FCC PART §15.255 AND ISED CANADA RSS-210

CERTIFICATION TEST REPORT

for the

KICK SENSOR (B2301/B2302)

FCC ID: CWTB230X

ISED ID: 1788F-B230X

WLL REPORT# 18420-01 REV 3

Prepared for:

ALPS ALPINE CO., LTD.

6-3-36 Furukawaoakazato

Osaki City, Miyagi-pier, 989-6181 (Japan)

Prepared By:

Washington Laboratories, Ltd.

4840 Winchester Boulevard., Suite #5

Frederick, Maryland 21703 (USA)

Testing Certificate AT-1448

FCC §15.255 and ISED Canada RSS-210 Certification Test Report

for the

ALPS ALPINE CO., LTD.

Kick Sensor (B2301/B2302)

FCC ID: CWTB230X

IC ID: 1788F-B230X

December 18, 2023

WLL Report# 18420-01 Rev 3

Prepared by:

Ryan Mascaro
RF Test Engineer

Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of ALPS ALPINE CO., LTD. to support the attached Application for Equipment Authorization. This test report and application filings are being submitted for a Field Disturbance Sensor Transmitter under Part §15.255 of the FCC Rules and Regulations and under Spectrum Management and Telecommunications Policy RSS-210, Issue 10 (12/2019) of Innovation, Science and Economic Development Canada (ISED). This certification test report documents the test configuration and testing results for the ALPS ALPINE CO., LTD. Kick Sensor (B2301/B2302). The information provided in this report is only applicable to the device herein documented, as the EUT.

Radiated testing up to 40 GHz was performed in the Free-space Anechoic Chamber Test-site (FACT) 3m Chamber of Washington Laboratories, LTD., located at 4840 Winchester Boulevard, Suite #5., Frederick, Maryland, 21703 (USA). Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC Laboratory in Columbia, Maryland.

Washington Laboratories, LTD., has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory. The Washington Laboratories, Ltd. ISED Canada number is 3035A.

The ALPS ALPINE CO., LTD. Kick Sensor (B2301/B2302) complies with the limits and requirements for a Field Disturbance Sensor Transmitter under Part §15.255 of the FCC Rules and Regulations, and under Innovation, Science and Economic Development Canada (ISED) RSS-210, Annex J, Issue 10 (12/2019).

Revision History	Description of Change	Release Date
Rev 0	Initial Release	December 18, 2023
Rev 1	ACB Comments, Dated: 12/20/2023	December 23, 2023
Rev 2	ACB Comments, Dated: 12/29/2023	January 4, 2024
Rev 3	Integration of Applicant Test Data, Annex A	January 11, 2024

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Compliance Statement

The ALPS ALPINE CO., LTD. Kick Sensor (B2301/B2302) complies with the limits and requirements for a Field Disturbance Sensor Transmitter under Part 15.255 of the FCC Rules and Regulations, and Innovation, Science and Economic Development Canada (ISED) RSS-210, Annex J, Issue 10 (12/2019).

1.2 Test Methods

Tests for radiated emissions were performed. All measurements were performed in accordance with C63.10-2013 "ANSI Procedures for Compliance Testing of Unlicensed Wireless Devices".

The measurement equipment conforms to ANSI C63.2 "Specifications for Electromagnetic Noise and Field Strength Instrumentation".

1.3 Test Dates

11/28/2023 – 12/15/2023 (also see Section 5 of this report)

1.4 Test Scope

The below table provides a summary of the testing series, and the final results of the compliance testing.

Table 1: Testing Summary and Results

FCC Rule Part	ISED Rule Part	Description	Result
§15.207(a)	RSS-Gen(8.8)	AC Mains Conducted Emissions	N/A
§2.1049	RSS-Gen(6.7)	Transmitter Occupied Bandwidth	Pass
§15.255(c)(2)(iii)(B)	RSS-210	Radiated Power Limits	Pass
N/A	N/A	Peak Transmitter Output Power	Pass
§15.255(d)(2) §15.209(a)	RSS-210(J.3)(b) RSS-Gen(8.9)	Unwanted and Spurious Emissions Below 40 GHz	Pass
§15.255(d)(1) §15.255(d)(3)	RSS-210(J.3)(a) RSS-210(J.3)(c)	Unwanted and Spurious Emissions Outside of the 57 GHz – 71 GHz Band	Pass
§15.255(f)	RSS-210(J.6)	Frequency Stability	Pass
§15.255(c)(2)(iii)(B)	RSS-210 RSS-Gen(8.2)	Transmitter Duty Cycle and Timing	Pass

1.5 Contract Information

Customer:	DSPR, Inc c/o ALPS ALPINE CO., LTD.
Purchase Order Number:	Deposit Terms
Quotation Number:	74186A

1.6 Test and Support Personnel

Washington Laboratories, LTD	Ryan Mascaro and Gregory Czumak
Customer Representative	Shiota Takehiko (DSPR)

1.7 Test Location

All measurements herein were performed at Washington Laboratories, LTD., test center in Frederick, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, LTD., has been accepted by the FCC and approved by ANAB, under Testing Certificate AT-1448, as an independent FCC test laboratory. The Washington Laboratories, LTD., ISED Canada number is 3035A.

1.8 EUT Digital Emissions

Please know that the digital portion of the EUT is covered under this test report. The EUT meets the radiated emission requirements of FCC Part §15.109(a) and ISED Canada ICES-003 when investigated from 30MHz to 40GHz. Additionally, the EUT is only to be powered by vehicle battery or vehicle wiring harness. The EUT shall not be directly, or indirectly, coupled to the AC public mains network. As such, the EUT is not subject to the provisions of FCC Part §15.107 and/or §15.207.

2 Test Results

2.1 Transmitter Occupied Bandwidth

2.1.1 Requirements

FCC Part §2.1049 and RSS-GEN(6.7)

2.1.2 Test Procedure

The OBW measurement was performed in accordance with ANSI C63.10 (2013), Section 6.9.

2.1.3 Test Data

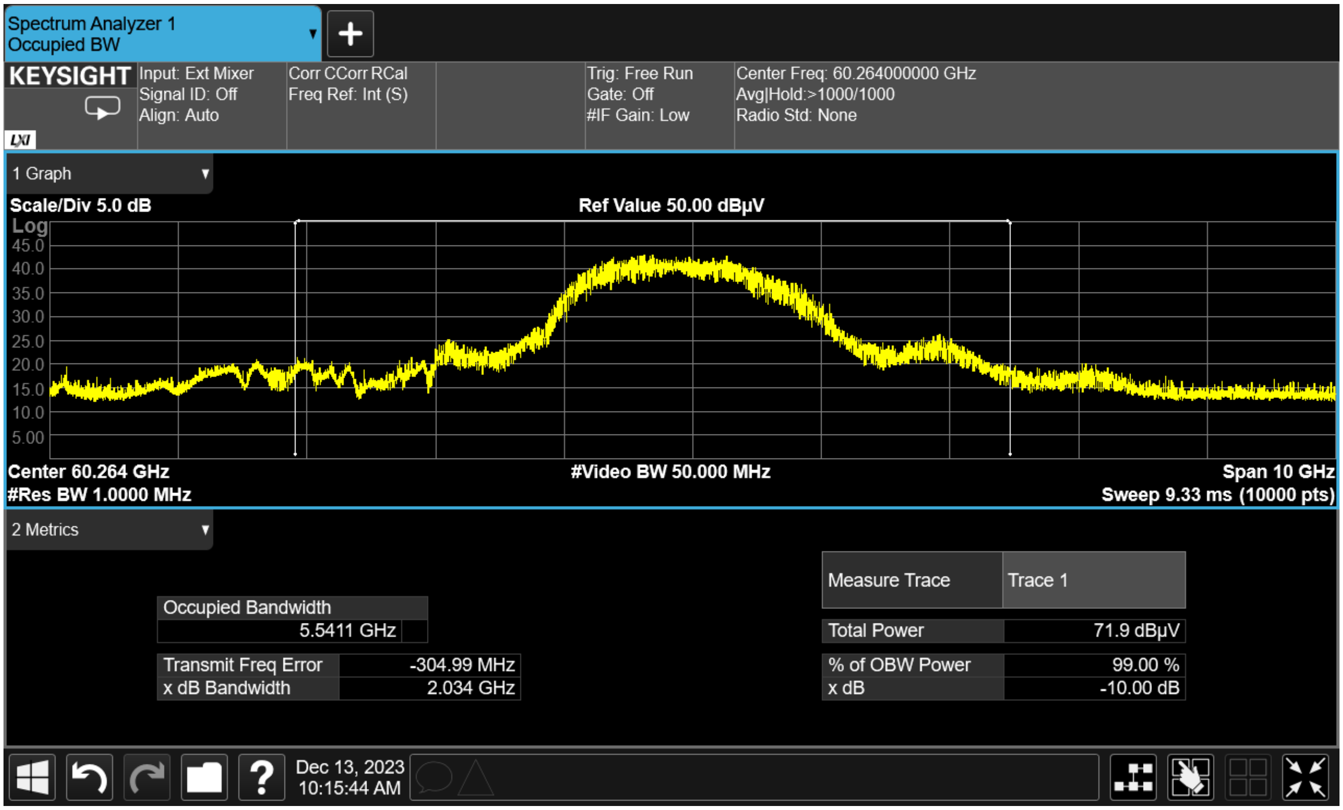
The EUT was set to a fully-modulated transmit mode.

The final data is provided below.

Table 2: Occupied Bandwidth Test Results

Center Frequency	10dB OBW	99% OBW
60.264 GHz	2.034 GHz	5.541 GHz

Figure 1: Transmitter Occupied Bandwidth



2.2 Radiated Power (EIRP), via Wideband RF Detector

2.2.1 Requirements

FCC Part §15.255(c)(2)(iii)(B)(2) and RSS-210.

Under this provision, the peak EIRP of the transmitter shall not exceed 20 dBm.

2.2.2 Test Procedure

This test was performed in accordance with ANSI C63.10 (2013), Section 9.11; using an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and has a video bandwidth of at least 10 MHz.

2.2.3 Test Data

The EUT complies with the requirements of this section.

The EUT Peak EIRP is less than 20 dBm.

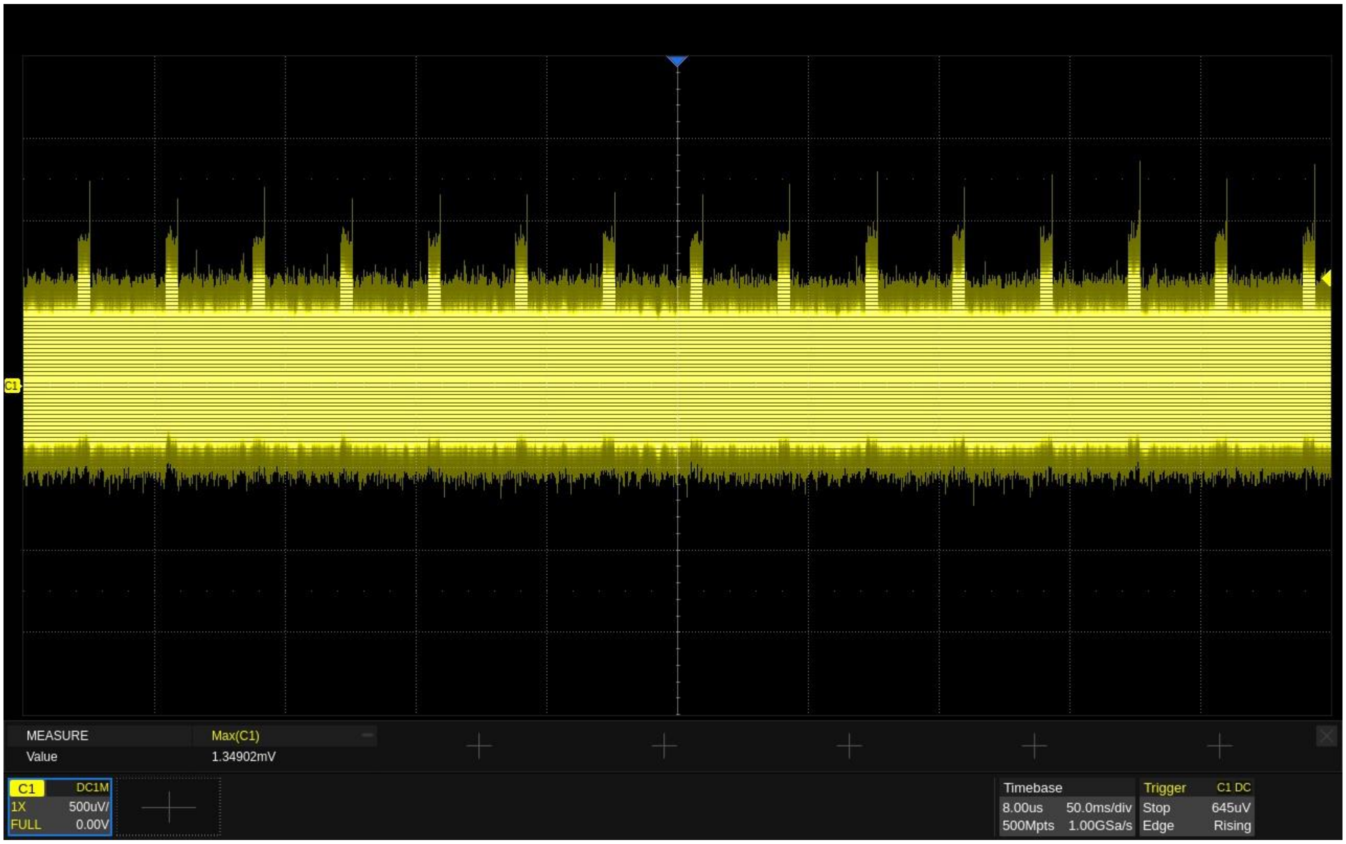
The EUT was set to a fully-modulated transmit mode.

The final data is provided below.

Table 3: Peak Transmitter Power (EIRP) Test Results, via RF Detector

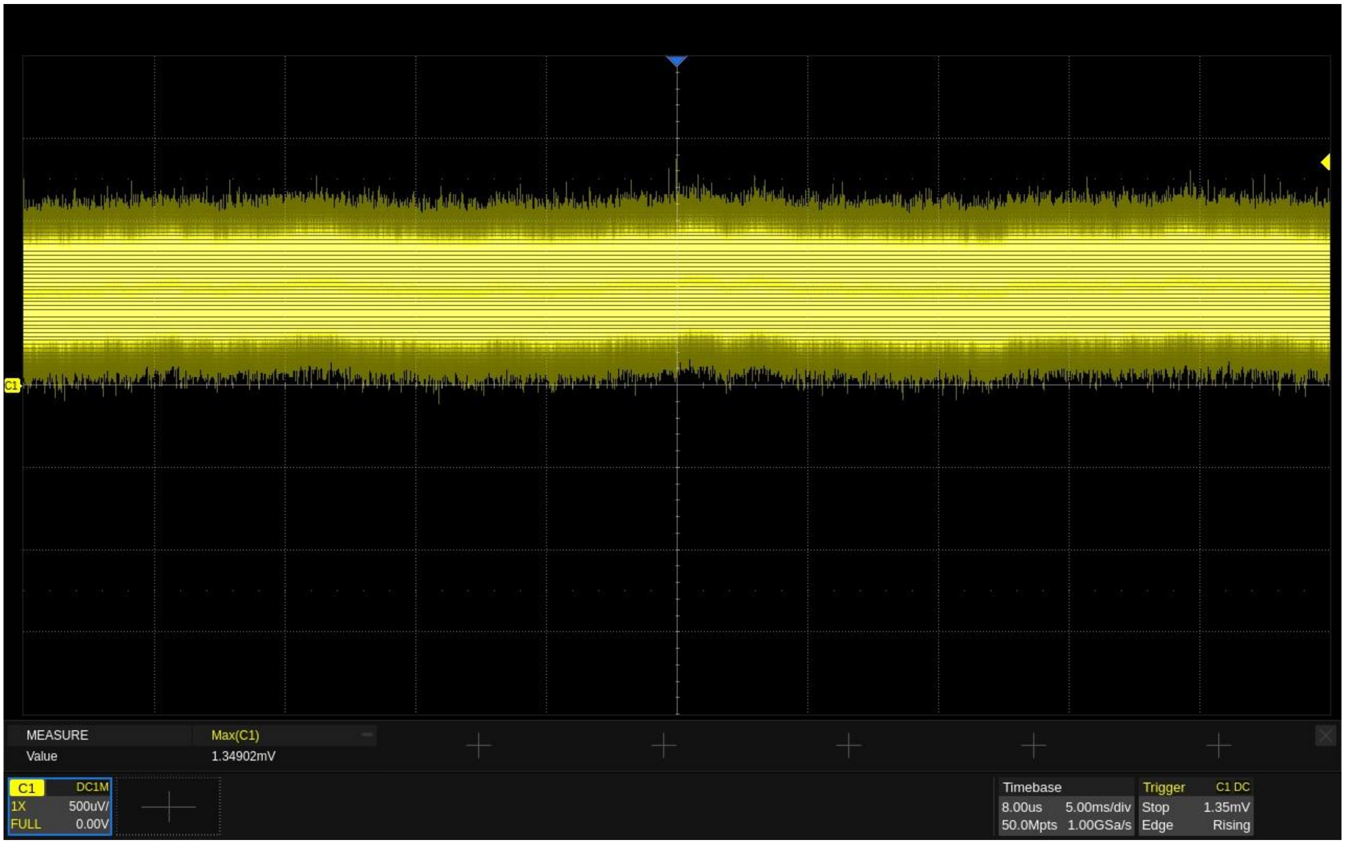
EUT Center Frequency (GHz)	DSO Level (mV)	Sub. Sig. Gen. (dBm)	EUT Antenna Gain (dBi)	Corrected Peak EIRP (dBm)	Peak Limit (dBm)	Margin (dB)
60.264	1.35	3.21	7.90	11.11	20.00	-8.89

Figure 2: EUT Transmitter Peak Power, via Wideband RF Detector



This plot represents the time-domain amplitude that was measured on the DSO, when the mm-wave test equipment was placed in the main beam of the EUT transmit signal. The highest voltage reading on the DSO was recorded as: 1.349 mV (Peak).

Figure 3: Substitution Method, Peak Level via RF Detector from Signal Generator



This plot represents the time-domain amplitude that was measured on the DSO, when the mm-wave test equipment was connected directly to the substitution source. The source (a signal generator) was set to output a CW at 60.264 GHz. The output of the signal generator was connected to the input of the mm-wave test equipment, and the drive-level amplitude was increased until the voltage reading on the DSO matched 1.349 mV. Once the DSO reached the equivalent peak level, the output power of the signal generator was recorded. In this case, the amplitude was +3.21 dBm (see Table 3).

2.3 Radiated Power (EIRP), via Field Strength

2.3.1 Requirements

FCC Part §15.255(c)(2)(iii)(B)(2) and RSS-210.

Under this provision, the peak EIRP of the transmitter shall not exceed 20 dBm.

