SNUPI Technologies

TEST REPORT FOR

Water Sensor Node
Model: 810-00011

Tested To The Following Standards:

FCC Part 15 Subpart C § 15.225

Report No.: 96653-17

Date of issue: February 18, 2015

ACCREDITED
Testing Certificates:
803.01, 803.02, 803.05, 803.06

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of EMC testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

Testing the Future
CKC LABORATORIES, INC.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

SNUPI Technologies
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Seattle, WA 98105

Representative: Patrick Vilbrandt
Customer Reference Number: 1095

REPORT PREPARED BY:

Dianne Dudley
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 96653

DATE OF EQUIPMENT RECEIPT: January 27, 2015
DATE(S) OF TESTING: January 27-29, 2015

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the sample equipment tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.

Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
22116 23rd Drive S.E., Suite A
Bothell, WA 98021-4413

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.00.14
Immunity	5.00.07

Site Registration & Accreditation Information

Location	CB #	TAIWAN	CANADA	FCC	JAPAN
Bothell	US0081	SL2-IN-E-1145R	3082C-1	318736	A-0148

SUMMARY OF RESULTS

Standard / Specification: FCC Part 15 Subpart C § 15.225

Test Procedure	Description	Modifications*	Results
15.215(c)	-20dB Occupied Bandwidth	NA	Pass
15.225(a)(b)(c)	Field Strength of Emissions / Emissions Mask	NA	Pass
15.225(d)	Field Strength of Spurious Emissions	NA	Pass
15.225(e)	Frequency Tolerance & Voltage Variation	NA	Pass

NA = Not applicable

Modifications* During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
No modifications were made during testing.

***Modifications listed above must be incorporated into all production units.**

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
None

EQUIPMENT UNDER TEST (EUT)

EQUIPMENT UNDER TEST

Water Sensor Node
Manuf: SNUPI Technologies
Model: 810-00011
Serial: 90-7A-F1-FF-FB-FC

PERIPHERAL DEVICES

The EUT was tested with the following peripheral device(s):

N300 Wireless Router
Manuf: Netgear
Model: WNR2000 v4
Serial: NA

Laptop
Manuf: Dell
Model: Precision M4400
Serial: NA

FCC PART 15 SUBPART C

15.215(c) -20dB Occupied Bandwidth

Test Conditions / Setup

The EUT is located on the test table. Antenna is located at 3m from the EUT. Measurement performed at ambient temperature. TX frequency is 13.56MHz.

