



Test Report Serial Number:

45461588 R1.0

Test Report Date:

26 May 2020

Project Number:

1494

EMC Test Report - New Certification

Applicant:



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

FCC ID:

IPH-03989

IC Registration Number

1792A-03989

Product Model Number / HVIN

A03989

In Accordance With:

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

Part 15 Low Power Communication Device Transmitter (DXX)

RSS-Gen, RSS-210 Issue 10

Low Power Transmitter (2400-2483.5MHz)

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-1



FCC Registration: CA3874

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1.0 DOCUMENT CONTROL

Revision History				
Samples Tested By:		Date(s) of Evaluation:		17 March - 3 April, 2020
Report Prepared By:		Report Reviewed By:		Ben Hewson
Report Revision	Description of Revision	Revised Section	Revised By	Revision Date
0.1	Initial Draft Release	n/a	Art Voss	12 May 2020
1.0	Initial Release	n/a	Art Voss	26 May 2020

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-03989
	ISED ID: 1792A-03989
Device Model(s) / HVIN:	A03989
Test Sample Serial No.:	3326988634 - Conducted, 3326988670 - OTA/SAR
Device Type:	Extremity Worn Digital Transceiver
FCC Equipment Class:	WiFi - Digital Transmission System (DTS)
	Bluetooth - Spread Spectrum Transmitter (DSS)
	Bluetooth LE/ANT - Low Power Communication Device Transmitter (DXX)
	NFC - Low Power Communication Device Transmitter (DXX)
ISED Equipment Class:	WiFi: Wi-Fi Device
	Bluetooth: Spread Spectrum/Digital Device (2400-2483.5MHz)
	Bluetooth LE/ANT - Low Power Device (2400-2483.5MHz)
	NFC - RFID Device
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): 17.84dBm
	Bluetooth - Spread Spectrum Transmitter (DSS): 14.11dBm
	BLE/ANT - Low Power Communication Device Transmitter (DXX): 4dBm
	NFC - Low Power Communication Device Transmitter (DXX): -36dBm
Antenna Type and Gain:	0.6dBi Max
Modulation:	WiFi: DSSS, OFDM, CCK, MCS0-7
Modulation:	BT BR: GFSK
Modulation:	BT EDR: Pi/4-DQPSK
Modulation:	BLE: GMSK
Modulation:	ANT: GFSK
Modulation:	NFC:
DUT Power Source:	3VDC Rechargeable Li-Ion
DUT Dimensions [LxWxH]	H x W x D: 50mm x 45mm x 18mm
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: A03989 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, 15.249, 15.225, ISED: RSS-Gen and RSS-210. As per FCC 47 CFR §2.1093 and Health Canada Safety Code 6, 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.

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.

12 May 2020

Date



4.0 TEST RESULT SUMMARY

TEST SUMMARY						
Section	Description of Test	Procedure Reference	Applicable Rule Part(s) FCC	Applicable Rule Part(s) ISED	Test Date	Result
7.0	Duty Cycle and Transmission Duration	ANSI C63.10-2013 KDB 558074 D01v05	§15.35(c)	n/a	17 Mar 2020	n/a
8.0	Occupied Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§2.1049	RSS-Gen (6.7)	18 Mar 2020	Pass
9.0	Field Strength (Fundamental)	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(a)(e)	RSS-Gen (6.12) RSS-210 (B.10)	26 Mar 2020	Pass
10.0	Band Edge	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(a)(e)	RSS-Gen (6.12) RSS-210 (B.10)	27 Mar 2020	Pass
11.0	Band Edge (NFC)	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(a)(e)	RSS-Gen (6.12) RSS-210 (B.10)	27 Mar 2020	Pass
12.0	Restricted Bands	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(d)(e) §15.209	RSS-Gen (8.10)	1 Apr 2020	Pass
13.0	Radiated Rx Emissions	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(d)(e) §15.209	RSS-Gen (8.10)	1 Apr 2020	Pass
14.0	Frequency Stability	ANSI C63.10-2013 KDB 558074 D01v05	§15.225	RSS-G210 B.6	3 Apr 2020	Pass

Test Station Day Log					
Date	Ambient Temp (°C)	Relative Humidity (%)	Barometric Pressure (kPa)	Test Station	Tests Performed Section(s)
17 Mar 2020	22.8	16	101.6	EMC	7, 8
18 Mar 2020	24.5	17	101.5	EMC	7, 8
26 Mar 2020	20.8	17	101.3	SAC	9,10
26 Mar 2020	6.0	46	101.2	OATS	9,10,11
27 Mar 2020	9.0	43	101.2	OATS	9,10,11
1 Apr 2020	4.0	33	102.1	OATS	12,13
3 Apr 2020	18.7	18	101.2	TC	14

EMC - EMC Test Bench

OATS - Open Area Test Site

LISN - LISN Test Area

IMM - Immunity Test Area

SAC - Semi-Anechoic Chamber

TC - Temperature Chamber

ESD - ESD Test Bench

RI - Radiated Immunity Chamber

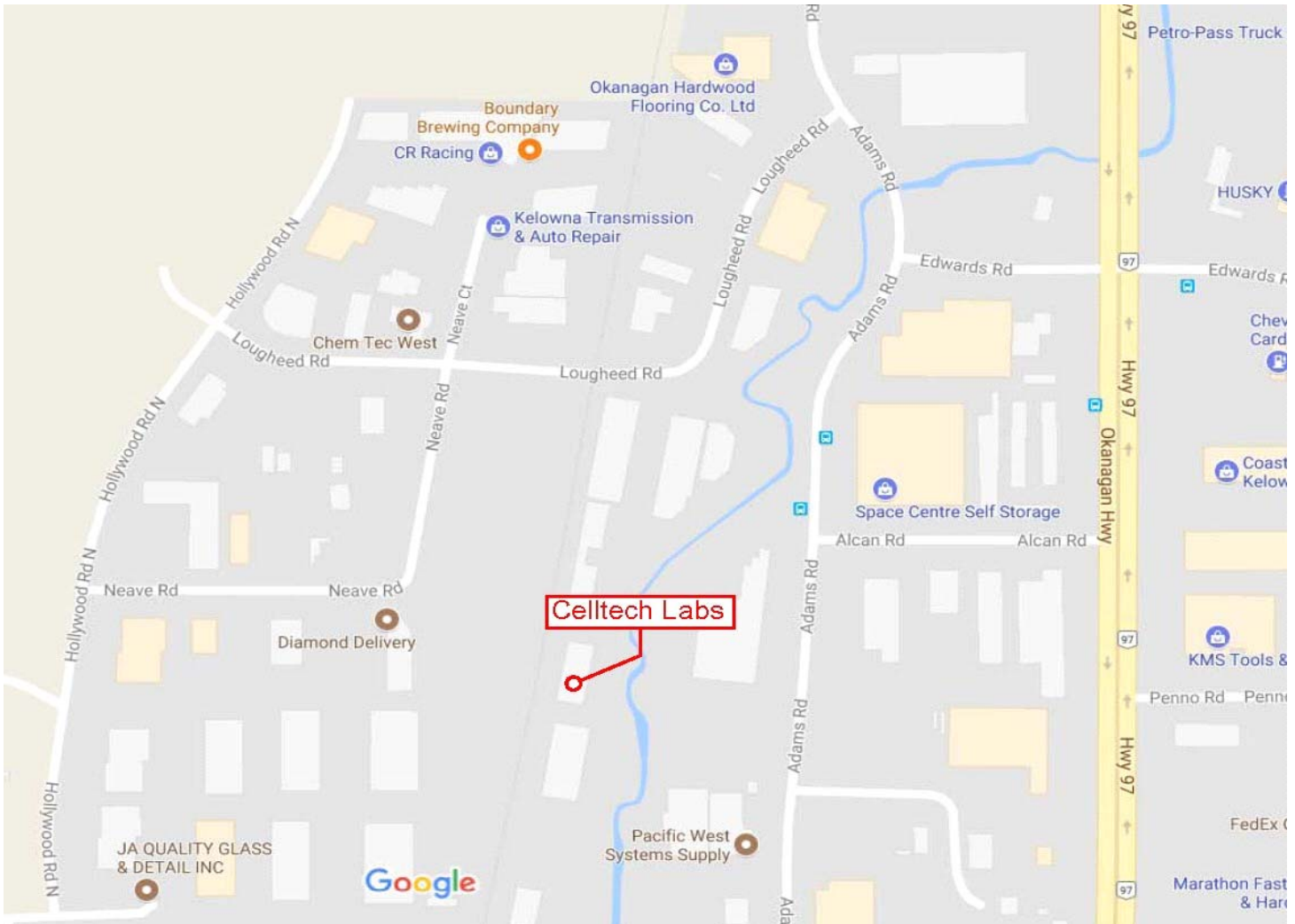
5.0 NORMATIVE REFERENCES

Normative References	
ISO/IEC 17025:2017	General requirements for the competence of testing and calibration laboratories
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 Sub Part C (15.249) Intentional 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 Subpart B: Unintentional Radiators
ISED	Innovation, Science and Economic Development Canada Spectrum Management and Telecommunications Radio Standards Specification RSS-Gen Issue 5: General Requirements and Information for the Certification of Radiocommunication Equipment
ISED	Innovation, Science and Economic Development Canada Spectrum Management and Telecommunications Radio Standards Specification RSS-210 Issue 10: Licence-Exempt Radio Apparatus: Category I Equipment
FCC KDB	OET Major Guidance Publications, Knowledge Data Base 558074 D01v05 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-1. Celltech is accredited to ISO 17025, through accrediting body A2LA and with certificate 2470.01.



7.0 DUTY CYCLE EVALUATION

Test Procedure

Normative Reference	KDB 558074 (6.0), ANSI C63.10 (11.6)
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Limits

KDB 558074 (6.0) C63.10 (11.6)	6.0 Duty cycle, transmission duration and maximum power control level b) The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on- and off-times of the transmitted signal. 1) Set the center frequency of the instrument to the center frequency of the transmission. 2) Set RBW $\geq$ OBW if possible; otherwise, set RBW to the largest available value. 3) Set detector = peak or average. 4) The zero-span measurement method shall not be used unless both RBW and VBW are $> 50/T$ and the number of sweep points across duration T exceeds 100.
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Test Setup	Appendix A Figure A.1
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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 Zero Span and Positive Trigger. The output power of the DUT was set to the manufacturer's highest output power setting at the Mid frequency channel as permitted by the device. The DUT was set to transmit at its maximum Duty Cycle. The variation in Duty Cycle was determined to be less than +/- 2%.

Plot 7.1 – Duty Cycle – Normal Operation, ANT, On-Time

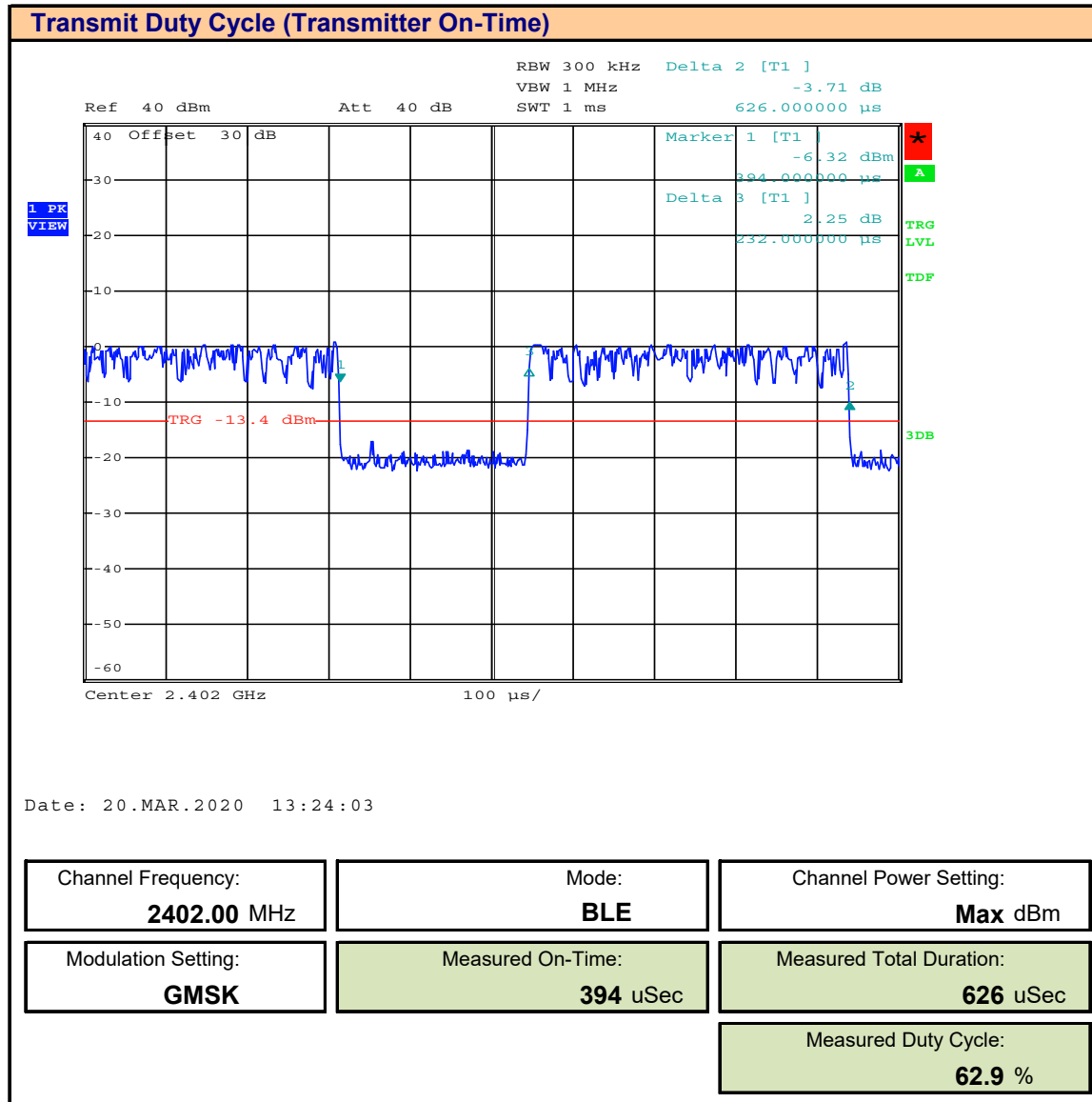


Table 7.1 - Summary of Duty Cycle Evaluation

Transmit Duty Cycle Results			
Frequency (MHz)	Mode	Operation	Measured Duty Cycle Cycle (%)
2402	ANT	BLE	62.9

The variation of the transmit duty cycle was less than 2%

8.0 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 $[10 \log (OBW/RBW)]$ 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.

