

02-Feb-26

**Manufacturer:** Garmin International, Inc.  
**Address:** 1200 E. 151st St.  
 Olathe, KS 66062-3426  
 U.S.A.  
**Chile Representative:** Matías Rodríguez Correa  
 La Pastora 170, Las Condes Santiago  
 Province CP 7550083, Chile  
**Contact Email:** [matias.rodriguez@garmin.com](mailto:matias.rodriguez@garmin.com)  
**Subject:** SUBTEL, Chile (Resolution 737) Certification Compliance 2026  
**Commercial Name:** Fenix 7X Pro

	Información (Information)
<b>Tipo de equipo (Equipment type)</b>	Portable Digital Transceiver
<b>Marca (Brand)</b>	Garmin 
<b>Modelo (Model)</b>	A04524
<b>Tecnología o modulación (Technology or modulation)</b>	ASK for NFC / GFSK for ANT/ GFSK for BTBR / $\pi/4$ -DQPSK, 8DPSK for BTEDR / GFSK for BLE/ DSSS for 802.11b / OFDM for 802.11g/n
<b>Frecuencias (Frequencies)</b>	13.56 MHz / 2402-2480 MHz / 2402-2480 MHz / 2402-2480 MHz / 2402-2480 MHz / 2412-2462 MHz
<b>Ganancia de antena (dBi) (Antenna gain (dBi))</b>	ANT -5.90 dBi / 802.15.1 -5.90 dBi / 802.15.1 -5.90 dBi / BLE -5.90 dBi / 802.11b/g/n -5.90 dBi
<b>P.i.r.e. (E.I R P.)</b>	-22.95 dBm, 0.00 mW / -7.49 dBm, 0.17 mW / 5.23 dBm, 3.33 mW / 4.33 dBm, 2.71 mW / -8.17 dBm, 0.15 mW / 12.42 dBm, 17.45 mW
<b>Módulos (Modules)</b>	NFC, ANT, BTBR, BTEDR, BLE, WiFi

As all measurements for NFC are made in radiated mode to comply with the field strength limits, gain information is not required to be noted in the reports or any additional documentation.

Declaration of Conformity Statement: the equipment previously identified complies with the provisions established in the Technical Standard for Small Range Equipment, approved by Exempt Resolution No.1,985 of 2017, of the Undersecretary of Telecommunications.

Declaración de conformidad: El equipo anteriormente identificado cumple con las disposiciones establecidas en la Norma Técnica para Equipos de Corto Alcance, aprobada mediante la Resolución Exenta N° 1.985 de 2017, de la Subsecretaría de Telecomunicaciones.



Test Report Serial Number:	<b>45461849 R1.0</b>
Test Report Date:	<b>3 April 2023</b>
Project Number:	<b>1621</b>

## EMC Test Report - New Certification

Applicant:



**Garmin International Inc.**  
**1200 East 151 St**  
**Olathe, KS, 66062**  
**USA**

FCC ID:

**IPH-A04524**

Product Model Number / HVIN

**A04524**

IC Registration Number

-

Product Marketing Name / PMN

**A04524**

In Accordance With:

**CFR Title 47, Part 15 Subpart C (§15.247), Part 15 Subpart B**  
 Digital Transmission System (DTS)

Approved By:

---

**Ben Hewson, President**  
 Celltech Labs Inc.  
 21-364 Lougheed Rd.  
 Kelowna, BC, V1X 7R8  
 Canada



Test Lab Certificate: 2470.01



**Industry  
Canada**

IC Registration 3874A



FCC Registration: CA3874

**This report shall not be reproduced in any form without the expressed written consent of Celltech Labs Inc.**

**Table of Contents**

1.0 REVISION HISTORY .....	5
2.0 CLIENT AND DUT INFORMATION .....	6
3.0 SCOPE.....	7
4.0 TEST SUMMARY.....	8
5.0 NORMATIVE REFERENCES .....	10
6.0 FACILITIES AND ACCREDITATIONS .....	11
7.0 OCCUPIED BANDWIDTH .....	12
8.0 DTS BANDWIDTH .....	21
9.0 ANTENNA PORT CONDUCTED POWER, (DTS).....	30
10.0 ANTENNA PORT CONDUCTED POWER, (DSS) .....	32
11.0 POWER SPECTRAL DENSITY.....	34
12.0 FHSS NUMBER OF HOPPING CHANNELS.....	43
13.0 FHSS CHANNEL SEPARATION.....	49
14.0 FHSS TIME OF OCCUPANCY.....	55
15.0 CONDUCTED SPURIOUS EMISSIONS -BAND EDGE.....	67
16.0 CONDUCTED SPURIOUS EMISSIONS .....	82
17.0 RADIATED TX SPURIOUS EMISSIONS, RESTRICTED BAND .....	84
18.0 RADIATED RX SPURIOUS EMISSIONS .....	88
19.0 POWER LINE CONDUCTED EMISSIONS .....	91
APPENDIX A – TEST SETUP DRAWINGS .....	96
APPENDIX B – EQUIPMENT LIST AND CALIBRATION.....	101
APPENDIX C – MEASUREMENT INSTRUMENT UNCERTAINTY.....	102
END OF REPORT.....	102
APPENDIX D – CONDUCTED POWER MEASUREMENT PLOTS.....	103
APPENDIX E – CONDUCTED SPURIOUS EMISSIONS MEASUREMENT PLOTS .....	103
APPENDIX F – RADIATED TX EMISSIONS MEASUREMENT PLOTS.....	103
APPENDIX G – RADIATED RX EMISSIONS MEASUREMENT PLOTS.....	103

**Table of Figures**

Figure A.1 – Test Setup – Conducted Measurements.....	96
Figure A.2 – Test Setup Radiated Measurements 9kHzMHz – 30MHz .....	97
Figure A.3 – Test Setup Radiated Measurements 30MHz – 1GHz.....	98
Figure A.4 – Test Setup Radiated Measurements 30MHz – 1GHz, Signal Substitution .....	98
Figure A.5 – Test Setup Radiated Measurements 1 – 18GHz, .....	99
Figure A.6 – Test Setup Radiated Measurements 18 – 26.5GHz, .....	99
Figure A.7 – Test Setup Conducted Emissions Measurements .....	100

**Table of Plots**

<i>Plot 7.1 – Occupied Bandwidth, 802.11b</i>	13
<i>Plot 7.2 – Occupied Bandwidth, 802.11g</i>	14
<i>Plot 7.3 – Occupied Bandwidth, 802.11n</i>	15
<i>Plot 7.4 – Occupied Bandwidth, BT BR</i>	17
<i>Plot 7.5 – Occupied Bandwidth, BT 2EDR</i>	18
<i>Plot 7.6 – Occupied Bandwidth, BT 3EDR</i>	19
<i>Plot 8.1 – 6dB DTS Bandwidth 802.11b</i>	22
<i>Plot 8.2 – 6dB DTS Bandwidth 802.11g</i>	23
<i>Plot 8.3 – 6dB DTS Bandwidth 802.11n</i>	24
<i>Plot 8.4 – 6dB DTS Bandwidth, BT BR</i>	26
<i>Plot 8.5 – 6dB DTS Bandwidth, BT 2EDR</i>	27
<i>Plot 8.6 – 6dB DTS Bandwidth, BT 3EDR</i>	28
<i>Plot 11.1 – Power Spectral Density, 802.11b</i>	35
<i>Plot 11.2 – Power Spectral Density, 802.11g</i>	36
<i>Plot 11.3 – Power Spectral Density, 802.11n</i>	37
<i>Plot 11.4 – Power Spectral Density, BT BR</i>	39
<i>Plot 11.5 – Power Spectral Density, BT 2EDR</i>	40
<i>Plot 11.6 – Power Spectral Density, BT 3EDR</i>	41
<i>Plot 12.1 – Number of Hopping Channels, BT BR</i>	44
<i>Plot 12.2 – Number of Hopping Channels, BT BR</i>	45
<i>Plot 12.3 – Number of Hopping Channels, BT 2EDR</i>	46
<i>Plot 12.4 – Number of Hopping Channels, BT 2EDR</i>	47
<i>Plot 13.1 – 20dB BW, BT BR</i>	50
<i>Plot 13.2 – FHSS Channel Separation, BT BR</i>	51
<i>Plot 13.3 – 20dB BW, BT 2EDR</i>	52
<i>Plot 13.4 – FHSS Channel Separation, BT 2EDR</i>	53
<i>Plot 14.1 – Time of Occupancy, DH1, 2-DH1, 3-DH1, DM1</i>	56
<i>Plot 14.2 – Time of Occupancy, DH1, 2-DH1, 3-DH1, DM1</i>	57
<i>Plot 14.3 – Time of Occupancy, DH3, 2-DH3, 3-DH3, DM3</i>	58
<i>Plot 14.4 – Time of Occupancy, DH3, 2-DH3, 3-DH3, DM3</i>	59
<i>Plot 14.5 – Time of Occupancy, DH5, 2-DH5, 3-DH5, DM5</i>	60
<i>Plot 14.6 – Time of Occupancy, DH5, 2-DH5, 3-DH5, DM5</i>	61
<i>Plot 14.7 – Time of Occupancy, EV4</i>	62
<i>Plot 14.8 – Time of Occupancy, EV4</i>	63
<i>Plot 14.9 – Time of Occupancy, EV5</i>	64
<i>Plot 14.10 – Time of Occupancy, EV5</i>	65
<i>Plot 15.1 – Band Edge, 802.11b</i>	68
<i>Plot 15.2 – Band Edge, 802.11b</i>	69
<i>Plot 15.3 – Band Edge, 802.11g</i>	70
<i>Plot 15.4 – Band Edge, 802.11g</i>	71
<i>Plot 15.5 – Band Edge, 802.11n</i>	72
<i>Plot 15.6 – Band Edge, 802.11n</i>	73
<i>Plot 15.7 – Band Edge, BT BR</i>	75
<i>Plot 15.8 – Band Edge, BT BR</i>	76
<i>Plot 15.9 – Band Edge, BT 2EDR</i>	77
<i>Plot 15.10 – Band Edge, BT 2EDR</i>	78
<i>Plot 15.11 – Band Edge, BT 3EDR</i>	79
<i>Plot 15.12 – Band Edge, BT 3EDR</i>	80
<i>Plot 19.1 – Power Line Conducted Emissions, Line 1</i>	92
<i>Plot 19.2 – Power Line Conducted Emissions, Line 2</i>	93

**Table of Tables**

<i>Table 7.1 – Summary of Occupied Bandwidth Measurements, (DTS)</i> .....	16
<i>Table 7.2 – Summary of Occupied Bandwidth Measurements (DSS)</i> .....	20
<i>Table 8.1 – Summary of 6dB DTS Bandwidth Measurements, (DTS)</i> .....	25
<i>Table 8.2 – Summary of 6dB DTS Bandwidth Measurements, (DSS)</i> .....	29
<i>Table 9.1 – Summary of Conducted Power Measurements, (DTS)</i> .....	31
<i>Table 10.1 – Summary of Conducted Power Measurements, (DSS)</i> .....	33
<i>Table 11.1 – Summary of Power Spectral Density Measurements, (DTS)</i> .....	38
<i>Table 11.2 – Summary of Power Spectral Density Measurements, (DSS)</i> .....	42
<i>Table 12.2 – Summary of FHSS Number of Hopping Channels</i> .....	48
<i>Table 13.1 – Summary of FHSS Channel Separation</i> .....	54
<i>Table 14.1 – Summary of FHSS Time of Occupancy</i> .....	66
<i>Table 15.1 – Summary of Spurious Emission Measurements – Band Edge, (DTS)</i> .....	74
<i>Table 15.2 – Summary of Spurious Emission Measurements – Band Edge, DSS</i> .....	81
<i>Table 16.1 – Summary of Conducted Spurious Emissions, (DTS)</i> .....	83
<i>Table 16.2 – Summary of Conducted Spurious Emissions, (DSS)</i> .....	83
<i>Table 17.1 – Summary of Radiated Tx Spurious Emissions, Restricted Band, (DTS)</i> .....	85
<i>Table 17.2 – Summary of Radiated Tx Spurious Emissions, (DTS)</i> .....	86
<i>Table 17.2 – Summary of Radiated Tx Spurious Emissions, (DSS)</i> .....	87
<i>Table 18.1 – Summary of Radiated Rx Spurious Emissions, (DTS)</i> .....	89
<i>Table 18.2 – Summary of Radiated Rx Spurious Emissions, (DSS)</i> .....	90
<i>Table 19.1 – Summary of Power Line Conducted Emissions – L1</i> .....	94
<i>Table 19.1 – Summary of Power Line Conducted Emissions – L2</i> .....	95
<i>Table A.1 – Conducted Measurement Setup</i> .....	96
<i>Table A.2 – Radiated Emissions Measurement Equipment</i> .....	97
<i>Table A.3 – Setup – Conducted Emissions Equipment List</i> .....	100

**1.0 REVISION HISTORY**

Revision History					
<b>Samples Tested By:</b>		Art Voss, P.Eng.	<b>Date(s) of Evaluation:</b>		15 January - 13 February, 2023
<b>Report Prepared By:</b>		Art Voss, P.Eng.	<b>Report Reviewed By:</b>		Ben Hewson
Report Revision	Description of Revision	Revised Section	Revised By	Revision Date	
0.1	Draft	n/a	Art Voss	20 March 2023	
1.0	Initial Release	n/a	Art Voss	3 April 2023	

**2.0 CLIENT AND DUT INFORMATION**

<b>Client Information</b>	
<b>Applicant Name</b>	<b>Garmin International Inc.</b>
<b>Applicant Address</b>	1200 East 151 St
	Olathe, KS, 66062
	USA
<b>DUT Information</b>	
<b>Device Identifier(s):</b>	<b>FCC ID:</b> <b>IPH-A04524</b>
<b>Device Model(s) / HVIN:</b>	A04524
<b>Device Marketing Name / PMN:</b>	A04524
<b>Test Sample Serial No.:</b>	3430501782 - Conducted, 3433323644 - OTA
<b>Device Type:</b>	Extremity Worn Digital Transceiver
<b>Equipment Class:</b>	Digital Transmission Systems (DTS)
	Spread Spectrum Transmitter (DSS)
	Low Power Communication Device (DXX)
	Global Navigation Satellite System (GNSS) Receivers
	NFC - Low Power Communication Device Transmitter (DXX)
<b>Transmit Frequency Range:</b>	WiFi (DTS): 2412-2462MHz
	BT/BLE/ANT: 2402-2480MHz
	NFC: 13.56MHz
<b>Manuf. Max. Rated Output Power:</b>	WiFi - Digital Transmission System (DTS): 18.32dBm
	BlueTooth - Spread Spectrum Transmitter (DSS): 11.11dBm
	BLE/ANT - Low Power Communication Device Transmitter (DXX): 2.10dBm
	NFC - Low Power Communication Device Transmitter (DXX): 55.19dBuV/m
<b>Antenna Type and Gain:</b>	-5.9dBi Max
<b>Modulation:</b>	WiFi: DSSS, OFDM, CCK, MCS0-7
	BT BR: GFSK
	BT EDR: Pi/4-DQPSK, 8DPSK
	BLE: GMSK
	ANT: GFSK
	NFC: ASK
<b>DUT Power Source:</b>	3VDC Rechargeable Li-Ion
<b>DUT Dimensions [LxWxH]</b>	H x W x D: 42mm dia x 4.5mm
<b>Deviation(s) from standard/procedure:</b>	None
<b>Modification of DUT:</b>	None

### 3.0 SCOPE

#### Preface:

This Certification Report was prepared on behalf of:

**Garmin International Inc.**

, (the '*Applicant*'), in accordance with the applicable Federal Communications Commission (FCC) CFR 47 and Innovation, Scientific and Economic Development (ISED) Canada rules parts and regulations (the '*Rules*'). The scope of this investigation was limited to only the equipment, devices and accessories (the '*Equipment*') supplied by the *Applicant*. The tests and measurements performed on this *Equipment* were only those set forth in the applicable *Rules* and/or the Test and Measurement Standards they reference. The *Rules* applied and the Test and Measurement Standards used during this evaluation appear in the Normative References section of this report. The limits set forth in the technical requirements of the applicable *Rules* were applied to the measurement results obtained during this evaluation and, unless otherwise noted, these limits were used as the Pass/Fail criteria. The Pass/Fail statements made in this report apply to only the tests and measurements performed on only the *Equipment* tested during this evaluation. Where applicable and permissible, information including test and measurement data and/or results from previous evaluations of same or similar equipment, devices and/or accessories may be cited in this report.

#### Device:

The Garmin Model/HVIN: A04524 is an extremity worn digital transceiver device consisting of a WiFi, BlueTooth (BT), BlueTooth Low Energy (BLE), Adaptive Network Topology (ANT) and Near Field Communication (NFC) transceivers. The WiFi and BT/BLE/ANT transceivers share the same antenna and cannot simultaneously transmit.

#### Requirement:

The transceivers of this *equipment* are subject to emissions evaluation in accordance with FCC: 47 CFR 2, 15C. As per FCC 47 CFR §2.1093, an RF Exposure (SAR) evaluation is required for this *Equipment* and the results of the RF Exposure (SAR) evaluation appear in a separate report.

#### Application:

This is an application for a New Certification.

#### Scope:

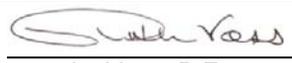
The scope of this investigation is limited to the evaluation and reporting of the wanted and spurious emissions in accordance with the rule parts cited in Normative References section of this report.

**4.0 TEST SUMMARY**

<b>TEST SUMMARY</b>					
<b>Section</b>	<b>Description of Test</b>	<b>Procedure Reference</b>	<b>Applicable Rule Part(s) FCC</b>	<b>Test Date</b>	<b>Result</b>
<b>7.0</b>	Occupied Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§2.1049	15, 21 Jan 2023	Pass
<b>8.0</b>	DTS Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§15.247(a)(2)	22 Jan 2023	Pass
<b>9.0</b>	Conducted Power (Fundamental)	ANSI C63.10-2013 KDB 558074 D01v05	§2.1046 §15.247(b)(3)	15 Jan, 8 Feb 2023	Pass
<b>10.0</b>	Conducted Power (Fundamental)	ANSI C63.10-2013 KDB 558074 D01v05	§2.1046 §15.247(b)(1)	15 Jan, 8 Feb 2023	Pass
<b>11.0</b>	Power Spectral Density	ANSI C63.10-2013 KDB 558074 D01v05	§15.247(e)	19, 23 Jan 2023	Pass
<b>12.0</b>	FHSS Hopping Characteristics	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)(iii)	20 Jan, 9 Feb 2023	Pass
<b>13.0</b>	FHSS Channel Separation	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)	20 Jan, 9 Feb 2023	Pass
<b>14.0</b>	FHSS Time of Occupancy	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)(iii)	20 Jan, 9 Feb 2023	Pass
<b>15.0</b>	Conducted Tx Spurious Emissions Band Edge	ANSI C63.10-2013 KDB 558074 D01v05	§2.1051 §15.247(d)	20 Jan, 13 Feb 2023	Pass
<b>16.0</b>	Conducted Tx Spurious Emissions	ANSI C63.10-2013 KDB 558074 D01v05	§2.1051 §15.247(d)	22 Jan 2023	Pass
<b>17.0</b>	Radiated Tx Spurious Emissions And Restricted Band	ANSI C63.4-2014 KDB 558074 D01v05	§15.109 §15.247(d)	31 Jan 2023	Pass
<b>18.0</b>	Radiated Rx Spurious Emissions	ANSI C63.4-2014 KDB 558074 D01v05	§15.109	31 Jan 2023	Pass
<b>19.0</b>	Power Line Conducted Emissions	ANSI C63.4-2014	§15.107	25 Jan 2023	Pass

Test Station Day Log					
Date	Ambient Temp (°C)	Relative Humidity (%)	Barometric Pressure (kPa)	Test Station	Tests Performed Section(s)
15 Jan 2023	21.6	17	101.6	EMC	7, 9, 10,
19 Jan 2023	22.1	18	101.2	EMC	11
20 Jan 2023	22.6	16	101.5	EMC	12, 13, 14, 15
21 Jan 2023	21.9	18	101.4	EMC	7
22 Jan 2023	22.1	18	101.3	EMC	8, 16
23 Jan 2023	22.5	17	101.1	EMC	11
25 Jan 2023	17.2	52	102.1	LISN	19
31 Jan 2023	0.0	87	101.5	OATS	17, 18
8 Feb 2023	22.5	16	101.0	EMC	9
9 Feb 2023	22.1	17	101.4	EMC	12, 13, 14
13 Feb 2023	21.9	18	102.4	EMC	15

**EMC** - EMC Test Bench                      **SAC** - Semi-Anechoic Chamber  
**OATS** - Open Area Test Site              **TC** - Temperature Chamber  
**LISN** - LISN Test Area                      **ESD** - ESD Test Bench  
**IMM** - Immunity Test Area                **RI** - Radiated Immunity Chamber

<p>I attest that the data reported herein is true and accurate within the tolerance of the Measurement Instrument Uncertainty; that all tests and measurements were performed in accordance with accepted practices or procedures; and that all tests and measurements were performed by me or by trained personnel under my direct supervision. The results of this investigation are based solely on the test sample(s) provided by the client which were not adjusted, modified or altered in any manner whatsoever, except as required to carry out specific tests or measurements. This test report has been completed in accordance with ISO/IEC 17025.</p>	 <p>Art Voss, P.Eng.          Technical Manager          Celltech Labs Inc.          14 February 2023          Date</p> 
---	--

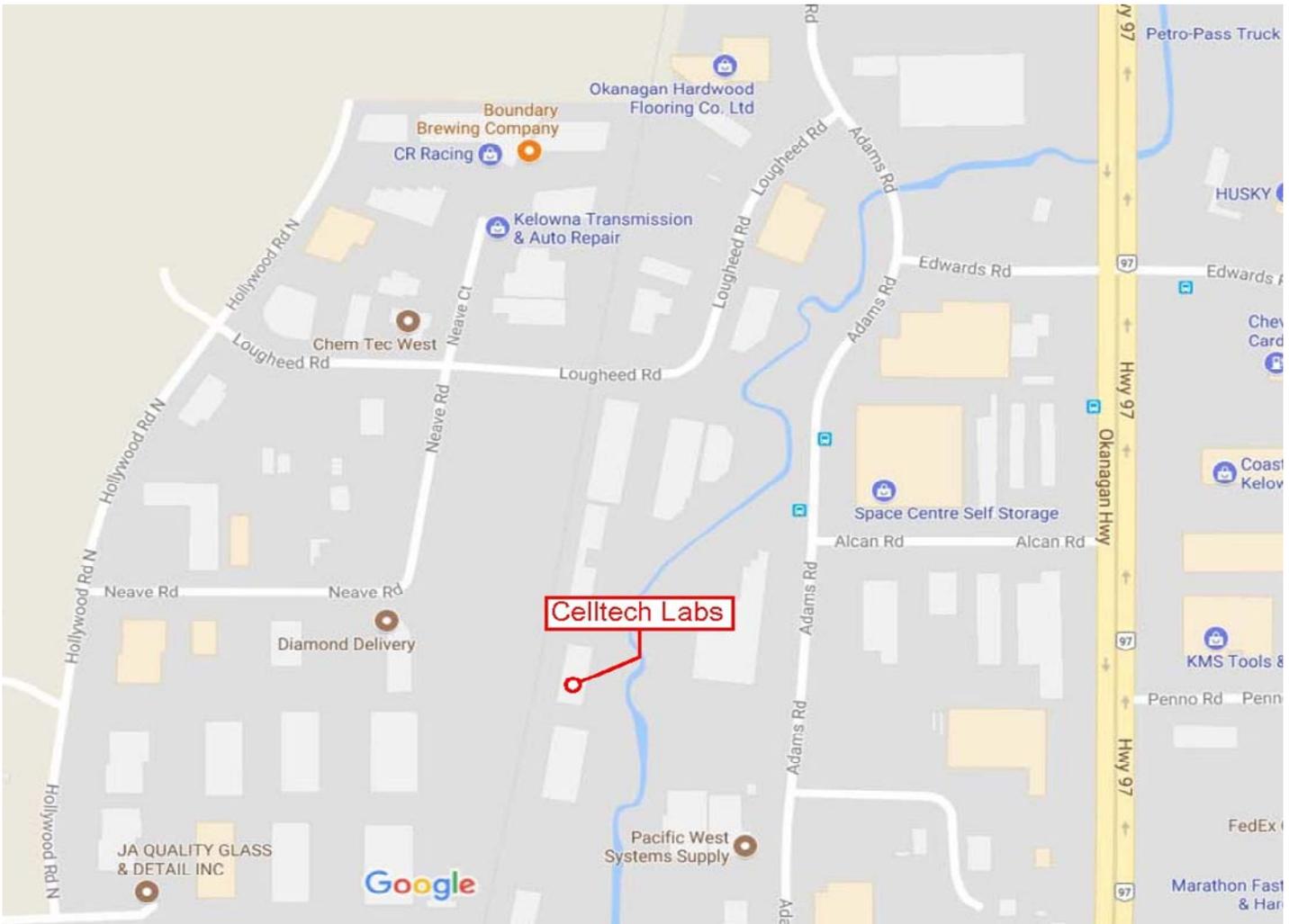
**5.0 NORMATIVE REFERENCES**

<b>Normative References</b>	
ISO/IEC 17025:2017	General requirements for the competence of testing and calibration laboratories
ANSI C63.4-2014	American National Standard of Procedures for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electric and Electronic Equipment in the Range of 9kHz to 40GHz
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
CFR	Code of Federal Regulations Title 47: Telecommunication Part 2: Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
CFR	Code of Federal Regulations Title 47: Telecommunication Part 15: Radio Frequency Devices Subpart B: Unintentional Radiators
CFR	Code of Federal Regulations Title 47: Telecommunication Part 15: Radio Frequency Devices Sub Part C (15.247) Intentional Radiators
FCC KDB 558074 D01v05r02	OET Major Guidance Publications, Knowledge Data Base Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247

**6.0 FACILITIES AND ACCREDITATIONS**

**Facility and Accreditation:**

The facilities used to evaluate this device outlined in this report are located at 21-364 Lougheed Road, Kelowna, British Columbia, Canada V1X 7R8. The radiated emissions site (OATS) conforms to the requirements set forth in ANSI C63.4 and is filed and listed with the FCC under Test Firm Registration Number CA3874 and Innovation, Science and Economic Development Canada under Test Site File Number ISED 3874A. Celltech is accredited to ISO 17025, through accrediting body A2LA and with certificate 2470.01.



## 7.0 OCCUPIED BANDWIDTH

### Test Procedure

<b>Normative Reference</b>	FCC 47 CFR §2.1046, §15.247(b)(3), RSS-Gen (6.1.2), RSS-247 (5.4)(d), KDB 558074 (8.3.2.1), ANSI C63.10 (6.9.3)
----------------------------	--

### General Procedure

KDB 558074 (8.3.2.1)	<p><b>8.3.2.1 General</b></p> <p>Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth.</p>
C63.10 (6.9.3)	<p><b>6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure</b></p> <p>The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:</p> <ol style="list-style-type: none"> <li>The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.</li> <li>The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.</li> <li>Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than <math>[10 \log (OBW/RBW)]</math> below the reference level. Specific guidance is given in 4.1.5.2.</li> <li>Step a) through step c) might require iteration to adjust within the specified range.</li> <li>Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.</li> <li>Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.</li> </ol>

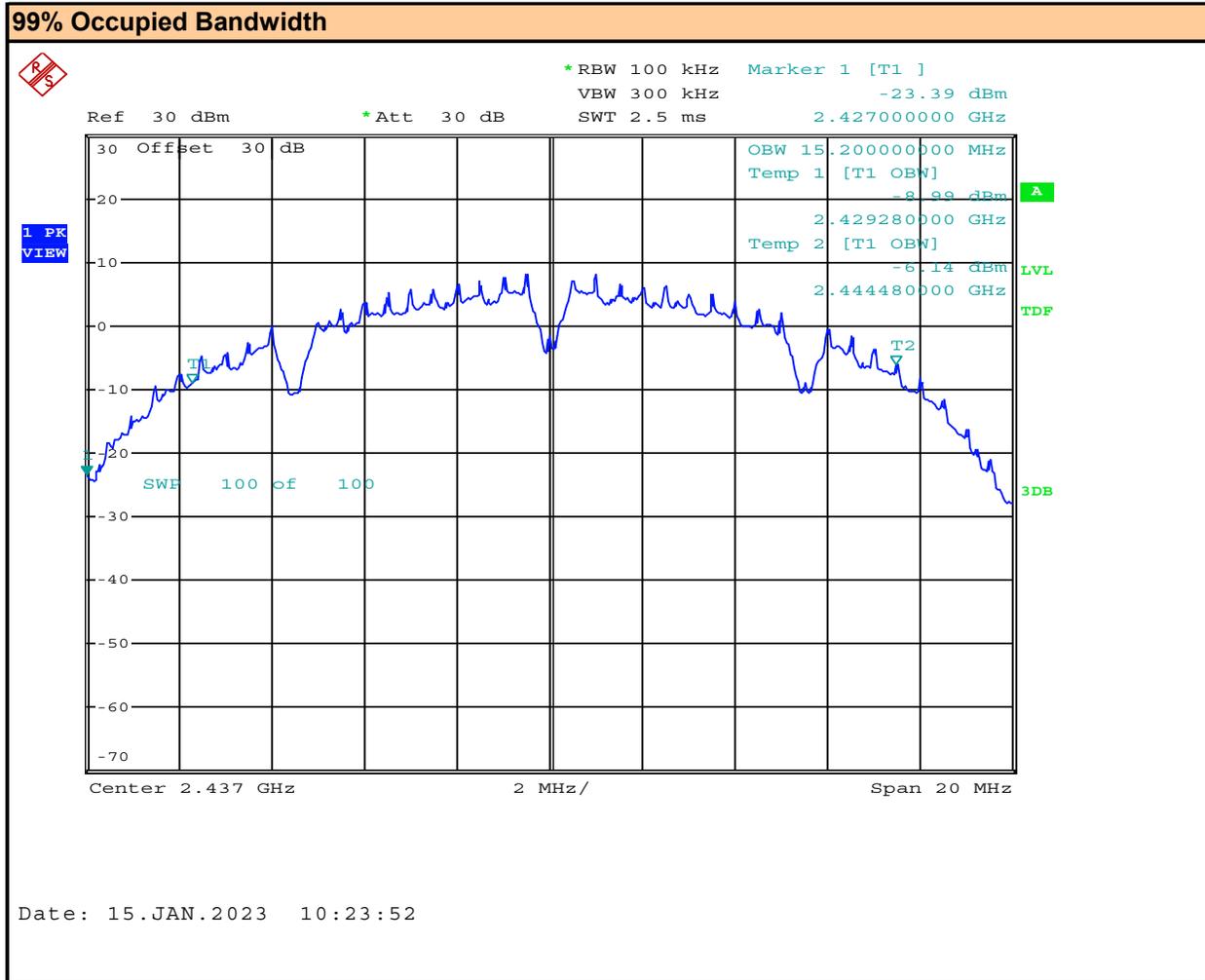
### Test Setup

**Appendix A - Figure A.1**

### Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as described above using the 99% Occupied Bandwidth function. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device. The DUT was set to transmit at its maximum Duty Cycle. The 99% Occupied Bandwidth was measured and recorded and used for the basis for measuring the Conducted Output Power (See Section 10.0) and Power Spectral Density (See Section 11.0).

**Plot 7.1 – Occupied Bandwidth, 802.11b**

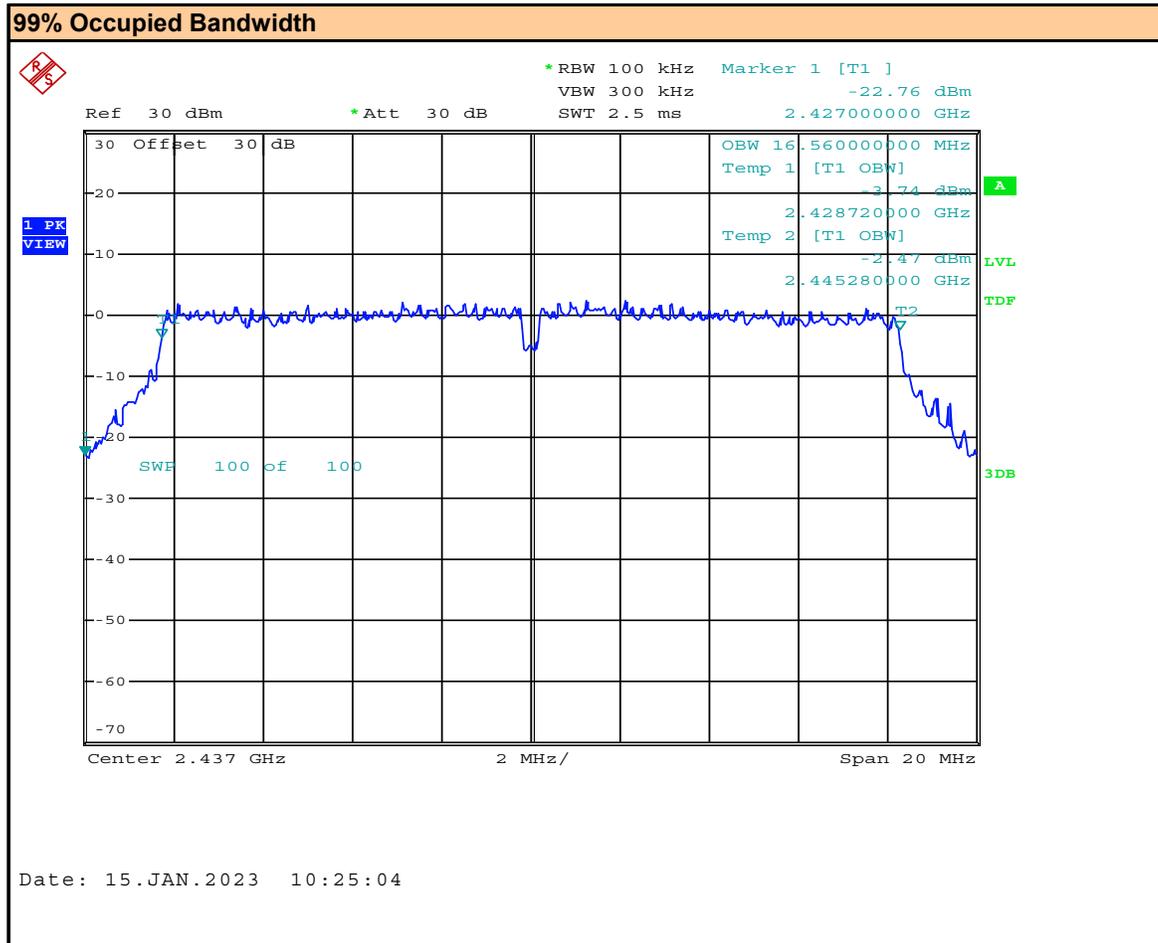


Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:

Measured Occupied Bandwidth:  MHz

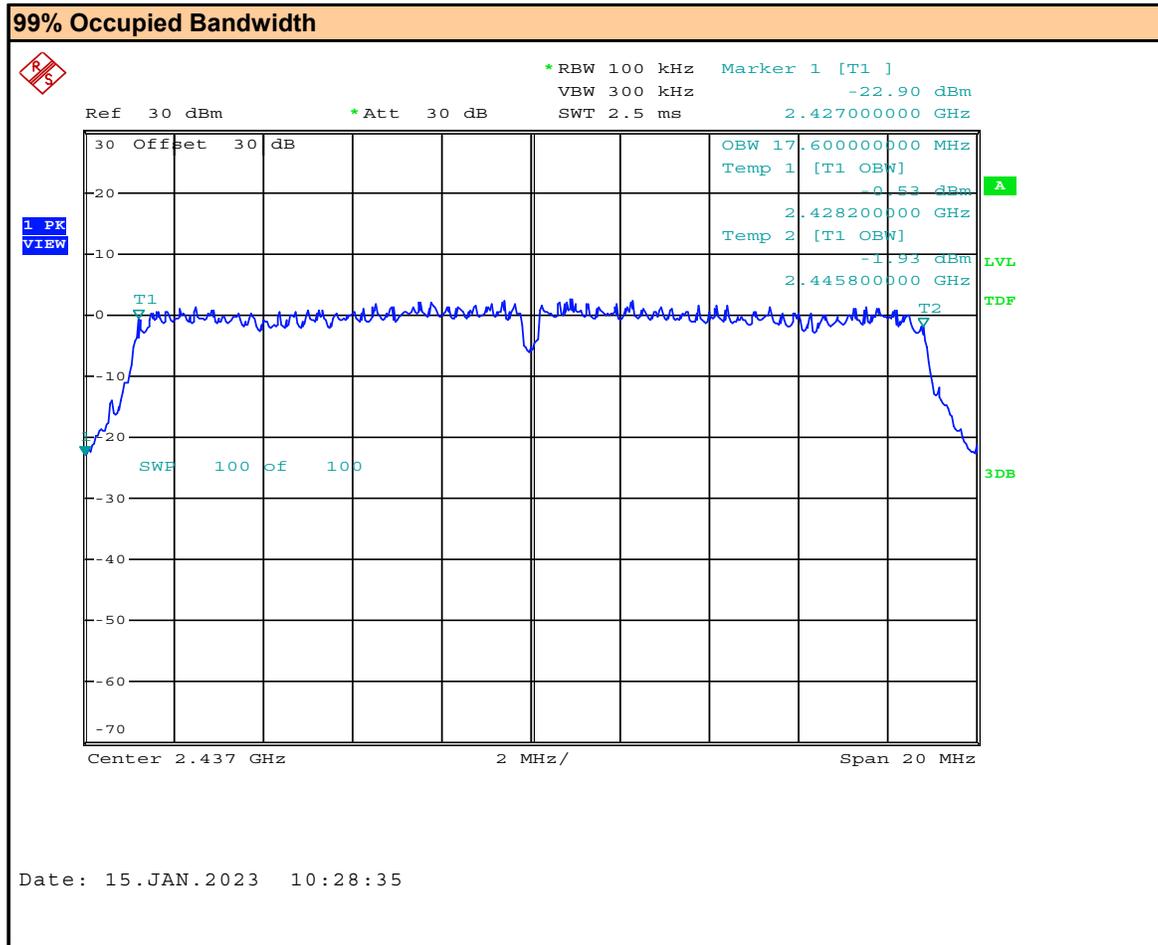
**Plot 7.2 – Occupied Bandwidth, 802.11g**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured Occupied Bandwidth:  MHz

**Plot 7.3 – Occupied Bandwidth, 802.11n**



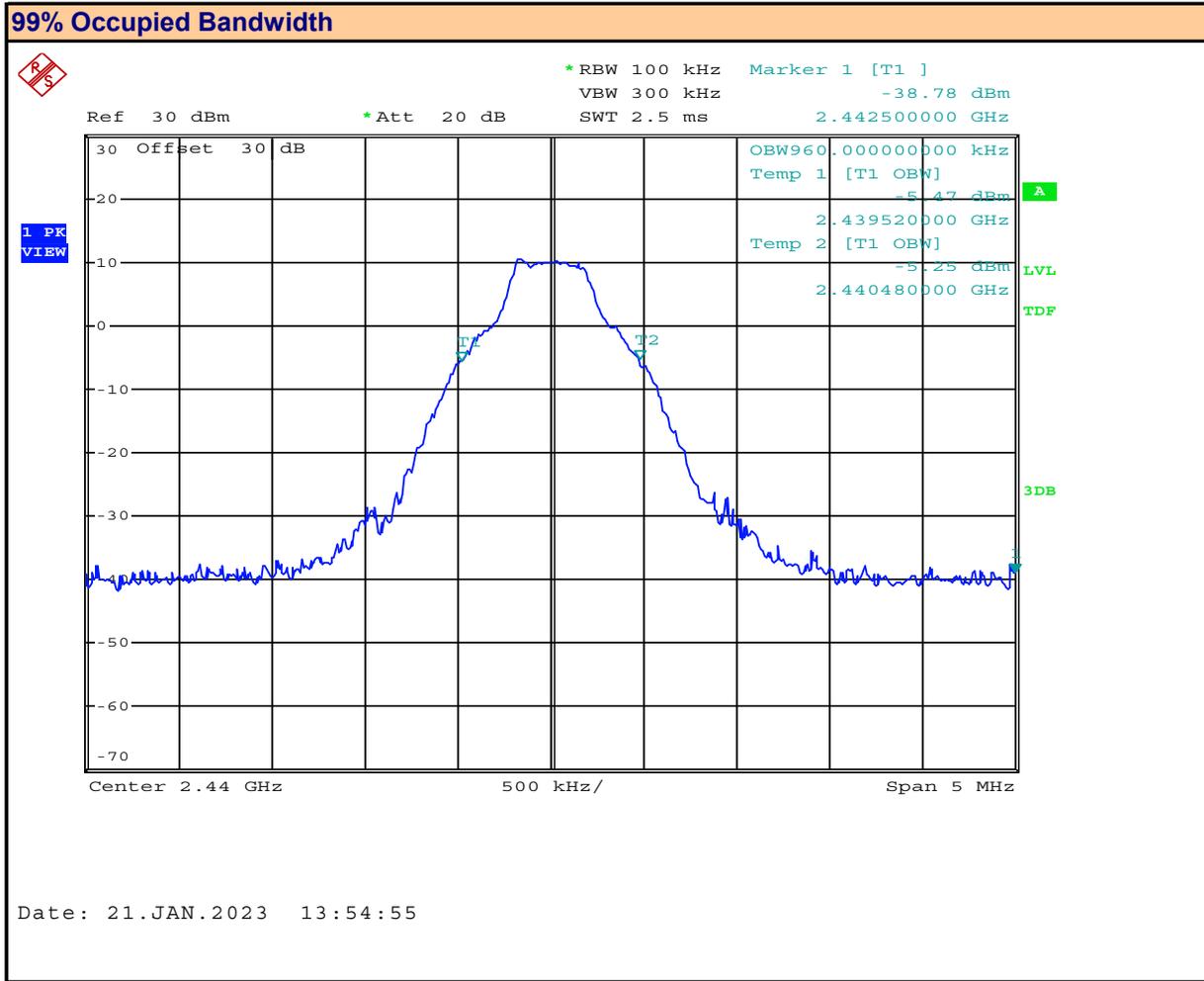
Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured Occupied Bandwidth:  MHz

**Table 7.1 – Summary of Occupied Bandwidth Measurements, (DTS)**

<b>99% Occupied Bandwidth Results:</b>					
<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>	<b>Mode</b>	<b>Modulation</b>	<b>Measured Occupied Bandwidth (MHz)</b>	<b>Emission Designator</b>
6	2437.0	802.11b	DSSS 5.5	15.2	15M2D1D
6	2437.0	802.11g	OFDM12	16.6	16M6D1D
6	2437.0	802.11n	MCS0	17.6	17M6D1D
<b>Result:</b>					<b>Complies</b>

**Plot 7.4 – Occupied Bandwidth, BT BR**

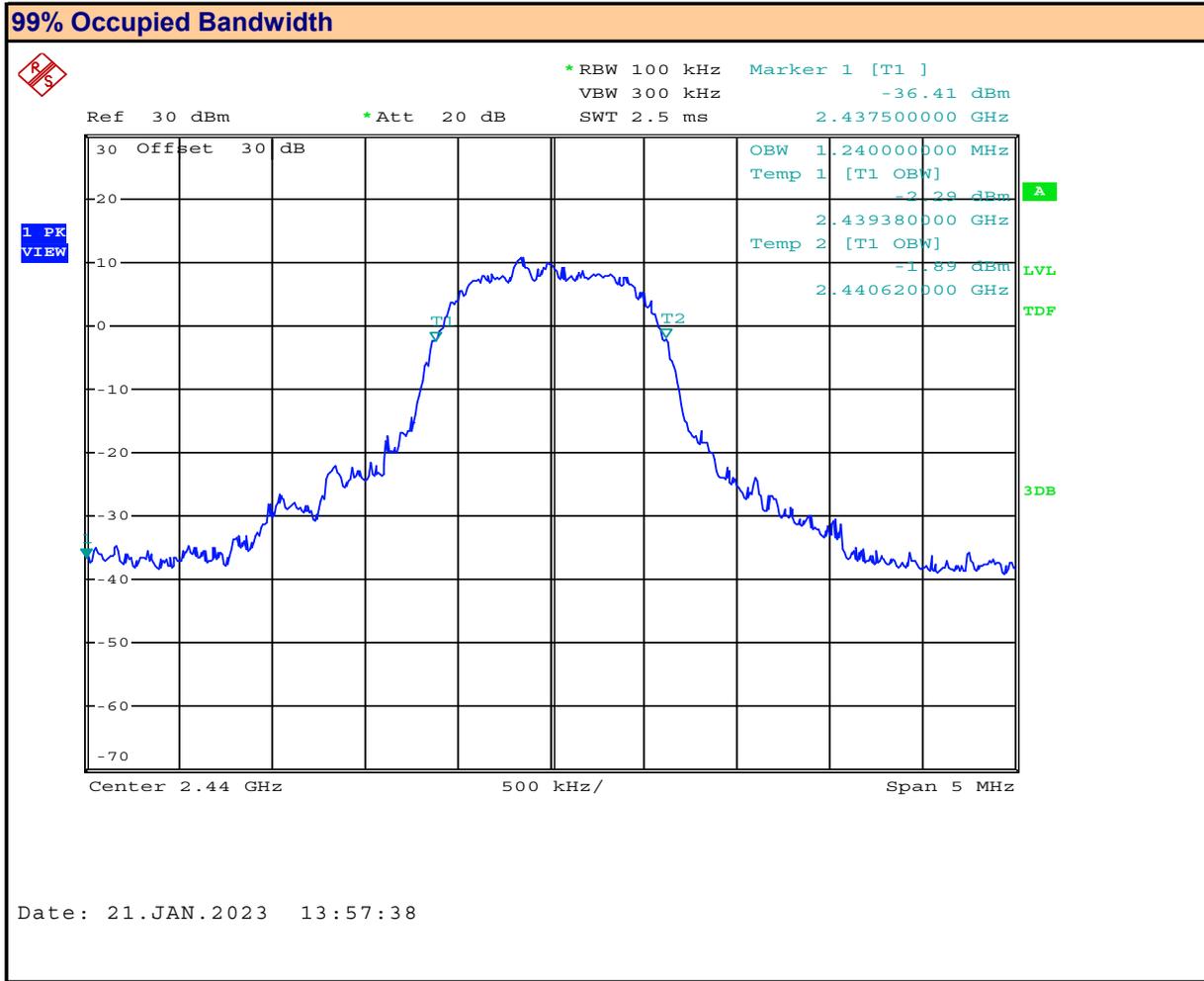


Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:

Measured Occupied Bandwidth:  MHz

**Plot 7.5 – Occupied Bandwidth, BT 2EDR**

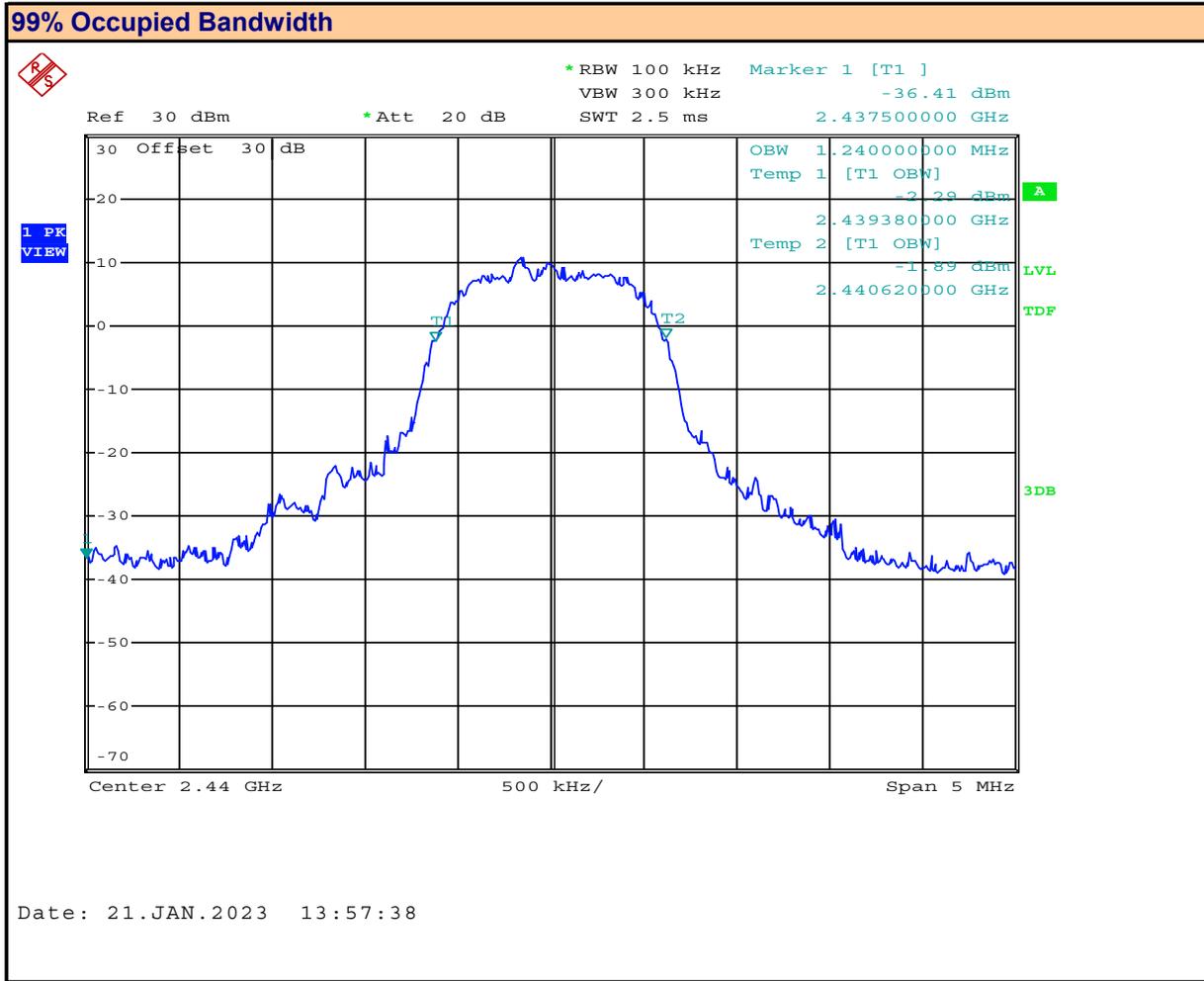


Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:

Measured Occupied Bandwidth:  MHz

**Plot 7.6 – Occupied Bandwidth, BT 3EDR**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured Occupied Bandwidth:  MHz

**Table 7.2 – Summary of Occupied Bandwidth Measurements (DSS)**

<b>99% Occupied Bandwidth Results:</b>					
<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>	<b>Mode</b>	<b>Modulation</b>	<b>Measured Occupied Bandwidth (MHz)</b>	<b>Emission Designator</b>
38	2440.0	BT BR	GFSK	0.960	960KF1D
38	2440.0	BT 2EDR	Pi/4-DQPSK	1.240	1M24G1D
38	2440.0	BT 3EDR	8-DSPK	1.240	1M24G1D
<b>Result:</b>					<b>Complies</b>

## 8.0 DTS BANDWIDTH

### Test Procedure

<b>Normative Reference</b>	FCC 47 CFR §2.1049, §15.247(a)(2), RSS-Gen (6.7), RSS-247 (5.2)(a), KDB 558074 (8.2), ANSI C63.10 (11.8.2)
----------------------------	---

### Limits

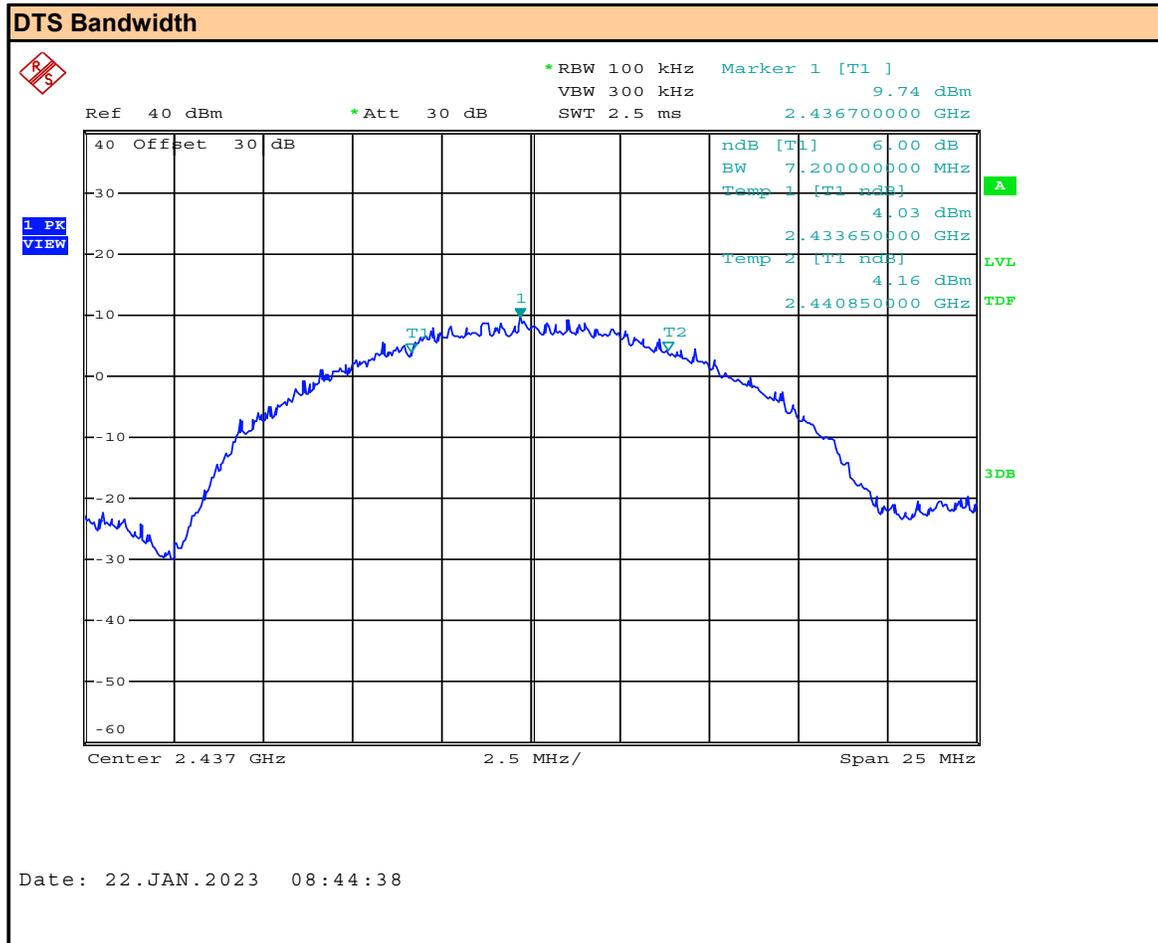
47 CFR §15.247(a)(2)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.
RSS-247 (5.2)(a)	5.2 Digital transmission systems DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: a) The minimum 6 dB bandwidth shall be 500 kHz.
KDB 558074 (8.2) C63.10 (11.8.2)	<b>8.2 Option 2</b> The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

<b>Test Setup</b>	<b>Appendix A</b> <b>Figure A.1</b>
-------------------	-------------------------------------

### Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device. The DUT was set to transmit at 100% Duty Cycle.

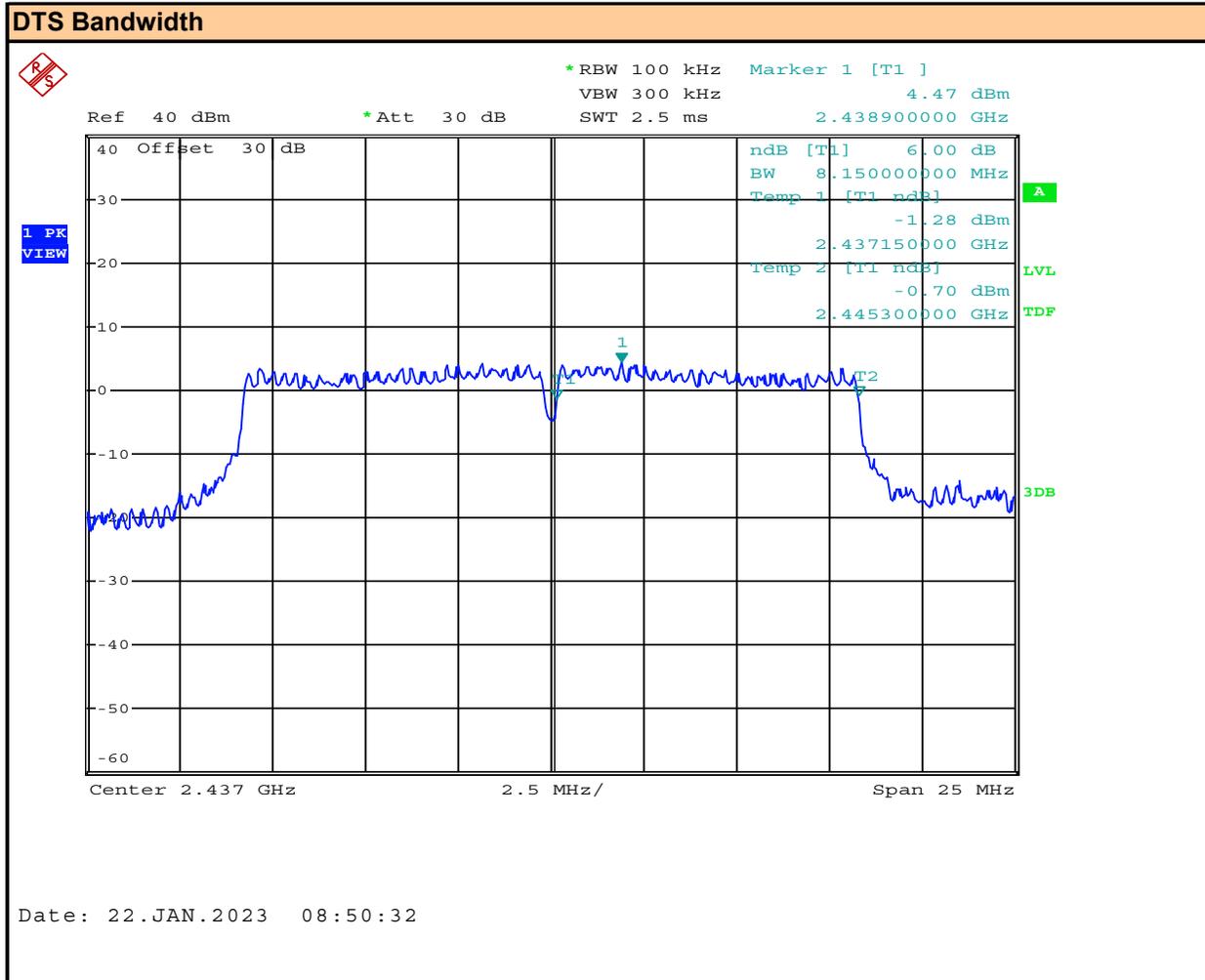
Plot 8.1 – 6dB DTS Bandwidth 802.11b



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured DTS Bandwidth:  MHz

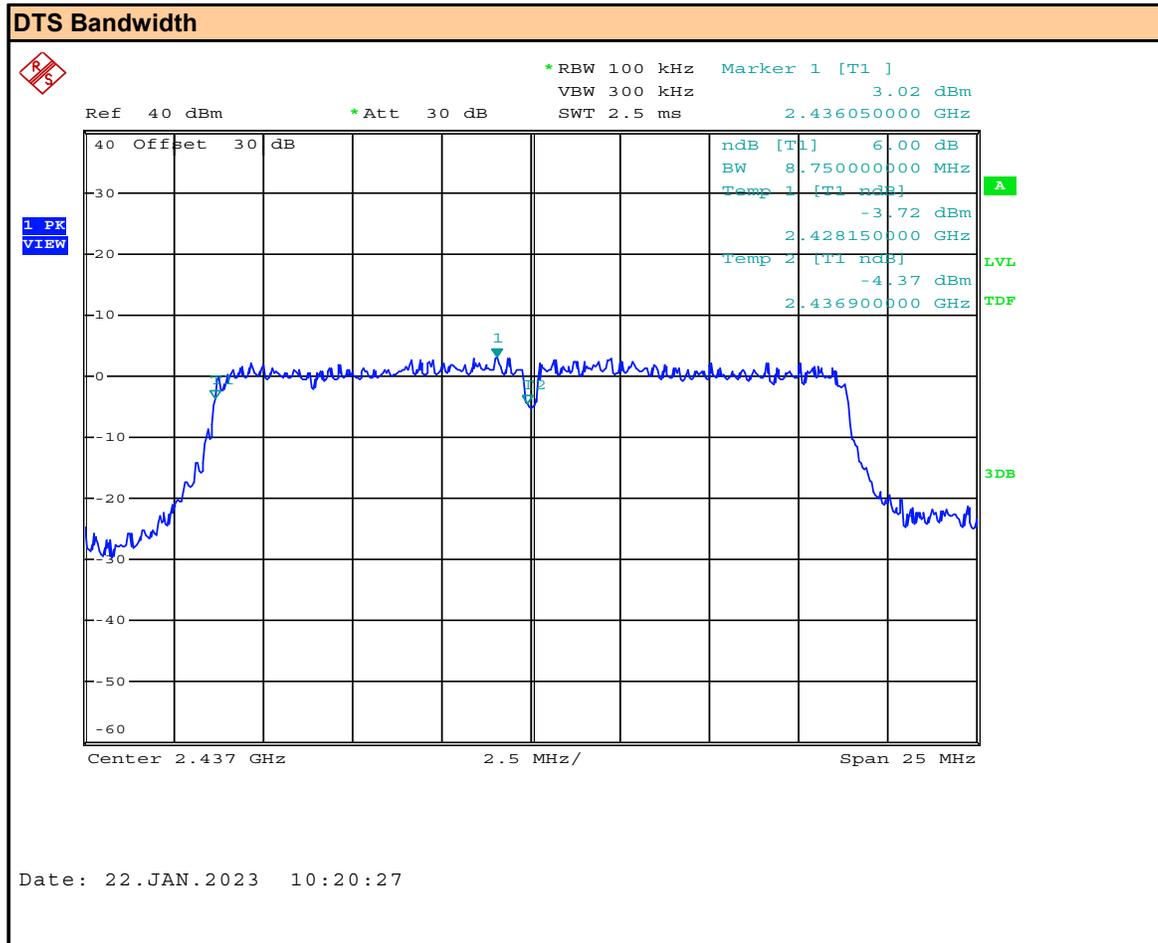
Plot 8.2 – 6dB DTS Bandwidth 802.11g



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured DTS Bandwidth:  MHz

Plot 8.3 – 6dB DTS Bandwidth 802.11n



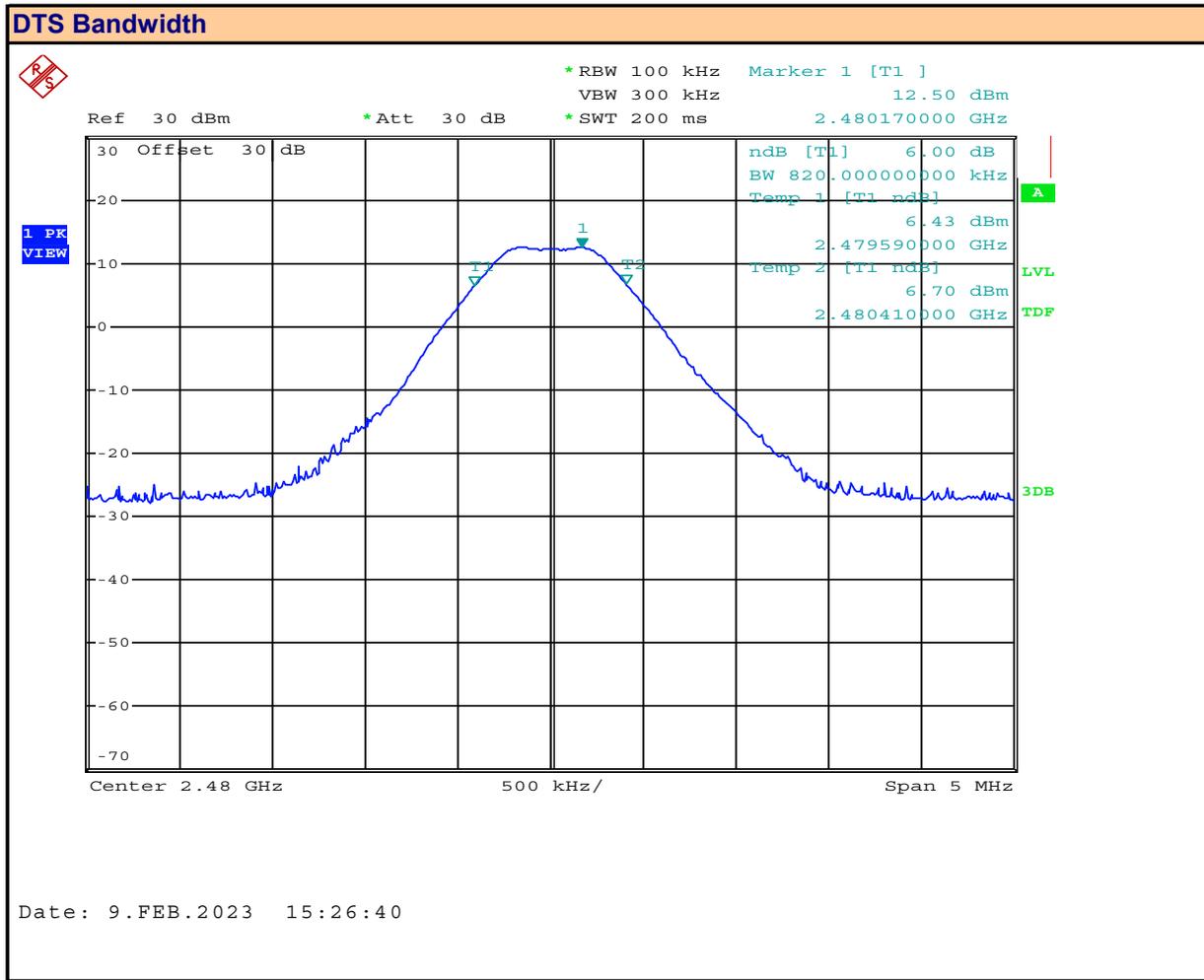
Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured DTS Bandwidth:  MHz

**Table 8.1 – Summary of 6dB DTS Bandwidth Measurements, (DTS)**

<b>DTS Bandwidth Results:</b>						
<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>	<b>Mode</b>	<b>Modulation</b>	<b>Measured DTS Bandwidth (MHz)</b>	<b>Minimum DTS Bandwidth (MHz)</b>	<b>Margin (MHz)</b>
6	2437.0	802.11b	DSSS 5.5	7.2	0.50	6.7
6	2437.0	802.11g	OFDM12	16.3		15.8
6	2437.0	802.11n	MCS0	17.5		17.0
					<b>Result:</b>	<b>Complies</b>

**Plot 8.4 – 6dB DTS Bandwidth, BT BR**



Channel:

Mode:

Channel Frequency:  MHz

Modulation:

Measured DTS Bandwidth:  MHz

Plot 8.5 – 6dB DTS Bandwidth, BT 2EDR



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured DTS Bandwidth:  MHz

Plot 8.6 – 6dB DTS Bandwidth, BT 3EDR



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured DTS Bandwidth:  MHz

**Table 8.2 – Summary of 6dB DTS Bandwidth Measurements, (DSS)**

<b>DTS Bandwidth Results:</b>						
<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>	<b>Mode</b>	<b>Modulation</b>	<b>Measured DTS Bandwidth (MHz)</b>	<b>Minimum DTS Bandwidth (MHz)</b>	<b>Margin (MHz)</b>
78	2480.0	BT BR	GFSK	0.468	0.500	0.820
78	2480.0	BT 2EDR	Pi/4-DQPSK	0.966		0.466
78	2480.0	BT 3EDR	8-DPSK	0.960		0.460
					<b>Result:</b>	<b>Complies</b>

**9.0 ANTENNA PORT CONDUCTED POWER, (DTS)**

**Test Procedure**

<b>Normative Reference</b>	FCC 47 CFR §2.1046, §15.247(b)(3), RSS-Gen (6.1.2), RSS-247 (5.4)(d), KDB 558074 (8.3.2), ANSI C63.10 (11.9.2.2.2)
----------------------------	---

**Limits**

47 CFR §15.247(b)(3)	(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.
RSS-247 (5.4)(d)	<b>5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.)</b> Devices shall comply with the following requirements, where applicable: d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e). As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.

**Table 9.1 – Summary of Conducted Power Measurements, (DTS)**

See Appendix D for Measurement Plots

Conducted Power Measurement Results:												
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured Power [P <sub>Meas</sub> ] (dBm)	Measured Power (W)	Conducted Limit [P <sub>Lim</sub> ] (dBm)	Conducted Margin (dB)	Antenna Gain (dBi)	EIRP [E <sub>Meas</sub> ] (dBm)	EIRP (W)	EIRP Limit [E <sub>Lim</sub> ] (dBm)	EIRP Margin (dB)
6	2437.00	802.11b	CCK 1MB	18.03	0.0635	30.00	12.0	-5.9	12.13	0.0163	36	23.9
			CCK 2MB	18.22	0.0664		11.8		12.32	0.0171		23.7
			DSSS 5.5	<b>18.32</b>	0.0679		11.7		12.42	0.0175		23.6
			DSSS 11	18.24	0.0667		11.8		12.34	0.0171		23.7
1	2412.00	802.11g	DSSS 5.5	18.09	0.0644		11.9		12.19	0.0166		23.8
11	2462.00		18.21	0.0662	11.8		12.31		0.0170	23.7		
1	2412.00	802.11g	OFDM12	17.02	0.0504		13.0		11.12	0.0129		24.9
6	2437.00			<b>17.40</b>	0.0550		12.6		11.50	0.0141		24.5
11	2462.00			14.23	0.0265		15.8		8.33	0.0068		27.7
1	2412.00	802.11n	MCS0	13.61	0.0230		16.4		7.71	0.0059		28.3
6	2437.00			<b>15.75</b>	0.0376		14.3		9.85	0.0097		26.2
11	2462.00			12.80	0.0191		17.2		6.90	0.0049		29.1
<b>Result:</b>												<b>Complies</b>

Conducted Margin = P<sub>Limit</sub> - P<sub>Meas</sub>

**10.0 ANTENNA PORT CONDUCTED POWER, (DSS)**

**Test Procedure**

<b>Normative Reference</b>	FCC 47 CFR §2.1046, §15.247(b)(3), RSS-Gen (6.1.2), RSS-247 (5.4)(d), KDB 558074 (8.3.2), ANSI C63.10 (11.9.2.2.2)
----------------------------	---

**Limits**

47 CFR §15.247(b)(3)	(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.
RSS-247 (5.4)(d)	<b>5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.)</b> Devices shall comply with the following requirements, where applicable: d) For DTSSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e). As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.

**Table 10.1 – Summary of Conducted Power Measurements, (DSS)**

See Appendix D for Measurement Plots

Conducted Power Measurement Results:												
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured Power [P <sub>Meas</sub> ] (dBm)	Measured Power (W)	Conducted Limit [P <sub>Lim</sub> ] (dBm)	Conducted Margin (dB)	Antenna Gain (dBi)	EIRP [E <sub>Meas</sub> ] (dBm)	EIRP (W)	EIRP Limit [E <sub>Lim</sub> ] (dBm)	EIRP Margin (dB)
0	2402.00	BT BR	GFSK	11.04	0.0127	30.00	19.0	-5.9	5.14	0.0033	36	30.9
38	2440.00			11.11	0.0129		18.9		5.21	0.0033		30.8
78	2480.00			11.13	0.0130		18.9		5.23	0.0033		30.8
0	2402.00	BT EDR2	Pi/4-DQPSK	10.11	0.0103		19.9		4.21	0.0026		31.8
38	2440.00			10.21	0.0105		19.8		4.31	0.0027		31.7
78	2480.00			10.23	0.0105		19.8		4.33	0.0027		31.7
0	2402.00	BT EDR3	8-DPSK	10.11	0.0103		19.9		4.21	0.0026		31.8
38	2440.00			10.11	0.0103		19.9		4.21	0.0026		31.8
78	2480.00			10.12	0.0103		19.9		4.22	0.0026		31.8
<b>Result:</b>											<b>Complies</b>	

Conducted Margin =  $P_{Lim} - P_{Meas}$

Conducted Margin =  $E_{Lim} - E_{Meas}$

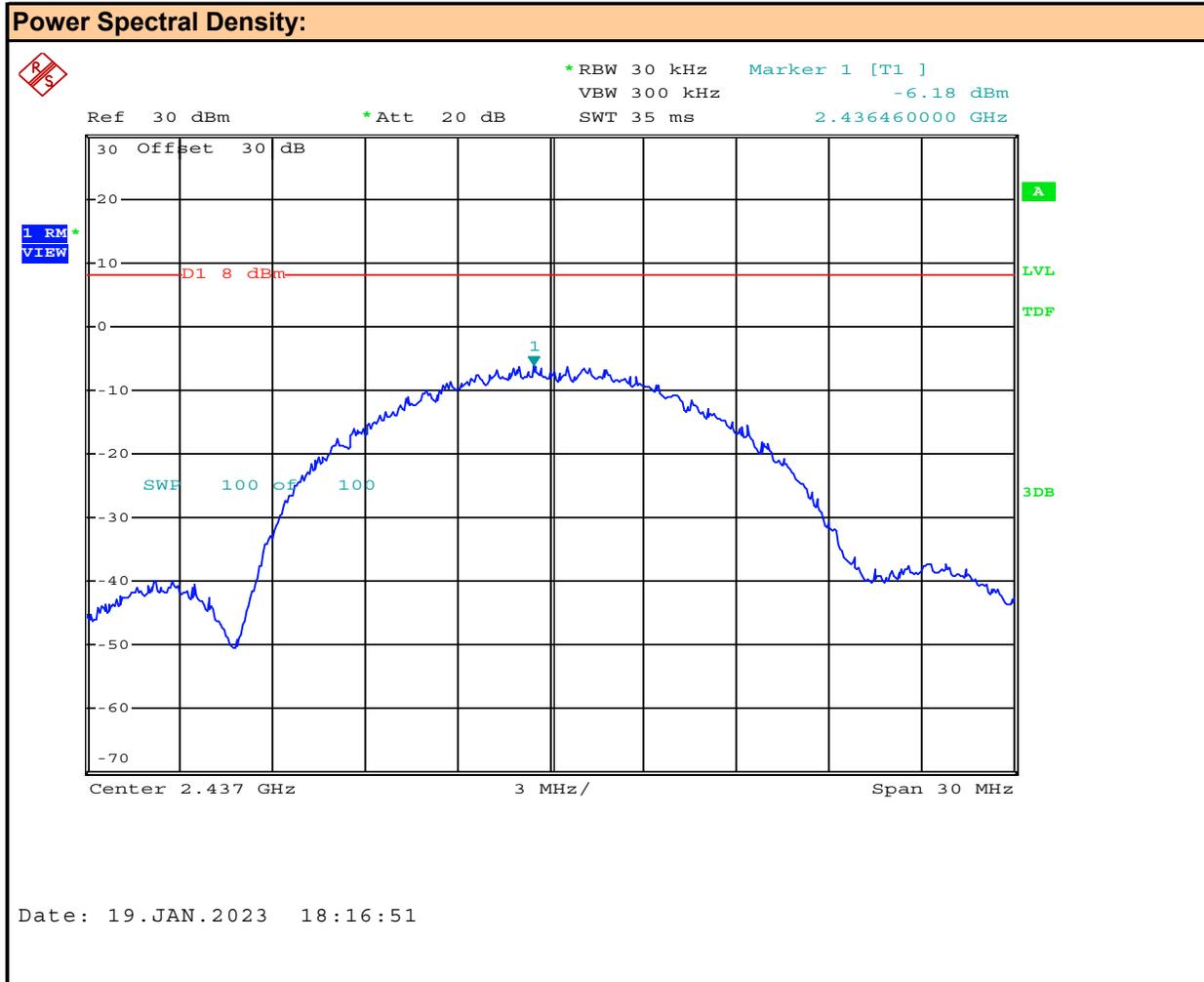
## 11.0 POWER SPECTRAL DENSITY

Test Procedure	
<b>Normative Reference</b>	FCC 47 CFR §15.247(e), RSS-247 (5.2)(b), KDB 558074 (10.3), ANSI C63.10 (11.10.3)
Limits	
47 CFR §15.247(e)	(e) 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.
RSS-247 (5.2)(b)	b) The transmitter power spectral density conducted from the transmitter 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 section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).
KDB 558074 (10.3) C63.10 (11.10.3)	<p><b>Method AVGPSD-1</b> (trace averaging with EUT transmitting at full power throughout each sweep)</p> <p>This procedure may be used when the maximum (average) conducted output power was used to demonstrate compliance to the output power limit. This is the baseline method for determining the maximum (average) conducted PSD level. If the instrument has an RMS power averaging detector, it must be used; otherwise, use the sample detector. The EUT must be configured to transmit continuously (duty cycle <math>\geq 98\%</math>); otherwise sweep triggering/signal gating must be implemented to ensure that measurements are made only when the EUT is transmitting at its maximum power control level (no transmitter off time is to be considered).</p> <ul style="list-style-type: none"> <li>a) Set instrument center frequency to DTS channel center frequency.</li> <li>b) Set span to at least 1.5 X OBW.</li> <li>c) Set RBW to: <math>3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}</math>.</li> <li>d) Set VBW <math>\geq 3 \times \text{RBW}</math>.</li> <li>e) Detector = RMS</li> <li>f) Ensure that the number of measurement points in the sweep <math>\geq 2 \times \text{span}/\text{RBW}</math>.</li> <li>g) Sweep time = auto couple.</li> <li>h) Employ trace averaging (RMS) mode over a minimum of 100 traces.</li> <li>i) Use the peak marker function to determine the maximum amplitude level.</li> <li>j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).</li> </ul>
<b>Test Setup</b>	<b>Appendix A                      Figure A.1</b>

### Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as described above. Number of Sweep Points  $\geq 2 \times \text{Span} / \text{RBW} = 2 \times (1.5\text{MHz} / 3\text{kHz}) = 1000$ , the SA was configured for 1001 Points. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device. The DUT was set to transmit at 100% Duty Cycle. The Power Spectral Density was measured and recorded.