2.3.2 Test Procedure

The EUT transmitter power was also verified via a field strength measurement. The calculations provided in ANSI C63.10 (2013), Section 9.5 were employed.

2.3.3 Test Data

The EUT complies with the requirements of this section.

The EUT Peak EIRP is less than 20 dBm.

The EUT was set to a fully-modulated transmit mode.

The radiated measurement test distance was 75cm, which remains in the far-field.

Please note that a BW Correction Factor of 33.08 dB was applied to the measurement. This provides more of a worst-case compensation, as compared to a Pulse Desensitization Factor.

The final data is provided below.

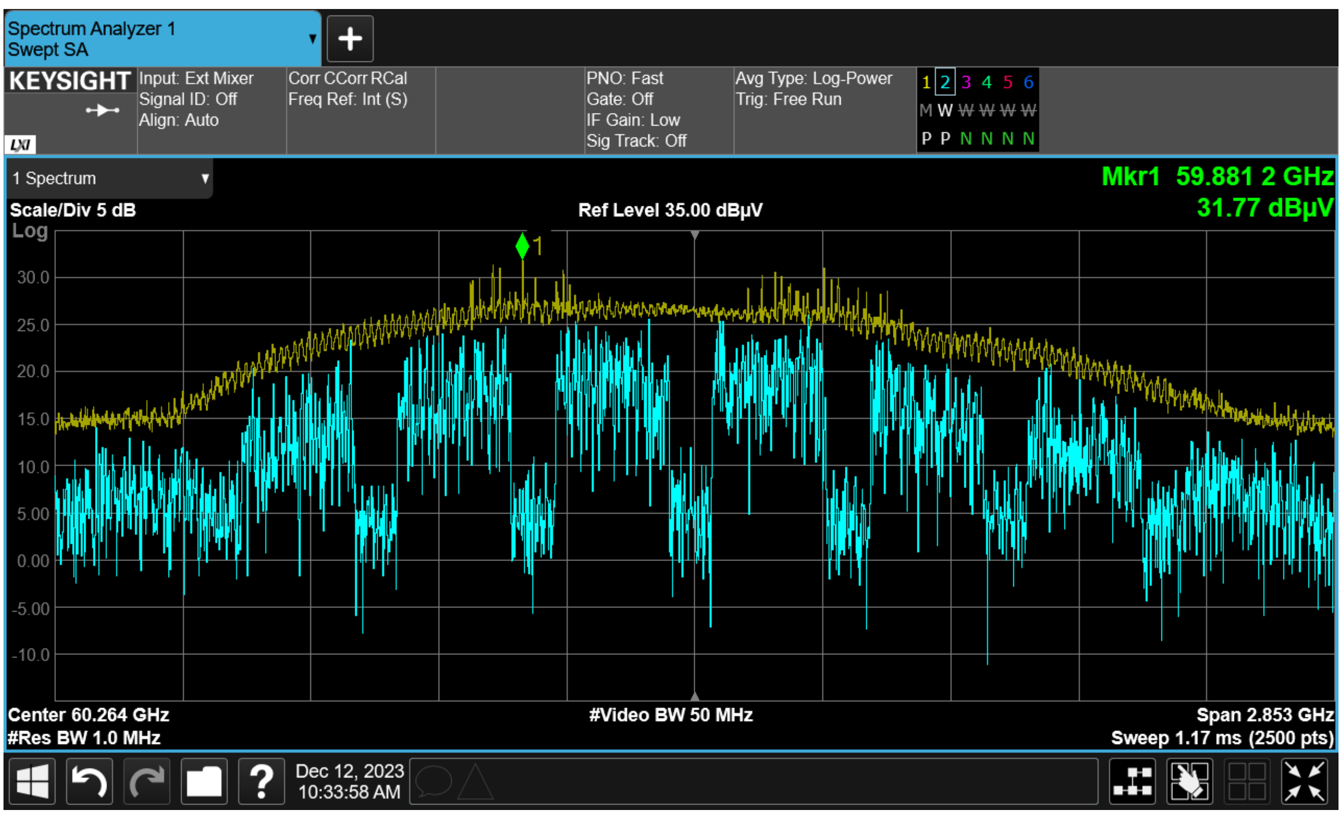
Table 4: Peak Transmitter Power (EIRP) Test Results, via Radiated Field Strength

EUT Center Frequency (GHz)	SA Level (dBuV)	Antenna Factor (dB/m)	SAX Conversion Loss (dB)	Emission Bandwidth Correction Factor (dB)	75cm Field Strength (dBuV/m)	EUT Peak EIRP (dBm)	Peak EIRP Limit (dBm)
60.264	31.77	43.25	10.35	33.08	118.45	11.25	20.0

Emission Bandwidth Factor		= 10LOG(OBW ÷ RBW)
		= 10LOG(2034 ÷ 1)
		= 33.08 dB
where,	OBW	= the transmitter -10dBc Occupied Bandwidth, in MHz
	RBW	= the measurement bandwidth used during the testing, in MHz

Peak EIRP$_{dBm}$		= $FS_{dBuV/m}$ + 20LOG(D_m) – 104.7
		= 118.45 + 20LOG(0.75) – 104.7
		= 11.25 dBm
where,	$FS_{dBuV/m}$	= the transmitter corrected field strength, in dBuV/m
	D_m	= the measurement distance, in meters

Figure 4: Uncorrected, Peak Transmitter Radiated Field Strength (75cm)



2.4 Peak Transmitter Conducted Output Power

2.4.1 Requirements

There is no limit for conducted output power. Nevertheless, the data is provided below.

2.4.2 Test Procedure

This test was performed in accordance with ANSI C63.10 (2013), Section 9.11; using an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band, and has a video bandwidth of at least 10 MHz.

2.4.3 Test Data

The EUT complies with the requirements of this section.

The EUT was set to a fully-modulated transmit mode.

The final data is provided below.

Table 5: Peak Transmitter Conducted Output Power – Test Results (Calculated)

EUT Center Frequency (GHz)	Peak EIRP (dBm)	EUT Antenna Gain (dBi)	Peak Conducted Power (mW)	Peak Conducted Power (dBm)	Peak Limit (mW)	Peak Limit (dBm)
60.246	11.11	7.90	2.094	3.21	500.0	27.0

$\text{Conducted Power}_{dBm} = \text{EIRP}_{dBm} - \text{Antenna Gain}_{dBi}$

$\text{Conducted Power}_{mW} = 10^{(dBm \div 10)}$

2.5 Radiated Spurious Emissions, Below 40 GHz

2.5.1 Requirements

FCC Part §15.255(d)(2), §15.209(a) and RSS-210(J.3)(b), RSS-Gen(8.9)

Under this provision, radiated emissions below 40 GHz shall not exceed the general limits as defined below.

Compliance Limits		
Frequency Range	**3m Limit**	
30 – 88 MHz	100 µV/m (QP)	
88 – 216 MHz	150 µV/m (QP)	
216 – 960 MHz	200 µV/m (QP)	
> 960 MHz	500 µV/m (AVG)	5000 µV/m (Peak)

2.5.2 Test Procedure

The requirements of FCC Part 15 and ICES-003 call for the EUT to be placed on a 1m X 1.5m non-conductive motorized turntable at a height of 80cm for radiated testing of frequencies up to 1000 MHz, and at a height of 1.5m for testing of frequencies above 1000 MHz.

An initial pre-scan of the EUT was performed to identify any emissions that exceed, or come within 6dB of, the applicable limit. This pre-scan was performed a with the employment of a spectrum analyzer peak detector function. The highest amplitude (worst-case) emissions noted during the pre-scan were selected for final compliance measurements.

The emissions from the EUT were maximized, and measured continuously, at every azimuth by rotating the turntable. Broadband log periodic and double-ridged horn antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 40 GHz were evaluated. The EUT peripherals were placed on the table in accordance with ANSI C63.4. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The detector function is set to quasi-peak for measurements below 1 GHz. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth. For measurements above 1 GHz, both the peak and the average levels are recorded, using a measurement bandwidth of 1 MHz. For average measurements, a video bandwidth setting of 10 Hz is used, in the case of video averaging; otherwise, an EMI AVG detector shall be employed.

2.5.3 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antenna(s) and other measurement equipment. These factors include the antenna factor ((AF)(in dB/m)), cable loss factors ((CF)(in dB)), and the pre-amplifier gain [if applicable] ((G)(in dB)). These correction values are algebraically added to the raw Spectrum Analyzer Voltage (in dBµV) to obtain the corrected radiated electric field, which shall be the final corrected logarithm amplitude ((Corr. Meas.)(in dBµV/m)). This logarithm amplitude is then compared to the FCC limit, which has been converted to a unit of log in dBµV/m.

<u>Example:</u>

Spectrum Analyzer Voltage:	VdBµV (SA)
Antenna Correction Factor:	AFdB/m
Cable Correction Factor:	CFdB
Pre-Amplifier Gain (if applicable):	GdB
Electric Field:	EdBµV/m = V dBµV (SA) + AFdB/m + CFdB - GdB
To convert from linear units of measure:	dBuV/m = 20LOG(uV/m)
To convert FCC limits, based on $D_{Measure}$:	3m Limit = 10m Limit + 20LOG(10/3)

Environmental Conditions During Radiated Emissions Testing

Ambient Temperature:	21.1 °C
Relative Humidity:	49 %

2.5.4 Test Data

The EUT complies with the requirements of this section.

The EUT was set to a fully-modulated transmit mode.

There were no emissions detected from the EUT in the frequency range of 30 MHz to 40 GHz.

The final data is provided below.

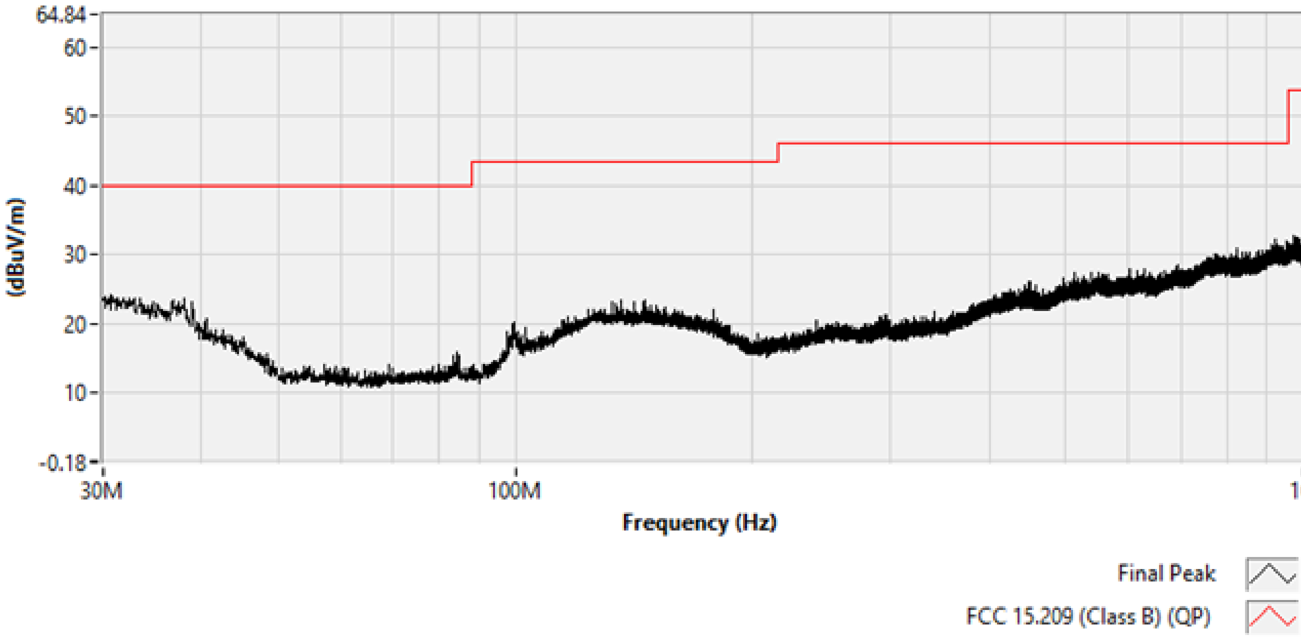
Table 6: Radiated Emissions Test Data, 30MHz to 40 GHz

Frequency (GHz)	Detector	Corr. Meas. (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
7.533 *	Peak	56.53	74	-17.47	180	Horiz, 180
	AVG	41.621	54	-12.379	180	Horiz, 150
10.257 *	Peak	60.106	74	-13.894	180	Vert, 180
	AVG	45.141	54	-8.859	180	Vert, 150
13.965 *	Peak	65.088	74	-8.912	180	Vert, 180
	AVG	49.917	54	-4.083	180	Vert, 150
17.948 *	Peak	63.732	74	-10.268	180	Horiz, 180
	AVG	48.331	54	-5.669	180	Horiz, 150
25.821 *	Peak	61.050	74	-12.950	0	Vert, 100
	AVG	47.230	54	-6.770	0	Vert, 100
39.318 *	Peak	66.950	74	-7.050	0	Vert, 100
	AVG	52.760	54	-1.240	0	Vert, 100

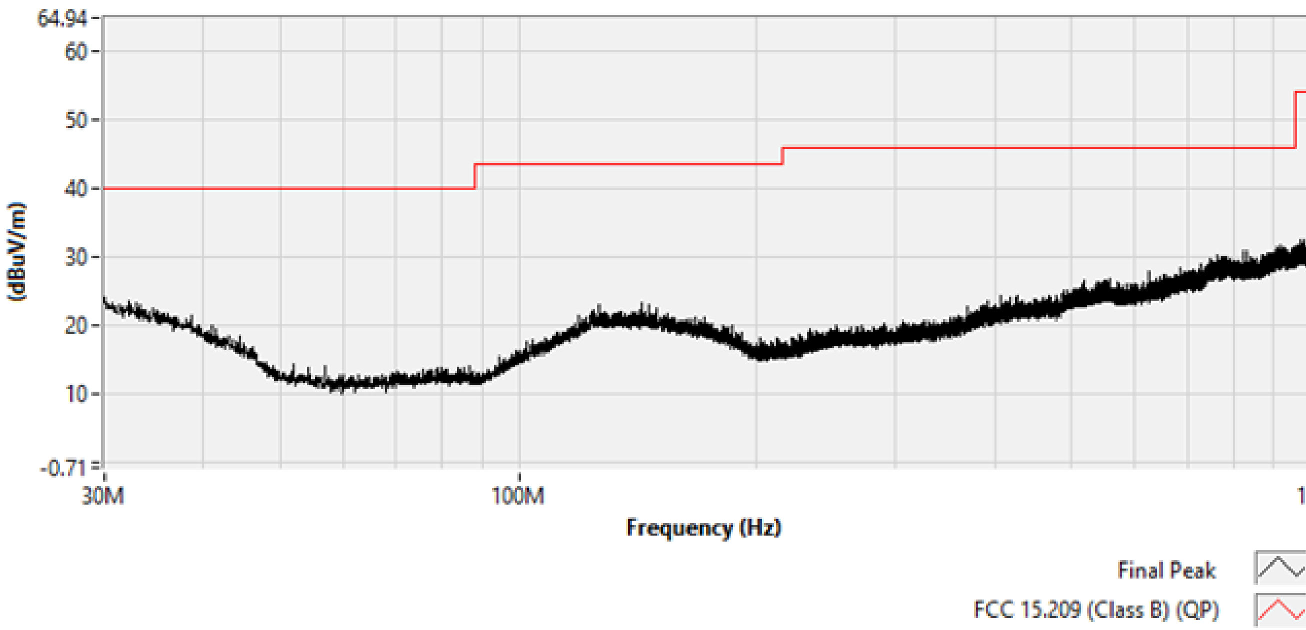
* Ambient Conditions

Note: EUT emissions not detected. Additionally, in the case of 30MHz to 40GHz, this data serves to address the digital requirements of FCC Part §15.109(a) and ISED Canada ICES-003.

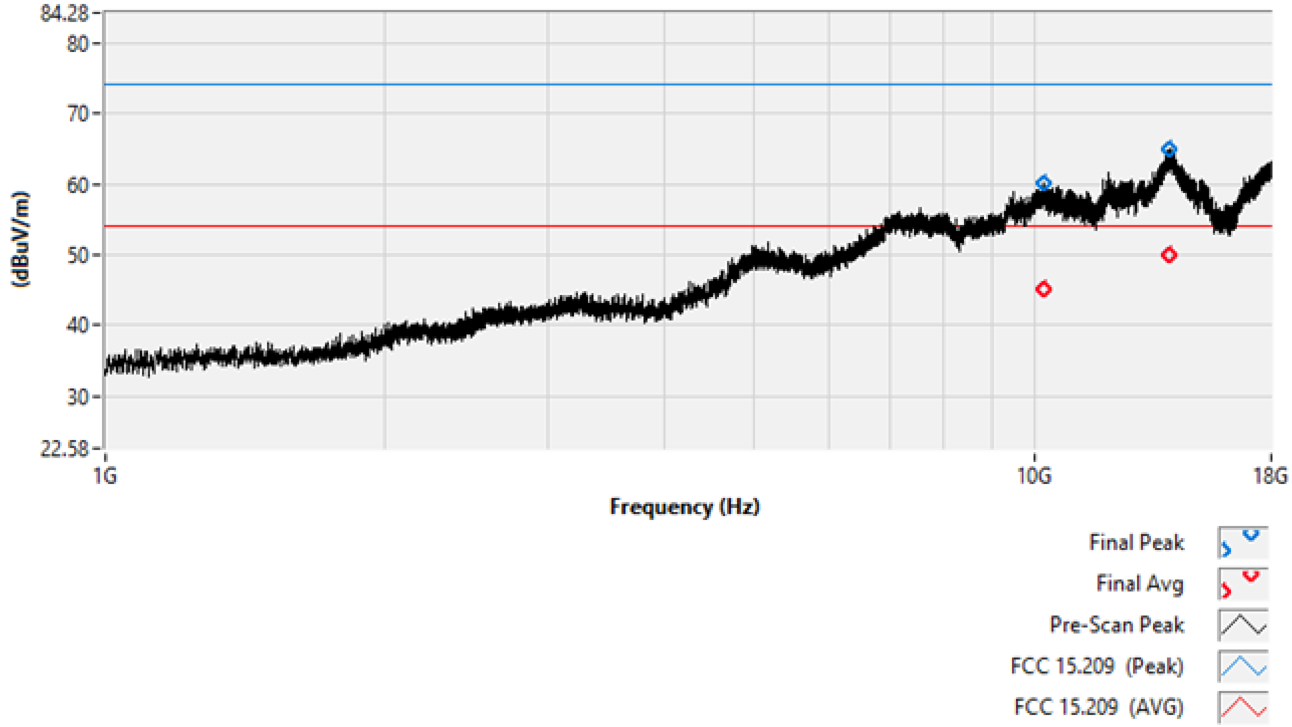
TX Enabled, Final Data (Vertical)



TX Enabled, Final Data (Horizontal)



TX Enabled, Final Data (Vertical)



TX Enabled, Final Data (Horizontal)