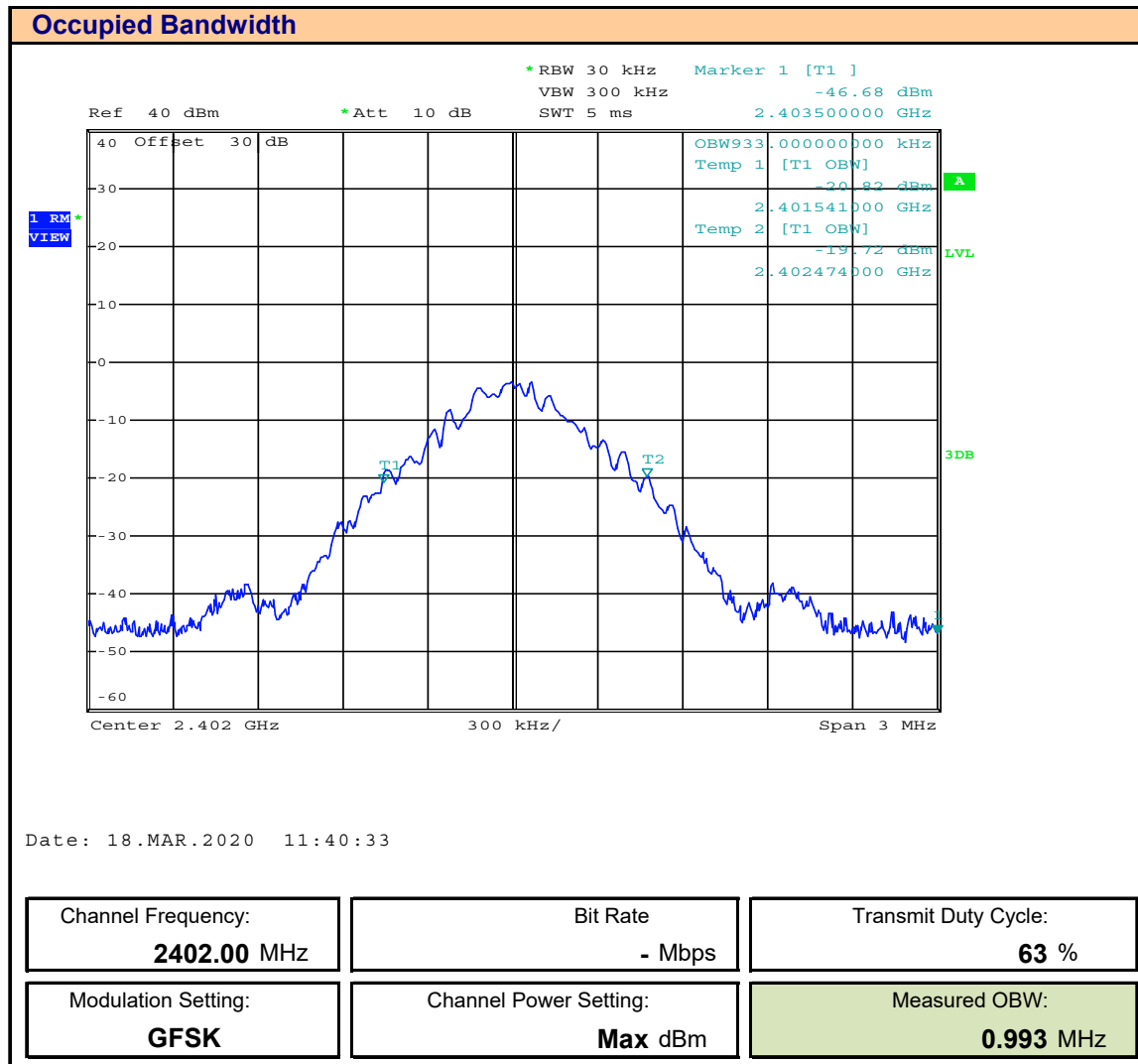
Test Setup

Appendix A - Figure A.1

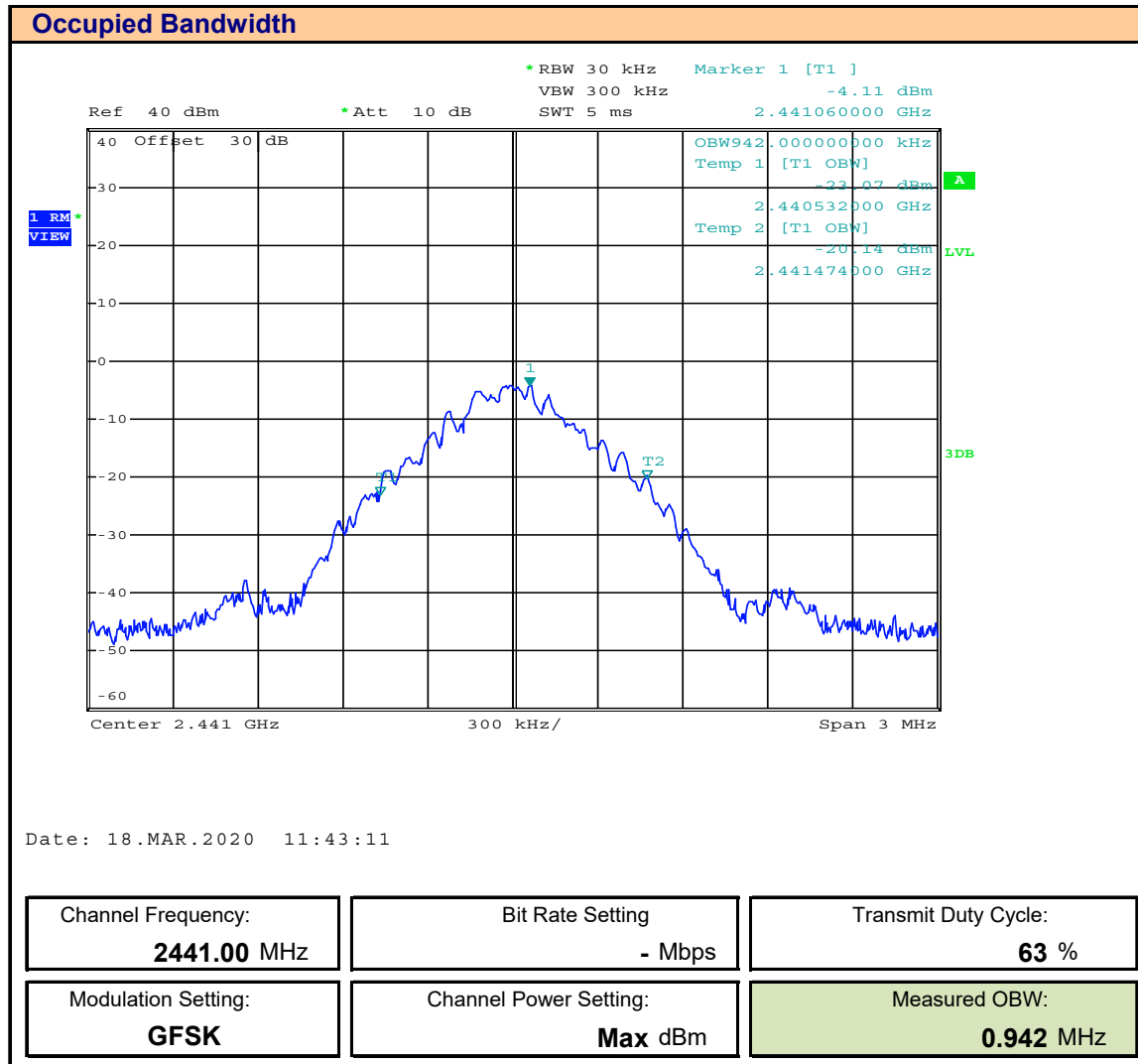
Measurement Procedure

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 8.1 – Occupied Bandwidth – 2402MHz, ANT



Plot 8.2 – Occupied Bandwidth – 2441MHz, ANT



Plot 8.3 – Occupied Bandwidth – 2480MHz, ANT

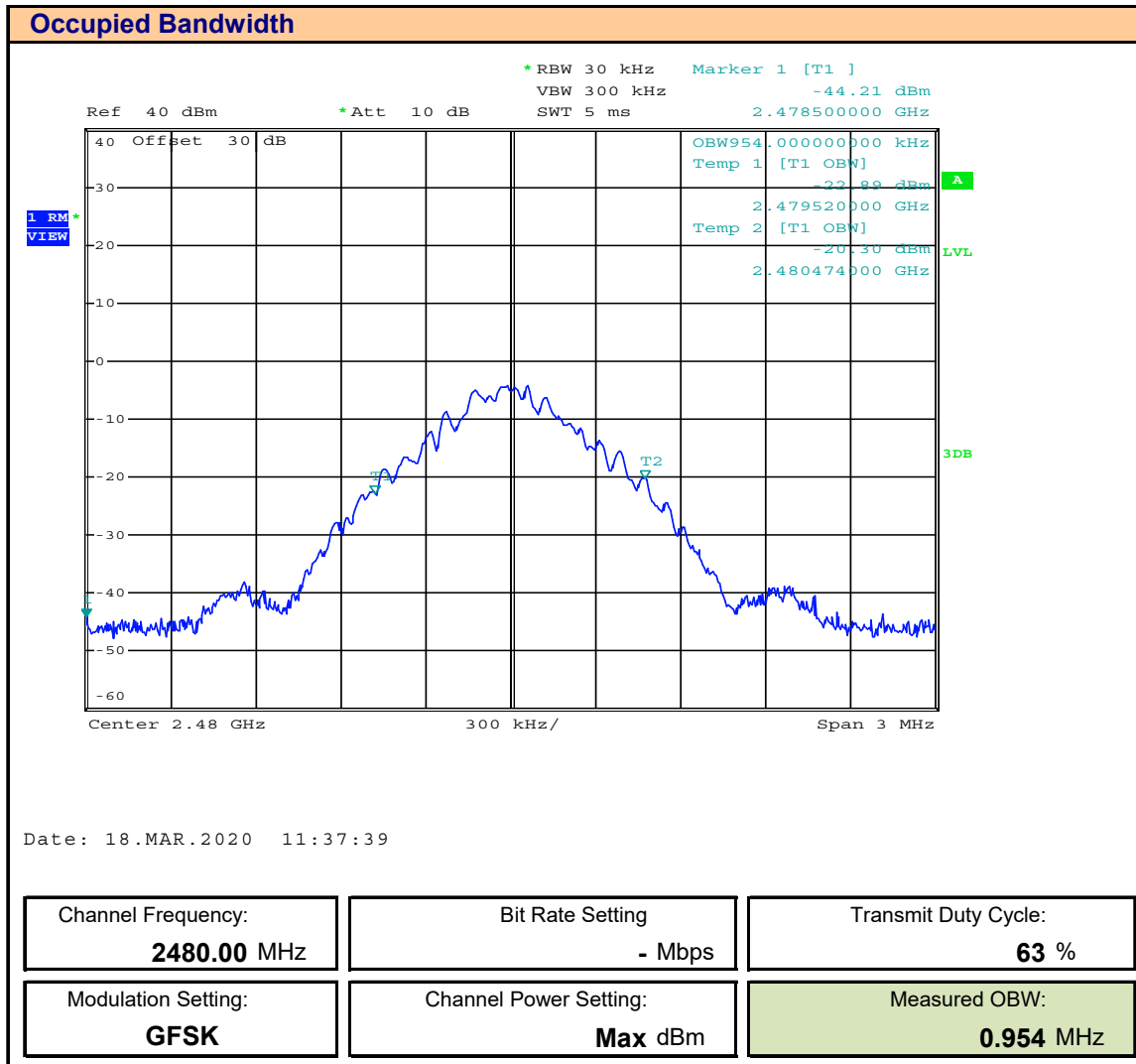
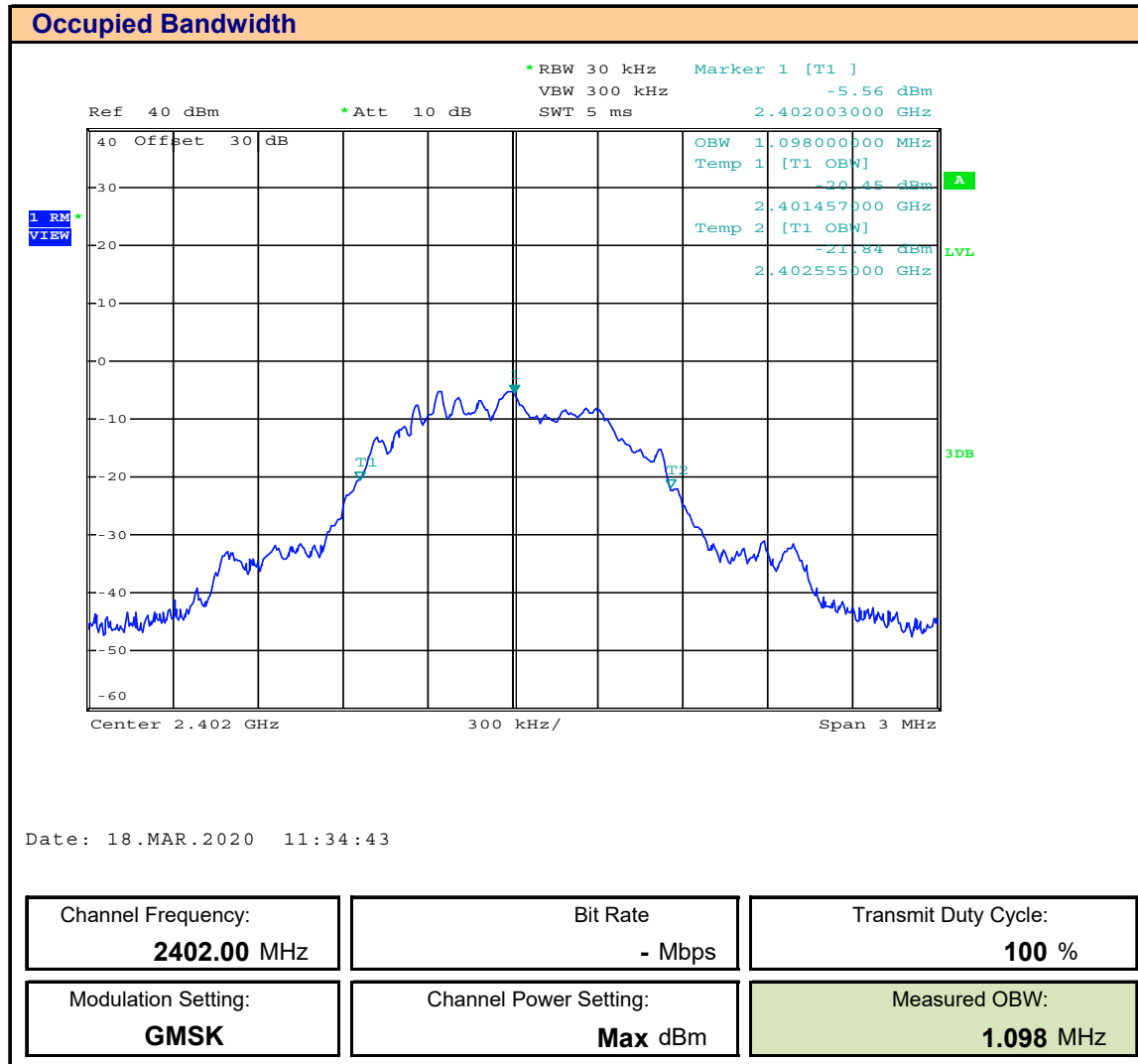


