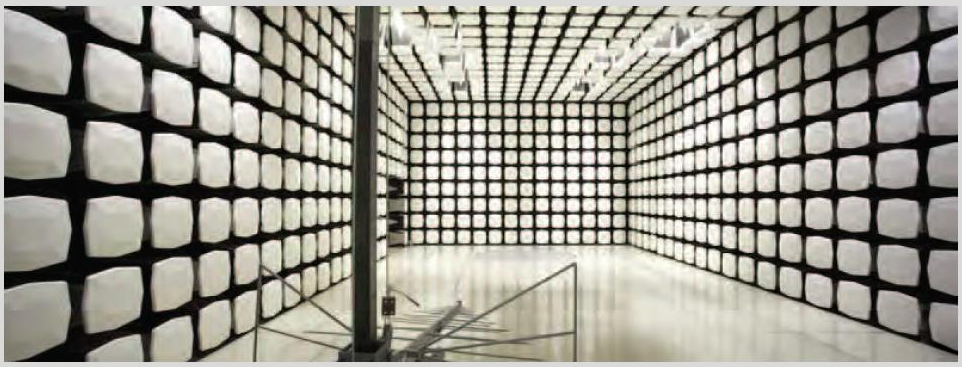
EchoNous, Inc.

Thor 1.0

FCC 15.247:2020

Bluetooth Radio

Report: ECHN0036, Issue Date: July 22, 2020



NVLAP LAB CODE: 200629-0

CERTIFICATE OF TEST

Last Date of Test: May 13, 2020
EchoNous, Inc.
EUT: Thor 1.0

Radio Equipment Testing

Standards

Specification	Method
FCC 15.247:2020	ANSI C63.10:2013

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS
6.5, 6.6	Spurious Radiated Emissions	Yes	Pass	
7.5	Duty Cycle	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS
7.8.2	Carrier Frequency Separation	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS
7.8.3	Number of Hopping Frequencies	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS
7.8.4	Dwell Time	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS
7.8.5	Output Power	Yes	Pass	
7.8.5	Equivalent Isotropic Radiated Power	Yes	Pass	
7.8.6	Band Edge Compliance	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS
7.8.6	Band Edge Compliance - Hopping Mode	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS
7.8.7	Occupied Bandwidth	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS
7.8.8	Spurious Conducted Emissions	No	N/A	Testing completed under previous filing. Please see filing documents under FCC ID: 2AU8B-ECHKMOS

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:

Kyle Holgate, Operations Manager

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing.

REVISION HISTORY

Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

United States

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

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

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

European Union

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

Australia/New Zealand

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

Korea

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

Japan

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

Taiwan

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

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

Singapore

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

Israel

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

Hong Kong

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

Vietnam

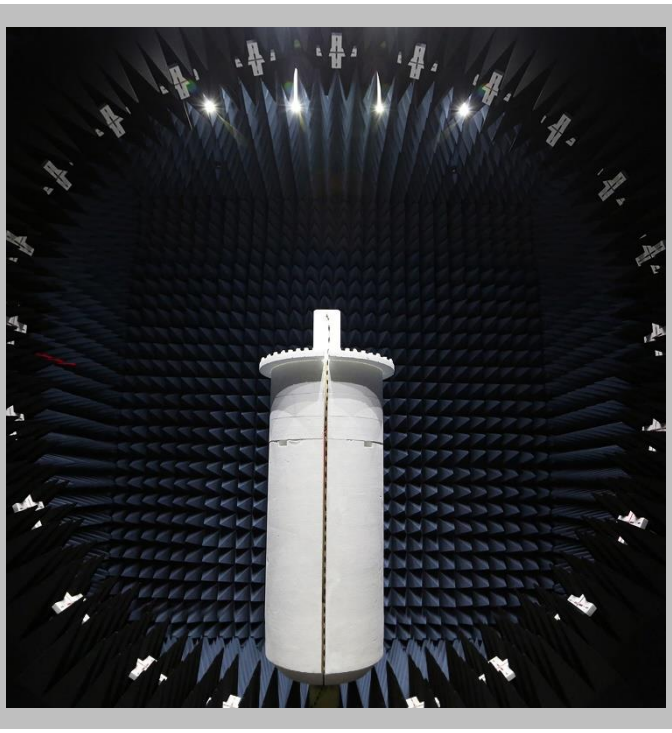
MIC – Recognized by MIC as a CAB for the acceptance of test data.

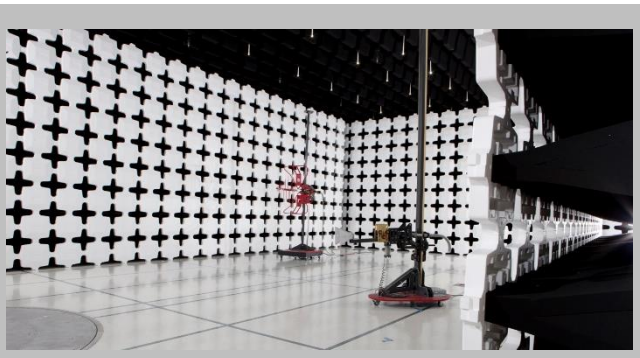
SCOPE

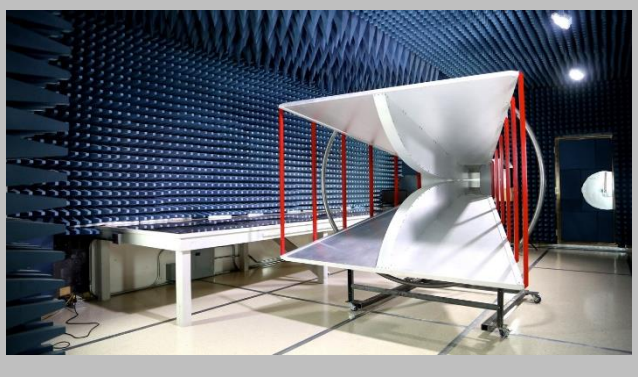
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

FACILITIES

California	Minnesota	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Labs NC01-05 19201 120th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP				
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code:201049-0	NVLAP Lab Code: 200629-0
Innovation, Science and Economic Development Canada				
2834B-1, 2834B-3	2834E-1, 2834E-3	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157







MEASUREMENT UNCERTAINTY

element
TMU.2015.07.10

Measurement Uncertainty

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

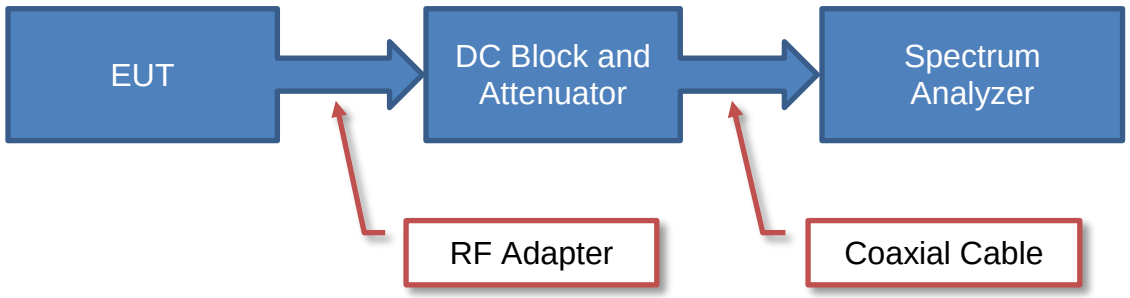
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable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

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

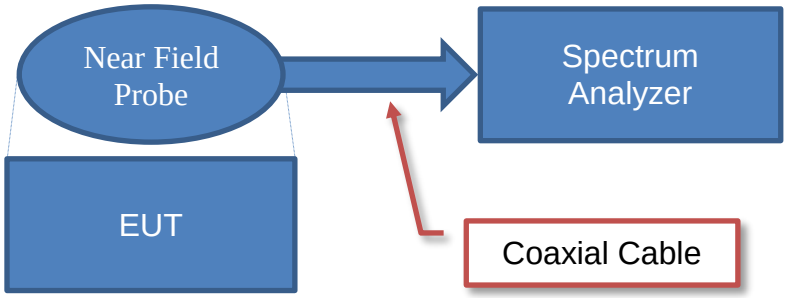
Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field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

Test Setup Block Diagrams

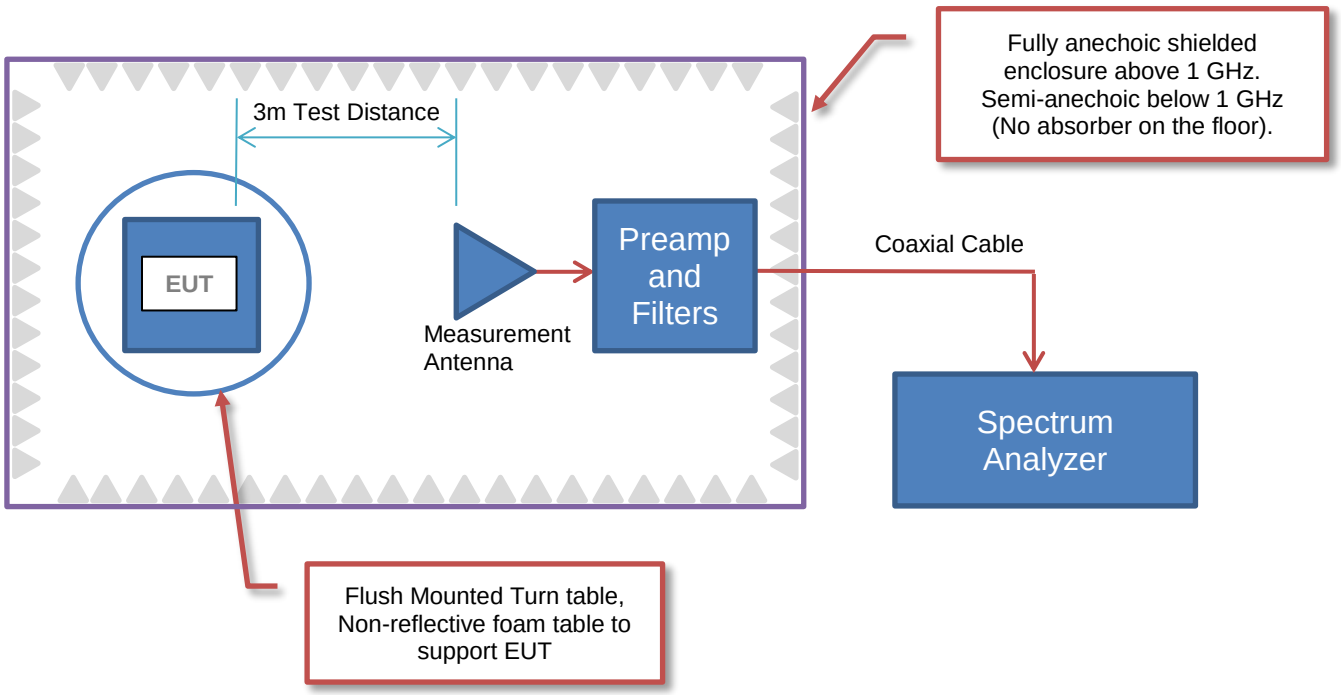
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	EchoNous, Inc.
Address:	8310 154th Ave NE, Bldg. B, Ste. 200
City, State, Zip:	Redmond, WA 98052
Test Requested By:	Laksh Raura
EUT:	Thor 1.0
First Date of Test:	May 12, 2020
Last Date of Test:	May 13, 2020
Receipt Date of Samples:	May 12, 2020
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Ultra Sound System with Thor Radio Module A,B,G,N,AC WLAN and Bluetooth 5.0 and BLE.

