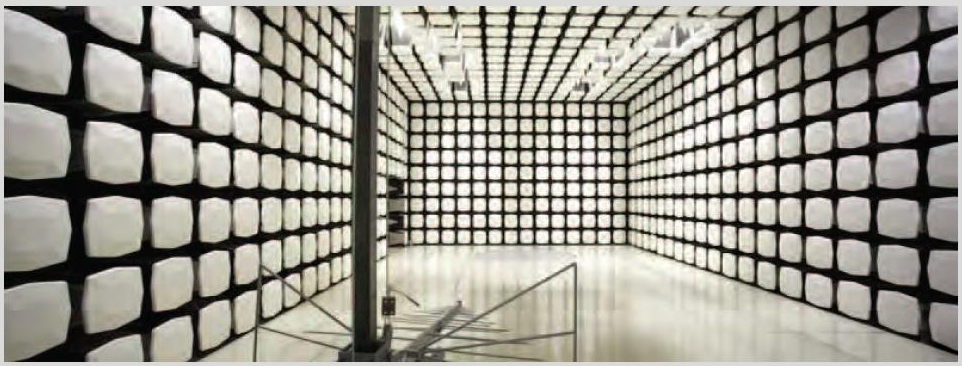
MSA Innovation, LLC

Lunar

FCC 15.247:2021

902 - 928 MHz Other Wideband (DTS) Transceiver

Report: MSAS0004.2, Issue Date: April 1, 2021



NVLAP LAB CODE: 200881-0

CERTIFICATE OF TEST

Last Date of Test: January 11, 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 (Transmitter)	No	N/A	Not required for battery powered EUT
6.5, 6.6, 11.12.1, 11.13.2	Spurious Radiated Emissions	Yes	Pass	
7.8.2	Carrier Frequency Separation	No	N/A	Not required for DTS devices.
7.8.3	Number of Hopping Frequencies	No	N/A	Not required for DTS devices.
7.8.4	Dwell Time	No	N/A	Not required for DTS devices.
7.8.6	Band Edge Compliance - Hopping Mode	No	N/A	Not required for DTS devices.
11.6	Duty Cycle	Yes	N/A	Characterization of radio operation.
11.8.2	Occupied Bandwidth	Yes	Pass	
11.9.1.1	Output Power	Yes	Pass	
11.9.1.1	Equivalent Isotropic Radiated Power	Yes	Pass	
11.10.2	Power Spectral Density	Yes	Pass	
11.11	Band Edge Compliance	Yes	Pass	
11.11	Spurious Conducted Emissions	Yes	Pass	

Deviations From Test Standards

None

Approved By:

Eric Brandon, Department Manager

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

REVISION HISTORY

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

ACCREDITATIONS AND AUTHORIZATIONS

United States

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

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

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

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

European Union

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

Australia/New Zealand

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

Korea

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

Japan

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

Taiwan

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

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

Singapore

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

Israel

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

Hong Kong

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

Vietnam

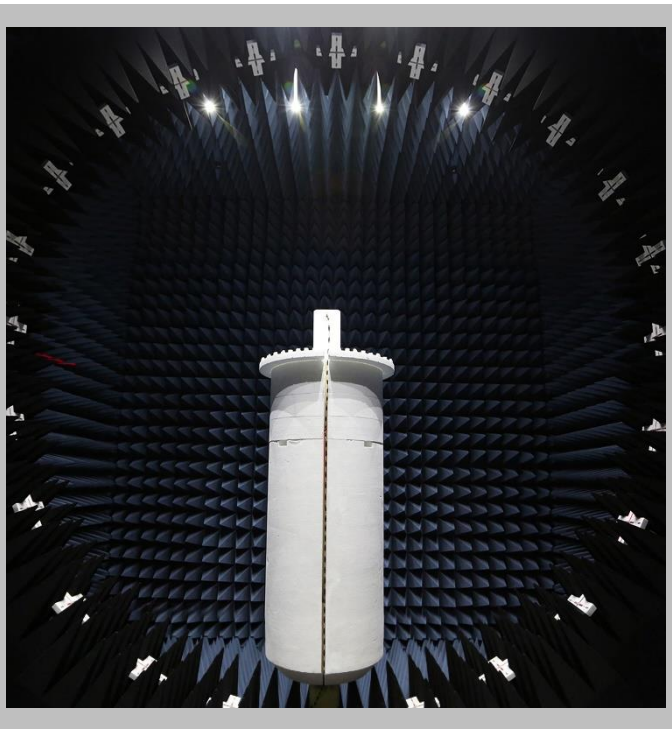
MIC – Recognized by MIC as a CAB for the acceptance of test data.

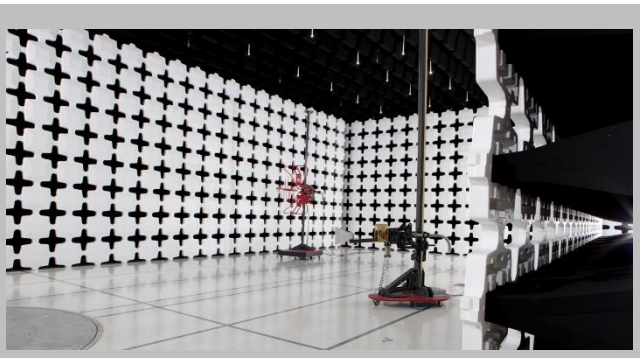
SCOPE

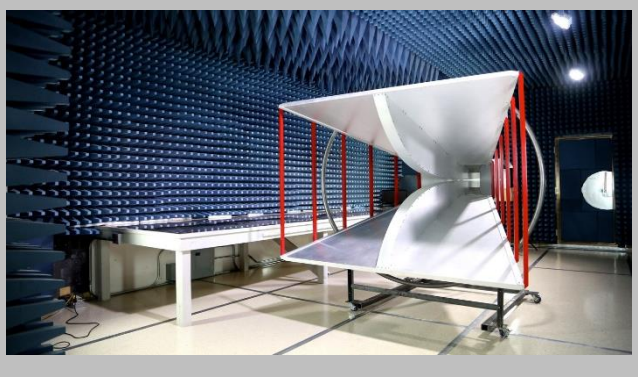
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

FACILITIES

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







MEASUREMENT UNCERTAINTY

element
TMU.2015.07.10

Measurement Uncertainty

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

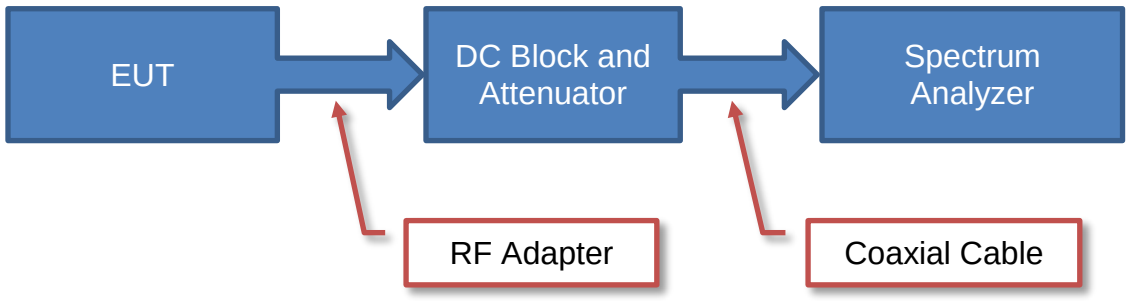
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable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

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

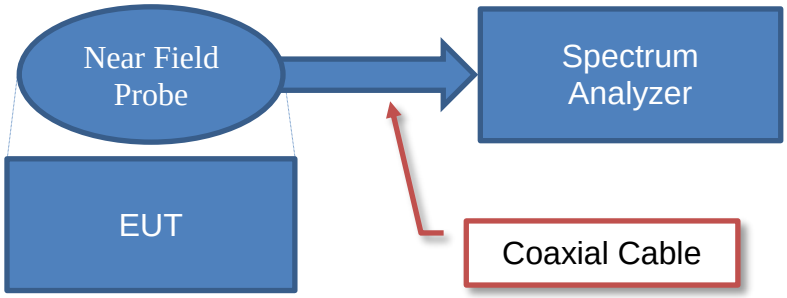
Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field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