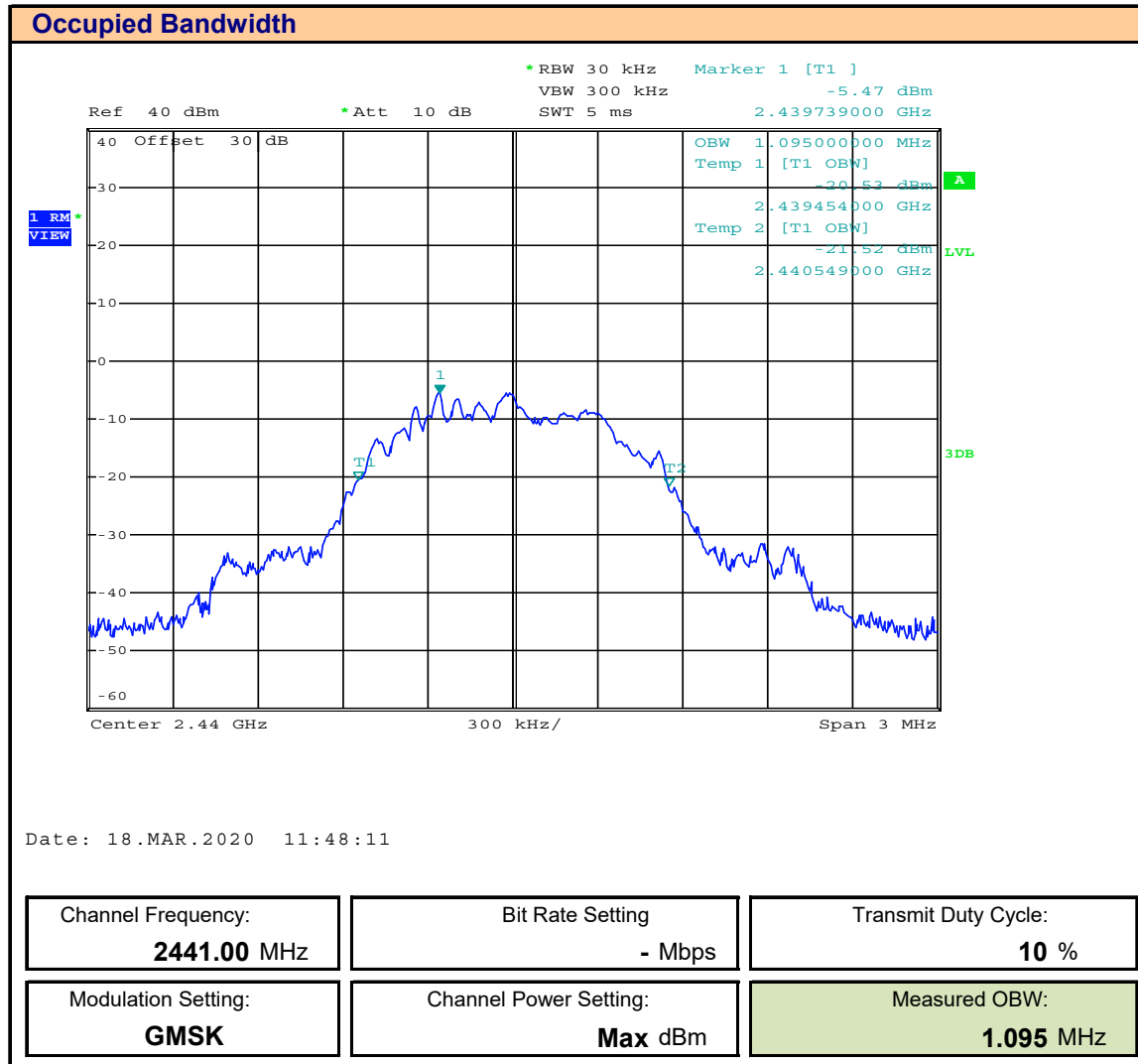
Table 8.1 - Summary of Occupied Bandwidth Measurements (ANT)

99% Occupied Bandwidth Measurement Results - ANT						
Frequency (MHz)	Modulation	Bit Rate (Mbps)	Transmit Duty Cycle (%)	Measured OBW (MHz)	Emission Designator	Result
2402.00	GFSK	-	100	0.993	n/a	Complies
2441.00	GFSK	-		0.942		Complies
2480.00	GFSK	-		0.954		Complies

Plot 8.4 – Occupied Bandwidth – 2402MHz, BLE



Plot 8.5 – Occupied Bandwidth – 2441MHz, BLE



Plot 8.6 – Occupied Bandwidth – 2480MHz, BLE

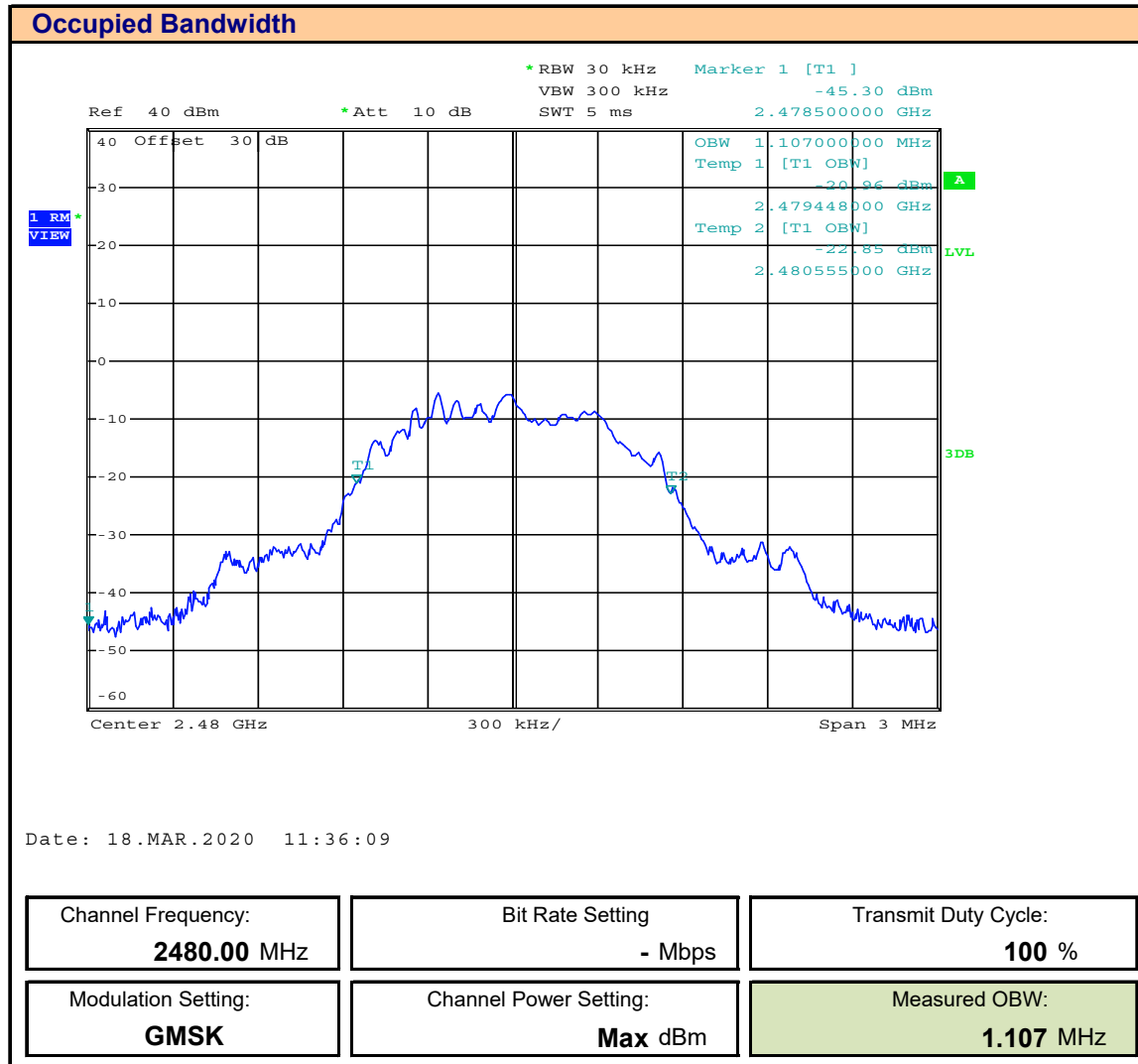


Table 8.2 - Summary of Occupied Bandwidth Measurements (BLE)

99% Occupied Bandwidth Measurement Results - BLE						
Frequency (MHz)	Modulation	Bit Rate (Mbps)	Transmit Duty Cycle (%)	Measured OBW (MHz)	Emission Designator	Result
2402.00	GMSK	-	100	1.098	n/a	Complies
2441.00	GMSK	-		1.095		Complies
2480.00	GMSK	-		1.107		Complies

Plot 8.7 – Occupied Bandwidth – 13.56MHz, NFC

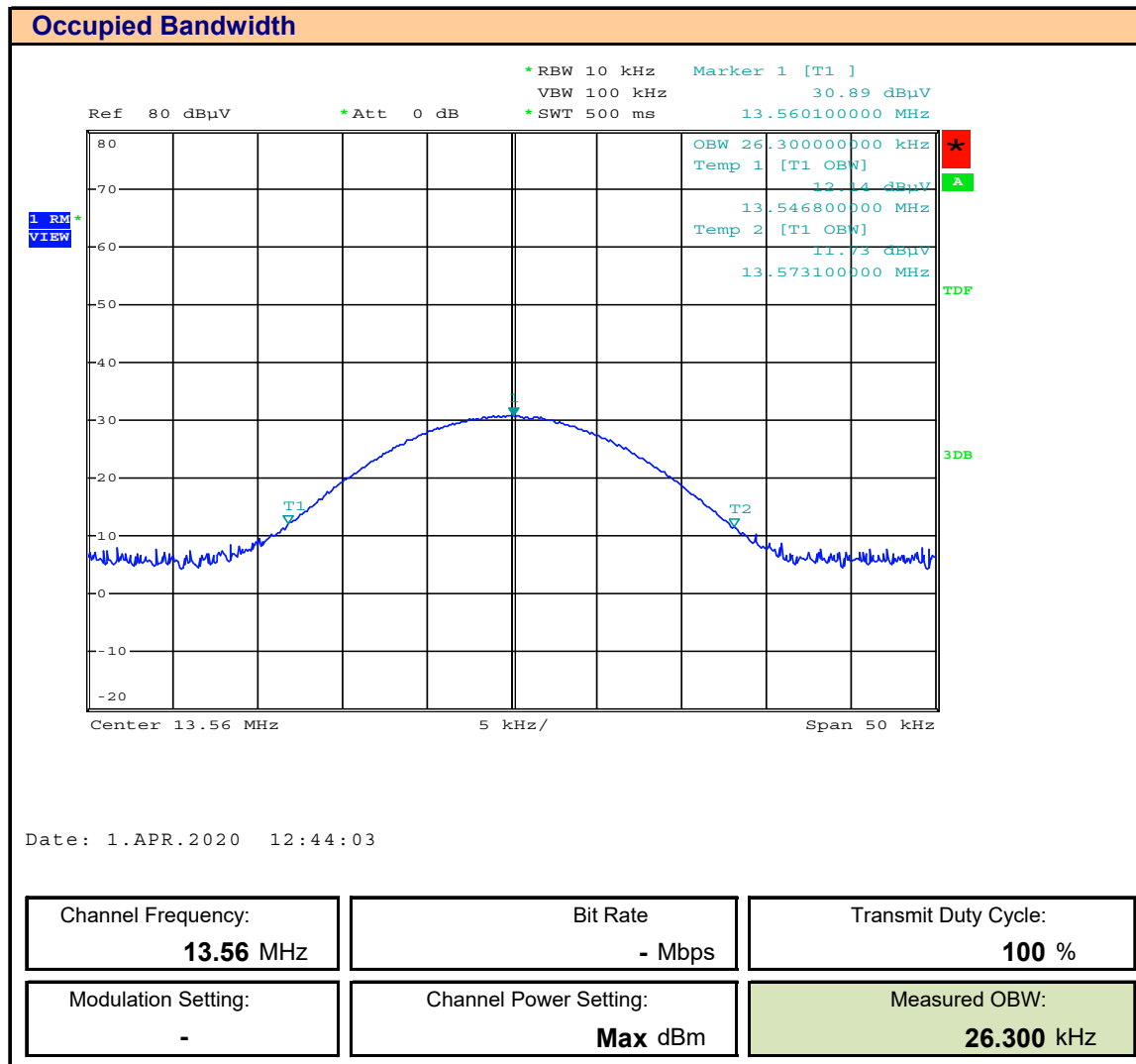


Table 8.2 - Summary of Occupied Bandwidth Measurements (NFC)

99% Occupied Bandwidth Measurement Results - NFC						
Frequency (MHz)	Modulation	Bit Rate (Mbps)	Transmit Duty Cycle (%)	Measured OBW (kHz)	Emission Designator	Result
13.56	-	-	100	26.300	n/a	Complies

9.0 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.
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Test Setup	Appendix A	Figure A.2
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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 9.1 - Summary of Field Strength Measurements (ANT)

See Appendix D for Measurement Plots

FCC §15.249(a), RSS-210 Radiated Field Strength											
Frequency (MHz)	Mode	Modulation	Power Setting ⁽¹⁾ (dBm)	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 @3m)	Limit (dBuV)	Margin (dB)
2402.0	ANT	GFSK	Max	Peak	Horizontal	59.93	4.6	28.3	88.23	114.0	25.8
2441.0						59.21			87.51		26.5
2480.0						58.88			87.18		26.8
2402.0					Vertical	64.65			92.95		21.1
2441.0						64.74			93.04		21.0
2480.0						62.36			90.66		23.3
2402.0				RMS	Horizontal	59.80			88.10	94.0	5.9
44.0						55.60			83.90		10.1
2480.0						57.93			86.23		7.8
2402.0					Vertical	64.38			92.68		1.3
2441.0						62.19			90.49		3.5
2480.0						60.26			88.56		5.4
						Result: Complies					

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

$$Margin = Limit - FS_{Corr}$$

(1) The output power is factory set to maximum

* Cable Loss Accounted For in Transducer Factor

Table 9.2 - Summary of Field Strength Measurements (BLE)

See Appendix D for Measurement Plots

FCC §15.249(a), RSS-210 Radiated Field Strength																
Frequency (MHz)	Mode	Modulation	Power Setting ⁽¹⁾ (dBm)	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 @3m)	Limit (dBuV)	Margin (dB)					
2402.0	BLE	GMSK	Max	Peak	Horizontal	57.95	4.6	28.3	86.25	114.0	27.8					
2441.0						60.00			88.30		25.7					
2480.0						58.58			86.88		27.1					
2402.0					Vertical	64.68			92.98		21.0					
2441.0						64.55			92.85		21.2					
2480.0						57.21			85.51		28.5					
2402.0				RMS	Horizontal	57.59			85.89	94.0	8.1					
2441.0						59.77			88.07		5.9					
2480.0						55.46			83.76		10.2					
2402.0					Vertical	64.51			92.81		1.2					
2441.0						60.85			89.15		4.8					
2480.0						55.10			83.40		10.6					
Result:											Complies					

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

$$Margin = Limit - FS_{Corr}$$

(1) The output power is factory set to maximum

* Cable Loss Accounted For in Transducer Factor

10.0 BAND EDGE

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.
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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.
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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.