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

CONFIGURATIONS

Configuration ECHN0036- 1

Software/Firmware Running during test	
Description	**Version**
Qualcomm Radio Control Tool	4

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Thor Radio Module AC WLAN and Bluetooth 5.0 and BLE	EchoNous, Inc.	Thor 1.0	HIUR2017005-04

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Lenovo	E590	PF-1KP4Z1
Laptop Power Supply	Lenovo	SA10R16875	8SSA10R16875C1SG93BGBAZ

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB-C Cable	No	0.9m	No	USB Cable Extension	Thor 1.0
USB-C Cable	No	1.2m	No	Thor 1.0	Unterminated
USB Cable Extension	No	3.0m	No	Laptop	USB-C Cable
Laptop AC Power Cable	No	0.8m	No	AC Mains	AC/DC Power Supply
Laptop DC Power Cable	No	1.7m	No	AC/DC Power Supply	Laptop

CONFIGURATIONS

Configuration ECHN0036- 2

Software/Firmware Running during test	
Description	**Version**
Qualcomm Radio Control Tool	4

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Thor Radio Module AC WLAN and Bluetooth 5.0 and BLE	EchoNous, Inc.	Thor 1.0	Pre-Production

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Lenovo	E590	PF-1KP4Z1
Laptop Power Supply	Lenovo	SA10R16875	8SSA10R16875C1SG93BGBAZ

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB-C Cable	No	0.9m	No	USB Cable Extension	Thor 1.0
USB-C Cable	No	1.2m	No	Thor 1.0	Unterminated
Laptop AC Power Cable	No	0.8m	No	AC Mains	AC/DC Power Supply
Laptop DC Power Cable	No	1.7m	No	AC/DC Power Supply	Laptop

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2020-05-12	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2020-05-13	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.
3	2020-05-13	Equivalent Isotropic Radiated Power	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

Modulation Types	Type	Channel	Position	Frequency (MHz)	Power Setting
DH5, 2DH5, 3DH5	FHSS	0	Low Channel	2402	8
		39	Mid Channel	2441	8
		78	High Channel	2480	8

SPURIOUS RADIATED EMISSIONS

PSA-ESCI 2020.04.03.0

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. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

BT EDR, Low Ch. 0 = 2402 MHz, Mid Ch. 39 = 2441 MHz, High Ch. 78 = 2480 MHz, Software power setting = 8.

POWER SETTINGS INVESTIGATED

3.7 VDC

CONFIGURATIONS INVESTIGATED

ECHN0036 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	26.5 GHz

SAMPLE CALCULATIONS

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Cable	Northwest EMC	N/A	NC8	2020-02-07	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AOD	2020-02-07	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AIY	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AOJ	2019-07-22	12 mo
Antenna - Standard Gain	EMCO	3160-08	AHO	NCR	0 mo
Cable	Northwest EMC	Standard Gain Horn Cable	NC3	2020-04-22	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AOK	2019-07-22	12 mo
Antenna - Standard Gain	EMCO	3160-07	AHP	NCR	0 mo
Filter - High Pass	Micro-Tronics	HPM50111	HHI	2019-09-26	12 mo
Attenuator	Fairview Microwave	SA18E-20	AQV	2019-07-22	12 mo
Cable	Northwest EMC	3115 Horn Cable	NC2	2020-04-20	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVZ	2020-04-20	12 mo
Antenna - Double Ridge	EMCO	3115	AHM	2018-06-11	24 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	PAB	2020-01-28	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AYL	2019-09-25	24 mo
Cable	Northwest EMC	Bilog Cables	NC1	2020-01-28	12 mo
Filter - Low Pass	Micro-Tronics	LPM50004	LFF	2019-11-08	12 mo
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFE	2019-07-16	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 (in no-hop, single channel mode) 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).

RMS measurements taken for a FHSS radio also may have a duty cycle correction subtracted using the formula 20*log(dc), based on the requirements for pulsed operation from ANSI C63.10 section 7.5.

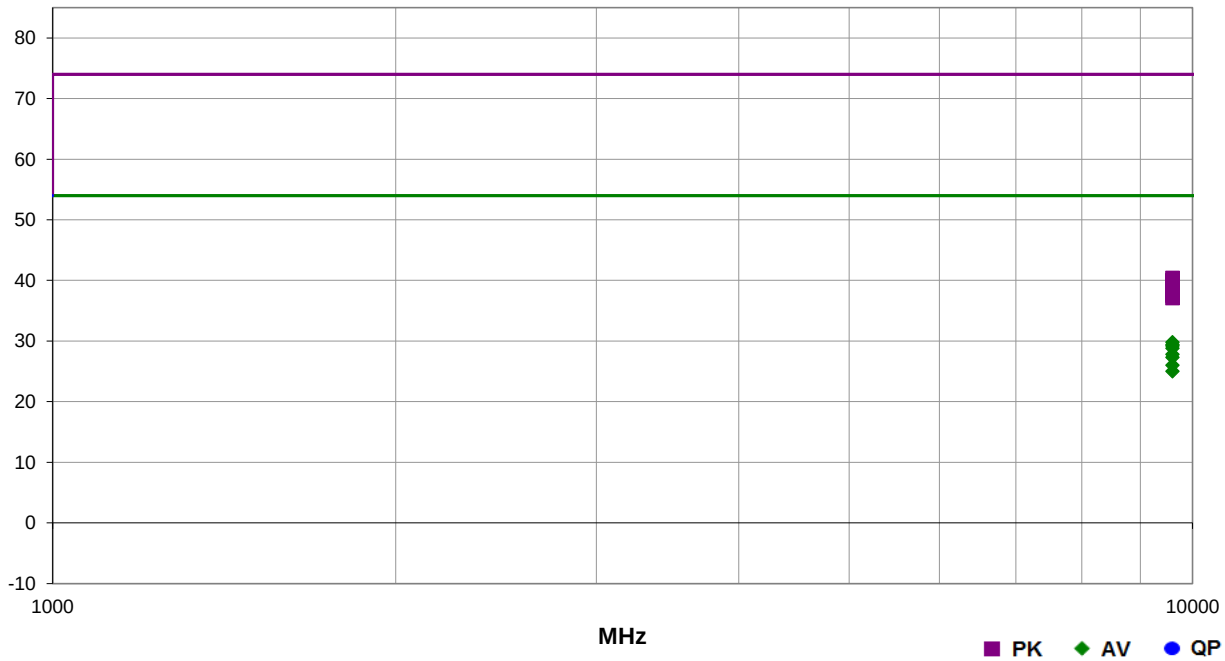
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.04.20.0 PSA-ESCI 2020.04.03.0

Work Order:	ECHN0036	**Date:**	2020-05-12		
Project:	None	**Temperature:**	23.9 °C		
Job Site:	NC01	**Humidity:**	42.2% RH		
Serial Number:	HIUR2017005-04	**Barometric Pres.:**	1006 mbar	**Tested by:**	Brian Fahey
EUT:	Thor 1.0				
Configuration:	1				
Customer:	EchoNous, Inc.				
Attendees:	None				
EUT Power:	3.7 VDC				
Operating Mode:	BT EDR, Low Ch. 0 = 2402 MHz, Software power setting = 8.				
Deviations:	None				
Comments:	See comments below for channel, modulation type, and EUT orientation. Note: The emission below does not fall in a restricted band. This was the only emission noted during pre-scans and was used to determine the worst case orientation of the EUT for measurements on the subsequent data sheets.				

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

Run #	12	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
9607.917	45.1	-4.7	1.5	271.0	0.0	Vert	PK	0.0	40.4	74.0	-33.6	Low Ch., DH5, EUT Horz
9608.175	44.7	-4.7	1.3	253.0	0.0	Horz	PK	0.0	40.0	74.0	-34.0	Low Ch., DH5, EUT Horz
9607.625	44.7	-4.7	1.5	261.0	0.0	Vert	PK	0.0	40.0	74.0	-34.0	Low Ch., DH5, EUT Vert
9608.100	43.2	-4.7	1.7	265.0	0.0	Horz	PK	0.0	38.5	74.0	-35.5	Low Ch., DH5, EUT on Side
9608.050	43.1	-4.7	1.5	267.0	0.0	Vert	PK	0.0	38.4	74.0	-35.6	Low Ch., 3DH5, EUT Horz
9608.467	42.4	-4.7	1.5	267.0	0.0	Vert	PK	0.0	37.7	74.0	-36.3	Low Ch., 2DH5, EUT Horz
9607.725	42.2	-4.7	1.5	268.0	0.0	Horz	PK	0.0	37.5	74.0	-36.5	Low Ch., DH5, EUT Vert
9608.542	41.8	-4.7	1.8	307.0	0.0	Vert	PK	0.0	37.1	74.0	-36.9	Low Ch., DH5, EUT on Side
9608.192	34.5	-4.7	1.5	271.0	0.0	Vert	AV	0.0	29.8	54.0	-24.2	Low Ch., DH5, EUT Horz
9608.167	34.1	-4.7	1.5	261.0	0.0	Vert	AV	0.0	29.4	54.0	-24.6	Low Ch., DH5, EUT Vert
9608.200	33.9	-4.7	1.3	253.0	0.0	Horz	AV	0.0	29.2	54.0	-24.8	Low Ch., DH5, EUT Horz
9608.158	33.5	-4.7	1.5	267.0	0.0	Vert	AV	0.0	28.8	54.0	-25.2	Low Ch., 3DH5, EUT Horz
9608.125	32.5	-4.7	1.5	267.0	0.0	Vert	AV	0.0	27.8	54.0	-26.2	Low Ch., 2DH5, EUT Horz
9608.217	32.0	-4.7	1.7	265.0	0.0	Horz	AV	0.0	27.3	54.0	-26.7	Low Ch., DH5, EUT on Side