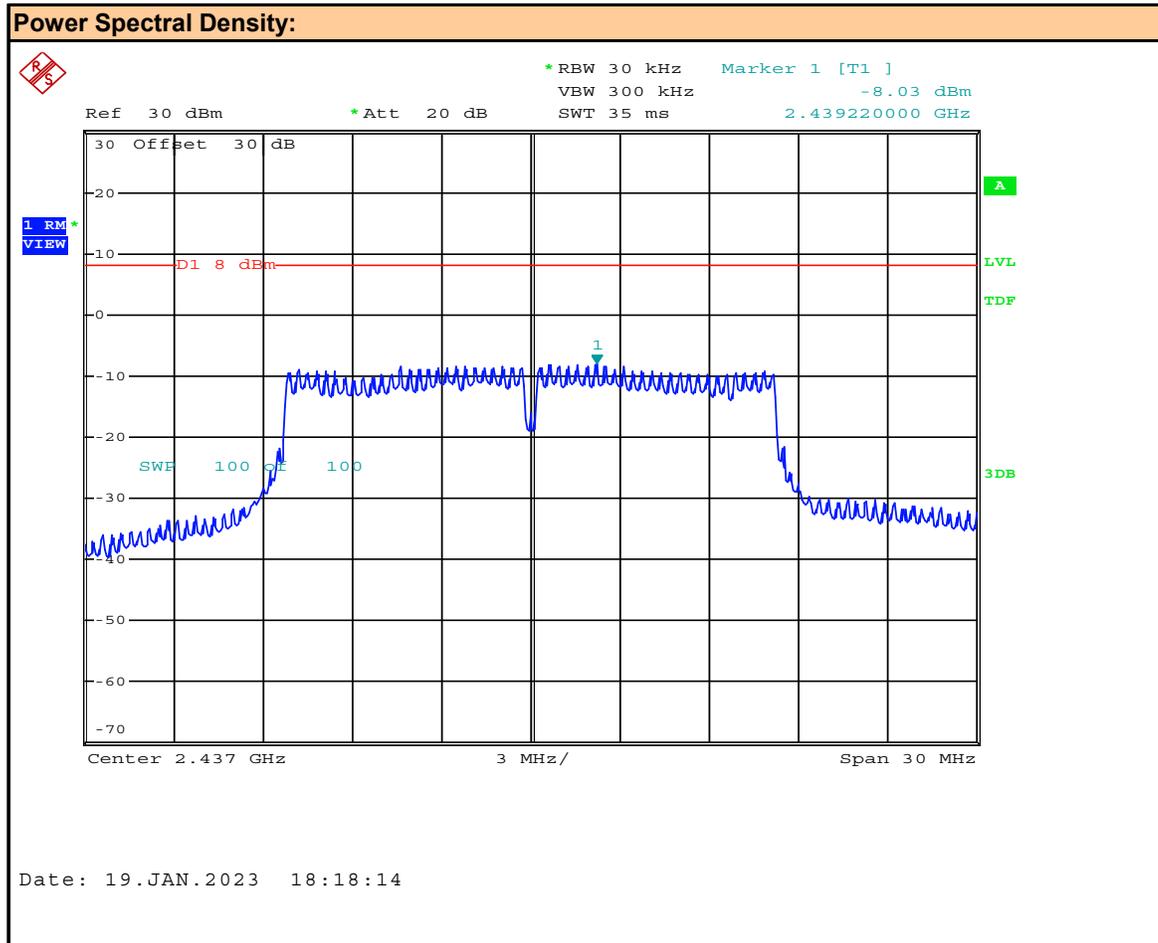
**Plot 11.1 – Power Spectral Density, 802.11b**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured PSD:  dBm

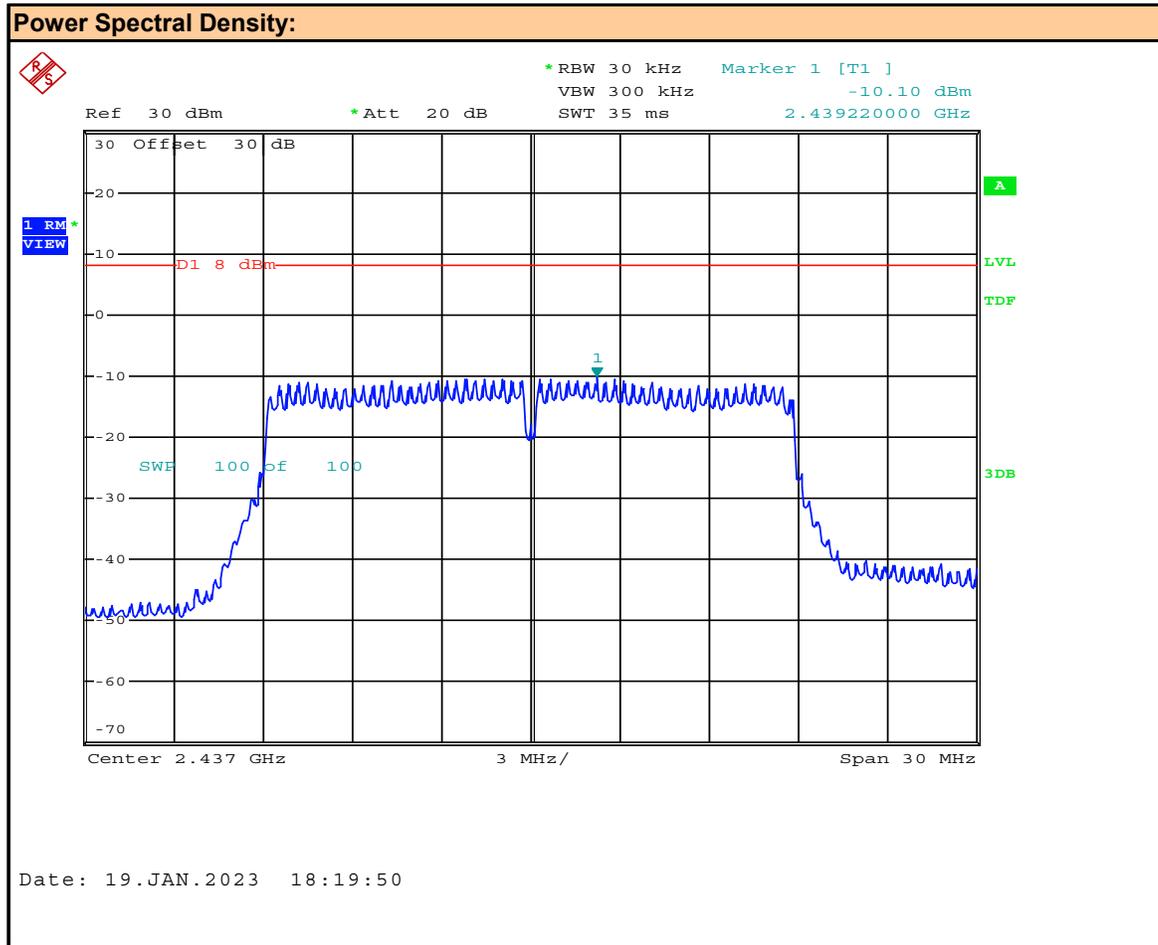
**Plot 11.2 – Power Spectral Density, 802.11g**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured PSD:  dBm

**Plot 11.3 – Power Spectral Density, 802.11n**



Channel:   
 Mode:

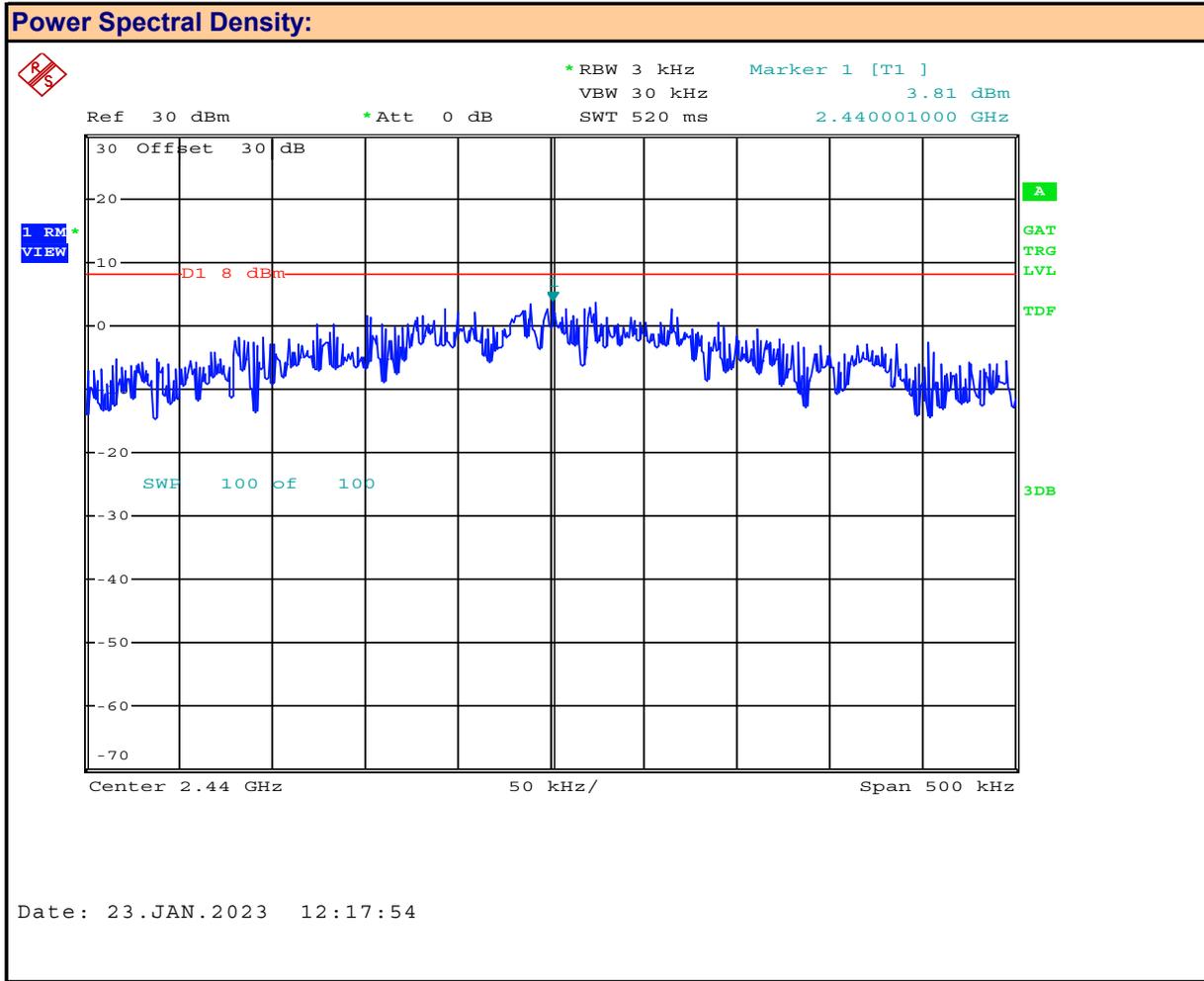
Channel Frequency:  MHz  
 Modulation:   
 Measured PSD:  dBm

**Table 11.1 – Summary of Power Spectral Density Measurements, (DTS)**

<b>Conducted Power Measurement Results:</b>						
<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>	<b>Mode</b>	<b>Modulation</b>	<b>Measured PSD [P<sub>Meas</sub>] (dBm)</b>	<b>Conducted Limit [P<sub>Lim</sub>] (dBm)</b>	<b>Margin (dB)</b>
6	2437.00	802.11b	DSSS 5.5	-6.18	8.00	14.2
6	2437.00	802.11g	OFDM 12	-8.03		16.0
6	2437.00	802.11n	MCS0	-10.10		18.1
					<b>Result:</b>	<b>Complies</b>

Conducted Margin = P<sub>Limit</sub> - P<sub>Meas</sub>

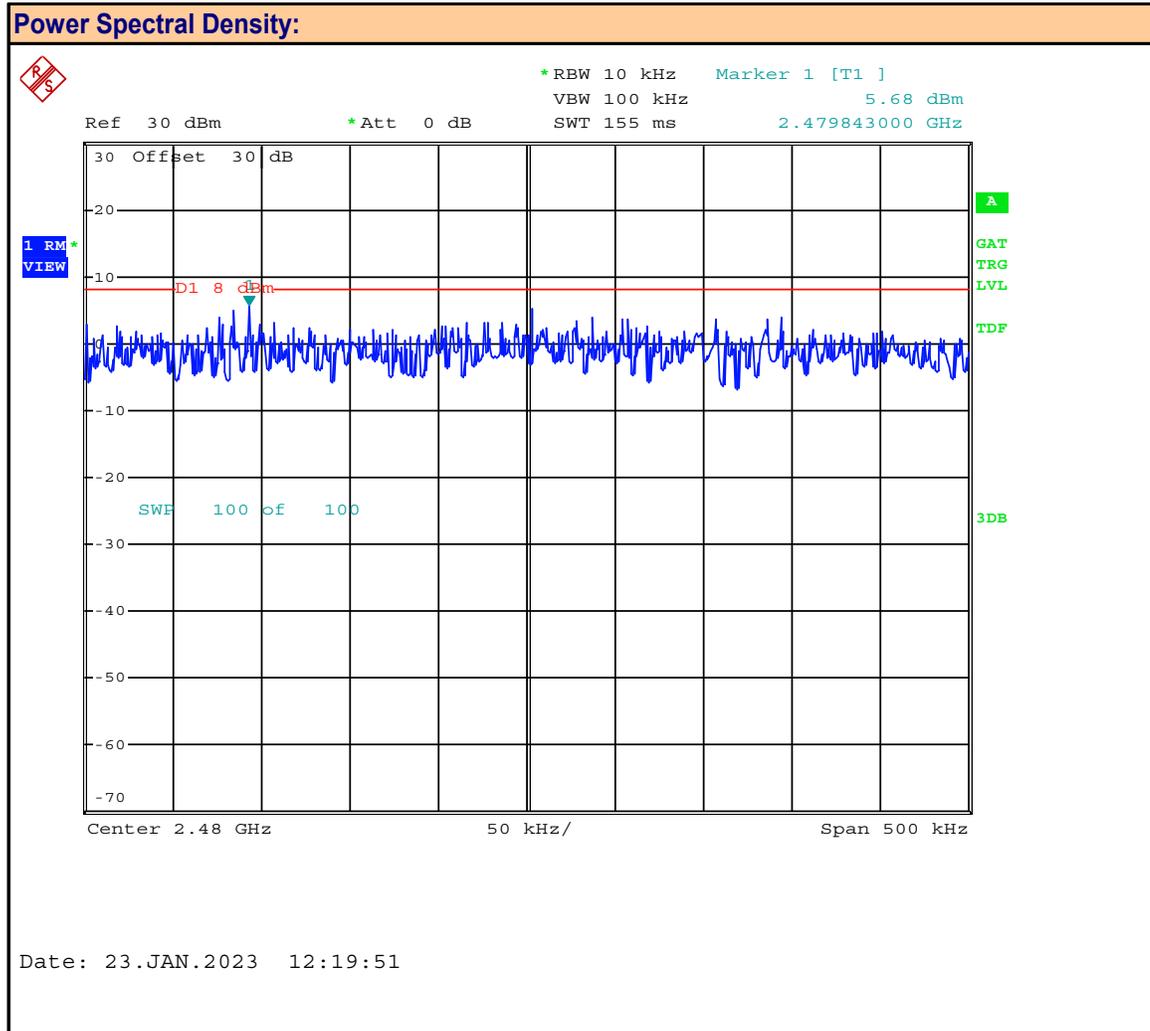
**Plot 11.4 – Power Spectral Density, BT BR**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured PSD:  dBm

**Plot 11.5 – Power Spectral Density, BT 2EDR**



Channel: **78**

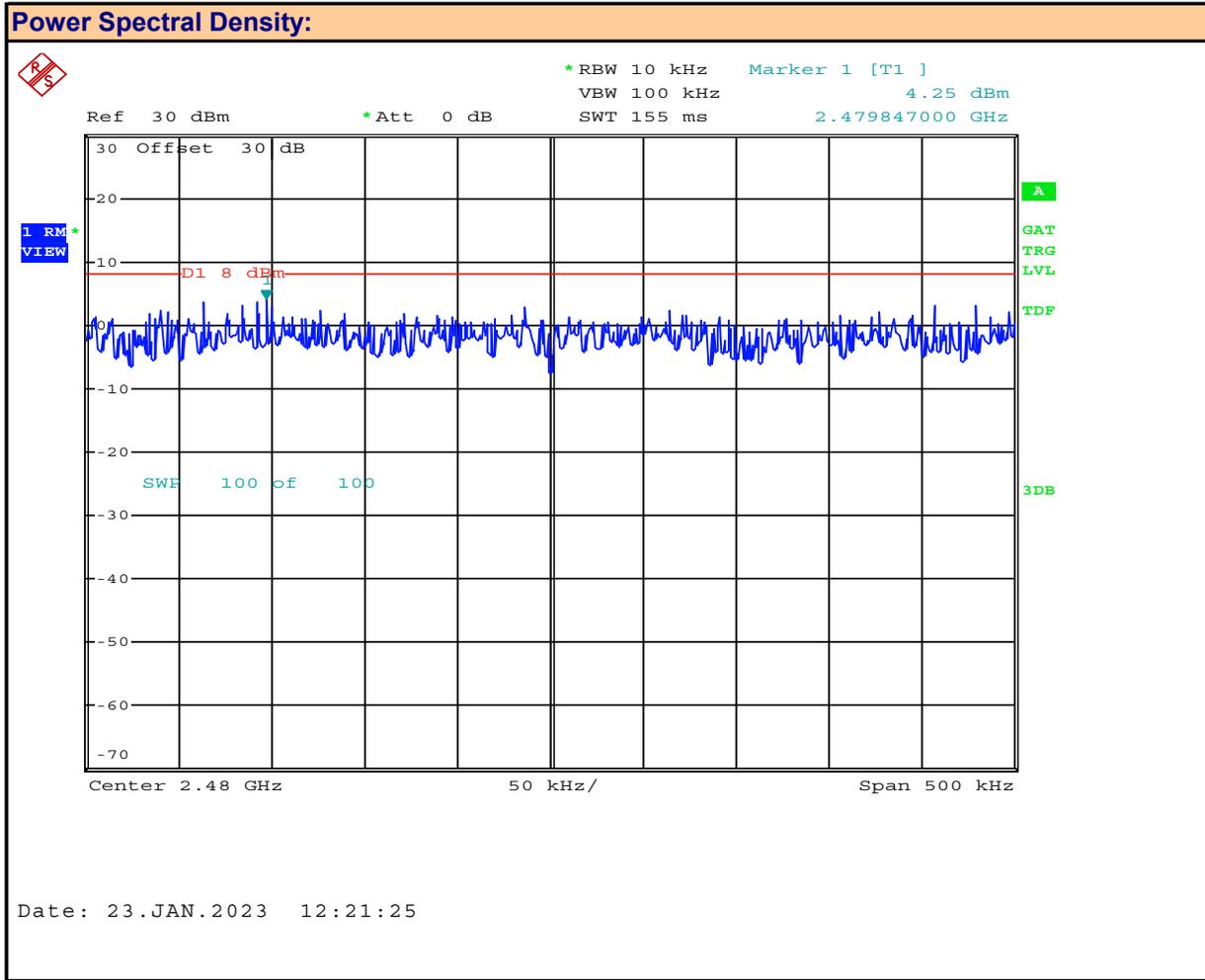
Mode: **BT 2EDR**

Channel Frequency: **2480** MHz

Modulation: **pi/4-DQPSK**

Measured PSD: **5.68** dBm

**Plot 11.6 – Power Spectral Density, BT 3EDR**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured PSD:  dBm

Table 11.2 – Summary of Power Spectral Density Measurements, (DSS)

<b>Conducted Power Measurement Results:</b>						
<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>	<b>Mode</b>	<b>Modulation</b>	<b>Measured PSD [P<sub>Meas</sub>] (dBm)</b>	<b>Conducted Limit [P<sub>Lim</sub>] (dBm)</b>	<b>Margin (dB)</b>
38	2440.00	BT BR	GFSK	3.81	8.00	4.2
78	2480.00	BT 2EDR	pi/4-DQPSK	5.68		2.3
78	2480.00	BT 3EDR	8-DPSK	4.25		3.8
					<b>Result:</b>	<b>Complies</b>

Conducted Margin =  $P_{Limit} - P_{Meas}$

**12.0 FHSS NUMBER OF HOPPING CHANNELS**

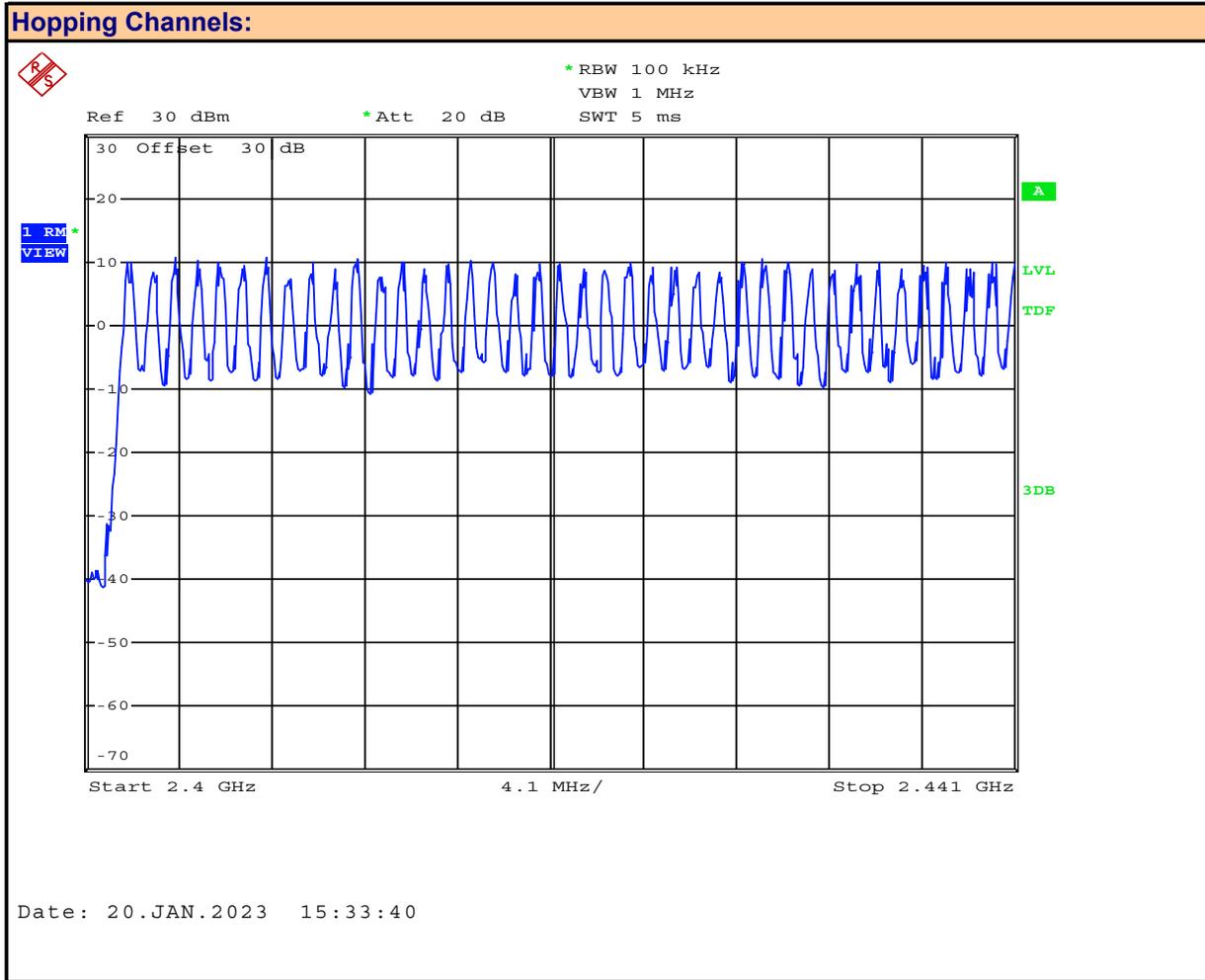
**Test Procedure**

<b>Normative</b>	<b>FCC 47 CFR §15.247, RSS-247</b>
<b>Reference</b>	<b>KDB 558074, ANSI C63.10</b>

**Limits**

47 CFR §15.247(a)(1)	(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
RSS-247 (5.1)(d)	<b>5.1 Frequency hopping systems (FHS)</b> The following applies to FHSs in each of the three bands: FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

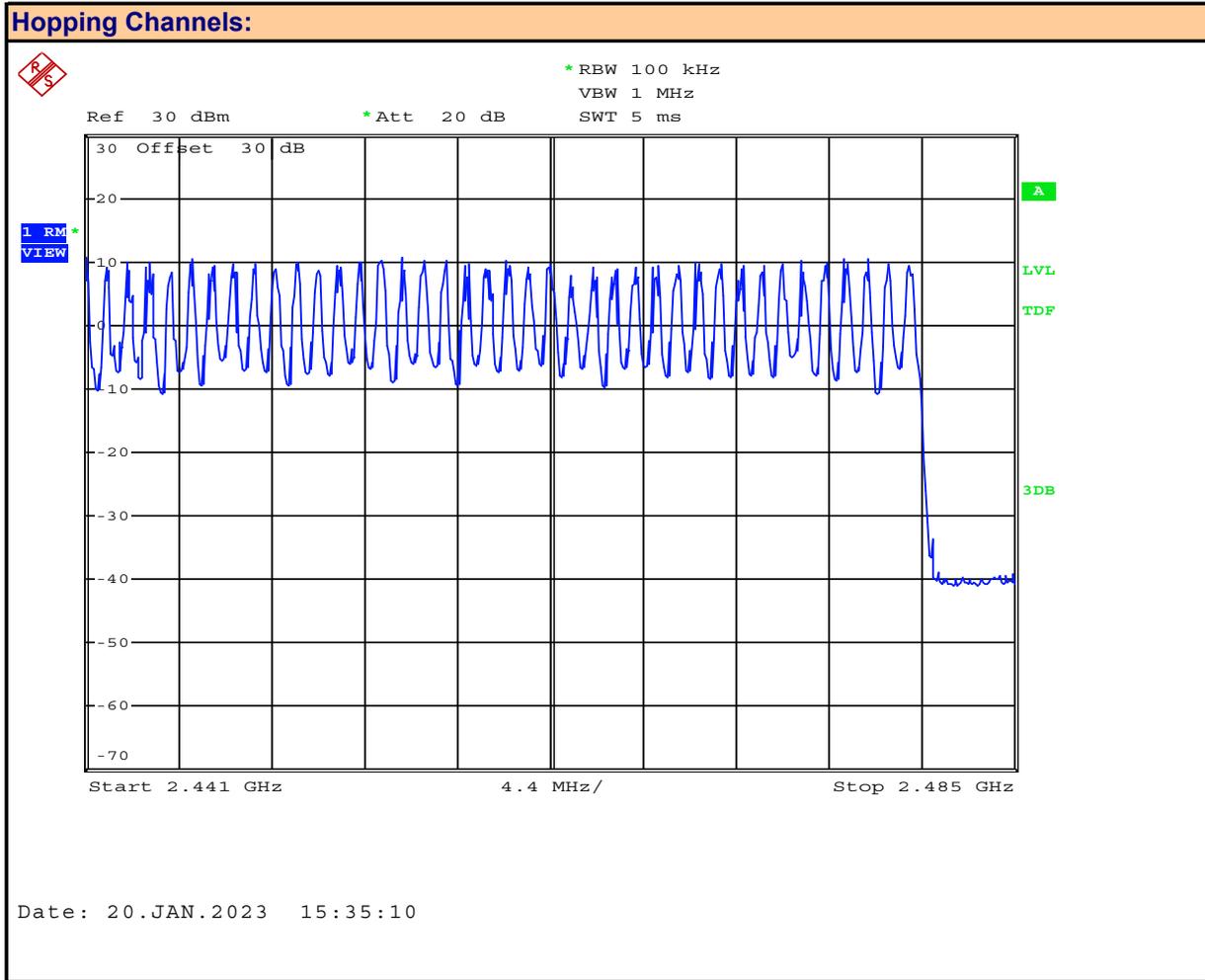
**Plot 12.1 – Number of Hopping Channels, BT BR**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Number of Hopping Channels

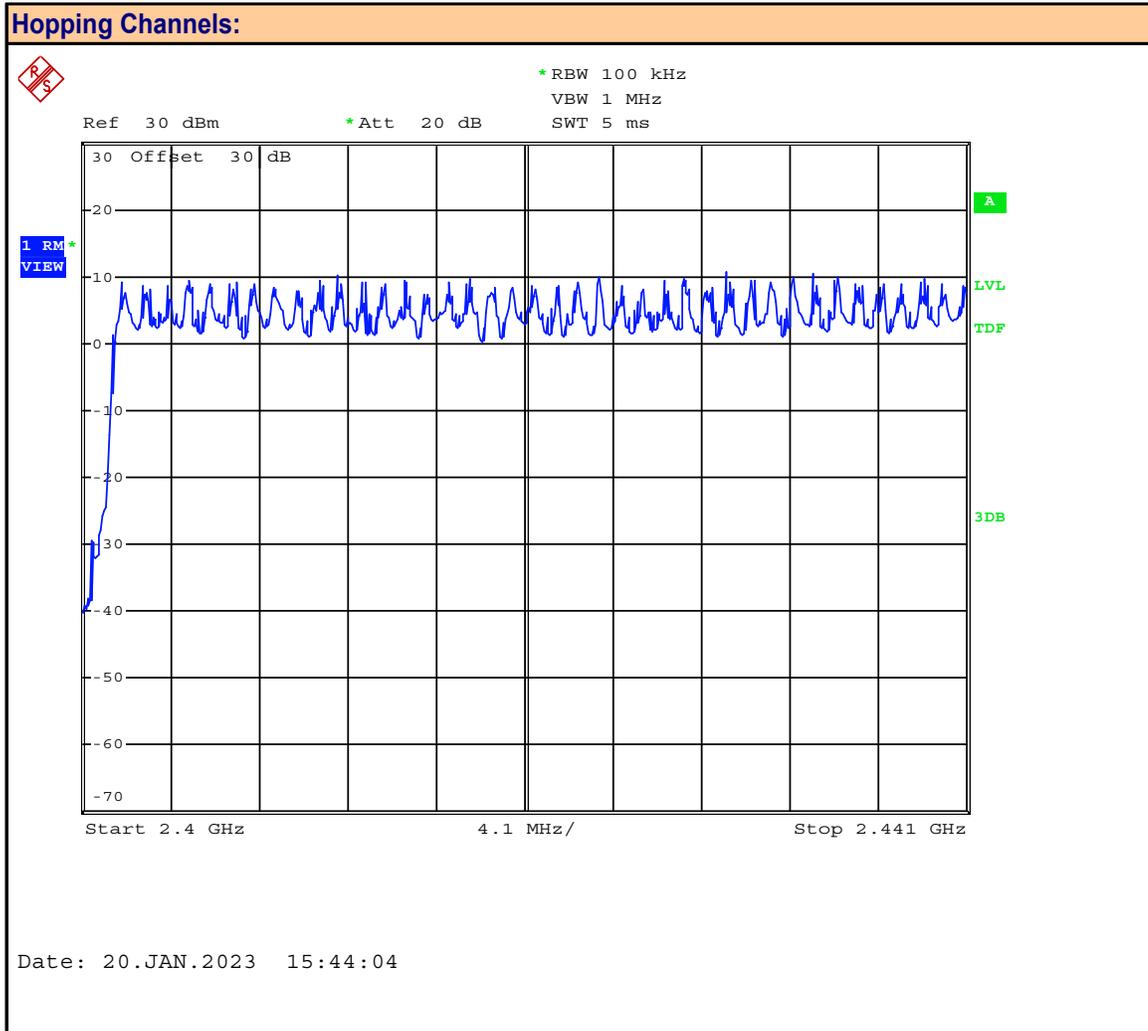
**Plot 12.2 – Number of Hopping Channels, BT BR**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Number of Hopping Channels

**Plot 12.3 – Number of Hopping Channels, BT 2EDR**



Channel:

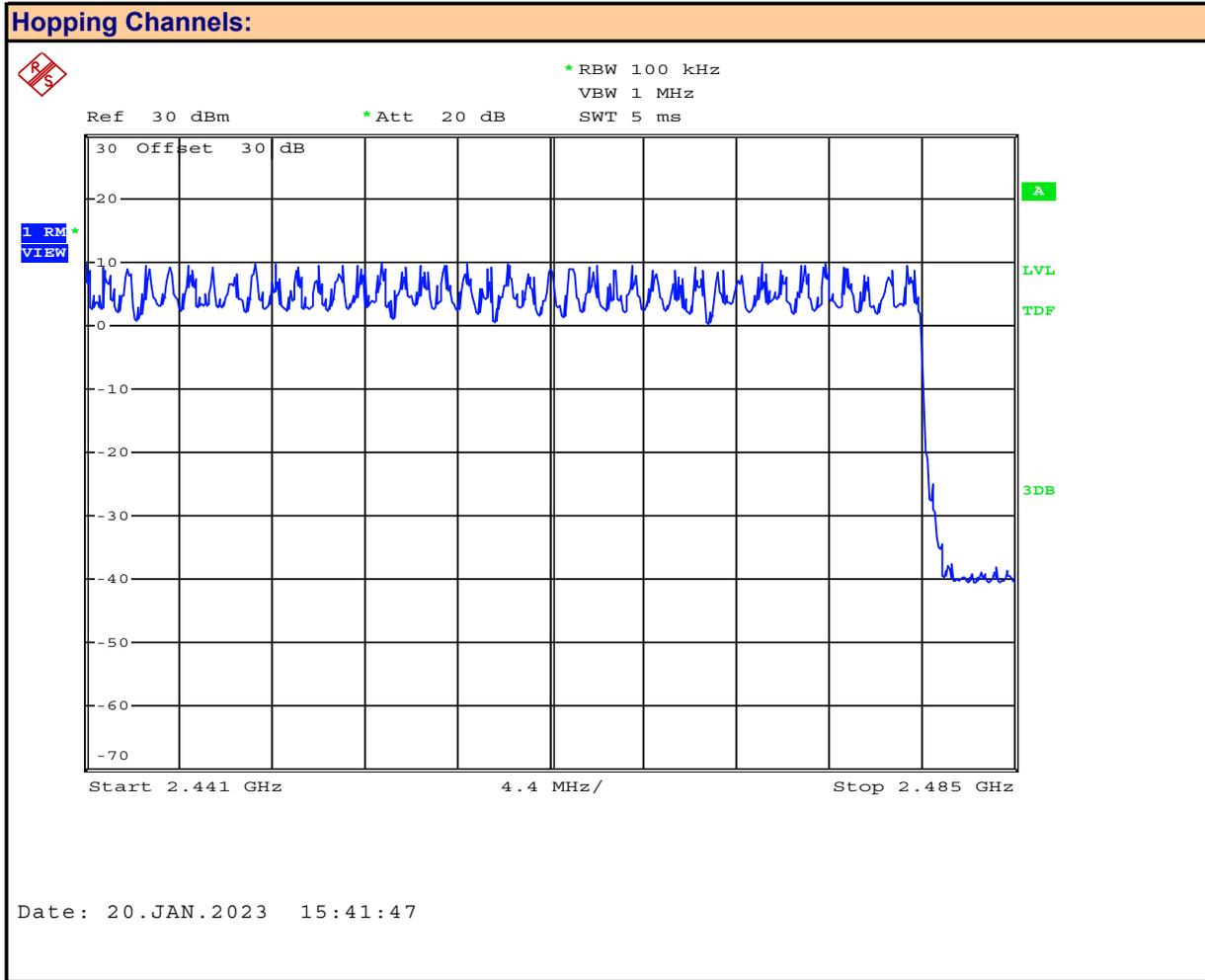
Channel Frequency:  MHz

Mode:

Modulation:

Number of Hopping Channels

**Plot 12.4 – Number of Hopping Channels, BT 2EDR**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Number of Hopping Channels

**Table 12.2 – Summary of FHSS Number of Hopping Channels**

<b>Hopping Channel Results DSS</b>		
<b>Frequency Range (MHz)</b>	<b>Modulation</b>	<b>Number of Hopping Channels</b>
2400-2441	Pi/4-DQPSK	40
2441-2485	Pi/4-DQPSK	39
<b>Total:</b>		79
2400-2441	GFSK	40
2441-2485	GFSK	39
<b>Total:</b>		79
<b>Result:</b>		<b>Complies</b>

**13.0 FHSS CHANNEL SEPARATION**

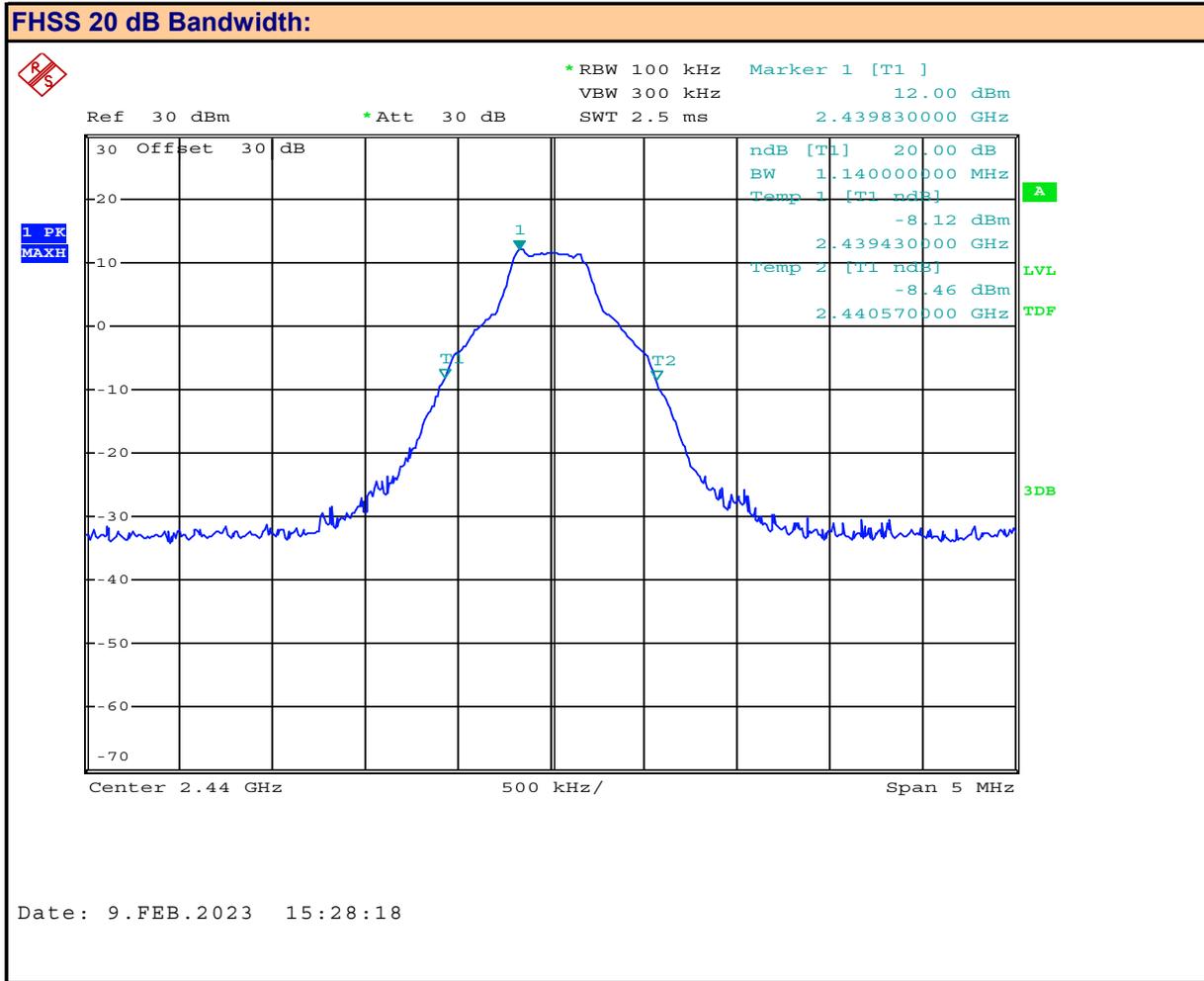
**Test Procedure**

<b>Normative</b>	<b>FCC 47 CFR §15.247, RSS-247</b>
<b>Reference</b>	<b>KDB 558074, ANSI C63.10</b>

**Limits**

47 CFR §15.247(a)(1)	(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400- 2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
RSS-247 (5.1)(db)	<b>5.1 Frequency hopping systems (FHS)</b> The following applies to FHSs in each of the three bands: FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

Plot 13.1 – 20dB BW, BT BR



Channel:

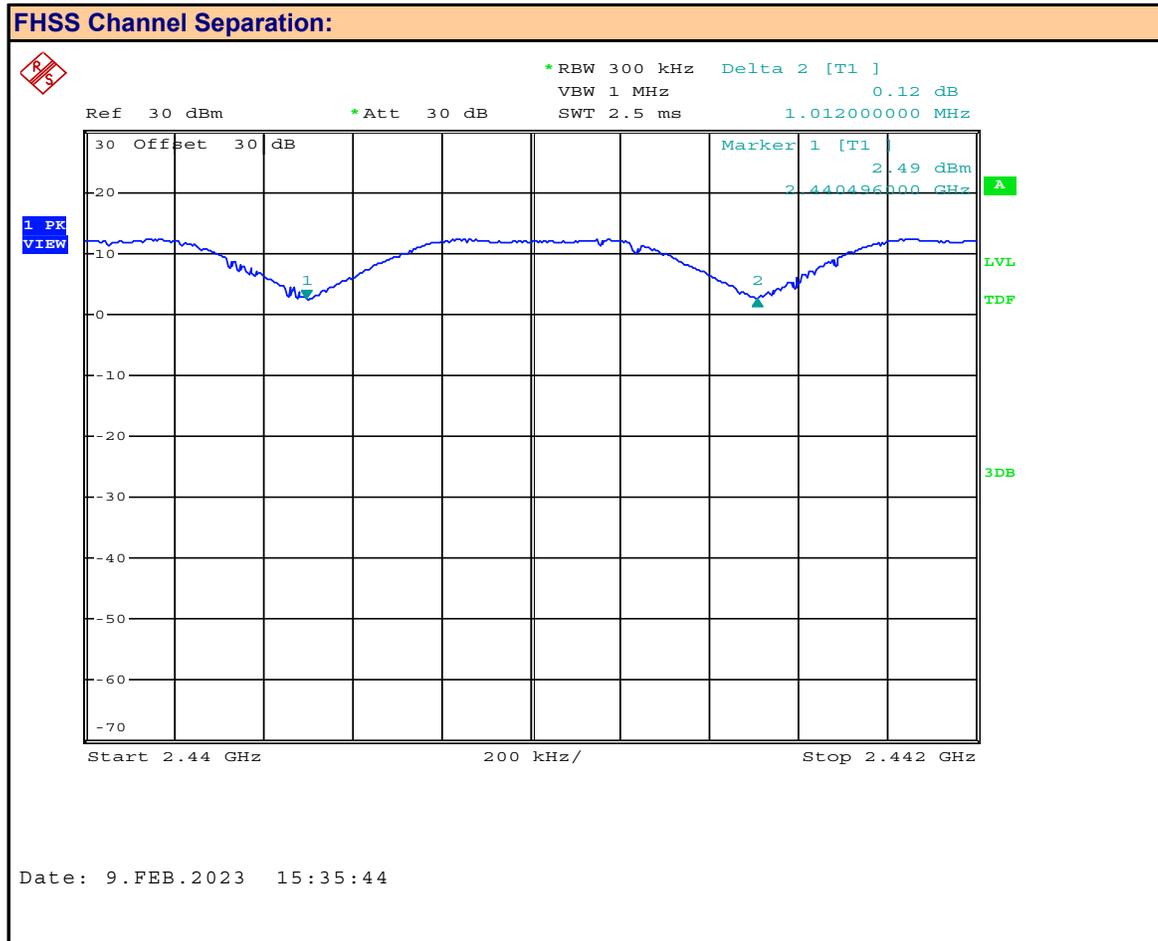
Mode:

Channel Frequency:  MHz

Modulation:

Measured 20dB Bandwidth:  MHz

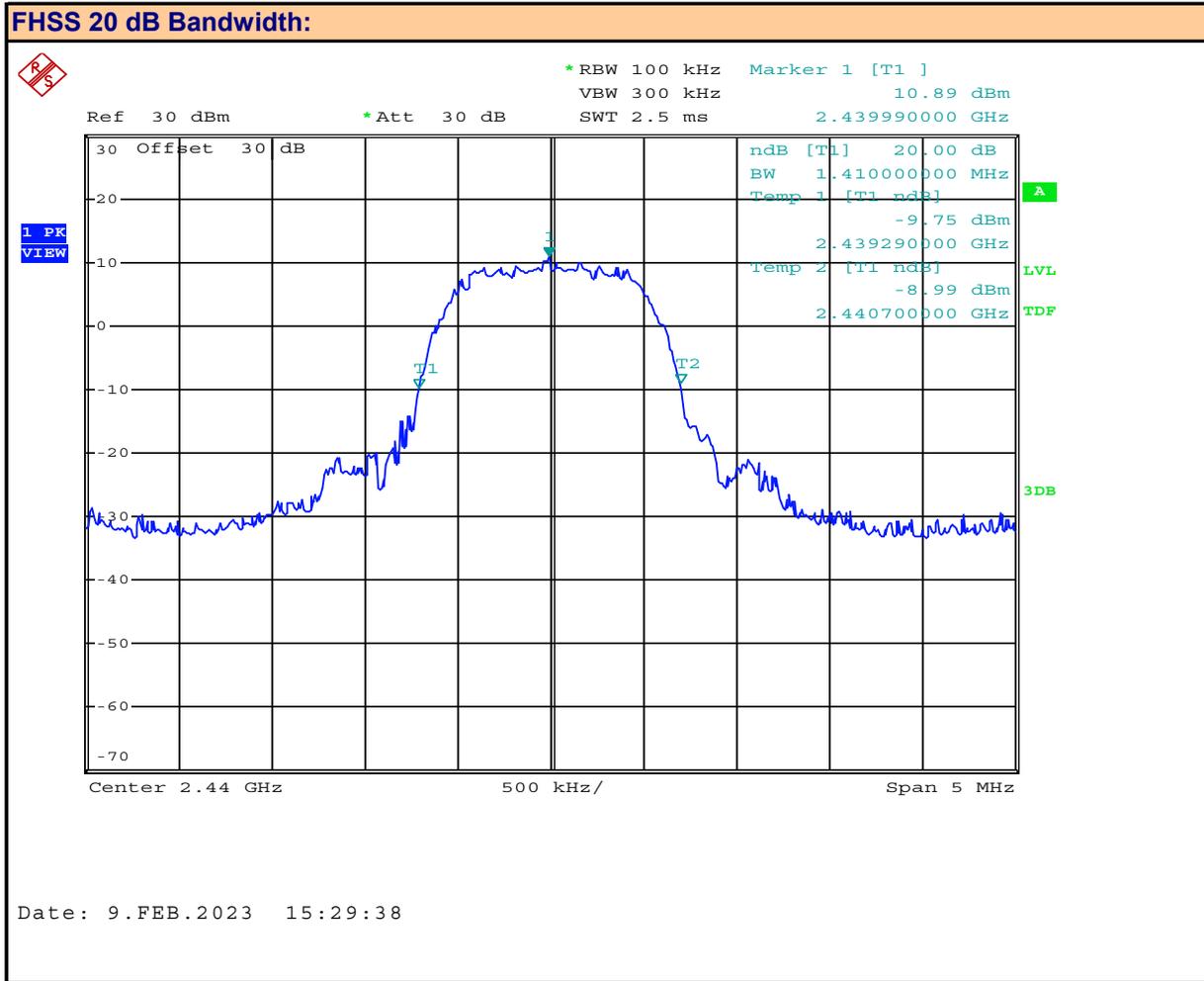
**Plot 13.2 – FHSS Channel Separation, BT BR**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured Channel Separation:  MHz

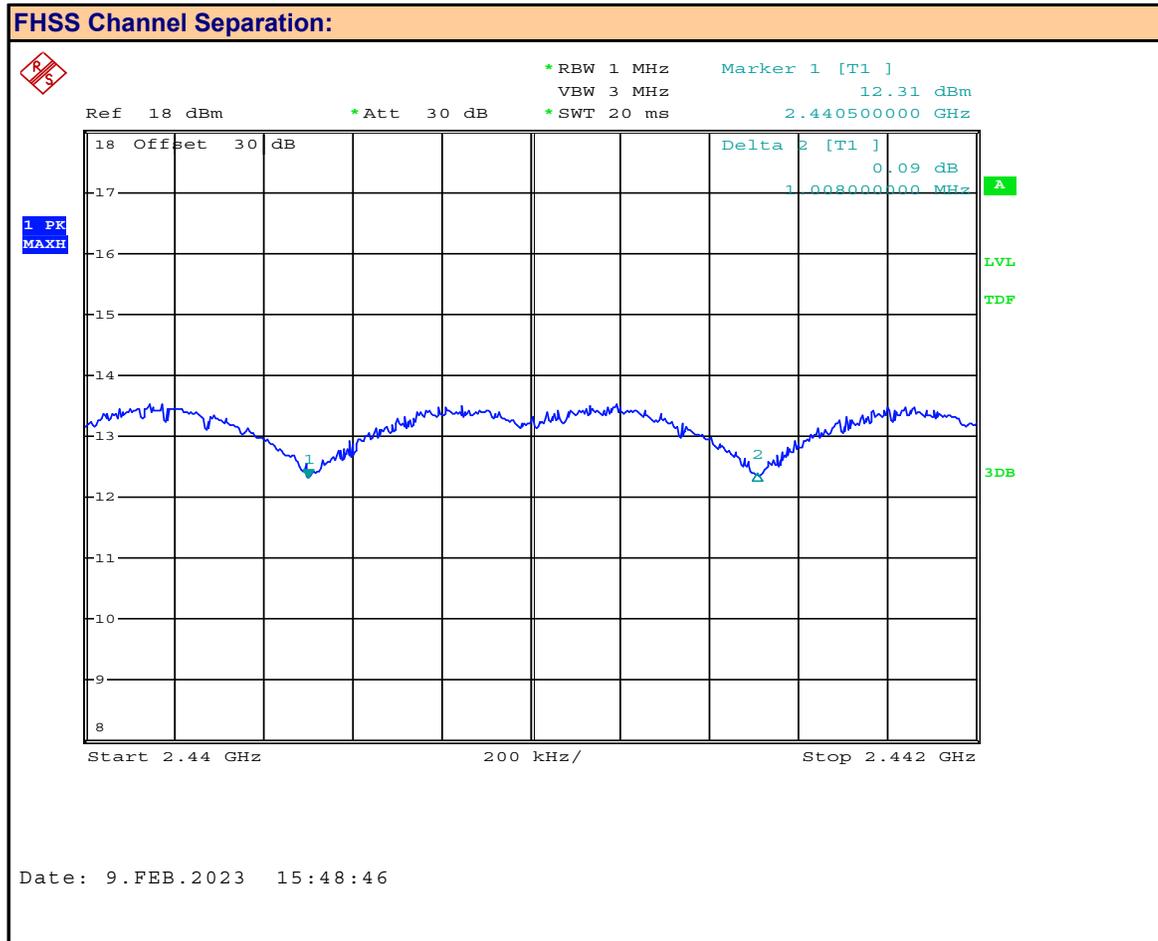
Plot 13.3 – 20dB BW, BT 2EDR



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured 20dB Bandwidth:  MHz

**Plot 13.4 – FHSS Channel Separation, BT 2EDR**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured Channel Separation:  MHz

**Table 13.1 – Summary of FHSS Channel Separation**

<b>Hopping Channel Separation Results DSS</b>				
<b>Modulation</b>	<b>20dB BW (MHz)</b>	<b>Channel Separation (MHz)</b>	<b>Minimum Bandwidth (MHz)</b>	<b>Margin (MHz)</b>
8-DPSK	1.14	1.012	0.760	0.252
Pi/4-DQPSK	1.41	1.008	0.940	0.068
<b>Result:</b>				<b>Complies</b>

Minimum Bandwidth = 20dB BW X 2/3

Margin = Channel Separation - Minimum Bandwidth

**14.0 FHSS TIME OF OCCUPANCY**

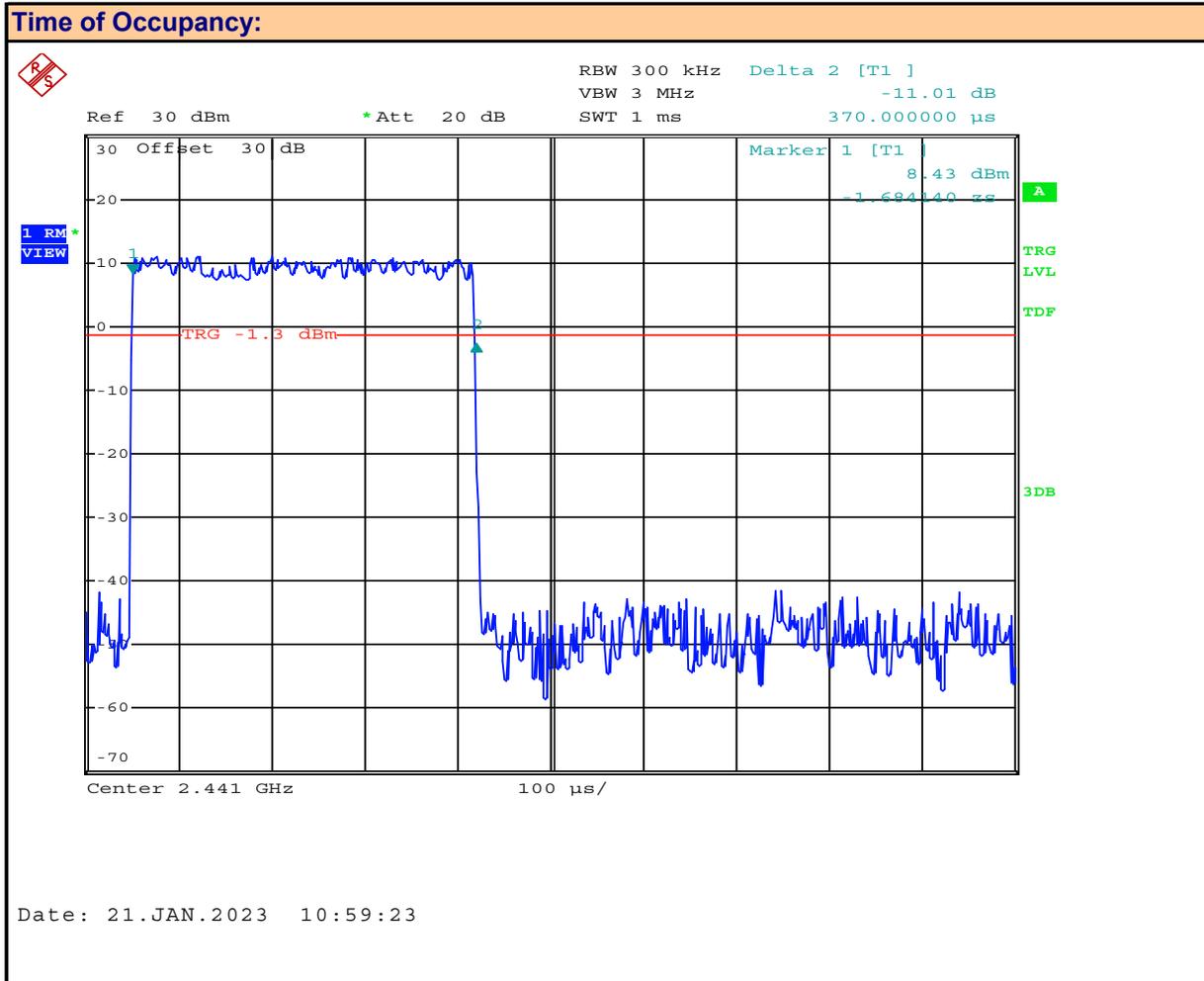
**Test Procedure**

<b>Normative</b>	<b>FCC 47 CFR §15.247, RSS-247</b>
<b>Reference</b>	<b>KDB 558074, ANSI C63.10</b>

**Limits**

47 CFR §15.247(a)(1)	(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
RSS-247 (5.1)(d)	<b>5.1 Frequency hopping systems (FHS)</b> FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

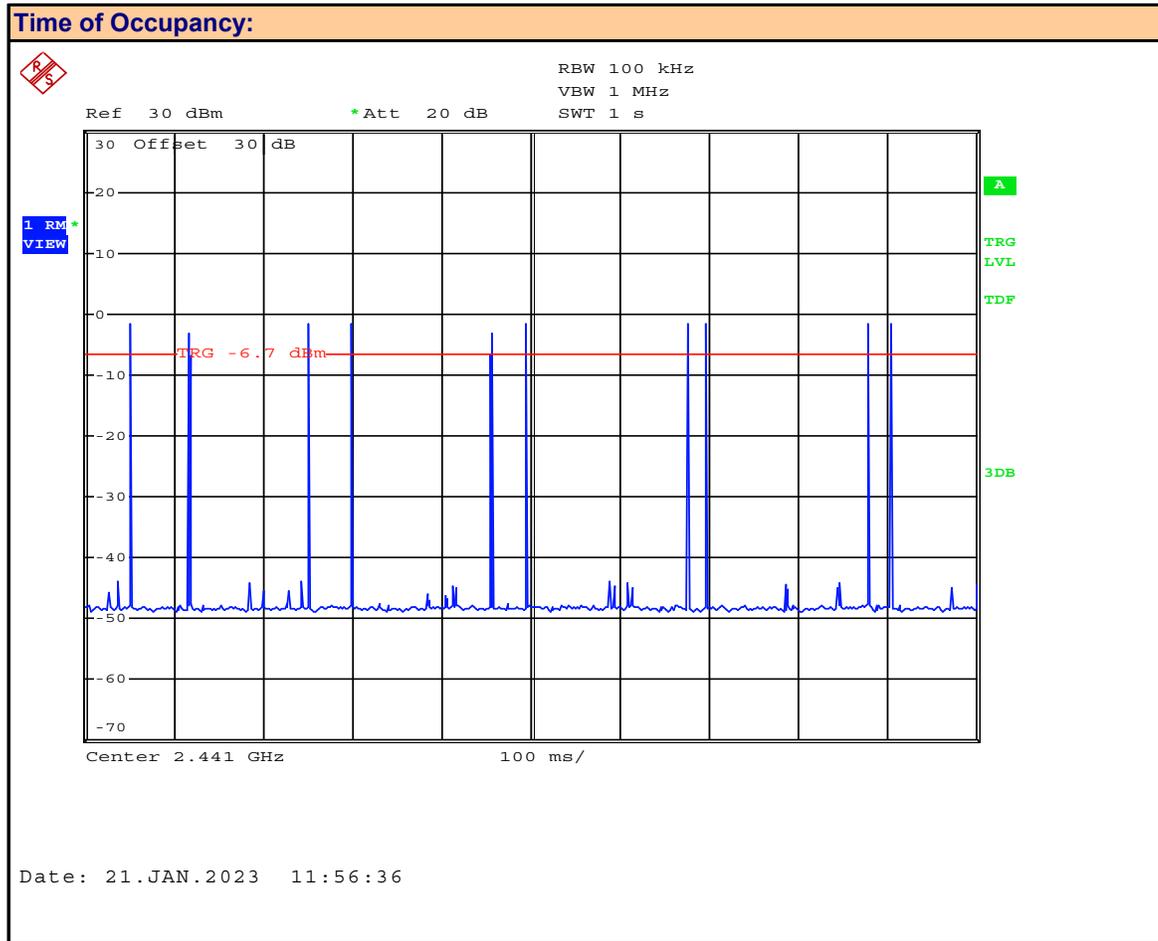
**Plot 14.1 – Time of Occupancy, DH1, 2-DH1, 3-DH1, DM1**



Packet: **DH1, DM1, 2-DH1, 3-DH1**

Measured On-Time: **370** uSec

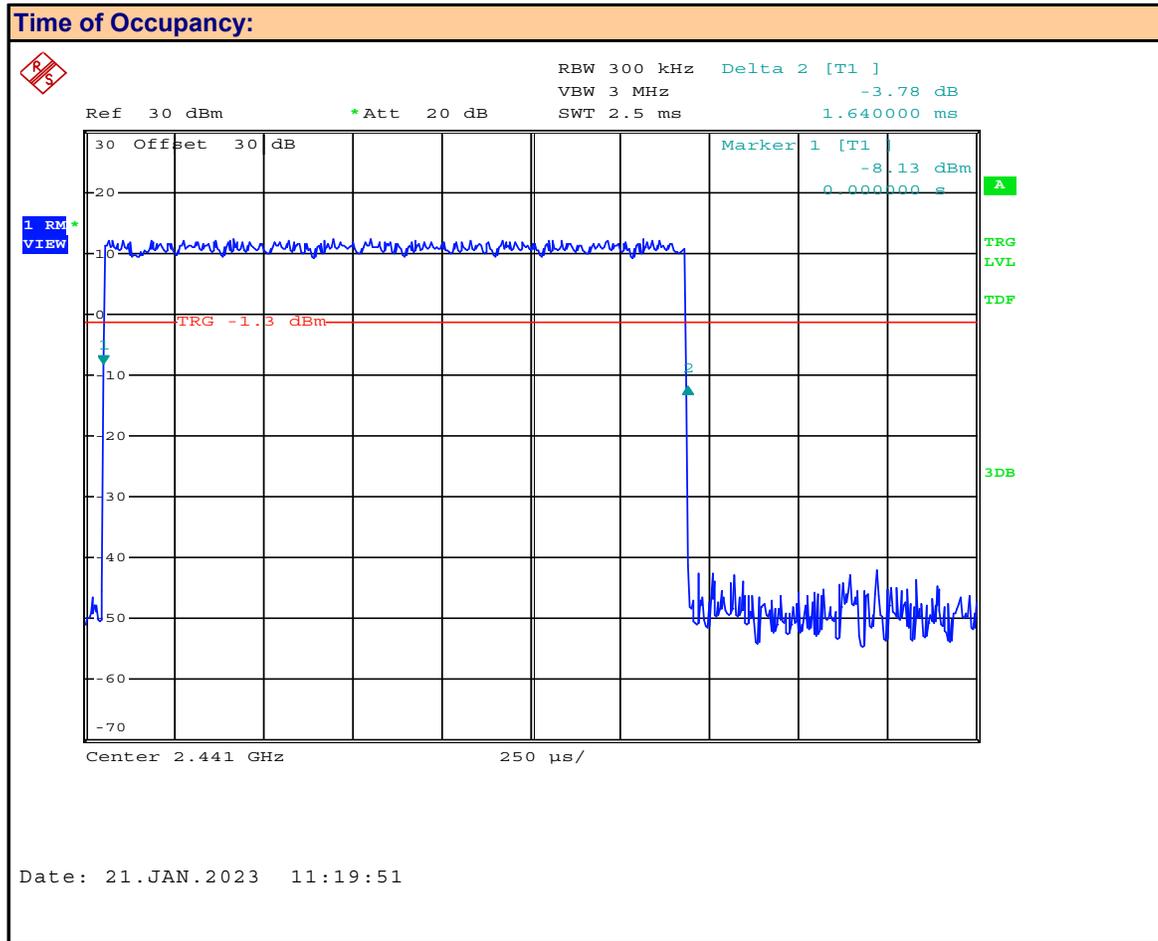
**Plot 14.2 – Time of Occupancy, DH1, 2-DH1, 3-DH1, DM1**



Packet: **DH1, DM1, 2-DH1, 3-DH1**

Transmit Count **10** /1000mSec

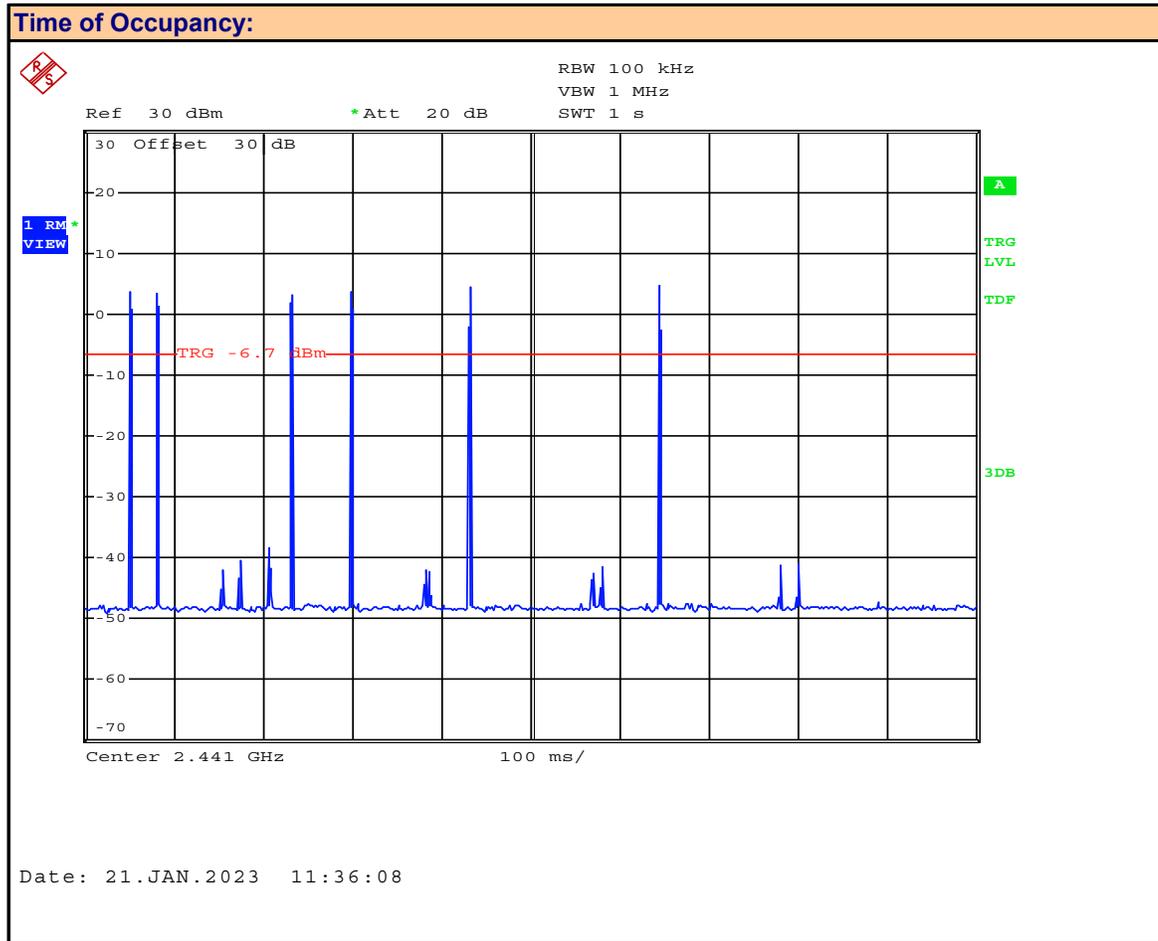
**Plot 14.3 – Time of Occupancy, DH3, 2-DH3, 3-DH3, DM3**



Packet: **DH3, DM3, 2-DH3, 3-DH3**

Measured On-Time: **1.64** mSec

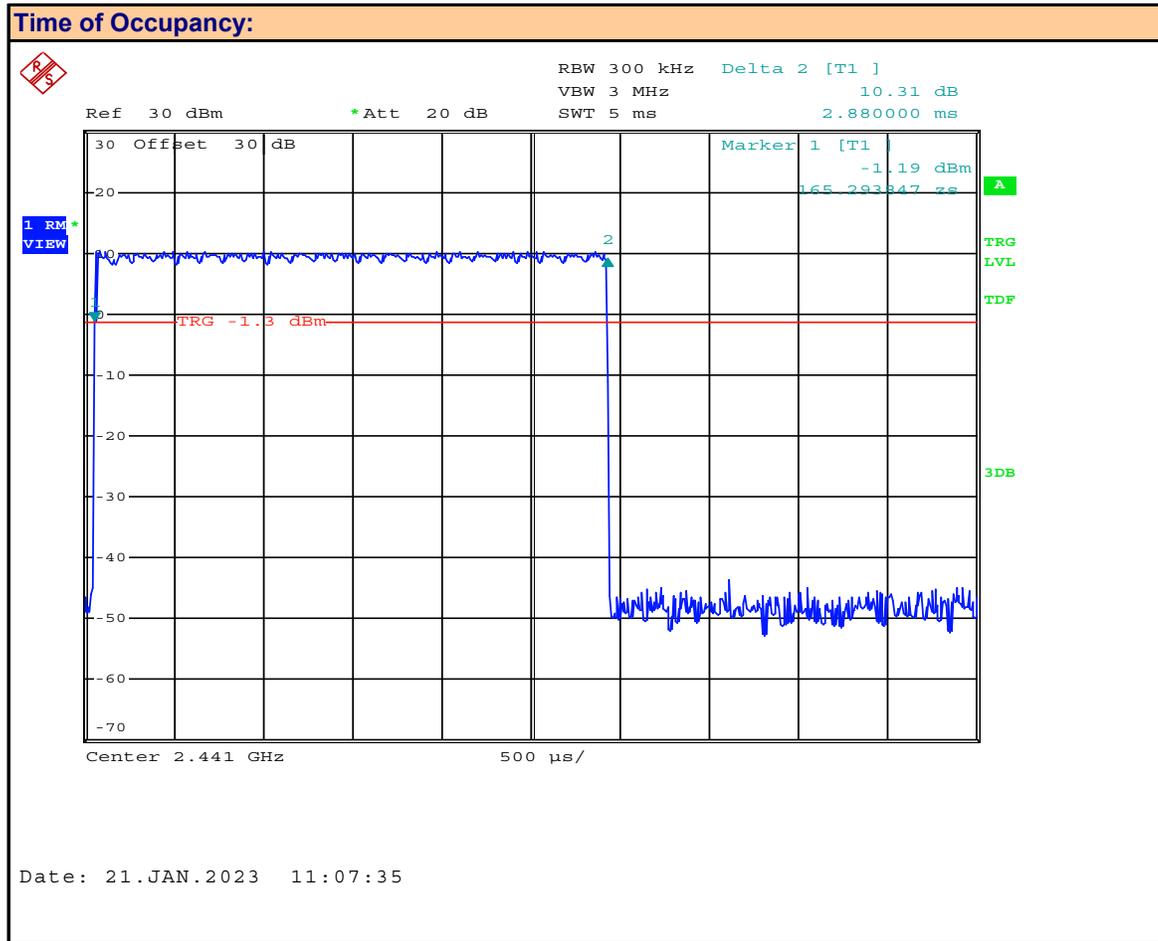
**Plot 14.4 – Time of Occupancy, DH3, 2-DH3, 3-DH3, DM3**



Packet: **DH3, DM3, 2-DH3, 3-DH3**

Transmit Count **6** /1000mSec

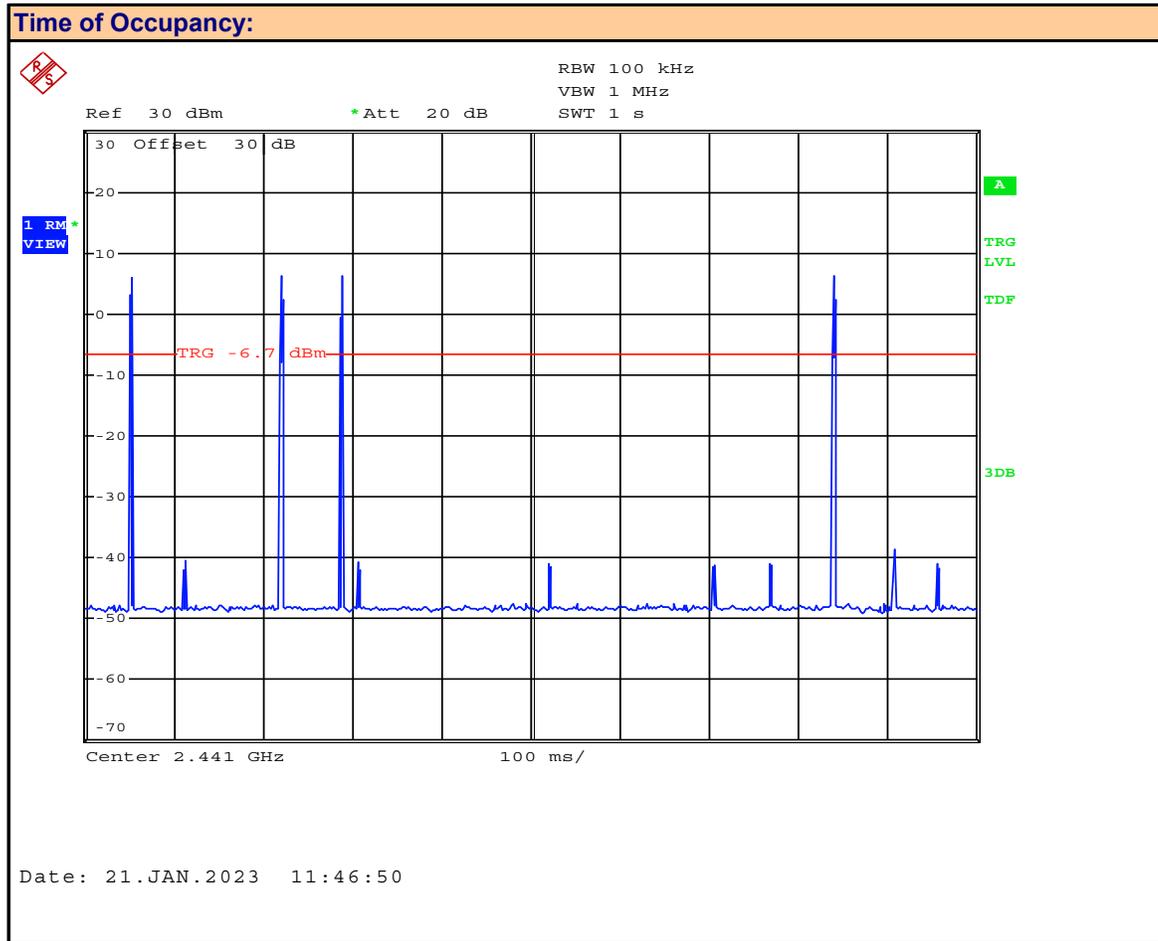
**Plot 14.5 – Time of Occupancy, DH5, 2-DH5, 3-DH5, DM5**



Packet: **DH5, DM5, 2-DH5, 3-DH5**

Measured On-Time: **2.88** mSec

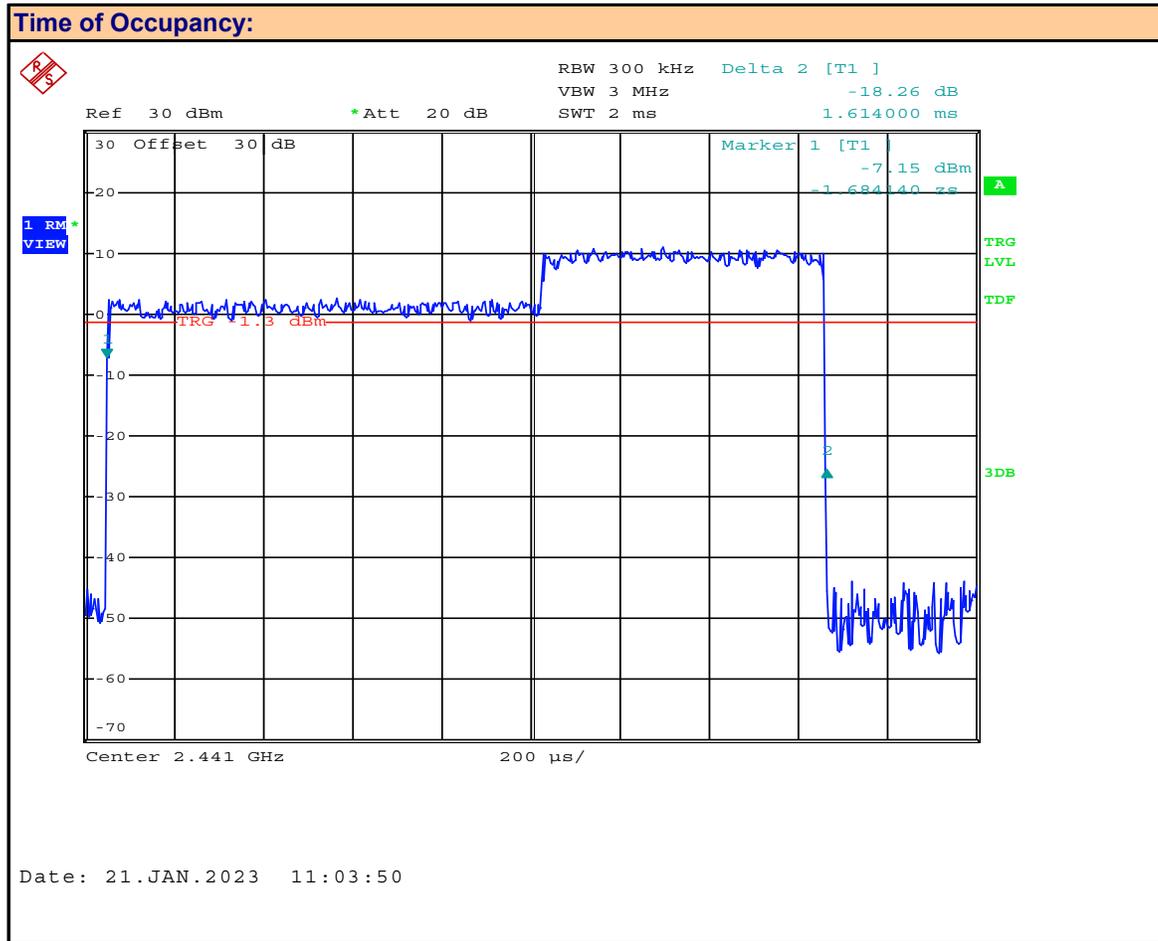
**Plot 14.6 – Time of Occupancy, DH5, 2-DH5, 3-DH5, DM5**



Packet: **DH5, DM5, 2-DH5, 3-DH5**

Transmit Count **4** /100mSec

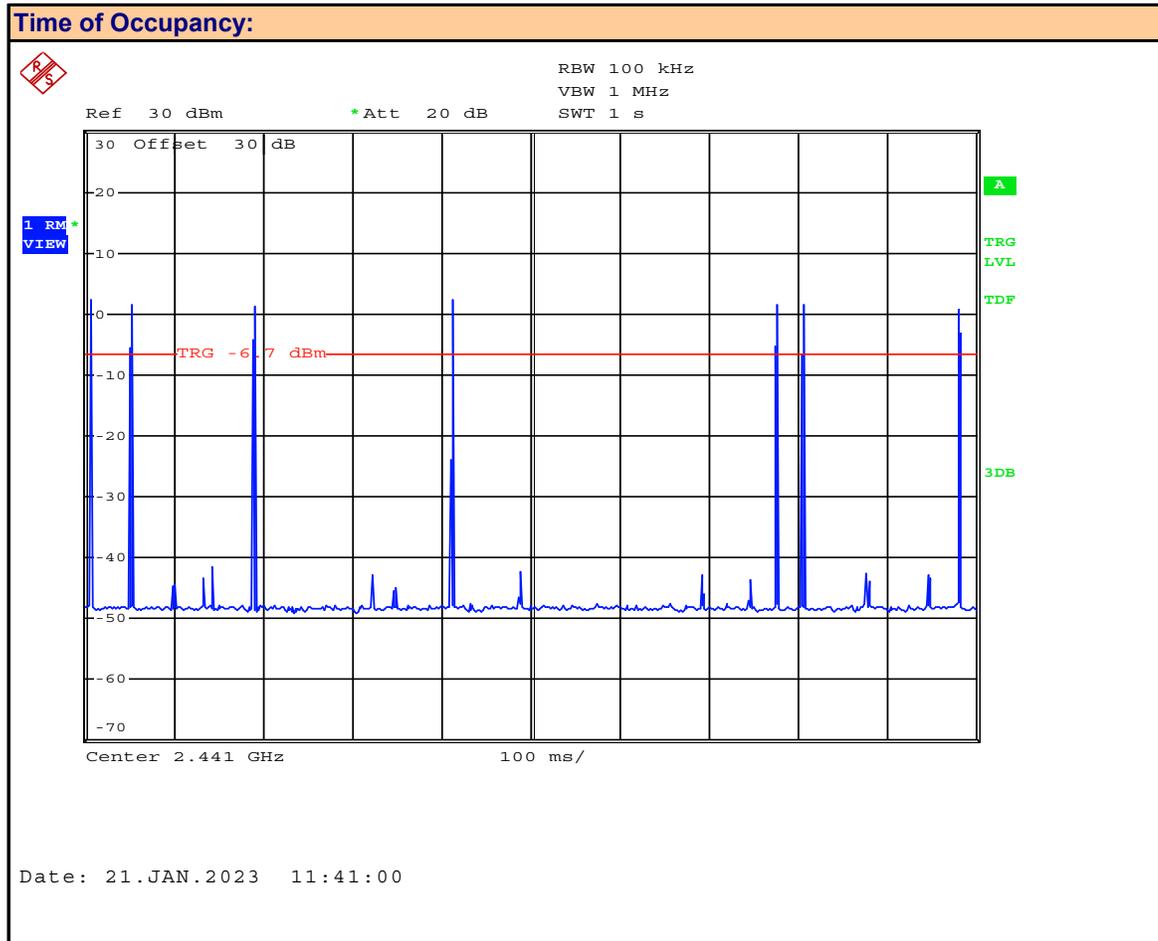
Plot 14.7 – Time of Occupancy, EV4



Packet: **EV4**

Measured On-Time: **1.614** mSec

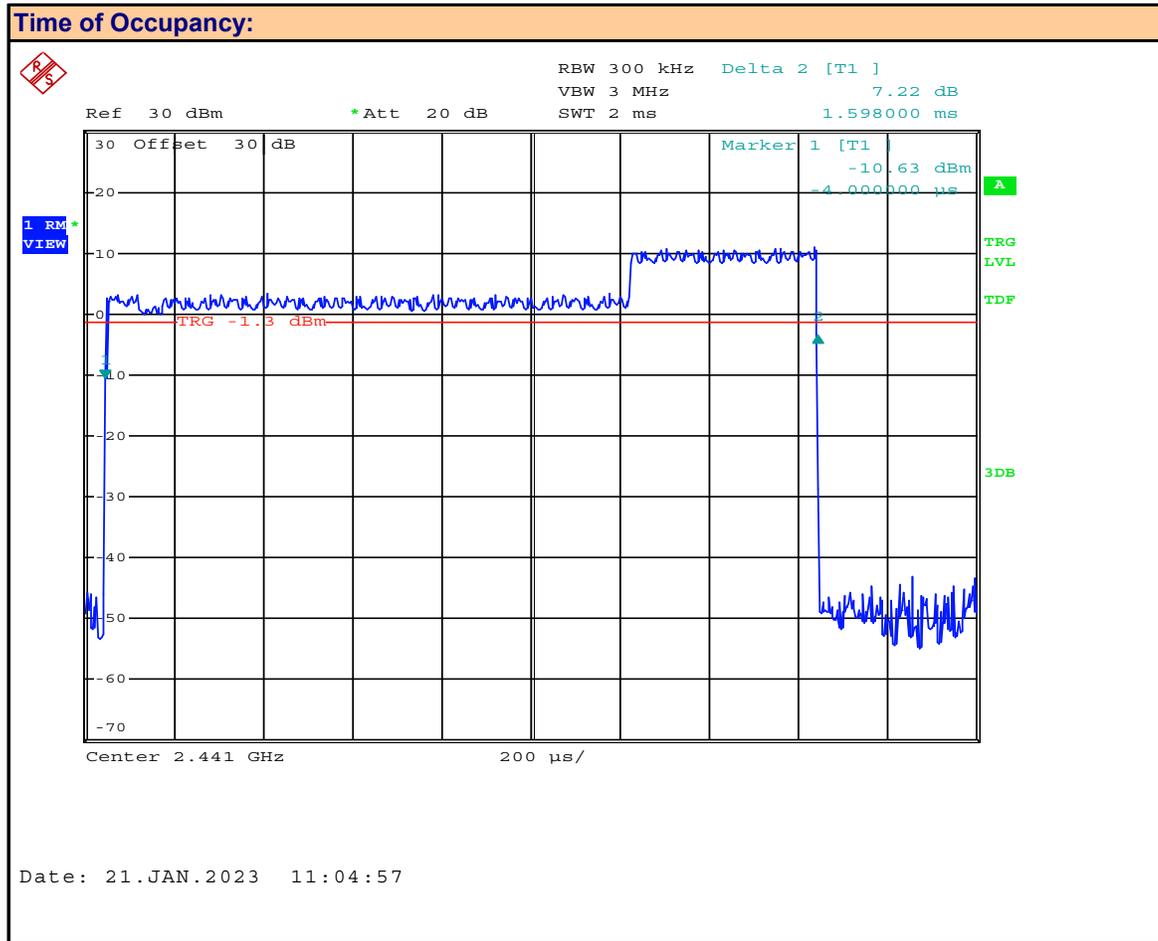
**Plot 14.8 – Time of Occupancy, EV4**



Packet: **EV4**

Transmit Count **7** /100mSec

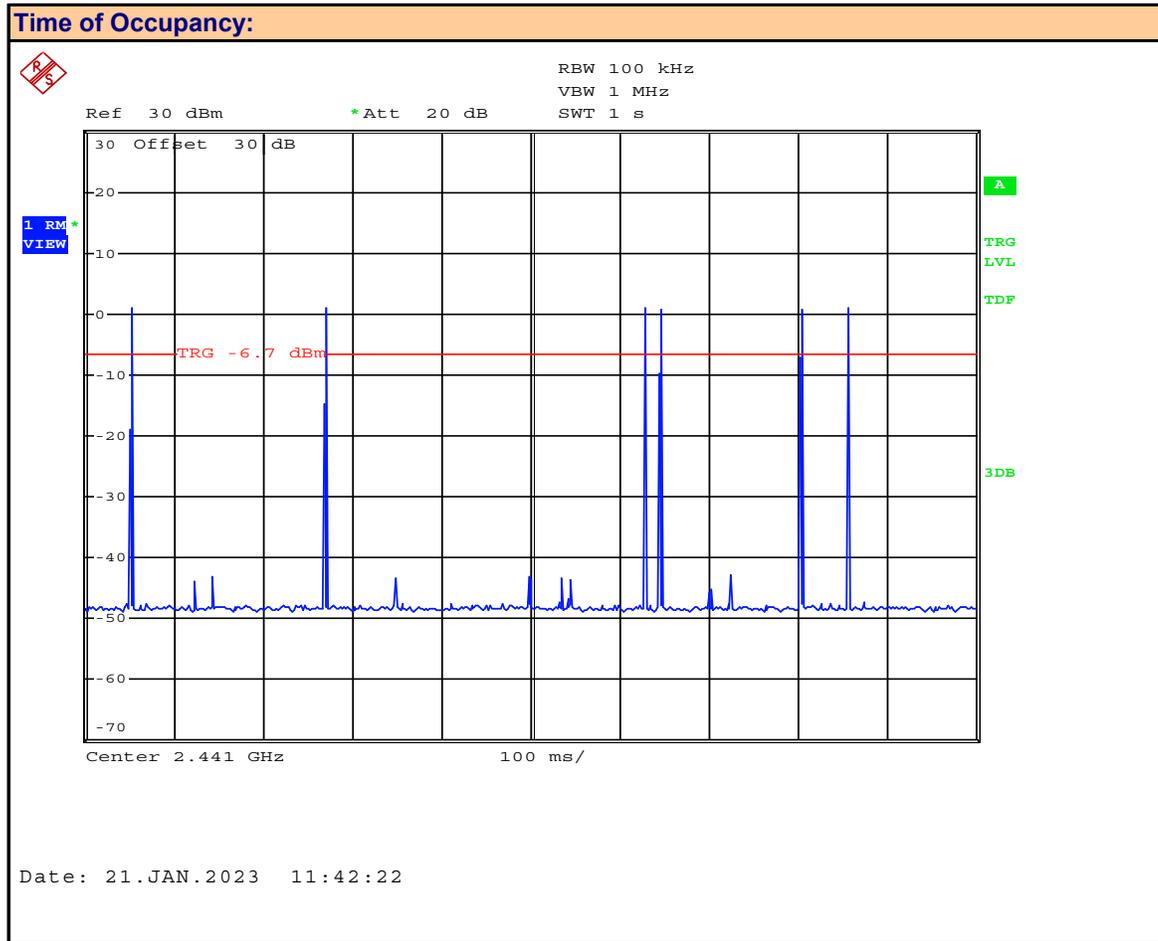
**Plot 14.9 – Time of Occupancy, EV5**



Packet: **EV5**

Measured On-Time: **1.598** mSec

**Plot 14.10 – Time of Occupancy, EV5**



Packet: **EV5**

Transmit Count **6** /1000mSec

Table 14.1 – Summary of FHSS Time of Occupancy

Accumulated Time of Occupancy										
Channel Frequency (MHz)	Packet	Channel On Time [t <sub>on</sub> ] (mSec)	Number of Transmits per Period [N <sub>Tx</sub> ]	Time of Period Occupancy [T <sub>Occ</sub> ] (mSec)	Observation Period [T <sub>P</sub> ] (mSec)	Number of Hopping Channels [N <sub>Hop</sub> ]	Required Observation Period [T <sub>Rqd</sub> ] (mSec)	Accumulated Time of Occupancy [T <sub>Acc</sub> ] (mSec)	Limit [Limit] (mSec)	Margin (mSec)
2441	DH1	0.370	10	3.700	1000	79	31600	116.92	400	283
	DH3	1.640	6	9.840				310.94		89
	DH5	2.880	4	11.520				364.03		36
	EV4	1.614	7	11.298				357.02		43
	DH5	1.598	6	9.588				302.98		97
<b>Result:</b>									<b>Complies</b>	

Time of Period Occupancy [T<sub>POcc</sub>] = Channel On Time [t<sub>on</sub>] x Number of Transmits per Period [N<sub>Tx</sub>]

Required Observation Period [T<sub>Rqd</sub>] = Number of Hopping Channels [N<sub>Hop</sub>] x 0.4Sec (400mSec)

Accumulated Time of Occupancy [T<sub>Acc</sub>] = Time of Period Occupancy [T<sub>Occ</sub>] x Required Observation Period [T<sub>Rqd</sub>] / Observation Period [T<sub>P</sub>]

Margin = Limit - [T<sub>Acc</sub>]

**15.0 CONDUCTED SPURIOUS EMISSIONS -BAND EDGE**

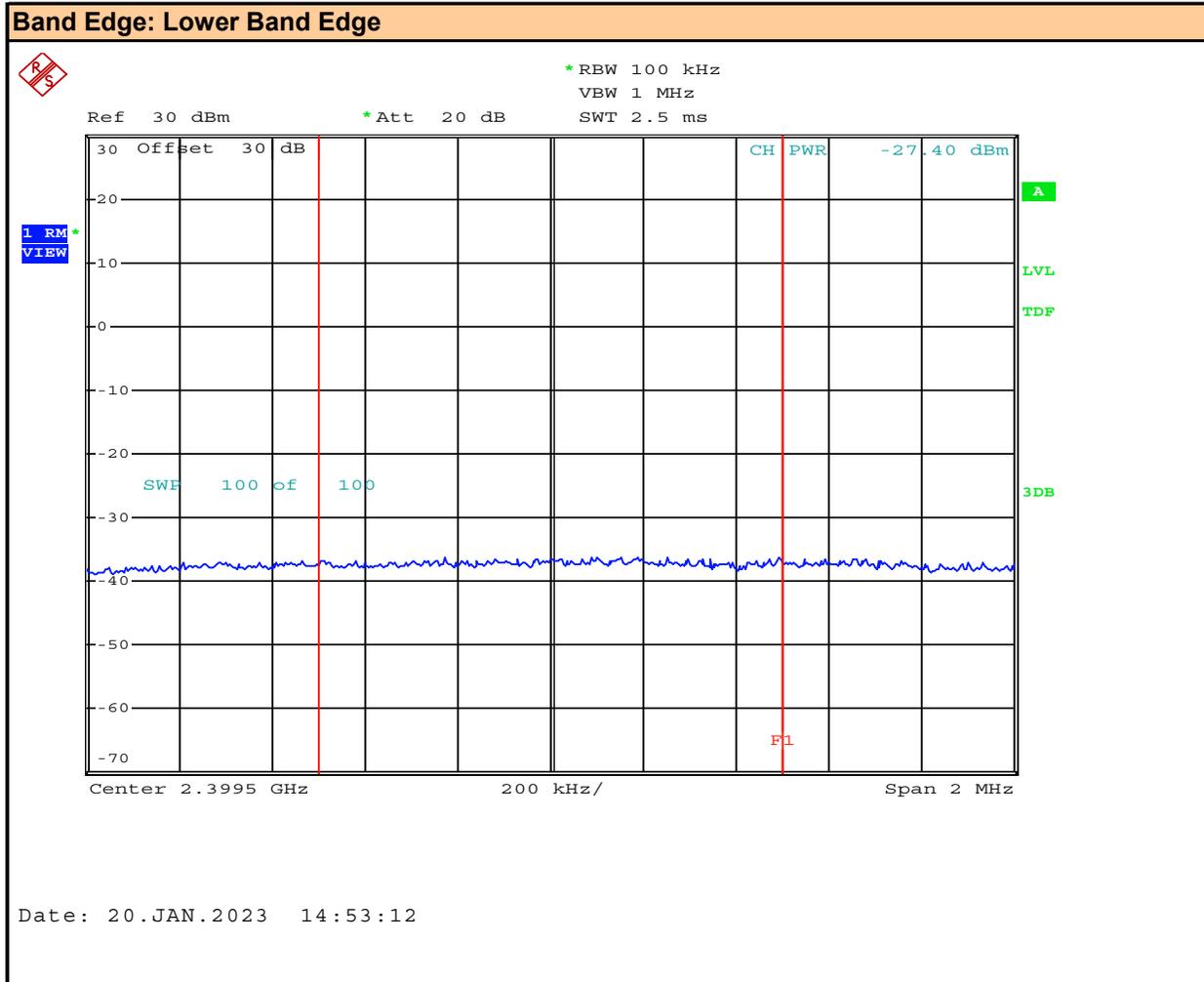
**Test Procedure**

<b>Normative Reference</b>	FCC 47 CFR §2.1051, §15.247(d), RSS-Gen (6.13), RSS-247 (5.5),
	KDB 558074 (11.3), ANSI C63.10 (11.11.3)

**Limits**

47 CFR §15.247(d)	(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.
KDB 558074 (11.3) C63.10 (11.11.3)	<p><b>11.1 General</b></p> <p>The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:</p> <p>b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc).</p> <p><b>11.2 Reference level measurement</b></p> <p>a) Set instrument center frequency to DTS channel center frequency.</p> <p>b) Set the span to <math>\geq 1.5 \times DTS \text{ bandwidth}</math>.</p> <p>c) Set the RBW = 100 kHz.</p> <p>d) Set the VBW <math>\geq 3 \times RBW</math>.</p> <p>e) Detector = peak.</p> <p>f) Sweep time = auto couple.</p> <p>g) Trace mode = max hold.</p> <p>h) Allow trace to fully stabilize.</p> <p>i) Use the peak marker function to determine the maximum PSD level.</p> <p>Note that the channel found to contain the maximum PSD level can be used to establish the reference</p>

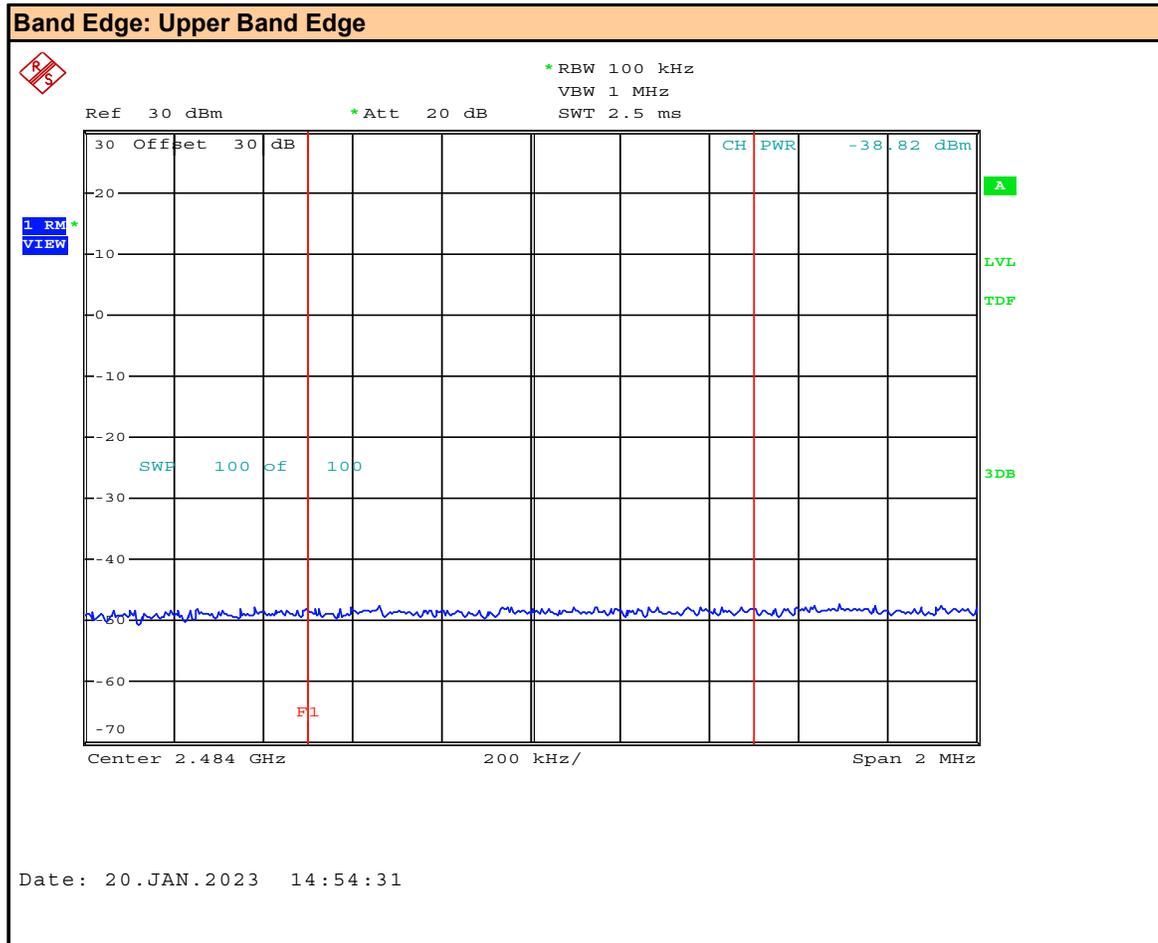
**Plot 15.1 – Band Edge, 802.11b**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

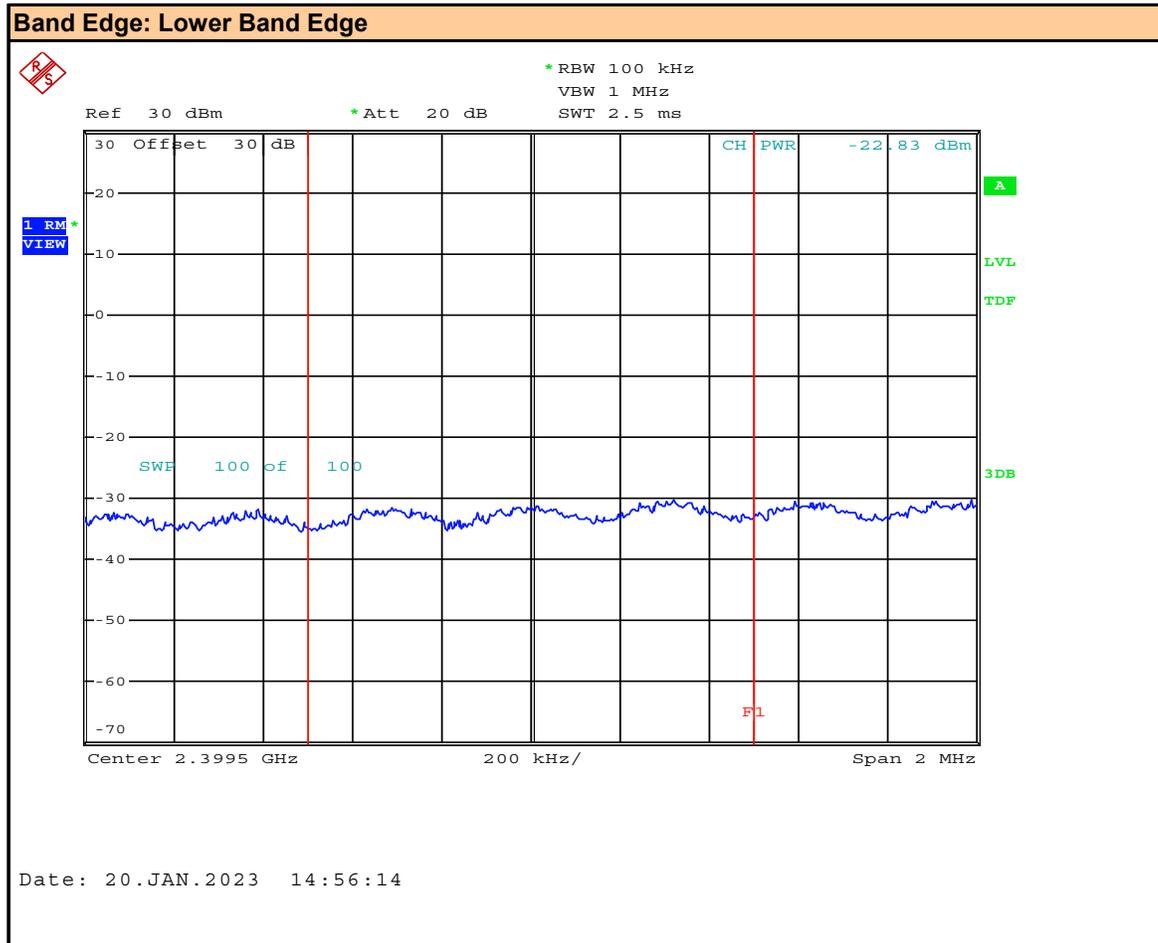
**Plot 15.2 – Band Edge, 802.11b**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

