Test Report Serial Number:	**45461897 R2.0**
Test Report Date:	**5 January 2024**
Project Number:	**1641**

EMC Test Report - New Certification

Applicant:

Zenner USA
15280 Addison Rs
Suite 240
Addison, TX, 75001, USA

FCC ID:

2ACOA-MS3

Product Model Number / HVIN

208-0041-001

Product Marketing Name / PMN

Mesh Stamp 3

In Accordance With:

CFR Title 47, Part 15 Subpart C (§15.247), Part 15 Subpart B

Digital Spread Spectrum System (DSS)

Approved By:

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

Test Lab Certificate: 2470.01

IC Registration 3874A

FCC Registration: CA3874

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1.0 DOCUMENT CONTROL

Revision History				
Samples Tested By:	Art Voss, P.Eng.	**Date(s) of Evaluation:**	2 October - 4 October, 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	26 October 2023
1.0	Initial Release	n/a	Art Voss	1 November 2023
2.0	Corrected HVIN	Cover, 2.0, 3.0	Art Voss	5 January 2024

2.0 CLIENT AND DUT INFORMATION

Client Information	
Applicant Name	**Zenner USA**
Applicant Address	15280 Addison Rd, Suite 240
	Addison, TX, 75001
	USA
DUT Information	
Device Identifier(s):	**ISED ID:** **26631-MS3**
Device Model(s) / HVIN:	208-0041-001
Device Marketing Name / PMN:	Mesh Stamp 3
Test Sample Serial No.:	75600
Device Type:	Digital Spread Spectrum Transceiver
ISED Equipment Class:	Wireless Local Area Network Device
Transmit Frequency Range:	MESH Mode (DSS): 902-928MHz
Manuf. Max. Rated Output Power:	MESH Mode (DSS): 500mW (27dBm)
Antenna Type and Gain:	0dBi Max*, Helical
Modulation:	FSK
DUT Dimensions [LxWxH] (cm)	H x W x D: 6.5 X 6.5 X 0.1
Deviation(s) from standard/procedure:	None
Modification of DUT:	None

3.0 SCOPE

Preface:

This Certification Report was prepared on behalf of:

Zenner USA

,(the '*Applicant*"), in accordance with the applicable Federal Communications Commission (FCC) CFR 47 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 Operation:

The Zenner USA Model/HVIN: 208-0041-001, Product Name/PMN: Mesh Stamp 3 (MS3) is a Class A limited modular digital spread spectrum (DSS) data transceiver operating in the 902-928MHz band. The MS3 module is to be used by the module manufacturer only and not intended to be marketed to the general public. The host products containing the MS3 module are utility meter-reading devices and requires professional installation by utility suppliers.

Requirement:

The transceivers of this *equipment* are subject to emissions evaluation in accordance with FCC: 47 CFR 2 and 15C. As per FCC 47 CFR §2.1091 an RF Exposure (MPE) evaluation is required for this *Equipment* and the results of the RF Exposure (MPE) 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 unwanted spurious emissions in accordance with the rule parts cited in Normative References section of this report.

4.0 TEST 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 Oct 2023	Pass
8.0	DTS Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§15.247(a)(2)	2 Oct 2023	Pass
9.0	20dB Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§15.247(a)(1)(i)	2 Oct 2023	Pass
10.0	Conducted Power (Fundamental)	ANSI C63.10-2013 KDB 558074 D01v05 KDB 558074 D01v05	§2.1046 §15.247(b)(2) §15.247(b)(3)	2 Oct 2023	Pass
11.0	FHSS Hopping Characteristics	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)(iii)	2 Oct 2023	Pass
12.0	FHSS Channel Separation	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)	2 Oct 2023	Pass
13.0	FHSS Time of Occupancy	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)(iii)	2 Oct 2023	Pass
14.0	Conducted Tx Spurious Emissions Band Edge	ANSI C63.10-2013 KDB 558074 D01v05	§2.1051 §15.247(d)	2 Oct 2023	Pass
15.0	Conducted Tx Spurious Emissions	ANSI C63.10-2013 KDB 558074 D01v05	§2.1051 §15.247(d)	2 Oct 2023	Pass
16.0	Radiated Tx Spurious Emissions And Restricted Band	ANSI C63.4-2014 KDB 558074 D01v05	§15.109 §15.247(d)	3 Oct 2023	Pass
17.0	Radiated Rx Spurious Emissions	ANSI C63.4-2014 KDB 558074 D01v05	§15.109	3 Oct 2023	Pass
18.0	Line Conducted Emissions	ANSI C63.4-2014 KDB 558074 D01v05	§15.107	4 Oct 2023	Pass

Test Station Day Log					
Date	**Ambient Temp (°C)**	**Relative Humidity (%)**	**Barometric Pressure (kPa)**	**Test Station**	**Tests Performed Section(s)**
2 Oct 2023	23.0	16	101.1	**EMC**	**7 thru 15**
3 Oct 2023	17.0	64	101.4	**OATS**	**16, 17**
4 Oct 2023	19.0	16	101.2	**LISN**	**18**

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

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.

4 October 2023
Date

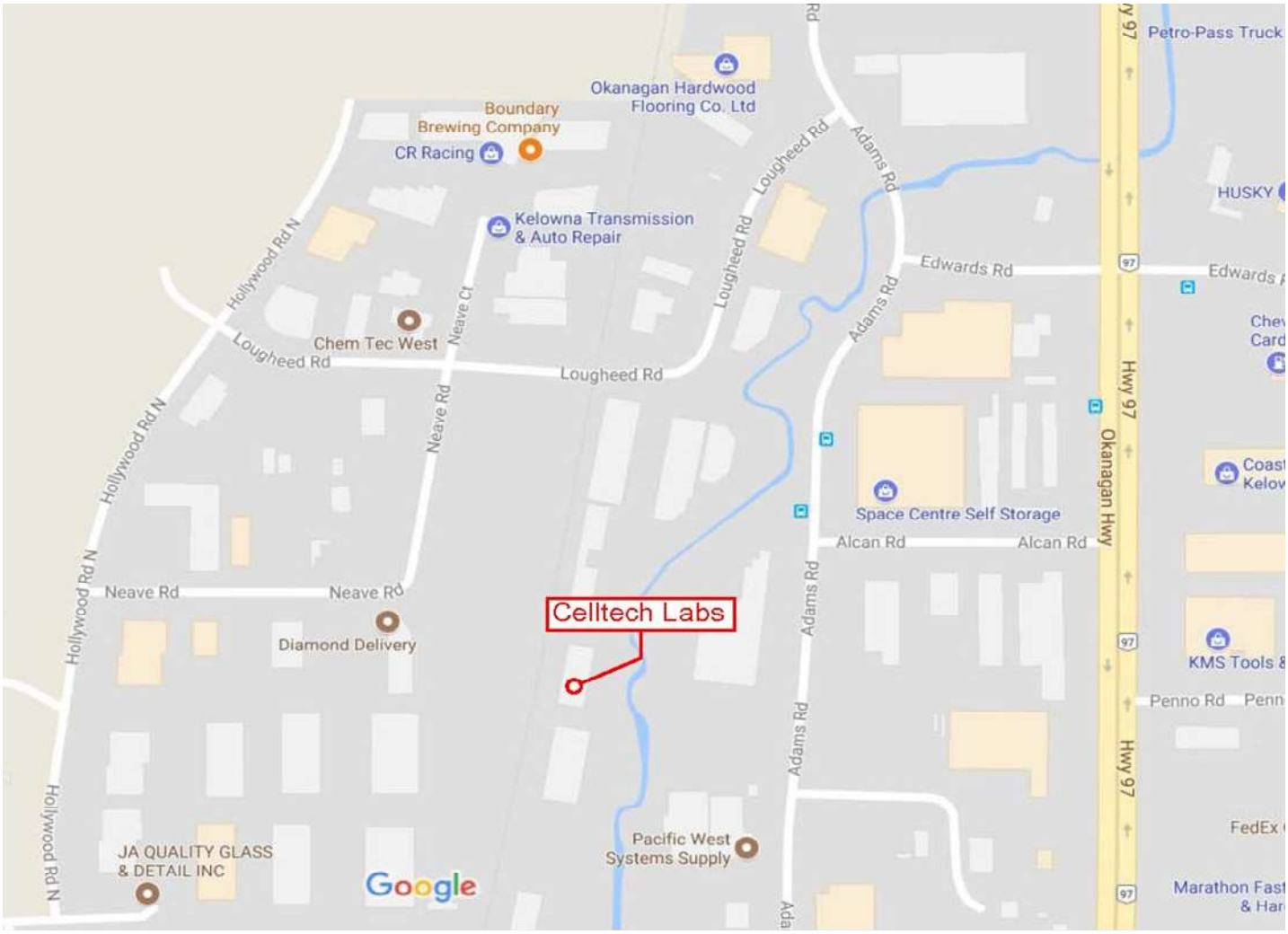
5.0 NORMATIVE REFERENCES

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 Title 47: Part 2:	Code of Federal Regulations Telecommunication Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
CFR Title 47: Part 2: Subpart (2.1091):	Code of Federal Regulations Telecommunication Frequency Allocations and Radio Treaty Matters; General Rules and Regulations Radiofrequency radiation exposure evaluation: mobile devices.
CFR Title 47: Part 15: Subpart B:	Code of Federal Regulations Telecommunication Radio Frequency Devices Unintentional Radiators
CFR Title 47: Part 15: Sub Part C (15.247)	Code of Federal Regulations Telecommunication Radio Frequency Devices Intentional Radiators
FCC KDB 558074 D01v05r02	OET Major Guidance Publications, Knowledge Data Base Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247

6.0 FACILITIES AND ACCREDITATIONS

Facility and Accreditation:

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



7.0 OCCUPIED BANDWIDTH

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

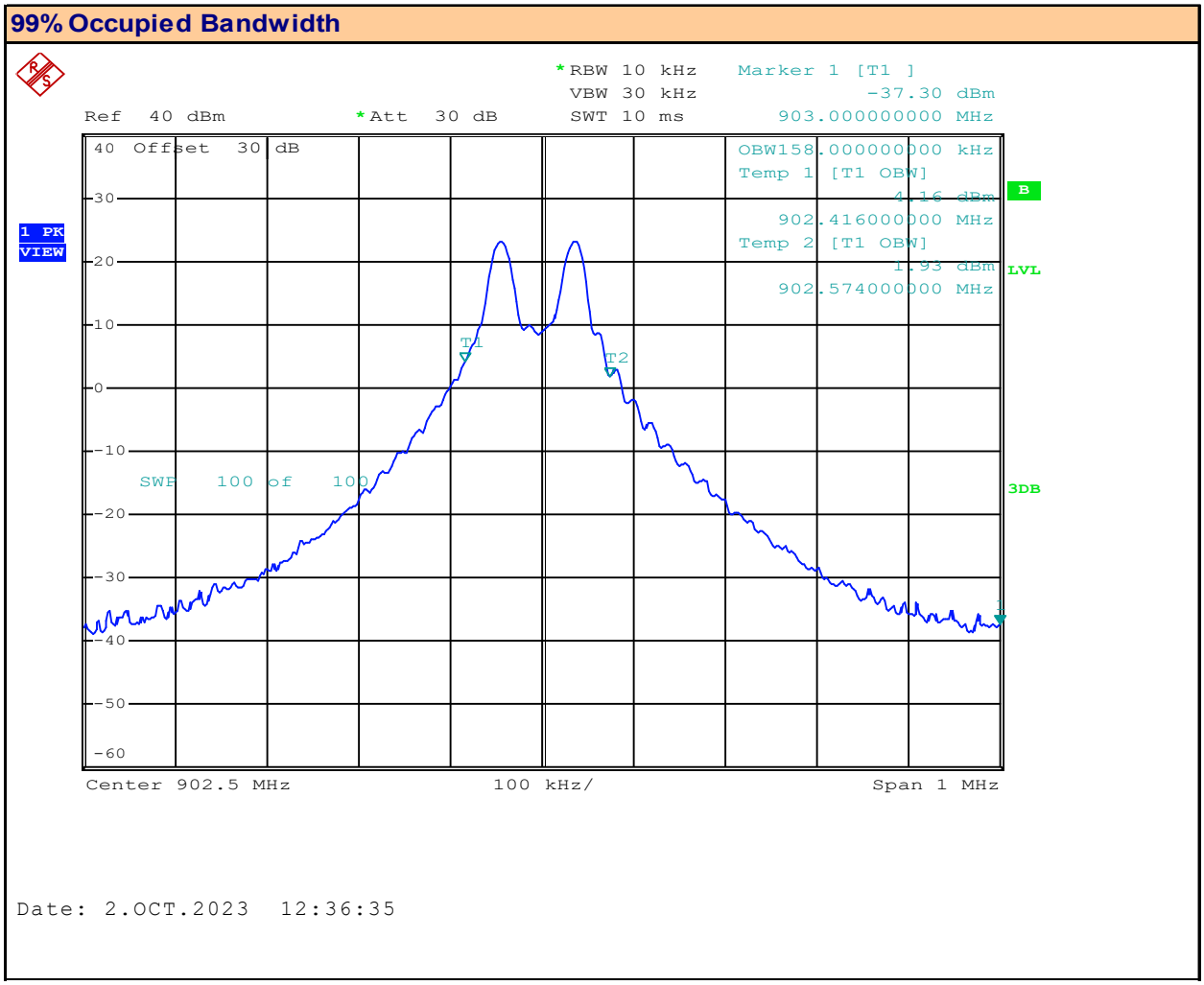
General Procedure	
KDB 558074 (8.3.2.1)	**8.3.2.1 General** Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth.
C63.10 (6.9.3)	**6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure** The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth: a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW. b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement. c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2. d) Step a) through step c) might require iteration to adjust within the specified range. e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used. f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

Test Setup	Appendix A - Figure A.1

Measurement Procedure

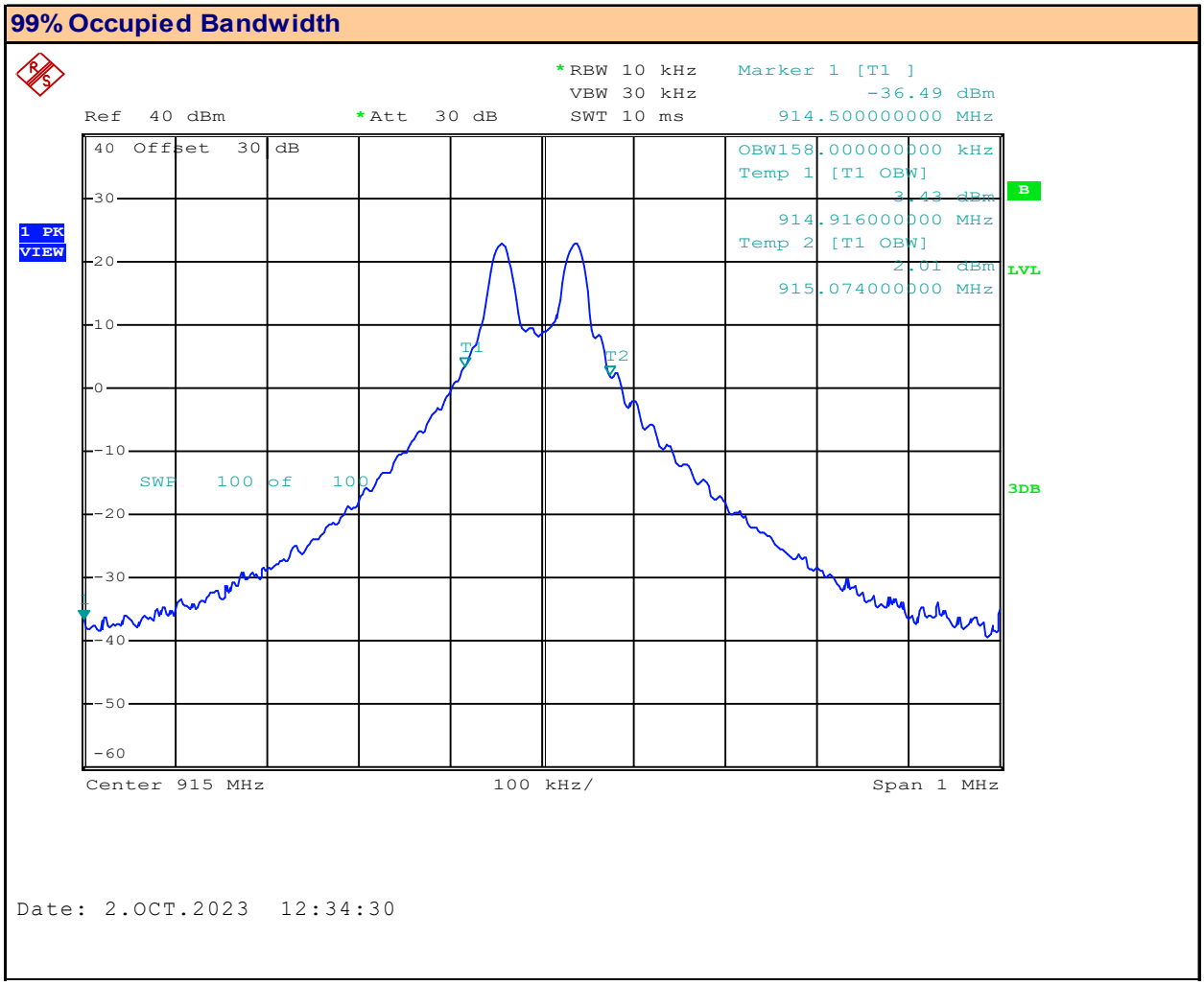
The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as described above using the 99% Occupied Bandwidth function. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High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

Plot 7.1 – Occupied Bandwidth, Ch 0



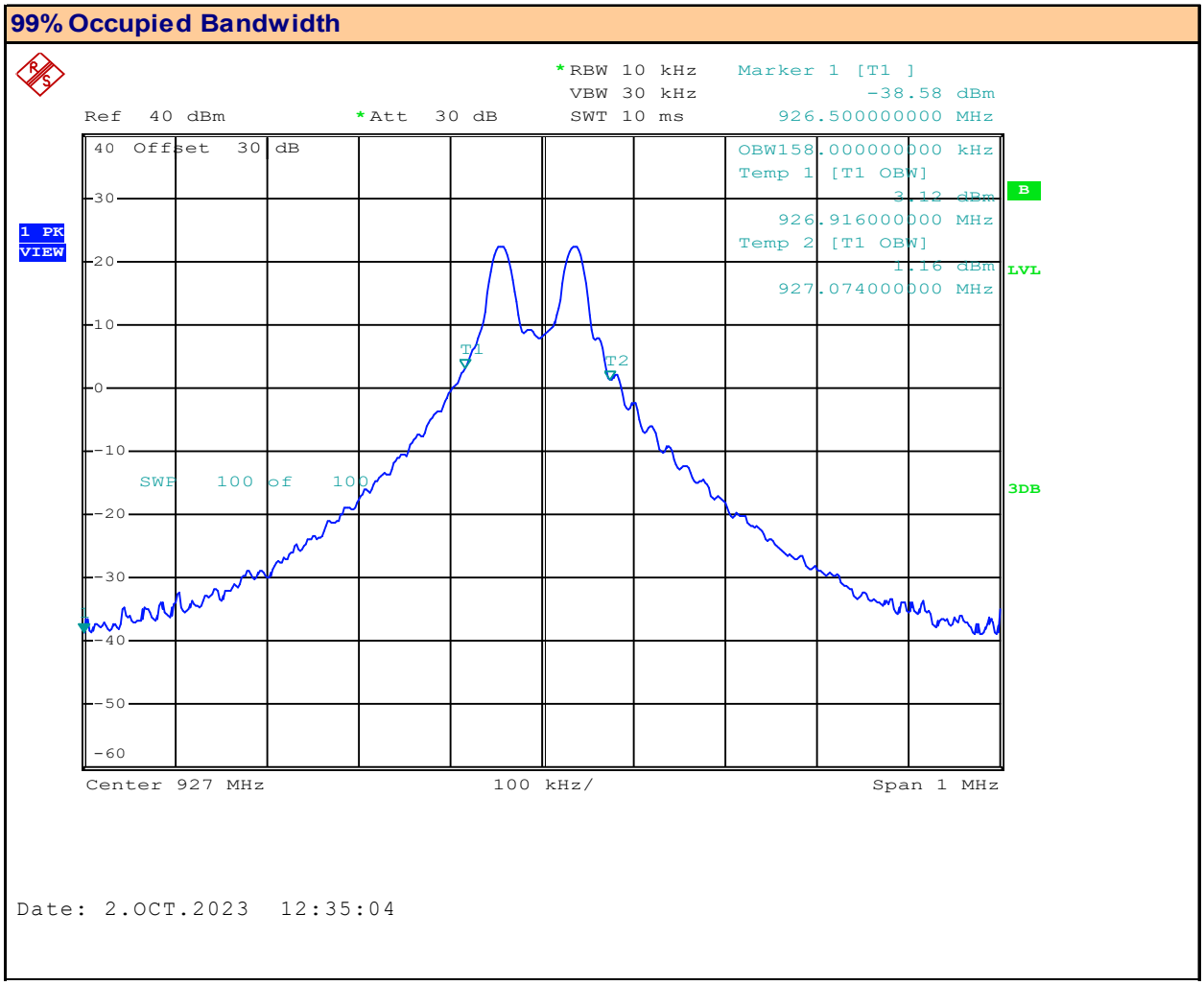
Channel:	**0**	**Channel Frequency:**	**902.5**	**MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**	
		Measured Occupied Bandwidth:	**158**	**kHz**

Plot 7.2 – Occupied Bandwidth, Ch 24



Channel:	**24**	**Channel Frequency:**	**915** **MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**
		Measured Occupied Bandwidth:	**158** **kHz**

Plot 7.3 – Occupied Bandwidth, Ch 49



Channel:	**49**	**Channel Frequency:**	**927** **MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**
		Measured Occupied Bandwidth:	**158** **kHz**

Table 7.1 – Summary of Occupied Bandwidth Measurements

99% Occupied Bandwidth Results:					
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured Occupied Bandwidth (kHz)	Emission Designator
0	902.5	Mesh	FSK	158.0	158KF1D
24	915.0			158.0	158KF1D
49	927.0			158.0	158KF1D
				Result:	Complies

8.0 DTS BANDWIDTH

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

Limits	
47 CFR §15.247(a)(2)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.
RSS-247 (5.2)(a)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: a) The minimum 6 dB bandwidth shall be 500 kHz.

