Washington Laboratories, Ltd.
www.wll.com
7560 Lindbergh Drive . Gaithersburg, MD 20879
301.216.1500 . info@wll.com

FCC Certification Test Report

MINE SAFETY APPLIANCES COMPANY
G1 RFID BOARD

WLL REPORT# 13432-01 Rev 2
May 17, 2014

Re-issued
October 22, 2014

FCC ID: P9R-10154953
IC ID: 324C-10154953

Prepared for:

MINE SAFETY APPLIANCES COMPANY
1000 Cranberry Woods Drive
Cranberry Township, PA 16066-520

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

ACCLASS ACCREDITED TESTING

Testing Certificate AT-1448

FCC Certification Test Report

For the
MINE SAFETY APPLIANCES COMPANY
G1 RFID BOARD
FCC ID: P9R-10154953
IC ID: 324C-10154953

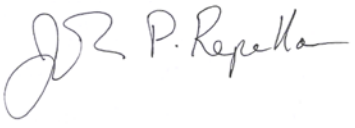
WLL REPORT# 13432-01 Rev 2
May 17, 2014

Re-issued
October 22, 2014

Prepared by:

John Reidell
EMC Compliance Engineer

Reviewed by:



John P. Repella
EMC & Wireless Lab Manager

Abstract

This report has been prepared on behalf of Mine Safety Appliances Company to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.225 of the FCC Rules and Regulations and Industry Canada RSS210. This Certification Test Report documents the test configuration and test results for a G1 RFID Board.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by the ANSI-ASQ National Accreditation Board/ACLASS. Refer to certificate and scope of accreditation AT-1448.

The G1 RFID Board complies with the limits for an Intentional Radiator device under FCC Part 15.225 and Industry Canada RSS 210.

Revision History	Reason	Date
Rev 0	Initial Release	May 17, 2014
Rev 1	Re-issue to correct FCC & IC ID numbers	May 24, 2014
Rev 2	Re-issue to correct FCC & IC ID numbers in Table 1	October 22, 2014

Table of Contents

List of Tables

List of Figures

1.1 Compliance Statement

The G1 RFID BOARD complies with the limits for an Intentional Radiator device under FCC Part 15.225 (10/2013) and Industry Canada RSS 210 (Issue 8).

1.2 Test Scope Summary

Tests for radiated and conducted emissions were performed. All measurements were performed in accordance with the 2003 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

Test Specification	Specific Description	Date Completed	Result	Modifications (Y/N)
CFR47 Part 15.207, RSS Gen section 7.2.4	Class B Conducted Emissions – AC Power Ports	N/A	Not Applicable	No
CFR47 Part 15.209, RSS Gen section 7.2.5	Class B Radiated Emissions	5/5/14	Complied	No
RSS Gen section 6	Receiver Spurious Emissions	5/5/14	Complied	No
CFR47 Part 15.225, RSS 210 section A2.6	Field Strength	5/5/14	Complied	No
CFR47 Part 15.225, RSS GEN section 4.7	Frequency Stability	5/7/14	Complied	No
CFR47 Part 2.1049	Occupied Bandwidth	5/6/14	Complied	No

1.3 Contract Information

Customer: Mine Safety Appliances Company
1000 Cranberry Woods Drive
Cranberry Township, PA 16066-5208

Purchase Order Number: 4501653577

Quotation Number: 67983

1.4 Test Dates

Testing was performed on the following date(s): 5/5/2014- 5/7/2014

1.5 Test and Support Personnel

Washington Laboratories, LTD — John Reidell

Customer Representative — David Kodrin

1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**ere**s**
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**C**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**decibel**
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**M**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification & Description

The Mine Safety Appliances Company G1 RFID Board is installed within a G1 Self Contained Breathing Apparatus (SCUBA) to detect and read an RFID tag during firefighting Applications.

