



element

Carnegie Technologies

World IoT LoRa Module

FCC 15.247:2019

902 - 928 MHz Hybrid Option 3 Transceiver

Report # CRNE0015.1



NVLAP LAB CODE: 201049-0



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CERTIFICATE OF TEST



Last Date of Test: June 13, 2019
Carnegie Technologies
Model: World IoT LoRa Module

Radio Equipment Testing

Standards

Specification	Method
FCC 15.207:2019	ANSI C63.10:2013
FCC 15.247:2019	

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	Yes	Pass	
6.5, 6.6	Spurious Radiated Emissions	Yes	Pass	
7.5	Duty Cycle	Yes	Pass	
7.8.2	Carrier Frequency Separation	Yes	Pass	
7.8.3	Number of Hopping Frequencies	Yes	Pass	
7.8.4	Dwell Time	Yes	Pass	
7.8.5	Output Power	Yes	Pass	
7.8.5	Equivalent Isotropic Radiated Power	Yes	Pass	
7.8.6	Band Edge Compliance	Yes	Pass	
7.8.6	Band Edge Compliance - Hopping Mode	Yes	Pass	
7.8.7	Occupied Bandwidth	Yes	Pass	
7.8.8	Spurious Conducted Emissions	Yes	Pass	
11.10.2	Power Spectral Density	Yes	Pass	

Deviations From Test Standards

None

Approved By:

Jeremiah Darden, Operations Manager

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

REVISION HISTORY



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

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

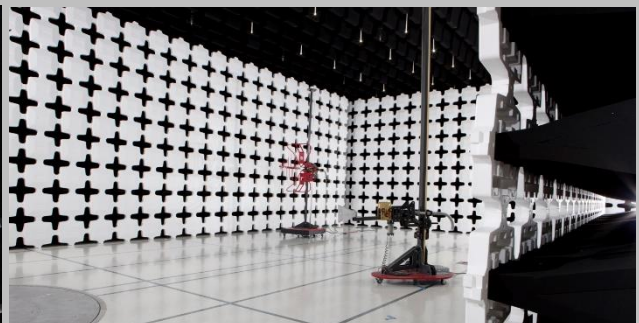
For details on the Scopes of our Accreditations, please visit:

<https://www.nwemc.com/emc-testing-accreditations>

FACILITIES



California Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Minnesota Labs MN01-10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Oregon Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Texas Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Washington Labs NC01-05 19201 120 th 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/RRR, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157



MEASUREMENT UNCERTAINTY

Measurement Uncertainty

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

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

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

Test	+ MU	- MU
Frequency Accuracy (Hz)	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)	5.1 dB	-5.1 dB
AC Powerline Conducted Emissions (dB)	2.4 dB	-2.4 dB

Test Setup Block Diagrams

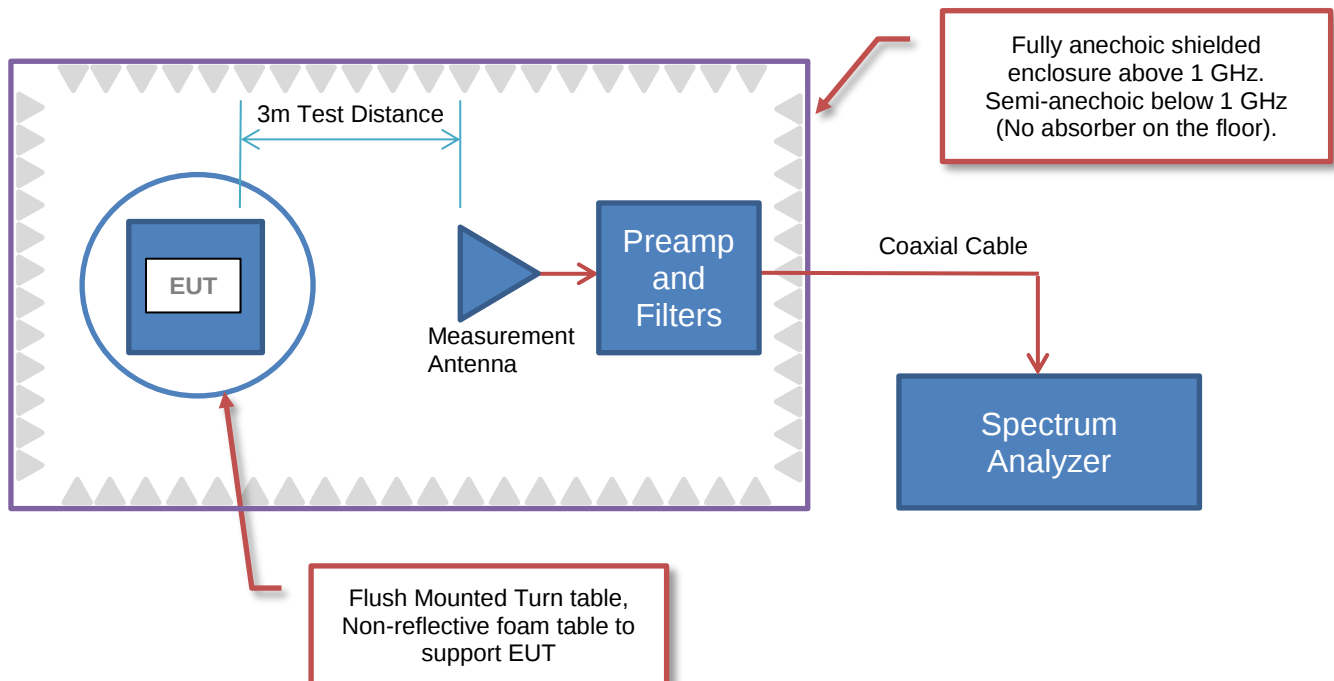
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions





POWER SETTINGS

The EUT was tested using the power settings provided by the manufacturer:

SETTINGS FOR ALL TESTS IN THIS REPORT

Modulation Types	Position	Frequency (MHz)	Power Setting
LORA	Low Channel	903	14dBm
LORA	Mid Channel	909	14dBm
LORA	High Channel	915	14dBm

PRODUCT DESCRIPTION



Client and Equipment Under Test (EUT) Information

Company Name:	Carnegie Technologies
Address:	9737 Great Hills Trail STE 260
City, State, Zip:	Austin, TX 78759
Test Requested By:	John Nagy
Model:	World IoT LoRa Module
First Date of Test:	June 12, 2019
Last Date of Test:	June 13, 2019
Receipt Date of Samples:	June 12, 2019
Equipment Design Stage:	Prototype
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
LoRa Radio Module
Testing Objective:
Seeking to demonstrate compliance under FCC 15.247:2019 for operation in the 902 - 928 MHz Band.

CONFIGURATIONS

Configuration CRNE0015- 1

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
World IoT LoRa Module (Direct Connect)	Carnegie Technologies	LV-WLM-271 / 830-000218-200 B	0190810450

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
FCC Test Carrier Assembly (Direct Connect)	Carnegie Technologies	830-000220-100 A	040819001
Lithium Battery	Energizer	Unknown	None
Test Terminal	Carnegie Technologies	Unknown	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power Leads (Direct Connect)	No	0.2m	No	Lithium Battery	FCC Test Carrier Assembly (Direct Connect)
Ribbon Cable	No	1m	No	Test Terminal	FCC Test Carrier Assembly (Direct Connect)

Configuration CRNE0015- 2

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
World IoT LoRa Module (With Antenna)	Carnegie Technologies	LV-WLM-271 / 830-000218-200 B	016

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
FCC Test Carrier Assembly (With Antenna)	Carnegie Technologies	830-000220-100 A	040919001

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power Leads (Radiated)	No	0.2m	No	Lithium Battery	FCC Test Carrier Assembly (With Antenna)

CONFIGURATIONS

Configuration CRNE0015- 3

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
World IoT LoRa Module (With Antenna)	Carnegie Technologies	LV-WLM-271 / 830-000218-200 B	016

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
FCC Test Carrier Assembly (With Antenna)	Carnegie Technologies	830-000220-100 A	040919001

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power Leads (Conducted)	No	1m	No	LISN	World IoT LoRa Module (With Antenna)

Configuration CRNE0015- 4

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
World IoT LoRa Module (Direct Connect)	Carnegie Technologies	LV-WLM-271 / 830-000218-200 B	0190810451

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
FCC Test Carrier Assembly (Direct Connect)	Carnegie Technologies	830-000220-100 A	040319001
Lithium Battery	Energizer	Unknown	None
Test Terminal	Carnegie Technologies	Unknown	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power Leads (Direct Connect)	No	0.2m	No	Lithium Battery	FCC Test Carrier Assembly (Direct Connect)
Ribbon Cable	No	1m	No	Test Terminal	FCC Test Carrier Assembly (Direct Connect)

CONFIGURATIONS

Configuration CRNE0015- 5

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
World IoT LoRa Module (With Antenna)	Carnegie Technologies	LV-WLM-271 / 830-000218-200 B	0190810466

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
FCC Test Carrier Assembly (With Antenna)	Carnegie Technologies	830-000220-100 A	0509190001

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power Leads (Radiated)	No	0.2m	No	Lithium Battery	FCC Test Carrier Assembly (With Antenna)

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2019-06-12	Carrier Frequency Separation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2019-06-12	Number of Hopping Frequencies	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
3	2019-06-12	Dwell Time	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
4	2019-06-12	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.
5	2019-06-12	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.
6	2019-06-12	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.
7	2019-06-12	Band Edge Compliance - Hopping Mode	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
8	2019-06-12	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.
9	2019-06-12	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.
10	2019-06-12	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.
11	2019-06-13	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.
12	2019-06-13	Spurious Radiated 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

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	ESCI	ARF	2018-07-20	2019-07-20
Cable - Conducted Cable Assembly	Northwest EMC	TXA, HHZ, TQU	TXAA	2019-01-30	2020-01-30
LISN	Solar Electronics	9252-50-R-24-BNC	LJK	2018-09-07	2019-09-07
Power Supply - DC	Ametek Programmable Power, Inc.	Sorenson XEL30-3D	TQE	NCR	NCR

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	2.4 dB	-2.4 dB

CONFIGURATIONS INVESTIGATED

CRNE0015-3

MODES INVESTIGATED

Continuously Transmitting at Mid Channel 909 MHz

POWERLINE CONDUCTED EMISSIONS



EUT:	World IoT LoRa Module	Work Order:	CRNE0015
Serial Number:	See Configuration	Date:	2019-06-13
Customer:	Carnegie Technologies	Temperature:	21.5°C
Attendees:	Joseph Haas	Relative Humidity:	46.7%
Customer Project:	None	Bar. Pressure:	1022 mb
Tested By:	Jonathan Kiefer	Job Site:	TX01
Power:	3VDC	Configuration:	CRNE0015-3

TEST SPECIFICATIONS

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

TEST PARAMETERS

Run #:	3	Line:	Positive Lead	Add. Ext. Attenuation (dB):	0
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COMMENTS

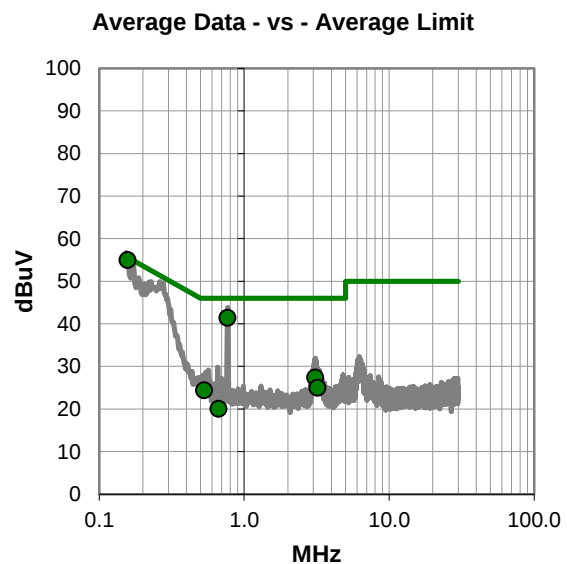
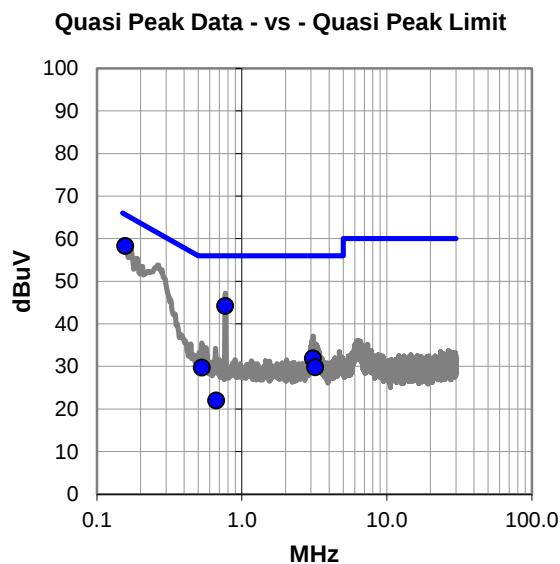
None

EUT OPERATING MODES

Continuously Transmitting at Mid Channel 909 MHz

DEVIATIONS FROM TEST STANDARD

None



POWERLINE CONDUCTED EMISSIONS

RESULTS - Run #3

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.157	38.0	20.3	58.3	65.6	-7.3
0.768	24.0	20.2	44.2	56.0	-11.8
3.098	11.7	20.2	31.9	56.0	-24.1
3.205	9.6	20.2	29.8	56.0	-26.2
0.530	9.6	20.1	29.7	56.0	-26.3
0.667	1.7	20.3	22.0	56.0	-34.0

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.157	34.7	20.3	55.0	55.6	-0.6
0.768	21.2	20.2	41.4	46.0	-4.6
3.098	7.2	20.2	27.4	46.0	-18.6
3.205	4.8	20.2	25.0	46.0	-21.0
0.530	4.3	20.1	24.4	46.0	-21.6
0.667	-0.3	20.3	20.0	46.0	-26.0

CONCLUSION

Pass



Tested By

POWERLINE CONDUCTED EMISSIONS



EUT:	World IoT LoRa Module	Work Order:	CRNE0015
Serial Number:	See Configuration	Date:	2019-06-13
Customer:	Carnegie Technologies	Temperature:	21.5°C
Attendees:	Joseph Haas	Relative Humidity:	46.7%
Customer Project:	None	Bar. Pressure:	1022 mb
Tested By:	Jonathan Kiefer	Job Site:	TX01
Power:	3VDC	Configuration:	CRNE0015-3

