REGULATORY COMPLIANCE TEST REPORT

FCC Part 15 Subpart C 15.247 (DTS), ISED RSS-247 Issue 2

Report No.: RFXP01-U2 Rev A

Company: Drum Workshop

Model Name: DWE-DLM1

REGULATORY COMPLIANCE TEST REPORT

Company Name: Drum Workshop

Model Name: DWE-DLM1

To: FCC CFR 47 Part 15 Subpart C 15.247 (DTS) & IC RSS-247 Issue 2

Test Report Serial No.: RFXP01-U2 Rev A

This report supersedes: NONE

Applicant: Drum Workshop
3450 Lunar Ct
Oxnard, California 93030
USA

Issue Date: 21st November 2022

This Test Report is Issued Under the Authority of:

MiCOM Labs, Inc.
575 Boulder Court
Pleasanton California 94566
USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

ACCREDITED
TESTING CERT #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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1. ACCREDITATION, LISTINGS & RECOGNITION

1.1. TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard ISO/IEC 17025:2017. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

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Accredited Laboratory

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Pleasanton, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

CORPORATE SEAL

Presented this 14th day of January 2022.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2023

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

1.2. RECOGNITION

MiCOM Labs, Inc is widely recognized for its wireless testing and certification capabilities. In addition to being recognized for Testing and Certification under Phase 2 Mutual Recognition Agreements (MRA) with Canada, Europe, United Kingdom and Japan, our international recognition includes Conformity Assessment Body (CAB) designation status under agreements with Asia Pacific (APEC) MRA Phase 1 countries giving acceptance of MiCOM Labs test reports. MiCOM Labs test reports are accepted globally.

Country	Recognition Body	Status	MRA Phase	Identification No.
USA	Federal Communications Commission (FCC)	TCB	-	US0159 Test Firm Designation#: US1084
Canada	Industry Canada (ISED)	FCB	APEC MRA 2	US0159 ISED#: 4143A
Japan	MIC (Ministry of Internal Affairs and Communication)	CAB	Japan MRA 2	RCB 210
	Japan Approvals Institute for Telecommunication Equipment (JATE)			
	VCCI	--	--	A-0012
Europe	European Commission	NB	EU MRA 2	NB 2280
United Kingdom	Department for Business, Energy & Industrial Strategy (BEIS)	AB	UK MRA 2	AB 2280
Mexico	Instituto Federal de Telecomunicaciones (IFT)	CAB	Mexico MRA 1	US0159
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)			
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)			
Singapore	Infocomm Development Authority (IDA)			
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)			
Vietnam	Ministry of Communication (MIC)			

TCB – Telecommunications Certification Bodies (TCB)
FCB – Foreign Certification Body
CAB – Conformity Assessment Body
NB – Notified Body
AB – Approved Body
MRA – Mutual Recognition Agreement
MRA Phase I - recognition for product testing
MRA Phase II – recognition for both product testing and certification

1.3. PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard ISO/IEC 17065:2012. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-02.pdf

Accredited Product Certification Body

A2LA has accredited

MiCOM LABS

Pleasanton, CA

This product certification body is accredited in accordance with the recognized International Standard ISO/IEC 17065:2012 *Requirements for bodies certifying products, processes and services*. This product certification body also meets the *A2LA R322 – Specific Requirements – Notified Body Accreditation Requirements* and *A2LA R308 - Specific Requirements - ISO-IEC 17065 - Telecommunication Certification Body Accreditation Program*. This accreditation demonstrates technical competence for a defined scope and the operation of a management system.

Presented this 14th day of January 2022

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2381.02
Valid to November 30, 2023

For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.

United States of America – Telecommunication Certification Body (TCB)
Industry Canada – Certification Body, CAB Identifier – US0159
Europe – Notified Body (NB), NB Identifier - 2280
UK – Approved Body (AB), AB Identifier - 2280
Japan – Recognized Certification Body (RCB), RCB Identifier - 210

1. DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft	29th September 2022	Draft for client comment
Rev A	21st November 2022	Initial release

In the above table the latest report revision will replace all earlier versions.

2. TEST RESULT CERTIFICATE

Manufacturer:	Drum Workshop 3450 Lunar Ct Oxnard, California 93030 USA	**Tested By:**	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Model:	DWE-DLM1	**Telephone:**	+1 925 462 0304
Equipment Type:	DTS Transceiver	**Fax:**	+1 925 462 0306
S/N's:	Proto 1, Proto 2		
Test Date(s):	9th - 14th September 2022	**Website:**	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC CFR 47 Part 15 Subpart C 15.247, ISED RSS-247 Issue 2	**EQUIPMENT COMPLIES**

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

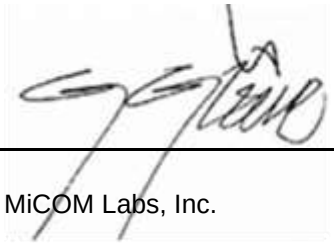
1. This document reports conditions under which testing was conducted and the results of testing performed.

2. Details of test methods used have been recorded and kept on file by the laboratory.

3. Test results apply only to the item(s) tested.

A2LA ACCREDITED TESTING CERT #2381.01

Approved & Released for MiCOM Labs, Inc. by:



Graeme Grieve
Quality Manager MiCOM Labs, Inc.

Gordon Hurst
President & CEO MiCOM Labs, Inc.

3. REFERENCES AND MEASUREMENT UNCERTAINTY

3.1. Normative References

REF.	PUBLICATION	YEAR	TITLE
I	KDB 558074 D01 v05r02	Apr 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.
II	A2LA	22nd June 2022	R105 - Requirement's When Making Reference to A2LA Accreditation Status
III	ANSI C63.10	2020	American National Standard for Testing Unlicensed Wireless Devices
IV	ANSI C63.4	2014	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
V	ETSI TR 100 028	2001-12	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
VI	FCC 47 CFR Part 15.247	Apr 2020	Radio Frequency Devices; Subpart C – Intentional Radiators
VII	ICES-003	Issue 7; Oct 2020	Information Technology Equipment (Including Digital Apparatus)
VIII	M 3003	EDITION 4 Oct 2019	Expression of Uncertainty and Confidence in Measurements
IX	RSS-247 Issue 2	Feb 2017	Digital Transmission Systems (DTSs), Frequency Hopping System (FHSs) and Licence-Exempt Local Area Network (LE-LEN) Devices
X	RSS-Gen Issue 5	Amendment 1,2 (Feb 2021)	General Requirements for Compliance of Radio Apparatus. With Amendments 1: March 2019 and 2: Feb 2021.
XI	FCC 47 CFR Part 2.1033	May 2021	FCC requirements and rules regarding photographs and test setup diagrams.

3.2. Test and Uncertainty Procedure

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

4. PRODUCT DETAILS AND TEST CONFIGURATIONS

4.1. Technical Details

Details	Description
Purpose:	Test of the Drum Workshop DWE-DLM1 to FCC CFR 47 Part 15 Subpart C 15.247 and ISED RSS-247.
Applicant:	Drum Workshop 3450 Lunar Ct Oxnard, California 93030 USA
Manufacturer:	Drum Workshop
Laboratory performing the tests:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Test report reference number:	RFXP01-U2
Date EUT received:	8th September 2022
Standard(s) applied:	FCC CFR 47 Part 15 Subpart C 15.247 ISED RSS-247
Dates of test (from - to):	9th - 14th September 2022
No of Units Tested:	2
Product Family Name:	DWE
Model(s):	DWE-DLM1
Technology:	DTS
Location for use:	Indoors and Outdoors
Declared Frequency Range(s):	2400 - 2483.5 MHz;
Type of Modulation:	GFSK
Declared Nominal Output Power (dBm):	+10 dBm
Transmit/Receive Operation:	Transceiver
Rated Input Voltage and Current:	Battery 3VDC
Operating Temperature Range:	+10°C to +50°C
ITU Emission Designator:	1M10F1D
Equipment Dimensions:	25mm x17mm x 3mm
Weight:	1 oz
Hardware Version:	Rev X1
Firmware Version:	Prototype

4.2. Scope Of Test Program

Drum Workshop DWE-DLM1

The scope of the test program was to test the Drum Workshop DWE-DLM1 configuration in the frequency ranges 2400 - 2483.5 MHz; for compliance against the following specification:

FCC CFR 47 Part 15 Subpart C 15.247 (DTS)
Radio Frequency Devices; Subpart C – Intentional Radiators

ISED RSS-247 Issue 2
Digital Transmission Systems (DTSs), Frequency Hopping System (FHSs) and License-Exempt Local Area Network (LE-LEN) Devices

MiCOM Labs, 575 Boulder Court, Pleasanton, California 94566 USA, Phone: +1 (925) 462 0304, Fax: +1 (925) 462 0306, www.micomlabs.com

4.3. Equipment Model(s) and Serial Number(s)

Type (EUT/ Support)	Equipment Description	Manufacturer	Model No.	Serial No.
EUT	Conducted Module	Drum Workshop	DWE-DLM1	Proto1
EUT	Radiated Module	Drum Workshop	DWE-DLM1	Proto2

4.4. Antenna Details

Type	Manufacturer	Model	Type	Gain (dBi)	Frequency Band (MHz)
Integral	MFG Johanson Technology	2450AT18A100E,	Chip	2.72	2400 - 2483.5
Integral	Drum Workshop	Wire	Wire	2.82	2400 - 2483.5

4.5. Cabling and I/O Ports

None, unit tested was a module

4.6. Test Configurations

Results for the following configurations are provided in this report:

Operational Mode(s) DTS	Data Rate with Highest Power MBit/s	Channel Frequency (MHz)			
		Low	Mid	High	Additional
		2400 - 2483.5 MHz			
GFSK	1.00	2,402.00	2,442.00	2,480.00	--

4.7. Equipment Modifications

1. NONE

4.8. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. NONE

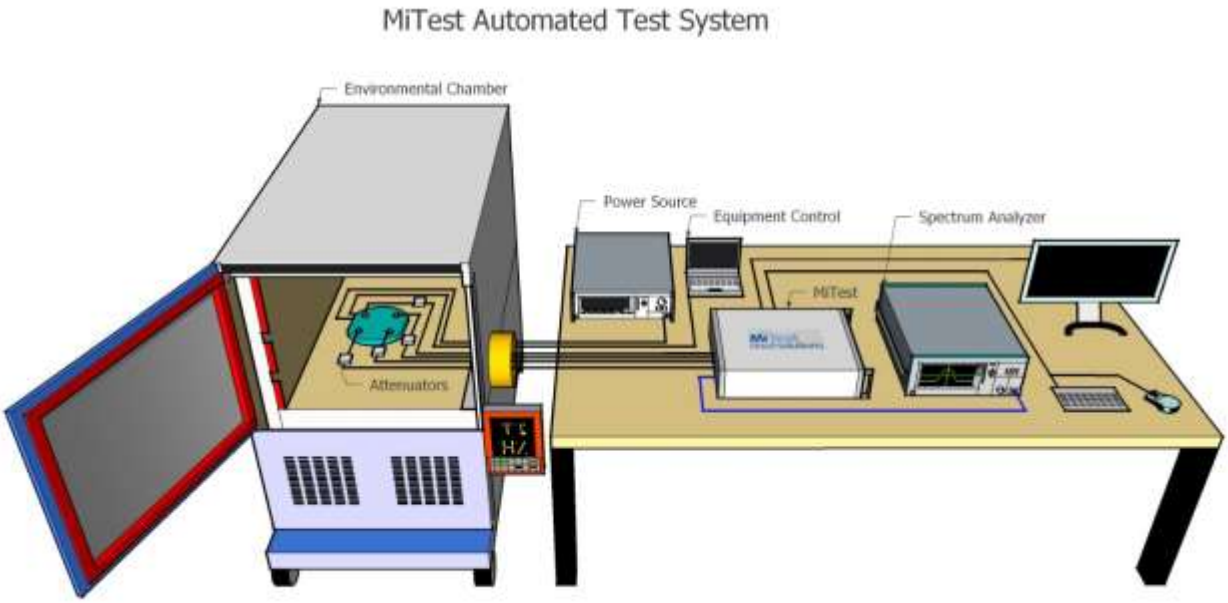
5. TEST SUMMARY

List of Measurements

Test Header	Result	Data Link
6 dB & 99% Bandwidth	Complies	View Data
Conducted Output Power	Complies	View Data
Power Spectral Density	Complies	View Data
Emissions	Complies	-
(1) Conducted Emissions	Complies	-
(i) Conducted Spurious Emissions	Complies	View Data
(ii) Conducted Band-Edge Emissions	Complies	View Data
(2) Radiated Emissions	Complies	-
(i) TX Spurious & Restricted Band Emissions	Complies	View Data
(ii) Restricted Edge & Band-Edge Emissions	Complies	View Data

6. TEST EQUIPMENT CONFIGURATION(S)

6.1. Conducted RF



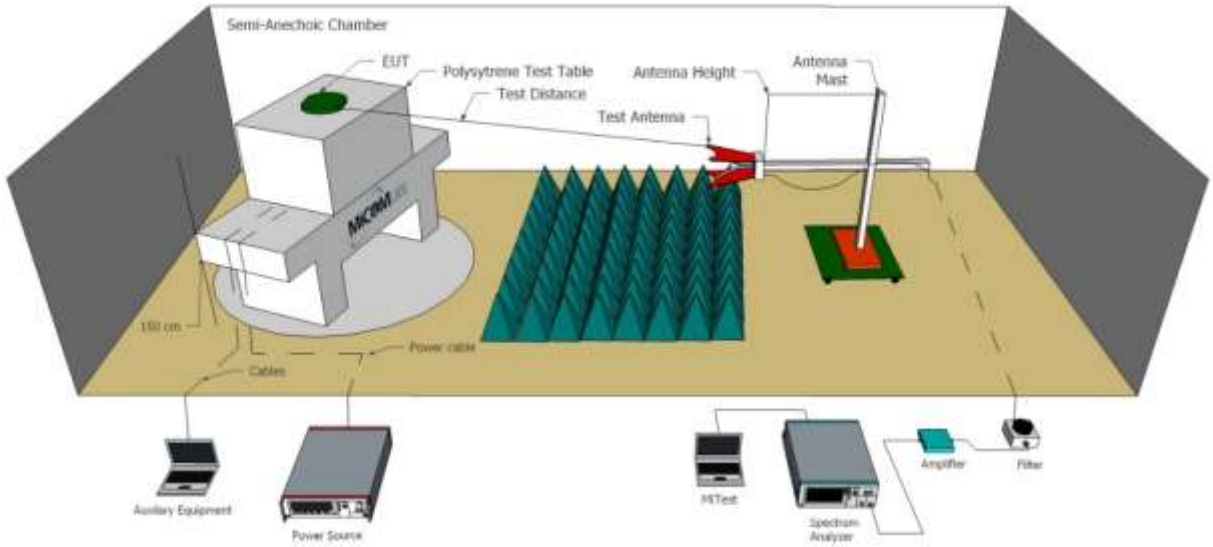
A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
#3 SA	MiTest Box to SA	Fairview Microwave	SCA1814-0101-72	#3 SA	7 Oct 2022
#3P1	EUT to MiTest box port 1	Fairview Microwave	SCA1814-0101-72	#3P1	7 Oct 2022
#3P2	EUT to MiTest box port 2	Fairview Microwave	SCA1814-0101-72	#3P2	7 Oct 2022
#3P3	EUT to MiTest box port 3	Fairview Microwave	SCA1814-0101-72	#3P3	7 Oct 2022
#3P4	EUT to MiTest box port 4	Fairview Microwave	SCA1812-0101-72	#3P4	7 Oct 2022
249	Thermocouple; Resistance Thermometer	Thermotronics	GR2105-02	9340 #2	30 Oct 2022
287	Rohde & Schwarz 40 GHz Receiver	Rhode & Schwarz	ESIB40	100201	8 Oct 2022
398	MiTest RF Conducted Test Software	MiCOM	MiTest ATS	Version 4.2.3.0	Not Required
405	DC Power Supply 0-60V	Agilent	6654A	MY4001826	Cal when used
408	USB to GPIB interface	National Instruments	GPIB-USB HS	14C0DE9	Not Required
441	USB Wideband Power Sensor	Boonton	55006	9179	20 Sep 2022
442	USB Wideband Power Sensor	Boonton	55006	9181	19 Oct 2022
445	PoE Injector	D-Link	DPE-101GL	QTAH1E2000625	Not Required
461	Spectrum Analyzer	Agilent	E4440A	MY46185537	27 Sep 2023
493	USB Wideband Power Sensor	Boonton	55006	9634	8 Oct 2022
494	USB Wideband Power Sensor	Boonton	55006	9726	19 Oct 2022
510	Barometer/Thermometer	Digi Sense	68000-49	170871375	4 Jan 2023
512	MiTest Cloud Solutions RF Test Box	MiCOM	2nd Gen with DFS	512	29 Jun 2023
555	Rhode & Schwarz Receiver (Firmware Version : 2.00 SP1)	Rhode & Schwarz	ESW 44	101893	28 Jun 2023
75	Environmental Chamber	Thermatron	SE-300-2-2	27946	20 Feb 2023