.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mine Safety Appliances Company
FCC ID:	P9R-10154953
IC ID:	324C-10154953
Model:	G1 RFID Board
FCC Rule Parts:	§15.225
Frequency Range:	13.56MHz
Maximum Output Power:	320.8 uV/m at 10 meters
Modulation:	OOK
Occupied Bandwidth:	1.8644 kHz
Type of Information:	Data
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Internal PCB
Frequency Tolerance:	>±0.01% (±100 ppm)
Interface Cables:	Power, I/O
Power Source & Voltage:	9Vdc from batteries

2.2 Test Configuration

The G1 RFID Board was configured for testing as indicated in the figure below. Power from a support 115 VAC to 9VDC power adaptor (EUT normally receives 9VDC from 6 C Cell batteries) was provided to EUT. In addition a RS232 (3 wire) line to USB was connected between the EUT and a support laptop. No other connections were necessary.

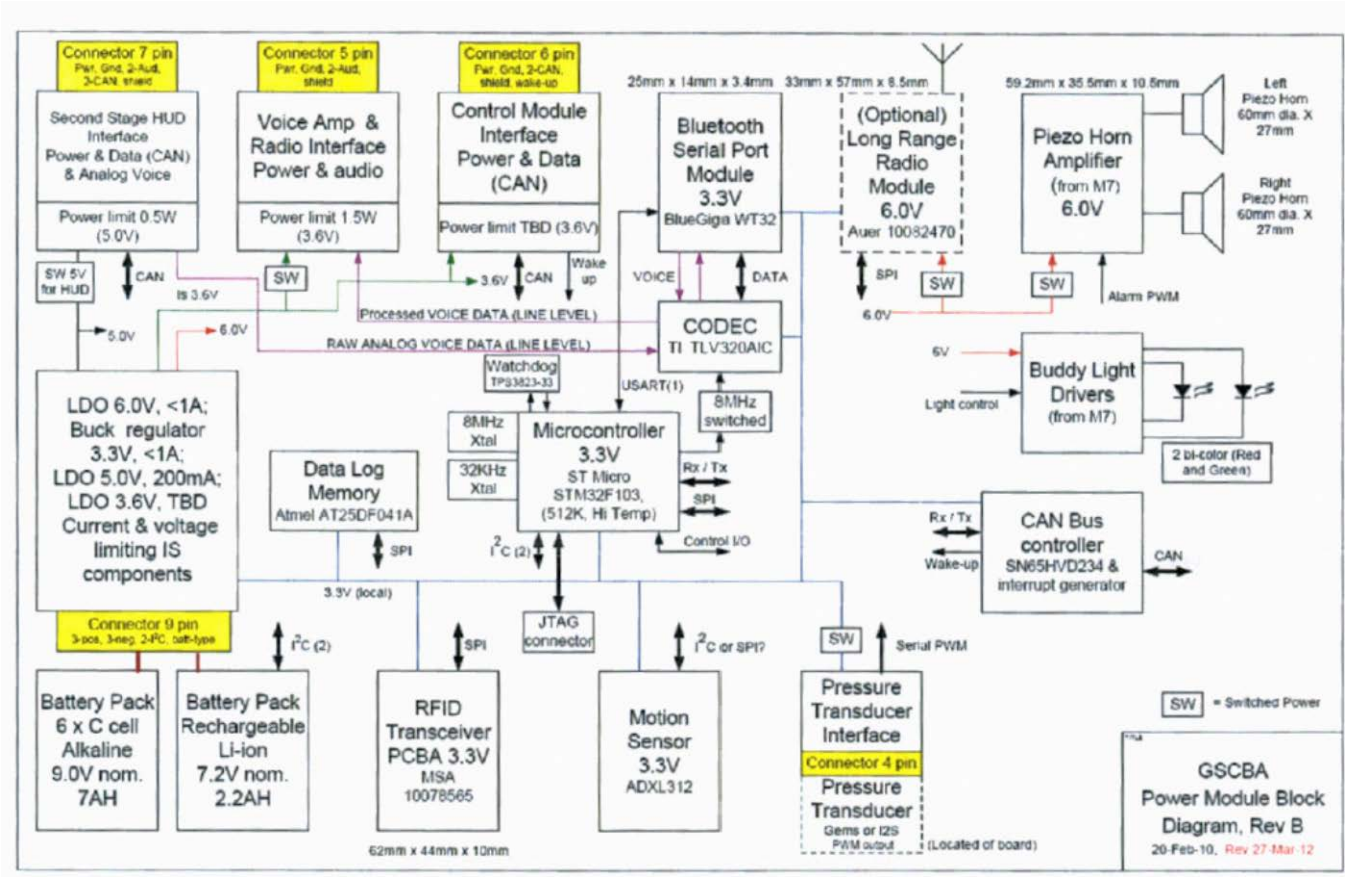


Figure 1: Test Configuration

2.3 Testing Algorithm

The Reader operates at a fixed frequency of 13.56MHz. A support laptop sent commands via "Hyper Terminal" to activate Reader to look for RDID tag, until power is removed.

2.4 Measurements

2.4.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40GHz

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

2.5 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + ...}$$

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$div_{a,\ b,\ c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	±2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	±4.55 dB

3 Test Equipment

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment

Test Name: **Radiated Emissions**		Test Date: **05/05/2014**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
31	EMCO - 6502	ANTENNA ACTIVE LOOP	3/18/2016
71	HP - 85685A	PRESELECTOR RF	1/9/2015
802	HP - 8568B	SPECTRUM ANALYZER	1/9/2015
69	HP - 85650A	ADAPTER QP	1/9/2015
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	1/17/2016

Test Name: **Temperature Stability**		Test Date: **5/7/2014**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
776	TENNY - TJR-A-WS4	1.22 CUFT	1/20/2015
815	MASTECH - HY5005-2	DUAL 050VDC POWER SUPPLY	CNR
774	FLUKE - 115	TRUE RMS MULTIMETER	2/6/2015

4 Test Results

4.1 Occupied Bandwidth

Occupied bandwidth measurement was performed by coupling the output of the EUT to the input of a spectrum analyzer using a near field probe.

The occupied bandwidth was measured as shown:

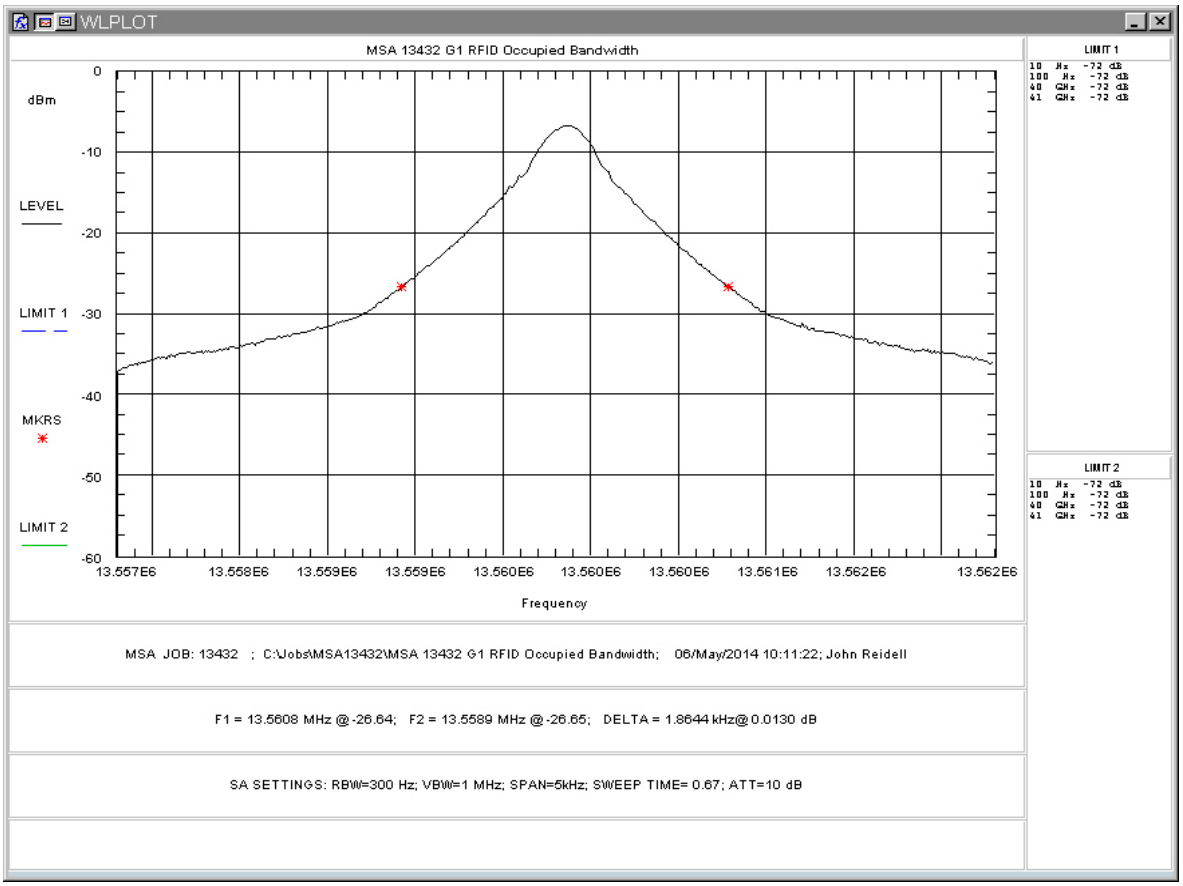


Figure 2: Occupied Bandwidth

Table 4 provides a summary of the Occupied Bandwidth Results.

Table 4: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
13.5608MHz	1.8644 kHz	N/A	Pass

4.2 Radiated Spurious Emissions: FCC §15.225, §15.209, RSS 210 §A2.6, RSS GEN §7.2.5

Radiated emissions from the EUT must comply with the field strength limits as specified in FCC Part 15.225 and 15.209 and IC RSS 210 and RSS GEN. The limits for the radiated emissions are as shown in the following table.

Table 5: Radiated Spurious Emissions Limits

Frequency (MHz)	Limit (μV/m)	Rule Part Reference
13.553 - 13.567	15,848 (@ 30m)	§15.225(a), §RSS 210 A2.6(a)
13.410 – 13.553	334 (@ 30m)	§15.225(b), §RSS 210 A2.6(b)
13.567 – 13.710	334 (@ 30m)	§15.225(b), §RSS 210 A2.6(b)
13.110 – 13.410	106 (@ 30m)	§15.225(c), §RSS 210 A2.6(c)
13.710 – 14.010	106 (@ 30m)	§15.225(c), §RSS 210 A2.6(c)
1.705 – 13.110 14.010 – 30.0	30 (@ 30m)	§15.225(d), §RSS 210 A2.6(c) §15.209, RSS GEN 7.2.5
30.00 – 88.00	100 (@ 3m)	§15.225(d), §RSS 210 A2.6(d) §15.209, RSS GEN 7.2.5
88.00 – 216.00	150 (@ 3m)	§15.225(d), §RSS 210 A2.6(d) §15.209, RSS GEN 7.2.5
216.00 – 960.00	200 (@ 3m)	§15.225(d), §RSS 210 A2.6(d) §15.209, RSS GEN 7.2.5
Above 960	500 (@ 3m)	§15.225(d), §RSS 210 A2.6(d) §15.209, RSS GEN 7.2.5

4.1.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on an Open Area Test Site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. For frequencies below 30MHz, the loop antenna was mounted on a tripod at a height of 1 meter and a distance of 10m from the EUT. Above 30MHz, Biconical and log periodic broadband receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters at a distance of 3 meters from the EUT. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured

Below 150 kHz, bandwidths used were 300Hz RBW and 10 kHz VBW. Between 150 kHz and 30 MHz, bandwidths used were 10 kHz RBW and 30 kHz VBW. Limits were interpolated from the 30 meter limit to the equivalent at 10 meters using the 40dB/decade roll-off. Three orientations of the loop antenna were tested. Above 30MHz, bandwidths used were 100 kHz RBW and 30 kHz VBW.

