FCC PART 90 C-V2X WAIVER + COLOCATION TEST REPORT

For

Commsignia, Inc.

5201 Great America Pkwy., Suite 320,
Santa Clara, CA 95054, USA

FCC ID: 2AOZ5-CM-RS4C

Report Type:	Product Type:
Original Report	Road-Side Unit

Prepared By:	Libass Thiaw Test Engineer
Report Number:	R2410023-CV2X
Report Date:	2024-11-20
Reviewed By:	Christian McCaig RF Lead Engineer

Bay Area Compliance Laboratories Corp.
1274 Anvilwood Avenue,
Sunnyvale, CA 94089, USA
Tel: +1 (408) 732-9162, Fax: +1 (408) 732-9164

ACCREDITED
CERTIFICATE #3297.02

TABLE OF CONTENTS

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2410023-CV2X	Original Report	2024-11-20

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test report was prepared on behalf of, *Commsignia, Inc*, and their product model: *ITS-RS4-D-W-C495-BL5-S-SGLB*; *FCC ID: 2AOZ5-CM-RS4C* or the "EUT" as referred to in this report. The EUT is a Safety Road Side Unit and operates in the 5850-5925 MHz band with an antenna gain of 7.6 dBi.

Model: ITS-RS4-M-W-C495-BL5-S-SGLB also contains a pre-certified cellular radio module with the following spec.

Additional Radio	EG25-G Mini PCIe
FCC ID	XMR201903EG25G
Operating Frequency	GSM850: 824-849 MHz; PCS: 1850-1910 MHz WCDMA: 1850-1910 MHz (Band II), 824-849 MHz (Band IV) LTE 1850-1910 MHz (B2), 1710-1755 MHz (B4) 824-849 MHz (B5), 2500-2570 MHz (B7) 699-716 MHz (B12), 777-787 MHz (B13) 1850-1915 MHz (B25), 814-849 MHz (B26) 2570-2620 MHz (B38), 2496-2690 MHz (B41)
Modulation	GMSK/8PSK/QPSK/16QAM
Antenna Gain	0 dBi (Band 5/12/13/26), 2.5 dBi (Band 2/4/25) 3.5 dBi (Band 7/38/41)
Average RF output power	25.81 dBm (GSM850), 22.81 dBm (PCS) 25 dBm (WCDMA/LTE)

1.2 Mechanical Description of EUT

The data gathered are from production samples provided by manufacturer with the following information,

The EUT model: ITS-RS4-M-W-C495-BL5-S-SGLB, serial number: 2311401006850 assigned by Commsignia, Inc. measures 26 cm (L), 23 cm (W), 8 cm (H), and weigh 2.6 kg.

1.3 Objective

This report was prepared on behalf of Commsignia, Inc. in accordance with Part 2, Part 90, Part 15 and KDB 511808 D01 Waiver. The objective was to determine compliance with FCC Part 2, Part 90, Part 15 and KDB 511808 D01 Waiver.

1.4 Related Submittal(s)/Grant(s)

N/A

1.5 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.26-2015, ANSI C63.10-2013 and KDB 511808 D01 Waiver

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5%
RF output power, conducted	±0.57 dB
Power Spectral Density, conducted	±1.48 dB
Unwanted Emissions, conducted	±1.57 dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2°C
Humidity	±5%
DC and low frequency voltages	±1.0%
Time	±2%
Duty Cycle	±3%

1.7 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.8 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- ***An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2017 by A2LA (Test Laboratory Accreditation Certificate Number 3297.02),*** in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2017 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2017 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.03)*** to certify

- For the USA (Federal Communications Commission):
  - 1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
  - 2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
  - 3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Industry Canada):
  - 1 All Scope 1-Licence-Exempt Radio Frequency Devices;
  - 2 All Scope 2-Licensed Personal Mobile Radio Services;
  - 3 All Scope 3-Licensed General Mobile & Fixed Radio Services;
  - 4 All Scope 4-Licensed Maritime & Aviation Radio Services;
  - 5 All Scope 5-Licensed Fixed Microwave Radio Services
  - 6 All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.
- For Singapore (Info-Communications Development Authority (IDA)):
  - 1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
  - 2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2
- For the Hong Kong Special Administrative Region:
  - 1 All Radio Equipment, per KHCA 10XX-series Specifications;
  - 2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
  - 3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
  - 1 MIC Telecommunication Business Law (Terminal Equipment):
    - All Scope A1 - Terminal Equipment for the Purpose of Calls;
    - All Scope A2 - Other Terminal Equipment
  - 2 Radio Law (Radio Equipment):
    - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
    - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
    - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.01)*** to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

- 1 Electronics and Office Equipment:
  - for Telephony (ver. 3.0)
  - for Audio/Video (ver. 3.0)
  - for Battery Charging Systems (ver. 1.1)
  - for Set-top Boxes & Cable Boxes (ver. 4.1)
  - for Televisions (ver. 6.1)

- for Computers (ver. 6.0)
- for Displays (ver. 6.0)
- for Imaging Equipment (ver. 2.0)
- for Computer Servers (ver. 2.0)

2 Commercial Food Service Equipment
- for Commercial Dishwashers (ver. 2.0)
- for Commercial Ice Machines (ver. 2.0)
- for Commercial Ovens (ver. 2.1)
- for Commercial Refrigerators and Freezers

3 Lighting Products
- For Decorative Light Strings (ver. 1.5)
- For Luminaires (including sub-components) and Lamps (ver. 1.2)
- For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
- For Integral LED Lamps (ver. 1.4)

4 Heating, Ventilation, and AC Products
- for Residential Ceiling Fans (ver. 3.0)
- for Residential Ventilating Fans (ver. 3.2)

5 Other
- For Water Coolers (ver. 3.0)

D- ***A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:***

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Innovation, Science and Economic development Canada - ISED) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
  - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
  - Nationally Recognized Test Laboratory (NRTL) – US OSHA

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.26-2015 and ANSI C63.10-2013.

The EUT was tested in a testing mode to represent worst-case results during the final qualification test. The power setting used for final formal testing are listed below.

