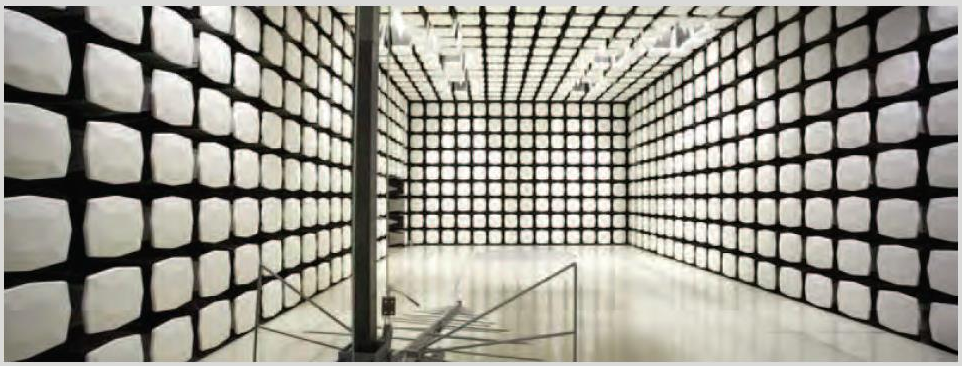
Multi-Tech Systems, Inc.

MTAC-003U00

FCC 15.247:2022, RSS-247 Issue 2:2017

902 – 928 MHz Wideband (DTS) Transceiver Radio

Report: MLTI0249.4 Rev. 3, Issue Date: September 20, 2023



ACCREDITED
CERT #3310.05

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CERTIFICATE OF TEST

Last Date of Test: July 21, 2023
Multi-Tech Systems, Inc.
EUT: MTAC-003U00

Radio Equipment Testing

Standards

Specification	Method
FCC 15.247:2022	ANSI C63.10:2013, KDB 558074 v05r02:2019
RSS-247 Issue 2:2017	
RSS-Gen Issue 5:2018+A1:2019+A2:2021	

Results

Test Description	Result	FCC Section(s)	RSS Section(s)	ANSI Method Section(s)	Comments
Band Edge Compliance	Pass	15.247(d), KDB 558074 -8.7	RSS-247 5.5	11.11	
Band Edge Compliance - Hopping Mode	N/A	15.247(d)	RSS-247 5.5	7.8.6	Not required for DTS devices.
Carrier Frequency Separation	N/A	15.247(a)(1)	RSS-247 5.1(b)	7.8.2	Not required for DTS devices.
DTS Bandwidth (6 dB)	N/A	15.247(a), KDB 558074 -8.2	RSS-247 5.2(a)	11.8.2	
Duty Cycle	N/A	15.247, KDB 558074 -6.0	RSS-Gen 3.2	11.6	
Dwell Time	N/A	15.247(a)(1)	RSS-247 5.1(d)	7.8.4	Not required for DTS devices.
Equivalent Isotropic Radiated Power	Pass	15.247(b), KDB 558074 -8.3.2	RSS-247 5.4(d)	11.9.1.1	
Number of Hopping Frequencies	N/A	15.247(a)(1)	RSS-247 5.1(d)	7.8.3	Not required for DTS devices.
Occupied Bandwidth (99%)	Pass	15.247(a), KDB 558074 -8.2	RSS-247 5.2(a)	6.9.3	
Output Power	Pass	15.247(b), KDB 558074 -8.3.2	RSS-247 5.4(d)	11.9.1.1	
Power Spectral Density	Pass	15.247(e), KDB 558074 -8.4	RSS-247 5.2(b)	11.10.2	
Powerline Conducted Emissions (Transmitter)	Pass	15.207	RSS-Gen 8.8	6.2	
Spurious Conducted Emissions	Pass	15.247(d), KDB 558074 -8.5	RSS-247 5.5	11.11	
Spurious Emissions in Restricted Bands (Conducted)	Pass	15.247(d), KDB 558074 -8.6	RSS-247 5.5	11.12.2	
Spurious Radiated Emissions	Pass	15.247(d), KDB 558074 -8.6	RSS-247 5.5	6.5, 6.6, 11.12.1, 11.13.2	
Powerline Conducted Emissions (Receiver)	N/A	15.107	RSS-Gen 7.2	ANSI C63.4 12.2.4	Not included per FCC 15.101 as this will be covered under SDoC rules for the FCC. RSS-Gen section 7 stated receiver requirements only apply to standalone receivers operating in the 30-960 MHz band and this is not a standalone receiver.
Spurious Emissions of the Receiver	N/A	15.101, 15.109	RSS-Gen 7.3	ANSI C63.4 - 12.2.5	

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

CERTIFICATE OF TEST

element
2022.04.01

Deviations From Test Standards

None

Approved By:

Cole Ghizzone, 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
01	Added configuration MLTI0281-1.	2023-04-11	16
	Updated equipment lists.	2023-04-11	18, 21, 29, 34, 38, 42 & 51
02	Replaced Powerline Conducted Emissions and Spurious Conducted Emissions with data tested under MLTI0319	2023-08-22	46-50, 66-72
	Removed unused configurations and added configurations from MLTI0319	2023-08-22	13-16
	Updated test dates	2023-08-22	2, 11, 17
	Added EUT names	2023-08-22	1, 2, 11
	Added last statement to functional description to explain why the second unit was partially tested	2023-08-22	11
	Updated EUT name on product description page, CoT, and cover page	2023-09-11	1, 2, 11*
	Added a line about this model being a part of the mCard series. The two enclosure names have been listed and it states that one is slide-in, the other integrated into the case. Updated the functional description to 2023 on FCC 15.247.	2023-09-11	11
	Added the Pulse Electronics antenna info (used with the waterproof enclosure) and CSS modulation and the channel frequencies.	2023-09-11	11
	DC block was used, this has been added.	2023-09-11	23
	Added RSS-Gen to Powerline CE.	2023-09-11	45-48
	Updated the equipment list (had to add a note to explain the cal dates) and frequency range.	2023-09-11	64-71
	Up to 12.4GHz was measured, changed 12750 to 12400.	2023-09-11	64
	Removed unused configurations	2023-09-11	13-14
03	Added RSS-247 standard to the 99% OBW and SRE modules.	2023-09-19	24, 66, 69
	Revised the power settings and antenna page with Comments section	2023-09-19	12
	Updated the antenna in configuration MLTI0319-1 with model number (W1063)	2023-09-19	14
	Fixed bookmark for PSD - removed 'edited'	2023-09-19	40

*page numbers above this line may have changed with revisions

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 - Each laboratory is accredited by A2LA to ISO / IEC 17025, and as a product certifier to ISO / IEC 17065 which allows Element to certify transmitters to FCC and IC specifications.

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 – Recognized as an EU Notified Body validated for the EMCD and RED Directives.

United Kingdom

BEIS – Recognized by the UK as an Approved Body under the UK Radio Equipment and UK EMC Regulations.

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.

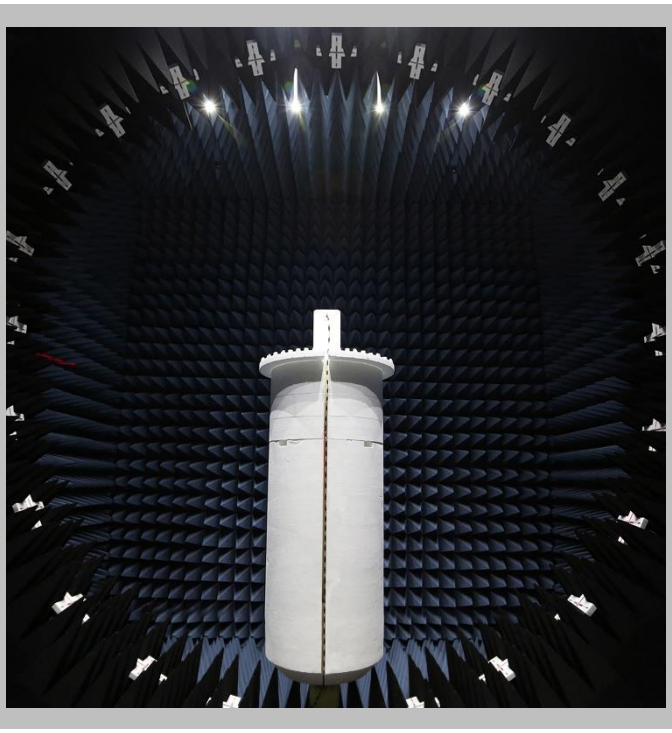
SCOPE

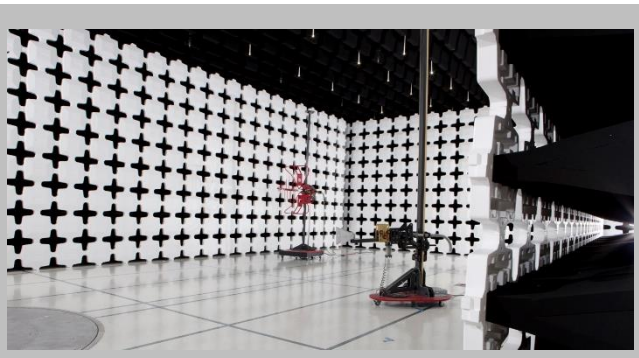
For details on the Scopes of our Accreditations, please visit:

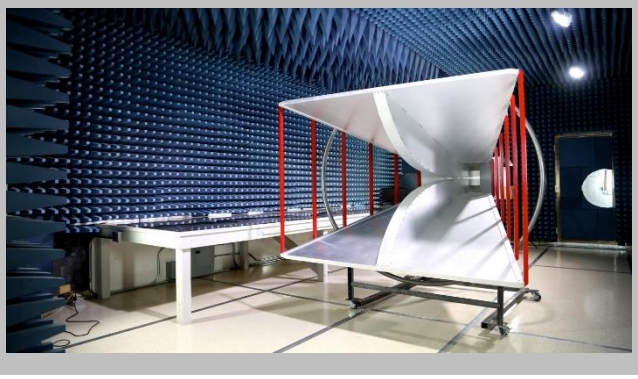
California Minnesota Oregon Texas Washington

FACILITIES

California	Minnesota	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-11 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
A2LA				
Lab Code: 3310.04	Lab Code: 3310.05	Lab Code: 3310.02	Lab Code: 3310.03	Lab Code: 3310.06
Innovation, Science and Economic Development Canada				
2834B-1, 2834B-3	2834E-1, 2834E-3	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157







MEASUREMENT UNCERTAINTY

element
TMU.2015.07.10

Measurement Uncertainty

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

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

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

Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	3.2 dB	-3.2 dB

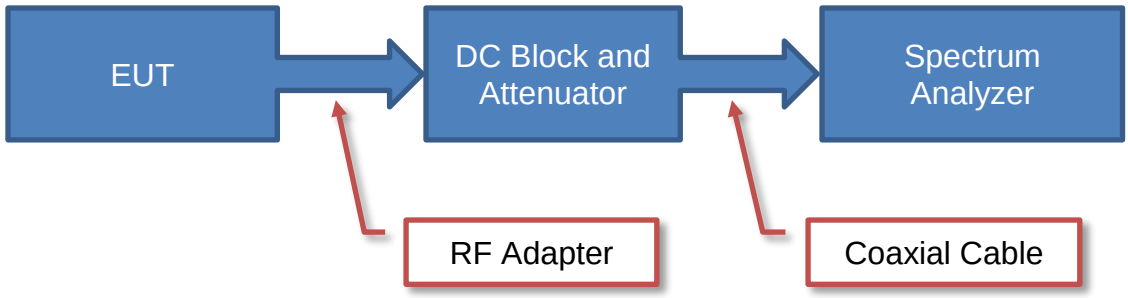
TEST SETUP BLOCK DIAGRAMS

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

Unless otherwise stated, measurements were made using the bandwidths and detectors specified. No video filter was used.

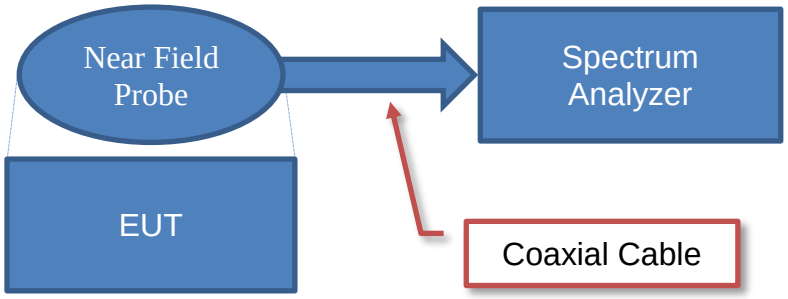
Antenna Port Conducted Measurements



Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

Near Field Test Fixture Measurements

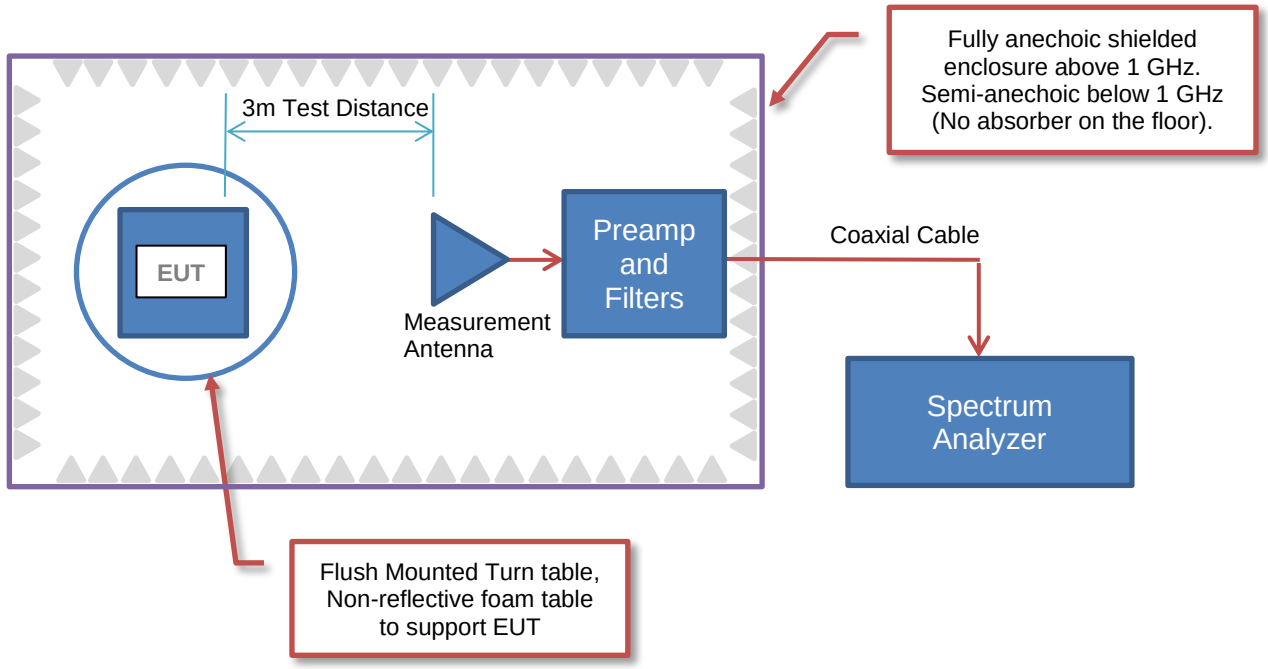


Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

TEST SETUP BLOCK DIAGRAMS

Emissions Measurements



Sample Calculation (logarithmic units)

Radiated Emissions:

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

Conducted Emissions:

Measured Level (Amplitude)		Factor: Transducer Factor		Factor: Cable Factor		External Attenuation		Adjusted Level
26.7	+	0.3	+	0.1	+	20.0	=	**47.1**

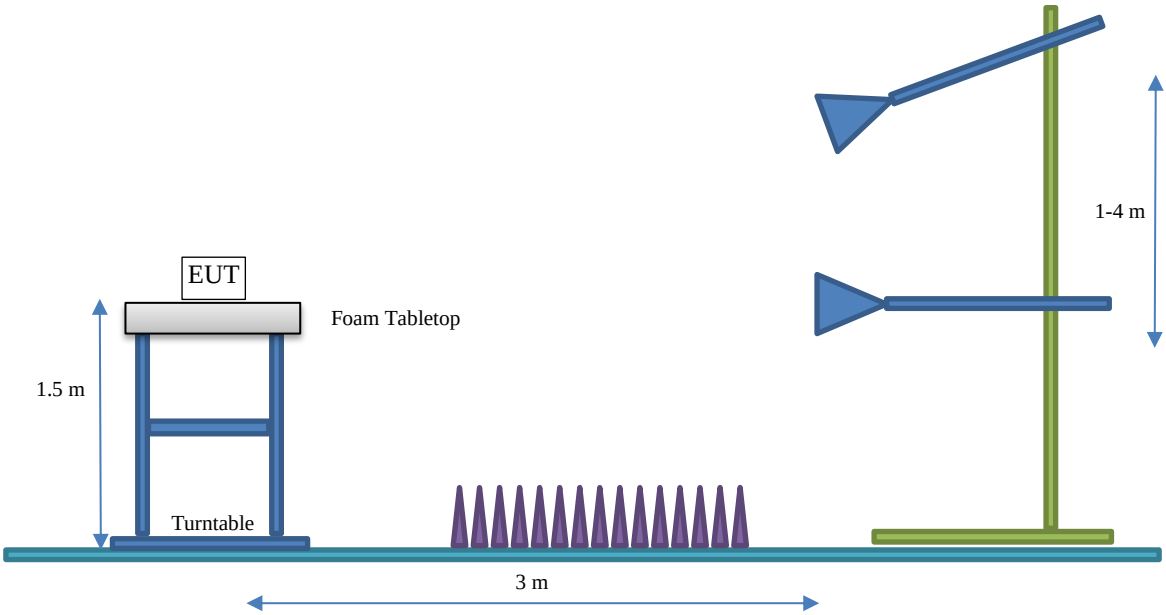
Radiated Power (ERP/EIRP) – Substitution Method:

Measured Level into Substitution Antenna (Amplitude dBm)		Substitution Antenna Factor (dBi)		EIRP to ERP (if applicable)		Measured power (dBm ERP/EIRP)
10.0	+	6.0	-	2.15	=	**13.9/16.0**

TEST SETUP BLOCK DIAGRAMS

Bore Sighting (>1GHz)

The diameter of the illumination area is the dimension of the line tangent to the EUT formed by 3 dB beamwidth of the measurement antenna at the measurement distance. At a 3 meter test distance, the diameter of the illumination area was 3.8 meters at 1 GHz and greater than 2.1 meters up to 6 GHz. Above 1 GHz, when required by the measurement standard, the antenna is pointed for both azimuth and elevation to maintain the receive antenna within the cone of radiation from the EUT. The specified measurement detectors were used for comparison of the emissions to the peak and average specification limits.



PRODUCT DESCRIPTION

Client and Equipment under Test (EUT) Information

Company Name:	Multi-Tech Systems, Inc.
Address:	2205 Woodale Dr
City, State, Zip:	Mounds View, MN 55112
Test Requested By:	Michael Kwilinski
EUT:	MTAC-003U00
First Date of Test:	May 26, 2022
Last Date of Test:	July 21, 2023
Receipt Date of Samples:	April 12, 2022
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 mCard™ gateway accessory cards provide the flexibility needed to manage a wide range of different wired and wireless interfaces and associated communication protocols required to connect sensors, appliances, and assets to the Conduit® programmable gateway.
Available options include a LoRaWAN® Ready mCard capable of supporting thousands of mDot™ long range RF modules monitoring and controlling remote field assets. The MTAC-003U00 is a part of the mCard series.
Want to know more about LoRaWAN technology?
Visit our LoRa® technology page today for the latest in-depth information.

The accessory card was integrated into a MTCDT-L4G1 and a MCTDTIP-L4G1 for radiated testing, by sliding into the housing or being integrated into the enclosure.

This was a module like system which we tested in both hosts for spurious radiated emissions since this is the test most likely to show degradation between hosts.

Testing Objective:

Seeking to demonstrate compliance under FCC 15.247:2023 and RSS-247 Issue 2:2017 for operation in the 902 - 928 MHz Band.

POWER SETTINGS AND ANTENNAS

The power settings, antenna gain value(s) and cable loss (if applicable) used for the testing contained in this report were provided by the customer and will affect the validity of the results. Element assumes no responsibility for the accuracy of this information. The power settings below reflect the maximum power that the EUT is allowed to transmit at during normal operation.

