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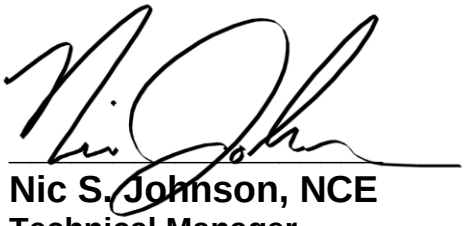
Amended

FCC/IC Test Report

Includes NCEE Labs report R20150623-20-01

Prepared for:	**Savox Communications**
Address:	**2025 SW 5th Street** **Lincoln, NE 68522**
Product:	**Clarity**
Test Report No:	**R20150623-20-01B**
Approved By:	 **Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
DATE:	**9 November 2017**
Total Pages:	**20**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Table of Figures and Tables

1.0 Summary of test results

1.1 Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
FCC Part 15.203	Unique Antenna Requirement	Pass	Permanently attached antenna
FCC Part 15.207 RSS-Gen Section 8.8	Conducted Emissions	N/A	No provisions for connection to AC mains
FCC Part 15.209 RSS-Gen Section 7.0	Receiver Radiated Emissions,	Pass	Meets the requirement of the limit.
FCC Part 15.209 RSS-Gen Section 8.9	Transmitter Radiated Emissions,	Pass	Meets the requirement of the limit.
FCC Part 15.215	Bandwidth and peak EIRP	NA	Informational only

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was a wireless covert neck-loop/microphone system used for interference free wireless communication. It operates at 12 kHz and transmits continuously when it is powered. IT does not have any receive capabilities.

EUT Received Date: 21 August 2015
EUT Tested Dates: 21 August 2015 – 28 August 2015*,
15 June 2017 (9kHz – 3MHz measurements)
26 June 2017 (3MHz – 30MHz measurements)

*Testing was completed in August 2015. The report was issued in June 2017. All test methods and standards methods were reviewed to ensure they met the current requirements as of June 2017. The testing is declared to be still valid and relevant.

MODEL	Clarity
Serial No.	NCEE Test 2 (assigned) The serial number was assigned by the lab as the test sample was not serialized.
POWER SUPPLY	Internal 3VDC, non-rechargeable batteries
ANTENNA TYPE	Internal Board Mount antenna

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 Laboratory description

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number :	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:
Relative humidity of 52 ± 4%

Temperature of 23 ± 3° Celsius

2.3 Description of test modes

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency
1	12 kHz

This is the only operating frequency.

2.4 Applied standards

The EUT operates at 12 kHz. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

(1) FCC Part 15, Subpart C (15.207, 15.209)
(2) ANSI C63.10:2013
(3) Industry Canada RSS-Gen Issue 4
(4) RSS-210 Issue 9

All test items have been performed and recorded as per the above.

2.5 Description of support units

None

2.6 Configuration of system under test

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

For duty cycle calculations, the unit was manually keyed as fast as possible.

The EUT was modified to be powered from a USB connection for testing purposes only.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Rohde & Schwarz Test Receiver	ES126	100037	20 Jan 2015	20 Jan 2016
Rohde & Schwarz Test Receiver**	ES07	100007	27 July 2016	27 July 2017
EMCO Loop antenna**	6512	00024936	25 Jan 2015	25 Jan 2018
EMCO Biconilog Antenna	3142B	1654	26 Jan 2015	26 Jan 2016

*Internal Characterization

Note: please see the testing dates listed in Section 2.0 for details on the calibration status of each piece of equipment during testing

**These were used for measurements from 9 kHz to 30MHz as tested on June 15, 2017 and June 26, 2017. The other tests were performed in August , 2015.

4.0 Detailed results

4.1 Unique antenna requirement

4.1.1 Standard applicable

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

4.1.2 Antenna description

The antenna permanently attached to the EUT and there is no connector.

4.2 Radiated emissions

Test Specifications: FCC Part 15.209
RSS-210 Section 4.3, 4.4
RSS-Gen Section 8.9

Test Method: ANSI C63.10, Section(s) 6.5

4.2.1 Limits for radiated emissions measurements

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

Table 1 – Radiated Emissions Spurious Limits

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

4.2.2 Test procedures

a. The EUT was placed on the top of a rotating table 0.8 meters and 1.5 meters above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters (unless noted) away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was measured in all 3 orthogonal axis. It was found that the Vertical position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

