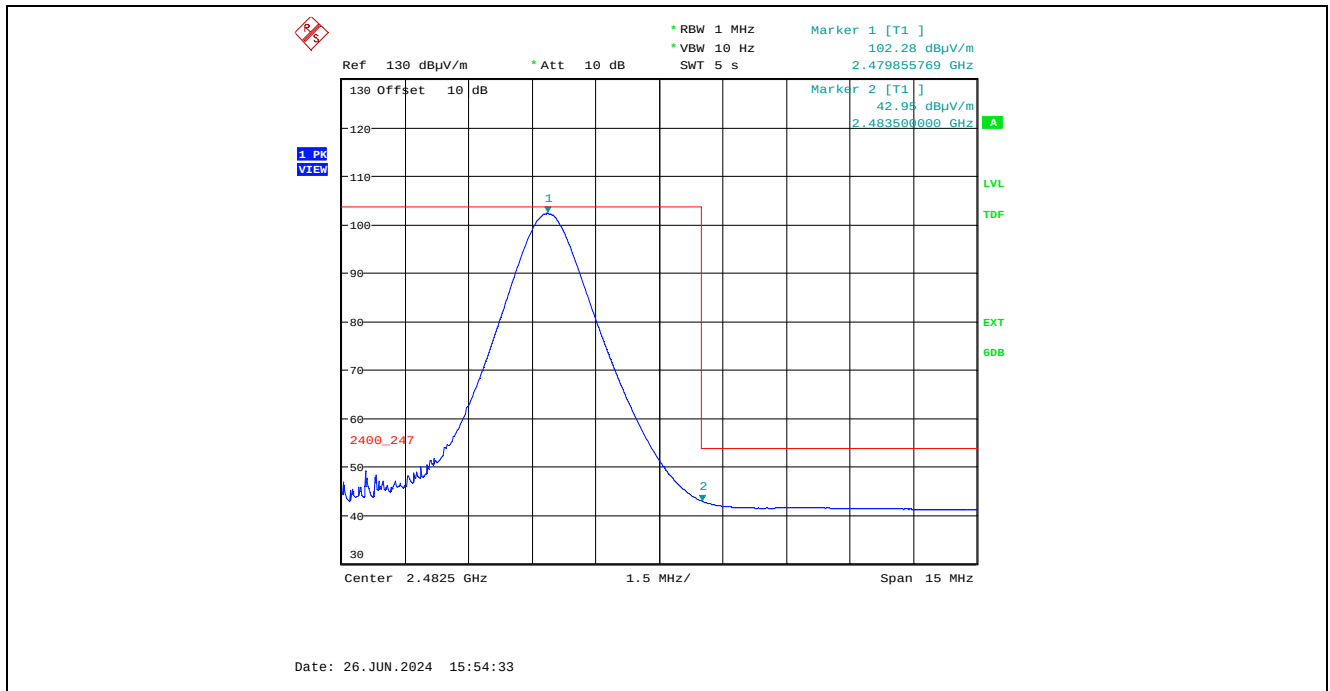
Plot 5.4.4.2.2.4. Radiated Band-Edge Emission at 3 m, Horizontal Polarization, Average
Low End of Frequency Band, 2402 MHz, GFSK Modulation, Coded PHY, 125 kb/s