ANTENNA GAIN

Type	Frequency Range (MHz)	Gain	Comments:
Pulse Larsen R08063/21704NM	806-960	3 dBi	Main antenna used with MTCDTIP models
Pulse Larsen W1063	868-928	1 dBi	Main antenna used with the MTCDT-L4G1 product
PCTEL MFB9155NF	902-928	5.07 dBi	Only for demonstration of max gain antenna

The EUT was tested using the power settings provided by the manufacturer which were based upon:

☒ Test software settings Test software/firmware installed on EUT: 6.0.0-dev2-124-gec36e32
☐ Rated power settings

SETTINGS FOR ALL TESTS IN THIS REPORT

Modulation Types	Position	Power Setting
Chirp Spread Spectrum modulation	Low Channel (923.3 MHz)	PA3 PWID15 Spreading Factor 10
	Mid Channel (925.1 MHz)	PA3 PWID15 Spreading Factor 10
	High Channel (927.5 MHz)	PA3 PWID15 Spreading Factor 10

CONFIGURATIONS

Configuration MLTI0249- 7

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
MTCDT	Multi-Tech Systems, Inc.	MTCDT	None (no label)
MTAC-003U00	Multi-Tech Systems, Inc.	MTAC-003U00	21679377

Peripherals in Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
AC Adapter (EUT)	Mega Electronics Inc	MJSW0901700N-5448	MJSW0901700N-5448

Remote Equipment Outside of Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Lenovo	ThinkPad	PK0WM2G
Power Supply (Thinkpad)	Lenovo	8DLX90NCT2A	None

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Cable (EUT)	No	1.5 m	No	MTAC-003U00	AC Adapter (EUT)
Ethernet Cable (benchtop)	No	1.9 m	No	MTCDT	Laptop

Configuration MLTI0266- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
MTAC-003U00	Multi-Tech Systems, Inc.	MTAC-003U00	21679377

Peripherals in Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
AC/DC Adapter	MEGA Electronics Inc.	FJ-SW0901700N	941828
Laptop	Lenovo	2320JPU	13821

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Power	Yes	1.4 m	No	AC/DC Adapter	MTAC-003U00
Cat5 Ethernet	No	1.8 m	No	MTAC-003U00	MTAC-003U00

CONFIGURATIONS

Configuration MLTI0319-1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
LoRa Antenna 1	Pulse Larsen	W1063	None
MTCDT-L4G1 (HOST)	Multi-Tech Systems, Inc.	MTCDT-L4G1	22728636

Peripherals in Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Power Supply	MEGA Electronics	FJ-SW0901700N	MJSW0901700N-5448

Remote Equipment Outside of Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Lenovo	Thinkpad	None

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
Power Cable	No	1.8m	No	Power Supply	MTCDT-L4G1 (HOST)
Ethernet Cable	No	>3m	No	LAN	Laptop

Configuration MLTI0319-2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
MTCDTIP-L4G1 (HOST)	Multi-Tech Systems, Inc.	MTCDTIP-L4G1	22761195
LoRa Antenna 2	Pulse Electronics	R08063/21704NM	None

Peripherals in Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
POE Injector	Intellinet	561235	None

Remote Equipment Outside of Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Lenovo	Thinkpad	None

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
AC Cable	No	1.8m	No	POE Injector	AC Mains
Ethernet Cable	No	2m	No	POE Injector	LAN
Ethernet Cable	No	>3m	No	LAN	Laptop

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2022-05-26	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.
2	2022-05-26	DTS Bandwidth (6 dB)	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	2022-05-26	Duty Cycle	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	2022-05-26	Equivalent Isotropic Radiated Power	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT was taken home by the client before the next scheduled test.
5	2022-05-26	Output Power	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
6	2022-05-26	Power Spectral Density	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	2022-05-26	Spurious Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT was returned to the manufacturer.
8	2022-12-16	Occupied Bandwidth (99%)	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT was returned to the manufacturer.
9	2023-07-20	Powerline Conducted Emissions (Transmitter)	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT was returned to the manufacturer.
10	2023-07-21	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

BAND EDGE COMPLIANCE

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	2019-12-31	2022-12-31
Attenuator	Fairview Microwave	SA18S5W-20	RFX	2021-06-02	2022-06-02
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	2021-09-12	2022-09-12
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2022-05-18	2023-05-18
Block - DC	Fairview Microwave	SD3379	AMI	2021-08-13	2022-08-13
Attenuator	S.M. Electronics	SA26B-20	RFW	2022-02-08	2023-02-08

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.

BAND EDGE COMPLIANCE

TbtTx 2022.05.02.0 XMit 2022.02.07.0

EUT:	**MTAC-003U00**			**Work Order:**	**MLTI0249**
Serial Number:	**21679377**			**Date:**	**26-May-22**
Customer:	**Multi-Tech Systems, Inc.**			**Temperature:**	**21.9 °C**
Attendees:	**Dylan Rosenfeldt**			**Humidity:**	**40.9% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Christopher Heintzelman**	**Power:**	**120VAC/60Hz**	**Job Site:**	**MN08**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

Power level: PA3, PWID15, spreading factor 10.

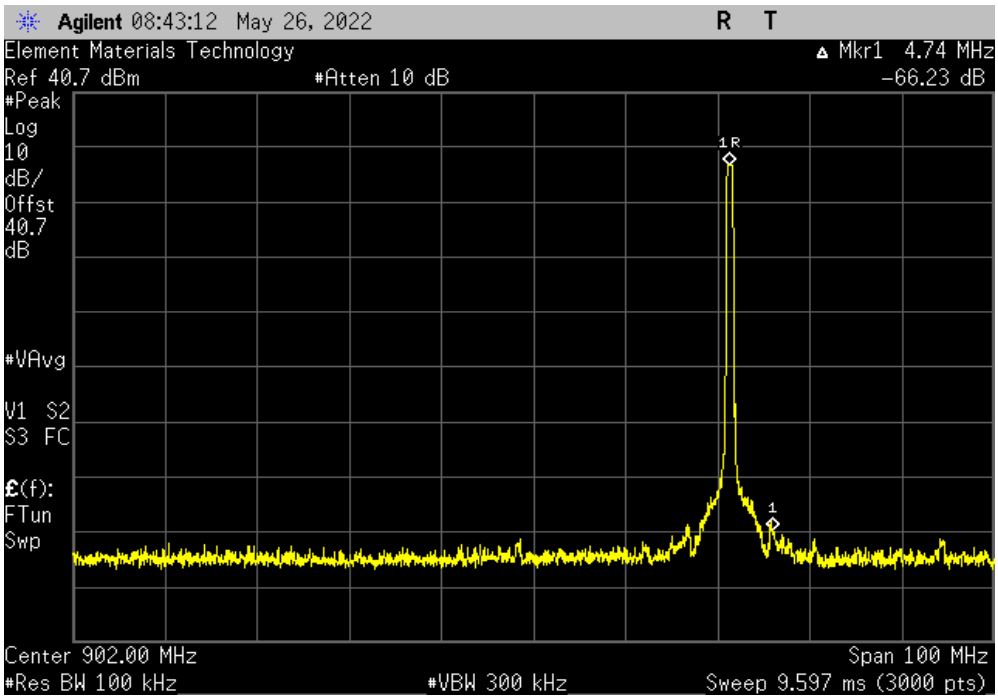
DEVIATIONS FROM TEST STANDARD

None

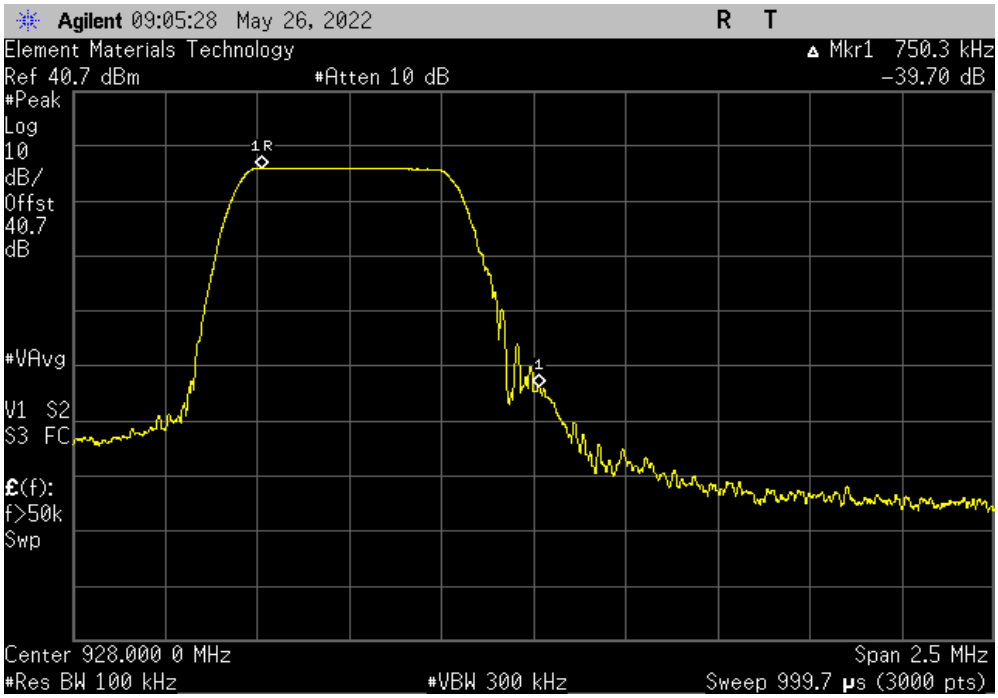
Configuration #	**7**	*Signature*

	Value (dBc)	**Limit ≤ (dBc)**	**Result**
LoRa CSS 500 kHz Bandwidth			
Low Channel, 923.3 MHz	-66.23	-30	Pass
High Channel, 927.5 MHz	-39.7	-30	Pass

LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-66.23	-30	Pass



LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-39.7	-30	Pass



DTS BANDWIDTH (6dB)

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	2019-12-31	2022-12-31
Block - DC	Fairview Microwave	SD3379	AMI	2021-08-13	2022-08-13
Attenuator	Fairview Microwave	SA18S5W-20	RFX	2021-06-02	2022-06-02
Attenuator	S.M. Electronics	SA26B-20	RFW	2022-02-08	2023-02-08
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	2021-09-12	2022-09-12
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2022-05-18	2023-05-18

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 DTS bandwidth was measured using 100 kHz resolution bandwidth and 300 kHz video bandwidth. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

DTS BANDWIDTH (6dB)

TbtTx 2022.05.02.0 XMit 2022.02.07.0

EUT:	**MTAC-003U00**			**Work Order:**	**MLTI0249**
Serial Number:	**21679377**			**Date:**	**26-May-22**
Customer:	**Multi-Tech Systems, Inc.**			**Temperature:**	**21.8 °C**
Attendees:	**Dylan Rosenfeldt**			**Humidity:**	**42.8% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Christopher Heintzelman**	**Power:**	**120VAC/60Hz**	**Job Site:**	**MN08**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

Power level: PA3, PWID15, spreading factor 10.

DEVIATIONS FROM TEST STANDARD

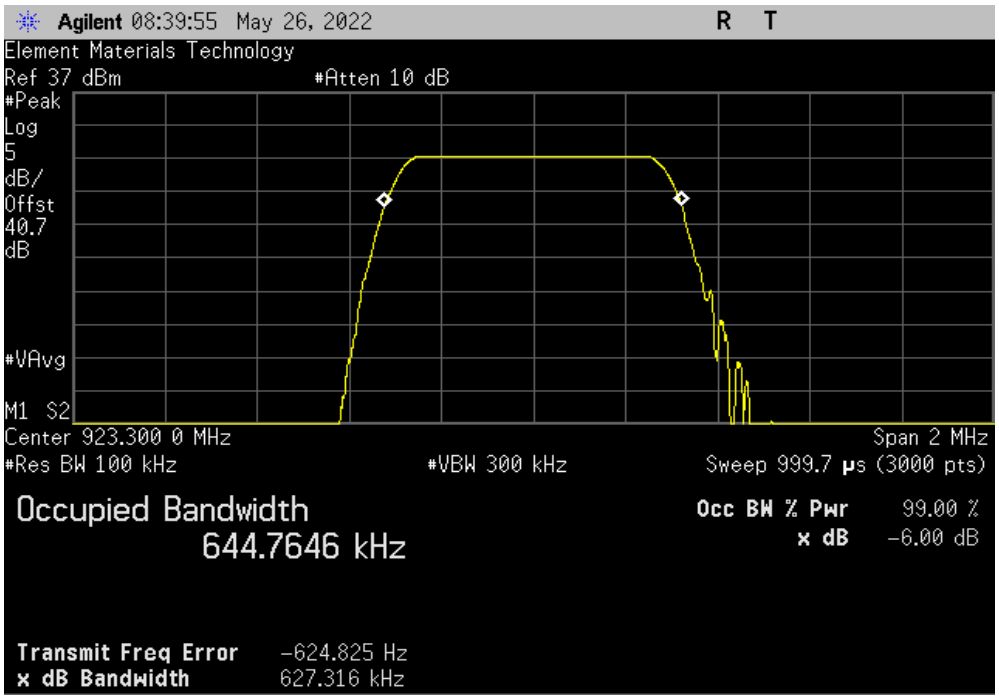
None

Configuration #	**7**	*Signature*

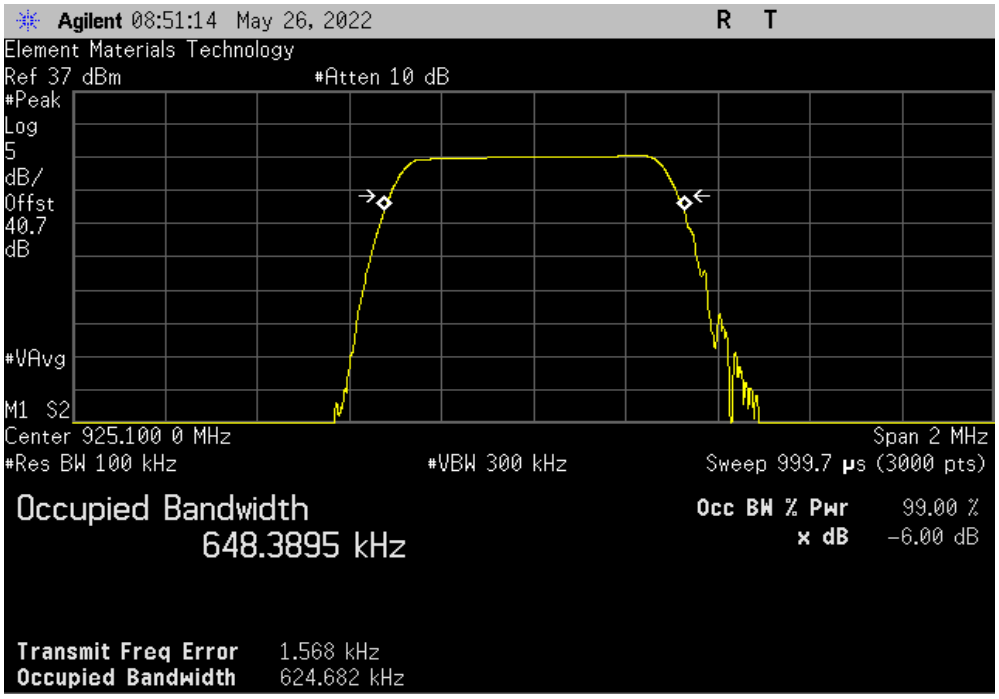
	Value	**Limit (>)**	**Result**
LoRa CSS 500 kHz Bandwidth			
Low Channel, 923.3 MHz	627.316 kHz	500 kHz	Pass
Mid Channel, 925.1 MHz	624.682 kHz	500 kHz	Pass
High Channel, 927.5 MHz	624.726 kHz	500 kHz	Pass

DTS BANDWIDTH (6dB)

LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
				Value	Limit (>)	Result
				627.316 kHz	500 kHz	Pass

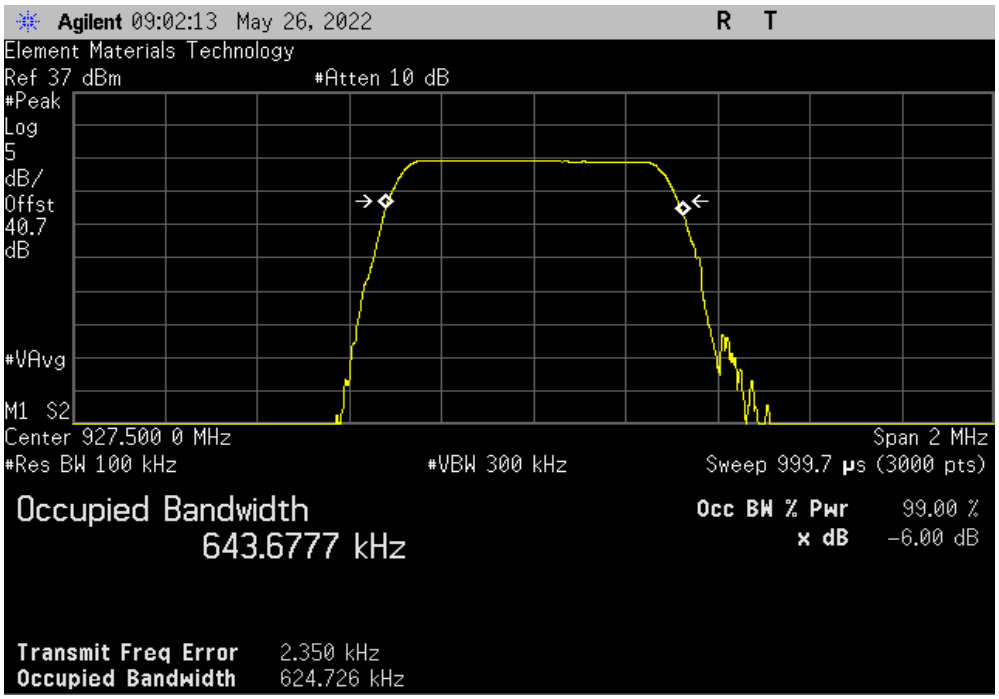


LoRa CSS 500 kHz Bandwidth, Mid Channel, 925.1 MHz						
				Value	Limit (>)	Result
				624.682 kHz	500 kHz	Pass



DTS BANDWIDTH (6dB)

LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz						
				Value	Limit (>)	Result
				624.726 kHz	500 kHz	Pass



OCCUPIED BANDWIDTH (99%)

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	S.M. Electronics	SA26B-20	RFW	2022-02-08	2023-02-08
Analyzer - Spectrum Analyzer	Agilent	E4443A	AAS	2022-06-06	2023-06-06
Signal Generator	Agilent	N5183A	TIK	2022-01-24	2025-01-24
Block - DC	Fairview Microwave	SD3379	AMI	2022-09-10	2023-09-10

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The 99% occupied bandwidth was measured with the EUT configured for continuous modulated operation.

Per ANSI C63.10:2013, 6.9.3, the spectrum analyzer was configured as follows:

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

The resolution bandwidth (RBW) of the spectrum analyzer was set to the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) bandwidth was set to at least 3 times the resolution bandwidth. The analyzer sweep time was set to auto to prevent video filtering or averaging. A sample detector was used unless the device was not able to be operated in a continuous transmit mode, in which case a peak detector was used.

The spectrum analyzer occupied bandwidth measurement function was used to sum the power of the transmission in linear terms to obtain the 99% bandwidth.

OCCUPIED BANDWIDTH (99%)

TbtTx 2022.06.03.0 XMit 2022.02.07.0

EUT:	MTAC-003U00	Work Order:	MLTI0249
Serial Number:	22481781	Date:	16-Dec-22
Customer:	Multi-Tech Systems, Inc.	Temperature:	21.4 °C
Attendees:	Brent Nielsen	Humidity:	29.4% RH
Project:	None	Barometric Pres.:	998 mbar
Tested by:	Trevor Buls	Power: 110VAC/60Hz	Job Site: MN10

TEST SPECIFICATIONS	Test Method
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

PA3, PWID 15, Spreading Factor 10, antenna port terminated. RF path include DC block, attenuator and cable.

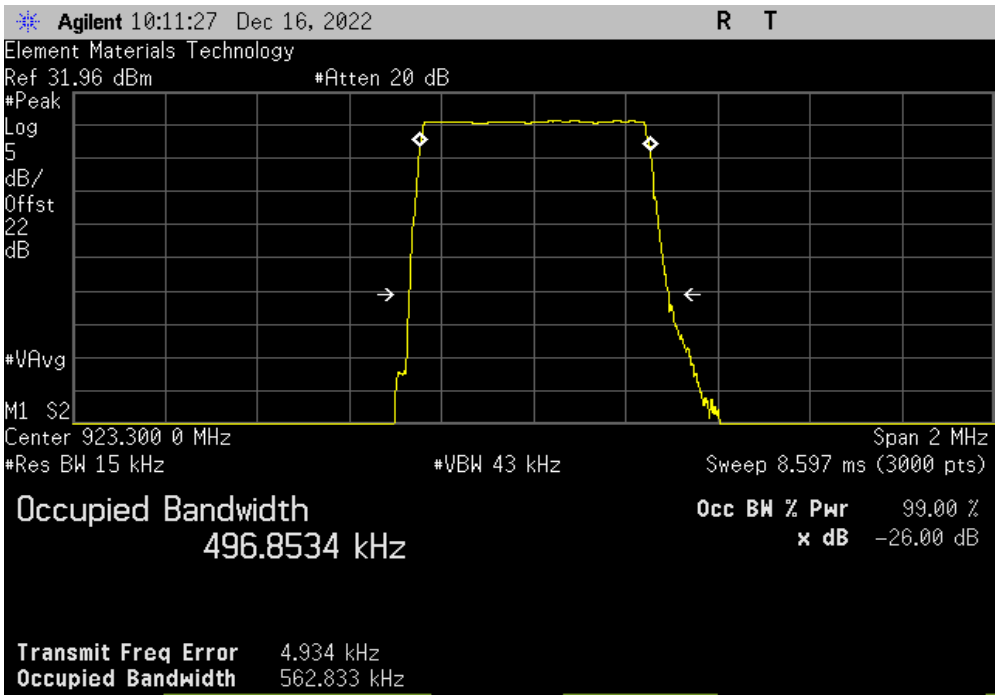
DEVIATIONS FROM TEST STANDARD

None

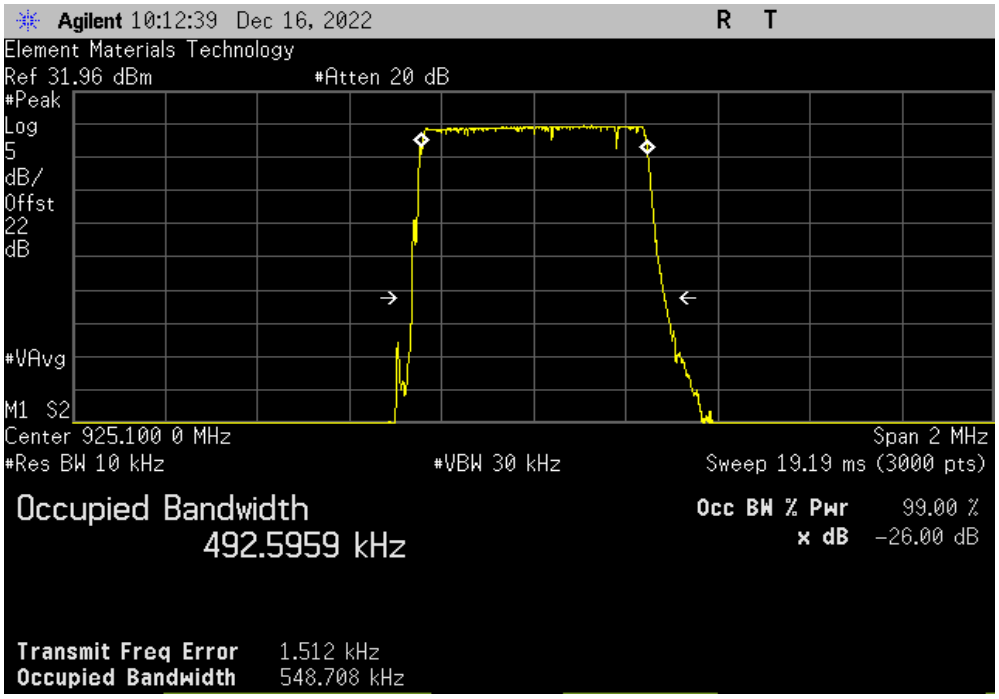
Configuration #	19	Signature Trevor Buls

