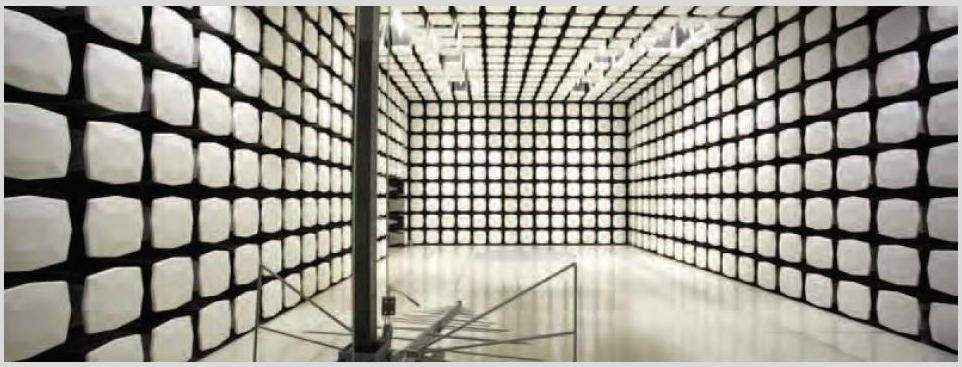
Multi-Tech Systems, Inc.

MTCAP-LNA3-915

FCC 15.247:2019
DTS

Report # MLTI0104 Rev. 1



NVLAP LAB CODE: 200881-0

CERTIFICATE OF TEST

Last Date of Test: September 20, 2019
Multi-Tech Systems, Inc.
EUT: MTCAP-LNA3-915

Radio Equipment Testing

Standards

Specification	Method
FCC 15.247:2019	ANSI C63.10:2013

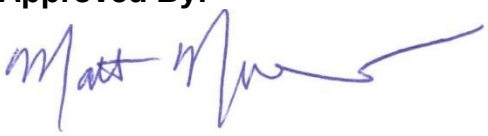
Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	No	N/A	Covered by previous testing under FCC ID AU792U13A16861.
6.5, 6.6, 11.12.1, 11.13.2	Spurious Radiated Emissions	Yes	Pass	
11.6	Duty Cycle	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.
11.9.1.1	Output Power	Yes	Pass	
11.9.1.1	Equivalent Isotropic Radiated Power	Yes	Pass	
11.11	Band Edge Compliance	No	N/A	Covered by previous testing under FCC ID AU792U13A16861.
7.8.6	Band Edge Compliance - Hopping Mode	No	N/A	Not required for DTS devices.
11.8.2	Occupied Bandwidth	Yes	Pass	
11.11	Spurious Conducted Emissions	No	N/A	Covered by previous testing under FCC ID AU792U13A16861.
11.10.2	Power Spectral Density	No	N/A	Covered by previous testing under FCC ID AU792U13A16861.

Deviations From Test Standards

None

Approved By:



Matt Nuernberg, Operations Manager

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

REVISION HISTORY

Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		
01	Equipment list updated	2019-10-14	11

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

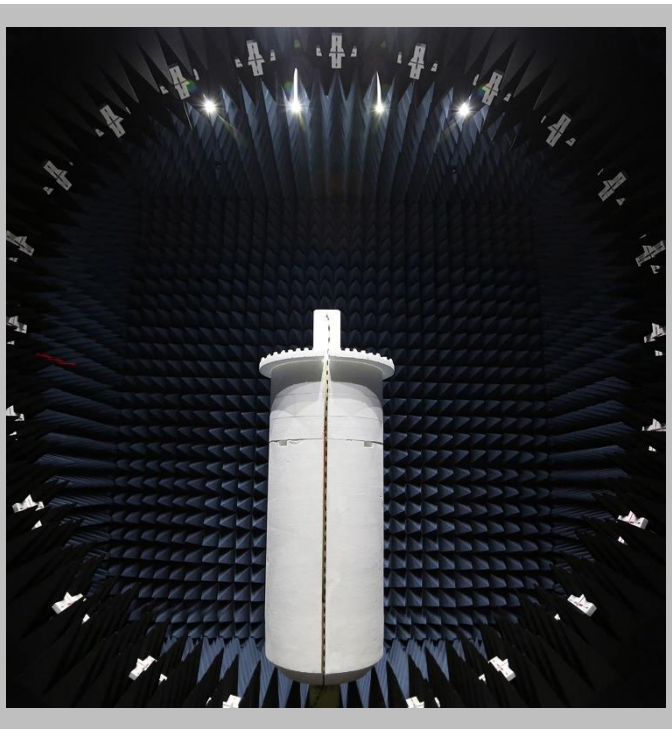
MIC – Recognized by MIC as a CAB for the acceptance of test data.

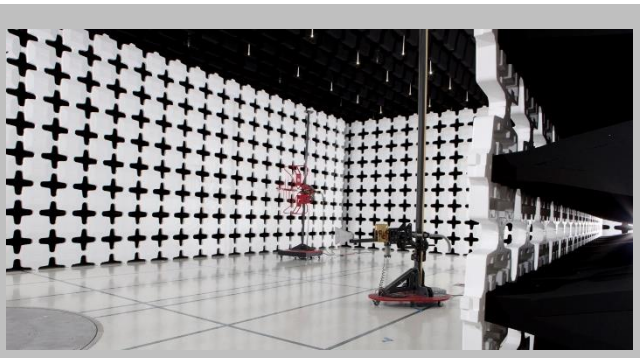
SCOPE

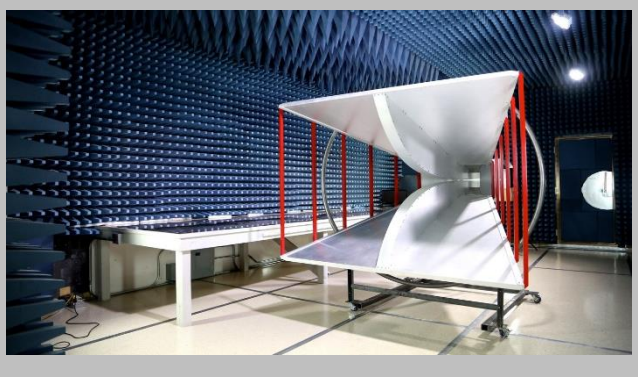
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

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







EMISSIONS MEASUREMENTS

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.

