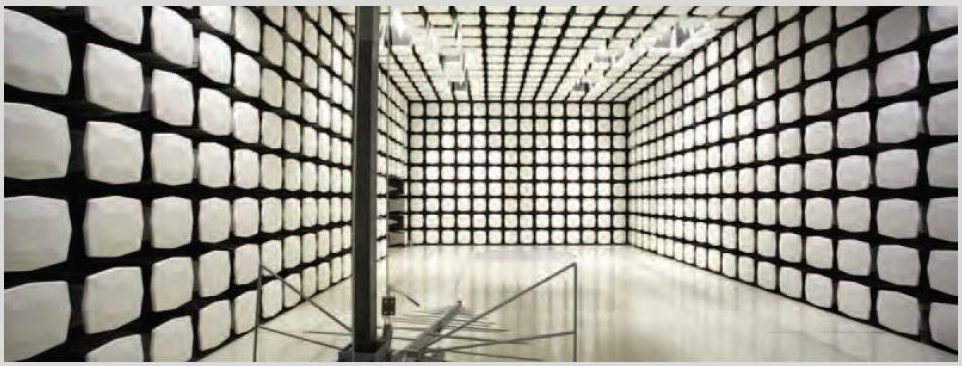
MSA Innovation, LLC

Lunar

FCC 15.247:2021

802.15.4 Radio (FHSS)

Report: MSAS0004, Issue Date: April 2, 2021



NVLAP LAB CODE: 200881-0

CERTIFICATE OF TEST

Last Date of Test: March 2, 2021
MSA Innovation, LLC
EUT: Lunar

Radio Equipment Testing

Standards

Specification	Method
FCC 15.247:2021	ANSI C63.10:2013

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	No	N/A	Not required for battery powered EUT
6.5, 6.6	Spurious Radiated Emissions	Yes	Pass	
7.5	Duty Cycle	Yes	Pass	
7.8.2	Carrier Frequency Separation	Yes	Pass	
7.8.3	Number of Hopping Frequencies	Yes	Pass	
7.8.4	Dwell Time	Yes	Pass	
7.8.5	Output Power	Yes	Pass	
7.8.5	Equivalent Isotropic Radiated Power	Yes	Pass	
7.8.6	Band Edge Compliance	Yes	Pass	
7.8.6	Band Edge Compliance - Hopping Mode	Yes	Pass	
7.8.7	Occupied Bandwidth	Yes	Pass	
7.8.8	Spurious Conducted Emissions	Yes	Pass	

Deviations From Test Standards

None

Approved By:

Trevor Buls

Trevor Buls, Principal EMC Test Engineer

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

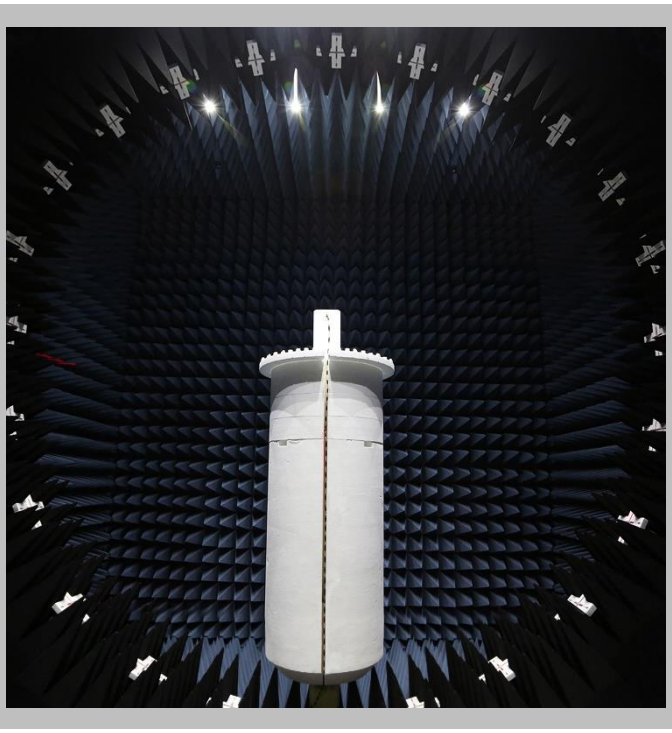
MIC – Recognized by MIC as a CAB for the acceptance of test data.

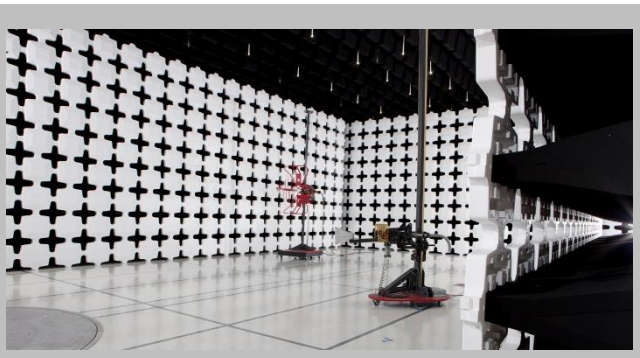
SCOPE

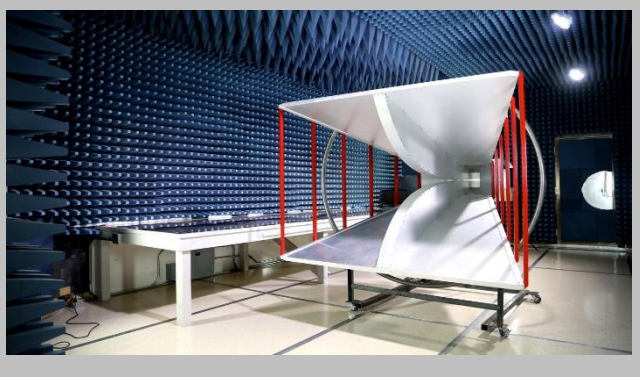
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

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.

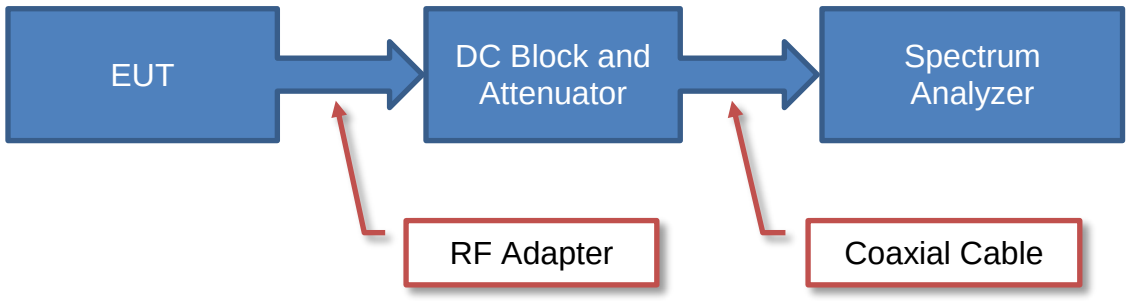
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable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

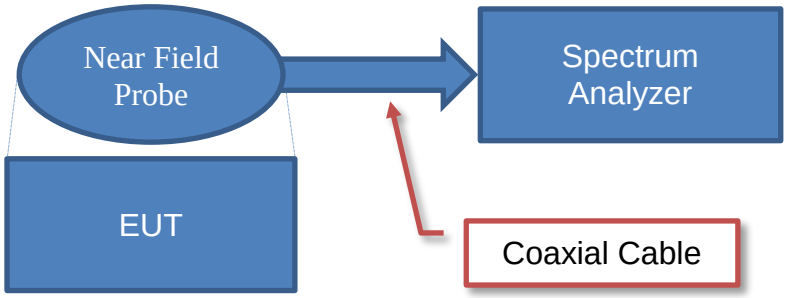
Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field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

Test Setup Block Diagrams

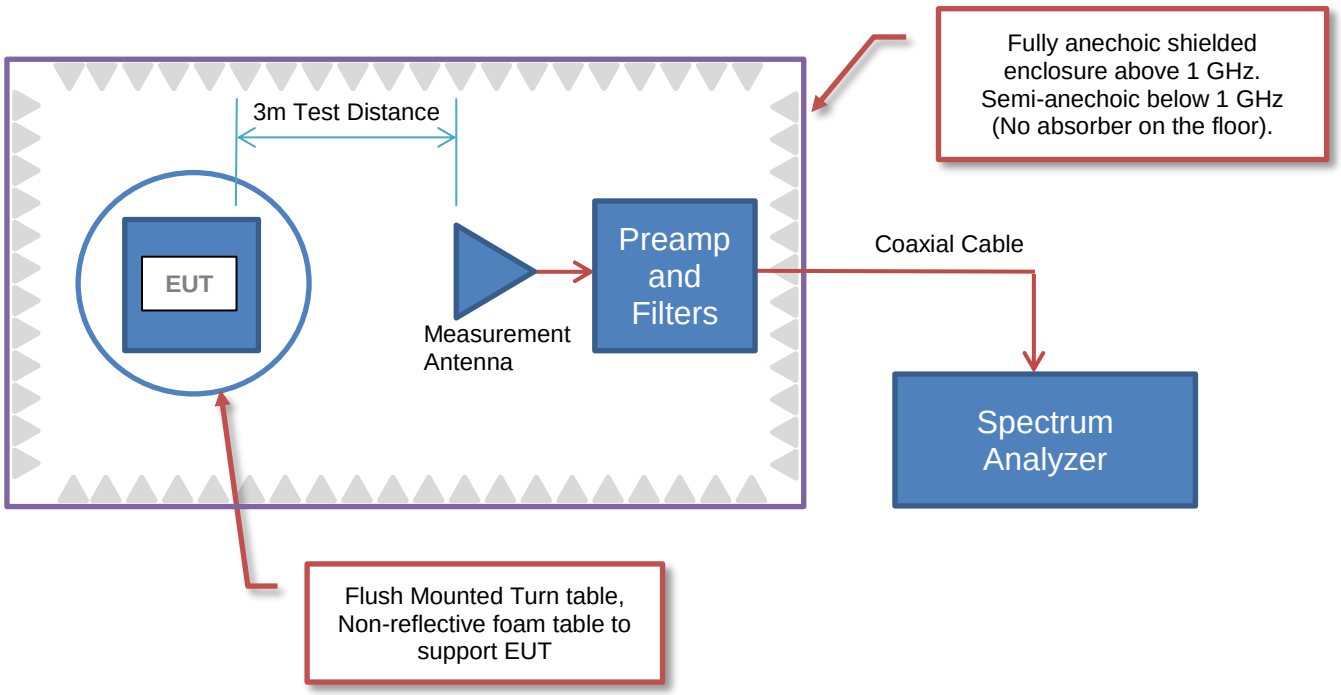
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	MSA Innovation, LLC
Address:	1100 Cranberry Woods Road
City, State, Zip:	Cranberry Township, PA 16066
Test Requested By:	Dustin Morris
EUT:	Lunar
First Date of Test:	August 26, 2020
Last Date of Test:	March 2, 2021
Receipt Date of Samples:	August 20, 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:
Handheld thermal imaging device used in industrial and government applications containing four RF transmitters and one GNSS receiver.

Testing Objective:
To demonstrate compliance of the 802.15.4 radio to FCC 15.247 requirements as a FHSS device.

CONFIGURATIONS

Configuration MSAS0004- 1

Software/Firmware Running during test	
Description	**Version**
Test Software	1.0

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Lunar	MSA Innovation, LLC	Lunar	7492

Configuration MSAS0004- 2

Software/Firmware Running during test	
Description	**Version**
Test Software	1.0

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Lunar	MSA Innovation, LLC	Lunar	9628

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Asus	UX433F	00325-96475-24912-AAOEM
Mouse	Kensington	M01215	B1517A002945

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB to Serial Cable	Yes	1.0m	No	Laptop	Lunar
USB Cable (Mouse	Yes	1.5m	No	Laptop	Mouse

Configuration MSAS0004- 5

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Lunar	MSA Innovation, LLC	Lunar	9240

CONFIGURATIONS

Configuration MSAS0004- 7

Software/Firmware Running during test	
Description	**Version**
Test Software	1.0

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Lunar	MSA Innovation, LLC	Lunar	9240

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Asus	UX433F	00325-96475-24912-AAOEM
Mouse	Kensington	M01215	B1517A002945

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB to Serial Cable	Yes	1.0m	No	Laptop	Lunar
USB Cable (Mouse	Yes	1.5m	No	Laptop	Mouse

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2020-08-26	Carrier Frequency Separation	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	2020-08-26	Dwell Time	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	2020-08-26	Band Edge Compliance - Hopping Mode	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	2020-12-18	Number of Hopping Frequencies	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	2020-12-18	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.
6	2020-12-18	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.
7	2020-12-18	Band Edge Compliance	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
8	2020-12-18	Spurious Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
9	2020-12-21	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.
10	2021-03-02	Occupied Bandwidth	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

Lunar	Power Setting
802.15.4 (FHSS)	+20 dBm

ANTENNA GAIN (dBi)

Type	Provided by:	Frequency Range (MHz)	Gain (dBi)
PIFA-1	N/A	2401	1.3
		2442	2.3
		2480	1.1
PIFA-2	N/A	2401	1.3
		2442	-0.8
		2480	-2.2

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

Transmitting on Low channel (2401 MHz), Mid channel (2442 MHz); FHSS modulation (CW); Antenna ports 1 & 2
Transmitting on High channel (2480 MHz); FHSS modulation (CW); Antenna ports 1 & 2

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

MSAS0004 - 1
MSAS0004 - 5

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
Attenuator	Fairview Microwave	SA18E-20	TWZ	2019-09-17	12 mo
Cable	ESM Cable Corp.	TTBJ141 KMKM-72	MNP	2019-09-11	12 mo
Amplifier - Pre-Amplifier	Miteq	JSD4-18002600-26-8P	APU	2019-09-11	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	0 mo
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	2020-03-10	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVW	2020-01-17	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	2020-01-17	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-08	AIQ	NCR	0 mo
Filter - Band Pass/Notch	K&L Microwave	3TNF-500/1000-N/N	HGS	2020-06-30	12 mo
Filter - Low Pass	Micro-Tronics	LPM50003	LFJ	2019-09-17	12 mo
Filter - High Pass	Micro-Tronics	HPM50108	LFM	2019-09-12	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	2020-01-17	12 mo
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	2019-09-17	12 mo
Antenna - Double Ridge	ETS-Lindgren	3115	AJQ	2019-01-16	24 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	2019-10-18	12 mo
Cable	ESM Cable Corp.	Bilog Cables	MNH	2019-10-18	12 mo
Antenna - Biconilog	ETS Lindgren	3142D	AXO	2019-09-03	24 mo
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	2019-12-23	12 mo
Filter - High Pass	Micro-Tronics	HPM50111	HFM	2020-09-14	12 mo
Amplifier - Pre-Amplifier	L-3 Narda-MITEQ	AMF-6F-12001800-30-10P	PAP	2020-02-18	12 mo
Cable	Element	Biconilog Cable	MNX	2020-02-18	12 mo
Cable	Element	Standard Gain Cable	MNW	2020-02-18	12 mo
Cable	Element	Double Ridge Guide Horn Cables	MNV	2020-02-18	12 mo
Filter - Low Pass	Micro-Tronics	LPM50004	HGG	2020-09-14	12 mo
Antenna - Biconilog	Ametek	CBL 6141B	AYS	2019-03-19	24 mo
Attenuator	Coaxicom	3910-20	AXY	2020-09-14	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVX	2020-02-18	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVC	2020-02-18	12 mo
Amplifier - Pre-Amplifier	Miteq	AM-1064-9079 and SA18E-10	AOO	2020-02-18	12 mo
Antenna - Standard Gain	ETS-Lindgren	3160-08	AJP	NCR	0 mo
Antenna - Standard Gain	ETS-Lindgren	3160-07	AJJ	NCR	0 mo
Antenna - Double Ridge	ETS Lindgren	3115	AIB	2020-09-03	24 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.

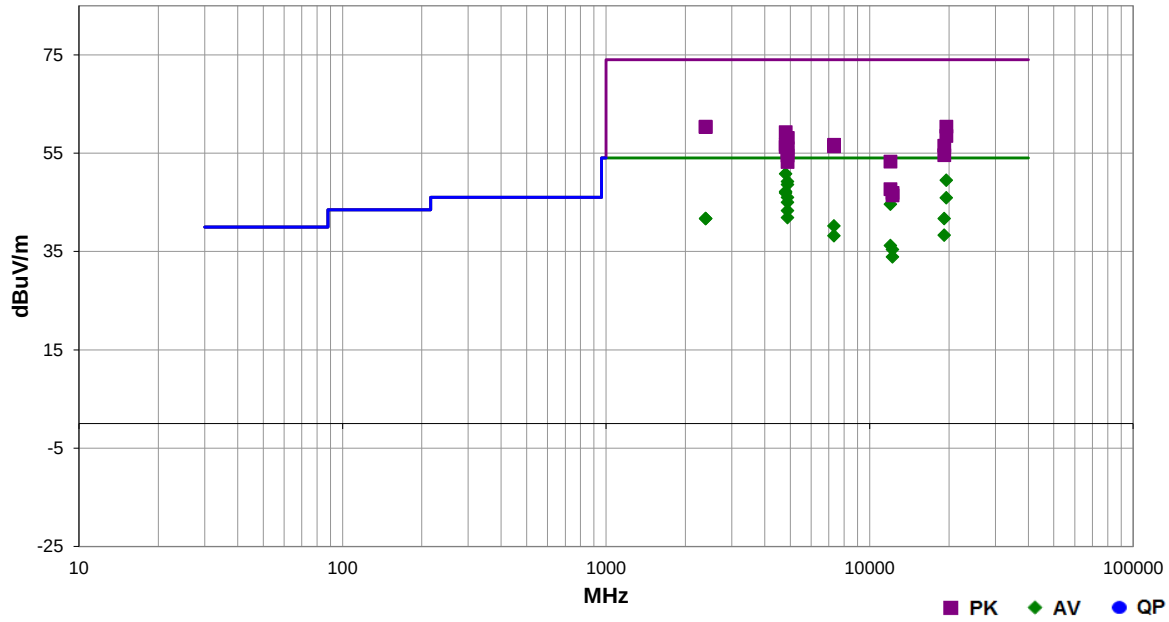
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.04.20.0 PSA-ESCI 2020.04.03.0

Work Order:	MSAS0004	**Date:**	2020-08-24		
Project:	None	**Temperature:**	22 °C		
Job Site:	MN05	**Humidity:**	57% RH		
Serial Number:	7492	**Barometric Pres.:**	1017 mbar	**Tested by:**	Andrew Rogstad
EUT:	Lunar				
Configuration:	1				
Customer:	MSA Safety				
Attendees:	Dustin Morris				
EUT Power:	Battery				
Operating Mode:	Transmitting on Low channel (2401 MHz), Mid channel (2442 MHz); FHSS modulation (CW); Antenna ports 1 & 2				
Deviations:	None				
Comments:	Test mode operates at 100% duty cycle, so no upward DCCF correction is applied. When operating in FHSS mode, the worst-case transmission time over any 100 ms period is 20 ms (provided in client attestation.) Downward DCCF correction applied based on 10*log(On Time/100 ms) = -7.0dB. High channel was retested at a different fundmental frequency. OOK modulation and CW were investigated and CW was determined to be the worst case.				

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

Run #	40	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Duty Cycle Correction Factor (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4802.042	53.2	4.6	2.1	275.0	3.0	0.0	Horz	AV	-7.0	50.8	54.0	-3.2	EUT vert, Low ch., Ant 2
19535.980	42.0	14.5	1.5	203.9	3.0	0.0	Horz	AV	-7.0	49.5	54.0	-4.5	EUT vert, Mid ch., Ant 2
4883.992	51.7	4.5	1.0	186.9	3.0	0.0	Vert	AV	-7.0	49.2	54.0	-4.8	EUT vert, Mid ch., Ant 2
4883.992	51.1	4.5	2.1	275.0	3.0	0.0	Horz	AV	-7.0	48.6	54.0	-5.4	EUT vert, Mid ch., Ant 2
4802.017	49.6	4.6	2.1	271.9	3.0	0.0	Horz	AV	-7.0	47.2	54.0	-6.8	EUT vert, Low ch., Ant 1
4801.975	49.3	4.6	2.0	185.0	3.0	0.0	Vert	AV	-7.0	46.9	54.0	-7.1	EUT vert, Low ch., Ant 2
4884.033	48.5	4.5	2.1	6.9	3.0	0.0	Horz	AV	-7.0	46.0	54.0	-8.0	EUT on side, Mid ch., Ant 2
19536.010	38.4	14.5	1.7	264.9	3.0	0.0	Vert	AV	-7.0	45.9	54.0	-8.1	EUT vert, Mid ch., Ant 2
4883.983	47.5	4.5	2.6	51.0	3.0	0.0	Vert	AV	-7.0	45.0	54.0	-9.0	EUT on side, Mid ch., Ant 2
12004.980	52.1	-0.5	1.6	182.9	3.0	0.0	Horz	AV	-7.0	44.6	54.0	-9.4	EUT vert, Low ch., Ant 2
4884.000	45.8	4.5	2.1	163.0	3.0	0.0	Vert	AV	-7.0	43.3	54.0	-10.7	EUT horz, Mid ch., Ant 2
2386.007	44.1	-3.7	1.5	72.0	3.0	20.0	Horz	PK	0.0	60.4	74.0	-13.6	EUT horz, Low ch., Ant 2
19536.020	45.9	14.5	1.5	203.9	3.0	0.0	Horz	PK	0.0	60.4	74.0	-13.6	EUT vert, Mid ch., Ant 2
2387.013	44.0	-3.7	1.5	340.9	3.0	20.0	Vert	PK	0.0	60.3	74.0	-13.7	EUT horz, Low ch., Ant 2
4884.000	44.4	4.5	1.9	300.0	3.0	0.0	Horz	AV	-7.0	41.9	54.0	-12.1	EUT horz, Mid ch., Ant 2
19208.020	34.4	14.3	1.5	210.0	3.0	0.0	Horz	AV	-7.0	41.7	54.0	-12.3	EUT vert, Low ch., Ant 2
2387.993	32.4	-3.7	1.5	72.0	3.0	20.0	Horz	AV	-7.0	41.7	54.0	-12.3	EUT horz, Low ch., Ant 2
2388.613	32.4	-3.7	1.5	340.9	3.0	20.0	Vert	AV	-7.0	41.7	54.0	-12.3	EUT horz, Low ch., Ant 2
4801.942	54.7	4.6	2.1	275.0	3.0	0.0	Horz	PK	0.0	59.3	74.0	-14.7	EUT vert, Low ch., Ant 2