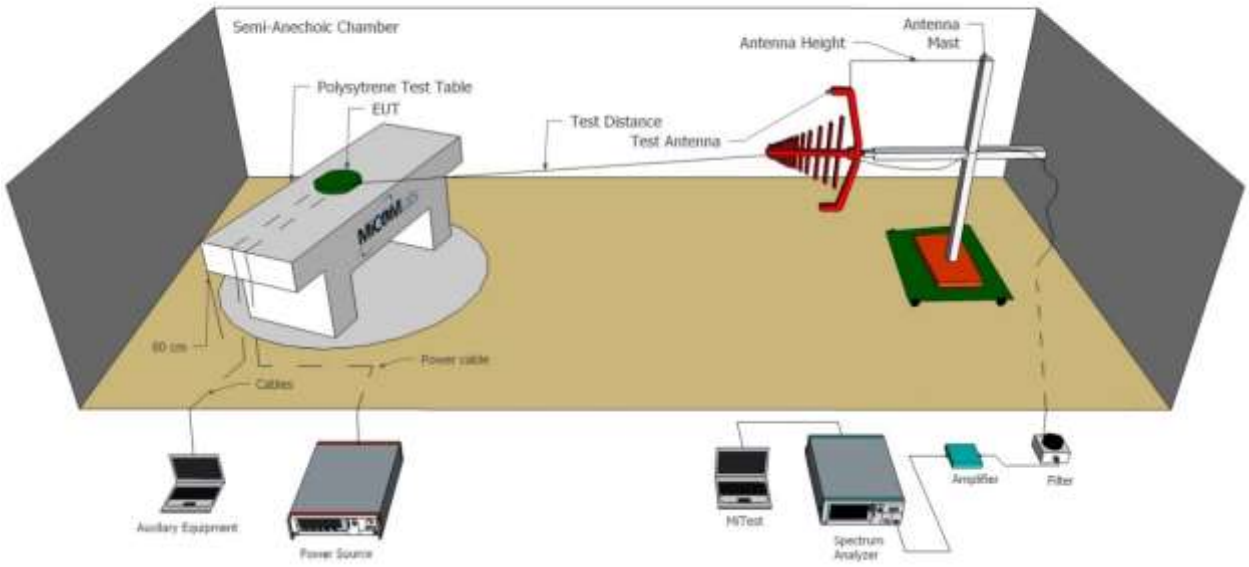
6.2. Radiated Emissions

The following tests were performed using the radiated test set-up shown in the diagram below.
Radiated emissions above and below 1GHz.

Radiated Emissions Above 1GHz Test Setup



Radiated Emissions Below 1GHz Test Setup



Test Equipment Utilized

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
170	Video System Controller for Semi Anechoic Chamber	Panasonic	WV-CU101	04R08507	Not Required
396	2.4 GHz Notch Filter	Microtronics	BRM50701	001	6 Oct 2022
397	Amp 10 - 2500MHz	MiCOM Labs	Amp 10 - 2500 MHz	NA	27 Oct 2022
399	ETS 1-18 GHz Horn Antenna	ETS	3117	00154575	30 Sep 2023
406	Amplifier for Radiated Emissions	MiCOM Labs	40dB 1 to 18GHz Amp	0406	2 Nov 2022
410	Desktop Computer	Dell	Inspiron 620	WS38	Not Required
411	Mast/Turntable Controller	Sunol Sciences	SC98V	060199-1D	Not Required
412	USB to GPIB Interface	National Instruments	GPIB-USB HS	11B8DC2	Not Required
413	Mast Controller	Sunol Science	TWR95-4	030801-3	Not Required
415	Turntable Controller	Sunol Sciences	Turntable Controller	None	Not Required
447	MiTest Rad Emissions Test Software Version 1.0	MiCOM	Rad Emissions Test Software	447	Not Required
462	Schwarzbeck cable from Antenna to Amplifier.	Schwarzbeck	AK 9513	462	27 Oct 2022
463	Schwarzbeck cable from Amplifier to Bulkhead.	Schwarzbeck	AK 9513	463	27 Oct 2022
464	Schwarzbeck cable from Bulkhead to Receiver	Schwarzbeck	AK 9513	464	27 Oct 2022
466	Low Pass Filter DC-1500 MHz	Mini-Circuits	NLP-1750+	VUU1040143 8	6 Oct 2022
467	2495 to 2650 MHz notch filter	MicroTronics	BRM50709	011	6 Oct 2022
480	Cable - Bulkhead to Amp	SRC Haverhill	157-3050360	480	6 Oct 2022
481	Cable - Bulkhead to Receiver	SRC Haverhill	151-3050787	481	6 Oct 2022
510	Barometer/Thermometer	Digi Sense	68000-49	170871375	4 Jan 2023
554	Precision SMA Cable	Fairview Microwave	SCE18060101-400CM	554	6 Oct 2022
555	Rhode & Schwarz Receiver (Firmware Version : 2.00 SP1)	Rhode & Schwarz	ESW 44	101893	28 Jun 2023

7. MEASUREMENT AND PRESENTATION OF TEST DATA

The measurement and graphical data presented in this test report was generated automatically using state-of-the-art technology creating an easy to read report structure. Numerical measurement data is separated from supporting graphical data (plots) through hyperlinks. Numerical measurement data can be reviewed without scrolling through numerous graphical pages to arrive at the next data matrix.

Plots have been relegated into the Appendix 'Graphical Data'.

Test and report automation was performed by MiTest. MiTest is an automated test system developed by MiCOM Labs. MiTest is the first cloud based modular test system enabling end-to-end automation of regulatory compliance testing for conducted RF testing.

The MiCOM Labs "MiTest" Automated Test System" (Patent Pending)

8. TEST RESULTS

8.1. 6 dB & 99% Bandwidth

Conducted Test Conditions for 6 dB and 99% Bandwidth			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	6 dB and 99 % Bandwidth	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)(2)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for 6 dB and 99% Bandwidth Measurement
The bandwidth at 6 dB and 99 % was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency.

Testing was performed under ambient conditions at nominal voltage. Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured and reported.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.

Limits for 6 dB and 99% Bandwidth

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(2) Systems using digital modulation techniques may operate in the 902-928 MHz and 2400-2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Equipment Configuration for 6 dB & 99% Bandwidth			
Variant:	GFSK	**Duty Cycle (%):**	99
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 6 dB Bandwidth (MHz) Port(s)				6 dB Bandwidth (MHz)	
MHz	a	b	c	d	Highest	Lowest
2402.0	0.705	--	--	--	0.705	0.705
2442.0	0.705	--	--	--	0.705	0.705
2480.0	0.705	--	--	--	0.705	0.705

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				Maximum 99% Bandwidth (MHz)
MHz	a	b	c	d	
2402.0	1.078	--	--	--	1.078
2442.0	1.082	--	--	--	1.082
2480.0	1.078	--	--	--	1.078

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

8.2. Conducted Output Power

Conducted Test Conditions for Fundamental Emission Output Power			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Output Power	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (b) & (c)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Fundamental Emission Output Power Measurement
In the case of average power measurements an average power sensor was utilized.

For peak power measurements the spectrum analyzer built-in power function was used to integrate peak power over the 20 dB bandwidth.

Testing was performed under ambient conditions at nominal voltage only. Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured, summed (Σ) and reported.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.
Supporting Information
Calculated Power = A + G + Y+ 10 log (1/x) dBm

A = Total Power [10*Log10 ($10^{a/10}$ + $10^{b/10}$ + $10^{c/10}$ + $10^{d/10}$)]
G = Antenna Gain
Y = Beamforming Gain
x = Duty Cycle (average power measurements only)

Limits for Fundamental Emission Output Power
(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following for non-frequency hopping systems:

(3) For systems using digital modulation in the 902-928 MHz and 2400-2483.5 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.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.
(1) Fixed point-to-point operation:
(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5

MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

Equipment Configuration for Peak Output Power			
Variant:	GFSK	**Duty Cycle (%):**	99.0
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	2.72
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Output Power (dBm) Port(s)				Calculated Total Power Σ Port(s)	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	dBm	dBm	dB	
2402.0	7.24	--	--	--	7.24	30.0	-22.76	Max
2442.0	6.45	--	--	--	6.45	30.0	-23.55	Max
2480.0	8.35	--	--	--	8.35	30.0	-21.65	Max

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-01 MEASURING RF OUTPUT POWER
Measurement Uncertainty:	±1.33 dB

The above measurements are true pulse readings and therefore a Duty Cycling correction factor is not required.

8.3. Power Spectral Density

Conducted Test Conditions for Power Spectral Density			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Power Spectral Density	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (e)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Power Spectral Density
The transmitter output was connected to a spectrum analyzer and the measured made in a 3 kHz resolution bandwidth using the analyzer auto-coupled sweep-time. A peak value was found over the full emission bandwidth and the spectrum downloaded for post processing purposes.

Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured separately. The Peak Power Spectral Density is the highest level found across the emission bandwidth. With multiple antenna port measurements the numerical analyzer data from each port is summed (å) and a link to this additional graphic is provided.

Testing was performed under ambient conditions at nominal voltage only.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.

Measure and sum the spectra across the outputs. With this technique, spectra are measured at each output of the device at the required resolution bandwidth. The individual spectra are then summed mathematically in linear power units. Unlike in-band power measurements, in which the sum involves a single measured value (output power) from each output, measurements for compliance with PSD limits involve summing entire spectra across corresponding frequency bins on the various outputs. Consistency is maintained for any device with multiple transmitter outputs to be certain the individual outputs are all aligned with the same span and same number of points. In this instance, the linear power spectrum value within the first spectral bin of output 0 is summed with that in the first spectral bin of output 1, and the first spectral bin of output 2, and so on up to the Nth output to obtain the true value for the first frequency bin of the summed spectrum. The summed spectrum value for each frequency bin is computed in this fashion. These summed spectral values were post processed and the resulting numerical and graphical data presented.

NOTE:
It may be observed that the spectrum in some antenna port plots break the limit line however this in itself does NOT constitute a failure. In all cases a spectrum summation plot is provided in order to prove compliance. A failure occurs only after the summation of all spectrum plots have been summed and are found to be greater than the limit line.

Supporting Information
Calculated Power = A + 10 log (1/x) dBm
A = Total Power Spectral Density [10 Log10 ($10^{a/10}$ + $10^{b/10}$ + $10^{c/10}$ + $10^{d/10}$)]
x = Duty Cycle

Limits Power Spectral Density
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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Equipment Configuration for Power Spectral Density - Peak			
Variant:	GFSK	**Duty Cycle (%):**	99.0
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	2.72
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Power Spectral Density Port(s) (dBm/3KHz)				Amplitude Summation	Limit	Margin
MHz	a	b	c	d	dBm/3KHz	dBm/3KHz	dB
2402.0	-16.902	--	--	--	-16.902	8.0	-24.9
2442.0	-17.410	--	--	--	-17.410	8.0	-25.4
2480.0	-19.186	--	--	--	-19.186	8.0	-27.2

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

8.4. Emissions

8.4.1. Conducted Emissions

8.4.1.1. Conducted Spurious Emissions

Conducted Test Conditions for Transmitter Conducted Spurious and Band-Edge Emissions			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Max Unwanted Emission Levels	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (d)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Transmitter Conducted Spurious and Band-Edge Emissions Measurement
Transmitter Conducted Spurious and Band-Edge emissions were measured at a limit of 30 dBc (average detector) or 20 dBc (peak detector) below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal. Measurements were made while EUT was operating in transmit mode of operation at the appropriate centre frequency closest to the band-edge. Emissions were maximized during the measurement and limits derived from the peak spectral power and drawn on each plot.

Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured separately. Testing was performed under ambient conditions at nominal voltage only.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.

Limits Transmitter Conducted Spurious and Band-Edge Emissions
(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 §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Equipment Configuration for Conducted Spurious Emissions - Peak			
Variant:	GFSK	**Duty Cycle (%):**	99
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Frequency Range	Conducted Spurious Emissions - Average (dBm)							
		Port a		Port b		Port c		Port d	
MHz	MHz	SE	Limit	SE	Limit	SE	Limit	SE	Limit
2402.0	30.0 - 26000.0	-40.768	-21.50	--	--	--	--	--	--
2442.0	30.0 - 26000.0	-40.615	-22.59	--	--	--	--	--	--
2480.0	30.0 - 26000.0	-39.847	-24.80	--	--	--	--	--	--

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	<=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB

Note: click the links in the above matrix to view the graphical image (plot).

8.4.1.2. Conducted Band-Edge Emissions

Conducted Test Conditions for Transmitter Conducted Spurious and Band-Edge Emissions			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Max Unwanted Emission Levels	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (d)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Transmitter Conducted Spurious and Band-Edge Emissions Measurement
Transmitter Conducted Spurious and Band-Edge emissions were measured at a limit of 30 dBc (average detector) or 20 dBc (peak detector) below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal. Measurements were made while EUT was operating in transmit mode of operation at the appropriate centre frequency closest to the band-edge. Emissions were maximized during the measurement and limits derived from the peak spectral power and drawn on each plot.

Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured separately. Testing was performed under ambient conditions at nominal voltage only.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.

