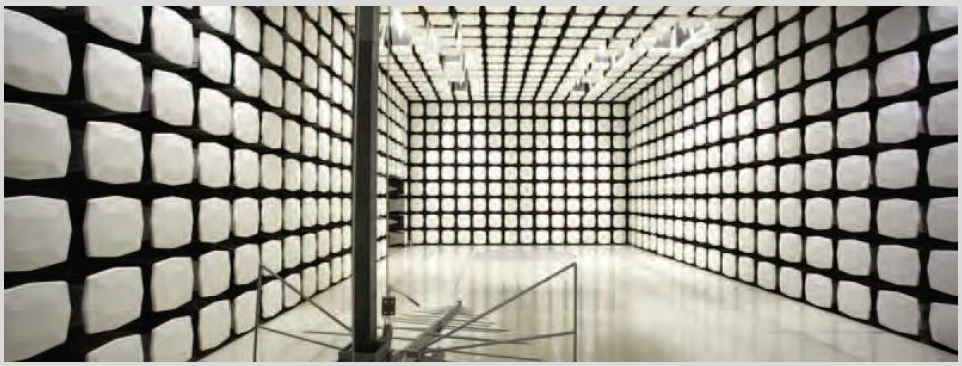
Starkey Laboratories, Inc.

Livio Custom BLE Hearing Aid (Right Ear)

FCC 15.247:2020

Bluetooth Low Energy (DTS) Radio

Report # STAK0202.3



NVLAP LAB CODE: 200881-0

CERTIFICATE OF TEST

Last Date of Test: January 13, 2020
Starkey Laboratories, Inc.
EUT: Livio Custom BLE Hearing Aid (Right Ear)

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.
11.12.1, 11.13.2, 6.5, 6.6	Spurious Radiated Emissions	Yes	Pass	
11.6	Duty Cycle	Yes	N/A	
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	

Deviations From Test Standards

None

Approved By:

Eric Brandon, Department 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

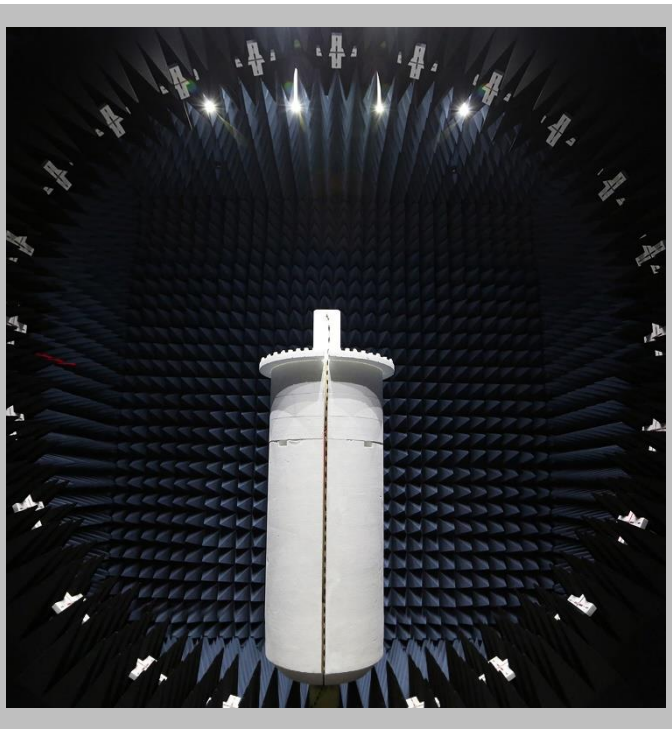
MIC – Recognized by MIC as a CAB for the acceptance of test data.

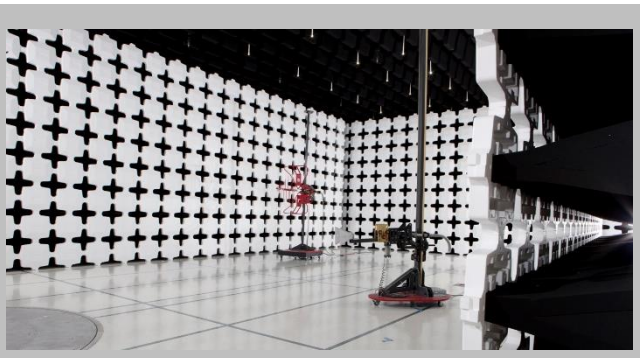
SCOPE

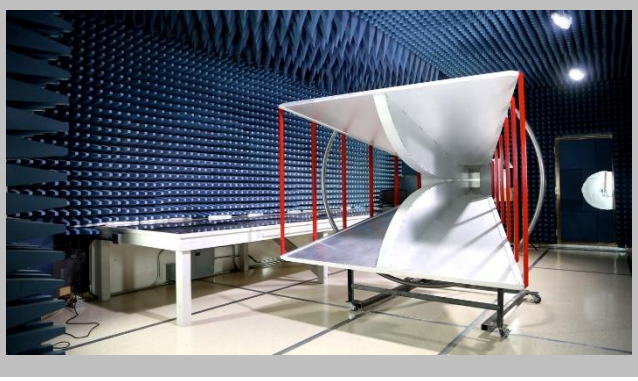
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

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.

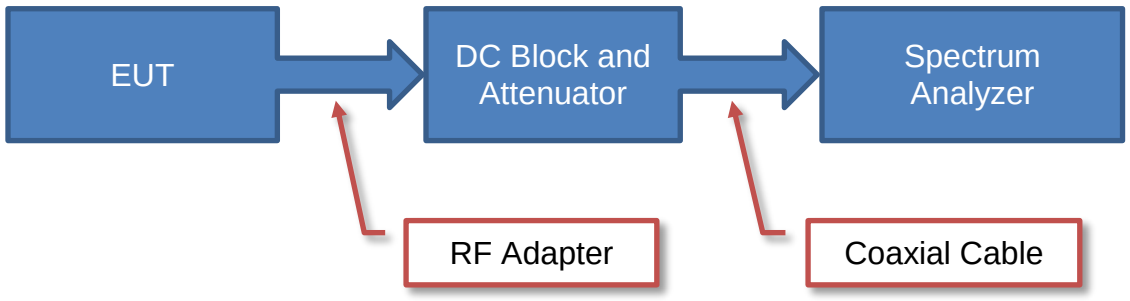
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable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

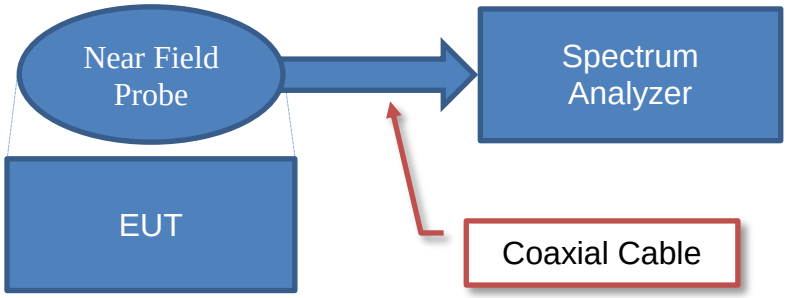
Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field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

Test Setup Block Diagrams

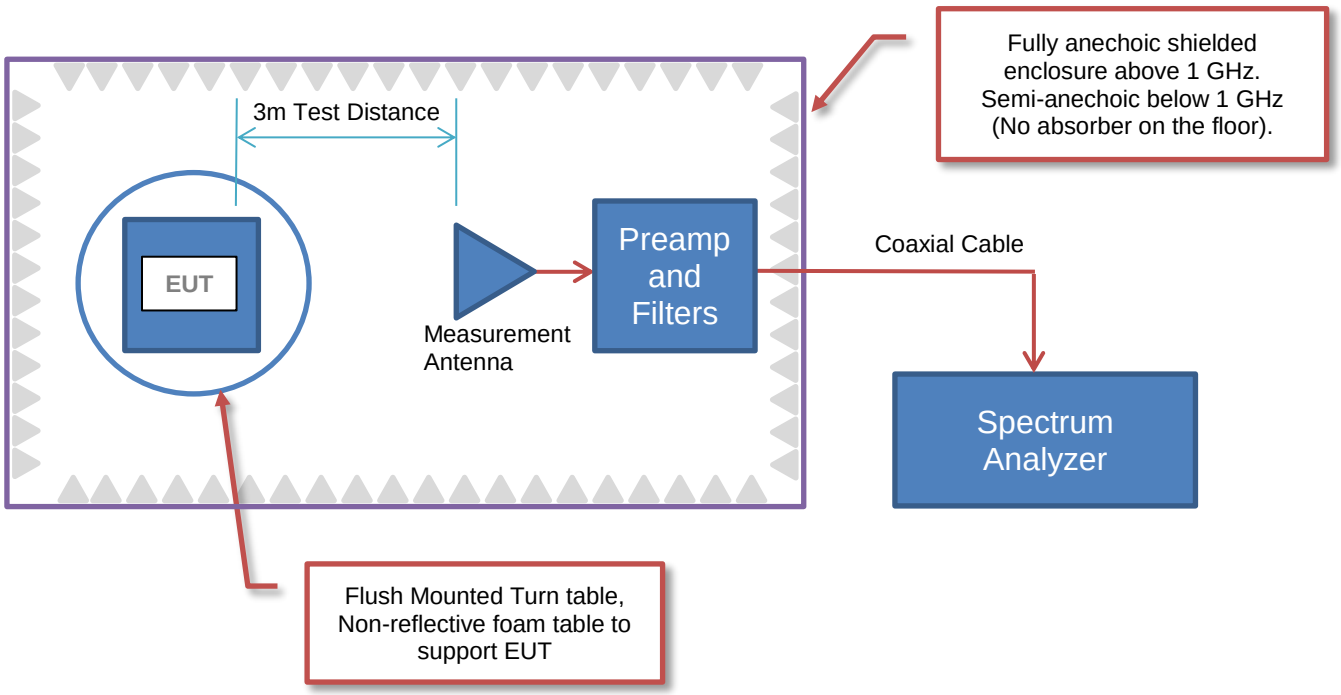
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	Starkey Laboratories, Inc.
Address:	6600 Washington Ave S
City, State, Zip:	Eden Prairie, MN 55344-3404
Test Requested By:	Bill Mitchell
EUT:	Livio Custom BLE Hearing Aid (Right Ear)
First Date of Test:	January 6, 2020
Last Date of Test:	January 13, 2020
Receipt Date of Samples:	December 18, 2019
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Custom ITE hearing aid with a 2.4 GHz BLE radio that will support both 1 MB/s BLE and 2 MB/s BLE per Bluetooth 5.0

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

CONFIGURATIONS

Configuration STAK0202- 2

Software/Firmware Running during test	
Description	**Version**
Firmware	7.2.0.7
Monaco	2.0.13.0

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Livio Custom BLE Hearing Aid (Right Ear)	Starkey Laboratories, Inc.	Livio Custom BLE Hearing Aid	2911328219

Configuration STAK0202- 4

Software/Firmware Running during test	
Description	**Version**
Firmware	7.2.0.7
Monaco	2.0.13.0

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Livio Custom BLE Hearing Aid Face Plate (Right Ear)	Starkey Laboratories, Inc.	Livio Custom BLE Hearing Aid Face Plate	2911328235

Remote Equipment Outside of Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
DC Power Supply	EZ Digital Co., Ltd.	GP-4303D	TQK
Multimeter	Fluke	117	MLS

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
AC Cable	No	1.8 m	No	AC Mains	DC Power Supply
DC Leads (x2)	No	1.0 m	No	DC Power Supply	Livio Custom BLE Hearing Aid Face Plate (Right Ear)
DC Leads (x2)	No	0.5 m	No	DC Power Supply	Multimeter

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2020-01-06	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.
2	2020-01-06	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	2020-01-06	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	2020-01-06	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	2020-01-06	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	2020-01-06	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	2020-01-06	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.
8	2020-01-13	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

POWER SETTINGS

The EUT was tested using the power settings provided by the manufacturer:

SETTINGS FOR ALL TESTS IN THIS REPORT

ITE BLE Hearing Aid	Power Setting
1 Mbps – Low channel (2402 MHz)	0 dBm
1 Mbps – Mid channel (2442 MHz)	0 dBm
1 Mbps – High channel (2480 MHz)	0 dBm
2 Mbps – Low channel (2402 MHz)	0 dBm
2 Mbps – Mid channel (2442 MHz)	0 dBm
2 Mbps – High channel (2480 MHz)	0 dBm

SPURIOUS RADIATED EMISSIONS

PSA-ESCI 2019.05.10

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

MODES OF OPERATION

Transmitting Bluetooth Low Energy (BLE) - Low channel (2402 MHz), Mid channel (2442 MHz), and High channel (2480 MHz); 1 Mbps and 2 Mbps

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

STAK0202 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	26500 MHz

SAMPLE CALCULATIONS

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	JSD4-18002600-26-8P	APU	11-Sep-2019	12 mo
Cable	ESM Cable Corp.	TTBJ141 KMKM-72	MNP	11-Sep-2019	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVW	8-Feb-2019	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-08	AIQ	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	8-Feb-2019	12 mo
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	8-Mar-2019	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	8-Feb-2019	12 mo
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	17-Sep-2019	12 mo
Antenna - Double Ridge	ETS-Lindgren	3115	AJQ	16-Jan-2019	24 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	18-Oct-2019	12 mo
Cable	ESM Cable Corp.	Bilog Cables	MNH	18-Oct-2019	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AYD	25-Jan-2018	24 mo
Attenuator	Fairview Microwave	SA18E-10	TYA	17-Sep-2019	12 mo
Attenuator	Fairview Microwave	SA18E-20	TWZ	17-Sep-2019	12 mo
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-2019	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 at the edges of the allowable band may be presented in an alternative method as provided for in the ANSI C63.10 Marker-Delta method. This method involves performing an in-band fundamental measurement followed by a screen capture of the fundamental and out-of-band emission using reduced measurement instrumentation bandwidths. The amplitude delta measured on this screen capture is applied to the fundamental emission value to show the out-of-band emission level as applied to the limit.

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(dc).

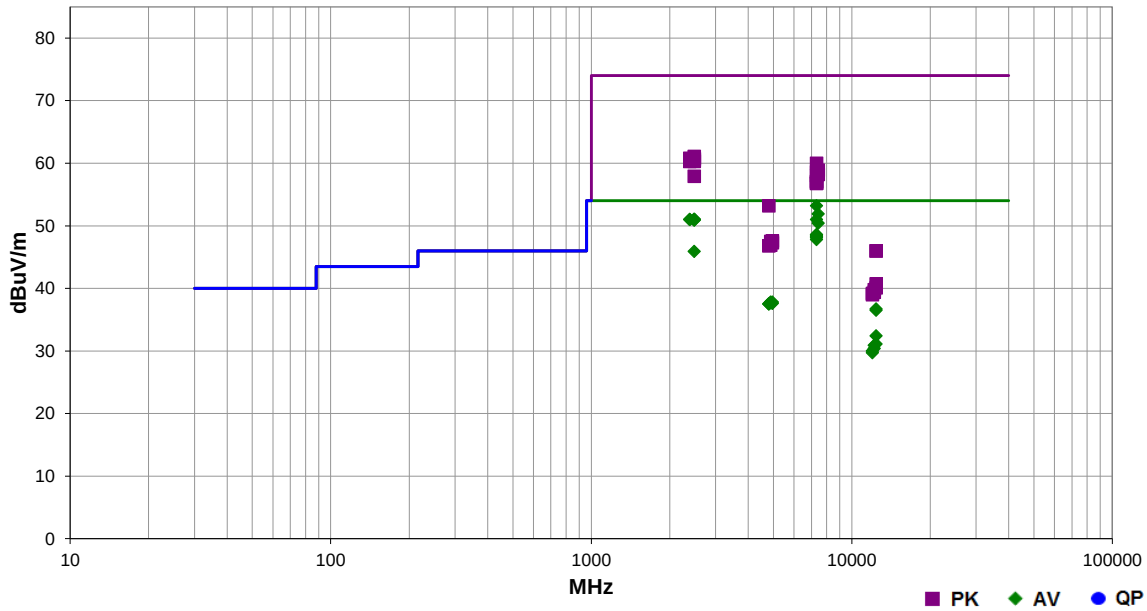
SPURIOUS RADIATED EMISSIONS

EmiR5 2019.08.15.1 PSA-ESCI 2019.05.10

Work Order:	STAK0202	**Date:**	13-Jan-2020		
Project:	None	**Temperature:**	22.8 °C		
Job Site:	MN05	**Humidity:**	20.7% RH		
Serial Number:	2911328219	**Barometric Pres.:**	1025 mbar	**Tested by:**	Andrew Rogstad, Chris Patterson
EUT:	Livio Custom BLE Hearing Aid (Right Ear)				
Configuration:	2				
Customer:	Starkey Laboratories, Inc.				
Attendees:	Charlie Esch				
EUT Power:	Battery				
Operating Mode:	Transmitting Bluetooth Low Energy (BLE) - Low channel (2402 MHz), Mid channel (2442 MHz), and High channel (2480 MHz); 1 Mbps and 2 Mbps				
Deviations:	None				
Comments:	Right ear. For the 1 Mbps mode a Duty Cycle Correction Factor (DCCF) of 2.1 dB was applied based on a measured duty cycle of 61.7%. For the 2 Mbps mode a DCCF of 5.0 dB was applied based on a measured duty cycle of 31.6%. See data comments for EUT orientation, transmit channel, and data rate.				

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

Run #	68	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
7325.408	37.6	13.5	2.3	171.0	2.1	0.0	Horz	AV	0.0	53.2	54.0	-0.8	EUT on side, Mid ch., 1 Mbps
7439.383	36.6	13.2	2.8	189.0	2.1	0.0	Horz	AV	0.0	51.9	54.0	-2.1	EUT on side, High ch., 1 Mbps
7325.400	35.4	13.5	1.4	160.0	2.1	0.0	Vert	AV	0.0	51.0	54.0	-3.0	EUT vert, Mid ch., 1 Mbps
2484.773	32.7	-3.8	1.5	279.0	2.1	20.0	Horz	AV	0.0	51.0	54.0	-3.0	EUT on side, High ch., 1 Mbps
2487.033	32.6	-3.7	2.3	304.9	2.1	20.0	Vert	AV	0.0	51.0	54.0	-3.0	EUT on side, High ch., 1 Mbps
2485.620	32.6	-3.7	1.5	184.0	2.1	20.0	Horz	AV	0.0	51.0	54.0	-3.0	EUT vert, High ch., 1 Mbps
2487.233	32.6	-3.7	1.5	84.0	2.1	20.0	Horz	AV	0.0	51.0	54.0	-3.0	EUT horz, High ch., 1 Mbps
2486.887	32.6	-3.7	1.5	192.9	2.1	20.0	Vert	AV	0.0	51.0	54.0	-3.0	EUT horz, High ch., 1 Mbps
2387.540	32.5	-3.6	1.5	168.9	2.1	20.0	Horz	AV	0.0	51.0	54.0	-3.0	EUT on side, Low ch., 1 Mbps
2389.153	32.5	-3.6	2.3	153.9	2.1	20.0	Vert	AV	0.0	51.0	54.0	-3.0	EUT on side, Low ch., 1 Mbps
2483.693	32.6	-3.8	1.5	0.0	2.1	20.0	Vert	AV	0.0	50.9	54.0	-3.1	EUT vert, High ch., 1 Mbps
7439.500	35.1	13.2	2.7	180.0	2.1	0.0	Vert	AV	0.0	50.4	54.0	-3.6	EUT vert, High ch., 1 Mbps
7325.317	33.0	13.5	1.8	286.0	2.1	0.0	Horz	AV	0.0	48.6	54.0	-5.4	EUT vert, Mid ch., 1 Mbps
7326.600	32.9	13.5	1.8	317.0	2.1	0.0	Vert	AV	0.0	48.5	54.0	-5.5	EUT on side, Mid ch., 1 Mbps
7325.550	32.7	13.5	1.9	289.0	2.1	0.0	Horz	AV	0.0	48.3	54.0	-5.7	EUT horz, Mid ch., 1 Mbps
7325.408	32.5	13.5	1.3	245.0	2.1	0.0	Vert	AV	0.0	48.1	54.0	-5.9	EUT horz, Mid ch., 1 Mbps
7324.775	29.3	13.5	2.0	156.0	5.0	0.0	Horz	AV	0.0	47.8	54.0	-6.2	EUT on side, Mid ch., 2 Mbps
2483.507	34.7	-3.8	3.4	66.0	5.0	10.0	Horz	AV	0.0	45.9	54.0	-8.1	EUT on side, High ch., 2 Mbps
2483.907	44.9	-3.8	1.5	84.0	0.0	20.0	Horz	PK	0.0	61.1	74.0	-12.9	EUT horz, High ch., 1 Mbps
2485.667	44.5	-3.7	1.5	184.0	0.0	20.0	Horz	PK	0.0	60.8	74.0	-13.2	EUT vert, High ch., 1 Mbps
2390.000	44.4	-3.6	2.3	153.9	0.0	20.0	Vert	PK	0.0	60.8	74.0	-13.2	EUT on side, Low ch., 1 Mbps
2485.380	44.4	-3.7	1.5	192.9	0.0	20.0	Vert	PK	0.0	60.7	74.0	-13.3	EUT horz, High ch., 1 Mbps