C-V2X

Channel	Frequency (MHz)	Power Setting	
		Chain 0	Chain 1
183	5915	40	40

LTE Band 2

Frequency (MHz)	Power Setting
1909.3	Default

2.2 EUT Exercise Software

The test utilities used were cmd prompt.

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E7450

2.5 EUT Internal Configuration Details

Manufacturer	Description	Model	S/N
Toradex	Computer on Module	Apalis iMX6Q 2 GB IT V1.1C	-
Commsignia	Main Board	CM-ITS-OB4 rev. 1.4 – E0	-

2.6 External I/O Cabling List and Details

Cable Descriptions	Length (m)	From	To
Ethernet cable	1.5	EUT	POE Switch
Ethernet cable	1.5	POE Switch	Laptop

2.7 EUT External Power Supply List and Details

Manufacturer	Description	Model	Serial number
PHIHONG	POE Power Switch	POE36U-1AT-R	P51101605D1

3 Summary of Test Results

Results reported relate only to the product tested.

FCC Rules	Description of Test	Results
FCC §2.1091	RF Exposure	Compliant
FCC §90.377	Output Power	Compliant
FCC §90.379	Transmit Spectrum Mask	Compliant
FCC §2.1049 & §90.209	Emission Bandwidth	Compliant
FCC §15.35(b), §15.205, §15.209, §15.247(d), §15.407(b)	Transmitter Spurious Emission-Radiated (Colocation)	Compliant

BACL is responsible for all the information provided in this report, except when information is provided by the customer as identified in this report. Information provided by the customer, e.g., antenna gain, can affect the validity of results.

4 FCC §2.1091 - RF Exposure

4.1 Applicable Standard

According to FCC §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* (100)	30
1.34-30	824/f	2.19/f	* ($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

4.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

4.3 MPE Results

Worst Case C-V2X

Maximum peak output power at antenna input terminal (dBm):	18.42
Maximum peak output power at antenna input terminal (mW):	69.50
Prediction distance (cm):	20
Prediction frequency (MHz):	5915
Maximum Antenna Gain, typical (dBi):	7.6
Maximum Antenna Gain (numeric):	5.75
Power density of prediction frequency at 20 cm (mW/cm^2):	0.08
MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

Additional Radios MPE Evaluation

LTE

Maximum peak output power at antenna input terminal (dBm):	25
Maximum peak output power at antenna input terminal (mW):	316.23
Prediction distance (cm):	20
Prediction frequency (MHz):	779.5
Maximum Antenna Gain, typical (dBi):	4.45
Maximum Antenna Gain (numeric):	2.786
Power density of prediction frequency at 20 cm (mW/cm^2):	0.175
MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	0.519

Radio Co-location MPE Evaluation

C-V2X + Cellular

$0.08/1+0.175/0.519=0.417 \leq 1.0$

Conclusion

The device compliances with FCC MPE limit at 20 cm distance.

5 FCC §90.377 - Output Power

5.1 Applicable Standard

According to FCC Waiver DA 24-363 All RSUs and OBUs authorized under this Order must operate using the technical characteristics and operating parameters, including power, height, and out-of-band emission limits, specified below, to ensure compliance with all existing technical rules applicable to ITS operations other than the requirement to use DSRC-based technology:

C-V2X OBU and RSU Operations

Frequency Range	Channel Bandwidth	OBU Limits	RSU EIRP Limit
5905–5925 MHz	20 megahertz	33 dBm EIRP*; 27dBm EIRP within 5 degrees of horizontal	33 dBm EIRP

*EIRP (equivalent isotropically radiated power)

5.2 Test Procedure

According to ANSI C63.26 the following test procedure was followed to measure the Output Power:

a) Set span to 2 × to 3 × the OBW.
b) Set RBW = 1% to 5% of the OBW.
c) Set VBW ≥ 3 × RBW.
d) Set number of measurement points in sweep ≥ 2 × span / RBW.
e) Sweep time:
1) Set = auto-couple, or
2) Set ≥ [10 × (number of points in sweep) × (transmission symbol period)] for single sweep (automation-compatible) measurement.
f) Detector = power averaging (rms).
g) Set sweep trigger to "free run."
h) Trace average at least 100 traces in power averaging (rms) mode if sweep is set to auto-couple. To accurately determine the average power over the on and off time of the transmitter, it can be necessary to increase the number of traces to be averaged above 100, or if using a manually configured sweep time, increase the sweep time.
i) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band or channel power measurement function with band/channel limits set equal to the OBW band edges. If the instrument does not have a band or channel power function, sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.
j) Add 10 log (1/duty cycle) to the measured power level to compute the average power during continuous

5.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
697	ETS- Lingerin	Power Sensor	7002-006	160097	2024-03-06	1 year
	-	SMA cable	-	-	Each time[1]	N/A
	-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

5.4 Test Environmental Conditions

Temperature:	22-26°C
Relative Humidity:	42-46%
ATM Pressure:	101-102 kPa

The testing was performed by Libass Thiaw on 2024-11-20 at RF site.

5.5 Test Results

Channel	Frequency (MHz)	Conducted Output Power		Antenna Gain (dBi)	E.I.R.P		
		Chain 0 (dBm)	Chain 1 (dBm)		Chain 0 (dBm)	Chain 1 (dBm)	Limit (dBm)
183	5915	18.42	16.50	7.6	26.02	24.1	33

