Test Report

FCC Rule Parts: 15.247, 22, 24, and 25

Report Number: AT72146079-3Z0

Manufacturer: RSAE Labs
Model: GS-6C

Test Begin Date: February 14, 2019
Test End Date: February 27, 2019

Report Issue Date: March 27, 2018

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: 2955.09

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

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This report contains 12 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate continued compliance with Parts 15.247, 22, 24, and 25 of the FCC's Code of Federal Regulations with respect to co-location of a licensed cellular module, an Iridium satellite radio, and a Zigbee transceiver.

1.2 Product Description

The RSAE Labs Global Sentinel GS-6C is a cargo container monitoring system. It utilizes 2.4GHz 802.15.4 transceiver, an approved cellular module, an approved Iridium Satellite module, and a GNSS receiver.

This test report documents the compliance of the intermodulation products and spurious emissions resulting from the colocation of a cellular modem, a 2.4GHz Zigbee radio, and an Iridium satellite transceiver.

Technical Information (Zigbee Radio):

Detail	Description
Frequency Range (MHz)	2405 – 2480
Number of Channels	16
Channel Spacing	5 MHz
Modulation Format	DSSS
Data Rates	250kbps
Operating Voltage	8.5Vdc (Battery)
Antenna Type(s) / Gain(s)	Ceramic Chip / 1.7dBi
FCC ID	2ASIM-GS6C1

Technical Information (Cellular Radio):

Detail	Description
Frequency Range	824.2 - 848.8 MHz (WCDMA Band 5 / GSM850) 1850.2 - 1909.8 MHz (WCDMA Band 2 / GSM1900)
Operating Voltage	8.5Vdc
Antenna Type / Gain	Isolated Magnetic Dipole (Non-detachable), 2.6 / 4.4dBi Ethertronics, P/N: P822601
Manufacturer	u-blox AG
FCC ID	XPY1CGM5NNN

Technical Information (Iridium Satellite):

Detail	Description
Frequency Range	1616.0 - 1626.5
Operating Voltage	8.5Vdc
Antenna Type / Gain	Ceramic Patch / 3dBi Peak Taoglas, P/N: IP.1621.25.4.A.02
Manufacturer	Iridium
FCC ID	Q639603N

Host Manufacturer Information:
RSAE Labs
P.O. Box 15922
Panama City, Florida, 32406 USA

Test Sample Serial Number: 42000012

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology and Considerations

For intermodulation product testing, each cellular technology was placed into maximum power transmission mode at the middle of each band under investigation; simultaneously, the Zigbee radio was placed into constant transmission at the center channel.

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following addresses:

TÜV SÜD America, Inc.
5945 Cabot Pkwy, Suite 100
Alpharetta, GA 30005
Phone: (678) 341-5900

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation/A2LA accreditation program and has been issued certificate number 2955.09 in recognition of this accreditation.

Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scopes of accreditation.

The Semi-Anechoic Chamber Test Sites and Conducted Emissions Sites have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 967699
ISED Canada Lab Code: 23932
VCCI Member Number: 1831
- VCCI Registration Number A-0295

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site – Chamber A

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 5' in diameter and is located 5'6" from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted EMCO Model 1060 installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chase from the turntable to the pit that allows for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit, so cables can be supplied to the EUT from the pit.

The chamber rear wall is covered with a mixture of Siepel pyramidal absorber. The side walls of the chamber are partially covered with Siepel pyramidal absorber.