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2483.753	44.4	-3.8	1.5	0.0	0.0	20.0	Vert	PK	0.0	60.6	74.0	-13.4	EUT vert, High ch., 1 Mbps
2484.653	44.2	-3.8	2.3	304.9	0.0	20.0	Vert	PK	0.0	60.4	74.0	-13.6	EUT on side, High ch., 1 Mbps
2485.187	44.0	-3.7	1.5	279.0	0.0	20.0	Horz	PK	0.0	60.3	74.0	-13.7	EUT on side, High ch., 1 Mbps
2388.160	43.9	-3.6	1.5	168.9	0.0	20.0	Horz	PK	0.0	60.3	74.0	-13.7	EUT on side, Low ch., 1 Mbps
7326.642	46.5	13.5	2.3	171.0	0.0	0.0	Horz	PK	0.0	60.0	74.0	-14.0	EUT on side, Mid ch., 1 Mbps
7440.583	45.7	13.2	2.8	189.0	0.0	0.0	Horz	PK	0.0	58.9	74.0	-15.1	EUT on side, High ch., 1 Mbps
7326.958	45.1	13.5	1.4	160.0	0.0	0.0	Vert	PK	0.0	58.6	74.0	-15.4	EUT vert, Mid ch., 1 Mbps
7439.042	45.0	13.2	2.7	180.0	0.0	0.0	Vert	PK	0.0	58.2	74.0	-15.8	EUT vert, High ch., 1 Mbps
7326.592	44.5	13.5	2.0	156.0	0.0	0.0	Horz	PK	0.0	58.0	74.0	-16.0	EUT on side, Mid ch., 2 Mbps
2483.547	46.7	-3.8	3.4	66.0	5.0	10.0	Horz	PK	0.0	57.9	74.0	-16.1	EUT on side, High ch., 2 Mbps
4884.017	31.0	4.7	1.5	138.9	2.1	0.0	Horz	AV	0.0	37.8	54.0	-16.2	EUT on side, Mid ch., 1 Mbps
4962.167	30.8	4.9	1.0	59.0	2.1	0.0	Horz	AV	0.0	37.8	54.0	-16.2	EUT on side, High ch., 1 Mbps
4883.233	30.9	4.7	1.5	121.9	2.1	0.0	Vert	AV	0.0	37.7	54.0	-16.3	EUT vert, Mid ch., 1 Mbps
4958.100	30.7	4.8	1.0	207.0	2.1	0.0	Vert	AV	0.0	37.6	54.0	-16.4	EUT vert, High ch., 1 Mbps
4803.217	30.8	4.6	1.5	317.0	2.1	0.0	Horz	AV	0.0	37.5	54.0	-16.5	EUT on side, Low ch., 1 Mbps
4803.003	30.8	4.6	1.5	12.0	2.1	0.0	Vert	AV	0.0	37.5	54.0	-16.5	EUT vert, Low ch., 1 Mbps
7326.275	43.6	13.5	1.9	289.0	0.0	0.0	Horz	PK	0.0	57.1	74.0	-16.9	EUT horz, Mid ch., 1 Mbps
7326.708	43.5	13.5	1.8	286.0	0.0	0.0	Horz	PK	0.0	57.0	74.0	-17.0	EUT vert, Mid ch., 1 Mbps
7325.492	43.3	13.5	1.3	245.0	0.0	0.0	Vert	PK	0.0	56.8	74.0	-17.2	EUT horz, Mid ch., 1 Mbps
7325.975	43.3	13.5	1.8	317.0	0.0	0.0	Vert	PK	0.0	56.8	74.0	-17.2	EUT on side, Mid ch., 1 Mbps
12400.680	29.2	5.4	1.5	36.0	2.1	0.0	Vert	AV	0.0	36.7	54.0	-17.3	EUT vert, High ch., 1 Mbps
12400.730	29.0	5.4	1.5	77.9	2.1	0.0	Horz	AV	0.0	36.5	54.0	-17.5	EUT on side, High ch., 1 Mbps
4803.073	48.6	4.6	1.5	12.0	0.0	0.0	Vert	PK	0.0	53.2	74.0	-20.8	EUT vert, Low ch., 1 Mbps
12398.800	30.9	-0.6	1.9	27.0	2.1	0.0	Horz	AV	0.0	32.4	54.0	-21.6	EUT on side, High ch., 1 Mbps
12398.850	29.6	-0.6	3.8	95.0	2.1	0.0	Vert	AV	0.0	31.1	54.0	-22.9	EUT vert, High ch., 1 Mbps
12208.760	30.5	-1.7	3.3	232.9	2.1	0.0	Vert	AV	0.0	30.9	54.0	-23.1	EUT vert, Mid ch., 1 Mbps
12208.790	30.0	-1.7	1.3	72.0	2.1	0.0	Horz	AV	0.0	30.4	54.0	-23.6	EUT on side, Mid ch., 1 Mbps
12008.590	30.1	-2.2	2.4	238.1	2.1	0.0	Vert	AV	0.0	30.0	54.0	-24.0	EUT vert, Low ch., 1 Mbps
12009.080	29.8	-2.2	1.5	358.0	2.1	0.0	Horz	AV	0.0	29.7	54.0	-24.3	EUT on side, Low ch., 1 Mbps
4959.583	42.8	4.8	1.0	59.0	0.0	0.0	Horz	PK	0.0	47.6	74.0	-26.4	EUT on side, High ch., 1 Mbps
4884.070	42.8	4.7	1.5	121.9	0.0	0.0	Vert	PK	0.0	47.5	74.0	-26.5	EUT vert, Mid ch., 1 Mbps
4959.467	42.5	4.8	1.0	207.0	0.0	0.0	Vert	PK	0.0	47.3	74.0	-26.7	EUT vert, High ch., 1 Mbps
4883.375	42.2	4.7	1.5	138.9	0.0	0.0	Horz	PK	0.0	46.9	74.0	-27.1	EUT on side, Mid ch., 1 Mbps
4803.040	42.2	4.6	1.5	317.0	0.0	0.0	Horz	PK	0.0	46.8	74.0	-27.2	EUT on side, Low ch., 1 Mbps
12401.220	40.6	5.4	1.5	36.0	0.0	0.0	Vert	PK	0.0	46.0	74.0	-28.0	EUT vert, High ch., 1 Mbps
12400.980	40.6	5.4	1.5	77.9	0.0	0.0	Horz	PK	0.0	46.0	74.0	-28.0	EUT on side, High ch., 1 Mbps
12399.450	41.3	-0.6	1.9	27.0	0.0	0.0	Horz	PK	0.0	40.7	74.0	-33.3	EUT on side, High ch., 1 Mbps
12399.170	40.7	-0.6	3.8	95.0	0.0	0.0	Vert	PK	0.0	40.1	74.0	-33.9	EUT vert, High ch., 1 Mbps
12211.180	41.5	-1.7	3.3	232.9	0.0	0.0	Vert	PK	0.0	39.8	74.0	-34.2	EUT vert, Mid ch., 1 Mbps
12208.490	41.1	-1.7	1.3	72.0	0.0	0.0	Horz	PK	0.0	39.4	74.0	-34.6	EUT on side, Mid ch., 1 Mbps
12008.650	41.4	-2.2	2.4	238.1	0.0	0.0	Vert	PK	0.0	39.2	74.0	-34.8	EUT vert, Low ch., 1 Mbps
12011.600	41.2	-2.2	1.5	358.0	0.0	0.0	Horz	PK	0.0	39.0	74.0	-35.0	EUT on side, Low ch., 1 Mbps

DUTY CYCLE

XMit 2019.09.05

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
Power Supply - DC	EZ Digital Co., Ltd.	GP-4030D	TQK	NCR	NCR
Meter - Multimeter	Fluke	117	MLS	23-Jan-17	23-Jan-20
Attenuator	S.M. Electronics	SA26B-20	TZP	9-Nov-19	9-Nov-20
Block - DC	Fairview Microwave	SD3379	AMZ	9-Nov-19	9-Nov-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

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

element

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	**Livio Custom BLE Hearing Aid (Right Ear)**			**Work Order:**	**STAK0202**
Serial Number:	**2911328235**			**Date:**	**6-Jan-20**
Customer:	**Starkey Laboratories, Inc.**			**Temperature:**	**23.1 °C**
Attendees:	**Charlie Esch**			**Humidity:**	**25.2% RH**
Project:	**None**			**Barometric Pres.:**	**1018 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**3.8 VDC**	**Job Site:**	**MN08**

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

COMMENTS

Right ear. Reference level offset includes Measurment Cable, DC Block, and 20 dB Attenuator.

DEVIATIONS FROM TEST STANDARD

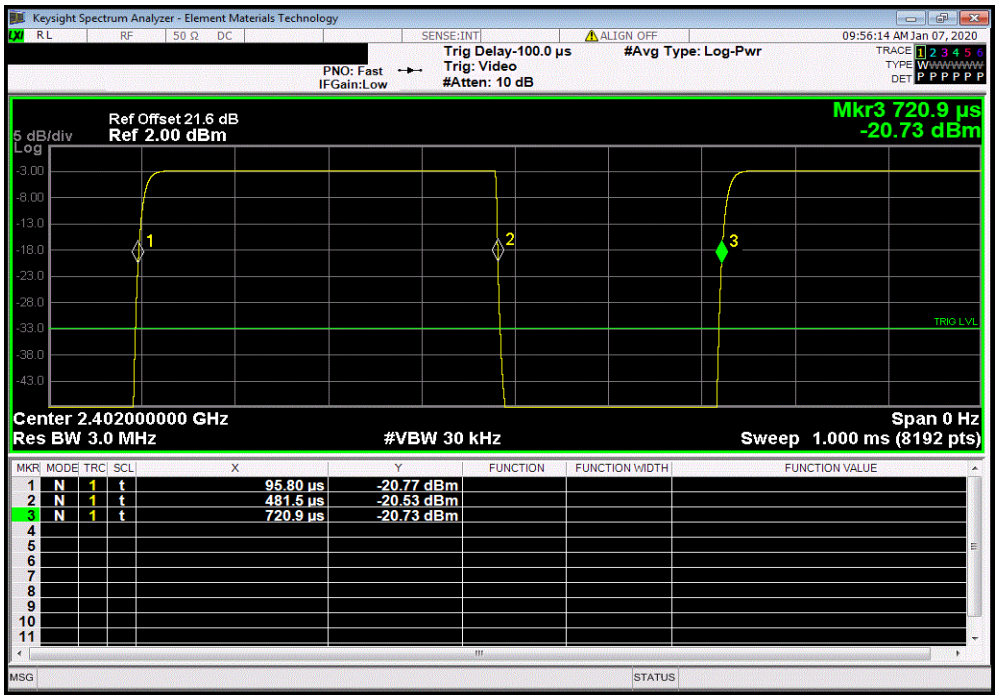
None

Configuration #	**4**	*Signature* Andrew Rogstad

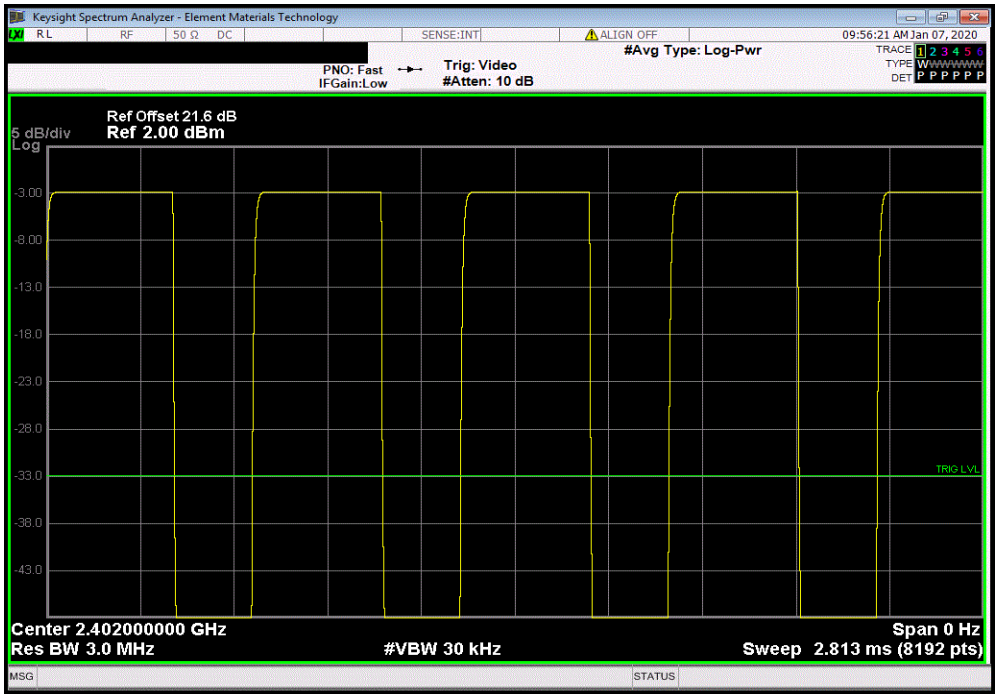
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
BLE/GFSK (1 Mbps)						
Low Channel, 2402 MHz	385.7 us	625.1 us	1	61.7	N/A	N/A
Low Channel, 2402 MHz	N/A	N/A	5	N/A	N/A	N/A
Mid Channel, 2442 MHz	385.5 us	625 us	1	61.7	N/A	N/A
Mid Channel, 2442 MHz	N/A	N/A	5	N/A	N/A	N/A
High Channel, 2480 MHz	385.5 us	625 us	1	61.7	N/A	N/A
High Channel, 2480 MHz	N/A	N/A	5	N/A	N/A	N/A
BLE/GFSK (2 Mbps)						
Low Channel, 2402 MHz	197.3 us	625.1 us	1	31.6	N/A	N/A
Low Channel, 2402 MHz	N/A	N/A	5	N/A	N/A	N/A
Mid Channel, 2442 MHz	197 us	625 us	1	31.5	N/A	N/A
Mid Channel, 2442 MHz	N/A	N/A	5	N/A	N/A	N/A
High Channel, 2480 MHz	197.2 us	625 us	1	31.6	N/A	N/A
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
	385.7 us	625.1 us	1	61.7	N/A	N/A

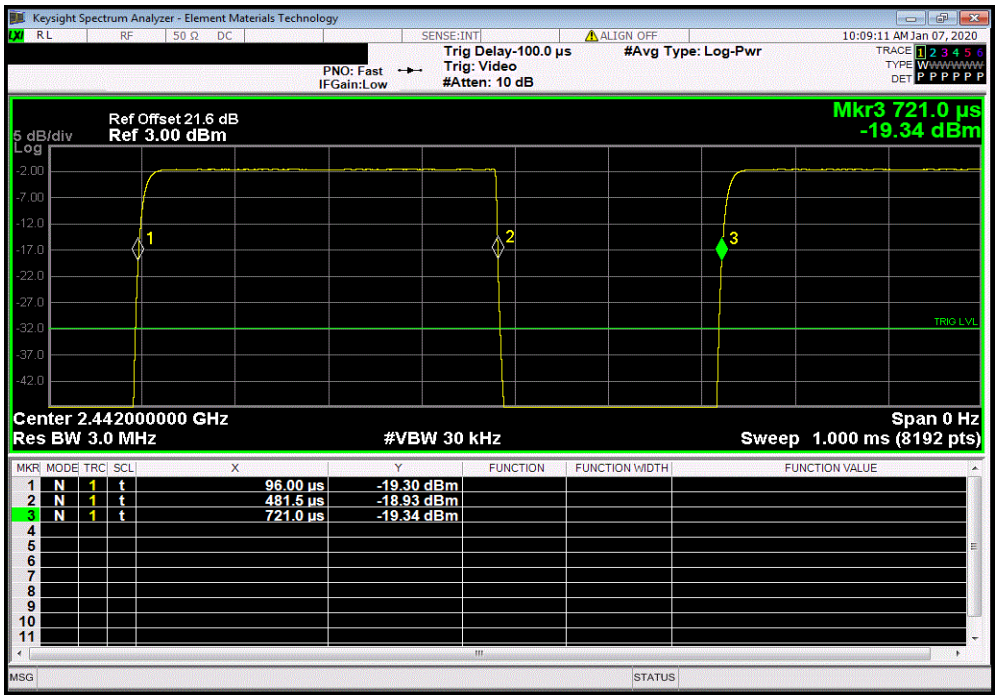


BLE/GFSK (1 Mbps), Low Channel, 2402 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

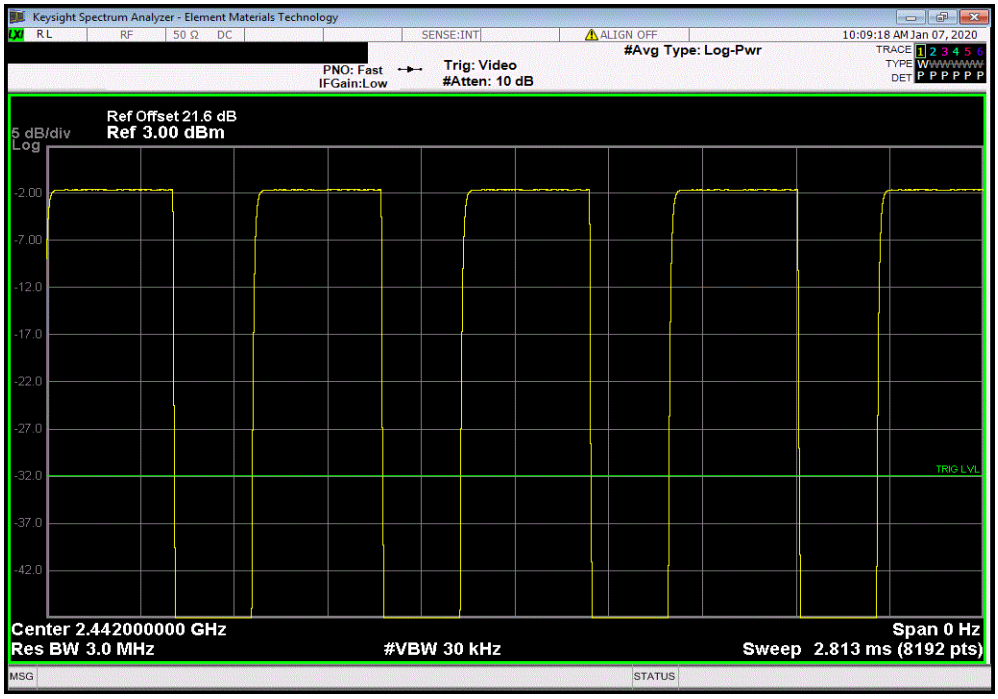


DUTY CYCLE

BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	385.5 us	625 us	1	61.7	N/A	N/A

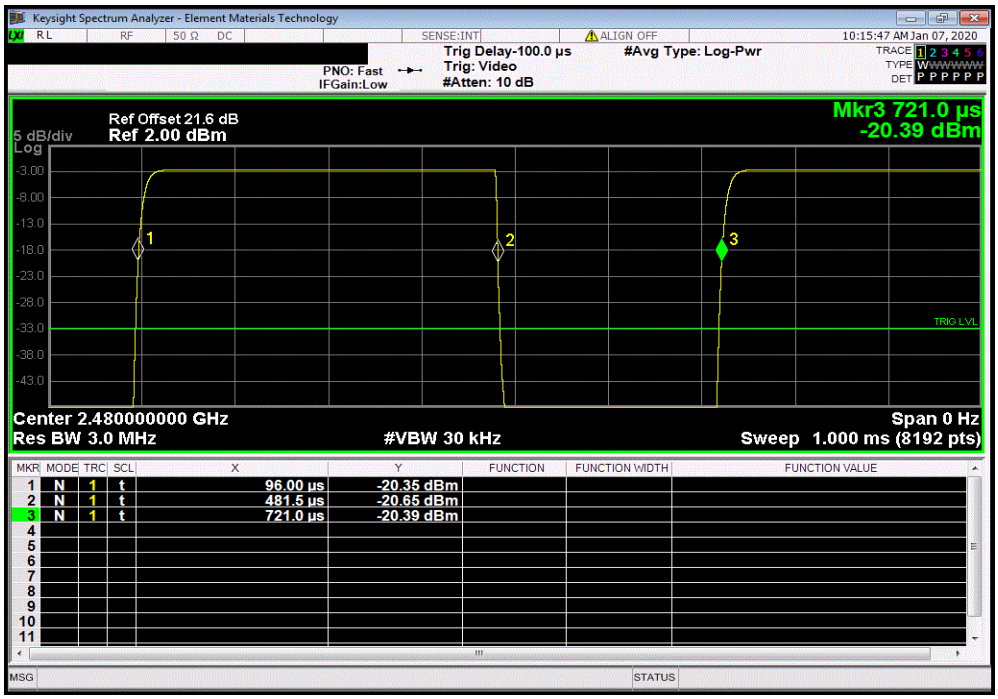


BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

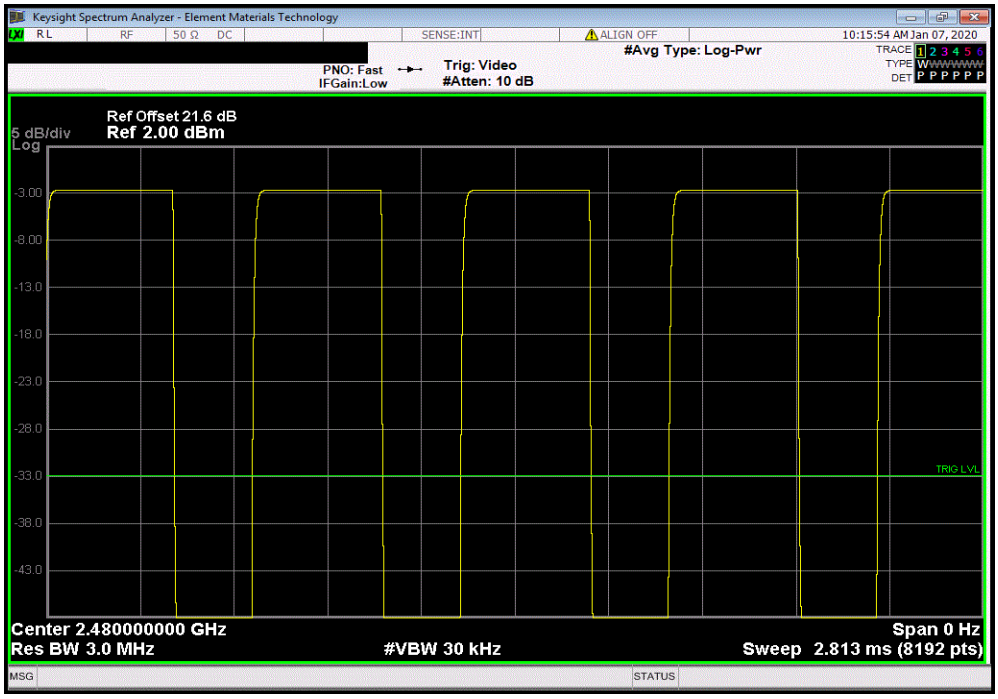


DUTY CYCLE

BLE/GFSK (1 Mbps), High Channel, 2480 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	385.5 us	625 us	1	61.7	N/A	N/A