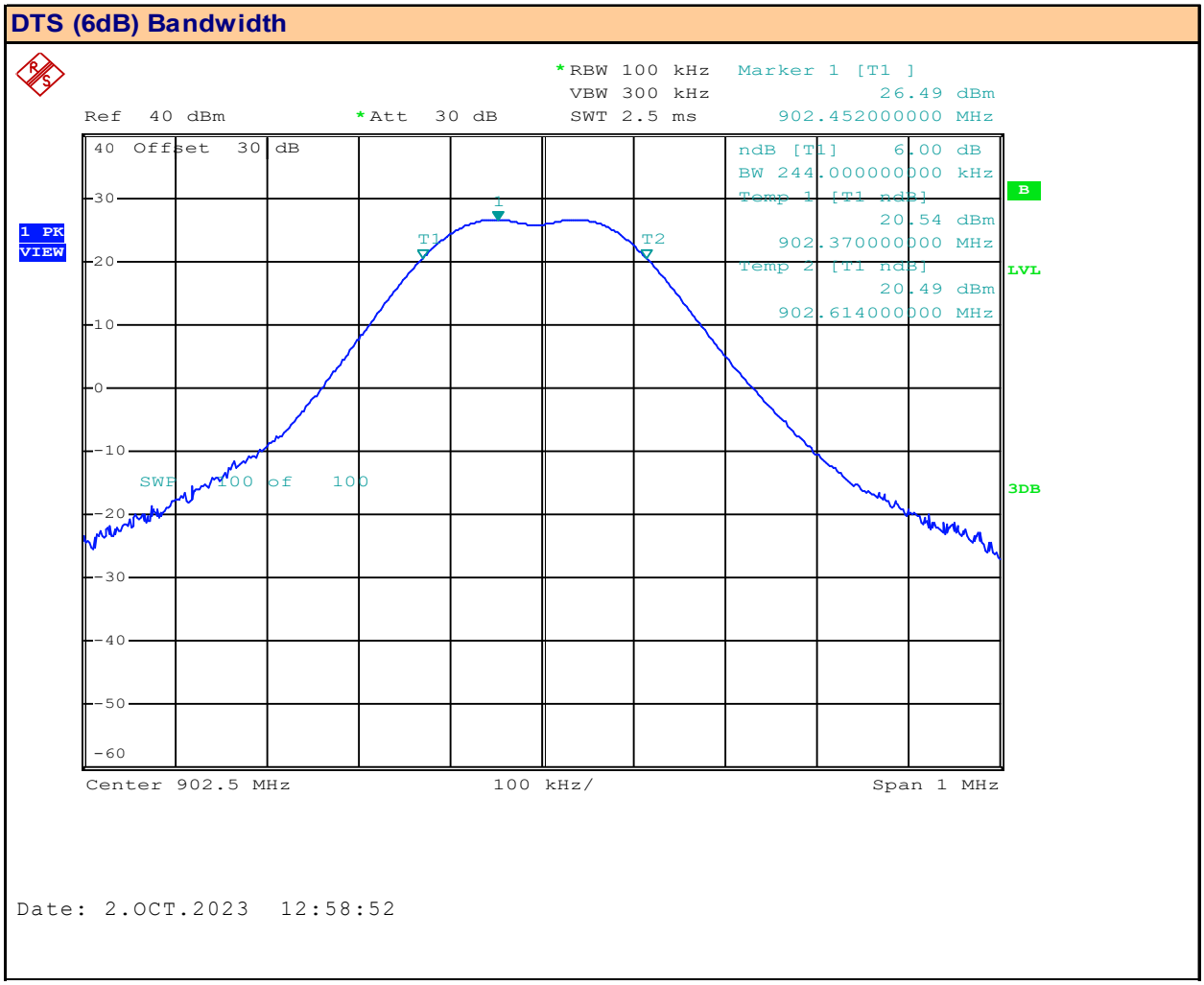
General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

Test Setup	Appendix A - Figure A.1

Measurement Procedure

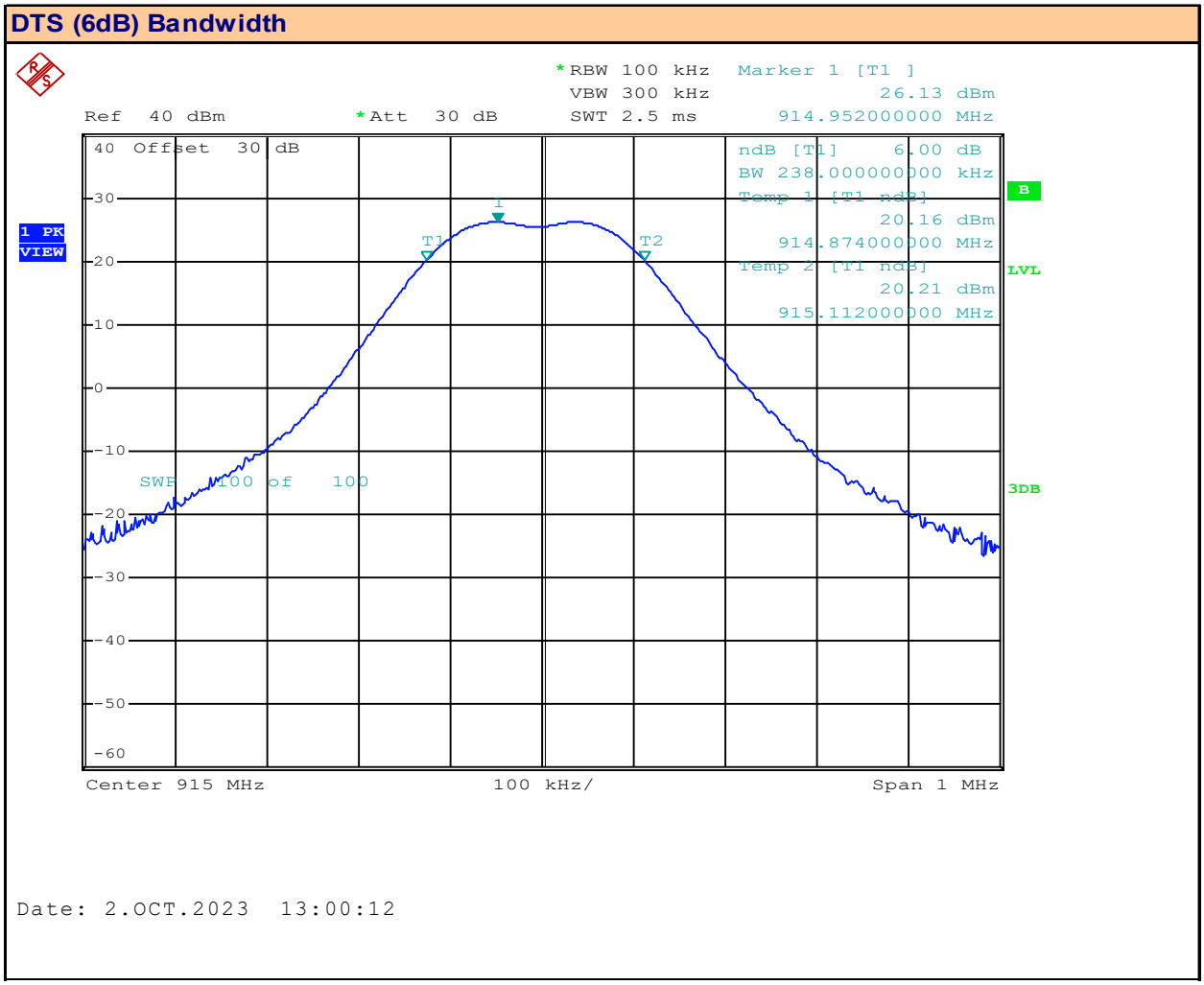
The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and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

Plot 8.1 – 6dB DTS Bandwidth, Ch 0



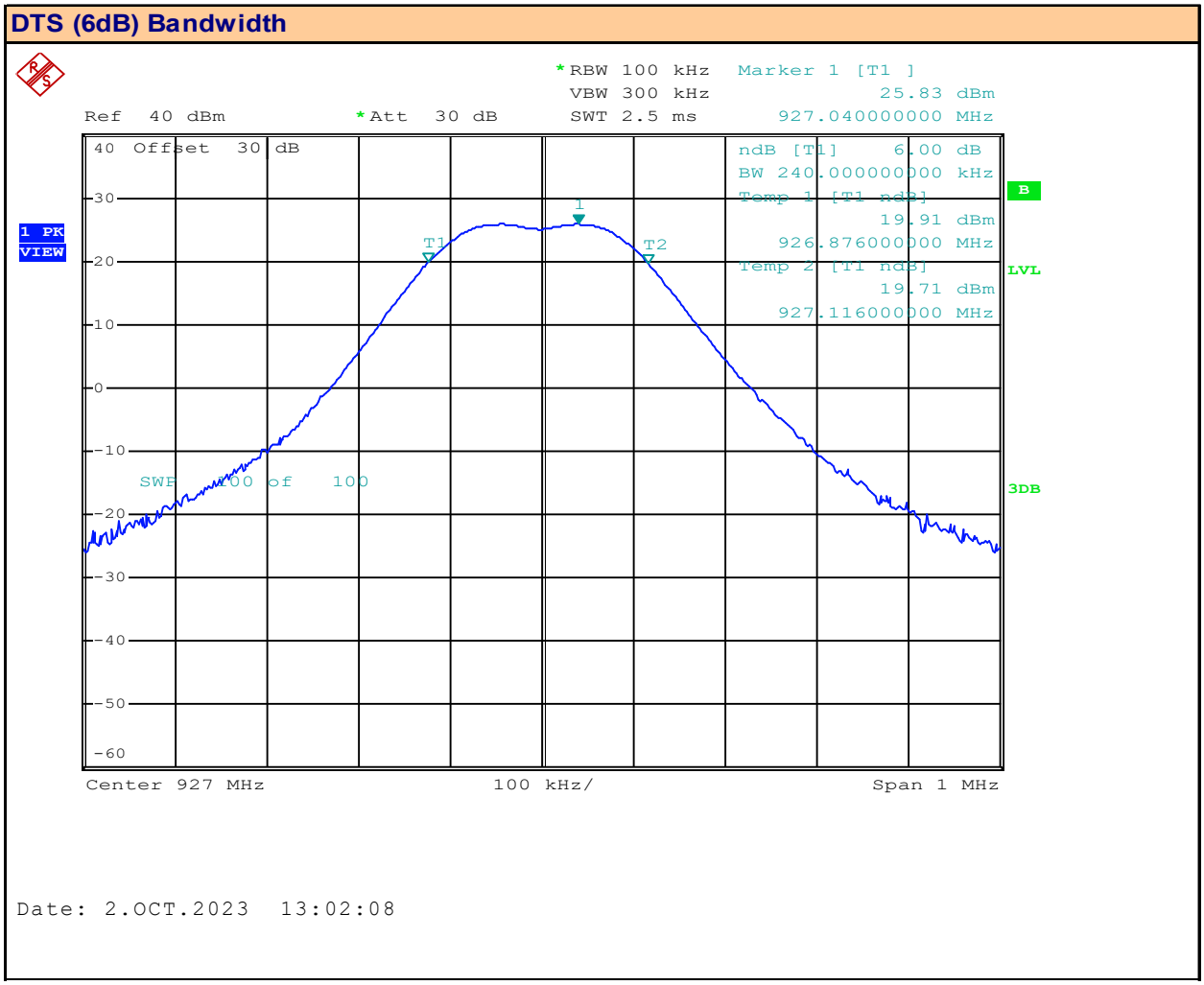
Channel:	**0**	**Channel Frequency:**	**902.5**	**MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**	
		Measured DTS Bandwidth:	**244**	**kHz**

Plot 8.2 – 6dB DTS Bandwidth, Ch 24



Channel:	**24**	**Channel Frequency:**	**915**	**MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**	
		Measured DTS Bandwidth:	**238**	**kHz**

Plot 8.3 – 6dB DTS Bandwidth, Ch 49



Channel:	**49**	**Channel Frequency:**	**927**	**MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**	
		Measured DTS Bandwidth:	**240**	**kHz**

Table 8.1 – Summary of 6dB DTS Bandwidth Measurements

DTS (6DB) Bandwidth Results:					
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured 6dB BW [BW] (kHz)	Margin
0	902.5	Mesh	FSK	244.0	n/a
24	915.0			238.0	n/a
49	927.0			240.0	n/a
				Result:	Complies

9.0 20DB BANDWIDTH

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(1)(i), RSS-Gen (6.7), RSS-247 (5.2)(c), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
§15.247(a)(1) (i)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
RSS-247 (5.2)(c)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

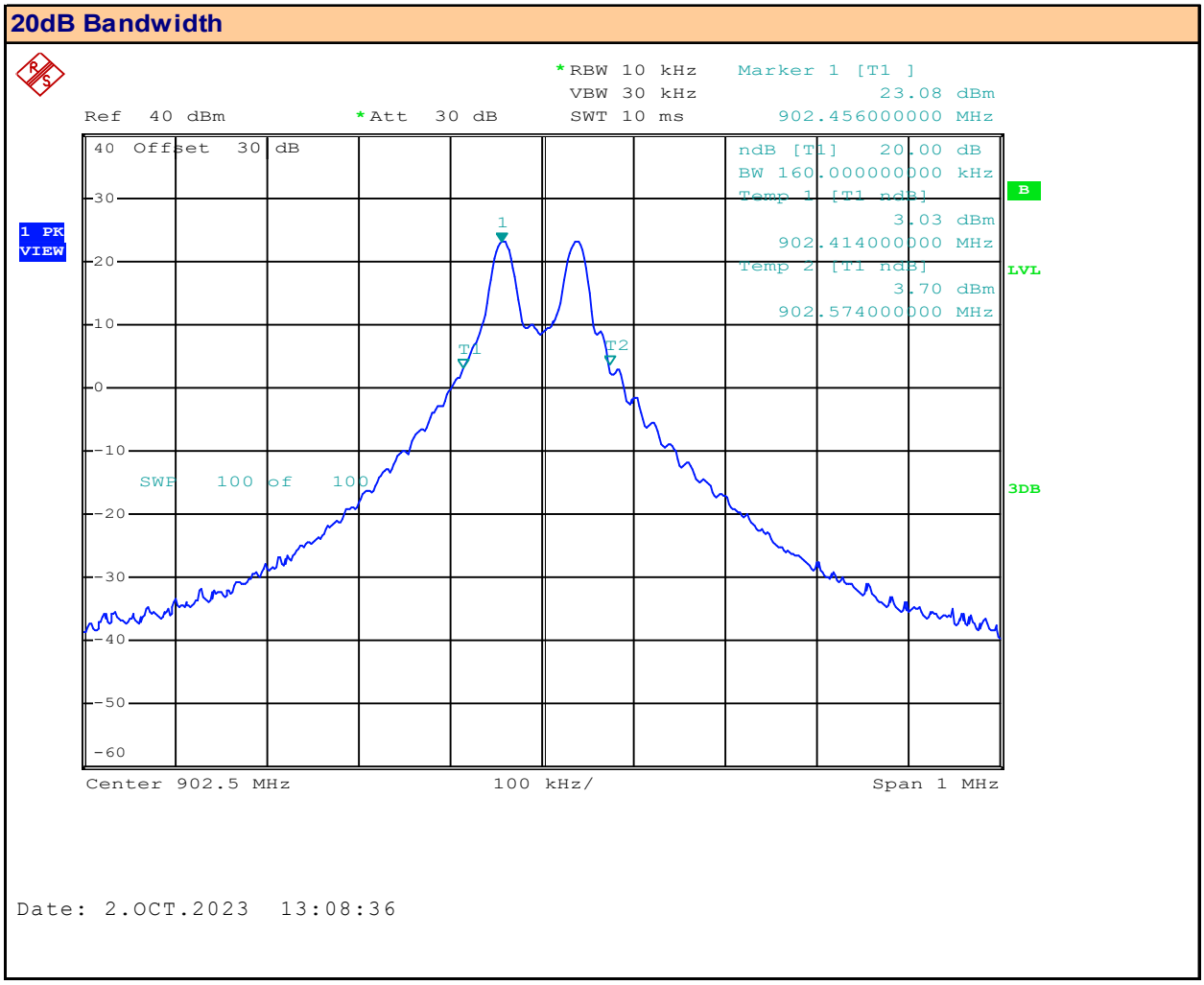
General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

Test Setup	Appendix A - Figure A.1

Measurement Procedure

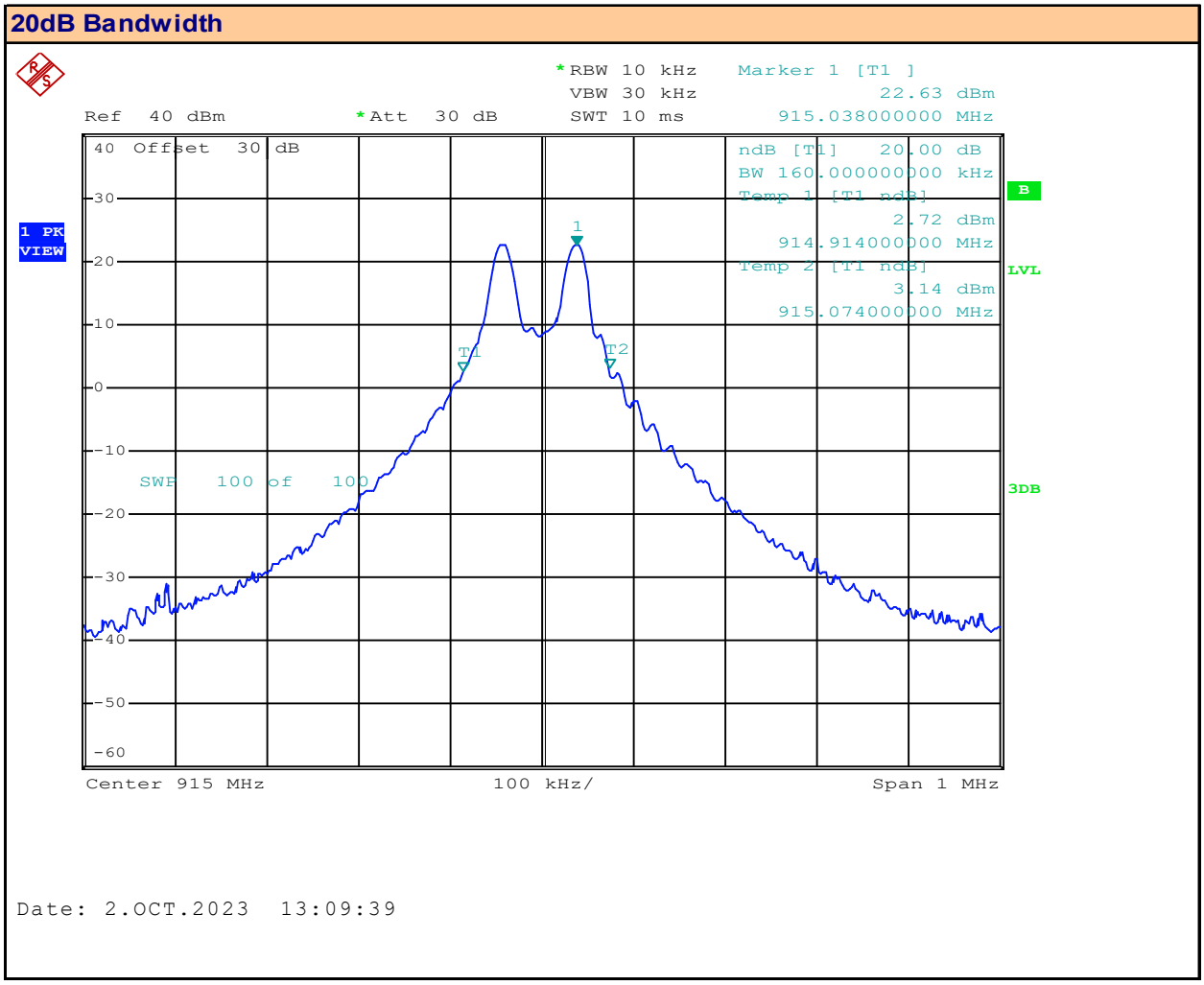
The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and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

