REGULATORY COMPLIANCE TEST REPORT

FCC CFR 47 Part 15 Subpart C 15.247 (DTS)

Report No.: PRES04-U2 Rev A

Company: Preston Cinema Systems

Model Name: TR6

REGULATORY COMPLIANCE TEST REPORT

Company Name: Preston Cinema Systems

Model Name: TR6

To: FCC CFR 47 Part 15 Subpart C 15.247 (DTS)

Test Report Serial No.: PRES04-U2 Rev A

This report supersedes: NONE

Applicant: Preston Cinema Systems
1659 11th Street
Santa Monica,
California 90404
United States of America

Issue Date: 17th July 2024

This Test Report is Issued Under the Authority of:

MiCOM Labs, Inc.
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Pleasanton California 94566
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A2LA 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*).

Presented this 28th day of February 2024.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2025

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 28th day of February 2024.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2381.02
Valid to November 30, 2025

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

2. DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft	16th July 2024	Draft report for review.
Rev A	17th July 2024	Initial release.
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In the above table the latest report revision will replace all earlier versions.

3. TEST RESULT CERTIFICATE

Manufacturer:	Preston Cinema Systems 1659 11th Street Santa Monica California 90404 United States of America	**Tested By:**	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Model:	TR6	**Telephone:**	+1 925 462 0304
Type Of Equipment:	2.4 GHz Transceiver	**Fax:**	+1 925 462 0306
S/N's:	1		
Test Date(s):	10th – 11th July 2024	**Website:**	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC CFR 47 Part 15 Subpart C 15.247 (DTS) & ISED RSS-247	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.

4. REFERENCES AND MEASUREMENT UNCERTAINTY

4.1. Normative References

REF.	PUBLICATION	YEAR	TITLE
I	KDB 662911 D01, D02, D03	D01 Oct 2013, D02 Oct 2011, D03 Oct 2020	Guidance for measurement of output emission of devices that employ single transmitter with multiple outputs or systems with multiple transmitters operating simultaneously in the same frequency band. 662911 D01 Multiple Transmitter Output v02r01, 662911 D02 MIMO with Cross Polarized Antenna v01, 662911 D03 MIMO Antenna Gain Measurement v01, OET 13TR1003 Directional Gain of 802 11 MIMO with CDD 04 05 2013
II	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.
III	A2LA	16th April 2024	R105 - Requirement's When Making Reference to A2LA Accreditation Status
IV	ANSI C63.10	2020	American National Standard for Testing Unlicensed Wireless Devices
V	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
VI	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
VII	FCC 47 CFR Part 15.247	Apr 2020	Radio Frequency Devices; Subpart C – Intentional Radiators
VIII	ICES-003	Issue 7; Oct 2020	Information Technology Equipment (Including Digital Apparatus)
IX	UKAS M3003	Edition 6 March 2024	The Expression of Uncertainty and Confidence in Measurements
X	RSS-247 Issue 3	Aug 2023	Digital Transmission Systems (DTSs), Frequency Hopping System (FHSs) and Licence-Exempt Local Area Network (LE-LEN) Devices
XI	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.
XII	FCC 47 CFR Part 2.1033	Feb 2023	FCC requirements and rules regarding photographs and test setup diagrams.
XIII	KDB 789033 D02 V02r01	Dec 2017	Guidelines For Compliance Testing Of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E
XIV	UKAS LAB 12	Edition 4 April 2022	The Expression of Uncertainty in Testing

4.2. 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.

5. PRODUCT DETAILS AND TEST CONFIGURATIONS

5.1. Technical Details

Details	Description
Purpose:	Test of the Preston Cinema Systems TR6 to FCC CFR 47 Part 15 Subpart C 15.247 (DTS). Radio Frequency Devices; Subpart C – Intentional Radiators
Applicant:	Preston Cinema Systems 1659 11th Street Santa Monica California/Los Angeles 90404 United States of America
Manufacturer:	Preston Cinema Systems
Laboratory performing the tests:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Test report reference number:	PRES04-U2
Date EUT received:	9th July 2024
Standard(s) applied:	FCC CFR 47 Part 15 Subpart C 15.247 (DTS)
Dates of test (from - to):	10th – 11th July 2024
No of Units Tested:	1
Product Family Name:	TR6
Model(s):	TR6
Location for use:	Indoors
Declared Frequency Range(s):	2400 - 2483.5 MHz
Type of Modulation:	GFSK
EUT Modes of Operation:	2400 - 2483.5 MHz; GFSK;
Declared Nominal Output Power (dBm):	+18.0 dBm
Transmit/Receive Operation:	Transceiver
Rated Input Voltage and Current:	5 VDC, 0.5A
Operating Temperature Range:	20 °C to 85 °C
ITU Emission Designator:	927KF1D
Equipment Dimensions:	50mm x 51mm x 10mm
Weight:	14 grams
Hardware Rev:	TR6
Firmware Rev:	1.00

5.2. Scope Of Test Program

Preston Cinema Systems TR6

The scope of the test program was to test the Preston Cinema Systems TR6. The TR6 operates in the frequency range 2400 - 2483.5 MHz; for compliance against the following specification:

The scope of the test program was to test the Preston Cinema Systems TR6 operating in the frequency range 2400 - 2483.5 MHz for compliance against the following specifications;-

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

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

Note: The EUT has two identical RF ports (A and B), with only one port active at a time. Port A was identified as having the highest power and was tested for this report.

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

Type (EUT/ Support)	Equipment Description	Manufacturer	Model No.	Serial No.
EUT Conducted	2.4 GHz Transceiver	Preston Cinema Systems	TR6	1
Support	Power Supply (5V 0.5A)	Phihong	PSM03A-060	--

5.4. Antenna Details

Type	Manufacturer	Model	Family	Gain (dBi)	BF Gain	Dir BW	X-Pol	Frequency Band (MHz)
External	Preston Cinema Systems	ANT-2.4-CW-RCS	Dipole	0.2	-	360	-	2400 - 2483.5

BF Gain - Beamforming Gain
Dir BW - Directional BeamWidth
X-Pol - Cross Polarization

5.5. Cabling and I/O Ports

1. NONE

5.6. Test Configurations

Results for the following configurations are provided in this report:

Operational Mode(s)	Data Rate with Highest Power MBit/s	Channel Frequency (MHz)		
		Low	Mid	High
2400 - 2483.5 MHz				
GFSK	1	2,402.00	2,440.00	2,476.00

5.7. Equipment Modifications

The following modifications were required to bring the equipment into compliance:
1. NONE

5.8. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:
1. NONE

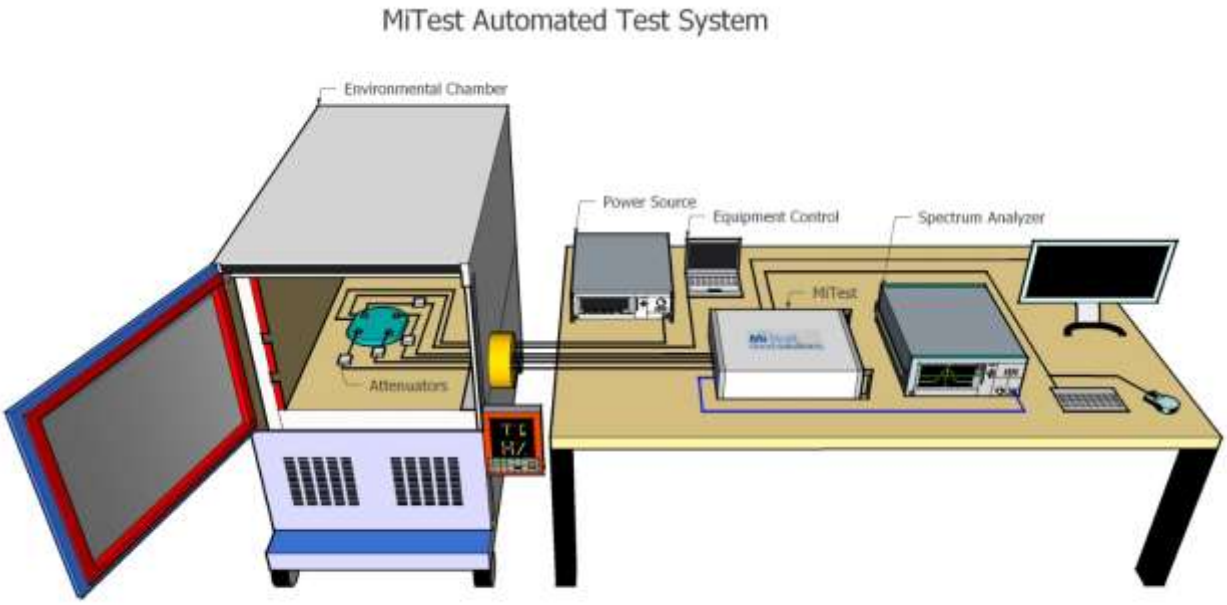
6. TEST SUMMARY

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
(3) Digital Emissions (0.03 - 1 GHz)	Complies	View Data

7. TEST EQUIPMENT CONFIGURATION(S)

7.1. Conducted RF



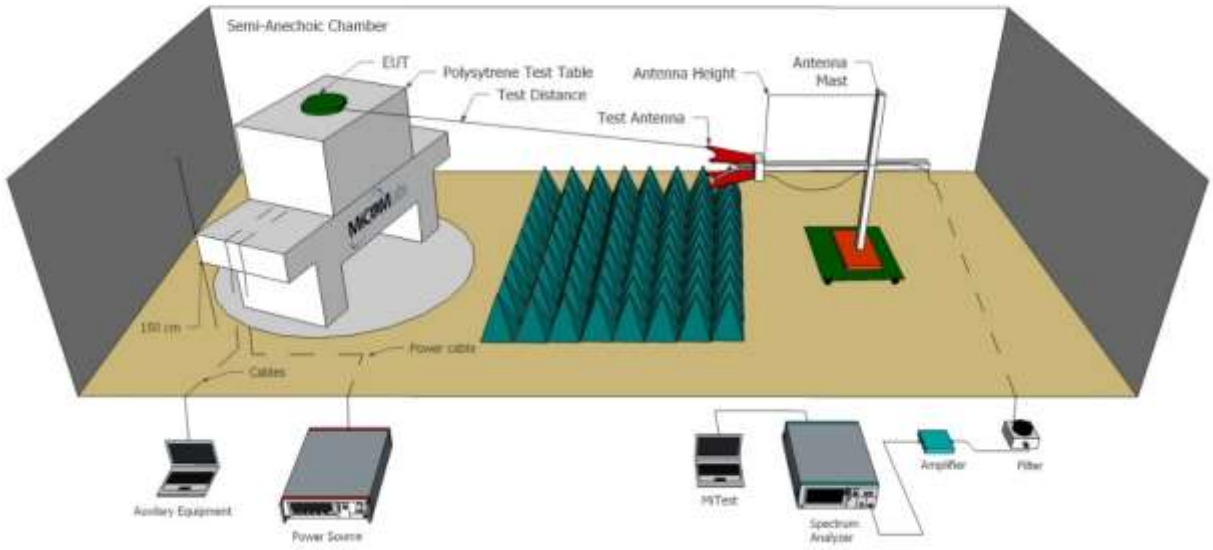
A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
#3 SA	MiTest Box to SA	Fairview Microwave	SCA1814-0101-72	#3 SA	26 Oct 2024
#3P1	EUT to MiTest box port 1	Fairview Microwave	SCA1814-0101-72	#3P1	26 Oct 2024
#3P2	EUT to MiTest box port 2	Fairview Microwave	SCA1814-0101-72	#3P2	26 Oct 2024
#3P3	EUT to MiTest box port 3	Fairview Microwave	SCA1814-0101-72	#3P3	26 Oct 2024
#3P4	EUT to MiTest box port 4	Fairview Microwave	SCA1812-0101-72	#3P4	26 Oct 2024
249	Thermocouple; Resistance Thermometer	Thermotronics	GR2105-02	9340 #2	22 Mar 2025
266	10 Hz to 50GHz MXA Signal Analyzer	Keysight	N9020B	MY60110791	25 Jul 2025
285	DC Power Supply	Keysight	E36155A	MY63000156	4 Dec 2024
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	4 Dec 2024
442	USB Wideband Power Sensor	Boonton	55006	9181	12 Dec 2024
445	PoE Injector	D-Link	DPE-101GL	QTAH1E2000625	Not Required
461	Spectrum Analyzer	Agilent	E4440A	MY46185537	27 Sep 2024
493	USB Wideband Power Sensor	Boonton	55006	9634	8 Oct 2024
494	USB Wideband Power Sensor	Boonton	55006	9726	12 Dec 2024
510	Barometer/Thermometer	Control Company	68000-49	170871375	20 Dec 2023
512	MiTest Cloud Solutions RF Test Box	MiCOM	2nd Gen	512	24 Oct 2024
516	USB Wideband Power Sensor	Boonton	RTP5006	10511	4 Dec 2024
75	Environmental Chamber	Thermatron	SE-300-2-2	27946	20 Nov 2024