Temperature: 23°C
Relative Humidity: 41%
Pressure: 103.3kPa
Date Tested: 1/27/15

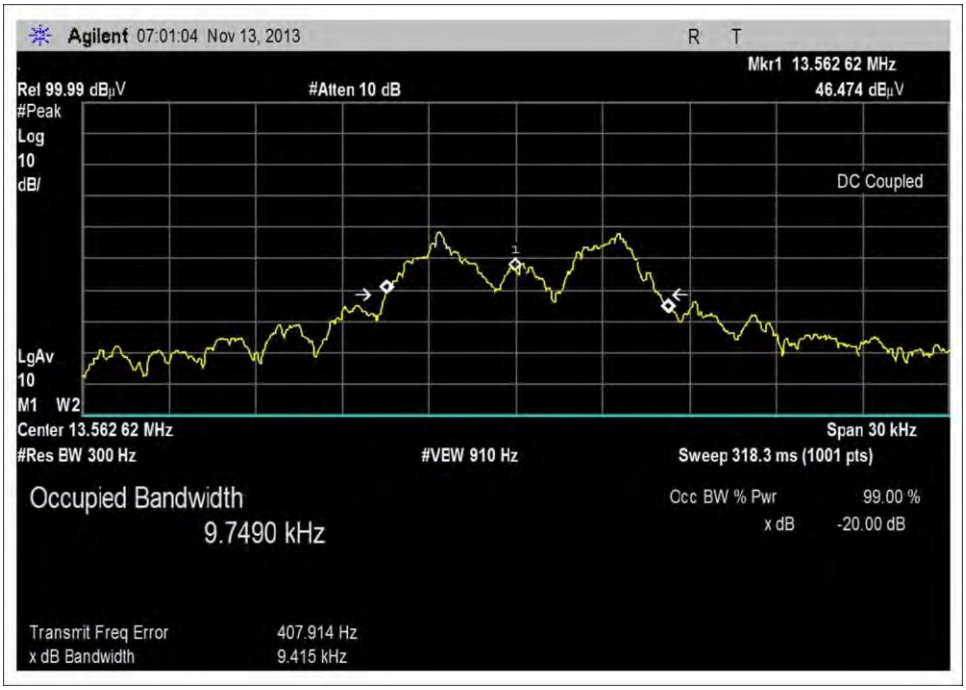
Test Engineer: Steven Pittsford

Test Equipment

Asset #	Description	Manufacturer	Model	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015
P06505	Cable	Astrolab	32026-29080-29080-84	10/18/2013	10/18/2015
P05305	Cable	Andrews	ETSI-50T	2/20/2014	2/20/2016
00052	Loop Antenna	EMCO	6502	5/20/2014	5/20/2016

Frequency	-20dB OBW	99% OBW
13.56MHz	8.568kHz	8.493kHz

Test Data


Agilent 07:01:04 Nov 13, 2013
R T
Mkr1 13.562 62 MHz
Ref 99.99 dBµV
#Atten 10 dB
46.474 dBµV
#Peak
Log
10
dB/
DC Coupled
LgAv
10
M1 W2
Center 13.562 62 MHz
Span 30 kHz
#Res BW 300 Hz
#VEW 910 Hz
Sweep 318.3 ms (1001 pts)
Occupied Bandwidth
9.7490 kHz
Occ BW % Pwr 99.00 %
x dB -20.00 dB
Transmit Freq Error 407.914 Hz
x dB Bandwidth 9.415 kHz

Test Setup Photos

15.225(a)(b)(c) Field Strength of Emissions / Emissions Mask

Test Conditions / Setup

The EUT is located on the test table. Antenna is located at 3m from the EUT. Measurement performed at ambient temperature. TX frequency is 13.56MHz. The EUT was tested both in standing and lying orientations. Emissions were maximized with only the worst being reported.

Temp: 23°C
Humidity: 41%
Pressure: 103.3kPa
Date Tested: 1/27/15

Test Engineer: Steven Pittsford

Test Equipment

Asset #	Description	Manufacturer	Model	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015
P06505	Cable	Astrolab	32026-29080-29080-84	10/18/2013	10/18/2015
P05305	Cable	Andrews	ETSI-50T	2/20/2014	2/20/2016
00052	Loop Antenna	EMCO	6502	5/20/2014	5/20/2016

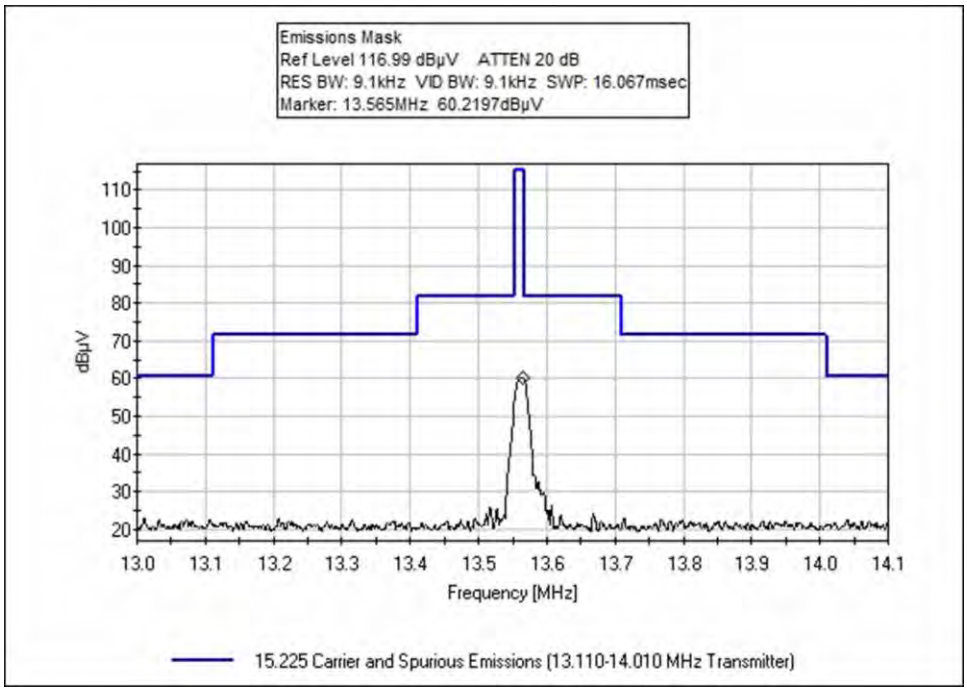
(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.
(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

