

RADIO TEST REPORT – APFWL

Type of assessment:

MPE Calculation report

Manufacturer:

**ORBCOMM License Corp.
(ORBCOMM Inc.)**

Equipment description:

Mobile Earth Station Modem

Product Marketing Name (PMN):

ST9100

Model Number:

ST9101, ST9100-C01, ST9100-D01

FCC ID:

FCC ID: XGS-ST9100

ISED certification number:

IC: 11881A-ST9100

Contains FCC ID:

XPYUBX21BE01, XGS-UNNB30

Contains IC:

8595A-UBX21BE01, 11881A-UNNB30

Specification:

- ◆ FCC 47 CFR Part 1 Subpart I, §§1.1307, 1.1310
- ◆ FCC 47 CFR Part 2 Subpart J, §2.1091
- ◆ KDB 447498 D01 General RF Exposure Guidance v06
- ◆ RSS-102 Issue 5 Amendment 1, (February 2021) – Annex A and B

Annex B - Declaration of RF Exposure Compliance

ATTESTATION: I attest that the information provided in Annex A is correct; that the Technical Brief was prepared and the information contained therein is correct; that the device evaluation was performed or supervised by me; that applicable measurement methods and evaluation methodologies have been followed; and that the device meets the SAR and/or RF field strength limits of RSS-102.

Date of issue: April 26, 2024

Hossein Zamani, EMC/RF Lab Manager

Prepared by



Signature

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The tests included in this report are within the scope of this accreditation.
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ANAB File Number: AT-3195 (Ottawa/Almonte); AT-3193 (Pointe-Claire); AT-3194 (Cambridge)



Lab locations

Company name	Nemko Canada Inc.			
Facilities	<i>Ottawa site:</i>	<i>Montréal site:</i>	<i>Cambridge site:</i>	
	303 River Road Ottawa, Ontario Canada K1V 1H2 Tel: +1 613 737 9680 Fax: +1 613 737 9691	292 Labrosse Avenue Pointe-Claire, Québec Canada H9R 5L8 Tel: +1 514 694 2684 Fax: +1 514 694 3528	1-130 Saltsman Drive Cambridge, Ontario Canada N3E 0B2 Tel: +1 519 650 4811	
Test site identifier	Organization	Ottawa/Almonte	Montreal	Cambridge
	FCC:	CA2040	CA2041	CA0101
	ISED:	2040A-4	2040G-5	24676
Website	www.nemko.com			

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1 Evaluation summary

1.1 MPE calculation for standalone transmission

1.1.1 References, definitions and limits

FCC §2.1091(d)

- (2) (2) For operations within the frequency range of 300 kHz and 6 GHz (inclusive), the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 in paragraph (e)(1) of this section, may be used instead of whole-body SAR limits as set forth in paragraphs (a) through (c) of this section to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b) of this part, except for portable devices as defined in §2.1093 of this chapter as these evaluations shall be performed according to the SAR provisions in §2.1093.

Table 1.1-1: Table 1 to §1.1310(e)(1)—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)
(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
300–1500			f / 300	<6
1500–100000			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
300–1500			f / 1500	<30
1500–100000			1.0	<30

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

RSS-102, Section 2.5.2

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $0.0131 f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

References, definitions and limits, continued

Equation from page 18 of OET Bulletin 65, Edition 97-01

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

where: S = power density (mW/cm² or W/m²)
 P = power input to the antenna (mW or W)
 G = power gain of the antenna in the direction of interest relative to an isotropic radiator
 R = distance to the center of radiation of the antenna (cm or m)

1.1.1 EUT technical information

Prediction frequency	1660.5 MHz
Antenna type	Max 4.5 dBi for standard antenna and 2.5 dBi for low elevation antenna, external active antenna made by ORBCOMM
Antenna gain	4.5 dBi
Number of antennas	1
Maximum transmitter conducted power	30.9 dBm (1.23 mW)
Prediction distance	20 cm
Duty cycle	<p>40%. The product is designed for machine-to-machine (M2M) applications, primarily focused on transmitting machine status information. Given the nature of this data—typically small-sized—and the compact design of the product the extended transmission periods are unnecessary. Furthermore, stringent control over power consumption dictates that the transmitting duty cycle be limited by both hardware and software, therefore this duty cycle is hard-coded and cannot be modified.</p> <p>To provide more context, the device’s transmitting duty cycle adheres to the following parameters:</p> <ul style="list-style-type: none"> • Transmission occurs every 5 seconds. • The maximum duration of transmitting activity within this 5-second window is capped at 2 seconds. • Consequently, the absolute maximum duty cycle does not exceed 40%.