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

Measurements were made using the bandwidths and detectors specified. No video filter was used.

Sample Calculations

Radiated Emissions:

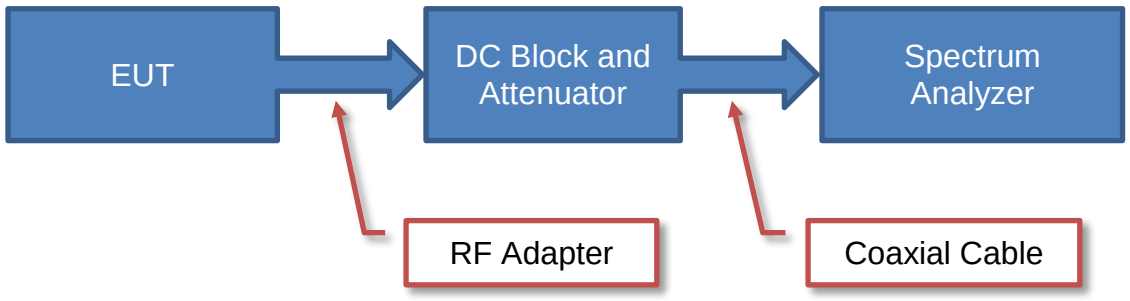
Field Strength		Measured Level		Antenna Factor		Cable Factor		Amplifier Gain		Distance Adjustment Factor		External Attenuation
33.5	=	42.6	+	28.6	+	3.1	-	40.8	+	0.0	+	0.0

Conducted Emissions:

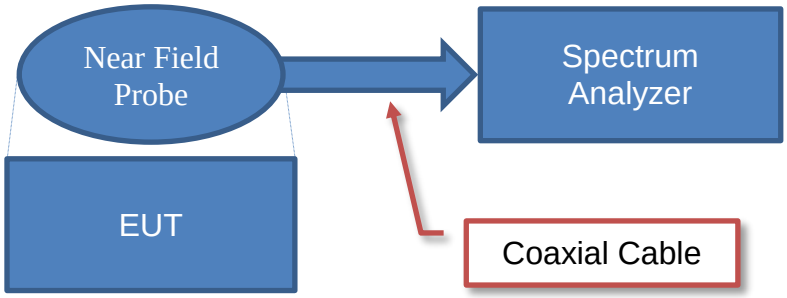
Adjusted Level		Measured Level		Transducer Factor		Cable Factor		External Attenuation
47.1	=	26.7	+	0.3	+	0.1	+	20.0

Test Setup Block Diagrams

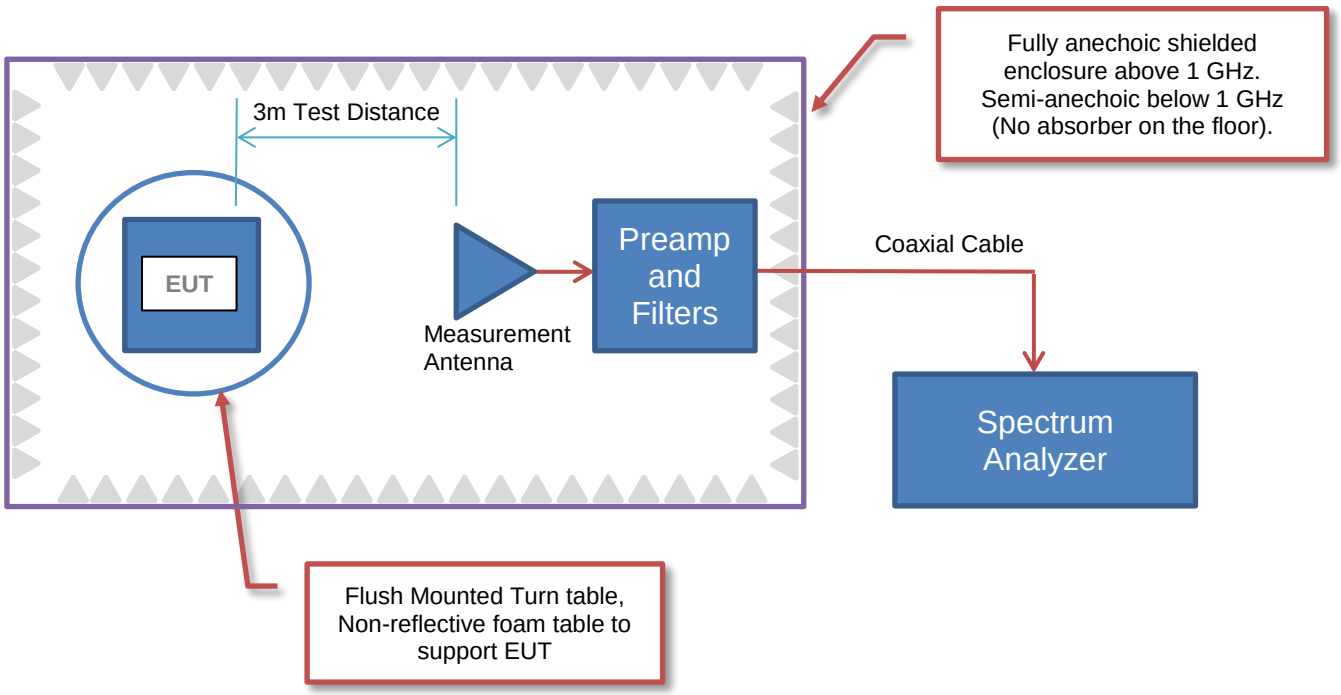
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	Multi-Tech Systems, Inc.
Address:	2205 Woodale Drive
City, State, Zip:	Saint Paul, MN 55112
Test Requested By:	Tim Gunn
EUT:	MTCAP-LNA3-915
First Date of Test:	September 20, 2019
Last Date of Test:	September 20, 2019
Receipt Date of Samples:	August 28, 2019
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
LoRa radio in a host device

Testing Objective:
Seeking to demonstrate compliance under FCC 15.247:2019 for operation in the 902 - 928 MHz Band.

