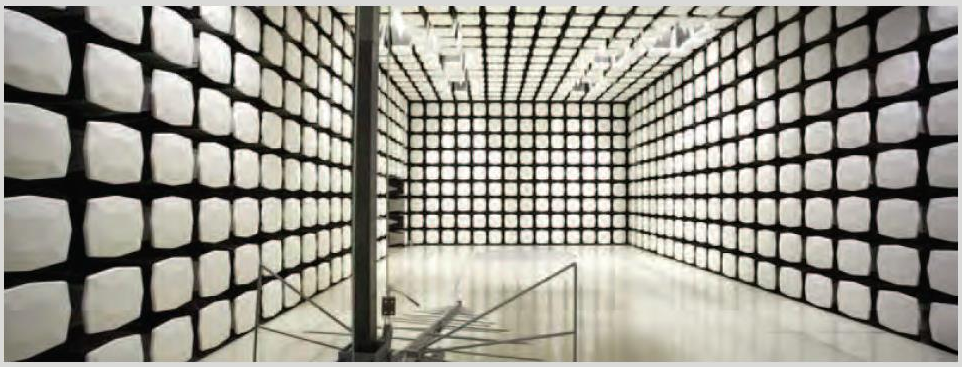
2333 Designs & Mfg.

LocatorX Rev A

FCC 15.247:2020
Bluetooth Low Energy

Report: 23DM0010.2, Issue Date: December 18, 2020



NVLAP LAB CODE: 200629-0

CERTIFICATE OF TEST

Last Date of Test: November 5, 2020
2333 Designs & Mfg.
EUT: LocatorX Rev A

Radio Equipment Testing

Standards

Specification	Method
FCC 15.247:2020	ANSI C63.10:2013, KDB 558074

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	No	N/A	Not required for a battery powered EUT.
11.6	Duty Cycle	Yes	Pass	
11.8.2	Occupied Bandwidth	Yes	Pass	
11.9.1.1	Output Power	Yes	Pass	
11.9.1.1	Equivalent Isotropic Radiated Power	Yes	Pass	
11.10.2	Power Spectral Density	Yes	Pass	
11.11	Band Edge Compliance	Yes	Pass	
11.11	Spurious Conducted Emissions	Yes	Pass	
11.12.1, 11.13.2, 6.5, 6.6	Spurious Radiated Emissions	Yes	Pass	

Deviations From Test Standards

None

Approved By:

Adam Bruno, 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. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing.

REVISION HISTORY

Revision Number	Description	Date (yyyy-mm-dd)	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) and as a CAB for the acceptance of test data.

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

MSIT / 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

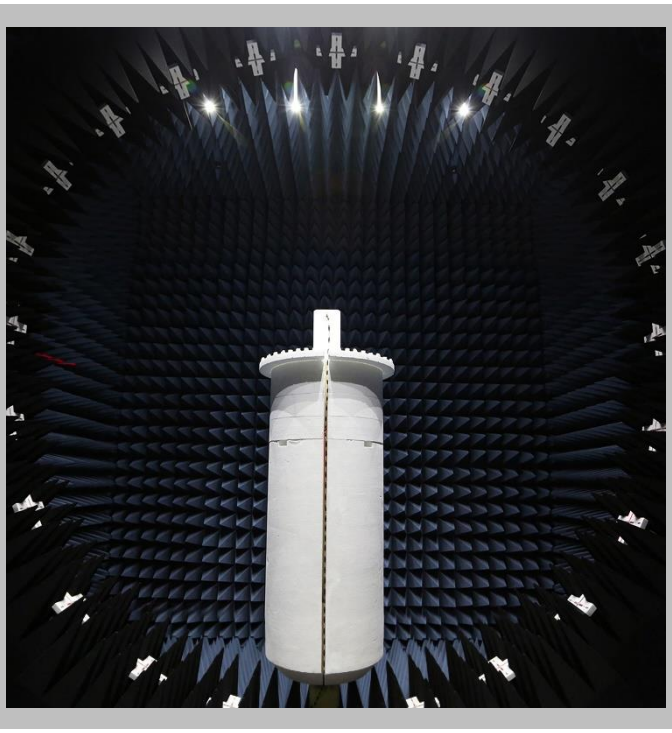
MIC – Recognized by MIC as a CAB for the acceptance of test data.

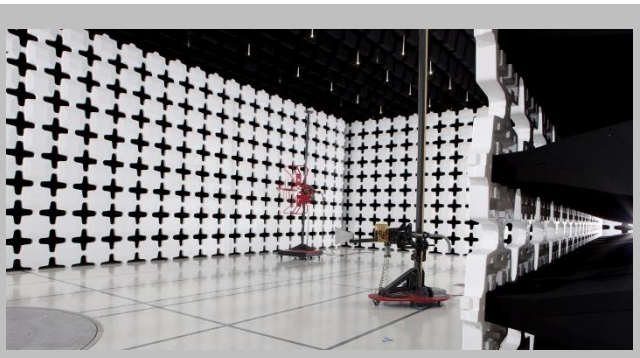
SCOPE

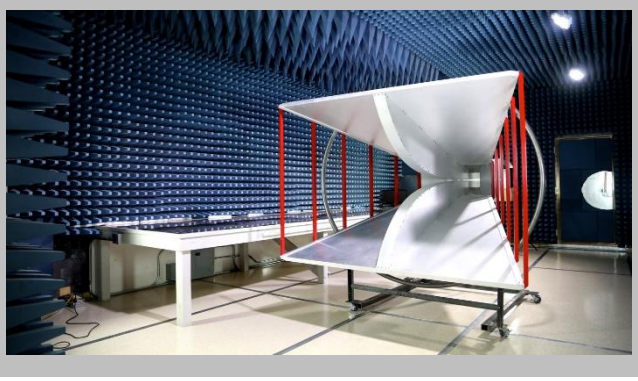
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

FACILITIES

California	Minnesota	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Labs NC01-05 19201 120th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP				
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	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	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157







MEASUREMENT UNCERTAINTY

element
TMU.2015.07.10

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.

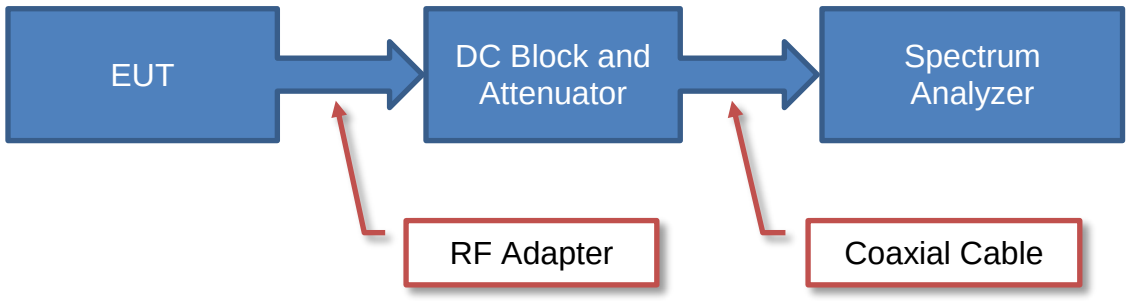
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable 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.

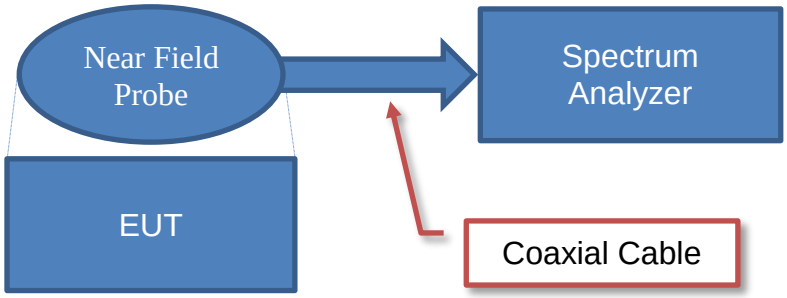
Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	2.6 dB	-2.6 dB

Test Setup Block Diagrams

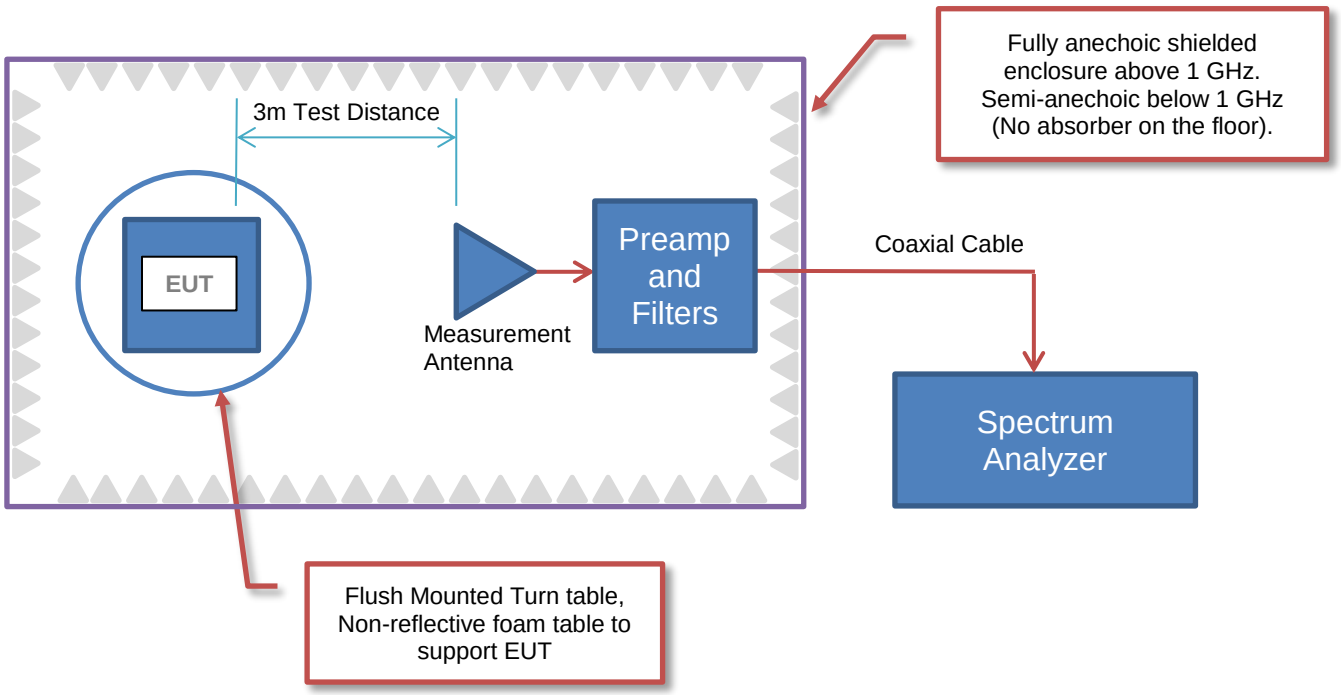
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	2333 Designs & Mfg.
Address:	32411 NE 134th St
City, State, Zip:	Duvall, WA 98019
Test Requested By:	Jeff Kriegbaum
EUT:	LocatorX Rev. A
First Date of Test:	October 12, 2020
Last Date of Test:	November 5, 2020
Receipt Date of Samples:	October 12, 2020
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
BLE enabled sensor. The LocatorX Rev. A employs a battery-powered Bluetooth Low Energy 5.1 radio that operates at 1 Mbps only. To enable operation over the duration of testing, individual samples were programmed to single channels.

Testing Objective:
To demonstrate compliance of the Bluetooth Low Energy radio to FCC 15.247 requirements.

