

Test Report Prepared By:

Electronics Test Centre  
27 East Lake Hill  
Airdrie, Alberta  
Canada  
T4A 2K3

[sales@etc-mpbtech.com](mailto:sales@etc-mpbtech.com)  
<http://www.etc-mpb.com>

Telephone: 1-403-912-0037

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**EMC testing of the Tektelic Communication Inc. Breeze-V in accordance with  
FCC Part 15.247, and ANSI C63.10: 2013 as referenced by FCC OET KDB  
558074 D01 15.247 Measurement Guidance v05r02.**

**FCC ID: 2ALEPT0007805**

Test Personnel: Imran Akram, Janet Mijares, Branden Van Hee

Prepared for: Tektelic Communication Inc.

7657 10<sup>th</sup> Street NE  
Calgary, Alberta  
Canada  
T2E 8X2

Telephone: 1-403-338-6910



Imran Akram  
[iakram@etc-mpbtech.com](mailto:iakram@etc-mpbtech.com)  
EMC Technologist  
Electronics Test Centre (Airdrie)



Marc Rousseau  
[marc.rousseau@mpbc.ca](mailto:marc.rousseau@mpbc.ca)  
QA Manager  
Electronics Test Centre (Airdrie)

REVISION RECORD

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## TABLE OF CONTENTS

1.0	INTRODUCTION	5
1.1	Scope .....	5
1.2	Applicant .....	5
1.3	Test Sample Description.....	5
1.4	General Test Conditions .....	5
1.5	Reference Standards .....	6
1.6	Test Methodology.....	6
1.6.1	Variations in Test Methodology.....	6
1.6.2	Test Sample Verification, Configuration & Modifications .....	6
1.6.3	Uncertainty of Measurement:.....	6
2.0	TEST CONCLUSION	7
2.1	AC Power Line Conducted Emissions: Transmit Mode .....	8
2.2	Channel Occupied Bandwidth.....	9
2.2.1	Test Guidance: ANSI C63.10-2013, Clause 6.9.2 & 6.9.3/ FCC OET KDB 558074 9	
2.2.2	Deviations From The Standard: .....	9
2.2.3	Test Equipment.....	9
2.2.4	Test Sample Verification, Configuration & Modifications .....	10
2.2.5	Channel Occupied Bandwidth Data: .....	10
2.3	Max Average Output Power .....	12
2.3.1	Test Guidance: ANSI C63.10-2013, Clause 11.9.2.2.2 Clause 7.8.5 / FCC OET KDB 558074 .....	12
2.3.2	Deviations From The Standard: .....	12
2.3.3	Test Equipment.....	12
2.3.4	Test Sample Verification, Configuration & Modifications .....	13
2.3.5	Max Average Output Power Data .....	13
2.4	Power Spectral Density.....	16
2.4.1	Test Guidance: ANSI C63.10-2013, Clause 11.10.3 / FCC OET KDB 558074 16	
2.4.2	Deviations From The Standard: .....	16
2.4.3	Test Equipment.....	16
2.4.4	Test Sample Verification, Configuration & Modifications .....	17
2.4.5	Average PSD Data.....	17
2.5	Band Edge Attenuation .....	19
2.5.1	Test Guidance: ANSI C63.10-2013 Clause 6.10.4 & 7.8.6, 6.10.6 / FCC OET KDB 558074.....	19
2.5.2	Deviations From The Standard: .....	20
2.5.3	Test Equipment.....	20
2.5.4	Test Sample Verification, Configuration & Modifications .....	20
2.5.5	Band Edge Data.....	20
2.6	Conducted Spurious Emissions (Non- Restricted Band) .....	23
2.6.1	Test Guidance: ANSI C63.10-2013, Clause 6.7, 7.8.8 / 558074 D01 15.247 Measurement Guidance v05r02.....	23
2.6.2	Deviations From The Standard: .....	23
2.6.3	Test Equipment.....	24
2.6.4	Test Sample Verification, Configuration & Modifications .....	24
2.6.5	Conducted Emissions Data:.....	24

2.7	Channel Separation (Hybrid Mode).....	28
2.7.1	Test Guidance: ANSI 63.10 Clause 7.8.2 / 558074 D01 15.247 Measurement Guidance v05r02.....	28
2.7.2	Deviations From The Standard:.....	28
2.7.3	Test Equipment.....	28
2.7.4	Test Sample Verification, Configuration & Modifications .....	28
2.7.5	Channel Separation Data:.....	29
2.8	Time of Occupancy (Hybrid Mode) .....	30
2.8.1	Test Guidance: ANSI 63.10 Clause 7.8.4 / 558074 D01 15.247 Measurement Guidance v05r02.....	30
2.8.2	Deviations From The Standard:.....	30
2.8.3	Test Equipment.....	30
2.8.4	Test Sample Verification, Configuration & Modifications .....	30
2.8.5	Dwell Time Data:.....	31
2.9	EUT Positioning Assessment.....	32
2.10	Radiated Spurious Emissions (Restricted Band) .....	33
2.8.1	Test Guidance: ANSI C63.10-2013, Clause 13.4.2 .....	34
2.8.2	Deviations From The Standard:.....	34
2.8.3	Test Equipment.....	34
2.8.4	Test Sample Verification, Configuration & Modifications .....	35
2.8.5	Radiated Emissions Data:.....	36
2.11	RF Exposure .....	40
3.0	TEST FACILITY .....	41
3.1	Location.....	41
3.2	Grounding Plan .....	41
3.3	Power Supply .....	41
	Appendix A – Test Setup Block Diagram .....	42