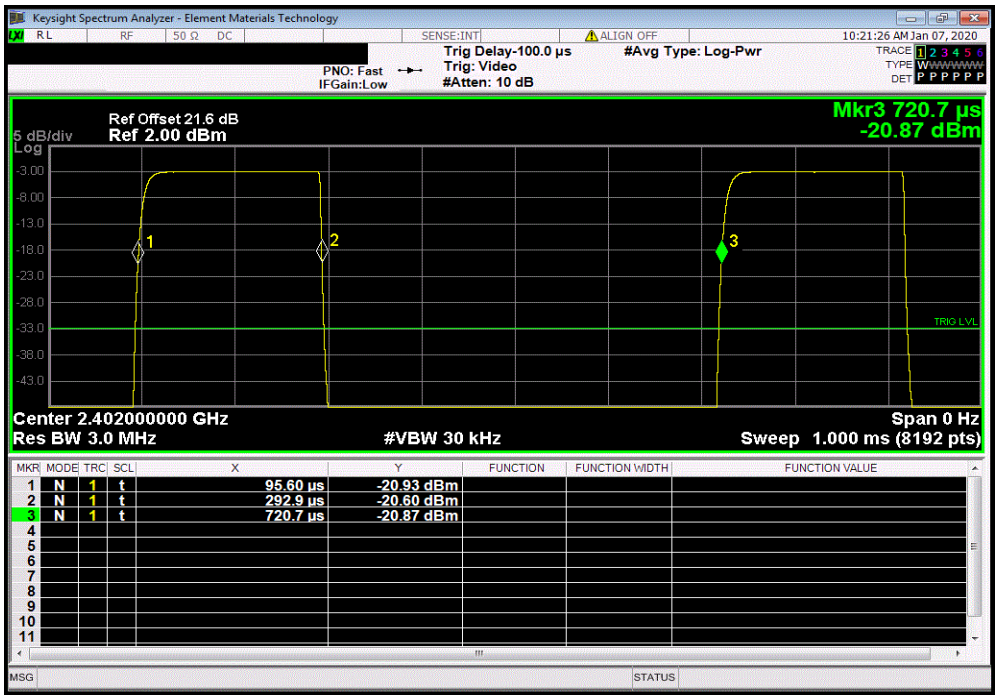


BLE/GFSK (1 Mbps), High Channel, 2480 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

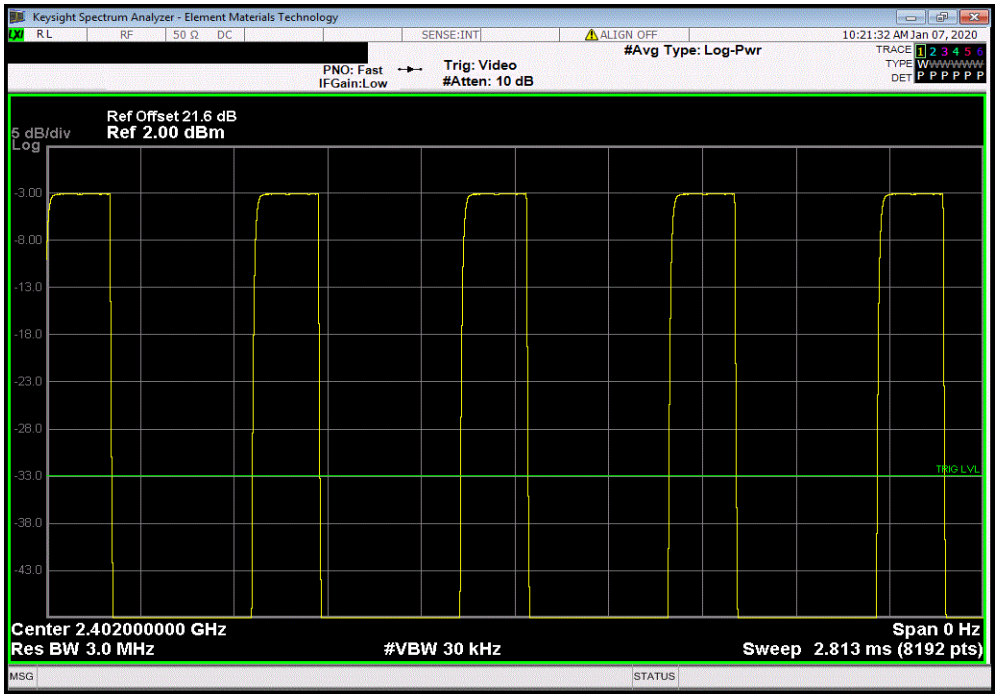


DUTY CYCLE

BLE/GFSK (2 Mbps), Low Channel, 2402 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	197.3 us	625.1 us	1	31.6	N/A	N/A

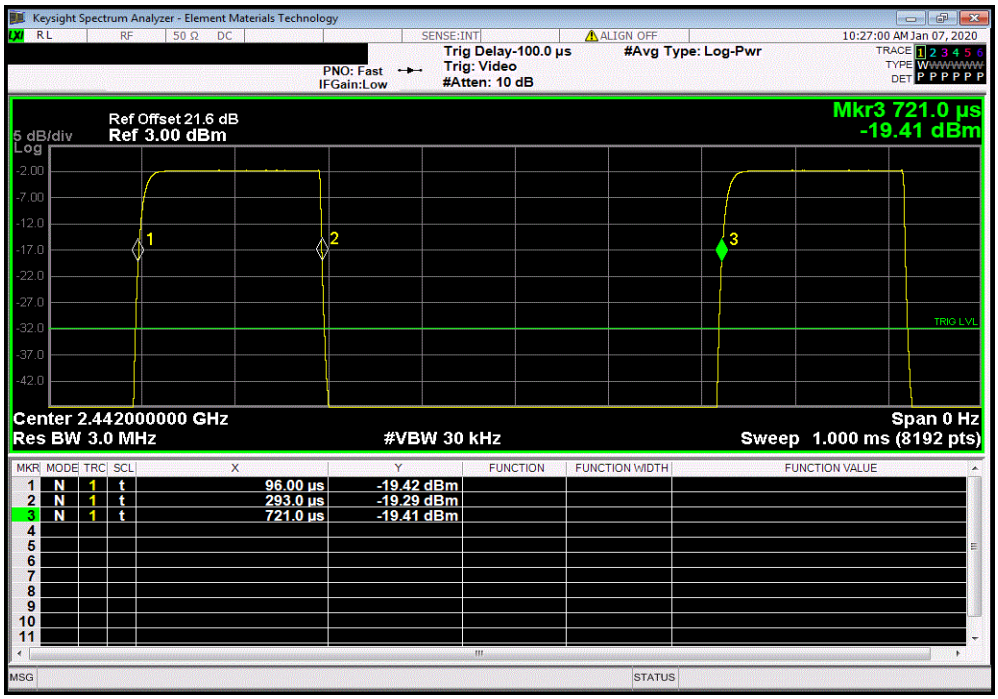


BLE/GFSK (2 Mbps), Low Channel, 2402 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

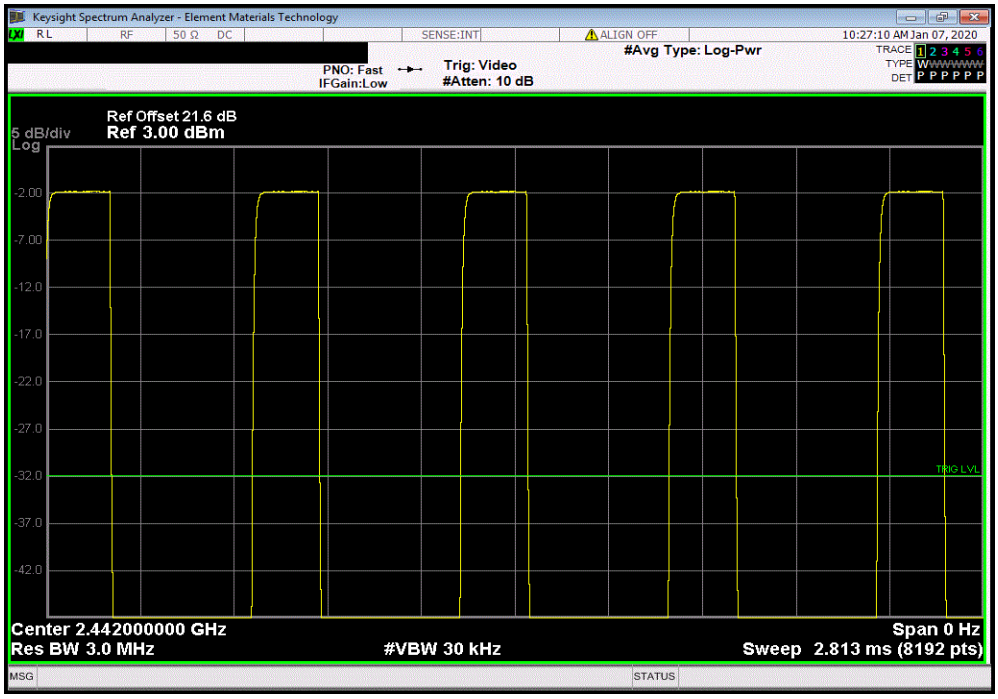


DUTY CYCLE

BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	197 us	625 us	1	31.5	N/A	N/A

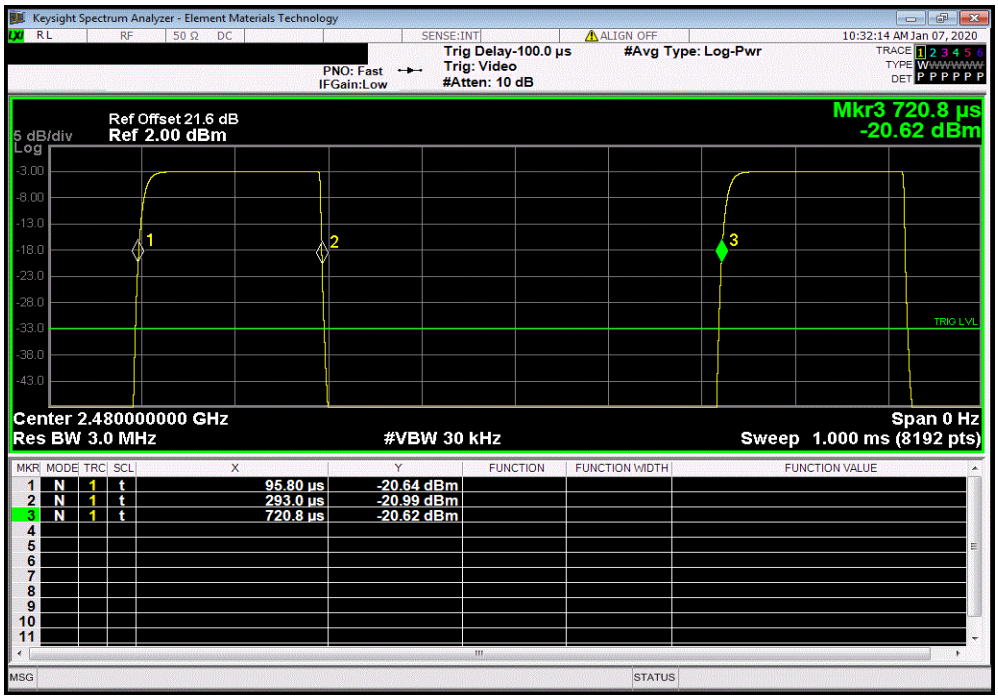


BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

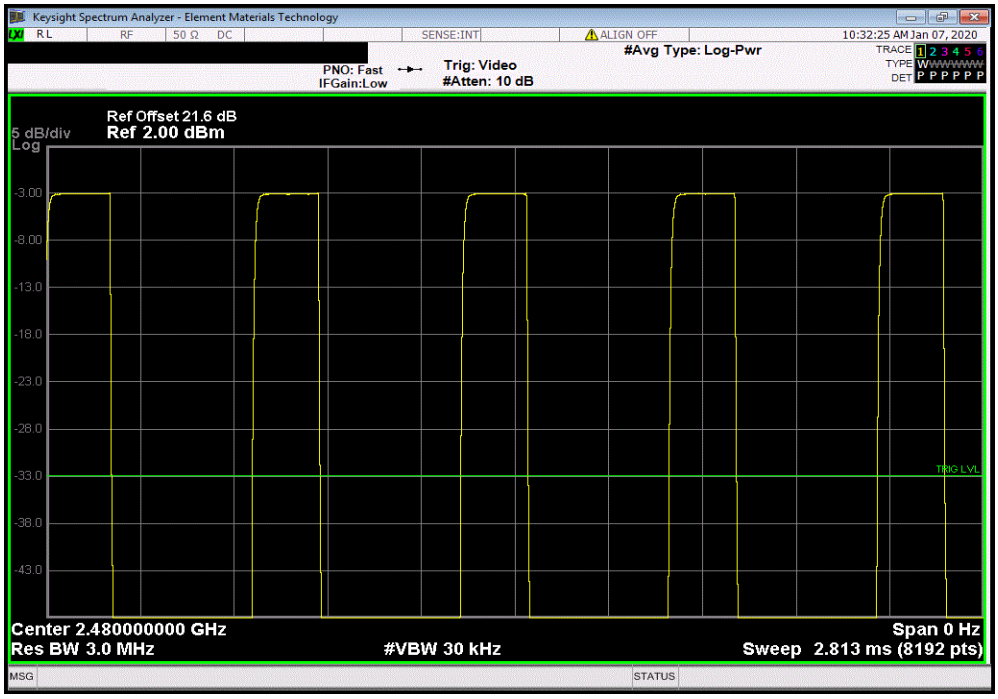


DUTY CYCLE

BLE/GFSK (2 Mbps), High Channel, 2480 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	197.2 us	625 us	1	31.6	N/A	N/A



BLE/GFSK (2 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



OCCUPIED BANDWIDTH

XMit 2019.09.05

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
Power Supply - DC	EZ Digital Co., Ltd.	GP-4030D	TQK	NCR	NCR
Meter - Multimeter	Fluke	117	MLS	23-Jan-17	23-Jan-20
Attenuator	S.M. Electronics	SA26B-20	TZP	9-Nov-19	9-Nov-20
Block - DC	Fairview Microwave	SD3379	AMZ	9-Nov-19	9-Nov-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

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 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

element

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	**Livio Custom BLE Hearing Aid (Right Ear)**			**Work Order:**	**STAK0202**
Serial Number:	**2911328235**			**Date:**	**6-Jan-20**
Customer:	**Starkey Laboratories, Inc.**			**Temperature:**	**23 °C**
Attendees:	**Charlie Esch**			**Humidity:**	**25.6% RH**
Project:	**None**			**Barometric Pres.:**	**1018 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**3.8 VDC**	**Job Site:**	**MN08**

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

COMMENTS

Right ear. Reference level offset includes Measurment Cable, DC Block, and 20 dB Attenuator.

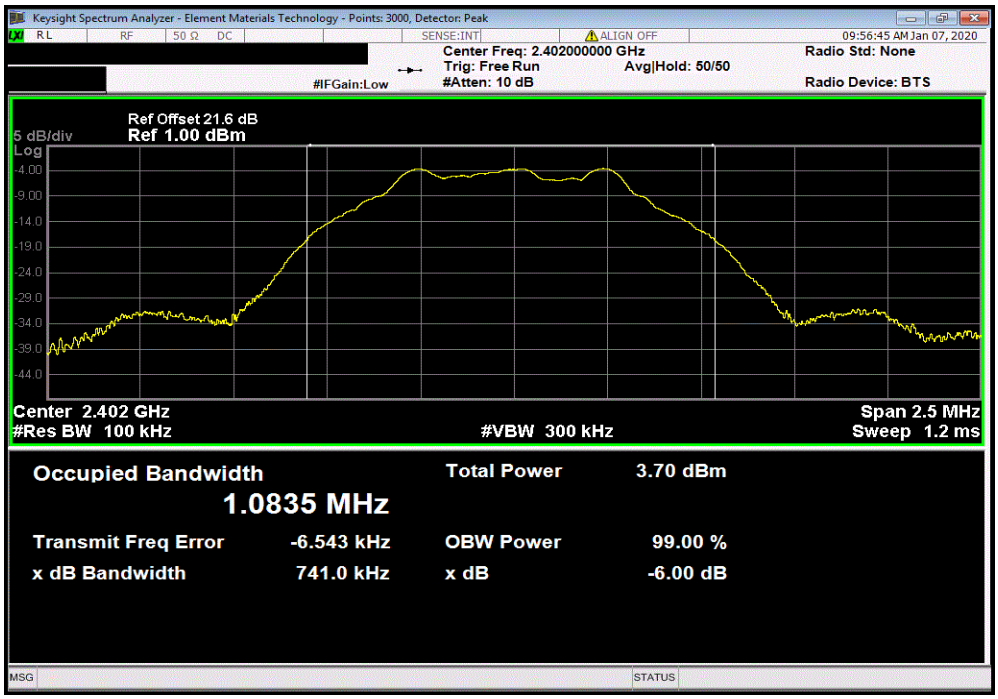
DEVIATIONS FROM TEST STANDARD

None

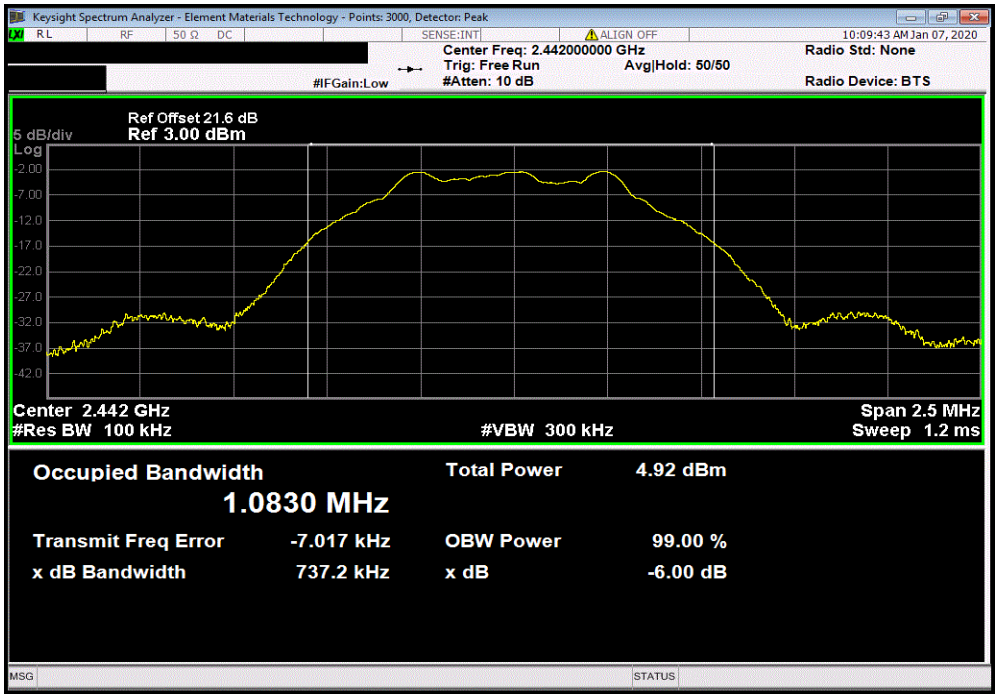
Configuration #	**4**	*Signature* Andrew Rogstad

		Value	**Limit (≥)**	**Result**
BLE/GFSK (1 Mbps)				
	Low Channel, 2402 MHz	741.03 kHz	500 kHz	Pass
	Mid Channel, 2442 MHz	737.178 kHz	500 kHz	Pass
	High Channel, 2480 MHz	749.86 kHz	500 kHz	Pass
BLE/GFSK (2 Mbps)				
	Low Channel, 2402 MHz	1.277 MHz	500 kHz	Pass
	Mid Channel, 2442 MHz	1.28 MHz	500 kHz	Pass
	High Channel, 2480 MHz	1.28 MHz	500 kHz	Pass

