Testing Tomorrow's Technology

Application

For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247

And

ISED Radio Standards Specification: RSS-Gen Issue 5 and RSS-247 Issue 3

For the

Mueller Systems, LLC

Model: MINODE6A

FCC ID: SM6-MINODE6A
IC: 9235A-MINODE6A

UST Project: 24-0031
Issue Date: March 19, 2024

Total Pages in This Report : 45

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I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date March 19, 2024

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANYS NAME: Mueller Systems, LLC

MODEL: MINODE6A

FCC ID: SM6-MINODE6A

IC: 9235A-MINODE6A

DATE: March 19, 2024

This report concerns (check one): Original grant [X]
Class II change

Equipment type: 902-915MHz DTS Transmitter device

FCC Rule	Description of Test	Result
15.247(b)(3)	Peak Output Power	PASS
15.247(a)(2)	6 dB Bandwidth	PASS
15.247(d)	Conducted & Radiated Spurious Emissions	PASS
15.247(b)	Output power	PASS
15.247(e)	Power Spectral Density	PASS
15.209	Spurious Radiated Emissions	PASS
15.207	Power line Conducted Emissions	N/A

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1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to the FCC Rules and Regulations Part 15, Section 247 and IC RSS 247 Issue 2.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on February 7, 2024 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Mueller Systems, LLC. Model MINODE6A. The EUT is an RF transceiver module. It operates in the unlicensed 902 to 928 MHz ISM band. The device offers three modes Frequency Hopping Spread Spectrum (FHSS), Digital Transmission Systems (DTS) and a cross between both these modes called Hybrid mode of operation.

The EUT uses RFV4 and LoRAWAN protocols. The protocol is dependent on the mode of operation.

This report is written to evaluate the DTS mode. The FHSS and Hybrid modes have been evaluated in a separate test report.

Mode of operation: DTS
Frequency Range: 903 MHz – 915.7255 MHz
Protocals: RFV4, LoRaWAN
Antenna: Monopole, 4.0 dBi Peak Gain @ 915 MHz
Modulation: CSS
Maximum Output Power: +27.7 dBm (measured)

1.4 Configuration of Tested System

The Test Sample was tested per ANSI C63.4:2014 and ANSI C63.4:2013, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz for FCC subpart A Digital equipment Verification requirements and per ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices for FCC subpart C Intentional Radiators.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is US5301. Additionally, this site has also been fully described and submitted to Industry Canada (ISED), and has been approved under file number 9900A-1.

1.6 Related Submittals

1.6.1 The EUT is subject to the following FCC authorizations:

a) Certification under section 15.247 as a transmitter.
b) Verification under 15.101 as a digital device and receiver.

1.6.2 Verification of the Digital apparatus

The Verification requirement shares many common report elements with the Certification report. Therefore, though this report is mostly intended to provide data for the Certification process, the Verification authorization report (part 15.107 and 15.109) for the EUT is included herein.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Mueller Systems, LLC	MINODE6A	Engineering Sample	FCC ID: SM6-MINODE6A (Pending) IC:9235A-MINODE6A (Pending)	None
Antenna See antenna details	--	--	--	--

U= Unshielded S= Shielded P= Power D= Data

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are indicated.

Table 2. Test Instruments

TEST INSTRUMENT	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	09/21/2024 2 yr.
SPECTRUM ANALYZER	E4440A	AGILENT TECHNOLOGIES INC	MY45304803	07/21/2025 2 yr.
BICONICAL ANTENNA	EMCO	EMCO	9307-1431	01/13/2025 2 yr.
HORN ANTENNA	SAS-571	A. H. SYSTEMS	605	04/28/2024 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	Extended 3/13/2024 2 yr.
LOOP ANTENNA	6502	ETS LINDGREN	9810-3246	12/7/2024 2 yr.
PREAMP	8449B	HEWLETT PACKARD	3008A00914	3/3/2024
PREAMP	8447D	HEWLETT-PACKARD	1937A01611	7/20/2024

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT or the Subpart B Unintentional Radiator Limits (Receiver and Digital Device) Requirements.

2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 below.

Table 3. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates over 10 MHz span, 3 test frequencies were used.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10^{th} harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to 5 times the highest internal clock frequency.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following.

2.5.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e., 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

2.5.2 Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified, there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz .

2.5.3 Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may be expressed logarithmically in dB.

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG) the duty cycle factor calculated will be applied.

2.7 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. Only the antenna(s) listed in Table 4 will be used with this module.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna	Mueller Systems, LLC	¼ Monopole	145-0037-001	4.0	Permanent

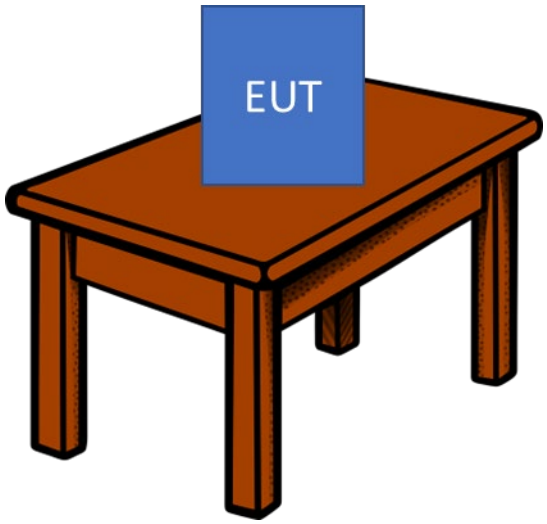

Figure 1. Test Configuration

2.9 Power Line Conducted Emissions (CFR 15.207)

Since the EUT is battery powered, this test was not applied.

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d)) (IC RSS 247 5.1 & 5.2)

Radiated Spurious measurements: The EUT was placed into a continuous transmit mode of operation (>98%) duty cycle) and tested per FCC Public Notice DA 00-705 and ANSI C63.10:2013. A preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the device. A preliminary scan was performed on the EUT to find the worst case results the EUT was tested in X, Y, and Z axes or in the orientation of normal operation if the device is designed to operate in a fixed position.

Radiated measurements were then conducted between the frequency range of 9 kHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (no greater than 40 GHz). In the band below 30 MHz a resolution bandwidth (RBW) of 9 kHz was used, emissions below 1 GHz were tested with a RBW of 120 kHz and emissions above 1 GHz were tested with a RBW of 1 MHz . All video bandwidth settings were at least three times the RBW value.

The EUT was investigated to CFR 15.209, General requirements for unwanted spurious emissions. The conducted spurious method as described below was used to investigate all other emissions emanating from the antenna port.

Conducted Spurious measurements: The EUT was put into a continuous-transmit mode of operation (>98% duty cycle) and tested per FCC Public Notice DA 00-705 for conducted out of band emissions emanating from the antenna port over the frequency range of 30 MHz to 25 GHz. A conducted scan was performed on the EUT to identify and record the spurious signals that were related to the transmitter.

