FCC CERTIFICATION

TEST REPORT

for the

SENSEONICS, INCORPORATED

FCC ID: 2AHYA-3402

WLL REPORT# 17891-01 REV 0

Prepared for:

Senseonics, Incorporated

20451 Seneca Meadows Parkway

Germantown, Maryland 20876

Prepared By:

Washington Laboratories, Ltd.

4840 Winchester Boulevard

Frederick, Maryland 21703

Testing Certificate AT-1448

FCC Certification

Test Report

for the

Senseonics, Incorporated

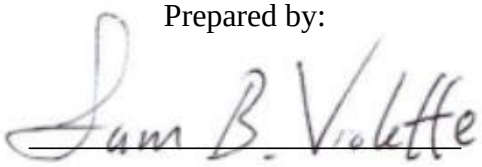
Transmitter - Phoenix2

FCC ID: 2AHYA-3402

January 10, 2023

WLL Report# 17891-01 Rev 0

Prepared by:



Samuel B. Violette
Vice President

Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of Senseonics, Incorporated 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 current at the time of testing and Regulations and Innovation, Science and Economic Development (ISED) Canada Spectrum Management and Telecommunications Policy. This Certification Test Report documents the test configuration and test results for the Senseonics, Incorporated Transmitter - Phoenix2.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 4840 Winchester Boulevard, Frederick, MD 21703. 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 ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory. (ISED Canada number 3035A).

The Senseonics, Incorporated Transmitter - Phoenix2 complies with the limits for an intentional radiator device under FCC Part 15.225.

Revision History	Description of Change	Date
Rev 0	Initial Release	January 10, 2023

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Compliance Statement

The Senseonics, Incorporated Transmitter - Phoenix2 complies with the limits for a Class B digital device under FCC Part 15.225.

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed in accordance with the 2014 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	Result	Modifications (Y/N)
CFR47 Part 15.207	Class B Conducted Emissions – AC Power Ports	Pass	N
CFR47 Part 15.209	Class B Radiated Emissions	Pass	N
CFR47 Part 15.225	Field Strength	Pass	N
CFR47 Part 15.225	Frequency Stability	Pass	N
CFR47 Part 2.1049	Occupied Bandwidth	Pass	N

1.3 Contract Information

Customer:	Senseonics, Incorporated
Purchase Order Number:	20753
Quotation Number:	73671

1.4 Test and Support Personnel

Washington Laboratories, LTD	Koster
Customer Representative	Joseph Hartle

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1: Device Summary

Manufacturer:	Senseonics, Incorporated
FCC ID:	2AHYA-3401
EUT Model:	Transmitter - Phoenix2
Serial Number of Unit Tested:	700240
FCC Rule Parts:	§15.255
Frequency Range:	13.553-13.567 MHz
Occupied Bandwidth:	0.810 kHz
Keying:	ASK
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	PCB Inductive Loop
Interface Cables:	USB Type A to Micro USB (Charging Only)
Power Source & Voltage:	Primary: 3.3Vdc, Battery Powered Secondary: AC/DC Wall adapter
Highest TX emission	515.28 MHz (3m, Radiated); 42.3 dBuV/m (QP)

The Senseonics, Incorporated Transmitter - Phoenix2 is a body-worn transmitter for glucose monitoring.

2.2 Test Configuration

The Transmitter - Phoenix2 was configured to transmit at 13.56MHz by a BLE connection via a phone application.

Table 2: System Configuration List

Name / Description	Model Number	Part Number	Serial Number	Revision
Phoenix2	LBL-103118-01	102985	700240	03

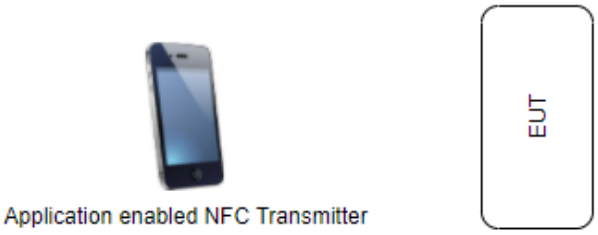


Figure 1: Test Configuration

2.3 Support Equipment

Table 3: Support Equipment

Item	Model/Part Number	Serial Number
Phone	Apple I-phone5	N/a

2.4 Testing Algorithm

The Transmitter - Phoenix2 was tested in a paired TX On Mode (13.56MHz @ 0.5 second) via a BLE connection.

