Federal Communications Commission
Office of Engineering and Technology
Laboratory Division

Equipment Authorization for Cellular Vehicle-to-Everything (C-V2X) Devices for Operation according to Part 90 and Part 95 Rules

02/24/2025

1. Introduction

This publication provides administrative and technical guidance for obtaining a certification grant under part 2 Subpart J of the Commission rules to permit cellular vehicle-to-everything (C-V2X) technology to operate in the upper 30 megahertz (5895-5925 MHz) of the 5.9 GHz band (5850-5925 MHz). This publication supersedes previous guidance provided under 511808 D01 C-V2X Waiver v01r01.

2. Equipment Authorization

The equipment must demonstrate the technical requirements in Part 90 Subpart M and Part 95 Subpart L rules.

Devices certified under the previous waiver order are grandfathered, and no additional action is required if no changes are made. Any changes—such as hardware or firmware—will void the previous certification, and no new permissive changes are permitted.

DSRC equipment must cease operation on or before December 14, 2026 (i.e., 2 years after the date the rules sunsetting DSRC operations were published in the Federal Register).

Roadside Units (RSU) will be filed as a separate application under the equipment class CVR.

On-board Units (OBU) without geo-fencing will be filed as a separate application under the equipment class CVO.

On-board Units (OBU) with geo-fencing will be filed as a separate application under the equipment class CVG.

Old equipment classes[1] are no longer permitted, as of 02/11/2025.

[1] Old equipment classes ITR, ITO for devices Certified under the FCC DA 23-343 and modified by DA 23-586: for AAEON Technology Inc (OHB)., Advantech Co., Ltd., Applied Information, Inc., Cohda Wireless Pty Ltd., Commsignia, Inc., Danlaw Inc., HARMAN International Industries, Inc., Kapsch TrafficCom USA Inc., and Panasonic Corporation of North America.DA 23-1048: DENSO International America, Inc.DA24-707: Autotalks, Innowireless, Keysight, Subaru. Publication as defined in KDB Publication 511808. And DSRC equipment under TNB.

