

# TEST REPORT

<b>KOSTEC CO., Ltd.</b> (Annyeong-dong) 26, 28, 30, Seja-ro 406beon-gil, Hwaseong-si, Gyeonggi-do, Republic of Korea Tel : 031-222-4251, Fax : -	Report No.: KST-FCR-250001	
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## 1. Applicant

- Name : Ettifos Co.
- Address : 405, 41, Beolmal-ro 50beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea

## 2. Test Item

- Product Name: SIRIUS C-V2X OBU
- Model Name: ETF-SIR-O5001
- Brand: None
- FCC ID: 2BHJL-ETF-SIR-O5001

## 3. Manufacturer

- Name : Ettifos Co.
- Address : 405, 41, Beolmal-ro 50beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea

## 4. Date of Test : 2025. 03. 13. ~ 2025. 03. 14.

FCC CFR 47, Part 95L

## 5. Test Method Used : 511808 D01 C-V2X v02 ANSI C 63.26-2015

## 6. Test Result : Compliance

## 7. Note: None

### Supplementary Information

The device bearing the brand name and FCC ID specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with measurement procedures specified in ANSI C 63.26-2015.

We attest to the accuracy of data and all measurements reported herein were performed by KOSTEC Co., Ltd. and were made under Chief Engineer's supervision. We assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.  
This test report is not related to KOLAS accreditation.

Affirmation	Tested by Name : Choo, Kwang-Yeol (Signature)	Technical Manager Name : Lee, Mi-Young (Signature)
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2025. 03. 17.

**KOSTEC Co., Ltd.**

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## 1. GENERAL INFORMATION

### 1.1 Test Facility

#### Test laboratory and address

KOSTEC Co., Ltd.

(Annyeong-dong) 26, 28, 30, Seja-ro 406beon-gil, Hwaseong-si, Gyeonggi-do, Republic of Korea

Telephone Number: 82-31-222-4251

Fax Number: -

#### Registration information

KOLAS No.: KT232

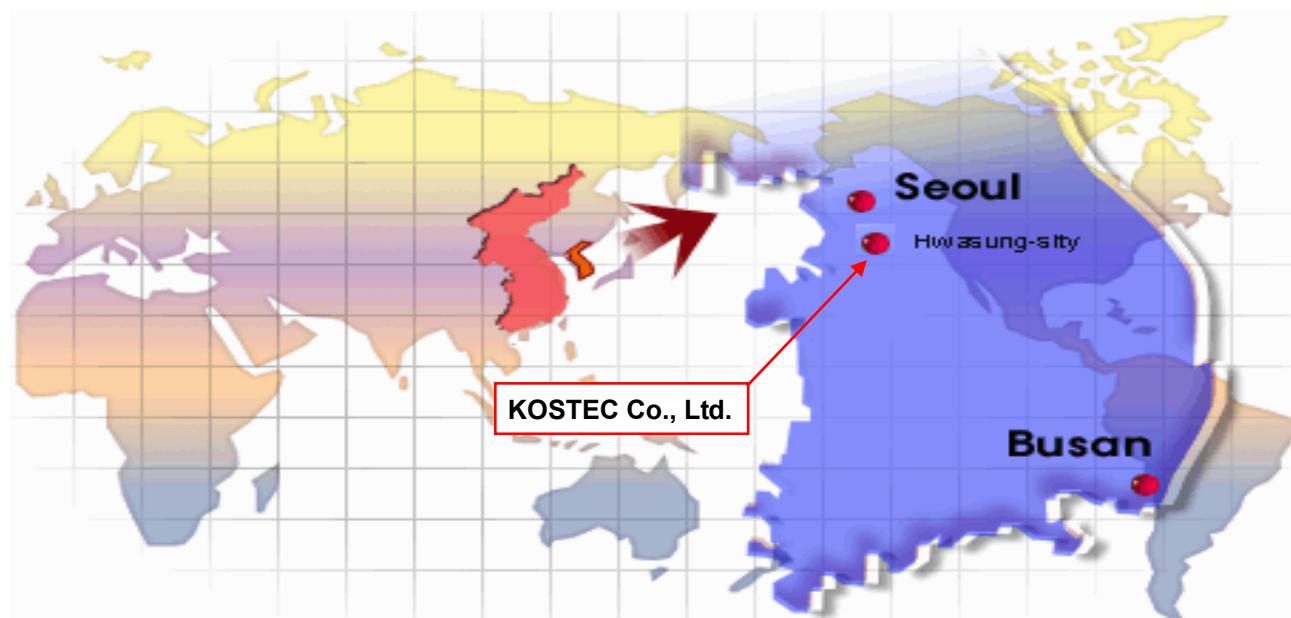
RRA (National Radio Research Agency): KR0041

FCC Designation No.: KR0041

IC Designation No.: KR0041

VCCI Membership No.: 2005

### 1.2 Location



### 1.3 Revision History of test report

Rev.	Revisions	Effect page	Reviewed	Date
-	Initial issue	All	Mi-Young, Lee	2025. 03. 17.

## 2. EQUIPMENT DESCRIPTION

The product specification described herein was declared by manufacturer. And refer to user's manual for the details.

Equipment Name	SIRIUS C-V2X OBU
Model No	ETF-SIR-O5001
Usage	C-V2X OBU
Serial Number	Proto type
Modulation type	16QAM
Emission Type	D1D
Maximum output power(E.I.R.P)	19.68 dBm
Operated Frequency	5 905 MHz ~ 5 925 MHz(Center Frequency: 5 915 MHz)
Channel Number	1
Operation temperature	-30 °C ~ 60 °C
Power Source	DC 12 V
Antenna Description	External dipole array antenna, gain : 8 dBi
Remark	<ol style="list-style-type: none"><li>1. The device was operating at its maximum output power for all measurements.</li><li>2. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case (X) is shown in the report.</li><li>3. The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description.</li></ol>
FCC ID	2BHJL-ETF-SIR-O5001

### 3. SYSTEM CONFIGURATION FOR TEST

#### 3.1 Characteristics of equipment

The Equipment Under Test (EUT) contains the following capabilities: This equipment is C-V2X OBU. The detailed explanation is refer as user manual.

#### 3.2 Used peripherals list

Description	Model No.	Serial No.	Manufacture	Remark
-	-	-	-	-

#### 3.3 Product Modification

N/A

#### 3.4 Declared Exemptions and Additional Product Notes

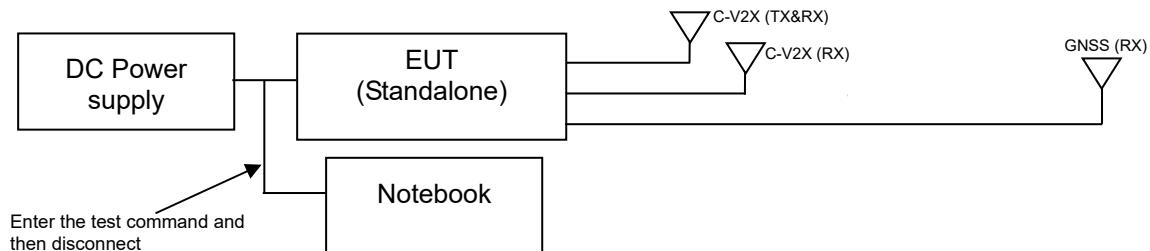
The EUT is an FCC Part 95, Subpart L device. The EUT is permanently installed in a transportation vehicle. As such, digital emissions are exempt from US regulations per FCC 15.103(a). The manufacturer declares compliance with all provisions of FCC Part 95L listed herein.

