

FCC Test Report

Report No.: FCC_RF_SL20011201-USSS-001

FCC ID: 2AVNYAMIRTU-1

Test Model: AR-IM001

Host Model: Seahorse 56 Micro Case

Received Date: 1/25/2020

Test Date: 1/25/2020

Issued Date: 02/12/2020

Applicant: Utility Systems Science and Software

Address: 9314 Bond Ave Suite: A , El Cajon , 92021

Manufacturer: Utility Systems Science and Software

Address: 9314 Bond Ave Suite: A , El Cajon , 92021

Issued By: Bureau Veritas Consumer Products Services, Inc.

Lab Address: 775 Montague Expressway, Milpitas, CA 95035

Test Location (1): 775 Montague Expressway, Milpitas, CA 95035

**FCC Registration /
Designation Number:** 540430/4842D



TESTING CERT # 2742-01

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Release Control Record

Issue No.	Description	Date Issued
FCC_RF_SL20011201-USSS-001	Original Report	02/12/2020

1 Certificate of Conformity

Product: AMI-RTU

Brand: US3-Cricket

Test Model: AR-IM001

Sample Status: Engineering Sample

Applicant: Utility Systems Science and Software

Test Date: 01/25/2020

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)

ANSI C63.10: 2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services, Inc., Milpitas Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Gary Chou

Prepared by : _____ **Date:** 02/12/2020
Gary Chou / Compliance Engineer

Ge Chen

Approved by : _____ **Date:** 02/12/2020
Ge Chen / Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (SECTION 15.247)				
FCC Clause	RSS Section(s)	Test Item	Result	Remarks
15.207	RSS-Gen[8.8]	AC Power Conducted Emission	N/A	EUT is powered via Battery.
15.205 & 15.209 & 15.247(d)	RSS-247[5.2])	Radiated Emissions & Band Edge Measurement	PASS	Meet the requirement of limit.

1. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.
2. Only spurious emissions and band edge were evaluated for this report.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.856 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	4.638 dB
Radiated Emissions above 1 GHz	Above 1GHz	4.580dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product Type	AMI-RTU
Brand	US3-Cricket
Test Model	AR-IM001
Host Model	Seahorse 56 Micro Case
Status of EUT	Engineering Sample
Power Supply Rating	7.4Vdc
Modulation Type	2FSK
Modulation Technology	FHSS
Transfer Rate	50 MBit/s
Operating Frequency	902MHz ~ 928MHz
Number of Channel	128
Antenna Type	Dipole Antenna
Antenna Connector	SMA (professionally installed)
Antenna Gain	2dBi

3.2 Description of Test Modes

128 channels are provided for test mode:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	902.2	40	910.2	80	918.2	120	926.2
1	902.4	41	910.4	81	918.4	121	926.4
2	902.6	42	910.6	82	918.6	122	926.6
3	902.8	43	910.8	83	918.8	123	926.8
4	903	44	911	84	919	124	927
5	903.2	45	911.2	85	919.2	125	927.2
6	903.4	46	911.4	86	919.4	126	927.4
7	903.6	47	911.6	87	919.6	127	927.6
8	903.8	48	911.8	88	919.8	128	927.8
9	904	49	912	89	920		
10	904.2	50	912.2	90	920.2		
11	904.4	51	912.4	91	920.4		
12	904.6	52	912.6	92	920.6		
13	904.8	53	912.8	93	920.8		
14	905	54	913	94	921		
15	905.2	55	913.2	95	921.2		
16	905.4	56	913.4	96	921.4		
17	905.6	57	913.6	97	921.6		
18	905.8	58	913.8	98	921.8		
19	906	59	914	99	922		
20	906.2	60	914.2	100	922.2		
21	906.4	61	914.4	101	922.4		
22	906.6	62	914.6	102	922.6		
23	906.8	63	914.8	103	922.8		
24	907	64	915	104	923		
25	907.2	65	915.2	105	923.2		
26	907.4	66	915.4	106	923.4		
27	907.6	67	915.6	107	923.6		
28	907.8	68	915.8	108	923.8		
29	908	69	916	109	924		
30	908.2	70	916.2	110	924.2		
31	908.4	71	916.4	111	924.4		
32	908.6	72	916.6	112	924.6		
33	908.8	73	916.8	113	924.8		
34	909	74	917	114	925		
35	909.2	75	917.2	115	925.2		
36	909.4	76	917.4	116	925.4		
37	909.6	77	917.6	117	925.6		
38	909.8	78	917.8	118	925.8		
39	910	79	918	119	926		