## **1.0 INTRODUCTION**

### **1.1 Scope**

The purpose of this report is to present the results of compliance testing performed in accordance with FCC Part 15.247 and ANSI C63.10-2013 to gain FCC Certification Authorization for Low-Power License-Exempt transmitters. All test procedures, limits, criteria, and results described in this report apply only to the Tektelic Communication Inc. Breeze-V test sample, referred to herein as the EUT (Equipment Under Test).

This report does not imply product endorsement by the Electronics Test Centre, A2LA, nor any Canadian Government agency.

### **1.2 Applicant**

This test report has been prepared for Tektelic Communication Inc., located in Calgary, Alberta, Canada.

### **1.3 Test Sample Description**

As provided to ETC (Airdrie) by Tektelic Communication Inc.:

<b>Product Name:</b>			Breeze-V
<b>Lora Radio</b>	<b>Frequency Range</b>		902.3 – 914.9 MHz
	<b>Type of Modulation</b>		LoRa 125KHz DSS
	<b>Associated Antennas</b>	<b>LoRa</b>	Ignion (Fractus Antennas S.L), RUN mXTENDTM (NN02-224) Peak Gain = 2.1 dBi, Chip Antenna
<b>Model# / Serial#</b>			T0007806 / 2210K0004
<b>Variant Name / Model#</b>			Breeze / T0007838, Vivid+ / T0007848
<b>Power supply:</b>			Battery Powered

This Breeze-V model contains all of the equipment options in this family of products. This model represents model number Breeze (T0007838) and Vivid+ (T0007848). This model was chosen as a worst-case condition for emission testing. Both T0007806/2210K0004 and T0007806/2210K0003 (Crystal/TCXO) tested for emission profile and found no difference in emission.

Detail differences between the models are given in family exhibit.

### **1.4 General Test Conditions**

The EUT was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. All inputs and outputs to and from other equipment associated with the EUT were adequately simulated.

Where relevant, the EUT was only tested using the monitoring methods and test criteria defined in this report.

The environmental conditions are recorded during each test, and are reported in the relevant sections of this document.

## 1.5 Reference Standards

Standards	Description
FCC, title 47 CFR § 15.247	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
FCC, title 47 CFR § 15.207	General Requirements for Compliance of Radio Apparatus
FCC, title 47 CFR § 15.209	Intentional radiator, conducted emission limits
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.10-2014	American National Standard for Methods of Measurement of Radio – Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 KHz to 40 GHz
558074 D01 15.247 Meas Guidance v05r02	Guidance For Compliance Measurements On Digital Transmission System, Frequency Hopping Spread Spectrum System, And Hybrid System Devices Operating Under Section 15.247 Of The FCC Rules

## 1.6 Test Methodology

Test methods are specified in the Basic Standard as referenced and/or modified by the Product Standard in the part of Section 2 of this report associated with each particular test case. Separate test report is provided to customer for RX mode under SDOC.

### 1.6.1 Variations in Test Methodology

Any variance in methodology or deviation from the reference Standard is documented in the part of Section 2 of this report associated with each particular Test Case.

### 1.6.2 Test Sample Verification, Configuration & Modifications

EUT setup, configuration, protocols for operation and monitoring of EUT functions, and any modifications performed in order to meet the requirements, are detailed in each Test Case of Section 2 of this report.

### 1.6.3 Uncertainty of Measurement:

The factors contributing to measurement uncertainty are identified and calculated in accordance with CISPR 16-4-2: 2011.

This uncertainty estimate represents an expended uncertainty expressed at approximately 95% confidence using a coverage factor of  $k = 2$ .

Test Method	Uncertainty
Radiated Emissions Level (9 KHz – 1 GHz)	±5.8 dB
Radiated Emissions Level (1 GHz – 18 GHz)	±4.9 dB
Radiated Emissions Level (18 GHz – 26.5 GHz)	±5.0 dB
Conducted Emissions Level (150 KHz – 30 MHz)	±3.0 dB
Uncertainty Conducted Power level	±0.5 dB
Uncertainty Conducted Spurious emission level	±0.6 dB
Uncertainty for Bandwidth test	±1.5 %

## 2.0 TEST CONCLUSION

### STATEMENT OF COMPLIANCE

The customer equipment referred to in this report was found to comply with the requirements, as summarized below.

The EUT was subjected to the following tests. Compliance status is reported as **Compliant** or **Non-compliant**. **N/A** indicates the test was Not Applicable to the EUT.

The measurement uncertainty is not accounted for determination of the statement of compliance. The statement of compliance is based only on the measurement value recorded.

**Note:** Maintenance of compliance is the responsibility of the Manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the EUT with respect to the standards detailed in this test report.

The following table summarizes the tests performed in terms of the specification, class or performance criterion applied, and the EUT modification state.

