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

Innovation, Science, and Economic Development Canada
Certification Per
IC RSS-Gen General Requirements for Radio Apparatus
And
RSS-247Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices

For the

Southern States, LLC

Model Number: ICS/TFDIR Sensor

FCC ID: 2ADWT-ICSS03
IC: 12660A-ICSS03

UST Project: 24-0101
Issue Date: July 18, 2024

Total Pages: 59

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I certify that I am authorized to sign for the Test Agency and that 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: July 18, 2024

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Southern States, LLC
ADDRESS: 30 Georgia Ave, Hampton GA 30028 USA
MODEL: ICS/TFDIR Sensor
FCC ID: 2ADWT-ICSS03
IC: 12660A-ICSS03
DATE: July 18, 2024

This report concerns (check one): ☒Original grant □Class II change

Equipment type: 2.4 GHz ZigBee Transceiver

Technical:
2403.5 MHz - 2480 MHz
Type of modulation:
O-QPSK
Data/Bit Rate:
250 kHz
Antenna Gain: 2.27 dBi (Flexible Trace Antenna)
Maximum Output Power: +2 dBm (measured)
Software Used to Program EUT: TI UniFlash
EUT Firmware Number: version: 3.4.1.00012
Power Setting: Max level

Report Prepared By:
US Tech
3505 Francis Circle
Alpharetta, GA30004

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1 General Information

1.1 Purpose of this Report

This report is prepared to convey test results and information concerning the suitability of this exact product for public distribution according to IC RSS-247 and FCC Rules and Regulations Part 15, Section 247.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on June 1, 2024 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the Southern States, LLC model ICS/TFDIR Sensor. The EUT is a wireless industrial utility power sensor used to monitor utility and power lines. It is designed to work with a companion base station and uses wireless communication for reporting and data transmission. The EUT streams data to the base station ICS Receiver via 2.4 GHz ISM band. The data is streamed via UART to Southern States equipment for access by the installing electric utility. It is a closed system accessible only by the installing utility company.

The EUT incorporates ZigBee technology. This report is an assessment of the ZigBee transmitter compared to FCC Part 15 Subpart C, Part 15.247 limits.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* for the intentional radiator aspect of the device and *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)* for the unintentional radiator aspect of the device as well as FCC subpart B and C of Part 15 and per FCC KDB Publication number 558074 v03r05 for Digital Transmission Systems Operating Under section 15.247.

Digital RF conducted and radiated emissions data below 1 GHz were taken with the measuring receiver (or spectrum analyzer's) resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1.0 GHz were made with a RBW of 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the RBW or as required per the standard throughout the evaluation process.

A list of EUT and Peripherals is found in Table 1. A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious and fundamental emissions 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 been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

a) Certification of the transmitter incorporated within the EUT, see test data presented herein.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
EUT/ Southern States, LLC	ICS-Sensor	Engineering Sample	FCC ID: 2ADWT-ICSS03 (Pending) IC: 12660A-ICSS03 (Pending)	PU

S= Shielded, U= Unshielded, 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 included.

Table 2. Test Instruments

TEST INSTRUMENT	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CALIBRATION DUE DATE
Spectrum Analyzer	Agilent	E4440A	MY45304803	7/21/2025 2 yr.
RF Preamp 100 kHz To 1.3 GHz	Hewlett-Packard	8447D	1937A02980	7/20/2024
Preamp 1.0 GHz To 26.0 GHz	Hewlett-Packard	8449B	3008A00480	3/04/2025
Loop Antenna	ETS Lindgren	6502	9810-3246	7/20/2024 2 yr.
Biconical Antenna	EMCO	3110B	9306-1708	1/13/2025 2yr.
Log Periodic Antenna	EMCO	3146	9110-3236	3/13/2026 2 yr.
Horn Antenna	EMCO	3115	9107-3723	3/13/2025 2 yr.
High Pass Filter	Microwave Circuits	H3R020G2	001DC9528	8/02/2024

Note 1: 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 modifications were made by US Tech to bring the EUT into compliance with FCC Part 15.247 or IC RSS-210 requirements.

2.3 Number of Measurements for Intentional Radiators (15.31(m), RSS-Gen 6.8)

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.

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 2.412 GHz to 2.462 GHz, 3 test frequencies will be used.

2.4 Frequency Range of Radiated Measurements (Part 15.33, RSS-Gen 6.13)

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 the range specified in 2.4.1 above, whichever is the higher range of investigation.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35, RSS-Gen 6.9, 6.13)

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.

2.6 EUT Antenna Requirements (CFR 15.203, RSS-Gen 6.7)

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 is 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	Molex	Flex trace	479500011	+2.27	u.fl

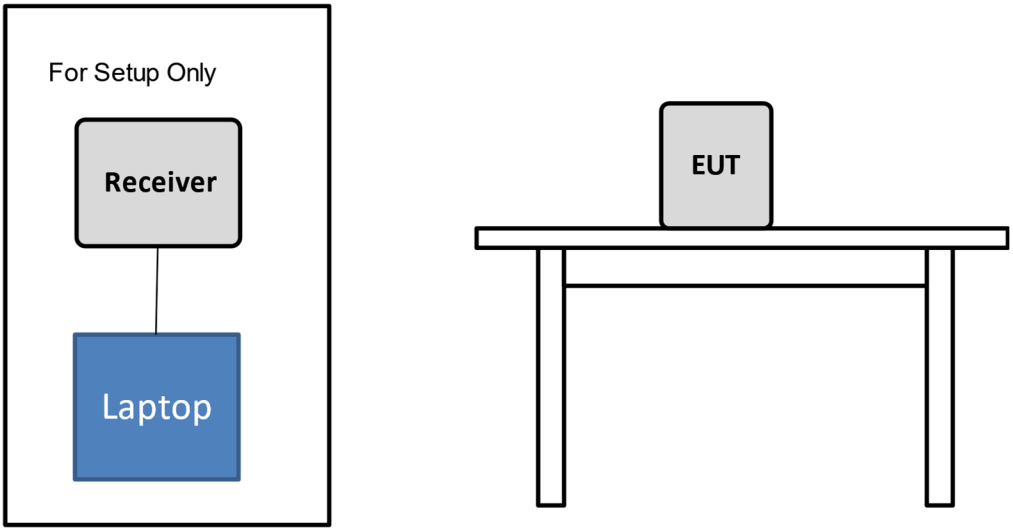

Figure 1. Block Diagram of Test Configuration

Note: PC used to program EUT for intentional spurious emissions

2.7 Restricted Bands of Operation (Part 15.205, RSS-Gen 8.10)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement (see paragraph 2.10).

2.8 Transmitter Duty Cycle (Part15.35 (c), RSS-Gen 6.10)

The EUT employs pulse transmission. However, for testing purpose the EUT was programmed to transmit at a rate >98%. The pulse transmission requirements of this subpart were acknowledge and considered during testing.

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 also be expressed logarithmically in dB.

