



IntriCon

Lumen 155

FCC 15.249:2017

Bluetooth Radio

Report # INCN0008.1



NVLAP Lab Code: 200881-0



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CERTIFICATE OF TEST

Last Date of Test: September 11, 2017

IntriCon

Model: Lumen 155

Radio Equipment Testing

Standards

Specification	Method
FCC 15.249:2017	ANSI C63.10:2013

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	No	N/A	Not required for a battery powered EUT
6.5, 6.6	Field Strength of Harmonics and Spurious Radiated Emissions	Yes	Pass	
6.6	Field Strength of Fundamental	Yes	Pass	
11.6	Duty Cycle	Yes	N/A	Characterization of radio operation.

Deviations From Test Standards

None

Approved By:

Matt Nuernberg, Operations Manager

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information.

REVISION HISTORY



Revision Number	Description	Date	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS



United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Element to certify transmitters to FCC and IC specifications.

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB). Certification chambers and Open Area Test Sites are filed with ISED.

European Union

European Commission – Within Element, we have a EU Notified Body validated for the EMCD and RED Directives.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIP / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

SCOPE

For details on the Scopes of our Accreditations, please visit:

<http://portlandcustomer.element.com/ts/scope/scope.htm>

<http://gsi.nist.gov/global/docs/cabs/designations.html>

MEASUREMENT UNCERTAINTY



Measurement Uncertainty

When a measurement is made, the result will be different from the true or theoretically correct value. The difference is the result of tolerances in the measurement system that cannot be completely eliminated. To the extent that technology allows us, it has been our aim to minimize this error. Measurement uncertainty is a statistical expression of measurement error qualified by a probability distribution.

A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable test description page. Our measurement data meets or exceeds the measurement uncertainty requirements of the applicable specification; therefore, the test data can be compared directly to the specification limit to determine compliance. The calculations for estimating measurement uncertainty are based upon ETSI TR 100 028 (or CISPR 16-4-2 as applicable), and are available upon request.

The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

Test	+ MU	- MU
Frequency Accuracy (Hz)	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	0.3 dB	-0.3 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	2.4 dB	-2.4 dB

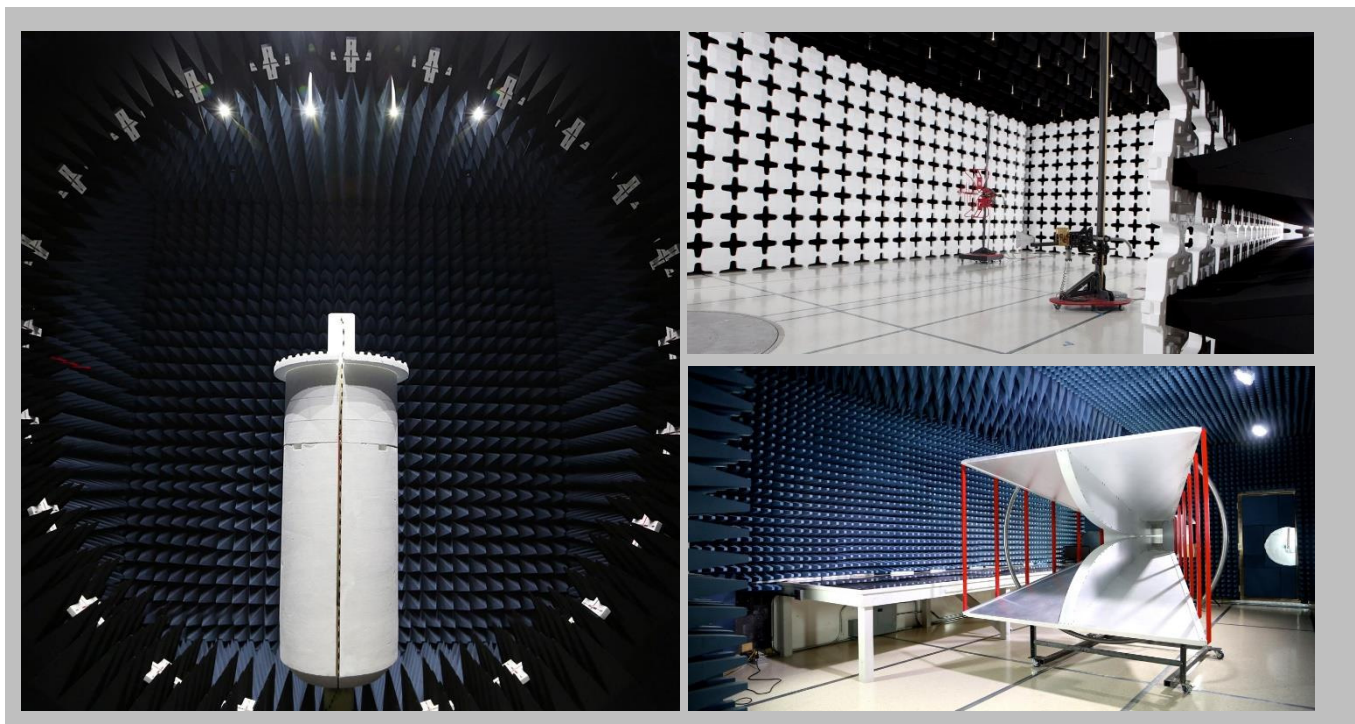
FACILITIES



2017.9.15

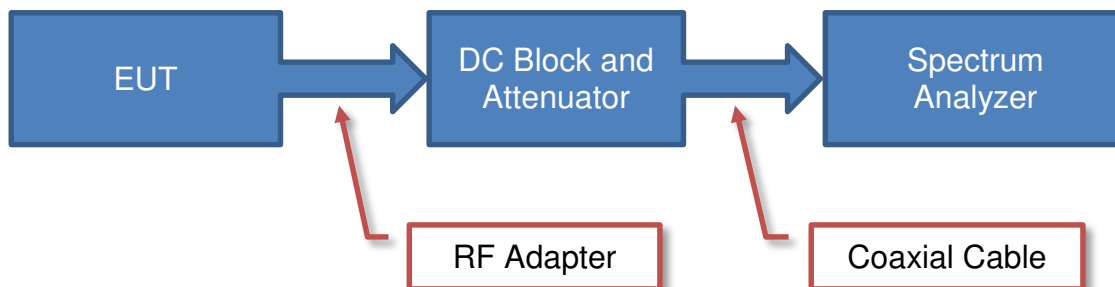


California Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Minnesota Labs MN01-08, MN10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	New York Labs NY01-04 4939 Jordan Rd. Elbridge, NY 13060 (315) 554-8214	Oregon Labs EV01-12 22975 NW Evergreen Pkwy Hillsboro, OR 97124 (503) 844-4066	Texas Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Washington Labs NC01-05 19201 120 th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP					
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200761-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code:201049-0	NVLAP Lab Code: 200629-0
Innovation, Science and Economic Development Canada					
2834B-1, 2834B-3	2834E-1, 2834E-3	N/A	2834D-1, 2834D-2	2834G-1	2834F-1
BSMI					
SL2-IN-E-1154R	SL2-IN-E-1152R	N/A	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI					
A-0029	A-0109	N/A	A-0108	A-0201	A-0110
Recognized Phase I CAB for ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA					
US0158	US0175	N/A	US0017	US0191	US0157