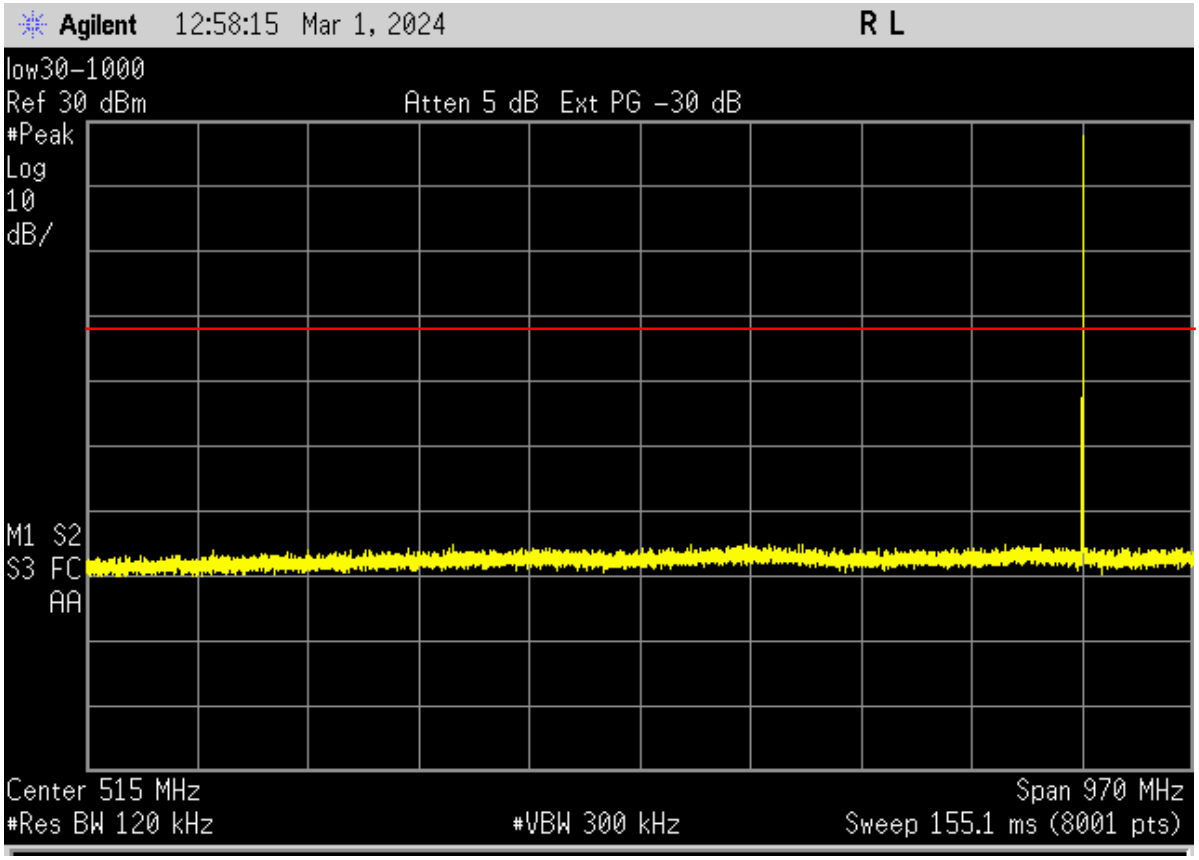

Figure 2. Conducted Spurious Emissions-Low Channel, 30MHz – 1 GHz

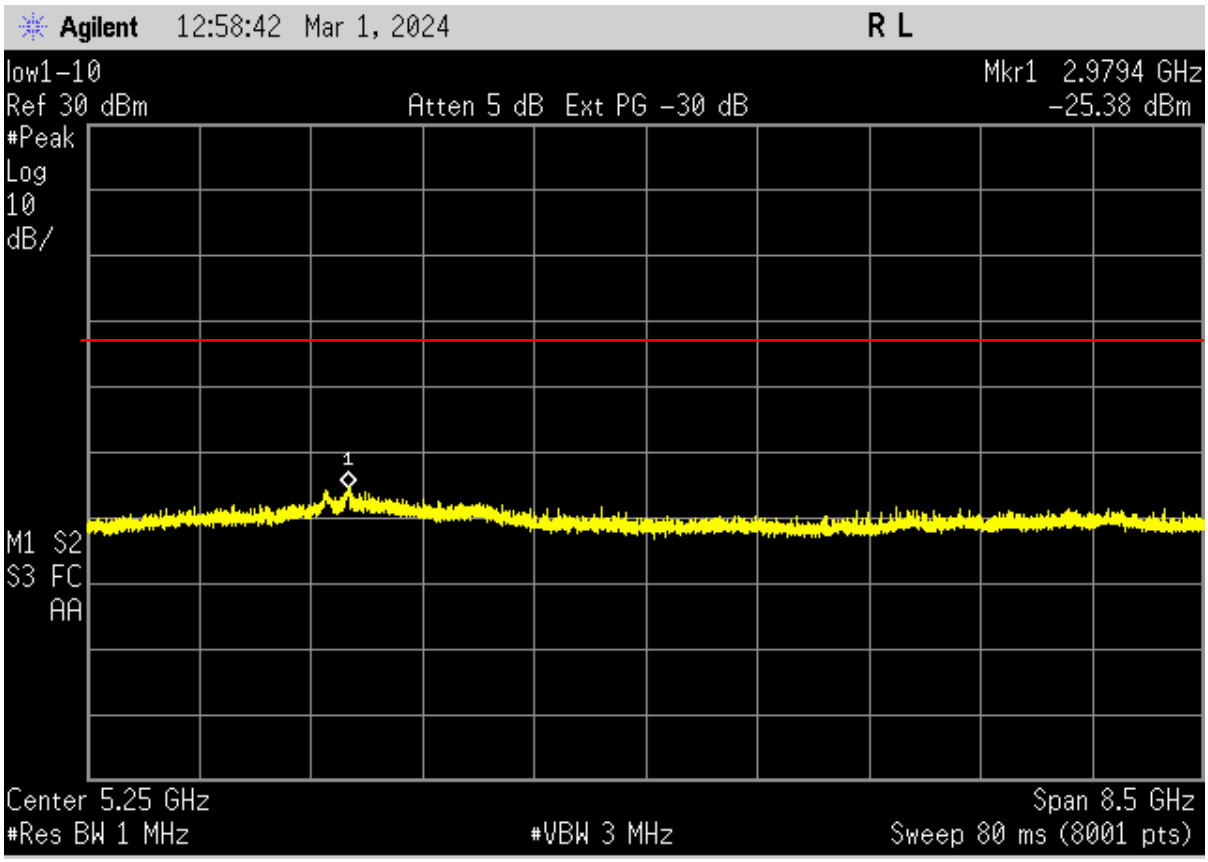

Figure 3. Conducted Spurious Emissions - Low Channel, 1 GHz – 9.5 GHz

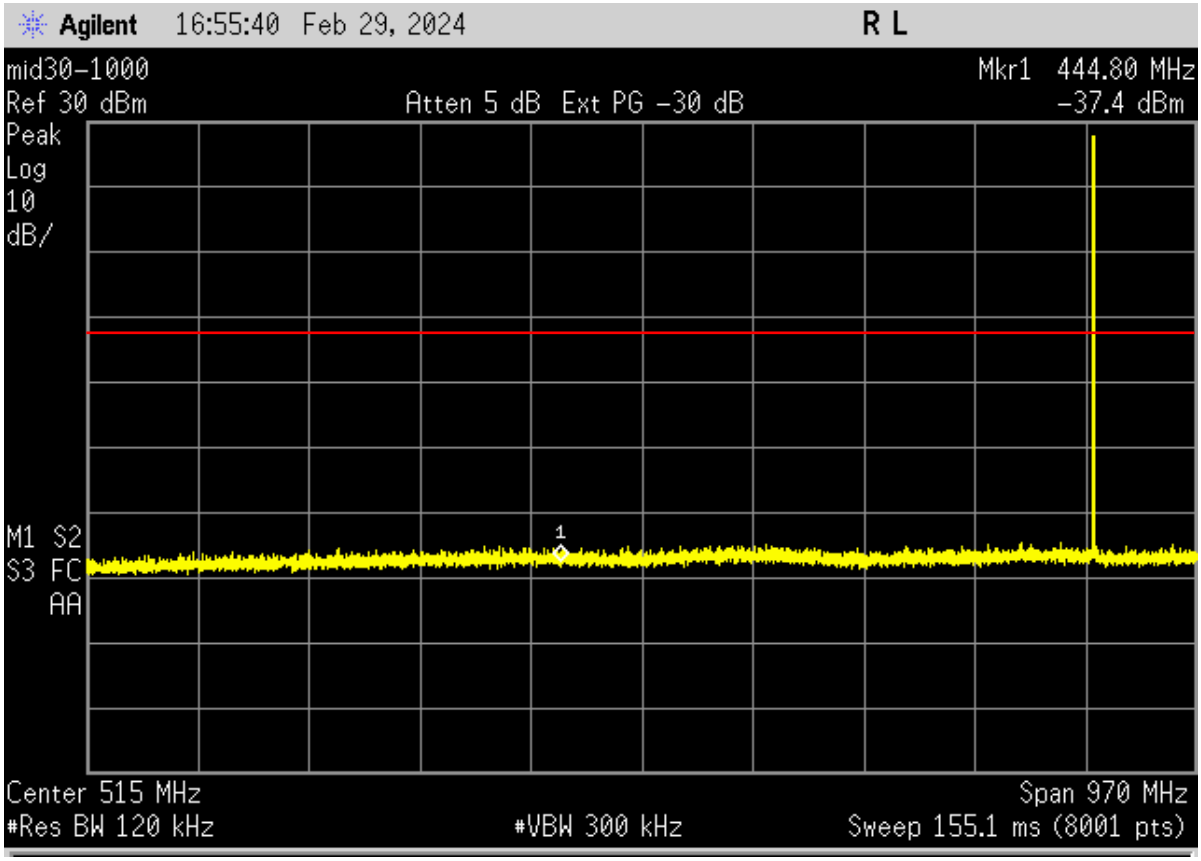

Figure 4. Conducted Spurious Emissions - Mid Channel, 30MHz – 1 GHz

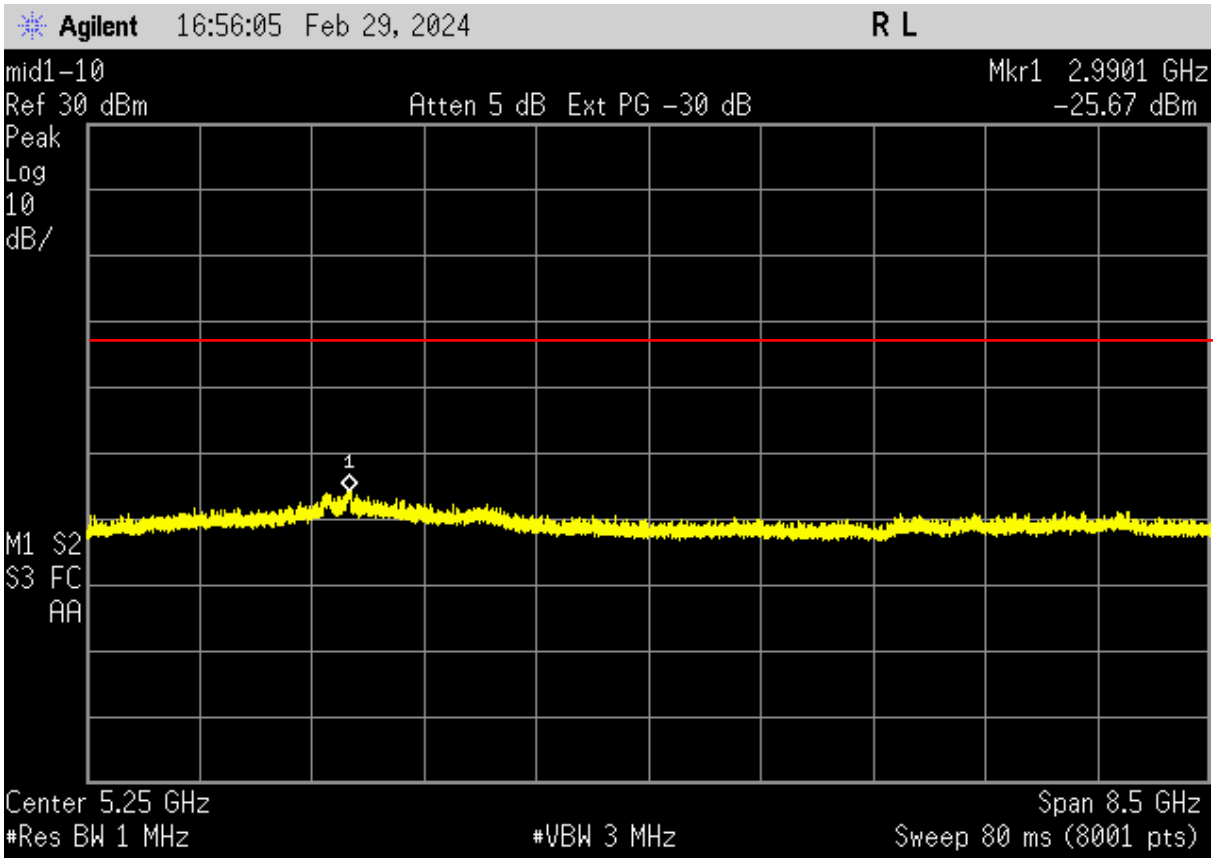

Figure 5. Conducted Spurious Emissions - Mid Channel, 1 GHz – 9.5 GHz

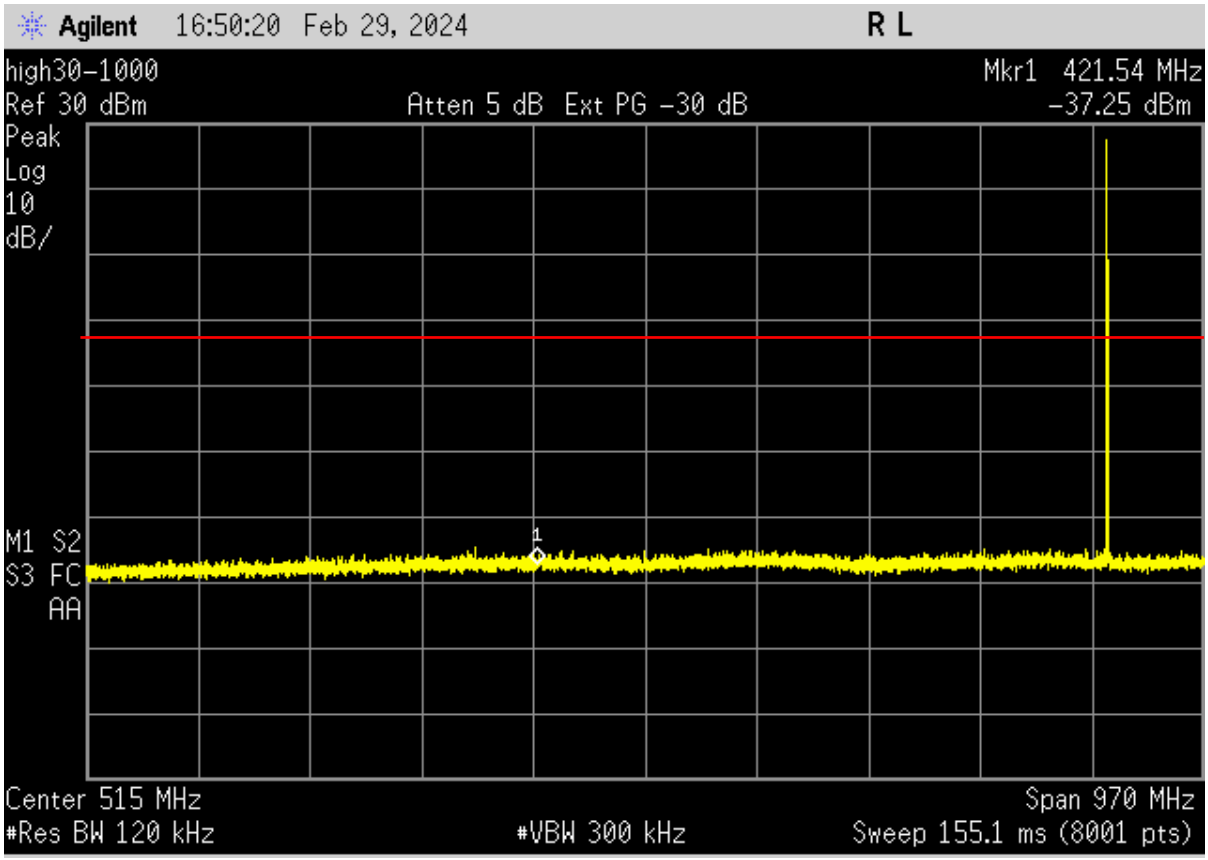

Figure 6. Conducted Spurious Emissions - High Channel, 30 MHz – 1 GHz

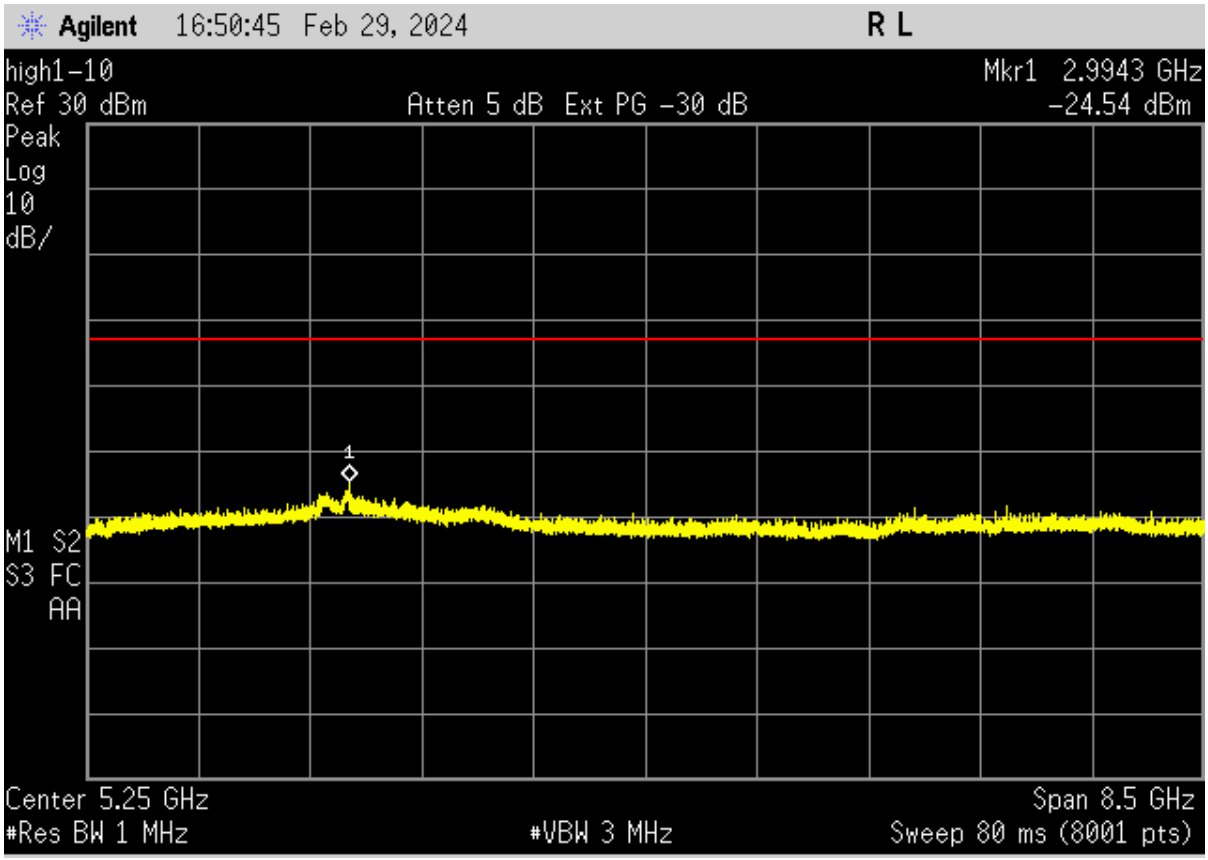

Figure 7. Conducted Spurious Emissions - High Channel, 1 GHz – 9.5 GHz

Table 5. Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**PK Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel								
903.65	100.81	--	26.15	126.96	--	3.0m/HORZ	--	**PK**
1807.50	51.67	--	-7.44	44.23	104.00	3.0m/HORZ	59.77	**PK**
*2710.98	50.90	--	-4.11	46.79	74.00	3.0m/HORZ	27.21	**PK**
*3614.56	42.51	--	-1.36	41.15	74.00	3.0m/HORZ	32.85	**PK**
*4518.36	44.12	--	1.08	45.20	74.00	3.0m/HORZ	28.80	**PK**
*5422.05	42.68	--	5.86	48.54	74.00	3.0m/HORZ	25.46	**PK**
6324.46	41.75	--	9.16	50.91	104.00	3.0m/HORZ	53.09	**PK**
7227.70	44.23	--	12.10	56.33	104.00	3.0m/HORZ	47.67	**PK**
*8132.26	40.43	--	12.46	52.89	74.00	3.0m/HORZ	21.11	**PK**
*9033.19	38.27	--	13.78	52.05	74.00	3.0m/HORZ	21.95	**PK**
Mid Channel								
909.43	100.90	--	26.16	127.06	--	3.0m/HORZ	--	**PK**
1818.90	52.07	--	-7.49	44.59	104.00	3.0m/HORZ	59.41	**PK**
*2728.99	52.43	--	-3.99	48.45	74.00	3.0m/HORZ	25.55	**PK**
*3637.37	42.03	--	-1.32	40.71	74.00	3.0m/HORZ	33.29	**PK**
*4546.21	45.17	--	0.98	46.15	74.00	3.0m/HORZ	27.85	**PK**
*5455.28	42.74	--	6.01	48.76	74.00	3.0m/HORZ	25.24	**PK**
6365.35	42.58	--	9.16	51.74	104.00	3.0m/HORZ	52.26	**PK**
*7274.98	42.22	--	12.00	54.23	74.00	3.0m/HORZ	19.77	**PK**
*8182.37	40.32	--	12.80	53.11	74.00	3.0m/HORZ	20.89	**PK**
*9091.15	39.05	--	14.19	53.24	74.00	3.0m/HORZ	20.76	**PK**
High Channel								
915.72	101.66	--	26.17	127.83	--	3.0m/HORZ	--	**PK**
1831.62	52.38	--	-7.48	44.90	104.00	3.0m/HORZ	59.10	**PK**
*2747.25	51.68	--	-3.99	47.69	74.00	3.0m/HORZ	26.31	**PK**
*3662.90	42.60	--	-0.96	41.64	74.00	3.0m/HORZ	32.36	**PK**
*4578.94	46.53	--	1.18	47.71	74.00	3.0m/HORZ	26.29	**PK**
5492.99	43.16	--	6.03	49.19	104.00	3.0m/HORZ	54.81	**PK**
6408.04	45.03	--	9.48	54.51	104.00	3.0m/HORZ	49.49	**PK**
*7326.58	41.53	--	11.85	53.38	74.00	3.0m/HORZ	20.62	**PK**
*8243.45	41.94	--	13.54	55.49	74.00	3.0m/HORZ	18.51	**PK**