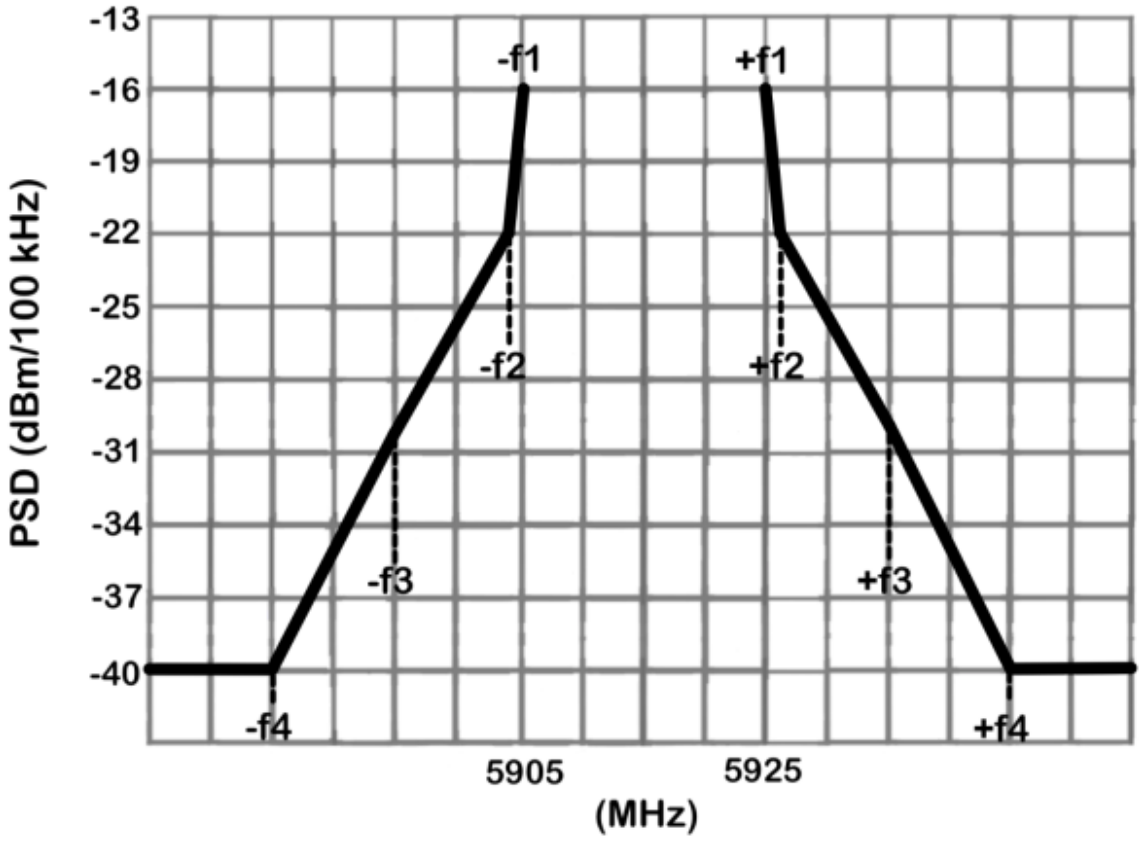
6 ASTM E2213-03 8.9.2 - Transmit Spectrum Mask

6.1 Applicable Standard

According to FCC Waiver DA 24-363 All RSUs and OBUs authorized under this Order must operate using the technical characteristics and operating parameters, including power, height, and out-of-band emission limits, specified below, to ensure compliance with all existing technical rules applicable to ITS operations other than the requirement to use DSRC-based technology:

C-V2X Out-of-Band Emissions (OOBE) Limits

Frequency Offset (MHz from Channel Edge)	OOBE EIRP Limits for C-V2X Transmissions (dBm/100 kHz)**
0.0	-16.0
1.0	-22.0
10.0	-30.0
20.0	-40.0



6.2 Test Procedure

According to FCC KDB Equipment Authorization for Cellular Vehicle-to-Everything Devices for Operation Pursuant to Waiver of Certain Part 90 and Part 95 Rules, the following procedure was followed for OOBE Mask Test:

1. Connect output of the antenna port to a spectrum analyzer or EMI receiver, with appropriate attenuation, as to not damage the instrumentation.

2. Set the reference level of the measuring equipment in accordance with the general procedures in section 4.2.3 of ANSI C63.26 - 2016.
3. Measure the power spectral density of the OOBE using the following procedure.

4. Set instrument center frequency to the frequency of channel being measured.

5. Set the span to at least 4 times the OBW.

6. Set resolution bandwidth (RBW) = 100 kHz.

7. Set video bandwidth (VBW) ≥ 3 × RBW

8. Number of points in sweep ≥ [2 X span / RBW].

9. Sweep time = auto.

10. Detector = power averaging (rms)

11. Trace mode = max hold.

12. Allow trace to fully stabilize.

6.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
1461	Rohde & Schwarz	Analyzer, Spectrum	FSQ26	200749	2024-08-06	1 year
-	-	SMA cable	-	-	Each time[1]	N/A
-	-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

6.4 Test Environmental Conditions

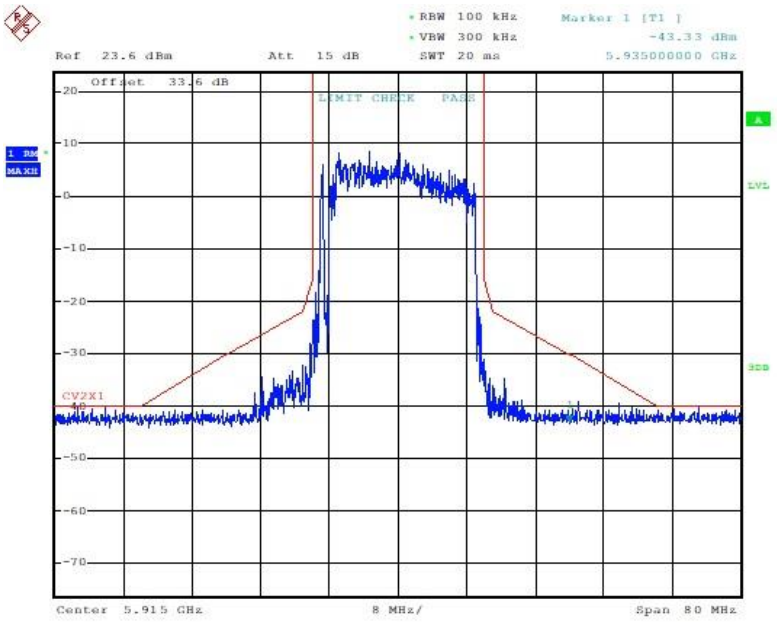
Temperature:	22-26°C
Relative Humidity:	42-46%
ATM Pressure:	101-102 kPa

The testing was performed by Libass Thiaw on 2024-10-25 at RF site.