CONFIGURATIONS

Configuration MLTI0104- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
MTCAP-LNA3-915	Multi-Tech Systems, Inc.	MTCAP-LNA3-915	Proto 1
AC Adapter	MEGA Electronics, Inc.	FJ-SW1260502500DN	FJ-SW1260502500DN

Remote Equipment Outside of Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Lenovo	T400	L3-AFA6P-09/01
AC Adapter (Laptop)	Lenovo	42T4418	11S42T4418ZGWG2985Y8
MTCAP-LNA3-915	Multi-Tech Systems, Inc.	MTCAP-LNA3-915	Proto 2

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Power	No	1.4 m	No	MTCAP-LNA3-915	AC Adapter (Laptop)
LAN Cat 6	No	>3 m	No	MTCAP-LNA3-915	Laptop
AC Power (Laptop)	No	0.8 m	No	AC Mains	AC Adapter (Laptop)
DC Power (Laptop)	No	1.7 m	No	AC Adapter (Laptop)	Laptop

Configuration MLTI0104- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
MTCAP-LNA3-915	Multi-Tech Systems, Inc.	MTCAP-LNA3-915	Proto 1
AC Adapter	MEGA Electronics, Inc.	FJ-SW1260502500DN	FJ-SW1260502500DN

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Lenovo	T400	L3-AFA6P-09/01
AC Adapter (Laptop)	Lenovo	42T4418	11S42T4418ZGWG2985Y8

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Power	No	1.4 m	No	MTCAP-LNA3-915	AC Adapter (Laptop)
LAN Cat 6	No	>3 m	No	MTCAP-LNA3-915	Laptop
AC Power (Laptop)	No	0.8 m	No	AC Mains	AC Adapter (Laptop)
DC Power (Laptop)	No	1.7 m	No	AC Adapter (Laptop)	Laptop

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2019-09-20	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	2019-09-20	Equivalent Isotropic Radiated Power (EIRP)	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	2019-09-20	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.
4	2019-09-20	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

SPURIOUS RADIATED EMISSIONS

PSA-ESCI 2019.05.10

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

MODES OF OPERATION

Transmitting LoRa - low, mid, or high channel at 923.3, 925.1, or 927.5 MHz.

POWER SETTINGS INVESTIGATED

110VAC/60Hz

CONFIGURATIONS INVESTIGATED

MLTI0104 - 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
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	8-Feb-2019	12 mo
Filter - High Pass	Micro-Tronics	HPM50108	LFM	12-Sep-2019	12 mo
Filter - Low Pass	Micro-Tronics	LPM50003	LFJ	17-Sep-2019	12 mo
Filter - Band Pass/Notch	K&L Microwave	3TNF-500/1000-N/N	HGS	13-Jul-2019	12 mo
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	8-Mar-2019	12 mo
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	17-Sep-2019	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	8-Feb-2019	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	0 mo
Antenna - Double Ridge	ETS-Lindgren	3115	AJQ	16-Jan-2019	24 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	2-Nov-2018	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AYD	25-Jan-2018	24 mo
Cable	ESM Cable Corp.	Bilog Cables	MNH	2-Nov-2018	12 mo
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFD	28-Jul-2019	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

SPURIOUS RADIATED EMISSIONS

TEST DESCRIPTION

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

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

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

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

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

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

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

Measurements at the edges of the allowable band may be presented in an alternative method as provided for in the ANSI C63.10 Marker-Delta method. This method involves performing an in-band fundamental measurement followed by a screen capture of the fundamental and out-of-band emission using reduced measurement instrumentation bandwidths. The amplitude delta measured on this screen capture is applied to the fundamental emission value to show the out-of-band emission level as applied to the limit.

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

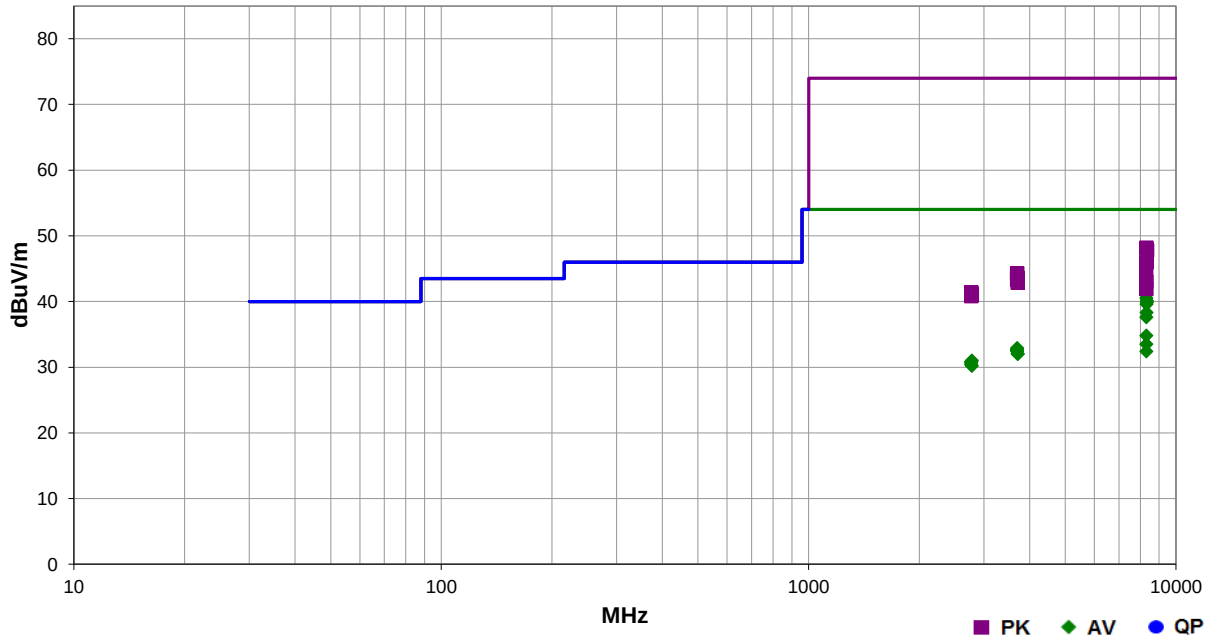
SPURIOUS RADIATED EMISSIONS

EmiR5 2019.08.01 PSA-ESCI 2019.05.10

Work Order:	MLTI0104	**Date:**	20-Sep-2019		
Project:	None	**Temperature:**	21.7 °C		
Job Site:	MN05	**Humidity:**	68.8% RH		
Serial Number:	Proto 1	**Barometric Pres.:**	1020 mbar	**Tested by:**	Kyle McMullan
EUT:	MTCAP-LNA3-915				
Configuration:	1				
Customer:	Multi-Tech Systems, Inc.				
Attendees:	Jim Asp				
EUT Power:	110VAC/60Hz				
Operating Mode:	Transmitting LoRa - low, mid, or high channel at 923.3, 925.1, or 927.5 MHz.				
Deviations:	None				
Comments:	None				