2.5 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, 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. The ISED Canada OATS number for Washington Laboratories, Ltd. is 3035A. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.6 Test Deviations

2.6.1 Deviations to the Standard

There were no deviations to the requirements established in the specification.

2.7 Measurements

2.7.1 References

ANSI C63.2 (Jan-2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (Jan 2014) 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 40 GHz

ANSI C63.10 (Jun 2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.8 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) 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 uc = standard uncertainty
a, b, c,.. = individual uncertainty elements
Diva, 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 ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)
uc = 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 4 below.

Table 4: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	±2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	±4.55 dB

3 Test Equipment

Table 5 shows a list of the test equipment used for measurements along with the calibration information.

Table 5: Test Equipment List

Test Name:	**Conducted Emissions**	Test Date:	**12/19/2022**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	5/26/2023
00125	SOLAR 8028-50-TS-24-BNC	LISN	9/15/2023
00126	SOLAR 8028-50-TS-24-BNC	LISN	9/15/2023
00895	HP 11947A	TRANSIENT LIMITER	2/21/2023
00330	WLL CE CABLE	BNC-BNC RF COAXIAL CABLE	5/6/2023
Test Name:	**Radiated Emissions**	Test Date:	**12/19/2022**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00382	SUNOL SCIENCES CORPORATION JB1	ANTENNA BICONLOG	11/7/2024
00856	EMCO 6507	ACTIVE LOOP ANT. 1kHz to 30MHz	5/23/2023
00626	ARA DRG-118/A	ANTENNA HORN	8/20/2023
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	5/26/2023

00528	AGILENT E4446A	3Hz-44GHz SPECTRUM ANALYZER	3/25/2023
00522	HP 8449B	PRE-AMPLIFIER 1-26.5GHZ	5/5/2023
00849	AH SYSTEMS SAC-18G-16	HF COAXIAL CABLE, LOW LOSS (16M)	1/21/2023
00065	HP 8447D	RF PRE-AMPLIFIER	5/6/2023
00865	STORM 874-0101-036	HIGH FREQUENCY CABLE	5/5/2023

4 Test Results

4.1 Occupied Bandwidth: FCC §15.225, §2.1049

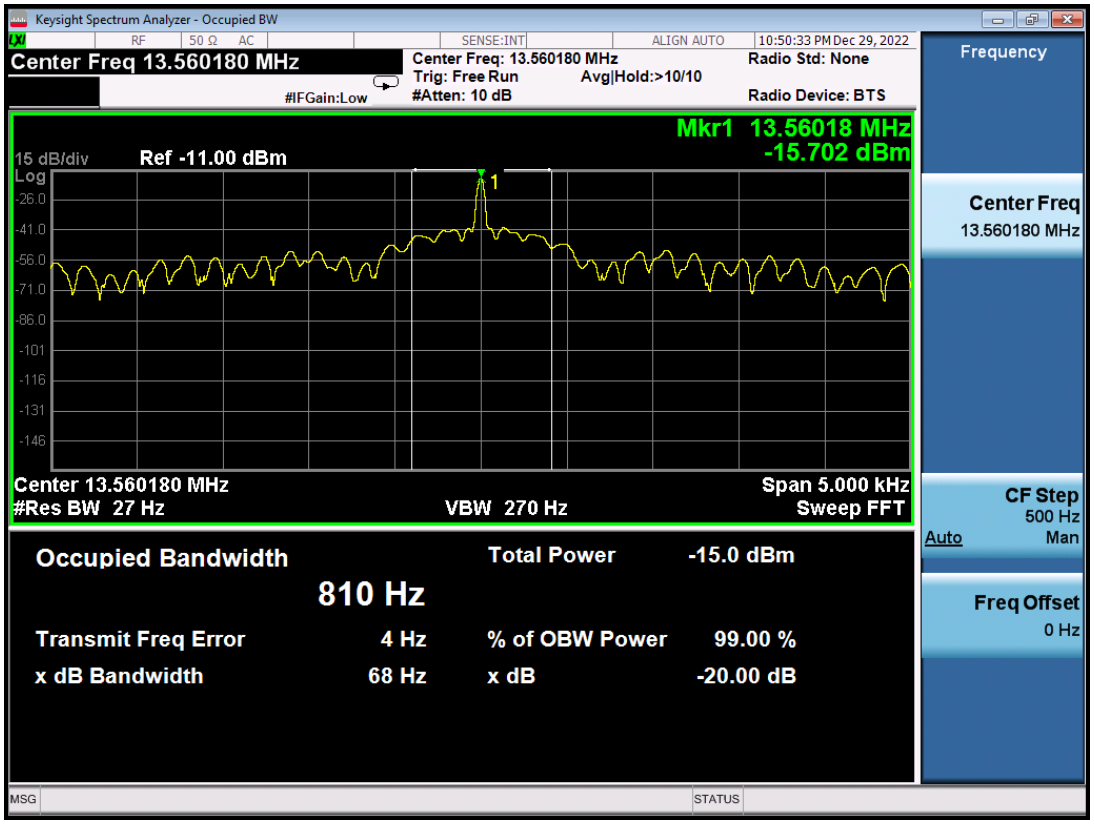
Occupied bandwidth measurement was performed by coupling the output of the EUT to the input of a spectrum analyzer using a near field probe. Table 4 provides a summary of the Occupied Bandwidth Results.