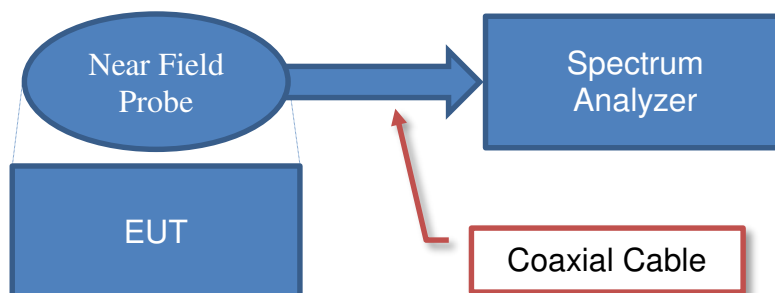


Test Setup Block Diagrams

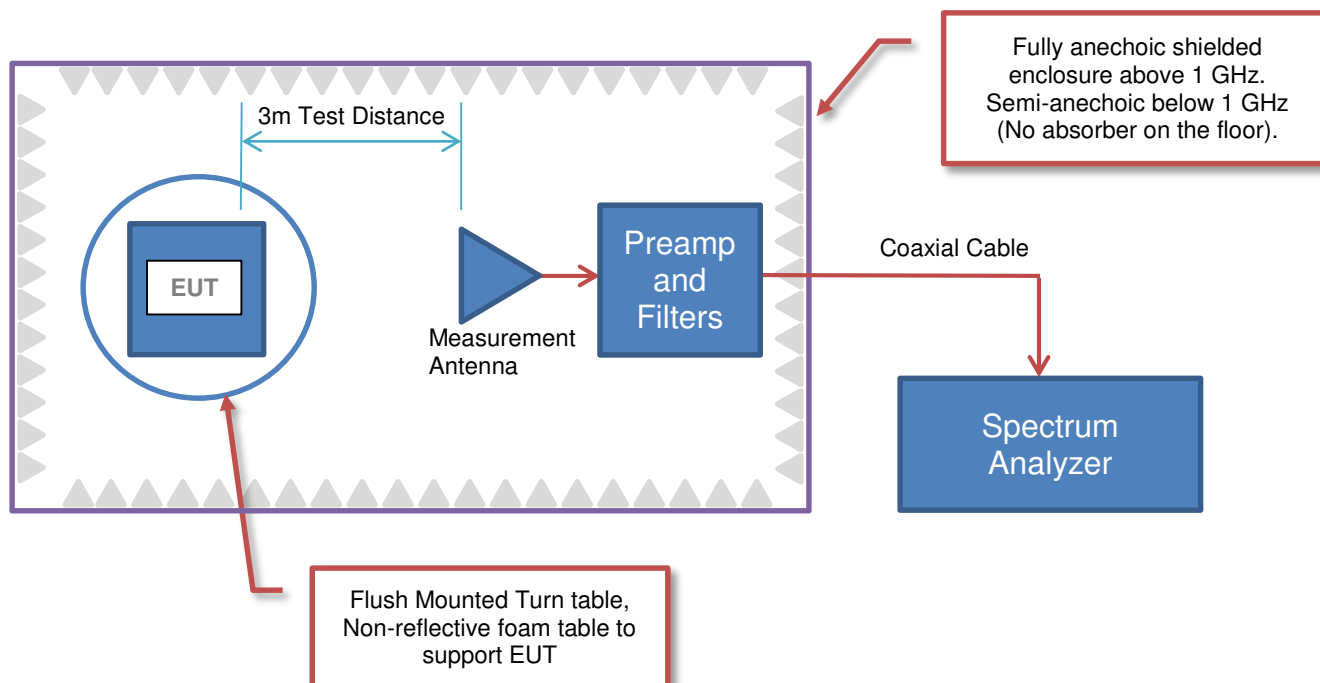
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions





PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	IntriCon
Address:	1260 Red Fox Road
City, State, Zip:	Arden Hills, MN 55112
Test Requested By:	Vijay Sundermurthy
Model:	Lumen 155
First Date of Test:	August 25, 2017
Last Date of Test:	September 22, 2017
Receipt Date of Samples:	August 25, 2017
Equipment Design Stage:	Preproduction
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:

The Lumen 155 hearing device is a behind-the-ear (BTE) hearing device powered by a 312 zinc-air battery. The hearing device has a digital signal processor as well as a 2.4 GHz radio. The radio has a dual stack architecture that can support both the BLE stack and the PAS stack. The BLE link is for data communication and is typically operated at 0dB TX from the hearing aid and less than 1% duty cycles. The PAS stack highly asymmetrical, with the accessory streaming audio to the hearing aid at +4dB with duty cycles being closer to 7% under optimal conditions. The antenna on the hearing aid is a custom flex antenna that wraps around the case of the device. We have previously assessed this antenna to have gain of -6.0 dBi.

Testing Objective:

Seeking to demonstrate compliance of the low power radio under FCC 15.249 for operation in the 2400 – 2483.5 MHz Band.

CONFIGURATIONS



Configuration INCN0008- 2

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Hearing Aid	IntriCon	L155	17YD000053

MODIFICATIONS



Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	9/5/2017	Field Strength of Harmonics and Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	9/11/2017	Field Strength of Fundamental	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS



PSA-ESCI 2017.06.01

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

Transmitting at 2402MHz Low Ch. and 2480MHz High Ch. Proprietary Audio Streaming (PAS)

Transmitting BLE at 2480MHz High Ch.

Transmitting BLE at 2444MHz Mid Ch.

Transmitting BLE at 2402MHz Low Ch.

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

INCN0008 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	26000 MHz
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SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFI	1/6/2017	12 mo
Cable	ESM Cable Corp.	TTBJ141 KMKM-72	MNU	9/15/2016	12 mo
Amplifier - Pre-Amplifier	Miteq	JSD4-18002600-26-8P	APU	9/12/2017	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVW	2/14/2017	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-08	AIQ	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	2/14/2017	12 mo
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	7/12/2017	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	0 mo
Filter - High Pass	Micro-Tronics	HPM50111	LFN	9/23/2016	12 mo
Attenuator	Fairview Microwave	SA18E-20	TWZ	9/23/2016	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	2/14/2017	12 mo
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	12/1/2016	12 mo
Antenna - Double Ridge	ETS Lindgren	3115	AJA	6/23/2016	24 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	12/1/2016	12 mo
Cable	ESM Cable Corp.	Bilog Cables	MNH	12/1/2016	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AYD	1/6/2016	24 mo

MEASUREMENT BANDWIDTHS

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

TEST DESCRIPTION

The highest gain antenna of each type to be used with the EUT was tested. The EUT was configured for the required transmit frequencies and the modes as showed in the data sheets.

For each configuration, the spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. These “pre-scans” are not included in the report. Final measurements on individual emissions were then made and included in this test report.

The highest gain antenna of each type to be used with the EUT was tested. The EUT was configured for the required transmit frequencies and the modes as showed in the data sheets.

For each configuration, the spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. These “pre-scans” are not included in the report. Final measurements on individual emissions were then made and included in this test report.

The individual emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and EUT antenna in three orthogonal axis, and adjusting the measurement antenna height and polarization (per ANSI C63.10). A preamp and high pass filter (and notch filter) were used for this test in order to provide sufficient measurement sensitivity.

