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Amended

FCC/IC Test Report

Includes NCEE Labs test report R20150213-20-02A and its amendment in full

Prepared for:	**Independent Technologies, LLC** **26 1st Ave SE** **New London, MN 56273**
Product:	**WESROC Satellite Tank Monitor**
Model:	**MT-9100STM**
FCC ID:	**RWB-MT9100STM**
IC:	**115A-MT9100STM**
Test Report No:	**R20150213-20-02B**
Approved By:	**Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
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ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
Original	29 January 2016	Original – Njohnson Prepared by KVepuri
A	2016 FEB 04	Corrected Table 1 -NJ
B	2016 FEB 24	Added Section 2.4 and added additional details. Added conducted output power measurements. Added note that 10 MHz RBW was used in Test Setup. -NJ

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1 Summary of Test Results

The equipment under test (EUT) was tested for compliance to FCC Part 25 and Part 2 as well as Industry Canada RSS-170, Issue 3. Below is a summary of the test results. Complete results can be found in Section 3.

Report Section		Description	Result
3.1	FCC § 2.1046, §87.131 RSS-170, 5.3, 5.4 TIA-603-D, Section 2.2.1 and 2.2.12	Power and emissions	Compliant

Test Methods:

(1) TIA/EIA-603-D:2010

Note: NCEE Labs' accreditation covers the test methods as listed above, but not all of the specific FCC rule parts. Since the rule parts specify only requirements and limits, the required measurements were performed only using test methods to which the lab is accredited.

2 EUT Description

The Equipment Under Test (EUT) was WESROC Satellite Tank Monitor from Independent Technologies.

2.1 Equipment under Test (EUT)

Table 1 – Equipment under Test (EUT)

PRODUCT	WESROC Satellite Tank Monitor
MODEL	MT-9100STM
FREQUENCY RANGE	1.61123246 – 1.61623246 GHz
POWER INPUT	3.9 VDC
POWER SUPPLY	3.9 VDC (Internal Battery)
ANTENNA TYPE	Patch
SERIAL NUMBER OF TEST UNIT	500001

2.2 Testing Location

All testing was performed at the NCEE Lincoln facility, which is an A2LA accredited EMC test laboratory accredited per scope 1953.01.

2.3 EUT Setup

The EUT was powered by 3.9 VDC, internal Battery for all the tests and had no auxiliary devices. The unit would normally be powered by a 3.6VDC battery, but for testing purposes a 3.9VDC battery was used to extend the transmitting time. Because the transmitter has regulated input power, this would not have an effect on the performance. It was tested by itself. The EUT was programmed by the manufacturer to transmit continually for testing purposes only.

The EUT was modified by the manufacturer to test with the device continuously transmitting a series of 1's and 0's, or to set the EUT to continuous receive mode for testing purposes.

The EUT contained a pre-approved transmit-only Globalstar Simplex module with FCC ID:L2V-STX3 IC: 3989A-STX3.

2.4 Test Purpose

The Globalstar STX-3 modular certification (FCC ID:L2V-STX3 IC: 3989A-STX3) did not specifically allow for a radio frequency switch in the signal path between the STX-3 module and the antenna. The modular approval also requires a maximum antenna gain of 5.1dB.

The EUT included a radio frequency switch in the transmit signal path. It also used a ground plane for the patch antenna that is larger than the manufacturer's reference ground plane. Using the data from the modular approval for FCC ID:L2V-STX3 IC: 3989A-STX3, and the test results of the EUT, this test report is intended to show that the EUT, including the RF Switch and non-reference antenna ground plane, is compliant with the intended transmit frequency, spurious emission, and output power requirements of the Globalstar STX-3 modular approval.

3 Test Results

3.1 Power and emissions

Test: FCC Part 25.204
RSS-170, Clause 5.3

Test Result: *Complies* Date: 14 January 2016- 28 January 2016

Test Description
All measurements were taken at a distance of 3m from the EUT and field strength measurements were used to calculate EIRP.

The resolution bandwidth was set to 10MHz for EIRP measurements and the video bandwidth was set to 10MHz to capture the maximum amount of signal. For conducted measurements, the RBW was set to 1 MHz and a banwidth correction factor was used to extrapolate to 2.3 MHz RBW. The analyzer used a peak detector in max hold mode. This represented the maximum output power.