1.1.2 MPE calculation

Fundamental transmit (prediction) frequency:	<u>1660.5</u> MHz	
Maximum measured conducted peak output power:	<u>30.9</u> dBm	
Cable and/or jumper loss:	<u>0</u> dB	
Maximum peak power at antenna input terminal:	<u>30.9</u> dBm	
Tx On time:	<u>0.400</u> ms	
Tx period time:	<u>1.000</u> ms	
Average factor:	<u>40</u> %	
Maximum calculated average power at antenna input terminal:	<u>492.1075083</u> mW	
Single Antenna gain (typical):	<u>4.5</u> dBi	
Number of antennae:	<u>1</u>	
Total system gain:	<u>4.50</u> dBi	
	FCC limit:	ISED limit:
Limit for uncontrolled exposure at prediction frequency:	<u>1.000000</u> mW/cm ²	<u>0.415764</u> mW/cm ²
	<u>10.000000</u> W/m ²	<u>4.157639</u> W/m ²
Minimum calculated prediction distance for compliance:	<u>20</u> cm	<u>20</u> cm
Typical (declared) distance:	<u>20</u> cm	<u>20</u> cm
Average power density at prediction frequency:	<u>0.275924</u> mW/cm ²	<u>0.275924</u> mW/cm ²
	<u>2.759244</u> W/m ²	<u>2.759244</u> W/m ²
Margin of Compliance:	<u>5.59</u> dB	<u>1.78</u> dB
Maximum allowable antenna gain:	<u>10.09</u> dBi	<u>6.28</u> dBi

1.1.3 Verdict

The calculation is below the limit; therefore, the product is passing the RF Exposure requirements for the declared distance.

1.1.4 RSS-102, Annex A - RF technical brief cover sheet – stand-alone operation

IC Certification Number	11881A-ST9100
Product marketing name (PMN)	ST9100
Hardware version identification number (HVIN)	ST9101, ST9100-C01, ST9100-D01
Firmware version identification number (FVIN)	N/A
Host marketing name (HMN)	N/A
Applicant company number	11881A
Applicant name	ORBCOMM License Corp. (ORBCOMM Inc.)
SAR/RF exposure test laboratory	2040A-4 (3 m semi anechoic chamber)
Type of evaluation	<input type="checkbox"/> SAR Evaluation: Device Used in the Vicinity of the Human Head <input type="checkbox"/> SAR Evaluation: Body-Worn Device and Body-Supported Device <input type="checkbox"/> SAR Evaluation: Limb-Worn Device <input checked="" type="checkbox"/> RF Exposure Evaluation <input type="checkbox"/> Nerve Stimulation Exposure Evaluation (SPR-002)
SAR evaluation	Multiple transmitters: <input type="checkbox"/> Yes <input type="checkbox"/> No
	Evaluated against exposure limits: <input type="checkbox"/> General Public Use <input type="checkbox"/> Controlled Use
	Duty cycle used in evaluation: N/A %
	Separation distance: N/A mm
	Standard used for evaluation: N/A
	SAR value: N/A W/kg <input type="checkbox"/> Measured <input type="checkbox"/> Computed <input type="checkbox"/> Calculated
Nerve Stimulation Evaluation (SPR-002)	Evaluated against exposure limits: <input type="checkbox"/> General Public Use <input type="checkbox"/> Controlled Use
	Measurement distance: N/A m
	Field Strength: N/A <input type="checkbox"/> V/m (electric) <input type="checkbox"/> A/m (magnetic) <input type="checkbox"/> Measured <input type="checkbox"/> Computed <input type="checkbox"/> Calculated
	Exposure condition: <input type="checkbox"/> Whole body/Torso/Head <input type="checkbox"/> Leg <input type="checkbox"/> Arm <input type="checkbox"/> Hand/Foot
RF exposure evaluation	Evaluated against exposure limits: <input checked="" type="checkbox"/> General Public Use <input type="checkbox"/> Controlled Use
	Duty cycle used in evaluation: 40 % (hard coded)
	Operational frequency: 1660.5 MHz
	Standard used for evaluation: Safety Code 6
	Measurement distance: 0.2 m
	RF value: 2.76 <input checked="" type="checkbox"/> W/m ² <input type="checkbox"/> V/m <input type="checkbox"/> A/m <input type="checkbox"/> Measured <input type="checkbox"/> Computed <input checked="" type="checkbox"/> Calculated

