SensorLink Corporation

TEST REPORT FOR

Radio SL, XCVR, 915.53M
Model: K660-066-005

Tested to The Following Standards:

FCC Part 15 Subpart C Section

15.249

Report No.: 106048-5

Date of issue: May 10, 2022

Test Certificate # 803.01

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 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:

SensorLink Corporation
1360 Stonegate Way
Ferndale, WA 98248

Representative: Darren Hoppins
Customer Reference Number: 067895

REPORT PREPARED BY:

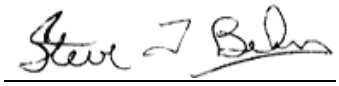
Lisa Bevington
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 106048

DATE OF EQUIPMENT RECEIPT: April 1, 2022
DATE(S) OF TESTING: April 1, 2022

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, 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.
Canyon Park
22116 23rd Drive S.E., Suite A
Bothell, WA 98021

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.20

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Canada	Japan
Canyon Park, Bothell, WA	US0103	US1024	3082C	A-0136
Brea, CA	US0103	US1024	3082D	A-0136
Fremont, CA	US0103	US1024	3082B	A-0136
Mariposa, CA	US0103	US1024	3082A	A-0136

*CKC's list of NIST designated countries can be found at: https://standards.gov/cabs/designations.html

SUMMARY OF RESULTS

Standard / Specification: FCC Part 15 Subpart C - 15.249

Test Procedure	Description	Modifications*	Results
15.215(c)	Occupied Bandwidth	NA	Pass
15.249(a)	Field Strength of Fundamental	NA	Pass
15.249(a)	Field Strength of Spurious Emissions	NA	Pass
15.207	AC Conducted Emissions	NA	NA1

NA = Not Applicable
NA1 = Not Applicable Manufacturer declares EUT is battery powered.

ISO/IEC 17025 Decision Rule
The declaration of pass or fail herein is based upon assessment to the specification(s) listed above, including where applicable, assessment of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

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)

During testing, numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Under Test:

Device	Manufacturer	Model #	S/N
Radio, SL, XCVR, 915.53M	SensorLink Corporation	K660-066-005	NA

Support Equipment:

Device	Manufacturer	Model #	S/N
None			

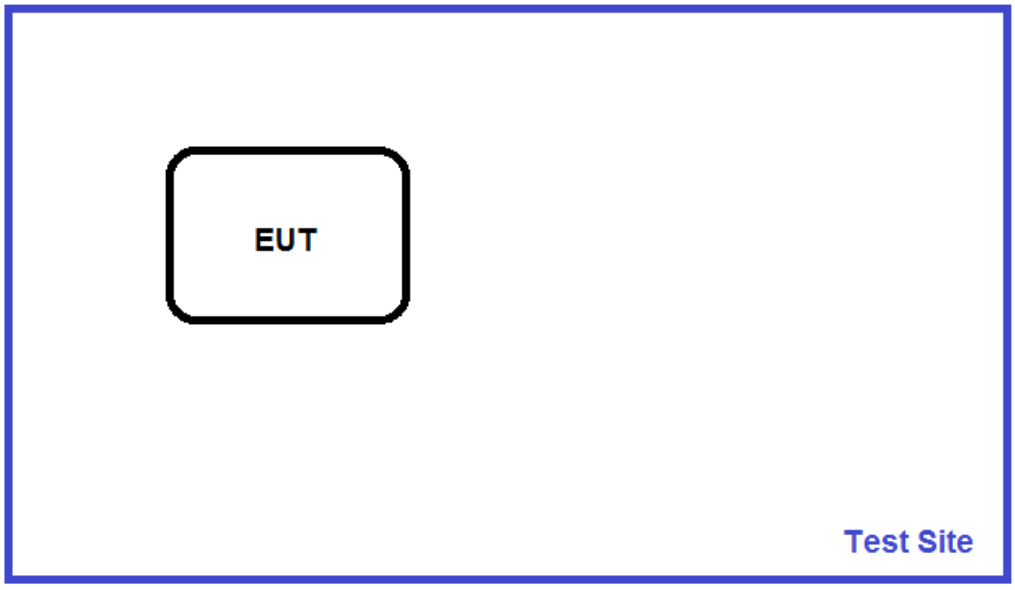
General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Radio Module
Modulation Type(s):	2FSK
Maximum Duty Cycle:	<1%
Antenna Type(s) and Gain:	PERMANENT-MOUNT QUARTER-WAVE MONOPOLE / -10.2dBi
Antenna Connection Type:	Integral
Nominal Input Voltage:	3.0 VDC +/-10%
Firmware / Software used for Test:	F570-066-005
The validity of results is dependent on the stated product details, the accuracy of which the manufacturer assumes full responsibility.	