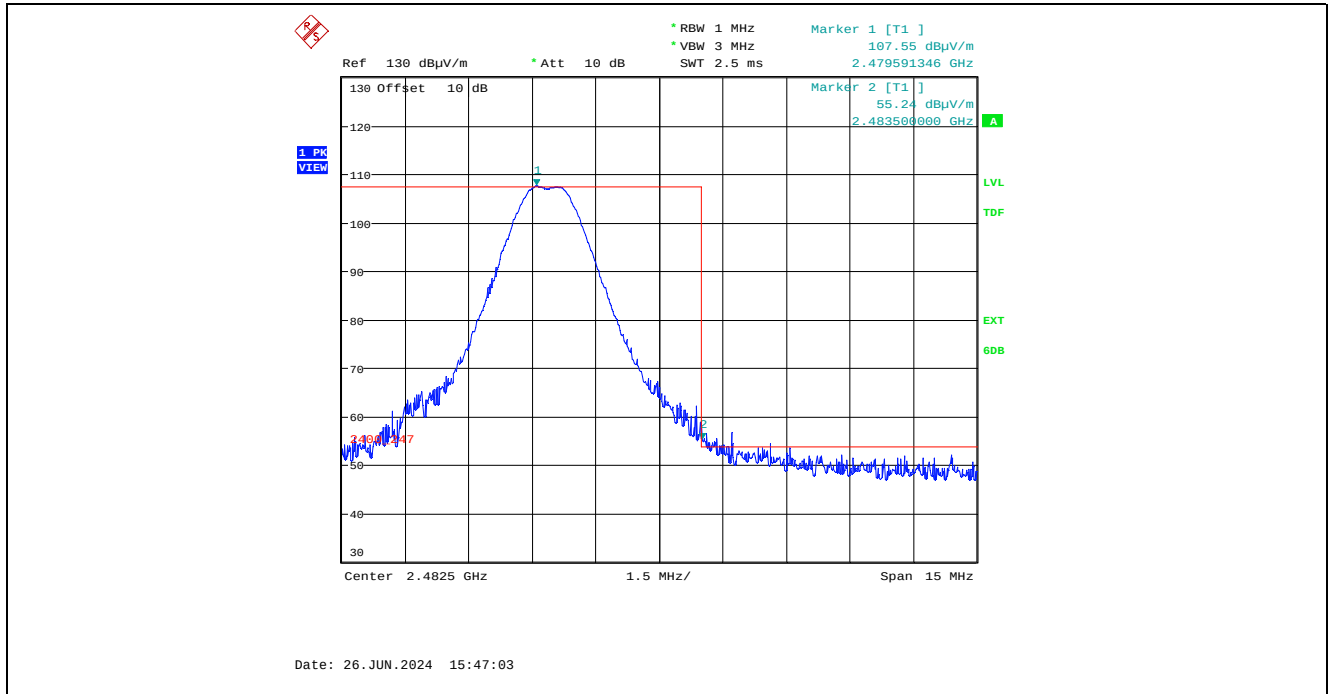
Plot 5.4.4.2.2.5. Radiated Band-Edge Emission at 3 m, Vertical Polarization, Peak
High End of Frequency Band, 2480 MHz, GFSK Modulation, Coded PHY, 125 kb/s



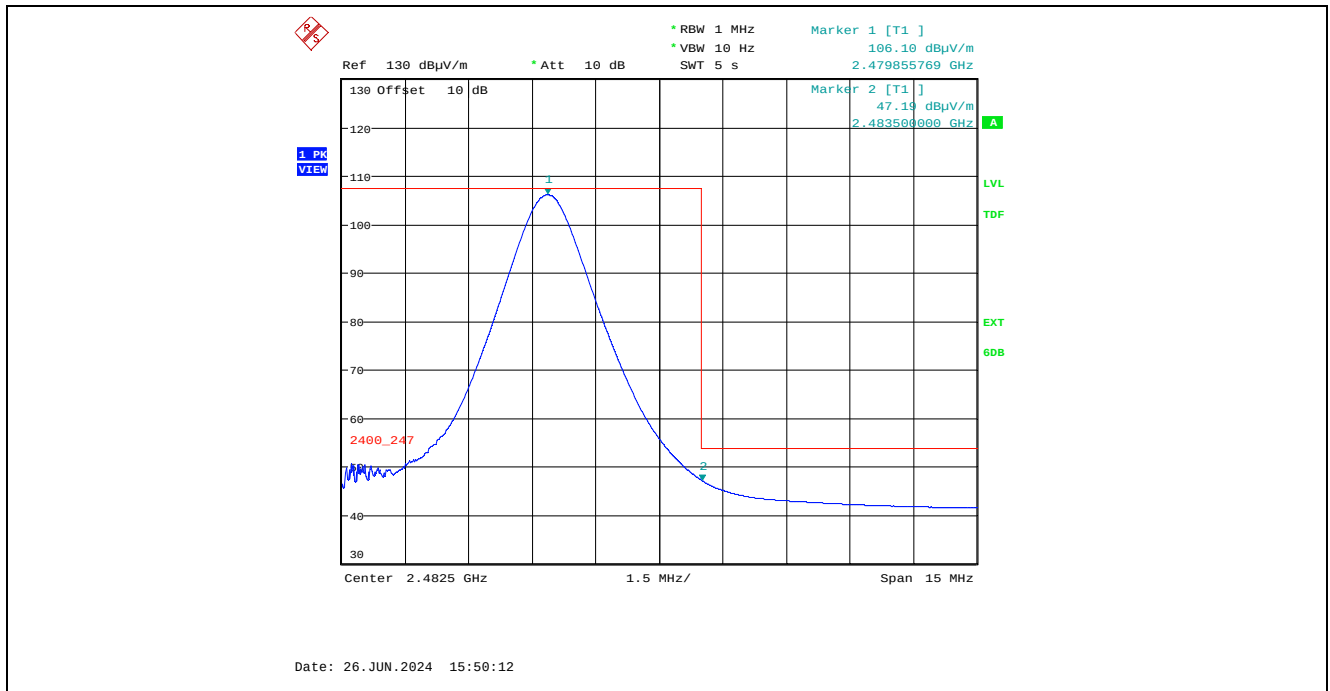
Plot 5.4.4.2.2.6. Radiated Band-Edge Emission at 3 m, Vertical Polarization, Average
High End of Frequency Band, 2480 MHz, GFSK Modulation, Coded PHY, 125 kb/s



