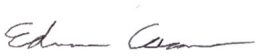
Engineering Test Report No. 2401464-05	
Report Date	July 26, 2024
Manufacturer Name	Lectronix, Inc
Manufacturer Address	5858 Enterprise Dr Lansing, MI 48911
Product Name Brand/Model No.	Wireless Tire Pressure Sensor APS3
Date Received	July 8, 2024
Assessment Date	July 25, 2024
Specifications	FCC 47 CFR Part 2.1093 KDB, 447498 D01 OET Bulletin 65:1997 RSS-102 EN 62311 EN 62479 AS/NZS 2772.2 RPS S-1
Test Facility	Elite Electronic Engineering, Inc. 1516 Centre Circle, Downers Grove, IL 60515
Signature	
Tested by	Edwin Casas
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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. ETR2401464-05

2. Introduction

The FCC, Innovation, Science and Economic Development Canada, European Union and Australia/New Zealand publish standards regarding the evaluation of the RF Exposure hazard of radio communications devices. An evaluation has been performed on the Lectronix, Inc Wireless Tire Pressure Sensor, Model No. APS3 pursuant to the relevant requirements.

3. Subject of Investigation

This document presents the demonstration of RF Exposure compliance on a Wireless Tire Pressure Sensor, (hereinafter referred to as the Equipment under Test (EUT)). The EUT was identified as follows:

EUT Identification	
Description	Wireless Tire Pressure Sensor
Model/Part No.	APS3
S/N	6ALE41 (C XMIT)
Radio Access Technology	Short Range Device (SRD)
Bands of Operation	433.92MHz
ERP	-20.5dBm
EIRP	-18.35dBm

4. Standards and Requirements

The tests were performed to selected portions of, and in accordance with the following specifications.

- 47 CFR Parts 1.1310, 2.1091 and 2.1093 Code of Federal Regulations, Title 47, Telecommunications
- KDB 447498 D01 – “RF Exposure Procedures and Equipment Authorization Polices for Mobile and Portable Devices, General RF Exposure Guidance v06”
- OET Bulletin 65 Edition 97-01:1997 – “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”
- ANSI/IEEE C95.1:1992 – "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz,"
- RSS-102, Issue 5 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands
- EN 62311:2020 Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)
- EN 62479:2010 Assessment of the Compliance of Low Power Electronic and Electrical Equipment with the Basic Restrictions Related to Human Exposure to Electromagnetic Fields (10MHz-300GHz)
- 1999/519/EC Council Recommendation on the Limitation of Exposure of The General Public to Electromagnetic fields (0Hz-300GHz)
- AS/NZS 2772.2: 2016 Principles and methods of measurement and computation-3 kHz to 300 GHz
- RSP S-1 Standard for Limiting Exposure to Radiofrequency Fields – 100 kHz to 300 GHz

5. Sample Calculations

The far field power density can be calculated using the following formula:

$$S = \frac{PG}{4\pi R^2} \quad (1)$$

where P is the transmit output power (mW), G is the maximum antenna gain relative to an isotropic antenna (linear) and R is the evaluation distance (cm).

In cases where multiple antennas are utilized for a single signal, the following formula is applied to calculate the maximum antenna gain:

$$Gain\ (dBi) = G + 10 \log \mathrm{N} \quad (2)$$

where N is the number of antennas, G is the gain of a single antenna.

A minimum separation distance can be calculated using the following formulas

$$Minimum\ Seperation\ Distance = \sqrt{\frac{PG}{4\pi(Power\ Density\ Limit)}} \quad (3)$$

where P is the transmit output power (mW) and G is the maximum antenna gain relative to an isotropic antenna (linear).