EUT Photo

Block Diagram of Test Setup(s)

Test Setup Block Diagram



FCC Part 15 Subpart C

15.215(c) Occupied Bandwidth (20dB BW)

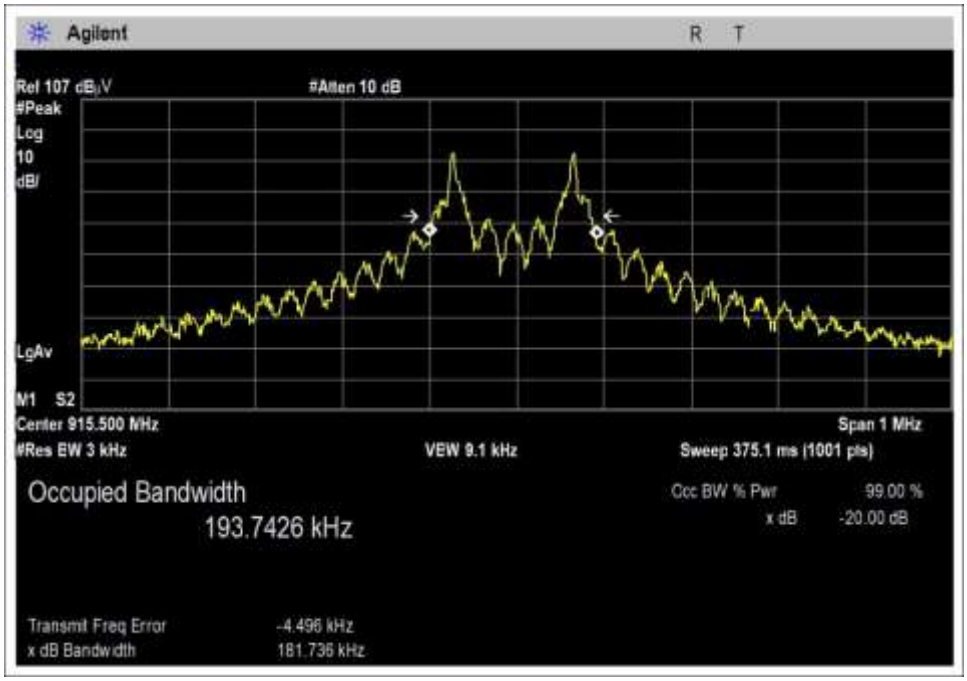
Test Setup/Conditions			
Test Location:	Canyon Park Lab C3	Test Engineer:	M. Harrison
Test Method:	ANSI C63.10 (2013)	Test Date(s):	4/1/2022
Configuration:	1		

Environmental Conditions			
Temperature (ºC)	22	Relative Humidity (%):	40

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02673	Spectrum Analyzer	Agilent	E4446A	2/3/2021	2/3/2023
03628	Biconilog Antenna	ETS	3142E	6/3/2021	6/3/2023
02307	Preamp	HP	8447D	1/6/2022	1/6/2024

