



Test Report Serial Number:

45461806 R1.0

Test Report Date:

1 March 2023

Project Number:

1618

EMC Test Report - New Certification

Applicant:



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

FCC ID:

IPH-A04595

Product Model Number / HVIN

A04595

IC Registration Number

-

Product Marketing Name / PMN

A04595

In Accordance With:

CFR Title 47, Part 15 Subpart C (§15.249), (§15.225), Part 15 Subpart
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.

© 2023 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	34
12.0 RADIATED RX SPURIOUS EMISSIONS.....	37
13.0 FREQUENCY STABILITY (NFC).....	39
14.0 POWER LINE CONDUCTED EMISSIONS	41
APPENDIX A – TEST SETUP DRAWINGS AND EQUIPMENT	46
APPENDIX B – EQUIPMENT LIST AND CALIBRATION.....	52
APPENDIX C – MEASUREMENT INSTRUMENT UNCERTAINTY.....	53
END OF REPORT.....	53
APPENDIX H – FIELD STRENGTH MEASUREMENT PLOTS	54
APPENDIX I– RADIATED TX EMISSIONS MEASUREMENT PLOTS.....	54
APPENDIX J– RADIATED RX MEASUREMENT PLOTS.....	54

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 10.1 – Out of Band Emissions, NFC.....	32
Plot 14.1 – Power Line Conducted Emissions, Line 1	42
Plot 14.2 – Power Line Conducted Emissions, Line 2	43

Table of Tables

Table 7.1 - Summary of Occupied Bandwidth Measurements (DXX).....	16
Table 8.1 - Summary of Field Strength Measurements (BT BLE)	18
Table 8.3 - Summary of Field Strength Measurements (NFC)	21
Table 9.1 - Summary of 20dB BW Measurements	27
Table 10.1 – Summary of Field Strength Measurements (NFC)	33
Table 11.1 – Summary of Radiated Tx Emissions.....	35
Table 11.2 – Summary of Radiated Emissions, Restricted Band (NFC)	36
Table 12.1 – Summary of Radiated Rx Emissions	38
Table 13.1 – Summary of Frequency Stability Measurements – FCC.....	40
Table 14.1 – Summary of Power Line Conducted Emissions – L1.....	44
Table 14.1 – Summary of Power Line Conducted Emissions – L2.....	45
Table A.1 – Setup - Conducted Measurements Equipment List.....	46
Table A.2 – Setup - Radiated Emissions Equipment List	47
Table A.3 – Setup – Frequency Stability Equipment List.....	51

Table of Figures

Figure A.1 – Test Setup Conducted Measurements.....	46
Figure A.2 – Test Setup Radiated Emissions Measurements Below 30MHz.....	48
Figure A.3 – Test Setup Radiated Emissions Measurements 30 – 1000MHz.....	48
Figure A.4 – Test Setup Radiated Emissions Measurements 30 – 1000MHz Signal Substitution.....	49
Figure A.5 – Test Setup Radiated Emissions Measurements 1 – 18GHz.....	49
Figure A.6 – Test Setup Radiated Emissions Measurements Above 18 GHz.....	50
Figure A.7 – Frequency Stability	51

1.0 DOCUMENT CONTROL

Revision History				
Samples Tested By:		Art Voss, P.Eng.		Date(s) of Evaluation: 15 January - 13 February, 2023
Report Prepared By:		Art Voss, P.Eng.		Report Reviewed By: Ben Hewson
Report Revision	Description of Revision	Revised Section	Revised By	Revision Date
0.1	Draft	n/a	Art Voss	14 February 2023
1.0	Initial Release	n/a	Art Voss	1 March 2023

2.0 CLIENT AND DUT 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-A04595
Device Model(s) / HVIN:	A04595
Device Marketing Name / PMN:	A04595
Test Sample Serial No.:	3430501782 - Conducted, 3430501693 - OTA
Device Type:	Extremity Worn Digital Transceiver
Equipment Class:	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)
Transmit Frequency Range:	WiFi (DTS): 2412-2462MHz
	BT/BLE/ANT: 2402-2480MHz
	NFC: 13.56MHz
Manuf. Max. Rated Output Power:	WiFi - Digital Transmission System (DTS): 16.96dBm
	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
Antenna Type and Gain:	-4.72dBi Max
Modulation:	WiFi: DSSS, OFDM, CCK, MCS0-7
	BT BR: GFSK
	BT EDR: Pi/4-DQPSK, 8DPSK
	BLE: GMSK
	ANT: GFSK
	NFC: ASK
DUT Power Source:	3VDC Rechargeable Li-Ion
DUT Dimensions [LxWxH]	H x W x D: 42mm dia x 4.5mm
Deviation(s) from standard/procedure:	None
Modification of DUT:	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: A04595 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

TEST SUMMARY						
Section	Description of Test	Procedure Reference	Applicable Rule Part(s) FCC	Applicable Rule Part(s) ISSED	Test Date	Result
7.0	Occupied Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§2.1049	RSS-Gen (6.7)	15, 21 Jan 2023	Pass
8.0	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
9.0	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
10.0	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
11.0	Restricted Bands	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(d)(e) §15.209	RSS-Gen (8.10)	31 Jan 2023	Pass
12.0	Radiated Rx Emissions	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(d)(e) §15.209	RSS-Gen (8.10)	31 Jan 2023	Pass
13.0	Frequency Stability	ANSI C63.10-2013 KDB 558074 D01v05	§15.225	RSS-G210 B.6	26 Jan 2023	Pass
14.0	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



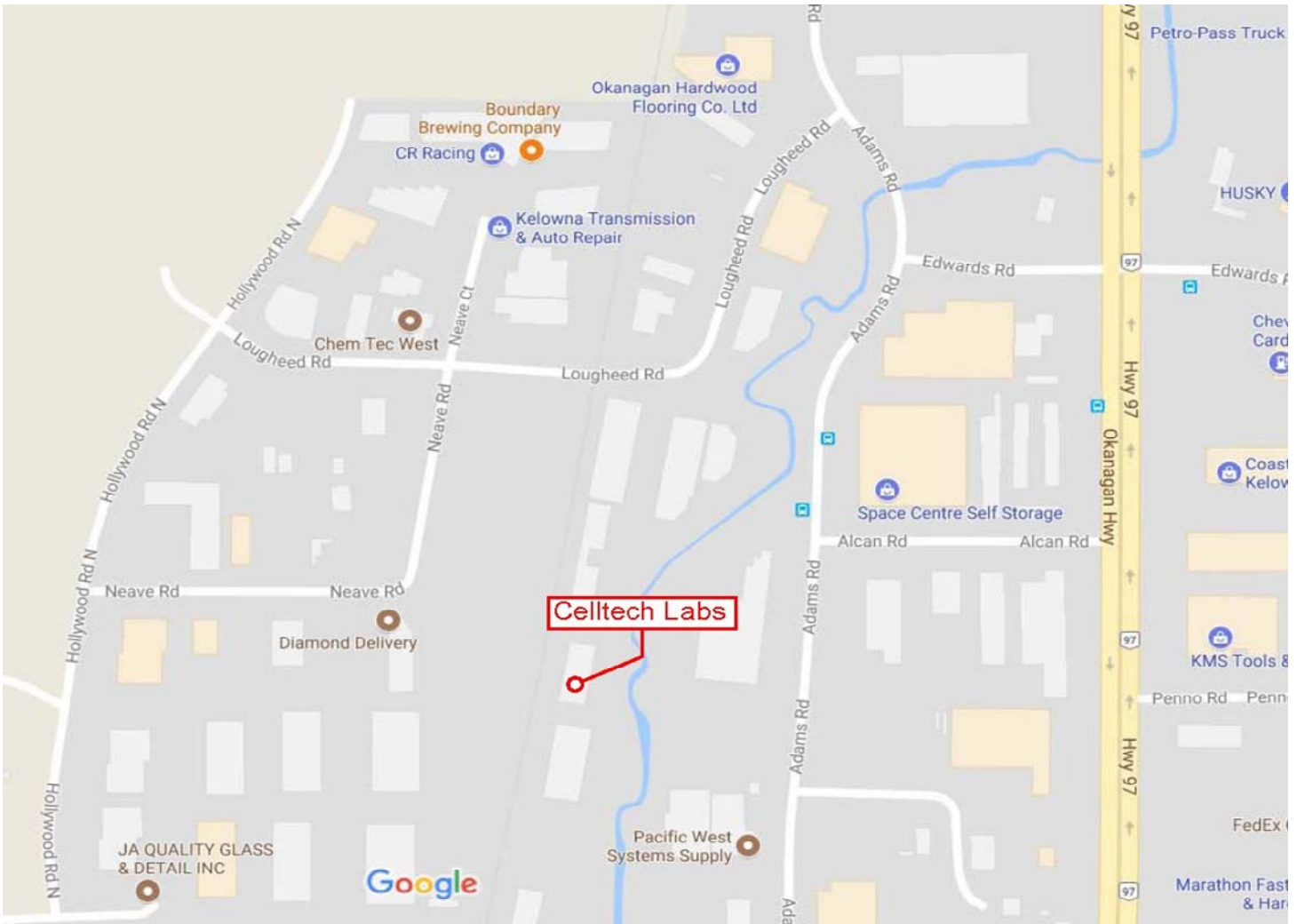
5.0 NORMATIVE REFERENCES

Normative References	
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

Normative	FCC 47 CFR §2.1046, RSS-Gen (6.1.2), RSS-247 (5.4)(d),
Reference	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:

- 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.
- 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.
- 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 $[10 \log (\text{OBW}/\text{RBW})]$ below the reference level. Specific guidance is given in 4.1.5.2.
- Step a) through step c) might require iteration to adjust within the specified range.
- 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.
- Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

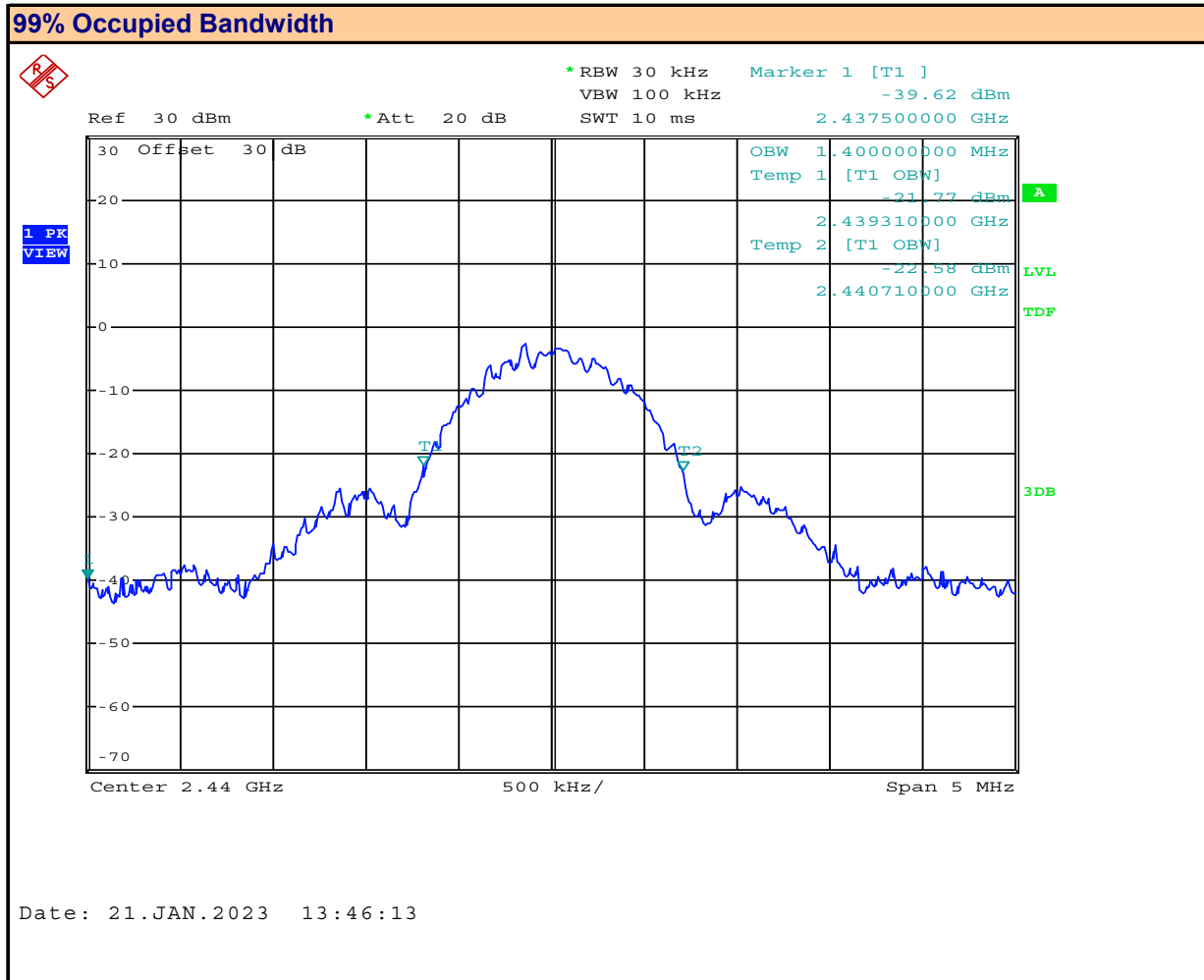
Test Setup

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.

