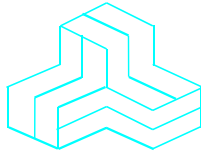


# ENGINEERING TEST REPORT



**S01-051 Bluetooth Control Module**  
**Model(s): S01-051G and S01-051J**  
**FCC ID: AU792U22C01871**

*Applicant:*

**Multi Tech Systems Inc**  
2205 Woodale Drive  
Mounds View, MN 55112  
USA

*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.: 22SMCS032\_FCC15C247**

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

Date: May 9, 2022

Report Prepared by: Dan Huynh

Tested by: Angus Au

Issued Date: May 9, 2022

Test Dates:  
March 11 - 31, 2022  
April 13, 2022

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## UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4  
Tel.: (905) 829-1570 Fax.: (905) 829-8050  
Website: [www.ultratech-labs.com](http://www.ultratech-labs.com), Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Email: [tri@ultratech-labs.com](mailto:tri@ultratech-labs.com)



1309



CA0001-2049



AT-1945



SL2-IN-E-1119R



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## EXHIBIT 1. INTRODUCTION

### 1.1. SCOPE

<b>Reference:</b>	FCC Part 15, Subpart C, Section 15.247
<b>Title:</b>	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15 – Radio Frequency Devices
<b>Purpose of Test:</b>	Equipment Certification for Digital Modulation Systems (DTS) Operating Under §15.247
<b>Test Procedures:</b>	<ul style="list-style-type: none"><li>ANSI C63.4</li><li>ANSI C63.10</li><li>FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02</li></ul>
<b>Environmental Classification:</b>	<input checked="" type="checkbox"/> Commercial, industrial or business environment <input type="checkbox"/> Residential environment

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

None.

### 1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2021	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	2013	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	
<b>Name:</b>	Multi Tech Systems Inc
<b>Address:</b>	2205 Woodale Drive Mounds View, MN 55112 USA

Manufacturer	
<b>Name:</b>	Multi Tech Systems Inc
<b>Address:</b>	2205 Woodale Drive Mounds View, MN 55112 USA

### 2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

<b>Brand Name:</b>	Multi Tech Systems Inc
<b>Product Name:</b>	S01-051 Bluetooth Control Module
<b>*Model Name or Number:</b>	S01-051G and S01-051J
<b>Serial Number:</b>	Test Sample
<b>Type of Equipment:</b>	Digital Transmission System (DTS)
<b>Input Power Supply Type:</b>	External Power Supply / AC/DC adapter / Battery
<b>Primary User Functions of EUT:</b>	Control water valve of automatic faucets with Bluetooth Low Energy
*The PCBA layout, the RF design/RF performance and antenna type of models S01-051G and S01-051J is the same. The differences between the 2 models are the value of resistor R27 and model S01-051J has 2 capacitors C15 and C16 populated on board, while model S01-051G does not have them. Model S01-051J was selected as the worst-case test sample derived from exploratory testing and for its additional feature.	

### 2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial, industrial or business environment
Power Supply Requirement:	<ul style="list-style-type: none"><li>6 VDC from 4 x AA Battery</li><li>6 VDC external power supply</li><li>24 VAC external transformer</li></ul>
RF Output Power Rating:	5.08 dBm, maximum peak conducted power
Operating Frequency Range:	2402 - 2480 MHz
RF Output Impedance:	50 $\Omega$
Modulation Type:	GFSK
Antenna Connector Types:	Integral, PCB antenna

### 2.4. ASSOCIATED ANTENNA DESCRIPTIONS

Antenna Type	Maximum Gain (dBi)
PCB antenna	2.5

### 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	Main DC	1	Barrel Audio connector	Non-shielded
2	Below deck to Above deck interface connection	1	Custom 4 pin connector	Non-shielded
3	Valve interface connection	1	Custom 2 pin 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:

None.

### 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:	6 VDC / 24 VAC

#### 3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

<b>Operating Modes:</b>	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
<b>Special Test Software:</b>	Test software provided by the Applicant to operate the EUT at each channel frequency continuously and in the range of typical modes of operation.
<b>Special Hardware Used:</b>	N/A
<b>Transmitter Test Antenna:</b>	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	
<b>Frequency Band(s):</b>	2402 - 2480 MHz
<b>Frequency(ies) Tested:</b>	2402 MHz, 2440 MHz, 2480 MHz
<b>RF Power Output:</b> (measured maximum output power at antenna terminals)	5.08 dBm Peak (3.221 mW)
<b>Normal Test Modulation:</b>	GFSK
<b>Modulating Signal Source:</b>	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	Yes
15.247(d), 15.209 & 15.205	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:

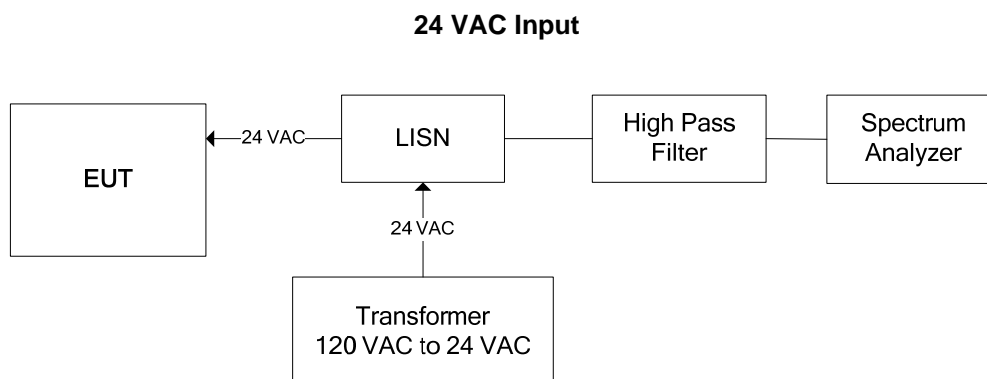
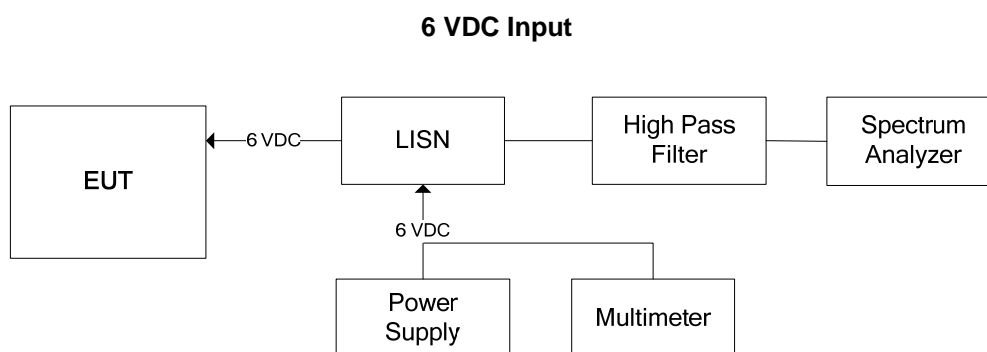
Frequency of emission (MHz)	Conducted Limits (dB $\mu$ V)	
	Quasi-peak	Average
0.15–0.5 .....	66 to 56* .....	56 to 46*
0.5–5 .....	56 .....	46
5–30 .....	60 .....	50