Measurements were made with the required detectors and annotated on the data for each individual point using the following annotation:

QP = Quasi-Peak Detector
PK = Peak Detector
AV = RMS Detector

Measurements were made to satisfy the specific requirements of the test specification for out of band emissions.

If there are no detectable emissions above the noise floor, the data included may show noise floor measurements for reference only.

Measurements at the edges of the allowable band may be presented in an alternative method as provided for in the ANSI C63.10 Marker-Delta method. This method involves performing an in-band fundamental measurement followed by a screen capture of the fundamental and out-of-band emission using reduced measurement instrumentation bandwidths. The amplitude delta measured on this screen capture is applied to the fundamental emission value to show the out-of-band emission level as applied to the limit.

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS



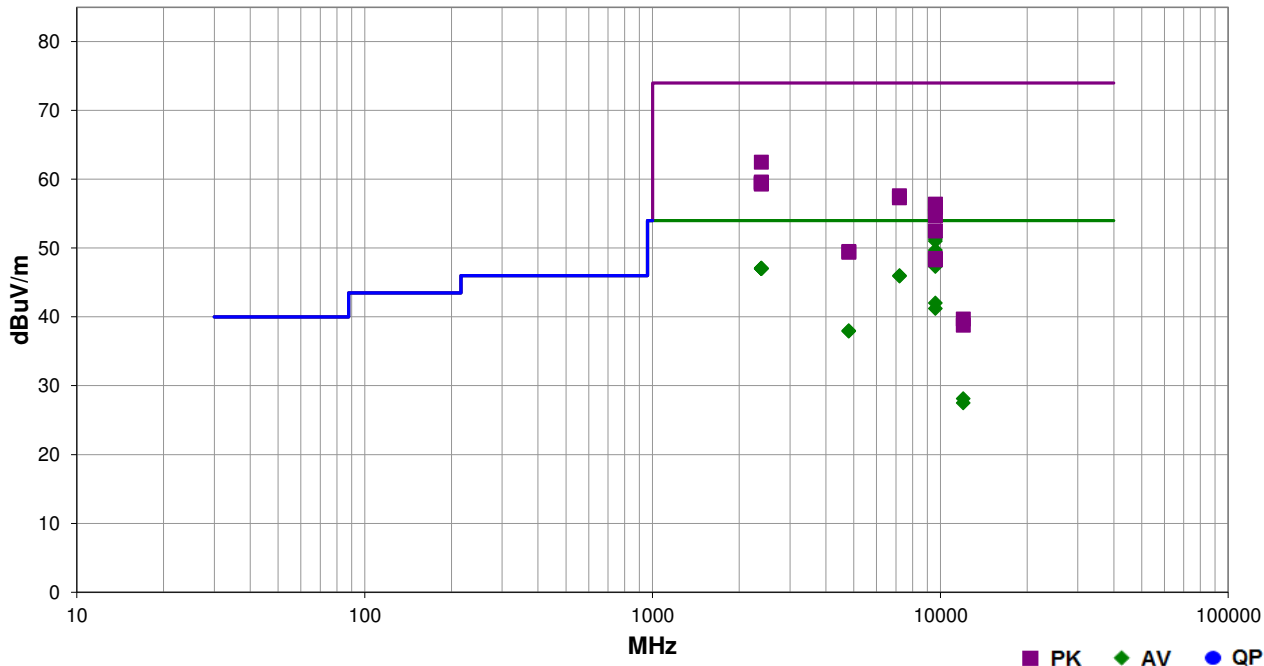
EmiRS 2017.07.11

PSA-ESCI 2017.06.01

Work Order:	INCN0008	Date:	09/05/17	
Project:	None	Temperature:	22.4 °C	
Job Site:	MN05	Humidity:	38.7% RH	
Serial Number:	17YD000062	Barometric Pres.:	1019 mbar	Tested by: Chris Patterson
EUT:	Lumen 155			
Configuration:	2			
Customer:	IntriCon			
Attendees:	Andrew Albing			
EUT Power:	Battery			
Operating Mode:	Transmitting BLE at 2402MHz Low Ch.			
Deviations:	None			
Comments:	None			

Test Specifications	Test Method
FCC 15.249:2017	ANSI C63.10:2013

Run #	11	Test Distance (m)	3	Antenna Height(s)	1 to 4(m)	Results	Pass
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Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
9609.058	54.9	-3.6	1.9	235.0	3.0	0.0	Horz	AV	0.0	51.3	54.0	-2.7	EUT On Side
9609.067	54.6	-3.6	2.7	160.1	3.0	0.0	Horz	AV	0.0	51.0	54.0	-3.0	EUT Horz
9607.392	53.3	-3.6	2.7	222.0	3.0	0.0	Vert	AV	0.0	49.7	54.0	-4.3	EUT Vert
9607.325	50.9	-3.6	3.2	78.0	3.0	0.0	Vert	AV	0.0	47.3	54.0	-6.7	EUT Horz
2388.465	29.4	-2.3	2.0	179.0	3.0	20.0	Vert	AV	0.0	47.1	54.0	-6.9	EUT Horz
2388.350	29.3	-2.3	1.0	118.0	3.0	20.0	Horz	AV	0.0	47.0	54.0	-7.0	EUT Vert
2388.485	29.3	-2.3	1.0	340.0	3.0	20.0	Vert	AV	0.0	47.0	54.0	-7.0	EUT Vert
2388.485	29.3	-2.3	1.0	224.1	3.0	20.0	Horz	AV	0.0	47.0	54.0	-7.0	EUT On Side
2388.345	29.3	-2.3	1.0	49.0	3.0	20.0	Vert	AV	0.0	47.0	54.0	-7.0	EUT On Side
2388.485	29.3	-2.3	1.0	117.0	3.0	20.0	Horz	AV	0.0	47.0	54.0	-7.0	EUT Horz
7208.408	30.5	15.5	1.2	79.0	3.0	0.0	Vert	AV	0.0	46.0	54.0	-8.0	EUT Vert
7208.417	30.4	15.5	1.0	13.0	3.0	0.0	Horz	AV	0.0	45.9	54.0	-8.1	EUT On Side
2388.435	44.8	-2.3	1.0	118.0	3.0	20.0	Horz	PK	0.0	62.5	74.0	-11.5	EUT Vert