Emissions were scanned from 9 kHz to 1GHz. Emissions from were measured using a Quasi-peak detector. Worst case emissions are reported in the data table.

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

Spectrum Analyzer Voltage (SA Level):	VdBμV
Antenna Factor (Ant Corr):	AFdB/m
Cable Loss Correction (Cable Corr):	CCdB
Amplifier Gain:	GdB (if applicable)
Electric Field (Corr Level):	EdBμV/m = VdBμV + AFdB/m + CCdB - GdB
To convert to linear units:	EμV/m = antilog (EdBμV/m/20)

4.1.2 Test Results

The EUT complies with the radiated emission requirements of §15.225. The following tables provide the test data.

Table 6: Radiated Emissions below 30MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
13.56	X	0.00	1.00	39.10	11.0	320.8	15848.0	-33.9
13.61	X	215.00	1.00	16.70	11.0	24.3	3340.0	-42.7
13.71	X	215.00	1.00	25.30	11.0	65.6	1060.0	-24.2
14.25	X	0.00	1.00	25.30	11.1	65.8	300.0	-13.2
15.12	X	180.00	1.00	26.00	11.1	71.5	300.0	-12.5
15.20	X	90.00	1.00	31.00	11.1	127.1	300.0	-7.5
16.26	X	270.00	1.00	24.20	11.0	57.5	300.0	-14.4
17.15	X	135.00	1.00	32.10	10.9	141.5	300.0	-6.5
19.57	X	180.00	1.00	24.00	10.7	54.5	300.0	-14.8
20.00	X	300.00	1.00	31.30	10.7	125.9	300.0	-7.5
27.02	X	0.00	1.00	28.20	9.4	76.1	300.0	-11.9
13.56	Y	180.00	1.00	26.50	11.0	75.2	15848.0	-46.5
13.61	Y	270.00	1.00	21.80	11.0	43.8	3340.0	-37.6
15.14	Y	45.00	1.00	23.30	11.1	52.4	300.0	-15.2
15.36	Y	135.00	1.00	21.90	11.1	44.5	300.0	-16.6
16.35	Y	270.00	1.00	18.30	11.0	29.1	300.0	-20.3
17.15	Y	0.00	1.00	25.50	10.9	66.2	300.0	-13.1
19.78	Y	90.00	1.00	23.40	10.7	50.8	300.0	-15.4
20.00	Y	0.00	1.00	24.40	10.7	56.9	300.0	-14.4
27.02	Y	90.00	1.00	21.90	9.4	36.9	300.0	-18.2
13.56	Z	60.00	1.00	20.90	11.0	39.5	15848.0	-52.1
13.60	Z	0.00	1.00	25.10	11.0	64.0	3340.0	-34.3
13.73	Z	0.00	1.00	22.40	11.0	47.0	1060.0	-27.1
14.25	Z	90.00	1.00	17.00	11.1	25.3	300.0	-21.5
15.14	Z	0.00	1.00	24.30	11.1	58.8	300.0	-14.2
16.27	Z	90.00	1.00	20.40	11.0	37.1	300.0	-18.2
17.15	Z	135.00	1.00	27.20	10.9	80.5	300.0	-11.4
19.58	Z	0.00	1.00	13.70	10.7	16.7	300.0	-25.1
20.00	Z	90.00	1.00	32.10	10.7	138.0	300.0	-6.7
27.01	Z	270.00	1.00	22.30	9.4	38.6	300.0	-17.8