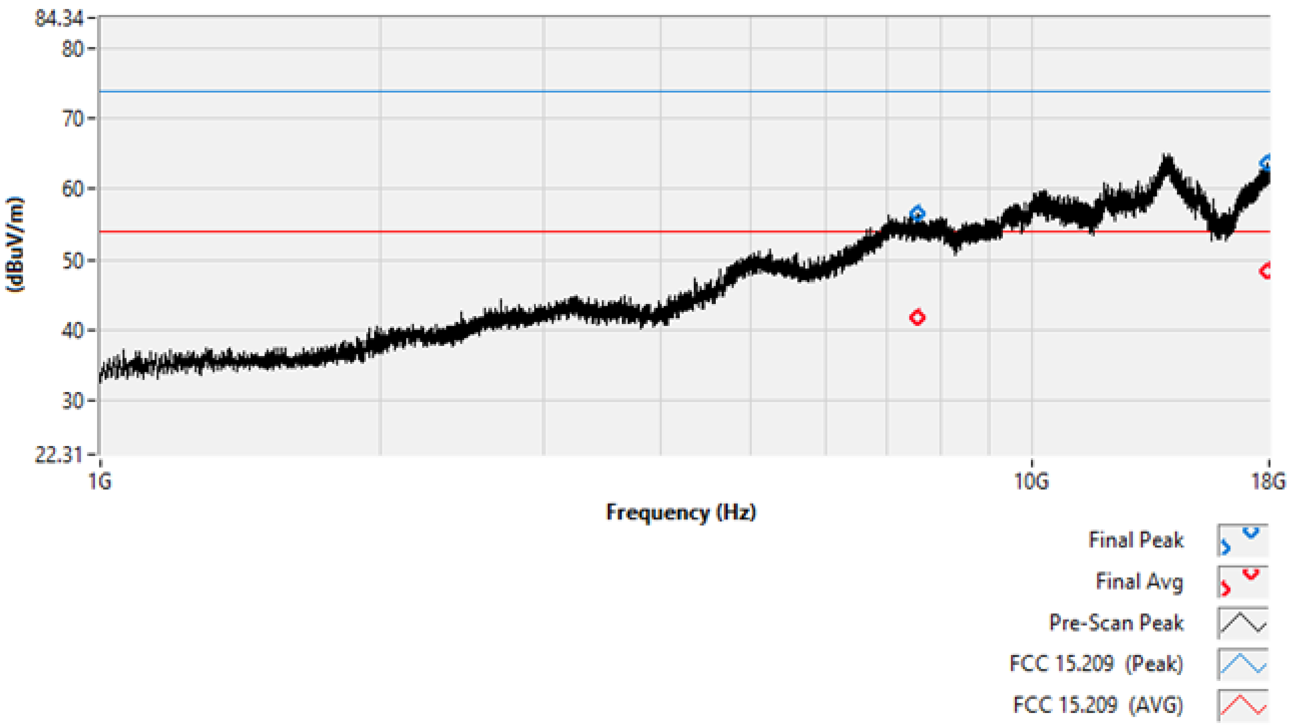
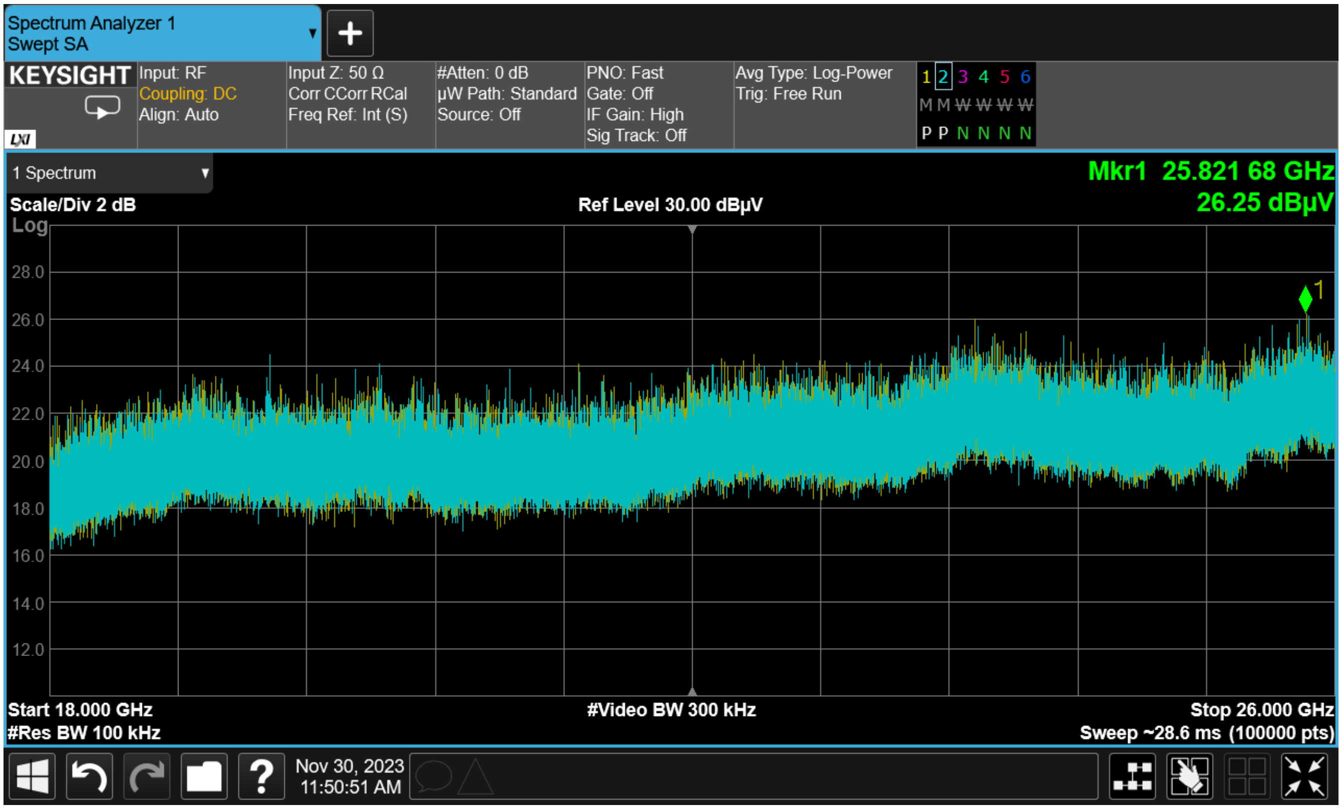


Figure 5: Uncorrected, Radiated Emissions Test Data, 18GHz to 26GHz



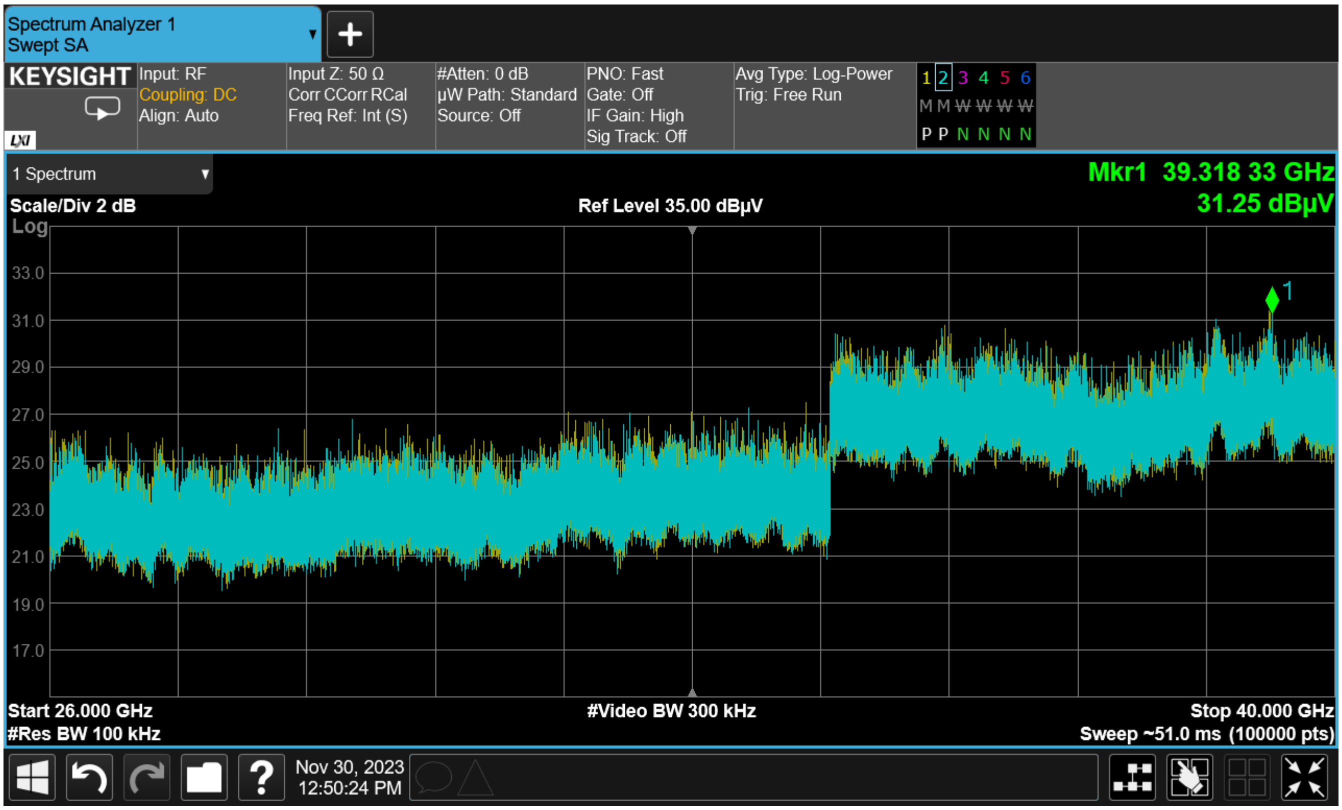
EUT emissions were not detected in this frequency range.

Trace 1 = EUT Transmitter Enabled

Trace 2 = Ambient

* the noise floor of the measurement system (ambient) was marked at 25.821 GHz

Figure 6: Uncorrected, Radiated Emissions Test Data, 26GHz to 40GHz



EUT emissions were not detected in this frequency range.

Trace 1 = EUT Transmitter Enabled

Trace 2 = Ambient

* the noise floor of the measurement system (ambient) was marked at 39.318 GHz

2.6 Radiated Spurious Emissions, 40 GHz to 200 GHz

2.6.1 Requirements

FCC Part §15.255(d)(1), §15.255(d)(3), and RSS-210(J.3)(a), RSS-210(J.3)(c)

Under this provision, the power density of any emissions outside of the 57 GHz to 71 GHz band shall consist solely of spurious emissions. The level of any emissions above 40 GHz shall not exceed 90 pW/cm^2 when measured at a distance of 3-meters.

2.6.2 Test Procedure

This test was performed in accordance with ANSI C63.10 (2013), Section 9.12. The EUT was investigated for radiated spurious emissions, across the frequency range of 40 GHz to 57 GHz, and from 71 GHz to 200 GHz. The EUT was placed on an 80cm high, non-conductive testing surface, and was investigated for emissions at a measurement distance of 5cm.

2.6.3 Test Data

The EUT complies with the requirements of this section.

The EUT was set to a fully-modulated transmit mode.

To ensure that all potential emissions were identified, a pre-scan was performed by hand, within a few centimeters of the EUT, in a full sphere around it, for each different band investigated.

The radiated measurement test distances were as follows:

Pre-Scan Investigation, 40GHz to 200GHz = 5cm
Final Measurements (if required) = 50cm

There were no unwanted or spurious emissions detected in the frequency range of 40GHz to 200GHz.

The final data is provided below.

To achieve the desired sensitivity at these frequencies, a reduced test distance was employed. As frequency increases, the near-field far-field intersection collapses in a linear fashion. We have calculated that an evaluation of 5 cm is adequate for these frequency bands.

For convenience, we will present the power density limits (pico-watts per square centimeter) in terms of microvolts per meter. This allows us to perform analysis using field strength, rather than power density.

First, the relationship between power density S (W/m^2) and field strength (volts per meter) is:

$S = E^2/Z_o \, W/m^2$

where, $Z_o = 377$ Ohms

Thus, $E = SQRT(Z_o * S)$ V/m

The limit is expressed as 90 pW/cm^2

Therefore, 90 pW = 90 E-12 Watts

And, $1cm^2 = 1e\text{-}4 \; m^2$

Hence,

$90 \; pW/cm^2 = 90e\text{-}12/1e\text{-}4 = 90e\text{-}8 \; W/m^2$

E = SQRT(377 * 90E-8) V/m

E = 0.01842 V/m

E = 18420.1 uV/m

E = 20LOG(18420.1) = 85.3 dBuV/m at 3m

The field strength readings can be converted to a distance other than 3m by the following equation:

Distance Correction Factor (dB) = $20LOG(D_{Measure} \div 3m)$

Where $D_{Measure}$ is the actual test distance of the measurement.

To convert the radiated electric energy, as measured on the spectrum analyzer, from dBuV to dBuV/m, the Antenna Factor (dB/m) is added to the voltage in dBuV.

Standard gain horns were used with nominal mid-band gain of 10 dBi.

To convert the antenna gain to an antenna factor, the following equation is employed:

AF (dB/m) = 10LOG(9.73 ÷ λ * SQRT(G(*numeric*))

The correction factors for the standard gain horns and mid-band mixers, as they relate to frequency, are provided below.

Table 7: Standard Gain Horns, Antenna Factors

Test Frequency (GHz)	RX Antenna Gain (dBi)	RX Antenna Gain (numeric)	Antenna Factor (dB/m)
50.0	10	10	42.0
70.0	10	10	43.4
120.0	10	10	45.8
190.0	10	10	47.5

Table 8: External (Harmonic) Mid-Band Mixer(s), Correction Factors

Test Frequency (GHz)	Mixer Loss (dB)
50.0	32
70.0	43
120.0	47
190.0	59

Finally, the 5cm radiated field strength values of the spurious domain are provided in the below table.

EUT emissions were not detected in the frequency range of 40 GHz to 57 GHz.

EUT emissions were not detected in the frequency range of 71 GHz to 200 GHz.

The levels provided below were ambient conditions, taken at the noise floor of the measurement system.

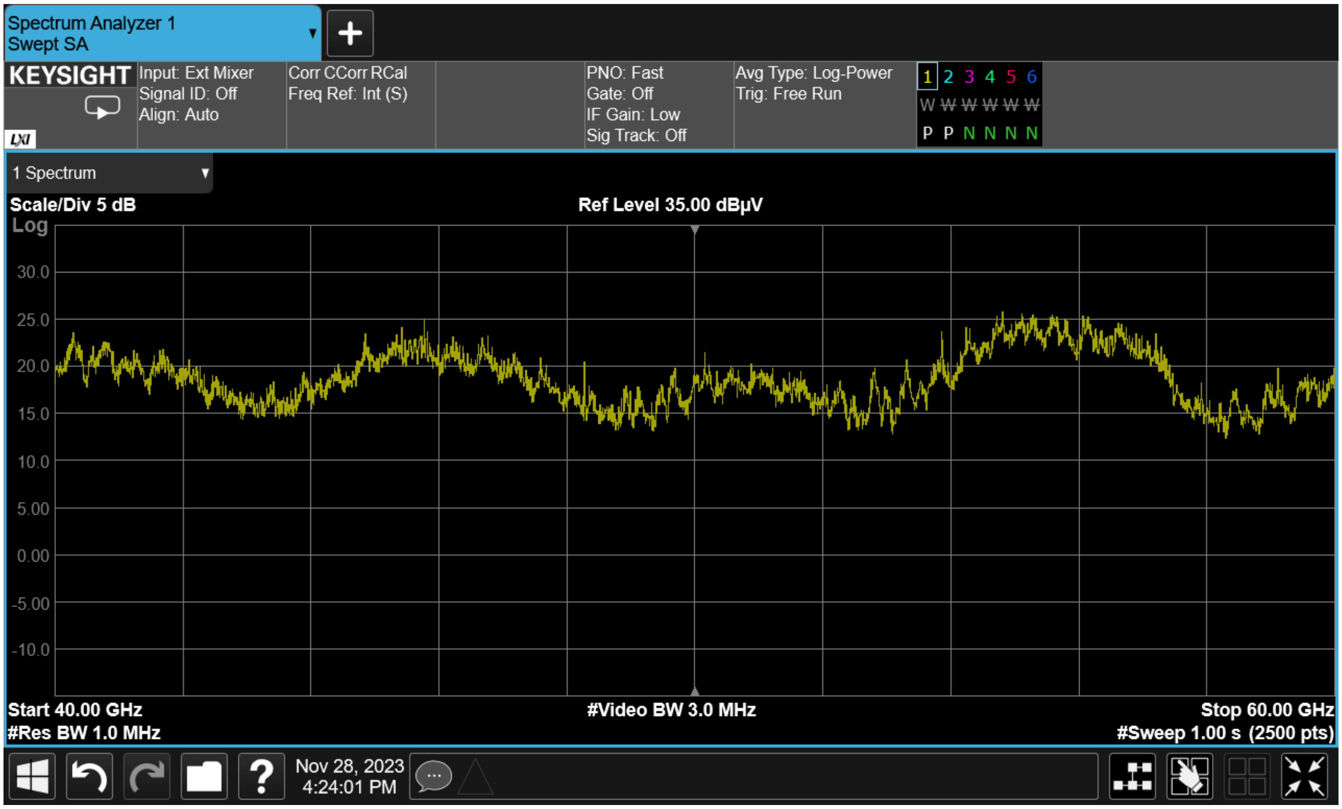
Table 9 includes only spurious emission data outside of the authorized band.