CONFIGURATIONS

Configuration 23DM0010- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
LocatorX BLE	2333 Designs & Mfg.	Rev. A	#1
LocatorX BLE	2333 Designs & Mfg.	Rev. A	#2
LocatorX BLE	2333 Designs & Mfg.	Rev. A	#3

Configuration 23DM0010- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
LocatorX BLE	2333 Designs & Mfg.	Rev. A	Low Channel
LocatorX BLE	2333 Designs & Mfg.	Rev. A	Mid Channel
LocatorX BLE	2333 Designs & Mfg.	Rev. A	High Channel

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2020-10-12	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	2020-11-05	Occupied Bandwidth	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
3	2020-11-05	Output Power	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
4	2020-11-05	Equivalent Isotropic Radiated Power	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
5	2020-11-05	Power Spectral Density	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
6	2020-11-05	Band Edge Compliance	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
7	2020-11-05	Spurious Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

POWER SETTINGS AND ANTENNAS

The power settings, antenna gain value(s) and cable loss (if applicable) used for the testing contained in this report were provided by the customer and will affect the validity of the results. Element assumes no responsibility for the accuracy of this information.

ANTENNA GAIN (dBi)

Type	Provided by:	Frequency Range (MHz)	Gain (dBi)
F Type	Dialog	2328 – 2.685	0

No adjustable power settings were provided. The EUT was tested using power settings pre-defined by the manufacturer.

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.

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.

OCCUPIED BANDWIDTH

XMit 2020.03.25.0

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.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Weinschel Corp.	7006	AMS	17-Jan-20	17-Jan-21
Attenuator	Weinschel	54A-20	TYR	17-Jan-20	17-Jan-21
Cable	Micro-Coax	D150A-1-0720-200	NCS	17-Jan-20	17-Jan-21
Generator - Signal	Agilent	E4422B	TGR	11-Aug-20	11-Aug-23
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	25-Jun-20	25-Jun-21

TEST DESCRIPTION

The EUT was set to the channels and modes listed in the datasheet.

The 6dB occupied bandwidth was measured using 100 kHz resolution bandwidth and 300 kHz video bandwidth. The 99.0% occupied bandwidth was also measured at the same time which can be needed during Output Power depending on the applicable method.

OCCUPIED BANDWIDTH

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	LocatorX Rev A			**Work Order:**	23DM0010
Serial Number:	See configurations			**Date:**	5-Nov-20
Customer:	2333 Designs & Mfg.			**Temperature:**	21.9 °C
Attendees:	None			**Humidity:**	52.4% RH
Project:	None			**Barometric Pres.:**	1021 mbar
Tested by:	Brian Fahey	**Power:**	3 VDC via Battery	**Job Site:**	NC0A

TEST SPECIFICATIONS	Test Method
FCC 15.247:2020	ANSI C63.10:2013

COMMENTS

Reference level offset includes RF measurement cable, 20 dB attenuator, and DC Block.

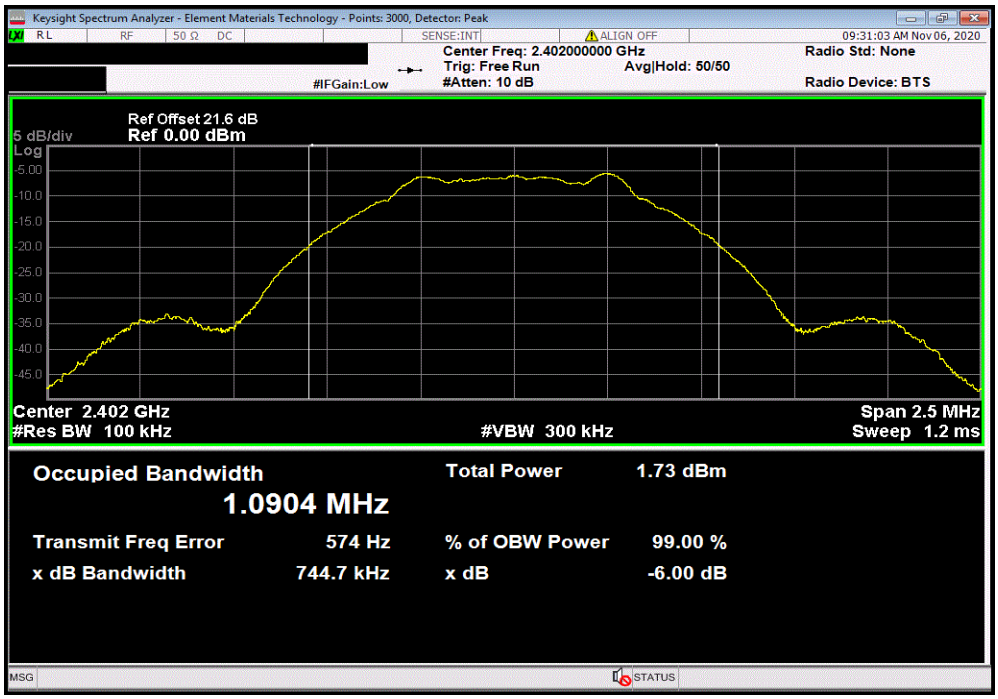
DEVIATIONS FROM TEST STANDARD

None

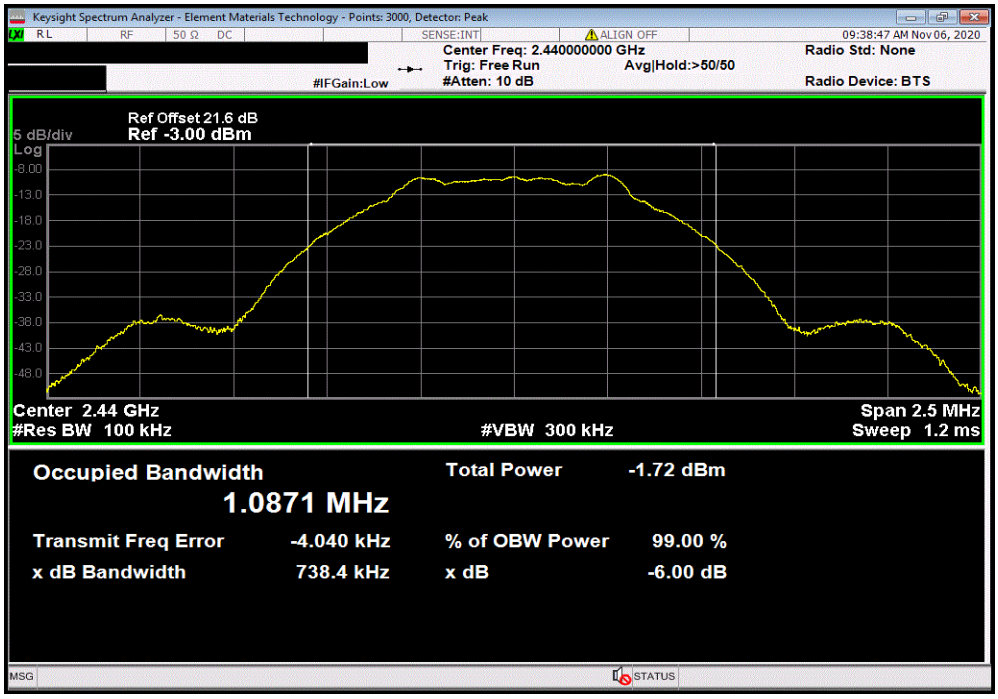
Configuration #	2	Signature

	Value	Limit (≥)	Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	744.732 kHz	500 kHz	Pass
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz	738.434 kHz	500 kHz	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	748.412 kHz	500 kHz	Pass

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Value	Limit (≥)	Result
				744.732 kHz	500 kHz	Pass



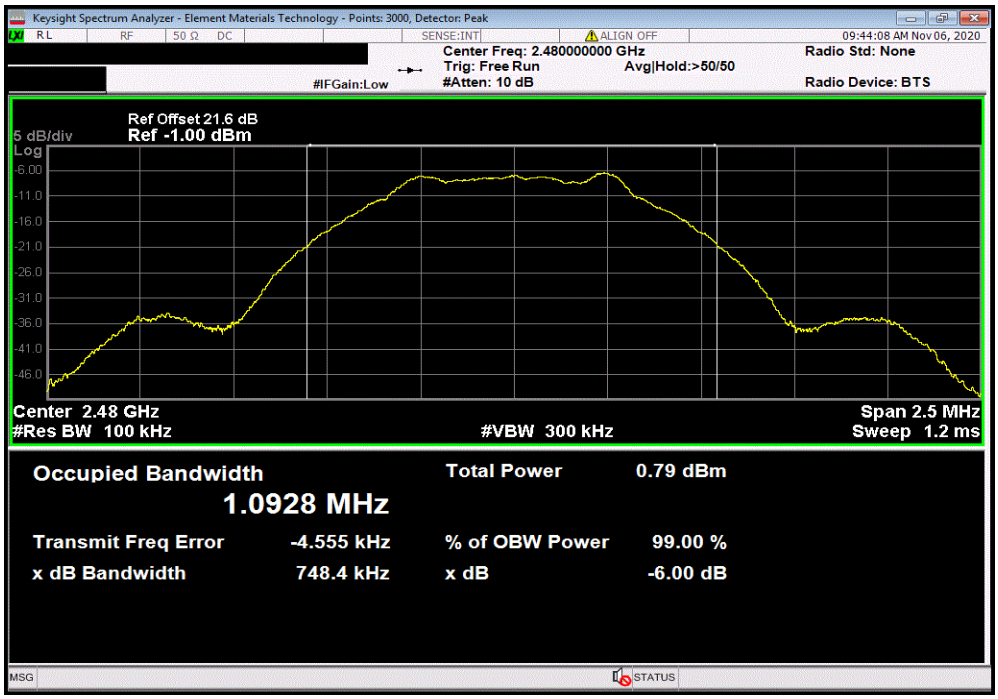
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz						
				Value	Limit (≥)	Result
				738.434 kHz	500 kHz	Pass



OCCUPIED BANDWIDTH

TbtTx 2019.08.30.0 XMit 2020.03.25.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Value	Limit (≥)	Result
				748.412 kHz	500 kHz	Pass



OUTPUT POWER

XMit 2020.03.25.0

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.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Weinschel Corp.	7006	AMS	17-Jan-20	17-Jan-21
Attenuator	Weinschel	54A-20	TYR	17-Jan-20	17-Jan-21
Cable	Micro-Coax	UFD150A-1-0720-200200	NCS	17-Jan-20	17-Jan-21
Generator - Signal	Agilent	E4422B	TGR	11-Aug-20	11-Aug-23
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	25-Jun-20	25-Jun-21

TEST DESCRIPTION

The transmit frequency was set to the required channels in each band. The transmit power was set to its default maximum.

Prior to measuring peak transmit power the DTS bandwidth (B) was measured.

The method found in ANSI C63.10:2013 Section 11.9.1.1 was used because the RBW on the analyzer was greater than the DTS Bandwidth of the radio.

OUTPUT POWER

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	LocatorX Rev A			**Work Order:**	23DM0010
Serial Number:	See configurations			**Date:**	5-Nov-20
Customer:	2333 Designs & Mfg.			**Temperature:**	21.9 °C
Attendees:	None			**Humidity:**	52.2% RH
Project:	None			**Barometric Pres.:**	1021 mbar
Tested by:	Brian Fahey	**Power:**	3 VDC via Battery	**Job Site:**	NC0A

TEST SPECIFICATIONS	Test Method
FCC 15.247:2020	ANSI C63.10:2013

COMMENTS

Reference level offset includes RF measurement cable, 20 dB attenuator, and DC Block.