Table 6: Occupied Bandwidth Results

Frequency (MHz)	Bandwidth (kHz)	Limit	Pass/Fail
13.560	0.810	N/a	Pass

The occupied bandwidth was measured as shown:

Figure 2: Occupied Bandwidth



4.2 Radiated Spurious Emissions: FCC §15.225, §15.209

Radiated emissions from the EUT must comply with the field strength limits as specified in FCC Part 15.225.

Table 7: Radiated Spurious Emissions Limits

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

4.2.1 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. 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 30MHz, bandwidths used were 10kHz RBW and 30kHz VBW. The reading was taken at 10m. A correction factor was used to adjust the 10-meter results to the equivalent at 30 meters using the 40dB/decade roll-off. Three orientations of the loop antenna were tested. Above 30MHz, bandwidths used were 100 kHz RBW and 30kHz VBW.

Emissions were scanned from 9 kHz to 1GHz. Emissions from were measured using a 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: Eµ V/m = antilog (EdBµV/m/20)

4.2.2 Test Results

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

Table 8: Radiated Emissions below 30MHz, NFC Fundamental, 3meter measurement distance

Frequency (MHz)	EUT Position (X, Y, & Z)	Antenna Position (X, Y, & Z)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
13.560	X	X	1.0	22.3	18.0	40.3	124.0	-83.8	QP
-	X	Y	1.0	20.2	18.0	38.2	124.0	-85.8	QP
-	X	Z	1.0	34.6	18.0	52.6	124.0	-71.4	QP
-	Y	X	1.0	25.9	18.0	43.9	124.0	-80.1	QP
-	Y	Y	1.0	21.4	18.0	39.4	124.0	-84.6	QP
-	Y	Z	1.0	31.3	18.0	49.3	124.0	-74.7	QP
-	Z	X	1.0	37.7	18.0	55.7	124.0	-68.3	QP
-	Z	Y	1.0	20.3	18.0	38.3	124.0	-85.7	QP
-	Z	Z	1.0	31.8	18.0	49.8	124.0	-74.2	QP

Note: 3meter Measurement Test Data

Table 9: Radiated Emissions below 30MHz, NFC Fundamental, 10meter measurement distance

Frequency (MHz)	EUT Position (X, Y, & Z)	Antenna Position (X, Y, & Z)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
13.560	X	X	1.0	12.6	18.0	30.6	103.0	-72.4	QP
-	X	Y	1.0	14.3	18.0	32.3	103.0	-70.7	QP
-	X	Z	1.0	12.3	18.0	30.3	103.0	-72.7	QP
-	Y	X	1.0	16.4	18.0	34.4	103.0	-68.6	QP
-	Y	Y	1.0	18.3	18.0	36.3	103.0	-66.8	QP
-	Y	Z	1.0	18.9	18.0	36.9	103.0	-66.1	QP
-	Z	X	1.0	20.4	18.0	38.4	103.0	-64.6	QP
-	Z	Y	1.0	16.9	18.0	34.9	103.0	-68.1	QP
-	Z	Z	1.0	18.7	18.0	36.7	103.0	-66.3	QP