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
9607.350	45.6	-3.6	2.0	164.1	3.0	0.0	Horz	AV	0.0	42.0	54.0	-12.0	EUT Vert
9607.383	44.8	-3.6	1.0	63.0	3.0	0.0	Vert	AV	0.0	41.2	54.0	-12.8	EUT On Side
2386.100	41.9	-2.3	1.0	224.1	3.0	20.0	Horz	PK	0.0	59.6	74.0	-14.4	EUT On Side
2387.985	41.8	-2.3	2.0	179.0	3.0	20.0	Vert	PK	0.0	59.5	74.0	-14.5	EUT Horz
2387.145	41.7	-2.3	1.0	340.0	3.0	20.0	Vert	PK	0.0	59.4	74.0	-14.6	EUT Vert
2387.560	41.7	-2.3	1.0	49.0	3.0	20.0	Vert	PK	0.0	59.4	74.0	-14.6	EUT On Side
2385.515	41.6	-2.3	1.0	117.0	3.0	20.0	Horz	PK	0.0	59.3	74.0	-14.7	EUT Horz
4801.825	31.4	6.6	1.0	60.0	3.0	0.0	Horz	AV	0.0	38.0	54.0	-16.0	EUT On Side
4801.600	31.3	6.6	2.3	113.1	3.0	0.0	Vert	AV	0.0	37.9	54.0	-16.1	EUT Vert
7204.933	42.1	15.5	1.0	13.0	3.0	0.0	Horz	PK	0.0	57.6	74.0	-16.4	EUT On Side
7205.083	41.8	15.5	1.2	79.0	3.0	0.0	Vert	PK	0.0	57.3	74.0	-16.7	EUT Vert
9607.208	60.0	-3.6	1.9	235.0	3.0	0.0	Horz	PK	0.0	56.4	74.0	-17.6	EUT On Side
9607.158	59.5	-3.6	2.7	160.1	3.0	0.0	Horz	PK	0.0	55.9	74.0	-18.1	EUT Horz
9607.250	58.3	-3.6	2.7	222.0	3.0	0.0	Vert	PK	0.0	54.7	74.0	-19.3	EUT Vert
9609.350	56.1	-3.6	3.2	78.0	3.0	0.0	Vert	PK	0.0	52.5	74.0	-21.5	EUT Horz
4803.925	42.9	6.6	2.3	113.1	3.0	0.0	Vert	PK	0.0	49.5	74.0	-24.5	EUT Vert
4805.900	42.8	6.6	1.0	60.0	3.0	0.0	Horz	PK	0.0	49.4	74.0	-24.6	EUT On Side
9607.192	52.1	-3.6	2.0	164.1	3.0	0.0	Horz	PK	0.0	48.5	74.0	-25.5	EUT Vert
9609.183	51.9	-3.6	1.0	63.0	3.0	0.0	Vert	PK	0.0	48.3	74.0	-25.7	EUT On Side
12011.470	29.2	-1.1	2.7	12.1	3.0	0.0	Vert	AV	0.0	28.1	54.0	-25.9	EUT Vert
12007.760	28.6	-1.1	1.7	12.1	3.0	0.0	Horz	AV	0.0	27.5	54.0	-26.5	EUT On side
12009.080	40.8	-1.1	1.7	12.1	3.0	0.0	Horz	PK	0.0	39.7	74.0	-34.3	EUT On side
12008.880	39.9	-1.1	2.7	12.1	3.0	0.0	Vert	PK	0.0	38.8	74.0	-35.2	EUT Vert

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS



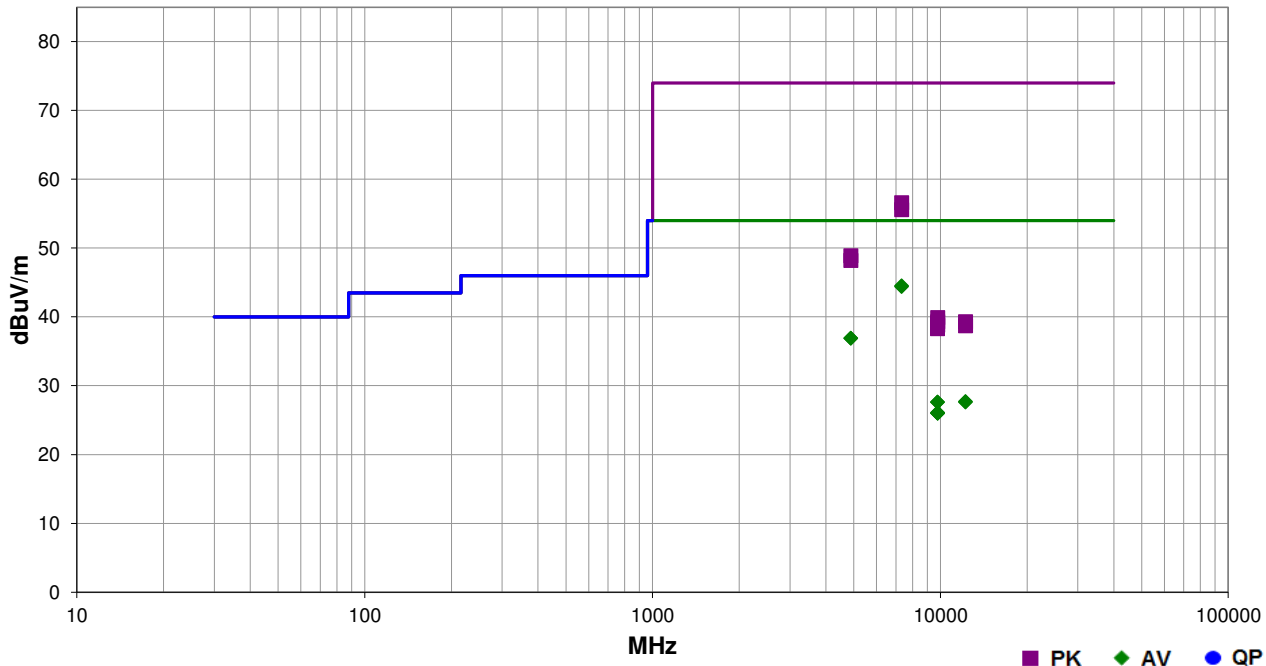
EmiRS 2017.07.11

PSA-ESCI 2017.06.01

Work Order:	INCN0008	Date:	09/05/17	
Project:	None	Temperature:	22.2 °C	
Job Site:	MN05	Humidity:	53.4% RH	
Serial Number:	17YD000062	Barometric Pres.:	1018 mbar	Tested by: Chris Patterson
EUT:	Lumen 155			
Configuration:	2			
Customer:	IntriCon			
Attendees:	Andrew Albing			
EUT Power:	Battery			
Operating Mode:	Transmitting BLE at 2442MHz Mid Ch.			
Deviations:	None			
Comments:	None			

Test Specifications	Test Method
FCC 15.249:2017	ANSI C63.10:2013

Run #	19	Test Distance (m)	3	Antenna Height(s)	1 to 4(m)	Results	Pass
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Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
7333.083	29.5	15.0	1.0	181.1	3.0	0.0	Vert	AV	0.0	44.5	54.0	-9.5	EUT Vert
7333.967	29.4	15.0	2.7	106.1	3.0	0.0	Horz	AV	0.0	44.4	54.0	-9.6	EUT On Side
4886.458	30.2	6.7	1.4	114.0	3.0	0.0	Vert	AV	0.0	36.9	54.0	-17.1	EUT Vert
4886.367	30.2	6.7	1.0	0.0	3.0	0.0	Horz	AV	0.0	36.9	54.0	-17.1	EUT On Side
7333.542	41.6	15.0	2.7	106.1	3.0	0.0	Horz	PK	0.0	56.6	74.0	-17.4	EUT On Side
7329.908	40.6	15.0	1.0	181.1	3.0	0.0	Vert	PK	0.0	55.6	74.0	-18.4	EUT Vert
4887.775	42.2	6.7	1.4	114.0	3.0	0.0	Vert	PK	0.0	48.9	74.0	-25.1	EUT Vert
4887.767	41.5	6.7	1.0	0.0	3.0	0.0	Horz	PK	0.0	48.2	74.0	-25.8	EUT On Side
12218.260	28.1	-0.4	3.7	140.0	3.0	0.0	Horz	AV	0.0	27.7	54.0	-26.3	EUT On Side
12218.030	28.0	-0.4	1.0	168.0	3.0	0.0	Vert	AV	0.0	27.6	54.0	-26.4	EUT Vert
9774.125	30.8	-3.2	1.0	97.0	3.0	0.0	Horz	AV	0.0	27.6	54.0	-26.4	EUT Horz
9776.300	30.7	-3.1	1.0	79.0	3.0	0.0	Vert	AV	0.0	27.6	54.0	-26.4	EUT Horz
9775.233	29.2	-3.1	1.5	317.0	3.0	0.0	Horz	AV	0.0	26.1	54.0	-27.9	EUT Vert