Limits Transmitter Conducted Spurious and Band-Edge Emissions
(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 §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Equipment Configuration for Conducted Low Band-Edge Emissions - Peak

Variant:	GFSK	**Duty Cycle (%):**	99.0
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency:	2402.0 MHz					
Band-Edge Frequency:	2400.0 MHz					
Test Frequency Range:	2390.0 - 2406.0 MHz					
Port(s)	**Band-Edge Markers and Limit**			**Revised Limit**		**Margin**
	M1 Amplitude (dBm)	**Plot Limit (dBm)**	**M2 Frequency (MHz)**	**Amplitude (dBm)**	**M2A Frequency (MHz)**	**(MHz)**
a	-45.39	-20.24	2401.30	--	--	-1.300

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	<=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB

Note: click the links in the above matrix to view the graphical image (plot).

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Equipment Configuration for Conducted High Band-Edge Emissions - Peak			
Variant:	GFSK	**Duty Cycle (%):**	99.0
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency:	2480.0 MHz					
Band-Edge Frequency:	2483.5 MHz					
Test Frequency Range:	2475.0 - 2500.0 MHz					
Port(s)	**Band-Edge Markers and Limit**			**Revised Limit**		**Margin**
	M3 Amplitude (dBm)	**Plot Limit (dBm)**	**M2 Frequency (MHz)**	**Amplitude (dBm)**	**M2A Frequency (MHz)**	**(MHz)**
a	-46.21	-22.61	2480.60	--	--	-2.900

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	<=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB

Note: click the links in the above matrix to view the graphical image (plot).

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8.4.2. Radiated Emissions

8.4.2.1. TX Spurious & Restricted Band Emissions

Radiated Test Conditions for Radiated Spurious and Band-Edge Emissions (Restricted Bands)			
Standard:	FCC CFR 47 Part 15 Subpart C 15.247 (DTS)	**Ambient Temp. (ºC):**	20.0 - 24.5
Test Heading:	Radiated Spurious and Band-Edge Emissions	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.205, 15.209	**Pressure (mBars):**	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Radiated Spurious and Band-Edge Emissions (Restricted Bands)
Radiated emissions for restricted bands above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned. Measurements on any restricted band frequency or frequencies above 1 GHz are based on the use of measurement instrumentation employing peak and average detectors. All measurements were performed using a resolution bandwidth of 1 MHz.

Test configuration and setup for Radiated Spurious and Band-Edge Measurement were per the Radiated Test Set-up specified in this document.

Orientation testing of the EUT was performed and the EUT standing upright was determined to be the worst case for Spurious and Band Edge emissions with the integral antennas attached.

Limits for Restricted Bands
Peak emission: 74 dBuV/m
Average emission: 54 dBuV/m

Average Measurements were performed following ANSI C63.10 section11.12.2.5.2 Trace averaging across on and off times of the EUT transmissions followed by a duty cycle correction.
RMS detector used, DCCF of 10log (1/D) where D is the Duty Cycle.

Field Strength Calculation
The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.
FS = R + AF + CORR - FO

where:
FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

Example:
Given receiver input reading of 51.5 dBmV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength (FS) of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBmV/m

Conversion between dBmV/m (or dBmV) and mV/m (or mV) are as follows:
Level (dBmV/m) = 20 * Log (level (mV/m))

40 dBmV/m = 100 mV/m
48 dBmV/m = 250 mV/m

Restricted Bands of Operation (15.205)

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

Frequency Band			
MHz	**MHz**	**MHz**	**GHz**
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
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	2690-2900	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	Above 38.6
13.36-13.41			

(b) Except as provided in paragraphs (d) and (e) of this section, 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 measurements.

(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.

(d) The following devices are exempt from the requirements of this section:

(1) Swept frequency field disturbance sensors operating between 1.705 and 37 MHz provided their emissions only sweep through the bands listed in paragraph (a) of this section, the sweep is never stopped with the fundamental emission within the bands listed in paragraph (a) of this section, and the fundamental emission is outside of the bands listed in paragraph (a) of this section more than 99% of the time the device is actively transmitting, without compensation for duty cycle.

(2) Transmitters used to detect buried electronic markers at 101.4 kHz which are employed by telephone companies.

(3) Cable locating equipment operated pursuant to §15.213.

(4) Any equipment operated under the provisions of §15.253, 15.255, and 15.256 in the frequency band 75-85 GHz, or §15.257 of this part.

(5) Biomedical telemetry devices operating under the provisions of §15.242 of this part are not subject to the restricted band 608-614 MHz but are subject to compliance within the other restricted bands.

(6) Transmitters operating under the provisions of subparts D or F of this part.

(7) Devices operated pursuant to §15.225 are exempt from complying with this section for the 13.36-13.41 MHz band only.

(8) Devices operated in the 24.075-24.175 GHz band under §15.245 are exempt from complying with the requirements of this section for the 48.15-48.35 GHz and 72.225-72.525 GHz bands only, and shall not exceed the limits specified in §15.245(b).

(9) Devices operated in the 24.0-24.25 GHz band under §15.249 are exempt from complying with the requirements of this section for the 48.0-48.5 GHz and 72.0-72.75 GHz bands only, and shall not exceed the limits specified in §15.249(a).

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of §15.245 shall not exceed the limits specified in §15.245(b).

Antenna 1

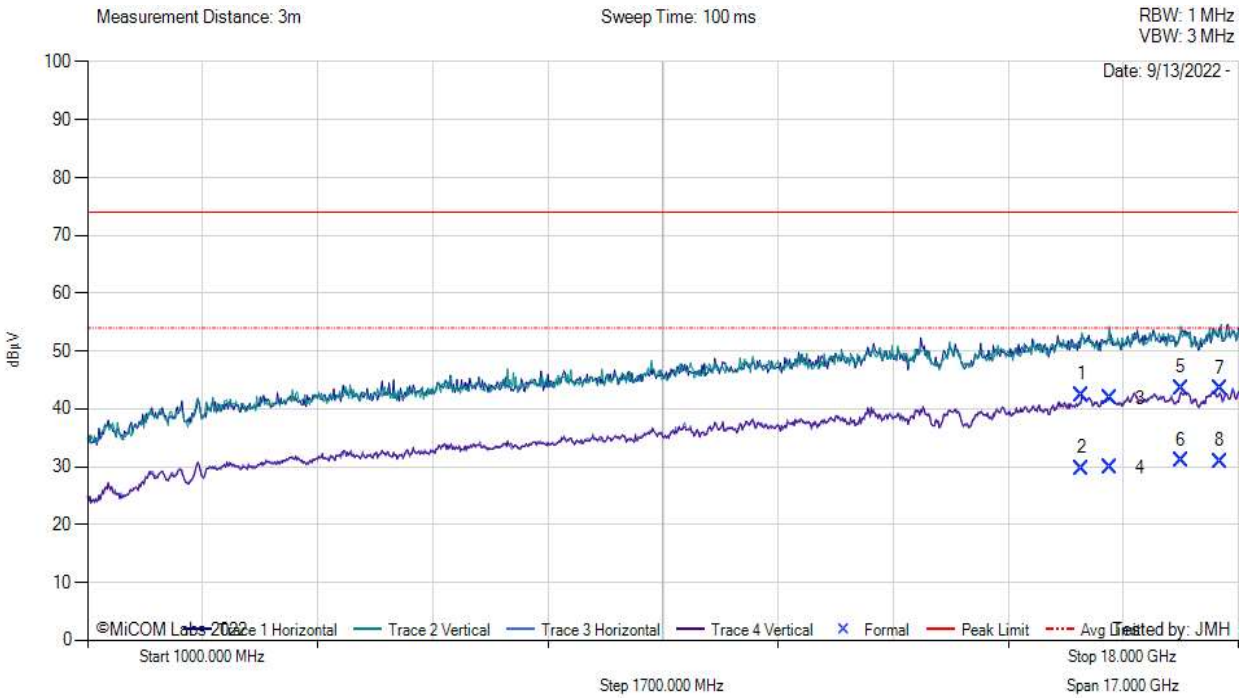
Equipment Configuration for Restricted Band Spurious Emissions

Antenna:	Integral Chip	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.72	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2402.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results

FCC Spurious 1 GHz -18 GHz

Variant: GFSK , Test Freq: 2402.00 MHz, Antenna: Ant 1, Power Setting: Max



1000.00 - 18000.00 MHz

Num	Frequency MHz	Raw dBµV	Cable Loss dB	AF dB/m	Level dBµV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBµV/m	Margin dB	Pass /Fail
1	15686.42	38.16	5.74	-1.48	42.43	MaxP	Vertical	126	59	74.0	-31.6	Pass
2	15686.42	25.48	5.74	-1.48	29.74	AVG	Vertical	126	59	54.0	-24.3	Pass
3	16097.47	37.13	6.09	-1.40	41.81	MaxP	Vertical	99	0	74.0	-32.2	Pass
4	16097.47	25.18	6.09	-1.40	29.86	AVG	Vertical	99	0	54.0	-24.1	Pass
5	17150.48	37.59	6.67	-0.64	43.63	MaxP	Vertical	148	231	74.0	-30.4	Pass
6	17150.48	24.99	6.67	-0.64	31.03	AVG	Vertical	148	231	54.0	-23.0	Pass
7	17726.24	37.80	6.33	-0.59	43.54	MaxP	Vertical	191	118	74.0	-30.5	Pass
8	17726.24	25.23	6.33	-0.59	30.96	AVG	Vertical	191	118	54.0	-23.0	Pass

Test Notes: EUT on table battery 2402 MHz ANT 1 with 2.4G Notch in front of amp by removing the fundamental frequency. No emissions were found 18 – 26 GHz

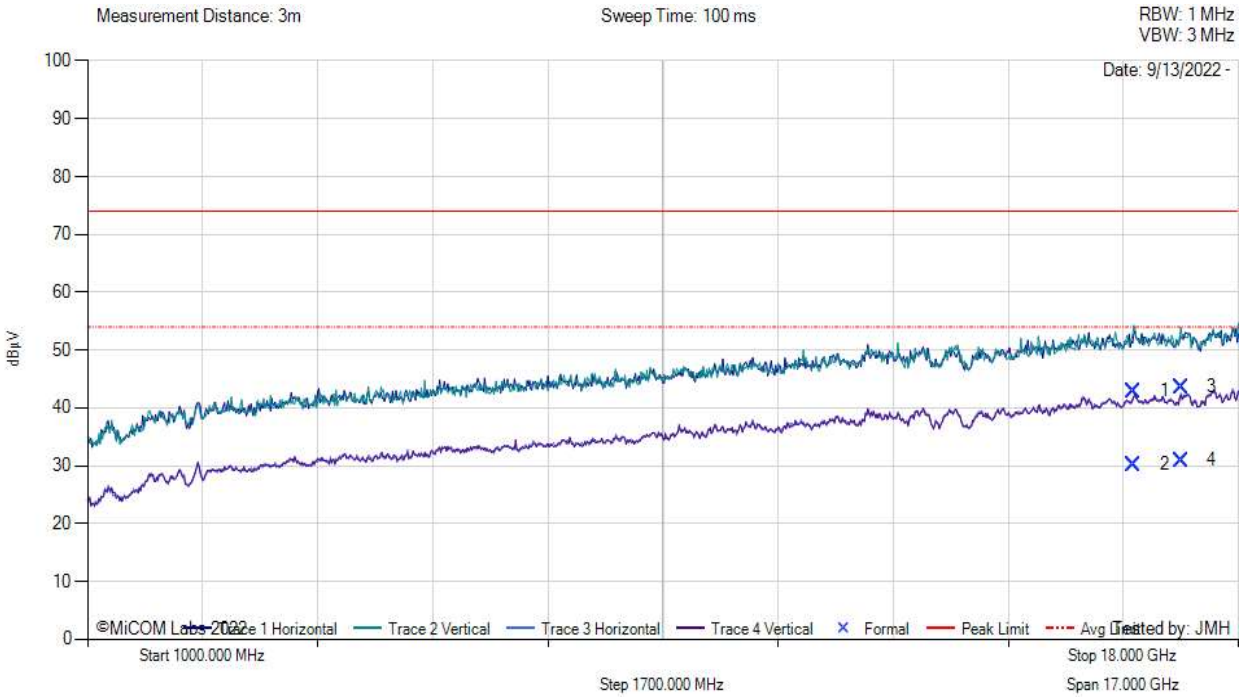
Equipment Configuration for Restricted Band Spurious Emissions

Antenna:	Integral Chip	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.72	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2442.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results

FCC Spurious 1 GHz -18 GHz

Variant: GFSK , Test Freq: 2442.00 MHz, Antenna: Ant 1, Power Setting: Max



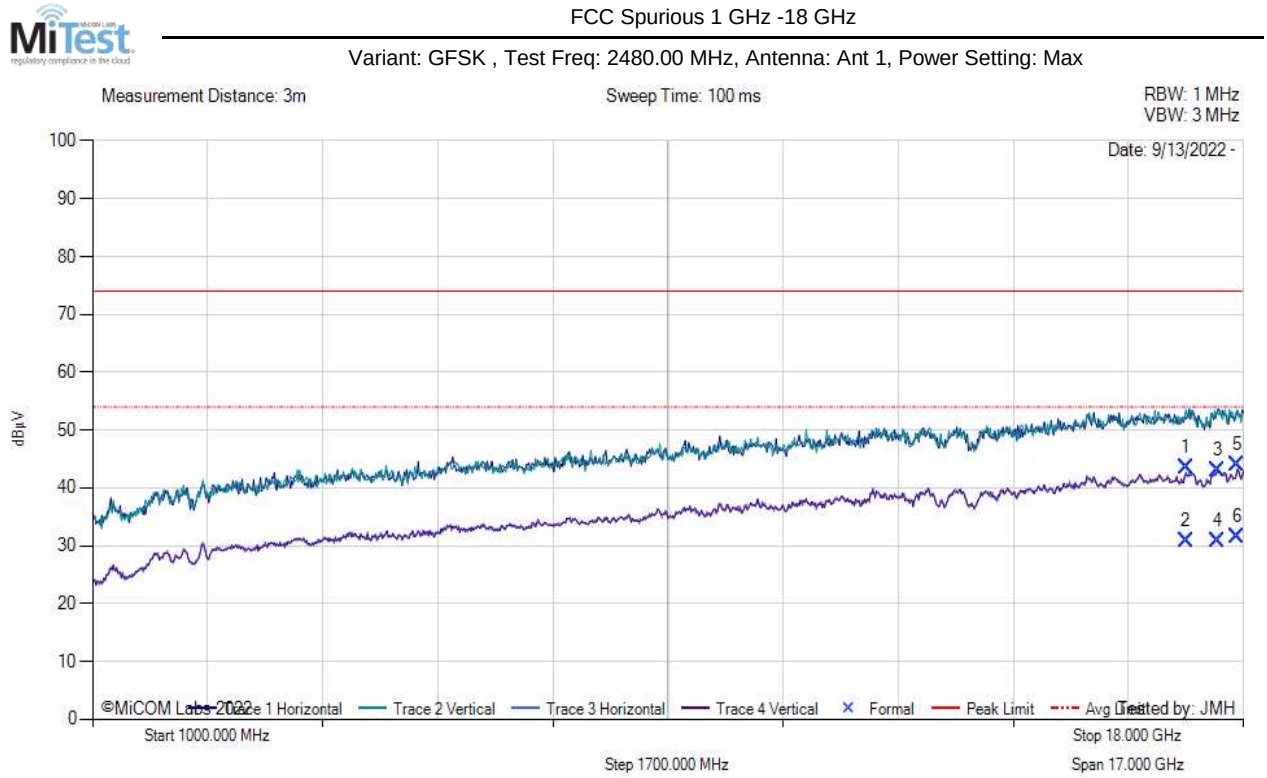
1000.00 - 18000.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	16454.70	37.22	6.15	-0.46	42.90	MaxP	Vertical	127	299	74.0	-31.1	Pass
2	16454.70	24.54	6.15	-0.46	30.22	AVG	Vertical	127	299	54.0	-23.8	Pass
3	17151.98	37.59	6.67	-0.63	43.64	MaxP	Vertical	188	56	74.0	-30.4	Pass
4	17151.98	24.91	6.67	-0.63	30.95	AVG	Vertical	188	56	54.0	-23.0	Pass
5	17999.64	37.15	6.42	0.06	43.63	MaxP	Vertical	105	249	74.0	-30.4	Pass
6	17999.64	24.76	6.42	0.06	31.24	AVG	Vertical	105	249	54.0	-22.8	Pass