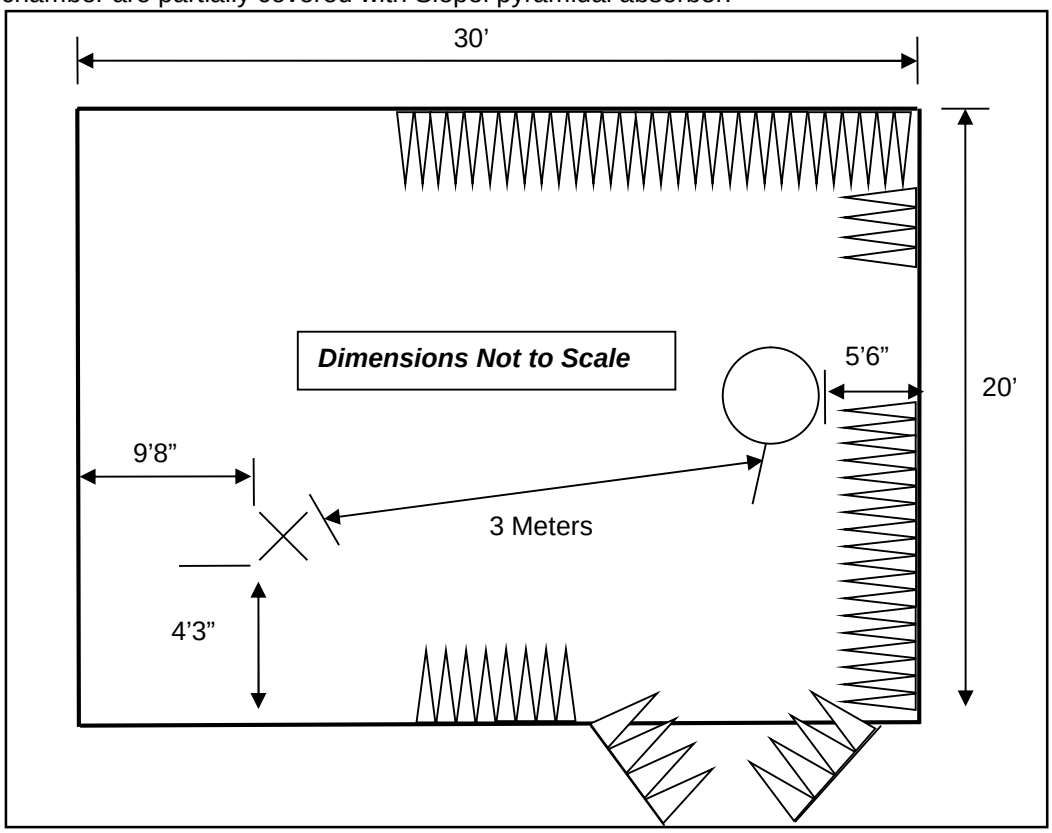

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site – Chamber A

2.3.2 Semi-Anechoic Chamber Test Site – Chamber B

The Semi-Anechoic Chamber Test Site consists of a 20'W x 30'L x 20'H shielded enclosure. The chamber is lined with ETS-Lindgren Ferrite Absorber, model number FT-1500. The ferrite tile 600 mm x 600 mm (2.62 in x 23.62 in) panels and are mounted directly on the inner walls of the chamber shield.

The specular regions of the chamber are lined with additional ETS-Lindgren PS-600 hybrid absorber to extend its frequency range up to 18GHz and beyond.

The turntable is a 2m ETS-Lindgren Model 2170 and installed off the center axis is located 5'6" from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the shield using #8 solid copper wire.

The antenna mast is an EMCO 1060 and is remotely controlled from the control room for both antenna height and polarization.