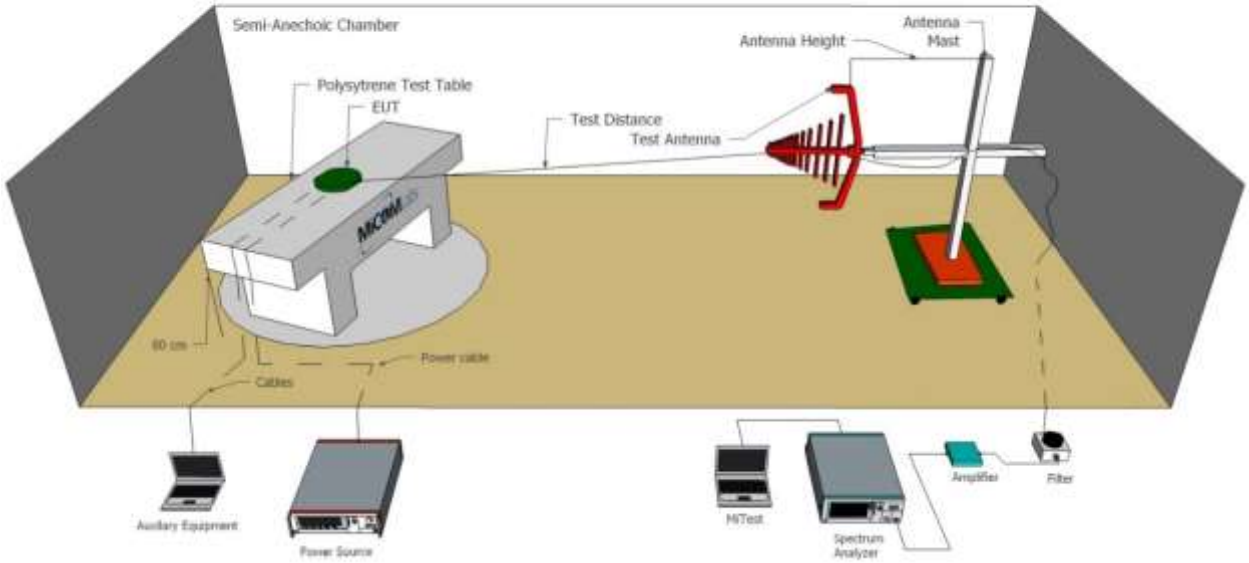
7.2. Radiated Emissions

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
338	Sunol 30 to 3000 MHz Antenna	Sunol	JB3	A052907	5 Dec 2024
342	2.4 GHz Notch Filter	EWT	EWT-14-0203	H1	13 Sep 2024
373	26III RMS Multimeter	Fluke	Fluke 26 series III	76080720	29 Sep 2024
399	ETS 1-18 GHz Horn Antenna	ETS	3117	00154575	7 Dec 2024
406	Amplifier for Radiated Emissions	MiCOM Labs	40dB 1 to 18GHz Amp	0406	2 Nov 2024
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
414	DC Power Supply 0-60V	HP	6274	1029A01285	Cal when used
415	Turntable Controller	Sunol Sciences	Turntable Controller	None	Not Required
416	Gigabit ethernet filter	ETS-Lingren	Gigafoil 260366	None	Not Required
447	MiTest Rad Emissions Test Software	MiCOM	Rad Emissions Test Software Version 1.0	447	Not Required
462	Schwarzbeck cable from Antenna to Amplifier.	Schwarzbeck	AK 9513	462	18 Sep 2024
463	Schwarzbeck cable from Amplifier to Bulkhead.	Schwarzbeck	AK 9513	463	18 Sep 2024
464	Schwarzbeck cable from Bulkhead to Receiver	Schwarzbeck	AK 9513	464	16 Sep 2024
465	Low Pass Filter DC-1000 MHz	Mini-Circuits	NLP-1200+	VUU01901402	14 Sep 2024
480	Cable - Bulkhead to Amp	SRC Haverhill	157-3050360	480	18 Sep 2024
481	Cable - Bulkhead to Receiver	SRC Haverhill	151-3050787	481	18 Sep 2024
510	Barometer/Thermometer	Digi Sense	68000-49	170871375	4 Jan 2026
554	Precision SMA Cable	Fairview Microwave	SCE18060101-400CM	554	18 Sep 2024
555	Rhode & Schwarz Receiver (Firmware Version : 3.10 SP1)	Rhode & Schwarz	ESW 44	101893	28 Jun 2025

8. 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)

9. TEST RESULTS

9.1. 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 (%):**	26
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	0.2
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	EC
Engineering Test Notes:	Channel 0, 2402 MHz, 26% Duty Cycle		

Test Measurement Results

Test Frequency	Measured 6 dB Bandwidth (MHz) Port(s)				6 dB Bandwidth (MHz)		Limit	Lowest Margin
MHz	a	b	c	d	Highest	Lowest	KHz	MHz
2402.0	0.920				0.920	0.920	≥500.0	-0.42
2440.0	0.927				0.927	0.927	≥500.0	-0.43
2476.0	0.887				0.887	0.887	≥500.0	-0.39

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				Maximum 99% Bandwidth (MHz)		
MHz	a	b	c	d			
2402.0	1.219				1.219		
2440.0	1.271				1.271		
2476.0	1.461				1.461		

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).

9.2. 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 (%):**	26.0
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	0.20
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	EC
Engineering Test Notes:	Channel 0, 2402 MHz, 26% Duty Cycle		

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	17.05				17.05	30.00	-12.95	Max
2440.0	16.83				16.83	30.00	-13.17	Max
2476.0	17.70				17.70	30.00	-12.30	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.

9.3. 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 (%):**	26.0
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	0.20
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	EC
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	-0.874				-0.874	8.0	-8.9
2440.0	1.879				1.879	8.0	-6.1
2476.0	-1.805				-1.805	8.0	-9.8

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).

9.4. Emissions

9.4.1. Conducted Emissions

9.4.1.1. 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 (%):**	26
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	0.2
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	EC
Engineering Test Notes:	Channel 0, 2402 MHz, 26% Duty Cycle		

Test Measurement Results

Test Frequency	Frequency Range	Conducted Spurious Emissions - Peak (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	-48.979	-30.14						
2440.0	30.0 - 26000.0	-47.627	-30.86						
2476.0	30.0 - 26000.0	-47.341	-11.64						

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).

9.4.1.2. 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 (%):**	26.0
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	0.2
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	EC
Engineering Test Notes:	Channel 0, 2402 MHz, 26% Duty Cycle		

Test Measurement Results

Channel Frequency:	2402.0 MHz					
Band-Edge Frequency:	2400.0 MHz					
Test Frequency Range:	2350.0 - 2405.0 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	-23.26	-9.44	2401.20			-1.200

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).

Equipment Configuration for Conducted High Band-Edge Emissions - Peak			
Variant:	GFSK	**Duty Cycle (%):**	26.0
Data Rate:	1.00 MBit/s	**Antenna Gain (dBi):**	0.2
Modulation:	GFSK	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	EC
Engineering Test Notes:	Channel 29, 2476 MHz, 26% Duty Cycle		

Test Measurement Results

Channel Frequency:	2476.0 MHz					
Band-Edge Frequency:	2483.5 MHz					
Test Frequency Range:	2475.0 - 2524.0 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	-54.19	-10.63	2476.70			-6.800

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).

9.4.2. Radiated Emissions

Radiated Test Conditions for Radiated Spurious and Band-Edge Emissions (Restricted Bands)			
Standard:	FCC CFR 47 Part 15 Subpart C 15.247 (DTS) ISED RSS-247	**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 RSS-247:5.5	**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).

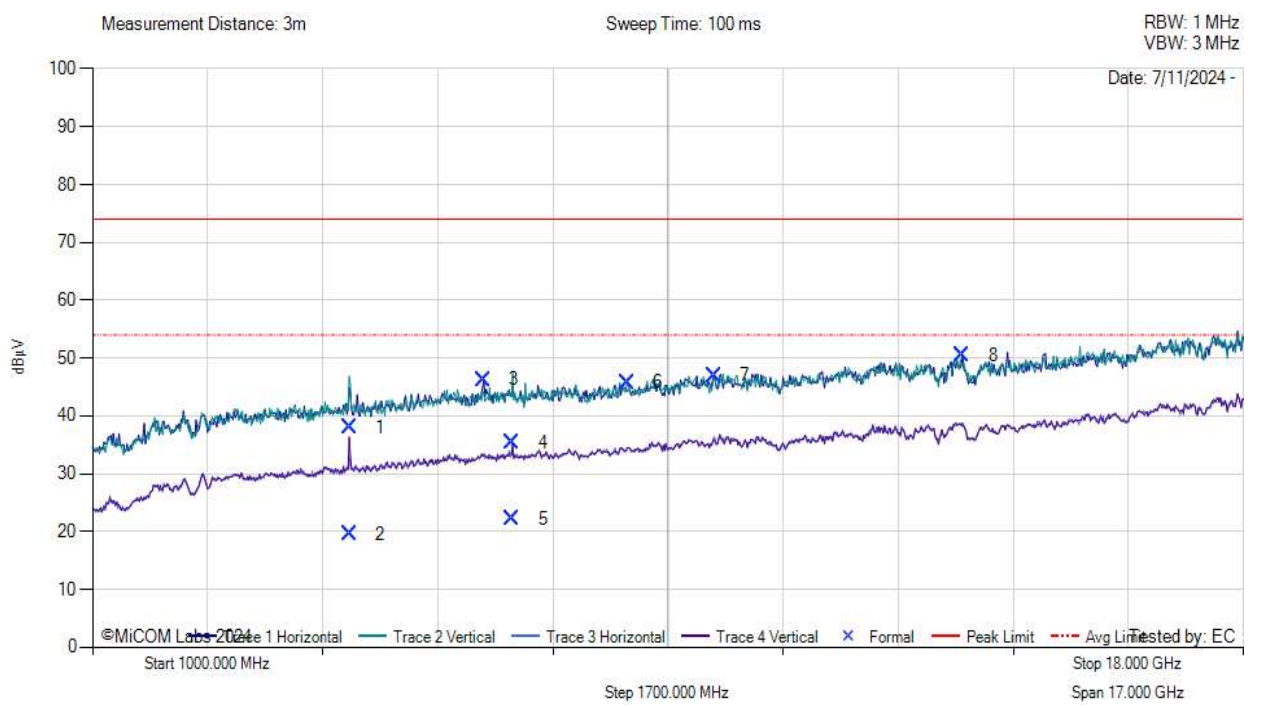
(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of §15.245 shall not exceed the limits specified in §15.245(b).