For sources with frequencies <30MHz

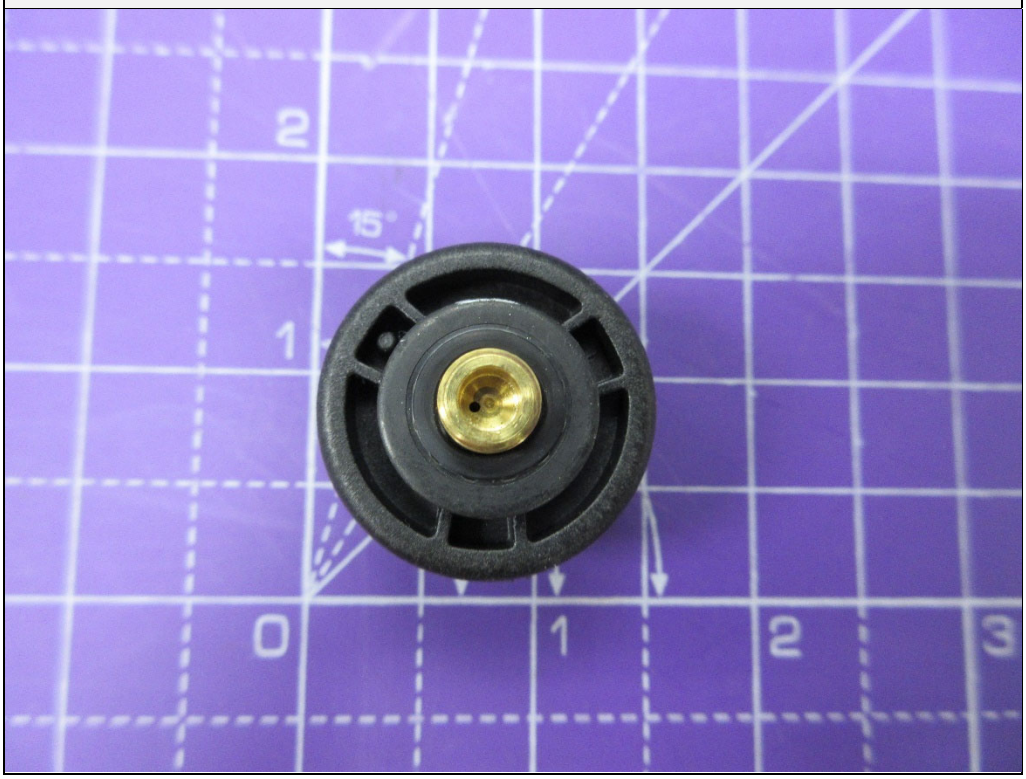
$$Seperation\ Distance = R\left(10^{\frac{(FS_{Limit} - FS_R)}{40}}\right)^{-1} \quad (4)$$

For sources with frequencies >30MHz

$$Seperation\ Distance = R\left(10^{\frac{(FS_{Limit} - FS_R)}{20}}\right)^{-1} \quad (5)$$

where R is the measurement distance, FS_{Limit} is the field strength limit and FS_R is the measured field strength at distance R.

6. Photographs of the EUT



C XMIT
DYNAMIC
C MEAS

7. Limits and Requirements

7.1. Requirements mandated by the FCC

Equipment pursuing compliance to the requirements with respect to the limits of human exposure to RF provided in FCC 1.1310, need follow the criteria in FCC 1.1307(b)(1).

Equipment exemption qualification must be demonstrated pursuant to FCC 1.1307(b)(3).

For single RF sources (i.e., any single portable device, mobile device or fixed RF source): A single RF source is exempt if:

- FCC 1.1307(b)(3)(i)(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance.
- FCC 1.1307(b)(3)(i)(B) The available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold Pth (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). Pth is given by:

$$P_{th}(mW) = \begin{cases} ERP_{20cm}\left(\frac{d}{20cm}\right)^{x} & d \le 20cm \\ ERP_{20cm} & 20cm < d \le 40cm \end{cases}$$

With

$$x = -\log_{10}\left(\frac{60}{ERP_{20cm}\sqrt{f}}\right)$$

Where f is in GHz, and

$$ERP_{20cm}(mW) = \begin{cases} 2040f & 0.3GHz \le f < 1.5GHz \\ 3060 & 1.5GHz \le f < 6GHz \end{cases}$$

- FCC 1.1307(b)(3)(i)(C) Using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

RF Source frequency (MHz)	Threshold ERP (watts)
0.3 – 1.34	1920 R^2
1.34 – 30	3450 R^2 / f^2
30 – 300	3.83 R^2
300 – 1,500	0.0128 R^2
1,500 – 100,000	19.2 R^2

If it is determined that the equipment under investigation is not exempt from routine evaluation an assessment must be performed to determine compliance in regard to the RF exposure limits by means of measurement or calculation of the electric field, magnetic field or power density. It may be the case that a minimum separation distance will need to be calculated or measured and maintained from the source of RF to meet the basic restrictions.

Per 1.1310(e)(1), the power density shall not exceed the levels below:

Limits for Occupational/Controlled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)
0.3 - 3.0	614	1.63	*100
3.0 – 30	1842 / f	4.89 / f	*900 / f^2
30 – 300	61.4	0.163	1.0
300 – 1,500	—	—	f / 300
1,500 – 100,000	—	—	5
Limits for General/Uncontrolled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)
0.3 – 1.34	614	1.63	*100
1.34 – 30	842 / f	2.19 / f	*180 / f^2
30 – 300	27.5	0.073	0.2
300 – 1,500	—	—	f / 1500
1,500 – 100,000	—	—	1.0
f – Frequency in MHz * – Plane wave Equivalent Power Density			

7.2. Requirements mandated by Innovation, Science and Economic Development Canada

The RF exposure level shall be determined by either measurement or by calculating the power density at an evaluation distance of 0.2m, as specified by ANSI/IEEE C95.1-1992.