Table 9: Radiated Spurious Emissions Test Results, 40 GHz to 200 GHz

Frequency Range (GHz)	SA Level (dBuV)	Antenna Factor (dB/m)	Mixer and Cable Loss (dB)	Distance Correction Factor (dB)	Corrected Level (dBuV/m)	3-meter Limit (dBuV/m)	Margin (dB)
40-57	25.20	42.0	32.0	35.6	63.62	85.3	-21.68
71-90	4.80	43.4	43.0	35.6	55.68	85.3	-29.62
90-140	20.16	45.8	47.0	35.6	77.38	85.3	-7.92
140-200	13.10	47.5	59.0	35.6	84.08	85.3	-1.22

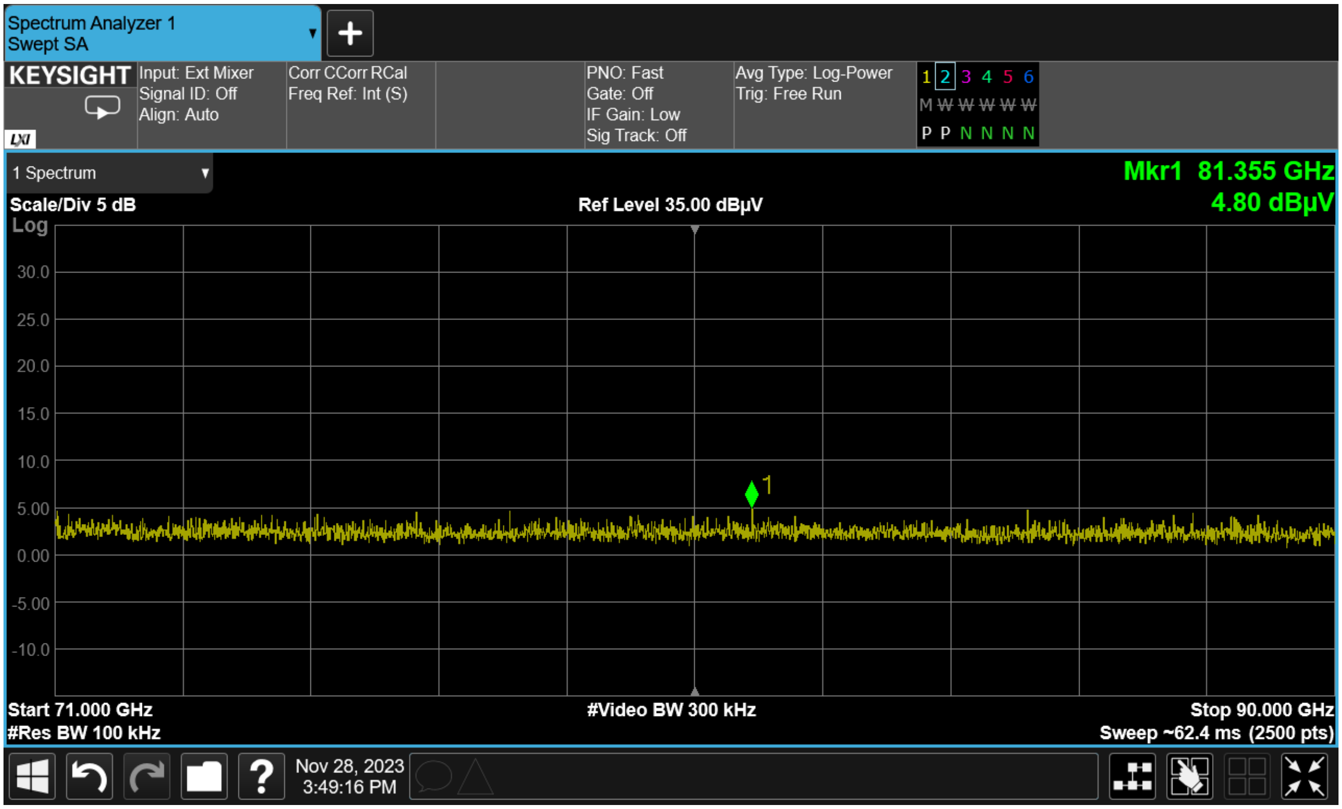
* all measurements were made at the noise floor (ambient)

Figure 7: Uncorrected, Radiated Emissions Test Data – Plot 1



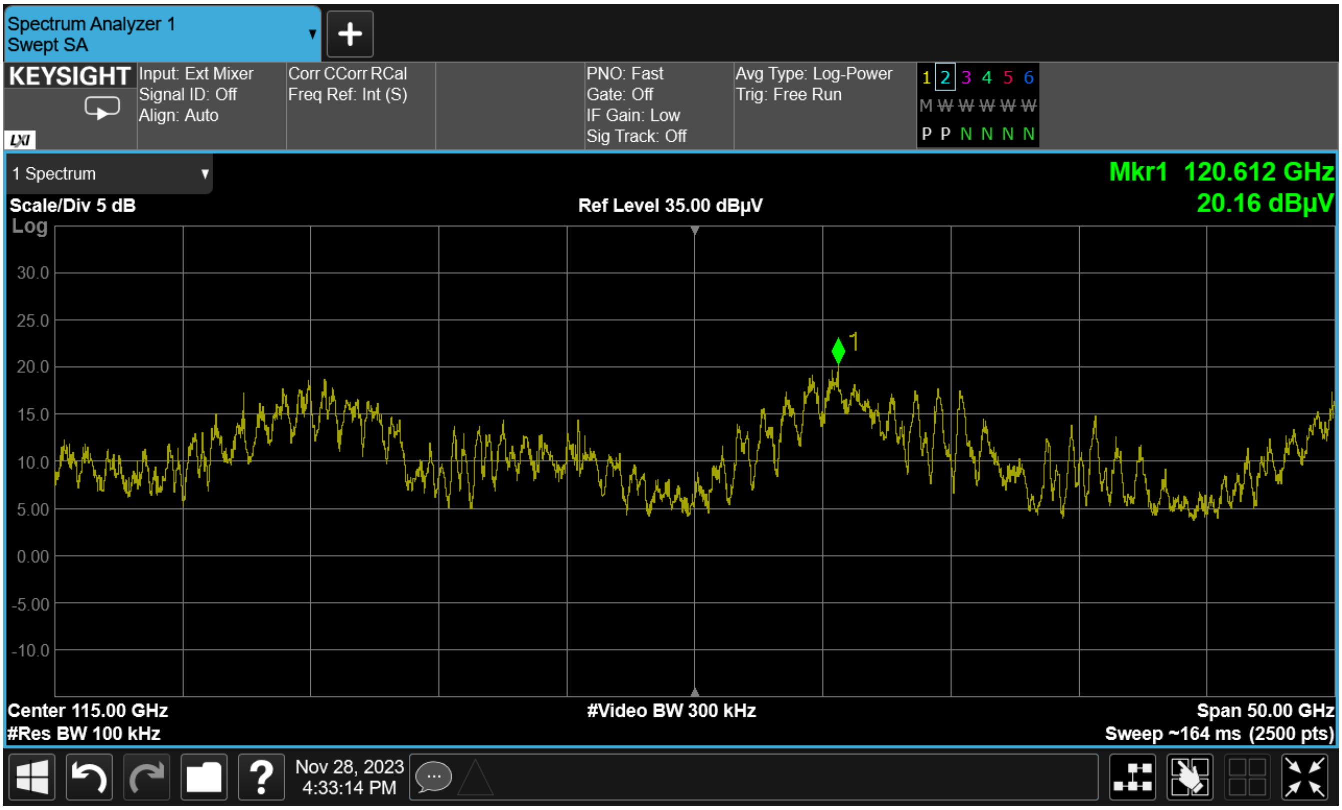
* EUT emissions were not detected in this frequency range.

Figure 8: Uncorrected, Radiated Emissions Test Data – Plot 2



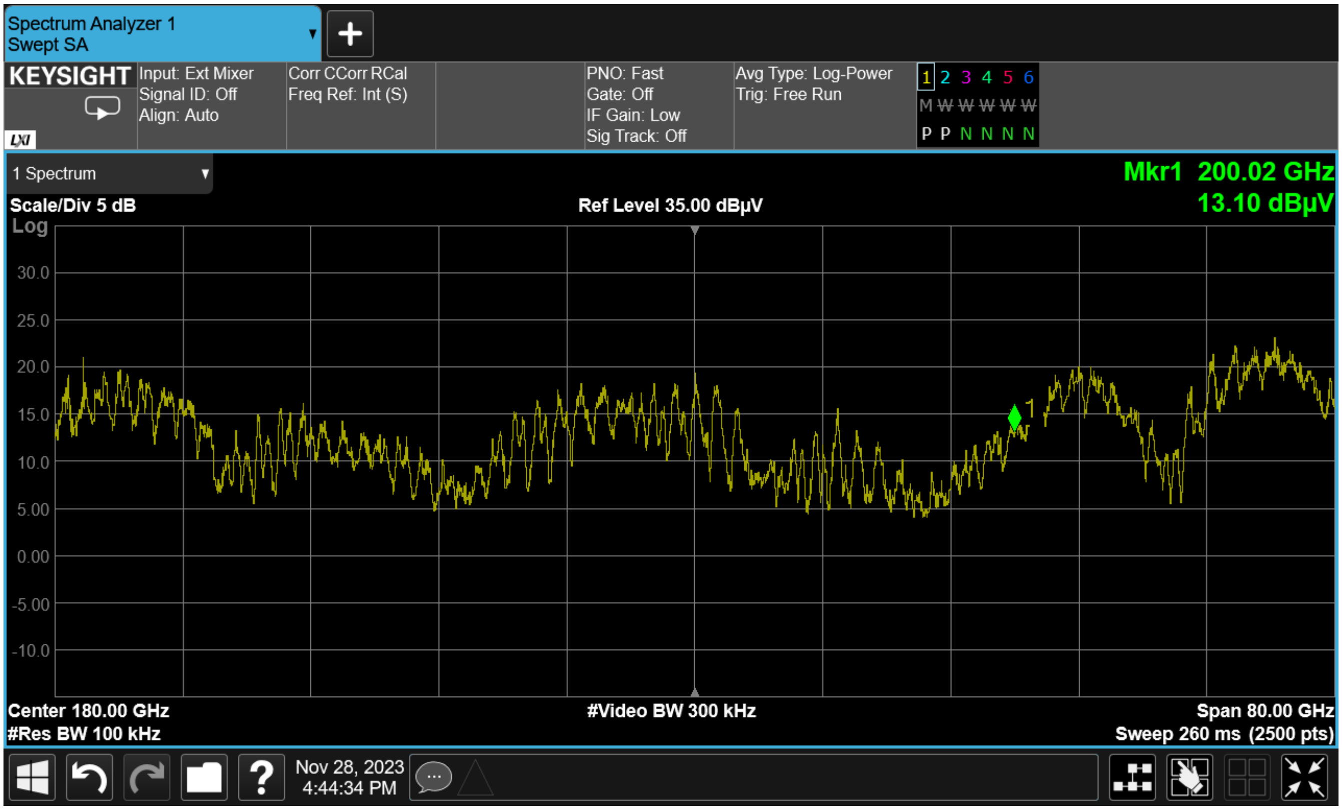
* EUT emissions were not detected in this frequency range.

Figure 9: Uncorrected, Radiated Emissions Test Data – Plot 3



* EUT emissions were not detected in this frequency range.

Figure 10: Uncorrected, Radiated Emissions Test Data – Plot 4



* EUT emissions were not detected in this frequency range.

2.7 Transmitter Frequency Stability

2.7.1 Requirements

FCC Part §15.255(f) and RSS-210(J.6)

Under this provision, fundamental transmit emissions must remain wholly contained within the frequency band of 57 GHz to 71 GHz, during all conditions of operation, when tested at the temperature and voltage variations specified.

The EUT shall maintain this frequency stability when operated over the temperature range of -20 to +50 degrees Celsius. Additionally, the input voltage shall be varied to the order of 85% to 115% of rated input voltage.

2.7.2 Test Procedure

This test was performed in accordance with ANSI C63.10 (2013), Section 6.8 and Section 9.14.

2.7.3 Test Data

The EUT complies with the requirements of this section.

The EUT was set to a fully-modulated transmit mode.

The radiated measurement distance was maintained at ~10cm to 15cm, for both the variations of temperature and variations of voltage testing.

To evaluate conformity during this test, the fundamental transmit signal was investigated for bandedge compliance, and the frequency excursion of the EUT emission mask (if any), was recorded.

The final data is provided below.

Table 10: Frequency Stability Test Data – Temperature

Start-Up				
Temperature (C)	**Baseline Spectral Mask**	**During Test Spectral Mask**	**Frequency Excursion**	**Result**
21 (ambient)	Compliant	--	--	N/A
50	--	Compliant	None	Pass
40	--	Compliant	None	Pass
30	--	Compliant	None	Pass
20	--	Compliant	None	Pass
10	--	Compliant	None	Pass
0	--	Compliant	None	Pass
-10	--	Compliant	None	Pass
-20	--	Compliant	None	Pass
2-Minutes				
Temperature (C)	**Baseline Spectral Mask**	**During Test Spectral Mask**	**Frequency Excursion**	**Result**
50	--	Compliant	None	Pass
40	--	Compliant	None	Pass
30	--	Compliant	None	Pass
20	Compliant	Compliant	None	Pass
10	--	Compliant	None	Pass
0	--	Compliant	None	Pass
-10	--	Compliant	None	Pass
-20	--	Compliant	None	Pass
5-Minutes				
Temperature (C)	**Baseline Spectral Mask**	**During Test Spectral Mask**	**Frequency Excursion**	**Result**
50	--	Compliant	None	Pass
40	--	Compliant	None	Pass
30	--	Compliant	None	Pass
20	Compliant	Compliant	None	Pass
10	--	Compliant	None	Pass
0	--	Compliant	None	Pass
-10	--	Compliant	None	Pass
-20	--	Compliant	None	Pass
10-Minutes				
Temperature (C)	**Baseline Spectral Mask**	**During Test Spectral Mask**	**Frequency Excursion**	**Result**
50	--	Compliant	None	Pass
40	--	Compliant	None	Pass
30	--	Compliant	None	Pass
20	Compliant	Compliant	None	Pass
10	--	Compliant	None	Pass
0	--	Compliant	None	Pass
-10	--	Compliant	None	Pass
-20	--	Compliant	None	Pass

Table 11: Frequency Stability Test Data – Voltage

Variations of Voltage	Supply Voltage (VDC)	During Test Spectral Mask	During Test Bandedge	Frequency Excursion	Result
85%	10.2	Compliant	Compliant	None	Pass
Nominal	12.0	Compliant	Compliant	None	Pass
115%	13.8	Compliant	Compliant	None	Pass

Figure 11: Frequency Excursion and Spectral Component Evaluation (Example Only)

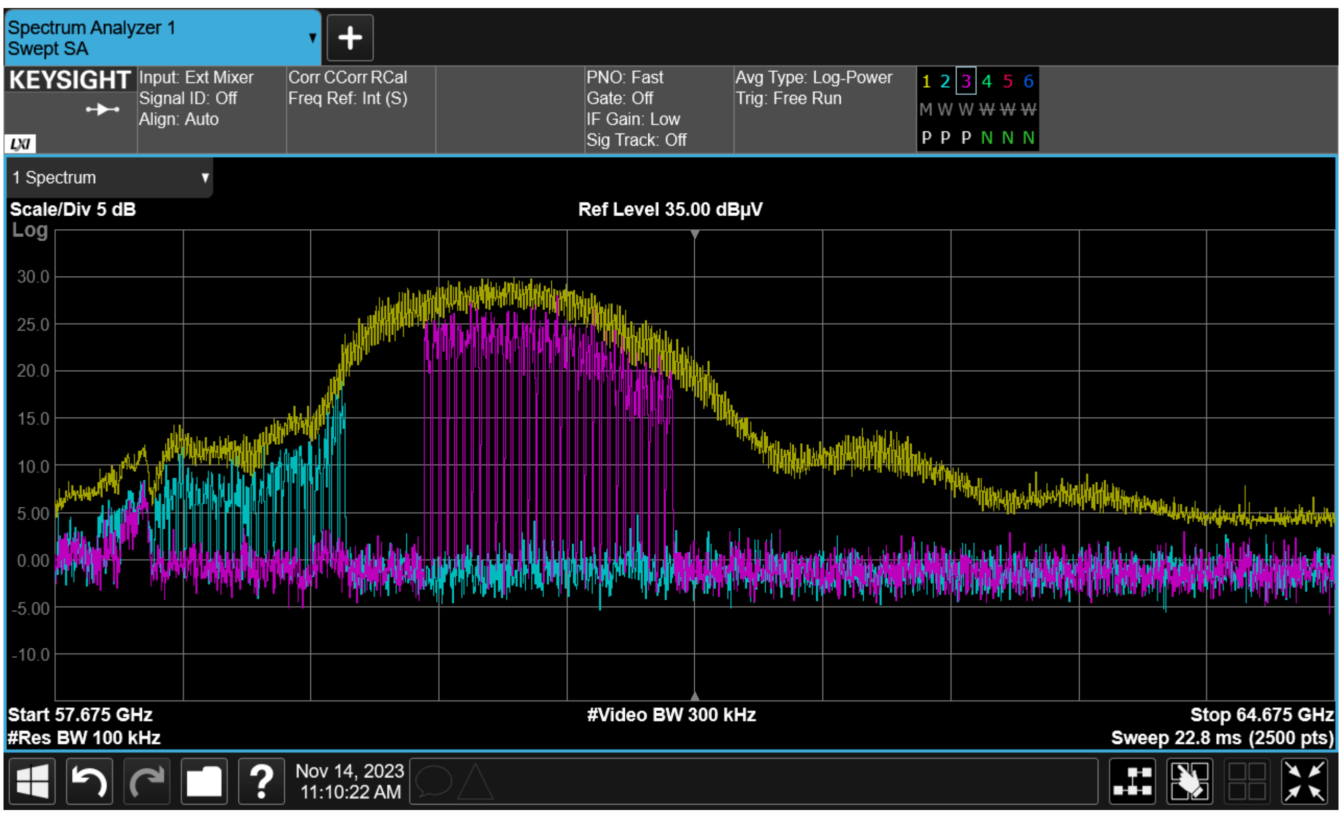
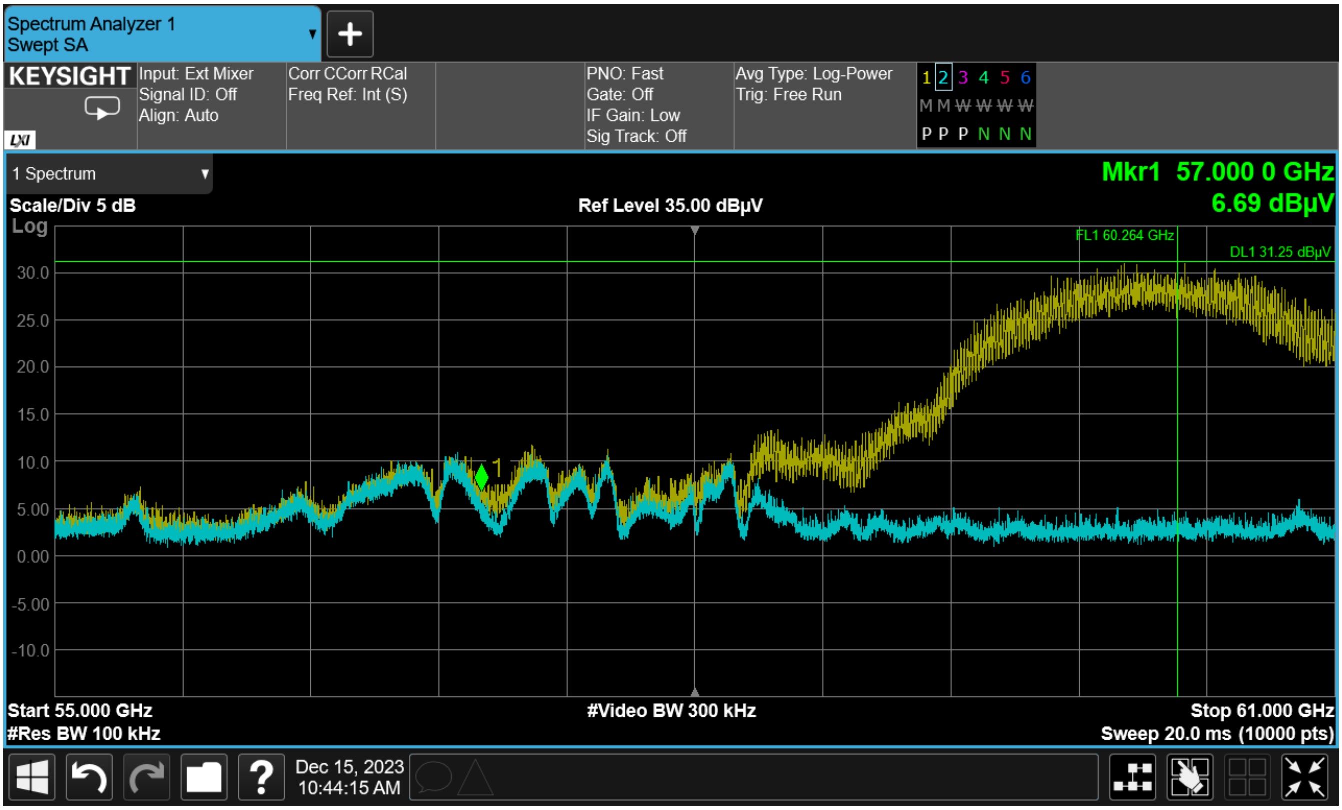


