SMART Technologies ULC

PQX-1 Pen (host) and PQXMOD1

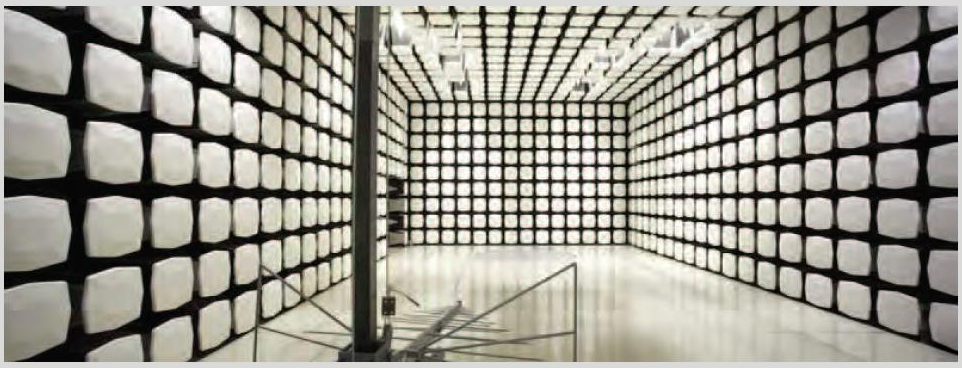
FCC 15.247:2023

RSS-247 Issue 2:2017

RSS-Gen Issue 5:2018+A1:2019+A2:2021

Bluetooth Low Energy (DTS) Radio

Report: SMTE0005.5 Rev. 1, Issue Date: June 8, 2023



CERT #3310.06

CERTIFICATE OF TEST

Last Date of Test: May 05, 2023
SMART Technologies ULC
EUT: PQX-1 Pen (host) and PQXMOD1

Radio Equipment Testing

Standards

Specification	Method
FCC 15.207:2023	ANSI C63.10:2013, FCC KDB 558074 v05r02:2019
FCC 15.247:2023	
RSS-247 Issue 2:2017	
RSS-Gen Issue 5:2018+A1:2019+A2:2021	

Results

Test Description	Result	Specification Section(s)	Method Section(s)	Comments
Powerline Conducted Emissions	N/A	15.207, RSS-Gen 8.8	6.2	Not required for a battery powered EUT.
Duty Cycle	See Data	KDB 558074 -6.0, RSS-Gen 3.2	11.6	
DTS Bandwidth (6 dB)	Pass	15.247(a)(2), KDB 558074 -8.2, RSS-247 5.2(a)	11.8.2	
Occupied Bandwidth (99%)	See Data	KDB 558074 -2.1, RSS-Gen 6.7	6.9.3	
Output Power	Pass	15.247(b)(3), KDB 558074 -8.3.1, RSS-247 5.4(d, f), RSS-Gen 6.12	11.9.1.1, 11.9.2.2.4	
Equivalent Isotropic Radiated Power	Pass	15.247(b)(3), KDB 558074 -8.3.1, RSS-247 5.4(d, f), RSS-Gen 6.12	11.9.1.1, 11.9.2.2.4	
Power Spectral Density	Pass	15.247(e), KDB 558074 -8.4, RSS-Gen 5.2(b)	11.10.2	
Band Edge Compliance	Pass	15.247(d), KDB 558074 -8.5, RSS-247 5.5	11.11	
Spurious Conducted Emissions	Pass	15.247(d), KDB 558074 -8.5, RSS-247 5.5	11.11	
Spurious Radiated Emissions - Spot Checks	Pass	15.247(d), KDB 558074 -8.6, 8.7, RSS-247 5.5, RSS-Gen 6.13, 8.10	11.12.1, 11.13.2, 6.5, 6.6	

Deviations From Test Standards

None

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.

CERTIFICATE OF TEST

Approved By:

Chuck Heller, Department Manager

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REVISION HISTORY

Revision Number	Description	Date (yyyy-mm-dd)	Page Number
01	Updated Test Name for Spurious Radiated Emissions	2023-06-07	51-64
01	Updated Cover Page	2023-06-07	01

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 - Each laboratory is accredited by A2LA to ISO / IEC 17025, and as a product certifier to ISO / IEC 17065 which allows Element to certify transmitters to FCC and IC specifications.

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 – Recognized as an EU Notified Body validated for the EMCD and RED Directives.

United Kingdom

BEIS – Recognized by the UK as an Approved Body under the UK Radio Equipment and UK EMC Regulations.

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.

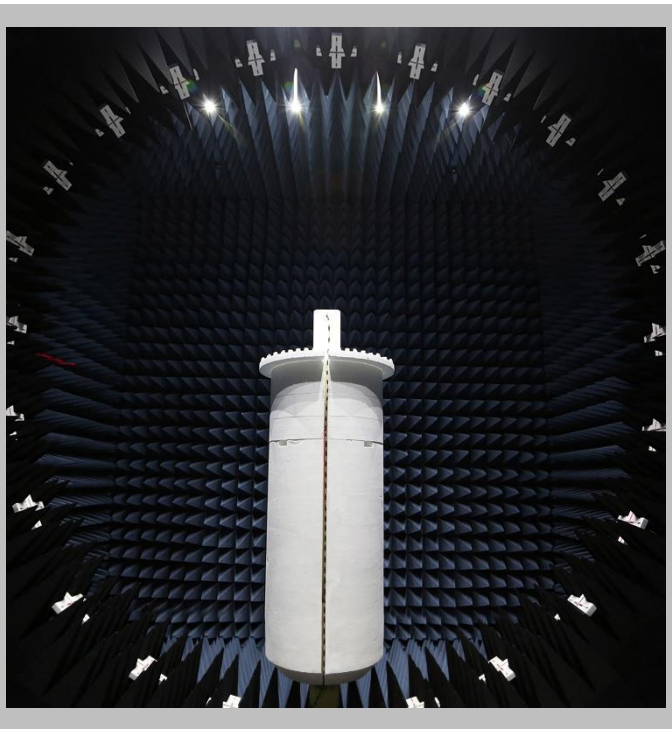
SCOPE

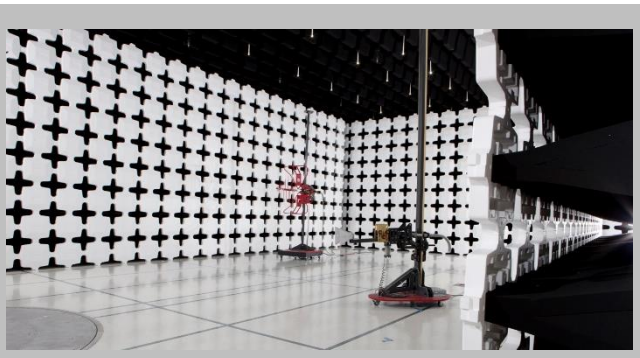
For details on the Scopes of our Accreditations, please visit:

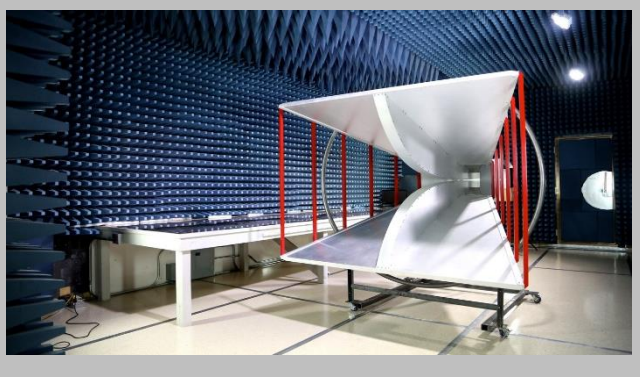
California Minnesota Oregon Texas Washington

FACILITIES

California	Minnesota	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-11 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
A2LA				
Lab Code: 3310.04	Lab Code: 3310.05	Lab Code: 3310.02	Lab Code: 3310.03	Lab Code: 3310.06
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 in the table below. A lab specific value may also be found in the applicable test description section. 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)	3.1 dB	-3.1 dB

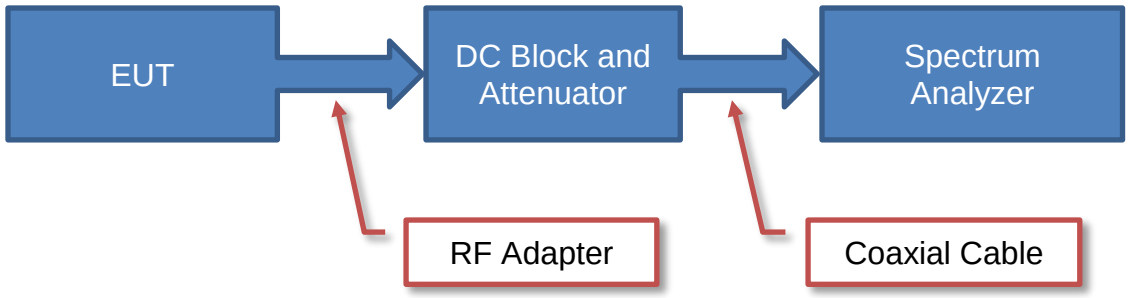
TEST SETUP BLOCK DIAGRAMS

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

Unless otherwise stated, measurements were made using the bandwidths and detectors specified. No video filter was used.

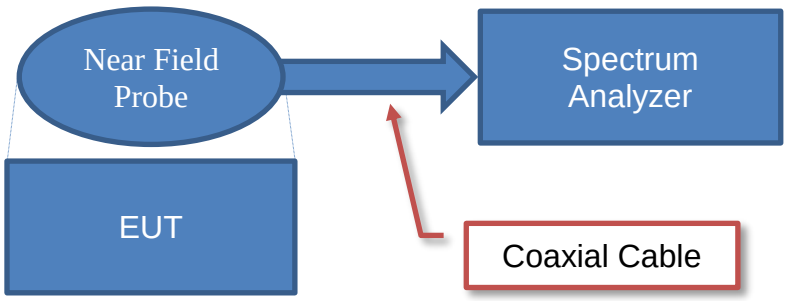
Antenna Port Conducted Measurements



Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

Near Field Test Fixture Measurements

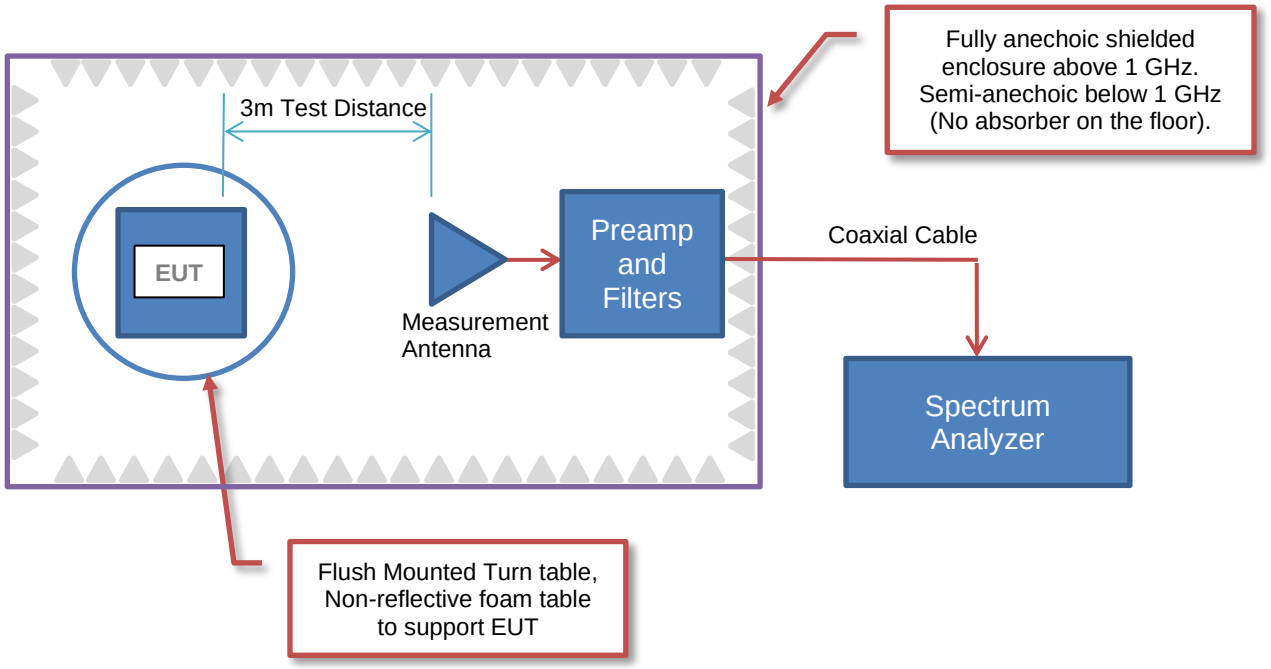


Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

TEST SETUP BLOCK DIAGRAMS

Emissions Measurements



Sample Calculation (logarithmic units)

Radiated Emissions:

Measured Level (Amplitude)		Factor: Antenna Factor		Factor: Cable Factor		Factor: Amplifier Gain		Distance Adjustment Factor		External Attenuation		Field Strength
42.6	+	28.6	+	3.1	-	40.8	+	0.0	+	0.0	=	**33.5**

Conducted Emissions:

Measured Level (Amplitude)		Factor: Transducer Factor		Factor: Cable Factor		External Attenuation		Adjusted Level
26.7	+	0.3	+	0.1	+	20.0	=	**47.1**

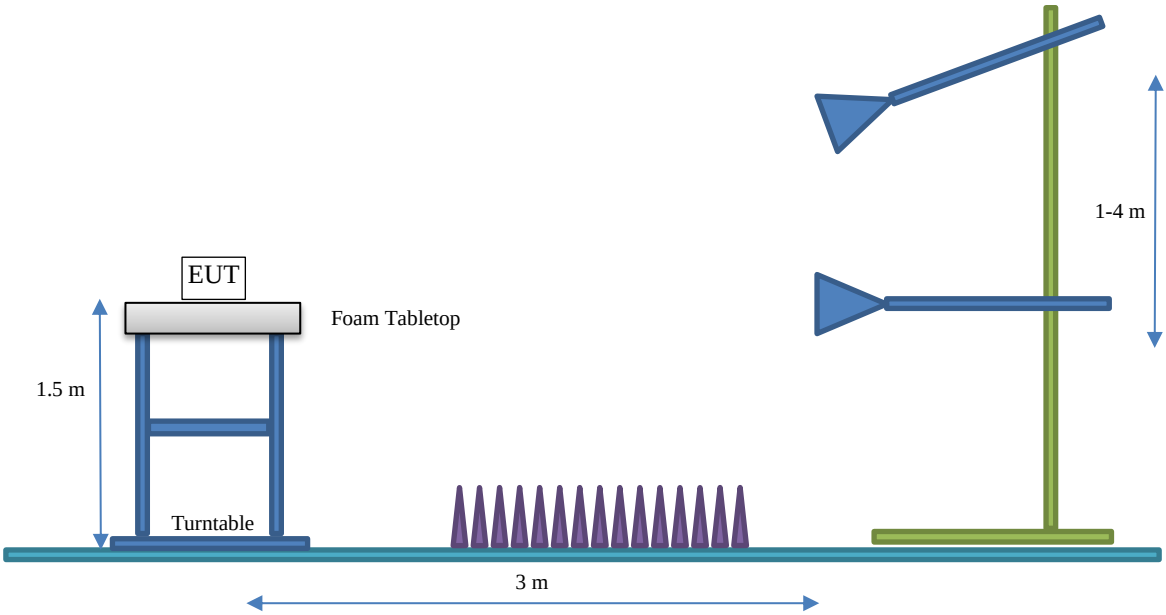
Radiated Power (ERP/EIRP) – Substitution Method:

Measured Level into Substitution Antenna (Amplitude dBm)		Substitution Antenna Factor (dBi)		EIRP to ERP (if applicable)		Measured power (dBm ERP/EIRP)
10.0	+	6.0	-	2.15	=	**13.9/16.0**

TEST SETUP BLOCK DIAGRAMS

Bore Sighting (>1GHz)

The diameter of the illumination area is the dimension of the line tangent to the EUT formed by 3 dB beamwidth of the measurement antenna at the measurement distance. At a 3 meter test distance, the diameter of the illumination area was 3.8 meters at 1 GHz and greater than 2.1 meters up to 6 GHz. Above 1 GHz, when required by the measurement standard, the antenna is pointed for both azimuth and elevation to maintain the receive antenna within the cone of radiation from the EUT. The specified measurement detectors were used for comparison of the emissions to the peak and average specification limits.



PRODUCT DESCRIPTION

Client and Equipment under Test (EUT) Information

Company Name:	SMART Technologies ULC
Address:	3636 Research Road NW
City, State, Zip:	Calgary, AB, T2L 1Y1
Test Requested By:	Sean MacKellar
EUT:	PQX-1 Pen (host) and PQXMOD1
First Date of Test:	March 7, 2023
Last Date of Test:	May 5, 2023
Receipt Date of Samples:	March 7, 2023
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
PQXMOD1 is a Bluetooth low energy radio module integrated on the main board within the SMART QX Series Pen, Model: PQX-1. PQX-1 is an electronic pen for use with QX series interactive flat panel display.

Testing Objective:
To demonstrate compliance of the module in the host per KDB 996369 for the Bluetooth radio to FCC 15.247/RSS-247 requirements.

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. The power settings below reflect the maximum power that the EUT is allowed to transmit at during normal operation.

ANTENNA GAIN (dBi)

Type	Provided by:	Frequency Range (MHz)	Gain (dBi)
Multilayer Chip	Wurth Elektronik	2400 - 2500	3

The EUT was tested using the power settings provided by the manufacturer which were based upon:

☒ Test software settings Test software/firmware installed on EUT:_____Atmosic SDK 5.1.0_____
☐ Rated power settings

SETTINGS FOR ALL TESTS IN THIS REPORT

Modulation Types / Data Rates	Type	Channel	Frequency (MHz)	Power Setting
BLE GFSK 1 Mbps	DTS	0	2402	4 dBm
		20	2442	4 dBm
		39	2480	0 dBm

CONFIGURATIONS

Configuration SMTE0005-5

Software/Firmware Running During Test	
Description	**Version**
Atmosic RF tool	1.6.4
Atmosic SDK	5.1.0

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Pen Board	SMART Technologies	PQXMOD1	Sample 1

Peripherals in Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Interface board	Atmosic	N/A	None
Laptop	HP	HSN-124C-4	5CG925B25F
DC Power Supply	Powerbes	SPS605	N/A

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB-A to mini-USB cable	Yes	1 meter	None	laptop	Interface board
flex cable	No	0.3 meters	None	interface board	Pen board
Red DC lead	No	0.9 meters	None	Pen board	DC Power Supply
Black DC lead	No	1.2 meters	None	Pen board	DC Power Supply

Configuration SMTE0005-7

Software/Firmware Running During Test	
Description	**Version**
Atmosic RF tool	1.6.4
Atmosic SDK	5.1.0

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Pen Board	SMART Technologies	PQXMOD1	Sample 1

Peripherals in Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Interface board	Atmosic	N/A	None
Laptop	HP	HSN-124C-4	5CG925B25F
DC Power Supply	Powerbes	SPS605	N/A

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB-A to mini-USB cable	Yes	1 meter	None	laptop	USB extension cable
USB extension cable	Yes	4.5 meters	None	USB-A cable	Interface board
flex cable	No	0.3 meters	None	interface board	Pen board
Red DC lead	No	0.9 meters	None	Pen board	DC Power Supply
Black DC lead	No	1.2 meters	None	Pen board	DC Power Supply

CONFIGURATIONS

Configuration SMTE0005-11

Software/Firmware Running During Test	
Description	**Version**
TX/RX pen firmware	1.9.7.199

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Pen	SMART Technologies	PQX-1	Sample 1

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2023-03-07	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.
2	2023-03-07	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.
3	2023-04-20	Duty Cycle	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	2023-04-20	DTS 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.
5	2023-04-20	Occupied Bandwidth (99%)	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	2023-04-20	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.
7	2023-04-20	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.
8	2023-04-20	Spurious Conducted 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.
9	2023-05-05	Spurious Radiated Emissions	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

DUTY CYCLE

XMit 2023.02.14.0

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
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2023-01-18	2024-01-18
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03
Attenuator	Fairview Microwave	SA4014-20	QAA	2023-02-17	2024-02-17
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25
Block - DC	Weinschel Corp.	7006	AMS	2023-01-18	2024-01-18

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The Duty Cycle (x) of the single channel operation of the radio as controlled by the provided test software was measured for each of the EUT operating modes.