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
9608.175	30.7	-4.7	1.5	268.0	0.0	Horz	AV	0.0	26.0	54.0	-28.0	Low Ch., DH5, EUT Vert
9608.183	29.7	-4.7	1.8	307.0	0.0	Vert	AV	0.0	25.0	54.0	-29.0	Low Ch., DH5, EUT on Side

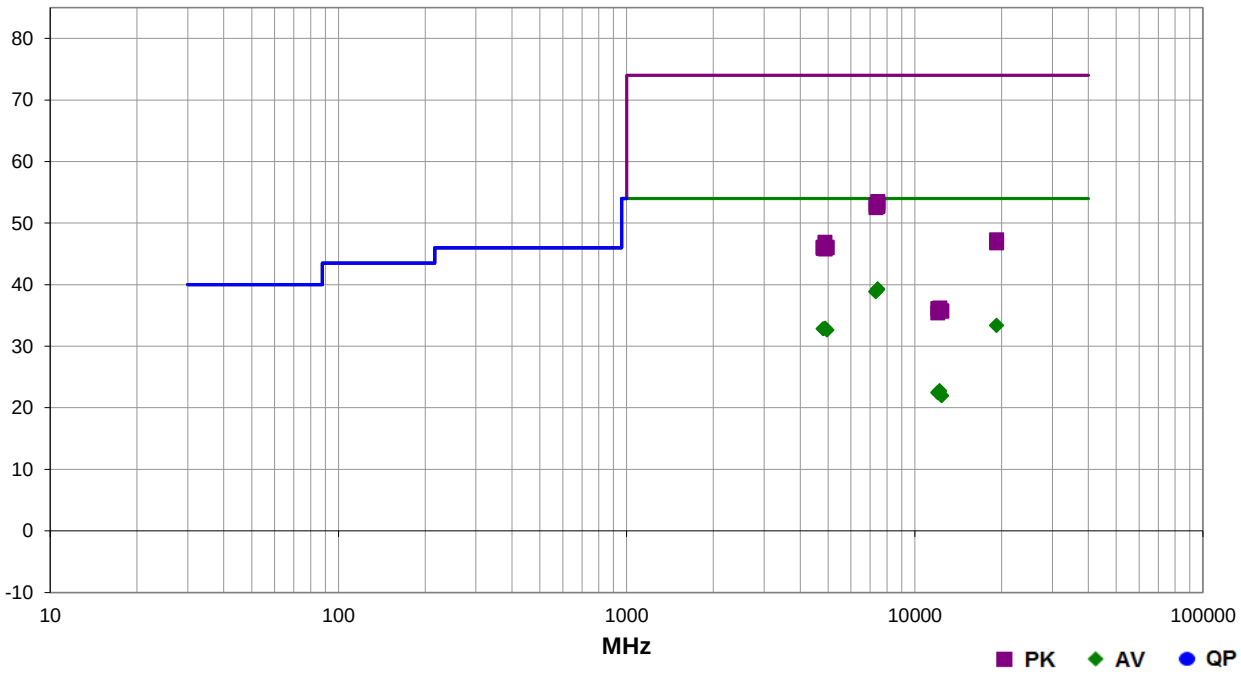
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.04.20.0 PSA-ESCI 2020.04.03.0

Work Order:	ECHN0036	**Date:**	2020-05-12		
Project:	None	**Temperature:**	23.9 °C		
Job Site:	NC01	**Humidity:**	42.2% RH		
Serial Number:	HIUR2017005-04	**Barometric Pres.:**	1006 mbar	**Tested by:**	Brian Fahey
EUT:	Thor 1.0				
Configuration:	1				
Customer:	EchoNous, Inc.				
Attendees:	None				
EUT Power:	3.7 VDC				
Operating Mode:	BT EDR, Low Ch. 0 = 2402 MHz, Mid Ch. 39 = 2441 MHz, High Ch. 78 = 2480 MHz, Software power setting = 8.				
Deviations:	None				
Comments:	See comments below for channel, modulation type, and EUT orientation.				

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

Run #	13	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
7440.700	38.3	15.2	1.5	360.0	0.0	Horz	PK	0.0	53.5	74.0	-20.5	High Ch., 3DH5, EUT Horz
7440.325	38.0	15.2	1.5	0.0	0.0	Horz	PK	0.0	53.2	74.0	-20.8	High Ch., 2DH5, EUT Horz
7325.183	38.3	14.7	1.5	360.0	0.0	Vert	PK	0.0	53.0	74.0	-21.0	Mid Ch., DH5, EUT Horz
7441.358	37.6	15.2	1.5	360.0	0.0	Vert	PK	0.0	52.8	74.0	-21.2	High Ch., DH5, EUT Horz
7440.167	37.5	15.2	1.5	360.0	0.0	Horz	PK	0.0	52.7	74.0	-21.3	High Ch., DH5, EUT Horz
7325.158	37.8	14.7	1.5	360.0	0.0	Horz	PK	0.0	52.5	74.0	-21.5	Mid Ch., DH5, EUT Horz
19215.200	46.7	0.6	1.3	0.0	0.0	Vert	PK	0.0	47.3	74.0	-26.7	Low Ch., DH5, EUT Horz
4880.333	37.0	9.9	1.5	0.0	0.0	Horz	PK	0.0	46.9	74.0	-27.1	Mid Ch., DH5, EUT Horz
19213.800	46.2	0.6	1.3	360.0	0.0	Horz	PK	0.0	46.8	74.0	-27.2	Low Ch., DH5, EUT Horz
4960.475	36.6	9.5	1.5	0.0	0.0	Horz	PK	0.0	46.1	74.0	-27.9	High Ch., DH5, EUT Horz
4805.542	36.3	9.8	1.5	0.0	0.0	Vert	PK	0.0	46.1	74.0	-27.9	Low Ch., DH5, EUT Horz
4957.667	36.5	9.5	1.5	0.0	0.0	Vert	PK	0.0	46.0	74.0	-28.0	High Ch., DH5, EUT Horz
4802.400	36.1	9.8	1.5	360.0	0.0	Horz	PK	0.0	45.9	74.0	-28.1	Low Ch., DH5, EUT Horz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4881.542	35.9	9.9	1.5	0.0	0.0	Vert	PK	0.0	45.8	74.0	-28.2	Mid Ch., DH5, EUT Horz
12204.930	38.1	-1.9	1.5	0.0	0.0	Vert	PK	0.0	36.2	74.0	-37.8	Mid Ch., DH5, EUT Horz
12011.330	38.5	-2.4	1.5	0.0	0.0	Horz	PK	0.0	36.1	74.0	-37.9	Low Ch., DH5, EUT Horz
12206.200	37.8	-1.9	1.5	360.0	0.0	Horz	PK	0.0	35.9	74.0	-38.1	Mid Ch., DH5, EUT Horz
12397.660	38.3	-2.6	1.5	0.0	0.0	Horz	PK	0.0	35.7	74.0	-38.3	High Ch., DH5, EUT Horz
12398.630	38.3	-2.6	1.5	360.0	0.0	Vert	PK	0.0	35.7	74.0	-38.3	High Ch., DH5, EUT Horz
12012.330	37.8	-2.4	1.5	360.0	0.0	Vert	PK	0.0	35.4	74.0	-38.6	Low Ch., DH5, EUT Horz
7441.425	24.1	15.2	1.5	360.0	0.0	Horz	AV	0.0	39.3	54.0	-14.7	High Ch., DH5, EUT Horz
7438.783	24.1	15.2	1.5	360.0	0.0	Vert	AV	0.0	39.3	54.0	-14.7	High Ch., DH5, EUT Horz
7442.208	24.0	15.2	1.5	0.0	0.0	Horz	AV	0.0	39.2	54.0	-14.8	High Ch., 2DH5, EUT Horz
7437.600	24.0	15.2	1.5	360.0	0.0	Horz	AV	0.0	39.2	54.0	-14.8	High Ch., 3DH5, EUT Horz
7321.558	24.2	14.7	1.5	360.0	0.0	Vert	AV	0.0	38.9	54.0	-15.1	Mid Ch., DH5, EUT Horz
7320.567	24.1	14.7	1.5	360.0	0.0	Horz	AV	0.0	38.8	54.0	-15.2	Mid Ch., DH5, EUT Horz
19215.610	32.8	0.6	1.3	0.0	0.0	Vert	AV	0.0	33.4	54.0	-20.6	Low Ch., DH5, EUT Horz
19218.040	32.7	0.6	1.3	360.0	0.0	Horz	AV	0.0	33.3	54.0	-20.7	Low Ch., DH5, EUT Horz
4883.675	23.0	9.9	1.5	0.0	0.0	Horz	AV	0.0	32.9	54.0	-21.1	Mid Ch., DH5, EUT Horz
4884.492	23.0	9.9	1.5	0.0	0.0	Vert	AV	0.0	32.9	54.0	-21.1	Mid Ch., DH5, EUT Horz
4804.133	23.0	9.8	1.5	0.0	0.0	Vert	AV	0.0	32.8	54.0	-21.2	Low Ch., DH5, EUT Horz
4803.500	23.0	9.8	1.5	360.0	0.0	Horz	AV	0.0	32.8	54.0	-21.2	Low Ch., DH5, EUT Horz
4958.142	23.1	9.5	1.5	0.0	0.0	Horz	AV	0.0	32.6	54.0	-21.4	High Ch., DH5, EUT Horz
4957.558	23.1	9.5	1.5	0.0	0.0	Vert	AV	0.0	32.6	54.0	-21.4	High Ch., DH5, EUT Horz
12202.530	24.7	-1.9	1.5	360.0	0.0	Horz	AV	0.0	22.8	54.0	-31.2	Mid Ch., DH5, EUT Horz
12202.590	24.5	-1.9	1.5	0.0	0.0	Vert	AV	0.0	22.6	54.0	-31.4	Mid Ch., DH5, EUT Horz
12007.570	24.9	-2.4	1.5	0.0	0.0	Horz	AV	0.0	22.5	54.0	-31.5	Low Ch., DH5, EUT Horz
12011.320	24.8	-2.4	1.5	360.0	0.0	Vert	AV	0.0	22.4	54.0	-31.6	Low Ch., DH5, EUT Horz
12399.980	24.5	-2.5	1.5	0.0	0.0	Horz	AV	0.0	22.0	54.0	-32.0	High Ch., DH5, EUT Horz
12400.000	24.4	-2.5	1.5	360.0	0.0	Vert	AV	0.0	21.9	54.0	-32.1	High Ch., DH5, EUT Horz