Uncorrected measurement = 60.2197dBµV + (-31.3dB corrections dues to antenna factors, cable loss and distance correction) = 28.9289µV/m @ 30 meters

Limit= 334 microvolts/meter at 30 meters.
uV/m= 10(dBµV/m/20)

Fundamental field strength = 27.86 µV/m @ 30 meters

Test Data


Emissions Mask
Ref Level 116.99 dBµV ATTEN 20 dB
RES BW: 9.1kHz VID BW: 9.1kHz SWP: 16.067msec
Marker: 13.565MHz 60.2197dBµV
dBµV
110
100
90
80
70
60
50
40
30
20
13.0
13.1
13.2
13.3
13.4
13.5
13.6
13.7
13.8
13.9
14.0
14.1
Frequency [MHz]
15.225 Carrier and Spurious Emissions (13.110-14.010 MHz Transmitter)

Test Setup Photos

15.225(d) Field Strength of Spurious Emissions

Test Data

Test Location: CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • (425) 402-1717

Customer: **SNUPI Technologies**
Specification: **15.225 Carrier and Spurious Emissions (13.110-14.010 MHz Transmitter)**
Work Order #: **96653** Date: 1/27/2015
Test Type: **Maximized Emissions** Time: 9:18:44 AM
Equipment: **Water Sensor Node** Sequence#: 2
Manufacturer: SNUPI Technologies Tested By: Steven Pittsford
Model: 810-00011
S/N: 90-7A-F1-FF-FB-FC

***Test Equipment*:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	ANP06505	Cable	32026-29080-29080-84	10/18/2013	10/18/2015
	AN02872	Spectrum Analyzer	E4440A	7/19/2013	7/19/2015
T2	ANP05305	Cable	ETSI-50T	2/20/2014	2/20/2016
T3	AN00052	Loop Antenna	6502	5/20/2014	5/20/2016

***Equipment Under Test* (* = EUT):**

Function	Manufacturer	Model #	S/N
Water Sensor Node*	SNUPI Technologies	810-00011	90-7A-F1-FF-FB-FC

Support Devices:

Function	Manufacturer	Model #	S/N

Test Conditions / Notes:

Temperature: 23°C
Pressure: 103.3kPa
Humidity: 41%
Frequency: 9k-30MHz
Test Method: ANSI C63.4 (2009)

Mode: Transmitting 2 packets per second

The EUT tested standing on side and lying down. Vertical and Horizontal Antenna polarities investigated. Only worst case emissions reported.