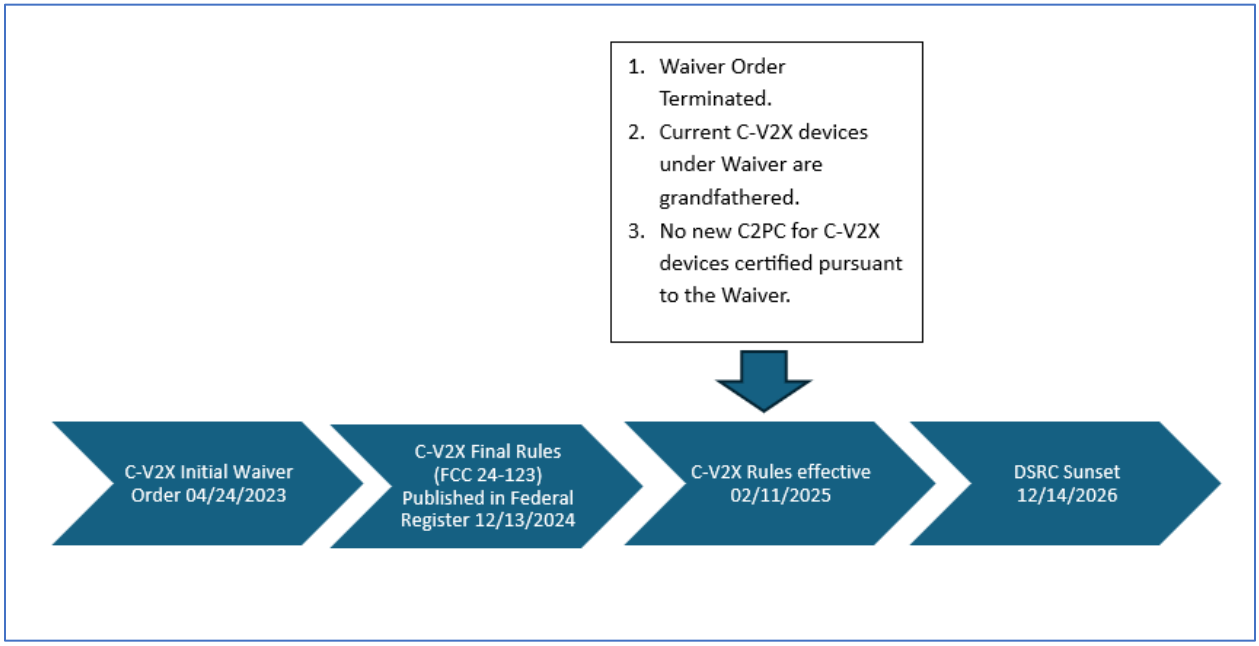

Figure 1. Timeline

2.1 Equipment Authorization Restrictions

a) Modules
   i. OBU modules with geofencing are not permitted.
   ii. RSU modules and OBU modules without geofencing capability are permitted; for all modules, the integration instructions filed with the application shall clearly state the conditions of use under the rules, including installation height for RSU modules.

b) Other
   i. Adding capability under the new rules to an existing device certified under the Waiver Order is not permitted. A device capable of operating under the new rules requires a new FCC ID. In other words, a composite device operating under the Waiver Order and the new rules is not permitted.

3. Technical Requirements

3.1 Occupied bandwidth

Measure 26 dB and 99% power bandwidth following procedures in ANSI C63.26 section 5.4.

3.2 C-2VX Transmit Power Test Procedures

OBUs and RSUs may be evaluated in a conducted or radiated setup to determine the maximum average root mean square (RMS) Effective Isotropic Radiated Power (EIRP). If conducted measurements are performed, ANSI C63.26 section 5.2.4 and Annex C shall be referenced. If radiated emission measurements are performed, ANSI C63.26 sections 5.5 and 5.2.4, along with Annex C, shall be referenced. Conducted power measurements shall only be used if the characterized antenna data and the antenna datasheet provide sufficient resolution to determine the antenna gain at the different elevation angles to show compliance, for example ±5 degrees.

While the limits are written as PSD EIRP limits, the measurement shall be interpreted as an integration across the channel bandwidth. All channels and bandwidths shall be evaluated for transmit power. All radio configurations (modulation, RB configuration, etc.) shall be investigated to ensure the worst-case configuration is evaluated.

For devices with MIMO capabilities, follow the procedures specified in KDB Publication 662911. Care shall be taken to identify if the transmitter output signals are considered correlated or uncorrelated for directional gain if EIRP is calculated.

Channel carrier aggregation techniques are permitted in the 5895-5925 MHz band. For an OBU, the total power of the aggregated channel shall comply with §95.3204 (a) or (b) as applicable to the type of OBU. For example, two 10MHz channels operating on 5895-5905 and 5905-5915 to create a 20MHz channel for an OBU without geofencing would have a 23 dBm/20 MHz limit. Aggregating two non-contiguous 10MHz channels on 5895-5905 and 5915-5925 to create a 20MHz channel is not permitted as that new channel is not defined. RSUs employing carrier aggregation techniques shall comply with §90.391.

Antenna specifications shall be included in the filing. This information can be included in the operational description if it is proprietary.

3.2.1 OBU Transmit Power Test Procedures

a) 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.

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†
5915-5925	10	33	33†
5895-5915	20	33	23
5905-5925	20	33	33†
5895-5925	30	33	23
	* Coordination zones of §90.387(b)[2] † Reduced to 27dBm within ± 5 degrees of horizontal		

Table 1. OBU EIRP Limits

b) 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.

c) 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.[3]

[2] *See* also, Table 3 below. Geofence radius is in kilometers (km).

[3] Electric field measurements are typically made in terms of dBµV/m and need to be converted to EIRP. This can be accomplished using the following equation: EIRP (dBm) = E_0 + 20log$_{10}$(d) – 104.8 where E_0 is the electric field measured in dBµV/m and d is the measurement distance in meters.