Test Setup Block Diagrams

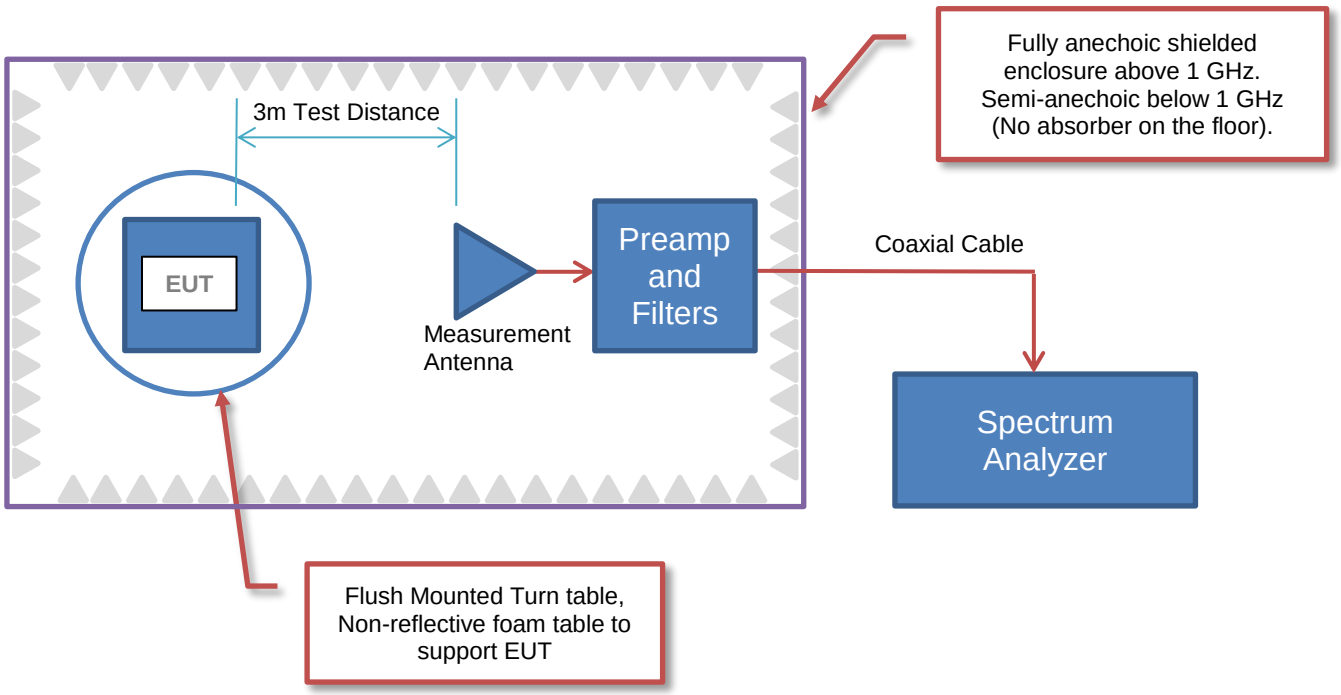
Antenna Port Conducted Measurements



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 20, 2020
Last Date of Test:	January 11, 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:
Seeking to demonstrate compliance under FCC 15.247:2021 for operation in the 902 - 928 MHz Band.

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

CONFIGURATIONS

Configuration MSAS0004- 13

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	2020-08-20	Occupied Bandwidth	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2020-08-20	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	2020-08-20	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.
4	2020-08-20	Band Edge Compliance	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
5	2020-08-20	Spurious Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
6	2020-08-20	Spurious Radiated Emissions	Modified from delivered configuration.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
7	2021-01-11	Power Spectral Density	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	Channel (MHz)	Power Setting
Other Wideband (DTS)	906	+13 dBm
	918	+20 dBm
	924	+20 dBm

ANTENNA GAIN (dBi)

Type	Provided by:	Frequency Range (MHz)	Gain (dBi)
Monopole	N/A	906	-3.59
		918	-6.02
		924	-7.64

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

Tx 918 MHz or 924 MHz modulated with a p setting of 20, or Tx 906 MHz modulated with a p setting of 13.

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

MSAS0004 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	10 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
Attenuator	Fairview Microwave	SA18E-20	TWZ	2019-09-17	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	AMF-6F-08001200-30-10P	AVV	2020-01-17	12 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	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 - Band Pass/Notch	K&L Microwave	3TNF-500/1000-N/N	HGS	2020-06-30	12 mo

MEASUREMENT BANDWIDTHS

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

TEST DESCRIPTION

The highest gain antenna of each type to be used with the EUT was tested. The EUT was configured for the required transmit frequencies and the modes as showed in the data sheets.

For each configuration, the spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. These “pre-scans” are not included in the report. Final measurements on individual emissions were then made and included in this test report.

The individual emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and EUT antenna in three orthogonal axis if required, and adjusting the measurement antenna height and polarization (per ANSI C63.10). A preamp and high pass filter (and notch filter) were used for this test in order to provide sufficient measurement sensitivity.

Measurements were made with the required detectors and annotated on the data for each individual point using the following annotation:

QP = Quasi-Peak Detector
PK = Peak Detector
AV = RMS Detector

Measurements were made to satisfy the specific requirements of the test specification for out of band emissions as well as the restricted band requirements.

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

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

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

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.

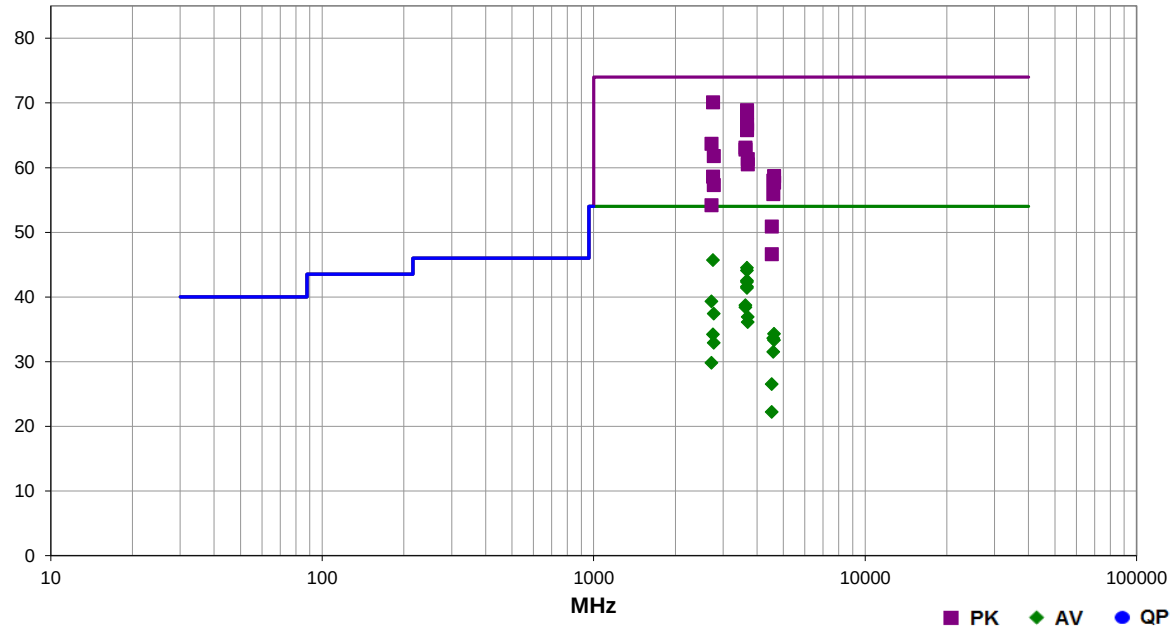
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.04.20.0 PSA-ESCI 2020.04.03.0

Work Order:	MSAS0004	**Date:**	2020-08-20		
Project:	None	**Temperature:**	22 °C		
Job Site:	MN05	**Humidity:**	57.8% RH		
Serial Number:	7492	**Barometric Pres.:**	1015 mbar	**Tested by:**	Kyle McMullan
EUT:	Lunar				
Configuration:	1				
Customer:	MSA Innovation, LLC				
Attendees:	Dustin Morris				
EUT Power:	Battery				
Operating Mode:	Tx 918 MHz or 924 MHz modulated with a p setting of 20, or Tx 906 MHz modulated with a p setting of 13. Transmitting with 100% duty cycle.				
Deviations:	None				
Comments:	When operating in the field, the worst-case transmission time over any 100 ms period is 6 ms. Per KDB 558074 Answer 3 A, a downward DCCF correction applied to peak data to create average measurements based on 20*log(On Time/100 ms) = -24.4 dB.				

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

Run #	8	**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
2753.258	73.1	-3.0	2.0	91.0		0.0	Horz	PK	0.0	70.1	74.0	-3.9	918 MHz, EUT On Side
3670.942	67.9	1.0	2.1	243.0		0.0	Horz	PK	0.0	68.9	74.0	-5.1	918 MHz, EUT On Side
3670.933	67.5	1.0	1.0	81.9		0.0	Vert	PK	0.0	68.5	74.0	-5.5	918 MHz, EUT Vert
3671.042	65.9	1.0	1.3	95.9		0.0	Horz	PK	0.0	66.9	74.0	-7.1	918 MHz, EUT Horz
3670.933	65.7	1.0	1.0	199.9		0.0	Vert	PK	0.0	66.7	74.0	-7.3	918 MHz, EUT Horz
3670.992	65.0	1.0	1.2	156.0		0.0	Vert	PK	0.0	66.0	74.0	-8.0	918 MHz, EUT On Side
3670.900	64.8	1.0	1.5	192.0		0.0	Horz	PK	0.0	65.8	74.0	-8.2	918 MHz, EUT Vert
2753.258	73.1	-3.0	2.0	91.0	-24.4	0.0	Horz	AV	0.0	45.7	54.0	-8.3	918 MHz, EUT On Side
3670.942	67.9	1.0	2.1	243.0	-24.4	0.0	Horz	AV	0.0	44.5	54.0	-9.5	918 MHz, EUT On Side
3670.933	67.5	1.0	1.0	81.9	-24.4	0.0	Vert	AV	0.0	44.1	54.0	-9.9	918 MHz, EUT Vert
2717.292	66.6	-2.9	1.1	360.0		0.0	Horz	PK	0.0	63.7	74.0	-10.3	906 MHz, EUT On Side
3623.125	62.2	0.9	1.1	218.9		0.0	Vert	PK	0.0	63.1	74.0	-10.9	906 MHz, EUT Vert
3624.875	61.9	0.9	1.1	8.0		0.0	Horz	PK	0.0	62.8	74.0	-11.2	906 MHz, EUT On Side
3671.042	65.9	1.0	1.3	95.9	-24.4	0.0	Horz	AV	0.0	42.5	54.0	-11.5	918 MHz, EUT Horz
3670.933	65.7	1.0	1.0	199.9	-24.4	0.0	Vert	AV	0.0	42.3	54.0	-11.7	918 MHz, EUT Horz
2771.350	64.7	-2.9	1.1	288.0		0.0	Horz	PK	0.0	61.8	74.0	-12.2	924 MHz, EUT On Side
3670.992	65.0	1.0	1.2	156.0	-24.4	0.0	Vert	AV	0.0	41.6	54.0	-12.4	918 MHz, EUT On Side
3670.900	64.8	1.0	1.5	192.0	-24.4	0.0	Horz	AV	0.0	41.4	54.0	-12.6	918 MHz, EUT Vert