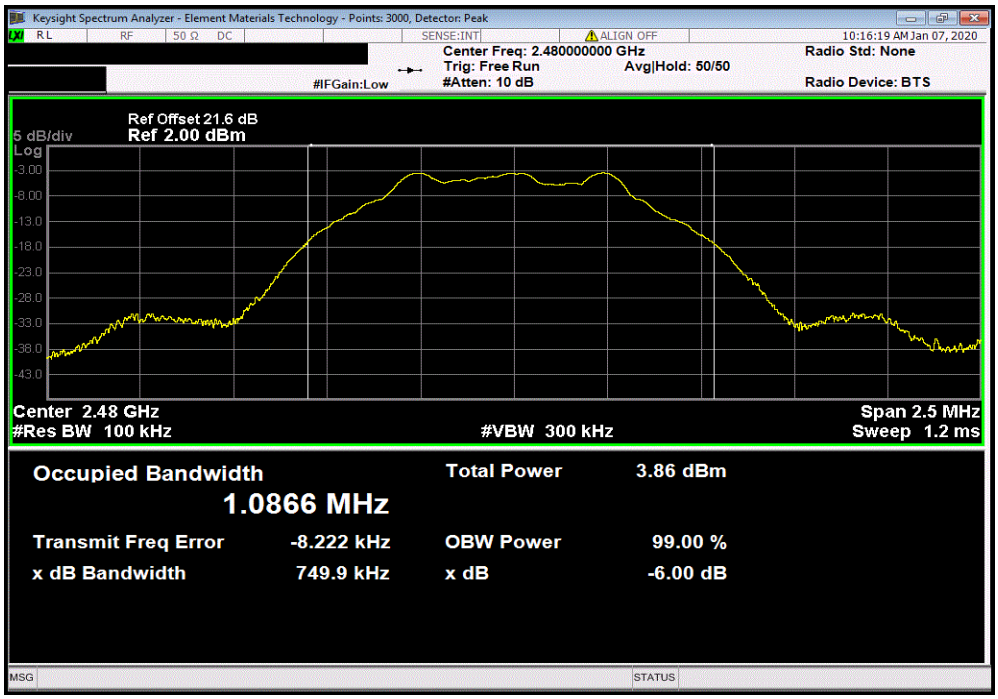
BLE/GFSK (1 Mbps), Low Channel, 2402 MHz						
				Value	Limit (≥)	Result
				741.03 kHz	500 kHz	Pass



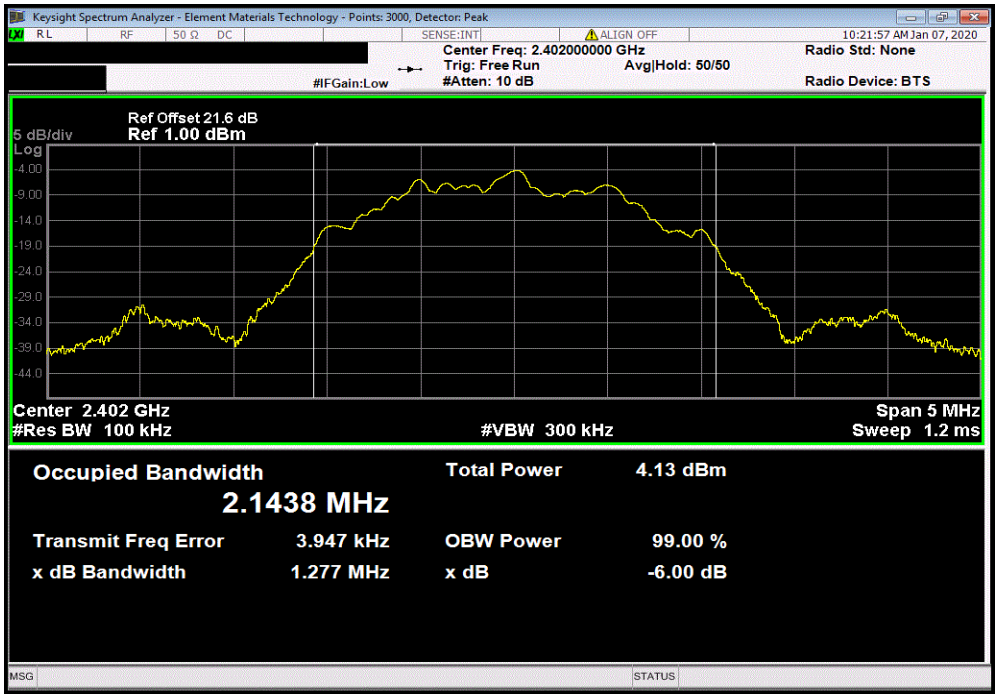
BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz						
				Value	Limit (≥)	Result
				737.178 kHz	500 kHz	Pass



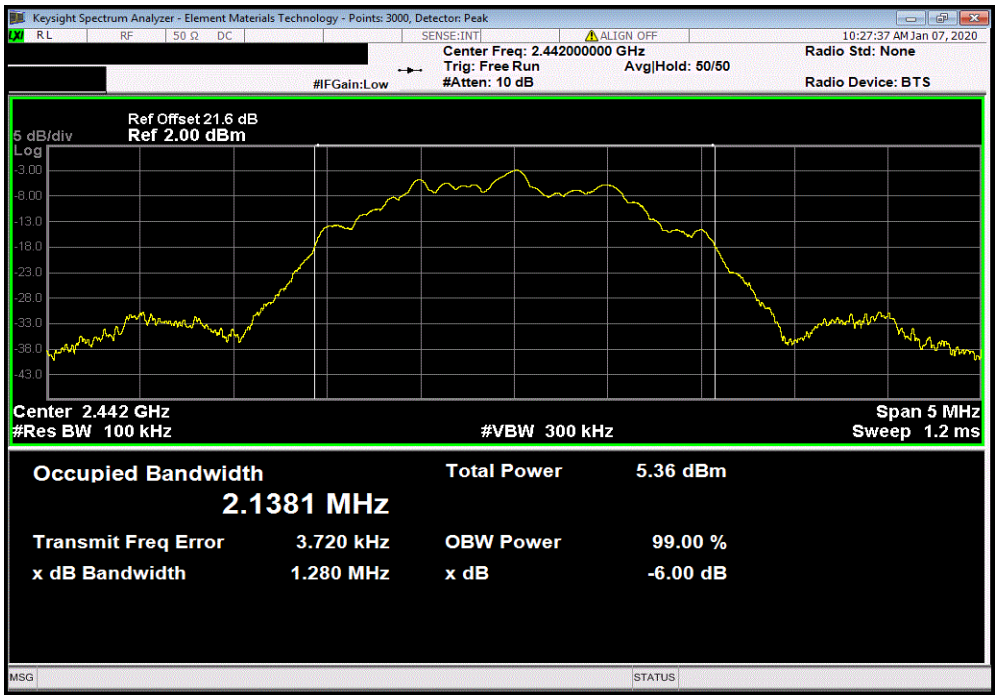
BLE/GFSK (1 Mbps), High Channel, 2480 MHz						
				Value	Limit (≥)	Result
				749.86 kHz	500 kHz	Pass



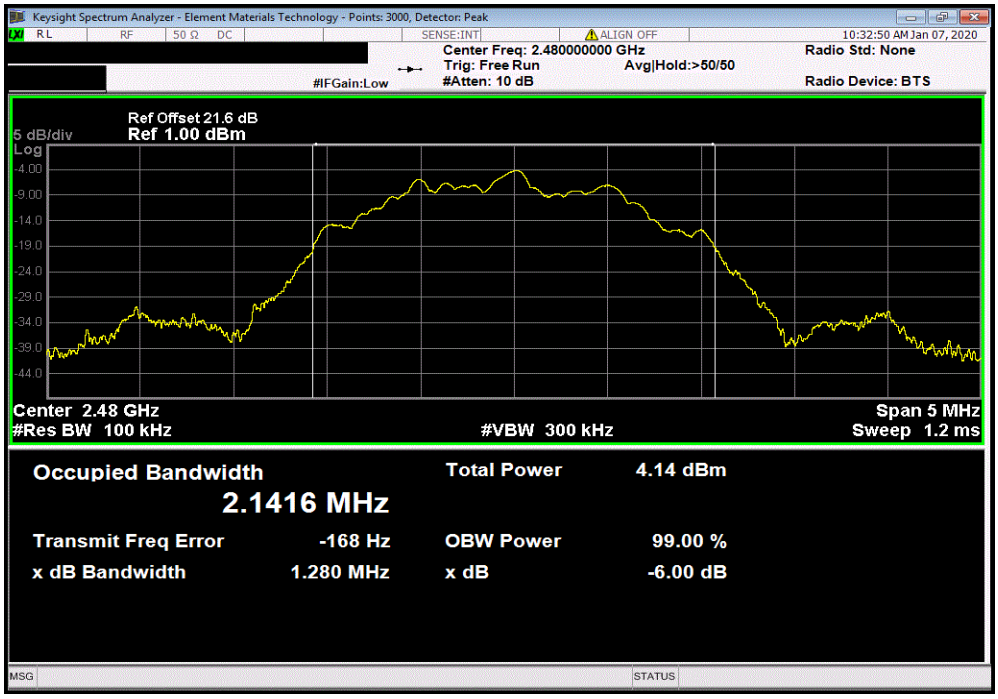
BLE/GFSK (2 Mbps), Low Channel, 2402 MHz						
				Value	Limit (≥)	Result
				1.277 MHz	500 kHz	Pass



BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz						
				Value	Limit (≥)	Result
				1.28 MHz	500 kHz	Pass



BLE/GFSK (2 Mbps), High Channel, 2480 MHz						
				Value	Limit (≥)	Result
				1.28 MHz	500 kHz	Pass



OUTPUT POWER

XMit 2019.09.05

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
Power Supply - DC	EZ Digital Co., Ltd.	GP-4030D	TQK	NCR	NCR
Meter - Multimeter	Fluke	117	MLS	23-Jan-17	23-Jan-20
Attenuator	S.M. Electronics	SA26B-20	TZP	9-Nov-19	9-Nov-20
Block - DC	Fairview Microwave	SD3379	AMZ	9-Nov-19	9-Nov-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

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

element

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	**Livio Custom BLE Hearing Aid (Right Ear)**			**Work Order:**	**STAK0202**
Serial Number:	**2911328235**			**Date:**	**6-Jan-20**
Customer:	**Starkey Laboratories, Inc.**			**Temperature:**	**23.1 °C**
Attendees:	**Charlie Esch**			**Humidity:**	**25.4% RH**
Project:	**None**			**Barometric Pres.:**	**1018 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**3.8 VDC**	**Job Site:**	**MN08**

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

COMMENTS

Right ear. Reference level offset includes Measurment Cable, DC Block, and 20 dB Attenuator.

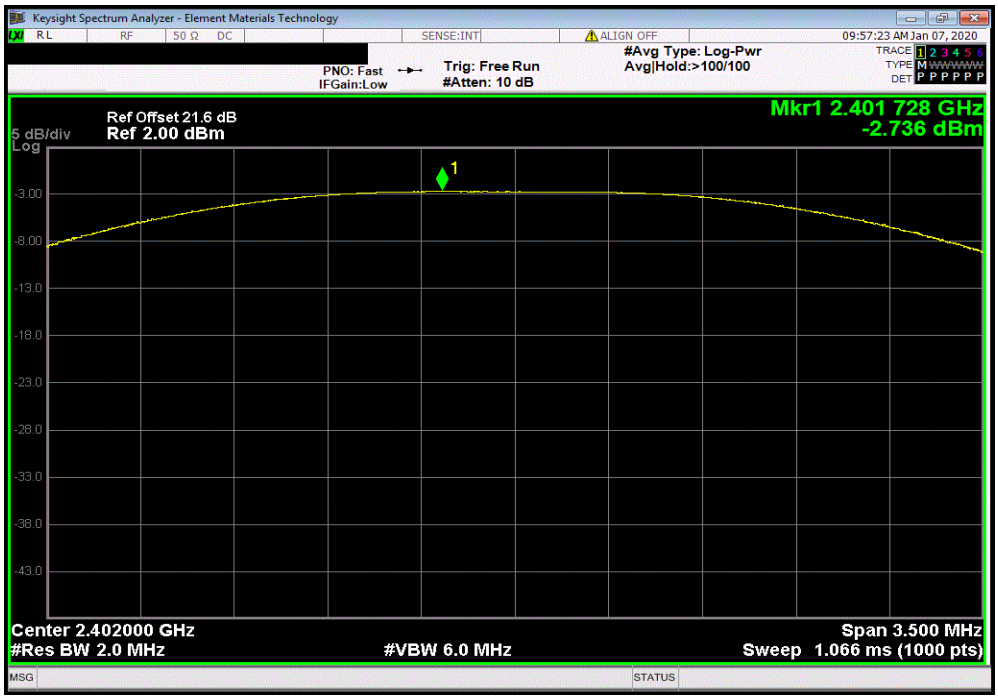
DEVIATIONS FROM TEST STANDARD

None

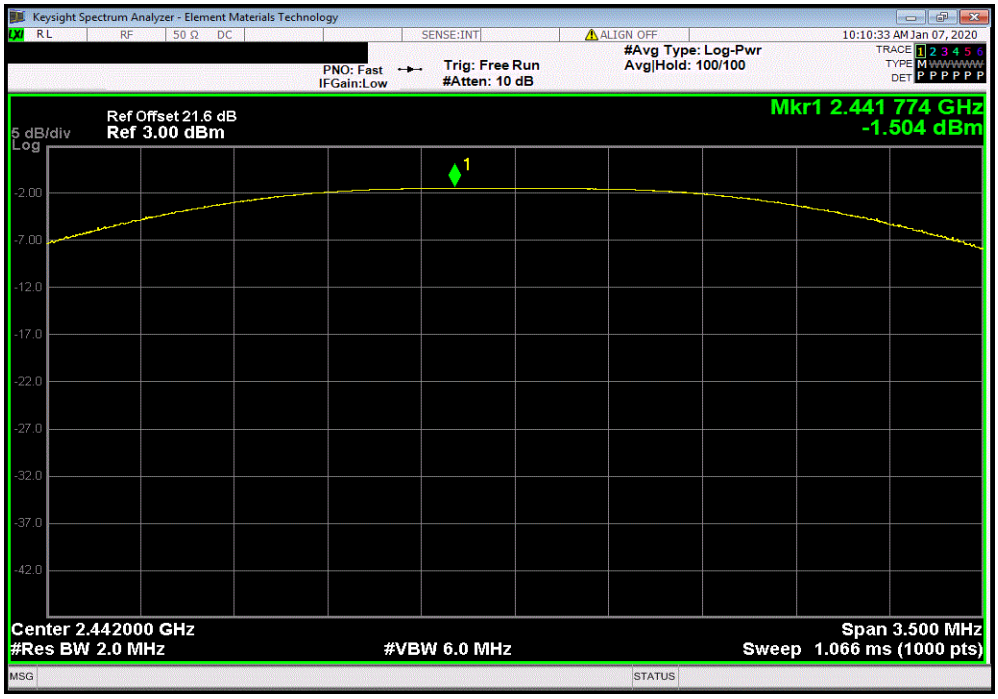
Configuration #	**4**	*Signature* Andrew Rogstad

	Out Pwr (dBm)	**Limit (dBm)**	**Result**
BLE/GFSK (1 Mbps)			
Low Channel, 2402 MHz	-2.736	30	Pass
Mid Channel, 2442 MHz	-1.504	30	Pass
High Channel, 2480 MHz	-2.521	30	Pass
BLE/GFSK (2 Mbps)			
Low Channel, 2402 MHz	-2.678	30	Pass
Mid Channel, 2442 MHz	-1.428	30	Pass
High Channel, 2480 MHz	-2.593	30	Pass

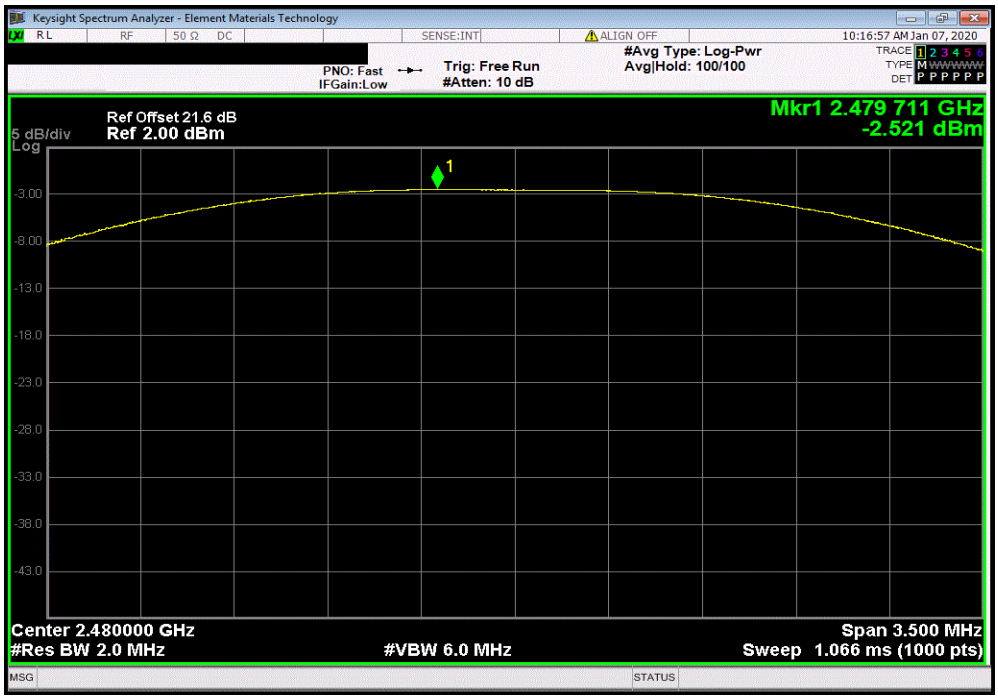
BLE/GFSK (1 Mbps), Low Channel, 2402 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-2.736	30	Pass



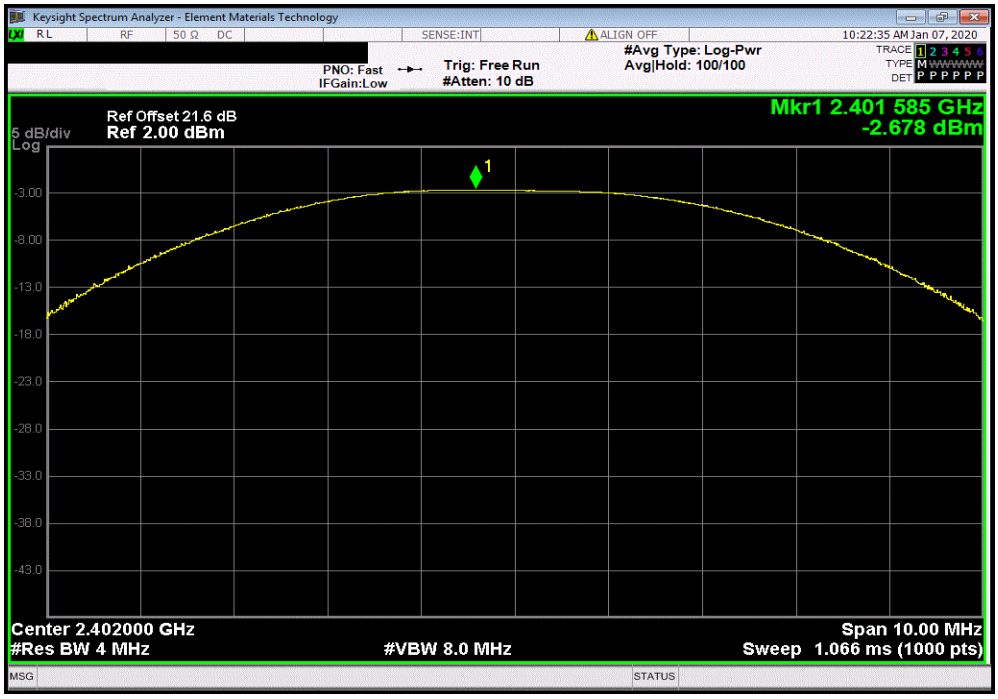
BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-1.504	30	Pass