Plot 9.1 – 20dB Bandwidth, Ch 0



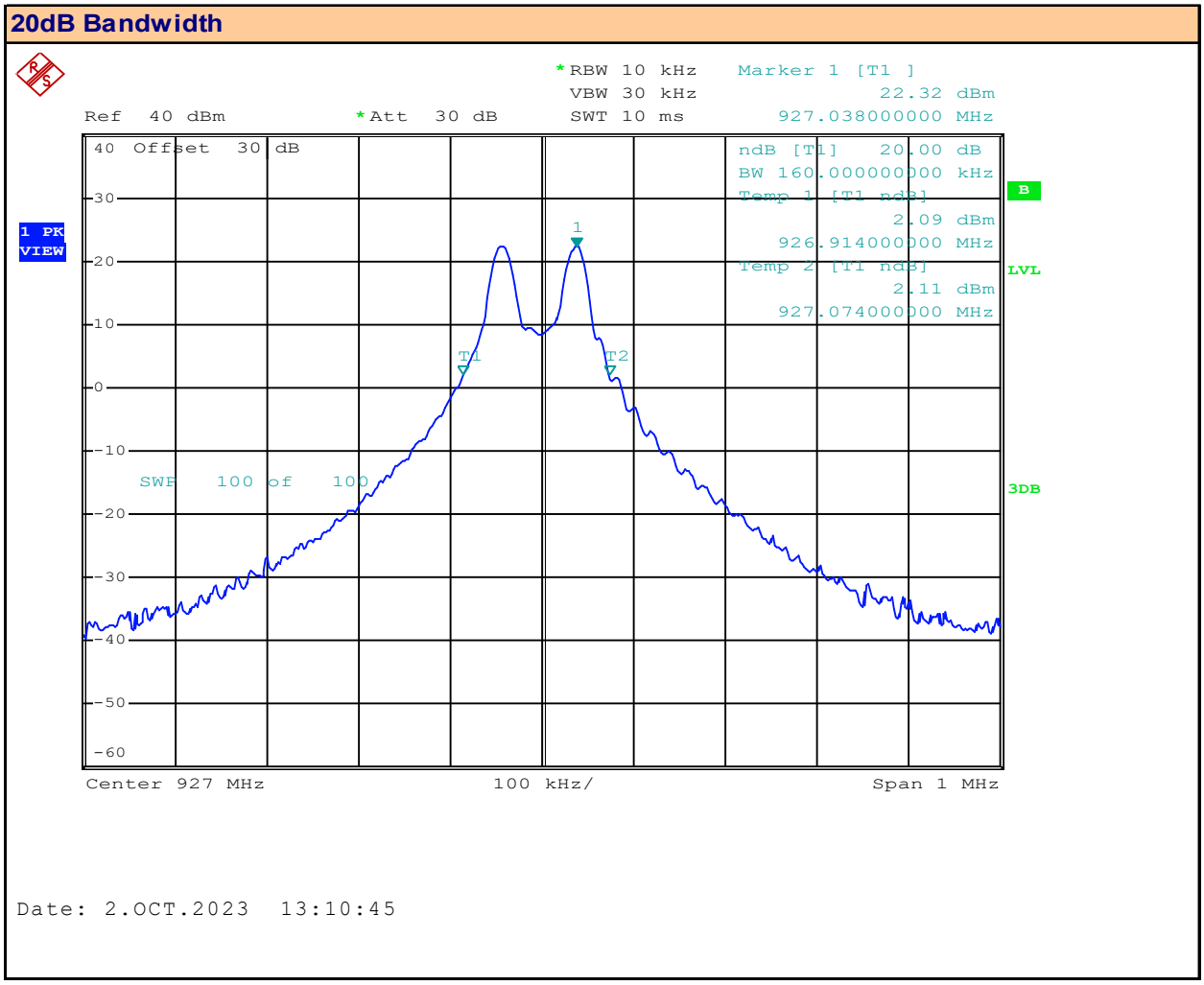
Channel:	**0**	**Channel Frequency:**	**902.5** **MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**
		Measured 20dB Bandwidth:	**160** **kHz**

Plot 9.2 – 20dB Bandwidth, Ch 24



Channel:	**24**	**Channel Frequency:**	**915**	**MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**	
		Measured 20dB Bandwidth:	**160**	**kHz**

Plot 9.3 – 20dB Bandwidth, Ch 49



Channel:	49	**Channel Frequency:**	927 MHz
Mode:	Mesh	**Modulation:**	FSK
		Measured 20dB Bandwidth:	160 kHz

Table 9.1 – Summary of 20dB Bandwidth Measurements,

20dB Bandwidth Results:					
Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured 20dB BW [BW] (kHz)	Margin
0	902.5	Mesh	FSK	160.0	n/a
24	915.0			160.0	n/a
49	927.0			160.0	n/a
				Result:	Complies

10.0 ANTENNA PORT CONDUCTED POWER, (DSS)

Test Procedure	
Normative Reference	FCC 47 CFR §2.1046, §15.247(b)(2), RSS-Gen (6.1.2), RSS-247 (5.4)(d), KDB 558074 (8.3.2), ANSI C63.10 (11.9.1.1)

Limits	
47 CFR §15.247(b)(2)	(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.
RSS-247 (5.4)(d)	**5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.)** Devices shall comply with the following requirements, where applicable: a) For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

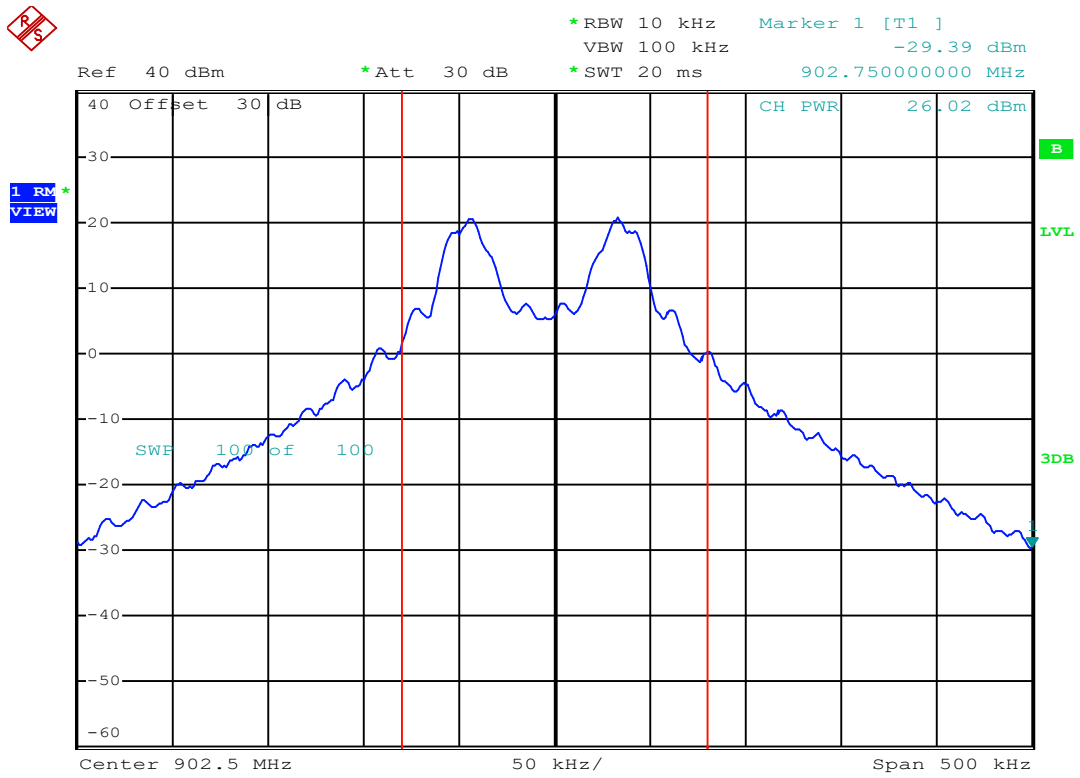
General Procedure	
KDB 558074 (8.3.2.1)	**8.3.2.1 General** Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth.
C63.10 (11.9.1.1)	**11.9.1.1** RBW ≥ DTS bandwidth The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement: a) Set the RBW ≥ DTS bandwidth. b) Set VBW ≥ [3 × RBW]. c) Set span ≥ [3 × RBW]. d) Sweep time = auto couple. e) Detector = peak. f) Trace mode = max hold. g) Allow trace to fully stabilize. h) Use peak marker function to determine the peak amplitude level.

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 Power was measured and recorded.

Plot 10.1 – Conducted Power, Ch 0

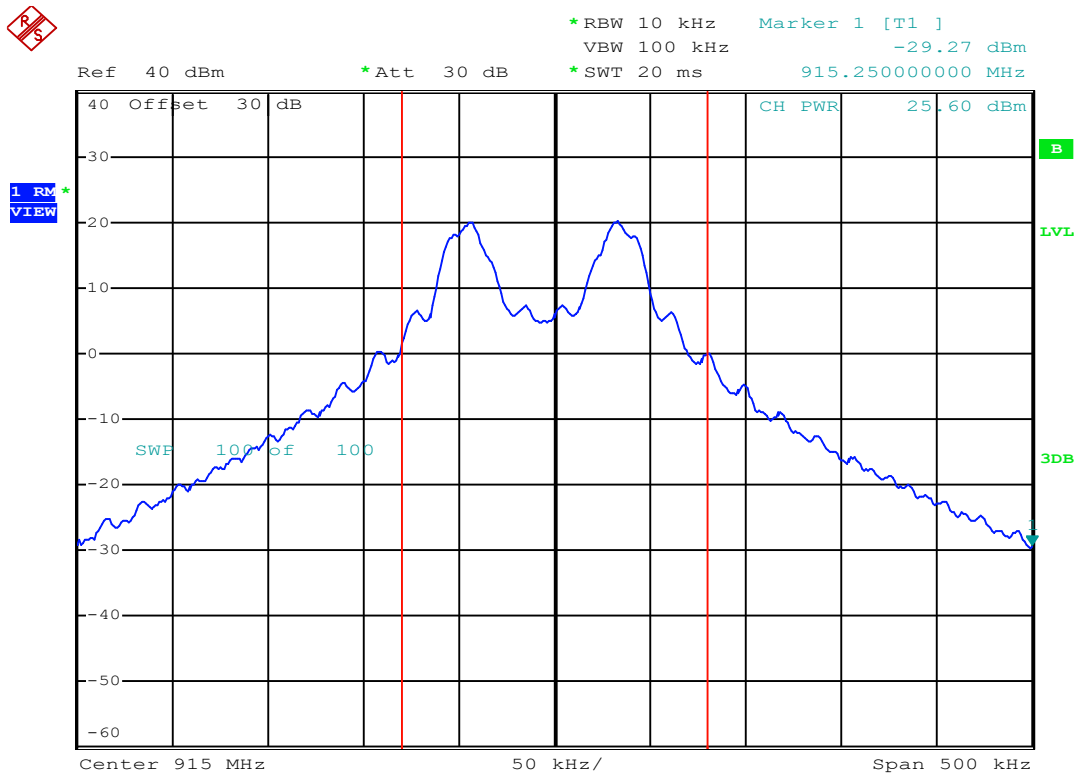
Conducted Power:



Channel:	0	**Channel Frequency:**	902.5 MHz
Mode:	Mesh	**Modulation:**	FSK
		Measured Channel Power:	26.02 dBm

Plot 10.2 – Conducted Power, Ch 24

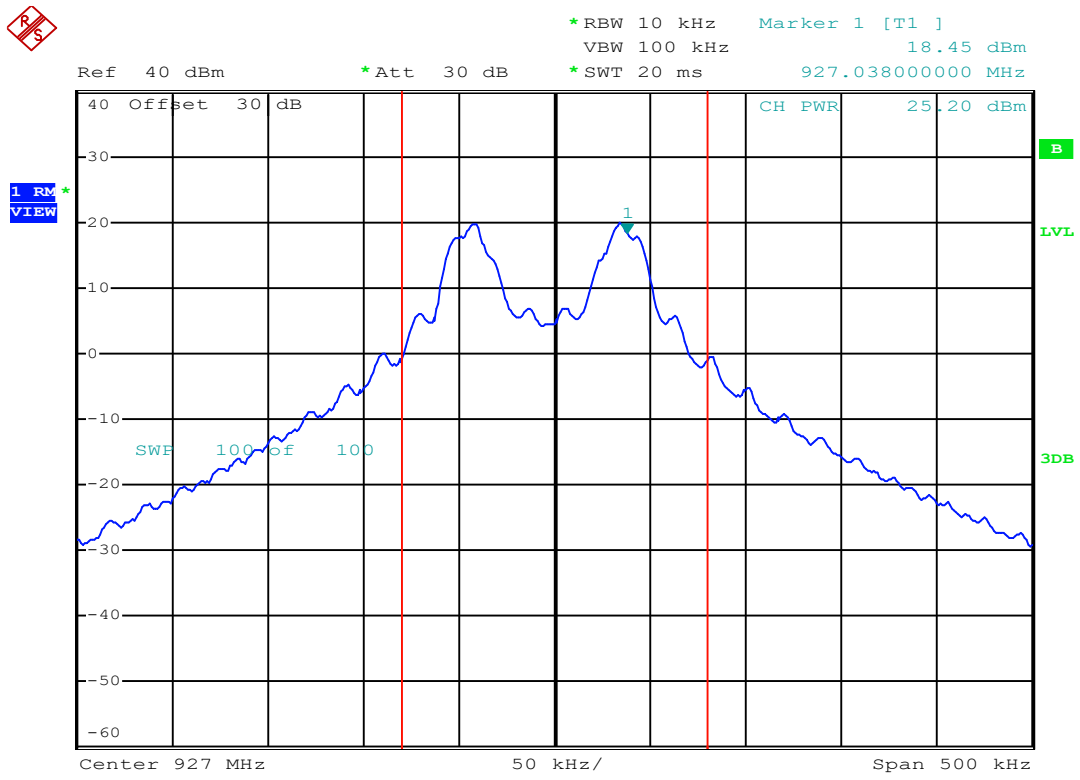
Conducted Power:



Channel:	24	**Channel Frequency:**	915 MHz
Mode:	Mesh	**Modulation:**	FSK
		Measured Channel Power:	25.6 dBm

Plot 10.3 – Conducted Power, Ch 49

Conducted Power:



Channel:	49	**Channel Frequency:**	927 MHz
Mode:	Mesh	**Modulation:**	FSK
		Measured Channel Power:	25.2 dBm

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

Conducted Power Measurement Results:										
Channel Number	Mode	Frequency (MHz)	Modulation	Measured Power [P_{Meas}] (dBm)	Conducted Limit [P_{Lim}] (dBm)	Conducted Margin (dB)	Antenna Gain (dBi)	EIRP [E_{Meas}] (dBm)	EIRP Limit [E_{Lim}] (dBm)	EIRP Margin (dB)
0	Mesh	902.50	FSK	26.020	30	4.0	0	26.02	36	10.0
24		915.00		25.600		4.4		25.60		10.4
49		927.00		25.200		4.8		25.20		10.8
									Result:	Complies

11.0 FHSS NUMBER OF HOPPING CHANNELS

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(1)(i), RSS-Gen (6.7), RSS-247 (5.2)(c), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
§15.247(a)(1) (i)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
RSS-247 (5.2)(c)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

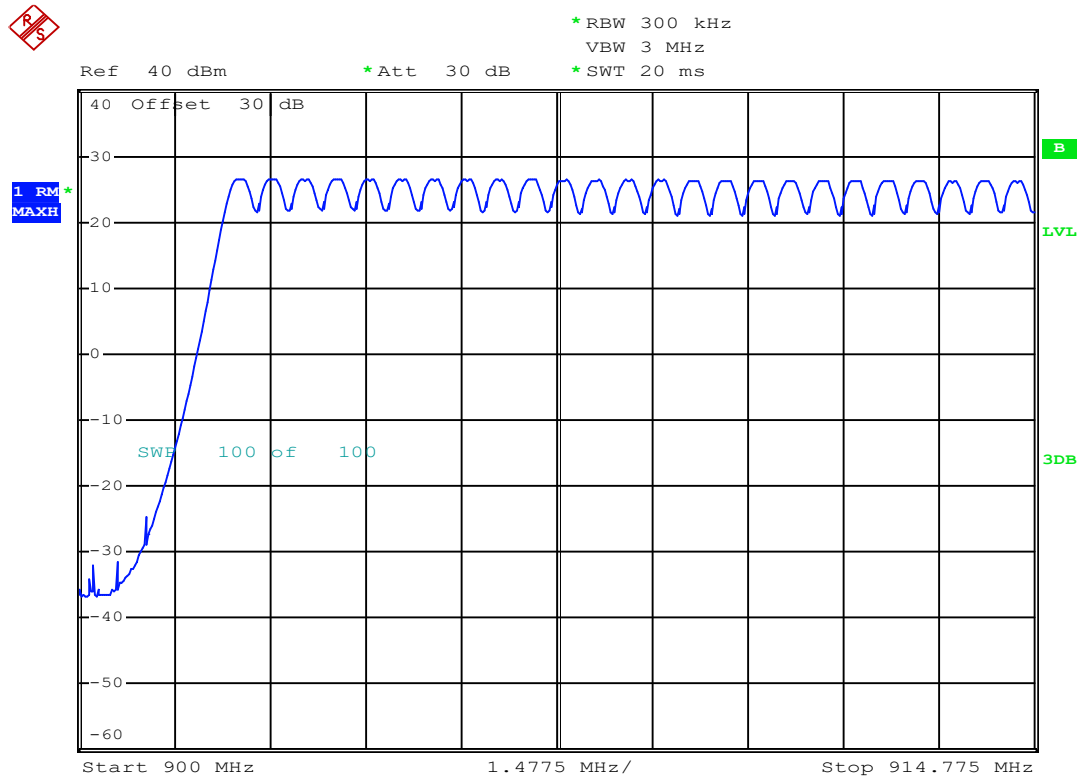
Test Setup	Appendix A - Figure A.1

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 above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device.

Plot 11.1 – Number of Hopping Channels, Part 1

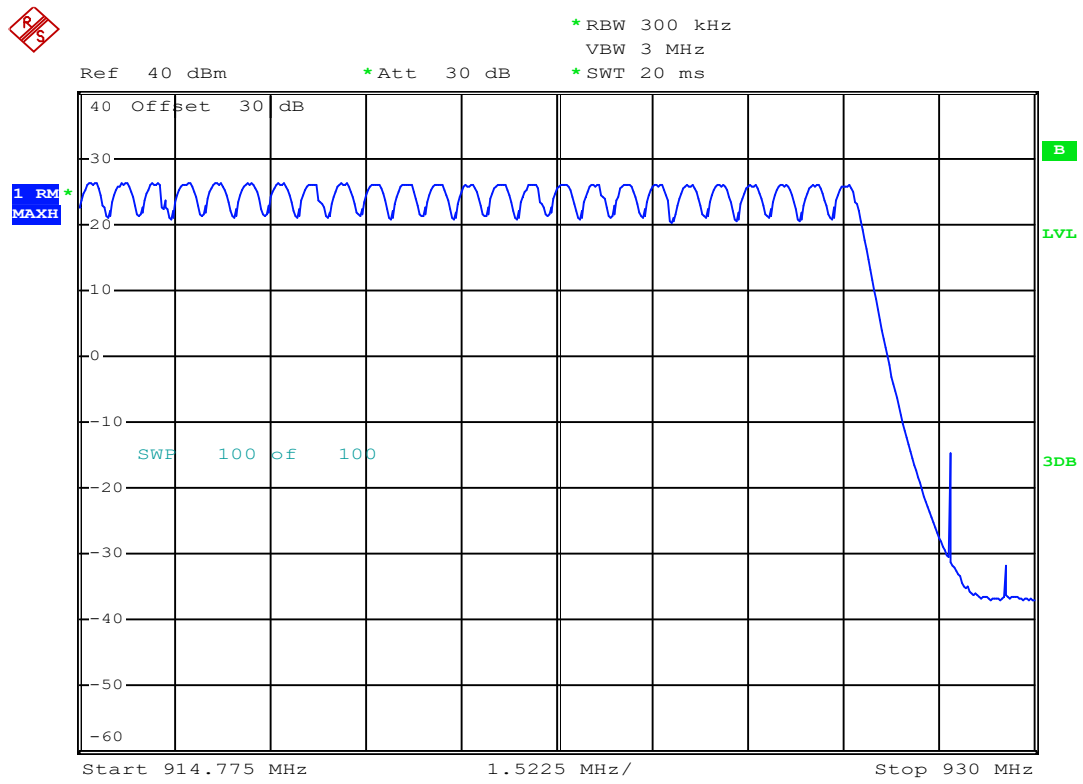
Number of Hopping Channels



Start Freq:	**900**	**MHz**	**Stop Freq:**	**914.8**	**MHz**
Mode:	**Mesh**		**Modulation:**	**FSK**	
			Number of Channels:	**25**	

Plot 11.2 – Number of Hopping Channels, Part 2

Number of Hopping Channels



Start Freq:	**914.8**	**MHz**	**Stop Freq:**	**930**	**MHz**
Mode:	**Mesh**		**Modulation:**	**FSK**	
			Number of Channels:	**25**	

Table 12.2 – Summary of FHSS Number of Hopping Channels

Number of Hopping Channels				
Start Frequency (MHz)	Channel Frequency (MHz)	Mode	Modulation	Number of Channels
900	915	Mesh	FSK	25
915	930			25
			Total	50

12.0 FHSS CHANNEL SEPARATION

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(1)(i), RSS-Gen (6.7), RSS-247 (5.2)(c), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
§15.247(a)(1) (i)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
RSS-247 (5.2)(c)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

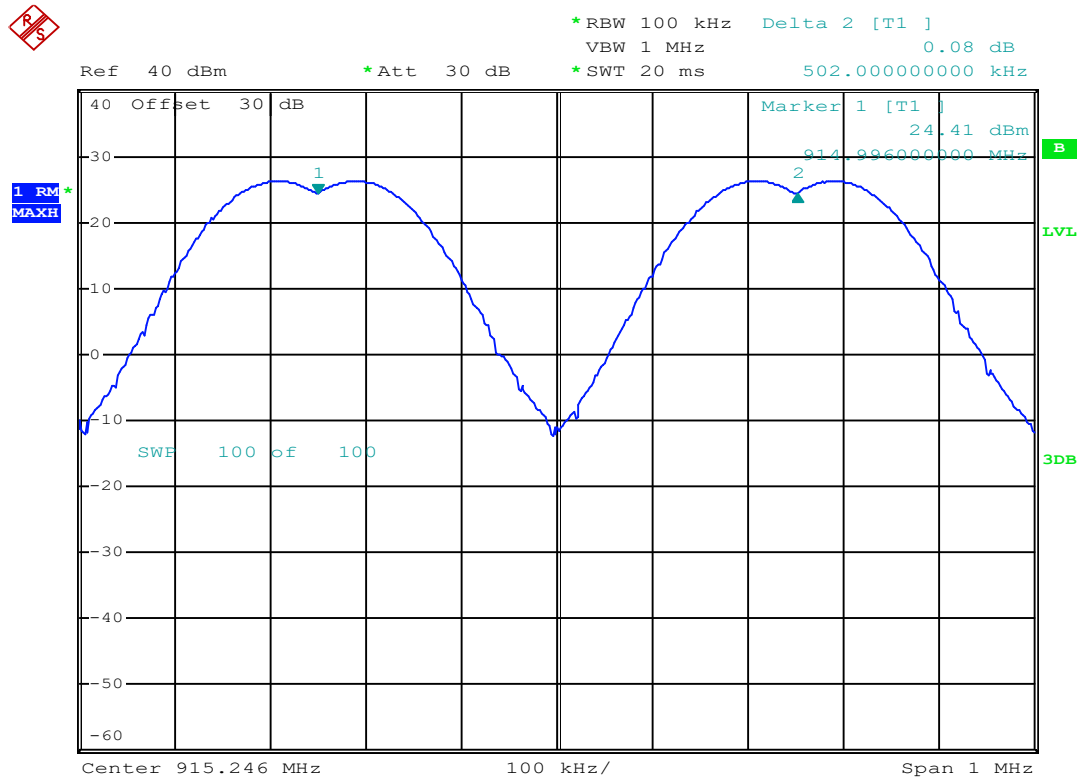
Test Setup	Appendix A - Figure A.1

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 above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device.