TEST MODE APPLICABILITY AND TESTED CHANNEL DETAIL

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	PLC	APCM	
-	√	√	-	-	-

Where **RE≥1G**: Radiated Emission above 1GHz **RE<1G**: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission **APCM**: Antenna Port Conducted Measurement

NOTE:

1. The EUT had been pre-tested on the positions of each 3 axis. The worst case was found when positioned on **X-plane**.
2. “-” means no effect.

Radiated Emission Test (Above 1GHz):

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE
-	0 to 128	0, 65, 128	FHSS	2FSK

Radiated Emission Test (Below 1GHz):

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE
-	128	65	FHSS	2FSK

Antenna Port Conducted Measurement:

- This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE
-	128	65	FHSS	2FSK

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE \geq 1G	25deg. C, 65%RH	7.4Vdc	Gary Chou
RE<1G	25deg. C, 65%RH	7.4Vdc	Gary Chou
APCM	21deg. C, 60%RH	7.4Vdc	Gary Chou

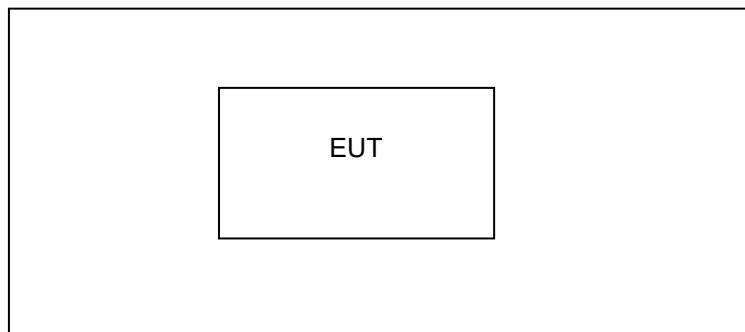
3.3 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	-	-	-	-	-	-

Note: The core(s) is (are) originally attached to the cable(s).

3.3.1 Configuration of System under Test



Note: EUT is powered via connection to "FCC Load Box" provided by client.

3.4 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.247)
KDB 558074 D01 15.247 Meas Guidance v05r02
ANSI C63.10-2013

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

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
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 (uV/m).
3. 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, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	08/28/2019	08/28/2020
Spectrum Analyzer KEYSIGHT	N9030B	MY57140374	07/22/2019	07/22/2020
Hybrid Antenna SUNAR	JB6	A111717	03/09/2019	03/09/2020
Horn Antenna ETS-Lindgren	3117	218554	11/06/2019	11/06/2020
Preamplifier RF-LAMBDA	RAMP00M50G A	17032300047	09/19/2019	09/19/2020
Preamplifier RF-BAY	LPA-6-30	11170602	05/06/2019	05/06/2020

NOTE:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The horn antenna and HP preamplifier (model: 3117) are used only for the measurement of emission frequency above 1GHz if tested.

TEST PROCEDURES

For Radiated emission below 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Both Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna 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 set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

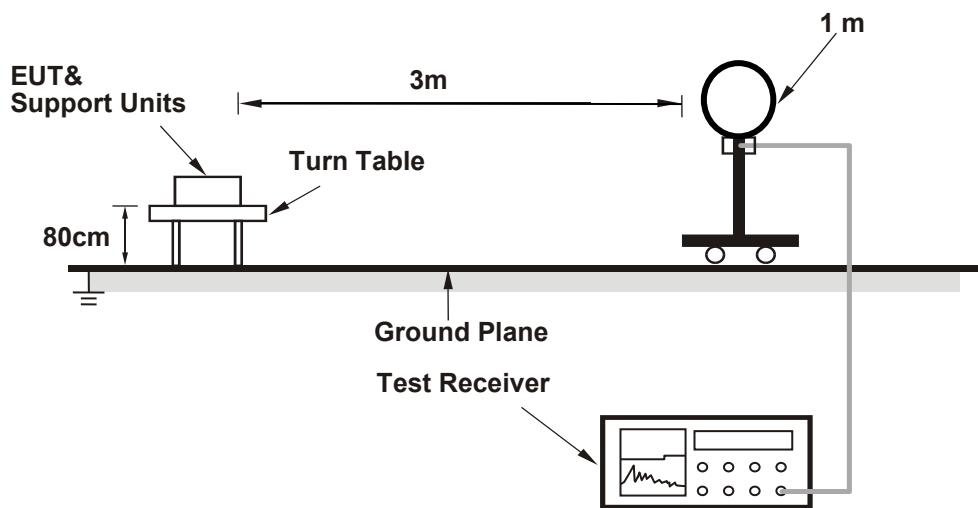
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle < 98%) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.3 Deviation from Test Standard