9.4.2.3. TX Spurious & Restricted Band Emissions

Equipment Configuration for FCC SPURIOUS 1 GHZ -18 GHZ 2M			
Antenna:	External	**Variant:**	ANT-2.4-CW-RCS
Antenna Gain (dBi):	0.2 dB	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	26%
Channel Frequency (MHz):	2402	**Data Rate:**	1 MB
Power Setting:	Max	**Tested By:**	EC

Test Measurement Results

FCC Spurious 1 GHz -18 GHz



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	4802.62	47.49	2.85	-12.31	38.03	MaxP	Vertical	153	126	74.0	-36.0	Pass
2	4802.62	29.08	2.85	-12.31	19.62	AVG	Vertical	153	126	54.0	-34.4	Pass
3	6780.00	51.06	3.51	35.80	46.29	MaxP	Horizontal	199	120	74.0	-27.7	Pass
4	7204.73	39.64	3.78	-8.01	35.41	MaxP	Vertical	164	66	74.0	-38.6	Pass
5	7204.73	26.41	3.78	-8.01	22.17	AVG	Vertical	164	66	54.0	-31.8	Pass
6	8905.00	49.38	4.09	36.03	45.78	MaxP	Vertical	148	299	74.0	-28.2	Pass
7	10180.00	47.63	4.42	37.45	46.96	MaxP	Vertical	199	209	74.0	-27.0	Pass
8	13852.00	52.23	5.29	39.11	50.39	MaxP	Horizontal	148	300	74.0	-23.6	Pass

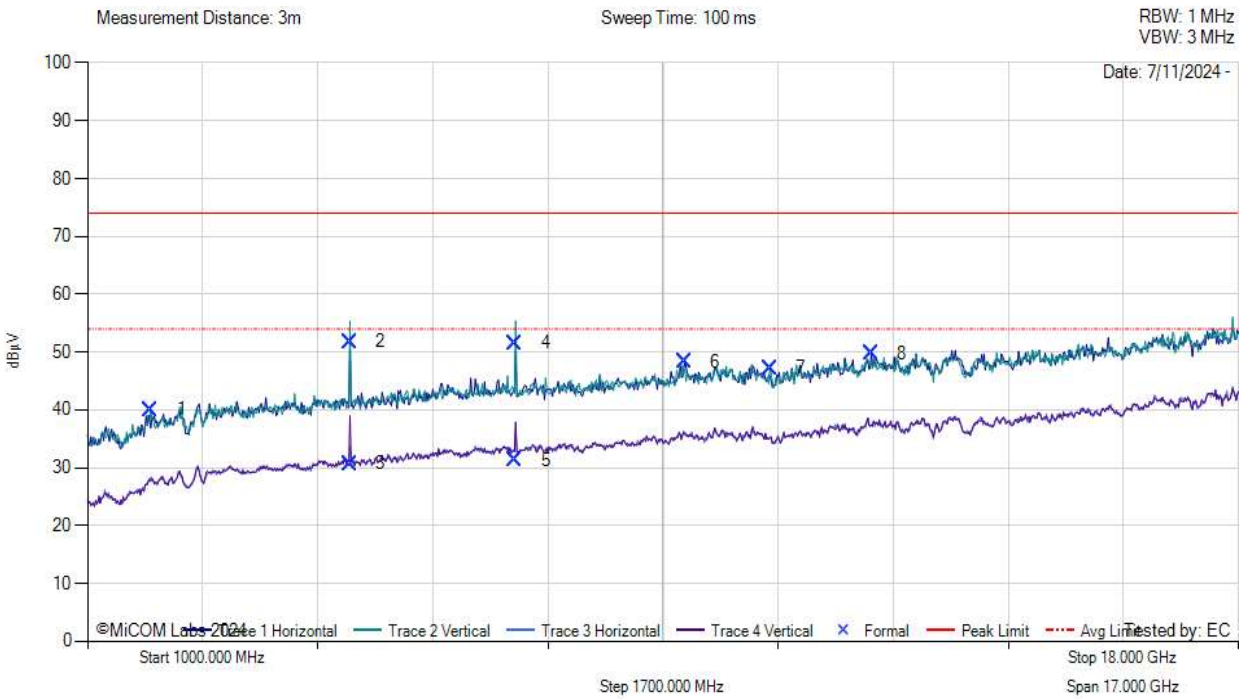
Test Notes: SN 1, GFSK, Channel 0 : 2402 MHz, Data rate : 1 MB, Max Power setting

Equipment Configuration for FCC SPURIOUS 1 GHZ -18 GHZ 2M

Antenna:	External	**Variant:**	ANT-2.4-CW-RCS
Antenna Gain (dBi):	0.2 dB	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	26%
Channel Frequency (MHz):	2440	**Data Rate:**	1 MB
Power Setting:	Max	**Tested By:**	EC

Test Measurement Results

FCC Spurious 1 GHz -18 GHz 2M



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	1935.00	51.81	1.76	31.15	40.07	MaxP	Vertical	199	330	74.0	-33.9	Pass
2	4879.17	61.19	2.84	-12.25	51.78	MaxP	Vertical	153	244	74.0	-22.2	Pass
3	4879.17	40.14	2.84	-12.25	30.72	AVG	Vertical	153	244	54.0	-23.3	Pass
4	7318.98	55.60	3.74	-7.78	51.56	MaxP	Vertical	196	220	74.0	-22.4	Pass
5	7318.98	35.31	3.74	-7.78	31.27	AVG	Vertical	196	220	54.0	-22.7	Pass
6	9823.00	49.48	4.36	37.06	48.37	MaxP	Horizontal	199	270	74.0	-25.6	Pass
7	11081.00	48.02	4.74	37.85	47.25	MaxP	Vertical	150	210	74.0	-26.7	Pass
8	12577.00	51.17	5.06	38.97	49.77	MaxP	Horizontal	199	0	74.0	-24.2	Pass

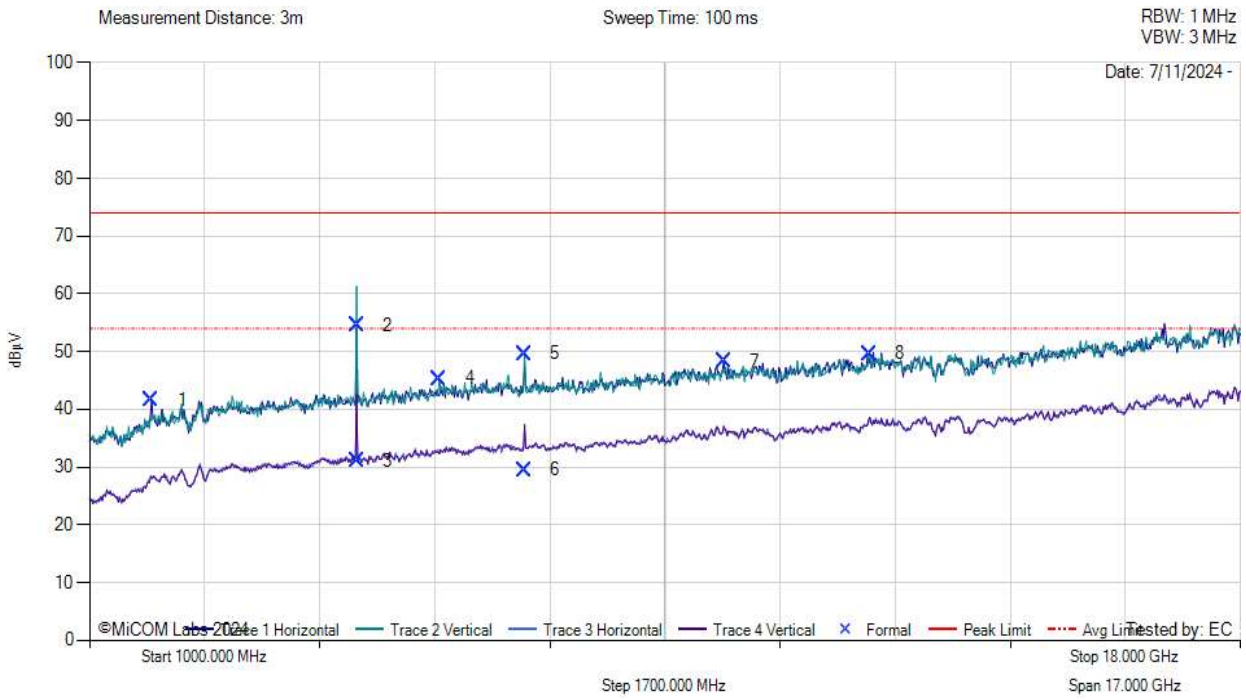
Test Notes: SN 1, GFSK, Channel 14 : 2440 MHz, Data rate : 1 MB, Max Power setting

Equipment Configuration for FCC SPURIOUS 1 GHZ -18 GHZ 2M

Antenna:	External	**Variant:**	ANT-2.4-CW-RCS
Antenna Gain (dBi):	0.2	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	26%
Channel Frequency (MHz):	2476.00	**Data Rate:**	1 MB
Power Setting:	Max	**Tested By:**	EC

Test Measurement Results

FCC Spurious 1 GHz -18 GHz



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	1918.00	53.41	1.77	31.08	41.55	MaxP	Horizontal	149	270	74.0	-32.4	Pass
2	4951.53	64.19	2.88	-12.47	54.60	MaxP	Vertical	169	265	74.0	-19.4	Pass
3	4951.53	40.65	2.88	-12.47	31.06	AVG	Vertical	169	265	54.0	-22.9	Pass
4	6168.00	51.26	3.27	35.47	45.29	MaxP	Vertical	149	149	74.0	-28.7	Pass
5	7428.75	53.78	3.74	-7.91	49.61	MaxP	Vertical	183	220	74.0	-24.4	Pass
6	7428.75	33.66	3.74	-7.91	29.49	AVG	Vertical	183	220	54.0	-24.5	Pass
7	10367.00	48.39	4.31	37.52	48.26	MaxP	Horizontal	199	330	74.0	-25.7	Pass
8	12526.00	50.53	5.47	38.93	49.62	MaxP	Vertical	149	299	74.0	-24.4	Pass