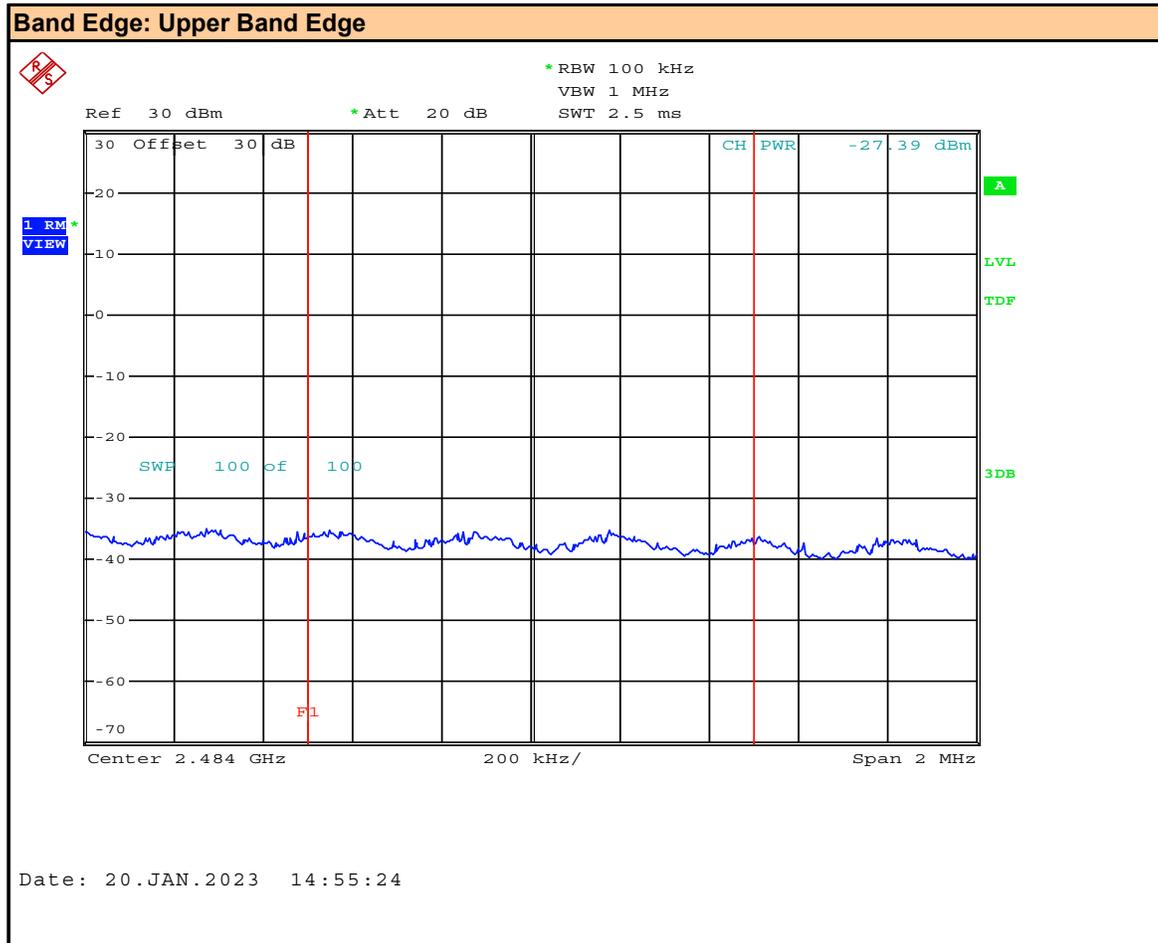
**Plot 15.3 – Band Edge, 802.11g**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

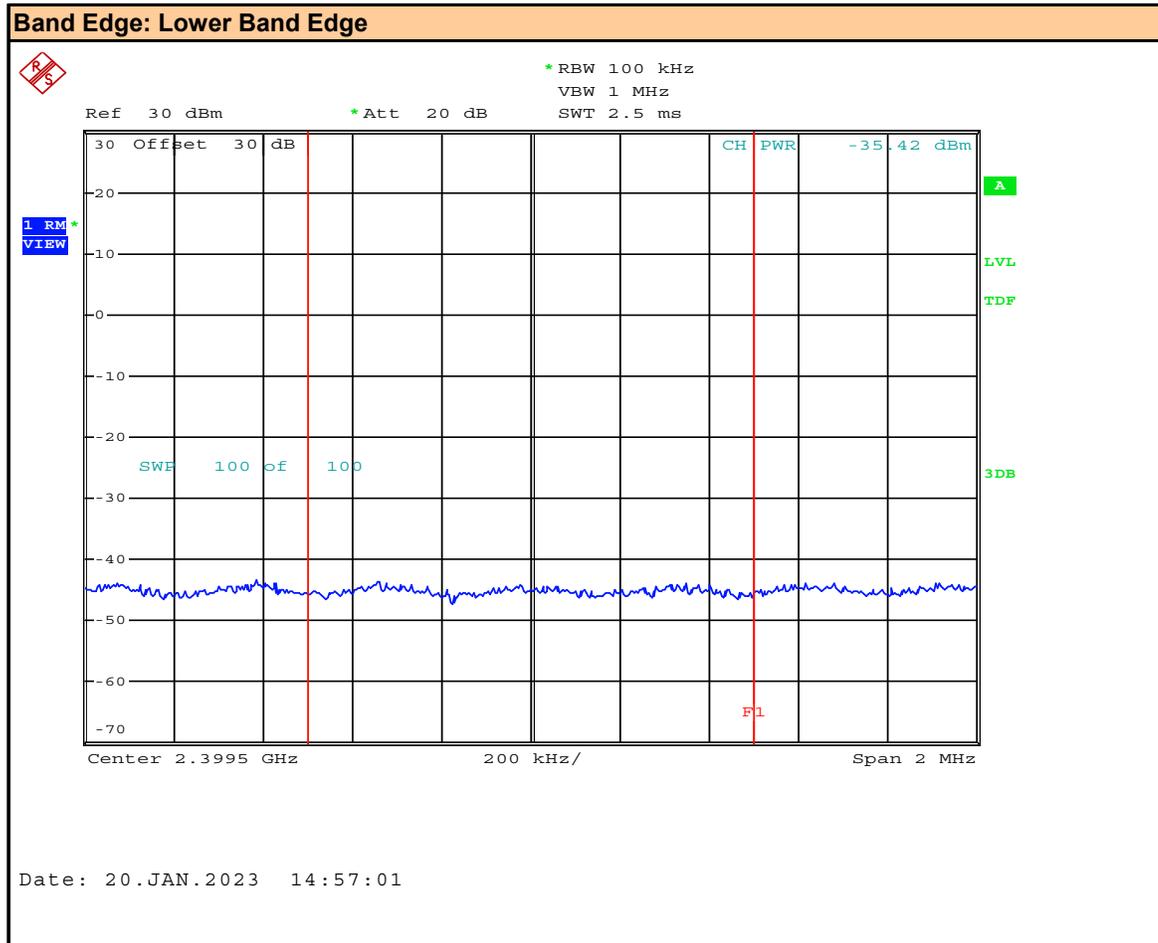
Plot 15.4 – Band Edge, 802.11g



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

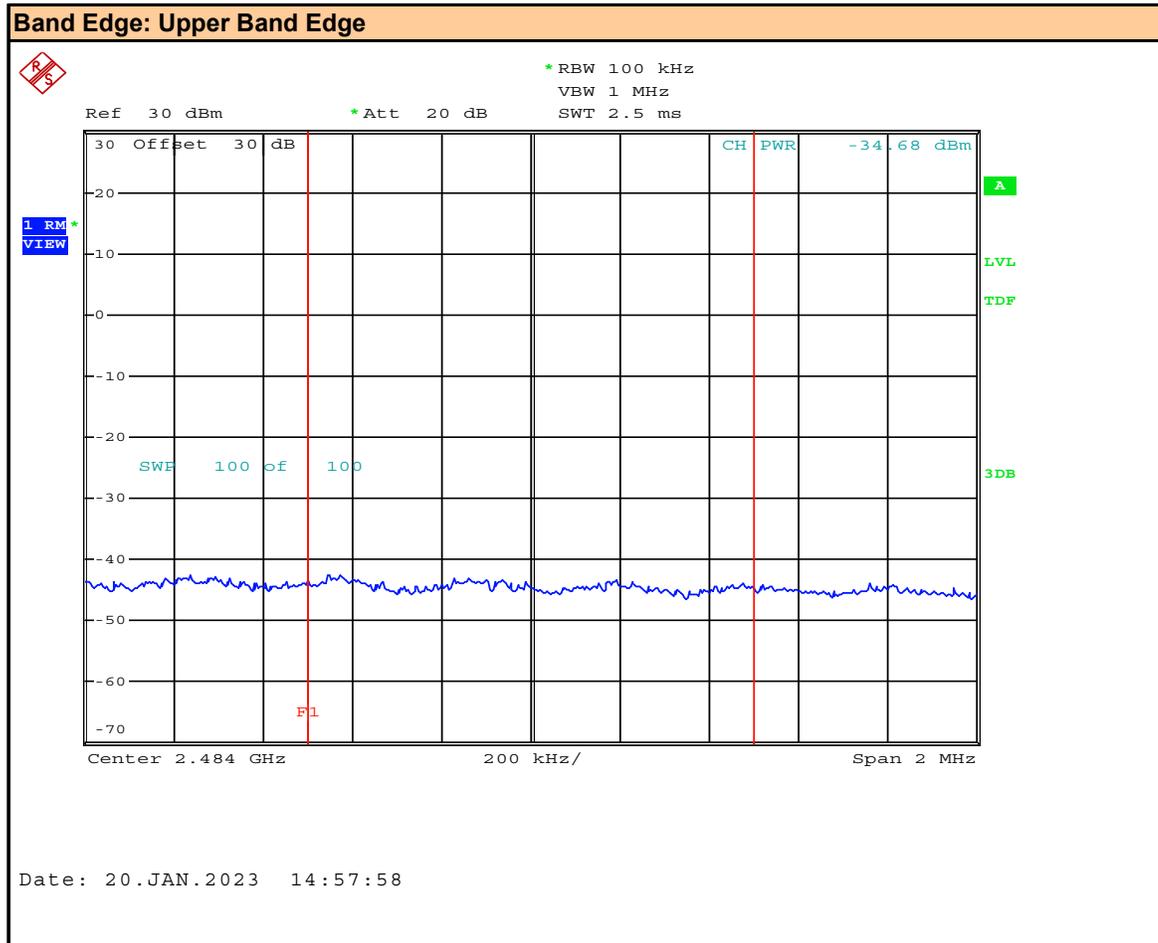
**Plot 15.5 – Band Edge, 802.11n**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

Plot 15.6 – Band Edge, 802.11n



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

Table 15.1 – Summary of Spurious Emission Measurements – Band Edge, (DTS)

Band Edge Measurement Results: 802.11													
Mode	Channel Number	Frequency (MHz)	Modulation	Emission Power [P <sub>Em</sub> ] (dBm)	Antenna Gain [G <sub>T</sub> ] (dBi)	Emission EIRP [E <sub>Em</sub> ] (dBm)	Fundamental Power [P <sub>Fund</sub> ] (dBm)	Fundamental EIRP [E <sub>Fund</sub> ] (dBm)	Attenuation [Atten] (dB)	Limit (dB)	Margin (dB)		
802.11b	1	2402.00	DSSS 5.5	-27.40	-5.9	-33.30	18.32	12.42	45.72	30	15.7		
	11	2462.00		-38.38		-44.28	18.32	12.42	56.70		26.7		
802.11g	1	2402.00	OFDM12	-22.83		-28.73	17.40	11.50	40.23		10.2		
	11	2462.00		-27.39		-33.29	17.40	11.50	44.79		14.8		
802.11n	1	2402.00	MCS0	-35.42		-41.32	15.75	9.85	51.17		21.2		
	11	2462.00		-34.68		-40.58	15.75	9.85	50.43		20.4		
									<b>Result:</b>		<b>Complies</b>		

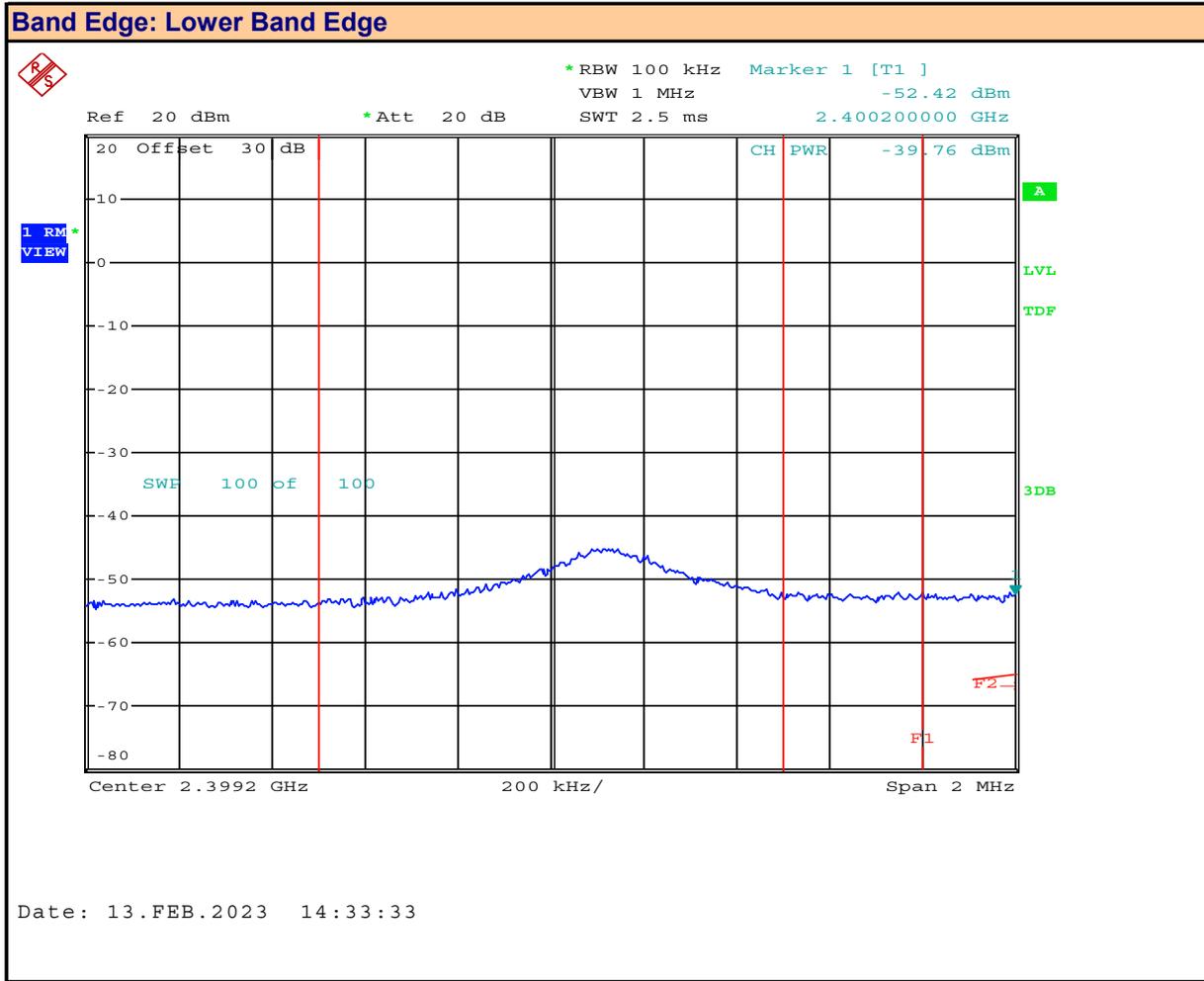
Emission [E<sub>Em</sub>] = [P<sub>Em</sub>] + [G<sub>T</sub>]

Fundamental EIRP [E<sub>Fund</sub>] = [P<sub>Fund</sub>] + [G<sub>T</sub>]

Attenuation [Atten] = [E<sub>Fund</sub>] - [E<sub>Em</sub>]

Margin = Attenuation - Limit

Plot 15.7 – Band Edge, BT BR



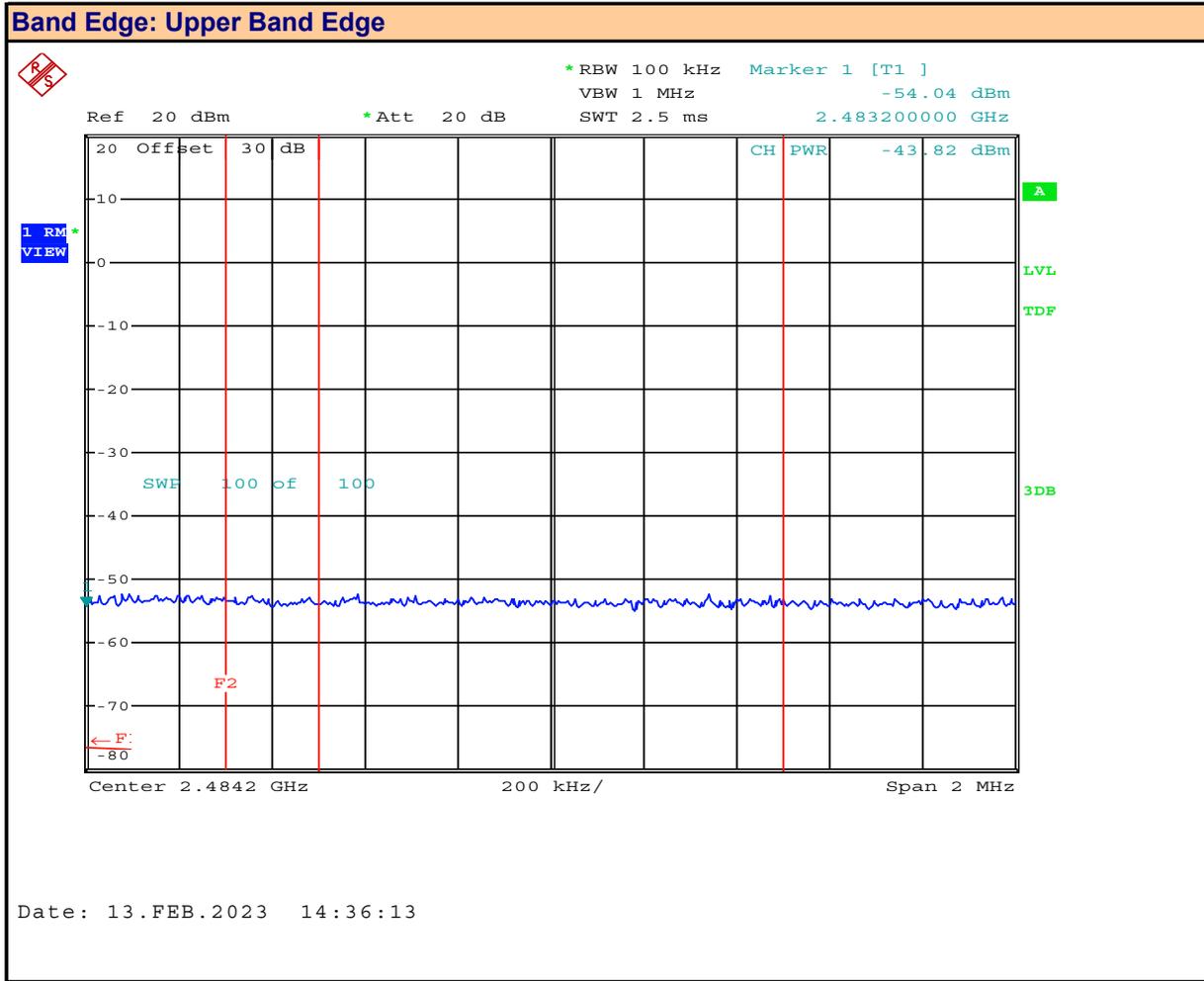
Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm





Plot 15.10 – Band Edge, BT 2EDR



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

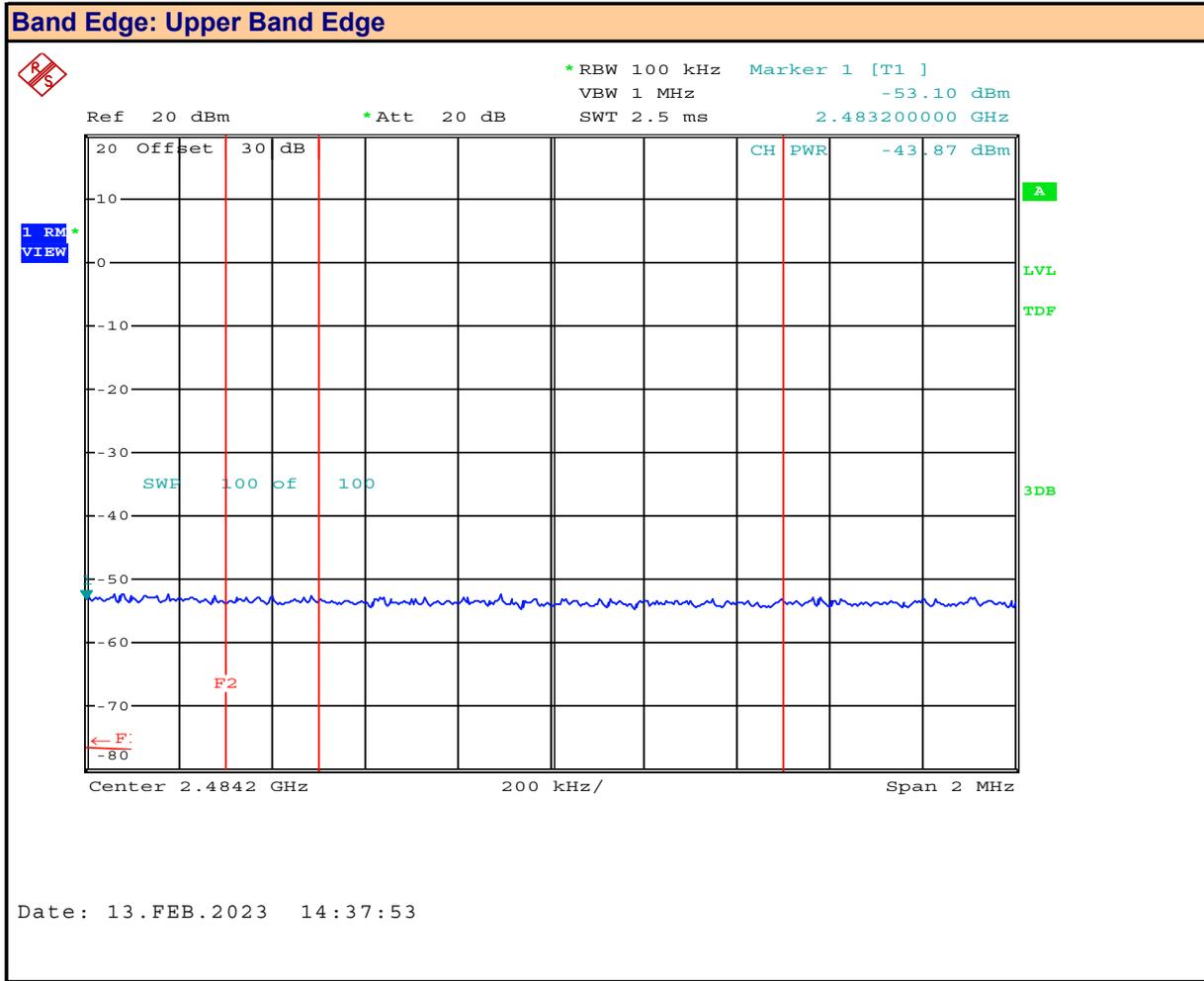
Plot 15.11 – Band Edge, BT 3EDR



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

Plot 15.12 – Band Edge, BT 3EDR



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Emission Power:  dBm

Table 15.2 – Summary of Spurious Emission Measurements – Band Edge, DSS

Band Edge Measurement Results: 802.11											
Mode	Channel Number	Frequency (MHz)	Modulation	Emission Power [P <sub>Em</sub> ] (dBm)	Antenna Gain [G <sub>T</sub> ] (dBi)	Emission EIRP [E <sub>Em</sub> ] (dBm)	Fundamental Power [P <sub>Fund</sub> ] (dBm)	Fundamental EIRP [E <sub>Fund</sub> ] (dBm)	Attenuation [Atten] (dB)	Limit (dB)	Margin (dB)
BT BR	0	2402.00	GFSK	-39.76	-5.9	-45.66	11.04	5.14	50.80	30	20.8
	78	2480.00		-34.77		-40.67	11.13	5.23	45.90		15.9
BT 2EDR	0	2402.00	Pi/4-DQPSK	-37.56		-43.46	10.11	4.21	47.67		17.7
	78	2480.00		-43.82		-49.72	10.23	4.33	54.05		24.1
BT 3EDR	0	2402.00	8-DPSK	-37.73		-43.63	10.11	4.21	47.84		17.8
	78	2480.00		-43.87		-49.77	10.12	4.22	53.99		24.0
<b>Result:</b>										<b>Complies</b>	

Emission [E<sub>Em</sub>] = [P<sub>Em</sub>] + [G<sub>T</sub>]

Fundamental EIRP [E<sub>Fund</sub>] = [P<sub>Fund</sub>] + [G<sub>T</sub>]

Attenuation [Atten] = [E<sub>Fund</sub>] - [E<sub>Em</sub>]

Margin = Attenuation - Limit

**16.0 CONDUCTED SPURIOUS EMISSIONS**

<b>Test Procedure</b>	
<b>Normative Reference</b>	FCC 47 CFR §2.1051, §15.247(d), RSS-Gen (6.13), RSS-247 (5.5), KDB 558074 (11.3), ANSI C63.10 (11.11.3)
<b>Limits</b>	
47 CFR §15.247(d)	(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.
KDB 558074 (11.3) C63.10 (11.11.3)	<p><b>11.1 General</b></p> <p>The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:</p> <p>b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc).</p> <p><b>11.2 Reference level measurement</b></p> <p>a) Set instrument center frequency to DTS channel center frequency.</p> <p>b) Set the span to <math>\geq 1.5 \times DTS \text{ bandwidth}</math>.</p> <p>c) Set the RBW = 100 kHz.</p> <p>d) Set the VBW <math>\geq 3 \times RBW</math>.</p> <p>e) Detector = peak.</p> <p>f) Sweep time = auto couple.</p> <p>g) Trace mode = max hold.</p> <p>h) Allow trace to fully stabilize.</p> <p>i) Use the peak marker function to determine the maximum PSD level.</p> <p>Note that the channel found to contain the maximum PSD level can be used to establish the reference</p>

**Table 16.1 – Summary of Conducted Spurious Emissions, (DTS)**

See Appendix E for Measurement Plots

<b>Conducted Spurious Emissions Measurement Results:</b>									
Mode	Channel Number	Frequency (MHz)	Modulation	Emission Power [P <sub>Em</sub> ] (dBm)	Emission Frequency (MHz)	Reference Measurement [P <sub>Fund</sub> ] (dBm)	Attenuation [Atten] (dB)	Limit (dB)	Margin (dB)
802.11b	6	2437.00	DSSS 5.5	-31.90	95.96	12.39	44.29	30	14.3
				-31.41	207		43.80		13.8
				-31.97	466		44.36		14.4
				-31.48	779		43.87		13.9
				-31.56	882		43.95		14.0
				16.42	Fundamental		-		-
				ND	-		-		-
				ND	-		-		-
				ND	-		-		-
				ND	-		-		-
12.39	Reference	-	-						
<b>Result:</b>								<b>Complies</b>	

Attenuation [Atten] = [P<sub>Fund</sub>] - [P<sub>Em</sub>]  
 Margin = Attenuation - Limit  
 ND = None Detected

**Table 16.2 – Summary of Conducted Spurious Emissions, (DSS)**

See Appendix E for Measurement Plots

<b>Conducted Spurious Emissions Measurement Results:</b>									
Mode	Channel Number	Frequency (MHz)	Modulation	Emission Power [P <sub>Em</sub> ] (dBm)	Emission Frequency (MHz)	Reference Measurement [P <sub>Fund</sub> ] (dBm)	Attenuation [Atten] (dB)	Limit (dB)	Margin (dB)
BT BR	78	2480.00	GFSK	-31.95	189.12	9.93	41.88	30	11.9
				-31.89	394		41.82		11.8
				-31.99	467.2		41.92		11.9
				-31.63	754.4		41.56		11.6
				-31.90	996.8		41.83		11.8
<b>Result:</b>								<b>Complies</b>	

Attenuation [Atten] = [P<sub>Fund</sub>] - [P<sub>Em</sub>]  
 Margin = Attenuation - Limit  
 ND = None Detected

**17.0 RADIATED TX SPURIOUS EMISSIONS, RESTRICTED BAND**

**Test Procedure**

<b>Normative Reference</b>	<b>FCC 47 CFR §2.1051, §15.247(d), §15.205(a), §15.205(c), §15.209(a)</b>
	<b>KDB 558074 (8.6), ANSI C63.10 (11.12)</b>

**Limits**

47 CFR §15.247(d)	(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)).																
47 CFR §15.209(a)	<p><b>§15.209 Radiated emission limits; general requirements.</b></p> <p>(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:</p> <table border="1"> <thead> <tr> <th>Frequency (MHz)</th> <th>Field Strength (microvolts/meter)</th> </tr> </thead> <tbody> <tr> <td>0.009 - 0.490</td> <td>2400/F (kHz) @300m</td> </tr> <tr> <td>0.490 - 1.705</td> <td>24000/F (kHz) @30m</td> </tr> <tr> <td>1.705 - 30</td> <td>30 @ 30m</td> </tr> <tr> <td>30 - 88</td> <td>100 @3m</td> </tr> <tr> <td>88 - 216</td> <td>150 @3m</td> </tr> <tr> <td>216 - 960</td> <td>200 @3m</td> </tr> <tr> <td>Above 960</td> <td>500 @3m</td> </tr> </tbody> </table>	Frequency (MHz)	Field Strength (microvolts/meter)	0.009 - 0.490	2400/F (kHz) @300m	0.490 - 1.705	24000/F (kHz) @30m	1.705 - 30	30 @ 30m	30 - 88	100 @3m	88 - 216	150 @3m	216 - 960	200 @3m	Above 960	500 @3m
Frequency (MHz)	Field Strength (microvolts/meter)																
0.009 - 0.490	2400/F (kHz) @300m																
0.490 - 1.705	24000/F (kHz) @30m																
1.705 - 30	30 @ 30m																
30 - 88	100 @3m																
88 - 216	150 @3m																
216 - 960	200 @3m																
Above 960	500 @3m																

Table 17.1 – Summary of Radiated Tx Spurious Emissions, Restricted Band, (DTS)

Summary of Radiated Tx (Restricted Band) Measurements											
Mode	Modulation	Channel	Frequency (MHz)	Polarity	Emission Frequency (MHz)	Avg Power (dBuV/m)	Limit		Peak Power (dBuV/m)	Limit	
							Avg (dBuV/m)	Margin (dB)		Peak (dBuV/m)	Margin (dB)
802.11b	DSSS 5.5	1	2412	H	2390	50.01	54.00	3.99	59.69	74.00	14.31
				V		51.51	54.00	2.49	60.76	74.00	13.24
		11	2462	H	2483.5	50.31	54.00	3.69	60.25	74.00	13.75
				V		50.7	54.00	3.30	60.8	74.00	13.20
802.11g	OFDM12	1	2412	H	2390	50.19	54.00	3.81	59.96	74.00	14.04
				V		51.34	54.00	2.66	60.33	74.00	13.67
		10	2457	H	2483.5	50.95	54.00	3.05	60.21	74.00	13.79
				V		51.68	54.00	2.32	61.85	74.00	12.15
		11	2462	H		52.67	54.00	1.33	63.36	74.00	10.64
				V		52.93	54.00	1.07	64.48	74.00	9.52
802.11n	MCS0	1	2412	H	2390	52.22	54.00	1.78	65.46	74.00	8.54
				V		50.06	54.00	3.94	61.64	74.00	12.36
		11	2462	H	2483.5	50.49	54.00	3.51	60.77	74.00	13.23
				V		51.28	54.00	2.72	61.1	74.00	12.90

No Other Emissions within 20dB of the limit observed.

**Table 17.2 – Summary of Radiated Tx Spurious Emissions, (DTS)**

See Appendix F for Measurement Plots

Summary of Radiated Tx Emissions										
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency (MHz)	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)
30-1000MHz	2412.0	Horizontal	41.1	8.83	17.96	0.72	0.00 (3)	27.5 (2)	40.0	12.5
30-1000MHz	2412.0	Horizontal	54.6	8.20	11.39	0.79	0.00 (3)	20.4 (2)	40.0	19.6
30-1000MHz	2412.0	Horizontal	57.3	8.03	10.87	0.80	0.00 (3)	19.7 (2)	40.0	20.3
30-1000MHz	2412.0	Horizontal	923.0	9.08	29.70	2.97	0.00 (3)	41.8 (2)	46.0	4.3
30-1000MHz	2412.0	Vertical	904.8	9.46	29.30	2.93	0.00 (3)	41.7 (2)	46.0	4.3
30-1000MHz	2412.0	Vertical	909.7	9.13	29.50	2.94	0.00 (3)	41.6 (2)	46.0	4.4
1 - 3GHz	2412.0	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
1 - 3GHz	2412.0	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
3-13GHz	2412.0	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
3-13GHz	2412.0	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
13-18GHz	2412.0	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
13-18GHz	2412.0	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
18-26GHz	2412.0	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
18-26GHz	2412.0	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
<b>Results:</b>									<b>Complies</b>	

- (1) No Emissions Detected (ND) above ambient or within 20dB of the limit
  - (2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
  - (3) External Amplifier not used
- $$E_{Corr} = E_{Meas} + ACF + L_C - G_A$$

**Table 17.2 – Summary of Radiated Tx Spurious Emissions, (DSS)**

See Appendix F for Measurement Plots

<b>Summary of Radiated Tx Emissions</b>											
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)	
30-1000MHz	2440.0	Horizontal	31.89	7.53	22.91	0.68	0.00 (3)	31.1 (2)	40.0	<b>8.9</b>	
30-1000MHz	2440.0	Horizontal	55.92	6.92	11.12	0.79	0.00 (3)	18.8 (2)	40.0	<b>21.2</b>	
30-1000MHz	2440.0	Horizontal	113.97	7.47	16.20	1.04	0.00 (3)	24.7 (2)	43.5	<b>18.8</b>	
30-1000MHz	2440.0	Vertical	729.10	8.51	28.30	2.66	0.00 (3)	39.5 (2)	46.0	<b>6.6</b>	
30-1000MHz	2440.0	Vertical	909.00	8.39	29.50	2.94	0.00 (3)	40.8 (2)	46.0	<b>5.2</b>	
1 - 3GHz	2440.0	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	<b>n/a</b>	
1 - 3GHz	2440.0	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	<b>n/a</b>	
3-13GHz	2440.0	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	<b>n/a</b>	
3-13GHz	2440.0	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	<b>n/a</b>	
13-18GHz	2440.0	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	<b>n/a</b>	
13-18GHz	2440.0	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	<b>n/a</b>	
18-26GHz	2440.0	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	<b>n/a</b>	
18-26GHz	2440.0	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	<b>n/a</b>	
<b>Results:</b>									<b>Complies</b>		

- (1) No Emissions Detected (ND) above ambient or within 20dB of the limit
  - (2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
  - (3) External Amplifier not used
- $$E_{Corr} = E_{Meas} + ACF + L_C - G_A$$

**18.0 RADIATED RX SPURIOUS EMISSIONS**

**Test Procedure**

<b>Normative Reference</b>	<b>FCC 47 CFR §15.109, ICES-003(6.2)</b> <b>ANSI C63.4:2014</b>
----------------------------	--

**Limits**

47 CFR §15.109	(a) Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values: 30-88MHz: 40dBuV/m 88-216MHz: 43.5dBuV/m 216-960MHz: 46dBuV/m > 960MHz: 54dBuV/m
ICES-003(6.2.1)	6.2.1 - Radiated Emissions Limits Below 1 GHz Class B: ITE that does not meet the conditions for Class A operation shall comply with the Class B radiated limits set out in Table 5 determined at a distance of 3 metres. 30-88MHz: 40dBuV/m 88-216MHz: 43.5dBuV/m 216-960MHz: 46dBuV/m > 960MHz: 54dBuV/m

<b>Test Setup</b>	<b>Appendix A</b> <b>Figure A.2</b>
-------------------	-------------------------------------

**Measurement Procedure**

The DUT was set up as per ANSI C63.4:2014. Emissions were scanned between 30MHz and 1000MHz. The turntable was rotated 360 degrees and the antenna was elevated to 4m to optimize the measured emissions.

**Table 18.1 – Summary of Radiated Rx Spurious Emissions, (DTS)**

See Appendix G Measurement Plots

<b>Summary of Radiated Rx Emissions</b>											
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>C</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)	
30-1000MHz	-	Horizontal	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	46.0	n/a	
30-1000MHz	-	Vertical	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	43.5	n/a	
1 - 3GHz	-	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a	
1 - 3GHz	-	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a	
3-13GHz	-	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a	
3-13GHz	-	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a	
13-18GHz	-	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a	
13-18GHz	-	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a	
18-26GHz	-	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a	
18-26GHz	-	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a	
<b>Results:</b>									<b>Complies</b>		

- (1) No Emissions Detected (ND) above ambient or within 20dB of the limit
  - (2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
  - (3) External Amplifier not used
- $$E_{Corr} = E_{Meas} + ACF + L_C - G_A$$

**Table 18.2 – Summary of Radiated Rx Spurious Emissions, (DSS)**

See Appendix G Measurement Plots

<b>Summary of Radiated Rx Emissions</b>											
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>C</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)	
30-1000MHz	-	Horizontal	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	46.0	n/a	
30-1000MHz	-	Vertical	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	43.5	n/a	
1 - 3GHz	-	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a	
1 - 3GHz	-	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a	
3-13GHz	-	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a	
3-13GHz	-	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a	
13-18GHz	-	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a	
13-18GHz	-	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a	
18-26GHz	-	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a	
18-26GHz	-	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a	
<b>Results:</b>									<b>Complies</b>		

- (1) No Emissions Detected (ND) above ambient or within 20dB of the limit
  - (2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
  - (3) External Amplifier not used
- $$E_{Corr} = E_{Meas} + ACF + L_C - G_A$$

**19.0 POWER LINE CONDUCTED EMISSIONS**

**Test Procedure**

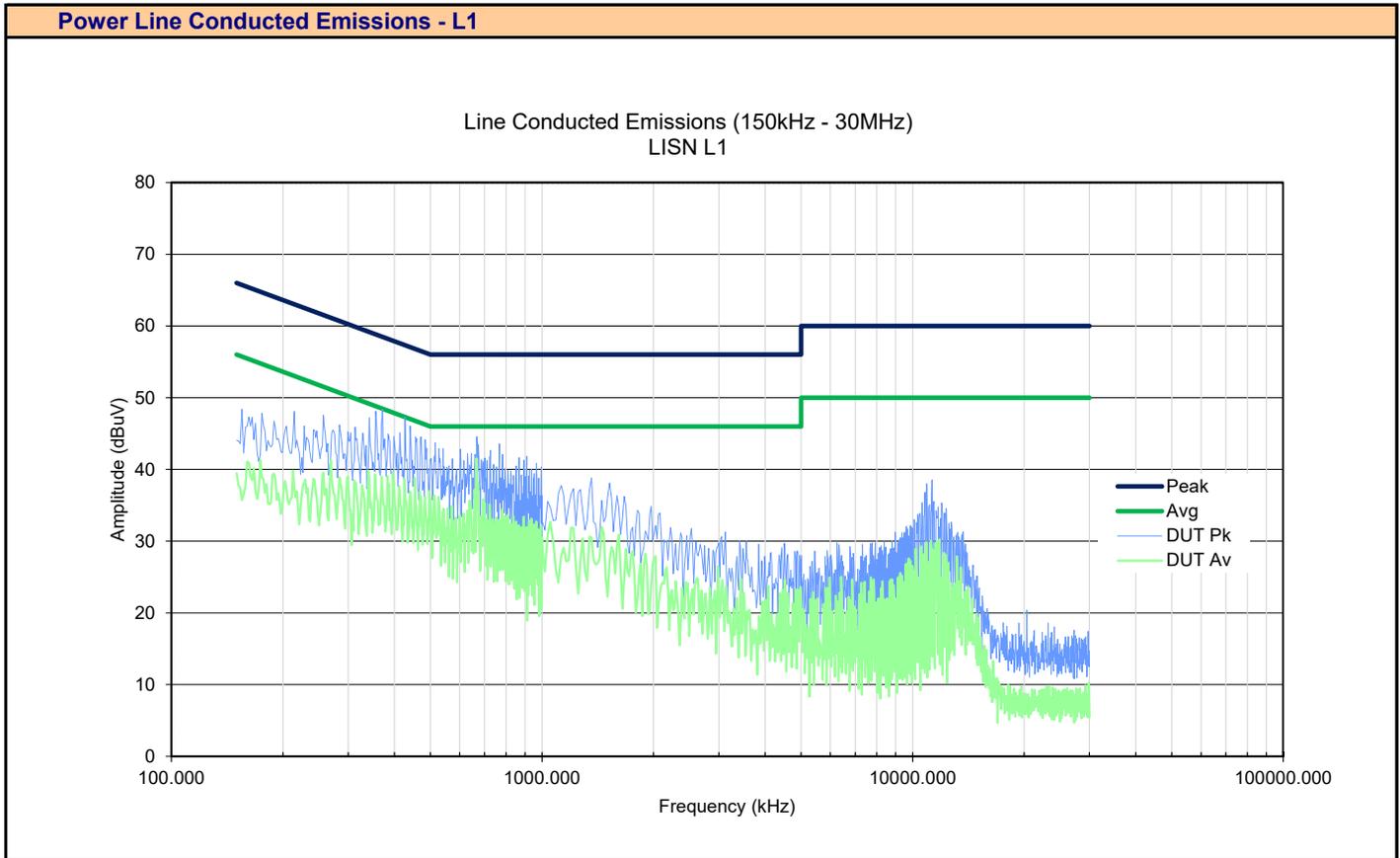
<b>Normative Reference</b>	<b>FCC 47 CFR §15.107, ICES-003(6.1) ANSI C63.4-2014</b>
----------------------------	--

**Limits**

47 CFR §15.107	(a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges. 0.15-0.5MHz: 66-56 dBuV Quasi Peak, 56-46 dBuV Average, Decreases with the logarithm of the frequency 0.5 - 5.0 MHz: 56 dBuV Quasi Peak, 46 dBuV Average 5.0 - 30.0 MHz: 60 dBuV Quasi Peak, 50 dBuV Average
ICES-003(6.1)	6.1 - AC Power Line Conducted Emissions Limits Class B: ITE that does not meet the conditions for Class A operation shall comply with the Class B radiated limits set out in Table 2. 0.15-0.5MHz: 66-56 dBuV Quasi Peak, 56-46 dBuV Average, Decreases with the logarithm of the 0.5 - 5.0 MHz: 56 dBuV Quasi Peak, 46 dBuV Average 5.0 - 30.0 MHz: 60 dBuV Quasi Peak, 50 dBuV Average

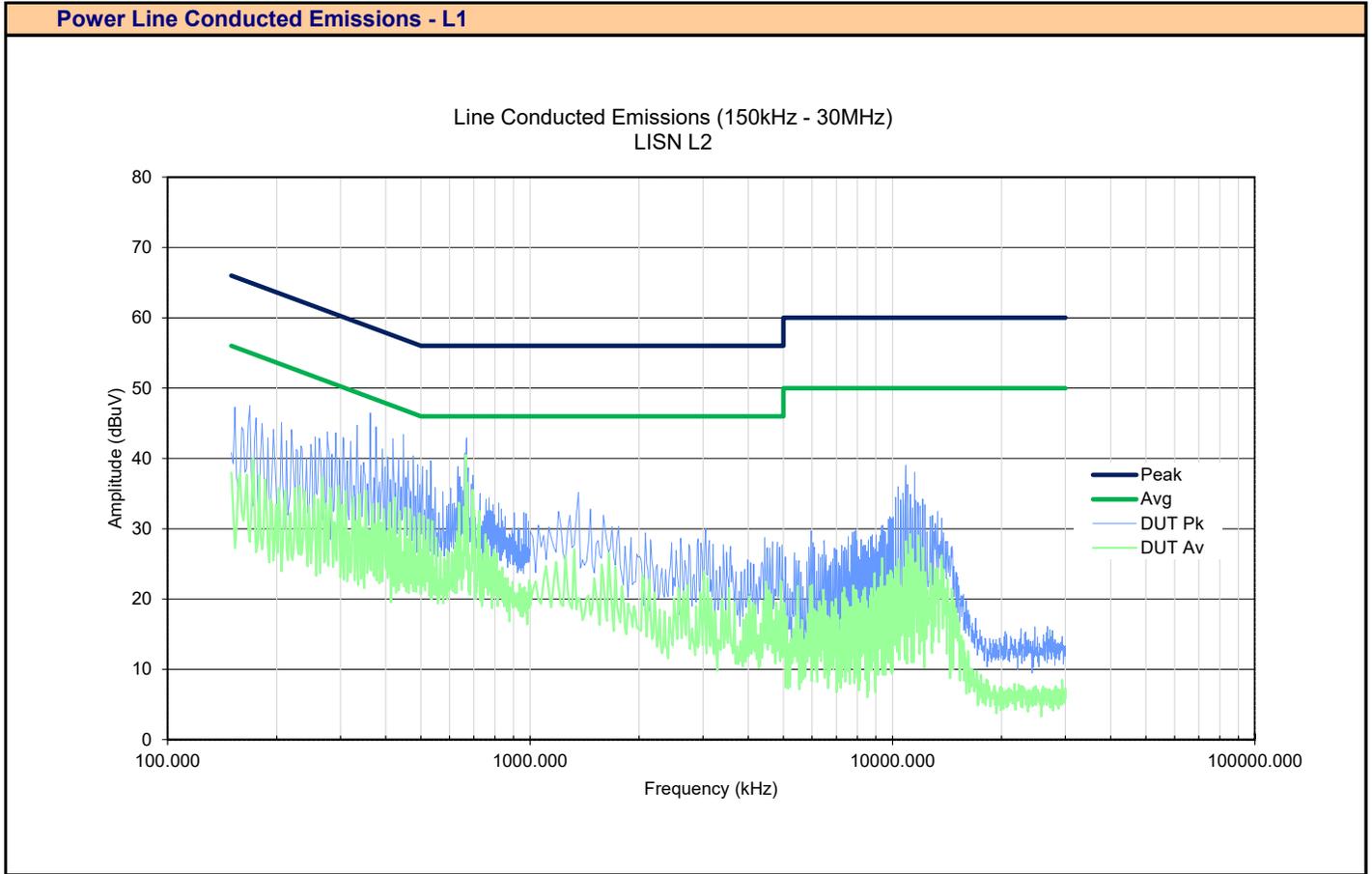
<b>Test Setup</b>	<b>Appendix A                      Figure A.7</b>
-------------------	---

**Plot 19.1 – Power Line Conducted Emissions, Line 1**



Channel:	<b>6</b>	Channel Frequency:	<b>2437</b> MHz
Mode:	<b>802.11b</b>	Modulation:	<b>CCK 1MB</b>
Emission Frequency:	<b>371kHz</b>	Measured Channel Power:	<b>48.38</b> dBuV

**Plot 19.2 – Power Line Conducted Emissions, Line 2**



Channel:	<b>6</b>	Channel Frequency:	<b>2437</b> MHz
Mode:	<b>802.11b</b>	Modulation:	<b>CCK 1MB</b>
Emission Frequency:	<b>362.5kHz</b>	Measured Channel Power:	<b>46.46</b> dBuV

**Table 19.1 – Summary of Power Line Conducted Emissions – L1**

<b>Summary of Power Line Conducted Tx Emissions</b>											
Measured Frequency Range (MHz)	Channel Frequency (MHz)	LISN Port	Emission Frequency [f <sub>Emm</sub> ] (kHz)	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Detector*	Insertion Loss [L <sub>LISN</sub> ] (dB)	Cable Loss [L <sub>C</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV)	Limit (dBuV)	Margin (dB)
150kHz - 30MHz	2437.0	L1	371.00 kHz	48.38	Peak	0.30	0.26	0.00 (3)	48.94 (2)	58.0	9.1
<b>Results:</b>										<b>Complies</b>	

\* In accordance with FCC §15.35 and ANSI C63.4, a Peak detector may be used to demonstrate compliance to Quasi-Peak limits provided the Resolution Bandwidth (RBW) is equal to or greater than Quasi-Peak bandwidth. The Detector RBW employed was ≥ 9kHz.

(2) LISN Insertion Loss, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{Corr} = E_{Meas} + L_{LISN} + L_C - G_A$$

Class B QP Limit = 56 - 20Log (f<sub>Emm</sub>/500) for f<sub>Emm</sub> = 150kHz to 500kHz

Class B Avg Limit = 46 - 20Log (f<sub>Emm</sub>/500) for f<sub>Emm</sub> = 150kHz to 500kHz

Class A QP Limit = 79dBuV for f<sub>Emm</sub> = 150kHz to 500kHz

Class A Avg Limit = 66dBuV for f<sub>Emm</sub> = 150kHz to 500kHz

$$\text{Margin} = \text{Limit} - E_{Corr}$$

**Table 19.1 – Summary of Power Line Conducted Emissions – L2**

<b>Summary of Power Line Conducted Tx Emissions</b>											
Measured Frequency Range (MHz)	Channel Frequency (MHz)	LISN Port	Emission Frequency [f <sub>Emm</sub> ] (kHz)	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Detector*	Insertion Loss [L <sub>LISN</sub> ] (dB)	Cable Loss [L <sub>C</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV)	Limit (dBuV)	Margin (dB)
150kHz - 30MHz	2437.0	L2	362.50 kHz	46.46	Peak	0.30	0.26	0.00 (3)	47.02 (2)	58.6	11.6
<b>Results:</b>										<b>Complies</b>	

\* In accordance with FCC §15.35 and ANSI C63.4, a Peak detector may be used to demonstrate compliance to Quasi-Peak limits provided the Resolution Bandwidth (RBW) is equal to or greater than Quasi-Peak bandwidth. The Detector RBW employed was ≥ 9kHz.

(2) LISN Insertion Loss, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{Corr} = E_{Meas} + L_{LISN} + L_C - G_A$$

Class B QP Limit = 56 - 20Log (f<sub>Emm</sub>/500) for f<sub>Emm</sub> = 150kHz to 500kHz

Class B Avg Limit = 46 - 20Log (f<sub>Emm</sub>/500) for f<sub>Emm</sub> = 150kHz to 500kHz

Class A QP Limit = 79dBuV for f<sub>Emm</sub> = 150kHz to 500kHz

Class A Avg Limit = 66dBuV for f<sub>Emm</sub> = 150kHz to 500kHz

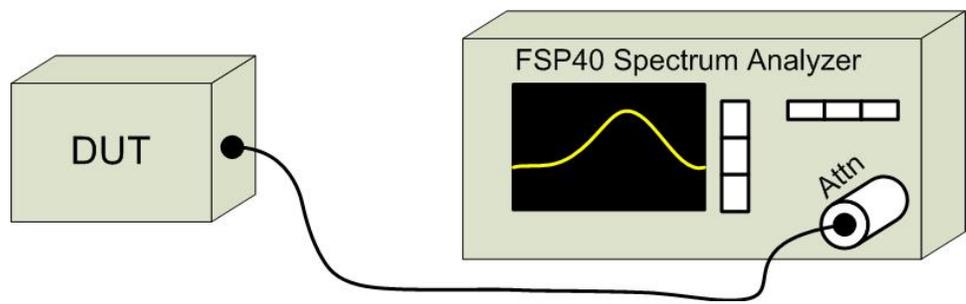
$$\text{Margin} = \text{Limit} - E_{Corr}$$

**APPENDIX A – TEST SETUP DRAWINGS**

**Table A.1 – Conducted Measurement Setup**

Equipment List				
Asset Number	Manufacturer	Model Number	Serial Number	Description
00241	R&S	FSU40	100500	Spectrum Analyzer
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable

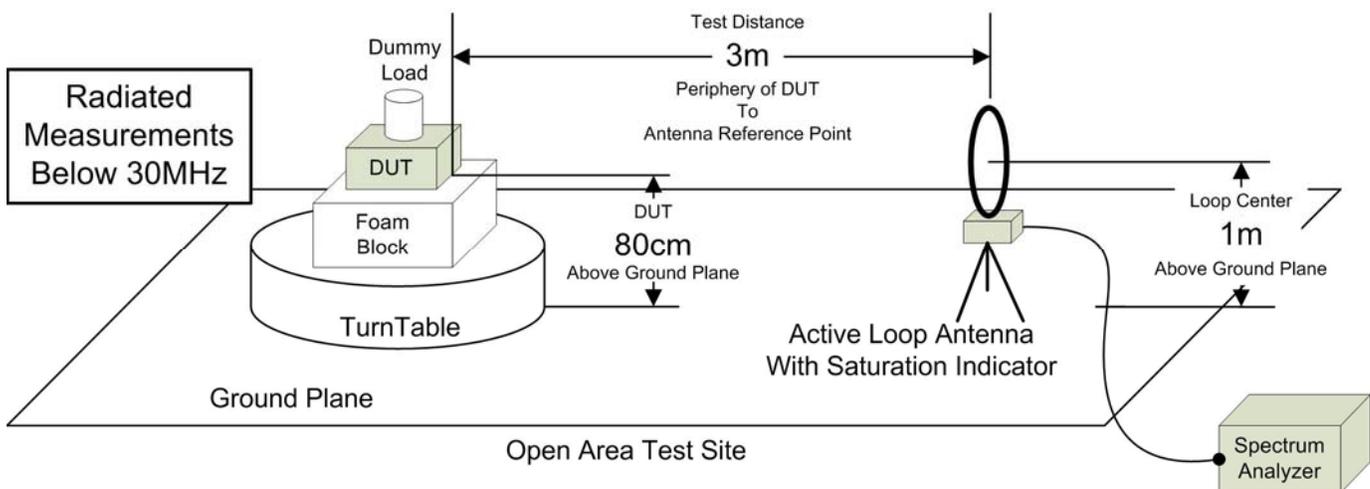
**Figure A.1 – Test Setup – Conducted Measurements**



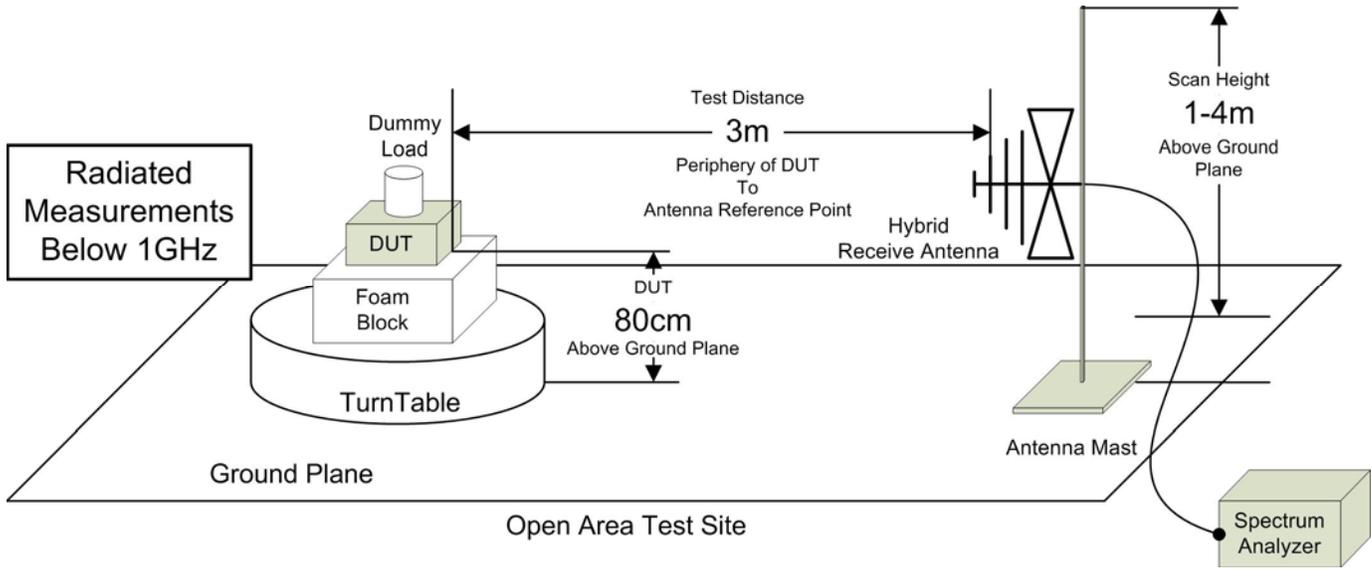
**Table A.2 – Radiated Emissions Measurement Equipment**

Equipment List				
Asset Number	Manufacturer	Model Number	Serial Number	Description
00050	Chase	CBL-6111A	1607	Bilog Antenna
00034	ETS	3115	6267	Double Ridged Guide Horn
00035	ETS	3115	6276	Double Ridged Guide Horn
00085	EMCO	6502	9203-2724	Loop Antenna
00161	Waveline Inc.	889		Standard Gain Horn 18-26GHz
00162	Waveline Inc.	889		Standard Gain Horn 18-26GHz
00165	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
00166	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
00333	HP	85685A	3010A01095	RF Preselector
00049	HP	85650A	2043A00162	Quasi-peak Adapter
00051	HP	8566B	2747A05510	Spectrum Analyzer
00241	R&S	FSU40	100500	Spectrum Analyzer
00265	Miteq	JS32-00104000-58-5P	1939850	Microwave L/N Amplifier
00071	EMCO	2090	9912-1484	Multi-Device Controller
00072	EMCO	2075	0001-2277	Mini-mast
00073	EMCO	2080	0002-1002	Turn Table
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable
00263B	Koaxis	KP10-1.00M-TD	263B	1m Armoured Cable
00275	TMS	LMR400	n/a	25m Cable
00278	TILE	34G3	n/a	TILE Test Software

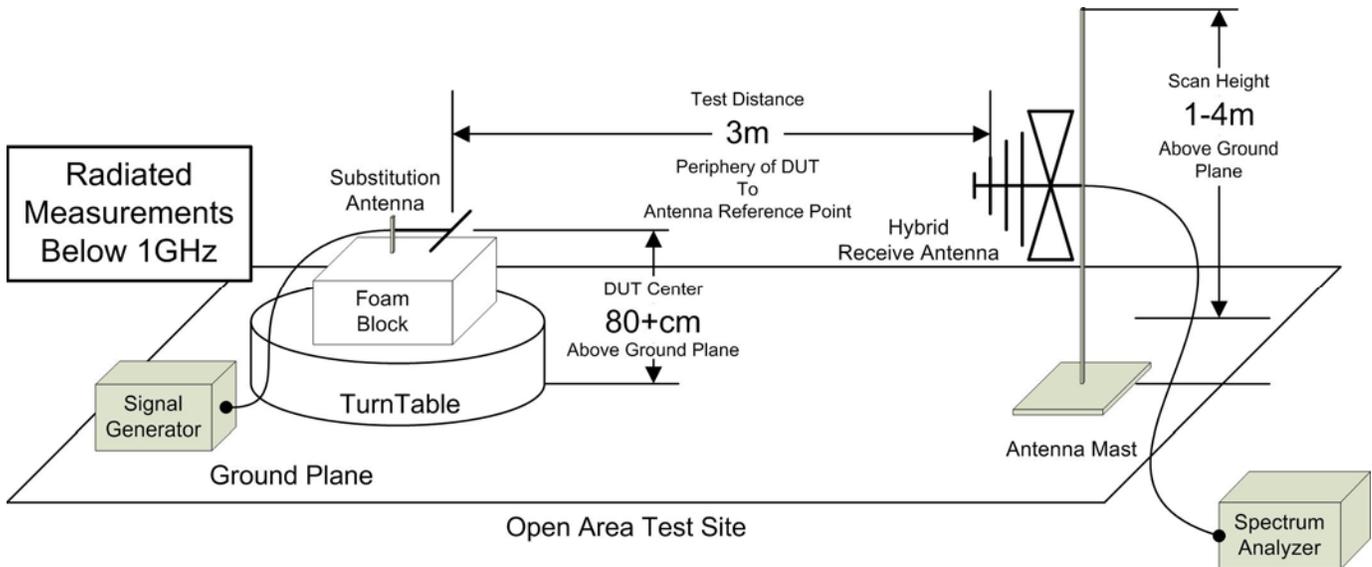
**Figure A.2 – Test Setup Radiated Measurements 9kHzMHz – 30MHz**



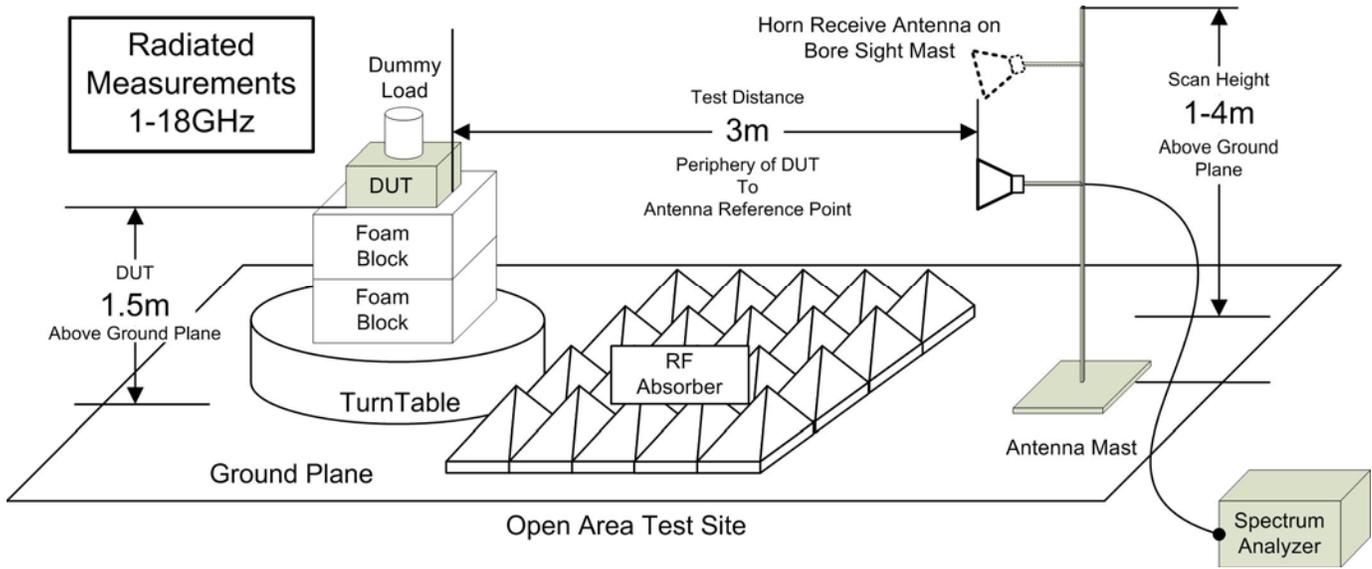
**Figure A.3 – Test Setup Radiated Measurements 30MHz – 1GHz**



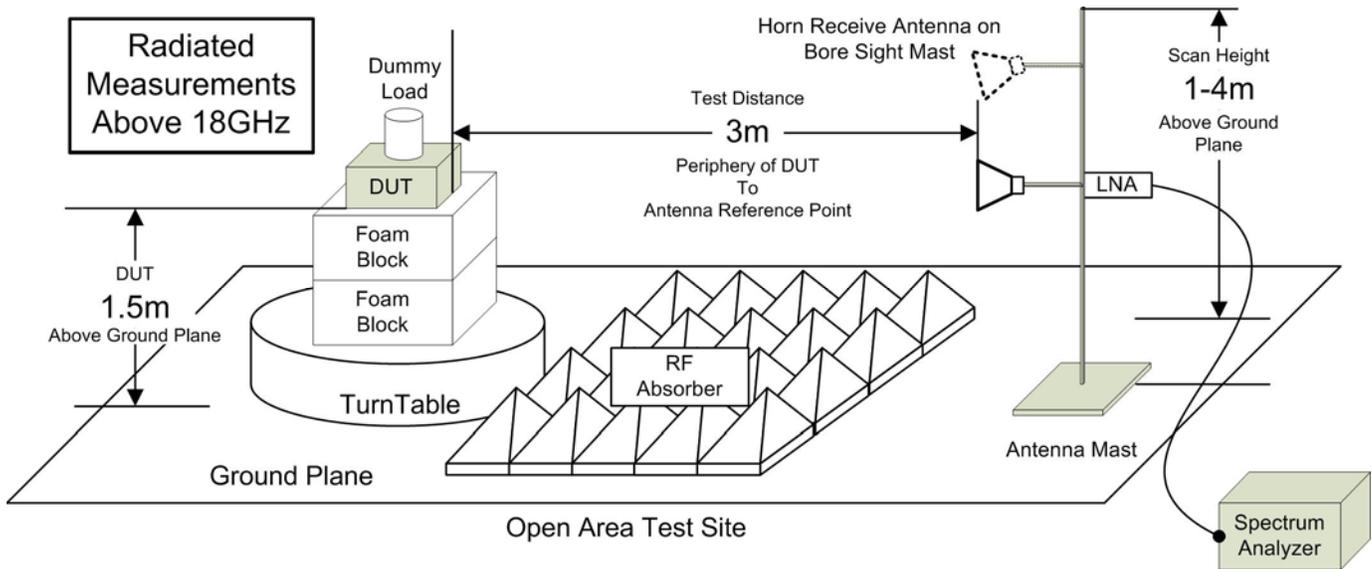
**Figure A.4 – Test Setup Radiated Measurements 30MHz – 1GHz, Signal Substitution**



**Figure A.5 – Test Setup Radiated Measurements 1 – 18GHz,**

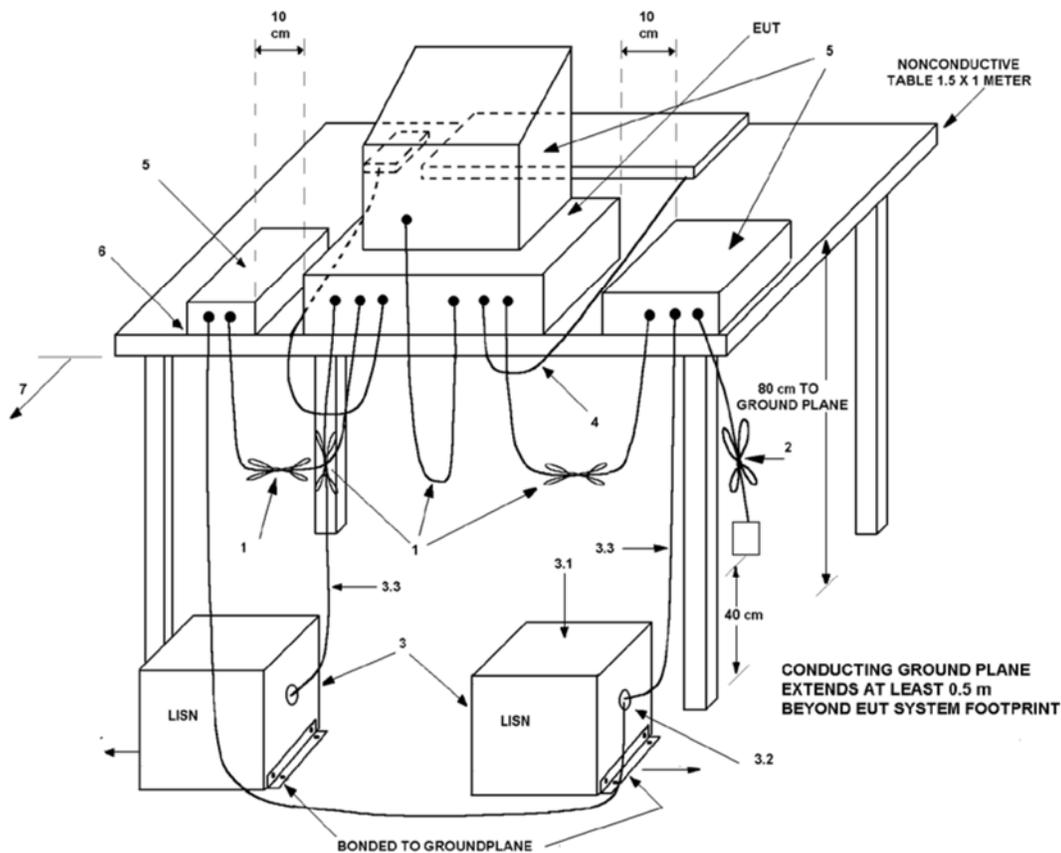


**Figure A.6 – Test Setup Radiated Measurements 18 – 26.5GHz,**



**Table A.3 – Setup – Conducted Emissions Equipment List**

Equipment List				
Asset Number	Manufacturer	Model Number	Serial Number	Description
00333	HP	85685A	3010A01095	RF Preselector
00049	HP	85650A	2043A00162	Quasi-peak Adapter
00051	HP	8566B	2747A05510	Spectrum Analyzer
00223	HP	8901A	3749A07154	Modulation Analyzer
00257	Com-Power	LI-215A	191934	LISN
00276	TMS	LMR400	n/a	4m Cable



**Figure A.7 – Test Setup Conducted Emissions Measurements**

**APPENDIX B – EQUIPMENT LIST AND CALIBRATION**

Equipment List					Last	Calibration	Calibration
Asset Number	Manufacturer	Model Number	Serial Number	Description	Calibrated	Interval	Due
00050	Chase	CBL-6111A	1607	Bilog Antenna	16 Nov 2020	Triennial	16 Nov 2023
00035	ETS	3115	6276	Double Ridged Guide Horn	4 Mar 2022	Triennial	4 Mar 2025
00085	EMCO	6502	9203-2724	Loop Antenna	6 Sep 2022	Triennial	6 Sep 2025
00333	HP	85685A	3010A01095	RF Preselector	23 Jun 2020	Triennial	30 Jun 2023
00049	HP	85650A	2043A00162	Quasi-peak Adapter	23 Jun 2020	Triennial	23 Jun 2023
00051	HP	8566B	2747A05510	Spectrum Analyzer	23 Jun 2020	Triennial	23 Jun 2023
00241	R&S	FSU40	100500	Spectrum Analyzer	10 Aug 2021	Triennial	10 Aug 2024
00005	HP	8648D	3847A00611	Signal Generator	23 Jun 2020	Triennial	23 Jun 2023
00003	HP	53181A	3736A05175	Frequency Counter	23 Jun 2020	Triennial	23 Jun 2023
00257	Com-Power	LI-215A	191934	LISN	27 Dec 2021	Triennial	27 Dec 2024
00071	EMCO	2090	9912-1484	Multi-Device Controller	n/a	n/a	n/a
00072	EMCO	2075	0001-2277	Mini-mast	n/a	n/a	n/a
00073	EMCO	2080	0002-1002	Turn Table	n/a	n/a	n/a
00081	ESPEC	ECT-2	0510154-B	Environmental Chamber	NCR	n/a	CNR
00234	VWR	61161-378	140320430	Temp/Humidity Meter	New	Triennial	New
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable	COU	n/a	COU
00264	Koaxis	KP10-7.00M-TD	264	7m Armoured Cable	COU	n/a	COU
00275	TMS	LMR400	n/a	25m Cable	COU	n/a	COU
00276	TMS	LMR400	n/a	4m Cable	COU	n/a	COU
00278	TILE	34G3	n/a	TILE Test Software	NCR	n/a	NCR

NCR: No Calibration Required  
COU: Calibrate On Use

**APPENDIX C – MEASUREMENT INSTRUMENT UNCERTAINTY**

<b>CISPR 16-4 Measurement Uncertainty ( U<sub>LAB</sub> )</b>	
This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence interval using a coverage factor of k=2	
<b>Radiated Emissions 30MHz - 200MHz</b>	
U <sub>LAB</sub> = 5.14dB    U <sub>CISPR</sub> = 6.3dB	
<b>Radiated Emissions 200MHz - 1000MHz</b>	
U <sub>LAB</sub> = 5.90dB    U <sub>CISPR</sub> = 6.3dB	
<b>Radiated Emissions 1GHz - 6GHz</b>	
U <sub>LAB</sub> = 4.80dB    U <sub>CISPR</sub> = 5.2dB	
<b>Radiated Emissions 6GHz - 18GHz</b>	
U <sub>LAB</sub> = 5.1dB    U <sub>CISPR</sub> = 5.5dB	
<b>Power Line Conducted Emissions 9kHz to 150kHz</b>	
U <sub>LAB</sub> = 2.96dB    U <sub>CISPR</sub> = 3.8dB	
<b>Power Line Conducted Emissions 150kHz to 30MHz</b>	
U <sub>LAB</sub> = 3.12dB    U <sub>CISPR</sub> = 3.4dB	
If the calculated uncertainty U <sub>lab</sub> is <b>less</b> than U <sub>CISPR</sub> then:	
1	Compliance is deemed to occur if <b>NO</b> measured disturbance exceeds the disturbance limit
2	Non-Compliance is deemed to occur if <b>ANY</b> measured disturbance <b>EXCEEDS</b> the disturbance limit
If the calculated uncertainty U <sub>lab</sub> is <b>greater</b> than U <sub>CISPR</sub> then:	
3	Compliance is deemed to occur if <b>NO</b> measured disturbance, increased by ( U <sub>lab</sub> - U <sub>CISPR</sub> ), exceeds the disturbance limit
4	Non-Compliance is deemed to occur if <b>ANY</b> measured disturbance, increased by ( U <sub>lab</sub> - U <sub>CISPR</sub> ), <b>EXCEEDS</b> the disturbance limit

<b>Other Measurement Uncertainties ( U<sub>LAB</sub> )</b>	
<b>RF Conducted Emissions 9kHz - 40GHz</b>	
U <sub>LAB</sub> = 1.0dB    U <sub>CISPR</sub> = n/a	
<b>Frequency/Bandwidth 9kHz - 40GHz</b>	
U <sub>LAB</sub> = 0.1ppm    U <sub>CISPR</sub> = n/a	
<b>Temperature</b>	
U <sub>LAB</sub> = 1°C    U <sub>CISPR</sub> = n/a	

**END OF REPORT**

**APPENDIX D – CONDUCTED POWER MEASUREMENT PLOTS**

**APPENDIX E – CONDUCTED SPURIOUS EMISSIONS MEASUREMENT PLOTS**

**APPENDIX F – RADIATED TX EMISSIONS MEASUREMENT PLOTS**

**APPENDIX G – RADIATED RX EMISSIONS MEASUREMENT PLOTS**



Test Report Serial Number:	<b>45461851 R1.0</b>
Test Report Date:	<b>3 April 2023</b>
Project Number:	<b>1621</b>

## EMC Test Report - New Certification

Applicant:



**Garmin International Inc.**  
**1200 East 151 St**  
**Olathe, KS, 66062**  
**USA**

FCC ID:

**IPH-A04524**

Product Model Number / HVIN

**A04524**

IC Registration Number

-

Product Marketing Name / PMN

**A04524**

In Accordance With:

**CFR Title 47, Part 15 Subpart C (§15.249), (§15.225), Part 15 Subpart B**  
 Part 15 Low Power Communication Device Transmitter (DXX)

Approved By:

---

**Ben Hewson, President**  
 Celltech Labs Inc.  
 21-364 Lougheed Rd.  
 Kelowna, BC, V1X 7R8  
 Canada



Test Lab Certificate: 2470.01



**Industry  
Canada**

IC Registration 3874A



FCC Registration: CA3874

**This report shall not be reproduced in any form without the expressed written consent of Celltech Labs Inc.**

## Table of Contents

1.0 DOCUMENT CONTROL.....	4
2.0 CLIENT AND DUT INFORMATION.....	5
3.0 SCOPE.....	6
4.0 TEST RESULT SUMMARY.....	7
5.0 NORMATIVE REFERENCES.....	9
6.0 FACILITIES AND ACCREDITATIONS.....	10
7.0 OCCUPIED BANDWIDTH.....	11
8.0 FIELD STRENGTH.....	17
9.0 20DB BW.....	22
10.0 OUT-OF-BAND EMISSIONS- NFC.....	28
11.0 RADIATED SPURIOUS EMISSIONS – RESTRICTED BANDS.....	33
12.0 RADIATED RX SPURIOUS EMISSIONS.....	36
13.0 FREQUENCY STABILITY (NFC).....	38
14.0 POWER LINE CONDUCTED EMISSIONS.....	40
APPENDIX A – TEST SETUP DRAWINGS AND EQUIPMENT.....	45
APPENDIX B – EQUIPMENT LIST AND CALIBRATION.....	51
APPENDIX C – MEASUREMENT INSTRUMENT UNCERTAINTY.....	52
END OF REPORT.....	52
APPENDIX H – FIELD STRENGTH MEASUREMENT PLOTS.....	53
APPENDIX I– RADIATED TX EMISSIONS MEASUREMENT PLOTS.....	53
APPENDIX J– RADIATED RX MEASUREMENT PLOTS.....	53

## Table of Plots

Plot 7.1 – Occupied Bandwidth, BLE1.....	12
Plot 7.2 – Occupied Bandwidth, BLE2.....	13
Plot 7.3 – Occupied Bandwidth, ANT.....	14
Plot 7.4 – Occupied Bandwidth, NFC.....	15
Plot 8.1 – Field Strength, NFC.....	19
Plot 8.1 – Field Strength, NFC.....	20
Plot 9.1 – 20dB Bandwidth, BLE1.....	23
Plot 9.2 – 20dB Bandwidth, BLE2.....	24
Plot 9.3 – 20dB Bandwidth, ANT.....	25
Plot 9.4 – 20dB Bandwidth, NFC.....	26
Plot 10.1 – Out of Band Emissions, NFC.....	29
Plot 10.2 – Out of Band Emissions, NFC.....	30
Plot 10.3 – Out of Band Emissions, NFC.....	31
Plot 14.1 – Power Line Conducted Emissions, Line 1.....	41
Plot 14.2 – Power Line Conducted Emissions, Line 2.....	42

## Table of Tables

<i>Table 7.1 - Summary of Occupied Bandwidth Measurements (DXX)</i> .....	16
<i>Table 8.1 - Summary of Field Strength Measurements (BT BLE)</i> .....	18
<i>Table 8.3 - Summary of Field Strength Measurements (NFC)</i> .....	21
<i>Table 9.1 - Summary of 20dB BW Measurements</i> .....	27
<i>Table 10.1 – Summary of Field Strength Measurements (NFC)</i> .....	32
<i>Table 11.1 – Summary of Radiated Tx Emissions</i> .....	34
<i>Table 11.2 – Summary of Radiated Emissions, Restricted Band (NFC)</i> .....	35
<i>Table 12.1 – Summary of Radiated Rx Emissions</i> .....	37
<i>Table 13.1 – Summary of Frequency Stability Measurements – FCC</i> .....	39
<i>Table 14.1 – Summary of Power Line Conducted Emissions – L1</i> .....	43
<i>Table 14.1 – Summary of Power Line Conducted Emissions – L2</i> .....	44
<i>Table A.1 – Setup - Conducted Measurements Equipment List</i> .....	45
<i>Table A.2 – Setup - Radiated Emissions Equipment List</i> .....	46
<i>Table A.3 – Setup – Frequency Stability Equipment List</i> .....	50

## Table of Figures

<i>Figure A.1 – Test Setup Conducted Measurements</i> .....	45
<i>Figure A.2 – Test Setup Radiated Emissions Measurements Below 30MHz</i> .....	47
<i>Figure A.3 – Test Setup Radiated Emissions Measurements 30 – 1000MHz</i> .....	47
<i>Figure A.4 – Test Setup Radiated Emissions Measurements 30 – 1000MHz Signal Substitution</i> .....	48
<i>Figure A.5 – Test Setup Radiated Emissions Measurements 1 – 18GHz</i> .....	48
<i>Figure A.6 – Test Setup Radiated Emissions Measurements Above 18 GHz</i> .....	49
<i>Figure A.7 – Frequency Stability</i> .....	50

**1.0 DOCUMENT CONTROL**

Revision History					
<b>Samples Tested By:</b>		Art Voss, P.Eng.	<b>Date(s) of Evaluation:</b>		15 January - 13 February, 2023
<b>Report Prepared By:</b>		Art Voss, P.Eng.	<b>Report Reviewed By:</b>		Ben Hewson
Report Revision	Description of Revision	Revised Section	Revised By	Revision Date	
0.1	Draft	n/a	Art Voss	20 March 2023	
1.0	Initial Release	n/a	Art Voss	3 April 2023	

## 2.0 CLIENT AND DUT INFORMATION

Client Information	
<b>Applicant Name</b>	Garmin International Inc.
<b>Applicant Address</b>	1200 East 151 St
	Olathe, KS, 66062
	USA
DUT Information	
<b>Device Identifier(s):</b>	<b>FCC ID:</b> IPH-A04524
<b>Device Model(s) / HVIN:</b>	A04524
<b>Device Marketing Name / PMN:</b>	A04524
<b>Test Sample Serial No.:</b>	3430501782 - Conducted, 3433323644 - OTA
<b>Device Type:</b>	Extremity Worn Digital Transceiver
<b>Equipment Class:</b>	Digital Transmission Systems (DTS)
	Spread Spectrum Transmitter (DSS)
	Low Power Communication Device (DXX)
	Global Navigation Satellite System (GNSS) Receivers
	NFC - Low Power Communication Device Transmitter (DXX)
<b>Transmit Frequency Range:</b>	WiFi (DTS): 2412-2462MHz
	BT/BLE/ANT: 2402-2480MHz
	NFC: 13.56MHz
<b>Manuf. Max. Rated Output Power:</b>	WiFi - Digital Transmission System (DTS): 18.32dBm
	BlueTooth - Spread Spectrum Transmitter (DSS): 11.11dBm
	BLE/ANT - Low Power Communication Device Transmitter (DXX): 2.10dBm
	NFC - Low Power Communication Device Transmitter (DXX): 55.19dBuV/m
<b>Antenna Type and Gain:</b>	-5.9dBi Max
<b>Modulation:</b>	WiFi: DSSS, OFDM, CCK, MCS0-7
	BT BR: GFSK
	BT EDR: Pi/4-DQPSK, 8DPSK
	BLE: GMSK
	ANT: GFSK
	NFC: ASK
<b>DUT Power Source:</b>	3VDC Rechargeable Li-Ion
<b>DUT Dimensions [LxWxH]</b>	H x W x D: 42mm dia x 4.5mm
<b>Deviation(s) from standard/procedure:</b>	None
<b>Modification of DUT:</b>	None

### 3.0 SCOPE

**Preface:**

This Certification Report was prepared on behalf of:

**Garmin International Inc.**

, (the '*Applicant*'), in accordance with the applicable Federal Communications Commission (FCC) CFR 47 and Innovation, Scientific and Economic Development (ISED) Canada rules parts and regulations (the '*Rules*'). The scope of this investigation was limited to only the equipment, devices and accessories (the '*Equipment*') supplied by the *Applicant*. The tests and measurements performed on this *Equipment* were only those set forth in the applicable *Rules* and/or the Test and Measurement Standards they reference. The *Rules* applied and the Test and Measurement Standards used during this evaluation appear in the Normative References section of this report. The limits set forth in the technical requirements of the applicable *Rules* were applied to the measurement results obtained during this evaluation and, unless otherwise noted, these limits were used as the Pass/Fail criteria. The Pass/Fail statements made in this report apply to only the tests and measurements performed on only the *Equipment* tested during this evaluation. Where applicable and permissible, information including test and measurement data and/or results from previous evaluations of same or similar equipment, devices and/or accessories may be cited in this report.

**Device:**

The Garmin Model/HVIN: A04524 is an extremity worn digital transceiver device consisting of a WiFi, BlueTooth (BT), BlueTooth Low Energy (BLE), Adaptive Network Topology (ANT) and Near Field Communication (NFC) transceivers. The WiFi and BT/BLE/ANT transceivers share the same antenna and cannot simultaneously transmit.

**Requirement:**

The transceivers of this *equipment* are subject to emissions evaluation in accordance with FCC: 47 CFR 2, 15C. As per FCC 47 CFR §2.1093, an RF Exposure (SAR) evaluation is required for this *Equipment* and the results of the RF Exposure (SAR) evaluation appear in a separate report.

**Application:**

This is an application for a New Certification.

**Scope:**

The scope of this investigation is limited to the evaluation and reporting of the wanted and spurious emissions in accordance with the rule parts cited in Normative References section of this report.

**4.0 TEST RESULT SUMMARY**

<b>TEST SUMMARY</b>						
<b>Section</b>	<b>Description of Test</b>	<b>Procedure Reference</b>	<b>Applicable Rule Part(s) FCC</b>	<b>Applicable Rule Part(s) ISED</b>	<b>Test Date</b>	<b>Result</b>
<b>7.0</b>	Occupied Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§2.1049	RSS-Gen (6.7)	15, 21 Jan 2023	Pass
<b>8.0</b>	Field Strength (Fundamental)	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(a)(e)	RSS-Gen (6.12) RSS-210 (B.10)	31 Jan 2023	Pass
<b>9.0</b>	20dB BW	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(a)(e)	RSS-Gen (6.12) RSS-210 (B.10)	31 Jan 2023	Pass
<b>10.0</b>	Band Edge (NFC)	ANSI C63.10-2013 KDB 558074 D01v05	§15.225(a)(c)	RSS-Gen (6.12) RSS-210 (B.10)	31 Jan 2023	Pass
<b>11.0</b>	Restricted Bands	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(d)(e) §15.209	RSS-Gen (8.10)	31 Jan 2023	Pass
<b>12.0</b>	Radiated Rx Emissions	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(d)(e) §15.209	RSS-Gen (8.10)	31 Jan 2023	Pass
<b>13.0</b>	Frequency Stability	ANSI C63.10-2013 KDB 558074 D01v05	§15.225	RSS-G210 B.6	26 Jan 2023	Pass
<b>14.0</b>	Power Line Conducted Emissions	ANSI C63.4-2014	§15.107	ICES-003(6.1)	25 Jan 2023	Pass

Test Station Day Log					
Date	Ambient Temp (°C)	Relative Humidity (%)	Barometric Pressure (kPa)	Test Station	Tests Performed Section(s)
15 Jan 2023	21.6	17	101.6	EMC	7
21 Jan 2023	21.9	18	101.4	EMC	7
25 Jan 2023	17.2	52	102.1	LISN	14
26 Jan 2023	14.6	35	102.7	TC	13
31 Jan 2023	0.0	87	101.5	OATS	8, 9, 10, 11, 12

**EMC** - EMC Test Bench                      **SAC** - Semi-Anechoic Chamber  
**OATS** - Open Area Test Site              **TC** - Temperature Chamber  
**LISN** - LISN Test Area                    **ESD** - ESD Test Bench  
**IMM** - Immunity Test Area                **RI** - Radiated Immunity Chamber

I attest that the data reported herein is true and accurate within the tolerance of the Measurement Instrument Uncertainty; that all tests and measurements were performed in accordance with accepted practices or procedures; and that all tests and measurements were performed by me or by trained personnel under my direct supervision. The results of this investigation are based solely on the test sample(s) provided by the client which were not adjusted, modified or altered in any manner whatsoever, except as required to carry out specific tests or measurements. This test report has been completed in accordance with ISO/IEC 17025.