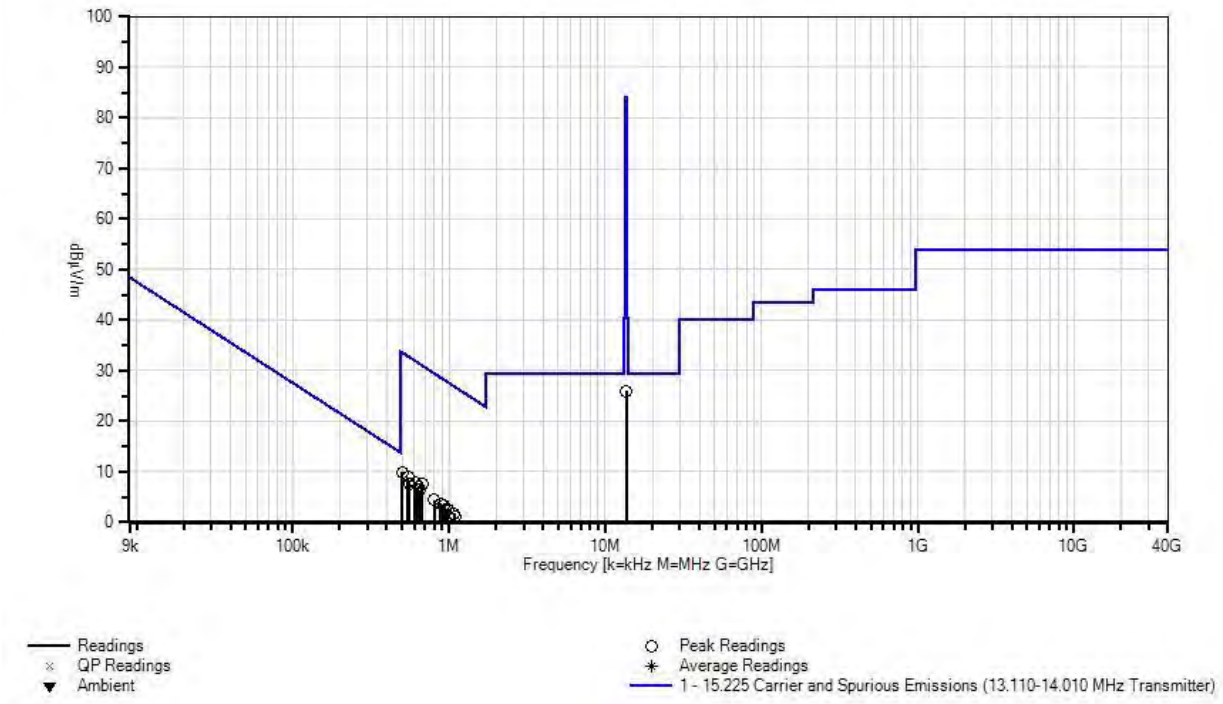
CISPR Bandwidth used
15.31 EUT has fresh battery installed.

Ext Attn: 0 dB

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
1	672.676k	37.9	+0.0	+0.0	+9.6		-40.0	7.5	31.0	-23.5	Perp 148
2	501.238k	40.3	+0.0	+0.0	+9.6		-40.0	9.9	33.6	-23.7	Perp 148
3	543.052k	39.4	+0.0	+0.0	+9.6		-40.0	9.0	32.9	-23.9	Perp 148
4	607.864k	38.4	+0.0	+0.0	+9.6		-40.0	8.0	31.9	-23.9	Perp 148
5	13.574M	57.3	+0.1	+0.1	+8.5		-40.0	26.0	50.5	-24.5	Perp 148
6	628.771k	37.4	+0.0	+0.0	+9.6		-40.0	7.0	31.6	-24.6	Perp 148
7	651.768k	36.8	+0.0	+0.0	+9.6		-40.0	6.4	31.3	-24.9	Perp 148
8	559.778k	38.1	+0.0	+0.0	+9.6		-40.0	7.7	32.6	-24.9	Perp 148
9	921.469k	33.4	+0.0	+0.1	+9.8		-40.0	3.3	28.3	-25.0	Perp 148
10	881.746k	33.8	+0.0	+0.1	+9.8		-40.0	3.7	28.7	-25.0	Perp 148
11	804.390k	34.7	+0.0	+0.1	+9.6		-40.0	4.4	29.5	-25.1	Perp 148
12	1.076M	31.8	+0.0	+0.1	+9.8		-40.0	1.7	26.9	-25.2	Perp 148
13	984.190k	32.5	+0.0	+0.1	+9.8		-40.0	2.4	27.7	-25.3	Perp 148
14	938.195k	32.7	+0.0	+0.1	+9.8		-40.0	2.6	28.1	-25.5	Perp 148
15	1.091M	31.1	+0.0	+0.1	+9.8		-40.0	1.0	26.8	-25.8	Perp 148

CKC Laboratories, Inc. Date: 1/27/2015 Time: 9:18:44 AM SNUPI Technologies WO#: 96653
Test Distance: 3 Meters Sequence#: 2 Perp & Para
SNUPI Technologies Water Sensor Node P/N: 810-00011