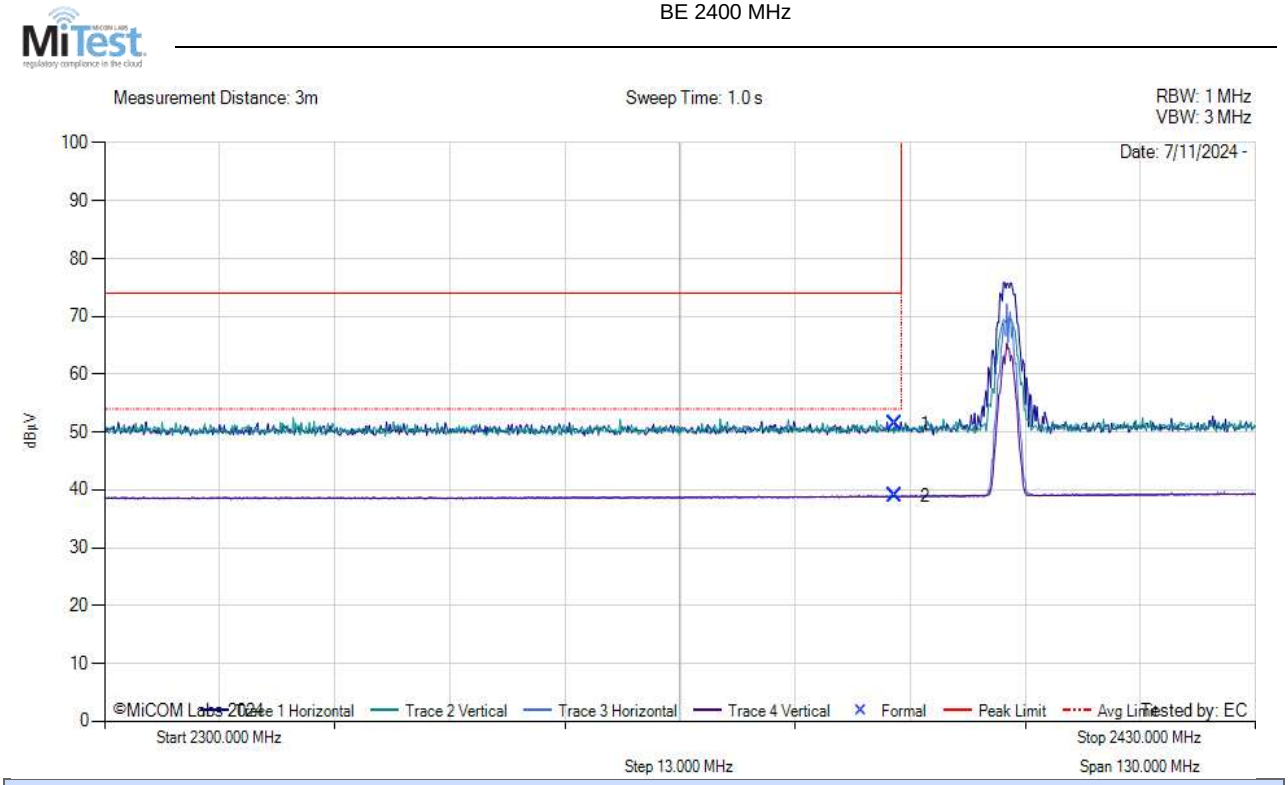
Test Notes: SN 1, GFSK, Channel 29 : 2476 MHz, Data rate : 1 MB, Max Power setting

9.4.2.4. Restricted Edge & Band-Edge Emissions

Equipment Configuration for BE 2400 MHZ			
Antenna:	External	**Variant:**	ANT-2.4-CW-RCS
Antenna Gain (dBi):	0.2 dB	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	26%
Channel Frequency (MHz):	2402.00	**Data Rate:**	1 MB
Power Setting:	Max	**Tested By:**	EC

Test Measurement Results

BE 2400 MHz



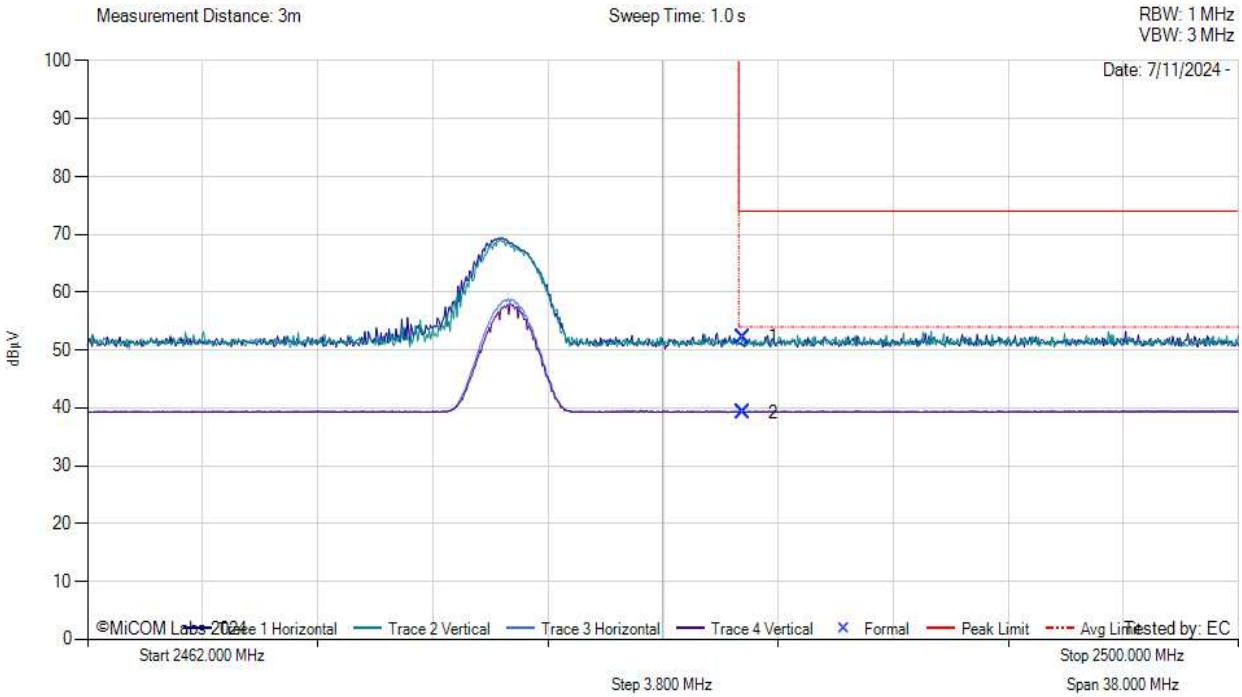
2300.00 - 2430.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	2389.31	27.38	1.96	32.14	51.48	MaxP	Vertical	149	299	74.0	-22.5	Pass
2	2389.31	14.82	1.96	32.14	38.92	AVG	Vertical	149	239	54.0	-15.1	Pass

Test Notes: SN 1, GFSK, Channel 0 : 2402 MHz, Data rate : 1 MB, Max Power setting,

Equipment Configuration for BE 2483.5 MHZ			
Antenna:	External	**Variant:**	ANT-2.4-CW-RCS
Antenna Gain (dBi):	0.2 dB	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	26%
Channel Frequency (MHz):	2476.00	**Data Rate:**	1 MB
Power Setting:	Max	**Tested By:**	EC

Test Measurement Results

BE 2483.5 MHz



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	2483.62	27.86	1.98	32.41	52.25	MaxP	Vertical	149	209	74.0	-21.7	Pass
2	2483.62	14.88	1.98	32.41	39.28	AVG	Vertical	149	269	54.0	-14.7	Pass

Test Notes: SN 1, GFSK, Channel 29 : 2476 MHz, Data rate : 1 MB, Max Power setting,

9.4.3. Digital Emissions (0.03 - 1 GHz)

FCC, Part 15 Subpart B §15.109
ISED ICES-003 Section 3.2.2

Test Procedure

Testing 30 – 1000 MHz was performed in a anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied between 1 and 4 meters. The emissions are recorded with receiver in peak hold mode.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR Compliant receiver. Emissions from 30 MHz – 1000 MHz are measured utilizing a CISPR compliant quasi-peak detector with a tuned receiver, using a bandwidth of 120 kHz. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Only the highest emissions relative to the limit are listed.

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

FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
FO = Distance Falloff Factor

CORR = Correction Factor = CL – AG + NFL

CL = Cable Loss
AG = Amplifier Gain
NFL = Notch Filter Loss or Waveguide Loss

Field Strength Calculation Example:

Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB/m; 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 of the measured emission is:

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

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

FCC and IC Spurious Emissions Limits

FCC, Part 15 Subpart B §15.109
ISED ICES-003 Section 3.2.2

Except for Class A digital device, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values.

Limits below 1 GHz:

The FCC limits are slightly lower in some sub bands and represent the more stringent requirements.

Class A limits

Frequency(MHz)	Quasi-peak Limit (dBµV/m)		Measurement Distance (meters)	Quasi-peak Limit (dBµV/m)		Measurement Distance (meters)
	ISED	FCC		ISED	FCC	
30 to 88	40.0	39.0	10	50.0	49.5	3
88 - 216	43.5	43.5	10	54.0	54.0	3
216 - 230	46.4	46.4	10	56.9	56.9	3
230 - 960	47.0		10	57.0		3
960 - 1000	49.5	49.5	10	60.0	60.0	3

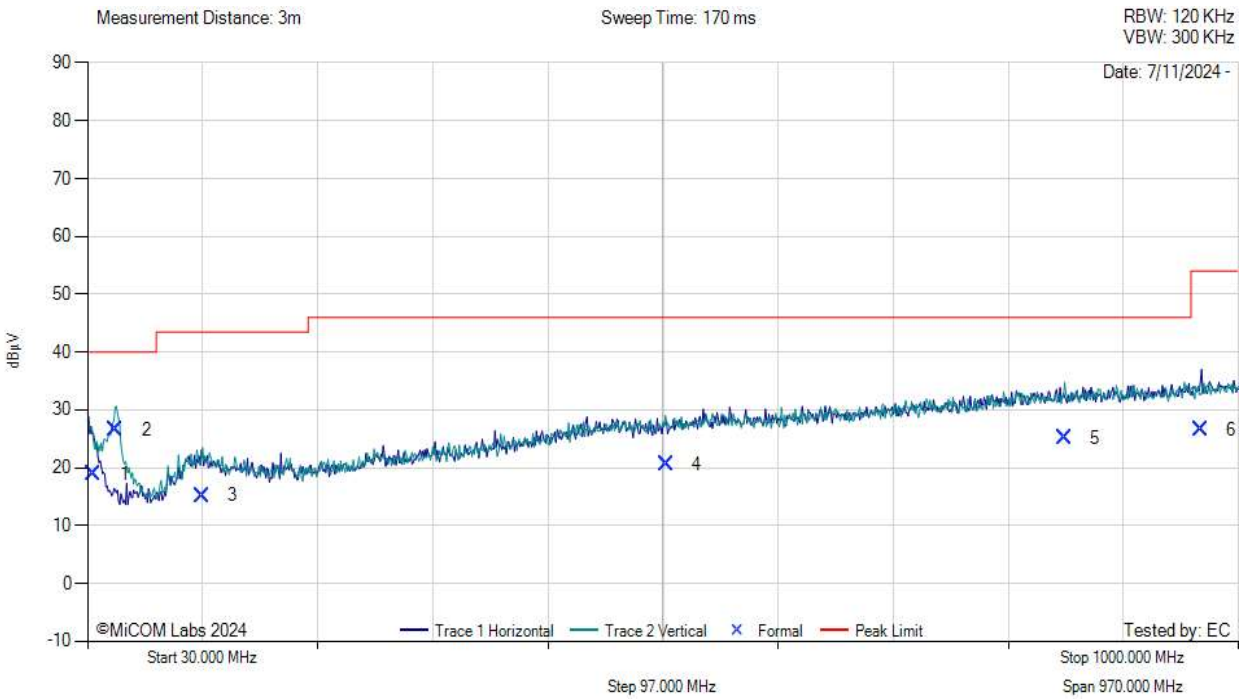
Class B limits

Frequency(MHz)	Quasi-peak Limit (dBµV/m)		Measurement Distance (meters)	Quasi-peak Limit (dBµV/m)		Measurement Distance (meters)
	ISED	FCC		ISED	FCC	
30 to 88	30.0	29.5	10	40.0	40.0	3
88 - 216	33.1	33.0	10	43.5	43.5	3
216 - 230	35.6	35.6	10	46.0	46.0	3
230 - 960	37.0		10	47.0		3
960 - 1000	43.5	43.5	10	54.0	54.0	3