	Value	Limit	Result
LoRa CSS 500 kHz Bandwidth			
Low Channel, 923.3 MHz	496.853 kHz	N/A	N/A
Mid Channel, 925.1 MHz	492.596 kHz	N/A	N/A
High Channel, 927.5 MHz	491.338 kHz	N/A	N/A

LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
				Value	Limit	Result
				496.853 kHz	N/A	N/A



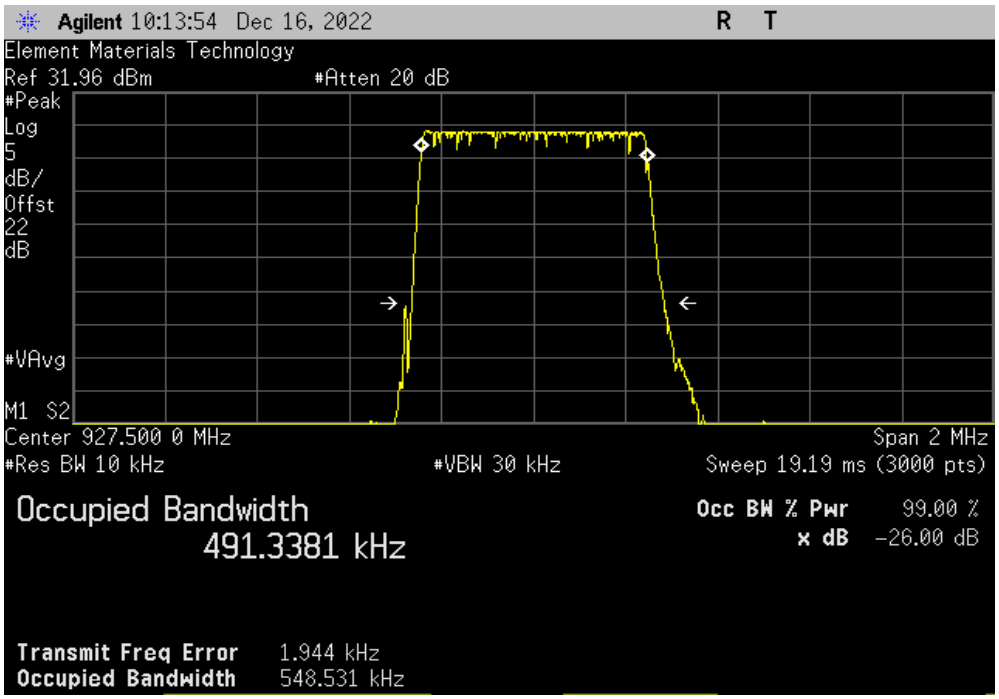
LoRa CSS 500 kHz Bandwidth, Mid Channel, 925.1 MHz						
				Value	Limit	Result
				492.596 kHz	N/A	N/A



OCCUPIED BANDWIDTH (99%)

TbtTx 2022.06.03.0 XMit 2022.02.07.0

LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz						
				Value	Limit	Result
				491.338 kHz	N/A	N/A



DUTY CYCLE

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	2019-12-31	2022-12-31
Attenuator	Fairview Microwave	SA18S5W-20	RFX	2021-06-02	2022-06-02
Block - DC	Fairview Microwave	SD3379	AMI	2021-08-13	2022-08-13
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	2021-09-12	2022-09-12
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2022-05-18	2023-05-18
Attenuator	S.M. Electronics	SA26B-20	RFW	2022-02-08	2023-02-08

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The Duty Cycle (x) of the single channel operation of the radio as controlled by the provided test software was measured for each of the EUT operating modes.

There is no compliance requirement to be met by this test, so therefore no Pass / Fail criteria.

The measurements were made using a zero span on the spectrum analyzer to see the pulses in the time domain. The transmit power was set to its default maximum.

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

If the transmit duty cycle < 98 percent, burst gating may have been used during some of the other tests in this report to only take the measurement during the burst duration.

DUTY CYCLE

TbtTx 2022.05.02.0 XMit 2022.02.07.0

EUT:	MTAC-003U00	Work Order:	MLTI0249
Serial Number:	21679377	Date:	26-May-22
Customer:	Multi-Tech Systems, Inc.	Temperature:	21.9 °C
Attendees:	Dylan Rosenfeldt	Humidity:	43.5% RH
Project:	None	Barometric Pres.:	1014 mbar
Tested by:	Christopher Heintzelman	Power: 120VAC/60Hz	Job Site: MN08

TEST SPECIFICATIONS	Test Method
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

Power level: PA3, PWID15, spreading factor 10. Duty cycle was found to be variable, so a pulse with a longer off time was used for these values.

DEVIATIONS FROM TEST STANDARD

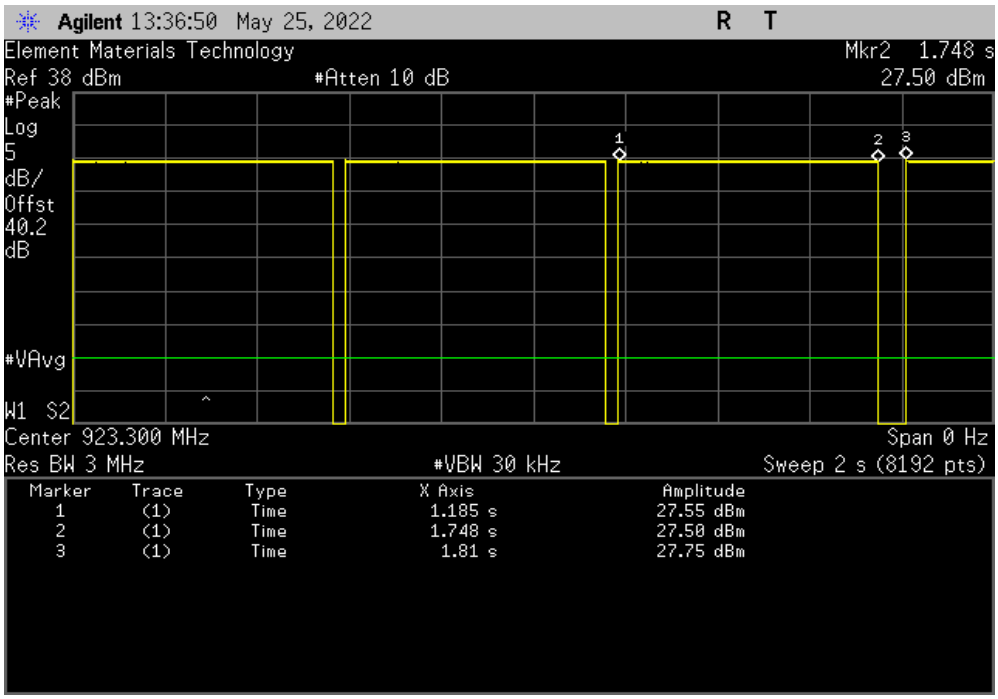
None

Configuration #	7	Signature

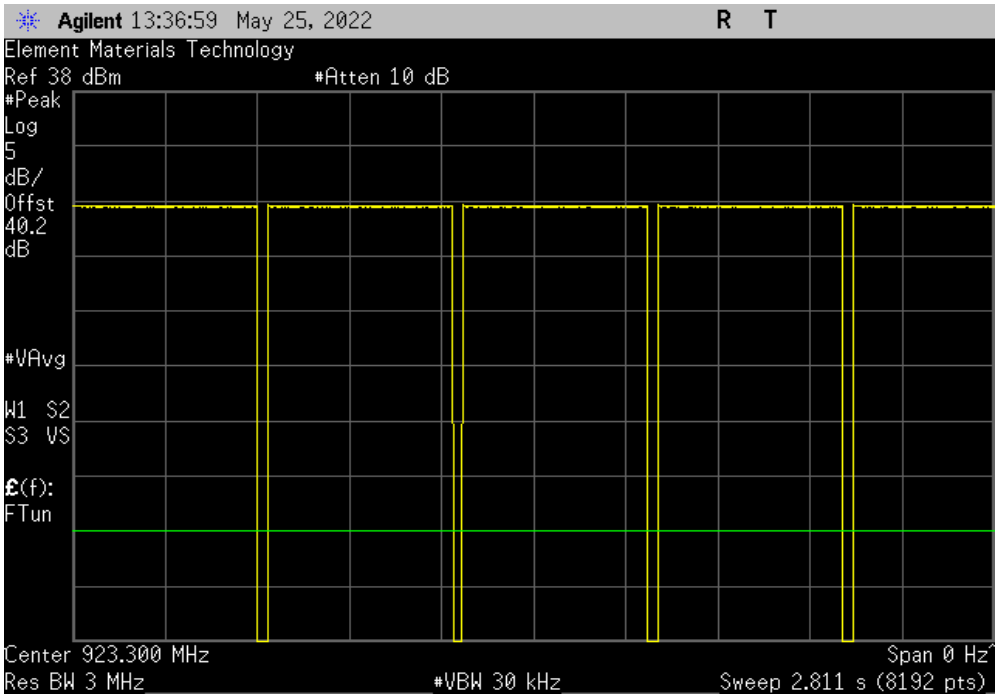
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
LoRa CSS 500 kHz Bandwidth						
Low Channel, 923.3 MHz	562.637 ms	624.664 ms	1	90.1	N/A	N/A
Low Channel, 923.3 MHz	N/A	N/A	5	N/A	N/A	N/A
Mid Channel, 925.1 MHz	563.858 ms	629.914 ms	1	89.5	N/A	N/A
Mid Channel, 925.1 MHz	N/A	N/A	5	N/A	N/A	N/A
High Channel, 927.5 MHz	563.736 ms	625.151 ms	1	90.2	N/A	N/A
High Channel, 927.5 MHz	N/A	N/A	5	N/A	N/A	N/A

DUTY CYCLE

LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	562.637 ms	624.664 ms	1	90.1	N/A	N/A

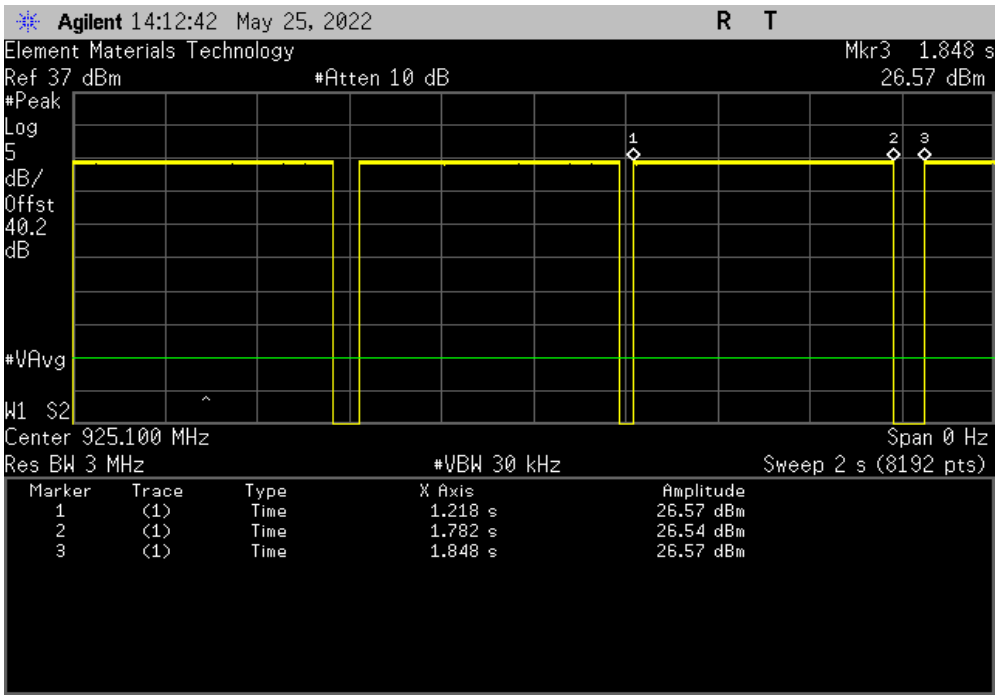


LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

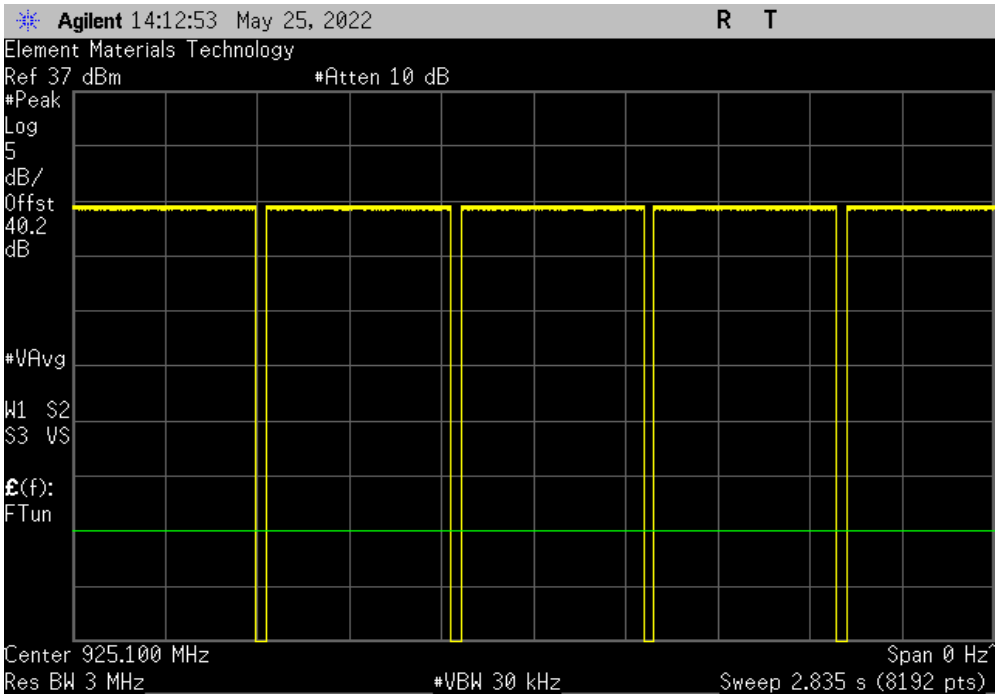


DUTY CYCLE

LoRa CSS 500 kHz Bandwidth, Mid Channel, 925.1 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	563.858 ms	629.914 ms	1	89.5	N/A	N/A



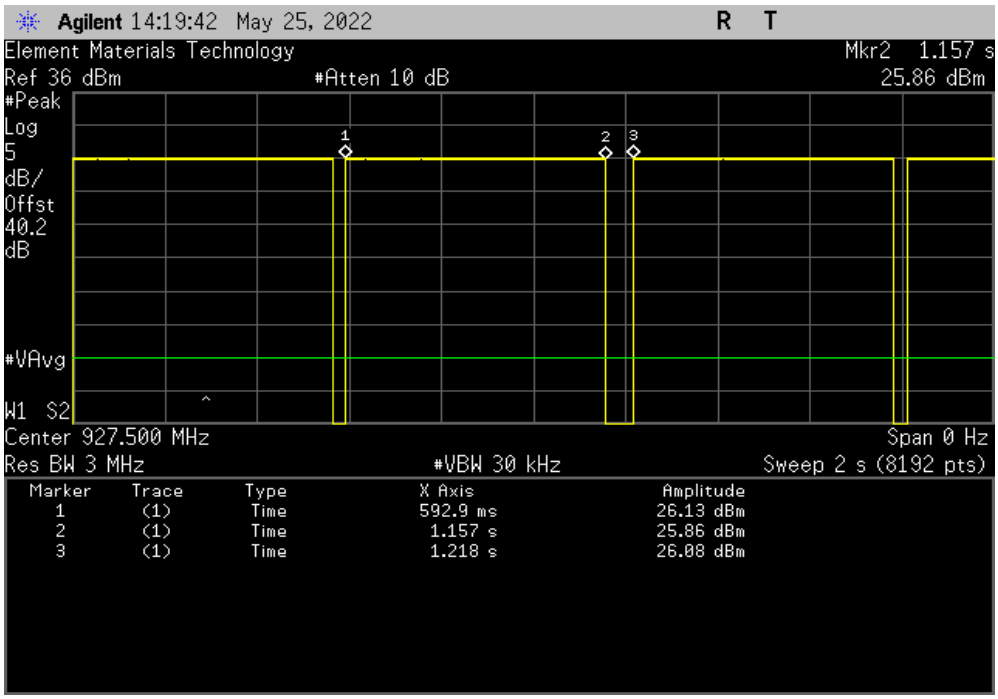
LoRa CSS 500 kHz Bandwidth, Mid Channel, 925.1 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A



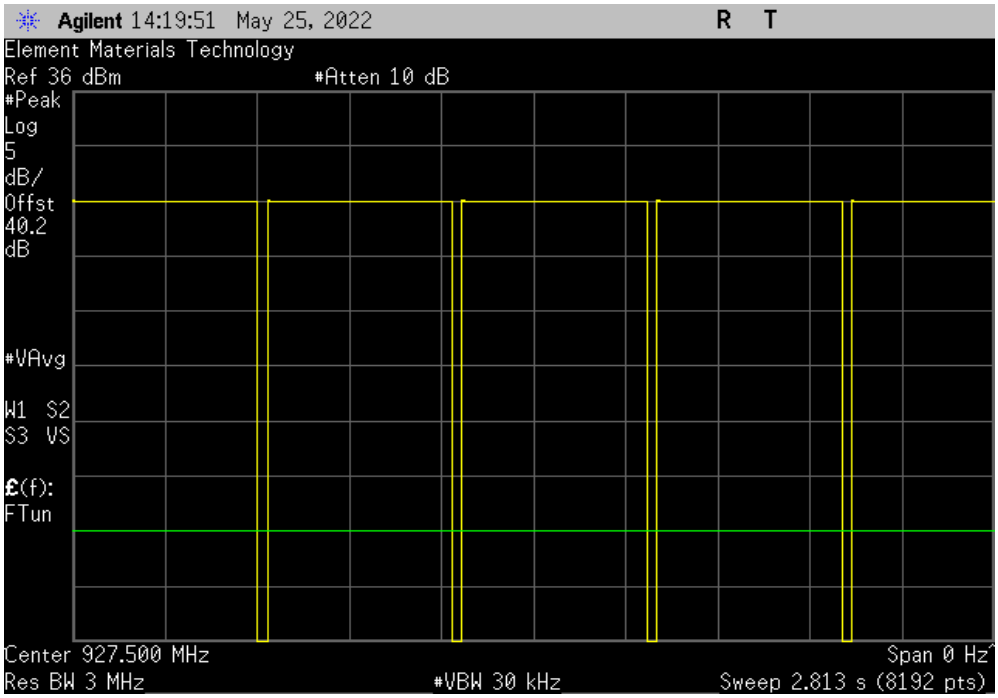
DUTY CYCLE

TbtTx 2022.05.02.0 XMit 2022.02.07.0

LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	563.736 ms	625.151 ms	1	90.2	N/A	N/A



LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	2019-12-31	2022-12-31
Attenuator	Fairview Microwave	SA18S5W-20	RFX	2021-06-02	2022-06-02
Block - DC	Fairview Microwave	SD3379	AMI	2021-08-13	2022-08-13
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	2021-09-12	2022-09-12
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2022-05-18	2023-05-18
Attenuator	S.M. Electronics	SA26B-20	RFW	2022-02-08	2023-02-08

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

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

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

TbtTx 2022.05.02.0 XMit 2022.02.07.0

EUT:	**MTAC-003U00**	**Work Order:**	**MLTI0249**
Serial Number:	**21679377**	**Date:**	**26-May-22**
Customer:	**Multi-Tech Systems, Inc.**	**Temperature:**	**22.1 °C**
Attendees:	**Dylan Rosenfeldt**	**Humidity:**	**41.7% RH**
Project:	**None**	**Barometric Pres.:**	**1013 mbar**
Tested by:	**Christopher Heintzelman**	**Power:** **120VAC/60Hz**	**Job Site:** **MN08**

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

Power level: PA3, PWID15, spreading factor 10.

