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GPS Industries, LLC
MPE REPORT

SCOPE OF WORK
MPE CALCULATION
ON THE V3-1005A

REPORT NUMBER
104290673LEX-002.2

ISSUE DATE	**REVISED DATE**
4/10/2020	2/15/2021

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DOCUMENT CONTROL NUMBER
Non-Specific EMC Report Shell Rev. December 2017

MPE TEST REPORT

Report Number: 104290673LEX-002.2
Project Number: G104290673

Report Issue Date: 4/10/2020
Report Revised Date: 2/15/2021

Product Name: V3-1005A

Standards: FCC Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

RSS-102 Issue 5 RF Field Strength Limits for Devices Used by the General Public

Tested by:
Intertek Testing Services NA, Inc.
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Lexington, KY 40510
USA

Client:
GPS Industries, LLC
1074 N. Orange Ave.
Sarasota, FL 34236
USA

Report prepared by

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Report reviewed by

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Staff Engineer

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
10	FCC Part 1.1310 Limits for Maximum Permissible Exposure (MPE) (Limits for General Population / Uncontrolled Exposure)	Pass
	RSS-102 Issue 5 RF Field Strength Limits (For Devices Used by the General Public)	Pass

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	GPS Industries, LLC
Address:	1074 N. Orange Ave. Sarasota, FL 34236 USA
Contact:	Karl Klinner
Telephone:	(941) 256-0572
Email:	Karl.klinner@irco.com
Manufacturer Information	
Manufacturer Name:	GPS Industries, LLC
Manufacturer Address:	1074 N. Orange Ave. Sarasota, FL 34236 USA

4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	V3-1005A
Model Number	V3-1005A
Serial Number	G 20 12 1014
Receive Date	3/23/2020
Test Start Date	3/24/2020
Test End Date	3/27/2020
Device Received Condition	Good
Test Sample Type	Production
Input Rating	12VDC
Frequency Band(s)	RFID: 13.56MHz Bluetooth: 2402 – 2480MHz WiFi: 2412 – 2462MHz Cellular: Band 4: 1710 – 1755MHz Band 13: 777 – 787MHz

Description of Equipment Under Test (provided by client)

The V3-1005A (Model V3-1005A) is a tracking device that installs on golf carts. It provides distances to holes, tracking capabilities for the golf carts, and has integrated Bluetooth, WiFi, Cellular, and RFID connectivity. The Bluetooth, WiFi, and Cellular radios onboard are certified transmitter modules as follows:

Cellular:
UBLOX
TOBY-L201
FCCID: XPYTOBYL201

Bluetooth / WiFi:
Texas Instruments
WL1831MODGBMOCT
FCCID: Z64-WL18SBMOD

4.1 Variant Models:

There were no variant models covered by this evaluation.

5 Antenna Gains:

The Bluetooth / WiFi antenna used was manufactured by Johanson Technology (part number P/N 2450AT45A100)
The gain specifications for this antenna are shown below:

Antenna Gain Based on Orientation	
Mounting1 Vertical Orientation (Page 2)	2.2 dBi typ. (XZ-V)
Mounting2 "Horizontal Orientation Type A" (Pages 4/5)	1.5 dBi typ. (XZ-V)
Mounting3 "Horizontal Orientation Type B" (Pages 7/8)	1.3 dBi typ. (XZ-V)

The LTE antenna used was manufactured by Taoglas (part number GSA.8841.A.105111). The gain specifications for this antenna are shown below:

Frequency (MHz)		698~960	1565~1612	1710~1990
In free space	30cm	1.56	1.38	3.79
	1M	1.36	0.98	3.40
	2M	1.04	0.58	2.92
	3M	0.73	0.08	2.37
	5M	0.03	-0.92	1.28
On the 2mm ABS Base	30cm	1.65	1.74	3.85
	1M	1.45	1.34	3.46
	2M	1.13	0.94	2.99
	3M	0.81	0.44	2.44
	5M	0.11	-0.56	1.34
On the Glass Base	30cm	1.52	3.20	4.76
	1M	1.32	2.80	4.37
	2M	0.99	2.40	3.89
	3M	0.68	1.90	3.34
	5M	-0.02	0.90	2.25

The gains selected for evaluation were at a 1m separation distance with the antenna on the 2mm ABS base.

