Excellence in Compliance Testing

Certification Test Report

FCC ID: VPYLB1CK982
IC: 772C-LB1CK982

FCC Rule Part: 15.247
ISED Canada Radio Standards Specification: RSS-247

ACS Report Number: 16-0186.W06.3B

Manufacturer: Murata Manufacturing Co., Ltd.
Model: LBEE5ZZ1CK-982

Test Begin Date: May 3, 2016
Test End Date: August 3, 2016

Report Issue Date: December 15, 2016

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: AT-2021

This report must not be used by the client to claim product certification, approval, or endorsement by ANAB, NIST, or any agency of the Federal Government.

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This report contains 14 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-247 for the tests documented herein.

1.2 Applicant Information

Murata Manufacturing Co., Ltd.
2200 Lake Park Drive
Smyrna, GA. 30080

1.3 Product Description

The Murata Manufacturing Co., Ltd. model LBEE5ZZ1CK-982 is an IEEE 802.11a/b/g/n/ac WLAN + Bluetooth 4.0 wireless transceiver module. The test report documents the compliance of the Bluetooth radio mode of operation.

Technical Details

Mode of Operation:	Bluetooth + Enhanced Data Rate (EDR)
Frequency Range:	2402 MHz - 2480 MHz
Number of Channels:	79
Channel Separation:	1 MHz
Modulations:	GFSK, π/4-DQPSK, 8DPSK
TX Data Rates:	GFSK: 1MBPS π/4-DQPSK: 2MBPS 8DPSK: 3MBPS
Antenna Type/Gain:	PCB Trace Antenna / 0.0 dBi

Model Number: LBEE5ZZ1CK-982

Test Sample Serial Number(s): 433900071FAC

Test Sample Condition: The equipment was provided in good condition without any physical damage.

1.4 Test Methodology and Considerations

The EUT was evaluated for radiated and power line conducted emissions for the Bluetooth mode of operation. Compliance to the RF Conducted emissions requirements are documented in a separate test report.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst case orientation was the Y-orientation. See test setup photos for more information.

For power line conducted emissions, the EUT was evaluated with a commercially available wall wart power supply.

Transmit Power Table Index setting during test – GFSK:	0
Transmit Power Table Index setting during test – π/4-DQPSK:	0
Transmit Power Table Index setting during test – 8-DPSK:	0

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by the ANSI-ASQ National Accreditation Board/ANAB accreditation program, and has been issued certificate number AT-2021 in recognition of this accreditation. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 391271
ISED Canada Lab Code: IC 4175A
VCCI Member Number: 1831
- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