19536.040	44.0	14.5	1.7	264.9	3.0	0.0	Vert	PK	0.0	58.5	74.0	-15.5	EUT vert, Mid ch., Ant 2
4883.942	53.6	4.5	2.1	275.0	3.0	0.0	Horz	PK	0.0	58.1	74.0	-15.9	EUT vert, Mid ch., Ant 2
4883.992	53.6	4.5	1.0	186.9	3.0	0.0	Vert	PK	0.0	58.1	74.0	-15.9	EUT vert, Mid ch., Ant 2
7326.000	33.8	13.4	1.5	253.9	3.0	0.0	Horz	AV	-7.0	40.2	54.0	-13.8	EUT vert, Mid ch., Ant 2
7326.042	43.3	13.4	1.5	253.9	3.0	0.0	Horz	PK	0.0	56.7	74.0	-17.3	EUT vert, Mid ch., Ant 2
4802.117	52.1	4.6	2.1	271.9	3.0	0.0	Horz	PK	0.0	56.7	74.0	-17.3	EUT vert, Low ch., Ant 1
19207.760	42.2	14.3	1.5	210.0	3.0	0.0	Horz	PK	0.0	56.5	74.0	-17.5	EUT vert, Low ch., Ant 2
7323.633	43.0	13.4	3.4	292.0	3.0	0.0	Vert	PK	0.0	56.4	74.0	-17.6	EUT vert, Mid ch., Ant 2
4801.958	51.7	4.6	2.0	185.0	3.0	0.0	Vert	PK	0.0	56.3	74.0	-17.7	EUT vert, Low ch., Ant 2
19208.060	31.0	14.3	1.5	271.0	3.0	0.0	Vert	AV	-7.0	38.3	54.0	-15.7	EUT vert, Low ch., Ant 2
7325.900	31.8	13.4	3.4	292.0	3.0	0.0	Vert	AV	-7.0	38.2	54.0	-15.8	EUT vert, Mid ch., Ant 2
4884.067	51.5	4.5	2.1	6.9	3.0	0.0	Horz	PK	0.0	56.0	74.0	-18.0	EUT on side, Mid ch., Ant 2
4883.917	50.8	4.5	2.6	51.0	3.0	0.0	Vert	PK	0.0	55.3	74.0	-18.7	EUT on side, Mid ch., Ant 2
19208.090	40.3	14.3	1.5	271.0	3.0	0.0	Vert	PK	0.0	54.6	74.0	-19.4	EUT vert, Low ch., Ant 2
4884.033	50.0	4.5	2.1	163.0	3.0	0.0	Vert	PK	0.0	54.5	74.0	-19.5	EUT horz, Mid ch., Ant 2
12004.980	43.7	-0.5	1.4	123.0	3.0	0.0	Vert	AV	-7.0	36.2	54.0	-17.8	EUT vert, Low ch., Ant 2
12209.980	42.4	0.0	1.5	134.0	3.0	0.0	Horz	AV	-7.0	35.4	54.0	-18.6	EUT vert, Mid ch., Ant 2
12004.940	53.8	-0.5	1.6	182.9	3.0	0.0	Horz	PK	0.0	53.3	74.0	-20.7	EUT vert, Low ch., Ant 2
4883.958	48.7	4.5	1.9	300.0	3.0	0.0	Horz	PK	0.0	53.2	74.0	-20.8	EUT horz, Mid ch., Ant 2
12210.050	40.9	0.0	1.8	229.9	3.0	0.0	Vert	AV	-7.0	33.9	54.0	-20.1	EUT vert, Mid ch., Ant 2
12004.950	48.2	-0.5	1.4	123.0	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	EUT vert, Low ch., Ant 2
12209.830	46.9	0.0	1.5	134.0	3.0	0.0	Horz	PK	0.0	46.9	74.0	-27.1	EUT vert, Mid ch., Ant 2
12210.110	46.4	0.0	1.8	229.9	3.0	0.0	Vert	PK	0.0	46.4	74.0	-27.6	EUT vert, Mid ch., Ant 2

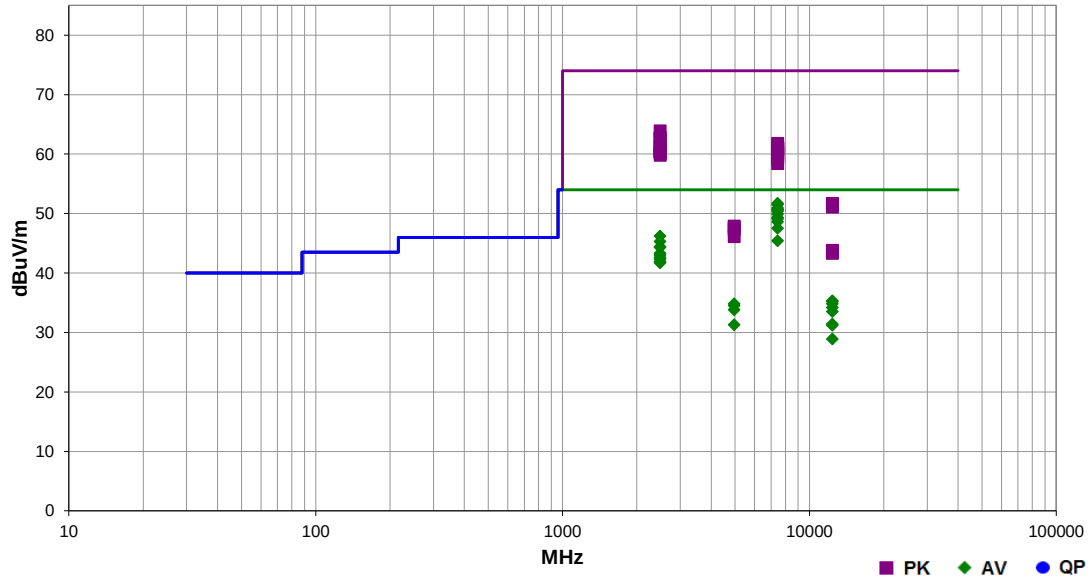
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.12.09.0 PSA-ESCI 2020.06.24.2

Work Order:	MSAS0004	**Date:**	2020-12-21		
Project:	None	**Temperature:**	22.2 °C		
Job Site:	MN09	**Humidity:**	24.7% RH		
Serial Number:	9240	**Barometric Pres.:**	1013 mbar	**Tested by:**	Dan Haas
EUT:	Lunar				
Configuration:	5				
Customer:	MSA Safety				
Attendees:	Dustin Morris				
EUT Power:	Battery				
Operating Mode:	Transmitting on High channel (2480 MHz); FHSS modulation (CW); Antenna ports 1 & 2				
Deviations:	None				
Comments:	Test mode operates at 100% duty cycle, so no upward DCCF correction is applied. When operating in FHSS mode, the worst-case transmission time over any 100 ms period is 20 ms (provided in client attestation.) Downward DCCF correction applied based on 10*log(On Time/100 ms) = -7.0dB. High channel was retested at a different fundmental frequency. OOK modulation and CW were investigated and CW was determined to be the worst case.				

Test Specifications	**Test Method**
FCC 15.247:2021	ANSI C63.10:2013

Run #	20	**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 (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
7439.967	44.1	14.6	3.5	80.0	-7.0	0.0	Vert	AV	0.0	51.7	54.0	-2.3	High ch. (2480MHz), EUT on Side, Ant. 2
7439.967	43.9	14.6	1.3	154.0	-7.0	0.0	Horz	AV	0.0	51.5	54.0	-2.5	High ch. (2480MHz), EUT Vert, Ant. 2
7439.992	43.3	14.6	2.1	36.0	-7.0	0.0	Horz	AV	0.0	50.9	54.0	-3.1	High ch. (2480MHz), EUT on Side, Ant. 1
7439.983	43.1	14.6	1.3	325.0	-7.0	0.0	Vert	AV	0.0	50.7	54.0	-3.3	High ch. (2480MHz), EUT Horiz, Ant. 1
7440.008	42.9	14.6	2.7	290.0	-7.0	0.0	Horz	AV	0.0	50.5	54.0	-3.5	High ch. (2480MHz), EUT on Side, Ant. 2
7440.008	42.8	14.6	2.5	243.0	-7.0	0.0	Horz	AV	0.0	50.4	54.0	-3.6	High ch. (2480MHz), EUT Horiz, Ant. 2
7440.000	42.3	14.6	1.1	286.0	-7.0	0.0	Vert	AV	0.0	49.9	54.0	-4.1	High ch. (2480MHz), EUT on Side, Ant. 1
7440.033	41.7	14.6	2.2	322.0	-7.0	0.0	Vert	AV	0.0	49.3	54.0	-4.7	High ch. (2480MHz), EUT Horiz, Ant. 2
7439.958	41.5	14.6	2.5	299.0	-7.0	0.0	Horz	AV	0.0	49.1	54.0	-4.9	High ch. (2480MHz), EUT Horiz, Ant. 1
7440.000	41.0	14.6	3.5	218.0	-7.0	0.0	Horz	AV	0.0	48.6	54.0	-5.4	High ch. (2480MHz), EUT Vert, Ant. 1
7440.008	39.9	14.6	2.9	223.0	-7.0	0.0	Vert	AV	0.0	47.5	54.0	-6.5	High ch. (2480MHz), EUT Vert, Ant. 2
2483.542	36.0	-2.8	1.0	16.0	-7.0	20.0	Horz	AV	0.0	46.2	54.0	-7.8	High ch. (2480MHz), EUT Horiz, Ant. 1
2483.633	46.7	-2.8	4.0	22.0	0.0	20.0	Horz	PK	0.0	63.9	74.0	-10.1	High ch. (2480MHz), EUT on Side, Ant. 1
7440.008	37.8	14.6	1.3	188.0	-7.0	0.0	Vert	AV	0.0	45.4	54.0	-8.6	High ch. (2480MHz), EUT Vert, Ant. 1
2483.533	35.1	-2.8	1.3	0.0	-7.0	20.0	Horz	AV	0.0	45.3	54.0	-8.7	High ch. (2480MHz), EUT Vert, Ant. 1
2483.508	45.6	-2.8	1.0	276.0	0.0	20.0	Vert	PK	0.0	62.8	74.0	-11.2	High ch. (2480MHz), EUT on Side, Ant. 1
2484.508	45.5	-2.8	1.3	0.0	0.0	20.0	Horz	PK	0.0	62.7	74.0	-11.3	High ch. (2480MHz), EUT Vert, Ant. 1
2484.117	45.4	-2.8	1.0	16.0	0.0	20.0	Horz	PK	0.0	62.6	74.0	-11.4	High ch. (2480MHz), EUT Horiz, Ant. 1
2483.517	34.2	-2.8	4.0	73.0	-7.0	20.0	Vert	AV	0.0	44.4	54.0	-9.6	High ch. (2480MHz), EUT Vert, Ant. 1
2483.500	34.1	-2.8	4.0	22.0	-7.0	20.0	Horz	AV	0.0	44.3	54.0	-9.7	High ch. (2480MHz), EUT on Side, Ant. 1
7439.917	47.2	14.6	3.5	80.0	0.0	0.0	Vert	PK	0.0	61.8	74.0	-12.2	High ch. (2480MHz), EUT on Side, Ant. 2
7440.033	46.8	14.6	1.3	154.0	0.0	0.0	Horz	PK	0.0	61.4	74.0	-12.6	High ch. (2480MHz), EUT Vert, Ant. 2
2483.700	44.1	-2.8	4.0	73.0	0.0	20.0	Vert	PK	0.0	61.3	74.0	-12.7	High ch. (2480MHz), EUT Vert, Ant. 1
2483.500	33.1	-2.8	1.3	123.0	-7.0	20.0	Vert	AV	0.0	43.3	54.0	-10.7	High ch. (2480MHz), EUT on Side, Ant. 2
7439.833	46.4	14.6	2.1	36.0	0.0	0.0	Horz	PK	0.0	61.0	74.0	-13.0	High ch. (2480MHz), EUT on Side, Ant. 1

7439.875	46.4	14.6	1.3	325.0	0.0	0.0	Vert	PK	0.0	61.0	74.0	-13.0	High ch. (2480MHz), EUT Horiz, Ant. 1
7440.067	46.4	14.6	2.7	290.0	0.0	0.0	Horz	PK	0.0	61.0	74.0	-13.0	High ch. (2480MHz), EUT on Side, Ant. 2
2483.600	32.8	-2.8	1.3	276.0	-7.0	20.0	Horz	AV	0.0	43.0	54.0	-11.0	High ch. (2480MHz), EUT Horiz, Ant. 2
2484.358	43.6	-2.8	1.3	215.0	0.0	20.0	Horz	PK	0.0	60.8	74.0	-13.2	High ch. (2480MHz), EUT on Side, Ant. 2
2488.142	43.6	-2.9	1.3	123.0	0.0	20.0	Vert	PK	0.0	60.7	74.0	-13.3	High ch. (2480MHz), EUT on Side, Ant. 2
2484.100	43.4	-2.8	1.3	37.0	0.0	20.0	Vert	PK	0.0	60.6	74.0	-13.4	High ch. (2480MHz), EUT Horiz, Ant. 1
7440.125	46.0	14.6	2.5	243.0	0.0	0.0	Horz	PK	0.0	60.6	74.0	-13.4	High ch. (2480MHz), EUT Horiz, Ant. 2
2483.508	32.4	-2.8	1.4	274.0	-7.0	20.0	Vert	AV	0.0	42.6	54.0	-11.4	High ch. (2480MHz), EUT Vert, Ant. 2
2483.783	43.2	-2.8	1.4	274.0	0.0	20.0	Vert	PK	0.0	60.4	74.0	-13.6	High ch. (2480MHz), EUT Vert, Ant. 2
2483.533	32.3	-2.8	1.3	37.0	-7.0	20.0	Vert	AV	0.0	42.5	54.0	-11.5	High ch. (2480MHz), EUT Horiz, Ant. 1
2483.667	43.1	-2.8	1.3	239.0	0.0	20.0	Vert	PK	0.0	60.3	74.0	-13.7	High ch. (2480MHz), EUT Horiz, Ant. 2
7439.900	45.6	14.6	3.5	218.0	0.0	0.0	Horz	PK	0.0	60.2	74.0	-13.8	High ch. (2480MHz), EUT Vert, Ant. 1
7439.925	45.6	14.6	1.1	286.0	0.0	0.0	Vert	PK	0.0	60.2	74.0	-13.8	High ch. (2480MHz), EUT on Side, Ant. 1
2483.583	32.1	-2.8	1.0	276.0	-7.0	20.0	Vert	AV	0.0	42.3	54.0	-11.7	High ch. (2480MHz), EUT on Side, Ant. 1
2483.542	42.9	-2.8	1.3	276.0	0.0	20.0	Horz	PK	0.0	60.1	74.0	-13.9	High ch. (2480MHz), EUT Horiz, Ant. 2
2486.775	42.6	-2.8	1.3	177.0	0.0	20.0	Horz	PK	0.0	59.8	74.0	-14.2	High ch. (2480MHz), EUT Vert, Ant. 2
7439.692	45.2	14.6	2.2	322.0	0.0	0.0	Vert	PK	0.0	59.8	74.0	-14.2	High ch. (2480MHz), EUT Horiz, Ant. 2
2483.550	31.7	-2.8	1.3	239.0	-7.0	20.0	Vert	AV	0.0	41.9	54.0	-12.1	High ch. (2480MHz), EUT Horiz, Ant. 2
2483.500	31.6	-2.8	1.3	215.0	-7.0	20.0	Horz	AV	0.0	41.8	54.0	-12.2	High ch. (2480MHz), EUT on Side, Ant. 2
7439.842	45.0	14.6	2.5	299.0	0.0	0.0	Horz	PK	0.0	59.6	74.0	-14.4	High ch. (2480MHz), EUT Horiz, Ant. 1
2484.125	31.5	-2.8	1.3	177.0	-7.0	20.0	Horz	AV	0.0	41.7	54.0	-12.3	High ch. (2480MHz), EUT Vert, Ant. 2
7440.042	44.6	14.6	2.9	223.0	0.0	0.0	Vert	PK	0.0	59.2	74.0	-14.8	High ch. (2480MHz), EUT Vert, Ant. 2
7439.867	43.8	14.6	1.3	188.0	0.0	0.0	Vert	PK	0.0	58.4	74.0	-15.6	High ch. (2480MHz), EUT Vert, Ant. 1
12400.010	28.2	14.1	1.3	360.0	-7.0	0.0	Vert	AV	0.0	35.3	54.0	-18.7	High ch. (2480MHz), EUT Vert, Ant. 1
12400.040	28.1	14.1	1.3	346.0	-7.0	0.0	Horz	AV	0.0	35.2	54.0	-18.8	High ch. (2480MHz), EUT Vert, Ant. 2
4960.008	36.2	5.6	1.4	357.0	-7.0	0.0	Horz	AV	0.0	34.8	54.0	-19.2	High ch. (2480MHz), EUT Vert, Ant. 2
12400.030	27.7	14.1	2.9	77.0	-7.0	0.0	Horz	AV	0.0	34.8	54.0	-19.2	High ch. (2480MHz), EUT Vert, Ant. 1
4959.942	35.9	5.6	2.3	167.0	-7.0	0.0	Horz	AV	0.0	34.5	54.0	-19.5	High ch. (2480MHz), EUT Vert, Ant. 1
12400.040	27.1	14.1	1.3	351.0	-7.0	0.0	Vert	AV	0.0	34.2	54.0	-19.8	High ch. (2480MHz), EUT on Side, Ant. 2
4959.875	35.2	5.6	1.8	253.0	-7.0	0.0	Vert	AV	0.0	33.8	54.0	-20.2	High ch. (2480MHz), EUT Vert, Ant. 1
12400.310	37.6	14.1	1.3	360.0	0.0	0.0	Vert	PK	0.0	51.7	74.0	-22.3	High ch. (2480MHz), EUT Vert, Ant. 1
12400.170	37.5	14.1	2.9	77.0	0.0	0.0	Horz	PK	0.0	51.6	74.0	-22.4	High ch. (2480MHz), EUT Vert, Ant. 1
12399.790	40.8	-0.3	1.6	7.0	-7.0	0.0	Horz	AV	0.0	33.5	54.0	-20.5	High ch. (2480MHz), EUT Vert, Ant. 2
12400.240	37.3	14.1	1.3	351.0	0.0	0.0	Vert	PK	0.0	51.4	74.0	-22.6	High ch. (2480MHz), EUT on Side, Ant. 2
12400.310	37.0	14.1	1.3	346.0	0.0	0.0	Horz	PK	0.0	51.1	74.0	-22.9	High ch. (2480MHz), EUT Vert, Ant. 2
12399.980	38.7	-0.3	1.3	7.0	-7.0	0.0	Horz	AV	0.0	31.4	54.0	-22.6	High ch. (2480MHz), EUT Vert, Ant. 1
4959.967	32.7	5.6	1.2	47.0	-7.0	0.0	Vert	AV	0.0	31.3	54.0	-22.7	High ch. (2480MHz), EUT on Side, Ant. 2
12399.990	38.5	-0.3	1.2	286.0	-7.0	0.0	Vert	AV	0.0	31.2	54.0	-22.8	High ch. (2480MHz), EUT on Side, Ant. 2
4960.367	42.3	5.6	1.4	357.0	0.0	0.0	Horz	PK	0.0	47.9	74.0	-26.1	High ch. (2480MHz), EUT Vert, Ant. 2
4959.850	42.1	5.6	2.3	167.0	0.0	0.0	Horz	PK	0.0	47.7	74.0	-26.3	High ch. (2480MHz), EUT Vert, Ant. 1
4960.242	41.7	5.6	1.8	253.0	0.0	0.0	Vert	PK	0.0	47.3	74.0	-26.7	High ch. (2480MHz), EUT Vert, Ant. 1
12399.910	36.2	-0.3	1.0	13.0	-7.0	0.0	Vert	AV	0.0	28.9	54.0	-25.1	High ch. (2480MHz), EUT Vert, Ant. 1
4959.833	40.5	5.6	1.2	47.0	0.0	0.0	Vert	PK	0.0	46.1	74.0	-27.9	High ch. (2480MHz), EUT on Side, Ant. 2
12399.760	44.1	-0.3	1.3	7.0	0.0	0.0	Horz	PK	0.0	43.8	74.0	-30.2	High ch. (2480MHz), EUT Vert, Ant. 1
12399.950	44.0	-0.3	1.6	7.0	0.0	0.0	Horz	PK	0.0	43.7	74.0	-30.3	High ch. (2480MHz), EUT Vert, Ant. 2
12399.880	43.9	-0.3	1.2	286.0	0.0	0.0	Vert	PK	0.0	43.6	74.0	-30.4	High ch. (2480MHz), EUT on Side, Ant. 2
12399.980	43.6	-0.3	1.0	13.0	0.0	0.0	Vert	PK	0.0	43.3	74.0	-30.7	High ch. (2480MHz), EUT Vert, Ant. 1

DUTY CYCLE

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
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

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 test software provided for operation in a fixed, single channel mode allows the EUT to operate continuously at 100% Duty Cycle.

CARRIER FREQUENCY SEPARATION

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
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Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

The channel carrier frequencies in the 2400-2483.5MHz band must be separated by 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Or, if the output power is less than 125 mW, the channel separation can be 25 kHz or 2/3 of the 20dB bandwidth. The EUT was operated in pseudorandom hopping mode. The spectrum was scanned across two adjacent peaks. The separation between the peaks of these channels was measured.

CARRIER FREQUENCY SEPARATION

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**26-Aug-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**22.2 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**57.6% RH**
Project:	**None**			**Barometric Pres.:**	**1011 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

None

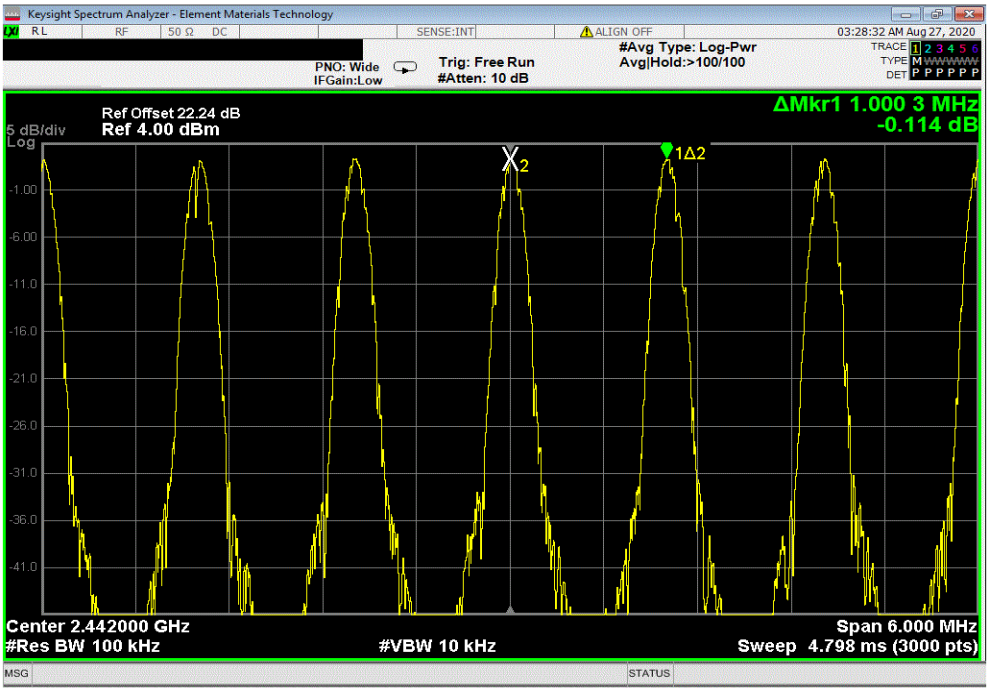
Configuration #	**2**	*Signature*

	Value	**Limit (≥)**	**Results**
Hopping Mode (All Channels)			
Antenna Port 1	1.0 MHz	25 kHz	Pass

CARRIER FREQUENCY SEPARATION

TbtTx 2019.08.30.0 XMit 2020.03.25.0

Hopping Mode (All Channels), Antenna Port 1						
				Value	Limit (≥)	Results
				1.0 MHz	25 kHz	Pass



NUMBER OF HOPPING FREQUENCIES

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
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMZ	4-Nov-20	4-Nov-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	14-Sep-20	14-Sep-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	14-Apr-20	14-Apr-21

TEST DESCRIPTION

The number of hopping frequencies was measured across the authorized band. The hopping function of the EUT was enabled.