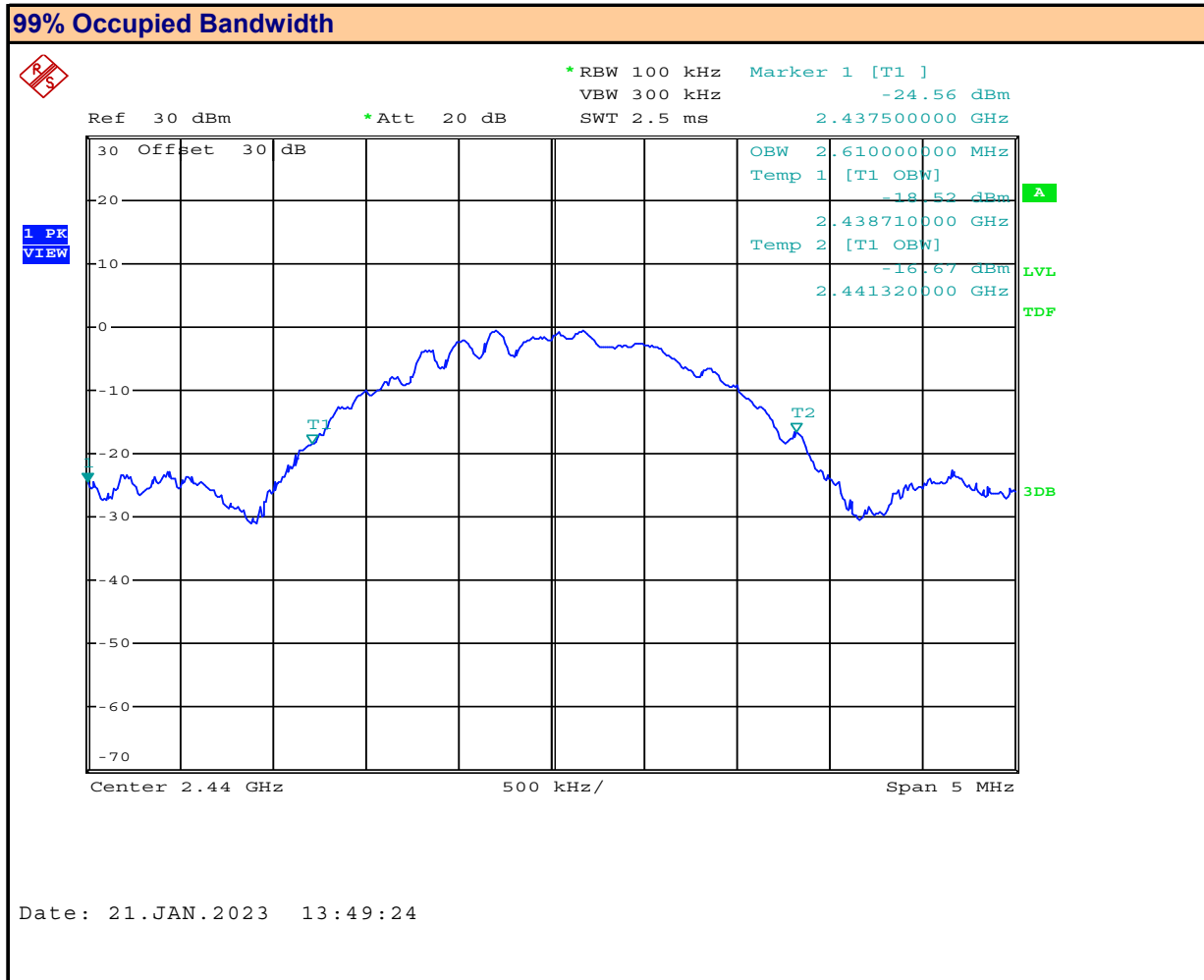
Plot 7.1 – Occupied Bandwidth, BLE1



Channel: **17**
Mode: **BT LE1**

Channel Frequency: **2440** MHz
Modulation: **GMSK**
Measured Occupied Bandwidth: **1.4** MHz

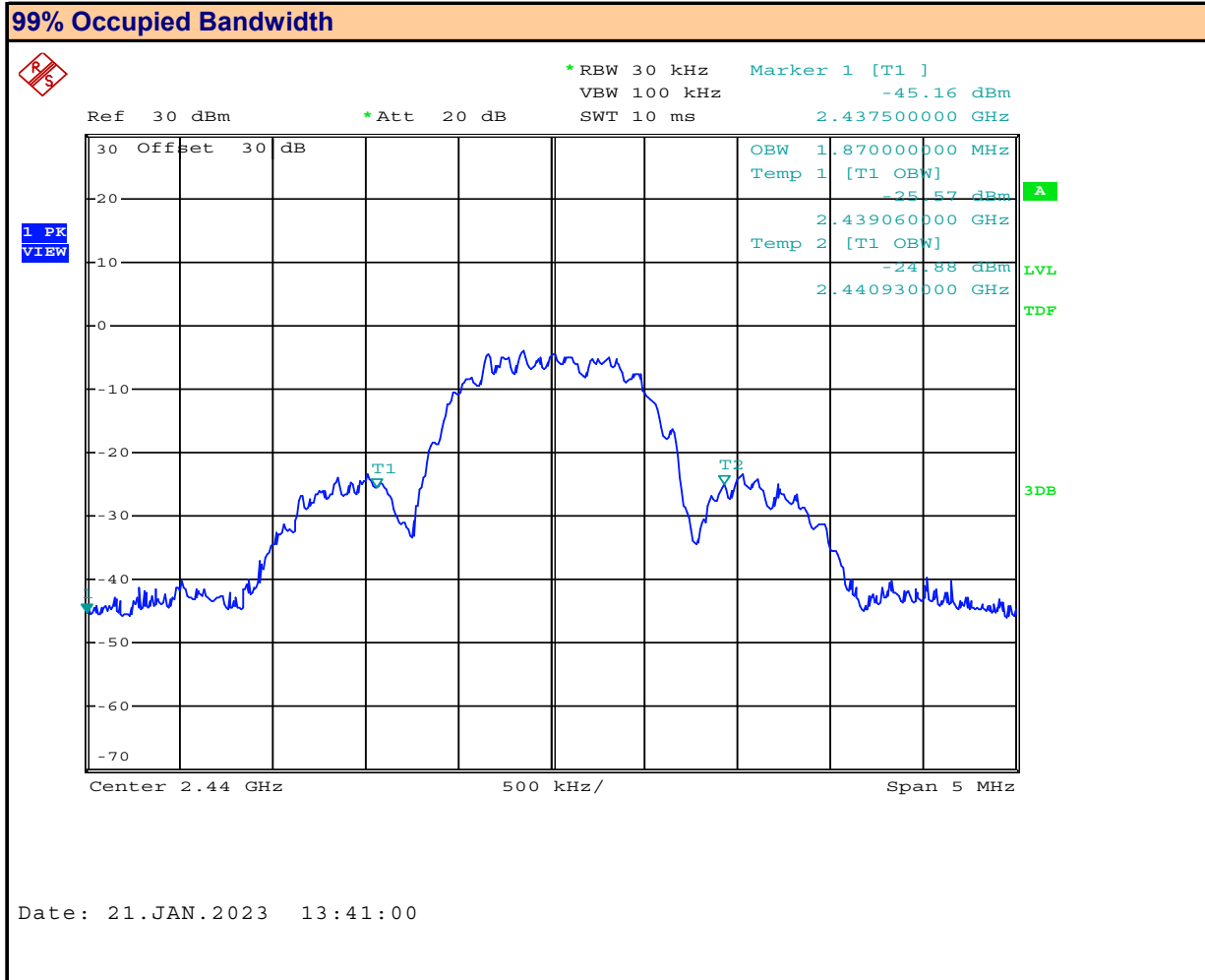
Plot 7.2 – Occupied Bandwidth, BLE2



Channel: **17**
Mode: **BT LE2**

Channel Frequency: **2440** MHz
Modulation: **GMSK**
Measured Occupied Bandwidth: **2.61** MHz

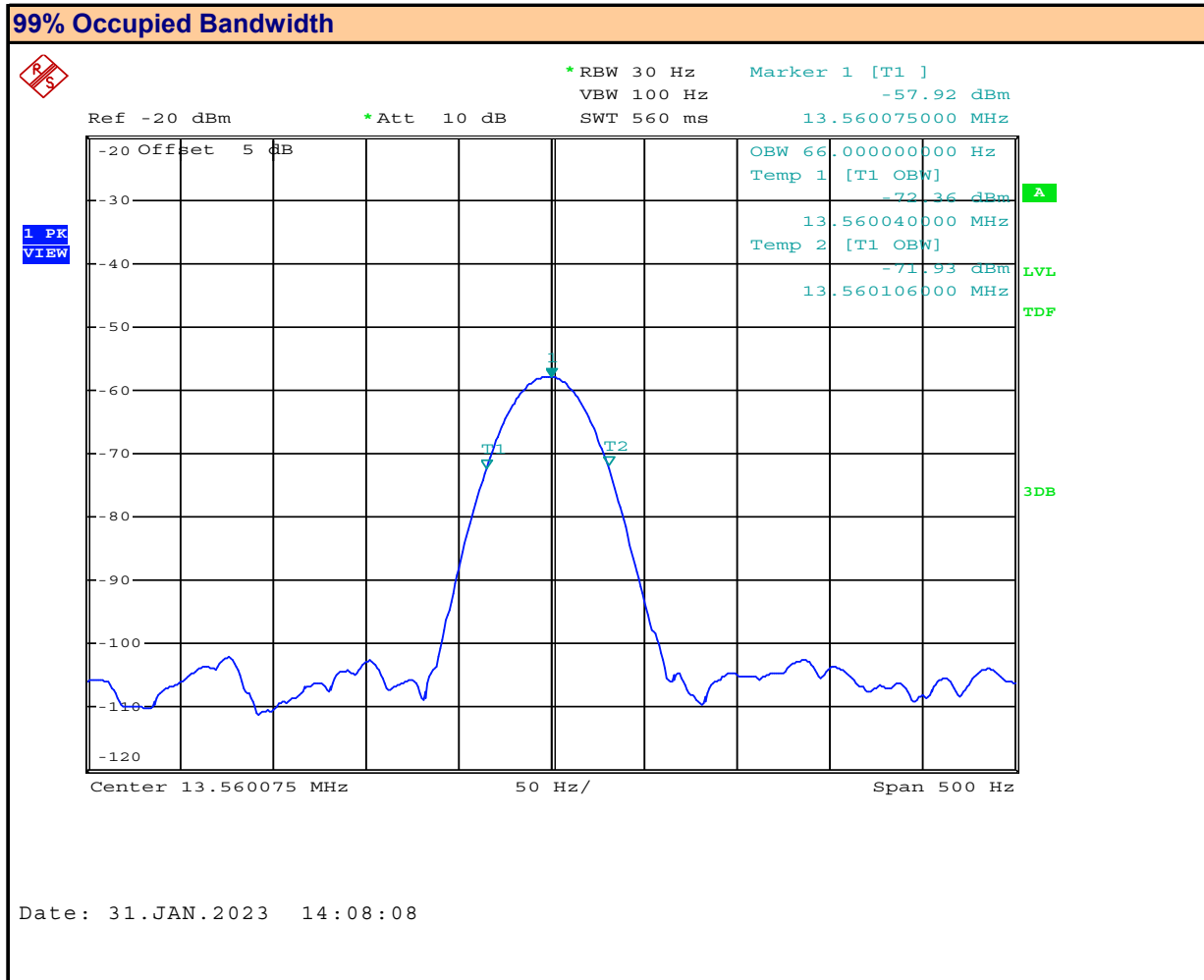
Plot 7.3 – Occupied Bandwidth, ANT



Channel: **38**
Mode: **ANT**

Channel Frequency: **2440** MHz
Modulation: **GFSK**
Measured Occupied Bandwidth: **1.87** 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)

99% Occupied Bandwidth Results:					
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured Occupied Bandwidth (MHz)	Emission Designator
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
Result:					Complies

8.0 FIELD STRENGTH

Test Procedure

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

Limits

§15.249(a)	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz. (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: 2400-2483.5MHz, Fundamental Field Strength: 50mV/m, Harmonic: 500uV/m
RSS-210 B.10(a)	Bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz and 24-24.25 GHz (a) The field strength of fundamental and harmonic emissions measured at 3 m shall not exceed the limits in table B2. 2400-2483.5MHz, Fundamental Field Strength: 50mV/m, Harmonic: 500uV/m

General Procedure

C63.10 (6.5.4)	6.5.4 Final radiated emission tests 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. 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.
----------------	---

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.