TEST SPECIFICATIONS

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

TEST PARAMETERS

Run #:	4	Line:	Negative Lead	Add. Ext. Attenuation (dB):	0
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COMMENTS

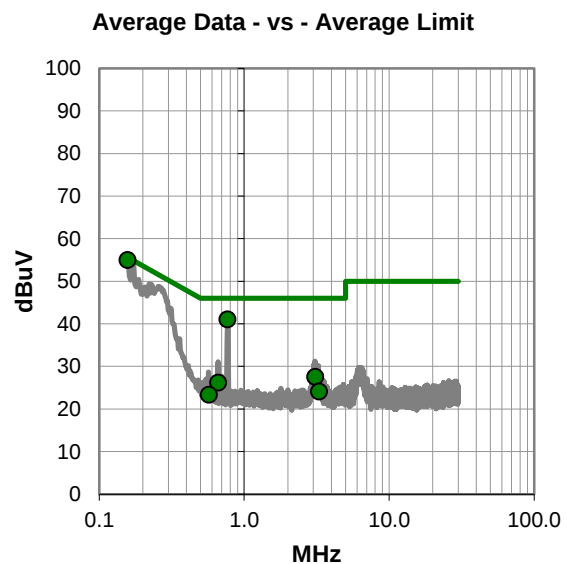
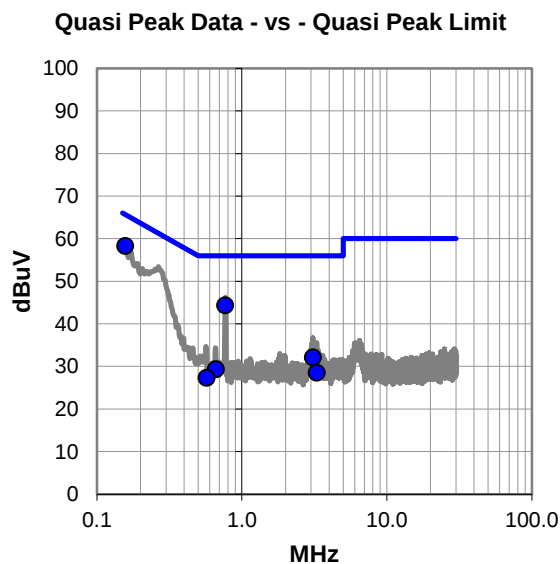
None

EUT OPERATING MODES

Continuously Transmitting at Mid Channel 909 MHz

DEVIATIONS FROM TEST STANDARD

None



POWERLINE CONDUCTED EMISSIONS

RESULTS - Run #4

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.157	38.0	20.3	58.3	65.6	-7.3
0.768	24.1	20.2	44.3	56.0	-11.7
3.090	11.9	20.2	32.1	56.0	-23.9
0.663	9.1	20.2	29.3	56.0	-26.7
3.293	8.3	20.2	28.5	56.0	-27.5
0.570	7.2	20.1	27.3	56.0	-28.7

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.157	34.7	20.3	55.0	55.6	-0.6
0.768	20.8	20.2	41.0	46.0	-5.0
3.090	7.3	20.2	27.5	46.0	-18.5
0.663	6.0	20.2	26.2	46.0	-19.8
3.293	3.9	20.2	24.1	46.0	-21.9
0.570	3.2	20.1	23.3	46.0	-22.7

CONCLUSION

Pass



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

Continuously Transmitting at Low Channel 903 MHz, Mid Channel 909 MHz, High Channel 915 MHz

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

CRNE0015 - 5

FREQUENCY RANGE INVESTIGATED

Start Frequency 30 MHz Stop Frequency 10000 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 - High Pass	Micro-Tronics	HPM50108	HGD	10-Oct-2018	12 mo
Attenuator	Weinschel Corp	4H-10	AWA	17-Mar-2019	12 mo
Attenuator	Weinschel Corp	4H-20	AWB	17-Mar-2019	12 mo
Filter - Band Reject	Wainwright Instruments	WTRCTV5-750-1000-20-70-60EEK	CUL	25-Feb-2019	12 mo
Filter - Low Pass	Micro-Tronics	LPM50003	HHT	1-Aug-2019	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	PAK	9-Oct-2018	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AJF	NCR	0 mo
Cable	Northwest EMC	8-18GHz	TXD	14-May-2019	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	PAJ	17-Mar-2019	12 mo
Antenna - Double Ridge	ETS Lindgren	3115	AJL	11-Oct-2018	24 mo
Cable	Northwest EMC	1-8.2 GHz	TXC	14-May-2019	12 mo
Amplifier - Pre-Amplifier	Fairview Microwave	FMAM63001	PAS	24-Jan-2019	12 mo
Antenna - Biconilog	ETS Lindgren	3143B	AYF	10-May-2018	24 mo
Cable	Northwest EMC	RE 9kHz - 1GHz	TXB	1-Aug-2019	12 mo
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFL	27-Feb-2019	12 mo

TEST DESCRIPTION

The highest gain antenna of each type to be used with the EUT was tested. The EUT was configured for the required transmit frequencies 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 $10 \cdot \text{LOG}(\text{dc})$.

SPURIOUS RADIATED EMISSIONS



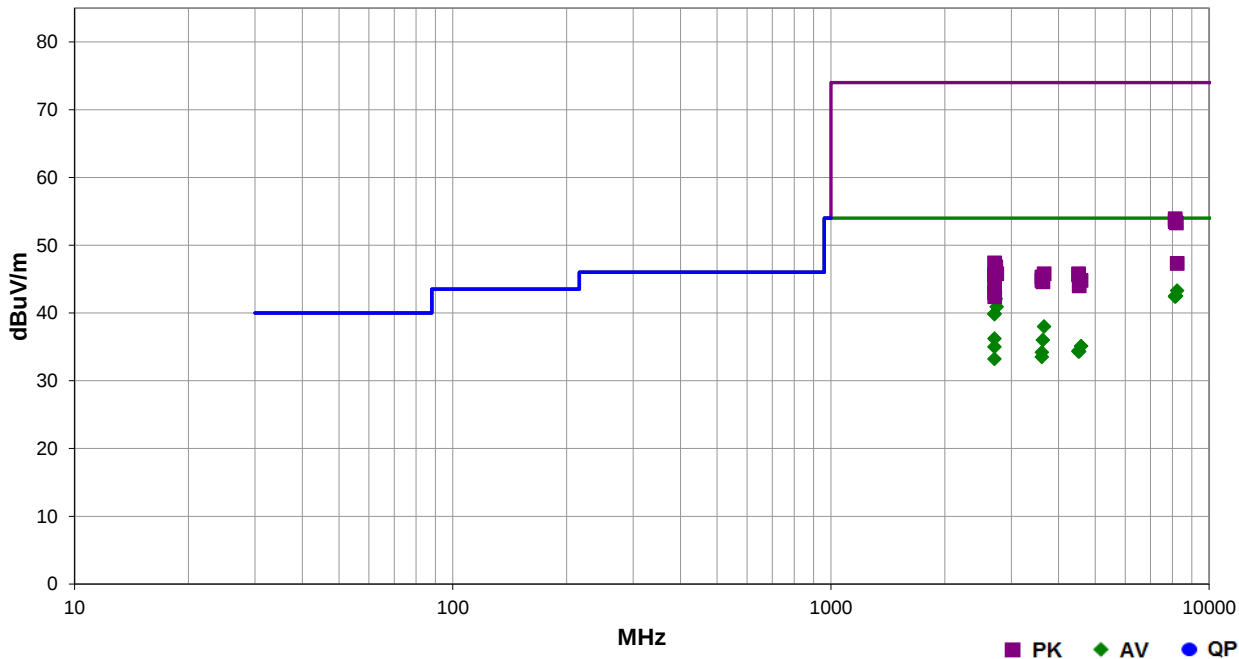
EmiRS 2019.08.01

PSA-ESCI 2019.05.10

Work Order:	CRNE0015	Date:	27-Aug-2019	<i>Jonathan Kiefer</i>
Project:	None	Temperature:	22.2 °C	
Job Site:	TX02	Humidity:	53.1% RH	
Serial Number:	See Configuration	Barometric Pres.:	1019 mbar	Tested by: Jonathan Kiefer
EUT:	World LoRa Module			
Configuration:	5			
Customer:	Carnegie Technologies			
Attendees:	None			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting at Low Channel 903 MHz, Mid Channel 909 MHz, High Channel 915 MHz			
Deviations:	None			
Comments:	See the table comments for EUT channel and orientation information.			

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

Run #	39	Test Distance (m)	3	Antenna Height(s)	1 to 4(m)	Results	Pass
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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
8235.367	49.7	-6.4	2.7	109.0	3.0	0.0	Horz	AV	0.0	43.3	54.0	-10.7	High Ch, EUT Y
2709.050	46.8	-3.6	3.6	188.0	3.0	0.0	Horz	AV	0.0	43.2	54.0	-10.8	Low Ch, EUT Y
8128.933	30.3	12.2	1.5	170.0	3.0	0.0	Horz	AV	0.0	42.5	54.0	-11.5	Low Ch, EUT Y
8181.333	30.1	12.4	1.5	115.0	3.0	0.0	Horz	AV	0.0	42.5	54.0	-11.5	Mid Ch, EUT Y
8128.408	30.2	12.2	1.5	16.9	3.0	0.0	Vert	AV	0.0	42.4	54.0	-11.6	Low Ch, EUT Z
2727.042	45.6	-3.5	4.0	195.0	3.0	0.0	Horz	AV	0.0	42.1	54.0	-11.9	Mid Ch, EUT Y
2744.917	44.4	-3.5	3.5	186.0	3.0	0.0	Horz	AV	0.0	40.9	54.0	-13.1	High Ch, EUT Y
2709.133	43.5	-3.6	3.9	176.0	3.0	0.0	Horz	AV	0.0	39.9	54.0	-14.1	Low Ch, EUT X
2709.058	43.4	-3.6	3.5	116.0	3.0	0.0	Vert	AV	0.0	39.8	54.0	-14.2	Low Ch, EUT Z
3660.000	36.8	1.2	3.1	193.0	3.0	0.0	Horz	AV	0.0	38.0	54.0	-16.0	High Ch, EUT Y
2709.100	39.8	-3.6	3.3	270.0	3.0	0.0	Horz	AV	0.0	36.2	54.0	-17.8	Low Ch, EUT Z
3636.167	34.9	1.1	2.5	196.9	3.0	0.0	Horz	AV	0.0	36.0	54.0	-18.0	Mid Ch, EUT Y
4587.500	31.9	3.2	1.9	141.0	3.0	0.0	Horz	AV	0.0	35.1	54.0	-18.9	High Ch, EUT Y
2709.025	38.6	-3.6	4.0	118.9	3.0	0.0	Vert	AV	0.0	35.0	54.0	-19.0	Low Ch, EUT X

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
4516.742	31.5	2.9	1.5	220.9	3.0	0.0	Horz	AV	0.0	34.4	54.0	-19.6	Low Ch, EUT Y
4517.025	31.4	2.9	1.5	194.0	3.0	0.0	Vert	AV	0.0	34.3	54.0	-19.7	Low Ch, EUT Z
4536.250	31.3	3.0	1.5	117.0	3.0	0.0	Horz	AV	0.0	34.3	54.0	-19.7	Mid Ch, EUT Y
3612.208	33.0	1.2	3.4	171.9	3.0	0.0	Vert	AV	0.0	34.2	54.0	-19.8	Low Ch, EUT Z
8128.525	41.7	12.2	1.5	16.9	3.0	0.0	Vert	PK	0.0	53.9	74.0	-20.1	Low Ch, EUT Z
3613.500	32.3	1.2	1.5	10.9	3.0	0.0	Horz	AV	0.0	33.5	54.0	-20.5	Low Ch, EUT Y
8127.575	41.3	12.2	1.5	170.0	3.0	0.0	Horz	PK	0.0	53.5	74.0	-20.5	Low Ch, EUT Y
8189.208	40.9	12.4	1.5	115.0	3.0	0.0	Horz	PK	0.0	53.3	74.0	-20.7	Mid Ch, EUT Y
2708.908	36.8	-3.6	1.5	225.9	3.0	0.0	Vert	AV	0.0	33.2	54.0	-20.8	Low Ch, EUT Y
2708.833	51.0	-3.6	3.6	188.0	3.0	0.0	Horz	PK	0.0	47.4	74.0	-26.6	Low Ch, EUT Y
8234.833	53.7	-6.4	2.7	109.0	3.0	0.0	Horz	PK	0.0	47.3	74.0	-26.7	High Ch, EUT Y
2726.958	50.3	-3.5	4.0	195.0	3.0	0.0	Horz	PK	0.0	46.8	74.0	-27.2	Mid Ch, EUT Y
4516.708	42.9	2.9	1.5	220.9	3.0	0.0	Horz	PK	0.0	45.8	74.0	-28.2	Low Ch, EUT Y
2744.917	49.3	-3.5	3.5	186.0	3.0	0.0	Horz	PK	0.0	45.8	74.0	-28.2	High Ch, EUT Y
3659.750	44.6	1.2	3.1	193.0	3.0	0.0	Horz	PK	0.0	45.8	74.0	-28.2	High Ch, EUT Y
2708.783	49.2	-3.6	3.9	176.0	3.0	0.0	Horz	PK	0.0	45.6	74.0	-28.4	Low Ch, EUT X
2709.033	49.2	-3.6	3.5	116.0	3.0	0.0	Vert	PK	0.0	45.6	74.0	-28.4	Low Ch, EUT Z
4515.017	42.7	2.9	1.5	194.0	3.0	0.0	Vert	PK	0.0	45.6	74.0	-28.4	Low Ch, EUT Z
3611.083	44.1	1.2	1.5	10.9	3.0	0.0	Horz	PK	0.0	45.3	74.0	-28.7	Low Ch, EUT Y
3612.125	43.6	1.2	3.4	171.9	3.0	0.0	Vert	PK	0.0	44.8	74.0	-29.2	Low Ch, EUT Z
4582.125	41.7	3.1	1.9	141.0	3.0	0.0	Horz	PK	0.0	44.8	74.0	-29.2	High Ch, EUT Y
3635.917	43.5	1.1	2.5	196.9	3.0	0.0	Horz	PK	0.0	44.6	74.0	-29.4	Mid Ch, EUT Y
2708.892	47.6	-3.6	3.3	270.0	3.0	0.0	Horz	PK	0.0	44.0	74.0	-30.0	Low Ch, EUT Z
4536.583	41.0	3.0	1.5	117.0	3.0	0.0	Horz	PK	0.0	44.0	74.0	-30.0	Mid Ch, EUT Y
2709.008	46.6	-3.6	4.0	118.9	3.0	0.0	Vert	PK	0.0	43.0	74.0	-31.0	Low Ch, EUT X
2709.183	46.0	-3.6	1.5	225.9	3.0	0.0	Vert	PK	0.0	42.4	74.0	-31.6	Low Ch, EUT Y

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. A direct connection was made between the RF output of the EUT and a spectrum analyzer. Attenuation and a DC block were used

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.