Plot 12.1 – Channel Separation, MESH

Hopping Channel Separation



Channel:	**n/a**	**Frequency:**	**n/a**	**MHz**
Mode:	**Mesh**	**Modulation:**	**FSK**	
		Measured Channel Separation:	**502**	**kHz**

Table 12.1 – Summary of FHSS Channel Separation

Hopping Channel Separation				
Mode	Modulation	Channel Separation (kHz)	20dB Bandwidth (kHz)	Margin
Mesh	FSK	502	160	342
			Result:	Complies

Margin = Channel Separation - 20dB Bandwidth

13.0 FHSS TIME OF OCCUPANCY

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(1)(i), RSS-Gen (6.7), RSS-247 (5.2)(c), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
§15.247(a)(1) (i)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
RSS-247 (5.2)(c)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

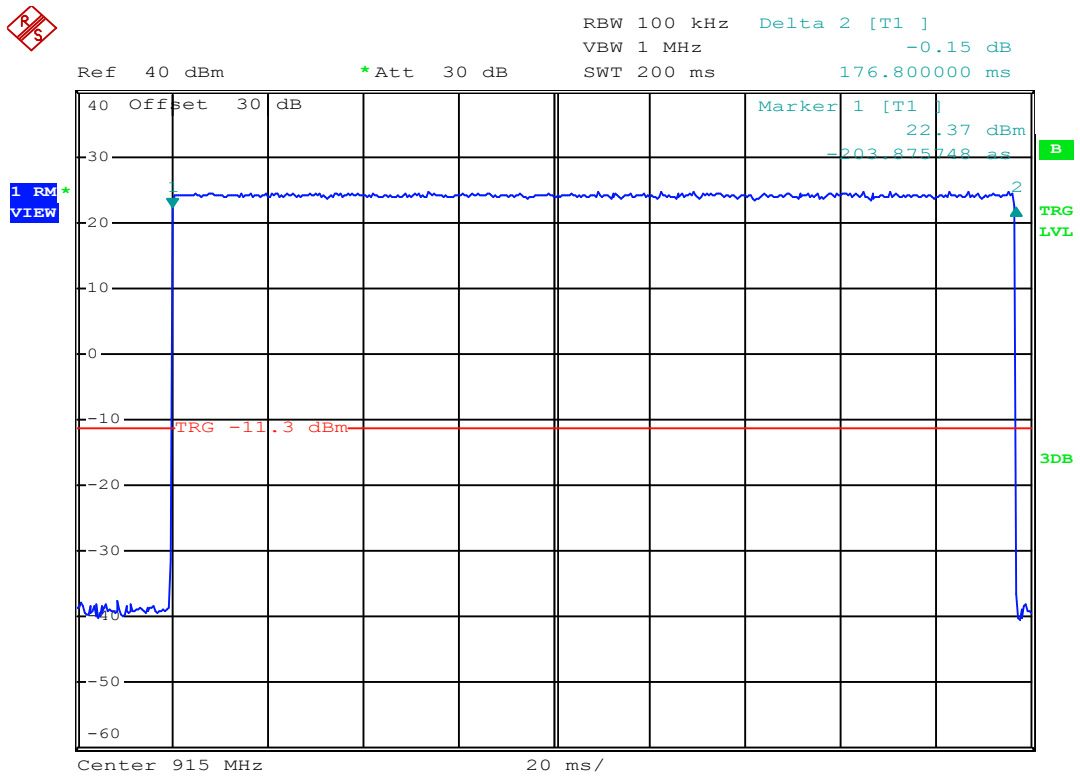
Test Setup	Appendix A - Figure A.1

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 above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device.

Plot 13.1 – Time of Occupancy, Dwell Time

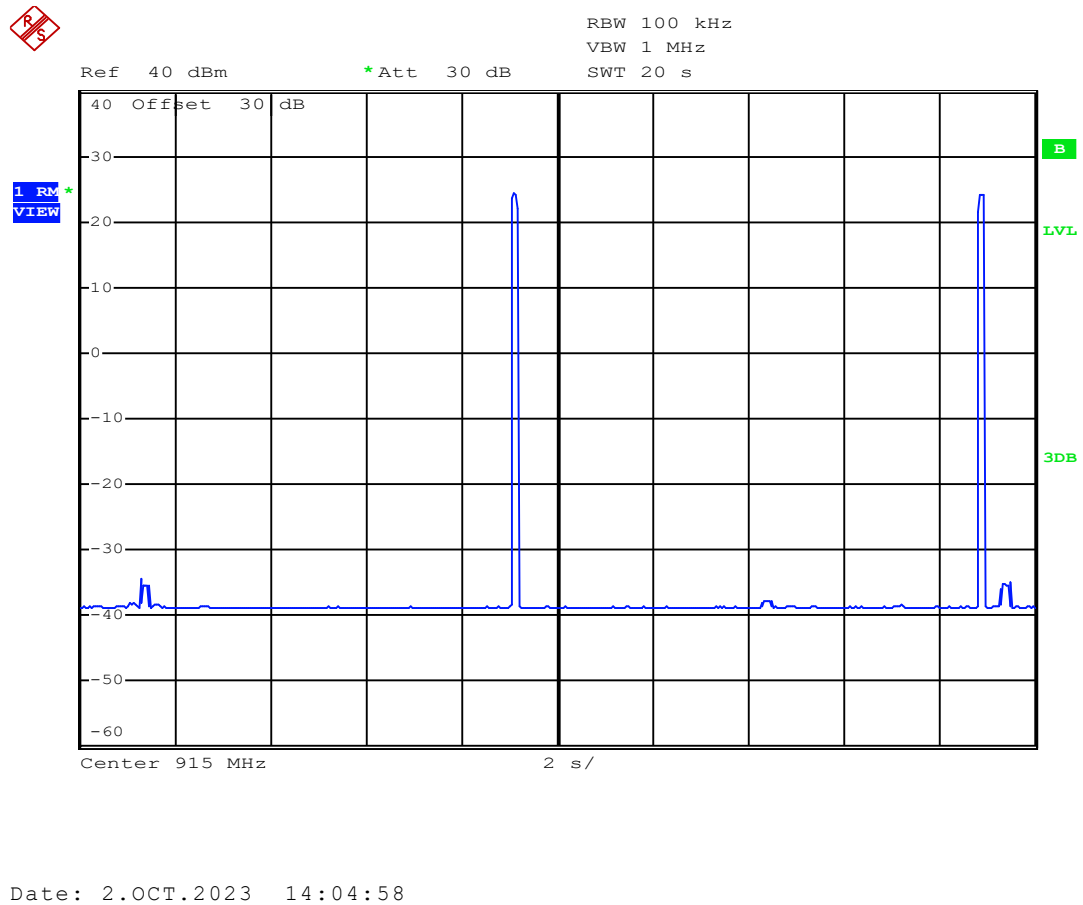
Dwell Time



Channel:	24		**Frequency:**	915	MHz
Mode:	Mesh		**Modulation:**	FSK	
			Measured Dwell Time:	176.8	mSec

Plot 13.2 – Time of Occupancy, Number of Transmits

Number of Transmits



Channel:	24	**Frequency:**	915 MHz
Mode:	Mesh	**Modulation:**	FSK
		Number of Transmits:	2

Table 13.1 – Summary of FHSS Time of Occupancy

Hopping Channel Time of Occupancy DSS										
Mode	**Modulation**	**Channel On Time (Dwell) [t_{on}] (mSec)**	**Number of Period Transmits [N_{Period}]**	**Observation Period [T_{Period}] (Sec)**	**Time of Period Occupancy [T_{Occ}] (mSec)**	**Total Observation Period [TT_{Period}] (mSec)**	**Accumulated Time of Occupancy [TT_{Occ}] (mSec)**	**Number of Hopping Channels [N_{Hop}]**	**Limit [Limit] (mSec)**	**Margin (mSec)**
MESH	FSK	176.8	2	20	353.6	20	353.60	50	400	46.4
									Result:	**Complies**

Time of Occupancy within the measurement (Observation) period [T_{Occ}] = On Time [T_{on}] X Number of Transmits within the Observation Period [N_{period}]

Total Observation Period [TT_{Period}] = 15mSec X Number of Hopping Channels = 15mSec X [N_{Hop}]

Accumulated Time of Occupancy [TT_{Occ}] = Time of Occupancy [T_{Occ}] X Total Observation Peroid [TT_{Period}] / Observation Period [T_{Period}]

Margin = Limit - TT_{Occ}

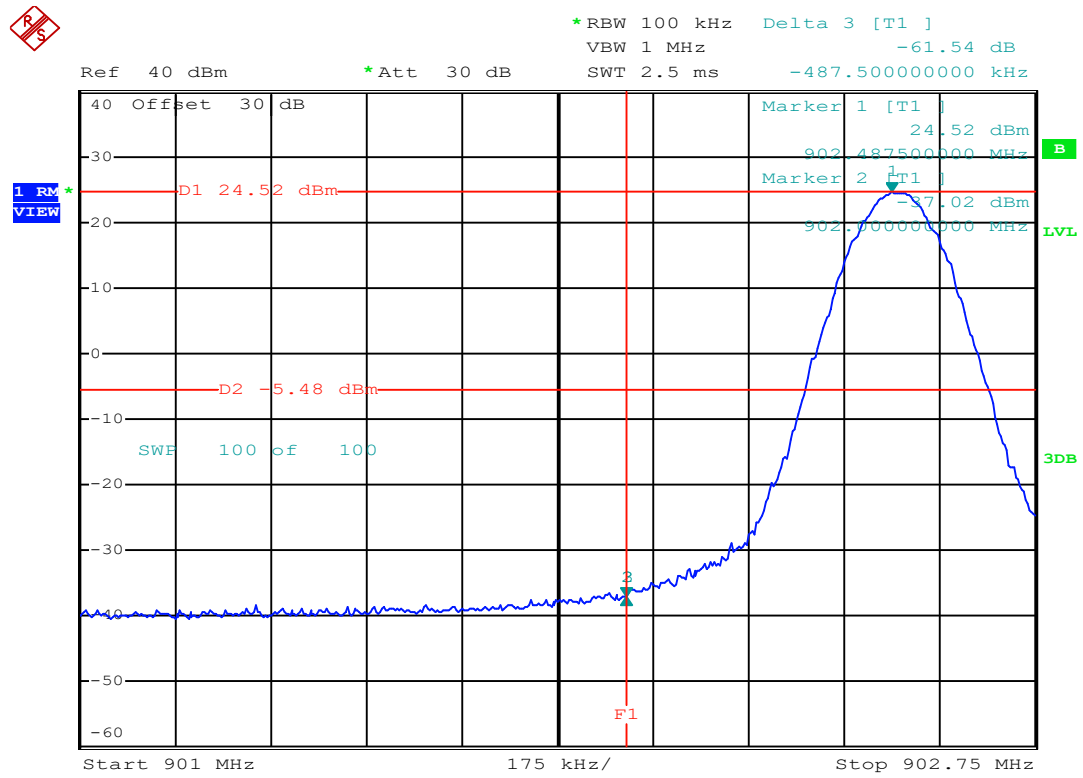
14.0 CONDUCTED SPURIOUS EMISSIONS -BAND EDGE

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

Limits	
47 CFR §15.247(d)	(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.
RSS-247 (5.5)	**5.5 Unwanted emissions** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e). As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.
KDB 558074 (11.3) C63.10 (11.11.3)	**11.1 General** The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions: b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc). **11.2 Reference level measurement** a) Set instrument center frequency to DTS channel center frequency. b) Set the span to ≥ 1.5 X *DTS bandwidth.* c) Set the RBW = 100 kHz. d) Set the VBW ≥ 3 X RBW. e) Detector = peak. f) Sweep time = auto couple. g) Trace mode = max hold. h) Allow trace to fully stabilize. i) Use the peak marker function to determine the maximum PSD level. Note that the channel found to contain the maximum PSD level can be used to establish the reference

Plot 14.1 – Conducted Spurious Emissions, Lower Band Edge, Ch 0

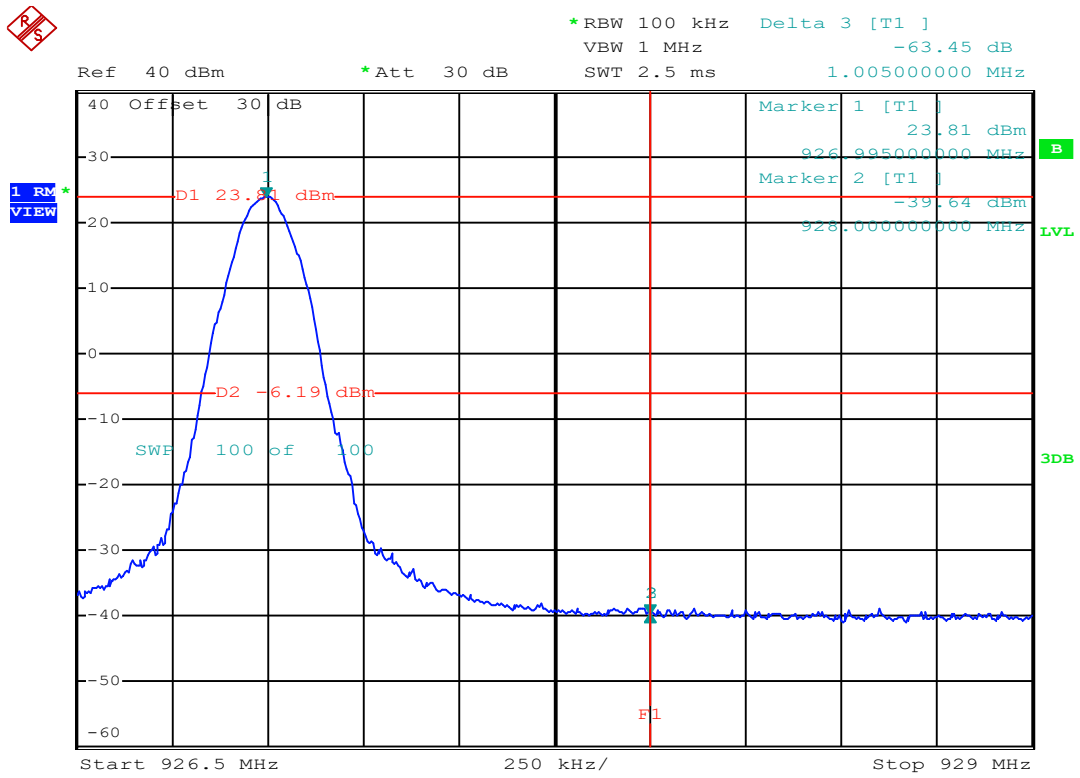
Band Edge: Lower Band Edge



Channel:	**0**	**Channel Frequency:**	**902.5** **MHz**
Mode:	**Mesh**	**Modulation:**	**O-QPSK**
		Emission Power:	**-37.02** **dBm**

Plot 14.2 – Conducted Spurious Emissions, Upper Band Edge, Ch 49

Band Edge: Upper Band Edge



Channel:	49	**Channel Frequency:**	924 MHz
Mode:	-	**Modulation:**	O-QPSK
		Emission Power:	-39.64 dBm

Table 14.1 – Summary of Conducted Spurious Emission Measurements – Band Edge,

Band Edge Measurement Results: 802.11							
Channel Number	Frequency (MHz)	Modulation	Emission Power [P_{Em}] (dBm)	Fundamental Power [P_{Fund}] (dBm)	Attenuation [Atten] (dB)	Limit (dB)	Margin (dB)
1	906.00	O-QPSK	-37.02	24.52	61.54	30	31.5
10	924.00	O-QPSK	-39.34	23.81	63.15	30	33.2
Result:						**Complies**	

Attenuation [Atten] = [P_{Fund}] - [P_{Em}]

Margin = [Atten] - Limit

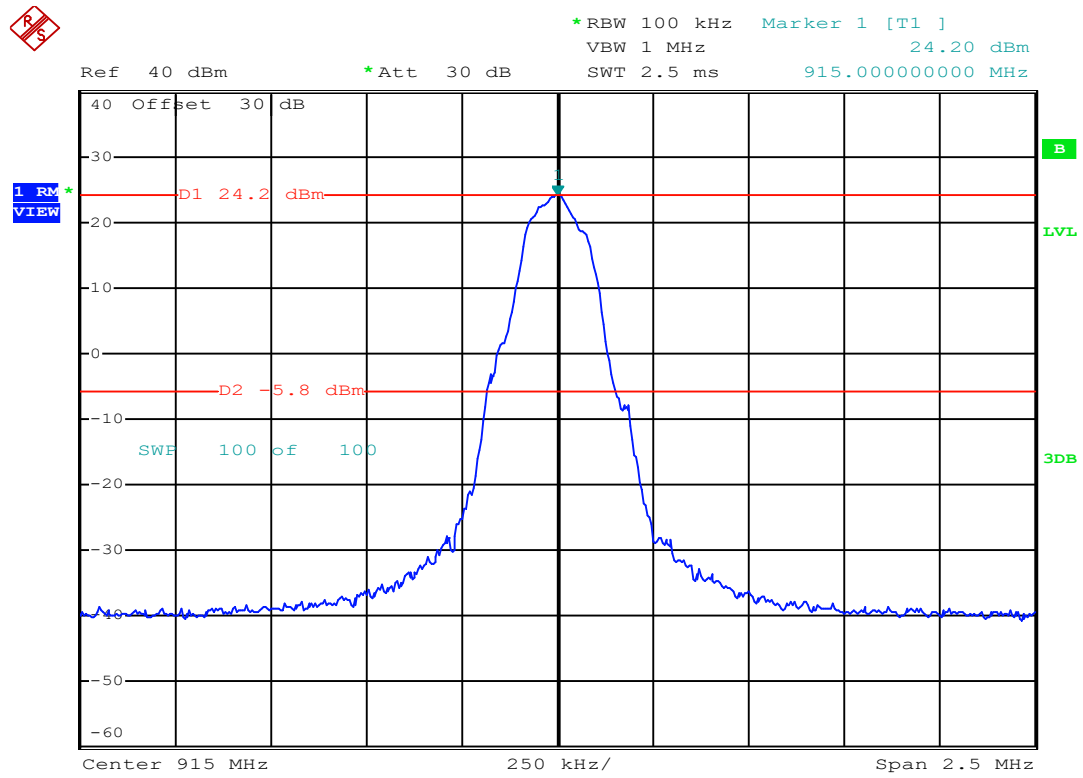
15.0 CONDUCTED SPURIOUS EMISSIONS

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

Limits	
47 CFR §15.247(d)	(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.
RSS-247 (5.5)	**5.5 Unwanted emissions** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e). As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.
KDB 558074 (11.3) C63.10 (11.11.3)	**11.1 General** The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions: b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc). **11.2 Reference level measurement** a) Set instrument center frequency to DTS channel center frequency. b) Set the span to ≥ 1.5 X *DTS bandwidth.* c) Set the RBW = 100 kHz. d) Set the VBW ≥ 3 X RBW. e) Detector = peak. f) Sweep time = auto couple. g) Trace mode = max hold. h) Allow trace to fully stabilize. i) Use the peak marker function to determine the maximum PSD level. Note that the channel found to contain the maximum PSD level can be used to establish the reference