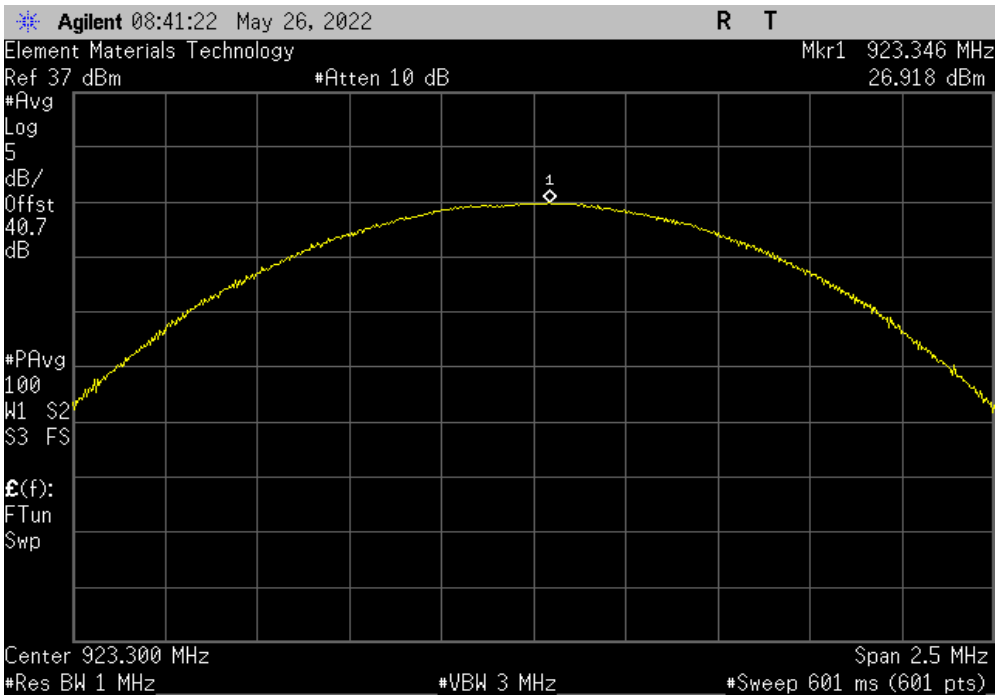
DEVIATIONS FROM TEST STANDARD

None

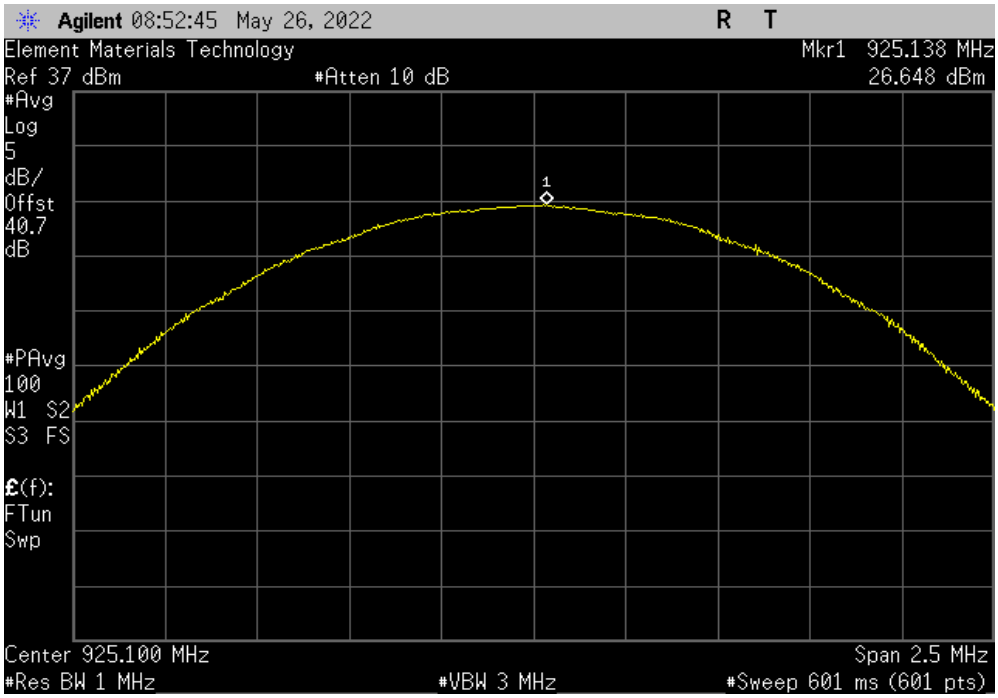
Configuration #	**7**	*Signature*

	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
LoRa CSS 500 kHz Bandwidth							
Low Channel, 923.3 MHz	26.918	0.5	27.4	5.07	32.5	36	Pass
Mid Channel, 925.1 MHz	26.648	0.5	27.1	5.07	32.2	36	Pass
High Channel, 927.5 MHz	26.033	0.4	26.4	5.07	31.5	36	Pass

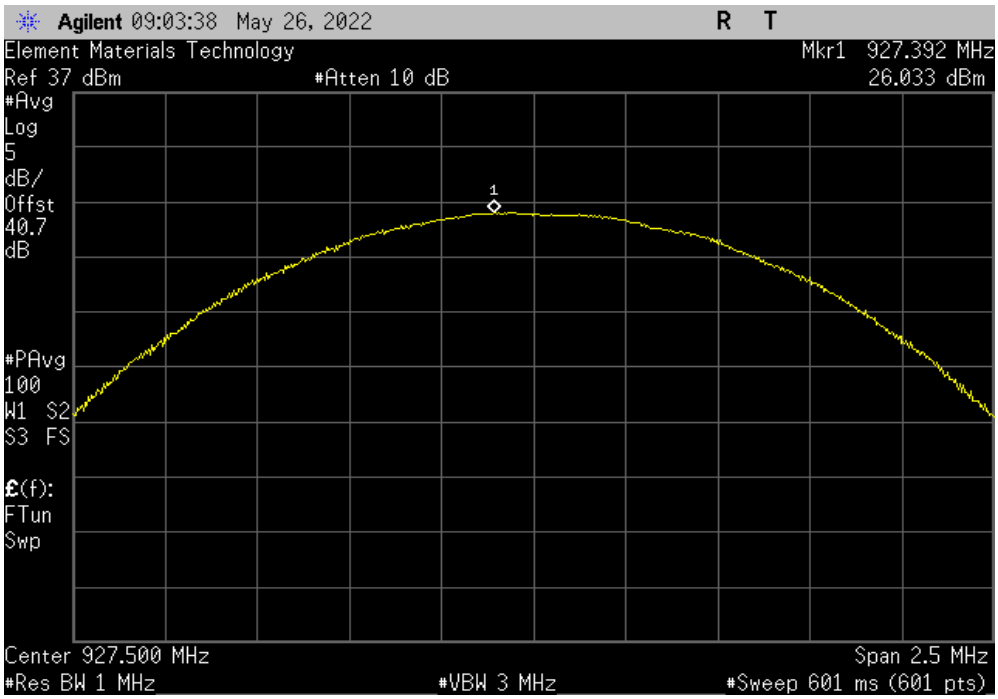
LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
26.918	0.5	27.4	5.07	32.5	36	Pass



LoRa CSS 500 kHz Bandwidth, 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
26.648	0.5	27.1	5.07	32.2	36	Pass



LoRa CSS 500 kHz Bandwidth, 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
26.033	0.4	26.4	5.07	31.5	36	Pass



OUTPUT POWER

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	2019-12-31	2022-12-31
Attenuator	Fairview Microwave	SA18S5W-20	RFX	2021-06-02	2022-06-02
Block - DC	Fairview Microwave	SD3379	AMI	2021-08-13	2022-08-13
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	2021-09-12	2022-09-12
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2022-05-18	2023-05-18
Attenuator	S.M. Electronics	SA26B-20	RFW	2022-02-08	2023-02-08

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

OUTPUT POWER

TbtTx 2022.05.02.0 XMit 2022.02.07.0

EUT:	MTAC-003U00			Work Order:	MLTI0249
Serial Number:	21679377			Date:	26-May-22
Customer:	Multi-Tech Systems, Inc.			Temperature:	21.9 °C
Attendees:	Dylan Rosenfeldt			Humidity:	43.4% RH
Project:	None			Barometric Pres.:	1013 mbar
Tested by:	Christopher Heintzelman	Power:	120VAC/60Hz	Job Site:	MN08

TEST SPECIFICATIONS	Test Method
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

Power level: PA3, PWID15, spreading factor 10.

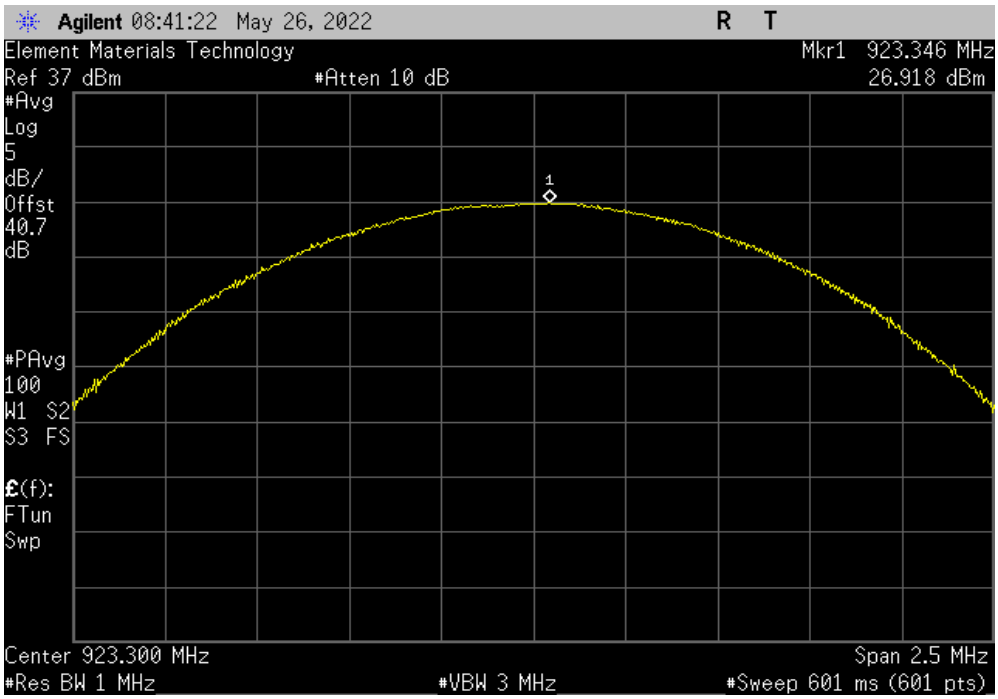
DEVIATIONS FROM TEST STANDARD

None

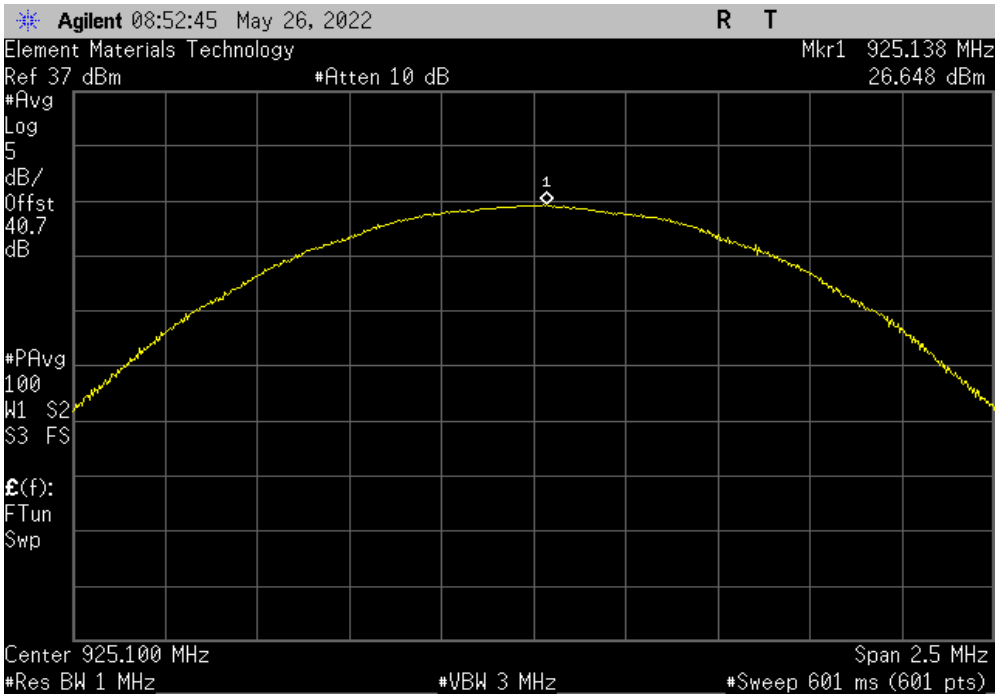
Configuration #	7	Signature

	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
LoRa CSS 500 kHz Bandwidth					
Low Channel, 923.3 MHz	26.918	0.5	27.4	30	Pass
Mid Channel, 925.1 MHz	26.648	0.5	27.1	30	Pass
High Channel, 927.5 MHz	26.033	0.4	26.4	30	Pass

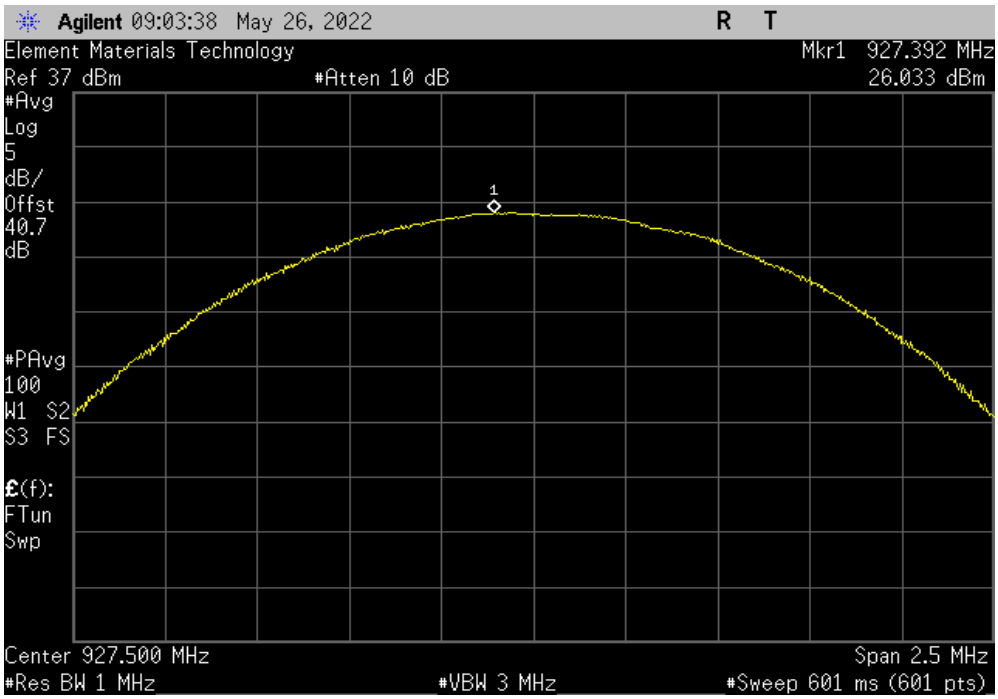
LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
		26.918	0.5	27.4	30	Pass



LoRa CSS 500 kHz Bandwidth, Mid Channel, 925.1 MHz						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
		26.648	0.5	27.1	30	Pass



LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz						
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
		26.033	0.4	26.4	30	Pass



POWER SPECTRAL DENSITY

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	2019-12-31	2022-12-31
Attenuator	Fairview Microwave	SA18S5W-20	RFX	2021-06-02	2022-06-02
Attenuator	S.M. Electronics	SA26B-20	RFW	2022-02-08	2023-02-08
Block - DC	Fairview Microwave	SD3379	AMI	2021-08-13	2022-08-13
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	2021-09-12	2022-09-12
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2022-05-18	2023-05-18

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 2022.05.02.0 XMit 2022.02.07.0

EUT:	MTAC-003U00	Work Order:	MLTI0249
Serial Number:	21679377	Date:	26-May-22
Customer:	Multi-Tech Systems, Inc.	Temperature:	22 °C
Attendees:	Dylan Rosenfeldt	Humidity:	42.2% RH
Project:	None	Barometric Pres.:	1013 mbar
Tested by:	Christopher Heintzelman	Power: 120VAC/60Hz	Job Site: MN08

TEST SPECIFICATIONS	Test Method
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

Power level: PA3, PWID15, spreading factor 10. A 0.5 dB correction factor was added to the data as the measured cable offset from the previous day (40.2 dB) was mistakenly used instead of the measured offset from the actual day of testing (40.7 dB).

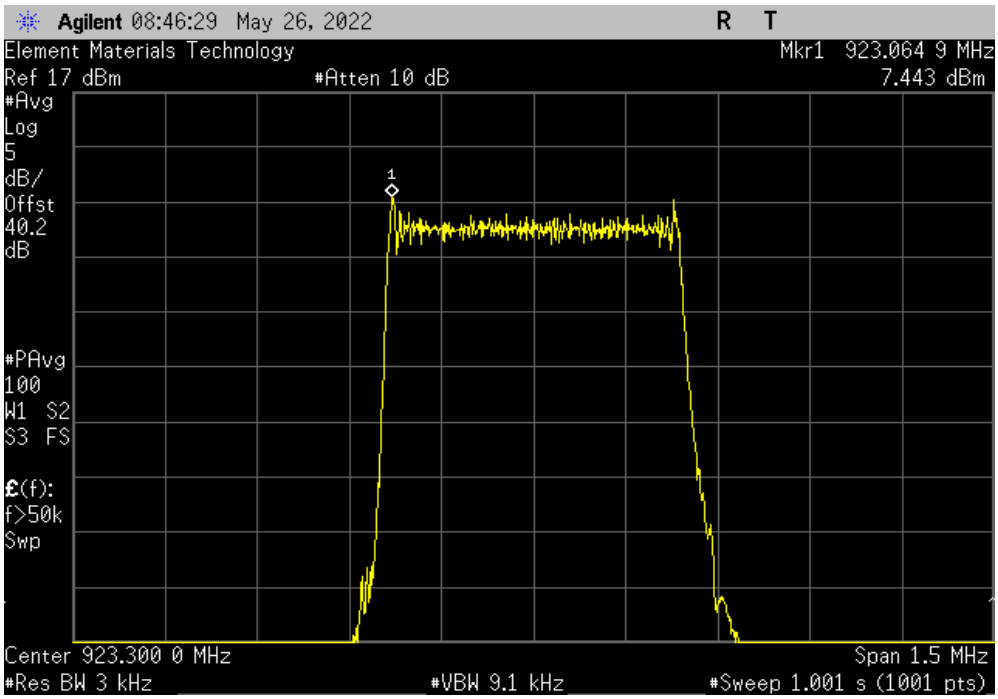
DEVIATIONS FROM TEST STANDARD

None

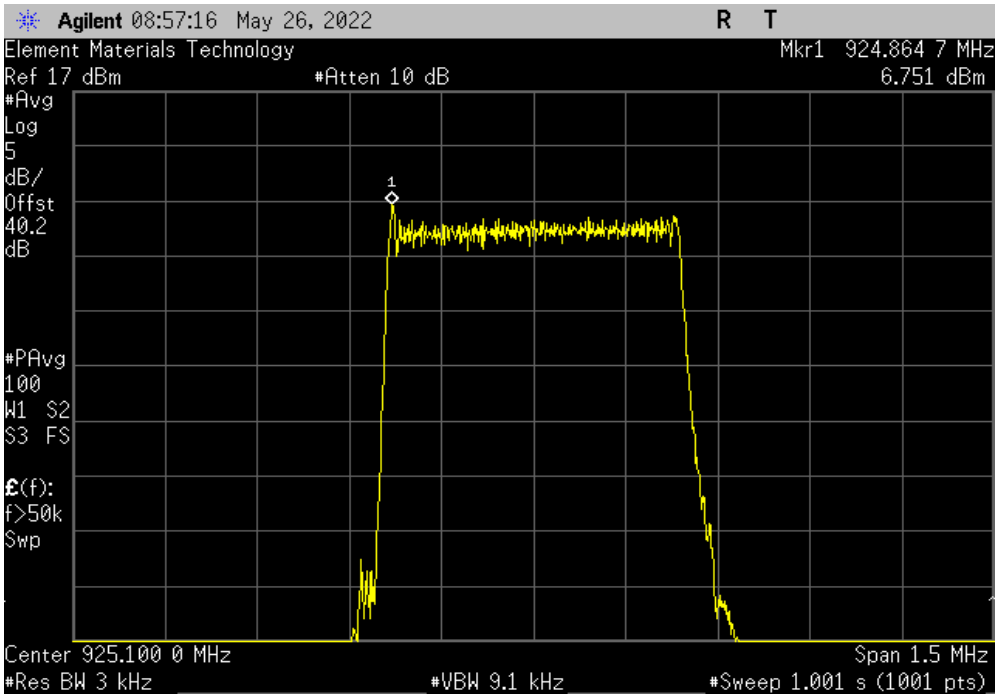
Configuration #	7	Signature

	Value dBm/3kHz	Offset Cor. Factor (dB)	Cor Value dBm/3kHz	Limit (dBm/3kHz)	Results
LoRa CSS 500 kHz Bandwidth					
Low Channel, 923.3 MHz	7.443	0.5	7.9	8	Pass
Mid Channel, 925.1 MHz	6.751	0.5	7.3	8	Pass
High Channel, 927.5 MHz	6.22	0.5	6.7	8	Pass

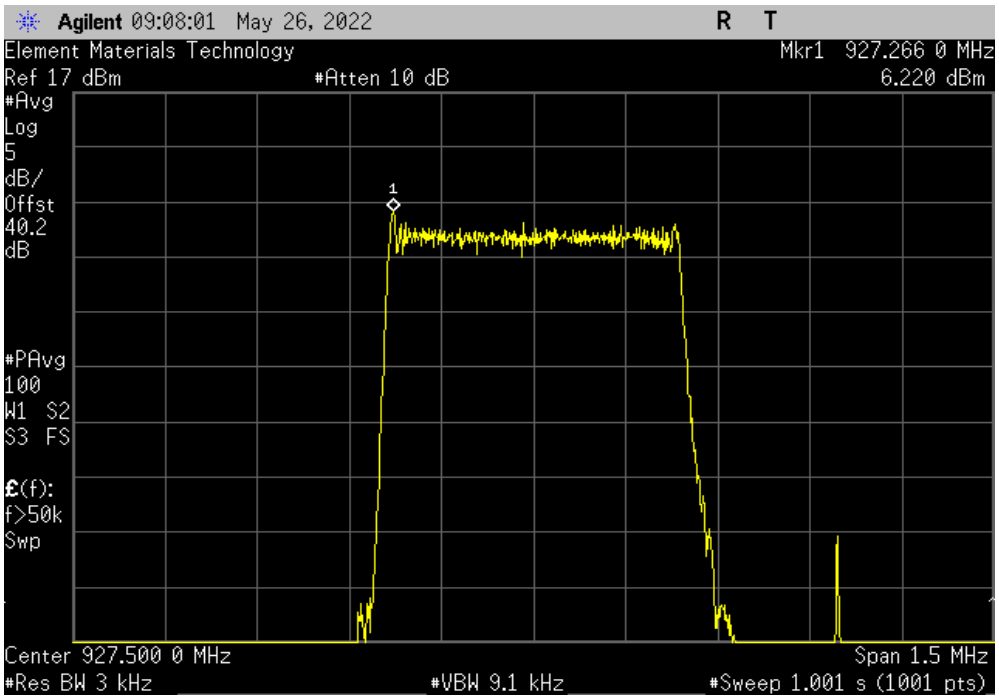
LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
		Value dBm/3kHz	Offset Cor. Factor (dB)	Cor Value dBm/3kHz	Limit (dBm/3kHz)	Results
		7.443	0.5	7.9	8	Pass



LoRa CSS 500 kHz Bandwidth, Mid Channel, 925.1 MHz						
		Value dBm/3kHz	Offset Cor. Factor (dB)	Cor Value dBm/3kHz	Limit (dBm/3kHz)	Results
		6.751	0.5	7.3	8	Pass



LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz						
		Value dBm/3kHz	Offset Cor. Factor (dB)	Cor Value dBm/3kHz	Limit (dBm/3kHz)	Results
		6.22	0.5	6.7	8	Pass



POWERLINE CONDUCTED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

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	Gauss Instruments	TDEMI 30M	ARS	2023-04-26	2024-04-26
Cable - Conducted Cable Assembly	Northwest EMC	MNC, HGN, TYK	MNCA	2023-03-09	2024-03-09
LISN	Solar Electronics	9252-50-R-24-BNC	LIY	2023-04-02	2024-04-02