\*Decreases linearly with the logarithm of the frequency

#### 5.1.2. Method of Measurements

ANSI C63.4

#### 5.1.3. Test Arrangement

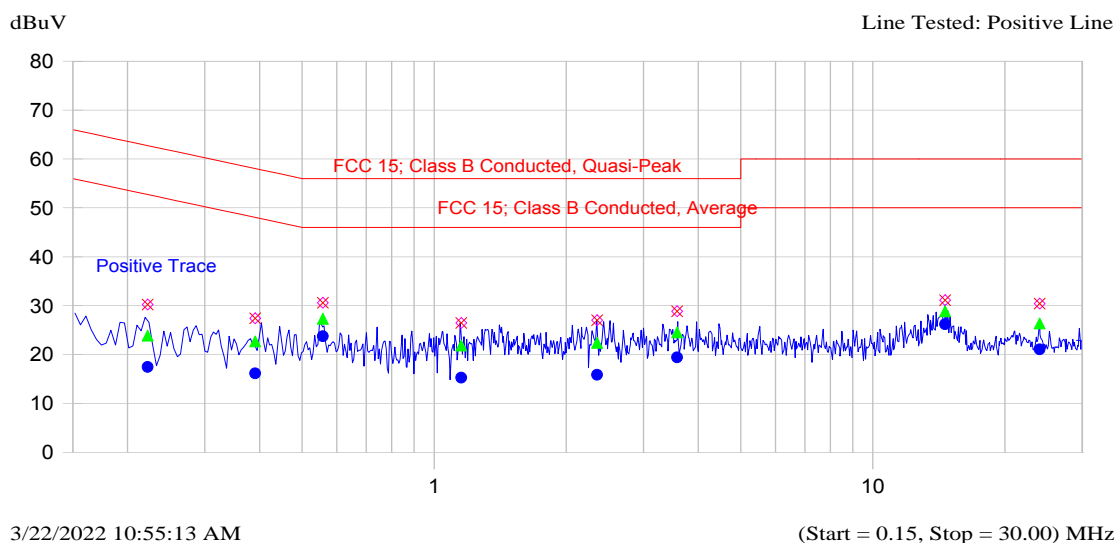




#### 5.1.4. Test Data

**Plot 5.1.4.1. Power Line Conducted Emissions**  
Line Voltage: 6 VDC; Line Tested: Positive Line

##### Current Graph

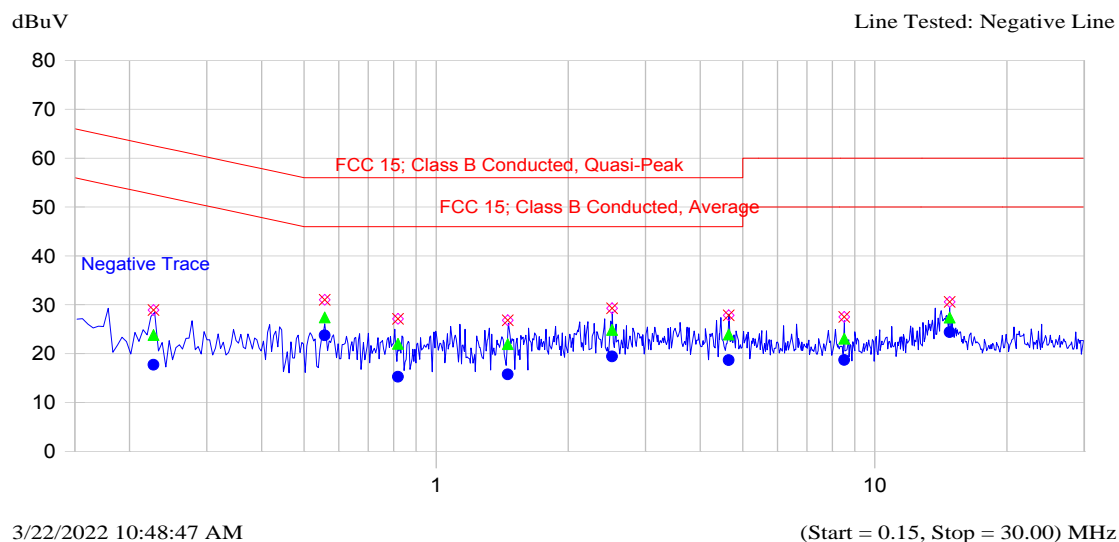


##### Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
24.000	30.4	26.4	-33.6	21.1	-28.9	Positive Trace
14.606	31.1	28.8	-31.2	26.2	-23.8	Positive Trace
3.579	28.8	24.5	-31.5	19.4	-26.6	Positive Trace
2.352	27.0	22.4	-33.6	15.9	-30.1	Positive Trace
1.153	26.5	21.9	-34.1	15.3	-30.7	Positive Trace
0.558	30.6	27.3	-28.7	23.7	-22.3	Positive Trace
0.391	27.4	22.7	-35.4	16.2	-31.9	Positive Trace
0.222	30.2	23.9	-38.9	17.5	-35.3	Positive Trace

**Plot 5.1.4.2. Power Line Conducted Emissions**  
Line Voltage: 6 VDC; Line Tested: Negative Line

### Current Graph

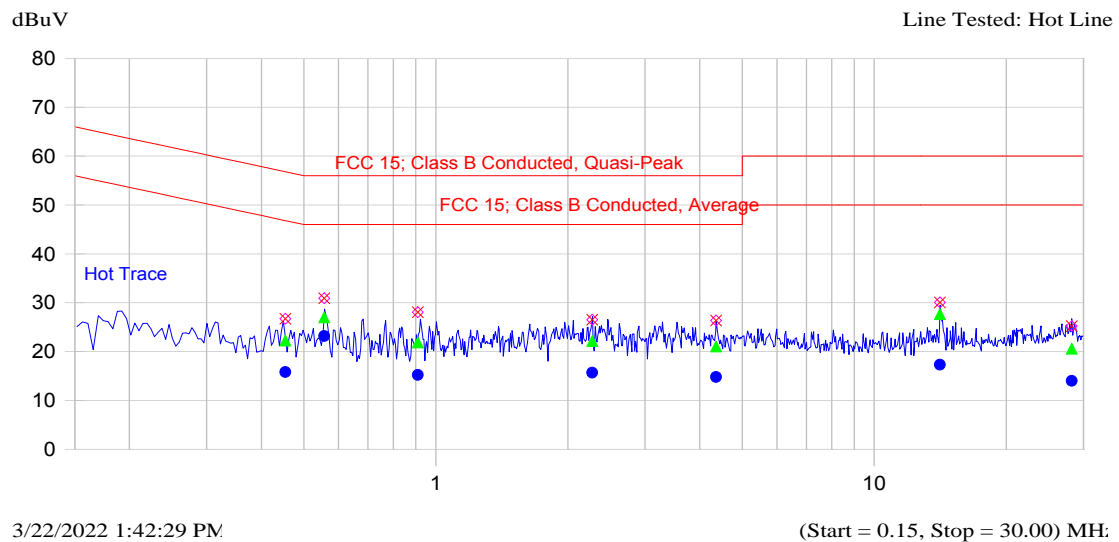


### Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
14.796	30.6	27.4	-32.6	24.4	-25.6	Negative Trace
8.511	27.5	23.1	-36.9	18.7	-31.3	Negative Trace
4.644	27.8	23.9	-32.1	18.7	-27.3	Negative Trace
2.516	29.3	24.9	-31.1	19.4	-26.6	Negative Trace
1.456	26.8	22.0	-34.0	15.8	-30.2	Negative Trace
0.818	27.1	22.0	-34.0	15.3	-30.7	Negative Trace
0.557	31.0	27.4	-28.6	23.8	-22.2	Negative Trace
0.227	28.9	23.8	-38.7	17.7	-34.8	Negative Trace

**Plot 5.1.4.3. Power Line Conducted Emissions**  
Line Voltage: 24 VAC; Line Tested: Hot Line

### Current Graph

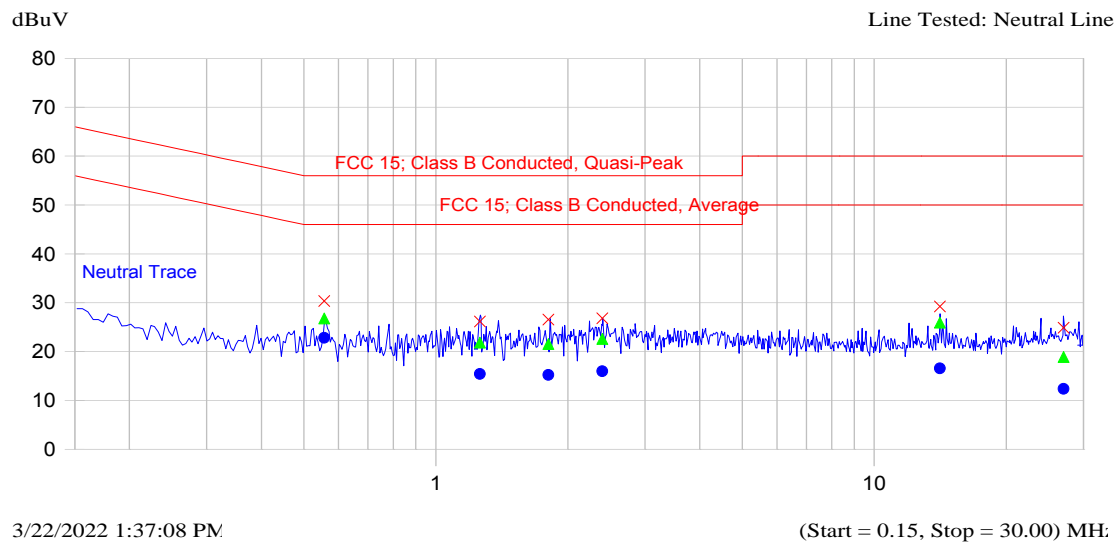


### Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
28.208	25.2	20.6	-39.4	14.0	-36.0	Hot Trace
14.120	30.0	27.7	-32.3	17.3	-32.7	Hot Trace
4.355	26.3	21.1	-34.9	14.8	-31.2	Hot Trace
2.273	26.5	22.2	-33.8	15.7	-30.3	Hot Trace
0.909	28.1	21.9	-34.1	15.2	-30.8	Hot Trace
0.557	30.9	27.0	-29.0	23.2	-22.8	Hot Trace
0.453	26.7	22.3	-34.6	15.8	-31.0	Hot Trace