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
3694.775	60.1	1.2	2.0	12.9		0.0	Horz	PK	0.0	61.3	74.0	-12.7	924 MHz, EUT On Side
3695.058	59.3	1.2	1.5	351.9		0.0	Vert	PK	0.0	60.5	74.0	-13.5	924 MHz, EUT Vert
2717.292	66.6	-2.9	1.1	360.0	-24.4	0.0	Horz	AV	0.0	39.3	54.0	-14.7	906 MHz, EUT On Side
3623.125	62.2	0.9	1.1	218.9	-24.4	0.0	Vert	AV	0.0	38.7	54.0	-15.3	906 MHz, EUT Vert
4621.092	54.3	4.4	2.1	160.0		0.0	Horz	PK	0.0	58.7	74.0	-15.3	924 MHz, EUT On Side

DUTY CYCLE

TEST DESCRIPTION

The Duty Cycle (x) were measured for each of the EUT operating modes. The measurements were made using a zero span on the spectrum analyzer to see the pulses in the time domain. The transmit power was set to its default maximum.

The duty cycle was calculated by dividing the transmission pulse duration (T) by the total period of a single on and total off time.

The EUT operates at 100% Duty Cycle.

OCCUPIED BANDWIDTH

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5182B	TFX	28-Apr-20	28-Apr-23
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

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

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

OCCUPIED BANDWIDTH

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**20-Aug-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**22.2 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**56.3% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

Reference level offset on the spectrum analyzer includes the measurement cable, 20 dB attenuator, and DC block.

DEVIATIONS FROM TEST STANDARD

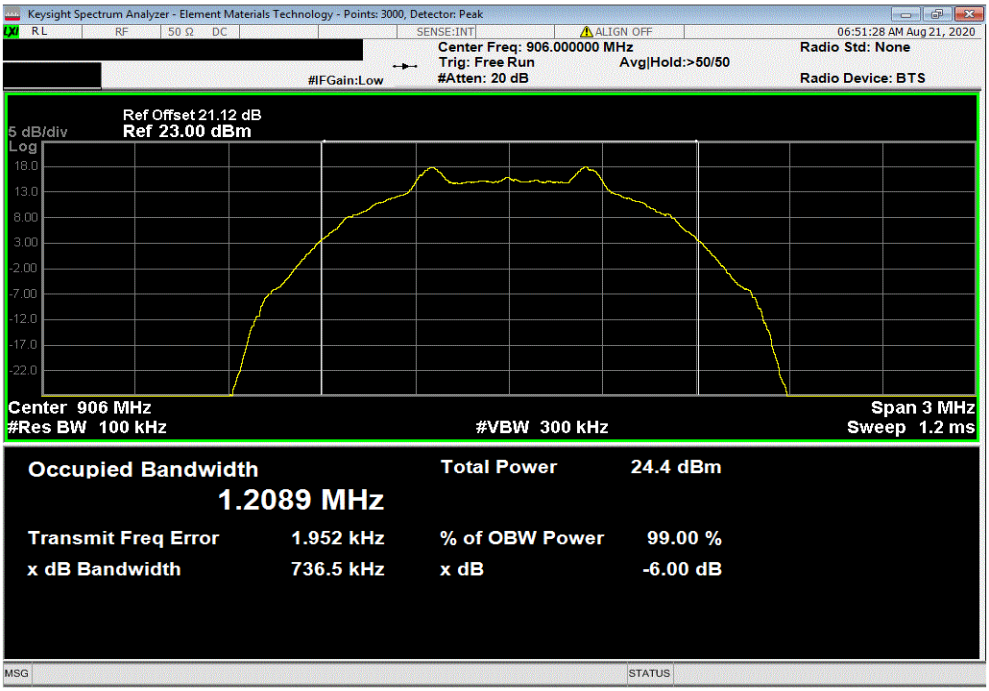
None

Configuration #	**2**	*Signature* Dustin Sparks

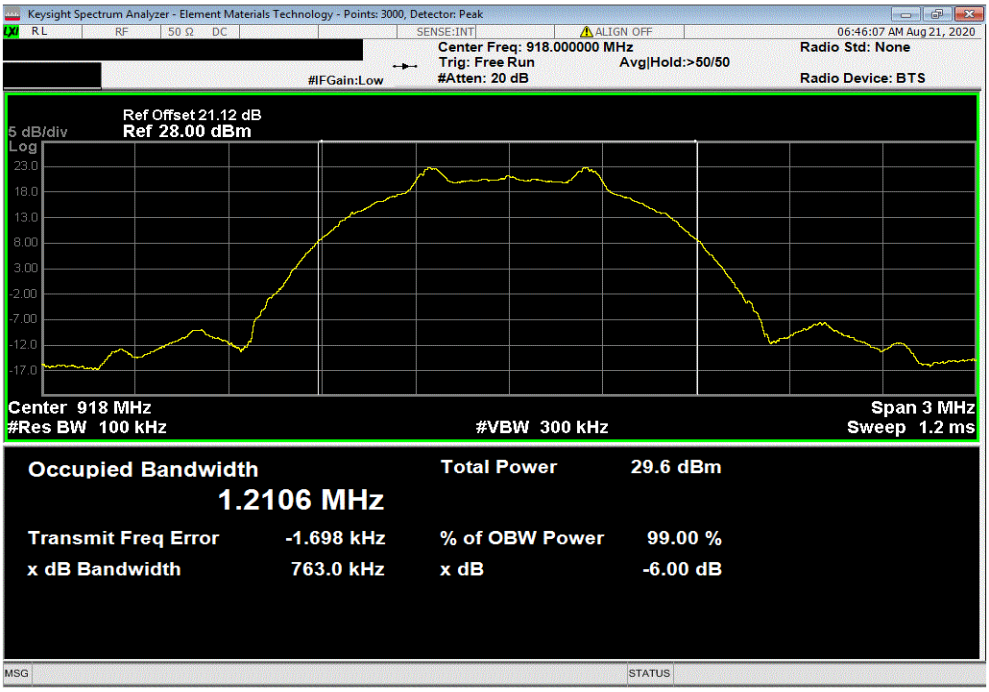
	Value	**Limit (>)**	**Result**
Low Channel (906 MHz)	736.484 kHz	500 kHz	Pass
Mid Channel (918 MHz)	762.99 kHz	500 kHz	Pass
High Channel (924 MHz)	746.675 kHz	500 kHz	Pass

OCCUPIED BANDWIDTH

Low Channel (906 MHz)						
				Value	Limit (>)	Result
				736.484 kHz	500 kHz	Pass



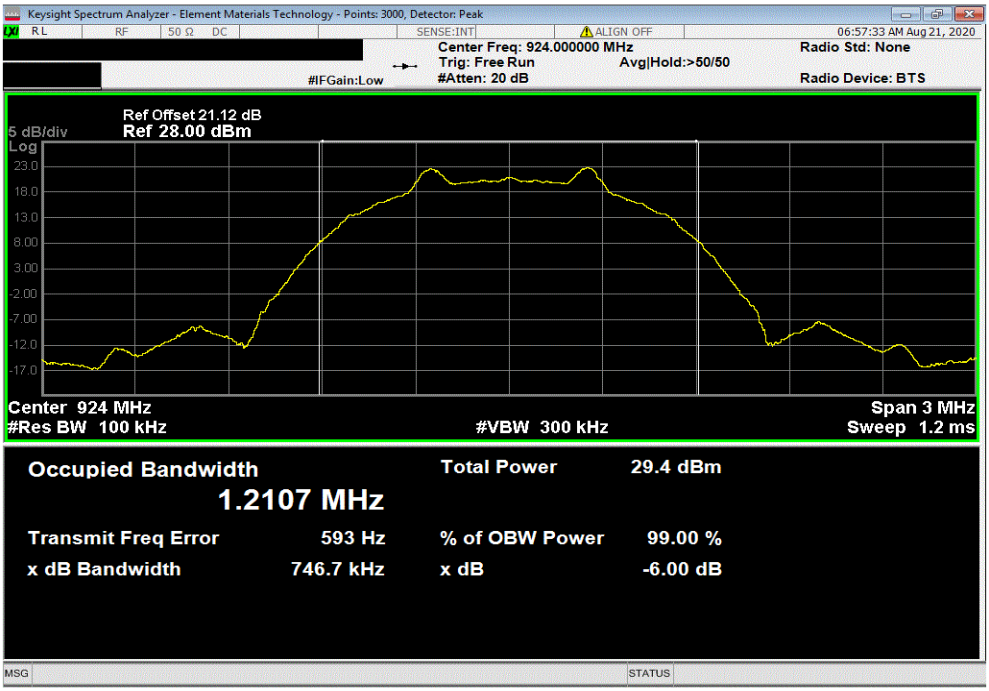
Mid Channel (918 MHz)						
				Value	Limit (>)	Result
				762.99 kHz	500 kHz	Pass