6.5 Test Results

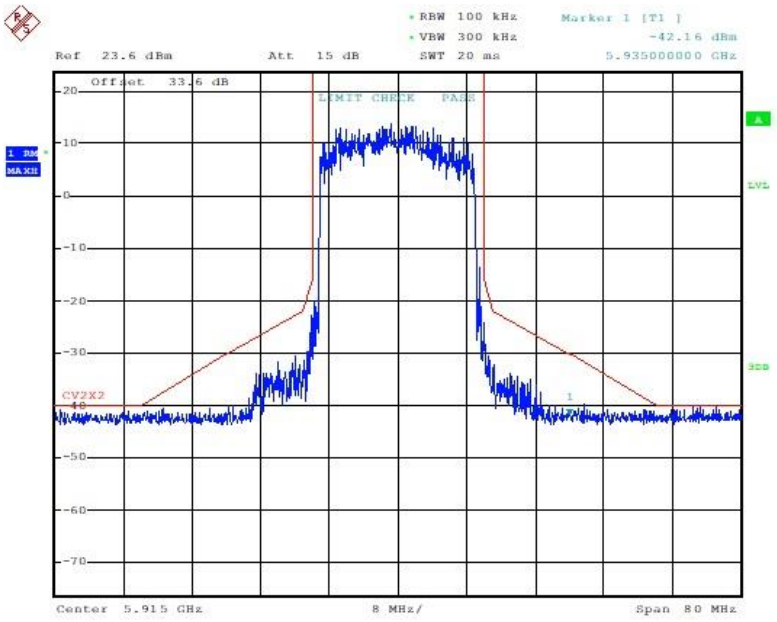
Please refer to the following plots for the test result

5915 MHz Emission Mask Chain 0



Date: 25.OCT.2024 20:31:29

5915 MHz Emission Mask Chain 1



Date: 25.OCT.2024 20:38:17

7 FCC §2.1049 - Emission Bandwidths

7.1 Applicable Standard

According to FCC Waiver DA 24-363 All RSUs and OBUs authorized under this Order must operate using the technical characteristics and operating parameters, including power, height, and out-of-band emission limits, specified below, to ensure compliance with all existing technical rules applicable to ITS operations other than the requirement to use DSRC-based technology:

C-V2X OBU and RSU Operations

Frequency Range	Channel Bandwidth	OBU Limits	RSU EIRP Limit
5905–5925 MHz	20 megahertz	33 dBm EIRP*; 27dBm EIRP within 5 degrees of horizontal	33 dBm EIRP

*EIRP (equivalent isotropically radiated power)

7.2 Test Procedure

Bandwidth was measured following procedures in ANSI-C63.26-2015 section 5.4.

The following procedure shall be used for measuring (99%) power bandwidth:

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts (typically a span of 1.5 × OBW is sufficient).

b) The nominal IF filter 3 dB bandwidth (RBW) shall be in the range of 1% to 5% of the anticipated OBW, and the VBW shall be set ≥ 3 × RBW.

c) Set the reference level of the instrument as required to prevent the signal amplitude from exceeding the maximum spectrum analyzer input mixer level for linear operation. See guidance provided in 4.2.3.

NOTE—Step a), step b), and step c) may require iteration to adjust within the specified tolerances.

d) Set the detection mode to peak, and the trace mode to max-hold.

The following procedure shall be used for measuring 26 dB power bandwidth:

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the spectrum analyzer shall be wide enough to see sufficient roll off of the signal to make the measurement.
b) The nominal RBW shall be in the range of 1% to 5% of the anticipated OBW, and the VBW shall be set ≥ 3 × RBW.
c) Set the reference level of the instrument as required to prevent the signal amplitude from exceeding the maximum spectrum analyzer input mixer level for linear operation. See guidance provided in 4.2.3.
NOTE—Step a), step b), and step c) may require iteration to adjust within the specified tolerances.
d) The dynamic range of the spectrum analyzer at the selected RBW shall be more than 10 dB below the target "−X dB" requirement, i.e., if the requirement calls for measuring the −26 dB OBW, the spectrum analyzer noise floor at the selected RBW shall be at least 36 dB below the reference level.
e) Set spectrum analyzer detection mode to peak, and the trace mode to max hold.
f) Determine the reference value by either of the following:
1) Set the EUT to transmit a modulated signal. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

2) Set the EUT to transmit an unmodulated carrier. Set the spectrum analyzer marker to the level of the carrier.
g) Determine the "−X dB amplitude" as equal to (Reference Value − X). Alternatively, this calculation can be performed on the spectrum analyzer using the delta-marker measurement function.
h) If the reference value was determined using an unmodulated carrier, turn the EUT modulation on, then either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise the trace from step f) shall be used for step i).
i) Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display such that each marker is at or slightly below the "−X dB amplitude" determined in step f). If a marker is below this "−X dB amplitude" value it should be as close as possible to this value. The OBW is the positive frequency difference between the two markers.

7.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
1461	Rohde & Schwarz	Analyzer, Spectrum	FSQ26	200749	2024-08-06	1 year
-	-	SMA cable	-	-	Each time[1]	N/A
-	-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

7.4 Test Environmental Conditions

Temperature:	22-26°C
Relative Humidity:	42-46%
ATM Pressure:	101-102 kPa

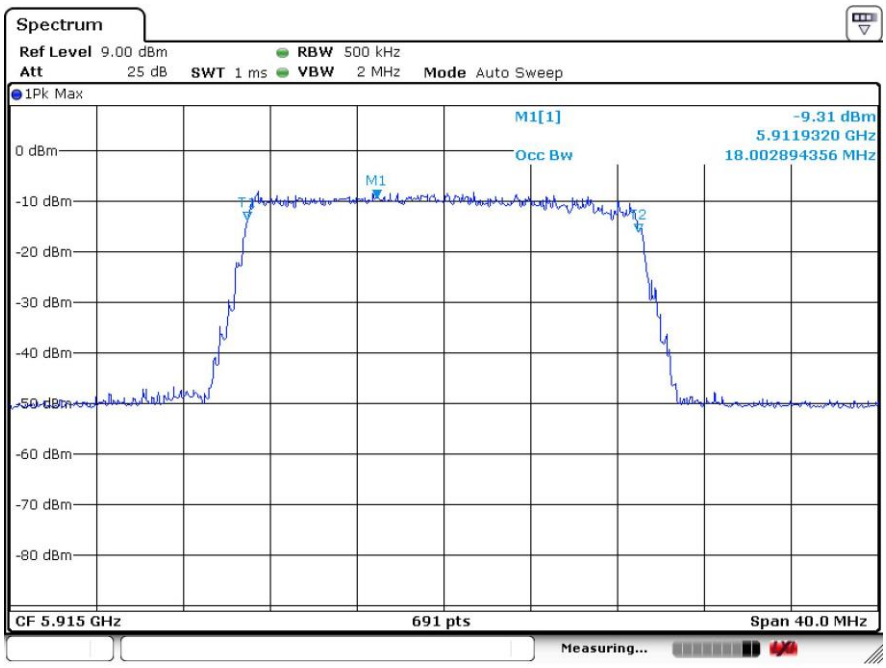
The testing was performed by Libass Thiaw on 2024-10-25 at RF site.