**Plot 5.1.4.4. Power Line Conducted Emissions**  
Line Voltage: 24 VAC; Line Tested: Neutral Line

### Current Graph



### Current List

Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
27.024	24.9	18.9	-41.1	12.4	-37.6	Neutral Trace
14.122	29.2	25.9	-34.1	16.6	-33.4	Neutral Trace
2.397	26.8	22.6	-33.4	16.0	-30.0	Neutral Trace
1.806	26.5	21.5	-34.5	15.2	-30.8	Neutral Trace
1.260	26.2	21.8	-34.2	15.4	-30.6	Neutral Trace
0.556	30.3	26.8	-29.2	22.8	-23.2	Neutral Trace

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

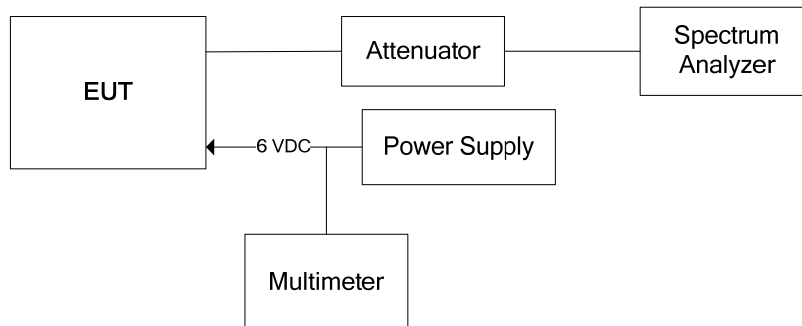
### 5.2.1. Limit(s)

