



Engineering Test Report No. 2401464-02

| | | |
|----------------------|--|--|
| Report Date | July 26, 2024 | |
| Manufacturer Name | Lectronix, Inc | |
| Manufacturer Address | 5858 Enterprise Dr Lansing, MI 48911 | |
| Model No. | APS3 | |
| Date Received | July 8, 2024 | |
| Test Dates | July 10, 2024 – July 19, 2024 | |
| Specifications | FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.231(e) Innovation, Science, and Economic Development Canada, RSS-210 Innovation, Science, and Economic Development Canada, RSS-GEN | |
| Test Facility | Elite Electronic Engineering, Inc. 1516 Centre Circle, Downers Grove, IL 60515 | FCC Reg. Number: 269750 IC Reg. Number: 2987A CAB Identifier: US0107 |
| Signature | | |
| Tested by | Edwin Casas | |
| Signature | | |
| Approved by | Raymond J. Klouda, Registered Professional Engineer of Illinois – 44894 | |
| PO Number | 2462-1A | |

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1. Report Revision History

| Revision | Date | Description |
|----------|-------------|---|
| – | 05 AUG 2024 | Initial Release of Engineering Test Report No. 2401464-02 |
| | | |

2. Introduction

2.1. Scope of Tests

This document presents the results of a series of RF emissions tests that were performed on the Lectronix, Inc Wireless Tire Pressure Sensor (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was manufactured and submitted for testing by Lectronix, Inc located in Lansing, MI.

2.2. Purpose

The test series was performed to determine if the EUT meets the RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.231(e).

The test series was also performed to determine if the EUT meets the RF emission requirements of the Industry Canada Radio Standards Specification RSS-Gen and Industry Canada Radio Standards Specification RSS-210 for Transmitters.

Testing was performed in accordance with ANSI C63.10-2013.

2.3. Identification of the EUT

The EUTs were identified as follows:

| EUT Identification | |
|---------------------------|-------------------------------|
| EUT#1 | |
| Product Description | Wireless Tire Pressure Sensor |
| Model/Part No. | APS3 |
| S/N | 2F526C (DYNAMIC) |
| Band of Operation | 433.92MHz |
| Modulation Type | FSK |
| Software/Firmware Version | DynOneSec 240304 |
| Size of EUT | 1.11" x 1.11" x 1.01" |
| EUT#2 | |
| Product Description | Wireless Tire Pressure Sensor |
| Model/Part No. | APS3 |
| S/N | 6A3834 (C XMIT) |
| Band of Operation | 433.92MHz |
| Modulation Type | FSK |
| Software/Firmware Version | FCC Cont Xmit 240618 |
| 20dB Bandwidth | 225.8kHz |
| 99% Bandwidth | 380.78kHz |
| Size of EUT | 1.11" x 1.11" x 1.01" |

The EUTs listed above were used throughout the test series.

3. Power Input

The EUTs were powered by 3VDC from internal batteries.

4. Grounding

The EUTs were not connected to ground.

5. Support Equipment

The EUTs were submitted for testing along with the following support equipment:

| Description | Model # | S/N |
|-------------------------------------|---------------------|-----|
| Laptop | Lenovo IdeaPad S340 | --- |
| XBR Receiver & Dipole Antenna (USB) | 23914-A.1 | --- |

6. Interconnect Leads

No interconnect leads were used during the tests.

7. Modifications Made to the EUT

No modifications were made to the EUTs during the testing.

8. Modes of Operation

| Mode | Description |
|-------------------------|---|
| Continuous Transmission | Continuous transmission at 433.92MHz. Enabled after applying air pressure to "C XMIT" (EUT#2). |
| Normal Operation | Normal transmit operation at 433.92MHz. Enabled after applying air pressure to "DYNAMIC" (EUT#1). |

9. Test Specifications

The tests were performed to selected portions of, and in accordance with the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.231 and Innovation, Science, and Economic Development Canada, RSS-210 test specification(s).

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C
- ANSI C63.4-2014, "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"
- ANSI C63.10-2013, "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices"
- RSS-210 Issue 10, December 2019, "License-Exempt Radio Apparatus: Category I Equipment"
- RSS-Gen Issue 5, March 2019, Amendment 1, Innovation, Science, and Economic Development Canada, "Spectrum Management and Telecommunications, Radio Standards Specification, General Requirements for Compliance of Radio Apparatus"

10. Test Plan

No test plan was provided. Instructions were provided by personnel from Lectronix, Inc and used in conjunction with the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.231, Innovation, Science, and Economic Development Canada, RSS-210, and ANSI C63.4-2014 specifications.

11. Deviation, Additions to, or Exclusions from Test Specifications

There were no deviations, additions to, or exclusions from the test specifications during this test series.

12. Laboratory Conditions

| Ambient Parameters | Value |
|----------------------|----------|
| Temperature | 23.3°C |
| Relative Humidity | 51% |
| Atmospheric Pressure | 1017.6mb |

13. Summary

The following EMC tests were performed and the results are shown below:

| Test Description | Requirements | Test Methods | S/N | Results |
|---------------------------------|-------------------------|----------------------|---------------------|----------|
| Duty Cycle Factor Measurements | FCC 15C ISED RSS-210 | ANSI C63.10: 2013 | 2F526C (DYNAMIC) | Conforms |
| Spurious Radiated Emissions | FCC 15C ISED RSS-210 | ANSI C63.10: 2013 | 6A3834 (C XMIT) | Conforms |
| Occupied Bandwidth Measurements | FCC 15C ISED RSS-210 | ANSI C63.10: 2013 | 2F526C (DYNAMIC) | Conforms |

14. Sample Calculations

For Powerline Conducted Emissions:

The resultant voltage level (VL) is a summation in decibels (dB) of the receiver meter reading (MTR) and the cable loss factor (CF).

$$\text{Formula 1: } VL \text{ (dBuV)} = MTR \text{ (dBuV)} + CF \text{ (dB)}$$

For Radiated Emissions:

The resultant field strength (FS) is a summation in decibels (dB) of the receiver meter reading (MTR), the antenna correction factor (AF), and the cable loss factor (CF). If an external preamplifier is used, the total is reduced by its gain (-PA). If a distance correction (DC) is required, it is added to the total.

$$\text{Formula 1: } FS \text{ (dBuV/m)} = MTR \text{ (dBuV)} + AF \text{ (dB/m)} + CF \text{ (dB)} + (-PA \text{ (dB)}) + DC \text{ (dB)}$$

To convert the Field Strength dBuV/m term to uV/m, the dBuV/m is first divided by 20. The Base 10 AntiLog is taken of this quotient. The result is the Field Strength value in uV/m terms.

$$\text{Formula 2: } FS \text{ (uV/m)} = \text{AntiLog} [(FS \text{ (dBuV/m)})/20]$$

15. Statement of Conformity

The Llectronix, Inc Wireless Tire Pressure Sensor, Model No. APS3, did fully conform to the selected requirements of FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.231 and Innovation, Science, and Economic Development Canada, RSS-210.