NUMBER OF HOPPING FREQUENCIES

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9240**			**Date:**	**18-Dec-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**23 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**25.2% RH**
Project:	**None**			**Barometric Pres.:**	**1014 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

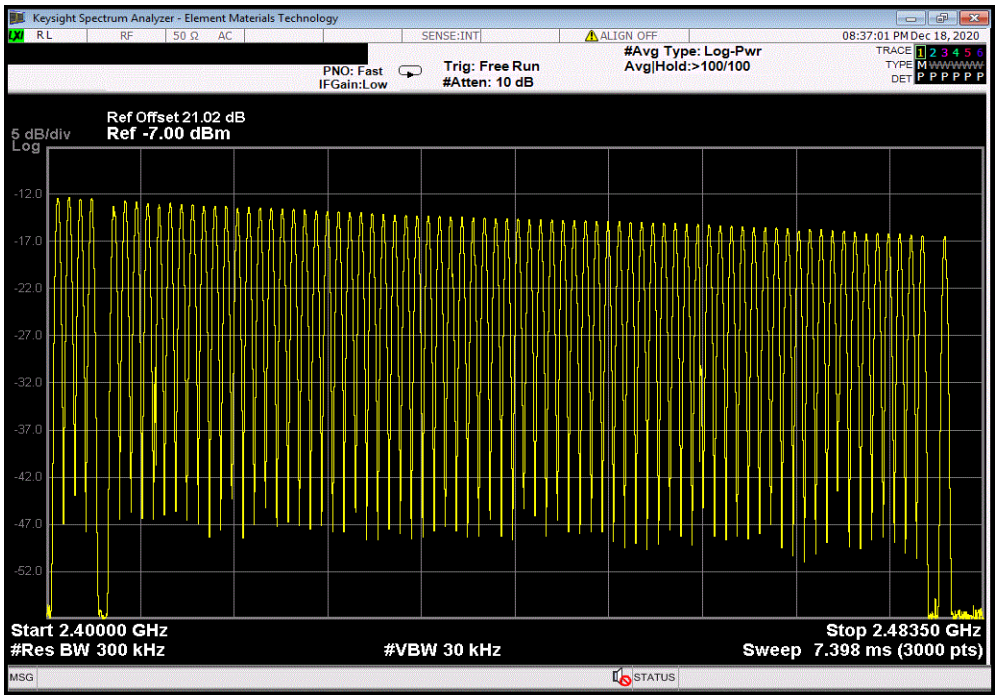
None

Configuration #	**7**	*Signature* Andrew Rogstad

	Number of Channels	**Limit (≥)**	**Results**
Hopping Mode (All Channels)			
Antenna Port 2	78	15	Pass

NUMBER OF HOPPING FREQUENCIES

Hopping Mode (All Channels), Antenna Port 2						
				Number of Channels	Limit (≥)	Results
				78	15	Pass



DWELL TIME

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
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

The average dwell time per hopping channel was measured at one hopping channel in the middle of the authorized band. The hopping function of the EUT was enabled.

The dwell time limit is based on the Number of Hopping Channels * 400 mS. For this FHSS radio it would be 78 Channels * 400mS = 31.2 seconds.

On Time During 31.2 Sec = Pulse Width * Average Number of Pulses * Scale Factor

- Average Number of Pulses is based on 4 samples.
- Scale Factor = 31.2 Sec / Screen Capture Sweep Time = 31.2 Sec / 6.24 Sec = 5

DWELL TIME

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**26-Aug-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**22.2 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**57.5% RH**
Project:	**None**			**Barometric Pres.:**	**1011 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

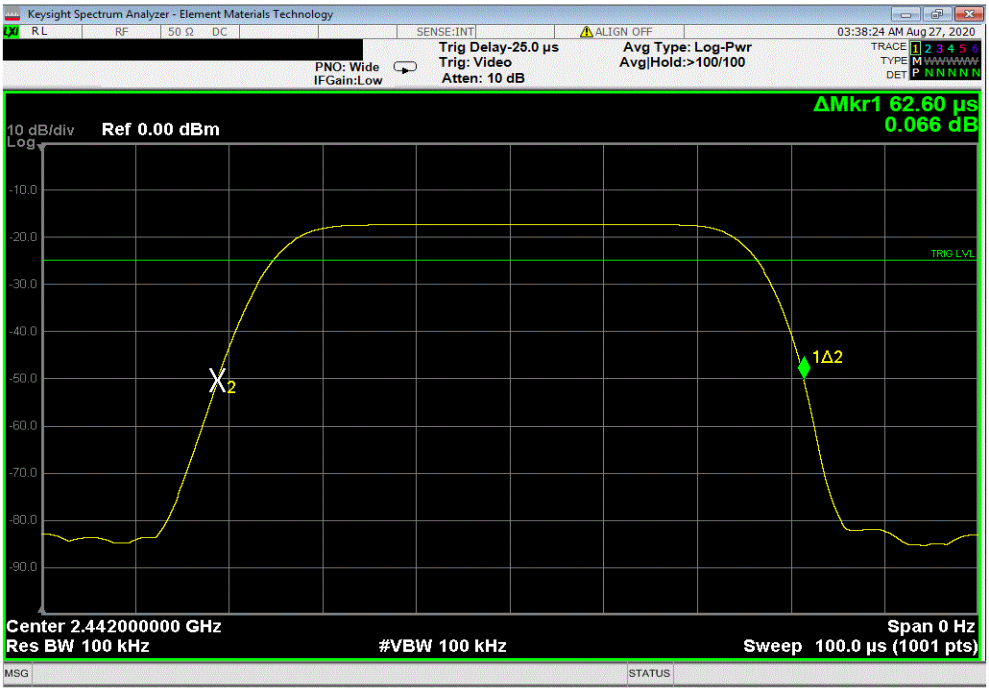
None

Configuration #	**2**	*Signature*

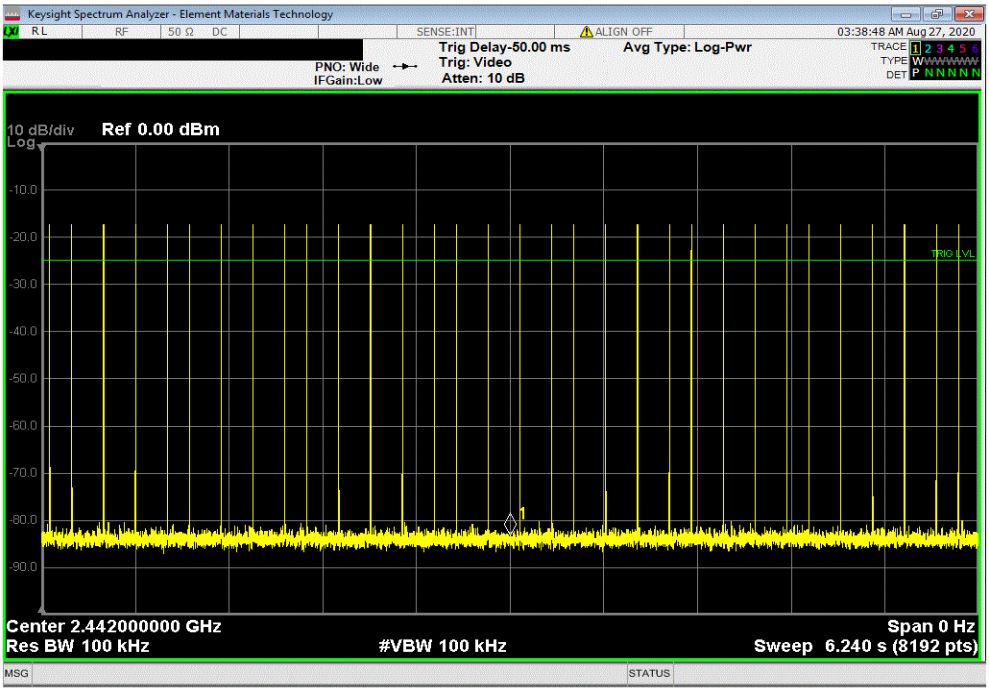
	Pulse Width (ms)	Number of Pulses	Average No. of Pulses	Scale Factor	On Time (ms) During 31.2 s	Limit (ms)	Results
Hopping Mode (All Channels)							
Antenna Port 1							
Mid Channel, 2442 MHz	0.063	N/A	N/A	N/A	N/A	N/A	N/A
Mid Channel, 2442 MHz	N/A	32	N/A	N/A	N/A	N/A	N/A
Mid Channel, 2442 MHz	N/A	32	N/A	N/A	N/A	N/A	N/A
Mid Channel, 2442 MHz	N/A	32	N/A	N/A	N/A	N/A	N/A
Mid Channel, 2442 MHz	N/A	32	N/A	N/A	N/A	N/A	N/A
Mid Channel, 2442 MHz	0.063	N/A	32	5	10.08	400	Pass

DWELL TIME

Hopping Mode (All Channels), Antenna Port 1, Mid Channel, 2442 MHz						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	Scale Factor	On Time (ms) During 31.2 s	Limit (ms)	Results
0.063	N/A	N/A	N/A	N/A	N/A	N/A

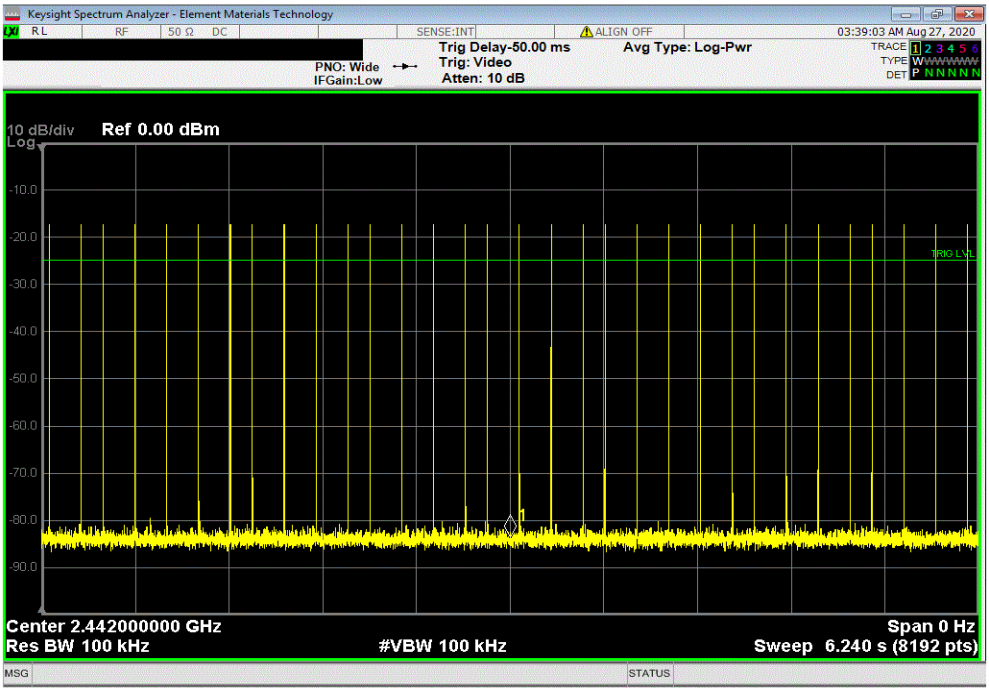


Hopping Mode (All Channels), Antenna Port 1, Mid Channel, 2442 MHz						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	Scale Factor	On Time (ms) During 31.2 s	Limit (ms)	Results
N/A	32	N/A	N/A	N/A	N/A	N/A

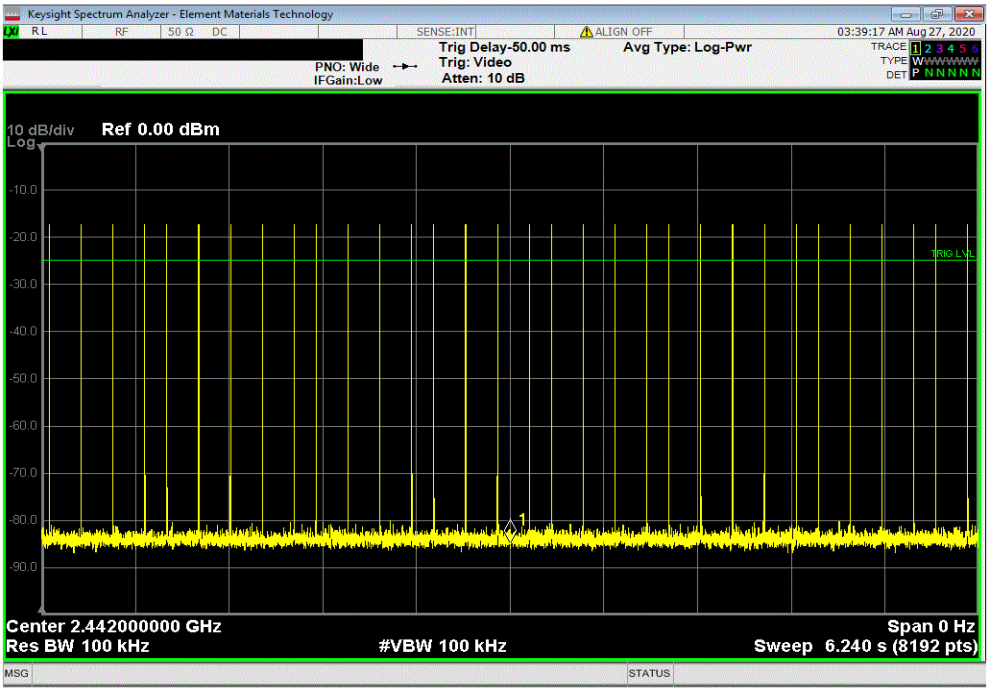


DWELL TIME

Hopping Mode (All Channels), Antenna Port 1, Mid Channel, 2442 MHz						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	Scale Factor	On Time (ms) During 31.2 s	Limit (ms)	Results
N/A	32	N/A	N/A	N/A	N/A	N/A

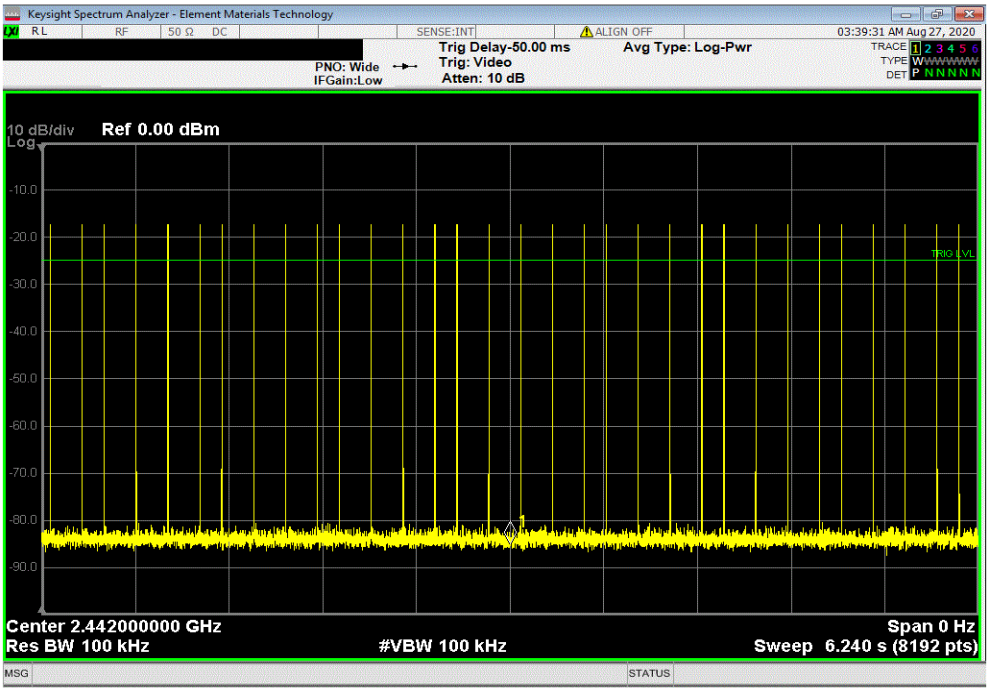


Hopping Mode (All Channels), Antenna Port 1, Mid Channel, 2442 MHz						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	Scale Factor	On Time (ms) During 31.2 s	Limit (ms)	Results
N/A	32	N/A	N/A	N/A	N/A	N/A



DWELL TIME

Hopping Mode (All Channels), Antenna Port 1, Mid Channel, 2442 MHz						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	Scale Factor	On Time (ms) During 31.2 s	Limit (ms)	Results
N/A	32	N/A	N/A	N/A	N/A	N/A



Hopping Mode (All Channels), Antenna Port 1, Mid Channel, 2442 MHz						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	Scale Factor	On Time (ms) During 31.2 s	Limit (ms)	Results
0.063	N/A	32	5	10.08	400	Pass

Calculation Only

No Screen Capture Required

OUTPUT POWER (HIGH CHANNEL)

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Fairview Microwave	SD3379	AMZ	4-Nov-20	4-Nov-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	14-Sep-20	14-Sep-21
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	14-Apr-20	14-Apr-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 (HIGH CHANNEL)

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9240**			**Date:**	**18-Dec-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**23.1 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**25.1% RH**
Project:	**None**			**Barometric Pres.:**	**1014 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

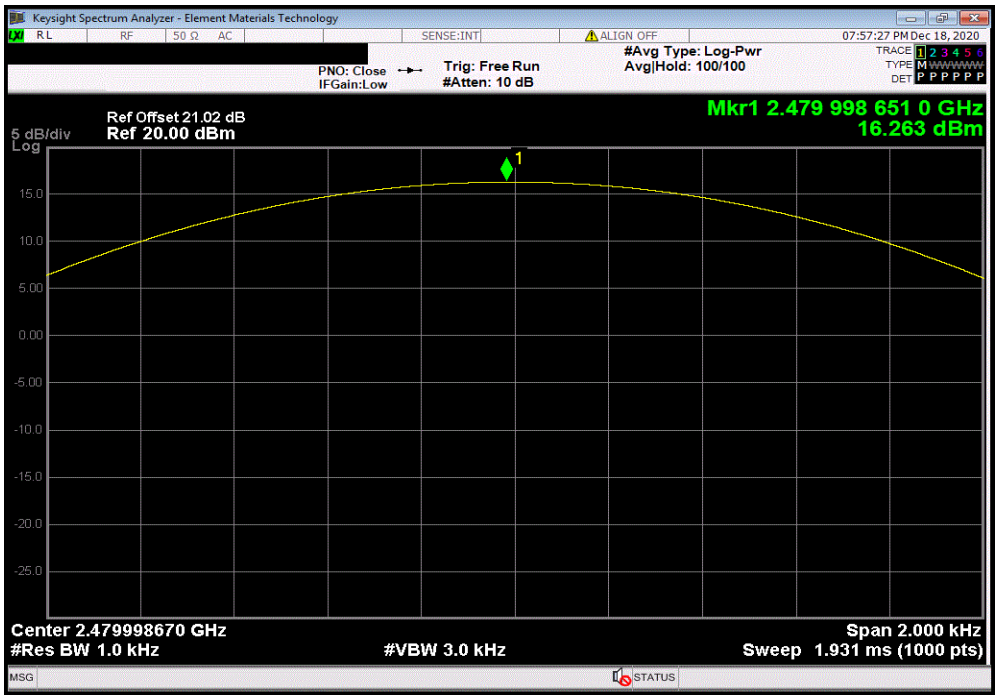
None

Configuration #	**7**	*Signature* Andrew Rogstad

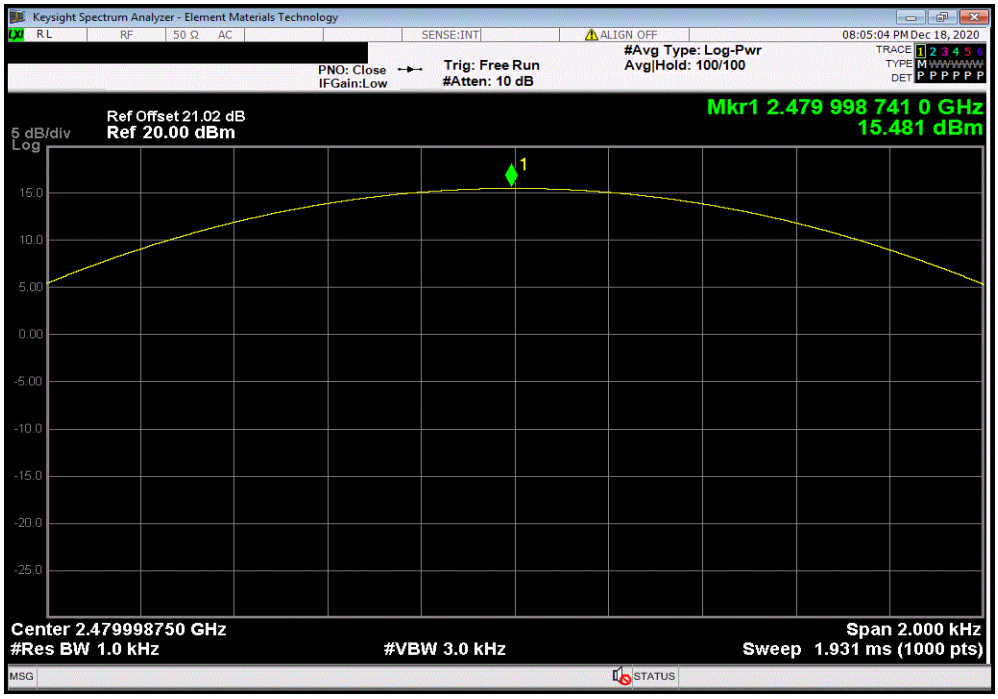
		Out Pwr (dBm)	**Limit (dBm)**	**Result**
Antenna Port 1				
	High Channel, 2480 MHz	16.263	21	Pass
Antenna Port 2				
	High Channel, 2480 MHz	15.481	21	Pass

OUTPUT POWER (HIGH CHANNEL)

Antenna Port 1, High Channel, 2480 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				16.263	21	Pass



Antenna Port 2, High Channel, 2480 MHz						
				Out Pwr (dBm)	Limit (dBm)	Result
				15.481	21	Pass