Test Location: CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • (425) 402-1717

Customer: **SNUPI Technologies**
Specification: **15.225 Carrier and Spurious Emissions (13.110-14.010 MHz Transmitter)**
Work Order #: **96653** Date: 1/27/2015
Test Type: **Maximized Emissions** Time: 09:12:35
Equipment: **Water Sensor Node** Sequence#: 1
Manufacturer: SNUPI Technologies Tested By: Steven Pittsford
Model: 810-00011
S/N: 90-7A-F1-FF-FB-FC

***Test Equipment*:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02307	Preamp	8447D	3/14/2014	3/14/2016
T2	ANP05360	Cable	RG214	12/1/2014	12/1/2016
T3	ANP05963	Cable	RG-214	2/21/2014	2/21/2016
T4	ANP06505	Cable	32026-29080-29080-84	10/18/2013	10/18/2015
	AN02872	Spectrum Analyzer	E4440A	7/19/2013	7/19/2015
T5	AN01996	Biconilog Antenna	CBL6111C	7/16/2014	7/16/2016

***Equipment Under Test* (* = EUT):**

Function	Manufacturer	Model #	S/N
Water Sensor Node*	SNUPI Technologies	810-00011	90-7A-F1-FF-FB-FC

Support Devices:

Function	Manufacturer	Model #	S/N

Test Conditions / Notes:

Temperature: 23°C
Pressure: 103.3kPa
Humidity: 41%
Frequency: 30-1000MHz
Test Method: ANSI C63.4 (2009)

Mode: Transmitting 2 packets per second

The EUT is tested standing on side and lying down. Vertical and Horizontal Antenna polarities investigated. Only worst case emissions reported.

CISPR Bandwidth used
15.31 EUT has fresh battery installed.