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
9774.725	29.2	-3.2	1.0	220.1	3.0	0.0	Horz	AV	0.0	26.0	54.0	-28.0	EUT On Side
9776.050	29.1	-3.1	1.7	129.0	3.0	0.0	Vert	AV	0.0	26.0	54.0	-28.0	EUT On Side
9775.267	29.1	-3.1	1.0	339.0	3.0	0.0	Vert	AV	0.0	26.0	54.0	-28.0	EUT Vert
9776.217	43.0	-3.1	1.0	339.0	3.0	0.0	Vert	PK	0.0	39.9	74.0	-34.1	EUT Vert
12219.170	39.7	-0.4	3.7	140.0	3.0	0.0	Horz	PK	0.0	39.3	74.0	-34.7	EUT On Side
9776.908	42.4	-3.1	1.7	129.0	3.0	0.0	Vert	PK	0.0	39.3	74.0	-34.7	EUT On Side
9774.258	42.3	-3.2	1.0	220.1	3.0	0.0	Horz	PK	0.0	39.1	74.0	-34.9	EUT On Side
9776.258	41.9	-3.1	1.0	97.0	3.0	0.0	Horz	PK	0.0	38.8	74.0	-35.2	EUT Horz
12217.700	39.1	-0.4	1.0	168.0	3.0	0.0	Vert	PK	0.0	38.7	74.0	-35.3	EUT Vert
9773.708	41.8	-3.2	1.5	317.0	3.0	0.0	Horz	PK	0.0	38.6	74.0	-35.4	EUT Vert
9773.600	41.5	-3.2	1.0	79.0	3.0	0.0	Vert	PK	0.0	38.3	74.0	-35.7	EUT Horz

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS



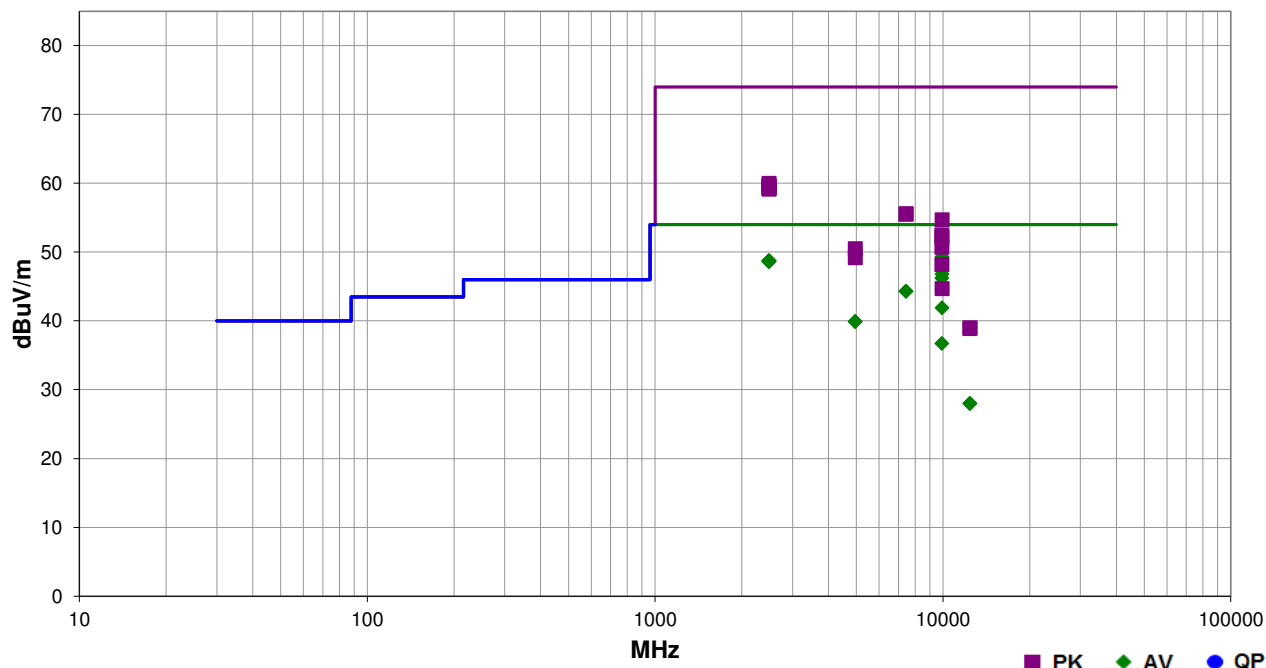
EmiRS 2017.07.11

PSA-ESCI 2017.06.01

Work Order:	INCN0008	Date:	09/05/17	
Project:	None	Temperature:	22.2 °C	
Job Site:	MN05	Humidity:	53.4% RH	
Serial Number:	17YD000062	Barometric Pres.:	1018 mbar	Tested by: Chris Patterson
EUT:	Lumen 155			
Configuration:	2			
Customer:	IntriCon			
Attendees:	Andrew Albing			
EUT Power:	Battery			
Operating Mode:	Transmitting BLE at 2480MHz High Ch.			
Deviations:	None			
Comments:	None			