Plot 15.1 – Conducted Spurious Emissions, Ch 24

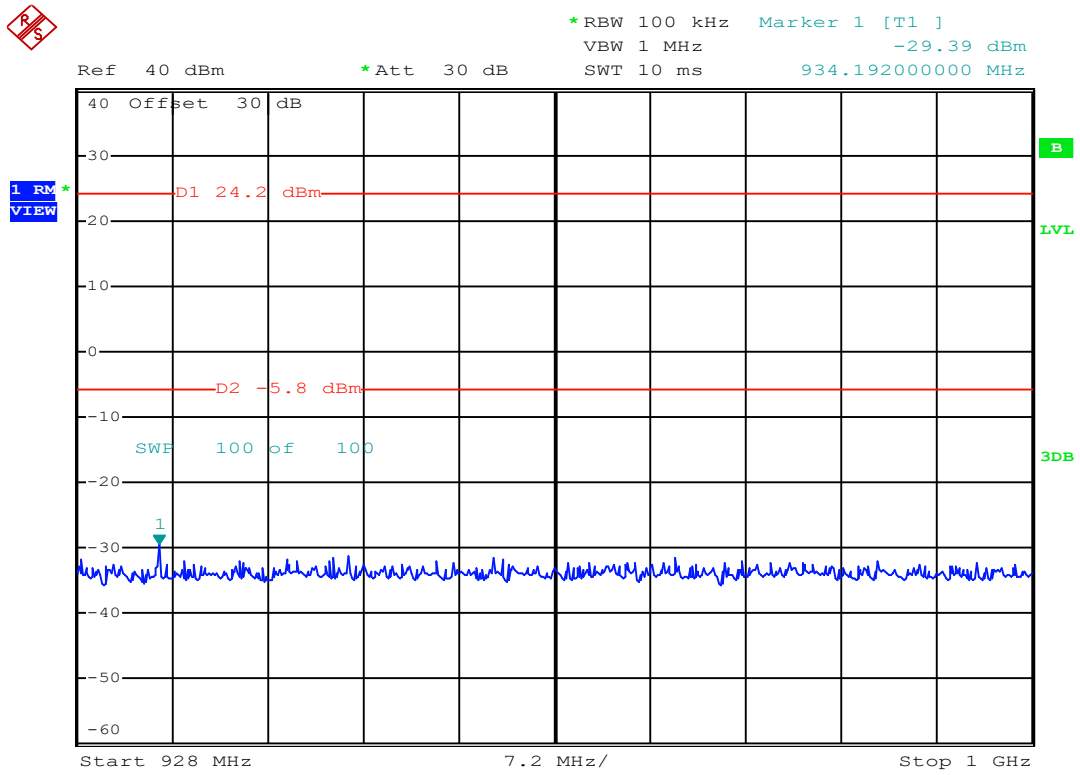
Conducted Spurious Emissions:



Channel:	**24**		**Channel Frequency:**	**915**	**MHz**
Mode:	**Mesh**		**Modulation:**	**FSK**	
Emission Frequency:	**Fundamental**	**MHz**	**Measured Emission:**	**24.2**	**dBm**

Plot 15.2 – Conducted Spurious Emissions, Ch 24

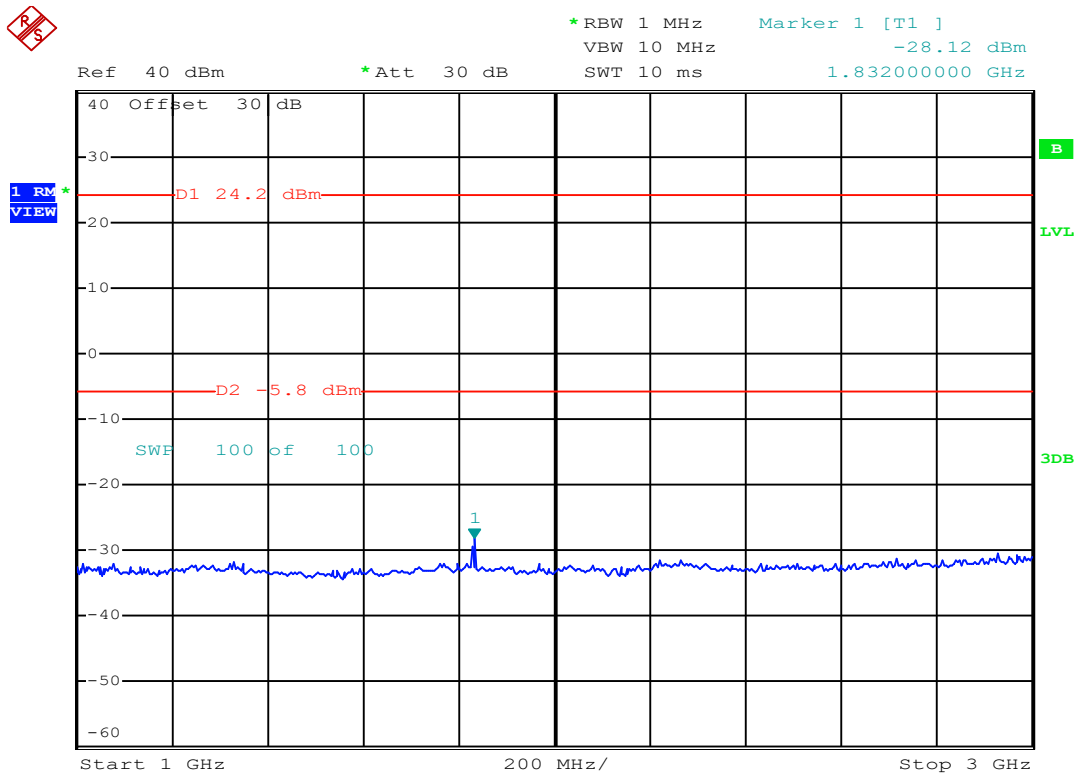
Conducted Spurious Emissions:



Channel:	**24**		**Channel Frequency:**	**915**	**MHz**
Mode:	**Mesh**		**Modulation:**	**FSK**	
Emission Frequency:	**934.2**	**MHz**	**Measured Emission:**	**-29.39**	**dBm**

Plot 15.2 – Conducted Spurious Emissions, Ch 24

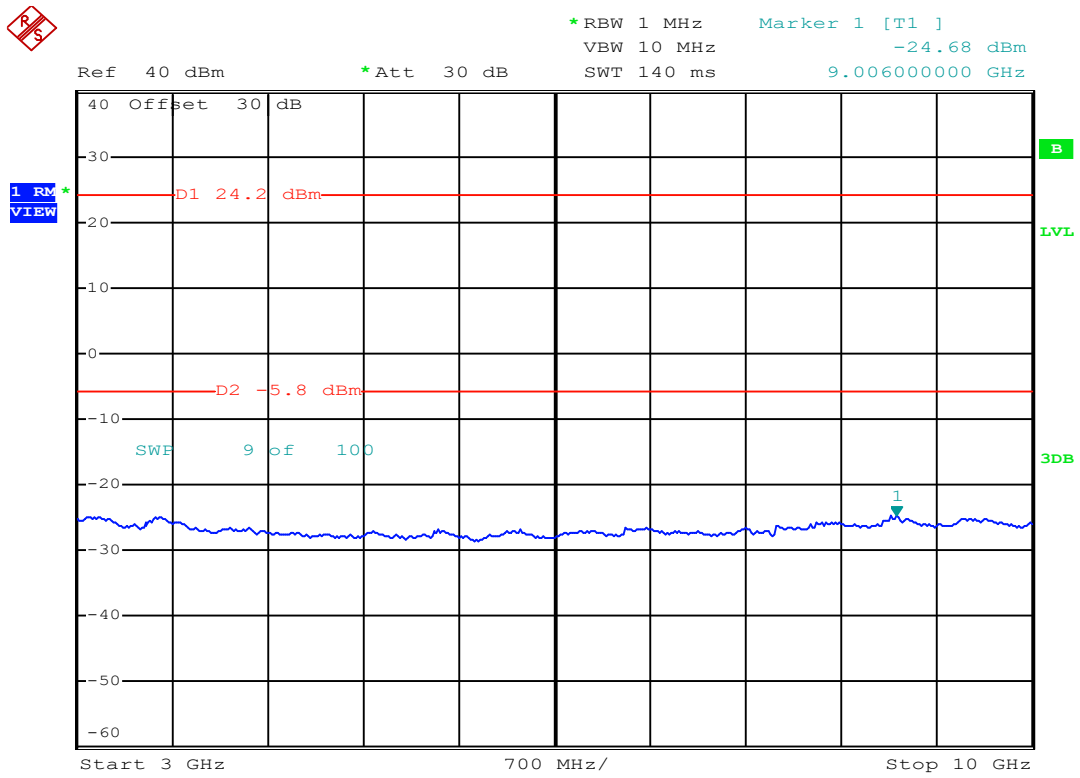
Conducted Spurious Emissions:



Channel:	24		**Channel Frequency:**	915	MHz
Mode:	Mesh		**Modulation:**	FSK	
Emission Frequency:	934.2	MHz	**Measured Emission:**	-29.39	dBm

Plot 15.3 – Conducted Spurious Emissions, Ch 24

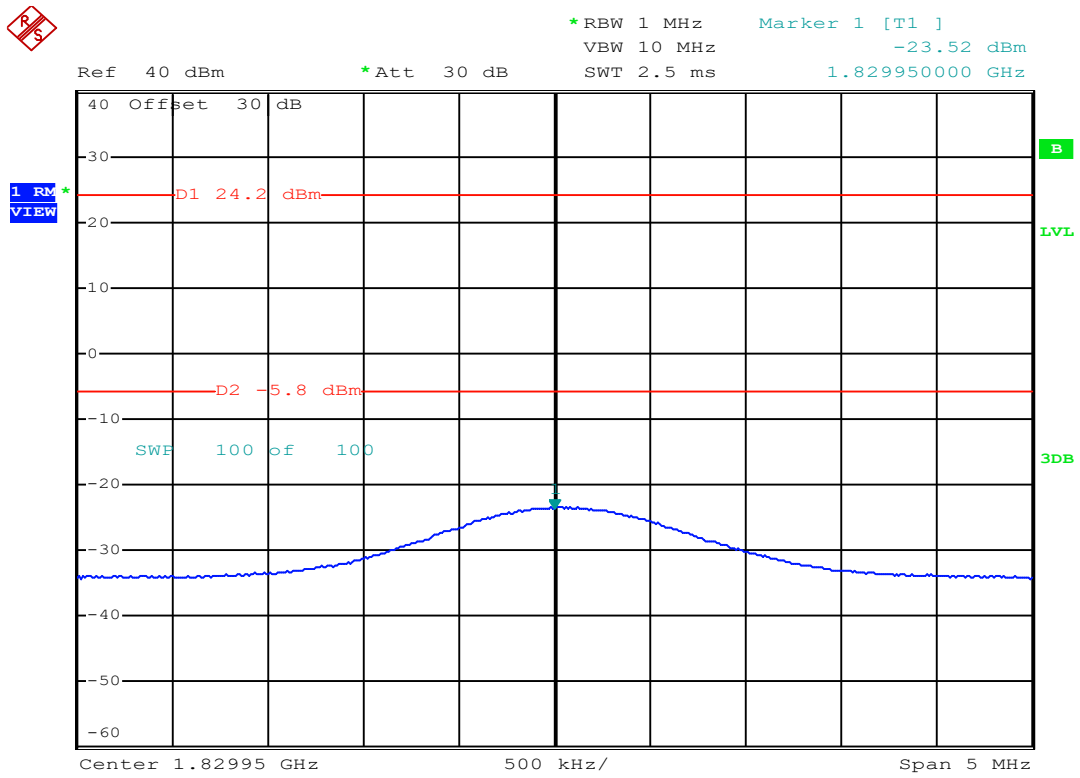
Conducted Spurious Emissions:



Channel:	24		**Channel Frequency:**	915	MHz
Mode:	Mesh		**Modulation:**	FSK	
Emission Frequency:	9006	MHz	**Measured Emission:**	-24.68	dBm

Plot 15.4 – Conducted Spurious Emissions, Ch 24

Conducted Spurious Emissions:



Channel:	**24**		**Channel Frequency:**	**915**	**MHz**
Mode:	**Mesh**		**Modulation:**	**FSK**	
Emission Frequency:	**1830**	**MHz**	**Measured Emission:**	**-23.52**	**dBm**

Table 15.1 – Summary of Conducted Spurious Emissions

Conducted Spurious Emissions Measurement Results:								
Channel Number	Frequency (MHz)	Modulation	Emission Power [P_{Em}] (dBm)	Emission Frequency (MHz)	Fundamental Measurment [P_{Fund}] (dBm)	Attenuation [Atten] (dB)	Limit (dB)	Margin (dB)
5	914.00	O-QPSK	-23.52	1830	24.20	47.72	30	17.7
							Complies	

Attenuation [Atten] = [P_{Fund}] - [P_{Em}]
Margin = Attenuation - Limit
ND = None Detected

16.0 RADIATED TX SPURIOUS EMISSIONS, RESTRICTED BAND

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)

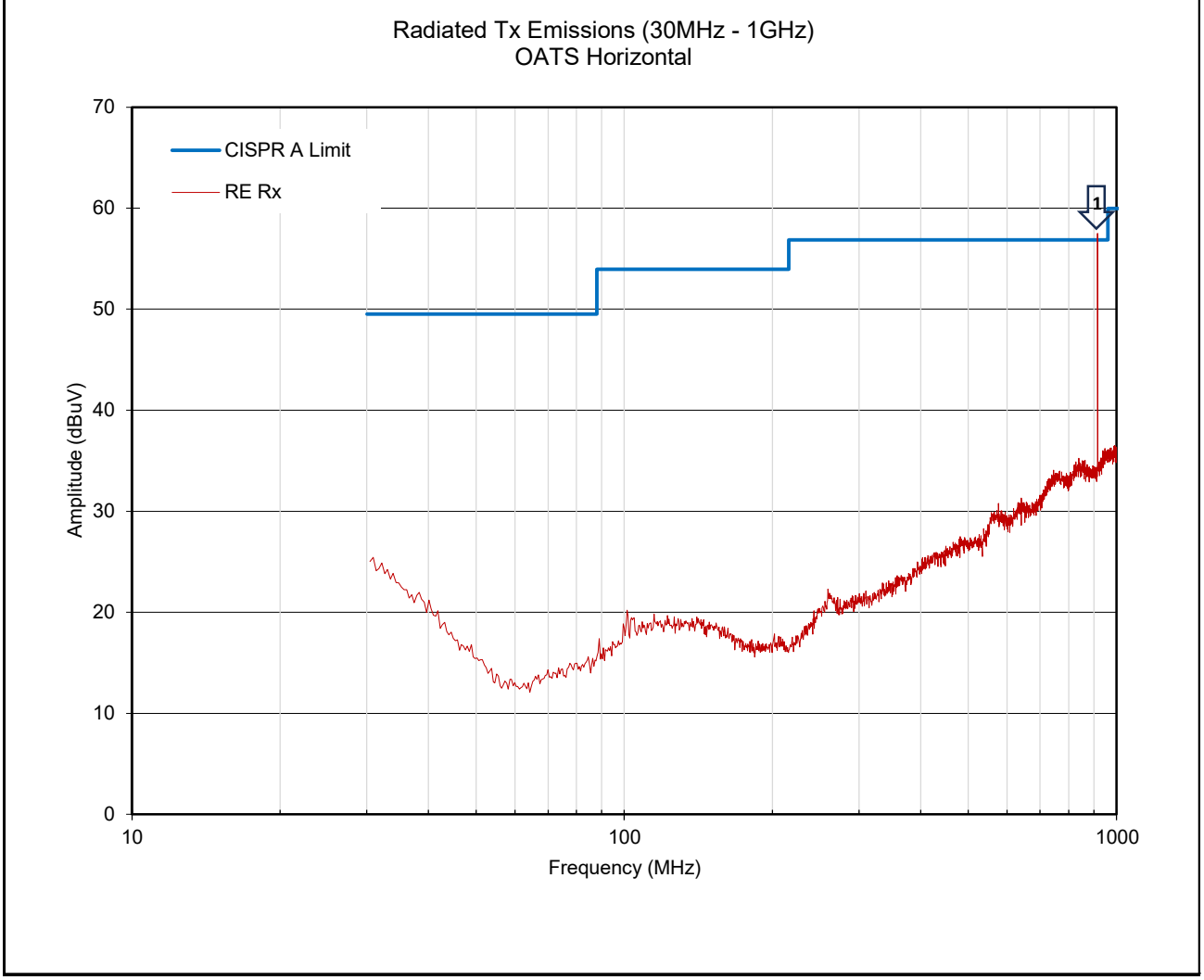
§15.209 Radiated emission limits; general requirements.

(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:

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

Plot 16.1 – Radiated Tx Spurious Emissions, Ch 24, Horizontal, 30 – 1000MHz

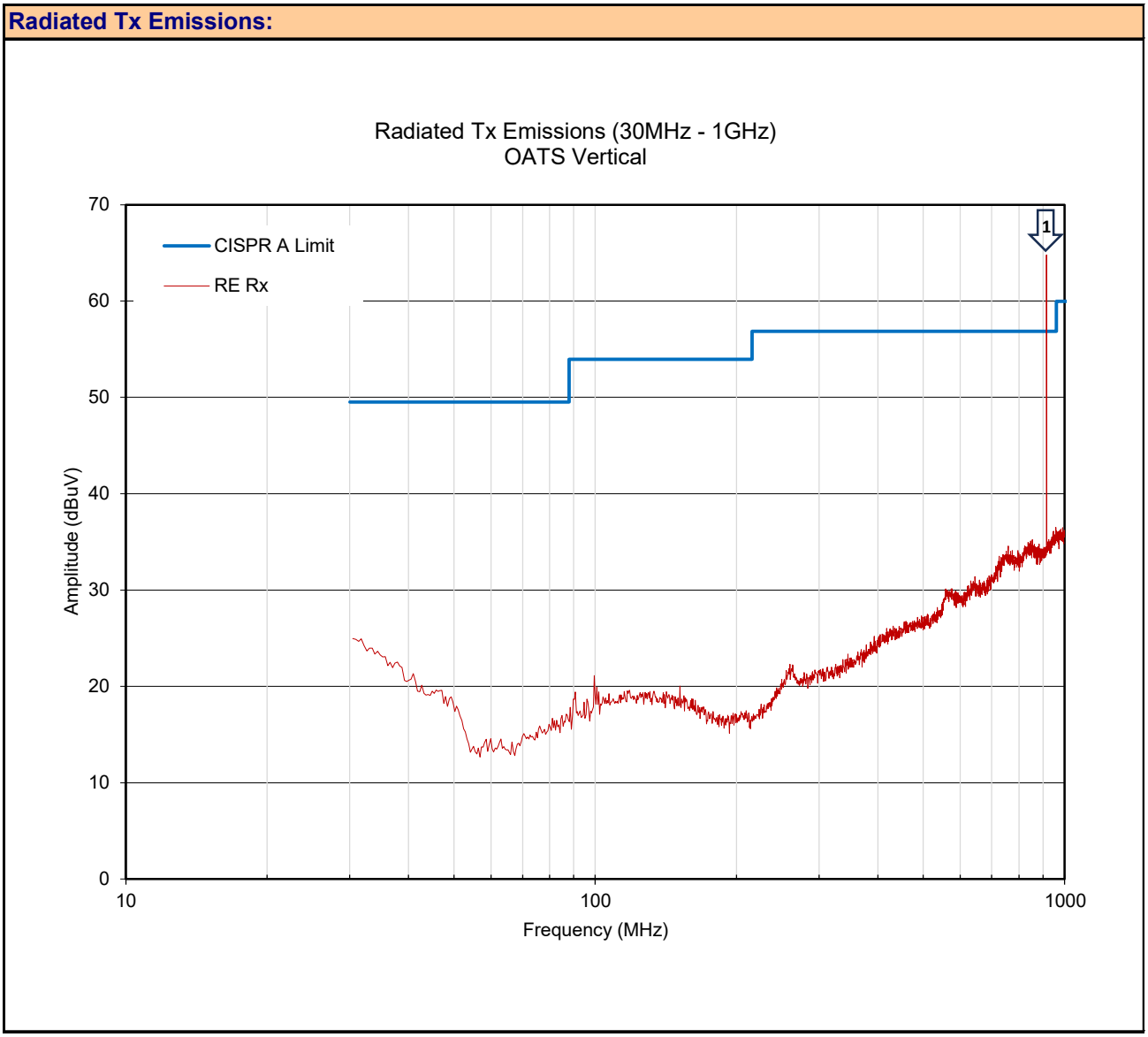
Radiated Tx Emissions:



Marker 1 = Fundamental

Plot 16.2 – Radiated Tx Spurious Emissions, Ch 24, Vertical, 30 – 1000MHz

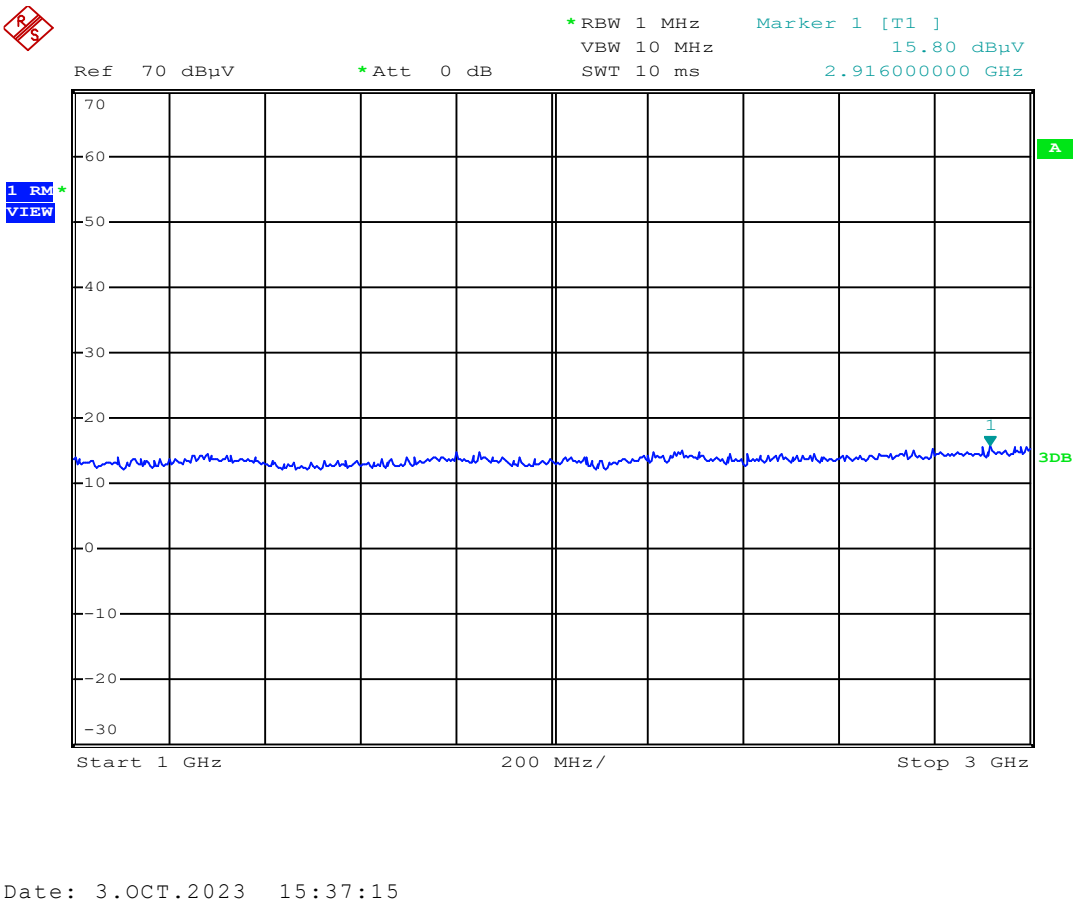
Radiated Tx Emissions:



Marker 1 = Fundamental

Plot 16.3 – Radiated Tx Spurious Emissions, Ch 24, Horizontal, 1 – 3GHz

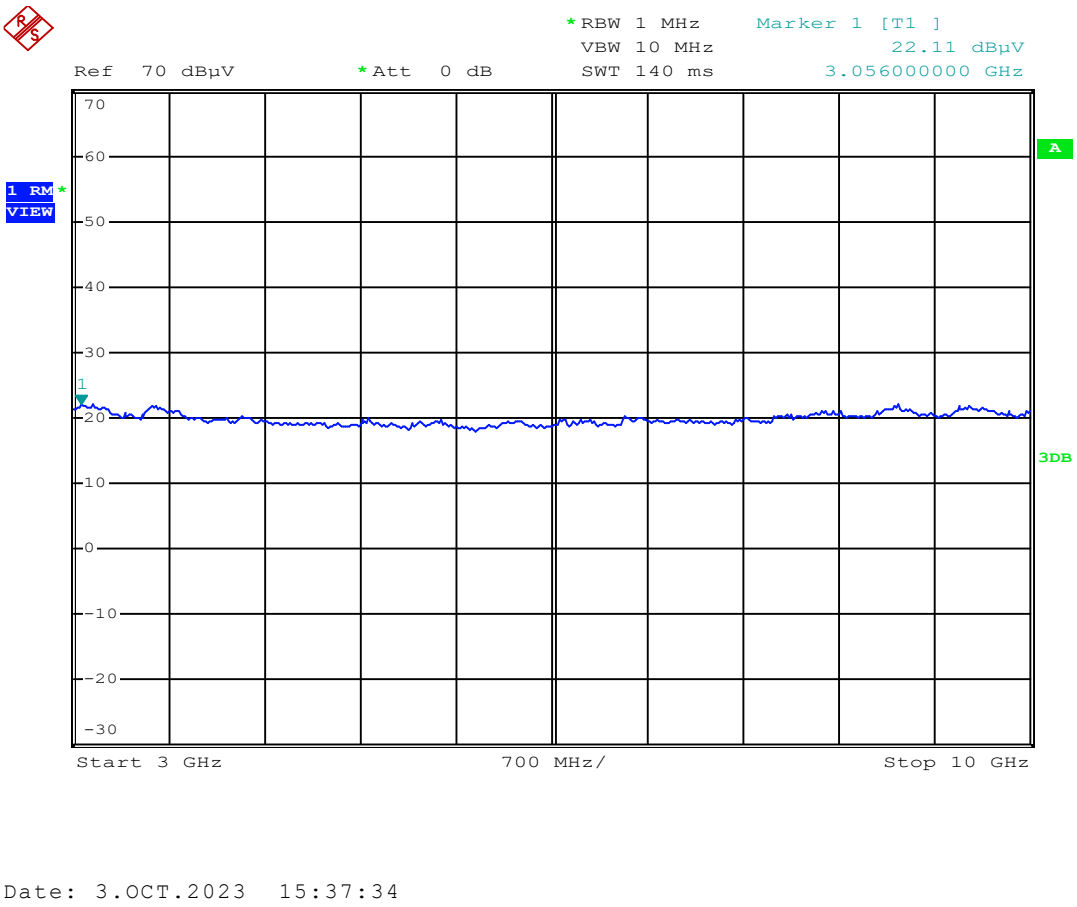
Radiated Tx Emissions:



Channel:	24		**Channel Frequency:**	915	MHz
Mode:	-		**Modulation:**	FSK	
Polarization:	Horizontal		**Measured Emission:**	-	dBm
Emission Frequency:	ND	MHz			

Plot 16.4 – Radiated Tx Spurious Emissions, Ch 24, Horizontal, 3 - 10GHz

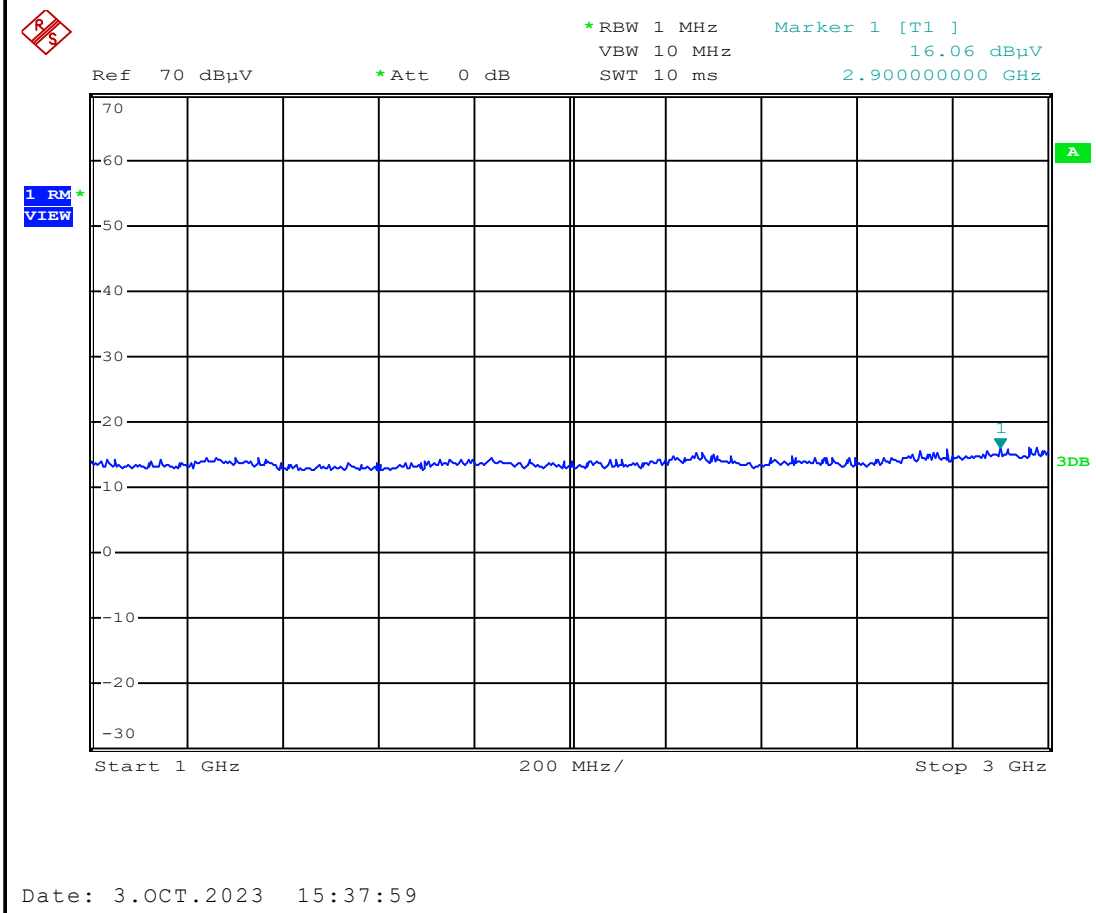
Radiated Tx Emissions:



Channel:	24		**Channel Frequency:**	915 MHz
Mode:	-		**Modulation:**	FSK
Polarization:	Horizontal		**Measured Emission:**	- dBm
Emission Frequency:	ND MHz			

Plot 16.5 – Radiated Tx Spurious Emissions, Ch 24, Vertical, 1 -3GHz

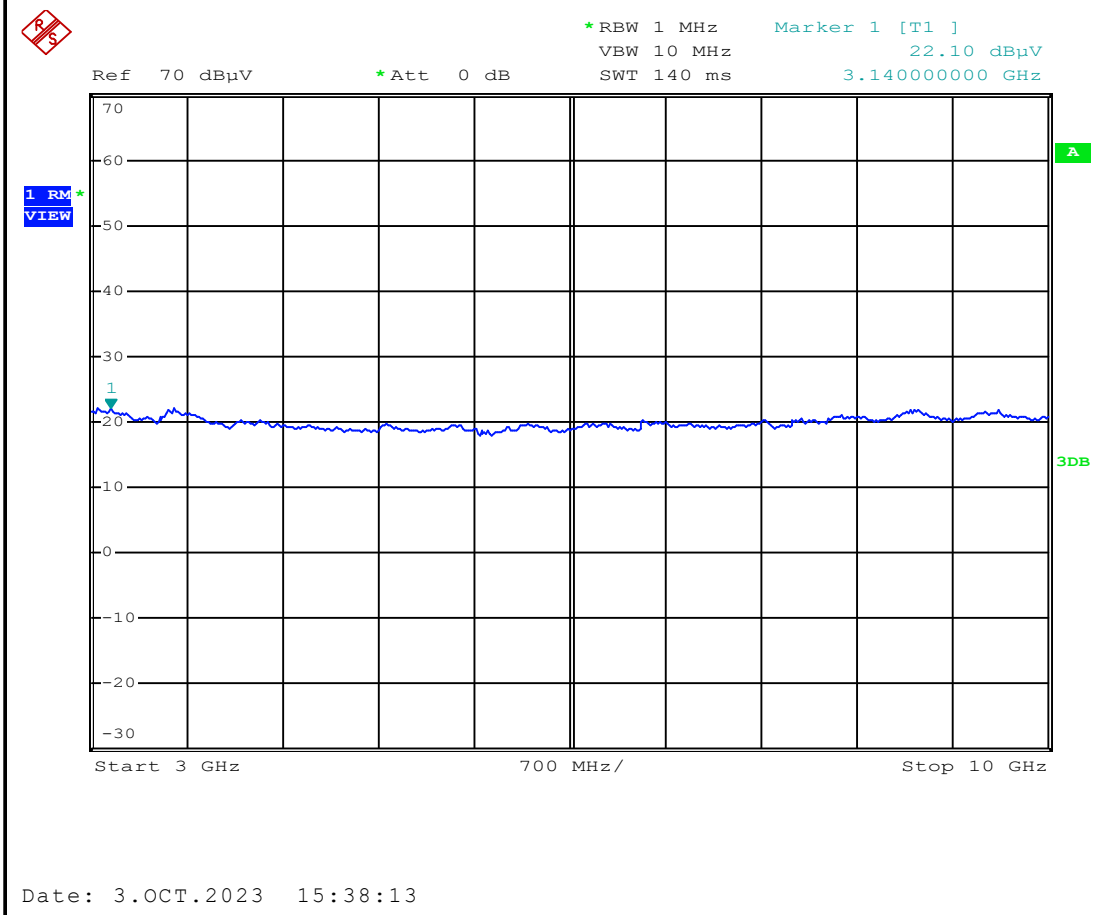
Radiated Tx Emissions:



Channel:	**24**		**Channel Frequency:**	**915**	**MHz**
Mode:	**-**		**Modulation:**	**FSK**	
Polarization:	**Vertical**		**Measured Emission:**	**-**	**dBm**
Emission Frequency:	**ND**	**MHz**			

Plot 16.6 – Radiated Tx Spurious Emissions, Ch 24, Vertical, 3 - 10GHz

Radiated Tx Emissions:



Channel:	24		**Channel Frequency:**	915	MHz
Mode:	-		**Modulation:**	FSK	
Polarization:	Vertical		**Measured Emission:**	-	dBm
Emission Frequency:	ND	MHz			

Table 16.1 – Summary of Radiated Tx Spurious Emissions

Summary of Radiated Tx Emissions									
Measured Frequency Range (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	Vertical	**ND**	**ND**	-	-	0.00 (3)	**ND** (2)	-	-
30-1000	Horizontal	**ND**	**ND**	-	-	0.00 (3)	**ND** (2)	-	-
1000-10000	Vertical	**ND**	**ND**	-	-	0.00 (3)	**ND** (2)	-	-
1000-10000	Horizontal	**ND**	**ND**	-	-	0.00 (3)	**ND** (2)	-	-
							Results:	**Complies**	

ND: No Emissions Detected above ambient or within 20dB of the limit

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

(3) External Amplier not used

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

Where ACF^E is the Electric Antenna Correction Factor

17.0 RADIATED RX SPURIOUS EMISSIONS

Test Procedure	
Normative Reference	**FCC 47 CFR §15.109, ICES-003(6.2)** **ANSI C63.4:2014**

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

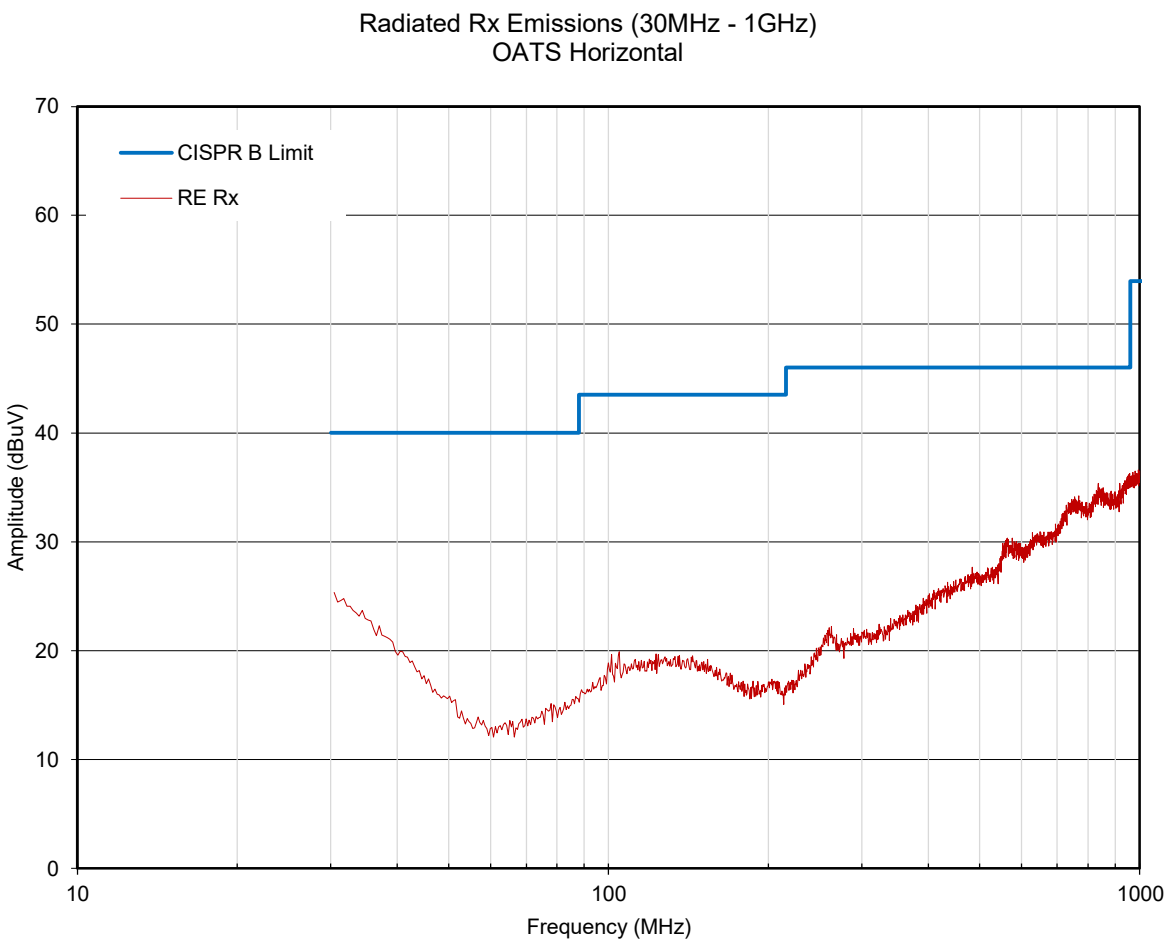
Test Setup	Appendix A Figure A.2

Measurement Procedure

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

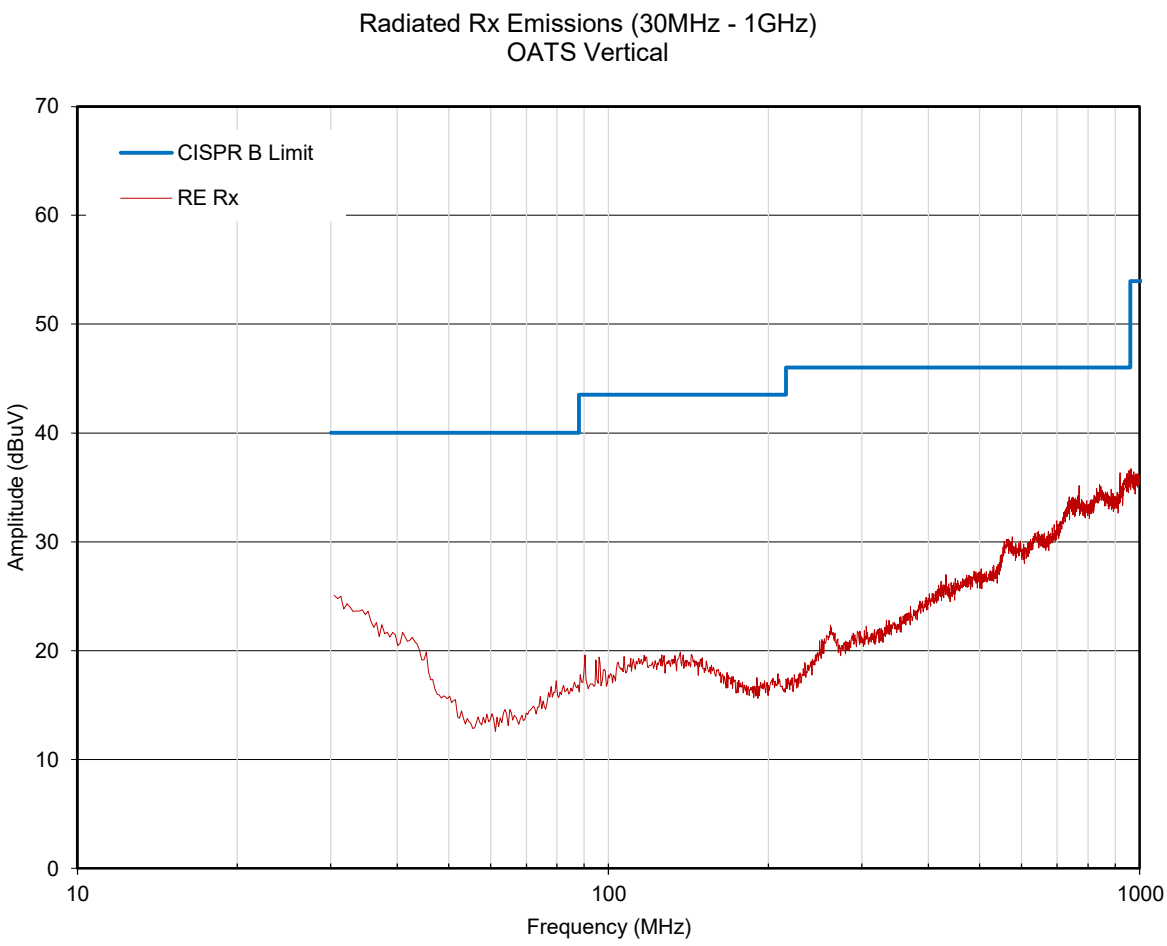
Plot 17.1 – Radiated Rx Spurious Emissions, Horizontal, 30 - 1000GHz

