



Test Report Serial Number:

45461922 R2.0

Test Report Date:

29 April 2024

Project Number:

1658

EMC Test Report - New Certification

Applicant:



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

FCC ID:

IPH-04808

Product Model Number / HVIN

A04808

Product Marketing Name / PMN

A04808

In Accordance With:

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

Part 15 Low Power Communication Device Transmitter (DXX)

Approved By:

Ben Hewson, President

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



Test Lab Certificate: 2470.01



Industry
Canada

IC Registration 3874A



FCC Registration: CA3874

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

© 2024 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	8
6.0 FACILITIES AND ACCREDITATIONS	9
7.0 OCCUPIED BANDWIDTH	10
8.0 NFC FIELD STRENGTH / EMISSIONS MASK	13
9.0 RADIATED SPURIOUS EMISSIONS – RESTRICTED BANDS	19
10.0 RADIATED RX SPURIOUS EMISSIONS	21
11.0 POWER LINE CONDUCTED EMISSIONS	23
12.0 FREQUENCY STABILITY (NFC)	28
APPENDIX A – TEST SETUP DRAWINGS AND EQUIPMENT	30
APPENDIX B – EQUIPMENT LIST AND CALIBRATION	37
APPENDIX C – MEASUREMENT INSTRUMENT UNCERTAINTY	38
END OF REPORT	38
APPENDIX I– RADIATED TX EMISSIONS MEASUREMENT PLOTS	39
APPENDIX J– RADIATED RX MEASUREMENT PLOTS	39

Table of Plots

Plot 7.1 – Occupied Bandwidth, NFC	11
Plot 8.1 – Field Strength, NFC, Front	14
Plot 8.2 – Field Strength, NFC, Side	15
Plot 8.3 – Emissions Mask, NFC, Side	16
Plot 11.1 – Power Line Conducted Emissions, Line 1	24
Plot 11.2 – Power Line Conducted Emissions, Line 2	25

Table of Tables

Table 7.1 - Summary of Occupied Bandwidth Measurements (NFC).....	12
Table 8.1 – Summary of Field Strength Measurements (NFC)	17
Table 8.1 – Summary of Field Strength Measurements (NFC) – Cont.....	18
Table 9.1 – Summary of Radiated Tx Emissions.....	20
Table 10.1 – Summary of Radiated Rx Emissions	22
Table 11.1 – Summary of Power Line Conducted Emissions – L1.....	26
Table 11.2 – Summary of Power Line Conducted Emissions – L2.....	27
Table 12.1 – Summary of Frequency Stability Measurements – FCC.....	29
Table A.1 – Setup - Conducted Measurements Equipment List.....	30
Table A.2 – Setup - Radiated Emissions Equipment List	31
Table A.3 – Power Line Conducted Measurement Equipment.....	35
Table A.4 – Setup – Frequency Stability Equipment List.....	36

Table of Figures

Figure A.1 – Test Setup Conducted Measurements.....	30
Figure A.2 – Test Setup Radiated Emissions Measurements Below 30MHz.....	32
Figure A.3 – Test Setup Radiated Emissions Measurements 30 – 1000MHz.....	32
Figure A.4 – Test Setup Radiated Emissions Measurements 30 – 1000MHz Signal Substitution.....	33
Figure A.5 – Test Setup Radiated Emissions Measurements 1 – 18GHz.....	33
Figure A.6 – Test Setup Radiated Emissions Measurements Above 18 GHz.....	34
Figure A.7 – Test Setup Power Line Conducted Measurements.....	35
Figure A.8 – Frequency Stability	36

1.0 DOCUMENT CONTROL

Revision History					
Samples Tested By:		Art Voss, P.Eng.	Date(s) of Evaluation:		18 March - 6 April, 2024
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	11 April 2024
0.2	Revised per applicant's review		-	Art Voss	15 April 2024
1.0	Initial Release		-	Art Voss	19 April 2024
2.0	Revised NFC OBW Results		7	Art Voss	29 April 2024

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):	ISED ID: 1792A-04808
Device Model(s) / HVIN:	A04808
Device Marketing Name / PMN:	A04808
Test Sample Serial No.:	3469058597 - Conducted, 3469058595 - OTA
Device Type:	Portable Transceiver
Equipment Class:	Wireless Local Area Network Device
	General Field Strength Device
Transmit Frequency Range:	WiFi (DTS): 2412-2472MHz
	BT/BLE/ANT: 2402-2480MHz
	NFC: 13.56MHz
Manuf. Max. Rated Output Power:	WiFi - Digital Transmission System (DTS): 12.2dBm EIRP
	Bluetooth - Spread Spectrum Transmitter (DSS): 6.2dBm EIRP
	BLE/ANT - Low Power Communication Device Transmitter (DTS): -2.3dBm EIRP
	NFC - Low Power Communication Device Transmitter (DXX): 55.62dBuV/m
Antenna Type and Gain:	-3.8dBi Max Slot Antenna
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:	4.5VDC Rechargeable Li-Ion
DUT Dimensions [LxWxH]	H x W x D: 51mm 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: A04808 is a portable 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	Test Date	Result
7.0	Occupied Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§2.1049	2-3 April 2024	Pass
8.0	NFC Field Strength, Mask	ANSI C63.10-2013 KDB 558074 D01v05	§15.225(a)(c)	2-3 April 2024	Pass
9.0	Radiated Tx Emission	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(d)(e) §15.209	2-3 April 2024	Pass
10.0	Radiated Rx Emissions	ANSI C63.10-2013 KDB 558074 D01v05	§15.249(d)(e) §15.209	2-3 April 2024	Pass
11.0	Power Line Conducted Emissions	ANSI C63.4-2014	§15.107	5 April 2024	Pass
12.0	Frequency Stability	ANSI C63.10-2013 KDB 558074 D01v05	§15.225	5 April 2024	Pass

Test Station Day Log					
Date	Ambient Temp (°C)	Relative Humidity (%)	Barometric Pressure (kPa)	Test Station	Tests Performed Section(s)
2 Apr 2024	10.0	60	101.9	OATS	7,8,9,10
3 Apr 2024	9.0	36	101.9	OATS	7,8,9,10
5 Apr 2024	17.0	37	100.7	LISN	11,12

EMC - EMC Test Bench

SAC - Semi-Anechoic Chamber

OATS - Open Area Test Site

TC - Temperature Chamber

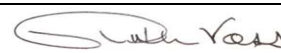
LISN - LISN Test Area

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.