  
 \_\_\_\_\_  
 Art Voss, P.Eng.  
 Technical Manager  
 Celltech Labs Inc.  
 14 February 2023  
 \_\_\_\_\_  
 Date



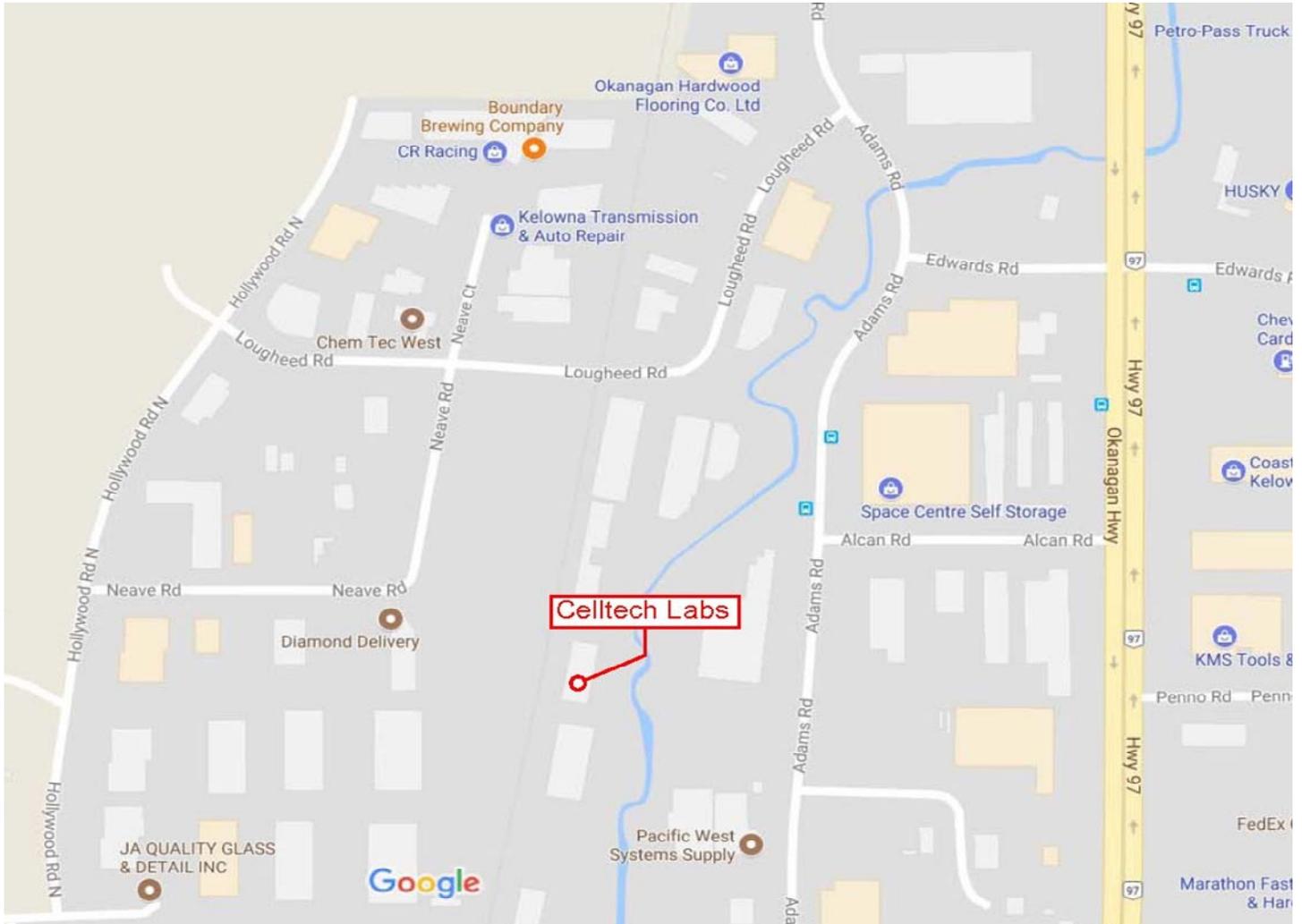
## 5.0 NORMATIVE REFERENCES

<b>Normative References</b>	
ISO/IEC 17025:2017	General requirements for the competence of testing and calibration laboratories
ANSI C63.4-2014	American National Standard of Procedures for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electric and Electronic Equipment in the Range of 9kHz to 40GHz
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
CFR	Code of Federal Regulations Title 47: Telecommunication Part 2: Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
CFR	Code of Federal Regulations Title 47: Telecommunication Part 15: Radio Frequency Devices Subpart B: Unintentional Radiators
CFR	Code of Federal Regulations Title 47: Telecommunication Part 15: Radio Frequency Devices Sub Part C (15.225) Intentional Radiators
CFR	Code of Federal Regulations Title 47: Telecommunication Part 15: Radio Frequency Devices Sub Part C (15.249) Intentional Radiators
FCC KDB 558074 D01v05r02	OET Major Guidance Publications, Knowledge Data Base Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247

## 6.0 FACILITIES AND ACCREDITATIONS

### Facility and Accreditation:

The facilities used to evaluate this device outlined in this report are located at 21-364 Lougheed Road, Kelowna, British Columbia, Canada V1X 7R8. The radiated emissions site (OATS) conforms to the requirements set forth in ANSI C63.4 and is filed and listed with the FCC under Test Firm Registration Number CA3874A-1 and Industry Canada under Test Site File Number IC 3874A. Celltech is accredited to ISO 17025, through accrediting body A2LA and with certificate 2470.01.



## 7.0 OCCUPIED BANDWIDTH

### Test Procedure

<b>Normative Reference</b>	FCC 47 CFR §2.1046, RSS-Gen (6.1.2), RSS-247 (5.4)(d), KDB 558074 (8.3.2.1), ANSI C63.10 (6.9.3)
----------------------------	---

### General Procedure

C63.10 (6.9.3)

#### 6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

- a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than  $[10 \log (OBW/RBW)]$  below the reference level. Specific guidance is given in 4.1.5.2.
- d) Step a) through step c) might require iteration to adjust within the specified range.
- e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

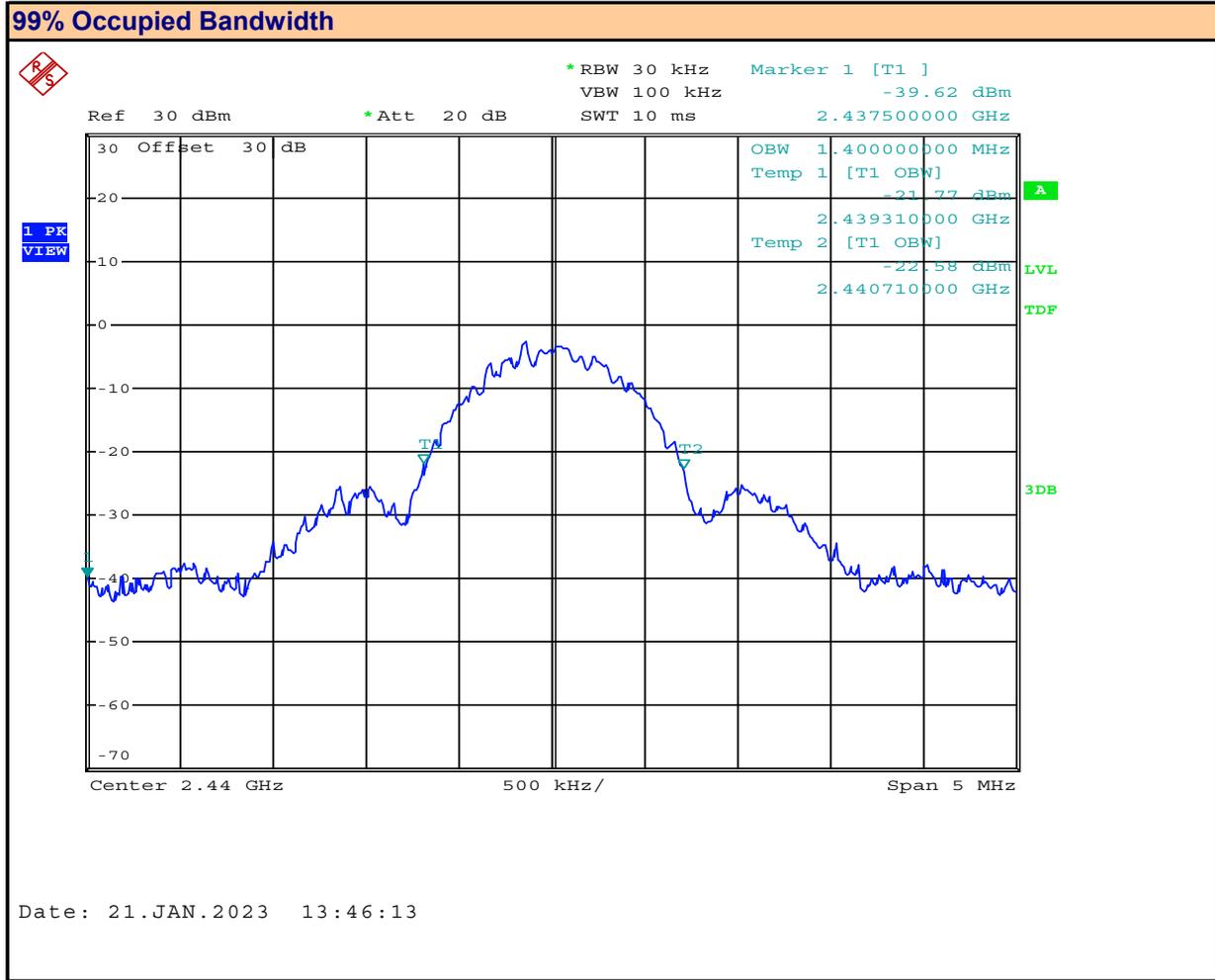
### Test Setup

Appendix A - Figure A.1

### Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as described above using the 99% Occupied Bandwidth function. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device. The DUT was set to transmit at its maximum Duty Cycle. The 99% Occupied Bandwidth was measured and recorded.

Plot 7.1 – Occupied Bandwidth, BLE1

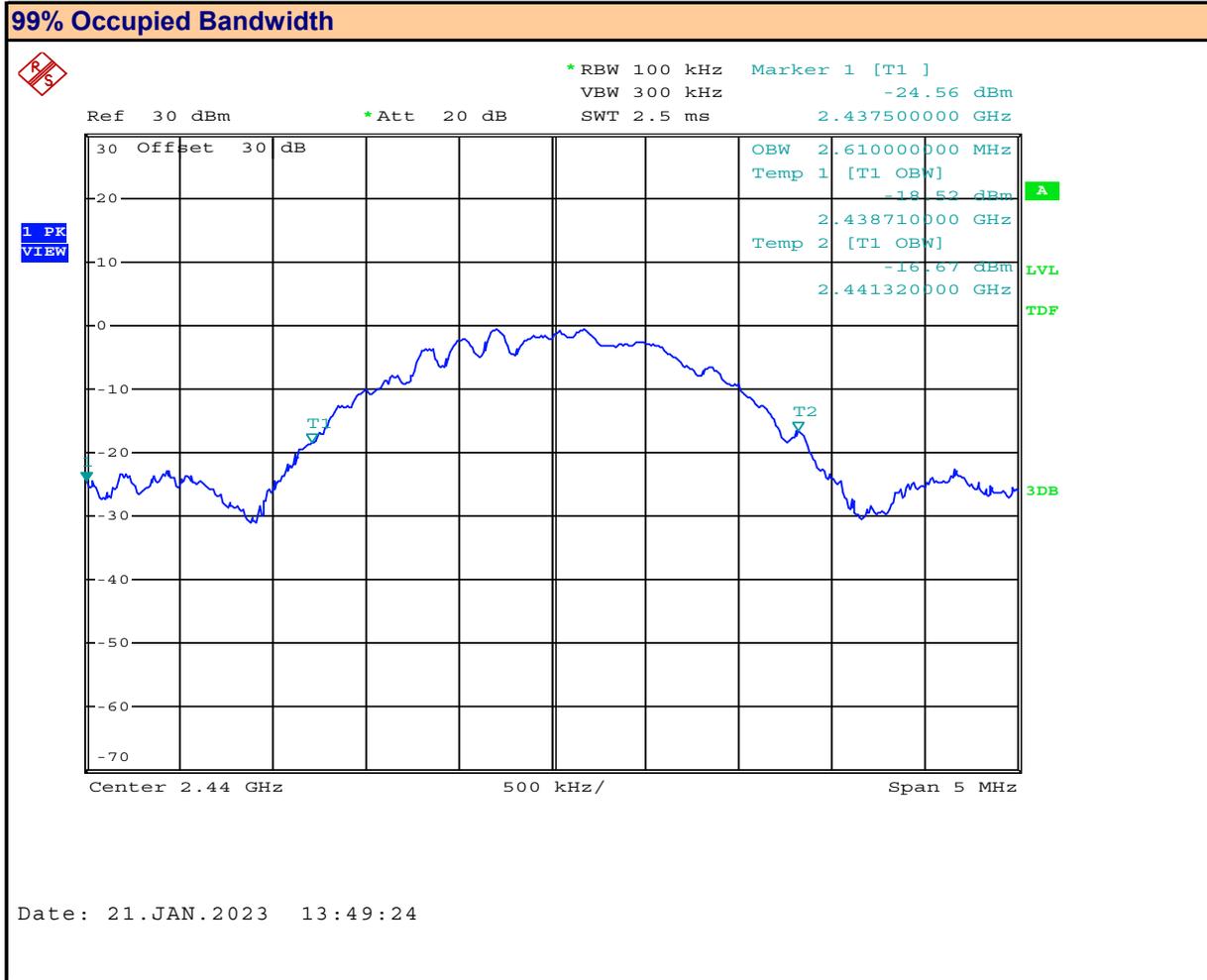


Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:

Measured Occupied Bandwidth:  MHz

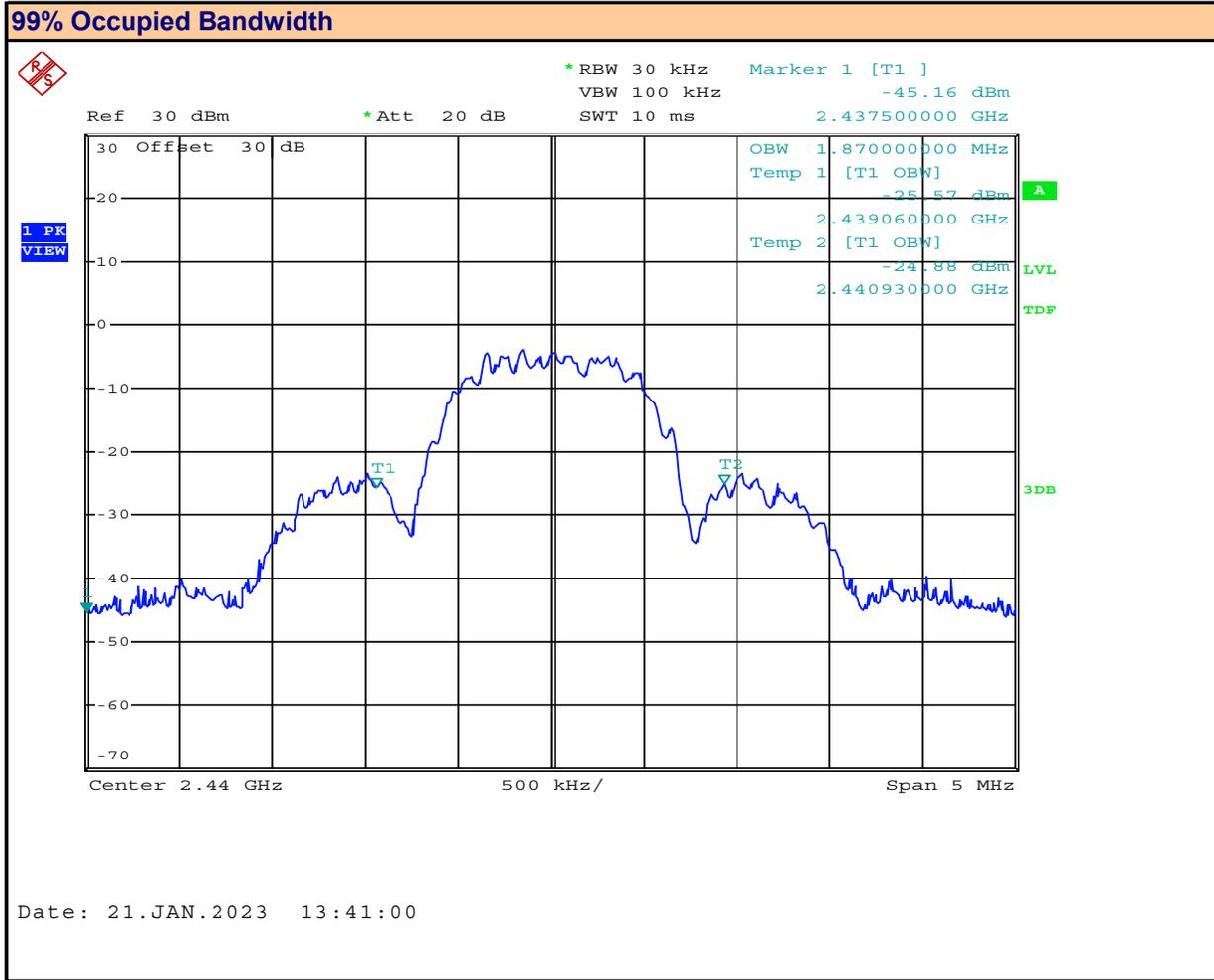
**Plot 7.2 – Occupied Bandwidth, BLE2**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured Occupied Bandwidth:  MHz

Plot 7.3 – Occupied Bandwidth, ANT

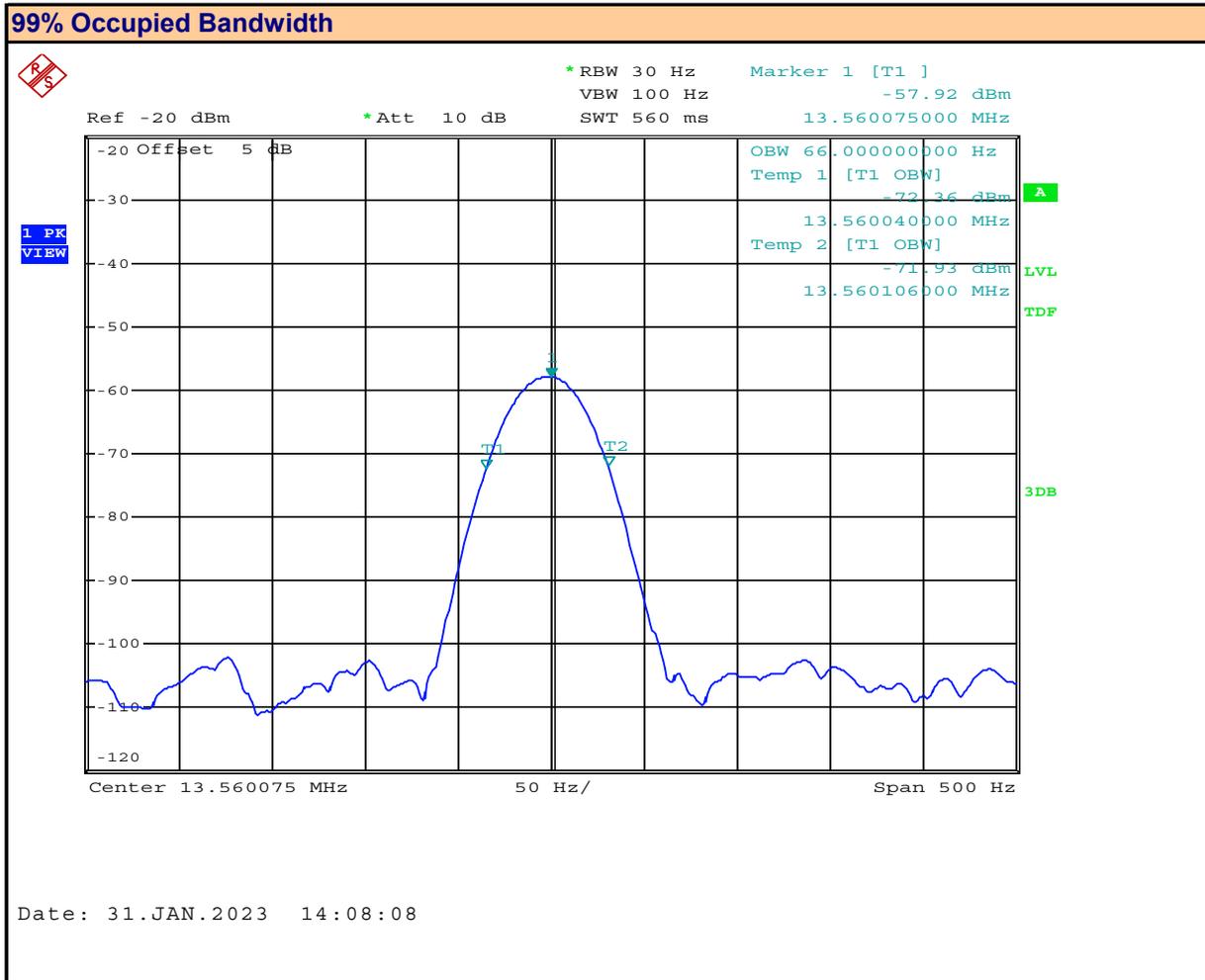


Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:

Measured Occupied Bandwidth:  MHz

Plot 7.4 – Occupied Bandwidth, NFC



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:

Measured Occupied Bandwidth:  Hz

**Table 7.1 - Summary of Occupied Bandwidth Measurements (DXX)**

<b>99% Occupied Bandwidth Results:</b>					
<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>	<b>Mode</b>	<b>Modulation</b>	<b>Measured Occupied Bandwidth (MHz)</b>	<b>Emission Designator</b>
17	2440.0	BT LE1	GMSK	1.400	1M40KF1D
17	2440.0	BT LE2	GMSK	2.610	2M61G1D
17	2440.0	ANT	GFSK	1.870	1M87F1D
-	13.6	NFC	ASK	66Hz	66HK1D
<b>Result:</b>					<b>Complies</b>

## 8.0 FIELD STRENGTH

### Test Procedure

<b>Normative Reference</b>	<b>FCC 47 CFR §2.1046, §15.249, RSS-210</b>
	<b>KDB 558074 (8.3.2), ANSI C63.10 (11.9.2.2.6)</b>

### Limits

§15.249(a)	<p><b>Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz.</b></p> <p>(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:</p> <p>2400-2483.5MHz, Fundamental Field Strength: 50mV/m, Harmonic: 500uV/m</p>
RSS-210 B.10(a)	<p><b>Bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz and 24-24.25 GHz</b></p> <p>(a) The field strength of fundamental and harmonic emissions measured at 3 m shall not exceed the limits in table B2.</p> <p>2400-2483.5MHz, Fundamental Field Strength: 50mV/m, Harmonic: 500uV/m</p>

### General Procedure

C63.10 (6.5.4)	<p><b>6.5.4 Final radiated emission tests</b></p> <p>Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable) and the frequency and amplitude of the six highest spurious emissions relative to the limit; emissions more than 20 dB below the limit do not need to be reported.</p> <p>Measurements are performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.</p>
----------------	---

### Test Setup

**Appendix A                      Figure A.2**

### Measurement Procedure

The DUT place on a 80cm high turntable on an Open Area Test Site (OATS) at a distance of 3m from the measurement antenna. The DUT was set to transmit at maximum power and duty cycle. The DUT was rotated 360 degrees and scanned with the receive antenna elevated from 1 to 4m. The emissions were measured and recorded.

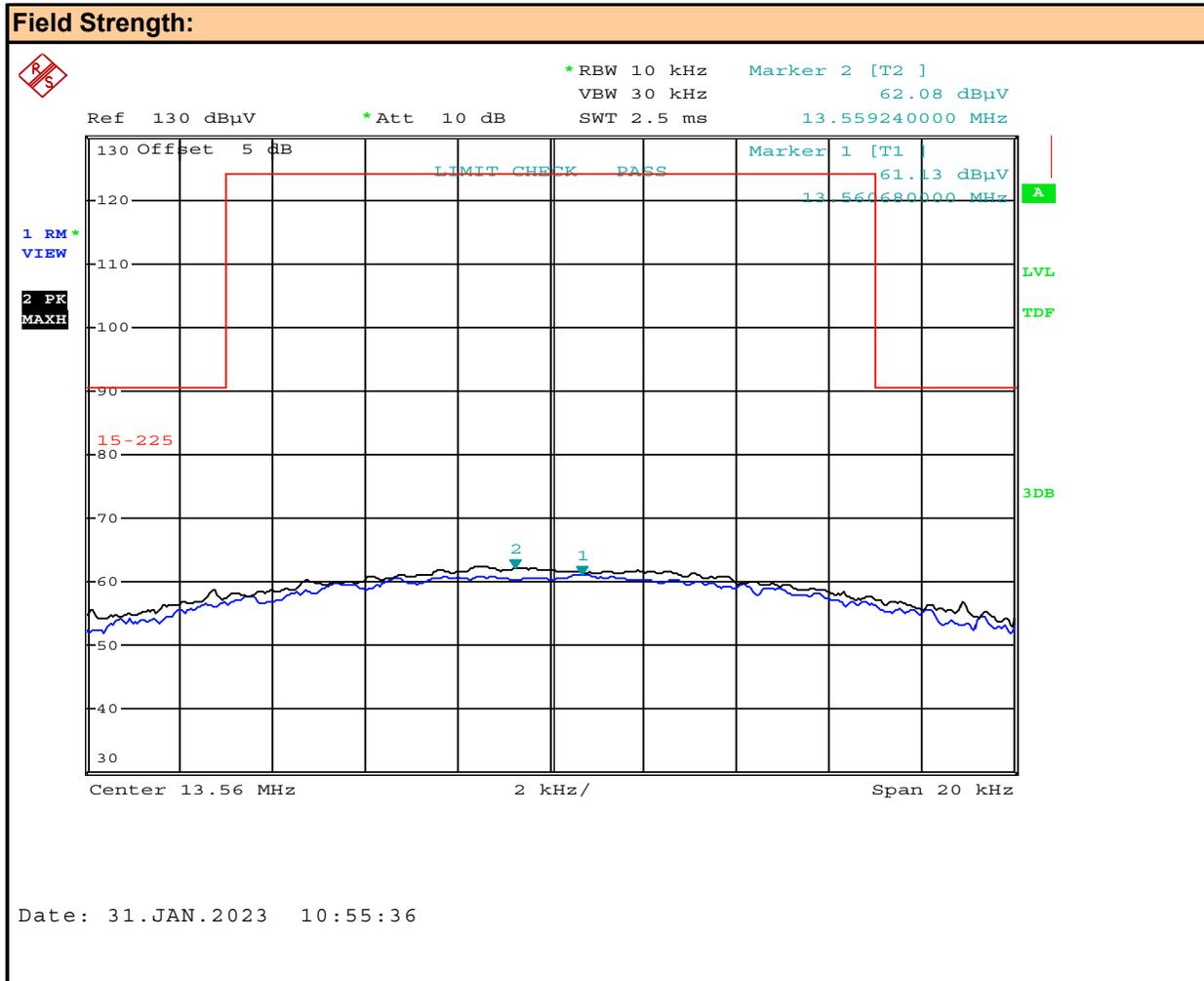
**Table 8.1 - Summary of Field Strength Measurements (BT BLE)**

See Appendix H for Measurement Plots

Field Strength Measurement Results:												
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Antenna Polarization	Measured Field Strength [Avg] (dBuV/m)	Measured Field Strength [Peak] (dBuV/m)	Avg Limit (dBuV/m)	Avg Margin (dB)	Peak Limit (dBuV/m)	Peak Margin (dB)		
37	2402.00	BT LE1	GMSK	Horizontal	80.82	82.74	94.0	13.18	114	31.26		
				Vertical	85.58	87.03		8.42		26.97		
17	2440.00			Horizontal	81.09	82.99		12.91		31.01		
				Vertical	87.06	88.26		6.94		25.74		
39	2480.00			Horizontal	75.93	78.88		18.07		35.12		
				Vertical	83.12	85.79		10.88		28.21		
0	2404.00			BT LE2	GMSK	Horizontal		85.38		87.55	8.62	26.45
						Vertical		84.60		86.79	9.40	27.21
17	2440.00	Horizontal	81.75			84.17	12.25	29.83				
		Vertical	82.14			84.50	11.86	29.50				
36	2478.00	Horizontal	73.89			77.93	20.11	36.07				
		Vertical	74.62			78.54	19.38	35.46				
0	2402.00	ANT	GFSK			Horizontal	79.86	82.07	14.14	31.93		
						Vertical	87.74	89.12	6.26	24.88		
38	2440.00			Horizontal	81.63	83.56	12.37	30.44				
				Vertical	86.57	88.01	7.43	25.99				
78	2480.00			Horizontal	74.48	77.88	19.52	36.12				
				Vertical	79.40	84.48	14.60	29.52				
								<b>Result:</b>	<b>Complies</b>			

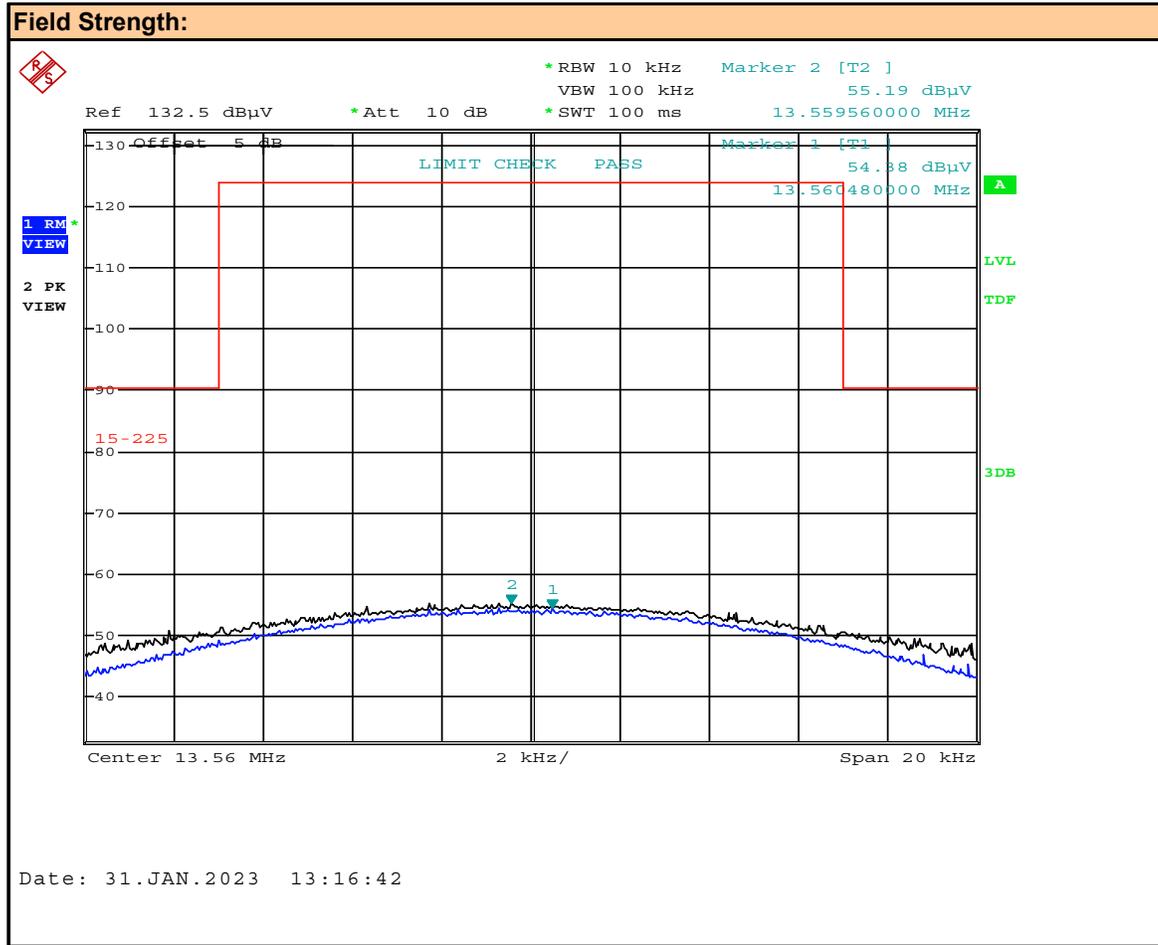
Conducted Margin = P<sub>Lim</sub> - P<sub>Meas</sub>

**Plot 8.1 – Field Strength, NFC**



Channel:	<input type="text" value="-"/>	Channel Frequency:	<input type="text" value="13.56"/> MHz
Mode:	<input type="text" value="NFC"/>	Modulation:	<input type="text" value="ASK"/>
Polarization:	<input type="text" value="Front"/>	Measured Field Strength (Avg):	<input type="text" value="61.13"/> dBuV/m
		Measured Field Strength (Pk):	<input type="text" value="62.08"/> dBuV/m

**Plot 8.1 – Field Strength, NFC**



Channel:	-	Channel Frequency:	13.56 MHz
Mode:	NFC	Modulation:	ASK
Polarization:	Side	Measured Field Strength (Avg):	54.38 dBuV/m
		Measured Field Strength (Pk):	55.19 dBuV/m

**Table 8.3 - Summary of Field Strength Measurements (NFC)**

Radiated Field Strength											
Frequency (MHz)	Mode	Modulation	Detector	Antenna Polarization	Measured Field Strength [FS <sub>Meas</sub> ] (dBuV @ 3m)	Cable Loss [L <sub>c</sub> ] (dBm)	Receive Antenna [ACF] (dB)	Corrected Field Strength [FS <sub>Corr</sub> ] (dBuV/m @3m)	Limit @30m [Lim <sub>30m</sub> ] (dBuV/m)	Limit* @3m [Lim <sub>3m</sub> ] (dBuV/m)	Margin (dB)
13.56	NFC	ASK	RMS	Front	61.13	0.5	10.65	72.28	84.00	124.0	51.7
				Side	54.38			65.53			58.5
			Peak	Front	62.08			73.23	104.00	144.0	70.8
				Side	55.19			66.34			77.7
<b>Result:</b>									<b>Complies</b>		

\* Limit @ 3m = Limit @ 30m + 40dB/decade = 84dBuV/m + 40dB = 124dBuV/m (Average)

\* Limit @ 3m = Limit @ 30m + 40dB/decade = 104dBuV/m + 40dB = 144dBuV/m (Peak)

$$FS_{Corr} = FS_{Meas} + ACF + L_c$$

$$Margin = Limit_{3m} - FS_{Corr}$$

Radiated Field Strength											
Frequency (MHz)	Mode	Modulation	Detector	Antenna Polarization	Measured Field Strength [FS <sub>Meas</sub> ] (dBuV @ 3m)	Cable Loss [L <sub>c</sub> ] (dBm)	Receive Antenna [ACF <sup>H</sup> ] (dBuA/m)	Corrected Field Strength [H <sub>Corr</sub> ] (dBuA/m @3m)	Limit @30m [Lim <sub>30m</sub> ] (dBuV/m)	Limit** @3m [Lim <sub>3m</sub> ] (dBuA/m)	Margin (dB)
13.56	NFC	ASK	RMS	Front	61.13	0.5	-40.85	20.78	84.00	72.5	51.7
				Side	54.38			14.03			58.5
			Peak	Front	62.08			21.73	104.00	92.5	70.8
				Side	55.19			14.84			77.7
<b>Result:</b>									<b>Complies</b>		

\*\* Limit @ 3m = Limit @ 30m + 40dB/decade = 84dBuV/m + 40dB = 124dBuV/m (Average)

\*\* Limit @ 3m = Limit @ 30m + 40dB/decade = 104dBuV/m + 40dB = 144dBuV/m (Peak)

In accordance with ISED Notice 2020 - DRS0023:

"Guidance on Magnetic Field Strength Radiated Emissions Measurements 9kHz - 30MHz"

**Limit Correction**

$$Limit^H (dBuA/m) = Limit^E (dBuV/m) - Z_0 (dB\Omega)$$

Where  $Z_0 = \text{Free-Space Impedance} = 120\pi\Omega = 377\Omega \Rightarrow 20\log 377\Omega = 51.5\text{dB}\Omega$

$$Limit^H (dBuA/m) = Limit^E (dBuV/m) - Z_0 (dB\Omega) = 124\text{dBuV/m} - 51.5\text{dB}\Omega = 72.5\text{dBuA/m @ 3m (Average)}$$

$$Limit^H (dBuA/m) = Limit^E (dBuV/m) - Z_0 (dB\Omega) = 144\text{dBuV/m} - 51.5\text{dB}\Omega = 92.5\text{dBuA/m @ 3m (Peak)}$$

**Measurement Correction**

$$H_{Corr} (dBuA/m) = E_{Meas} (dBuV) + ACF^H (dB/\Omega m) + L_c - G_A$$

Where  $ACF^H$  is the Magnetic Antenna Correction Factor,  $L_c$  is Cable Loss,  $G_A$  is Pre-Amplifier Gain

External Pre-Amplifier ( $G_A$ ) not used

$$Margin = Limit_{3m} - H_{Corr}$$

**9.0 20DB BW**

**Test Procedure**

<b>Normative Reference</b>	<b>FCC 47 CFR §2.1051, §15.215</b>
	<b>ANSI C63.10 (6.10.3)</b>

**Limits**

§15.215(c)	<p><b>Additional provisions to the general radiated emission limitations.</b></p> <p>(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.</p>
------------	--

**General Procedure**

C63.10 (6.3.10)	<p><b>6.10.3 Unlicensed wireless device operational configuration</b></p> <p>Set the EUT to operate at 100% duty cycle or equivalent “normal mode of operation.”<sup>54</sup> Testing shall be performed at the lowest frequency channel and highest frequency channel within the allowed operating band.<sup>55</sup> Testing shall be performed for each frequency with every applicable unlicensed wireless device configuration. If more than one power output level is available, then testing shall be done with the appropriate maximum power output for each antenna combination or modulation, as recorded in the unlicensed wireless device conducted power measurement results. The highest gain of each antenna type shall be used for this test.</p>
-----------------	---

<sup>54</sup> For unlicensed wireless devices unable to be configured for 100% duty cycle even in test mode, configure the system for the longest duration duty cycle supported.

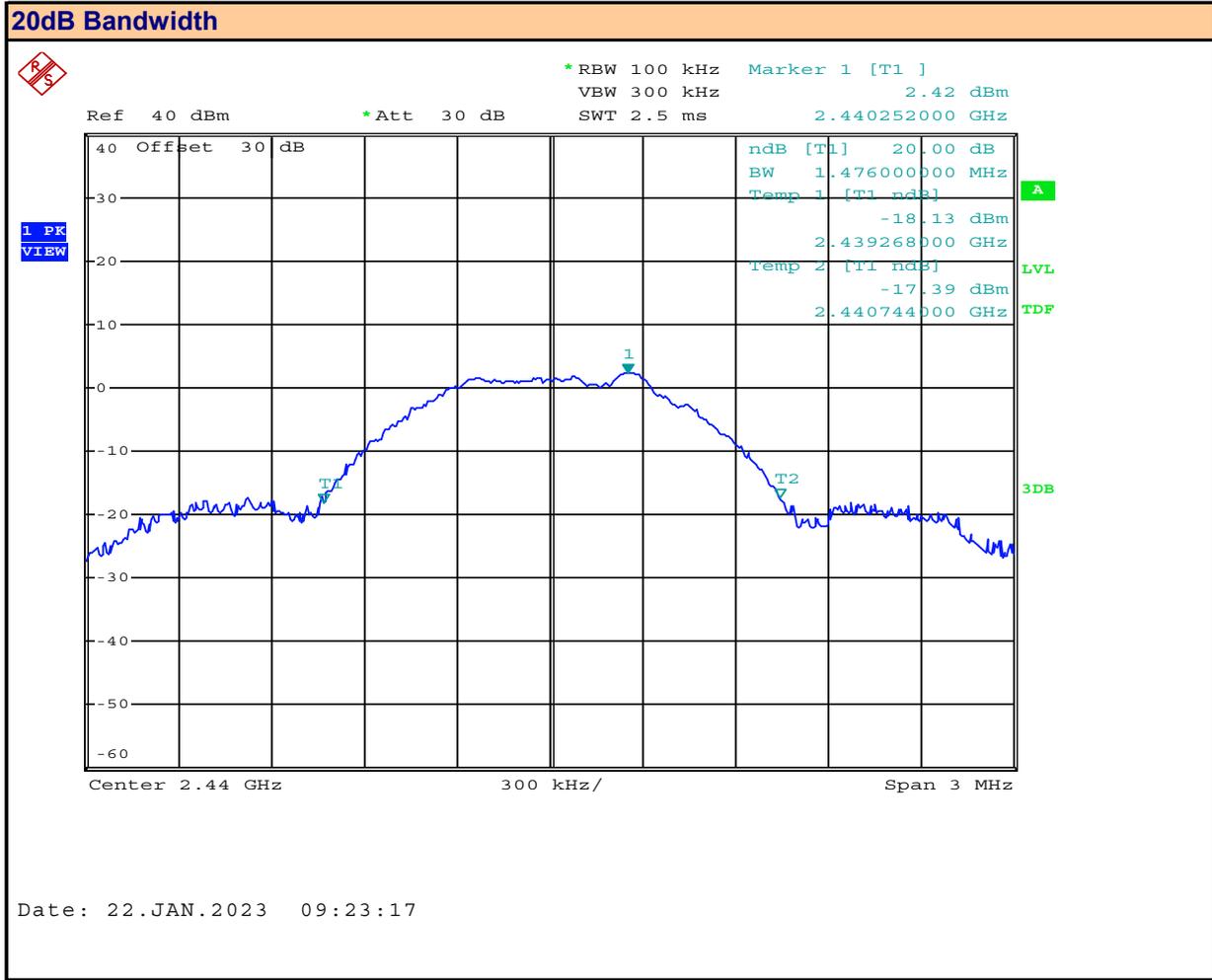
<sup>55</sup> Some radios operating, for example, in the 2.4 GHz band, have hardware capability to operate at frequencies outside the band permitted by the regulatory authority. Testing shall only be done at the lowest and highest frequencies within the allowed frequency band (see Annex A for examples of regulatory requirements and frequency ranges).

<b>Test Setup</b>	<b>Appendix A</b>	<b>Figure A.1</b>
-------------------	-------------------	-------------------

**Measurement Procedure**

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as described above. The output power of the DUT was set to the manufacturer's highest output power setting at the Low and High frequency channels as permitted by the device. The unwanted band edge emissions were measured and recorded.

Plot 9.1 – 20dB Bandwidth, BLE1



Channel:

Mode:

Channel Frequency:  MHz

Modulation:

Measured 20dB Bandwidth:  MHz

Plot 9.2 – 20dB Bandwidth, BLE2



Channel:

Mode:

Channel Frequency:  MHz

Modulation:

Measured 20dB Bandwidth:  MHz

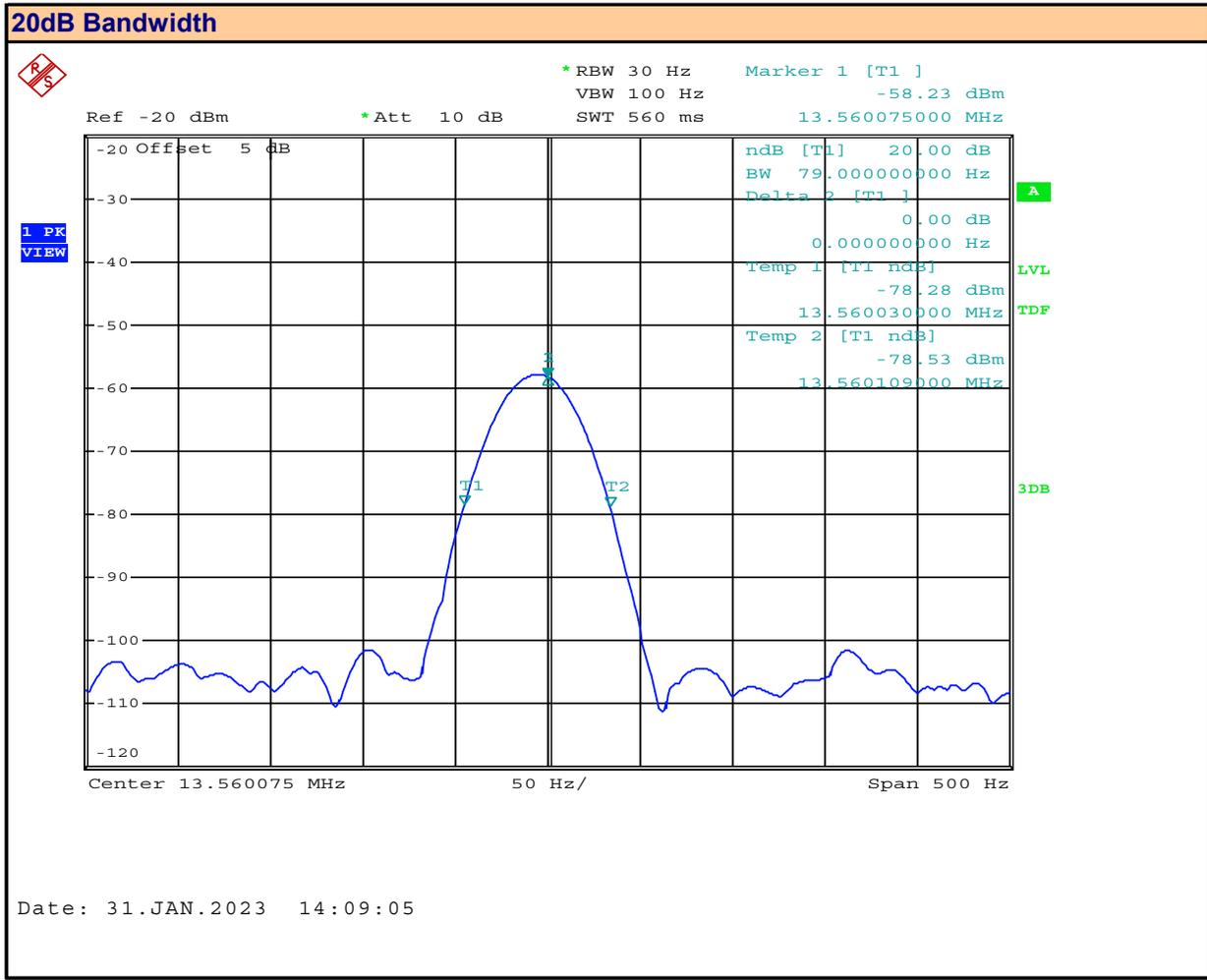
**Plot 9.3 – 20dB Bandwidth, ANT**



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured 20dB Bandwidth:  MHz

Plot 9.4 – 20dB Bandwidth, NFC



Channel:   
 Mode:

Channel Frequency:  MHz  
 Modulation:   
 Measured 20dB Bandwidth:  Hz

**Table 9.1 - Summary of 20dB BW Measurements**

<b>20dB Bandwidth Results:</b>				
<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>	<b>Mode</b>	<b>Modulation</b>	<b>Measured 20dB Bandwidth (MHz)</b>
17	2440.0	BT LE1	GMSK	1.476
17	2440.0	BT LE2	GMSK	2.850
38	2440.0	ANT	GFSK	1.452
-	13.6	NFC	ASK	79Hz
<b>Result:</b>				<b>Complies</b>

**10.0 OUT-OF-BAND EMISSIONS- NFC**

**Test Procedure**

<b>Normative Reference</b>	<b>FCC 47 CFR §2.1046, §15.225, RSS-210</b>
	<b>KDB 558074 (8.3.2), ANSI C63.10 (11.9.2.2.6)</b>

**Limits**

§15.225	<p><b>Operation within the band 13.110-14.010 MHz.</b></p> <p>(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.</p> <p>(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.</p> <p>(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.</p> <p>(d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.</p>
RSS-210 B.10(6)	<p><b>Band 13.110-14.010 MHz</b></p> <p>(a) the field strength of any emission shall not exceed the following limits:</p> <p>(i) 15.848 mV/m (84 dBµV/m) at 30 m, within the band 13.553-13.567 MHz</p> <p>(ii) 334 µV/m (50.5 dBµV/m) at 30 m, within the bands 13.410-13.553 MHz and 13.567-13.710 MHz</p> <p>(iii) 106 µV/m (40.5 dBµV/m) at 30 m, within the bands 13.110-13.410 MHz and 13.710-14.010 MHz</p> <p>(iv) RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz</p>

**General Procedure**

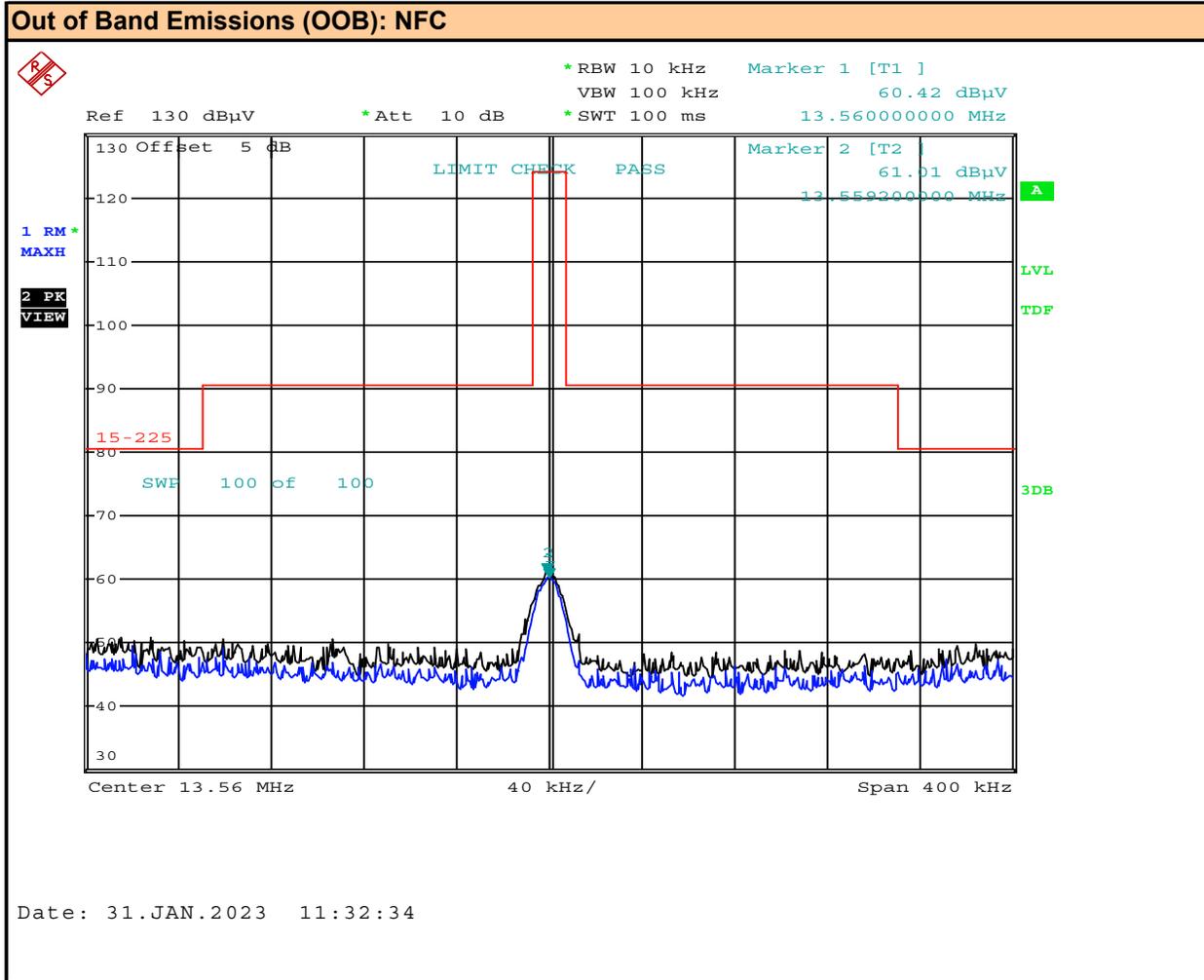
C63.10 (6.5.4)	<p><b>6.5.4 Final radiated emission tests</b></p> <p>Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable) and the frequency and amplitude of the six highest spurious emissions relative to the limit; emissions more than 20 dB below the limit do not need to be reported.</p> <p>Measurements are performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.</p>
----------------	---

<b>Test Setup</b>	<b>Appendix A</b>	<b>Figure A.2</b>
-------------------	-------------------	-------------------

**Measurement Procedure**

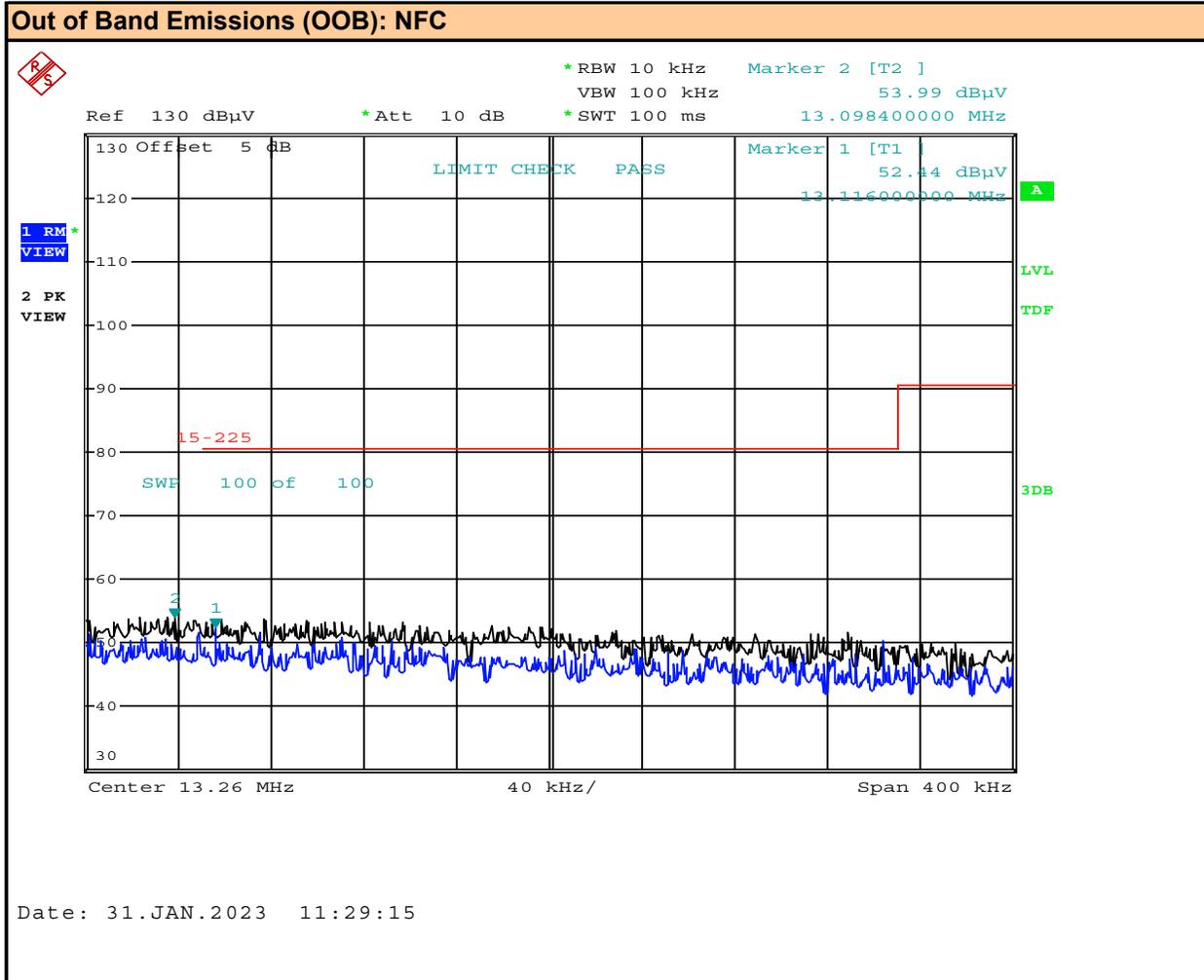
The DUT place on a 80cm high turntable on an Open Area Test Site (OATS) at a distance of 3m from the measurement antenna. The DUT was set to transmit at maximum power and duty cycle. The DUT was rotated 360 degrees and scanned with the receive antenna elevated from 1 to 4m. The emissions were measured and recorded.

**Plot 10.1 – Out of Band Emissions, NFC**



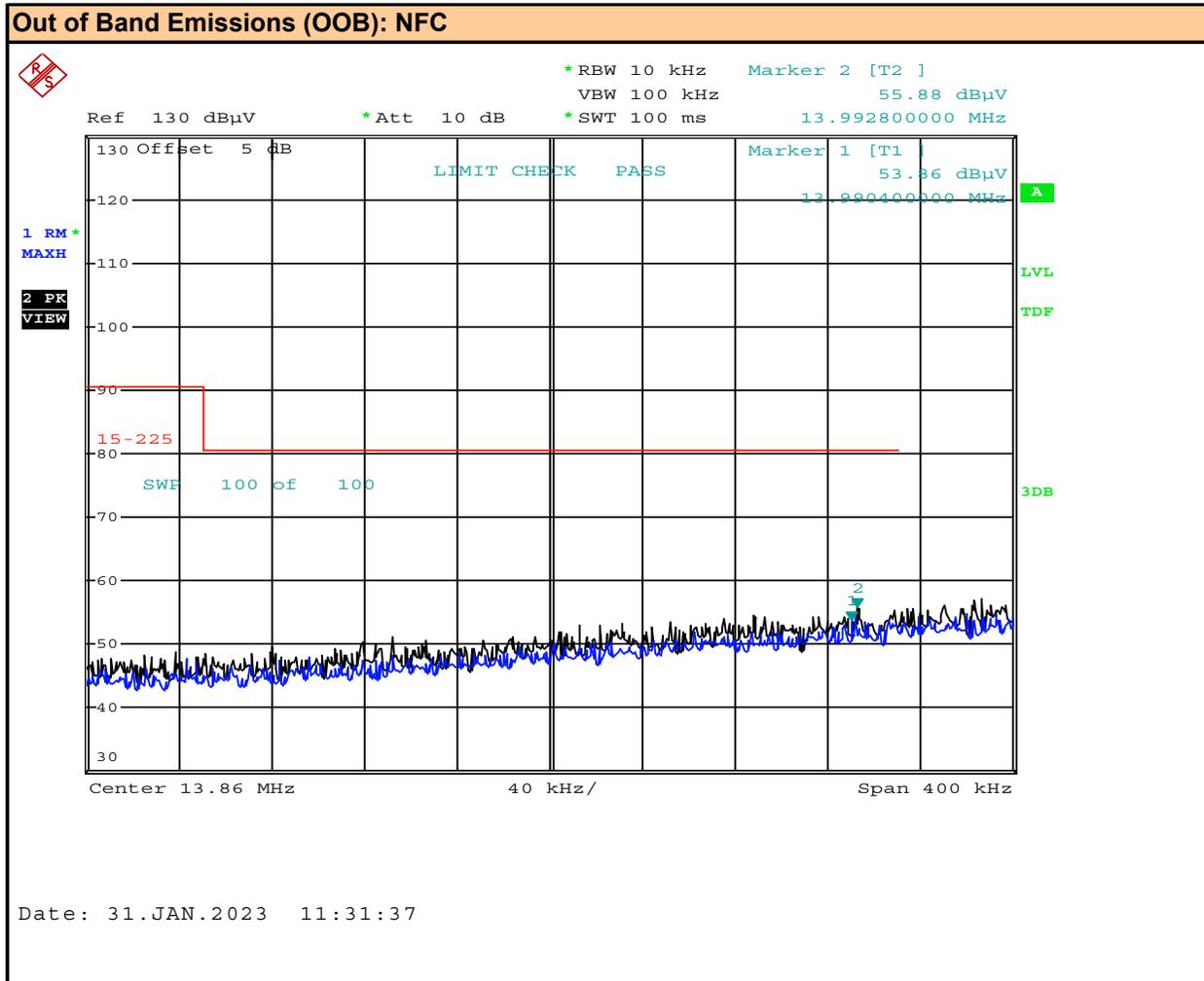
Channel:	-	Channel Frequency:	13.56 MHz
Mode:	NFC	Modulation:	ASK
Polarization:	Front	Measured OOB Emissions (Avg):	- dBuV/m
		Measured OOB Emissions (Pk):	- dBuV/m

**Plot 10.2 – Out of Band Emissions, NFC**



Channel:	<input type="text" value="-"/>	Channel Frequency:	<input type="text" value="13.56"/>	MHz
Mode:	<input type="text" value="NFC"/>	Modulation:	<input type="text" value="ASK"/>	
Polarization:	<input type="text" value="Front"/>	Measured OOB Emissions (Avg):	<input type="text" value="-"/>	dBuV/m
		Measured OOB Emissions (Pk):	<input type="text" value="-"/>	dBuV/m

**Plot 10.3 – Out of Band Emissions, NFC**



Channel:	<input type="text" value="-"/>	Channel Frequency:	<input type="text" value="13.56"/>	MHz
Mode:	<input type="text" value="NFC"/>	Modulation:	<input type="text" value="ASK"/>	
Polarization:	<input type="text" value="Front"/>	Measured OOB Emissions (Avg):	<input type="text" value="-"/>	dBuV/m
		Measured OOB Emissions (Pk):	<input type="text" value="-"/>	dBuV/m

Table 10.1 – Summary of Field Strength Measurements (NFC)

Out of Band Emissions Summary									
Frequency (MHz)	Mode	Modulation	Detector	Antenna Polarization	Measured Emissions [FS <sub>Meas</sub> ] (dBuV @ 3m)	Cable Loss [L <sub>c</sub> ] (dBm)	Receive Antenna [ACF] (dB)	Corrected Field Strength [FS <sub>Corr</sub> ] (dBuV/m @3m)	Margin (dB)
13.56	NFC	ASK	RMS	Front	ND	0.5	10.65	-	-
			Peak	Front	ND			-	-
<b>Result:</b>									<b>Complies</b>

\* Limit @ 3m = Limit @ 30m + 40dB/decade = 84dBuV/m + 40dB = 124dBuV/m (Average)

\* Limit @ 3m = Limit @ 30m + 40dB/decade = 104dBuV/m + 40dB = 144dBuV/m (Peak)

$$FS_{Corr} = FS_{Meas} + ACF + L_C$$

$$Margin = Limit_{3m} - FS_{Corr}$$

ND: None Detected

**11.0 RADIATED SPURIOUS EMISSIONS – RESTRICTED BANDS**

**Test Procedure**

<b>Normative Reference</b>	<b>FCC 47 CFR §2.1051, §15.247(d), §15.205(a), §15.205(c), §15.209(a)</b>
	<b>KDB 558074 (8.6), ANSI C63.10 (11.12)</b>

**Limits**

47 CFR §15.247(d)	(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)).																
47 CFR §15.209(a)	<p><b>§15.209 Radiated emission limits; general requirements.</b></p> <p>(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:</p> <table border="1"> <thead> <tr> <th>Frequency (MHz)</th> <th>Field Strength (microvolts/meter)</th> </tr> </thead> <tbody> <tr> <td>0.009 - 0.490</td> <td>2400/F (kHz) @300m</td> </tr> <tr> <td>0.490 - 1.705</td> <td>24000/F (kHz) @30m</td> </tr> <tr> <td>1.705 - 30</td> <td>30 @ 30m</td> </tr> <tr> <td>30 - 88</td> <td>100 @3m</td> </tr> <tr> <td>88 - 216</td> <td>150 @3m</td> </tr> <tr> <td>216 - 960</td> <td>200 @3m</td> </tr> <tr> <td>Above 960</td> <td>500 @3m</td> </tr> </tbody> </table>	Frequency (MHz)	Field Strength (microvolts/meter)	0.009 - 0.490	2400/F (kHz) @300m	0.490 - 1.705	24000/F (kHz) @30m	1.705 - 30	30 @ 30m	30 - 88	100 @3m	88 - 216	150 @3m	216 - 960	200 @3m	Above 960	500 @3m
Frequency (MHz)	Field Strength (microvolts/meter)																
0.009 - 0.490	2400/F (kHz) @300m																
0.490 - 1.705	24000/F (kHz) @30m																
1.705 - 30	30 @ 30m																
30 - 88	100 @3m																
88 - 216	150 @3m																
216 - 960	200 @3m																
Above 960	500 @3m																

**Table 11.1 – Summary of Radiated Tx Emissions**

See Appendix I for Measurement Plots

<b>Summary of Radiated Tx Emissions</b>										
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>C</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)
30-1000MHz	2412.0	Horizontal	42.15	7.59	17.31	0.73	0.00 (3)	25.6 (2)	40.0	14.4
30-1000MHz	2412.0	Horizontal	51.33	7.51	12.47	0.77	0.00 (3)	20.8 (2)	40.0	19.2
30-1000MHz	2412.0	Horizontal	827.80	8.44	29.22	2.82	0.00 (3)	40.5 (2)	46.0	5.5
30-1000MHz	2412.0	Vertical	908.30	8.46	29.50	2.94	0.00 (3)	40.9 (2)	46.0	5.1
30-1000MHz	2412.0	Vertical	911.10	8.30	29.41	2.95	0.00 (3)	40.7 (2)	46.0	5.4
1 - 3GHz	2412.0	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
1 - 3GHz	2412.0	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
3-13GHz	2412.0	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
3-13GHz	2412.0	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
13-18GHz	2412.0	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
13-18GHz	2412.0	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
18-26GHz	2412.0	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
18-26GHz	2412.0	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
<b>Results:</b>									<b>Complies</b>	

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit

(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{Corr} = E_{Meas} + ACF + L_C - G_A$$

**Table 11.2 – Summary of Radiated Emissions, Restricted Band (NFC)**

See Appendix I for Measurement Plots

<b>Summary of Radiated Tx Emissions (Restricted Band)</b>										
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)
9kHz - 30MHz	2412.0	Front	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	n/a	n/a
9kHz - 30MHz	2412.0	Side	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	n/a	n/a
30-1000MHz	2412.0	Horizontal	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	n/a	n/a
30-1000MHz	2412.0	Vertical	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	n/a	n/a
1 - 3GHz	2412.0	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
1 - 3GHz	2412.0	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
<b>Results:</b>									<b>Complies</b>	

- (1) No Emissions Detected (ND) above ambient or within 20dB of the limit
  - (2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
  - (3) External Amplifier not used
- $$E_{Corr} = E_{Meas} + ACF + L_C - G_A$$

## 12.0 RADIATED RX SPURIOUS EMISSIONS

### Test Procedure

<b>Normative Reference</b>	FCC 47 CFR §2.1046
	KDB 558074 (8.3.2), ANSI C63.10 (11.9.2.2.6)

### General Procedure

C63.10 (6.5.4)	<p><b>6.5.4 Final radiated emission tests</b></p> <p>Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable) and the frequency and amplitude of the six highest spurious emissions relative to the limit; emissions more than 20 dB below the limit do not need to be reported.</p> <p>Measurements are performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.</p>
----------------	---

<b>Test Setup</b>	<b>Appendix A</b>	<b>Figure A.2</b>
-------------------	-------------------	-------------------

### Measurement Procedure

The DUT place on a 80cm high turntable on an Open Area Test Site (OATS) at a distance of 3m from the measurement antenna. The DUT was set to transmit at maximum power and duty cycle. The DUT was rotated 360 degrees and scanned with the receive antenna elevated from 1 to 4m. The emissions were measured and recorded.

**Table 12.1 – Summary of Radiated Rx Emissions**

See Appendix J for Measurement Plots

<b>Summary of Radiated Rx Emissions</b>											
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>C</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)	
30-1000MHz	-	Horizontal	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	46.0	n/a	
30-1000MHz	-	Vertical	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	43.5	n/a	
1 - 3GHz	-	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a	
1 - 3GHz	-	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a	
3-13GHz	-	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a	
3-13GHz	-	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a	
13-18GHz	-	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a	
13-18GHz	-	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a	
18-26GHz	-	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a	
18-26GHz	-	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a	
<b>Results:</b>									<b>Complies</b>		

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit

(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{Corr} = E_{Meas} + ACF + L_C - G_A$$

### 13.0 FREQUENCY STABILITY (NFC)

#### Test Conditions

<b>Normative Reference</b>	<b>FCC 47 CFR §2.1055, §15.225, RSS-Gen, RSS-210</b>
----------------------------	--

#### Limits

47 CFR §15.225	(e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of $-20$ degrees to $+ 50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.
RSS-210 B.6	(b) the carrier frequency stability shall not exceed $\pm 100$ ppm

#### Measurement Procedure

##### 47 CFR §2.1055 Frequency Stability

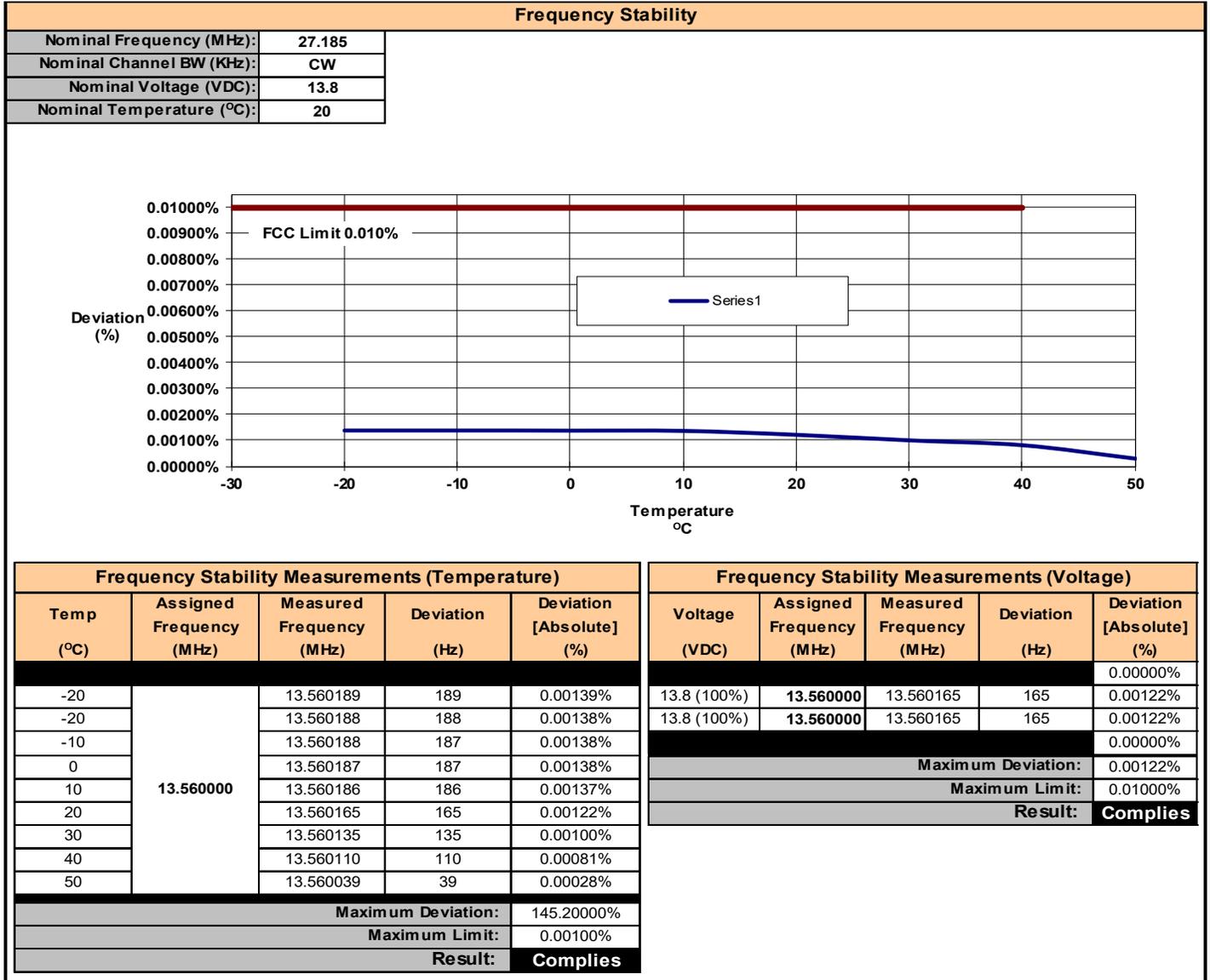
- (a) The frequency stability shall be measured with variation of ambient temperature as follows:
- (1) From  $-30^{\circ}$  to  $+50^{\circ}$  centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
  - (b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than  $10^{\circ}$  centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement.
- (d) The frequency stability shall be measured with variation of primary supply voltage as follows:
- (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

#### Test Setup

Appendix A

5

Table 13.1 – Summary of Frequency Stability Measurements – FCC



## 14.0 POWER LINE CONDUCTED EMISSIONS

### Test Procedure

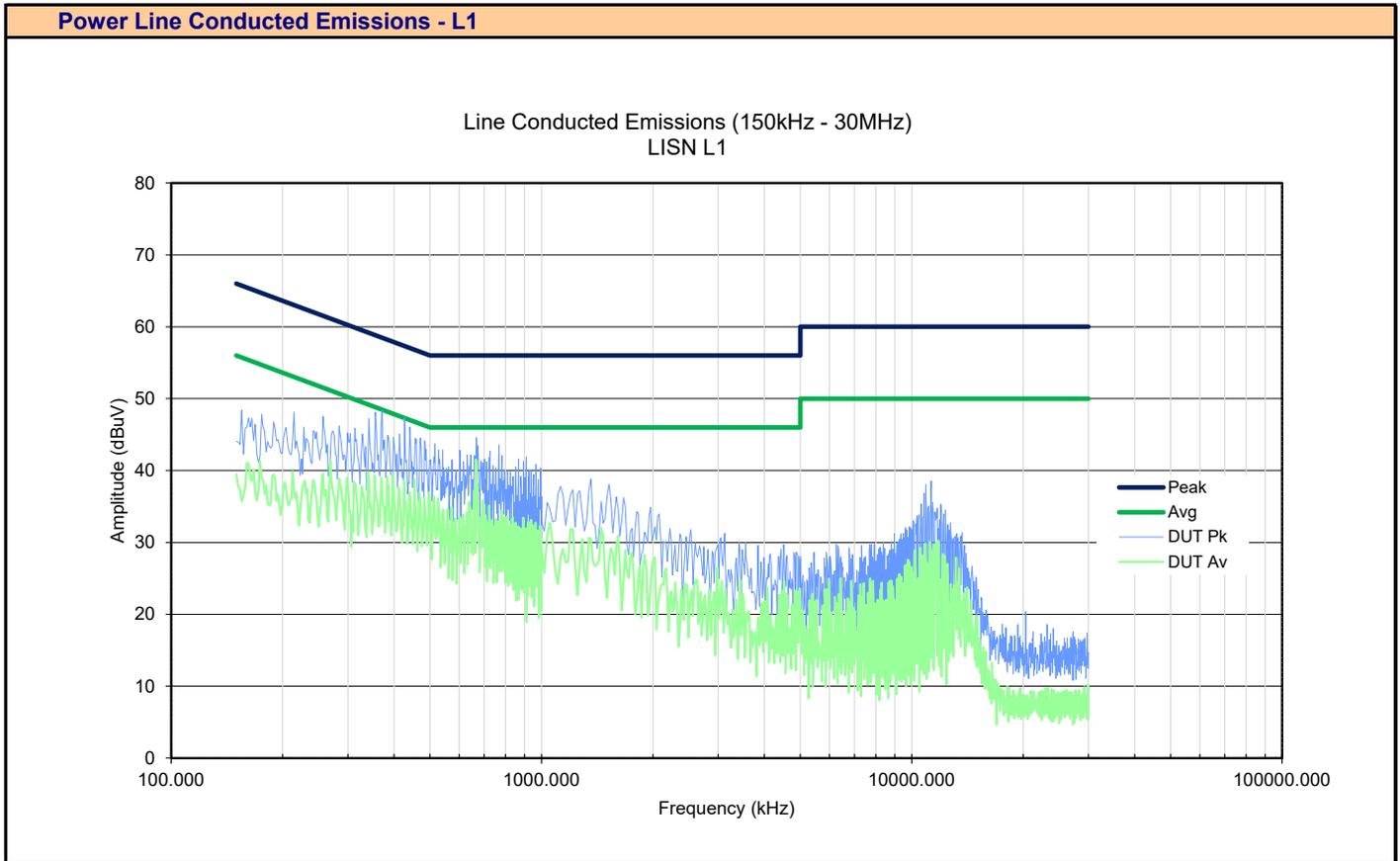
<b>Normative Reference</b>	FCC 47 CFR §15.107, ICES-003(6.1) ANSI C63.4-2014
----------------------------	--

### Limits

47 CFR §15.107	(a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges. 0.15-0.5MHz: 66-56 dBuV Quasi Peak, 56-46 dBuV Average, Decreases with the logarithm of the frequency 0.5 - 5.0 MHz: 56 dBuV Quasi Peak, 46 dBuV Average 5.0 - 30.0 MHz: 60 dBuV Quasi Peak, 50 dBuV Average
ICES-003(6.1)	6.1 - AC Power Line Conducted Emissions Limits Class B: ITE that does not meet the conditions for Class A operation shall comply with the Class B radiated limits set out in Table 2. 0.15-0.5MHz: 66-56 dBuV Quasi Peak, 56-46 dBuV Average, Decreases with the logarithm of the 0.5 - 5.0 MHz: 56 dBuV Quasi Peak, 46 dBuV Average 5.0 - 30.0 MHz: 60 dBuV Quasi Peak, 50 dBuV Average

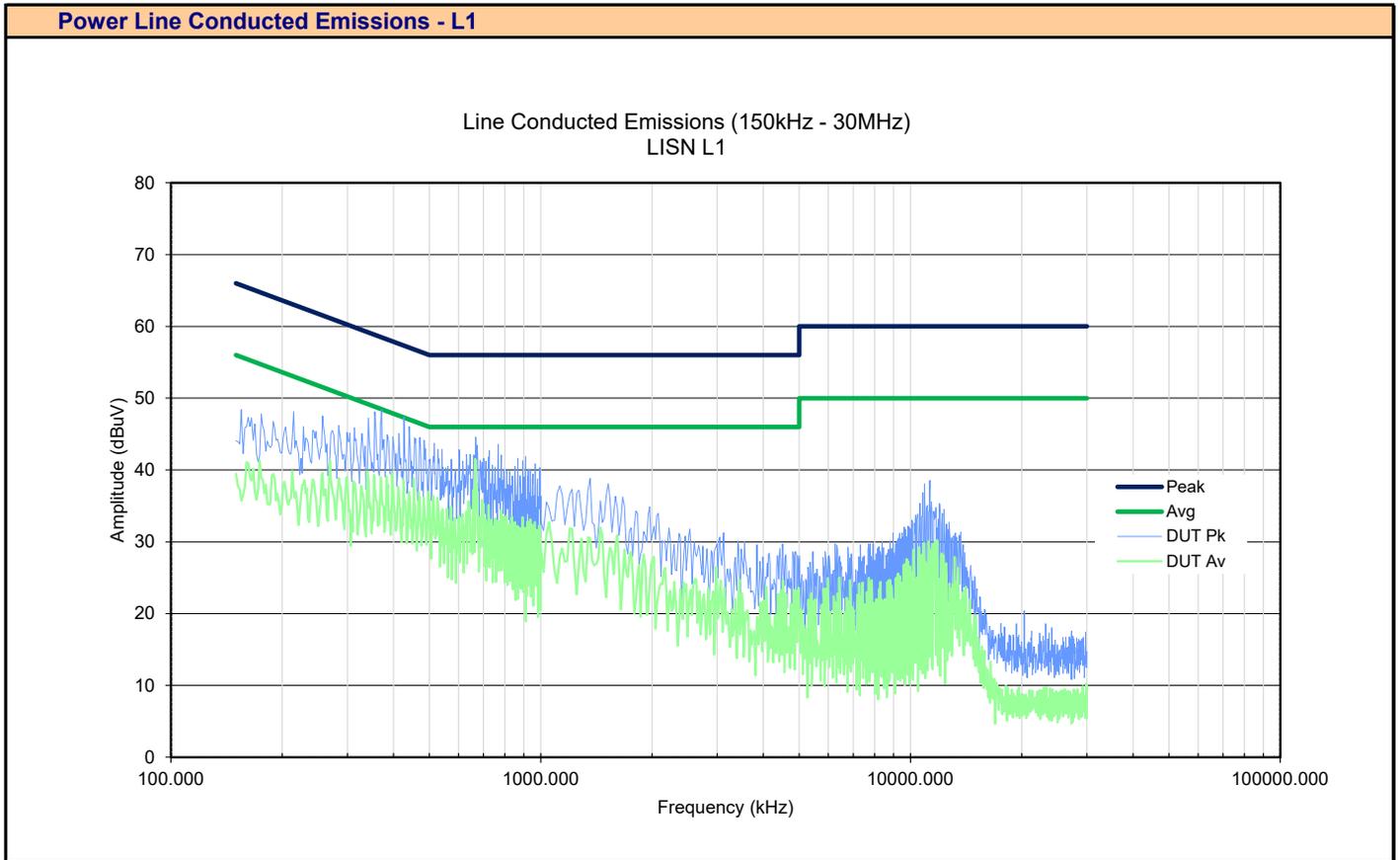
<b>Test Setup</b>	<b>Appendix A</b> <b>Figure A.7</b>
-------------------	-------------------------------------

**Plot 14.1 – Power Line Conducted Emissions, Line 1**



Channel:	<b>6</b>	Channel Frequency:	<b>2437</b> MHz
Mode:	<b>802.11b</b>	Modulation:	<b>CCK 1MB</b>
Emission Frequency:	<b>371kHz</b>	Measured Channel Power:	<b>48.38</b> dBuV

Plot 14.2 – Power Line Conducted Emissions, Line 2



Channel:	<b>6</b>	Channel Frequency:	<b>2437</b> MHz
Mode:	<b>802.11b</b>	Modulation:	<b>CCK 1MB</b>
Emission Frequency:	<b>371kHz</b>	Measured Channel Power:	<b>48.38</b> dBuV

**Table 14.1 – Summary of Power Line Conducted Emissions – L1**

<b>Summary of Power Line Conducted Tx Emissions</b>											
Measured Frequency Range (MHz)	Channel Frequency (MHz)	LISN Port	Emission Frequency [f <sub>Emm</sub> ]	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Detector*	Insertion Loss [L <sub>LISN</sub> ] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV)	Limit (dBuV)	Margin (dB)
150kHz - 30MHz	2437.0	L1	371.00 kHz	48.38	Peak	0.30	0.26	0.00 (3)	48.94 (2)	58.0	9.1
<b>Results:</b>										<b>Complies</b>	

\* In accordance with FCC §15.35 and ANSI C63.4, a Peak detector may be used to demonstrate compliance to Quasi-Peak limits provided the Resolution Bandwidth (RBW) is equal to or greater than Quasi-Peak bandwidth. The Detector RBW employed was ≥ 9kHz.

(2) LISN Insertion Loss, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{Corr} = E_{Meas} + L_{LISN} + L_c - G_A$$

Class B QP Limit = 56 - 20Log (f<sub>Emm</sub>/500) for f<sub>Emm</sub> = 150kHz to 500kHz

Class B Avg Limit = 46 - 20Log (f<sub>Emm</sub>/500) for f<sub>Emm</sub> = 150kHz to 500kHz

Class A QP Limit = 79dBuV for f<sub>Emm</sub> = 150kHz to 500kHz

Class A Avg Limit = 66dBuV for f<sub>Emm</sub> = 150kHz to 500kHz

$$\text{Margin} = \text{Limit} - E_{Corr}$$

**Table 14.1 – Summary of Power Line Conducted Emissions – L2**

<b>Summary of Power Line Conducted Tx Emissions</b>											
Measured Frequency Range (MHz)	Channel Frequency (MHz)	LISN Port	Emission Frequency [f <sub>Emm</sub> ] (kHz)	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Detector*	Insertion Loss [L <sub>LISN</sub> ] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV)	Limit (dBuV)	Margin (dB)
150kHz - 30MHz	2437.0	L2	362.50 kHz	46.46	Peak	0.30	0.26	0.00 (3)	47.02 (2)	58.6	11.6
<b>Results:</b>										<b>Complies</b>	

\* In accordance with FCC §15.35 and ANSI C63.4, a Peak detector may be used to demonstrate compliance to Quasi-Peak limits provided the Resolution Bandwidth (RBW) is equal to or greater than Quasi-Peak bandwidth. The Detector RBW employed was ≥ 9kHz.