There is no compliance requirement to be met by this test, so therefore no Pass / Fail criteria.

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.

If the transmit duty cycle < 98 percent, burst gating may have been used during some of the other tests in this report to only take the measurement during the burst duration.

DUTY CYCLE

TbtTx 2022.06.03.0 XMit 2023.02.14.0

EUT:	**PQXMOD1**			**Work Order:**	**SMTE0005**
Serial Number:	**Conducted Sample**			**Date:**	**04/20/2023**
Customer:	**SMART Technologies**			**Temperature:**	**20.9°C**
Attendees:	**Sean MacKellar**			**Humidity:**	**42.9%**
Project:	**None**			**Barometric Pres.:**	**1020 mbar**
Tested by:	**Harry Zhao**	**Power:**	**1.5 VDC**	**Job Site:**	**NC06**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

COMMENTS

Reference level offset: DC Block, 20 dB attenuator, patch cable, and measurement cable

DEVIATIONS FROM TEST STANDARD

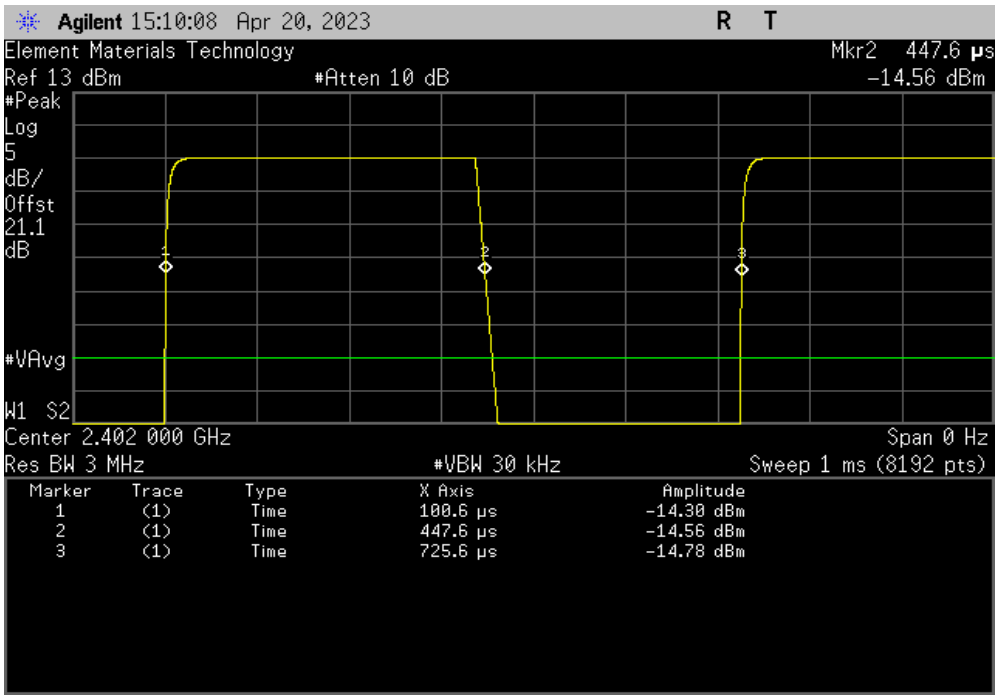
None

Configuration #	**5**	*Signature*

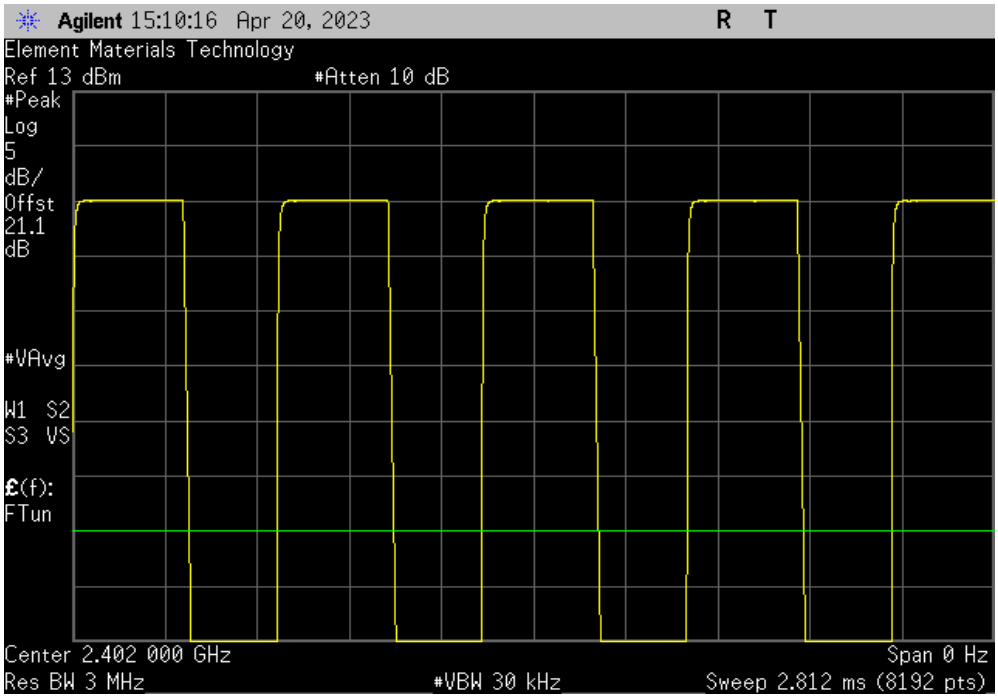
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	346.964 us	625 us	1	55.5	N/A	N/A
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	N/A	N/A	5	N/A	N/A	N/A
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	346.974 us	624.9 us	1	55.5	N/A	N/A
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	N/A	N/A	5	N/A	N/A	N/A
BLE/GFSK 1 Mbps High Channel, 2480 MHz	346.572 us	625.1 us	1	55.4	N/A	N/A
BLE/GFSK 1 Mbps High Channel, 2480 MHz	N/A	N/A	5	N/A	N/A	N/A

DUTY CYCLE

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	346.964 us	625 us	1	55.5	N/A	N/A

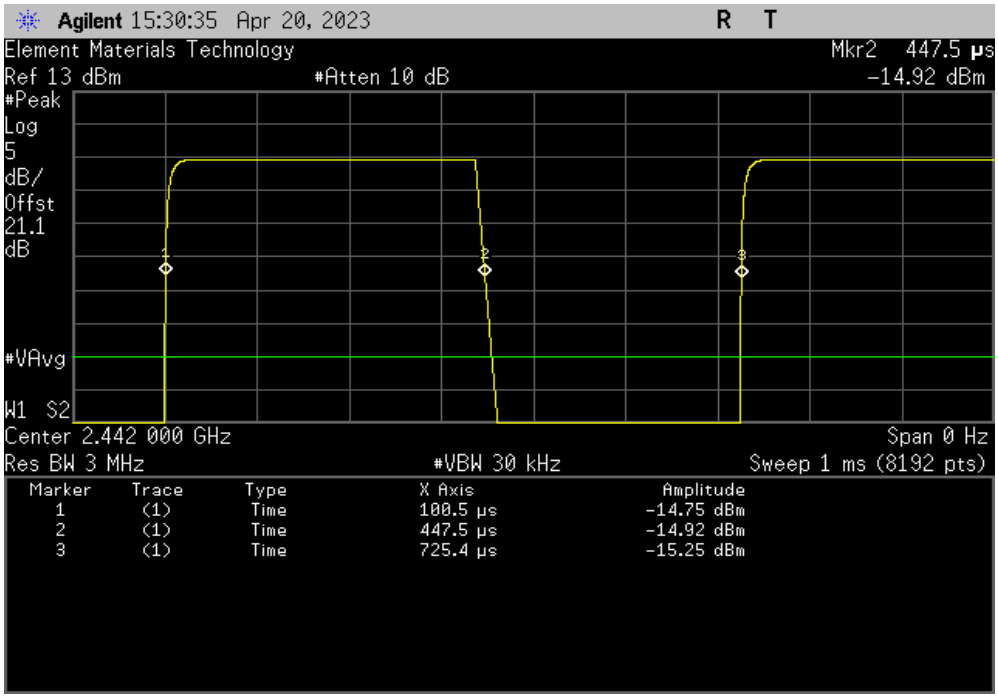


BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

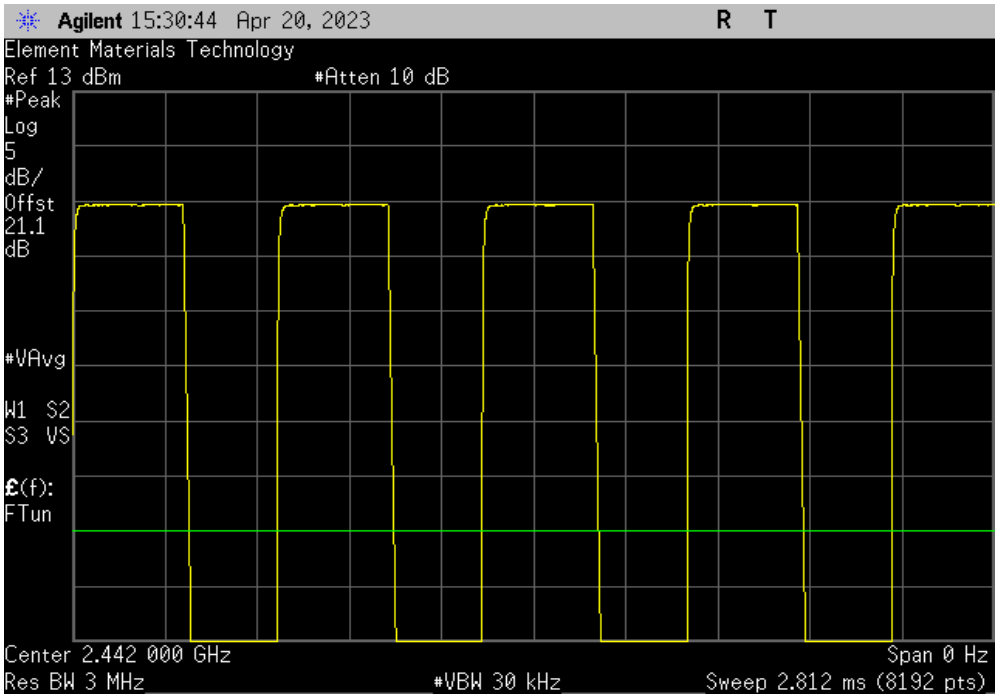


DUTY CYCLE

BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	346.974 us	624.9 us	1	55.5	N/A	N/A

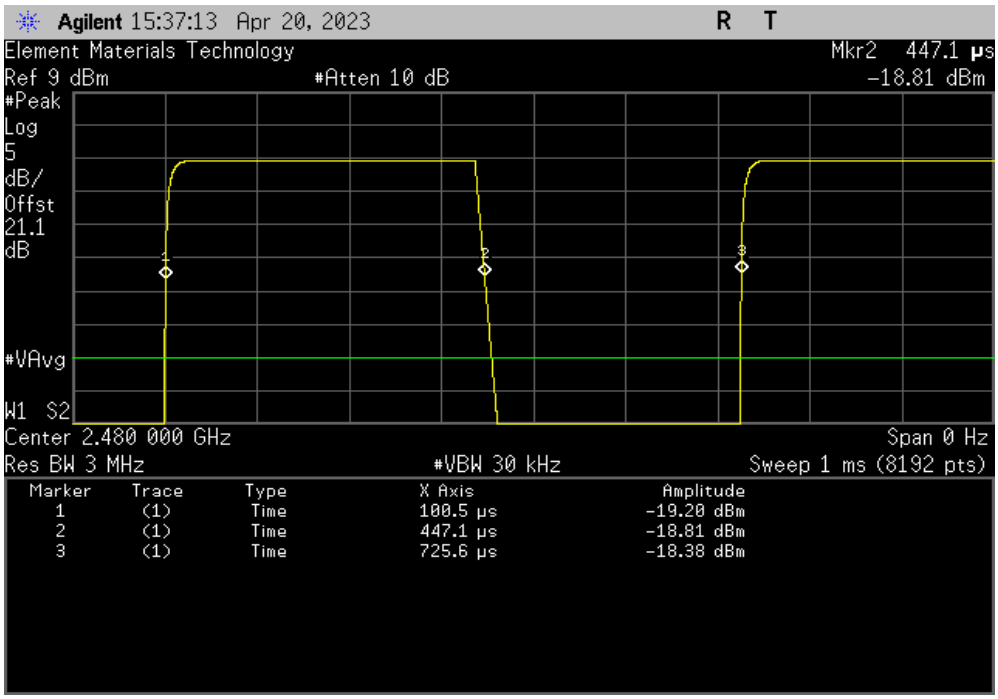


BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

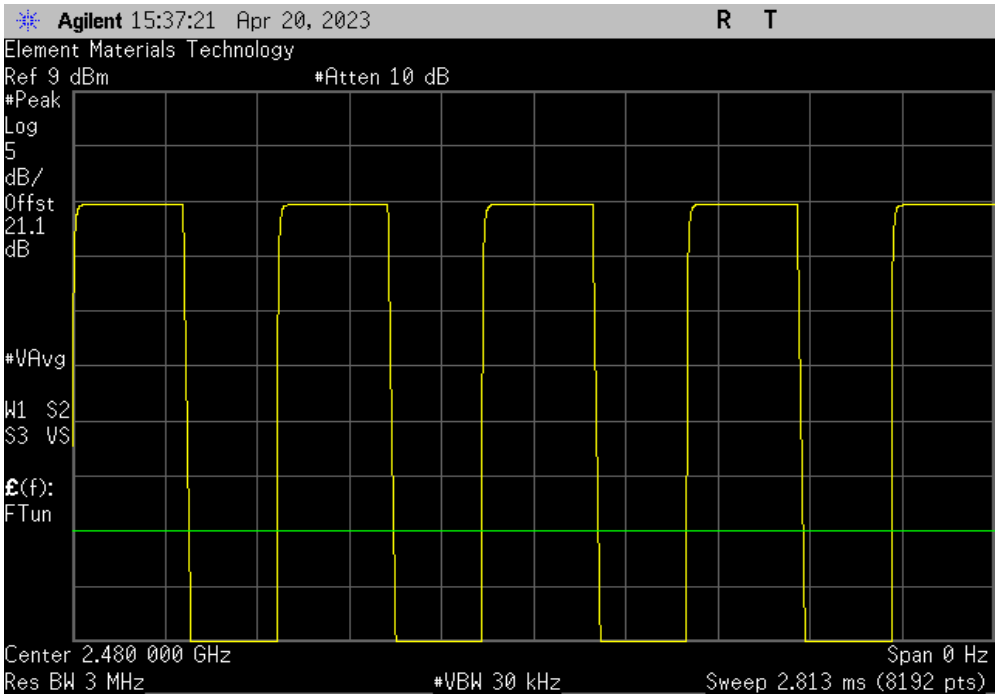


DUTY CYCLE

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	346.572 us	625.1 us	1	55.4	N/A	N/A



BLE/GFSK 1 Mbps High Channel, 2480 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A



DTS BANDWIDTH (6 dB)

XMit 2023.02.14.0

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
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2023-01-18	2024-01-18
Attenuator	Fairview Microwave	SA4014-20	QAA	2023-02-17	2024-02-17
Block - DC	Weinschel Corp.	7006	AMS	2023-01-18	2024-01-18

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

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

The 6dB DTS bandwidth was measured using 100 kHz resolution bandwidth and 300 kHz video bandwidth. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

DTS BANDWIDTH (6 dB)

TbtTx 2022.06.03.0 XMit 2023.02.14.0

EUT:	**PQXMOD1**			**Work Order:**	**SMTE0005**
Serial Number:	**Conducted Sample**			**Date:**	**04/20/2023**
Customer:	**SMART Technologies**			**Temperature:**	**20.4°C**
Attendees:	**Sean MacKellar**			**Humidity:**	**44.7%**
Project:	**None**			**Barometric Pres.:**	**1020 mbar**
Tested by:	**Harry Zhao**	**Power:**	**1.5 VDC**	**Job Site:**	**NC06**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

COMMENTS

Reference level offset: DC Block, 20 dB attenuator, patch cable, and measurement cable