Equipment Configuration for 30 MHZ TO 1 GHZ 2M			
Antenna:	External	**Variant:**	ANT-2.4-CW-RCS
Antenna Gain (dBi):	0.2	**Modulation:**	GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	26%
Channel Frequency (MHz):	2402.00	**Data Rate:**	1 MB
Power Setting:	Max	**Tested By:**	EC

Test Measurement Results

30 MHz to 1 GHz

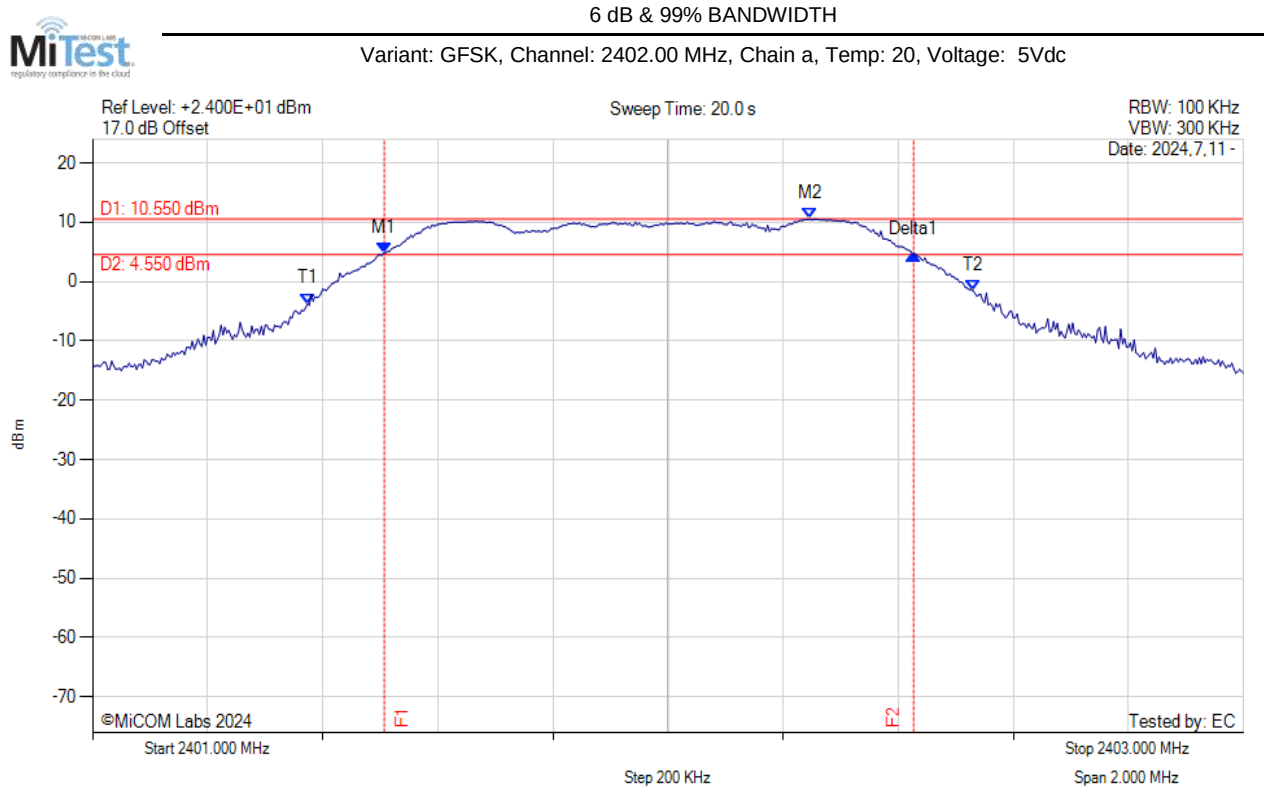


30.00 - 1000.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB/m**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	35.33	22.86	3.58	-7.49	18.95	MaxQP	Horizontal	160	245	40.0	-21.1	Pass
2	53.92	40.24	3.75	-17.48	26.52	MaxQP	Vertical	99	30	40.0	-13.5	Pass
3	126.83	22.23	4.23	-11.30	15.17	MaxQP	Vertical	111	149	43.5	-28.3	Pass
4	517.76	21.65	5.76	-6.78	20.63	MaxQP	Vertical	111	270	46.0	-25.4	Pass
5	853.11	20.67	6.80	-2.37	25.10	MaxQP	Vertical	125	177	46.0	-20.9	Pass
6	968.25	20.56	7.15	-1.09	26.62	MaxQP	Horizontal	149	121	54.0	-27.4	Pass

Test Notes: SN 1, GFSK, Channel 0 : 2402 MHz, Data rate : 1 MB, Max Power setting

A. APPENDIX - GRAPHICAL IMAGES

A.1. 6 dB & 99% Bandwidth

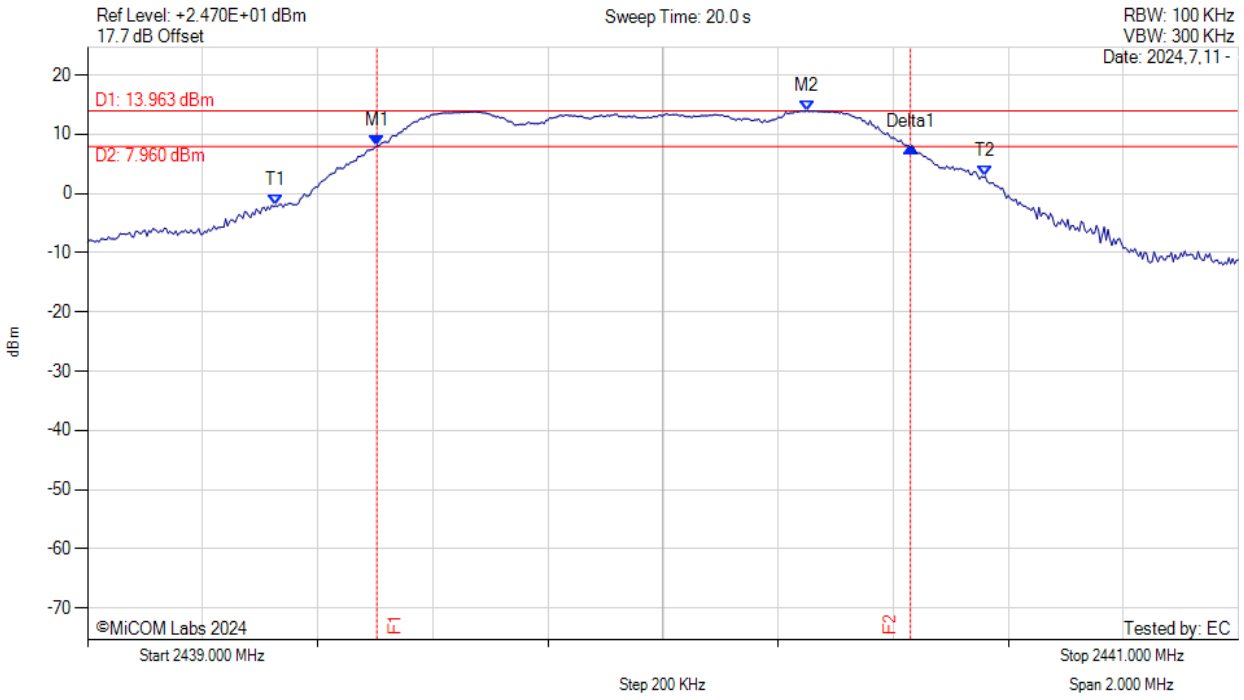


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAXH	M1 : 2401.507 MHz : 4.891 dBm M2 : 2402.247 MHz : 10.550 dBm Delta1 : 920 KHz : -0.420 dB T1 : 2401.373 MHz : -3.716 dBm T2 : 2402.530 MHz : -1.496 dBm OBW : 1.219 MHz	Measured 6 dB Bandwidth: 0.920 MHz Limit: ≥500.0 kHz Margin: -0.42 MHz

back to matrix

6 dB & 99% BANDWIDTH

Variant: GFSK, Channel: 2440.00 MHz, Chain a, Temp: 20, Voltage: 5Vdc

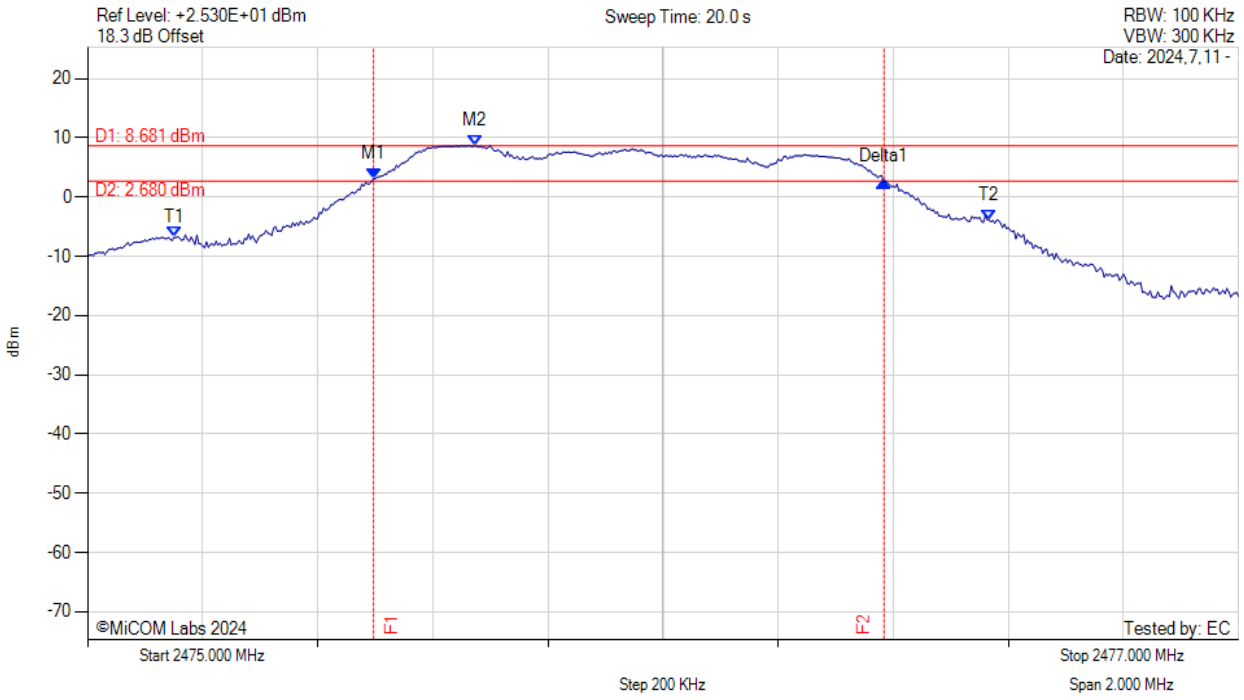


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAXH	M1 : 2439.503 MHz : 8.027 dBm M2 : 2440.250 MHz : 13.963 dBm Delta1 : 927 KHz : -0.149 dB T1 : 2439.327 MHz : -2.037 dBm T2 : 2440.560 MHz : 2.881 dBm OBW : 1.271 MHz	Measured 6 dB Bandwidth: 0.927 MHz Limit: ≥500.0 kHz Margin: -0.43 MHz