7.5 Test Results

Chain	Frequency (MHz)	99% Bandwidth (MHz)	26dB Bandwidth (MHz)
0	5915	18.00	18.70
1	5915	17.89	18.70

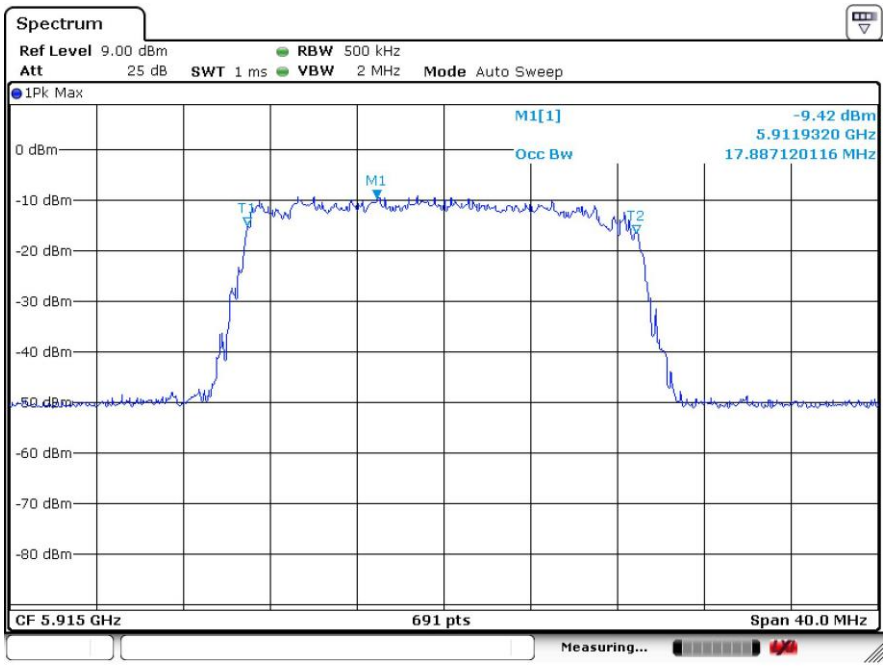
Please refer to the following plots for the test results