Test Specifications	**Test Method**
FCC 15.247:2019	ANSI C63.10:2013

Run #	23	**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	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
8309.530	48.2	-7.0	3.8	55.0	3.0	0.0	Horz	AV	0.0	41.2	54.0	-12.8	EUT Vert, Low Ch
8309.490	47.5	-7.0	1.5	286.0	3.0	0.0	Horz	AV	0.0	40.5	54.0	-13.5	EUT On Side, Low Ch
8347.580	47.0	-6.9	3.6	40.0	3.0	0.0	Horz	AV	0.0	40.1	54.0	-13.9	EUT Vert, High Ch
8347.500	46.8	-6.9	2.2	91.0	3.0	0.0	Vert	AV	0.0	39.9	54.0	-14.1	EUT Horz, High Ch
8325.780	46.5	-6.9	2.4	328.0	3.0	0.0	Vert	AV	0.0	39.6	54.0	-14.4	EUT Horz, Mid Ch
8325.860	45.2	-6.9	4.0	322.9	3.0	0.0	Horz	AV	0.0	38.3	54.0	-15.7	EUT Vert, Mid Ch
8309.580	44.6	-7.0	2.1	73.0	3.0	0.0	Vert	AV	0.0	37.6	54.0	-16.4	EUT Horz, Low Ch
8309.620	41.8	-7.0	4.0	225.0	3.0	0.0	Vert	AV	0.0	34.8	54.0	-19.2	EUT On Side, Low Ch
8309.370	40.5	-7.0	1.5	354.9	3.0	0.0	Vert	AV	0.0	33.5	54.0	-20.5	EUT Vert, Low Ch
3700.350	31.9	1.0	1.6	58.0	3.0	0.0	Horz	AV	0.0	32.9	54.0	-21.1	EUT Vert, Mid Ch
3693.467	31.6	1.1	1.5	47.0	3.0	0.0	Vert	AV	0.0	32.7	54.0	-21.3	EUT Horz, Low Ch
3693.750	31.5	1.1	1.5	304.9	3.0	0.0	Horz	AV	0.0	32.6	54.0	-21.4	EUT Vert, Low Ch
8309.620	39.4	-7.0	1.5	23.9	3.0	0.0	Horz	AV	0.0	32.4	54.0	-21.6	EUT Horz, Low Ch
3698.400	31.3	1.1	1.7	40.0	3.0	0.0	Vert	AV	0.0	32.4	54.0	-21.6	EUT Horz, Mid Ch
3710.100	31.0	1.0	1.5	268.9	3.0	0.0	Horz	AV	0.0	32.0	54.0	-22.0	EUT Vert, High Ch
3710.025	31.0	1.0	1.5	358.9	3.0	0.0	Vert	AV	0.0	32.0	54.0	-22.0	EUT Horz, High Ch
2782.667	33.7	-2.7	1.5	343.9	3.0	0.0	Vert	AV	0.0	31.0	54.0	-23.0	EUT Horz, High Ch

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2775.300	33.5	-2.7	1.5	342.0	3.0	0.0	Vert	AV	0.0	30.8	54.0	-23.2	EUT Horz, Mid Ch
2775.217	33.5	-2.7	1.4	1.0	3.0	0.0	Horz	AV	0.0	30.8	54.0	-23.2	EUT Vert, Mid Ch
2769.992	33.6	-2.9	1.5	192.9	3.0	0.0	Horz	AV	0.0	30.7	54.0	-23.3	EUT Vert, Low Ch
2770.017	33.3	-2.9	1.5	148.0	3.0	0.0	Vert	AV	0.0	30.4	54.0	-23.6	EUT Horz, Low Ch
2782.460	32.9	-2.7	2.8	52.0	3.0	0.0	Horz	AV	0.0	30.2	54.0	-23.8	EUT Vert, High Ch
8309.700	55.2	-7.0	3.8	55.0	3.0	0.0	Horz	PK	0.0	48.2	74.0	-25.8	EUT Vert, Low Ch
8309.870	55.1	-7.0	1.5	286.0	3.0	0.0	Horz	PK	0.0	48.1	74.0	-25.9	EUT On Side, Low Ch
8347.580	54.7	-6.9	2.2	91.0	3.0	0.0	Vert	PK	0.0	47.8	74.0	-26.2	EUT Horz, High Ch
8347.500	54.7	-6.9	3.6	40.0	3.0	0.0	Horz	PK	0.0	47.8	74.0	-26.2	EUT Vert, High Ch
8326.650	54.0	-6.9	2.4	328.0	3.0	0.0	Vert	PK	0.0	47.1	74.0	-26.9	EUT Horz, Mid Ch
8326.320	52.9	-6.9	4.0	322.9	3.0	0.0	Horz	PK	0.0	46.0	74.0	-28.0	EUT Vert, Mid Ch
8309.160	52.9	-7.0	2.1	73.0	3.0	0.0	Vert	PK	0.0	45.9	74.0	-28.1	EUT Horz, Low Ch
3698.008	43.2	1.1	1.7	40.0	3.0	0.0	Vert	PK	0.0	44.3	74.0	-29.7	EUT Horz, Mid Ch
3695.667	43.2	1.1	1.5	304.9	3.0	0.0	Horz	PK	0.0	44.3	74.0	-29.7	EUT Vert, Low Ch
8308.030	50.8	-7.0	4.0	225.0	3.0	0.0	Vert	PK	0.0	43.8	74.0	-30.2	EUT On Side, Low Ch
3711.667	42.6	1.0	1.5	358.9	3.0	0.0	Vert	PK	0.0	43.6	74.0	-30.4	EUT Horz, High Ch
3693.758	42.3	1.1	1.5	47.0	3.0	0.0	Vert	PK	0.0	43.4	74.0	-30.6	EUT Horz, Low Ch
3700.308	42.3	1.0	1.6	58.0	3.0	0.0	Horz	PK	0.0	43.3	74.0	-30.7	EUT Vert, Mid Ch
8309.030	50.0	-7.0	1.5	354.9	3.0	0.0	Vert	PK	0.0	43.0	74.0	-31.0	EUT Vert, Low Ch
3709.292	41.9	1.0	1.5	268.9	3.0	0.0	Horz	PK	0.0	42.9	74.0	-31.1	EUT Vert, High Ch
8310.200	48.9	-7.0	1.5	23.9	3.0	0.0	Horz	PK	0.0	41.9	74.0	-32.1	EUT Horz, Low Ch
2771.892	44.3	-2.9	1.5	148.0	3.0	0.0	Vert	PK	0.0	41.4	74.0	-32.6	EUT Horz, Low Ch
2773.460	44.0	-2.7	2.8	52.0	3.0	0.0	Horz	PK	0.0	41.3	74.0	-32.7	EUT Vert, High Ch
2774.800	44.0	-2.7	1.4	1.0	3.0	0.0	Horz	PK	0.0	41.3	74.0	-32.7	EUT Vert, Mid Ch
2770.233	44.2	-2.9	1.5	192.9	3.0	0.0	Horz	PK	0.0	41.3	74.0	-32.7	EUT Vert, Low Ch
2783.742	43.7	-2.7	1.5	343.9	3.0	0.0	Vert	PK	0.0	41.0	74.0	-33.0	EUT Horz, High Ch
2774.658	43.5	-2.7	1.5	342.0	3.0	0.0	Vert	PK	0.0	40.8	74.0	-33.2	EUT Horz, Mid Ch