(2) LISN Insertion Loss, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{Corr} = E_{Meas} + L_{LISN} + L_c - G_A$$

Class B QP Limit = 56 - 20Log (f<sub>Emm</sub>/500) for f<sub>Emm</sub> = 150kHz to 500kHz

Class B Avg Limit = 46 - 20Log (f<sub>Emm</sub>/500) for f<sub>Emm</sub> = 150kHz to 500kHz

Class A QP Limit = 79dBuV for f<sub>Emm</sub> = 150kHz to 500kHz

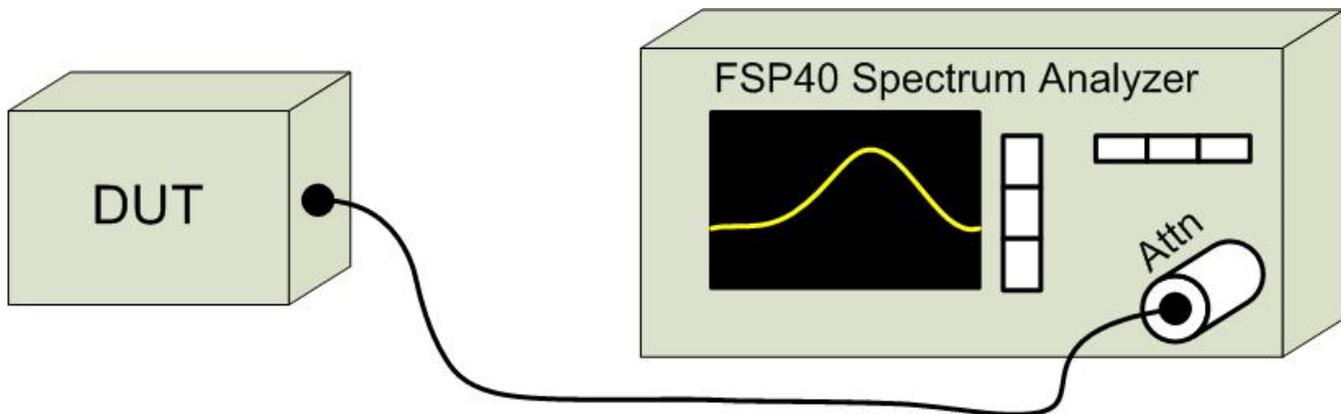
Class A Avg Limit = 66dBuV for f<sub>Emm</sub> = 150kHz to 500kHz

$$\text{Margin} = \text{Limit} - E_{Corr}$$

**APPENDIX A – TEST SETUP DRAWINGS AND EQUIPMENT**

**Table A.1 – Setup - Conducted Measurements Equipment List**

Equipment List				
Asset Number	Manufacturer	Model Number	Serial Number	Description
00241	R&S	F5U40	100500	Spectrum Analyzer
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable



**Figure A.1 – Test Setup Conducted Measurements**

**Table A.2 – Setup - Radiated Emissions Equipment List**

<b>Equipment List</b>				
<b>Asset Number</b>	<b>Manufacturer</b>	<b>Model Number</b>	<b>Serial Number</b>	<b>Description</b>
00050	Chase	CBL-6111A	1607	Bilog Antenna
00034	ETS	3115	6267	Double Ridged Guide Horn
00035	ETS	3115	6276	Double Ridged Guide Horn
00085	EMCO	6502	9203-2724	Loop Antenna
00161	Waveline Inc.	889		Standard Gain Horn 18-26GHz
00162	Waveline Inc.	889		Standard Gain Horn 18-26GHz
00165	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
00166	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
00333	HP	85685A	3010A01095	RF Preselector
00049	HP	85650A	2043A00162	Quasi-peak Adapter
00051	HP	8566B	2747A05510	Spectrum Analyzer
00241	R&S	FSU40	100500	Spectrum Analyzer
00265	Miteq	JS32-00104000-58-5P	1939850	Microwave L/N Amplifier
00071	EMCO	2090	9912-1484	Multi-Device Controller
00072	EMCO	2075	0001-2277	Mini-mast
00073	EMCO	2080	0002-1002	Turn Table
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable
00263B	Koaxis	KP10-1.00M-TD	263B	1m Armoured Cable
00275	TMS	LMR400	n/a	25m Cable
00278	TILE	34G3	n/a	TILE Test Software

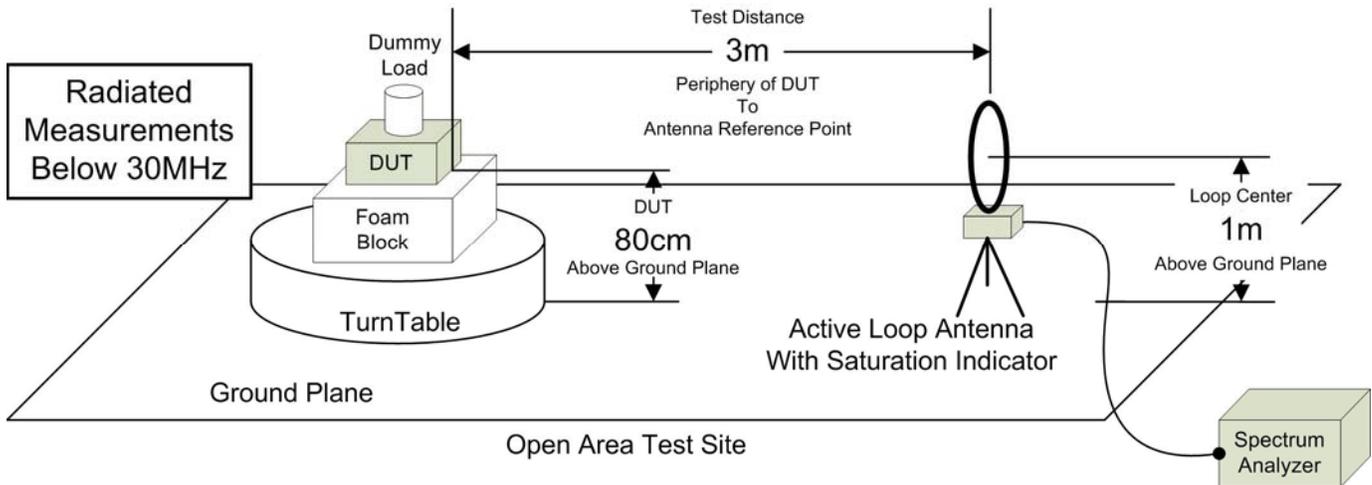


Figure A.2 – Test Setup Radiated Emissions Measurements Below 30MHz

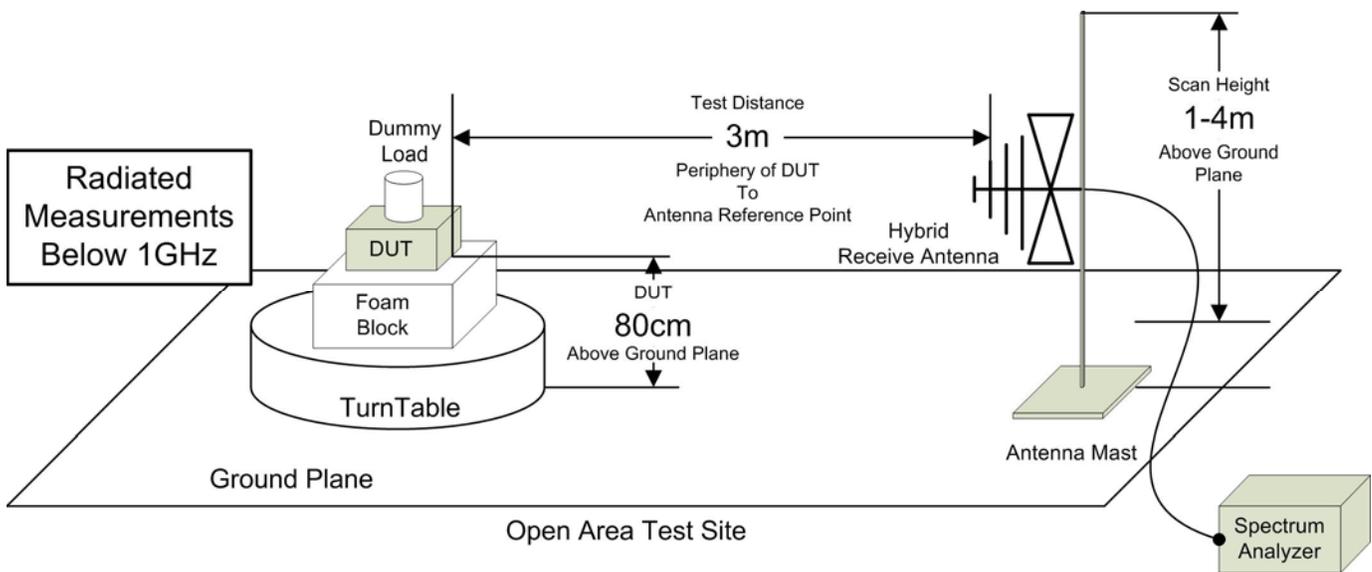
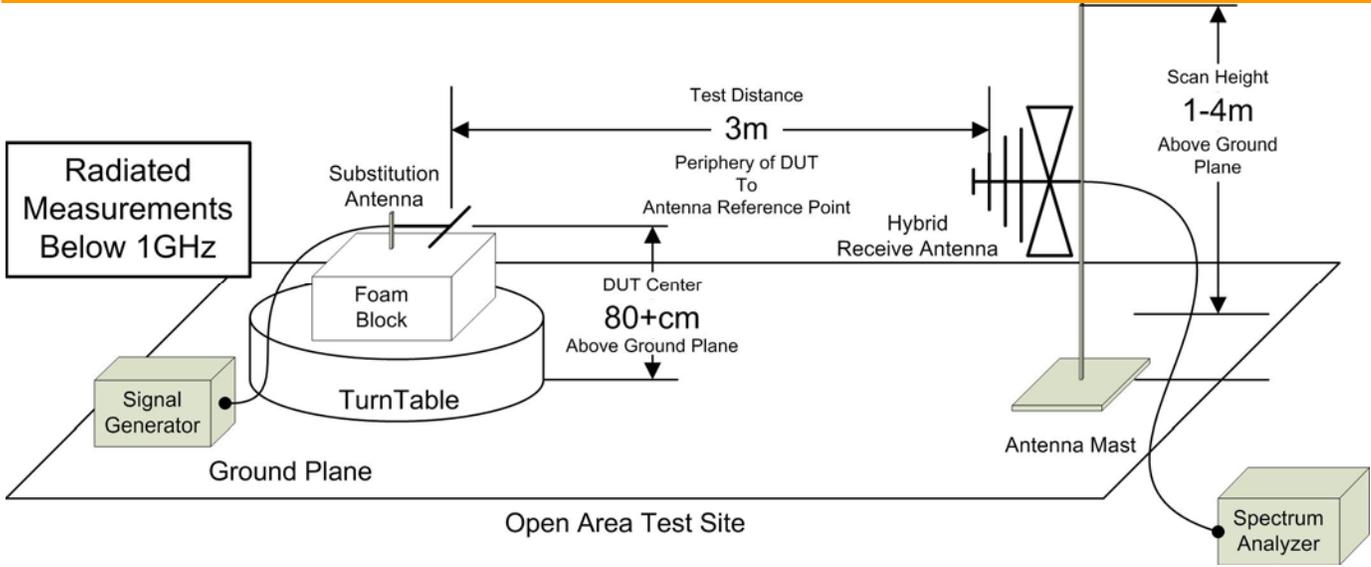
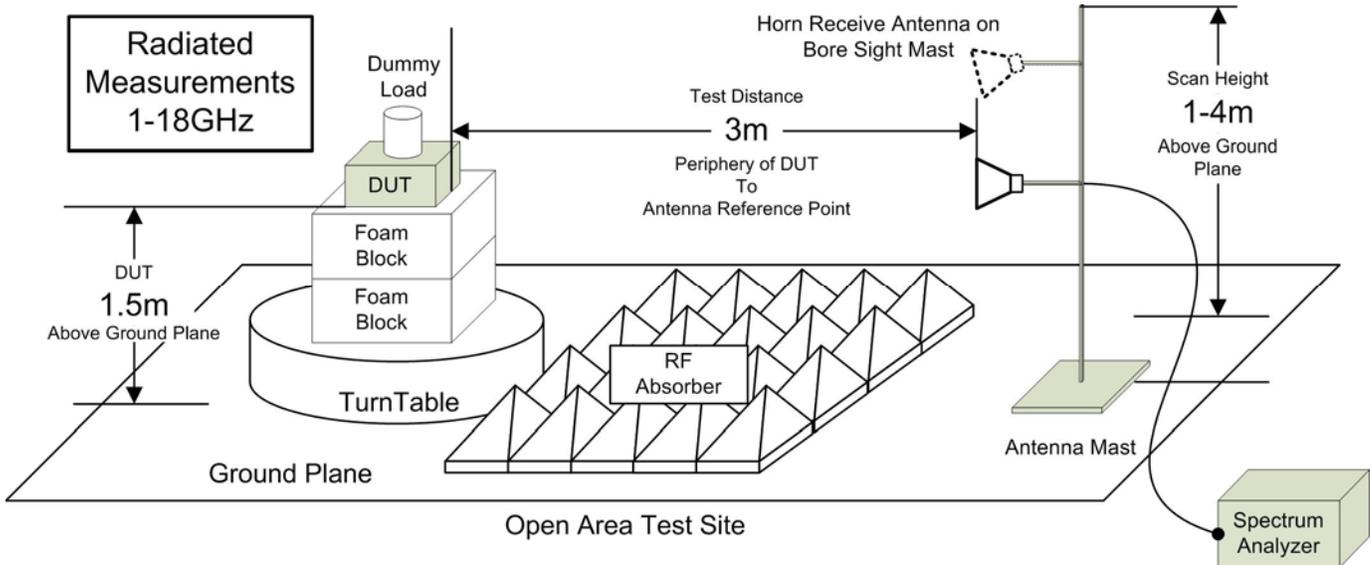


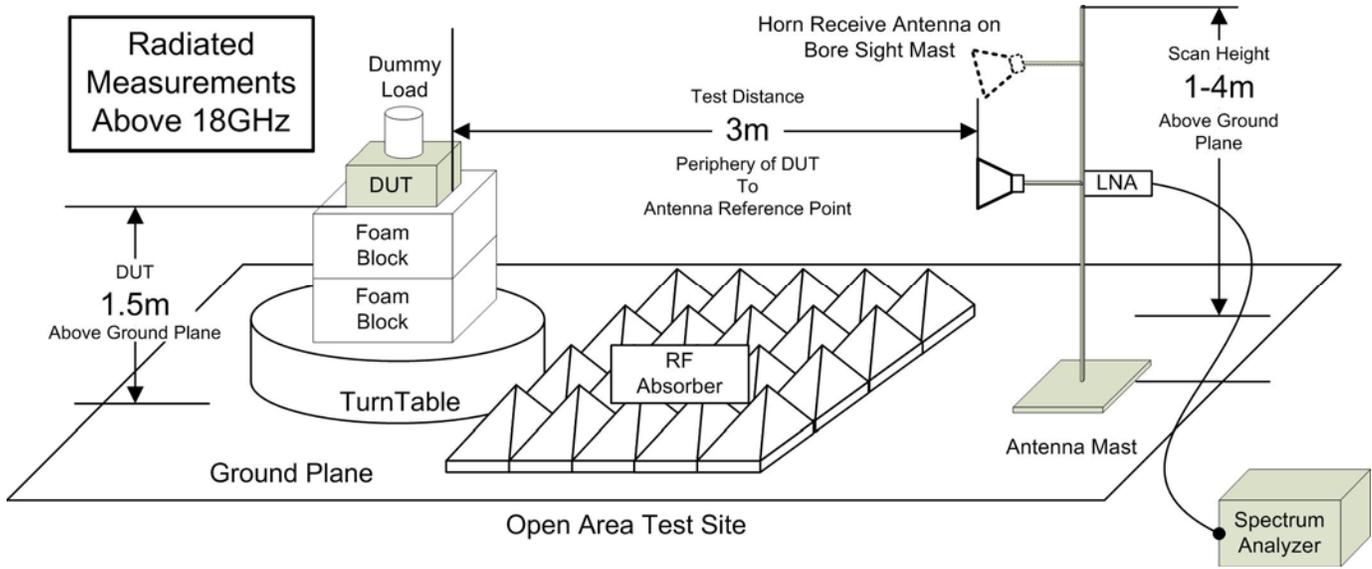
Figure A.3 – Test Setup Radiated Emissions Measurements 30 – 100MHz



**Figure A.4 – Test Setup Radiated Emissions Measurements 30 – 1000MHz Signal Substitution**



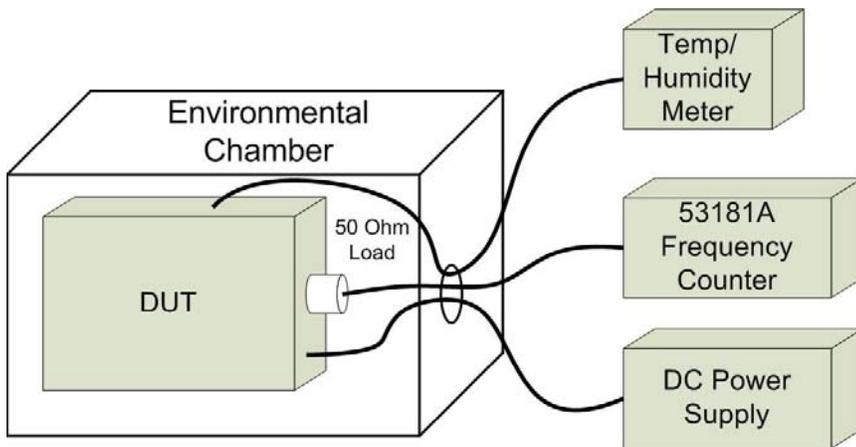
**Figure A.5 – Test Setup Radiated Emissions Measurements 1 – 18GHz**



**Figure A.6 – Test Setup Radiated Emissions Measurements Above 18 GHz**

**Table A.3 – Setup – Frequency Stability Equipment List**

<b>Equipment List</b>				
<b>Asset Number</b>	<b>Manufacturer</b>	<b>Model Number</b>	<b>Serial Number</b>	<b>Description</b>
00241	R&S	FSU40	100500	Spectrum Analyzer
00081	ESPEC	ECT-2	0510154-B	Environmental Chamber
00234	VWR	61161-378	140320430	Temp/Humidity Meter



**Figure A.7 – Frequency Stability**

**APPENDIX B – EQUIPMENT LIST AND CALIBRATION**

Equipment List					Last	Calibration	Calibration
Asset Number	Manufacturer	Model Number	Serial Number	Description	Calibrated	Interval	Due
00050	Chase	CBL-6111A	1607	Bilog Antenna	16 Nov 2020	Triennial	16 Nov 2023
00035	ETS	3115	6276	Double Ridged Guide Horn	4 Mar 2022	Triennial	4 Mar 2025
00085	EMCO	6502	9203-2724	Loop Antenna	6 Sep 2022	Triennial	6 Sep 2025
00333	HP	85685A	3010A01095	RF Preselector	23 Jun 2020	Triennial	30 Jun 2023
00049	HP	85650A	2043A00162	Quasi-peak Adapter	23 Jun 2020	Triennial	23 Jun 2023
00051	HP	8566B	2747A05510	Spectrum Analyzer	23 Jun 2020	Triennial	23 Jun 2023
00241	R&S	FSU40	100500	Spectrum Analyzer	10 Aug 2021	Triennial	10 Aug 2024
00005	HP	8648D	3847A00611	Signal Generator	23 Jun 2020	Triennial	23 Jun 2023
00003	HP	53181A	3736A05175	Frequency Counter	23 Jun 2020	Triennial	23 Jun 2023
00257	Com-Power	LI-215A	191934	LISN	27 Dec 2021	Triennial	27 Dec 2024
00071	EMCO	2090	9912-1484	Multi-Device Controller	n/a	n/a	n/a
00072	EMCO	2075	0001-2277	Mini-mast	n/a	n/a	n/a
00073	EMCO	2080	0002-1002	Turn Table	n/a	n/a	n/a
00081	ESPEC	ECT-2	0510154-B	Environmental Chamber	NCR	n/a	CNR
00234	VWR	61161-378	140320430	Temp/Humidity Meter	New	Triennial	New
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable	COU	n/a	COU
00264	Koaxis	KP10-7.00M-TD	264	7m Armoured Cable	COU	n/a	COU
00275	TMS	LMR400	n/a	25m Cable	COU	n/a	COU
00276	TMS	LMR400	n/a	4m Cable	COU	n/a	COU
00278	TILE	34G3	n/a	TILE Test Software	NCR	n/a	NCR

NCR: No Calibration Required

COU: Calibrate On Use

**APPENDIX C – MEASUREMENT INSTRUMENT UNCERTAINTY**

<b>CISPR 16-4 Measurement Uncertainty ( U<sub>LAB</sub> )</b>	
This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence interval using a coverage factor of k=2	
<b>Radiated Emissions 30MHz - 200MHz</b>	
<b>U<sub>LAB</sub> = 5.14dB U<sub>CISPR</sub> = 6.3dB</b>	
<b>Radiated Emissions 200MHz - 1000MHz</b>	
<b>U<sub>LAB</sub> = 5.90dB U<sub>CISPR</sub> = 6.3dB</b>	
<b>Radiated Emissions 1GHz - 6GHz</b>	
<b>U<sub>LAB</sub> = 4.80dB U<sub>CISPR</sub> = 5.2dB</b>	
<b>Radiated Emissions 6GHz - 18GHz</b>	
<b>U<sub>LAB</sub> = 5.1dB U<sub>CISPR</sub> = 5.5dB</b>	
<b>Power Line Conducted Emissions 9kHz to 150kHz</b>	
<b>U<sub>LAB</sub> = 2.96dB U<sub>CISPR</sub> = 3.8dB</b>	
<b>Power Line Conducted Emissions 150kHz to 30MHz</b>	
<b>U<sub>LAB</sub> = 3.12dB U<sub>CISPR</sub> = 3.4dB</b>	
If the calculated uncertainty <b>U<sub>lab</sub></b> is <b>less</b> than <b>U<sub>CISPR</sub></b> then:	
1	Compliance is deemed to occur if <b>NO</b> measured disturbance exceeds the disturbance limit
2	Non-Compliance is deemed to occur if <b>ANY</b> measured disturbance <b>EXCEEDS</b> the disturbance limit
If the calculated uncertainty <b>U<sub>lab</sub></b> is <b>greater</b> than <b>U<sub>CISPR</sub></b> then:	
3	Compliance is deemed to occur if <b>NO</b> measured disturbance, increased by ( <b>U<sub>lab</sub> - U<sub>CISPR</sub></b> ), exceeds the disturbance limit
4	Non-Compliance is deemed to occur if <b>ANY</b> measured disturbance, increased by ( <b>U<sub>lab</sub> - U<sub>CISPR</sub></b> ), <b>EXCEEDS</b> the disturbance limit

<b>Other Measurement Uncertainties ( U<sub>LAB</sub> )</b>	
<b>RF Conducted Emissions 9kHz - 40GHz</b>	
<b>U<sub>LAB</sub> = 1.0dB U<sub>CISPR</sub> = n/a</b>	
<b>Frequency/Bandwidth 9kHz - 40GHz</b>	
<b>U<sub>LAB</sub> = 0.1ppm U<sub>CISPR</sub> = n/a</b>	
<b>Temperature</b>	
<b>U<sub>LAB</sub> = 1°C U<sub>CISPR</sub> = n/a</b>	

**END OF REPORT**

**APPENDIX H – FIELD STRENGTH MEASUREMENT PLOTS**

**APPENDIX I – RADIATED TX EMISSIONS MEASUREMENT PLOTS**

**APPENDIX J – RADIATED RX MEASUREMENT PLOTS**

## SAR Test Report - New Application

Applicant:



Maximum Reported 10g SAR			W/kg
Extremity (wrist)	Wifi (DTS)	<b>21.00</b>	
	BT/BLE (DSS)	<b>&lt;0.1</b>	
General Pop. Limit:		<b>4.00</b>	

**Garmin International Inc.**  
**Olathe, KS, 66062**  
**USA**

FCC ID:

**IPH-A04524**

Product Model Number / HVIN

**A04524**

IC Registration Number

Product Name / PMN

**A04524**

In Accordance With:

**FCC 47 CFR §2.1093**

Radiofrequency Radiation Exposure Evaluation: Portable Devices

Approved By:



**Ben Hewson, President**  
Celltech Labs Inc.  
21-364 Lougheed Rd.  
Kelowna, BC, V1X 7R8  
Canada



Test Lab Certificate: 2470.01



**Industry  
Canada**

IC Registration 3874A



FCC Registration: CA3874

This report shall not be reproduced in any form without the expressed written consent of Celltech Labs Inc.

## Table of Contents

1.0 DOCUMENT CONTROL.....	4
2.0 CLIENT AND DEVICE INFORMATION.....	5
3.0 SCOPE OF EVALUATION.....	6
4.0 NORMATIVE REFERENCES.....	7
5.0 STATEMENT OF COMPLIANCE.....	8
6.0 SAR MEASUREMENT SYSTEM.....	9
7.0 RF CONDUCTED POWER MEASUREMENT.....	10
TABLE 7.0 CONDUCTED POWER MEASUREMENTS – 2.4GHz WiFi.....	10
TABLE 7.1 CONDUCTED POWER MEASUREMENTS – BT.....	11
8.0 NUMBER OF TEST CHANNELS ( $N_c$ ) / SAR TEST REDUCTION.....	12
9.0 ACCESSORIES EVALUATED.....	13
TABLE 9.0 ACCESSORIES EVALUATED.....	13
10.0 SAR MEASUREMENT SUMMARY.....	14
TABLE 10.0: MEASURED RESULTS.....	14
11.0 SCALING OF MAXIMUM MEASURE SAR.....	15
TABLE 11.0 SAR SCALING – EXTREMITY.....	15
TABLE 11.1 SAR TEST EXCLUSION, TEST REDUCTION AND SIMULTANEOUS ANALYSIS.....	17
12.0 SAR EXPOSURE LIMITS.....	18
TABLE 12.0 EXPOSURE LIMITS.....	18
13.0 DETAILS OF SAR EVALUATION.....	19
13.0 DAY LOG.....	19
13.1 DUT SETUP AND CONFIGURATION.....	20
13.2 DUT POSITIONING.....	20
13.3 GENERAL PROCEDURES AND REPORTING.....	21
13.4 FLUID DIELECTRIC AND SYSTEMS PERFORMANCE CHECK.....	22
13.5 SCAN RESOLUTION 100MHz TO 2GHz.....	22
13.6 SCAN RESOLUTION 2GHz TO 3GHz.....	23
13.7 SCAN RESOLUTION 5GHz TO 6GHz.....	23
14.0 MEASUREMENT UNCERTAINTIES.....	24
TABLE 14.0 MEASUREMENT UNCERTAINTY.....	24
15.0 FLUID DIELECTRIC PARAMETERS.....	25
TABLE 15.0 FLUID DIELECTRIC PARAMETERS 2450MHz HEAD TSL.....	25
16.0 SYSTEM VERIFICATION TEST RESULTS.....	26
TABLE 16.0 SYSTEM VERIFICATION RESULTS 2450MHz HEAD TSL.....	26
17.0 SYSTEM VALIDATION SUMMARY.....	27
TABLE 17.0 SYSTEM VALIDATION SUMMARY.....	27
18.0 MEASUREMENT SYSTEM SPECIFICATIONS.....	27
TABLE 18.0 MEASUREMENT SYSTEM SPECIFICATIONS.....	27

<b>19.0 TEST EQUIPMENT LIST</b> .....	<b>29</b>
TABLE 19.0 EQUIPMENT LIST AND CALIBRATION .....	29
<b>20.0 FLUID COMPOSITION</b> .....	<b>30</b>
TABLE 20.0 FLUID COMPOSITION 2450MHZ HEAD TSL .....	30
<b>END OF REPORT</b> .....	<b>30</b>
<b>APPENDIX A – SYSTEM VERIFICATION PLOTS</b> .....	<b>31</b>
<b>APPENDIX B – MEASUREMENT PLOTS OF MAXIMUM MEASURED SAR</b> .....	<b>33</b>
<b>APPENDIX C - SETUP PHOTOS</b> .....	<b>37</b>
FIGURE C.1 – PHOTO – SETUP: EXTREMITY, DUT BACK – SILICONE BAND (B1) .....	37
FIGURE C.2 – PHOTO – SETUP: EXTREMITY, DUT BACK - METAL BAND (B2) .....	38
<b>APPENDIX D – PROBE CALIBRATION</b> .....	<b>39</b>
<b>APPENDIX E – DIPOLE CALIBRATION</b> .....	<b>40</b>
<b>APPENDIX F - PHANTOM</b> .....	<b>41</b>

## 1.0 DOCUMENT CONTROL

Revision History					
<b>Samples Tested By:</b>		Ben Hewson/Trevor Whillock		<b>Date(s) of Evaluation:</b>	4, 5 January 2023
<b>Report Prepared By:</b>		Ben Hewson		<b>Report Reviewed By:</b>	Art Voss
Report Revision	Description of Revision	Revised Section	Revised By	Revision Date	
0.1	Draft	n/a	Ben Hewson	30 March 2023	
1.0	Initial Release	n/a	Ben Hewson		
2.0	Revised NFC Exclusion Data	11.0	Art Voss	12 April 2023	

## 2.0 CLIENT AND DEVICE INFORMATION

Client Information	
Applicant Name	Garmin International Inc.
Applicant Address	1200 East 151 St
	Olathe, KS, 66062
	USA
DUT Information	
Device Identifier(s):	FCC ID: IPH-A04524
	ISED ID:
Device Model(s) / HVIN:	A04524
EUT Name:	A04524
Test Sample Serial No.:	Production Sample Prototype
Device Type:	Extremity Worn Digital Device
Equipment Class	Digital Transmission System (DTS)
	Spread Spectrum Transmission System (DSS)
	Low Power Communication Device (DXX)
	Global Navigation Satellite System (GNSS) Receivers
	NFC - Low Power Communication Device Transmitter (DXX)
Transmit Frequency Range:	ANT (DXX): 2402-2480MHz
	BT (DTS, DSS): 2402-2480MHz
	WiFi (DTS): 2412-2462MHz
Manuf. Max. Rated Output Power:	ANT (DXX): 1.6mW (2.1dBm)
	BT BR (DSS): 12.97mW (11.13dBm)
	BT 2EDR (DTS): 10.5mW (10.23dBm)
	BT 3EDR (DTS): 10.3mW (10.12dBm)
	BT LE1 (DTS): 1.5mW (1.65dBm)
	BT LE2 (DTS): 1.6mW (1.95dBm)
	802.11b (DTS): 0.07W (18.32dBm)
	802.11g (DTS): 0.05W (17.40dBm)
802.11n (DTS): 0.04W (15.75dBm)	
Antenna Type and Gain:	2.4GHz: -5.90 dBi PIFA
Modulation:	ANT: GFSK:
	BT BR: GFSK
	BT 2EDR: $\pi/4$ -DQPSK
	BT 3EDR: 8DPSK
	BLE: GMSK
	WiFi: CCK, DSSS, OFDM, MCS
DUT Power Source:	5V USB, Internal Li-Ion Battery
DUT Dimensions [LxWxH]	L x W x H: 53mm x 54mm x 15mm
Deviation(s) from standard/procedure:	None

### 3.0 SCOPE OF EVALUATION

This Certification Report was prepared on behalf of:

**Garmin International Inc.**

, (the '*Applicant*'), in accordance with the applicable Federal Communications Commission (FCC) CFR 47 (the '*Rules*'). The scope of this investigation was limited to only the equipment, devices and accessories (the '*Equipment*') supplied by the *Applicant*. The tests and measurements performed on this *Equipment* were only those set forth in the applicable *Rules* and/or the Test and Measurement Standards they reference. The *Rules* applied and the Test and Measurement Standards used during this evaluation appear in the Normative References section of this report. The limits set forth in the technical requirements of the applicable *Rules* were applied to the measurement results obtained during this evaluation and, unless otherwise noted, these limits were used as the Pass/Fail criteria. The Pass/Fail statements made in this report apply to only the tests and measurements performed on only the *Equipment* tested during this evaluation. Where applicable and permissible, information including test and measurement data and/or results from previous evaluations of same or similar equipment, devices and/or accessories may be cited in this report.

As per FCC 47 CFR Part §2.1091 and §2.1093, an RF Exposure evaluation report is required for this *Equipment* and the results of the RF Exposure evaluation appear in this report.

The A04524 FCC ID: IPH-A04524, is a wrist-worn transceiver that is capable of operating in the 2.4GHz WiFi and Bluetooth frequency bands and has an additional NFC feature that operates at a fixed transmit frequency of 13.56MHz. The device is not capable of simultaneous transmission between transmitters. The device is intended for General Population Use. The product operates from an internal proprietary Li-ion rechargeable battery which can be connected to a compliant USB interface port, AC or DC adapter for charging. Test samples provided by the manufacturer were capable of transmitting at select frequencies and modulations preset by the manufacturer. An additional antenna modification was prepared for one sample allowing the ability to connect test equipment for antenna port conducted power analysis.

## 4.0 NORMATIVE REFERENCES

<b>Normative References*</b>	
ANSI / ISO 17025	General Requirements for competence of testing and calibration laboratories
FCC CFR Title 47 Part 2 Title 47: Part 2.1093:	Code of Federal Regulations Telecommunication Radiofrequency Radiation Exposure Evaluation: Portable Devices
IEC International Standard /IEEE International Committee on Electromagnetic Safety IEC/IEEE 62209-1528	Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1528; Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)
FCC KDB KDB 865664 D01v01r04	SAR Measurement Requirements for 100MHz to 6GHz
FCC KDB KDB 447498 D01v06	Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies
FCC KDB KDB 248227 D01v02r02	SAR Guidance for IEEE 802.11 (WiFi) Transmitters
* When the issue number or issue date is omitted, the latest version is assumed.	

## 5.0 STATEMENT OF COMPLIANCE

This measurement report demonstrates that samples of the product model(s) were evaluated for Specific Absorption Rate (SAR) on the date(s) shown, in accordance with the Measurement Procedures cited and were found to comply with the Standard(s) Applied based on the Exposure Limits of the Use Group indicated for which the product is intended to be used.

<b>Applicant:</b> Garmin International Inc.	<b>Model / HVIN:</b> A04524	
<b>Standard(s) Applied:</b> FCC 47 CFR §2.1093	<b>Measurement Procedure(s):</b> FCC KDB 865664, FCC KDB 447498, FCC KDB 248227 IEC/IEEE Standard 62209-1528	
<b>Reason For Issue:</b> <input checked="" type="checkbox"/> New Certification <input type="checkbox"/> Class I Permissive Change <input type="checkbox"/> Class II Permissive Change	<b>Use Group:</b> <input checked="" type="checkbox"/> General Population / Uncontrolled <input type="checkbox"/> Occupational / Controlled	<b>Limits Applied:</b> <input type="checkbox"/> 1.6W/kg - 1g Volume <input type="checkbox"/> 8.0W/kg - 1g Volume <input checked="" type="checkbox"/> 4.0W/kg - 10g Volume
<b>Reason for Change:</b>	<b>Date(s) Evaluated:</b> 4, 5 January 2023	

The results of this investigation are based solely on the test sample(s) provided by the applicant which was not adjusted, modified or altered in any manner whatsoever except as required to carry out specific tests or measurements. A description of the device, operating configuration, detailed summary of the test results, methodologies and procedures used during this evaluation, the equipment used and the various provisions of the rules are included in this test report.

I attest that the data reported herein is true and accurate within the tolerance of the Measurement Instrument Uncertainty; that all tests and measurements were performed in accordance with accepted practices or procedures; and that all tests and measurements were performed by me or by trained personnel under my direct supervision. The results of this investigation are based solely on the test sample(s) provided by the client which were not adjusted, modified or altered in any manner whatsoever, except as required to carry out specific tests or measurements. This test report has been completed in accordance with ISO/IEC 17025.	
	Trevor Whillock Test Lab Engineer Celltech Labs Inc. 5 January 2023 Date

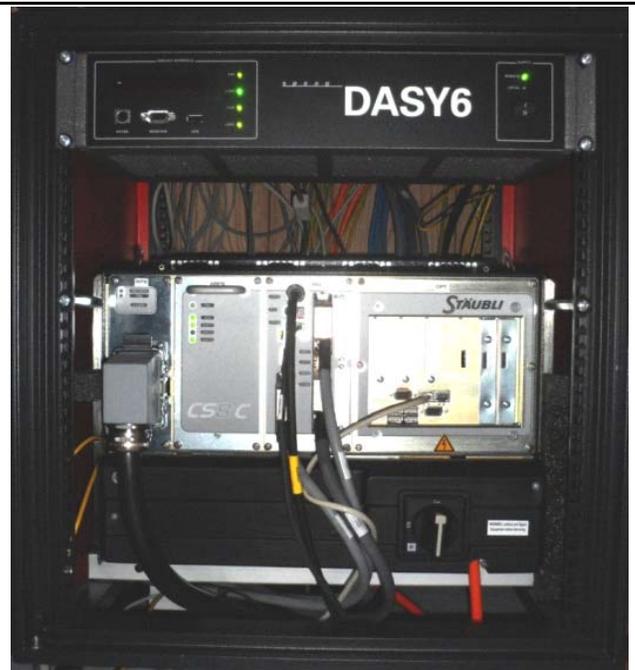
## 6.0 SAR MEASUREMENT SYSTEM

### SAR Measurement System

Celltech Labs Inc. SAR measurement facility employs a Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland. The DASY6 measurement system is comprised of the measurement server, a robot controller, a computer, a near-field probe, a probe alignment sensor, an Elliptical Planar Phantom (ELI) phantom and a specific anthropomorphic mannequin (SAM) phantom for Head and/or Body SAR evaluations. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF). A cell controller system contains the power supply, robot controller and a teach pendant (Joystick) to control the robot's servo motors. The Staubli robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical form the DAE to digital electronic signal and transfers data to the DASY6 measurement server. The DAE4 utilizes a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter, a command decoder and a control logic unit. Transmission to the DASY6 measurement server is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe-mounting device includes two different sensor systems for frontal and sidewise probe contacts. The sensor systems are also used for mechanical surface detection and probe collision detection. The robot utilizes a controller with built in VME-bus computer.



**DASY 6 SAR System with SAM Phantom**



**DASY 6 Measurement Controller**

**7.0 RF CONDUCTED POWER MEASUREMENT**

Table 7.0 Conducted Power Measurements – 2.4GHz WiFi

A04524-Conducted Power Measurements									
Channel	Frequency (MHz)	Measured Power (dBm)	Rated Power (dBm)	Delta (dB)	SAR Test Channel (Y/N)	Mode	BW (MHz)	Modulation	
6	2437	18.03			-	WLAN 2.4G	20	DSSS-1Mbps	802.11b
		18.22			-			DSSS-2Mbps	
		18.32			-			DSSS-5.5Mbps	
		18.24			-			DSSS-11Mbps	
1	2412	18.09	18.32	-0.23	Y	WLAN 2.4G	20	DSSS-5.5Mbps	802.11b
6	2437	18.32	18.32	0.00	Y				
11	2462	18.21	18.32	-0.11	Y				
1	2412	17.02	17.40	-0.38	-	WLAN 2.4G	20	OFDM-12Mbps	802.11g
6	2437	17.40	17.40	0.00					
11	2462	17.09	17.40	-0.31	-				
1	2412	13.61	15.75	-2.14	-	WLAN 2.4G	20	MCS-0	802.11n
6	2437	15.75	15.75	0.00	-				
11	2462	10.38	15.75	-5.37	-				

**Table 7.1 Conducted Power Measurements – BT**

A04524- Conducted Power Measurements								
Mode	Modulation	Channel	Frequency (MHz)	Measured Power (dBm)	Measured Power (mW)	Rated Power (mW)	Delta (mW)	SAR test Channel
ANT	GFSK	0	2402.00	-1.06	0.8	1.6	0.82	-
		39	2440.00	2.10	1.6	1.6	-0.02	-
		79	2480.00	-1.22	0.8	1.6	0.84	-
BT BR	GFSK	0	2402.00	11.04	12.70	12.97	0.27	-
		38	2441.00	11.11	12.90	12.97	0.07	-
		78	2480.00	11.13	12.97	12.97	0.00	Y
BT 2EDR	$\pi/4$ -DQPSK	3	2402.00	10.11	10.30	10.50	0.20	-
		38	2441.00	10.21	10.50	10.50	0.00	-
		78	2480.00	10.23	10.50	10.50	0.00	-
BT 3EDR	8DPSK	3	2402.00	10.11	10.30	10.30	0.00	-
		38	2441.00	10.11	10.30	10.30	0.00	-
		78	2480.00	10.12	10.30	10.30	0.00	-
BT 3EDR	8DPSK	3	2402.00	10.11	10.30	10.30	0.00	-
		38	2441.00	10.11	10.30	10.30	0.00	-
		78	2480.00	10.12	10.30	10.30	0.00	-
BT LE1	GMSK	37	2402.00	-1.88	0.7	1.5	0.82	-
		17	2440.00	1.65	1.5	1.5	0.04	-
		39	2480.00	-1.50	0.7	1.5	0.79	-
BT LE2	GMSK	37	2402.00	1.95	1.6	1.6	0.00	-
		17	2440.00	1.75	1.5	1.6	0.10	-
		39	2480.00	-2.00	0.6	1.6	1.00	-

The rated power and tolerance are stated for typical transmission modes and data rates. Some modes and data rates may produce lower than rated conducted power levels. Power measurements taken across the various channels, modes and data rates did not produce levels in excess of the Rated Power plus Tolerance. SAR was evaluated using the power level setting and duty cycle specified by the manufacturer to be the max output power and produce the most conservative SAR. SAR was evaluated at the maximum average tune up tolerance. See section 2.0 Client and Device Information for details. The reported SAR was not scaled down.

## 8.0 NUMBER OF TEST CHANNELS ( $N_c$ ) / SAR TEST REDUCTION

### 2.4GHz WiFi SAR Evaluation

In accordance with FCC KDB 248227, when higher maximum output power is not specified for the other channels, channels 1, 6 and 11 are used to configure 22 MHz DSSS and 20 MHz OFDM channels for SAR measurements.

#### 802.11b DSSS SAR Test Requirements

802.11b DSSS SAR test reduction is determined according to the following:

a) When the reported SAR of the highest measured maximum output power channel (see 3.1) for the exposure configuration is  $\leq 0.8$  W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

b) When the reported SAR is  $> 0.8$  W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is  $> 1.2$  W/kg, SAR is required for the third channel; i.e., all channels require testing.

When 10g Extremity applies, the test reduction thresholds are multiplied by 2.5, or 2.0W/kg and 3W/kg, respectively.

#### 2.4GHz 802.11g/n OFDM SAR Test Requirements

SAR is not required for the following 2.4 GHz OFDM conditions:

a) When KDB Publication 447498 D01 SAR test exclusion applies to the OFDM configuration.

b) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg.

When 10g Extremity applies, the test reduction threshold is multiplied by 2.5, or 3W/kg.

#### BT/BLE/ANT SAR Test Requirements

General SAR test reduction per FCC KDB 447498D01

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid band or highest output power channel is:

$\leq 0.8$ W/kg or 2.0W/kg, for 1-g or 10-g respectively, when the transmission band is  $\leq 100$ Mhz.

## 9.0 ACCESSORIES EVALUATED

Table 9.0 Accessories Evaluated

Accessory List				
Test Report ID Number	Manufacturer's Part Number	Description	SAR Evaluated	SAR Tested
<b>B1</b>	010-13117-00	Silicone Band	<b>Y</b>	<b>Y</b>
<b>B2</b>	010-12864-08	Metal Band	<b>Y</b>	<b>Y</b>

## 10.0 SAR MEASUREMENT SUMMARY

Table 10.0: Measured Results

Measured 10g SAR Results - EXTREMITY Configuration																
Date	Plot ID	Test Frequency (MHz)	DUT Configuration					Accessories	Spacing		Measured SAR (W/kg)	SAR Drift (dB)	Delta Power (dB)	Crest Factor n	Fluid Sensitivity n	<u>reported</u> SAR (W/kg)
			Pos	Mode	BW	Mod	BR		DUT (mm)	Antenna (mm)						
1/5/23	E1	2412	Extremity	802.11b	20	DSSS	5.5	B1	0	0	0.157	-0.230	-0.230	1.000	1.000	0.175
1/5/23	E2	2437	Extremity	802.11b	20	DSSS	5.5	B1	0	0	0.113	-0.040	0.000	1.000	1.000	0.114
1/5/23	E3	2462	Extremity	802.11b	20	DSSS	5.5	B1	0	0	0.191	-0.350	-0.110	1.000	1.000	0.212
1/5/23	E4	2437	Extremity	802.11b	20	DSSS	5.5	B2	0	0	0.176	-0.300	0.000	1.000	1.000	0.189
1/5/23	E6	2402	Extremity	BT Classic				B1	0	0	0.035	0.150	-0.090	1.000	1.000	0.035
1/5/23	E7	2440	Extremity	BT Classic				B1	0	0	0.034	0.110	-0.020	1.000	1.000	0.034
1/5/23	E8	2480	Extremity	BT Classic				B1	0	0	0.037	-0.090	0.000	1.000	1.000	0.038
Applicable SAR Limit								Use Group				Limit				
FCC CFR 2.1093			Health Canada Safety Code 6					General Population/User Unaware				4 W/kg				

## 11.0 SCALING OF MAXIMUM MEASURE SAR

Table 11.0 SAR Scaling – Extremity

Scaling of Maximum Measured SAR (10g)				
Measured Parameters		Configuration		
		Extremity	Extremity	
Plot ID		E3	E8	
Maximum Measured SAR <sub>M</sub>		0.191	0.037	(W/kg)
Frequency		2462	2480	(MHz)
Drift	Power Drift	-0.350	-0.090	(dB)
Conducted Power		18.210	11.130	(dBm)
DC	Transmit Duty Cycle	100.000	100.0	(%)
Fluid Deviation from Target				
Δe	Permittivity	-7.46%	-7.20%	
Δσ	Conductivity	3.75%	2.73%	

Fluid Sensitivity Calculation (10g)			EEE 62209-1528
Delta SAR = Ce * Δe + Cσ * Δσ			
Ce = (0.003456*f <sup>3</sup> ) - (0.03531*f <sup>2</sup> ) + (0.07675*f) - 0.186			
Cσ = (0.004479*f <sup>3</sup> ) - (0.01586*f <sup>2</sup> ) - (0.1972*f) + 0.7717			
f	Frequency (GHz)	2.462	2.48
	Ce	-0.159	-0.160
	Cσ	0.257	0.253
	Ce * Δe	0.012	0.012
	Cσ * Δσ	0.010	0.007
	ΔSAR	0.022 <sup>(3)</sup>	0.018 <sup>(3)</sup>

Note(3): Delta SAR is Positive, SAR Adjustment for Fluid Sensitivity is not Required, in accordance with ISED Notice 2012-DRS0529

Manufacturer's Tuneup Tolerance			
Measured Conducted Power	18.210	11.130	(dBm)
Rated Conducted Power	18.320	11.130	(dBm)
ΔP	-0.110	0.000 <sup>(4)</sup>	(dB)

Note(4): SAR was Evaluated at the Maximum Tuneup Tolerance. SAR Adjustment is not Required.

Crest Factor			
Transmit Duty Cycle (DC)	100.000	100.0	(%)
CF (1/DC)	1.000 <sup>(5)</sup>	1.00	###

Note(5): Crest Factor = 1 (100% Duty Cycle), Crest Factor Adjustment not Required.

SAR Adjustment for Fluid Sensitivity			
SAR <sub>1</sub> = SAR <sub>M</sub> X [ΔSAR]	0.191	0.037	(W/kg)
SAR Adjustment for Tuneup Tolerance			
SAR <sub>2</sub> = SAR <sub>1</sub> + [ΔP]	0.196	0.037	(W/kg)
SAR Adjustment for Drift			
SAR <sub>3</sub> = SAR <sub>2</sub> + [Drift]	0.212	0.038	(W/kg)
SAR Adjustment for Crest Factor			
SAR <sub>4</sub> = SAR <sub>3</sub> x [CF]	0.212	0.038	(W/kg)
reported 10g SAR			
SAR <sub>4</sub>	0.21	0.04	(W/kg)

**NOTES to Table 11.0**

(1) Scaling of the Maximum Measured SAR is based on the highest, 100% duty cycle, Face, Body and/or Head SAR measured of ALL test channels, configurations and accessories used during THIS evaluation. The Measured Fluid Deviation parameters apply only to deviation of the tissue equivalent fluids used at the frequencies which produced the highest measured SAR. The Measured Conducted Power applies to the Conducted Power measured at the frequencies producing the highest Face and Body SAR. The Measured Drift is the SAR drift associated with that specific SAR measurement. The Reported SAR is the accumulation of all SAR Adjustments from the applicable Steps 1 through 4. The Plot ID is for identification of the SAR Measurement Plots in Annex A of this report.

NOTE: Some of the scaling factors in Steps 1 through 4 may not apply and are identified by light gray text.

**Step 1**

Per IEC/IEEE 62209-1528 and FCC KDB 865664. Scaling required only when Measured Fluid Deviation is greater than 5%. If the Measured Fluid Deviation is greater than 5%, Table 9.1 will be shown and will indicate the SAR scaling factor in percent (%). SAR is MULTIPLIED by this scaling factor only when the scaling factor is positive (+).

**Step 2**

Per KDB 447498. Scaling required only when the difference (Delta) between the Measured Conducted Power and the Manufacturer's Rated Conducted Power is (-) Negative. The absolute value of Delta is ADDED to the SAR.

**Step 3**

Per IEC/IEEE 62209-1528. Scaling required only when Measured Drift is (-) Negative. The absolute value of Measured Drift is added to Reported or Simultaneous Reported SAR.

**Step 4**

Per KDB 447498 4.3.2. The SAR, either measured or calculated, of ANY and ALL simultaneous transmitters must be added together and includes all contributors.

**Step 5**

The Reported SAR is the Maximum Final Adjusted Cumulative SAR from the applicable Steps 1 through 4 and are reported on Page 1 of this report.

## Table 11.1 SAR Test Exclusion, Test Reduction and Simultaneous Analysis

### SAR Test Exclusion BLE/ANT

The SAR test exclusion threshold for the BLE/ANT transmitter as per FCC KDB 447498 4.3.1 is as follows:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \times [\sqrt{f(\text{GHz})}] \leq 7.5$  for 10-g SAR

$$\text{Max. Power} = 1.6\text{mW}$$

$$f = 2.440\text{GHz}$$

$$\text{Distance} = 5\text{mm}$$

$$[1.6\text{mW} / 5\text{mm}] \times [\sqrt{2.48}] = 0.195 \leq 7.5$$

The BLE/ANT transmitters meet the SAR test exclusion threshold

### SAR Test Exclusion NFC

The SAR test exclusion threshold for the NFC transmitter as per FCC KDB 447498 4.3.1 is as follows:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \times [\sqrt{f(\text{GHz})}] \leq 7.5$  for 10-g SAR

$$\text{Max. Power (EIRP)} = FS - 104.7 + 20\text{Log}(d), \text{ where } FS = \text{measured Field Strength}, d = \text{measurement distance}$$

$$\text{Max. Power (EIRP)} = 73.23\text{dBuV/m (Peak)} - 104.7 + 20\text{Log}(3) = -21.9\text{dBm} = 0.0065\text{mW}$$

$$\text{Max. Power (EIRP)} = 0.0065\text{mW}$$

$$f = 0.01356\text{GHz}$$

$$\text{Distance} = 5\text{mm}$$

$$[0.0065\text{mW} / 5\text{mm}] \times [\sqrt{0.01356}] = 0.00015 \leq 7.5$$

The NFC transmitter meets the SAR test exclusion threshold

### 802.11b DSSS SAR Test Reduction

802.11b DSSS SAR was evaluated on all required channels. 802.11b DSSS SAR Test Reduction was not applied.

### 2.4GHz 802.11g/n OFDM SAR Test Reduction

$$\text{Max. Power DSSS } (P_{DSSS}) = 67.9\text{mW}$$

$$\text{Max. Power OFDM } (P_{OFDM}) = 55.0\text{mW}$$

$$\text{Max. reported DSSS SAR } (SAR_{DSSS}) = 0.212\text{W/kg } 10\text{g Extremity}$$

$$\text{Exclusion} = [P_{OFDM} / P_{DSSS}] \times SAR_{DSSS} \leq 3.0\text{W/kg } 10\text{g}$$

$$\text{Exclusion} = [55.0\text{mW} / 67.9\text{mW}] \times 0.212\text{W/kg} = 0.172\text{W/kg} \leq 3.0\text{W/kg} \text{ for } 10\text{g Extremity}$$

The 2.4GHz 802.11g/n OFDM transmitter meets the SAR test exclusion requirement

### Bluetooth SAR Test Reduction

Bluetooth was evaluated for SAR at a transmit duty cycle of 100 % in the worst-case configuration from the WiFi test evaluation.

The duty cycle cannot be altered in test mode or by the user.

General SAR test reduction per FCC KDB 447498D01

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid band or highest output power channel is:

$$\leq 0.8\text{W/kg} \text{ or } 2.0\text{W/kg}, \text{ for } 1\text{-g} \text{ or } 10\text{-g} \text{ respectively, when the transmission band is } \leq 100\text{MHz}.$$

### Simultaneous SAR Evaluation

This device is not capable of simultaneous transmission between the BT/BLE/ANT and WiFi transmitters.

The WiFi and Bluetooth transmitters were evaluated for Standalone SAR Only.

Simultaneous transmission evaluation with NFC and 802.11b/g/n/BT/BLT/ANT is not required

## 12.0 SAR EXPOSURE LIMITS

Table 12.0 Exposure Limits

SAR RF EXPOSURE LIMITS			
FCC 47 CFR§2.1093	Health Canada Safety Code 6	General Population / Uncontrolled Exposure <sup>(4)</sup>	Occupational / Controlled Exposure <sup>(5)</sup>
Spatial Average <sup>(1)</sup> (averaged over the whole body)		0.08 W/kg	0.4 W/kg
Spatial Peak <sup>(2)</sup> (Head and Trunk averaged over any 1 g of tissue)		1.6 W/kg	8.0 W/kg
Spatial Peak <sup>(3)</sup> (Hands/Wrists/Feet/Ankles averaged over 10 g)		<b>4.0 W/kg</b>	20.0 W/kg
(1) The Spatial Average value of the SAR averaged over the whole body.			
(2) The Spatial Peak value of the SAR averaged over any 1 gram of tissue, defined as a tissue volume in the shape of a cube and over the appropriate averaging time.			
(3) The Spatial Peak value of the SAR averaged over any 10 grams of tissue, defined as a tissue volume in the shape of a cube and over the appropriate averaging time.			
(4) Uncontrolled environments are defined as locations where there is potential exposure to individuals who have no knowledge or control of their potential exposure.			
(5) Controlled environments are defined as locations where there is potential exposure to individuals who have knowledge of their potential exposure and can exercise control over their exposure.			

## 13.0 DETAILS OF SAR EVALUATION

### 13.0 Day Log

DAY LOG					Fluid Dielectric	SPC	Test	Task
Date	Ambient Temp (°C)	Fluid Temp (°C)	Relative Humidity (%)	Barometric Pressure (kPa)				
04 Jan 2023	25.4	23.6	18%	102.0	X	X		2450H
05 Jan 2023	24.5	24.1	19%	101.1			X	2450H

\*Per IEC/IEEE 62209-1528, test series was started within 24 hours of Fluid Parameter Measurement

### 13.1 DUT Setup and Configuration

DUT Setup and Configuration	
1	The device was evaluated for Extremity (wrist worn), from a flat phantom filled with head tissue-equivalent medium. The DUT was evaluated for SAR in accordance with the procedures described in RSS-102, IEC/IEEE 62209-1528, FCC KDB 447498, 865664, 248227.
2	<p>2.4GHz 802.11g/n OFDM SAR Test Exclusion</p> <p>As Per KDB 248227 D01v02r02 - 5.2.2,            b) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is <math>\leq 1.2W/kg</math></p> <p>When applying this formula to EU Extremity limits the adjusted SAR is <math>\leq 1.5W/kg</math>, and for Body limits is <math>\leq 3.0W/kg</math>.</p> <p>Maximum 802.11g/n OFDM specified power(POFDM)= 17.4 dBm (54.95mW)            Maximum 802.11b DSSS specified power (PDSSS)= 18.32 dBm (67.92mW)            Ratio OFDM/DSSS power = 0.92 dBm (95%)            Highest reported SAR (SARMAX)= 0.21W/kg</p> <p>POFDM/PDSSS X SARMAX = 0.20 W/kg <math>\leq</math> 3.0 W/kg (Extremity) and <math>\leq</math> 1.5 W/kg (Body) and SAR test exclusion applies.</p>
3	The Device was capable of transmitting at various modulations, data rates and duty cycles. The Conducted Power was highest when measured in DSSS Mode-5.5 Mbps at 100% Duty cycle than any other configuration in the 2.4GHz Band. The DUT was evaluated for SAR at the maximum conducted output power level, preset by the manufacturer.
4	Bluetooth was evaluated for SAR in BT BR (GFSK) mode with a transmit duty cycle of 100% in the worst-case configuration from the WiFi test evaluation. The Duty cycle could not be altered in test mode or by the user. The DUT was evaluated for SAR at the maximum conducted output power level, preset by the manufacturer.
5	Each SAR evaluation was performed with a fully charged battery.

### 13.2 DUT Positioning

DUT Positioning	
<b>Positioning</b>	The DUT Positioner was securely fastened to the Phantom Platform. Registration marks were placed on the DUT and the Positioner to ensure consistent positioning of the DUT for each test evaluation.
<b>FACE Configuration</b>	Devices that are designed to be worn on the wrist and may operate with in speaker mode for voice communication, with the device positioned next to the mouth. When next-to-mouth SAR evaluation is required, the device is positioned at 10mm from a flat phantom filled with head tissue-equivalent medium.
<b>BODY Configuration</b>	Devices that are designed to be worn on the Body are positioned on the device holder with the surface of the DUT being 5mm from bottom of the phantom in the Body configuration.
<b>HEAD Configuration</b>	This device is not intended to be held to the ear and was not tested in the HEAD configuration.
<b>Limb Worn Configuration</b>	Devices that are designed to be worn on the wrist are positioned with the back side directly against the phantom surface with the strap removed or opened to allow direct contact of the DUT to the phantom surface.

### 13.3 General Procedures and Reporting

General Procedures and Reporting	
<b>General Procedures</b>	<p>The fluid dielectric parameters of the Active Tissue Simulating Liquid (TSL) were measured as described in this Section, recorded and entered into the DASY Measurement Server. Active meaning the TSL used during the SAR evaluation of the DUT. The temperature of the Active TSL was measured and recorded prior to performing a System Performance Check (SPC). An SPC was performed with the Active TSL prior to the start of the test series. The temperature of the Active TSL was measured throughout the day and the Active TSL temperature was maintained to <math>\pm 0.5^{\circ}\text{C}</math>. The Active TSL temperature was maintained to within <math>\pm 1.0^{\circ}\text{C}</math> throughout the test series. TSL analysis and SPC were repeated when the Active TSL use exceeded 84 hours.</p> <p>An Area Scan exceeding the length and width of the DUT projection was performed and the locations of all maximas within 2dB of the Peak SAR recorded. A Zoom Scan centered over the Peak SAR location(s) was performed and the 1g and 10g SAR values recorded. The resolutions of the Area Scan and Zoom Scan are described in the Scan Resolution table(s) in this Section. A Power Reference Measurement was taken at the phantom reference point immediately prior to the Area Scan. A Power Drift measurement was taken at the phantom reference point immediately following the Zoom Scan to determine the power drift. A Z-Scan from the <u>Maximum Distance to Phantom Surface</u> to the fluid surface was performed following the power drift measurement.</p>
<b>Reporting</b>	<p>Where appropriate the 1g SAR, 10g SAR and power drift measurements are recorded in the SAR Measurement Summary tables in the SAR Measurement Summary Section of this report. The SAR values shown in the 100% DC (Duty Cycle) column are the SAR values reported by the SAR Measurement Server with the DUT operating at or compensated for a 100% transmit duty cycle. A duty cycle compensation (crest factor) and fluid sensitivity scaling factor is shown, as well as other information such as transmit channel and frequency, modulation, accessories tested and DUT-phantom separation distance.</p> <p>In the Scaling of Maximum Measured SAR Section of this report, the highest measured SAR in the BODY and/or FACE and/or EXTREMITY (limb-worn) configurations, within the entire scope of this assessment, are, when applicable, scaled for Fluid Sensitivity, Manufacturer's Tune-Up Tolerance, Simultaneous Transmission and Drift. With the exception of Duty Cycle correction/compensation, SAR values are <u>ONLY</u> scaled up, not down. The final results of this scaling is the <u>reported SAR</u> which appears on the Cover Page of this report.</p>

### 13.4 Fluid Dielectric and Systems Performance Check

Fluid Dielectric and Systems Performance Check	
<b>Fluid Dielectric Measurement Procedure</b>	
<p>The fluid dielectric parameters of the Tissue Simulating Liquid (TSL) are measured using the Open-Ended Coax Method connected to an Agilent 8753ET Network Analyzer connected to a measurement server running Aprel Dielectric Property Measurement System. A frequency range of <math>\pm 100\text{MHz}</math> for frequencies <math>&gt; 300\text{MHz}</math> and <math>\pm 50\text{MHz}</math> for frequencies <math>\leq 300\text{MHz}</math> with frequency step size of <math>10\text{MHz}</math> is used. The center frequency is centered around the SAR measurement probe's calibration point for that TSL frequency range. A calibration of the setup is performed using a short-open-deionized water (at <math>23^\circ\text{C}</math> in a 300ml beaker) method. A sample of the TSL is placed in a 300ml beaker and the open-ended coax is submerged approximately 8mm below the fluid surface in the approximate center of the beaker. A check of the setup is made to ensure no air is trapped under the open-ended coax. The sample of TSL is measured and compared to the FCC KDB 865664 targets for HEAD or BODY for the entire fluid measurement range. Fluid adjustment are made if the dielectric parameters are <math>&gt; 5\%</math> in range that the DUT is to be tested. If the adjustments fail to bring the parameters to <math>\leq 5\%</math> but are <math>&lt; 10\%</math>, the SAR Fluid Sensitivity as per IEC\IEEE 62209-1528 and FCC KDB 865664 are applied to the highest measured SAR. A TSL with dielectric parameters <math>&gt; 10\%</math> in the DUT test frequency range are not used.</p>	
<b>Systems Performance Check</b>	
<p>The fluid dielectric parameters of the Active TSL are entered into the DASY Measurement Server at each of the <math>10\text{MHz}</math> step size intervals. Active meaning the TSL used during the SAR evaluation of the DUT. The DASY Measurement System will automatically interpolate the dielectric parameters for DUT test frequencies that fall between the <math>10\text{MHz}</math> step intervals.</p> <p>A Systems Performance Check (SPC) is performed in accordance with IEC\IEEE 62209-1528 "System Check" and FCC KDB 865664 "System Verification". A validation source, dipole or Confined Loop Antenna (CLA), is placed under the geometric center of the phantom and separated from the phantom in accordance to the validation source's Calibration Certificate data. A CW signal set to the frequency of the validate source's and SAR measurement probe's calibration frequency with a forward power set to the validation source's Calibration Certificate data power setting is applied to the validation source. An Area Scan is centered over the projection of the validation source's feed point and an Area Scan is taken. A Zoom Scan centered over the Peak SAR measurement of the Area Scan and the 1g and 10g SAR is measured. The measured 1g and 10g SAR is compared to the 1g and 10g SAR measurements from the validation source's Calibration Certificate. When required, the measured SAR is normalized to 1.0W and compared to the normalized SAR indicated on the validation source's Calibration Certificate. The SPC is considered valid when the measured and normalized SAR is <math>\leq 10\%</math> of the measured and normalize SAR of the validation source's Calibration Certificate.</p> <p>The fluid dielectric parameters of the Active TSL and SPC are repeated when the Active TSL has been in use for greater than 84 hours or if the Active TSL temperature has exceed <math>\pm 1^\circ\text{C}</math> of the initial fluid analysis.</p>	

### 13.5 Scan Resolution 100MHz to 2GHz

Scan Resolution 100MHz to 2GHz	
<b>Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)</b>	<b><math>4 \pm 1 \text{ mm}</math></b>
<b>Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)</b>	<b><math>5^\circ \pm 1^\circ</math></b>
<b>Area Scan Spatial Resolution <math>\Delta X, \Delta Y</math></b>	<b>15 mm</b>
<b>Zoom Scan Spatial Resolution <math>\Delta X, \Delta Y</math></b>	<b>7.5 mm</b>
<b>Zoom Scan Spatial Resolution <math>\Delta Z</math> (Uniform Grid)</b>	<b>5 mm</b>
<b>Zoom Scan Volume X, Y, Z</b>	<b>30 mm</b>
<b>Phantom</b>	<b>ELI</b>
<b>Fluid Depth</b>	<b><math>150 \pm 5 \text{ mm}</math></b>
An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima.	
A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR	

### 13.6 Scan Resolution 2GHz to 3GHz

Scan Resolution 2GHz to 3GHz	
Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)	4 ± 1 mm
Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)	5° ± 1°
Area Scan Spatial Resolution ΔX, ΔY	12 mm
Zoom Scan Spatial Resolution ΔX, ΔY	5 mm
Zoom Scan Spatial Resolution ΔZ (Uniform Grid)	5 mm
Zoom Scan Volume X, Y, Z	30 mm
Phantom	ELI
Fluid Depth	150 ± 5 mm
An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima.	
A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR	

### 13.7 Scan Resolution 5GHz to 6GHz

Scan Resolution 5GHz to 6GHz	
Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)	4 ± 1 mm
Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)	5° ± 1°
Area Scan Spatial Resolution ΔX, ΔY	10 mm
Zoom Scan Spatial Resolution ΔX, ΔY	4 mm
Zoom Scan Spatial Resolution ΔZ (Uniform Grid)	2 mm
Zoom Scan Volume X, Y, Z	22 mm
Phantom	ELI
Fluid Depth	100 ± 5 mm
An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima.	
A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR	

## 14.0 MEASUREMENT UNCERTAINTIES

### Table 14.0 Measurement Uncertainty

Measurement uncertainty table is not required per KDB 865664 D01 v01r04 section 2.8.2 page 12. SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is  $\geq 1.5$  W/kg for 1-g SAR. The equivalent ratio (1.5/1.6) should be applied to extremity and occupational exposure conditions. The highest reported SAR value is less than 1.5W/kg. Therefore, the measurement uncertainty table is not required.

**15.0 FLUID DIELECTRIC PARAMETERS**

**Table 15.0 Fluid Dielectric Parameters 2450MHz HEAD TSL**

\*\*\*\*\*  
 Aprel Laboratory  
 Test Result for UIM Dielectric Parameter  
 Wed 04/Jan/2023 15:57:42  
 Freq Frequency(GHz)  
 FCC\_eHFCC OET 65 Supplement C (June 2001) Limits for Head Epsilon  
 FCC\_sHFCC OET 65 Supplement C (June 2001) Limits for Head Sigma  
 Test\_e Epsilon of UIM  
 Test\_s Sigma of UIM  
 \*\*\*\*\*

Freq	FCC_eHFCC	FCC_sHFCC	Test_e	Test_s
.4000	39.29	1.76	36.44	1.81
2.4100	39.27	1.76	36.39	1.81
2.4200	39.25	1.77	36.32	1.83
2.4300	39.24	1.78	36.13	1.83
2.4400	39.22	1.79	36.34	1.86
2.4500	39.20	1.80	36.31	1.88
2.4600	39.19	1.81	36.25	1.88
2.4700	39.17	1.82	36.32	1.88
2.4800	39.16	1.83	36.34	1.88

FLUID DIELECTRIC PARAMETERS								Fluid Sensitivity Calculation IEC/IEEE 62209-1528 7.8.2			
Date:	4-Jan-2023	Fluid Temp:	23.6	Frequency:	2450MHz	Tissue:	Head	ΔSAR 1g	ΔSAR 10g	SAR Correction Factor (1)	
Freq (MHz)	Test ε	Test σ (S/m)	Target ε	Target σ (S/m)	Deviation Permittivity	Deviation Conductivity	1g			10g	
2400.0000		36.4400	1.8100	39.2900	1.76	-7.25%	2.84%	0.030	0.019	1.000	1.000
2402.0000	*	36.4300	1.8100	39.2860	1.76	-7.27%	2.84%	0.030	0.019	1.000	1.000
2410.0000		36.3900	1.8100	39.2700	1.76	-7.33%	2.84%	0.030	0.019	1.000	1.000
2412.0000	*	36.3760	1.8140	39.2660	1.76	-7.36%	2.95%	0.031	0.019	1.000	1.000
2420.0000		36.3200	1.8300	39.2500	1.77	-7.46%	3.39%	0.033	0.021	1.000	1.000
2430.0000		36.1300	1.8300	39.2400	1.78	-7.93%	2.81%	0.031	0.020	1.000	1.000
2437.0000	*	36.2770	1.8510	39.2260	1.79	-7.52%	3.58%	0.034	0.021	1.000	1.000
2440.0000	*	36.3400	1.8600	39.2200	1.79	-7.34%	3.91%	0.035	0.022	1.000	1.000
2450.0000		36.3100	1.8800	39.2000	1.80	-7.37%	4.44%	0.038	0.023	1.000	1.000
2460.0000		36.2500	1.8800	39.1900	1.81	-7.50%	3.87%	0.035	0.022	1.000	1.000
2462.0000	*	36.2640	1.8800	39.1860	1.81	-7.46%	3.75%	0.035	0.022	1.000	1.000
2470.0000		36.3200	1.8800	39.1700	1.82	-7.28%	3.30%	0.032	0.020	1.000	1.000
2480.0000	*	36.3400	1.8800	39.1600	1.83	-7.20%	2.73%	0.029	0.018	1.000	1.000

\*Channel Frequency Tested

## 16.0 SYSTEM VERIFICATION TEST RESULTS

Table 16.0 System Verification Results 2450MHz HEAD TSL

System Verification Test Results					
Date		Frequency (MHz)	Validation Source		
			P/N		S/N
4 Jan 2023		2450	D2450V2		825
Fluid Type	Fluid Temp °C	Ambient Temp °C	Ambient Humidity (%)	Forward Power (mW)	Source Spacing (mm)
Head	23.6	25	18%	250	10
Fluid Parameters					
Permittivity			Conductivity		
Measured	Target	Deviation	Measured	Target	Deviation
36.31	39.20	-7.37%	1.88	1.80	4.44%
Measured SAR					
1 gram			10 gram		
Measured	Target	Deviation	Measured	Target	Deviation
14.00	13.18	6.22%	6.38	6.01	6.24%
Measured SAR Normalized to 1.0W					
1 gram			10 gram		
Normalized	Target	Deviation	Normalized	Target	Deviation
56.00	52.72	6.22%	25.52	24.02	6.27%
<p>Prior to the SAR evaluations, system checks were performed on the planar section of the phantom and a SPEAG validation dipole in accordance with the procedures described in IEC\IEEE 62209-1528, FCC KDB 846224.</p> <p>The dielectric parameters of the simulated tissue mixture were measured prior to the system performance check using a Dielectric Probe Kit and a Network Analyzer.</p> <p>The forward power was applied to the dipole and the system was verified to a tolerance of +10% from the system manufacturer's dipole calibration target SAR value.</p> <p>The forward power applied was same forward power applied by the calibration lab during the calibration of this validation source.</p>					

## 17.0 SYSTEM VALIDATION SUMMARY

Table 17.0 System Validation Summary

SAR Validation SummaryChart							
Validation Date	Validation Source	Source S/N	Validation Frequency	Tissue	Linearity	Isotropy	Extrapolation
3-May-22	D2450V2	825	2450	Head	✓	✓	✓

## 18.0 MEASUREMENT SYSTEM SPECIFICATIONS

Table 18.0 Measurement System Specifications

Measurement System Specification	
<b>Specifications</b>	
Positioner	Stäubli Unimation Corp. Robot Model: TX90XL
Repeatability	+/- 0.035 mm
No. of axis	6.0
<b>Data Acquisition Electronic (DAE) System</b>	
<b>Cell Controller</b>	
Processor	Intel(R) Core(TM) i7-7700
Clock Speed	3.60 GHz
Operating System	Windows 10 Professional
<b>Data Converter</b>	
Features	Signal Amplifier, multiplexer, A/D converter, and control logic
Software	Measurement Software: DASY6, V 6.4.0.12171 / DASY52 V10.2(1504) Postprocessing Software: SEMCAD X, V14.6.12(7470)
Connecting Lines	Optical downlink for data and status info., Optical uplink for commands and clock
<b>DASY Measurement Server</b>	
Function	Real-time data evaluation for field measurements and surface detection
Hardware	Intel ULV Celeron CPU 400 MHz; 128 MB chip disk; 128 MB RAM
Connections	COM1, COM2, DAE, Robot, Ethernet, Service Interface
<b>E-Field Probe</b>	
Model	EX3DV4
Serial No.	3600
Construction	Triangular core fiber optic detection system
Frequency	10 MHz to 6 GHz
Linearity	±0.2 dB (30 MHz to 3 GHz)
<b>Phantom</b>	
Type	MFP V5.1C Planar Phantom
Shell Material	Fiberglass
Thickness	2mm +/- .2mm
Volume	> 8 Liter

**Table 18.1**

<b>Measurement System Specification (Continued)</b>		
<b>Probe Specification</b>		
Construction:	Symmetrical design with triangular core; Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents (e.g. DGBE))	 <p><b>EX3DV4 E-Field Probe</b></p>
Calibration:	ISO/IEC 17025	
Frequency:	4 MHz - 10 GHz; Linearity: $\pm 0.2$ dB (30 MHz - 10 GHz)	
Directivity:	$\pm 0.1$ dB in TSL (rotation around probe axis) $\pm 0.3$ dB in TSL (rotation normal to probe axis)	
Dynamic Range:	10 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB (noise: typically <1 mW/g)	
Dimensions:	Overall length: 337 mm; (tip: 20 mm) Tip diameter: 2.5 mm; Tip (body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	
Application:	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields); the only probe that enables compliance testing for frequencies up to 6 GHz with precision of better than 30%	
<b>Phantom Specification</b>		
<p>The ELI V5.0 phantom is an elliptical planar fiberglass shell phantom with a shell thickness of 2.0mm +/- .2mm at the planar area. This phantom conforms to OET Bulletin 65, Supplement C, IEC\IEEE 62209-1528.</p>		 <p><b>ELI Phantom</b></p>
<b>Phantom Specification</b>		
<p>The SAM V4.0 phantom is a flat planar fiberglass shell phantom with a shell thickness of 2.0mm +/- .2mm at the planar area. This phantom conforms to OET Bulletin 65, Supplement C, IEC\IEEE 62209-1528.</p>		 <p><b>SAM Phantom</b></p>
<b>Phantom Specification</b>		
<p>The MFP V5.1C phantom is a flat planar fiberglass shell phantom with a shell thickness of 2.0mm +/- .2mm at the planar area. This phantom conforms to OET Bulletin 65, Supplement C, IEC\IEEE 62209-1528.</p>		 <p><b>MFP Phantom</b></p>
<b>Device Positioner Specification</b>		
<p>The DASY device positioner has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections.</p>		 <p><b>Device Positioner</b></p>

## 19.0 TEST EQUIPMENT LIST

Table 19.0 Equipment List and Calibration

Test Equipment List				
DESCRIPTION	ASSET NO.	SERIAL NO.	DATE CALIBRATED	CALIBRATION DUE
Schmid & Partner DASY 6 System	-	-	-	-
-DASY Measurement Server	00158	1078	CNR	CNR
-Robot	00046	599396-01	CNR	CNR
-DAE4	00019	353	14-Apr-22	14-Apr-23
-EX3DV4 E-Field Probe	00213	3600	20-Apr-22	20-Apr-23
-D2450V2 Validation Dipole	00219	825	24-Apr-21	24-Apr-24
MFP Phantom	00355	1177/2	CNR	CNR
HP 85070C Dielectric Probe Kit	00033	none	CNR	CNR
HP 8753ET Network Analyzer	00134	US39170292	6-Jan-21	6-Jan-24
Rohde & Schwarz SMR20 Signal Generator	00006	100104	11-Aug-20	11-Aug-23
Amplifier Research 10W1000C Power Amplifier	00041	27887	CNR	CNR
Amplifier Research 5S1G4 Power Amplifier	00106	26235	CNR	CNR
Narda Directional Coupler 3020A	00064	-	CNR	CNR
Kangaroo VWR Humidity/Thermometer	00334	192385455	5-Aug-19	5-Jan-23
Digital Multi Meter DMR-1800	00250	TE182	23-Jun-20	23-Jun-23
Bipolar Power Supply 6299A	00086	1144A02155	CNR	CNR
DC-18G 10W 30db Attenuator	00102	-	COU	COU
R&S FSP40 Spectrum Analyzer	00241	100500	9-Aug-21	9-Aug-24
HP 8566B Spectrum Analyzer	00051	2747A055100	29-Jun-20	29-Jun-23
RF Cable-SMA	00311	-	CNR	CNR
HP Calibration Kit	00145	-	CNR	CNR

CNR = Calibration Not Required

COU = Calibrate on Use

Note: Per KDB 865664, Dipoles are evaluated annually for return loss and impedance. The dipole's SAR target can only be assessed by the SAR equipment manufacturer and remains the target until the dipole is recalibrated by the manufacturer. The dipole's SAR is evaluated and compared to this target during each and every System Verification which is performed prior to and/or during each DUT SAR evaluation. The results of these verifications are shown in Section 16.0

**20.0 FLUID COMPOSITION**

Table 20.0 Fluid Composition 2450MHz HEAD TSL

Tissue Simulating Liquid (TSL) Composition				2450MHz Head
Component by Percent Weight				
Water	Glycol	Salt <sup>(1)</sup>	HEC <sup>(2)</sup>	Bacteriacide <sup>(3)</sup>
52.0	48.0	0.0	0.0	0.0

(1) Non-Iodinized

(2) HydroxyEthyl-Cellulose: Sigma-Aldrich P/N 54290-500g

(3) Dow Chemical Dovicil 75 Antimicrobial Perservative

**END OF REPORT**

## APPENDIX A – SYSTEM VERIFICATION PLOTS

**DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:825**  
**Procedure Name: SPC 2450H\_Input=250mw, Target=[11.86]13.18][14.50]W/kg\_ 2 2 2**

Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.88$  S/m;  $\epsilon_r = 36.31$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Left Section

Date/Time: 1/4/2023 4:48:04 PM

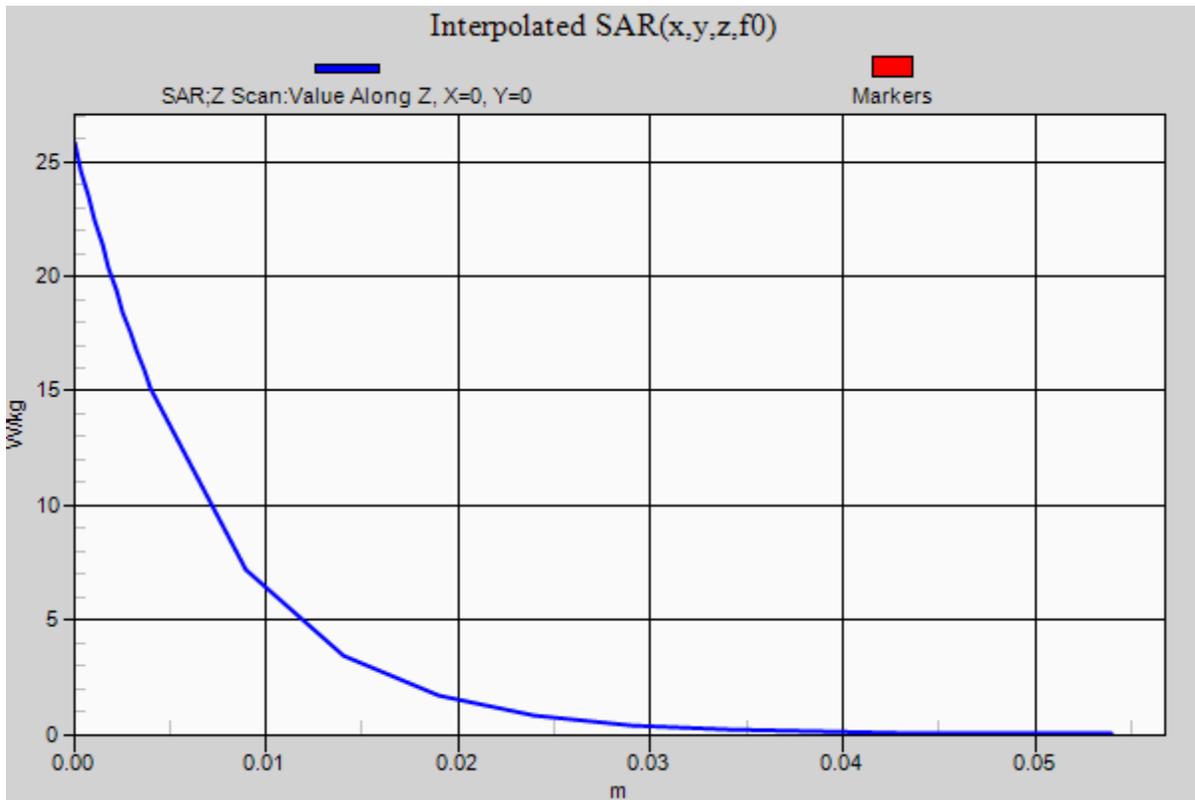
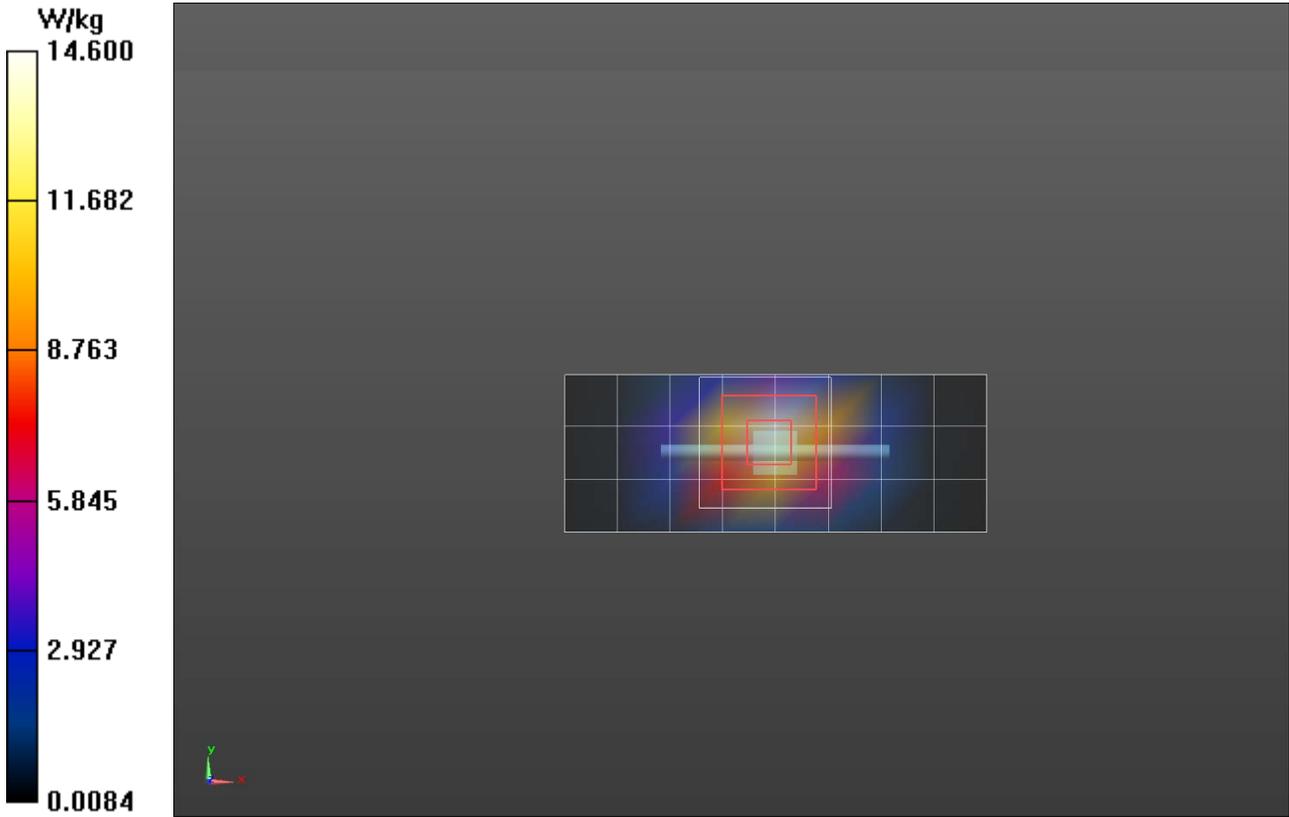
DASY5 Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.58, 6.58, 6.58) @ 2450 MHz; Calibrated: 4/20/2022
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 4/14/2022
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 00355
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**SPC/SPC 2450H\_Input=250mw, Target=[11.86]13.18][14.50]W/kg\_ 2 2 2/Area Scan (9x4x1):** Measurement grid: dx=12mm, dy=12mm  
Maximum value of SAR (measured) = 14.6 W/kg

**SPC/SPC 2450H\_Input=250mw, Target=[11.86]13.18][14.50]W/kg\_ 2 2 2/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 90.07 V/m; Power Drift = -0.02 dB  
Peak SAR (extrapolated) = 30.6 W/kg  
**SAR(1 g) = 14 W/kg; SAR(10 g) = 6.38 W/kg**  
Smallest distance from peaks to all points 3 dB below = 10.8 mm  
Ratio of SAR at M2 to SAR at M1 = 46.8%  
Maximum value of SAR (measured) = 15.8 W/kg

**SPC/SPC 2450H\_Input=250mw, Target=[11.86]13.18][14.50]W/kg\_ 2 2 2/Z Scan (1x1x22):** Measurement grid: dx=20mm, dy=20mm, dz=5mm  
Penetration depth = 6.919 (6.667, 7.038) [mm]  
Maximum value of SAR (interpolated) = 25.8 W/kg



## APPENDIX B – MEASUREMENT PLOTS OF MAXIMUM MEASURED SAR

### Plot E3

**DUT: A04524; Type: Extremity Worn Transmitter; Serial: Sample Production Prototype**  
**Procedure Name: E3-A04524,Extremity-Back Side, 2462 MHz, Silicone Band-WIFI, DSSS-5.5Mbps**

Communication System: UID 0, CW (0); Frequency: 2462 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2462$  MHz;  $\sigma = 1.88$  S/m;  $\epsilon_r = 36.264$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Left Section

Date/Time: 1/5/2023 8:09:42 PM

DASY5 Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.58, 6.58, 6.58) @ 2462 MHz; Calibrated: 4/20/2022
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 4/14/2022
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 00355
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**2450H A04524 /E3-A04524,Extremity-Back Side, 2462 MHz, Silicone Band-WIFI, DSSS-5.5Mbps/Area Scan (8x8x1):** Measurement grid: dx=12mm, dy=12mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.720 W/kg

**2450H A04524 /E3-A04524,Extremity-Back Side, 2462 MHz, Silicone Band-WIFI, DSSS-5.5Mbps/Zoom Scan (7x7x7)/Cube 0:**

Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 16.72 V/m; Power Drift = -0.35 dB  
Peak SAR (extrapolated) = 1.69 W/kg  
**SAR(1 g) = 0.610 W/kg; SAR(10 g) = 0.191 W/kg**  
Smallest distance from peaks to all points 3 dB below = 7.6 mm  
Ratio of SAR at M2 to SAR at M1 = 40.5%

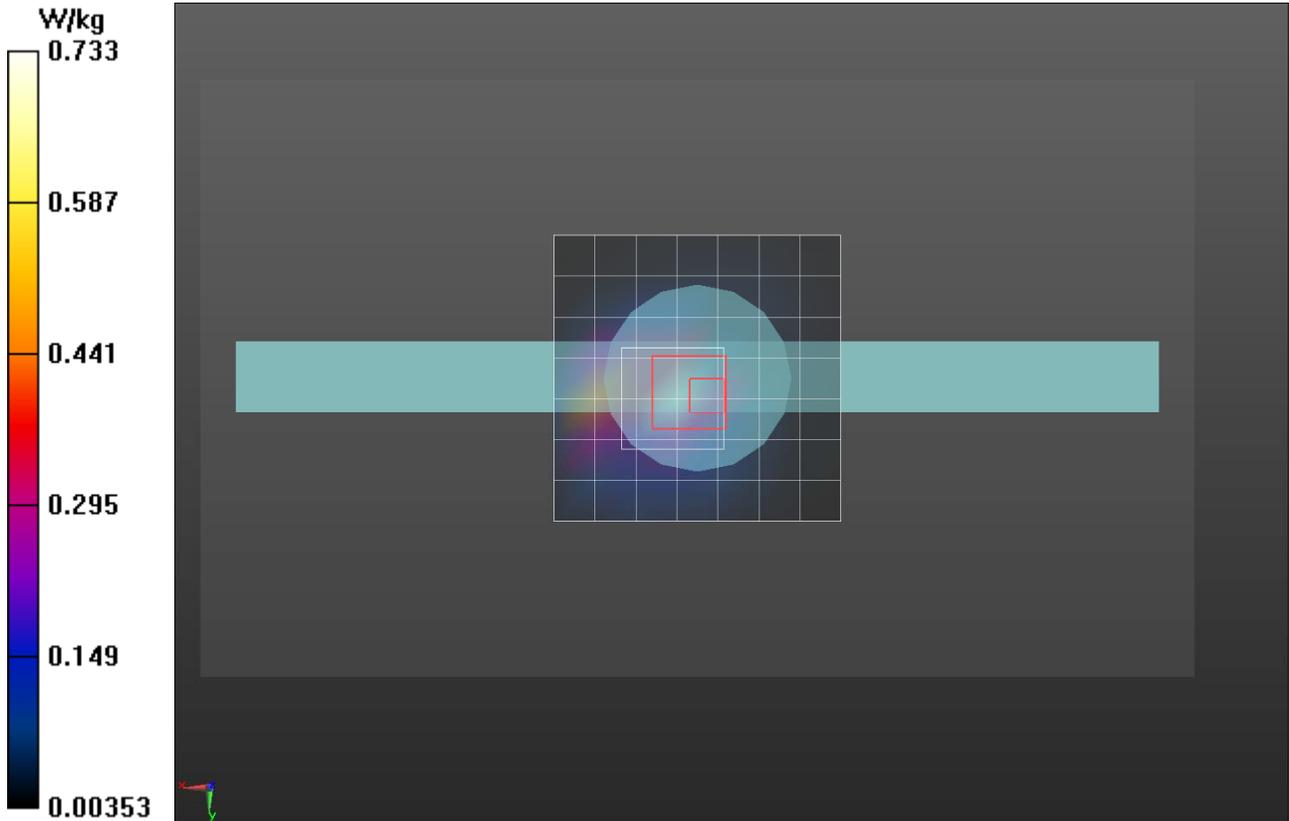
[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.745 W/kg

**2450H A04524 /E3-A04524,Extremity-Back Side, 2462 MHz, Silicone Band-WIFI, DSSS-5.5Mbps/Z Scan (1x1x17):** Measurement grid: dx=20mm, dy=20mm, dz=20mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Penetration depth = n/a (n/a, 6.623) [mm]  
Maximum value of SAR (interpolated) = 0.733 W/kg



## Plot E8

**DUT: A04524; Type: Extremity Worn Transmitter; Serial: Production Sample Prototype**  
**Procedure Name: E8-A04524,Extremity-Back Side,ch-78 2480 MHz, B1, BT, GFSK**

Communication System: UID 0, CW (0); Frequency: 2480 MHz;Duty Cycle: 1:1  
Medium parameters used:  $f = 2480$  MHz;  $\sigma = 1.88$  S/m;  $\epsilon_r = 36.34$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Left Section

Date/Time: 1/5/2023 5:35:53 PM

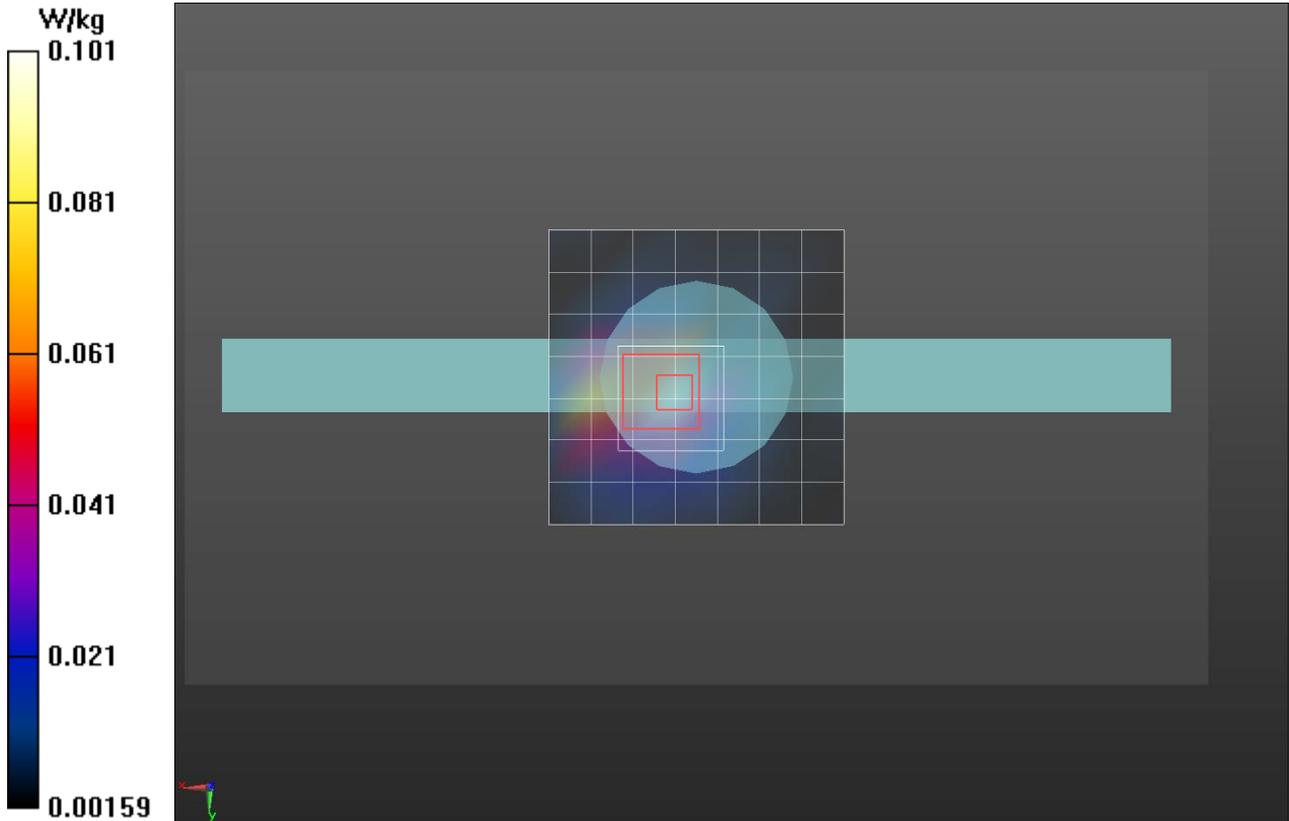
DASY5 Configuration:

- Probe: EX3DV4 – SN3600; ConvF(6.58, 6.58, 6.58) @ 2480 MHz; Calibrated: 4/20/2022
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 4/14/2022
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 00355
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**2450H A04524 /E8-A04524,Extremity-Back Side,ch-78 2480 MHz, B1, BT, GFSK/Area Scan (8x8x1):** Measurement grid: dx=12mm, dy=12mm  
Maximum value of SAR (measured) = 0.109 W/kg

**2450H A04524 /E8-A04524,Extremity-Back Side,ch-78 2480 MHz, B1, BT, GFSK/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 6.139 V/m; Power Drift = -0.09 Db  
Peak SAR (extrapolated) = 0.220 W/kg  
**SAR(1 g) = 0.090 W/kg; SAR(10 g) = 0.037 W/kg**  
Smallest distance from peaks to all points 3 Db below = 5.7 mm  
Ratio of SAR at M2 to SAR at M1 = 44.3%  
Maximum value of SAR (measured) = 0.101 W/kg

**2450H A04524 /E8-A04524,Extremity-Back Side,ch-78 2480 MHz, B1, BT, GFSK/Z Scan (1x1x17):** Measurement grid: dx=20mm, dy=20mm, dz=20mm  
Penetration depth = n/a (n/a, 6.598) [mm]  
Maximum value of SAR (interpolated) = 0.101 W/kg



**APPENDIX D – PROBE CALIBRATION**



Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Celltech**

Certificate No: **EX3-3600\_Apr22**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3600**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5,  
QA CAL-25.v7  
Calibration procedure for dosimetric E-field probes**

Calibration date: **April 20, 2022**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-22 (No. 217-03527)	Apr-23
DAE4	SN: 660	13-Oct-21 (No. DAE4-660_Oct21)	Oct-22
Reference Probe ES3DV2	SN: 3013	27-Dec-21 (No. ES3-3013_Dec21)	Dec-22
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	
			Issued: April 20, 2022

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

### Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below *ConvF*).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* *frequency\_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.48	0.48	0.38	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	101.6	98.8	101.6	

### Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	147.6	$\pm 2.5 \%$	$\pm 4.7 \%$
		Y	0.0	0.0	1.0		140.0		
		Z	0.0	0.0	1.0		146.8		

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

<sup>A</sup> The uncertainties of Norm X,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Pages 5 and 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-124
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

**Note:** Measurement distance from surface can be increased to 3-4 mm for an *Area Scan* job.

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unc (k=2)
30	55.0	0.75	12.25	12.25	12.25	0.00	1.00	± 13.3 %
150	52.3	0.76	9.65	9.65	9.65	0.00	1.00	± 13.3 %
450	43.5	0.87	8.78	8.78	8.78	0.16	1.30	± 13.3 %
750	41.9	0.89	8.23	8.23	8.23	0.46	0.86	± 12.0 %
835	41.5	0.90	8.11	8.11	8.11	0.51	0.80	± 12.0 %
900	41.5	0.97	7.99	7.99	7.99	0.47	0.80	± 12.0 %
1640	40.2	1.31	7.45	7.45	7.45	0.28	0.86	± 12.0 %
1810	40.0	1.40	7.35	7.35	7.35	0.35	0.86	± 12.0 %
1900	40.0	1.40	7.30	7.30	7.30	0.33	0.86	± 12.0 %
2300	39.5	1.67	6.79	6.79	6.79	0.36	0.90	± 12.0 %
2450	39.2	1.80	6.58	6.58	6.58	0.33	0.90	± 12.0 %
2600	39.0	1.96	6.49	6.49	6.49	0.38	0.90	± 12.0 %
5250	35.9	4.71	4.55	4.55	4.55	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.18	4.18	4.18	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.16	4.16	4.16	0.40	1.80	± 13.1 %

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

### Calibration Parameter Determined in Head Tissue Simulating Media

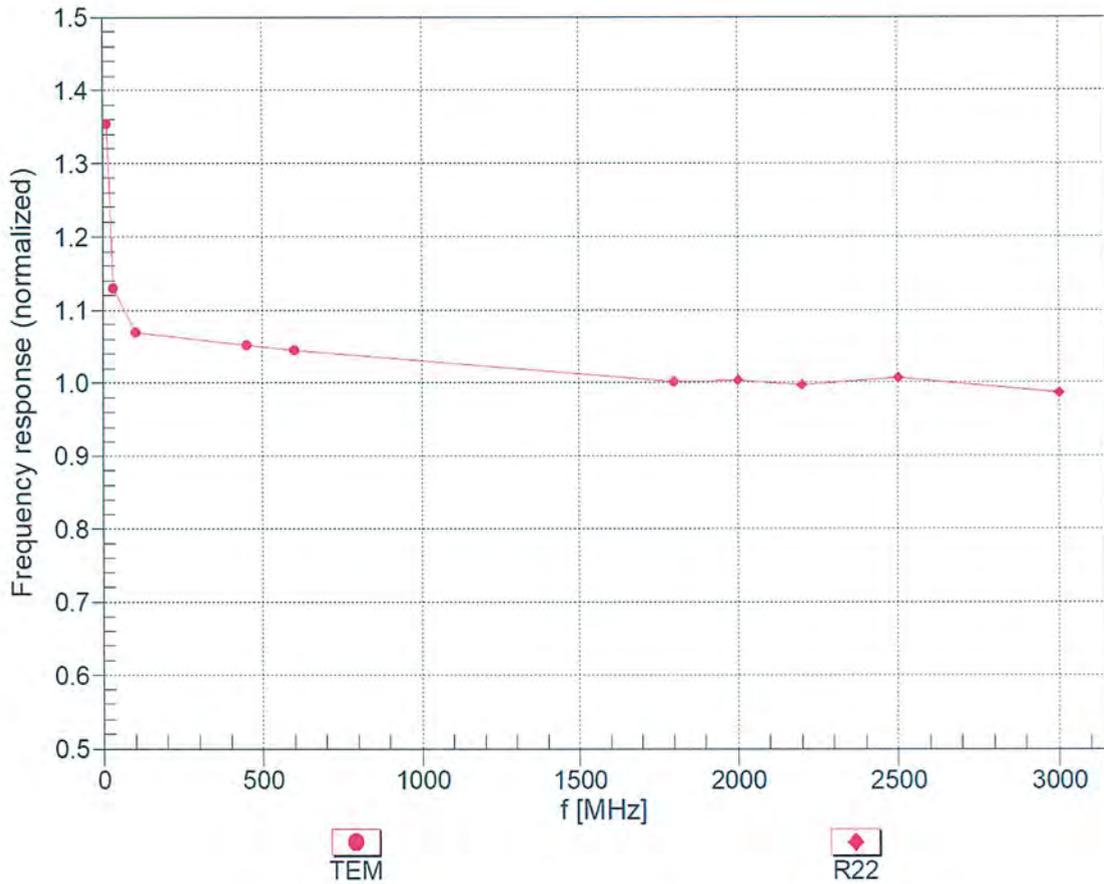
f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unc (k=2)
6500	34.5	6.07	4.75	4.75	4.75	0.20	2.50	± 18.6 %

<sup>C</sup> Frequency validity at 6.5 GHz is -600/+700 MHz, and ± 700 MHz at or above 7 GHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies 6-10 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz; below ± 2% for frequencies between 3-6 GHz; and below ± 4% for frequencies between 6-10 GHz at any distance larger than half the probe tip diameter from the boundary.