*9156.85	38.42	--	14.03	52.45	74.00	3.0m/HORZ	21.55	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. The EUT was placed in 2 orthogonal positions and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 903.65 MHz:

Magnitude of Measured Frequency	100.81	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	26.15	dB/m
1 meter to 3-meter extrapolation	0.00	dB
Corrected Result	126.96	dBuV/m

Test Date: February 8-26, 2024

Tested By
Signature: Ian Charboneau Name: Ian Charboneau

Table 6. Average Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel								
903.65	66.00	--	26.15	92.15	--	3.0m/HORZ	--	**AVG**
1807.50	44.64	--	-7.44	37.2	94.00	3.0m/HORZ	56.8	**AVG**
*2710.98	42.39	--	-4.11	38.28	54.00	3.0m/HORZ	15.72	**AVG**
*3614.56	29.12	--	-1.36	27.76	54.00	3.0m/HORZ	26.24	**AVG**
*4518.36	30.66	--	1.08	31.74	54.00	3.0m/HORZ	22.26	**AVG**
*5422.05	28.00	--	5.86	33.86	54.00	3.0m/HORZ	20.14	**AVG**
6324.46	26.40	--	9.16	35.56	94.00	3.0m/HORZ	58.44	**AVG**
7227.70	28.97	--	12.10	41.07	94.00	3.0m/HORZ	52.93	**AVG**
*8132.26	25.65	--	12.46	38.11	54.00	3.0m/HORZ	15.89	**AVG**
*9033.19	23.93	--	13.78	37.71	54.00	3.0m/HORZ	16.29	**AVG**
Mid Channel								
909.43	65.53	--	26.16	91.69	--	3.0m/HORZ	--	**AVG**
1818.90	43.39	--	-7.49	35.9	94.00	3.0m/HORZ	58.1	**AVG**
*2728.99	41.70	--	-3.99	37.71	54.00	3.0m/HORZ	16.29	**AVG**
*3637.37	28.74	--	-1.32	27.42	54.00	3.0m/HORZ	26.58	**AVG**
*4546.21	31.48	--	0.98	32.46	54.00	3.0m/HORZ	21.54	**AVG**
*5455.28	29.02	--	6.01	35.03	54.00	3.0m/HORZ	18.97	**AVG**
6365.35	27.51	--	9.16	36.67	94.00	3.0m/HORZ	57.33	**AVG**
*7274.98	27.73	--	12.00	39.73	54.00	3.0m/HORZ	14.27	**AVG**
*8182.37	25.81	--	12.80	38.61	54.00	3.0m/HORZ	15.39	**AVG**
*9091.15	25.18	--	14.19	39.37	54.00	3.0m/HORZ	14.63	**AVG**
High Channel								
915.72	66.82	--	26.17	92.99	--	3.0m/HORZ	--	**AVG**
1831.62	46.64	--	-7.48	39.16	94.00	3.0m/HORZ	54.84	**AVG**
*2747.25	42.56	--	-3.99	38.57	54.00	3.0m/HORZ	15.43	**AVG**
*3662.90	28.40	--	-0.96	27.44	54.00	3.0m/HORZ	26.56	**AVG**
*4578.94	32.94	--	1.18	34.12	54.00	3.0m/HORZ	19.88	**AVG**
5492.99	28.77	--	6.03	34.8	94.00	3.0m/HORZ	59.2	**AVG**
6408.04	29.29	--	9.48	38.77	94.00	3.0m/HORZ	55.23	**AVG**
*7326.58	26.89	--	11.85	38.74	54.00	3.0m/HORZ	15.26	**AVG**
*8243.45	25.42	--	13.54	38.96	54.00	3.0m/HORZ	15.04	**AVG**
*9156.85	23.43	--	14.03	37.46	54.00	3.0m/HORZ	16.54	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. The EUT was placed in 2 orthogonal positions and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 903.65 MHz:

Magnitude of Measured Frequency	66.00	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	26.15	dB/m
1 meter to 3-meter extrapolation	0.00	dB
Corrected Result	92.15	dBuV/m

Test Date: February 8-26, 2024

Tested By
Signature: Ian Charboneau Name: Ian Charboneau

2.11 Band Edge Measurements – (CFR 15.247 (d))

Band Edge measurements are made following the guidelines in FCC KDB Publication No. DA 00-705 with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Antenna port conducted measurements are performed to demonstrate compliance with the requirement of 15.247(d) that all emissions outside of the band edges be attenuated by at least 20 dB when compared to its highest in-band value (contained in a 100 kHz band).

To capture the band edge set the Spectrum Analyzer frequency span large enough (usually around 3 MHz) to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation. Conducted measurements are performed with RBW ≥1% of the frequency span. In all cases, the VBW is set ≥ RBW. See figure and calculations below for more detail. This measurement was performed with the EUT continuously transmitting on the low and high channels.

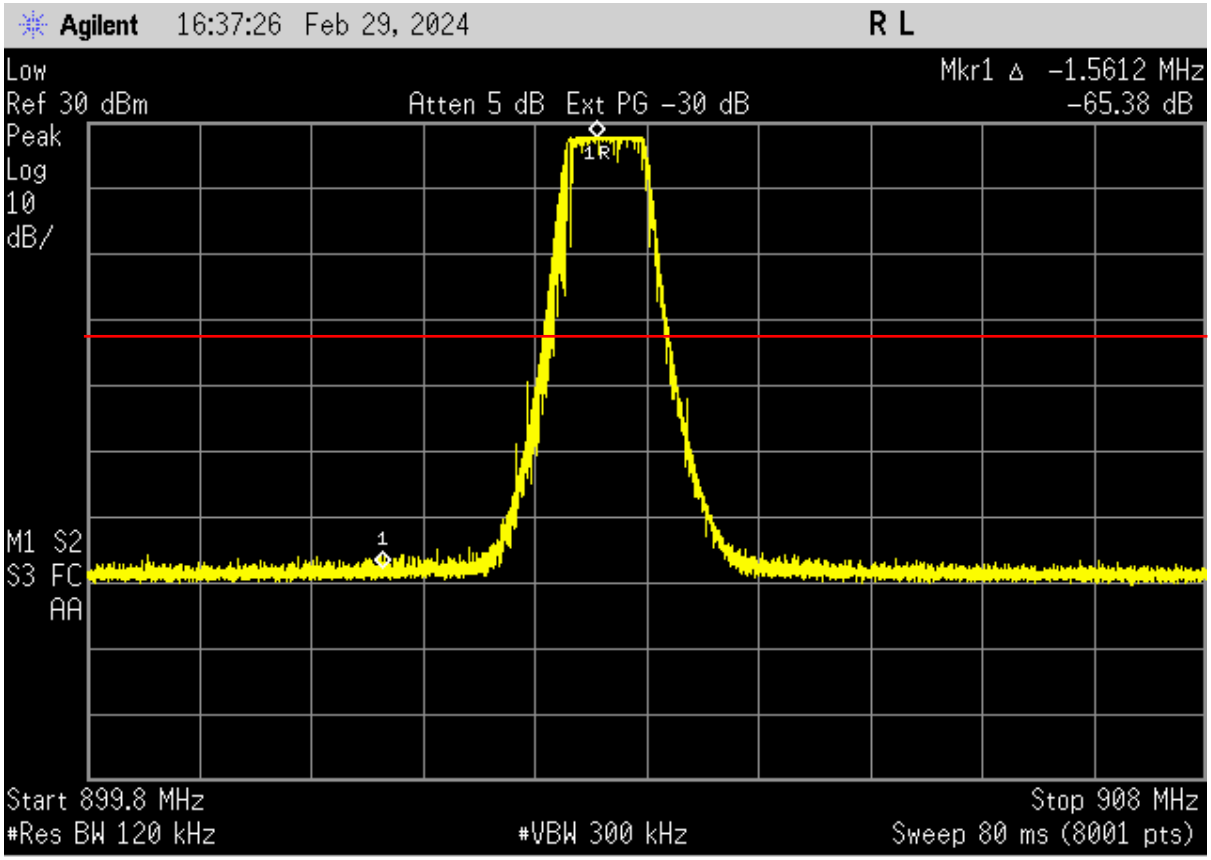

Figure 8. Band Edge Compliance, Low Channel Delta - Peak

All emissions greater than 100 kHz bandwidth outside the frequency band in which the DTS intentional radiator is operating is at least 20 dB below the fundamental.

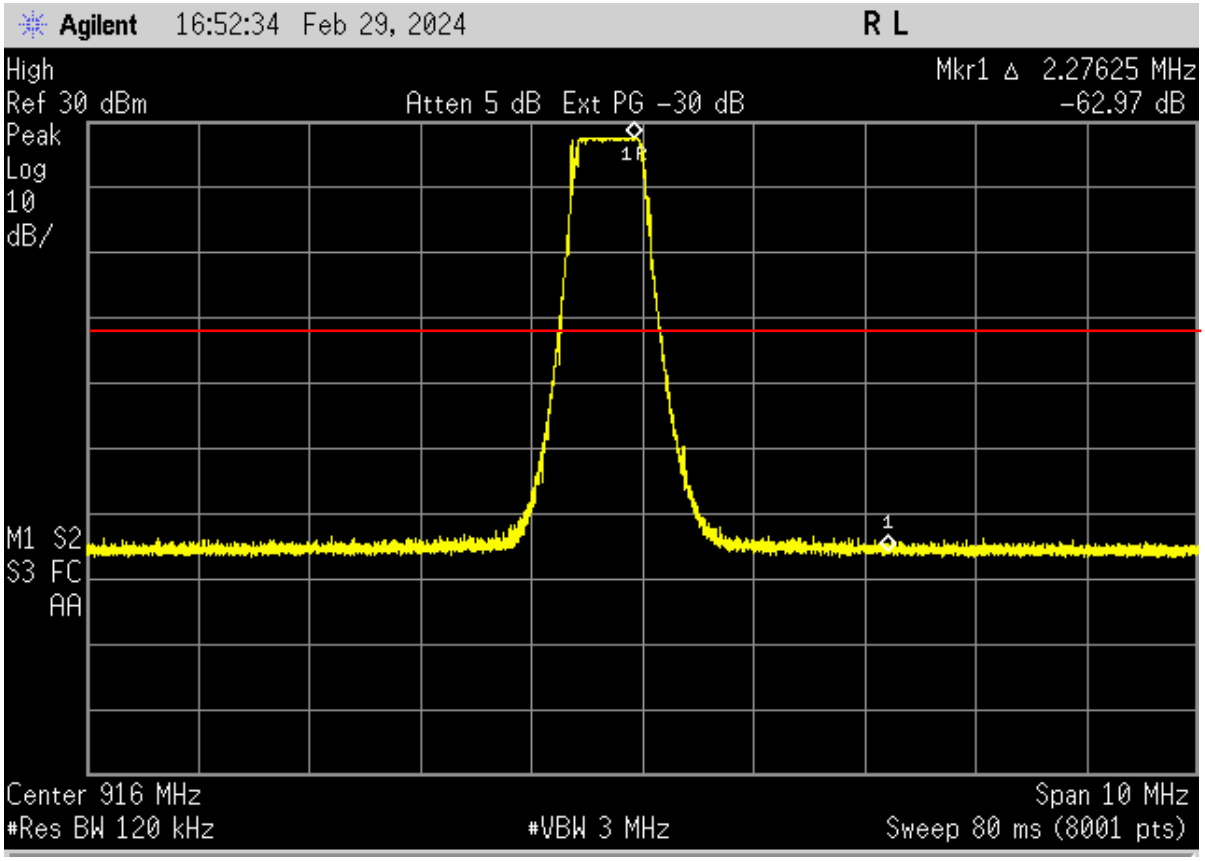

Figure 9. Band Edge Compliance, High Channel Delta – Peak

All emissions greater than 100 kHz bandwidth outside the frequency band in which the DTS intentional radiator is operating is at least 20 dB below the fundamental.

2.12 6 dB Bandwidth and 99% Bandwidth (IC RSS 247 5.2,CFR 15.247 (a) (2))

For DTS systems operating in the 902-928 MHz band the minimum allowed 6 dB bandwidth is 500 kHz.

These measurements were performed while the EUT was in a constant transmit mode. A method similar to the marker delta method was used to capture the points. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW. The 6 dB Bandwidth requirement for DTS devices is greater than 500 kHz.