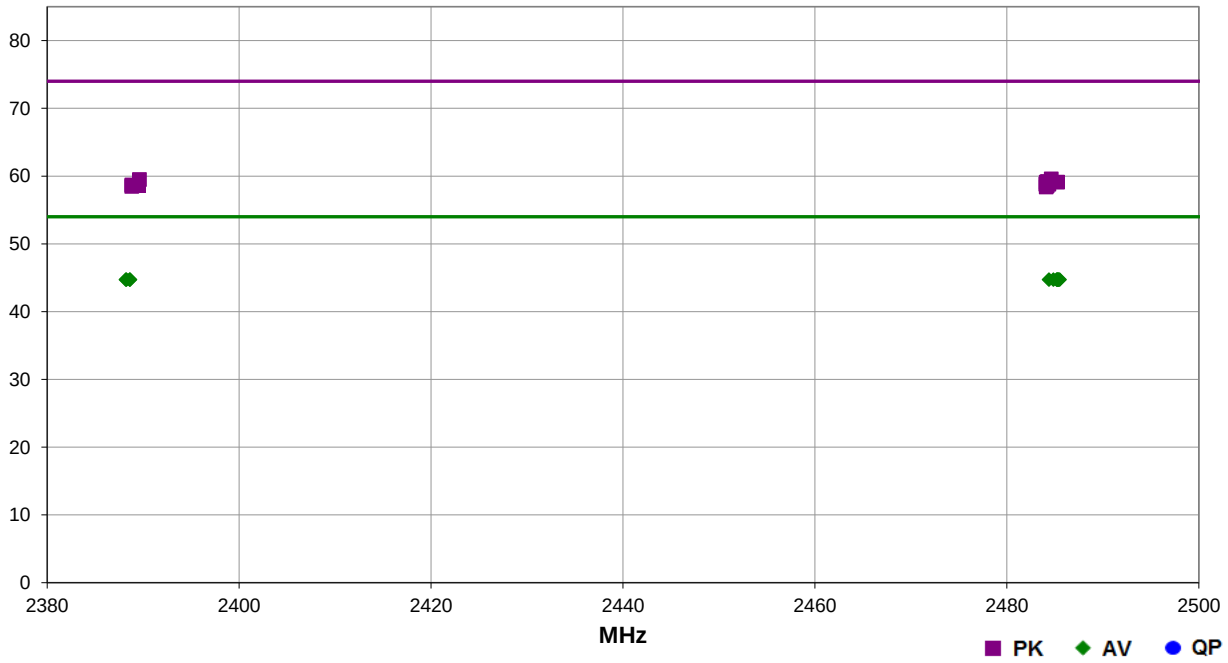
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.04.20.0 PSA-ESCI 2020.04.03.0

Work Order:	ECHN0036	**Date:**	2020-05-12		
Project:	None	**Temperature:**	23.9 °C		
Job Site:	NC01	**Humidity:**	42.2% RH		
Serial Number:	HIUR2017005-04	**Barometric Pres.:**	1006 mbar	**Tested by:**	Brian Fahey
EUT:	Thor 1.0				
Configuration:	1				
Customer:	EchoNous, Inc.				
Attendees:	None				
EUT Power:	3.7 VDC				
Operating Mode:	BT EDR, Low Ch. 0 = 2402 MHz, High Ch. 78 = 2480 MHz, Software power setting = 8.				
Deviations:	None				
Comments:	See comments below for channel, modulation type, and EUT orientation.				

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

Run #	16	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2484.627	40.3	-0.7	1.5	66.0	20.0	Horz	PK	0.0	59.6	74.0	-14.4	High Ch., DH5, EUT Vert
2389.620	40.0	-0.5	1.5	91.0	20.0	Horz	PK	0.0	59.5	74.0	-14.5	Low Ch., 2DH5, EUT Horz
2484.213	39.9	-0.7	1.5	32.0	20.0	Vert	PK	0.0	59.2	74.0	-14.8	High Ch., DH5, EUT Vert
2484.097	39.8	-0.7	1.5	332.0	20.0	Vert	PK	0.0	59.1	74.0	-14.9	High Ch., DH5, EUT Horz
2485.280	39.8	-0.7	2.0	167.0	20.0	Horz	PK	0.0	59.1	74.0	-14.9	High Ch., DH5, EUT on Side
2484.047	39.5	-0.7	1.5	347.0	20.0	Horz	PK	0.0	58.8	74.0	-15.2	High Ch., DH5, EUT Horz
2484.377	39.5	-0.7	1.5	305.0	20.0	Horz	PK	0.0	58.8	74.0	-15.2	High Ch., 2DH5, EUT Horz
2388.820	39.2	-0.5	1.5	279.0	20.0	Horz	PK	0.0	58.7	74.0	-15.3	Low Ch., DH5, EUT Horz
2484.200	39.3	-0.7	1.5	279.0	20.0	Horz	PK	0.0	58.6	74.0	-15.4	High Ch., 3DH5, EUT Horz
2389.530	39.1	-0.5	1.5	206.0	20.0	Vert	PK	0.0	58.6	74.0	-15.4	Low Ch., DH5, EUT Horz
2388.813	39.0	-0.5	1.5	209.0	20.0	Horz	PK	0.0	58.5	74.0	-15.5	Low Ch., 3DH5, EUT Horz
2484.093	39.1	-0.7	1.5	229.0	20.0	Vert	PK	0.0	58.4	74.0	-15.6	High Ch., DH5, EUT on Side
2485.360	25.4	-0.7	1.5	347.0	20.0	Horz	AV	0.0	44.7	54.0	-9.3	High Ch., DH5, EUT Horz
2485.190	25.4	-0.7	1.5	332.0	20.0	Vert	AV	0.0	44.7	54.0	-9.3	High Ch., DH5, EUT Horz
2484.387	25.4	-0.7	1.5	66.0	20.0	Horz	AV	0.0	44.7	54.0	-9.3	High Ch., DH5, EUT Vert
2485.253	25.4	-0.7	1.5	32.0	20.0	Vert	AV	0.0	44.7	54.0	-9.3	High Ch., DH5, EUT Vert

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2484.843	25.4	-0.7	2.0	167.0	20.0	Horz	AV	0.0	44.7	54.0	-9.3	High Ch., DH5, EUT on Side
2485.497	25.4	-0.7	1.5	229.0	20.0	Vert	AV	0.0	44.7	54.0	-9.3	High Ch., DH5, EUT on Side
2485.403	25.4	-0.7	1.5	305.0	20.0	Horz	AV	0.0	44.7	54.0	-9.3	High Ch., 2DH5, EUT Horz
2485.283	25.4	-0.7	1.5	279.0	20.0	Horz	AV	0.0	44.7	54.0	-9.3	High Ch., 3DH5, EUT Horz
2388.597	25.2	-0.5	1.5	279.0	20.0	Horz	AV	0.0	44.7	54.0	-9.3	Low Ch., DH5, EUT Horz
2388.643	25.2	-0.5	1.5	206.0	20.0	Vert	AV	0.0	44.7	54.0	-9.3	Low Ch., DH5, EUT Horz
2388.210	25.2	-0.5	1.5	91.0	20.0	Horz	AV	0.0	44.7	54.0	-9.3	Low Ch., 2DH5, EUT Horz
2388.263	25.2	-0.5	1.5	209.0	20.0	Horz	AV	0.0	44.7	54.0	-9.3	Low Ch., 3DH5, EUT Horz

OUTPUT POWER

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Cable	Micro-Coax	UFD150A-1-0720-200200	NCS	17-Jan-20	17-Jan-21
Attenuator	Fairview Microwave	SA4014-20	TKV	17-Jan-20	17-Jan-21
Block - DC	Fairview Microwave	SD3379	AMU	20-Jan-20	20-Jan-21
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	28-May-19	28-May-20
Generator - Signal	Agilent	N5181A	TGZ	31-Aug-18	31-Aug-21

TEST DESCRIPTION

The peak output power was measured with the EUT set to low, medium and high transmit frequencies. The EUT was transmitting in a no hop mode at the data rate(s) listed in the datasheet.

The method found in ANSI C63.10:2013 Section 7.8.5 was used for a FHSS radio.

OUTPUT POWER

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Thor 1.0**			**Work Order:**	**ECHN0036**
Serial Number:	**Pre-Production**			**Date:**	**13-May-20**
Customer:	**EchoNous, Inc.**			**Temperature:**	**23.1 °C**
Attendees:	**None**			**Humidity:**	**40.8% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Brian Fahey**	**Power:**	**3.7 VDC**	**Job Site:**	**NC0A**