If it is found that the product meets the low power exclusion level criteria listed in RSS 102 Section 2.5.2, no further RF exposure evaluation is required. The low power exclusion level criteria are given in the following table (f is given in MHz):

RF Source Frequency (MHz)	Threshold ERP (watts)
$f < 20$ MHz	$x \leq 1$
20 MHz $\leq f < 48$ MHz	$x \leq \frac{4.49}{f^{0.5}}$
48 MHz $\leq f < 300$ MHz	$x \leq 0.6$
300 MHz $\leq f < 6$ GHz	$x \leq (1.31 * 10^{-2}) * f^{0.6834}$
6 GHz $\leq f$	$x \leq 5$

If it is determined that the measured or calculated power density does not meet the basic restrictions, a separation distance must be measured or calculated such that the basic restrictions are met.

Per RSS 102 Section 4, the power density shall not exceed the levels below:

Limits for Occupational/Controlled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)
0.003 – 10*	170	180	—
0.1 – 10*	—	1.6 / f	—
1.29 – 10*	193 / $f^{0.5}$	—	—
10 – 20	61.4	0.163	10
20 – 48	129.8 / $f^{0.25}$	0.3444 / $f^{0.25}$	44.72 / $f^{0.5}$
48 – 100	49.33	0.1309	6.455
100 – 6000	15.60 $f^{0.25}$	0.04138 $f^{0.25}$	0.6455 $f^{0.5}$
6000 – 15000	137	0.364	50
15000 – 150000	137	0.364	50
150000 – 300000	0.354 $f^{0.5}$	9.40×10^{-4} $f^{0.5}$	3.33×10^{-4} f
Limits for General/Uncontrolled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)
0.003 – 10*	83	90	—
0.1 – 10*	—	0.73 / f	—
1.1 – 10*	87 / $f^{0.5}$	—	—
10 – 20	27.46	0.0728	2
20 – 48	58.07 / $f^{0.25}$	0.1540 / $f^{0.25}$	8.944 / $f^{.05}$
48 – 300	22.06	0.05852	1.291
300 – 6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619 $f^{0.6834}$
6000 – 15000	61.4	0.163	10
15000 – 150000	61.4	0.163	10
150000 – 300000	0.158 $f^{0.5}$	4.21×10^{-4} $f^{0.5}$	6.67×10^{-5} f
f – Frequency in MHz			

*Limits only apply to Specific Absorption Rate and Nerve Stimulation requirements.

7.3. Requirements mandated by the European Union and outlined in EN 62311

The RF exposure level shall be determined by either measurement or by calculating the power density at an evaluation distance of 0.2m, as specified by ANSI/IEEE C95.1-1992. If it is determined that the measured or calculated power density does not meet the basic restrictions, a separation distance must be measured or calculated such that the basic restrictions are met. If the device output power is less than the low power exclusion level, then the device is deemed to comply with the basic restrictions listed in the 1999/519/EC Council Recommendation.

Per the 1999/519/EC Council Recommendation, the measured field strength shall not exceed the levels below:

Reference Levels for Maximum Exposure			
Frequency Range	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)
0 – 1Hz	—	3.2×10^4	—
1 – 8Hz	10000	3.2×10^4 / f^2	—
8 – 25Hz	10000	4000 / f	—
0.025 – 0.8kHz	250 / f	4 / f	—

0.8 – 3kHz	250 / f	5	—
3 – 150kHz	87	5	—
0.15 – 1MHz	87	0.73 / f	—
1 – 10MHz	87 / $f^{1/2}$	0.73 / f	—
10 – 400MHz	28	0.073	2
400 – 2000MHz	1.375 $f^{0.5}$	0.0037 / $f^{0.5}$	f / 200
2 – 300GHz	61	0.16	10
f as indicated in the frequency range column			

7.4. Requirements mandated by Australia/New Zealand and outlined in AS/NZS 2772.2

As stated in Schedule 5 of RPS 3, S5.2.2, the evaluation of transmitting equipment for compliance with RPS S-1 is not required where the nominal mean power output averaged over 6 minutes does not exceed the levels listed in the table below. For devices exceeding the power levels below, evaluation of transmitting equipment for compliance with this standard is not required where it can be demonstrated that in normal use the mean radiated power output does not exceed the alternative low-power exclusion levels as defined in IEC 62479 (2010).