CARRIER FREQUENCY SEPARATION



XMI 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-20

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The channel carrier frequencies in the 902-928 band must be separated by 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. The EUT was operated in pseudorandom hopping mode. The spectrum was scanned across two adjacent peaks. The separation between the peaks of these channels was measured.

CARRIER FREQUENCY SEPARATION



TM/Tx 2018.09.13 XM/ 2019.05.15

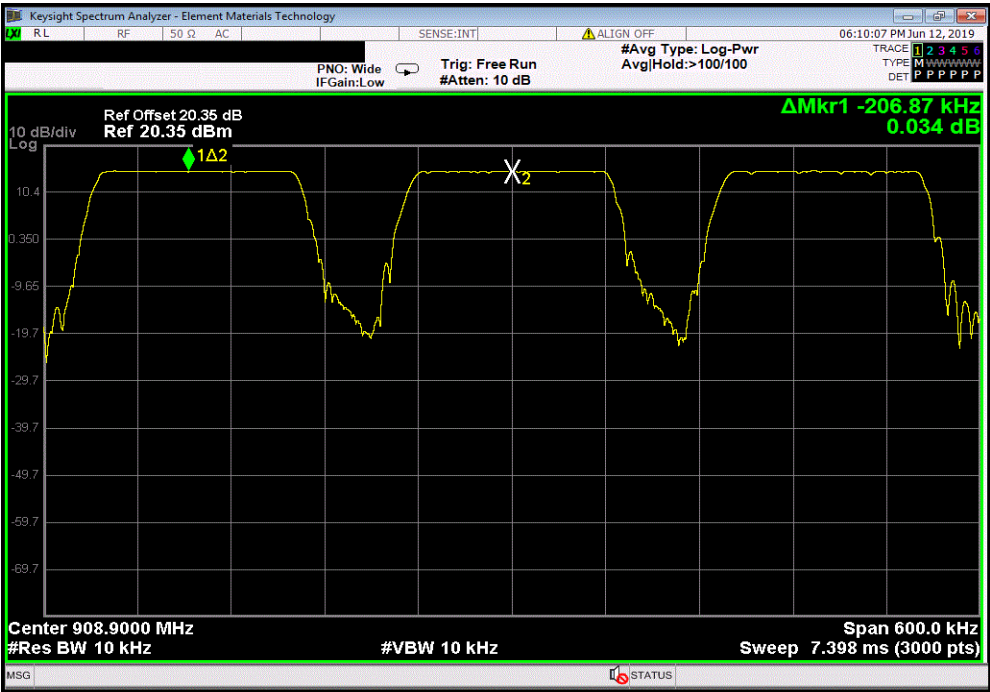
EUT: World IoT LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 12-Jun-19	
Customer: Carnegie Technologies		Temperature: 22.3 °C	
Attendees: Joseph Haas		Humidity: 48.6% RH	
Project: None		Barometric Pres.: 1019 mbar	
Tested by: Jonathan Kiefer		Power: Battery	
		Job Site: TX09	
TEST SPECIFICATIONS		Test Method	
FCC 15.247:2019		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.35 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Jonathan Kiefer</i>	
		Value	Limit (±)
Hopping Mode (All Channels)		206.87 kHz	163.633 kHz
			Results
			Pass

CARRIER FREQUENCY SEPARATION



TMTx 2018.09.13 XMt 2019.05.15

Hopping Mode (All Channels)						
				Value	Limit (≥)	Results
				206.87 kHz	163.633 kHz	Pass



NUMBER OF HOPPING FREQUENCIES



XMIT 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-20

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The number of hopping frequencies was measured across the authorized band. The hopping function of the EUT was enabled.

NUMBER OF HOPPING FREQUENCIES



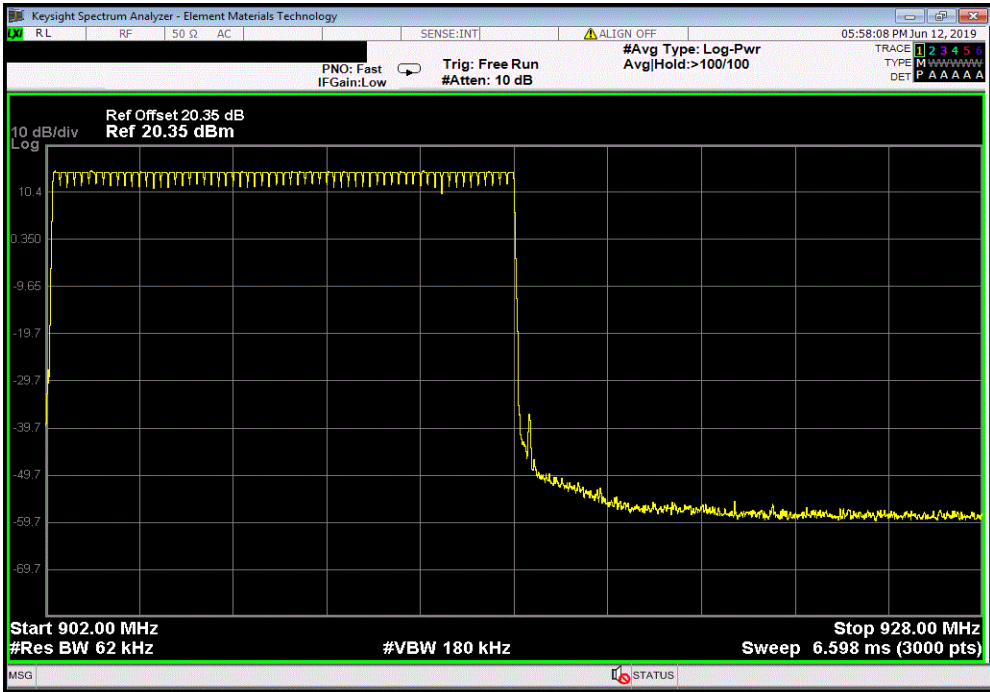
XMM 2019.05.15

EUT: World IoT LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 12-Jun-19	
Customer: Carnegie Technologies		Temperature: 22.1 °C	
Attendees: Joseph Haas		Humidity: 47.7% RH	
Project: None		Barometric Pres.: 1018 mbar	
Tested by: Jonathan Kiefer		Power: Battery	
		Job Site: TX09	
TEST SPECIFICATIONS		Test Method	
FCC 15.247:2019		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.35 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Jonathan Kiefer</i>	
		Number of Channels	Limit
Hopping Mode (All Channels)		64	N/A
			Result
			N/A

NUMBER OF HOPPING FREQUENCIES



Hopping Mode (All Channels)						
				Number of Channels	Limit	Result
				64	N/A	N/A



DWELL TIME



XMIT 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-20

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The average dwell time per hopping channel was measured at one hopping channel in the middle of the authorized band. The hopping function of the EUT was enabled.

The dwell time limit is based on the Number of Hopping Channels * 400 mS. For this device it would be 64 Channels * 400mS = 25.6

DWELL TIME



TM1Tx 2018.09.13 XM18 2019.05.15

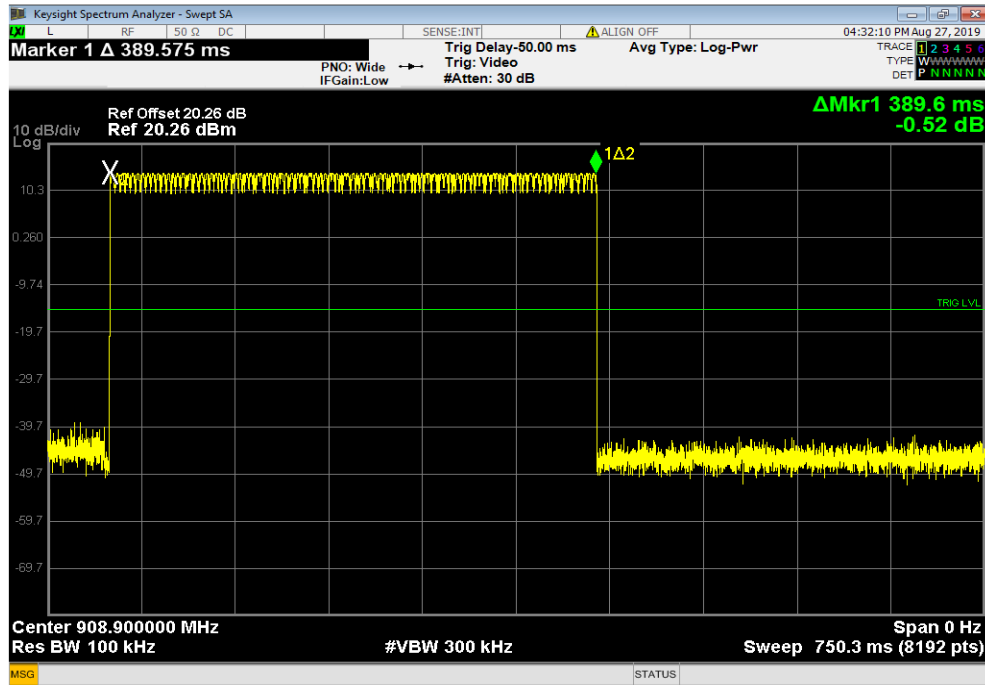
EUT: World LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 27-Aug-19	
Customer: Carnegie Technologies		Temperature: 22.4 °C	
Attendees: Joseph Haas		Humidity: 54.7% RH	
Project: None		Barometric Pres.: 1015 mbar	
Tested by: Jonathan Kiefer		Power: Battery	
		Job Site: TX09	
TEST SPECIFICATIONS			
FCC 15.247:2019		Test Method	
		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.26 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	4	Signature <i>Jonathan Kiefer</i>	
		Pulse Width (ms)	Number of Pulses
		Average No. of Pulses	On Time (ms) During 25.6 s
		Limit (ms)	Results
Hopping Mode (All Channels)	389.6	N/A	N/A
Hopping Mode (All Channels)	N/A	1	N/A
Hopping Mode (All Channels)	N/A	1	N/A
Hopping Mode (All Channels)	N/A	1	N/A
Hopping Mode (All Channels)	N/A	1	N/A
Hopping Mode (All Channels)	389.6	N/A	1
			389.6
			400
			Pass

DWELL TIME

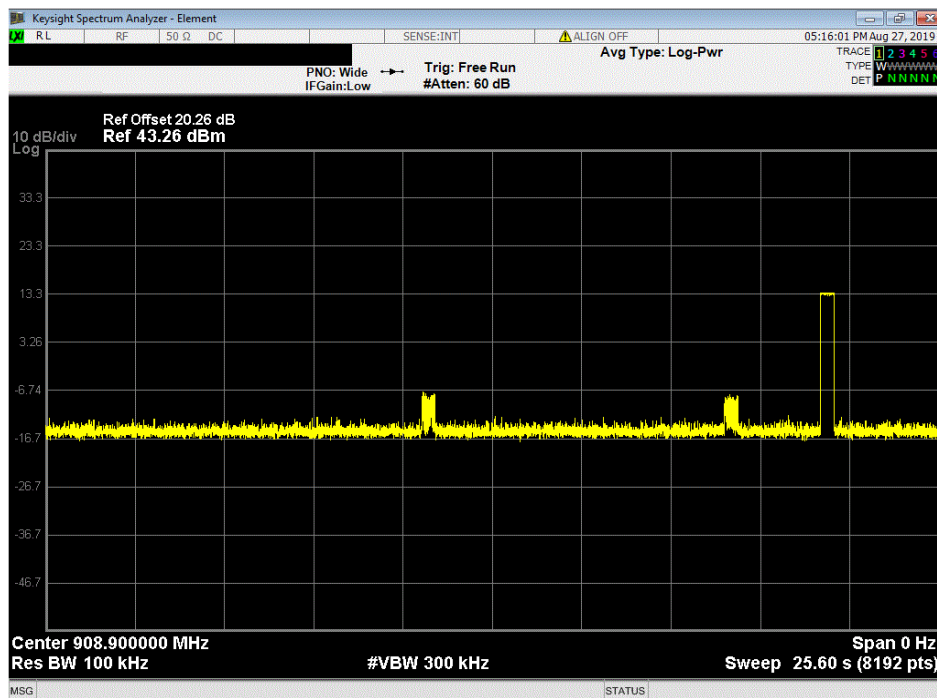


TMTx 2018.09.13 XMI 2019.05.15

Hopping Mode (All Channels)						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	On Time (ms) During 25.6 s	Limit (ms)	Results	
389.6	N/A	N/A	N/A	N/A	N/A	N/A



Hopping Mode (All Channels)						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	On Time (ms) During 25.6 s	Limit (ms)	Results	
N/A	1	N/A	N/A	N/A	N/A	N/A