DEVIATIONS FROM TEST STANDARD

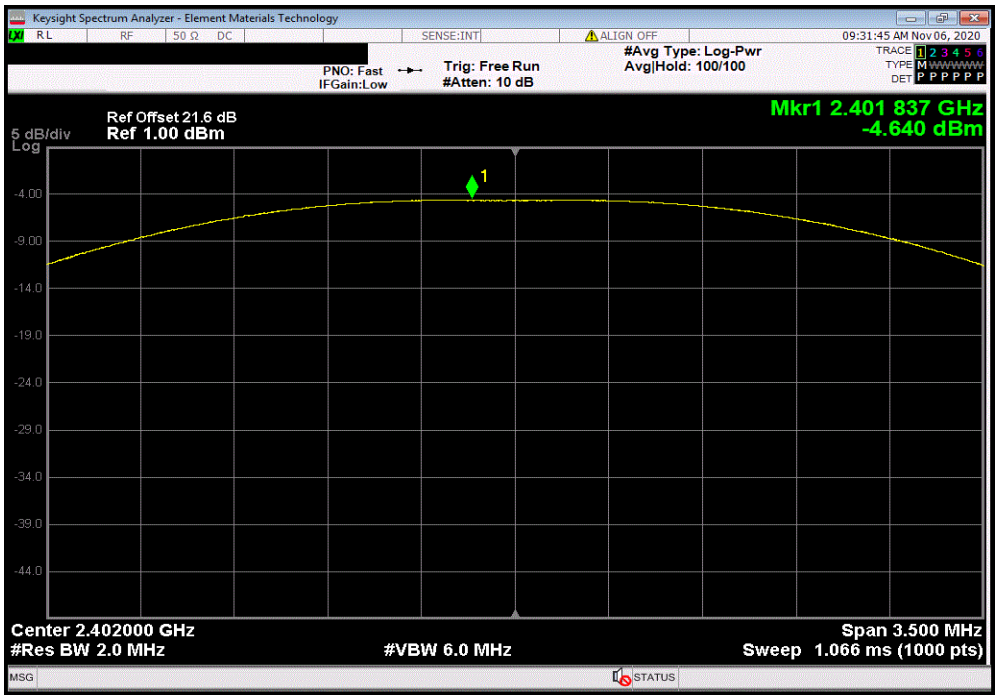
None

Configuration #	2	Signature

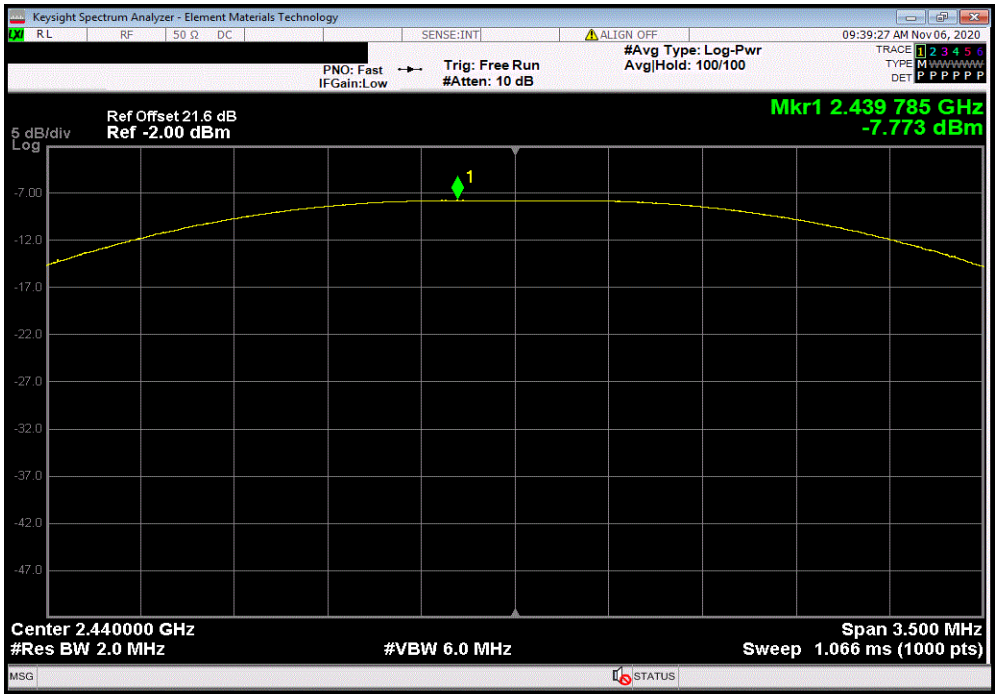
	Out Pwr (dBm)	Limit (dBm)	Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	-4.64	30	Pass
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz	-7.773	30	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	-5.589	30	Pass

OUTPUT POWER

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-4.64	30	Pass

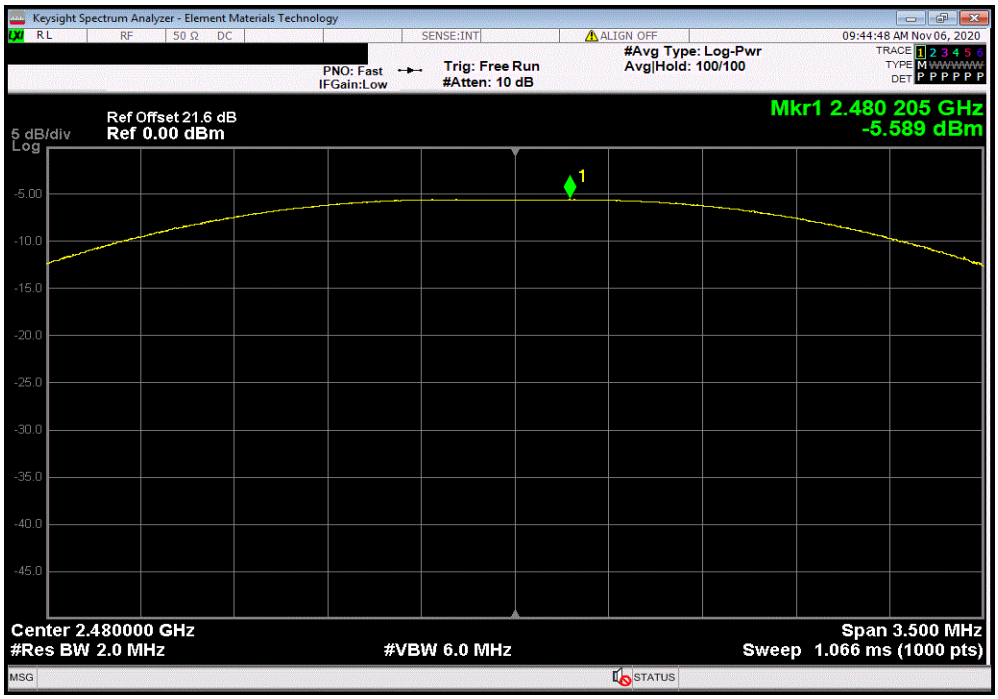


BLE/GFSK 1 Mbps Mid Channel, 2440 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-7.773	30	Pass



OUTPUT POWER

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-5.589	30	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

XMit 2020.03.25.0

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TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Weinschel Corp.	7006	AMS	17-Jan-20	17-Jan-21
Attenuator	Weinschel	54A-20	TYR	17-Jan-20	17-Jan-21
Cable	Micro-Coax	UFD150A-1-0720-200200	NCS	17-Jan-20	17-Jan-21
Generator - Signal	Agilent	E4422B	TGR	11-Aug-20	11-Aug-23
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	25-Jun-20	25-Jun-21

TEST DESCRIPTION

The transmit frequency was set to the required channels in each band. The transmit power was set to its default maximum.

Prior to measuring peak transmit power the DTS bandwidth (B) was measured.

The method found in ANSI C63.10:2013 Section 11.9.1.1 was used because the RBW on the analyzer was greater than the DTS Bandwidth of the radio.

Equivalent Isotropic Radiated Power (EIRP) = Max Measured Power + Antenna gain (dBi)

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	LocatorX Rev A			**Work Order:**	23DM0010
Serial Number:	See configurations			**Date:**	5-Nov-20
Customer:	2333 Designs & Mfg.			**Temperature:**	21.9 °C
Attendees:	None			**Humidity:**	52.4% RH
Project:	None			**Barometric Pres.:**	1021 mbar
Tested by:	Brian Fahey	**Power:**	3 VDC via Battery	**Job Site:**	NC0A

TEST SPECIFICATIONS	Test Method
FCC 15.247:2020	ANSI C63.10:2013

COMMENTS

Reference level offset includes RF measurement cable, 20 dB attenuator, and DC Block.

DEVIATIONS FROM TEST STANDARD

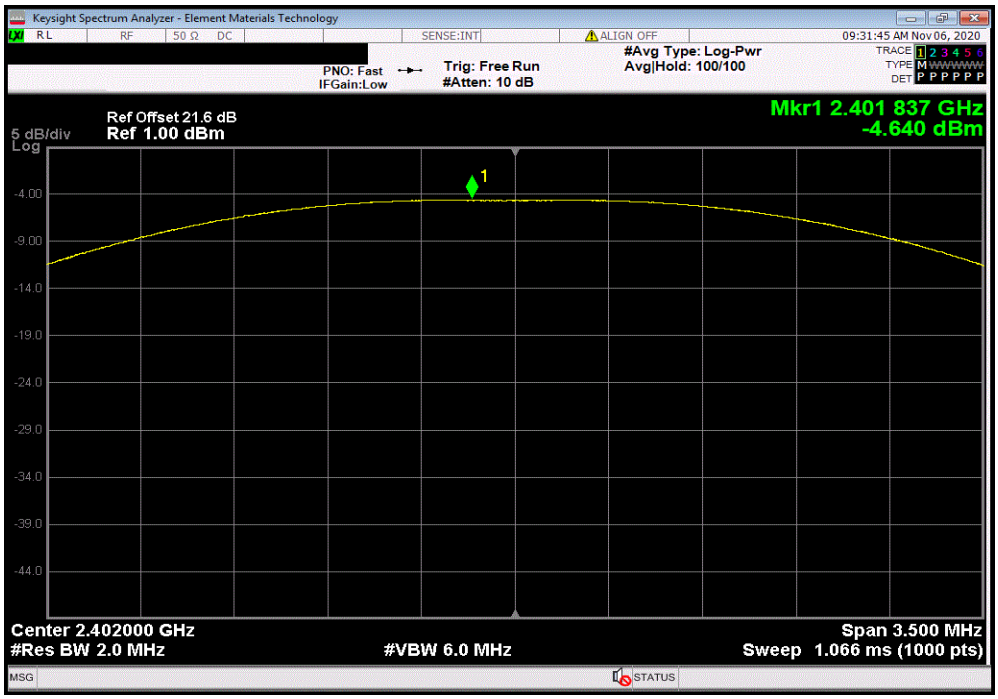
None

Configuration #	2	Signature

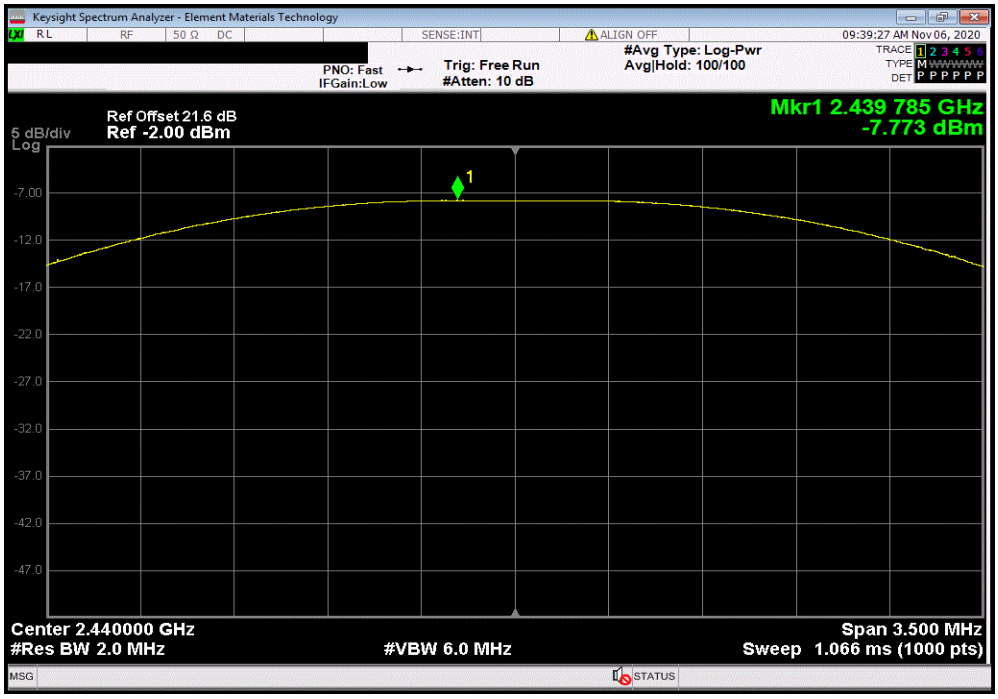
	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	-4.64	0	-4.64	36	Pass
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz	-7.773	0	-7.773	36	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	-5.589	0	-5.589	36	Pass

