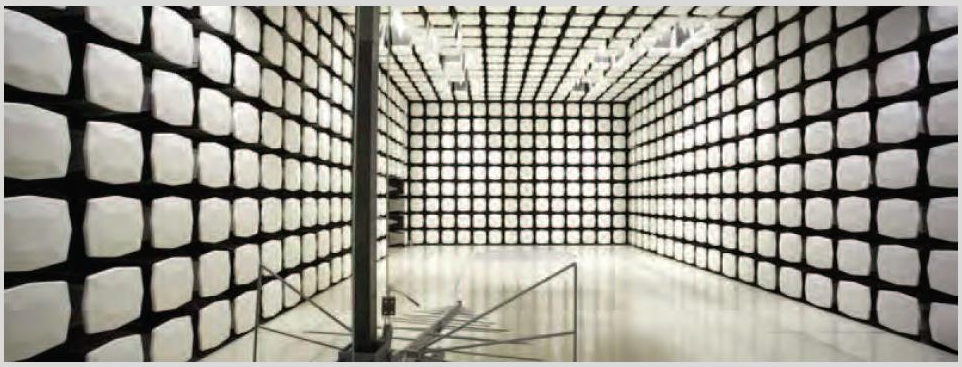
Multi-Tech Systems, Inc.

MTCAP2-915-042-POE

DTS Transceiver
FCC 15.207:2019, FCC 15.207:2020, FCC 15.247:2019

Report # MLTI0132.1 Rev. 2



NVLAP LAB CODE: 200881-0

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CERTIFICATE OF TEST

Last Date of Test: February 4, 2020
Multi-Tech Systems, Inc.
EUT: MTCAP2-915-042-POE

Radio Equipment Testing

Standards

Specification	Method
FCC 15.207:2019	ANSI C63.10:2013, KDB 558074
FCC 15.207:2020	
FCC 15.247:2019	

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions (Transmitter)	Yes	Pass	
6.5, 6.6	Spurious Radiated Emissions	Yes	Pass	
7.5	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.
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	No	N/A	Not required for DTS devices.
7.8.7	Occupied Bandwidth	Yes	Pass	
7.8.8	Spurious Conducted Emissions	Yes	Pass	
11.10.2	Power Spectral Density	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		
01	Product Description updated	2020-01-10	8
02	FCC 15.207:2020 added	2020-02-07	Cover, 2
02	Updated Configurations	2020-02-07	10
02	Updated last day of testing	2020-02-07	2, 8, 11
02	Added data	2020-02-07	17-23

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

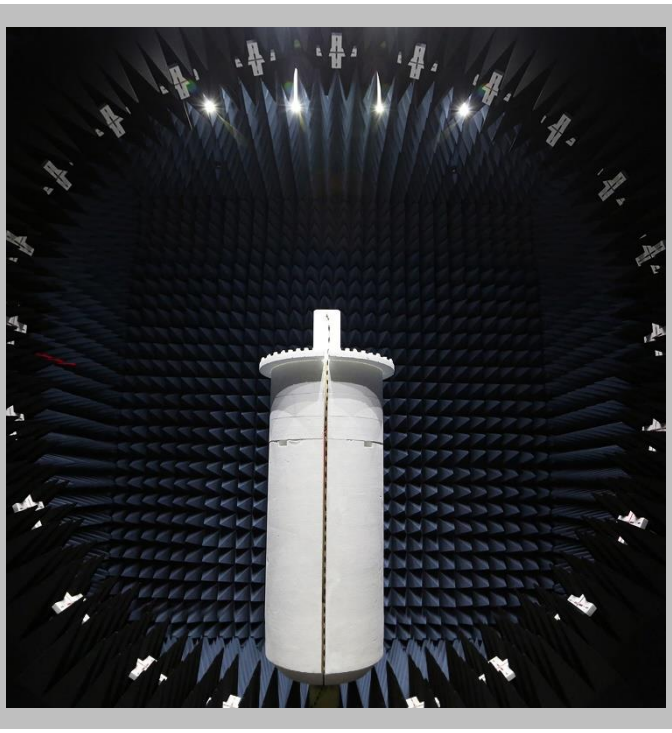
MIC – Recognized by MIC as a CAB for the acceptance of test data.

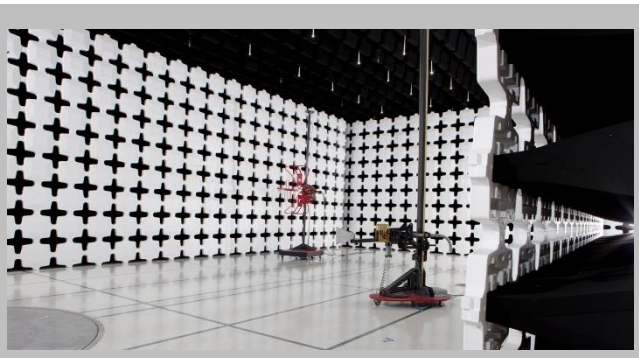
SCOPE

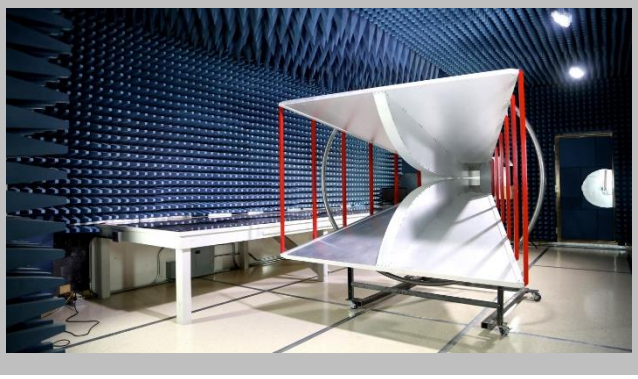
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

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:

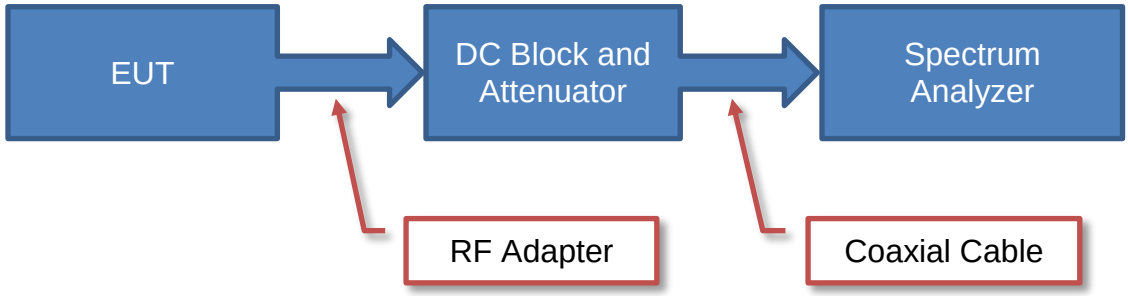
Field Strength		Measured Level		Antenna Factor		Cable Factor		Amplifier Gain		Distance Adjustment Factor		External Attenuation
33.5	=	42.6	+	28.6	+	3.1	-	40.8	+	0.0	+	0.0

Conducted Emissions:

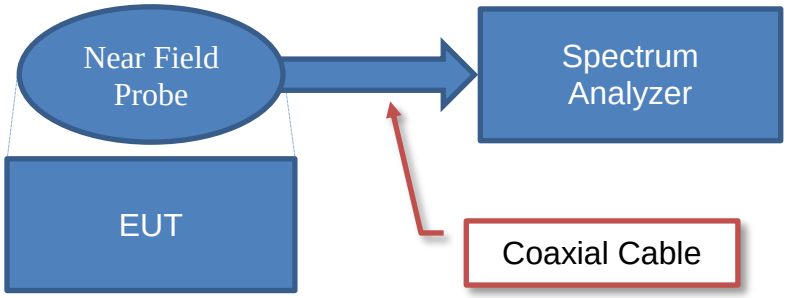
Adjusted Level		Measured Level		Transducer Factor		Cable Factor		External Attenuation
47.1	=	26.7	+	0.3	+	0.1	+	20.0

Test Setup Block Diagrams

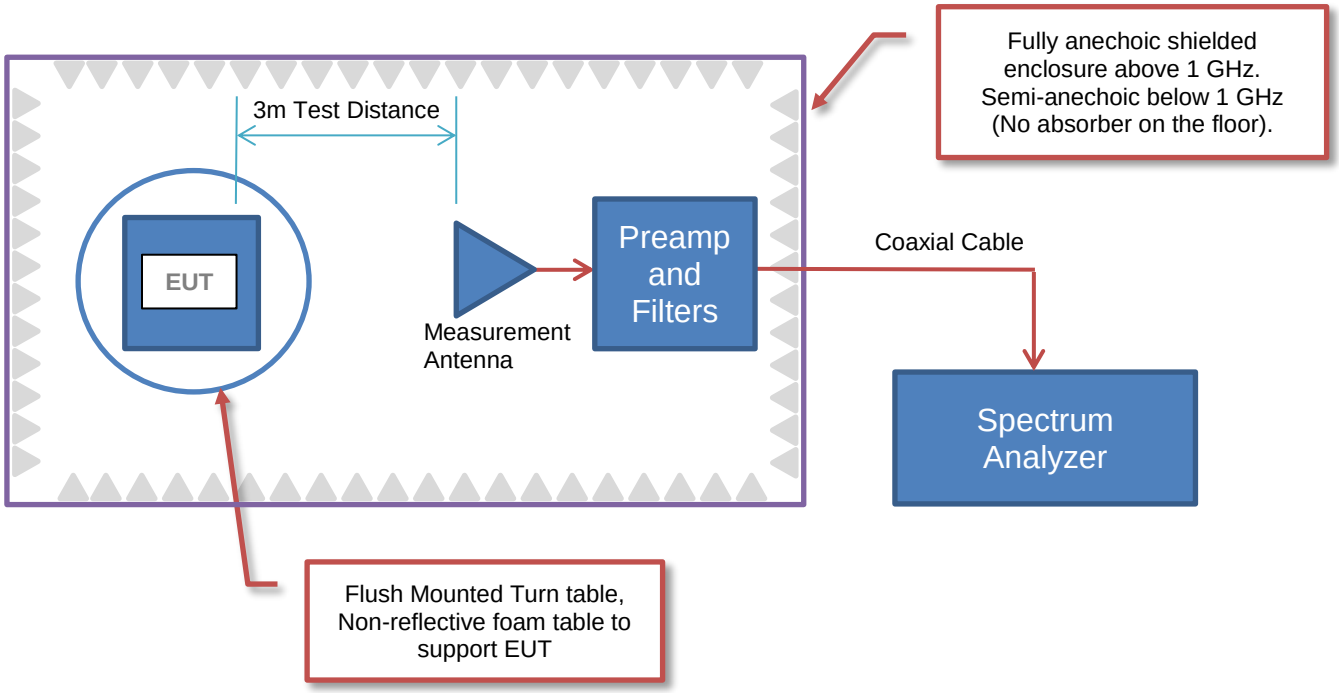
Antenna Port Conducted Measurements



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:	St. Paul, MN 55112
Test Requested By:	Jim Asp
EUT:	MTCAP2-915-042-POE
First Date of Test:	December 26, 2019
Last Date of Test:	February 4, 2020
Receipt Date of Samples:	November 25, 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:
The MultiConnect® Conduit™ AP harnesses the power of the LoRaWAN™ protocol to provide deep in-building penetration and connectivity to thousands of IoT assets. Easy to deploy thanks to integrated antennas, it can be mounted on walls or ceilings to extend LoRa® connectivity in commercial buildings like hotels, convention centers, offices and retail facilities providing coverage in difficult to reach areas cell tower or rooftop deployments may not penetrate. The Conduit AP offers two development environments for developers and users alike. For advanced developers, the mLinux, Yocto Linux BSP integrates directly to a cloud-based LoRaWAN Network Server, enterprise data center or public operator's core network. While the AEP features an easy-to-use graphical interface set-up and includes a built-in LoRa Network Server to connect locally clustered assets on a private LoRaWAN network directly to your choice of IoT data platforms. The AEP extends complex processing to the edge to reduce upstream communication and operational costs. Either way, the access point provides your choice of 4G-LTE or Ethernet IP backhaul.