OCCUPIED BANDWIDTH

TbtTx 2019.08.30.0 XMit 2020.03.25.0

High Channel (924 MHz)							
					Value	Limit (>)	Result
					746.675 kHz	500 kHz	Pass



OUTPUT POWER

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5182B	TFX	28-Apr-20	28-Apr-23
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

The fundamental emission output power (maximum average conducted output power) was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

Prior to measuring output power; the emission bandwidth (B) and the transmission pulse duration (T) were measured. Both are required to determine the method of measuring Maximum Conducted Output Power. The transmission pulse duration (T) was measured using a zero span on the spectrum analyzer to see the pulses in the time domain.

The method AVGSA-2 in section 11.9.2.2.4 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging across ON and OFF times of the EUT transmissions in the spectrum analyzer channel power function using an RMS detector. Following the measurement a duty cycle correction was applied by adding [10 log (1 / D)], where D is the duty cycle, to the measured power to compute the average power during the actual transmission times.

The AVGSA-2 method was modified as the emissions bandwidth (B) was less than the available resolution bandwidth (RBw) of the spectrum analyzer. RBw was set wider than B. This follows the guidance of section 11.9.1.1 and is equivalent to a measurement with a power meter AVGPM per section 11.9.2.3.

OUTPUT POWER

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**20-Aug-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**22.2 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**56.3% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

Reference level offset on the spectrum analyzer includes the measurement cable, 20 dB attenuator, and DC block.

DEVIATIONS FROM TEST STANDARD

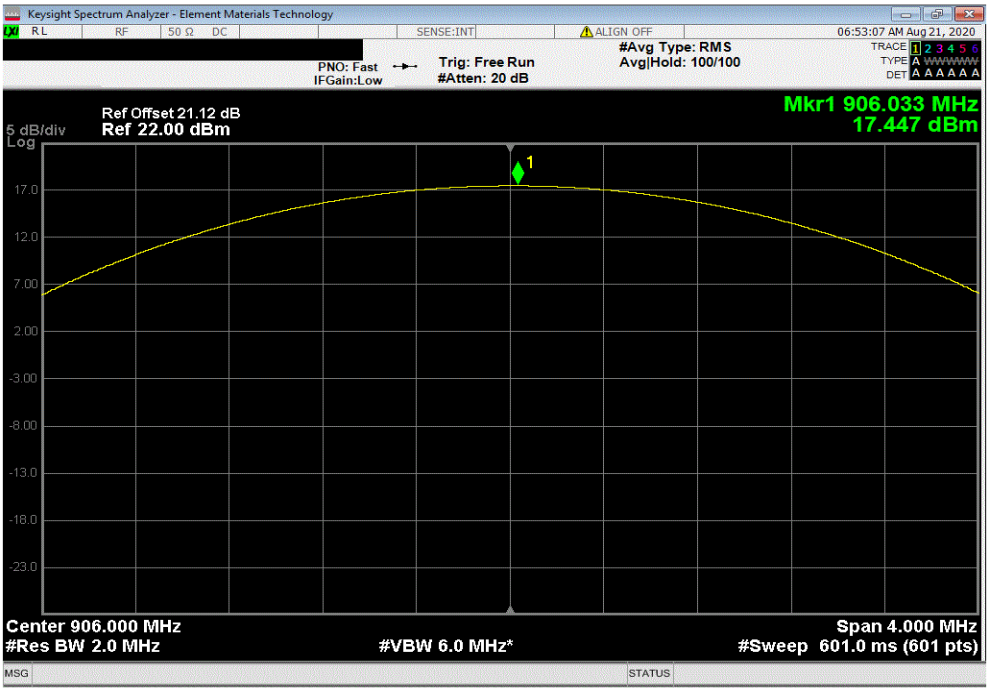
None

Configuration #	**2**	*Signature* Dustin Sparks

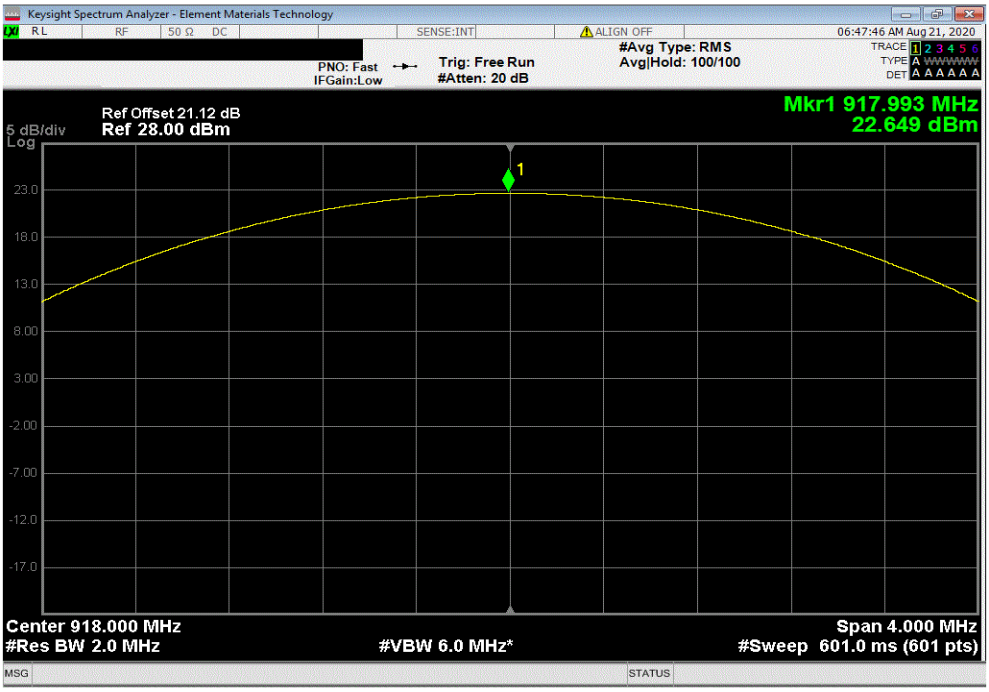
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Output Pwr (dBm)	Limit (dBm)	Results
Low Channel (906 MHz)	17.447	0	17.447	30	Pass
Mid Channel (918 MHz)	22.649	0	22.649	30	Pass
High Channel (924 MHz)	22.411	0	22.411	30	Pass

OUTPUT POWER

Low Channel (906 MHz)						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Output Pwr (dBm)	Limit (dBm)	Results
		17.447	0	17.447	30	Pass



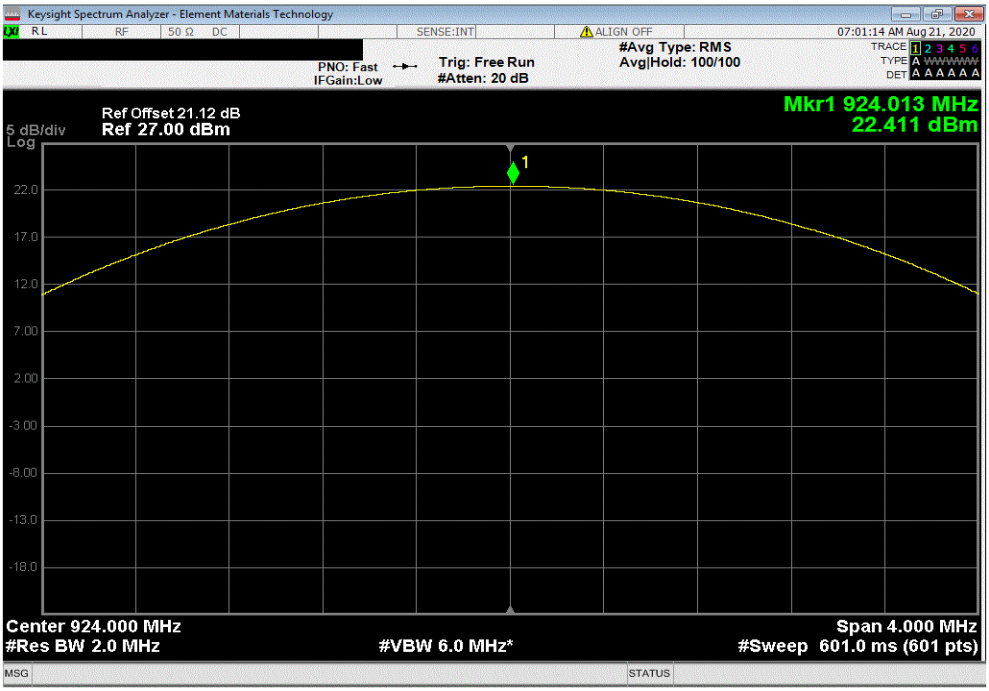
Mid Channel (918 MHz)						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Output Pwr (dBm)	Limit (dBm)	Results
		22.649	0	22.649	30	Pass



OUTPUT POWER

TbtTx 2019.08.30.0 XMit 2020.03.25.0

High Channel (924 MHz)						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Output Pwr (dBm)	Limit (dBm)	Results
		22.411	0	22.411	30	Pass



EQUIVALENT ISOTROPIC RADIATED 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	N5182B	TFX	28-Apr-20	28-Apr-23
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	21-Dec-19	21-Dec-20

TEST DESCRIPTION

The fundamental emission output power (maximum average conducted output power) was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

Prior to measuring output power; the emission bandwidth (B) and the transmission pulse duration (T) were measured. Both are required to determine the method of measuring Maximum Conducted Output Power. The transmission pulse duration (T) was measured using a zero span on the spectrum analyzer to see the pulses in the time domain.