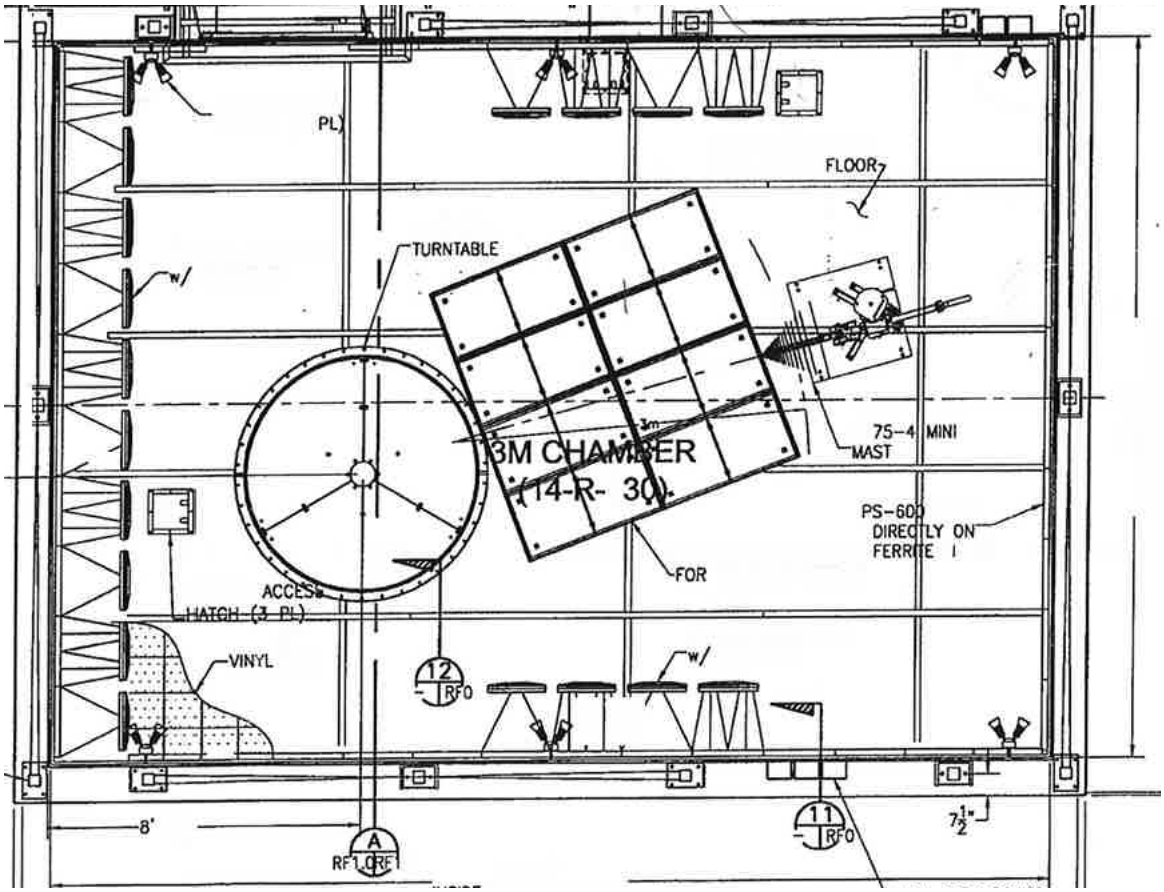

Figure 2.3.2-1: Semi-Anechoic Chamber Test Site – Chamber B

2.4 Conducted Emissions Test Site Description

2.4.1 Conducted Emissions Test Site

The AC mains conducted EMI site is located in the main EMC lab. It consists of a 12' x 10' horizontal coupling plane(HCP) as well as a 12'x8' vertical coupling plane(VCP). The HGP is constructed of 4' x 10' sheets of particle board sandwiched by galvanized steel sheets. These panels are bonded using 11AWG 1/8" x 2" by 10' galvanized sheet steel secured to the panels via by screws. The VCP is constructed of three 4'x8' sheets of 11AWG solid aluminum.

The HCP and VCP are electrically bonded together using 1"x1" angled aluminum secured with screws.

The site is of sufficient size to test table top and floor standing equipment in accordance with ANSI C63.10.