5915 MHz 99% Occupied Bandwidth Chain 0



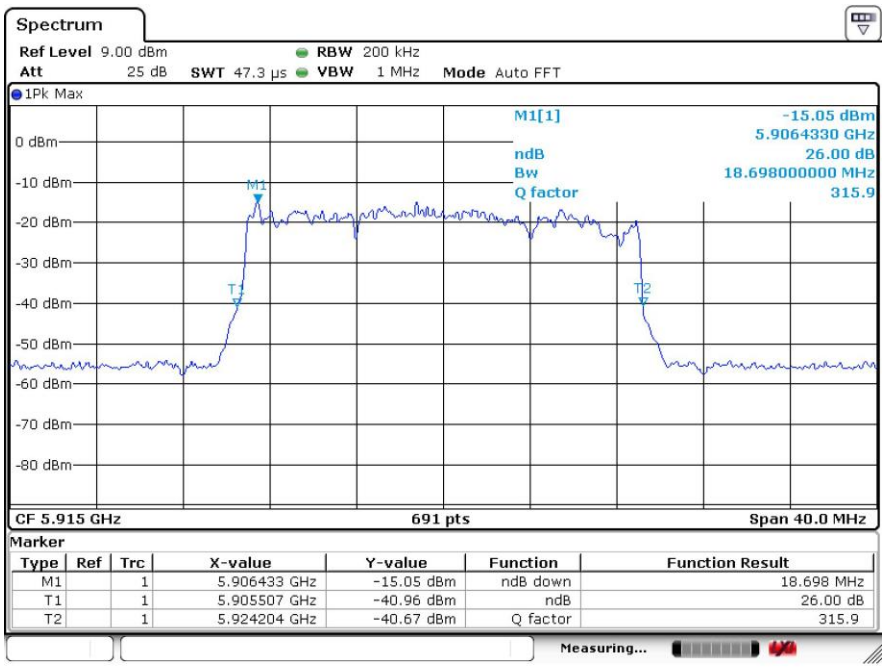
Date: 25.OCT.2024 10:25:01

5915 MHz 99% Occupied Bandwidth Chain 1



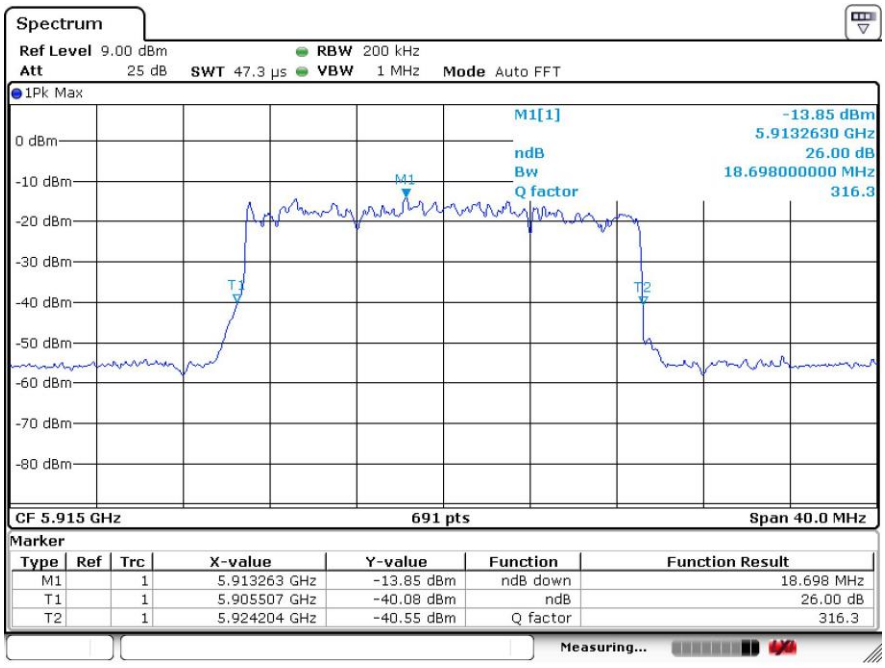
Date: 25.OCT.2024 10:30:34

5915 MHz 26dB Occupied Bandwidth Chain 0



Date: 25.OCT.2024 10:39:11

5915 MHz 26dB Occupied Bandwidth Chain 1



Date: 25.OCT.2024 10:35:59

8 FCC §15.35(b), §15.205, §15.209, §15.247(d), §15.407(b) – Spurious Radiated Emissions

8.1 Applicable Standard

As per FCC §15.35(b): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410 608 – 614	960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d),

in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

As per FCC §15.407 (b),

For transmitters operating in the 5.15–5.25 GHz band: All emissions outside of the 5.15–5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
For transmitters operating in the 5.25–5.35 GHz band: All emissions outside of the 5.15–5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
For transmitters operating in the 5.47–5.725 GHz band: All emissions outside of the 5.47–5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
For transmitters operating solely in the 5.725–5.850 GHz band:

All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.
Devices certified before March 2, 2017 with antenna gain greater than 10 dBi may demonstrate compliance with the emission limits in § 15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease by March 2, 2018. Devices certified before March 2, 2018 with antenna gain of 10 dBi or less may demonstrate compliance with the emission limits in § 15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease before March 2, 2020.

The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.
Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.
The provisions of §15.205 apply to intentional radiators operating under this section.

8.2 Measurement Procedure

The C-V2X transmitted spectrum mask is relative to the device class of operation. The power in the transmitted spectrum for all DSRC devices shall be −25 dBm or less within 100 kHz outside all channel and band edges. This will be accomplished by attenuating the transmitted signal 100 kHz outside the channel and band edges by 55 + 10log(*P*) dB, where *P* is the total transmitted power in watts. The transmitted spectral density of the transmitted signal for all devices shall fall within the spectral mask, as detailed in Table 10.5 The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

For co-location scans: For the radiated emissions test, the EUT host, and all support equipment power cords were connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT was set 3 meter away from the testing antenna, which was varied from 1-4 meter, and the EUT was placed on a turntable, which was 0.8 meter and 1.5 meter above the ground plane for below and above 1000 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna's polarity should be changed between horizontal and vertical.

The spectrum analyzer or receiver was set as:

Below 1000 MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 1000 MHz:

(1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto
(2) Average: RBW = 1MHz / VBW = 10Hz or 1/T / Sweep = Auto

8.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
327	Sunol Sciences	System Controller	SC110V	122303-1	N/R	N/A
1075	Sunol Sciences	Boresight Tower	TLT3	050119-7	N/R	N/A
1388	Sunol Sciences	Flush Mount Turntable	FM	112005-2	N/R	N/A
316	Sonoma Instruments	Preamplifier 10 kHz - 2.5 GHz	317	260406	2024-08-30	6 months
1432	Keysight Technologies	MXE EMI Receiver, Multi-touch	N9038B	MY60180008	2024-01-15	1 year
321	Sunol Sciences	Biconilog Antenna	JB3	A020106-2; 1504	2023-12-18	2 years
1245	-	6dB Attenuator	PE7390-6	01182018A	2023-12-18	2 years
1246	Hewlet Packard	RF Limiter	11867A	01734	2024-04-09	1 year
672	Micro-Tronics	2.4 - 2.6 GHz Notch Filter	BRM50701	160	2024-03-06	1 year
1521	Mini-Circuits	Low Pass Filter	15542 NLP-1200+	V UU83501811	2024-10-01	1 year
1248	Pasternack	RG214 COAX Cable	PE3062	-	2024-04-09	1 year
1249	Time microwave	LMR-400 Cable Dc-3 GHz	AE13684	2k80612-5 6fts	2024-04-09	1 year
1295	Carlisle Interconnected Technologies	10m Coaxial Cable	UFB142A-1-3937-200200	64639890912-001	2024-10-16	1 year
1359	Pasternack	N 600in RF Cable	PE3496LF-600	-	2024-07-26	6 months
1192	ETS Lindgren	Horn Antenna	3117	00218973	2024-10-23	2 years
188	Sunol Sciences	Horn Antenna	DRH-118	A052704	2023-11-06	2 year
1397	Mini Circuit	CBL ASSY 2.92 MM PLUG TO PLUG 12"	FL086-12KM+	QN2318110-2318	2024-08-16	6 months
1394	Mini Circuit	CBL ASSY 2.92 MM PLUG TO PLUG 12"	FL086-12KM+	QN2318110-2318	2024-08-16	6 months
1449	BACL	Preamplifier	BACL1313-A100M18G	4052472	2024-08-19	6 months
91	Wisewave	Horn Antenna	ARH-4223-02	10555-02	2024-03-14	2 years
92	Wisewave	Horn Antenna	ARH-2823-02	10555-01	2024-06-26	2 years
1451	BACL	Preamplifier	BACL-1313-A1840	4052432	2024-08-16	6 months
EMCO	Horn Antenna	3115	9511-4627	2022-11-22	2 years	EMCO
-	SMA cable	-	C0002	Each time[1]	N/A	-
Rohde & Schwarz	Wideband Radio Communication Tester	CMW 500	1201.0002K50	N/R	N/R	Rohde & Schwarz