Plot 5.4.4.2.2.7. Radiated Band-Edge Emission at 3 m, Horizontal Polarization, Peak
High End of Frequency Band, 2480 MHz, GFSK Modulation, Coded PHY, 125 kb/s



Plot 5.4.4.2.2.8. Radiated Band-Edge Emission at 3 m, Horizontal Polarization, Average
High End of Frequency Band, 2480 MHz, GFSK Modulation, Coded PHY, 125 kb/s



5.5. POWER SPECTRAL DENSITY [§ 15.247(e)]

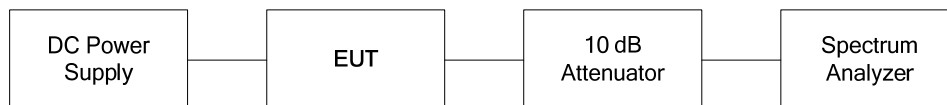
5.5.1. Limit(s)

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5.5.2. Method of Measurements

FCC KDB 558074 D01 15.247 Meas Guidance V05r02, Section 8.4 and ANSI C63.10, 11.10.2 Method PKPSD

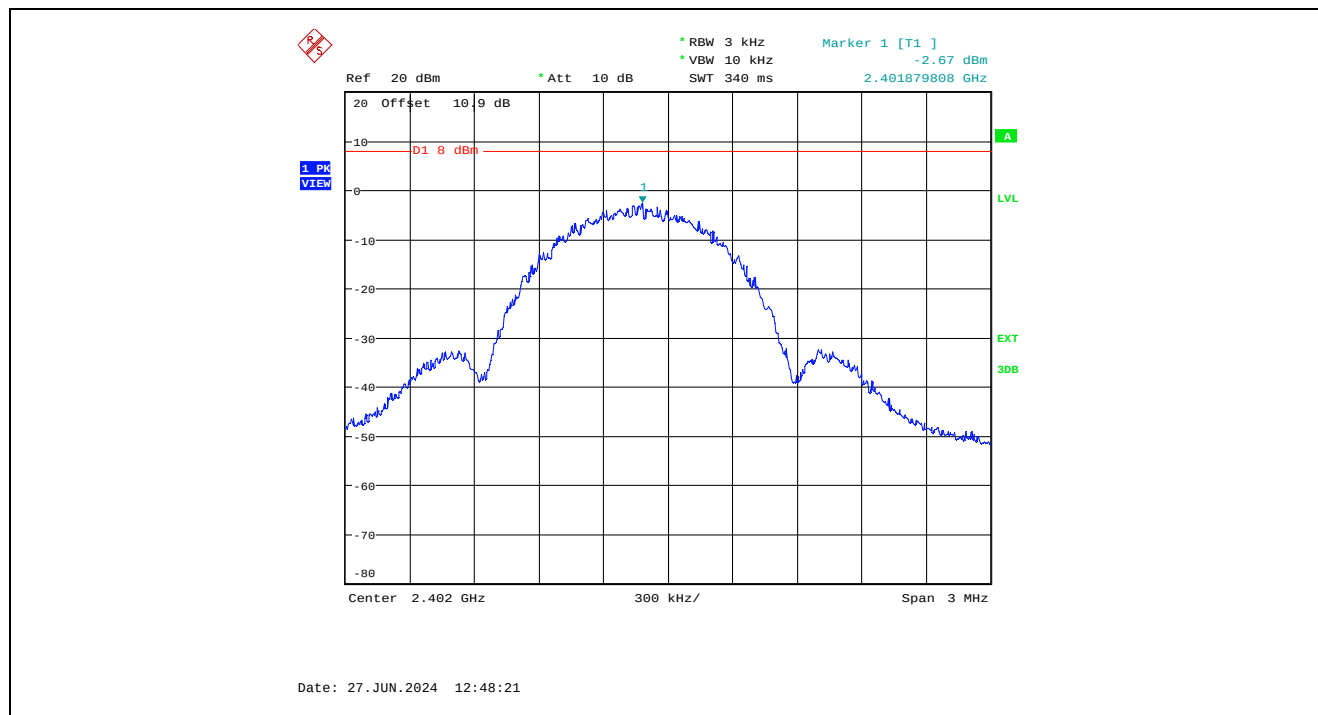
5.5.3. Test Arrangement



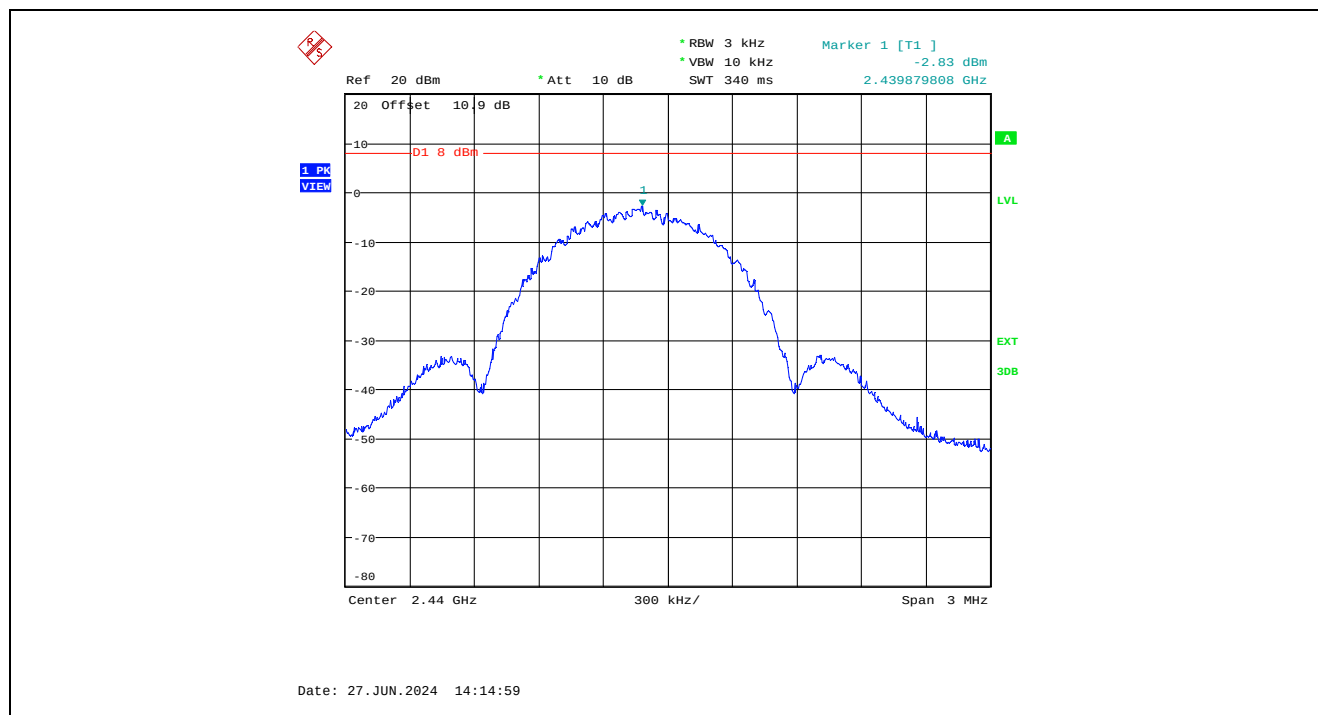
5.5.4. Test Data