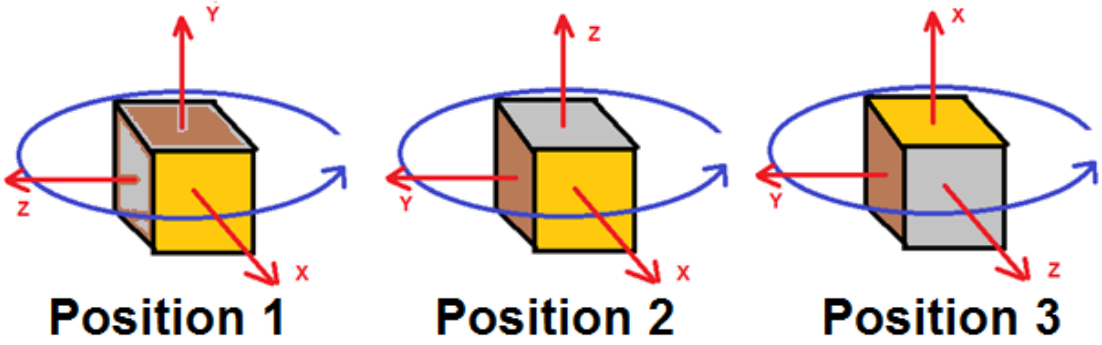


Figure 1 - Testing configuration in all 3 axis

Position 1 was found to produce the highest emissions in the preview scan. Therefore, all final measurements were performed in this orientation.

For the actual test configuration, please refer to the test setup photos exhibit for actual photos of the EUT.

4.2.5 EUT operating conditions

The EUT was powered by 3 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest

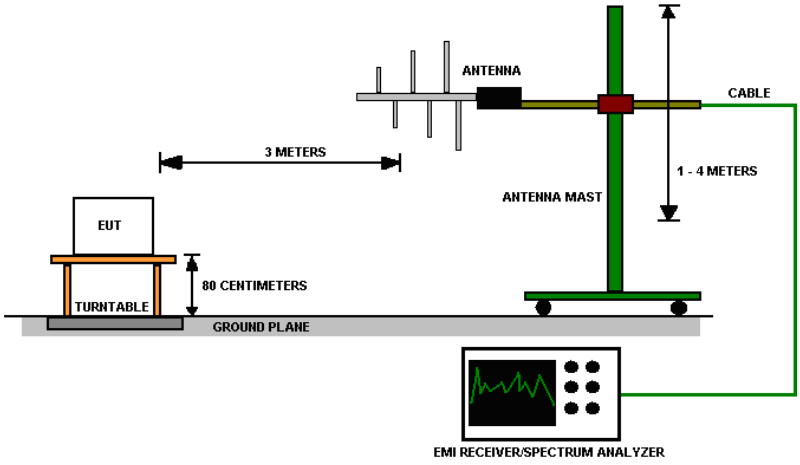


Figure 2 - Radiated Emissions Test Setup

The EUT was tested in both the vertical and horizontal in all 3 positions shown in Figure 2 below in order to measure emissions in all 3 orthogonal axis of the EUT and meet the requirements from ANSI C63.10 Section 5.10.1.

EUT	Clarity	MODE	Transmit
INPUT POWER	3 VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri, NJohnson