11 April 2024

Date



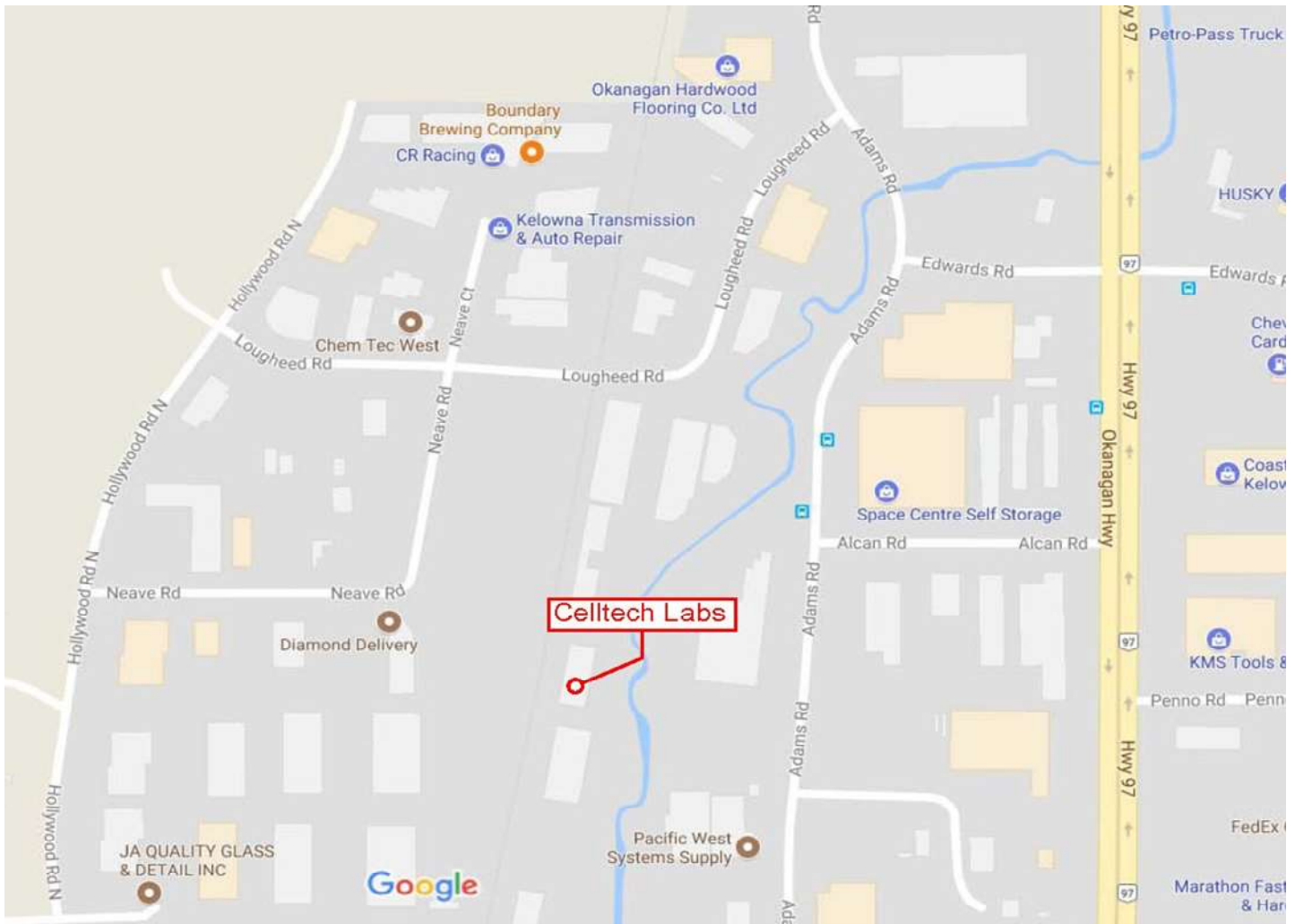
5.0 NORMATIVE REFERENCES

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 CA3874 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, §15.225
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:

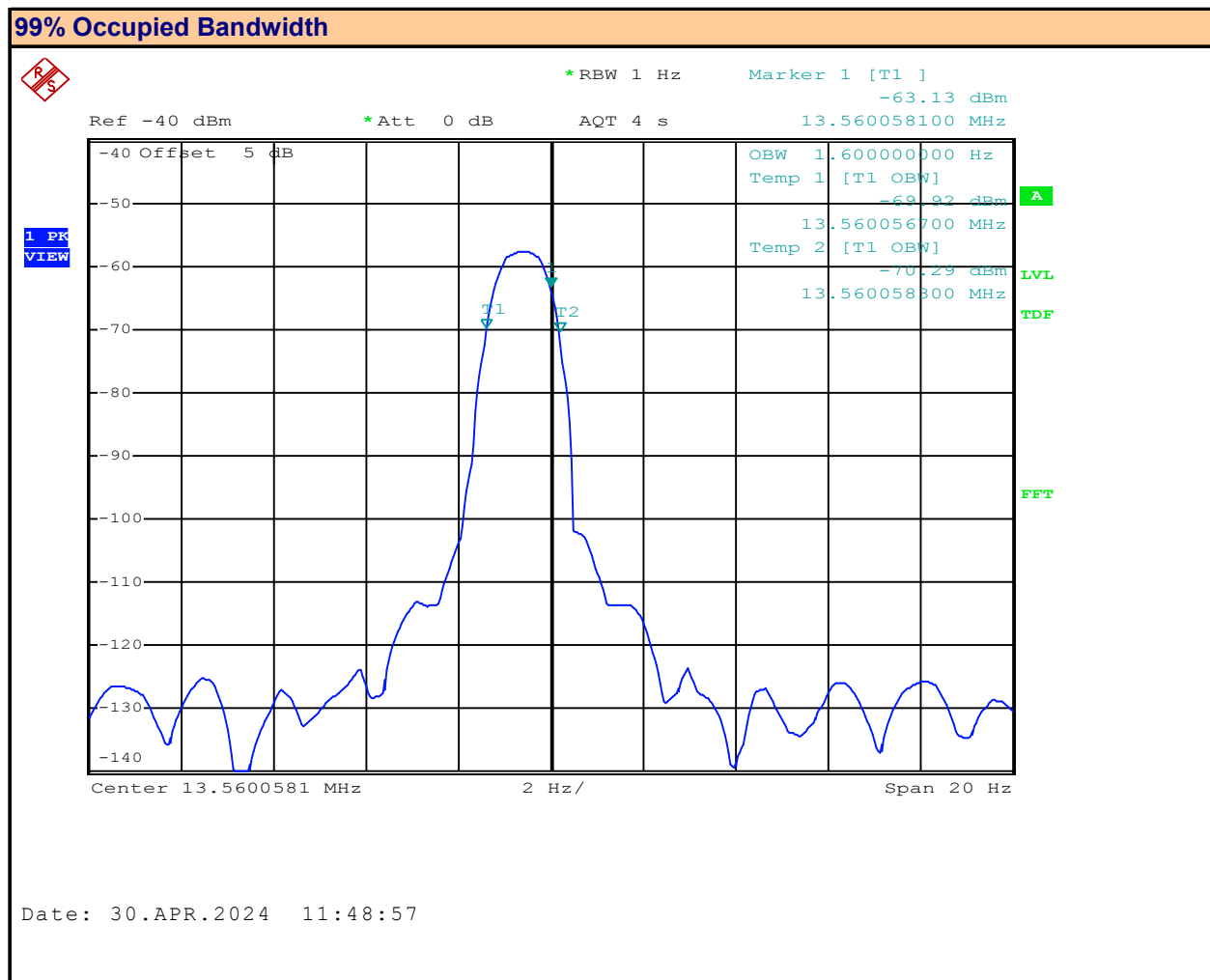
- The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately 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 7.1 – Occupied Bandwidth, NFC



Channel: -
Mode: NFC

Channel Frequency: 13.56 MHz
Modulation: ASK
Measured Occupied Bandwidth: 1.6 Hz

Table 7.1 - Summary of Occupied Bandwidth Measurements (NFC)

99% Occupied Bandwidth Results: NFC					
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured Occupied Bandwidth (Hz)	Emission Designator
-	13.56	NFC	ASK	66.00	1H60K1D
Result:					Complies

8.0 NFC FIELD STRENGTH / EMISSIONS MASK

Test Procedure

Normative Reference	FCC 47 CFR §2.1046, §15.225
	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