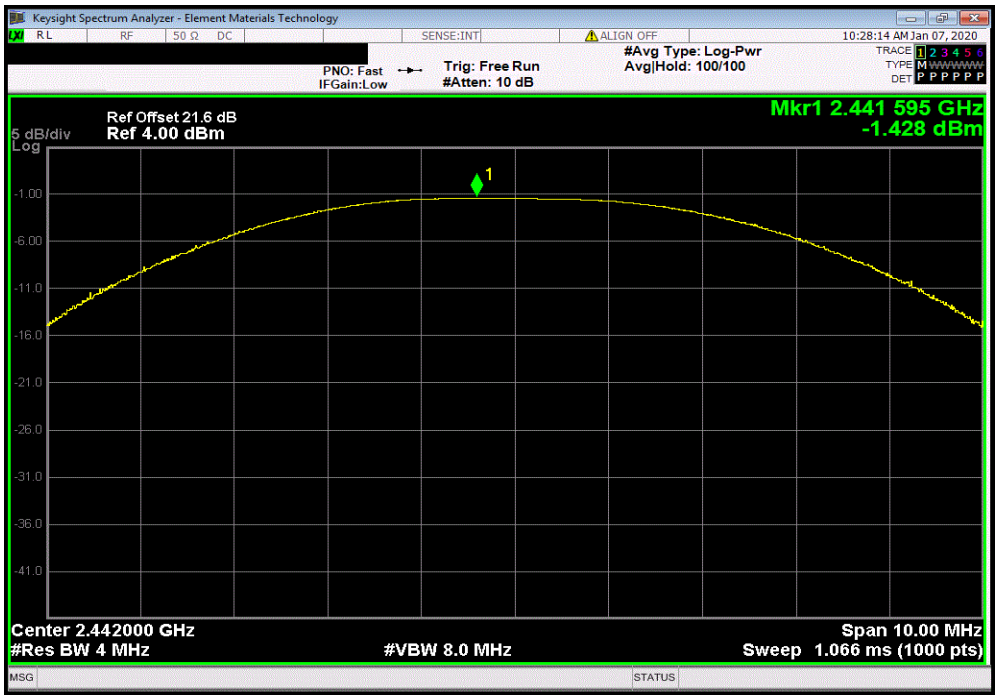
BLE/GFSK (1 Mbps), High Channel, 2480 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-2.521	30	Pass



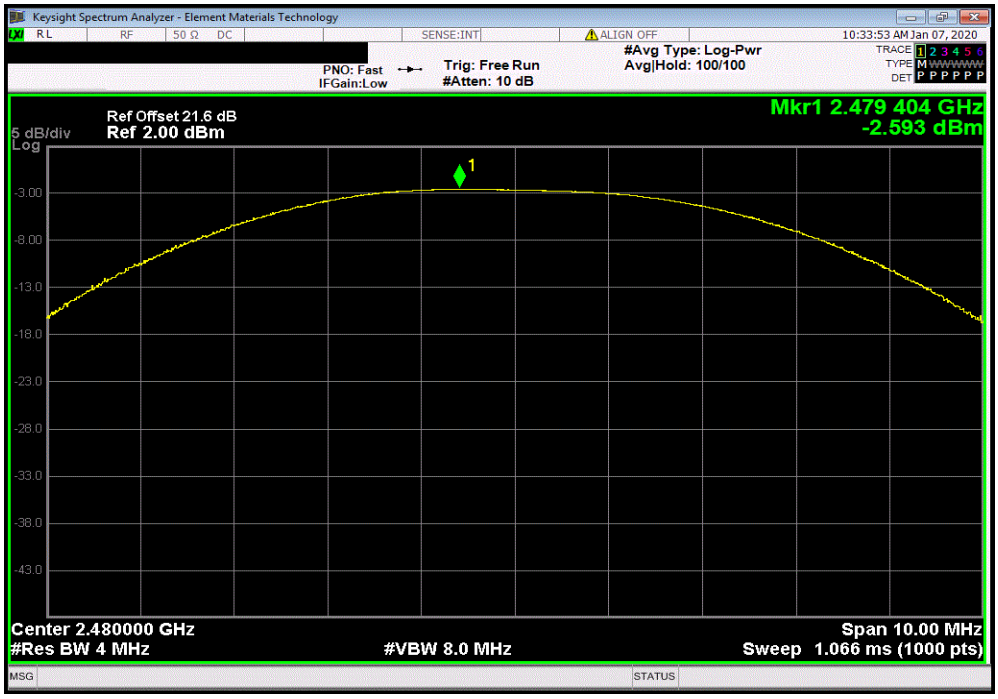
BLE/GFSK (2 Mbps), Low Channel, 2402 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-2.678	30	Pass



BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-1.428	30	Pass



BLE/GFSK (2 Mbps), High Channel, 2480 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				-2.593	30	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

XMit 2019.09.05

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
Power Supply - DC	EZ Digital Co., Ltd.	GP-4030D	TQK	NCR	NCR
Meter - Multimeter	Fluke	117	MLS	23-Jan-17	23-Jan-20
Attenuator	S.M. Electronics	SA26B-20	TZP	9-Nov-19	9-Nov-20
Block - DC	Fairview Microwave	SD3379	AMZ	9-Nov-19	9-Nov-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

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.

The antenna gain was added to the conducted output power value to calculate the EIRP.

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

element

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	**Livio Custom BLE Hearing Aid (Right Ear)**			**Work Order:**	**STAK0202**
Serial Number:	**2911328235**			**Date:**	**6-Jan-20**
Customer:	**Starkey Laboratories, Inc.**			**Temperature:**	**23 °C**
Attendees:	**Charlie Esch**			**Humidity:**	**25.5% RH**
Project:	**None**			**Barometric Pres.:**	**1018 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**3.8 VDC**	**Job Site:**	**MN08**

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

COMMENTS

Right ear. Reference level offset includes Measurment Cable, DC Block, and 20 dB Attenuator.

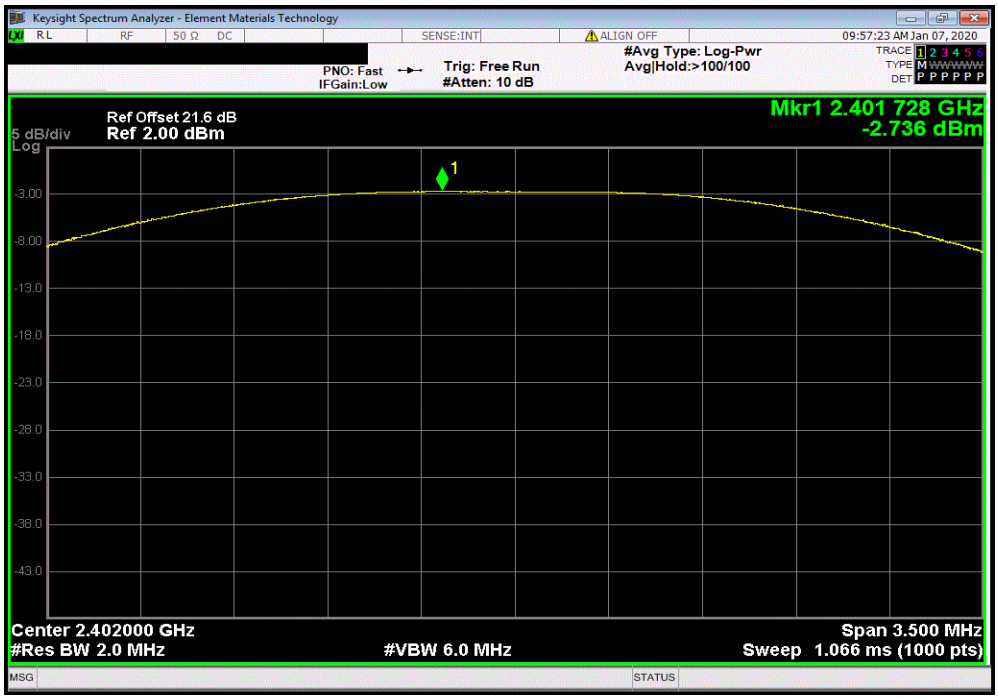
DEVIATIONS FROM TEST STANDARD

None

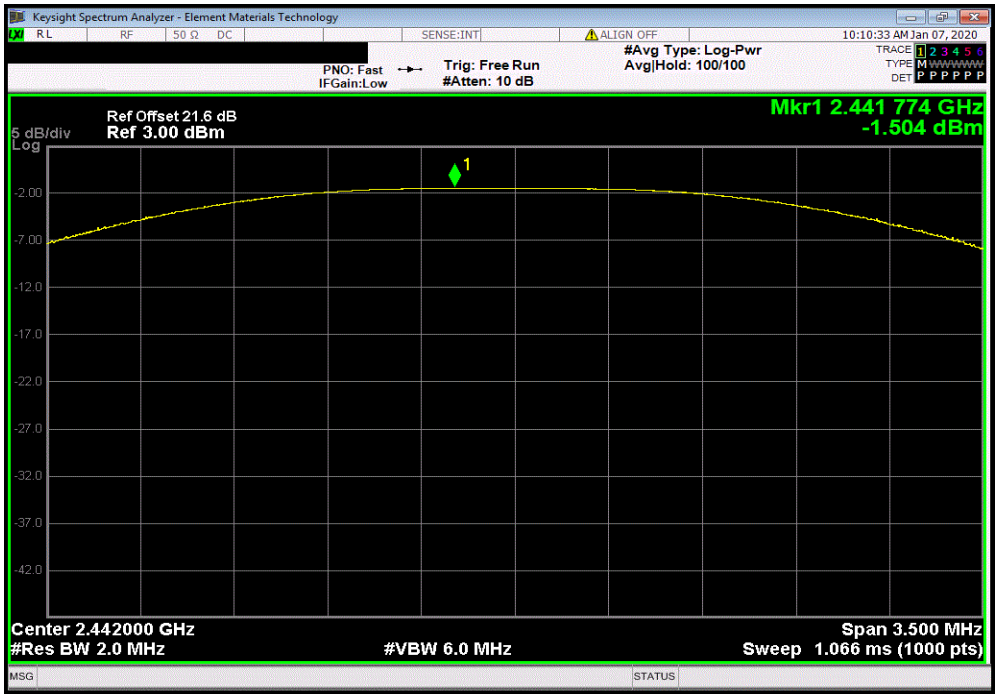
Configuration #	**4**	*Signature* Andrew Rogstad

	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
BLE/GFSK (1 Mbps)					
Low Channel, 2402 MHz	-2.736	-2	-4.736	36	Pass
Mid Channel, 2442 MHz	-1.504	-2	-3.504	36	Pass
High Channel, 2480 MHz	-2.521	-2	-4.521	36	Pass
BLE/GFSK (2 Mbps)					
Low Channel, 2402 MHz	-2.678	-2	-4.678	36	Pass
Mid Channel, 2442 MHz	-1.428	-2	-3.428	36	Pass
High Channel, 2480 MHz	-2.593	-2	-4.593	36	Pass

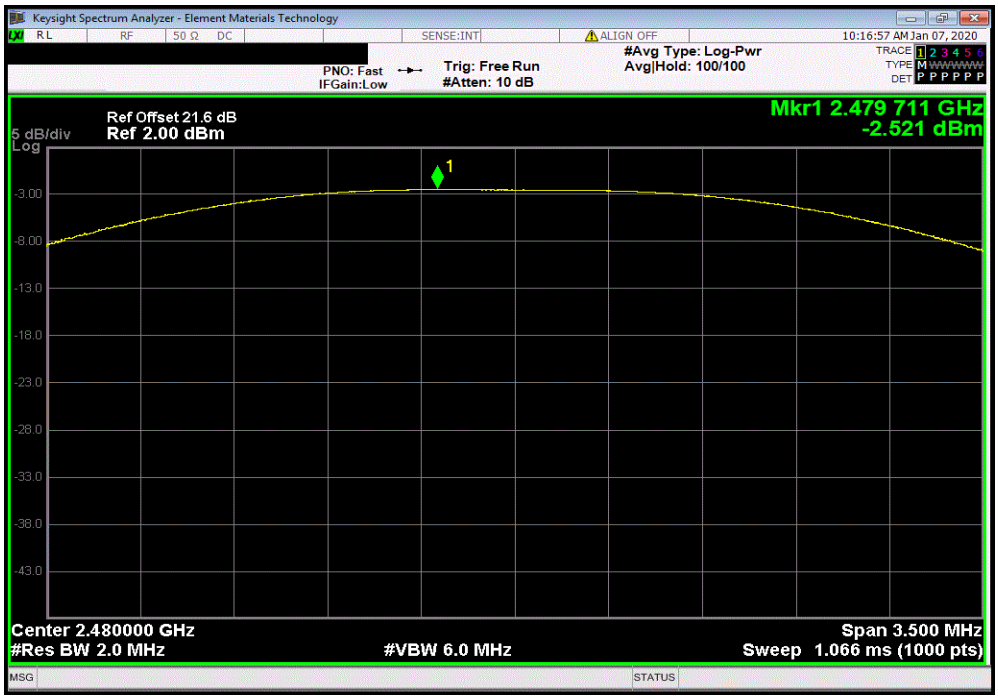
BLE/GFSK (1 Mbps), Low Channel, 2402 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-2.736	-2	-4.736	36	Pass



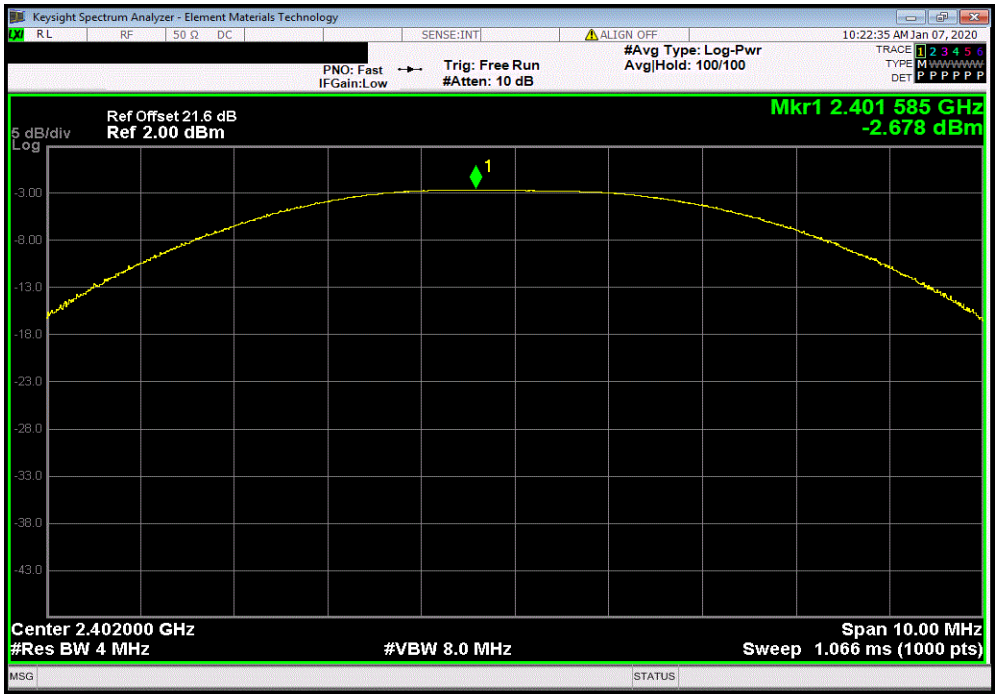
BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-1.504	-2	-3.504	36	Pass



BLE/GFSK (1 Mbps), High Channel, 2480 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-2.521	-2	-4.521	36	Pass

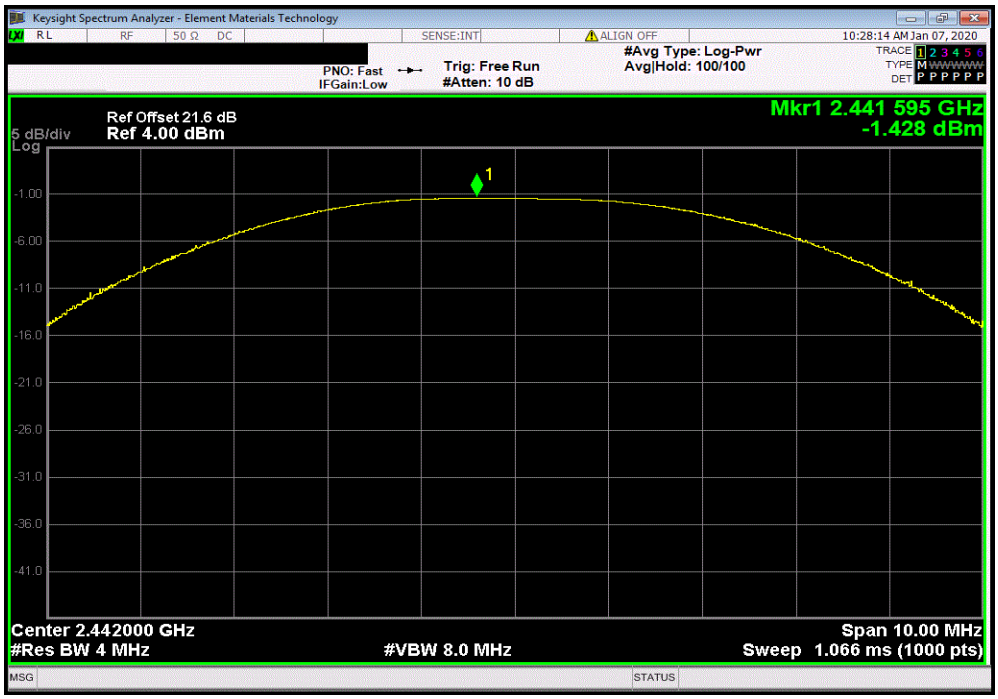


BLE/GFSK (2 Mbps), Low Channel, 2402 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-2.678	-2	-4.678	36	Pass

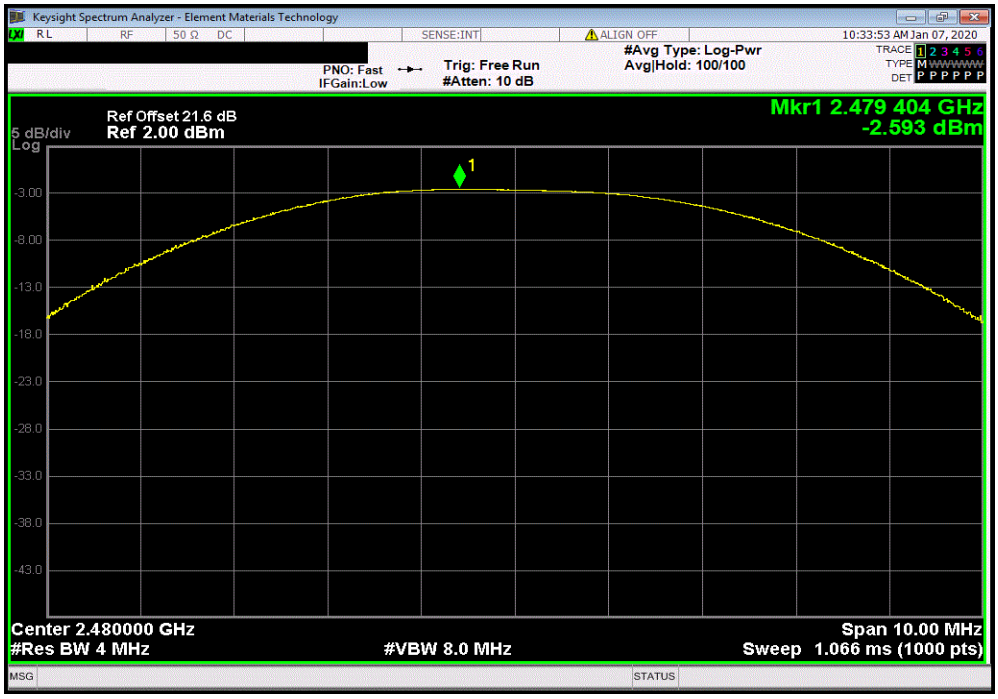


EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-1.428	-2	-3.428	36	Pass



BLE/GFSK (2 Mbps), High Channel, 2480 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		-2.593	-2	-4.593	36	Pass



POWER SPECTRAL DENSITY

XMit 2019.09.05

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
Power Supply - DC	EZ Digital Co., Ltd.	GP-4030D	TQK	NCR	NCR
Meter - Multimeter	Fluke	117	MLS	23-Jan-17	23-Jan-20
Attenuator	S.M. Electronics	SA26B-20	TZP	9-Nov-19	9-Nov-20
Block - DC	Fairview Microwave	SD3379	AMZ	9-Nov-19	9-Nov-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

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

element

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	**Livio Custom BLE Hearing Aid (Right Ear)**			**Work Order:**	**STAK0202**
Serial Number:	**2911328235**			**Date:**	**6-Jan-20**
Customer:	**Starkey Laboratories, Inc.**			**Temperature:**	**23.1 °C**
Attendees:	**Charlie Esch**			**Humidity:**	**25.2% RH**
Project:	**None**			**Barometric Pres.:**	**1018 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**3.8 VDC**	**Job Site:**	**MN08**

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

COMMENTS

Right ear. Reference level offset includes Measurment Cable, DC Block, and 20 dB Attenuator.