2.9 Antenna Conducted Intentional and Spurious Emissions (CFR 15.209, 15.247(d)) (IC RSS 247, 5.5))

The EUT was put into a continuous-transmit mode of operation and tested per ANSI C63.10-2013 for conducted out-of-band emissions emanating from the antenna port over the frequency range of 30 MHz to ten times the highest clock frequency generate or used in this case, 25 GHz. A conducted scan was performed on the EUT to identify and record spurious signals that were related to the transmitter. Antenna Conducted Emissions of a significant magnitude that fell within restricted bands were then measured as radiated emissions in the EMC Chamber. The conducted emissions graphs are found in the figures below. The limit for antenna conducted power is 1 Watt (30 dBm) per 15.247 (b)(3).

For Conducted RF antenna tests, the RBW was set to 100 kHz, video bandwidth (VBW)> RBW, scan up through the 10^{th} harmonic of the fundamental frequency. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band.

Figure 2. Bench Test Setup

Test Date: June 6-11, 2024

Tested by
Signature: Ian Charboneau Name: Ian Charboneau

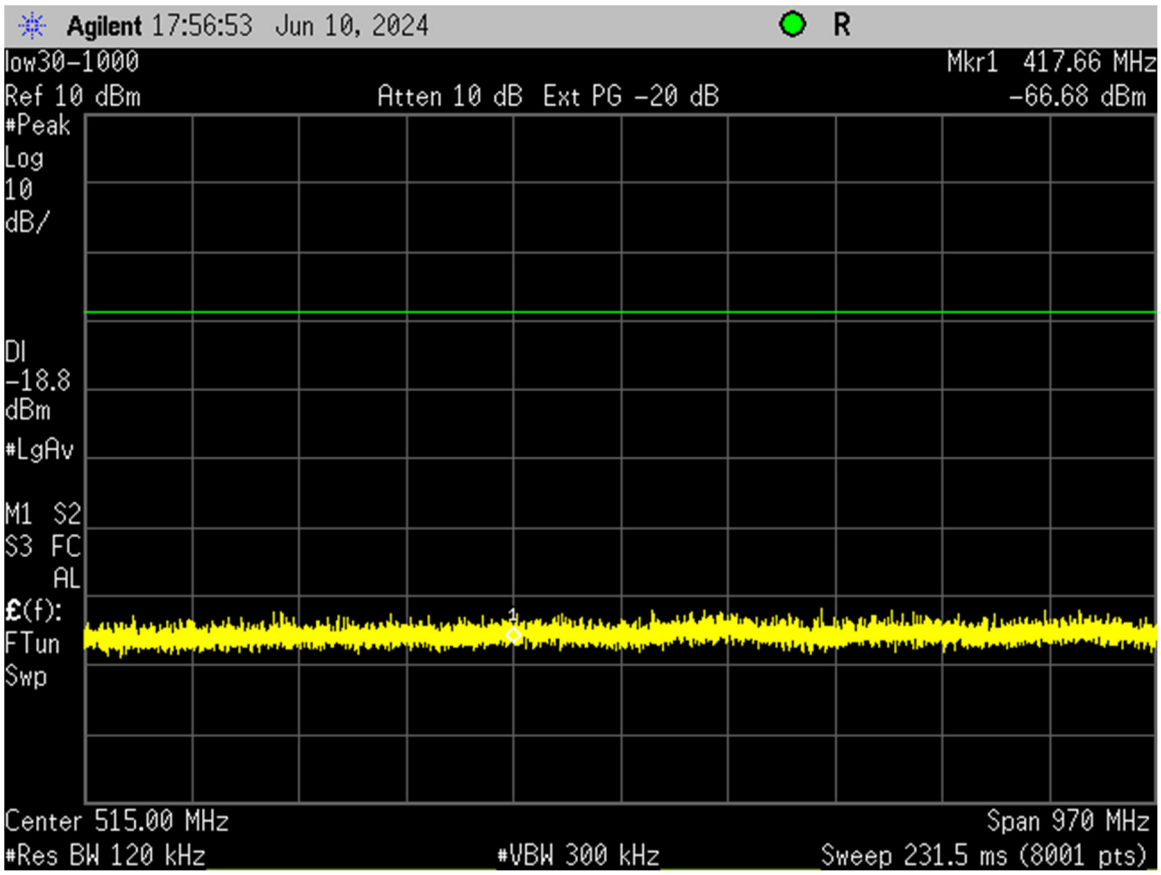

Figure 3. Sensor, Low, 30-1000 MHz

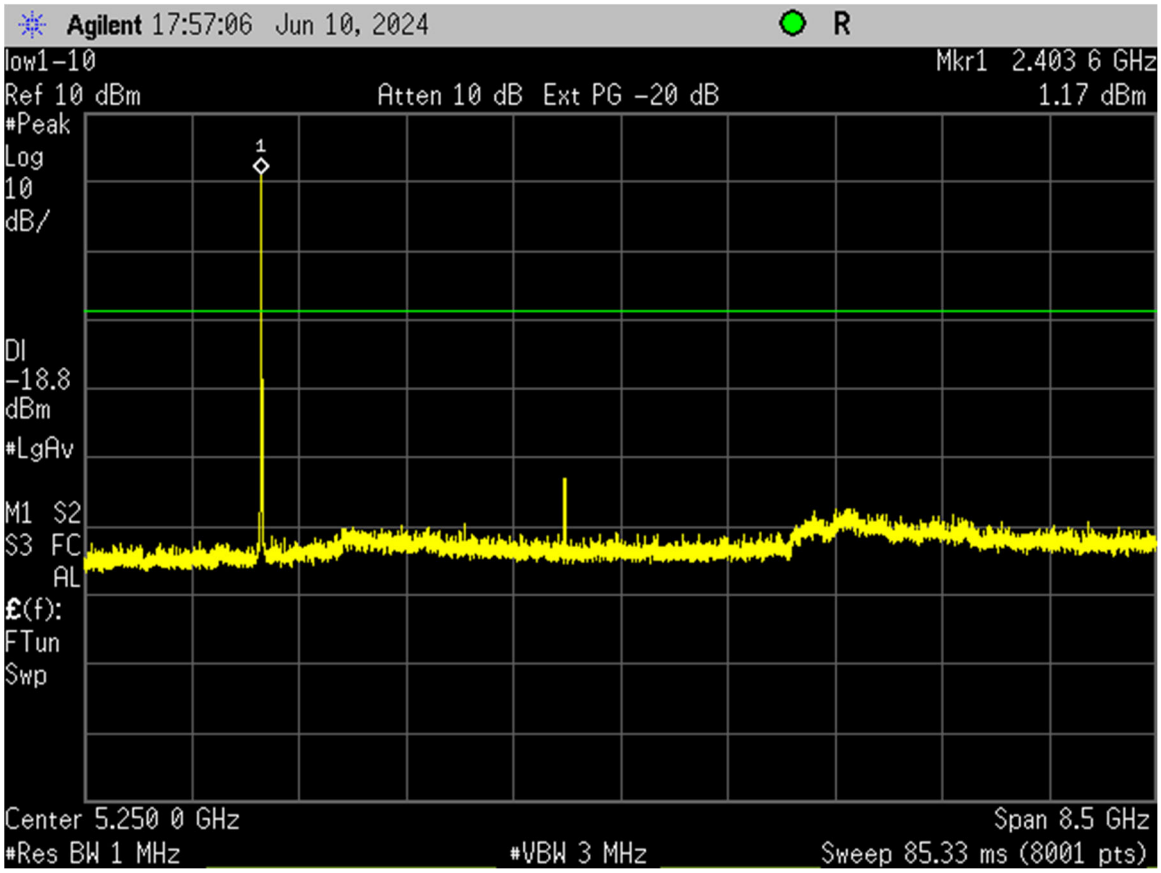

Figure 4. Sensor, Low, 1-9 GHz

(Note: Intentional Emission seen for radio operating at 2403.5 MHz)