16. Certification

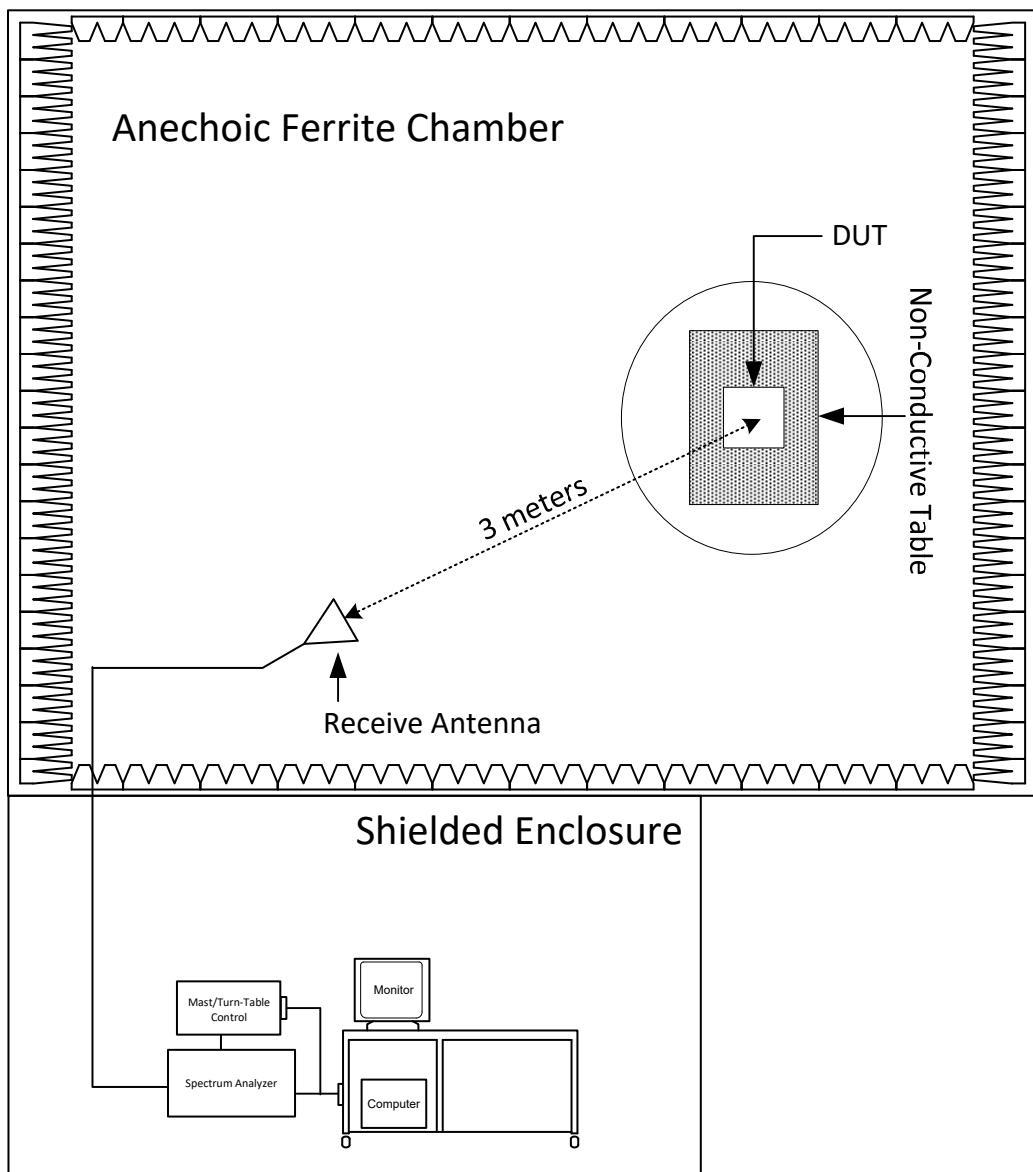
Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.231 and Innovation, Science, and Economic Development Canada, RSS-210 test specifications. The data presented in this test report pertains to the EUTs as provided by the customer on the test date specified. Any electrical or mechanical modifications made to the EUTs subsequent to the specified test date will serve to invalidate the data and void this certification.

17. Photographs of EUT





18. Block Diagram of Test Setup



Radiated Measurements Test Setup

19. Equipment List

| Eq ID | Equipment Description | Manufacturer | Model No. | Serial No. | Frequency Range | Cal Date | Due Date |
|-------|---------------------------------|--------------------|--------------------------|--------------|-----------------|------------|------------|
| APW10 | PREAMPLIFIER | PLANAR ELECTRONICS | PE2-35-120-5R0-10-12-SFF | PL11685/1241 | 1GHZ-20GHZ | 3/20/2024 | 3/20/2025 |
| CDZ3 | LAB WORKSTATION | ELITE | LWS-10 | | WINDOWS 10 | CNR | |
| NTA3 | BILOG ANTENNA | TESEQ | 6112D | 32853 | 25-1000MHz | 11/17/2022 | 11/17/2024 |
| NWQ0 | DOUBLE RIDGED WAVEGUIDE ANTENNA | ETS LINDGREN | 3117 | 66657 | 1GHZ-18GHZ | 6/24/2024 | 6/24/2026 |
| RBG2 | EMI ANALYZER | ROHDE & SCHWARZ | ESW44 | 101591 | 2HZ-44GHZ | 6/16/2024 | 6/16/2025 |
| RBG4 | EMI ANALYZER | ROHDE & SCHWARZ | ESW44 | 103007 | 2HZ-44GHZ | 3/16/2024 | 3/16/2025 |
| SES0 | 24VDC POWER SUPPLY | P-TRANS | FS-32024-1M | 001 | 18-27VDC | NOTE 1 | |
| T3D1 | 3DB, 50W ATTENUATOR | WEINSCHEL | 46-3-34 | BB1583 | DC-18GHZ | 12/20/2023 | 12/20/2025 |

N/A: Not Applicable

I/O: Initial Only

CNR: Calibration Not Required

NOTE 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

20. Duty Cycle Factor Measurements

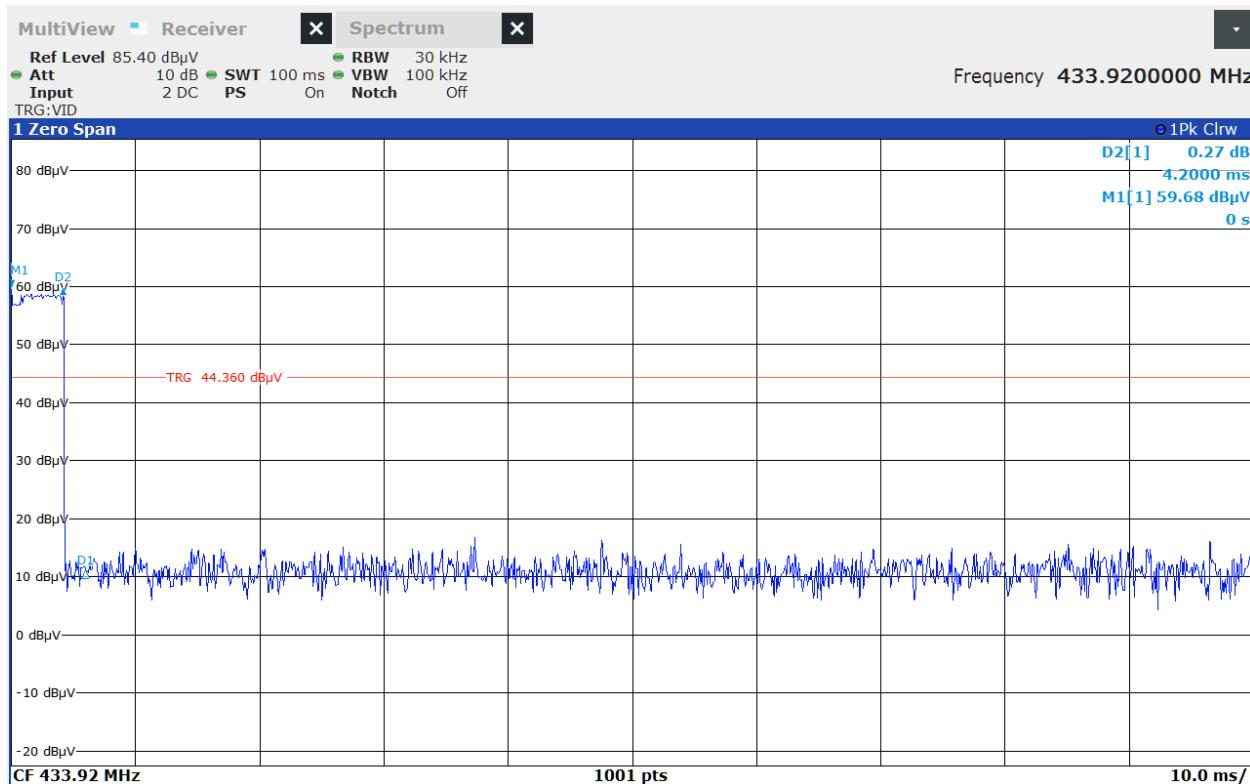
| Test Information | |
|------------------|-------------------------------|
| Manufacturer | Lectronix, Inc |
| Product | Wireless Tire Pressure Sensor |
| Model | APS3 |
| Serial No | 2F526C (DYNAMIC) |
| Mode | Normal Operation |
| Test Date | 7/10/2024 |