Test Notes: EUT on table battery 2442 MHz Ant 1. 2.4G notch in front of amp to prevent overload by removing the fundamental frequency. No emissions were found 18 – 26 GHz

Equipment Configuration for Restricted Band Spurious Emissions

Antenna:	Integral Chip	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.72	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2480.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results



1000.00 - 18000.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	17150.70	37.48	6.67	-0.64	43.52	MaxP	Vertical	154	139	74.0	-30.5	Pass
2	17150.70	24.86	6.67	-0.64	30.90	AVG	Vertical	154	139	54.0	-23.1	Pass
3	17625.70	38.02	6.32	-1.30	43.04	MaxP	Horizontal	115	95	74.0	-31.0	Pass
4	17625.70	25.83	6.32	-1.30	30.84	AVG	Horizontal	115	95	54.0	-23.2	Pass
5	17913.48	36.78	6.72	0.46	43.95	MaxP	Vertical	193	238	74.0	-30.0	Pass
6	17913.48	24.33	6.72	0.46	31.50	AVG	Vertical	193	238	54.0	-22.5	Pass

Test Notes: EUT on table battery 2480 MHz Ant 1. 2.4G notch in front of amp to prevent overload by removing the fundamental frequency. No emissions were found 18 – 26 GHz

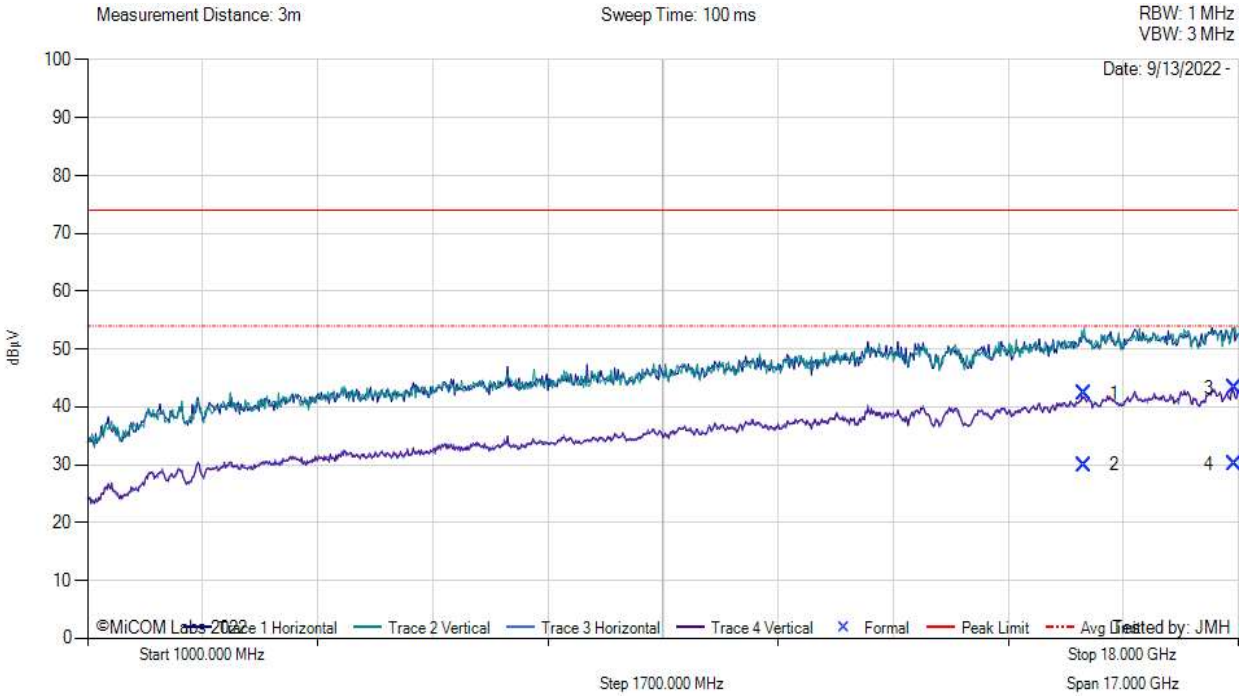
Antenna 2

Equipment Configuration for Restricted Band Spurious Emissions			
Antenna:	Integral Dipole	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.82	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2402.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results

FCC Spurious 1 GHz -18 GHz

Variant: GFSK , Test Freq: 2402.00 MHz, Antenna: Ant 2, Power Setting: Max



1000.00 - 18000.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	15721.04	37.91	5.84	-1.39	42.35	MaxP	Vertical	102	0	74.0	-31.6	Pass
2	15721.04	25.56	5.84	-1.39	30.01	AVG	Vertical	102	0	54.0	-24.0	Pass
3	17948.31	37.54	6.29	-0.55	43.28	MaxP	Vertical	148	73	74.0	-30.7	Pass
4	17948.31	24.32	6.29	-0.55	30.05	AVG	Vertical	148	73	54.0	-23.9	Pass

Test Notes: EUT on table battery 2402 MHz Ant 2. 2.4G Notch in front of amp to prevent overload by removing the fundamental frequency. No emissions were found 18 – 26 GHz

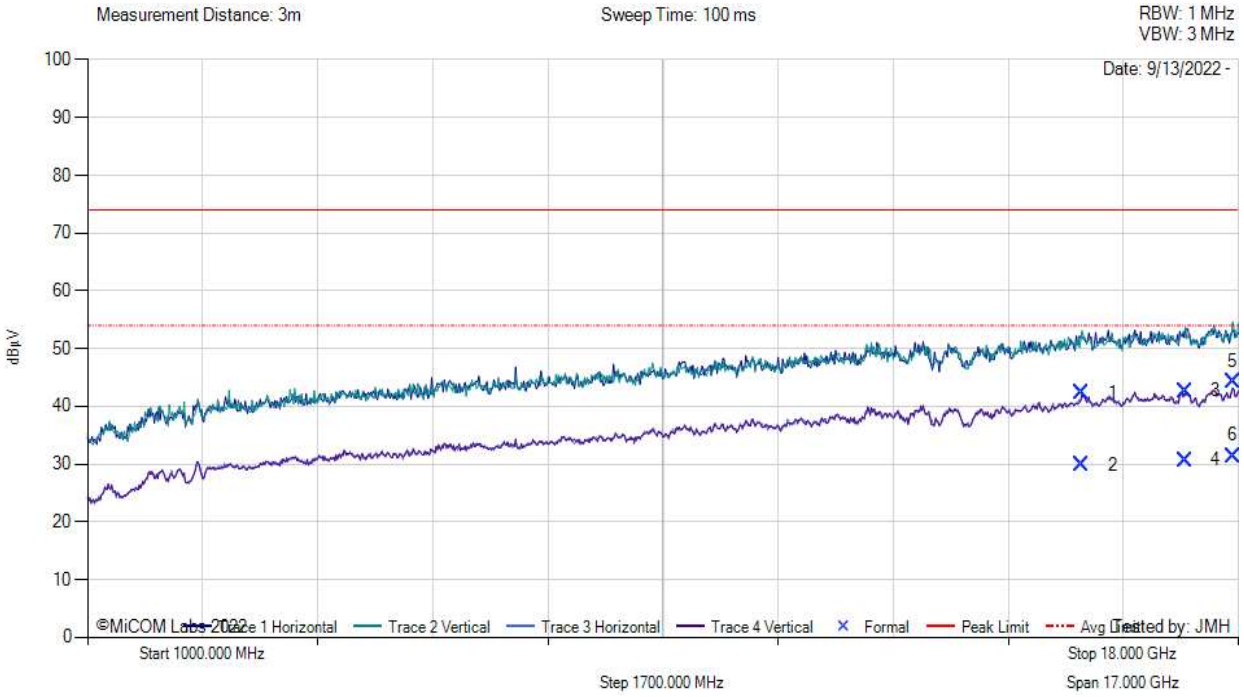
Equipment Configuration for Restricted Band Spurious Emissions

Antenna:	Integral Dipole	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.82	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2442.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results

FCC Spurious 1 GHz -18 GHz

Variant: GFSK , Test Freq: 2442.00 MHz, Antenna: Ant 2, Power Setting: Max



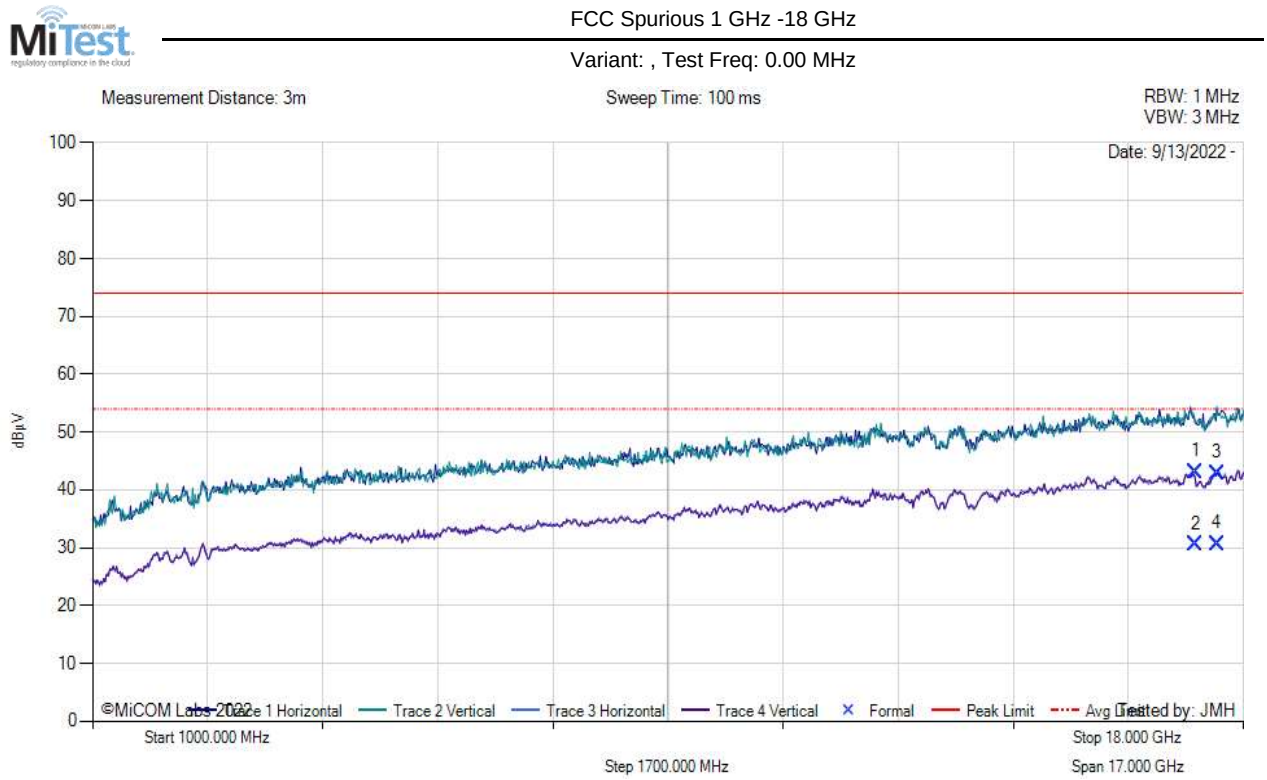
1000.00 - 18000.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	15688.41	37.96	5.75	-1.43	42.28	MaxP	Vertical	100	132	74.0	-31.7	Pass
2	15688.41	25.56	5.75	-1.43	29.88	AVG	Vertical	100	132	54.0	-24.1	Pass
3	17216.21	37.29	6.55	-1.15	42.69	MaxP	Vertical	159	209	74.0	-31.3	Pass
4	17216.21	25.26	6.55	-1.15	30.66	AVG	Vertical	159	209	54.0	-23.3	Pass
5	17916.59	37.11	6.63	0.46	44.21	MaxP	Vertical	168	94	74.0	-29.8	Pass
6	17916.59	24.36	6.63	0.46	31.45	AVG	Vertical	168	94	54.0	-22.5	Pass

Test Notes: EUT on table battery 2442 MHz Ant 2. 2.4G Notch in front of amp to prevent overload. by removing the fundamental frequency. No emissions were found 18 – 26 GHz

Equipment Configuration for Restricted Band Spurious Emissions

Antenna:	Integral Dipole	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.82	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2480.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results



1000.00 - 18000.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	17292.71	38.40	6.38	-1.65	43.13	MaxP	Vertical	169	64	74.0	-30.9	Pass
2	17292.71	25.89	6.38	-1.65	30.63	AVG	Vertical	169	64	54.0	-23.4	Pass
3	17608.76	38.26	6.37	-1.70	42.92	MaxP	Vertical	99	120	74.0	-31.1	Pass
4	17608.76	26.02	6.37	-1.70	30.68	AVG	Vertical	99	120	54.0	-23.3	Pass

Test Notes:
EUT on table battery 2480 MHz Ant 2. 2.4G Notch in front of amp to prevent overload by removing the fundamental frequency. No emissions were found 18 – 26 GHz