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-4.64	0	-4.64	36	Pass

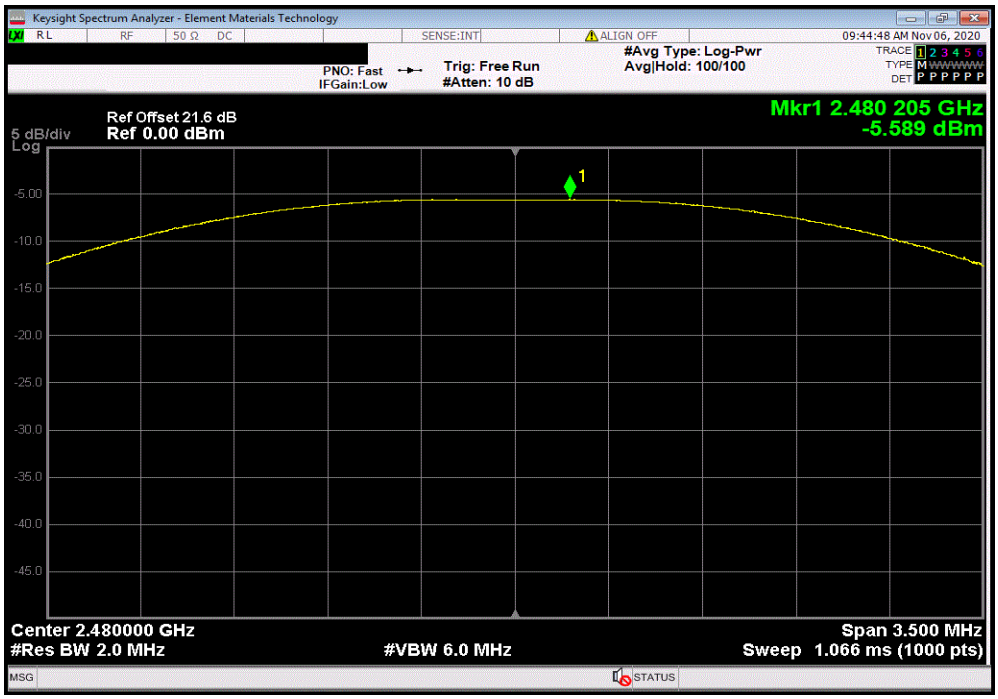


BLE/GFSK 1 Mbps Mid Channel, 2440 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-7.773	0	-7.773	36	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-5.589	0	-5.589	36	Pass



POWER SPECTRAL DENSITY

XMit 2020.03.25.0

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.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Weinschel Corp.	7006	AMS	17-Jan-20	17-Jan-21
Attenuator	Weinschel	54A-20	TYR	17-Jan-20	17-Jan-21
Cable	Micro-Coax	UFD150A-1-0720-200200	NCS	17-Jan-20	17-Jan-21
Generator - Signal	Agilent	E4422B	TGR	11-Aug-20	11-Aug-23
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	25-Jun-20	25-Jun-21

TEST DESCRIPTION

The maximum power spectral density measurements was measured using the channels and modes as called out on the following data sheets.

Per the procedure outlined in ANSI C63.10 the peak power spectral density was measured in a 3 kHz RBW.

POWER SPECTRAL DENSITY

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	LocatorX Rev A			**Work Order:**	23DM0010
Serial Number:	See configurations			**Date:**	5-Nov-20
Customer:	2333 Designs & Mfg.			**Temperature:**	21.9 °C
Attendees:	None			**Humidity:**	52.2% RH
Project:	None			**Barometric Pres.:**	1021 mbar
Tested by:	Brian Fahey	**Power:**	3 VDC via Battery	**Job Site:**	NC0A

TEST SPECIFICATIONS	Test Method
FCC 15.247:2020	ANSI C63.10:2013

COMMENTS

Reference level offset includes RF measurement cable, 20 dB attenuator, and DC Block.

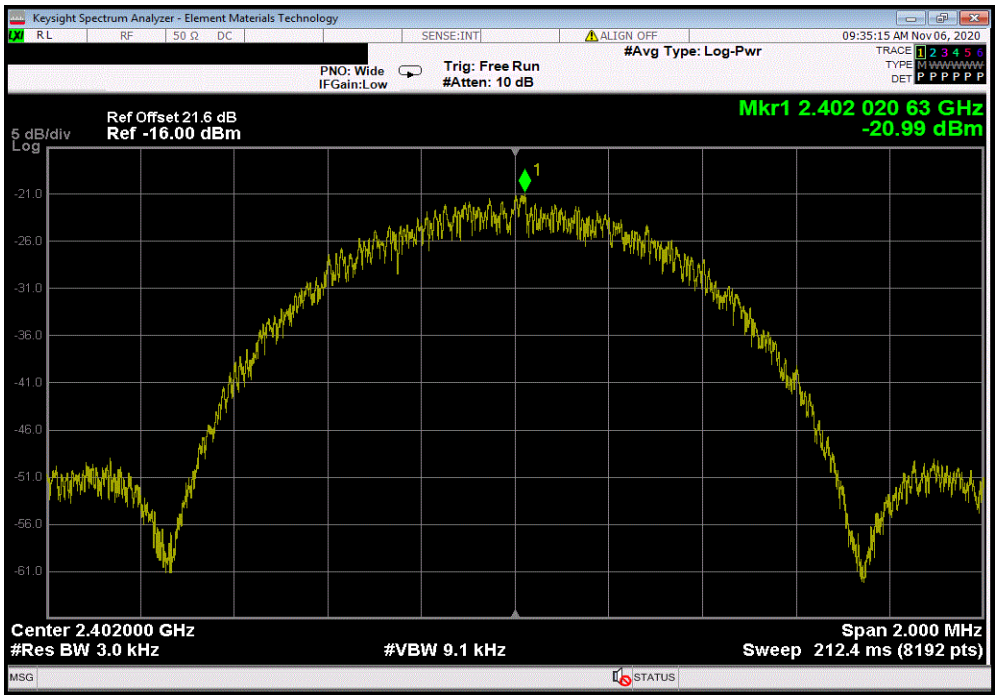
DEVIATIONS FROM TEST STANDARD

None

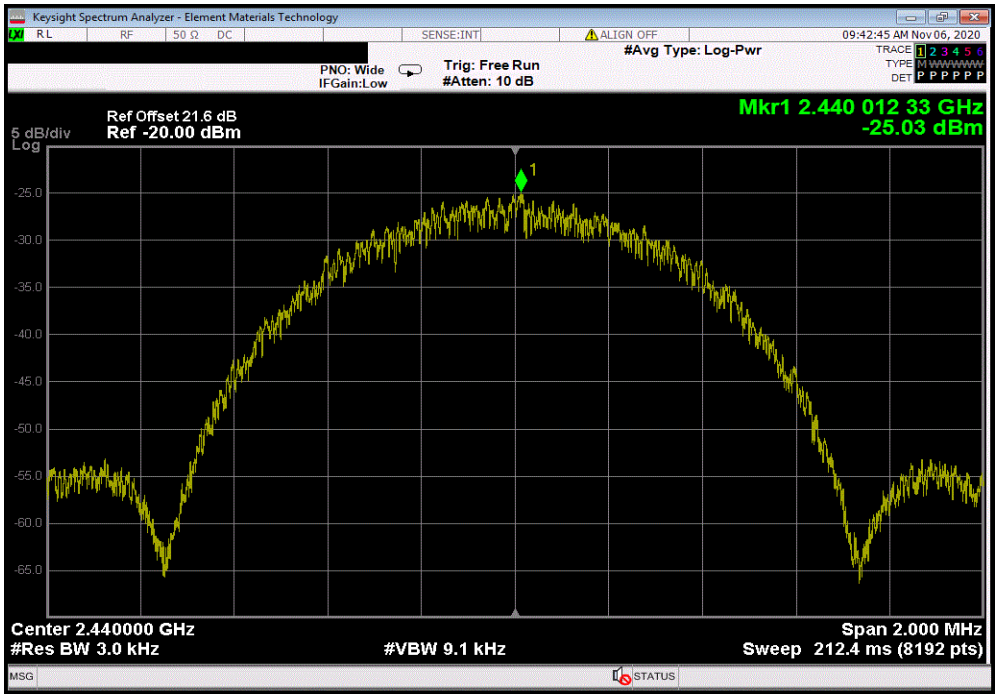
Configuration #	2	Signature

	Value dBm/3kHz	Limit < dBm/3kHz	Results
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	-20.985	8	Pass
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz	-25.025	8	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	-21.646	8	Pass

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-20.985	8	Pass

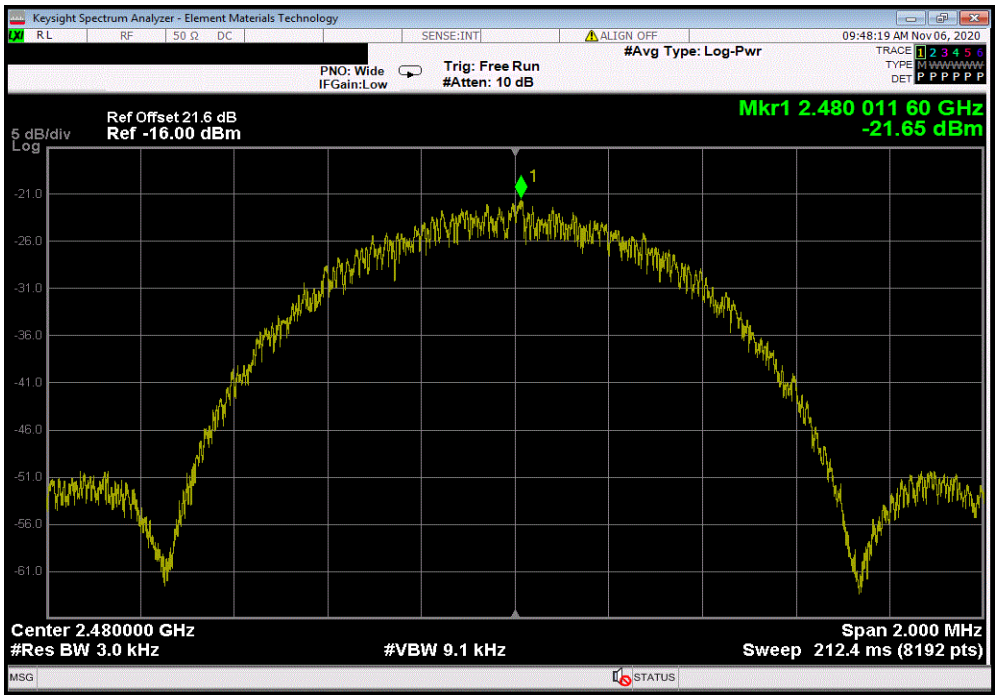


BLE/GFSK 1 Mbps Mid Channel, 2440 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-25.025	8	Pass



POWER SPECTRAL DENSITY

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-21.646	8	Pass



BAND EDGE COMPLIANCE

XMit 2020.03.25.0

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.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Weinschel Corp.	7006	AMS	17-Jan-20	17-Jan-21
Attenuator	Weinschel	54A-20	TYR	17-Jan-20	17-Jan-21
Cable	Micro-Coax	UFD150A-1-0720-200200	NCS	17-Jan-20	17-Jan-21
Generator - Signal	Agilent	E4422B	TGR	11-Aug-20	11-Aug-23
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	25-Jun-20	25-Jun-21

TEST DESCRIPTION

The spurious RF conducted emissions at the edges of the authorized bands were measured with the EUT set to low and high transmit frequencies in each available band. The channels closest to the band edges were selected. The EUT was transmitting at the data rate(s) listed in the datasheet.