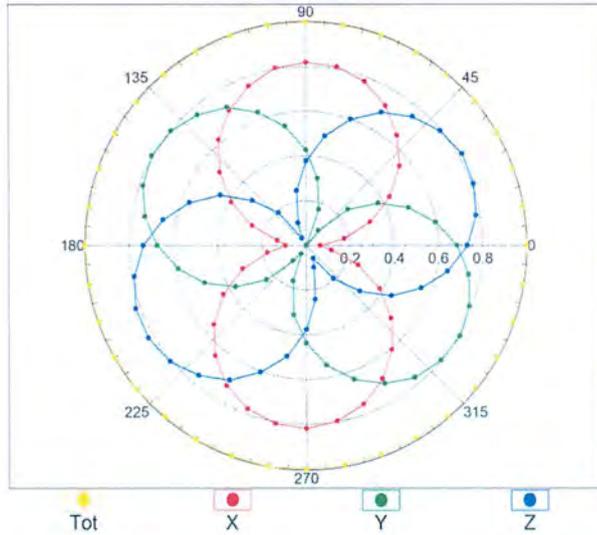
# Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



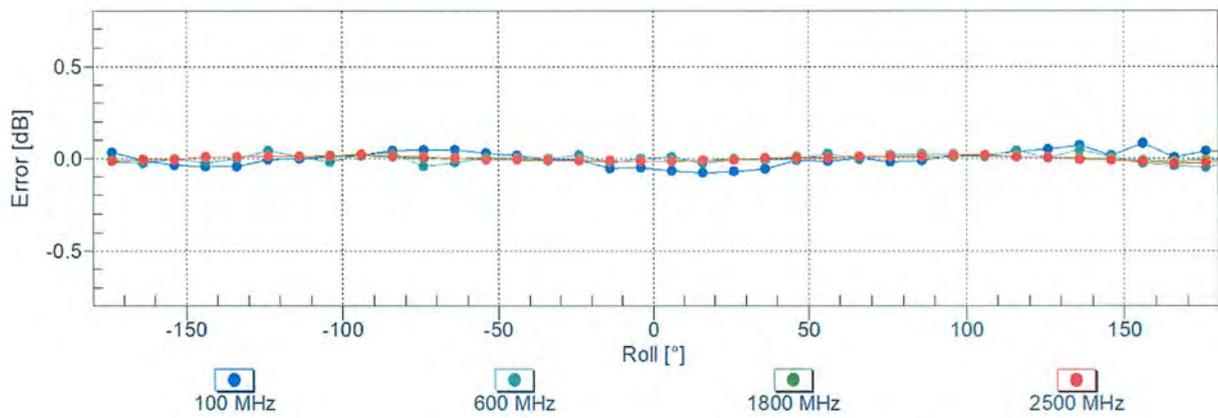
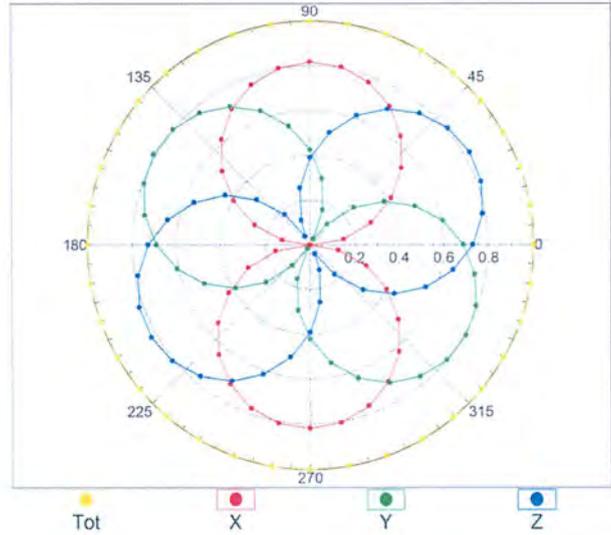
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

### Receiving Pattern ( $\phi$ ), $\theta = 0^\circ$

f=600 MHz,TEM

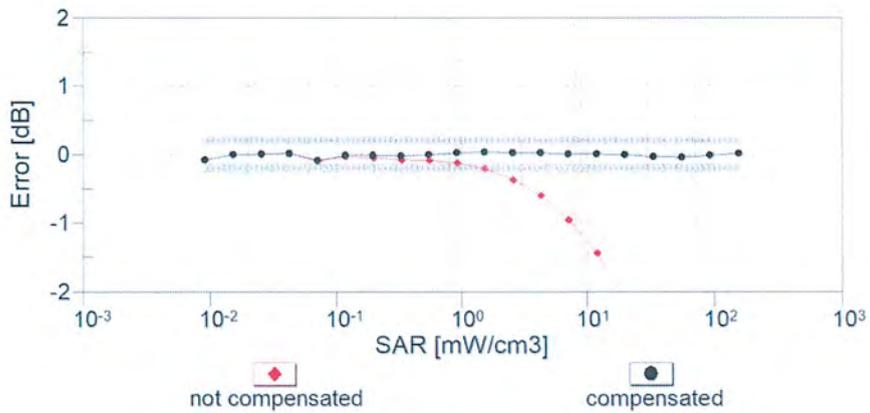
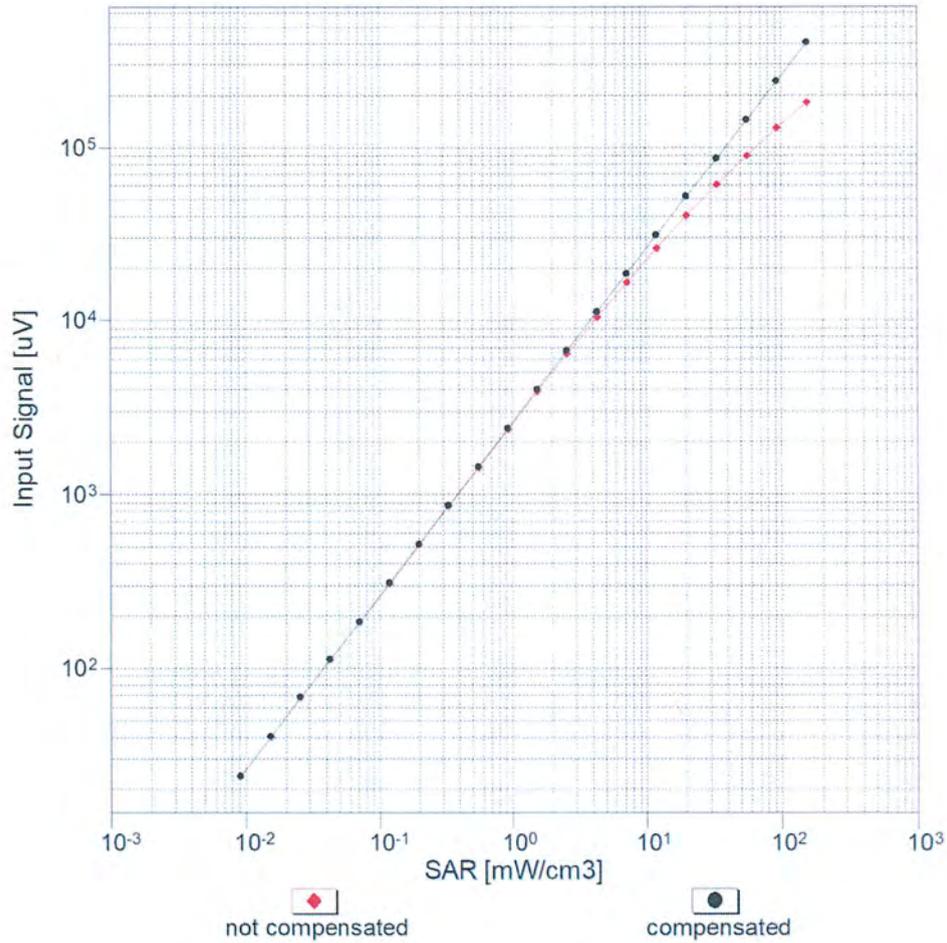


f=1800 MHz,R22



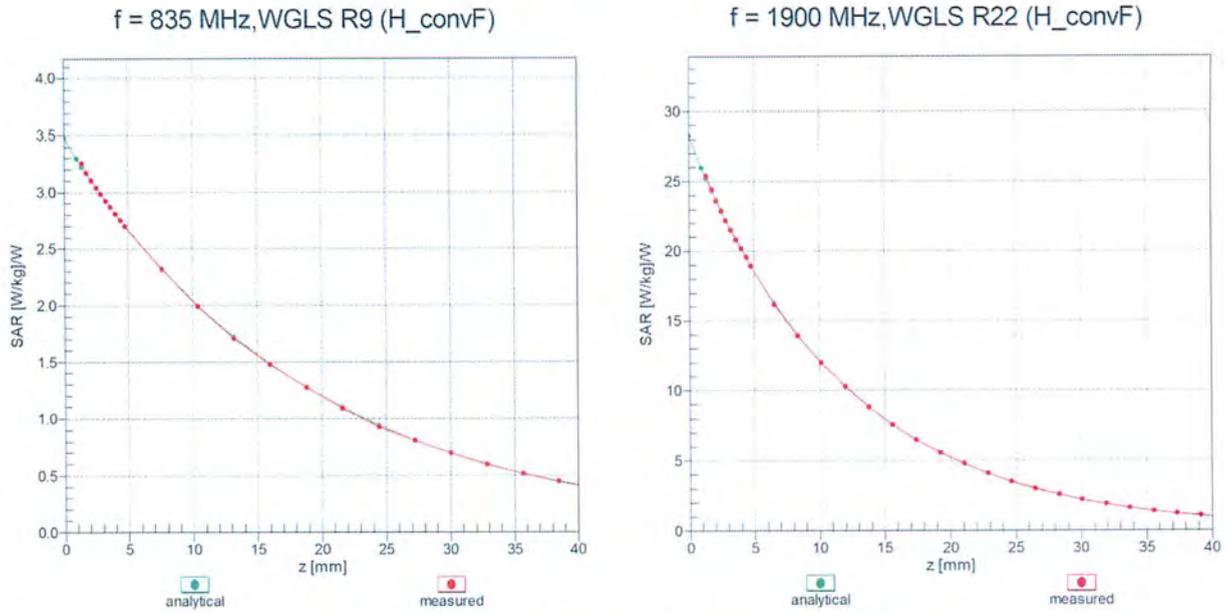
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f_{\text{eval}}= 1900 \text{ MHz}$ )

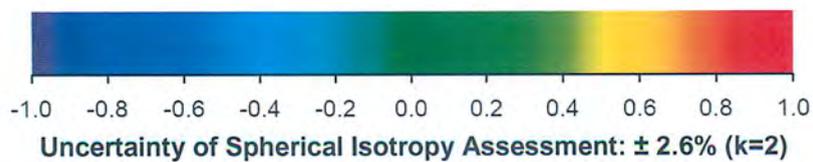
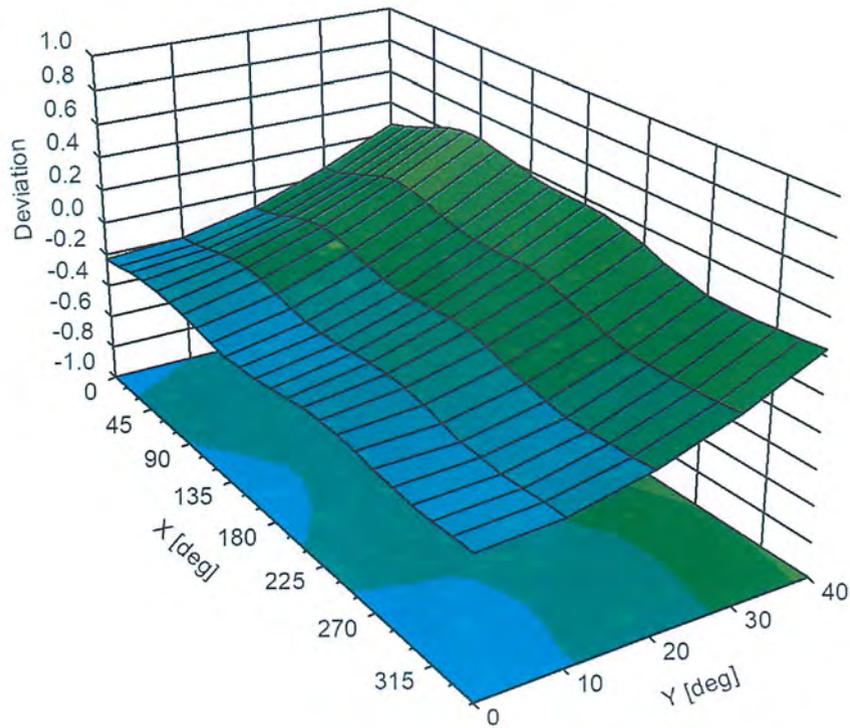


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \vartheta$ ), f = 900 MHz



**APPENDIX E – DIPOLE CALIBRATION**

# NCL CALIBRATION LABORATORIES

Calibration File No: DC-1904

Project Number: 5921

**Client.: Celltech**

Address: 21 – 364 Lougheed Road, Kelowna, BC V1X 7R8, Canada

## CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Validation Dipole (Head)

Manufacturer: SPEAG

Part number: D2450V2

Frequency: 2450 MHz

Serial No: 825

Calibrated: 27/04/2021

Released on: 05/05/2021

This Calibration Certificate is incomplete unless accompanied by the Calibration Results Summary

Released by: \_\_\_\_\_

Pieter Erasmus, Quality Manager

**NCL** Calibration Laboratories

Suite 102, 303 Terryfox Dr.  
Ottawa, Ontario, K2K 3J1  
Canada

Division of APREL Lab.  
Tel: (613) 435-8300  
Fax: (613) 435-8306

## Conditions

Dipole SN 825 was a re-calibration.

**Ambient Temperature of the Laboratory:** 21 °C +/- 0.5°C  
**Temperature of the Tissue:** 21 °C +/- 0.5°C

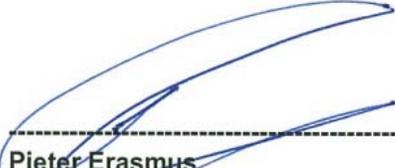
### Primary Measurement Standards

Instrument		Serial Number		Cal due date
Signal Generator	HP	83640B	3844A00689	Sept. 17, 2022
Network Analyzer	Keysight	E5063A	MY54502902	Mar. 9, 2023
Spectrum Analyzer	Keysight	N9030B	MY57140772	Apr. 20, 2023

### Attestation

The below named signatories have conducted the calibration and review of the data which is presented in this calibration report.

We the undersigned attest that to the best of our knowledge the calibration has been accurately conducted and that all information contained within this report has been reviewed for accuracy and any uncertainties if applicable disclosed.



-----  
Pieter Erasmus  
Quality Manager



-----  
Maryna Nesterova  
Test and Calibration Engineer

### Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

### Tissue Validation

Tissue	Frequency	Dielectric constant, $\epsilon_r$	Conductivity, $\sigma$ [S/m]
Head	2450 MHz	40.73	1.86

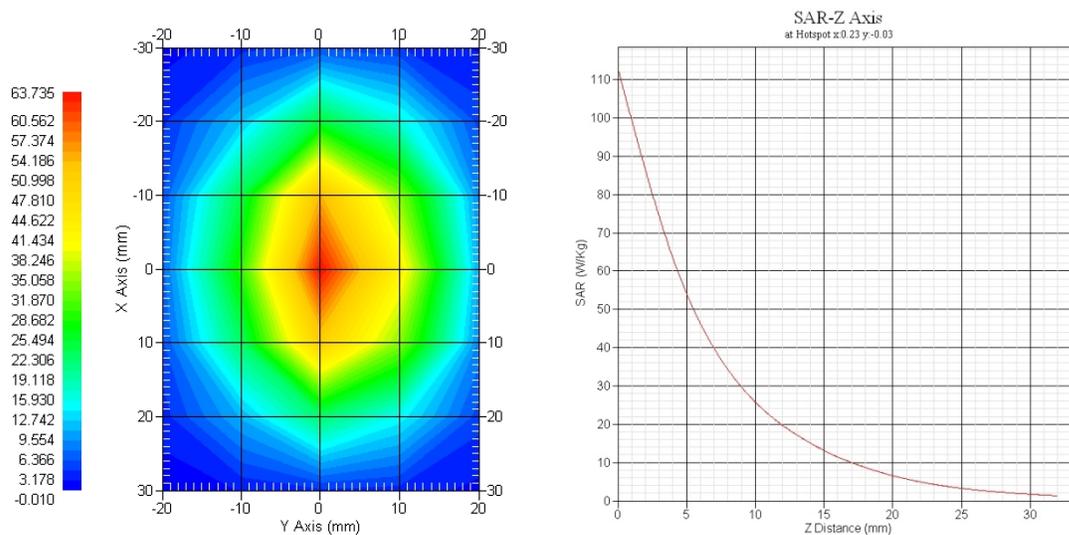
### Electrical Specification

Tissue	Frequency	Return Loss	Impedance	SWR:
Head	2450 MHz	-19.83 dB	43.26 $\Omega$	1.23U

### System Validation Results

Tissue	Frequency	1-Gram SAR	10-Gram SAR	Uncertainty
Head	2450 MHz	52.719 W/kg	24.015 W/kg	19.8%

### Head



**Introduction**

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole SN 825. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-020 30 MHz to 6 GHz E-Field Probe Serial Number 225.

**References**

- IEEE Standard 1528:2013  
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1:2016  
Human Exposure to RF Fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices
- IEC 62209-2:2019  
Human exposure to RF fields from hand-held and body-mounted wireless devices - Human models, instrumentation, and procedures - Part 2: specific absorption rate (SAR) for wireless communication devices (30 MHz - 6 GHz)
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9 kHz to 40 GHz

**Conditions**

**Ambient Temperature of the Laboratory:** 21 °C +/- 0.5°C

**Temperature of the Tissue:** 21 °C +/- 0.5°C

**Dipole Calibration uncertainty**

The calibration uncertainty for the dipole is made up of various parameters presented below.

	Tolerance, %
<b>Mechanical</b>	2.00
<b>Positioning Error</b>	0.10
<b>Electrical</b>	0.37
<b>Tissue Permittivity</b>	3.88
<b>Tissue Conductivity</b>	3.56
<b>Dipole Validation</b>	1.70
<b>Combined Uncertainty, k=2</b>	<b>4.81</b>

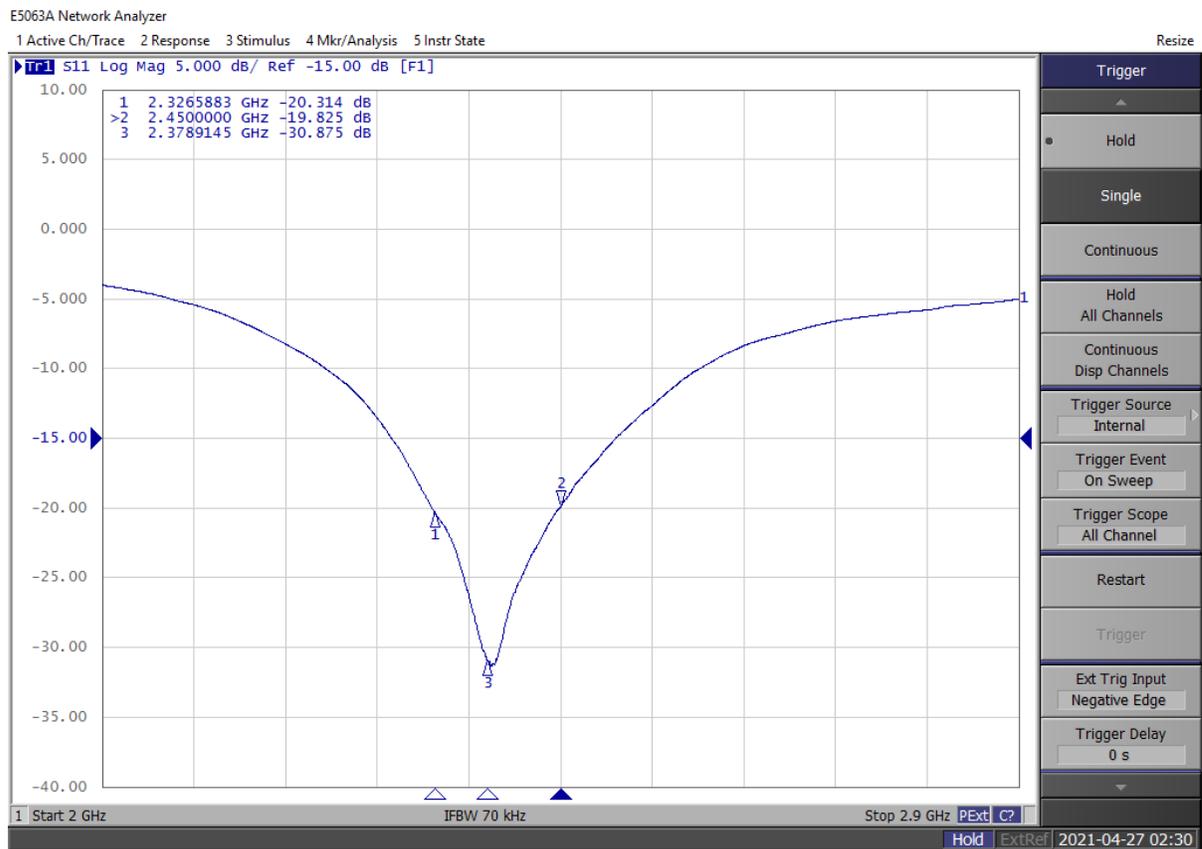
The Following Graphs are the results as displayed on the Vector Network Analyzer.  
**Electrical Calibration**

Test	Head
S11 R/L	-19.83 dB
Impedance	43.26 $\Omega$
SWR	1.23 U

**S11 Parameter Return Loss**

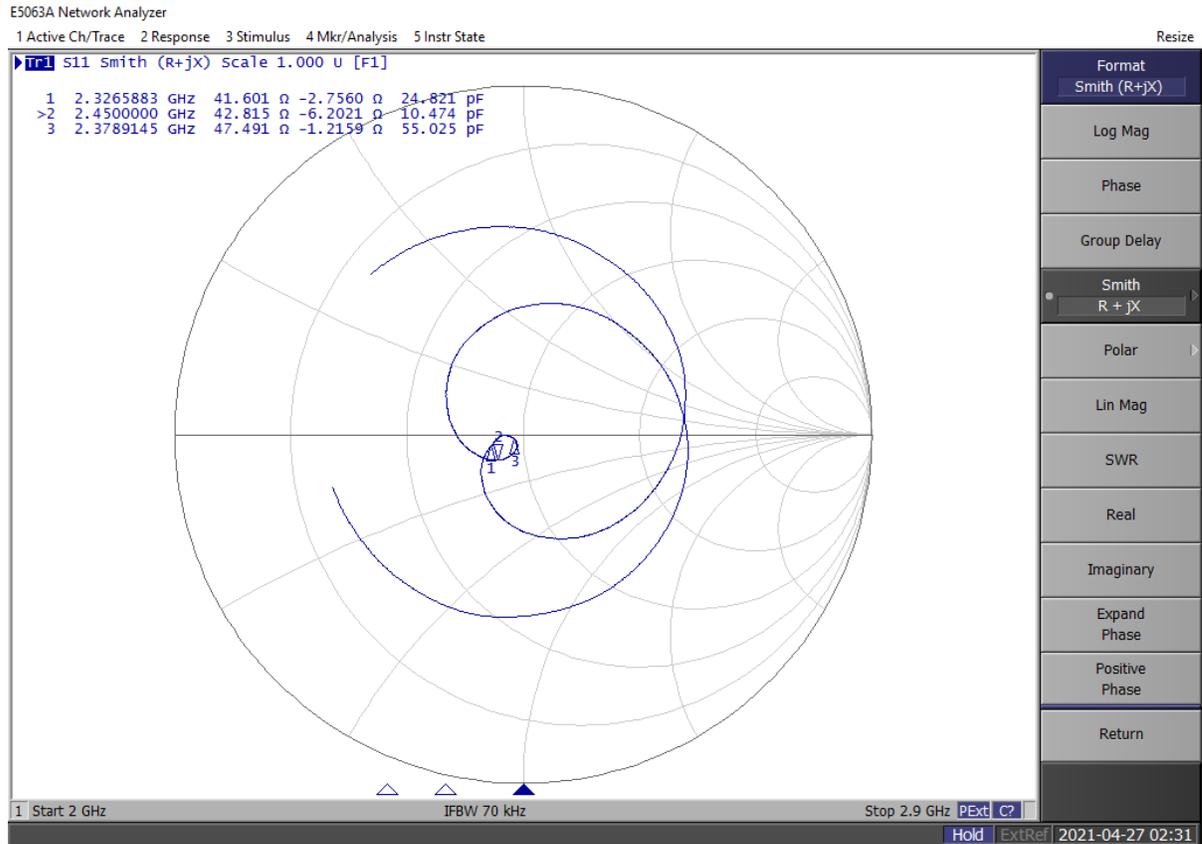
**Head**

Frequency Range 2326.59 MHz to 2450 MHz



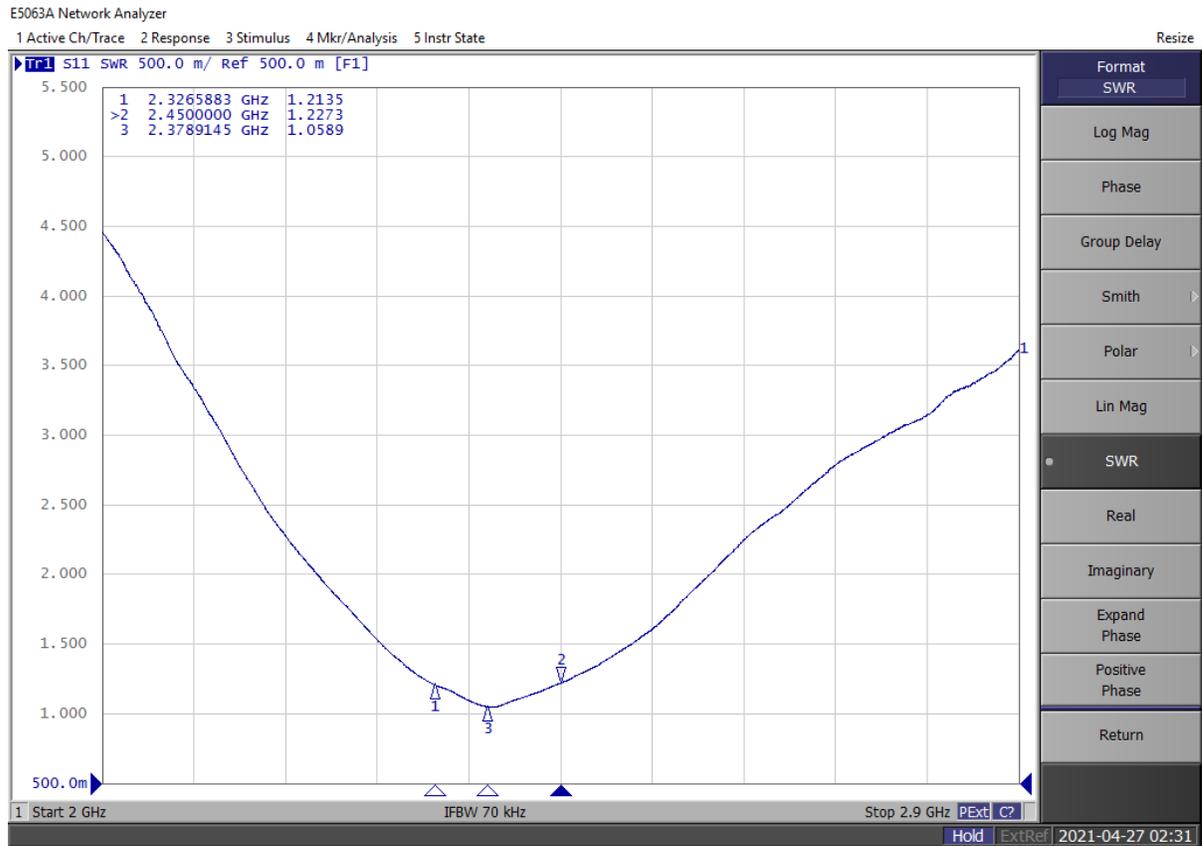
# Smith Chart Dipole Impedance

## Head



# SWR

## Head



**APPENDIX F - PHANTOM**

## Certificate of conformity / First Article Inspection

Item	Triple Modular Flat Phantom V5.1
Type No	QD 000 P51 C
Series No	1100 and higher
Manufacturer / Origin	Untersee Composites Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

### Tests

The sub-units of item 1100 are identified with the designation 1100/1, 1100/2 and 1100/3. Tests were conducted on all 3 sub-units of this phantom.

Test	Requirement	Details	Units tested
Material thickness	Compliant with the standard requirements.	2 mm +/- 0.2 mm 30 points over the bottom area	all
Material parameters	Dielectric parameters for required frequencies	200 MHz – 6 GHz - Relative permittivity 3 - 5 Loss tangent < 0.05.	Material sample
Material resistivity	The material is compatible with the liquids defined in the standards if handled and cleaned according to the instructions.	DGBE based simulating liquids. Observe Technical Note for material compatibility.	Material Samples
Shape	Internal dimensions	Internal height: > 175 mm Bottom internal length: 280 mm Bottom internal width: 175 mm Nominal filling height: 155 mm Nominal volume: 9.2 l	Pre-series, design
Sagging	Depending on standard	No initial sagging (negative preshaped, change < 0.5 mm)	1100/2

### Standards

- [1] IEEE 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- [2] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005
- [3] IEC 62209 – 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures, Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", March 2010
- [4] KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Conformity

Based on the dimensions and sample tests above, we certify that this item is in compliance with the standards [1] to [4] for frequencies > 700 MHz, if operated according to the specific requirements.

Date 16.07.2015

Signature / Stamp

**s p e a g**

Schmid & Partner Engineering AG  
 Zeughausstrasse 43, 8004 Zurich, Switzerland  
 Phone +41 44 245 9700, Fax +41 44 245 9779  
 info@speag.com, http://www.speag.com

**Conducted Power Measurement Results:**

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured Power [P <sub>Meas</sub> ] (dBm)	Measured Power (W)	Conducted Limit [P <sub>Lim</sub> ] (dBm)	Conducted Margin (dB)	Antenna Gain (dBi)	EIRP [E <sub>Meas</sub> ] (dBm)	EIRP (W)	EIRP Limit [E <sub>Lim</sub> ] (dBm)	EIRP Margin (dB)
6	2437.00	802.11b	CCK 1MB	18.03	0.0635	30.00	12.0	-5.9	12.13	0.0163	36	23.9
			CCK 2MB	18.22	0.0664		11.8		12.32	0.0171		23.7
			DSSS 5.5	<b>18.32</b>	0.0679		11.7		12.42	0.0175		23.6
			DSSS 11	18.24	0.0667		11.8		12.34	0.0171		23.7
1	2412.00	802.11g	OFDM12	18.09	0.0644		11.9		12.19	0.0166		23.8
11	2462.00			18.21	0.0662		11.8		12.31	0.0170		23.7
1	2412.00			17.02	0.0504		13.0		11.12	0.0129		24.9
6	2437.00			<b>17.40</b>	0.0550		12.6		11.50	0.0141		24.5
11	2462.00	14.23	0.0265	15.8	8.33		0.0068		27.7			
1	2412.00	802.11n	MCS0	13.61	0.0230		16.4		7.71	0.0059		28.3
6	2437.00			<b>15.75</b>	0.0376		14.3		9.85	0.0097		26.2
11	2462.00			12.80	0.0191		17.2		6.90	0.0049		29.1
<b>Result:</b>												<b>Complies</b>

Conducted Margin = P<sub>Limit</sub> - P<sub>Meas</sub>

# Conducted Power:

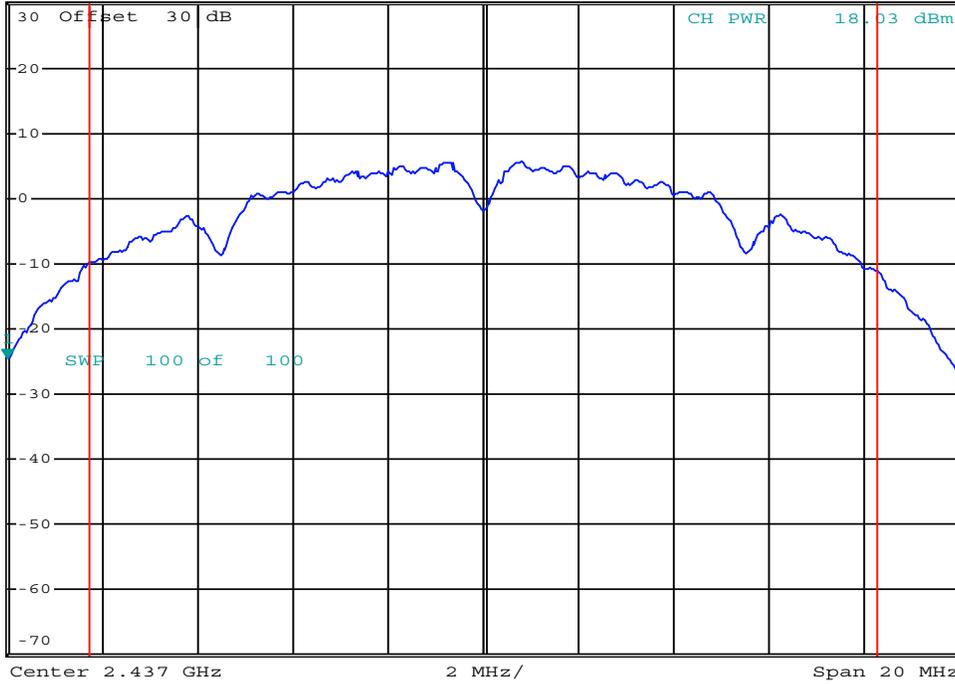


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -24.47 dBm  
SWT 2.5 ms 2.427000000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 15.JAN.2023 10:39:29

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Measured Channel Power:  dBm

# Conducted Power:

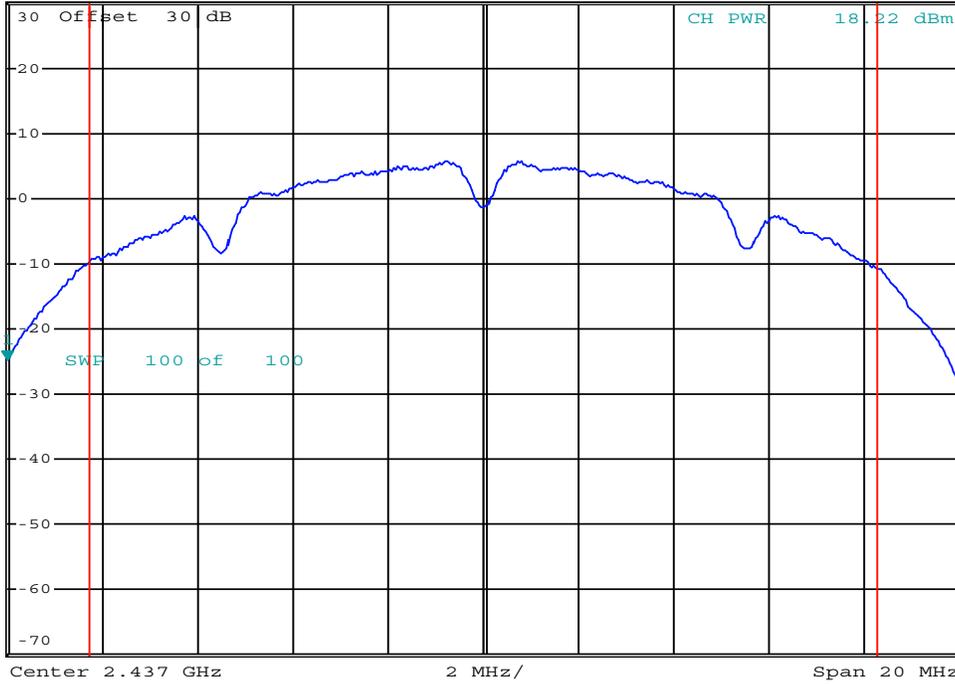


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -24.66 dBm  
SWT 2.5 ms 2.427000000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 15.JAN.2023 10:38:19

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Measured Channel Power:  dBm

# Conducted Power:

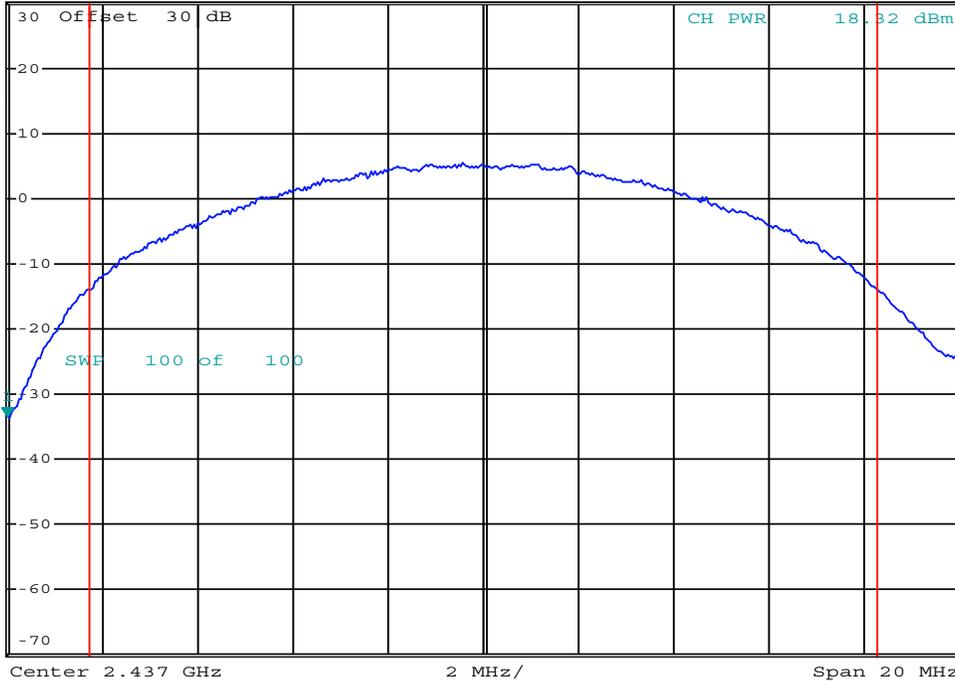


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -33.38 dBm  
SWT 2.5 ms 2.427000000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM  
VIEW



Date: 15.JAN.2023 10:35:51

Channel:   
Mode:

Channel Frequency:  MHz  
Modulation:   
Measured Channel Power:  dBm

# Conducted Power:

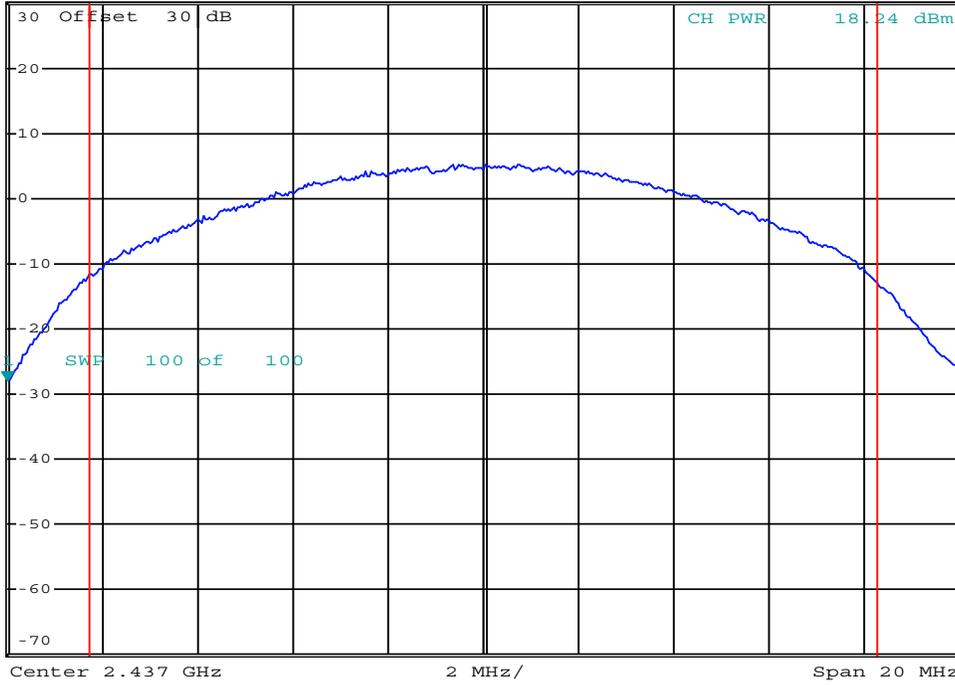


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -27.85 dBm  
SWT 2.5 ms 2.427000000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 15.JAN.2023 10:36:56

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Measured Channel Power:  dBm

# Conducted Power:

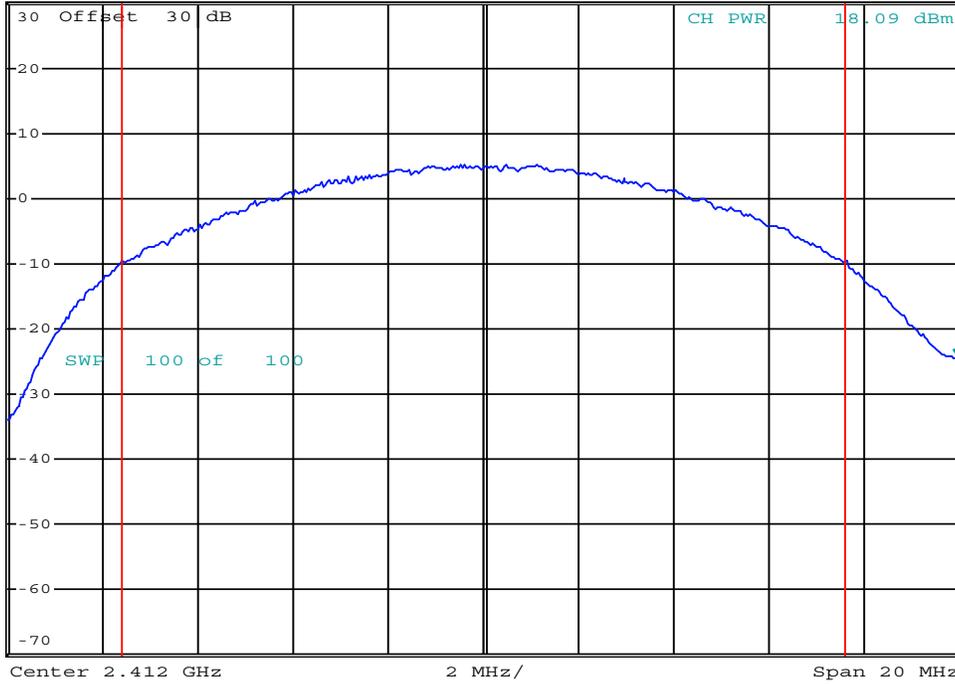


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -24.41 dBm  
SWT 2.5 ms 2.422000000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 15.JAN.2023 10:44:41

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Measured Channel Power:  dBm

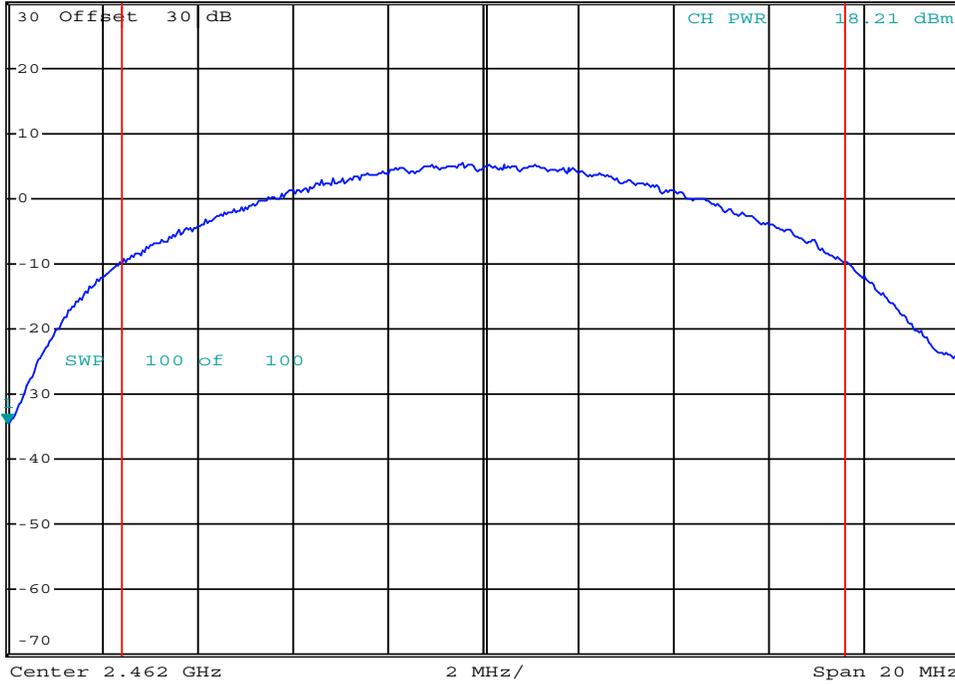
# Conducted Power:



\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -34.31 dBm  
SWT 2.5 ms 2.452000000 GHz

Ref 30 dBm

\*Att 30 dB



Date: 15.JAN.2023 10:42:30

Channel:   
Mode:

Channel Frequency:  MHz  
Modulation:   
Measured Channel Power:  dBm

# Conducted Power:

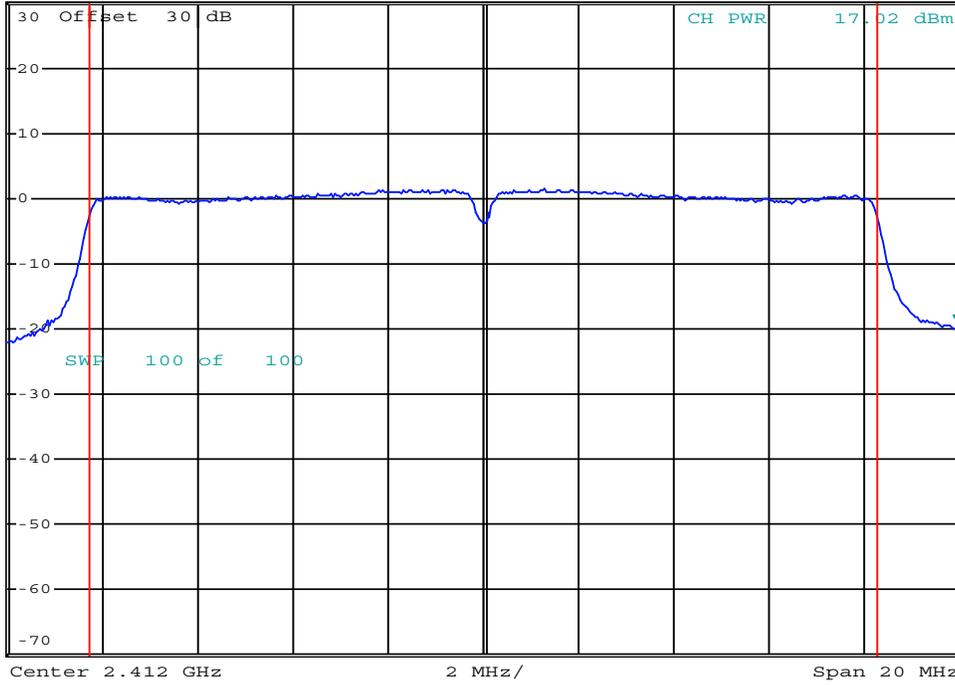


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -19.24 dBm  
SWT 2.5 ms 2.422000000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 15.JAN.2023 10:54:55

Channel:   
Mode:

Channel Frequency:  MHz  
Modulation:   
Measured Channel Power:  dBm

# Conducted Power:

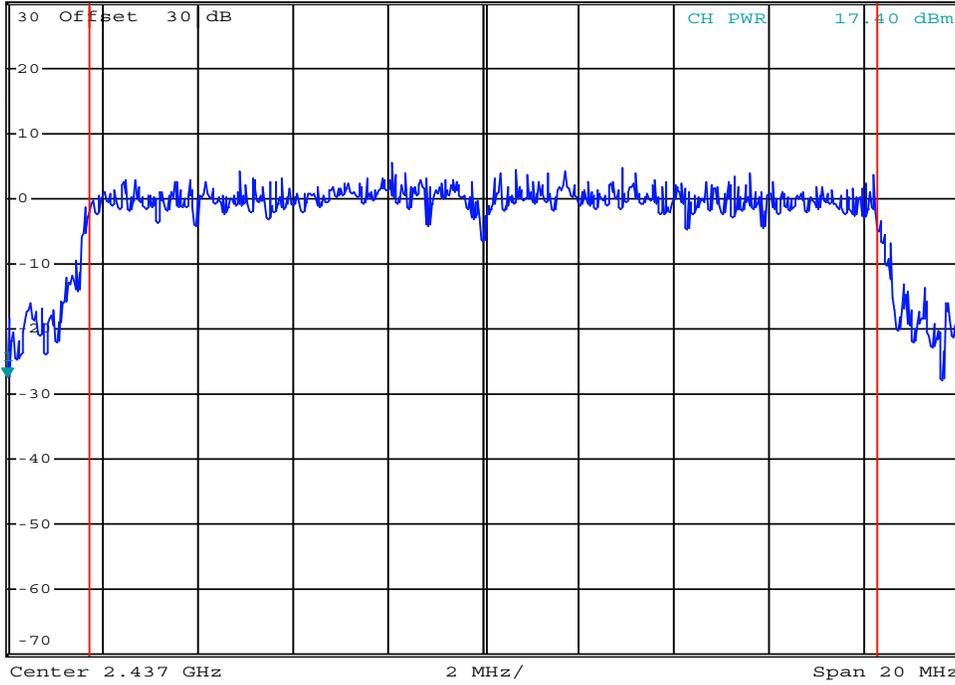


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -27.22 dBm  
SWT 2.5 ms 2.427000000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 15.JAN.2023 10:50:00

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Measured Channel Power:  dBm

# Conducted Power:

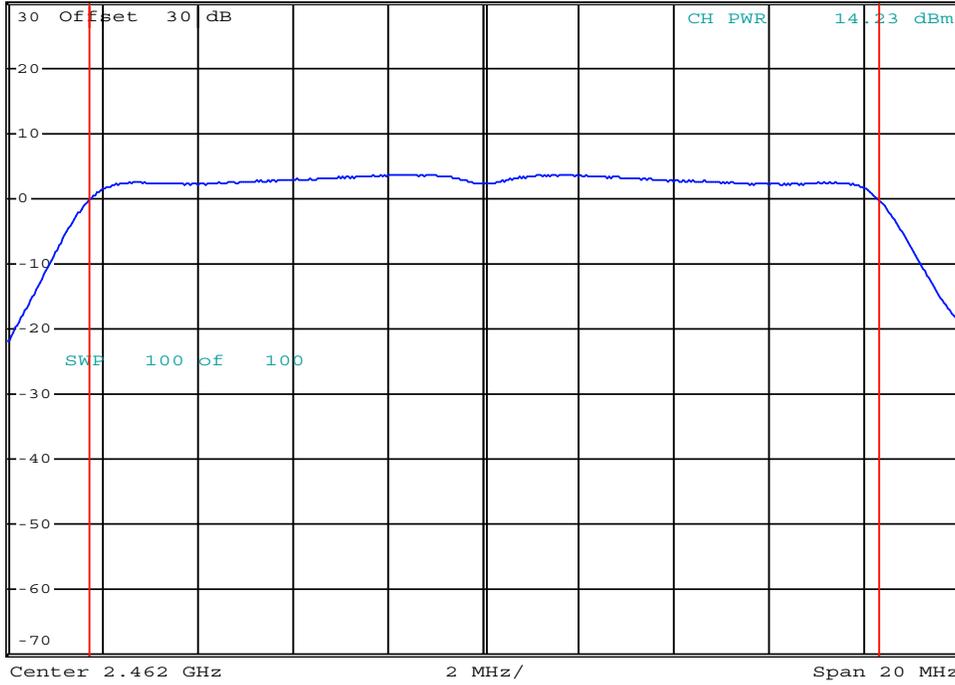


\*RBW 1 MHz  
VBW 10 MHz  
SWT 2.5 ms

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 8.FEB.2023 13:31:06

Channel:

Mode:

Channel Frequency:  MHz

Modulation:

Measured Channel Power:  dBm

# Conducted Power:

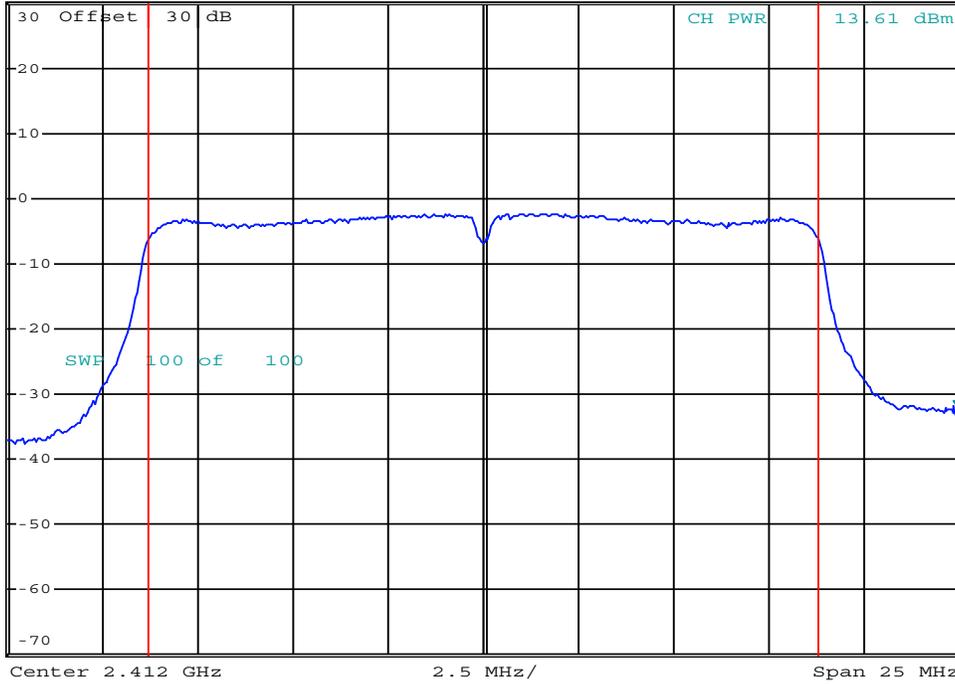


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -32.22 dBm  
SWT 2.5 ms 2.424500000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 15.JAN.2023 11:04:23

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Measured Channel Power:  dBm

# Conducted Power:

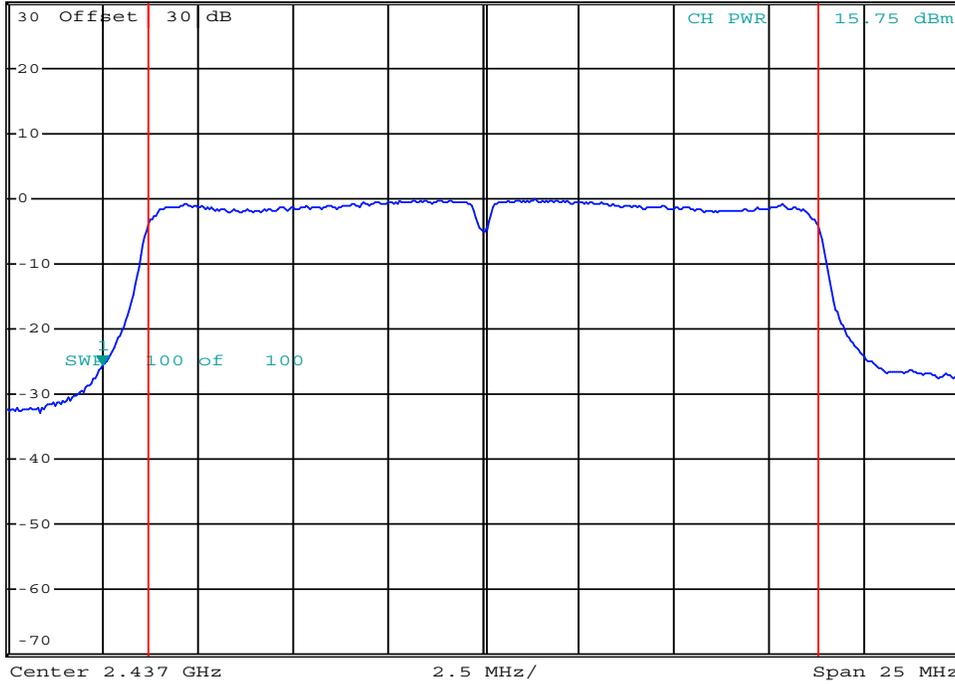


\*RBW 300 kHz Marker 1 [T1 ]  
VBW 3 MHz -25.55 dBm  
SWT 2.5 ms 2.427000000 GHz

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 15.JAN.2023 10:58:23

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Measured Channel Power:  dBm

# Conducted Power:

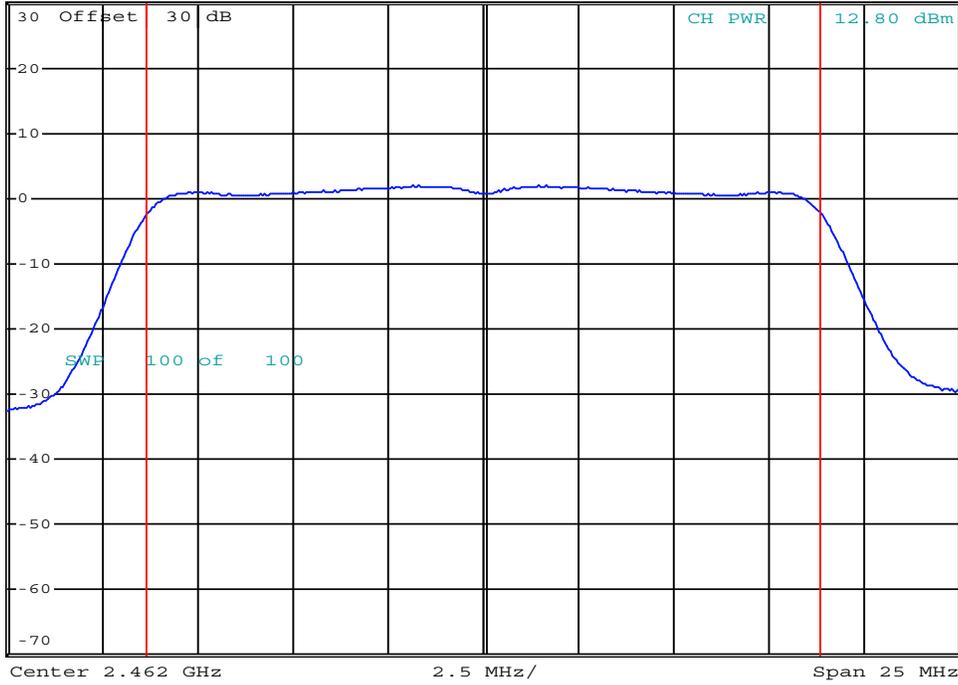


\*RBW 1 MHz  
VBW 10 MHz  
SWT 2.5 ms

Ref 30 dBm

\*Att 30 dB

1 RM\*  
VIEW



Date: 8.FEB.2023 13:32:15

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Measured Channel Power:  dBm

**Conducted Power Measurement Results:**

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured Power [P <sub>Meas</sub> ] (dBm)	Measured Power (W)	Conducted Limit [P <sub>Lim</sub> ] (dBm)	Conducted Margin (dB)	Antenna Gain (dBi)	EIRP [E <sub>Meas</sub> ] (dBm)	EIRP (W)	EIRP Limit [E <sub>Lim</sub> ] (dBm)	EIRP Margin (dB)
0	2402.00	BT BR	GFSK	11.04	0.0127	30.00	19.0	-5.9	5.14	0.0033	36	30.9
38	2440.00			11.11	0.0129		18.9		5.21	0.0033		30.8
78	2480.00			11.13	0.0130		18.9		5.23	0.0033		30.8
0	2402.00	BT EDR2	Pi/4-DQPSK	10.11	0.0103		19.9		4.21	0.0026		31.8
38	2440.00			10.21	0.0105		19.8		4.31	0.0027		31.7
78	2480.00			10.23	0.0105		19.8		4.33	0.0027		31.7
0	2402.00	BT EDR3	8-DPSK	10.11	0.0103		19.9		4.21	0.0026		31.8
38	2440.00			10.11	0.0103		19.9		4.21	0.0026		31.8
78	2480.00			10.12	0.0103		19.9		4.22	0.0026		31.8
<b>Result:</b>											<b>Complies</b>	

$$\text{Conducted Margin} = P_{\text{Lim}} - P_{\text{Meas}}$$

$$\text{Conducted Margin} = E_{\text{Lim}} - E_{\text{Meas}}$$

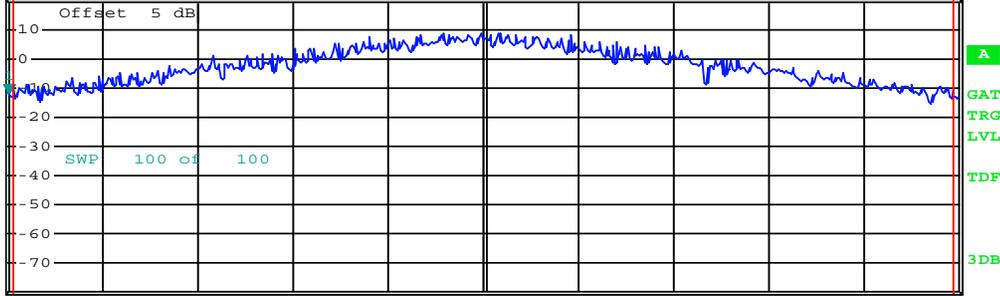


# Conducted Power:



Ref 20 dBm      \*Att 30 dB      \*RBW 100 kHz      Marker 1 [T1]      -11.35 dBm  
VBW 1 MHz      \*SWT 20 ms      2.439510000 GHz

1 RM  
VIEW



**Tx Channel**  
Bandwidth      970 kHz      Power      11.11 dBm

Date: 21.JAN.2023 14:20:38

Channel:

Mode:

Channel Frequency:  MHz

Modulation:

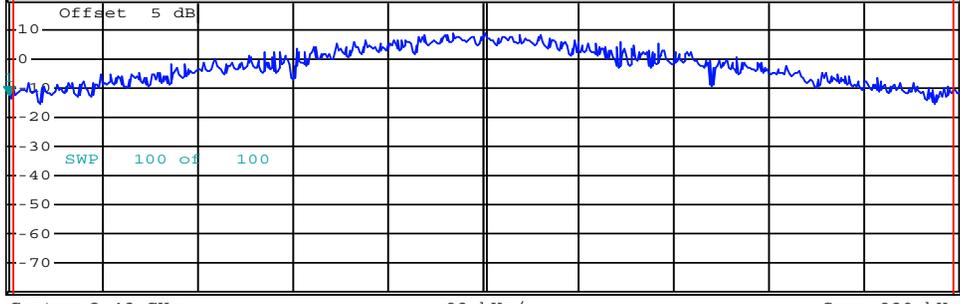
Measured Channel Power:  dBm

# Conducted Power:



Ref 20 dBm      \*Att 30 dB      \*RBW 100 kHz      Marker 1 [T1]      -11.61 dBm  
VBW 1 MHz      \*SWT 20 ms      2.479510000 GHz

1 RM  
VIEW



Center 2.48 GHz      98 kHz/      Span 980 kHz

**Tx Channel**  
Bandwidth      970 kHz      Power      11.13 dBm

Date: 21.JAN.2023 14:21:31

Channel:   
Mode:

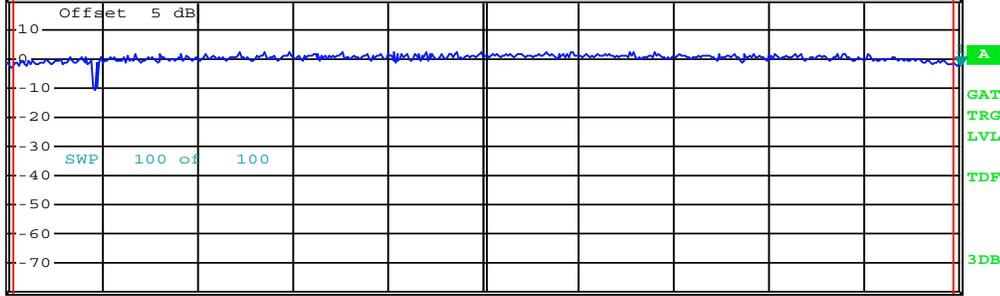
Channel Frequency:  MHz  
Modulation:   
Measured Channel Power:  dBm

# Conducted Power:



Ref 20 dBm      \* Att 30 dB      \* RBW 100 kHz      Marker 1 [T1]      -1.77 dBm  
VBW 1 MHz      \* SWT 100 ms      2.402490000 GHz

1 RM  
VIEW



Center 2.402 GHz      98 kHz/      Span 980 kHz

**Tx Channel**  
Bandwidth      970 kHz      Power      10.11 dBm

Date: 21.JAN.2023 14:23:06

Channel:   
Mode:

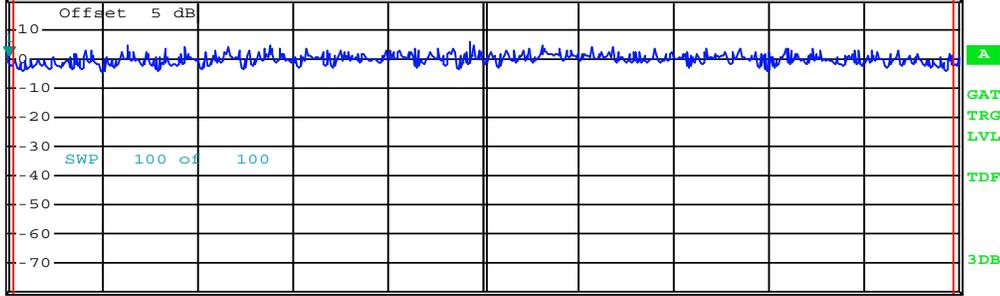
Channel Frequency:  MHz  
Modulation:   
Measured Channel Power:  dBm

# Conducted Power:



Ref 20 dBm      \*Att 30 dB      \*RBW 100 kHz      Marker 1 [T1]      1.32 dBm  
VBW 1 MHz      2.439510000 GHz  
SWT 20 ms

1 RM  
VIEW



Tx Channel  
Bandwidth

970 kHz

Power

10.21 dBm

Date: 21.JAN.2023 14:24:07

Channel: 38

Channel Frequency: 2440 MHz

Mode: BT EDR2

Modulation: Pi/4-DQPSK

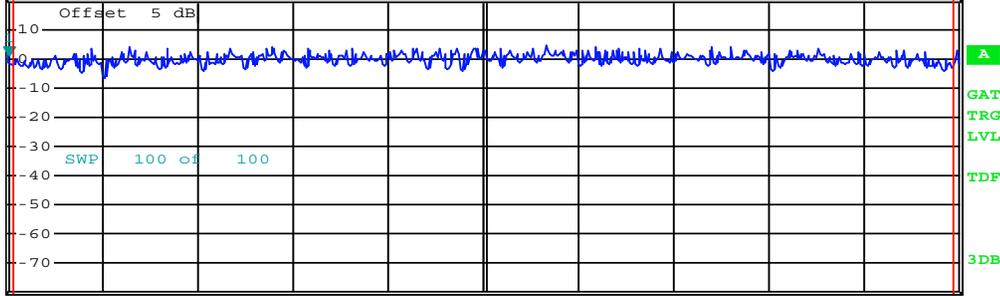
Measured Channel Power: 10.21 dBm

# Conducted Power:



Ref 20 dBm      \*Att 30 dB      \*RBW 100 kHz      Marker 1 [T1]      1.51 dBm  
VBW 1 MHz      2.479510000 GHz  
SWT 20 ms

1 RM  
VIEW



Center 2.48 GHz      98 kHz/      Span 980 kHz

Tx Channel  
Bandwidth

970 kHz

Power

10.23 dBm

Date: 21.JAN.2023 14:24:59

Channel:

Mode:

Channel Frequency:  MHz

Modulation:

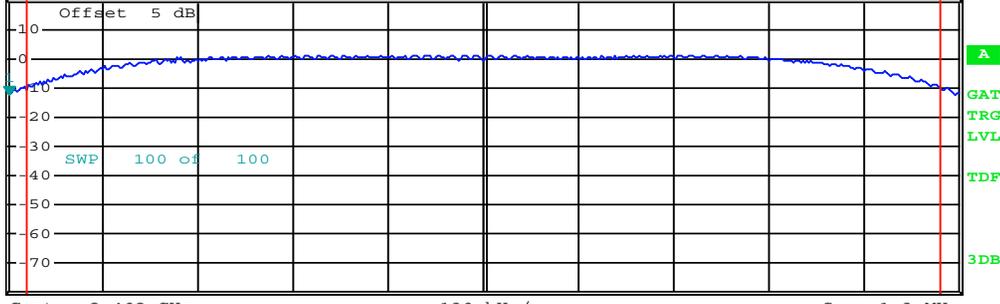
Measured Channel Power:  dBm

# Conducted Power:



Ref 20 dBm      \* Att 30 dB      \* RBW 100 kHz      Marker 1 [T1]      -11.82 dBm  
\* SWT 200 ms      2.401350000 GHz

1 RM  
VIEW



Center 2.402 GHz      130 kHz/      Span 1.3 MHz

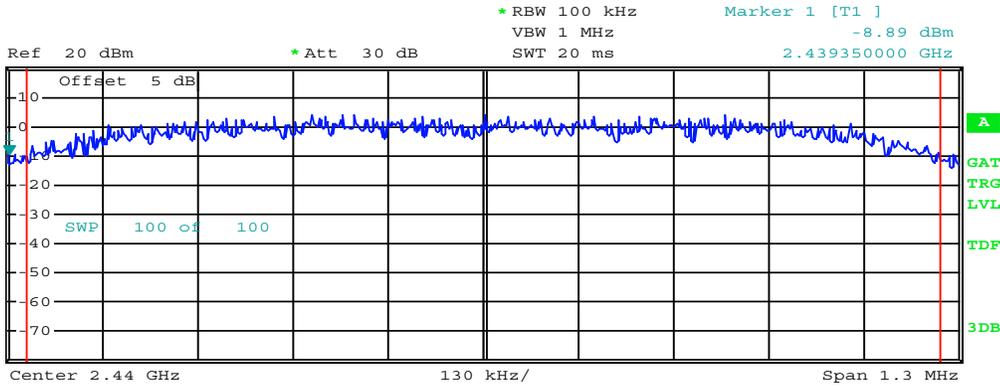
**Tx Channel**  
Bandwidth      1.25 MHz      Power      10.11 dBm

Date: 21.JAN.2023 14:27:09

Channel:   
Mode:

Channel Frequency:  MHz  
Modulation:   
Measured Channel Power:  dBm

# Conducted Power:



**Tx Channel**  
Bandwidth      1.25 MHz      Power      10.11 dBm

Date: 21.JAN.2023 14:28:09

Channel:   
Mode:

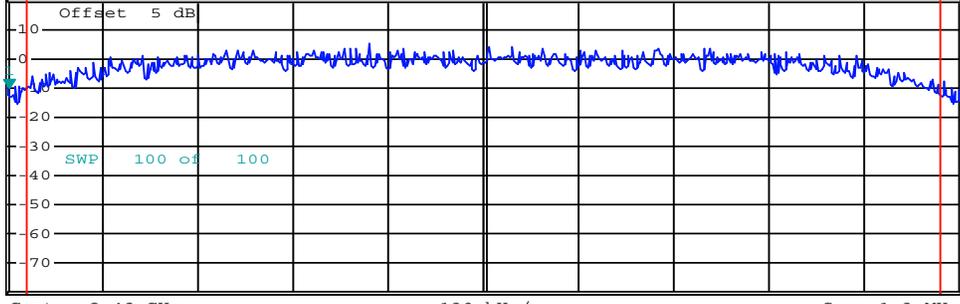
Channel Frequency:  MHz  
Modulation:   
Measured Channel Power:  dBm

# Conducted Power:



Ref 20 dBm      \* Att 30 dB      \* RBW 100 kHz      Marker 1 [T1 ]  
VBW 1 MHz      -9.44 dBm  
SWT 20 ms      2.479350000 GHz

1 RM  
VIEW



Center 2.48 GHz      130 kHz/      Span 1.3 MHz

**Tx Channel**  
Bandwidth      1.25 MHz      Power      10.12 dBm

Date: 21.JAN.2023 14:29:16

Channel:

Mode:

Channel Frequency:  MHz

Modulation:

Measured Channel Power:  dBm

**Conducted Spurious Emissions Measurement Results:**

Mode	Channel Number	Frequency (MHz)	Modulation	Emission Power [P <sub>Em</sub> ] (dBm)	Emission Frequency (MHz)	Reference Measurement [P <sub>Fund</sub> ] (dBm)	Attenuation [Atten] (dB)	Limit (dB)	Margin (dB)
802.11b	6	2437.00	DSSS 5.5	-31.90	95.96	12.39	44.29	30	14.3
				-31.41	207		43.80		13.8
				-31.97	466		44.36		14.4
				-31.48	779		43.87		13.9
				-31.56	882		43.95		14.0
				16.42	Fundamental		-		-
				ND	-		-		-
				ND	-		-		-
				ND	-		-		-
				ND	-		-		-
				12.39	Reference		-		-
<b>Result:</b>								<b>Complies</b>	

Attenuation [Atten] = [P<sub>Fund</sub>] - [P<sub>Em</sub>]

Margin = Attenuation - Limit

ND = None Detected

### Conducted Spurious Emissions:

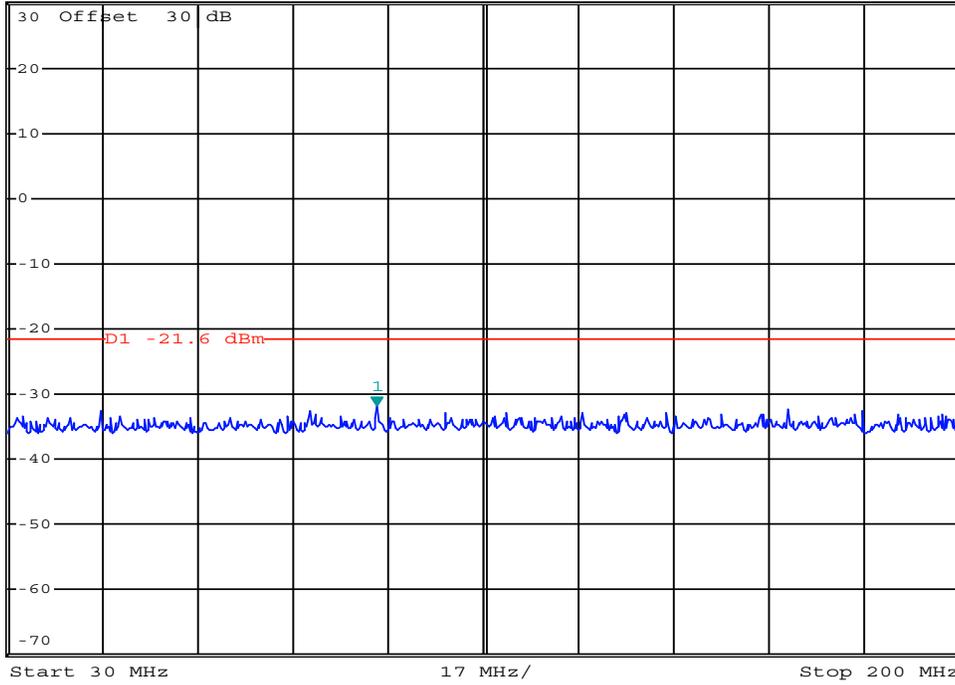


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -31.90 dBm  
SWT 20 ms 95.96000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 15:50:05

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Conducted Spurious Emissions:

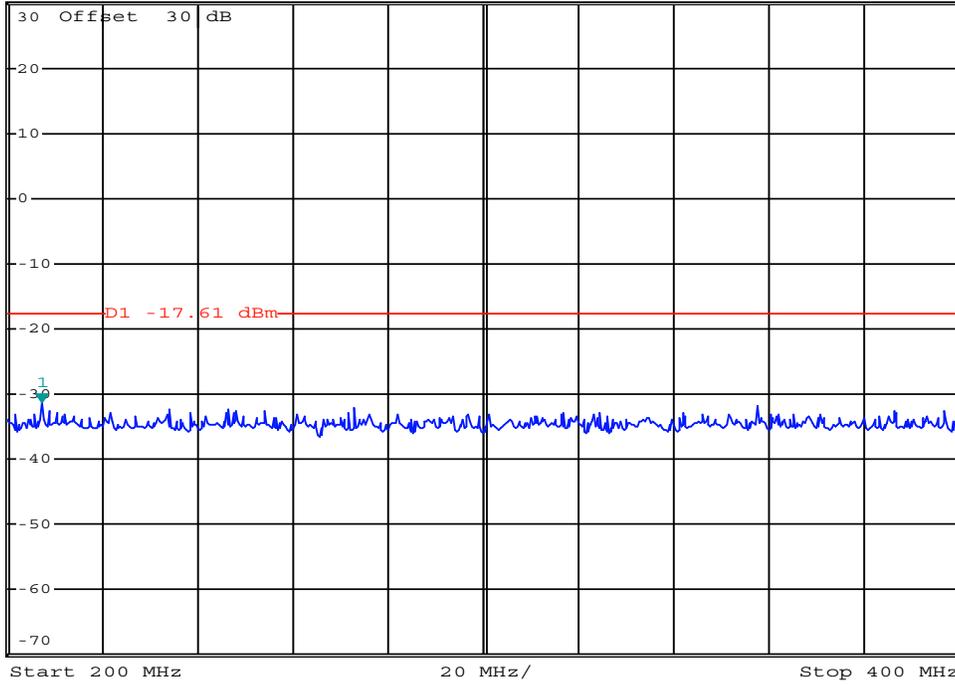


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -31.41 dBm  
SWT 20 ms 207.200000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:13:58

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Conducted Spurious Emissions:

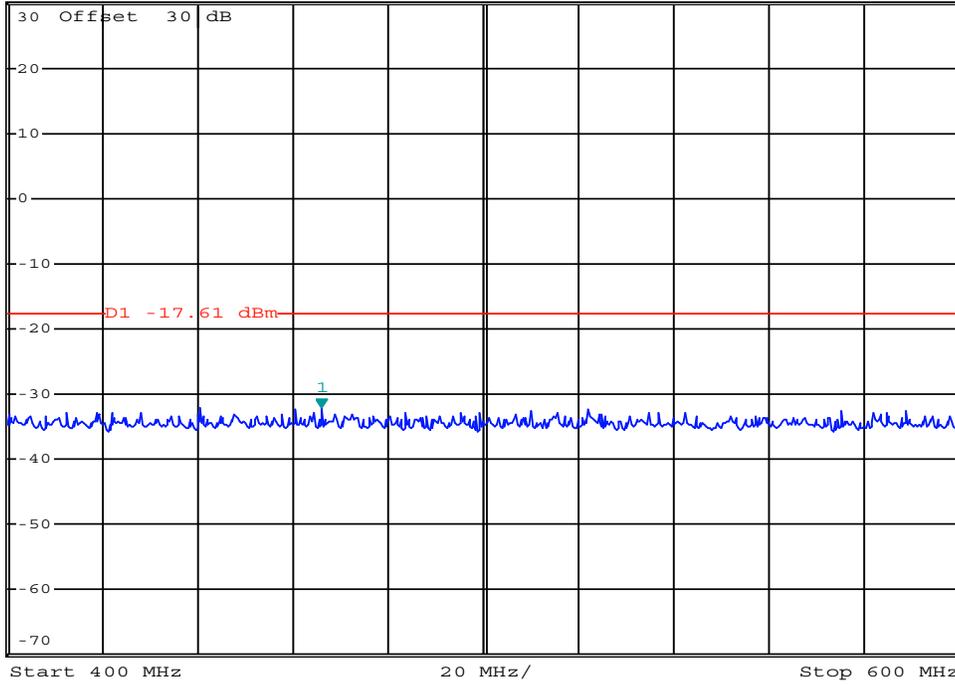


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -31.97 dBm  
SWT 20 ms 466.000000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:14:47

Channel: 6

Channel Frequency: 2437 MHz

Mode: 802.11b

Modulation: DSSS 5.5

Emission Frequency: 466 MHz

Measured Emission: -31.97 dBm

# Conducted Spurious Emissions:

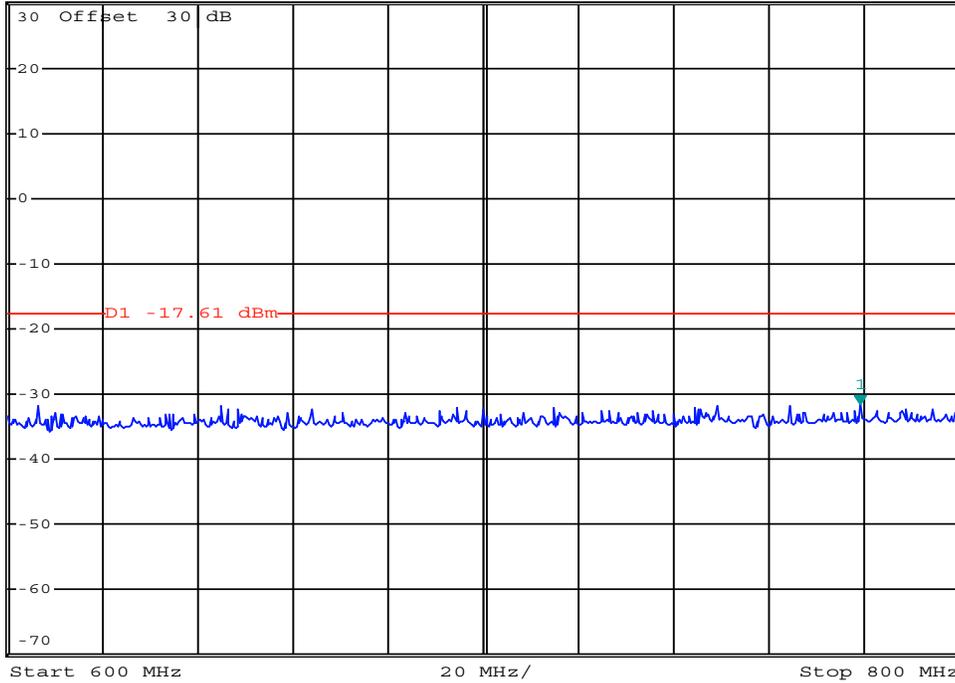


\*RBW 100 kHz    Marker 1 [T1 ]  
VBW 300 kHz    -31.48 dBm  
SWT 20 ms      779.200000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:16:23