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

COMMENTS

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

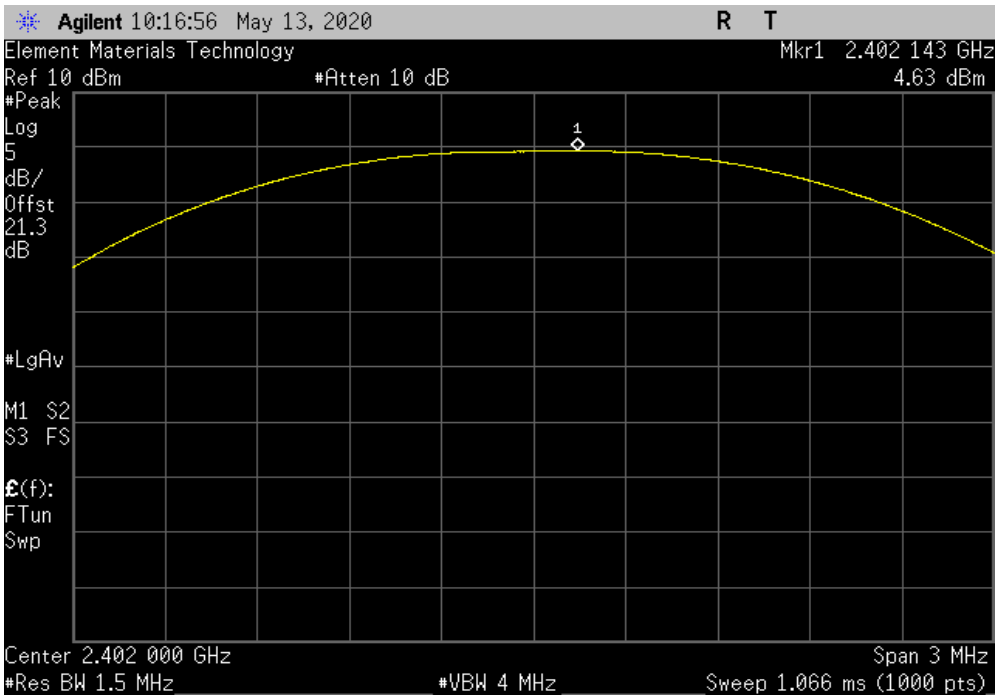
DEVIATIONS FROM TEST STANDARD

None

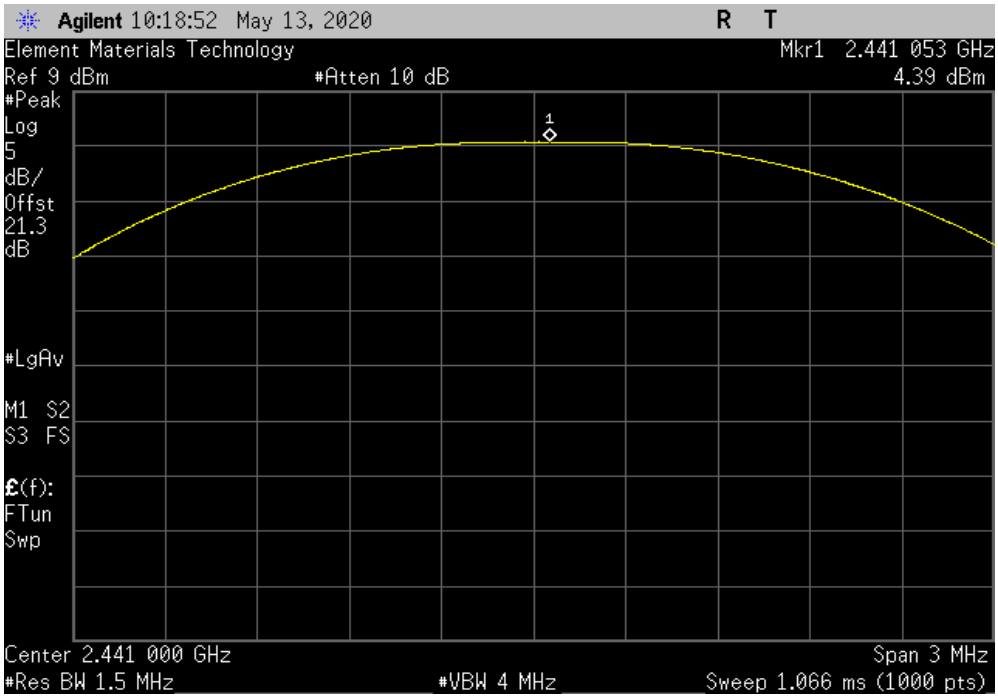
Configuration #	**2**	*Signature*

		Out Pwr (dBm)	**Limit (dBm)**	**Result**
DH5, GFSK				
	Low Channel, 2402 MHz	4.629	21	Pass
	Mid Channel, 2441 MHz	4.385	21	Pass
	High Channel, 2480 MHz	6.511	21	Pass
2DH5, pi/4-DQPSK				
	Low Channel, 2402 MHz	3.705	21	Pass
	Mid Channel, 2441 MHz	3.471	21	Pass
	High Channel, 2480 MHz	5.611	21	Pass
3DH5, 8-DPSK				
	Low Channel, 2402 MHz	4.106	21	Pass
	Mid Channel, 2441 MHz	3.829	21	Pass
	High Channel, 2480 MHz	5.959	21	Pass

DH5, GFSK, Low Channel						
				Out Pwr (dBm)	Limit (dBm)	Result
				4.629	21	Pass

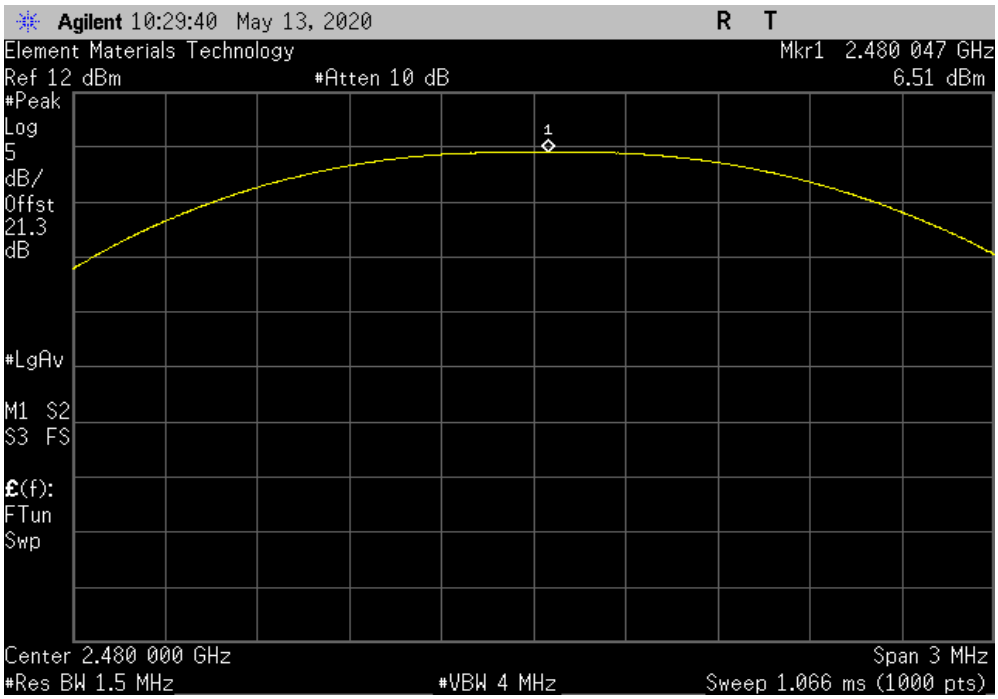


DH5, GFSK, Mid Channel						
				Out Pwr (dBm)	Limit (dBm)	Result
				4.385	21	Pass

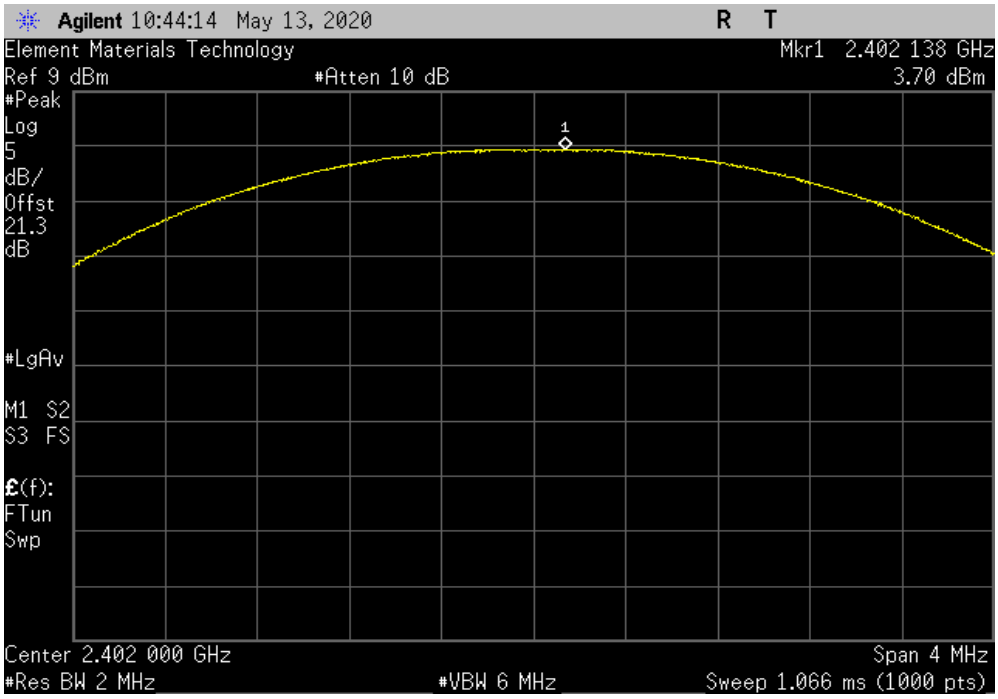


OUTPUT POWER

DH5, GFSK, High Channel						
				Out Pwr (dBm)	Limit (dBm)	Result
				6.511	21	Pass

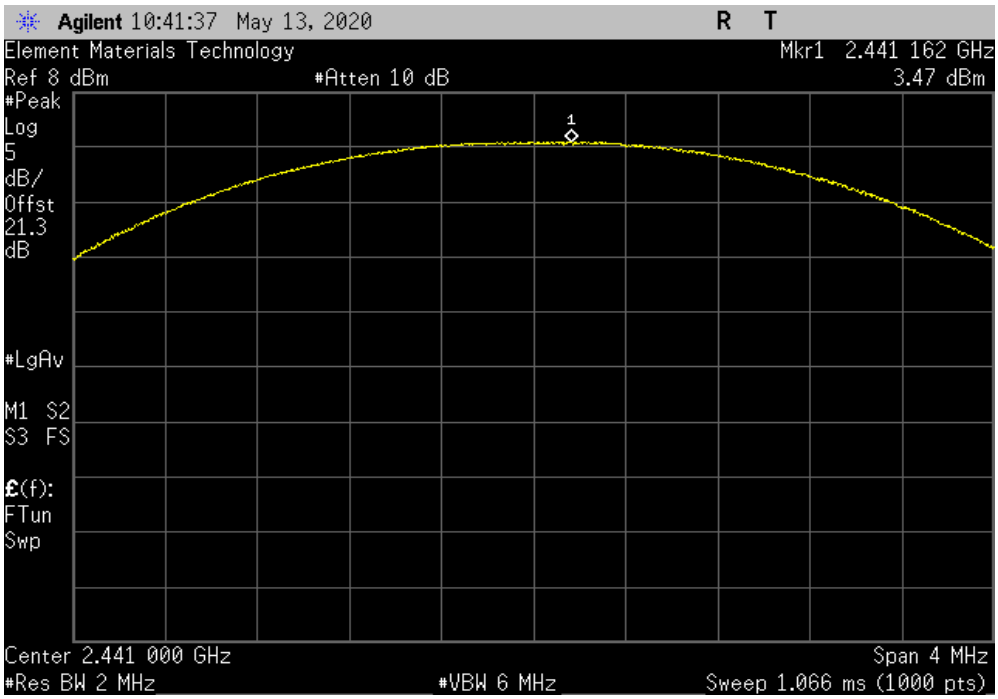


2DH5, pi/4-DQPSK, Low Channel						
				Out Pwr (dBm)	Limit (dBm)	Result
				3.705	21	Pass