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

CONFIGURATIONS

Configuration MLTI0132- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Wireless Device	Multi-Tech Systems, Inc.	MTCAP2-915-042L-POE	20637489

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Gigabit PoE Injector	Hawking Technology	HPOE2	HEMCPOE217410007
DC Power Supply	HP	HP E3612A	KR30701360
Laptop	Lenovo	ThinkPad X230	PK0WM2A
Power Supply (Laptop)	Lenovo	92P1109	11S92P1109Z1ZBTZ71CBVP

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Power Cable (Gigabit PoE Injector)	No	1.8m	No	DC Power Supply	Gigabit PoE Injector
Ethernet Cable	No	1.9m	No	Gigabit PoE Injector	Wireless Device
AC Mains Cable (DC Power Supply)	No	1.8m	No	DC Power Supply	AC Mains
AC Cable (Laptop)	No	1.0m	No	AC Mains	Power Supply (Laptop)
DC Cable (Laptop)	No	1.8m	Yes	Power Supply (Laptop)	Laptop
Ethernet Cable	No	1.8m	No	Gigabit PoE Injector	Laptop

CONFIGURATIONS

Configuration MLTI0138- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Wireless Device	Multi-Tech Systems, Inc.	MTCAP2-915-042L-POE	20589952
AC/DC Power Adapter	MEGA	FJ-SW1260502500DN	MJSW1260502500DN

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Lenovo	ThinkPad X230	PK0WM2A

Remote Equipment Outside of Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Power Supply (Laptop)	Lenovo	92P1109	11S92P1109Z1ZBTZ71CBVP

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
Ethernet Cable	None	1.9m	None	Wireless Device	Laptop
AC/DC Power Adapter Cable	None	1.8m	None	Wireless Device	AC/DC Power Adapter
AC Cable (Laptop)	No	1.0m	No	AC Mains	Power Supply (Laptop)
DC Cable (Laptop)	No	1.8m	Yes	Power Supply (Laptop)	Laptop

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2019-12-26	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2019-12-27	Powerline 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.
3	2019-12-27	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	2019-12-27	Equivalent Isotropic Radiated Power	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
5	2019-12-27	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.
6	2019-12-27	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.
7	2019-12-27	Spurious Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
8	2019-12-27	Power Spectral Density	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.
9	2020-02-04	Powerline Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

POWERLINE CONDUCTED EMISSIONS

element
WTD.2019.10.29.0

TEST DESCRIPTION

Using the mode of operation and configuration noted within this report, conducted emissions tests were performed. The frequency range investigated (scanned), is also noted in this report. Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Per the standard, an insulating material was also added to ground plane between the EUT's power and remote I/O cables. Equipment is tested with power cords that are normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically those measurements are made using a LISN (Line Impedance Stabilization Network), the 50ohm measuring port is terminated by a 50ohm EMI meter or a 50ohm resistive load. All 50ohm measuring ports of the LISN are terminated by 50ohm. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Receiver	Rohde & Schwarz	ESR7	ARI	2019-07-08	2020-07-08
Cable - Conducted Cable Assembly	Northwest EMC	MNC, HGN, TYK	MNCA	2019-03-13	2020-03-13
LISN	Solar Electronics	9252-50-R-24-BNC	LIY	2019-03-15	2020-03-15
LISN	Solar Electronics	9252-50-R-24-BNC	LIQ	2019-10-04	2020-10-04

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	2.4 dB	-2.4 dB

CONFIGURATIONS INVESTIGATED

MLTI0132-1

MODES INVESTIGATED

Transmitting LoRa - mid channel (925.1 MHz)

POWERLINE CONDUCTED EMISSIONS

EUT:	MTCAP2-915-042-POE	Work Order:	MLTI0132
Serial Number:	20637489	Date:	2019-12-27
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.4°C
Attendees:	Jim Asp	Relative Humidity:	25.2%
Customer Project:	None	Bar. Pressure:	1026 mb
Tested By:	Dustin Sparks	Job Site:	MN03
Power:	54VDC via PoE	Configuration:	MLTI0132-1

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2019	ANSI C63.10:2013

TEST PARAMETERS

Run #:	14	Line:	Neutral	Add. Ext. Attenuation (dB):	0

COMMENTS

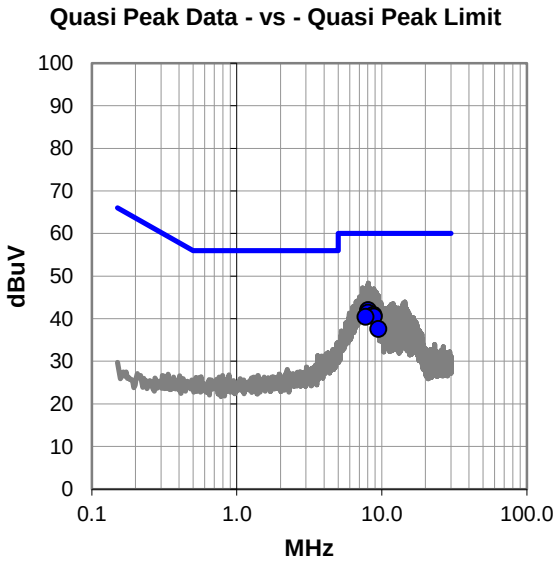
None

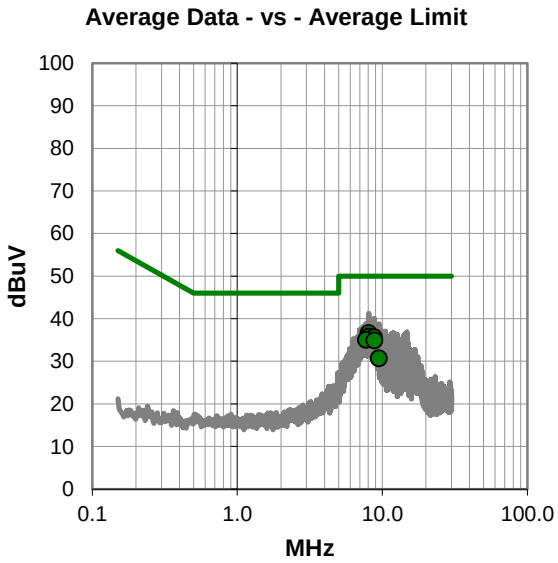
EUT OPERATING MODES

Transmitting LoRa - mid channel (925.1 MHz)

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

element
WTD.2019.10.29.0

RESULTS - Run #14

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
8.1	21.200	20.8	42.0	60.0	-18.0
8.0	20.600	20.8	41.4	60.0	-18.6
8.8	20.000	20.9	40.9	60.0	-19.1
8.8	19.600	20.9	40.5	60.0	-19.5
7.7	19.600	20.8	40.4	60.0	-19.6
9.5	16.700	20.9	37.6	60.0	-22.4

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
8.1	15.800	20.8	36.6	50.0	-13.4
8.0	15.000	20.8	35.8	50.0	-14.2
8.8	14.700	20.9	35.6	50.0	-14.4
7.7	14.200	20.8	35.0	50.0	-15.0
8.8	14.000	20.9	34.9	50.0	-15.1
9.5	9.800	20.9	30.7	50.0	-19.3

CONCLUSION

Pass

Dustin Sparks

Tested By

POWERLINE CONDUCTED EMISSIONS

EUT:	MTCAP2-915-042-POE	Work Order:	MLTI0132
Serial Number:	20637489	Date:	2019-12-27
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.4°C
Attendees:	Jim Asp	Relative Humidity:	25.2%
Customer Project:	None	Bar. Pressure:	1026 mb
Tested By:	Dustin Sparks	Job Site:	MN03
Power:	54VDC via PoE	Configuration:	MLTI0132-1

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2019	ANSI C63.10:2013

TEST PARAMETERS

Run #:	15	Line:	High Line	Add. Ext. Attenuation (dB):	0

COMMENTS

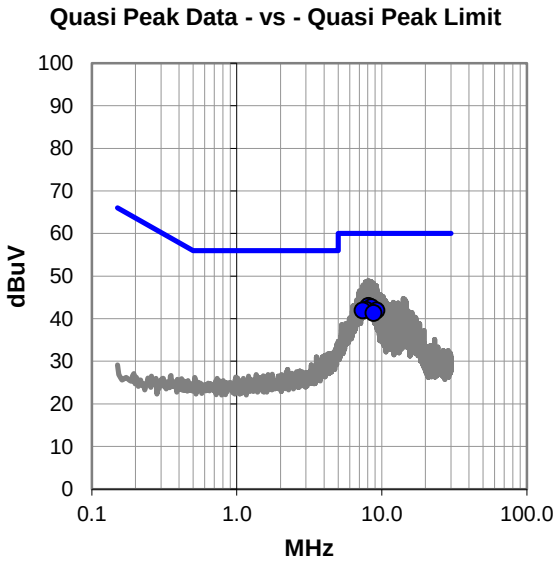
None

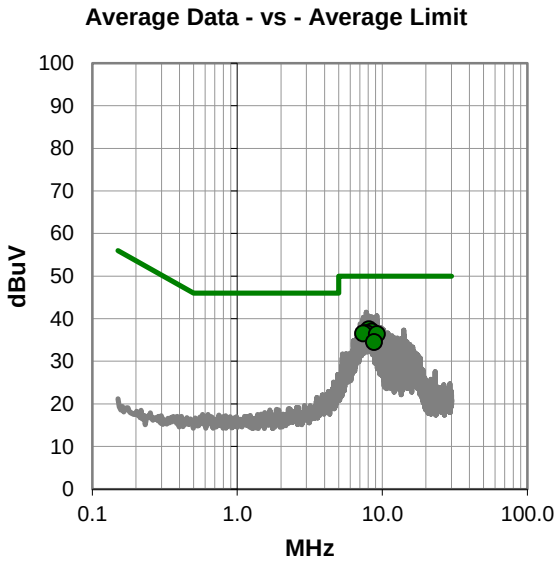
EUT OPERATING MODES

Transmitting LoRa - mid channel (925.1 MHz)

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

element
WTD.2019.10.29.0

RESULTS - Run #15

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
8.1	22.200	20.8	43.0	60.0	-17.0
8.5	21.800	20.9	42.7	60.0	-17.3
7.8	21.300	20.8	42.1	60.0	-17.9
9.2	21.000	20.9	41.9	60.0	-18.1
7.4	21.100	20.8	41.9	60.0	-18.1
8.8	20.400	20.9	41.3	60.0	-18.7

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
8.1	16.700	20.8	37.5	50.0	-12.5
8.5	16.100	20.9	37.0	50.0	-13.0
7.8	15.800	20.8	36.6	50.0	-13.4
7.4	15.700	20.8	36.5	50.0	-13.5
9.2	15.500	20.9	36.4	50.0	-13.6
8.8	13.600	20.9	34.5	50.0	-15.5

CONCLUSION

Pass

Dustin Sparks

Tested By

POWERLINE CONDUCTED EMISSIONS

element
WTD.2019.10.29.0

TEST DESCRIPTION

Using the mode of operation and configuration noted within this report, conducted emissions tests were performed. The frequency range investigated (scanned), is also noted in this report. Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Per the standard, an insulating material was also added to ground plane between the EUT's power and remote I/O cables. Equipment is tested with power cords that are normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically those measurements are made using a LISN (Line Impedance Stabilization Network), the 50ohm measuring port is terminated by a 50ohm EMI meter or a 50ohm resistive load. All 50ohm measuring ports of the LISN are terminated by 50ohm. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Cable - Conducted Cable Assembly	Northwest EMC	MNC, HGN, TYK	MNCA	2019-03-13	2020-03-13
Receiver	Rohde & Schwarz	ESR7	ARI	2019-07-08	2020-07-08
LISN	Solar Electronics	9252-50-R-24-BNC	LIY	2019-03-15	2020-03-15
LISN	Solar Electronics	9252-50-R-24-BNC	LIQ	2019-10-04	2020-10-04

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	2.4 dB	-2.4 dB

CONFIGURATIONS INVESTIGATED

MLTI0138-2

MODES INVESTIGATED

Transmit Mode Mid channel Max Power

POWERLINE CONDUCTED EMISSIONS

EUT:	MTCAP2-915-042-POE	Work Order:	MLTI0138
Serial Number:	20589952	Date:	2020-02-04
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.3°C
Attendees:	Jim Asp	Relative Humidity:	20.8%
Customer Project:	None	Bar. Pressure:	1028 mb
Tested By:	Glen Creuziger / Trevor Buls	Job Site:	MN03
Power:	120VAC/60Hz	Configuration:	MLTI0138-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2020	ANSI C63.10:2013