Note: 10meter Measurement Test Data

Table 10: Radiated Emissions below 30MHz, Spurious, 10meter measurement Distance

Frequency (MHz)	EUT Position (X, Y, & Z)	Antenna Position (X, Y, & Z)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (dBuV/m)	10m Limit (dBuV/m)	Margin (dB)	Detector
13.485	Z	X	1.0	10.5	18.0	28.9	70.0	-41.1	QP
13.509	Z	X	1.0	10.9	18.0	28.5	70.0	-41.5	QP
13.534	Z	X	1.0	10.5	18.0	28.6	70.0	-41.4	QP
12.700	Z	X	1.0	10.6	18.0	28.6	50.0	-21.4	QP
13.150	Z	X	1.0	10.5	18.0	28.5	60.0	-31.5	QP
13.560	Z	X	1.0	20.4	18.0	38.4	84.0	-45.6	QP
13.600	Z	X	1.0	14.4	18.0	32.4	70.0	-37.6	QP

Note: 1) 10meter Measurement Test Data. 2) Z/X, EUT / Ant. Orientation produces highest spurious emissions.

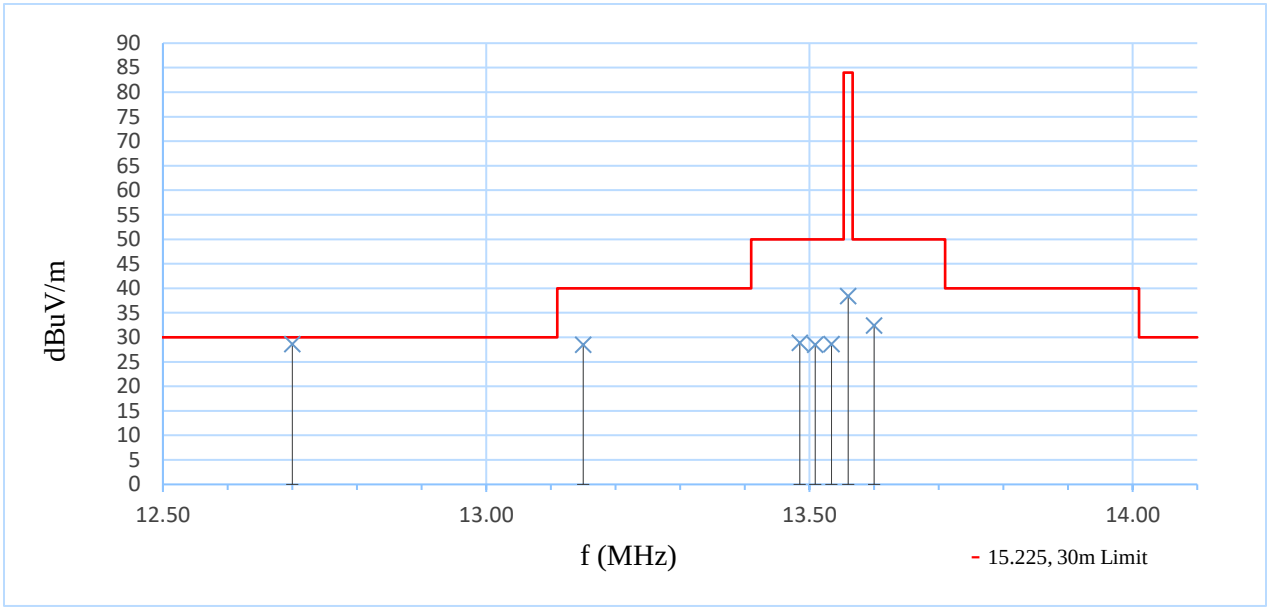


Figure 3: 10meter Emission Test Data compared to 30meter Limit

Table 11: 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)	Detector
81.30	V	0.0	1.2	36.1	-17.3	8.7	100.0	-21.2	QP
135.60	V	0.0	1.2	30.5	-11.5	8.9	150.0	-24.5	QP
162.72	V	0.0	1.2	32.5	-12.7	9.8	150.0	-23.7	QP
216.96	V	0.0	1.2	32.3	-13.9	8.3	200.0	-27.6	QP
244.08	V	0.0	1.2	32.1	-13.1	8.9	200.0	-27.0	QP
271.11	V	0.0	1.2	30.7	-11.1	9.5	200.0	-26.5	QP
298.32	V	0.0	1.2	32.0	-10.9	11.4	200.0	-24.9	QP
515.28	V	0.0	1.2	39.4	-6.2	46.1	200.0	-12.8	QP
81.30	H	0.0	1.2	36.2	-17.3	8.8	100.0	-21.1	QP
135.60	H	0.0	1.2	30.6	-11.5	9.1	150.0	-24.4	QP
162.72	H	0.0	1.2	32.0	-12.7	9.2	150.0	-24.2	QP
216.96	H	0.0	1.2	32.1	-13.9	8.1	200.0	-27.8	QP
244.08	H	0.0	1.2	32.5	-13.1	9.3	200.0	-26.6	QP
271.11	H	0.0	1.2	30.5	-11.1	9.3	200.0	-26.7	QP
298.32	H	0.0	1.2	31.9	-10.9	11.2	200.0	-25.0	QP
515.28	H	0.0	1.2	38.7	-6.2	42.3	200.0	-13.5	QP