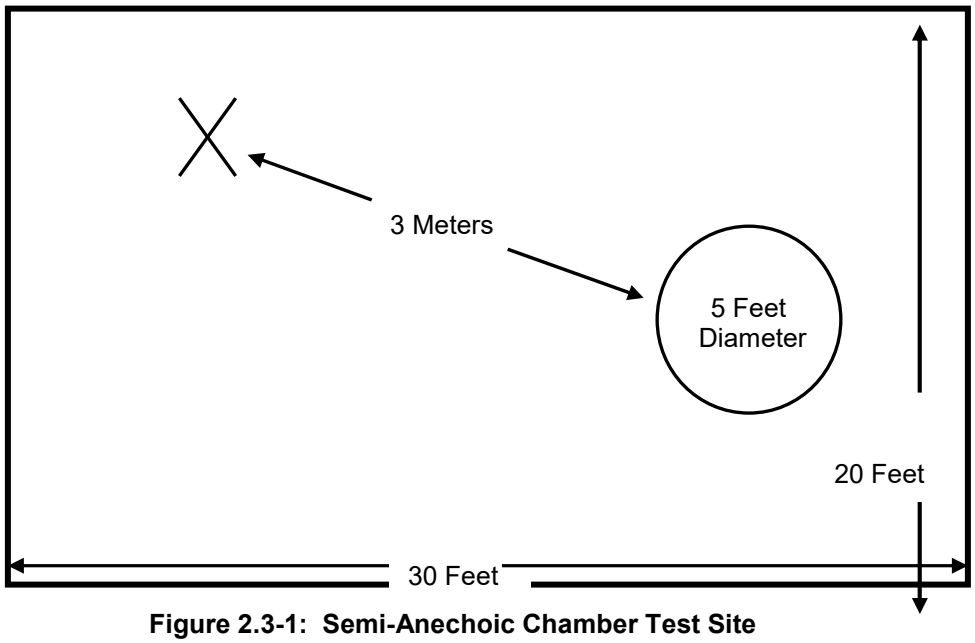

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

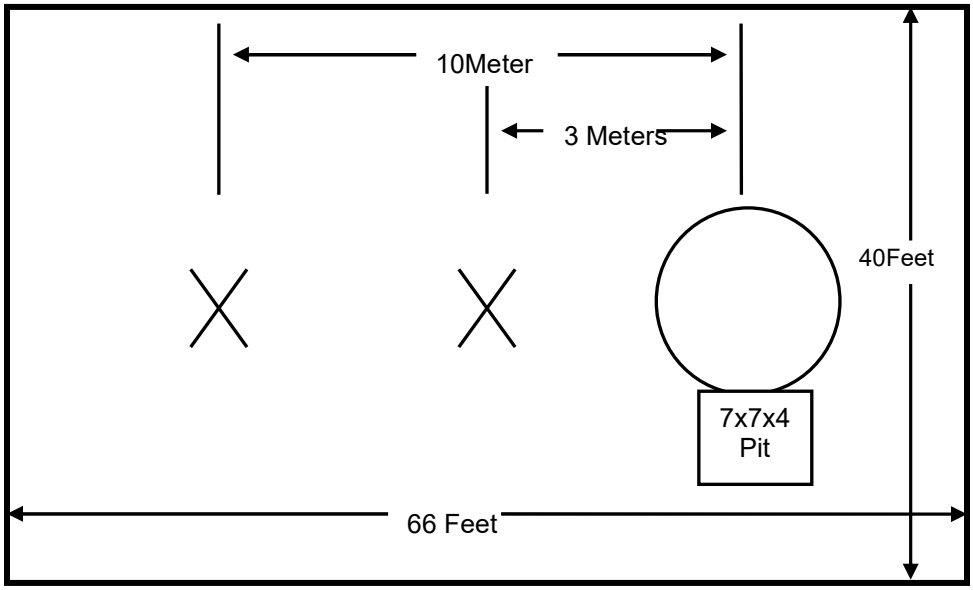

Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 4.1.3-1:

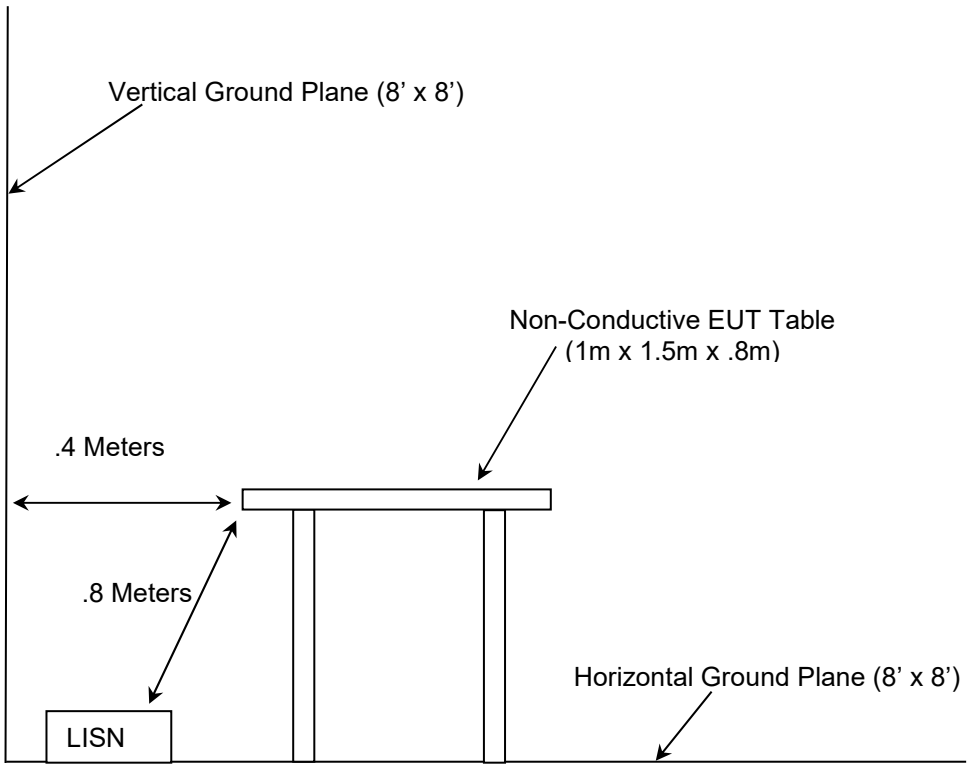

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2016
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2016
- ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4, Nov 2014.

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	7/14/2015	7/14/2016
2	Rohde & Schwarz	ESMI - Receiver	Spectrum Analyzers	839587/003	7/14/2015	7/14/2016
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/30/2015	4/30/2017
40	EMCO	3104	Antennas	3211	2/10/2015	2/10/2017
73	Agilent	8447D	Amplifiers	2727A05624	7/15/2015	7/15/2016
167	ACS	Chamber EMI Cable Set	Cable Set	167	10/20/2015	10/20/2016
292	Florida RF Cables	SMR-290AW-480.0-SMR	Cables	N/A	2/17/2016	2/17/2017
324	ACS	Belden	Cables	8214	5/2/2016	5/2/2017
334	Rohde&Schwarz	3160-09	Antennas	49404	11/4/2010	NCR
335	Suhner Sucoflex	SF-102A	Cables	882/2A	7/14/2015	7/14/2016
338	Hewlett Packard	8449B	Amplifiers	3008A01111	8/21/2015	8/21/2017
345	Suhner Sucoflex	102A	Cables	1077/2A	7/14/2015	7/14/2016
412	Electro Metrics	LPA-25	Antennas	1241	7/24/2014	7/24/2016
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	10/30/2015	10/30/2016
432	Microwave Circuits	H3G020G4	Filters	264066	5/20/2015	5/20/2016
616	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	9/3/2015	9/3/2016
3010	Rohde & Schwarz	ENV216	LISN	3010	7/11/2016	7/11/2017
RE112	Rohde & Schwarz	ESIB26	Receiver	836119/012	7/13/2016	7/13/2017

NCR = No Calibration Required

NOTE: All test equipment was used only during active calibration cycles as reported above.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Evaluation Board	Murata	Type 1CK EVB	N/A
2	Bench Power Supply	Hewlett Packard	E3630A	KR64308603
3	Wall Wart Power Supply	ChungKwang Tech, Inc.	EDF0500150A1BA	N/A

Table 5-2: Cable Description

Item	Cable Type	Length	Shield	Termination
A	DC Power Cable	200 cm	No	1 – 2
B	DC Power Cable	250 cm	No	1 – 3