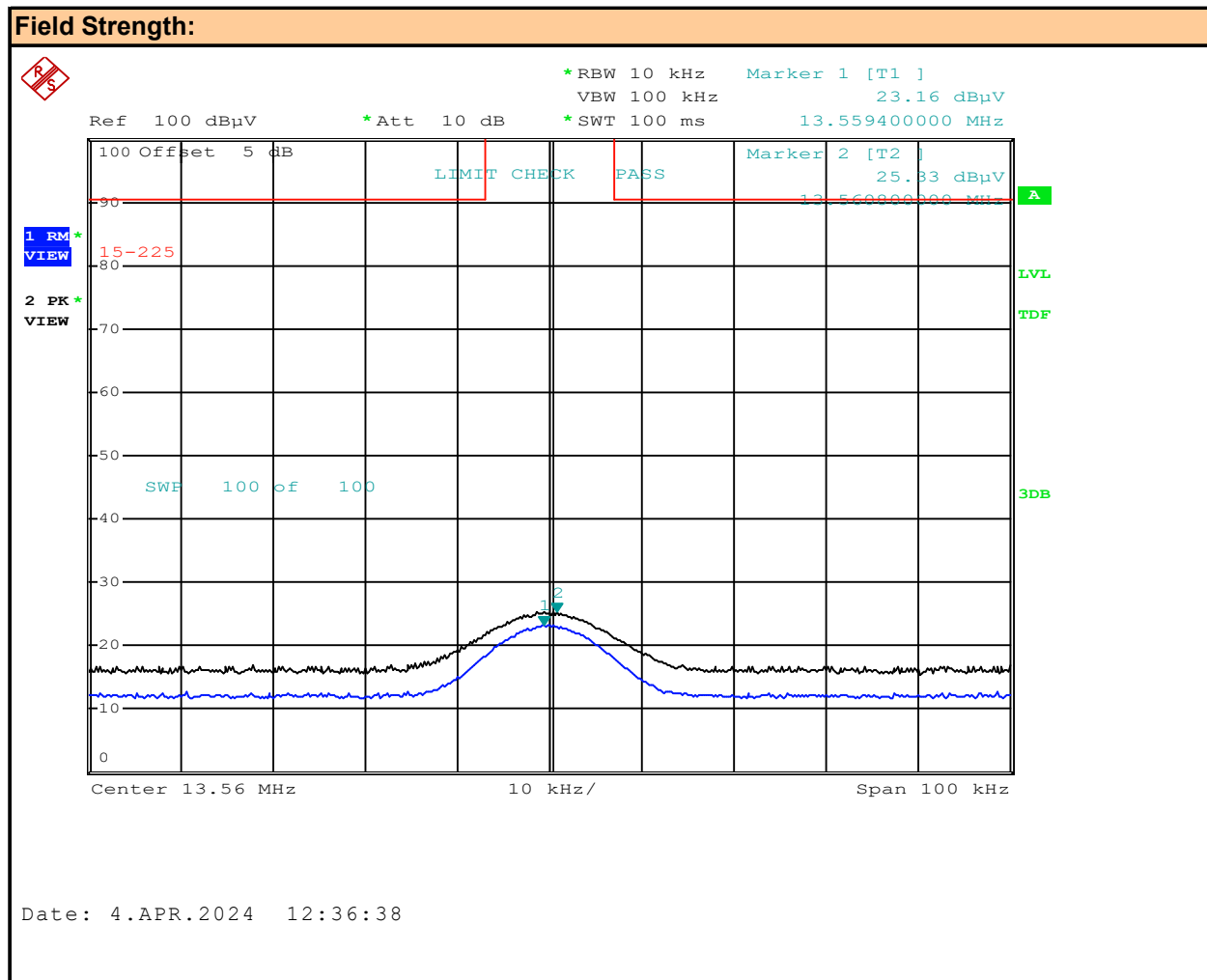
C63.10 (6.5.4)	6.5.4 Final radiated emission tests Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have 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 8.1 – Field Strength, NFC, Front