OUTPUT POWER

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	D150A-1-0720-200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

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

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**26-Aug-20**
Customer:	**MSA Safety**			**Temperature:**	**22.2 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**57.5% RH**
Project:	**None**			**Barometric Pres.:**	**1011 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

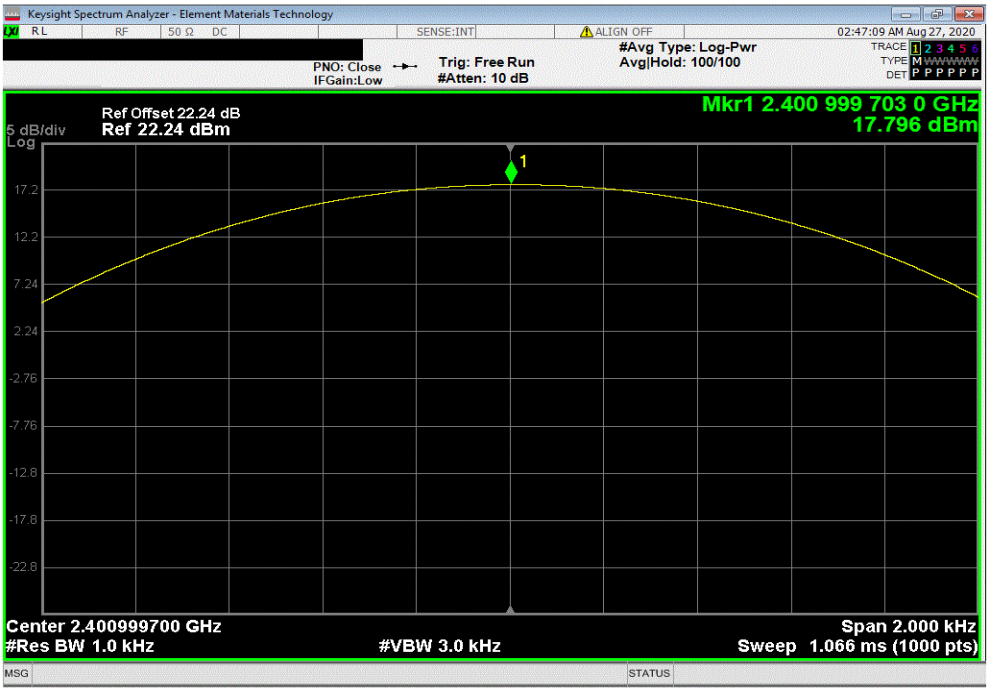
DEVIATIONS FROM TEST STANDARD

None

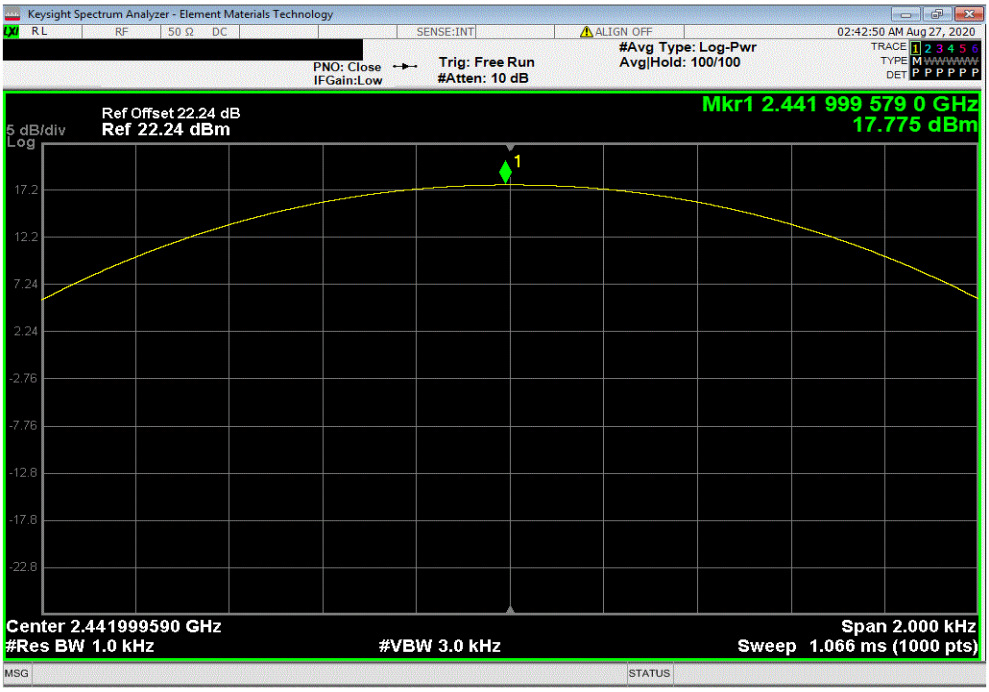
Configuration #	**2**	*Signature* Andrew Rogstad

		Out Pwr (dBm)	**Limit (dBm)**	**Result**
Antenna Port 1				
	Low Channel, 2401 MHz	17.796	21	Pass
	Mid Channel, 2442 MHz	17.775	21	Pass
Antenna Port 2				
	Low Channel, 2401 MHz	16.868	21	Pass
	Mid Channel, 2442 MHz	17.586	21	Pass

Antenna Port 1, Low Channel, 2401 MHz							
					Out Pwr (dBm)	Limit (dBm)	Result
					17.796	21	Pass

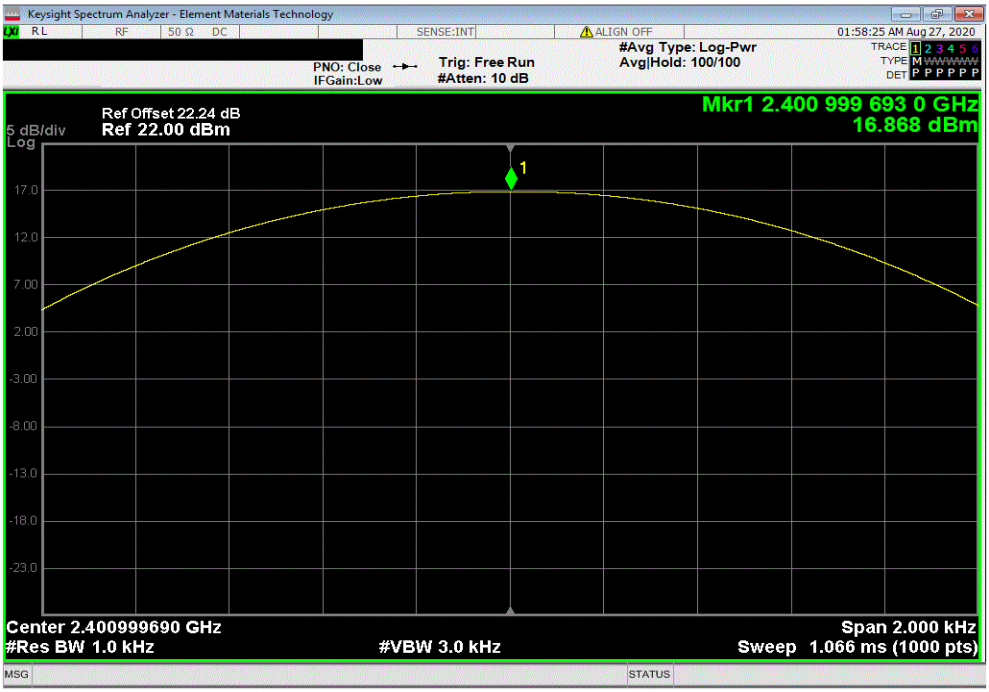


Antenna Port 1, Mid Channel, 2442 MHz							
					Out Pwr (dBm)	Limit (dBm)	Result
					17.775	21	Pass

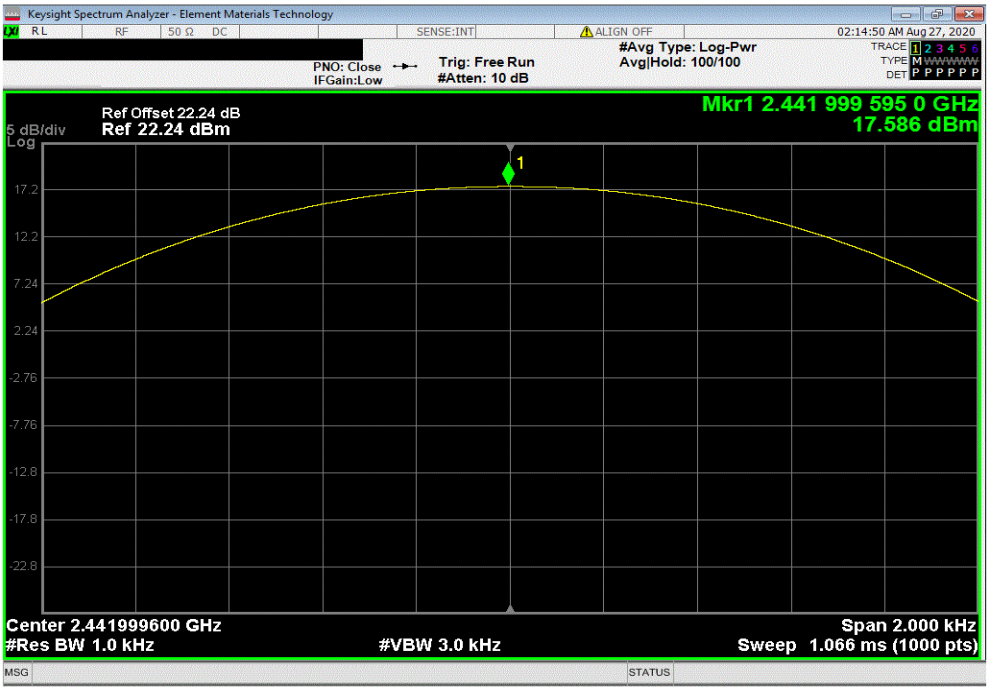


OUTPUT POWER

Antenna Port 2, Low Channel, 2401 MHz							
					Out Pwr (dBm)	Limit (dBm)	Result
					16.868	21	Pass



Antenna Port 2, Mid Channel, 2442 MHz							
					Out Pwr (dBm)	Limit (dBm)	Result
					17.586	21	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP) (HIGH CHANNEL)

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Fairview Microwave	SD3379	AMZ	4-Nov-20	4-Nov-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	14-Sep-20	14-Sep-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	14-Apr-20	14-Apr-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) (HIGH CHANNEL)

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	Lunar			**Work Order:**	MSAS0004
Serial Number:	9240			**Date:**	18-Dec-20
Customer:	MSA Innovation, LLC			**Temperature:**	23.1 °C
Attendees:	Dustin Morris			**Humidity:**	25.2% RH
Project:	None			**Barometric Pres.:**	1014 mbar
Tested by:	Andrew Rogstad	**Power:**	Battery	**Job Site:**	MN08

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

None

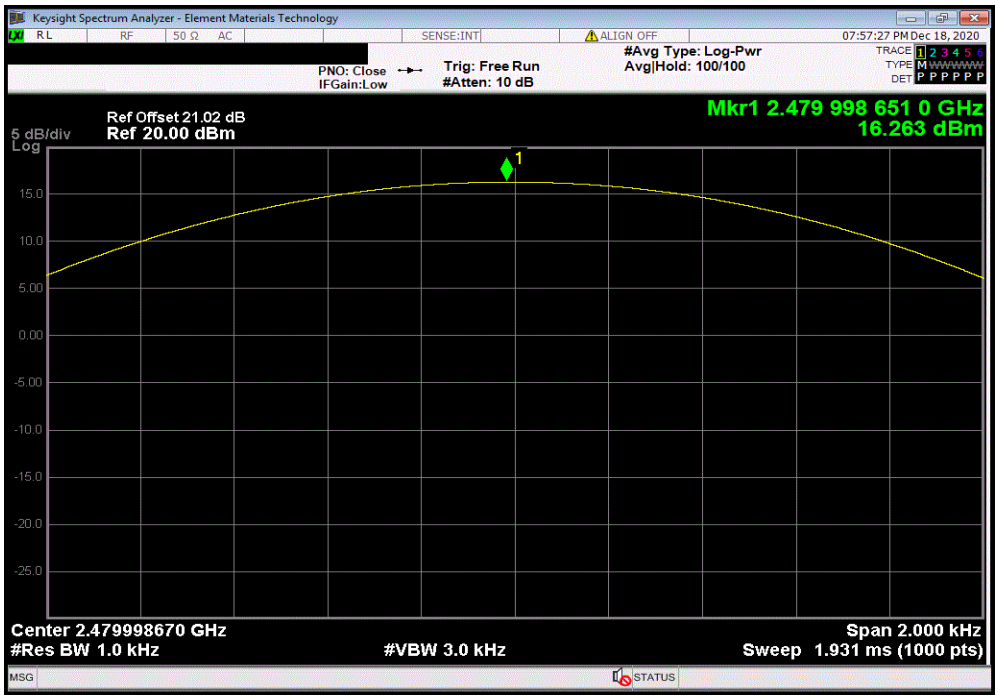
Configuration #	7	Signature

		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
Antenna Port 1						
	High Channel, 2480 MHz	16.263	1.1	17.363	27	Pass
Antenna Port 2						
	High Channel, 2480 MHz	15.481	-2.2	13.281	27	Pass

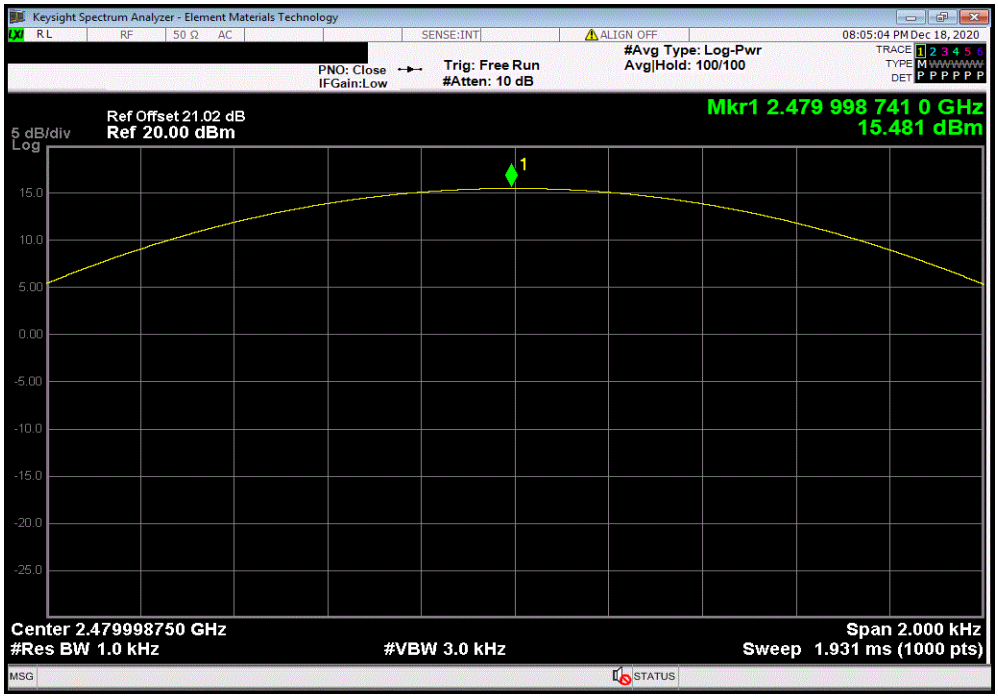
EQUIVALENT ISOTROPIC RADIATED POWER (EIRP) (HIGH CHANNEL)

TbtTx 2019.08.30.0 XMit 2020.03.25.0

Antenna Port 1, High Channel, 2480 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		16.263	1.1	17.363	27	Pass



Antenna Port 2, High Channel, 2480 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		15.481	-2.2	13.281	27	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
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	D150A-1-0720-200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

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:	Lunar			**Work Order:**	MSAS0004
Serial Number:	9628			**Date:**	26-Aug-20
Customer:	MSA Safety			**Temperature:**	22.3 °C
Attendees:	Dustin Morris			**Humidity:**	57.4% RH
Project:	None			**Barometric Pres.:**	1011 mbar
Tested by:	Andrew Rogstad	**Power:**	Battery	**Job Site:**	MN08

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

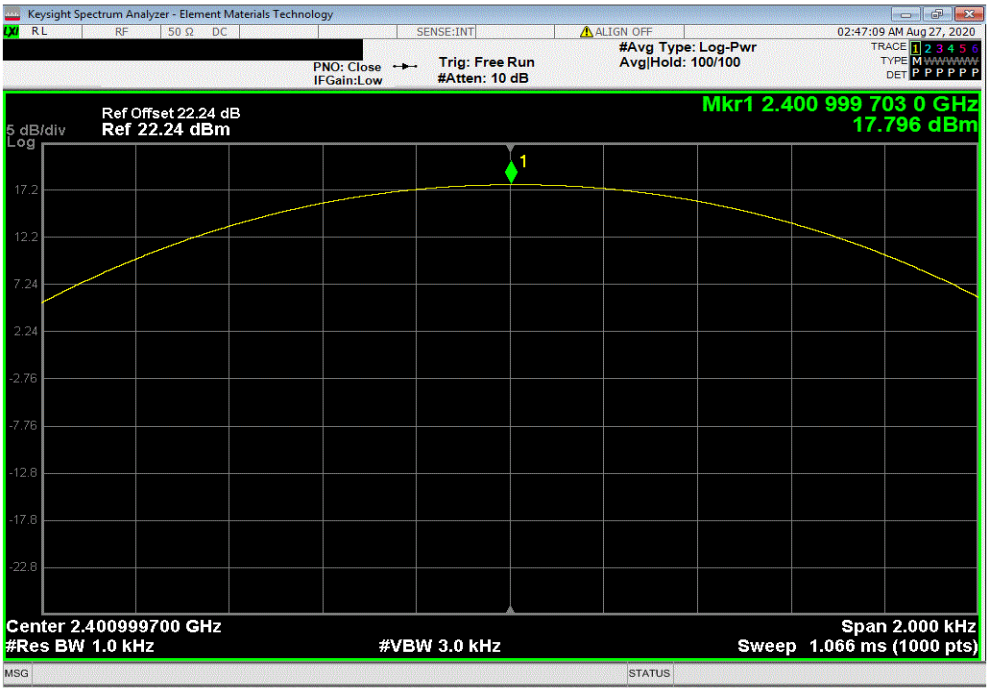
None

Configuration #	**2**	*Signature*

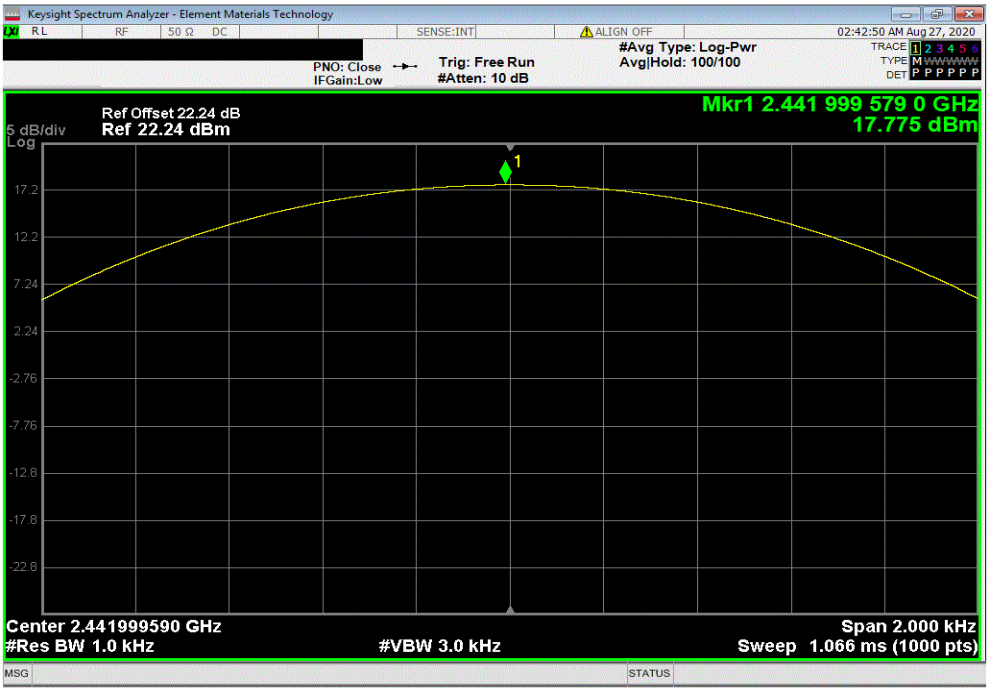
	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
Antenna Port 1					
Low Channel, 2401 MHz	17.796	1.3	19.096	27	Pass
Mid Channel, 2442 MHz	17.775	2.3	20.075	27	Pass
Antenna Port 2					
Low Channel, 2401 MHz	16.868	1.3	18.168	27	Pass
Mid Channel, 2442 MHz	17.586	-0.8	16.786	27	Pass

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

Antenna Port 1, Low Channel, 2401 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		17.796	1.3	19.096	27	Pass

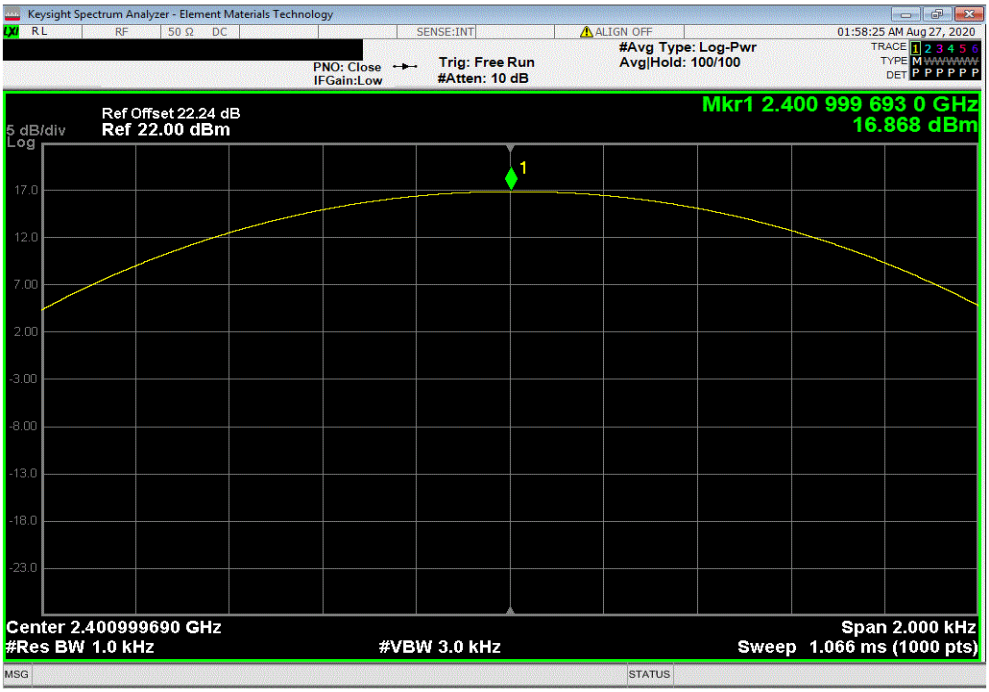


Antenna Port 1, Mid Channel, 2442 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		17.775	2.3	20.075	27	Pass

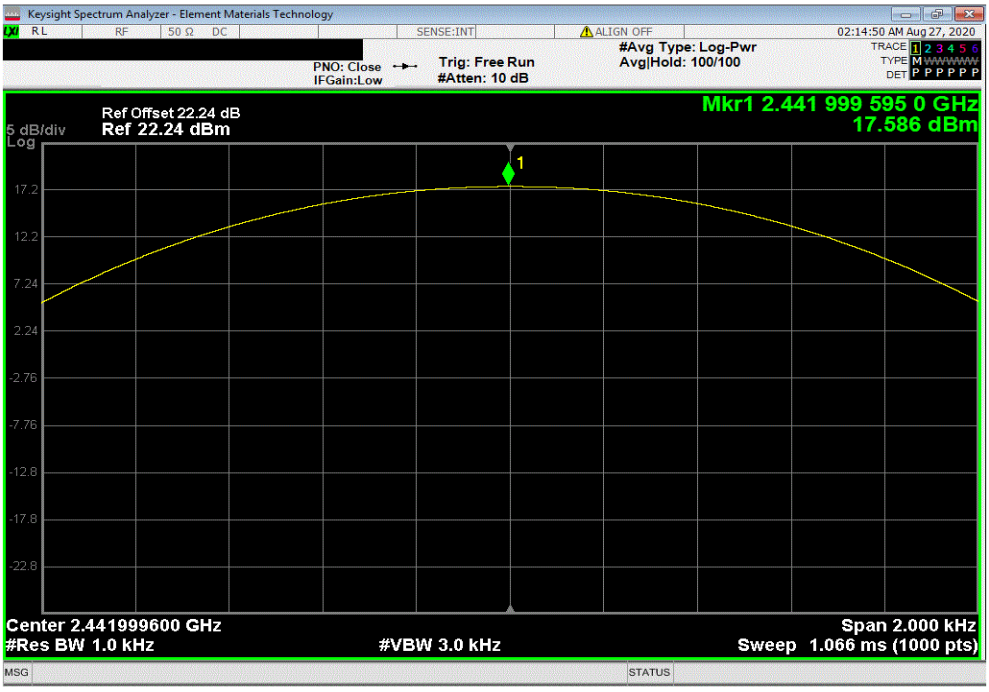


EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

Antenna Port 2, Low Channel, 2401 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		16.868	1.3	18.168	27	Pass



Antenna Port 2, Mid Channel, 2442 MHz						
		Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		17.586	-0.8	16.786	27	Pass



BAND EDGE COMPLIANCE (HIGH CHANNEL)

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Fairview Microwave	SD3379	AMZ	4-Nov-20	4-Nov-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	14-Sep-20	14-Sep-21
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	14-Apr-20	14-Apr-21

TEST DESCRIPTION

The 20 dB occupied bandwidth was measured with the EUT set to low, medium and high transmit frequencies in the band. The EUT was transmitting at the data rate(s) listed in the datasheet in a no-hop mode.