Test Case	Test Type	Specification	Test Sample	Mod.	Config.	Result
2.1	AC Conducted Emissions	15.207	Breeze-V	none	see § 2.1	Compliant
2.2	Occupied Bandwidth	15.247(a)(1) 15.247(2)(2)	Breeze-V	none	see § 2.2	Compliant
2.3	Max Output average Power Conducted	15.247(b)	Breeze-V	none	see § 2.3	Compliant
2.4	Power Spectral Density	15.247(e) 15.247(f)	Breeze-V	none	see § 2.4	Compliant
2.5	Band Edge	15.247(d)	Breeze-V	none	see § 2.5	Compliant
2.6	Conducted Spurious Emission (Non-Restricted Band Operation)	15.247(d)	Breeze-V	none	see § 2.6	Compliant
2.7	Minimum channel separation	15.247(a)(1)	Breeze-V	none	see § 2.7	Compliant
2.8	Average time of Occupancy for hybrid System	15.247(f)	Breeze-V	none	see § 2.8	Compliant
2.9	EUT Position	ANSI C63.4	Breeze-V	-	see § 2.9	assed
2.10	Radiated Spurious Emission (Restricted Band Operation)	15.205, 15.209 15.247(d)	Breeze-V	none	see § 2.10	Compliant
2.11	RF Exposure	15.247(i)	Breeze-V	none	see § 2.11	Compliant

Refer to the test data for applicable test conditions.

## 2.1 AC Power Line Conducted Emissions: Transmit Mode

Test Lab: Electronics Test Centre, Airdrie	EUT: Breeze-V
Test Personnel:	Standard: FCC Part 15.207
Date:	Basic Standard: ANSI C63.10: 2013
<b>EUT status: N/A</b>	
<b>Comments:</b> EUT is internal Battery Powered. No Direct or indirect Connection to AC main.	



## 2.2 Channel Occupied Bandwidth

Test Lab: Electronics Test Centre, Airdrie	EUT: Breeze-V
Test Personnel: Imran Akram	Standard: FCC PART 15.247
Date: 2022-03-08 (20.7°C, 14.2% RH)	Basic Standard: ANSI C63.10-2013 FCC OET KDB 558074
<b>EUT status: Compliant</b>	

### Specification: FCC Part 15.247 (a, 2), FCC 15.215 (c)

**Criteria:** There is no requirement for this type of hybrid system to comply with the 500 kHz minimum bandwidth normally associated with a DTS transmission.

### 2.2.1 Test Guidance: ANSI C63.10-2013, Clause 6.9.2 & 6.9.3/ FCC OET KDB 558074

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Use the following spectrum analyzer setting:	
Span	Between two time and five times the channel center frequency OBW
RBW	1% to 5% of the OBW
VBW	Approximately three times of RBW
Sweep	Auto Couple
Detector Function	Peak
Trace	Max Hold
Allow the trace to stabilize. The automated 99% BW function of the spectrum analyzer is engaged, 20dB bandwidth is measured with the X dB function.	

### 2.2.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

### 2.2.3 Test Equipment

Testing was performed with the following equipment:

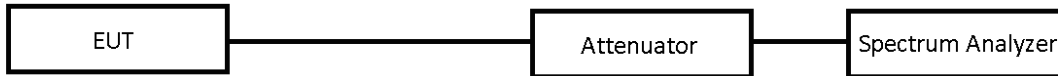
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
MXE EMI Receiver	Agilent	N9010A FW A.25.05	6130	2021-06-18	2022-06-18
Temp/Humidity	Extech	42270	5892	2021-04-05	2022-04-15
Attenuator	Mini-Circuits®	BWS102W263	6932	Cal. before each use	
Coaxial Cables (RF)	Huber+Suhner	Enviroflex 400	-	Cal. before each use	