Polarization: **Front**

Channel: **-**

Mode: **NFC**

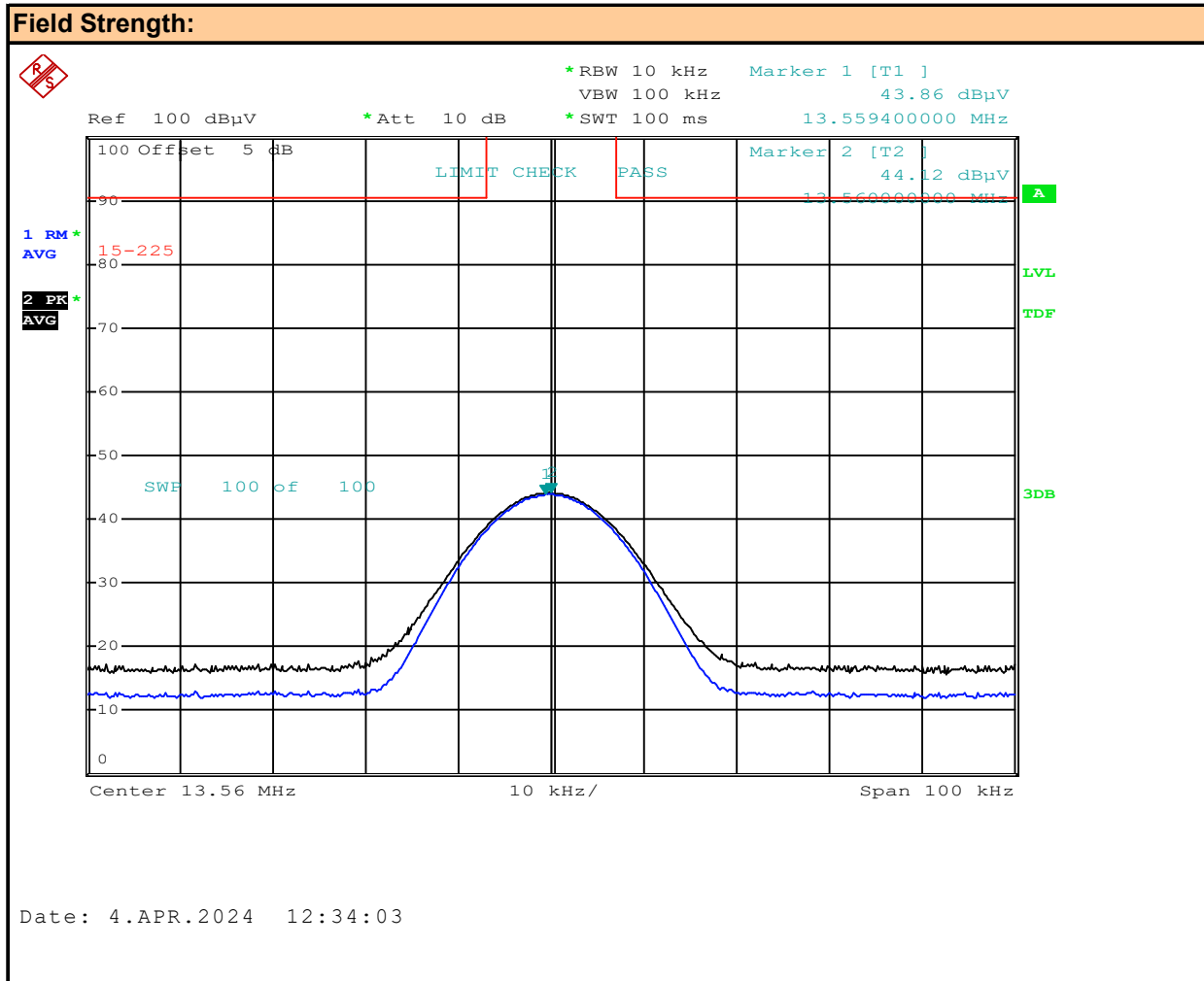
Channel Frequency: **13.56** MHz

Modulation: **ASK**

Measured Field Strength (Pk): **25.33** dBμV/m

Measured Field Strength (Av): **23.16** dBμV/m

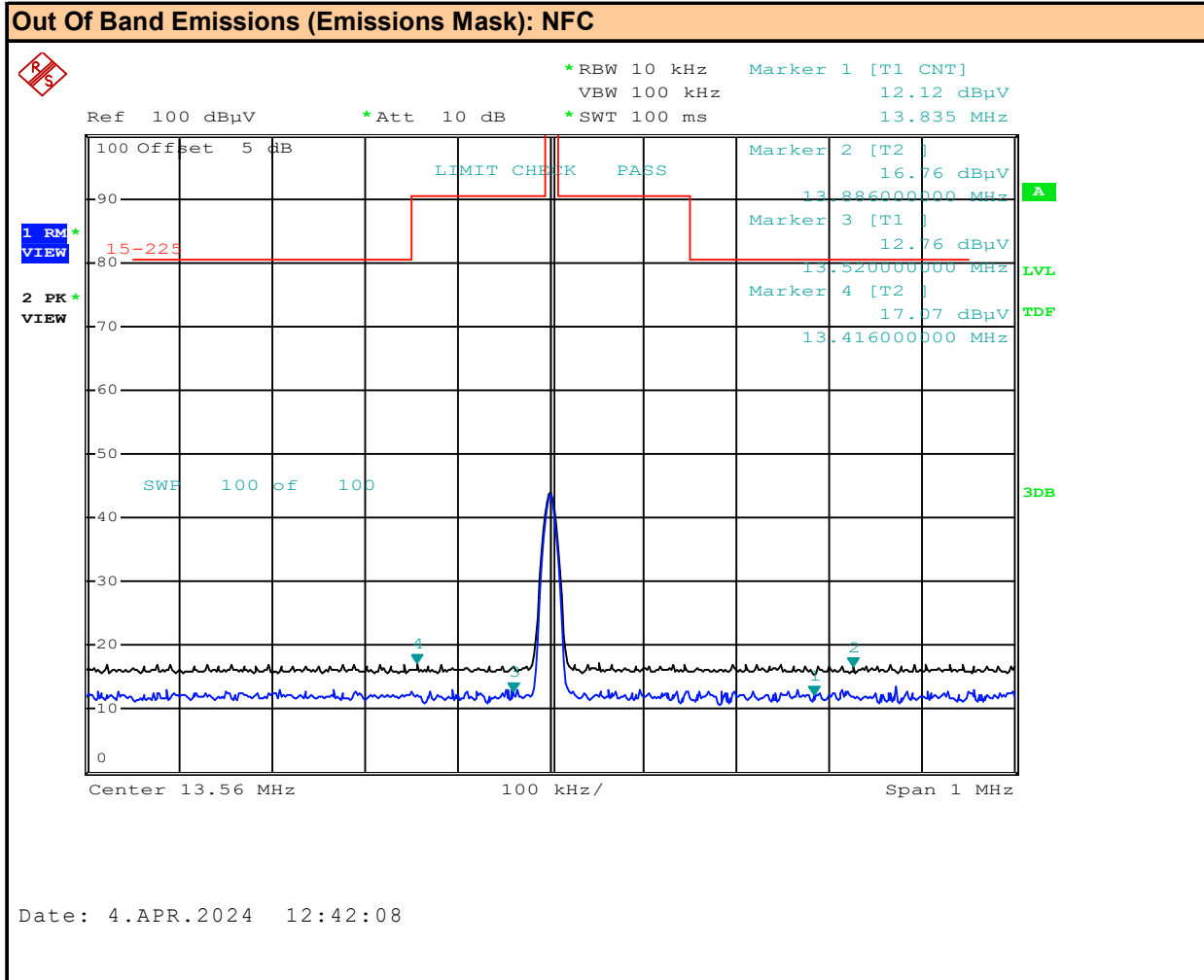
Plot 8.2 – Field Strength, NFC, Side



Polarization: **Side**
Channel: **-**
Mode: **NFC**

Channel Frequency: **13.56** MHz
Modulation: **ASK**
Measured Field Strength (Pk): **44.12** dBμV/m
Measured Field Strength (Av): **43.86** dBμV/m

Plot 8.3 – Emissions Mask, NFC, Side



Polarization: **Side**

Channel: **-**

Mode: **NFC**

Channel Frequency: **13.56** MHz

Modulation: **ASK**

Table 8.1 – 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 (dB)	Emissions Mask
13.56	NFC	ASK	RMS	Front	23.16	0.5	10.5	34.16	84.00	124.0	89.8	Pass
				Side	43.86			54.86			69.1	Pass
			Peak	Front	25.33			36.33	104.00	144.0	107.7	Pass
				Side	44.12			55.12			88.9	Pass
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)

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

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

Table 8.1 – Summary of Field Strength Measurements (NFC) – Cont.

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 (dB)	Emissions Mask
13.56	NFC	ASK	RMS	Front	23.16	0.5	-41	-17.34	84.00	72.5	89.8	Pass
				Side	43.86			3.36			69.1	Pass
			Peak	Front	25.33			-15.17	104.00	92.5	107.7	Pass
				Side	44.12			3.62			88.9	Pass
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)

In accordance with ISED Notice 2020 - DRS0023:

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

Limit Correction

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

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

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

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

Measurement Correction

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

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

$$\text{Margin} = \text{Limit}_{3\text{m}} - H_{\text{Corr}}$$

9.0 RADIATED SPURIOUS EMISSIONS – RESTRICTED BANDS

Test Procedure

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

Limits

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:	
	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 9.1 – Summary of Radiated Tx Emissions

See Appendix I for Measurement Plots

Summary of Radiated Tx Emissions										
Measured Frequency Range (MHz)	Channel Frequency (MHz)	Antenna Polarization	Emission Frequency (MHz)	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)
30-1000 MHz	13.6	Horizontal	ND	(1) AV	n/a	n/a	0.00 (3)	ND	n/a	(1)
		Vertical	ND	(1) AV	n/a	n/a	0.00 (3)	ND	n/a	(1)
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

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

Where ACF^E is the Electric Antenna Correction Factor

* Without Manufacturer's Accessories, ** With Manufacturer's Accessories

10.0 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 10.1 – Summary of Radiated Rx Emissions

See Appendix J for Measurement Plots

Summary of Radiated Rx Emissions										
Measured Frequency Range (MHz)	Channel Frequency (MHz)	Antenna Polarization	Emission Frequency (MHz)	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)
30-1000	-	Horizontal	(1)	(1) AV	-	-	0.00 (3)	(1)	-	(1)
30-1000	-	Vertical	(1)	(1) AV	-	-	0.00 (3)	(1)	-	(1)
Results:									Complies	

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

(3) External Amplifier not used

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

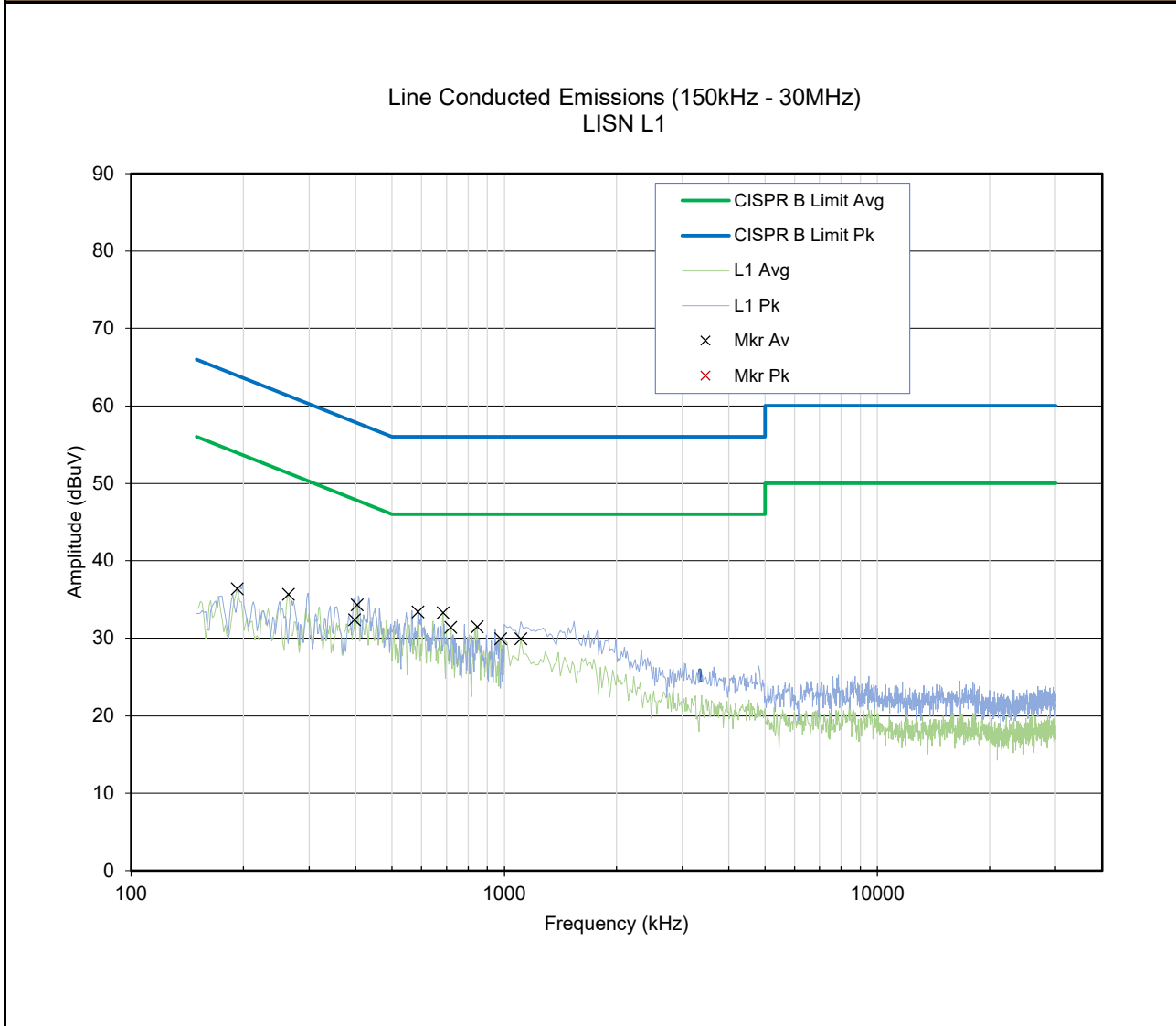
Where ACF^E is the Electric Antenna Correction Factor