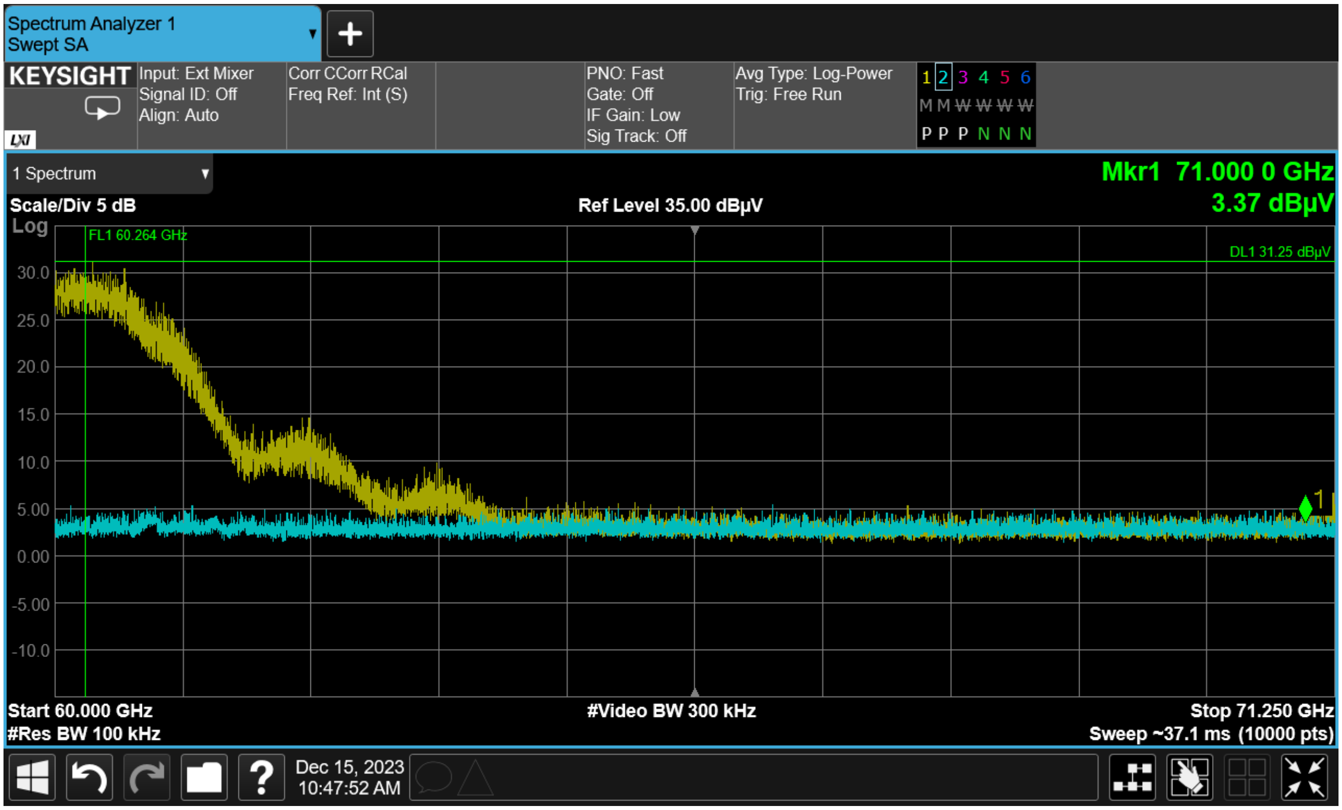
Figure 12: Frequency Excursion Evaluation – Lower Bandedge



Trace 1 = EUT Transmit Enabled (during stabilization testing)

Trace 2 = Ambient

Figure 13: Frequency Excursion Evaluation – Upper Bandedge



Trace 1 = EUT Transmit Enabled (during stabilization testing)

Trace 2 = Ambient

2.8 Transmitter Duty Cycle and Timing Scheme

2.8.1 Requirements

FCC Part §15.255(c)(2)(iii)(B)(2) and RSS-210

Under this provision, fundamental transmit emissions must meet the following timing requirement: the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 16.5 milliseconds within any contiguous interval of 33 milliseconds when operated outdoors, when being used in vehicular applications to perform specific tasks of moving something or someone, except for in-cabin applications.

2.8.2 Test Procedure

Due to the very extremely high frequency, complexity, and brevity, of the transmitter emission scheme, the manufacturer had to perform some of the timing measurements. This test section includes these data, which was supplied by the applicant.

2.8.3 Test Results Summary

The EUT complies with the requirements of this section.

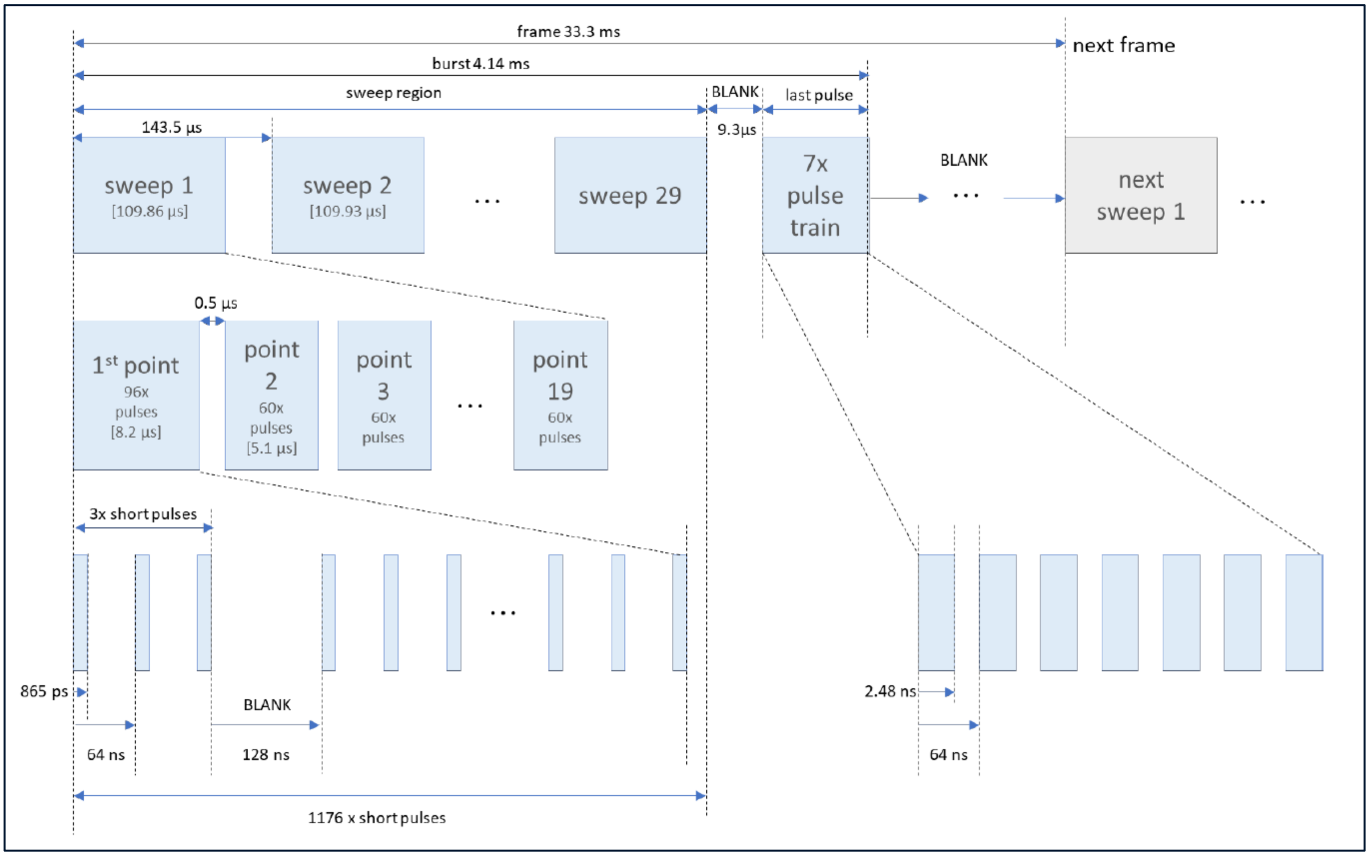
The EUT was set to a fully-modulated transmit mode.

The final data is provided below.

The applicant has provided the following information, which serves to explain the transmit pulsing scheme.

Please note that Figure 17 provides the "Blank" period of the transmitter off-time, which shall serve to demonstrate compliance with FCC Part §15.255(c)(2)(iii)(B). Overall, this period is >> 50% of 33.3 ms.

Figure 14: Timing and Pulse Behavior Summary (Applicant Supplied)



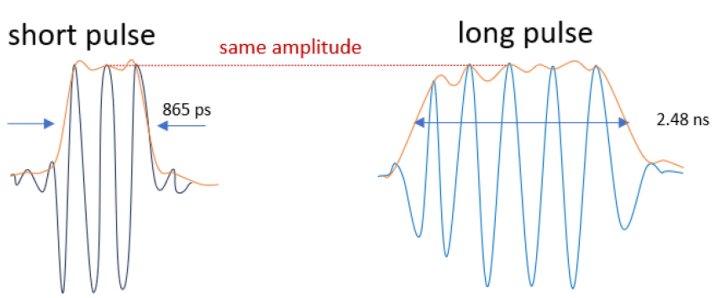
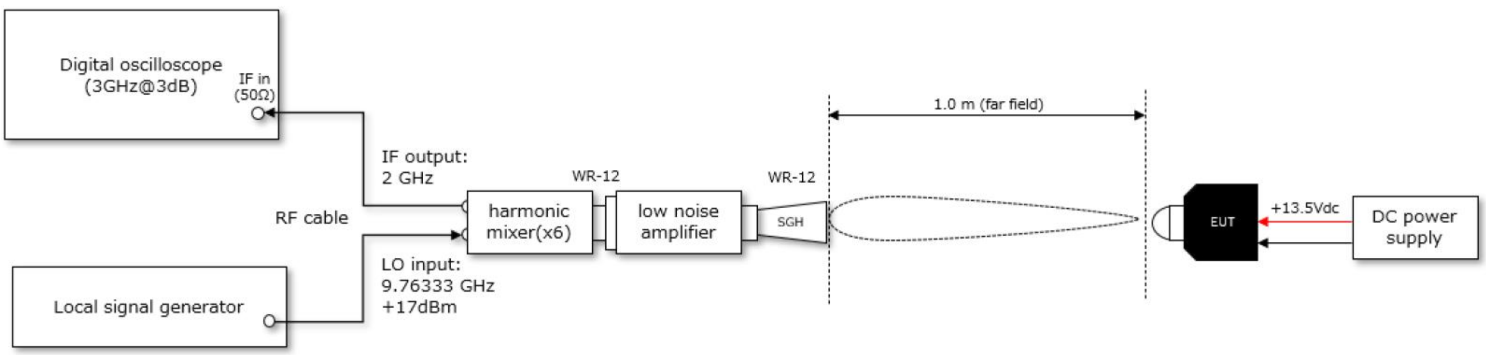
Profile	Pulse characteristics	PRI
B2301 (Profile 3)		64 ns

Table 12: Timing and Pulse Parameters (Applicant Supplied)

region	descriptions	physical parameters
frame	frame length	33.30 ms
	burst length (s)	4.14 ms
	long pulse Ton time [last pulse region] (s)	17.36 ns
	short pulse Ton time [sweep region] (s)	1.017 us
	total Ton time in a frame (s)	1.035 us
	long pulse share in frame	**0.0000521%**
	short pulse share in frame	0.02457%
	long pulse share in burst	**0.0004193%**
	short pulse share in burst	0.02457%
	long pulse share in Ton time	**1.7%**
	short pulse share in Ton time	**98.3%**
last pulse	pulse length (s)	2.48 ns
	cycle length (s)	64 ns
	num of pulses	7
	total on time (s)	17.36 ns
	pulse position	end of burst
	pulse train length (s)	386.48 ns
sweep	sweep length (s)	109.86 us
	number of sweeps in a frame	29
	sweep cycle (s)	143.5 us
measurement points	pulse length (s)	865 ps
	cycle length (s)	64 ns
	number of pulses in pulse train cycle	3
	blank within point	128 ns
	blank b/w points (s)	0.5 us
	num of points	19
	point-1 length (s)	8.2 us
	point length (s)	5.1 us
	num of pulses in point 1	96
	num of pulses in points	1080
	num of pulse in total	1176.0

Figure 15: Testing Configuration for Timing Measurements (Applicant Supplied)



2.8.4 Final Test Data

Tx on time = [sweep region length] * [sweep region duty ratio] + pulse train length

= 4.405 ms * (103 us/144 us) + 388 ns

= **3.1512 ms**

Figure 16: Measured Pulse Train and Burst Profile, Plot 1 (Applicant Supplied)

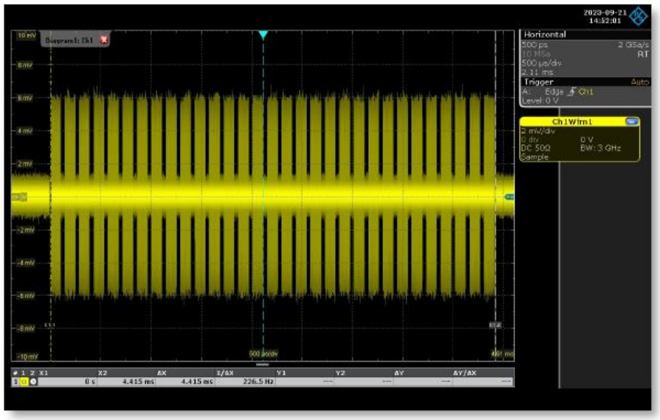
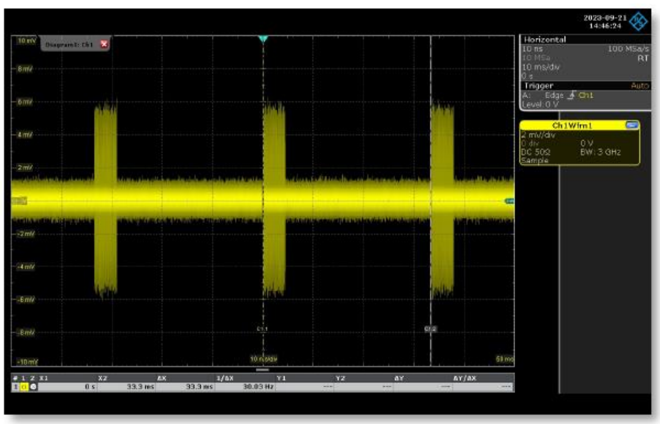
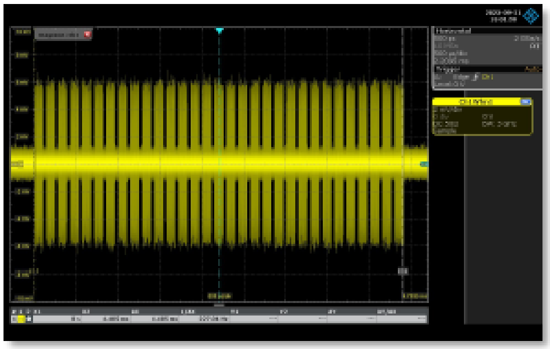
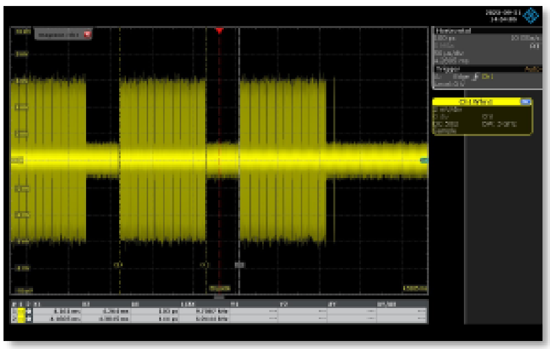
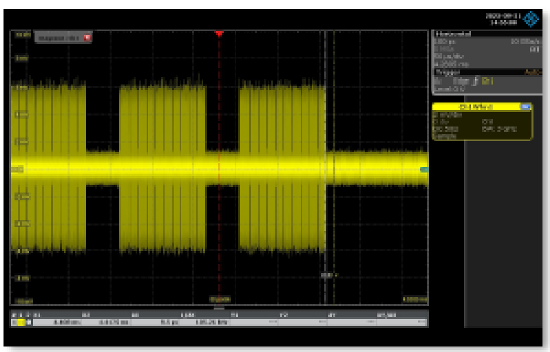
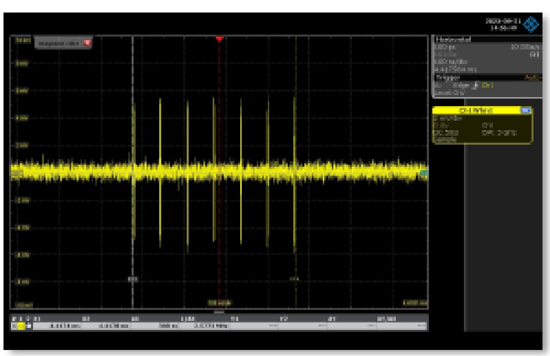
Pol.	diagram	measured value
H		Burst length. [Sweep region + pulse train] 4.415 ms
H		Burst cycle. 33.3 ms

Figure 17: Measured Pulse Train and Burst Profile, Plot 2 (Applicant Supplied)

H		Sweep region. 4.405ms
H		Single sweep length 103 us Sweep cycle. 144 us
H		BLANK b/w sweep region and last pulse train. 9.5 us
H		Last Pulse train length. 388 ns

The following plots were taken by Washington Laboratories, LTD. These plots serve to confirm the details of the transmitter timing.