#### 3.5 Operating Mode

Constantly transmitting with a modulated carrier at maximum power on the center frequency.

#### 3.6 Test Setup of EUT

The measurements were taken in continuous transmit mode using the test mode which controlled by Teraterm. The test command and the test Jig and cables were provided by the applicant.



### 3.7 Parameters of Test Software Setting

During testing, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

TX Power setting value during test

Band	Rate	TX Power setting value		
		Low CH	Middle CH	High CH
5.9 GHz band	30.7 Mbps	N/A	default	N/A

Test Program : TeraTerm

```

root@telechips-tcc8050-sub:~# ucfg set freq 5865 20 30 && ucfg set rp sc 10 5 0
Set Frequency: 5875 -> 5865, BH: 1 -> 1(20), SC8: 1 -> 1(30)
Same Subchannel: 10, 5, 0

root@telechips-tcc8050-sub:~# ucfg set ant cfg 3 && ucfg save
Set Antenna Configuration: 1 -> 3. Need to reboot to adjust the configuration

Save User Configuration to file(282)
#version2.0.3
ucfg set dev pc5_ip 0 0 0 0
ucfg set rf pow 20
ucfg set rf block 0
ucfg set freq 5865 20 30
ucfg set bup sum 0 14
ucfg set rp sc 10 5 0
ucfg set rp prd 0 100
ucfg set psch 2 10
ucfg set psch 1 8 4
ucfg set psch 0 3
ucfg set harq 0
ucfg set ant cfg 3
ucfg set cc 0

root@telechips-tcc8050-sub:~# sed -i -e '/TX Num Of PKT/ s/: -\?([0-9])*/: -1/' /etc/nr_l1_test_param.txt
root@telechips-tcc8050-sub:~# sed -i -e '/TX Start Slot/ s/: -\?([0-9])*/: 0/' /etc/nr_l1_test_param.txt
root@telechips-tcc8050-sub:~# sed -i -e '/TX PKT Interval/ s/: -\?([0-9])*/: 1/' /etc/nr_l1_test_param.txt
root@telechips-tcc8050-sub:~# sed -i -e '/TX PSCH Orth/ s/: -\?([0-9])*/: 0/' /etc/nr_l1_test_param.txt
root@telechips-tcc8050-sub:~# sed -i -e '/MCS Index 0/ s/: [0-9])*/: 16/' /etc/nr_l1_test_param.txt
root@telechips-tcc8050-sub:~# sed -i -e '/PSCH NID/ s/: -\?([0-9])*/: 0/' /etc/nr_l1_test_param.txt
root@telechips-tcc8050-sub:~# reboot

```

### 3.8 Duty Cycle Of Test signal

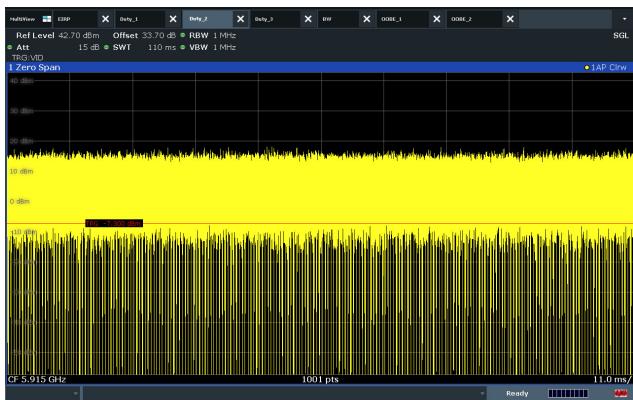
Duty cycle = Tx on/(Tx on+ Tx off), Duty factor =  $10 \times \log(1/\text{duty cycle})$

Mode	Voltage [V]	Frequency [MHz]	Data rate [Mbps]	Tx Cycle Time [us]	Tx On-Time [us]	Duty Cycle [%]	Duty Correction [dB]
C-V2X	12.0	5.915	30.7	500	470	94	0.27

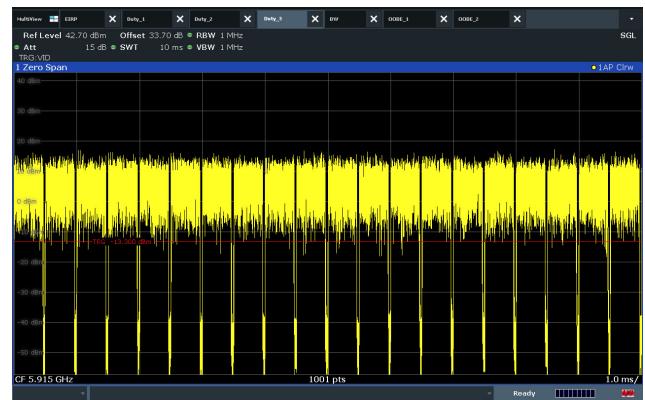
NOTE:

Duty factor is shown as a data point only and is not considered in the calculation of fundamental power.

