



Global Product Certification
EMC-EMF Safety Approvals

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47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: Mobile devices

Test Sample: Collision Avoidance System
Model Number: CAS-GPS NODE
Part Number: PROD1116-E2, PROD1116-L2, PROD1116-P2,
PROD1116-S2

Report Number: M180709-7
Tested For: GE Digital Mining Technology

Date of Issue: 24 April 2019

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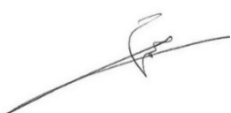
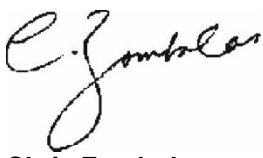
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47 CFR Part 2.1091

Radiofrequency Radiation Exposure Evaluation: Mobile devices

Test Sample:	Collison Avoidance System
Model Number:	CAS-GPS NODE
Part Number:	PROD1116-E2, PROD1116-L2, PROD1116-P2, PROD1116-S2
Tested for:	GE Digital Mining Technology
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KDB:	447498 D01 General RF Exposure Guidance v06 RF exposure procedures and equipment authorization policies for mobile and portable devices.
Result:	The CAS-GPS NODE complied with the RF exposure requirements of 47 CFR Part 2.1091, however an exclusion zone of 20 cm in front of the radiating elements applies, elsewhere the exposure level was below the mobile device limits.
Test Date:	4 th September 2018
Test Officer:	 Emad Mansour EMR/EME Test Engineer EMC Technologies
Checked by:	 Chris Zombolas Technical Director EMC Technologies Pty Ltd

1 INTRODUCTION

This report is intended to demonstrate compliance of the CAS-GPS NODE Collision Avoidance System with the RF exposure requirements of 47 CFR Part 2.1091. Evaluation was performed in accordance with FCC KDB 447498 D01.

The test sample was provided by the Client. The conclusion herein is based on the information provided by the client.

2 GENERAL INFORMATION

(Information supplied by the Client)

CAS-GPS Intelligent multi-purpose node comprises of a high-performance GPS receiver, Vehicle to Vehicle (V2V) radio transceiver, high accuracy Ranging RF transceiver (ToF), RS-232/485 communications, Digital Input (2) / Output (1), Personal Area Network (PAN) and internal battery.

The device assessed was a Collision Avoidance System Node, Model: PROD1116-E1, PROD1116-L1, PROD1116-P1, PROD1116-S1. It included a transmitter operating at 920 MHz for Vehicle to Vehicle (V2V) communication, a Bluetooth/WiFi transmitter at 2.4 & 5 GHz band and a ranging RF component (TOF) operating at 2.4 GHz band (spatial diversity antenna design). Transmit parameters are shown in table 1 and were provided by the customer.

Table 1: DUT Parameters

Radio Module	SRD	Time of Flight (ToF)	PAN
Operating band:	920 MHz	2.4 GHz	2.4 and 5 GHz
Number of Channels:	1	1	39/79
Nominal power	100 mW	10 mW	BT: +11.0 dBm WiFi 2.4 GHz : +14.4 dBm WiFi 5 GHz: +13.7
Antenna type and gain:	Integral antenna +2dBi peak gain	Integral antenna +2dBi peak gain	Integral antenna <3dBi peak gain
Modulation(s):	4GFSK	CSS	GFSK / p/4-DQPSK & 8DPSK
Nominal bandwidth:	1 MHz	22 or 80 MHz	1 MHz
Radio module (if used):	No (Discrete ckt)	Yes	Yes
Module Model No.	-	NANOPAN 5375	ODIN-W2