1.2 MPE calculation for simultaneous transmission

1.2.1 References, definitions and limits

FCC §2.1091(d)

- (2) (2) For operations within the frequency range of 300 kHz and 6 GHz (inclusive), the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 in paragraph (e)(1) of this section, may be used instead of whole-body SAR limits as set forth in paragraphs (a) through (c) of this section to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b) of this part, except for portable devices as defined in §2.1093 of this chapter as these evaluations shall be performed according to the SAR provisions in §2.1093.

Table 1.2-1: Table 1 to §1.1310(e)(1)—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)
(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
300–1500			f / 300	<6
1500–100000			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
300–1500			f / 1500	<30
1500–100000			1.0	<30

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

RSS-102, Section 2.5.2

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $0.0131 f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

References, definitions and limits, continued

Equation from page 18 of OET Bulletin 65, Edition 97-01

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

where: S = power density (mW/cm² or W/m²)
 P = power input to the antenna (mW or W)
 G = power gain of the antenna in the direction of interest relative to an isotropic radiator
 R = distance to the center of radiation of the antenna (cm or m)

1.2.2 EUT technical information

	Transmitter 1 (Satellite)	Transmitter 2 (Cell)	Transmitter 3 (BLE)
Prediction frequency	1.6605 GHz	824 GHz	2.4 GHz
Antenna gain	4.5 dBi	3.0 dBi	3.0 dBi
Maximum transmitter conducted power	30.9 dBm -60% - hard coded	33.5 dBm, -50% - GSM protocol	7.9 dBm
Prediction distance	35 cm	35 cm	35 cm

1.2.3 MPE calculation

	Transmitter 1		Transmitter 2		Transmitter 3	
Fundamental transmit (prediction) frequency:	1660.5 MHz		824.2 MHz		2402 MHz	
Maximum measured conducted peak output power:	30.9 dBm		33.5 dBm		7.9 dBm	
Cable and/or jumper loss:	0 dB		0 dB		0 dB	
Maximum peak power at antenna input terminal:	30.9 dBm		33.5 dBm		7.9 dBm	
Tx On time:	0.400 ms		0.500 ms		1.000 ms	
Tx period time:	1.000 ms		1.000 ms		1.000 ms	
Average factor:	40 %		50 % - GSM		100 %	
calculated average power at antenna input terminal:	492.108 mW		1119.36 mW		6.166 mW	
Single Antenna gain (typical):	4.5 dBi		3 dBi		3 dBi	
Number of antennae:	1		1		1	
Total system gain:	4.50 dBi		3.00 dBi		3.00 dBi	
MPE limit for uncontrolled exposure at prediction frequency:	ISED limit	FCC limit	ISED limit	FCC limit	ISED limit	FCC limit
	0.415764 mW/cm ²	1.000000 mW/cm ²	0.257604 mW/cm ²	1.000000 mW/cm ²	0.535080 mW/cm ²	1.000000 mW/cm ²
Minimum calculated prediction distance for compliance:	4.157639 W/m ²	10.000000 W/m ²	2.576038 W/m ²	10.000000 W/m ²	5.350805 W/m ²	10.000000 W/m ²
	20 cm	20 cm	26 cm	20 cm	20 cm	20 cm
Typical (declared) distance:	35 cm	35 cm	35 cm	35 cm	35 cm	35 cm
Average power density at prediction frequency:	0.090098 mW/cm ²	0.090098 mW/cm ²	0.145086 mW/cm ²	0.145086 mW/cm ²	0.000799 mW/cm ²	0.000799 mW/cm ²
	0.900978 W/m ²	0.900978 W/m ²	1.450855 W/m ²	1.450855 W/m ²	0.007992 W/m ²	0.007992 W/m ²
Combined MPE compliance:	6.64 dB	10.45 dB	2.49 dB	8.38 dB	28.26 dB	30.97 dB
Margin of Compliance:	11.14 dBi	10.45 dBi	5.49 dBi	8.38 dBi	31.26 dBi	30.97 dBi
Maximum allowable antenna gain:	0.217	0.090	0.563	0.145	0.001	0.001
Average power density to MPE limit ratio:	0.236					
Total sum of ratios for FCC:	0.781					
Total sum of ratios for ISED:	1					
Maximum allowed sum of ratios:						