TEST PARAMETERS

Run #:	9	Line:	High Line	Add. Ext. Attenuation (dB):	0

COMMENTS

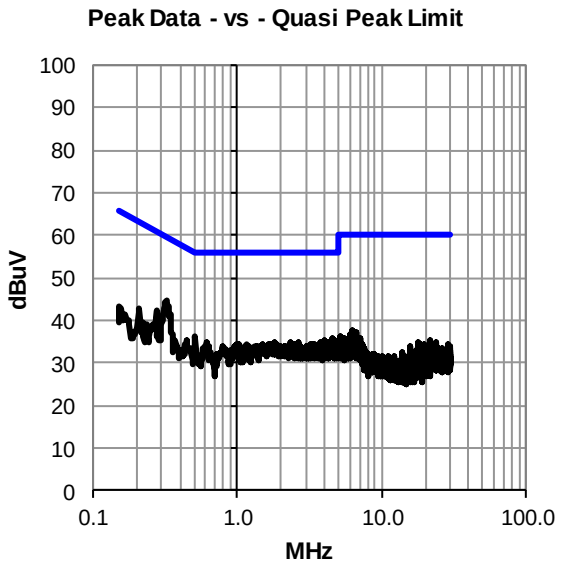
None

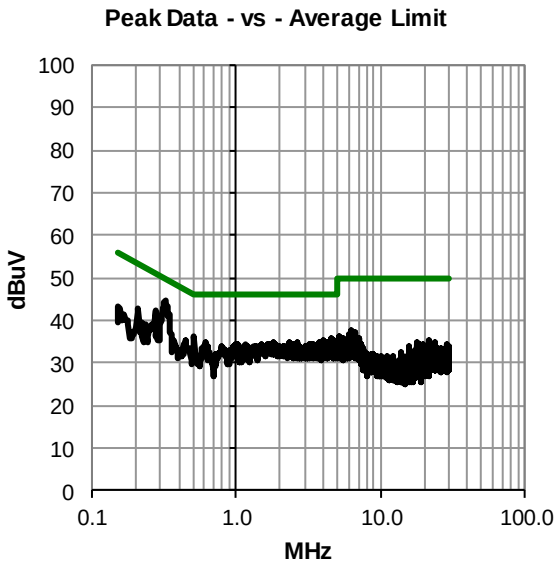
EUT OPERATING MODES

Transmit Mode Mid channel Max Power

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

element
WTD.2019.10.29.0

RESULTS - Run #9

Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.3	24.300	20.6	44.9	59.7	-14.8
0.3	21.500	20.7	42.2	61.0	-18.8
0.5	15.500	20.6	36.1	56.0	-19.9
4.6	14.900	20.7	35.6	56.0	-20.4
0.2	21.900	20.7	42.6	63.2	-20.6
4.7	14.700	20.6	35.3	56.0	-20.7
5.0	14.700	20.6	35.3	56.0	-20.7
4.7	14.600	20.6	35.2	56.0	-20.8
4.0	14.300	20.8	35.1	56.0	-20.9
4.2	14.300	20.7	35.0	56.0	-21.0
4.8	14.400	20.6	35.0	56.0	-21.0
2.4	14.200	20.7	34.9	56.0	-21.1
2.7	14.200	20.7	34.9	56.0	-21.1
4.9	14.300	20.6	34.9	56.0	-21.1
0.6	14.300	20.5	34.8	56.0	-21.2
1.8	14.200	20.6	34.8	56.0	-21.2
3.8	13.900	20.8	34.7	56.0	-21.3
4.1	13.900	20.8	34.7	56.0	-21.3
0.4	14.900	20.6	35.5	56.9	-21.4
3.2	13.700	20.8	34.5	56.0	-21.5
1.0	13.800	20.6	34.4	56.0	-21.6
1.0	13.800	20.6	34.4	56.0	-21.6
1.2	13.700	20.6	34.3	56.0	-21.7
1.3	13.400	20.6	34.0	56.0	-22.0
0.8	13.300	20.6	33.9	56.0	-22.1

Peak Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.3	24.300	20.6	44.9	49.7	-4.8
0.3	21.500	20.7	42.2	51.0	-8.8
0.5	15.500	20.6	36.1	46.0	-9.9
4.6	14.900	20.7	35.6	46.0	-10.4
0.2	21.900	20.7	42.6	53.2	-10.6
4.7	14.700	20.6	35.3	46.0	-10.7
5.0	14.700	20.6	35.3	46.0	-10.7
4.7	14.600	20.6	35.2	46.0	-10.8
4.0	14.300	20.8	35.1	46.0	-10.9
4.2	14.300	20.7	35.0	46.0	-11.0
4.8	14.400	20.6	35.0	46.0	-11.0
2.4	14.200	20.7	34.9	46.0	-11.1
2.7	14.200	20.7	34.9	46.0	-11.1
4.9	14.300	20.6	34.9	46.0	-11.1
0.6	14.300	20.5	34.8	46.0	-11.2
1.8	14.200	20.6	34.8	46.0	-11.2
3.8	13.900	20.8	34.7	46.0	-11.3
4.1	13.900	20.8	34.7	46.0	-11.3
0.4	14.900	20.6	35.5	46.9	-11.4
3.2	13.700	20.8	34.5	46.0	-11.5
1.0	13.800	20.6	34.4	46.0	-11.6
1.0	13.800	20.6	34.4	46.0	-11.6
1.2	13.700	20.6	34.3	46.0	-11.7
1.3	13.400	20.6	34.0	46.0	-12.0
0.8	13.300	20.6	33.9	46.0	-12.1

CONCLUSION

Pass

Trevor Buls

Tested By

POWERLINE CONDUCTED EMISSIONS

EUT:	MTCAP2-915-042-POE	Work Order:	MLTI0138
Serial Number:	20589952	Date:	2020-02-04
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.3°C
Attendees:	Jim Asp	Relative Humidity:	20.8%
Customer Project:	None	Bar. Pressure:	1028 mb
Tested By:	Glen Creuziger / Trevor Buls	Job Site:	MN03
Power:	120VAC/60Hz	Configuration:	MLTI0138-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2020	ANSI C63.10:2013

TEST PARAMETERS

Run #:	10	Line:	Neutral	Add. Ext. Attenuation (dB):	0

COMMENTS

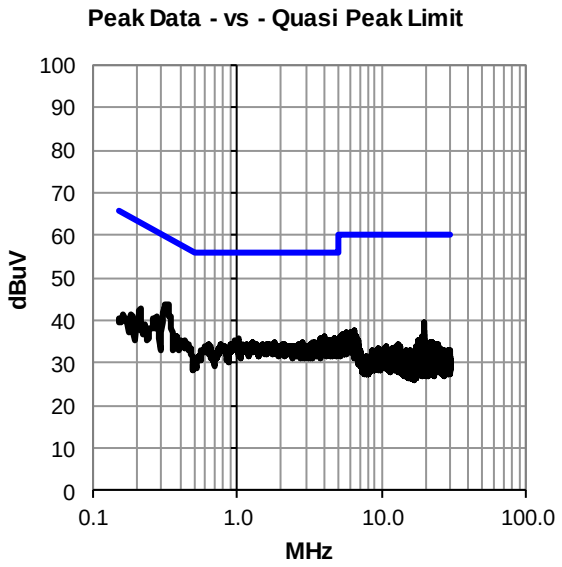
None

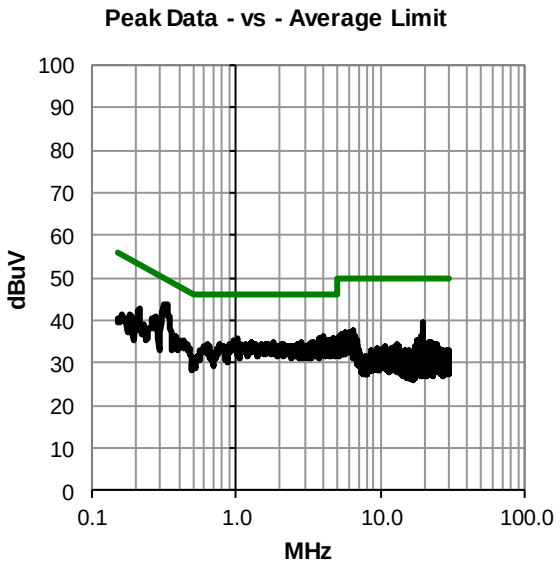
EUT OPERATING MODES

Transmit Mode Mid channel Max Power

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

element
WTD.2019.10.29.0

RESULTS - Run #10

Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.3	23.200	20.6	43.8	59.7	-15.9
4.0	15.400	20.8	36.2	56.0	-19.8
0.3	20.200	20.7	40.9	61.0	-20.1
0.2	22.200	20.7	42.9	63.1	-20.2
4.7	15.100	20.7	35.8	56.0	-20.2
4.7	15.200	20.6	35.8	56.0	-20.2
1.0	15.100	20.6	35.7	56.0	-20.3
3.7	14.800	20.8	35.6	56.0	-20.4
4.2	14.800	20.7	35.5	56.0	-20.5
5.0	14.900	20.6	35.5	56.0	-20.5
19.6	18.200	21.1	39.3	60.0	-20.7
4.1	14.400	20.8	35.2	56.0	-20.8
4.4	14.500	20.7	35.2	56.0	-20.8
4.2	14.400	20.7	35.1	56.0	-20.9
4.3	14.400	20.7	35.1	56.0	-20.9
4.5	14.400	20.7	35.1	56.0	-20.9
1.8	14.400	20.6	35.0	56.0	-21.0
1.3	14.300	20.6	34.9	56.0	-21.1
2.9	14.200	20.7	34.9	56.0	-21.1
3.4	14.100	20.8	34.9	56.0	-21.1
3.3	13.700	20.8	34.5	56.0	-21.5
2.7	13.700	20.7	34.4	56.0	-21.6
3.2	13.600	20.8	34.4	56.0	-21.6
0.6	13.700	20.6	34.3	56.0	-21.7
0.8	13.600	20.6	34.2	56.0	-21.8

Peak Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.3	23.200	20.6	43.8	49.7	-5.9
4.0	15.400	20.8	36.2	46.0	-9.8
0.3	20.200	20.7	40.9	51.0	-10.1
0.2	22.200	20.7	42.9	53.1	-10.2
4.7	15.100	20.7	35.8	46.0	-10.2
4.7	15.200	20.6	35.8	46.0	-10.2
1.0	15.100	20.6	35.7	46.0	-10.3
3.7	14.800	20.8	35.6	46.0	-10.4
4.2	14.800	20.7	35.5	46.0	-10.5
5.0	14.900	20.6	35.5	46.0	-10.5
19.6	18.200	21.1	39.3	50.0	-10.7
4.1	14.400	20.8	35.2	46.0	-10.8
4.4	14.500	20.7	35.2	46.0	-10.8
4.2	14.400	20.7	35.1	46.0	-10.9
4.3	14.400	20.7	35.1	46.0	-10.9
4.5	14.400	20.7	35.1	46.0	-10.9
1.8	14.400	20.6	35.0	46.0	-11.0
1.3	14.300	20.6	34.9	46.0	-11.1
2.9	14.200	20.7	34.9	46.0	-11.1
3.4	14.100	20.8	34.9	46.0	-11.1
3.3	13.700	20.8	34.5	46.0	-11.5
2.7	13.700	20.7	34.4	46.0	-11.6
3.2	13.600	20.8	34.4	46.0	-11.6
0.6	13.700	20.6	34.3	46.0	-11.7
0.8	13.600	20.6	34.2	46.0	-11.8

CONCLUSION

Pass

Trevor Buls

Tested By

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 channel (923.3 MHz), mid channel (925.1 MHz), and high channel (927.5 MHz); modulated, 500 kHz channel bandwidth.