Table 7. 6 dB Bandwidth

Frequency (MHz)	6 dB Bandwidth (kHz)	99% Bandwidth (kHz)
903.65	683.70	560.51
909.40	681.42	609.79
915.70	684.70	549.20

Test Date: March 1, 2024

Tested By
Signature:  Name: Ian Charboneau

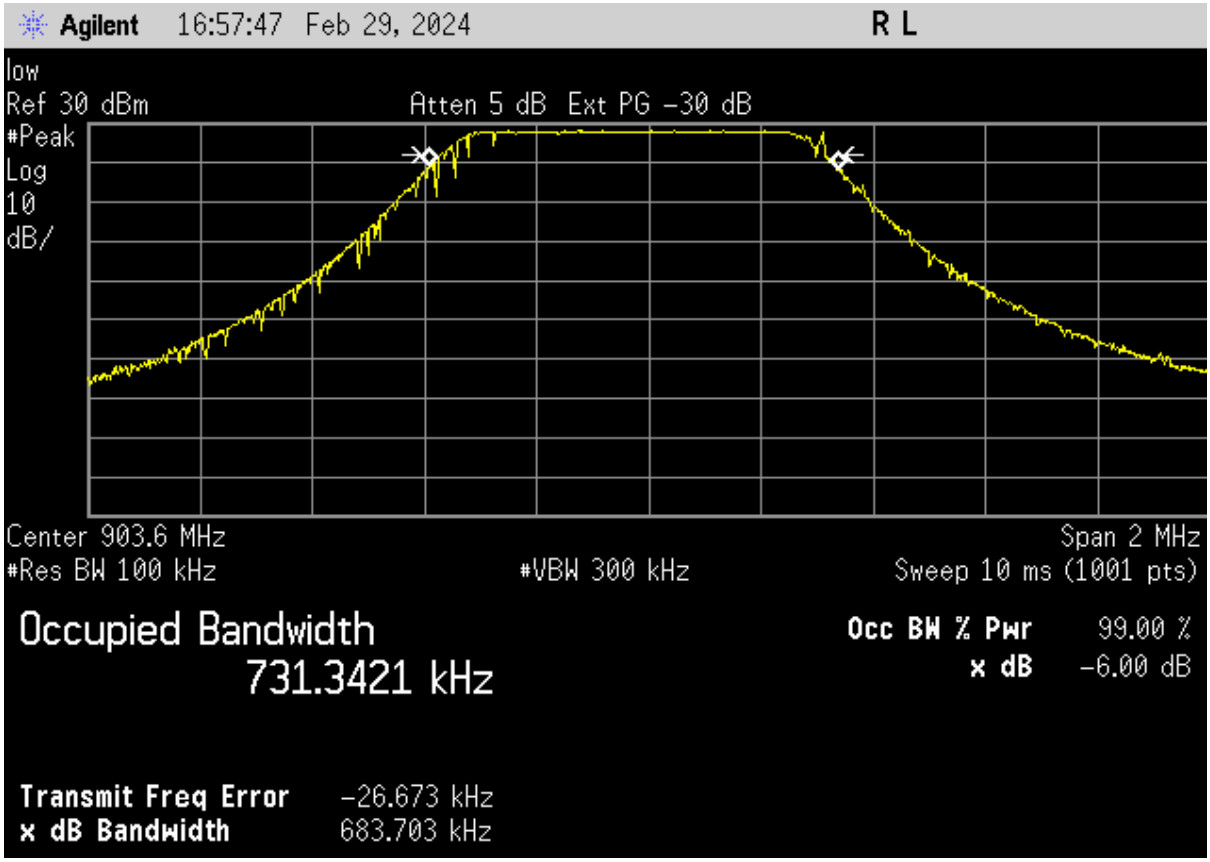

Figure 10. DTS Bandwidth – Low Channel

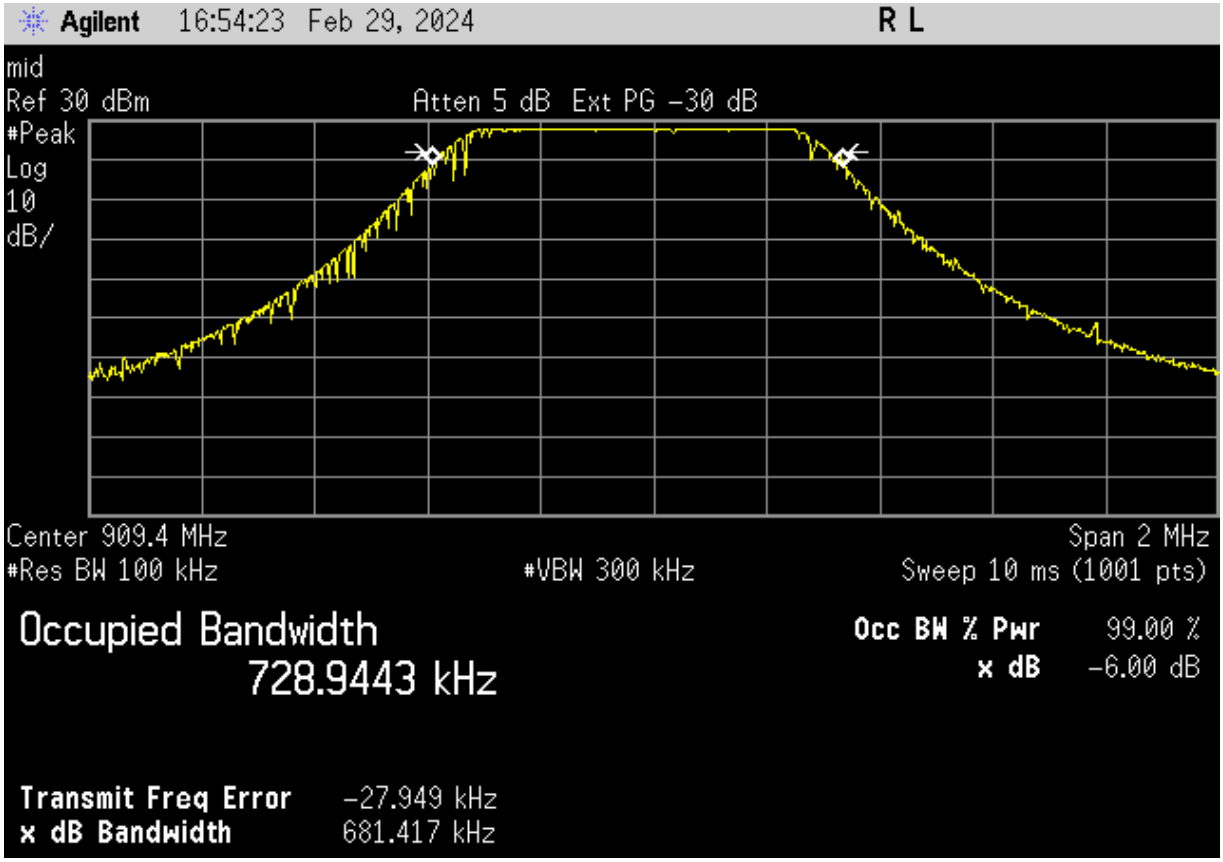

Figure 11. DTS Bandwidth – Mid Channel

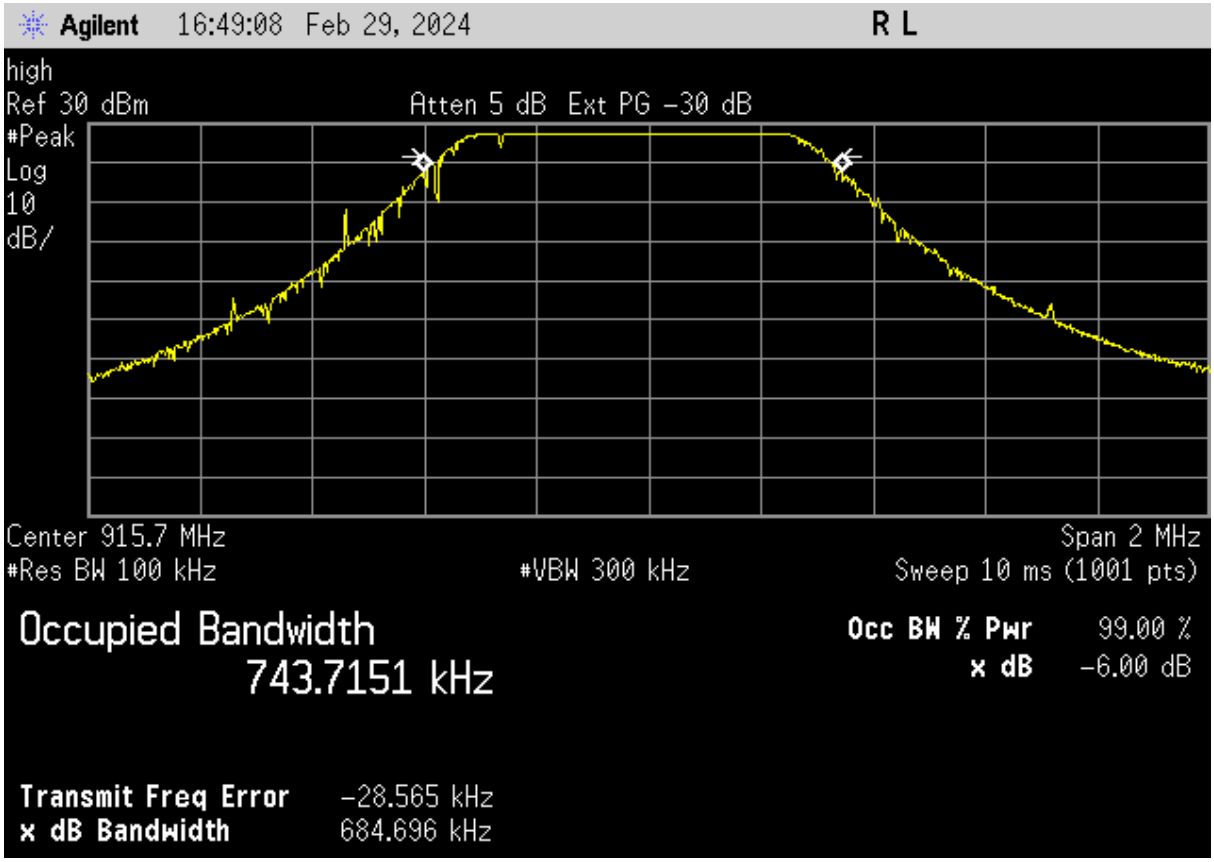

Figure 12. DTS Bandwidth – High Channel

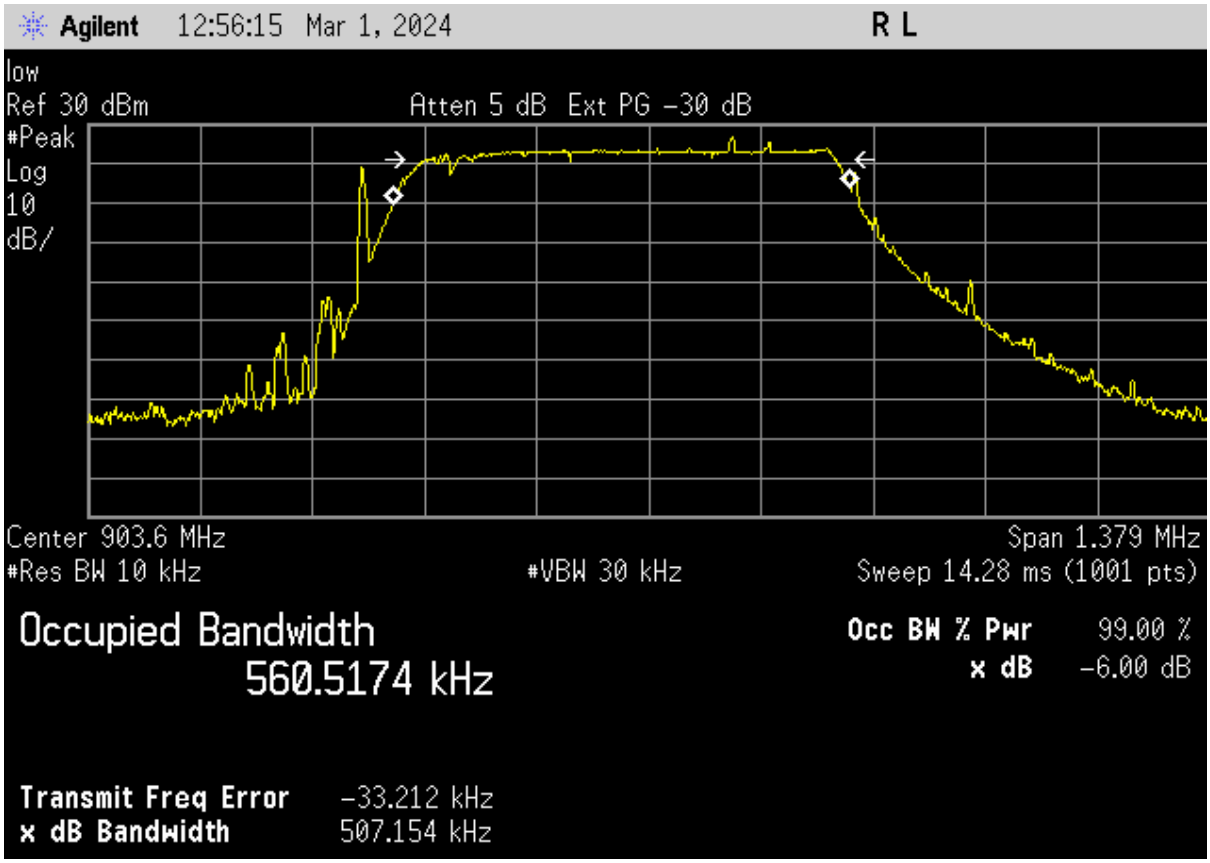

Figure 13. 99% Bandwidth – Low Channel

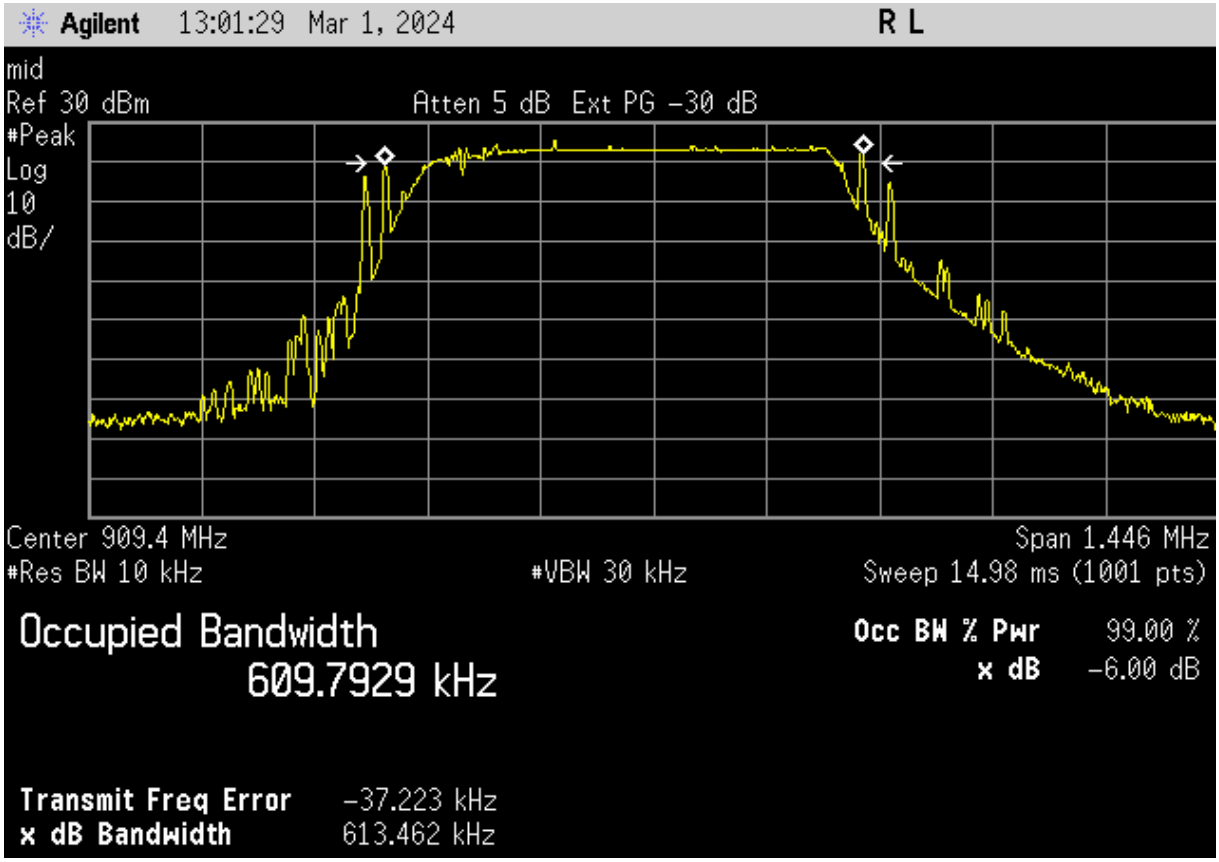

Figure 14. 99% Bandwidth – Mid Channel

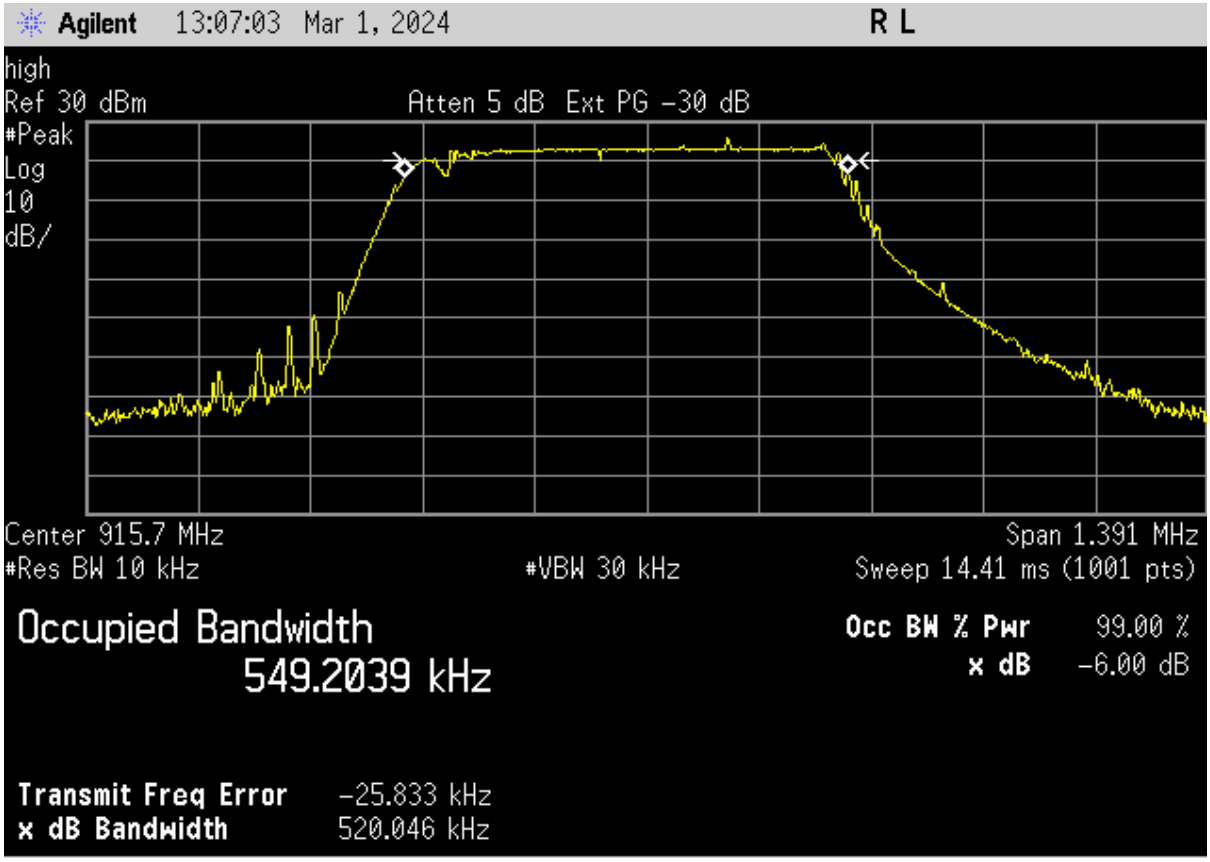

Figure 15. 99% Bandwidth – High Channel

2.14 Maximum Conducted Output Power (CFR 15.247 (b) (3))

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

Peak power within the band 902.125 MHz to 927.80 MHz was measured per FCC KDB Publication DA 00-705 as an Antenna Conducted test with a spectrum analyzer by connecting the spectrum analyzer directly, via a short RF cable, and attenuators to the antenna output terminals on the EUT. The spectrum analyzer was set for an impedance of 50 Ω with the RBW set greater than the 6 dB bandwidth of the EUT, and the VBW ≥ RBW. Peak antenna conducted output power is tabulated in the table below.