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

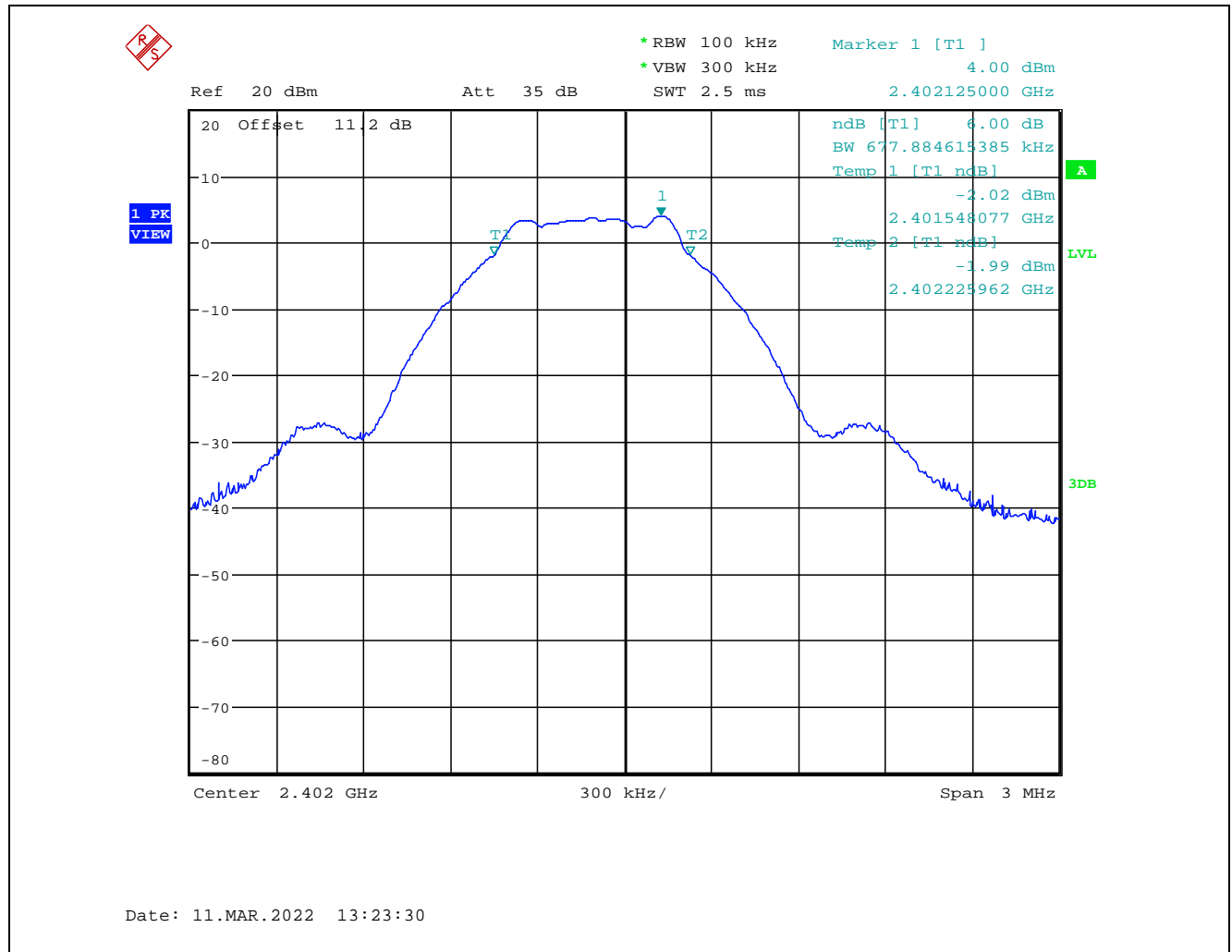
### 5.2.3. Test Arrangement



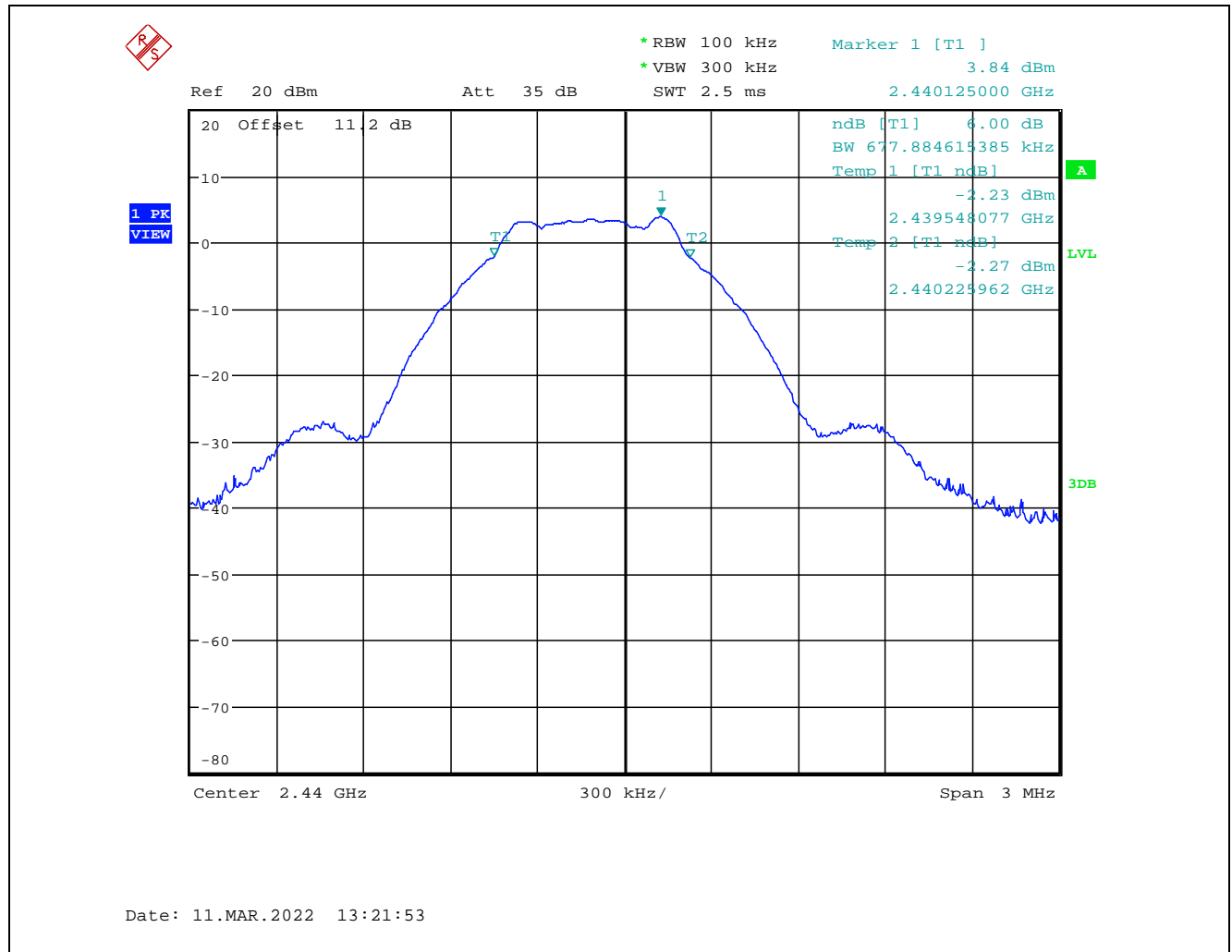
### 5.2.4. Test Data

Modulation	Power Setting	Frequency (MHz)	6dB BW, 1Mbps (kHz)	Min. Limit (kHz)
GFSK	5 dBm	2402	677.885	500
		2440	677.885	500
		2480	673.077	500

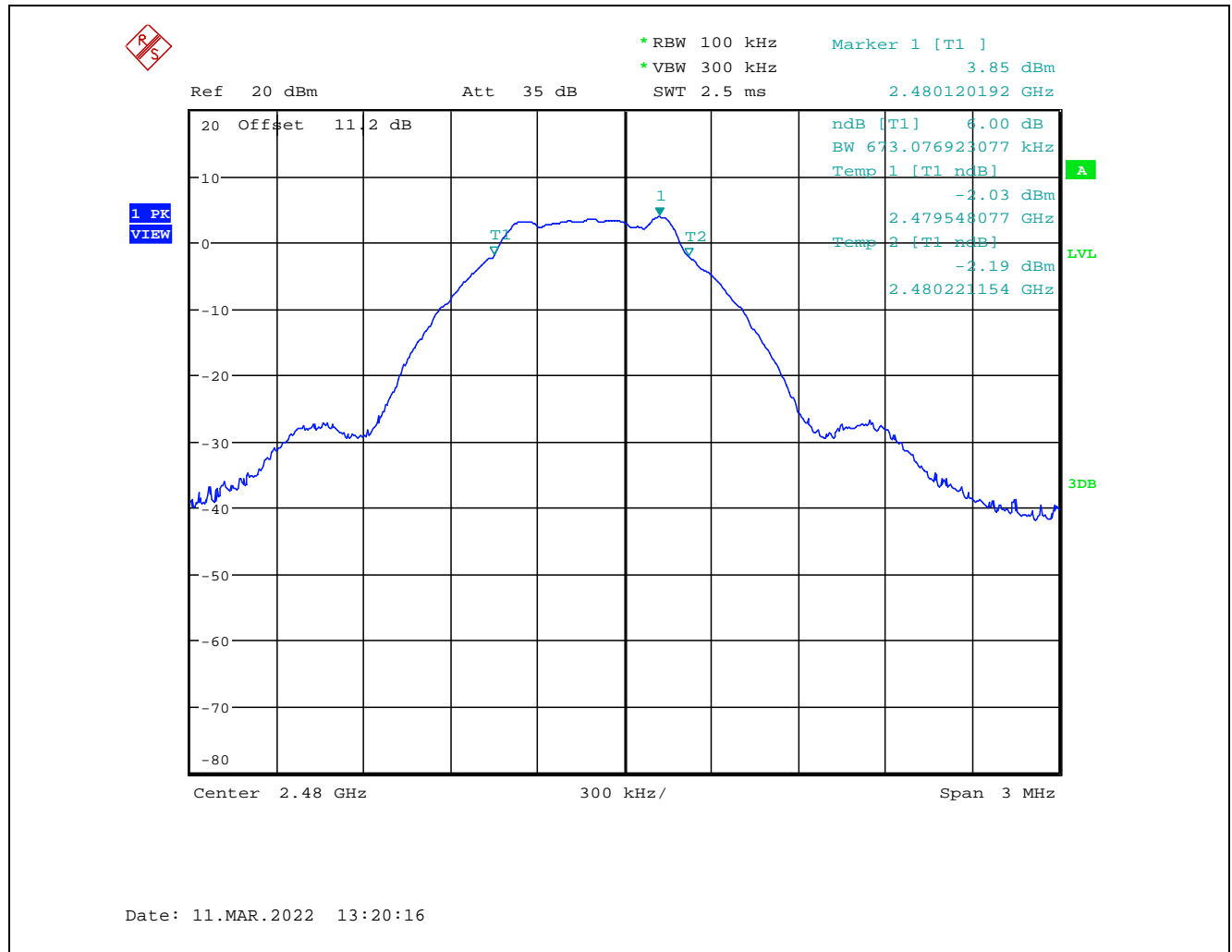
**Plot 5.2.4.1.** 6 dB Bandwidth, GFSK Modulation, 5 dBm Power Setting, 2402 MHz, 1 Mbps



**Plot 5.2.4.2.** 6 dB Bandwidth, GFSK Modulation, 5 dBm Power Setting, 2440 MHz, 1 Mbps



**Plot 5.2.4.3.** 6 dB Bandwidth, GFSK Modulation, 5 dBm Power Setting, 2480 MHz, 1 Mbps





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

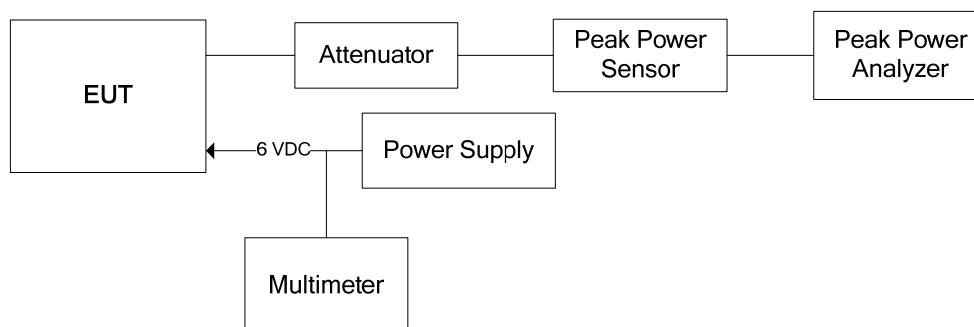
#### 5.3.1. Limit(s)

**§ 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 & Test Arrangement

FCC KDB 558074 D01 15.247 Meas Guidance V05r02, Section 8.3.1.3 PKPM1 Peak-reading power meter method and ANSI C63.10 Section 11.9.1.3

#### 5.3.3. Test Arrangement



#### 5.3.4. Test Data

Modulation	Power Setting	Data Rate (Mbps)	Frequency (MHz)	Peak Power (dBm)	Maximum Antenna Gain (dBi)	EIRP (dBm)	Peak Power Limit (dBm)
GFSK	High Power (5 dBm)	1	2402	5.08	2.5	7.58	30
			2440	5.01	2.5	7.51	30
			2480	4.87	2.5	7.37	30
	Low Power (0 dBm)	1	2402	0.81	2.5	3.31	30
			2440	0.62	2.5	3.12	30
			2480	0.50	2.5	3.00	30

#### 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
<sup>1</sup> 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	( <sup>2</sup> )
13.36–13.41.			

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.