The method AVGSA-2 in section 11.9.2.2.4 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging across ON and OFF times of the EUT transmissions in the spectrum analyzer channel power function using an RMS detector. Following the measurement a duty cycle correction was applied by adding [10 log (1 / D)], where D is the duty cycle, to the measured power to compute the average power during the actual transmission times.

The AVGSA-2 method was modified as the emissions bandwidth (B) was less than the available resolution bandwidth (RBw) of the spectrum analyzer. RBw was set wider than B. This follows the guidance of section 11.9.1.1 and is equivalent to a measurement with a power meter AVGPM per section 11.9.2.3.

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

EQUIVALENT ISOTROPIC RADIATED POWER

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	Lunar			**Work Order:**	MSAS0004
Serial Number:	9628			**Date:**	20-Aug-20
Customer:	MSA Innovation, LLC			**Temperature:**	22.2 °C
Attendees:	Dustin Morris			**Humidity:**	56.4% RH
Project:	None			**Barometric Pres.:**	1013 mbar
Tested by:	Dustin Sparks	**Power:**	Battery	**Job Site:**	MN08

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

COMMENTS

Reference level offset on the spectrum analyzer includes the measurement cable, 20 dB attenuator, and DC block.

DEVIATIONS FROM TEST STANDARD

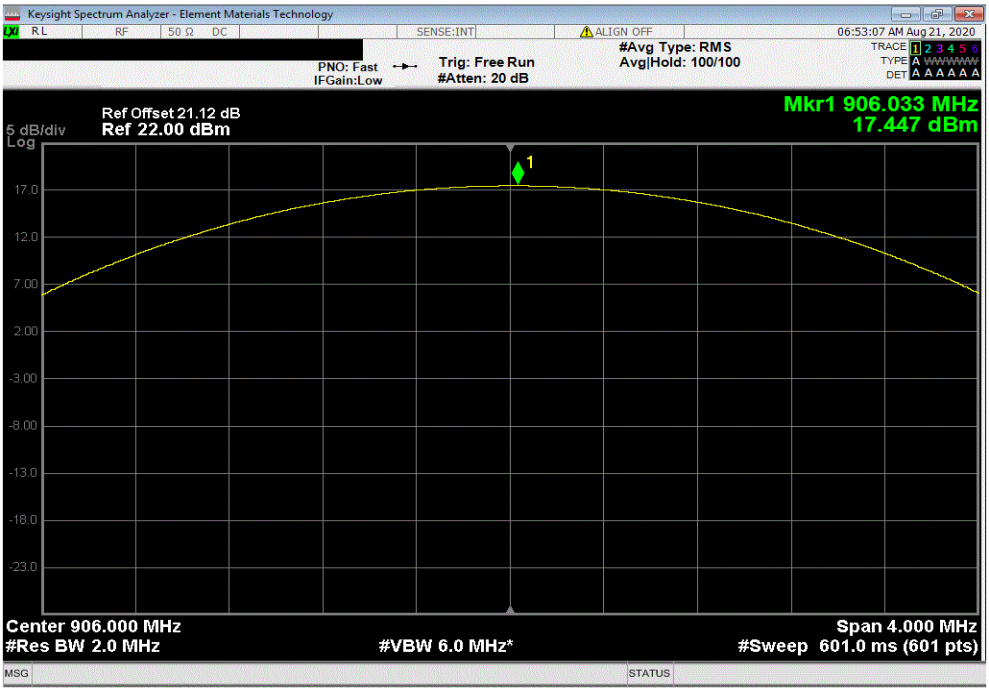
None

Configuration #	2	Signature

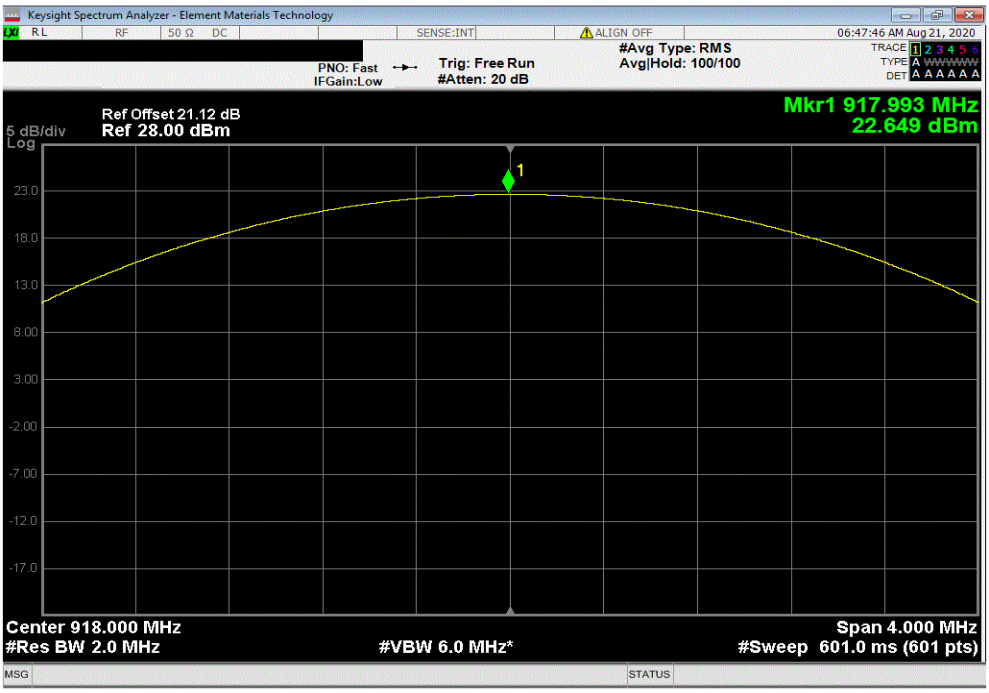
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Results
Low Channel (906 MHz)	17.447	0	-3.59	13.9	36	Pass
Mid Channel (918 MHz)	22.649	0	-6.02	16.6	36	Pass
High Channel (924 MHz)	22.411	0	-7.64	14.8	36	Pass

EQUIVALENT ISOTROPIC RADIATED POWER

Low Channel (906 MHz)						
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Results
	17.447	0	-3.59	13.9	36	Pass

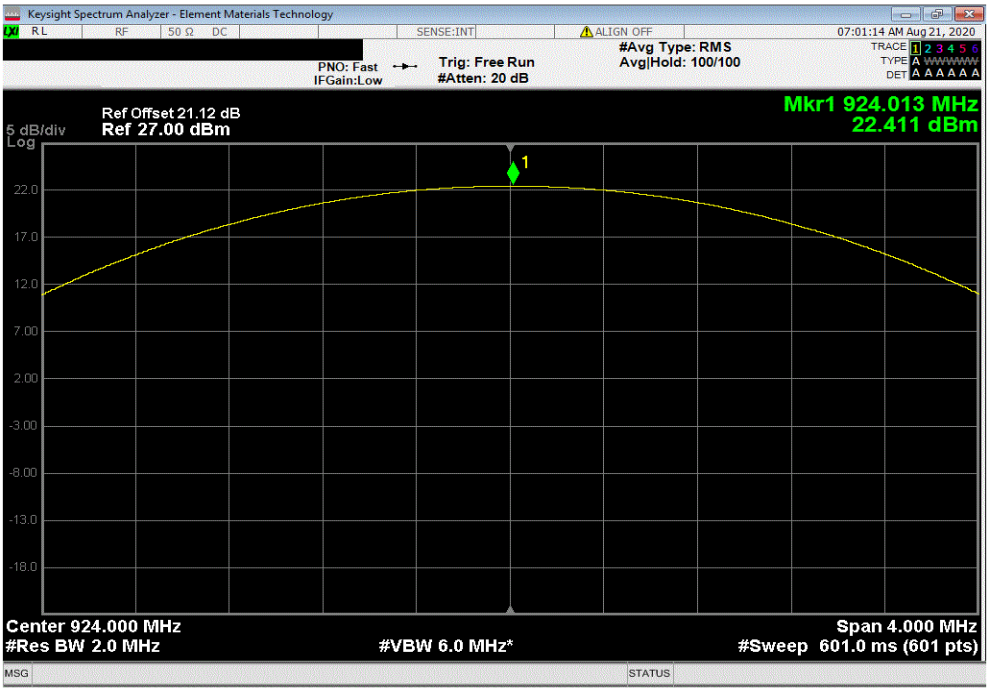


Mid Channel (918 MHz)						
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Results
	22.649	0	-6.02	16.6	36	Pass



EQUIVALENT ISOTROPIC RADIATED POWER

High Channel (924 MHz)						
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Results
	22.411	0	-7.64	14.8	36	Pass



POWER SPECTRAL DENSITY

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	SA18S5W-20	RFX	2020-06-03	2021-06-03
Block - DC	Fairview Microwave	SD3379	AMZ	2020-11-04	2021-11-04
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	2020-04-14	2021-04-14

TEST DESCRIPTION

The power spectral density was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

The method AVGPSD-1 in section 11.10.3 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging and RMS detection across the full power of the burst. This method is allowed as the same method has been used to determine the conducted output power.