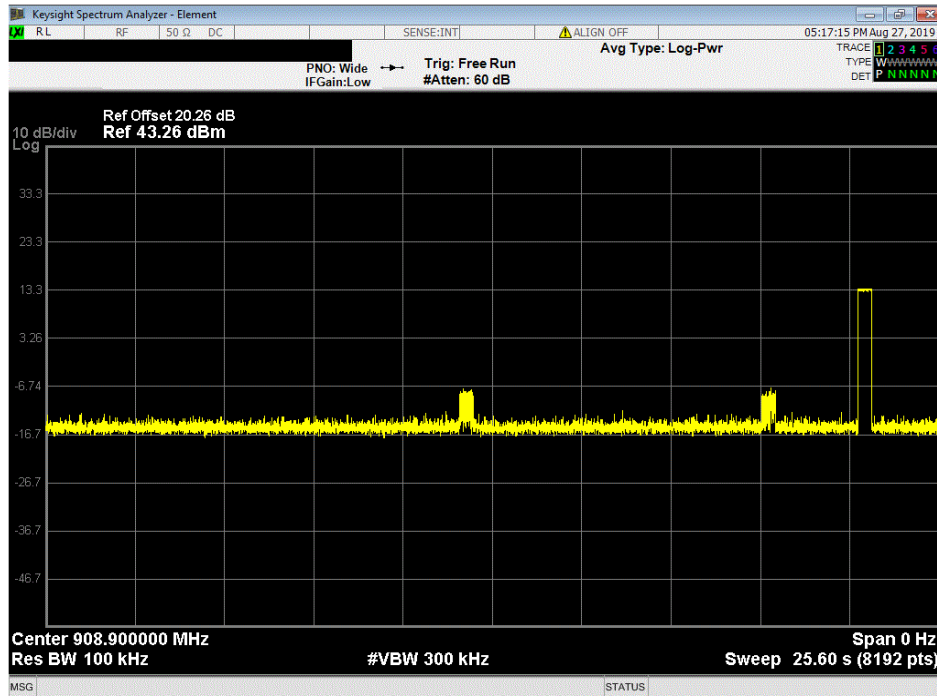


DWELL TIME

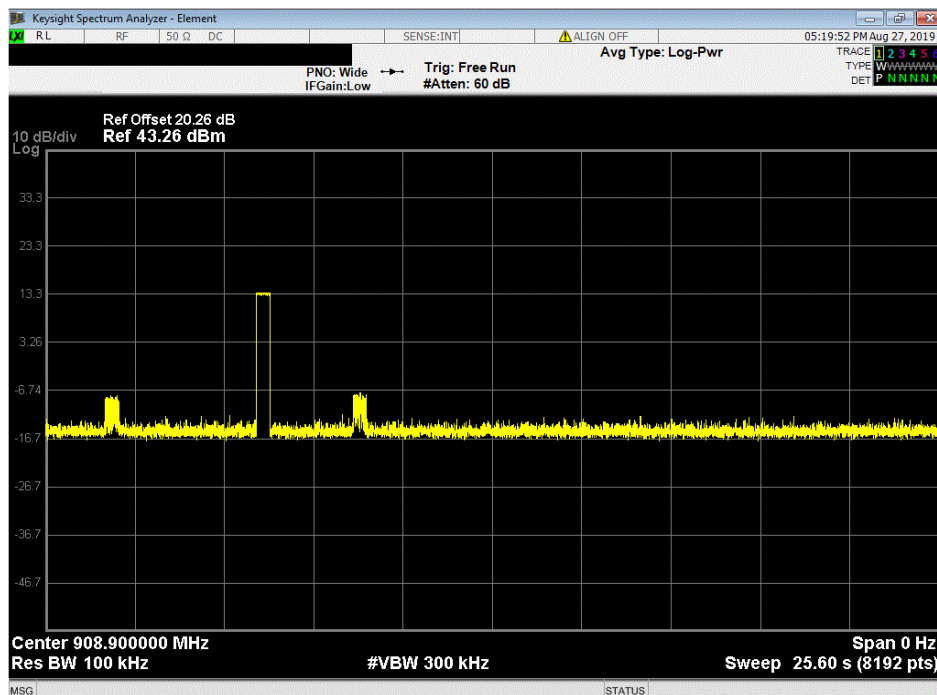


TMTx 2018.09.13 XMt 2019.05.15

Hopping Mode (All Channels)						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	On Time (ms) During 25.6 s	Limit (ms)	Results	
N/A	1	N/A	N/A	N/A	N/A	N/A



Hopping Mode (All Channels)						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	On Time (ms) During 25.6 s	Limit (ms)	Results	
N/A	1	N/A	N/A	N/A	N/A	N/A

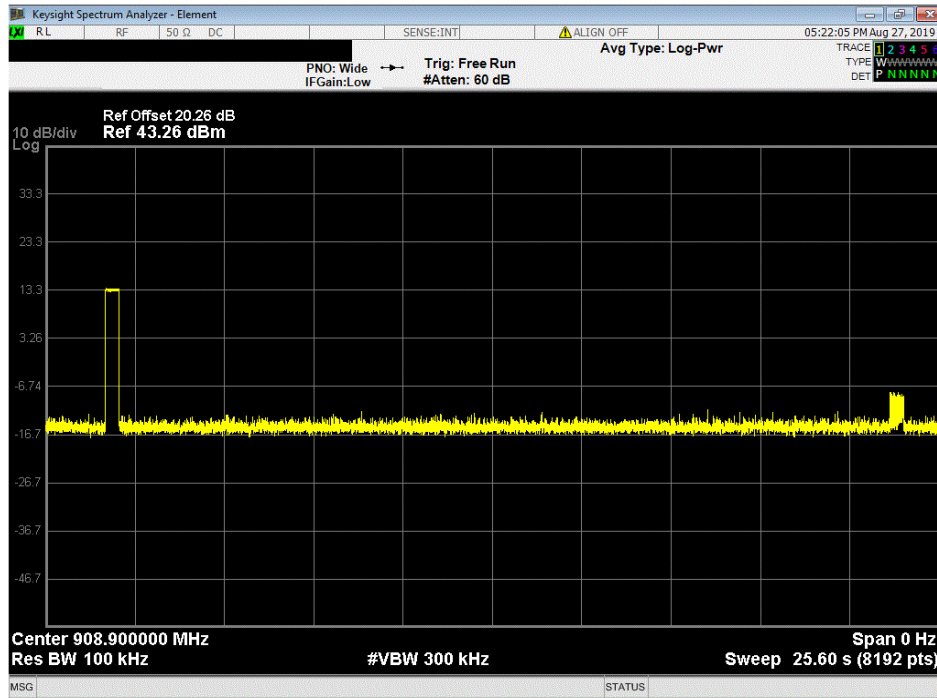


DWELL TIME



TMTx 2018.09.13 XMt 2019.05.15

Hopping Mode (All Channels)						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	On Time (ms) During 25.6 s	Limit (ms)	Results	
N/A	1	N/A	N/A	N/A	N/A	



Hopping Mode (All Channels)						
Pulse Width (ms)	Number of Pulses	Average No. of Pulses	On Time (ms) During 25.6 s	Limit (ms)	Results	
389.6	N/A	1	389.6	400	Pass	

Calculation Only

No Screen Capture Required

OUTPUT POWER



XMIT 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-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.

The method AVGSA-1 in section 11.9.2.2.2 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging with the EUT transmitting at full power throughout each sweep using an RMS detector. Following the measurement a duty cycle correction factor 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



TM1Tx 2018.09.13 XM18 2019.05.15

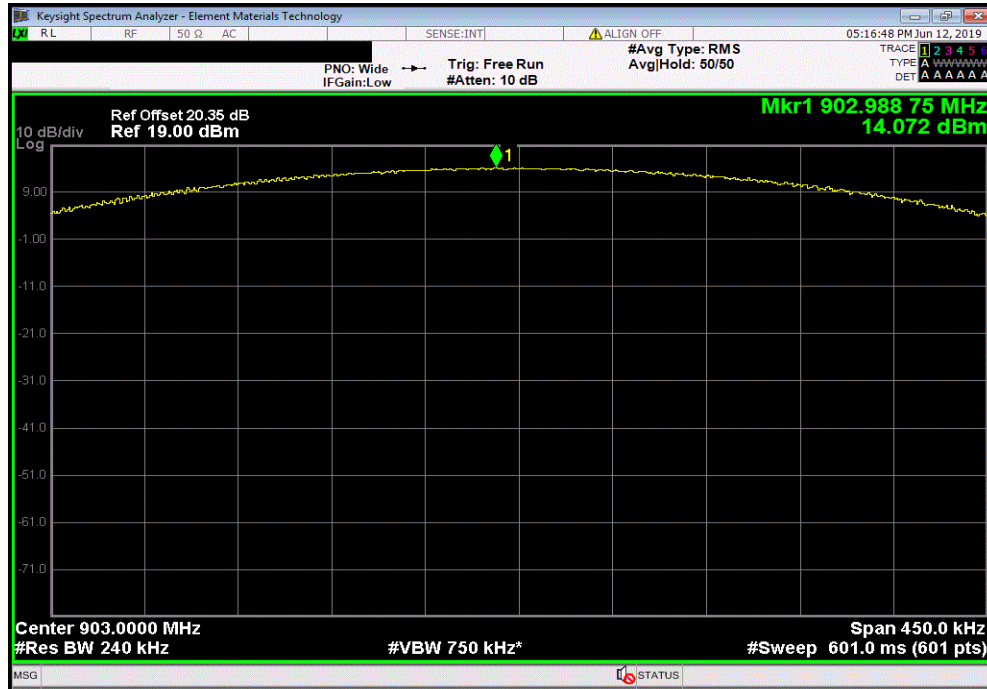
EUT: World IoT LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 12-Jun-19	
Customer: Carnegie Technologies		Temperature: 22 °C	
Attendees: Joseph Haas		Humidity: 47.5% RH	
Project: None		Barometric Pres.: 1019 mbar	
Tested by: Jonathan Kiefer		Power: Battery	
Job Site: TX09			
TEST SPECIFICATIONS			
FCC 15.247:2019		Test Method	
		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.35 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Jonathan Kiefer</i>	
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)
Low Channel, 903 MHz		14.072	0
Mid Channel, 909 MHz		14.155	0
High Channel, 915 MHz		14.147	0
		Value (dBm)	Limit (dBm)
		14.1	30
		14.2	30
		14.1	30
			Results
			Pass
			Pass
			Pass

OUTPUT POWER

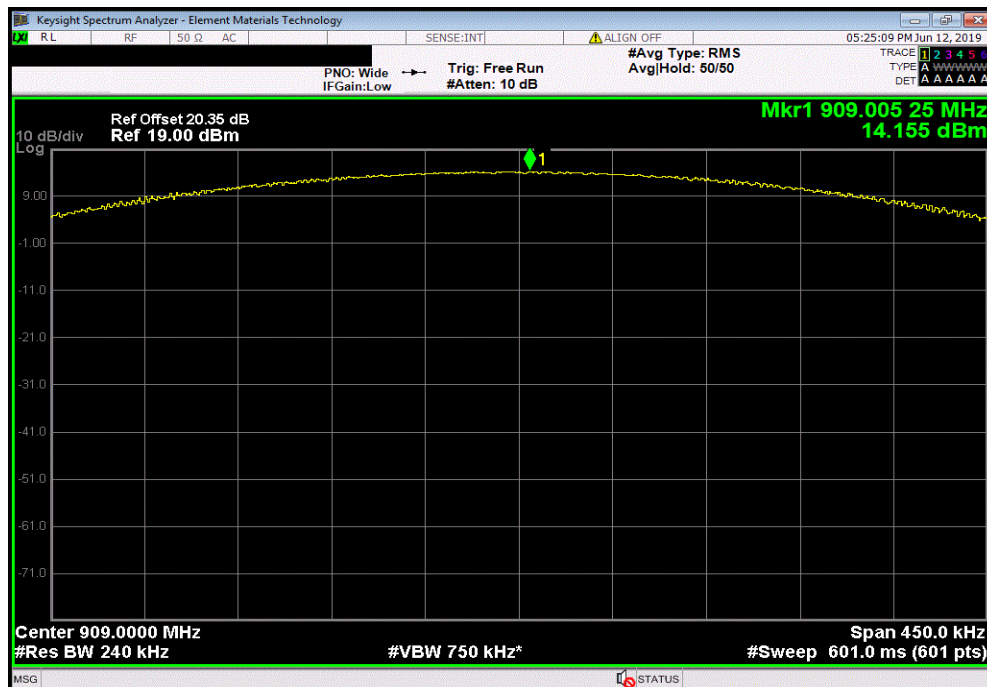


TMTx 2018.09.13 XMI 2019.05.15

Low Channel, 903 MHz						
Avg Cond	Duty Cycle		Value	Limit	Results	
Pwr (dBm)	Factor (dB)		(dBm)	(dBm)		
14.072	0		14.1	30	Pass	



Mid Channel, 909 MHz						
Avg Cond	Duty Cycle		Value	Limit	Results	
Pwr (dBm)	Factor (dB)		(dBm)	(dBm)		
14.155	0		14.2	30	Pass	

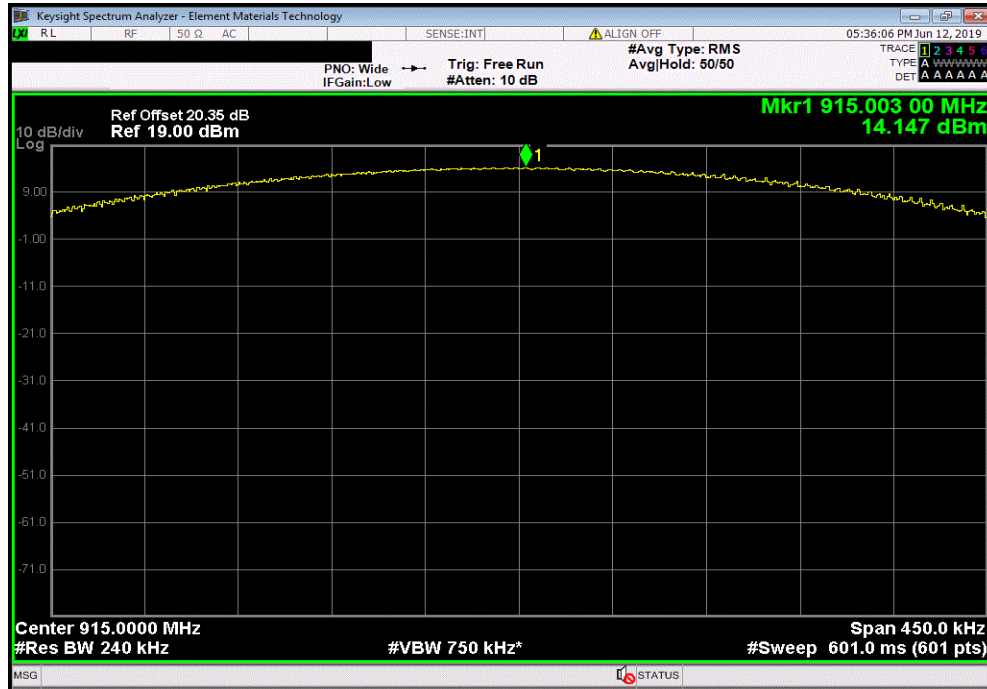


OUTPUT POWER



TMTx 2018.09.13 XMt 2019.05.15

High Channel, 915 MHz						
Avg Cond	Duty Cycle		Value	Limit	Results	
Pwr (dBm)	Factor (dB)		(dBm)	(dBm)		
14.147	0		14.1	30	Pass	



EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)



XMI 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-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.