Figure 18: ~109us Sweep Region Period (Time Domain)

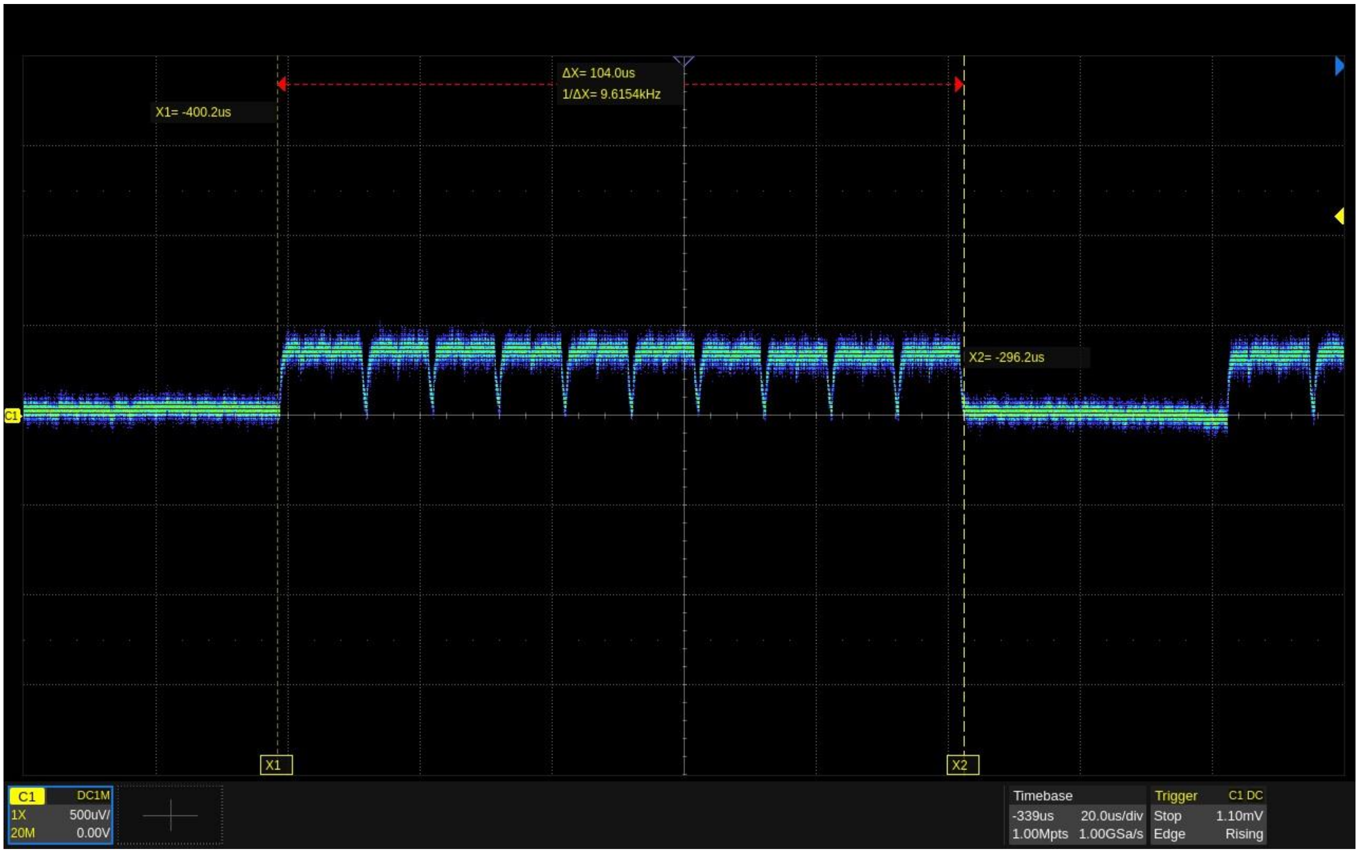


Figure 19: ~109us Sweep Region Period (Frequency Domain)

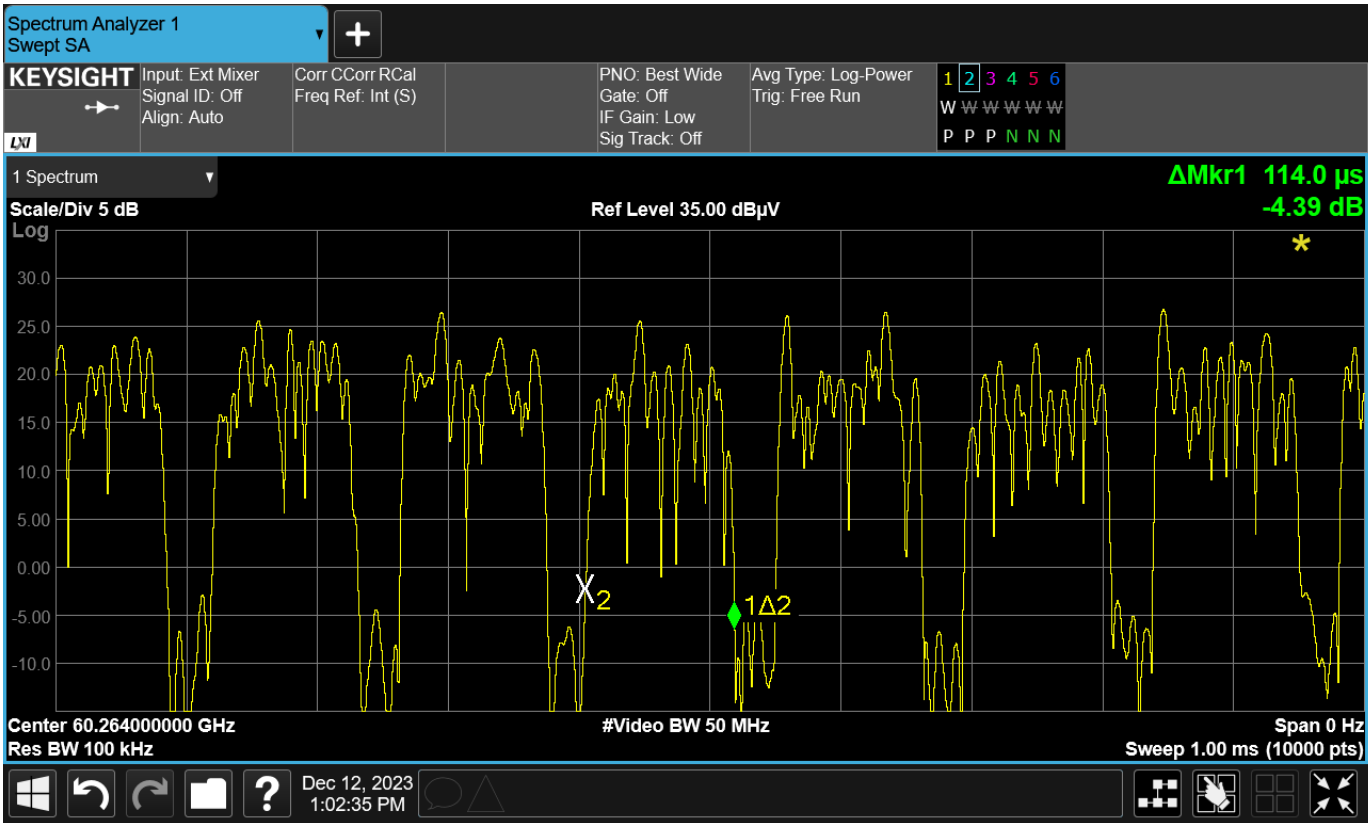


Figure 20: 143.5us Sweep Cycle (Time Domain)

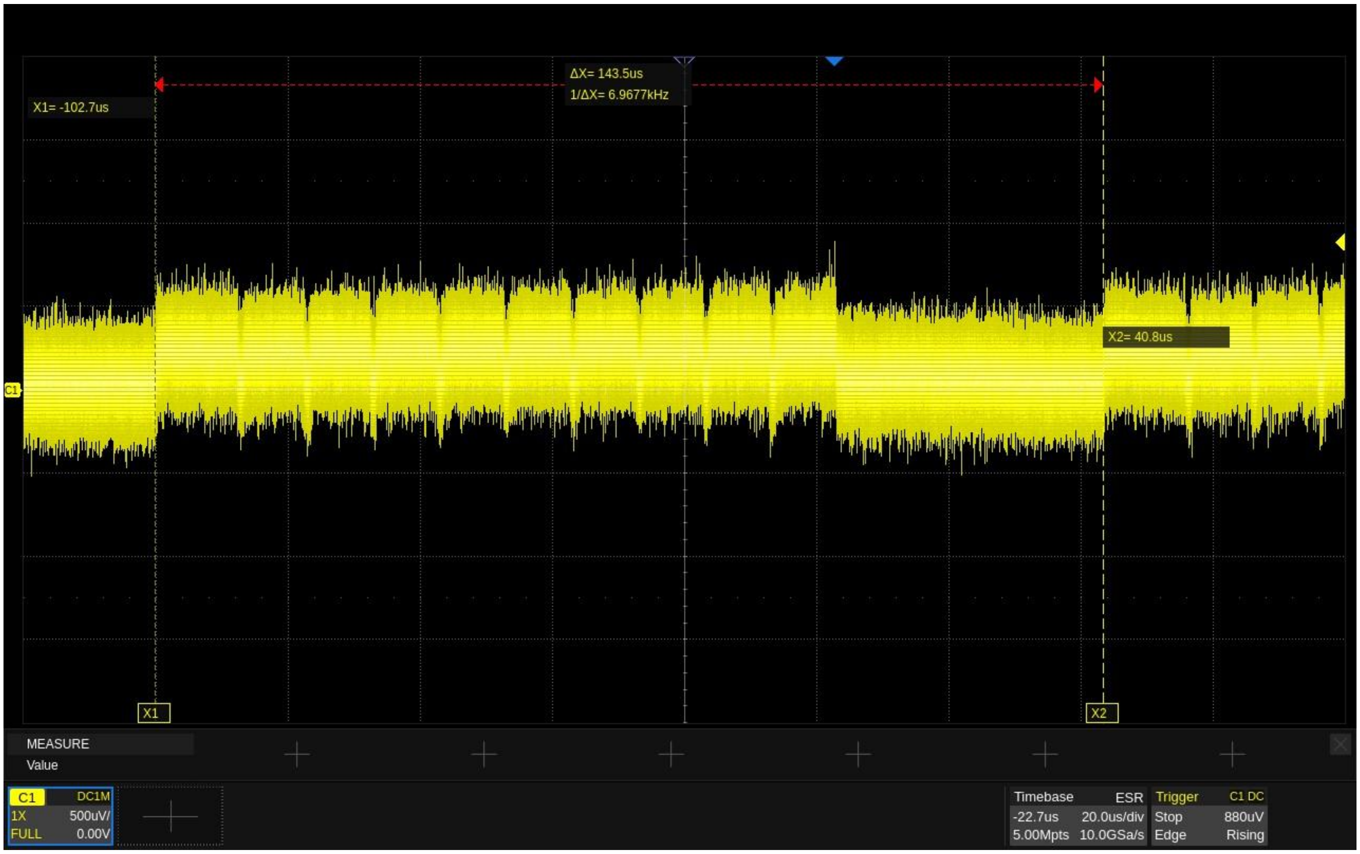
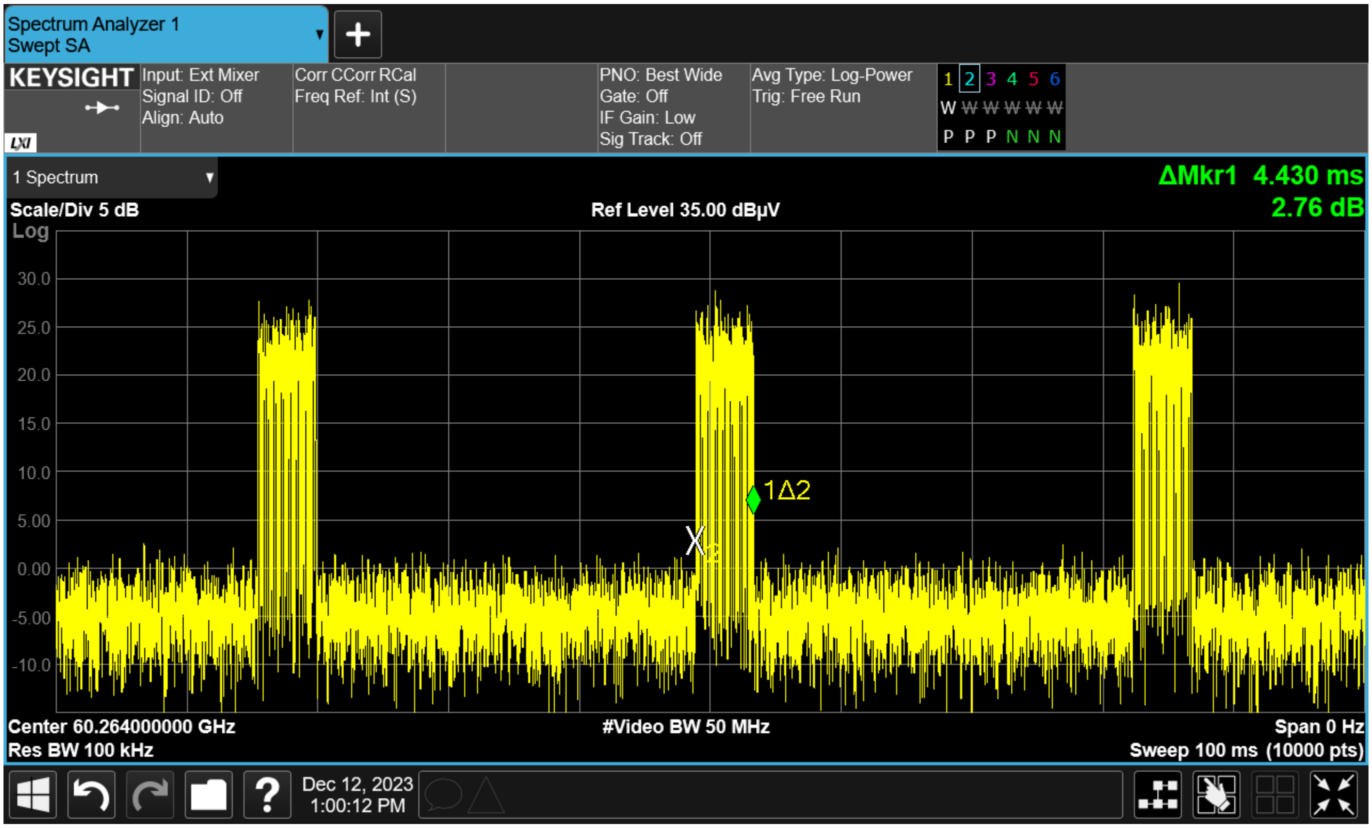


Figure 21: 4ms Burst Frame (Frequency Domain)



3 Equipment Under Test

3.1 EUT Identification & Description

The ALPS ALPINE CO., LTD., Kick Sensor (B2301/B2302) is intended for the proximity detection of a human kick-motion, which them would allow the rear hatch of a vehicle to open and/or close.

3.2 Testing Algorithm

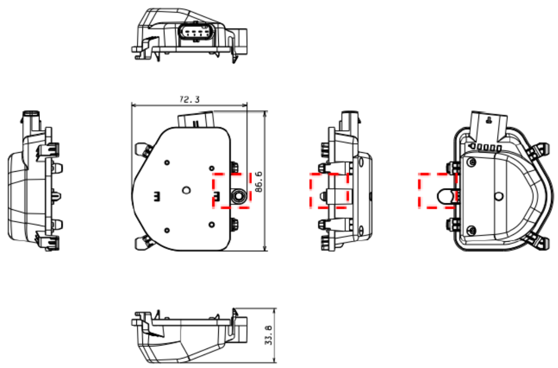
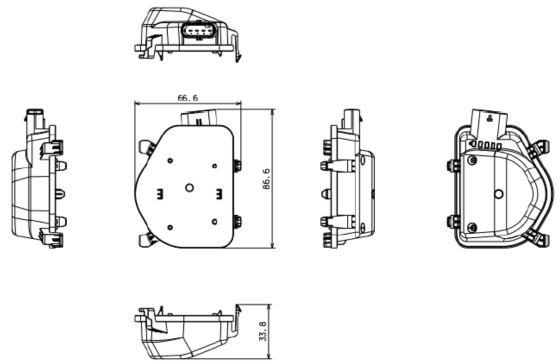
The EUT was supplied to the test lab, under the following notation from the applicant: “the device has two modes, kick action detection mode and power save mode. And the kick detection action mode is the worst case as a result of DSPR measurements. Therefore the EUT is fixed to kick action detection mode and operates continuously”.

3.3 Test Configuration

During testing, the Kick Sensor (B2301/B2302) was powered by +12VDC, either from a battery or bench-top power supply.

Please note the following configuration details, declared by the applicant: “RF signal configuration is only one. There is no variation. But the shape of enclosure of EUT will be slightly changed in mass production. (See instruction manual). Test sample outline is below picture. It has mounting hole for screw at near the connector, this hole will be deleted in mass production model number B2301/2302”.

Table 13: EUT Model Number and Configuration Details

	Model No B2301	Model No. B2302
Outline		
IC & Xtal parts selection	LIN transceiver: ・TJA1028(NXP Texas Instruments) or ・TLIN1028(Texas Instruments) or ・TLE8457(Infineon) 24MHz X'tal for Radar IC: ・ NX2016SA (NDK) or ・FCX-06-24 (RIVER)	LIN transceiver: ・TLIN1028(Texas Instruments) 24MHz X'tal for Radar IC: ・ NX2016SA (NDK)

* Please note: the applicant has declared that the B2301 and B2302 models are electrically identical. Therefore, the oscillators are identical in their specs, and they are pin-for-pin compatible. As such, this test report is representative of both the B2301 and the B2302.