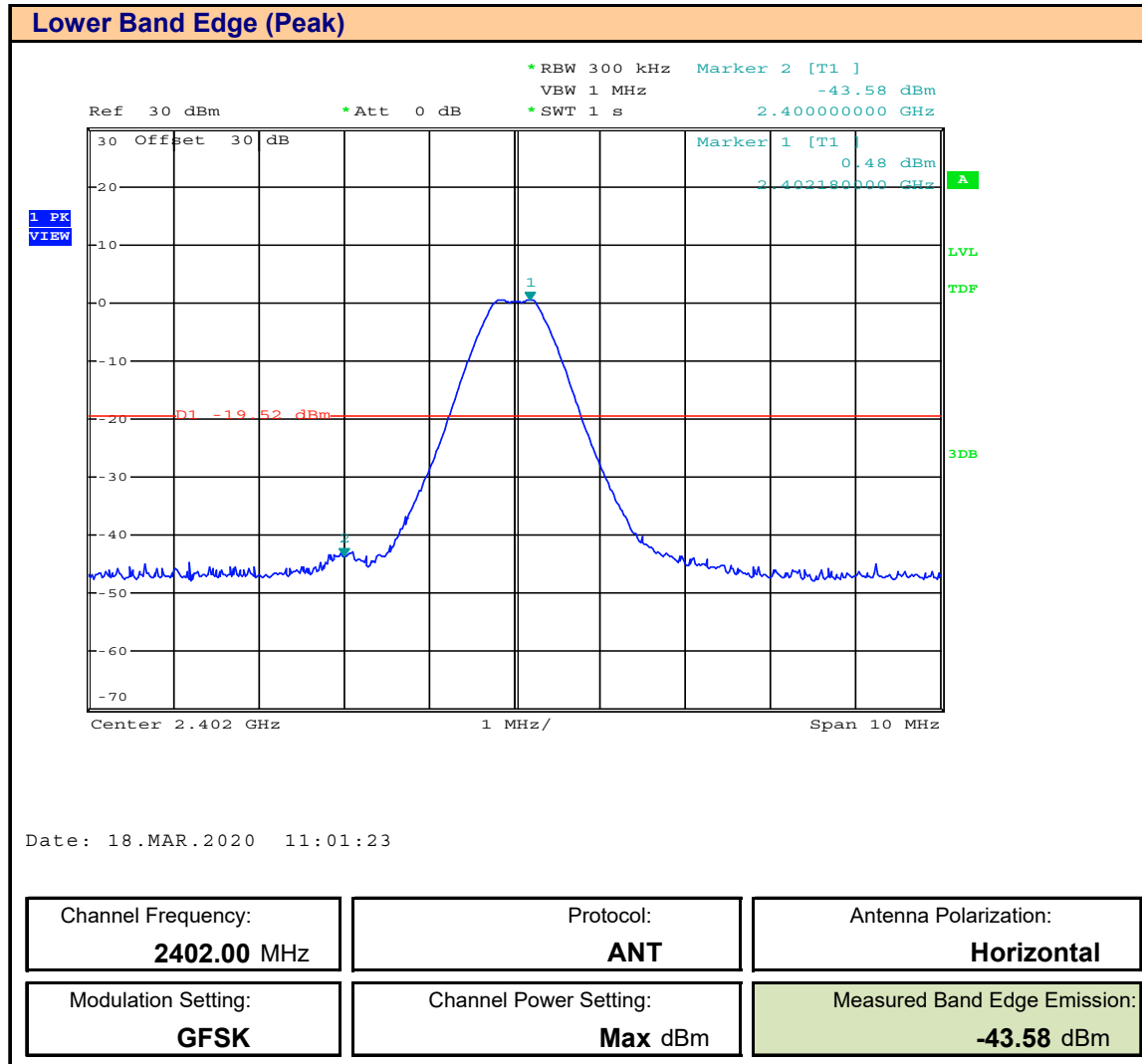
⁵⁵ Some radios operating, for example, in the 2.4 GHz band, have hardware capability to operate at frequencies outside the band permitted by the regulatory authority. Testing shall only be done at the lowest and highest frequencies within the allowed frequency band (see Annex A for examples of regulatory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

Test Setup	Appendix A	Figure A.1
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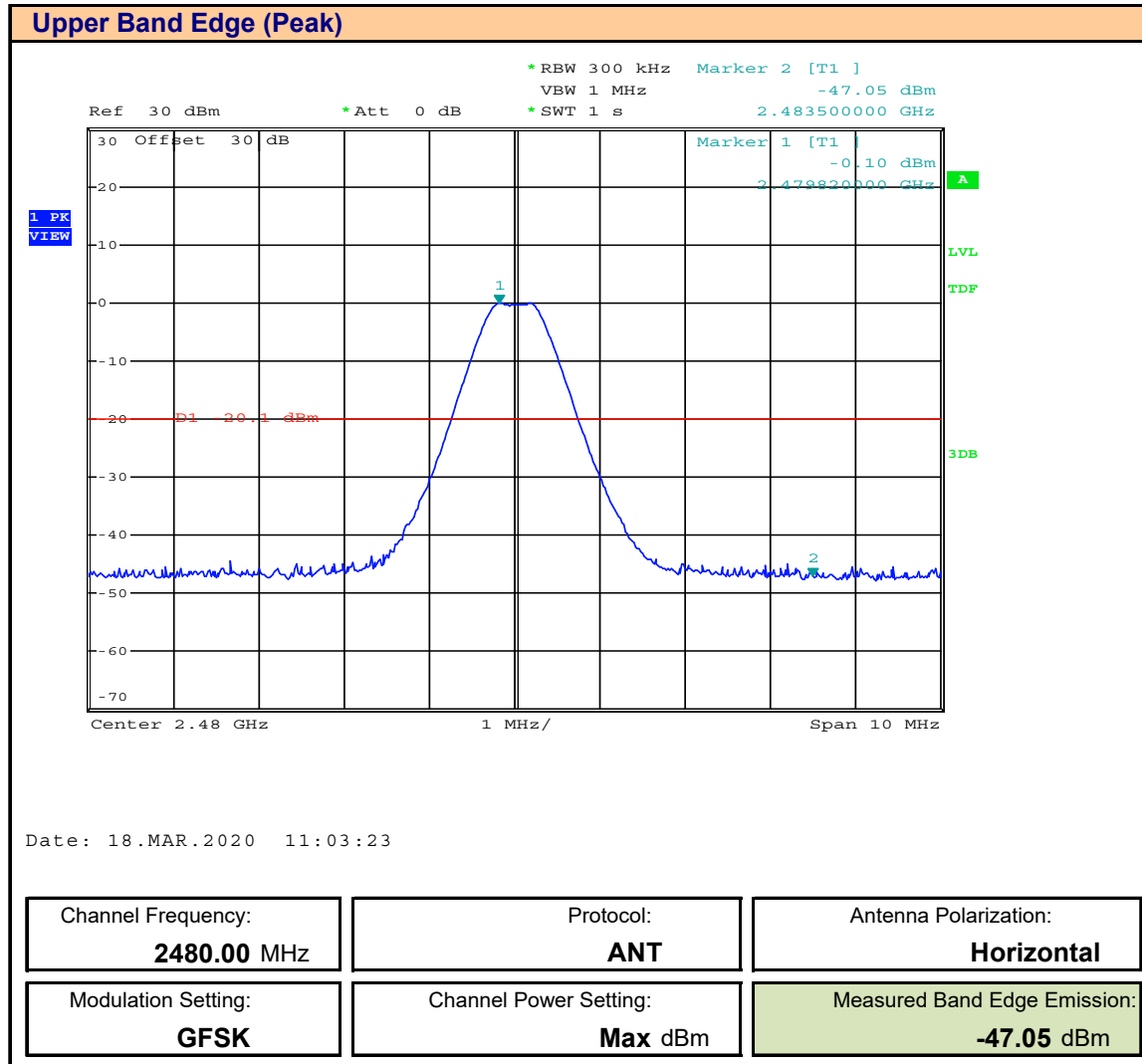
Measurement Procedure

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.

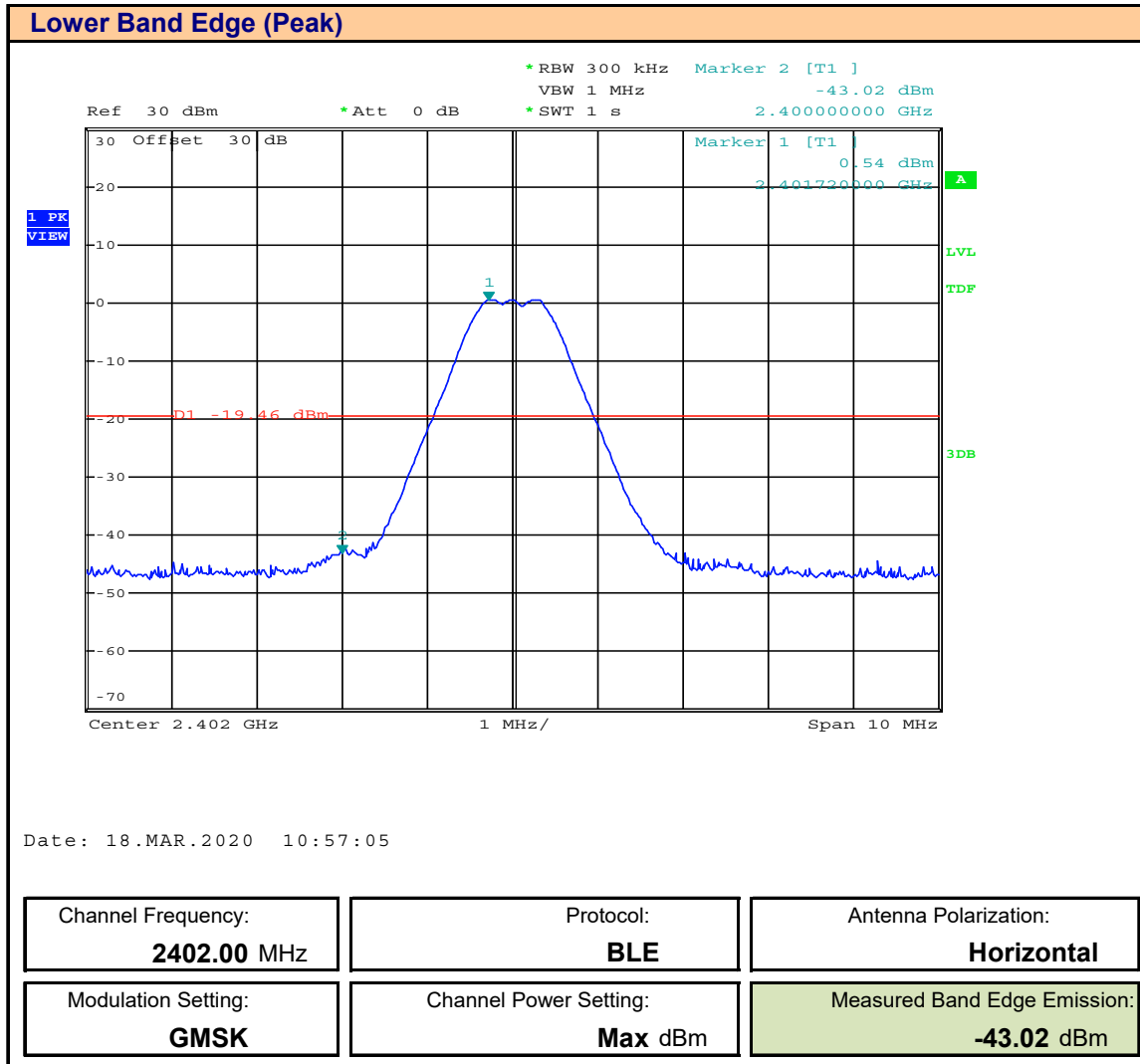
Plot 10.1 – Lower Band Edge (ANT)



Plot 10.2 – Upper Band Edge (ANT)



Plot 10.3 – Lower Band Edge (BLE)



Plot 10.4 – Upper Band Edge (BLE)