Modulation	Mode	Data Rate	Frequency (MHz)	PSD (dBm)	Max. Limit (dBm)	Margin (dBm)
GFSK	1M	1 Mb/s	2402	-2.67	8	-10.67
			2440	-2.83	8	-10.83
			2480	-2.85	8	-10.85
	Coded PHY	125 kb/s	2402	7.23	8	-0.77
			2440	7.15	8	-0.85
			2480	7.06	8	-0.94

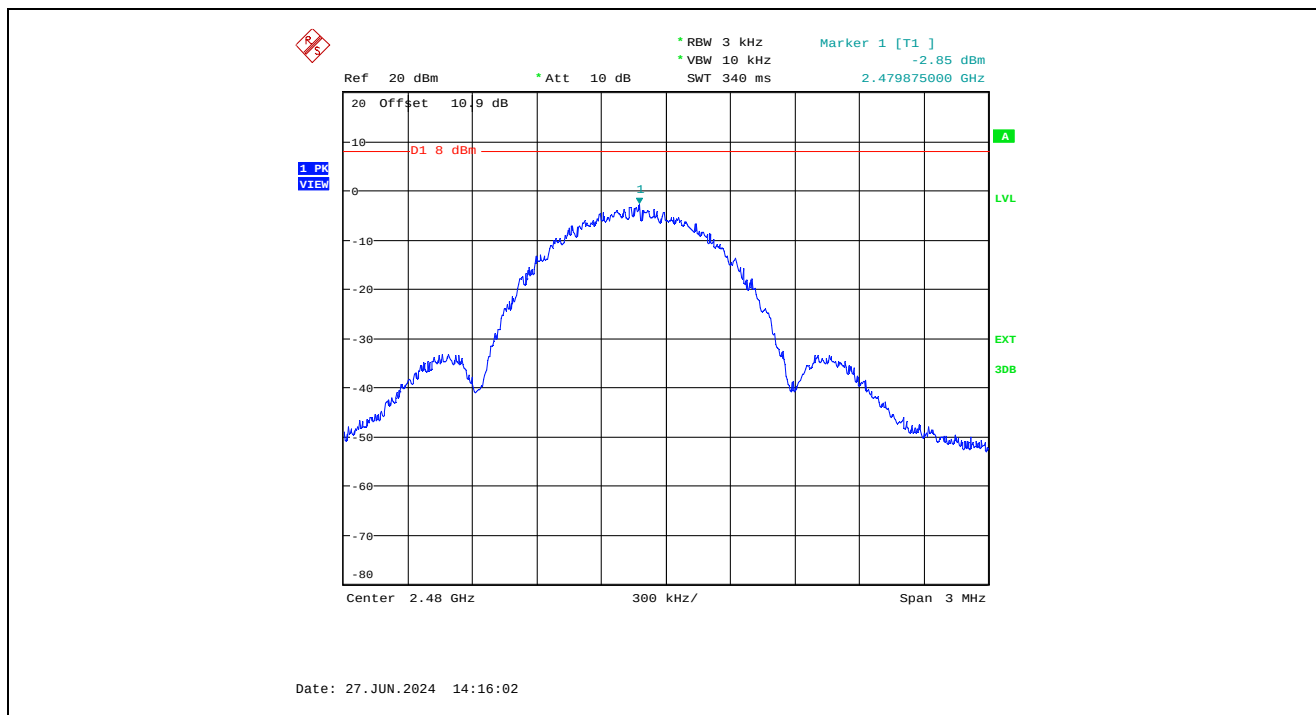
Plot 5.5.4.1. Power Spectral Density, GFSK Modulation, 1M, 1 Mb/s, 2402 MHz