<sup>2</sup> Above 38.6

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

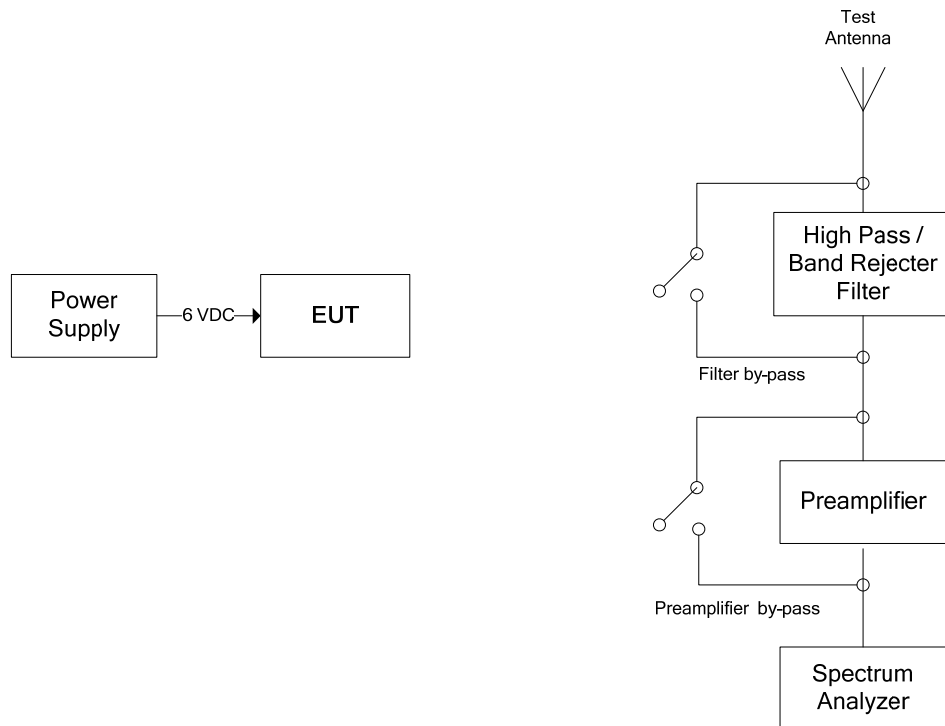
Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

#### 5.4.2. Method of Measurements

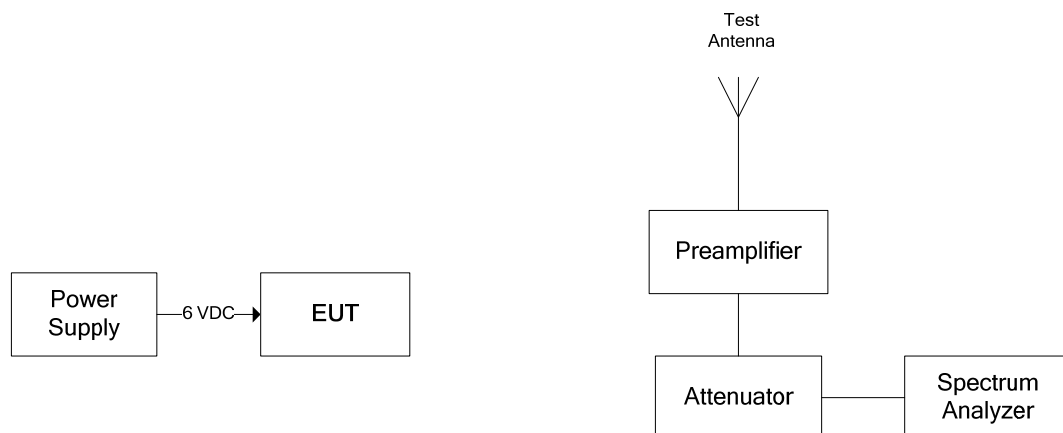
KDB 558074 D01 DTS Meas Guidance v05r02 Sections 8.5, 8.6, 8.7 and ANSI C63.10.

#### 5.4.3. Test Arrangement

##### Transmitter Radiated Spurious Emission



##### Band-Edge RF Radiated Emission



#### 5.4.4. Test Data

##### 5.4.4.1. Transmitter Radiated Spurious Emissions

###### 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.

Fundamental Frequency:		2402 MHz					
Frequency Test 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	100.10	--	V	--	--	--	--
2402.0	102.22	--	H	--	--	--	--
4804.0	44.59	34.52	H	54.0	82.2	-19.5	Pass*
12010.0	55.22	42.51	V	54.0	82.2	-11.5	Pass*
12010.0	57.88	44.42	H	54.0	82.2	-9.6	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					
Frequency Test 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	101.91	--	V	--	--	--	--
2440.0	105.37	--	H	--	--	--	--
4880.0	45.84	37.28	H	54.0	85.4	-16.7	Pass*
7320.0	61.54	52.70	V	54.0	85.4	-1.3	Pass*
7320.0	58.42	48.72	H	54.0	85.4	-5.3	Pass*
12200.0	62.05	49.38	V	54.0	85.4	-4.6	Pass*
12200.0	62.37	49.87	H	54.0	85.4	-4.1	Pass*
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.							

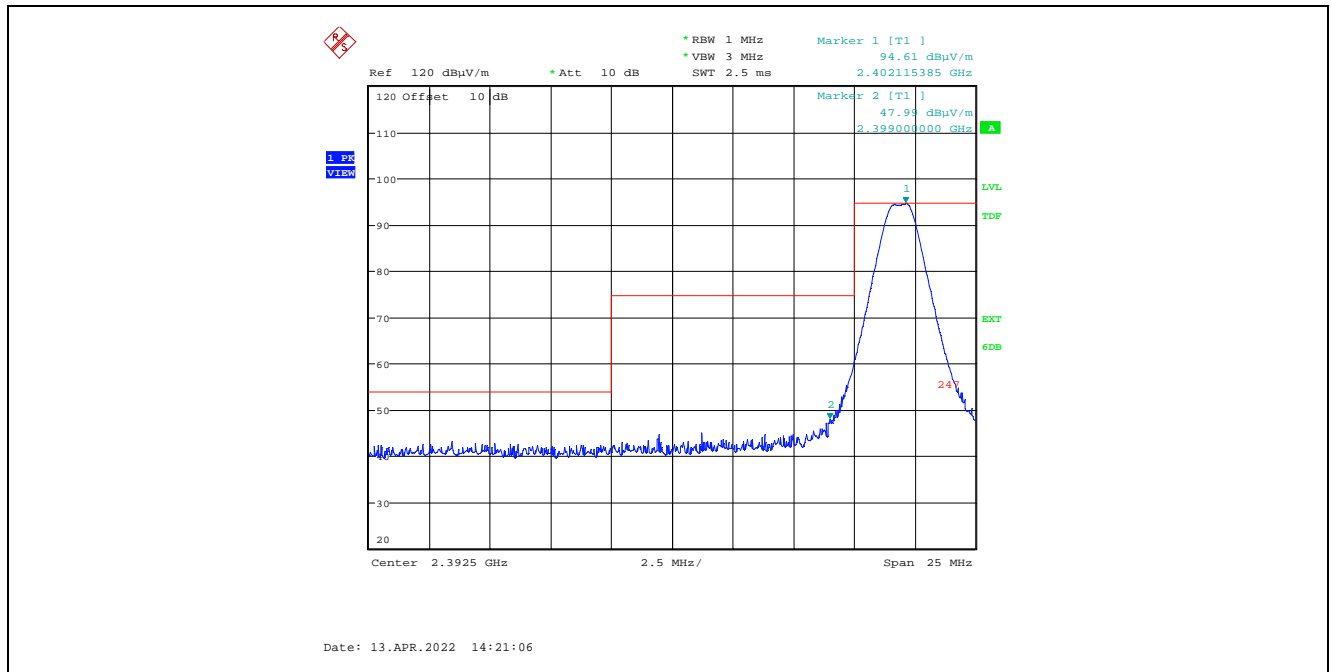
\*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:		2480 MHz					
Frequency Test 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	101.94	--	V	--	--	--	--
2480.0	102.01	--	H	--	--	--	--
4960.0	44.33	35.31	H	54.0	82.0	-18.7	Pass*
7440.0	61.45	52.79	V	54.0	82.0	-1.2	Pass*
7440.0	56.99	47.57	H	54.0	82.0	-6.4	Pass*
12400.0	60.53	47.80	V	54.0	82.0	-6.2	Pass*
12400.0	59.66	46.85	H	54.0	82.0	-7.2	Pass*
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.							