110 ms



10 ms



2 ms



### 3.9 Used Test Equipment List

No.	Instrument	Model	S/N	Manufacturer	Next Cal Date	Cal interval	used
1	T & H Chamber	PL-3J	15003623	ESPEC CORP	2025.08.13	1 year	<input checked="" type="checkbox"/>
2	T & H Chamber	SH-662	93000067	ESPEC CORP	2025.08.13	1 year	<input type="checkbox"/>
3	T & H Chamber	SH-642	93011406	ESPEC CORP	2025.08.13	1 year	<input type="checkbox"/>
4	Spectrum Analyzer	8563EC	3046A00527	Agilent Technology	2026.01.08	1 year	<input type="checkbox"/>
5	Spectrum Analyzer	FSV30	104029	Rohde & Schwarz	2025.08.12	1 year	<input type="checkbox"/>
6	Spectrum Analyzer	FSV30	20-353063	Rohde & Schwarz	2026.01.08	1 year	<input type="checkbox"/>
7	Spectrum Analyzer	FSV40	101727	Rohde & Schwarz	2025.08.12	1 year	<input type="checkbox"/>
8	Signal Analyzer	FSW43	101294	Rohde & Schwarz	2026.01.08	1 year	<input checked="" type="checkbox"/>
9	Signal Analyzer	FSW85	101602	Rohde & Schwarz	2025.07.03	1 year	<input type="checkbox"/>
10	EMI Test Receiver	ESCI7	100823	Rohde & Schwarz	2026.01.07	1 year	<input type="checkbox"/>
11	EMI Test Receiver	ESPI	100488	Rohde & Schwarz	2026.01.06	1 year	<input type="checkbox"/>
12	EMI Test Receiver	ESI	837514/004	Rohde & Schwarz	2025.08.12	1 year	<input checked="" type="checkbox"/>
13	Vector Signal Analyzer	89441A	3416A02620	Agilent Technology	2026.01.09	1 year	<input type="checkbox"/>
14	Network Analyzer	8753ES	US39170869	AGILENT	2025.08.13	1 year	<input type="checkbox"/>
15	EPM Series Power meter	E4418B	GB39512547	Agilent Technology	2026.01.08	1 year	<input type="checkbox"/>
16	RF Power Sensor	E9300A	MY41496631	Agilent Technology	2026.01.08	1 year	<input type="checkbox"/>
17	Microwave Frequency Counter	5352B	2908A00480	Agilent Technology	2026.01.06	1 year	<input type="checkbox"/>
18	Audio Analyzer	8903B	3514A16919	Agilent Technology	2026.01.06	1 year	<input type="checkbox"/>
19	Audio Telephone Analyzer	DD-5601CID	520010281	CREDIX	2026.01.06	1 year	<input type="checkbox"/>
20	Modulation Analyzer	8901A	3041A05716	H.P	2026.01.08	1 year	<input type="checkbox"/>
21	Digital storage Oscilloscope	TDS3052	B015962	Tektronix	2025.08.13	1 year	<input type="checkbox"/>
22	ESG-D Series Signal Generator	E4436B	US39260458	Agilent Technology	2026.01.09	1 year	<input type="checkbox"/>
23	Vector Signal Generator	SMBV100A	257557	Rohde & Schwarz	2026.01.09	1 year	<input type="checkbox"/>
24	GNSS Signal Generator	TC-2800A	2800A000494	TESCOM CO., LTD.	2026.01.09	1 year	<input type="checkbox"/>
25	Signal Generator	SMB100A	179628	Rohde & Schwarz	2026.01.09	1 year	<input checked="" type="checkbox"/>
26	Signal Generator	N5173B	MY57280148	KEYSIGHT	2025.05.30	1 year	<input type="checkbox"/>
27	SLIDAC	None	0207-4	Myoung sung Ele.	2026.01.06	1 year	<input type="checkbox"/>
28	DC Power supply	DDPS-3K	U03-109	Digitech Power	2026.01.07	1 year	<input type="checkbox"/>
29	DC Power supply	E3610A	KR24104505	Agilent Technology	2026.01.06	1 year	<input type="checkbox"/>
30	DC Power supply	UP-3005T	68	Unicon Co.,Ltd	2026.01.06	1 year	<input type="checkbox"/>
31	DC Power Supply	SM 3400-D	114701000117	DELTA ELEKTRONIKA	2026.01.06	1 year	<input type="checkbox"/>
32	DC Power supply	6632B	MY43004005	Agilent Technology	2026.01.06	1 year	<input checked="" type="checkbox"/>
33	DC Power Supply	6632B	MY43004137	Agilent Technology	2026.01.06	1 year	<input type="checkbox"/>
34	Termination	1433-3	LM718	WEINSCHEL	2026.01.08	1 year	<input type="checkbox"/>
35	Termination	1432-3	QR946	AEROFLEX/WEINSCHEL	2026.01.08	1 year	<input type="checkbox"/>
36	Attenuator	8498A	3318A09485	HP	2026.01.08	1 year	<input type="checkbox"/>
37	Step Attenuator	8494B	3308A32809	HP	2026.01.08	1 year	<input type="checkbox"/>
38	RF Step Attenuator	RSP	100091	Rohde & Schwarz	2026.01.09	1 year	<input type="checkbox"/>
39	Attenuator	18B50W-20F	64671	INMET	2026.01.09	1 year	<input type="checkbox"/>
40	Attenuator	10 dB	1	Rohde & Schwarz	2026.01.08	1 year	<input type="checkbox"/>
41	Attenuator	54A-10	74564	WEINSCHEL	2025.08.19	1 year	<input checked="" type="checkbox"/>
42	Attenuator	56-10	66920	WEINSCHEL	2026.01.08	1 year	<input checked="" type="checkbox"/>
43	Attenuator	SA18N100-20	001	FAIRVIEW MICROWAVE	2025.08.12	1 year	<input type="checkbox"/>
44	Attenuator	SA26B-10	33464/2134	FAIRVIEW MICROWAVE	2025.08.19	1 year	<input type="checkbox"/>
45	Attenuator	SA4018-10	DC 2126	FAIRVIEW MICROWAVE	2025.08.19	1 year	<input type="checkbox"/>
46	Power divider	11636B	51212	HP	2026.01.08	1 year	<input type="checkbox"/>
47	3Way Power divider	KPDSU3W	00070365	KMW	2025.08.12	1 year	<input type="checkbox"/>
48	4Way Power divider	70052651	173834	KRYTAR	2026.01.08	1 year	<input type="checkbox"/>
49	3Way Power divider	1580	SQ361	WEINSCHEL	2026.01.08	1 year	<input type="checkbox"/>
50	OSP	OSP120	101577	Rohde & Schwarz	2026.01.09	1 year	<input type="checkbox"/>
51	White noise audio filter	ST31EQ	101902	SoundTech	2025.08.13	1 year	<input type="checkbox"/>