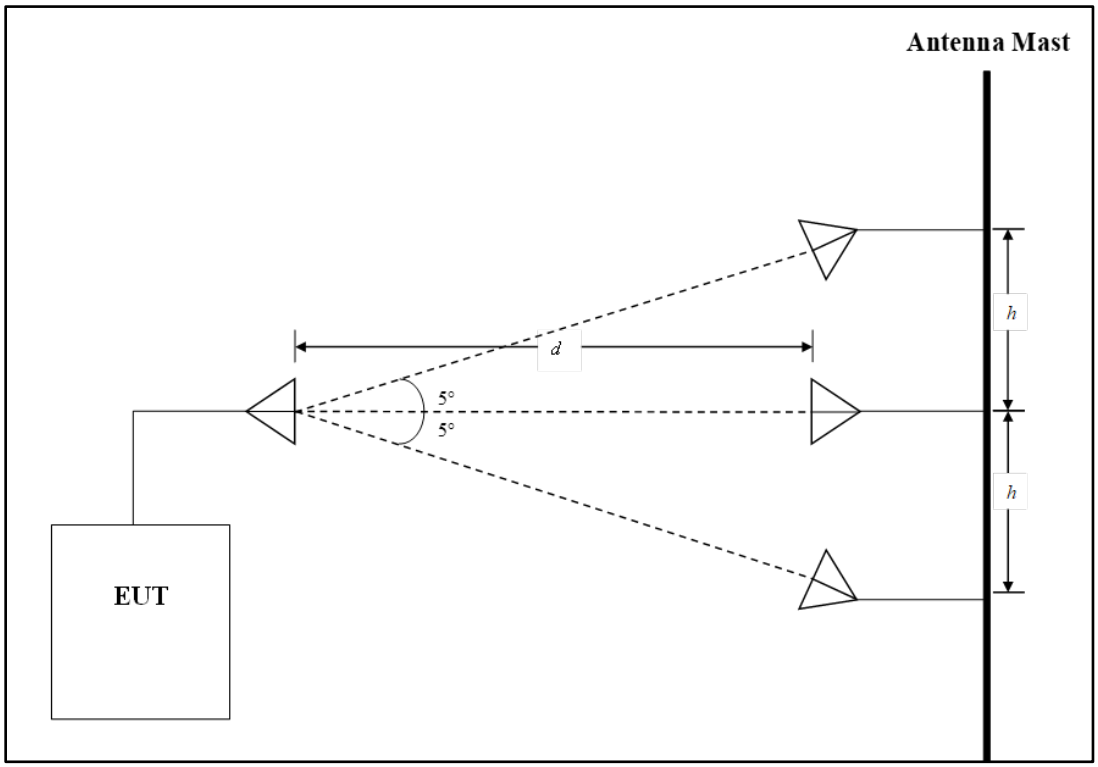

Figure 2. C-V2X OBU Radiated Test Setup Diagram

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[4] relative to the transmit antenna. Measurements or calculations for EIRP shall be performed at the upper and lower edges of the ±5-degree beam width. If the maximum EIRP is less than 27 dBm, then additional testing for ±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 ± 5 degrees elevation from the horizontal plane.

[4] Antenna mast height (h) is determined by 0.0875*d, where d is the measurement distance.

3.2.2 RSU Transmit Power Test Procedures

a) RSUs employing C-V2X technologies shall have a maximum EIRP not exceeding the limits provided in §90.391. The EIRP is measured as the maximum EIRP toward the horizon or horizontal, whichever is greater, of the gain associated with the main or center of the transmission beam. The radiation center of an RSU antenna shall not exceed 8 meters above the roadway surface bed. An RSU may employ an antenna with a height exceeding 8 meters but not exceeding 15 meters, provided the EIRP is reduced accordingly, as outlined in Table 2.

b) If an RSU transmit antenna operates between 8 and 15 meters, additional measurements shall be made to demonstrate the proper reduction in EIRP. The user/installation manual must provide adequate guidance to ensure the installer has enough information to input the correct power based on the installation height.

Channel (MHz)	**Channel Bandwidth** (MHz)	**EIRP*** (dBm/BW)
5895-5925	10	33 dBm
5895-5925	20	33 dBm
5895-5925	30	33 dBm
* Up to 8 meters above the roadway surface bed. To operate above 8 and up to 15 meters the EIRP shall be reduced by 20*log(H_t/8), where H_t is the height of the RSU transmit antenna above the roadway surface bed.		

Table 2. RSU EIRP Limits

3.3 Out-of-Band Emissions (OOBE)

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 ± 1 megahertz of the band edges.
   2. -13 dBm/MHz within ± 1 megahertz to ± 5 megahertz of the band edges.
   3. -16 dBm/MHz within ± 5 megahertz to ± 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.