8.4.2.2. Restricted Edge & Band-Edge Emissions

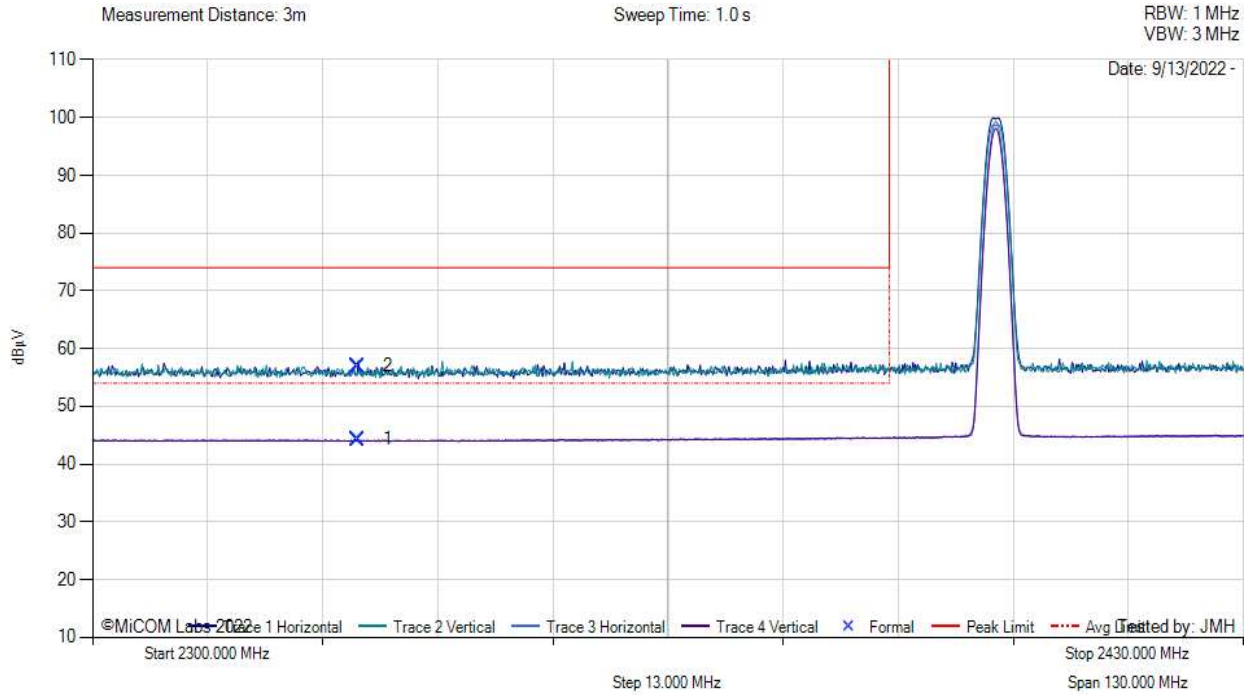
Antenna 1

Equipment Configuration for 2390 MHz Radiated Band-Edge Emissions			
Antenna:	Integral Chip	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.72	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2402.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results

BE 2400 MHz

Variant: GFSK , Test Freq: 2402.00 MHz, Antenna: Ant 1, Power Setting: Max



2300.00 - 2430.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	2329.95	10.63	1.93	31.70	44.26	AVG	Horizontal	164	12	54.0	-9.7	Pass
2	2329.95	23.38	1.93	31.70	57.01	MaxP	Horizontal	164	12	74.0	-17.0	Pass

Test Notes: EUT on table battery 2402 MHz ANT 1

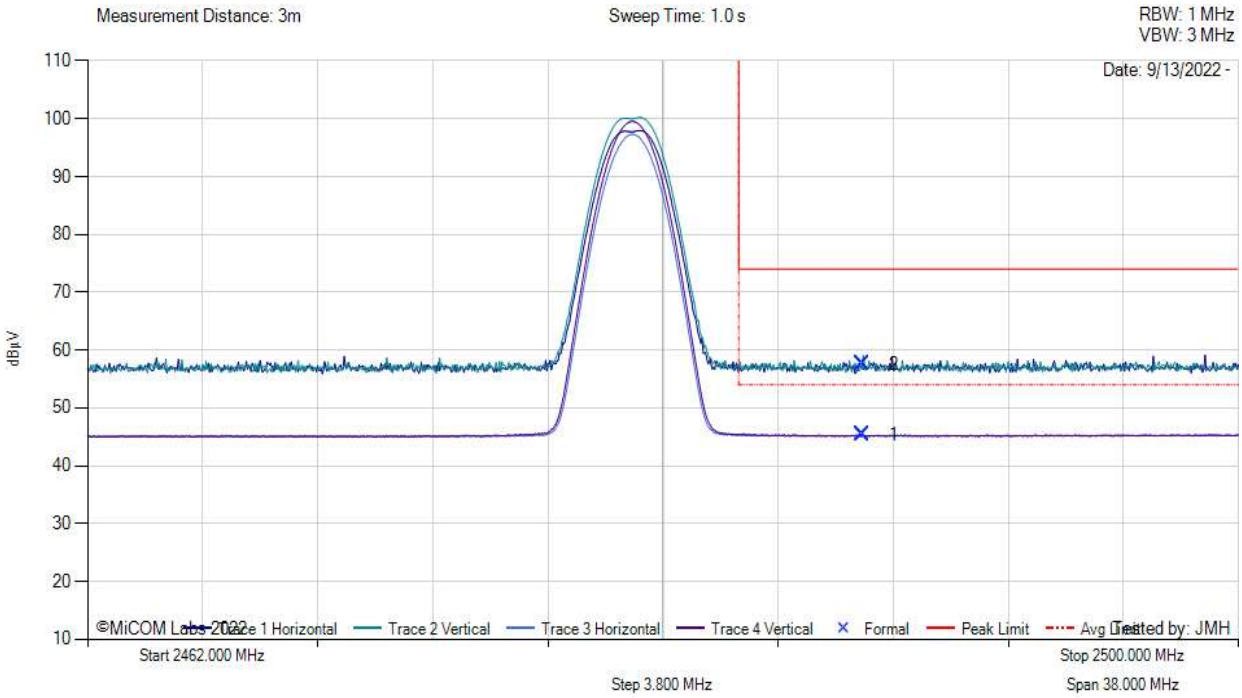
Equipment Configuration for 2483.5 MHz Radiated Band-Edge Emissions

Antenna:	Integral Chip	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.72	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2480.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results

BE 2483.5 MHz

Variant: GFSK , Test Freq: 2480.00 MHz, Antenna: Ant 1, Power Setting: Max



2462.00 - 2500.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	2487.60	10.97	1.98	32.38	45.32	AVG	Vertical	186	28	54.0	-8.7	Pass
2	2487.60	23.25	1.98	32.38	57.60	MaxP	Vertical	186	28	74.0	-16.4	Pass

Test Notes: EUT on table battery 2480 MHz . Ant 1

Antenna 2

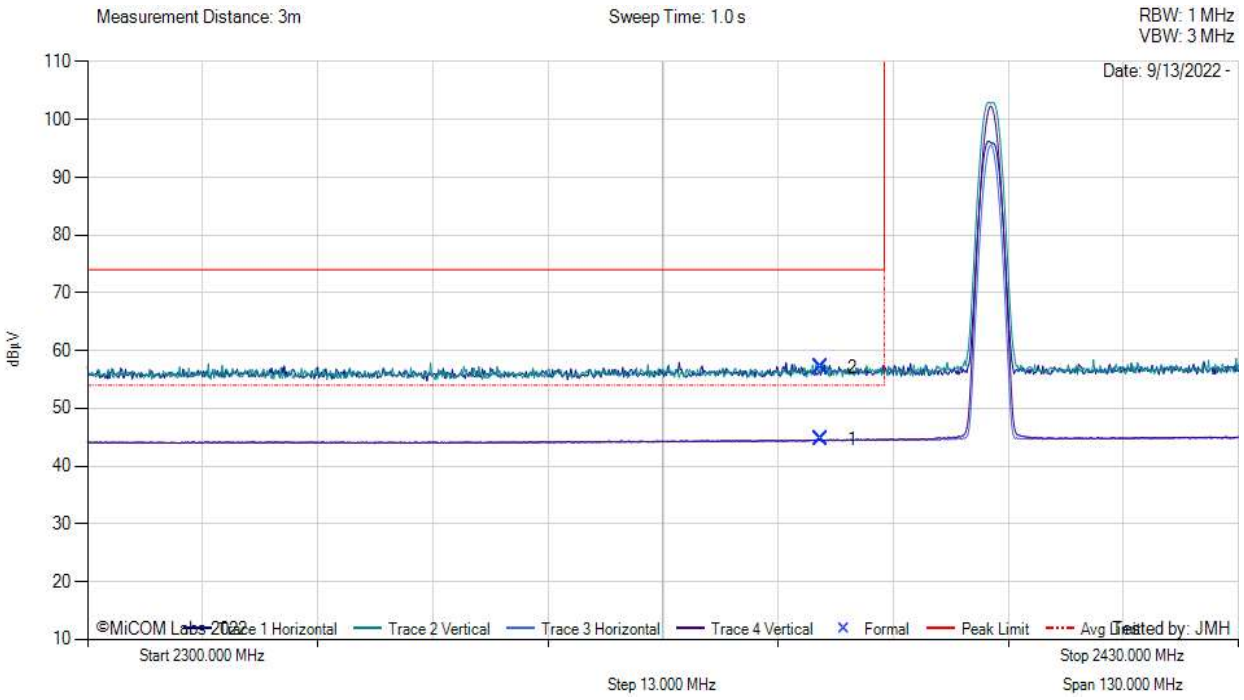
Equipment Configuration for 2390 MHz Radiated Band-Edge Emissions			

Antenna:	Integral Dipole	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.82	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2402.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results

BE 2400 MHz

Variant: GFSK , Test Freq: 2402.00 MHz, Antenna: Ant 2, Power Setting: Max



2300.00 - 2430.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	2382.91	10.63	1.97	31.98	44.58	AVG	Vertical	163	0	54.0	-9.4	Pass
2	2382.91	23.20	1.97	31.98	57.15	MaxP	Vertical	163	0	74.0	-16.9	Pass

Test Notes: EUT on table battery 2402 MHz .Ant 2

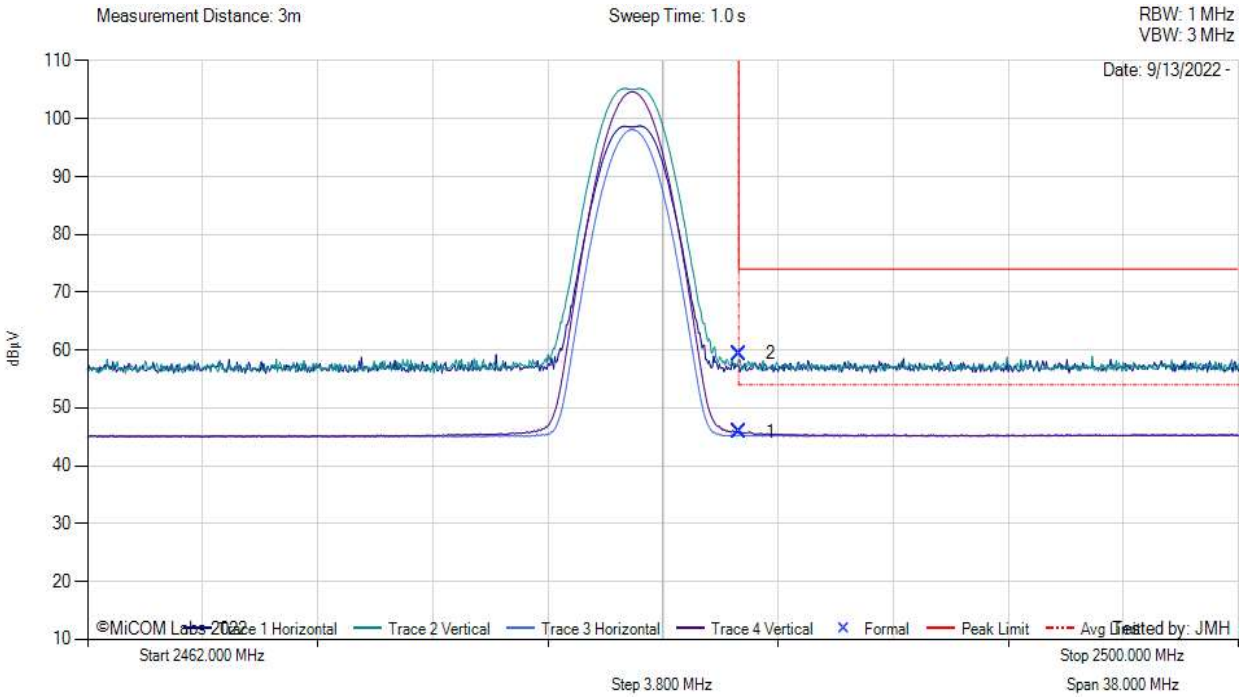
Equipment Configuration for 2483.5 MHz Radiated Band-Edge Emissions

Antenna:	Integral Dipole	**Variant:**	DWE-DLM1
Antenna Gain (dBi):	2.82	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	2480.00	**Data Rate:**	1 Mbit/s
Power Setting:	Max	**Tested By:**	JMH

Test Measurement Results

BE 2483.5 MHz

Variant: GFSK , Test Freq: 2480.00 MHz, Antenna: Ant 2, Power Setting: Max

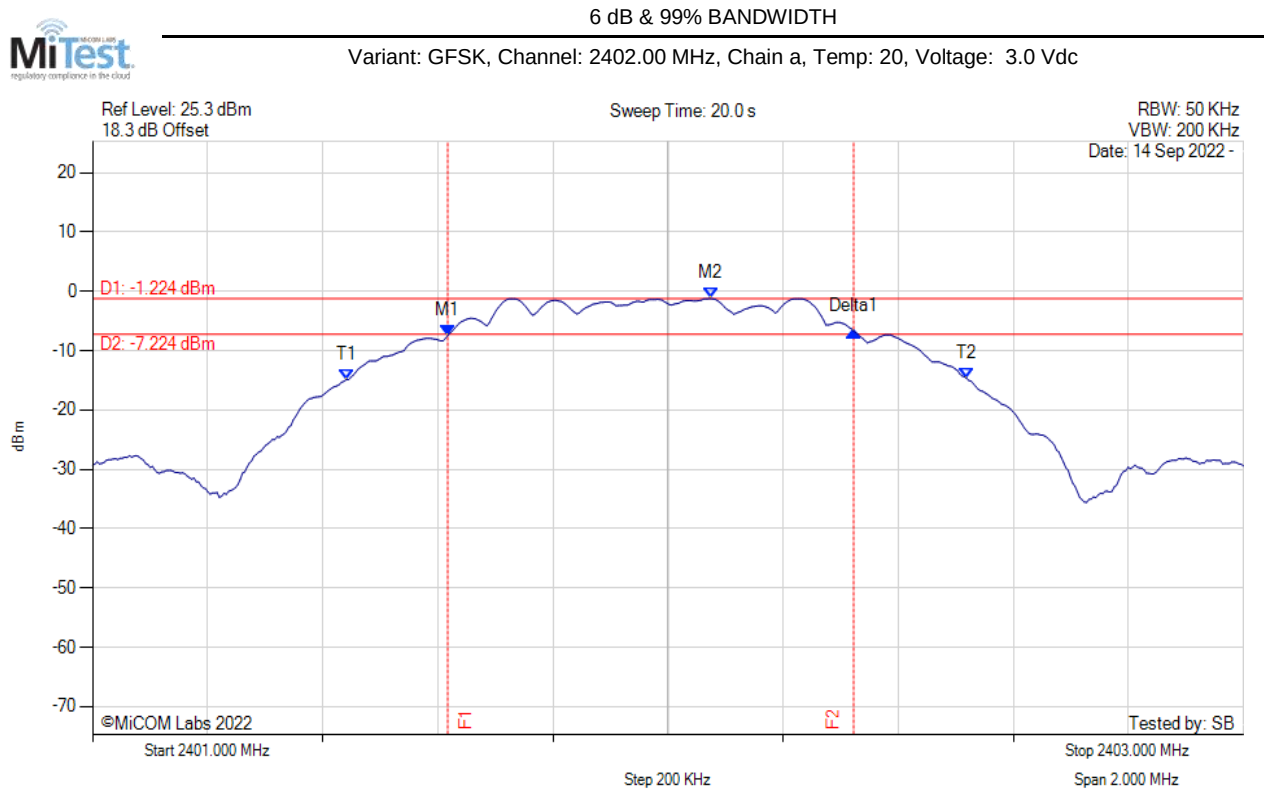


2462.00 - 2500.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	2483.53	11.50	1.98	32.37	45.85	AVG	Vertical	100	59	54.0	-8.2	Pass
2	2483.53	25.07	1.98	32.37	59.42	MaxP	Vertical	100	59	74.0	-14.6	Pass

Test Notes: EUT on table battery 2480 MHz Ant 2.