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.

OUTPUT POWER

XMit 2019.09.05

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Agilent	N5173B	TIW	5-Jul-17	5-Jul-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Attenuator	Fairview Microwave	18B5W-26	RFY	7-Jun-19	7-Jun-20
Block - DC	Fairview Microwave	SD3379	AMI	6-Aug-19	6-Aug-20
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The 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-1 in section 11.9.2.2.2 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging across with the EUT transmitting at full power throughout each sweep. in the spectrum analyzer channel power function using an RMS detector.

OUTPUT POWER

element

TbtTx 2019.08.02 XMit 2019.09.05

EUT:	MTCAP-LNA3-915			**Work Order:**	MLTI0104
Serial Number:	Proto 1			**Date:**	20-Sep-19
Customer:	Multi-Tech Systems, Inc.			**Temperature:**	21.8 °C
Attendees:	Jim Asp			**Humidity:**	62.3% RH
Project:	None			**Barometric Pres.:**	1017 mbar
Tested by:	Kyle McMullan	**Power:**	110VAC/60Hz	**Job Site:**	MN08

TEST SPECIFICATIONS	Test Method
FCC 15.247:2019	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

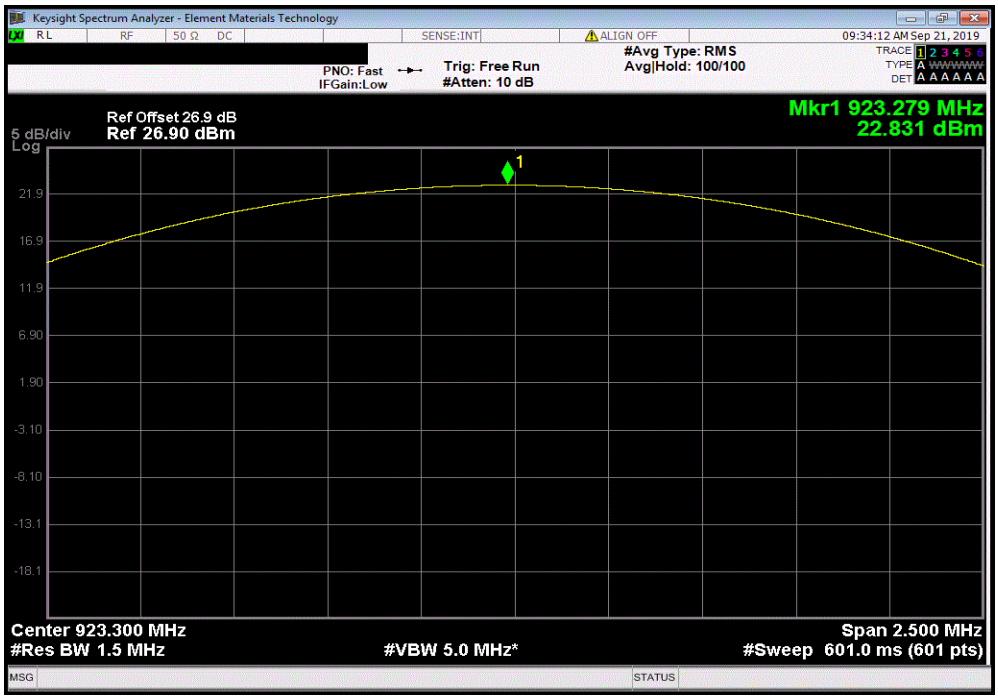
None

Configuration #	2	Signature

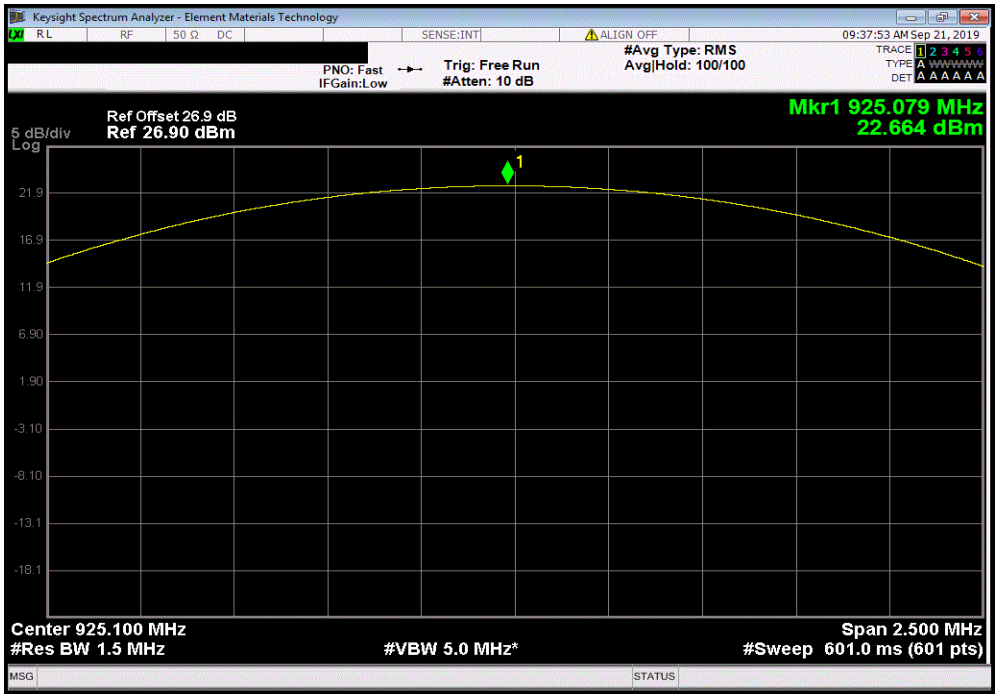
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
LoRa Low Channel, 923.3 MHz	22.831	0	22.8	30	Pass
LoRa Mid Channel, 925.1 MHz	22.664	0	22.7	30	Pass
LoRa High Channel, 927.5 MHz	22.523	0	22.5	30	Pass