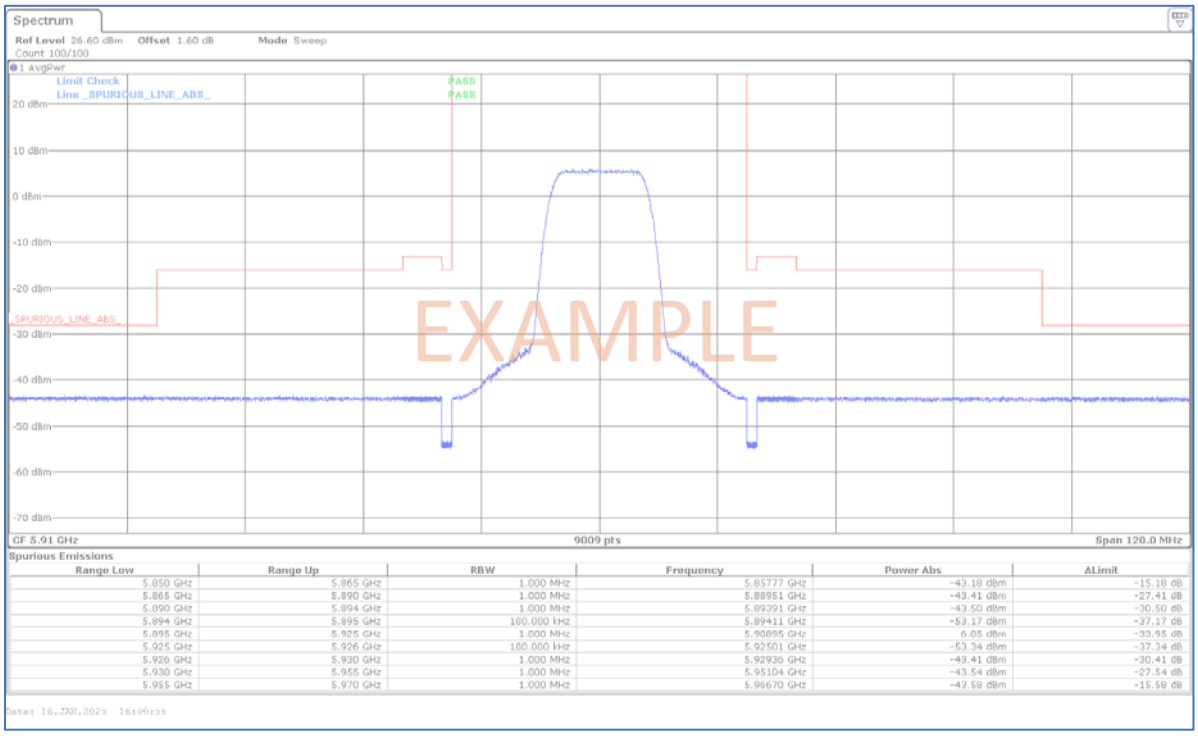

Figure 3. Example of C-V2X OOBE limits plot

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	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	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	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto
Sweep Time	1.01 ms	1.01 ms	1.01 ms	1.01 ms	1.01 ms	1.01 ms	1.01 ms	1.01 ms	1.01 ms
Detector	RMS	RMS	RMS	RMS	RMS	RMS	RMS	RMS	RMS
Ref. Level	26.6 dBm	26.6 dBm	26.6 dBm	26.6 dBm	26.6 dBm	26.6 dBm	26.6 dBm	26.6 dBm	26.6 dBm
RF Att. Mode	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual
RF Attenuator	40 dB	40 dB	40 dB	40 dB	40 dB	40 dB	40 dB	40 dB	40 dB
Preamp	Off	Off	Off	Off	Off	Off	Off	Off	Off
Sweep Points	1001	1001	1001	1001	1001	1001	1001	1001	1001
Stop After Sweep	Off	Off	Off	Off	Off	Off	Off	Off	Off
Transducer	None	None	None	None	None	None	None	None	None
Limit Check	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute	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 (N_{ANT}), where N_{ANT} 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.