6 Output Power:

The maximum output powers used for the MPE calculations were taken from the module FCC grants as shown below:

RFID	46.48dBuV/m @ 3m (-48.75dBm, EIRP)
Bluetooth	4.9mW (6.9dBm, Conducted)
WiFi	243.2mW (23.85dBm, Conducted)
LTE Band 13	167.9mW (22.25dBm, Conducted)
LTE Band 4	210.9mW (23.22dBm, Conducted)

7 FCC Limits

§ 1.1310: The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

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

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

8 RSS-102 Issue 5 Exposure Limits:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	-2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142\ f^{0.3417}$	$0.008335\ f^{0.3417}$	$0.02619\ f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\ f^{0.5}$	$4.21 \times 10^{-4}\ f^{0.5}$	$6.67 \times 10^{-5}\ f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

9 Test Procedure

An MPE evaluation for was performed in order to show that the device was compliant with the general population exposure limits from FCC §2.1091 and RSS-102 Issue 5. The maximum power density was calculated for each transmitter band at a separation distance of 20cm using the maximum declared output power including tune up tolerance.

For each transmitter the maximum RF exposure at a 20 cm distance using the formula:

$$ConductedPower_{mW} = 10^{ConductedPower(dBm)/10}$$

$$PowerDensity = \frac{ConductedPower_{mW} \times Ant.Gain}{4\pi \times (20_{cm})^2}$$

For transmitters that could operate simultaneously, the MPE to limit ratio for each was calculated and then summed. If the sum of the MPE to limit ratios was less than 1, that specific combination of transmitters was deemed to comply.

10 Results:

The calculated maximum power density at 20cm distance was equal to or less than the required limits for general population exposure for FCC Part 1.1310 and RSS-102 Issue 5.

Per RSS-102 Section 2.5.2 the RFID radio is exempt from RF exposure evaluation since it transmits below 20MHz and has an EIRP of less than 1W. Per FCC 2.1091(c)(3) the RFID radio is excluded from RF exposure evaluation since it operates under rule part 15.225.

For simultaneous transmission any one cellular band could transmit with the Bluetooth and WiFi radios. The worst case simultaneous transmission configuration was chosen and the MPE to Limit ratios for each individual power density measurement were summed. When this sum was equal to or less than 1 it indicates that the worst case simultaneous transmission configuration also meets the applicable power density limits.

FCC MPE Data

Duty Cycle	100 (%)							
Separation Dist.	20 (cm)							
Operating Mode	Frequecy (MHz)	Declared Max Cond. Power (Inc. Tolerance) (dBm)	Duty Cycle Adjusted Cond. Output Power (dBm)	Antenna Gain (dB)	MPE Value (mW/cm^2)	MPE Limit (mW/cm^2)	Margin to Limit (mW/cm^2)	MPE / Limit Ratio (for Co-Location)
LTE Band 4	1710	23.22	23.22	3.46	0.0926	1.00	0.9074	0.0926
LTE Band 13	777	22.25	22.25	1.45	0.0466	0.52	0.4714	0.0900
Bluetooth	2402	6.9	6.9	2.2	0.0016	1.00	0.9984	0.0016
WiFi	2412	23.85	23.85	2.2	0.0801	1.00	0.9199	0.0801

Worst case simultaneous transmission (LTE Band 4 with Bluetooth and WiFi)
0.0926 + 0.0016 + 0.0801 = 0.1743
Since this total is less than 1 the V3-1005A passes for simultaneous transmission MPE as well.

RSS-102 Issue 5 MPE Data

Duty Cycle	100 (%)							
Separation Dist.	20 (cm)							
Operating Mode	Frequecy (MHz)	Declared Max Cond. Power (Inc. Tolerance) (dBm)	Duty Cycle Adjusted Cond. Output Power (dBm)	Antenna Gain (dB)	MPE Value (W/m^2)	MPE Limit (W/m^2)	Margin to Limit (W/m^2)	MPE / Limit Ratio (for Co-Location)
LTE Band 4	1710	23.22	23.22	3.46	0.9263	4.24	3.3157	0.2184
LTE Band 13	777	22.25	22.25	1.45	0.4664	2.47	2.0079	0.1885
Bluetooth	2402	6.9	6.9	2.2	0.0162	5.35	5.3346	0.0030
WiFi	2412	23.85	23.85	2.2	0.8012	5.37	4.5648	0.1493

Worst case simultaneous transmission (LTE Band 4 with Bluetooth and WiFi)
0.2184 + 0.0030 + 0.1493 = 0.3707
Since this total is less than 1 the V3-1005A passes for simultaneous transmission MPE as well.

11 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	4/10/2020	104290673LEX-002	BCT	BL	Original Issue
1	1/28/2021	104290673LEX-002.1	BCT	BL	Fixed typo on module info
2	2/15/2021	104290673LEX-002.2	BCT	BL	Fixed antenna gains