BAND EDGE COMPLIANCE (HIGH CHANNEL)

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9240**			**Date:**	**18-Dec-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**23.1 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**25.3% RH**
Project:	**None**			**Barometric Pres.:**	**1014 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

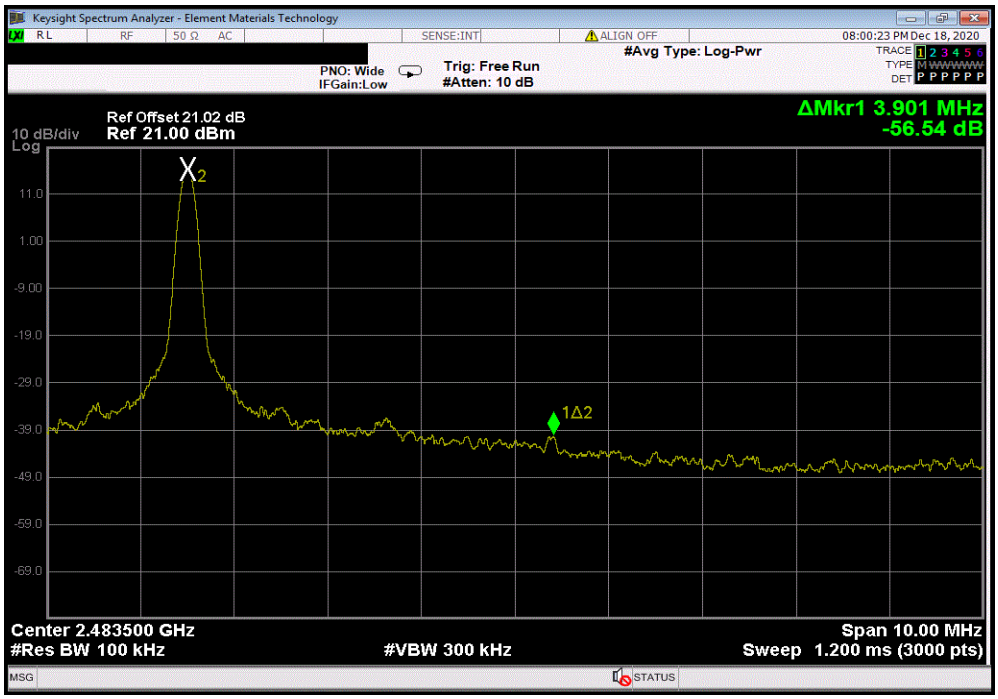
None

Configuration #	**7**	*Signature* Andrew Rogstad

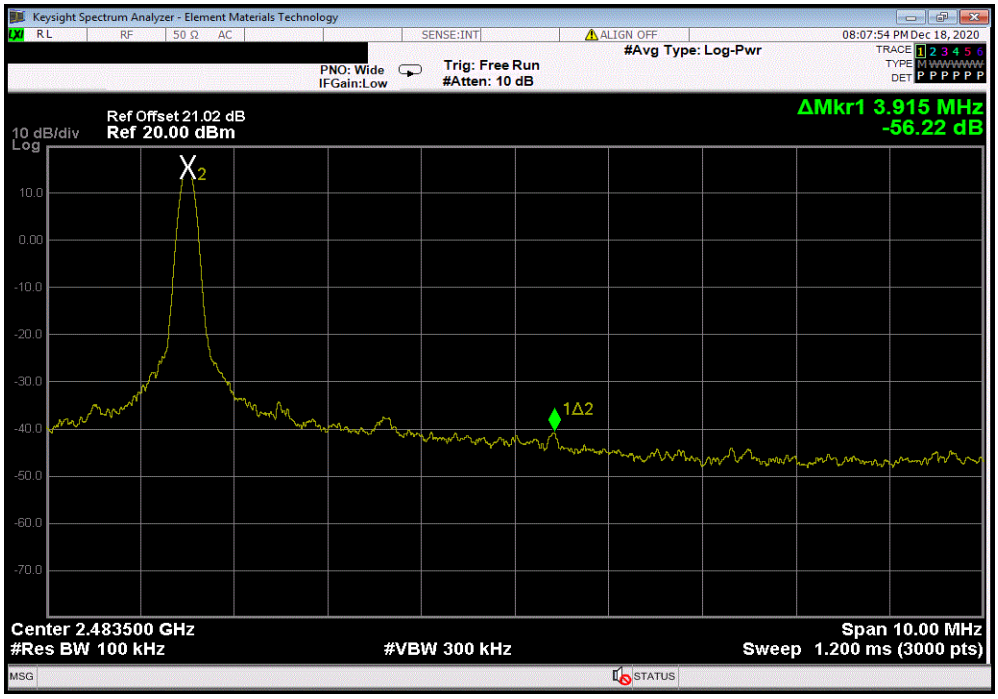
		Value (dBc)	**Limit ≤ (dBc)**	**Result**
Antenna Port 1				
	High Channel, 2480 MHz	-56.54	-20	Pass
Antenna Port 2				
	High Channel, 2480 MHz	-56.22	-20	Pass

BAND EDGE COMPLIANCE (HIGH CHANNEL)

Antenna Port 1, High Channel, 2480 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-56.54	-20	Pass



Antenna Port 2, High Channel, 2480 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-56.22	-20	Pass



BAND EDGE COMPLIANCE (LOW CHANNEL)

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
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

The spurious RF conducted emissions at the edges of the authorized band were measured with the EUT set to low and high transmit frequencies. The EUT was transmitting at the data rate(s) listed in the datasheet in a no hop mode. The channels closest to the band edges were selected.

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

BAND EDGE COMPLIANCE (LOW CHANNEL)

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**26-Aug-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**22.3 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**57.3% RH**
Project:	**None**			**Barometric Pres.:**	**1011 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

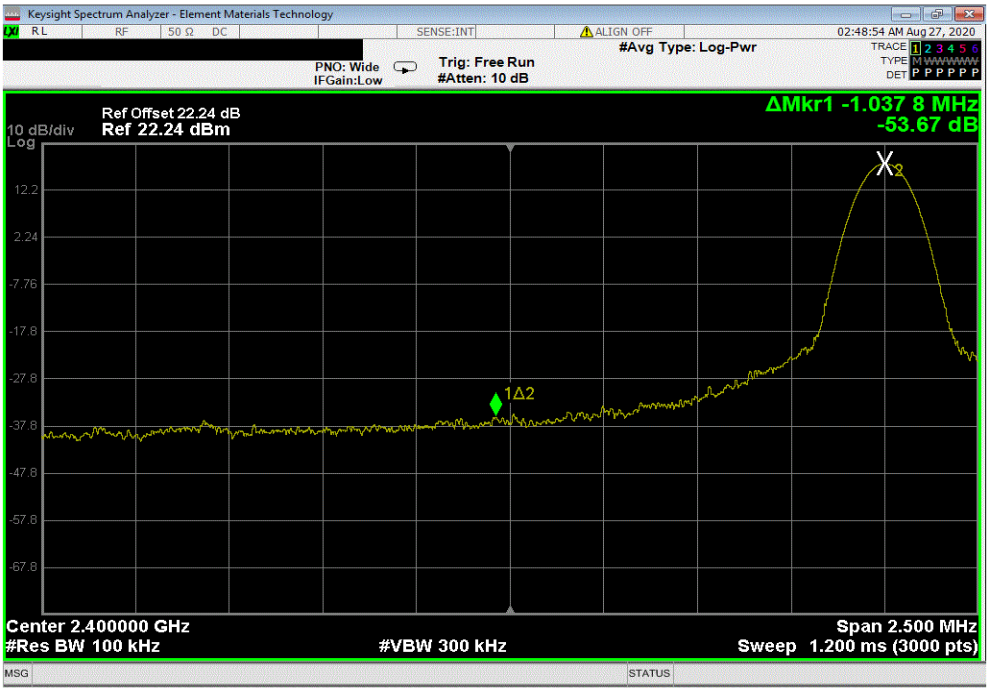
None

Configuration #	**2**	*Signature* Andrew Rogstad

		Value (dBc)	**Limit ≤ (dBc)**	**Result**
Antenna Port 1				
	Low Channel, 2401 MHz	-53.67	-20	Pass
Antenna Port 2				
	Low Channel, 2401 MHz	-52.86	-20	Pass

BAND EDGE COMPLIANCE (LOW CHANNEL)

Antenna Port 1, Low Channel, 2401 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-53.67	-20	Pass



Antenna Port 2, Low Channel, 2401 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-52.86	-20	Pass

BAND EDGE COMPLIANCE -HOPPING MODE

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
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

The spurious RF conducted emissions at the edges of the authorized band were measured with the EUT set to its normal pseudo-random hopping sequence. 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 -HOPPING MODE

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	Lunar			**Work Order:**	MSAS0004
Serial Number:	9628			**Date:**	26-Aug-20
Customer:	MSA Innovation, LLC			**Temperature:**	22.2 °C
Attendees:	Dustin Morris			**Humidity:**	57.6% RH
Project:	None			**Barometric Pres.:**	1011 mbar
Tested by:	Andrew Rogstad	**Power:**	Battery	**Job Site:**	MN08

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

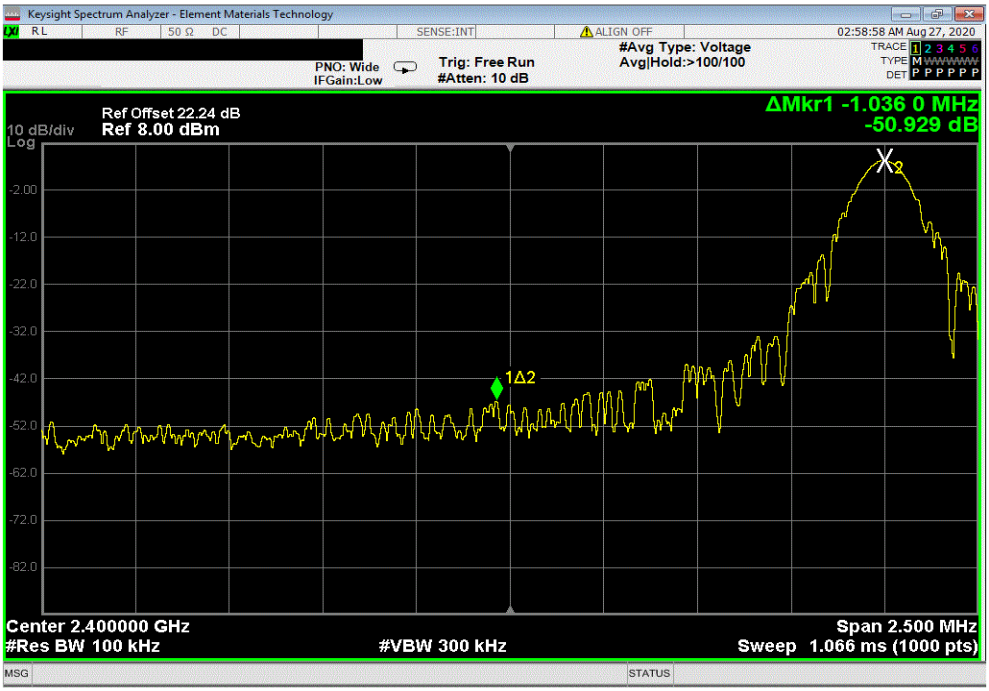
None

Configuration #	2	Signature

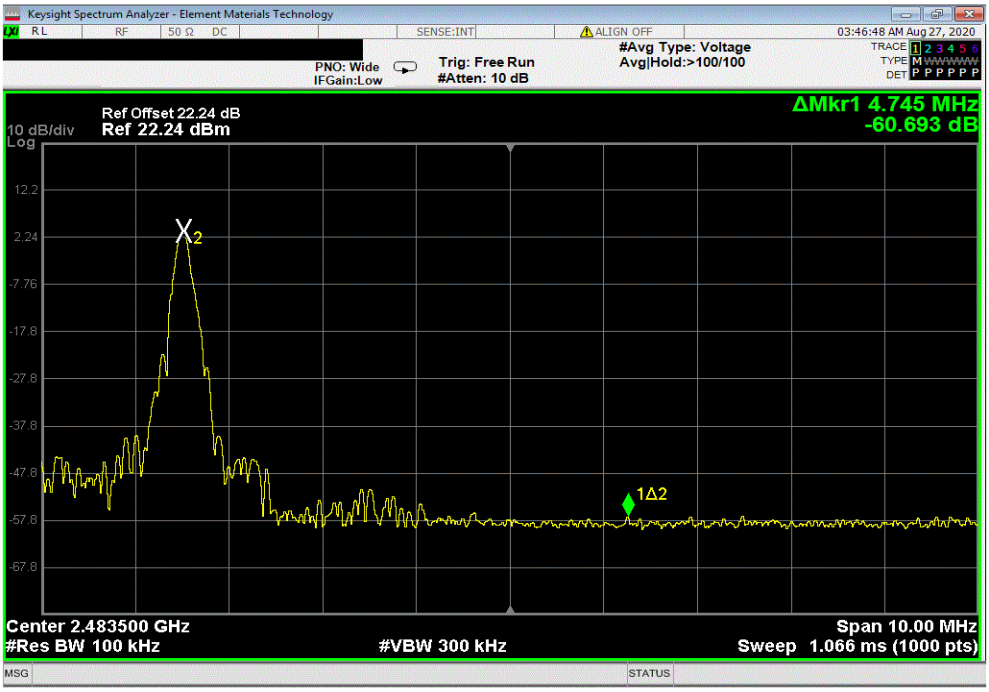
	Value (dBc)	Limit ≤ (dBc)	Result
Hopping Mode (All Channels)			
Antenna Port 1			
Low Channel, 2401 MHz	-50.93	-20	Pass
High Channel, 2480 MHz	-60.69	-20	Pass

BAND EDGE COMPLIANCE -HOPPING MODE

Hopping Mode (All Channels), Antenna Port 1, Low Channel, 2401 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-50.93	-20	Pass



Hopping Mode (All Channels), Antenna Port 1, High Channel, 2480 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-60.69	-20	Pass



OCCUPIED BANDWIDTH (HIGH CHANNEL)

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Fairview Microwave	SD3379	AMZ	4-Nov-20	4-Nov-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	14-Sep-20	14-Sep-21
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	14-Apr-20	14-Apr-21

TEST DESCRIPTION

The 20 dB occupied bandwidth was measured with the EUT set to low, medium and high transmit frequencies in the band. The EUT was transmitting at the data rate(s) listed in the datasheet in a no-hop mode.

OCCUPIED BANDWIDTH (HIGH CHANNEL)

XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9240**			**Date:**	**18-Dec-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**22.9 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**25% RH**
Project:	**None**			**Barometric Pres.:**	**1014 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

Reference level offset includes measurement cable, attenuator, and DC block. The EUT uses a CW signal when in FHSS mode. Screenshots were taken to reflect that a CW signal was used during testing.

DEVIATIONS FROM TEST STANDARD

None

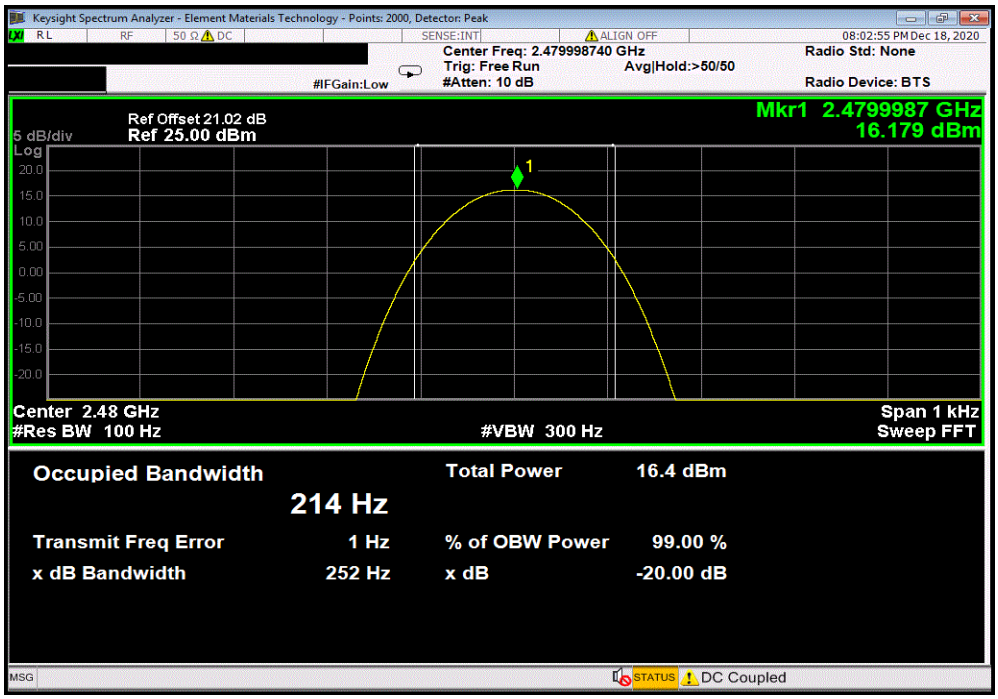
Configuration #	**7**	*Signature* Andrew Rogstad

		Value (Hz)	**Limit**	**Result**
Antenna Port 1				
	High channel, 2480 MHz	252	N/A	Pass
Antenna Port 2				
	High channel, 2480 MHz	253	N/A	Pass

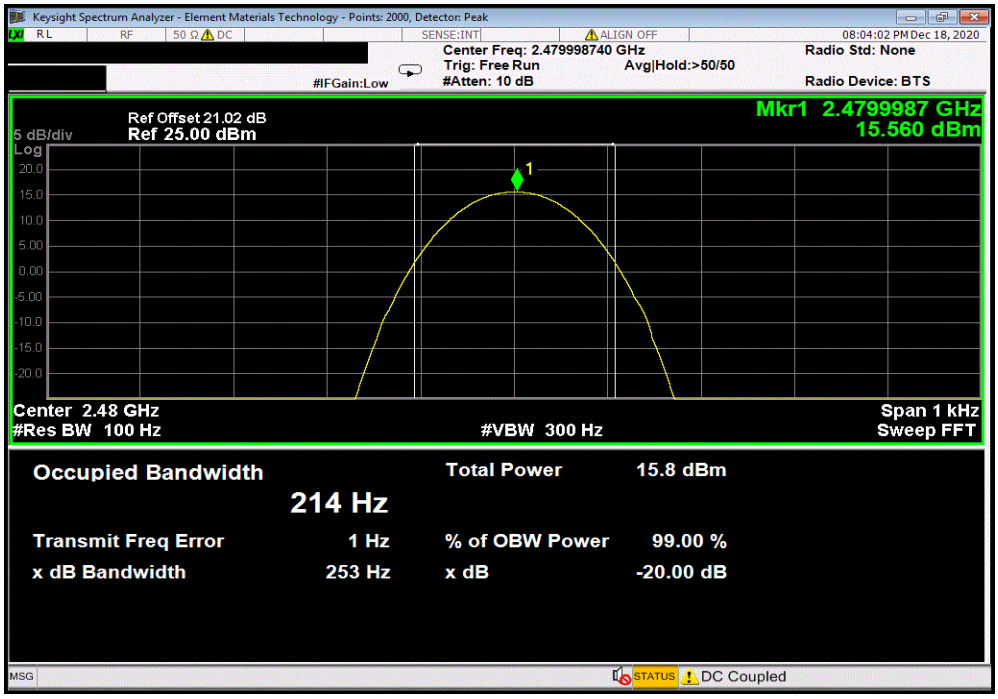
OCCUPIED BANDWIDTH (HIGH CHANNEL)

XMit 2020.03.25.0

Antenna Port 1, High channel, 2480 MHz						
				Value (Hz)	Limit	Result
				252	N/A	Pass



Antenna Port 2, High channel, 2480 MHz						
				Value (Hz)	Limit	Result
				253	N/A	Pass



OCCUPIED BANDWIDTH

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	D150A-1-0720-200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

The 20 dB occupied bandwidth was measured with the EUT set to low, medium and high transmit frequencies in the band. The EUT was transmitting at the data rate(s) listed in the datasheet in a no-hop mode.