Exposure Scenario	Low Power Exclusion Level at Frequency, f		
	100 kHz ≤ f ≤ 6 GHz	6 GHz ≤ f ≤ 30 GHz	30 GHz ≤ f ≤ 300 GHz
Occupational	100 mW	40 mW	20 mW
General Public	20 mW	8 mW	4 mW

The RF exposure levels shall be assessed either by measurement or by calculating the power density at an evaluation distance of ??m, as specified by ANSI/IEEE C95.1-1992. If it is determined that the measured or calculated power density does not meet the basic restrictions, a minimum separation distance must be measured or calculated such that the basic restrictions are met. The assessment is based on transmitter power levels, transmit frequency(s) and antenna parameters.

Per RPS 3, the calculated power density shall not exceed the levels below:

Limits for Occupational/Controlled Exposure			
Frequency Range	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)
100kHz – 1MHz	614	1.63 / f	-
1MHz – 10MHz	614 / f	1.63 / f	1000 / f^2
10MHz – 400MHz	61.4	0.163	10
400MHz – 2GHz	3.07 x $f^{0.5}$	0.00814 / $f^{0.5}$	f / 40
2GHz – 300GHz	137	0.364	50
Limits for General/Uncontrolled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)
100kHz – 150kHz	86.8	4.86	-
150KHz – 1MHz	86.8	0.729 / f	-
1MHz – 10MHz	86.8 / $f^{0.5}$	0.729 / f	-
10MHz – 400MHz	27.4	0.0729	2
400MHz – 2GHz	1.37 x $f^{0.5}$	0.00364 x $f^{0.5}$	f / 200
2GHz – 300GHz	61.4	0.163	10
f – Frequency in MHz			

8. Assessment Results

8.1. RF Exposure Evaluation Relevant to the Requirements of the FCC

Radio Access Technology	*f* Transmit Frequency (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	P Conducted Output Power (dBm)	ERP (dBm)	EIRP (dBm)
SRD	433.92	---	---	---	-20.5	---

Radio Access Technology	*f* Transmit Frequency (MHz)	ERP (W)	ERPth (W)
SRD	433.92	8.913E-06	0.222167

The equipment under investigation is determined to be exempt from routine evaluation.

8.2. RF Exposure Evaluation Relevant to the Requirements of the ISED

Radio Access Technology	*f* Transmit Frequency (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	P Conducted Output Power (dBm)	ERP (dBm)	EIRP (dBm)
SRD	433.92	---	---	---	-20.5	-18.35

Radio Access Technology	*f* Transmit Frequency (MHz)	EIRP (W)	FRL Exemption Limit (W)
SRD	433.92	1.462E-05	0.8311455

The equipment under investigation is determined to be exempt from routine evaluation.

8.3. RF Exposure Evaluation Relevant to the Requirements of the EU

Radio Access Technology	*f* Transmit Frequency (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	P Conducted Output Power (dBm)	EIRP (dBm)
SRD	433.92	---	---	---	-18.35

Radio Access Technology	*f* Transmit Frequency (MHz)	Electric Field Strength (V/m)	Electric Field Strength Limit (V/m)	Magnetic Field Strength (A/m)	Magnetic Field Strength Limit (A/m)	S_C Calculated Power Density (mW/cm^2)	S_L Power Density Limit (mW/cm^2)
SRD	433.92	---	28.642276	---	0.0770738	2.909E-05	2.1696

8.4. RF Exposure Evaluation Relevant to the Requirements of Australia/New Zealand

Radio Access Technology	*f* Transmit Frequency (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	P Conducted Output Power (dBm)	EIRP (dBm)
SRD	433.92	---	---	---	-18.35

Radio Access Technology	*f* Transmit Frequency (MHz)	Electric Field Strength (V/m)	Electric Field Strength Limit (V/m)	Magnetic Field Strength (A/m)	Magnetic Field Strength Limit (A/m)	S_C Calculated Power Density (mW/cm^2)	S_L Power Density Limit (mW/cm^2)
SRD	433.92	---	28.642276	---	0.0770738	2.909E-05	2.1696

9. Statement of Compliance

The Lectronix, Inc Wireless Tire Pressure Sensor, Model APS3 is in compliance with the FCC, Innovation, Science and Economic Development Canada, European Union and Australia/New Zealand requirements for RF Exposure at a minimum separation distance of 20cm.

10. 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, Innovation, Science and Economic Development Canada, European Union and Australia/New Zealand requirements for RF Exposure test specifications. The data presented in this test report pertains to the EUT as provided by the customer on the test date specified. Any electrical or mechanical modifications made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.