eurofins | E&E
HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

7/14/2023

Waites Sensor Technologies
20 West 11th Street
Suite 200
Covington KY 41011
USA

Dear Daniel Lamarca,

Enclosed is the EMC test report for testing of the Waites Sensor Technologies, SM6 tested to the requirements of FCC Part 2.1091, RSS-102 Issue 5, IEC62311: Ed. 2.0

Thank you for using the services of Eurofins E&E North America. If you have any questions regarding these results or if MET can be of further service to you, please do feel free to contact me.

Sincerely,

Nancy LaBrecque
Documentation Department
Eurofins Electrical and Electronic Testing NA, Inc.

Reference: WIRA125306_MPE_R2

A2LA ACCREDITED TESTING CERT #0591.06

RF Exposure Criteria
Test Report
Using Maximum Permissible Exposure (MPE) Calculations

for the

Waites Sensor Technologies
SM6

Tested under

FCC Part 2.1091, RSS-102 Issue 5, IEC62311: Ed. 2.0

Report: WIRA125306_MPE_R2

7/14/2023

Bryan Taylor, Wireless Team Lead
Electromagnetic Compatibility Lab

Nancy LaBrecque
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.247 under normal use and maintenance.

Matthew Hinojosa
EMC Manager, Austin Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
0	4/24/2023	Initial Issue.
1	4/27/2023	Included the variant SKU's in the list of versions covered by this test report
2	7/14/2023	Added changes requested by TCB reviewer

Table of Contents

1.0 Requirements Summary **8**
2.0 Equipment Configuration **9**
2.1 Overview 9
2.2 Test Site 10
2.3 References 10
2.4 Description of Test Sample 11
2.5 Modifications 11
2.5.1 Modifications to EUT 11
2.5.2 Modifications to Test Standard 11
2.6 Disposition of EUT 11
3.0 Transmitter Requirements **12**

List of Tables

Table 1. Summary of Test Results 8
Table 2. EUT Summary Table 9
Table 3. References 10
Table 4. Support Equipment 11

List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
CISPR	**C**omite **I**nternational **S**pecial des **P**erturbations **R**adioelectriques (International Special Committee on Radio Interference)
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**er**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**H**er**z**
kPa	**k**ilo**Pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**H**ertz
µ**H**	**microH**enry
µ**F**	**microF**arad
µ**s**	**micros**econds
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

1.0 Requirements Summary

Page Number	Test Name	Result
12	IEC62311: 2019 MPE Limits (For General Public Exposure)	**Compliant**
13	RSS-102 Issue 5 MPE Limits (For General Public Exposure)	**Compliant**
13	FCC Part 2.1091 MPE Limits (For General Public Exposure)	**Compliant**

Table 1. Summary of Test Results

2.0 Equipment Configuration

2.1 Overview

Eurofins MET Labs was contracted by Waites Sensor Technologies to perform testing on the SM6, under Waites Sensor Technologies's purchase order number P2621.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Waites Sensor Technologies SM6.

The results obtained relate only to the item(s) tested.

FCCID / ICID:	FCCID: 2AUGB-SM6 ICID: 25402-SM6	
Model(s) Tested:	SM6	
Model(s) Covered:	SM6-1150 SM6-0864 SM6-2300 SM6-0101 All of the variants have the same RF circuitry with the only difference being the use of different accelerometers.	
EUT Specifications:	Primary Power: 3.3VDC	
	Type of Modulations:	OQPSK
	Equipment Code:	DTS
	Peak RF Output Power:	18.58dBm
	EUT Frequency Ranges:	2405-2480 MHz
	Number of Channels:	16
	Available Channels:	2405MHz, 2410MHz, 2415MHz, 2420MHz, 2425MHz, 2430MHz, 2435MHz, 2440MHz, 2445MHz, 2450MHz, 2455MHz, 2460MHz, 2465MHz, 2470MHz, 2475MHz, 2480MHz
	Data Rate:	250kbps
	Antenna Type:	Inverted F PCB Antenna
	Antenna Gain:	5.3dBi (see note[1])
	Size (HxWxD) inches:	2.56x1.32x1.44
	Weight (lbs):	0.187
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Bryan Taylor	
Report Date(s):	3/20/2023 through 4/5/2023	

Table 2. EUT Summary Table

[1] The antenna gain information was provided by Waites Sensor Technologies

2.2 Test Site

All testing was performed at Eurofins E&E North America, Austin, TX. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

2.3 References

IEC62311 Edition 2.0 (2019-04)	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)
RSS-102: Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
FCC Part 2.1091	Radiofrequency radiation exposure evaluation: mobile devices.