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	3.2 dB	-3.2 dB

CONFIGURATIONS INVESTIGATED

MLTI0319-1

MODES INVESTIGATED

Radio transmitting Middle channel 925.1 MHz, whip antenna connected to radio

POWERLINE CONDUCTED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

EUT:	MTCDT-L4G1	Work Order:	MLTI0319
Serial Number:	22728636	Date:	2023-07-20
Customer:	Multi-Tech Systems, Inc.	Temperature:	23.1°C
Attendees:	Brent Nielsen	Relative Humidity:	49.7%
Customer Project:	None	Bar. Pressure (PMSL):	1016 mb
Tested By:	Marcelo Aguayo	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	MLTI0319-1

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2023	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

TEST PARAMETERS

Run #:	1	Line:	High Line	Add. Ext. Attenuation (dB):	0

COMMENTS

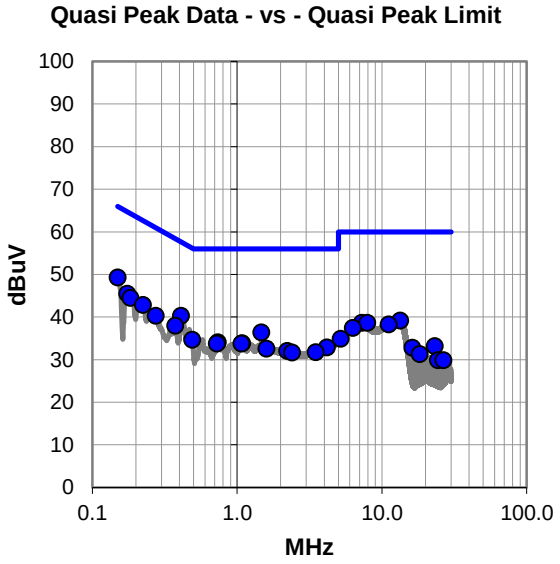
./test_loragw_hal_tx -d /dev/spidev1.0 -f 925.1 -r 1250 -m CW -n 1000 -s 10 -b 125 -z 255 --pwid 15 --pa 3

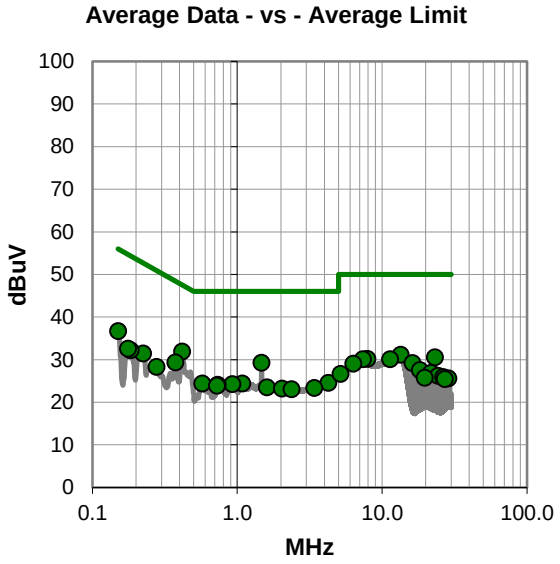
EUT OPERATING MODES

Radio transmitting Middle channel 925.1 MHz, whip antenna connected to radio

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #1

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.150	28.8	20.5	49.3	66.0	-16.7
0.411	20.3	20.0	40.3	57.6	-17.3
0.174	25.2	20.3	45.5	64.7	-19.2
1.470	16.3	20.1	36.4	56.0	-19.6
0.184	24.2	20.3	44.5	64.3	-19.8
0.223	22.7	20.2	42.9	62.7	-19.8
0.374	18.0	20.0	38.0	58.4	-20.4
0.274	20.2	20.1	40.3	61.0	-20.7
13.357	18.2	21.0	39.2	60.0	-20.8
7.248	18.2	20.5	38.7	60.0	-21.3
7.924	18.1	20.6	38.7	60.0	-21.3
0.490	14.7	20.0	34.7	56.2	-21.5
11.162	17.5	20.8	38.3	60.0	-21.7
0.734	14.0	20.1	34.1	56.0	-21.9
1.082	13.8	20.1	33.9	56.0	-22.1
0.725	13.7	20.1	33.8	56.0	-22.2
1.072	13.7	20.1	33.8	56.0	-22.2
6.296	17.1	20.4	37.5	60.0	-22.5
4.181	12.6	20.3	32.9	56.0	-23.1
1.598	12.5	20.1	32.6	56.0	-23.4
2.221	11.9	20.2	32.1	56.0	-23.9
3.499	11.5	20.3	31.8	56.0	-24.2
2.399	11.5	20.2	31.7	56.0	-24.3
5.182	14.6	20.3	34.9	60.0	-25.1
23.129	11.2	22.0	33.2	60.0	-26.8

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.415	11.9	20.0	31.9	47.5	-15.6
1.470	9.2	20.1	29.3	46.0	-16.7
13.420	10.2	21.0	31.2	50.0	-18.8
0.374	9.4	20.0	29.4	48.4	-19.0
0.150	16.2	20.5	36.7	56.0	-19.3
23.129	8.6	22.0	30.6	50.0	-19.4
7.924	9.6	20.6	30.2	50.0	-19.8
7.375	9.6	20.5	30.1	50.0	-19.9
11.333	9.3	20.8	30.1	50.0	-19.9
16.229	7.9	21.3	29.2	50.0	-20.8
6.316	8.7	20.4	29.1	50.0	-20.9
0.223	11.3	20.2	31.5	52.7	-21.2
4.256	4.3	20.3	24.6	46.0	-21.4
0.574	4.4	20.0	24.4	46.0	-21.6
1.082	4.3	20.1	24.4	46.0	-21.6
0.922	4.2	20.1	24.3	46.0	-21.7
0.730	4.0	20.1	24.1	46.0	-21.9
0.184	11.9	20.3	32.2	54.3	-22.1
0.176	12.3	20.3	32.6	54.7	-22.1
0.725	3.8	20.1	23.9	46.0	-22.1
18.243	6.1	21.5	27.6	50.0	-22.4
1.600	3.4	20.1	23.5	46.0	-22.5
0.277	8.2	20.1	28.3	50.9	-22.6
3.408	3.1	20.3	23.4	46.0	-22.6
2.034	3.1	20.1	23.2	46.0	-22.8

CONCLUSION

Pass

Tested By

POWERLINE CONDUCTED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

EUT:	MTCDT-L4G1	Work Order:	MLTI0319
Serial Number:	22728636	Date:	2023-07-20
Customer:	Multi-Tech Systems, Inc.	Temperature:	23.1°C
Attendees:	Brent Nielsen	Relative Humidity:	49.7%
Customer Project:	None	Bar. Pressure (PMSL):	1016 mb
Tested By:	Marcelo Aguayo	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	MLTI0319-1

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2023	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

TEST PARAMETERS

Run #:	2	Line:	Neutral	Add. Ext. Attenuation (dB):	0

COMMENTS

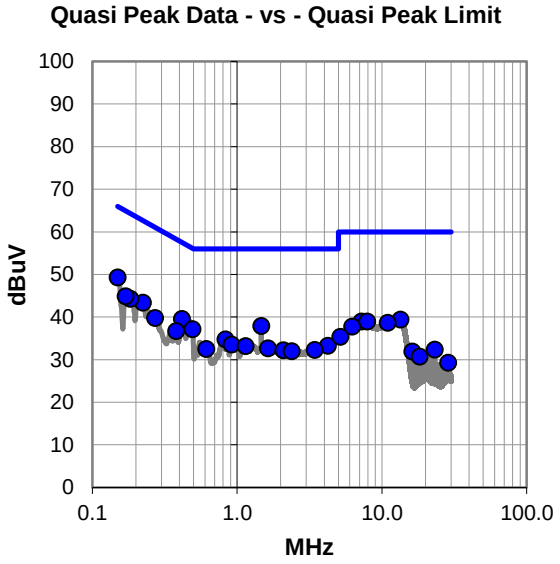
./test_loragw_hal_tx -d /dev/spidev1.0 -f 925.1 -r 1250 -m CW -n 1000 -s 10 -b 125 -z 255 --pwid 15 --pa 3

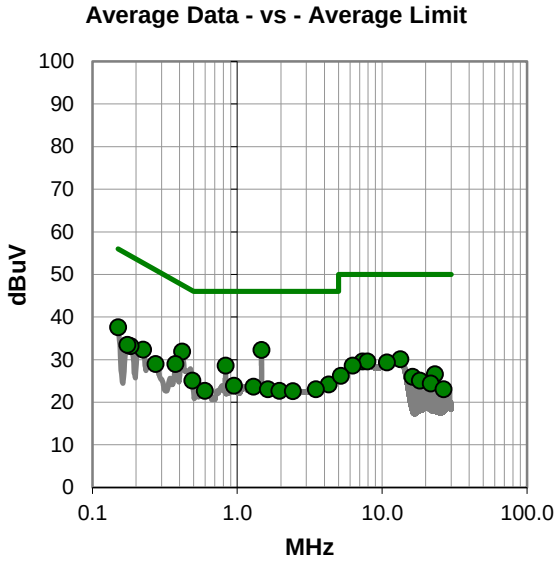
EUT OPERATING MODES

Radio transmitting Middle channel 925.1 MHz, whip antenna connected to radio

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #2

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.150	28.8	20.5	49.3	66.0	-16.7
0.415	19.6	20.0	39.6	57.5	-17.9
1.471	17.8	20.1	37.9	56.0	-18.1
0.492	17.2	20.0	37.2	56.1	-18.9
0.223	23.2	20.2	43.4	62.7	-19.3
0.184	24.0	20.3	44.3	64.3	-20.0
0.170	24.5	20.4	44.9	65.0	-20.1
13.420	18.4	21.0	39.4	60.0	-20.6
7.228	18.5	20.5	39.0	60.0	-21.0
7.922	18.4	20.6	39.0	60.0	-21.0
0.831	14.7	20.1	34.8	56.0	-21.2
10.973	17.9	20.8	38.7	60.0	-21.3
0.272	19.7	20.1	39.8	61.1	-21.3
0.379	16.7	20.0	36.7	58.3	-21.6
6.226	17.4	20.4	37.8	60.0	-22.2
0.917	13.5	20.1	33.6	56.0	-22.4
4.236	13.0	20.3	33.3	56.0	-22.7
1.143	13.1	20.1	33.2	56.0	-22.8
1.638	12.6	20.1	32.7	56.0	-23.3
0.612	12.5	20.0	32.5	56.0	-23.5
3.432	12.0	20.3	32.3	56.0	-23.7
2.085	12.1	20.1	32.2	56.0	-23.8
2.379	11.8	20.2	32.0	56.0	-24.0
5.164	15.1	20.3	35.4	60.0	-24.6
23.129	10.4	22.0	32.4	60.0	-27.6

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
1.471	12.2	20.1	32.3	46.0	-13.7
0.415	11.9	20.0	31.9	47.5	-15.6
0.831	8.5	20.1	28.6	46.0	-17.4
0.150	17.1	20.5	37.6	56.0	-18.4
0.374	9.0	20.0	29.0	48.4	-19.4
13.357	9.1	21.0	30.1	50.0	-19.9
0.223	12.2	20.2	32.4	52.7	-20.3
7.312	9.1	20.5	29.6	50.0	-20.4
7.922	9.0	20.6	29.6	50.0	-20.4
10.794	8.6	20.8	29.4	50.0	-20.6
0.184	12.9	20.3	33.2	54.3	-21.1
0.490	5.1	20.0	25.1	46.2	-21.1
0.174	13.2	20.3	33.5	54.7	-21.2
6.267	8.2	20.4	28.6	50.0	-21.4
4.270	3.9	20.3	24.2	46.0	-21.8
0.272	8.9	20.1	29.0	51.1	-22.1
0.946	3.8	20.1	23.9	46.0	-22.1
1.290	3.6	20.1	23.7	46.0	-22.3
1.625	3.0	20.1	23.1	46.0	-22.9
3.485	2.8	20.3	23.1	46.0	-22.9
0.597	2.7	20.0	22.7	46.0	-23.3
1.952	2.6	20.1	22.7	46.0	-23.3
23.129	4.6	22.0	26.6	50.0	-23.4
2.420	2.4	20.2	22.6	46.0	-23.4
5.184	5.9	20.3	26.2	50.0	-23.8

CONCLUSION

Pass

Tested By

SPURIOUS CONDUCTED EMISSIONS

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5171B (EXG)	TEY	2019-12-31	2022-12-31
Attenuator	Fairview Microwave	SA18S5W-20	RFX	2021-06-02	2022-06-02
Block - DC	Fairview Microwave	SD3379	AMI	2021-08-13	2022-08-13
Cable	Micro-Coax	UFD150A-1-0720-200200	MNL	2021-09-12	2022-09-12
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	2022-05-18	2023-05-18
Attenuator	S.M. Electronics	SA26B-20	RFW	2022-02-08	2023-02-08

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 fundamental was measured with a 100 kHz resolution bandwidth and the highest value was recorded. The rest of the spectrum was then measured with a 100 kHz resolution bandwidth and the highest value was found. The difference between the value found on the fundamental and the rest of the spectrum was compared against the limit to determine compliance.

SPURIOUS CONDUCTED EMISSIONS

TbtTx 2022.05.02.0 XMit 2022.02.07.0

EUT:	MTAC-003U00	Work Order:	MLTI0249
Serial Number:	21679377	Date:	26-May-22
Customer:	Multi-Tech Systems, Inc.	Temperature:	21.9 °C
Attendees:	Dylan Rosenfeldt	Humidity:	42% RH
Project:	None	Barometric Pres.:	1013 mbar
Tested by:	Christopher Heintzelman	Power: 120VAC/60Hz	Job Site: MN08

TEST SPECIFICATIONS	Test Method
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

Power level: PA3, PWID15, spreading factor 10.

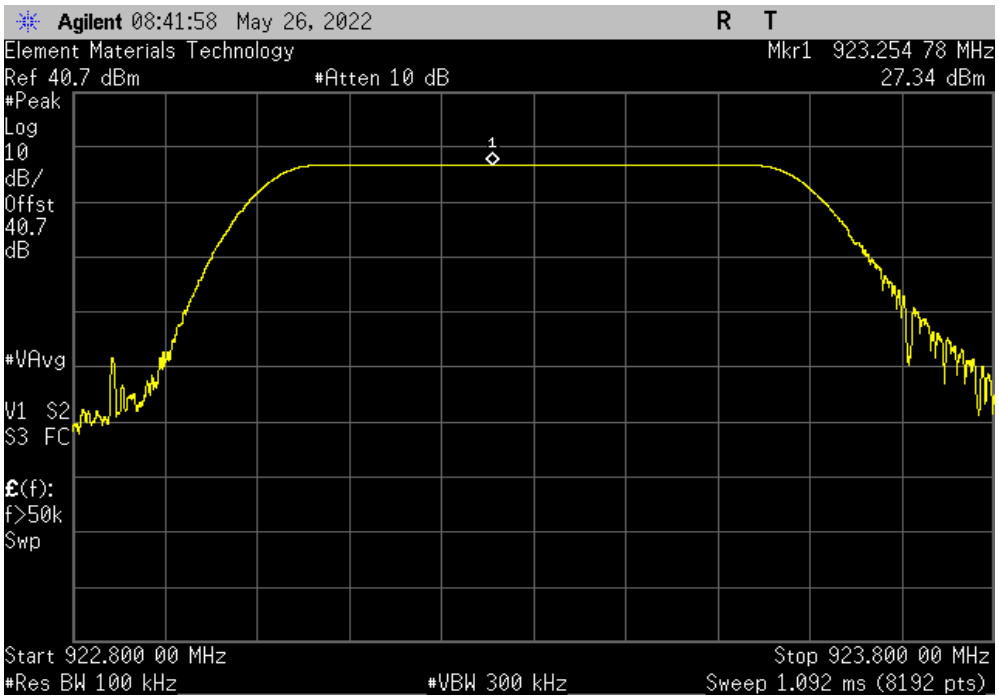
DEVIATIONS FROM TEST STANDARD

None

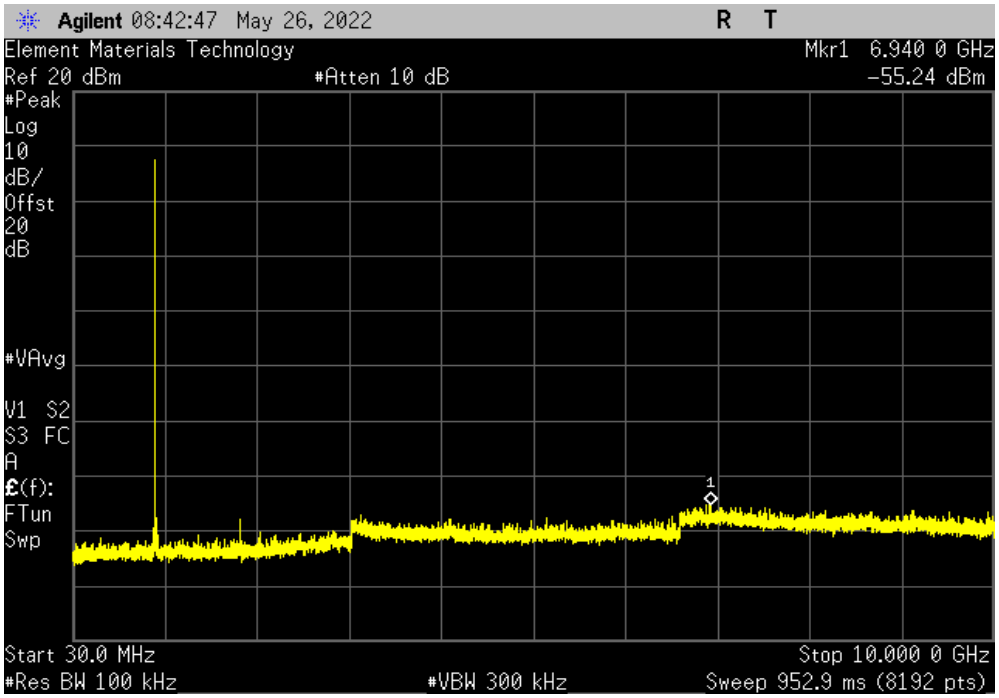
Configuration #	7	Signature

	Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
LoRa CSS 500 kHz Bandwidth					
Low Channel, 923.3 MHz	Fundamental	923.25	N/A	N/A	N/A
Low Channel, 923.3 MHz	30 MHz - 10 GHz	6940	-82.58	-30	Pass
Mid Channel, 925.1 MHz	Fundamental	925.26	N/A	N/A	N/A
Mid Channel, 925.1 MHz	30 MHz - 10 GHz	6806.1	-81.83	-30	Pass
High Channel, 927.5 MHz	Fundamental	927.26	N/A	N/A	N/A
High Channel, 927.5 MHz	30 MHz - 10 GHz	929.5	-79	-30	Pass

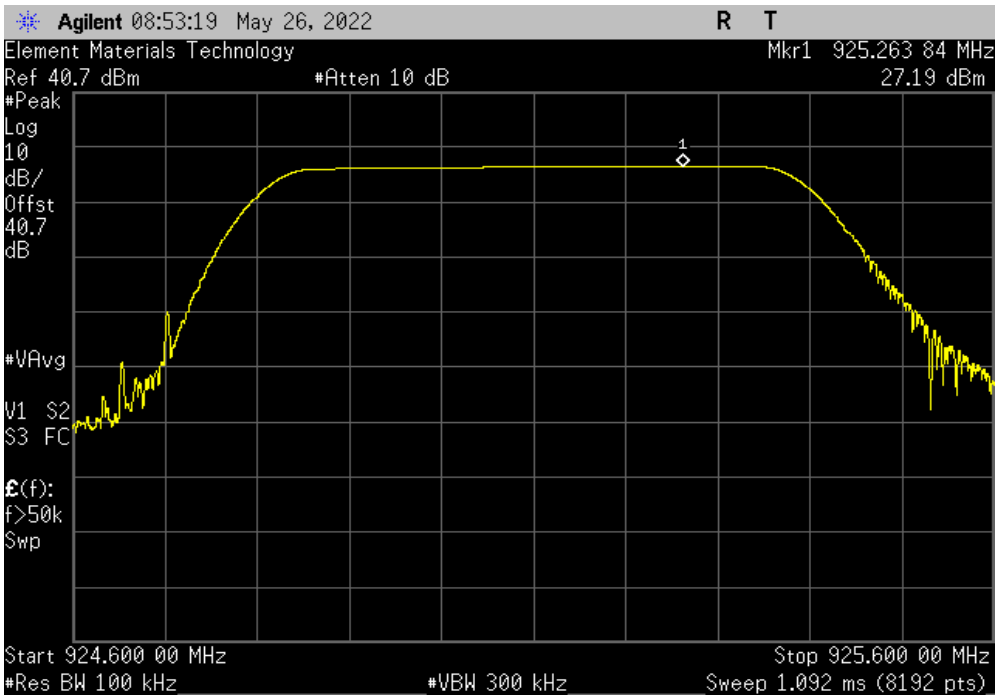
LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz						
	Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental		923.25	N/A	N/A	N/A



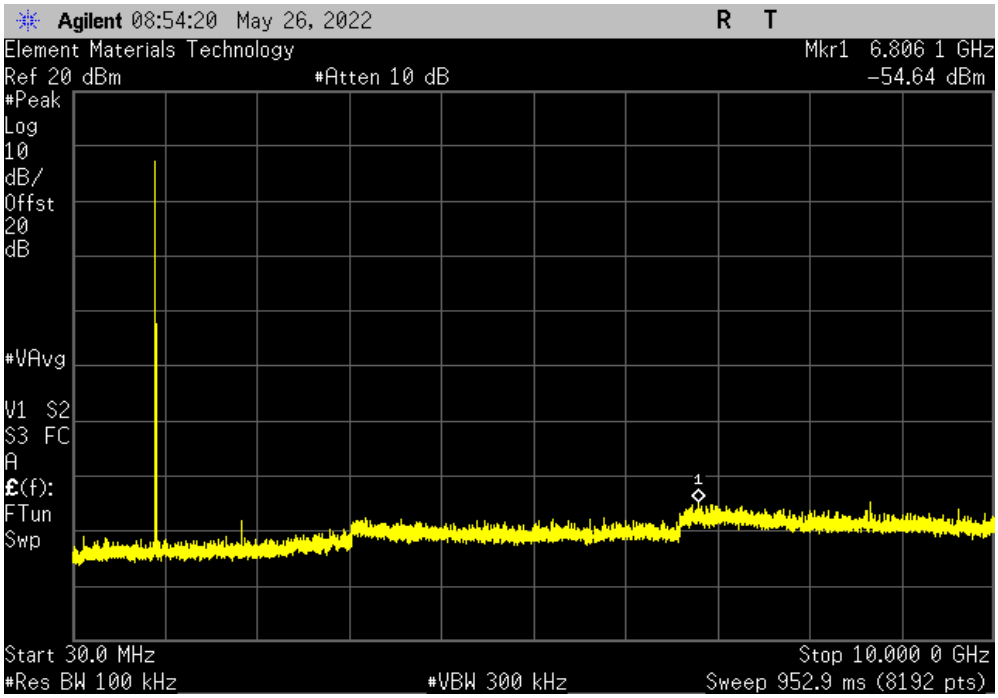
LoRa CSS 500 kHz Bandwidth, Low Channel, 923.3 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 10 GHz	6940	-82.58	-30	Pass