No.	Instrument	Model	S/N	Manufacturer	Next Cal Date	Cal interval	used
52	Dual directional coupler	778D	17693	HEWLETT PACKARD	2026.01.09	1 year	<input type="checkbox"/>
53	Dual directional coupler	772D	2839A00924	HEWLETT PACKARD	2026.01.09	1 year	<input type="checkbox"/>
54	Band rejection filter	3TNF-0006	26	DOVER Tech	2026.01.09	1 year	<input type="checkbox"/>
55	Band rejection filter	3TNF-0007	311	DOVER Tech	2026.01.09	1 year	<input type="checkbox"/>
56	Band rejection filter	WTR-BRF2442-84NN	09020001	WAVE TECH Co.,LTD	2026.01.09	1 year	<input type="checkbox"/>
57	Band rejection filter	WRCJV12-5695-5725-5825-5855-50SS	1	Wainwright Instruments GmbH	2026.01.09	1 year	<input type="checkbox"/>
58	Band rejection filter	WRCJV12-5120-5150-5350-5380-40SS	4	Wainwright Instruments GmbH	2026.01.09	1 year	<input type="checkbox"/>
59	Band rejection filter	WRCGV10-2360-2400-2500-2540-50SS	2	Wainwright Instruments GmbH	2026.01.09	1 year	<input type="checkbox"/>
60	Band rejection filter	CTF-155M-S1	001	RF One Electronics	2025.08.12	1 year	<input type="checkbox"/>
61	Band rejection filter	CTF-435M-S1	001	RF One Electronics	2025.08.12	1 year	<input type="checkbox"/>
62	Band rejection filter	CTF-5890M-70MS1	1	RF One Electronics	2026.01.09	1 year	<input type="checkbox"/>
63	Highpass Filter	WHJS1100-10EF	1	WAINWRIGHT	2026.01.08	1 year	<input type="checkbox"/>
64	Highpass Filter	WHJS3000-10EF	1	WAINWRIGHT	2026.01.08	1 year	<input type="checkbox"/>
65	Highpass Filter	WHNX6-5530-7000-26500-40CC	2	Wainwright Instruments GmbH	2026.01.13	1 year	<input checked="" type="checkbox"/>
66	Highpass Filter	WHNX6-2370-3000-26500-40CC	4	Wainwright Instruments GmbH	2026.01.13	1 year	<input type="checkbox"/>
67	WideBand Radio Communication Tester	CMW500	102276	Rohde & Schwarz	2026.01.09	1 year	<input type="checkbox"/>
68	WideBand Radio Communication Tester	CMW500	117235	Rohde & Schwarz	2026.01.15	1 year	<input type="checkbox"/>
69	WideBand Radio Communication Tester	MT8000A	6261987920	Anritsu	2026.01.08	1 year	<input type="checkbox"/>
70	WideBand Radio Communication Tester	MT8821C	6262287695	Anritsu	2026.01.08	1 year	<input type="checkbox"/>
71	Bluetooth Tester	TC-3000B	3000B6A0166	TESCOM CO., LTD.	2026.01.10	1 year	<input type="checkbox"/>
72	Loop Antenna	6502	9203-0493	EMCO	2025.05.23	2 year	<input type="checkbox"/>
73	Loop Antenna	FMZB1513	#374	Schwarzbeck	2027.02.11	2 year	<input checked="" type="checkbox"/>
74	BiconiLog Antenna <sub>(R)</sub>	3142C	35880	ETS-LINDGREN	2026.10.17	2 year	<input checked="" type="checkbox"/>
75	Trilog-Broadband Antenna <sub>(R)</sub>	VULB 9168	9168-606	SCHWARZBECK	2026.09.03	2 year	<input type="checkbox"/>
76	Biconical Antenna <sub>(T)</sub>	VUBA9117	9117-342	Schwarzbeck	2026.01.16	2 year	<input type="checkbox"/>
77	Horn Antenna	3115	9605-4834	EMCO	2026.02.21	1 year	<input type="checkbox"/>
78	Horn Antenna	QMS-00208	21909	STEATITE ANTENNA	2025.04.22	1 year	<input type="checkbox"/>
79	Horn Antenna <sub>(R)</sub>	3117	00135191	ETS-LINDGREN	2025.03.26	1 year	<input checked="" type="checkbox"/>
80	Horn Antenna <sub>(T)</sub>	3115	2996	EMCO	2026.01.07	1 year	<input type="checkbox"/>
81	Horn Antenna <sub>(R)</sub>	BBHA 9170	9170-722	SCHWARZBECK	2026.01.13	1 year	<input checked="" type="checkbox"/>
82	Horn Antenna <sub>(T)</sub>	BBHA 9170	743	SCHWARZBECK	2026.01.07	1 year	<input type="checkbox"/>
83	AMPLIFIER(A_10)	TK-PA01S	220109-L	TESTEK	2026.01.07	1 year	<input type="checkbox"/>
84	AMPLIFIER(C_3)	TK-PA01S	200141-L	TESTEK	2025.08.12	1 year	<input checked="" type="checkbox"/>
85	PREAMPLIFIER(C_3)	8449B	3008A02577	Agilent	2026.01.06	1 year	<input type="checkbox"/>
86	RF PRE AMPLIFIER	SCU08F2	100762	Rohde & Schwarz	2025.08.22	1 year	<input type="checkbox"/>
87	AMPLIFIER	TK-PA18	150003	TESTEK	2026.01.07	1 year	<input checked="" type="checkbox"/>
88	AMPLIFIER	TK-PA1840H	160010-L	TESTEK	2026.01.06	1 year	<input checked="" type="checkbox"/>
89	Horn Antenna	M19RH	T01	OML, Inc.	2025.04.03	1 year	<input type="checkbox"/>
90	Horn Antenna	M12RH	T02	OML, Inc.	2025.04.03	1 year	<input type="checkbox"/>
91	Horn Antenna	M08RH	T03	OML, Inc.	2025.04.03	1 year	<input type="checkbox"/>
92	Horn Antenna	M05RH	T04	OML, Inc.	2025.04.03	1 year	<input type="checkbox"/>
93	Horn Antenna	M03RH	T05	OML, Inc.	2025.04.03	1 year	<input type="checkbox"/>
94	Harmonic Mixer	M12HWD	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>
95	Harmonic Mixer	M08HWD	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>
96	Harmonic Mixer	M05HWD	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>
97	Harmonic Mixer	M03HWD	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>
98	Source Module	S19MS-A	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>
99	Source Module	S12MS-A	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>
100	Source Module	S08MS-A	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>
101	Source Module	S05MS-A	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>
102	Source Module	S03MS-A	200529-1	OML, Inc.	2025.04.08	1 year	<input type="checkbox"/>

## 4. SUMMARY TEST RESULTS

Description of Test	FCC Rule	Result/Remarks	Reference Clause	Used	Test Result
Occupied Bandwidth	2.1049 95.3203	26 dB BW: 19.62 MHz F <sub>L</sub> : 5 905.192 MHz F <sub>H</sub> : 5 924.808 MHz 99% BW: 17.96 MHz	Clause 5.1	<input checked="" type="checkbox"/>	Compliance
Frequency Stability	2.1055 95.3203	6.12 ppm			
C-V2x Transmit Power	2.1046 95.3204(a)	19.68 dBm EIRP	Clause 5.2	<input checked="" type="checkbox"/>	Compliance
Transmit Emission Mask(OOBE)	95.3205(a)	Meet the requirement of limit. Minimum passing margin is -16.74 dB at 5 895.57 MHz (Abs. value: -32.74 dBm)	Clause 5.3	<input checked="" type="checkbox"/>	Compliance
Transmit Chain Spurious Emissions	95.3205(a)	Meet the requirement of limit. Minimum passing margin is -15.65 dB at 39 485.0 MHz (Abs. value: -43.65 dBm)	Clause 5.4	<input checked="" type="checkbox"/>	Compliance
<p>Compliance/pass : The EUT complies with the essential requirements in the standard.</p> <p>Not Compliance : The EUT does not comply with the essential requirements in the standard.</p> <p>N/A : The test was not applicable in the standard.</p>					

### Procedure Reference

FCC CFR 47, Part 95L

511808 D01 C-V2X v02

ANSI C 63.26-2015, ANSI C 63.4-2014

## 5. MEASUREMENT RESULTS

### 5.1 Occupied Bandwidth

#### 5.1.1 Standard Applicable

##### FCC

The OBW is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

#### 5.1.2 Test Environment conditions

- Ambient temperature : (21) °C • Relative Humidity : (41 ~ 43) % R.H.

#### 5.1.3 Measurement Procedure

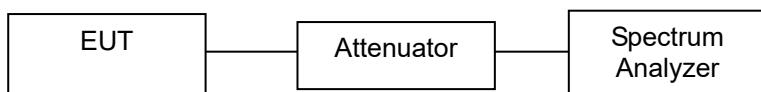
##### FOR 99 PERCENT OCCUPIED BANDWIDTH

- The following procedure shall be used for measuring (99 %) power bandwidth:
- Set center frequency to the nominal EUT channel center frequency.
- Set span = 1.5 times to 5.0 times the OBW.
- Set RBW = 1 % to 5 % of the OBW
- Set VBW  $\geq$  3 · RBW
- Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- Use the 99 % power bandwidth function of the instrument (if available).
- If the instrument does not have a 99 % power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5 % of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

##### FOR 26dB BANDWIDTH

- Set RBW = approximately 1% of the emission bandwidth.
- Set the VBW > RBW.
- Detector = Peak.
- Trace mode = max hold.
- Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

#### 5.1.4 Test setup



### 5.1.5 Measurement Result

Mode	Voltage [V]	Frequency [MHz]	26 dB Bandwidth [MHz]	F <sub>L</sub> [MHz]	F <sub>L</sub> Limit [MHz]	F <sub>H</sub> [MHz]	F <sub>H</sub> Limit [MHz]	99 % Bandwidth [MHz]	Test Results
C-V2X	5.0	5 915	19.62	5 905.192	5 905	5 924.808	5 925	17.96	Compliance

NOTE:

- KDB Guidance 511808 D01 C-V2X v02, section 3.1 Both 26dB and 99% OBW is to be measured.
- OBW must stay within the channel.
- 26 dB Bandwidth = F<sub>H</sub> - F<sub>L</sub>