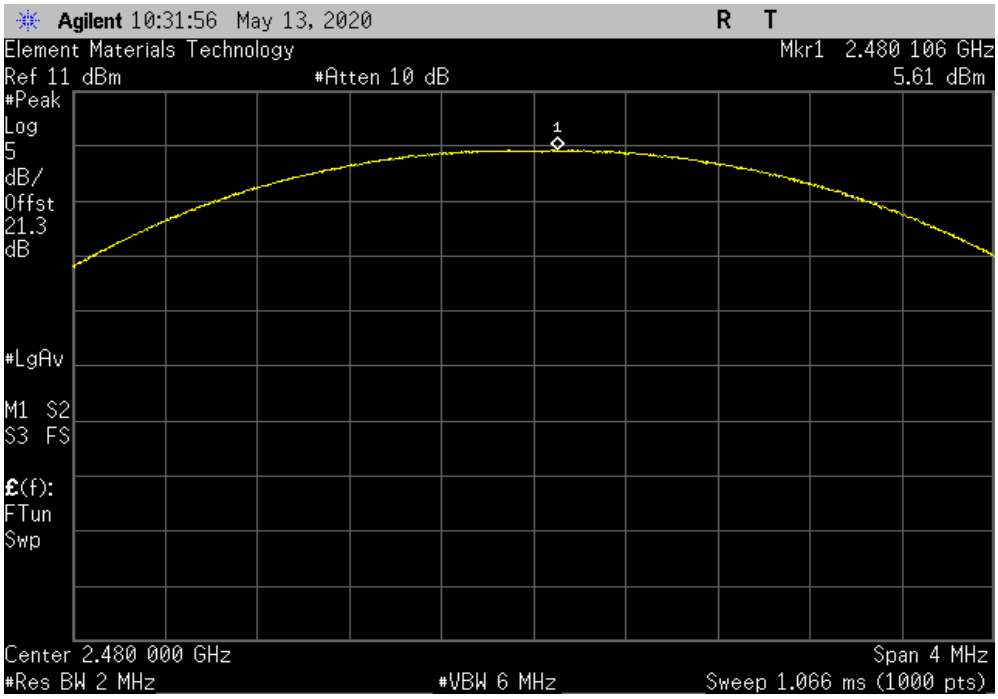


OUTPUT POWER

2DH5, pi/4-DQPSK, Mid Channel							
					Out Pwr (dBm)	Limit (dBm)	Result
					3.471	21	Pass

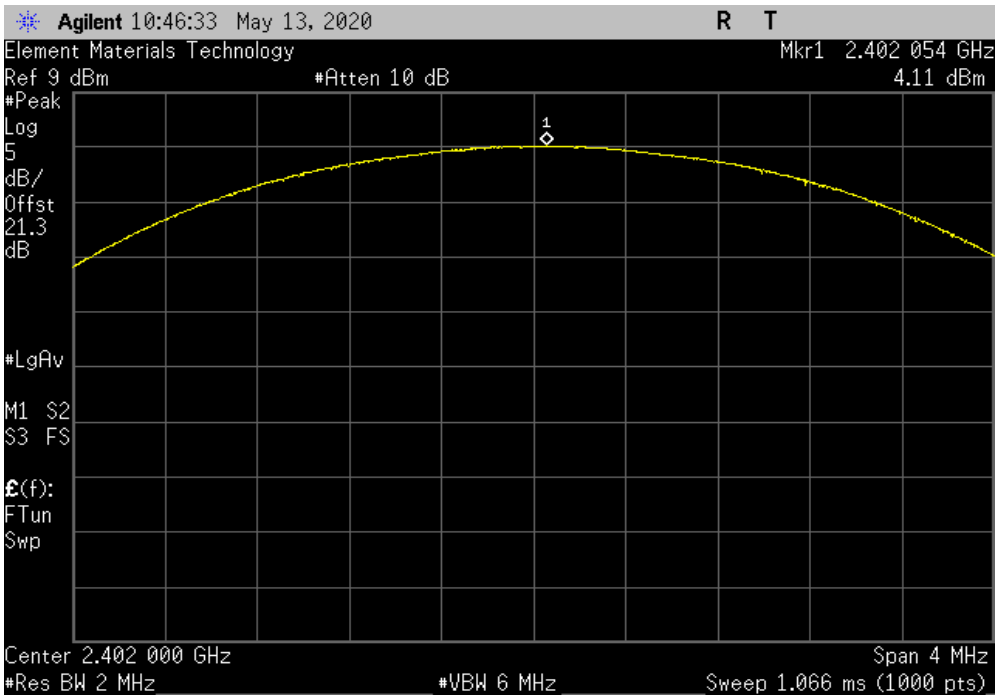


2DH5, pi/4-DQPSK, High Channel							
					Out Pwr (dBm)	Limit (dBm)	Result
					5.611	21	Pass

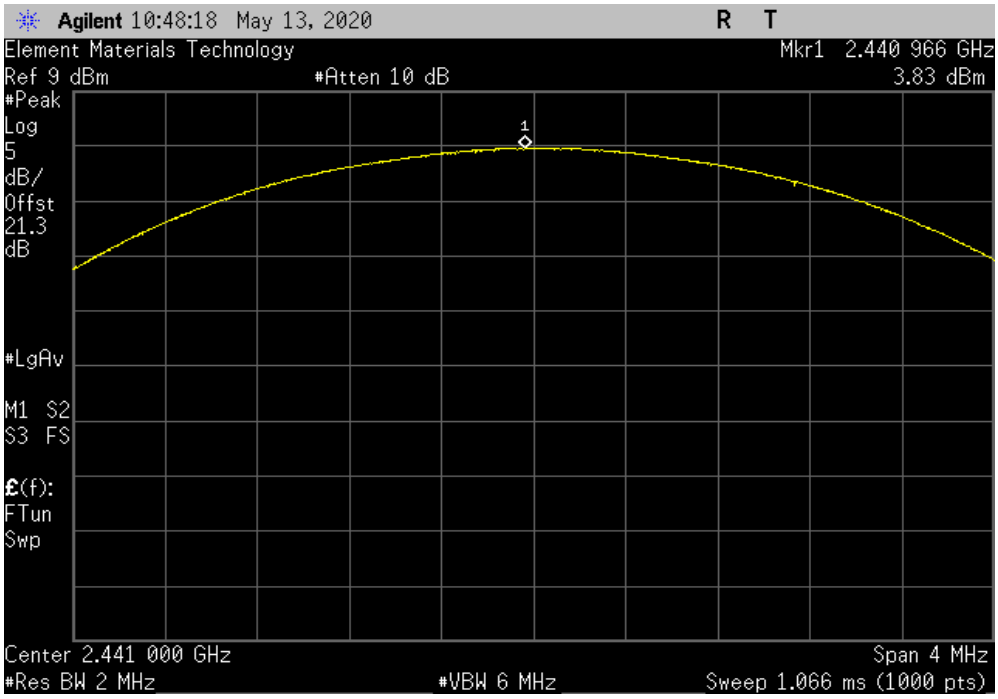


OUTPUT POWER

3DH5, 8-DPSK, Low Channel							
					Out Pwr (dBm)	Limit (dBm)	Result
					4.106	21	Pass

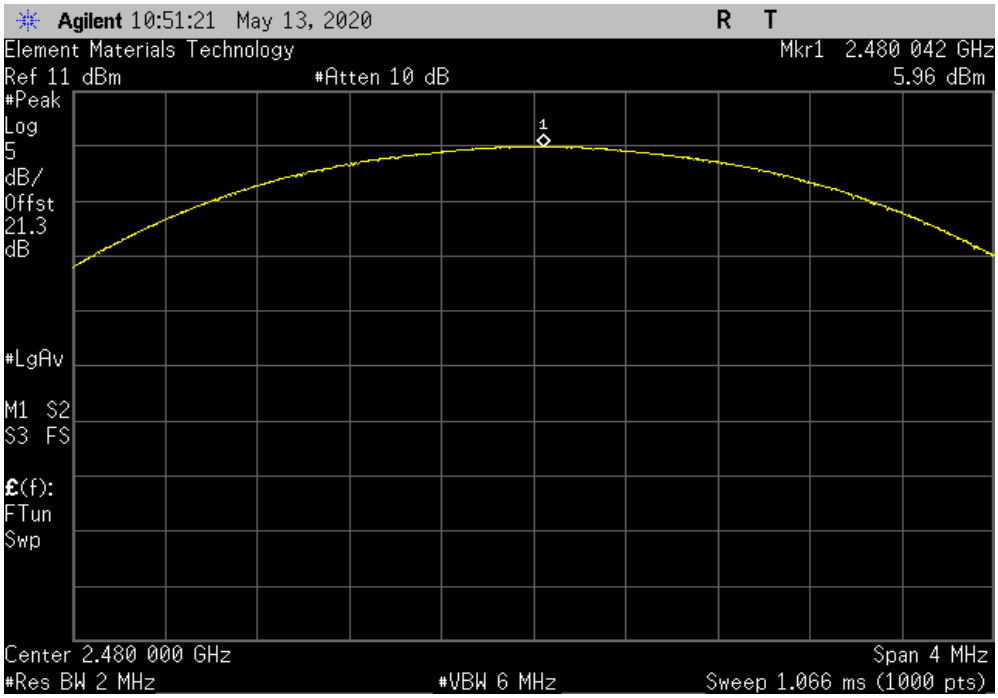


3DH5, 8-DPSK, Mid Channel							
					Out Pwr (dBm)	Limit (dBm)	Result
					3.829	21	Pass



OUTPUT POWER

3DH5, 8-DPSK, High Channel						
				Out Pwr (dBm)	Limit (dBm)	Result
				5.959	21	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Cable	Micro-Coax	UFD150A-1-0720-200200	NCS	17-Jan-20	17-Jan-21
Attenuator	Fairview Microwave	SA4014-20	TKV	17-Jan-20	17-Jan-21
Block - DC	Fairview Microwave	SD3379	AMU	20-Jan-20	20-Jan-21
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAT	28-May-19	28-May-20
Generator - Signal	Agilent	N5181A	TGZ	31-Aug-18	31-Aug-21

TEST DESCRIPTION

The peak output power was measured with the EUT set to low, medium and high transmit frequencies. The EUT was transmitting in a no hop mode at the data rate(s) listed in the datasheet.