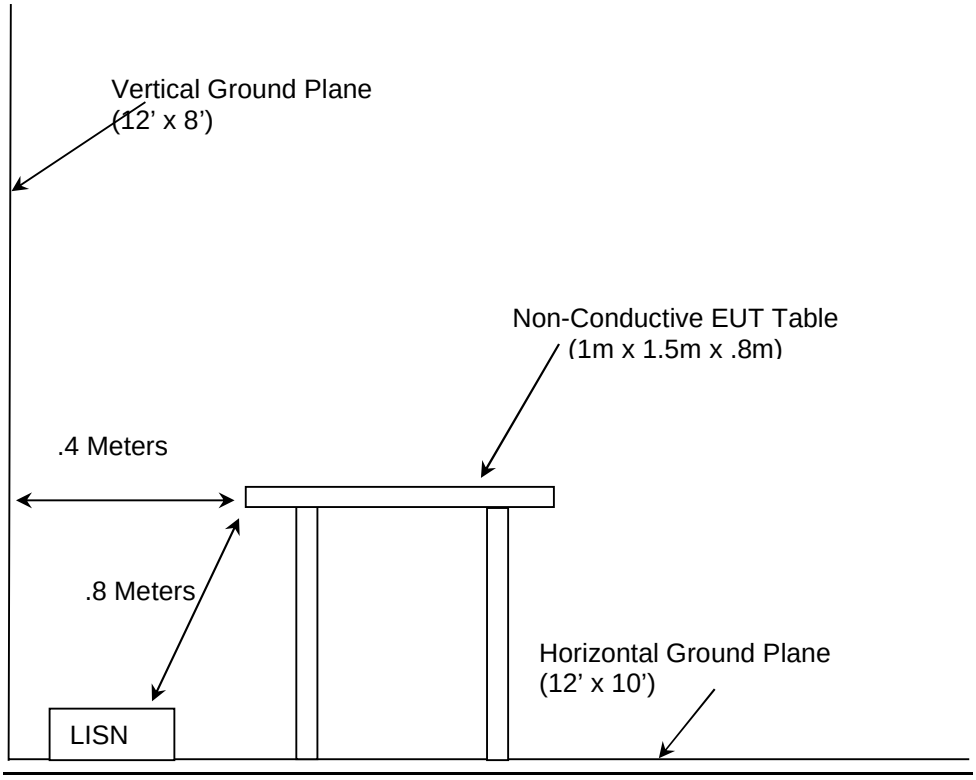

Figure 2.4.1-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.26: 2015: American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter A, Part 2, Subpart J: Equipment Authorization Procedures, 2019
- US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter A, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2019
- FCC KDB 558074 D01 DTS Meas Guidance v05r01 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, February 11, 2019
- US Code of Federal Regulations (CFR): Title 47, Title 47, Chapter I, Subchapter B, Part 22: Equipment Authorization Procedures, 2019
- US Code of Federal Regulations (CFR): Title 47, Title 47, Chapter I, Subchapter B, Part 24: Equipment Authorization Procedures, 2019

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
30	Spectrum Technologies	DRH-0118	1-18GHz Horn Antenna	970102	05/09/2017	05/09/2019
321	Hewlett Packard	HPC 8447D	Low Freq. Pre-Amp	1937A02809	09/12/2018	09/12/2019
329	A.H.Systems	SAS-571	Horn Antenna	721	08/03/2017	08/03/2019
331	Microwave Circuits	H1G513G1	Microwave Bandpass Filter	31417	05/16/2018	05/16/2019
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	07/11/2017	07/11/2019
432	Microwave Circuits	H3G020G4	Highpass Filter	264066	05/16/2018	05/16/2019
609	Rohde & Schwarz	SMB100A	Signal Generator (100kHz - 20GHz)	175334	07/12/2018	07/12/2019
701	United Microwave Products Inc.	AA-190-20.00.0	Cable	N/A	07/25/2018	07/25/2019
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	11/06/2018	11/06/2019
851	TUV ATLANTA	FMC0101951-100CM	ASAC Cable Set Consisting of 566, 619, and 643	N/A	09/26/2018	09/26/2019
852	Teseq	CBL 6112D	Bilog Antenna; Attenuator	51617	10/15/2018	10/15/2019

NCR = No Calibration Required
NOTE: All Equipment only used during active calibration cycles.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment – Radiated Emissions

Item	Equipment Type	Manufacturer	Model/Part Number	Serial Number
No support equipment was required – once placed in test mode, the EUT was tested standalone				

Table 5-2: Cable Description – Radiated Emissions

Cable	Cable Type	Length	Shield	Termination
The EUT is a stand-alone, battery-powered device with no provisions for external cabling				