Test Specifications	Test Method
FCC 15.249:2017	ANSI C63.10:2013

Run #	25	Test Distance (m)	3	Antenna Height(s)	1 to 4(m)	Results	Pass
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Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
9921.108	52.3	-3.0	1.7	130.1	3.0	0.0	Horz	AV	0.0	49.3	54.0	-4.7	EUT Horz
2487.935	31.2	-2.5	1.0	110.0	3.0	20.0	Horz	AV	0.0	48.7	54.0	-5.3	EUT Vert
2485.020	31.2	-2.5	3.7	347.0	3.0	20.0	Vert	AV	0.0	48.7	54.0	-5.3	EUT Vert
2487.465	31.2	-2.5	3.1	88.1	3.0	20.0	Vert	AV	0.0	48.7	54.0	-5.3	EUT On side
2486.810	31.2	-2.5	1.0	232.0	3.0	20.0	Horz	AV	0.0	48.7	54.0	-5.3	EUT Horz
2486.900	31.2	-2.5	1.4	289.9	3.0	20.0	Vert	AV	0.0	48.7	54.0	-5.3	EUT Horz
2486.560	31.1	-2.5	1.0	326.9	3.0	20.0	Horz	AV	0.0	48.6	54.0	-5.4	EUT On side
9921.133	49.8	-3.0	2.4	85.0	3.0	0.0	Vert	AV	0.0	46.8	54.0	-7.2	EUT On Side
9919.342	49.2	-3.0	1.4	34.1	3.0	0.0	Horz	AV	0.0	46.2	54.0	-7.8	EUT On Side
9921.117	47.7	-3.0	2.0	246.0	3.0	0.0	Vert	AV	0.0	44.7	54.0	-9.3	EUT Vert
7440.675	29.3	15.0	1.6	257.9	3.0	0.0	Vert	AV	0.0	44.3	54.0	-9.7	EUT On side
7439.450	29.3	15.0	1.0	317.0	3.0	0.0	Horz	AV	0.0	44.3	54.0	-9.7	EUT Horz
9921.092	44.9	-3.0	3.0	322.0	3.0	0.0	Vert	AV	0.0	41.9	54.0	-12.1	EUT Horz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2485.075	42.5	-2.5	3.7	347.0	3.0	20.0	Vert	PK	0.0	60.0	74.0	-14.0	EUT Vert
4959.925	33.1	6.8	1.0	278.0	3.0	0.0	Vert	AV	0.0	39.9	54.0	-14.1	EUT On side
4960.358	33.1	6.8	1.0	205.0	3.0	0.0	Horz	AV	0.0	39.9	54.0	-14.1	EUT Horz
2485.035	42.2	-2.5	1.0	110.0	3.0	20.0	Horz	PK	0.0	59.7	74.0	-14.3	EUT Vert
2486.350	42.1	-2.5	1.4	289.9	3.0	20.0	Vert	PK	0.0	59.6	74.0	-14.4	EUT Horz
2487.620	41.9	-2.5	1.0	232.0	3.0	20.0	Horz	PK	0.0	59.4	74.0	-14.6	EUT Horz
2486.610	41.7	-2.5	1.0	326.9	3.0	20.0	Horz	PK	0.0	59.2	74.0	-14.8	EUT On side
2485.305	41.7	-2.5	3.1	88.1	3.0	20.0	Vert	PK	0.0	59.2	74.0	-14.8	EUT On side
9919.392	39.7	-3.0	1.9	107.0	3.0	0.0	Horz	AV	0.0	36.7	54.0	-17.3	EUT Vert
7437.550	40.6	15.0	1.0	317.0	3.0	0.0	Horz	PK	0.0	55.6	74.0	-18.4	EUT Horz
7441.475	40.5	15.0	1.6	257.9	3.0	0.0	Vert	PK	0.0	55.5	74.0	-18.5	EUT On side
9921.225	57.7	-3.0	1.7	130.1	3.0	0.0	Horz	PK	0.0	54.7	74.0	-19.3	EUT Horz
9919.250	55.5	-3.0	2.4	85.0	3.0	0.0	Vert	PK	0.0	52.5	74.0	-21.5	EUT On Side
9919.233	55.2	-3.0	1.4	34.1	3.0	0.0	Horz	PK	0.0	52.2	74.0	-21.8	EUT On Side
9919.150	53.7	-3.0	2.0	246.0	3.0	0.0	Vert	PK	0.0	50.7	74.0	-23.3	EUT Vert
4960.417	43.7	6.8	1.0	278.0	3.0	0.0	Vert	PK	0.0	50.5	74.0	-23.5	EUT On side
4959.567	42.4	6.8	1.0	205.0	3.0	0.0	Horz	PK	0.0	49.2	74.0	-24.8	EUT Horz
9919.333	51.2	-3.0	3.0	322.0	3.0	0.0	Vert	PK	0.0	48.2	74.0	-25.8	EUT Horz
12399.700	27.8	0.2	1.0	143.0	3.0	0.0	Horz	AV	0.0	28.0	54.0	-26.0	EUT Horz
12399.310	27.8	0.2	2.4	228.1	3.0	0.0	Vert	AV	0.0	28.0	54.0	-26.0	EUT On Side
9921.142	47.7	-3.0	1.9	107.0	3.0	0.0	Horz	PK	0.0	44.7	74.0	-29.3	EUT Vert
12399.350	38.8	0.2	1.0	143.0	3.0	0.0	Horz	PK	0.0	39.0	74.0	-35.0	EUT Horz
12398.420	38.7	0.2	2.4	228.1	3.0	0.0	Vert	PK	0.0	38.9	74.0	-35.1	EUT On Side

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS



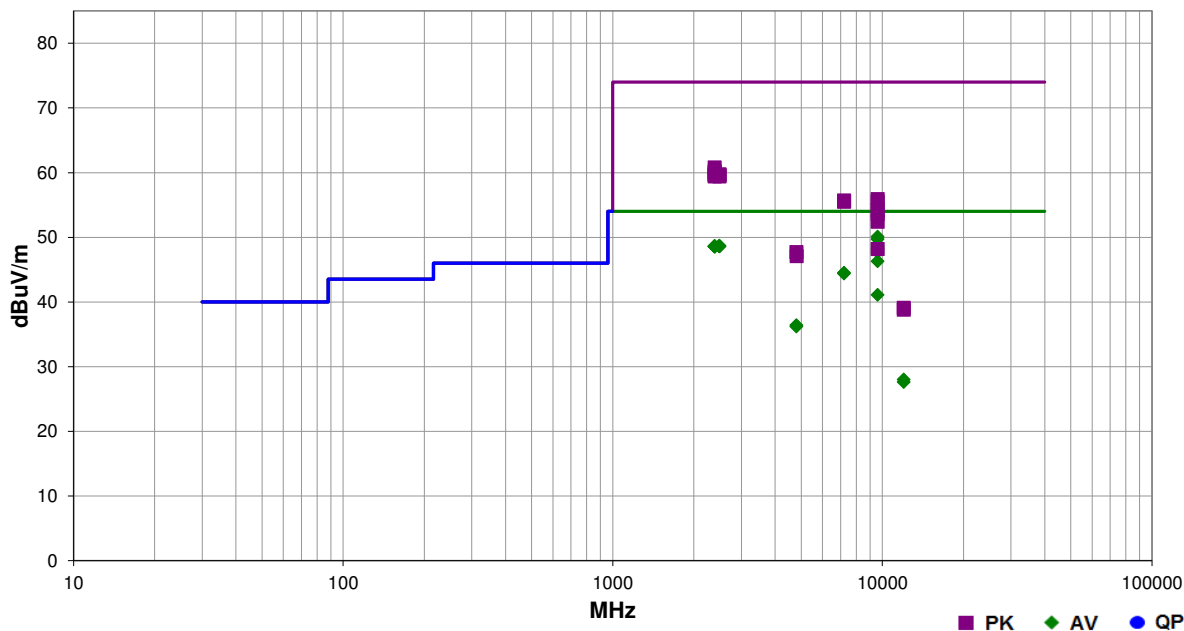
EmiRS 2017.07.11

PSA-ESCI 2017.06.01

Work Order:	INCN0008	Date:	09/05/17	
Project:	None	Temperature:	22.2 °C	
Job Site:	MN05	Humidity:	53.4% RH	
Serial Number:	17YD000062	Barometric Pres.:	1018 mbar	
EUT:	Lumen 155			
Configuration:	2			
Customer:	IntriCon			
Attendees:	Andrew Albing			
EUT Power:	Battery			
Operating Mode:	Transmitting at 2402MHz Low Ch. and 2480MHz High Ch. Propriety Audio Streaming (PAS)			
Deviations:	None			
Comments:	None			