See Annex A for an example of how the EIRP is calculated in order to report maximum power output.

Test Environment
Testing was performed at the NCEE Labs Lincoln facility. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 35 ± 5%
Temperature of 22 ± 2º C

Test Setup
The EUT was set to continuously transmit on one channel at a time. See Section 2.3 for details.

Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
100037	Rhode & Schwarz	ES126	EMI Test Receiver	20 Jan 2015
100007	Rohde & Schwarz	ESI7	EMI Test Receiver	22 Jul 2015
6415	EMCO	3115	DRG Horn	20 Jan 2015**
6416	EMCO	3115	DRG Horn	14 Jan 2014**
3545700803	Rohde & Schwarz	TS-PR18	Preamplifier	14 Dec 2015*
BG1808	Weinschel	48-30-43	30 dB Attenuator	15 Dec 2015*
00319	Mini-Circuits	UNAT-20	20 dB Attenuator	15 Dec 2015*

*Verification date
** Two-year calibration cycle

Test Results
The power measurements were found to comply. The peak directional gain (boresight) of the antenna system of the EUT was determined to be at an elevation of 90 degrees above horizontal. Radiated measurements were made in the direction of the boresight.

Table 2 – Transmitter Peak Output Power

Frequency	Conducted Output Measurement*	Bandwidth CF	Antenna Gain	EIRP Output Power
MHz	dBm	dB	(dBi)	(dBm)
1.61623246	16.03	3.6	4.0	23.63
1.61123246	16.39	3.6	4.0	23.99

Bandwidth correction formula: 10 log(1/2.3) = 3.6 dB

*Measured with 1MHz RBW

Table 3 – EIRP Results - Harmonics Low Channel (1611.25 MHz)

Frequency	EIRP Measurement	Limit	Result
GHz	dBm	dBm	
3.2222475	-47.00	-13.00	Pass
4.8837500	-46.95	-13.00	Pass
6.4450000	-49.25	-13.00	Pass

Table 4 – EIRP Results - Harmonics High Channel (1618.75 MHz)

Frequency	EIRP Measurement	Limit	Result
GHz	dBm	dBm	
3.2378500	-55.00	-13.00	Pass
4.8562500	-50.60	-13.00	Pass
6.4750000	-48.00	-13.00	Pass

Annex A – Sample Field Strength Calculation

Radiated Emissions

The field strength is calculated in decibels (dB) by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = R + AF - (-CF + AG)$$

where FS = Field Strength

R = Receiver Amplitude Receiver reading in dBμV

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Preamplifier Amplifier Gain

Assume a receiver reading of 55.00 dBμV is obtained. The Antenna Factor of 12.00 and a Cable Factor of 1.10 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.10 dBμV/m.

FS = 55.00 + 12.00 – (-1.10 + 20.00) = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20] = 254.1 μV/m

Conducted Emissions

Receiver readings are compared directly to the conducted emissions limits in decibels (dB) by adding the cable loss and LISN insertion loss to the receiver reading. The basic equations with a sample calculation is as follows;

$$FS = R + IL - (-CF)$$

where V = Conducted Emissions Voltage Measurement

R = Receiver reading in dBμV

IL = LISN Insertion Loss

CF = Cable Attenuation Factor

Assume a receiver reading of 52.00 dBμV is obtained. The LISN insertion loss of 0.80 dB and a Cable Factor of 1.10 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

V = 52.00 + 0.80 - (-1.10) = 53.90 dBμV/m

The 53.90 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20] = 495.45 μV/m

*Note: NCEE Labs uses the Rohde and Schwarz ES-K1 software package. In this software, all cable losses are listed as negative. This is why cable loss is subtracting in the preceding equations.

Margin is calculated by taking the limit and subtracting the Field

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Stregnth (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

Power (watts) = 10^[Power (dBm)/10] x 1000

Field Strength (dBμV/m) = Field Stregth (dBm) = 107 (for 50Ω measurement systems)

Field Stregnth (V/m) = 10^[Field Stregnth (dBμV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

Annex B – Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44

Expanded uncertainty values are calculated to a confidence level of 95%.