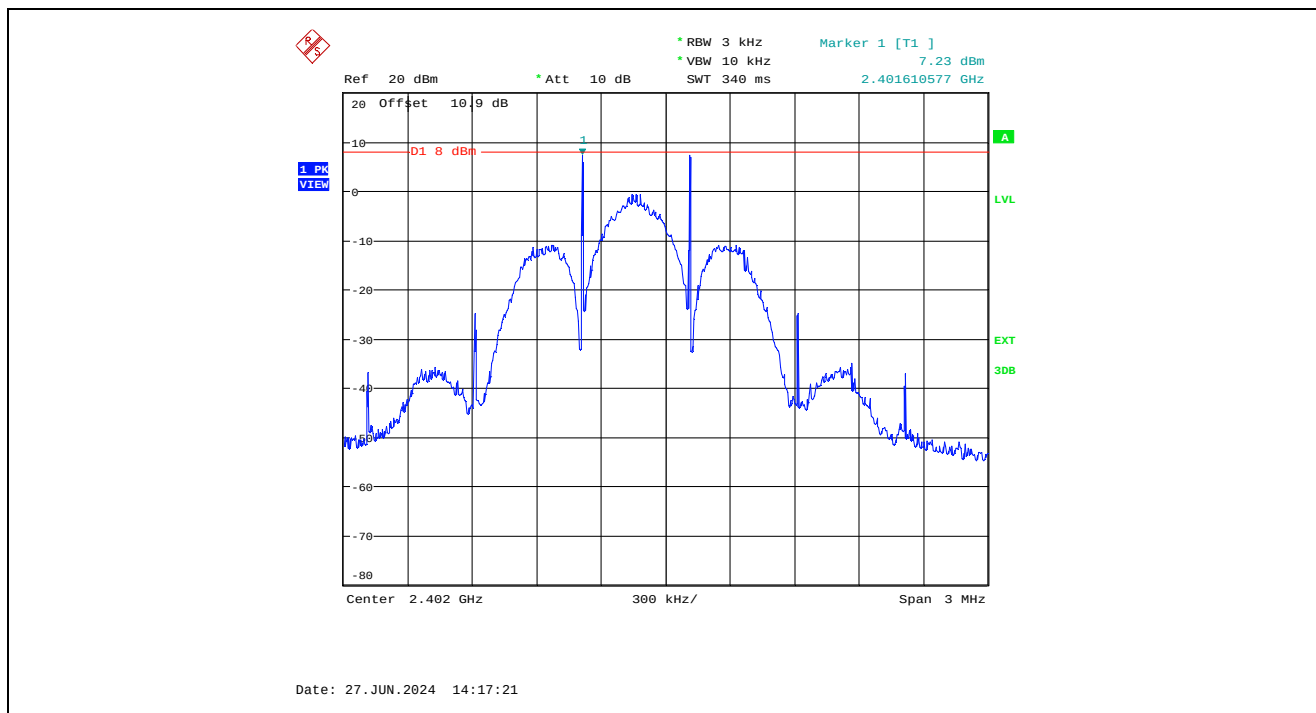
Plot 5.5.4.2. Power Spectral Density, GFSK Modulation, 1M, 1 Mb/s, 2440 MHz