The method found in ANSI C63.10:2013 Section 7.8.5 was used for a FHSS radio.

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

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	Thor 1.0			**Work Order:**	ECHN0036
Serial Number:	Pre-Production			**Date:**	13-May-20
Customer:	EchoNous, Inc.			**Temperature:**	23.3 °C
Attendees:	None			**Humidity:**	39.7% RH
Project:	None			**Barometric Pres.:**	1013 mbar
Tested by:	Brian Fahey	**Power:**	3.7 VDC	**Job Site:**	NC0A

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

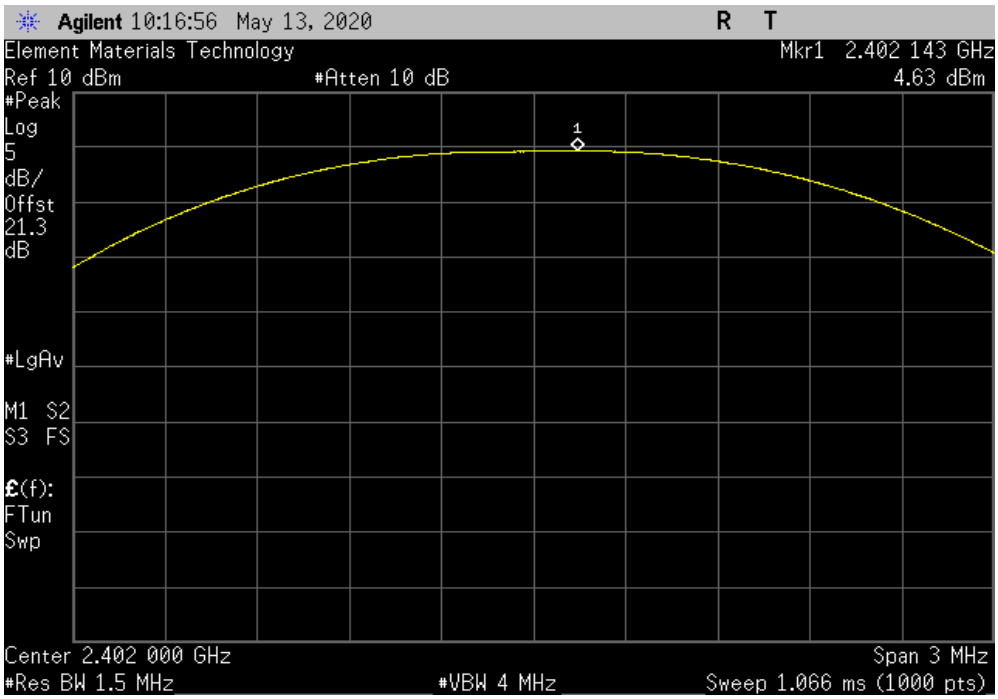
None

Configuration #	2	*Signature*

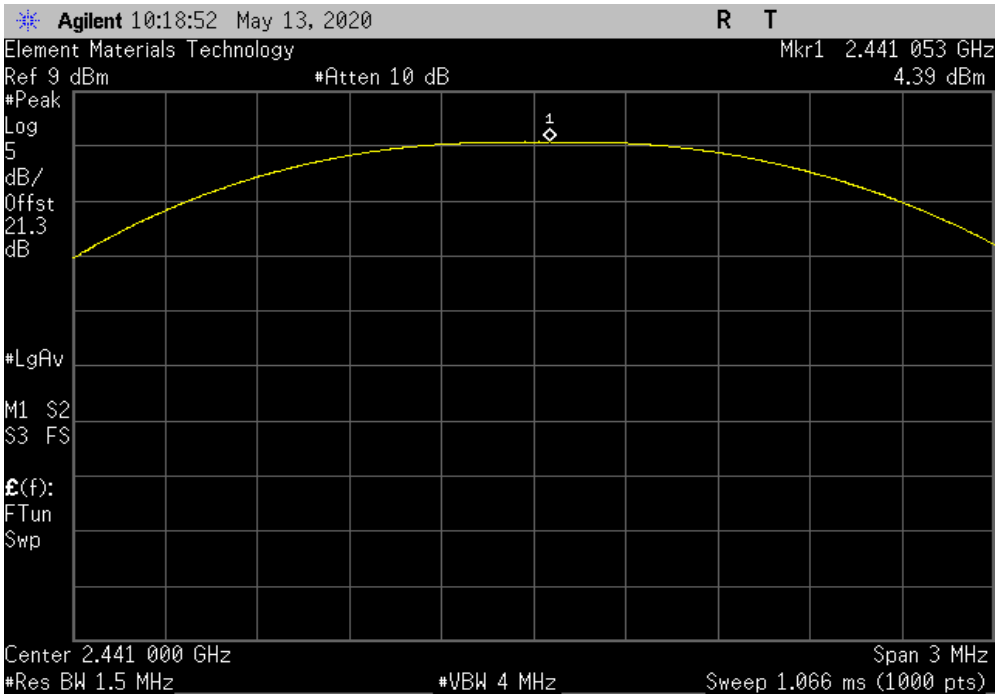
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
DH5, GFSK						
	Low Channel, 2402 MHz	4.629	-1.29	3.339	27	Pass
	Mid Channel, 2441 MHz	4.385	-1.29	3.095	27	Pass
	High Channel, 2480 MHz	6.511	-1.29	5.221	27	Pass
2DH5, pi/4-DQPSK						
	Low Channel, 2402 MHz	3.705	-1.29	2.415	27	Pass
	Mid Channel, 2441 MHz	3.471	-1.29	2.181	27	Pass
	High Channel, 2480 MHz	5.611	-1.29	4.321	27	Pass
3DH5, 8-DPSK						
	Low Channel, 2402 MHz	4.106	-1.29	2.816	27	Pass
	Mid Channel, 2441 MHz	3.829	-1.29	2.539	27	Pass
	High Channel, 2480 MHz	5.959	-1.29	4.669	27	Pass

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

DH5, GFSK, Low Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		4.629	-1.29	3.339	27	Pass



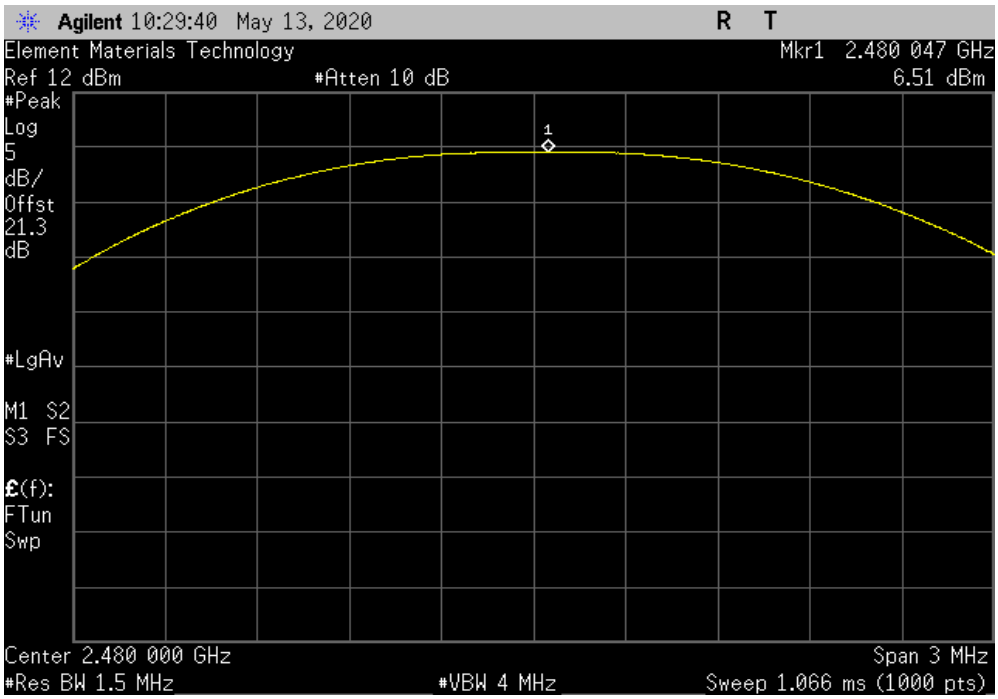
DH5, GFSK, Mid Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		4.385	-1.29	3.095	27	Pass



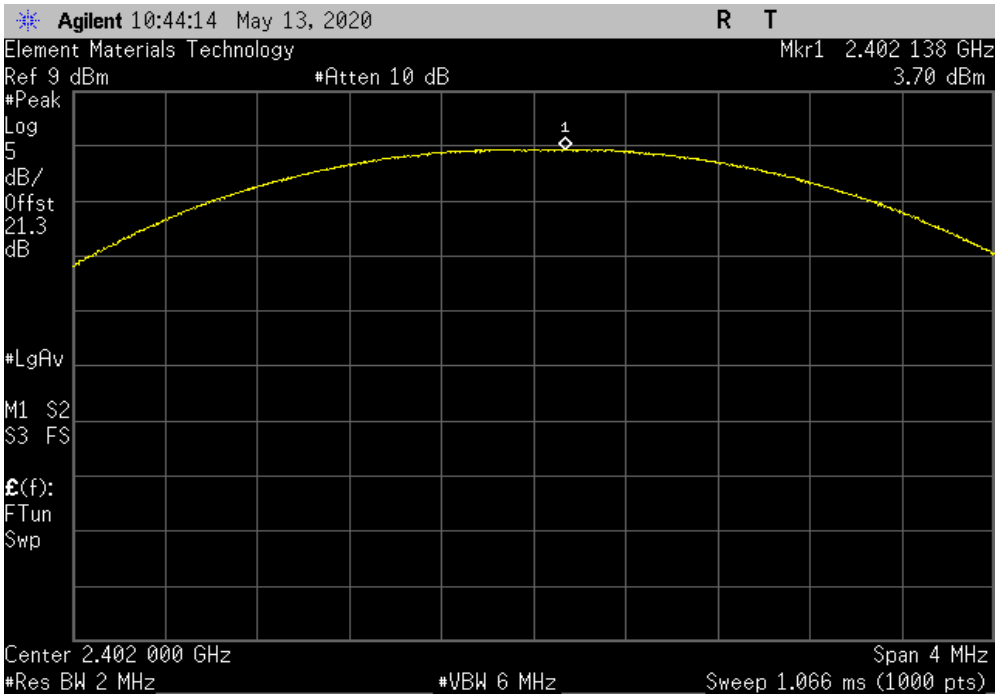
EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