The spectrum was scanned below the lower band edge and above the higher band edge.

BAND EDGE COMPLIANCE

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	LocatorX Rev A			Work Order:	23DM0010
Serial Number:	See configurations			Date:	5-Nov-20
Customer:	2333 Designs & Mfg.			Temperature:	21.9 °C
Attendees:	None			Humidity:	52.8% RH
Project:	None			Barometric Pres.:	1020 mbar
Tested by:	Brian Fahey	Power:	3 VDC via Battery	Job Site:	NC0A

TEST SPECIFICATIONS	Test Method
FCC 15.247:2020	ANSI C63.10:2013

COMMENTS

Reference level offset includes RF measurement cable, 20 dB attenuator, and DC Block.

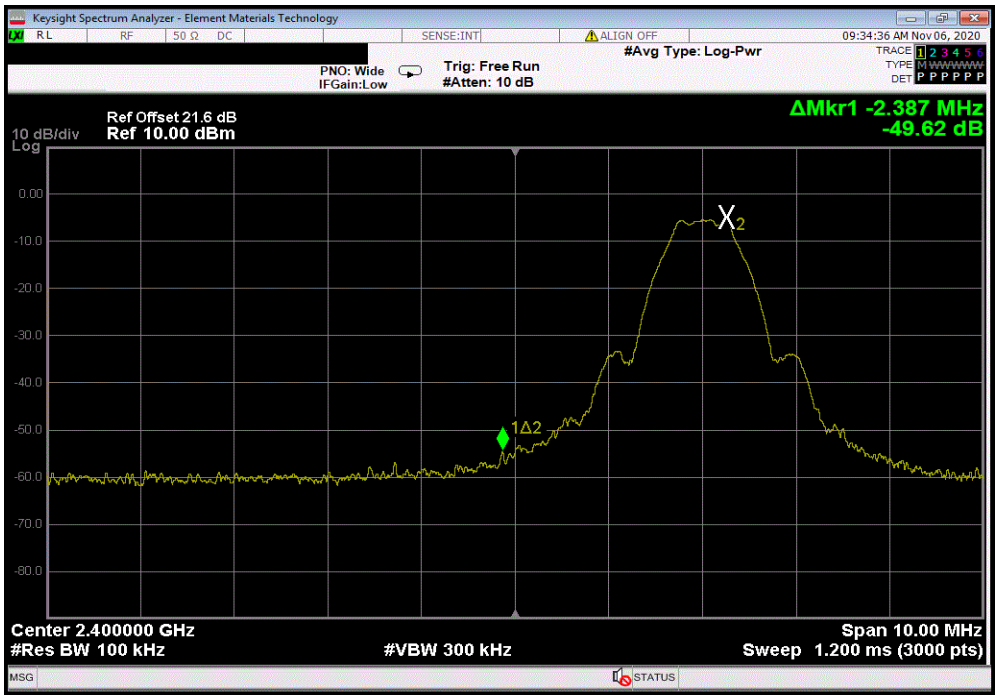
DEVIATIONS FROM TEST STANDARD

None

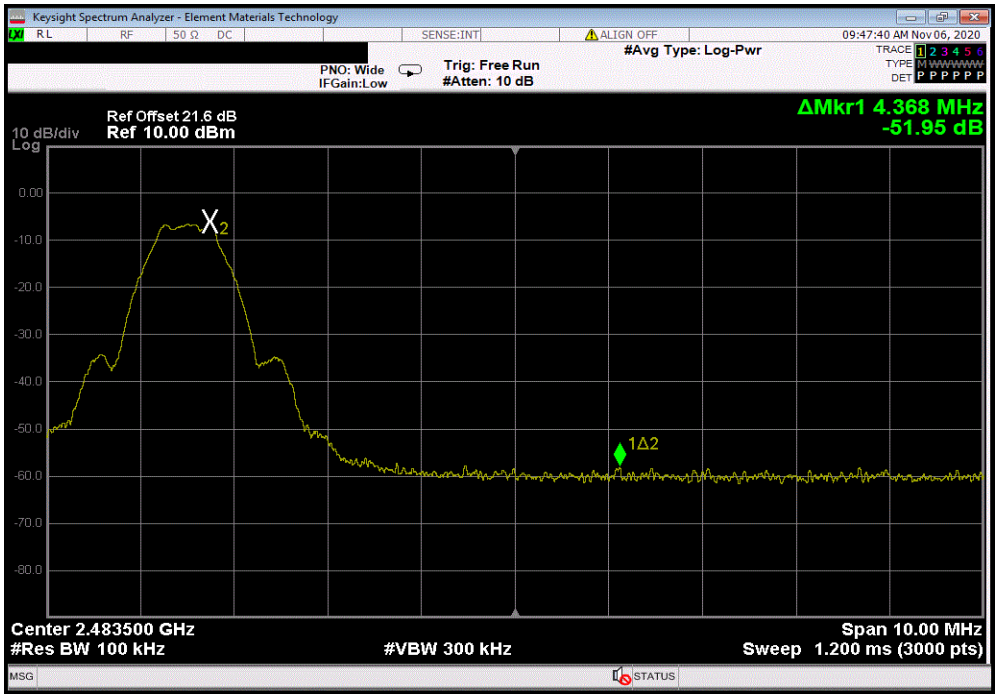
Configuration #	2	Signature

	Value (dBc)	Limit ≤ (dBc)	Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	-49.62	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	-51.95	-20	Pass

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-49.62	-20	Pass



BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-51.95	-20	Pass



SPURIOUS CONDUCTED EMISSIONS

XMit 2020.03.25.0

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.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Weinschel Corp.	7006	AMS	17-Jan-20	17-Jan-21
Attenuator	Weinschel	54A-20	TYR	17-Jan-20	17-Jan-21
Cable	Micro-Coax	UFD150A-1-0720-200200	NCS	17-Jan-20	17-Jan-21
Generator - Signal	Agilent	E4422B	TGR	11-Aug-20	11-Aug-23
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	25-Jun-20	25-Jun-21

TEST DESCRIPTION

The spurious RF conducted emissions were measured with the EUT set to low, medium and high transmit frequencies. The EUT was transmitting at the data rate(s) listed in the datasheet. For each transmit frequency, the spectrum was scanned throughout the specified frequency range.

SPURIOUS CONDUCTED EMISSIONS

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	LocatorX Rev A			**Work Order:**	23DM0010
Serial Number:	See configurations			**Date:**	5-Nov-20
Customer:	2333 Designs & Mfg.			**Temperature:**	21.9 °C
Attendees:	None			**Humidity:**	52.2% RH
Project:	None			**Barometric Pres.:**	1021 mbar
Tested by:	Brian Fahey	**Power:**	3 VDC via Battery	**Job Site:**	NC0A

TEST SPECIFICATIONS	Test Method
FCC 15.247:2020	ANSI C63.10:2013

COMMENTS

Reference level offset includes RF measurement cable, 20 dB attenuator, and DC Block.

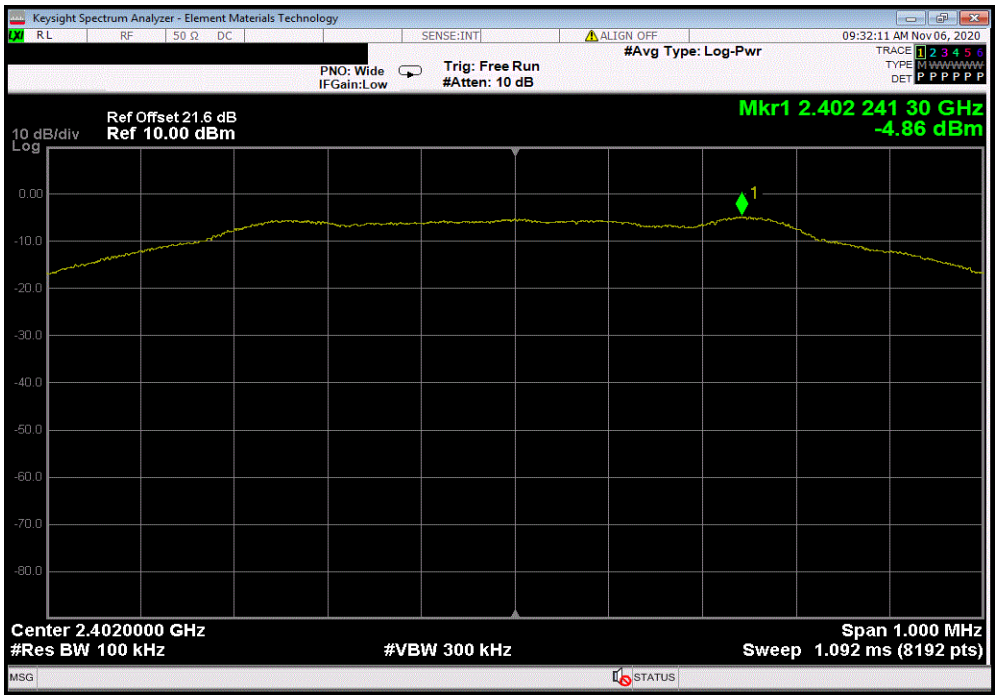
DEVIATIONS FROM TEST STANDARD

None

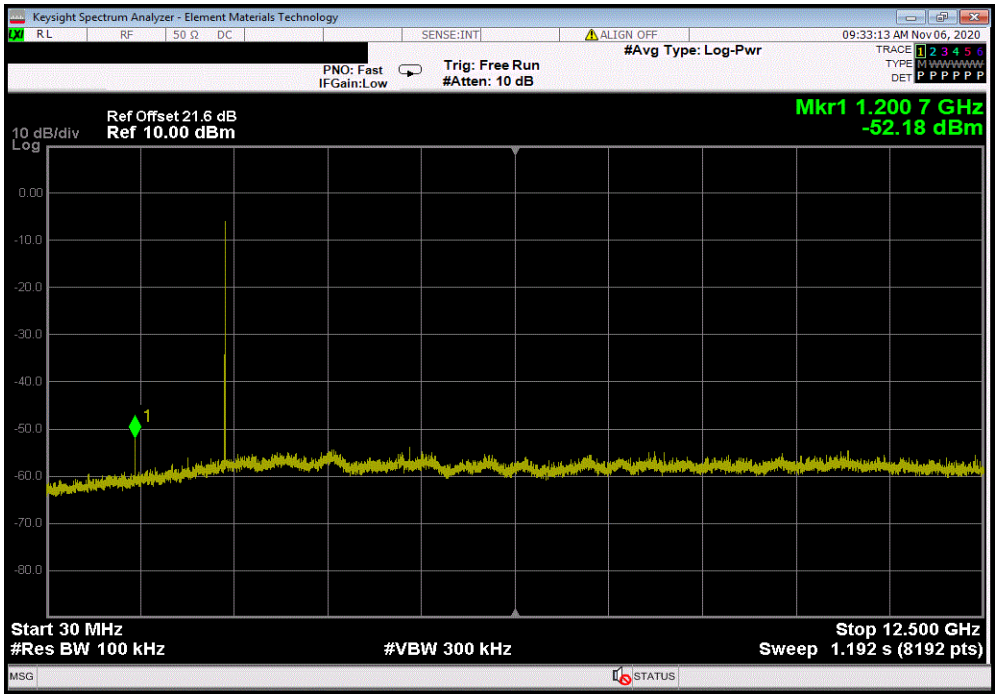
Configuration #	2	Signature

	Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	Fundamental	2402.24	N/A	N/A	N/A
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	30 MHz - 12.5 GHz	1200.73	-47.33	-20	Pass
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	12.5 GHz - 25 GHz	23908.86	-45.75	-20	Pass
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz	Fundamental	2440.25	N/A	N/A	N/A
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz	30 MHz - 12.5 GHz	1220.52	-42.76	-20	Pass
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz	12.5 GHz - 25 GHz	23716.58	-43.22	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	Fundamental	2480.24	N/A	N/A	N/A
BLE/GFSK 1 Mbps High Channel, 2480 MHz	30 MHz - 12.5 GHz	1240.31	-44.57	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	12.5 GHz - 25 GHz	24035.53	-45.73	-20	Pass