Test Specifications	Test Method
FCC 15.249:2017	ANSI C63.10:2013

Run #	29	Test Distance (m)	3	Antenna Height(s)	1 to 4(m)	Results	Pass
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Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
9609.383	53.7	-3.6	1.9	162.0	3.0	0.0	Horz	AV	0.0	50.1	54.0	-3.9	EUT Horz Low Ch.
9609.342	53.3	-3.6	1.9	246.0	3.0	0.0	Horz	AV	0.0	49.7	54.0	-4.3	EUT On Side Low Ch.
2487.555	31.2	-2.5	1.5	52.1	3.0	20.0	Horz	AV	0.0	48.7	54.0	-5.3	EUT On Side High Ch.
2385.008	30.9	-2.3	1.0	283.9	3.0	20.0	Horz	AV	0.0	48.6	54.0	-5.4	EUT Horz Low Ch.
2388.650	30.9	-2.3	1.0	77.1	3.0	20.0	Vert	AV	0.0	48.6	54.0	-5.4	EUT Horz Low Ch.
2388.242	30.9	-2.3	1.0	322.9	3.0	20.0	Horz	AV	0.0	48.6	54.0	-5.4	EUT On Side Low Ch.
2388.725	30.9	-2.3	1.0	307.0	3.0	20.0	Horz	AV	0.0	48.6	54.0	-5.4	EUT Vert Low Ch.
2386.283	30.9	-2.3	2.8	14.0	3.0	20.0	Vert	AV	0.0	48.6	54.0	-5.4	EUT Vert Low Ch.
2485.760	31.1	-2.5	1.0	330.9	3.0	20.0	Vert	AV	0.0	48.6	54.0	-5.4	EUT On Side High Ch.
2485.775	31.1	-2.5	3.1	250.9	3.0	20.0	Horz	AV	0.0	48.6	54.0	-5.4	EUT Vert High Ch.
2485.035	31.1	-2.5	1.4	257.0	3.0	20.0	Vert	AV	0.0	48.6	54.0	-5.4	EUT Vert High Ch.
2389.050	30.8	-2.3	1.2	239.9	3.0	20.0	Vert	AV	0.0	48.5	54.0	-5.5	EUT On Side Low Ch.
9607.075	51.8	-3.6	1.9	86.0	3.0	0.0	Vert	AV	0.0	48.2	54.0	-5.8	EUT On Side Low Ch.
9607.058	51.3	-3.6	2.3	181.1	3.0	0.0	Vert	AV	0.0	47.7	54.0	-6.3	EUT Vert Low Ch.
9609.350	49.9	-3.6	3.4	106.1	3.0	0.0	Vert	AV	0.0	46.3	54.0	-7.7	EUT Horz Low Ch.
7208.367	29.0	15.5	1.0	39.0	3.0	0.0	Vert	AV	0.0	44.5	54.0	-9.5	EUT On Side Low Ch.
7207.633	28.9	15.5	1.0	275.9	3.0	0.0	Horz	AV	0.0	44.4	54.0	-9.6	EUT Horz Low Ch.
9609.317	44.7	-3.6	1.6	80.1	3.0	0.0	Horz	AV	0.0	41.1	54.0	-12.9	EUT Vert Low Ch.

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2385.258	43.1	-2.3	2.8	14.0	3.0	20.0	Vert	PK	0.0	60.8	74.0	-13.2	EUT Vert Low Ch.
2387.183	42.5	-2.3	1.2	239.9	3.0	20.0	Vert	PK	0.0	60.2	74.0	-13.8	EUT On Side Low Ch.
2388.283	42.3	-2.3	1.0	307.0	3.0	20.0	Horz	PK	0.0	60.0	74.0	-14.0	EUT Vert Low Ch.
2386.883	42.0	-2.3	1.0	283.9	3.0	20.0	Horz	PK	0.0	59.7	74.0	-14.3	EUT Horz Low Ch.
2485.265	42.2	-2.5	1.5	52.1	3.0	20.0	Horz	PK	0.0	59.7	74.0	-14.3	EUT On Side High Ch.
2485.400	42.2	-2.5	1.4	257.0	3.0	20.0	Vert	PK	0.0	59.7	74.0	-14.3	EUT Vert High Ch.
2386.458	41.9	-2.3	1.0	77.1	3.0	20.0	Vert	PK	0.0	59.6	74.0	-14.4	EUT Horz Low Ch.
2486.040	42.0	-2.5	1.0	330.9	3.0	20.0	Vert	PK	0.0	59.5	74.0	-14.5	EUT On Side High Ch.
2386.133	41.7	-2.3	1.0	322.9	3.0	20.0	Horz	PK	0.0	59.4	74.0	-14.6	EUT On Side Low Ch.
2487.740	41.9	-2.5	3.1	250.9	3.0	20.0	Horz	PK	0.0	59.4	74.0	-14.6	EUT Vert High Ch.
4801.550	29.8	6.6	1.0	358.9	3.0	0.0	Vert	AV	0.0	36.4	54.0	-17.6	EUT On Side Low Ch.
4802.575	29.6	6.6	1.0	246.9	3.0	0.0	Horz	AV	0.0	36.2	54.0	-17.8	EUT Horz Low Ch.
9606.917	59.5	-3.6	1.9	162.0	3.0	0.0	Horz	PK	0.0	55.9	74.0	-18.1	EUT Horz Low Ch.
7204.208	40.2	15.5	1.0	39.0	3.0	0.0	Vert	PK	0.0	55.7	74.0	-18.3	EUT On Side Low Ch.
9609.525	59.1	-3.6	1.9	246.0	3.0	0.0	Horz	PK	0.0	55.5	74.0	-18.5	EUT On Side Low Ch.
7206.317	40.0	15.5	1.0	275.9	3.0	0.0	Horz	PK	0.0	55.5	74.0	-18.5	EUT Horz Low Ch.
9606.950	57.8	-3.6	1.9	86.0	3.0	0.0	Vert	PK	0.0	54.2	74.0	-19.8	EUT On Side Low Ch.
9606.875	57.2	-3.6	2.3	181.1	3.0	0.0	Vert	PK	0.0	53.6	74.0	-20.4	EUT Vert Low Ch.
9609.525	56.0	-3.6	3.4	106.1	3.0	0.0	Vert	PK	0.0	52.4	74.0	-21.6	EUT Horz Low Ch.
9606.933	51.8	-3.6	1.6	80.1	3.0	0.0	Horz	PK	0.0	48.2	74.0	-25.8	EUT Vert Low Ch.
12008.940	29.1	-1.1	1.9	261.0	3.0	0.0	Vert	AV	0.0	28.0	54.0	-26.0	EUT On Side Low Ch.
4801.692	41.1	6.6	1.0	358.9	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	EUT On Side Low Ch.
12008.580	28.7	-1.1	2.4	153.0	3.0	0.0	Horz	AV	0.0	27.6	54.0	-26.4	EUT Horz Low Ch.
4804.675	40.5	6.6	1.0	246.9	3.0	0.0	Horz	PK	0.0	47.1	74.0	-26.9	EUT Horz Low Ch.
12009.270	40.2	-1.1	1.9	261.0	3.0	0.0	Vert	PK	0.0	39.1	74.0	-34.9	EUT On Side Low Ch.
12009.840	39.9	-1.1	2.4	153.0	3.0	0.0	Horz	PK	0.0	38.8	74.0	-35.2	EUT Horz Low Ch.