3.4 OBU Geofencing Requirements and Test Procedures

OBUs incorporating a geofencing mechanism to protect the appropriate areas around coordination zones listed in Table 3 may operate at higher power outside these zones per Table 1. A geolocation mechanism is mandatory for OBUs with geofencing capability, filed under equipment class CVG, and must include the following in a separate test report:

a) Applicants for certification must provide a narrative describing the geofencing mechanism used.
b) The geofencing mechanism may be an integrated Global Navigation Satellite System (GNSS) or a separate GNSS system source that uses a full-time connection.
c) The GNSS system source can only be received from U.S. licensed or approved satellites under §25.137; e.g., GLONASS and BEIDOU are not permitted.
d) Specify the expected meter accuracy for one standard deviation or Circular Error Probability (CEP).
e) Specify maximum EIRP when the device cannot retrieve an accurate location fix. That is the EIRP in a default mode as an OBU without geofencing.
f) Applicants must verify that the device reduces power when entering a coordination zone. This can be done by creating a local test coordination zone and radius on the OBU to demonstrate how the OBU adjusts its power when entering the test location. The test report must include the time between high and low power versus entry time and power adjustment. It must also list the test coordination zone, the radius used for testing, and the speed at which the device traveled when entering the coordination zone.
g) If coordination zones and parameters are subsequently modified or new coordination zones and parameters are added, a mechanism must be available to update OBUs with the new information. Since no standard is identified, a manufacturer shall provide details of how this is accomplished. All geofencing OBUs shall have internet access to a manufacturer's push service to update coordination zones and parameters if necessary, according to FCC 24-123 paragraph 47. Coordination zones based on industry community understanding shall use the Commission's Universal Licensing System (ULS) database, which will be updated as soon as practicable based on NTIA, authorizing additional station locations and coordinates.
h) At a minimum, information identified in e) & f) above must be provided in a test report specific to the geofencing requirements and placed in the “Test Reports” exhibit type on form 731. Information required in a), b), c), d) & g) may be included in the operational description as long as it is clearly identified.

Location	Latitude	Longitude	Coordination Zone Radius (km)
Anclote, Florida	28°11'18"N	82°47'40"W	45
Cape Canaveral, Florida	28°28'54"N	80°34'35"W	47
Cape San Blas, Florida	29°40'31"N	85°20'48"W	47
Carabelle Field, Florida	29°50'38"N	84°39'46"W	36
Charleston, South Carolina	32°51'48"N	79°57'48"W	16
Edwards, California	34°56'43"N	117°54'50"W	53
Eglin, Florida	30°37'51"N	86°24'16"W	103
Fort Walton Beach, Florida	30°24'53"N	86°39'58"W	41
Kennedy Space Center Florida	28°25'29"N	80°39'51"W	47
Key West, Florida	24°33'09"N	81°48'28"W	12
Kirtland AFB, New Mexico	34°59'51"N	106°28'54"W	15
Kokeepark, Hawaii	22°07'35"N	159°40'06"W	5
MacDill, Florida	27°50'37"N	82°30'04"W	47
NV Test Training Range, Nevada	37°18'27"N	116°10'24"W	186
Patuxent River, Maryland	38°16'55"N	76°25'12"W	6
Pearl Harbor, Hawaii	21°21'17"N	157°57'51"W	16
Pillar Point, California	37°29'52"N	122°29'59"W	36
Poker Flat, Alaska	65°07'36"N	147°29'21"W	13
Port Canaveral, Florida	28°24'42"N	80°36'17"W	19
Port Hueneme, California	34°08'60"N	119°12'24"W	24
Point Mugu, California	34°07'17"N	119°09'1"W	18
Saddlebunch Keys, Florida	24°38'51"N	81°36'22"W	29
San Diego, California	32°43'00"N	117°11'00"W	11
San Nicolas Island, California	33°14'47"N	119°31'07"W	195
Tonopah Test Range, Nevada	37°44'00"N	116°43'00"W	2
Vandenberg, California	34°34'58"N	120°33'42"W	55
Venice, Florida	27°04'37"N	82°27'03"W	50
Wallops Island, Virgina	37°51'23"N	75°30'41"W	48
White Sands Missile Range, New Mexico	32°58'26"N	106°23'43"W	158
Yuma, Arizona	32°54'03"N	114°23'10"W	2

Table 3. Coordination Locations (§90.387(b))

Note: This list is current as of 2/20/2025 and will be updated as soon as practicable if NTIA authorizes additional station locations and coordinates.

Change Notice:

09/15/2023: initial publication
02/09/2024: 511808 D01 C-V2X Waiver v01r01 replaces 511808 D01 C-V2X Waiver v01. Figure 2. Emissions Mask requirements were corrected to out-of-band emission requirements.
02/24/2025: 511808 D01 C-V2X v02 replaces 511808 D01 C-V2X Waiver v01r01 to account for FCC 24-123A.