OCCUPIED BANDWIDTH

XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**26-Aug-20**
Customer:	**MSA Safety**			**Temperature:**	**22.2 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**57.8% RH**
Project:	**None**			**Barometric Pres.:**	**1011 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

Reference level offset includes measurement cable, DC block, and 20 dB attenuator. The EUT uses a CW signal when in FHSS mode. Screenshots were taken to reflect that a CW signal was used during testing.

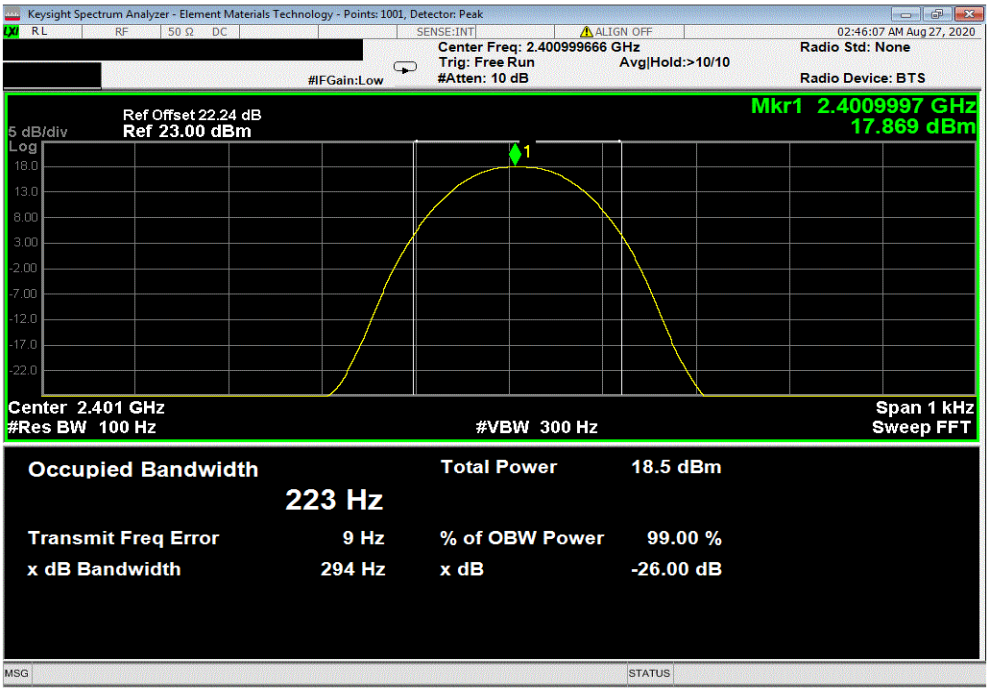
DEVIATIONS FROM TEST STANDARD

None

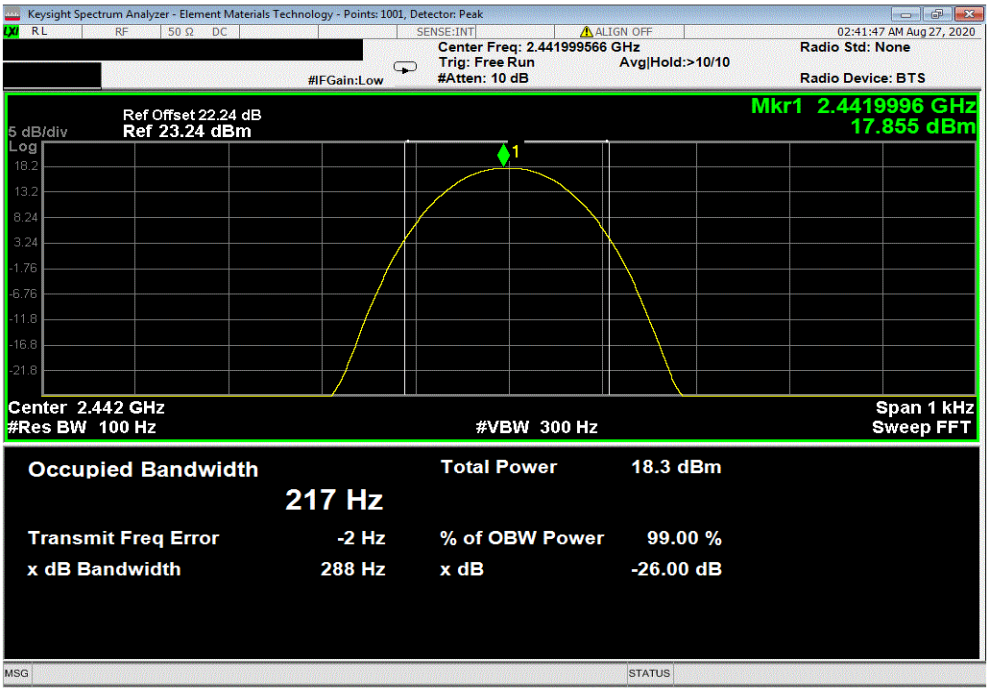
Configuration #	**2**	*Signature*

		Value (Hz)	**Limit**	**Result**
Antenna Port 1				
	Low channel, 2401 MHz	294	N/A	Pass
	Mid channel, 2442 MHz	288	N/A	Pass
Antenna Port 2				
	Low channel, 2401 MHz	273	N/A	Pass
	Mid channel, 2442 MHz	274	N/A	Pass

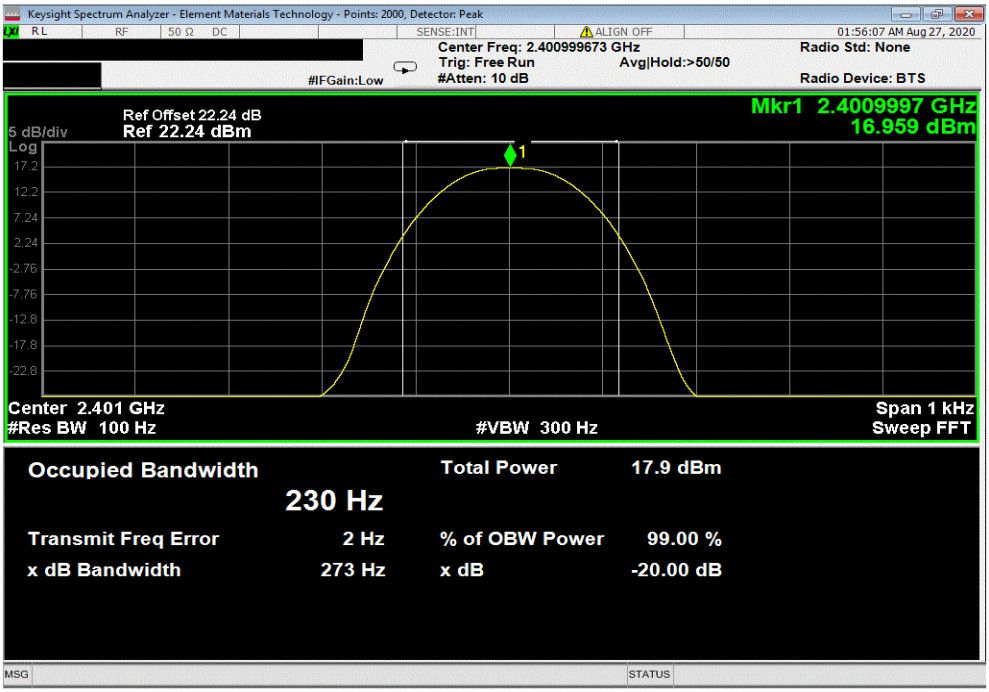
Antenna Port 1, Low channel, 2401 MHz						
				Value (Hz)	Limit	Result
				294	N/A	Pass



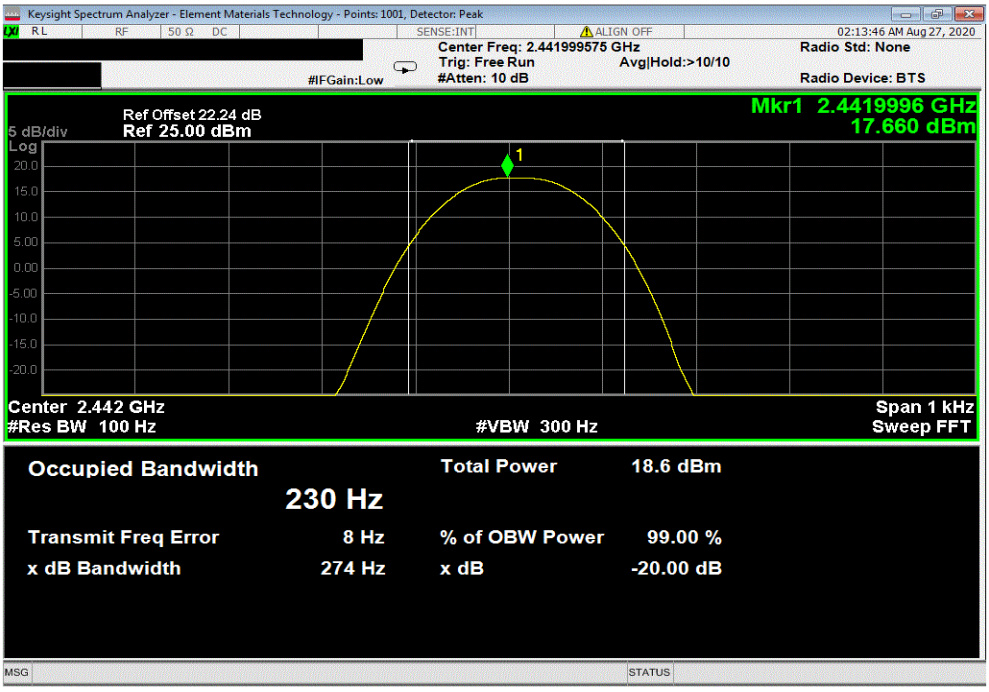
Antenna Port 1, Mid channel, 2442 MHz						
				Value (Hz)	Limit	Result
				288	N/A	Pass



Antenna Port 2, Low channel, 2401 MHz						
				Value (Hz)	Limit	Result
				273	N/A	Pass



Antenna Port 2, Mid channel, 2442 MHz						
				Value (Hz)	Limit	Result
				274	N/A	Pass



OCCUPIED CHANNEL BANDWIDTH (OOK Modulation)

XMit 2020.12.30.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Agilent	N5183A	TIK	2019-04-30	2022-04-30
Cable	Micro-Coax	D150A-1-0720-200	MNL	2020-09-14	2021-09-14
Attenuator	Fairview Microwave	18B5W-26	RFY	2020-06-03	2021-06-03
Block - DC	Fairview Microwave	SD3379	AMZ	2020-11-04	2021-11-04
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2020-07-14	2021-07-14

TEST DESCRIPTION

The 20 dB occupied bandwidth was measured with the EUT set to low, medium and high transmit frequencies in the band. The EUT was transmitting at the data rate(s) listed in the datasheet in a no-hop mode.

OCCUPIED CHANNEL BANDWIDTH (OOK Modulation)

TbtTx 2019.08.30.0 XMit 2020.12.30.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**1726**			**Date:**	**2-Mar-21**
Customer:	**MSA Safety**			**Temperature:**	**23.4 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**20.6% RH**
Project:	**None**			**Barometric Pres.:**	**1014 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**Battery**	**Job Site:**	**MN08**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2021	ANSI C63.10:2013

COMMENTS

EUT transmits a CW signal using OOK modulation. Resolution bandwidth was set to 1 kHz and span was set to 200 kHz in order to show a worst-case bandwidth and establish consistency.

DEVIATIONS FROM TEST STANDARD

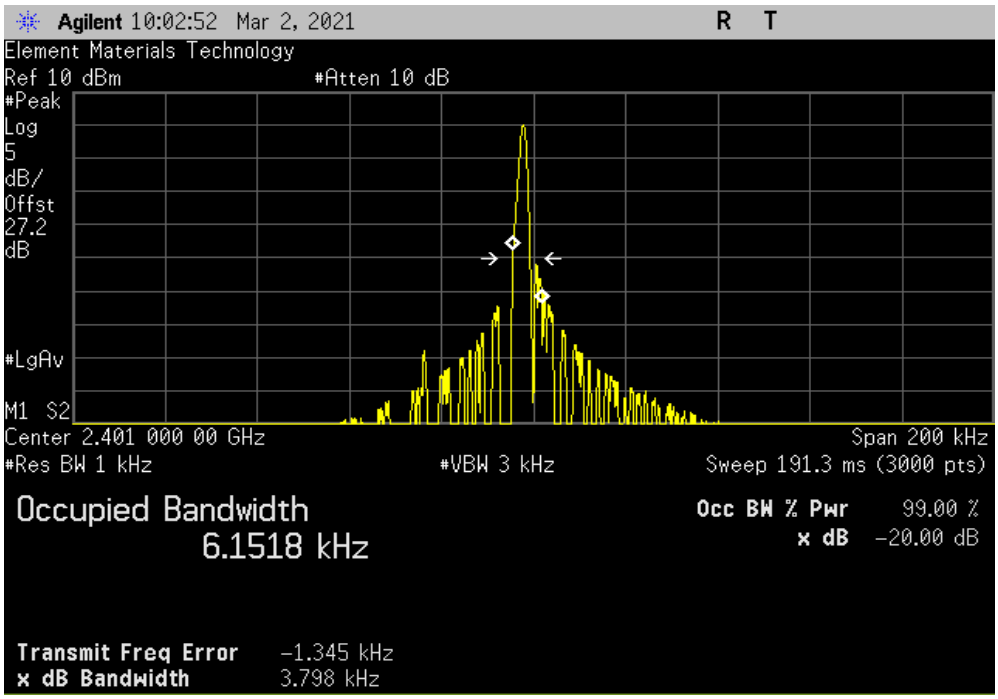
None

Configuration #	**15**	*Signature* Dustin Sparks

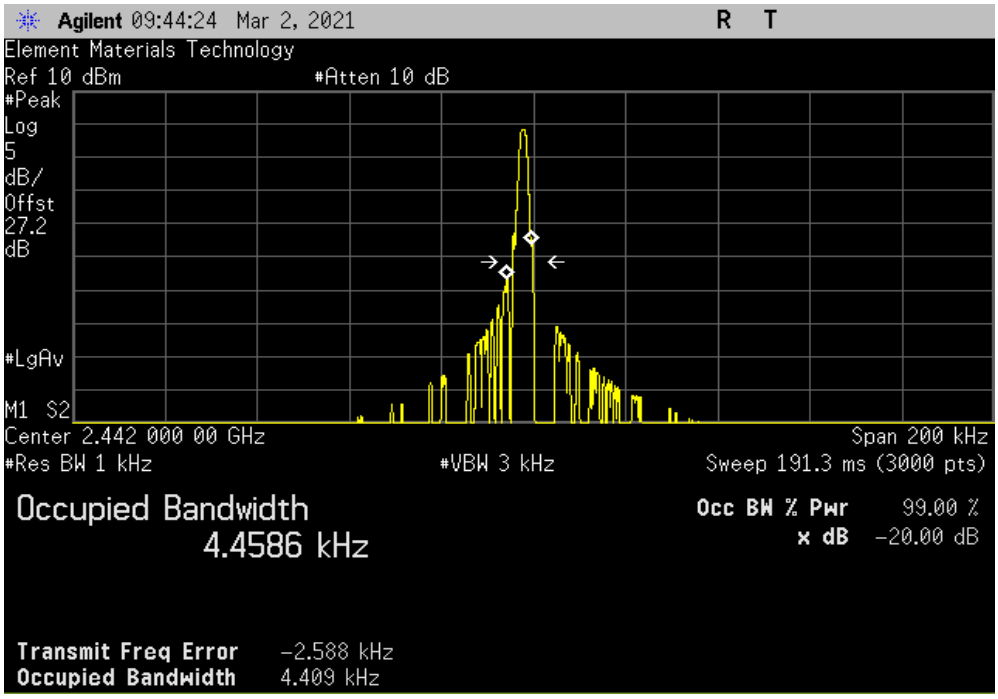
		Value	**Limit (≤)**	**Result**
Antenna 1				
	Low Channel, 2401 MHz	3.797 kHz	1.5 MHz	Pass
	Mid Channel, 2442 MHz	4.409 kHz	1.5 MHz	Pass
	High Channel, 2481 MHz	4.548 kHz	1.5 MHz	Pass
Antenna 2				
	Low Channel, 2401 MHz	3.758 kHz	1.5 MHz	Pass
	Mid Channel, 2442 MHz	3.845 kHz	1.5 MHz	Pass
	High Channel, 2481 MHz	4.921 kHz	1.5 MHz	Pass

OCCUPIED CHANNEL BANDWIDTH (OOK Modulation)

Antenna 1, Low Channel, 2401 MHz						
				Value	Limit (≤)	Result
				3.797 kHz	1.5 MHz	Pass

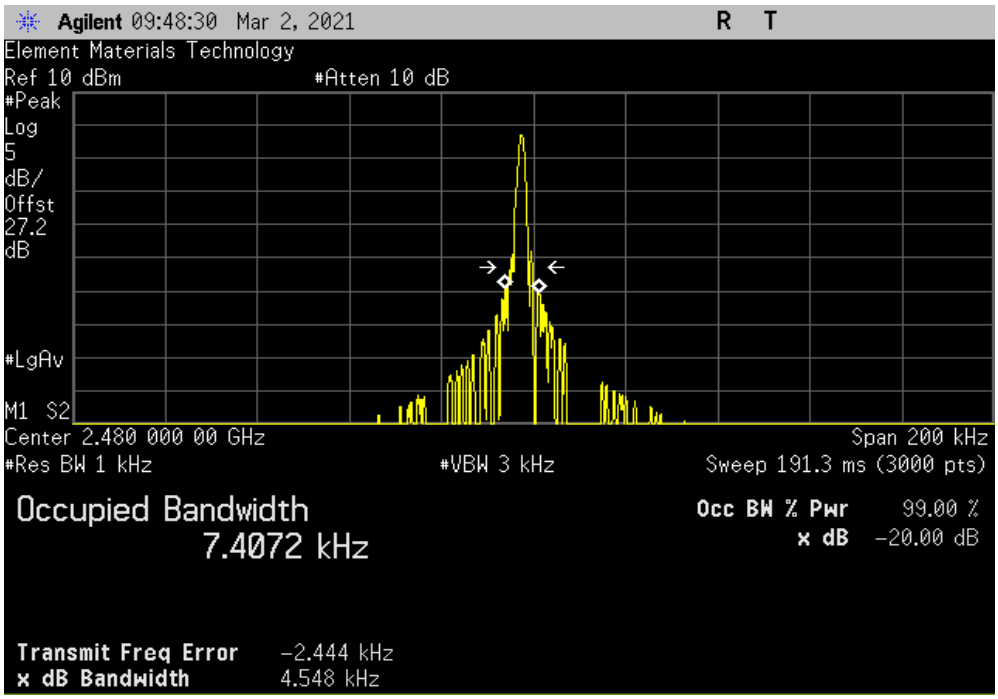


Antenna 1, Mid Channel, 2442 MHz						
				Value	Limit (≤)	Result
				4.409 kHz	1.5 MHz	Pass

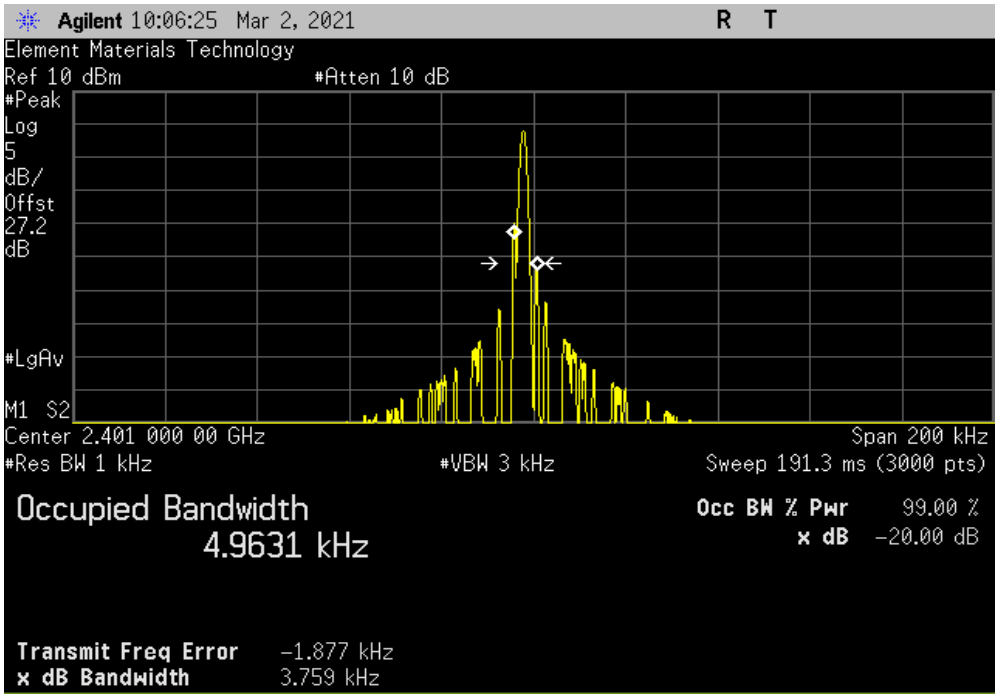


OCCUPIED CHANNEL BANDWIDTH (OOK Modulation)

Antenna 1, High Channel, 2481 MHz						
				Value	Limit (≤)	Result
				4.548 kHz	1.5 MHz	Pass

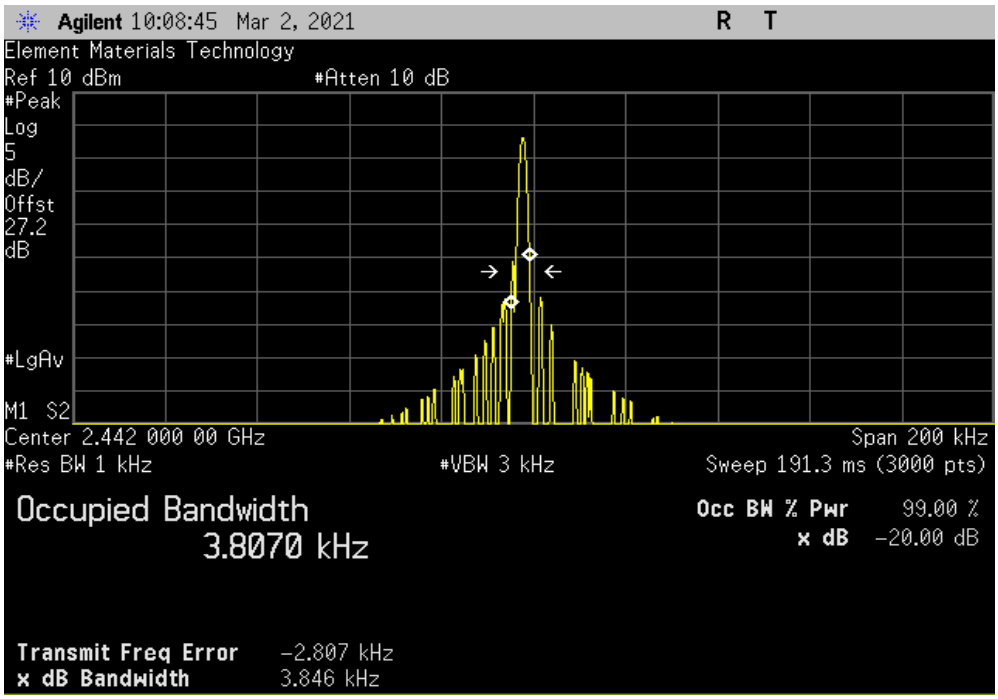


Antenna 2, Low Channel, 2401 MHz						
				Value	Limit (≤)	Result
				3.758 kHz	1.5 MHz	Pass