DEVIATIONS FROM TEST STANDARD

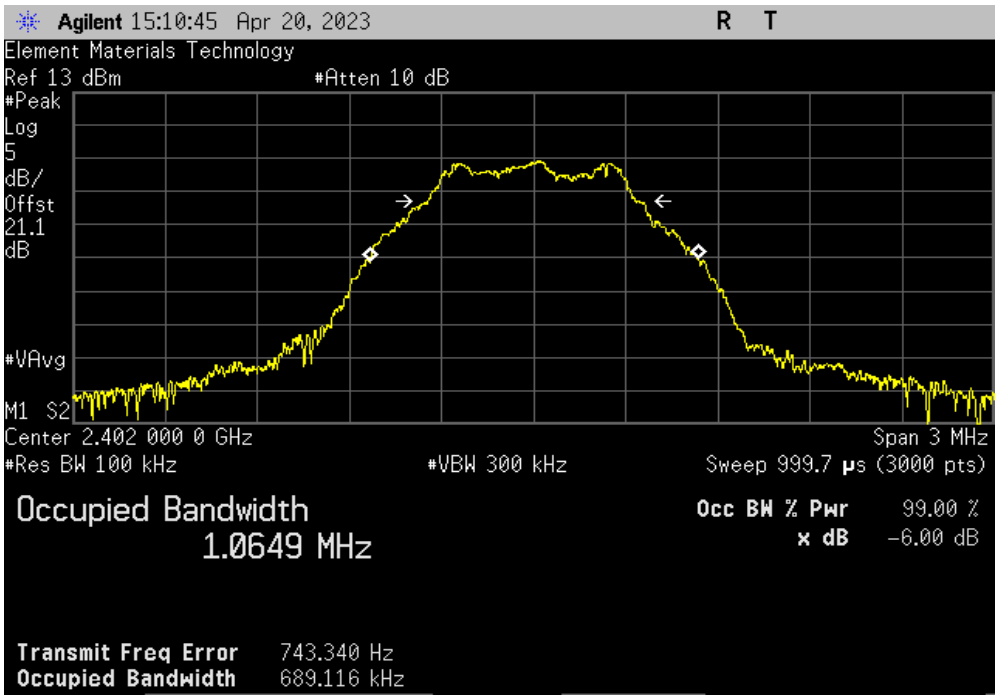
None

Configuration #	**5**	*Signature*

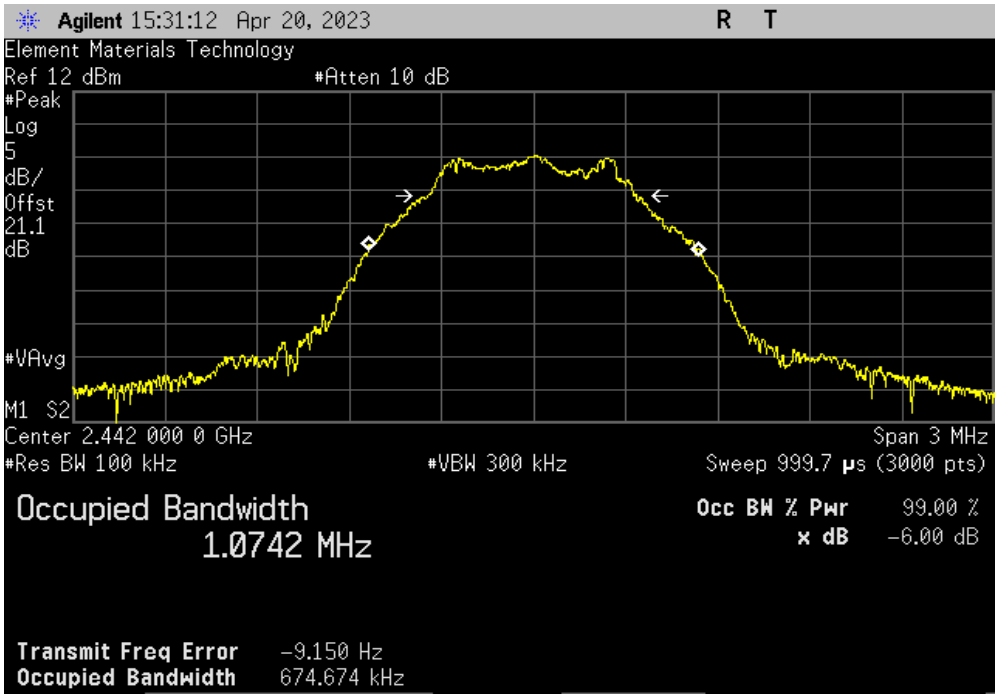
	Value	**Limit (≥)**	**Result**
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	689.117 kHz	500 kHz	Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	674.674 kHz	500 kHz	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	695.851 kHz	500 kHz	Pass

DTS BANDWIDTH (6 dB)

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

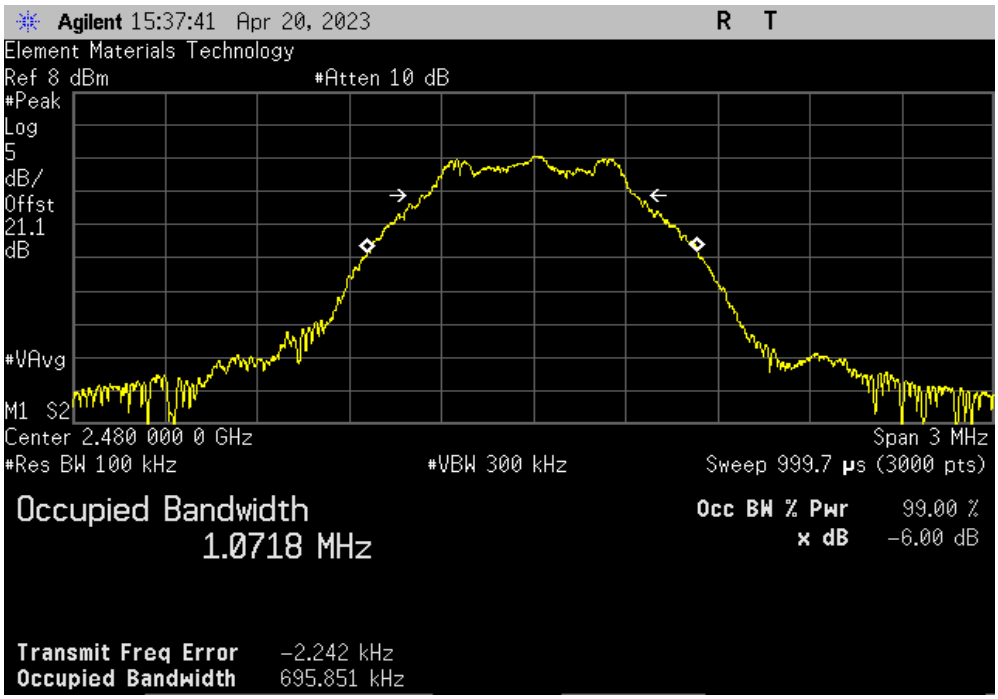


BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
				Value	Limit (≥)	Result
				674.674 kHz	500 kHz	Pass



DTS BANDWIDTH (6 dB)

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



OCCUPIED BANDWIDTH (99%)

XMit 2023.02.14.0

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
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2023-01-18	2024-01-18
Attenuator	Fairview Microwave	SA4014-20	QAA	2023-02-17	2024-02-17
Block - DC	Weinschel Corp.	7006	AMS	2023-01-18	2024-01-18

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The 99% occupied bandwidth was measured with the EUT configured for continuous modulated operation.

Per ANSI C63.10:2013, 6.9.3, the spectrum analyzer was configured as follows:

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

The resolution bandwidth (RBW) of the spectrum analyzer was set to the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) bandwidth was set to at least 3 times the resolution bandwidth. The analyzer sweep time was set to auto to prevent video filtering or averaging. A sample detector was used unless the device was not able to be operated in a continuous transmit mode, in which case a peak detector was used.

The spectrum analyzer occupied bandwidth measurement function was used to sum the power of the transmission in linear terms to obtain the 99% bandwidth.

OCCUPIED BANDWIDTH (99%)

TbtTx 2022.06.03.0 XMit 2023.02.14.0

EUT:	**PQXMOD1**			**Work Order:**	**SMTE0005**
Serial Number:	**Conducted Sample**			**Date:**	**04/20/2023**
Customer:	**SMART Technologies**			**Temperature:**	**20.6°C**
Attendees:	**Sean MacKellar**			**Humidity:**	**44.1%**
Project:	**None**			**Barometric Pres.:**	**1020 mbar**
Tested by:	**Harry Zhao**	**Power:**	**1.5 VDC**	**Job Site:**	**NC06**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

COMMENTS

Reference level offset: DC Block, 20 dB attenuator, patch cable, and measurement cable

DEVIATIONS FROM TEST STANDARD

None

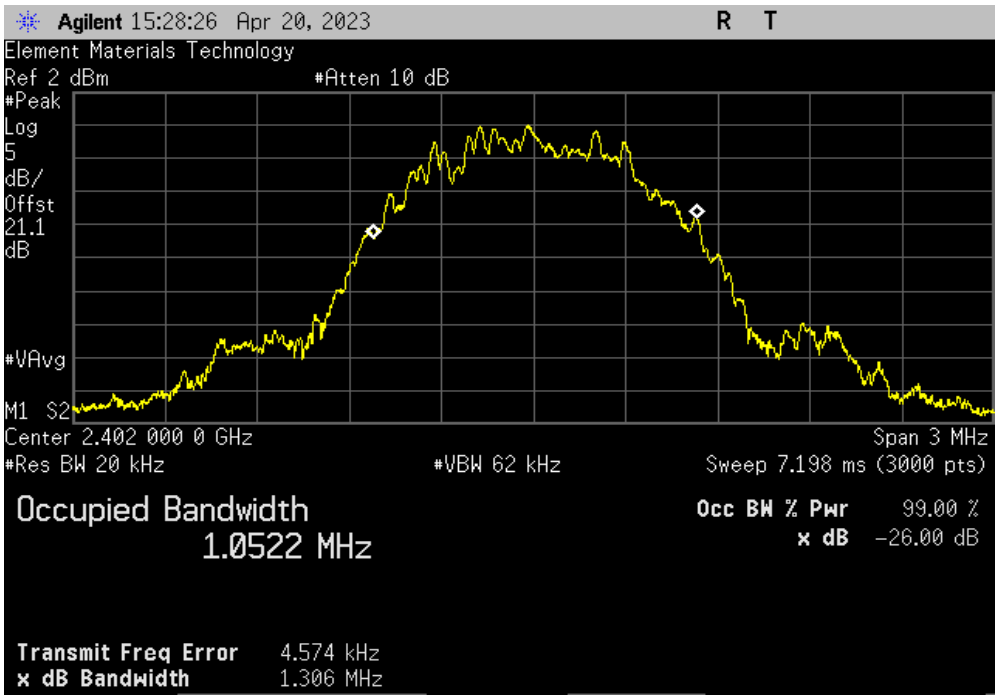
Configuration #	**5**	*Signature*

	Value	**Limit**	**Result**
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	1.052 MHz	N/A	N/A
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	1.061 MHz	N/A	N/A
BLE/GFSK 1 Mbps High Channel, 2480 MHz	1.056 MHz	N/A	N/A

OCCUPIED BANDWIDTH (99%)

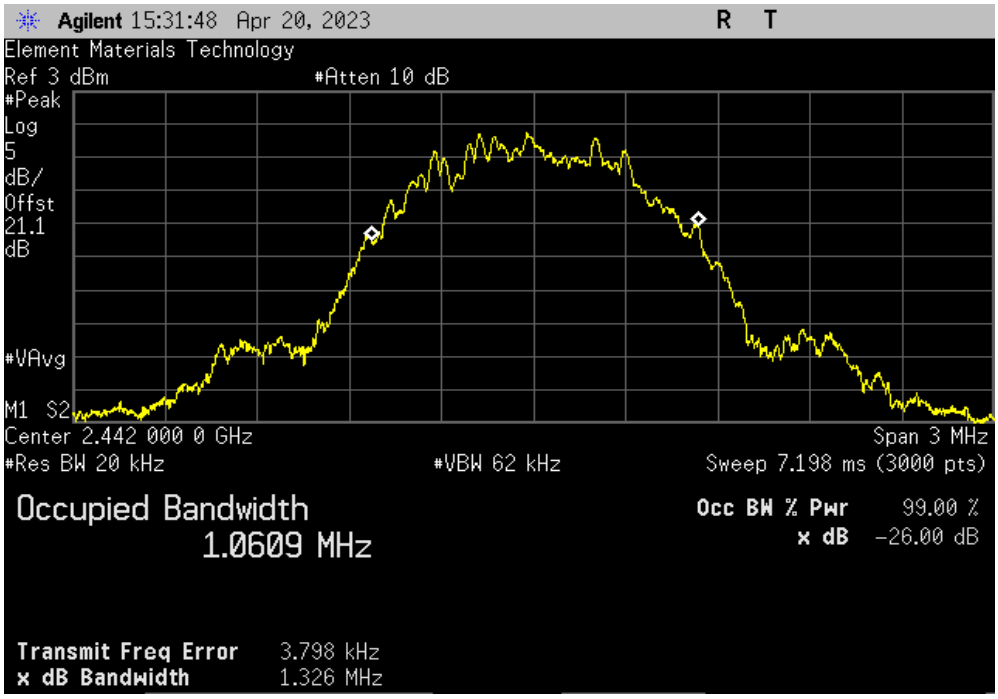
BLE/GFSK 1 Mbps Low Channel, 2402 MHz

				Value	Limit	Result
				1.052 MHz	N/A	N/A



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz

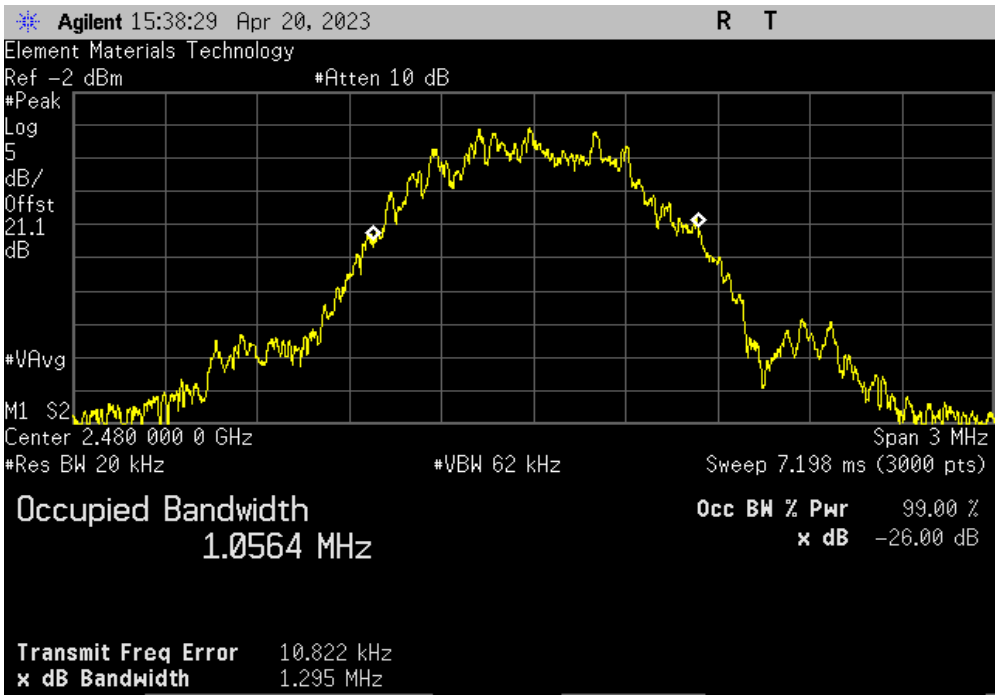
				Value	Limit	Result
				1.061 MHz	N/A	N/A



OCCUPIED BANDWIDTH (99%)

BLE/GFSK 1 Mbps High Channel, 2480 MHz

				Value	Limit	Result
				1.056 MHz	N/A	N/A



OUTPUT POWER

XMit 2022.12.28.0

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	2023-01-18	2024-01-18
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2023-01-18	2024-01-18
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03
Attenuator	Fairview Microwave	SA4014-20	QAA	2023-02-17	2024-02-17
Analyzer - Spectrum Analyzer	Agilent	E4440A	AAX	2023-01-19	2024-01-19
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

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 2022.06.03.0 XMit 2022.12.28.0

EUT:	**PQXMOD1**			**Work Order:**	**SMTE0005**
Serial Number:	**Conducted Sample**			**Date:**	**03/07/2023**
Customer:	**SMART Technologies**			**Temperature:**	**20.1°C**
Attendees:	**Sean MacKellar**			**Humidity:**	**32.1%**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Harry Zhao**	**Power:**	**1.5 VDC**	**Job Site:**	**NC06**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

COMMENTS

Reference level offset: DC Block, 20 dB attenuator, patch cable, and measurement cable

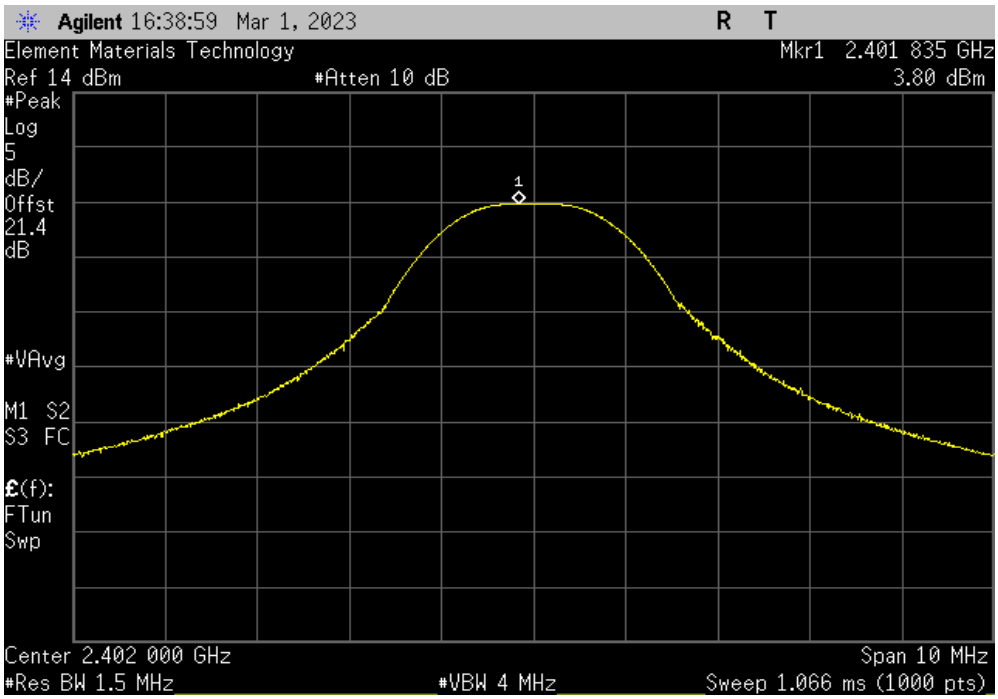
DEVIATIONS FROM TEST STANDARD

None

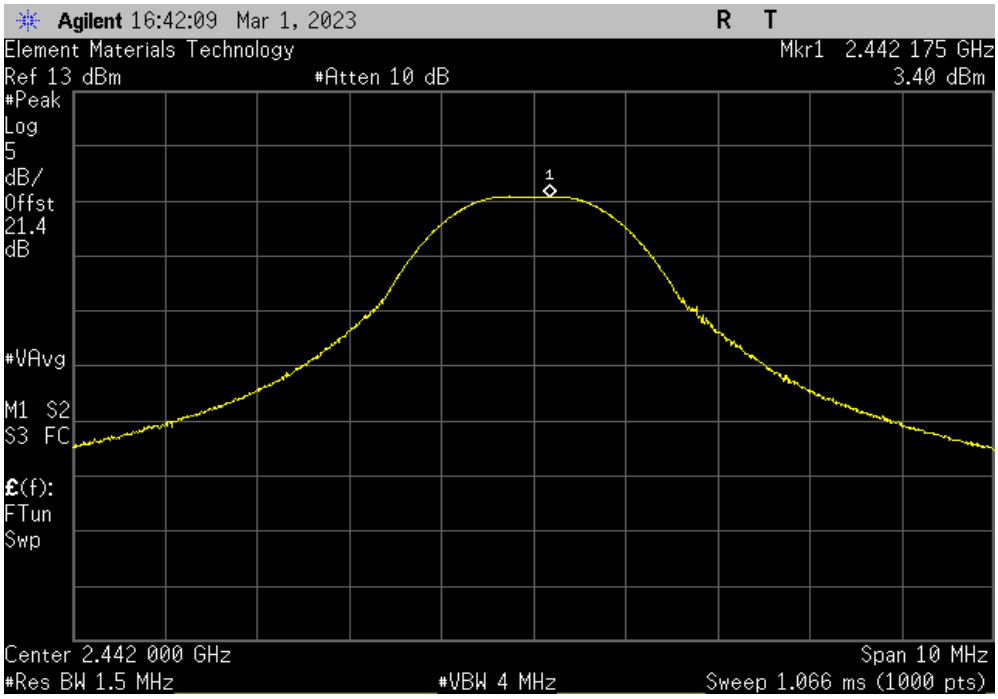
Configuration #	**5**	*Signature*

	Out Pwr (dBm)	**Limit (dBm)**	**Result**
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	3.798	30	Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	3.403	30	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	-0.71	30	Pass