| Test Setup Details | |
|--------------------|------------|
| Setup Format | Tabletop |
| Type of Test Site | Bench Test |
| Notes | None |

| Measurement Uncertainty | |
|---|----------------------------------|
| Measurement Type | Expanded Measurement Uncertainty |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz) | 4.3 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz) | 3.1 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz) | 3.2 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz) | 3.3 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz) | 3.4 |

| Procedures | |
|--|--|
| <p>The duty cycle factor is used to convert peak detected readings to average readings. This factor is computed from the time domain trace of the pulse modulation signal. The following procedure was used to measure a representative sample:</p> <ol style="list-style-type: none"> 1) With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed on the spectrum analyzer. 2) The pulse width is measured and a plot of this measurement is recorded. 3) Next the number of pulses in the word period is measured and a plot is recorded. 4) Finally the length of the word period is measured and a third plot is recorded. If the word period exceeds 100msec, the word period is limited to 100msec. 5) The pulse width and number of pulses for the word period are used to compute the on-time. The duty cycle is then computed as the (on-time/ word period). 6) The duty cycle factor is computed from the duty cycle. | |

| Test Details | |
|-------------------|------------------|
| Manufacturer | Lectronix, Inc |
| Model | APS3 |
| S/N | 2F526C (DYNAMIC) |
| Mode | Normal Operation |
| Carrier Frequency | 433.92MHz |
| Parameters | On time = 4.2ms |
| Notes | None |



Manufacturer : Lectronix Inc
 Model Number : DYNAMIC
 Serial Number : 2F526C
 Mode : Normal Operation
 Parameters : Duty Cycle
 Date : 7/10/2024 3:35:48 PM
 Notes : 4.2ms

TRACE1 : Normal Peak (dB μ V) Trace

$$\text{Duty Cycle Factor} = 20 \log\left(\frac{4.2\text{msec}}{100\text{msec}}\right) = -27.53\text{dB}$$

21. Spurious Radiated Emissions

| Test Information | |
|------------------|-------------------------------|
| Manufacturer | Lectronix, Inc |
| Product | Wireless Tire Pressure Sensor |
| Model | APS3 |
| Serial No | 6A3834 (C XMIT) |
| Mode | Continuous Transmission |
| Test Date | 7/12/2024 |

| Test Setup Details | |
|--------------------|-----------------------|
| Setup Format | Tabletop |
| Type of Test Site | Semi-Anechoic Chamber |
| Test site used | Room 29 |
| Notes | None |

| Measurement Uncertainty | |
|---|----------------------------------|
| Measurement Type | Expanded Measurement Uncertainty |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz) | 4.3 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz) | 3.1 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz) | 3.2 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz) | 3.3 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz) | 3.4 |

| Requirements | | |
|--|----------------------------------|---|
| The EUT must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.205 et seq. as well as the requirements of the RSS-GEN specification Section 8.10. | | |
| Carrier Frequency (MHz) | Field Strength of Carrier (µV/m) | Field Strength of Spurious Emissions (µV/m) |
| 70-130 | 500 | 50 |
| 130-174 | 500 to 1500* | 50 to 150* |
| 174-260 | 1500 | 150 |
| 260-470 | 1500 to 5000* | 150 to 500* |
| Above 470 | 5000 | 500 |

*Linear interpolations

Procedures

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2014 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

A preliminary radiated emissions test was performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 30MHz to 4.5GHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final emission tests were then manually performed over the frequency range of 30MHz to 4.5GHz. Between 30MHz and 1000MHz, a bi-log antenna was used as the pick-up device. The EUT was placed on an 80cm high non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.

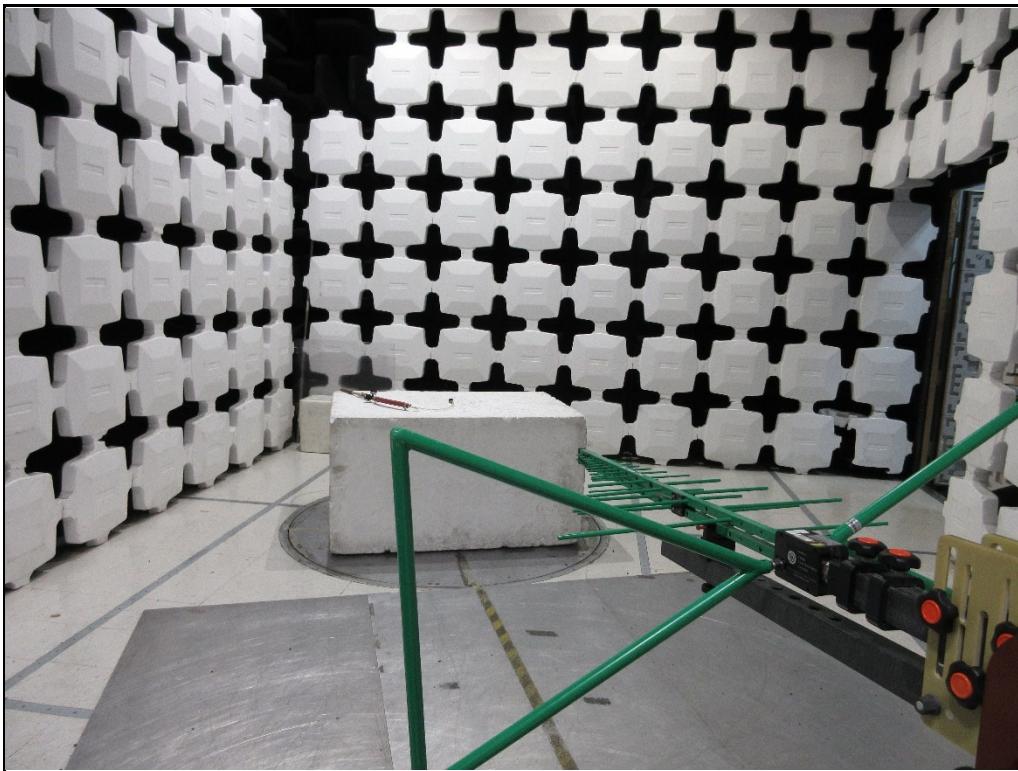
Above 1GHz, a broadband double ridged waveguide antenna was used as the pick-up device. The EUT was placed on an 150cm high non-conductive stand. A peak detector with a resolution bandwidth of 1 MHz was used on the spectrum analyzer.