Table 7: Radiated Emissions above 30MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
39.76	V	90.00	1.00	7.10	14.2	11.6	100.0	-18.7
47.65	V	180.00	1.00	9.60	8.9	8.4	100.0	-21.5
57.20	V	270.00	1.00	11.00	6.9	7.9	100.0	-22.1
72.35	V	180.00	1.00	11.80	8.5	10.3	100.0	-19.7
79.99	V	135.00	1.00	8.40	8.1	6.7	100.0	-23.5
147.29	V	90.00	1.00	10.50	13.0	15.0	150.0	-20.0
163.07	V	0.00	1.00	14.60	13.0	24.0	150.0	-15.9
217.52	V	270.00	2.25	18.40	12.1	33.5	200.0	-15.5
247.98	V	45.00	1.15	11.50	13.7	18.3	200.0	-20.8
255.99	V	270.00	1.00	11.90	13.8	19.4	200.0	-20.3
271.99	V	135.00	1.00	10.10	15.5	19.0	200.0	-20.5
39.35	H	0.00	4.00	6.90	14.6	11.9	100.0	-18.5
47.66	H	270.00	4.00	10.00	8.9	8.8	100.0	-21.1
57.19	H	0.00	4.00	10.90	6.9	7.8	100.0	-22.2
72.36	H	0.00	4.00	17.20	8.5	19.3	100.0	-14.3
85.81	H	90.00	4.00	9.50	7.9	7.4	100.0	-22.6
114.29	H	270.00	4.00	4.30	13.9	8.1	150.0	-25.4
147.11	H	270.00	4.00	9.60	13.0	13.5	150.0	-20.9
162.40	H	0.00	4.00	12.20	13.0	18.2	150.0	-18.3
217.52	H	0.00	1.40	11.70	12.1	15.5	200.0	-22.2
247.99	H	0.00	2.74	11.40	13.7	18.1	200.0	-20.9
255.97	H	180.00	2.76	11.60	13.8	18.7	200.0	-20.6
352.55	H	190.00	1.93	7.10	17.5	17.1	200.0	-21.4

4.2 Frequency Stability: FCC Part §2.1055, §15.225, RSS GEN §4.7, RSS 210 §A2.6

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances. Per §15.225(e) and RSS 210 A2.6 the frequency tolerance shall be maintained within ±0.01% of the reference frequency.

4.2.1 Test Procedure

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

The frequency stabilities can be maintained to a lesser temperature range provided that the transmitter is automatically inhibited from operating outside the lesser temperature range.

The RF carrier frequency shall not depart from the reference frequency (reference frequency is the frequency at 20ºC and rated supply voltage) in excess of +/-1356 Hz.

The EUT is powered by 9Vdc voltage supplied via an external adjustable AC/DC power supply.

4.2.2 Test Results

The EUT complies with the temperature stability requirements of the specified standards. Test results are given in Table 9.

Table 8: Frequency Stability Test Data

Limit: 0.010%

Temperature (Centigrade)	Frequency (MHz)	Difference (Hz)	Deviation (%)
(20)Ambient	13.559870	0.0	0
-30	13.559680	-190.0	0.001401
-20	13.559800	-70.0	0.000516
-10	13.559850	-20.0	0.000147
0	13.559850	-20.0	0.000147
10	13.559880	10.0	0.000074
20	13.559900	30.0	0.000221
30	13.559850	-20.0	0.000147
40	13.559850	-20.0	0.000147
50	13.559850	-20.0	0.000147

Voltage Variations

Voltage (Volts)	Frequency (MHz)	Difference (Hz)	Deviation (%)	Voltage (Volts)
At rated	13.559850	0	0.0	9VDC
At 85%	13.559850	0	0.000000	67.5VDC
At 115%	13.559870	-20	0.000147	10.35VDC