POWER SPECTRAL DENSITY

element

TbtTx 2019.08.30.0 XMit 2020.12.30.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9240**			**Date:**	**11-Jan-21**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**23.3 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**25.4% RH**
Project:	**None**			**Barometric Pres.:**	**1016 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

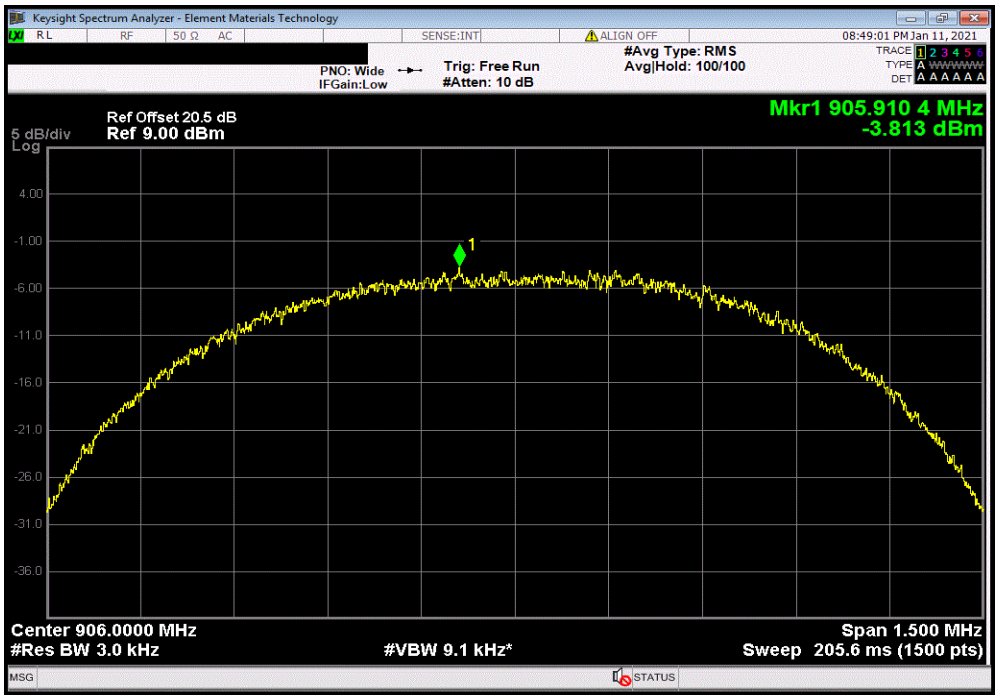
None

Configuration #	**13**	*Signature* Dustin Sparks

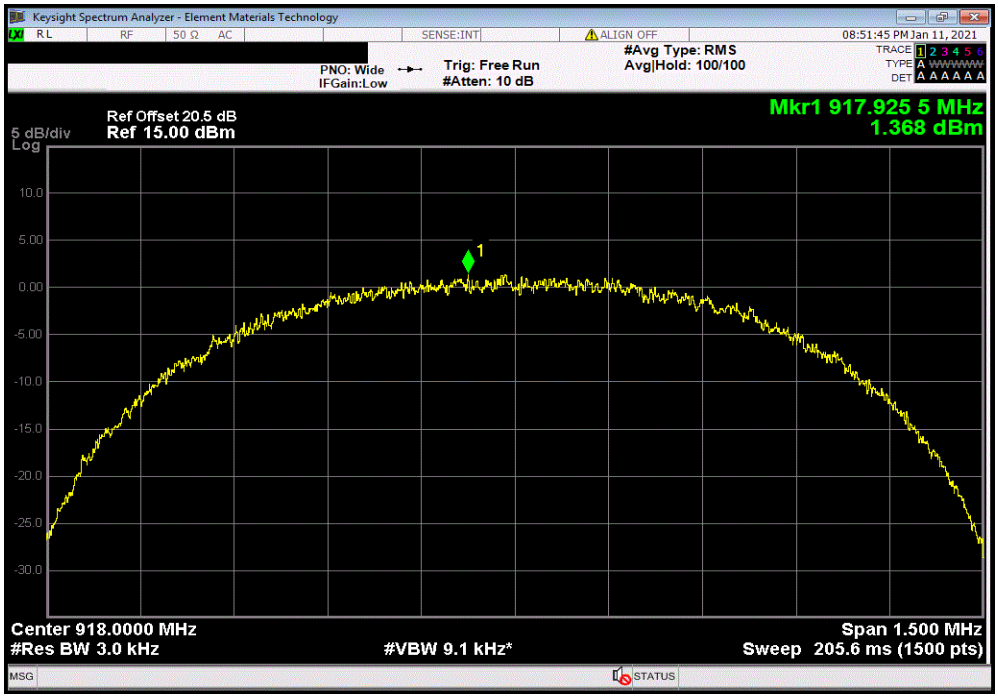
	Value dBm/3kHz	**Limit (dBm/3kHz)**	**Results**
Low Channel (906 MHz)	-3.813	8	Pass
Mid Channel (918 MHz)	1.368	8	Pass
High Channel (924 MHz)	0.844	8	Pass

POWER SPECTRAL DENSITY

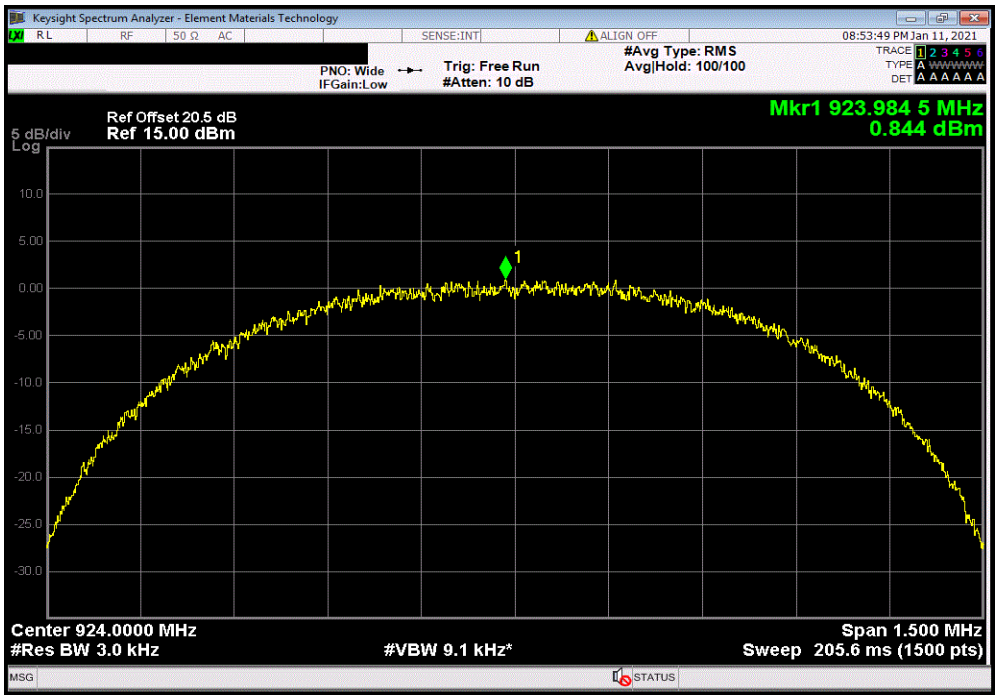
Low Channel (906 MHz)						
				Value dBm/3kHz	Limit (dBm/3kHz)	Results
				-3.813	8	Pass



Mid Channel (918 MHz)						
				Value dBm/3kHz	Limit (dBm/3kHz)	Results
				1.368	8	Pass



High Channel (924 MHz)						
				Value dBm/3kHz	Limit (dBm/3kHz)	Results
				0.844	8	Pass



BAND EDGE COMPLIANCE

XMit 2020.03.25.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5182B	TFX	28-Apr-20	28-Apr-23
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
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 bands were measured with the EUT set to low and high transmit frequencies in each available band. The channels closest to the band edges were selected. The EUT was transmitting at the data rate(s) listed in the datasheet.

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

An RMS detector was used to match the method called out for Output Power. Because the reference level was taken with an RMS detector, the attenuation requirement is -30 dBc.

BAND EDGE COMPLIANCE

element

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**20-Aug-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**22.2 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**56.5% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

Reference level offset on the spectrum analyzer includes the measurement cable, 20 dB attenuator, and DC block.