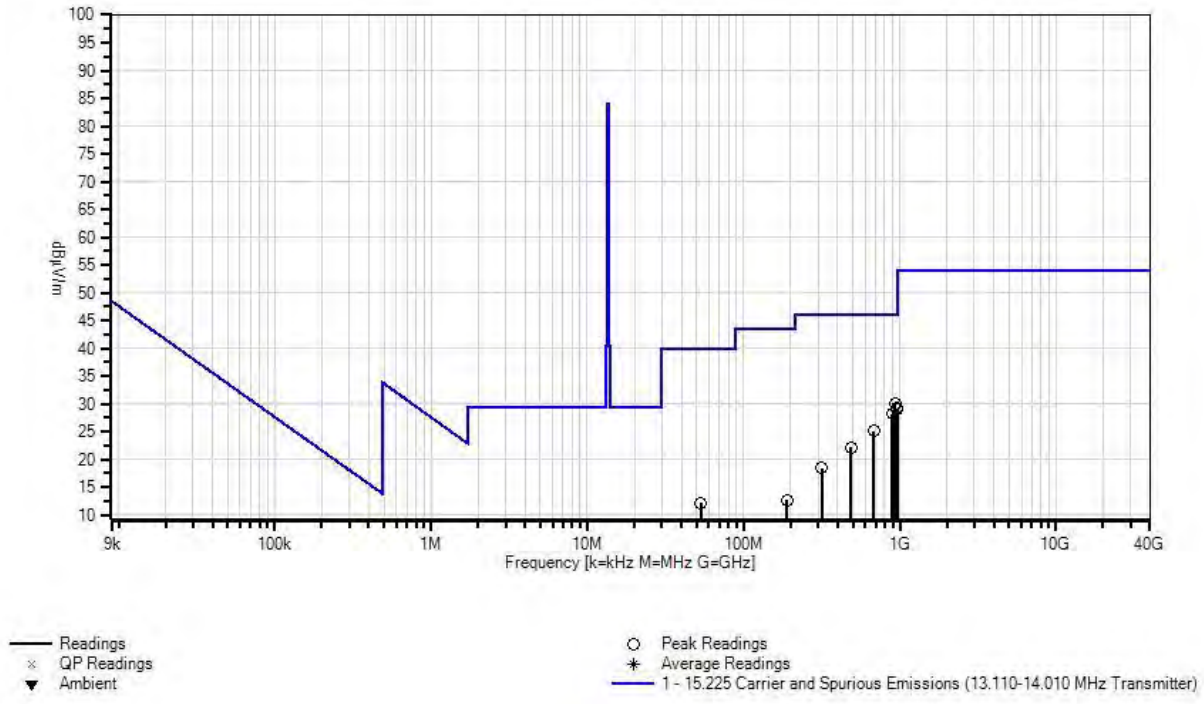
Ext Attn: 0 dB

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	935.707M	28.9	-27.3 +23.8	+2.1	+1.5	+0.9	+0.0	29.9	46.0	-16.1	V & H 148
2	958.614M	28.0	-27.3 +23.9	+2.1	+1.6	+0.9	+0.0	29.2	46.0	-16.8	V & H 148
3	948.722M	27.9	-27.3 +23.9	+2.1	+1.6	+0.9	+0.0	29.1	46.0	-16.9	V & H 148

4	891.984M	27.6	-27.4 +23.6	+2.0	+1.5	+0.9	+0.0	28.2	46.0	-17.8	V & H 148
5	678.560M	28.9	-28.2 +20.6	+1.7	+1.3	+0.8	+0.0 360	25.1	46.0	-20.9	V & H 148
6	487.610M	29.0	-28.1 +18.0	+1.4	+1.1	+0.7	+0.0 338	22.1	46.0	-23.9	V & H 148
7	318.100M	28.8	-27.1 +14.3	+1.1	+0.8	+0.5	+0.0 267	18.4	46.0	-27.6	V & H 148
8	53.450M	30.9	-27.9 +8.1	+0.4	+0.3	+0.3	+0.0 85	12.1	40.0	-27.9	V & H 148
9	190.130M	28.9	-27.4 +9.3	+0.8	+0.6	+0.4	+0.0 189	12.6	43.5	-30.9	V & H 148

CKC Laboratories, Inc. Date: 1/27/2015 Time: 09:12:35 SNUPI Technologies WO#: 96653
Test Distance: 3 Meters Sequence#: 1 V & H
SNUPI Technologies Water Sensor Node P/N: 810-00011



Test Setup Photos

15.225(e) Frequency Tolerance & Voltage Variation

Test Conditions / Setup / Data

The EUT is located inside the temperature chamber. The temperature will change from -20°C to +50°C in 10° increments. An infrared thermometer with a thermocouple attachment is being used to monitor the actual temperature on the EUT. After the EUT has reached thermal stabilization the measurements are performed. Frequency variation cannot be higher than ±0.01% or ±1.356kHz. RBW setting = 1kHz, VBW=3kHz

Test Engineer: Steven Pittsford Test Date: 2/5/2015

Test Equipment

Asset #	Description	Manufacturer	Model	Cal Date	Cal Due
02757	Temperature Chamber	Bemco	F100/350-8	2/5/2015	2/5/2017
02242	Thermometer	Omega	HH-26K	5/2/2014	5/2/2016
02673	Spectrum Analyzer	Agilent	E4446A	10/4/2013	10/4/2015

Test Specification **15.225**
Device Model #: 810-00011
Operating Voltage: 3V Battery VDC/VAC
Frequency Limit: 0.01%

Temperature Variations			
		Channel 1 (MHz)	**Dev. (%)**
Channel Frequency:		**13.562433**	
Temp (C)	Voltage		
-20	3V Battery	13.562418	0.00011
-10	3V Battery	13.562286	0.00108
0	3V Battery	13.562188	0.00181
10	3V Battery	13.562381	0.00038
20	3V Battery	13.562433	0.00000
30	3V Battery	13.562503	0.00052
40	3V Battery	13.562398	0.00026
50	3V Battery	13.562468	0.00026
Voltage Variations (±15%)			
20	NA		
20	3V Battery	13.562433	0.00000
20	NA		
Max Deviation (%)			**0.00181**
			PASS

Test Setup Photos

Temperature Chamber, View #1

Temperature Chamber, View #2

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in dBµV/m, the spectrum analyzer reading in dBµV was corrected by using the following formula. This reading was then compared to the applicable specification limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/m)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or carrot ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point the measuring device is set into the linear mode and the scan time is reduced.