POWER SETTINGS INVESTIGATED

54VDC via PoE

CONFIGURATIONS INVESTIGATED

MLTI0132 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	12400 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
Filter - Low Pass	Micro-Tronics	LPM50004	LFK	17-Sep-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
Attenuator	Fairview Microwave	SA18E-10	TYA	17-Sep-2019	12 mo
Attenuator	Fairview Microwave	SA18E-20	TWZ	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
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
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	8-Feb-2019	12 mo
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	17-Sep-2019	12 mo
Antenna - Double Ridge	ETS-Lindgren	3115	AJQ	16-Jan-2019	24 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	18-Oct-2019	12 mo
Cable	ESM Cable Corp.	Bilog Cables	MNH	18-Oct-2019	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AYD	25-Jan-2018	24 mo
Analyzer - Spectrum Analyzer	Agilent	E4440A	AAX	5-Apr-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

PSA-ESCI 2019.05.10

TEST DESCRIPTION

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

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

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

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

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

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

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

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

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

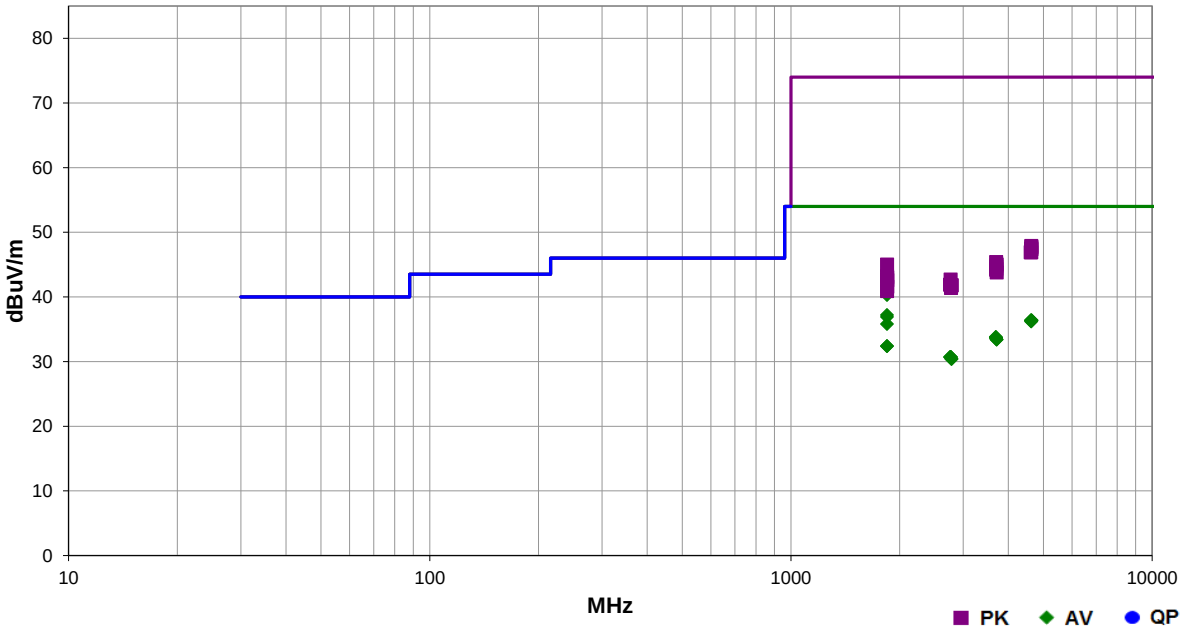
SPURIOUS RADIATED EMISSIONS

EmiR5 2019.08.15.1 PSA-ESCI 2019.05.10

Work Order:	MLTI0132	**Date:**	26-Dec-2019		
Project:	None	**Temperature:**	22.6 °C		
Job Site:	MN05	**Humidity:**	29% RH		
Serial Number:	20637489	**Barometric Pres.:**	1015 mbar	**Tested by:**	Dustin Sparks
EUT:	MTCAP2-915-042-POE				
Configuration:	1				
Customer:	Multi-Tech Systems, Inc.				
Attendees:	Jim Asp				
EUT Power:	54VDC via PoE				
Operating Mode:	Transmitting LoRa - low channel (923.3 MHz), mid channel (925.1 MHz), and high channel (927.5 MHz); modulated, 500 kHz channel bandwidth.				
Deviations:	None				
Comments:	Mix 15, PA 3				

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

Run #	18	**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
1846.583	45.0	-4.7	1.5	160.0	3.0	0.0	Vert	AV	0.0	40.3	54.0	-13.7	Low ch, EUT vert
1846.633	41.9	-4.7	1.5	117.0	3.0	0.0	Horz	AV	0.0	37.2	54.0	-16.8	Low ch, EUT horz
1846.600	41.6	-4.7	1.5	199.0	3.0	0.0	Horz	AV	0.0	36.9	54.0	-17.1	Low ch, EUT on side
4623.040	32.0	4.4	1.5	126.0	3.0	0.0	Horz	AV	0.0	36.4	54.0	-17.6	Low ch, EUT horz
4638.558	32.0	4.4	1.5	120.9	3.0	0.0	Horz	AV	0.0	36.4	54.0	-17.6	High ch, EUT horz
4626.710	31.9	4.4	1.58	267.0	3.0	0.0	Vert	AV	0.0	36.3	54.0	-17.7	Low ch, EUT vert
4625.567	31.9	4.4	1.5	138.8	3.0	0.0	Horz	AV	0.0	36.3	54.0	-17.7	Mid ch, EUT horz
4639.592	31.9	4.4	1.74	289.9	3.0	0.0	Vert	AV	0.0	36.3	54.0	-17.7	High ch, EUT vert
4626.925	31.8	4.4	1.5	245.0	3.0	0.0	Vert	AV	0.0	36.2	54.0	-17.8	Mid ch, EUT vert
1846.633	40.5	-4.7	1.5	192.0	3.0	0.0	Vert	AV	0.0	35.8	54.0	-18.2	Low ch, EUT horz
3692.820	32.7	1.1	3.36	245.0	3.0	0.0	Vert	AV	0.0	33.8	54.0	-20.2	Low ch, EUT vert
3694.990	32.6	1.1	1.5	26.0	3.0	0.0	Horz	AV	0.0	33.7	54.0	-20.3	Low ch, EUT horz
3698.100	32.6	1.1	1.5	2.9	3.0	0.0	Horz	AV	0.0	33.7	54.0	-20.3	Mid ch, EUT horz
3698.200	32.5	1.1	1.5	84.9	3.0	0.0	Vert	AV	0.0	33.6	54.0	-20.4	Mid ch, EUT vert
3711.833	32.4	1.0	1.44	237.9	3.0	0.0	Horz	AV	0.0	33.4	54.0	-20.6	High ch, EUT horz
3712.117	32.4	1.0	1.5	260.0	3.0	0.0	Vert	AV	0.0	33.4	54.0	-20.6	High ch, EUT vert
1846.542	37.1	-4.7	1.5	260.0	3.0	0.0	Horz	AV	0.0	32.4	54.0	-21.6	Low ch, EUT vert
1846.608	37.1	-4.7	1.5	246.9	3.0	0.0	Vert	AV	0.0	32.4	54.0	-21.6	Low ch, EUT on side

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
2758.570	33.6	-2.9	1.5	283.9	3.0	0.0	Horz	AV	0.0	30.7	54.0	-23.3	Low ch, EUT horz
2762.570	33.6	-2.9	1.5	206.0	3.0	0.0	Vert	AV	0.0	30.7	54.0	-23.3	Low ch, EUT vert
2774.400	33.4	-2.7	1.5	16.0	3.0	0.0	Vert	AV	0.0	30.7	54.0	-23.3	Mid ch, EUT vert
2774.617	33.4	-2.7	1.5	358.0	3.0	0.0	Horz	AV	0.0	30.7	54.0	-23.3	Mid ch, EUT horz
2783.208	33.1	-2.7	1.5	160.1	3.0	0.0	Horz	AV	0.0	30.4	54.0	-23.6	High ch, EUT horz
2784.867	33.1	-2.7	1.5	103.9	3.0	0.0	Vert	AV	0.0	30.4	54.0	-23.6	High ch, EUT vert
4626.167	43.5	4.4	1.5	138.8	3.0	0.0	Horz	PK	0.0	47.9	74.0	-26.1	Mid ch, EUT horz
4635.192	43.3	4.4	1.74	289.9	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	High ch, EUT vert
4619.830	43.1	4.3	1.5	126.0	3.0	0.0	Horz	PK	0.0	47.4	74.0	-26.6	Low ch, EUT horz
4635.750	43.0	4.4	1.5	120.9	3.0	0.0	Horz	PK	0.0	47.4	74.0	-26.6	High ch, EUT horz
4610.120	42.6	4.3	1.58	267.0	3.0	0.0	Vert	PK	0.0	46.9	74.0	-27.1	Low ch, EUT vert
4625.183	42.5	4.4	1.5	245.0	3.0	0.0	Vert	PK	0.0	46.9	74.0	-27.1	Mid ch, EUT vert
3700.525	44.4	1.0	1.5	2.9	3.0	0.0	Horz	PK	0.0	45.4	74.0	-28.6	Mid ch, EUT horz
1846.658	49.7	-4.7	1.5	160.0	3.0	0.0	Vert	PK	0.0	45.0	74.0	-29.0	Low ch, EUT vert
3711.467	44.0	1.0	1.5	260.0	3.0	0.0	Vert	PK	0.0	45.0	74.0	-29.0	High ch, EUT vert
3704.820	43.7	1.0	1.5	26.0	3.0	0.0	Horz	PK	0.0	44.7	74.0	-29.3	Low ch, EUT horz
3701.370	43.4	1.0	3.36	245.0	3.0	0.0	Vert	PK	0.0	44.4	74.0	-29.6	Low ch, EUT vert
3700.817	43.2	1.0	1.5	84.9	3.0	0.0	Vert	PK	0.0	44.2	74.0	-29.8	Mid ch, EUT vert
3710.217	42.8	1.0	1.44	237.9	3.0	0.0	Horz	PK	0.0	43.8	74.0	-30.2	High ch, EUT horz
1846.392	47.9	-4.7	1.5	199.0	3.0	0.0	Horz	PK	0.0	43.2	74.0	-30.8	Low ch, EUT on side
1846.750	47.6	-4.6	1.5	117.0	3.0	0.0	Horz	PK	0.0	43.0	74.0	-31.0	Low ch, EUT horz
2767.320	45.6	-2.9	1.5	206.0	3.0	0.0	Vert	PK	0.0	42.7	74.0	-31.3	Low ch, EUT vert
1846.675	47.3	-4.7	1.5	192.0	3.0	0.0	Vert	PK	0.0	42.6	74.0	-31.4	Low ch, EUT horz
2758.820	44.8	-2.9	1.5	283.9	3.0	0.0	Horz	PK	0.0	41.9	74.0	-32.1	Low ch, EUT horz
2784.075	44.5	-2.7	1.5	160.1	3.0	0.0	Horz	PK	0.0	41.8	74.0	-32.2	High ch, EUT horz
2783.675	44.5	-2.7	1.5	103.9	3.0	0.0	Vert	PK	0.0	41.8	74.0	-32.2	High ch, EUT vert
2773.958	44.4	-2.7	1.5	16.0	3.0	0.0	Vert	PK	0.0	41.7	74.0	-32.3	Mid ch, EUT vert
1846.733	46.3	-4.7	1.5	246.9	3.0	0.0	Vert	PK	0.0	41.6	74.0	-32.4	Low ch, EUT on side
2773.175	44.1	-2.7	1.5	358.0	3.0	0.0	Horz	PK	0.0	41.4	74.0	-32.6	Mid ch, EUT horz
1846.383	45.6	-4.7	1.5	260.0	3.0	0.0	Horz	PK	0.0	40.9	74.0	-33.1	Low ch, EUT vert

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	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Cable	Micro-Coax	D150A-1-0720-200	MNL	15-Sep-19	15-Sep-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 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. The sweep time was set to an appropriate value for the number of points required for RMS measurements. The RBW was set greater than the emissions bandwidth of the EUT, so neither the channel power function nor the integration method were needed. 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.

OUTPUT POWER

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	MTCAP2-915-042-POE			Work Order:	MLTI0132
Serial Number:	20637489			Date:	27-Dec-19
Customer:	Multi-Tech Systems, Inc.			Temperature:	22.3 °C
Attendees:	Jim Asp			Humidity:	25.5% RH
Project:	None			Barometric Pres.:	1026 mbar
Tested by:	Dustin Sparks	Power:	54VDC via PoE	Job Site:	MN08