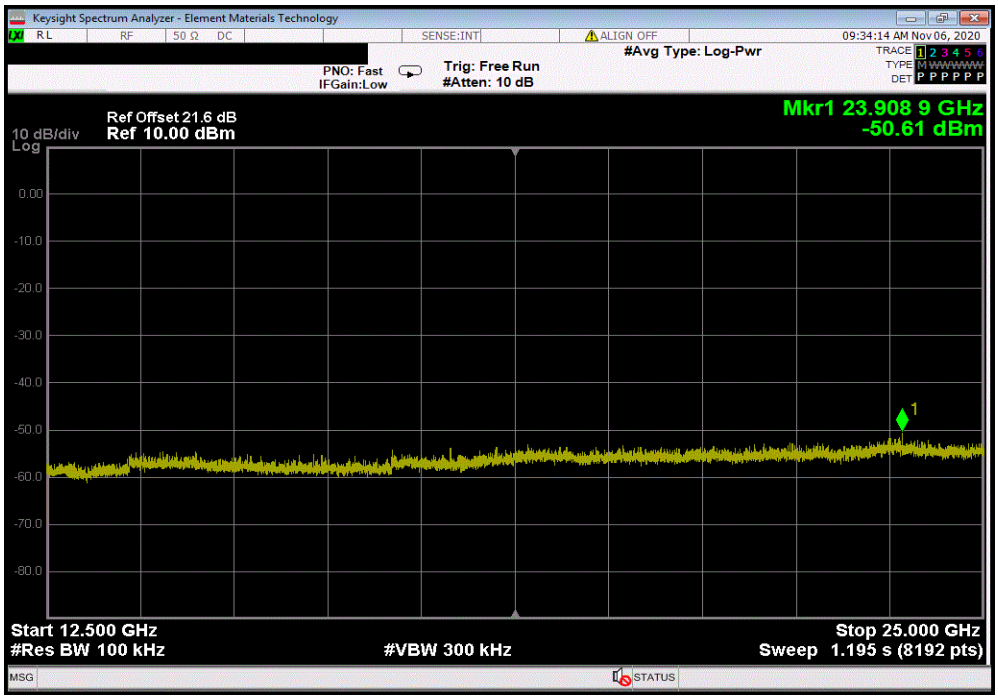
BLE/GFSK 1 Mbps Low Channel, 2402 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2402.24	N/A	N/A	N/A



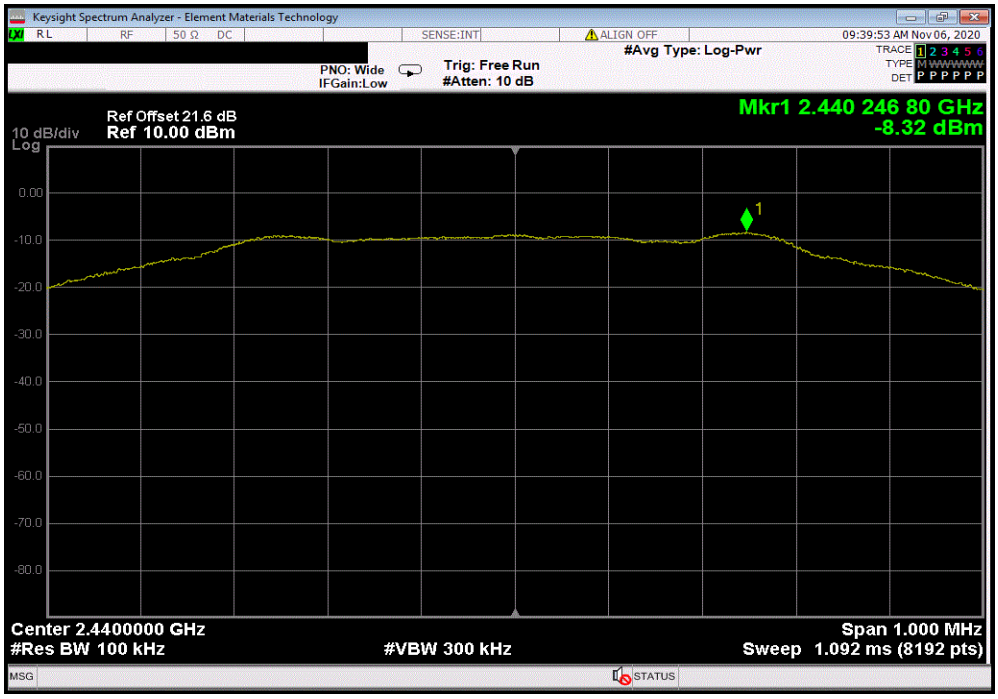
BLE/GFSK 1 Mbps Low Channel, 2402 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	1200.73	-47.33	-20	Pass



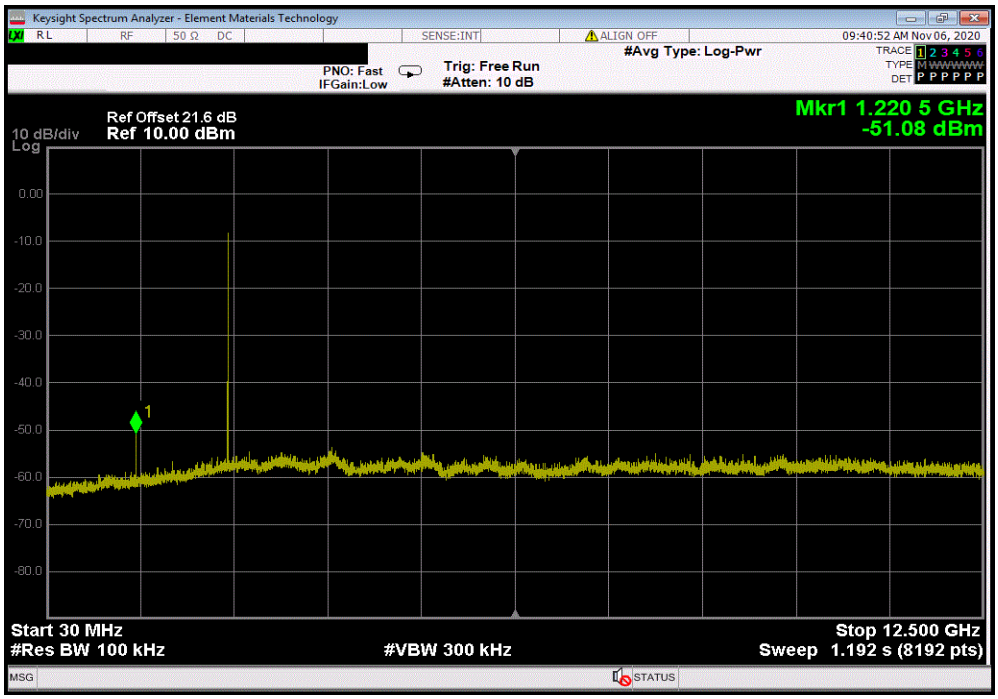
BLE/GFSK 1 Mbps Low Channel, 2402 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	23908.86	-45.75	-20	Pass



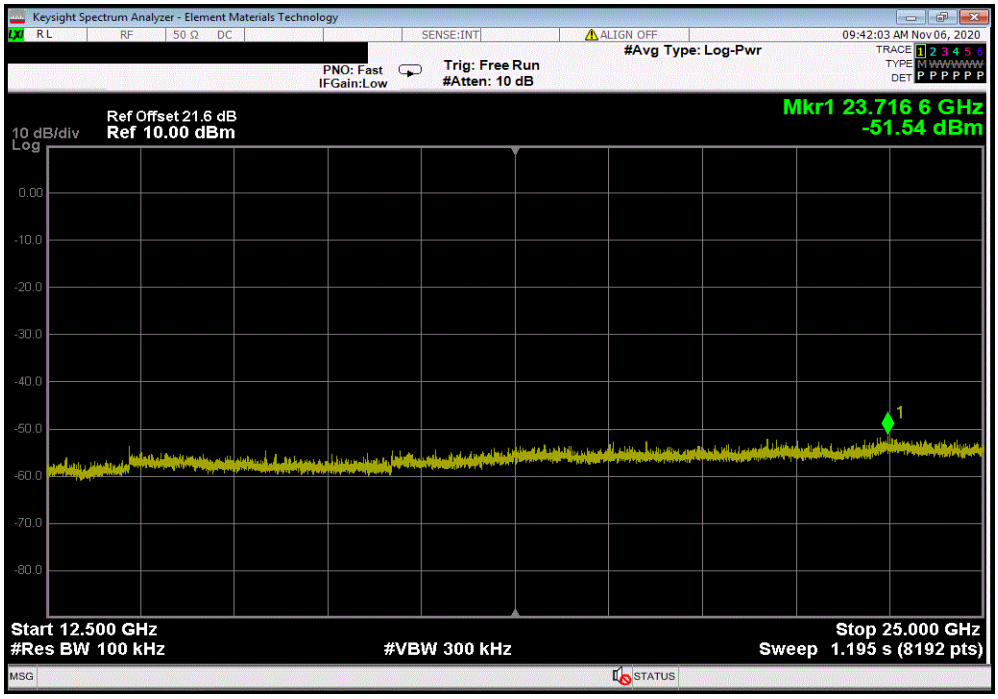
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2440.25	N/A	N/A	N/A



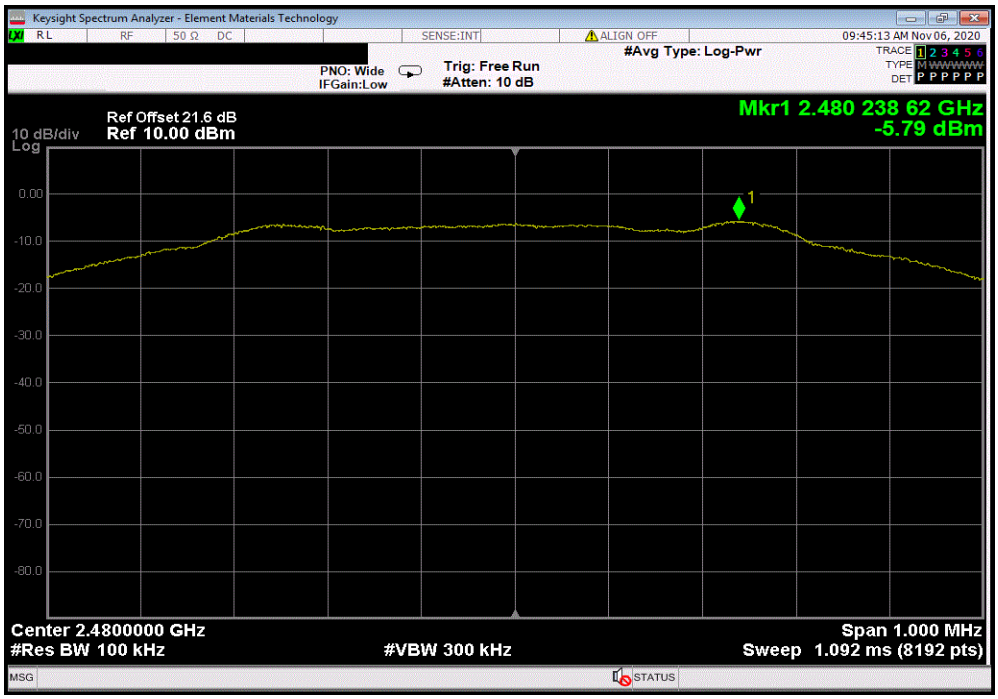
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	1220.52	-42.76	-20	Pass