Test Data Summary					
Frequency (MHz)	**Antenna Port**	**Modulation**	**Measured (kHz)**	**Limit (kHz)**	**Results**
915.5	1	2FSK	181.7	None	NA

Plot(s)


Agilent
R T
Ref 107 dBµV
#Atten 10 dB
#Peak
Log
10
dB/
LgAv
M1 S2
Center 915.500 MHz
Span 1 MHz
#Res BW 3 kHz
VBW 9.1 kHz
Sweep 375.1 ms (1001 pts)
Occupied Bandwidth
193.7426 kHz
Occ BW % Pwr 99.00 %
x dB -20.00 dB
Transmit Freq Error -4.496 kHz
x dB Bandwidth 181.736 kHz

Test Setup Photo(s)

0.8m, Below 1GHz, View 1

0.8m, Below 1GHz, View 2

15.249(a) Field Strength of Fundamental

Test Setup/Conditions			
Test Location:	Canyon Park Lab C3	Test Engineer:	M. Harrison
Test Method:	ANSI C63.10 (2013)	Test Date(s):	4/1/2022
Configuration:	1		

Environmental Conditions			
Temperature (ºC)	22	Relative Humidity (%):	40

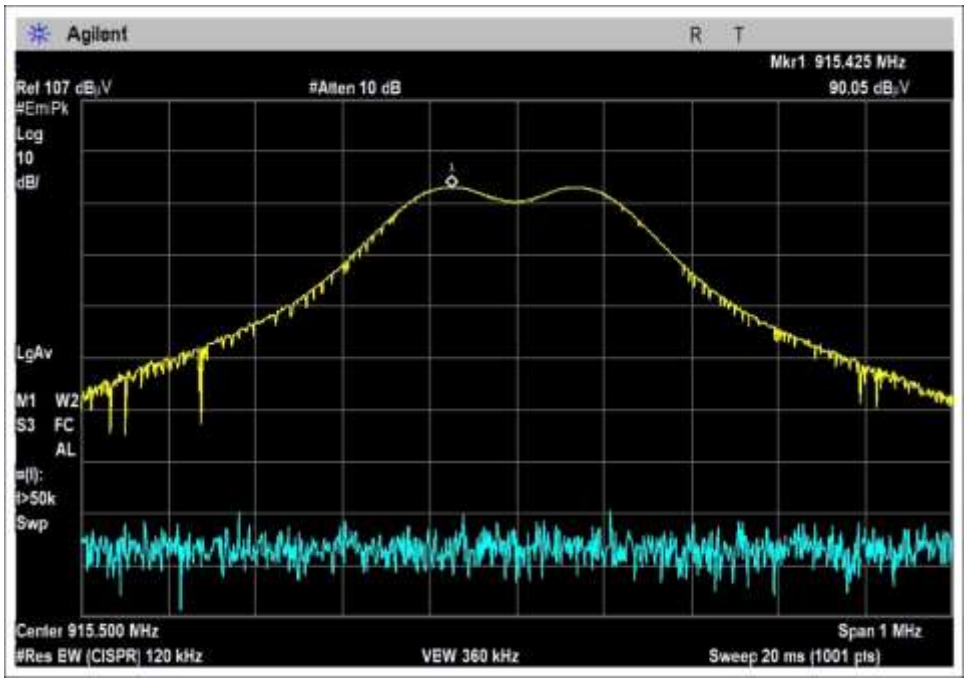
Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02673	Spectrum Analyzer	Agilent	E4446A	2/3/2021	2/3/2023
03628	Biconilog Antenna	ETS	3142E	6/3/2021	6/3/2023
02307	Preamp	HP	8447D	1/6/2022	1/6/2024

Test Data Summary - Voltage Variations					
Frequency (MHz)	**Modulation / Ant Port**	**$V_{Minimum}$ (dBuV/m)**	**$V_{Nominal}$ (dBuV/m)**	**$V_{Maximum}$ (dBuV/m)**	**Max Deviation from $V_{Nominal}$ (dB)**
915.5	2FSK / 1		92.9		

Test performed using operational mode with the highest output power, representing worst case.