The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

To ensure that maximum or worst case, emission levels were measured, the following steps were taken:

- 1) The EUT was rotated so that all of its sides were exposed to the receiving antenna.
- 2) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
- 3) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
- 4) For hand-held or body-worn devices, the EUT was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

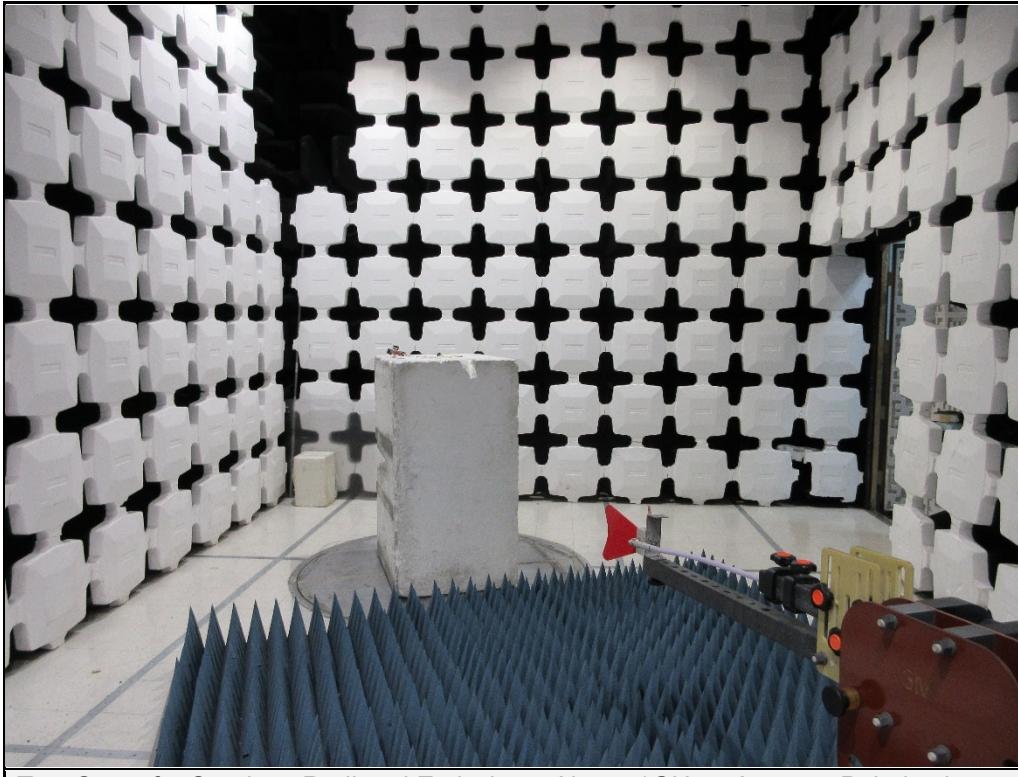
In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer and the antenna cannot be raised to 4 meters. The measuring antenna is raised or lowered as much as the cable will allow and the EUT is rotated through all axis to ensure the maximum readings are recorded.



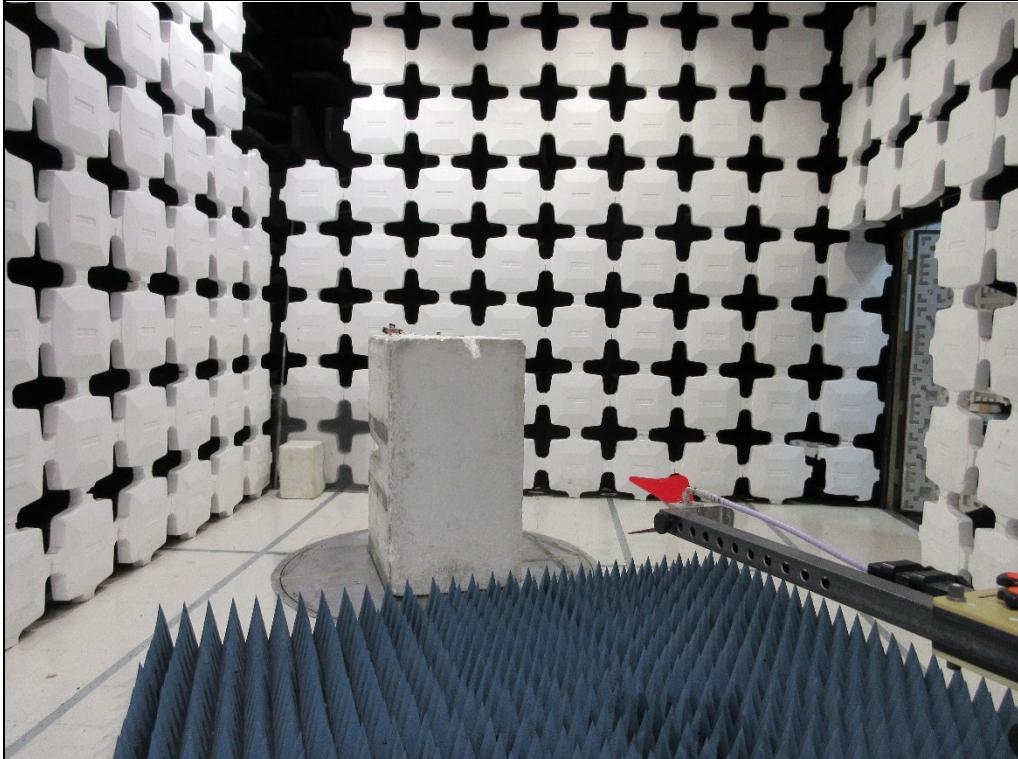
Test Setup for Spurious Radiated Emissions, 30-1000MHz – Antenna Polarization
Horizontal



Test Setup for Spurious Radiated Emissions, 30-1000MHz – Antenna Polarization
Vertical



Test Setup for Spurious Radiated Emissions, Above 1GHz – Antenna Polarization
Horizontal



Test Setup for Spurious Radiated Emissions, Above 1GHz – Antenna Polarization
Vertical

| Test Details | | | | | | | | | | | |
|-------------------|--|--|--|--|--|--|--|--|--|--|--|
| Manufacturer | | Lectronix, Inc | | | | | | | | | |
| Model | | APS3 | | | | | | | | | |
| S/N | | 6A3834 (C XMIT) | | | | | | | | | |
| Mode | | Continuous Transmission | | | | | | | | | |
| Carrier Frequency | | 433.92MHz | | | | | | | | | |
| Requirements | | Field Strength of Carrier Limit = 4398.7 μ V/m | | | | | | | | | |
| Notes | | None | | | | | | | | | |

| Freq. MHz | Ant Pol | Meter Reading (dBuV) | Ambient | CBL Fac (dB) | Ant Fac (dB/m) | Pre Amp (dB) | Duty Cycle (dB) | Total (dBuV/m) | Total (uV/m) | Limit (uV/m) | Margin (dB) |
|-----------|---------|----------------------|---------|--------------|----------------|--------------|-----------------|----------------|--------------|--------------|-------------|
| 433.920 | H | 50.3 | | 1.1 | 22.2 | 0.0 | -27.5 | 46.0 | 200.6 | 4398.7 | -26.8 |
| 433.920 | V | 48.1 | | 1.1 | 22.2 | 0.0 | -27.5 | 43.8 | 155.7 | 4398.7 | -29.0 |
| 867.840 | H | 12.7 | | 1.5 | 26.4 | 0.0 | -27.5 | 13.1 | 4.5 | 439.9 | -39.8 |
| 867.840 | V | 7.0 | | 1.5 | 26.4 | 0.0 | -27.5 | 7.4 | 2.3 | 439.9 | -45.5 |
| 1301.760 | H | 18.6 | | 1.9 | 29.5 | 0.0 | -27.5 | 22.5 | 13.4 | 500.0 | -31.4 |
| 1301.760 | V | 17.1 | | 1.9 | 29.5 | 0.0 | -27.5 | 21.0 | 11.2 | 500.0 | -33.0 |
| 1735.680 | H | 15.4 | * | 2.2 | 30.7 | 0.0 | -27.5 | 20.7 | 10.9 | 500.0 | -33.2 |
| 1735.680 | V | 15.3 | * | 2.2 | 30.7 | 0.0 | -27.5 | 20.6 | 10.7 | 500.0 | -33.4 |
| 2169.600 | H | 16.2 | * | 2.5 | 32.5 | 0.0 | -27.5 | 23.7 | 15.3 | 500.0 | -30.3 |
| 2169.600 | V | 19.1 | | 2.5 | 32.5 | 0.0 | -27.5 | 26.6 | 21.3 | 500.0 | -27.4 |
| 2603.520 | H | 18.2 | | 2.7 | 33.0 | 0.0 | -27.5 | 26.4 | 20.8 | 500.0 | -27.6 |
| 2603.520 | V | 19.8 | | 2.7 | 33.0 | 0.0 | -27.5 | 27.9 | 24.9 | 500.0 | -26.1 |
| 3037.440 | H | 17.0 | * | 3.0 | 33.5 | 0.0 | -27.5 | 25.9 | 19.8 | 500.0 | -28.0 |
| 3037.440 | V | 18.4 | * | 3.0 | 33.5 | 0.0 | -27.5 | 27.3 | 23.1 | 500.0 | -26.7 |
| 3471.360 | H | 17.2 | * | 3.2 | 33.9 | 0.0 | -27.5 | 26.7 | 21.6 | 500.0 | -27.3 |
| 3471.360 | V | 18.8 | | 3.2 | 33.9 | 0.0 | -27.5 | 28.4 | 26.2 | 500.0 | -25.6 |
| 3905.280 | H | 17.4 | * | 3.4 | 34.6 | 0.0 | -27.5 | 27.8 | 24.6 | 500.0 | -26.2 |
| 3905.280 | V | 17.8 | * | 3.4 | 34.6 | 0.0 | -27.5 | 28.2 | 25.7 | 500.0 | -25.8 |
| 4339.200 | H | 18.5 | * | 3.5 | 34.9 | 0.0 | -27.5 | 29.4 | 29.5 | 500.0 | -24.6 |
| 4339.200 | V | 17.5 | * | 3.5 | 34.9 | 0.0 | -27.5 | 28.4 | 26.4 | 500.0 | -25.5 |