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

COMMENTS

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

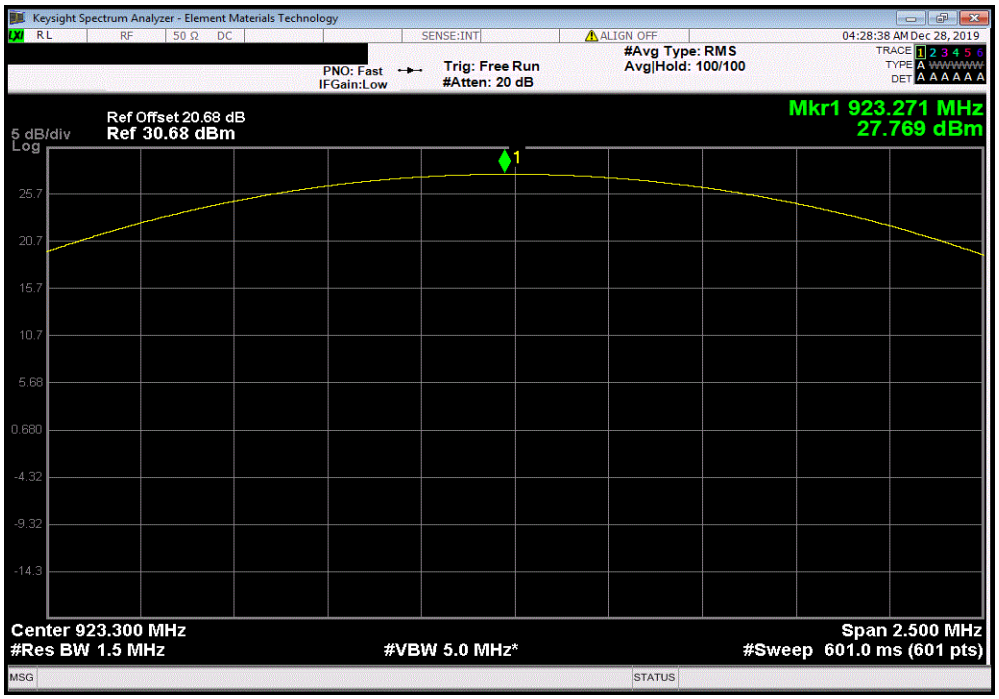
DEVIATIONS FROM TEST STANDARD

None

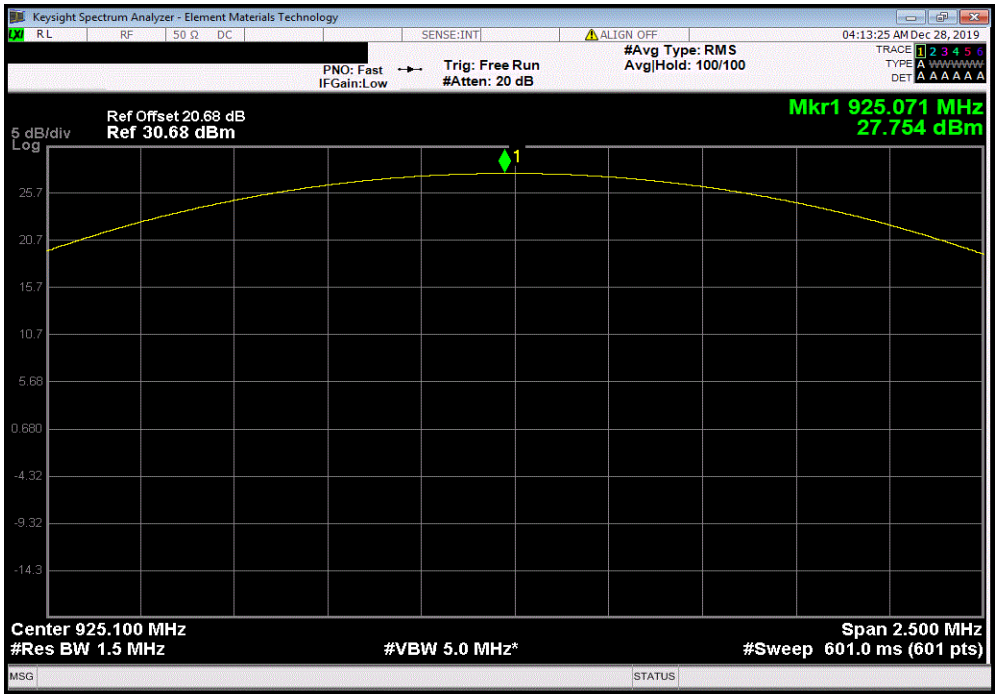
Configuration #	1	Signature

	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Limit (dBm)	Results
LoRa, Low Channel (923.3 MHz)	27.769	0	30	Pass
LoRa, Mid Channel (925.1 MHz)	27.754	0	30	Pass
LoRa, High Channel (927.5 MHz)	27.402	0	30	Pass

LoRa, Low Channel (923.3 MHz)						
			Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Limit (dBm)	Results
			27.769	0	30	Pass



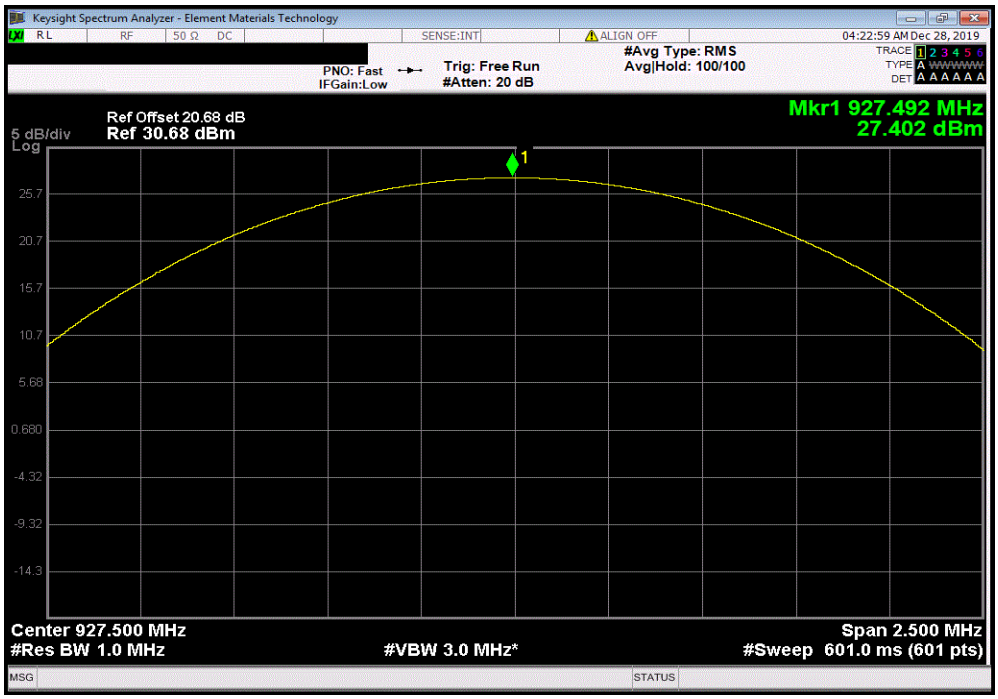
LoRa, Mid Channel (925.1 MHz)						
			Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Limit (dBm)	Results
			27.754	0	30	Pass



OUTPUT POWER

TbtTx 2019.08.30.0 XMit 2019.09.05

LoRa, High Channel (927.5 MHz)						
			Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Limit (dBm)	Results
			27.402	0	30	Pass



EQUIVALENT ISOTROPIC RADIATED 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	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-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 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.

EQUIVALENT ISOTROPIC RADIATED POWER

element

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	MTCAP2-915-042-POE	Work Order:	MLTI0132
Serial Number:	20637489	Date:	27-Dec-19
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.4 °C
Attendees:	Jim Asp	Humidity:	26.1% RH
Project:	None	Barometric Pres.:	1026 mbar
Tested by:	Dustin Sparks	Power: 54VDC via PoE	Job Site: MN08

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

COMMENTS

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

DEVIATIONS FROM TEST STANDARD

None

Configuration #	1	Signature

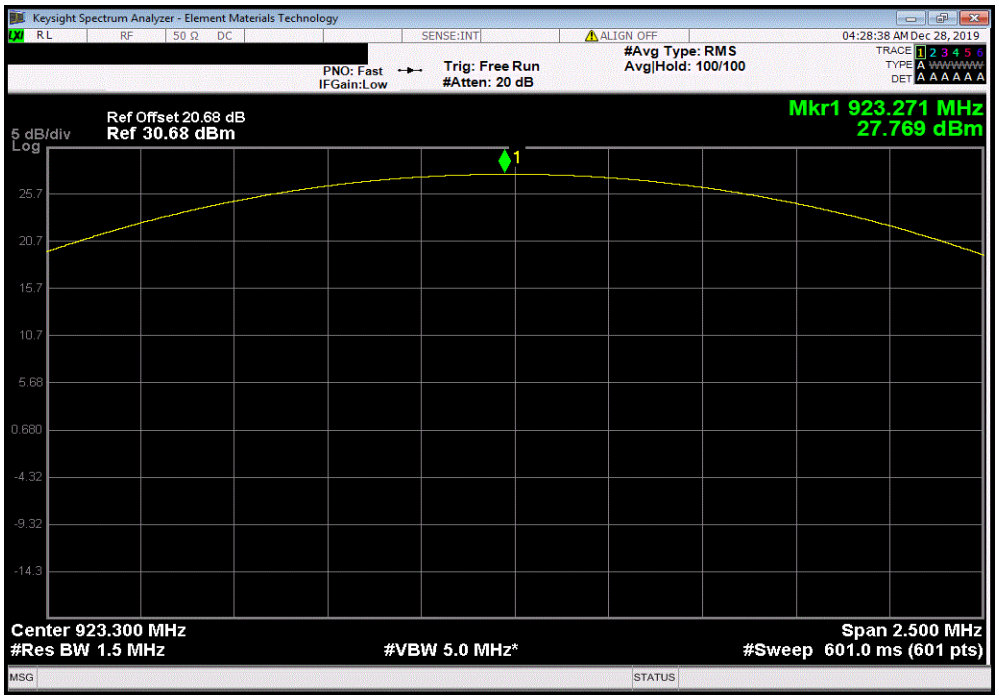
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Results
LoRa, Low Channel (923.3 MHz)	27.769	0	3	30.8	36	Pass
LoRa, Mid Channel (925.1 MHz)	27.754	0	3	30.8	36	Pass
LoRa, High Channel (927.5 MHz)	27.402	0	3	30.4	36	Pass

EQUIVALENT ISOTROPIC RADIATED POWER

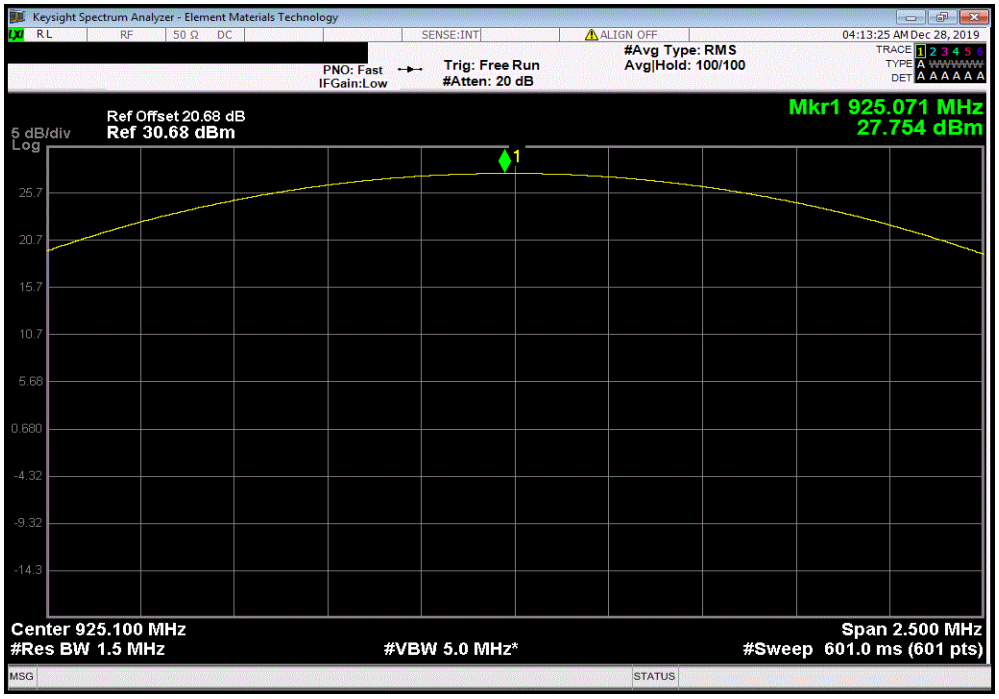
element

TbtTx 2019.08.30.0 XMit 2019.09.05

LoRa, Low Channel (923.3 MHz)						
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Results
	27.769	0	3	30.8	36	Pass



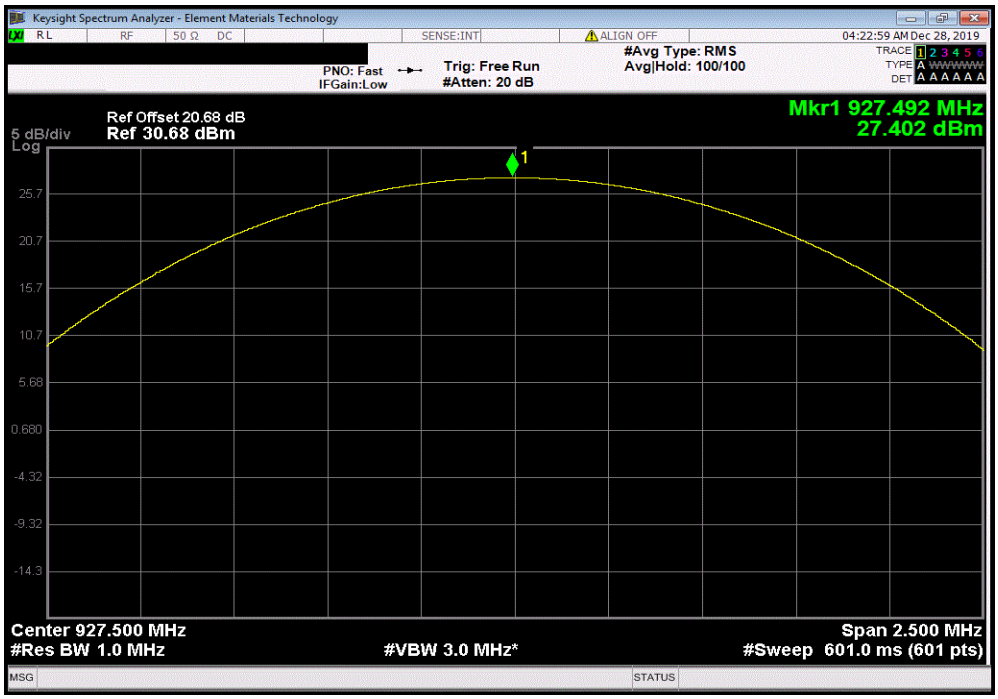
LoRa, Mid Channel (925.1 MHz)						
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Results
	27.754	0	3	30.8	36	Pass