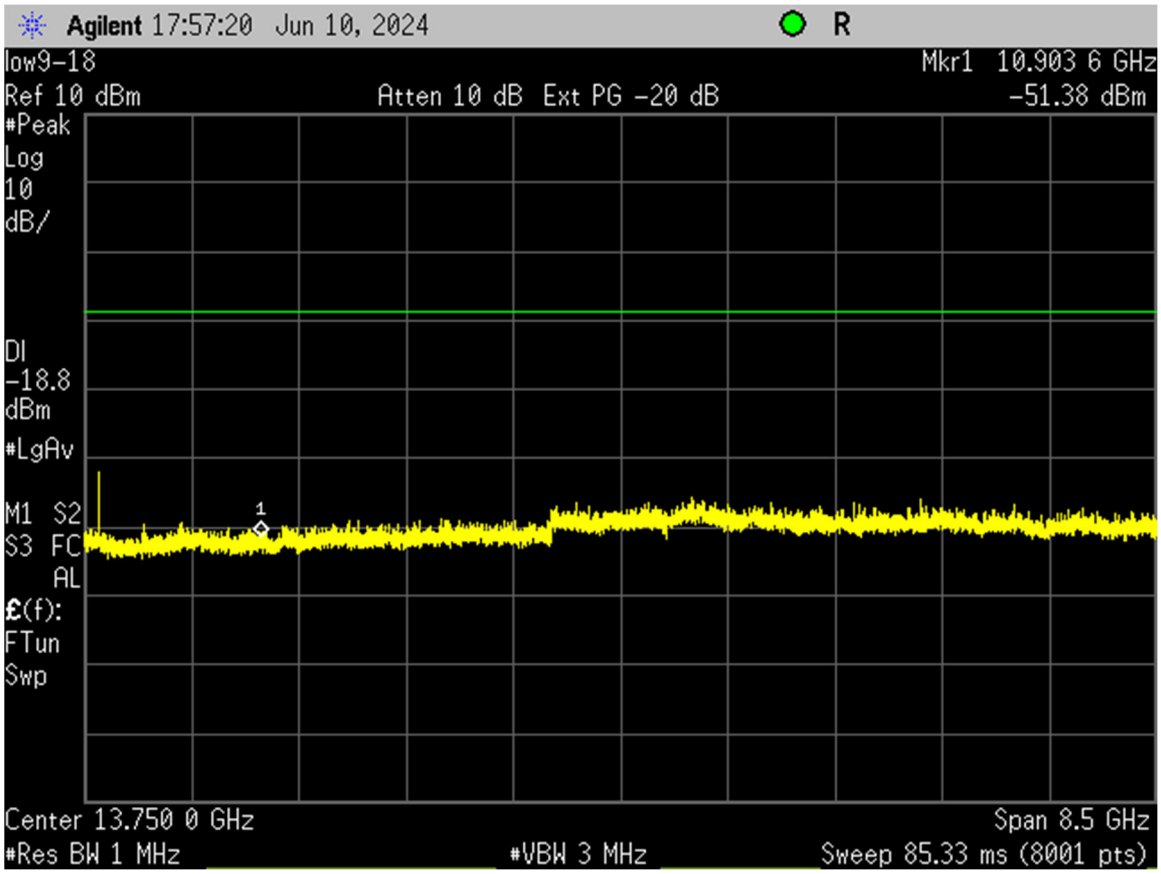

Figure 5. Sensor, Low, 9-18 GHz

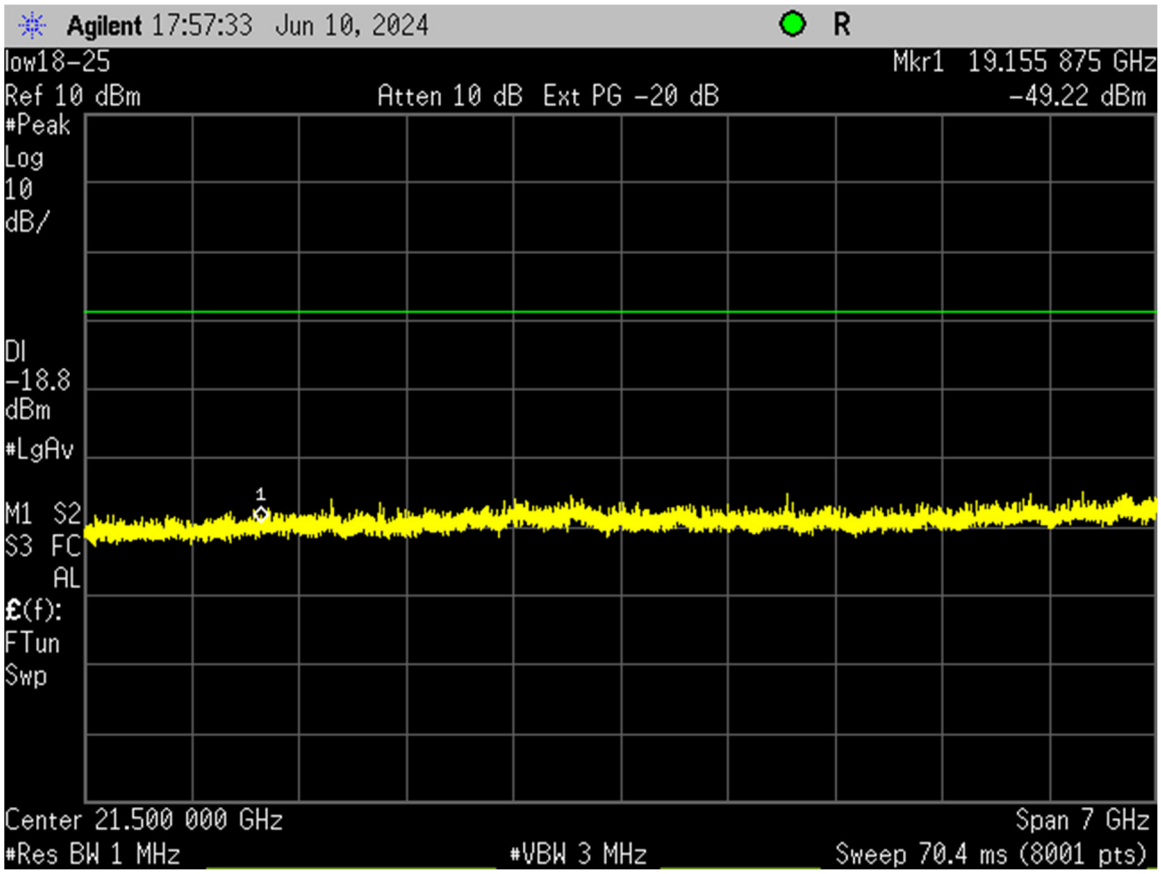

Figure 6. Sensor, Low, 18-25 GHz

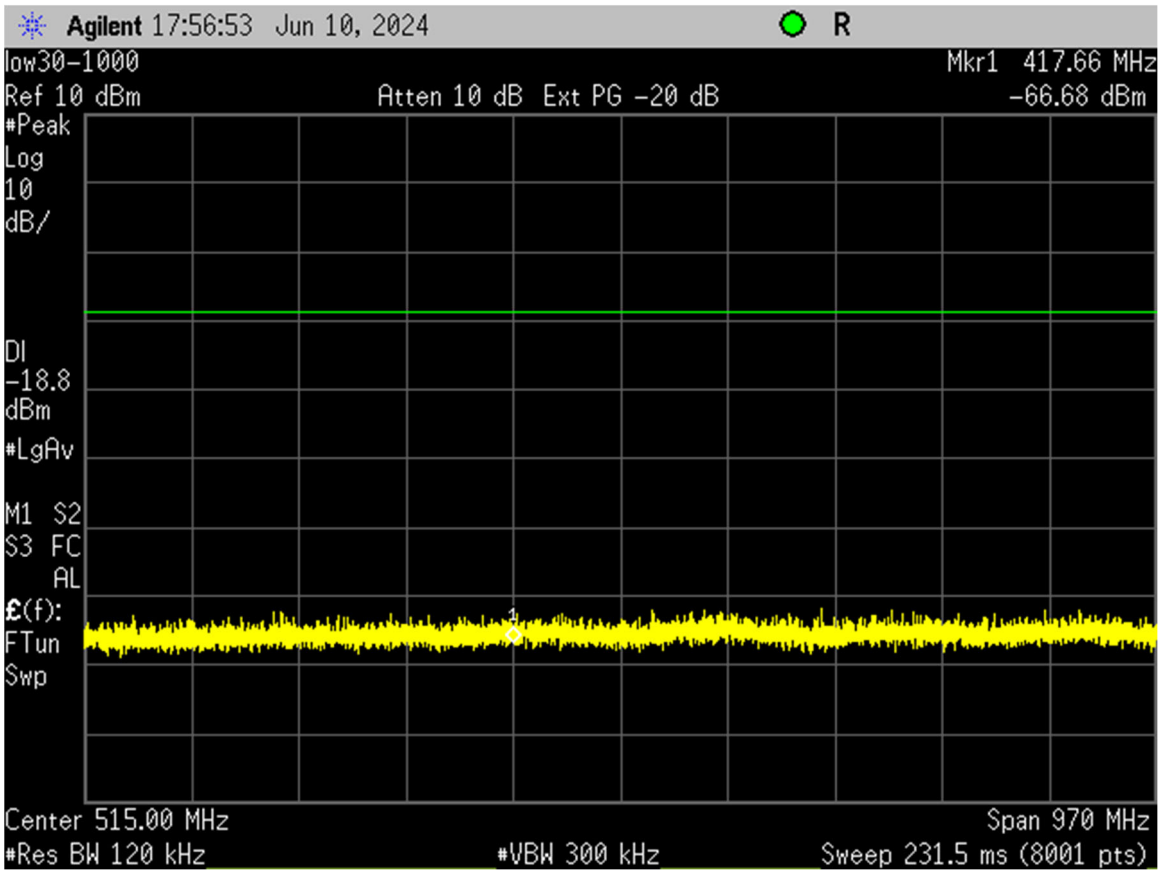