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

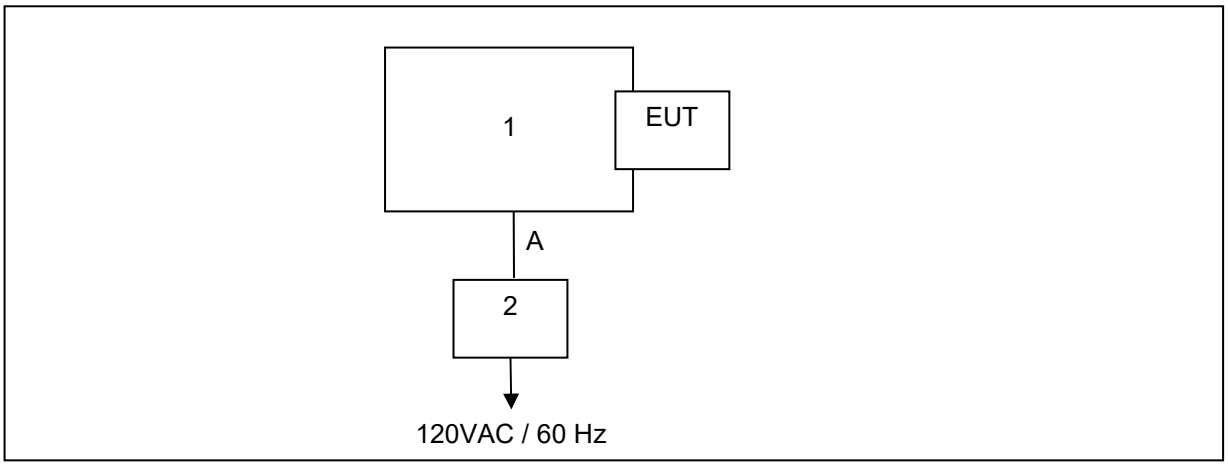

Figure 6-1: Test Setup Block Diagram – Radiated Emissions

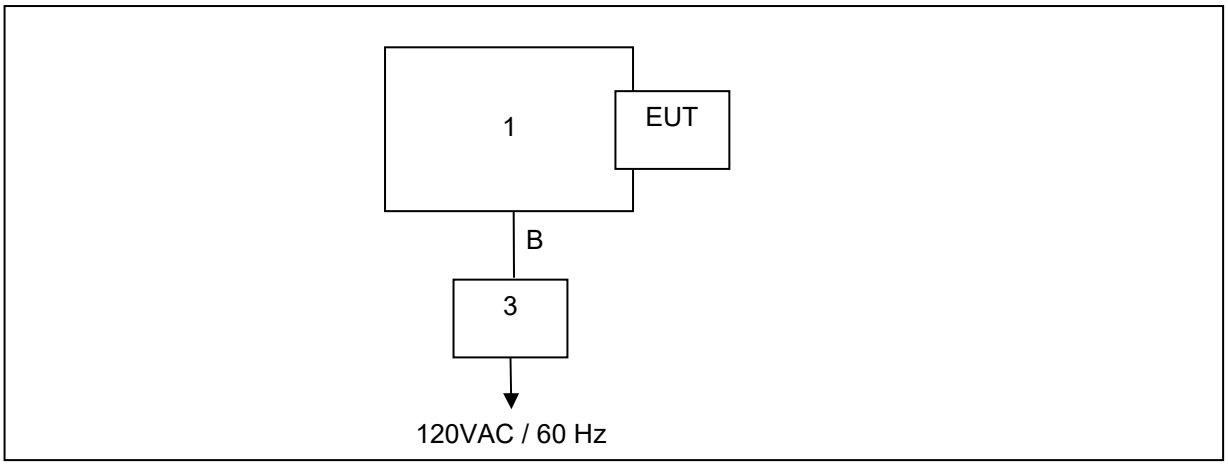

Figure 6-2: Test Setup Block Diagram – Power Line Conducted Emissions

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC 15.203

The EUT utilizes a PCB trace antenna. The antenna is integral to the device and cannot be removed or replaced by the end user. The gain of the antenna is 0.0dBi.