22. Occupied Bandwidth Measurements

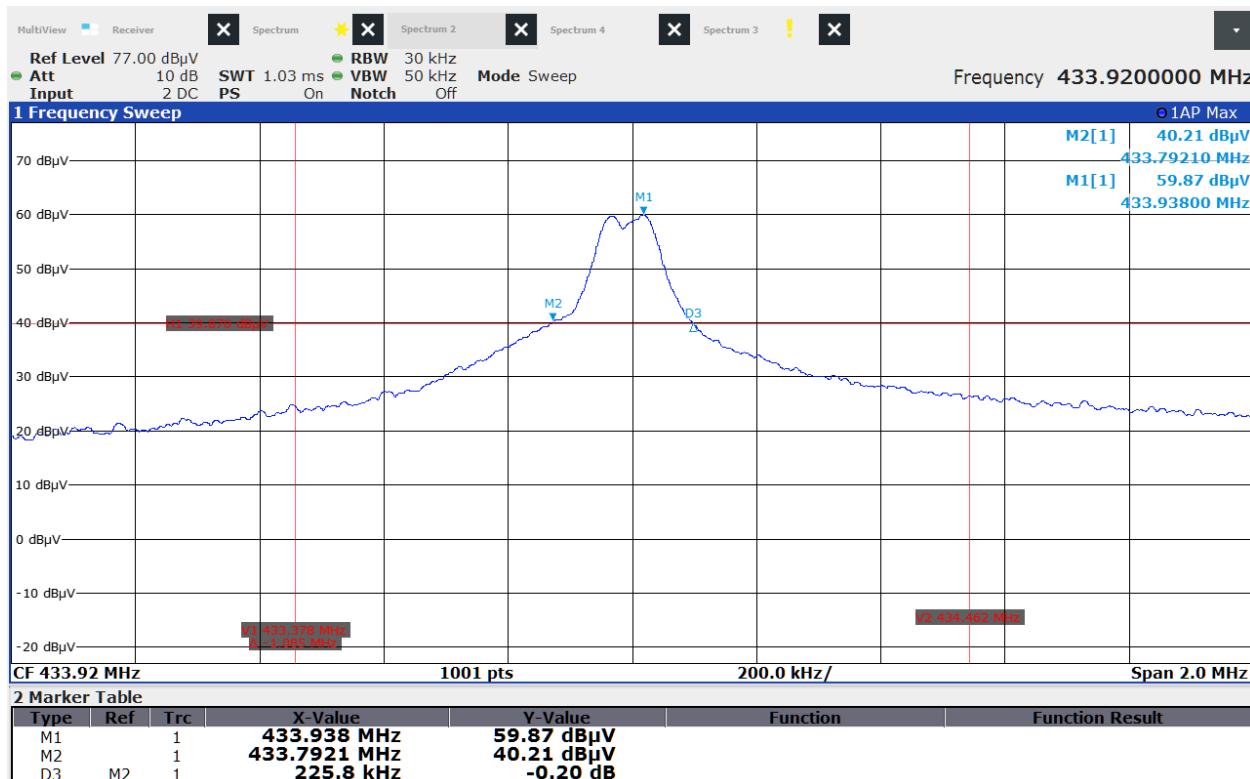
| Test Information | |
|------------------|-------------------------------|
| Manufacturer | Lectronix, Inc |
| Product | Wireless Tire Pressure Sensor |
| Model | APS3 |
| Serial No | 6A3834 (C XMIT) |
| Mode | Continuous Transmission |
| Test Date | 7/11/2024 |

| Test Setup Details | |
|--------------------|------------|
| Setup Format | Tabletop |
| Type of Test Site | Bench Test |
| Notes | None |

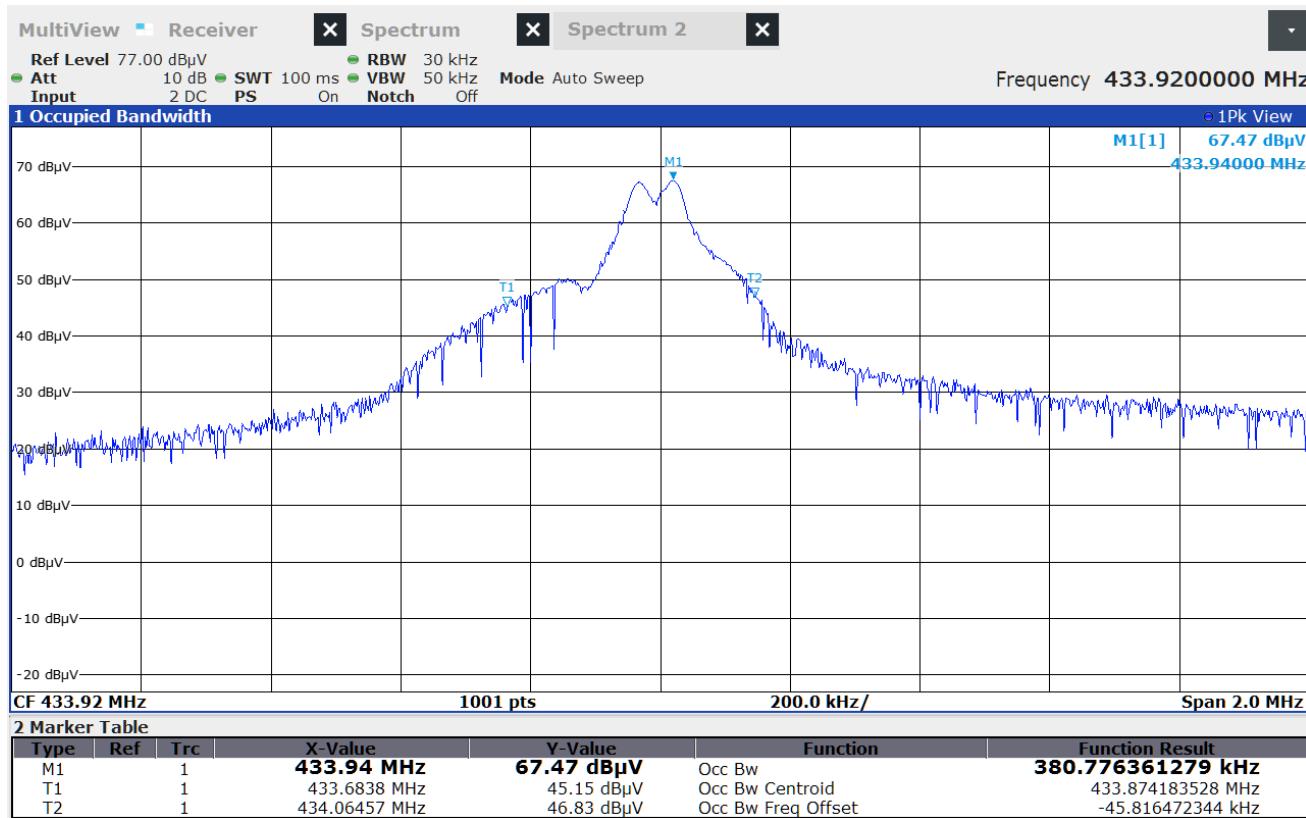
| Measurement Uncertainty | |
|---|----------------------------------|
| Measurement Type | Expanded Measurement Uncertainty |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz) | 4.3 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz) | 3.1 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz) | 3.2 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz) | 3.3 |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz) | 3.4 |