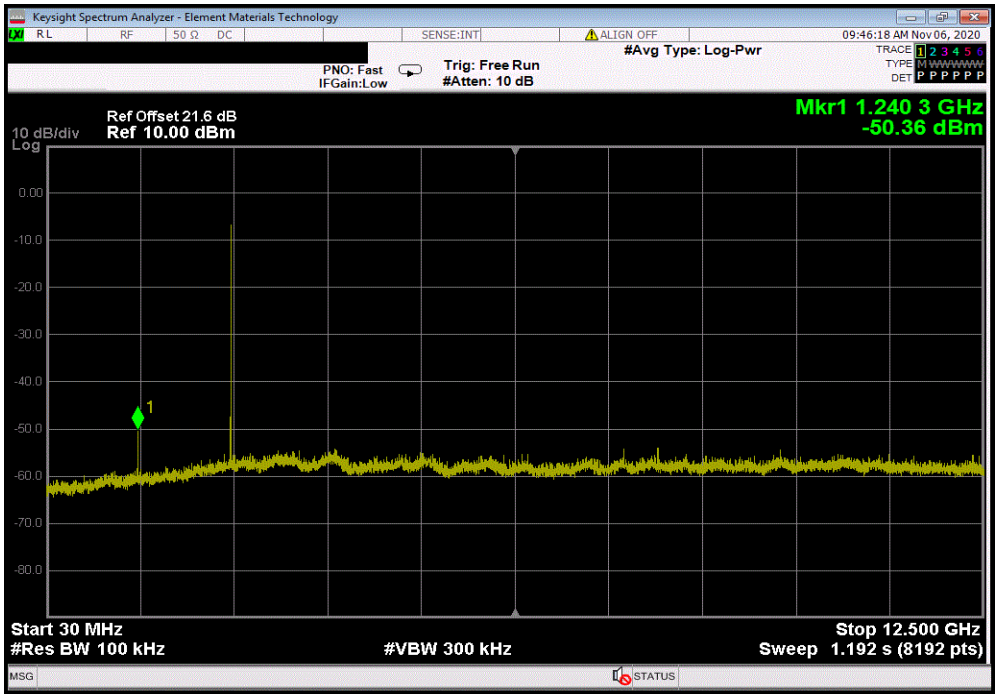
BLE/GFSK 1 Mbps Mid Channel, 2440 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	23716.58	-43.22	-20	Pass



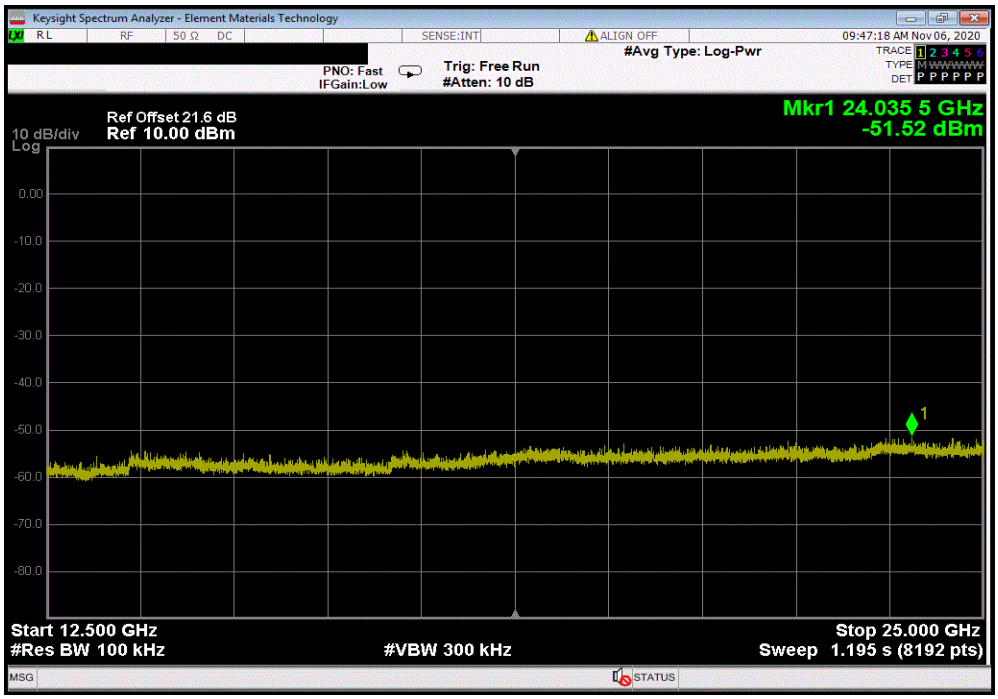
BLE/GFSK 1 Mbps High Channel, 2480 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2480.24	N/A	N/A	N/A



BLE/GFSK 1 Mbps High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	1240.31	-44.57	-20	Pass



BLE/GFSK 1 Mbps High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	24035.53	-45.73	-20	Pass



SPURIOUS RADIATED EMISSIONS

element

PSA-ESCI 2020.06.24.2

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

BTLE Tx, GFSK, 1 Mbps, 100% Duty Cycle, Low Channel = 2402 MHz, High Channel = 2480 MHz.
BTLE Tx, GFSK, 1 Mbps, 100% Duty Cycle, Low Channel = 2402 MHz, Mid Channel = 2440 MHz, High Channel = 2480 MHz.

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

23DM0010 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	26 GHz

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	Northwest EMC	N/A	NC8	2020-02-07	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AOD	2020-02-07	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AIY	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AOJ	2020-08-26	12 mo
Antenna - Standard Gain	EMCO	3160-08	AHO	NCR	0 mo
Cable	High Speed Interconnects	EW292A-NGNG-300	NC3	2020-08-28	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AOK	2020-08-26	12 mo
Antenna - Standard Gain	EMCO	3160-07	AHP	NCR	0 mo
Filter - High Pass	Micro-Tronics	HPM50111	HHI	2020-09-25	12 mo
Attenuator	Fairview Microwave	SA18E-20	AQV	2020-07-28	12 mo
Cable	Northwest EMC	3115 Horn Cable	NC2	2020-04-20	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVZ	2020-04-20	12 mo
Antenna - Double Ridge	EMCO	3115	AHM	2020-07-01	24 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	PAB	2020-01-28	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AYL	2019-09-25	24 mo
Cable	Northwest EMC	Bilog Cables	NC1	2020-01-28	12 mo
Filter - Low Pass	Micro-Tronics	LPM50004	LFF	2019-11-08	12 mo
Analyzer - Spectrum Analyzer	Agilent	E4440A	AAX	2020-04-15	12 mo

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 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 if required, 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 as well as the restricted band requirements.

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

Measurements within 2 MHz of the allowable band may have been taken using the integration method from ANSI C63.10 clause 11.13.3. This procedure uses the channel power feature of the spectrum analyzer to integrate the power of the emission within a 1 MHz bandwidth.

Where the radio test software does not provide for a duty cycle at continuous transmit conditions (> 98%) and the RMS (power average) measurements were made across the on and off times of the EUT transmissions, a duty cycle correction is added to the measurements using the formula of 10*log(1/dc).

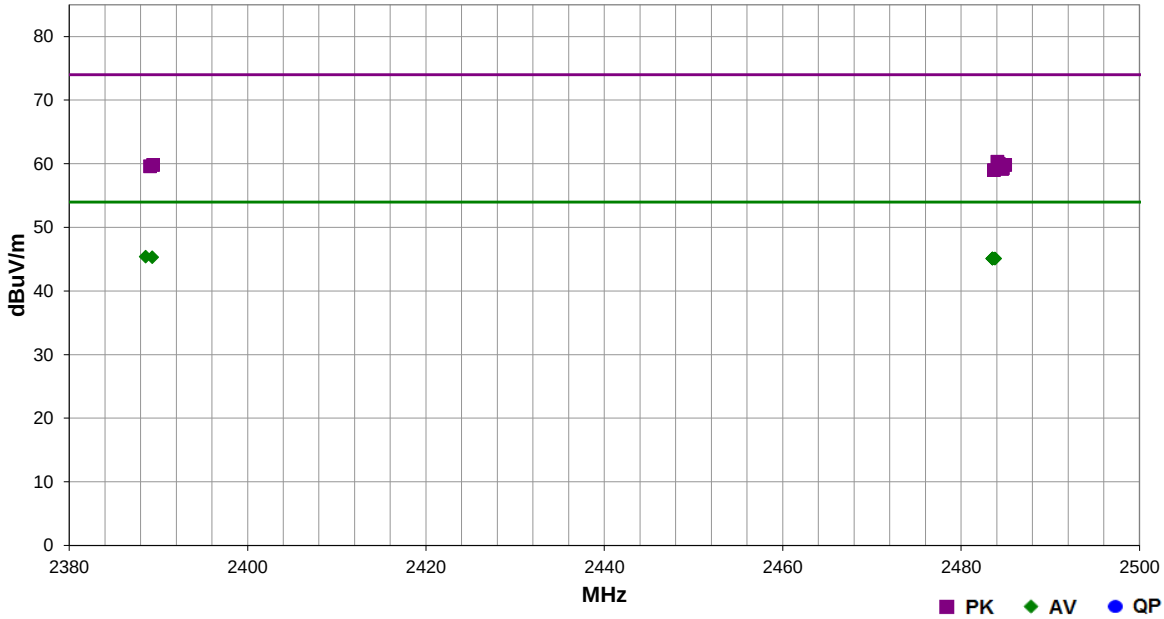
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.06.24.4 PSA-ESCI 2020.06.24.2

Work Order:	23DM0010	**Date:**	2020-10-12		
Project:	None	**Temperature:**	22.6 °C		
Job Site:	NC01	**Humidity:**	50.6% RH		
Serial Number:	See configurations	**Barometric Pres.:**	1025 mbar	**Tested by:**	Brian Fahey
EUT:	LocatorX Rev A				
Configuration:	1				
Customer:	2333 Designs & Mfg.				
Attendees:	None				
EUT Power:	Battery				
Operating Mode:	BTLE Tx, GFSK, 1 Mbps, 100% Duty Cycle, Low Channel = 2402 MHz, High Channel = 2480 MHz.				
Deviations:	None				
Comments:	See measurement comments for Channel and EUT orientation.				