A. APPENDIX - GRAPHICAL IMAGES

A.1. 6 dB & 99% Bandwidth

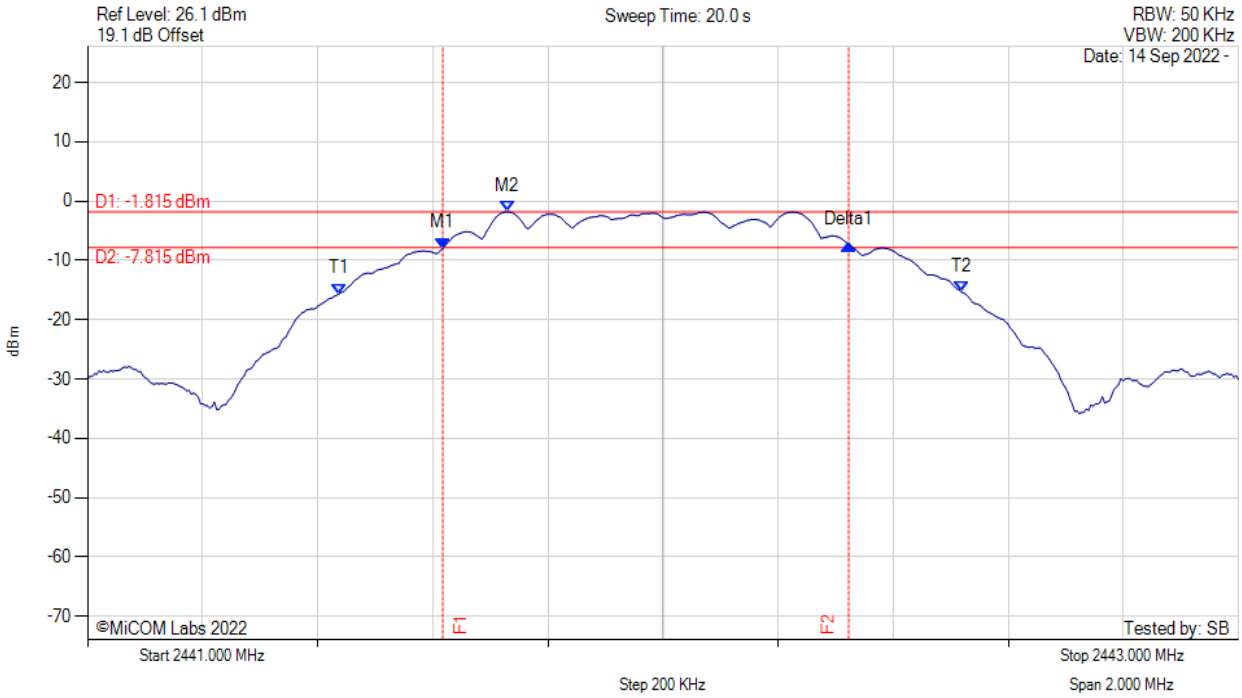


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAX HOLD	M1 : 2401.617 MHz : -7.470 dBm M2 : 2402.074 MHz : -1.224 dBm Delta1 : 705 KHz : 0.769 dB T1 : 2401.441 MHz : -14.875 dBm T2 : 2402.519 MHz : -14.671 dBm OBW : 1.078 MHz	Measured 6 dB Bandwidth: 0.705 MHz

back to matrix

6 dB & 99% BANDWIDTH

Variant: GFSK, Channel: 2442.00 MHz, Chain a, Temp: 20, Voltage: 3.0 Vdc

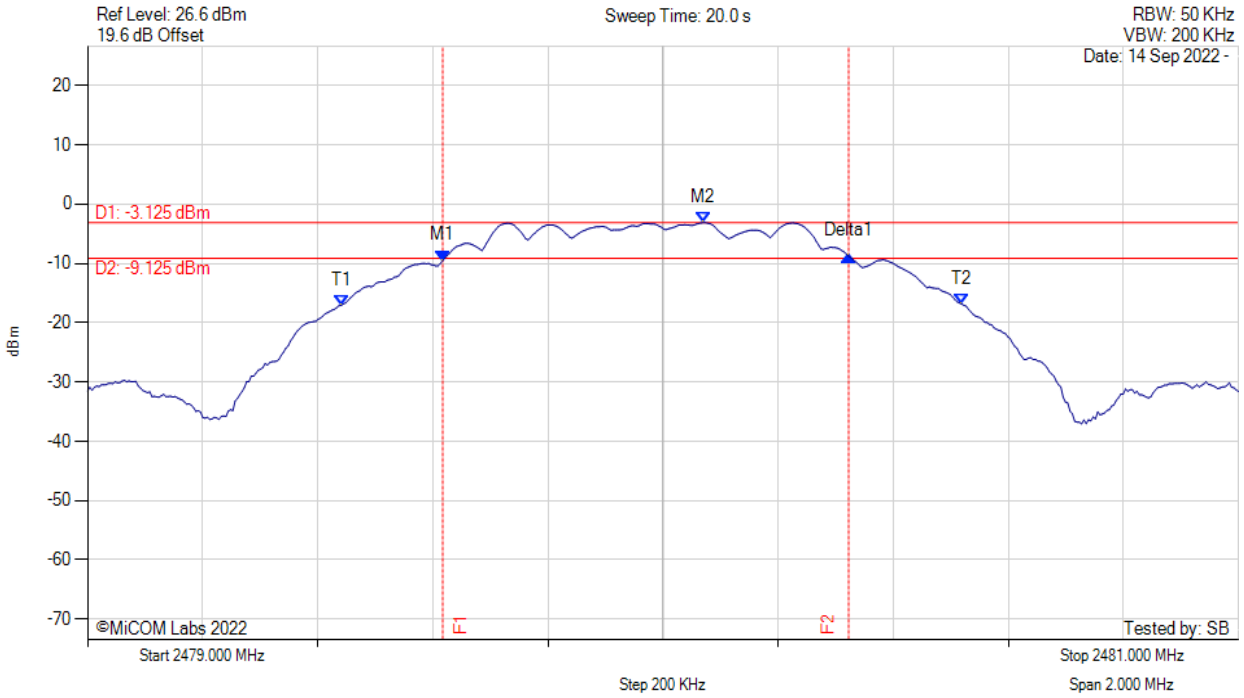


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAX HOLD	M1 : 2441.617 MHz : -7.941 dBm M2 : 2441.729 MHz : -1.815 dBm Delta1 : 705 KHz : 0.669 dB T1 : 2441.437 MHz : -15.653 dBm T2 : 2442.519 MHz : -15.340 dBm OBW : 1.082 MHz	Measured 6 dB Bandwidth: 0.705 MHz

back to matrix

6 dB & 99% BANDWIDTH

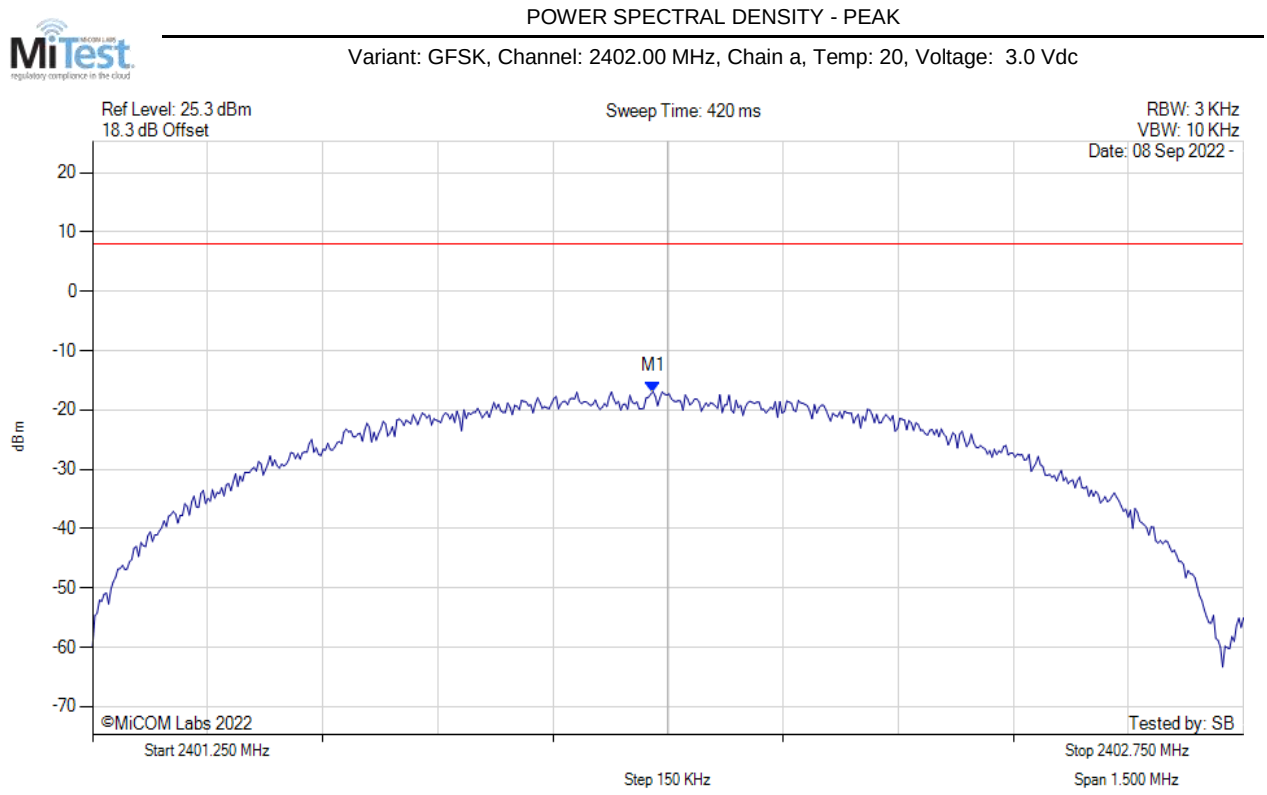
Variant: GFSK, Channel: 2480.00 MHz, Chain a, Temp: 20, Voltage: 3.0 Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAX HOLD	M1 : 2479.617 MHz : -9.536 dBm M2 : 2480.070 MHz : -3.125 dBm Delta1 : 705 KHz : 0.750 dB T1 : 2479.441 MHz : -17.079 dBm T2 : 2480.519 MHz : -16.863 dBm OBW : 1.078 MHz	Measured 6 dB Bandwidth: 0.705 MHz

back to matrix

A.2. Power Spectral Density

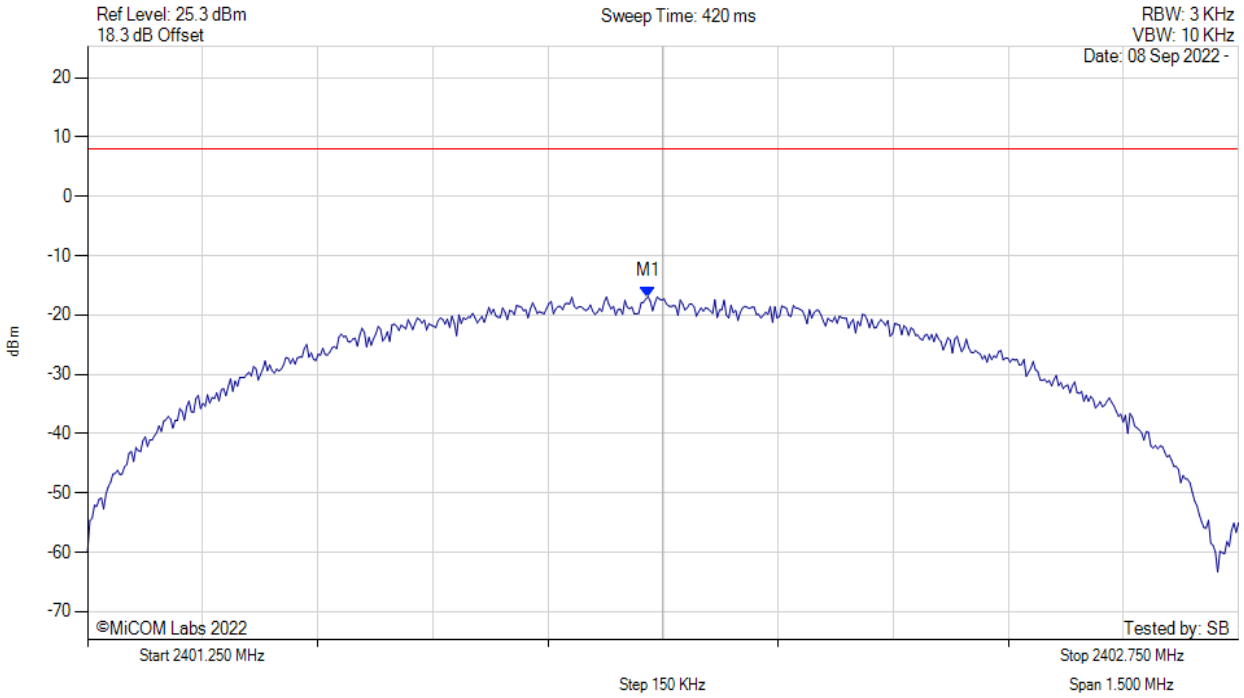


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2401.980 MHz : -16.902 dBm	Limit: ≤ 8.000 dBm Margin: 24.90 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2402.00 MHz, SUM, Temp: 20, Voltage: 3.0 Vdc