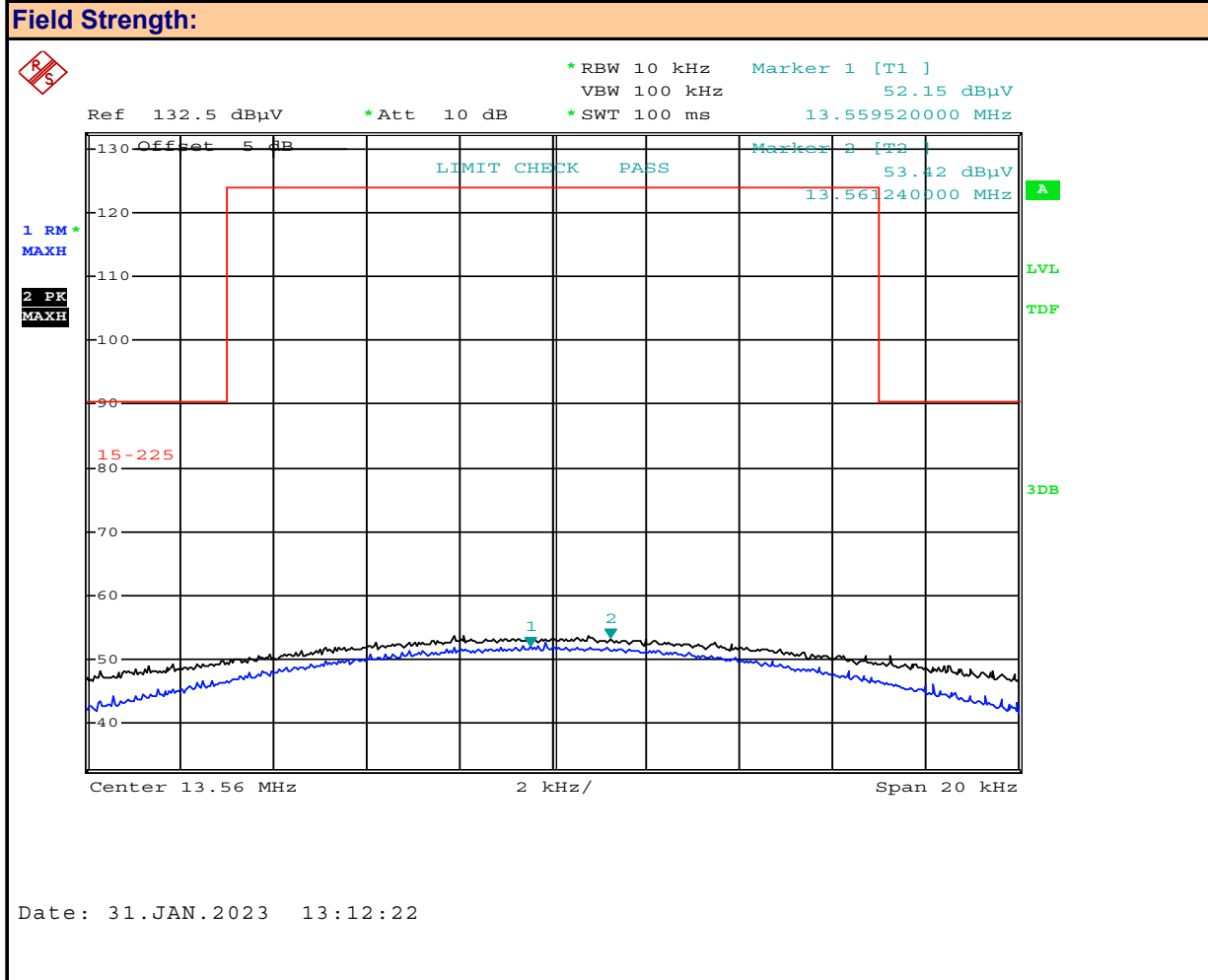
Table 8.1 - Summary of Field Strength Measurements (BT BLE)

See Appendix H for Measurement Plots

Conducted Power 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	84.76	87.06	94.0	9.24	114	26.94	
				Vertical	87.41	89.17		6.59		24.83	
17	2440.00			Horizontal	85.33	87.37		8.67		26.63	
				Vertical	89.46	91.07		4.54		22.93	
39	2480.00			Horizontal	80.13	83.19		13.87		30.81	
				Vertical	83.12	85.79		10.88		28.21	
0	2404.00	BT LE2	GMSK	Horizontal	84.09	86.97		9.91		27.03	
				Vertical	83.12	92.13		10.88		21.87	
17	2440.00			Horizontal	81.97	85.51		12.03		28.49	
				Vertical	83.12	86.44		10.88		27.56	
36	2478.00			Horizontal	77.26	82.10		16.74		31.90	
				Vertical	79.75	84.14		14.25		29.86	
0	2402.00	ANT	GFSK	Horizontal	82.28	84.77		11.72		29.23	
				Vertical	84.70	86.88		9.30		27.12	
38	2440.00			Horizontal	81.34	84.35		12.66		29.65	
				Vertical	85.12	87.32		8.88		26.68	
78	2480.00			Horizontal	75.21	80.14		18.79		33.86	
				Vertical	81.59	84.48		12.41		29.52	
Result:									Complies		

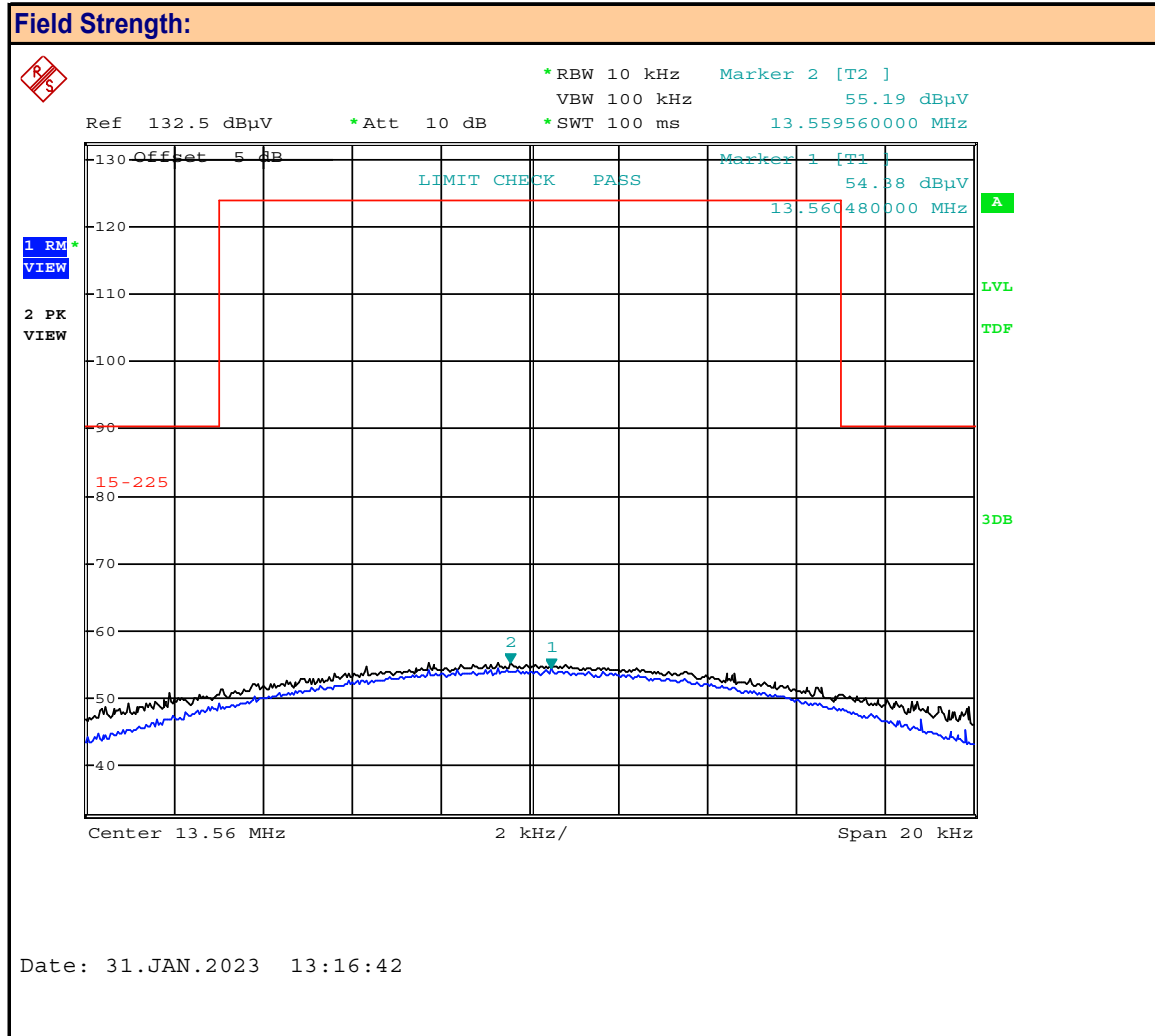
Conducted Margin = $P_{Lim} - P_{Meas}$

Plot 8.1 – Field Strength, NFC



Channel:	-	Channel Frequency:	13.56 MHz
Mode:	NFC	Modulation:	ASK
Polarization:	Front	Measured Field Strength (Avg):	52.15 dBuV/m
		Measured Field Strength (Pk):	53.42 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 _{Meas}] (dBuV @ 3m)	Cable Loss [L _c] (dBm)	Receive Antenna [ACF] (dB)	Corrected Field Strength [FS _{Corr}] (dBuV/m @3m)	Limit @30m [Lim _{30m}] (dBuV/m)	Limit* @3m [Lim _{3m}] (dBuV/m)	Margin
13.56	NFC	ASK	RMS	Front	52.15	0.5	10.65	63.30	84.00	124.0	60.7
				Side	54.38			65.53			58.5
			Peak	Front	54.38			65.53	104.00	144.0	78.5
				Side	55.19			66.34			77.7
				Result:							

* 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 _{Meas}] (dBuV @ 3m)	Cable Loss [L _c] (dBm)	Receive Antenna [ACF ^H] (dBuA/m)	Corrected Field Strength [H _{Corr}] (dBuA/m @3m)	Limit @30m [Lim _{30m}] (dBuV/m)	Limit** @3m [Lim _{3m}] (dBuA/m)	Margin
13.56	NFC	ASK	RMS	Front	52.15	0.5	-40.85	11.80	84.00	72.5	60.7
				Side	54.38			14.03			58.5
			Peak	Front	54.38			14.03	104.00	92.5	78.5
				Side	55.19			14.84			77.7
				Result:							

** 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

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

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

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

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

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

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

Limits

§15.215(c)	Additional provisions to the general radiated emission limitations. (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.
------------	--

General Procedure

C63.10 (6.3.10)	6.10.3 Unlicensed wireless device operational configuration Set the EUT to operate at 100% duty cycle or equivalent “normal mode of operation.”⁵⁴ Testing shall be performed at the lowest frequency channel and highest frequency channel within the allowed operating band.⁵⁵ 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.
-----------------	---

⁵⁴ 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.

⁵⁵ 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).

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. 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.