7.2 Power Line Conducted Emissions – FCC 15.207, ISED Canada: RSS-Gen 8.8

7.2.1 Measurement Procedure

ANSI C63.10 section 6 was the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.2.2 Measurement Results

Table 7.2.2-1: Conducted EMI Results Line 1

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
0.153708	---	25.08	55.78	30.70	L1	9.7
0.153708	39.52	---	65.78	26.26	L1	9.7
0.158019	---	24.71	55.53	30.82	L1	9.7
0.158019	38.04	---	65.53	27.49	L1	9.7
0.206713	---	21.21	53.14	31.93	L1	9.7
0.206713	34.74	---	63.17	28.43	L1	9.7
0.229159	---	18.88	52.25	33.37	L1	9.7
0.229159	31.13	---	62.29	31.16	L1	9.7
0.371143	---	23.30	48.30	25.00	L1	9.7
0.371143	29.32	---	58.32	29.00	L1	9.7
0.468036	---	11.29	46.50	35.21	L1	9.7
0.468036	19.27	---	56.51	37.24	L1	9.7

Table 7.2.2-2: Conducted EMI Results Line 2

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
0.170657	---	19.61	54.83	35.22	N	9.7
0.170657	38.04	---	64.85	26.81	N	9.7
0.352906	---	19.28	48.69	29.41	N	9.7
0.352906	28.95	---	58.73	29.78	N	9.7
0.372845	---	21.35	48.26	26.91	N	9.7
0.372845	28.96	---	58.29	29.33	N	9.7
0.414228	---	9.55	47.44	37.89	N	9.7
0.414228	20.34	---	57.46	37.12	N	9.7
0.487475	---	10.32	46.19	35.87	N	9.7
0.487475	18.56	---	56.19	37.63	N	9.7
0.670040	---	7.14	46.00	38.86	N	9.7
0.670040	14.34	---	56.00	41.66	N	9.7

7.3 Emission Levels

7.3.1 Emissions into Restricted Frequency Bands – 15.205, 15.209; ISED Canada: RSS-GEN 8.9/8.10

7.3.1.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30MHz to 25GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a RBW of 120 kHz and a VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

7.3.1.2 Measurement Results

Table 7.3.1.2-1: Radiated Spurious Emissions Tabulated Data – GFSK

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
All emissions were attenuated below the noise floor of the instrumentation										
Middle Channel										
All emissions were attenuated below the noise floor of the instrumentation										
High Channel										
2483.5	47.26	35.38	H	-4.93	42.33	30.45	74.0	54.0	31.7	23.5
2483.5	46.05	34.22	V	-4.93	41.12	29.29	74.0	54.0	32.9	24.7
4960	45.31	35.32	V	2.46	47.77	37.78	74.0	54.0	26.2	16.2

Table 7.3.1.2-2: Radiated Spurious Emissions Tabulated Data – π/4-DQPSK

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
All emissions were attenuated below the noise floor of the instrumentation										
Middle Channel										
All emissions were attenuated below the noise floor of the instrumentation										
High Channel										
All emissions were attenuated below the noise floor of the instrumentation										

Table 7.3.1.2-3: Radiated Spurious Emissions Tabulated Data – 8-DPSK

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
All emissions were attenuated below the noise floor of the instrumentation										
Middle Channel										
All emissions were attenuated below the noise floor of the instrumentation										
High Channel										
All emissions were attenuated below the noise floor of the instrumentation										

7.3.1.3 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Example Calculation: Peak – GFSK

Corrected Level: 47.26 – 4.93 = 42.33dBuV/m
Margin: 74.0dBuV/m – 42.33dBuV/m = 31.7dB

Example Calculation: Average – GFSK

Corrected Level: 35.38 – 4.93 - 0 = 30.45dBuV
Margin: 54.0dBuV – 30.45dBuV =23.5dB

8 CONCLUSION

In the opinion of ACS, Inc. the LBEE5ZZ1CK-982, manufactured by Murata Manufacturing Co., Ltd. meets the requirements of FCC Part 15 subpart C and ISED Canada's Radio Standards Specification RSS-247.

END REPORT