Test Data Summary – Radiated Field Strength Measurement					
Frequency (MHz)	**Modulation**	**Ant. Type**	**Measured (dBuV/m @ 3m)**	**Limit (dBuV/m @ 3m)**	**Results**
915.5	2FSK	PERMANENT-MOUNT QUARTER-WAVE MONOPOLE	92.9	≤94	Pass

Plot Data


Agilent
R T
Mkr1 915.425 MHz
Ref 107 dBµV
#Atten 10 dB
90.05 dBµV
#Em Pk
Log
10
dB/
LgAv
M1 W2
S3 FC
AL
#>50k
Swp
Center 915.500 MHz
Span 1 MHz
#Res BW (CISPR) 120 kHz
VBW 360 kHz
Sweep 20 ms (1001 pts)

Test Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)		
Customer:	**SensorLink Corporation**		
Specification:	**15.249 Carrier and Spurious Emissions (902-928 MHz Transmitter)**		
Work Order #:	**106048**	Date:	4/1/2022
Test Type:	**Maximized Emissions**	Time:	10:22:15
Tested By:	Matt Harrison	Sequence#:	4
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

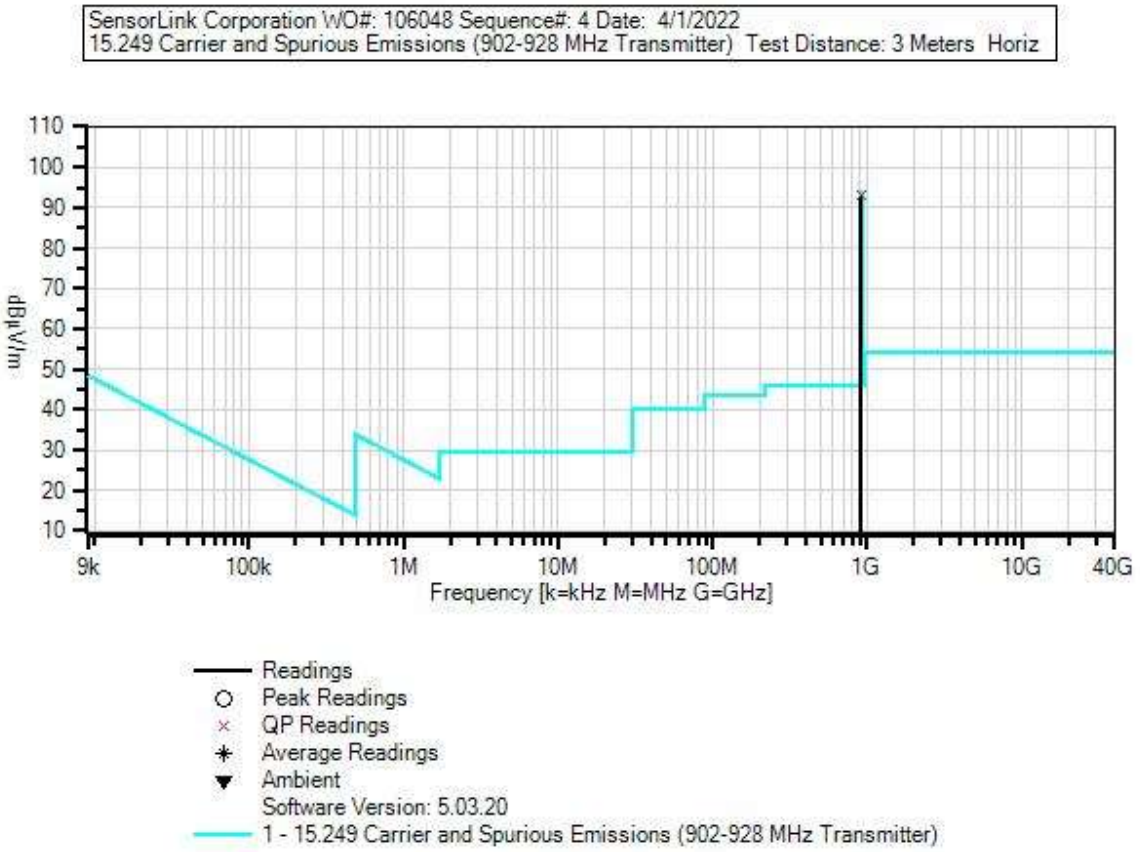
Environmental Conditions:
Temperature: 20°C
Humidity: 42%
Pressure: 101.7kPa