11.0 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 11.1 – Power Line Conducted Emissions, Line 1

Line Conducted Emissions



Plot 11.2 – Power Line Conducted Emissions, Line 2

Line Conducted Emissions

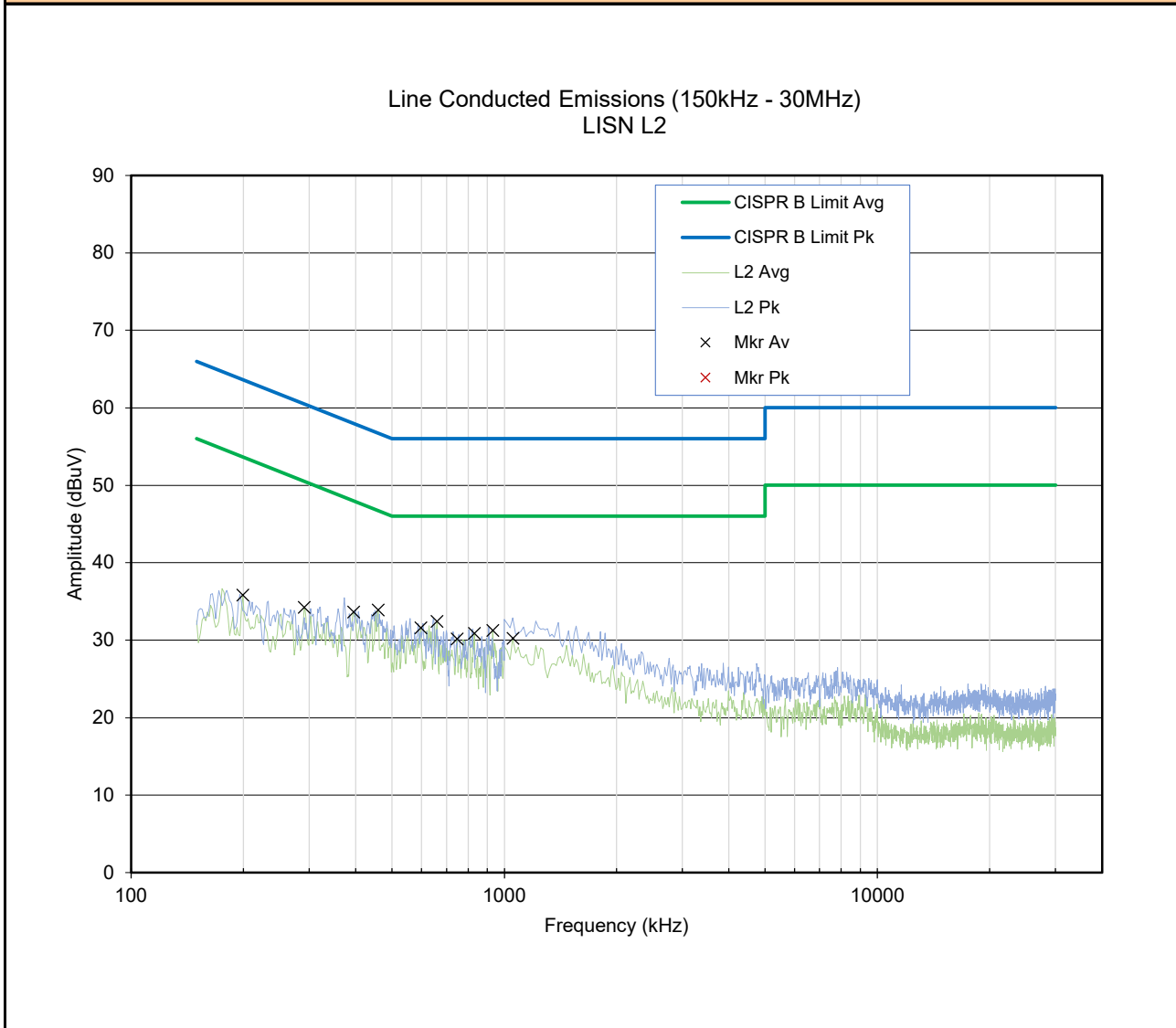


Table 11.1 – Summary of Power Line Conducted Emissions – L1

§15.107, ICES-003 (6.1)					
Emission	LISN	Detector	Corrected Emission	Limit	Margin
Frequency	Port		[E_{Corr}]*	[Limit]	[Margin]
			(W)	(dBuV/m)	(dB)
192.5 kHz	L1	Average	36.40	54.3	17.9
263.9 kHz	L1	Average	35.65	51.6	15.9
396.5 kHz	L1	Average	32.39	48.0	15.6
403.3 kHz	L1	Average	34.31	47.9	13.6
586.9 kHz	L1	Average	33.40	46.0	12.6
685.5 kHz	L1	Average	33.26	46.0	12.7
717.8 kHz	L1	Average	31.38	46.0	14.6
847.0 kHz	L1	Average	31.48	46.0	14.5
977.9 kHz	L1	Average	29.92	46.0	16.1
1108.0 kHz	L1	Average	29.92	46.0	16.1
Results:				Complies	

* Measurement Compensated for Cable Loss and Antenna Correction Factor

$$E_{\text{Corr}} = E_{\text{Meas}} + L_C + \text{AFC}$$

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

Table 11.2 – Summary of Power Line Conducted Emissions – L2

§15.107, ICES-003 (6.1)					
Emission	LISN	Detector	Corrected Emission	Limit	Margin
Frequency	Port		[E_{Corr}]*	[Limit]	[Margin]
			(W)	(dBuV/m)	(dB)
199.3 kHz	L2	Average	35.83	54.0	18.2
291.1 kHz	L2	Average	34.22	50.7	16.5
394.8 kHz	L2	Average	33.64	48.1	14.4
459.4 kHz	L2	Average	33.88	46.7	12.9
597.1 kHz	L2	Average	31.59	46.0	14.4
660.0 kHz	L2	Average	32.40	46.0	13.6
746.7 kHz	L2	Average	30.14	46.0	15.9
831.7 kHz	L2	Average	30.85	46.0	15.2
932.0 kHz	L2	Average	31.23	46.0	14.8
1054.0 kHz	L2	Average	30.22	46.0	15.8
Results:				Complies	

* Measurement Compensated for Cable Loss and Antenna Correction Factor

$$E_{\text{Corr}} = E_{\text{Meas}} + L_C + \text{AFC}$$

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

12.0 FREQUENCY STABILITY (NFC)

Test Conditions

Normative Reference FCC 47 CFR §2.1055, §15.225

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.