EQUIVALENT ISOTROPIC RADIATED POWER

TbtTx 2019.08.30.0 XMit 2019.09.05

LoRa, High Channel (927.5 MHz)						
	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Results
	27.402	0	3	30.4	36	Pass



BAND EDGE COMPLIANCE

XMit 2019.09.05

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-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 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

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	MTCAP2-915-042-POE	Work Order:	MLTI0132
Serial Number:	20637489	Date:	27-Dec-19
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.3 °C
Attendees:	Jim Asp	Humidity:	25.6% RH
Project:	None	Barometric Pres.:	1026 mbar
Tested by:	Dustin Sparks	Power: 54VDC via PoE	Job Site: MN08

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

COMMENTS

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

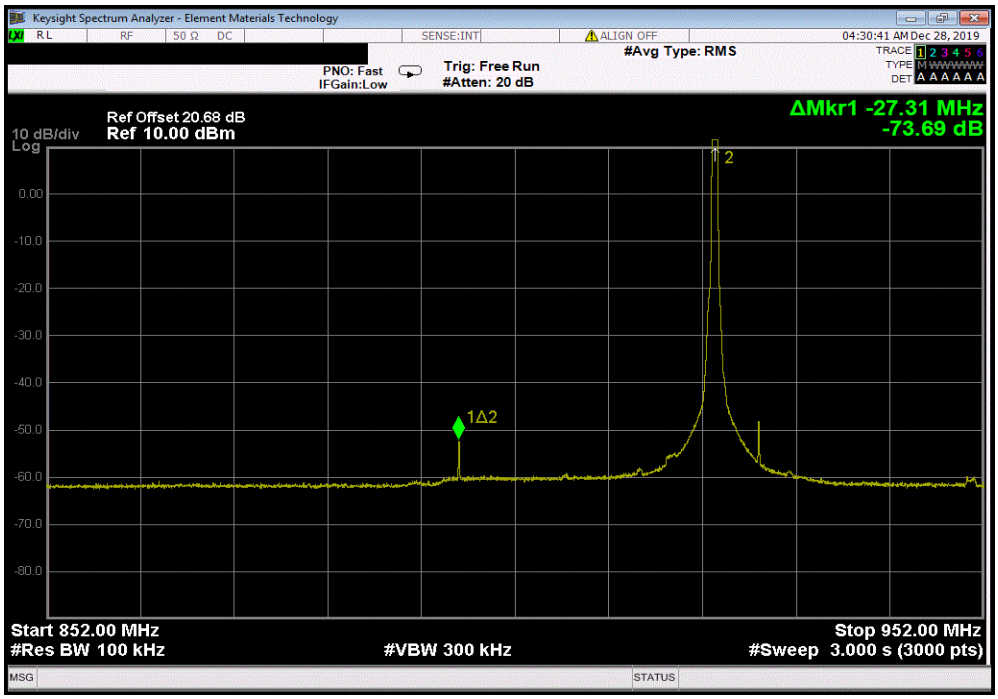
DEVIATIONS FROM TEST STANDARD

None

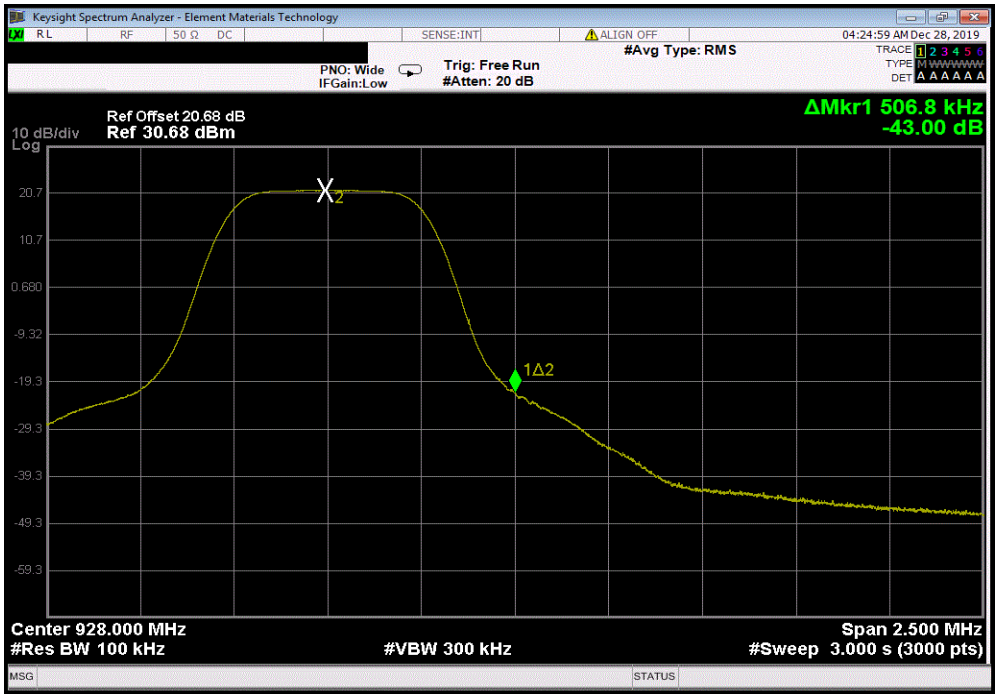
Configuration #	1	Signature

	Value (dBc)	Limit ≤ (dBc)	Result
LoRa, Low Channel (923.3 MHz)	-73.7	-30	Pass
LoRa, High Channel (927.5 MHz)	-43	-30	Pass

LoRa, Low Channel (923.3 MHz)						
				Value (dBc)	Limit ≤ (dBc)	Result
				-73.7	-30	Pass



LoRa, High Channel (927.5 MHz)						
				Value (dBc)	Limit ≤ (dBc)	Result
				-43	-30	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	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-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 2019.08.30.0 XMit 2019.09.05

EUT:	MTCAP2-915-042-POE			Work Order:	MLTI0132
Serial Number:	20637489			Date:	27-Dec-19
Customer:	Multi-Tech Systems, Inc.			Temperature:	22.3 °C
Attendees:	Jim Asp			Humidity:	25.6% RH
Project:	None			Barometric Pres.:	1026 mbar
Tested by:	Dustin Sparks	Power:	54VDC via PoE	Job Site:	MN08

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

COMMENTS

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

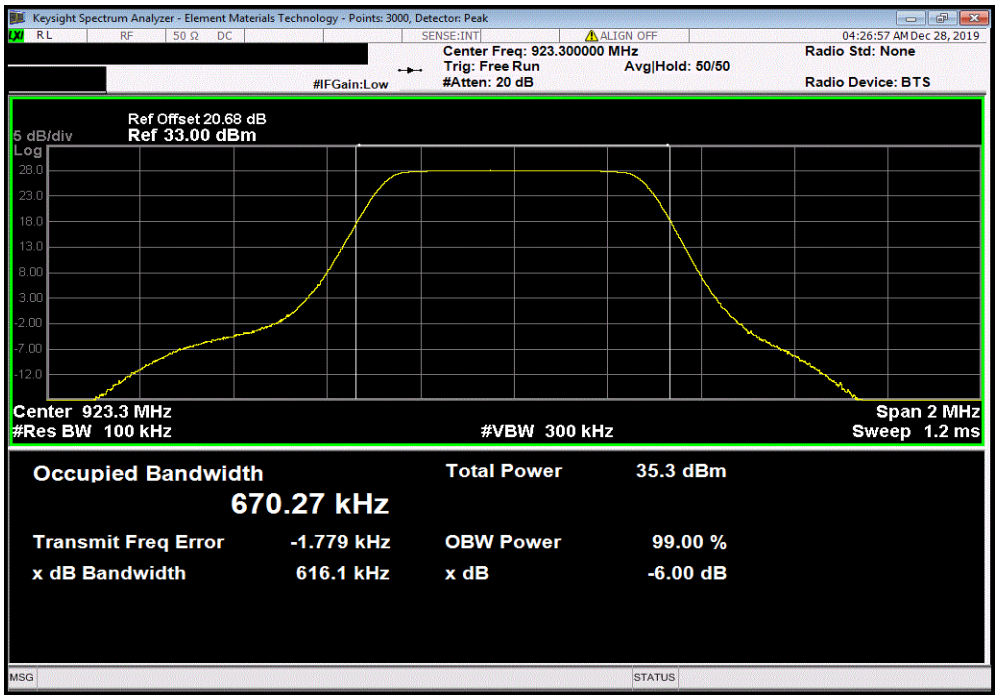
DEVIATIONS FROM TEST STANDARD

None

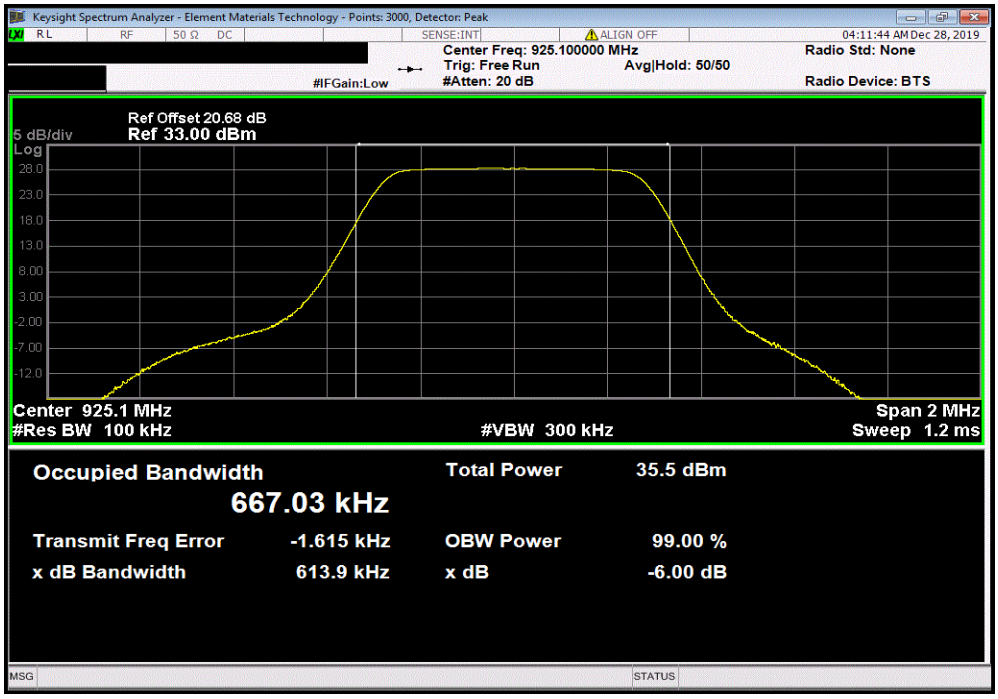
Configuration #	1	Signature

	Value	Limit (>)	Result
LoRa, Low Channel (923.3 MHz)	616.065 kHz	500 kHz	Pass
LoRa, Mid Channel (925.1 MHz)	613.852 kHz	500 kHz	Pass
LoRa, High Channel (927.5 MHz)	607.181 kHz	500 kHz	Pass