Method: ANSI C63.10: 2013

Frequency range: Fundamental

Setup:
Host Module is setup on an 80cm Styrofoam table in a standalone configuration. X, Y, and Z axes investigated, horizontal and vertical antenna polarities investigated, worst case reported.

Channel: 915 MHz
<1% Duty Cycle
PWR Output: 3dBm



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02307	Preamp	8447D	1/6/2022	1/6/2024
T2	AN03628	Biconilog Antenna	3142E	6/3/2021	6/3/2023
T3	ANP05360	Cable	RG214	2/4/2022	2/4/2024
T4	ANP06515	Cable	Heliax	7/1/2020	7/1/2022
T5	ANP06540	Cable	Heliax	1/17/2022	1/17/2024
T6	AN02673	Spectrum Analyzer	E4446A	2/3/2021	2/3/2023

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

#	Freq	Rdng	T1	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
			T5	T6							
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	915.425M	86.0	-27.3	+29.9	+2.4	+1.6	+0.0	92.9	94.0	-1.1	Horiz
	QP		+0.3	+0.0			111		X-Axis		100
^	915.425M	90.1	-27.3	+29.9	+2.4	+1.6	+0.0	97.0	94.0	+3.0	Horiz
			+0.3	+0.0			111		X-Axis		100

Test Setup Photo(s)

0.8m, Below 1GHz, View 1

0.8m, Below 1GHz, View 2

X-Axis

Y-Axis

Z-Axis

15.249(a) Radiated Emissions and Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)		
Customer:	**SensorLink Corporation**		
Specification:	**15.249 Carrier and Spurious Emissions (902-928 MHz Transmitter)**		
Work Order #:	**106048**	Date:	4/1/2022
Test Type:	**Maximized Emissions**	Time:	14:39:56
Tested By:	Matt Harrison	Sequence#:	6
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Environmental Conditions:
Temperature: 20°C
Humidity: 42%
Pressure: 101.7kPa