Additionally, all the frequencies denoted in Table 11 were identified via a near-field pre-scan and confirmed to be products of the EUT. However, no EUT Emissions were detectable at 3m. As such, each of the measurement provided above, were made at the noise floor and the field strength values are that of ambient conditions.

4.3 Conducted Emissions (AC Power Line) FCC §15.225, §15.207

The EUT was placed on an 80 cm high 1 x 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 x 2-meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak or peak, as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth.

All emissions were measured with the EUT intact apart from the fundamental transmit frequency of 13.56MHz. To measure 13.56MHz, the internal antenna was replaced with a resistive load.

Tested with a CUIinc model SDI65-24-U 100 – 240V~ 50-60Hz to 24VDC wall adaptor.

AC Power Line conducted emissions test data are included in

Table 12.

Table 12: AC Power Conducted Emissions Test Data

NEUTRAL										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.161	51.4	28.2	9.9	0.6	61.9	38.7	65.4	55.4	-3.5	-13.7
0.199	47.8	25.9	9.9	0.5	58.2	36.3	63.7	53.7	-5.4	-17.3
0.250	44.5	22.5	9.9	0.4	54.9	32.9	61.8	51.8	-6.9	-18.9
0.311	40.8	21.6	9.9	0.4	51.1	31.9	59.9	49.9	-8.8	-18.1
0.513	32.1	13.1	9.9	0.3	42.3	23.4	56.0	46.0	-13.7	-22.6
3.553	23.0	11.9	10.3	0.4	33.7	22.6	56.0	46.0	-22.3	-23.4
5.301	27.3	16.9	10.4	0.5	38.2	27.8	60.0	50.0	-21.8	-22.2
PHASE / L1										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.157	49.3	27.4	9.9	0.4	59.7	37.8	65.6	55.6	-5.9	-17.8
0.188	47.1	24.6	9.9	0.4	57.4	34.9	64.1	54.1	-6.7	-19.2
0.269	41.0	20.0	9.9	0.3	51.3	30.3	61.1	51.1	-9.9	-20.9
0.315	39.1	19.0	9.9	0.3	49.3	29.2	59.8	49.8	-10.5	-20.6
0.332	38.4	18.3	9.9	0.3	48.6	28.5	59.4	49.4	-10.8	-20.9
0.391	34.6	18.0	9.9	0.3	44.8	28.2	58.0	48.0	-13.2	-19.8
0.634	27.0	12.0	9.9	0.3	37.2	22.2	56.0	46.0	-18.8	-23.8
3.194	20.0	11.0	10.2	0.3	30.6	21.6	56.0	46.0	-25.4	-24.4

4.4 Frequency Stability: FCC §15.225, §2.1055,

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances. Per §15.225(e).

4.4.1 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 -20°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) more than +/-1356 Hz.

The EUT was powered by 24Vdc voltage.

Per ANSI 63.10 the EUT was tested at each temperature at the turn on point, 2-minute point, 5-minute point, and 10-minute point.

4.4.2 Test Results

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

Table 13.

Table 13: Frequency Stability Test Data

Temperature (C)	Frequency (MHz)	Deviation (Hz)	Limit (+/- Hz)	Pass/Fail
22(ambient)	13.560211	0	1356	**NA**
-20	13.560221	10	1356	Pass
-10	13.560235	24	1356	Pass
0	13.560238	27	1356	Pass
10	13.560216	5	1356	Pass
20	13.560192	-19	1356	Pass
30	13.560141	-70	1356	Pass
40	13.560103	-108	1356	Pass
50	13.560083	-128	1356	Pass