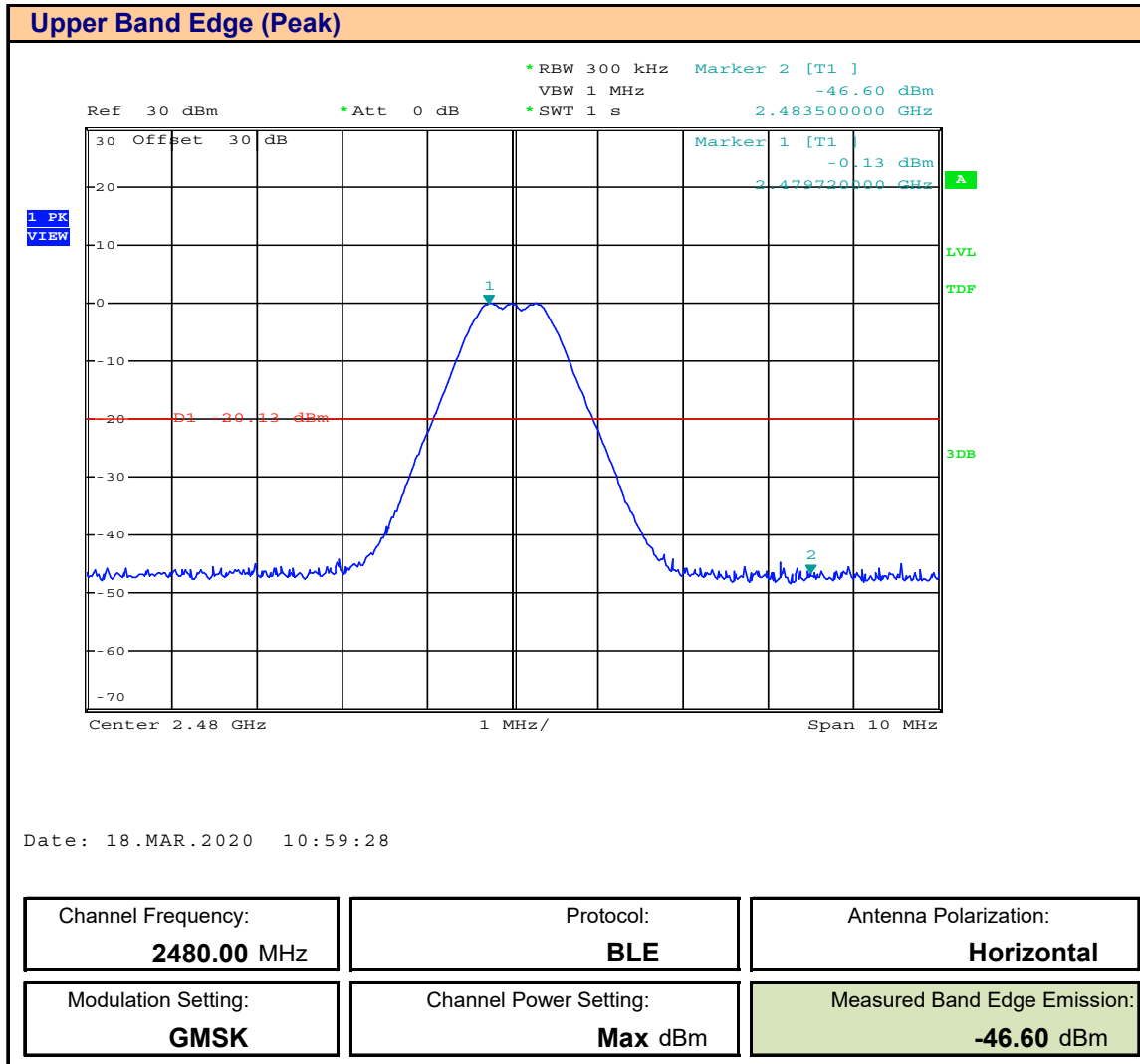


Table 10.1 - Summary of Band Edge Measurements

Band Edge Emission Measurement						
Channel Frequency (MHz)	Mode	Modulation	Power Setting ⁽¹⁾ (dBm)	Measured Emission [E _{Meas}] (dBm)	Limit Line [A _L] (dBm)	Margin (dB)
2402	ANT	GFSK	Max	-43.58	-19.52	24.06
2480				-47.05	-20.10	26.95
2402	BLE	GMSK		-43.02	-19.46	23.56
2480				-46.60	-20.13	26.47
Result:					Complies	

(1) The output power is factory set to maximum

$$\text{Margin} = A_L - E_{\text{MEAS}}$$

11.0 NFC EVALUATION

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

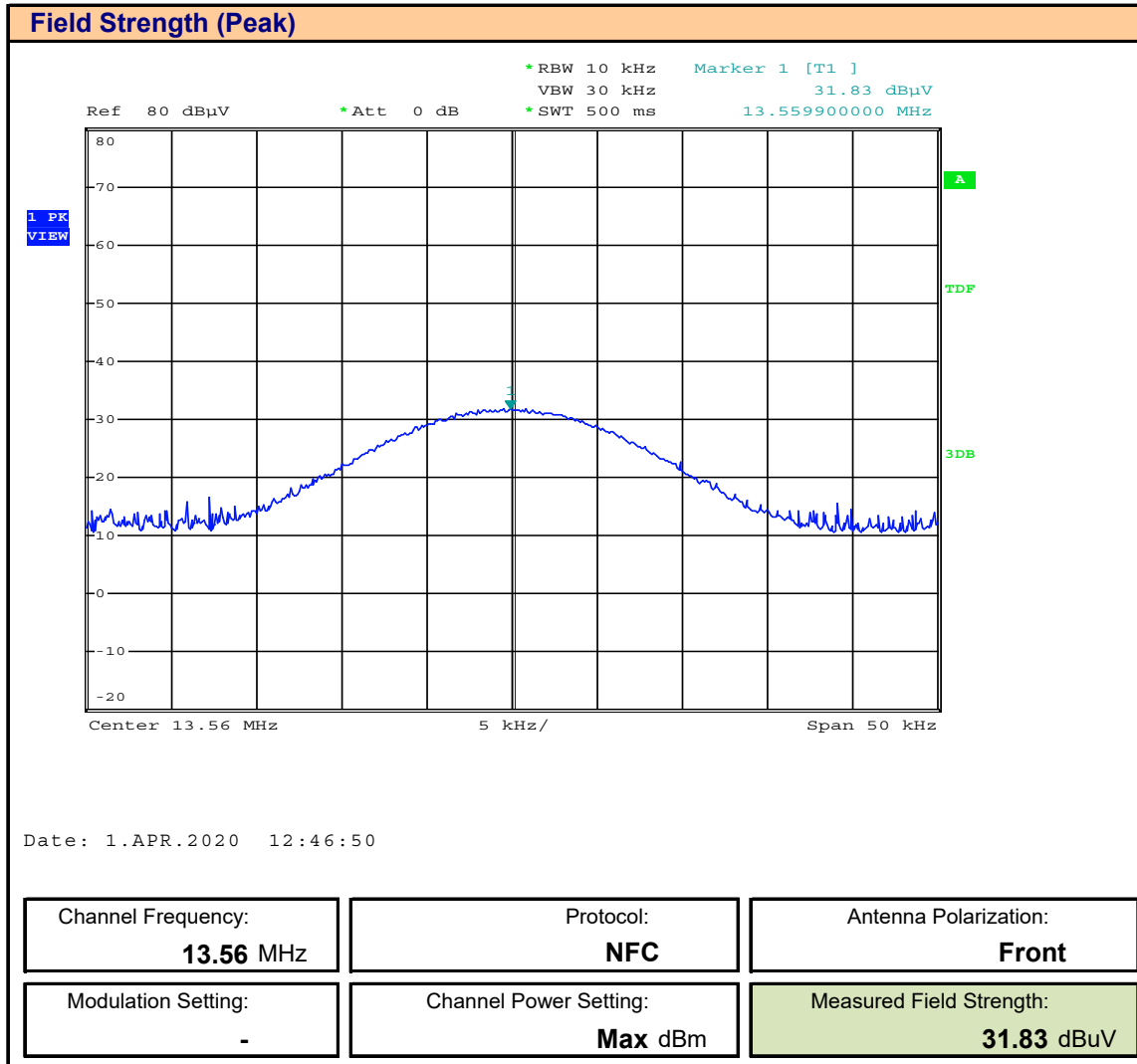
C63.10 (6.5.4)	6.5.4 Final radiated emission tests Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have 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.
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Test Setup	Appendix A	Figure A.2
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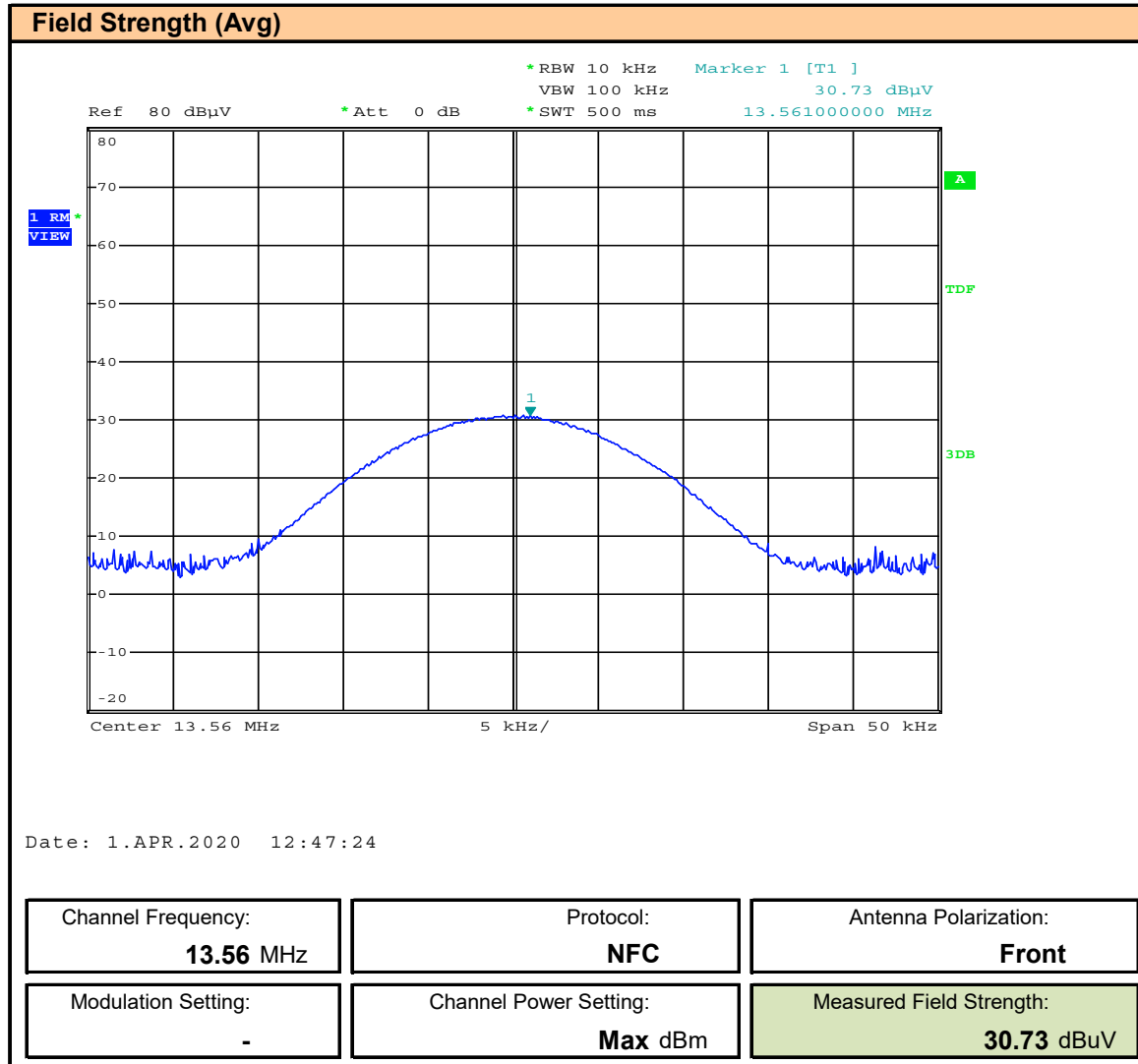
Measurement Procedure

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.