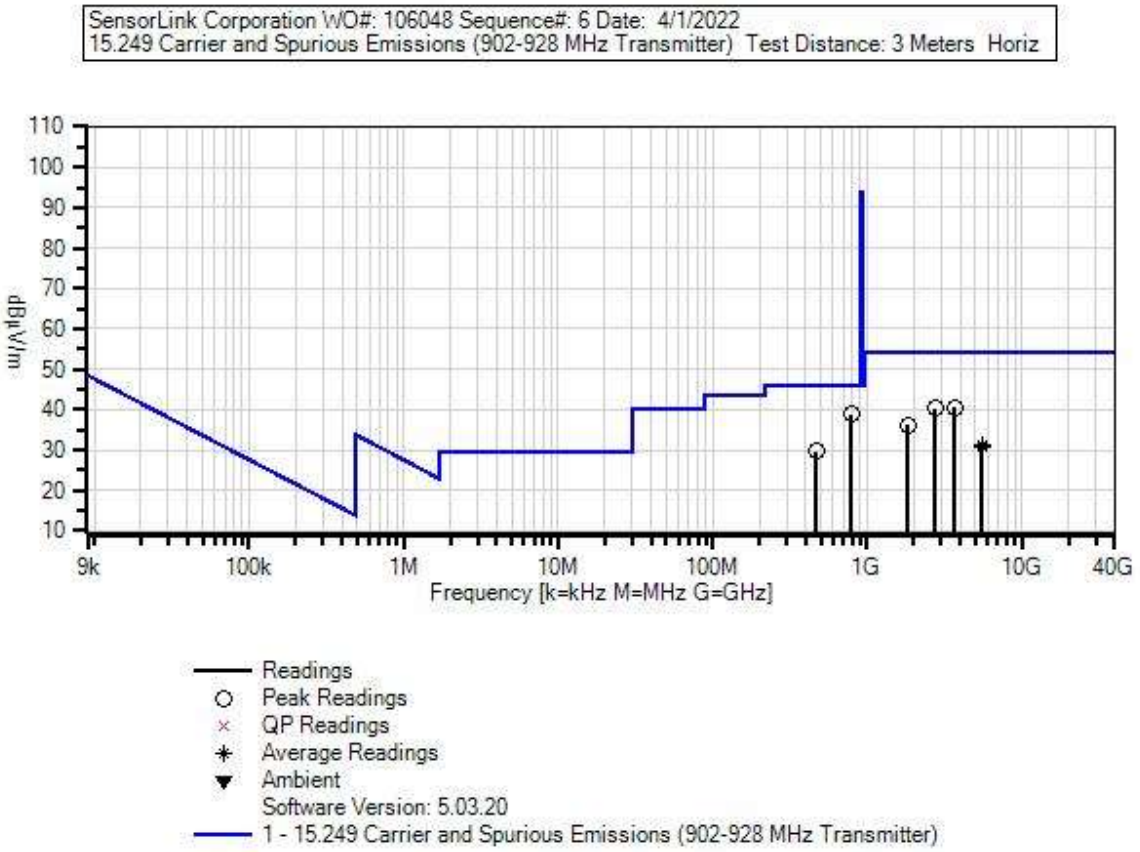
Method: ANSI C63.10: 2013

Frequency range: 9k-10GHz

Setup:
Module is setup on an 80cm high for below 1GHz and 1.5m above 1GHz high on a Styrofoam table in a standalone configuration. X, Y, and Z axes investigated, horizontal and vertical antenna polarities investigated, worst case reported.

Channel: 915 MHz
<1% Duty Cycle
PWR Output: 3dBm

No emissions found within 20 dB of the limit below 30 MHz.



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02307	Preamp	8447D	1/6/2022	1/6/2024
T2	AN03628	Biconilog Antenna	3142E	6/3/2021	6/3/2023
T3	ANP05360	Cable	RG214	2/4/2022	2/4/2024
T4	ANP06515	Cable	Heliax	7/1/2020	7/1/2022
T5	ANP06540	Cable	Heliax	1/17/2022	1/17/2024
	AN02673	Spectrum Analyzer	E4446A	2/3/2021	2/3/2023
	AN00052	Loop Antenna	6502	5/4/2020	5/4/2022
T6	AN03540	Preamp	83017A	5/14/2021	5/14/2023
T7	AN02374ANSI	Horn Antenna	RGA-60	5/25/2021	5/25/2023
T8	ANP07505	Cable	CLU40-KMKM-02.00F	1/26/2021	1/26/2023
T9	AN03170	High Pass Filter	HM1155-11SS	9/16/2021	9/16/2023