| Requirements | |
|---|---|
| FCC 15.231(c): | <p>The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.</p> <p>RSS-210, Annex A, Section A.1.3:</p> <p>The occupied bandwidth (99% Bandwidth) of momentarily operated devices shall be less than or equal to 0.25% of the center frequency for devices operating between 70 MHz and 900 MHz. For devices operating above 900 MHz, the occupied bandwidth shall be less than or equal to 0.5% of the center frequency.</p> |
| Procedures | |
| <p>The EUT was measured on a test bench. The unit was set to transmit continuously. With an antenna positioned nearby, occupied bandwidth emissions were displayed on the spectrum analyzer. The resolution bandwidth was set to 30kHz and span was set to 2MHz. A screen capture was taken of the frequency spectrum near the carrier using a screen dump function on the spectrum analyzer.</p> | |

| Test Details | |
|-------------------|-------------------------|
| Manufacturer | Lectronix, Inc |
| Model | APS3 |
| S/N | 6A3834 (C XMIT) |
| Mode | Continuous Transmission |
| Carrier Frequency | 433.92MHz |
| Notes | 20dB BW = 225.8kHz |



| Test Details | |
|-------------------|-------------------------|
| Manufacturer | Lectronix, Inc |
| Model | APS3 |
| S/N | 6A3834 (C XMIT) |
| Mode | Continuous Transmission |
| Carrier Frequency | 433.92MHz |
| Parameters | 99% BW = 380.78kHz |
| Notes | None |



23. Scope of Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

ELITE ELECTRONIC ENGINEERING, INC.
1516 Centre Circle
Downers Grove, IL 60515
Robert Bugielski (QA Manager) Phone: 630 495 9770 ext. 168
Email: rbugielski@elitetest.com
Craig Fanning (EMC Lab Manager) Phone: 630 495 9770 ext. 112
Email: cfanning@elitetest.com
Brandon Lugo (Automotive Team Leader) Phone: 630 495 9770 ext. 163
Email: blugo@elitetest.com
Richard King (FCC/Commercial Team Leader) Phone: 630 495 9770 ext. 123
Email: reking@elitetest.com
Website: www.elitetest.com

ELECTRICAL

Valid To: June 30, 2025

Certificate Number: 1786.01

In recognition of the successful completion of the A2LA Accreditation Program evaluation process, accreditation is granted to this laboratory to perform the following automotive electromagnetic compatibility and other electrical tests:

Test Technology:*Transient Immunity**(Max Voltage 60V/Max current 100A)*Test Method(s)¹:

ISO 7637-2 (including emissions); ISO 7637-3;
ISO 16750-2:2012, Sections 4.6.3 and 4.6.4;
CS-11979, Section 6.4; CS.00054, Section 5.9;
EMC-CS-2009.1 (CI220); FMC1278 (CI220, CI221, CI222);
GMW 3097, Section 3.5; SAE J1113-11; SAE J1113-12;
ECE Regulation 10.06 Annex 10

*Electrostatic Discharge (ESD)**(Up to +/-25kV)*

ISO 10605 (2001, 2008);

CS-11979 Section 7.0; CS.00054, Section 5.10;

EMC-CS-2009.1 (CI 280); FMC1278 (CI280); SAE J1113-13;

GMW 3097 Section 3.6

Conducted Emissions

CISPR 25 (2002, 2008), Sections 6.2 and 6.3;

CISPR 25 (2016), Sections 6.3 and 6.4;

CS-11979, Section 5.1; CS.00054, Sections 5.6.1 and 5.6.2;

GMW 3097, Section 3.3.2;

EMC-CS-2009.1 (CE 420); FMC1278 (CE420, CE421, CE 430, CE440)

(A2LA Cert. No. 1786.01) 08/15/2023



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5202 Presidents Court, Suite 220 | Frederick, MD 21703-8515 | Phone: 301 644 3248 | Fax: 240 454 9449 | www.A2LA.org

| <u>Test Technology:</u> | <u>Test Method(s)¹:</u> |
|--|--|
| Radiated Emissions Anechoic (Up to 6GHz) | CISPR 25 (2002, 2008), Section 6.4; CISPR 25 (2016), Section 6.5; CS-11979, Section 5.3; CS.00054, Section 5.6.3; GMW 3097, Section 3.3.1; EMC-CS-2009.1 (RE 310); FMC1278 (RE310, RE320); |
| Vehicle Radiated Emissions | CISPR 12; CISPR 36; ICES-002; ECE Regulation 10.06 Annex 5 |
| Bulk Current Injection (BCI) (1 to 400MHz 500mA) | ISO 11452-4; CS-11979, Section 6.1; CS.00054, Section 5.8.1; GMW 3097, Section 3.4.1; SAE J1113-4; EMC-CS-2009.1 (RI112); FMC1278 (RI112); ECE Regulation 10.06 Annex 9 |
| Radiated Immunity Anechoic (Up to 6GHz and 200V/m) (Including Radar Pulse 600V/m) | ISO 11452-2; CS-11979, Section 6.2; CS.00054, Section 5.8.2; GMW 3097, Section 3.4.2; EMC-CS-2009.1 (RI114); FMC1278 (RI114); SAE J1113-21; ECE Regulation 10.06 Annex 9 |
| Radiated Immunity Magnetic Field | ISO 11452-8; FMC 1278 (RI140) |
| Radiated Immunity Reverb (360MHz to 6GHz and 100V/m) | ISO/IEC 61000-4-21; GMW 3097, Section 3.4.3; EMC-CS-2009.1 (RI114); FMC1278 (RI114); ISO 11452-11 |
| Radiated Immunity (Portable Transmitters) (Up to 6GHz and 20W) | ISO 11452-9; EMC-CS-2009.1 (RI115); FMC1278 (RI115); GMW 3097, Sec 3.4.4 |
| Vehicle Radiated Immunity (ALSE) | ISO 11451-2; ECE Regulation 10.06 Annex 6 |
| Vehicle Product Specific EMC Standards | EN 14982; EN ISO 13309; ISO 13766; EN 50498; EC Regulation No. 2015/208; EN 55012 |
| Electrical Loads | ISO 16750-2 |
| Stripline | ISO 11452-5 |
| Transverse Electromagnetic (TEM) Cell | ISO 11452-3 |

Test Technology:
Test Method(s)¹:
Emissions

Radiated and Conducted
(3m Semi-anechoic chamber,
up to 40 GHz)

47 CFR, FCC Part 15 B (using ANSI C63.4:2014);
47 CFR, FCC Part 18 (using FCC MP-5:1986);
ICES-001; ICES-003; ICES-005;
IEC/CISPR 11, Ed. 4.1 (2004-06); AS/NZS CISPR 11 (2004);
IEC/CISPR 11 Ed 5 (2009-05) + A1 (2010);
KN 11 (2008-5) with RRL Notice No. 2008-3 (May 20, 2008);
CISPR 11; EN 55011; KS C 9811; CNS 13803 (1997, 2003);
CISPR 14-1; EN 55014-1; AS/NZS CISPR 14.1;
CISPR 16-2-1 (2008); CISPR 16-2-1; KS C 9814-1; KN 14-1;
IEC/CISPR 22 (1997);
EN 55022 (1998) + A1(2000);
EN 55022 (1998) + A1(2000) + A2(2003); EN 55022 (2006);
IEC/CISPR 22 (2008-09); AS/NZS CISPR 22 (2004);
AS/NZS CISPR 22, 3rd Edition (2006); KN 22 (up to 6 GHz);
CNS 13438 (up to 6 GHz); VCCI V-3 (up to 6 GHz);
CISPR 32; EN 55032; KS C 9832; KN 32;
ECE Regulation 10.06 Annex 7 (Broadband);
ECE Regulation 10.06 Annex 8 (Narrowband);
ECE Regulation 10.06 Annex 14 (Conducted)