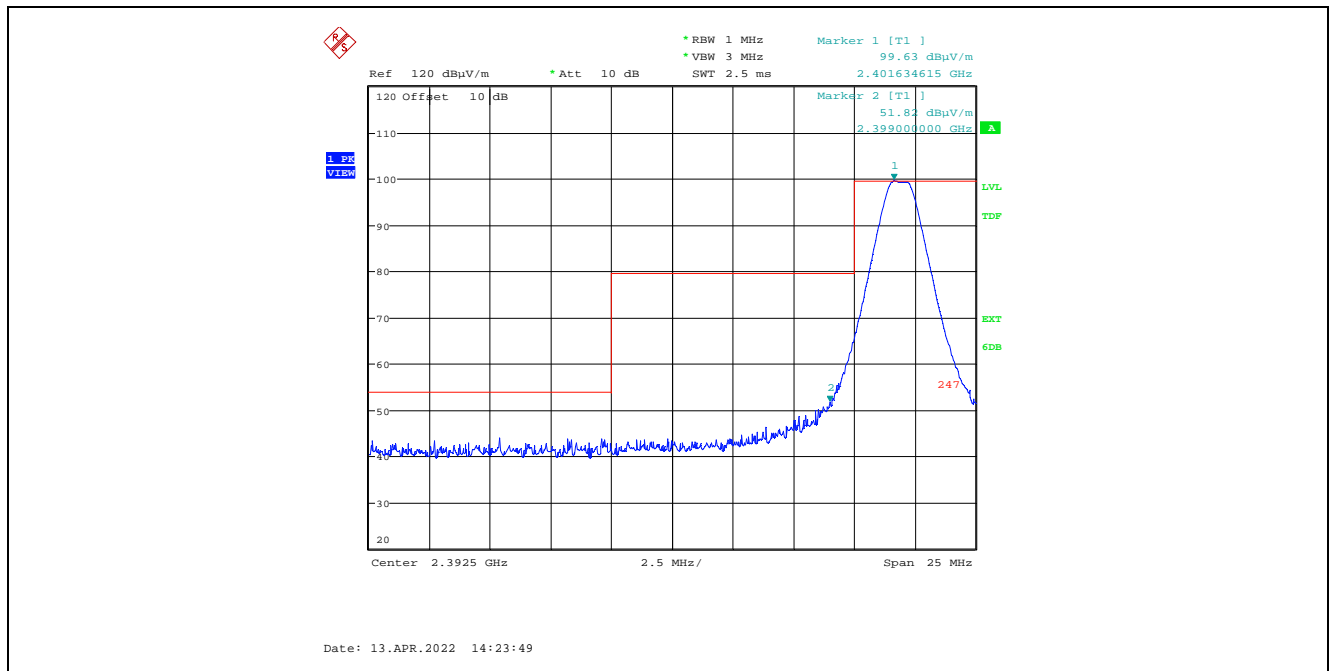
\*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

#### 5.4.4.2. Band-Edge RF Radiated Emissions

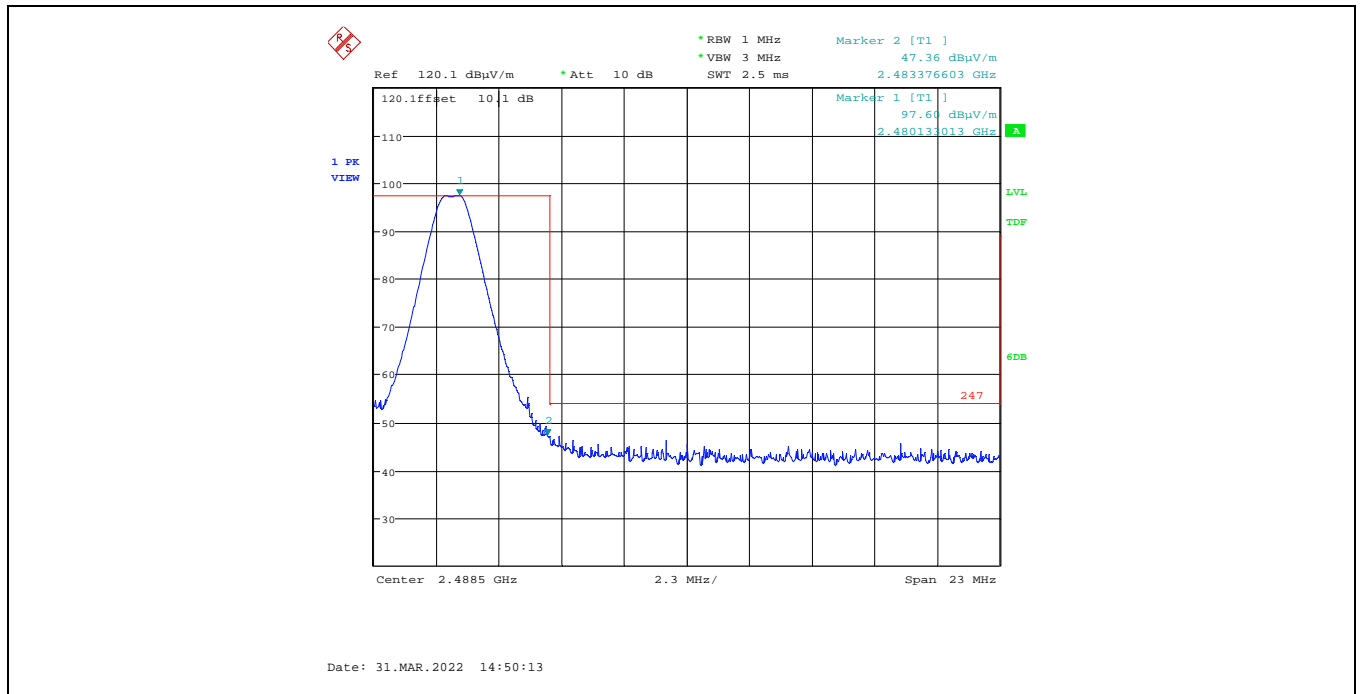
**Plot 5.4.4.2.1.** Band-Edge RF Radiated Emissions at 3 m, Vertical Polarization  
2402 MHz, Low End of Frequency Band



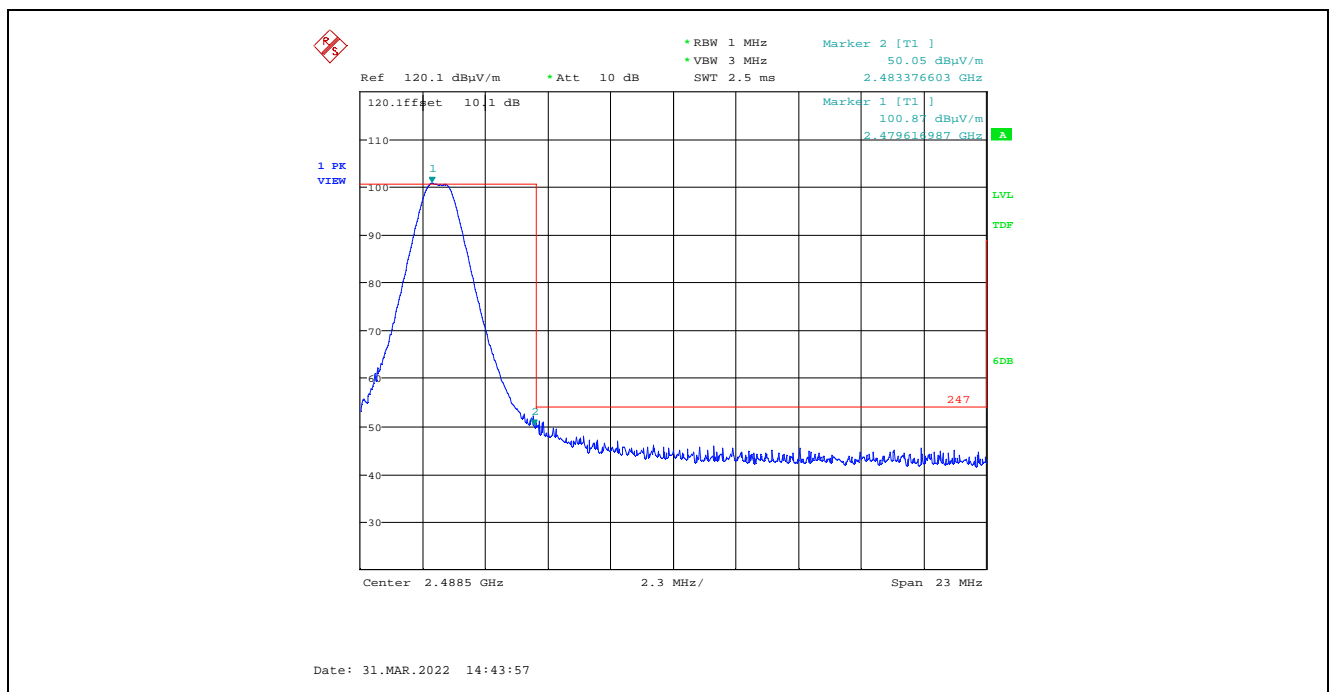
**Plot 5.4.4.2.2.** Band-Edge RF Radiated Emissions at 3 m, Horizontal Polarization  
2402 MHz, Low End of Frequency Band