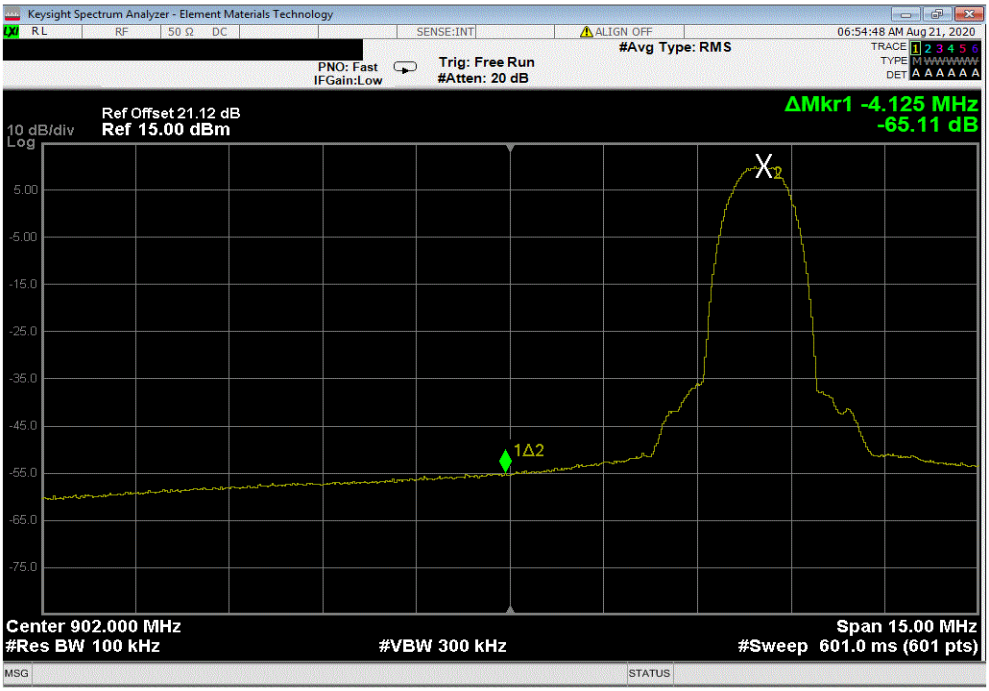
DEVIATIONS FROM TEST STANDARD

None

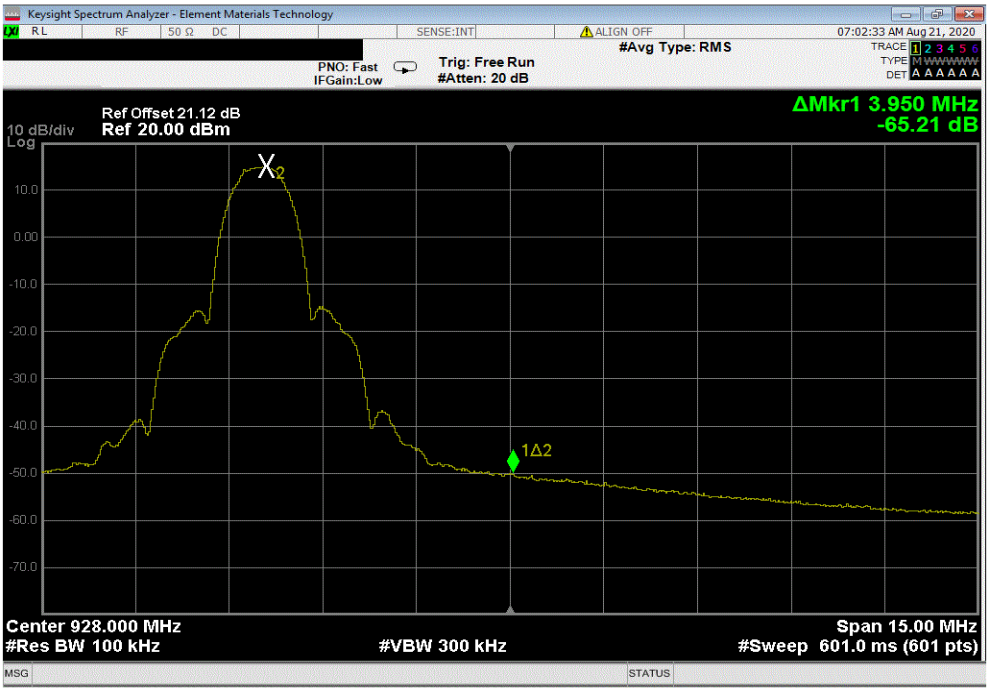
Configuration #	**2**	*Signature* Dustin Sparks

	Value (dBc)	**Limit ≤ (dBc)**	**Result**
Low Channel (906 MHz)	-65.11	-30	Pass
High Channel (924 MHz)	-65.21	-30	Pass

Low Channel (906 MHz)						
				Value (dBc)	Limit ≤ (dBc)	Result
				-65.11	-30	Pass



High Channel (924 MHz)						
				Value (dBc)	Limit ≤ (dBc)	Result
				-65.21	-30	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	N5182B	TFX	28-Apr-20	28-Apr-23
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-20
Attenuator	S.M. Electronics	SA26B-20	RFW	10-Feb-20	10-Feb-21
Block - DC	Fairview Microwave	SD3379	AMI	5-Aug-20	5-Aug-21
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. For each transmit frequency, the spectrum was scanned throughout the specified frequency range.

Because an RMS detector was used to measure Output Power, the attenuation requirement is -30 dBc.

SPURIOUS CONDUCTED EMISSIONS

TbtTx 2019.08.30.0 XMit 2020.03.25.0

EUT:	**Lunar**			**Work Order:**	**MSAS0004**
Serial Number:	**9628**			**Date:**	**20-Aug-20**
Customer:	**MSA Innovation, LLC**			**Temperature:**	**22.3 °C**
Attendees:	**Dustin Morris**			**Humidity:**	**56.1% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**Battery**	**Job Site:**	**MN08**

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

COMMENTS

Reference level offset on the spectrum analyzer includes the measurement cable, 20 dB attenuator, and DC block.