## - Frequency Stability

Temperature [°C]	Voltage [V]	F <sub>L</sub> [MHz]	F <sub>L</sub> Limit [MHz]	F <sub>H</sub> [MHz]	F <sub>H</sub> Limit [MHz]	26 dB BW [MHz]	Stability (ppm)	Test Results
75	13.8	5 905.221	5 905	5 924.836	5 925	19.61	4.80	Compliance
75	12.0	5 905.217	5 905	5 924.833	5 925	19.62	4.22	Compliance
75	10.2	5 905.212	5 905	5 924.828	5 925	19.62	3.42	Compliance
65	12.0	5 905.209	5 905	5 924.824	5 925	19.62	2.73	Compliance
55	12.0	5 905.204	5 905	5 924.820	5 925	19.62	2.03	Compliance
45	12.0	5 905.200	5 905	5 924.816	5 925	19.62	1.36	Compliance
35	12.0	5 905.195	5 905	5 924.812	5 925	19.62	0.58	Compliance
25	12.0	5 905.192	5 905	5 924.808	5 925	19.62	0.00	Compliance
15	12.0	5 905.188	5 905	5 924.804	5 925	19.62	-0.65	Compliance
5	12.0	5 905.184	5 905	5 924.799	5 925	19.62	-1.48	Compliance
-5	12.0	5 905.179	5 905	5 924.795	5 925	19.62	-2.24	Compliance
-15	12.0	5 905.175	5 905	5 924.791	5 925	19.62	-2.89	Compliance
-20	12.0	5 905.170	5 905	5 924.788	5 925	19.62	-3.57	Compliance
-25	12.0	5 905.167	5 905	5 924.785	5 925	19.62	-4.09	Compliance
-30	13.8	5 905.163	5 905	5 924.781	5 925	19.62	-4.79	Compliance
-30	12.0	5 905.159	5 905	5 924.777	5 925	19.62	-5.49	Compliance
-30	10.2	5 905.155	5 905	5 924.772	5 925	19.62	-6.12	Compliance
	F <sub>L</sub> MIN	5 905.155	F <sub>H</sub> MAX	5 924.772	OBW MAX	19.62		Compliance

## NOTE:

•KDB Guidance 511808 D01 C-V2x v02, section 3.1 the 26 dB OBW is measured.

•Frequency stability in reference to normal operating temp frequency is computed in ppm as:  $(F_c(\text{temp})\text{MHz} - F_c(\text{nom})\text{MHz})/F_c(\text{nom})\text{MHz}$  where  $F_c = F_L + (F_H - F_L)/2$

## 5.2 C-V2X Transmit Power

### 5.2.1 Standard Applicable

#### FCC

C-V2X OBU

Channel (MHz)	Channel Bandwidth (MHz)	EIRP with Geofencing outside zone (dBm/BW)	EIRP with Geofencing operating within zone* or without Geofencing (dBm/BW)
5895-5905	10	33	23
5905-5915	10	33	33 <sup>†</sup>
5915-5925	10	33	33 <sup>†</sup>
5895-5915	20	33	23
5905-5925	20	33	33 <sup>†</sup>
5895-5925	30	33	23
<small>* Coordination zones of §90.387(b)<sup>2</sup>  <small>† Reduced to 27dBm within ± 5 degrees of horizontal</small> </small>			

Table 1. OBU EIRP Limits

### 5.2.2 Test Environment conditions

- Ambient temperature : (18 ~ 20) °C
- Relative Humidity : (40 ~ 42) % R.H.

### 5.2.3 Measurement Procedure

According to requirements of 511808 D01 C-V2X Waiver v01, OBU Transmit Power Test Procedures :

- OBUs employing C-V2X technologies shall have a maximum EIRP that does not exceed the limits provided in §95.3204. The EIRP is measured as the maximum EIRP toward the horizon or horizontally, whichever is greater, based on the gain associated with the main or center of the transmission beam. The EIRP may be calculated from conducted power measurements using characterized antenna data or the antenna data sheet; however, the antenna data must have sufficient resolution to determine the antenna gain within ±5 degrees from the horizontal plane.
- Radiated measurements shall be made if there is insufficient resolution in the antenna data to determine compliance. The resolution should be such that the antenna gain can be determined at ±5 degrees elevation. The general test setup is shown in Figure 2. The OBU transmit antenna shall be placed at a height of 1.5 meters and oriented such that the antenna's main lobe is facing parallel to the ground plane. The OBU shall be configured for testing to represent the actual installation.
- The measurement antenna may be placed at any test distance if it is in the far field of the OBU transmit antenna and at least 3 meters away.

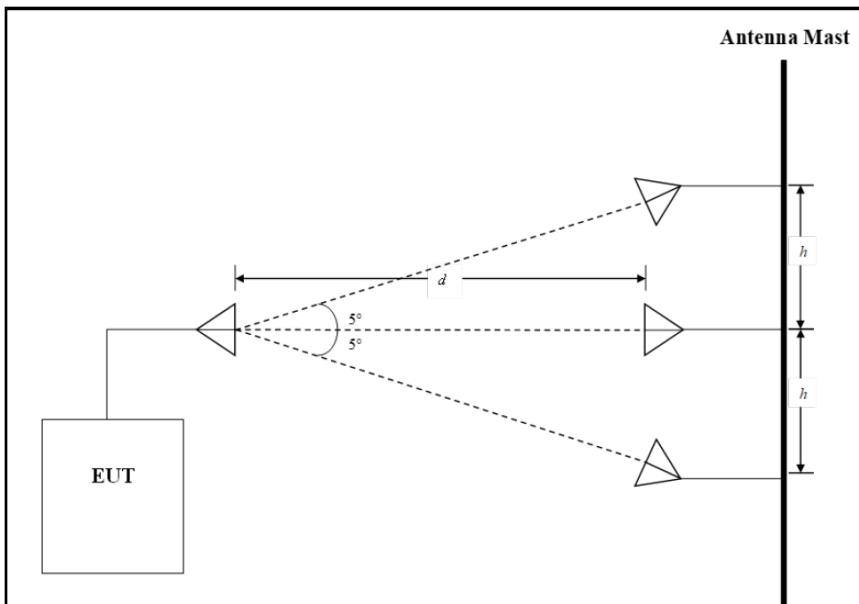


Figure 2. C-V2X OBU Radiated Test Setup Diagram

d) Several operating bands require the beam to be evaluated based on whether the device is transmitting in the coordination zone or operating without geofencing capabilities, as shown in Table 1. To determine compliance in these bands, after the maximum EIRP is measured, the receive measurement antenna shall be elevated to the appropriate height<sup>4</sup> relative to the transmit antenna. Measurements or calculations for EIRP shall be performed at the upper and lower edges of the  $\pm 5$ -degree beam width. If the maximum EIRP is less than 27 dBm, then additional testing for  $\pm 5$  degrees is not required.

e) OBUs with a maximum EIRP  $> 27$  dBm shall describe the mechanism for reducing the main beam power to 27 dBm under §95.3204(a)(5) when the beam is within the  $\pm 5$  degrees elevation from the horizontal plane.

#### 5.2.4 Test setup

Please refer to the test setup photo

#### 5.2.5 Measurement Result

Mode	Frequency [MHz]	Distance(d) [m]	Meas Result( $E_0$ ) [dB $\mu$ V/m]	CF [dB]	EIRP [dBm]	EIRP Limit [dBm]	Test Results
C-V2X	5 915	3	114.94	95.26	19.68	27.0	Compliance

NOTE:

• KDB Guidance 511808 D01 C-V2x v02, section 3.2.1 d). 27dBm EIRP is chosen as the limit to show compliance without requiring additional elevation test data.