## 2.2.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagrams for Occupied Bandwidth testing:

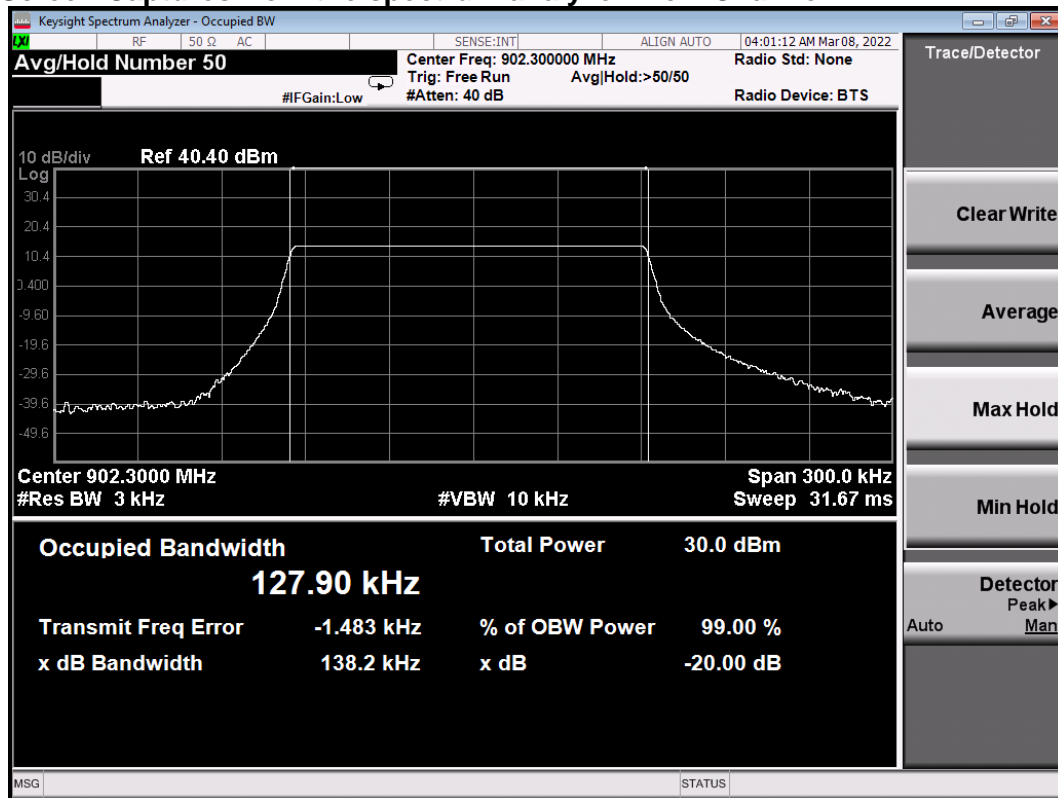
Conducted:



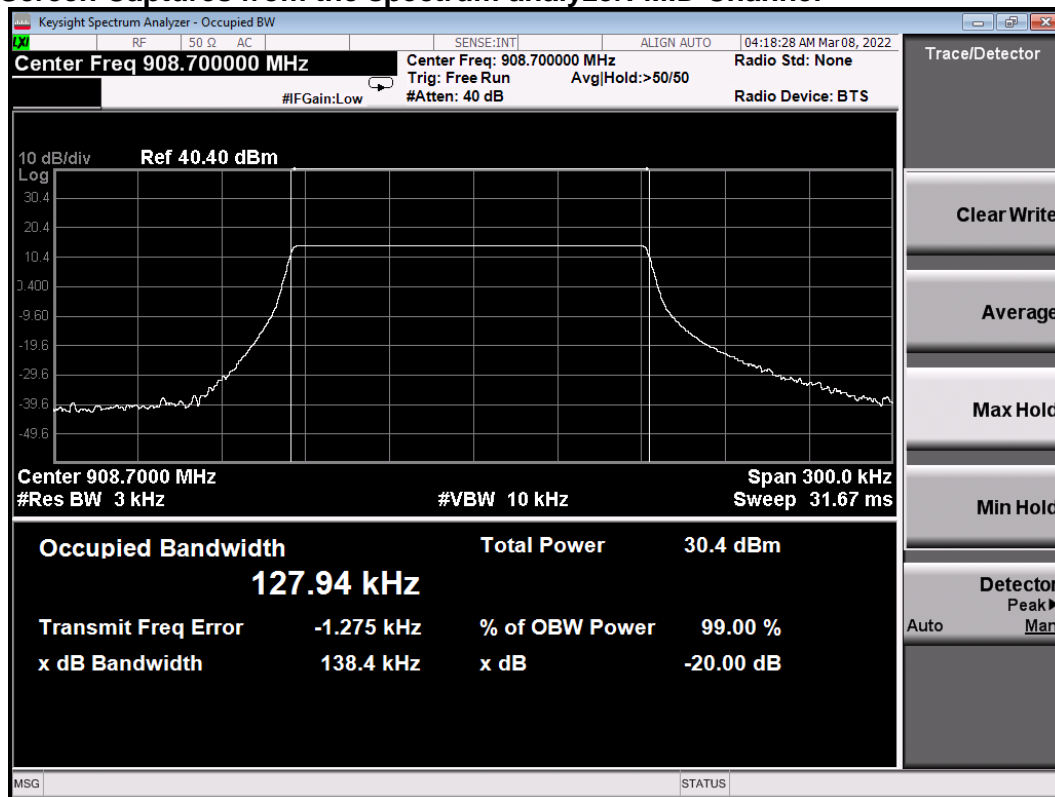
## 2.2.5 Channel Occupied Bandwidth Data:

Mode of operation	Channel	Freq. [MHz]	20 dB OBW [kHz]	99% OBW [KHz]
LoRa 125KHz	Low	902.3	138.2	127.90
	Mid	908.7	138.4	127.94
	High	914.9	138.4	127.95