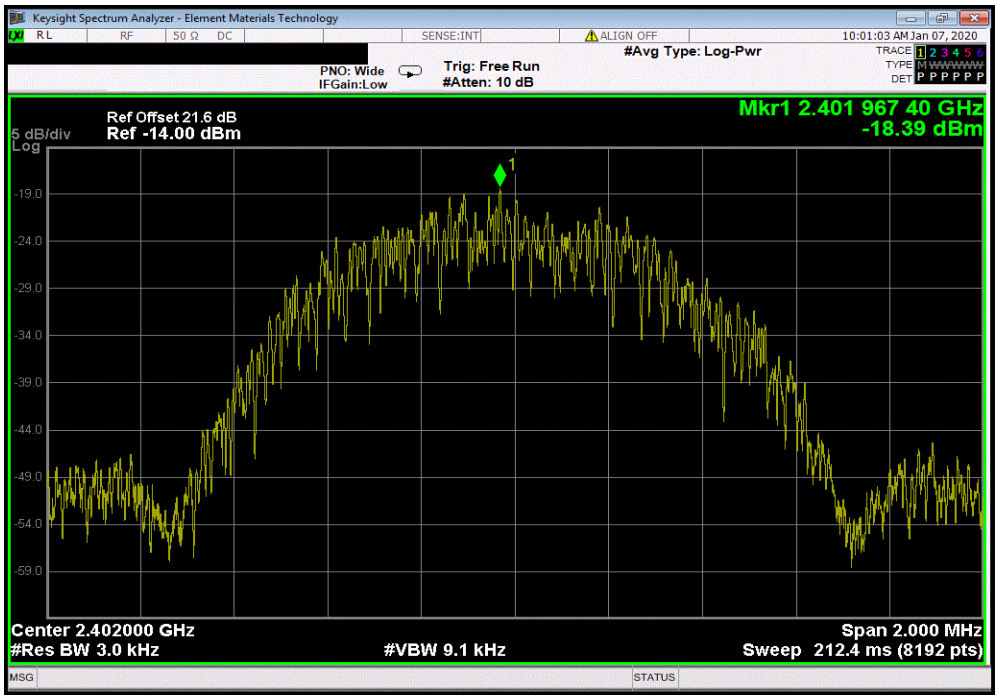
DEVIATIONS FROM TEST STANDARD

None

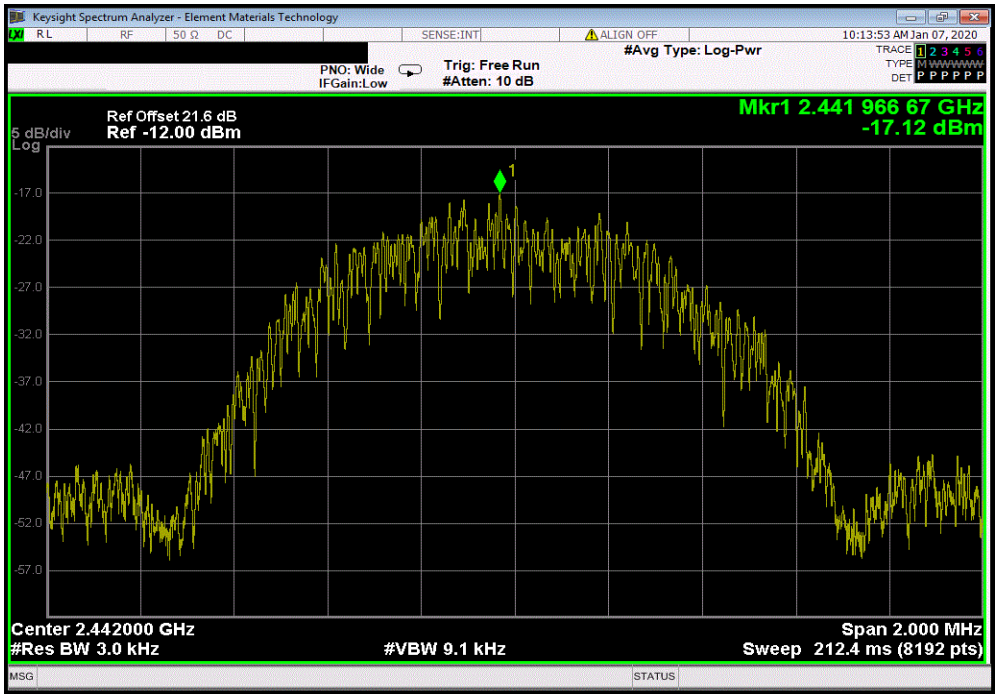
Configuration #	**4**	*Signature* Andrew Rogstad

	Value dBm/3kHz	**Limit < dBm/3kHz**	**Results**
BLE/GFSK (1 Mbps)			
Low Channel, 2402 MHz	-18.386	8	Pass
Mid Channel, 2442 MHz	-17.119	8	Pass
High Channel, 2480 MHz	-18.095	8	Pass
BLE/GFSK (2 Mbps)			
Low Channel, 2402 MHz	-20.951	8	Pass
Mid Channel, 2442 MHz	-19.668	8	Pass
High Channel, 2480 MHz	-20.775	8	Pass

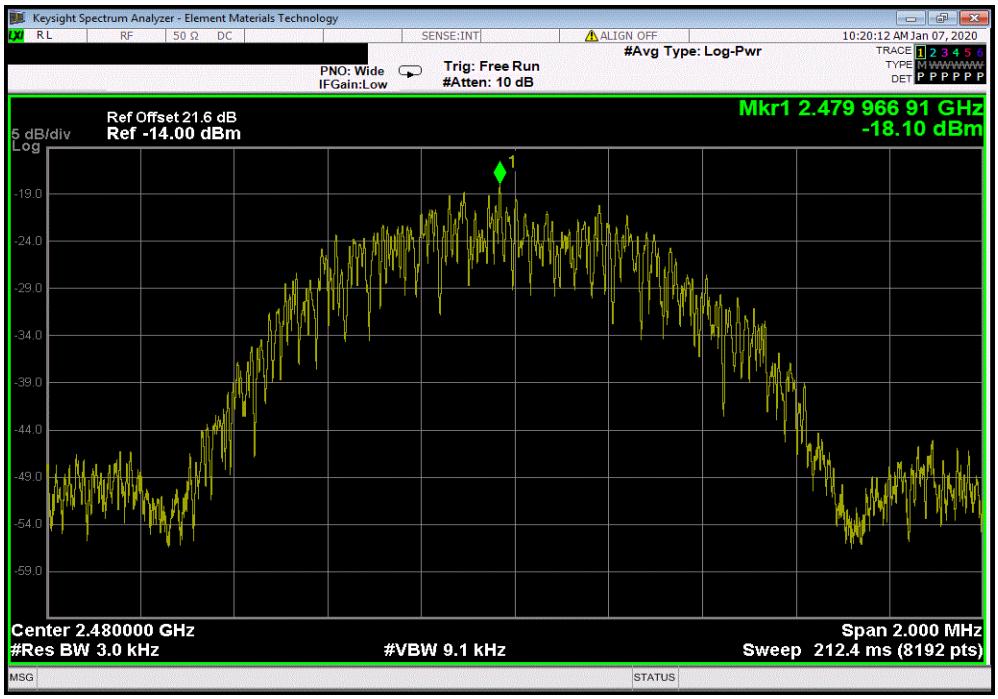
BLE/GFSK (1 Mbps), Low Channel, 2402 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-18.386	8	Pass



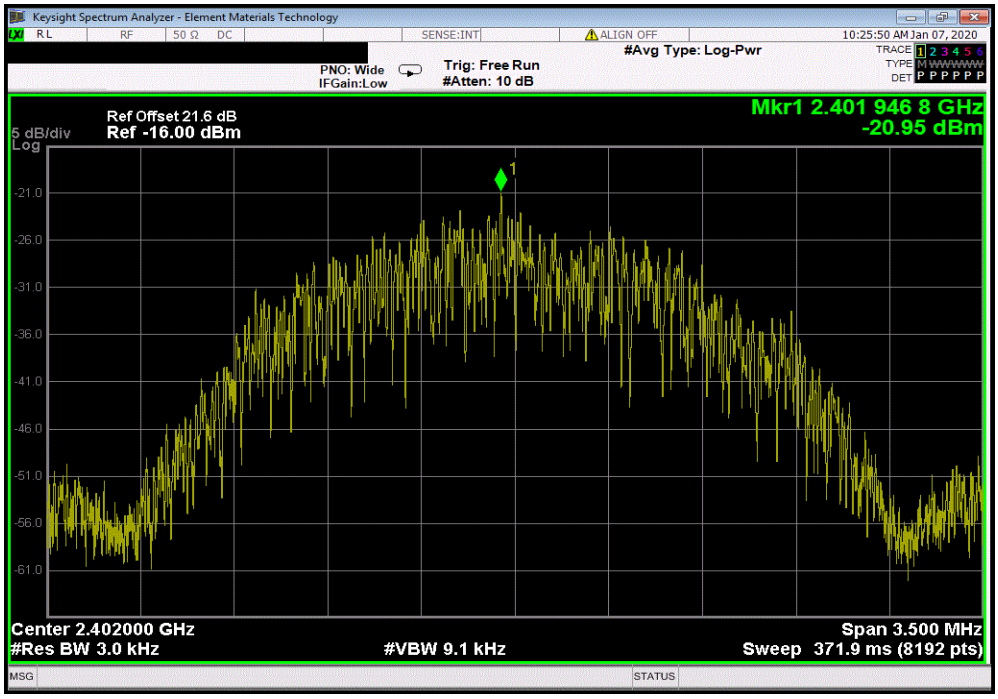
BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-17.119	8	Pass



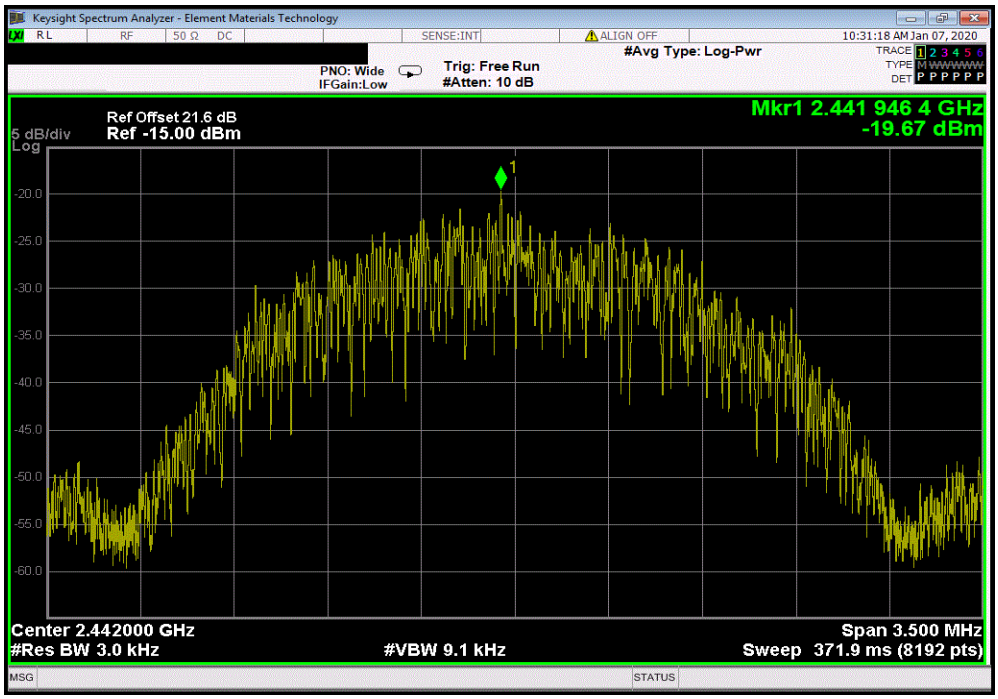
BLE/GFSK (1 Mbps), High Channel, 2480 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-18.095	8	Pass



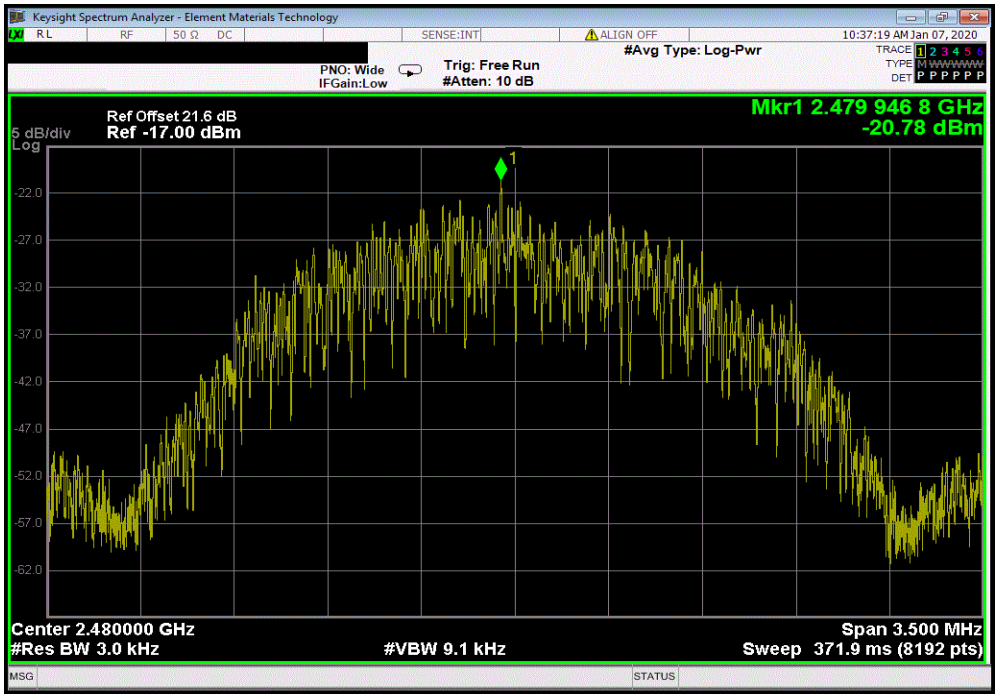
BLE/GFSK (2 Mbps), Low Channel, 2402 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-20.951	8	Pass



BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-19.668	8	Pass



BLE/GFSK (2 Mbps), High Channel, 2480 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-20.775	8	Pass



BAND EDGE COMPLIANCE

XMit 2019.09.05

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
Power Supply - DC	EZ Digital Co., Ltd.	GP-4030D	TQK	NCR	NCR
Meter - Multimeter	Fluke	117	MLS	23-Jan-17	23-Jan-20
Attenuator	S.M. Electronics	SA26B-20	TZP	9-Nov-19	9-Nov-20
Block - DC	Fairview Microwave	SD3379	AMZ	9-Nov-19	9-Nov-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

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

element

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	**Livio Custom BLE Hearing Aid (Right Ear)**			**Work Order:**	**STAK0202**
Serial Number:	**2911328235**			**Date:**	**6-Jan-20**
Customer:	**Starkey Laboratories, Inc.**			**Temperature:**	**23 °C**
Attendees:	**Charlie Esch**			**Humidity:**	**25.6% RH**
Project:	**None**			**Barometric Pres.:**	**1018 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**3.8 VDC**	**Job Site:**	**MN08**

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

COMMENTS

Right ear. Reference level offset includes Measurment Cable, DC Block, and 20 dB Attenuator.

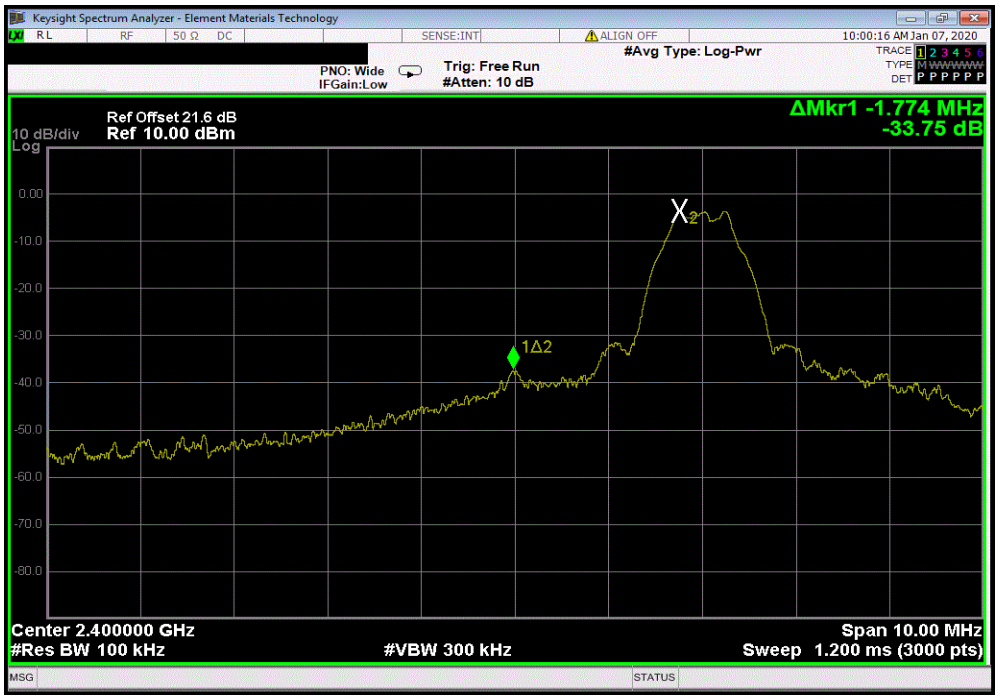
DEVIATIONS FROM TEST STANDARD

None

Configuration #	**4**	*Signature* Andrew Rogstad

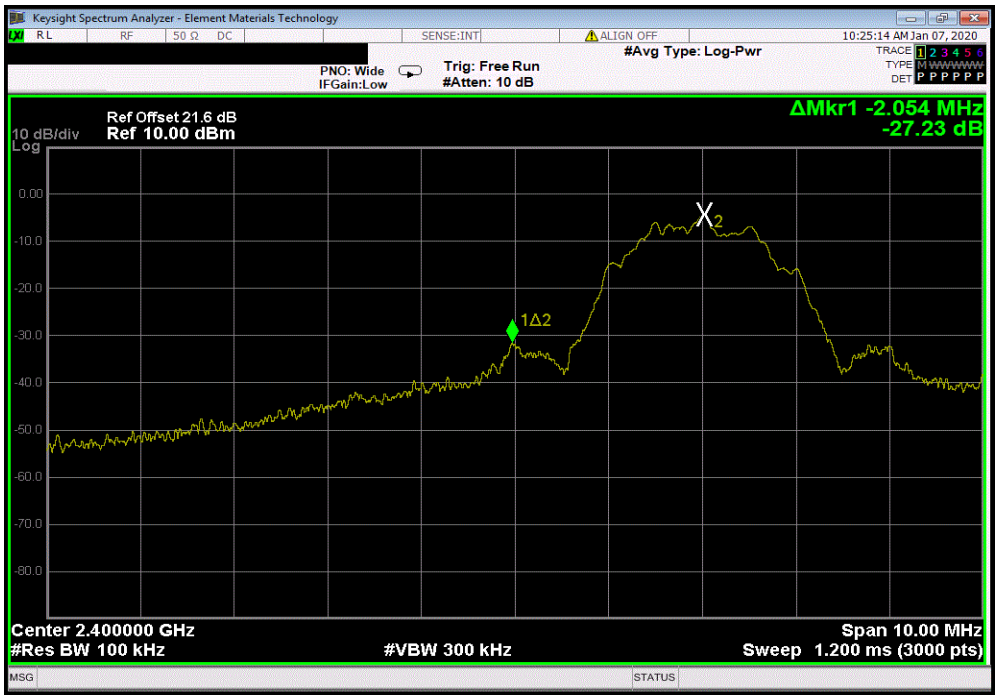
	Value (dBc)	**Limit ≤ (dBc)**	**Result**
BLE/GFSK (1 Mbps)			
Low Channel, 2402 MHz	-33.75	-20	Pass
High Channel, 2480 MHz	-44.18	-20	Pass
BLE/GFSK (2 Mbps)			
Low Channel, 2402 MHz	-27.23	-20	Pass
High Channel, 2480 MHz	-40.16	-20	Pass

BLE/GFSK (1 Mbps), Low Channel, 2402 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-33.75	-20	Pass

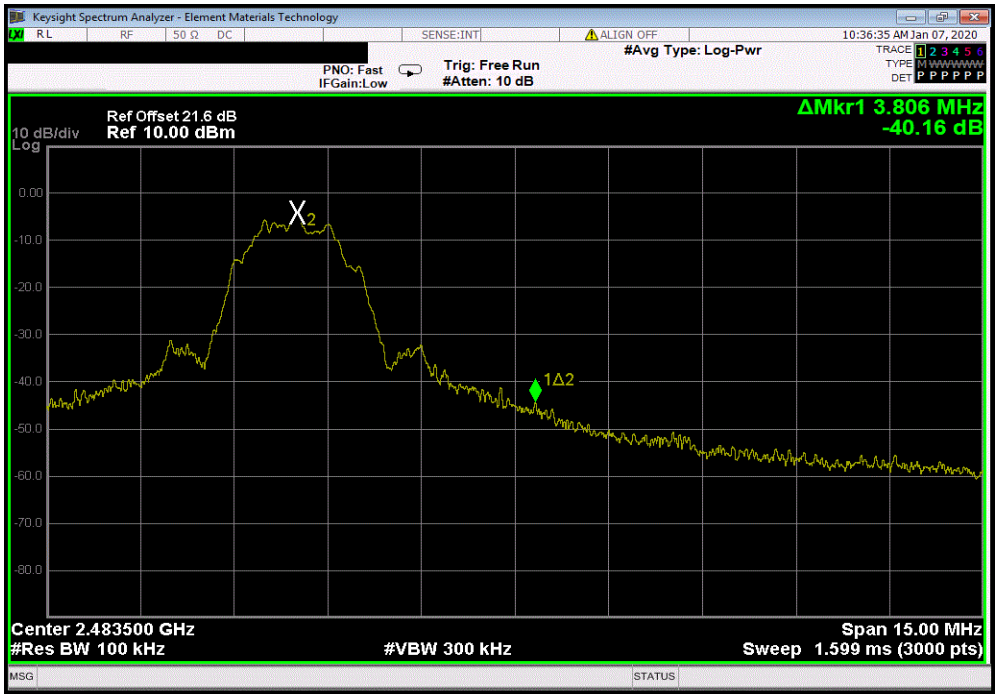


BLE/GFSK (1 Mbps), High Channel, 2480 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-44.18	-20	Pass

BLE/GFSK (2 Mbps), Low Channel, 2402 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-27.23	-20	Pass



BLE/GFSK (2 Mbps), High Channel, 2480 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-40.16	-20	Pass



SPURIOUS CONDUCTED EMISSIONS

XMit 2019.09.05

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
Power Supply - DC	EZ Digital Co., Ltd.	GP-4030D	TQK	NCR	NCR
Meter - Multimeter	Fluke	117	MLS	23-Jan-17	23-Jan-20
Attenuator	S.M. Electronics	SA26B-20	TZP	9-Nov-19	9-Nov-20
Block - DC	Fairview Microwave	SD3379	AMZ	9-Nov-19	9-Nov-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

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 spectrum was scanned throughout the specified frequency range.