1362	Marvelous Microwave Inc	SMA Notch Filter, 5925MHz - 7125MHz	5925.7125.S1	D30002N	2024-04-14	1 year

Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

8.4 Test Environmental Conditions

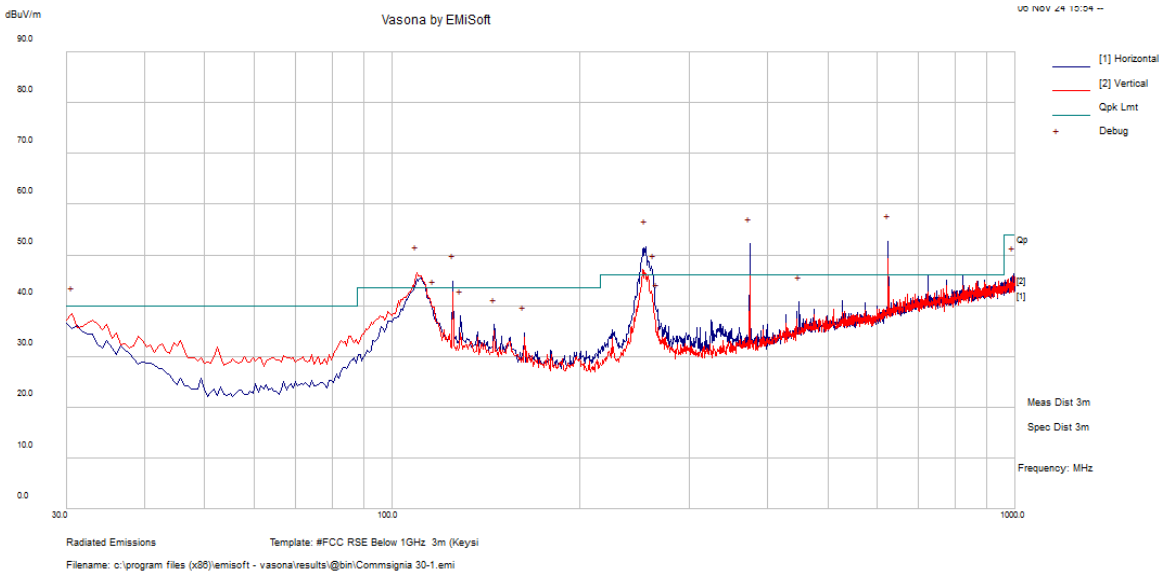
Temperature:	22-26°C
Relative Humidity:	42-46%
ATM Pressure:	101-102 kPa

The testing was performed by Libass Thiaw from 2024-10-23 to 2024-11-06 at RF site.at 5 meter Chamber 3.

8.5 Test Results

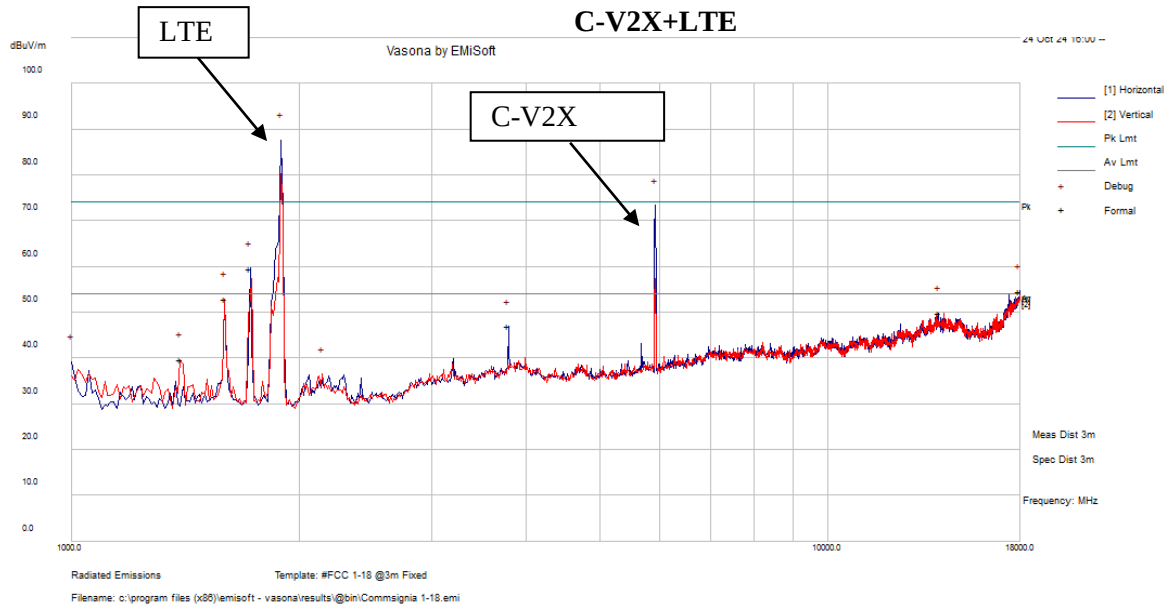
1. 30 MHz – 1 GHz, Measured at 3 meters

C-V2X+LTE



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Detector	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
109.6638	50.55	-7.62	42.93	QP	V	100	65	43.5	-0.57
128.8675	13.69	-6.21	7.48	QP	H	157	57	43.5	-16.02
125.0266	39.37	-6.18	33.2	QP	H	269	116	43.5	-10.31
624.9813	40.88	2.67	43.56	QP	H	123	325	46	-2.44
255.0806	51.11	-7.62	43.49	QP	H	152	256	46	-2.51
375.0041	47.79	-3.67	44.11	QP	H	100	304	46	-1.89