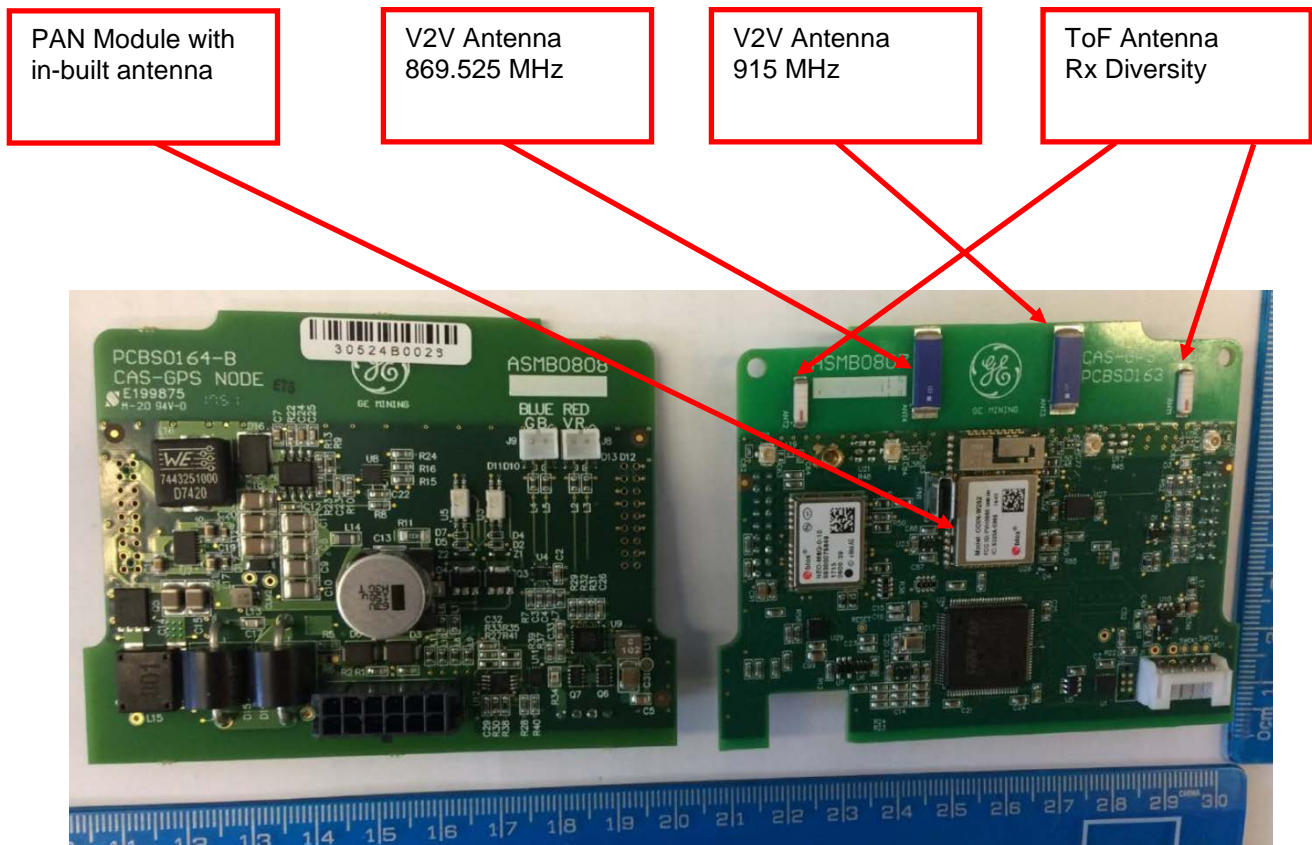


Figure 1: Location of transmitting antennas

3 LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE), §1.1310

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 Exposure				
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
300-1,500			f/300	6
1,500-100,000			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
300-1,500			f/1500	30
1,500-100,000			1.0	30

Where f = Frequency in MHz, * = Plane-wave power density

4 UNCERTAINTY

EMC Technologies has evaluated the tools and methods used to perform Radiated Electromagnetic Field predictions.

The estimated measurement uncertainties for the test shown within this report are as follows:

Electromagnetic Modelling

30 MHz to 100GHz ±2.8 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

5 ASSUMPTION IN THIS ASSESSMENT

This assessment does not include accumulated RF fields from nearby sites/antennas or possible radio signal reflections or attenuation due to buildings or the general environment.

Antenna Parameters and power settings were supplied by the customer.

A 100% duty cycle is assumed for ISM/UMTS and LTE

The aperture of the radiating element assumed to be a point source in free space conditions.

Free Space medium and far field condition.

6 EVALUATION RESULT

The MPE was evaluated at 20 cm to show compliance with the power density listed in table 1,

The following formula was used to calculate the power density at 20 cm

$$S = \frac{P * G}{4\pi R^2}$$

$$S = \frac{EIRP}{4\pi R^2}$$

Where

(S): Power density (mW/cm^2)

(P): Output power at antenna terminal (mW)

(G): Gain (ratio)

(R): Minimum test separation distance (20 cm)

Technology	Frequency Band	Power	Gain	Duty Cycle	EIRP	EIRP	Flux Density at 20 cm	Flux Density limit	Percentage of the limit
		<i>dBm</i>	<i>dBi</i>	%	<i>dBm</i>	<i>mW</i>	<i>mW/cm²</i>	<i>mW/cm²</i>	%
SRD	SRD 920MHz	20	2	100%	22.00	158.49	0.0315	0.61	5.14%
ToF	ToF 2400 MHz	10	2	100%	12.00	15.85	0.0032	1.00	0.32%
PAN	BT 2.4 GHz	11	3	100%	14.00	25.12	0.0050	1.00	0.50%
	WiFi 2.4 GHz	14.4	3	100%	17.40	54.95	0.0109	1.00	1.09%
	WiFi 5 GHz	13.7	3	100%	16.70	46.77	0.0093	1.00	0.93%
Worst case t Co-location consideration at 20 cm (SRD, ToF, Bt, WiFi 2.4 GHz and WiFi 5 GHz)									7.98%

7 CO-LOCATION CONSIDERATION:

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 .

$$\sum_1^N \frac{S_{eqN}}{S_{limN}} = \frac{S_{eq1}}{S_{lim1}} + \frac{S_{eq2}}{S_{lim2}} + \dots + \frac{S_{eqN}}{S_{limN}} \leq 1$$

Where: S_{eq} = Power Spectral density (mW/cm²) of a specific transmitter
 S_{lim} = MPE limit (mW/cm²)

The following simultaneous transmissions are possible:

Module 1	Module 2	Module 3 (BT and WiFi)	MPE Ratio Sum	Result
SRD	ToF	PAN	0.08	Pass

8 CONCLUSION

The CAS-GPS NODE was evaluated on behalf of GE Digital Mining Technology with the RF exposure requirements of 47 CFR Part 2.1091. An exclusion zone of 20 cm was required in front of the radiating elements, away from this area the electric field calculated at 20 cm did not exceed the MPE limit.