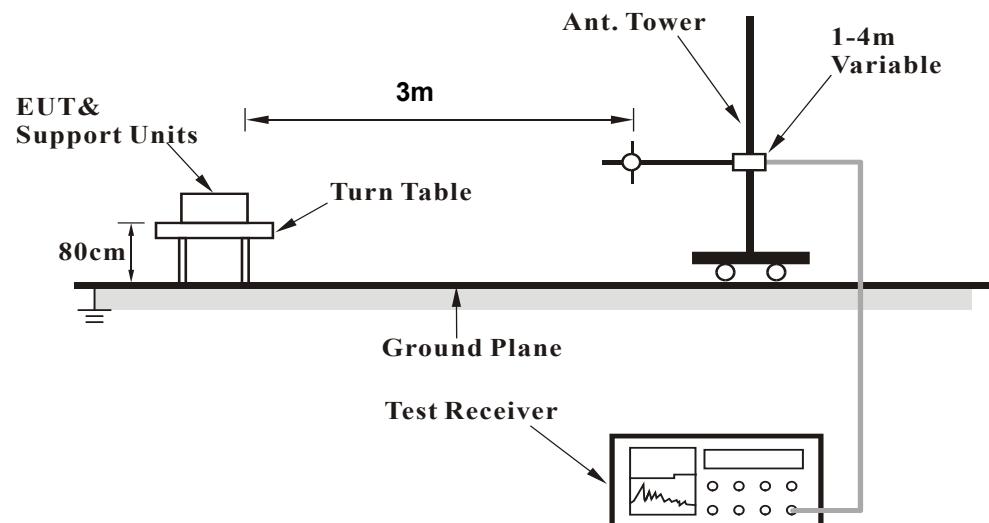
No deviation.

4.1.4 Test Setup

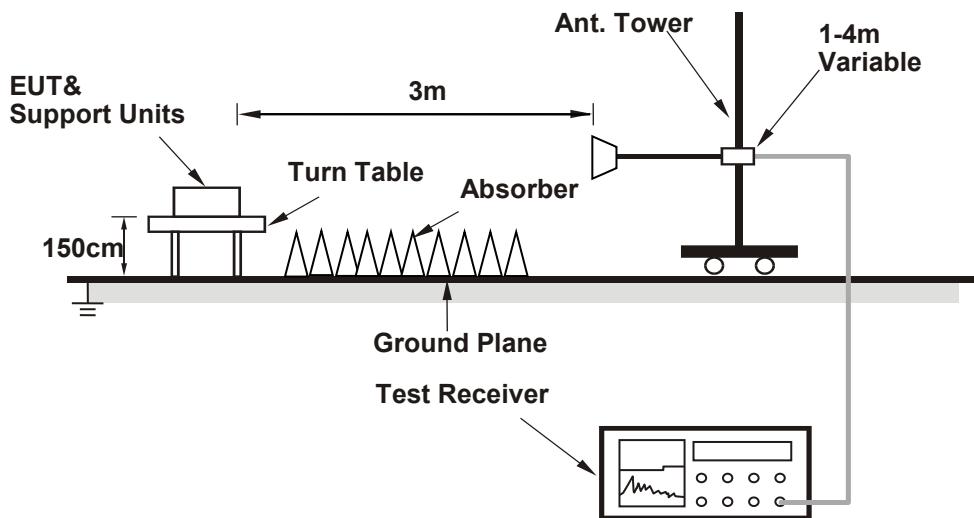
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.5 EUT Operating Conditions

- Connected the EUT with the Notebook Computer which is placed on remote site.
- Controlling software has been activated to set the EUT on specific status.