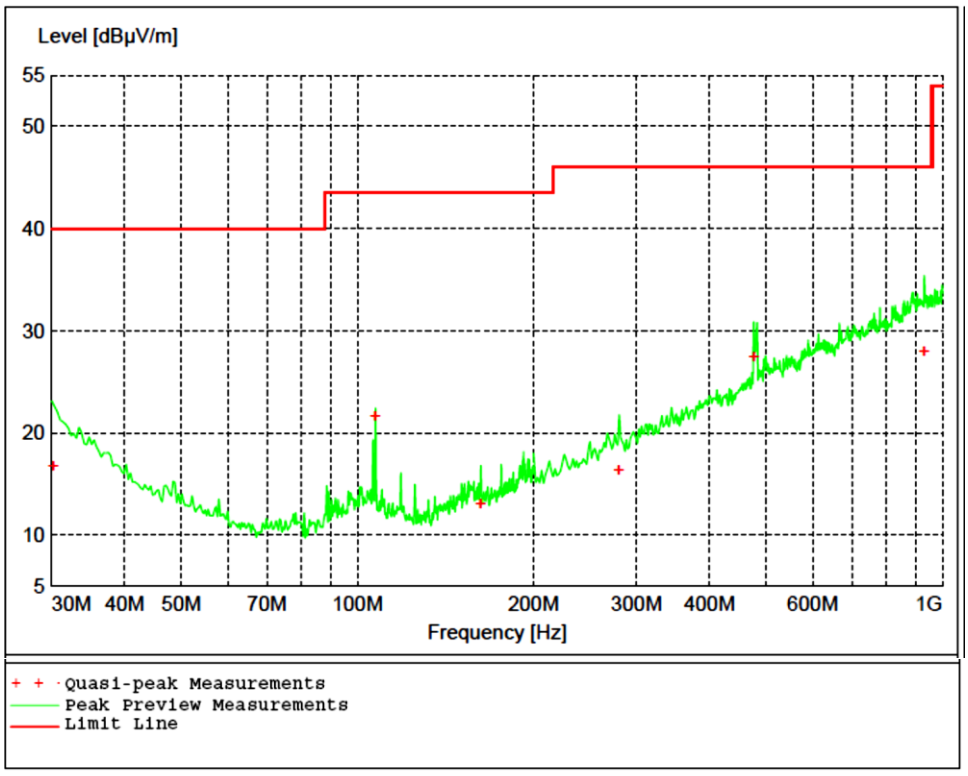


Figure 3 - Radiated Emissions Plot, Receive
Vertical orientation was fond to be the worse-case

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. Since peak measurements were compliant with the average limit, average measurements were not required

Table 2 - Radiated Emissions Quasi-peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
30.180000	16.75	40.00	23.30	293	96	HORI
107.280000	21.60	43.50	21.90	233	116	VERT
162.480000	13.04	43.50	30.50	213	202	HORI
280.020000	16.30	46.00	29.70	104	354	VERT
476.280000	27.37	46.00	18.60	107	192	VERT
931.080000	28.02	46.00	18.00	99	26	HORI

4.2.6 Test results

EUT	Clarity	MODE	Transmit
INPUT POWER	3 VDC	FREQUENCY RANGE	9 kHz – 30 MHz

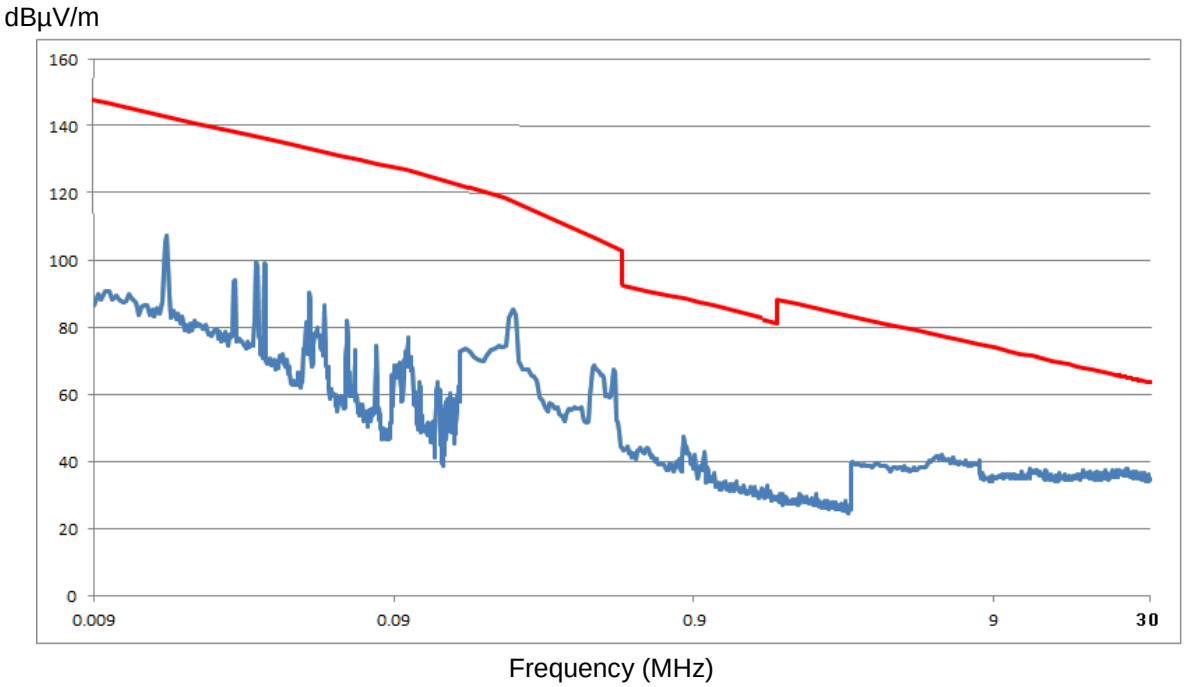


Figure 4 – Radiated emissions plot, 9 kHz – 30 MHz

All emissions were at least 10 dB below the limit

All measurements were performed at a distance of 1m with distance correction and near-field correction values from ANSI C63.10, Section 6.4.4.2, Equations 2, 3 and 4:

d_{limit} = Limit at 300m = d_{limit}
$d_{near\ field}$ = ʎ/2π
ʎ = (3x10^8 m/s) / f (/s)
$d_{measure}$ = 1m
d_{limit} = Limits from FCC Part 15.209, shown in Table 1 of Section 4.2.1 of report
FS_{max} = Field strength measured at $d_{measure}$
FS_{limit} = Measured value at specified limit with free-space correction

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. Since peak measurements were compliant with the average limit, average measurements were not required.