• Electric field measurements are typically made in terms of dB $\mu$ V/m and need to be converted to EIRP. This can be accomplished using the following equation: EIRP (dBm) =  $E_0 + 20\log_{10}(d) - 104.8$  where  $E_0$  is the electric field measured in dB $\mu$ V/m and d is the measurement distance in meters.

• CF(Conversion Factor) =  $20\log_{10}(d) - 104.8$

• Meas Result (dB $\mu$ V/m) : Test receiver reading value(Included Antenna factor.(dB/m), CL(dB), AMP(dB) Factor)

## 5.3 Transmit Emission Mask(OOBE)

### 5.3.1 Standard Applicable

#### FCC

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

1. -16 dBm/100 kHz within  $\pm 1$  megahertz of the band edges.
2. -13 dBm/MHz within  $\pm 1$  megahertz to  $\pm 5$  megahertz of the band edges.
3. -16 dBm/MHz within  $\pm 5$  megahertz to  $\pm 30$  megahertz of the band edges and
4. -28 dBm/MHz beyond 30 megahertz from the band edges.

### 5.3.2 Test Environment conditions

- Ambient temperature : (21) °C • Relative Humidity : (41 ~ 43) % R.H.

### 5.3.3 Measurement Procedure

RSUs and OBUs must comply with the following guidelines:

- a) Conducted limits measured at the antenna input must not exceed:
  1. -16 dBm/100 kHz within  $\pm 1$  megahertz of the band edges.
  2. -13 dBm/MHz within  $\pm 1$  megahertz to  $\pm 5$  megahertz of the band edges.
  3. -16 dBm/MHz within  $\pm 5$  megahertz to  $\pm 30$  megahertz of the band edges and
  4. -28 dBm/MHz beyond 30 megahertz from the band edges.
- b) Compliance can be verified using an RMS average detector.
- c) The general test methods of ANSI C63.26, section 5.7.3 and 5.7.4 shall be used.
- d) There is no requirement as to how the plots are to be formatted or displayed, as long as all applicable data is presented.
- e) For example, if the lab possesses a spectrum analyzer capable of performing segmented measurements with control of RBW, VBW, sweep time, number of points, detector type, etc., per segment, then all the segments from 1. – 4. in a) above, may appear on one single plot as shown in Figure 3.
- f) When using the emission mask for plots or segments, ensure that the spectrum analyzer's automatic measurement feature is enabled to clearly display the "pass" or "fail" result on the plot as shown in Figure 3.

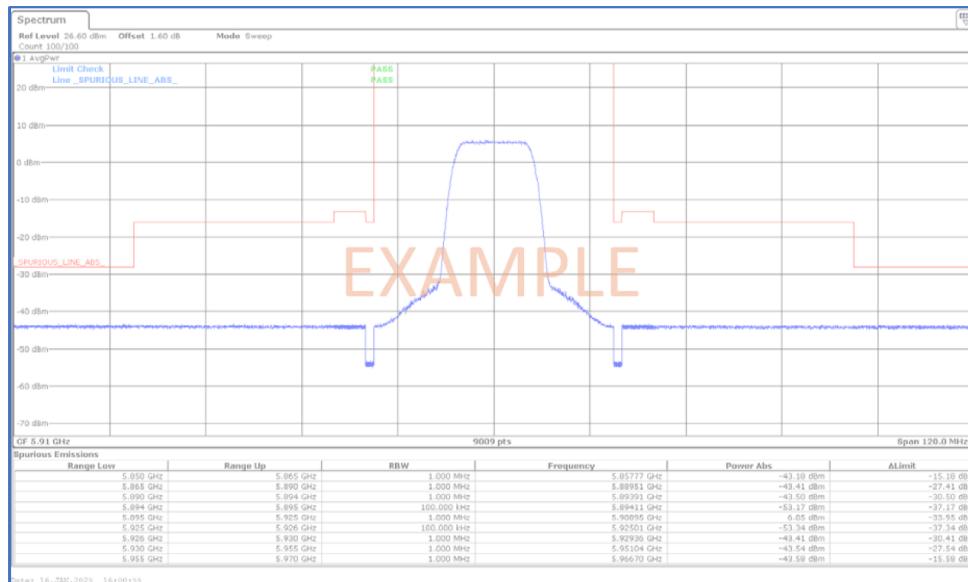


Figure 3. Example of C-V2X OOBE limits plot

g) If this method is used, then the report shall also include an example table from one channel displaying the RBW, VBW, sweep time, number of points, detector, etc. for each range in the emission mask.

Sweep List									
	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8	Range 9
Range Start	5.85 GHz	5.865 GHz	5.89 GHz	5.894 GHz	5.895 GHz	5.925 GHz	5.926 GHz	5.93 GHz	5.955 GHz
Range Stop	5.865 GHz	5.89 GHz	5.894 GHz	5.895 GHz	5.925 GHz	5.926 GHz	5.93 GHz	5.955 GHz	5.97 GHz
Filter Type	Gaussian								
RBW	1 MHz	1 MHz	1 MHz	100 kHz	1 MHz	100 kHz	1 MHz	1 MHz	1 MHz
VBW	3 MHz	3 MHz	3 MHz	300 kHz	3 MHz	300 kHz	3 MHz	3 MHz	3 MHz
Sweep Time Mode	Auto								
Sweep Time	1.01 ms								
Detector	RMS								
Ref. Level	26.6 dBm								
RF Att. Mode	Manual								
RF Attenuator	40 dB								
Preamplifier	Off								
Sweep Points	1001	1001	1001	1001	1001	1001	1001	1001	1001
Stop After Sweep	Off								
Transducer	None								
Limit Check	Absolute								
Abs Limit Start	-28 dBm	-16 dBm	-13 dBm	-16 dBm	40 dBm	-16 dBm	-13 dBm	-16 dBm	-28 dBm
Abs Limit Stop	-28 dBm	-16 dBm	-13 dBm	-16 dBm	40 dBm	-16 dBm	-13 dBm	-16 dBm	-28 dBm

Figure 4. Example table of Spectrum Analyzer settings

h) If individual segments are measured, and the pertinent information, RBW, VBW, sweep time, number of points, etc. are displayed on the plot, then there is no need to add an additional sweep list table.

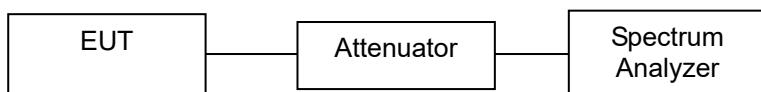
i) For devices with MIMO capabilities, follow the procedures specified in KDB Publication 662911 for summing emissions or adjusting emission levels measured on individual outputs by 10 log (NANT), where NANT is the number of outputs.

j) Testing shall be performed on all potential channel bandwidths and all potential power outputs which the RSU or OBU is capable of transmitting. If the RSU or OBU is capable of carrier aggregation (e.g., transmit a 10 MHz and 20 MHz channel simultaneously) then these combinations shall also be investigated. Care shall be taken to evaluate the impact of intermodulation while additional carriers are active and multiple configurations are possible (e.g., varying resource block configurations for 4G LTE).

k) Measurements shall be performed up to 40 GHz.

l) In addition to conducted measurements, the RSU or OBU shall also be tested for cabinet radiation with the antenna output terminated into a load.