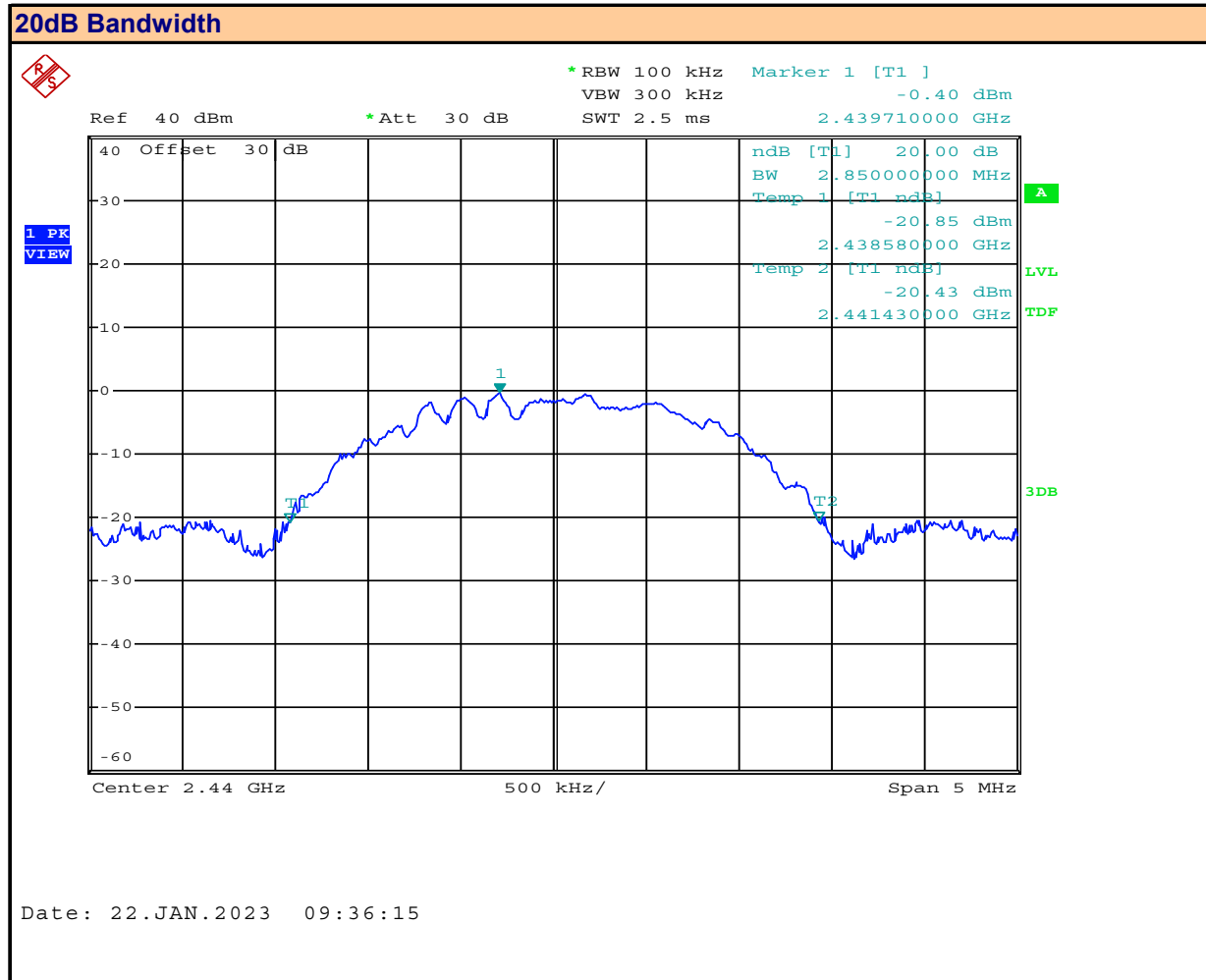
Plot 9.1 – 20dB Bandwidth, BLE1



Channel: **17**
Mode: **BT LE1**

Channel Frequency: **2440** MHz
Modulation: **GMSK**
Measured 20dB Bandwidth: **1.476** MHz

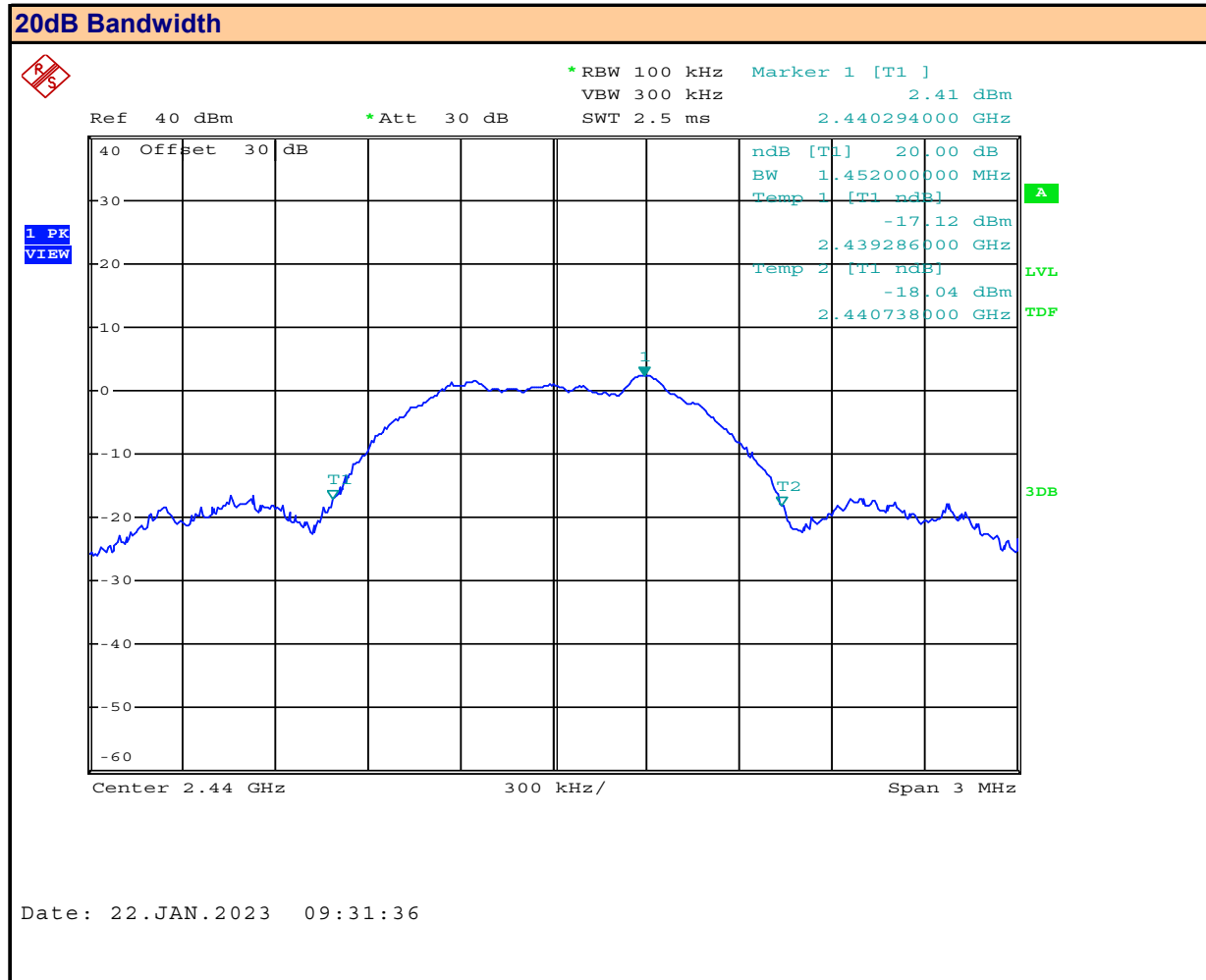
Plot 9.2 – 20dB Bandwidth, BLE2



Channel: **17**
Mode: **BT LE2**

Channel Frequency: **2440** MHz
Modulation: **GMSK**
Measured 20dB Bandwidth: **2.85** MHz

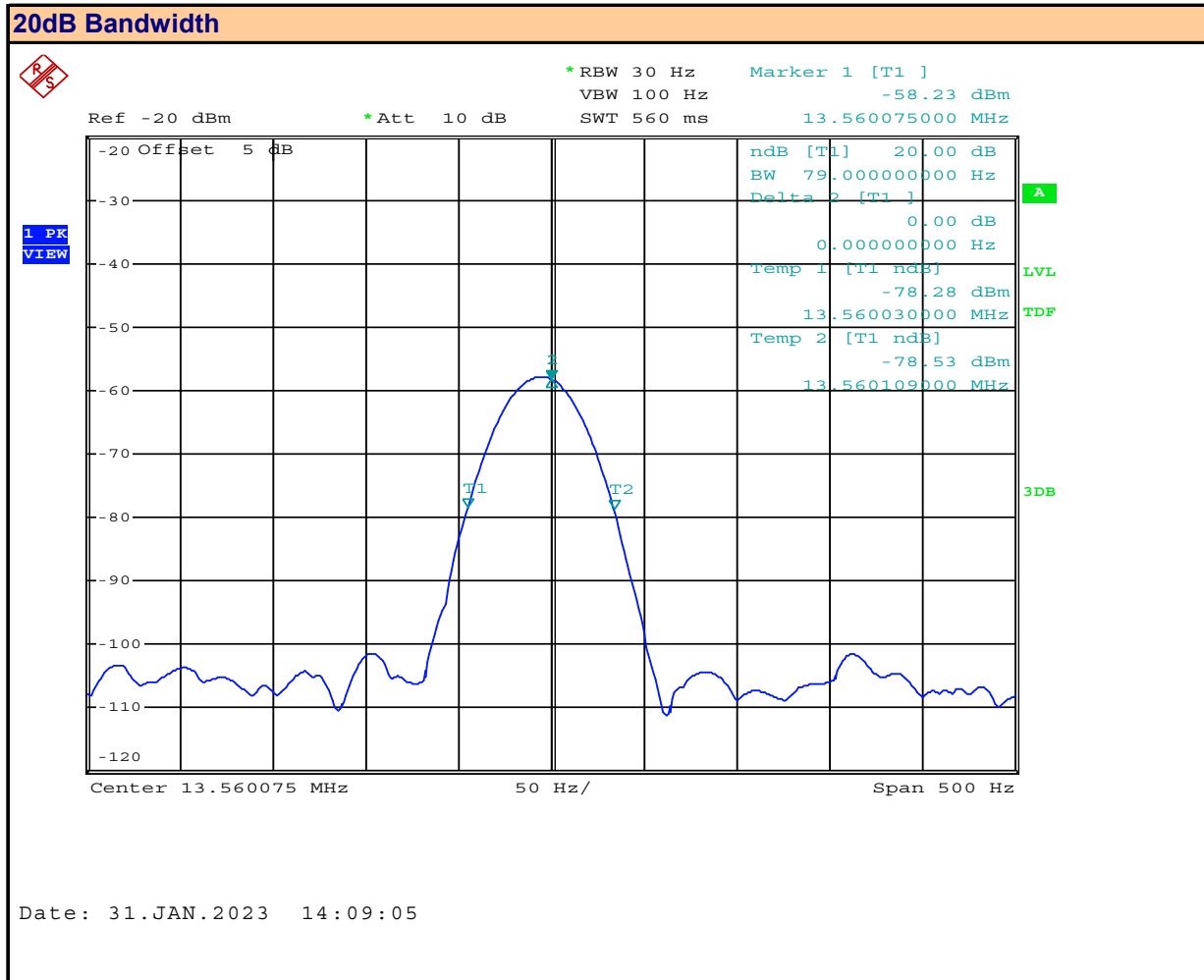
Plot 9.3 – 20dB Bandwidth, ANT



Channel: **38**
Mode: **ANT**

Channel Frequency: **2440** MHz
Modulation: **GFSK**
Measured 20dB Bandwidth: **1.452** 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

20dB Bandwidth Results:				
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured 20dB Bandwidth (MHz)
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
Result:				Complies

10.0 OUT-OF-BAND EMISSIONS- NFC

Test Procedure

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

Limits

§15.225	Operation within the band 13.110-14.010 MHz. (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. (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. (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. (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.
RSS-210 B.10(6)	Band 13.110-14.010 MHz (a) the field strength of any emission shall not exceed the following limits: (i) 15.848 mV/m (84 dBµV/m) at 30 m, within the band 13.553-13.567 MHz (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 (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 (iv) RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz

General Procedure

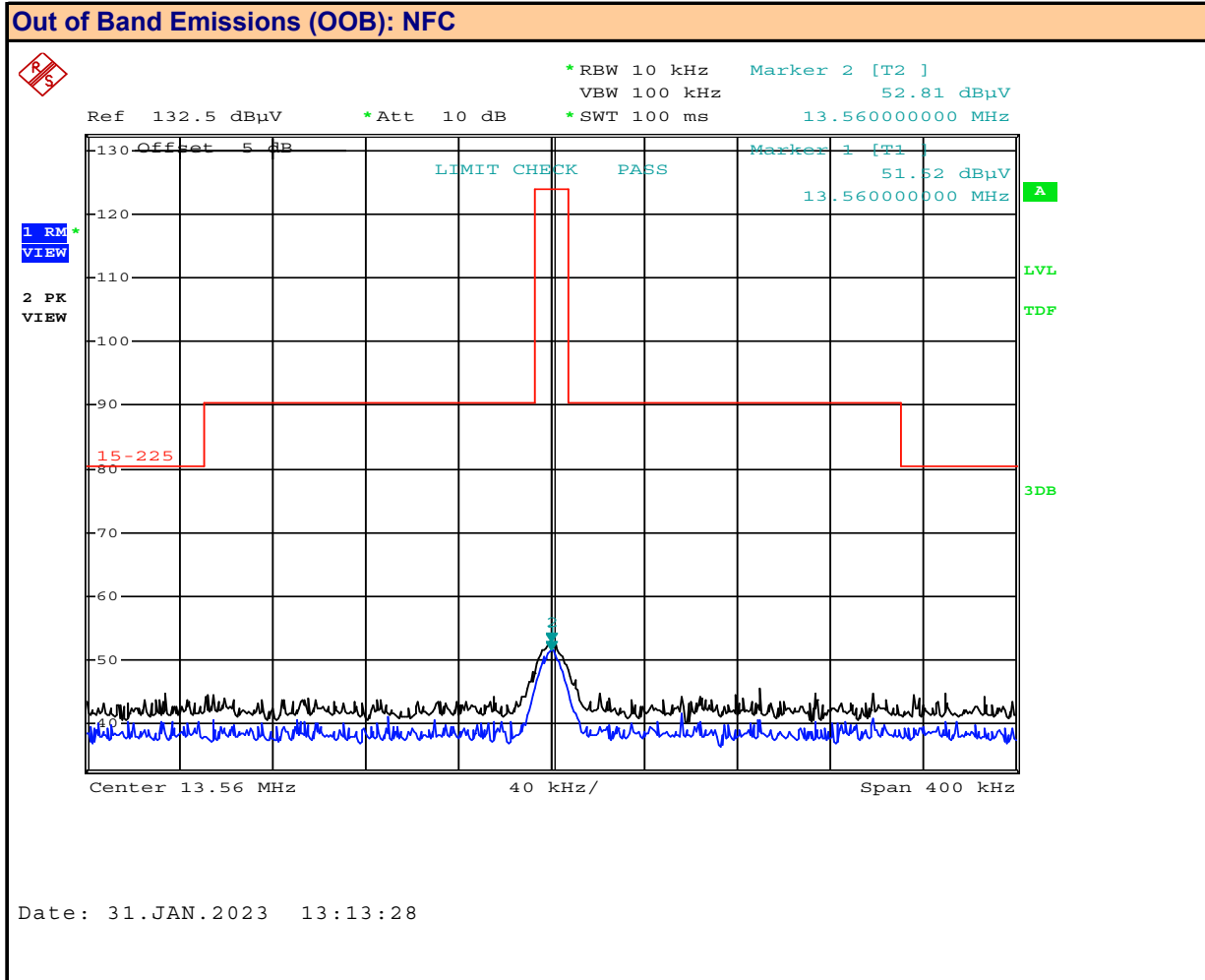
C63.10 (6.5.4)	6.5.4 Final radiated emission tests Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have 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. 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.
----------------	---

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.