Figure 7. Sensor, Mid, 30-1000 MHz

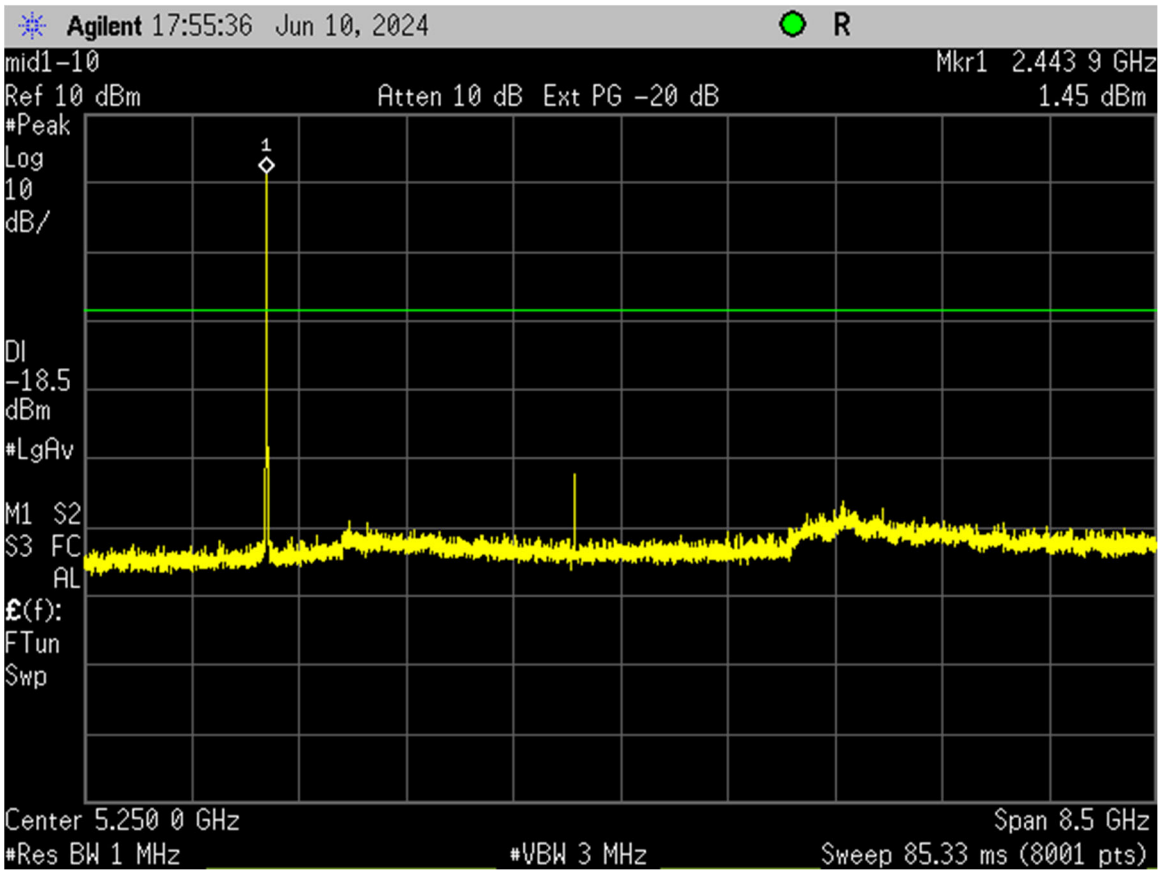

Figure 8. Sensor, Mid, 1-9 GHz

(Note: Intentional Emission seen for radio operating at 2443.5 MHz)