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

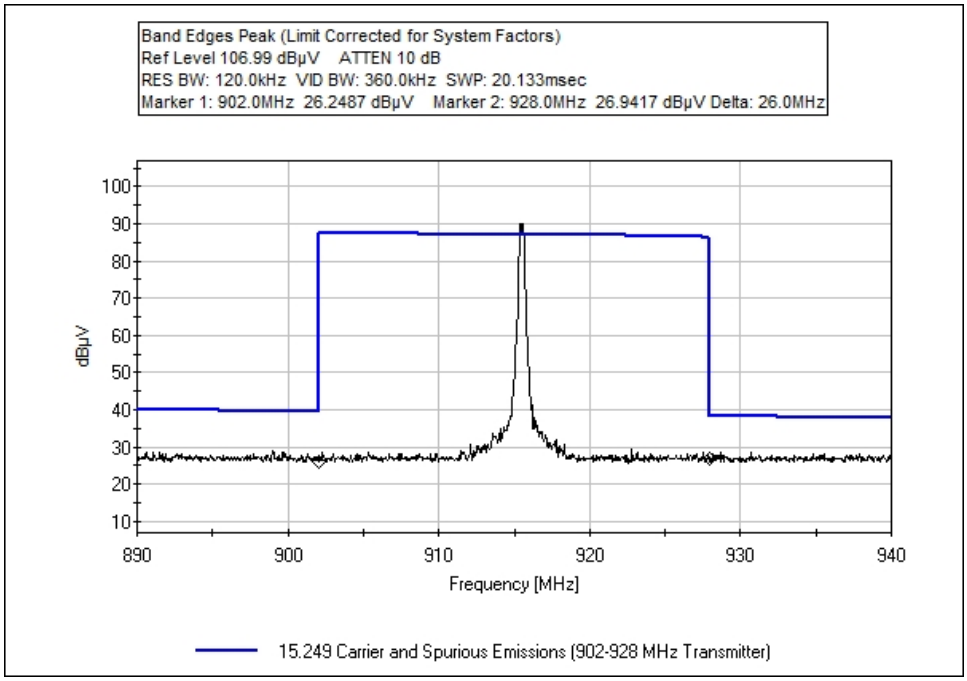
#	Freq	Rdng	T1 T5 T9	T2 T6	T3 T7	T4 T8	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	781.700M	33.6	-27.7 +0.3 +0.0	+28.9 +0.0	+2.2 +0.0	+1.5 +0.0	+0.0	38.8	46.0	-7.2	Horiz
2	3662.000M	38.2	+0.0 +0.6 +0.2	+0.0 -33.8	+0.0 +31.7	+3.4 +0.3	+0.0	40.6	54.0	-13.4	Horiz
3	2746.595M	41.1	+0.0 +0.5 +0.3	+0.0 -34.1	+0.0 +29.3	+2.9 +0.3	+0.0	40.3	54.0	-13.7	Horiz
4	465.600M	30.8	-28.0 +0.2 +0.0	+24.0 +0.0	+1.5 +0.0	+1.1 +0.0	+0.0	29.6	46.0	-16.4	Horiz
5	1831.000M	39.6	+0.0 +0.4 +0.6	+0.0 -34.7	+0.0 +27.5	+2.4 +0.3	+0.0	36.1	54.0	-17.9	Horiz
6	5492.550M Ave	24.4	+0.0 +0.8 +0.4	+0.0 -33.6	+0.0 +34.7	+4.4 +0.3	+0.0	31.4	54.0	-22.6	Vert
^	5492.550M	44.3	+0.0 +0.8 +0.4	+0.0 -33.6	+0.0 +34.7	+4.4 +0.3	+0.0	51.3	54.0	-2.7	Vert
8	5492.455M Ave	23.9	+0.0 +0.8 +0.4	+0.0 -33.6	+0.0 +34.7	+4.4 +0.3	+0.0	30.9	54.0	-23.1	Horiz
^	5492.455M	41.8	+0.0 +0.8 +0.4	+0.0 -33.6	+0.0 +34.7	+4.4 +0.3	+0.0	48.8	54.0	-5.2	Horiz

Band Edge

Band Edge Summary					
Frequency (MHz)	**Modulation**	**Ant. Type**	**Field Strength (dBuV/m @3m)**	**Limit (dBuV/m @3m)**	**Results**
902	2FSK	PERMANENT-MOUNT QUARTER-WAVE MONOPOLE	32.6	<46	Pass
928	2FSK	PERMANENT-MOUNT QUARTER-WAVE MONOPOLE	34.5	<46	Pass