The method AVGSA-1 in section 11.9.2.2.2 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging with the EUT transmitting at full power throughout each sweep using an RMS detector. Following the measurement a duty cycle correction factor 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 actual antenna gain of the EUT was added to the conducted output power to derive the EIRP values.

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)



THxTx 2018.09.13 XMt 2019.05.15

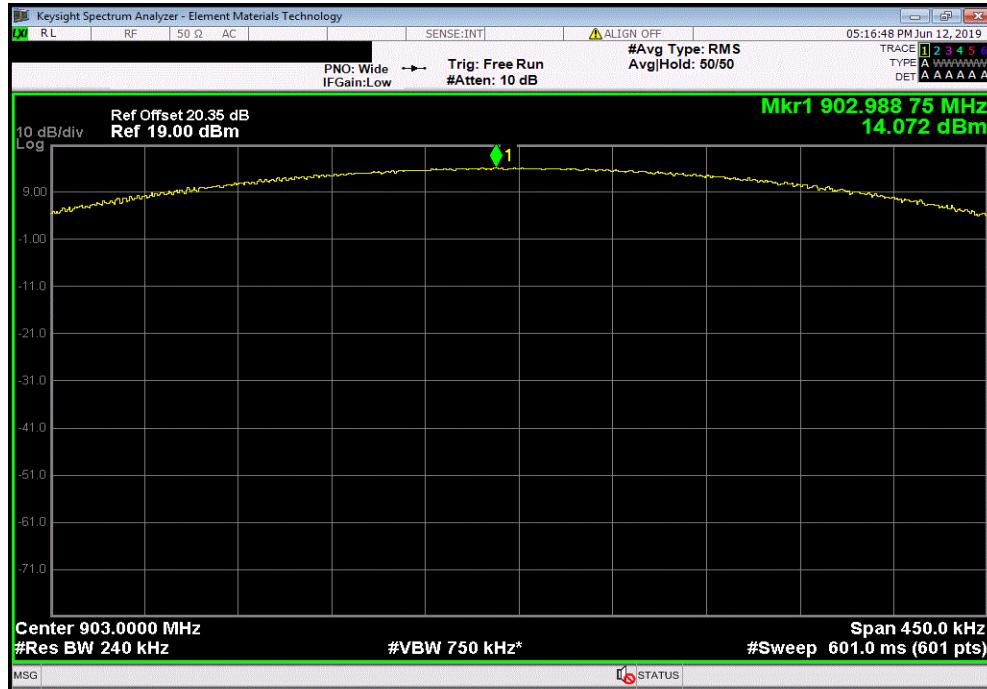
EUT: World IoT LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 12-Jun-19	
Customer: Carnegie Technologies		Temperature: 22 °C	
Attendees: Joseph Haas		Humidity: 47.5% RH	
Project: None		Barometric Pres.: 1019 mbar	
Tested by: Jonathan Kiefer		Power: Battery	
Job Site: TX09			
TEST SPECIFICATIONS			
FCC 15.247:2019		Test Method	
		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.35 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Jonathan Kiefer</i>	
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)
		Antenna Gain (dBi)	EIRP Value (dBm)
		Limit (dBm)	Results
Low Channel, 903 MHz		14.072	0
Mid Channel, 909 MHz		14.155	0
High Channel, 915 MHz		14.147	0

EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

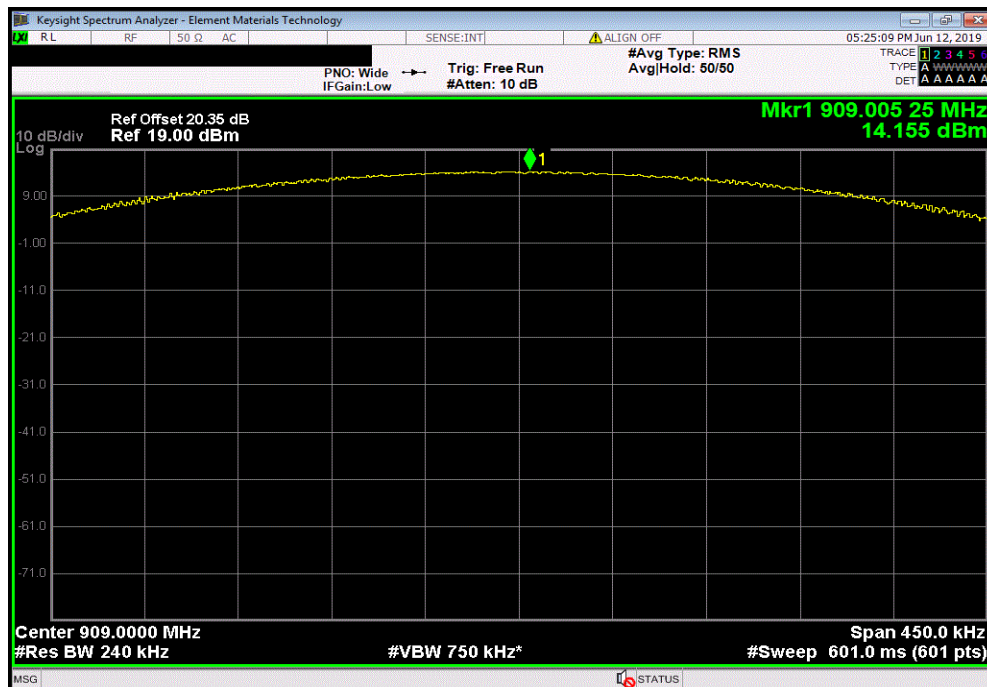


TMTx 2018.09.13 XMI 2019.05.15

Low Channel, 903 MHz						
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP Value (dBm)	Limit (dBm)	Results	
14.072	0	2	16.072	36	Pass	



Mid Channel, 909 MHz						
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Antenna Gain (dBi)	EIRP Value (dBm)	Limit (dBm)	Results	
14.155	0	2	16.155	36	Pass	

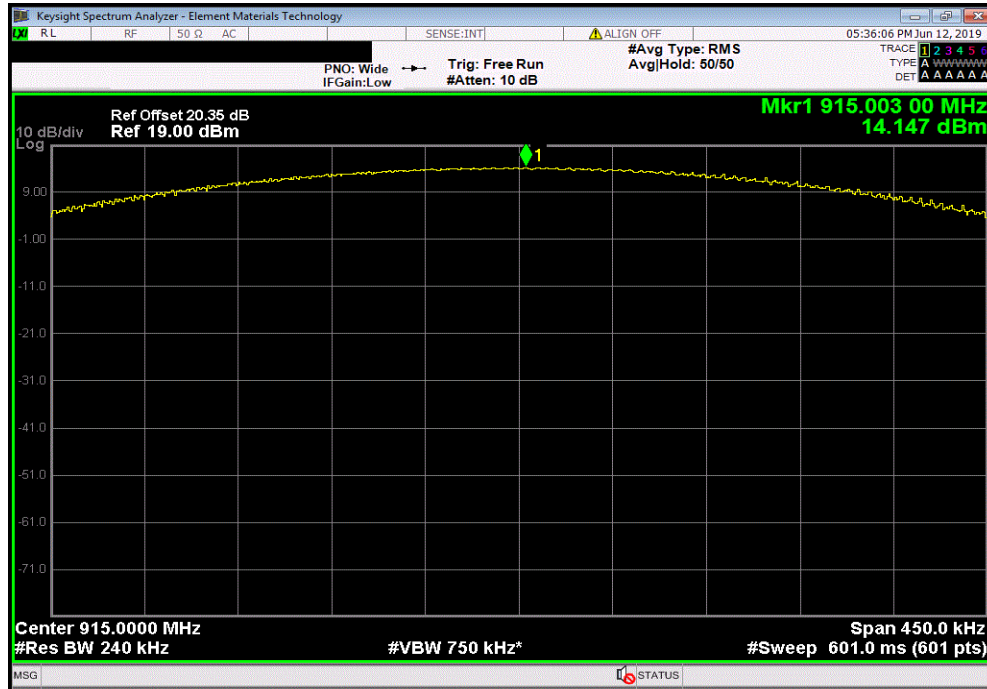


EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)



TMTx 2018.09.13 XMt 2019.05.15

High Channel, 915 MHz						
Avg Cond	Duty Cycle	Antenna	EIRP	Limit	Results	
Pwr (dBm)	Factor (dB)	Gain (dBi)	Value (dBm)	(dBm)		
14.147	0	2	16.147	36	Pass	



BAND EDGE COMPLIANCE



XMI 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-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



TM1Tx 2018.09.13 XM18 2019.05.15

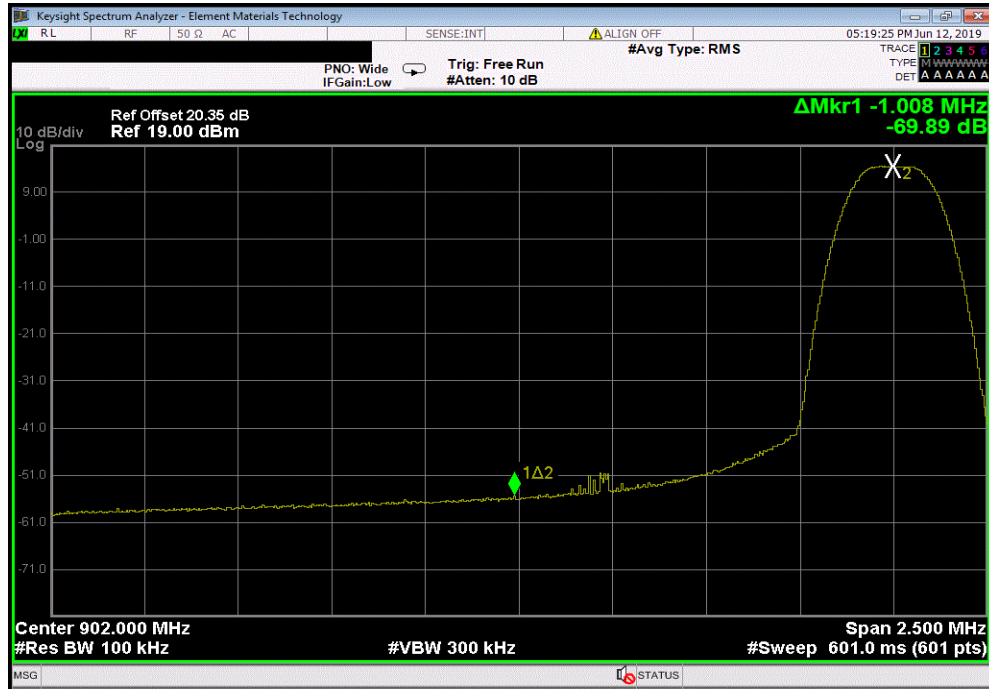
EUT: World IoT LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 12-Jun-19	
Customer: Carnegie Technologies		Temperature: 22 °C	
Attendees: John Nagy		Humidity: 49% RH	
Project: None		Barometric Pres.: 1019 mbar	
Tested by: Jonathan Kiefer	Power: Battery	Job Site: TX09	
TEST SPECIFICATIONS			
FCC 15.247:2019		Test Method	
		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.35 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Jonathan Kiefer</i>	
		Value (dBc)	Limit ≤ (dBc) Result
Low Channel, 903 MHz		-69.89	-30 Pass
High Channel, 915 MHz		-79.13	-30 Pass

BAND EDGE COMPLIANCE

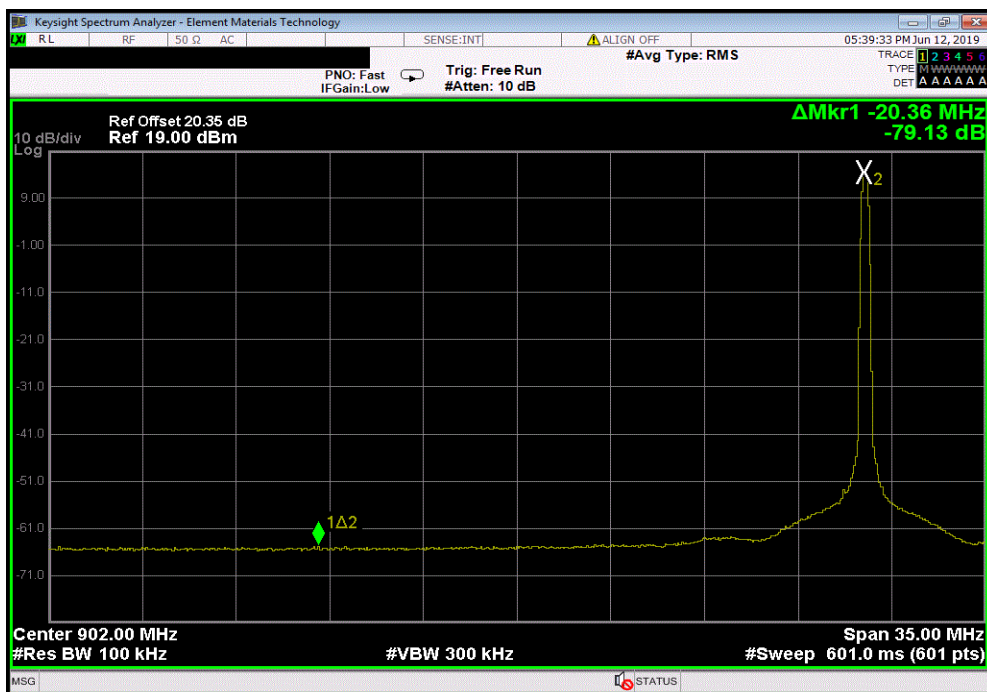


TMTx 2018.09.13 XMI 2019.05.15

Low Channel, 903 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-69.89	-30	Pass



High Channel, 915 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-79.13	-30	Pass



BAND EDGE COMPLIANCE - HOPPING MODE



XMI 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-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 band were measured with the EUT set to its normal pseudo-random hopping sequence. The EUT was transmitting at the data rate(s) listed in the datasheet.