Table 8. Maximum Antenna Conducted Output Power per Part 15.247 (b) (3)

Frequency of Fundamental (MHz)	Raw Test Data dBm	Converted Data (mW)	FCC Limit (mW Maximum)
903.65	27.66	583.44	1000
909.40	27.56	570.16	1000
915.70	27.29	535.79	1000

Test Date: March 1, 2024

Tested By
Signature:  Name: Ian Charboneau

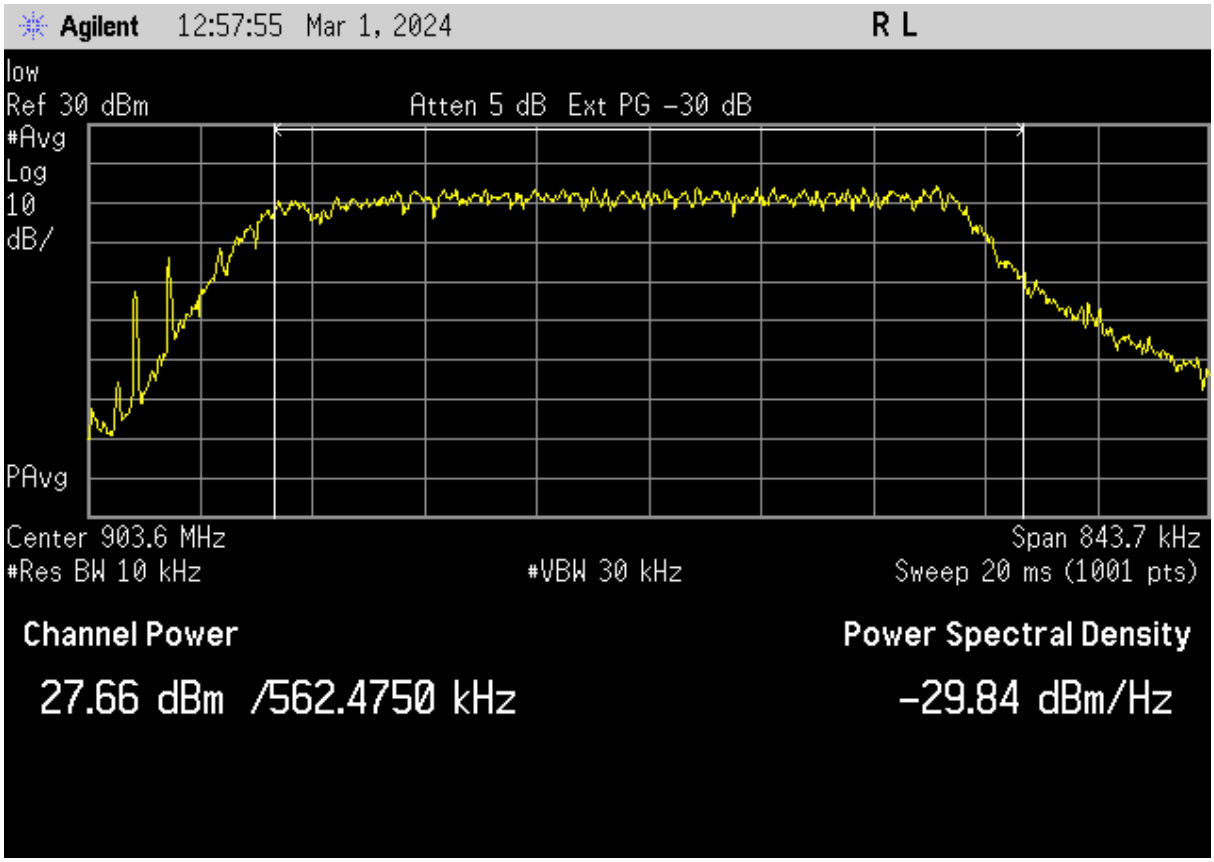

Figure 16. Peak Antenna Conducted Output Power, Low Channel

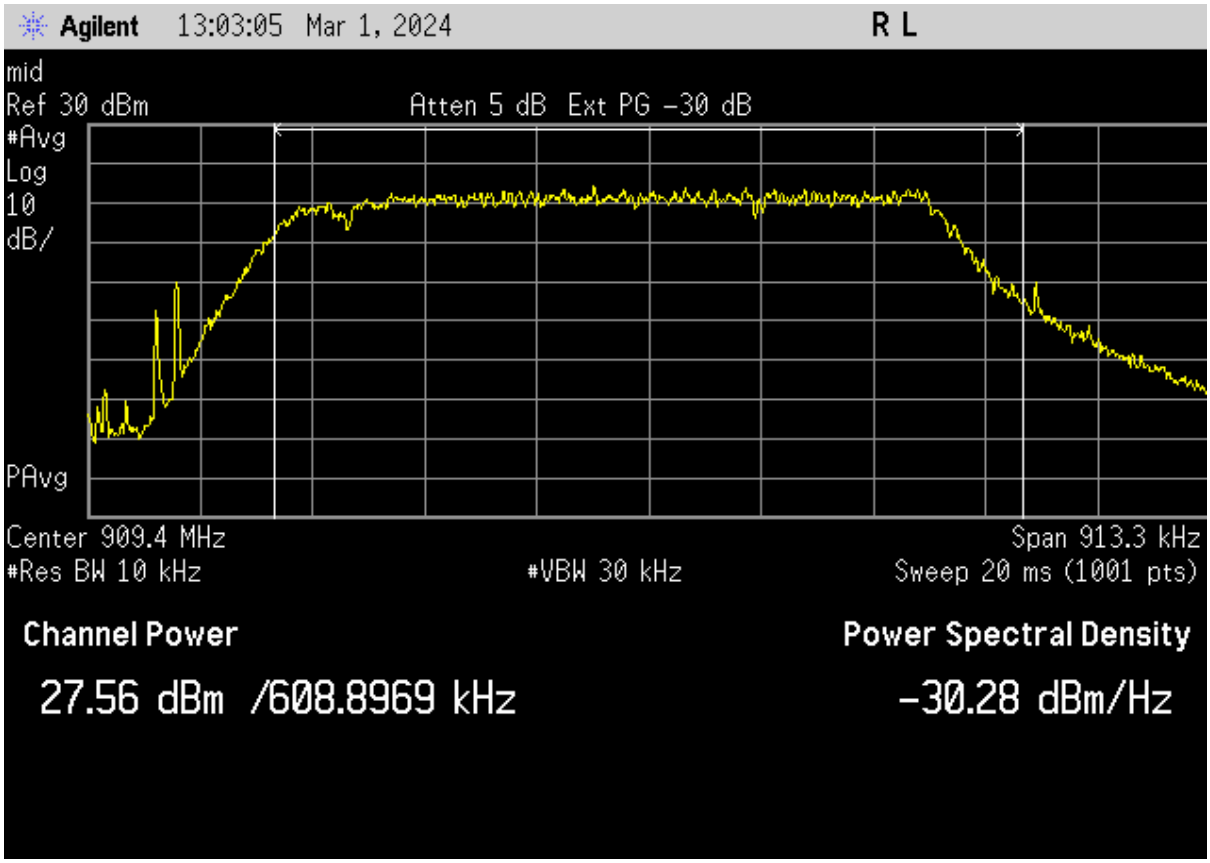

Figure 17. Peak Antenna Conducted Output Power, Mid Channel

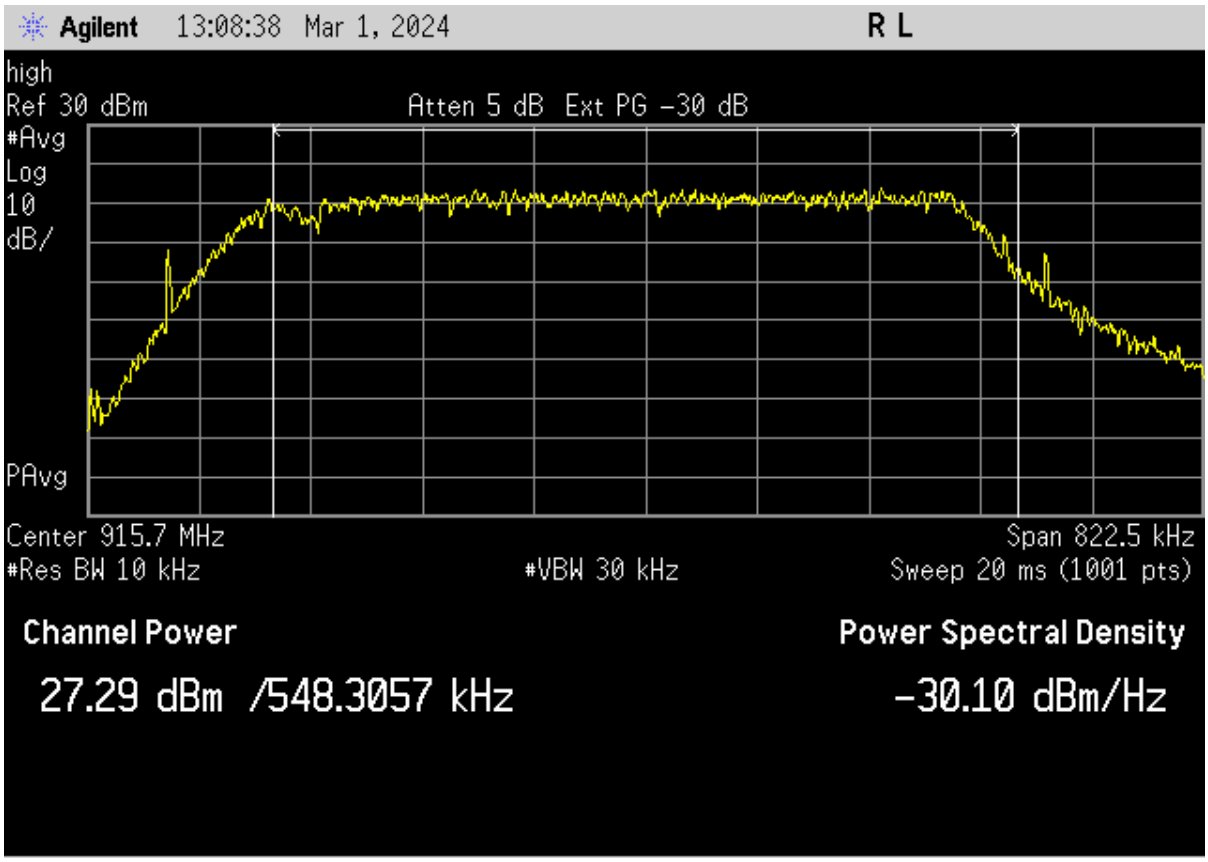

Figure 18. Peak Antenna Conducted Output Power, High Channel

2.15 Power Spectral Density (CRF 15.247(e))

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Table 9. Power Spectral Density per Part 15.247 (e)

Frequency of Fundamental (MHz)	Raw Test Data (dBm)	FCC Limit (dBm Maximum)
903.65	7.837	8.0
909.40	7.436	8.0
915.70	7.366	8.0