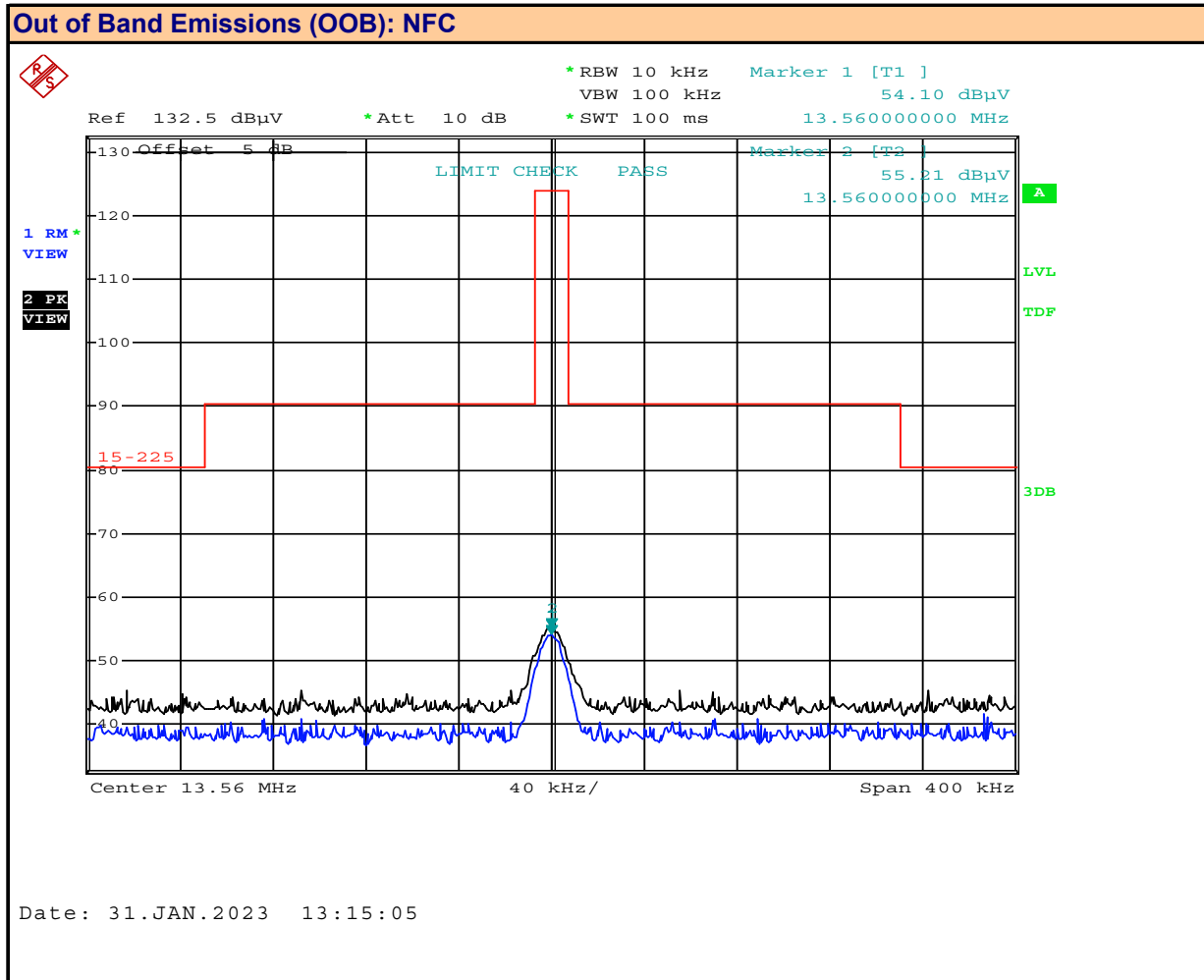
Plot 10.1 – Out of Band Emissions, NFC



Channel: -
Mode: NFC
Polarization: Front

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

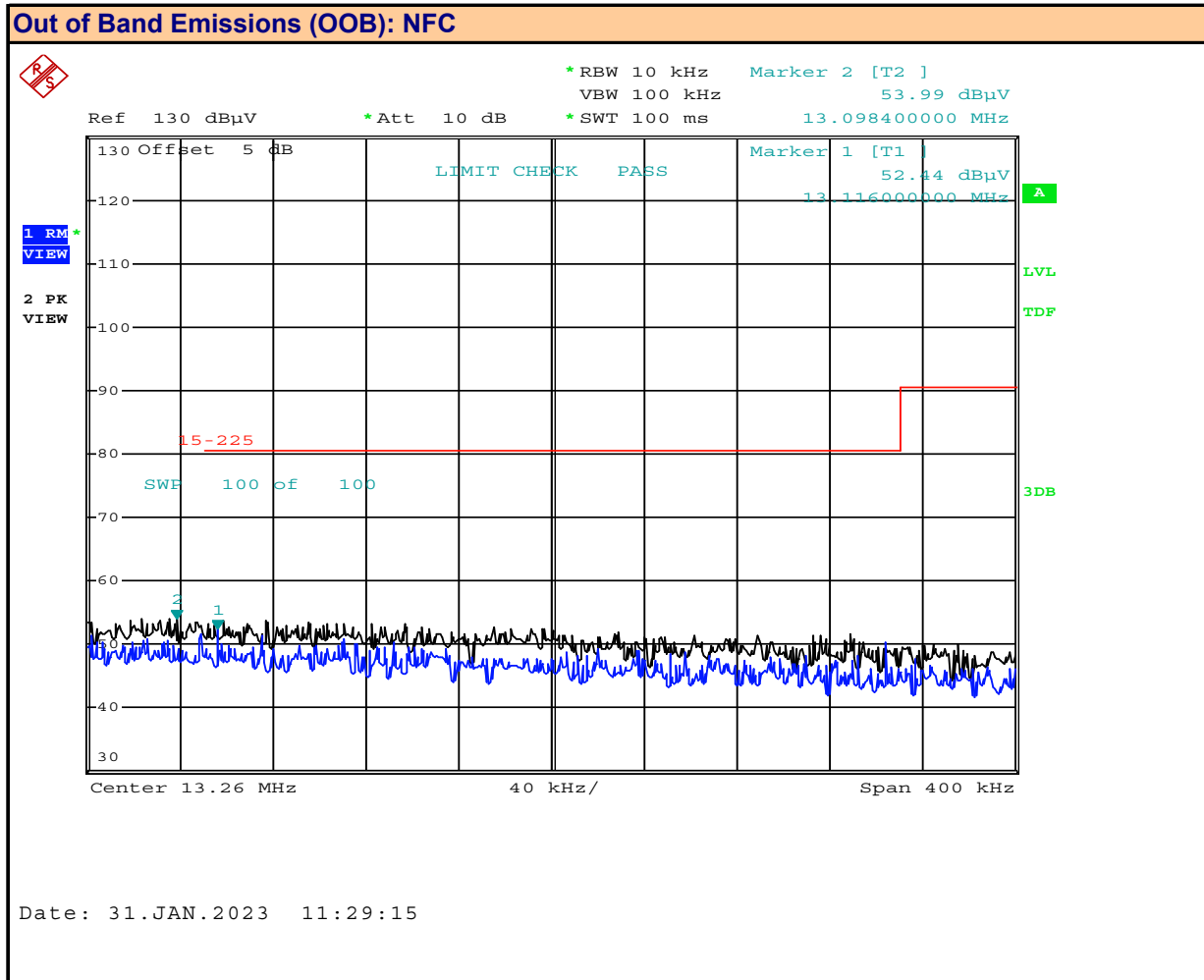
Plot 10.2 – Out of Band Emissions, NFC



Channel: -
Mode: NFC
Polarization: Front

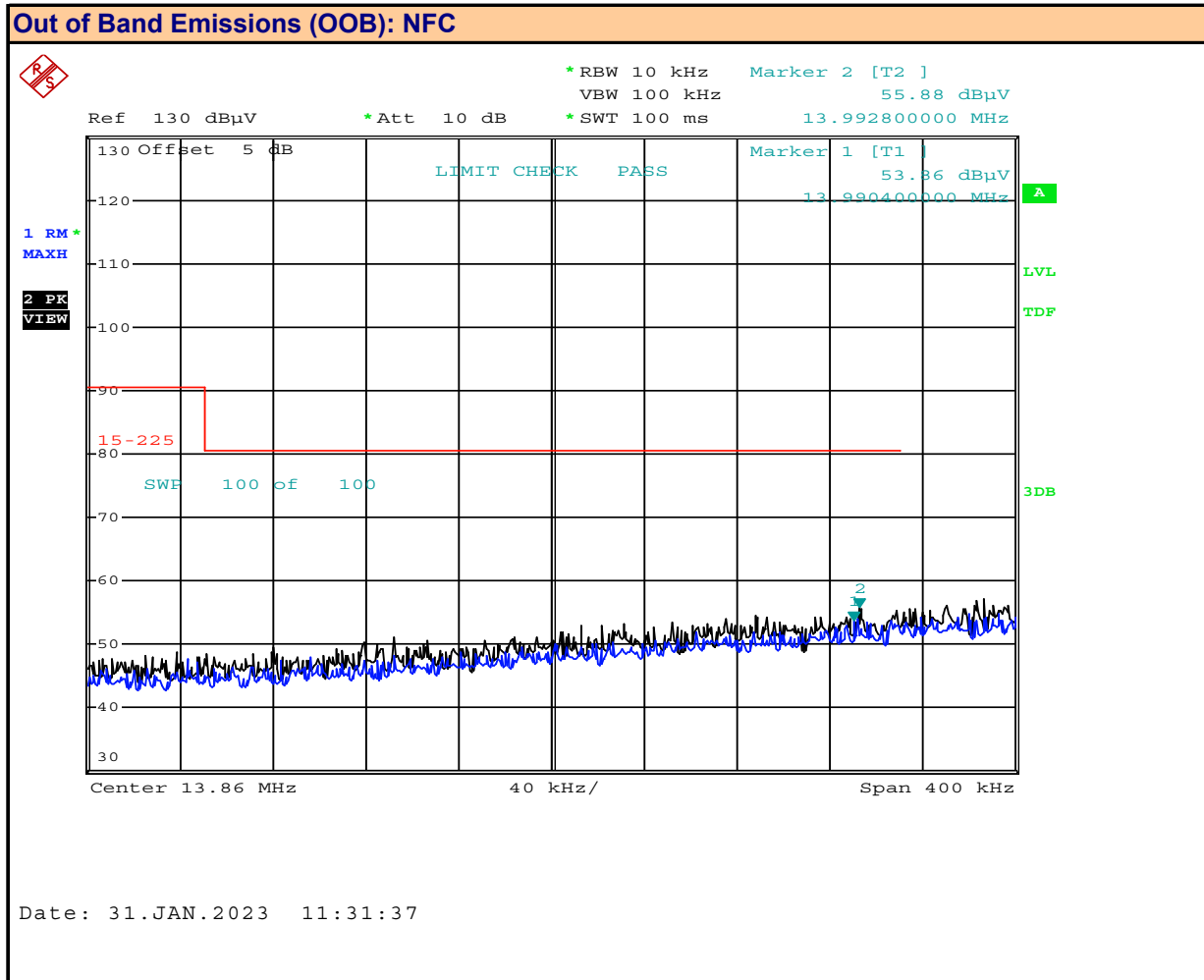
Channel Frequency: 13.56 MHz
Modulation: ASK
Measured OOB Emissions (Avg): - dBuV/m
Measured OOB Emissions (Pk): - dBuV/m

Plot 10.3 – Out of Band Emissions, NFC



Channel: Channel Frequency: MHz
Mode: Modulation:
Polarization: Measured OOB Emissions (Avg): dBuV/m
Measured OOB Emissions (Pk): dBuV/m

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

Table 10.1 – Summary of Field Strength Measurements (NFC)

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

* 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

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

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)	§15.209 Radiated emission limits; general requirements. (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: <table> <tr> <th>Frequency (MHz)</th><th>Field Strength (microvolts/meter)</th></tr> <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> </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

Summary of Radiated Tx Emissions										
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E _{Meas}] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L _C] (dB)	Amplifier Gain [G _A] (dB)	Corrected Emission [E _{Corr}] (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
Results:									Complies	

(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

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

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

See Appendix I for Measurement Plots

Summary of Radiated Tx Emissions (Restricted Band)											
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E _{Meas}] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L _c] (dB)	Amplifier Gain [G _A] (dB)	Corrected Emission [E _{Corr}] (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	
Results:									Complies		

(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

$$E_{\text{Corr}} = E_{\text{Meas}} + \text{ACF} + L_c - G_A$$

12.0 RADIATED RX SPURIOUS EMISSIONS

Test Procedure

Normative Reference	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)	6.5.4 Final radiated emission tests 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. 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.
----------------	---

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 12.1 – Summary of Radiated Rx Emissions

See Appendix J for Measurement Plots

Summary of Radiated Rx Emissions											
Measured Frequency Range (MHz)	Channel Frequency	Antenna Polarization	Emission Frequency	Measured Emission [E _{Meas}] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L _C] (dB)	Amplifier Gain [G _A] (dB)	Corrected Emission [E _{Corr}] (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	
Results:									Complies		

(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

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

13.0 FREQUENCY STABILITY (NFC)

Test Conditions

Normative Reference FCC 47 CFR §2.1055, §15.225, RSS-Gen, RSS-210

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 ± 100 ppm

Measurement Procedure

47 CFR §2.1055 Frequency Stability

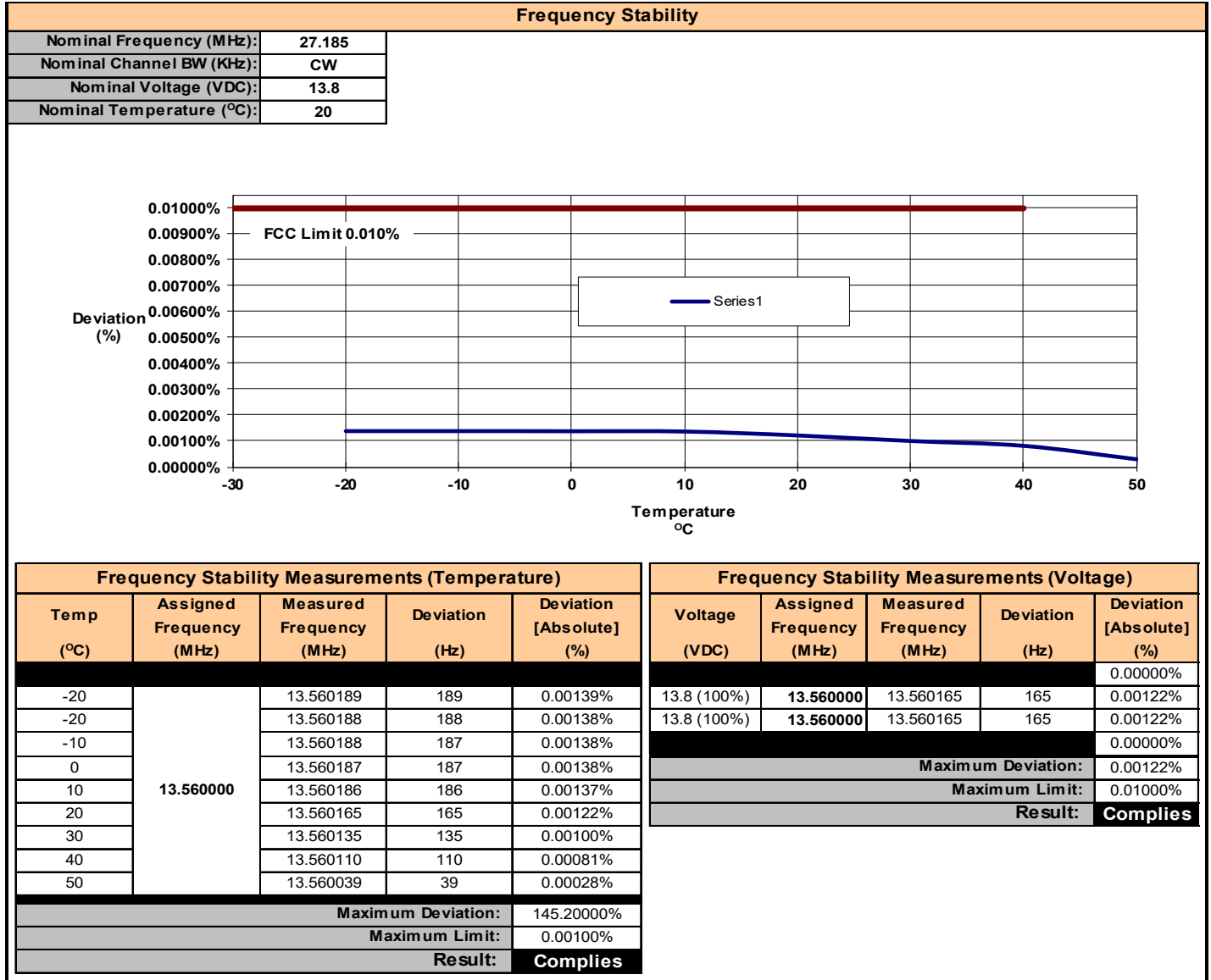
- (a) The frequency stability shall be measured with variation of ambient temperature as follows:
- (1) From -30° to $+50^{\circ}$ centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
 - (b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° 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

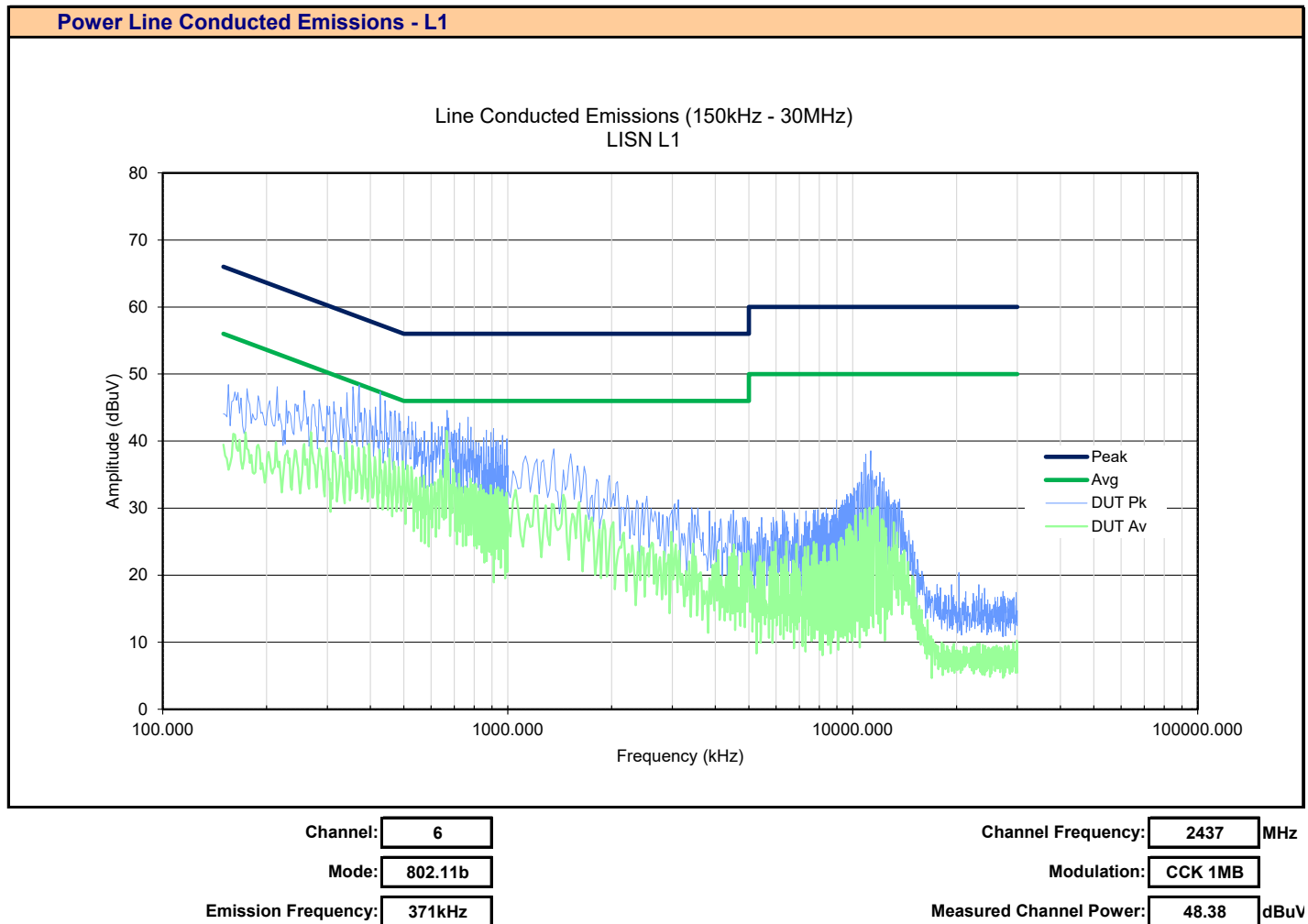
Normative Reference FCC 47 CFR §15.107, ICES-003(6.1)
ANSI C63.4-2014