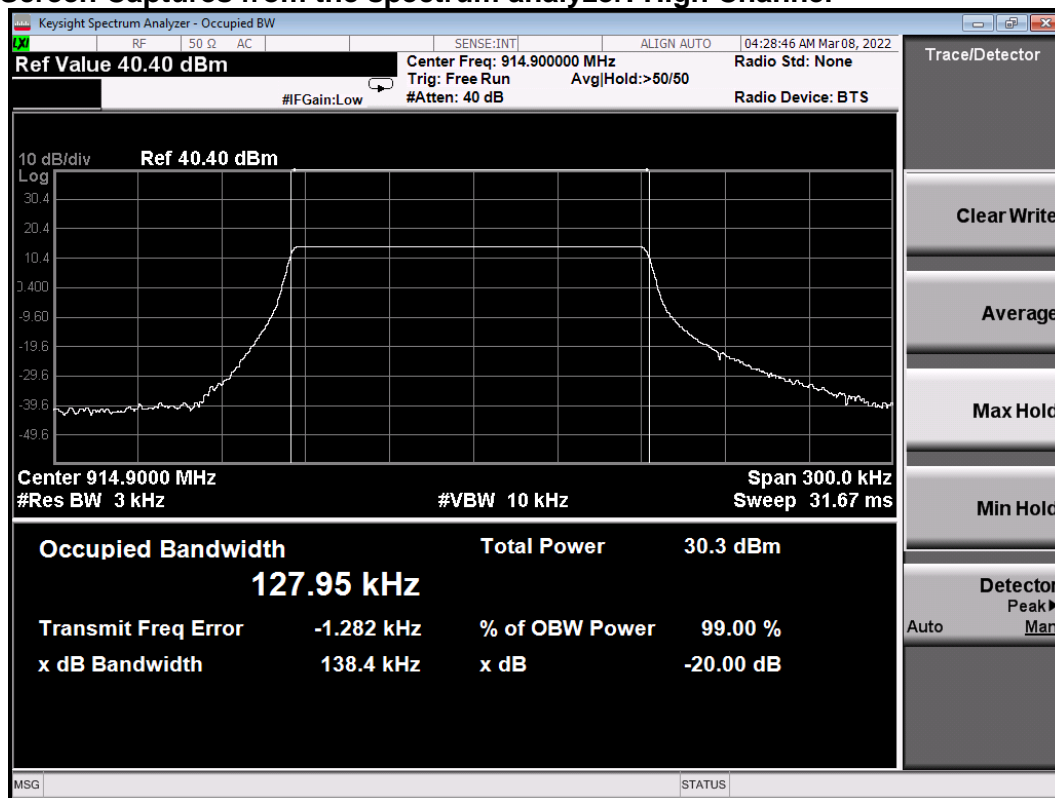
### Screen Captures from the spectrum analyzer: Low Channel



### Screen Captures from the spectrum analyzer: MID Channel



### Screen Captures from the spectrum analyzer: High Channel



## 2.3 Max Average Output Power

Test Lab: Electronics Test Centre, Airdrie	EUT: Breeze-V
Test Personnel: : Imran Akram	Standard: FCC PART 15.247
Date: 2022-03-08 (20.7°C,14.2% RH)	Basic Standard: ANSI C63.10: 2013 FCC OET KDB 558074
EUT status: Compliant	

### Specification: FCC Part 15.247

**Criteria** For systems using digital modulation / hybrid in the 902-928 MHz bands: 1 Watt.

### 2.3.1 Test Guidance: ANSI C63.10-2013, Clause 11.9.2.2.2 Clause 7.8.5 / FCC OET KDB 558074

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

### 2.3.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

### 2.3.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
MXE EMI Receiver	Agilent	N9010A FW A.25.05	6130	2021-06-18	2022-06-18
Temp/Humidity	Extech	42270	5892	2021-04-05	2022-04-15
Attenuator	Mini-Circuits®	BWS102W263	6932	Cal. before each use	
Coaxial Cables (RF)	Huber+Suhner	Enviroflex 400	-	Cal. before each use	

### 2.3.4 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

Test setup diagrams for Peak Power testing:

Conducted:

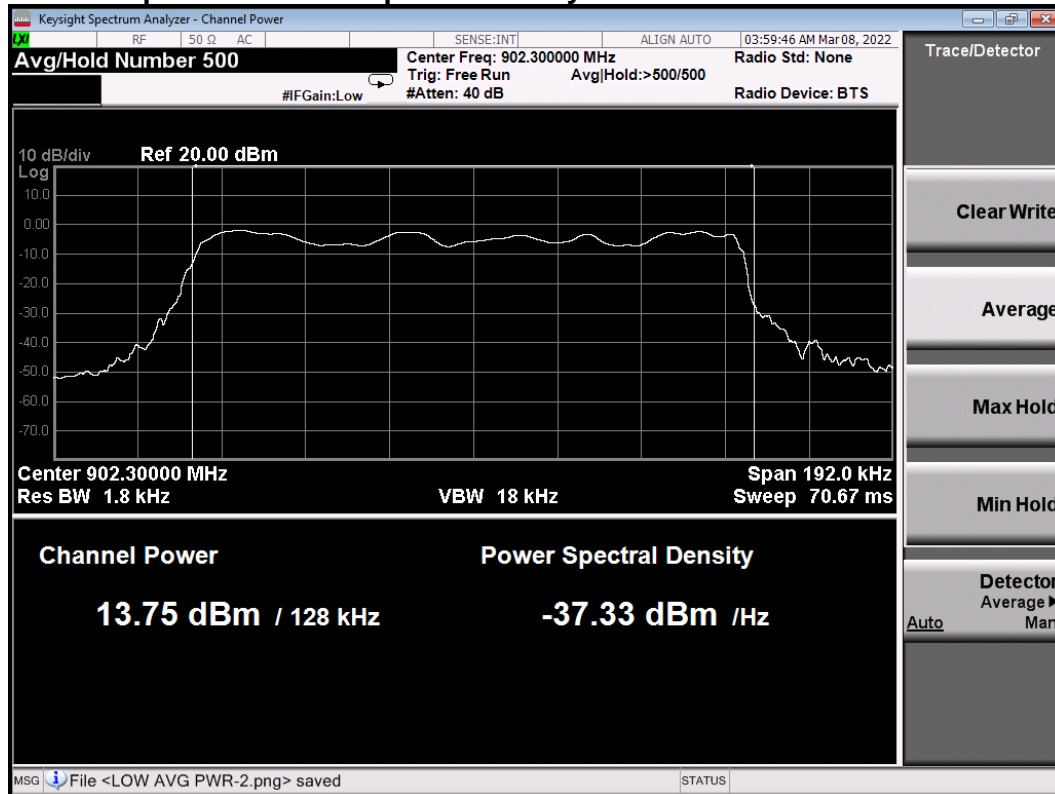


### 2.3.5 Max Average Output Power Data

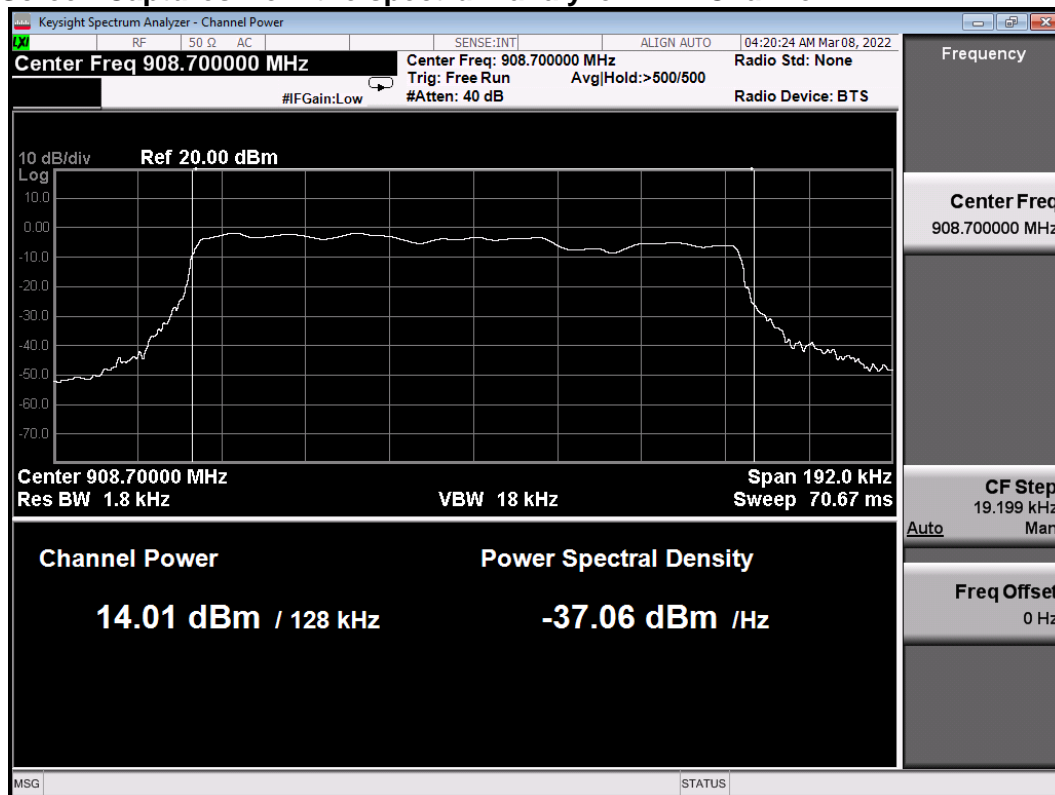
Mode of Operation	Channel	Freq. [MHz]	Out Put Power (dBm)	Out Put Power Limit (dBm)
LoRa 500 KHz	Low	902.3	13.75	30
	Mid	908.7	14.01	30
	High	914.9	14.62	30

Output Power Method AVGSA-1 For DTS	
Span	$\geq 1.5$ times the OBW
RBW	1 – 5 % of the OBW, $\leq 1$ MHz
VBW	$\geq 3 \times$ RBW
Number of Points in sweep	$\geq 2 \times$ Span / RBW
Sweep time	Auto Couple
Detector	RMS (Power Averaging)
Sweep trigger	Free Run (Duty Cycle $\geq 98\%$ )
Trace Average	Minimum 100 traces in power Averaging (RMS)
Power measured	Integrated the spectrum across the OBW of the signal using the S/A band power measurement function, with band limit set equal to the OBW band edge.