**Plot 5.4.4.2.3.** Band-Edge RF Radiated Emissions at 3 m, Vertical Polarization  
2480 MHz, High End of Frequency Band



**Plot 5.4.4.2.4.** Band-Edge RF Radiated Emissions at 3 m, Horizontal Polarization  
2480 MHz, High End of Frequency Band





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

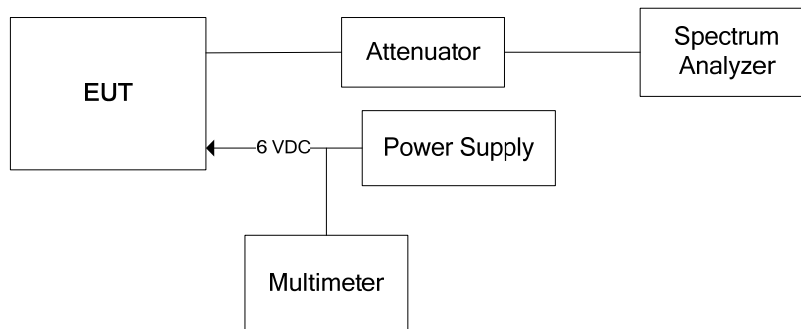
### 5.5.1. Limit(s)

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 PKPSD

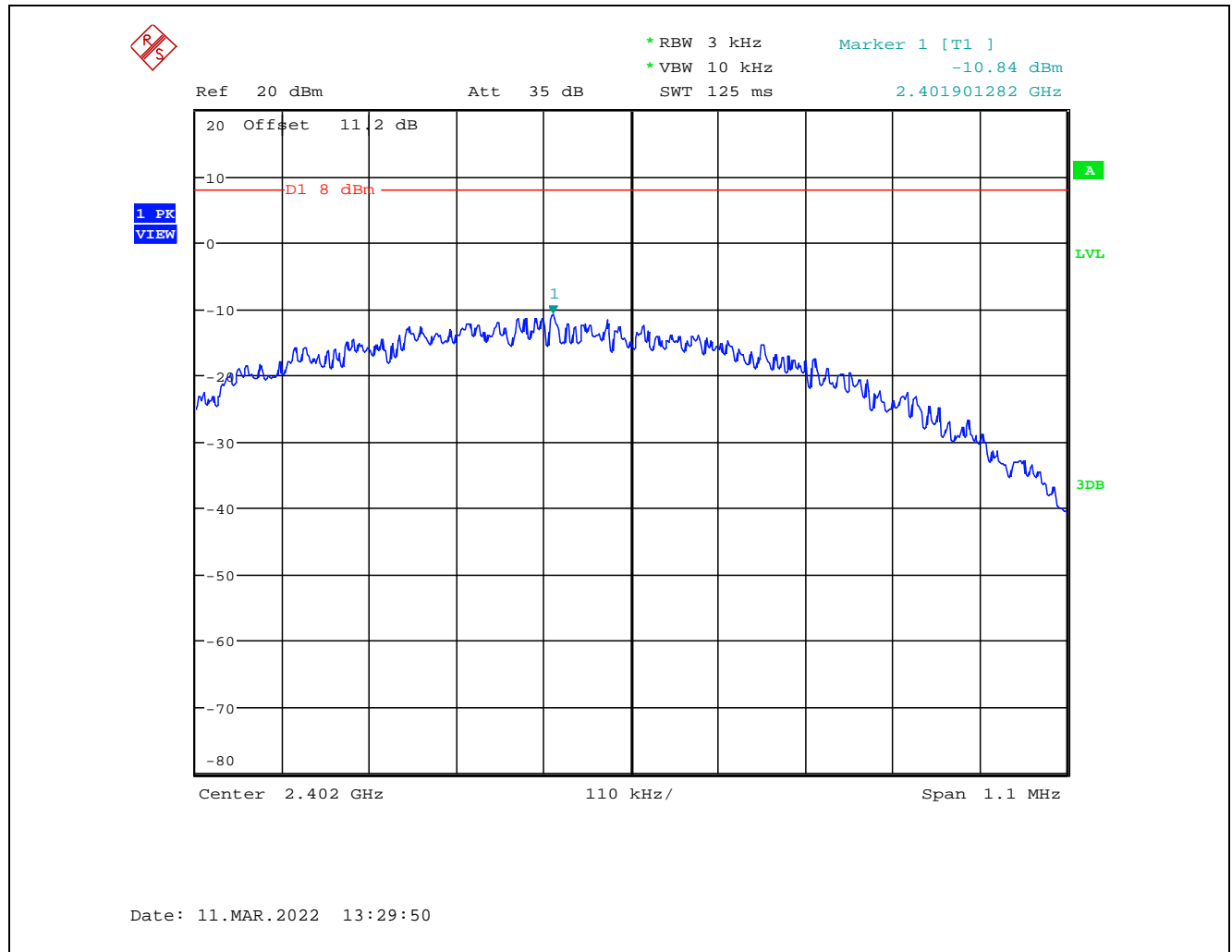
### 5.5.3. Test Arrangement



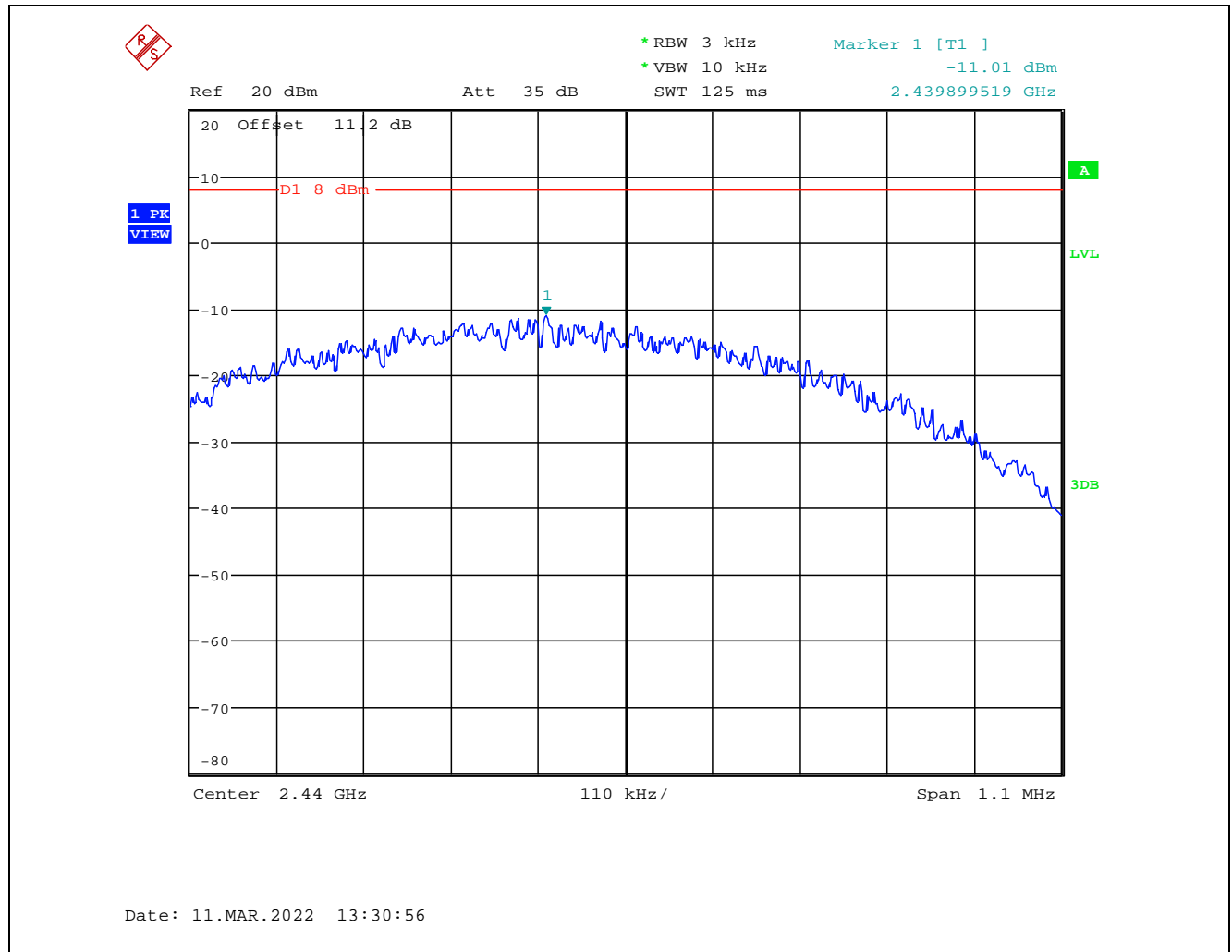
### 5.5.4. Test Data

Modulation	Power Setting	Data Rate (Mbps)	Frequency (MHz)	PSD (dBm)	Max. Limit (dBm)	Margin (dBm)
GFSK	High Power (5 dBm)	1	2402	-10.84	8	-18.84
			2440	-11.01	8	-19.01
			2480	-10.98	8	-18.98