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				3.798	30	Pass



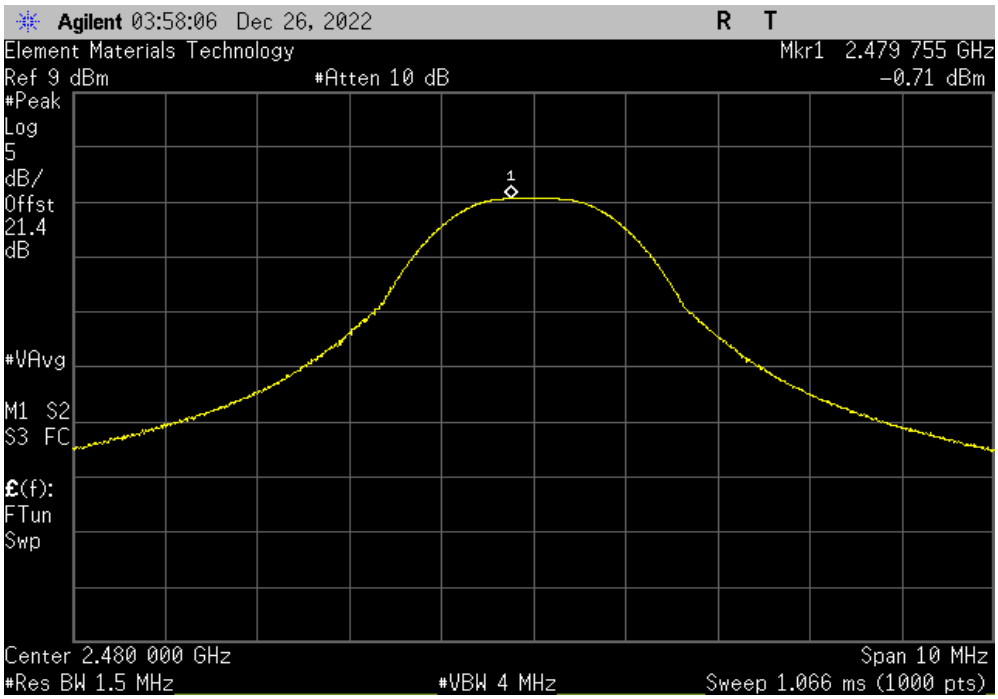
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				3.403	30	Pass



OUTPUT POWER

TbtTx 2022.06.03.0 XMit 2022.12.28.0

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-0.71	30	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

XMit 2022.12.28.0

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
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25
Block - DC	Weinschel Corp.	7006	AMS	2023-01-18	2024-01-18
Attenuator	Fairview Microwave	SA4014-20	QAA	2023-02-17	2024-02-17
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2023-01-18	2024-01-18
Analyzer - Spectrum Analyzer	Agilent	E4440A	AAX	2023-01-19	2024-01-19

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

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)

TbtTx 2022.06.03.0 XMit 2022.12.28.0

EUT:	**PQXMOD1**			**Work Order:**	**SMTE0005**
Serial Number:	**Conducted Sample**			**Date:**	**03/07/2023**
Customer:	**SMART Technologies**			**Temperature:**	**20.1°C**
Attendees:	**Sean MacKellar**			**Humidity:**	**32.1%**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Harry Zhao**	**Power:**	**1.5 VDC**	**Job Site:**	**NC06**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

COMMENTS

Reference level offset: DC Block, 20 dB attenuator, patch cable, and measurement cable

DEVIATIONS FROM TEST STANDARD

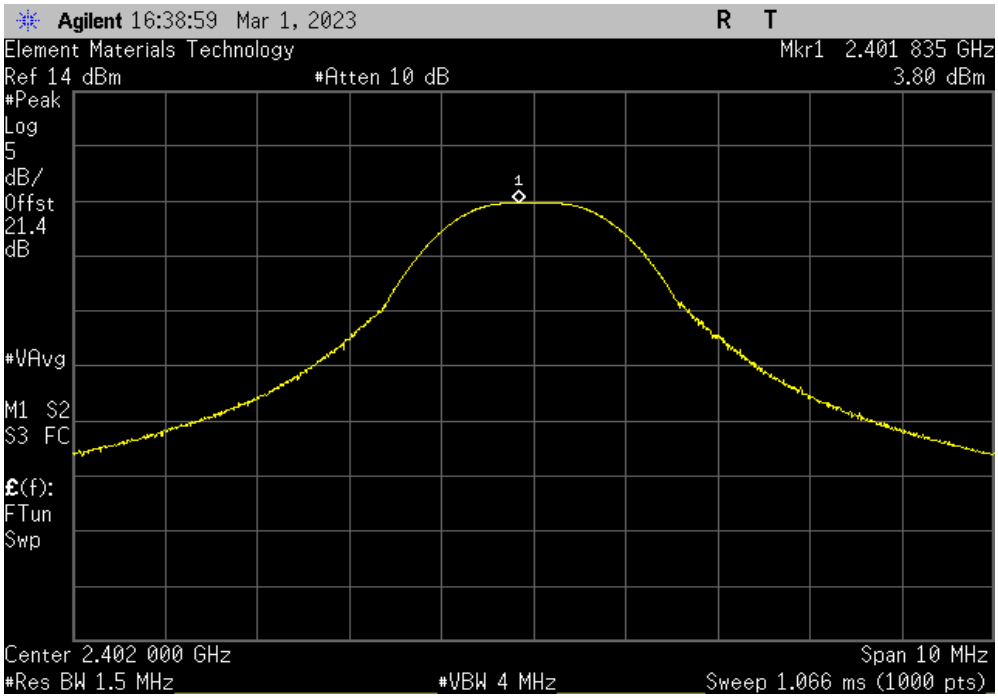
None

Configuration #	**5**	*Signature*

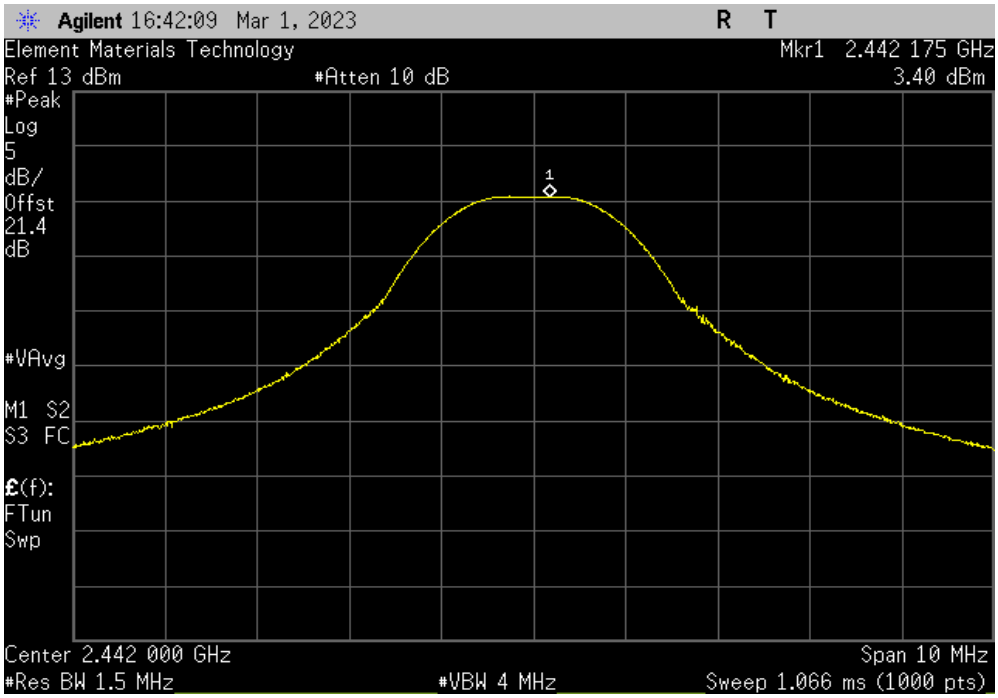
	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	3.798	3	6.798	36	Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	3.403	3	6.403	36	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	-0.71	3	2.29	36	Pass

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
		3.798	3	6.798	36	Pass

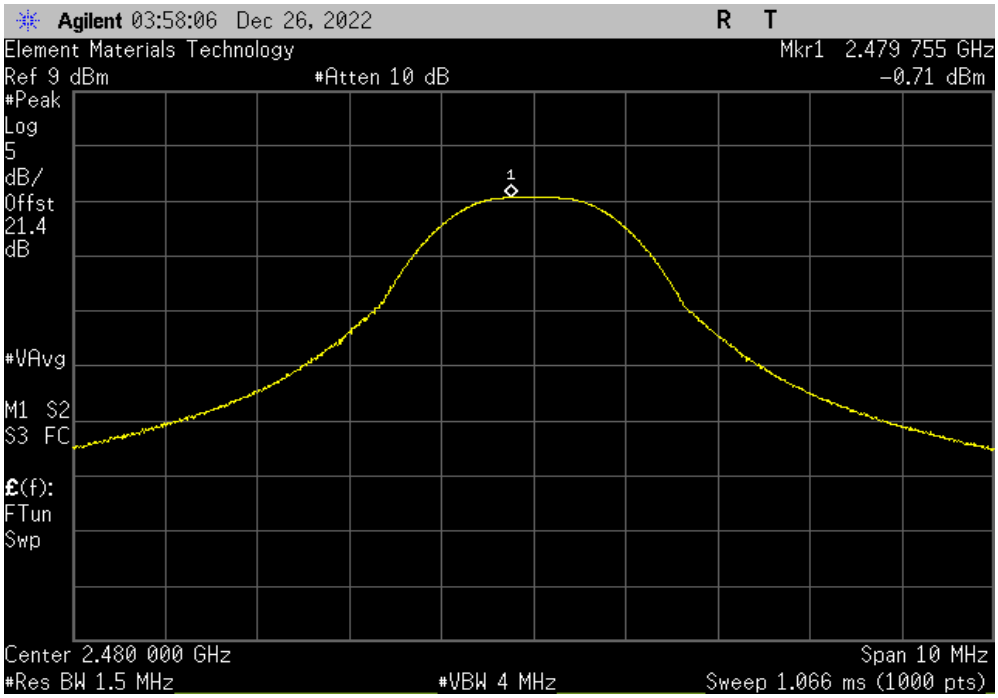


BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		3.403	3	6.403	36	Pass



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
		-0.71	3	2.29	36	Pass



POWER SPECTRAL DENSITY

XMit 2023.02.14.0

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
Attenuator	Fairview Microwave	SA4014-20	QAA	2023-02-17	2024-02-17
Block - DC	Weinschel Corp.	7006	AMS	2023-01-18	2024-01-18
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2023-01-18	2024-01-18
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

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 2022.06.03.0 XMit 2023.02.14.0

EUT:	**PQXMOD1**			**Work Order:**	**SMTE0005**
Serial Number:	**Conducted Sample**			**Date:**	**04/20/23**
Customer:	**SMART Technologies**			**Temperature:**	**20.9°C**
Attendees:	**Sean MacKellar**			**Humidity:**	**43.2%**
Project:	**None**			**Barometric Pres.:**	**1020 mbar**
Tested by:	**Harry Zhao**	**Power:**	**1.5 VDC**	**Job Site:**	**NC06**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

COMMENTS

Reference level offset: DC Block, 20 dB attenuator, patch cable, and measurement cable

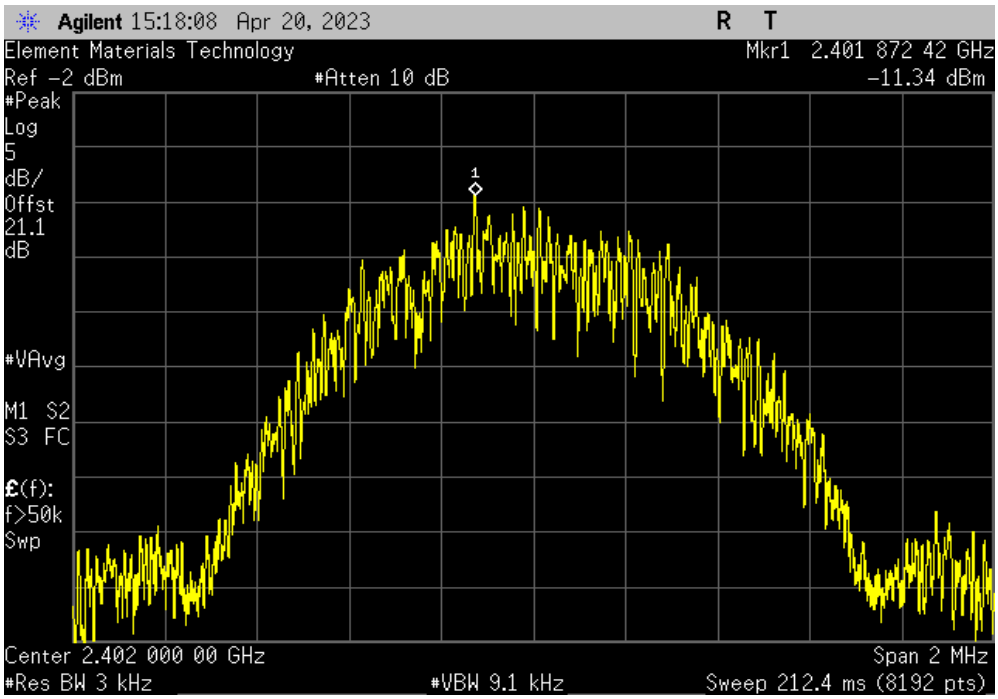
DEVIATIONS FROM TEST STANDARD

None

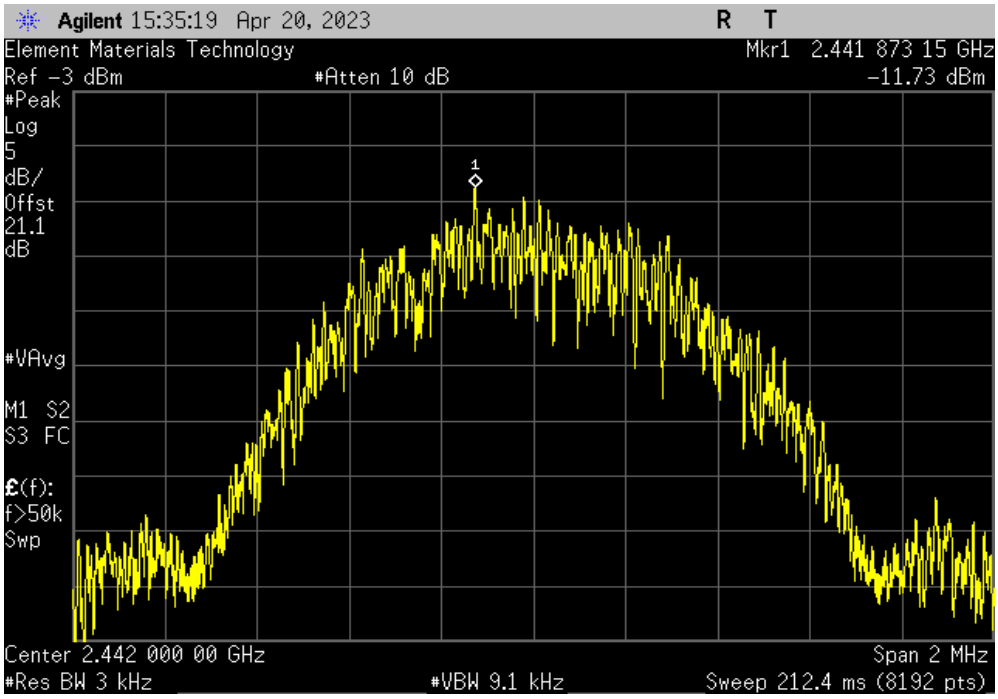
Configuration #	**5**	*Signature*

	Value dBm/3kHz	**Limit < dBm/3kHz**	**Results**
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	-11.344	8	Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	-11.731	8	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	-15.581	8	Pass

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-11.344	8	Pass

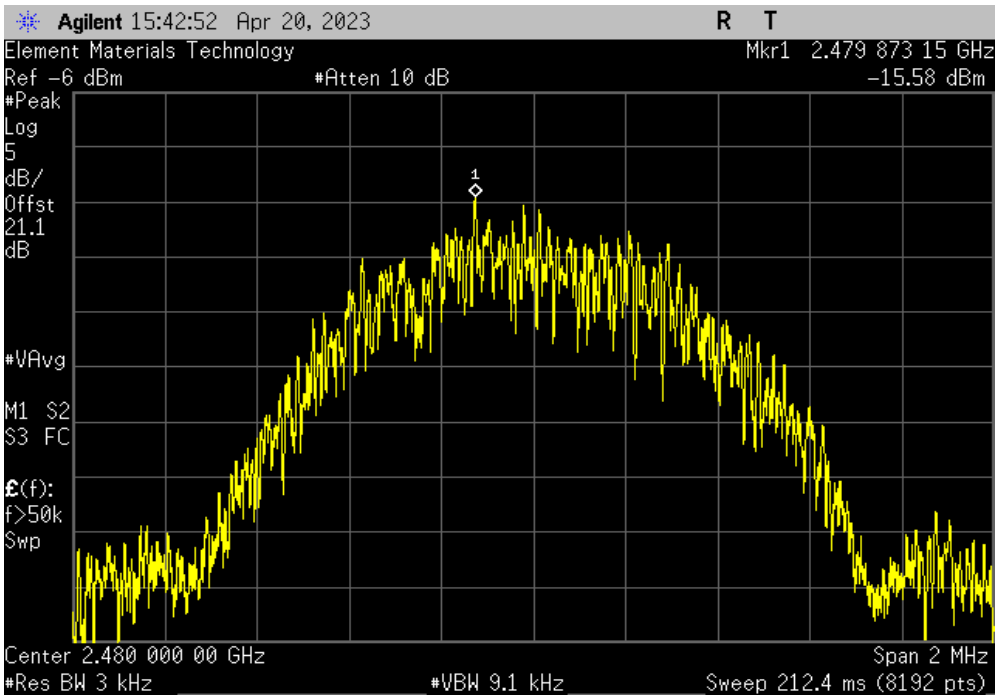


BLE/GFSK 1 Mbps Mid Channel, 2442 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-11.731	8	Pass



POWER SPECTRAL DENSITY

BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-15.581	8	Pass



BAND EDGE COMPLIANCE

XMit 2023.02.14.0

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
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2023-01-18	2024-01-18
Attenuator	Fairview Microwave	SA4014-20	QAA	2023-02-17	2024-02-17
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25
Block - DC	Weinschel Corp.	7006	AMS	2023-01-18	2024-01-18

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

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 2022.06.03.0 XMit 2023.02.14.0

EUT:	**PQXMOD1**			**Work Order:**	**SMTE0005**
Serial Number:	**Conducted Sample**			**Date:**	**04/20/2023**
Customer:	**SMART Technologies**			**Temperature:**	**20.4°C**
Attendees:	**Sean MacKellar**			**Humidity:**	**42.6%**
Project:	**None**			**Barometric Pres.:**	**1020 mbar**
Tested by:	**Harry Zhao**	**Power:**	**1.5 VDC**	**Job Site:**	**NC06**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

COMMENTS

Reference level offset: DC Block, 20 dB attenuator, patch cable, and measurement cable