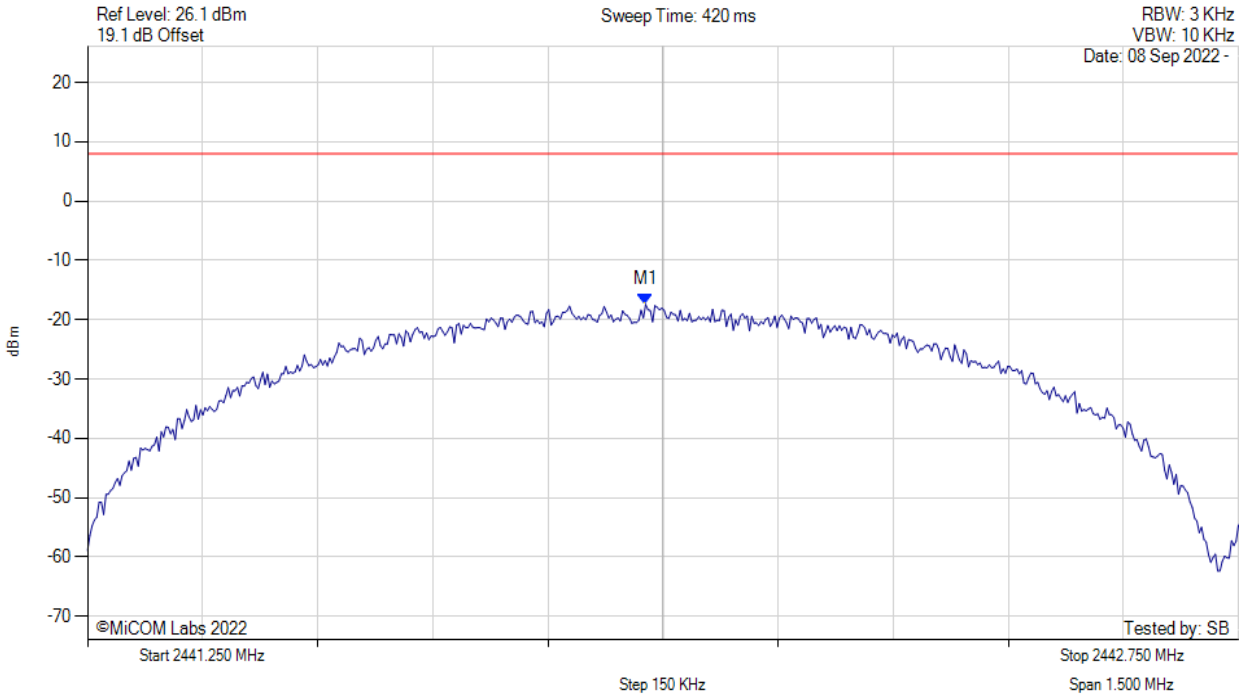


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2401.980 MHz : -16.902 dBm	Limit: ≤ 8.0 dBm Margin: -24.9 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2442.00 MHz, Chain a, Temp: 20, Voltage: 3.0 Vdc

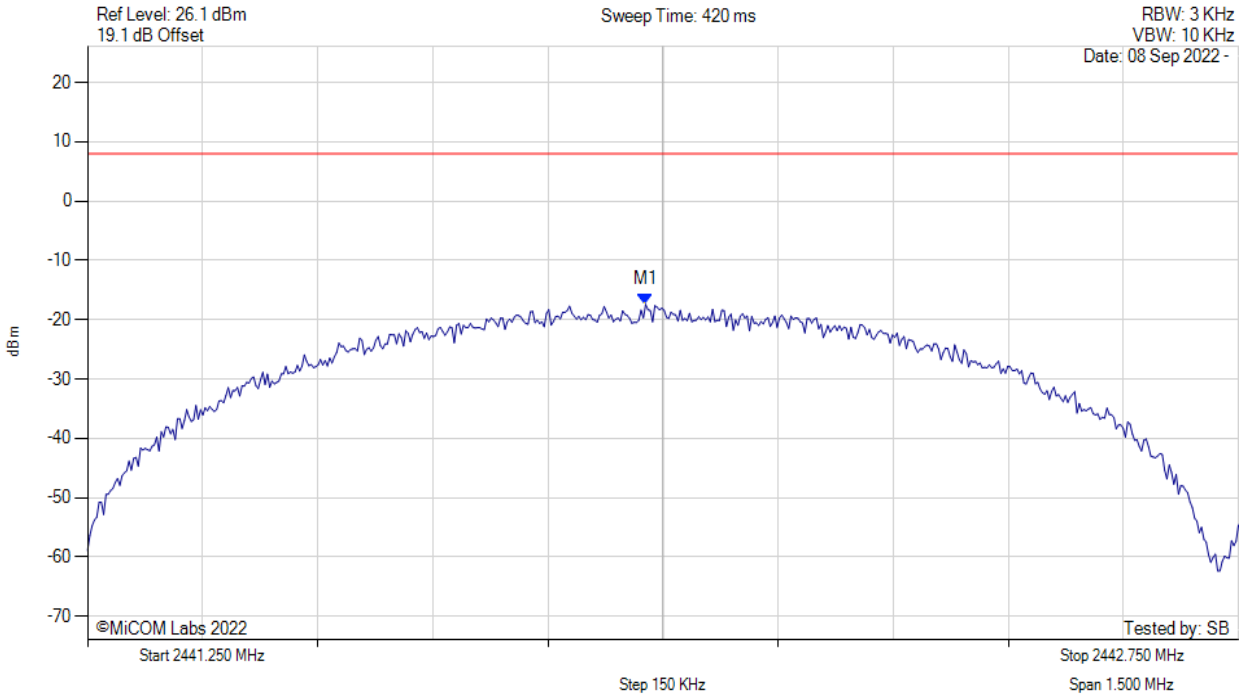


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2441.977 MHz : -17.410 dBm	Limit: ≤ 8.000 dBm Margin: 25.41 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2442.00 MHz, SUM, Temp: 20, Voltage: 3.0 Vdc

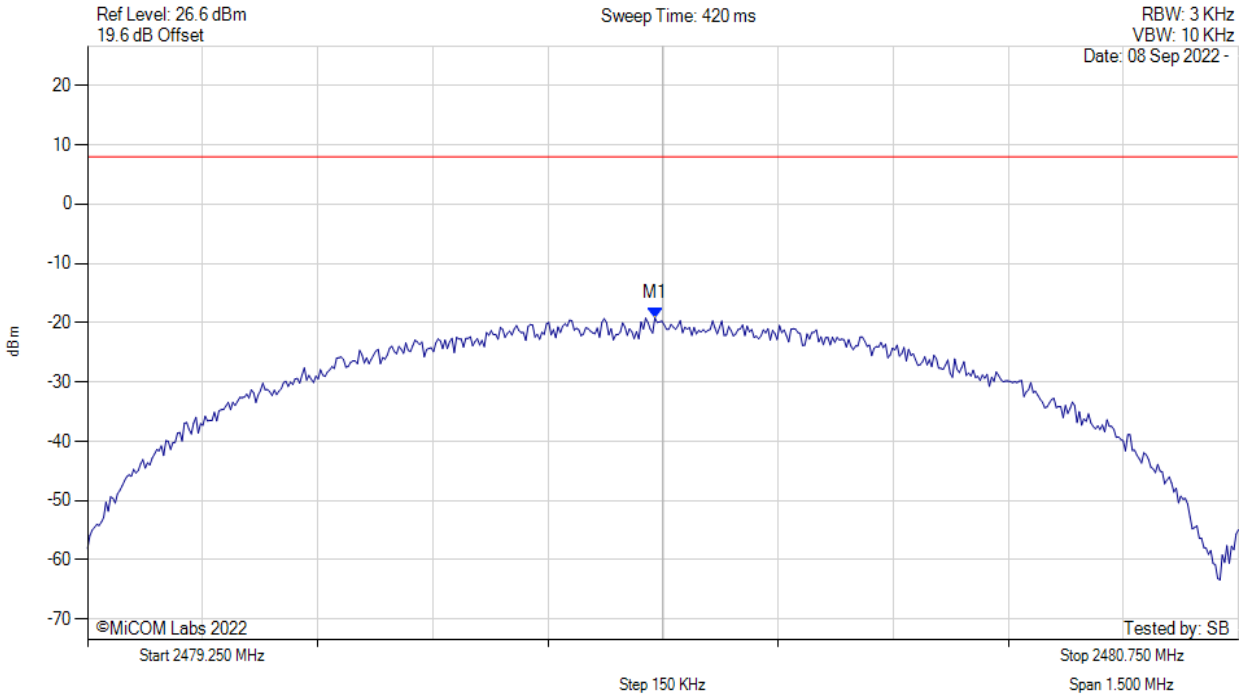


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2441.977 MHz : -17.410 dBm	Limit: ≤ 8.0 dBm Margin: -25.4 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2480.00 MHz, Chain a, Temp: 20, Voltage: 3.0 Vdc

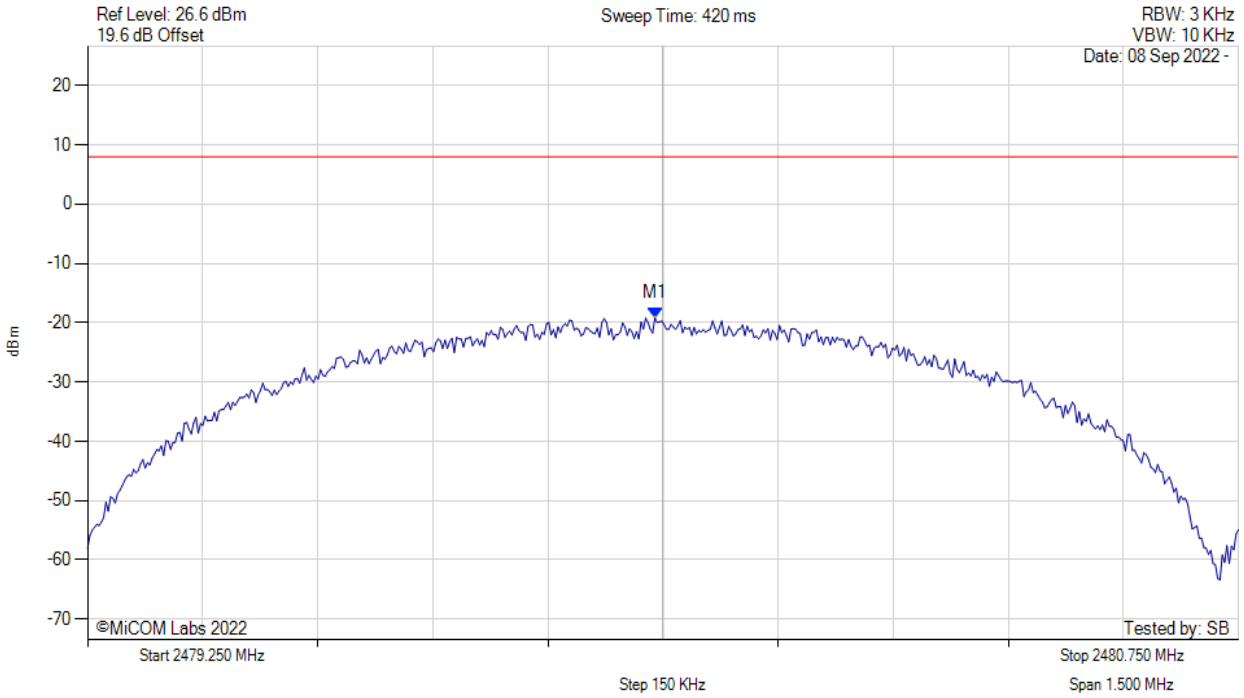


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2479.989 MHz : -19.186 dBm	Limit: ≤ 8.000 dBm Margin: 27.19 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2480.00 MHz, SUM, Temp: 20, Voltage: 3.0 Vdc



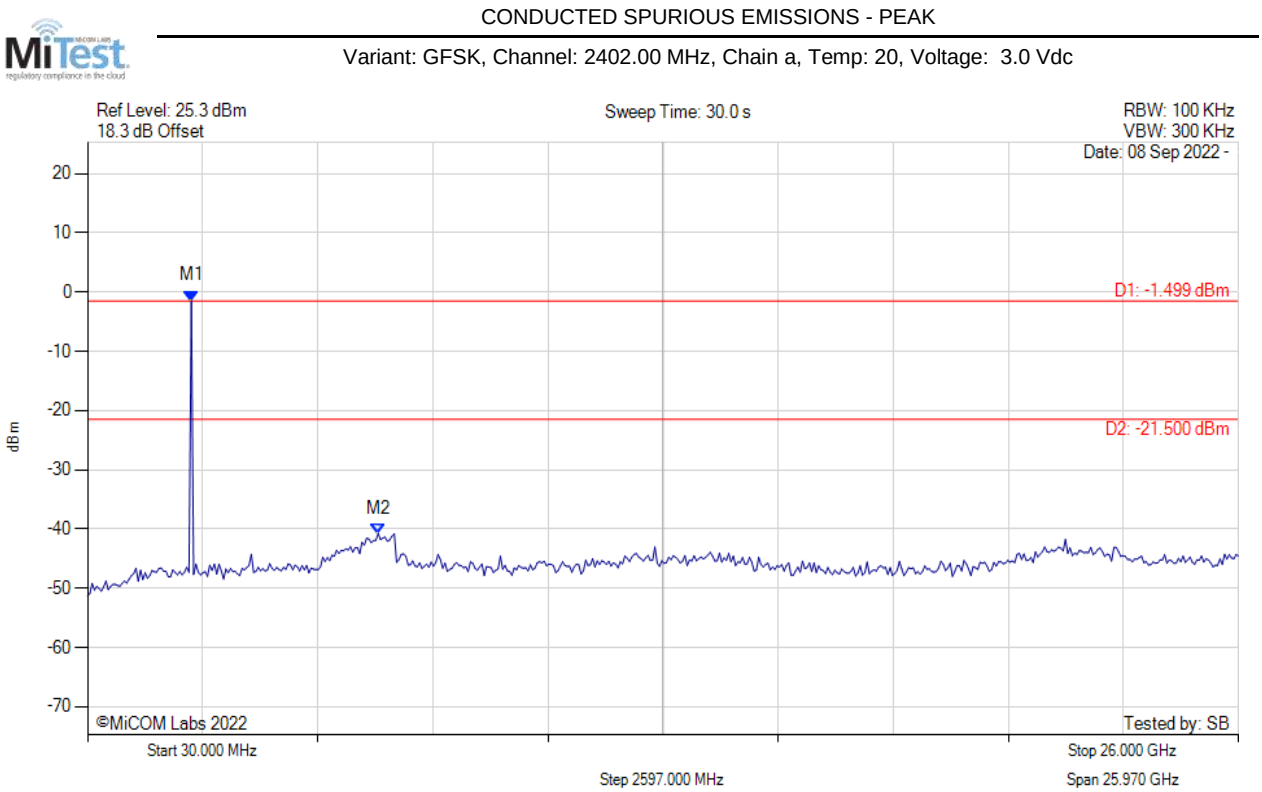
Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2479.989 MHz : -19.186 dBm	Limit: ≤ 8.0 dBm Margin: -27.2 dB