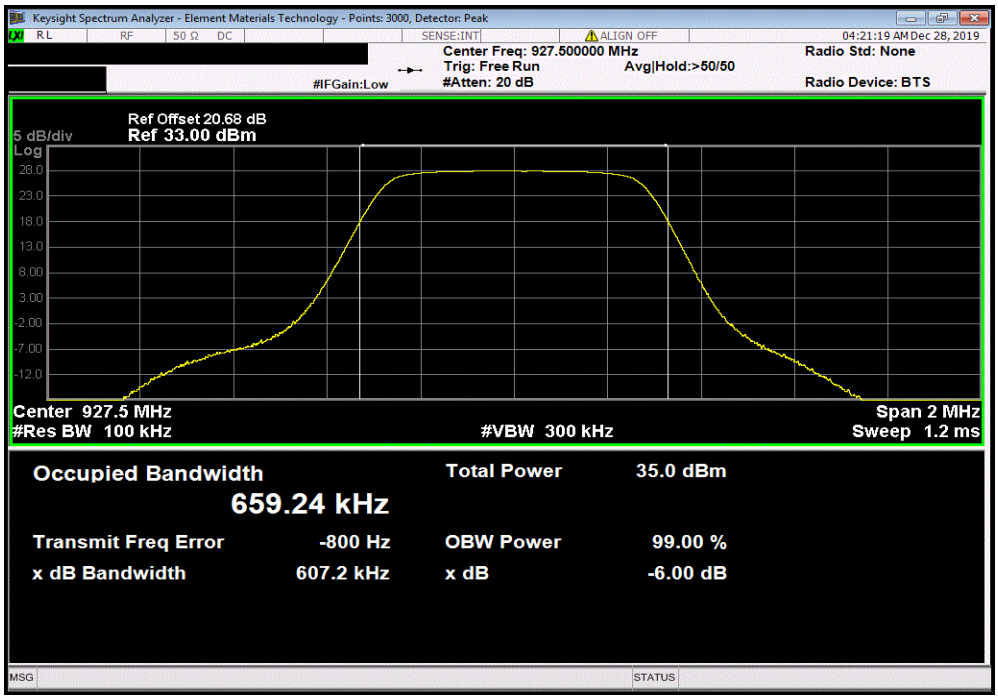
LoRa, Low Channel (923.3 MHz)						
				Value	Limit (>)	Result
				616.065 kHz	500 kHz	Pass



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



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



SPURIOUS CONDUCTED EMISSIONS

XMit 2019.09.05

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-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 spurious RF conducted emissions were measured with the EUT set to low, medium and high transmit frequencies. The EUT was transmitting at the data rate(s) listed in the datasheet. For each transmit frequency, the spectrum was scanned throughout the specified frequency range.

SPURIOUS CONDUCTED EMISSIONS

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	MTCAP2-915-042-POE	Work Order:	MLTI0132
Serial Number:	20637489	Date:	27-Dec-19
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.8 °C
Attendees:	Jim Asp	Humidity:	26.1% RH
Project:	None	Barometric Pres.:	1026 mbar
Tested by:	Dustin Sparks	Power: 54VDC via PoE	Job Site: MN08

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

COMMENTS

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

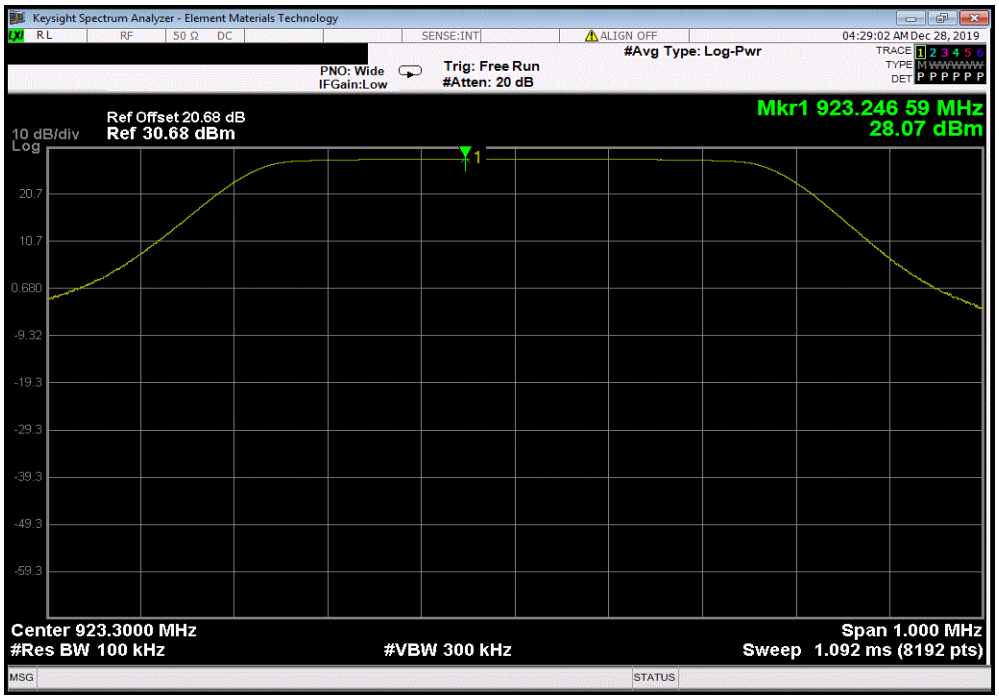
DEVIATIONS FROM TEST STANDARD

None

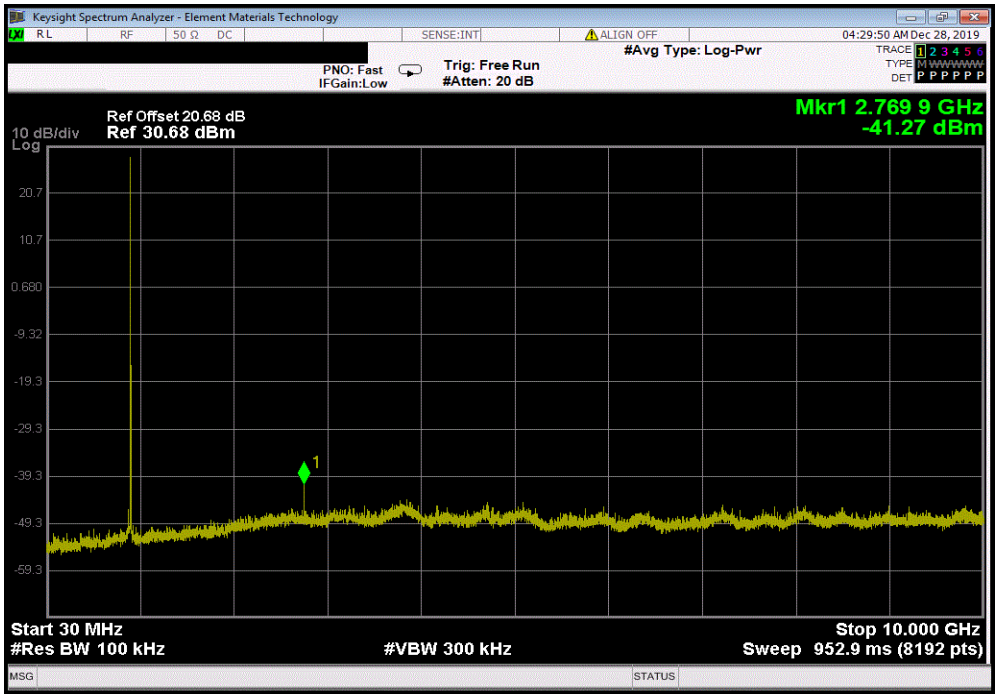
Configuration #	1	Signature

	Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
LoRa, Low Channel (923.3 MHz)	Fundamental	923.25	N/A	N/A	N/A
LoRa, Low Channel (923.3 MHz)	30 MHz - 10 GHz	2769.89	-69.34	-30	Pass
LoRa, Mid Channel (925.1 MHz)	Fundamental	925.05	N/A	N/A	N/A
LoRa, Mid Channel (925.1 MHz)	30 MHz - 10 GHz	2774.76	-70.24	-30	Pass
LoRa, High Channel (927.5 MHz)	Fundamental	927.45	N/A	N/A	N/A
LoRa, High Channel (927.5 MHz)	30 MHz - 10 GHz	929.5	-63.56	-30	Pass

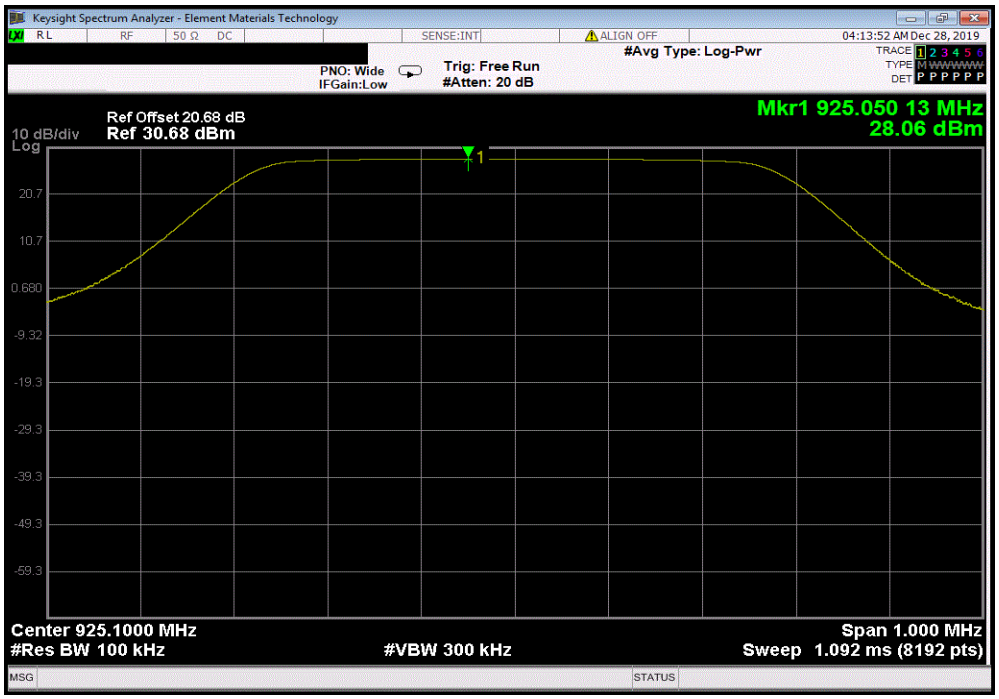
LoRa, Low Channel (923.3 MHz)						
	Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental		923.25	N/A	N/A	N/A



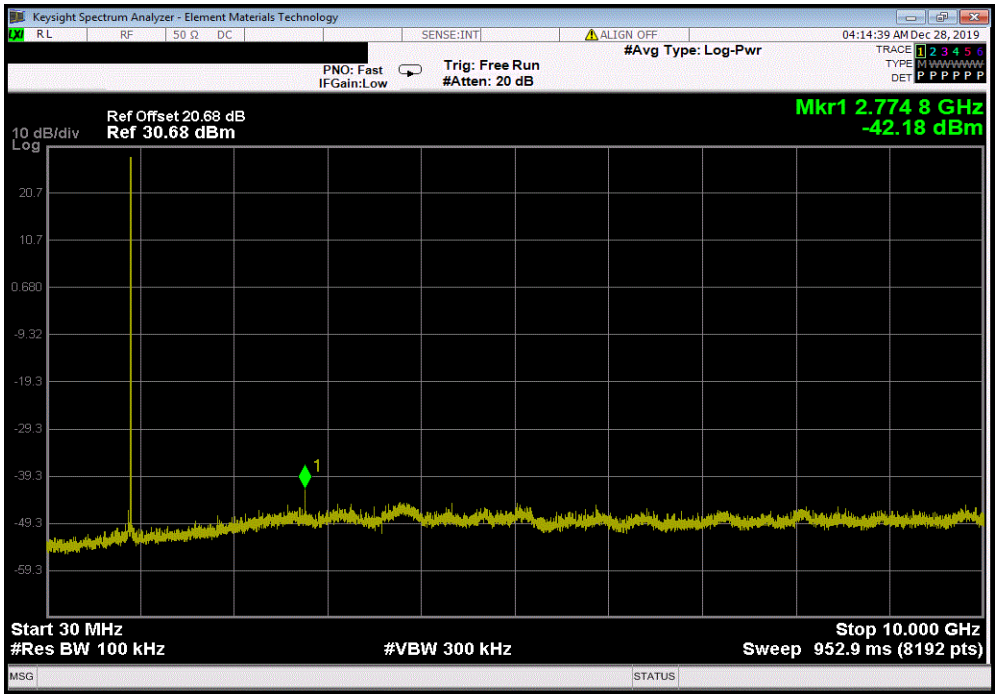
LoRa, Low Channel (923.3 MHz)				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 10 GHz	2769.89	-69.34	-30	Pass