OUTPUT POWER

LoRa Low Channel, 923.3 MHz						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
		22.831	0	22.8	30	Pass

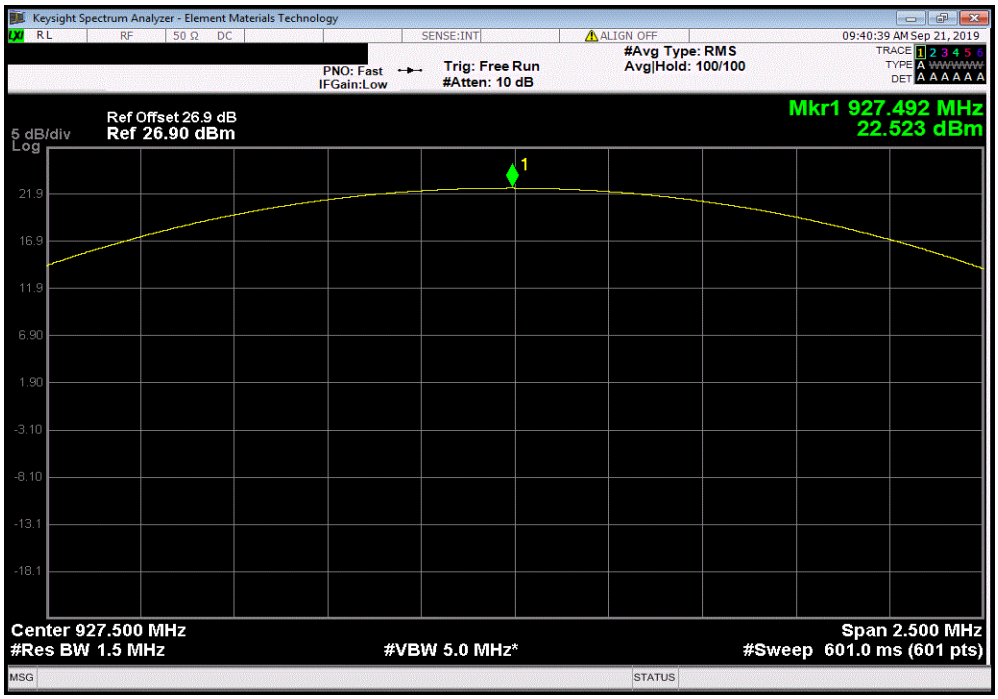


LoRa Mid Channel, 925.1 MHz						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
		22.664	0	22.7	30	Pass



OUTPUT POWER

LoRa High Channel, 927.5 MHz						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
		22.523	0	22.5	30	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

XMit 2019.09.05

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Agilent	N5173B	TIW	5-Jul-17	5-Jul-20
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	MNU	11-Apr-19	11-Apr-20
Attenuator	Fairview Microwave	18B5W-26	RFY	7-Jun-19	7-Jun-20
Block - DC	Fairview Microwave	SD3379	AMI	6-Aug-19	6-Aug-20
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The 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 manufacturer declared antenna gain was added to the output power to calculate the EIRP.

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

element

TbtTx 2019.08.02 XMit 2019.09.05

EUT:	MTCAP-LNA3-915			**Work Order:**	MLTI0104
Serial Number:	Proto 1			**Date:**	20-Sep-19
Customer:	Multi-Tech Systems, Inc.			**Temperature:**	21.8 °C
Attendees:	Jim Asp			**Humidity:**	62.2% RH
Project:	None			**Barometric Pres.:**	1017 mbar
Tested by:	Kyle McMullan	**Power:**	110VAC/60Hz	**Job Site:**	MN08

TEST SPECIFICATIONS	Test Method
FCC 15.247:2019	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

Configuration #	2	Signature

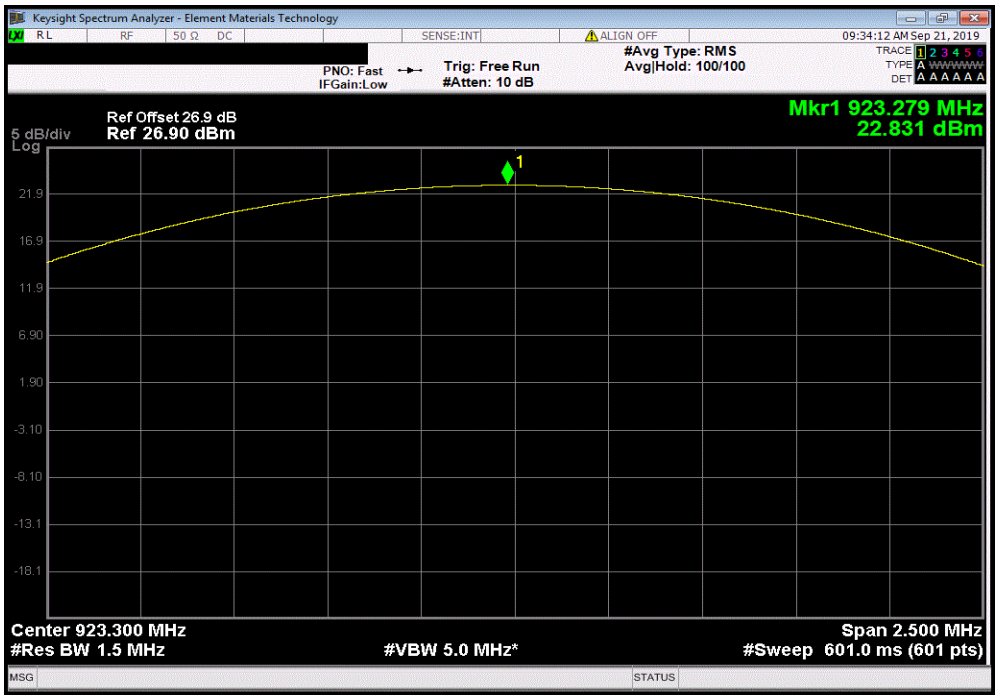
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
LoRa Low Channel, 923.3 MHz	22.831	0	22.8	3	25.8	36	Pass
LoRa Mid Channel, 925.1 MHz	22.664	0	22.7	3	25.7	36	Pass
LoRa High Channel, 927.5 MHz	22.523	0	22.5	3	25.5	36	Pass