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

BAND EDGE COMPLIANCE - HOPPING MODE



XMM 2019.05.15

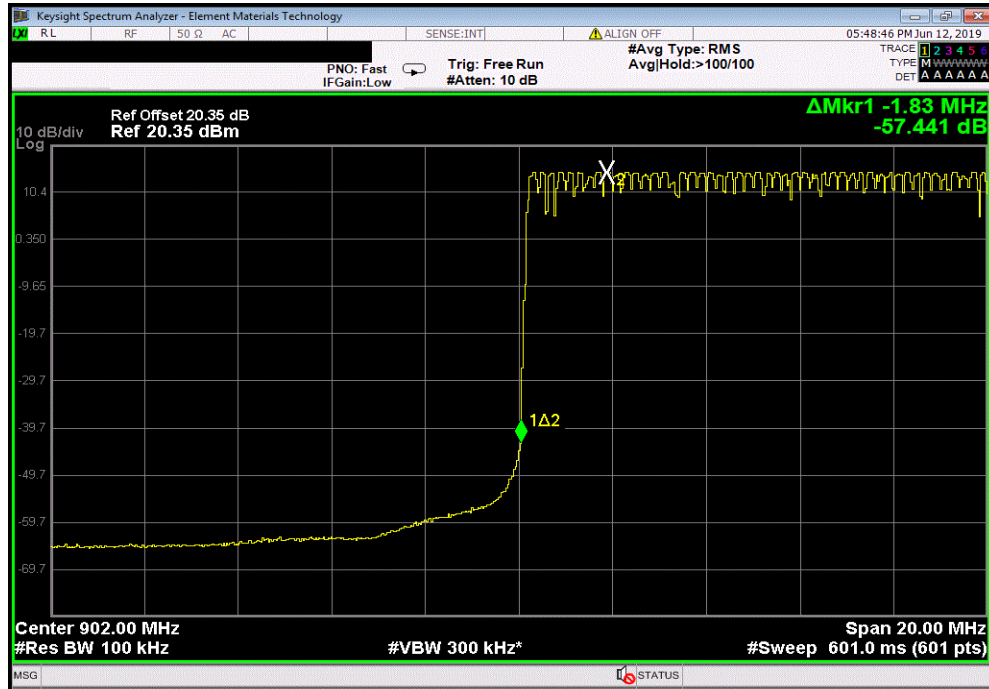
EUT: World IoT LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 12-Jun-19	
Customer: Carnegie Technologies		Temperature: 22.1 °C	
Attendees: Joseph Haas		Humidity: 49.4% RH	
Project: None		Barometric Pres.: 1018 mbar	
Tested by: Jonathan Kiefer		Power: Battery	
		Job Site: TX09	
TEST SPECIFICATIONS		Test Method	
FCC 15.247:2019		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.35 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Jonathan Kiefer</i>	
		Value (dBc)	Limit ≤ (dBc) Result
Hopping Mode (All Channels) - Lower Band Edge		-57.441	-30 Pass
Hopping Mode (All Channels) - Higher Band Edge		-73.555	-30 Pass

BAND EDGE COMPLIANCE - HOPPING MODE

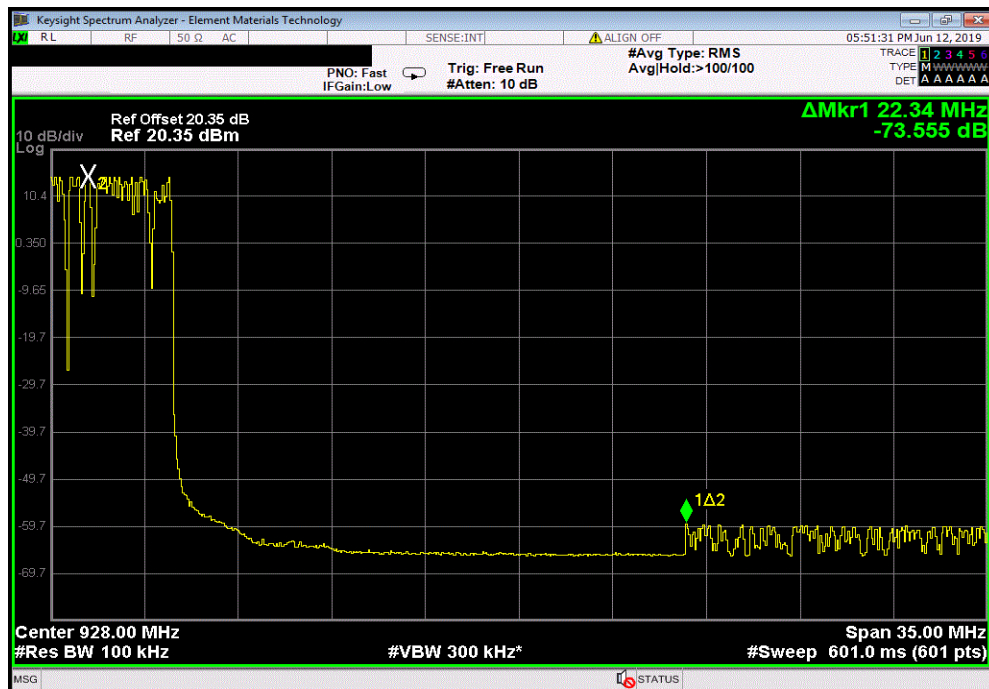


XMM 2019.05.15

Hopping Mode (All Channels) - Lower Band Edge						
				Value (dBc)	Limit ≤ (dBc)	Result
				-57.441	-30	Pass



Hopping Mode (All Channels) - Higher Band Edge						
				Value (dBc)	Limit ≤ (dBc)	Result
				-73.555	-30	Pass



OCCUPIED BANDWIDTH



XMI 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-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 20dB occupied bandwidth was measured using 100 kHz resolution bandwidth and 300 kHz video bandwidth.

For a hybrid system, there is no minimum occupied bandwidth requirement; therefore, the occupied bandwidth measurement is for characterization purposes only.

OCCUPIED BANDWIDTH



TM1Tx 2018.09.13 XM18 2019.05.15

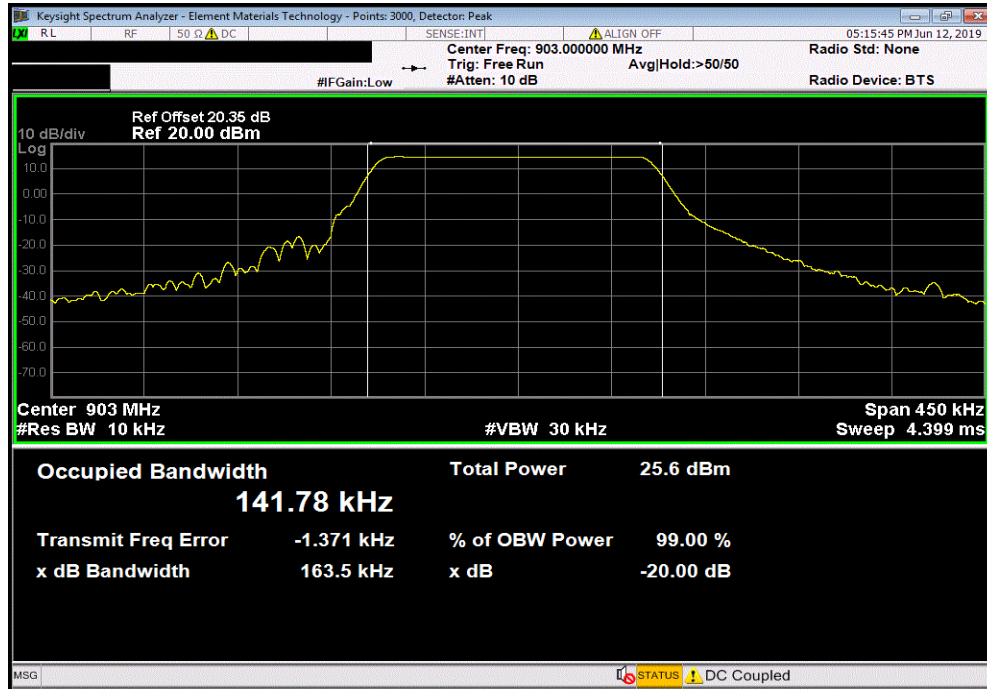
EUT: World IoT LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 12-Jun-19	
Customer: Carnegie Technologies		Temperature: 22.1 °C	
Attendees: Joseph Haas		Humidity: 46.8% RH	
Project: None		Barometric Pres.: 1019 mbar	
Tested by: Jonathan Kiefer	Power: Battery	Job Site: TX09	
TEST SPECIFICATIONS		Test Method	
FCC 15.247:2019		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.35 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Jonathan Kiefer</i>	
		Value	Limit
Low Channel, 903 MHz		163.484 kHz	N/A
Mid Channel, 909 MHz		163.259 kHz	N/A
High Channel, 915 MHz		163.633 kHz	N/A
			Result
			Pass
			Pass
			Pass

OCCUPIED BANDWIDTH

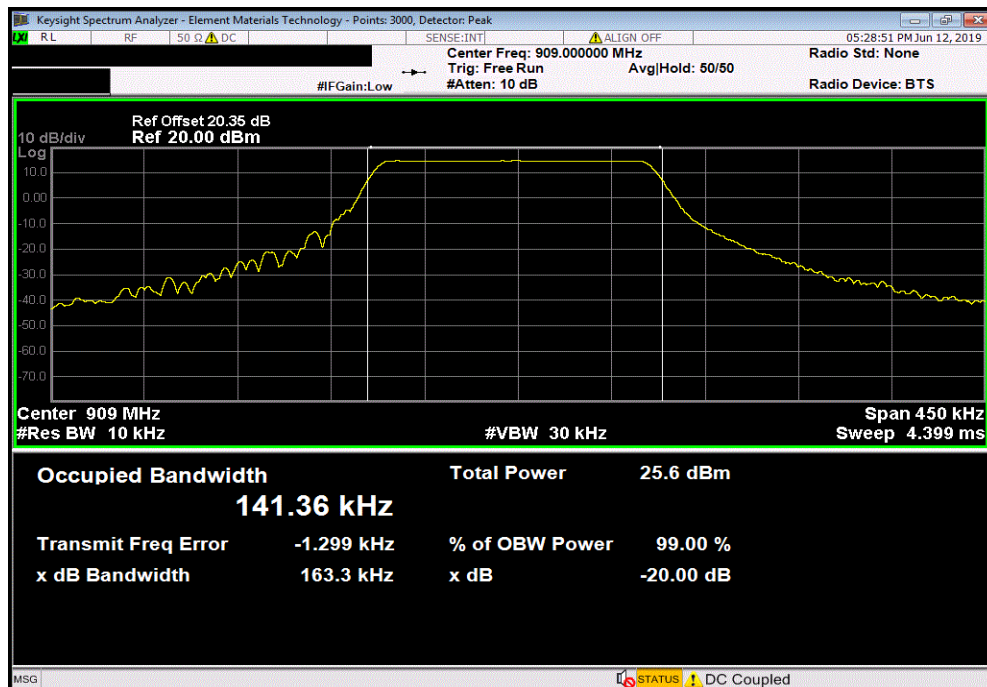


TMTx 2018.09.13 XMt 2019.05.15

Low Channel, 903 MHz						
				Value	Limit	Result
				163.484 kHz	N/A	Pass



Mid Channel, 909 MHz						
				Value	Limit	Result
				163.259 kHz	N/A	Pass

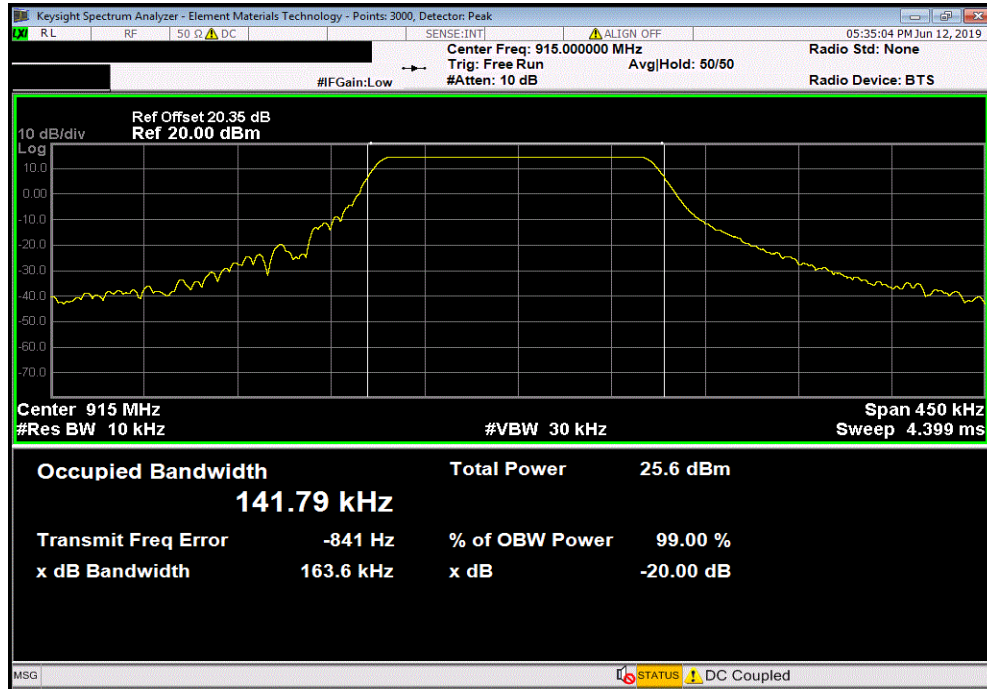


OCCUPIED BANDWIDTH



TMTx 2018.09.13 XMt 2019.05.15

High Channel, 915 MHz						
				Value	Limit	Result
				163.633 kHz	N/A	Pass



SPURIOUS CONDUCTED EMISSIONS



XMit 2019.06.11

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Attenuator	Fairview Microwave	SA4018-20	TYW	17-Mar-19	17-Mar-20
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Generator - Signal	Keysight	N5171B-506	TEW	2-May-18	2-May-21
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFL	27-Feb-19	27-Feb-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