Table 3. References

2.4 Description of Test Sample

The SM6 is a wireless temperature and vibration sensor used for machine health monitoring.

2.5 Modifications

2.5.1 Modifications to EUT

No modifications were made to the EUT.

2.5.2 Modifications to Test Standard

No modifications were made to the test standard.

2.6 Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Waites Sensor Technologies upon completion of testing.

Ref. ID	Name/Description	Manufacturer	Model Number	Customer Supplied Calibration Data
None	Laptop	Toshiba	Not Labeled	None
None	Test software	Waites Sensor Technologies	radio_compliance_test.exe	None

Table 4. Support Equipment

3.0 Maximum Permissible Exposure Results

3.1 IEC62311 (ICNIRP) RF Exposure Limits

Table 7. Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values).[a]

Frequency range	E-field strength (V m^{-1})	H-field strength (A m^{-1})	B-field (μT)	Equivalent plane wave power density S_{eq} (W m^{-2})
up to 1 Hz	—	3.2×10^4	4×10^4	—
1–8 Hz	10,000	$3.2 \times 10^4/f^2$	$4 \times 10^4/f^2$	—
8–25 Hz	10,000	$4{,}000/f$	$5{,}000/f$	—
0.025–0.8 kHz	$250/f$	$4/f$	$5/f$	—
0.8–3 kHz	$250/f$	5	6.25	—
3–150 kHz	87	5	6.25	—
0.15–1 MHz	87	$0.73/f$	$0.92/f$	—
1–10 MHz	$87/f^{1/2}$	$0.73/f$	$0.92/f$	—
10–400 MHz	28	0.073	0.092	2
400–2,000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	$f/200$
2–300 GHz	61	0.16	0.20	10

[a] Note:
1. f as indicated in the frequency range column.
2. Provided that basic restrictions are met and adverse indirect effects can be excluded, field strength values can be exceeded.
3. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2, and B^2 are to averaged over any 6-min period.
4. For peak values at frequencies up to 100 kHz see Table 4, note 3.
5. For peak values at frequencies exceeding 100 kHz see Figs. 1 and 2. Between 100 kHz and 10 MHz, peak values for the field strengths are obtained by interpolation from the 1.5-fold peak at 100 kHz to the 32-fold peak at 10 MHz. For frequencies exceeding 10 MHz it is suggested that the peak equivalent plane wave power density, as averaged over the pulse width does not exceed 1,000 times the S_{eq} restrictions, or that the field strength does not exceed 32 times the field strength exposure levels given in the table.
6. For frequencies exceeding 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over any $68/f^{1.05}$-min period (f in GHz).
7. No E-field value is provided for frequencies <1 Hz, which are effectively static electric fields. perception of surface electric charges will not occur at field strengths less than 25 kVm^{-1}. Spark discharges causing stress or annoyance should be avoided.

3.2 RSS-102 RF 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 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000/$f^{1.2}$

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

3.3 FCC Exposure Limits

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(i) 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
(ii) 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

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

Test Procedure:

An MPE evaluation for was performed in order to show that the device was compliant with the general population exposure limits. 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:

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

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

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.

Test Results:

The Temperature and Vibration Sensor was **compliant** with FCC Part 2.1091, RSS-102 Issue 5, IEC62311: Ed. 2.0. The calculated maximum power density at 20cm distance was equal to or less than the required limits for general population exposure for FCC Part 2.1091, RSS-102 Issue 5, IEC62311: Ed. 2.0.

Test Data:

Duty Cycle	100 (%)						
Separation Dist.	20 (cm)						
Operating Mode	Frequency (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)
802.15.4	2405	19.5	19.50	5.3	0.0601	1.0000	0.9399

FCC MPE Data

Duty Cycle	100 (%)						
Separation Dist.	20 (cm)						
Operating Mode	Frequency (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)
802.15.4	2405	19.5	19.50	5.3	0.6008	5.3554	4.7546

ISED MPE Data

Duty Cycle	100 (%)						
Separation Dist.	20 (cm)						
Operating Mode	Frequency (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)
802.15.4	2405	19.5	19.50	5.3	0.6008	10.0000	9.3992

IEC62311 MPE Data

Test Engineer(s): **Bryan Taylor**

Test Date(s): 3/20/2023 to 4/5/2023