NOTE:

From CISPR 16-1-1:2010,the following resolution bandwidths were used for measurements:

Frequency range	Measurement resolution bandwidth
9 kHz – 150 kHz	200 Hz
0.150 MHz – 30 MHz	9 kHz
30 MHz tp 1000 MHz	120 kHz
1 GHz to 40 GHz	1 MHz

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

Frequency channel and one in the middle of its operating range.

4.3 Intentional Emission Bandwidth and field Strength

Test Specifications: FCC Part 15.215
RSS-Gen Section 6.6

Test Method: ANSI C63.10, Section(s) 6.9.2

4.3.1 Limits of bandwidth measurements

The 99% occupied bandwidth and peak EIRP are displayed for informational purposes only.

4.3.2 Test procedures

All measurements were taken at a distance of 3m from the EUT. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 1MHz RBW and 10 MHz VBW.

The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

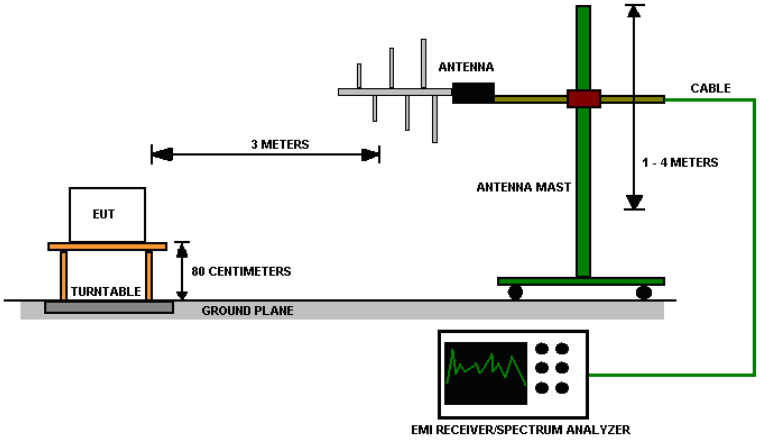


Figure 5 - Bandwidth Measurements Test Setup

4.3.5 EUT operating conditions

The EUT was powered by 3 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.3.6 Test results

EUT	Clarity	MODE	Transmit
INPUT POWER	3 VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