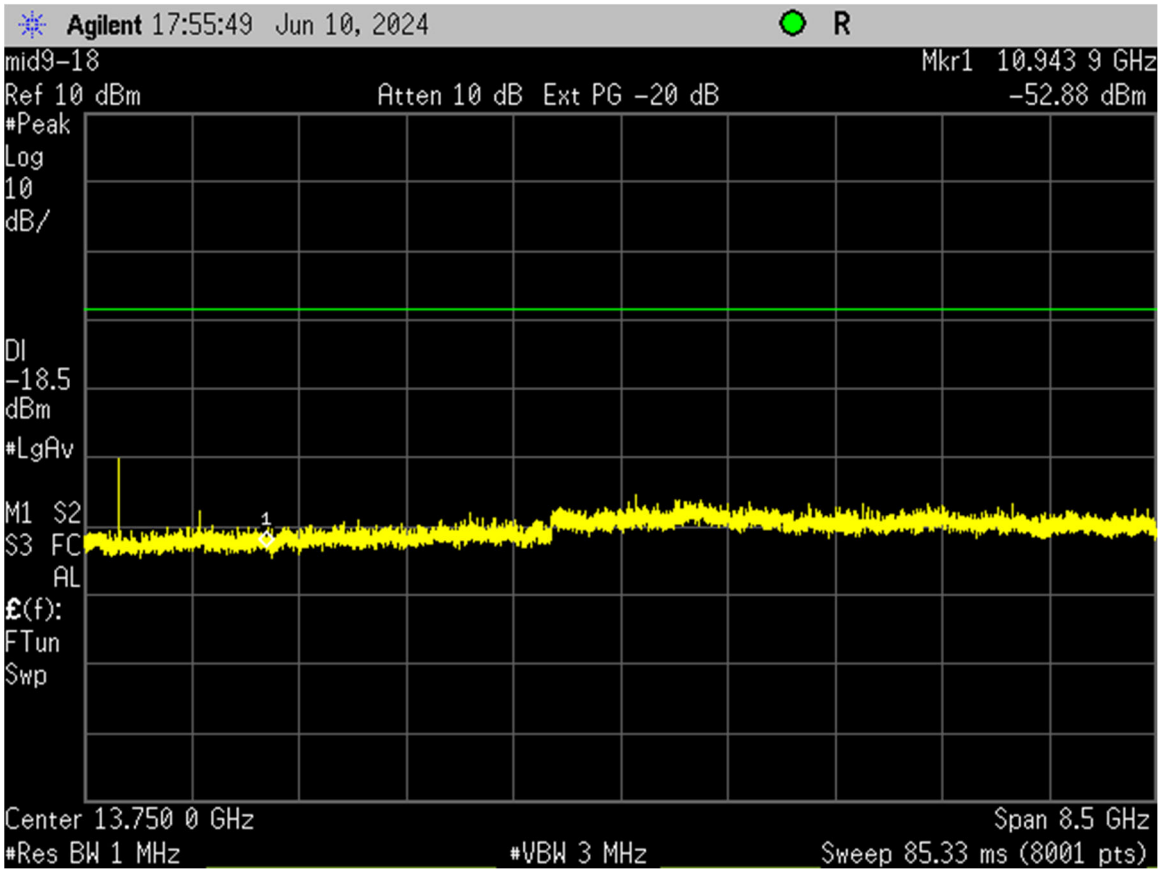

Figure 9. Sensor, Mid, 9-18 GHz

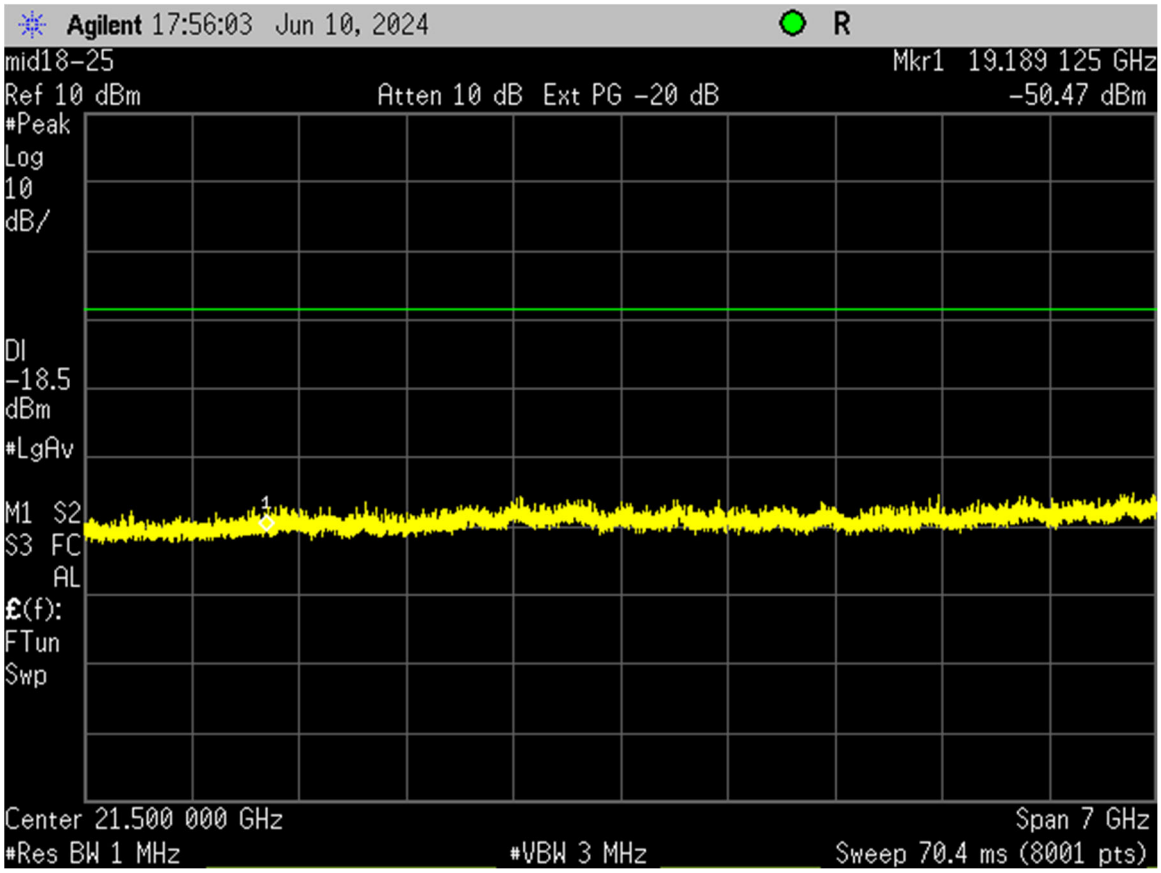

Figure 10. Sensor, Mid, 18-25 GHz

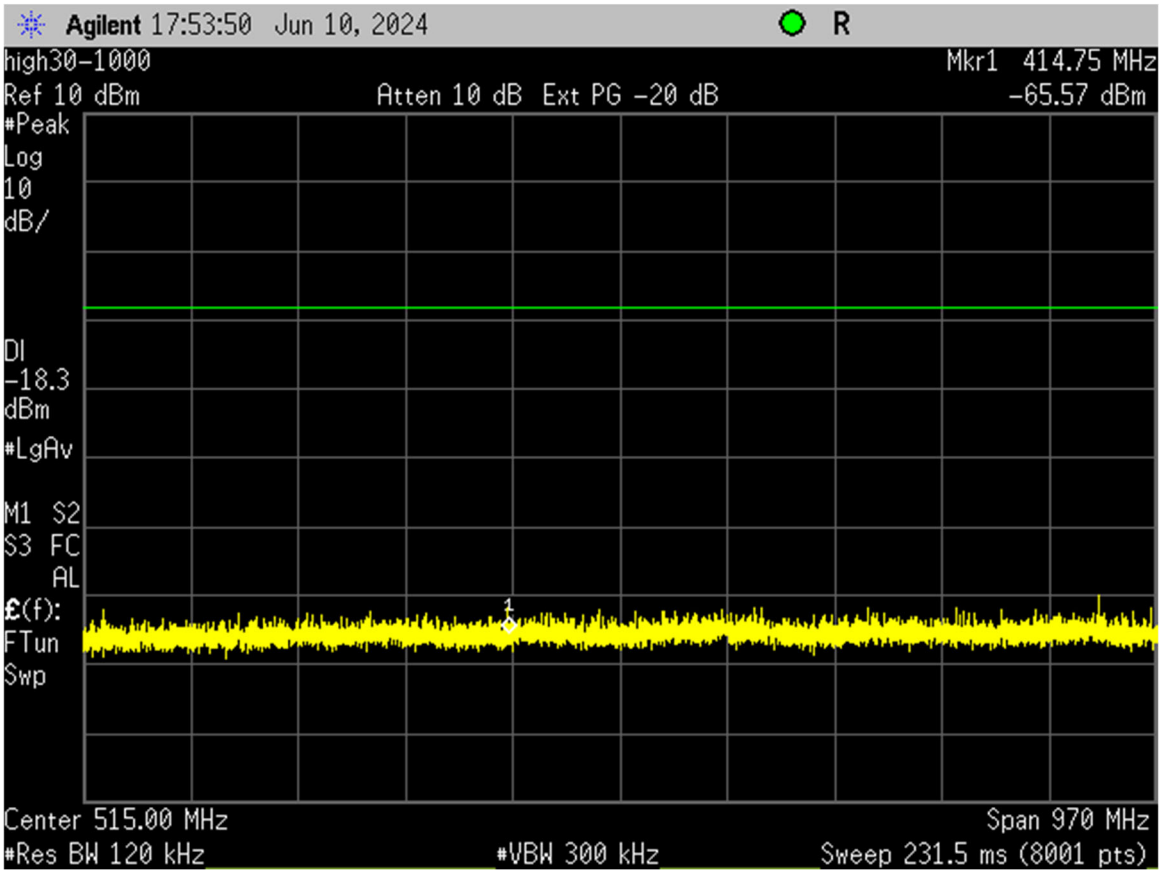