back to matrix

A.3. Emissions

A.3.1. Conducted Emissions

A.3.1.1. Conducted Spurious Emissions

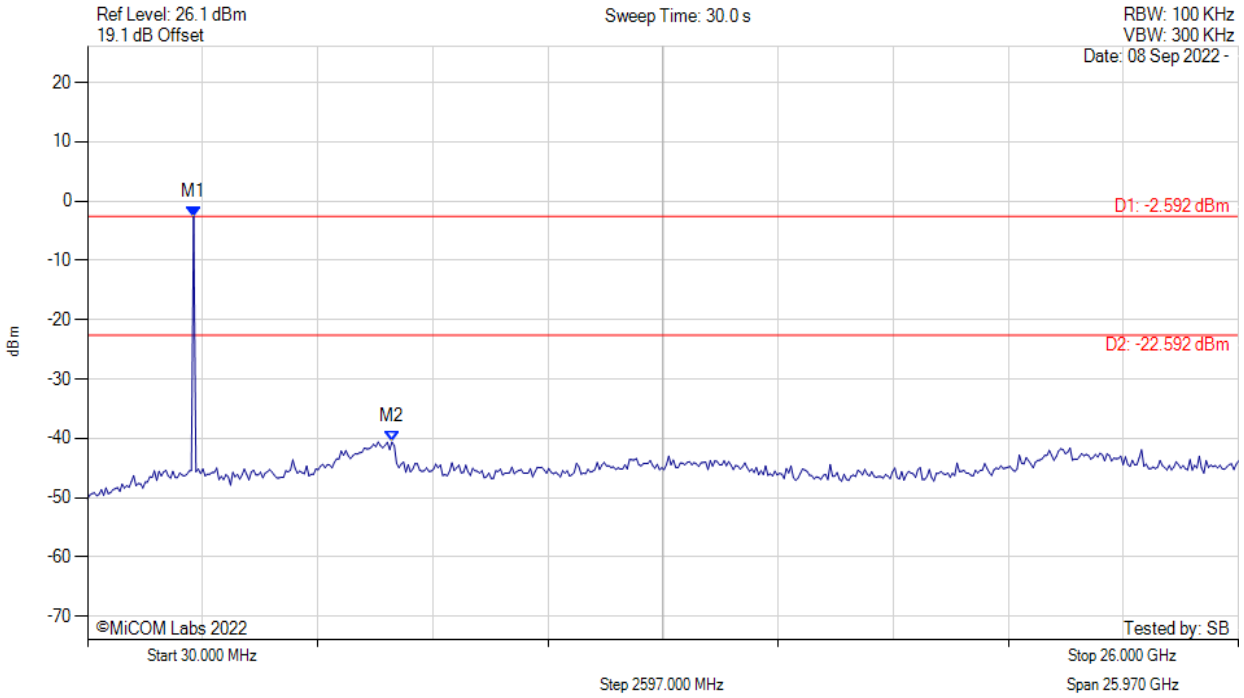


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2371.984 MHz : -1.499 dBm M2 : 6587.555 MHz : -40.768 dBm	Limit: -21.50 dBm Margin: -19.27 dB

back to matrix

CONDUCTED SPURIOUS EMISSIONS - PEAK

Variant: GFSK, Channel: 2442.00 MHz, Chain a, Temp: 20, Voltage: 3.0 Vdc

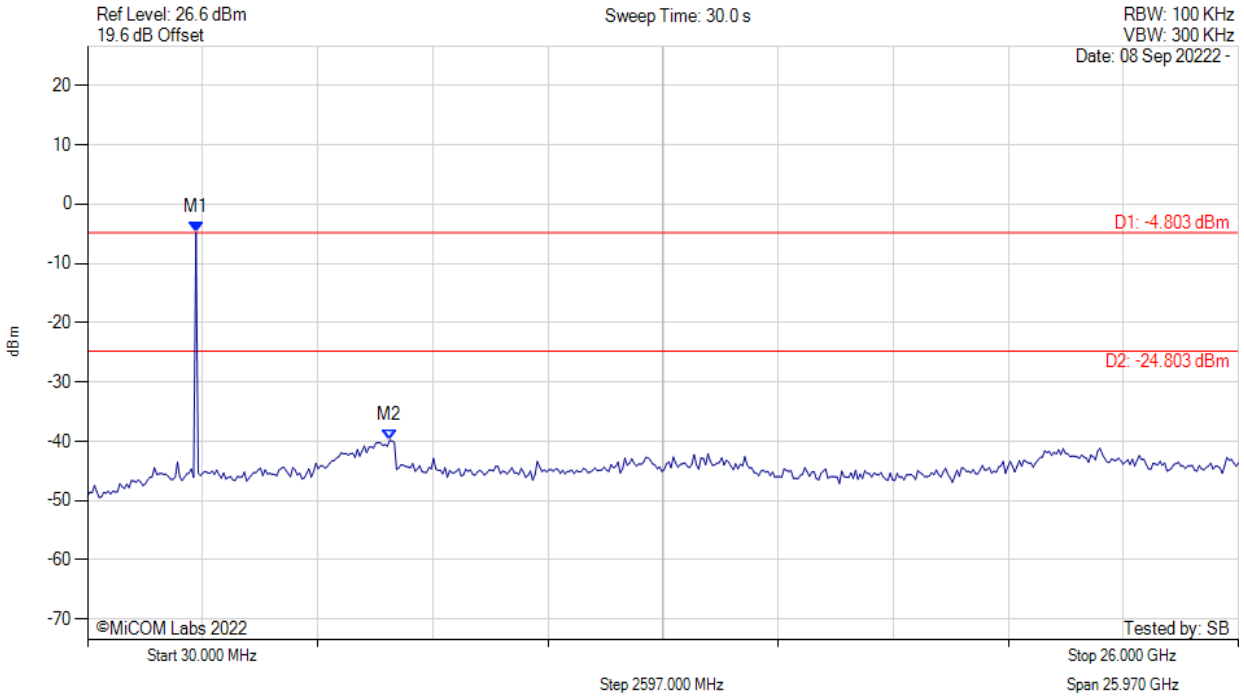


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2424.028 MHz : -2.592 dBm M2 : 6899.820 MHz : -40.615 dBm	Limit: -22.59 dBm Margin: -18.03 dB

back to matrix

CONDUCTED SPURIOUS EMISSIONS - PEAK

Variant: GFSK, Channel: 2480.00 MHz, Chain a, Temp: 20, Voltage: 3.0 Vdc



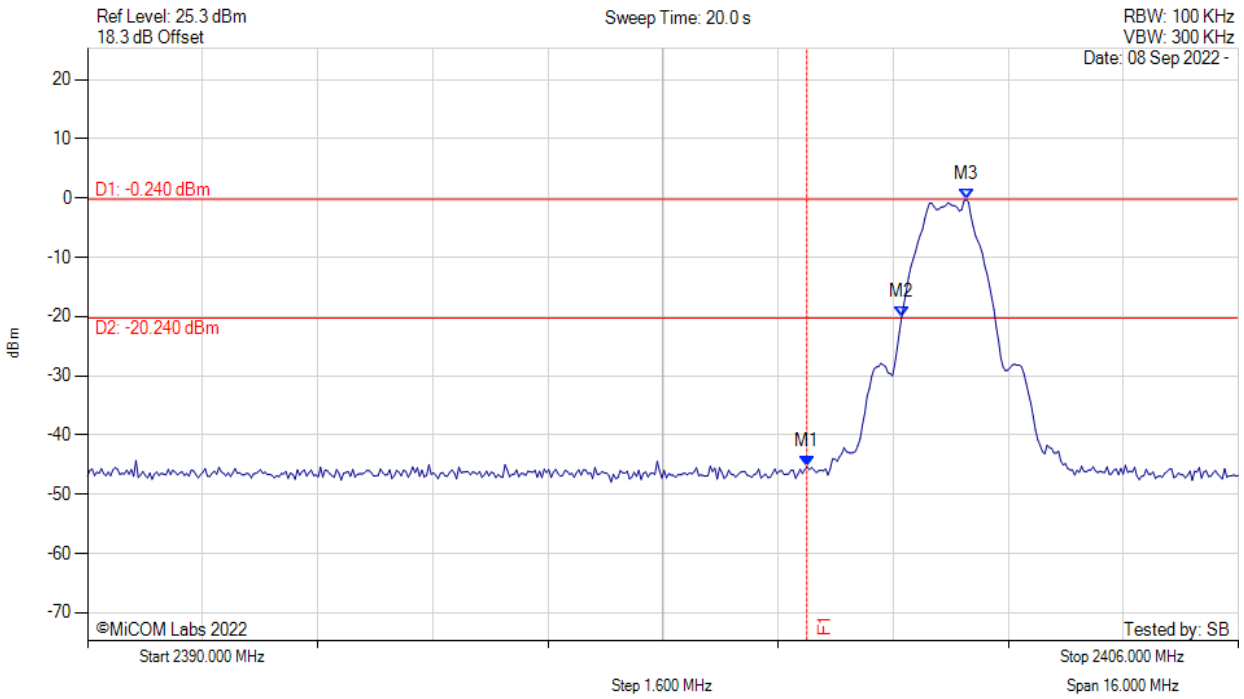
Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2476.072 MHz : -4.803 dBm M2 : 6847.776 MHz : -39.847 dBm	Limit: -24.80 dBm Margin: -15.05 dB

back to matrix

A.3.1.2. Conducted Band-Edge Emissions

CONDUCTED LOW BAND-EDGE EMISSION - PEAK

Variant: GFSK, Channel: 2402.00 MHz, Chain a, Temp: 20, Voltage: 3.0 Vdc

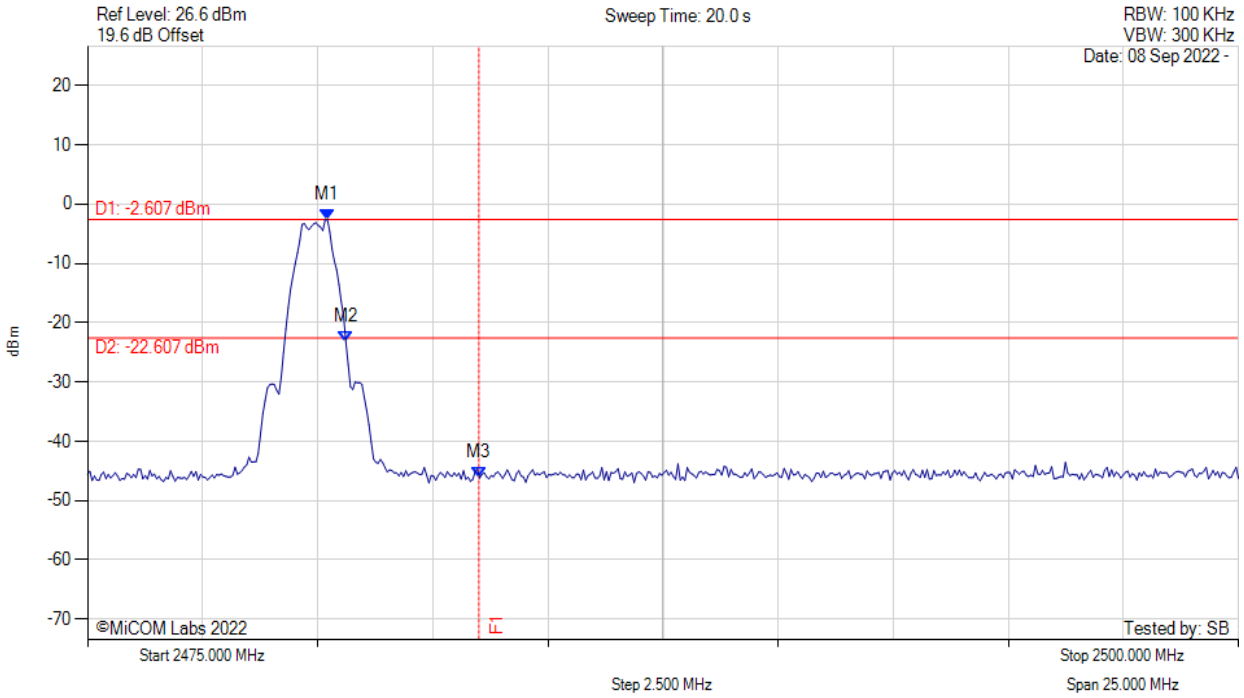


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = CLR/WRITE	M1 : 2400.000 MHz : -45.393 dBm M2 : 2401.319 MHz : -20.018 dBm M3 : 2402.216 MHz : -0.240 dBm	Channel Frequency: 2402.00 MHz

back to matrix

CONDUCTED HIGH BAND-EDGE EMISSION - PEAK

Variant: GFSK, Channel: 2480.00 MHz, Chain a, Temp: 20, Voltage: 3.0 Vdc

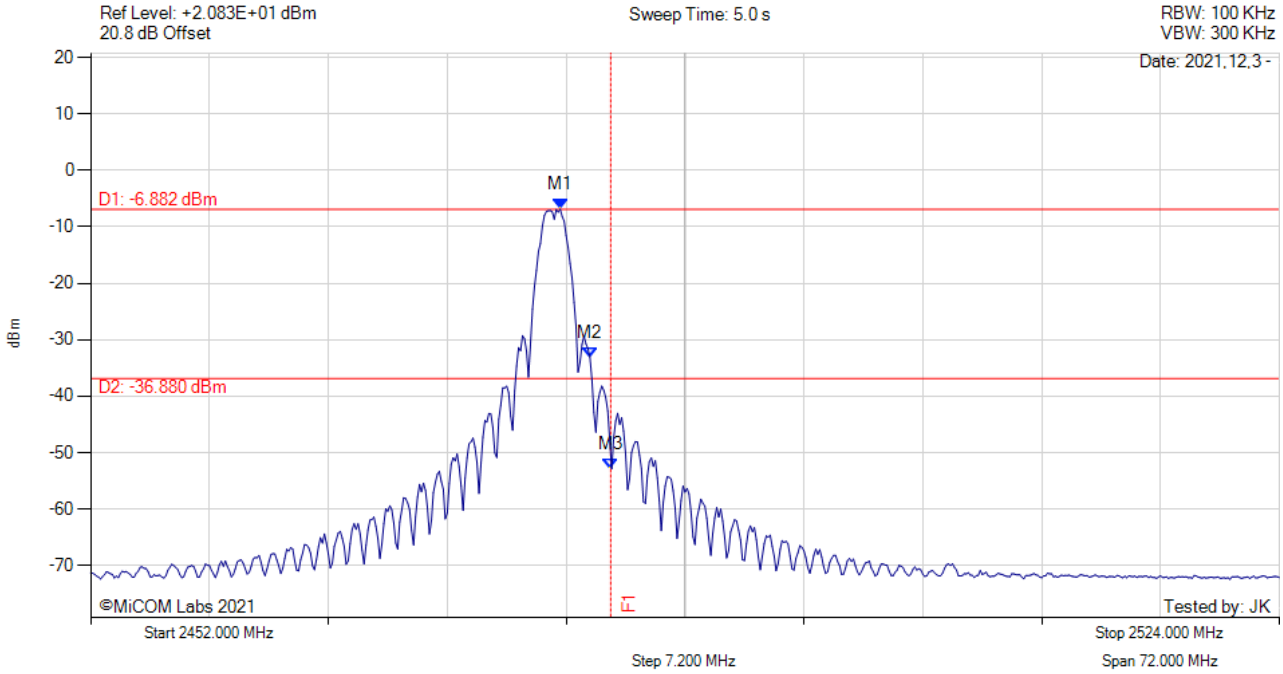


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2480.210 MHz : -2.607 dBm M2 : 2480.611 MHz : -23.231 dBm M3 : 2483.500 MHz : -46.206 dBm	Channel Frequency: 2480.00 MHz

back to matrix

CONDUCTED HIGH BAND-EDGE EMISSIONS - AVERAGE

Variant: QPSK, Channel: 2480.00 MHz, Chain a, Temp: 20, Voltage: 3.3 Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = AVER Sweep Count = 0 RF Atten (dB) = 10 Trace Mode = VIEW	M1 : 2480.440 MHz : -6.882 dBm M2 : 2482.240 MHz : -33.126 dBm M3 : 2483.500 MHz : -52.851 dBm	Channel Frequency: 2480.00 MHz

back to matrix

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