SPURIOUS CONDUCTED EMISSIONS

element

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	**Livio Custom BLE Hearing Aid (Right Ear)**			**Work Order:**	**STAK0202**
Serial Number:	**2911328235**			**Date:**	**6-Jan-20**
Customer:	**Starkey Laboratories, Inc.**			**Temperature:**	**23.1 °C**
Attendees:	**Charlie Esch**			**Humidity:**	**25.3% RH**
Project:	**None**			**Barometric Pres.:**	**1018 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**3.8 VDC**	**Job Site:**	**MN08**

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

COMMENTS

Right ear. Reference level offset includes Measurment Cable, DC Block, and 20 dB Attenuator.

DEVIATIONS FROM TEST STANDARD

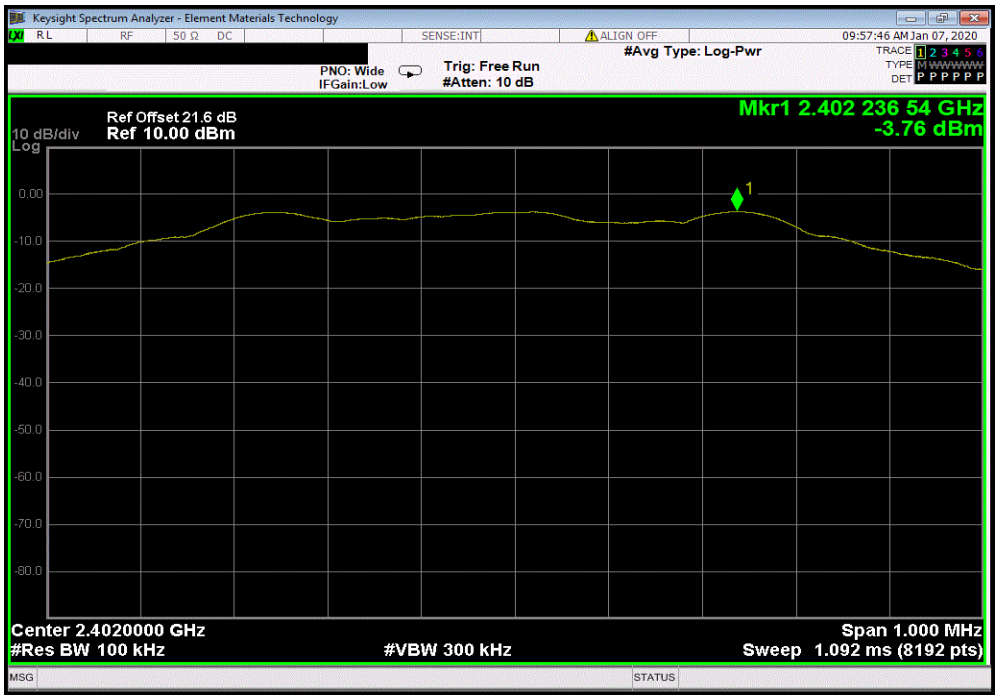
None

Configuration #	**4**	*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
	Low Channel, 2402 MHz	30 MHz - 12.5 GHz	7206.61	-44.14	-20	Pass
	Low Channel, 2402 MHz	12.5 GHz - 25 GHz	24021.79	-47.48	-20	Pass
	Mid Channel, 2442 MHz	Fundamental	2442.24	N/A	N/A	N/A
	Mid Channel, 2442 MHz	30 MHz - 12.5 GHz	7325.35	-48.34	-20	Pass
	Mid Channel, 2442 MHz	12.5 GHz - 25 GHz	24206.45	-48.29	-20	Pass
	High Channel, 2480 MHz	Fundamental	2480.23	N/A	N/A	N/A
	High Channel, 2480 MHz	30 MHz - 12.5 GHz	7439.53	-49.32	-20	Pass
	High Channel, 2480 MHz	12.5 GHz - 25 GHz	24104.2	-47.53	-20	Pass
BLE/GFSK (2 Mbps)						
	Low Channel, 2402 MHz	Fundamental	2402.01	N/A	N/A	N/A
	Low Channel, 2402 MHz	30 MHz - 12.5 GHz	2397.34	-42.28	-20	Pass
	Low Channel, 2402 MHz	12.5 GHz - 25 GHz	23911.92	-46.87	-20	Pass
	Mid Channel, 2442 MHz	Fundamental	2442.01	N/A	N/A	N/A
	Mid Channel, 2442 MHz	30 MHz - 12.5 GHz	3915.17	-50.22	-20	Pass
	Mid Channel, 2442 MHz	12.5 GHz - 25 GHz	19475.64	-48	-20	Pass
	High Channel, 2480 MHz	Fundamental	2480.01	N/A	N/A	N/A
	High Channel, 2480 MHz	30 MHz - 12.5 GHz	3802.51	-48.57	-20	Pass
	High Channel, 2480 MHz	12.5 GHz - 25 GHz	23931.75	-46.91	-20	Pass

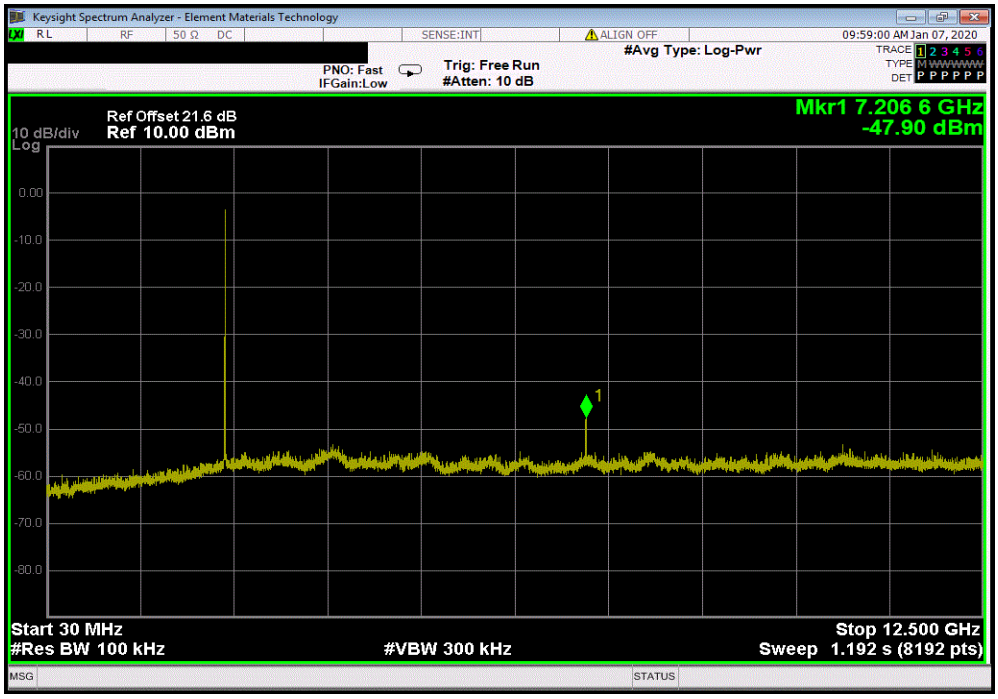
BLE/GFSK (1 Mbps), Low Channel, 2402 MHz

Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Fundamental		2402.24	N/A	N/A	N/A

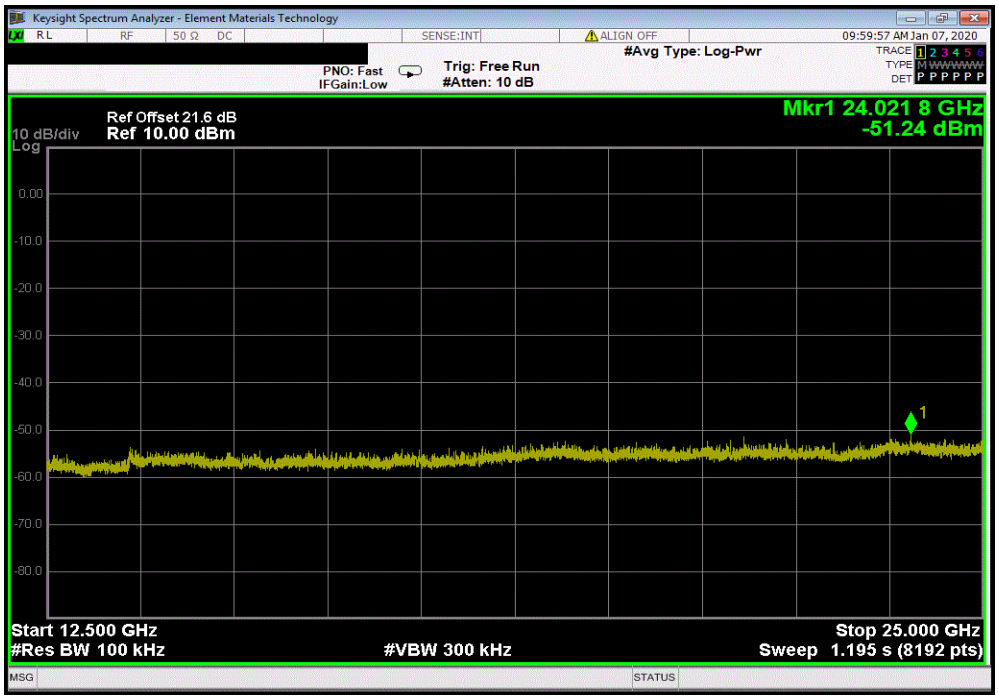


BLE/GFSK (1 Mbps), Low Channel, 2402 MHz

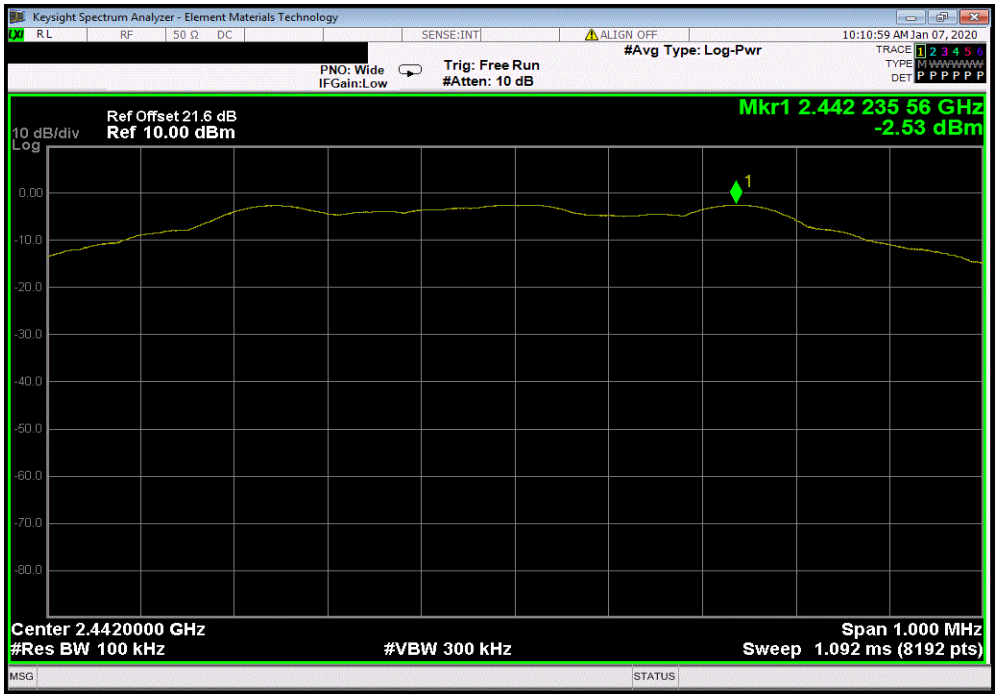
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	7206.61	-44.14	-20	Pass



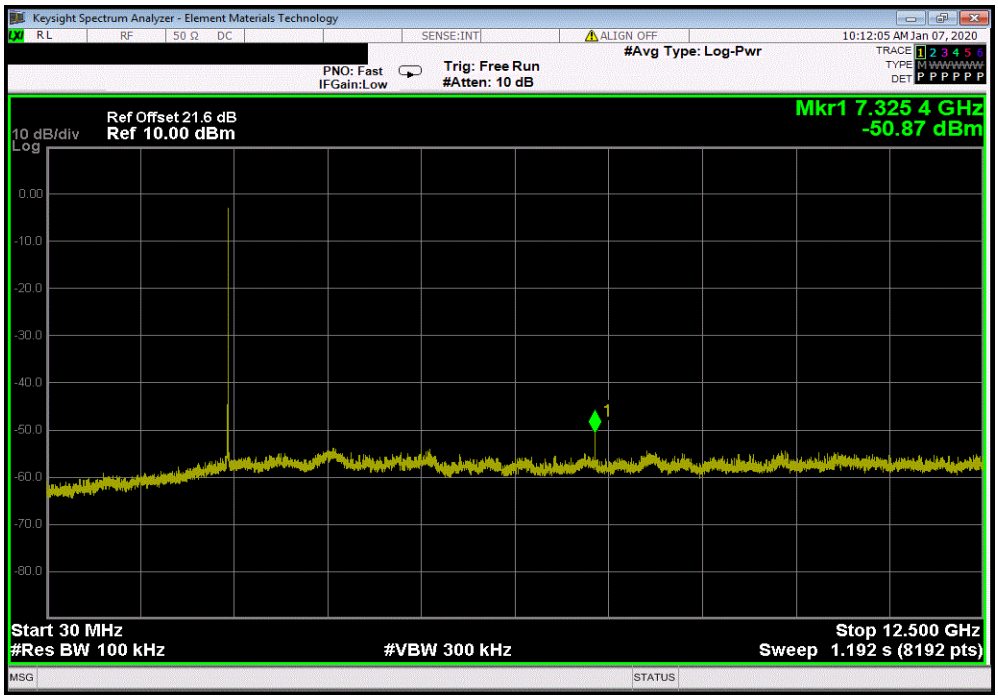
BLE/GFSK (1 Mbps), Low Channel, 2402 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	24021.79	-47.48	-20	Pass



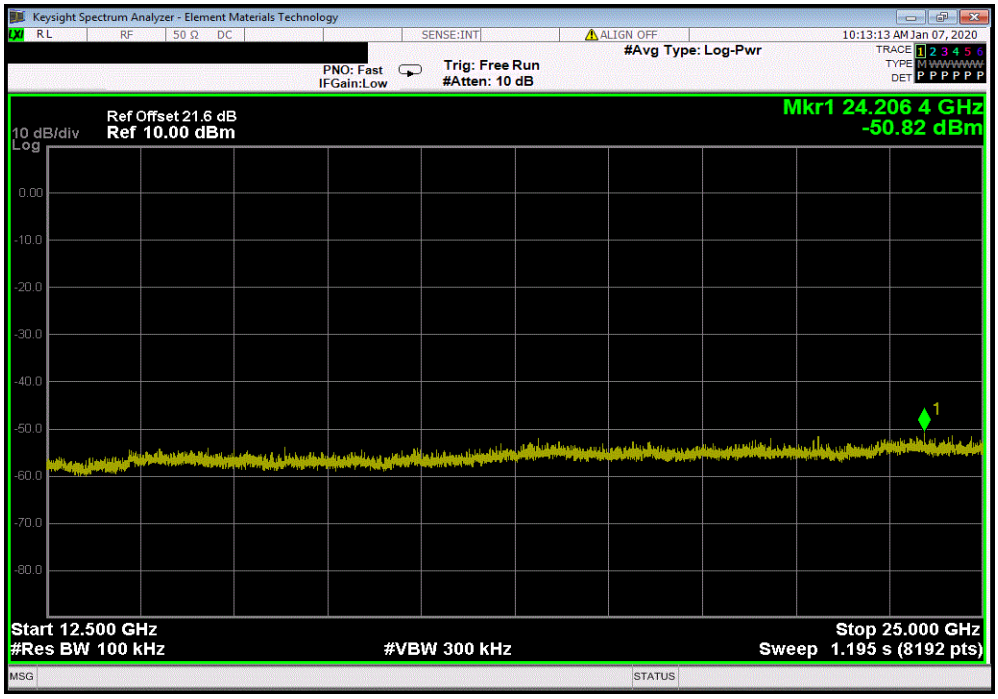
BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Fundamental	2442.24	N/A	N/A	N/A



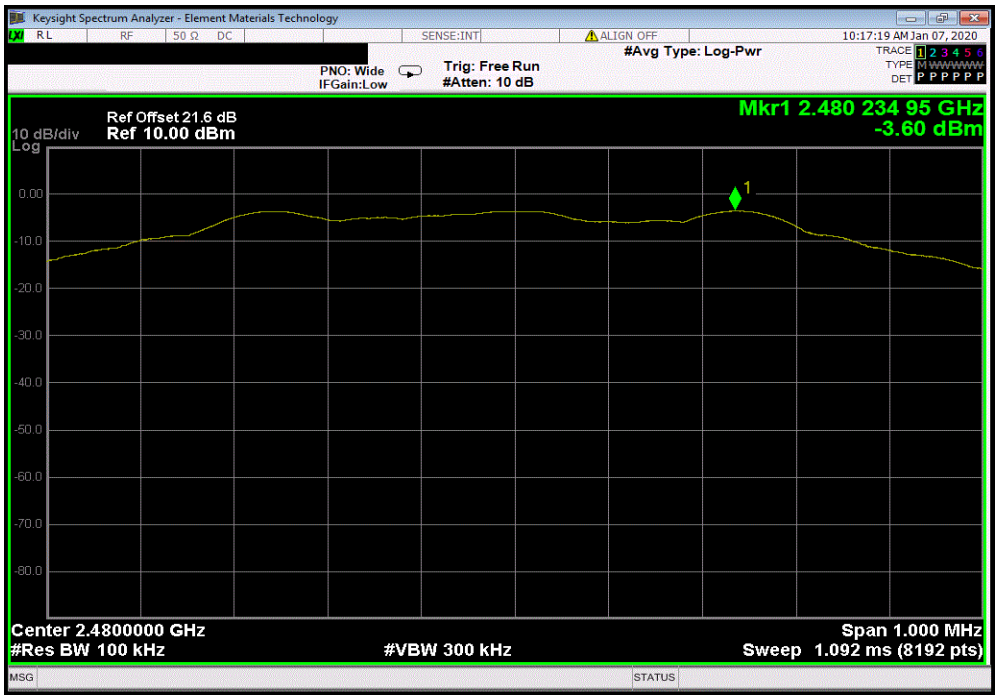
BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	7325.35	-48.34	-20	Pass



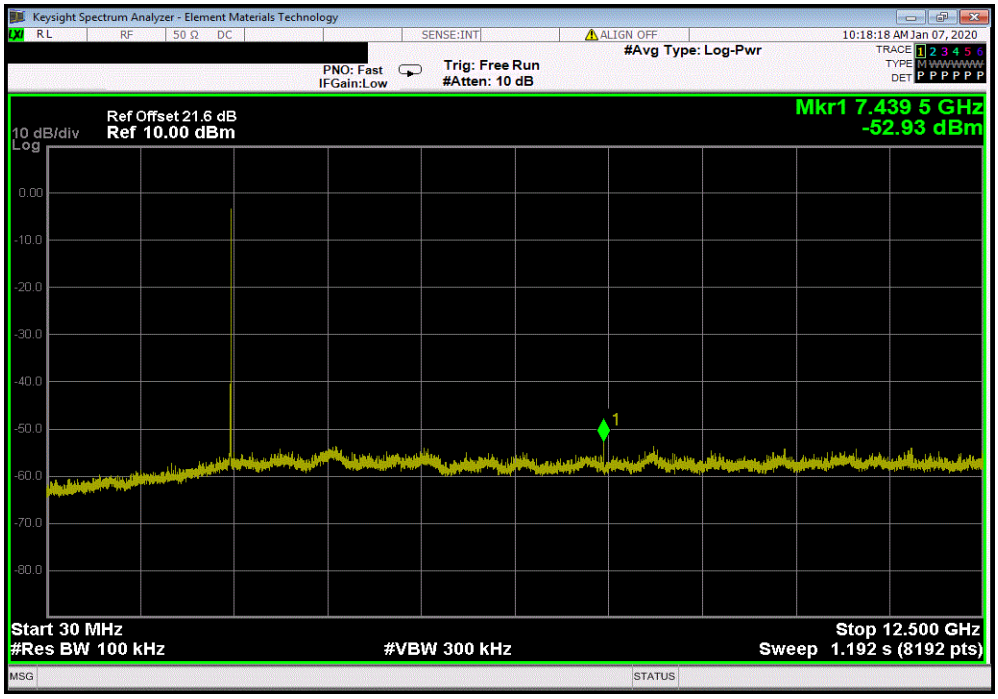
BLE/GFSK (1 Mbps), Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	24206.45	-48.29	-20	Pass