Figure 11. Sensor, High, 30-1000 MHz

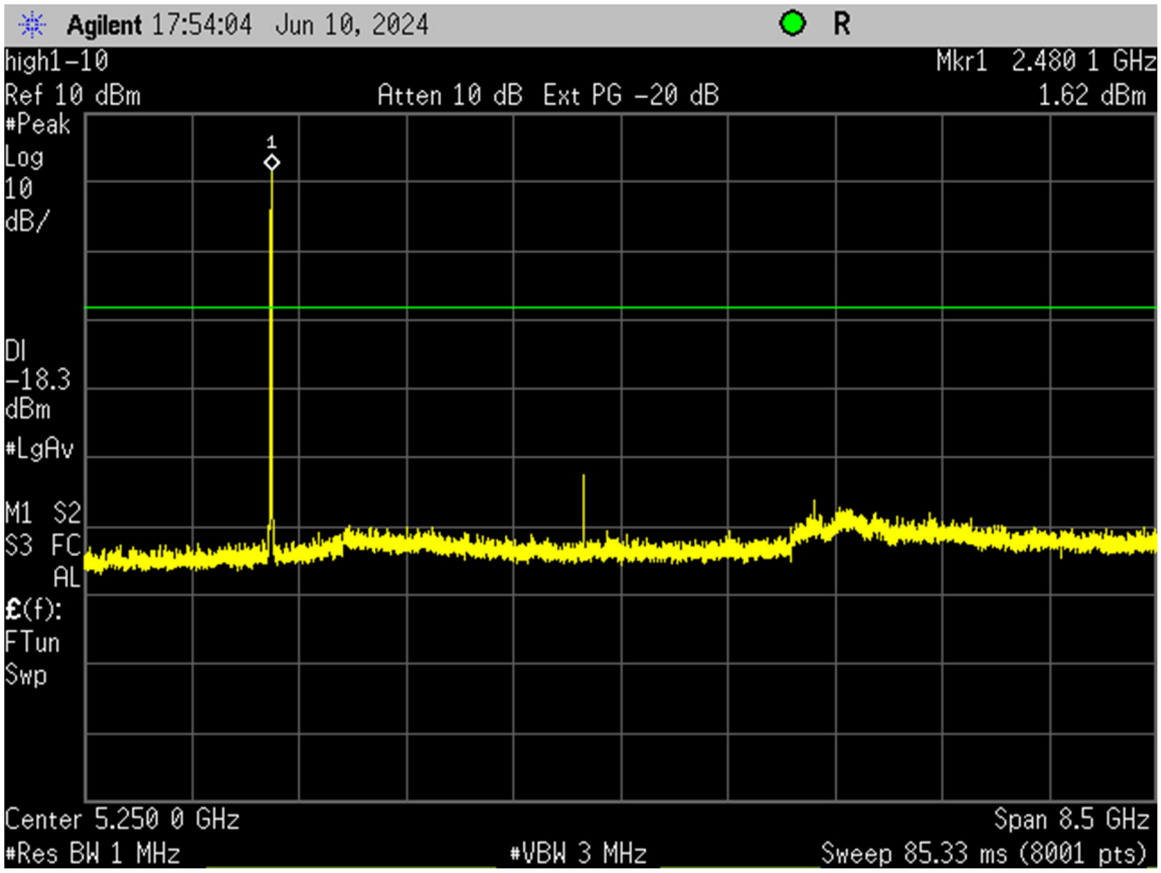

Figure 12. Sensor, High, 1-9 GHz

(Note: Intentional Emission seen for radio operating at 2480 MHz)