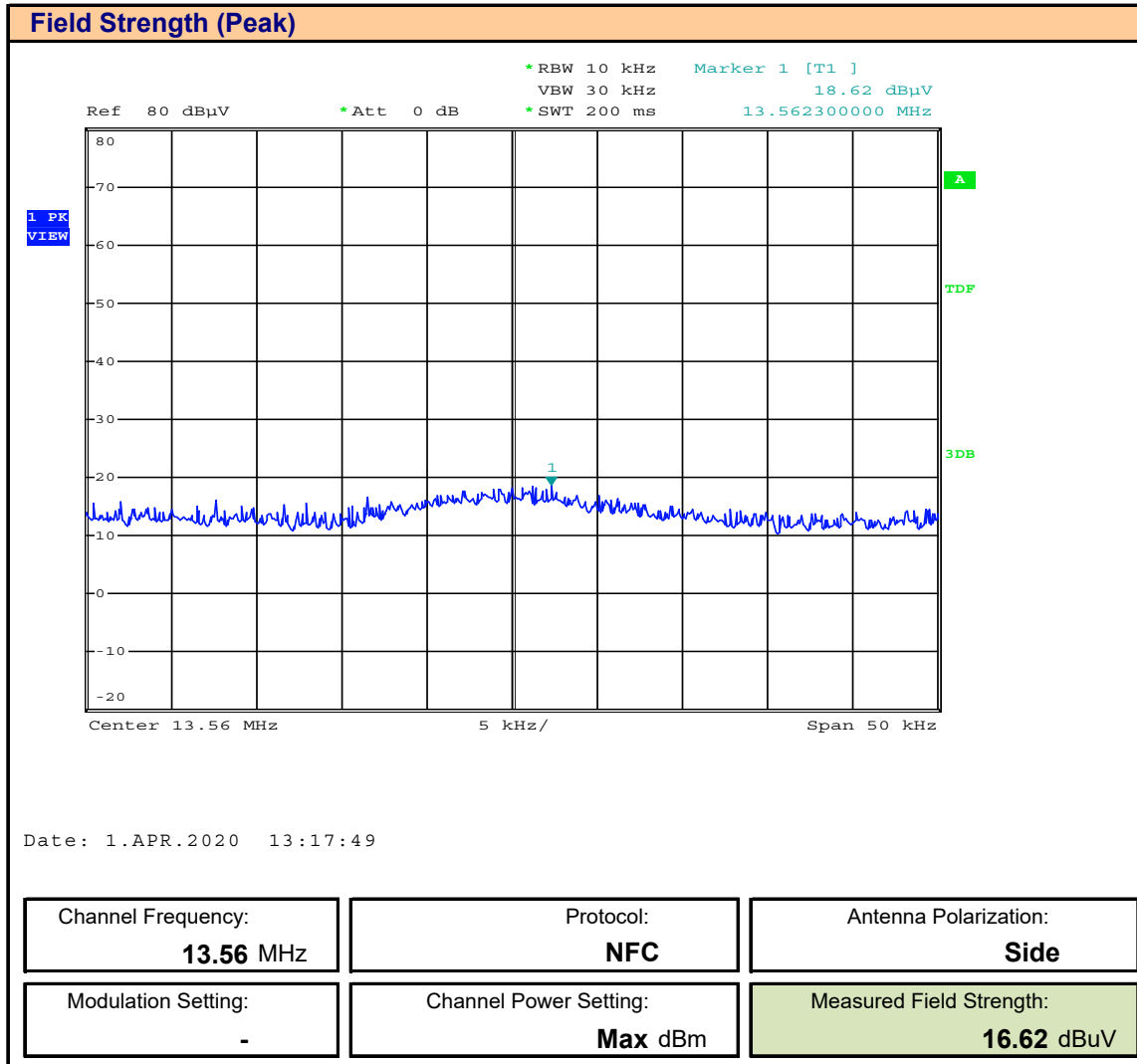
Plot 11.1 – Field Strength, Front, Peak



Plot 11.2 – Field Strength, Front, Avg



Plot 11.3 – Field Strength, Side, Peak



Plot 11.4 – Field Strength, Side, Avg

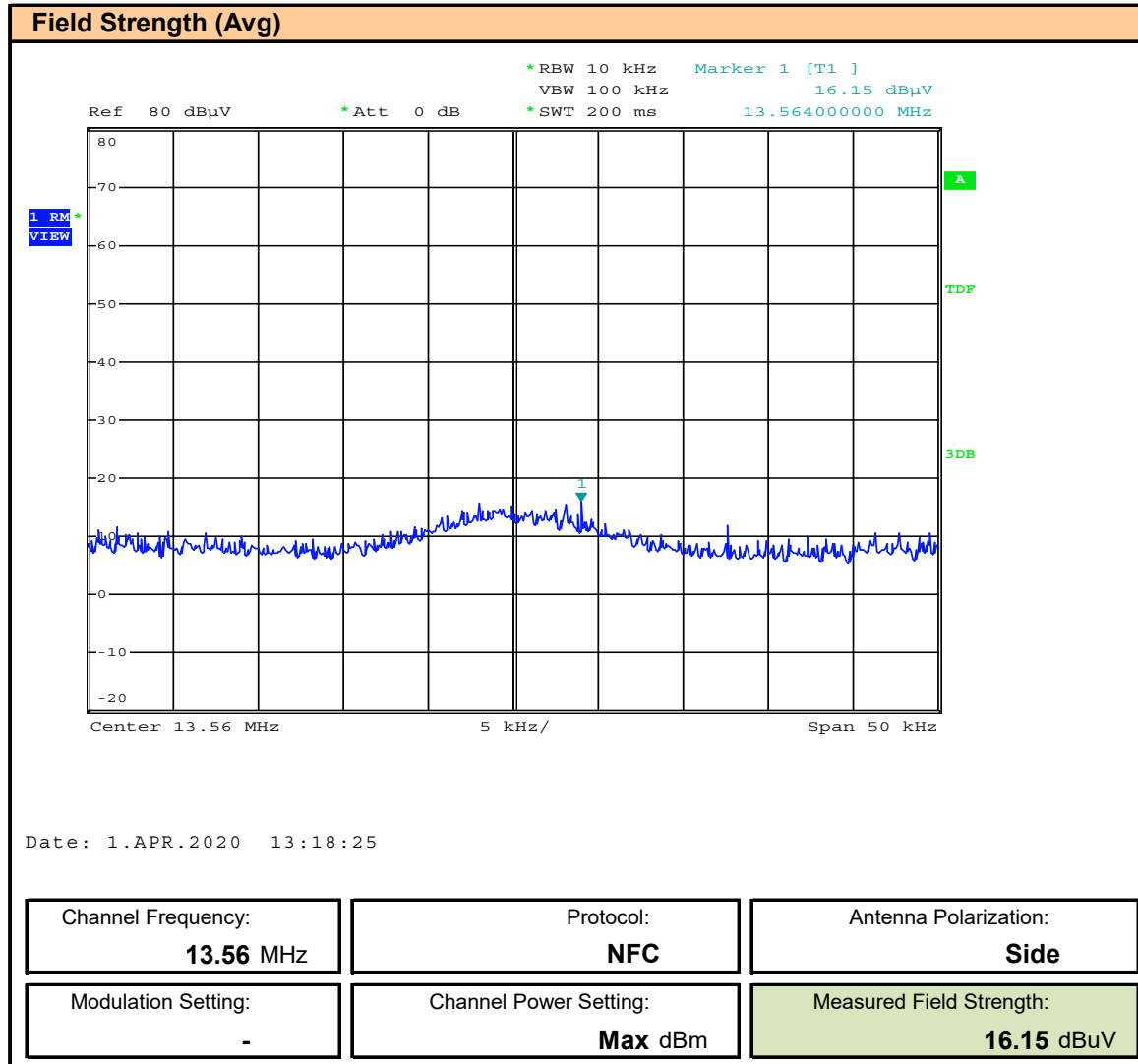


Table 11.1 – Summary of Field Strength Measurements (NFC)

FCC §15.249(a), RSS-210 Radiated Field Strength											
Frequency (MHz)	Mode	Modulation	Power Setting ⁽¹⁾ (dBm)	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 @3m)	Limit (dBuV)	Margin (dB)
13.56	NFC	-	Max	Peak	Front	31.83	0.5	10.7	42.53	144.0	101.5
13.56					Side	16.62			27.32		116.7
13.56				Avg	Front	30.73			41.43	124.0	82.6
13.56					Side	16.15			26.85		97.2
Result:										Complies	

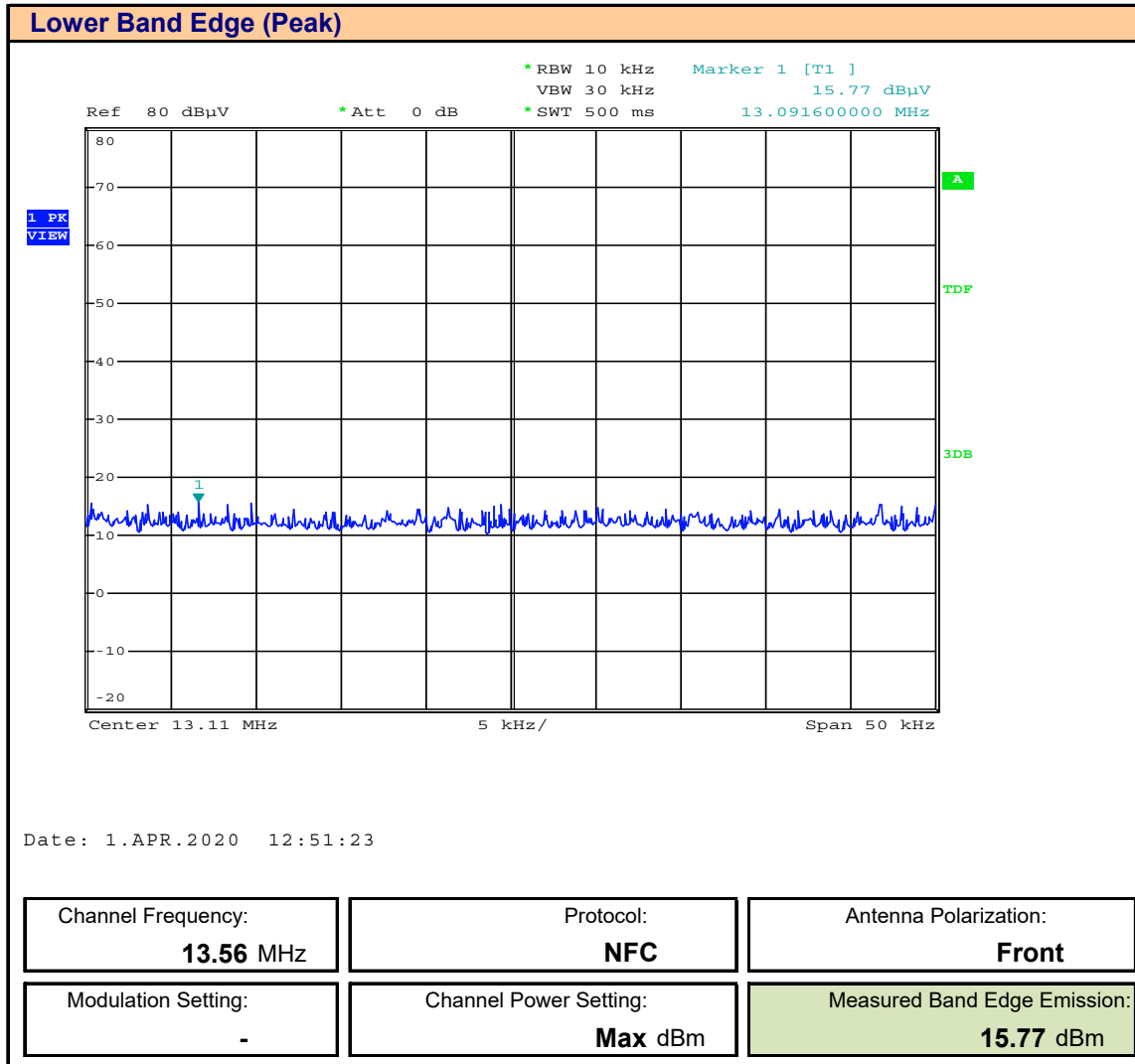
$$FS_{Corr} = FS_{Meas} + ACF + L_c$$

$$Margin = Limit - FS_{Corr}$$

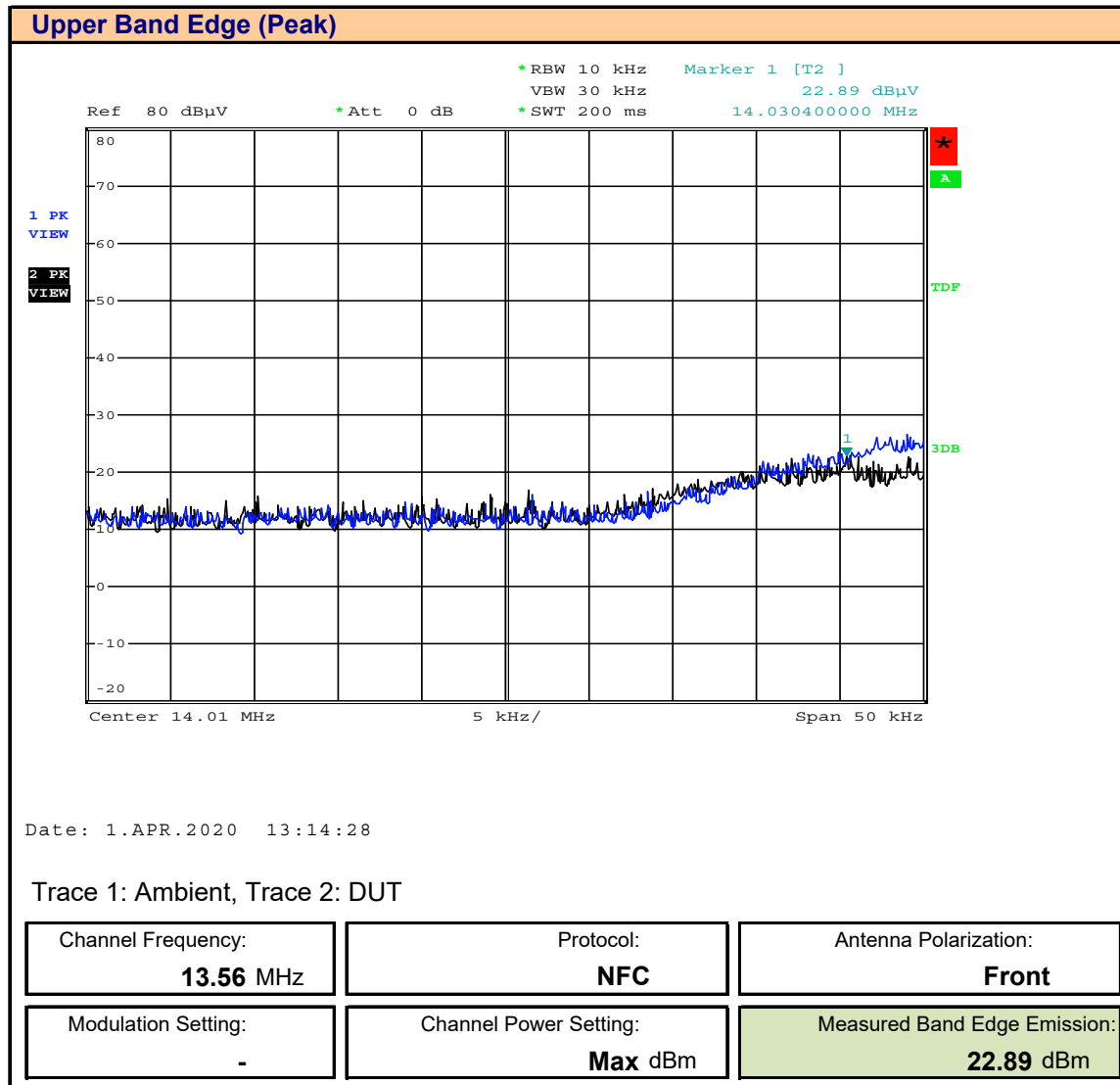
(1) The output power is factory set to maximum