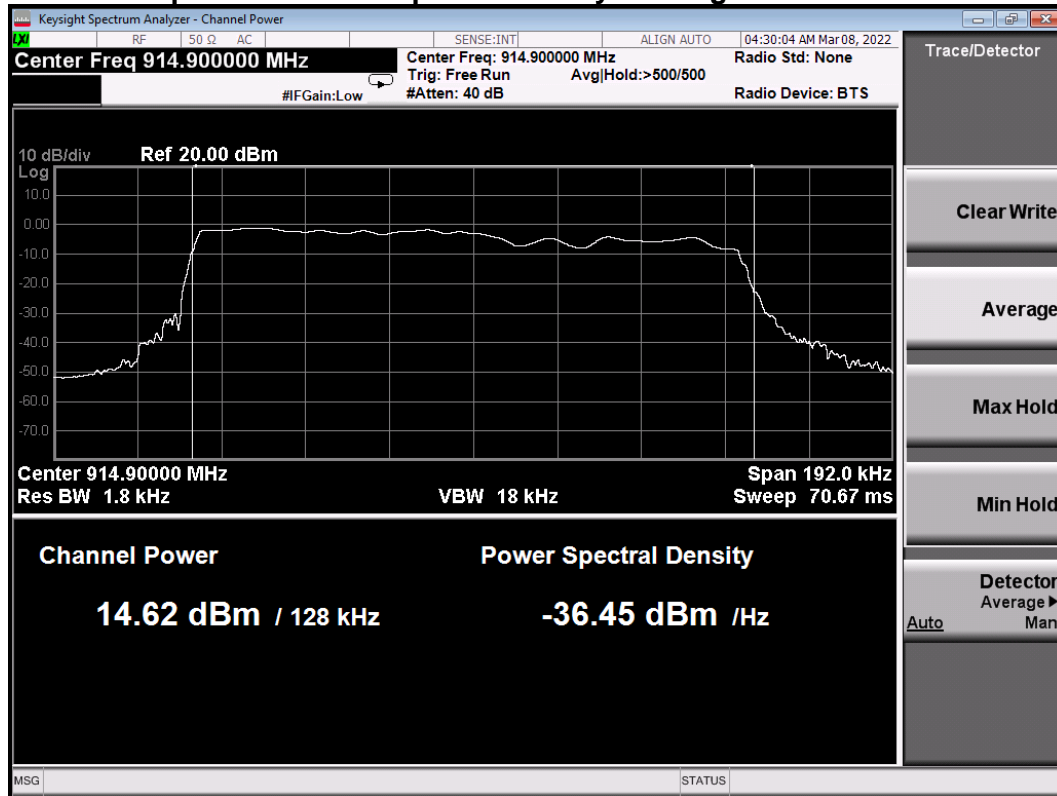
## Screen Captures from the spectrum analyzer Low Channel



## Screen Captures from the spectrum analyzer: MID Channel



## Screen Captures from the spectrum analyzer: High Channel



## 2.4 Power Spectral Density

Test Lab: Electronics Test Centre, Airdrie

EUT: Breeze-V

Test Personnel: : Imran Akram

Standard: FCC PART 15.247

Basic Standard: ANSI C63.10: 2013

Date: 2022-03-08 (20.7°C,14.2% RH)

**EUT status: Compliant**

### Specification: FCC Part 15.247(f)

**Criteria** The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

#### 2.4.1 Test Guidance: ANSI C63.10-2013, Clause 11.10.3 / FCC OET KDB 558074

This measurement is performed at low, mid and high frequencies, in continuous transmission, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

#### Use the following Spectrum Analyzer settings

Span	At least 1.5 times the OBW of channel center Frequency
RBW	3 KHz
VBW	$\geq 3 \times \text{VBW}$
Sweep	Auto Couple
Detector Function	Power averaging (RMS) or Sample detector (when RMS not available.
Trace	Employ trace average (rms) mode over a minimum of 100 traces.
Ensure that the number of measurement points in the sweep $\geq [2 \times \text{span} / \text{RBW}]$ . Allow the trace to stabilize. Use the peak marker function to determine the maximum amplitude level.	

#### 2.4.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

#### 2.4.3 Test Equipment

Testing was performed with this equipment:

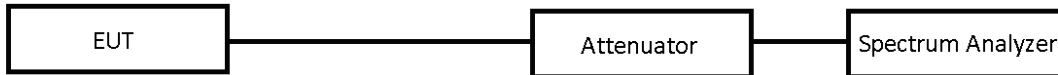
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
MXE EMI Receiver	Agilent	N9010A FW A.25.05	6130	2021-06-18	2022-06-18
Temp/Humidity	Extech	42270	5892	2021-04-05	2022-04-15
Attenuator	Mini-Circuits®	BWS102W263	6932	Cal. before each use	
Coaxial Cables (RF)	Huber+Suhner	Enviroflex 400	-	Cal. before each use	