DEVIATIONS FROM TEST STANDARD

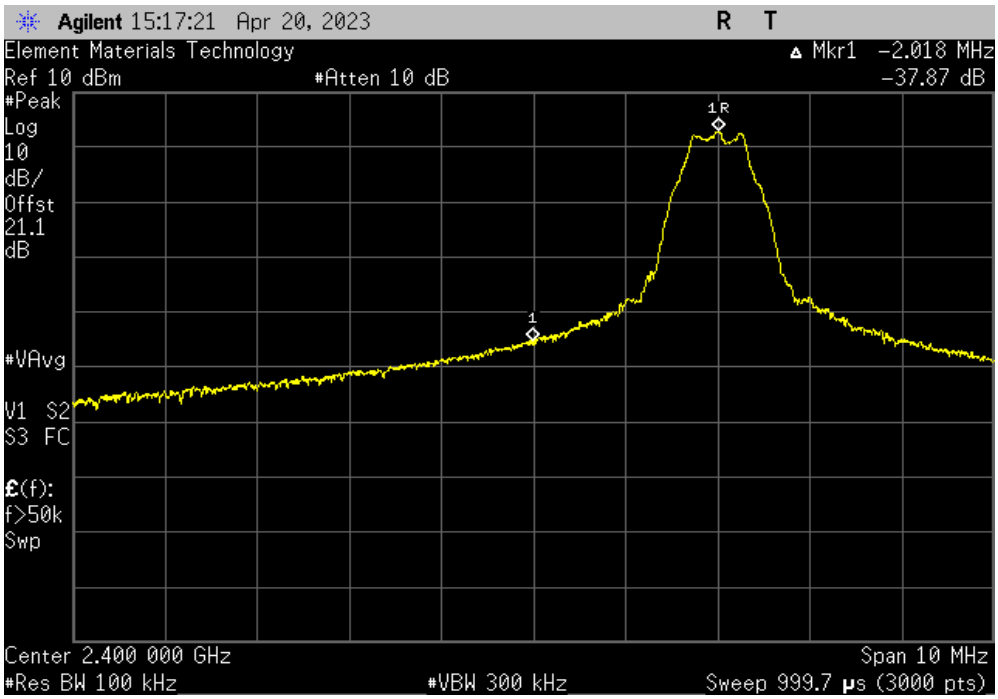
None

Configuration #	**5**	*Signature*

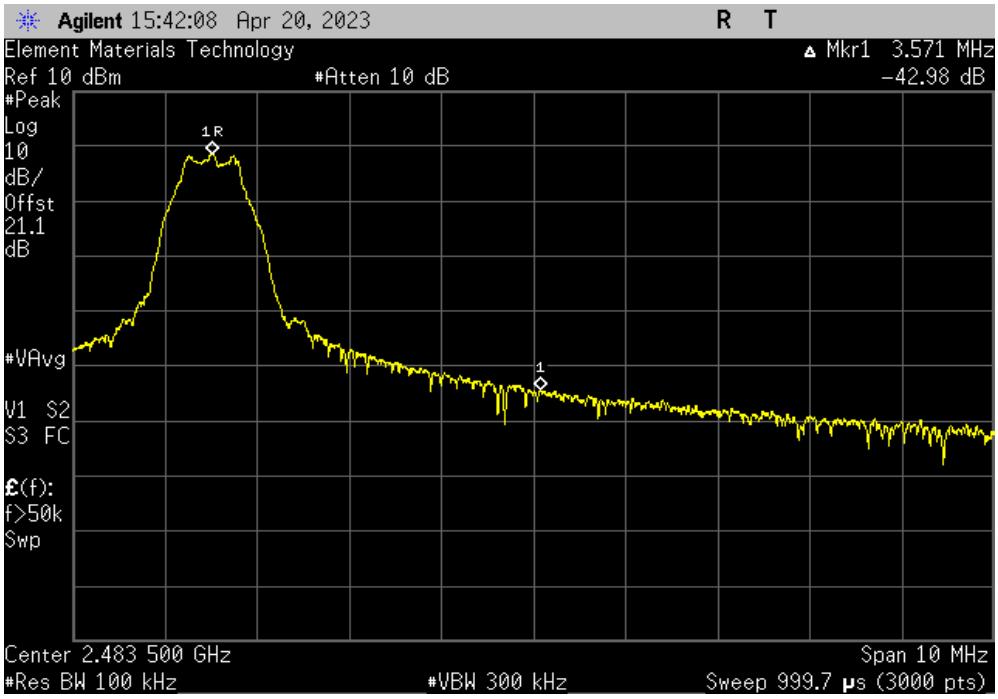
	Value (dBc)	**Limit ≤ (dBc)**	**Result**
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	-37.87	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	-42.98	-20	Pass

BAND EDGE COMPLIANCE

BLE/GFSK 1 Mbps Low Channel, 2402 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-37.87	-20	Pass



BLE/GFSK 1 Mbps High Channel, 2480 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-42.98	-20	Pass



SPURIOUS CONDUCTED EMISSIONS

XMit 2023.02.14.0

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
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2023-01-18	2024-01-18
Attenuator	Fairview Microwave	SA4014-20	QAA	2023-02-17	2024-02-17
Block - DC	Weinschel Corp.	7006	AMS	2023-01-18	2024-01-18
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

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 fundamental was measured with a 100 kHz resolution bandwidth and the highest value was recorded. The rest of the spectrum was then measured with a 100 kHz resolution bandwidth and the highest value was found. The difference between the value found on the fundamental and the rest of the spectrum was compared against the limit to determine compliance.

The reference level offset for the fundamental screen capture was based on a measured value of the loss between the spectrum analyzer and the EUT which was verified at the time of test. The remaining screen capture(s) use an internal transducer factor on the analyzer to correct the displayed trace based on the cable loss over frequency. The reference level offset for the additional screen capture(s) is then based on the expected attenuator value and any other losses.

Fundamental Offset = Ref Lvl Offset showing measured composite factor of all losses

Remaining Screen capture(s) Offset = “Internal” cable loss factor not shown on screen capture + Ref Lvl Offset showing expected attenuator value and any other losses

SPURIOUS CONDUCTED EMISSIONS

TbtTx 2022.06.03.0 XMit 2023.02.14.0

EUT:	**PQXMOD1**			**Work Order:**	**SMTE0005**
Serial Number:	**Conducted Sample**			**Date:**	**04/20/2023**
Customer:	**SMART Technologies**			**Temperature:**	**20.9°C**
Attendees:	**Sean MacKellar**			**Humidity:**	**43.1%**
Project:	**None**			**Barometric Pres.:**	**1020 mbar**
Tested by:	**Harry Zhao**	**Power:**	**1.5 VDC**	**Job Site:**	**NC06**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

COMMENTS

Reference level offset: DC Block, 20 dB attenuator, patch cable, and measurement cable

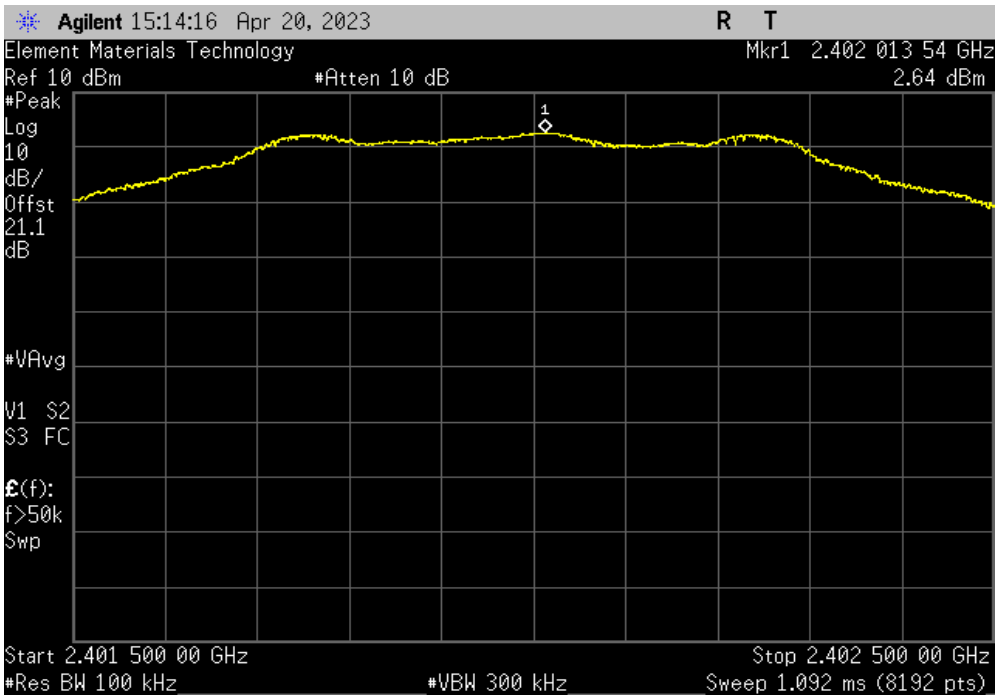
DEVIATIONS FROM TEST STANDARD

None

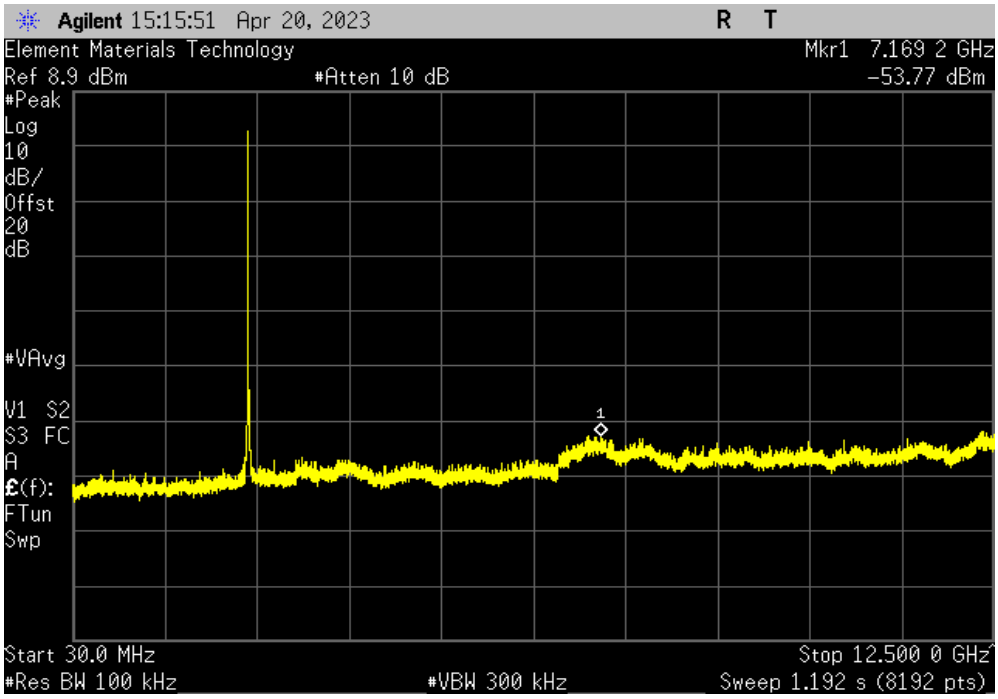
Configuration #	**5**	*Signature*

	Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	Fundamental	2402.01	N/A	N/A	N/A
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	30 MHz - 12.5 GHz	7169.2	-56.41	-20	Pass
BLE/GFSK 1 Mbps Low Channel, 2402 MHz	12.5 GHz - 25 GHz	24798.6	-51.01	-20	Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	Fundamental	2442.01	N/A	N/A	N/A
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	30 MHz - 12.5 GHz	12302.1	-55.15	-20	Pass
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz	12.5 GHz - 25 GHz	23657.1	-50.61	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	Fundamental	2480.02	N/A	N/A	N/A
BLE/GFSK 1 Mbps High Channel, 2480 MHz	30 MHz - 12.5 GHz	7071.7	-53.24	-20	Pass
BLE/GFSK 1 Mbps High Channel, 2480 MHz	12.5 GHz - 25 GHz	24929.8	-46.65	-20	Pass

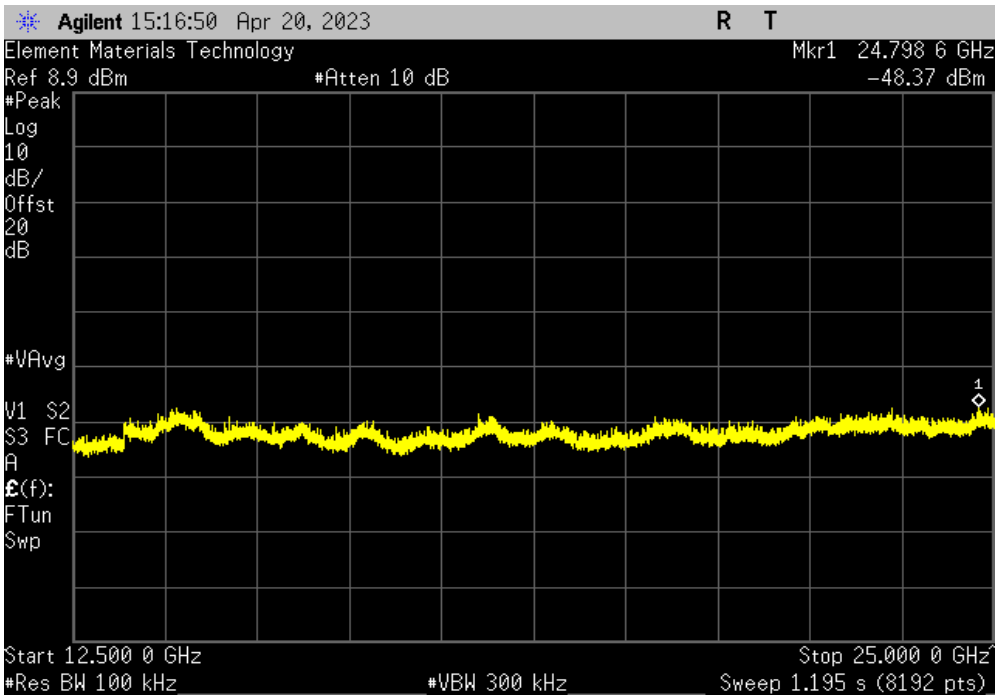
BLE/GFSK 1 Mbps Low Channel, 2402 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2402.01	N/A	N/A	N/A



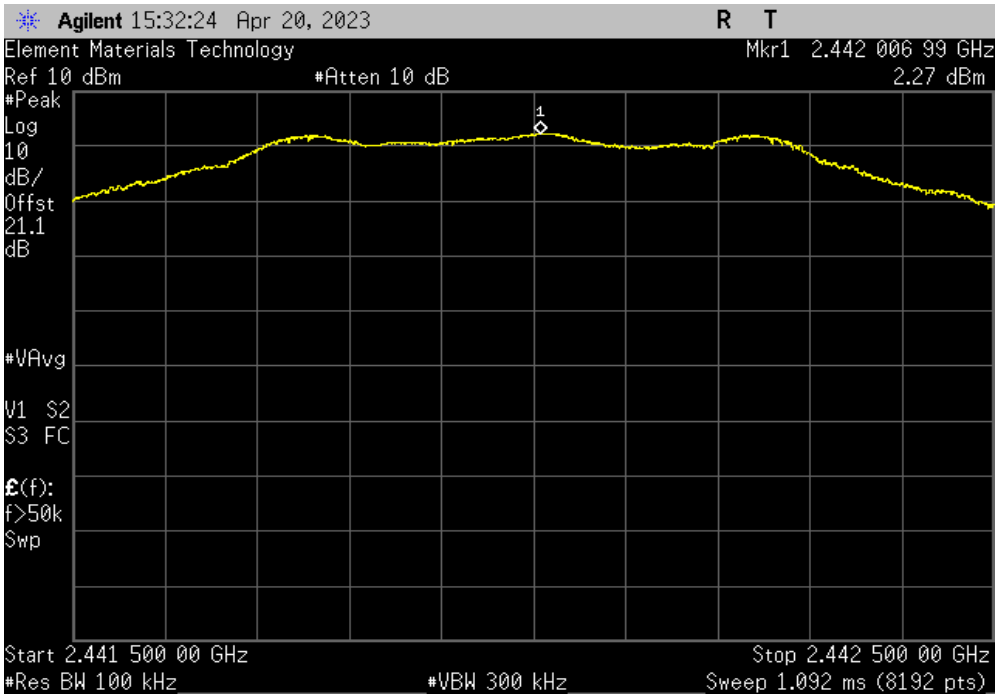
BLE/GFSK 1 Mbps Low Channel, 2402 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	7169.2	-56.41	-20	Pass



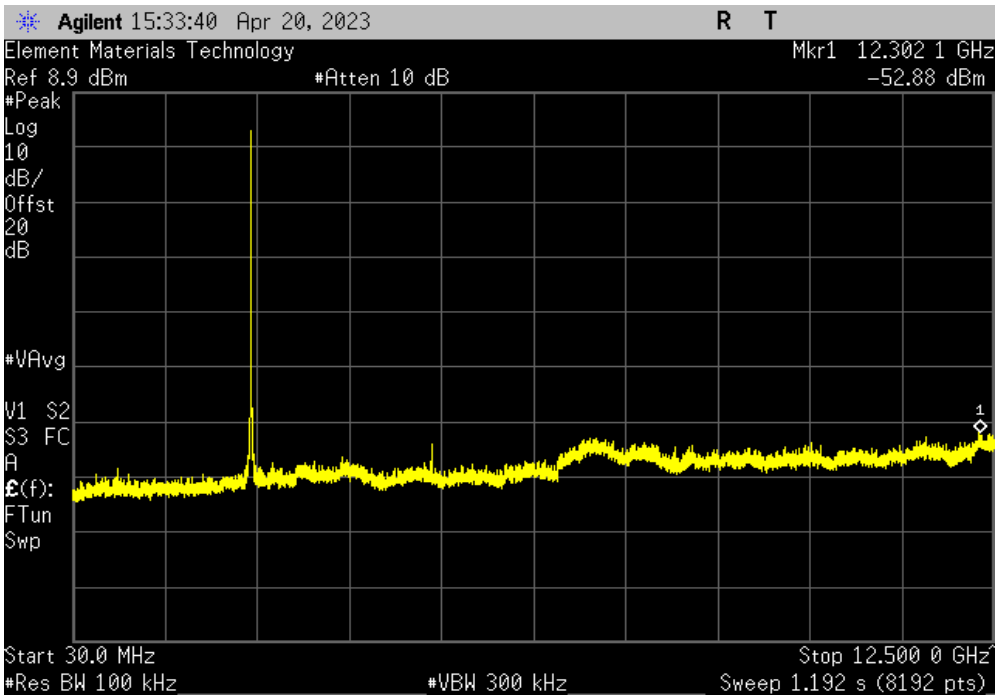
BLE/GFSK 1 Mbps Low Channel, 2402 MHz				
Frequency Range	**Measured Freq (MHz)**	**Max Value (dBc)**	**Limit ≤ (dBc)**	**Result**
12.5 GHz - 25 GHz	24798.6	-51.01	-20	Pass