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:

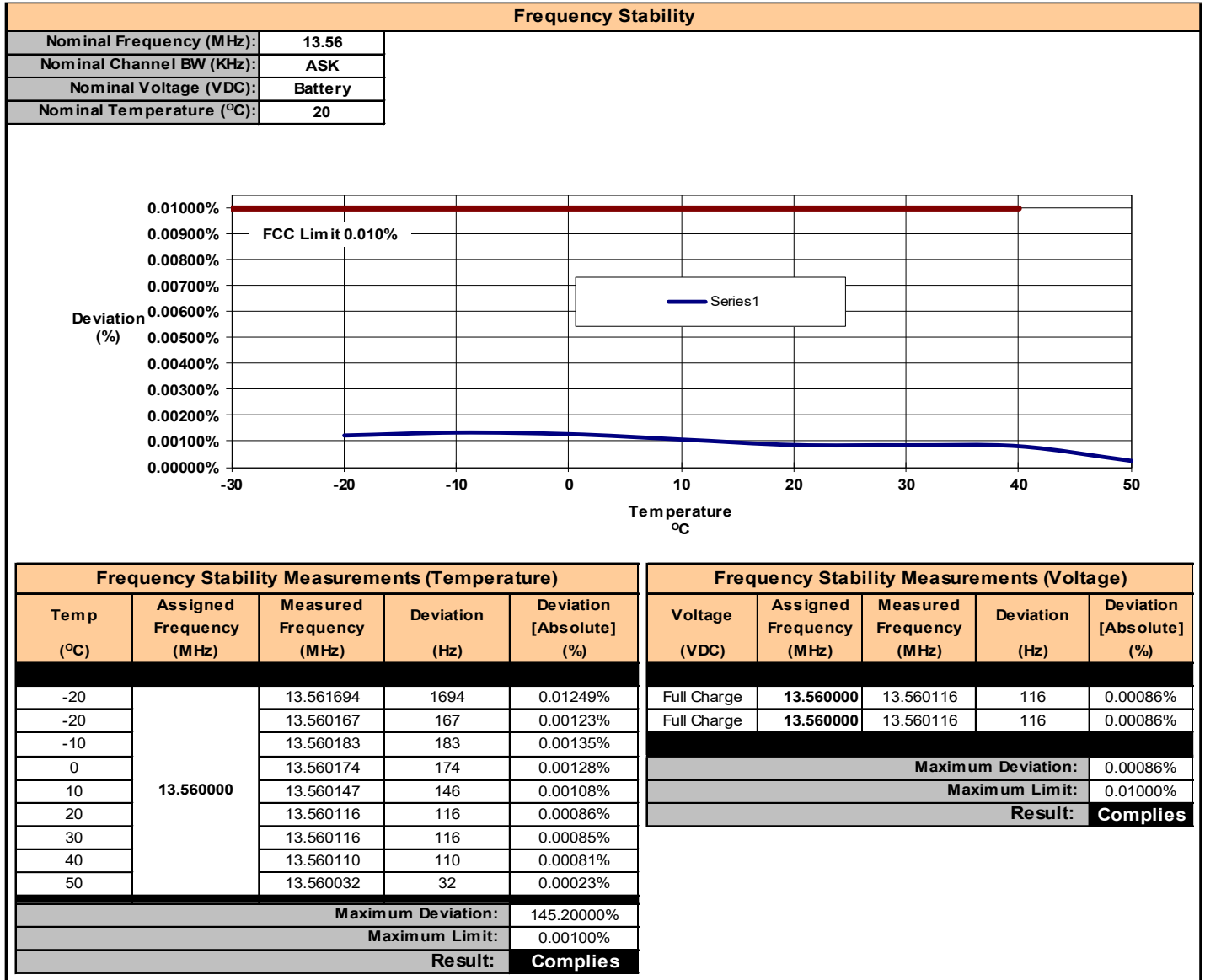
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