THSTx 2019.08.02 XMM 2019.06.11

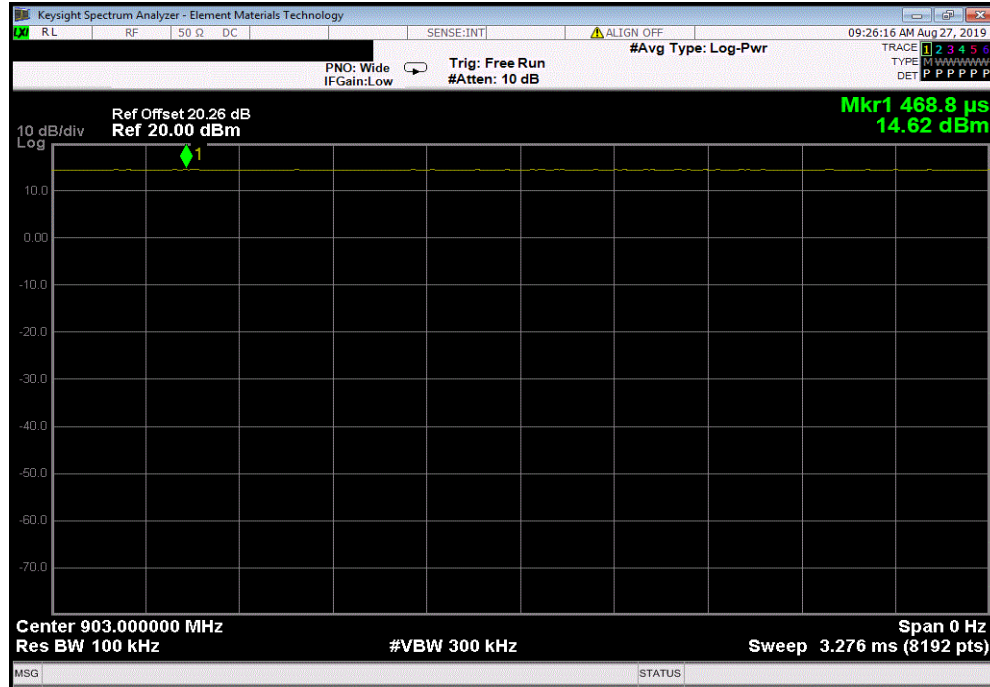
EUT: World LoRa Module		Work Order: CRNE0015			
Serial Number: See Configuration		Date: 27-Aug-19			
Customer: Carnegie Technologies		Temperature: 22 °C			
Attendees: None		Humidity: 53.3% RH			
Project: None		Barometric Pres.: 1018 mbar			
Tested by: Jonathan Kiefer		Power: Battery			
		Job Site: TX09			
TEST SPECIFICATIONS		Test Method			
FCC 15.247:2019		ANSI C63.10:2013			
COMMENTS					
Ref Offset 20.26 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.					
DEVIATIONS FROM TEST STANDARD					
None					
Configuration #	4	Signature <i>Jonathan Kiefer</i>			
	Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result
Low Channel, 903 MHz	Fundamental	903	N/A	N/A	N/A
Low Channel, 903 MHz	30 MHz - 12.5 GHz	2709.43	-51.8	-30	Pass
Low Channel, 903 MHz	12.5 GHz - 25 GHz	13545.35	-63.08	-30	Pass
Mid Channel, 909 MHz	Fundamental	909	N/A	N/A	N/A
Mid Channel, 909 MHz	30 MHz - 12.5 GHz	2727.7	-52	-30	Pass
Mid Channel, 909 MHz	12.5 GHz - 25 GHz	13635.39	-62.47	-30	Pass
High Channel, 915 MHz	Fundamental	915	N/A	N/A	N/A
High Channel, 915 MHz	30 MHz - 12.5 GHz	2744.44	-52.29	-30	Pass
High Channel, 915 MHz	12.5 GHz - 25 GHz	12809.79	-64.03	-30	Pass

SPURIOUS CONDUCTED EMISSIONS

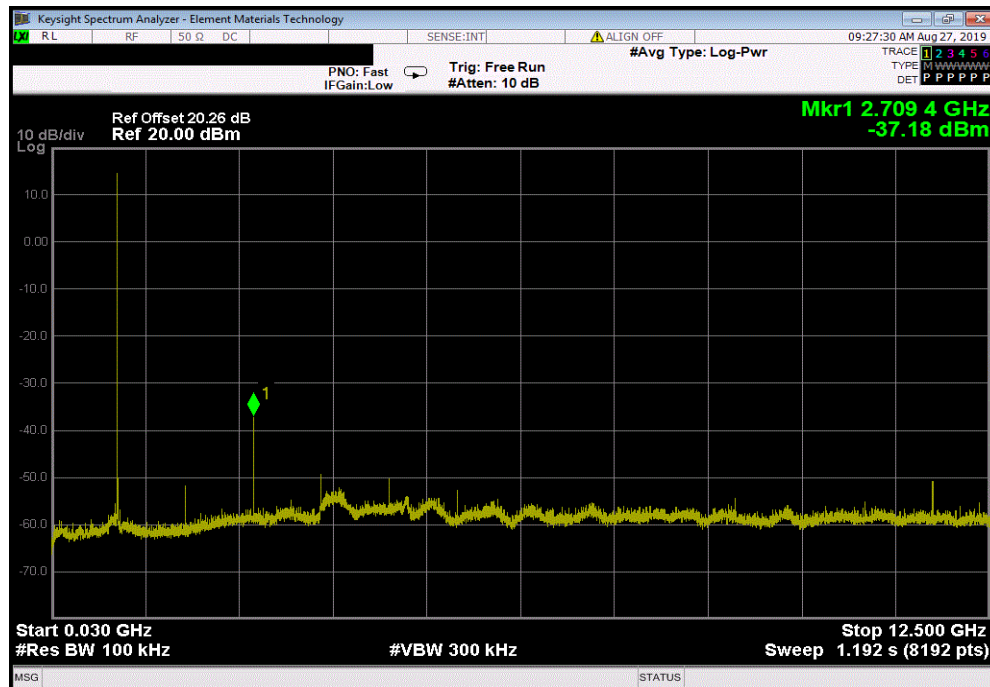


TMTx 2019.08.02 XMt 2019.06.11

Low Channel, 903 MHz						
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result		
Fundamental	903	N/A	N/A	N/A		



Low Channel, 903 MHz						
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result		
30 MHz - 12.5 GHz	2709.43	-51.8	-30	Pass		

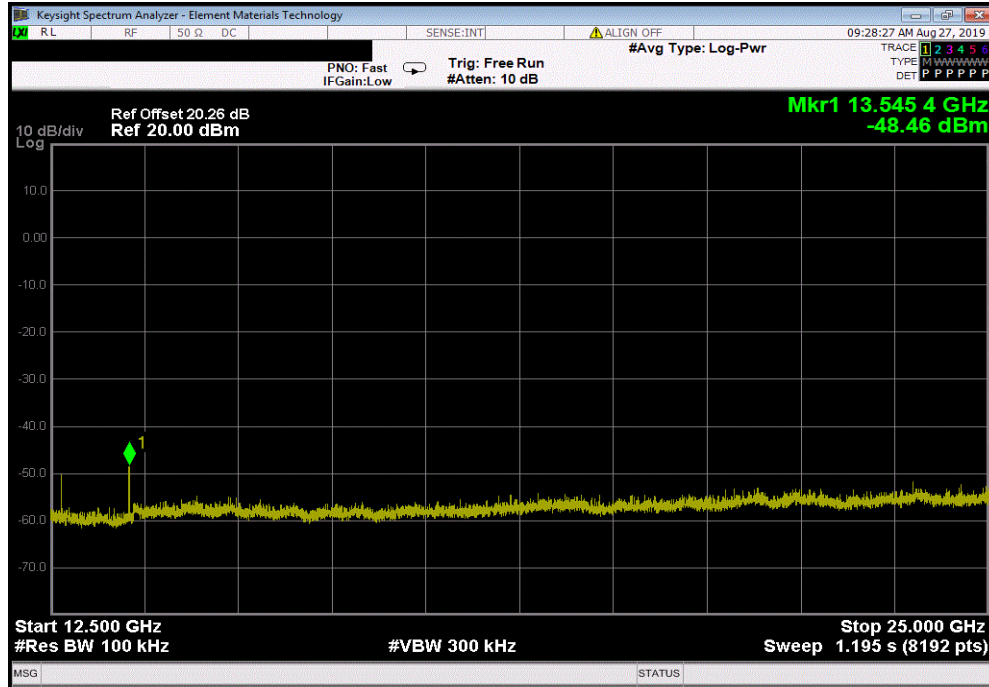


SPURIOUS CONDUCTED EMISSIONS

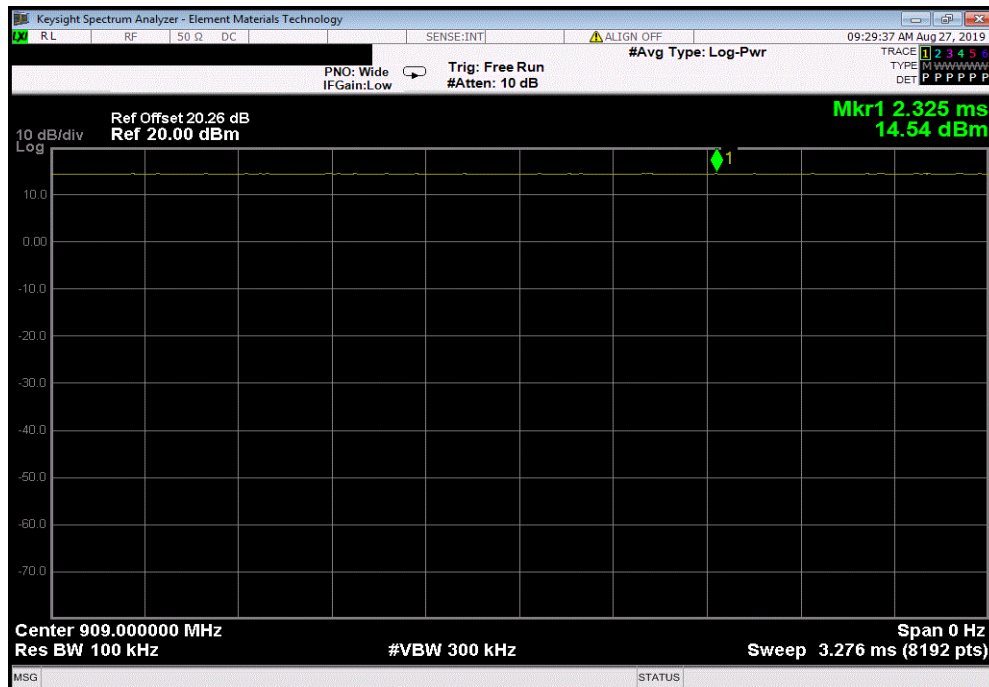


TMTx 2019.08.02 XMI 2019.06.11

Low Channel, 903 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
12.5 GHz - 25 GHz	13545.35	-63.08	-30	Pass	



Mid Channel, 909 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
Fundamental	909	N/A	N/A	N/A	

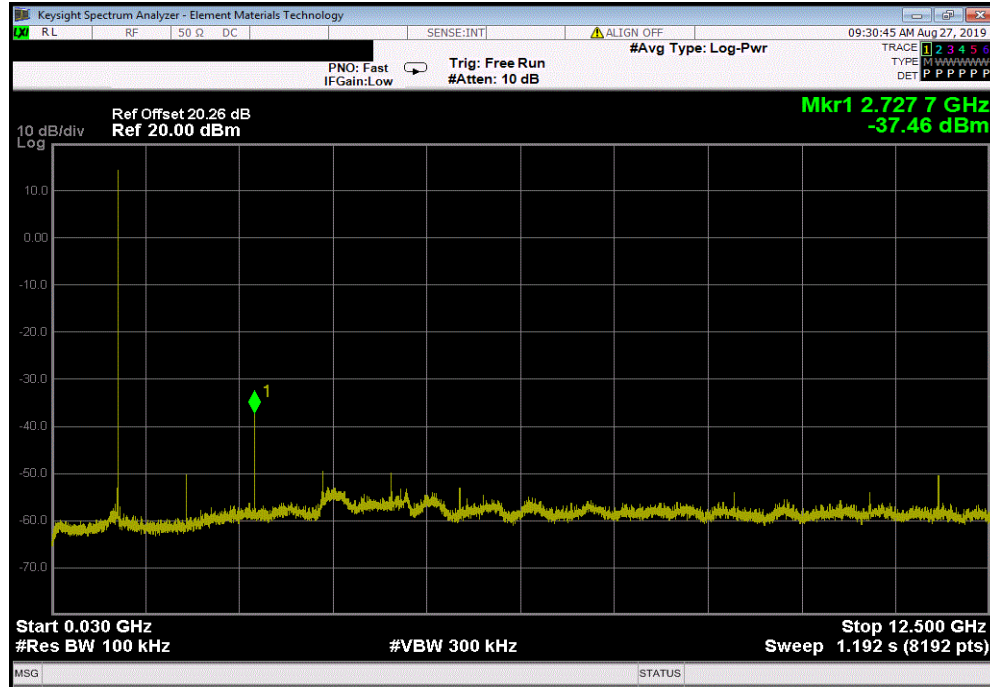


SPURIOUS CONDUCTED EMISSIONS

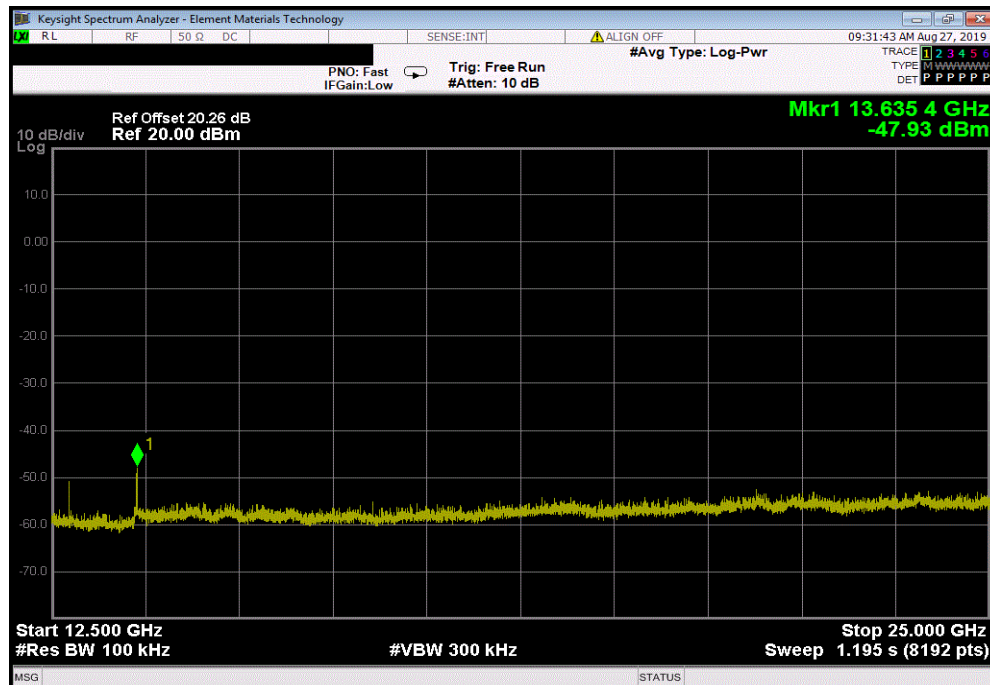


TMTx 2019.08.02 XMI 2019.06.11

Mid Channel, 909 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
30 MHz - 12.5 GHz	2727.7	-52	-30	Pass	