Test Specifications	**Test Method**
FCC 15.247:2020	ANSI C63.10:2013

Run #	17	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



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
2388.570	26.0	-0.6	2.03	278.0	3.0	20.0	Vert	AV	0.0	45.4	54.0	-8.6	Low Ch., EUT Vert
2389.310	25.9	-0.6	1.5	189.0	3.0	20.0	Horz	AV	0.0	45.3	54.0	-8.7	Low Ch., EUT Vert
2483.833	25.9	-0.8	3.1	6.0	3.0	20.0	Vert	AV	0.0	45.1	54.0	-8.9	High Ch., EUT Horz
2483.510	25.9	-0.8	1.1	303.0	3.0	20.0	Horz	AV	0.0	45.1	54.0	-8.9	High Ch., EUT Horz
2483.743	25.9	-0.8	1.7	231.0	3.0	20.0	Horz	AV	0.0	45.1	54.0	-8.9	High Ch., EUT on Side
2483.500	25.9	-0.8	1.5	252.0	3.0	20.0	Vert	AV	0.0	45.1	54.0	-8.9	High Ch., EUT on Side
2483.527	25.9	-0.8	1.5	183.0	3.0	20.0	Horz	AV	0.0	45.1	54.0	-8.9	High Ch., EUT Vert
2483.533	25.9	-0.8	1.5	24.0	3.0	20.0	Vert	AV	0.0	45.1	54.0	-8.9	High Ch., EUT Vert
2484.053	41.1	-0.8	1.5	24.0	3.0	20.0	Vert	PK	0.0	60.3	74.0	-13.7	High Ch., EUT Vert
2484.220	40.8	-0.8	1.5	183.0	3.0	20.0	Horz	PK	0.0	60.0	74.0	-14.0	High Ch., EUT Vert
2484.923	40.6	-0.8	3.1	6.0	3.0	20.0	Vert	PK	0.0	59.8	74.0	-14.2	High Ch., EUT Horz
2389.397	40.4	-0.6	1.5	189.0	3.0	20.0	Horz	PK	0.0	59.8	74.0	-14.2	Low Ch., EUT Vert
2389.057	40.2	-0.6	2.03	278.0	3.0	20.0	Vert	PK	0.0	59.6	74.0	-14.4	Low Ch., EUT Vert
2484.667	40.1	-0.8	1.1	303.0	3.0	20.0	Horz	PK	0.0	59.3	74.0	-14.7	High Ch., EUT Horz
2484.600	40.0	-0.8	1.5	252.0	3.0	20.0	Vert	PK	0.0	59.2	74.0	-14.8	High Ch., EUT on Side
2483.673	39.8	-0.8	1.7	231.0	3.0	20.0	Horz	PK	0.0	59.0	74.0	-15.0	High Ch., EUT on Side

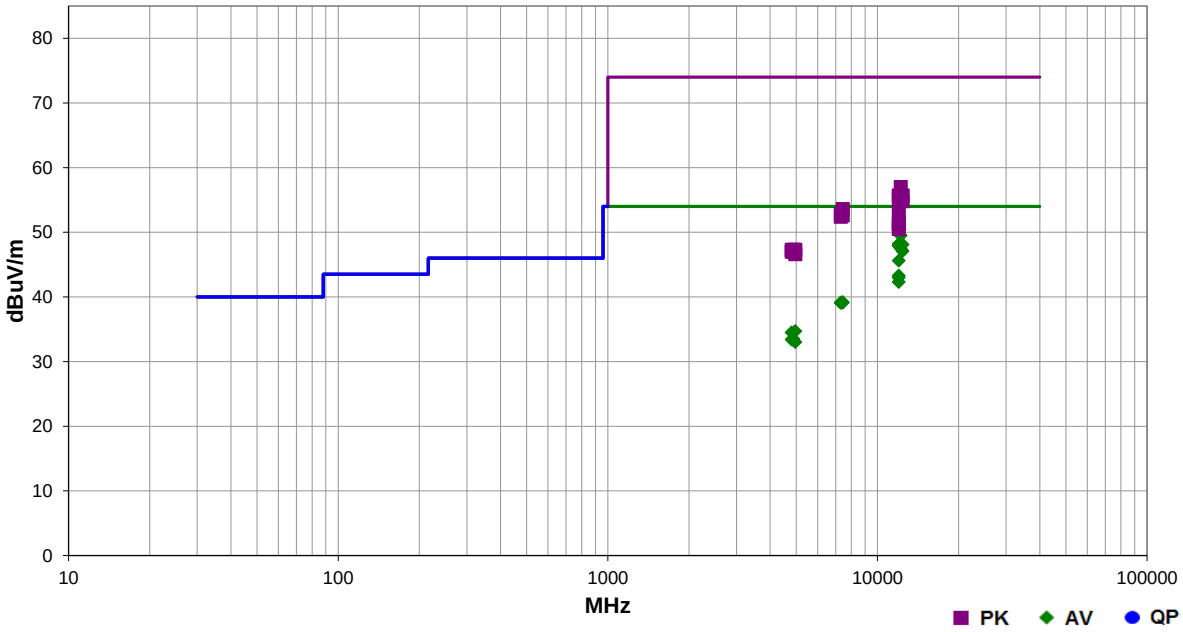
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.06.24.4 PSA-ESCI 2020.06.24.2

Work Order:	23DM0010	**Date:**	2020-10-12		
Project:	None	**Temperature:**	22.6 °C		
Job Site:	NC01	**Humidity:**	50.6% RH		
Serial Number:	See configurations	**Barometric Pres.:**	1025 mbar	**Tested by:**	Brian Fahey
EUT:	LocatorX Rev A				
Configuration:	1				
Customer:	2333 Designs & Mfg.				
Attendees:	None				
EUT Power:	Battery				
Operating Mode:	BTLE Tx, GFSK, 1 Mbps, 100% Duty Cycle, Low Channel = 2402 MHz, Mid Channel = 2440 MHz, High Channel = 2480 MHz.				
Deviations:	None				
Comments:	See measurement comments for Channel and EUT orientation.				

Test Specifications	**Test Method**
FCC 15.247:2020	ANSI C63.10:2013

Run #	15	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



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
12201.150	47.5	2.0	1.0	348.0	3.0	0.0	Horz	AV	0.0	49.5	54.0	-4.5	Mid Ch., EUT Horz
12008.900	45.7	2.5	1.27	243.0	3.0	0.0	Horz	AV	0.0	48.2	54.0	-5.8	Low Ch., EUT Horz
12398.870	46.1	2.0	1.26	254.0	3.0	0.0	Horz	AV	0.0	48.1	54.0	-5.9	High Ch., EUT Horz
12011.100	45.4	2.5	1.0	257.0	3.0	0.0	Vert	AV	0.0	47.9	54.0	-6.1	Low Ch., EUT on Side
12201.160	45.5	2.0	1.0	76.0	3.0	0.0	Vert	AV	0.0	47.5	54.0	-6.5	Mid Ch., EUT on Side
12398.870	45.1	2.0	1.26	276.0	3.0	0.0	Vert	AV	0.0	47.1	54.0	-6.9	High Ch., EUT on Side
12011.100	43.1	2.5	1.01	43.0	3.0	0.0	Horz	AV	0.0	45.6	54.0	-8.4	Low Ch., EUT Vert
12008.890	40.8	2.5	1.39	96.0	3.0	0.0	Vert	AV	0.0	43.3	54.0	-10.7	Low Ch., EUT Horz
12011.120	40.5	2.5	2.5	333.0	3.0	0.0	Horz	AV	0.0	43.0	54.0	-11.0	Low Ch., EUT on Side
12011.100	39.8	2.5	1.5	202.0	3.0	0.0	Vert	AV	0.0	42.3	54.0	-11.7	Low Ch., EUT Vert
7439.308	24.2	15.0	1.5	23.0	3.0	0.0	Horz	AV	0.0	39.2	54.0	-14.8	High Ch., EUT Horz
7441.308	24.1	15.0	4.0	319.0	3.0	0.0	Vert	AV	0.0	39.1	54.0	-14.9	High Ch., EUT on Side
7320.658	24.6	14.5	1.5	340.0	3.0	0.0	Vert	AV	0.0	39.1	54.0	-14.9	Mid Ch., EUT on Side
7319.333	24.6	14.5	2.28	287.0	3.0	0.0	Horz	AV	0.0	39.1	54.0	-14.9	Mid Ch., EUT Horz
12201.330	55.0	2.0	1.0	348.0	3.0	0.0	Horz	PK	0.0	57.0	74.0	-17.0	Mid Ch., EUT Horz
12011.330	53.2	2.5	1.27	243.0	3.0	0.0	Horz	PK	0.0	55.7	74.0	-18.3	Low Ch., EUT Horz
12398.750	53.7	2.0	1.26	254.0	3.0	0.0	Horz	PK	0.0	55.7	74.0	-18.3	High Ch., EUT Horz
12011.270	53.0	2.5	1.0	257.0	3.0	0.0	Vert	PK	0.0	55.5	74.0	-18.5	Low Ch., EUT on Side

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
12201.390	52.9	2.0	1.0	76.0	3.0	0.0	Vert	PK	0.0	54.9	74.0	-19.1	Mid Ch., EUT on Side
12398.730	52.8	2.0	1.26	276.0	3.0	0.0	Vert	PK	0.0	54.8	74.0	-19.2	High Ch., EUT on Side
4960.258	25.2	9.5	1.83	185.0	3.0	0.0	Horz	AV	0.0	34.7	54.0	-19.3	High Ch., EUT Horz
4803.692	24.8	9.7	1.5	172.0	3.0	0.0	Horz	AV	0.0	34.5	54.0	-19.5	Low Ch., EUT Horz
7441.300	38.6	15.0	4.0	319.0	3.0	0.0	Vert	PK	0.0	53.6	74.0	-20.4	High Ch., EUT on Side
4879.533	23.7	9.8	1.5	196.0	3.0	0.0	Vert	AV	0.0	33.5	54.0	-20.5	Mid Ch., EUT on Side
12011.250	50.9	2.5	1.01	43.0	3.0	0.0	Horz	PK	0.0	53.4	74.0	-20.6	Low Ch., EUT Vert
4879.633	23.6	9.8	1.5	180.0	3.0	0.0	Horz	AV	0.0	33.4	54.0	-20.6	Mid Ch., EUT Horz
4804.125	23.7	9.7	1.5	41.0	3.0	0.0	Vert	AV	0.0	33.4	54.0	-20.6	Low Ch., EUT on Side
4959.825	23.5	9.5	1.5	97.0	3.0	0.0	Vert	AV	0.0	33.0	54.0	-21.0	High Ch., EUT on Side
7318.317	38.3	14.5	2.28	287.0	3.0	0.0	Horz	PK	0.0	52.8	74.0	-21.2	Mid Ch., EUT Horz
7441.650	37.6	15.0	1.5	23.0	3.0	0.0	Horz	PK	0.0	52.6	74.0	-21.4	High Ch., EUT Horz
7320.000	37.9	14.5	1.5	340.0	3.0	0.0	Vert	PK	0.0	52.4	74.0	-21.6	Mid Ch., EUT on Side
12008.780	48.9	2.5	1.39	96.0	3.0	0.0	Vert	PK	0.0	51.4	74.0	-22.6	Low Ch., EUT Horz
12008.820	48.8	2.5	2.5	333.0	3.0	0.0	Horz	PK	0.0	51.3	74.0	-22.7	Low Ch., EUT on Side
12011.270	48.0	2.5	1.5	202.0	3.0	0.0	Vert	PK	0.0	50.5	74.0	-23.5	Low Ch., EUT Vert
4959.575	37.8	9.5	1.83	185.0	3.0	0.0	Horz	PK	0.0	47.3	74.0	-26.7	High Ch., EUT Horz
4881.650	37.5	9.8	1.5	196.0	3.0	0.0	Vert	PK	0.0	47.3	74.0	-26.7	Mid Ch., EUT on Side
4804.050	37.6	9.7	1.5	172.0	3.0	0.0	Horz	PK	0.0	47.3	74.0	-26.7	Low Ch., EUT Horz
4879.392	37.2	9.8	1.5	180.0	3.0	0.0	Horz	PK	0.0	47.0	74.0	-27.0	Mid Ch., EUT Horz
4803.975	37.3	9.7	1.5	41.0	3.0	0.0	Vert	PK	0.0	47.0	74.0	-27.0	Low Ch., EUT on Side
4958.442	37.1	9.5	1.5	97.0	3.0	0.0	Vert	PK	0.0	46.6	74.0	-27.4	High Ch., EUT on Side