Test Setup

Appendix A

5

Table 12.1 – Summary of Frequency Stability Measurements – FCC



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

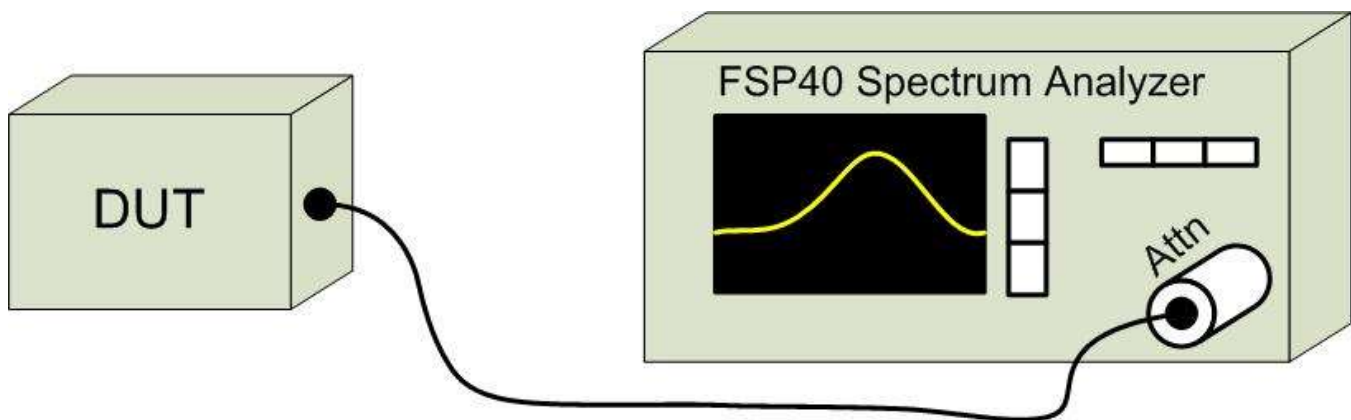


Figure A.1 – Test Setup Conducted Measurements

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

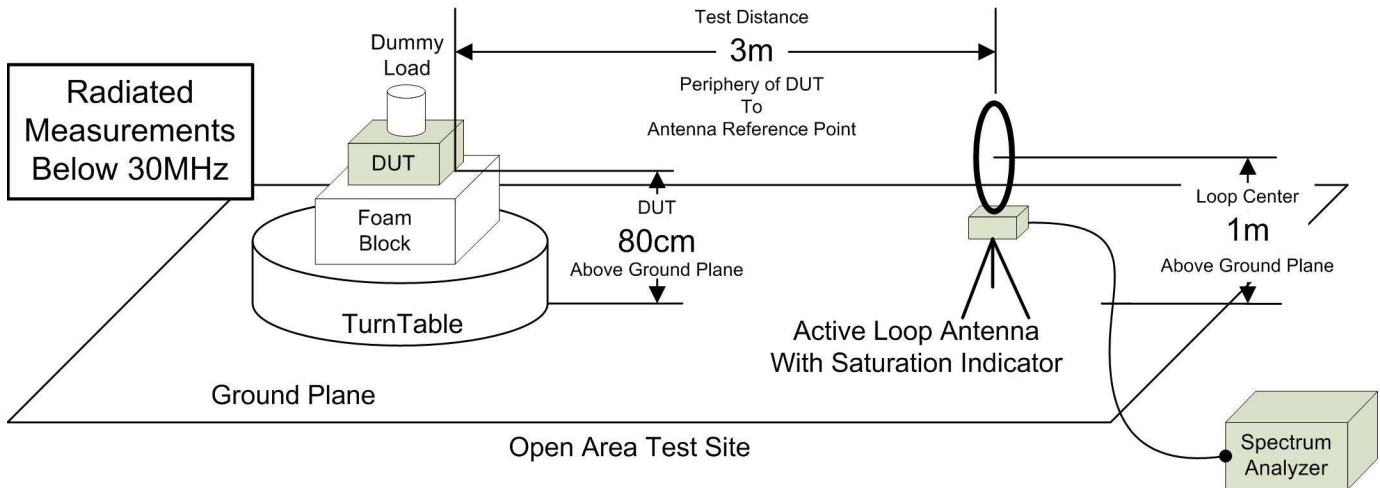


Figure A.2 – Test Setup Radiated Emissions Measurements Below 30MHz

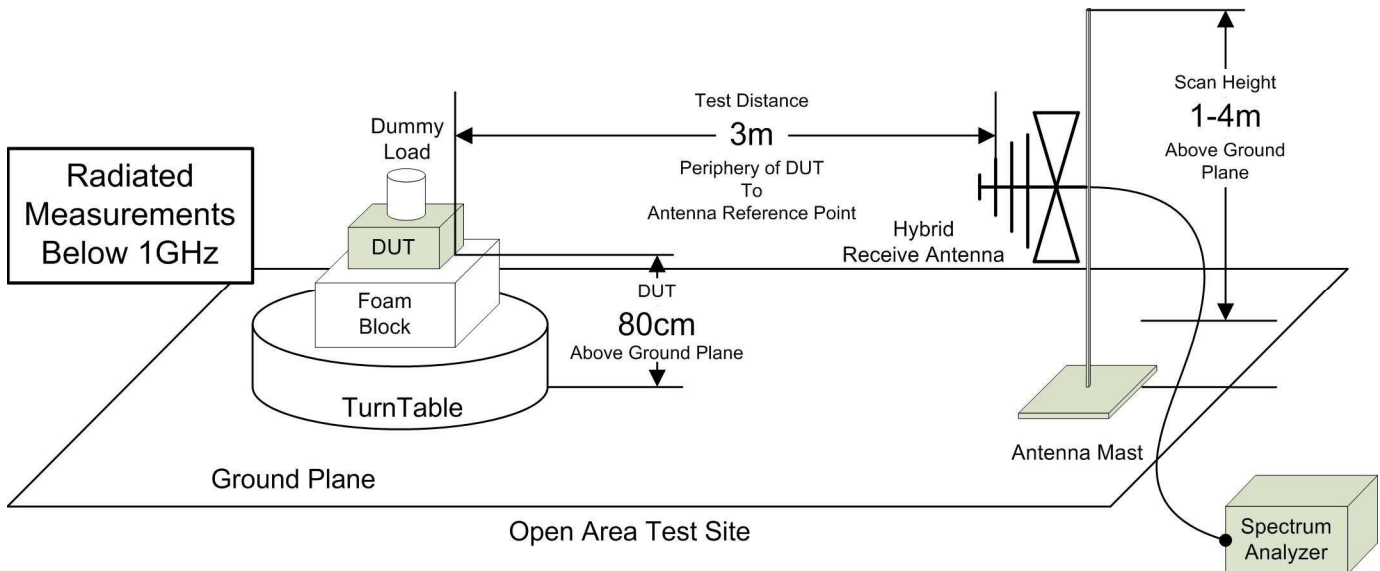


Figure A.3 – Test Setup Radiated Emissions Measurements 30 – 1000MHz

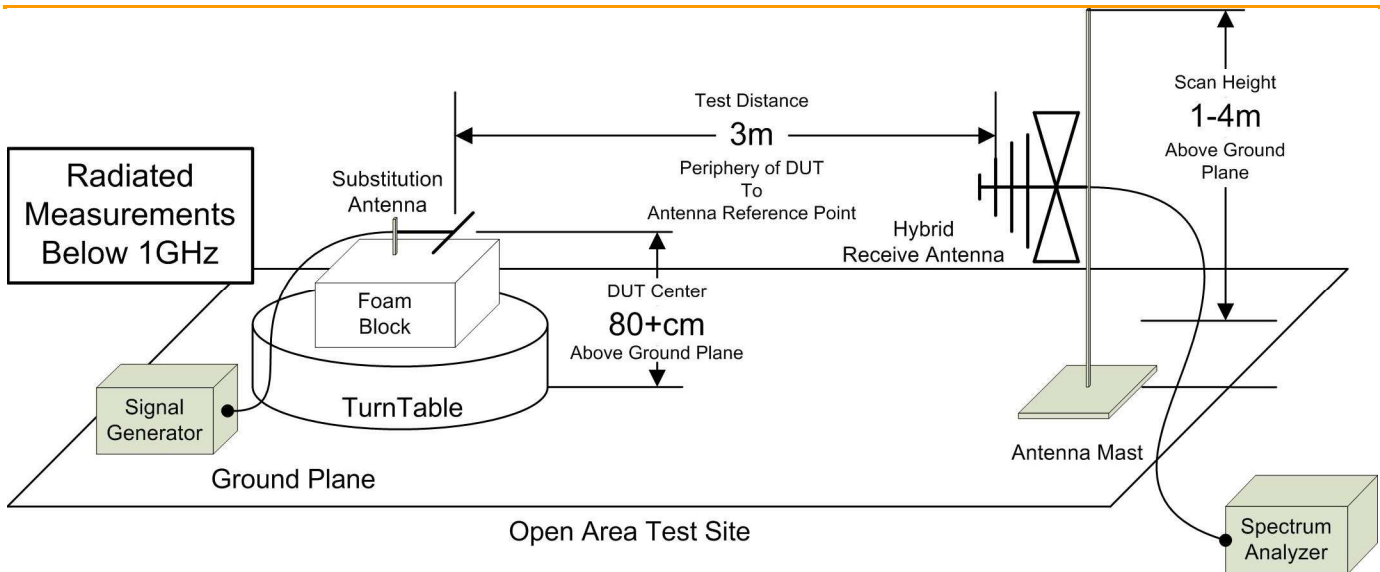


Figure A.4 – Test Setup Radiated Emissions Measurements 30 – 1000MHz Signal Substitution