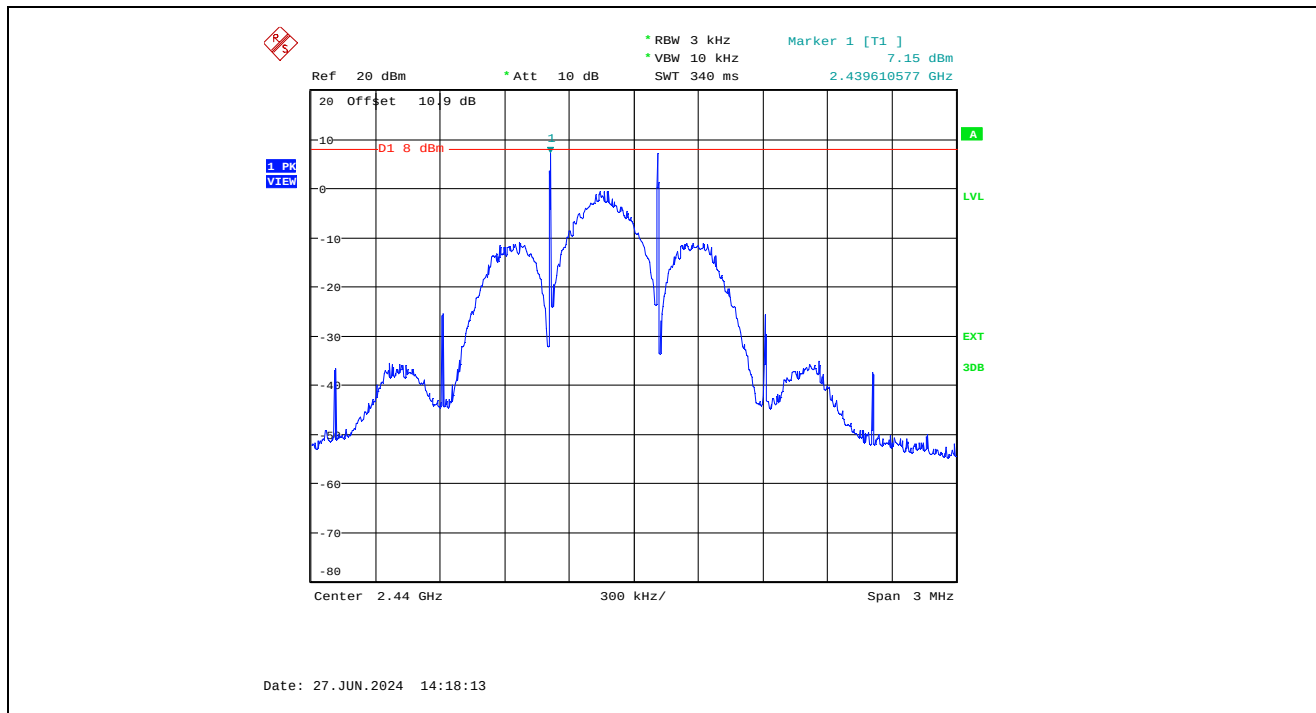
Plot 5.5.4.3. Power Spectral Density, GFSK Modulation, 1M, 1 Mb/s, 2480 MHz



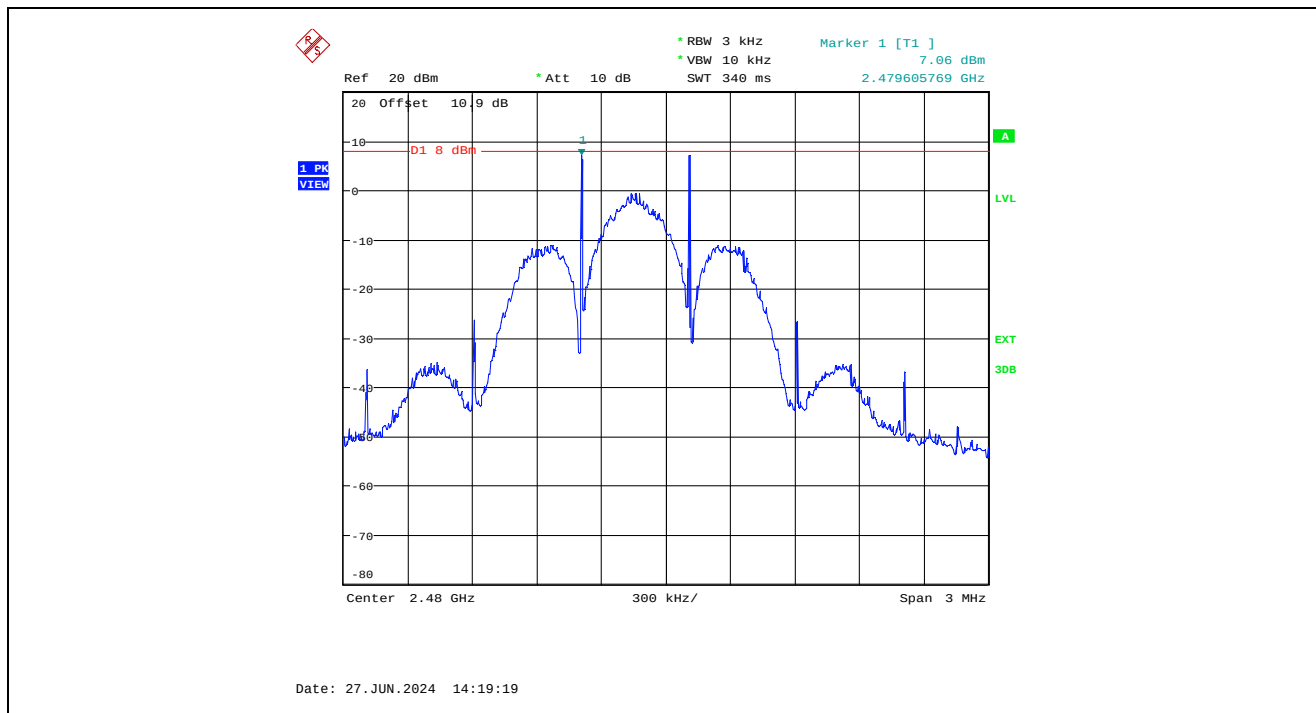
Plot 5.5.4.4. Power Spectral Density, GFSK Modulation, Coded PHY, 125 kb/s, 2402 MHz