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

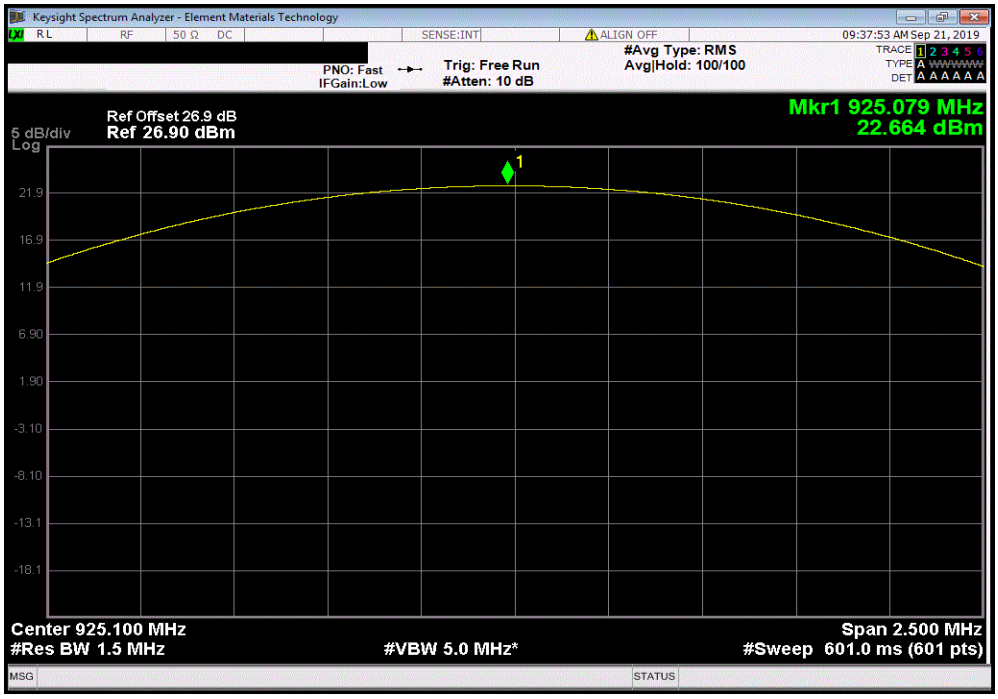
element

TbtTx 2019.08.02 XMit 2019.09.05

LoRa Low Channel, 923.3 MHz						
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
22.831	0	22.8	3	25.8	36	Pass



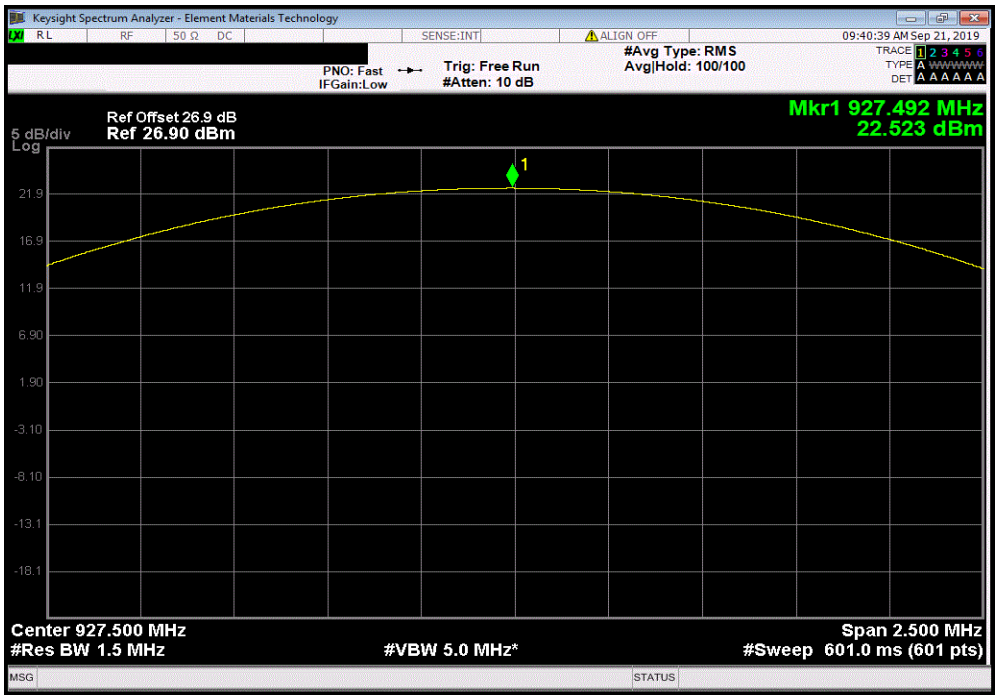
LoRa Mid Channel, 925.1 MHz						
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
22.664	0	22.7	3	25.7	36	Pass



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

TbtTx 2019.08.02 XMit 2019.09.05

LoRa High Channel, 927.5 MHz						
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
22.523	0	22.5	3	25.5	36	Pass



OCCUPIED BANDWIDTH

XMit 2019.09.05

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Agilent	N5173B	TIW	5-Jul-17	5-Jul-20
Attenuator	Fairview Microwave	18B5W-26	RFY	7-Jun-19	7-Jun-20
Attenuator	S.M. Electronics	SA26B-20	RFW	13-Feb-19	13-Feb-20
Block - DC	Fairview Microwave	SD3379	AMI	6-Aug-19	6-Aug-20
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	1-May-19	1-May-20

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The EUT was set to the channels and modes listed in the datasheet.