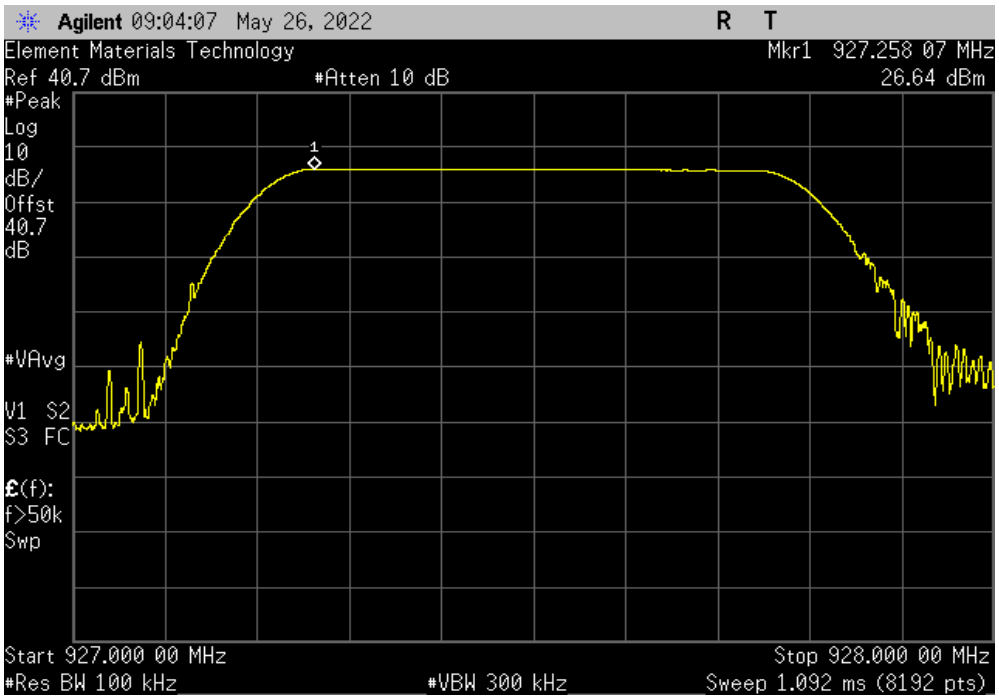
LoRa CSS 500 kHz Bandwidth, Mid Channel, 925.1 MHz						
	Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental		925.26	N/A	N/A	N/A



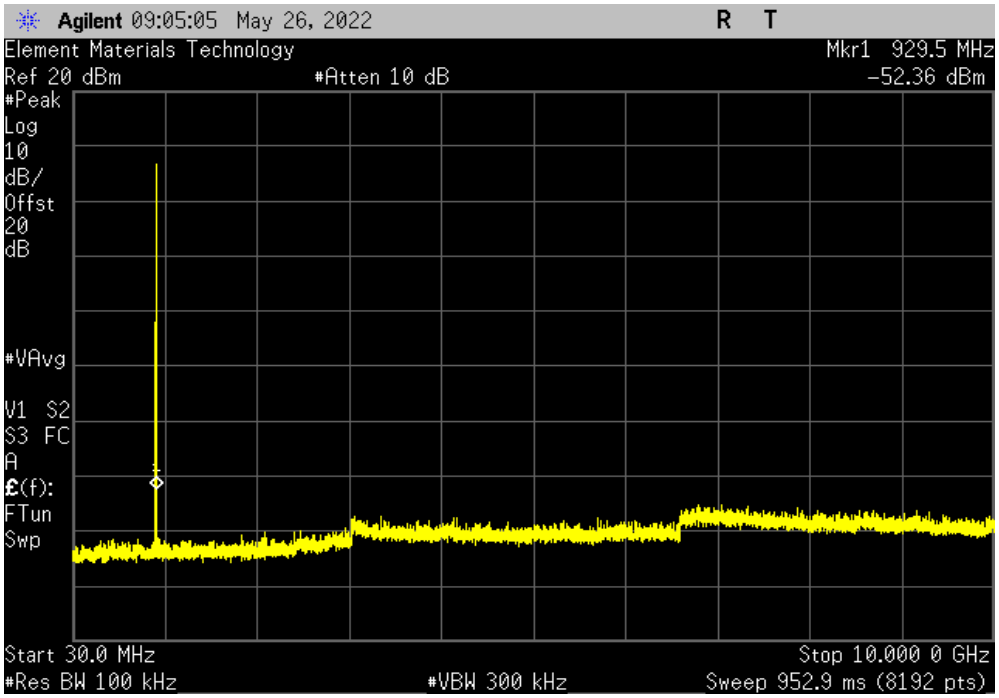
LoRa CSS 500 kHz Bandwidth, Mid Channel, 925.1 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 10 GHz	6806.1	-81.83	-30	Pass



LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz						
	Frequency Range		Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
	Fundamental		927.26	N/A	N/A	N/A



LoRa CSS 500 kHz Bandwidth, High Channel, 927.5 MHz				
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
30 MHz - 10 GHz	929.5	-79	-30	Pass



SPURIOUS EMISSIONS IN RESTRICTED BANDS (CONDUCTED)

XMit 2022.02.07.0

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Agilent	N5182A	TIF	2020-08-29	2023-08-29
Block - DC	Fairview Microwave	SD3379	AMZ	2021-11-05	2022-11-05
Cable	ESM Cable Corp.	TTBJ141 KMKM-72	MNO	2021-08-04	2022-08-04
Filter - Band Pass/Notch	K&L Microwave	3TNF-500/1000-N/N	HGS	2022-06-22	2023-06-22
Filter - High Pass	Micro-Tronics	HPM50108	LFM	2021-09-09	2022-09-09
Filter - Low Pass	Micro-Tronics	LPM50003	LFJ	2021-09-09	2022-09-09
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	2022-06-10	2023-06-10

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 measured with a 100 kHz RBW for frequencies between 30 MHz and 1 GHz and a 1 MHz RBW for frequencies above 1 GHz. The VBW was set to be 3 times as large as the RBW.

The conducted output power at each frequency within a restricted band was measured. Notch filters, low pass filters, and high pass filters were used to achieve sufficient measurement sensitivity. Initially, peak measurements were performed across the spectrum. If a peak measurement complies with a peak, average, or a quasi-peak limit, the peak value is sufficient to demonstrate compliance.

The detector was set to peak, the sweep time was set to auto, and the trace was set to max-hold until the trace stabilized. If the peak value exceeded the quasi-peak or the average limit, another measurement would then need to be performed. For this test, this was not necessary.

The conducted output power was then adjusted for the cable loss of the calibrated cable used at that frequency. The appropriate maximum ground reflection factor was also added based on the frequency range. The maximum ground reflection factor is: 6 dB at or below 30 MHz, 4.7 dB above 30 MHz and below 1000 MHz, inclusive, and 0 dB when above 1000 MHz. The adjusted output power then had the maximum antenna gain (in dBi) added to calculate the EIRP. From the EIRP, the electric field was calculated by the following formula:

$$E = EIRP - 20\log(d) + 104.8$$

Where E is the electric field strength in dBuV/m, EIRP is the equivalent isotropically radiated power in dBm, and d is the specified measurement distance in m.

SPURIOUS EMISSIONS IN RESTRICTED BANDS (CONDUCTED)

XMit 2022.02.07.0

EUT:	MTAC-003U00	Work Order:	MLTI0266
Serial Number:	21679377	Date:	20-Jul-22
Customer:	Multi-Tech Systems, Inc.	Temperature:	21.4 °C
Attendees:	Dylan Rosenfield, Jim Asp	Humidity:	53.9% RH
Project:	None	Barometric Pres.:	1007 mbar
Tested by:	Kyle McMullan	Power: 110VAC/60Hz	Job Site: MN05

TEST SPECIFICATIONS	Test Method
FCC 15.247:2022	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

COMMENTS

Corrected value includes cable loss factor for cable MNO and the appropriate ground reflection factor for the EIRP. See the test description for a more detailed look at the EIRP. The second harmonic of this radio does not fall into a restricted band. All of the first 10 harmonics that fall into a restricted band have been measured. QP limits apply for measurements below 1 GHz, while both peak and average limits apply above 1 GHz.

DEVIATIONS FROM TEST STANDARD

None

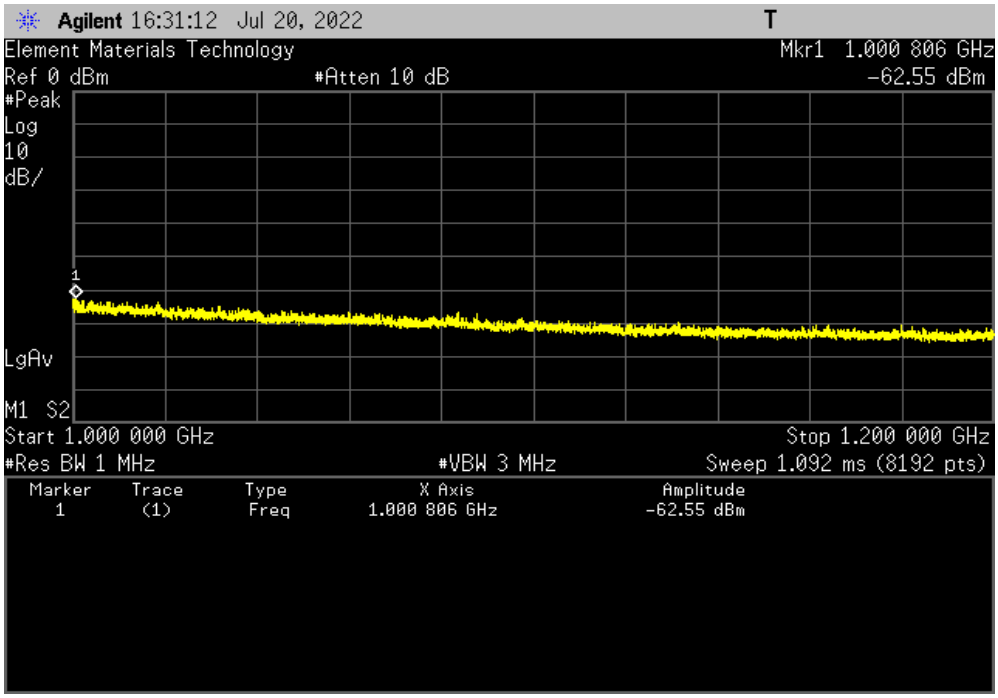
Configuration #	2	Signature

	Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
Low Channel - 923.3 MHz							
30 - 425 MHz	-72.3	-67.1	5.1	33.2	N/A	46	Pass
425 - 1000 MHz	-70.1	-64.6	5.1	35.7	N/A	46	Pass
1 - 1.2 GHz	-62.5	-61.5	5.1	38.8	74	54	Pass
1.2 - 5.5 GHz	-50.9	-49.2	5.1	51.1	74	54	Pass
5.5 - 10 GHz	-68.4	-64.0	5.1	36.3	74	54	Pass
Mid Channel - 925.1 MHz							
30 - 425 MHz	-73.8	-68.6	5.1	31.7	N/A	46	Pass
425 - 1000 MHz	-69.1	-63.6	5.1	36.7	N/A	46	Pass
1 - 1.2 GHz	-63.1	-62.1	5.1	38.2	74	54	Pass
1.2 - 5.5 GHz	-51.0	-49.3	5.1	51.0	74	54	Pass
5.5 - 10 GHz	-69.3	-65.9	5.1	34.4	74	54	Pass
High Channel - 927.5 MHz							
30 - 425 MHz	-73.4	-68.2	5.1	32.1	N/A	46	Pass
425 - 1000 MHz	-68.3	-62.8	5.1	37.5	N/A	46	Pass
1 - 1.2 GHz	-60.8	-59.8	5.1	40.5	74	54	Pass
1.2 - 5.5 GHz	-52.8	-51.1	5.1	49.2	74	54	Pass
5.5 - 10 GHz	-70.6	-66.2	5.1	34.1	74	54	Pass

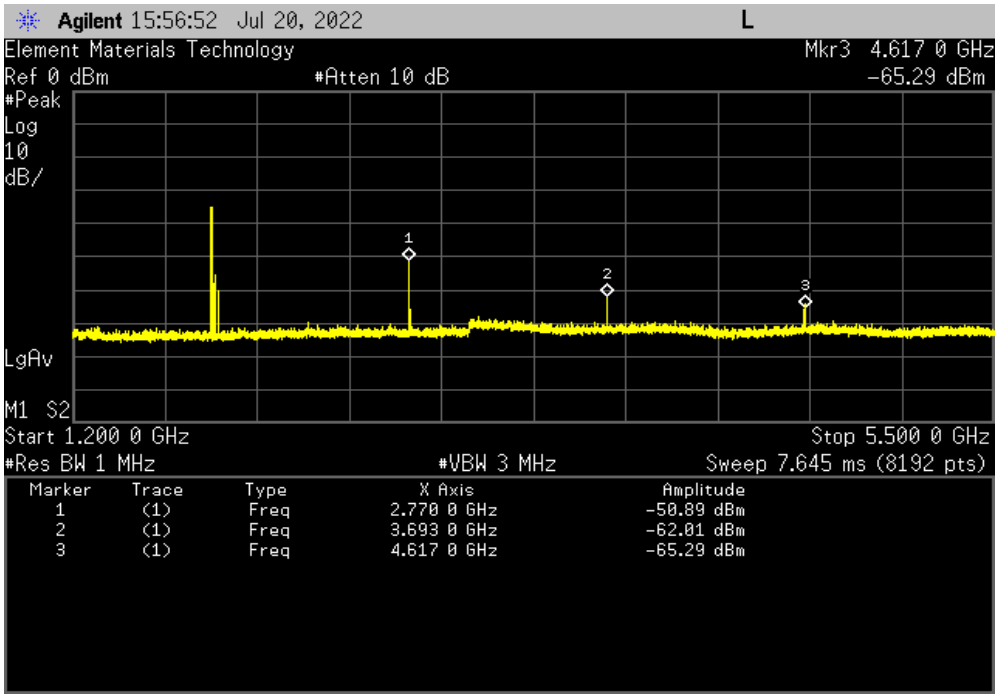
SPURIOUS EMISSIONS IN RESTRICTED BANDS (CONDUCTED)

XMit 2022.02.07.0

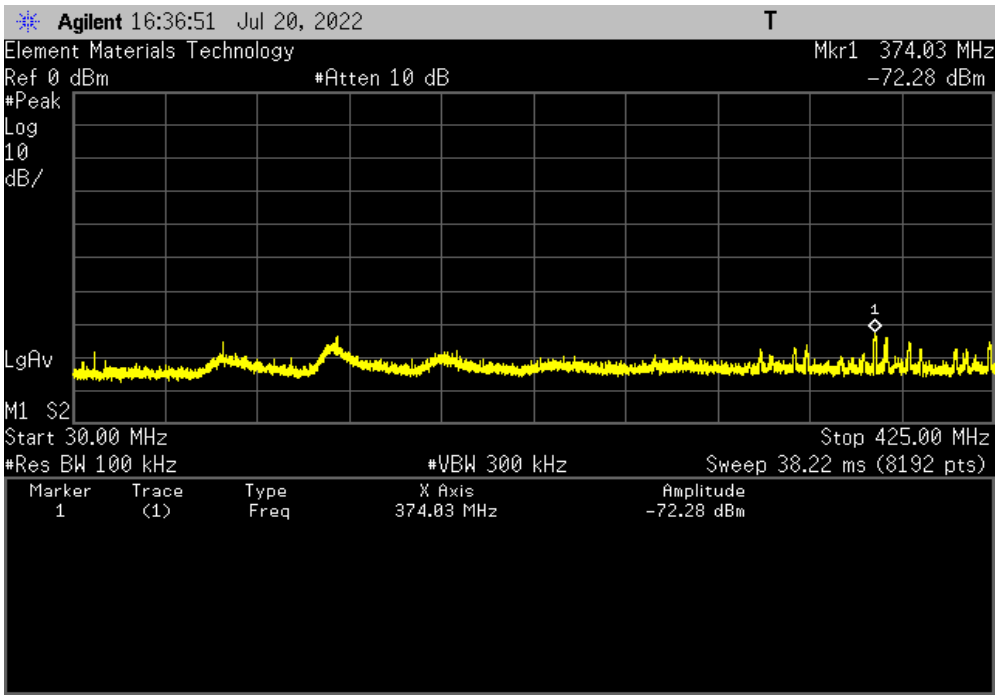
Low Channel - 923.3 MHz, 1 - 1.2 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-62.5	-61.5	5.07	38.8	74	54	Pass



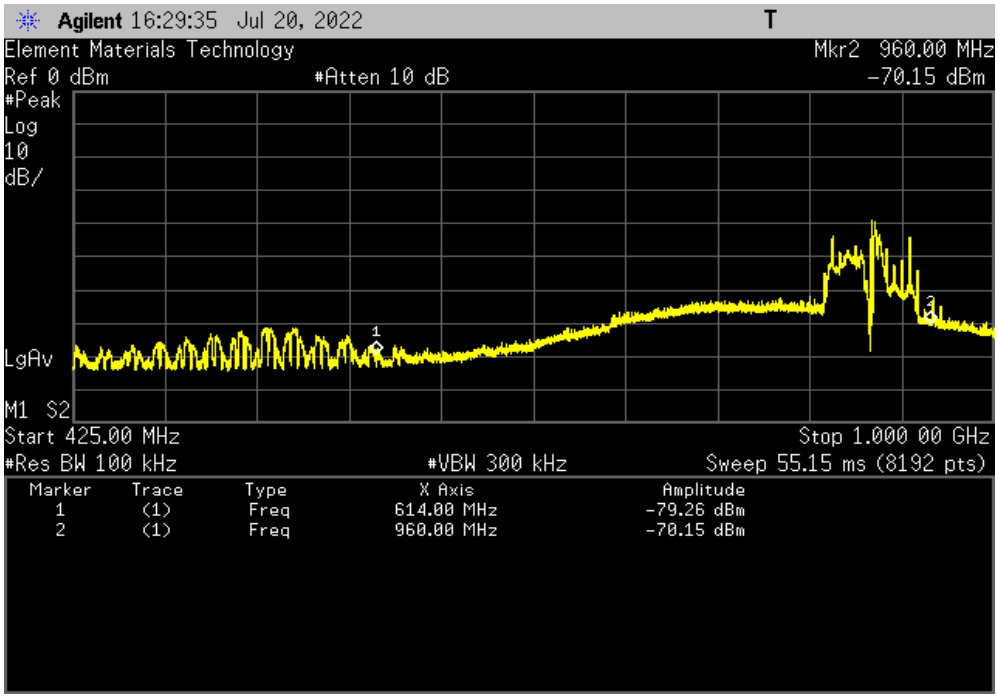
Low Channel - 923.3 MHz, 1.2 - 5.5 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-50.9	-49.2	5.07	51.1	74	54	Pass



Low Channel - 923.3 MHz, 30 - 425 MHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-72.3	-67.1	5.07	33.2	N/A	46	Pass



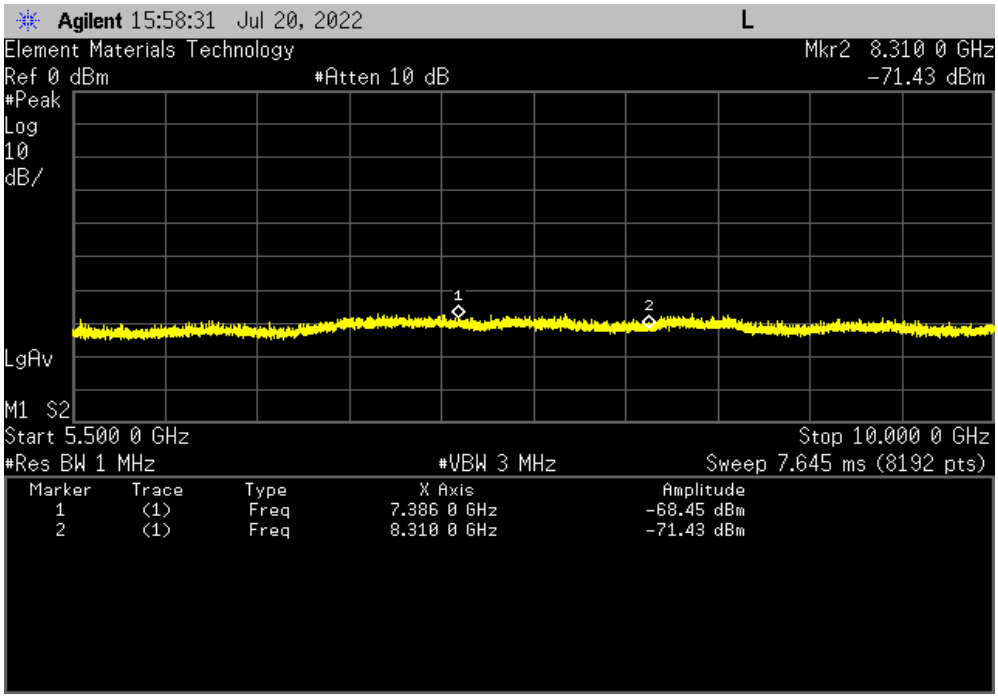
Low Channel - 923.3 MHz, 425 - 1000 MHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-70.1	-64.6	5.07	35.7	N/A	46	Pass