### 5.3.4 Test setup



### 5.3.5 Measurement Result

Mode	Frequency [MHz]	Measurement Results [dBm]	Limit [dBm]	Test Results
C-V2X	5 915	Note	Note	Compliance

Note:

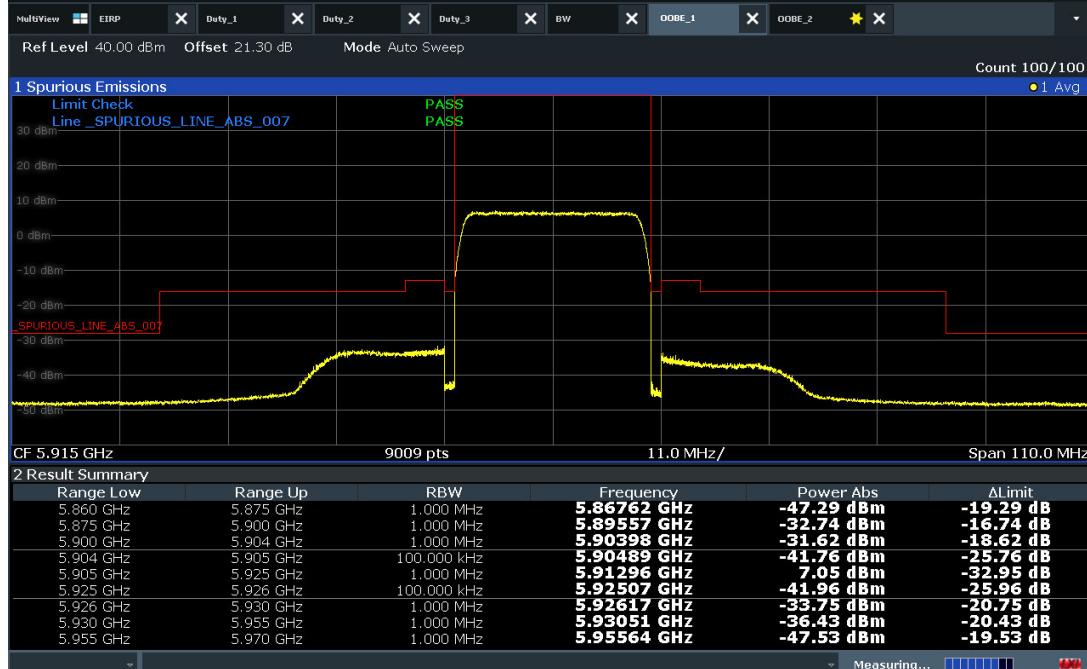
Refer to following test plots

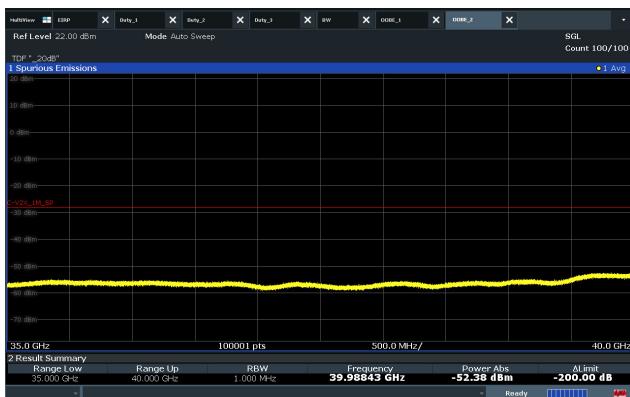
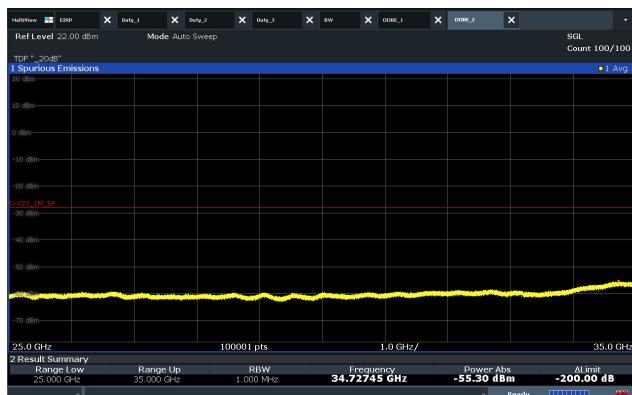
### 5.3.6 Test Plot (OOBE)

Table of Spectrum Analyzer Settings

	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8	Range 9
Range Start	5.86 GHz	5.875 GHz	5.9 GHz	5.904 GHz	5.905 GHz	5.925 GHz	5.926 GHz	5.93 GHz	5.955 GHz
Range Stop	5.875 GHz	5.9 GHz	5.904 GHz	5.905 GHz	5.925 GHz	5.926 GHz	5.93 GHz	5.955 GHz	5.97 GHz
Filter Type	Normal(3dB)								
RBW	1 MHz	1 MHz	1 MHz	100 kHz	1 MHz	100 kHz	1 MHz	1 MHz	1 MHz
VBW	3 MHz	3 MHz	3 MHz	300 kHz	3 MHz	300 kHz	3 MHz	3 MHz	3 MHz
Sweep Time Mode	Auto								
Sweep Time	1.01 ms								
Detector	RMS								
Ref Level	40 dBm								
RF Att Mode	Manual								
RF Attenuation	20 dB								
Preamp	Off								
Sweep Points	1001	1001	1001	1001	1001	1001	1001	1001	1001
Stop After Sweep	Off								
Transducer	None								
Limit Check	Absolute								
Abs Limit Start	-28 dBm	-16 dBm	-13 dBm	-16 dBm	40 dBm	-16 dBm	-13 dBm	-16 dBm	-28 dBm
Abs Limit Stop	-28 dBm	-16 dBm	-13 dBm	-16 dBm	40 dBm	-16 dBm	-13 dBm	-16 dBm	-28 dBm

### C-V2X OOBE





## 5.4 Transmit Chain Spurious Emissions

### 5.4.1 Standard Applicable

#### FCC

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

1. -16 dBm/100 kHz within  $\pm 1$  megahertz of the band edges.
2. -13 dBm/MHz within  $\pm 1$  megahertz to  $\pm 5$  megahertz of the band edges.
3. -16 dBm/MHz within  $\pm 5$  megahertz to  $\pm 30$  megahertz of the band edges and
4. -28 dBm/MHz beyond 30 megahertz from the band edges.

### 5.4.2 Test Environment conditions

- Ambient temperature : (18 ~ 20) °C • Relative Humidity : (40 ~ 42) % R.H.

### 5.4.3 Measurement Procedure

The measurements procedure of the Spurious RF Radiated emissions is as following describe method.

1. The EUT was placed on the top of a rotating table (0.8 meters for below 1 GHz and 1.5 meters for above 1 GHz) above the ground at a 3 meter camber. The table was rotated 360 degree to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna master.
3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both Horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotating table was turned from 0 - 360 degrees to find the maximum reading.
5. The measuring receiver was set to peak detector and specified bandwidth with max hold function.
6. Low, Middle and high channels were measured, and radiation measurements are performed in X, Y, Z axis positioning. And found the worst axis position and only the test worst case mode is recorded in the report.

- The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter.  
The worst-case emissions are reported.
- Field strengths are calculated using the Measurement quantity conversions in ANSI C63.26-2015 Section 5.2.7:
  - a)  $E(\text{dBuV/m}) = \text{Measured amplitude level (dBm)} + 107 + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$
  - b)  $EIRP (\text{dBm}) = E(\text{dBuV/m}) + 20\log D - 104.8$ ; where D is the measurement distance in meters.