back to matrix

6 dB & 99% BANDWIDTH

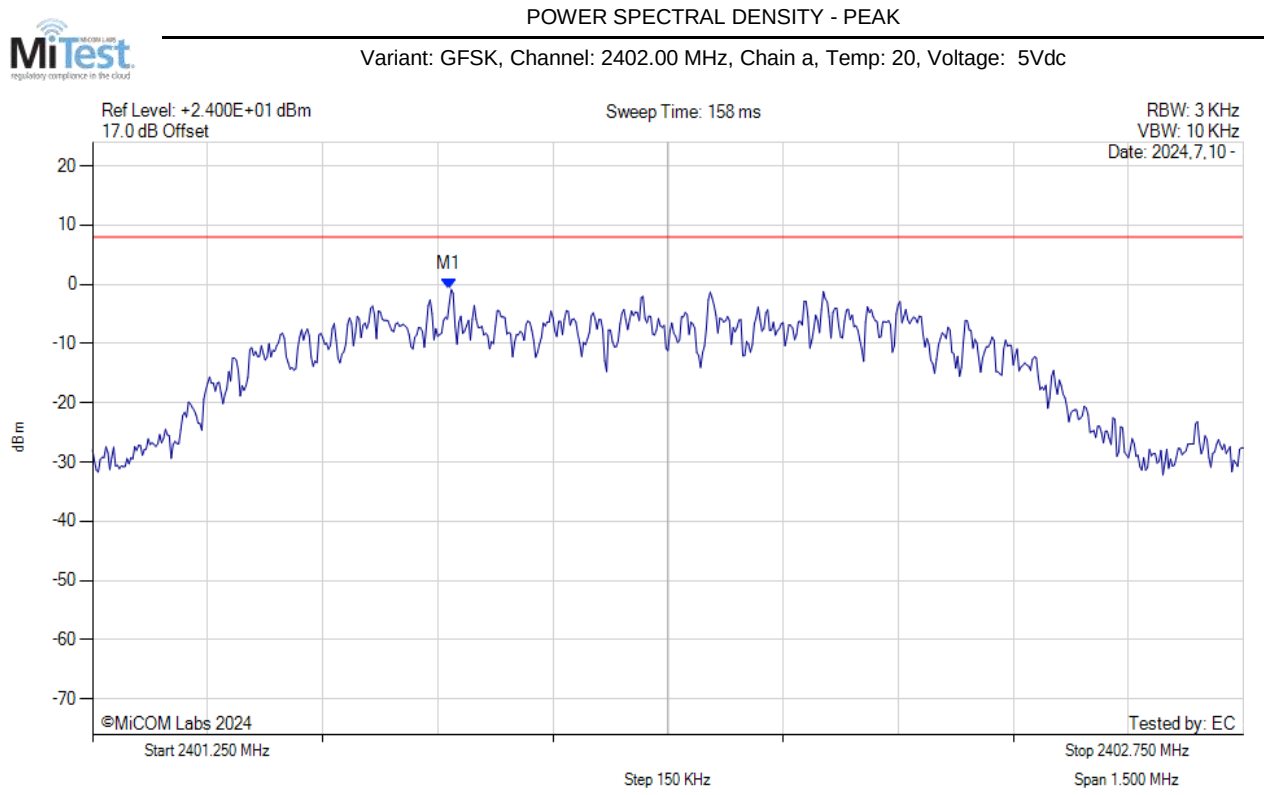
Variant: GFSK, Channel: 2476.00 MHz, Chain a, Temp: 20, Voltage: 5Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAXH	M1 : 2475.497 MHz : 3.056 dBm M2 : 2475.673 MHz : 8.681 dBm Delta1 : 887 KHz : -0.553 dB T1 : 2475.150 MHz : -6.818 dBm T2 : 2476.567 MHz : -3.885 dBm OBW : 1.461 MHz	Measured 6 dB Bandwidth: 0.887 MHz Limit: ≥500.0 kHz Margin: -0.39 MHz

back to matrix

A.2. Power Spectral Density

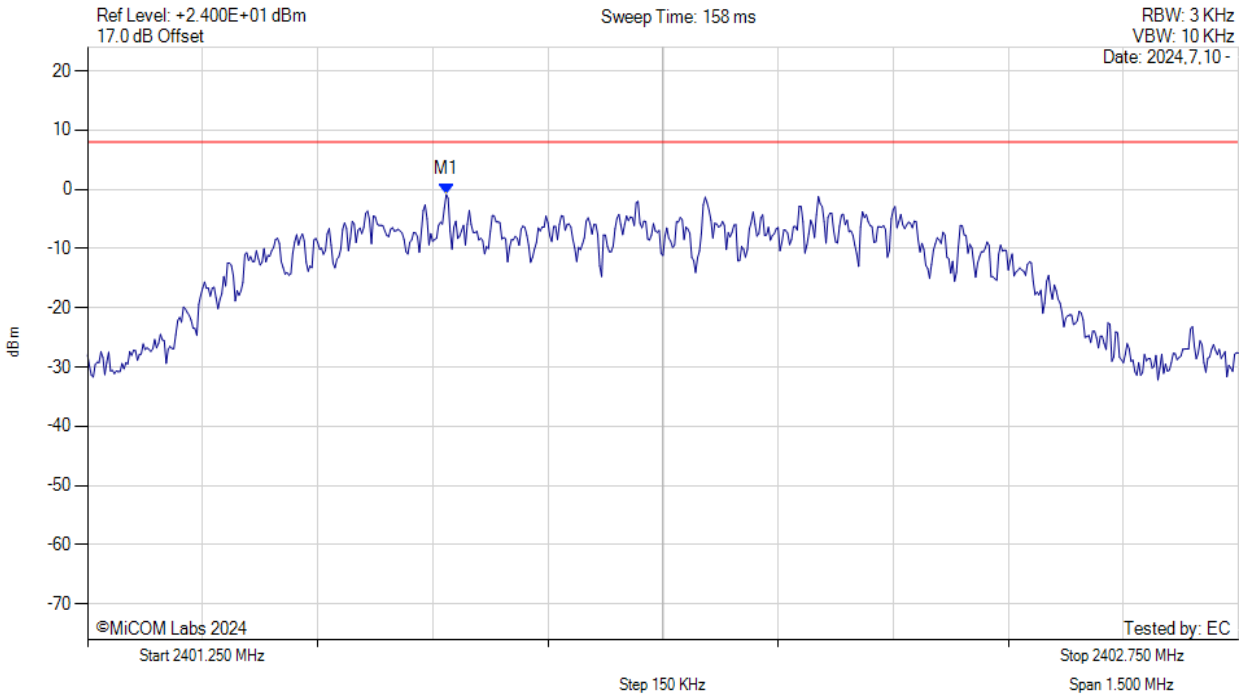


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 30 Trace Mode = VIEW	M1 : 2401.714 MHz : -0.874 dBm	Limit: ≤ 8.000 dBm Margin: 8.87 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2402.00 MHz, SUM, Temp: 20, Voltage: 5Vdc

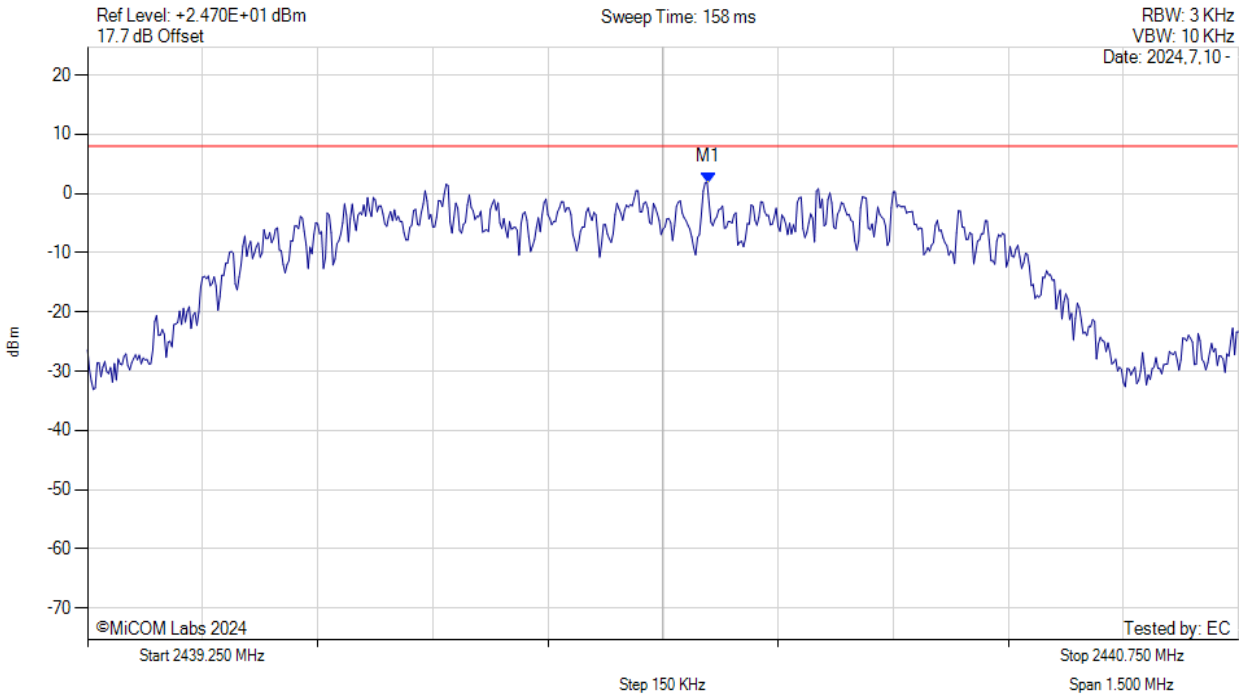


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 30 Trace Mode = VIEW	M1 : 2401.718 MHz : -0.874 dBm	Limit: ≤ 8.0 dBm Margin: -8.9 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2440.00 MHz, Chain a, Temp: 20, Voltage: 5Vdc

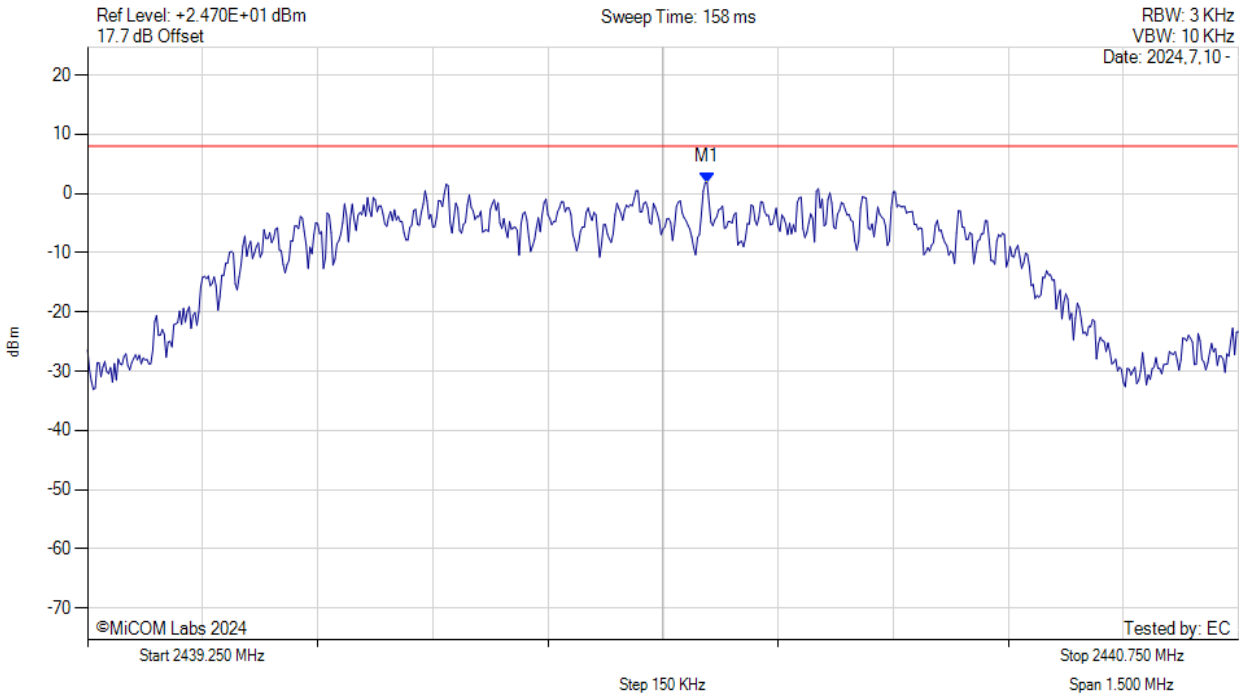


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 30 Trace Mode = VIEW	M1 : 2440.059 MHz : 1.879 dBm	Limit: ≤ 8.000 dBm Margin: -6.12 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2440.00 MHz, SUM, Temp: 20, Voltage: 5Vdc