Cellular Radiated Spurious Emissions

ETSI TS 151 010-1 GSM; 3GPP TS 51.010-1, Sec 12;
ETSI TS 134 124 UMTS; 3GPP TS 34.124;
ETSI TS 136 124 LTE; E-UTRA; 3GPP TS 36.124

Current Harmonics

IEC 61000-3-2; IEC 61000-3-12;
EN 61000-3-2; KN 61000-3-2;
KS C 9610-3-2; ECE Regulation 10.06 Annex 11

Flicker and Fluctuations

IEC 61000-3-3; IEC 61000-3-11;
EN 61000-3-3; KN 61000-3-3;
KS C 9610-3-3; ECE Regulation 10.06 Annex 12

Immunity

Electrostatic Discharge

IEC 61000-4-2, Ed. 1.2 (2001);
IEC 61000-4-2 (1995) + A1(1998) + A2(2000);
EN 61000-4-2 (1995); EN 61000-4-2 (2009-05);
KN 61000-4-2 (2008-5);
RRL Notice No. 2008-4 (May 20, 2008);
IEC 61000-4-2; EN 61000-4-2; KN 61000-4-2;
KS C 9610-4-2; IEEE C37.90.3 2001

Radiated Immunity

IEC 61000-4-3 (1995) + A1(1998) + A2(2000);
IEC 61000-4-3, Ed. 3.0 (2006-02);
IEC 61000-4-3, Ed. 3.2 (2010);
KN 61000-4-3 (2008-5);
RRL Notice No. 2008-4 (May 20, 2008);
IEC 61000-4-3; EN 61000-4-3; KN 61000-4-3;
KS C 9610-4-3; IEEE C37.90.2 2004

Test Technology:
Test Method(s)¹:
Immunity (cont'd)

Electrical Fast Transient/Burst

IEC 61000-4-4, Ed. 2.0 (2004-07);
 IEC 61000-4-4, Ed. 2.1 (2011);
 IEC 61000-4-4 (1995) + A1(2000) + A2(2001);
 KN 61000-4-4 (2008-5);
 RRL Notice No. 2008-5 (May 20, 2008);
 IEC 61000-4-4; EN 61000-4-4; KN 61000-4-4;
 KS C 9610-4-4; ECE Regulation 10.06 Annex 15

Surge

IEC 61000-4-5 (1995) + A1(2000);
 IEC 61000-4-5, Ed 1.1 (2005-11);
 EN 61000-4-5 (1995) + A1(2001);
 KN 61000-4-5 (2008-5);
 RRL Notice No. 2008-4 (May 20, 2008);
 IEC 61000-4-5; EN 61000-4-5; KN 61000-4-5;
 KS C 9610-4-5;
 IEEE C37.90.1 2012; IEEE STD C62.41.2 2002;
 ECE Regulation 10.06 Annex 16

Conducted Immunity

IEC 61000-4-6 (1996) + A1(2000);
 IEC 61000-4-6, Ed 2.0 (2006-05);
 IEC 61000-4-6 Ed. 3.0 (2008);
 KN 61000-4-6 (2008-5);
 RRL Notice No. 2008-4 (May 20, 2008);
 EN 61000-4-6 (1996) + A1(2001); IEC 61000-4-6;
 EN 61000-4-6; KN 61000-4-6; KS C 9610-4-6

 Power Frequency Magnetic Field
 Immunity (*Down to 3 A/m*)

IEC 61000-4-8 (1993) + A1(2000); IEC 61000-4-8 (2009);
 EN 61000-4-8 (1994) + A1(2000);
 KN 61000-4-8 (2008-5);
 RRL Notice No. 2008-4 (May 20, 2008);
 IEC 61000-4-8; EN 61000-4-8; KN 61000-4-8; KS C 9610-4-8

 Voltage Dips, Short Interrupts, and Line
 Voltage Variations

IEC 61000-4-11, Ed. 2 (2004-03);
 KN 61000-4-11 (2008-5);
 RRL Notice No. 2008-4 (May 20, 2008);
 IEC 61000-4-11; EN 61000-4-11; KN 61000-4-11;
 KS C 9610-4-11

Ring Wave

IEC 61000-4-12, Ed. 2 (2006-09);
 EN 61000-4-12:2006;
 IEC 61000-4-12; EN 61000-4-12; KN 61000-4-12;
 IEEE STD C62.41.2 2002

Test Technology:

Generic and Product Specific EMC Standards

Test Method(s)¹:

IEC/EN 61000-6-1; AS/NZS 61000-6-1; KN 61000-6-1;
 KS C 9610-6-1; IEC/EN 61000-6-2; AS/NZS 61000-6-2;
 KN 61000-6-2; KS C 9610-6-2; IEC/EN 61000-6-3;
 AS/NZS 61000-6-3; KN 61000-6-3; KS C 9610-6-3;
 IEC/EN 61000-6-4; AS/NZS 61000-6-4; KN 61000-6-4;
 KS C 9610-6-4; EN 50130-4; EN 61326-1; EN 50121-3-2;
 EN 12895; EN 50270; EN 50491-1; EN 50491-2; EN 50491-3;
 EN 55015; EN 60730-1; EN 60945; IEC 60533;
 EN 61326-2-6; EN 61800-3; IEC/CISPR 14-2; EN 55014-2;
 AS/NZS CISPR 14.2; KN 14-2; KS C 9814-2;
 IEC/CISPR 24; AS/NZS CISPR 24; EN 55024; KN 24;
 IEC/CISPR 35; AS/NZS CISPR 35; EN 55035; KN 35;
 KS C 9835; IEC 60601-1-2; IIS T0601-1-2

TxRx EMC Requirements

EN 301 489-1; EN 301 489-3; EN 301 489-9;
 EN 301 489-17; EN 301 489-19; EN 301 489-20

European Radio Test Standards

ETSI EN 300 086-1; ETSI EN 300 086-2;
 ETSI EN 300 113-1; ETSI EN 300 113-2;
 ETSI EN 300 220-1; ETSI EN 300 220-2;
 ETSI EN 300 220-3-1; ETSI EN 300 220-3-2;
 ETSI EN 300 330-1; ETSI EN 300 330-2;
 ETSI EN 300 440-1; ETSI EN 300 440-2;
 ETSI EN 300 422-1; ETSI EN 300 422-2;
 ETSI EN 300 328; ETSI EN 301 893;
 ETSI EN 301 511; ETSI EN 301 908-1;
 ETSI EN 908-2; ETSI EN 908-13;
 ETSI EN 303 413; ETSI EN 302 502;
 EN 303 340; EN 303 345-2; EN 303 345-3; EN 303 345-4

Canadian Radio Tests

RSS-102 measurement (RF Exposure Evaluation);
 RSS-102 measurement (Nerve Stimulation);
 SPR-002; RSS-111; RSS-112; RSS-117; RSS-119; RSS-123;
 RSS-125; RSS-127; RSS-130; RSS-131; RSS-132; RSS-133;
 RSS-134; RSS-135; RSS-137; RSS-139; RSS-140; RSS-141;
 RSS-142; RSS-170; RSS-181; RSS-182; RSS-191; RSS-192;
 RSS-194; RSS-195; RSS-196; RSS-197; RSS-199; RSS-210;
 RSS-211; RSS-213; RSS-215; RSS-216; RSS-220; RSS-222;
 RSS-236; RSS-238; RSS-243; RSS-244; RSS-247; RSS-248;
 RSS-251; RSS-252; RSS-287; RSS-288; RSS-310; RSS-GEN