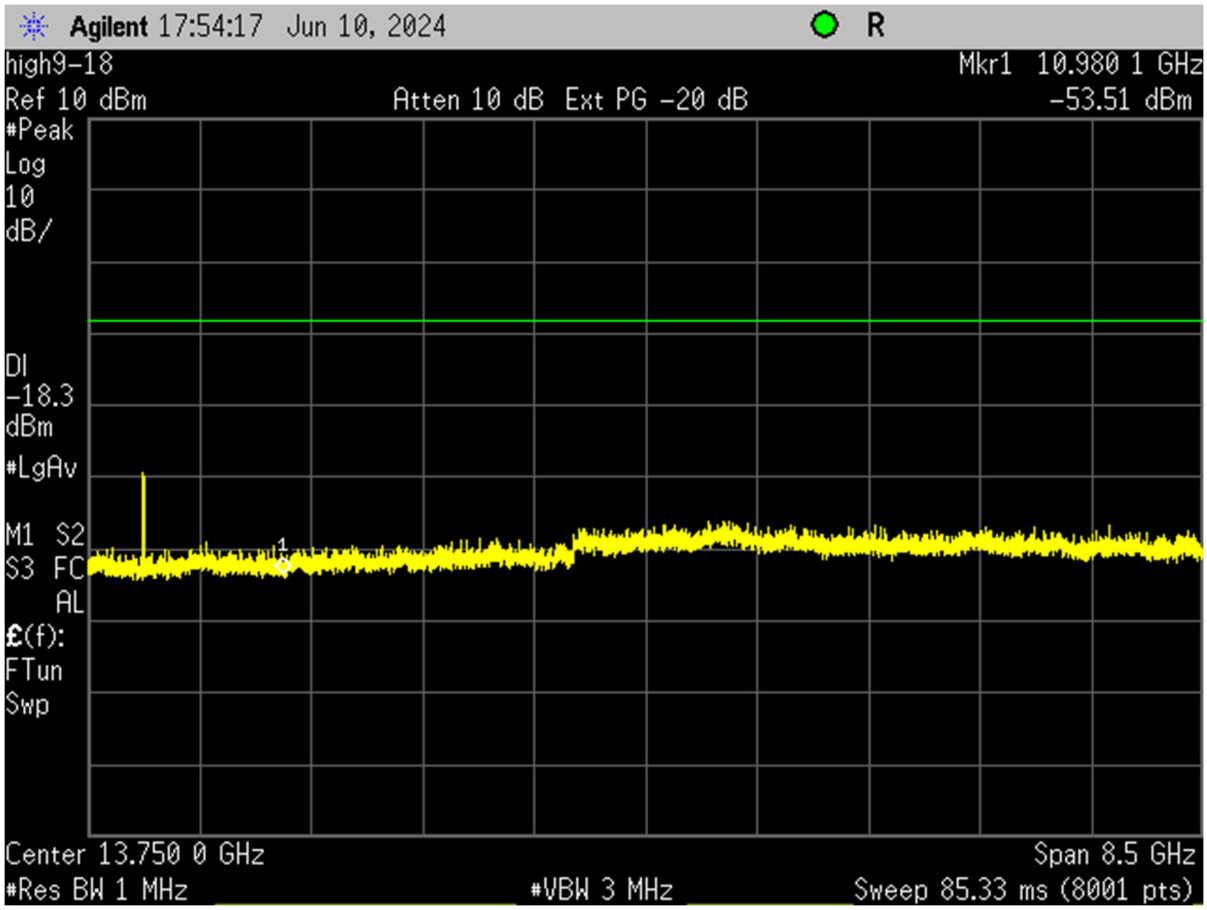

Figure 13. Sensor, High, 9-18 GHz

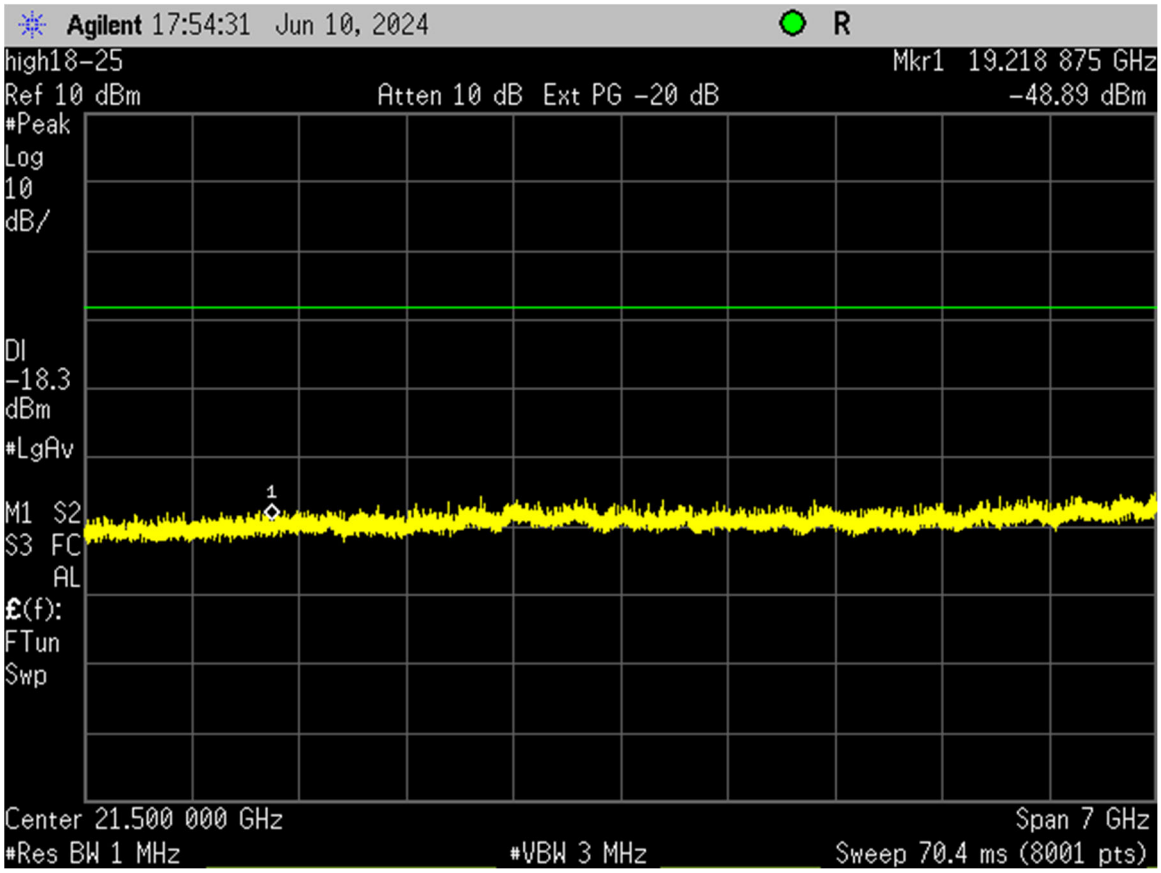

Figure 14. Sensor, High, 18-25 GHz

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d), RSS-247, 5.5)

On the test site, the EUT was placed on top of a non-conductive table 80 cm above the floor for measurements below 1 GHz and 150 cm above the floor for measurements > 1 GHz. The EUT was also evaluated in three orthogonal positions to determine the worst case position. The front of the EUT faced the measurement antenna located 3 meters away. Each signal measured was maximized by raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the spectrum analyzer display (with channel A in the Clear-Write mode and channel B in the Max-Hold mode) for the largest signal visible. The exact antenna height where the signal was maximized was recorded for reproducibility purposes. Additionally, the EUT was rotated about its Y-axis while monitoring the Spectrum Analyzer display for maximum. The EUT azimuth was recorded for reproducibility purposes. The EUT was measured when both maxima were simultaneously satisfied.

For radiated measurements, the EUT was set into a continuous transmit mode. Below 1 GHz, the RBW of the measuring instrument was set equal to 120 kHz. Peak measurements above 1 GHz were measured using a RBW = 1 MHz, with a VBW ≥ RBW. The results of peak radiated spurious emissions falling within restricted bands are given in Table 6 below.

For average measurements above 1 GHz, the emissions were measured using RBW = 1 MHz and VBW = 10 Hz, or the duty cycle correction factor was applied to the Peak recorded value.