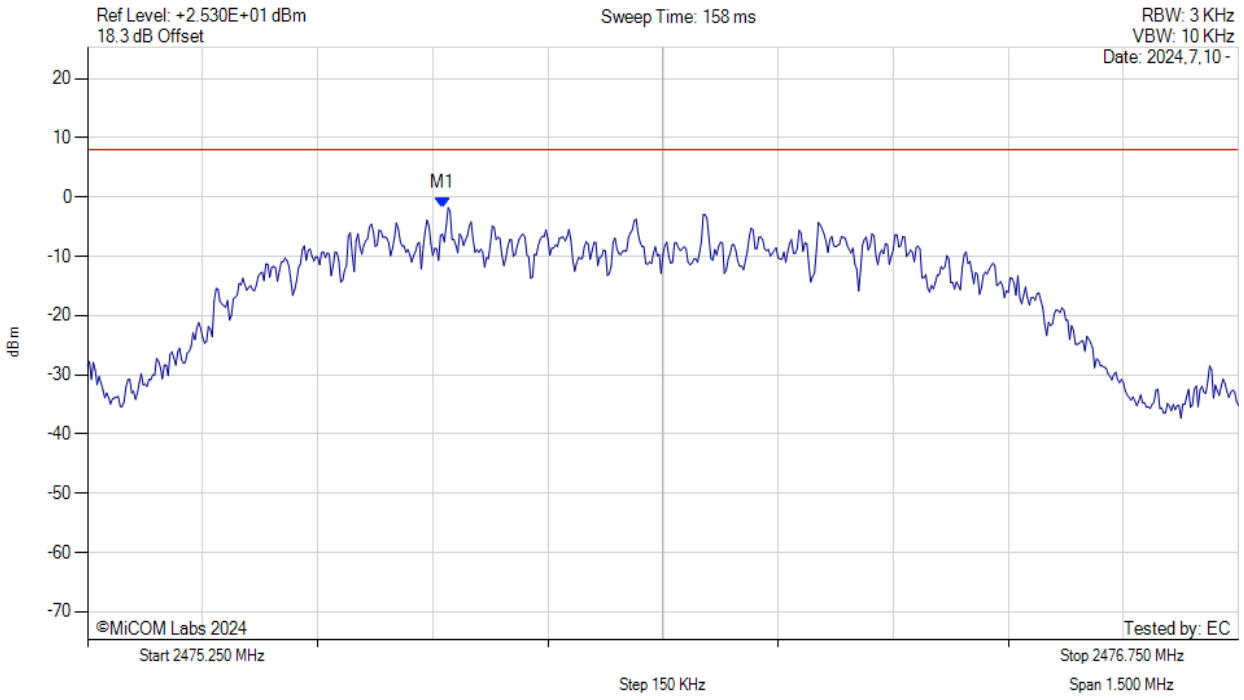


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 30 Trace Mode = VIEW	M1 : 2440.058 MHz : 1.879 dBm	Limit: ≤ 8.0 dBm Margin: -6.1 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2476.00 MHz, Chain a, Temp: 20, Voltage: 5Vdc

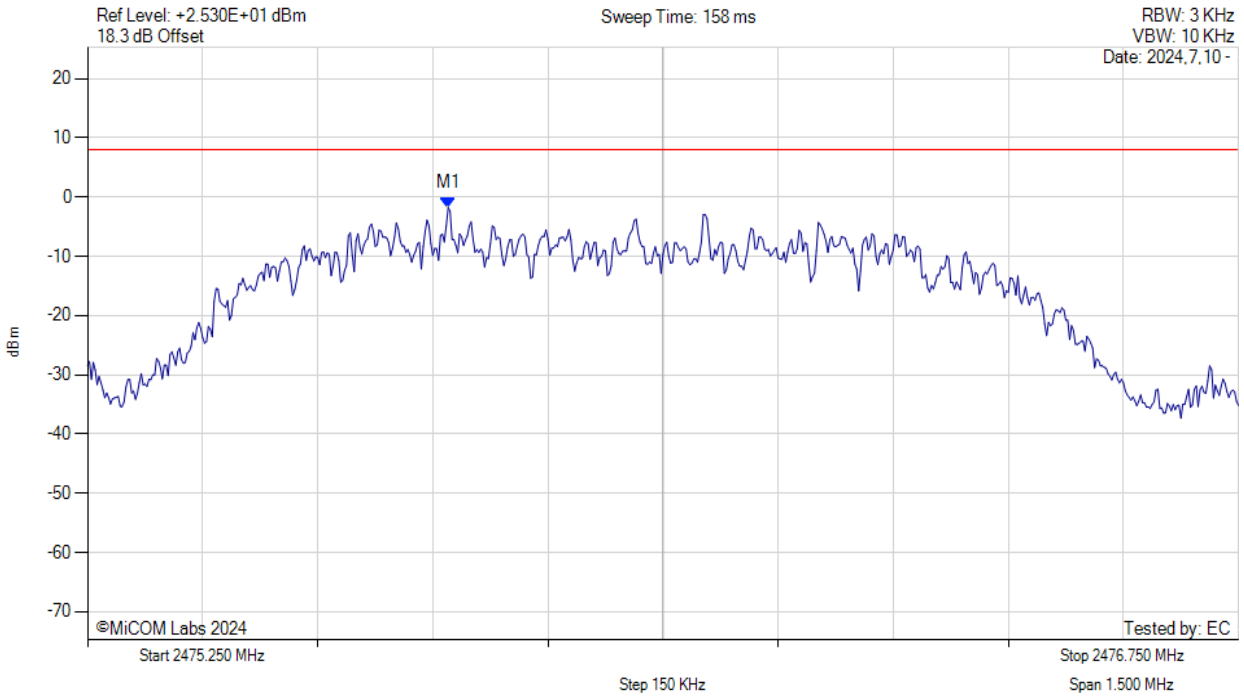


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 30 Trace Mode = VIEW	M1 : 2475.712 MHz : -1.805 dBm	Limit: ≤ 8.000 dBm Margin: 9.80 dB

back to matrix

POWER SPECTRAL DENSITY - PEAK

Variant: GFSK, Channel: 2476.00 MHz, SUM, Temp: 20, Voltage: 5Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 30 Trace Mode = VIEW	M1 : 2475.720 MHz : -1.805 dBm	Limit: ≤ 8.0 dBm Margin: -9.8 dB