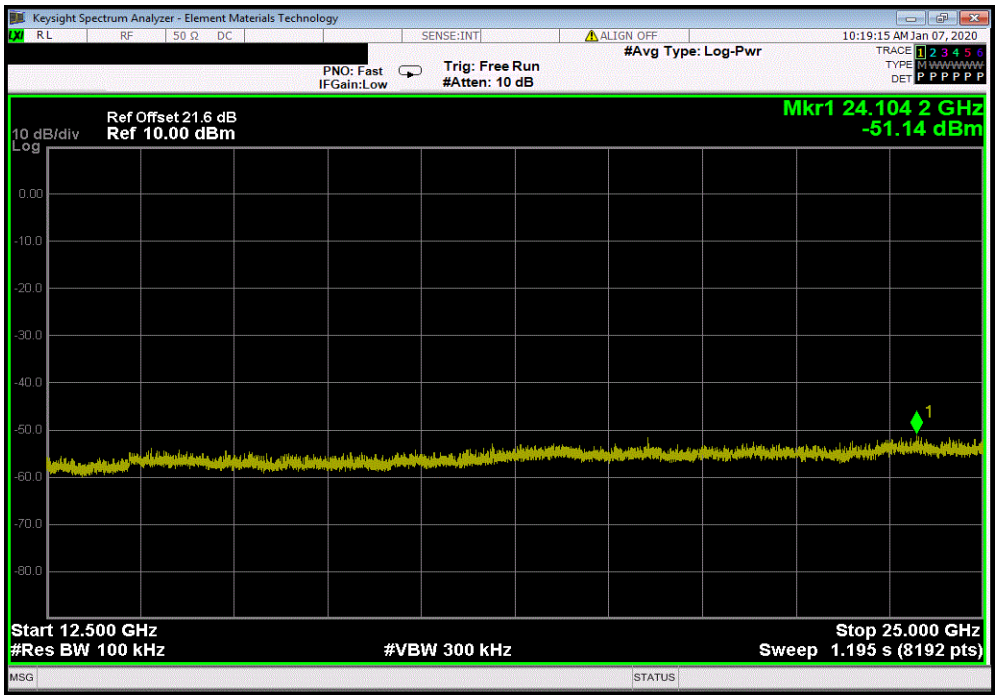
BLE/GFSK (1 Mbps), High Channel, 2480 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2480.23	N/A	N/A	N/A



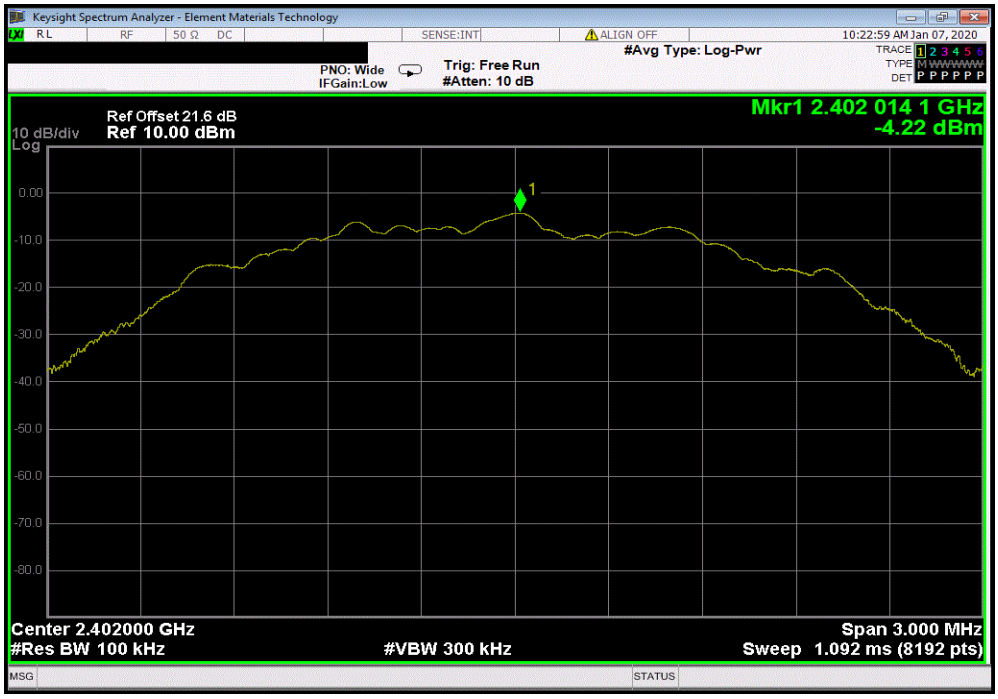
BLE/GFSK (1 Mbps), High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	7439.53	-49.32	-20	Pass



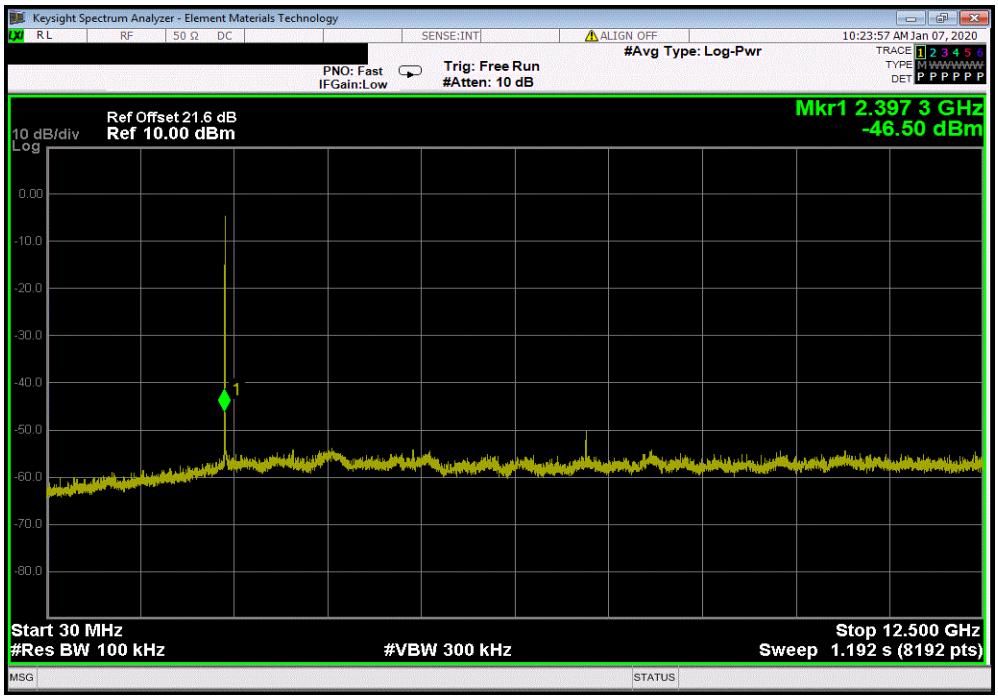
BLE/GFSK (1 Mbps), High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	24104.2	-47.53	-20	Pass



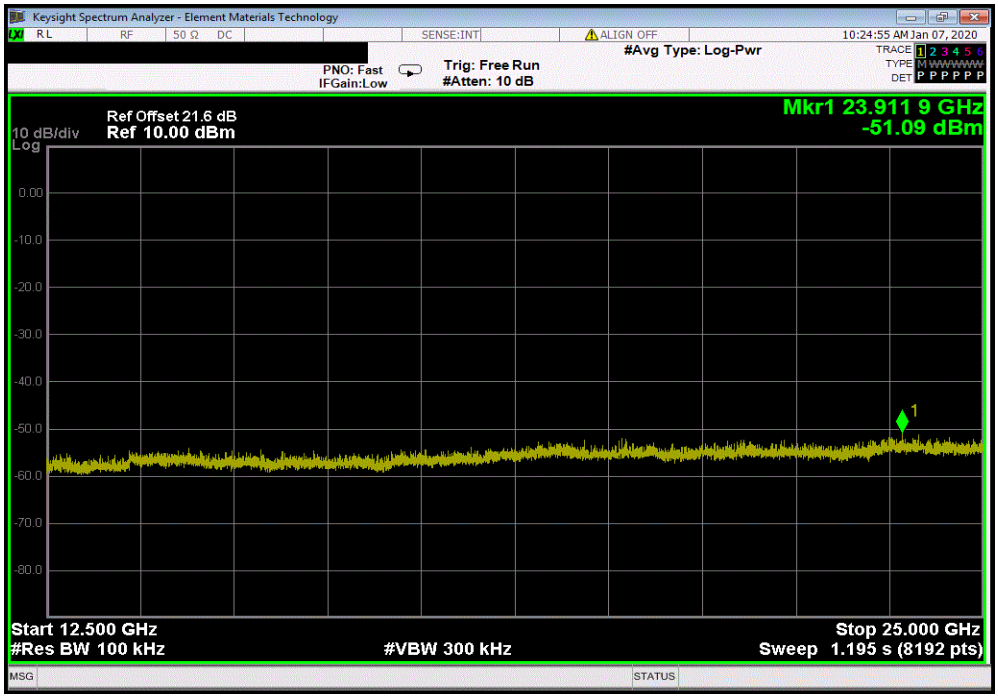
BLE/GFSK (2 Mbps), Low Channel, 2402 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Fundamental	2402.01	N/A	N/A	N/A



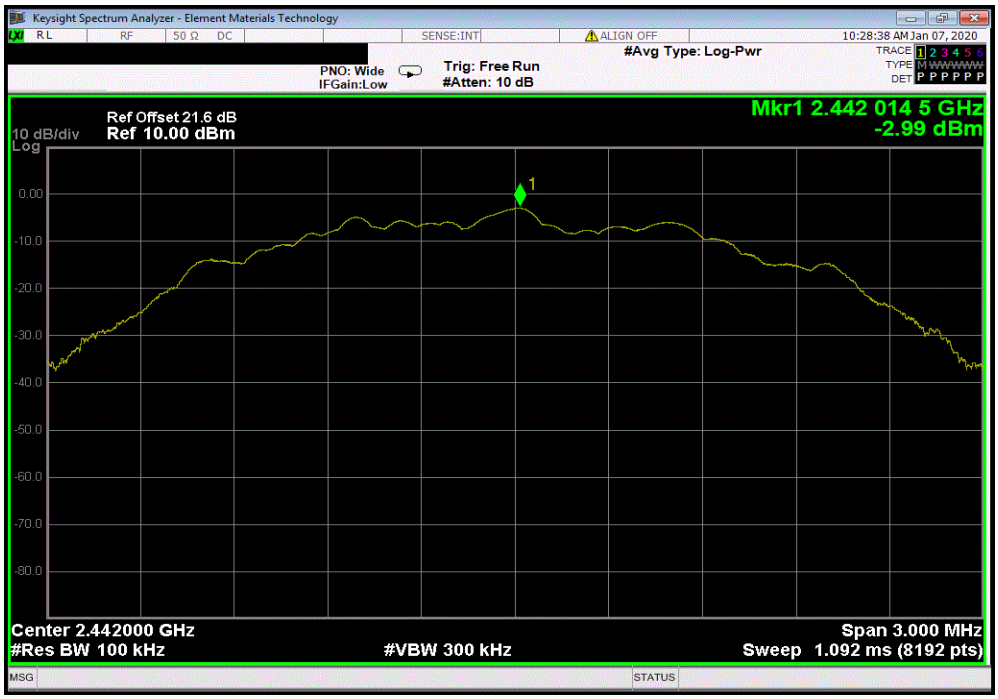
BLE/GFSK (2 Mbps), Low Channel, 2402 MHz				
Frequency Range	**Measured Freq (MHz)**	**Max Value (dBc)**	**Limit ≤ (dBc)**	**Result**
30 MHz - 12.5 GHz	2397.34	-42.28	-20	Pass



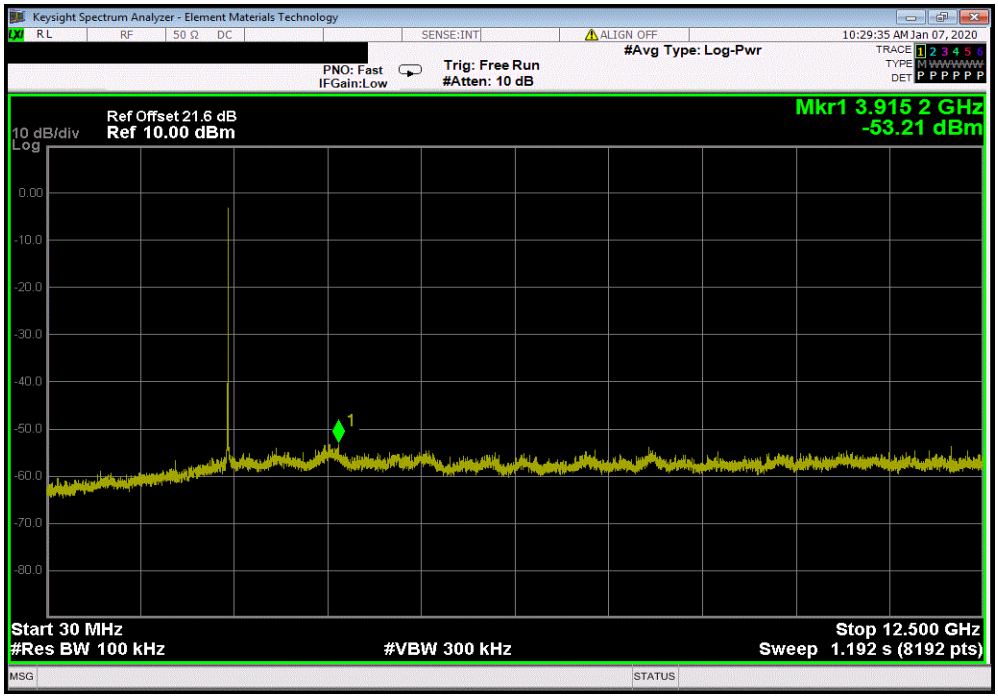
BLE/GFSK (2 Mbps), Low Channel, 2402 MHz				
Frequency Range	**Measured Freq (MHz)**	**Max Value (dBc)**	**Limit ≤ (dBc)**	**Result**
12.5 GHz - 25 GHz	23911.92	-46.87	-20	Pass



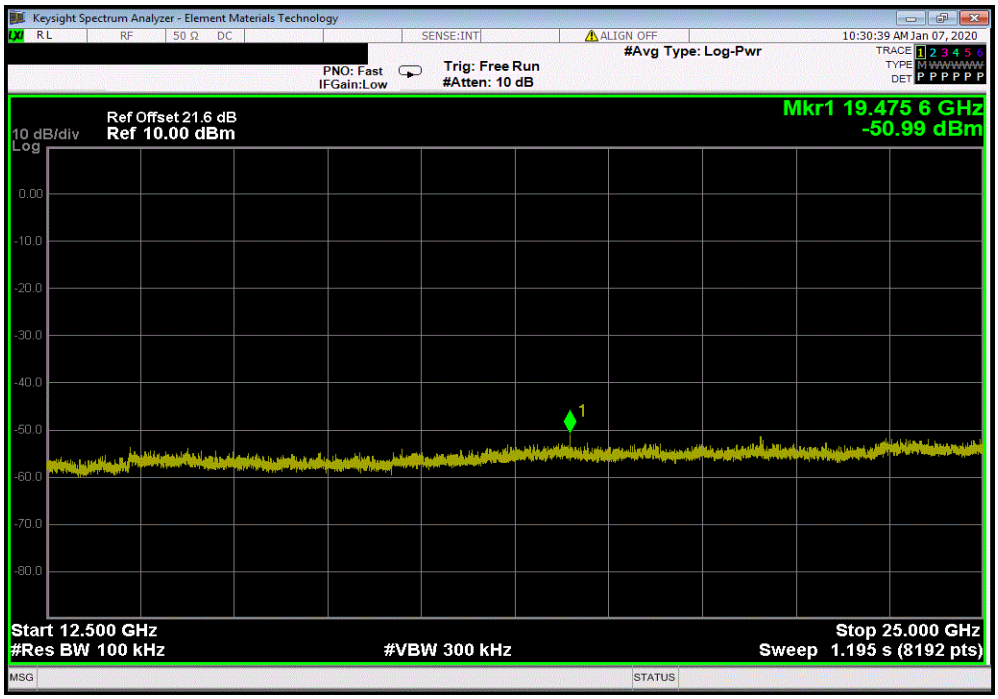
BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2442.01	N/A	N/A	N/A



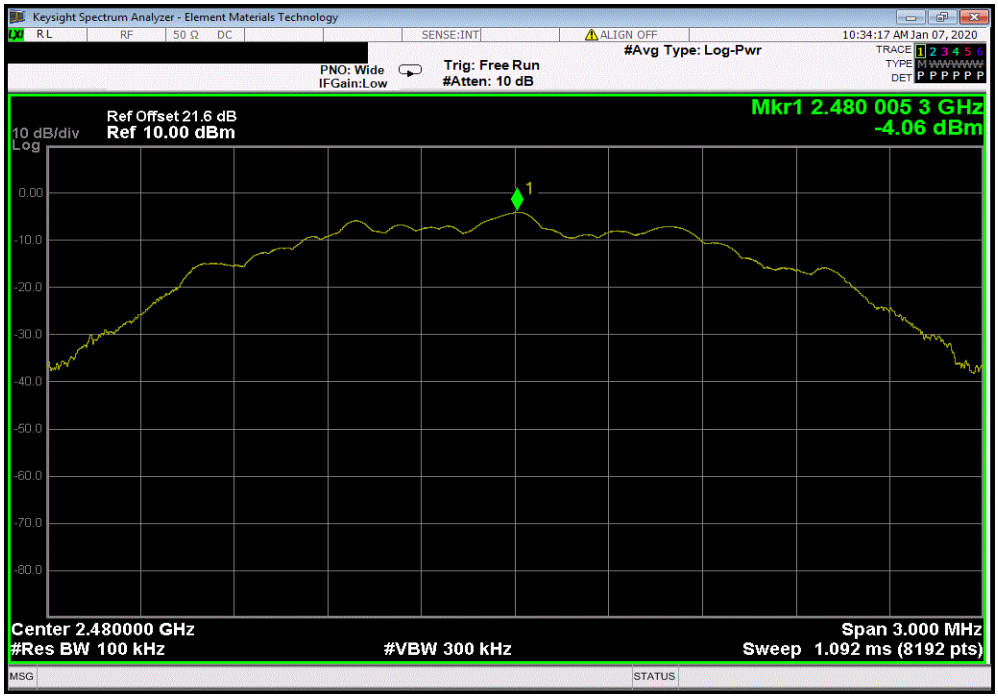
BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	3915.17	-50.22	-20	Pass



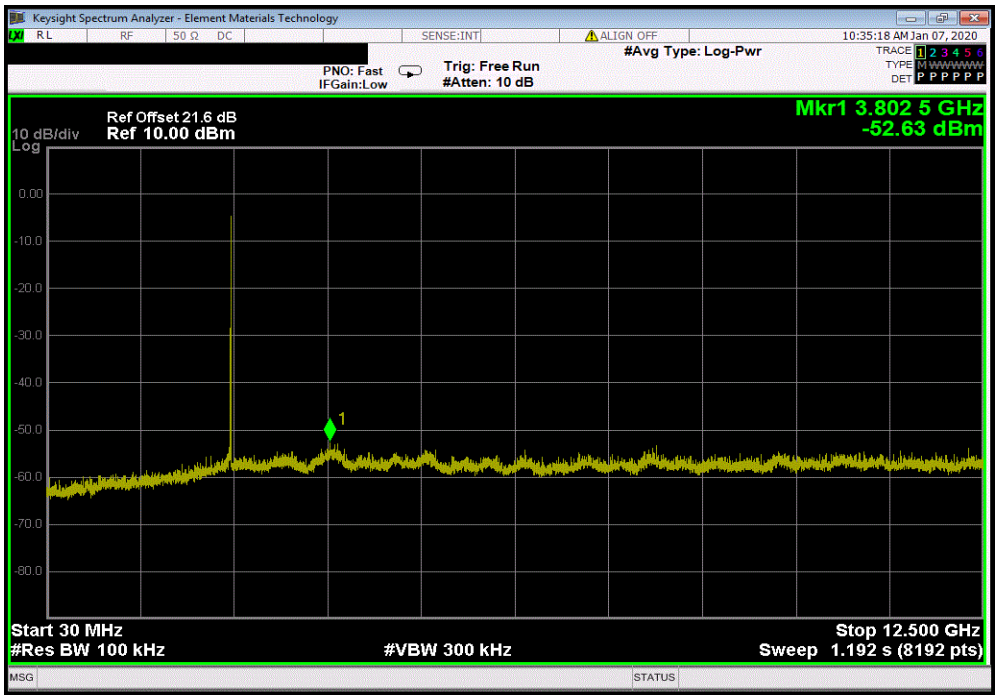
BLE/GFSK (2 Mbps), Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	19475.64	-48	-20	Pass



BLE/GFSK (2 Mbps), High Channel, 2480 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2480.01	N/A	N/A	N/A



BLE/GFSK (2 Mbps), High Channel, 2480 MHz				
Frequency Range	**Measured Freq (MHz)**	**Max Value (dBc)**	**Limit ≤ (dBc)**	**Result**
30 MHz - 12.5 GHz	3802.51	-48.57	-20	Pass



BLE/GFSK (2 Mbps), High Channel, 2480 MHz				
Frequency Range	**Measured Freq (MHz)**	**Max Value (dBc)**	**Limit ≤ (dBc)**	**Result**
12.5 GHz - 25 GHz	23931.75	-46.91	-20	Pass