Test performed using operational mode with the highest output power, representing worst case

Band Edge Plot



Band Edge Data

Test Location: CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)
Customer: **SensorLink Corporation**
Specification: **15.249 Carrier and Spurious Emissions (902-928 MHz Transmitter)**
Work Order #: **106048** Date: 4/1/2022
Test Type: **Maximized Emissions** Time: 10:47:23
Tested By: Matt Harrison Sequence#: 5
Software: EMITest 5.03.20

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Environmental Conditions:
Temperature: 20°C
Humidity: 42%
Pressure: 101.7kPa

Method: ANSI C63.10: 2013

Frequency range: 902-928MHz

Setup:
Host Module is setup on an 80cm Styrofoam table in a standalone configuration. X, Y, and Z axes investigated, horizontal and vertical antenna polarities investigated, worst case reported.

Channel: 915 MHz
<1% Duty Cycle
PWR Output: 3dBm

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02307	Preamp	8447D	1/6/2022	1/6/2024
T2	AN03628	Biconilog Antenna	3142E	6/3/2021	6/3/2023
T3	ANP05360	Cable	RG214	2/4/2022	2/4/2024
T4	ANP06515	Cable	Heliax	7/1/2020	7/1/2022
T5	ANP06540	Cable	Heliax	1/17/2022	1/17/2024
T6	AN02673	Spectrum Analyzer	E4446A	2/3/2021	2/3/2023

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

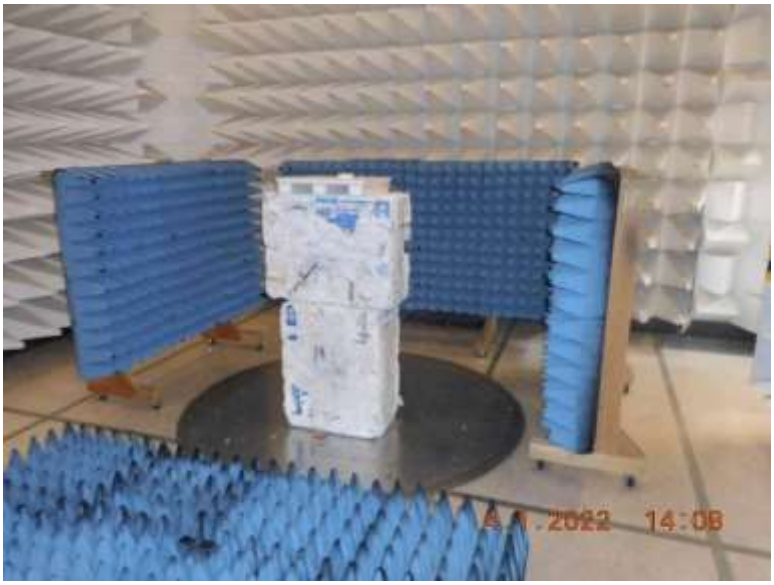
#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	928.000M	26.9	-27.3 +0.3	+30.6 +0.0	+2.4	+1.6	+0.0	34.5	46.0 FCC/RSS	-11.5	Horiz
2	902.000M	26.2	-27.4 +0.3	+29.6 +0.0	+2.3	+1.6	+0.0	32.6	46.0 FCC/RSS	-13.4	Horiz

Test Setup Photo(s)

0.8m, Below 1GHz, View 1

0.8m, Below 1GHz, View 2

1.5m, Above 1GHz, View 1



1.5m, Above 1GHz, View 2

X-Axis

Y-Axis

Z-Axis

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

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

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.

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. Individual measurements were compared with the displayed limit value in the margin column. The margin was calculated based on subtracting the limit value from the corrected measurement value; a positive margin represents a measurement exceeding the limit, while a negative margin represents a measurement less than the limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB/m)
+	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 caret ("^") 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.