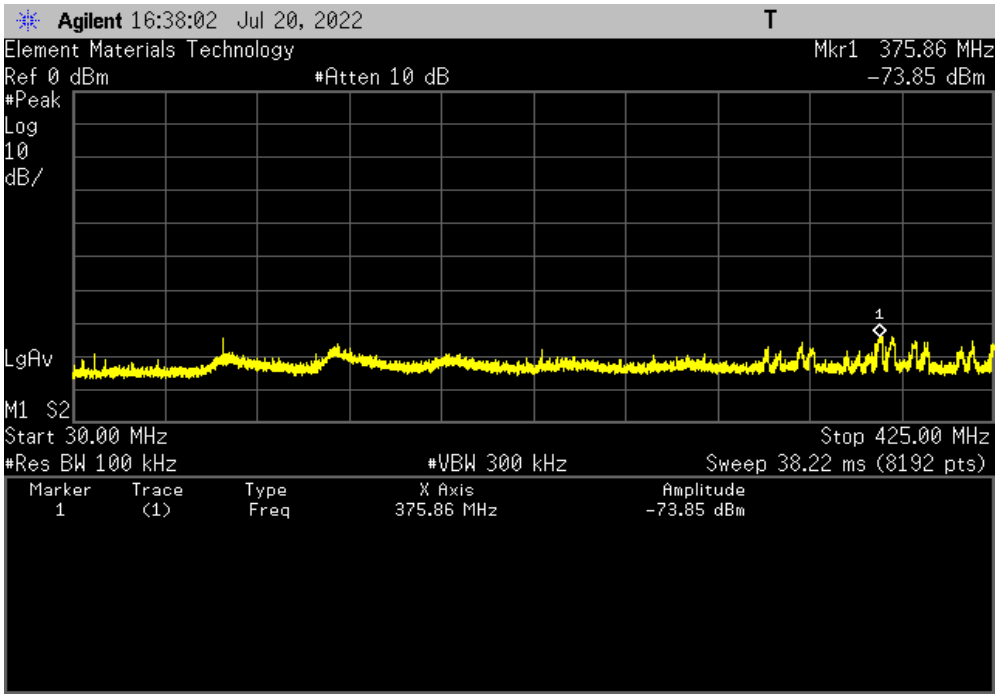
SPURIOUS EMISSIONS IN RESTRICTED BANDS (CONDUCTED)

XMit 2022.02.07.0

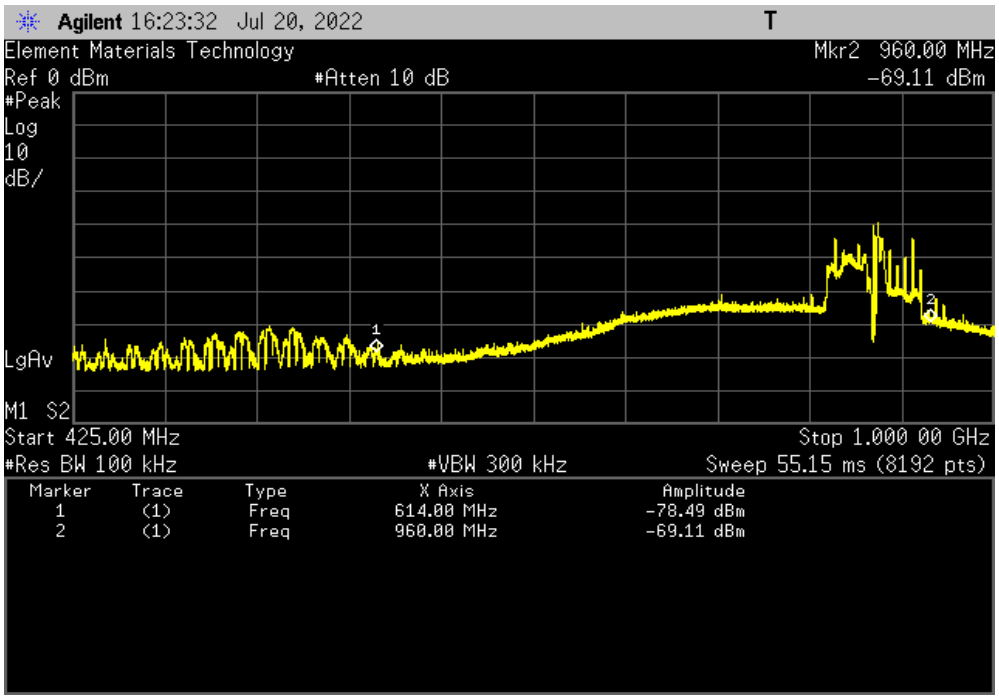
Low Channel - 923.3 MHz, 5.5 - 10 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-68.4	-64	5.07	36.3	74	54	Pass



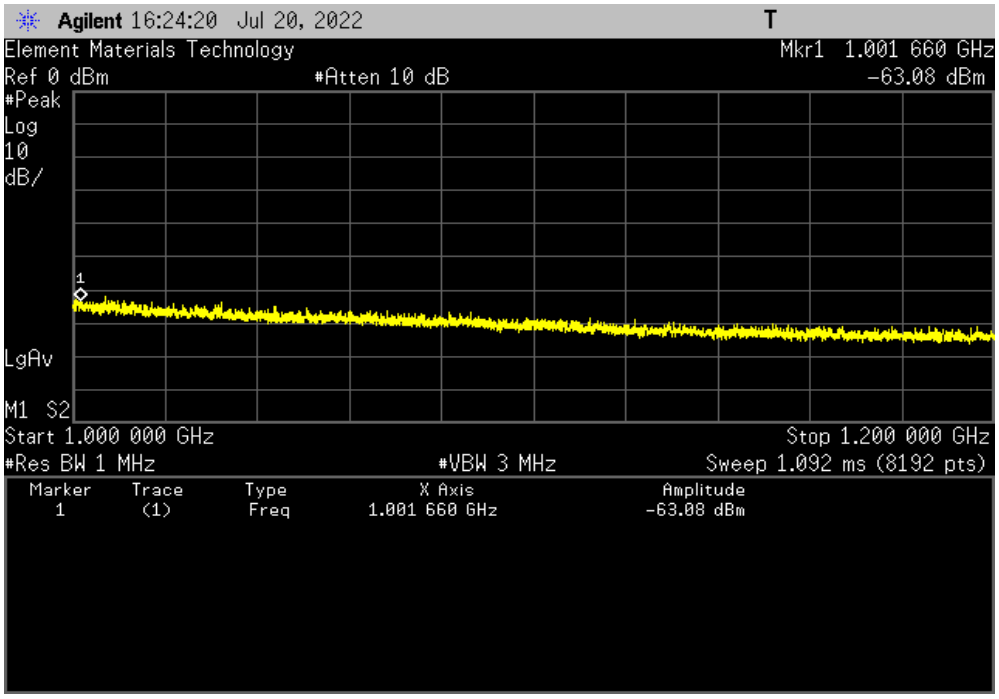
Mid Channel - 925.1 MHz, 30 - 425 MHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-73.8	-68.6	5.07	31.7	N/A	46	Pass



Mid Channel - 925.1 MHz, 425 - 1000 MHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-69.1	-63.6	5.07	36.7	N/A	46	Pass



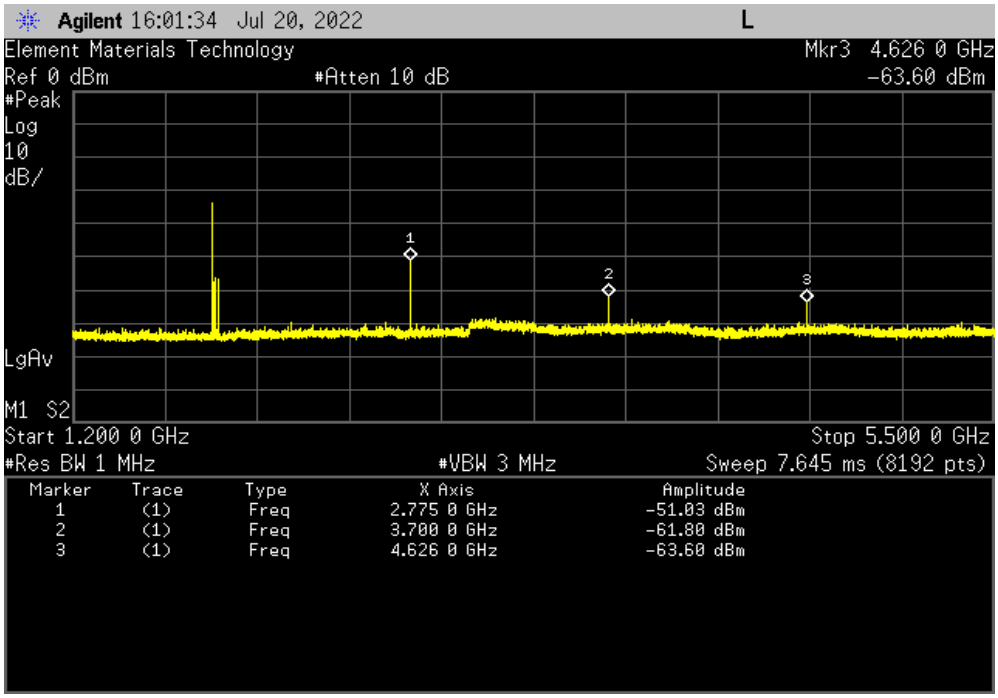
Mid Channel - 925.1 MHz, 1 - 1.2 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-63.1	-62.1	5.07	38.2	74	54	Pass



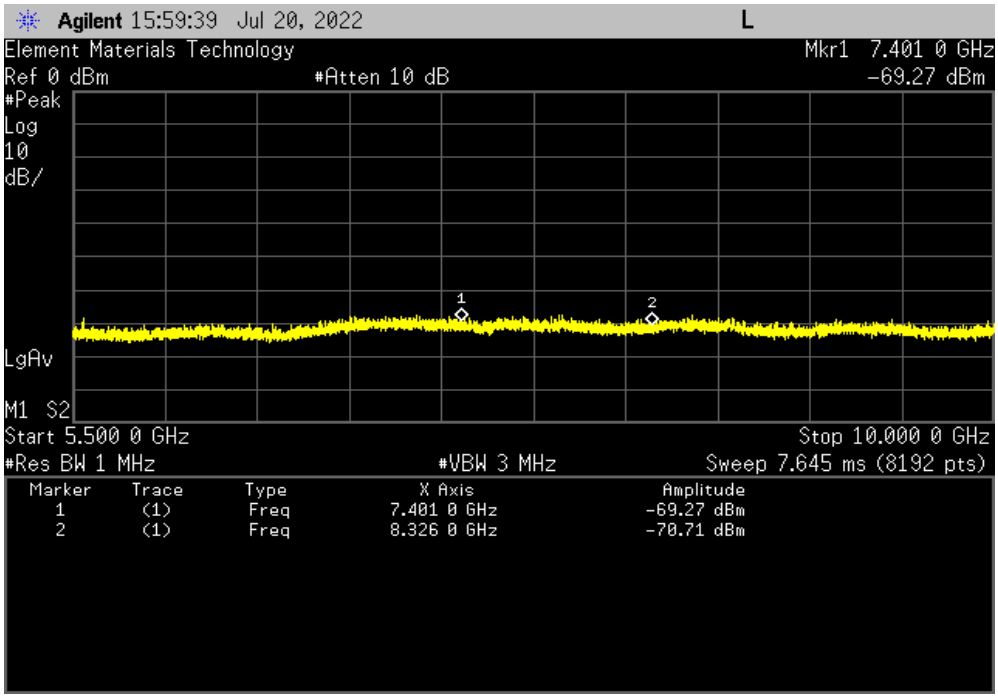
SPURIOUS EMISSIONS IN RESTRICTED BANDS (CONDUCTED)

XMit 2022.02.07.0

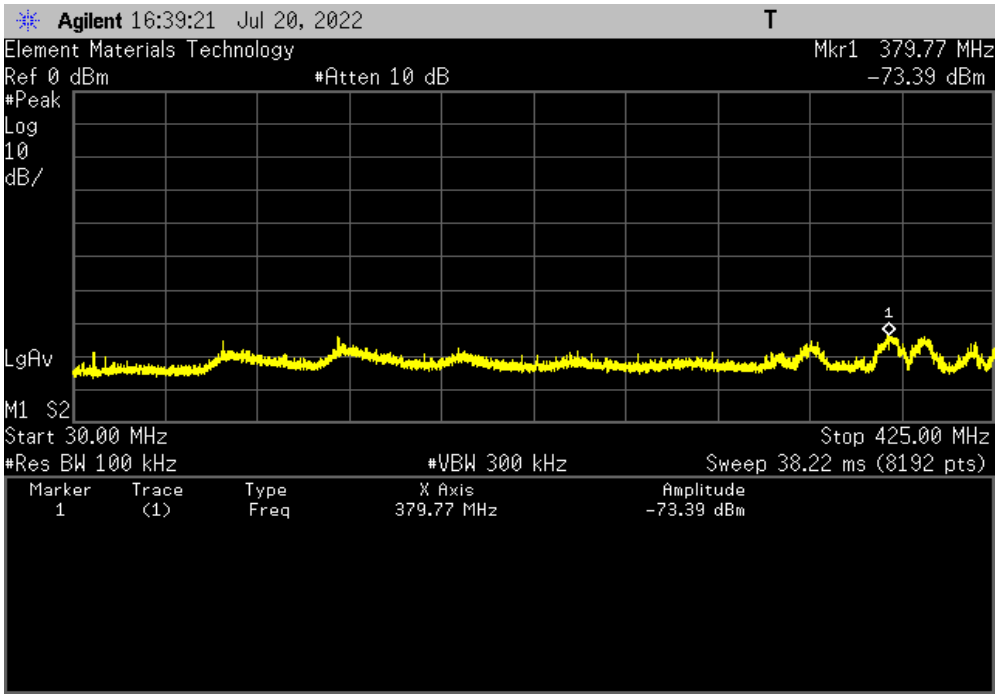
Mid Channel - 925.1 MHz, 1.2 - 5.5 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-51.0	-49.3	5.07	51.0	74	54	Pass



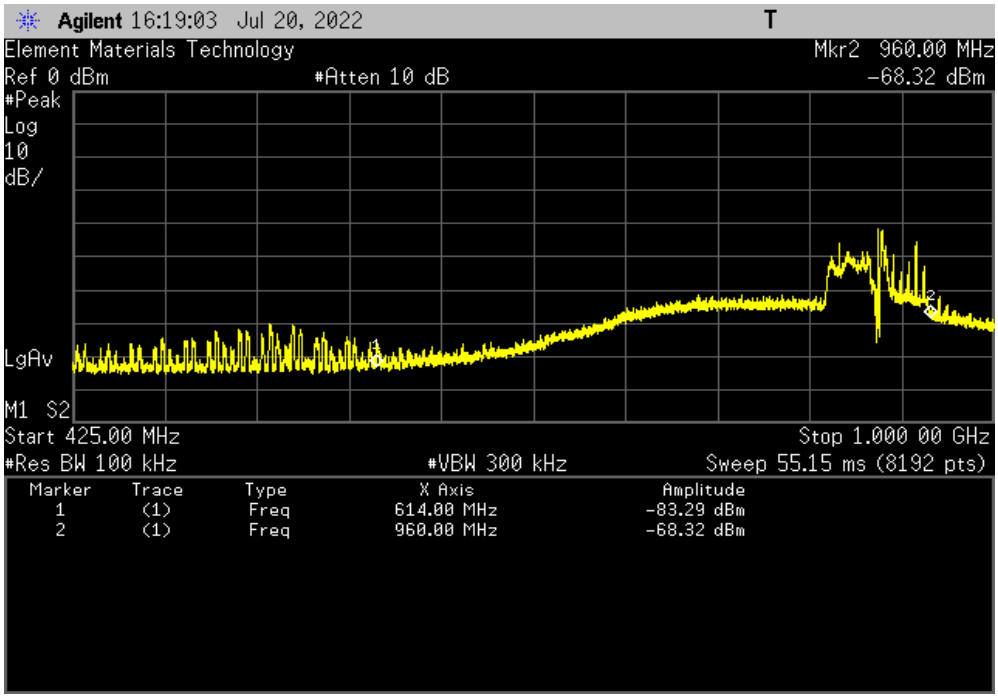
Mid Channel - 925.1 MHz, 5.5 - 10 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-69.3	-65.9	5.07	34.4	74	54	Pass



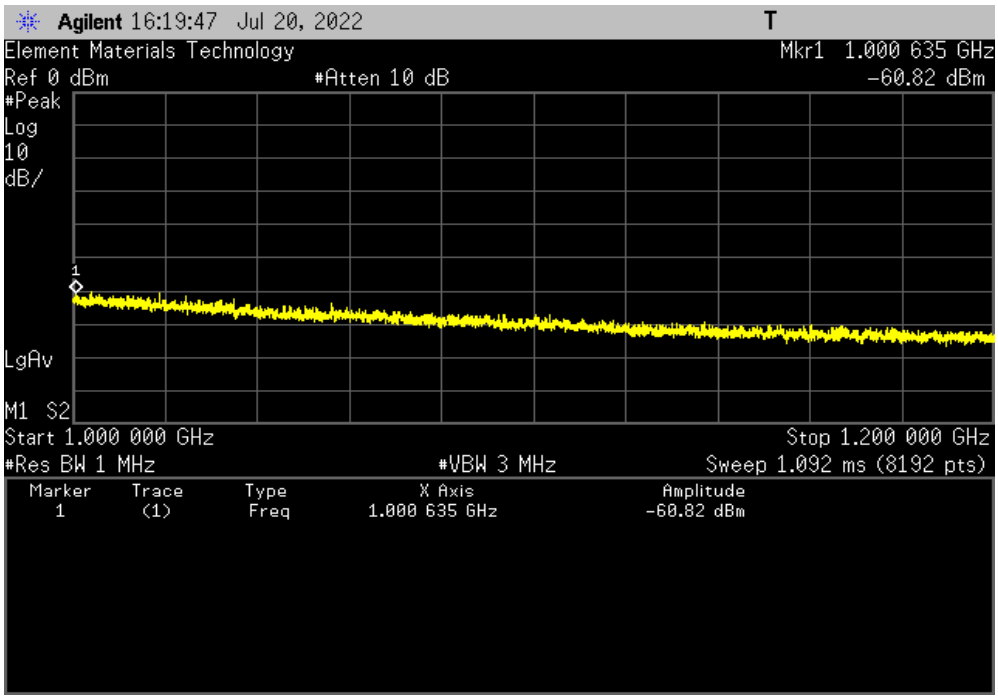
High Channel - 927.5 MHz, 30 - 425 MHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-73.4	-68.2	5.07	32.1	N/A	46	Pass



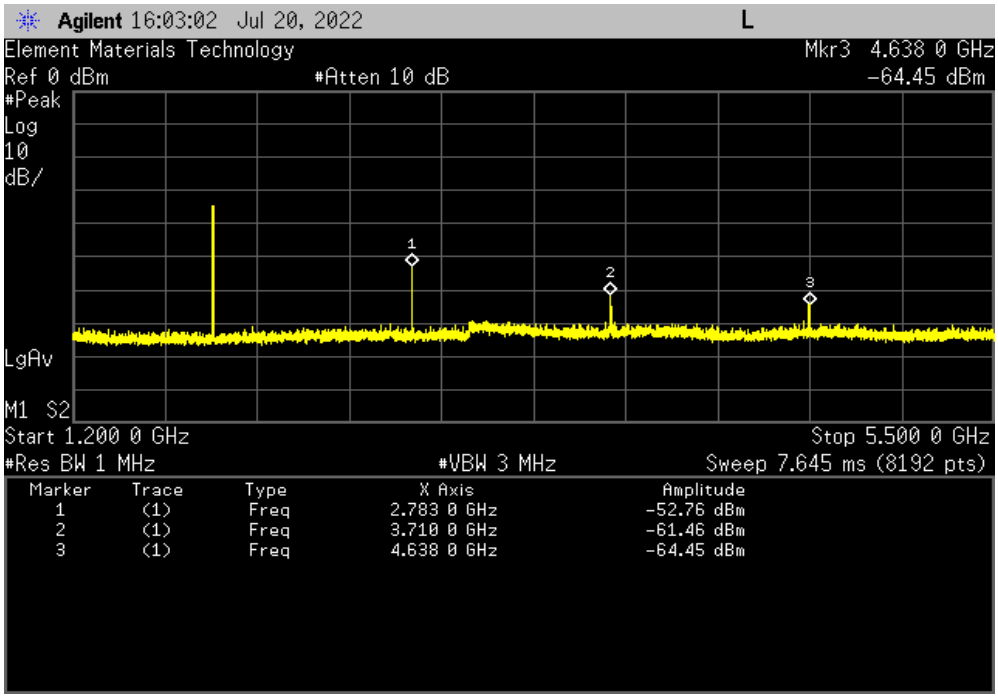
High Channel - 927.5 MHz, 425 - 1000 MHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-68.3	-62.8	5.07	37.5	N/A	46	Pass



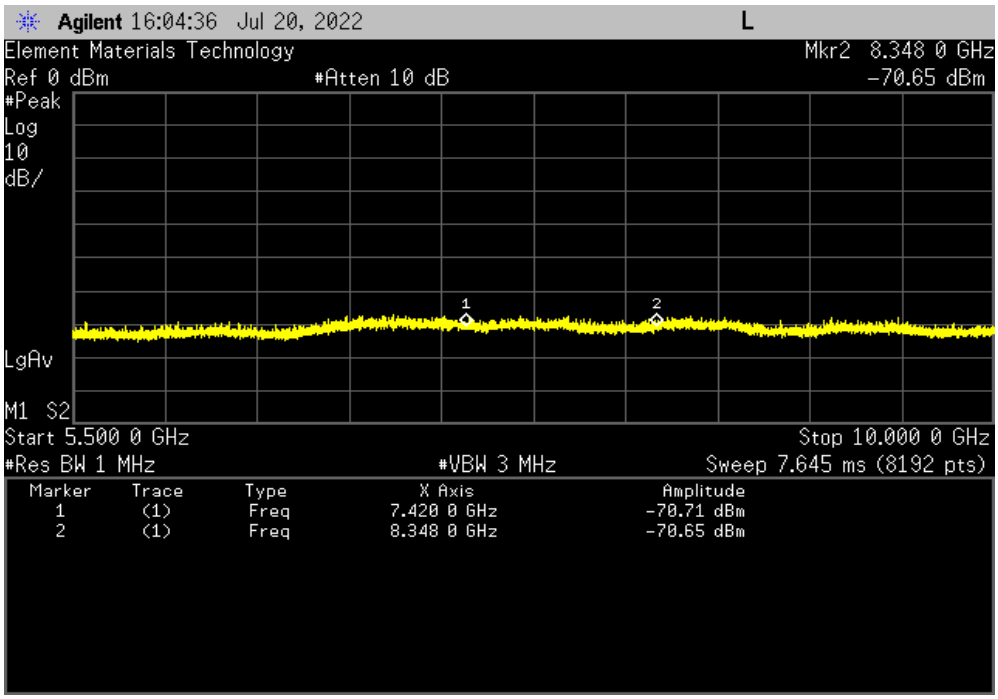
High Channel - 927.5 MHz, 1 - 1.2 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-60.8	-59.8	5.07	40.5	74	54	Pass



High Channel - 927.5 MHz, 1.2 - 5.5 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-52.8	-51.1	5.07	49.2	74	54	Pass



High Channel - 927.5 MHz, 5.5 - 10 GHz						
Measured Peak OP (dBm)	Corrected Peak OP (dBm)	Antenna Gain (dBi)	Peak E-Field (dBµV/m)	Peak Limit (dBµV/m)	QP/Avg Limit (dBµV/m)	Result
-70.6	-66.2	5.07	34.1	74	54	Pass



SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

TEST DESCRIPTION

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

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

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

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

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

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

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

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

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Antenna - Double Ridge	ETS Lindgren	3115	AIP	2022-07-20	2024-07-20
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	2023-01-14	2024-01-14
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	2023-01-14	2024-01-14
Filter - High Pass	Micro-Tronics	HPM50108	LFM	2022-08-27	2023-08-27
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	2023-02-06	2024-02-06
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	NCR
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	2023-01-14	2024-01-14
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	2023-01-14	2024-01-14
Antenna - Biconilog	ETS Lindgren	3142D	AXO	2021-09-14	2023-09-14
Cable	ESM Cable Corp.	Bilog Cables	MNH	2022-10-08	2023-10-08
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	2022-10-08	2023-10-08
Filter - Low Pass	Micro-Tronics	LPM50004	LFK	2022-08-27	2023-08-27
Analyzer - Spectrum Analyzer*	Agilent	N9010A	AFL	2022-03-22	2023-03-22

*Spectrum analyzer was used for pre-scan data only taken on 2022-12-08 which was in calibration during the testing.

SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	5.2 dB	-5.2 dB

FREQUENCY RANGE INVESTIGATED

30 MHz TO 12400 GHz

POWER INVESTIGATED

110VAC/60Hz

CONFIGURATIONS INVESTIGATED

MLTI0319-1
MLTI0319-2
MLTI0249-18

MODES INVESTIGATED

Transmitting LoRa Low, Mid and High Chs (923.3, 925.1 and 927.5 MHz) 500Hz BW modulated

SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

EUT:	MTAC-003U00	Work Order:	MLTI0319
Serial Number:	See Configurations	Date:	2023-07-21
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.7°C
Attendees:	Brent Nielsen	Relative Humidity:	54%
Customer Project:	None	Bar. Pressure (PMSL):	1018 mb
Tested By:	Marcelo Aguayo	Job Site:	MN05
Power:	110VAC/60Hz	Configuration:	MLTI0319-1

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

TEST PARAMETERS

Run #:	12	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)

COMMENTS

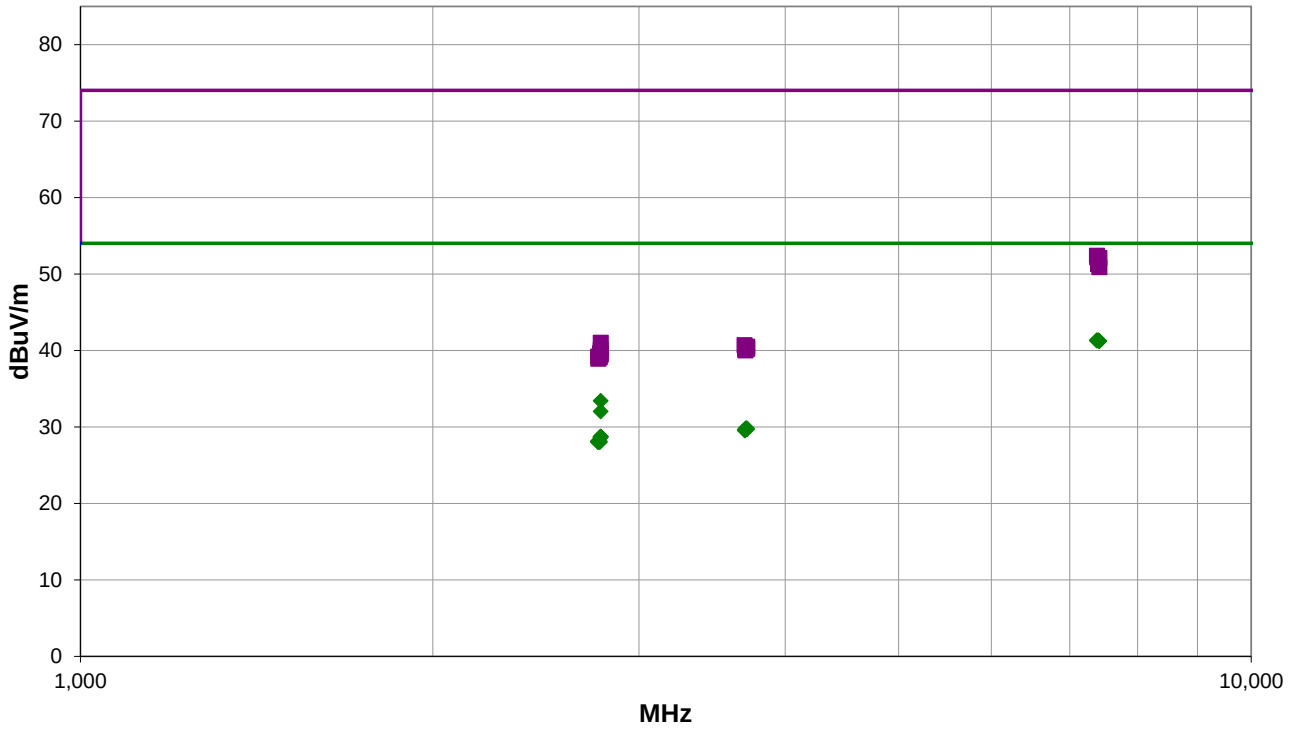
Command used : ./test_loragw_hal_tx -d /dev/spidev1.0 --pa 3 --pwid 15 -r 1250 -t 40500 -n 10000 -m LORA -z 255 -s 10 -f 923.3 -b 500. Setup on the “module-like” computer peripheral was according to ANSI C63.10:2013 section 5.10.3.
98% Duty Cycle.
MTCDT-L4G1 integrated into MTAC-003U00.

EUT OPERATING MODES

Transmitting LoRa Low, Mid and High Chs (923.3, 925.1 and 927.5 MHz) 500Hz BW modulated

DEVIATIONS FROM TEST STANDARD

None



Run #: 12 ■ PK ◆ AV ● QP

SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #12

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	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
7402.800	29.4	11.9	1.5	300.9	3.0	0.0	Horz	AV	0.0	41.3	54.0	-12.7	EUT Horz, Mid Ch
7402.550	29.4	11.9	1.5	145.0	3.0	0.0	Vert	AV	0.0	41.3	54.0	-12.7	EUT Horz, Mid Ch
7384.017	29.5	11.8	1.5	170.0	3.0	0.0	Horz	AV	0.0	41.3	54.0	-12.7	EUT Horz, Low Ch
7384.442	29.5	11.8	1.5	319.9	3.0	0.0	Vert	AV	0.0	41.3	54.0	-12.7	EUT Horz, Low Ch
7418.158	29.3	11.9	1.5	276.9	3.0	0.0	Horz	AV	0.0	41.2	54.0	-12.8	EUT Horz, High Ch
7419.192	29.3	11.9	1.5	148.0	3.0	0.0	Vert	AV	0.0	41.2	54.0	-12.8	EUT Horz, High Ch
2782.308	36.8	-3.4	3.87	69.0	3.0	0.0	Vert	AV	0.0	33.4	54.0	-20.6	EUT Horz, High Ch
7385.050	40.6	11.8	1.5	170.0	3.0	0.0	Horz	PK	0.0	52.4	74.0	-21.6	EUT Horz, Low Ch
7386.958	40.3	11.9	1.5	319.9	3.0	0.0	Vert	PK	0.0	52.2	74.0	-21.8	EUT Horz, Low Ch
7419.025	40.2	11.9	1.5	148.0	3.0	0.0	Vert	PK	0.0	52.1	74.0	-21.9	EUT Horz, High Ch
2782.533	35.4	-3.4	3.29	279.9	3.0	0.0	Horz	AV	0.0	32.0	54.0	-22.0	EUT Horz, High Ch
7402.017	39.4	11.9	1.5	300.9	3.0	0.0	Horz	PK	0.0	51.3	74.0	-22.7	EUT Horz, Mid Ch
7400.417	39.4	11.9	1.5	145.0	3.0	0.0	Vert	PK	0.0	51.3	74.0	-22.7	EUT Horz, Mid Ch
7420.442	39.0	11.9	1.5	276.9	3.0	0.0	Horz	PK	0.0	50.9	74.0	-23.1	EUT Horz, High Ch
3709.567	30.8	-1.0	2.52	232.0	3.0	0.0	Vert	AV	0.0	29.8	54.0	-24.2	EUT Horz, High Ch
3701.625	31.0	-1.2	1.5	343.0	3.0	0.0	Vert	AV	0.0	29.8	54.0	-24.2	EUT Horz, Mid Ch
3712.217	30.7	-1.0	2.88	77.0	3.0	0.0	Horz	AV	0.0	29.7	54.0	-24.3	EUT Horz, High Ch
3700.767	30.9	-1.2	1.5	288.0	3.0	0.0	Horz	AV	0.0	29.7	54.0	-24.3	EUT Horz, Mid Ch
3694.433	30.8	-1.2	1.5	145.0	3.0	0.0	Vert	AV	0.0	29.6	54.0	-24.4	EUT Horz, Low Ch
3695.267	30.7	-1.2	3.52	184.0	3.0	0.0	Horz	AV	0.0	29.5	54.0	-24.5	EUT Horz, Low Ch
2783.408	32.1	-3.4	1.47	303.0	3.0	0.0	Horz	AV	0.0	28.7	54.0	-25.3	EUT On Side, High Ch
2782.700	32.1	-3.4	1.5	265.9	3.0	0.0	Vert	AV	0.0	28.7	54.0	-25.3	EUT On Side, High Ch
2783.133	32.1	-3.4	2.76	52.0	3.0	0.0	Vert	AV	0.0	28.7	54.0	-25.3	EUT Vert, High Ch
2781.833	32.1	-3.5	1.1	293.0	3.0	0.0	Horz	AV	0.0	28.6	54.0	-25.4	EUT Vert, High Ch
2777.600	31.6	-3.5	1.5	130.0	3.0	0.0	Horz	AV	0.0	28.1	54.0	-25.9	EUT Horz, Mid Ch
2767.600	31.6	-3.5	1.5	166.0	3.0	0.0	Vert	AV	0.0	28.1	54.0	-25.9	EUT Horz, Low Ch
2777.775	31.5	-3.5	1.5	177.0	3.0	0.0	Vert	AV	0.0	28.0	54.0	-26.0	EUT Horz, Mid Ch
2767.725	31.5	-3.5	1.11	91.0	3.0	0.0	Horz	AV	0.0	28.0	54.0	-26.0	EUT Horz, Low Ch
2782.242	44.4	-3.4	1.47	303.0	3.0	0.0	Horz	PK	0.0	41.0	74.0	-33.0	EUT On Side, High Ch
3691.892	41.9	-1.2	3.52	184.0	3.0	0.0	Horz	PK	0.0	40.7	74.0	-33.3	EUT Horz, Low Ch
3712.092	41.5	-1.0	2.88	77.0	3.0	0.0	Horz	PK	0.0	40.5	74.0	-33.5	EUT Horz, High Ch
3712.183	41.2	-1.0	2.52	232.0	3.0	0.0	Vert	PK	0.0	40.2	74.0	-33.8	EUT Horz, High Ch
3698.258	41.4	-1.2	1.5	343.0	3.0	0.0	Vert	PK	0.0	40.2	74.0	-33.8	EUT Horz, Mid Ch
3695.375	41.4	-1.2	1.5	145.0	3.0	0.0	Vert	PK	0.0	40.2	74.0	-33.8	EUT Horz, Low Ch
2782.258	43.5	-3.4	1.5	265.9	3.0	0.0	Vert	PK	0.0	40.1	74.0	-33.9	EUT On Side, High Ch
3699.233	41.2	-1.2	1.5	288.0	3.0	0.0	Horz	PK	0.0	40.0	74.0	-34.0	EUT Horz, Mid Ch
2780.658	43.2	-3.5	3.87	69.0	3.0	0.0	Vert	PK	0.0	39.7	74.0	-34.3	EUT Horz, High Ch
2781.075	43.1	-3.5	1.1	293.0	3.0	0.0	Horz	PK	0.0	39.6	74.0	-34.4	EUT Vert, High Ch
2780.275	43.0	-3.5	2.76	52.0	3.0	0.0	Vert	PK	0.0	39.5	74.0	-34.5	EUT Vert, High Ch
2781.108	42.9	-3.5	3.29	279.9	3.0	0.0	Horz	PK	0.0	39.4	74.0	-34.6	EUT Horz, High Ch

SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	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
2768.492	42.7	-3.5	1.5	166.0	3.0	0.0	Vert	PK	0.0	39.2	74.0	-34.8	EUT Horz, Low Ch
2775.600	42.6	-3.5	1.5	130.0	3.0	0.0	Horz	PK	0.0	39.1	74.0	-34.9	EUT Horz, Mid Ch
2777.142	42.6	-3.5	1.5	177.0	3.0	0.0	Vert	PK	0.0	39.1	74.0	-34.9	EUT Horz, Mid Ch
2769.917	42.4	-3.5	1.11	91.0	3.0	0.0	Horz	PK	0.0	38.9	74.0	-35.1	EUT Horz, Low Ch

CONCLUSION

Pass

Tested By

SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

EUT:	MTAC-003U00	Work Order:	MLTI0319
Serial Number:	See Configurations	Date:	2023-07-21
Customer:	Multi-Tech Systems, Inc.	Temperature:	22.7°C
Attendees:	Brent Nielsen	Relative Humidity:	54%
Customer Project:	None	Bar. Pressure (PMSL):	1018 mb
Tested By:	Marcelo Aguayo	Job Site:	MN05
Power:	110VAC/60Hz	Configuration:	MLTI0319-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2023	ANSI C63.10:2013
RSS-247 Issue 2:2017	ANSI C63.10:2013

TEST PARAMETERS

Run #:	20	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)

COMMENTS

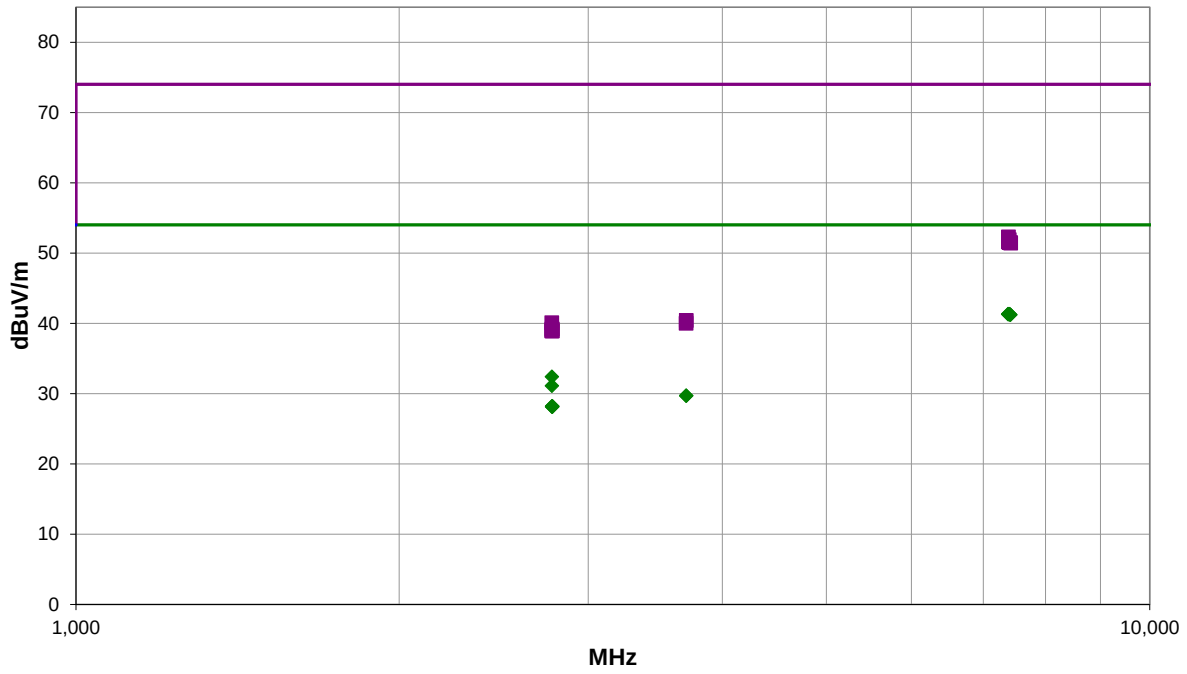
Command used: ./test_loragw_hal_tx -d /dev/spidev0.0 --pa 3 --pwid 15 -r 1250 -t 40500 -n 10000 -m LORA -z 255 -s 10 -f 923.3 -b 500. Setup on the “module-like” computer peripheral was according to ANSI C63.10:2013 section 5.10.3. The long antenna will only ever be used with the IP67 host.
98% Duty Cycle.
MTCDTIP-L4G1 integrated into MTAC-003U00.

EUT OPERATING MODES

Transmitting LoRa Low, Mid and High Chs (923.3, 925.1 and 927.5 MHz) 500Hz BW modulated

DEVIATIONS FROM TEST STANDARD

None



Run #: 20 ■ PK ◆ AV ● QP

SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #20

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	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
7402.842	29.4	11.9	2.64	300.9	3.0	0.0	Horz	AV	0.0	41.3	54.0	-12.7	EUT Horz, Mid Ch
7401.450	29.4	11.9	1.5	91.0	3.0	0.0	Vert	AV	0.0	41.3	54.0	-12.7	EUT Horz, Mid Ch
7384.933	29.5	11.8	3.39	207.9	3.0	0.0	Horz	AV	0.0	41.3	54.0	-12.7	EUT Horz, Low Ch
7385.500	29.5	11.8	1.5	135.0	3.0	0.0	Vert	AV	0.0	41.3	54.0	-12.7	EUT Horz, Low Ch
7417.717	29.3	11.9	1.5	74.9	3.0	0.0	Horz	AV	0.0	41.2	54.0	-12.8	EUT Horz, High Ch
7418.200	29.3	11.9	1.5	276.9	3.0	0.0	Vert	AV	0.0	41.2	54.0	-12.8	EUT Horz, High Ch
2775.650	35.9	-3.5	1.5	236.9	3.0	0.0	Horz	AV	0.0	32.4	54.0	-21.6	EUT Horz, Mid Ch
7387.583	40.4	11.9	3.39	207.9	3.0	0.0	Horz	PK	0.0	52.3	74.0	-21.7	EUT Horz, Low Ch
7401.575	40.0	11.9	2.64	300.9	3.0	0.0	Horz	PK	0.0	51.9	74.0	-22.1	EUT Horz, Mid Ch
7387.275	39.7	11.9	1.5	135.0	3.0	0.0	Vert	PK	0.0	51.6	74.0	-22.4	EUT Horz, Low Ch
7398.650	39.6	11.9	1.5	91.0	3.0	0.0	Vert	PK	0.0	51.5	74.0	-22.5	EUT Horz, Mid Ch
7420.242	39.6	11.9	1.5	74.9	3.0	0.0	Horz	PK	0.0	51.5	74.0	-22.5	EUT Horz, High Ch
7421.583	39.5	11.9	1.5	276.9	3.0	0.0	Vert	PK	0.0	51.4	74.0	-22.6	EUT Horz, High Ch
2775.817	34.6	-3.5	2.25	265.9	3.0	0.0	Vert	AV	0.0	31.1	54.0	-22.9	EUT Horz, Mid Ch
3702.342	30.9	-1.2	1.5	44.0	3.0	0.0	Horz	AV	0.0	29.7	54.0	-24.3	EUT Horz, Mid Ch
3701.917	30.9	-1.2	1.5	307.0	3.0	0.0	Vert	AV	0.0	29.7	54.0	-24.3	EUT Horz, Mid Ch
2777.667	31.7	-3.5	1.5	99.9	3.0	0.0	Vert	AV	0.0	28.2	54.0	-25.8	EUT On Side. Mid Ch
2777.008	31.7	-3.5	2.2	116.0	3.0	0.0	Horz	AV	0.0	28.2	54.0	-25.8	EUT On Side. Mid Ch
2777.625	31.6	-3.5	1.5	170.0	3.0	0.0	Horz	AV	0.0	28.1	54.0	-25.9	EUT Vert, Mid Ch
2777.242	31.6	-3.5	1.5	96.9	3.0	0.0	Vert	AV	0.0	28.1	54.0	-25.9	EUT Vert, Mid Ch
3702.567	41.6	-1.2	1.5	44.0	3.0	0.0	Horz	PK	0.0	40.4	74.0	-33.6	EUT Horz, Mid Ch
2774.175	43.6	-3.5	2.25	265.9	3.0	0.0	Vert	PK	0.0	40.1	74.0	-33.9	EUT On Side. Mid Ch
3700.542	41.2	-1.2	1.5	307.0	3.0	0.0	Vert	PK	0.0	40.0	74.0	-34.0	EUT Horz, Mid Ch
2775.183	42.7	-3.5	1.5	170.0	3.0	0.0	Horz	PK	0.0	39.2	74.0	-34.8	EUT Vert, Mid Ch
2776.458	42.7	-3.5	1.5	96.9	3.0	0.0	Vert	PK	0.0	39.2	74.0	-34.8	EUT Vert, Mid Ch
2774.458	42.5	-3.5	1.5	99.9	3.0	0.0	Vert	PK	0.0	39.0	74.0	-35.0	EUT Horz, Mid Ch
2774.567	42.4	-3.5	1.5	236.9	3.0	0.0	Horz	PK	0.0	38.9	74.0	-35.1	EUT Horz, Mid Ch
2777.750	42.4	-3.5	2.2	116.0	3.0	0.0	Horz	PK	0.0	38.9	74.0	-35.1	EUT On Side. Mid Ch

CONCLUSION

Pass

Tested By

End of Test Report