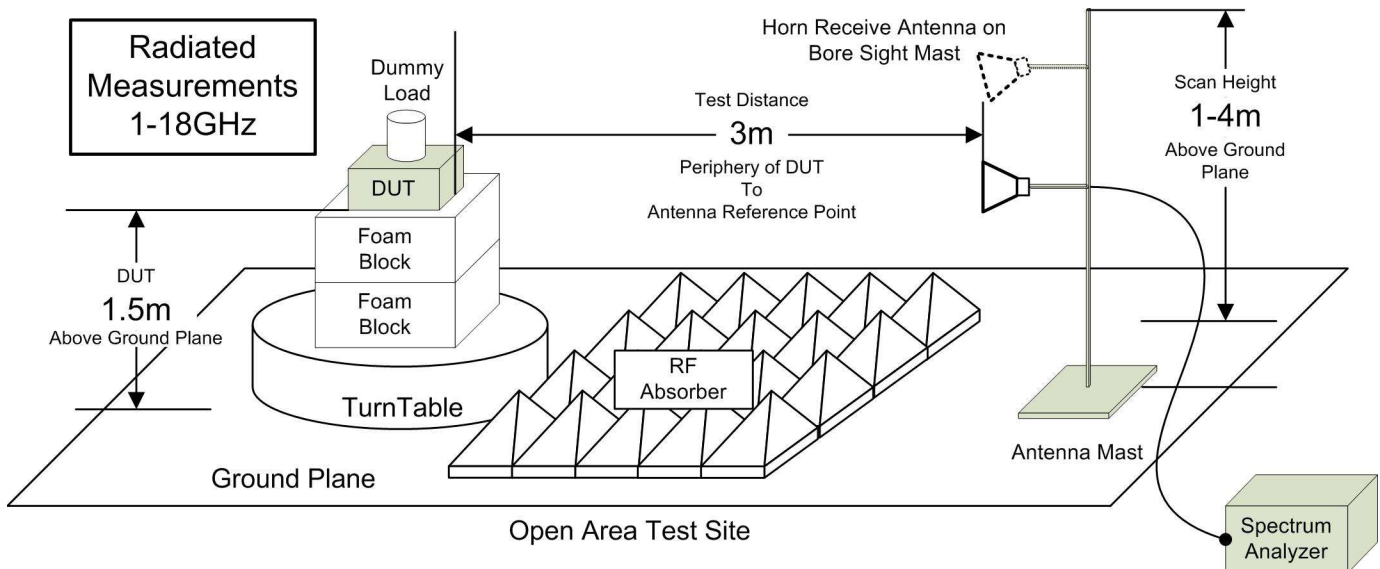


Figure A.5 – Test Setup Radiated Emissions Measurements 1 – 18GHz

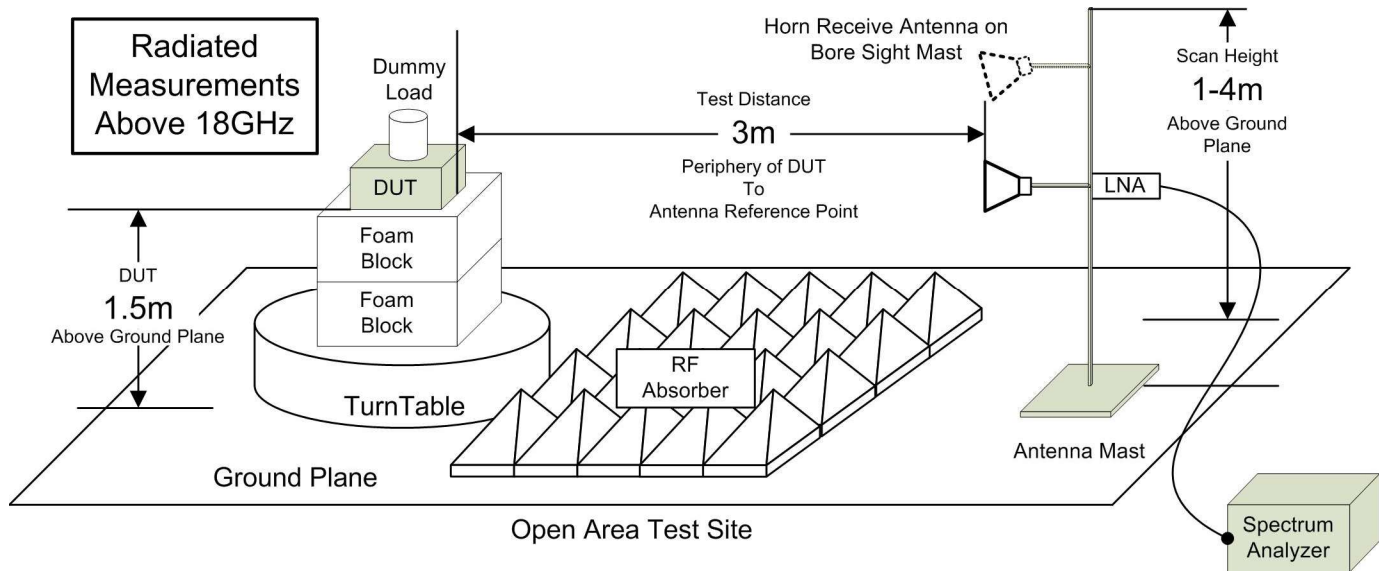


Figure A.6 – Test Setup Radiated Emissions Measurements Above 18 GHz

Table A.3 – Power Line Conducted Measurement Equipment

Equipment List			
Asset Number	Manufacturer	Model Number	Description
00241	R&S	FSU40	Spectrum Analyzer
00275	Coaxis	LMR400	25m Cable
00276	Coaxis	LMR400	4m Cable
00278	TILE	34G3	TILE Test Software
00257	Comm Power	LI-215A	LISN

Figure A.7 – Test Setup Power Line Conducted Measurements

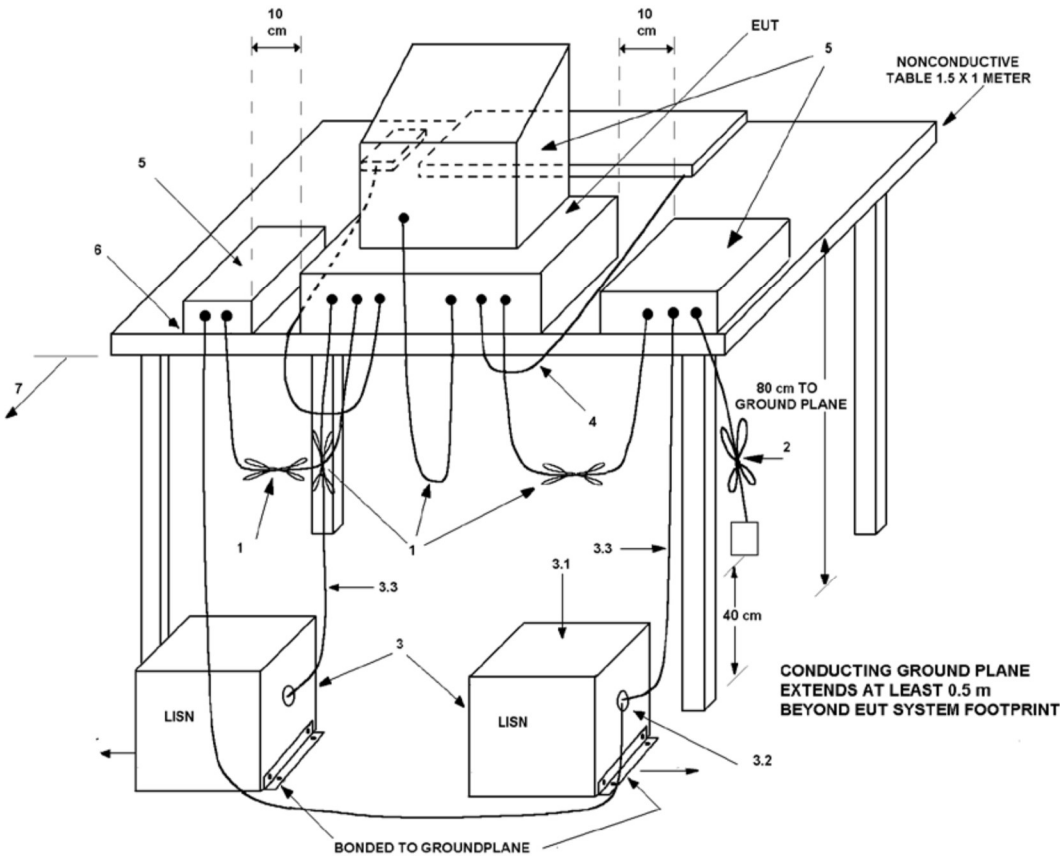


Table A.4 – Setup – Frequency Stability Equipment List

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

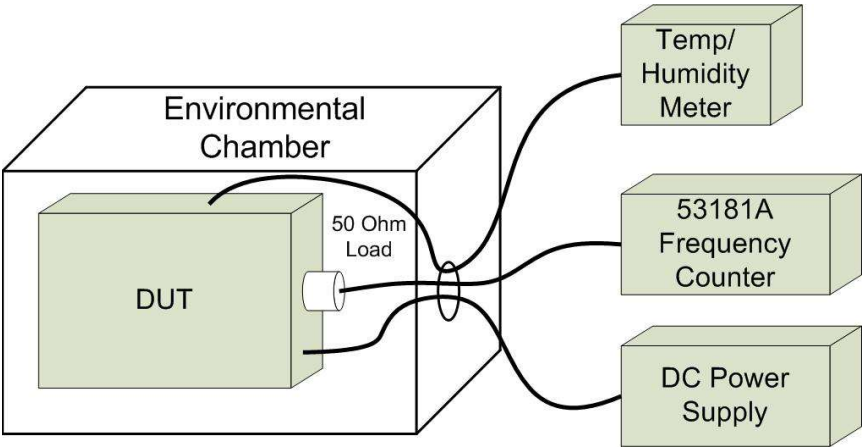


Figure A.8 – Frequency Stability

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 2023	Triennial	16 Nov 2026
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
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
00241	R&S	FSU40	100500	Spectrum Analyzer	10 Aug 2021	Triennial	10 Aug 2024
00005	HP	8648D	3847A00611	Signal Generator	28 Jun 2023	Triennial	28 Jun 2026
00003	HP	53181A	3736A05175	Frequency Counter	28 Jun 2023	Triennial	28 Jun 2026
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
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

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

Radiated Emissions 200MHz - 1000MHz

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

Radiated Emissions 1GHz - 6GHz

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

Radiated Emissions 6GHz - 18GHz

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

Power Line Conducted Emissions 9kHz to 150kHz

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

Power Line Conducted Emissions 150kHz to 30MHz

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

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

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

Frequency/Bandwidth 9kHz - 40GHz

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

Temperature

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

END OF REPORT

APPENDIX I– RADIATED TX EMISSIONS MEASUREMENT PLOTS

APPENDIX J– RADIATED RX MEASUREMENT PLOTS