* Cable Loss Accounted For in Transducer Factor

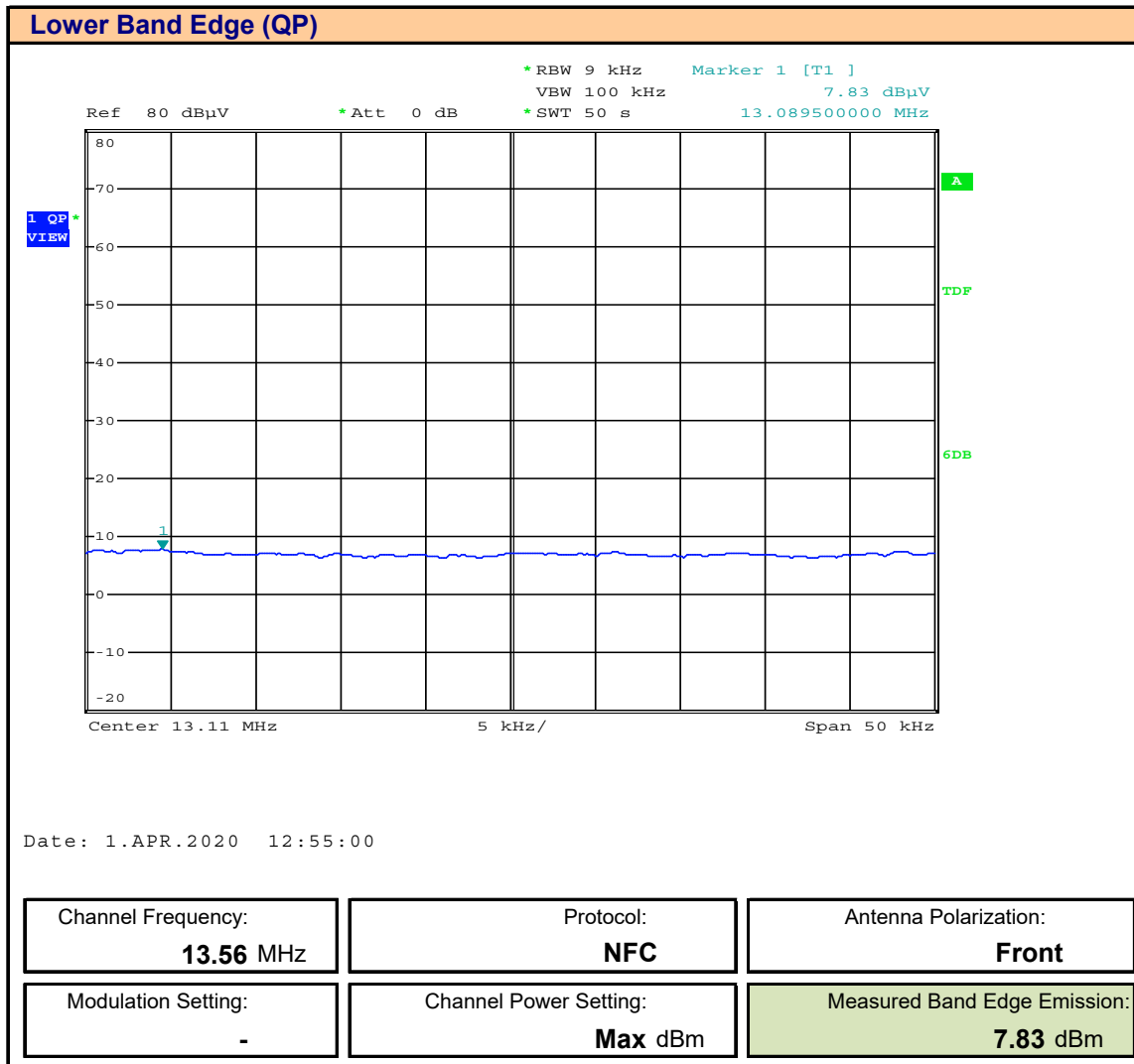
Plot 11.5 – Lower Band Edge, Peak



Plot 11.6 – Upper Band Edge, Peak



Plot 11.7 – Lower Band Edge, QP



Plot 11.8– Upper Band Edge, QP

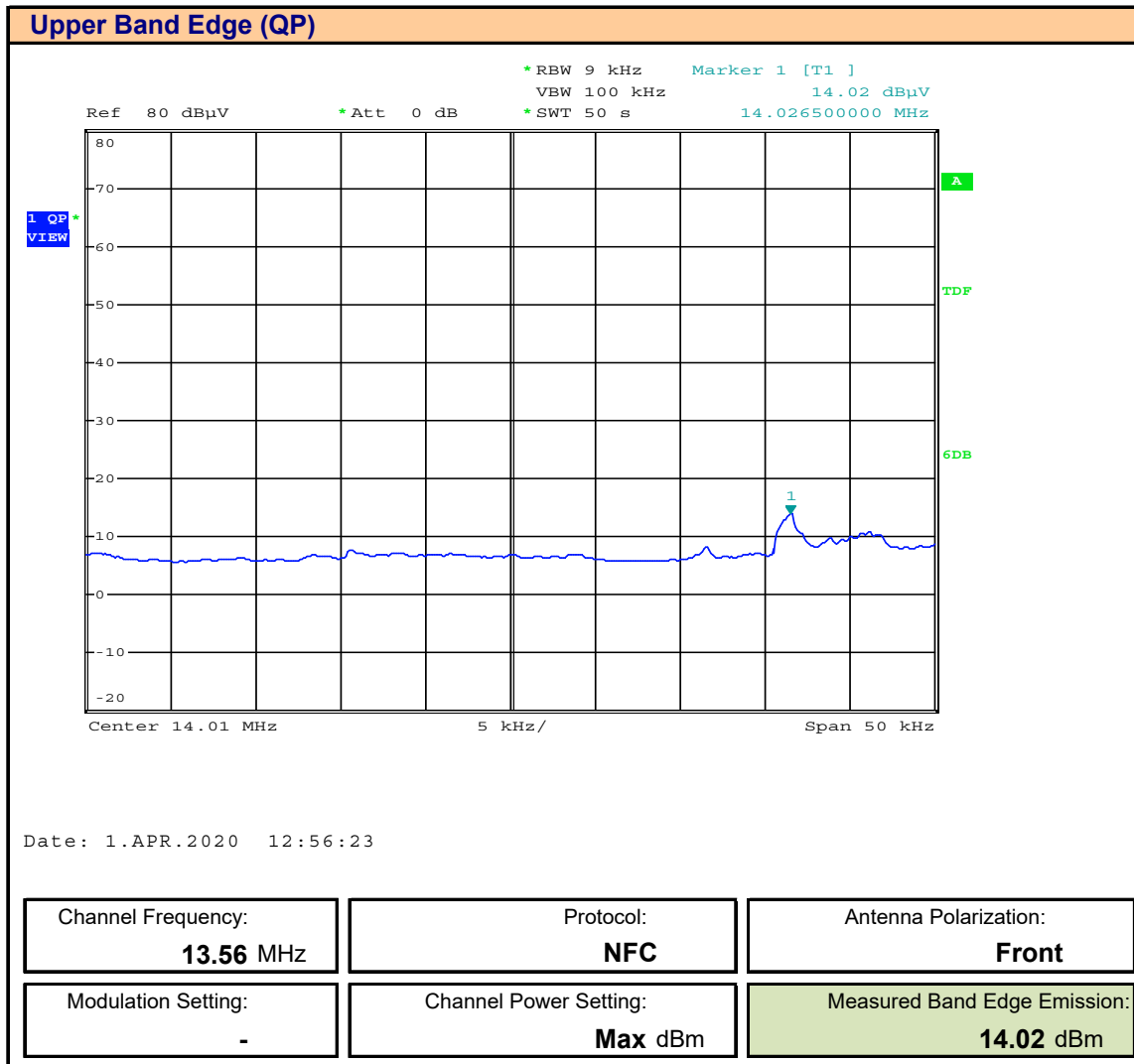


Table 11.2 – Summary of Band Edge Evaluation (NFC)

Band Edge Emission Measurement										
Channel Frequency (MHz)	Mode	Antenna Polarization	Power Setting ⁽¹⁾ (dBm)	Detector	Measured Field Strength [E _{Meas}] (dBuV/m @ 3m)	Cable Loss* [L _c] (dBm)	Receive Antenna [ACF] (dB)	Corrected Field Strength [FS _{corr}] (dBuV @3m)	Limit** [A _L] (dBuV @3m)	Margin (dB)
13.56	NFC	Front	Max	Peak	15.77	0.50	10.70	26.47	40.00	13.53
					22.89			33.59		6.41
		Side		QP	7.83			18.53		21.47
					14.02			24.72		15.28
Result:									Complies	

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

$$Margin = Limit - FS_{Corr}$$

(1) The output power is factory set to maximum

* Cable Loss Accounted For in Transducer Factor

** Worst Case Limit

12.0 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 12.1 – Summary of Radiated Emissions, Restricted Band (ANT)

See Appendix E for Measurement Plots

Measurement Results								
Frequency Range	Antenna Polarization	Bit Rate (Mbps)	Modulation	Power Setting ⁽¹⁾ (dBm)	Transmit Duty Cycle (%)	Measured Emission [E _{Meas}] (dBm)	Worst Case Limit ⁽⁴⁾ [A _L] (dBuV @ 3m)	Margin (dB)
9kHz - 30MHz	Front	-	GFSK	Max	100	ND	69.5	n/a
30-1000MHz	Horizontal					ND	40.0	n/a
1 - 3GHz						ND	54.0	n/a
3 - 13.6GHz						ND	54.0	n/a
13.6 - 18GHz						ND	54.0	n/a
18-25GHz						ND	54.0	n/a
9kHz - 30MHz	Side					ND	69.5	n/a
30-1000MHz	Vertical					ND	40.0	n/a
1 - 3GHz						ND	54.0	n/a
3 - 13.6GHz						ND	54.0	n/a
13.6 - 18GHz						ND	54.0	n/a
18-25GHz						ND	54.0	n/a
Results:							Complies	

Table 12.2 – Summary of Radiated Emissions, Restricted Band (BLE)

See Appendix E for Measurement Plots

Measurement Results								
Frequency Range	Antenna Polarization	Bit Rate (Mbps)	Modulation	Power Setting ⁽¹⁾ (dBm)	Transmit Duty Cycle (%)	Measured Emission [E _{Meas}] (dBm)	Worst Case Limit ⁽⁴⁾ [A _L] (dBuV @ 3m)	Margin (dB)
9kHz - 30MHz	Front	-	GMSK	Max	100	ND	69.5	n/a
30-1000MHz	Horizontal					ND	40.0	n/a
1 - 3GHz						ND	54.0	n/a
3 - 13.6GHz						ND	54.0	n/a
13.6 - 18GHz						ND	54.0	n/a
18-25GHz						ND	54.0	n/a
9kHz - 30MHz						Side	ND	69.5
30-1000MHz	Vertical					ND	40.0	n/a
1 - 3GHz						ND	54.0	n/a
3 - 13.6GHz						ND	54.0	n/a
13.6 - 18GHz						ND	54.0	n/a
18-25GHz						ND	54.0	n/a

Table 12.3 – Summary of Radiated Emissions, Restricted Band (NFC)

See Appendix E for Measurement Plots

Measurement Results								
Frequency Range	Antenna Polarization	Bit Rate (Mbps)	Modulation	Power Setting ⁽¹⁾ (dBm)	Transmit Duty Cycle (%)	Measured Emission [E _{Meas}] (dBm)	Worst Case Limit ⁽⁴⁾ [A _L] (dBuV @ 3m)	Margin (dB)
9kHz - 30MHz	Front	-	-	Max	100	ND	69.5	n/a
30-1000MHz	Horizontal					ND	40.0	n/a
9kHz - 30MHz	Side					ND	69.5	n/a
30-1000MHz	Vertical					ND	40.0	n/a
Results:							Complies	

13.0 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.
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Test Setup	Appendix A	Figure A.2
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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 13.1 – Summary of Radiated Rx Emissions

See Appendix F for Measurement Plots

Measurement Results								
Frequency Range	Antenna Polarization	Bit Rate (Mbps)	Modulation	Power Setting ⁽¹⁾ (dBm)	Transmit Duty Cycle (%)	Measured Emission [E _{Meas}] (dBm)	Worst Case Limit ⁽⁴⁾ [A _L] (dBuV @ 3m)	Margin (dB)
9kHz - 30MHz	Front	n/a	n/a	n/a	n/a	ND	69.5	n/a
30-1000MHz	Horizontal					ND	40.0	n/a
1 - 3GHz						ND	54.0	n/a
3 - 13.6GHz						ND	54.0	n/a
13.6 - 18GHz						ND	54.0	n/a
9kHz - 30MHz	Side					ND	69.5	n/a
30-1000MHz	Vertical					ND	40.0	n/a
1 - 3GHz						ND	54.0	n/a
3 - 13.6GHz						ND	54.0	n/a
13.6 - 18GHz						ND	54.0	n/a
Results:							Complies	

14.0 FREQUENCY STABILITY (NFC)

Test Conditions

Normative Reference	FCC 47 CFR §2.1055, §15.225, RSS-Gen, RSS-210
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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 14.1 – Summary of Frequency Stability Measurements (%)

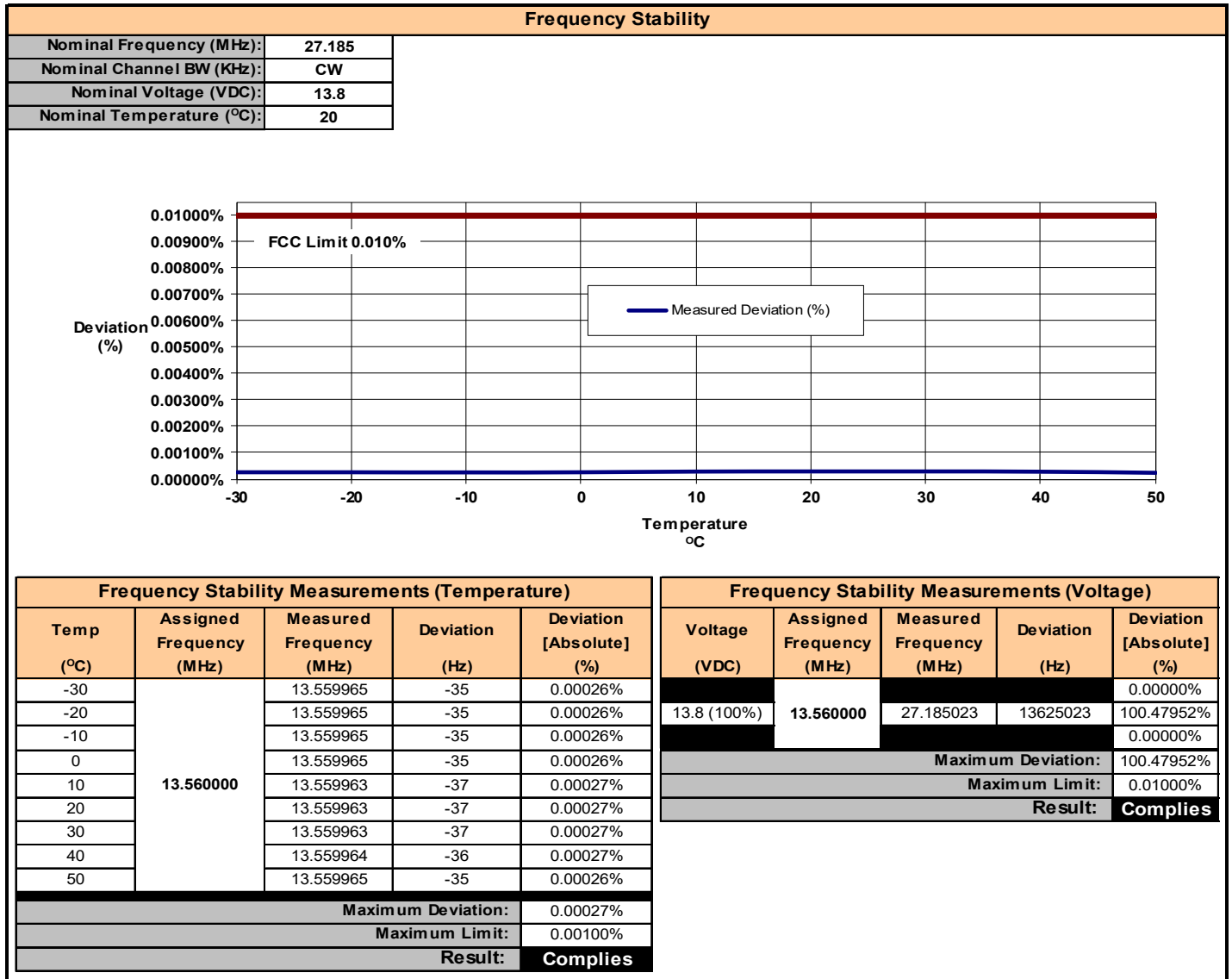
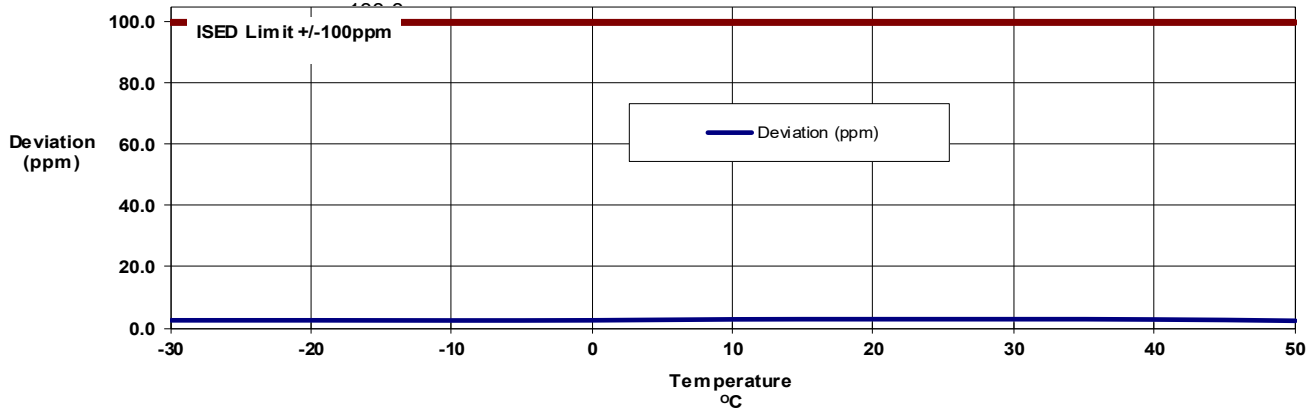