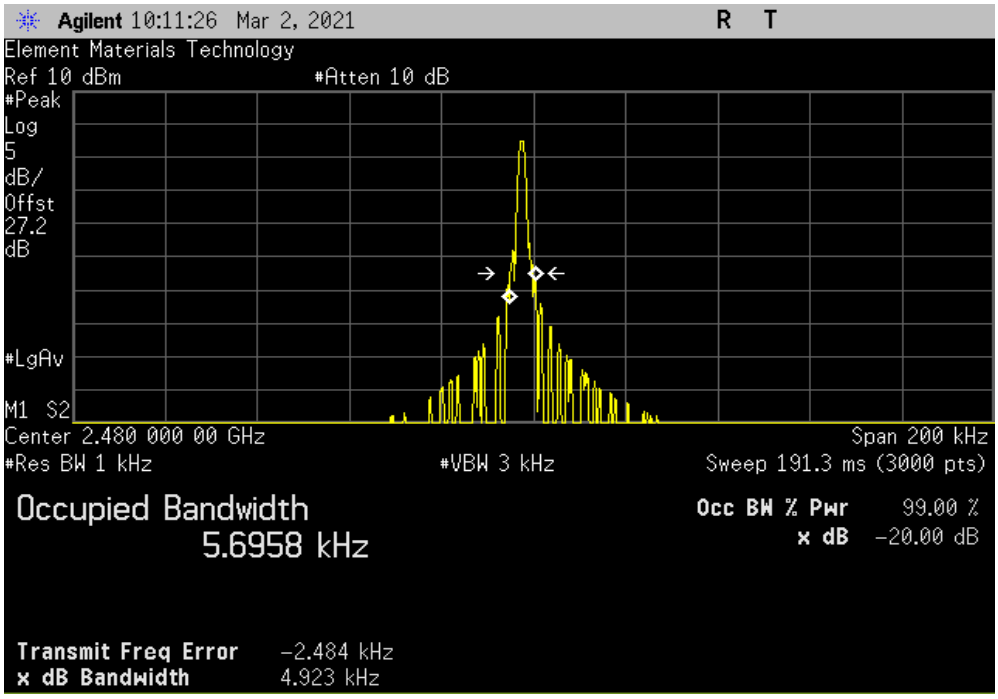


OCCUPIED CHANNEL BANDWIDTH (OOK Modulation)

Antenna 2, Mid Channel, 2442 MHz						
				Value	Limit (≤)	Result
				3.845 kHz	1.5 MHz	Pass



Antenna 2, High Channel, 2481 MHz						
				Value	Limit (≤)	Result
				4.921 kHz	1.5 MHz	Pass



SPURIOUS CONDUCTED EMISSIONS (HIGH CHANNEL)

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
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Block - DC	Fairview Microwave	SD3379	AMZ	4-Nov-20	4-Nov-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	14-Sep-20	14-Sep-21
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	14-Apr-20	14-Apr-21

TEST DESCRIPTION

The spurious RF conducted emissions were measured with the EUT set to low, medium and high transmit frequencies. The EUT was transmitting at the data rate(s) listed in the datasheet in a no-hop mode. For each transmit frequency, the spectrum was scanned throughout the specified frequency range.

SPURIOUS CONDUCTED EMISSIONS (HIGH CHANNEL)

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9240**			**Date:**	**18-Dec-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**23.1 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**25.2% RH**
Project:	**None**			**Barometric Pres.:**	**1014 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

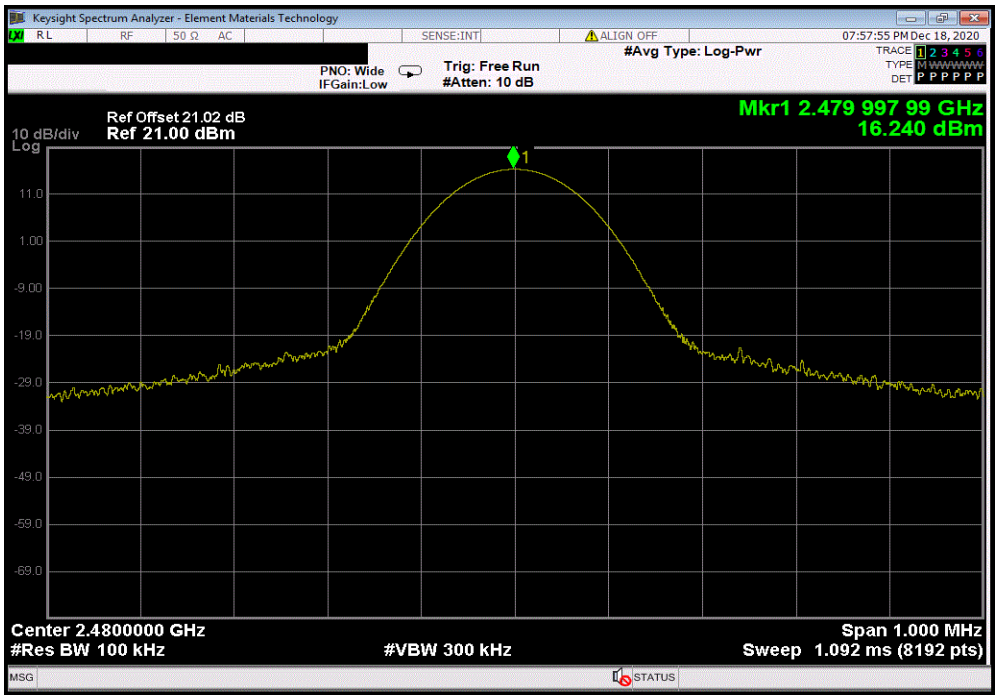
None

Configuration #	**7**	*Signature* 

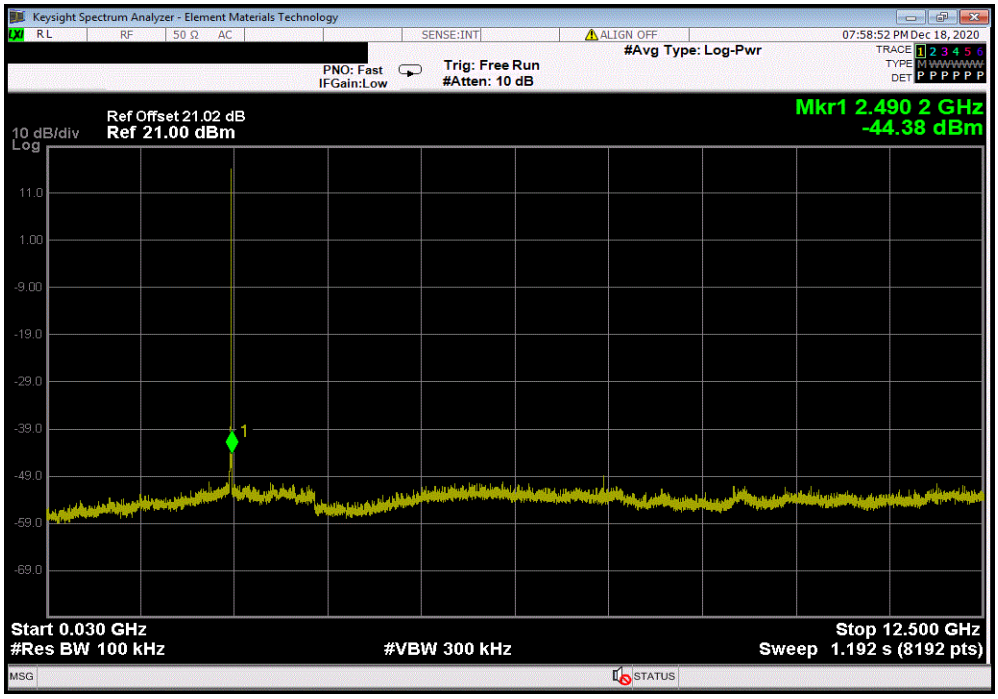
		Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Antenna Port 1						
	High Channel, 2480 MHz	Fundamental	2480	N/A	N/A	N/A
	High Channel, 2480 MHz	30 MHz - 12.5 GHz	2490.2	-60.62	-20	Pass
	High Channel, 2480 MHz	12.5 GHz - 25 GHz	24928.27	-55.96	-20	Pass
Antenna Port 2						
	High Channel, 2480 MHz	Fundamental	2480	N/A	N/A	N/A
	High Channel, 2480 MHz	30 MHz - 12.5 GHz	2490.2	-60.71	-20	Pass
	High Channel, 2480 MHz	12.5 GHz - 25 GHz	24786.35	-54.71	-20	Pass

SPURIOUS CONDUCTED EMISSIONS (HIGH CHANNEL)

Antenna Port 1, High Channel, 2480 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2480	N/A	N/A	N/A

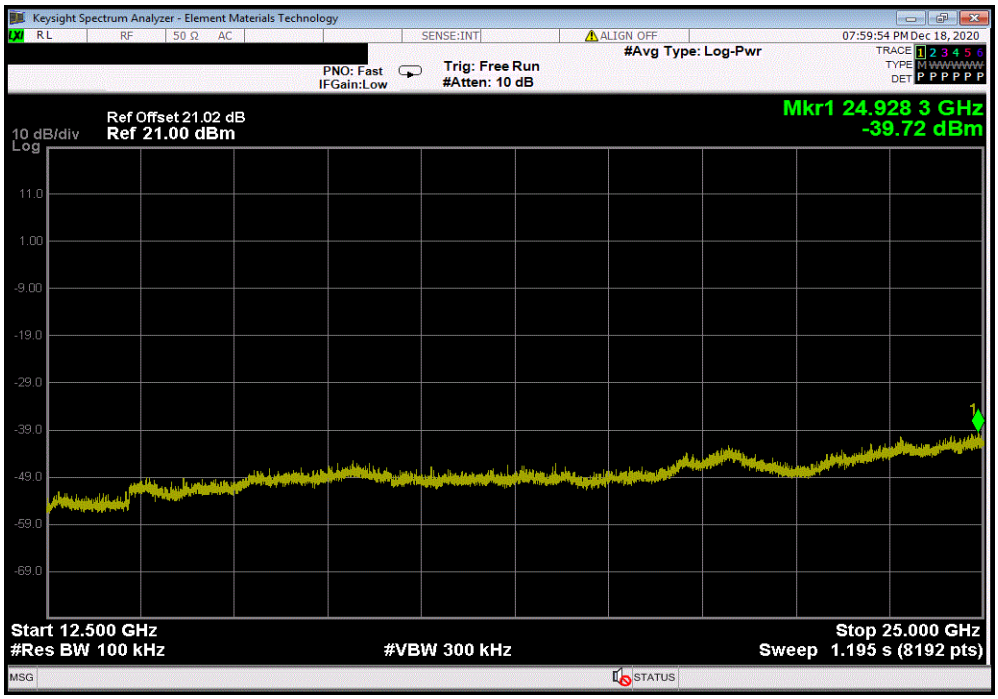


Antenna Port 1, High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	2490.2	-60.62	-20	Pass

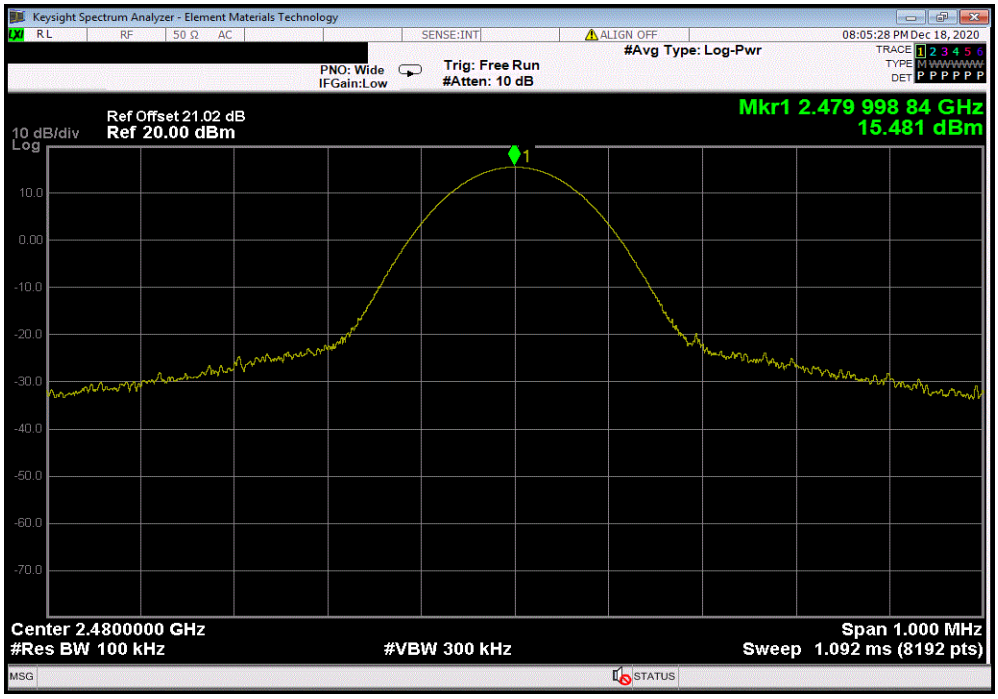


SPURIOUS CONDUCTED EMISSIONS (HIGH CHANNEL)

Antenna Port 1, High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	24928.27	-55.96	-20	Pass

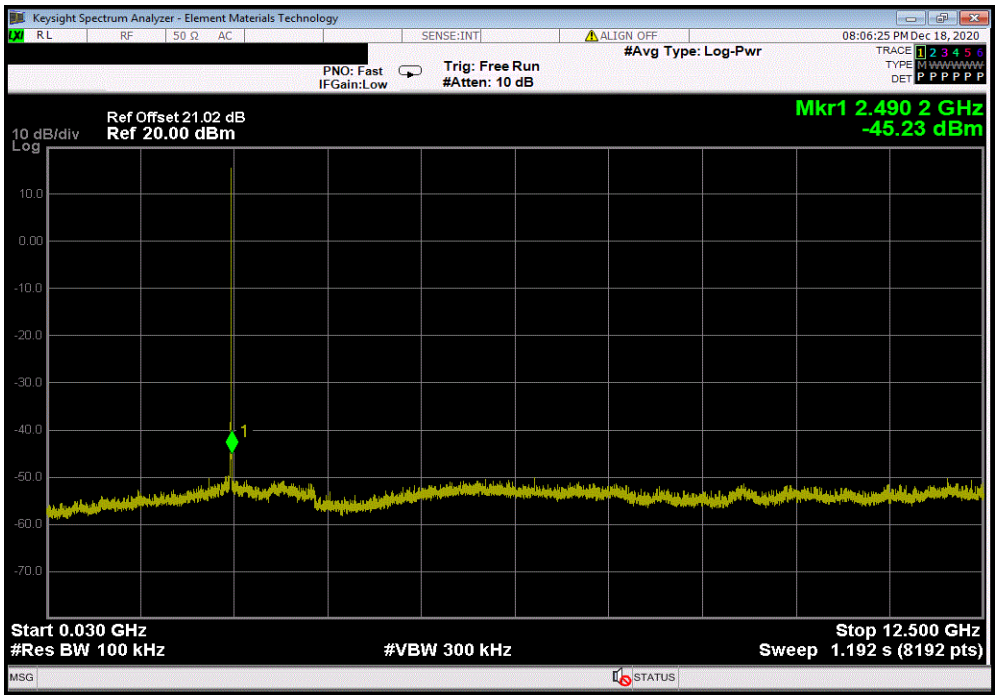


Antenna Port 2, High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Fundamental	2480	N/A	N/A	N/A

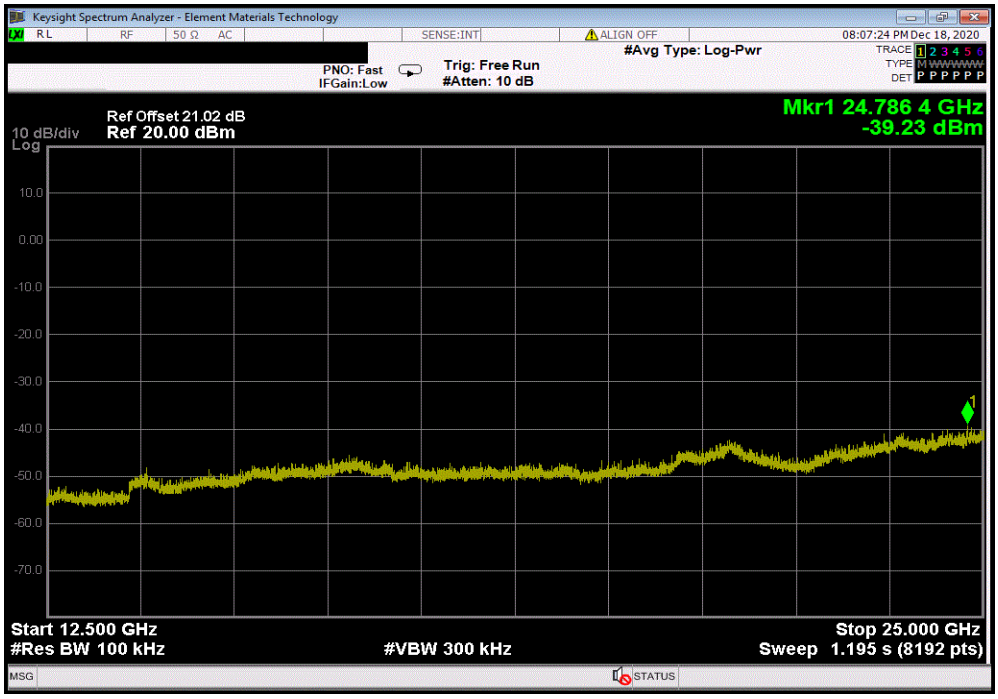


SPURIOUS CONDUCTED EMISSIONS (HIGH CHANNEL)

Antenna Port 2, High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	2490.2	-60.71	-20	Pass



Antenna Port 2, High Channel, 2480 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	24786.35	-54.71	-20	Pass



SPURIOUS CONDUCTED EMISSIONS

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	31-Dec-19	31-Dec-22
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Cable	Micro-Coax	D150A-1-0720-200	MNL	15-Sep-19	15-Sep-20
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

The spurious RF conducted emissions were measured with the EUT set to low, medium and high transmit frequencies. The EUT was transmitting at the data rate(s) listed in the datasheet in a no-hop mode. For each transmit frequency, the spectrum was scanned throughout the specified frequency range.

SPURIOUS CONDUCTED EMISSIONS

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**26-Aug-20**
Customer:	**MSA Safety**			**Temperature:**	**22.2 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**57.5% RH**
Project:	**None**			**Barometric Pres.:**	**1011 mbar**
Tested by:	**Andrew Rogstad**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

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

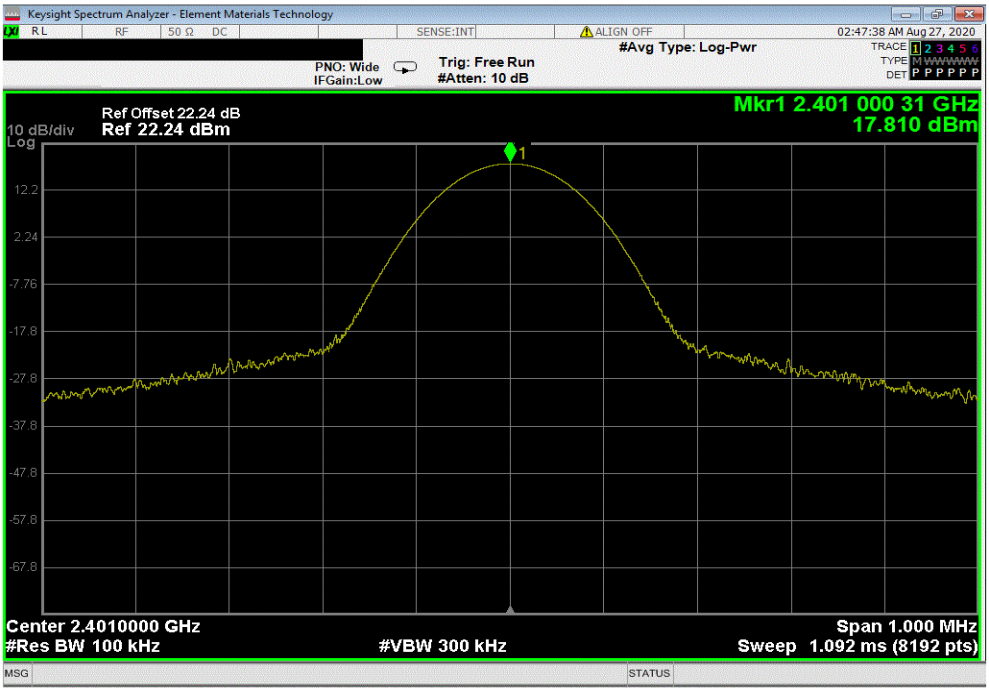
DEVIATIONS FROM TEST STANDARD

None

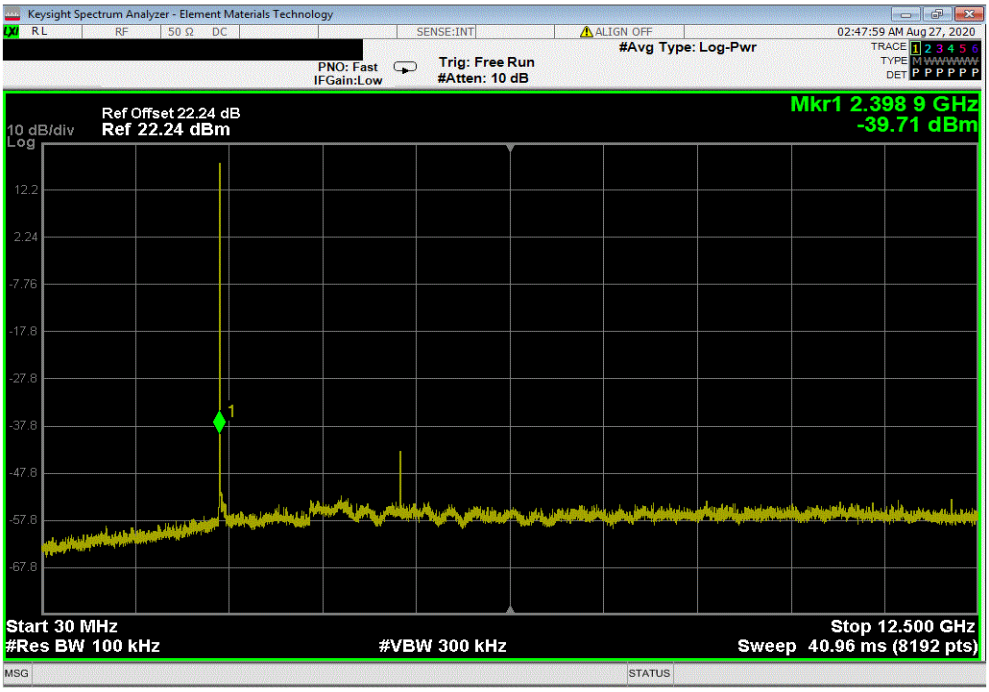
Configuration #	**2**	*Signature*

		Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Antenna Port 1						
	Low Channel, 2401 MHz	Fundamental	2401	N/A	N/A	N/A
	Low Channel, 2401 MHz	30 MHz - 12.5 GHz	2398.86	-57.52	-20	Pass
	Low Channel, 2401 MHz	12.5 GHz - 25 GHz	24606.28	-68.17	-20	Pass
	Mid Channel, 2442 MHz	Fundamental	2442	N/A	N/A	N/A
	Mid Channel, 2442 MHz	30 MHz - 12.5 GHz	4052.19	-69.99	-20	Pass
	Mid Channel, 2442 MHz	12.5 GHz - 25 GHz	23582.29	-67.44	-20	Pass
Antenna Port 2						
	Low Channel, 2401 MHz	Fundamental	2401	N/A	N/A	N/A
	Low Channel, 2401 MHz	30 MHz - 12.5 GHz	2398.86	-55.8	-20	Pass
	Low Channel, 2401 MHz	12.5 GHz - 25 GHz	24113.36	-66.67	-20	Pass
	Mid Channel, 2442 MHz	Fundamental	2442	N/A	N/A	N/A
	Mid Channel, 2442 MHz	30 MHz - 12.5 GHz	3688.33	-70.28	-20	Pass
	Mid Channel, 2442 MHz	12.5 GHz - 25 GHz	22408.74	-66.79	-20	Pass