Limits

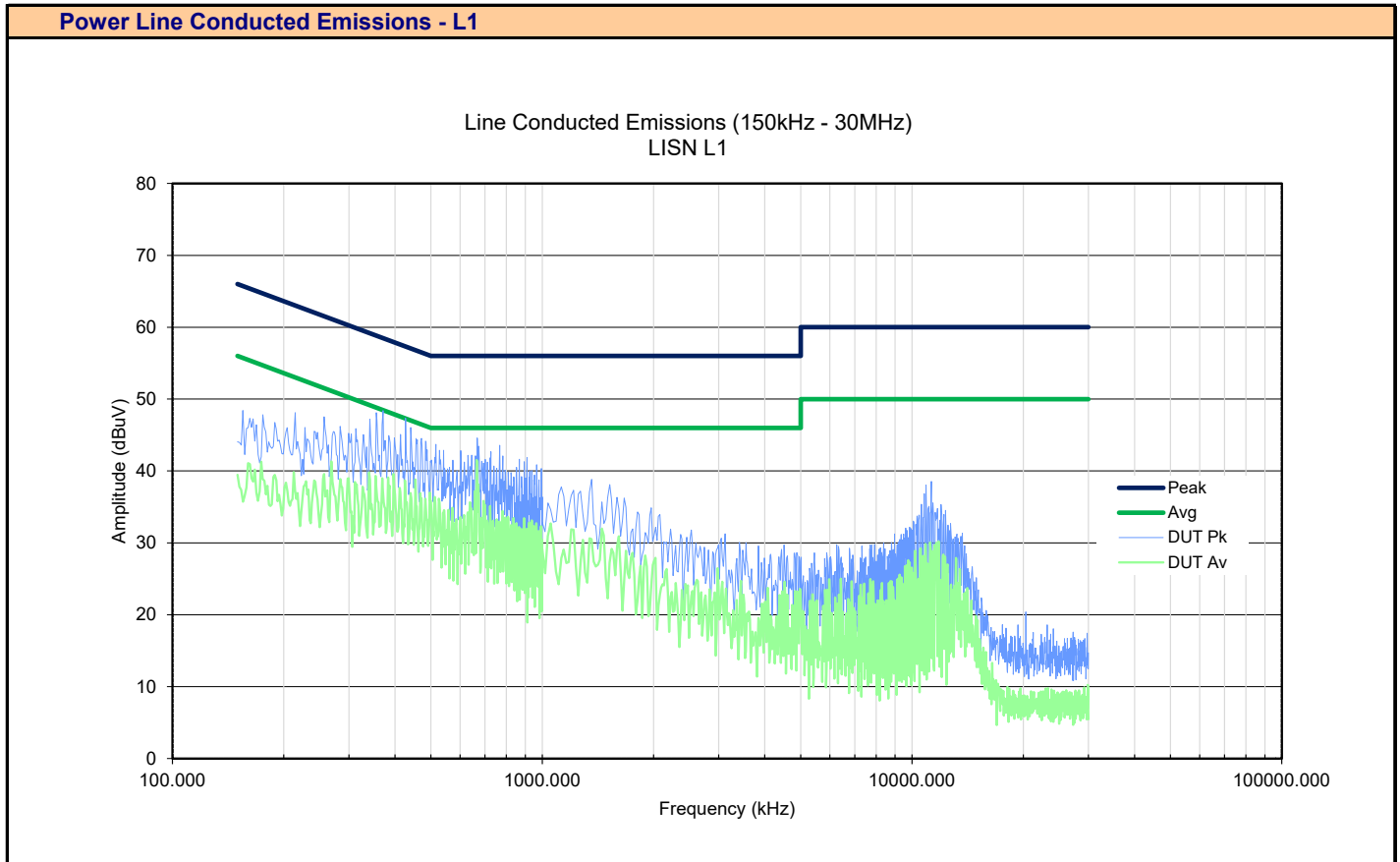
47 CFR §15.107	(a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 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 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

Test Setup Appendix A Figure A.7

Plot 14.1 – Power Line Conducted Emissions, Line 1



Plot 14.2 – Power Line Conducted Emissions, Line 2



Channel: **6**

Mode: **802.11b**

Emission Frequency: **371kHz**

Channel Frequency: **2437** MHz

Modulation: **CCK 1MB**

Measured Channel Power: **48.38** dBuV

Table 14.1 – Summary of Power Line Conducted Emissions – L1

Summary of Power Line Conducted Tx Emissions											
Measured Frequency Range (MHz)	Channel Frequency (MHz)	LISN Port	Emission Frequency [f _{Emm}] (kHz)	Measured Emission [E _{Meas}] (dBuV)	Detector*	Insertion Loss [L _{LISN}] (dB)	Cable Loss [L _C] (dB)	Amplifier Gain [G _A] (dB)	Corrected Emission [E _{Corr}] (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
Results:										Complies	

* 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_{Emm}/500) for f_{Emm} = 150kHz to 500kHz

Class B Avg Limit = 46 - 20Log (f_{Emm}/500) for f_{Emm} = 150kHz to 500kHz

Class A QP Limit = 79dBuV for f_{Emm} = 150kHz to 500kHz

Class A Avg Limit = 66dBuV for f_{Emm} = 150kHz to 500kHz

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

Table 14.1 – Summary of Power Line Conducted Emissions – L2

Summary of Power Line Conducted Tx Emissions											
Measured Frequency Range (MHz)	Channel Frequency (MHz)	LISN Port	Emission Frequency [f _{Emm}]	Measured Emission [E _{Meas}] (dBuV)	Detector*	Insertion Loss [L _{LISN}] (dB)	Cable Loss [L _C] (dB)	Amplifier Gain [G _A] (dB)	Corrected Emission [E _{Corr}] (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
Results:										Complies	

* 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_{Emm}/500) for f_{Emm} = 150kHz to 500kHz

Class B Avg Limit = 46 - 20Log (f_{Emm}/500) for f_{Emm} = 150kHz to 500kHz

Class A QP Limit = 79dBuV for f_{Emm} = 150kHz to 500kHz

Class A Avg Limit = 66dBuV for f_{Emm} = 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	FSU40	100500	Spectrum Analyzer
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable

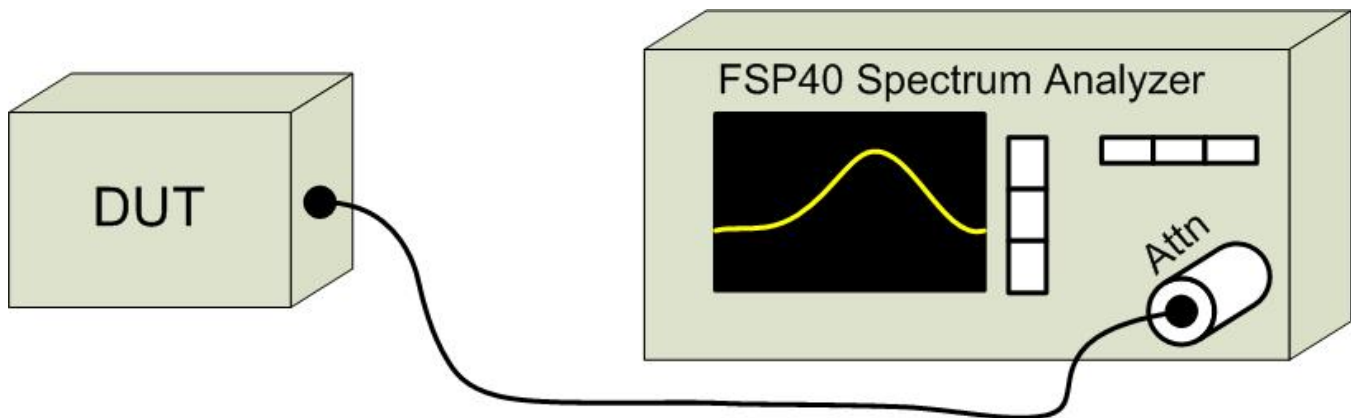


Figure A.1 – Test Setup Conducted Measurements

Table A.2 – Setup - Radiated Emissions Equipment List

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

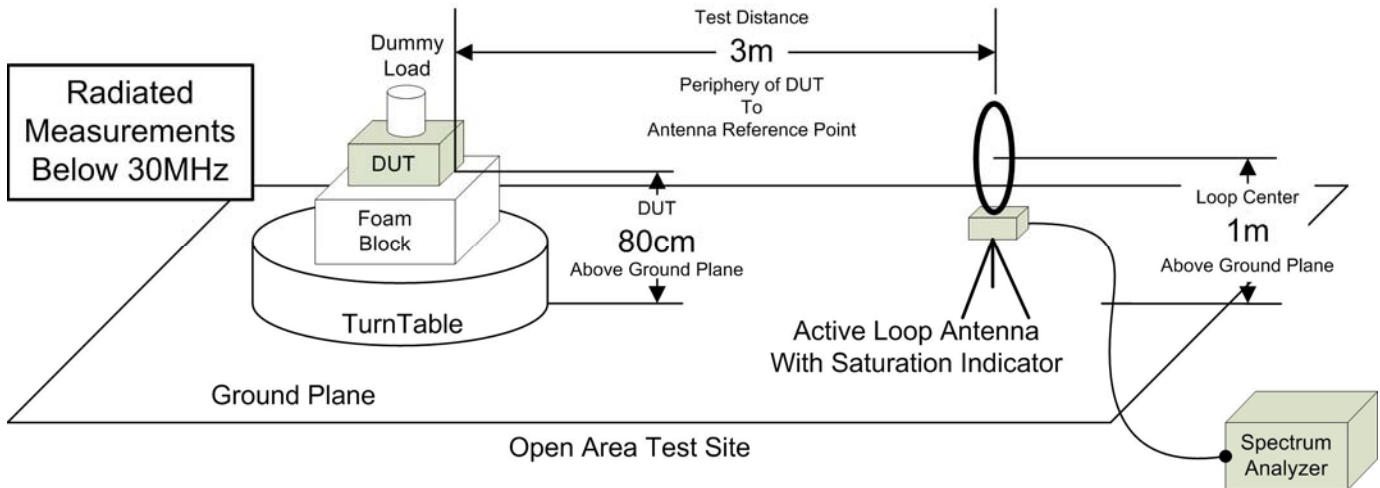


Figure A.2 – Test Setup Radiated Emissions Measurements Below 30MHz

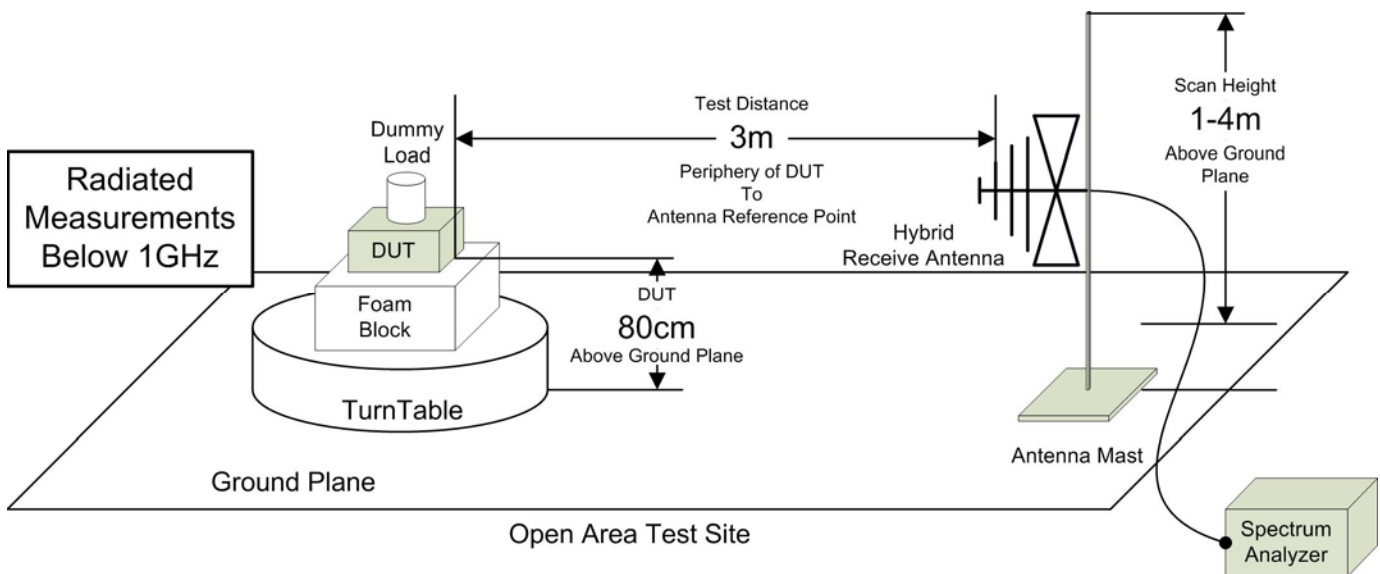


Figure A.3 – Test Setup Radiated Emissions Measurements 30 – 1000MHz

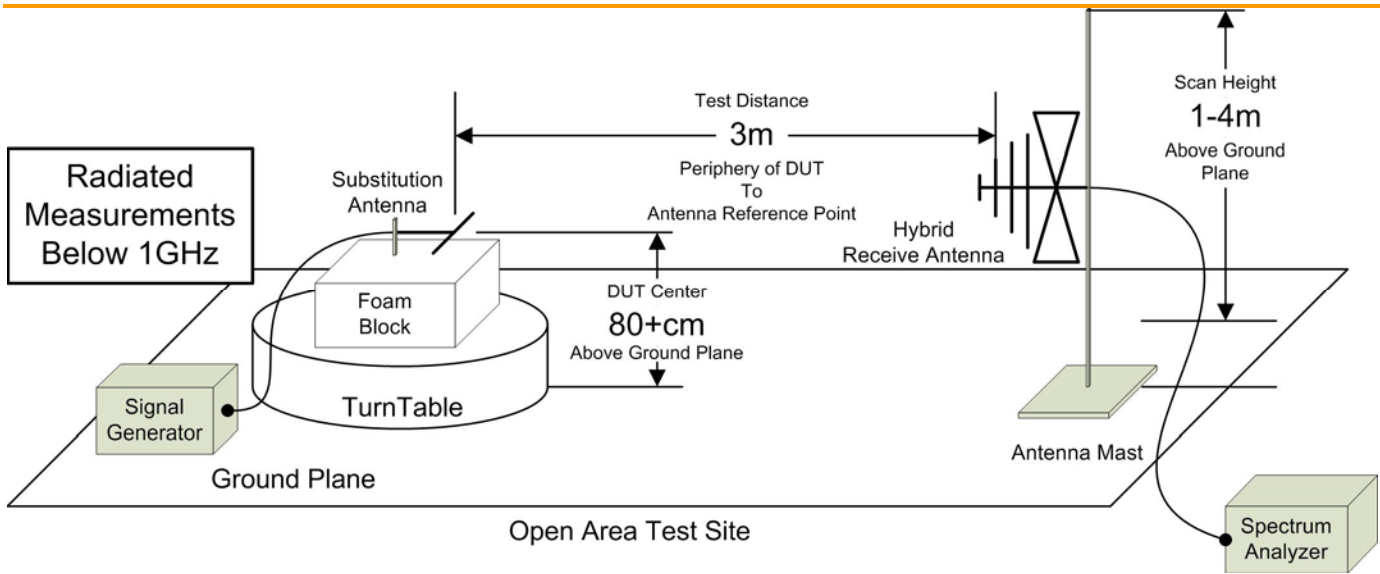


Figure A.4 – Test Setup Radiated Emissions Measurements 30 – 1000MHz Signal Substitution

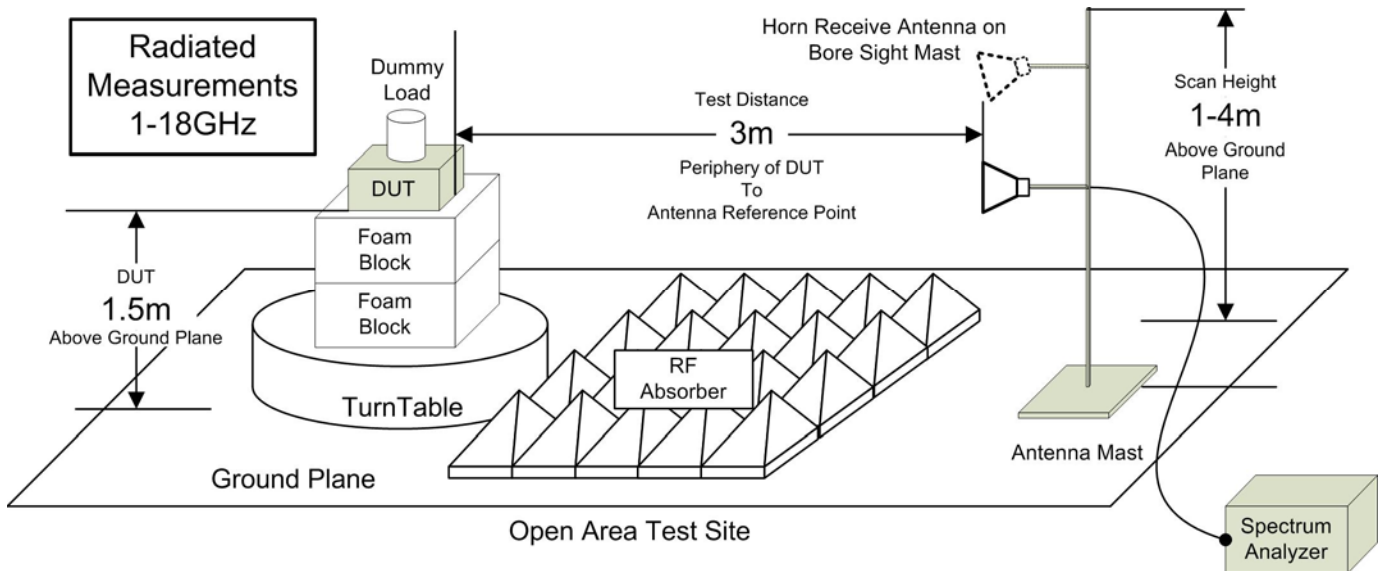


Figure A.5 – Test Setup Radiated Emissions Measurements 1 – 18GHz

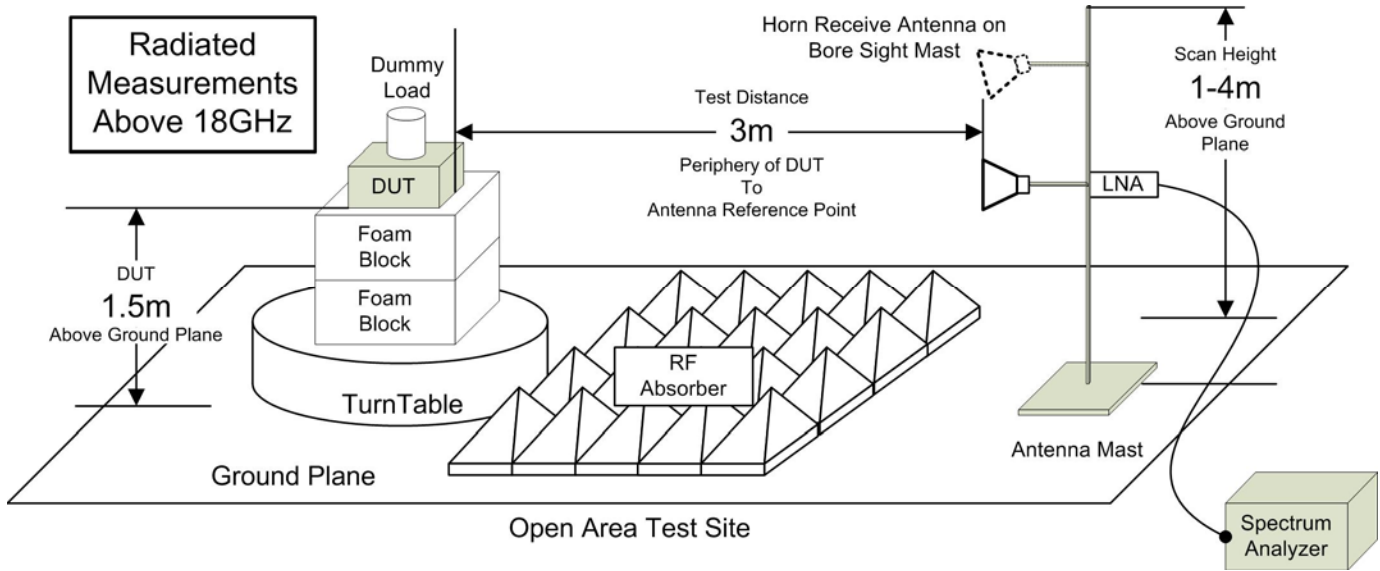


Figure A.6 – Test Setup Radiated Emissions Measurements Above 18 GHz

Table A.3 – Setup – Frequency Stability Equipment List

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

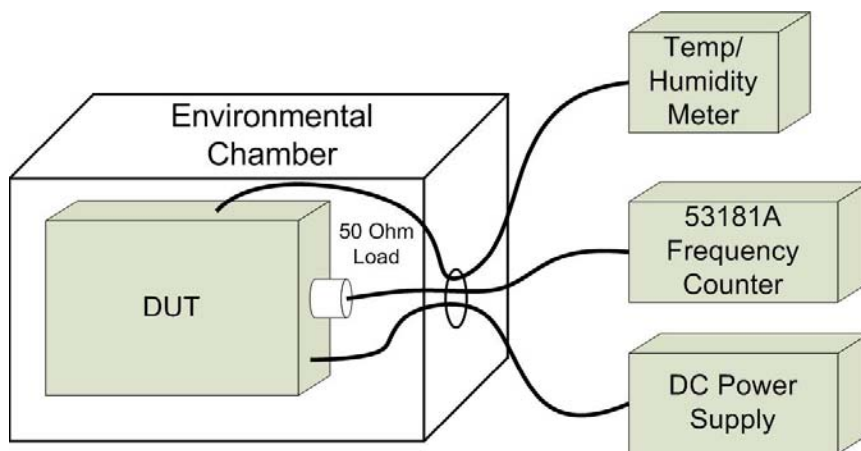


Figure A.7 – Frequency Stability

APPENDIX B – EQUIPMENT LIST AND CALIBRATION

Equipment List							
Asset Number	Manufacturer	Model Number	Serial Number	Description	Last Calibrated	Calibration Interval	Calibration 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

CISPR 16-4 Measurement Uncertainty (U_{LAB})

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence interval using a coverage factor of $k=2$

Radiated Emissions 30MHz - 200MHz

$$U_{LAB} = 5.14\text{dB} \quad U_{CISPR} = 6.3\text{dB}$$

Radiated Emissions 200MHz - 1000MHz

$$U_{LAB} = 5.90\text{dB} \quad U_{CISPR} = 6.3\text{dB}$$

Radiated Emissions 1GHz - 6GHz

$$U_{LAB} = 4.80\text{dB} \quad U_{CISPR} = 5.2\text{dB}$$

Radiated Emissions 6GHz - 18GHz

$$U_{LAB} = 5.1\text{dB} \quad U_{CISPR} = 5.5\text{dB}$$

Power Line Conducted Emissions 9kHz to 150kHz

$$U_{LAB} = 2.96\text{dB} \quad U_{CISPR} = 3.8\text{dB}$$

Power Line Conducted Emissions 150kHz to 30MHz

$$U_{LAB} = 3.12\text{dB} \quad U_{CISPR} = 3.4\text{dB}$$

If the calculated uncertainty U_{lab} is **less** than U_{CISPR} then:

- | | |
|---|---|
| 1 | Compliance is deemed to occur if NO measured disturbance exceeds the disturbance limit |
| 2 | Non-Compliance is deemed to occur if ANY measured disturbance EXCEEDS the disturbance limit |

If the calculated uncertainty U_{lab} is **greater** than U_{CISPR} then:

- | | |
|---|--|
| 3 | Compliance is deemed to occur if NO measured disturbance, increased by ($U_{lab} - U_{CISPR}$), exceeds the disturbance limit |
| 4 | Non-Compliance is deemed to occur if ANY measured disturbance, increased by ($U_{lab} - U_{CISPR}$), EXCEEDS the disturbance limit |

Other Measurement Uncertainties (U_{LAB})

RF Conducted Emissions 9kHz - 40GHz

$$U_{LAB} = 1.0\text{dB} \quad U_{CISPR} = \text{n/a}$$

Frequency/Bandwidth 9kHz - 40GHz

$$U_{LAB} = 0.1\text{ppm} \quad U_{CISPR} = \text{n/a}$$

Temperature

$$U_{LAB} = 1^{\circ}\text{C} \quad U_{CISPR} = \text{n/a}$$

END OF REPORT

APPENDIX H – FIELD STRENGTH MEASUREMENT PLOTS

APPENDIX I– RADIATED TX EMISSIONS MEASUREMENT PLOTS

APPENDIX J– RADIATED RX MEASUREMENT PLOTS