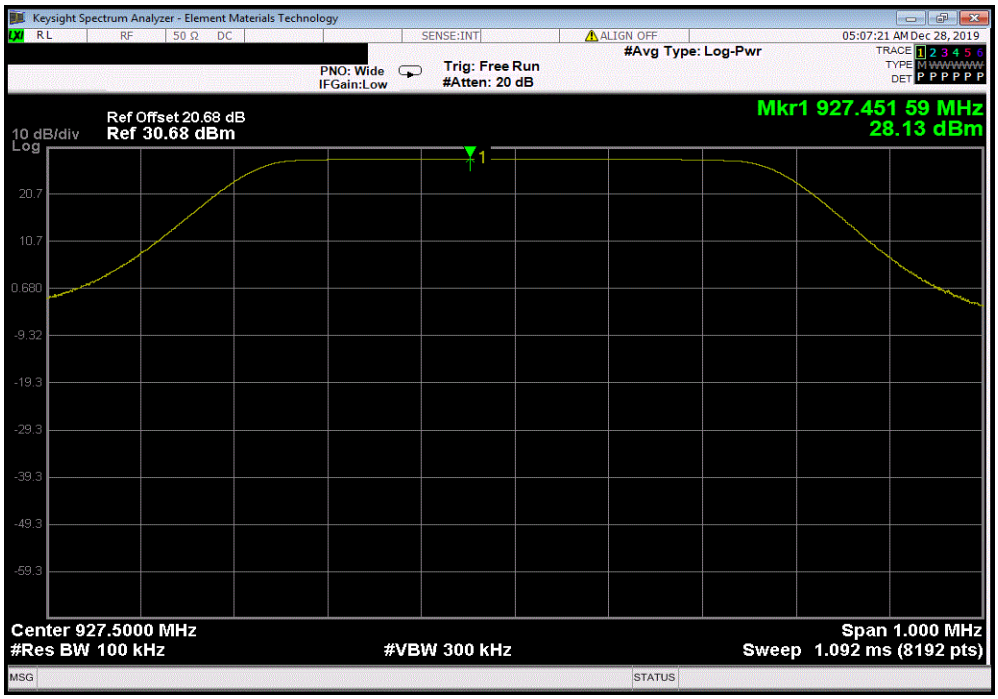
LoRa, Mid Channel (925.1 MHz)						
	Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental		925.05	N/A	N/A	N/A



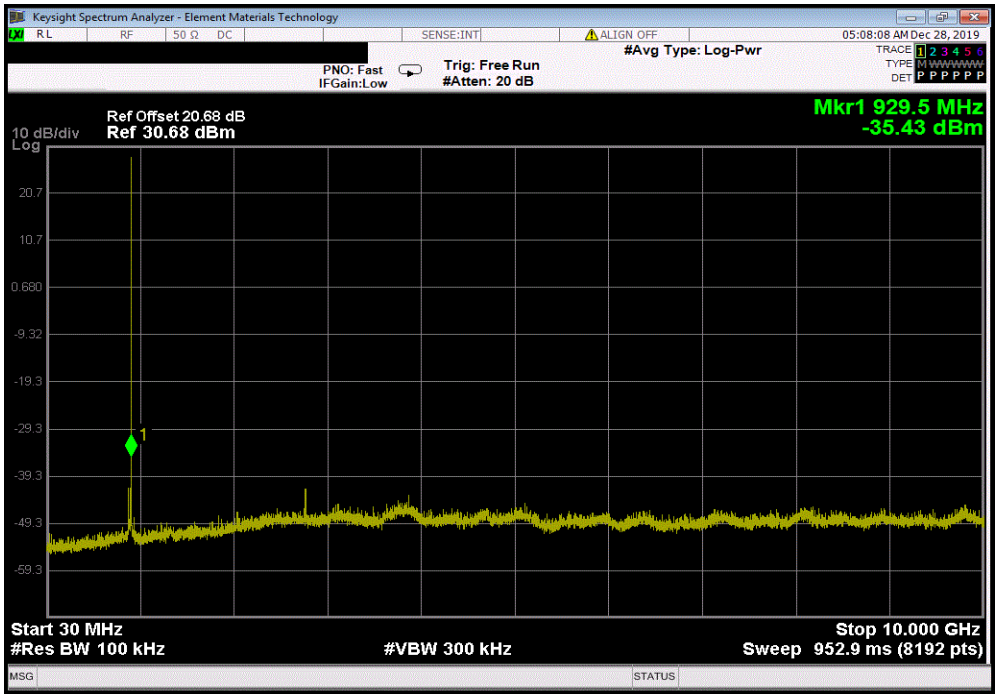
LoRa, Mid Channel (925.1 MHz)				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 10 GHz	2774.76	-70.24	-30	Pass



LoRa, High Channel (927.5 MHz)						
	Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental		927.45	N/A	N/A	N/A



LoRa, High Channel (927.5 MHz)				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 10 GHz	929.5	-63.56	-30	Pass



POWER SPECTRAL DENSITY

XMit 2019.09.05

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5182B	TFX	22-Oct-18	22-Oct-21
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	15-Sep-19	15-Sep-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 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

TbtTx 2019.08.30.0 XMit 2019.09.05

EUT:	MTCAP2-915-042-POE	Work Order:	MLTI0132
Serial Number:	20637489	Date:	27-Dec-19
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.6 °C
Attendees:	Jim Asp	Humidity:	26.4% RH
Project:	None	Barometric Pres.:	1026 mbar
Tested by:	Dustin Sparks	Power: 54VDC via PoE	Job Site: MN08

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

COMMENTS

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

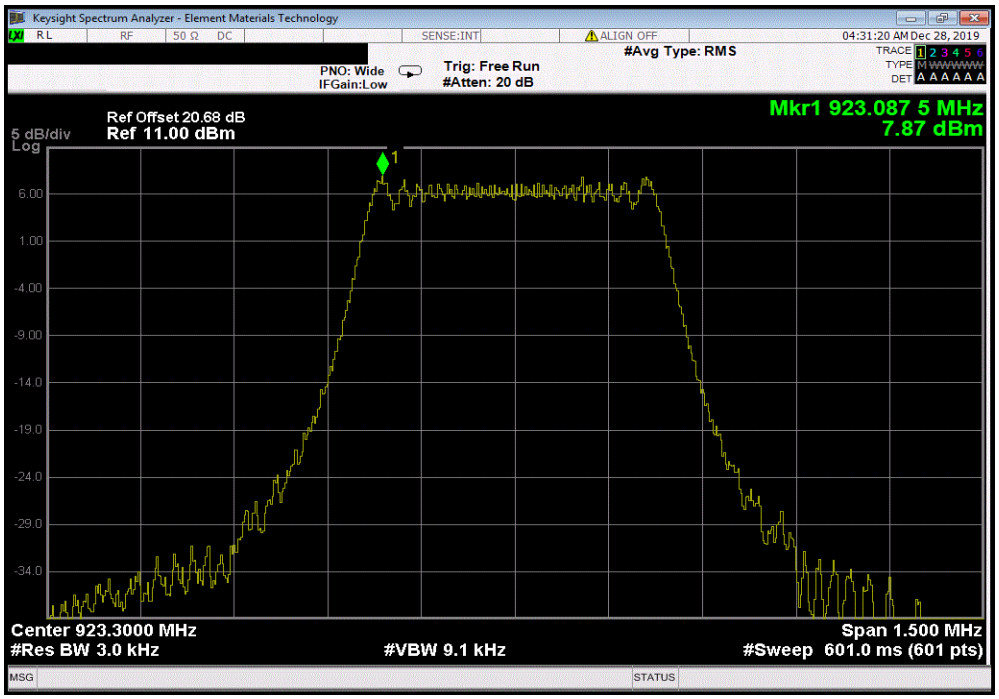
DEVIATIONS FROM TEST STANDARD

None

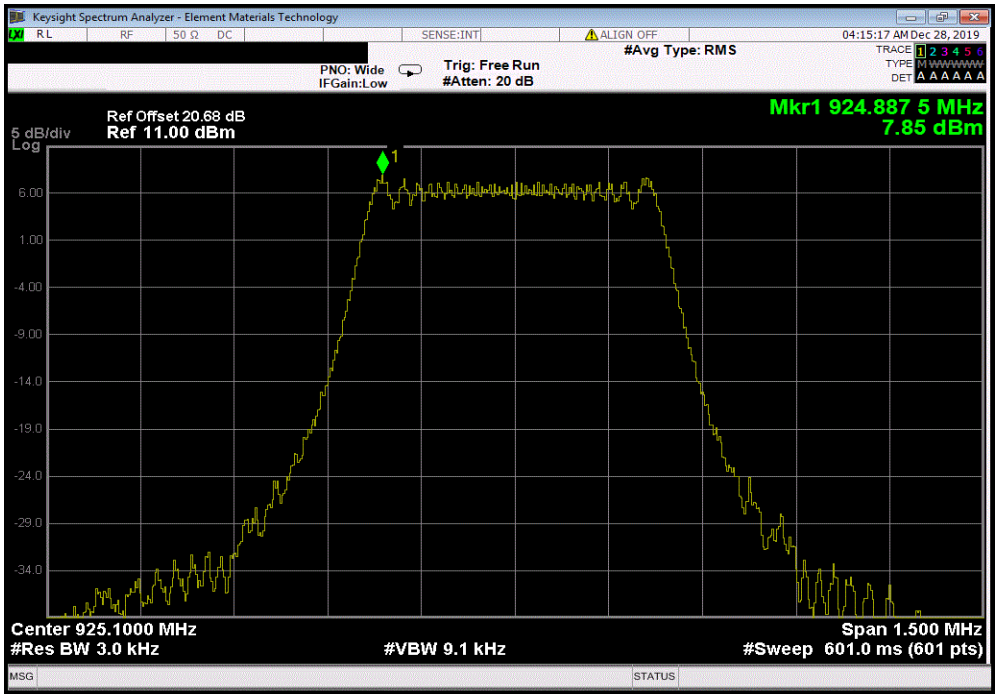
Configuration #	1	Signature

	Value (dBm/3kHz)	Limit (dBm/3kHz)	Results
LoRa, Low Channel (923.3 MHz)	7.874	8	Pass
LoRa, Mid Channel (925.1 MHz)	7.847	8	Pass
LoRa, High Channel (927.5 MHz)	7.586	8	Pass

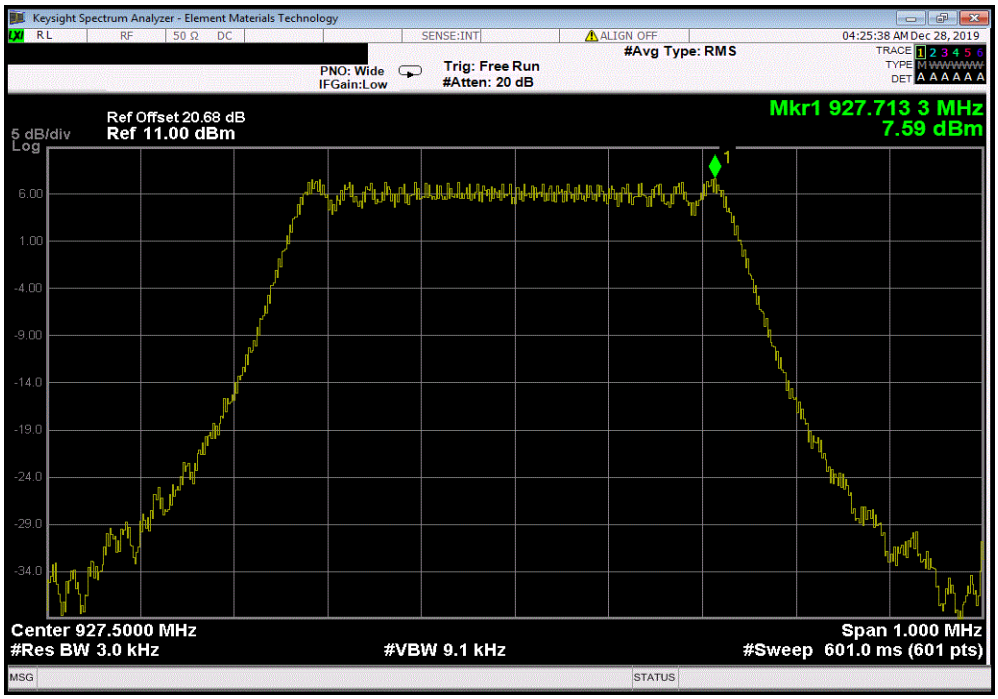
LoRa, Low Channel (923.3 MHz)						
				Value (dBm/3kHz)	Limit (dBm/3kHz)	Results
				7.874	8	Pass



LoRa, Mid Channel (925.1 MHz)						
				Value (dBm/3kHz)	Limit (dBm/3kHz)	Results
				7.847	8	Pass



POWER SPECTRAL DENSITY

TbtTx 2019.08.30.0 XMit 2019.09.05

LoRa, High Channel (927.5 MHz)						
				Value (dBm/3kHz)	Limit (dBm/3kHz)	Results
				7.586	8	Pass