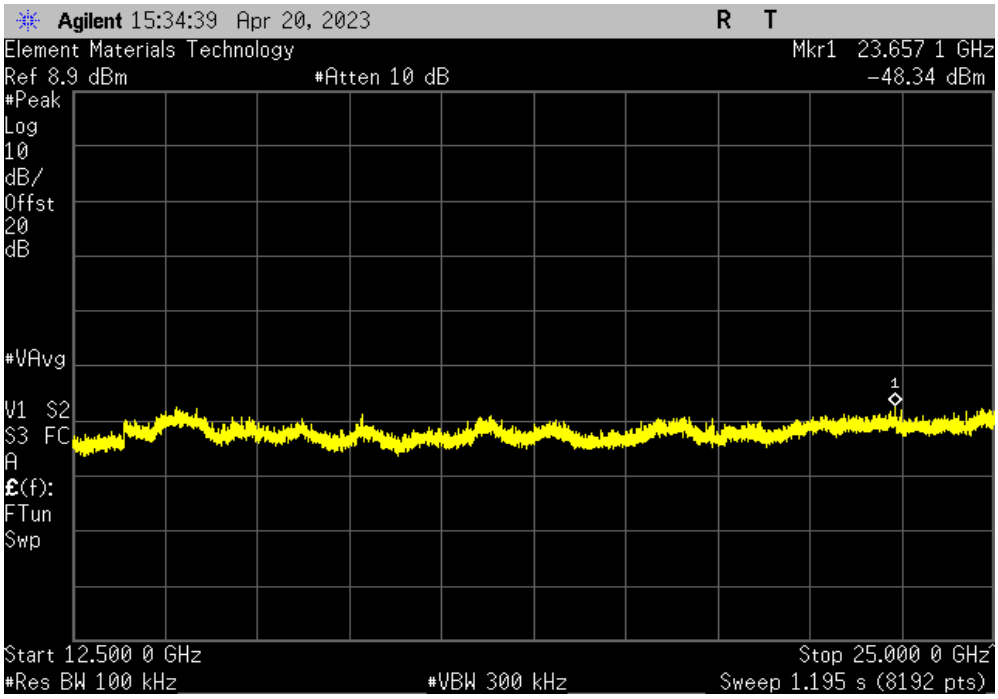
BLE/GFSK 1 Mbps Mid Channel, 2442 MHz				
Frequency Range	**Measured Freq (MHz)**	**Max Value (dBc)**	**Limit ≤ (dBc)**	**Result**
Fundamental	2442.01	N/A	N/A	N/A



BLE/GFSK 1 Mbps Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	12302.1	-55.15	-20	Pass

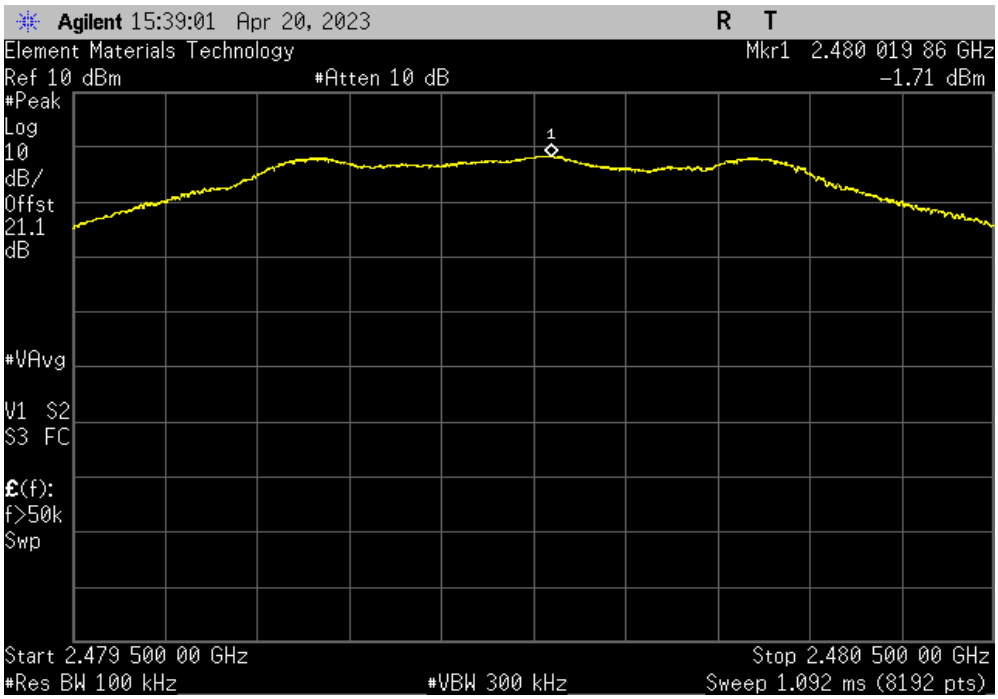


BLE/GFSK 1 Mbps Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	23657.1	-50.61	-20	Pass



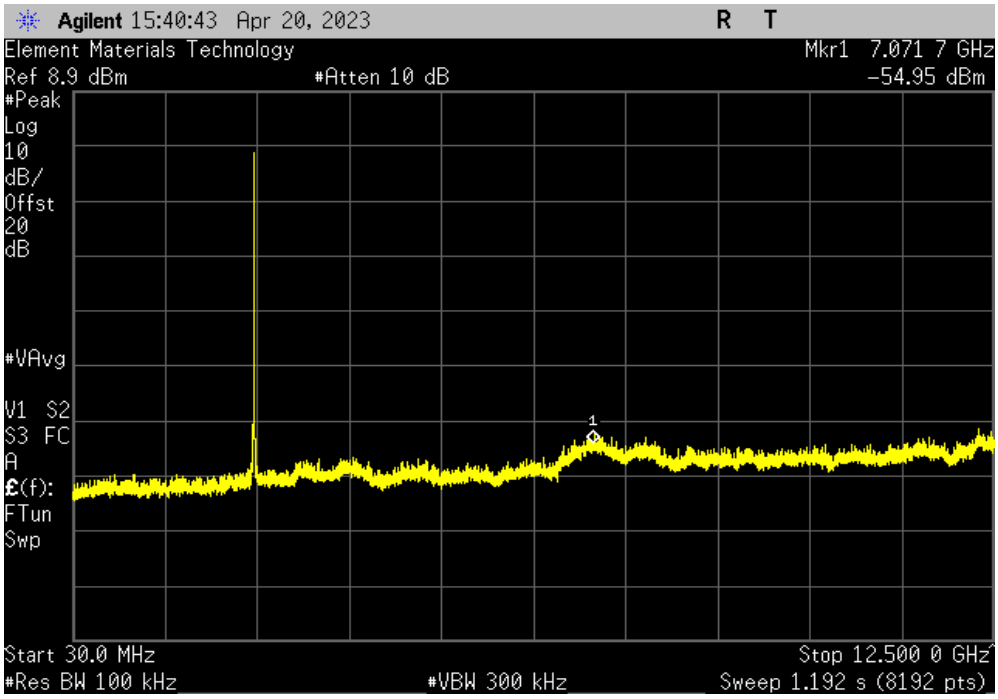
BLE/GFSK 1 Mbps High Channel, 2480 MHz

Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Fundamental		2480.02	N/A	N/A	N/A



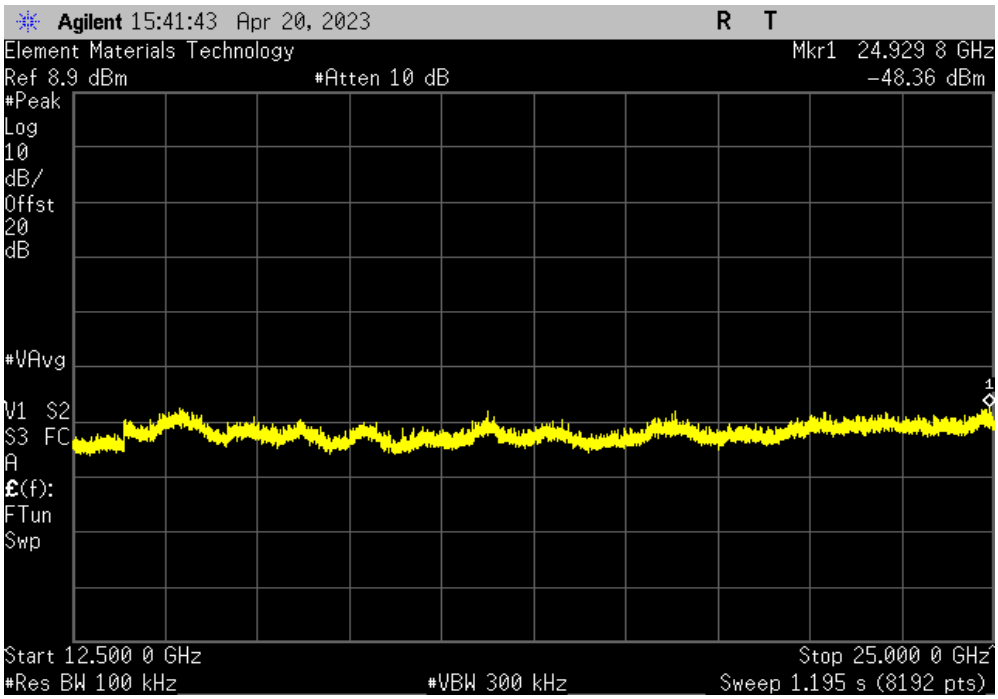
BLE/GFSK 1 Mbps High Channel, 2480 MHz

Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	7071.7	-53.24	-20	Pass



SPURIOUS CONDUCTED EMISSIONS

BLE/GFSK 1 Mbps High Channel, 2480 MHz				
Frequency Range	**Measured Freq (MHz)**	**Max Value (dBc)**	**Limit ≤ (dBc)**	**Result**
12.5 GHz - 25 GHz	24929.8	-46.65	-20	Pass



SPURIOUS RADIATED EMISSIONS – PEN BOARD

element
WTD.2022.12.01.0
EmiR5 2022.07.06.0
PSA-ESCI 2022.12.29.0

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 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).

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Antenna - Double Ridge	EMCO	3115	AHM	2022-07-13	2024-07-13
Cable	Northwest EMC	3115 Horn Cable	NC2	2022-04-14	2023-04-14
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVZ	2022-04-14	2023-04-14
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	2022-11-03	2023-11-03
Antenna - Standard Gain	EMCO	3160-07	AHP	NCR	NCR
Cable	High Speed Interconnects	EW292A-NGNG-300	NC3	2022-08-30	2023-08-30
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AOK	2022-08-04	2023-08-04
Antenna - Standard Gain	EMCO	3160-08	AHO	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AOJ	2022-08-04	2023-08-04
Filter - High Pass	Micro-Tronics	HPM50111	HHI	2022-10-03	2023-10-03
Attenuator	Fairview Microwave	SA18E-20	AQV	2022-07-28	2023-07-28
Filter - Low Pass	Micro-Tronics	LPM50004	LFF	2022-11-01	2023-11-01
Cable	Northwest EMC	Bilog Cables	NC1	2023-01-29	2024-01-29
Antenna - Biconilog	Teseq	CBL 6141B	AYL	2021-10-05	2023-10-05
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	PAB	2023-01-29	2024-01-29
Antenna - Standard Gain	ETS Lindgren	3160-09	AIY	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AOD	2022-03-21	2023-03-21
Cable	Northwest EMC	N/A	NC8	2022-03-21	2023-03-21

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	5.2 dB	-5.2 dB

FREQUENCY RANGE INVESTIGATED

30 MHz TO 26.5 GHz

POWER INVESTIGATED

1.5 VDC via DC converter 120V/60Hz

SPURIOUS RADIATED EMISSIONS – PEN BOARD

element
WTD.2022.12.01.0
EmiR5 2022.07.06.0
PSA-ESCI 2022.12.29.0

CONFIGURATIONS INVESTIGATED

SMTE0005-7

MODES INVESTIGATED

Transmitting BLE, Low Channel 0 = 2402 MHz, Middle Channel 20 = 2442 MHz, High Channel 39 = 2480 MHz, Data rate = 1 Mbps

SPURIOUS RADIATED EMISSIONS – PEN BOARD

element
WTD.2022.12.01.0
EmiR5 2022.07.06.0
PSA-ESCI 2022.12.29.0

EUT:	PQXMOD1	Work Order:	SMTE0005
Serial Number:	Sample 1	Date:	2023-03-03
Customer:	SMART Technologies	Temperature:	20.9°C
Attendees:	Sean MacKellar	Relative Humidity:	30.5%
Customer Project:	None	Bar. Pressure (PMSL):	1014 mb
Tested By:	Harry Zhao	Job Site:	NC01
Power:	1.5 VDC via DC converter 120V/60Hz	Configuration:	SMTE0005-7

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

TEST PARAMETERS

Run #:	95	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)

COMMENTS

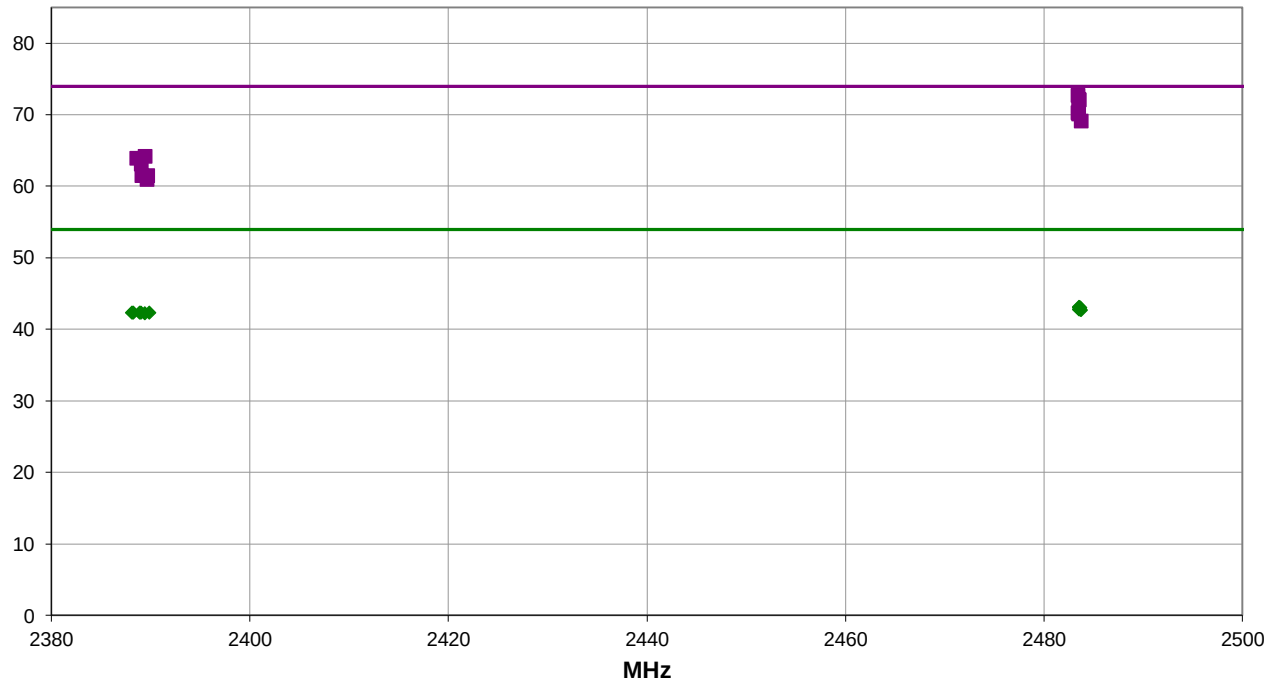
Pen Board/Module (Final LC matching). The test mode operates at 54% duty cycle (DC), an upward duty cycle correction factor (DCCF) of 10*log(1/DC) = 10*log(1/0.54) = 2.676 dB was applied to the average measurements. When in actual operation, the max operating duty cycle is 9.02%. A downward DCCF correction applied based on 10*log(0.0902) = -10.445 dB was applied to the average measurements. Total correction applied = -7.72 dB. See data comments below for EUT orientation, power, and channel.

EUT OPERATING MODES

Transmitting BLE, Low Channel 0 = 2402 MHz, Middle Channel 20 = 2442 MHz, High Channel 39 = 2480 MHz, Data rate = 1 Mbps

DEVIATIONS FROM TEST STANDARD

None



Run #: 95 PK AV QP

SPURIOUS RADIATED EMISSIONS – PEN BOARD

element
WTD.2022.12.01.0
EmiR5 2022.07.06.0
PSA-ESCI 2022.12.29.0

RESULTS - Run #95

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/ Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2483.510	51.4	1.2	3.9	148.0	0.0	20.0	Vert	PK	0.0	72.6	74.0	-1.4	Ch. 39, EUT in Z-axis, 0 dBm
2483.537	50.9	1.2	3.8	157.0	0.0	20.0	Vert	PK	0.0	72.1	74.0	-1.9	Ch. 39, EUT in Y-axis, 0 dBm
2483.617	50.8	1.2	3.8	207.0	0.0	20.0	Vert	PK	0.0	72.0	74.0	-2.0	Ch. 39, EUT in X-axis, 0 dBm
2483.503	49.0	1.2	3.3	88.0	0.0	20.0	Horz	PK	0.0	70.2	74.0	-3.8	Ch. 39, EUT in Z-axis, 0 dBm
2483.577	48.8	1.2	1.0	232.0	0.0	20.0	Horz	PK	0.0	70.0	74.0	-4.0	Ch. 39, EUT in X-axis, 0 dBm
2483.797	47.8	1.2	2.1	139.0	0.0	20.0	Horz	PK	0.0	69.0	74.0	-5.0	Ch. 39, EUT in Y-axis, 0 dBm
2389.510	43.1	1.0	1.5	223.0	0.0	20.0	Horz	PK	0.0	64.1	74.0	-9.9	Ch. 0, EUT in X-axis, 4 dBm
2388.667	42.8	1.0	1.3	173.0	0.0	20.0	Vert	PK	0.0	63.8	74.0	-10.2	Ch. 0, EUT in Y-axis, 4 dBm
2483.587	29.6	1.2	3.8	207.0	-7.7	20.0	Vert	AV	0.0	43.1	54.0	-10.9	Ch. 39, EUT in X-axis, 0 dBm
2389.100	42.0	1.0	1.5	272.0	0.0	20.0	Horz	PK	0.0	63.0	74.0	-11.0	Ch. 0, EUT in Z-axis, 4 dBm
2483.717	29.5	1.2	3.9	148.0	-7.7	20.0	Vert	AV	0.0	43.0	54.0	-11.0	Ch. 39, EUT in Z-axis, 0 dBm
2483.560	29.5	1.2	3.8	157.0	-7.7	20.0	Vert	AV	0.0	43.0	54.0	-11.0	Ch. 39, EUT in Y-axis, 0 dBm
2483.543	29.3	1.2	3.3	88.0	-7.7	20.0	Horz	AV	0.0	42.8	54.0	-11.2	Ch. 39, EUT in Z-axis, 0 dBm
2483.677	29.3	1.2	1.0	232.0	-7.7	20.0	Horz	AV	0.0	42.8	54.0	-11.2	Ch. 39, EUT in X-axis, 0 dBm
2483.760	29.2	1.2	2.1	139.0	-7.7	20.0	Horz	AV	0.0	42.7	54.0	-11.3	Ch. 39, EUT in Y-axis, 0 dBm
2388.930	29.0	1.0	1.5	223.0	-7.7	20.0	Horz	AV	0.0	42.3	54.0	-11.7	Ch. 0, EUT in X-axis, 4 dBm
2388.113	29.0	1.0	1.5	85.0	-7.7	20.0	Vert	AV	0.0	42.3	54.0	-11.7	Ch. 0, EUT in X-axis, 4 dBm
2388.293	29.0	1.0	1.5	272.0	-7.7	20.0	Horz	AV	0.0	42.3	54.0	-11.7	Ch. 0, EUT in Z-axis, 4 dBm
2389.860	29.0	1.0	3.3	170.0	-7.7	20.0	Horz	AV	0.0	42.3	54.0	-11.7	Ch. 0, EUT in Y-axis, 4 dBm
2389.060	29.0	1.0	1.3	173.0	-7.7	20.0	Vert	AV	0.0	42.3	54.0	-11.7	Ch. 0, EUT in Y-axis, 4 dBm
2389.397	28.9	1.0	1.5	231.0	-7.7	20.0	Vert	AV	0.0	42.2	54.0	-11.8	Ch. 0, EUT in Z-axis, 4 dBm
2389.143	40.4	1.0	1.5	231.0	0.0	20.0	Vert	PK	0.0	61.4	74.0	-12.6	Ch. 0, EUT in Z-axis, 4 dBm
2389.723	40.4	1.0	3.3	170.0	0.0	20.0	Horz	PK	0.0	61.4	74.0	-12.6	Ch. 0, EUT in Y-axis, 4 dBm
2389.680	39.9	1.0	1.5	85.0	0.0	20.0	Vert	PK	0.0	60.9	74.0	-13.1	Ch. 0, EUT in X-axis, 4 dBm