Mexico Radio Tests

IFT-008-2015; NOM-208-SCFI-2016

Japan Radio Tests

Radio Law No. 131, Ordinance of MPT No. 37, 1981,
 MIC Notification No. 88:2004, Table No. 22-11;
 ARIB STD-T66, Regulation 18

Taiwan Radio Tests

LP-0002 (July 15, 2020)

| <u>Test Technology:</u> | <u>Test Method(s)¹:</u> |
|---|---|
| <i>Australia/New Zealand Radio Tests</i> | AS/NZS 4268; Radiocommunications (Short Range Devices) Standard (2014) |
| <i>Hong Kong Radio Tests</i> | HKCA 1039 Issue 6; HKCA 1042; HKCA 1033 Issue 7; HKCA 1061; HKCA 1008; HKCA 1043; HKCA 1057; HKCA 1073 |
| <i>Korean Radio Test Standards</i> | KN 301 489-1; KN 301 489-3; KN 301 489-9; KN 301 489-17; KN 301 489-52; KS X 3124; KS X 3125; KS X 3130; KS X 3126; KS X 3129 |
| <i>Vietnam Radio Test Standards</i> | QCVN 47:2015/BTTTT; QCVN 54:2020/BTTTT; QCVN 55:2011/BTTTT; QCVN 65:2013/BTTTT; QCVN 73:2013/BTTTT; QCVN 74:2020/BTTTT; QCVN 112:2017/BTTTT; QCVN 117:2020/BTTTT |
| <i>Vietnam EMC Test Standards</i> | QCVN 18:2014/BTTTT; QCVN 86:2019/BTTTT; QCVN 96:2015/BTTTT; QCVN 118:2018/BTTTT |
| <i>Unlicensed Radio Frequency Devices (3 Meter Semi-Anechoic Room)</i> | 47 CFR FCC Part 15C, 15D, 15E, 15F, 15G, 15H (using ANSI C63.10:2013, ANSI C63.17:2013 and FCC KDB 905462 D02 (v02)) |
| <i>Licensed Radio Service Equipment</i> | 47 CFR FCC Parts 20, 22, 24, 25, 27, 30, 73, 74, 80, 87, 90, 95, 96, 97, 101 (using ANSI/TIA-603-E, TIA-102.CAAA-E, ANSI C63.26:2015) |
| <i>OIA (Over the Air) Performance</i> GSM, GPRS, EGPRS UMTS (W-CDMA) LTE including CAT M1 A-GPS for UMTS/GSM LTS A-GPS, A-GLONASS, SIB8/SIB16 Large Device/Laptop/Tablet Testing Integrated Device Testing WiFi 802.11 a/b/g/n/a | CTIA Test Plan for Wireless Device Over-the-Air Performance (Method for Measurement for Radiated Power and Receiver Performance) V3.8.2; CTIA Test Plan for RF Performance Evaluation of WiFi Mobile Converged Devices V2.1.0 |

Test Technology: Test Method(s)¹:

Electrical Measurements and Simulation

AC Voltage / Current

(1mV to 5kV) 60 Hz
 (0.1V to 250V) up to 500 MHz
 (1µA to 150A) 60 Hz

FAA AC 150/5345-10H;
 FAA AC 150/5345-43J;
 FAA AC 150/5345-44K;
 FAA AC 150/5345-46E;
 FAA AC 150/5345-47C;

DC Voltage / Current

(1mV to 15 kV) / (1µA to 10A)

FAA EB 67D

Power Factor / Efficiency / Crest Factor

(Power to 30kW)

Resistance

(1mΩ to 4000MΩ)

Surge

(Up to 10 kV / 5 kA) (Combination Wave and Ring Wave)

On the following products and materials:

Telecommunications Terminal Equipment (TTE), Radio Equipment, Network Equipment, Information Technology Equipment (ITE), Automotive Electronic Equipment, Automotive Hybrid Electronic Devices, Maritime Navigation and Radio Communication Equipment and Systems, Vehicles, Boats and Internal Combustion Engine Driven Devices, Automotive, Aviation, and General Lighting Products, Medical Electrical Equipment, Motors, Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment, Household Appliances, Electric Tools, Low-voltage Switchgear and Control gear, Programmable Controllers, Electrical Equipment for Measurement, Control and Laboratory Use, Base Materials, Power and Data Transmission Cables and Connectors

¹ When the date, edition, version, etc. is not identified in the scope of accreditation, laboratories may use the version that immediately precedes the current version for a period of one year from the date of publication of the standard measurement method, per part C., Section 1 of A2LA R101 - *General Requirements- Accreditation of ISO-IEC 17025 Laboratories*.

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1²

| Rule Subpart/Technology | Test Method | Maximum Frequency (MHz) |
|---|--------------------------|-------------------------|
| <u>Unintentional Radiators</u> Part 15B | ANSI C63.4:2014 | 40000 |
| <u>Industrial, Scientific, and Medical Equipment</u> Part 18 | FCC MP-5 (February 1986) | 40000 |
| <u>Intentional Radiators</u> Part 15C | ANSI C63.10:2013 | 40000 |

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Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1²

| Rule Subpart/Technology | Test Method | Maximum Frequency (MHz) |
|---|--|-------------------------|
| <u>Unlicensed Personal Communication Systems Devices</u> | | |
| Part 15D | ANSI C63.17:2013 | 40000 |
| <u>U-NII without DFS Intentional Radiators</u> | | |
| Part 15E | ANSI C63.10:2013 | 40000 |
| <u>U-NII with DFS Intentional Radiators</u> | | |
| Part 15E | FCC KDB 905462 D02 (v02) | 40000 |
| <u>UWB Intentional Radiators</u> | | |
| Part 15F | ANSI C63.10:2013 | 40000 |
| <u>BPL Intentional Radiators</u> | | |
| Part 15G | ANSI C63.10:2013 | 40000 |
| <u>White Space Device Intentional Radiators</u> | | |
| Part 15H | ANSI C63.10:2013 | 40000 |
| <u>Commercial Mobile Services (FCC Licensed Radio Service Equipment)</u> | | |
| Parts 22 (cellular), 24, 25 (below 3 GHz), and 27 | ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015 | 40000 |
| <u>General Mobile Radio Services (FCC Licensed Radio Service Equipment)</u> | | |
| Parts 22 (non-cellular), 90 (below 3 GHz), 95, 97, and 101 (below 3 GHz) | ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015 | 40000 |
| <u>Citizens Broadband Radio Services (FCC Licensed Radio Service Equipment)</u> | | |
| Part 96 | ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015 | 40000 |
| <u>Maritime and Aviation Radio Services</u> | | |
| Parts 80 and 87 | ANSI/TIA-603-E; ANSI C63.26:2015 | 40000 |
| <u>Microwave and Millimeter Bands Radio Services</u> | | |
| Parts 25, 30, 74, 90 (above 3 GHz), 97 (above 3 GHz), and 101 | ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015 | 40000 |

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Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1²

| Rule Subpart/Technology | Test Method | Maximum Frequency (MHz) |
|--|--|-------------------------|
| <u>Broadcast Radio Services</u> | | |
| Parts 73 and 74 (below 3 GHz) | ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015 | 40000 |
| <u>Signal Boosters</u> | | |
| Part 20 (Wideband Consumer Signal Boosters, Provider-specific signal boosters, and Industrial Signal Boosters) Section 90.219 | ANSI C63.26:2015 | 40000 |

² Accreditation does not imply acceptance to the FCC equipment authorization program. Please see the FCC website (<https://apps.fcc.gov/oetcf/eas/>) for a listing of FCC approved laboratories.



Accredited Laboratory

A2LA has accredited

ELITE ELECTRONIC ENGINEERING INC.

Downers Grove, IL

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 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 15th day of August 2023.



Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1786.01
Valid to June 30, 2025

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