Table 14: EUT System Configuration List

Name / Description	Model Number	Part Number	Serial Number	Rev. #
Kick Sensor	B2301/B2302	UKBZB2B001A	N/A	1

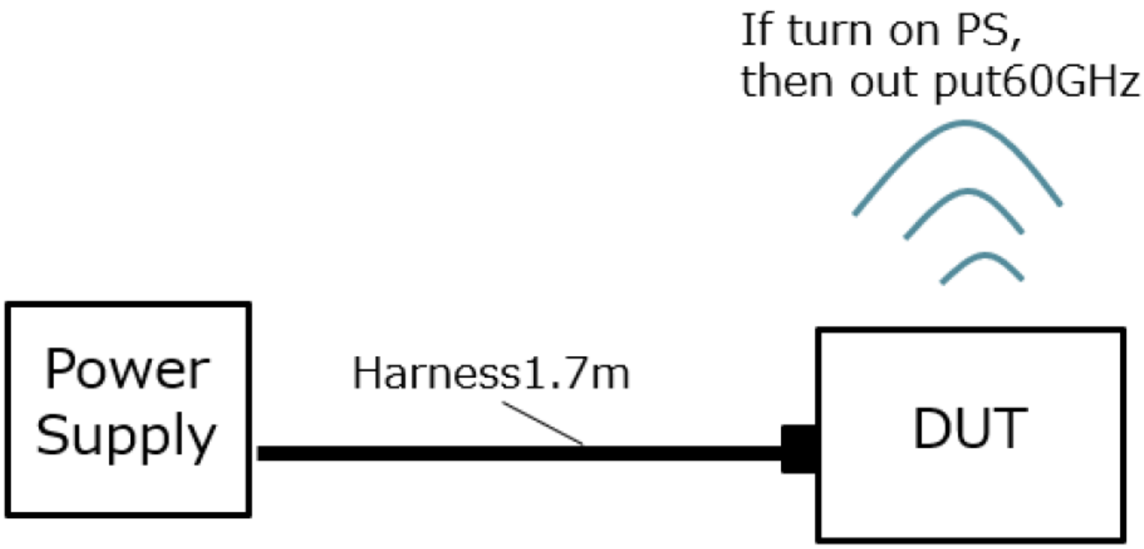
Table 15: Support Equipment (for testing)

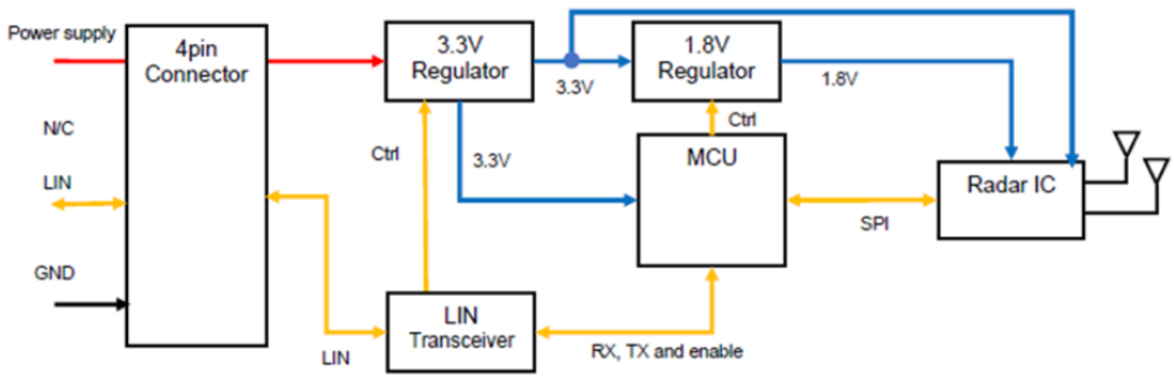
Name / Description	Manufacturer	Model Number	Customer Supplied Calibration Data
De-bug Harness	ALPSALPINE	N/A	N/A

Table 16: Cable Configuration (for tested)

Ref.	Port on EUT	Cable Description	Qty.	Length	Shielded	Termination
1	GND	EUT GND	1	1.7	No	N/A
2	NC	N/A	1	1.7	No	N/A
3	LIN	N/A	N/A	N/A	N/A	N/A
4	VBAT	+12VDC	1	1.7	No	N/A

Figure 22: EUT Test Configuration Diagram (Example Only)





LIN connection is not needed for testing

Table 17: EUT, Transmitter and Device Summary

Manufacturer:	ALPS ALPINE CO., LTD.		
FCC ID:	CWTB230X		
IC ID:	1788F-B230X		
Model:	Kick Sensor (B2301/B2302)		
Serial Number as Tested:	Not Declared by Applicant		
TX Frequency Range:	57.493 GHz to 63.035 GHz (based on 99% OBW)		
Maximum Peak Power:	EIRP	11.11 dBm	12.9 mW
	Conducted	3.21 dBm	2.1 mW
Modulation:	Pulse Amplitude Modulation		
Occupied Bandwidth:	10dB	2.034 GHz	
	99%	5.541 GHz	
ISED Emissions Designator:	5G54K3N		
Keying:	Automatic		
Type of Information:	Field Motion Sensor		
Power Output Level Settings:	Fixed, via Software during production		
Antenna Details:	Manufacturer	Acconeer AB	
	Max Gain	7.9 dBi	
Maximum Data Rate:	Not Declared by Applicant		
Software/Firmware:	5AB-01703X18 (test mode)		
Tune-Up Procedure:	Tolerance Declared by Applicant: ± 0.0dB		
Pulsed Transmitter:	Yes		
Transmitter Timing:	3% ≤ Duty Cycle of EUT ≤ 10 % (estimated)		
Power Source & Voltage:	+12 VDC (vehicle mounted)		
Transmitter Power Density at 20cm:	Calculated	0.026 W/m^2	RSS-102, Annex A2
Highest Spurious Emission:	Ambient	200 GHz at 5cm: 84.08 dBuV/m (PK)	

4 Measurements

4.1.1 References

ANSI C63.2 (Jan-2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (Jan 2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10 (Jun 2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

4.2 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{{div_a}^2} + \frac{b^2}{{div_b}^2} + \frac{c^2}{{div_c}^2} + \ldots\ldots}$$

where,

uc	= standard uncertainty
a, b, c,..	= individual uncertainty elements
Diva, b, c	= the individual uncertainty element divisor based on the probability distribution
Divisor	= 1.732 for rectangular distribution
Divisor	= 2 for normal distribution
Divisor	= 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

where,

U = expanded uncertainty
k = coverage factor
k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)
uc = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 18 below.

Table 18: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	± 2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	± 4.55 dB

5 Test Equipment

Table 19: Test Equipment List

Test Name: **Radiated Emissions Below 40GHz**		Test Date: 11/30/2023	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00942	AGILENT, MXA	SPECTRUM ANALYZER	12/19/2024
00644	SUNOL SCIENCES CORP.	ANTENNA, LOGPERIOD	11/7/2024
00626	ARA, DRG-118/A	ANTENNA, HORN	6/19/2024
00627	AGILENT, 8449B	RF PRE-AMPLIFIER	5/24/2024
00276	ELECTRO-METRICS, BPA-1000	RF PRE-AMPLIFIER	5/19/2024
00453	AH SYSTEMS, PAM-1840	PRE-AMPLIFIER, 40GHZ	8/7/2024
00806	MINI-CIRCUITS, 3061	HIGH FREQUENCY CABLE, SMA	12/28/2023
00977	JUNKOSHA, USA MX-322	6M COAXIAL CABLE, SMA/N	12/28/2023
00519	MEGAPHASE, TM40-K1	HF COAXIAL CABLE, 3.5MM	12/28/2023
00209	NARDA, V637	25GHZ-40GHZ HORN	CNR
00210	NARDA, V638	18GHZ-26.5GHZ HORN	CNR

Test Name: **Fundamental Transmitter**		Test Date:	12/12/2023
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00989	10Gsps, SPO ECO 2GHz	DIGITAL STORAGE OSCILLOSCOPE	6/8/2024
00967	MILLIMETER-WAVE, 950V/385	BROADBAND RF DETECTOR	9/23/2024
00834	ULTIFLEX, UFA360	HF COAXIAL CABLE	12/28/2023
30692	ANRITSU, MG3696A	65 GHZ SIGNAL GENERATOR	11/27/2024
00928	VIGINIA DIODES, WR12 SAX	57GHZ-90GHZ DOWNCONVERTER	12/28/2023
00993	KEYSIGHT, N9020B	SPECTRUM ANALYZER	11/6/2025
00929	MILLITECH SGH12	57-90 GHZ HORN	CNR

Test Equipment List, Continued

Test Name: **Spurious Emissions Above 40GHz**		Test Date: 11/28/2023	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00993	KEYSIGHT, N9020B	SPECTRUM ANALYZER	11/6/2025
00834	ULTIFLEX, UFA360	HF COAXIAL CABLE	12/28/2023
00928	VIGINIA DIODES, WR12 SAX	57GHZ-90GHZ DOWNCONVERTER	12/28/2023
00906	OML, M12HW	HF HARMONIC MIXER, 90GHZ	CNR
00905	OML, M08HW	HF HARMONIC MIXER, 140GHZ	CNR
00930	MILLITECH SGH8	90-140 GHZ HORN	CNR
00929	MILLITECH SGH12	57-90 GHZ HORN	CNR
00931	MILLITECH SGH6	110-170 GHZ HORN	CNR

Test Name: **Frequency Stability**		Test Date: 11/29/2023 & 12/15/2023	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00993	KEYSIGHT, N9020B	SPECTRUM ANALYZER	11/6/2025
00834	ULTIFLEX, UFA360	HF COAXIAL CABLE	12/28/2023
00928	VIGINIA DIODES, WR12 SAX	57GHZ-90GHZ DOWNCONVERTER	12/28/2023
00776	TENNY	TJR-A-WS4, CHAMBER	10/24/2024
00800	FLUKE, 87V TRUE RMS	DIGITAL MULTIMETER	7/31/2024
00947	HANMATEK, HM305	DC POWER SUPPLY, 3A MAX	CNR

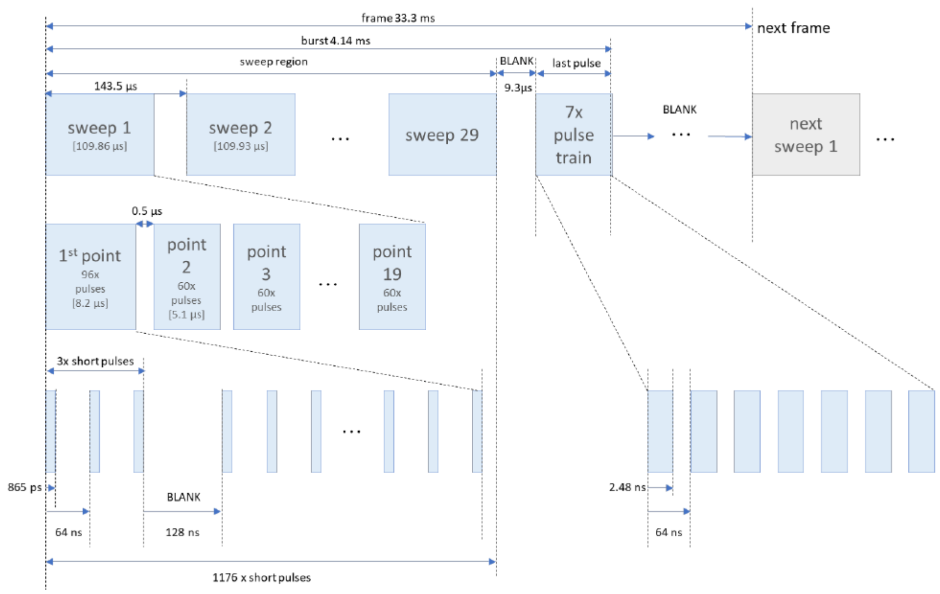
6 ANNEX A

Due to the very extremely high frequency, complexity, and brevity, of the transmitter emission scheme, the manufacturer had to perform some of the measurements. This section provides the test data taken by the applicant/manufacturer to demonstrate compliance with FCC Rule Part §15.255(c).

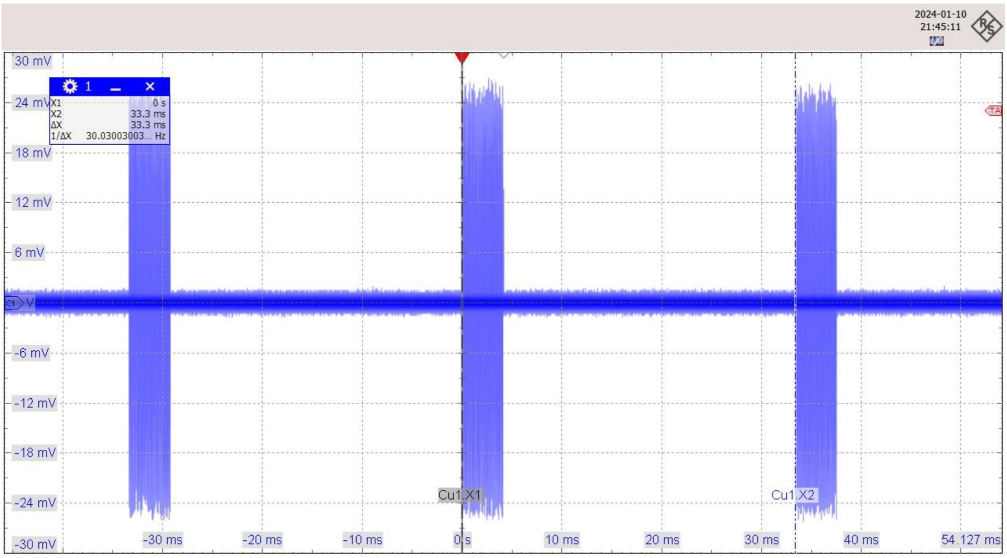
Annex A.1

Requirement: for pulsed field disturbance sensors/radars operating in the 57–64 GHz band, the transmit duty cycle shall not exceed 10% during any 0.3 µs time window.

Pulse design configuration



Measured 33.3ms period pulse waveform



Short Pulse

The sweep region is configured with a large number of very short pulse components.

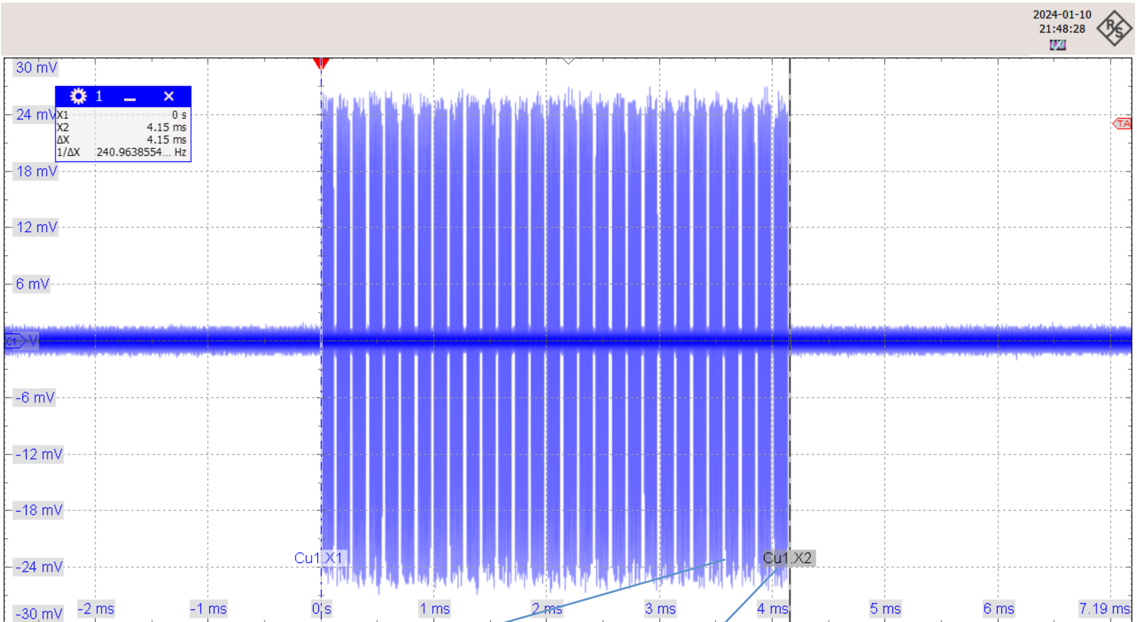


Fig. sweep region

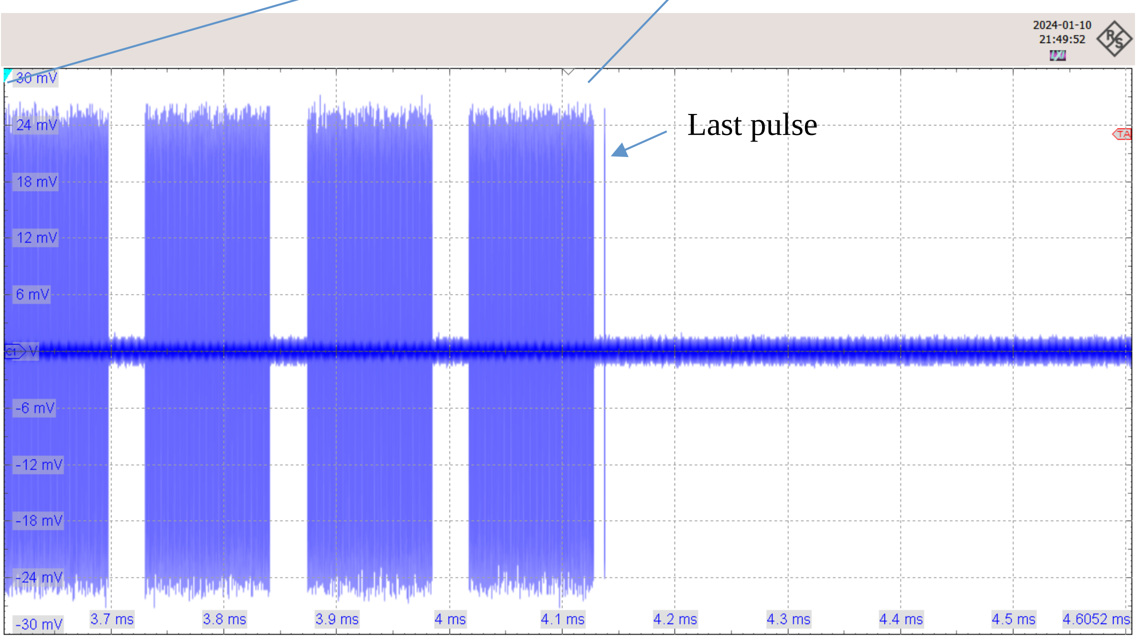
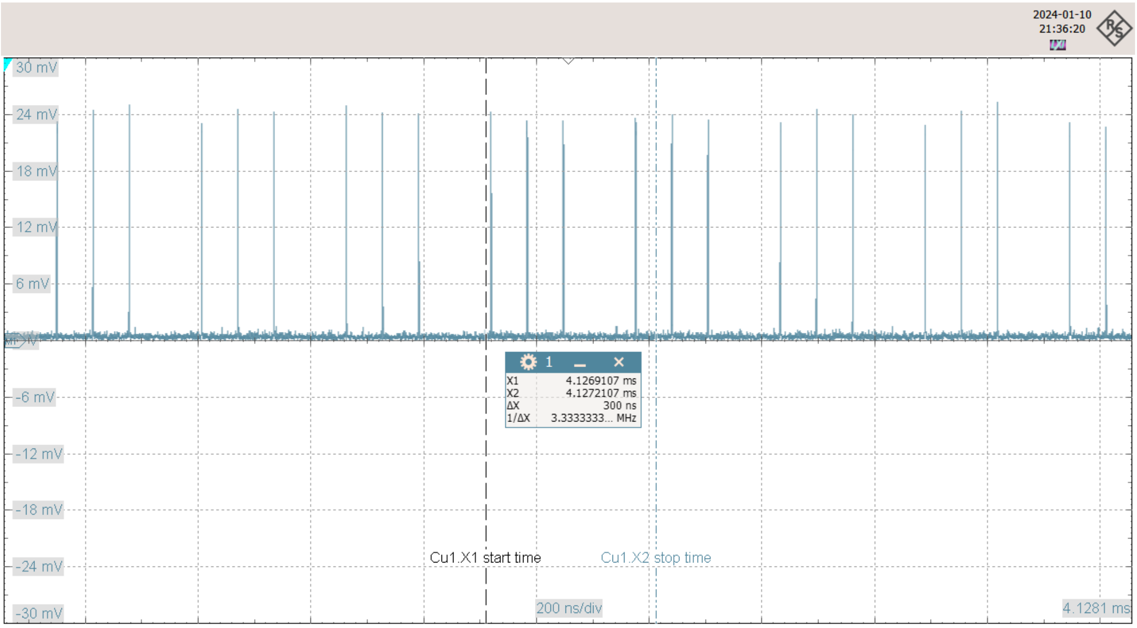