4.1.6 Test Results

Above 1GHz Data:

2FSK

CHANNEL	TX Mode 902.2MHz	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 25GHz		Average

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1802.191	H	43.9	55.2	-11.9	32	43.3	54	74	22	30.7	344	130.6	Pass
2	2704.672	H	43.1	55	-9	34.1	46	54	74	19.9	28	223	275.5	Pass
3	3608.215	H	42.8	54.3	-7.8	35	46.5	54	74	19	27.5	313	112	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Limit value(dBuV/m) - Level (dBuV/m)

CHANNEL			TX Mode 915.2 MHz			DETECTOR FUNCTION			Peak					
FREQUENCY RANGE			1GHz ~ 25GHz						Average					
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1830.107	H	44.2	60.4	-11.5	32.7	48.9	54	74	21.3	25.1	399	37.4	Pass
2	2744.55	H	43.5	54.5	-9.1	34.4	45.4	54	74	19.6	28.6	374	0	Pass
3	3364.259	H	43.8	55.1	-7.9	35.9	47.2	54	74	18.1	26.8	117	111.6	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Limit value(dBuV/m) - Level (dBuV/m)

CHANNEL			TX Mode 927.8 MHz			DETECTOR FUNCTION			Peak					
FREQUENCY RANGE			1GHz ~ 25GHz						Average					
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1853.834	H	45	58.8	-11.2	33.8	47.6	54	74	20.2	26.4	147	224.9	Pass
2	2781.123	H	43.7	57.8	-9.1	34.6	48.7	54	74	19.4	25.3	268	201.5	Pass
3	3710.254	H	43	54.5	-7.6	35.4	46.9	54	74	18.6	27.1	162	226	Pass

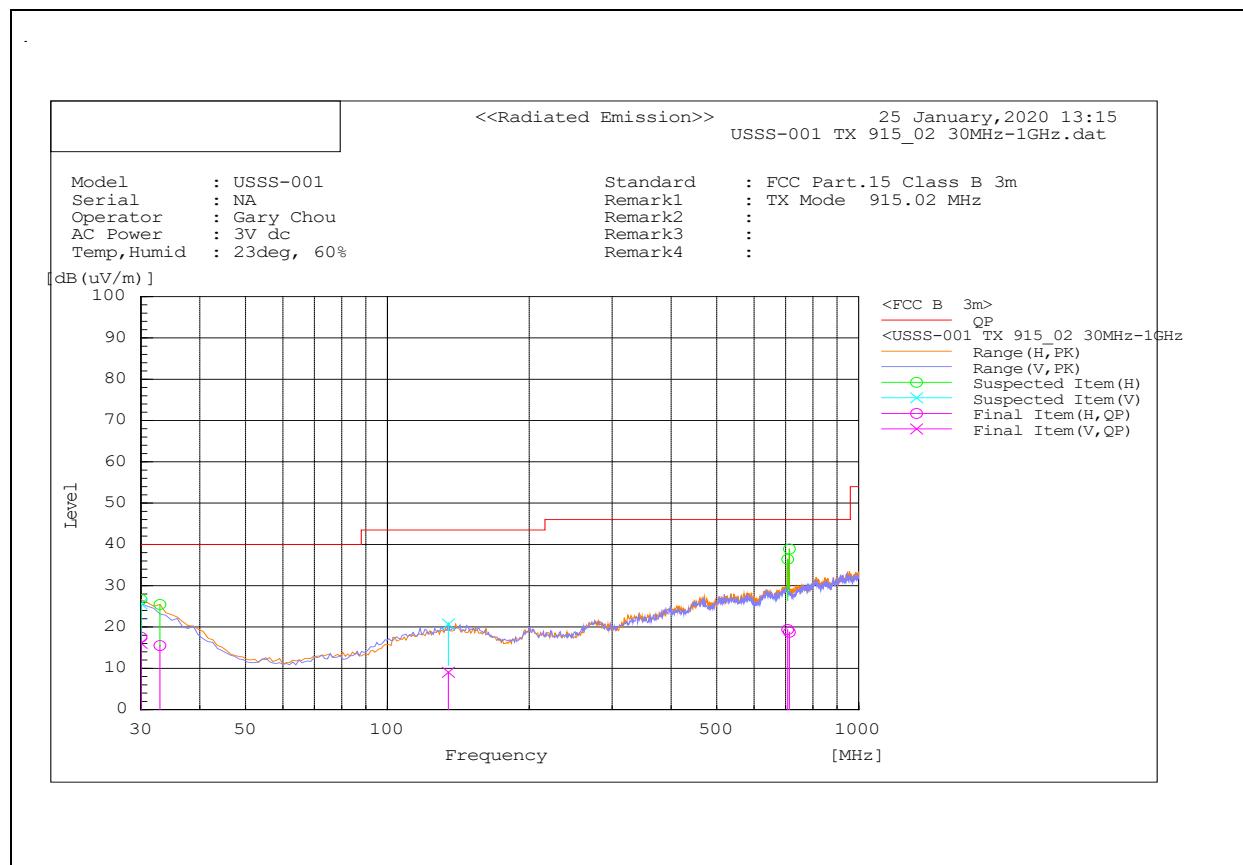
REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Limit value(dBuV/m) - Level (dBuV/m)