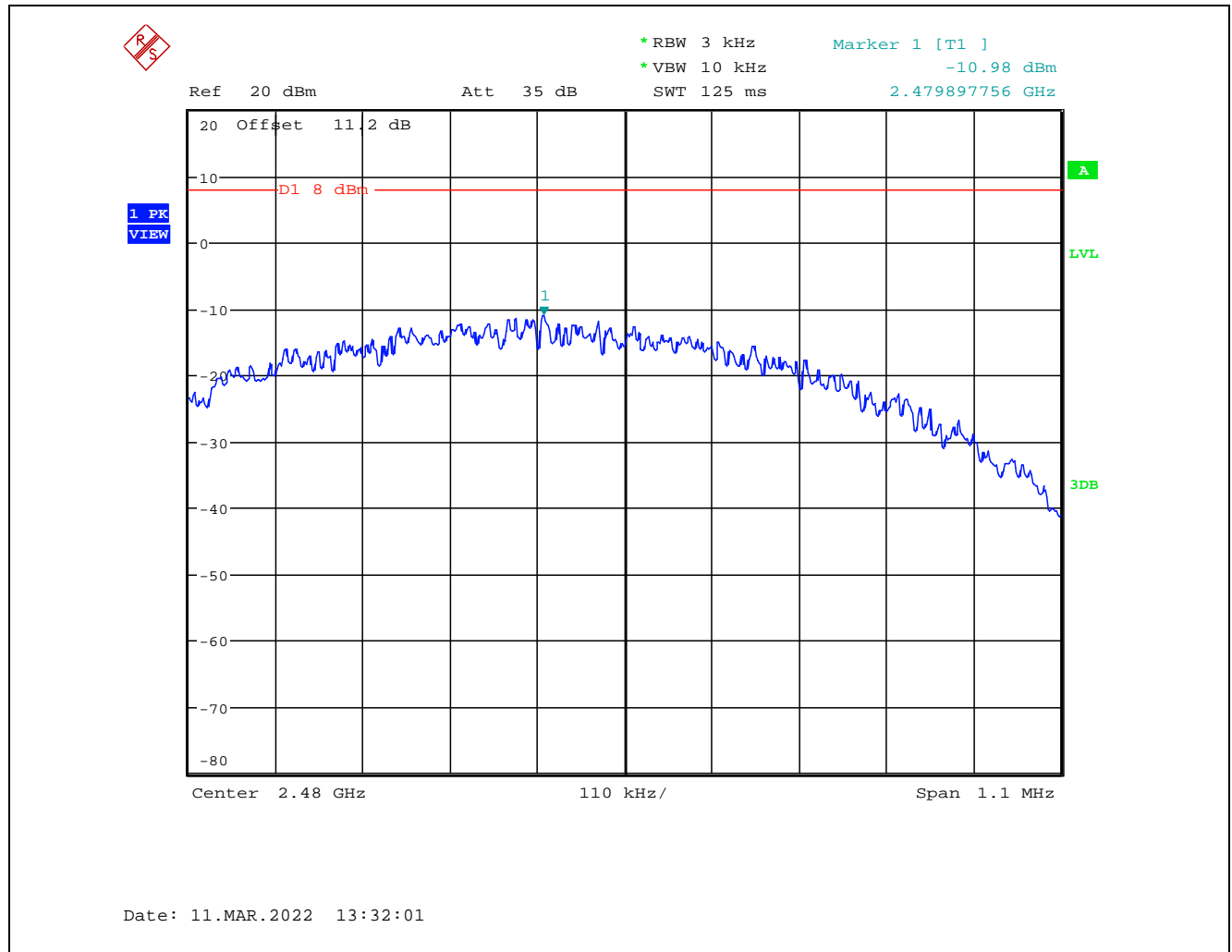
**Plot 5.5.4.1.** Power Spectral Density, GFSK Modulation, High Power, 2402 MHz, 1 Mbps



**Plot 5.5.4.2.** Power Spectral Density, GFSK Modulation, High Power, 2440 MHz, 1 Mbps



**Plot 5.5.4.3.** Power Spectral Density, GFSK Modulation, High Power, 2480 MHz, 1 Mbps



## 5.6. RF EXPOSURE REQUIRMENTS [§§ 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 <sup>2</sup> )	Averaging time (minutes)
<b>(A) Limits for Occupational/Controlled Exposures</b>				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f <sup>2</sup> )	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f <sup>2</sup> )	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 can not 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/cm<sup>2</sup>  
G: numeric gain of antenna relative to isotropic radiator  
r: distance to centre of radiation in cm

### 5.6.3. RF Evaluation

MPE Evaluation for EUT with 2.5 dBi Antenna							
Frequency (MHz)	Maximum Conducted Power (dBm)	Maximum Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm <sup>2</sup> )	MPE Limit (mW/cm <sup>2</sup> )
2402	4.73	2.5	7.23	5.28	20	0.0011	1.0

## EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	Hewlett Packard	8593EM	3710A00223	9 kHz – 22 GHz	05 Nov 2022
High Pass filter	Rohde & Schwarz	EZ-25	830164/006	150 kHz – 30 MHz	06 Aug 2022
LISN Used	Schwarzbeck	NSLK 8127	8127276	9 kHz–30 MHz	20 Oct 2022
DC Power Supply	HQ Power	PS 613U	NSN	0 – 30 VDC, 3A	See Note 1
Transformer	OperatingTech	OTE-40-24-ACW22-N	-	120VAC 60Hz 60W – 24VAC	See Note 1
Spectrum Analyzer	Rohde & Schwarz	FSU26	100398	20Hz–26.5 GHz	20 Sep 2023
Attenuator	Hewlett Packard	8493C	0461	DC–26.5 GHz	See Note 1
Peak Power Analyzer	Hewlett Packard	8991A	3342A00657	---	11 Mar 2024
Peak Power Sensor	Hewlett Packard	84814A	3205A00175	0.5-40GHz	11 Mar 2024
Horn Antenna	ETS-Lindgren	3115	9911-5955	1 - 18GHz	12 Oct 2022
Preamplifier	Hewlett Packard	8449B	3008A00769	1 - 26.5GHz	11 Sep 2022
Attenuator	Hewlett Packard	3493C	00751	DC–26.5 GHz	See Note 1
Power Supply	Hewlett Packard	6218C	---	0-50Vdc / 0-0.2A	See Note 1
Multimeter	Fluke	8842A	4142055	20 mV to 1000 V	03 Aug 2023
EMI Receiver	Rohde & Schwarz	FSU26	200946	20Hz–26.5 GHz	11 Mar 2023
Biconilog Antenna	EMCO	3142C	00034792	26-2000MHz	16 May 2022
Horn Antenna	ETS	3160-09	00118385	18-26GHz	22 Jan 2023
Preamplifier	Com-Power	PAM-118A	551052	500 MHz - 18GHz	11 Sep 2022
Preamplifier	Com-Power	PAM-840A	18050002	18 – 40 GHz	28 Sep 2022
Band Reject Filter	Microtronics	BRM50701	105	Cut off 2.170-3 GHz	See Note 1
High Pass Filter	K & L	11SH-10-4000/T 12000	4	Cut off 2.4GHz	See Note 1
Note 1: Internal Verification/Calibration check					

## ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

File #: 22SMCS032\_FCC15C247  
May 9, 2022

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

## 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	$\pm 2.62$
Conducted Output Power	$\pm 0.63$ dB
Power Spectral Density	$\pm 0.63$ dB
Occupied Bandwidth	$\pm 0.20$ Hz
Transmitter Band-edge Radiated Emissions	$\pm 2.76$ dB (1-18GHz)
Transmitter Spurious Radiated Emissions	$\pm 4.20$ dB (30 MHz – 1 GHz)
	$\pm 2.70$ dB (1 – 18 GHz)
	$\pm 3.11$ dB (18 – 26.5 GHz)