1.2.4 Verdict

The calculation is below the limit; therefore, the product is passing the RF Exposure requirements for the declared distance.

1.2.5 RSS-102, Annex A - RF technical brief cover sheet – simultaneous operation

IC Certification Number	11881A-ST9100
Product marketing name (PMN)	ST9100
Hardware version identification number (HVIN)	ST9101, ST9100-C01, ST9100-D01
Firmware version identification number (FVIN)	N/A
Host marketing name (HMN)	N/A
Applicant company number	11881A
Applicant name	ORBCOMM License Corp. (ORBCOMM Inc.)
SAR/RF exposure test laboratory	2040A-4 (3 m semi anechoic chamber)
Type of evaluation	<input type="checkbox"/> SAR Evaluation: Device Used in the Vicinity of the Human Head <input type="checkbox"/> SAR Evaluation: Body-Worn Device and Body-Supported Device <input type="checkbox"/> SAR Evaluation: Limb-Worn Device <input checked="" type="checkbox"/> RF Exposure Evaluation <input type="checkbox"/> Nerve Stimulation Exposure Evaluation (SPR-002)
SAR evaluation	Multiple transmitters: <input type="checkbox"/> Yes <input type="checkbox"/> No
	Evaluated against exposure limits: <input type="checkbox"/> General Public Use <input type="checkbox"/> Controlled Use
	Duty cycle used in evaluation: N/A %
	Separation distance: N/A mm
	Standard used for evaluation: N/A
	SAR value: N/A W/kg <input type="checkbox"/> Measured <input type="checkbox"/> Computed <input type="checkbox"/> Calculated
Nerve Stimulation Evaluation (SPR-002)	Evaluated against exposure limits: <input type="checkbox"/> General Public Use <input type="checkbox"/> Controlled Use
	Measurement distance: N/A m
	Field Strength: N/A <input type="checkbox"/> V/m (electric) <input type="checkbox"/> A/m (magnetic) <input type="checkbox"/> Measured <input type="checkbox"/> Computed <input type="checkbox"/> Calculated
	Exposure condition: <input type="checkbox"/> Whole body/Torso/Head <input type="checkbox"/> Leg <input type="checkbox"/> Arm <input type="checkbox"/> Hand/Foot
RF exposure evaluation	Evaluated against exposure limits: <input checked="" type="checkbox"/> General Public Use <input type="checkbox"/> Controlled Use
	Duty cycle used in evaluation: BLE 100, MSES 40, GSM 50 %
	Operational frequency: 2402, 824.2, 1660.5 MHz
	Standard used for evaluation: Safety Code 6
	Measurement distance: 0.35 m
	RF value: 2.35 <input checked="" type="checkbox"/> W/m ² <input type="checkbox"/> V/m <input type="checkbox"/> A/m <input type="checkbox"/> Measured <input type="checkbox"/> Computed <input checked="" type="checkbox"/> Calculated

End of the test report