Radiated Rx Emissions:



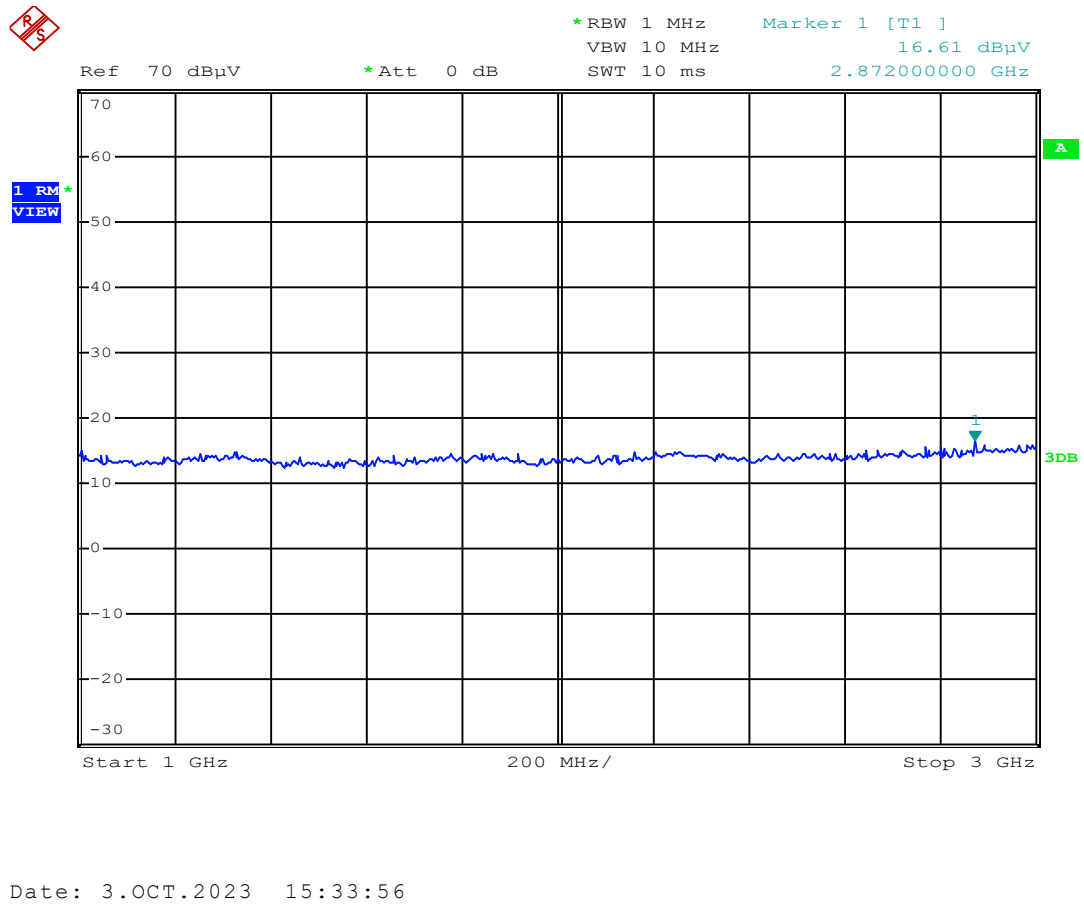
Plot 17.2 – Radiated Rx Spurious Emissions, Vertical, 30 - 1000GHz

Radiated Rx Emissions:



Plot 17.3 – Radiated Rx Spurious Emissions, Horizontal, 1 – 3GHz

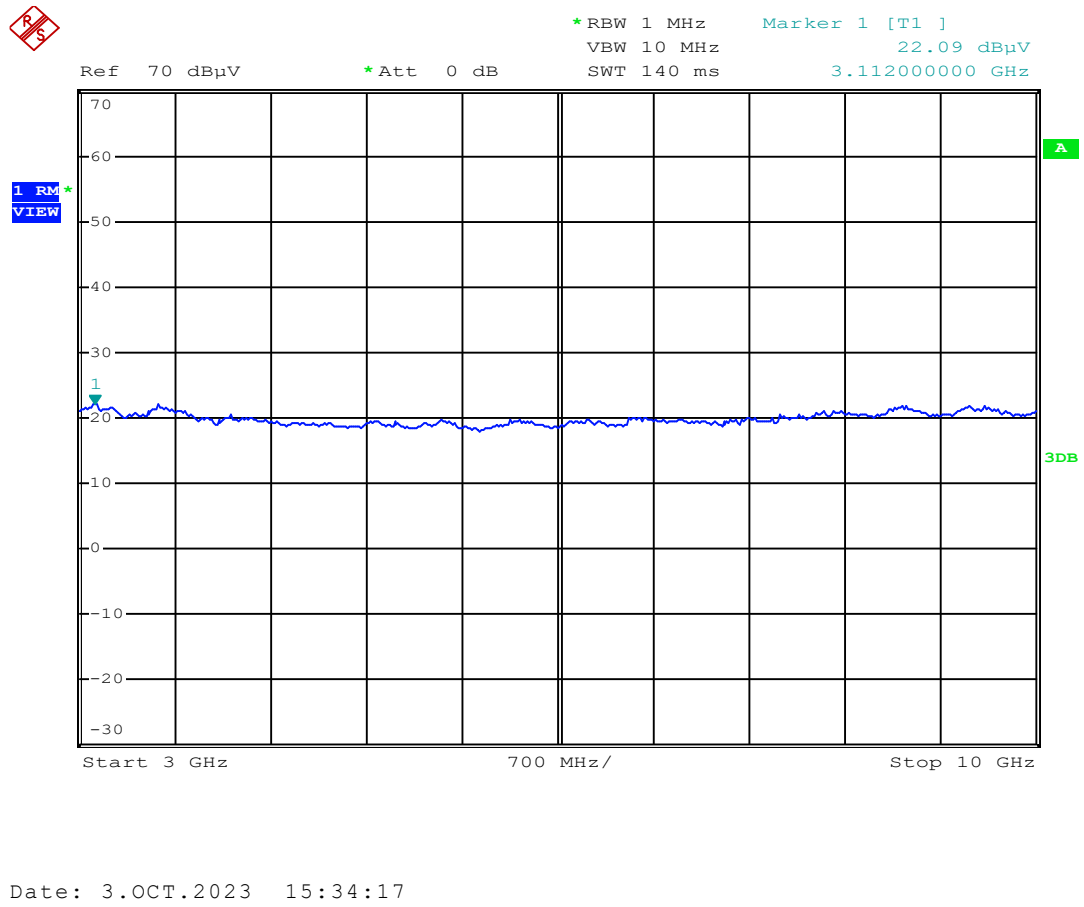
Radiated Rx Emissions:



Channel:	-		**Channel Frequency:**	- MHz
Mode:	-		**Modulation:**	-
Polarization:	Horizontal		**Measured Emission:**	- dBm
Emission Frequency:	ND MHz			

Plot 17.4 – Radiated Rx Spurious Emissions, Horizontal, 3 - 10GHz

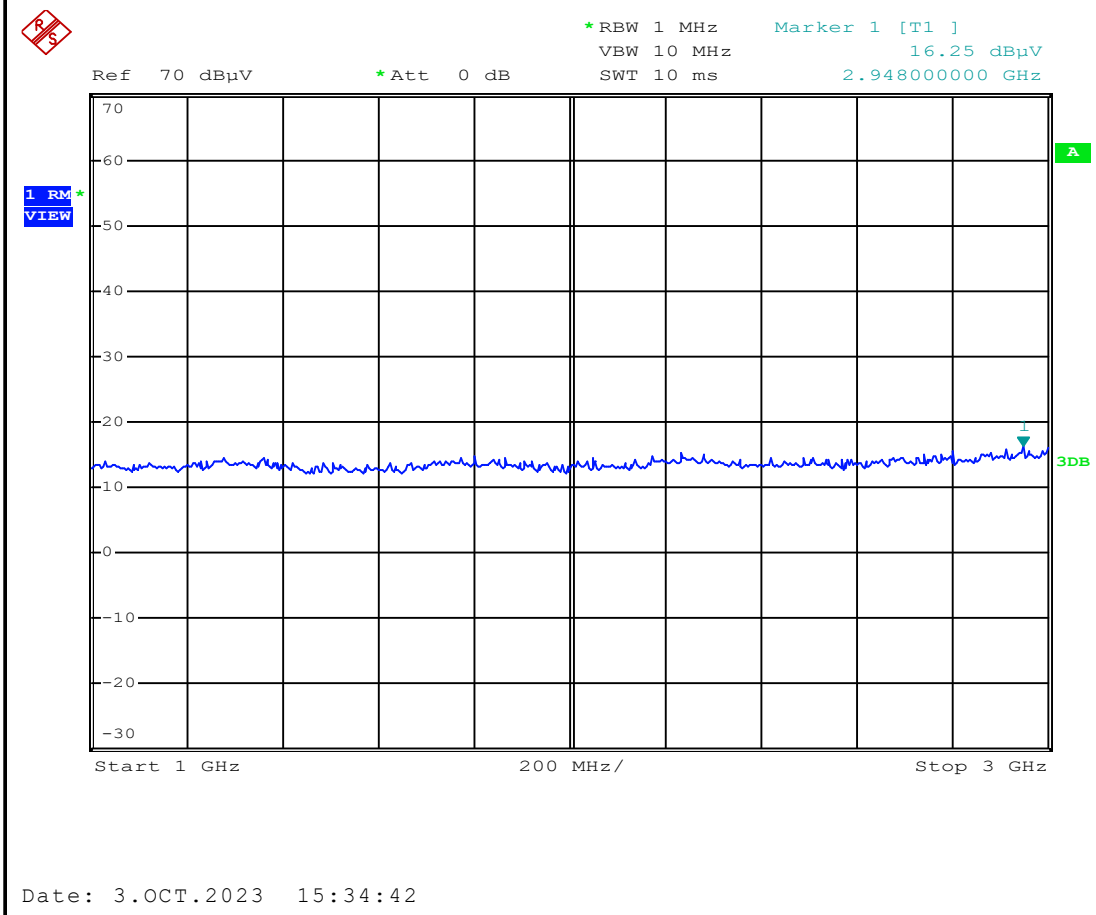
Radiated Rx Emissions:



Channel:	-		**Channel Frequency:**	- MHz
Mode:	-		**Modulation:**	-
Polarization:	Horizontal		**Measured Emission:**	- dBm
Emission Frequency:	ND MHz			

Plot 17.5 – Radiated Rx Spurious Emissions, Vertical, 1 -3GHz

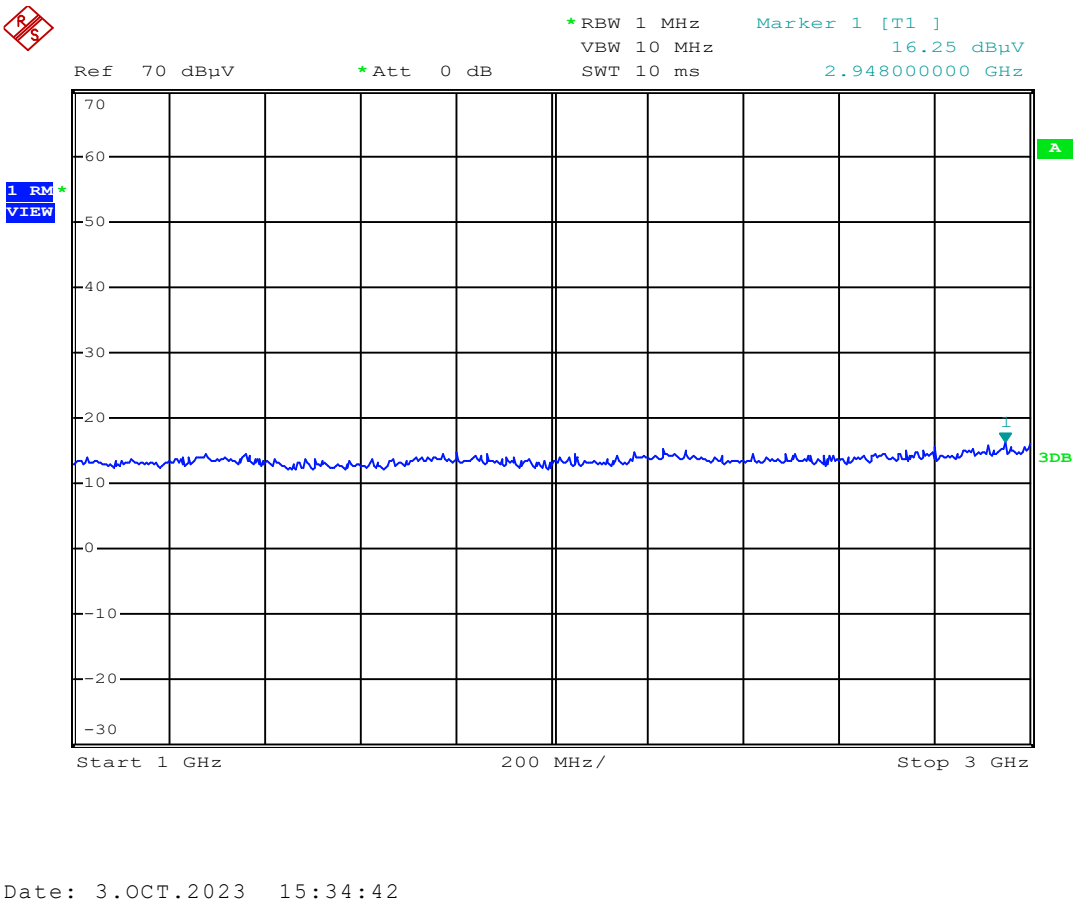
Radiated Rx Emissions:



Channel:	-		**Channel Frequency:**	- MHz
Mode:	-		**Modulation:**	-
Polarization:	Vertical		**Measured Emission:**	- dBm
Emission Frequency:	ND MHz			

Plot 17.6 – Radiated Rx Spurious Emissions, Vertical, 3 - 10GHz

Radiated Rx Emissions:



Channel:	-		**Channel Frequency:**	- MHz
Mode:	-		**Modulation:**	-
Polarization:	Vertical		**Measured Emission:**	- dBm
Emission Frequency:	ND MHz			

Table 17.1 – Summary of Radiated Rx Spurious Emissions

Summary of Radiated Rx Emissions									
Measured Frequency Range (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	Vertical	**ND**	**ND**	-	-	0.00 (3)	**ND** (2)	-	-
30-1000	Horizontal	**ND**	**ND**	-	-	0.00 (3)	**ND** (2)	-	-
1000-10000	Vertical	**ND**	**ND**	-	-	0.00 (3)	**ND** (2)	-	-
1000-10000	Horizontal	**ND**	**ND**	-	-	0.00 (3)	**ND** (2)	-	-
							Results:	**Complies**	

ND: No Emissions Detected above ambient or within 20dB of the limit

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

(3) External Amplier not used

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

Where ACF^E is the Electric Antenna Correction Factor

18.0 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	(b) For a Class A digital device 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 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 boundary between the frequency ranges. 0.15 - 0.5 MHz: 79 dBuV Quasi Peak, 66 dBuV Average 0.5 - 30.0 MHz: 73 dBuV Quasi Peak, 60 dBuV Average
ICES-003(6.1)	6.1 - AC Power Line Conducted Emissions Limits Class A: ITE that meets the conditions for Class A operation defined in Section 2.2 shall comply with the Class A conducted limits set out below in Table 1. 0.15 - 0.5 MHz: 79 dBuV Quasi Peak, 66 dBuV Average 0.5 - 30.0 MHz: 73 dBuV Quasi Peak, 60 dBuV Average

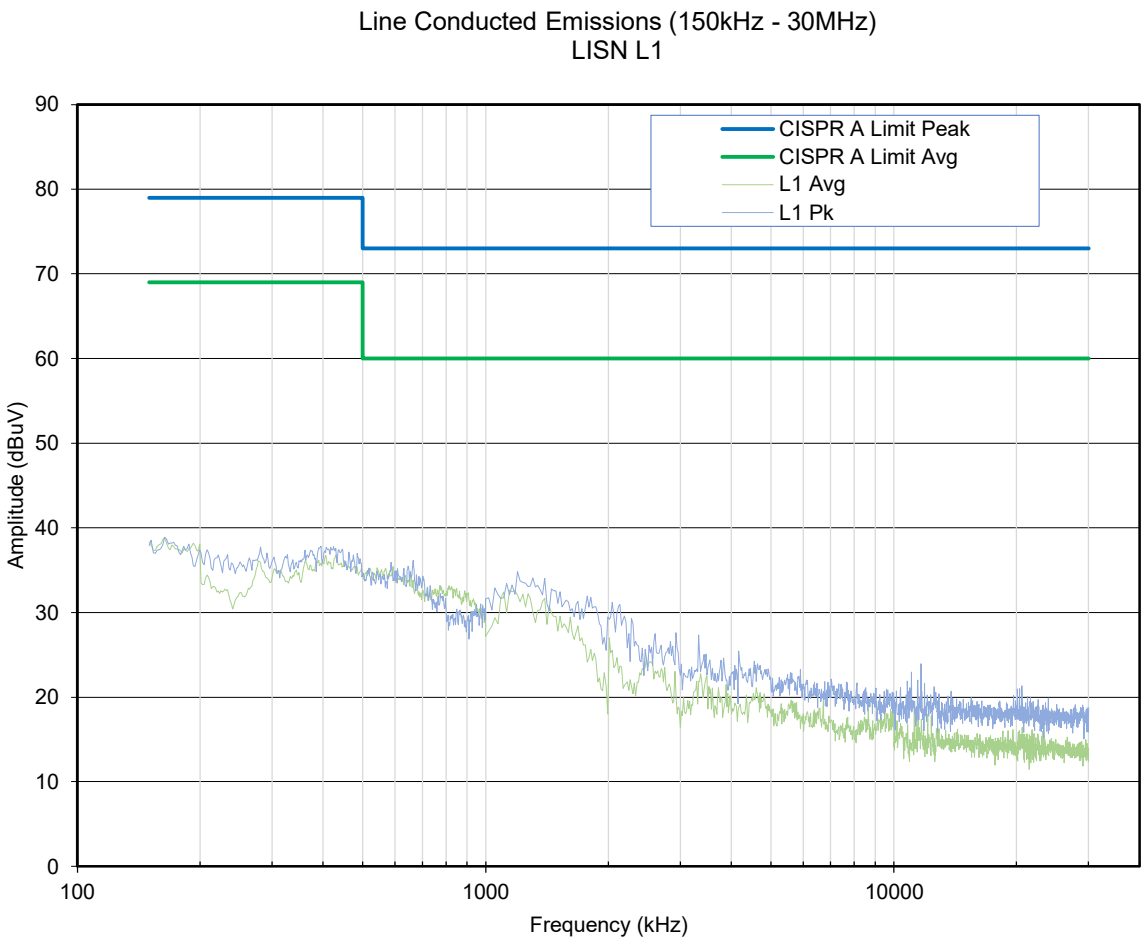
Test Setup	Appendix A Figure A.7

Measurement Procedure

The device was connected to the LISN as shown in Appendix A. The input power supply was connected to a 208VAC, 1PH power source. The AC Line Conducted emissions were measured from 150kHz to 30MHz on both Lines L1 and L2 while the DUT was set to maximum output power.