Below 1GHz Data:

CHANNEL	TX Mode 915.2 MHz	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit(QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	30	H	-9.2	26.7	17.5	40	22.5	350	243.6	Pass
2	30	H	-9.2	25.3	16.1	40	23.9	130	47.3	Pass
3	32.91	H	-9.1	24.6	15.5	40	24.5	196	10.5	Pass
4	134.76	V	-10.9	20	9.1	43.5	34.4	103	307.5	Pass
5	707.06	H	-9	28.4	19.4	46	26.6	396	28.4	Pass
6	712.88	H	-9.8	28.5	18.7	46	27.3	209	281.6	Pass


REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Limit value(dBuV/m) - Level (dBuV/m)

4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.

2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date Of Calibration	Due Date Of Calibration
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	08/28/2019	11/28/2020
Transient Limiter ELECTRO-METRICS	EM-7600-5	106	12/31/2019	12/31/2020
LISN EMCO	3816/2NM	214372	01/14/2020	01/14/2021

4.2.3 Test Procedures

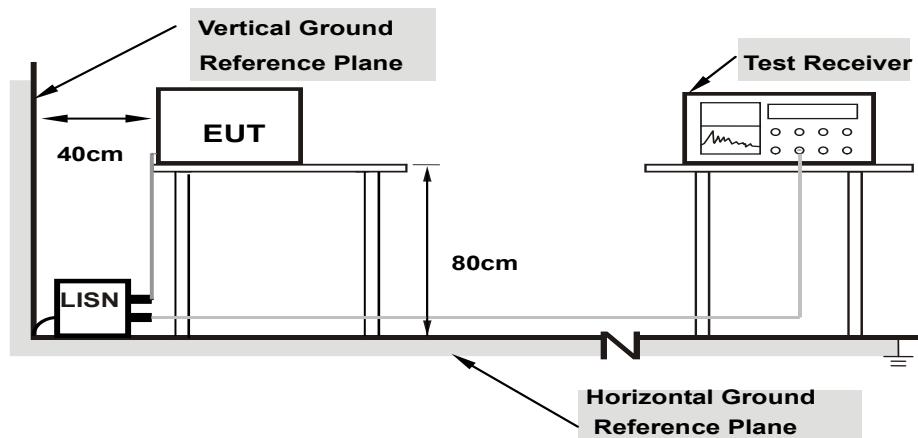
- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation From Test Standard

No deviation.

4.2.5 Test Setup



Note: 1. Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT Operating Condition

Same as 4.1.6.

4.2.7 Test Results

Tests not applicable because EUT is powered by Battery

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information on the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

Milpitas EMC/RF/Safety/Telecom Lab

775 Montague Expressway, Milpitas, CA 95035
Tel: +1 408 526 1188

Sunnyvale OTA/Bluetooth Lab

1293 Anvilwood Avenue, Sunnyvale, CA 94089
Tel: +1 669 600 5293

Littleton EMC/RF/Safety/Environmental Lab

1 Distribution Center Cir #1, Littleton, MA 01460
Tel: +1 978 486 8880

Irvine OTA/PTCRB/Bluetooth/V2X Lab

15 Musick, Irvine, CA 92618
Tel: +1 949 716 6512

Email: sales.eaw@us.bureauveritas.com

Web Site: www.cpsusa-bureauveritas.com

The address and road map of all our labs can be found in our web site also.

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