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

## Conducted Spurious Emissions:

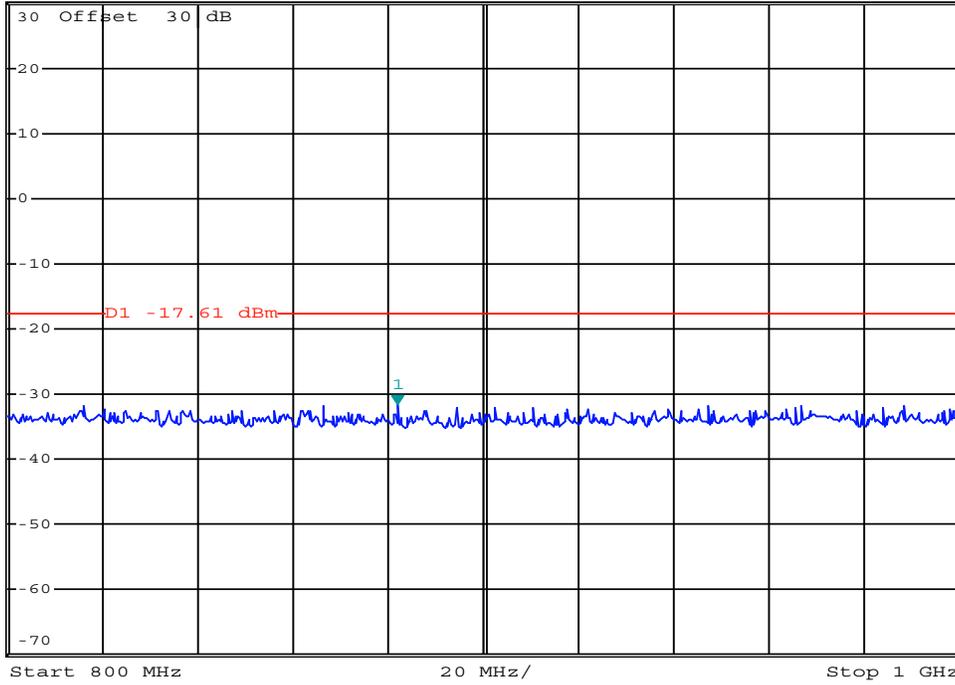


\*RBW 100 kHz Marker 1 [T1 ]  
 VBW 300 kHz -31.56 dBm  
 SWT 20 ms 882.000000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
 VIEW



Date: 22.JAN.2023 14:18:12

Channel: 6

Channel Frequency: 2437 MHz

Mode: 802.11b

Modulation: DSSS 5.5

Emission Frequency: 882 MHz

Measured Emission: -31.56 dBm

# Conducted Spurious Emissions:

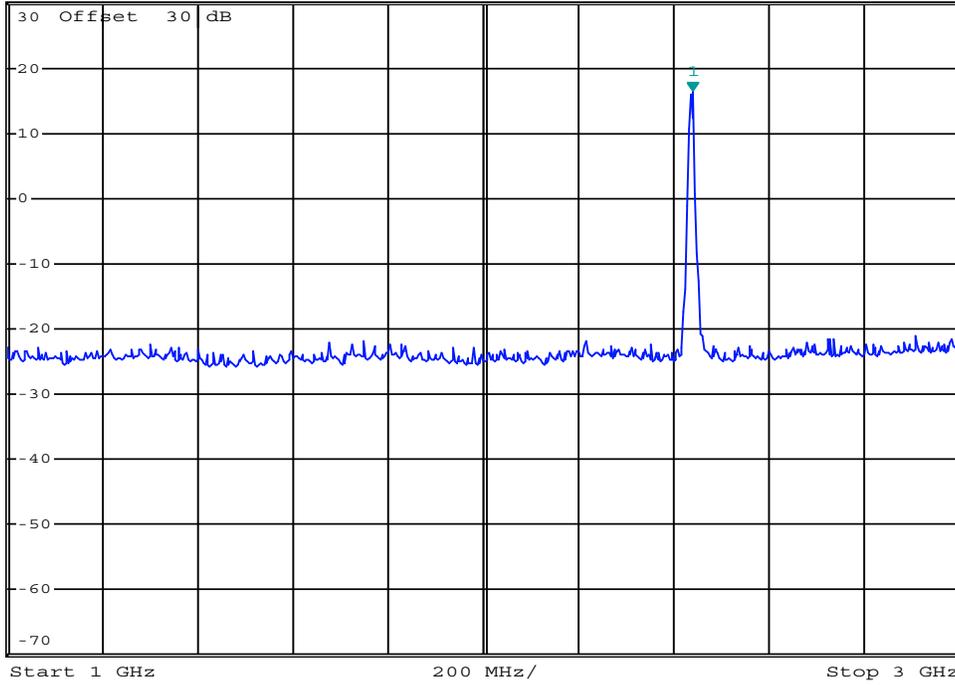


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    16.42 dBm  
SWT 10 ms    2.440000000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:39:25

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

Marker 1 = Fundamental

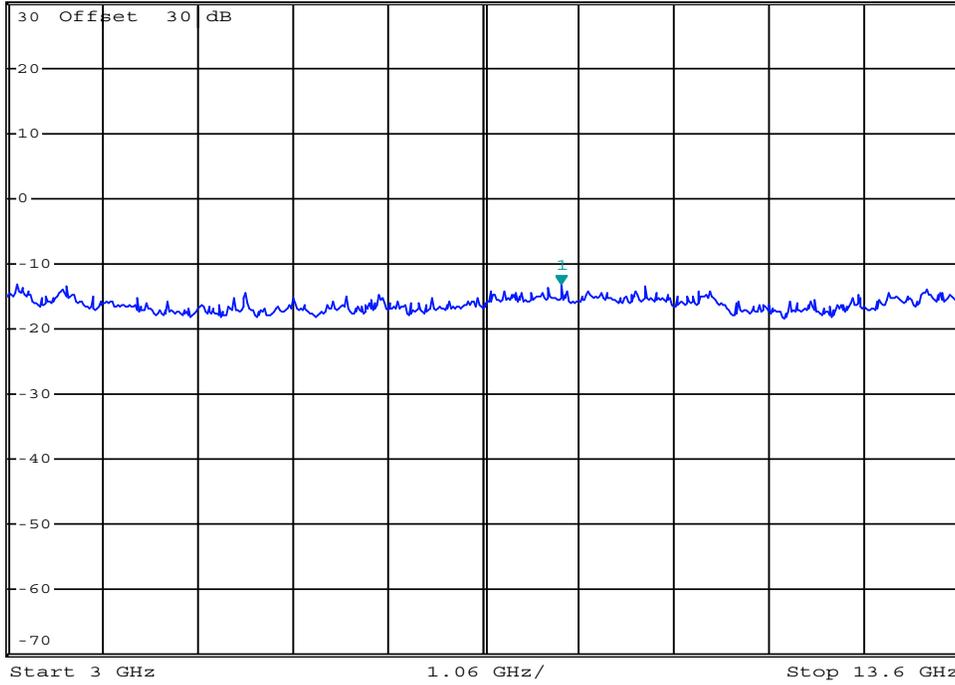
# Conducted Spurious Emissions:



\*RBW 1 MHz    Marker 1 [T1 ]  
VEW 3 MHz    -13.07 dBm  
SWT 215 ms    9.169200000 GHz

Ref 30 dBm    \*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:40:25

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Conducted Spurious Emissions:

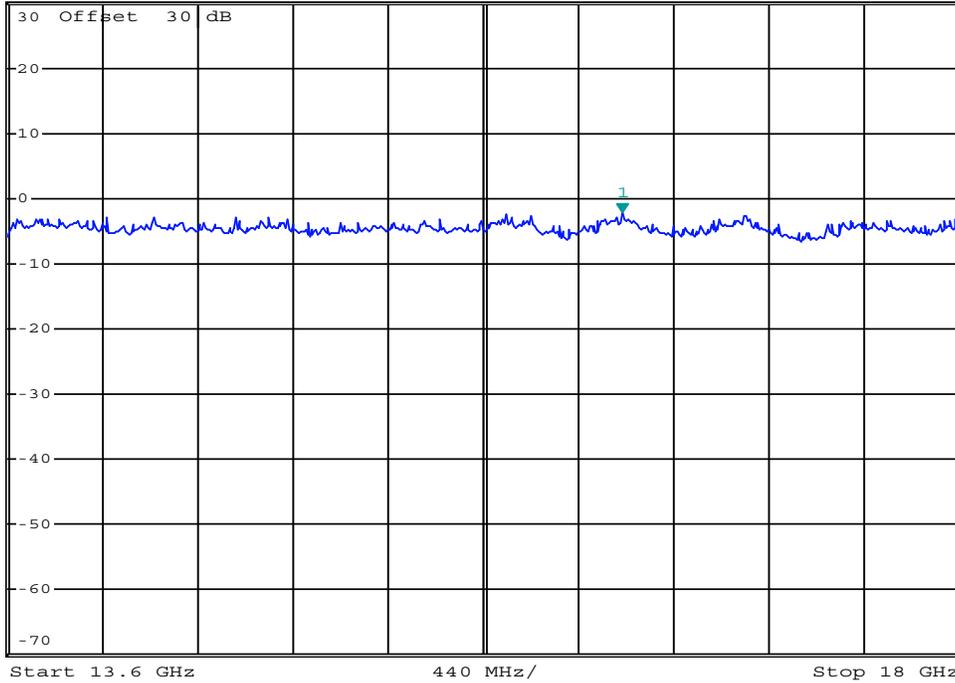


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    -2.25 dBm  
SWT 90 ms    16.442400000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:41:34

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Conducted Spurious Emissions:

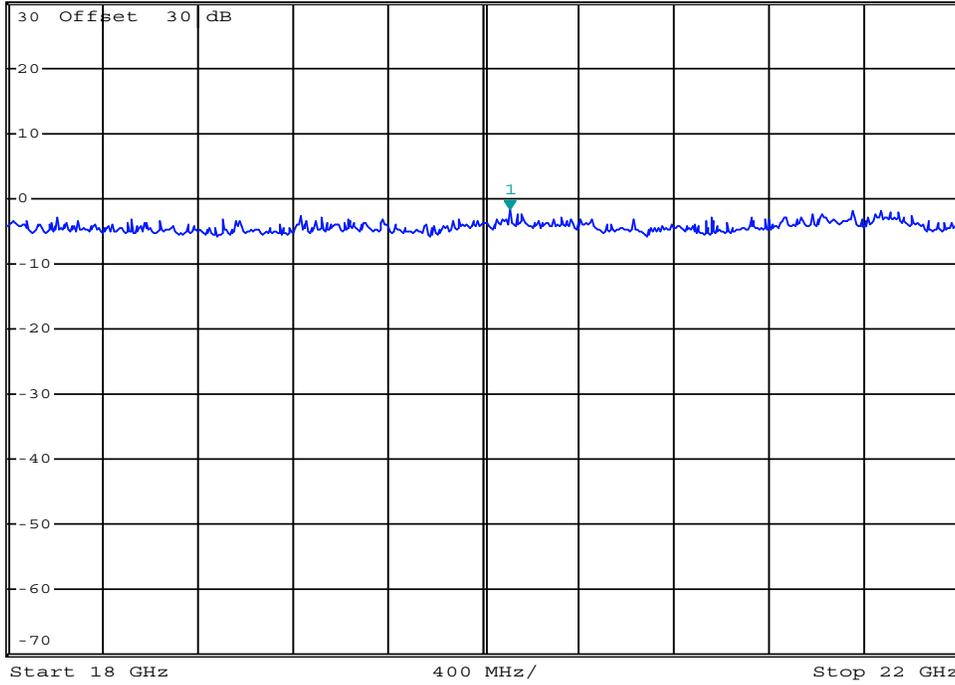


\*RBW 1 MHz    Marker 1 [T1 ]  
VEW 3 MHz    -1.66 dBm  
SWT 80 ms    20.112000000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:42:51

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Conducted Spurious Emissions:

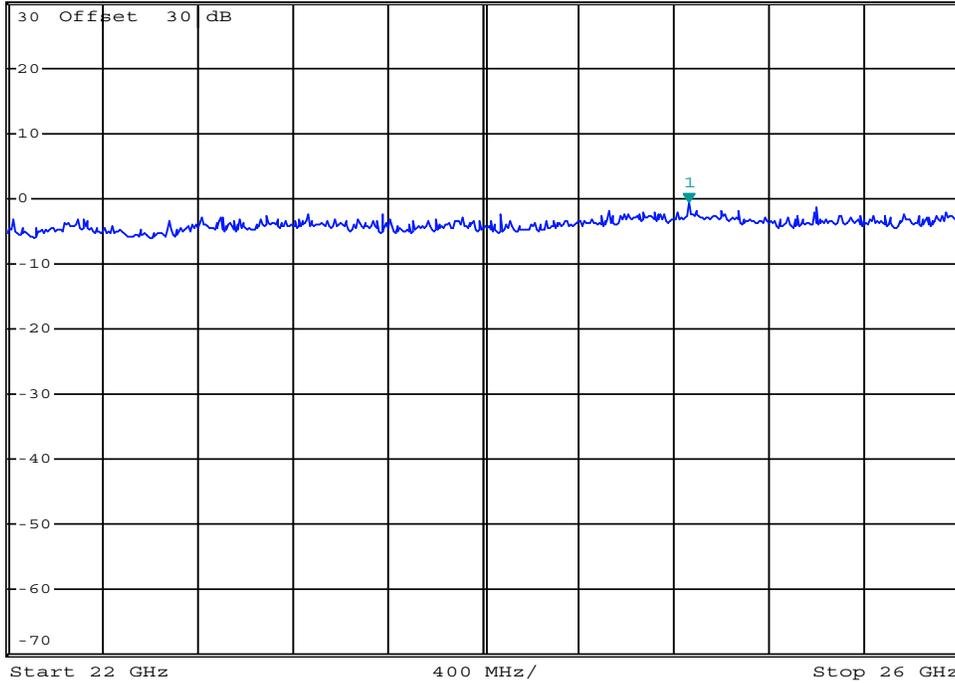


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    -0.52 dBm  
SWT 80 ms    24.864000000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:43:56

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Reference Measurement

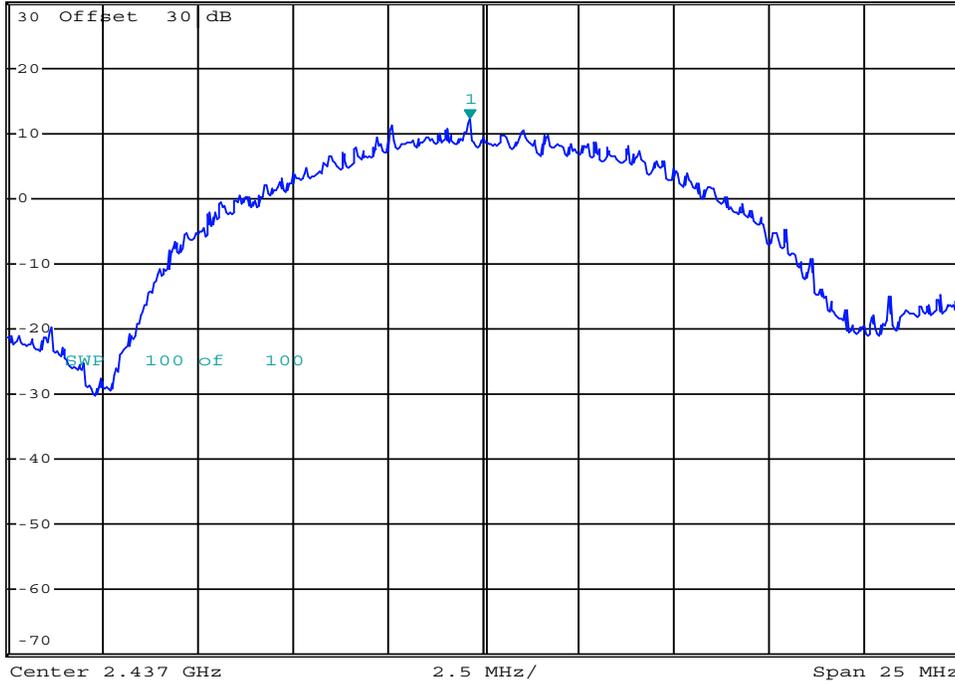


\*RBW 100 kHz Marker 1 [T1 ]  
VEW 300 kHz 12.39 dBm  
SWT 2.5 ms 2.436650000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:06:28

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Reference Measurement:  dBm

**Conducted Spurious Emissions Measurement Results:**

Mode	Channel Number	Frequency (MHz)	Modulation	Emission Power [P <sub>Em</sub> ] (dBm)	Emission Frequency (MHz)	Reference Measurement [P <sub>Fund</sub> ] (dBm)	Attenuation [Atten] (dB)	Limit (dB)	Margin (dB)
BT BR	78	2480.00	GFSK	-31.95	189.12	9.93	41.88	30	11.9
				-31.89	394		41.82		11.8
				-31.99	467.2		41.92		11.9
				-31.63	754.4		41.56		11.6
				-31.90	996.8		41.83		11.8
<b>Result:</b>								<b>Complies</b>	

Attenuation [Atten] = [P<sub>Fund</sub>] - [P<sub>Em</sub>]

Margin = Attenuation - Limit

ND = None Detected

## Conducted Spurious Emissions:

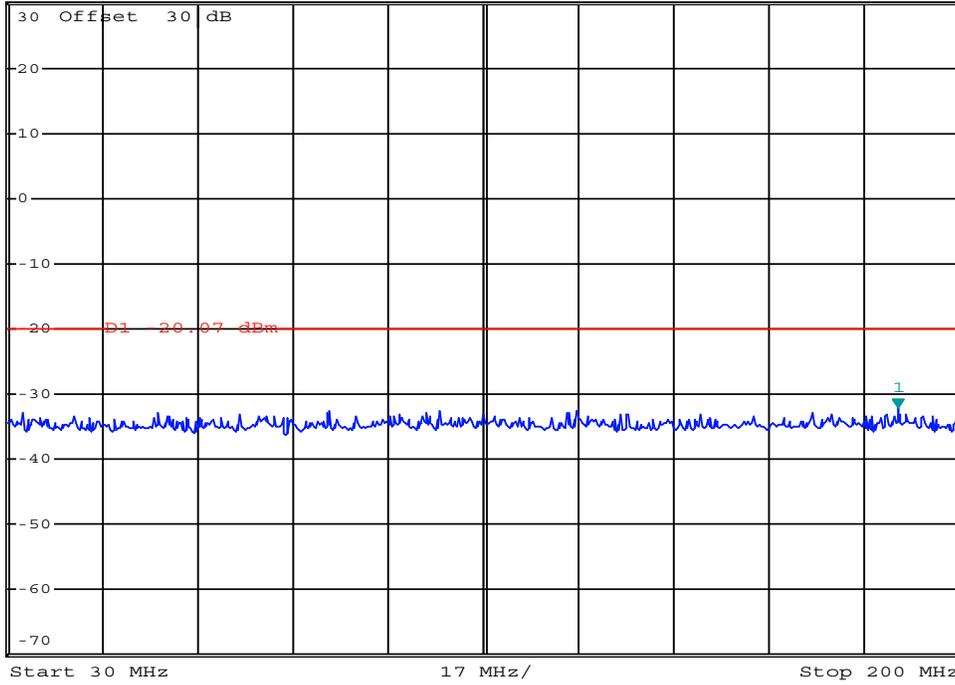


\*RBW 100 kHz Marker 1 [T1 ]  
 VBW 300 kHz -31.95 dBm  
 SWT 20 ms 189.12000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
 VIEW



Date: 22.JAN.2023 14:52:17

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Conducted Spurious Emissions:

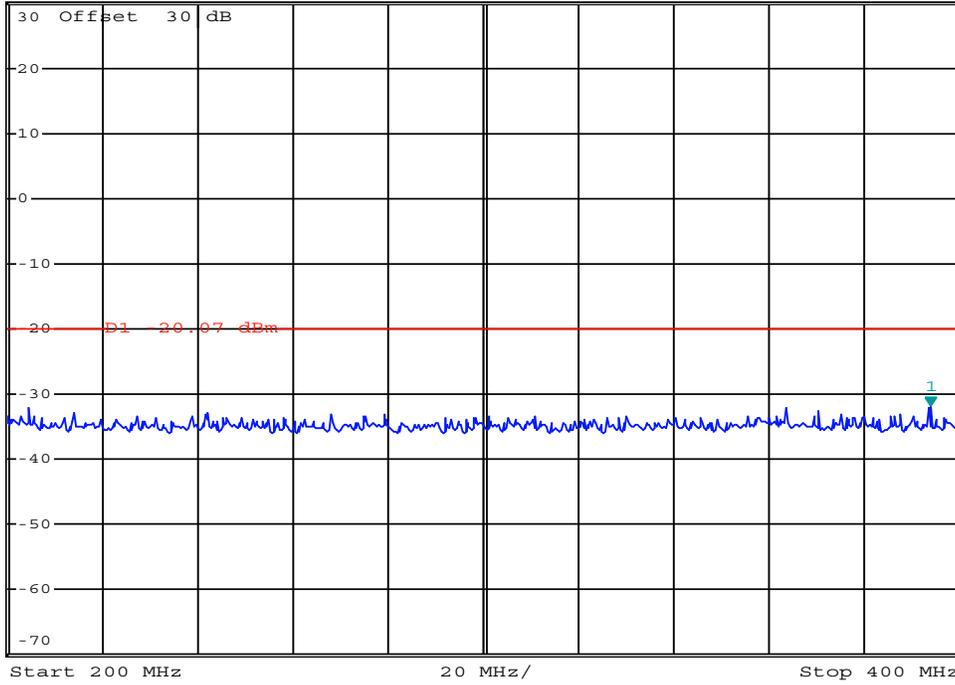


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -31.89 dBm  
SWT 20 ms 394.000000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:53:29

Channel: 78

Channel Frequency: 2480 MHz

Mode: BT BR

Modulation: GFSK

Emission Frequency: 394 MHz

Measured Emission: -31.89 dBm

### Conducted Spurious Emissions:

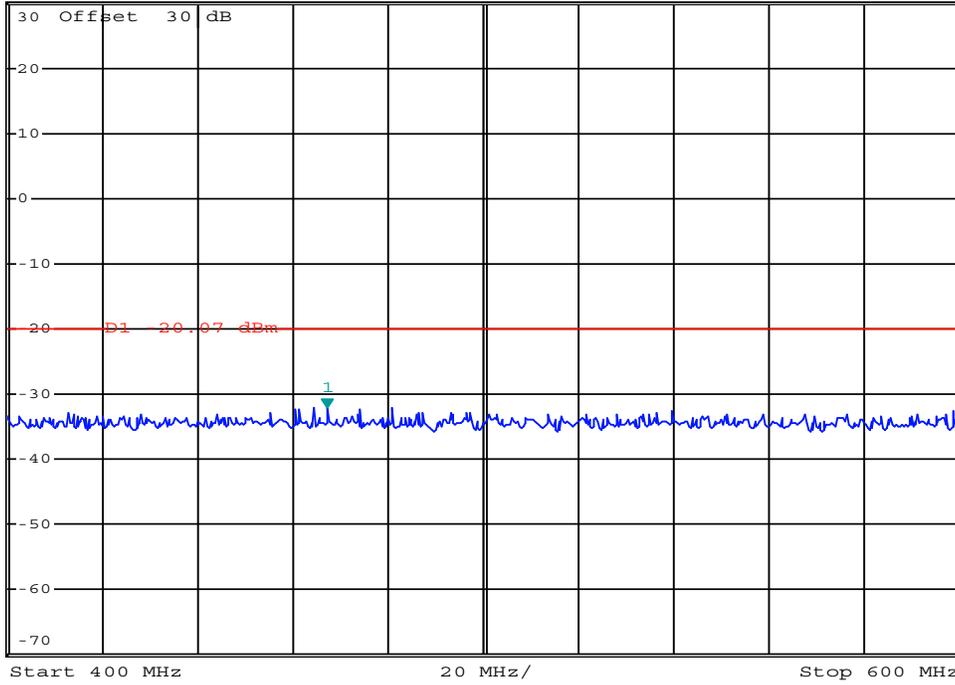


\*RBW 100 kHz    Marker 1 [T1 ]  
VBW 300 kHz    -31.99 dBm  
SWT 20 ms      467.200000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:54:31

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Conducted Spurious Emissions:

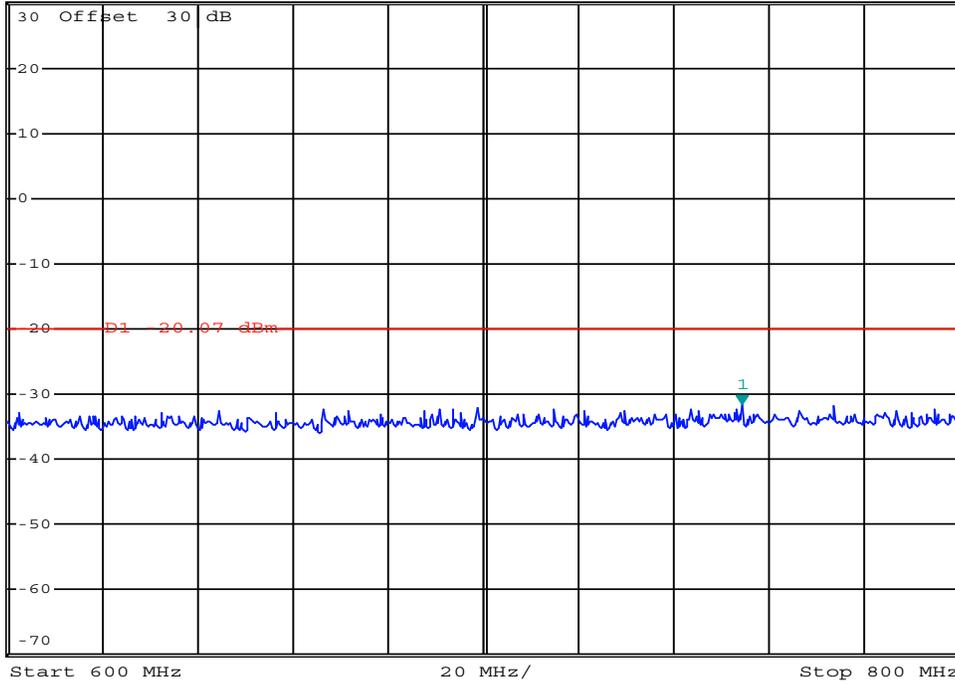


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -31.63 dBm  
SWT 20 ms 754.40000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:55:24

Channel: 78

Channel Frequency: 2480 MHz

Mode: BT BR

Modulation: GFSK

Emission Frequency: 754.4 MHz

Measured Emission: -31.63 dBm

# Conducted Spurious Emissions:

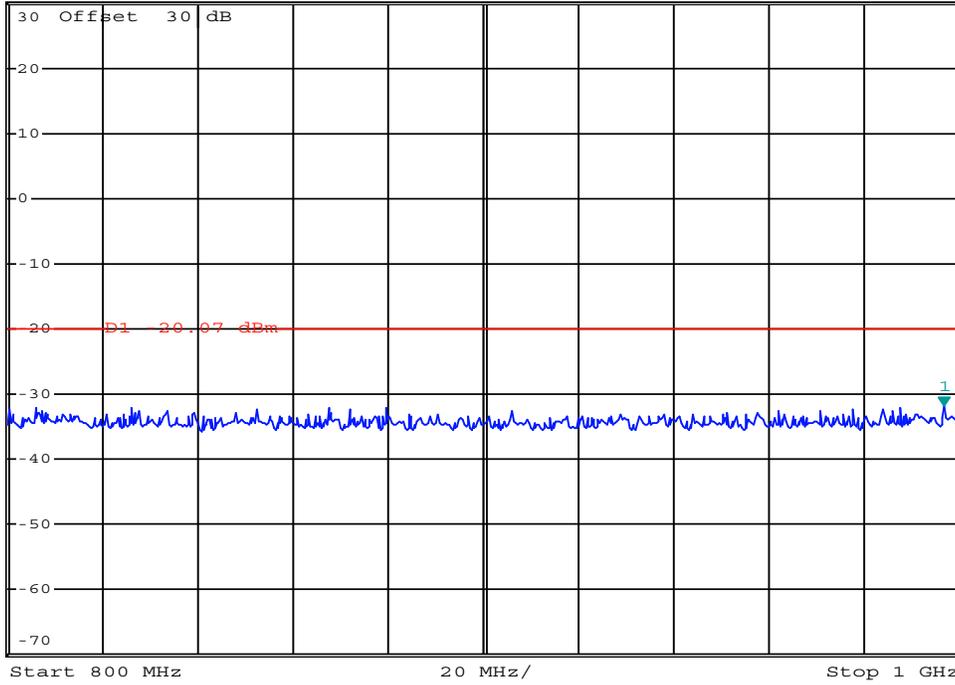


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz -31.90 dBm  
SWT 20 ms 996.800000000 MHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:56:47

Channel: 78

Channel Frequency: 2480 MHz

Mode: BT BR

Modulation: GFSK

Emission Frequency: 996.8 MHz

Measured Emission: -31.9 dBm

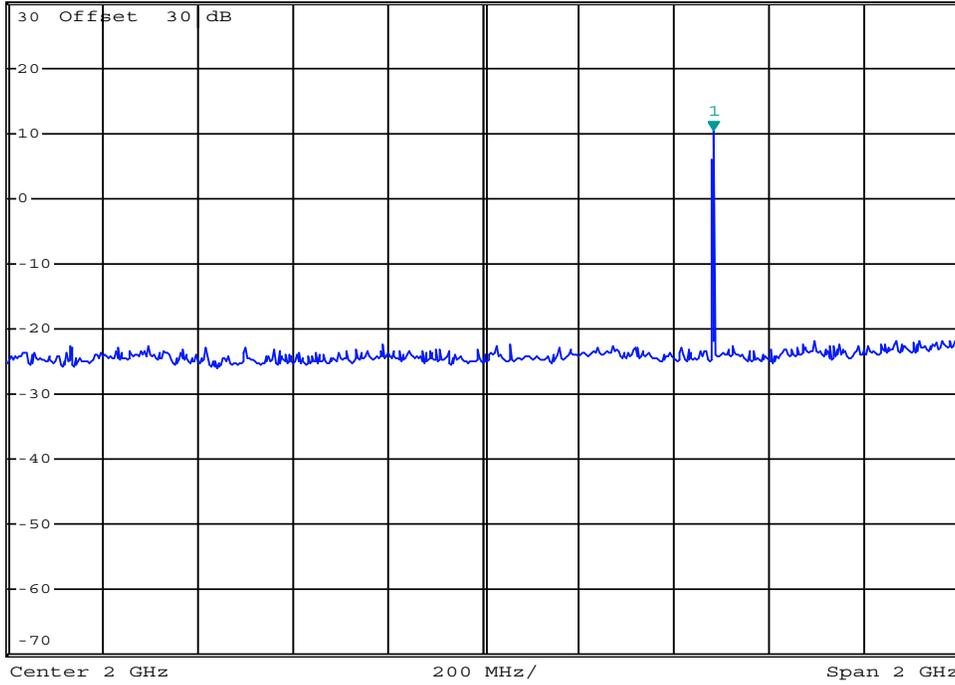
# Conducted Spurious Emissions:



\*RBW 1 MHz    Marker 1 [T1 ]  
VEW 3 MHz    10.48 dBm  
SWT 10 ms    2.484000000 GHz

Ref 30 dBm    \*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:58:10

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

Marker 1 = Fundamental



# Conducted Spurious Emissions:

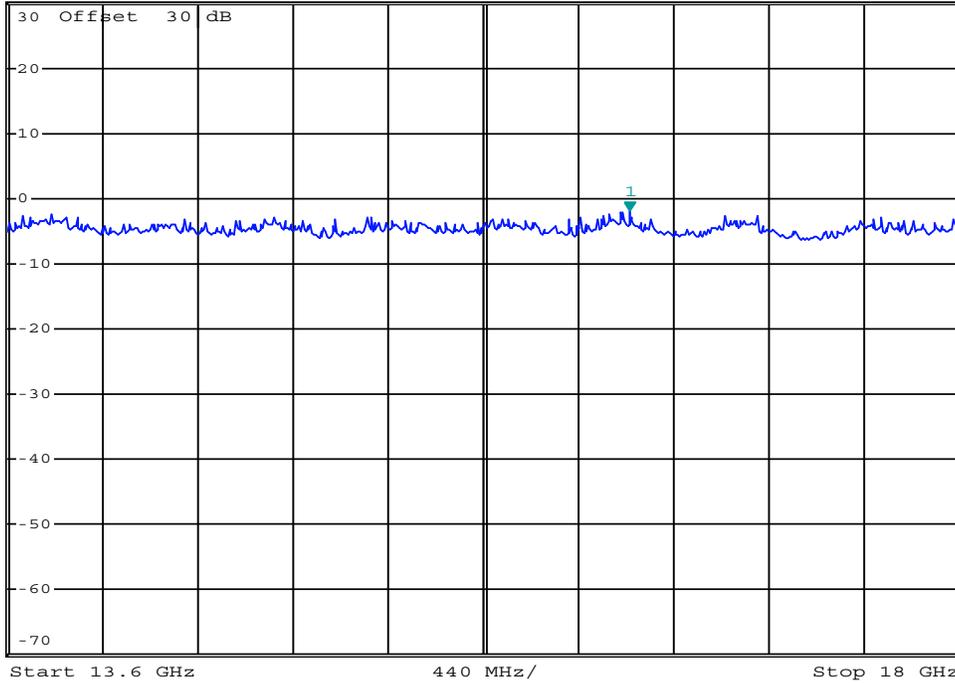


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    -1.80 dBm  
SWT 90 ms    16.477600000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 15:00:13

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Conducted Spurious Emissions:

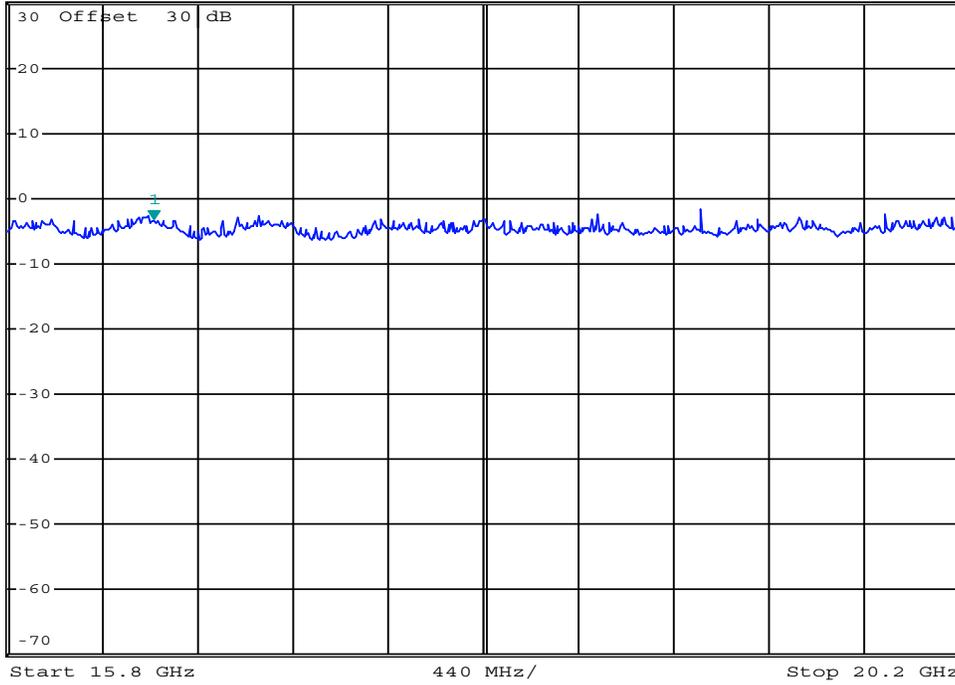


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    -3.29 dBm  
SWT 90 ms    16.477600000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 15:00:56

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

### Conducted Spurious Emissions:

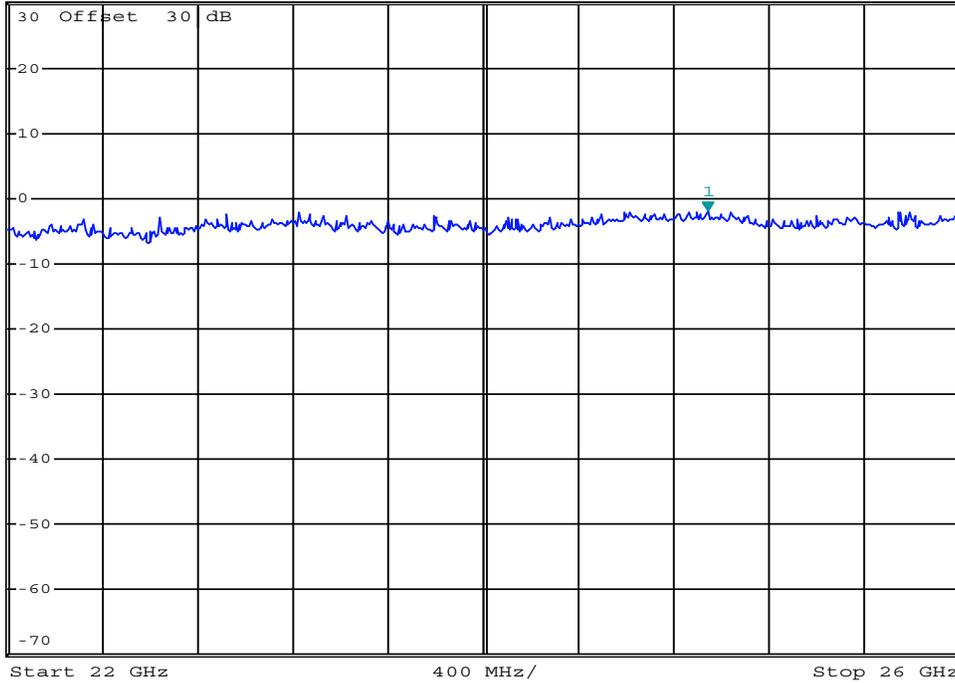


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    -2.00 dBm  
SWT 80 ms    24.944000000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 15:01:42

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Emission Frequency:  MHz

Measured Emission:  dBm

# Reference Measurement

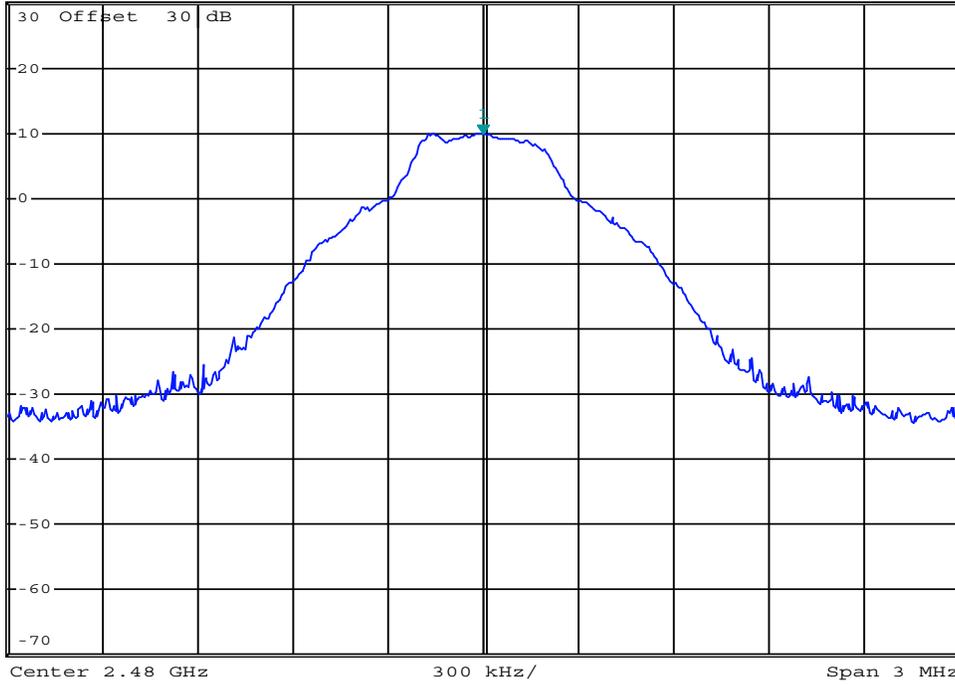


\*RBW 100 kHz    Marker 1 [T1 ]  
VEW 300 kHz                    9.93 dBm  
SWT 2.5 ms                    2.480000000 GHz

Ref 30 dBm

\*Att 30 dB

1 PK  
VIEW



Date: 22.JAN.2023 14:50:21

Channel:   
Mode:

Channel Frequency:  MHz  
Modulation:   
Reference Measurement:  dBm

## Summary of Radiated Tx Emissions

Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency (MHz)	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)
30-1000MHz	2412.0	Horizontal	41.1	8.83	17.96	0.72	0.00 (3)	27.5 (2)	40.0	12.5
30-1000MHz	2412.0	Horizontal	54.6	8.20	11.39	0.79	0.00 (3)	20.4 (2)	40.0	19.6
30-1000MHz	2412.0	Horizontal	57.3	8.03	10.87	0.80	0.00 (3)	19.7 (2)	40.0	20.3
30-1000MHz	2412.0	Horizontal	923.0	9.08	29.70	2.97	0.00 (3)	41.8 (2)	46.0	4.3
30-1000MHz	2412.0	Vertical	904.8	9.46	29.30	2.93	0.00 (3)	41.7 (2)	46.0	4.3
30-1000MHz	2412.0	Vertical	909.7	9.13	29.50	2.94	0.00 (3)	41.6 (2)	46.0	4.4
1 - 3GHz	2412.0	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
1 - 3GHz	2412.0	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
3-13GHz	2412.0	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
3-13GHz	2412.0	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
13-18GHz	2412.0	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
13-18GHz	2412.0	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
18-26GHz	2412.0	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
18-26GHz	2412.0	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
<b>Results:</b>									<b>Complies</b>	

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit

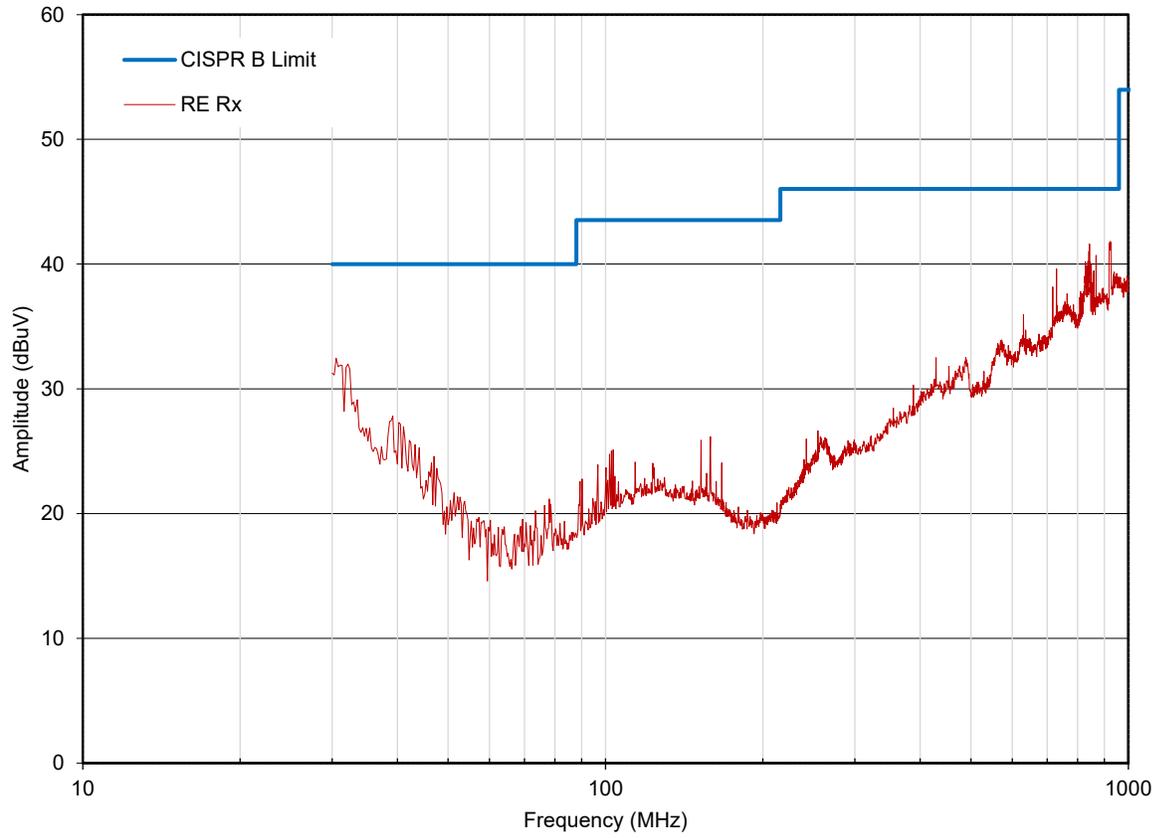
(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{\text{Corr}} = E_{\text{Meas}} + \text{ACF} + L_{\text{C}} - G_{\text{A}}$$

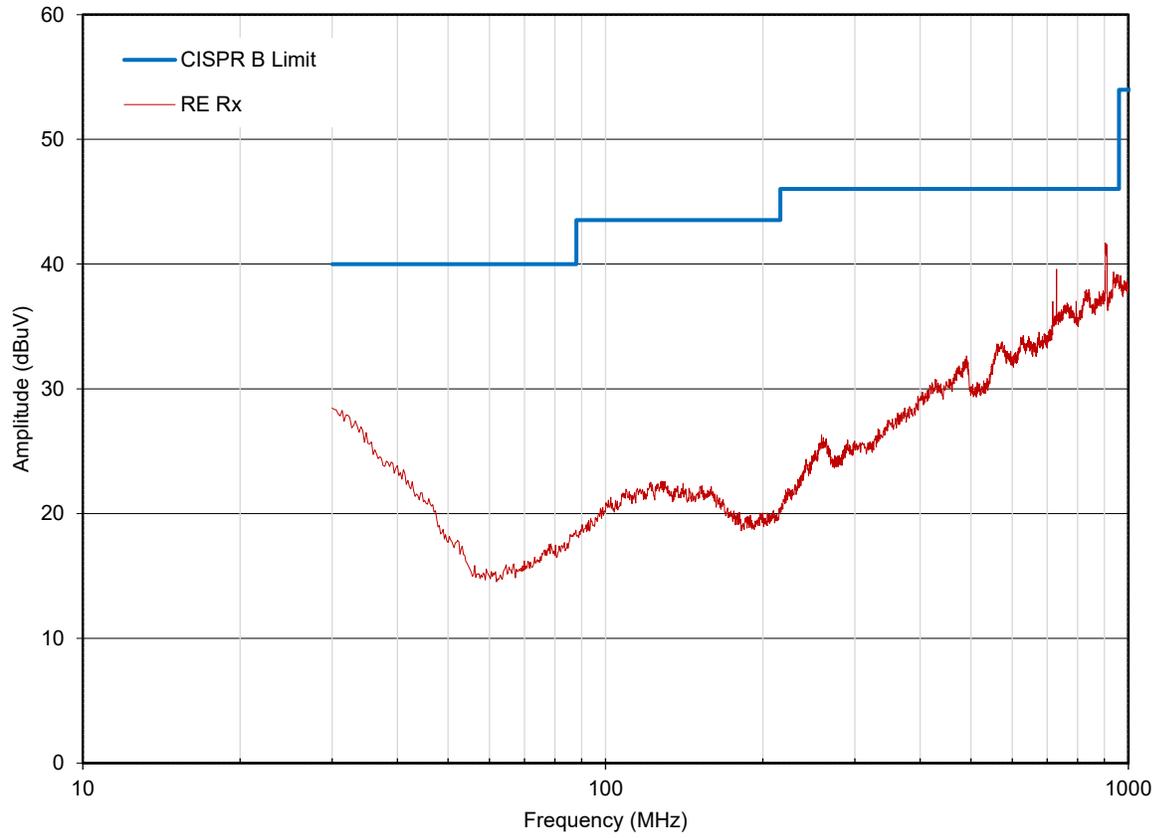
**Radiated Tx Emissions:**

Radiated Tx Emissions (30MHz - 1GHz)  
OATS Horizontal



**Radiated Tx Emissions:**

Radiated Tx Emissions (30MHz - 1GHz)  
OATS Vertical



# Radiated Tx Emissions:

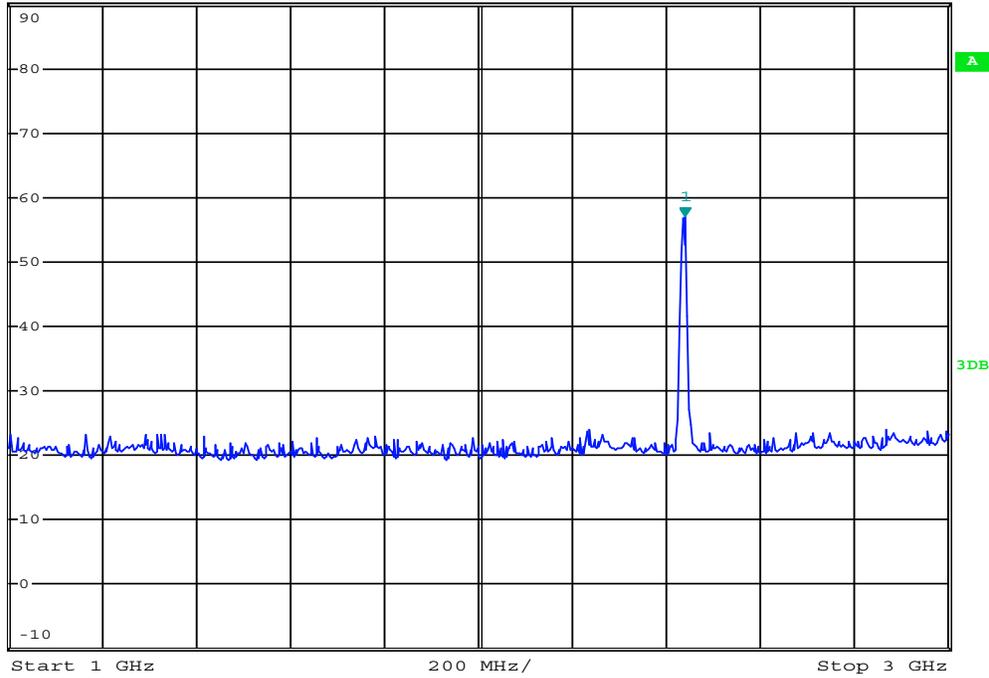


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    56.96 dBμV  
SWT 10 ms    2.440000000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 17:52:44

Channel:

Mode:

Polarization:

Marker 1 = Fundamental

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

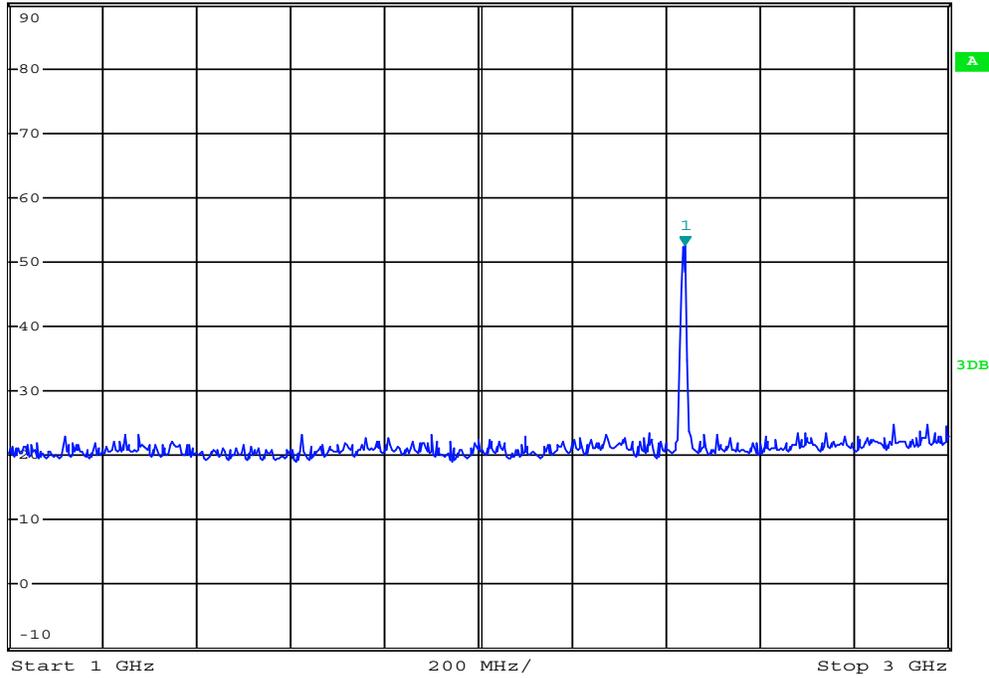


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 3 MHz      52.58 dBμV  
SWT 10 ms      2.440000000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 18:11:38

Channel:

Mode:

Polarization:

Marker 1 = Fundamental

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

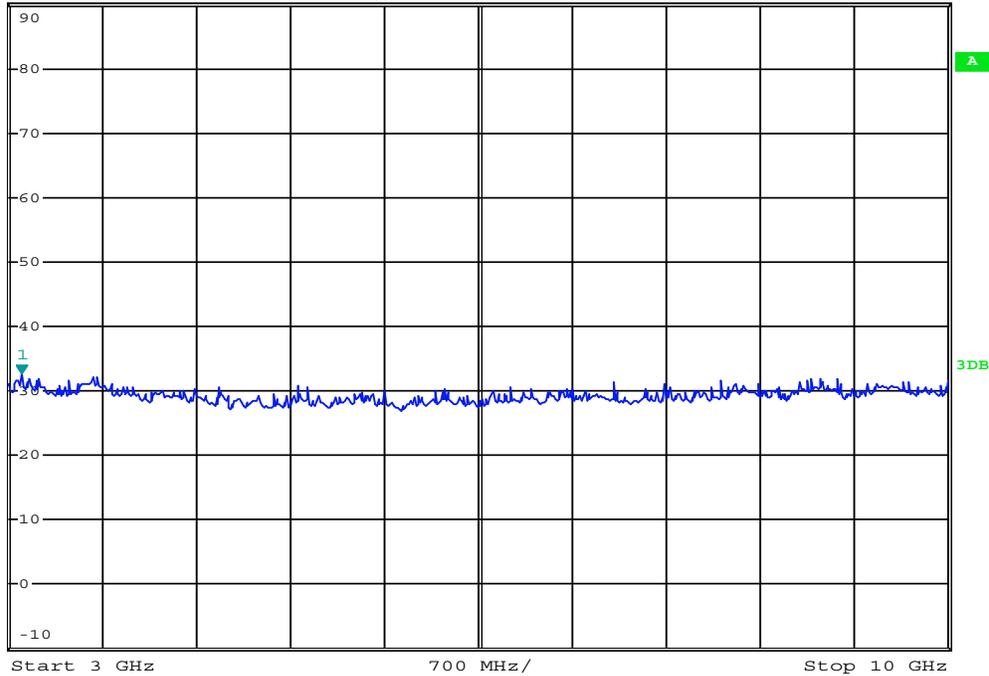


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 3 MHz      32.57 dBμV  
SWT 140 ms      3.098000000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 17:53:02

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

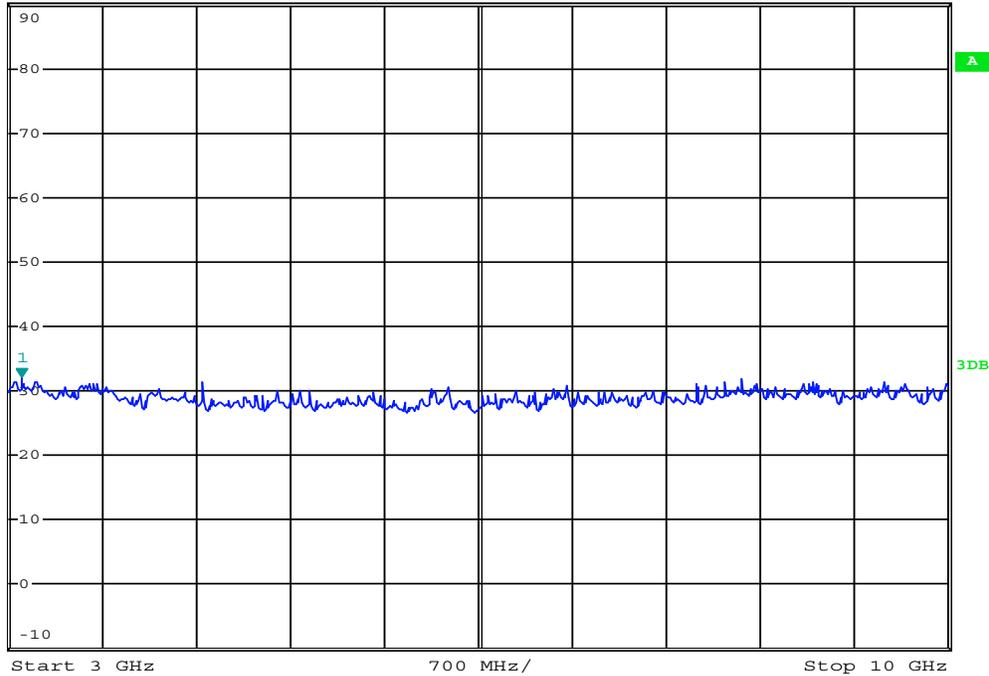


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 3 MHz      32.03 dBμV  
SWT 140 ms      3.098000000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 18:11:53

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm



# Radiated Tx Emissions:

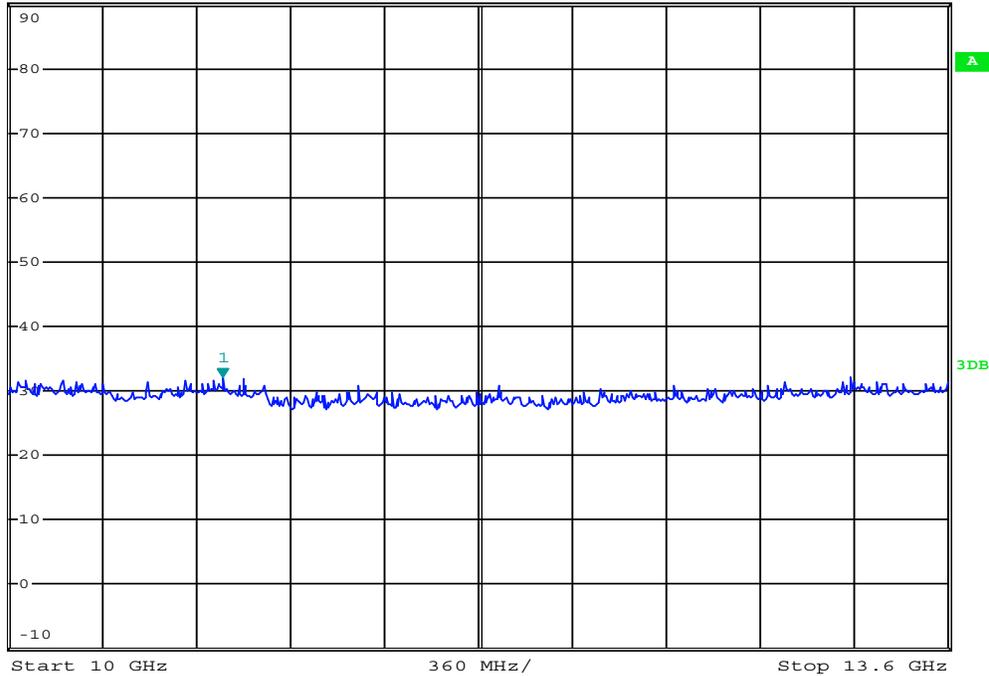


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    32.10 dBμV  
SWT 75 ms    10.82080000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 18:12:46

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

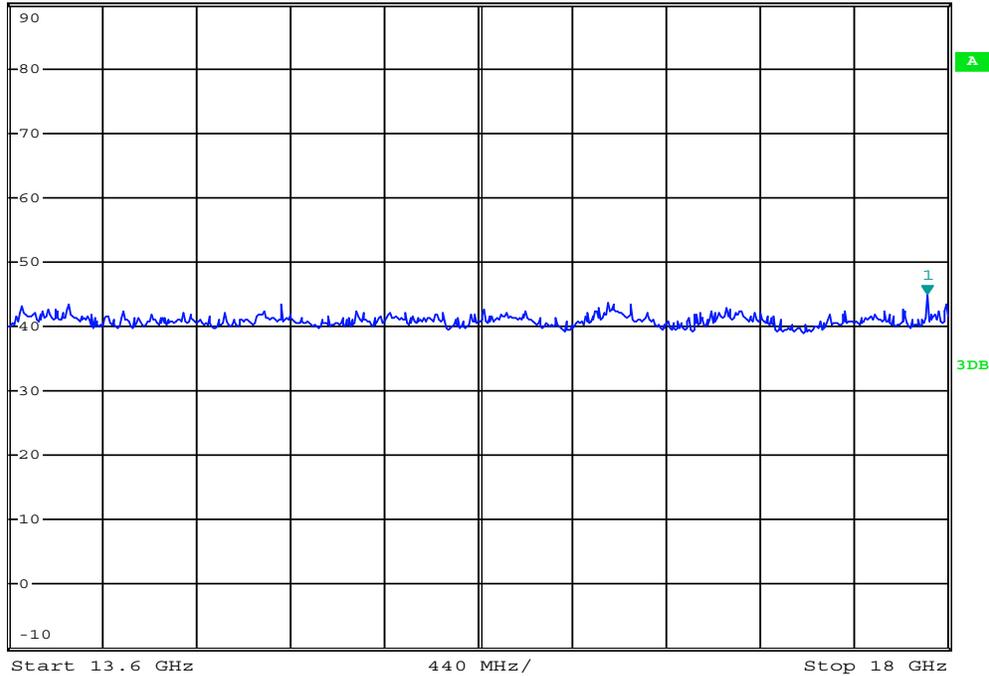


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    44.91 dBμV  
SWT 90 ms    17.903200000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 17:54:25

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

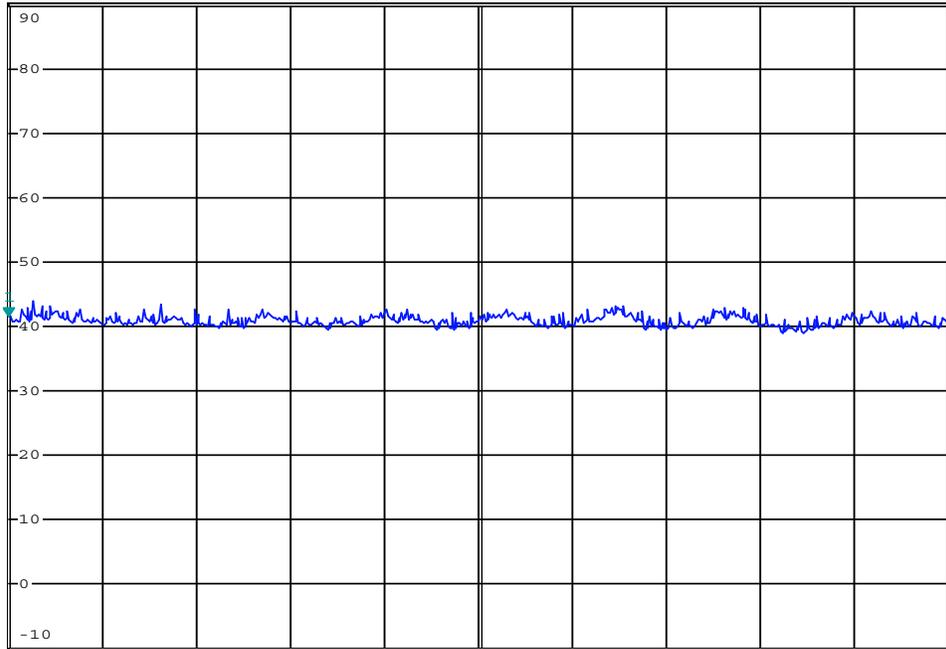


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 3 MHz      41.67 dBμV  
SWT 90 ms      13.600000000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Start 13.6 GHz      440 MHz/      Stop 18 GHz

Date: 31.JAN.2023 18:13:05

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

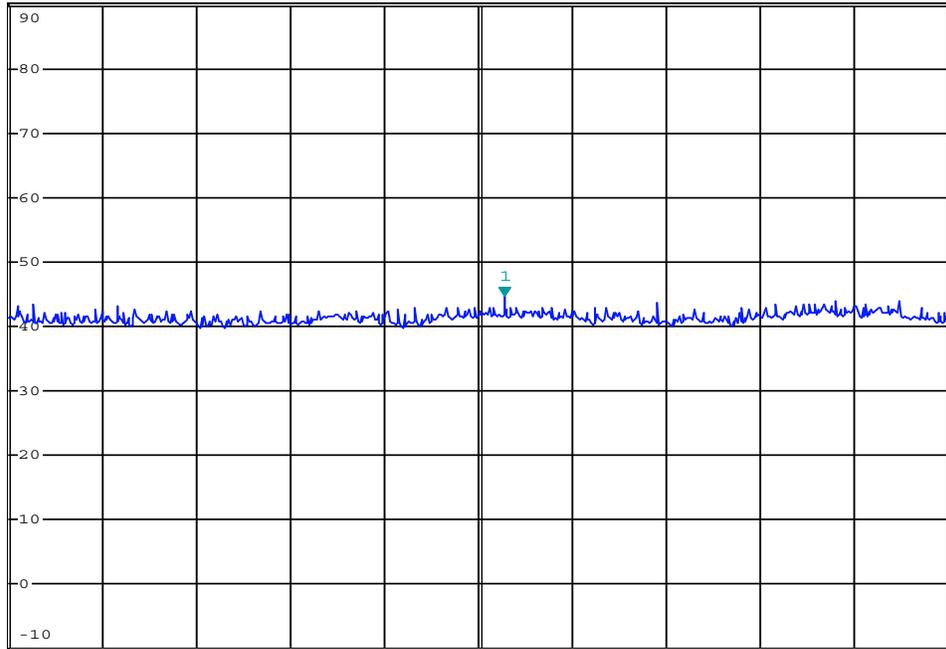


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 3 MHz      44.84 dBμV  
SWT 80 ms      20.11200000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Start 18 GHz

400 MHz/

Stop 22 GHz

Date: 31.JAN.2023 18:45:41

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm





# Radiated Tx Emissions:

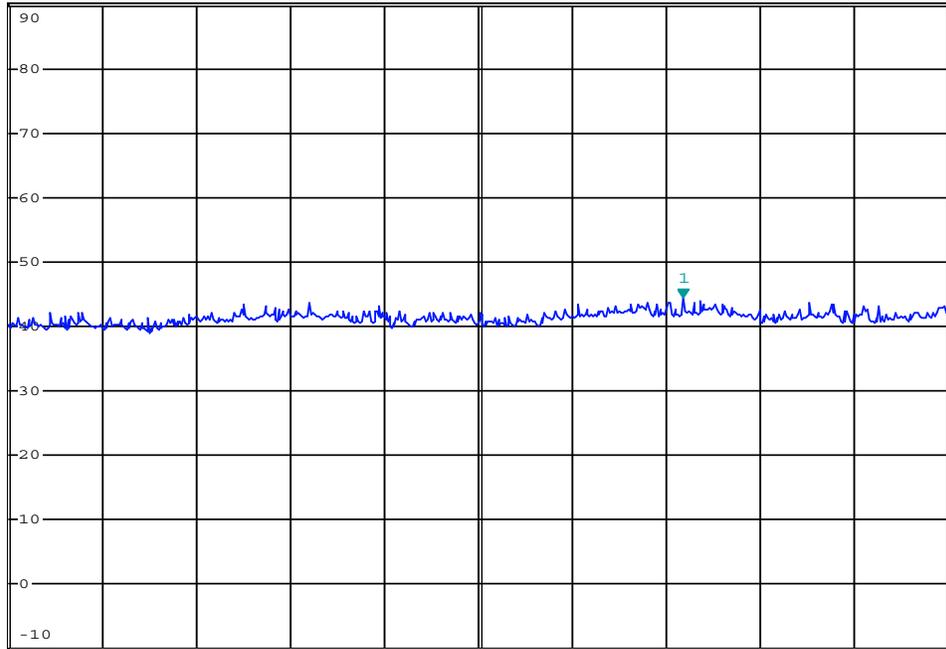


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    44.53 dBμV  
SWT 80 ms    24.872000000 GHz

Ref 90 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 18:46:30

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

## Summary of Radiated Tx Emissions

Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)
30-1000MHz	2440.0	Horizontal	31.89	7.53	22.91	0.68	0.00 (3)	31.1 (2)	40.0	8.9
30-1000MHz	2440.0	Horizontal	55.92	6.92	11.12	0.79	0.00 (3)	18.8 (2)	40.0	21.2
30-1000MHz	2440.0	Horizontal	113.97	7.47	16.20	1.04	0.00 (3)	24.7 (2)	43.5	18.8
30-1000MHz	2440.0	Vertical	729.10	8.51	28.30	2.66	0.00 (3)	39.5 (2)	46.0	6.6
30-1000MHz	2440.0	Vertical	909.00	8.39	29.50	2.94	0.00 (3)	40.8 (2)	46.0	5.2
1 - 3GHz	2440.0	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
1 - 3GHz	2440.0	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
3-13GHz	2440.0	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
3-13GHz	2440.0	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
13-18GHz	2440.0	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
13-18GHz	2440.0	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
18-26GHz	2440.0	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
18-26GHz	2440.0	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
<b>Results:</b>									<b>Complies</b>	

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit

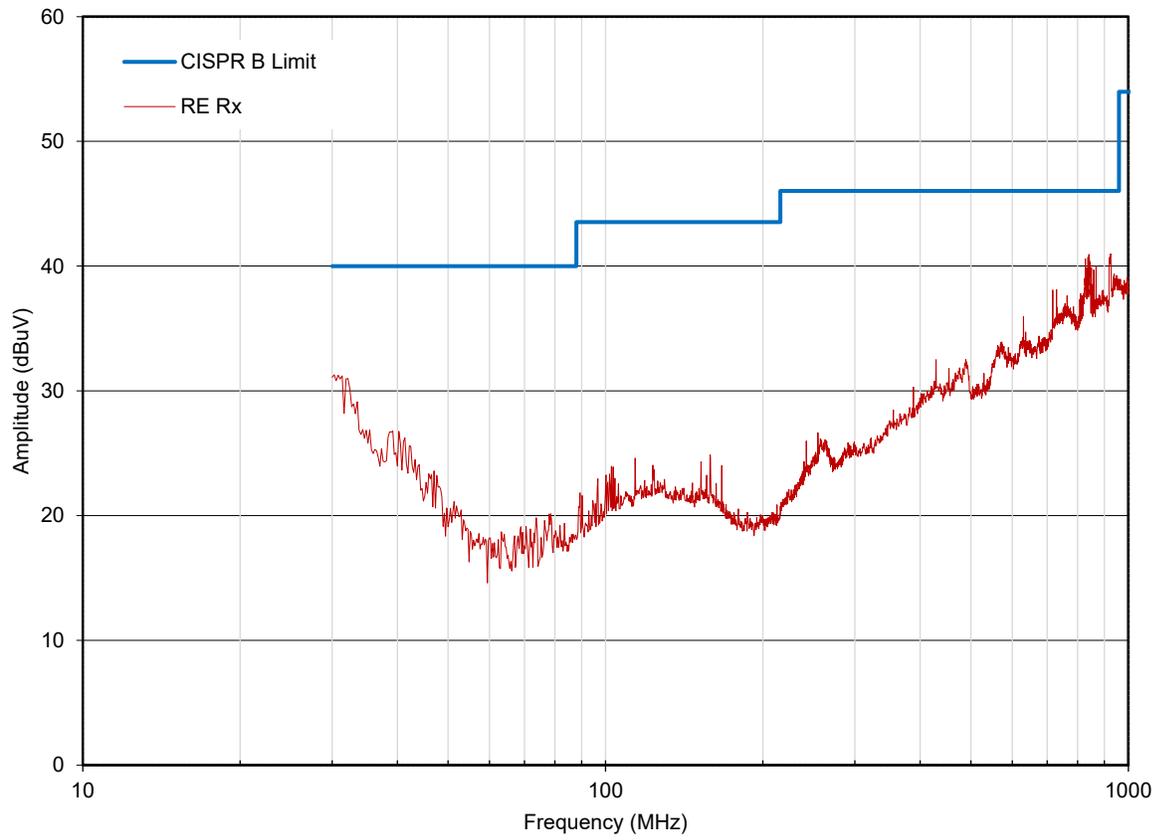
(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{\text{Corr}} = E_{\text{Meas}} + \text{ACF} + L_{\text{C}} - G_{\text{A}}$$

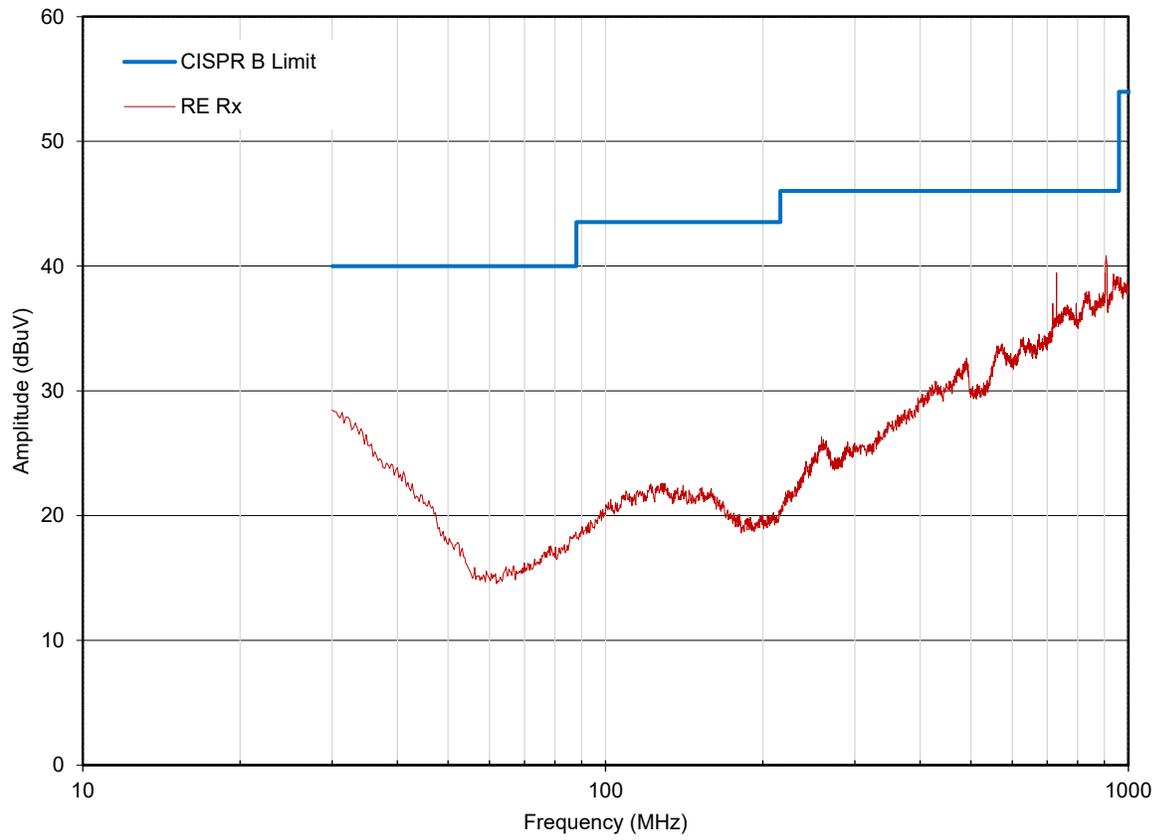
**Radiated Tx Emissions:**

Radiated Tx Emissions (30MHz - 1GHz)  
OATS Horizontal



**Radiated Tx Emissions:**

Radiated Tx Emissions (30MHz - 1GHz)  
OATS Vertical



# Radiated Tx Emissions:

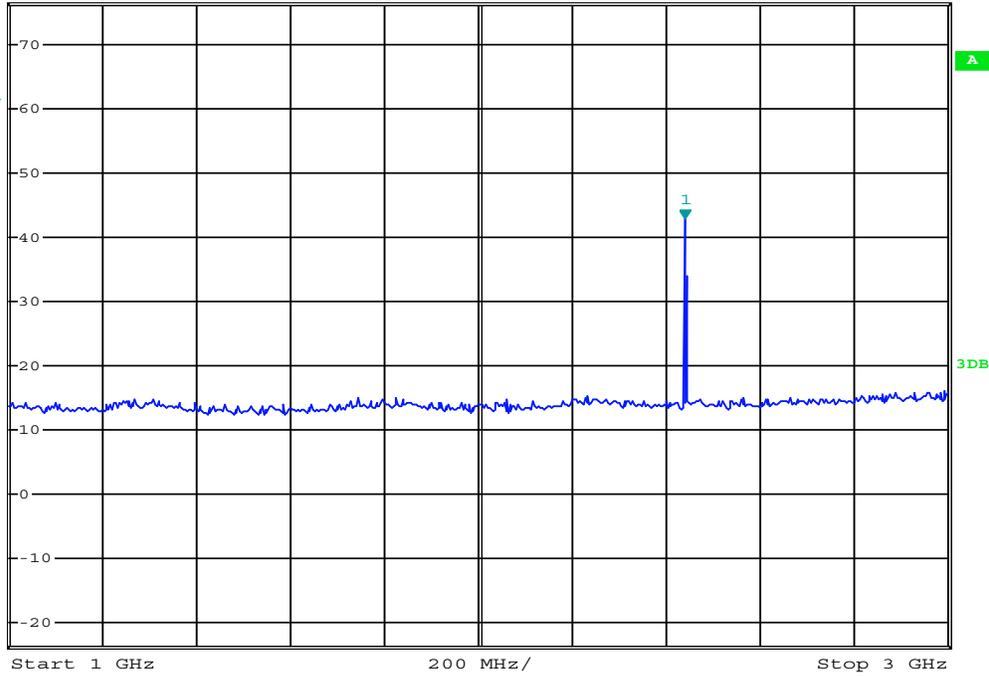


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 10 MHz      42.74 dBμV  
SWT 10 ms      2.440000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:16:57

Channel:

Mode:

Polarization:

Marker 1 = Fundamental

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

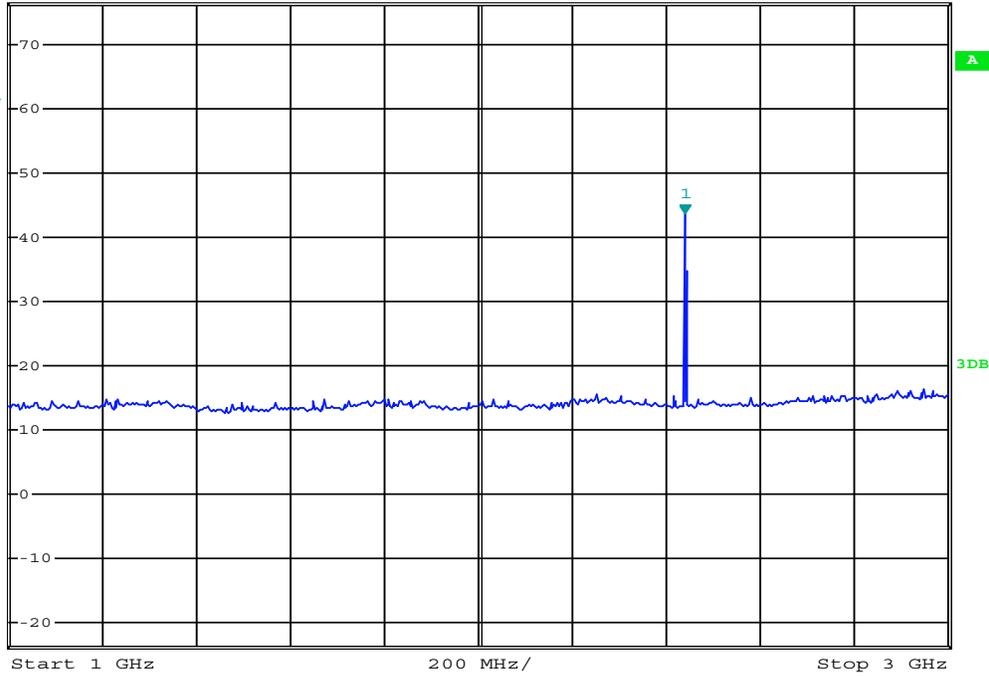


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 10 MHz      43.66 dBμV  
SWT 10 ms      2.440000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:15:04

Channel:

Mode:

Polarization:

Marker 1 = Fundamental

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm



# Radiated Tx Emissions:

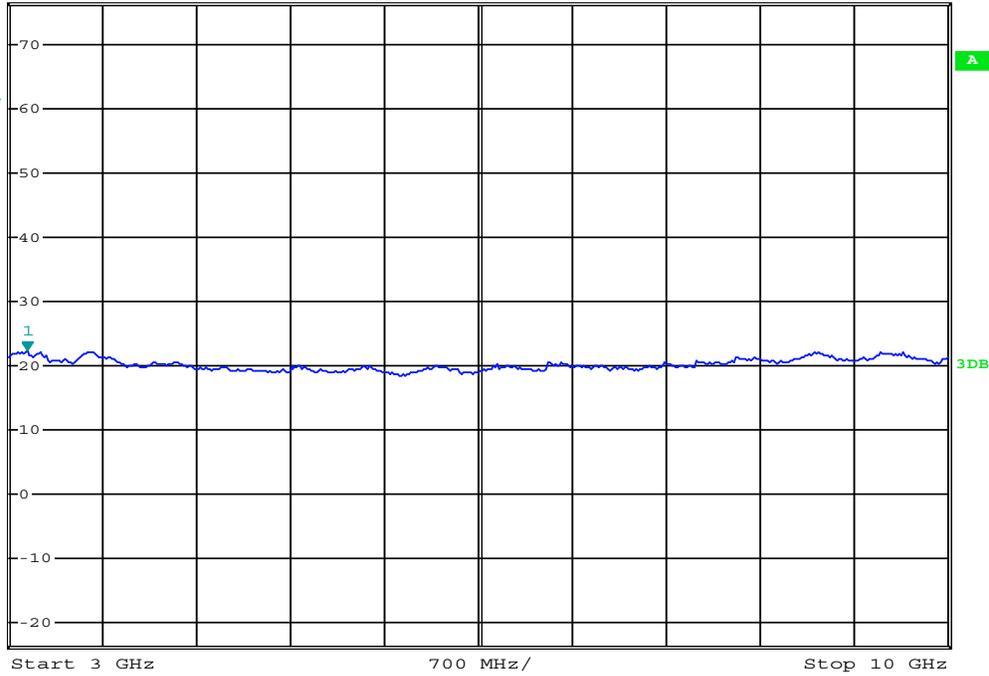


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    22.28 dBμV  
SWT 140 ms    3.140000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:15:22

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm



# Radiated Tx Emissions:

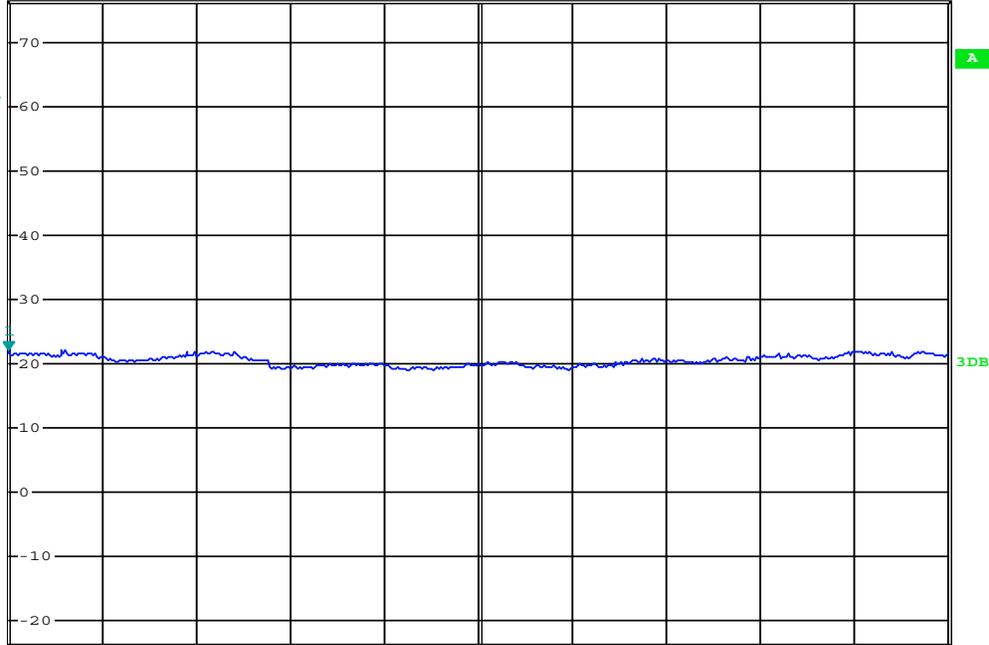


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    22.19 dBμV  
SWT 75 ms    10.000000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Start 10 GHz

360 MHz/

Stop 13.6 GHz

Date: 31.JAN.2023 15:15:40

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

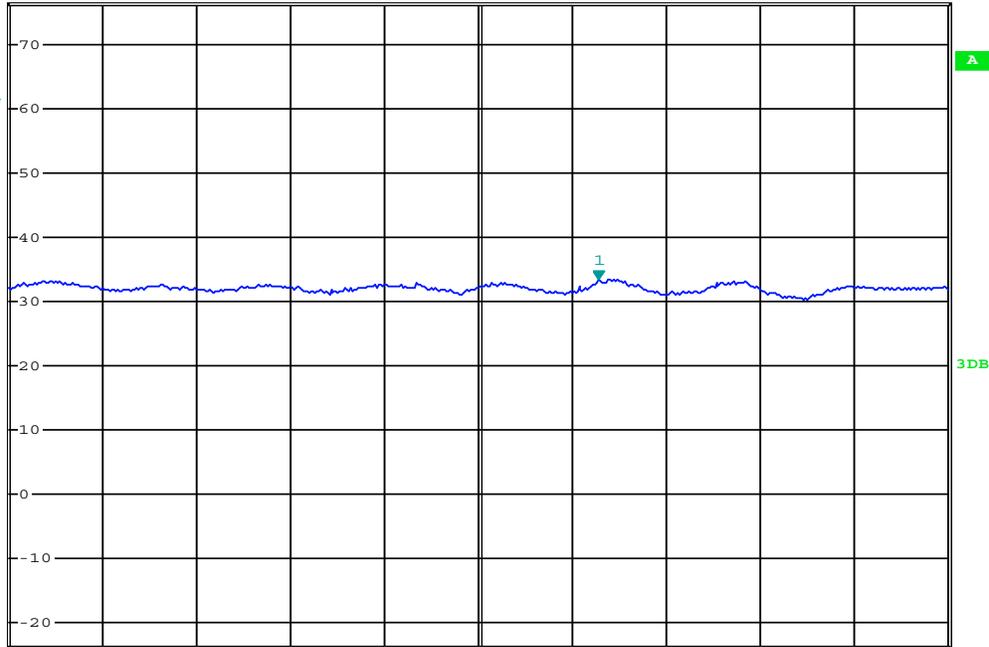


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    33.53 dBμV  
SWT 90 ms    16.363200000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Start 13.6 GHz

440 MHz/

Stop 18 GHz

Date: 31.JAN.2023 15:18:13

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

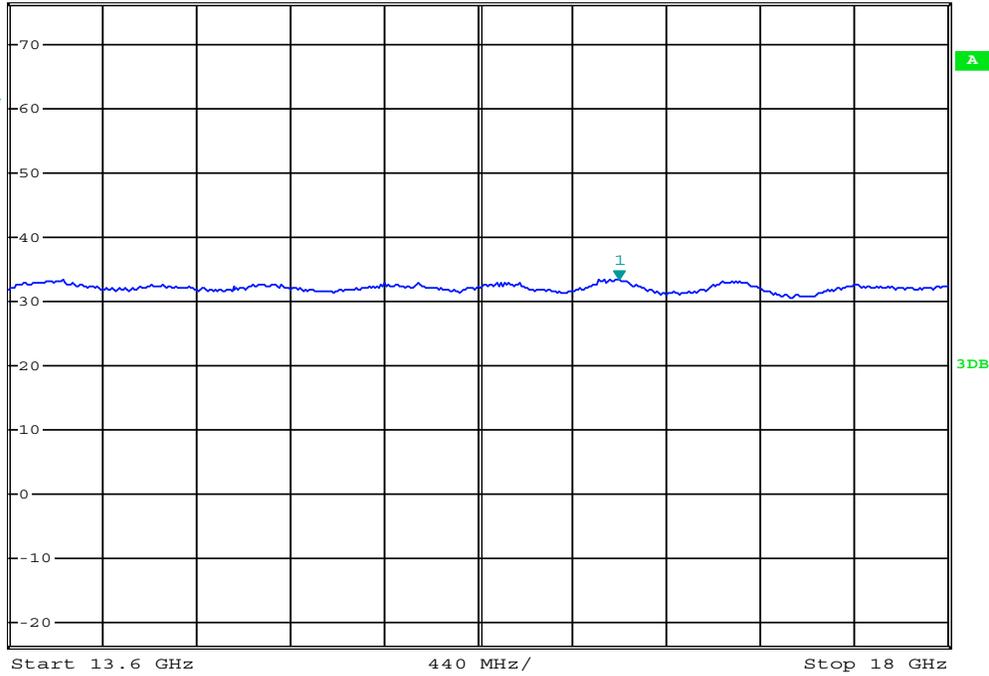


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    33.37 dBμV  
SWT 90 ms    16.460000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:16:04