Fig. end of sweep region and last pulse

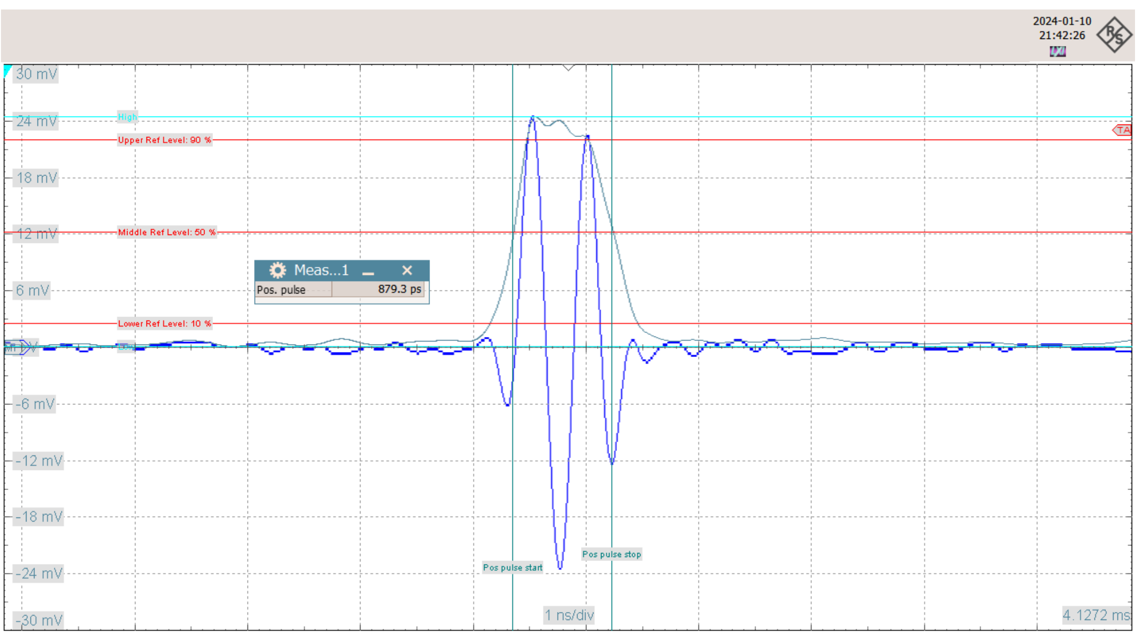
The short pulses are transmitted in a sequential pattern, with three or four single pulses being transmitted in any 300 ns interval in the Sweep region.

A diagram of any 2us observed within the Sweep region is shown below.

Within this range, up to 4 single-pulse components were included in an arbitrary 300ns timeframe.



The width of one short pulse was confirmed to be 879.3 ps by the following measurement.

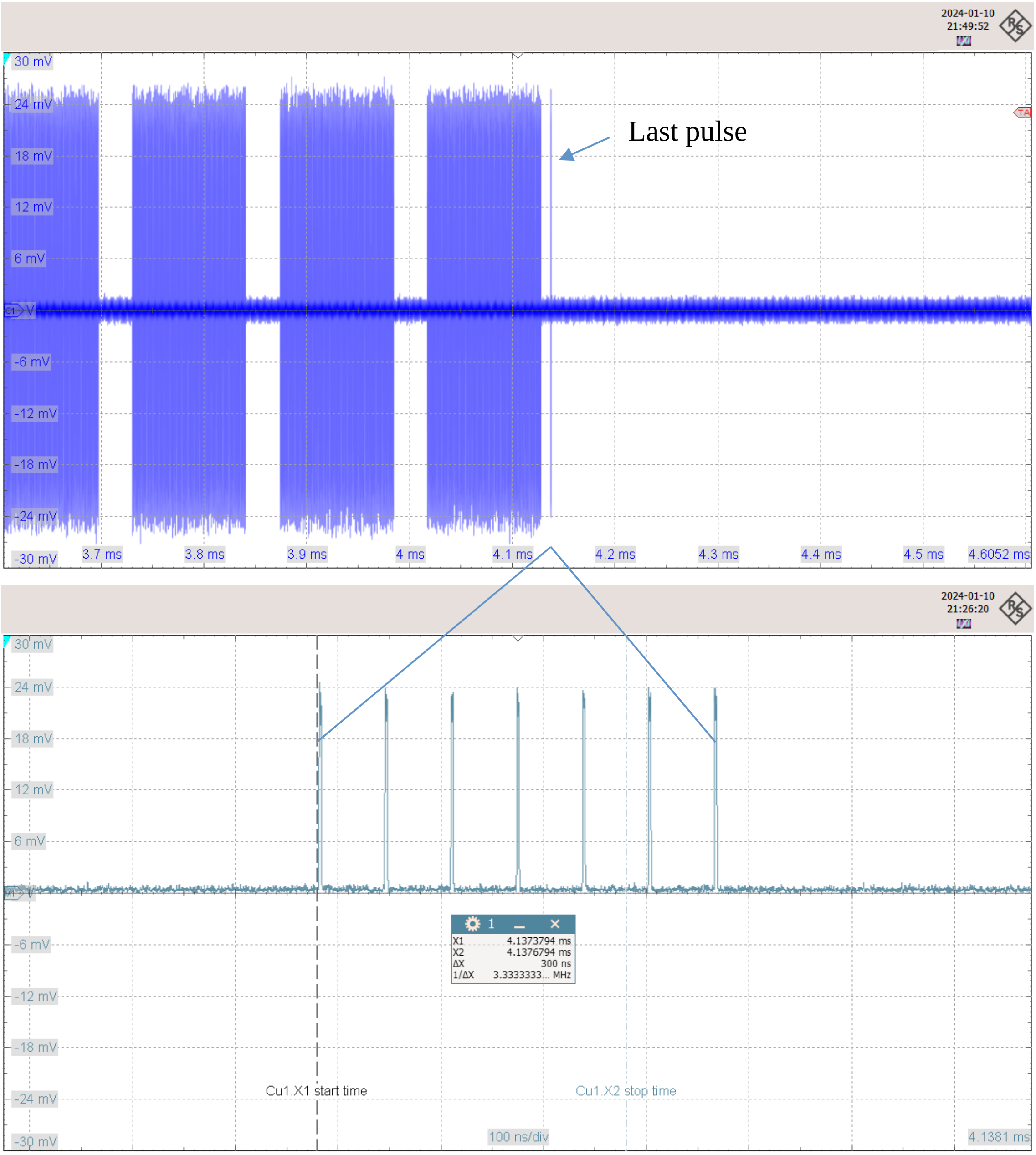


Therefore, the duty factor for the 300ns time frame in the sweep region that consists of short pulses is calculated as follows:

4x 879.3 ps/300 ns = **1.1724 % (limit: 10%)**

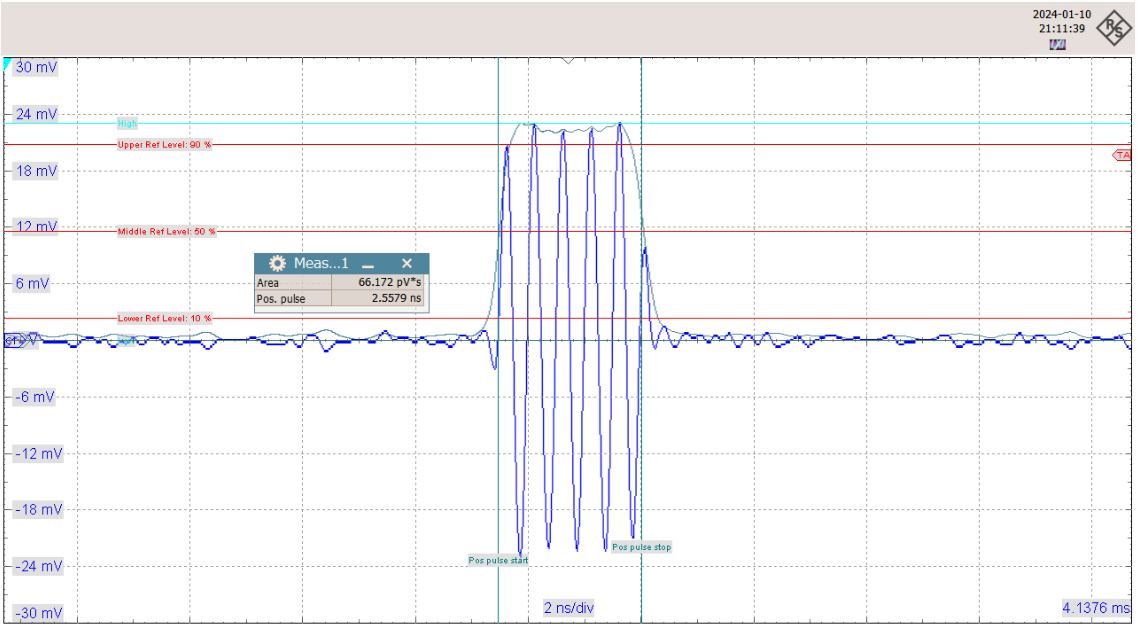
Long Pulse

The long pulse configures the last pulse region.



The last-pulse region is composed of seven long pulses, with a maximum of five long-pulse components observed within an arbitrary 300 ns time frame.

The long pulse component width was observed as 2.5579ns as shown below.

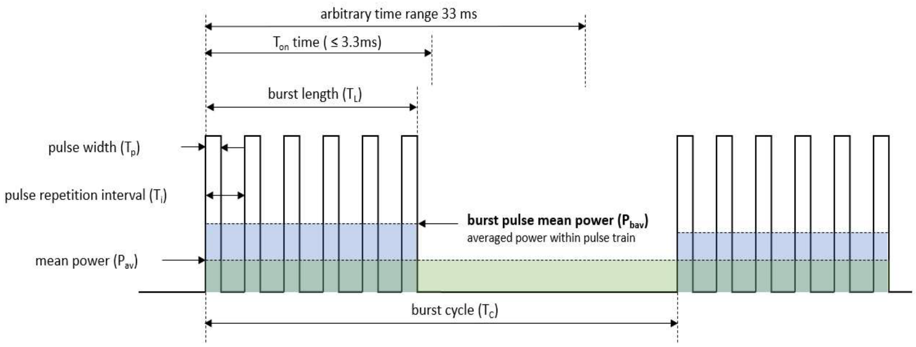


Therefore, the duty factor for the 300ns time frame in the last-pulse region that consists of long pulses is calculated as follows:

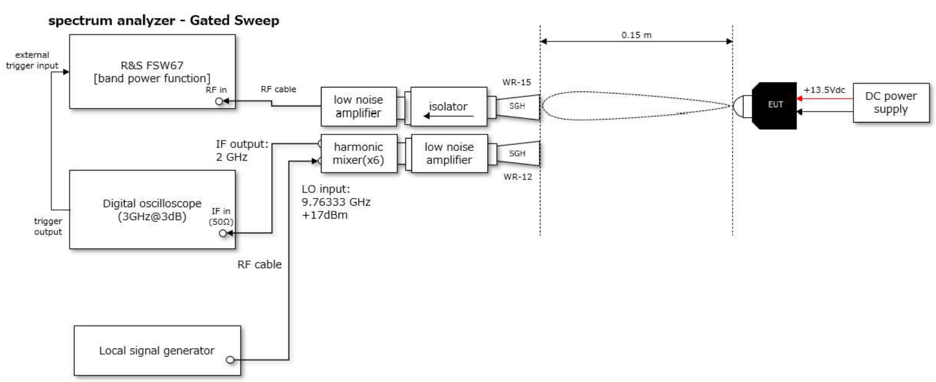
5x 2.5579ns/300 ns = **4.26 % (limit: 10%)**

Annex A.2

Requirement: the average integrated EIRP within the frequency band 61.5–64.0 GHz shall not exceed 5 dBm in any 0.3 μs time window.

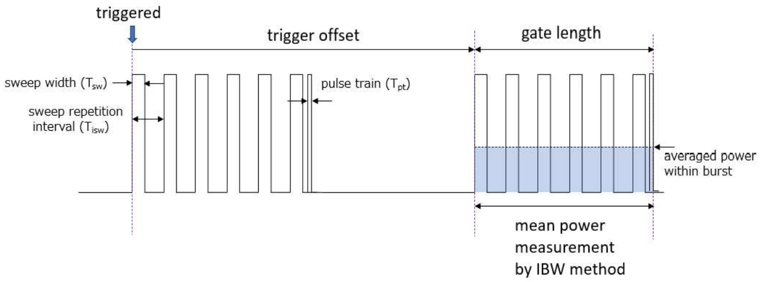


pulse train mean power



test system configuration for burst average power measurement.

Applying the Gate sweep to the IBW method average power measurement enables an average power measurement only to the burst transmission interval. To accurately capture the transmit interval of the EUT, the DSO takes on a role of a trigger signal generator while always receiving the transmit signal at the desired frequency of the EUT and provides the start timing of the burst signal to the spectrum analyzer.



trigger/gate setting of gated sweep measurement for burst average power measurement

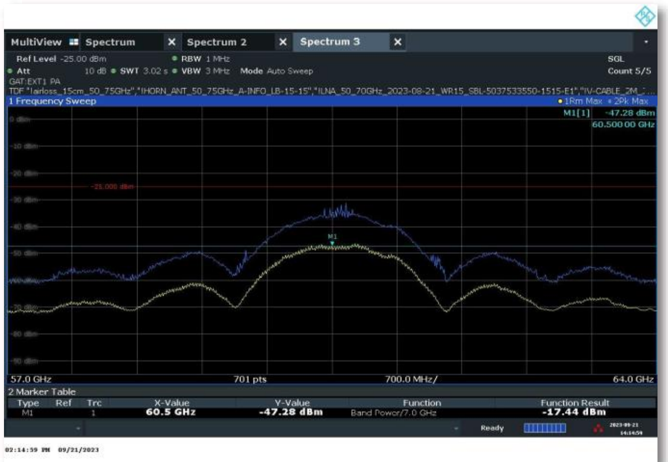
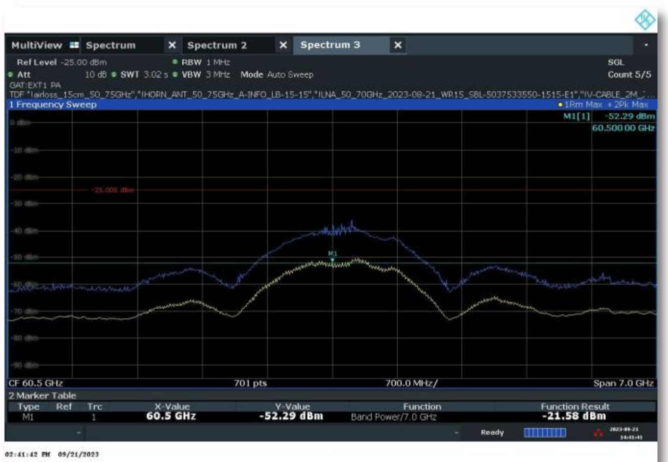
The measurement results we have are only the results measured according to the test method based on the Japanese Radio Law. Japanese Radio Law specifies EIRP power results as the sum of polarization V and H. A different approach is needed for the measurement of average power per FCC 255.15(C)(3). Polarization applies to the lager value of V or H.

FCC 255.15(C)(3) is defined as the average power within any 300ns time window The average power can be calculated from the already measured Peak EIRP value and the duty factor of the 300ns time window.

Average EIRP = Peak EIRP (dBm) + 10*log(duty factor within 300ns)

= Peak EIRP (dBm) + 10*log(0.0426) = Peak EIRP − 13.7 dB

The worst-case Peak EIRP measurement results is 11.25 dBm, the resulting Average EIRP (within the 300 ns time window) is -2.45 dBm.

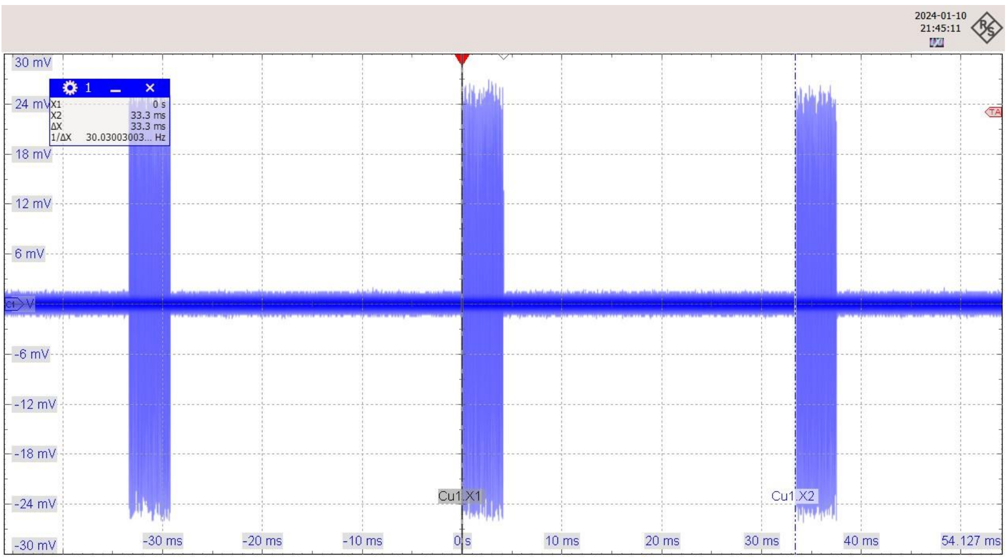
Pol.	diagram	measured value
H		frequency: 60.5GHz bandpower span: 7 GHz RBW: 1MHz Reading value: **-17.44 dBm**
V		frequency: 60.5GHz bandpower span: 7 GHz RBW: 1MHz Reading value: **-21.58 dBm**

band power [e.i.r.p.] read value [H+V]	-16.02 dBm	
antenna gain with reflector (design value)	7.9 dBi	
calculated conducted mean power	**-23.92 dBm**	**0.004051 mW**

Annex A.3

Requirement: a field disturbance sensor may operate in any of the modes in the above sub-sections so long as the device operates in only one mode at any time and does so for at least 33 milliseconds before switching to another mode.

The B230x device has two modes: normal mode and standby mode.
The device operates in one of these modes, and the two modes never operate simultaneously.
Both modes always operate in 33.3 ms cycles.



Transmit time waveform of a B230x device operating at 33.3 ms period.