Mid Channel, 909 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
12.5 GHz - 25 GHz	13635.39	-62.47	-30	Pass	

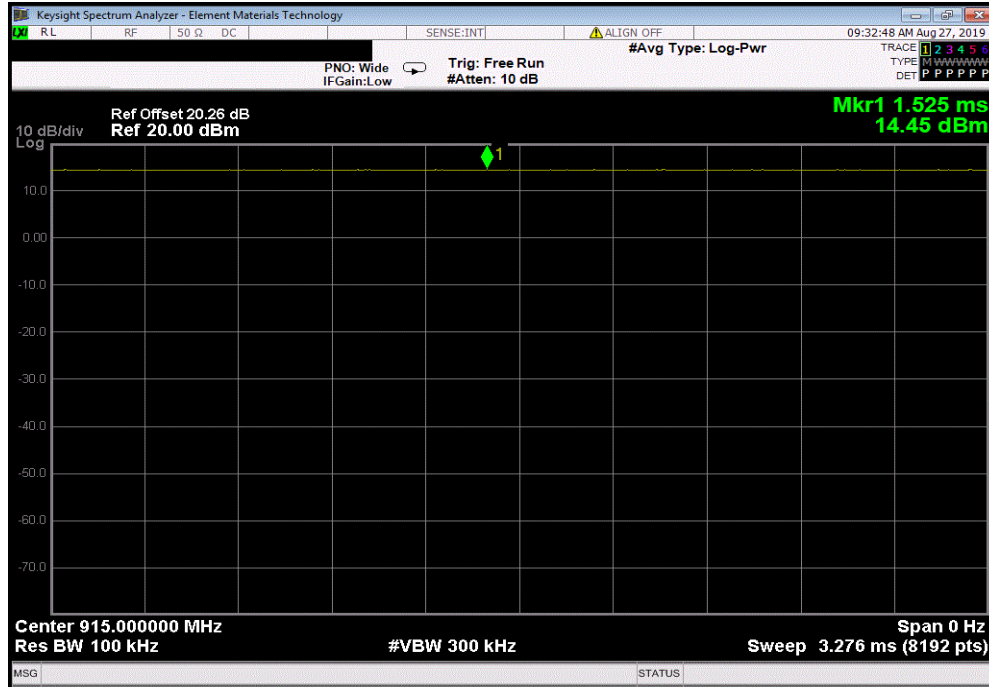


SPURIOUS CONDUCTED EMISSIONS

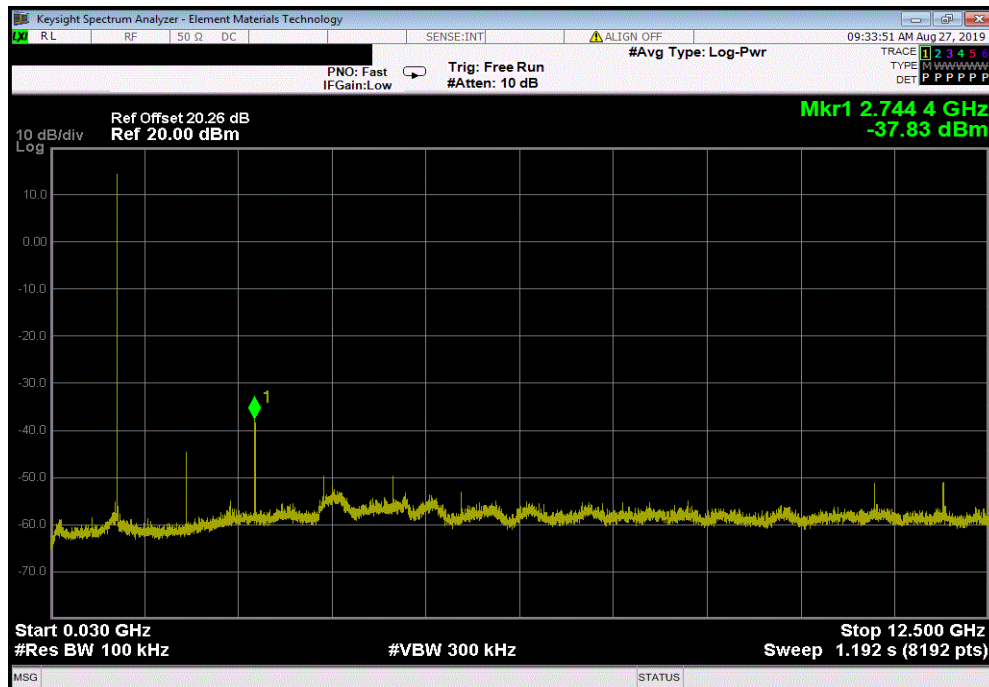


TMTx 2019.08.02 XMI 2019.06.11

High Channel, 915 MHz						
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result		
Fundamental	915	N/A	N/A	N/A		



High Channel, 915 MHz						
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result		
30 MHz - 12.5 GHz	2744.44	-52.29	-30	Pass		

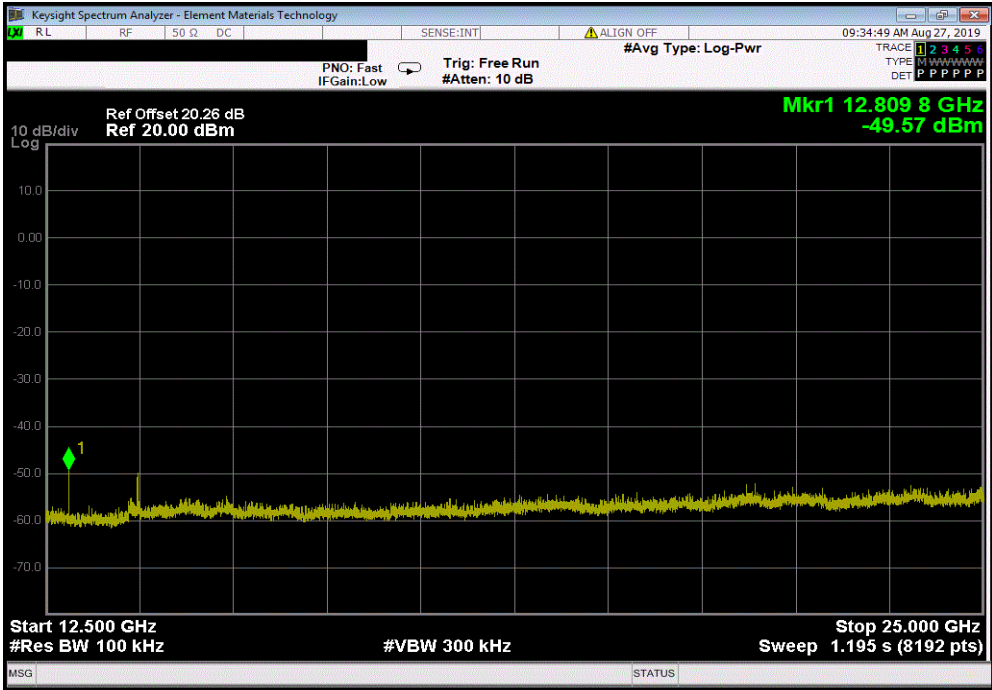


SPURIOUS CONDUCTED EMISSIONS



TMTx 2019.08.02 XMI 2019.06.11

High Channel, 915 MHz					
Frequency Range	Measured Freq (MHz)	Max Value (dBc)	Limit ≤ (dBc)	Result	
12.5 GHz - 25 GHz	12809.79	-64.03	-30	Pass	



POWER SPECTRAL DENSITY



XMIT 2019.05.15

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-506	TEW	2-May-18	2-May-21
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-19	19-Mar-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 AVGPDS-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



THxTx 2018.09.13 XMtM 2019.05.15

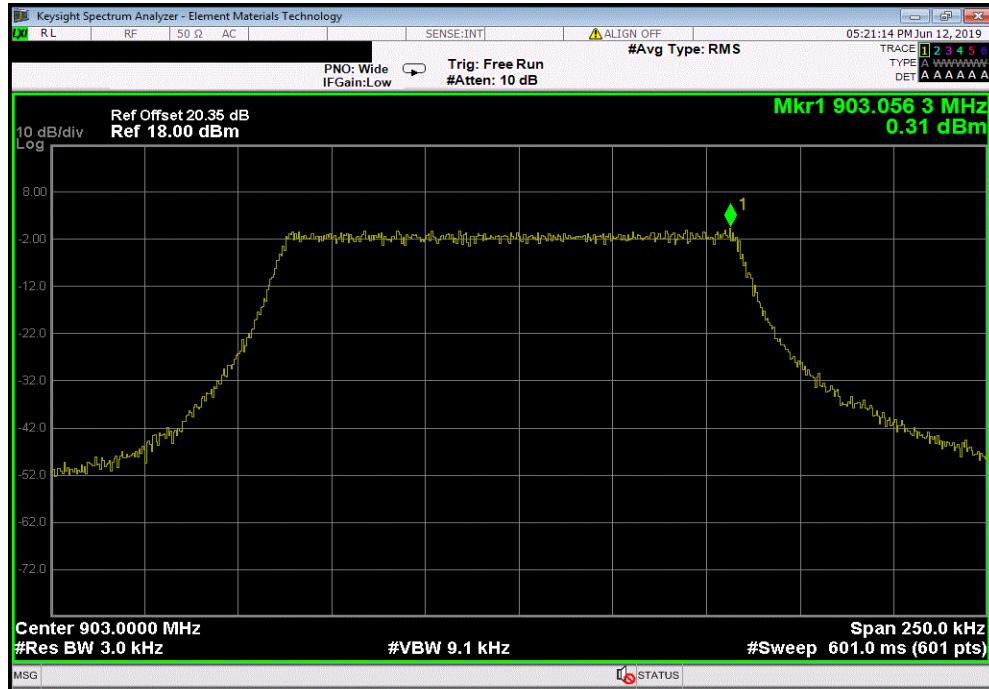
EUT: World IoT LoRa Module		Work Order: CRNE0015	
Serial Number: See Configuration		Date: 12-Jun-19	
Customer: Carnegie Technologies		Temperature: 22.1 °C	
Attendees: Joseph Haas		Humidity: 49.8% RH	
Project: None		Barometric Pres.: 1019 mbar	
Tested by: Jonathan Kiefer		Power: Battery	
		Job Site: TX09	
TEST SPECIFICATIONS		Test Method	
FCC 15.247:2019		ANSI C63.10:2013	
COMMENTS			
Ref Offset 20.35 dB (20 dB attenuator + DC Block + Cable). EUT has a PIFA antenna with a 2.0 dBi antenna gain.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Jonathan Kiefer</i>	
		Value dBm/3kHz	Limit < dBm/3kHz
Low Channel, 903 MHz		0.31	8
Mid Channel, 909 MHz		-0.136	8
High Channel, 915 MHz		0.073	8
			Results
			Pass
			Pass
			Pass

POWER SPECTRAL DENSITY

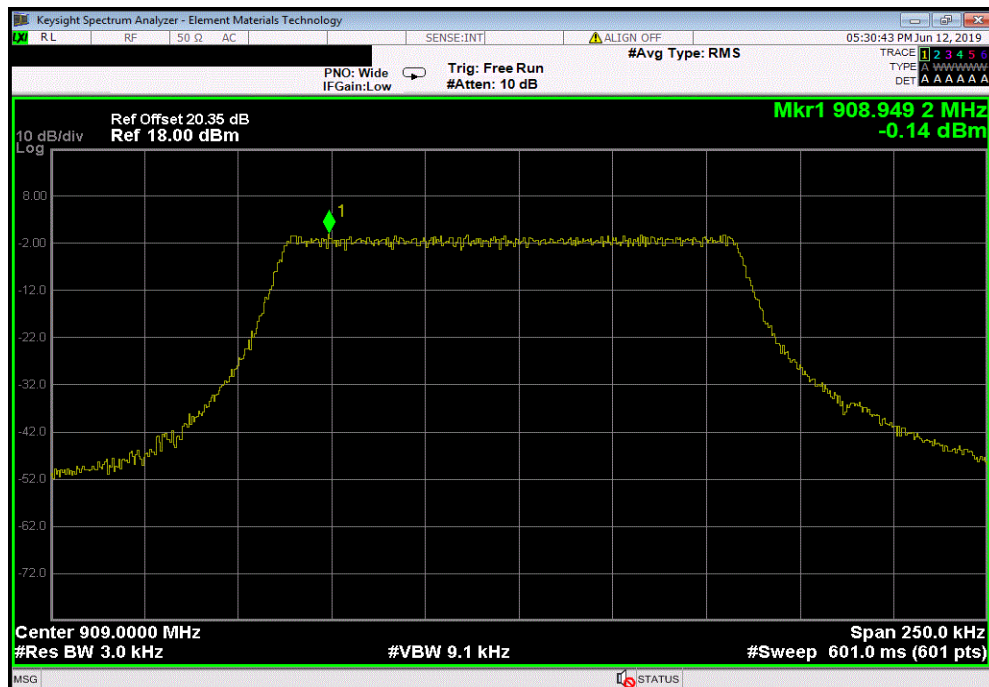


TMTx 2018.09.13 XMt 2019.05.15

Low Channel, 903 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				0.31	8	Pass



Mid Channel, 909 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				-0.136	8	Pass



POWER SPECTRAL DENSITY



TMTx 2018.09.13 XMt 2019.05.15

High Channel, 915 MHz						
				Value dBm/3kHz	Limit < dBm/3kHz	Results
				0.073	8	Pass