back to matrix

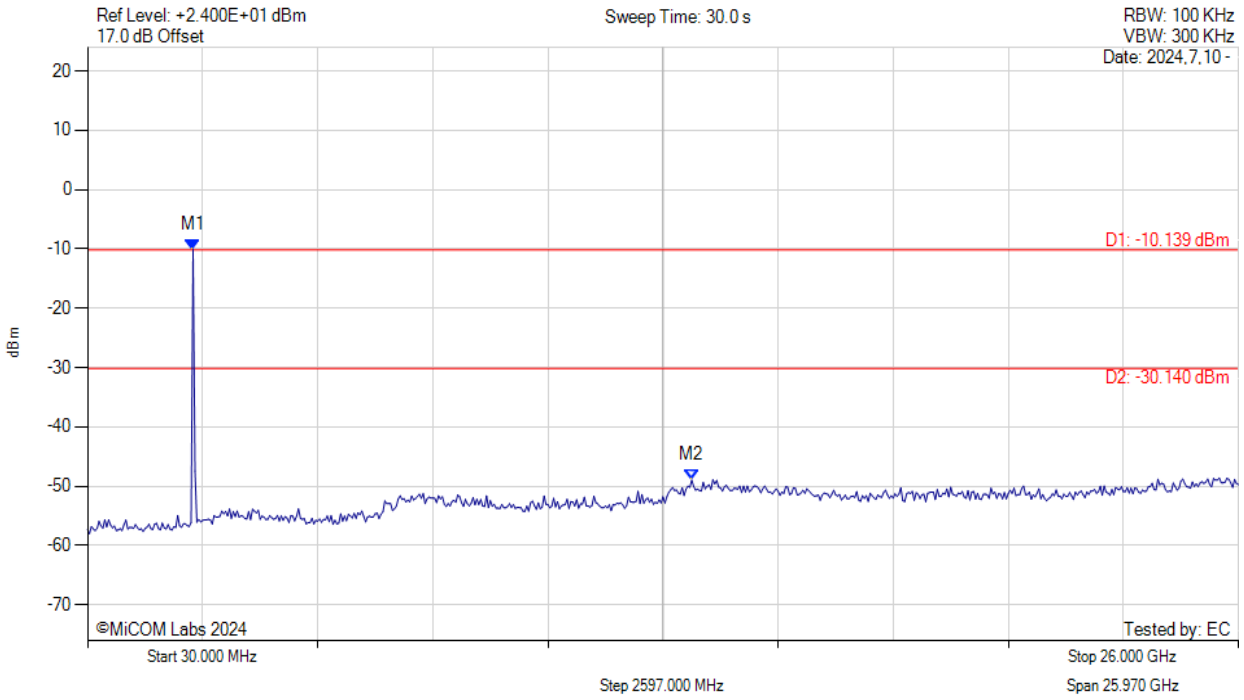
A.3. Emissions

A.3.1. Conducted Emissions

A.3.1.1. Conducted Spurious Emissions

CONDUCTED SPURIOUS EMISSIONS - PEAK

Variant: GFSK, Channel: 2402.00 MHz, Chain a, Temp: 20, Voltage: 5Vdc

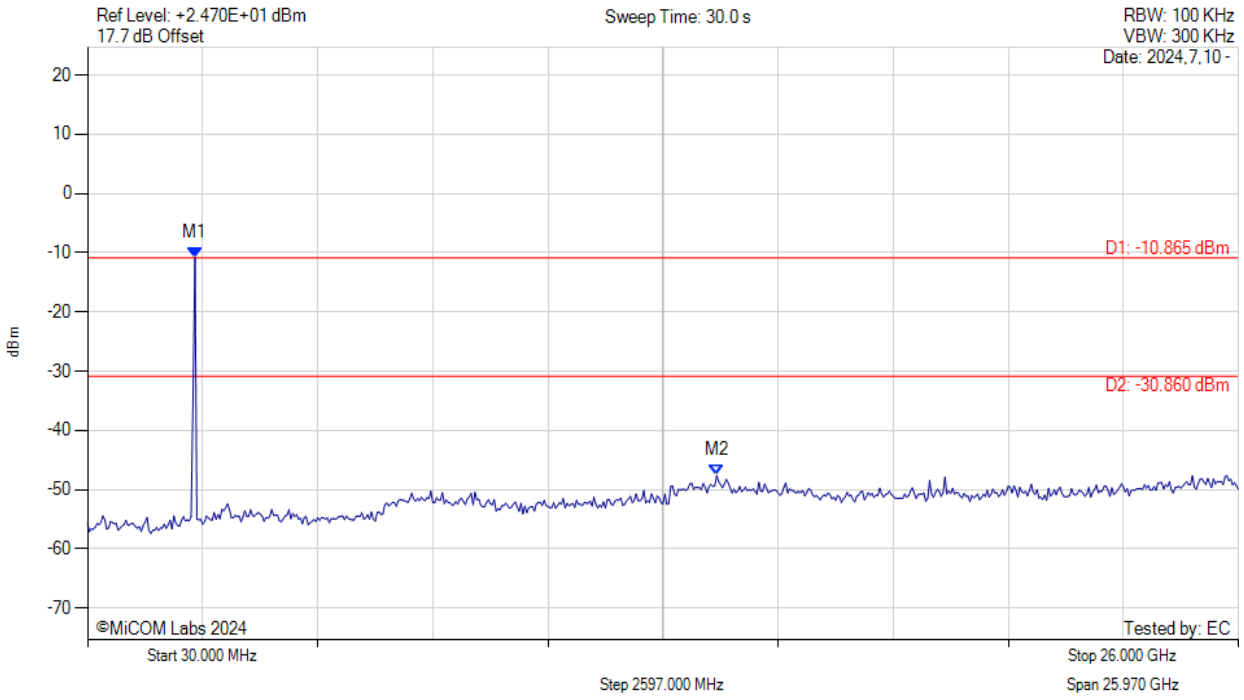


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2410.000 MHz : -10.139 dBm M2 : 13.664 GHz : -48.979 dBm	Limit: -30.14 dBm Margin: -18.84 dB

back to matrix

CONDUCTED SPURIOUS EMISSIONS - PEAK

Variant: GFSK, Channel: 2440.00 MHz, Chain a, Temp: 20, Voltage: 5Vdc

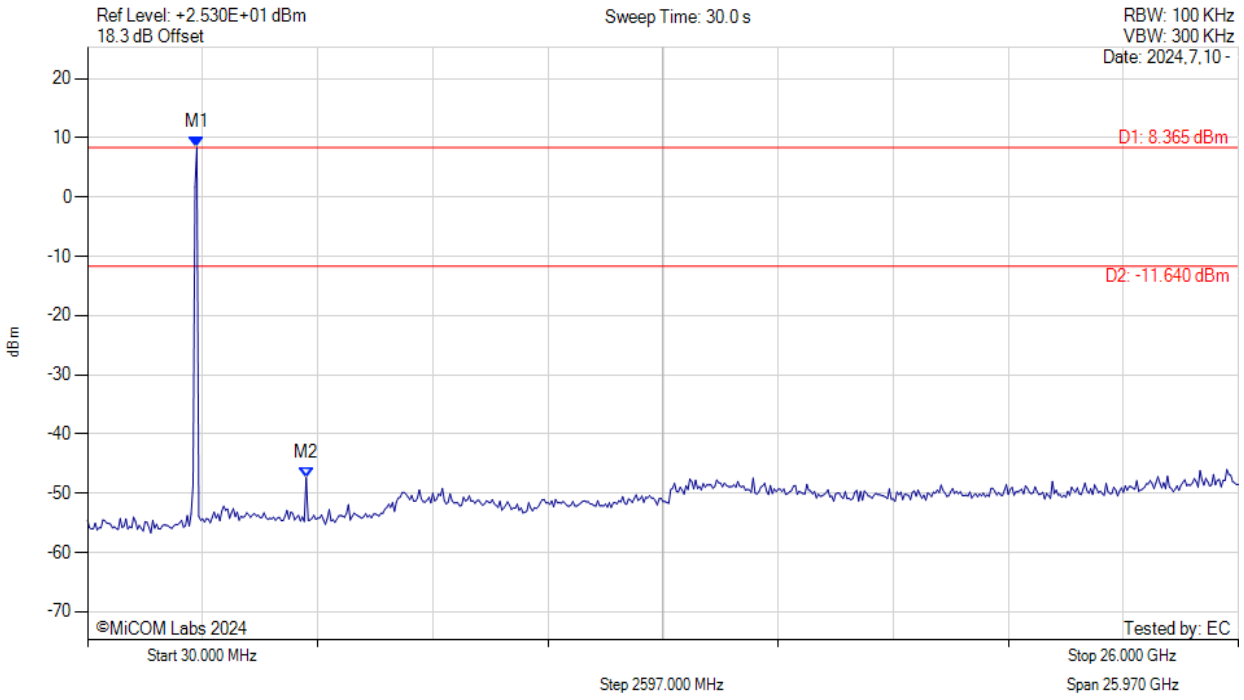


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2450.000 MHz : -10.865 dBm M2 : 14.230 GHz : -47.627 dBm	Limit: -30.86 dBm Margin: -16.77 dB

back to matrix

CONDUCTED SPURIOUS EMISSIONS - PEAK

Variant: GFSK, Channel: 2476.00 MHz, Chain a, Temp: 20, Voltage: 5Vdc



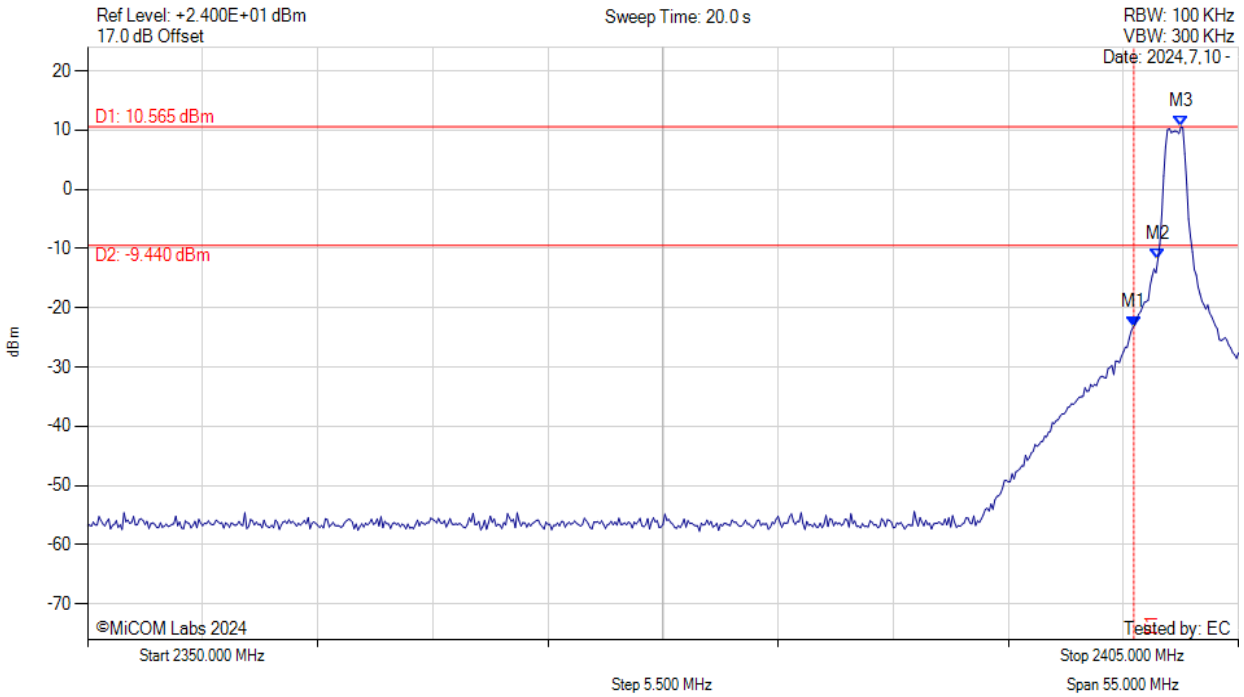
Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2500.000 MHz : 8.365 dBm M2 : 4960.000 MHz : -47.341 dBm	Limit: -11.64 dBm Margin: -35.70 dB

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: 5Vdc

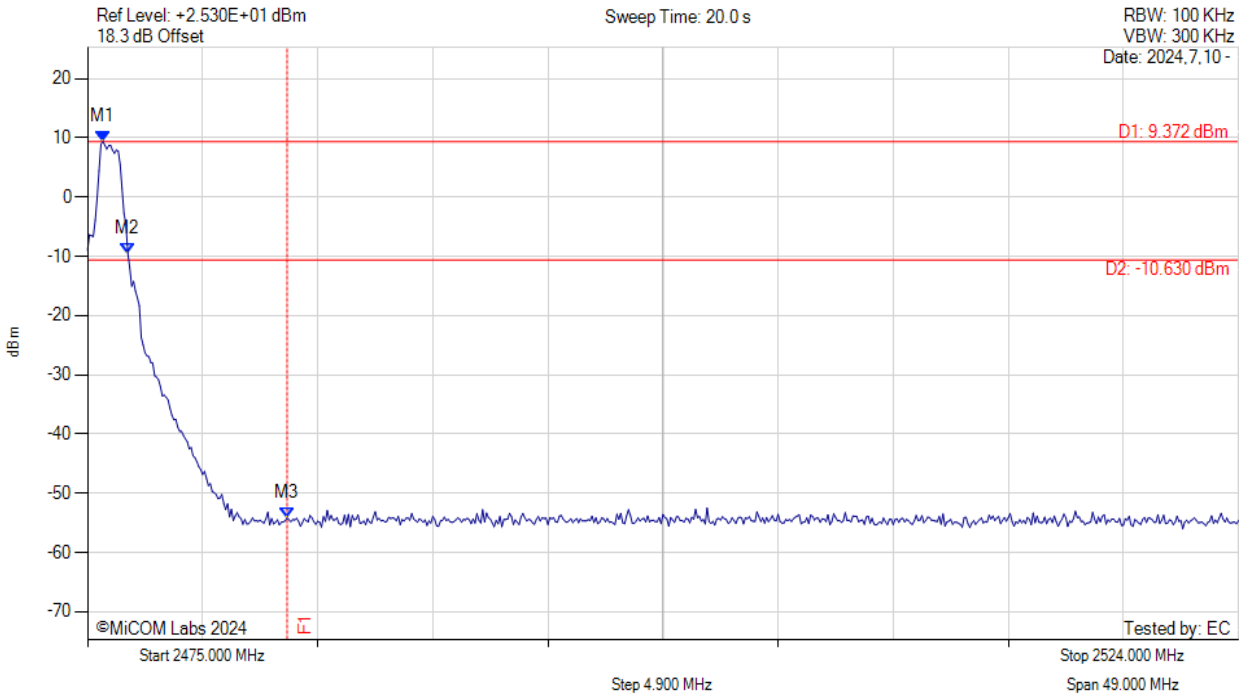


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2400.000 MHz : -23.255 dBm M2 : 2401.150 MHz : -11.814 dBm M3 : 2402.250 MHz : 10.565 dBm	Channel Frequency: 2402.00 MHz

back to matrix

CONDUCTED HIGH BAND-EDGE EMISSION - PEAK

Variant: GFSK, Channel: 2476.00 MHz, Chain a, Temp: 20, Voltage: 5Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = POS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2475.650 MHz : 9.372 dBm M2 : 2476.710 MHz : -9.458 dBm M3 : 2483.500 MHz : -54.194 dBm	Channel Frequency: 2476.00 MHz

back to matrix

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