FIELD STRENGTH OF FUNDAMENTAL



PSA-ESCI 2017.06.01

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

Transmitting BLE and PAS - low channel (2402 MHz), mid channel (2442 MHz) and high channel (2480 MHz)

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

INCN0008 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency 2400 MHz Stop Frequency 2483.5 MHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Cable	Element	Double Ridge Guide Horn Cables	MNV	2/16/2017	12 mo
Antenna - Double Ridge	ETS-Lindgren	3115	AJQ	11/14/2016	24 mo
Analyzer - Spectrum Analyzer	Agilent	E4440A	AAX	3/16/2017	12 mo

MEASUREMENT BANDWIDTHS

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

TEST DESCRIPTION

The antennas to be used with the EUT were tested. The EUT was transmitting and while set at the lowest channel, a middle channel, and the highest channel available. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna height and polarization, and manipulating the EUT and EUT antenna in 3 orthogonal planes.

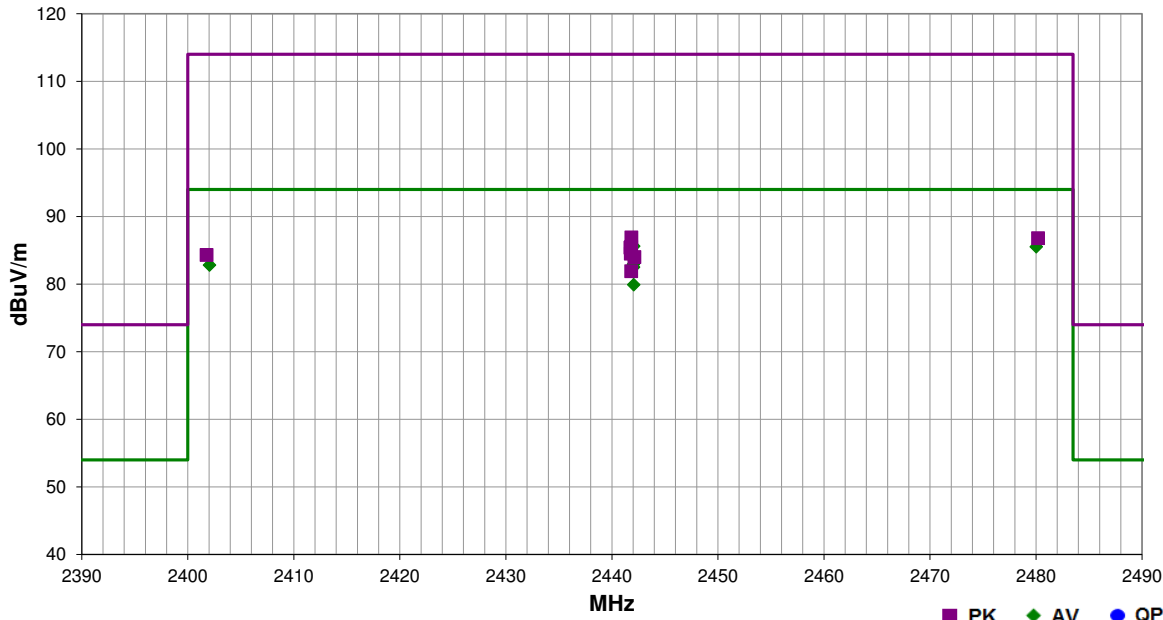
FIELD STRENGTH OF FUNDAMENTAL



Work Order:	INCN0008	Date:	09/11/17	<i>Dustin Sparks</i>
Project:	None	Temperature:	22.2 °C	
Job Site:	MN09	Humidity:	54.9% RH	
Serial Number:	17YD000053	Barometric Pres.:	1024 mbar	Tested by: Dustin Sparks
EUT:	Lumen 155			
Configuration:	2			
Customer:	IntriCon			
Attendees:	Andrew Albing			
EUT Power:	Battery			
Operating Mode:	Transmitting BLE and PAS - low channel (2402 MHz), mid channel (2442 MHz) and high channel (2480 MHz)			
Deviations:	None			
Comments:	None			

Test Specifications	Test Method
FCC 15.249:2017	ANSI C63.10:2013

Run #	9	Test Distance (m)	3	Antenna Height(s)	1 to 4(m)	Results	Pass
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Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2442.058	49.0	36.6	3.0	131.0	3.0	0.0	Horz	AV	0.0	85.6	94.0	-8.4	Mid ch, PAS, EUT on side
2480.033	48.7	36.8	2.9	95.0	3.0	0.0	Horz	AV	0.0	85.5	94.0	-8.5	High ch, PAS, EUT on side
2442.067	47.5	36.6	1.0	270.0	3.0	0.0	Vert	AV	0.0	84.1	94.0	-9.9	Mid ch, PAS, EUT horizontal
2442.058	47.4	36.6	3.1	48.0	3.0	0.0	Horz	AV	0.0	84.0	94.0	-10.0	Mid ch, PAS, EUT horizontal
2442.050	47.1	36.6	2.6	250.0	3.0	0.0	Vert	AV	0.0	83.7	94.0	-10.3	Mid ch, PAS, EUT vertical
2442.025	46.3	36.6	2.8	239.0	3.0	0.0	Horz	AV	0.0	82.9	94.0	-11.1	Mid ch, BLE, EUT on side
2402.050	46.5	36.3	3.3	196.0	3.0	0.0	Horz	AV	0.0	82.8	94.0	-11.2	Low ch, PAS, EUT on side
2442.042	45.9	36.6	3.3	171.0	3.0	0.0	Horz	AV	0.0	82.5	94.0	-11.5	Mid ch, PAS, EUT vertical
2442.067	43.3	36.6	1.0	58.0	3.0	0.0	Vert	AV	0.0	79.9	94.0	-14.1	Mid ch, PAS, EUT on side
2441.833	50.3	36.6	3.0	131.0	3.0	0.0	Horz	PK	0.0	86.9	114.0	-27.1	Mid ch, PAS, EUT on side
2480.192	50.0	36.8	2.9	95.0	3.0	0.0	Horz	PK	0.0	86.8	114.0	-27.2	High ch, PAS, EUT on side
2441.817	48.9	36.6	1.0	270.0	3.0	0.0	Vert	PK	0.0	85.5	114.0	-28.5	Mid ch, PAS, EUT horizontal
2441.750	48.8	36.6	3.1	48.0	3.0	0.0	Horz	PK	0.0	85.4	114.0	-28.6	Mid ch, PAS, EUT horizontal
2441.792	48.5	36.6	2.6	250.0	3.0	0.0	Vert	PK	0.0	85.1	114.0	-28.9	Mid ch, PAS, EUT vertical
2441.775	47.9	36.6	2.8	239.0	3.0	0.0	Horz	PK	0.0	84.5	114.0	-29.5	Mid ch, BLE, EUT on side
2401.767	48.0	36.3	3.3	196.0	3.0	0.0	Horz	PK	0.0	84.3	114.0	-29.7	Low ch, PAS, EUT on side
2442.117	47.4	36.6	3.3	171.0	3.0	0.0	Horz	PK	0.0	84.0	114.0	-30.0	Mid ch, PAS, EUT vertical
2441.808	45.3	36.6	1.0	58.0	3.0	0.0	Vert	PK	0.0	81.9	114.0	-32.1	Mid ch, PAS, EUT on side

DUTY CYCLE



TEST DESCRIPTION

The Duty Cycle (x) were measured for each of the EUT operating modes. The measurements were made using a zero span on the spectrum analyzer to see the pulses in the time domain. The transmit power was set to its default maximum. A direct connection was made between the RF output of the EUT and a spectrum analyzer. Attenuation and a DC block were used

The duty cycle was calculated by dividing the transmission pulse duration (T) by the total period of a single on and total off time.

The EUT operates at 100% Duty Cycle.