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm





# Radiated Tx Emissions:

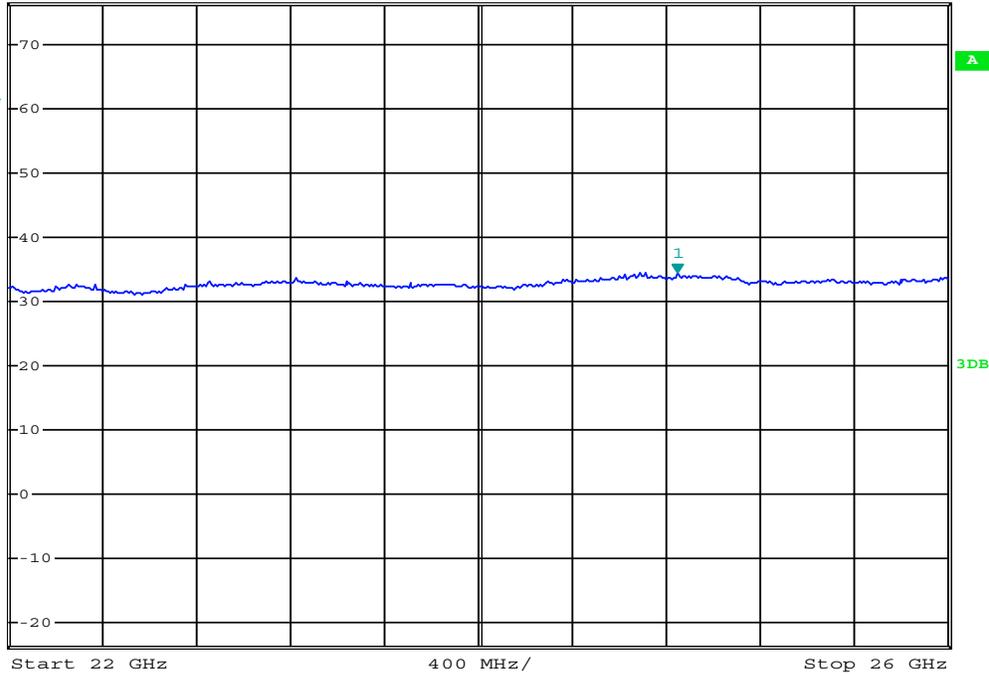


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    34.39 dBμV  
SWT 80 ms    24.848000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:46:51

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm



**Field Strength Measurement Results:**

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Antenna Polarization	Measured Field Strength [Avg] (dBuV/m)	Measured Field Strength [Peak] (dBuV/m)	Avg Limit (dBuV/m)	Avg Margin (dB)	Peak Limit (dBuV/m)	Peak Margin (dB)
37	2402.00	BT LE1	GMSK	Horizontal	80.82	82.74	94.0	13.18	114	31.26
				Vertical	85.58	87.03		8.42		26.97
17	2440.00			Horizontal	81.09	82.99		12.91		31.01
				Vertical	87.06	88.26		6.94		25.74
39	2480.00	BT LE2		Horizontal	75.93	78.88		18.07		35.12
				Vertical	83.12	85.79		10.88		28.21
0	2404.00			Horizontal	85.38	87.55		8.62		26.45
				Vertical	84.60	86.79		9.40		27.21
17	2440.00	ANT	Horizontal	81.75	84.17	12.25		29.83		
			Vertical	82.14	84.50	11.86		29.50		
36	2478.00		Horizontal	73.89	77.93	20.11		36.07		
			Vertical	74.62	78.54	19.38		35.46		
0	2402.00	ANT	Horizontal	79.86	82.07	14.14		31.93		
			Vertical	87.74	89.12	6.26		24.88		
38	2440.00		Horizontal	81.63	83.56	12.37		30.44		
			Vertical	86.57	88.01	7.43		25.99		
78	2480.00	ANT	Horizontal	74.48	77.88	19.52	36.12			
			Vertical	79.40	84.48	14.60	29.52			
<b>Result:</b>								<b>Complies</b>		

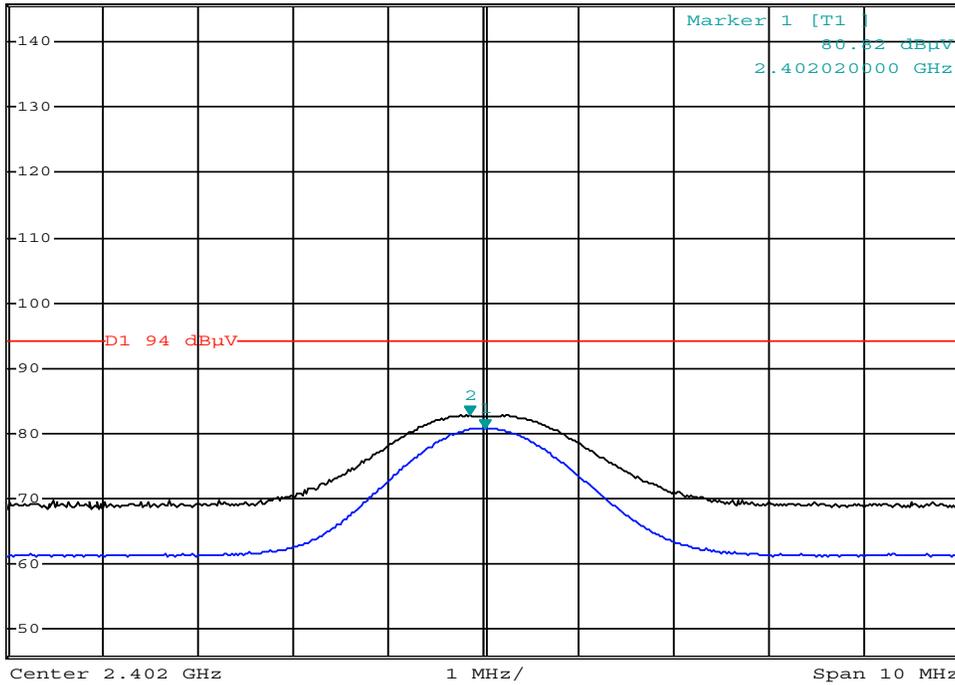
Conducted Margin =  $P_{Lim} - P_{Meas}$

# Field Strength:



Ref 145.7 dB $\mu$ V      \*Att 0 dB      \*RBW 1 MHz      Marker 2 [T2 ]  
 \*RBW 1 MHz      VEW 10 MHz      82.74 dB $\mu$ V  
 \*SWT 20 ms      2.401860000 GHz

1 RM  
VIEW  
2 PK  
VIEW



Date: 31.JAN.2023 16:18:13

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Field Strength (Avg):  dB $\mu$ V/m

Measured Field Strength (Pk):  dB $\mu$ V/m

# Field Strength:

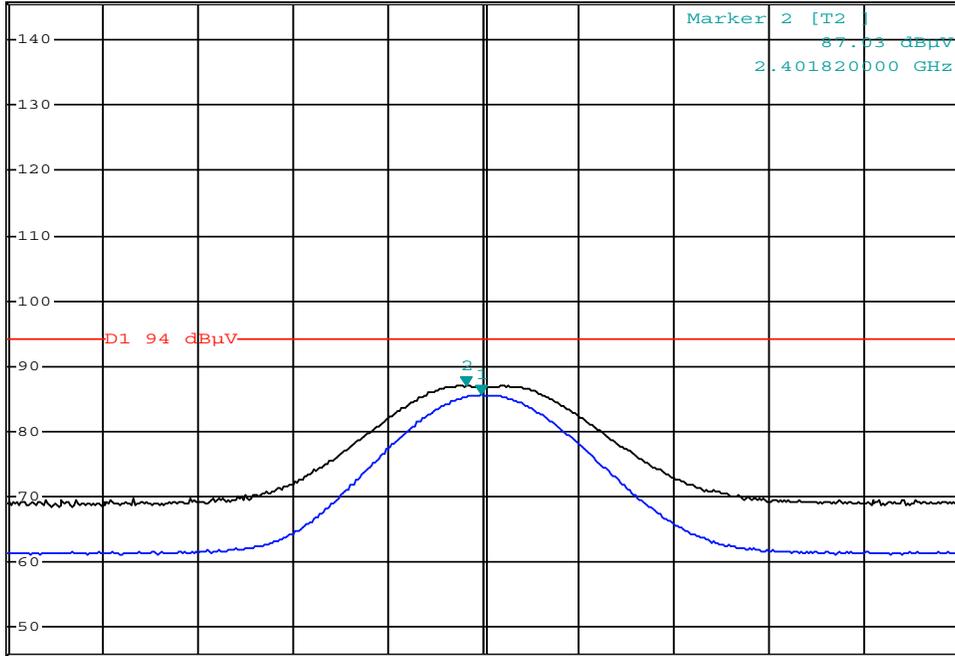


\*RBW 1 MHz      Marker 1 [T1 ]  
 VBW 10 MHz      85.58 dBuV  
 \*Att 0 dB      \*SWT 20 ms      2.401980000 GHz

Ref 145.7 dBuV

1 RM  
VIEW

2 PK  
VIEW



Center 2.402 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:19:16

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

# Field Strength:

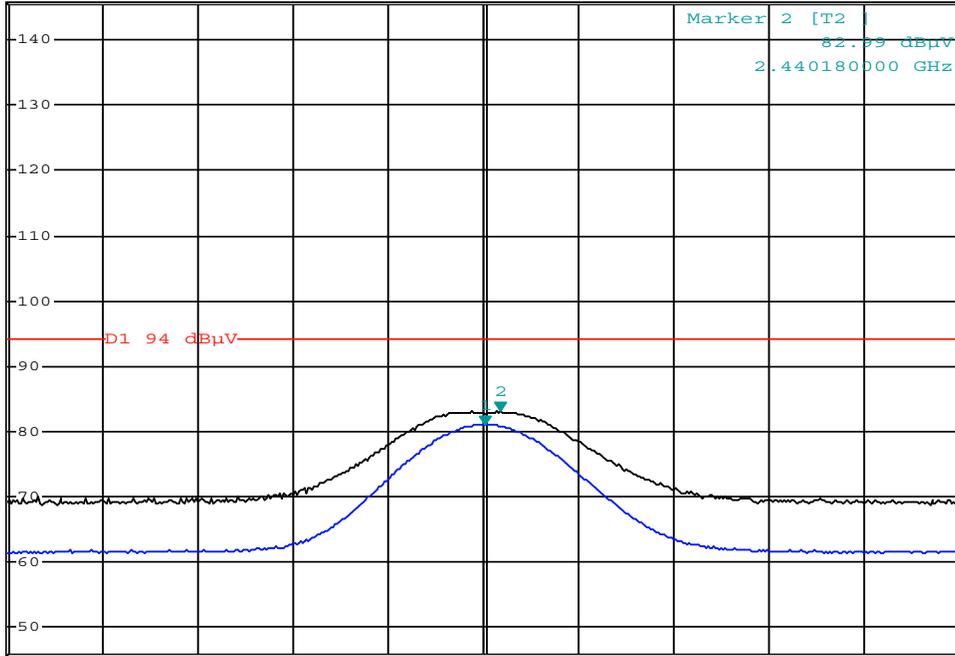


\*RBW 1 MHz      Marker 1 [T1 ]  
 VBW 10 MHz      81.09 dBuV  
 \*Att 0 dB      \*SWT 20 ms      2.440020000 GHz

Ref 145.7 dBuV

1 RM\*  
VIEW

2 PK\*  
VIEW



Center 2.44 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:21:33

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

# Field Strength:

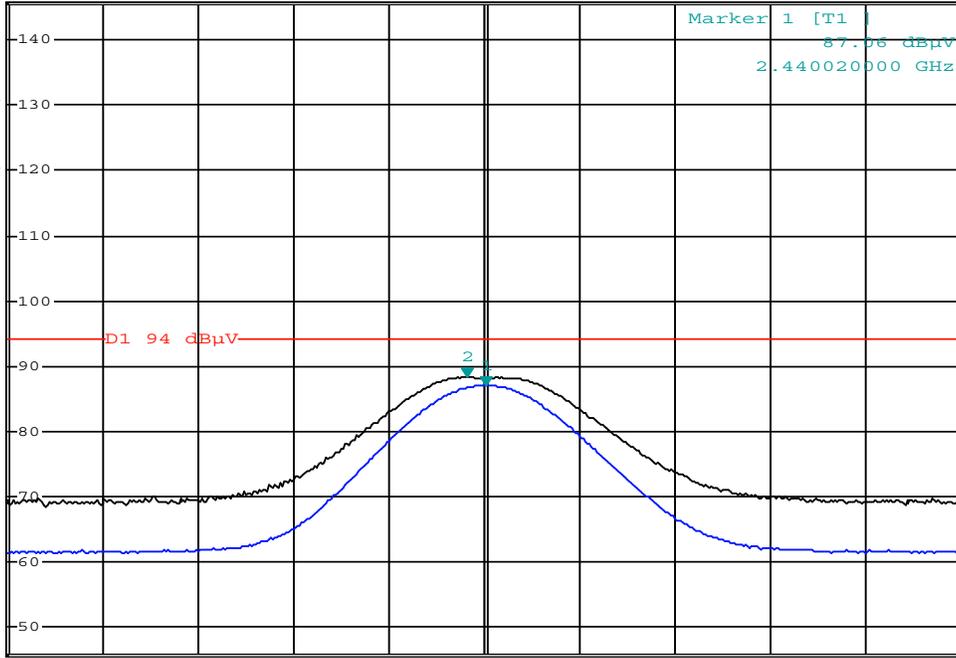


\*RBW 1 MHz      Marker 2 [T2 ]  
 VBW 10 MHz      88.26 dBμV  
 \*SWT 20 ms      2.439820000 GHz

Ref 145.7 dBμV      \*Att 0 dB

1 RM \*  
 VIEW

2 PK \*  
 VIEW



Center 2.44 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:20:37

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Polarization:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

# Field Strength:

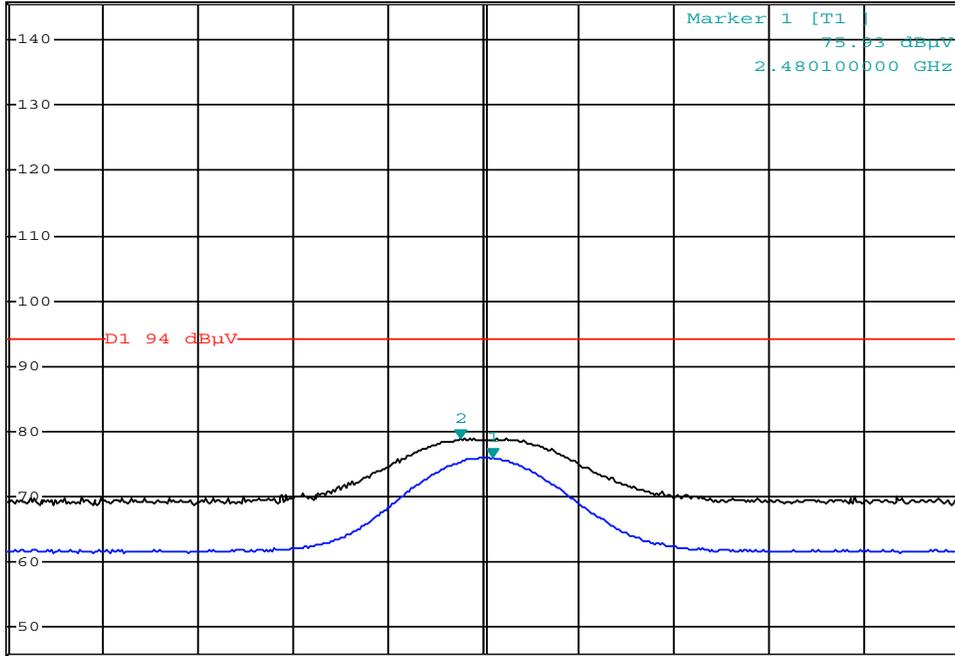


\*RBW 1 MHz      Marker 2 [T2 ]  
 \*Att 0 dB      VBW 10 MHz      78.88 dBuV  
 \*SWT 20 ms      2.479760000 GHz

Ref 145.7 dBuV

1 RM  
VIEW

2 PK  
VIEW



Center 2.48 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:22:59

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Polarization:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

# Field Strength:



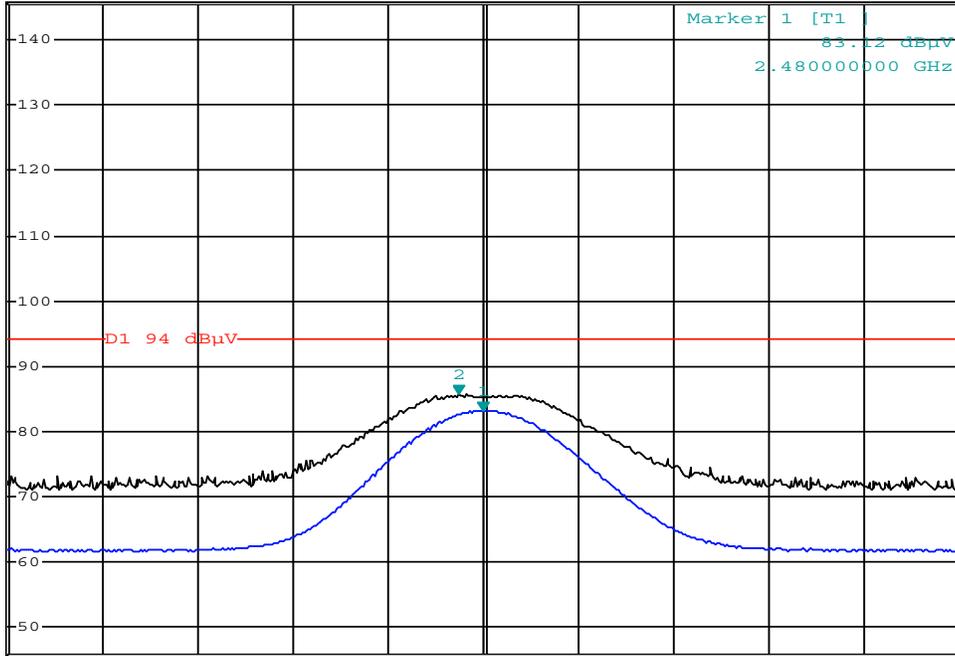
\*RBW 1 MHz      Marker 2 [T2 ]  
 VBW 10 MHz      85.79 dBuV  
 \*SWT 20 ms      2.479740000 GHz

Ref 145.7 dBuV

\*Att 0 dB

1 RM  
 VIEW

2 PK  
 VIEW



Center 2.48 GHz      1 MHz/      Span 10 MHz

Date: 10.JAN.2023 15:43:07

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Polarization:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

# Field Strength:

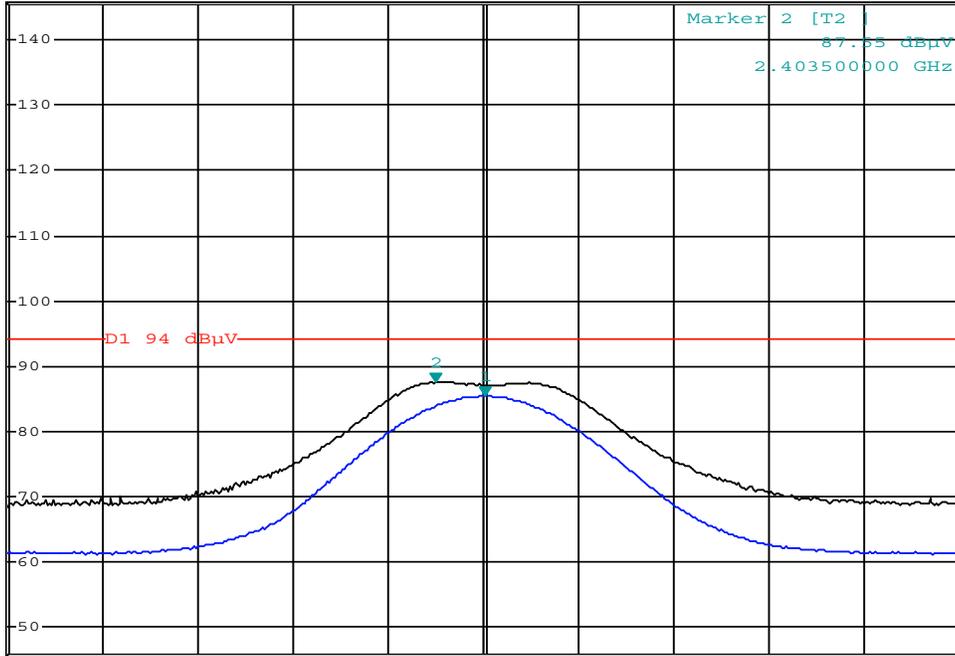


\*RBW 1 MHz      Marker 1 [T1 ]  
 VBW 10 MHz      85.38 dBuV  
 \*Att 0 dB      \*SWT 20 ms      2.404020000 GHz

Ref 145.7 dBuV

1 RM\*  
VIEW

2 PK\*  
VIEW



Center 2.404 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:26:07

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Polarization:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

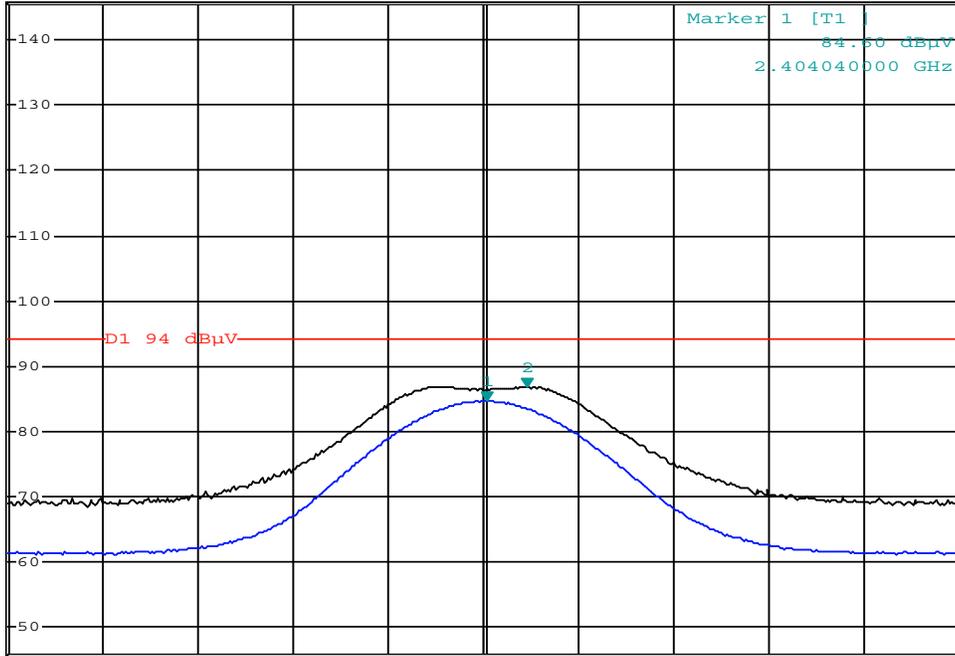
# Field Strength:



Ref 145.7 dB $\mu$ V      \*Att 0 dB      \*RBW 1 MHz      Marker 2 [T2 ]  
 \*RBW 1 MHz      VEW 10 MHz      86.79 dB $\mu$ V  
 \*SWT 20 ms      2.404460000 GHz

1 RM\*  
VIEW

2 PK\*  
VIEW



Center 2.404 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:25:15

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Field Strength (Avg):  dB $\mu$ V/m

Measured Field Strength (Pk):  dB $\mu$ V/m

# Field Strength:



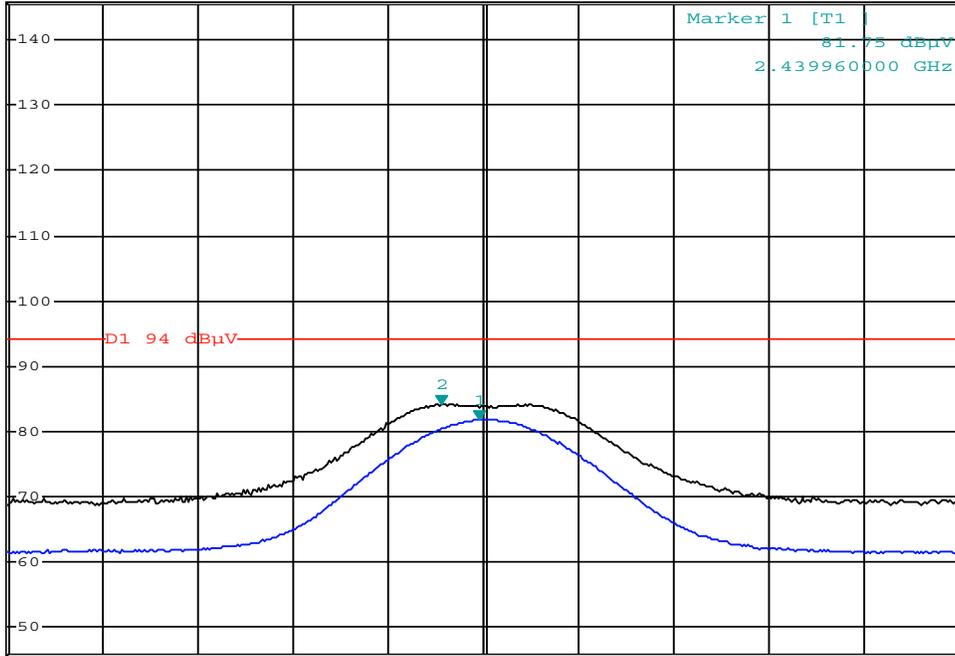
\*RBW 1 MHz      Marker 2 [T2 ]  
 VBW 10 MHz      84.17 dBuV  
 \*SWT 20 ms      2.439560000 GHz

Ref 145.7 dBuV

\*Att 0 dB

1 RM\*  
VIEW

2 PK\*  
VIEW



Date: 31.JAN.2023 16:27:42

Channel: 17

Mode: BT LE2

Polarization: Horizontal

Channel Frequency: 2440 MHz

Modulation: GMSK

Measured Field Strength (Avg): 81.75 dBuV/m

Measured Field Strength (Pk): 84.17 dBuV/m

# Field Strength:

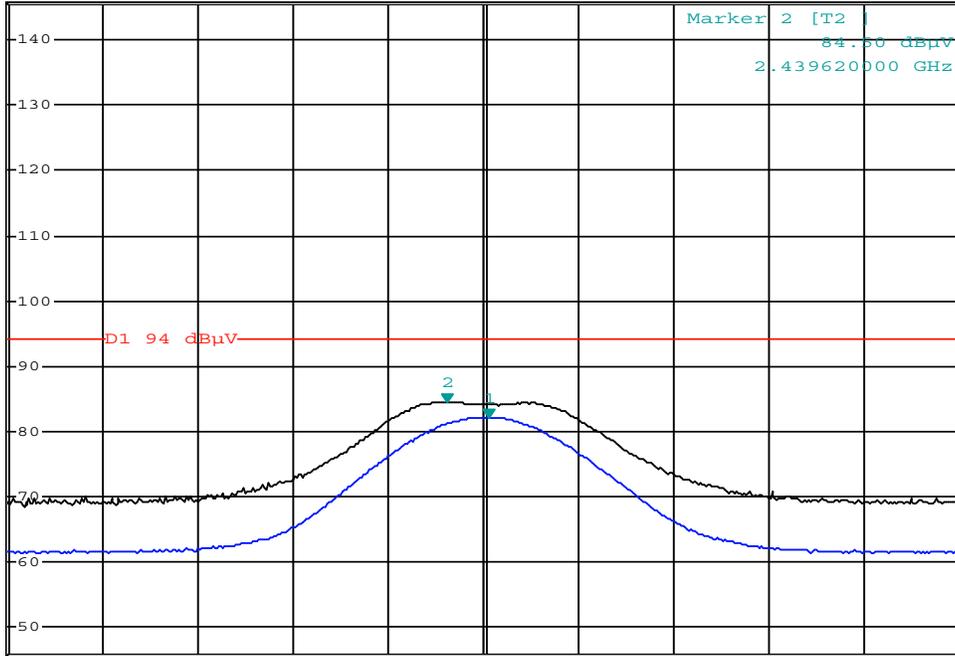


\*RBW 1 MHz      Marker 1 [T1 ]  
 VBW 10 MHz      82.14 dBuV  
 \*Att 0 dB      \*SWT 20 ms      2.440060000 GHz

Ref 145.7 dBuV

1 RM\*  
VIEW

2 PK\*  
VIEW



Date: 31.JAN.2023 16:28:34

Channel: 17

Mode: BT LE2

Polarization: Vertical

Channel Frequency: 2440 MHz

Modulation: GMSK

Measured Field Strength (Avg): 82.14 dBuV/m

Measured Field Strength (Pk): 84.5 dBuV/m

# Field Strength:

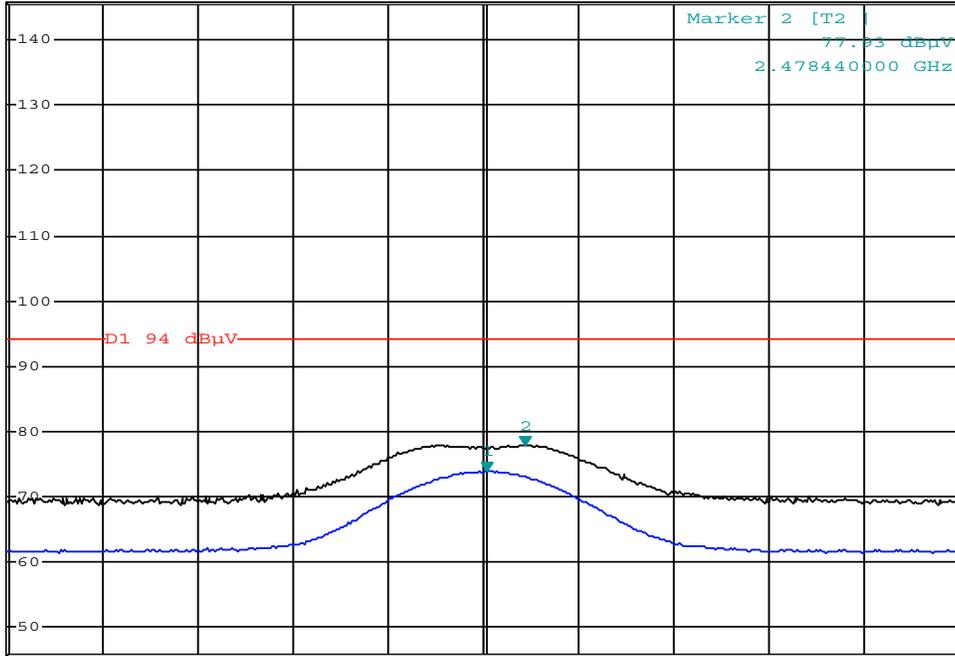


\*RBW 1 MHz      Marker 1 [T1 ]  
 VBW 10 MHz      73.89 dBuV  
 \*Att 0 dB      \*SWT 20 ms      2.478040000 GHz

Ref 145.7 dBuV

1 RM  
 VIEW

2 PK  
 VIEW



Center 2.478 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:30:43

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Polarization:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

# Field Strength:



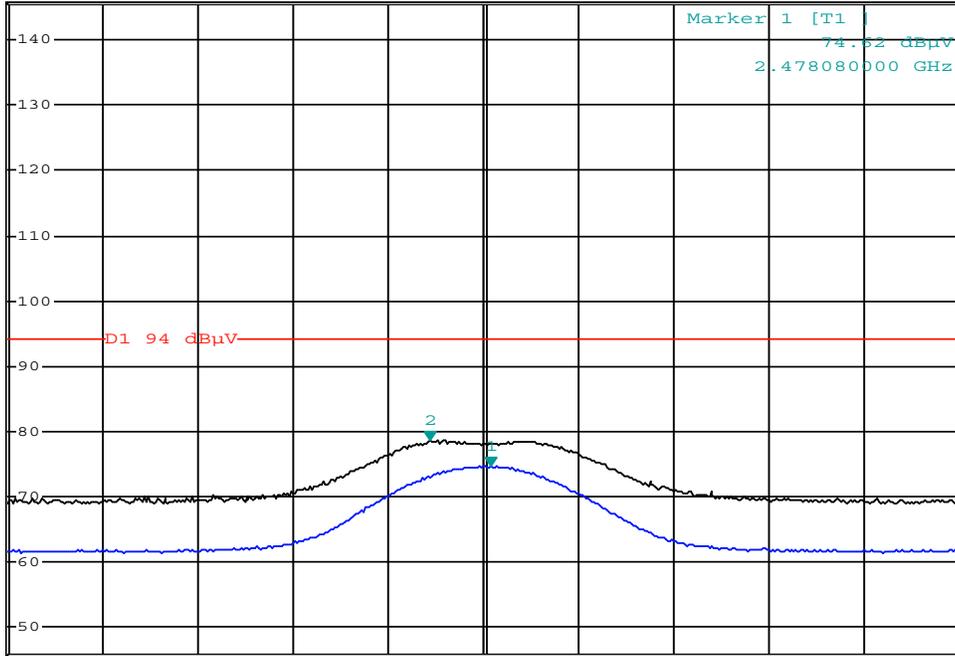
\*RBW 1 MHz      Marker 2 [T2 ]  
 VBW 10 MHz      78.54 dBuV  
 \*SWT 20 ms      2.477440000 GHz

Ref 145.7 dBuV

\*Att 0 dB

1 RM  
 VIEW

2 PK  
 VIEW



Date: 31.JAN.2023 16:29:51

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Polarization:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

# Field Strength:



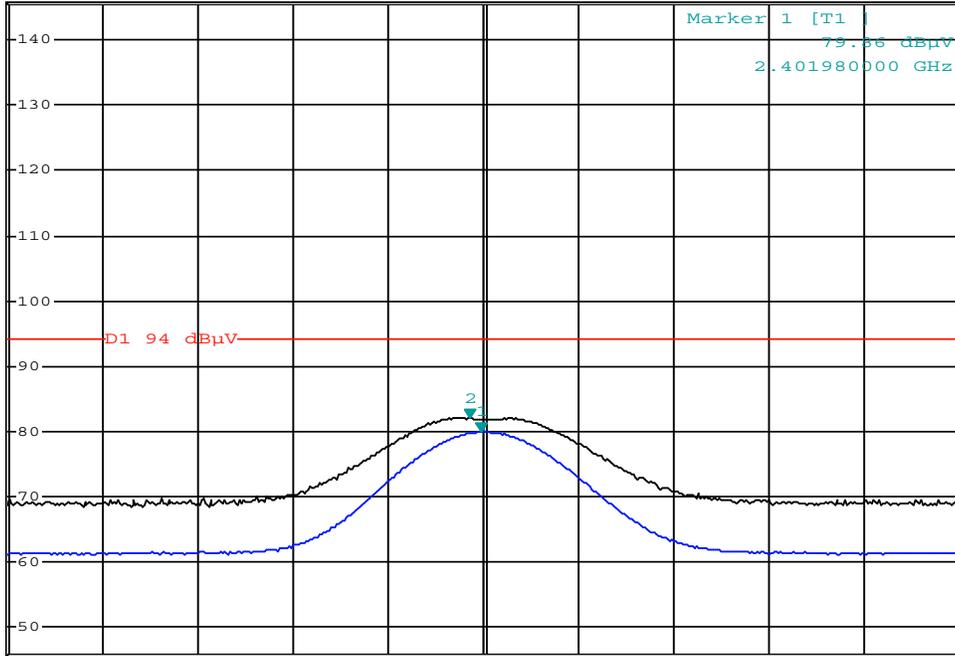
\*RBW 1 MHz      Marker 2 [T2 ]  
 VBW 10 MHz      82.07 dBuV  
 \*SWT 20 ms      2.401860000 GHz

Ref 145.7 dBuV

\*Att 0 dB

1 RM\*  
VIEW

2 PK\*  
VIEW



Date: 31.JAN.2023 16:32:26

Channel: 0

Mode: ANT

Polarization: Horizontal

Channel Frequency: 2402 MHz

Modulation: GFSK

Measured Field Strength (Avg): 79.86 dBuV/m

Measured Field Strength (Pk): 82.07 dBuV/m

# Field Strength:



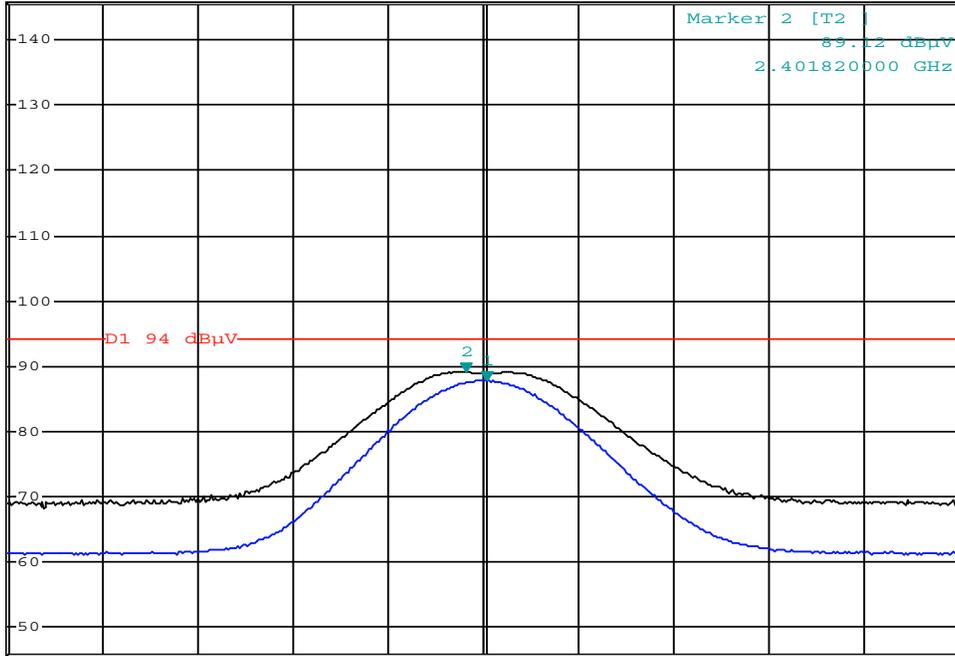
\*RBW 1 MHz      Marker 1 [T1 ]  
 VBW 10 MHz      87.74 dBuV  
 \*SWT 20 ms      2.402040000 GHz

Ref 145.7 dBuV

\*Att 0 dB

1 RM\*  
VIEW

2 PK\*  
VIEW



Center 2.402 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:33:20

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

# Field Strength:



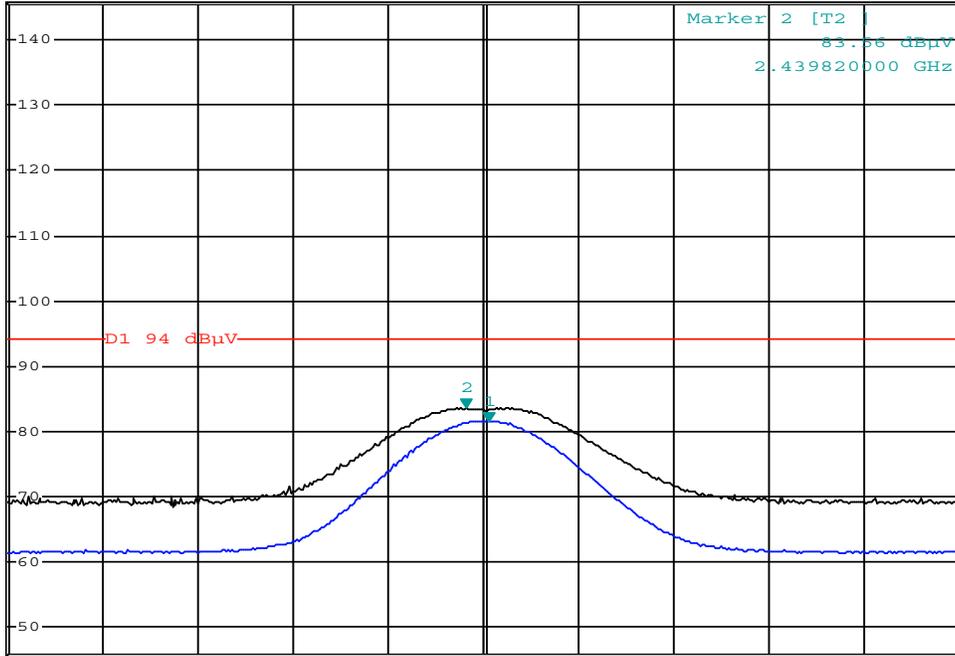
\*RBW 1 MHz      Marker 1 [T1 ]  
 VBW 10 MHz      81.63 dBuV  
 \*SWT 20 ms      2.440060000 GHz

Ref 145.7 dBuV

\*Att 0 dB

1 RM  
 VIEW

2 PK  
 VIEW



Center 2.44 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:35:29

Channel: 38

Mode: ANT

Polarization: Horizontal

Channel Frequency: 2440 MHz

Modulation: GFSK

Measured Field Strength (Avg): 81.63 dBuV/m

Measured Field Strength (Pk): 83.56 dBuV/m

# Field Strength:



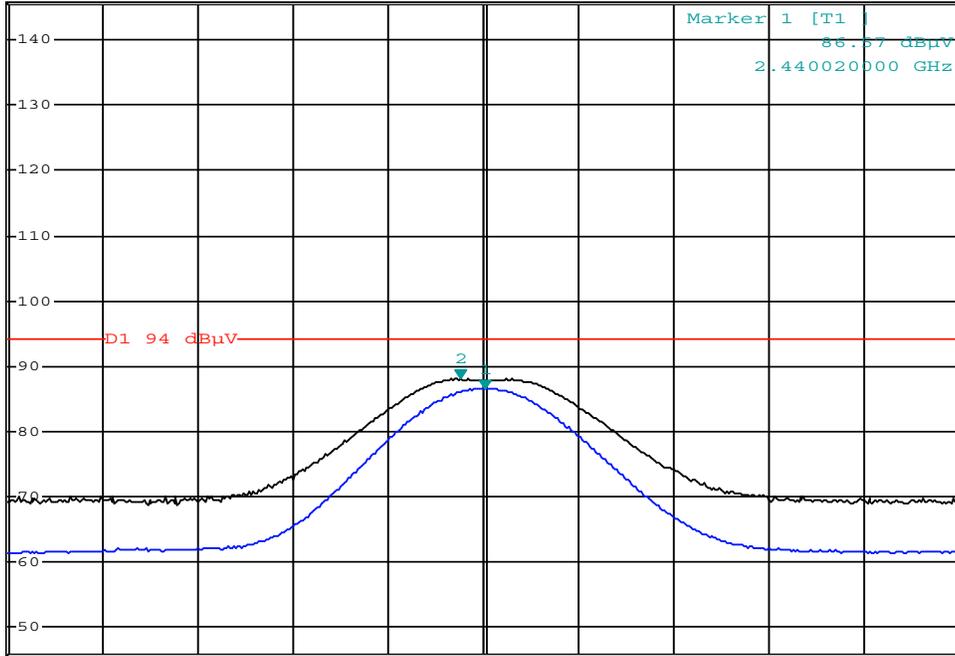
\*RBW 1 MHz      Marker 2 [T2 ]  
 VBW 10 MHz      88.01 dBuV  
 \*SWT 20 ms      2.439760000 GHz

Ref 145.7 dBuV

\*Att 0 dB

1 RM  
 VIEW

2 PK  
 VIEW



Center 2.44 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:34:38

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

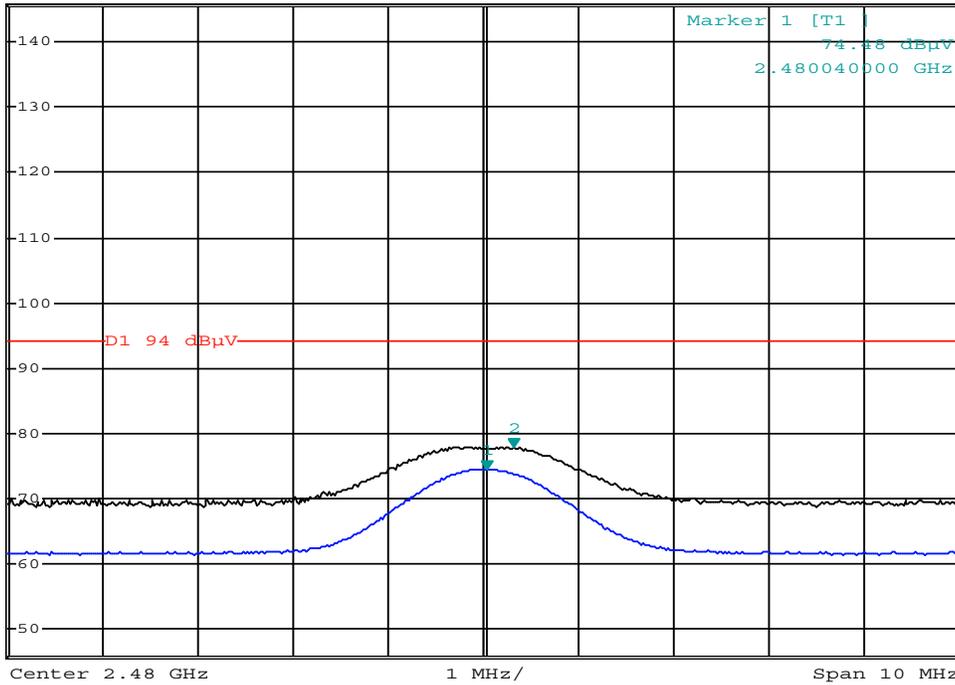
# Field Strength:



Ref 145.7 dB $\mu$ V      \*Att 0 dB      \*RBW 1 MHz      Marker 2 [T2 ]  
 \*RBW 1 MHz      VBW 10 MHz      77.88 dB $\mu$ V  
 \*SWT 20 ms      2.480320000 GHz

1 RM\*  
VIEW

2 PK\*  
VIEW



Date: 31.JAN.2023 16:36:46

Channel: 78

Mode: ANT

Polarization: Horizontal

Channel Frequency: 2480 MHz

Modulation: GFSK

Measured Field Strength (Avg): 74.48 dB $\mu$ V/m

Measured Field Strength (Pk): 77.88 dB $\mu$ V/m

# Field Strength:

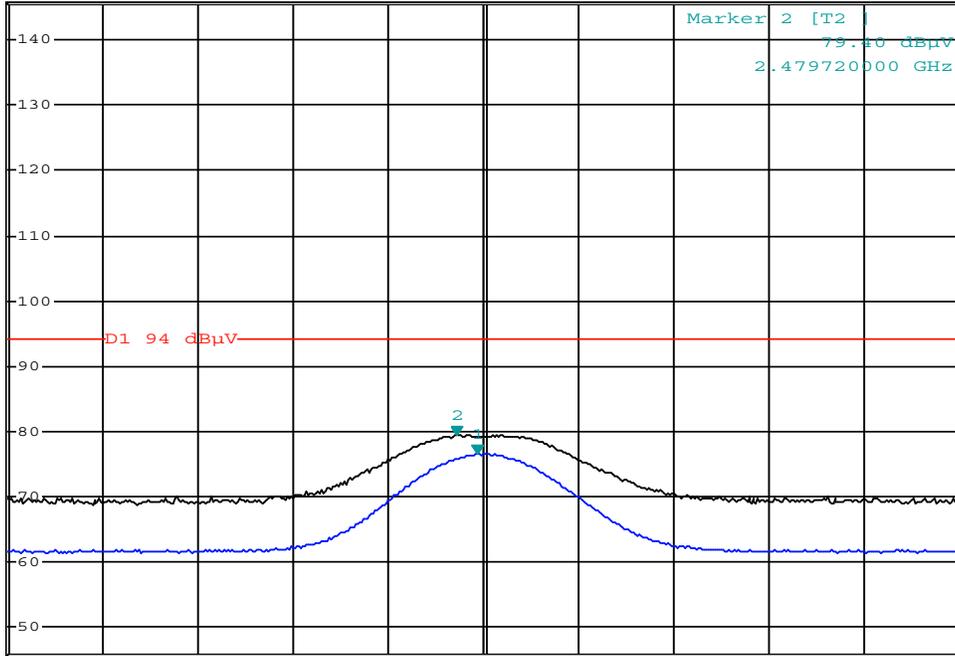


\*RBW 1 MHz      Marker 1 [T1 ]  
 VBW 10 MHz      76.49 dBuV  
 \*Att 0 dB      \*SWT 20 ms      2.479940000 GHz

Ref 145.7 dBuV

1 RM\*  
VIEW

2 PK\*  
VIEW



Center 2.48 GHz      1 MHz/      Span 10 MHz

Date: 31.JAN.2023 16:37:34

Channel:

Channel Frequency:  MHz

Mode:

Modulation:

Polarization:

Measured Field Strength (Avg):  dBuV/m

Measured Field Strength (Pk):  dBuV/m

## Summary of Radiated Tx Emissions

Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)
30-1000MHz	2440.0	Horizontal	31.89	7.53	22.91	0.68	0.00 (3)	31.1 (2)	40.0	8.9
30-1000MHz	2440.0	Horizontal	55.92	6.92	11.12	0.79	0.00 (3)	18.8 (2)	40.0	21.2
30-1000MHz	2440.0	Horizontal	113.97	7.47	16.20	1.04	0.00 (3)	24.7 (2)	43.5	18.8
30-1000MHz	2440.0	Vertical	729.10	8.51	28.30	2.66	0.00 (3)	39.5 (2)	46.0	6.6
30-1000MHz	2440.0	Vertical	909.00	8.39	29.50	2.94	0.00 (3)	40.8 (2)	46.0	5.2
1 - 3GHz	2440.0	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
1 - 3GHz	2440.0	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
3-13GHz	2440.0	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
3-13GHz	2440.0	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
13-18GHz	2440.0	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
13-18GHz	2440.0	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
18-26GHz	2440.0	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
18-26GHz	2440.0	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
<b>Results:</b>									<b>Complies</b>	

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit

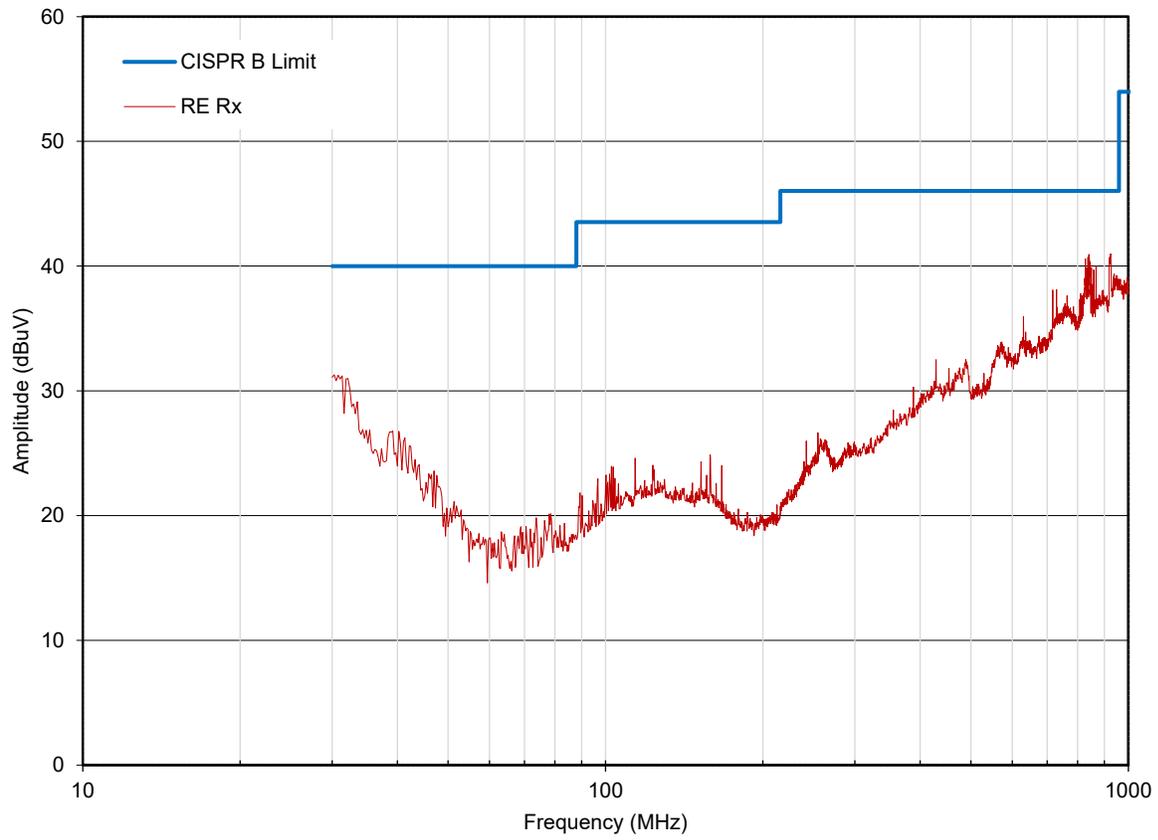
(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{\text{Corr}} = E_{\text{Meas}} + \text{ACF} + L_{\text{C}} - G_{\text{A}}$$

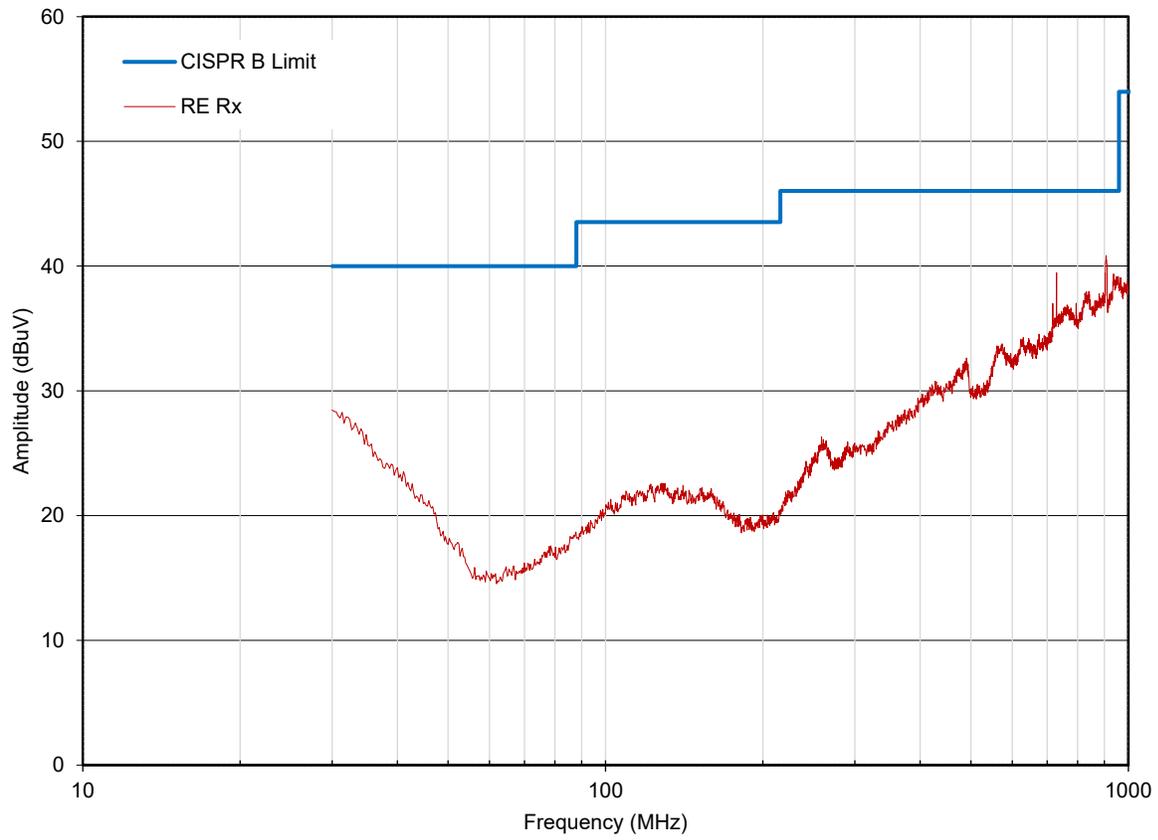
**Radiated Tx Emissions:**

Radiated Tx Emissions (30MHz - 1GHz)  
OATS Horizontal



**Radiated Tx Emissions:**

Radiated Tx Emissions (30MHz - 1GHz)  
OATS Vertical



# Radiated Tx Emissions:

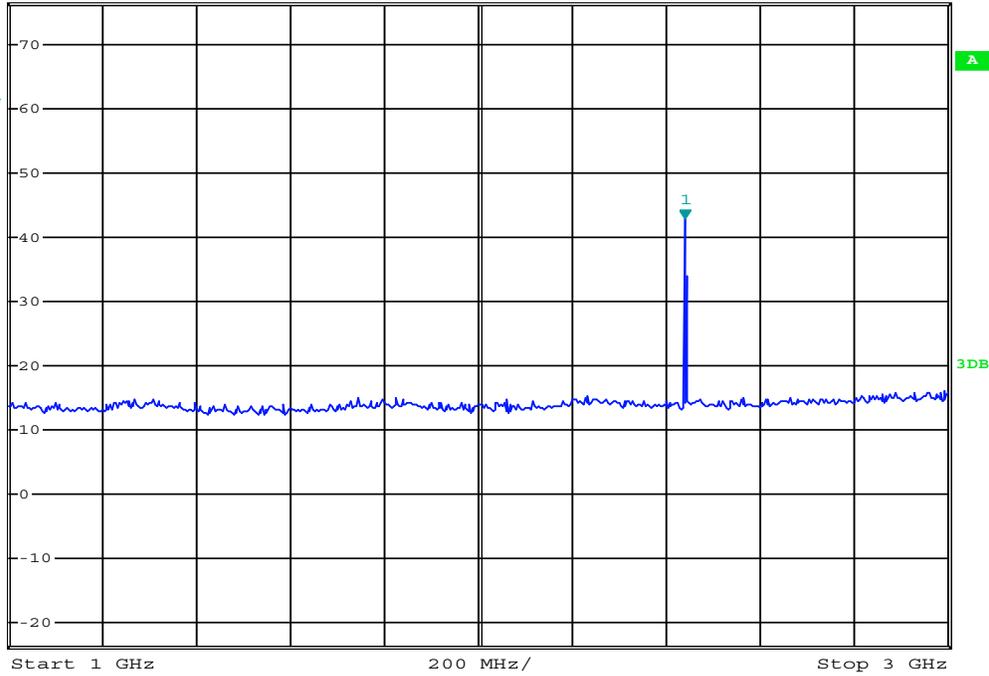


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 10 MHz      42.74 dBμV  
SWT 10 ms      2.440000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:16:57

Channel:

Mode:

Polarization:

Marker 1 = Fundamental

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

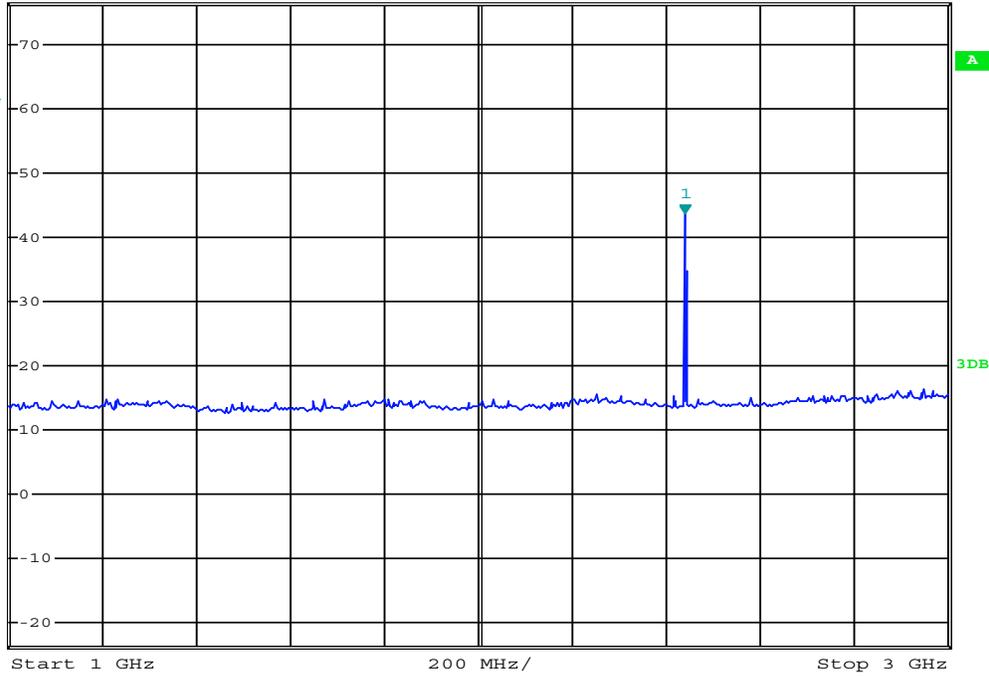


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 10 MHz      43.66 dBμV  
SWT 10 ms      2.440000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:15:04

Channel:

Mode:

Polarization:

Marker 1 = Fundamental

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm







# Radiated Tx Emissions:

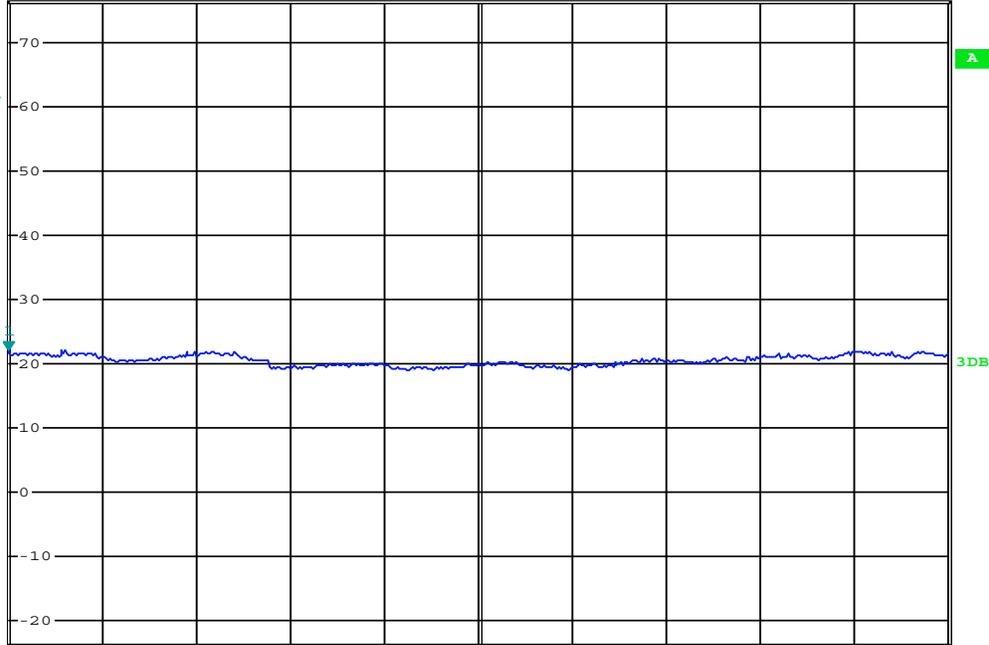


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    22.19 dBμV  
SWT 75 ms    10.000000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Start 10 GHz

360 MHz/

Stop 13.6 GHz

Date: 31.JAN.2023 15:15:40

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

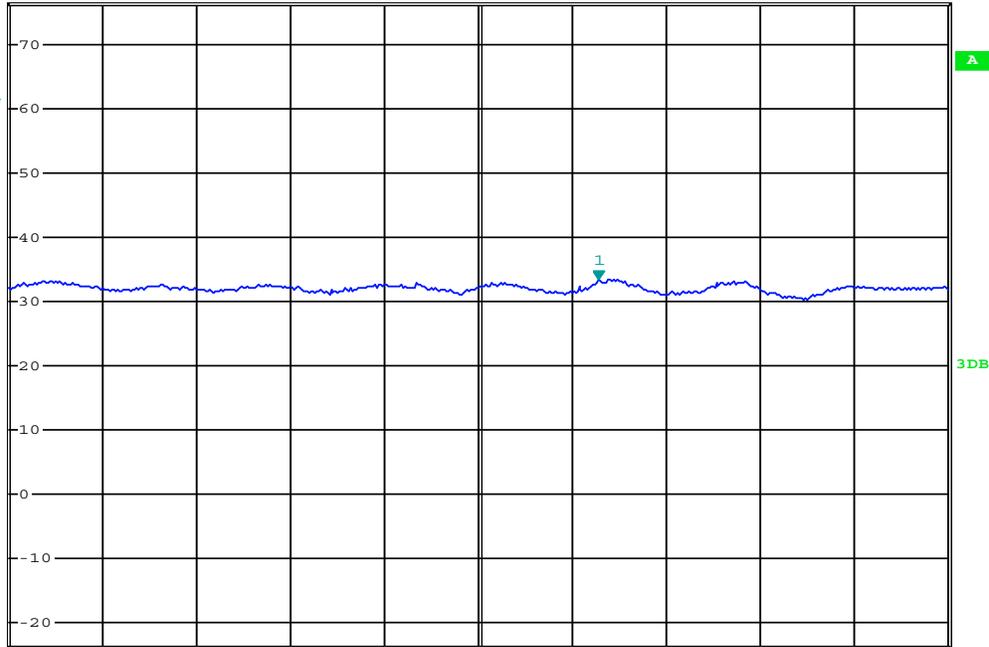


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    33.53 dBμV  
SWT 90 ms    16.363200000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Start 13.6 GHz

440 MHz/

Stop 18 GHz

Date: 31.JAN.2023 15:18:13

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

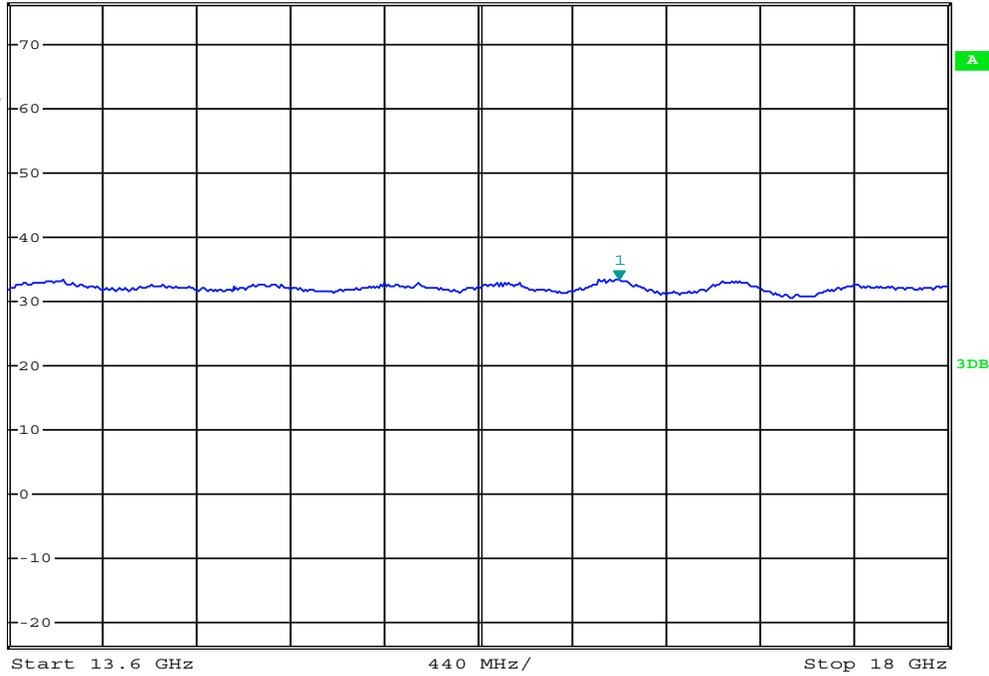


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    33.37 dBμV  
SWT 90 ms    16.460000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:16:04

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

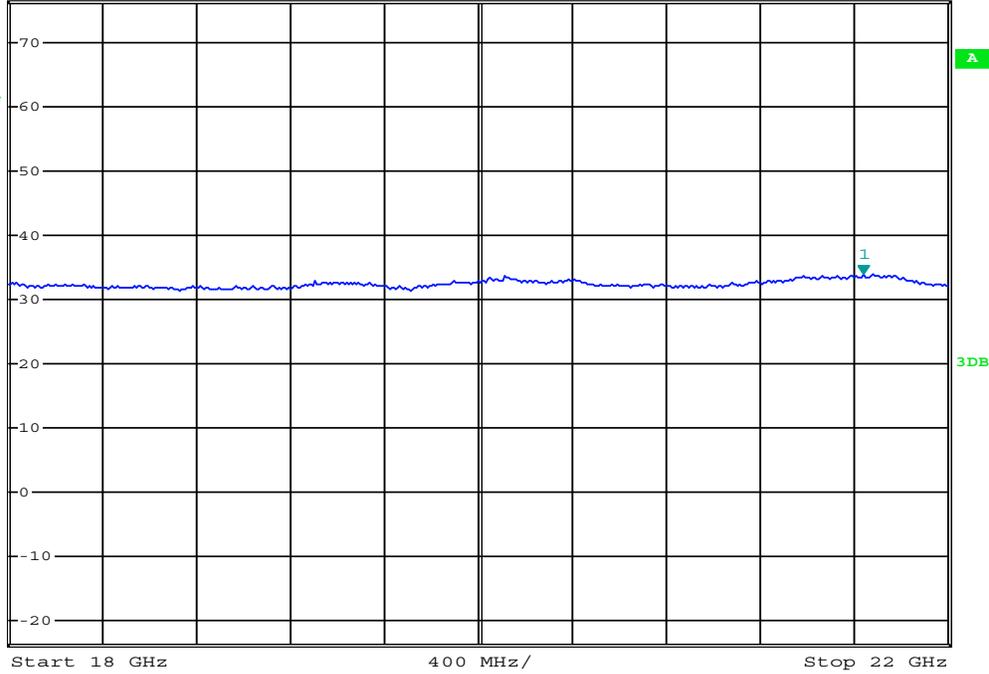


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    33.88 dBμV  
SWT 80 ms    21.640000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:46:36

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm

# Radiated Tx Emissions:

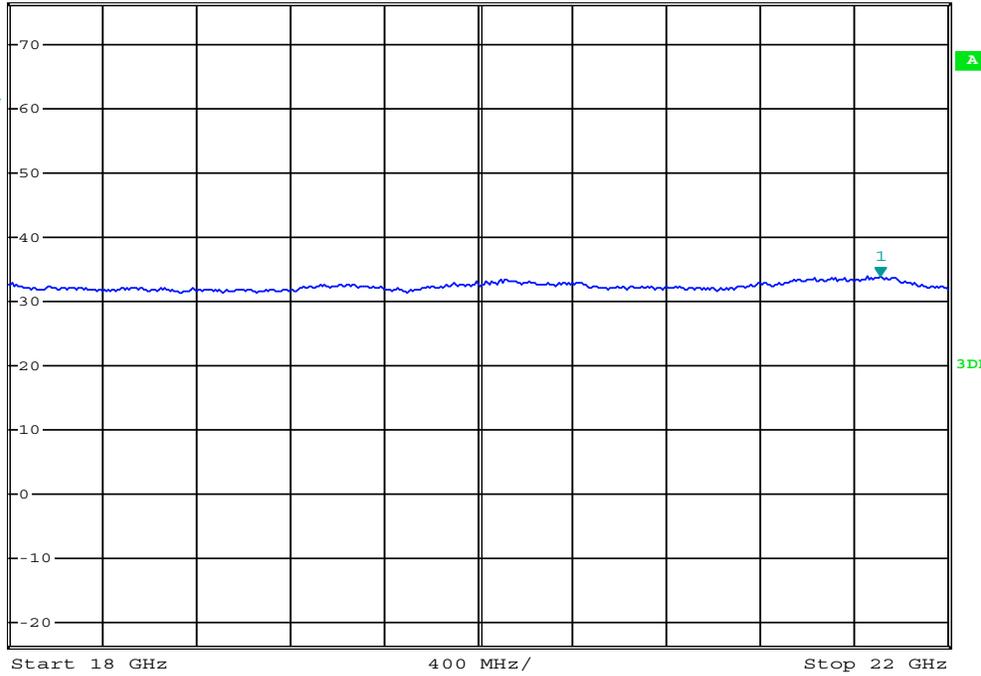


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 10 MHz    33.94 dBμV  
SWT 80 ms    21.712000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:47:16

Channel:

Mode:

Polarization:

Channel Frequency:  MHz

Modulation:

Measured Emission:  dBm





## Summary of Radiated Rx Emissions

Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E <sub>Meas</sub> ] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L <sub>c</sub> ] (dB)	Amplifier Gain [G <sub>A</sub> ] (dB)	Corrected Emission [E <sub>Corr</sub> ] (dBuV/m)	Limit (dBuV)	Margin (dB)
30-1000MHz	-	Horizontal	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	46.0	n/a
30-1000MHz	-	Vertical	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	43.5	n/a
1 - 3GHz	-	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
1 - 3GHz	-	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	54.0	n/a
3-13GHz	-	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
3-13GHz	-	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	54.0	n/a
13-18GHz	-	Horizontal	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
13-18GHz	-	Vertical	ND	ND (1)	38.75	16.54	0.00 (3)	ND	54.0	n/a
18-26GHz	-	Horizontal	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
18-26GHz	-	Vertical	ND	ND (1)	43.50	21.86	26.00	ND	54.0	n/a
<b>Results:</b>									<b>Complies</b>	

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit

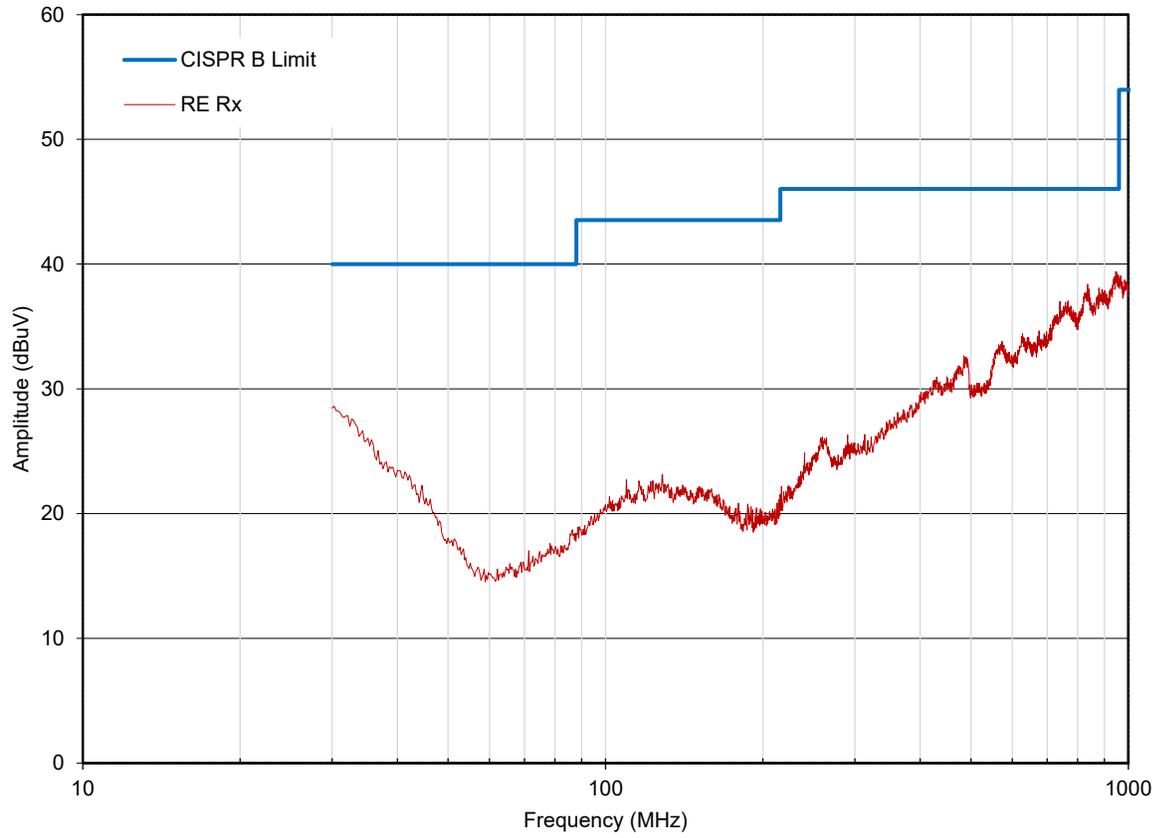
(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor

(3) External Amplifier not used

$$E_{\text{Corr}} = E_{\text{Meas}} + \text{ACF} + L_{\text{C}} - G_{\text{A}}$$

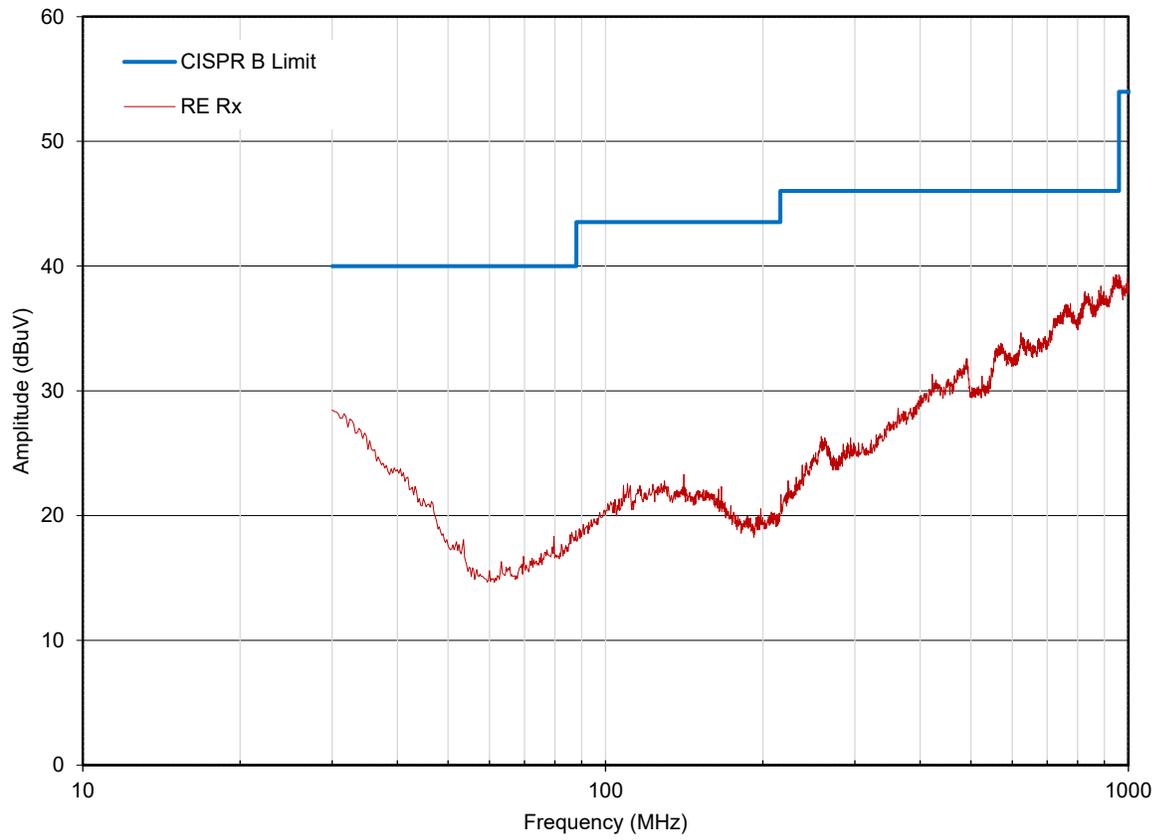
**Radiated Rx Emissions:**

Radiated Rx Emissions (30MHz - 1GHz)  
OATS Horizontal



**Radiated Rx Emissions:**

Radiated Rx Emissions (30MHz - 1GHz)  
OATS Vertical













# Radiated Rx Emissions:

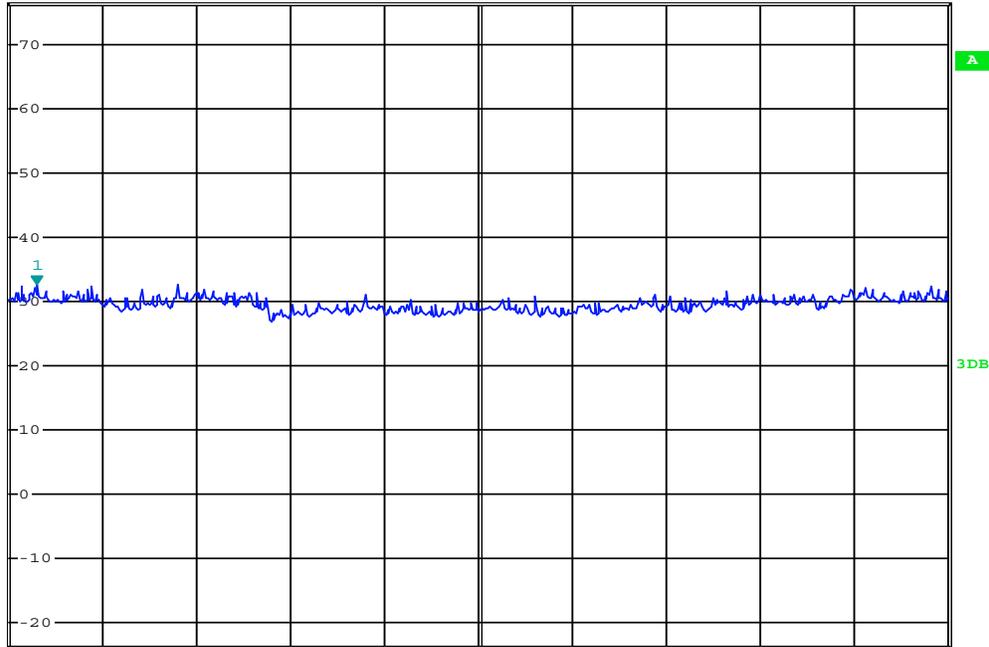


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    32.72 dBμV  
SWT 75 ms    10.108000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 PK  
VIEW



Start 10 GHz

360 MHz/

Stop 13.6 GHz

Date: 31.JAN.2023 16:37:33

Polarization:

Measured Emission:  dBm

# Radiated Rx Emissions:

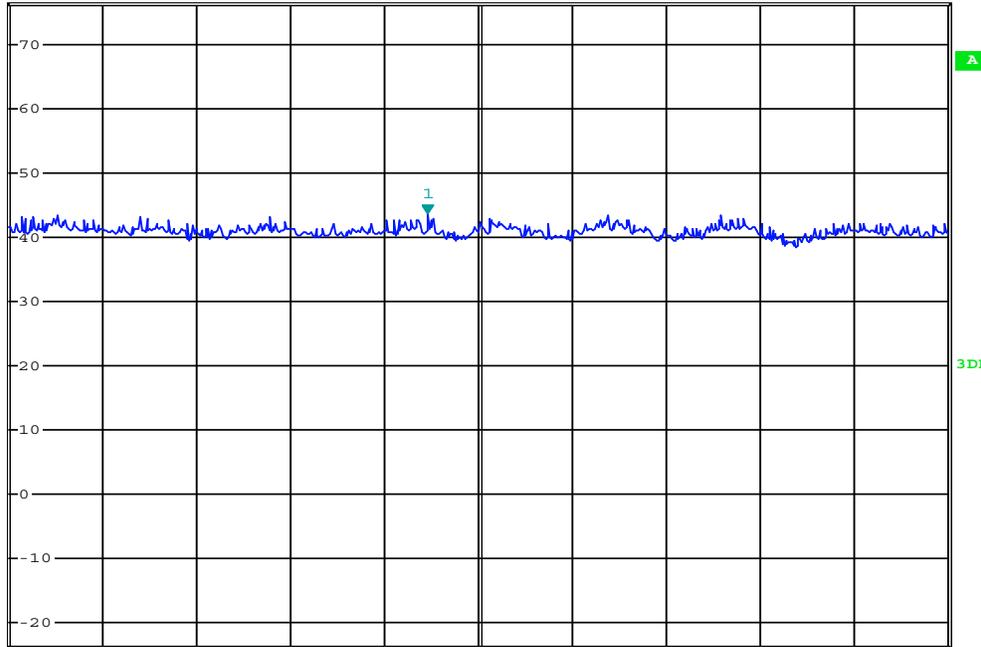


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    43.53 dBμV  
SWT 90 ms    15.562400000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 16:39:00

Polarization:

Measured Emission:  dBm

# Radiated Rx Emissions:

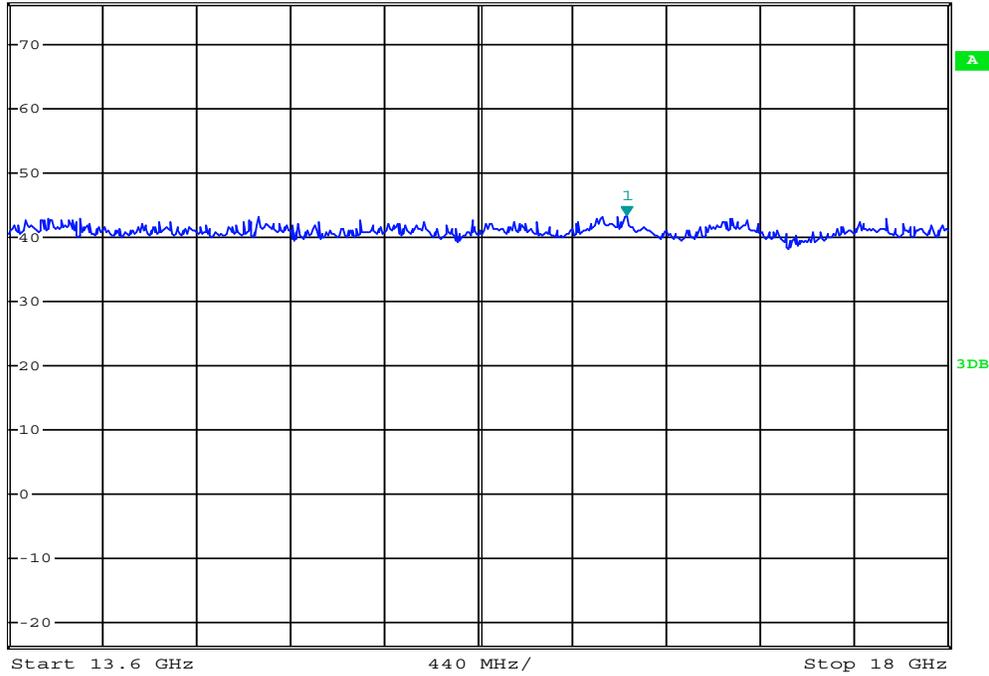


\*RBW 1 MHz    Marker 1 [T1 ]  
VBW 3 MHz    43.39 dBμV  
SWT 90 ms    16.495200000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 PK  
VIEW



Date: 31.JAN.2023 16:46:45

Polarization:

Measured Emission:  dBm



# Radiated Rx Emissions:

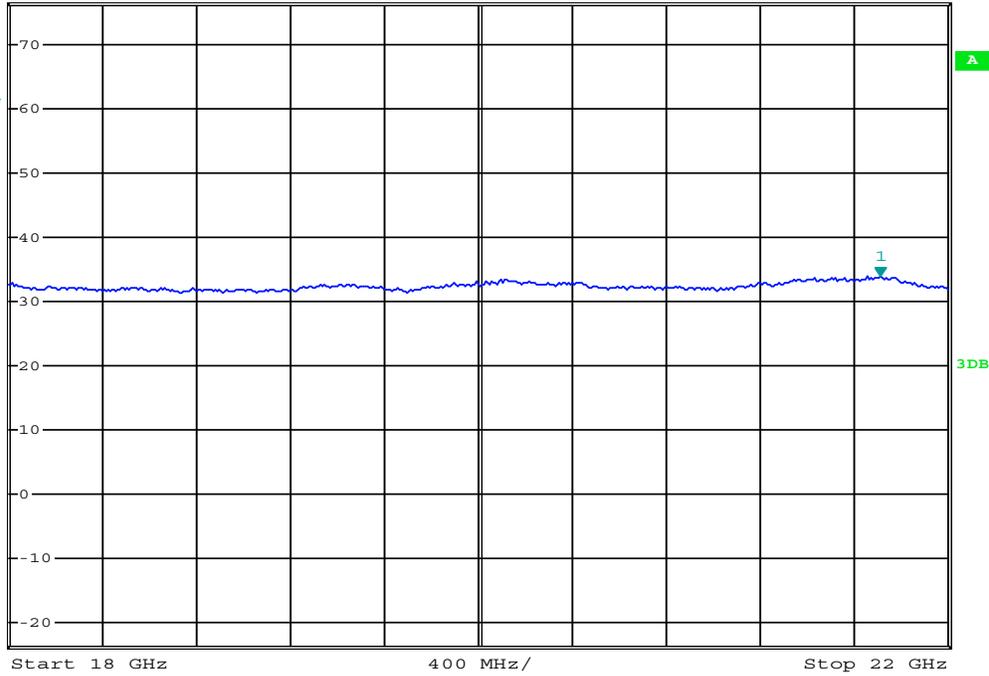


\*RBW 1 MHz      Marker 1 [T1 ]  
VBW 10 MHz      33.94 dBμV  
SWT 80 ms      21.712000000 GHz

Ref 76.3 dBμV

\*Att 0 dB

1 RM  
VIEW



Date: 31.JAN.2023 15:47:16

Polarization:

Measured Emission:  dBm