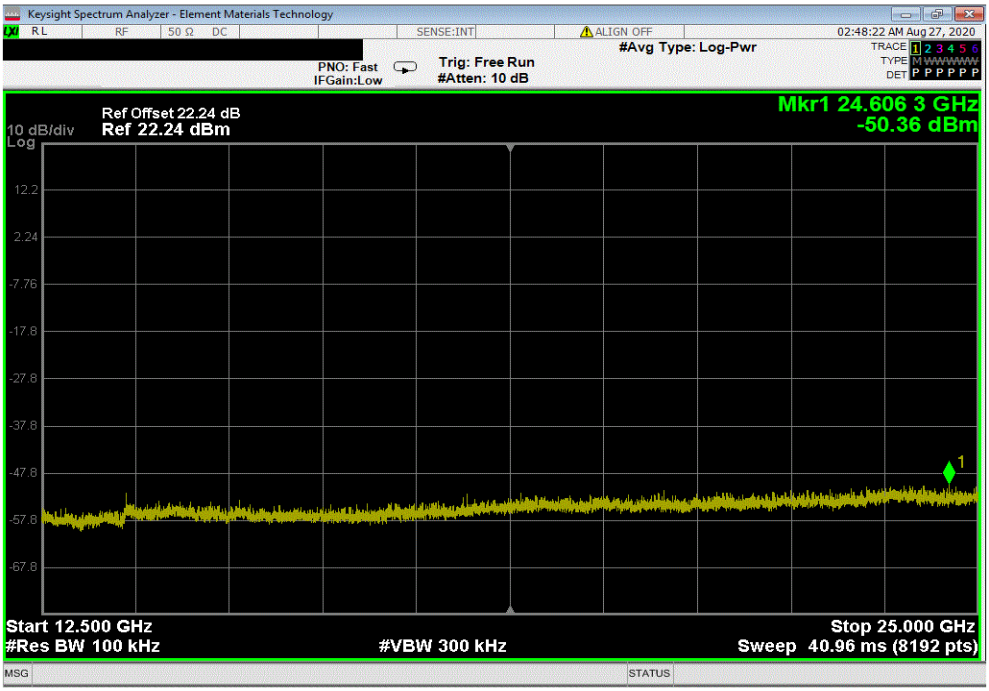
Antenna Port 1, Low Channel, 2401 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2401	N/A	N/A	N/A



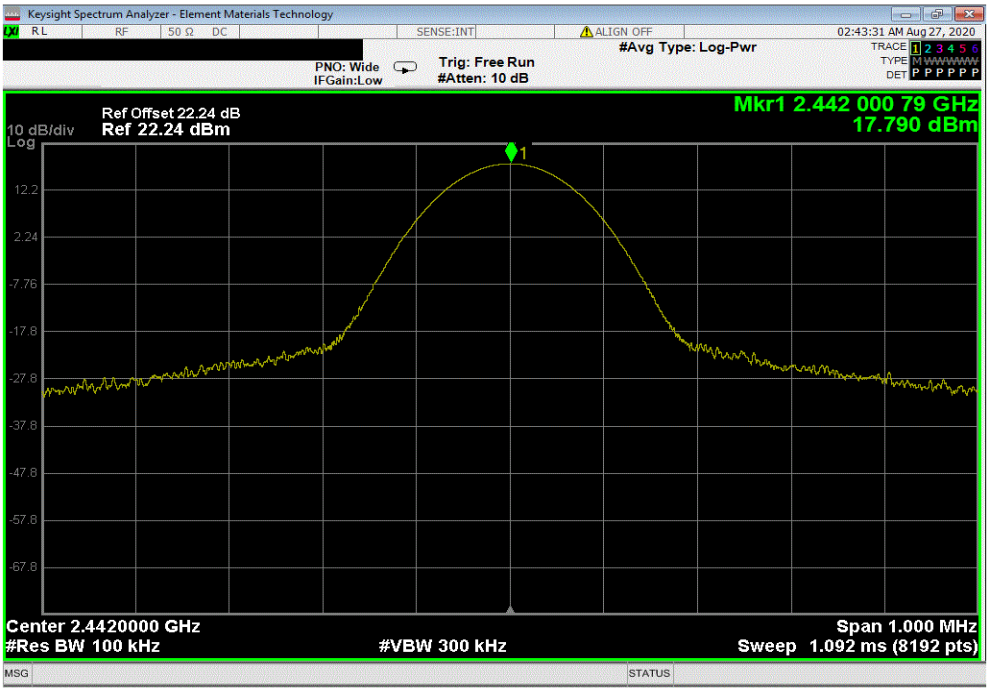
Antenna Port 1, Low Channel, 2401 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	2398.86	-57.52	-20	Pass



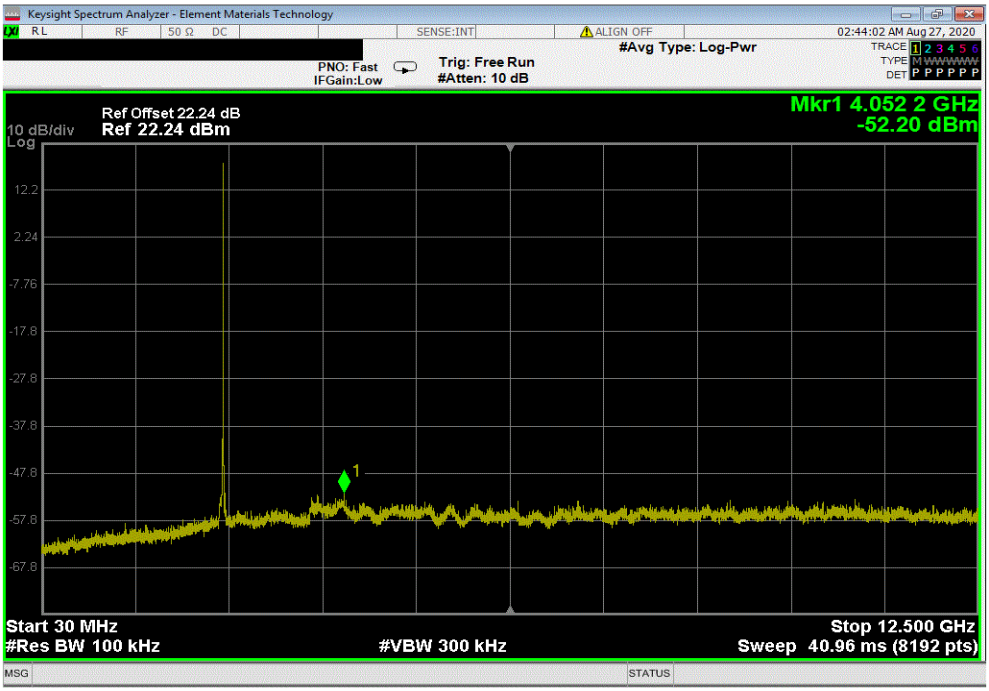
Antenna Port 1, Low Channel, 2401 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	24606.28	-68.17	-20	Pass



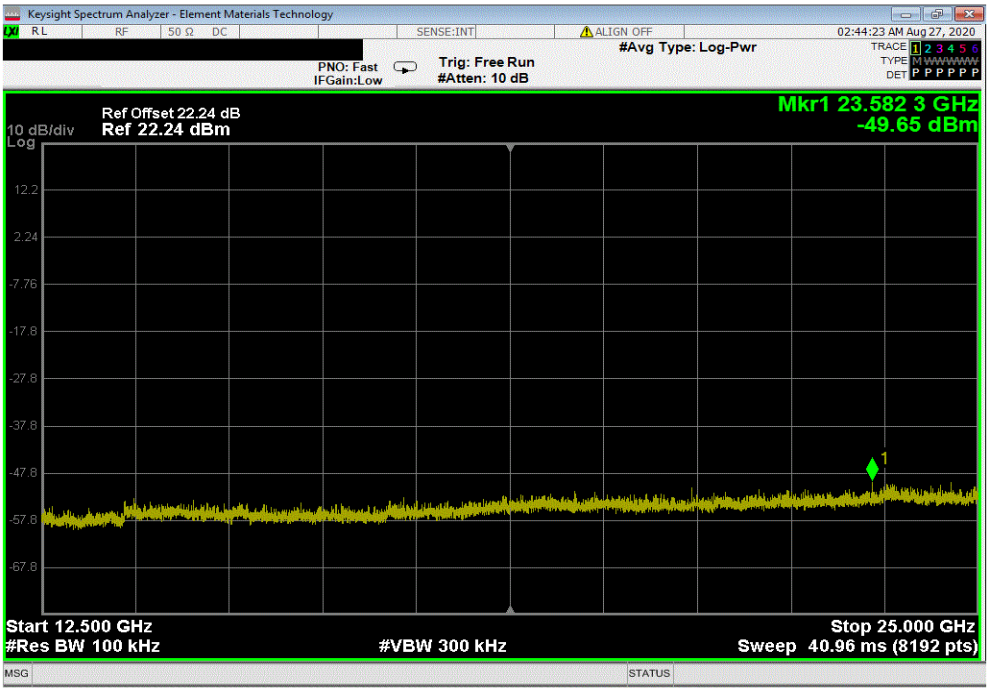
Antenna Port 1, Mid Channel, 2442 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2442	N/A	N/A	N/A



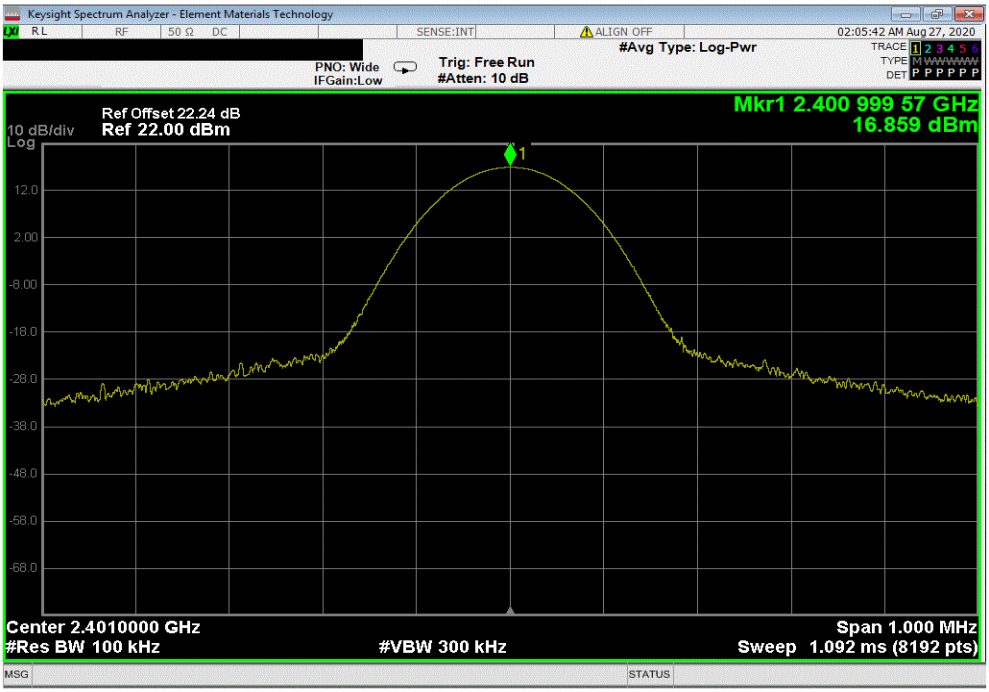
Antenna Port 1, Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	4052.19	-69.99	-20	Pass



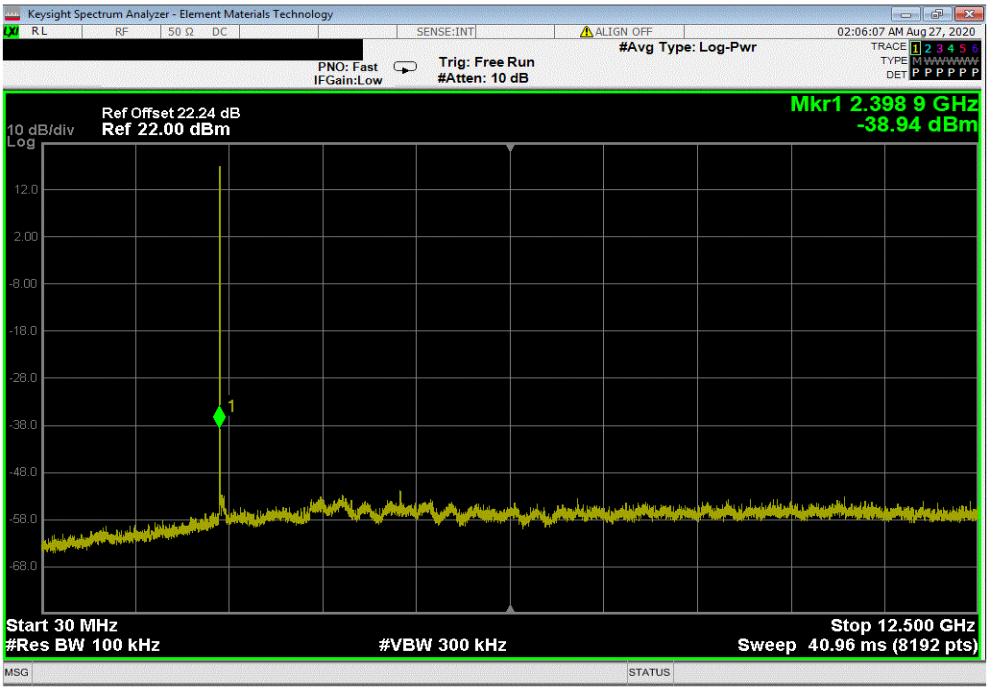
Antenna Port 1, Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	23582.29	-67.44	-20	Pass



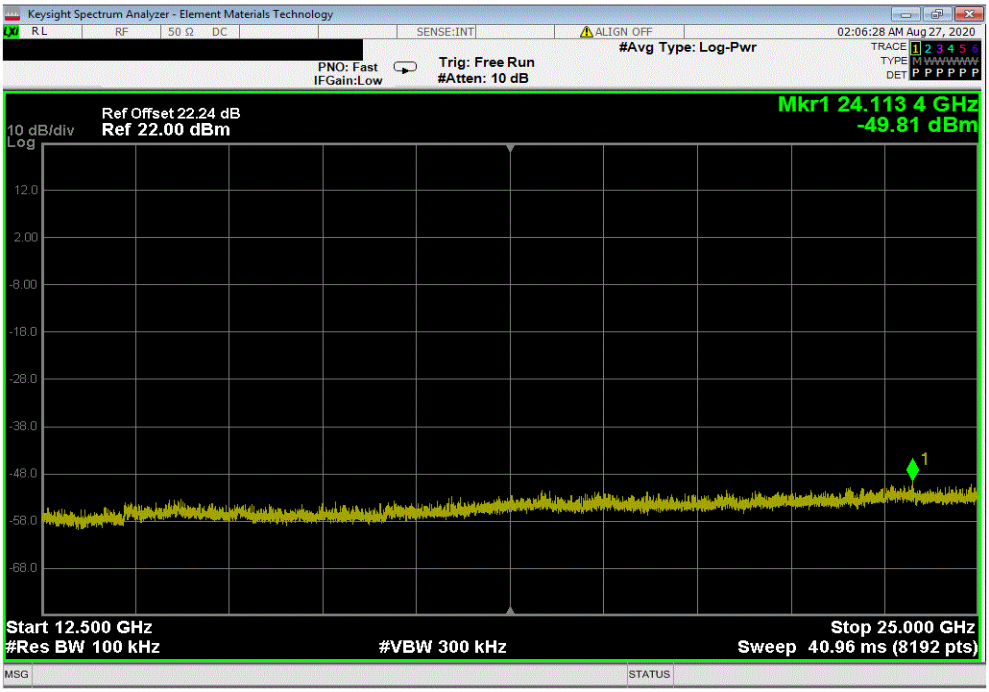
Antenna Port 2, Low Channel, 2401 MHz					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	2401	N/A	N/A	N/A



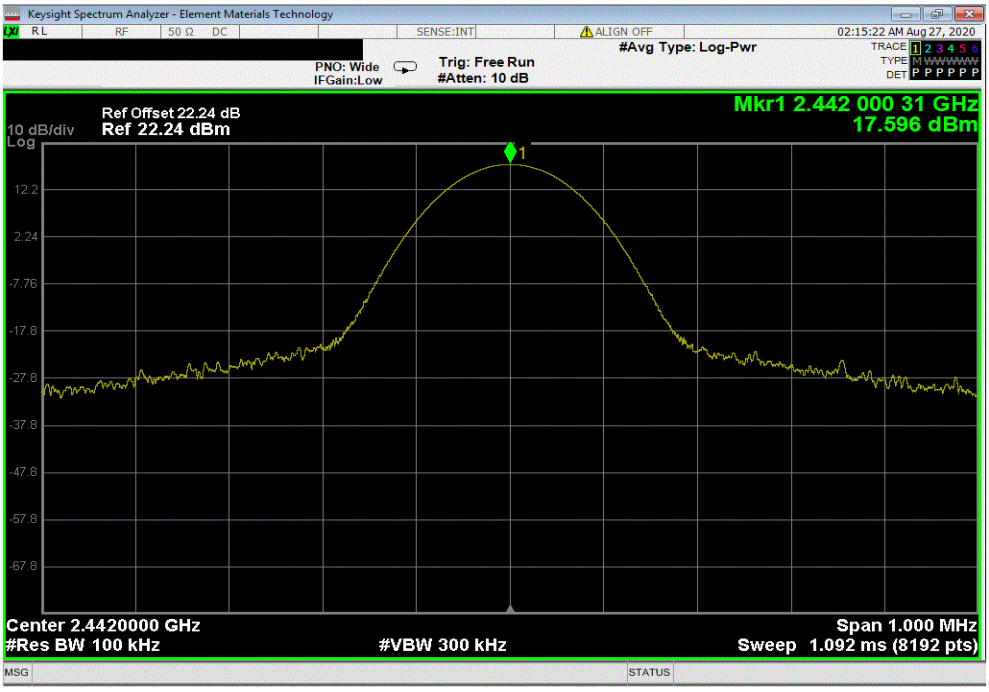
Antenna Port 2, Low Channel, 2401 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	2398.86	-55.8	-20	Pass



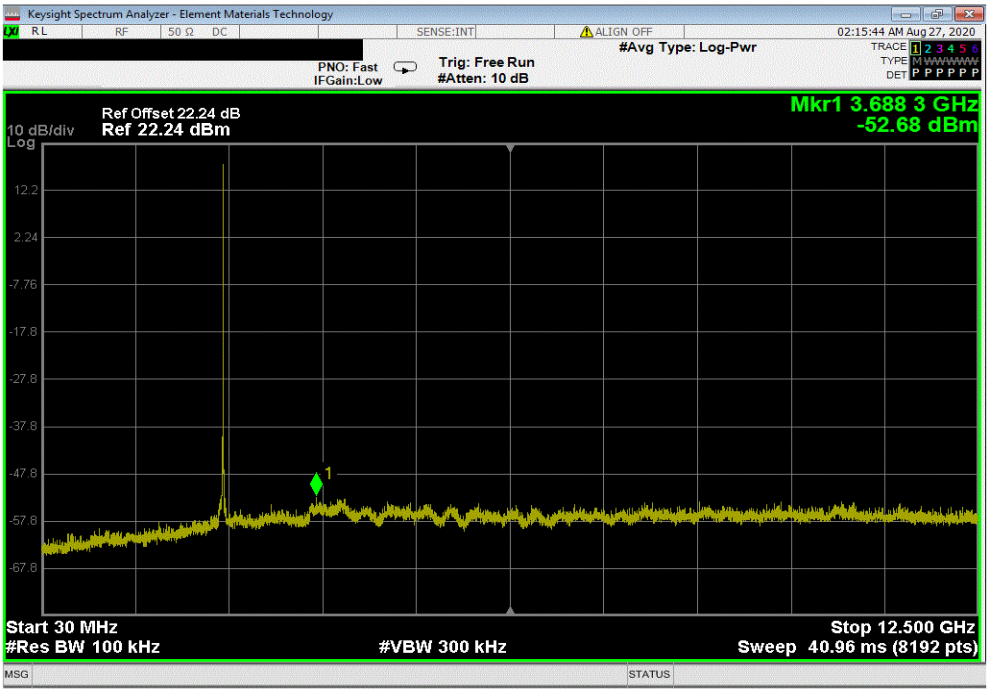
Antenna Port 2, Low Channel, 2401 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	24113.36	-66.67	-20	Pass



Antenna Port 2, Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Fundamental	2442	N/A	N/A	N/A



Antenna Port 2, Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12.5 GHz	3688.33	-70.28	-20	Pass



Antenna Port 2, Mid Channel, 2442 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
12.5 GHz - 25 GHz	22408.74	-66.79	-20	Pass