Plot 18.1 – Line Conducted Emissions, L1 Line

Line Conducted Emissions



Plot 18.2 – Line Conducted Emissions, L2 Neutral

Line Conducted Emissions

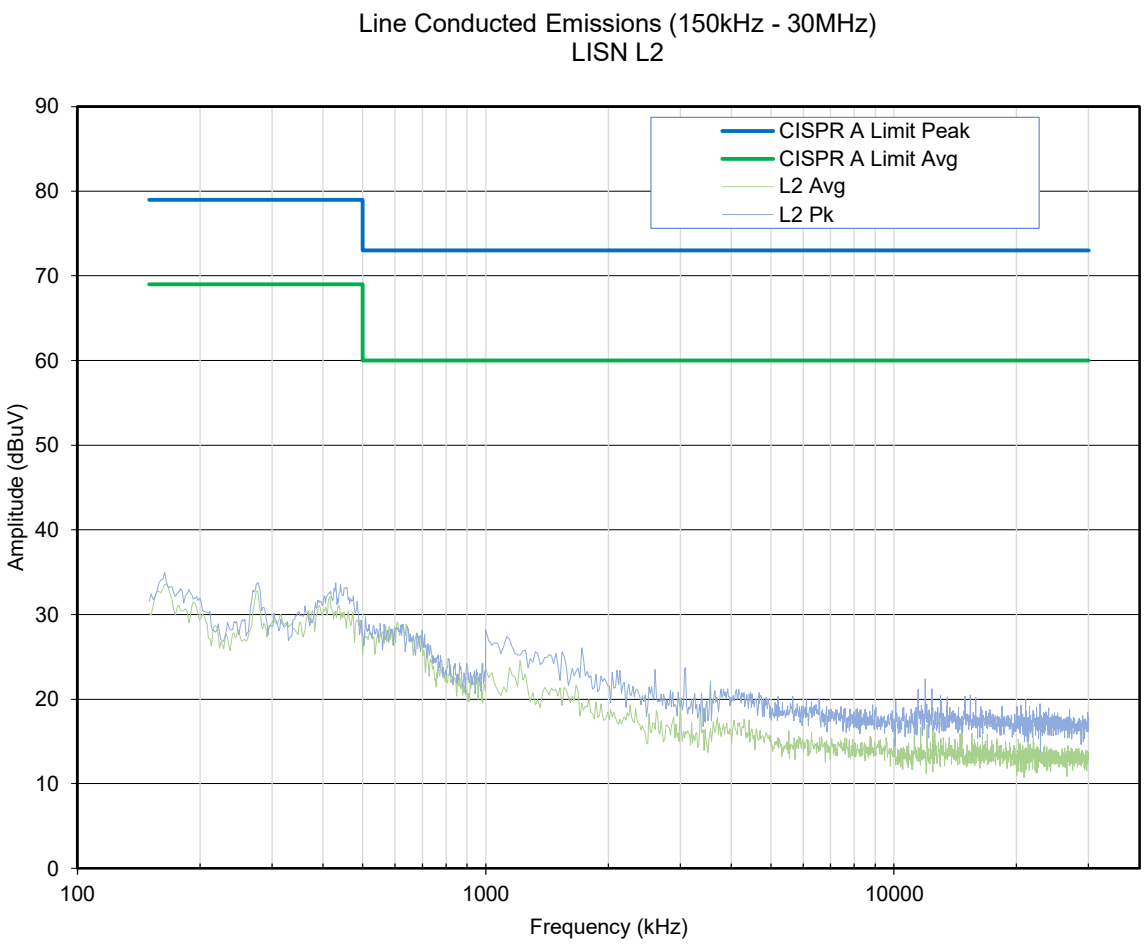


Table 18.1 – Summary of Line Conducted Emissions

§15.107, ICES-003 (6.1)								
	Emission Frequency (MHz)	LISN Port	Measured Emission [E_{Meas}] (dBuV)	Cable Loss [L_C] (dB)	Antenna Correction [ACF] (dB)	Corrected Emission [E_{Corr}] (W)	Limit @3m [Limit] (dBuV/m)	Margin [Margin] (dB)
*	164.0 kHz	L1	**			-	-	-
*	152.0 kHz	L2	**			-	-	-
						Results:	**Complies**	

* Measurement Compensated for Cable Loss and Antenna Correction Factor
$E_{Corr} = E_{Meas} + L_C + AFC$
Margin = Limit - E_{Corr}

** No Emissions within 20dB of the limit detected

APPENDIX A – TEST SETUP DRAWINGS

Table A.1 – Conducted Measurement Setup

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

Figure A.1 – Test Setup – Conducted Measurements

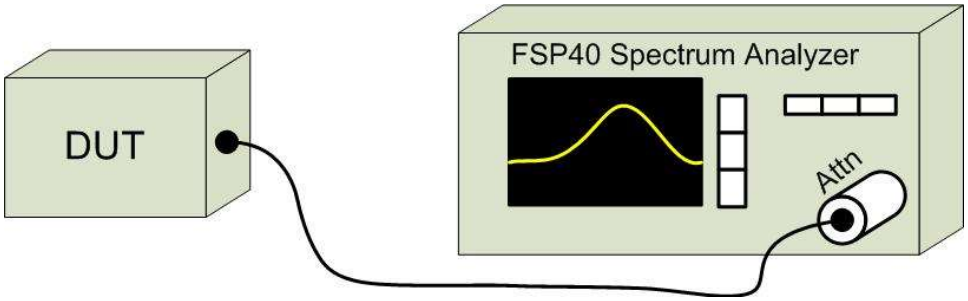


Table A.2 – Radiated Emissions Measurement Equipment

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

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

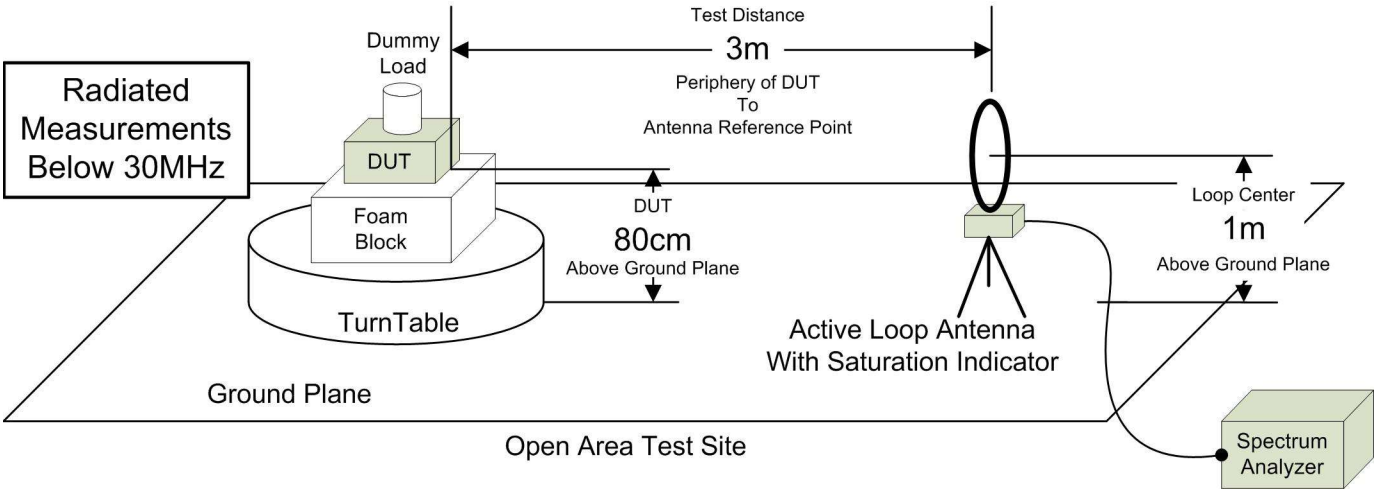


Figure A.3 – Test Setup Radiated Measurements 30MHz – 1GHz

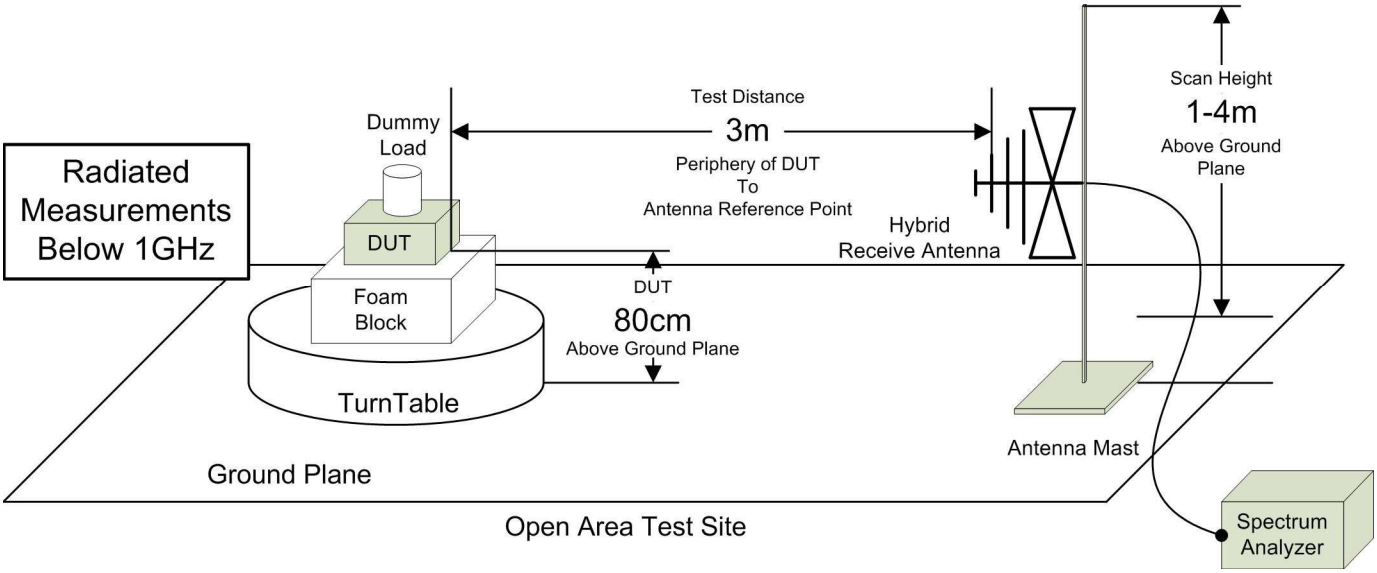


Figure A.4 – Test Setup Radiated Measurements 30MHz – 1GHz, Signal Substitution

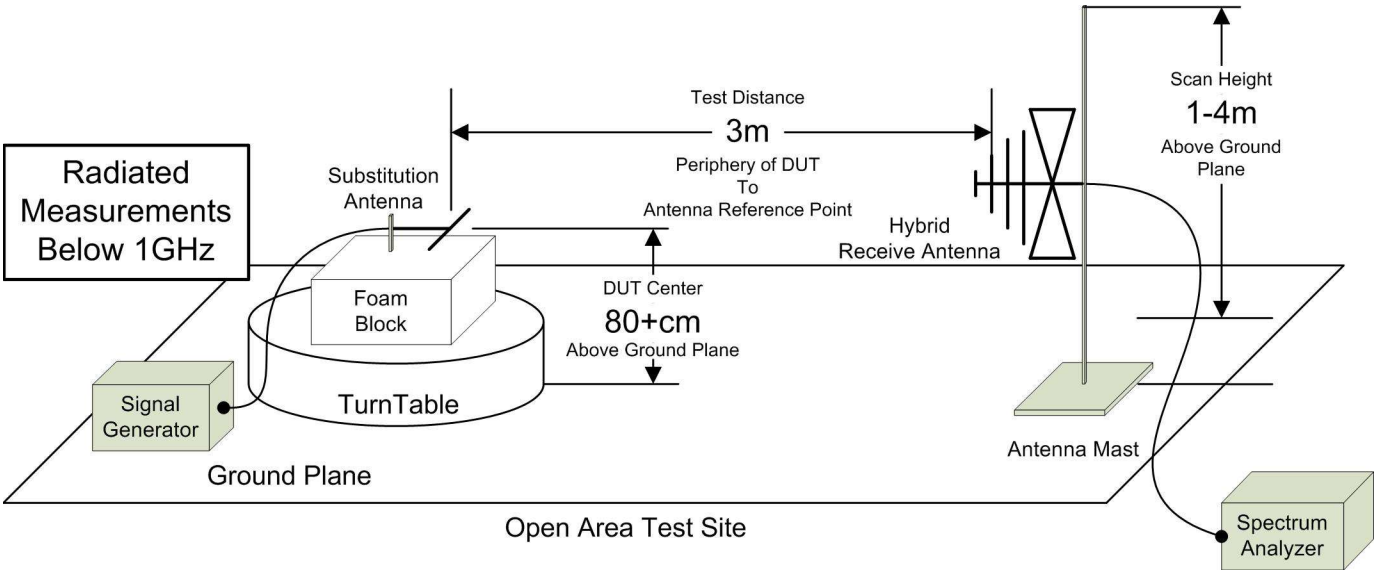


Figure A.5 – Test Setup Radiated Measurements 1 – 18GHz,

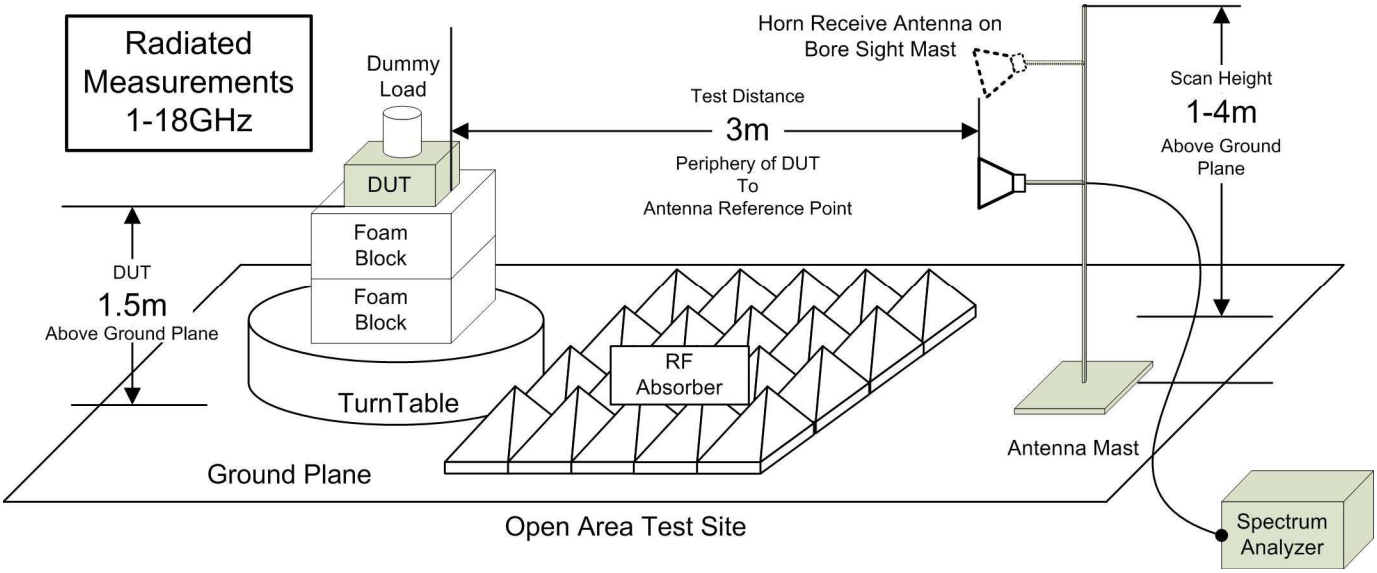


Figure A.6 – Test Setup Radiated Measurements 18 – 26.5GHz,

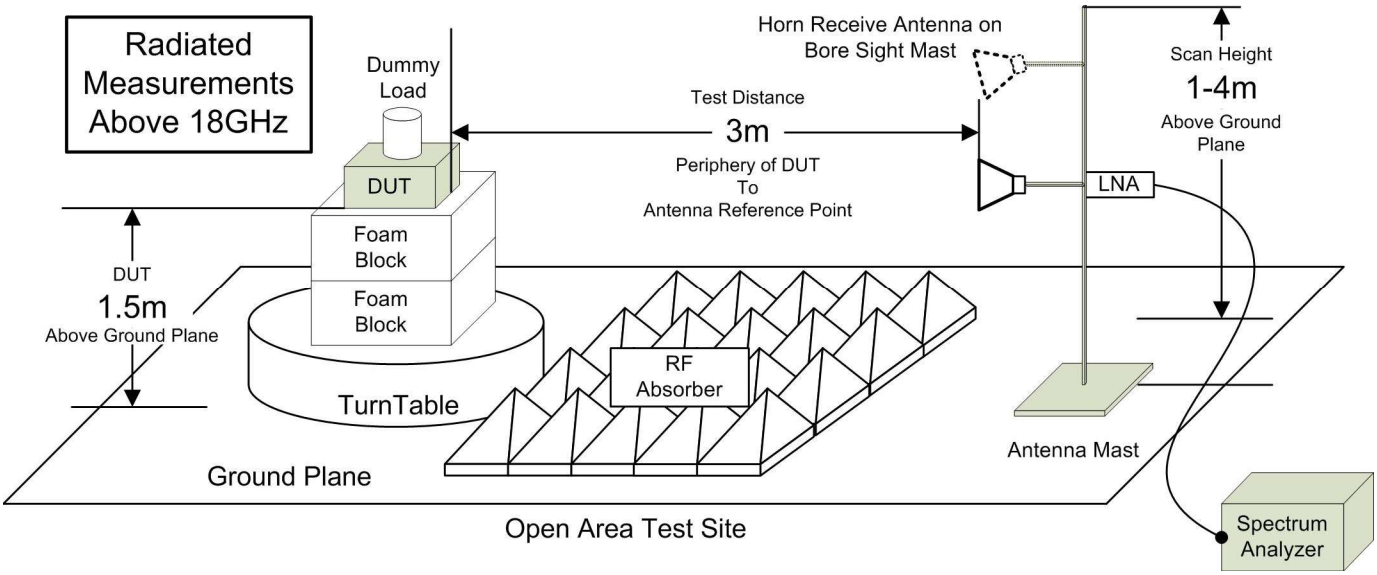
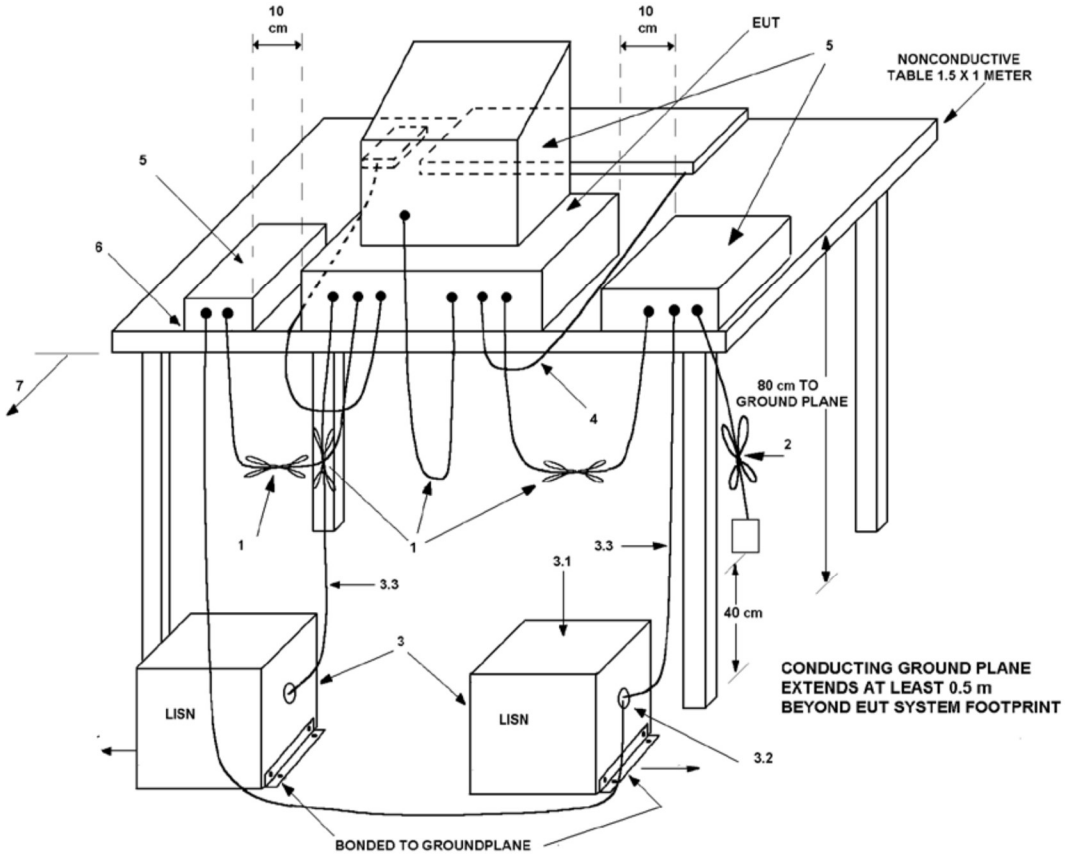


Table A.3 – Power Line Conducted Measurement Equipment

Equipment List			
Asset Number	**Manufacturer**	**Model Number**	**Description**
00051	HP	8566B	Spectrum Analyzer
00049	HP	85650A	Quasi-peak Adapter
00047	HP	85685A	RF Preselector
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



APPENDIX B – EQUIPMENT LIST AND CALIBRATION

Table B.1 – Equipment Calibration Information

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
00241	R&S	FSU40	100500	Spectrum Analyzer	10 Aug 2021	Triennial	10 Aug 2024
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
00275	TMS	LMR400	n/a	25m Cable	COU	n/a	COU
00065	Pasternack	PE7014-30	n/a	30dB Attenuator	COU	n/a	COU
00130	Pasternack	PE7019-30	n/a	30dB Attenuator	COU	n/a	COU
00322	Mini-Circuits	BW-N5W5+	n/a	5dB Attenuator cal w/ 00050	16 Nov 2020	Triennial	16 Nov 2023

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} = 5.14dB U_{CISPR} = 6.3dB	
Radiated Emissions 200MHz - 1000MHz	
U_{LAB} = 5.90dB U_{CISPR} = 6.3dB	
Radiated Emissions 1GHz - 6GHz	
U_{LAB} = 4.80dB U_{CISPR} = 5.2dB	
Radiated Emissions 6GHz - 18GHz	
U_{LAB} = 5.1dB U_{CISPR} = 5.5dB	
Power Line Conducted Emissions 9kHz to 150kHz	
U_{LAB} = 2.96dB U_{CISPR} = 3.8dB	
Power Line Conducted Emissions 150kHz to 30MHz	
U_{LAB} = 3.12dB U_{CISPR} = 3.4dB	
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} = 1.0dB U_{CISPR} = n/a
Frequency/Bandwidth 9kHz - 40GHz
U_{LAB} = 0.1ppm U_{CISPR} = n/a
Temperature
U_{LAB} = 1^{O}C U_{CISPR} = n/a

END OF REPORT