### 5.4.4 Measurement Uncertainty

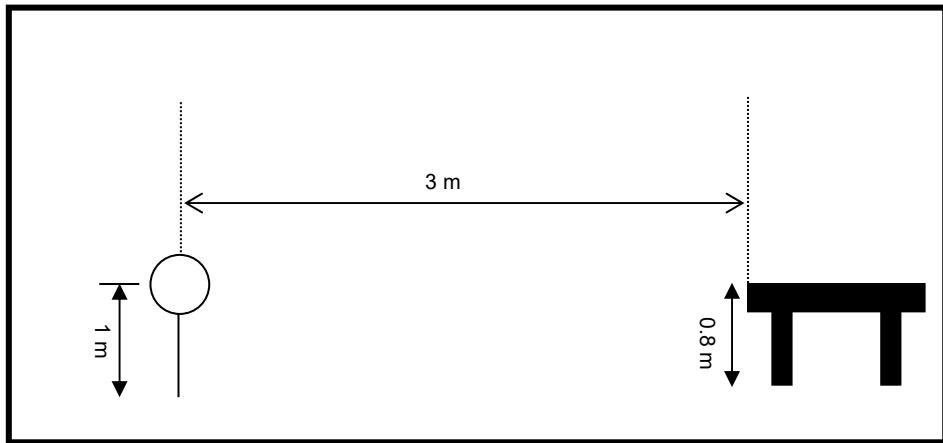
The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of  $k = 2$  to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the UCISPR measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Radiated Emission measurement: Below 1 GHz: 3.88 dB (CL: Approx 95 %, k=2)

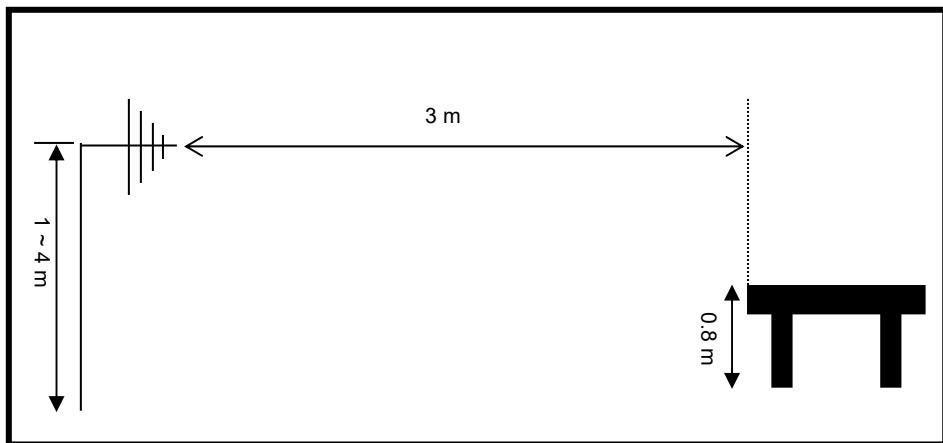
Above 1 GHz: 3.04 dB (CL: Approx 95 %, k=2)

#### 5.4.5 Test Configuration

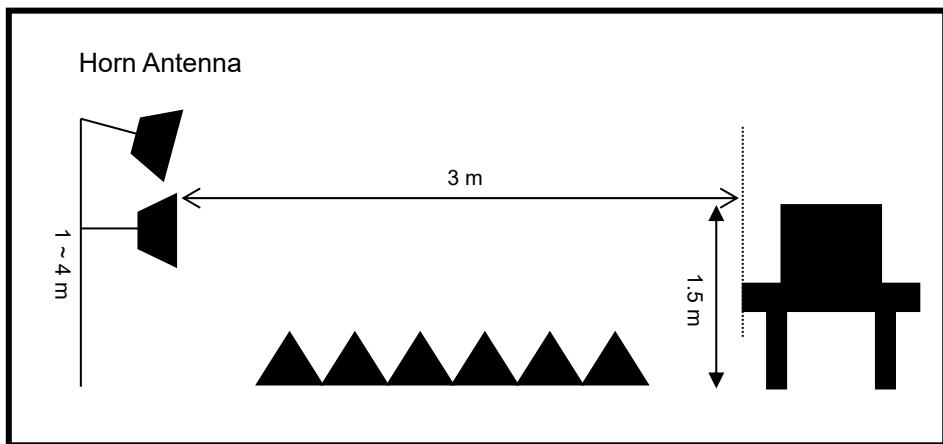
Radiated emission setup, below 30 MHz



Radiated emission setup, below 1 000 MHz



Radiated emission setup, above 1 GHz



### 5.4.6 Measurement Result

Meas. Range (GHz)	Freq. (GHz)	Reading (dB $\mu$ V/m)	Antenna			CL (dB)	AMP (dB)	Meas Result (dB $\mu$ V/m)	EIRP (dBm)	Limit (dBm)	Mgn. (dB)	Result
			PK	Height (m)	Pol. (H/V)			PK	PK		PK	
0.03 ~ 1.0	0.118	35.43	1-4	V	12.71	1.55	46.50	35.43	-59.77	-28	31.77	Compliance
	0.358	37.21	1-4	V	20.94	2.68	46.41	37.21	-57.99	-28	29.99	Compliance
	0.558	33.20	1-4	H	24.95	3.30	46.24	33.20	-62.00	-28	34.00	Compliance
1.0 ~ 3.0	2.717	43.82	1.5	H	31.82	7.52	45.64	43.82	-51.38	-28	23.38	Compliance
	2.461	44.21	1.5	V	31.56	6.80	45.66	44.21	-50.99	-28	22.99	Compliance
3.0 ~ 7.0	5.429	44.78	1.5	V	33.97	10.71	45.39	44.78	-50.42	-28	22.42	Compliance
	6.551	45.57	1.5	H	35.14	11.88	44.86	45.57	-49.63	-28	21.63	Compliance
7.0 ~ 18.0	17.168	48.74	1.5	H	41.61	19.63	44.53	48.74	-46.46	-28	18.46	Compliance
	17.331	48.86	1.5	V	41.53	19.67	44.20	48.86	-46.34	-28	18.34	Compliance
18.0 ~ 26.0	25.962	47.88	1.5	H	39.30	15.97	48.83	47.88	-47.32	-28	19.32	Compliance
	26.000	48.23	1.5	V	39.30	15.99	48.81	48.23	-46.97	-28	18.97	Compliance
26.0 ~ 40.0	39.485	51.55	1.5	H	46.20	19.03	51.07	51.55	-43.65	-28	15.65	Compliance
	39.180	51.41	1.5	V	46.20	18.94	51.49	51.41	-43.79	-28	15.79	Compliance

#### ※Note

- Freq.(MHz) : Measurement frequency
- Reading(dB $\mu$ V/m) : includes values for Antenna factor, Cable loss, and Amp gain
- Antenna (Height, Pol, Fctr) : Antenna Height, Polarization and Factor
- CL(dB) : Cable loss
- AMP(dB) : Preamplifier gain(dB)
- Measurement distance: 3 m
- Meas Result (dB $\mu$ V/m) : Reading(dB $\mu$ V/m) + Antenna factor.(dB/m) + CL(dB) - AMP(dB)
- EIRP(dBm): E(dBuV/m) + 20logD - 104.8; where D is measurement distance in meters.
- Limit(dBm): Limit according to ref. KDB Guidance 511808 D01 C-V2X v02, section 3.3
- Mgn(dB) : Limit (dBm) - EIRP(dBm)
- The transmitter radiated spectrum was investigated from 30 MHz to 40 GHz.