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

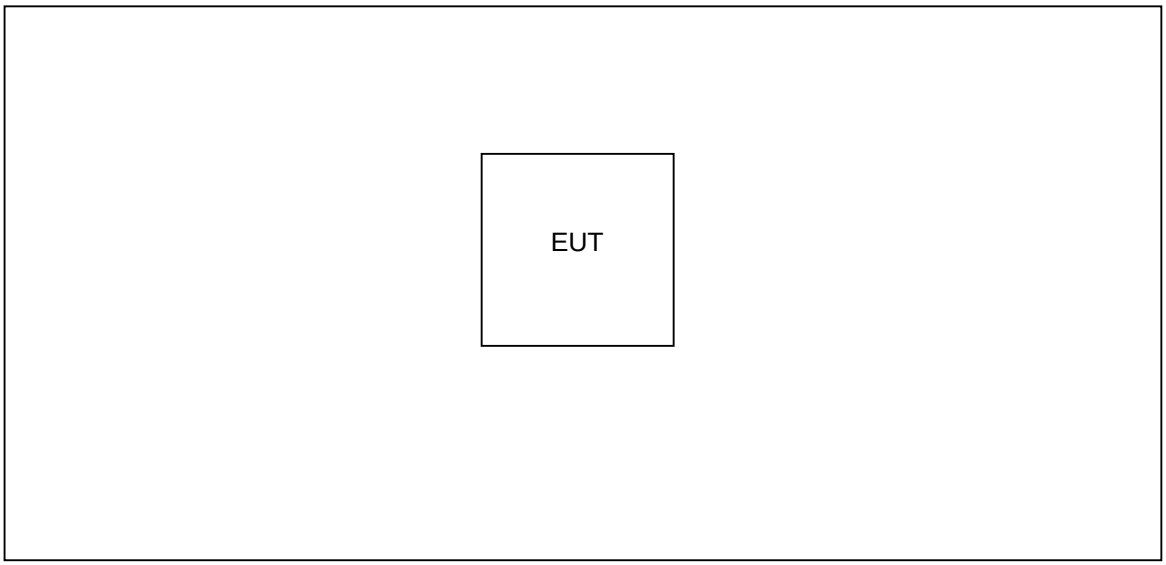

Figure 6-1: Test Setup Block Diagram

7 SUMMARY OF TESTS

7.1.1 Intermodulation Products due to Simultaneous Transmissions

7.1.1.1 Measurement Procedure

The unwanted emissions due to intermodulation products up to the 5th order were investigated over the frequency range of 30 MHz to 18 GHz.

The EUT was rotated through 360° and the receive antenna height was varied from 1 meter to 4 meters so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, RMS measurements were made using a resolution bandwidth RBW of 100 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, RMS measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

Each identified emission was measured and followed up using the substitution method to determine the ERP / EIRP value at those frequencies. These were compared to the licensed limit of -13dBm.

7.1.1.2 Measurement Results

Performed by: Tyler Leeson, Jeremy Pickens

Table 7.1.1.2-1: Substitution Method Results- Simultaneous Transmission

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Position (o)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
Zigbee 2405, GSM 1741.6MHz, Iridium Satelite 1621.02									
3242.04	-61.20	-55.60	H	199.00	285.00	6.33	-49.27	-13.00	36.27
3242.04	-67.7	-60.9	V	199	218	6.33	-54.57	-13.00	41.57
7215	-64.2	-49.1	H	101	267	5.28	-43.82	-13.00	30.82
7215	-57.4	-40.6	V	113	44	5.28	-35.32	-13.00	22.32
Zigbee 2405, GSM 1880MHz, Iridium Satelite 1621.02									
3242.04	-61.6	-56	H	145	276	6.33	-49.67	-13.00	36.67
3242.04	-65.9	-58.1	V	157	329	6.33	-51.77	-13.00	38.77
7215	-61.5	-46.1	H	156	306	5.28	-40.82	-13.00	27.82
7215	-62.8	-46.4	V	168	20	5.28	-41.12	-13.00	28.12
Zigbee 2405, GSM 836.6MHz, Iridium Satelite 1621.02									
1568.87	-50.1	-40	H	159	65	6.61	-33.39	-13.00	20.39
1568.87	-49.8	-48	V	253	0	6.61	-41.39	-13.00	28.39
1673.2	-30.9	-27.7	H	129	64	6.28	-21.42	-13.00	8.42
1673.2	-27	-20.7	V	155	150	6.28	-14.42	-13.00	1.42
3242.04	-61.3	-55.7	H	160	271	6.33	-49.37	-13.00	36.37
3242.04	-62.8	-54	V	188	15	6.33	-47.67	-13.00	34.67
7215	-61.3	-45.9	H	164	310	5.28	-40.62	-13.00	27.62
7215	-62.8	-46.4	V	153	16	5.28	-41.12	-13.00	28.12

Note: Zigbee spurious emissions measurements for standalone operation are included in a separate test report

8 ESTIMATION OF MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

Table 8-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	± 0.009 %
RF Conducted Output Power	± 0.349 dB
Power Spectral Density	± 0.372 dB
Antenna Port Conducted Emissions	± 1.264 dB
Radiated Emissions ≤ 1 GHz	± 5.814 dB
Radiated Emissions > 1 GHz	± 4.318 dB
Temperature	± 0.860 °C
Radio Frequency	± 2.832 x 10^{-8}
AC Power Line Conducted Emissions	± 3.360 dB

9 CONCLUSION

In the opinion of TÜV SÜD America, Inc. the GS-6C, manufactured by RSAE Labs meets the requirements of FCC Parts 15.247, 22, 24, and 25 for the tests documented in this test report.

END REPORT