Table 14.2 – Summary of Frequency Stability Measurements (PPM)

Frequency Stability

Nominal Frequency (MHz):	13.56
Nominal Channel BW (KHz):	CW
Nominal Voltage (VDC):	3
Nominal Temperature (°C):	20



Frequency Stability Measurements (Temperature)				
Temp (°C)	Assigned Frequency (MHz)	Measured Frequency (MHz)	Deviation (Hz)	Deviation [Absolute] (ppm)
-30	13.560000	13.559965	-35	2.60
-20		13.559965	-35	2.60
-10		13.559965	-35	2.59
0		13.559965	-35	2.60
10		13.559963	-37	2.70
20		13.559963	-37	2.71
30		13.559963	-37	2.71
40		13.559964	-36	2.68
50		13.559965	-35	2.55
Maximum Deviation:				2.71
Maximum Limit:				100.00
Result:				Complies

Frequency Stability Measurements (Voltage)				
Voltage (VDC)	Assigned Frequency (MHz)	Measured Frequency (MHz)	Deviation (Hz)	Deviation [Absolute] (ppm)
3%	13.560000	13.559963	-37	2.71
Maximum Deviation:				2.71
Maximum Limit:				100.00
Result:				Complies

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

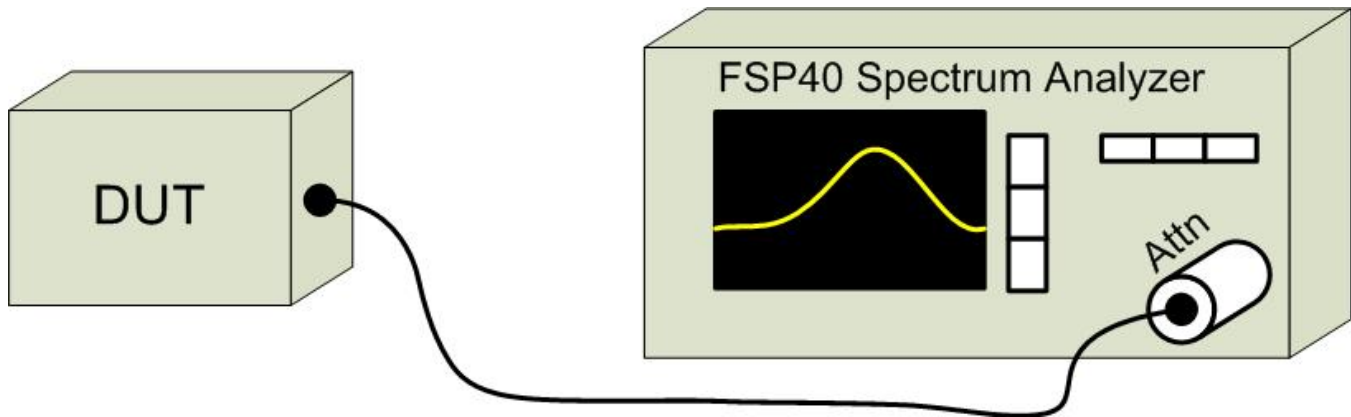


Figure A.1 – Test Setup Conducted Measurements

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
*	00165	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
*	00047	HP	85685A	2837A00826	RF Preselector
*	00049	HP	85650A	2043A00162	Quasi-peak Adapter
*	00051	HP	8566B	2747A05510	Spectrum Analyzer
*	00241	R&S	FSU40	100500	Spectrum Analyzer
*	00005	HP	8648D	3847A00611	Signal Generator
*	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
*	00263B	Koaxis	KP10-1.00M-TD	263B	1m Armoured Cable
*	00264	Koaxis	KP10-7.00M-TD	264	7m Armoured Cable
*	00275	TMS	LMR400	n/a	25m Cable
*	00276	TMS	LMR400	n/a	4m Cable
*	00277	TMS	LMR400	n/a	4m Cable
*	00278	TILE	34G3	n/a	TILE Test Software

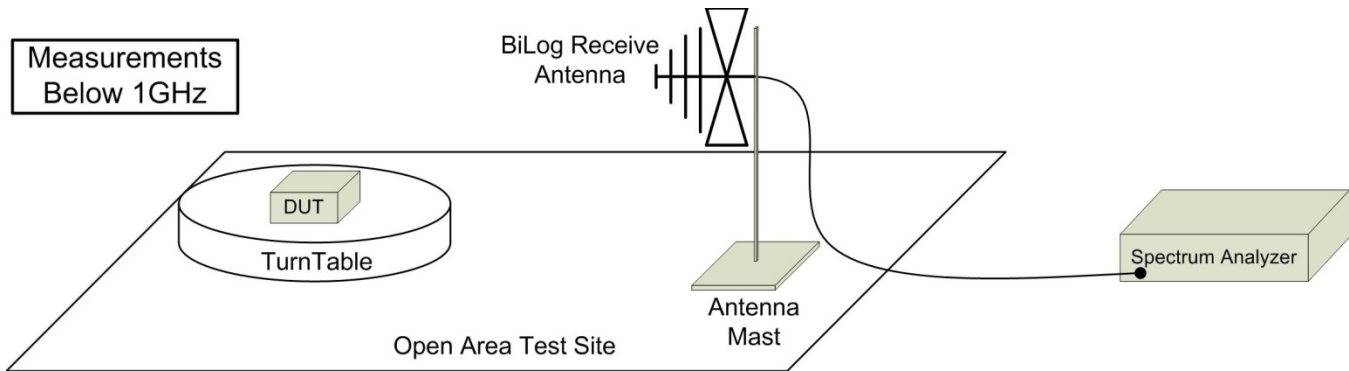


Figure A.2 – Test Setup Radiated Emissions Measurements 30-1000MHz

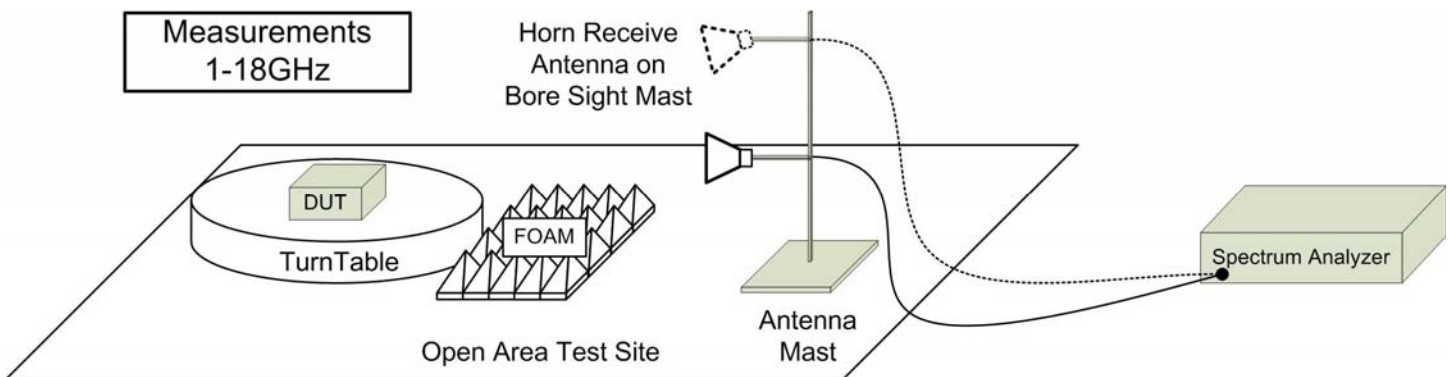


Figure A.3 – Test Setup Radiated Emissions Measurements 1-18GHz

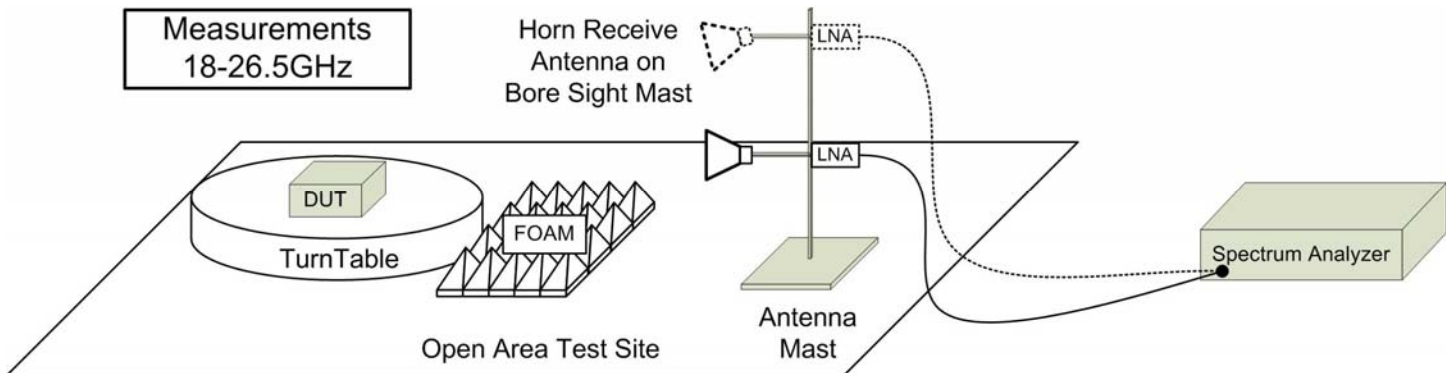


Figure A.4 – Test Setup Radiated Emissions Measurements 18-26.5GHz

Table A.3 – Setup – Frequency Stability Equipment List

Equipment List					
(*)	Asset Number	Manufacturer	Model Number	Serial Number	Description
*	00085	EMCO	6502	9203-2724	Loop Antenna
*	00241	R&S	FSU40	100500	Spectrum Analyzer

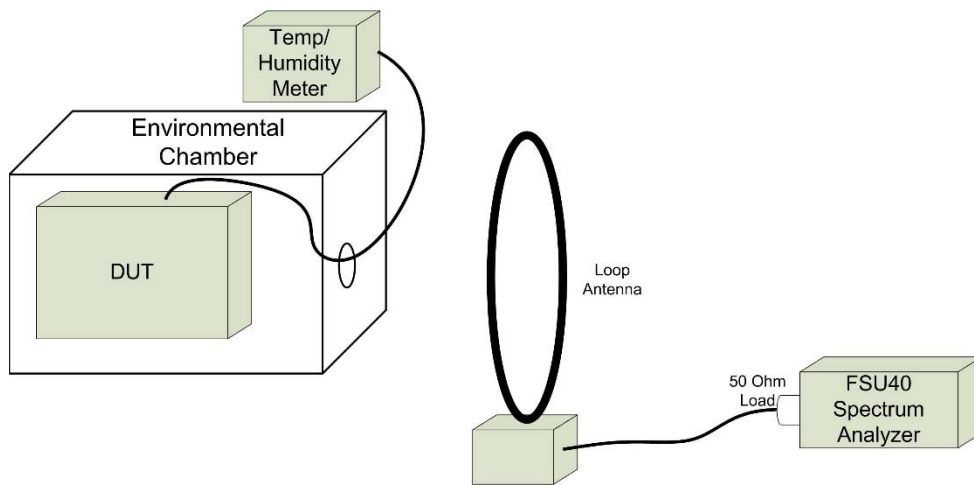


Figure A.5 – Frequency Stability

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	3 Jan 2019	Triennial	3 Jan 2022
*	00034	ETS	3115	6267	Double Ridged Guide Horn	26 Nov 2018	Triennial	26 Nov 2021
*	00035	ETS	3115	6276	Double Ridged Guide Horn	22 Mar 2019	Triennial	21 Mar 2022
*	00085	EMCO	6502	9203-2724	Loop Antenna	11 Jun 2019	Triennial	11 Jun 2022
*	00161	Waveline Inc.	889		Standard Gain Horn 18-26GHz	NCR	n/a	NCR
*	00165	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz	NCR	n/a	NCR
*	00047	HP	85685A	2837A00826	RF Preselector	23 Jun 2017	Triennial	23 Jun 2020
*	00049	HP	85650A	2043A00162	Quasi-peak Adapter	23 Jun 2017	Triennial	23 Jun 2020
*	00051	HP	8566B	2747A05510	Spectrum Analyzer	23 Jun 2017	Triennial	23 Jun 2020
*	00241	R&S	FSU40	100500	Spectrum Analyzer	15 May 2018	Triennial	15 May 2021
*	00005	HP	8648D	3847A00611	Signal Generator	21 Jun 2017	Triennial	21 Jun 2020
*	00265	Miteq	JS32-00104000-58-5P	1939850	Microwave L/N Amplifier	COU	n/a	COU
*	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	27 Jan 2020	Triennial	27 Jan 2023
*	00263B	Koaxis	KP10-1.00M-TD	263B	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
*	00277	TMS	LMR400	n/a	4m Cable	COU	n/a	COU
*	00278	TILE	34G3	n/a	TILE Test Software	NCR	n/a	NCR

* Used during the course of this investigation

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 $k=2$

30MHz - 200MHz

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

200MHz - 1000MHz

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

1GHz - 6GHz

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

6GHz - 18GHz

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

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 |

END OF REPORT

APPENDIX D – FIELD STRENGTH MEASUREMENT PLOTS

APPENDIX E – RADIATED TX MEASUREMENT PLOTS

APPENDIX F – RADIATED RX MEASUREMENT PLOTS