CONCLUSION

Pass

Tested By

SPURIOUS RADIATED EMISSIONS – PEN BOARD

element
WTD.2022.12.01.0
EmiR5 2022.07.06.0
PSA-ESCI 2022.12.29.0

EUT:	PQXMOD1	Work Order:	SMTE0005
Serial Number:	Sample 1	Date:	2023-03-03
Customer:	SMART Technologies	Temperature:	20.9°C
Attendees:	Sean MacKellar	Relative Humidity:	30.5%
Customer Project:	None	Bar. Pressure (PMSL):	1014 mb
Tested By:	Harry Zhao	Job Site:	NC01
Power:	1.5 VDC via DC converter 120V/60Hz	Configuration:	SMTE0005-7

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

TEST PARAMETERS

Run #:	94	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)

COMMENTS

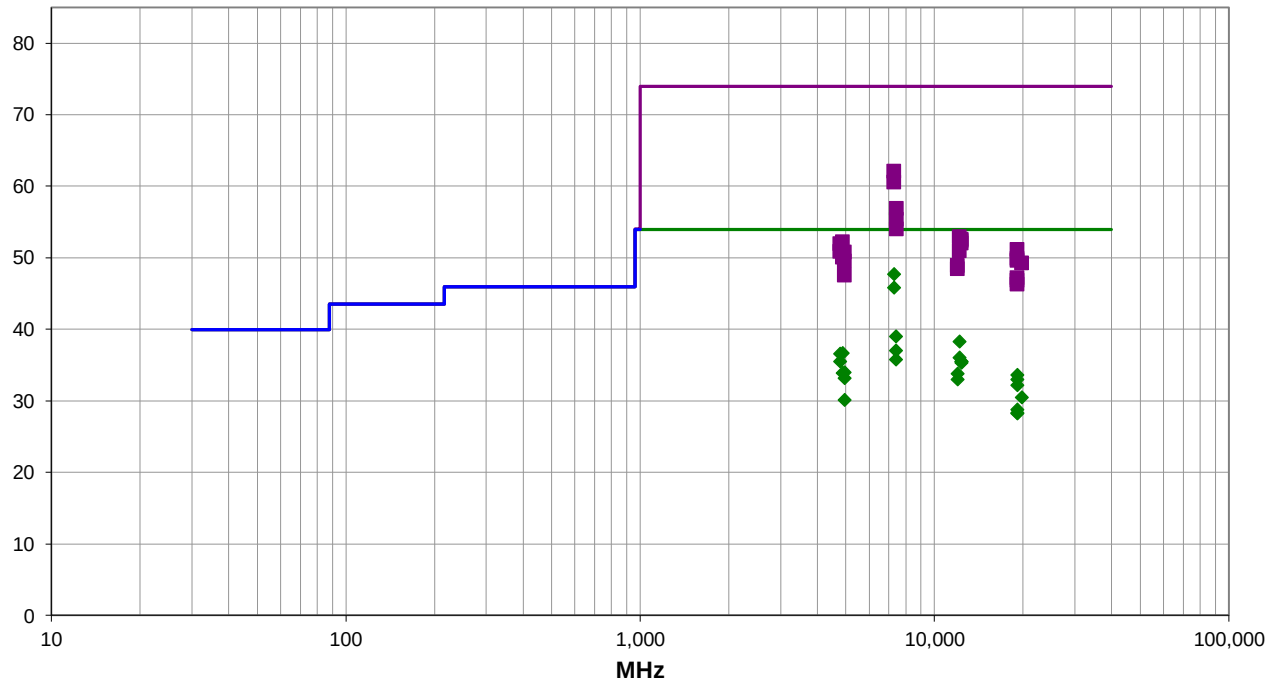
Pen Board/Module (Final LC matching). The test mode operates at 54% duty cycle (DC), an upward duty cycle correction factor (DCCF) of 10*log(1/DC) = 10*log(1/0.54) = 2.676 dB was applied to the average measurements. When in actual operation, the max operating duty cycle is 9.02%. A downward DCCF correction applied based on 10*log(0.0902) = -10.445 dB was applied to the average measurements. Total correction applied = -7.72 dB. See data comments below for EUT orientation, power, and channel.

EUT OPERATING MODES

Transmitting BLE, Low Channel 0 = 2402 MHz, Middle Channel 20 = 2442 MHz, High Channel 39 = 2480 MHz, Data rate = 1 Mbps

DEVIATIONS FROM TEST STANDARD

None



Run #: 94 PK AV QP

SPURIOUS RADIATED EMISSIONS – PEN BOARD

element
WTD.2022.12.01.0
EmiR5 2022.07.06.0
PSA-ESCI 2022.12.29.0

RESULTS - Run #94

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/ Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
7325.483	40.9	14.5	3.2	94.0	-7.7	0.0	Vert	AV	0.0	47.7	54.0	-6.3	Ch. 20, EUT in Z-axis, 4 dBm
7325.483	39.0	14.5	2.3	232.0	-7.7	0.0	Horz	AV	0.0	45.8	54.0	-8.2	Ch. 20, EUT in X-axis, 4 dBm
7326.708	47.5	14.5	3.2	94.0	0.0	0.0	Vert	PK	0.0	62.0	74.0	-12.0	Ch. 20, EUT in Z-axis, 4 dBm
7326.742	46.0	14.5	2.3	232.0	0.0	0.0	Horz	PK	0.0	60.5	74.0	-13.5	Ch. 20, EUT in X-axis, 4 dBm
7439.517	31.6	15.1	1.2	66.0	-7.7	0.0	Vert	AV	0.0	39.0	54.0	-15.0	Ch. 39, EUT in Z-axis, 0 dBm
12208.880	48.1	-2.1	3.2	360.0	-7.7	0.0	Horz	AV	0.0	38.3	54.0	-15.7	Ch. 20, EUT in X-axis, 4 dBm
7439.380	29.6	15.1	2.4	120.0	-7.7	0.0	Horz	AV	0.0	37.0	54.0	-17.0	Ch. 39, EUT in Y-axis, 0 dBm
7440.317	41.7	15.1	1.2	66.0	0.0	0.0	Vert	PK	0.0	56.8	74.0	-17.2	Ch. 39, EUT in Z-axis, 0 dBm
4883.950	34.3	10.1	3.0	227.0	-7.7	0.0	Horz	AV	0.0	36.7	54.0	-17.3	Ch. 20, EUT in X-axis, 4 dBm
4803.858	34.6	9.7	1.0	70.0	-7.7	0.0	Horz	AV	0.0	36.6	54.0	-17.4	Ch. 0, EUT in X-axis, 4 dBm
12208.980	45.8	-2.1	1.4	63.0	-7.7	0.0	Vert	AV	0.0	36.0	54.0	-18.0	Ch. 20, EUT in Z-axis, 4 dBm
7439.483	28.4	15.1	3.0	229.0	-7.7	0.0	Horz	AV	0.0	35.8	54.0	-18.2	Ch. 39, EUT in X-axis, 0 dBm
12401.130	41.3	1.9	2.4	83.0	-7.7	0.0	Vert	AV	0.0	35.5	54.0	-18.5	Ch. 39, EUT in Z-axis, 0 dBm
12401.000	41.3	1.9	1.9	196.0	-7.7	0.0	Horz	AV	0.0	35.5	54.0	-18.5	Ch. 39, EUT in Y-axis, 0 dBm
4803.967	33.5	9.7	2.8	87.0	-7.7	0.0	Vert	AV	0.0	35.5	54.0	-18.5	Ch. 0, EUT in Z-axis, 4 dBm
7440.750	40.2	15.1	2.4	120.0	0.0	0.0	Horz	PK	0.0	55.3	74.0	-18.7	Ch. 39, EUT in Y-axis, 0 dBm
12401.080	41.1	1.9	1.0	359.0	-7.7	0.0	Horz	AV	0.0	35.3	54.0	-18.7	Ch. 39, EUT in X-axis, 0 dBm
7440.333	38.9	15.1	3.0	229.0	0.0	0.0	Horz	PK	0.0	54.0	74.0	-20.0	Ch. 39, EUT in X-axis, 0 dBm
4959.970	31.7	10.0	1.7	148.0	-7.7	0.0	Horz	AV	0.0	34.0	54.0	-20.0	Ch. 39, EUT in Y-axis, 0 dBm
4883.892	31.5	10.1	1.5	70.0	-7.7	0.0	Vert	AV	0.0	33.9	54.0	-20.1	Ch. 20, EUT in Z-axis, 4 dBm
12008.930	44.2	-2.7	1.5	63.0	-7.7	0.0	Vert	AV	0.0	33.8	54.0	-20.2	Ch. 0, EUT in Z-axis, 4 dBm
19214.060	41.0	0.3	1.8	80.0	-7.7	0.0	Vert	AV	0.0	33.6	54.0	-20.4	Ch. 0, EUT in Z-axis, 4 dBm
4960.017	30.9	10.0	3.6	186.0	-7.7	0.0	Vert	AV	0.0	33.2	54.0	-20.8	Ch. 39, EUT in Z-axis, 0 dBm
19214.180	40.4	0.3	1.6	176.0	-7.7	0.0	Horz	AV	0.0	33.0	54.0	-21.0	Ch. 0, EUT in Y-axis, 4 dBm
12008.860	43.4	-2.7	3.6	355.0	-7.7	0.0	Horz	AV	0.0	33.0	54.0	-21.0	Ch. 0, EUT in X-axis, 4 dBm
12211.290	55.0	-2.1	3.2	360.0	0.0	0.0	Horz	PK	0.0	52.9	74.0	-21.1	Ch. 20, EUT in X-axis, 4 dBm
12400.030	50.6	1.9	2.4	83.0	0.0	0.0	Vert	PK	0.0	52.5	74.0	-21.5	Ch. 39, EUT in Z-axis, 0 dBm
12401.090	50.4	1.9	1.9	196.0	0.0	0.0	Horz	PK	0.0	52.3	74.0	-21.7	Ch. 39, EUT in Y-axis, 0 dBm
4884.367	42.1	10.1	3.0	227.0	0.0	0.0	Horz	PK	0.0	52.2	74.0	-21.8	Ch. 20, EUT in X-axis, 4 dBm
19214.130	39.6	0.3	1.5	79.0	-7.7	0.0	Vert	AV	0.0	32.2	54.0	-21.8	Ch. 0, EUT in X-axis, 4 dBm
12401.030	50.1	1.9	1.0	359.0	0.0	0.0	Horz	PK	0.0	52.0	74.0	-22.0	Ch. 39, EUT in X-axis, 0 dBm
4804.500	42.2	9.7	1.0	70.0	0.0	0.0	Horz	PK	0.0	51.9	74.0	-22.1	Ch. 0, EUT in X-axis, 4 dBm
19214.030	50.8	0.3	1.8	80.0	0.0	0.0	Vert	PK	0.0	51.1	74.0	-22.9	Ch. 0, EUT in Z-axis, 4 dBm
12211.340	53.0	-2.1	1.4	63.0	0.0	0.0	Vert	PK	0.0	50.9	74.0	-23.1	Ch. 20, EUT in Z-axis, 4 dBm
4804.133	41.1	9.7	2.8	87.0	0.0	0.0	Vert	PK	0.0	50.8	74.0	-23.2	Ch. 0, EUT in Z-axis, 4 dBm
4960.400	40.7	10.0	1.7	148.0	0.0	0.0	Horz	PK	0.0	50.7	74.0	-23.3	Ch. 39, EUT in Y-axis, 0 dBm
19838.180	36.5	1.7	1.8	85.0	-7.7	0.0	Vert	AV	0.0	30.5	54.0	-23.5	Ch. 39, EUT in Z-axis, 0 dBm
4959.933	27.8	10.0	1.5	349.0	-7.7	0.0	Horz	AV	0.0	30.1	54.0	-23.9	Ch. 39, EUT in X-axis, 0 dBm
4883.717	39.9	10.1	1.5	70.0	0.0	0.0	Vert	PK	0.0	50.0	74.0	-24.0	Ch. 20, EUT in Z-axis, 4 dBm
19218.040	49.5	0.3	1.6	176.0	0.0	0.0	Horz	PK	0.0	49.8	74.0	-24.2	Ch. 0, EUT in Y-axis, 4 dBm
19214.120	49.3	0.3	1.5	79.0	0.0	0.0	Vert	PK	0.0	49.6	74.0	-24.4	Ch. 0, EUT in X-axis, 4 dBm
4959.592	39.5	10.0	3.6	186.0	0.0	0.0	Vert	PK	0.0	49.5	74.0	-24.5	Ch. 39, EUT in Z-axis, 0 dBm
19838.060	47.5	1.7	1.8	85.0	0.0	0.0	Vert	PK	0.0	49.2	74.0	-24.8	Ch. 39, EUT in Z-axis, 0 dBm

SPURIOUS RADIATED EMISSIONS – PEN BOARD

element
WTD.2022.12.01.0
EmiR5 2022.07.06.0
PSA-ESCI 2022.12.29.0

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/ Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
12011.180	51.5	-2.7	1.5	63.0	0.0	0.0	Vert	PK	0.0	48.8	74.0	-25.2	Ch. 0, EUT in Z-axis, 4 dBm
19214.250	36.2	0.3	1.7	359.0	-7.7	0.0	Vert	AV	0.0	28.8	54.0	-25.2	Ch. 0, EUT in Y-axis, 4 dBm
12011.250	51.1	-2.7	3.6	355.0	0.0	0.0	Horz	PK	0.0	48.4	74.0	-25.6	Ch. 0, EUT in X-axis, 4 dBm
19217.420	35.7	0.3	1.5	317.0	-7.7	0.0	Horz	AV	0.0	28.3	54.0	-25.7	Ch. 0, EUT in X-axis, 4 dBm
19213.530	35.6	0.3	1.5	137.0	-7.7	0.0	Horz	AV	0.0	28.2	54.0	-25.8	Ch. 0, EUT in Z-axis, 4 dBm
4959.683	37.5	10.0	1.5	349.0	0.0	0.0	Horz	PK	0.0	47.5	74.0	-26.5	Ch. 39, EUT in X-axis, 0 dBm
19215.750	46.8	0.3	1.5	137.0	0.0	0.0	Horz	PK	0.0	47.1	74.0	-26.9	Ch. 0, EUT in Z-axis, 4 dBm
19213.930	46.5	0.3	1.7	359.0	0.0	0.0	Vert	PK	0.0	46.8	74.0	-27.2	Ch. 0, EUT in Y-axis, 4 dBm
19217.730	45.9	0.3	1.5	317.0	0.0	0.0	Horz	PK	0.0	46.2	74.0	-27.8	Ch. 0, EUT in X-axis, 4 dBm

CONCLUSION

Pass

Tested By

SPURIOUS RADIATED EMISSIONS – ASSEMBLED PEN

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.02.14.0

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 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).

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Agilent	E4440A	AAX	2023-01-19	2024-01-19
Filter - Low Pass	Micro-Tronics	LPM50004	LFF	2022-11-01	2023-11-01
Cable	Northwest EMC	Bilog Cables	NC1	2023-01-29	2024-01-29
Antenna - Biconilog	Teseq	CBL 6141B	AYL	2021-10-05	2023-10-05
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	PAB	2023-01-29	2024-01-29
Antenna - Double Ridge	EMCO	3115	AHM	2022-07-13	2024-07-13
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVZ	2023-04-25	2024-04-25
Cable	Northwest EMC	3115 Horn Cable	NC2	2023-04-25	2024-04-25
Attenuator	Fairview Microwave	SA18E-20	AQV	2022-07-28	2023-07-28
Filter - High Pass	Micro-Tronics	HPM50111	HHI	2022-10-03	2023-10-03
Antenna - Standard Gain	EMCO	3160-07	AHP	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AOK	2022-08-04	2023-08-04
Cable	High Speed Interconnects	EW292A-NGNG-300	NC3	2022-08-30	2023-08-30
Antenna - Standard Gain	EMCO	3160-08	AHO	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AOJ	2022-08-04	2023-08-04
Antenna - Standard Gain	ETS Lindgren	3160-09	AIY	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AOD	2022-03-21	2023-03-21
Cable	Northwest EMC	N/A	NC8	2022-03-21	2023-03-21

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	5.2 dB	-5.2 dB

FREQUENCY RANGE INVESTIGATED

30 MHz TO 26.5 GHz

SPURIOUS RADIATED EMISSIONS – ASSEMBLED PEN

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.02.14.0

POWER INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

SMTE0005-11

MODES INVESTIGATED

Transmitting BLE, Low Channel 0 = 2402 MHz, Middle Channel 19 = 2440 MHz, High Channel 39 = 2480 MHz, Data rate = 1 Mbps

SPURIOUS RADIATED EMISSIONS – ASSEMBLED PEN

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.02.14.0

EUT:	PQXMOD1 in PQX-1 host	Work Order:	SMTE0005
Serial Number:	Sample 1	Date:	2023-05-03
Customer:	SMART Technologies	Temperature:	22.1°C
Attendees:	Sean MacKellar	Relative Humidity:	46%
Customer Project:	None	Bar. Pressure (PMSL):	1007 mb
Tested By:	Harry Zhao	Job Site:	NC01
Power:	Battery	Configuration:	SMTE0005-11

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

TEST PARAMETERS

Run #:	137	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)

COMMENTS

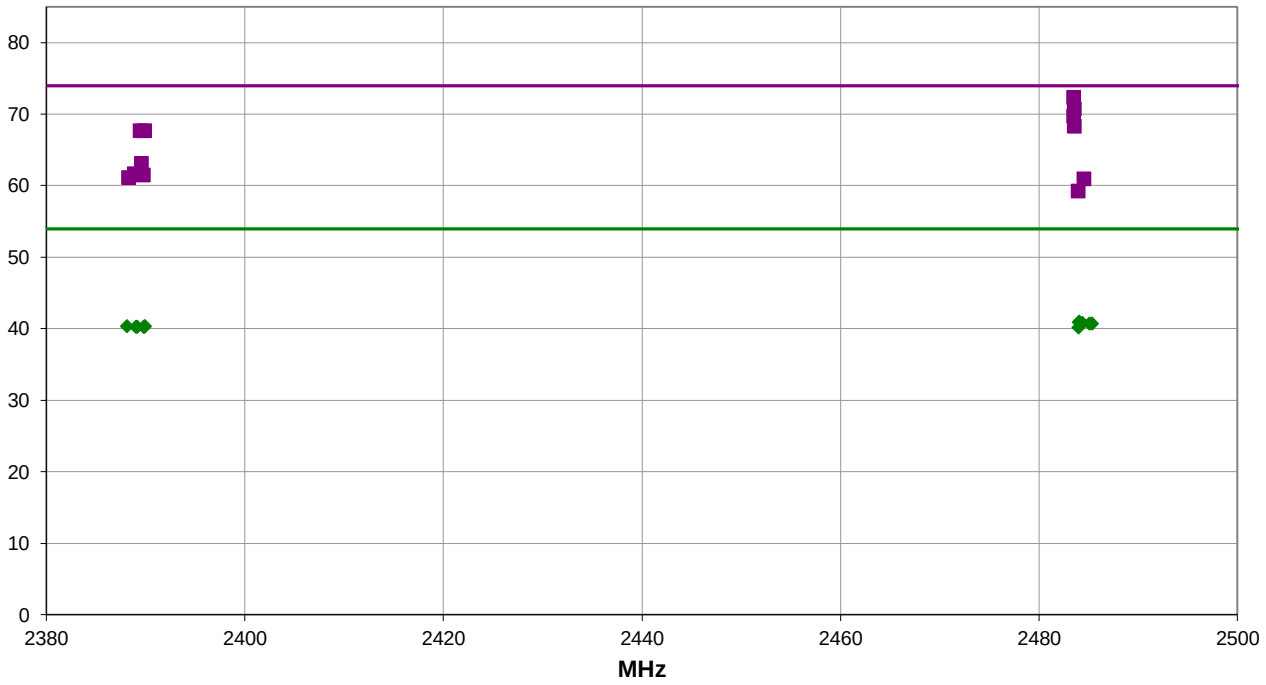
The test mode operates at 85.2% duty cycle (DC), an upward duty cycle correction factor (DCCF) of 10*log(1/DC) = 10*log(1/0.54) = 0.696 dB was applied to the average measurements. When in actual operation, the max operating duty cycle is 9.02%. A downward DCCF correction applied based on 10*log(0.0902) = -10.445 dB was applied to the average measurements. Total correction applied = -9.749 dB. See data comments below for channel, EUT orientation, and channel transmit power.