2. 1 GHz-18 GHz, Measured at 3 meters

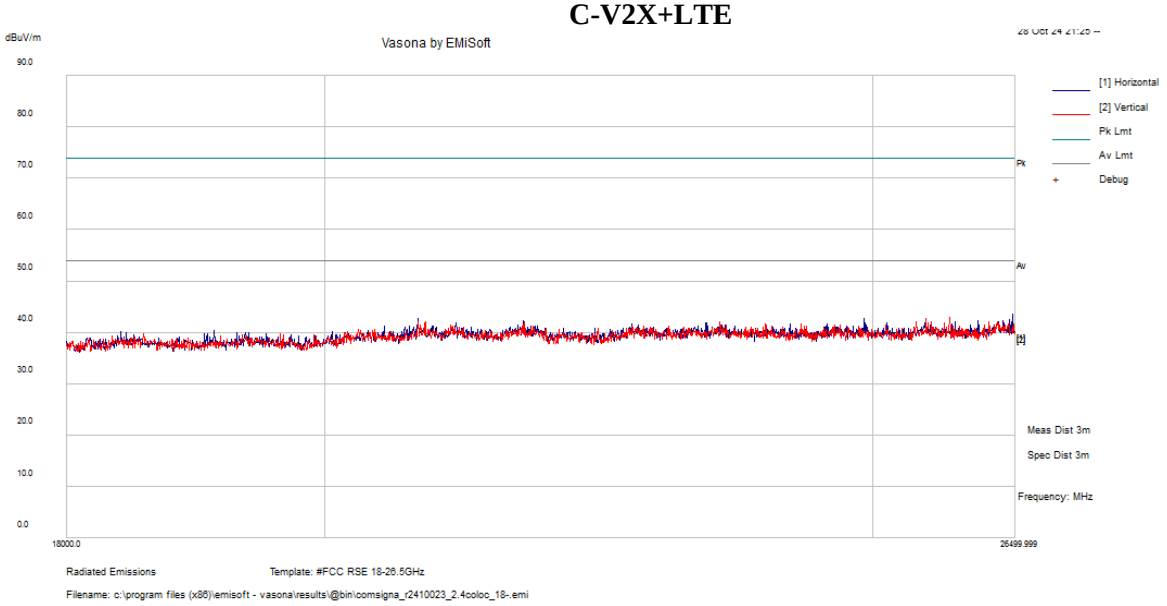


Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Detector	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
1720.6	60.41	-10.63	49.77	Peak	H	258	163	74	-24.23
17959.14	36.31	19.06	55.38	Peak	H	237	335	74	-18.62
1593.003	74.61	-11.21	63.41	Peak	V	207	254	74	-10.59
14024.98	36.33	13.48	49.81	Peak	H	100	152	74	-24.19
3785.313	49.56	-3	46.56	Peak	H	225	73	74	-27.44
1393.695	54.63	-12.43	42.2	Peak	V	102	56	74	-31.8
1720.6	32.54	-10.63	21.91	Average	H	258	163	54	-32.09
17959.14	17.8	19.06	36.87	Average	H	237	335	54	-17.13
1593.003	34.24	-11.21	23.04	Average	V	207	254	54	-30.96
14024.98	17.9	13.48	31.38	Average	H	100	152	54	-22.62
3785.313	35.85	-3	32.85	Average	H	225	73	54	-21.15
1393.695	31.84	-12.43	19.41	Average	V	102	56	54	-34.59

18 GHz to 26.5 GHz, Measured at 3 meters

Note: *Peak emissions are under average limits*

C-V2X+LTE

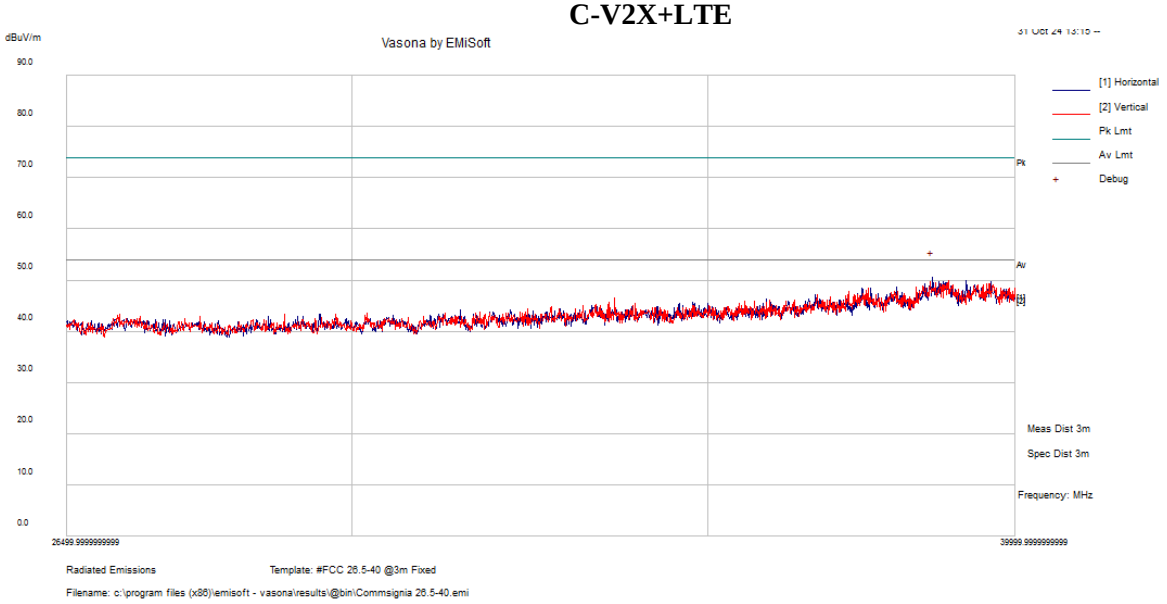


Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Detector	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
24938.71	39.28	1.98	41.26	Peak	V	200	352	54	-12.74

3. 26.5 GHz to 40 GHz, Measured at 3 meters

Note: *Peak emissions are under average limits*

C-V2X+LTE



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Detector	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)
38582.5	38.81	11.65	50.46	Peak	H	200	0	54	-3.54

9 Annex B (Normative) – Test Setup Photographs

Please refer to attachment.

10 Annex C (Normative) – EUT External Photographs

Please refer to attachment.

11 Annex D (Normative) – EUT Internal Photographs

Please refer to attachment.

12 Annex F (Normative) - A2LA Electrical Testing Certificate

Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets A2LA R222 - Specific Requirements EPA ENERGY STAR Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 13th day of September 2024.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2026

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

Please follow the web link below for a full ISO 17025 scope.

https://www.a2la.org/scopepdf/3297-02.pdf

---END OF REPORT ---