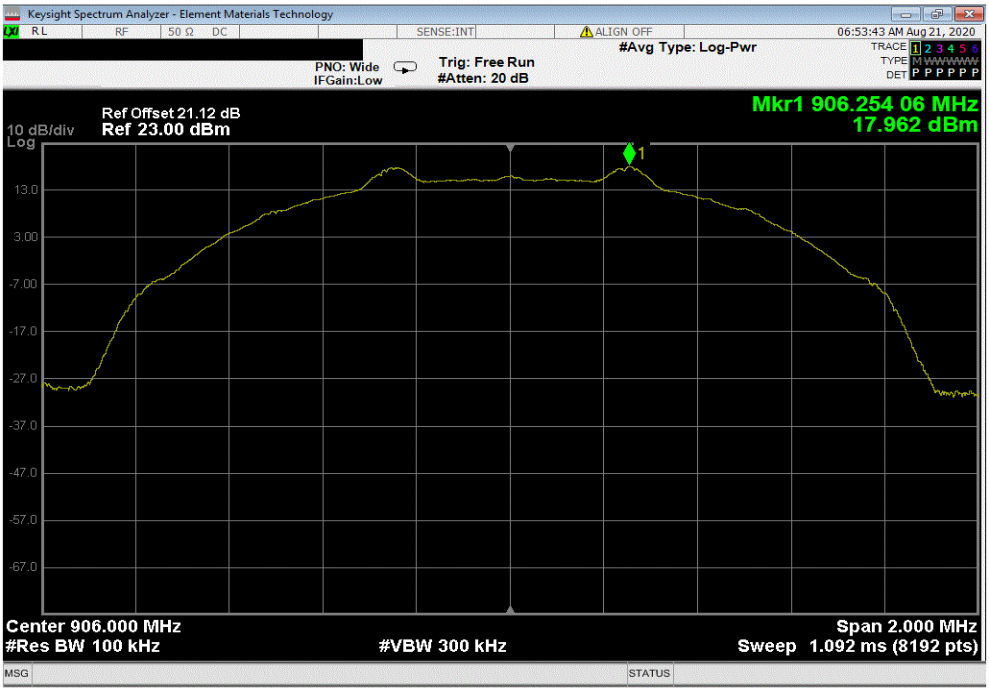
DEVIATIONS FROM TEST STANDARD

None

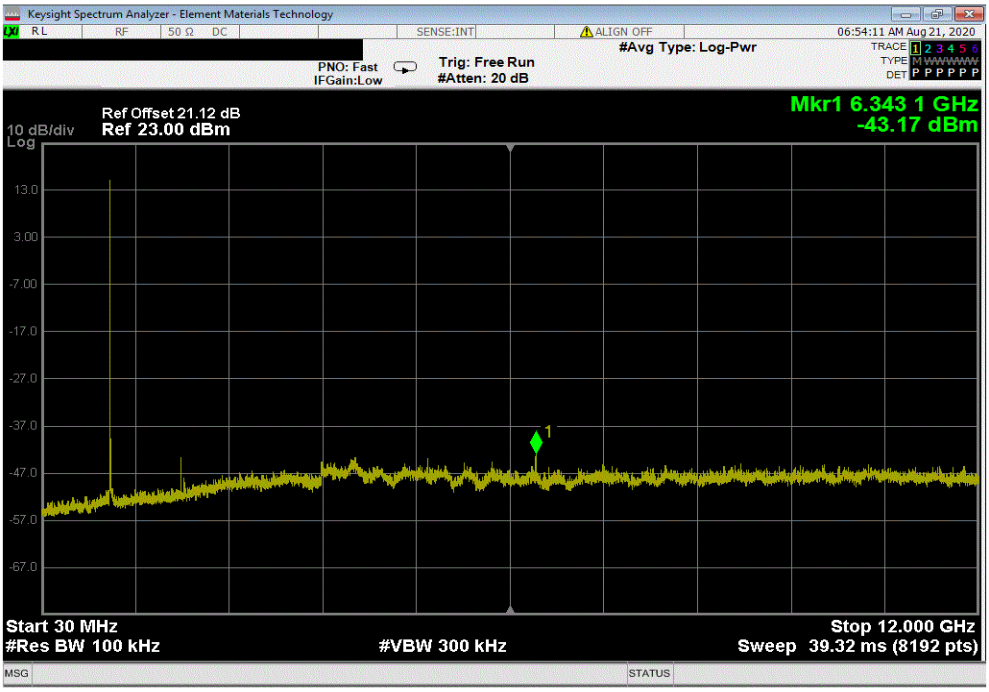
Configuration #	**2**	*Signature* Dustin Sparks

	Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Low Channel (906 MHz)	Fundamental	906.25	N/A	N/A	N/A
Low Channel (906 MHz)	30 MHz - 12 GHz	6343.08	-61.13	-30	Pass
Mid Channel (918 MHz)	Fundamental	917.76	N/A	N/A	N/A
Mid Channel (918 MHz)	30 MHz - 12 GHz	6427.83	-56.1	-30	Pass
High Channel (924 MHz)	Fundamental	924.25	N/A	N/A	N/A
High Channel (924 MHz)	30 MHz - 12 GHz	6465.83	-58.28	-30	Pass

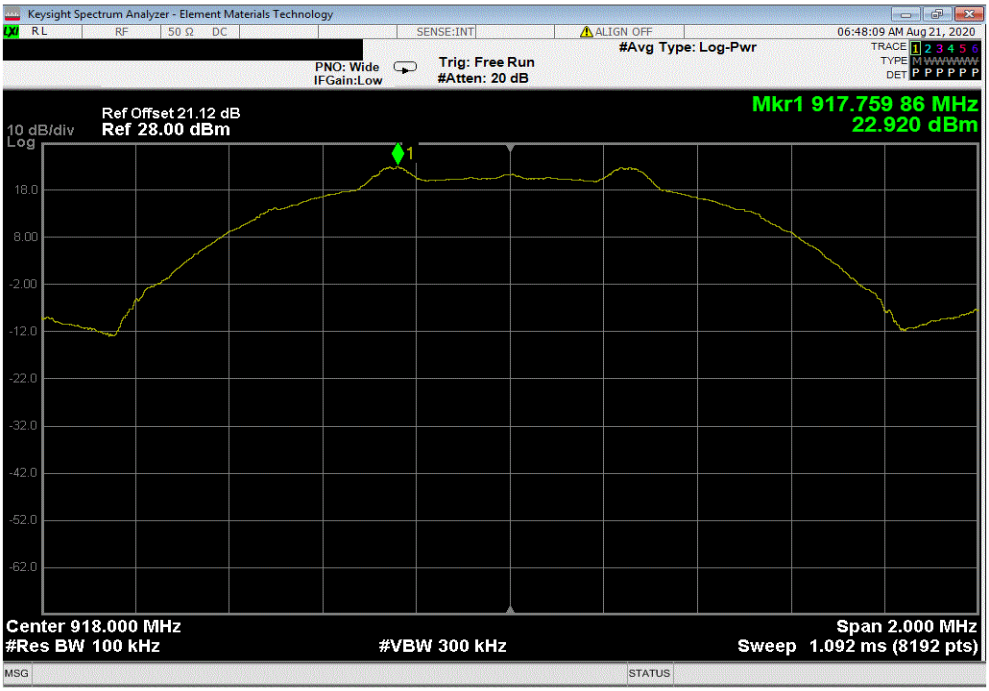
Low Channel (906 MHz)					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	906.25	N/A	N/A	N/A



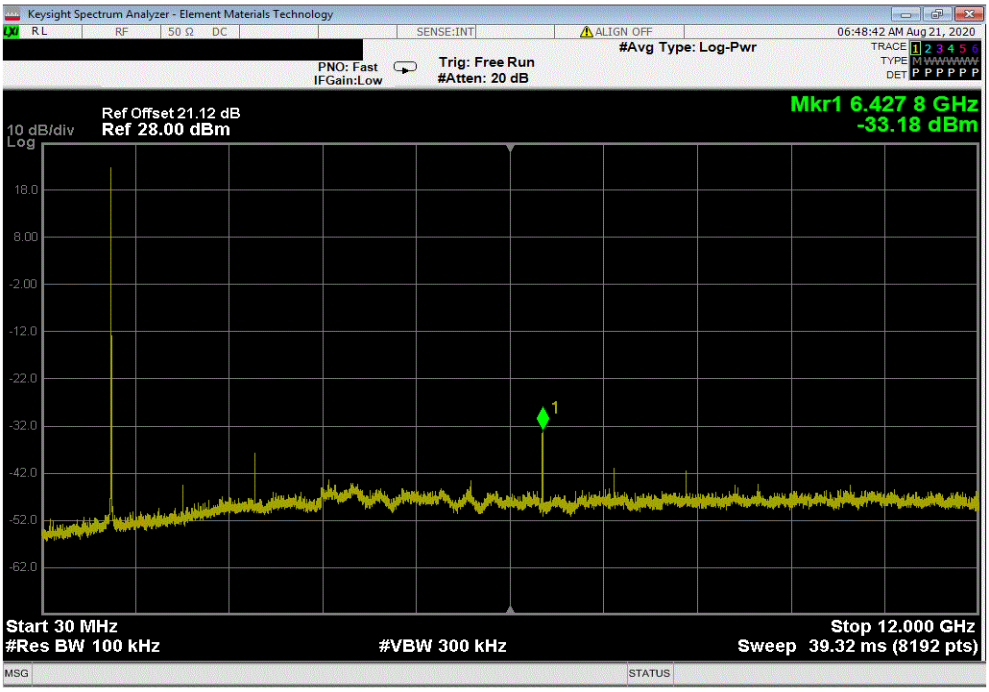
Low Channel (906 MHz)				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12 GHz	6343.08	-61.13	-30	Pass



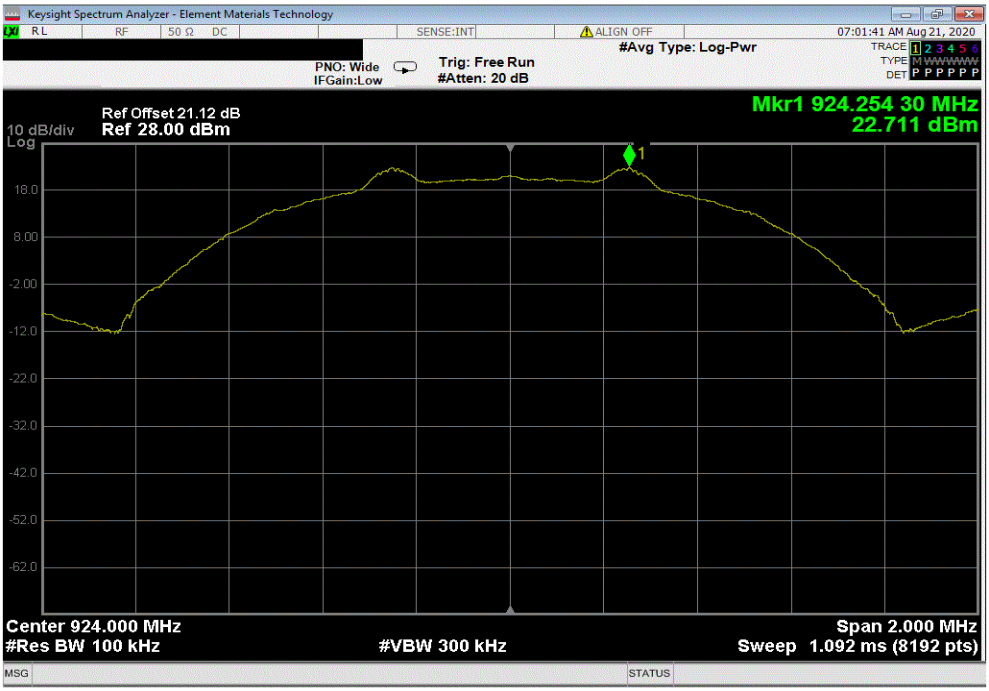
Mid Channel (918 MHz)					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	917.76	N/A	N/A	N/A



Mid Channel (918 MHz)				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12 GHz	6427.83	-56.1	-30	Pass



High Channel (924 MHz)					
Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental	924.25	N/A	N/A	N/A



High Channel (924 MHz)				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 12 GHz	6465.83	-58.28	-30	Pass