EUT OPERATING MODES

Transmitting BLE, Low Channel 0 = 2402 MHz, Middle Channel 19 = 2440 MHz, High Channel 39 = 2480 MHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 137 PK AV QP

SPURIOUS RADIATED EMISSIONS – ASSEMBLED PEN

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.02.14.0

RESULTS - Run #137

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/ Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2483.593	51.0	1.3	1.1	34.0	0.0	20.0	Horz	PK	0.0	72.3	74.0	-1.7	Ch. 39, EUT in Y-axis, 0 dBm
2483.617	49.3	1.3	4.0	72.0	0.0	20.0	Vert	PK	0.0	70.6	74.0	-3.4	Ch. 39, EUT in Y-axis, 0 dBm
2483.573	48.4	1.3	3.8	54.0	0.0	20.0	Vert	PK	0.0	69.7	74.0	-4.3	Ch. 39, EUT in X-axis, 0 dBm
2483.650	46.9	1.3	3.9	107.0	0.0	20.0	Vert	PK	0.0	68.2	74.0	-5.8	Ch. 39, EUT in Z-axis, 0 dBm
2389.953	46.5	1.1	1.5	296.0	0.0	20.0	Horz	PK	0.0	67.6	74.0	-6.4	Ch. 0, EUT in X-axis, 4 dBm
2389.490	46.5	1.1	1.5	210.0	0.0	20.0	Horz	PK	0.0	67.6	74.0	-6.4	Ch. 0, EUT in Y-axis, 4 dBm
2389.627	41.9	1.1	4.0	280.0	0.0	20.0	Vert	PK	0.0	63.0	74.0	-11.0	Ch. 0, EUT in Y-axis, 4 dBm
2388.897	40.5	1.1	3.1	89.0	0.0	20.0	Vert	PK	0.0	61.6	74.0	-12.4	Ch. 0, EUT in Z-axis, 4 dBm
2389.817	40.3	1.1	4.0	262.0	0.0	20.0	Vert	PK	0.0	61.4	74.0	-12.6	Ch. 0, EUT in X-axis, 4 dBm
2388.317	39.9	1.1	1.1	52.0	0.0	20.0	Horz	PK	0.0	61.0	74.0	-13.0	Ch. 0, EUT in Z-axis, 4 dBm
2484.063	29.4	1.3	1.1	34.0	-9.7	20.0	Horz	AV	0.0	41.0	54.0	-13.0	Ch. 39, EUT in Y-axis, 0 dBm
2484.613	39.6	1.3	1.5	6.0	0.0	20.0	Horz	PK	0.0	60.9	74.0	-13.1	Ch. 39, EUT in Z-axis, 0 dBm
2484.103	29.3	1.3	4.0	72.0	-9.7	20.0	Vert	AV	0.0	40.9	54.0	-13.1	Ch. 39, EUT in Y-axis, 0 dBm
2484.400	29.2	1.3	3.8	54.0	-9.7	20.0	Vert	AV	0.0	40.8	54.0	-13.2	Ch. 39, EUT in X-axis, 0 dBm
2485.117	29.1	1.3	1.5	6.0	-9.7	20.0	Horz	AV	0.0	40.7	54.0	-13.3	Ch. 39, EUT in Z-axis, 0 dBm
2485.377	29.1	1.3	3.9	107.0	-9.7	20.0	Vert	AV	0.0	40.7	54.0	-13.3	Ch. 39, EUT in Z-axis, 0 dBm
2388.107	29.0	1.1	1.5	296.0	-9.7	20.0	Horz	AV	0.0	40.4	54.0	-13.6	Ch. 0, EUT in X-axis, 4 dBm
2389.950	29.0	1.1	1.5	210.0	-9.7	20.0	Horz	AV	0.0	40.4	54.0	-13.6	Ch. 0, EUT in Y-axis, 4 dBm
2389.070	28.9	1.1	4.0	262.0	-9.7	20.0	Vert	AV	0.0	40.3	54.0	-13.7	Ch. 0, EUT in X-axis, 4 dBm
2389.177	28.9	1.1	4.0	280.0	-9.7	20.0	Vert	AV	0.0	40.3	54.0	-13.7	Ch. 0, EUT in Y-axis, 4 dBm
2389.880	28.9	1.1	1.1	52.0	-9.7	20.0	Horz	AV	0.0	40.3	54.0	-13.7	Ch. 0, EUT in Z-axis, 4 dBm
2389.790	28.9	1.1	3.1	89.0	-9.7	20.0	Vert	AV	0.0	40.3	54.0	-13.7	Ch. 0, EUT in Z-axis, 4 dBm
2484.000	28.6	1.3	1.3	113.0	-9.7	20.0	Horz	AV	0.0	40.2	54.0	-13.8	Ch. 39, EUT in X-axis, 0 dBm, AV RMS Integration/Band Edge
2484.000	37.9	1.3	1.3	113.0	0.0	20.0	Horz	PK	0.0	59.2	74.0	-14.8	Ch. 39, EUT in X-axis, 0 dBm, AV RMS Integration/Band Edge

CONCLUSION

Pass

Tested By

SPURIOUS RADIATED EMISSIONS – ASSEMBLED PEN

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.02.14.0

EUT:	PQXMOD1 in PQX-1 host	Work Order:	SMTE0005
Serial Number:	Sample 1	Date:	2023-05-03
Customer:	SMART Technologies	Temperature:	22.1°C
Attendees:	Sean MacKellar	Relative Humidity:	46%
Customer Project:	None	Bar. Pressure (PMSL):	1007 mb
Tested By:	Harry Zhao	Job Site:	NC01
Power:	Battery	Configuration:	SMTE0005-11

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

TEST PARAMETERS

Run #:	145	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)

COMMENTS

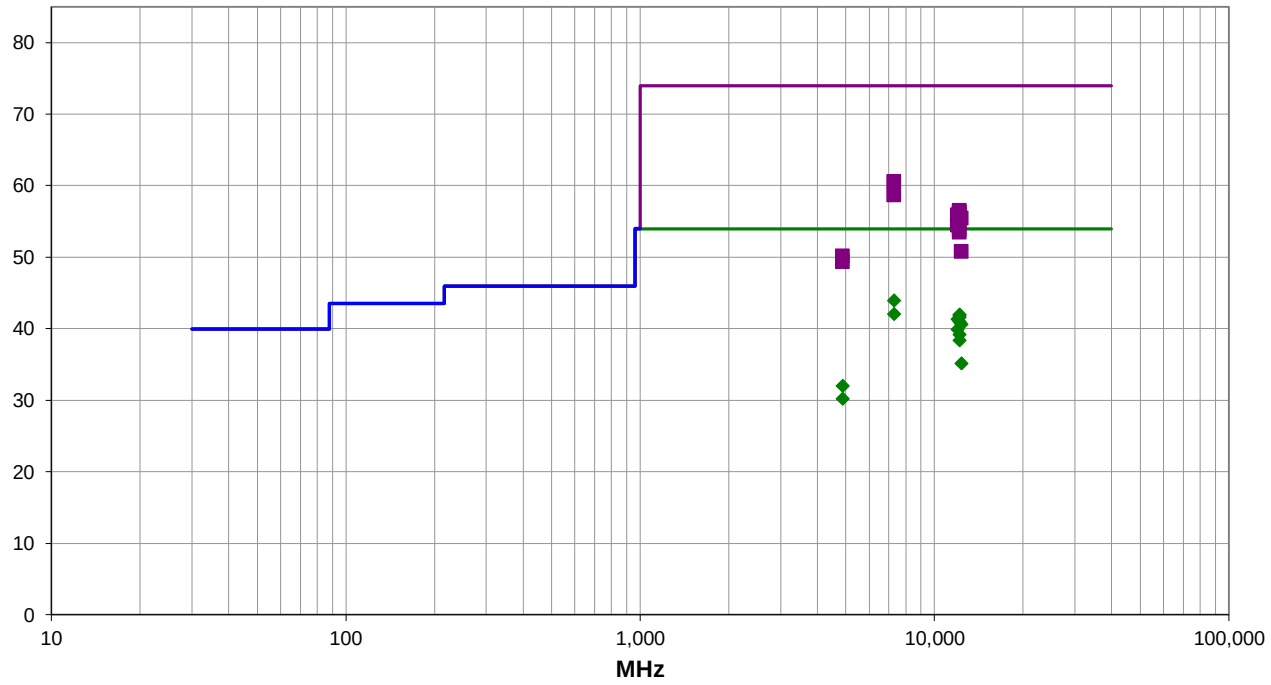
The test mode operates at 85.2% duty cycle (DC), an upward duty cycle correction factor (DCCF) of 10*log(1/DC) = 10*log(1/0.54) = 0.696 dB was applied to the average measurements. When in actual operation, the max operating duty cycle is 9.02%. A downward DCCF correction applied based on 10*log(0.0902) = -10.445 dB was applied to the average measurements. Total correction applied = -9.749 dB. See data comments below for channel, EUT orientation, and channel transmit power.

EUT OPERATING MODES

Transmitting BLE, Low Channel 0 = 2402 MHz, Middle Channel 19 = 2440 MHz, High Channel 39 = 2480 MHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 145

PK AV QP

SPURIOUS RADIATED EMISSIONS – ASSEMBLED PEN

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.02.14.0

RESULTS - Run #145

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/ Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
7319.450	39.0	14.7	3.0	64.0	-9.7	0.0	Horz	AV	0.0	44.0	54.0	-10.0	Ch. 19, EUT in Z-axis, 4 dBm
7320.558	37.1	14.7	1.8	166.0	-9.7	0.0	Vert	AV	0.0	42.1	54.0	-11.9	Ch. 19, EUT in Y-axis, 4 dBm
12201.160	53.9	-2.2	1.5	210.0	-9.7	0.0	Vert	AV	0.0	42.0	54.0	-12.0	Ch. 19, EUT in Y-axis, 4 dBm
12201.110	53.8	-2.2	1.5	356.0	-9.7	0.0	Horz	AV	0.0	41.9	54.0	-12.1	Ch. 19, EUT in Z-axis, 4 dBm
12201.130	53.5	-2.2	4.0	5.0	-9.7	0.0	Vert	AV	0.0	41.6	54.0	-12.4	Ch. 19, EUT in X-axis, 4 dBm
12011.120	53.8	-2.7	3.4	156.0	-9.7	0.0	Vert	AV	0.0	41.4	54.0	-12.6	Ch. 0, EUT in Y-axis, 4 dBm
12201.070	52.9	-2.2	1.4	67.0	-9.7	0.0	Horz	AV	0.0	41.0	54.0	-13.0	Ch. 19, EUT in X-axis, 4 dBm
12398.900	52.7	-2.4	1.1	88.0	-9.7	0.0	Horz	AV	0.0	40.6	54.0	-13.4	Ch. 39, EUT in Z-axis, 0 dBm
7319.367	45.8	14.7	3.0	64.0	0.0	0.0	Horz	PK	0.0	60.5	74.0	-13.5	Ch. 19, EUT in Z-axis, 4 dBm
12011.120	52.3	-2.7	1.5	187.0	-9.7	0.0	Horz	AV	0.0	39.9	54.0	-14.1	Ch. 0, EUT in Z-axis, 0 dBm
12201.100	51.1	-2.2	1.5	252.0	-9.7	0.0	Horz	AV	0.0	39.2	54.0	-14.8	Ch. 19, EUT in Y-axis, 4 dBm
7319.208	43.9	14.7	1.8	166.0	0.0	0.0	Vert	PK	0.0	58.6	74.0	-15.4	Ch. 19, EUT in Y-axis, 4 dBm
12201.170	50.3	-2.2	3.0	244.0	-9.7	0.0	Vert	AV	0.0	38.4	54.0	-15.6	Ch. 19, EUT in Z-axis, 4 dBm
12201.380	58.7	-2.2	1.5	210.0	0.0	0.0	Vert	PK	0.0	56.5	74.0	-17.5	Ch. 19, EUT in Y-axis, 4 dBm
12201.270	58.5	-2.2	1.5	356.0	0.0	0.0	Horz	PK	0.0	56.3	74.0	-17.7	Ch. 19, EUT in Z-axis, 4 dBm
12201.260	58.2	-2.2	4.0	5.0	0.0	0.0	Vert	PK	0.0	56.0	74.0	-18.0	Ch. 19, EUT in X-axis, 4 dBm
12011.260	58.5	-2.7	3.4	156.0	0.0	0.0	Vert	PK	0.0	55.8	74.0	-18.2	Ch. 0, EUT in Y-axis, 4 dBm
12201.150	57.7	-2.2	1.4	67.0	0.0	0.0	Horz	PK	0.0	55.5	74.0	-18.5	Ch. 19, EUT in X-axis, 4 dBm
12398.680	57.8	-2.4	1.1	88.0	0.0	0.0	Horz	PK	0.0	55.4	74.0	-18.6	Ch. 39, EUT in Z-axis, 0 dBm
12398.890	47.3	-2.4	1.6	257.0	-9.7	0.0	Vert	AV	0.0	35.2	54.0	-18.8	Ch. 39, EUT in Y-axis, 0 dBm
12011.340	57.1	-2.7	1.5	187.0	0.0	0.0	Horz	PK	0.0	54.4	74.0	-19.6	Ch. 0, EUT in Z-axis, 0 dBm
12201.310	56.0	-2.2	1.5	252.0	0.0	0.0	Horz	PK	0.0	53.8	74.0	-20.2	Ch. 19, EUT in Y-axis, 4 dBm
12201.030	55.6	-2.2	3.0	244.0	0.0	0.0	Vert	PK	0.0	53.4	74.0	-20.6	Ch. 19, EUT in Z-axis, 4 dBm
4879.967	31.4	10.3	3.3	311.0	-9.7	0.0	Horz	AV	0.0	32.0	54.0	-22.0	Ch. 19, EUT in Z-axis, 4 dBm
12398.790	53.1	-2.4	1.6	257.0	0.0	0.0	Vert	PK	0.0	50.7	74.0	-23.3	Ch. 39, EUT in Y-axis, 0 dBm
4879.967	29.6	10.3	1.5	138.0	-9.7	0.0	Vert	AV	0.0	30.2	54.0	-23.8	Ch. 19, EUT in Y-axis, 4 dBm
4879.692	39.8	10.3	3.3	311.0	0.0	0.0	Horz	PK	0.0	50.1	74.0	-23.9	Ch. 19, EUT in Z-axis, 4 dBm
4880.350	39.0	10.3	1.5	138.0	0.0	0.0	Vert	PK	0.0	49.3	74.0	-24.7	Ch. 19, EUT in Y-axis, 4 dBm

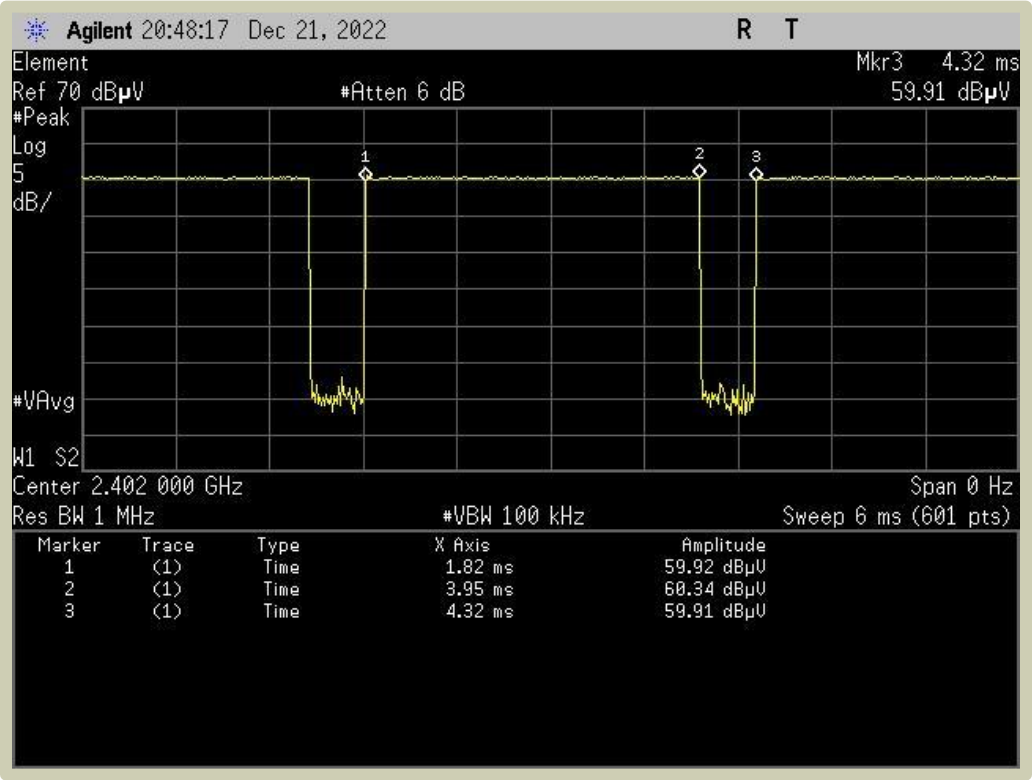
CONCLUSION

Pass

Tested By

SPURIOUS RADIATED EMISSIONS – ASSEMBLED PEN

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.02.14.0



Screenshot of the transmission duty cycle from Pen

Duty Cycle of Pen Transmission = (X_2-X_1/ X_3-X_1) = (3.95-1.82)/(4.32-1.82) = 85.2%

End of Test Report