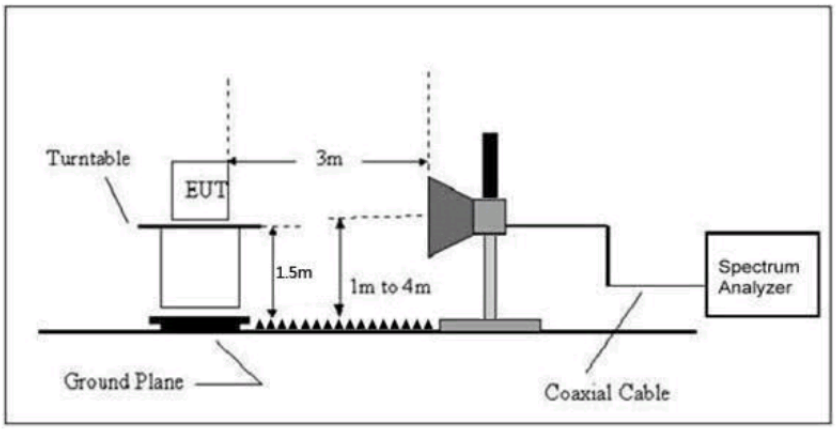

Figure 15. Radiated Emissions Setup (Fundamental and Harmonics)

Table 5. Sensor-Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15,247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel - PEAK								
2403.50	62.33	0.00	32.05	94.38	--	3.0m./VERT	--	**PK**
*4807.00	43.78	0.00	0.45	44.23	74.0	3.0m./VERT	29.8	**PK**
7210.50	40.51	0.00	7.83	48.34	74.0	3.0m./VERT	25.7	**PK**
Mid Channel – PEAK								
2443.50	60.08	0.00	32.31	92.39	--	3.0m./VERT	--	**PK**
*4887.00	45.78	0.00	1.25	47.03	74.0	3.0m./VERT	27.0	**PK**
*7330.50	40.01	0.00	8.52	48.53	74.0	3.0m./VERT	25.5	**PK**
High Channel– PEAK								
2480.00	57.63	0.00	32.56	90.19	--	3.0m./VERT	--	**PK**
*4960.00	45.98	0.00	1.22	47.20	74.0	3.0m./VERT	26.8	**PK**
*7440.00	39.90	0.00	7.69	47.60	74.0	3.0m./VERT	26.4	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209& 15.247.
2. No other signals detected within 20 dB of specification limit. Harmonics are investigated up to the 10^{th} harmonic.
3. The EUT was placed in three orthogonal positions, tested while broadcasting from each antenna, 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 2403.5 MHz:

Magnitude of Measured Frequency	62.33	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	32.05	dB/m
Corrected Result	94.38	dBuV/m

Test Date: June 4-6, 2024

Tested by
Signature:  Name: Ian Charboneau

Table 6. Sensor-Average Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15,247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
	Low Channel - Average							
2403.50	57.12	0.00	32.05	89.17	--	3.0m./VERT	--	**AVG**
*4807.00	45.02	0.00	0.45	45.47	54.0	3.0m./VERT	8.5	**AVG**
7210.50	37.38	0.00	7.83	45.21	54.0	3.0m./VERT	8.8	**AVG**
	Mid Channel–Average							
2443.50	55.84	0.00	32.31	88.15	--	3.0m./VERT	--	**AVG**
*4887.00	44.95	0.00	1.25	46.20	54.0	3.0m./VERT	7.8	**AVG**
*7330.50	37.49	0.00	8.52	46.01	54.0	3.0m./VERT	8.0	**AVG**
	High Channel–Average							
2480.00	54.08	0.00	32.56	86.64	--	3.0m./VERT	--	**AVG**
*4960.00	44.47	0.00	1.22	45.69	54.0	3.0m./VERT	8.3	**AVG**
*7440.00	39.01	0.00	7.69	46.71	54.0	3.0m./VERT	7.3	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics are investigated up to the 10th harmonic
3. The EUT was placed in three orthogonal positions, tested while broadcasting from each antenna, 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 2403.5MHz:

Magnitude of Measured Frequency	57.12	dBuV
+Additional Factor (filter + duty cycle)	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	32.05	dB/m
Corrected Result	89.17	dBuV/m

Test Date: June 4-6, 2024

Tested by
Signature: Ian Charboneau Name: Ian Charboneau

2.11 Band Edge Measurements (CFR 15.247(d), RSS-247, 5.5)

Band Edge measurements are made following the guidelines in ANSI C63.10-2013 Clause 6.10 with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Restricted band and band edge tests are performed as radiated measurements. The test instrument used for testing has both Peak and Average detection. In consideration of Clause 5.8 of ANSI C63.10-2013, the EUT was set to its highest rated output power level during testing. The results are collected and presented below.

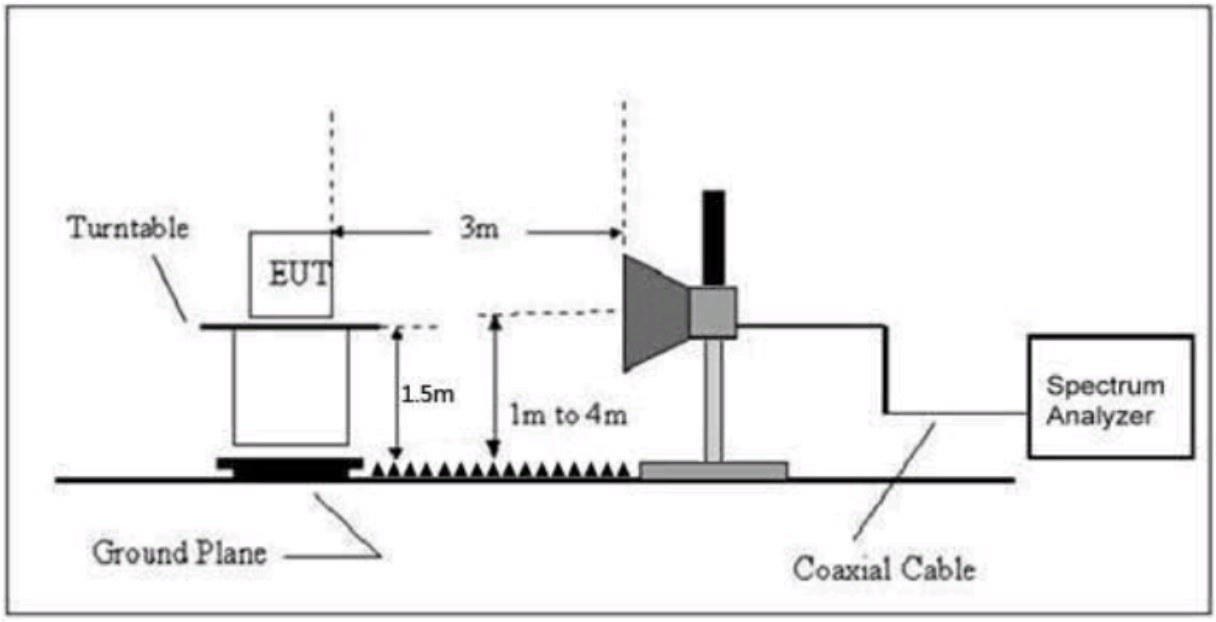

Figure 16. Radiated Emissions Setup