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

OCCUPIED BANDWIDTH

TbtTx 2019.08.02 XMit 2019.09.05

EUT:	MTCAP-LNA3-915			**Work Order:**	MLTI0104
Serial Number:	Proto 1			**Date:**	20-Sep-19
Customer:	Multi-Tech Systems, Inc.			**Temperature:**	21.7 °C
Attendees:	Jim Asp			**Humidity:**	62% RH
Project:	None			**Barometric Pres.:**	1017 mbar
Tested by:	Kyle McMullan	**Power:**	110VAC/60Hz	**Job Site:**	MN08

TEST SPECIFICATIONS	Test Method
FCC 15.247:2019	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

Configuration #	2	Signature

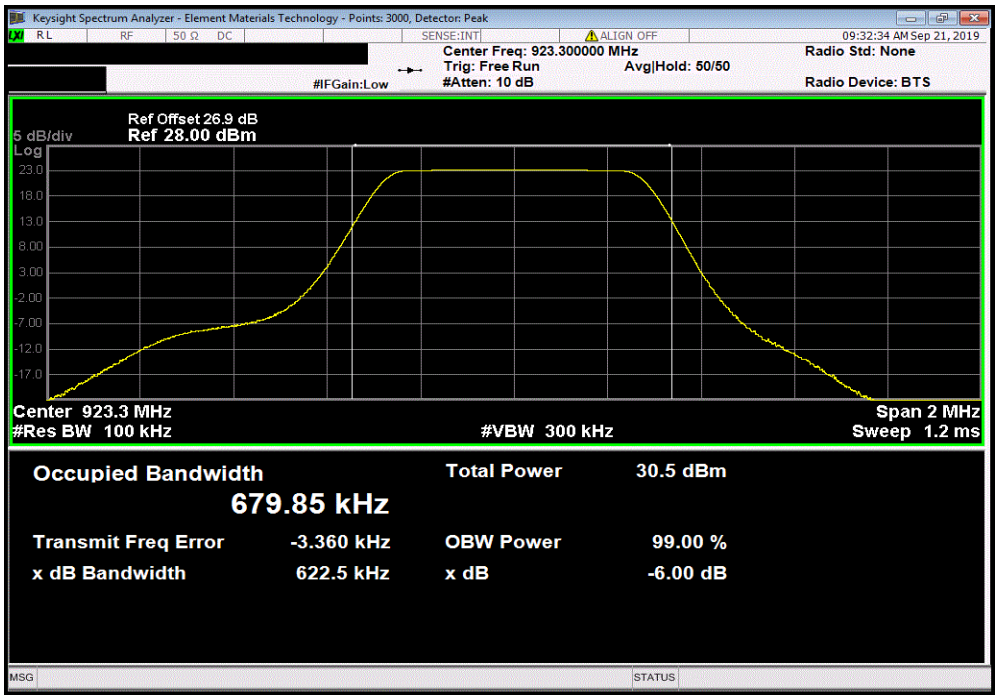
	Value	Limit (>)	Result
LoRa Low Channel, 923.3 MHz	622.47 kHz	500 kHz	Pass
LoRa Mid Channel, 925.1 MHz	621.587 kHz	500 kHz	Pass
LoRa High Channel, 927.5 MHz	621.251 kHz	500 kHz	Pass

OCCUPIED BANDWIDTH

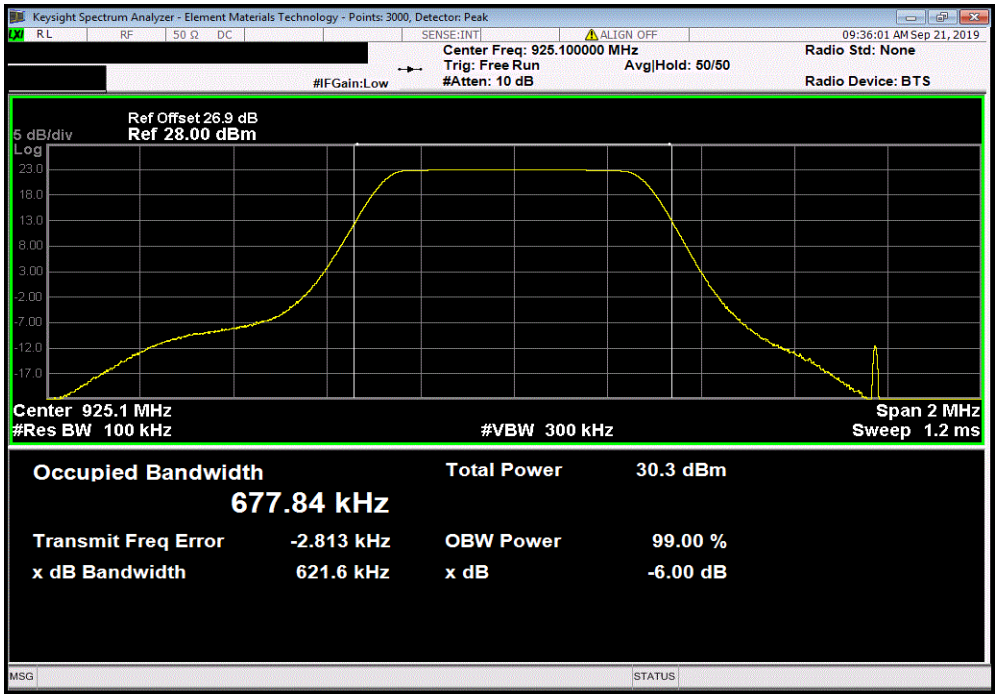
element

TbtTx 2019.08.02 XMit 2019.09.05

LoRa Low Channel, 923.3 MHz						
				Value	Limit (>)	Result
				622.47 kHz	500 kHz	Pass



LoRa Mid Channel, 925.1 MHz						
				Value	Limit (>)	Result
				621.587 kHz	500 kHz	Pass



OCCUPIED BANDWIDTH

LoRa High Channel, 927.5 MHz						
				Value	Limit (>)	Result
				621.251 kHz	500 kHz	Pass