TbtTx 2019.08.30.0 XMit 2020.03.25.0

DH5, GFSK, High Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		6.511	-1.29	5.221	27	Pass



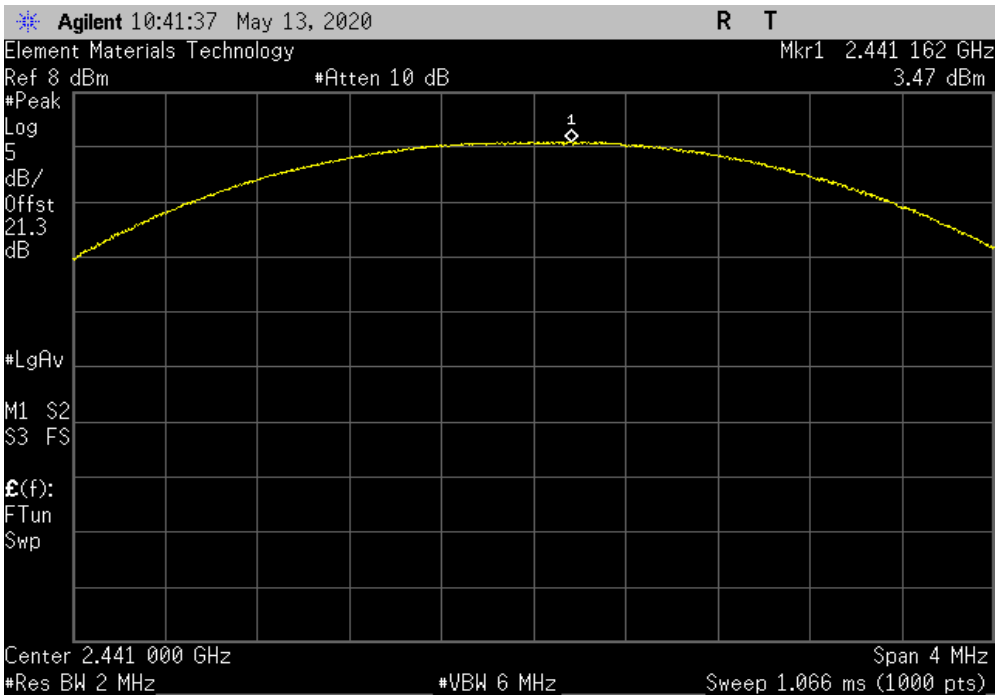
2DH5, pi/4-DQPSK, Low Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		3.705	-1.29	2.415	27	Pass



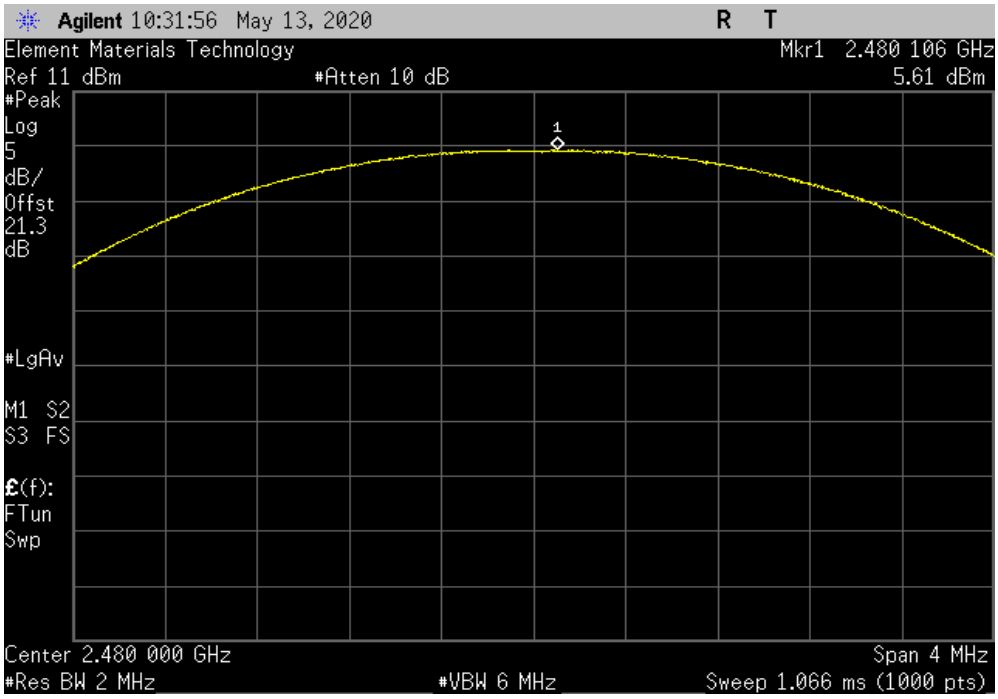
EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

TbtTx 2019.08.30.0 XMit 2020.03.25.0

2DH5, pi/4-DQPSK, Mid Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		3.471	-1.29	2.181	27	Pass

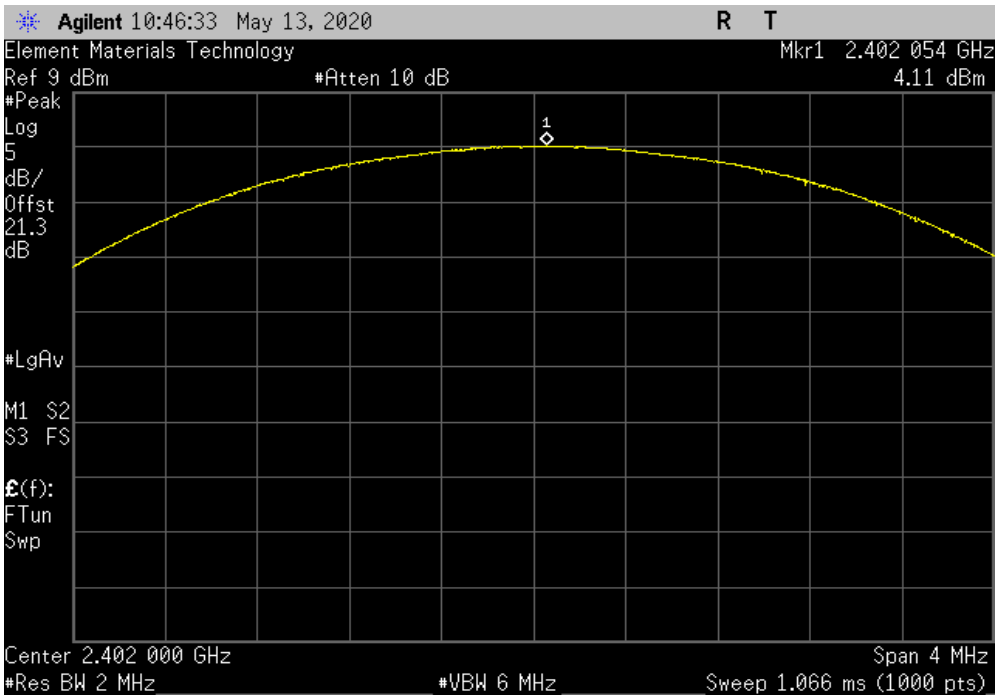


2DH5, pi/4-DQPSK, High Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		5.611	-1.29	4.321	27	Pass

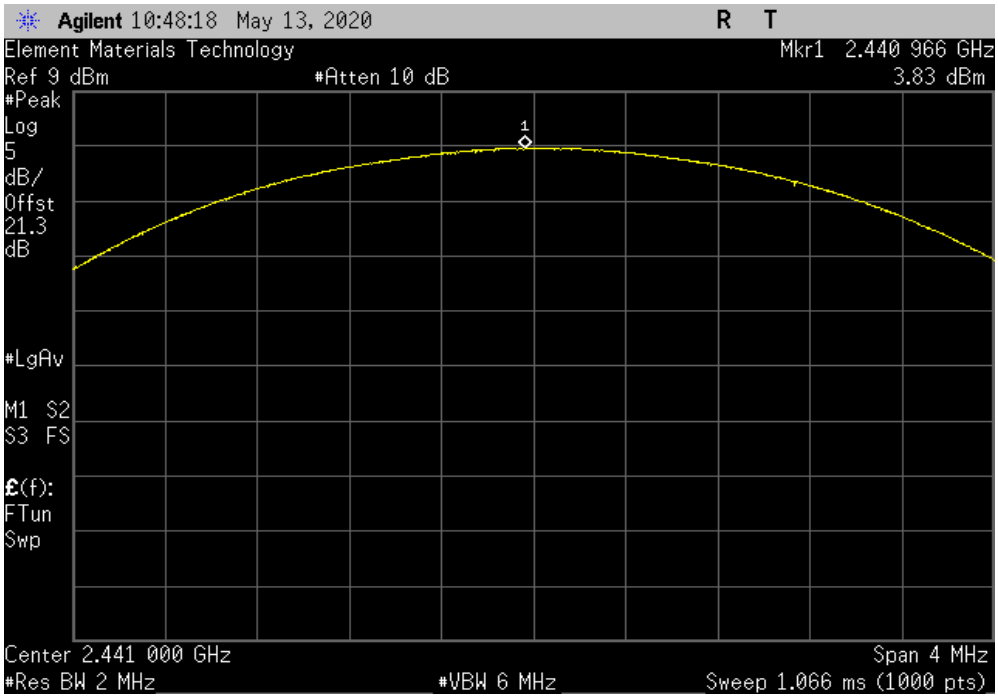


EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

3DH5, 8-DPSK, Low Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		4.106	-1.29	2.816	27	Pass



3DH5, 8-DPSK, Mid Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		3.829	-1.29	2.539	27	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

TbtTx 2019.08.30.0 XMit 2020.03.25.0

3DH5, 8-DPSK, High Channel						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		5.959	-1.29	4.669	27	Pass