Plot 5.5.4.5. Power Spectral Density, GFSK Modulation, Coded PHY, 125 kb/s, 2440 MHz



Plot 5.5.4.6. Power Spectral Density, GFSK Modulation, Coded PHY, 125 kb/s, 2480 MHz



5.6. RF EXPOSURE REQUIREMENTS [§§ 15.247(i), 1.1310 & 2.1091]

5.6.1. Limits

§ 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

5.6.2. Method of Measurements

Calculation Method of Power Density/RF Safety Distance:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where,
P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm²
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

5.6.3. RF Evaluation

Frequency (MHz)	*EUT EIRP (dBm)	EUT EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
2402	15.49	35.400	20	0.007	1.0

*Maximum tune-up power declared by the manufacturer + antenna gain (14 dBm + 1.49 dBi).

EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	Agilent	E7401A	US40240432	9 kHz - 22 GHz	06 Nov 2024
High Pass filter	Rohde & Schwarz	EZ-25	830164/007	Cut off 150 kHz	12 Oct 2024
LISN	NSLK 8127	NSLK 8127	8127276	9 kHz - 30 MHz	11 Dec 2024
DC Power supply	HQ Power	PS613U	-	0 – 30 Vdc	See Note 1
Multimeter	Fluke	8842A	5436283	DC 20 mV – 1000 V	28 Aug 2025
Spectrum Analyzer	Rohde & Schwarz	FSU26	200946	20 Hz - 26.5 GHz	26 Mar 2026
Attenuator	Pasternack	PE7024-10	3	DC - 26.5 GHz	See Note 1
Horn Antenna	ETS	3115	9701-5061	1 – 18 GHz	09 Aug 2024
EMI Receiver	Rohde & Schwarz	ESU40	100037	20 Hz - 40 GHz	21 Sep 2024
Biconilog Antenna	EMCO	3142C	00034792	26 - 2000 MHz	16 Dec 2025
Preamp	Com-Power	PAM-118A	551052	500 MHz - 18 GHz	06 Oct 2024
Preamp	Hewlett Packard	8449B	3003A00769	1000 MHz - 26.5 GHz	08 Nov 2024
High Pass Filter	K & L	11SH10-1500/T8000	2	1.0 - 1.5 GHz	See Note 1
Note 1: Internal Verification/Calibration check					

ULTRATECH GROUP OF LABS

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EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

Test Description	Expanded Uncertainty, K=2 for 95% Confidence Level
Power Line Conducted Emissions	± 2.62
Conducted Output Power	± 0.63 dB
Power Spectral Density	± 0.63 dB
Occupied Bandwidth	± 0.20 Hz
Radiated Emissions	± 4.82 dB (30 MHz – 1 GHz)
	± 3.43 dB (1 – 18 GHz)
	± 3.11 dB (18 – 26.5 GHz)

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