99% Occupied Bandwidth

CHANNEL	CHANNEL FREQUENCY (kHz)	20dB BW (Hz)
1	12	268.54

Fundamental Field Stregnth

CHANNEL	CHANNEL FREQUENCY (kHz)	1m level (dBµV/m)
1	12	113.46

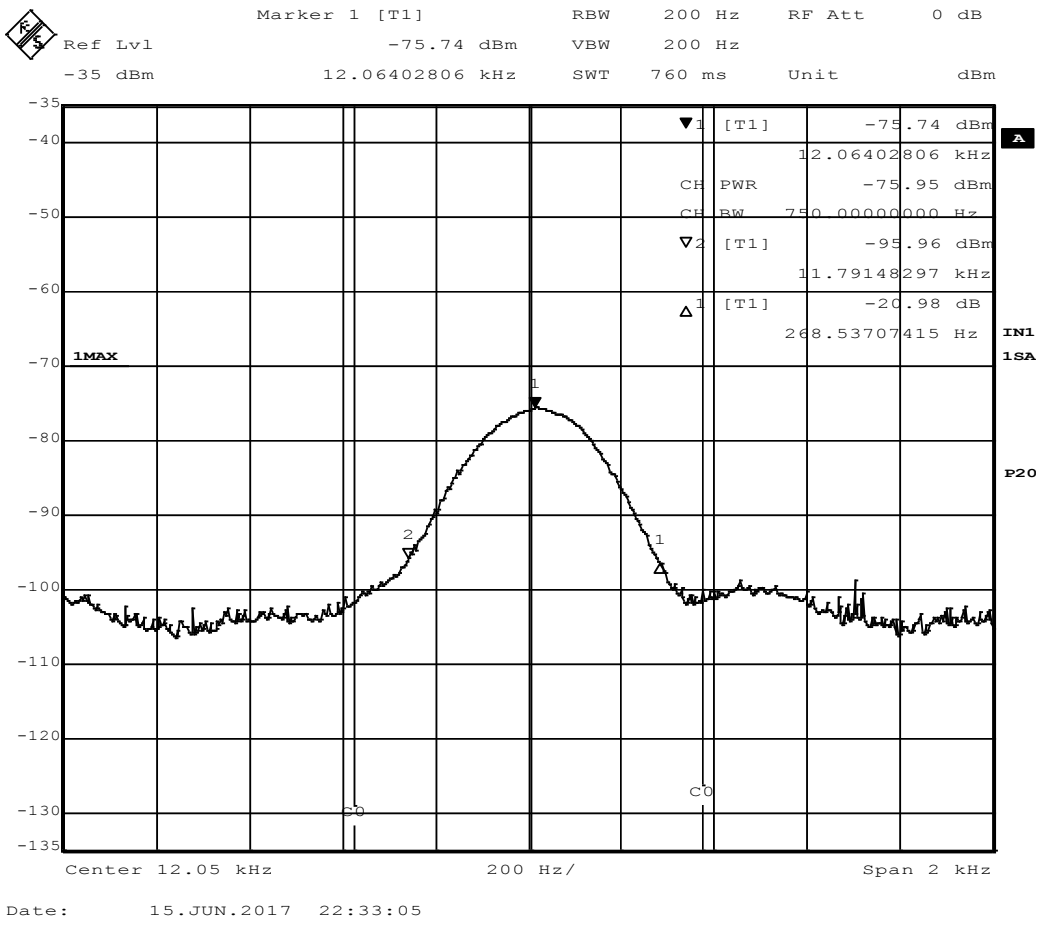


Figure 6 - 20 dB Bandwidth, Field Strength at 1m

All measurements were performed at a distance of 1m with distance correction and near-field correction values from ANSI C63.10, Section 6.4.4.2, Equation 2:

d_{limit} = Limit at 300m = = 46.02 dBµV/m
$d_{near\ field}$ = ʎ/2π = 3980.89 m
ʎ = (3x10^8 m/s) / f (/s) = 2500 meters
$d_{measure}$ = Measurement distance = 1m
d_{limit} = Limits from FCC Part 15.209, shown in Table 1 of Section 4.2.1 of report
= 200 uV/m = 106.02 dBuV/m
FS_{max} = Field strength measured at $d_{measure}$
FS_{limit} = Measured value at specified limit distance with distance and near-field correction

FS_{max} = RA + 107 + CL + AF

CL = Cable loss = 0.2 dB
dBm to dBµV/m conversion at 50Ω = 107

RA = receiver amplitude (dBm) taken from Figure 7 on next page
AF = Antenna Factor = 82.0 dB

FS_{max} = -75.74 dBm + 107 + 82.0 + 0.2 = **113.46 dBµV/m**

$FS_{limit\ at\ 300m}$ = 42.45 dBuV/m (calculated using values and equation above)

$FS_{limit\ with\ at\ 1m\ with\ near\ field\ correction}$ = 42.45 dBµV/m + 99.08 dB = **145.1 dBµV/m**

Margin = 31.64 dB

Appendix A: Measurement Uncertainty

Where relevant, the following measurement uncertainty levels apply to tests performed in this test report:

Test	Frequency Range	NCEE Labs Uncertainty Value (dB)	Maximum Uncertainty Values per CISPR 16-4-2:2011
AC Line Conducted Emissions	150kHz - 30MHz	3.30	3.40
Radiated Emissions, 10m	30MHz - 1GHz	3.82	5.30
Radiated Emissions, 3m	9kHz – 30MHz	4.95	N/A
Radiated Emissions, 3m	30MHz – 1GHz	4.25	5.30
Radiated Emissions, 3m	1GHz – 18GHz	5.08	5.20
Radiated Emissions, 3m	6GHz – 18GHz	5.08	5.50

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

NCEE Labs meets the maximum uncertainty requirements per CISPR 16-4-2:2011, and therefore does not require a minimum passing margin to state that an EUT is less than the field strength limits of the applicable CISPR, IEC or EN limit per CISPR 16-4-2:2011, Section 4.1.

Appendix B: Sample Calculation

Field Strength Calculation

The field strength is calculated 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 = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 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

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

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 Strength (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

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

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

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

Gain = 1 (numeric gain for isotropic radiator)

Conversion from 3m field strength to EIRP (d=3):

EIRP = (FS x d^2)/30 = FS [(d^2)/30] = FS [0.3}

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = -95.23

10log(10^) is the conversion from micro to milli

REPORT END