Test Date: March 1, 2024

Tested By
Signature: _____ Name: Ian Charboneau

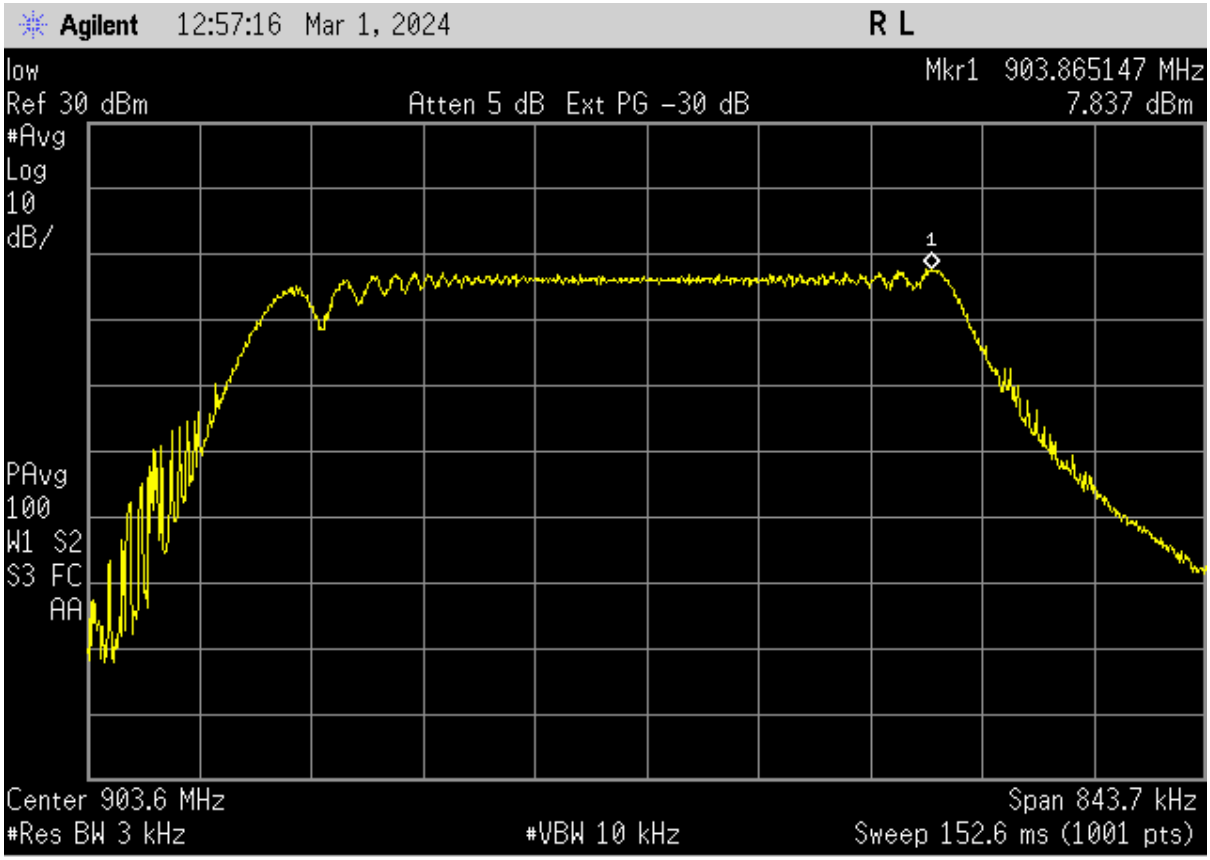

Figure 19. Power Spectral Density, Low Channel

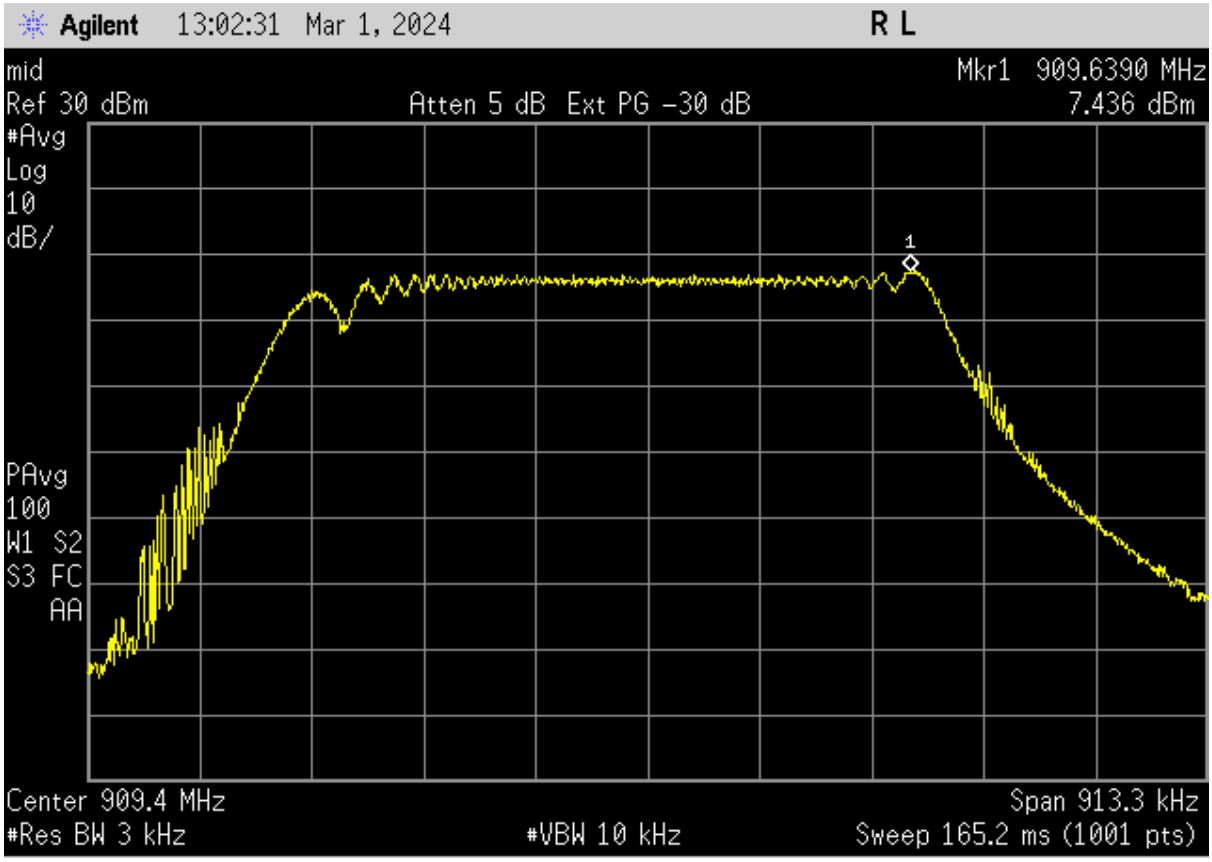

Figure 20. Power Spectral Density, Mid Channel

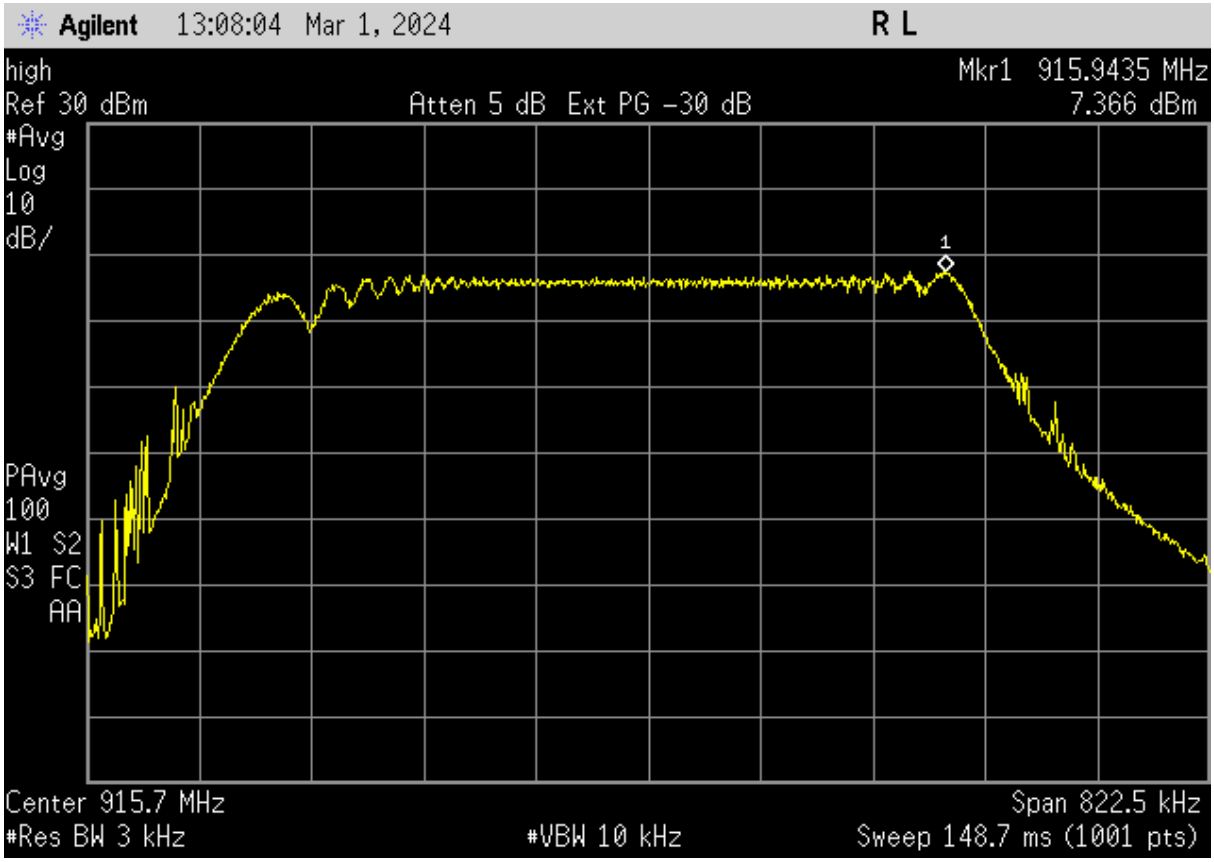

Figure 21. Power Spectral Density, High Channel

2.17 Powerline Emissions (CFR 15.207)

The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.107, per ANSI C63.4:2014, Paragraph 7, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmission.

The EUT was battery powered; therefore, this test was not applied.

Table 10. Transmitter Power Line Conducted Emissions Test Data, Part 15.107

150KHz to 30 MHz with Class A Limits						
Frequency (MHz)	**Test Data (dBuV)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
This test is not applicable to this EUT. The host device will be powered exclusively by a battery pack. No means for AC mains connection.						

Sample calculation: N/A

Test Date: February 29, 2024

Tested By
Signature:  Name: Ian Charboneau

2.18 Intentional Radiator, Radiated Emissions (CFR 15.209)

Radiated emissions disturbance Measurements were performed with an instrument having both peak and quasi-peak detectors over the frequency range of 9 KHz to 10 GHz. Measurements of the radiated emissions were made with the receiver antenna at a distance of 3 m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

Table 11. Radiated Emissions, 9 kHz - 30 MHz

9 kHz to 30 MHz, 15.209 limits							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
All emissions were more than 20 dB below the limit							

Sample Calculation: N/A

Test Date: February 12, 2024

Tested By
Signature: Ian Charboneau Name: Ian Charboneau

Table 12. Radiated Emissions 30 MHz to 1000 MHz (CFR 15.209)

30 MHz to 1000 MHz, 15.209 limits							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
All emissions were more than 20 dB below the limit							

Sample calculation: N/A

Test Date: February 12, 2024

Tested By
Signature: Ian Charboneau Name: Ian Charboneau

Table 13. Radiated Emissions 1 GHz to 10 GHz (CFR 15.209)

1 GHz to 10 GHz, 15.209 limits							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
All emissions were more than 20 dB below the limit							

Sample calculation: N/A

Test Date: February 12, 2024

Tested By
Signature:  Name: Ian Charboneau

2.19 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

219.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ± 2.78 dB.

2.19.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna (1 GHz to 18 GHz) is ± 5.21dB.

3 Conclusion

The EUT is deemed to have met the requirements of this subpart as tested and presented in this test report.