#### 2.4.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

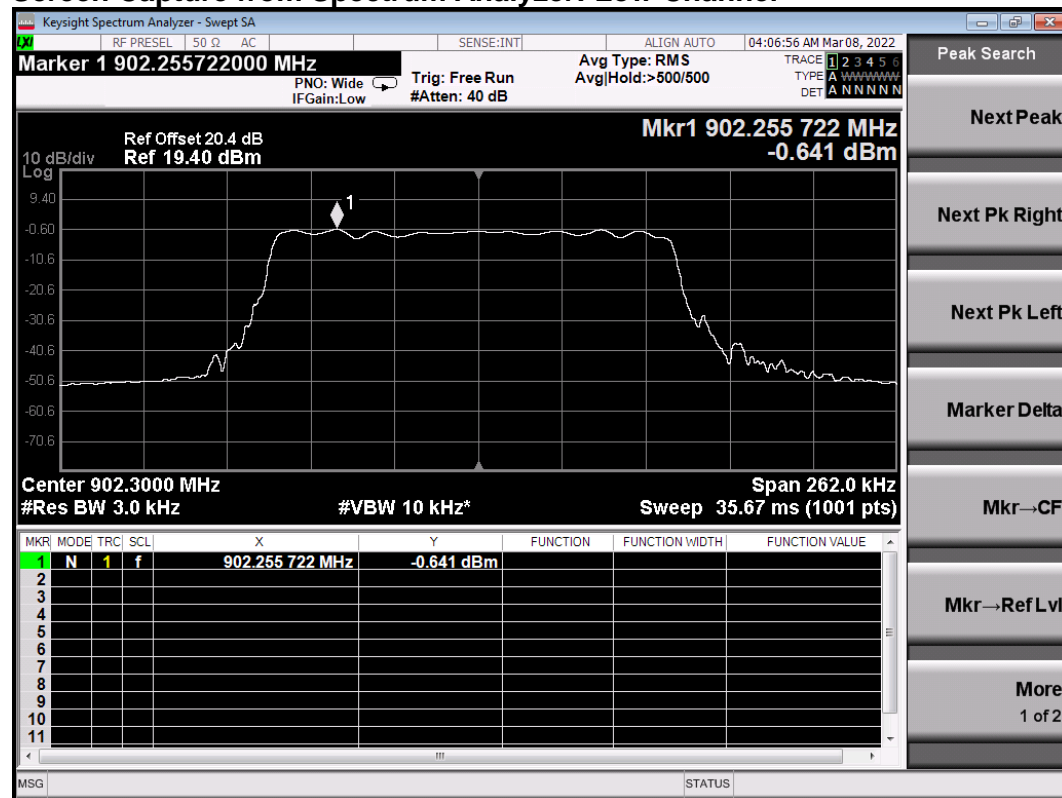
Test setup diagrams for Peak Power Spectral Density testing:  
Conducted:



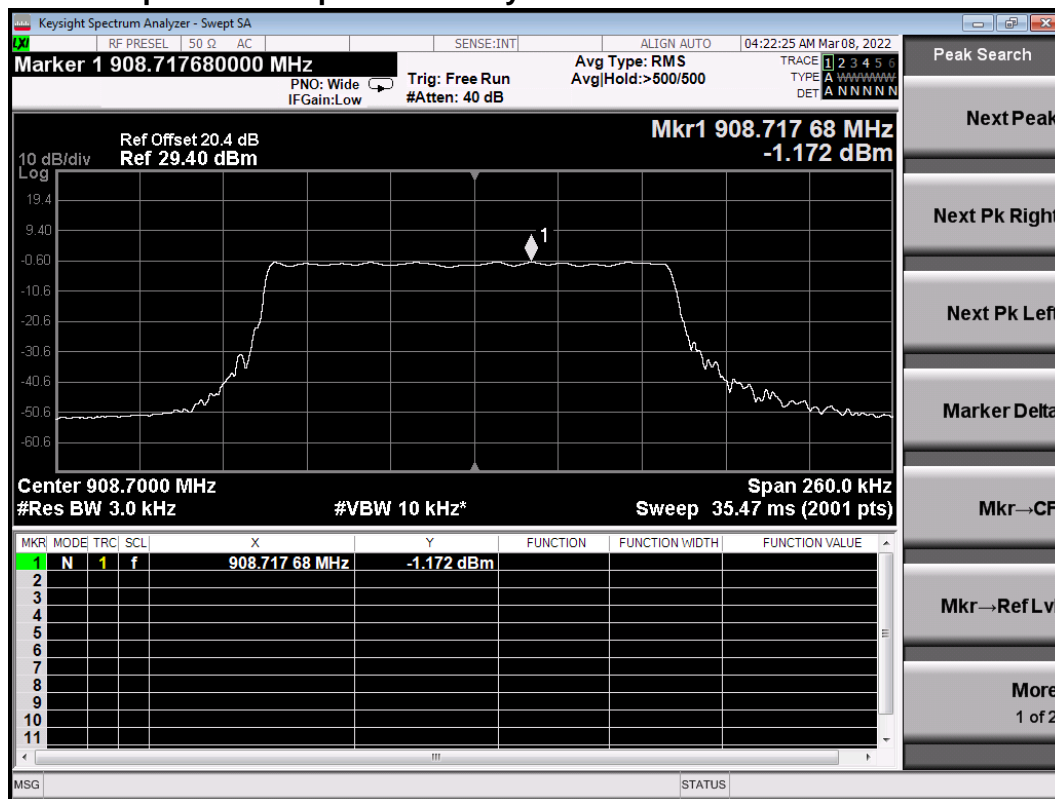
#### 2.4.5 Average PSD Data

Mode of operation	Channel	Freq. [MHz]	PSD (dBm)	PSD Limit (dBm)
LoRa 125 KHz	Low	902.3	-0.641	8
	Mid	908.7	-1.172	8
	High	914.9	-0.657	8

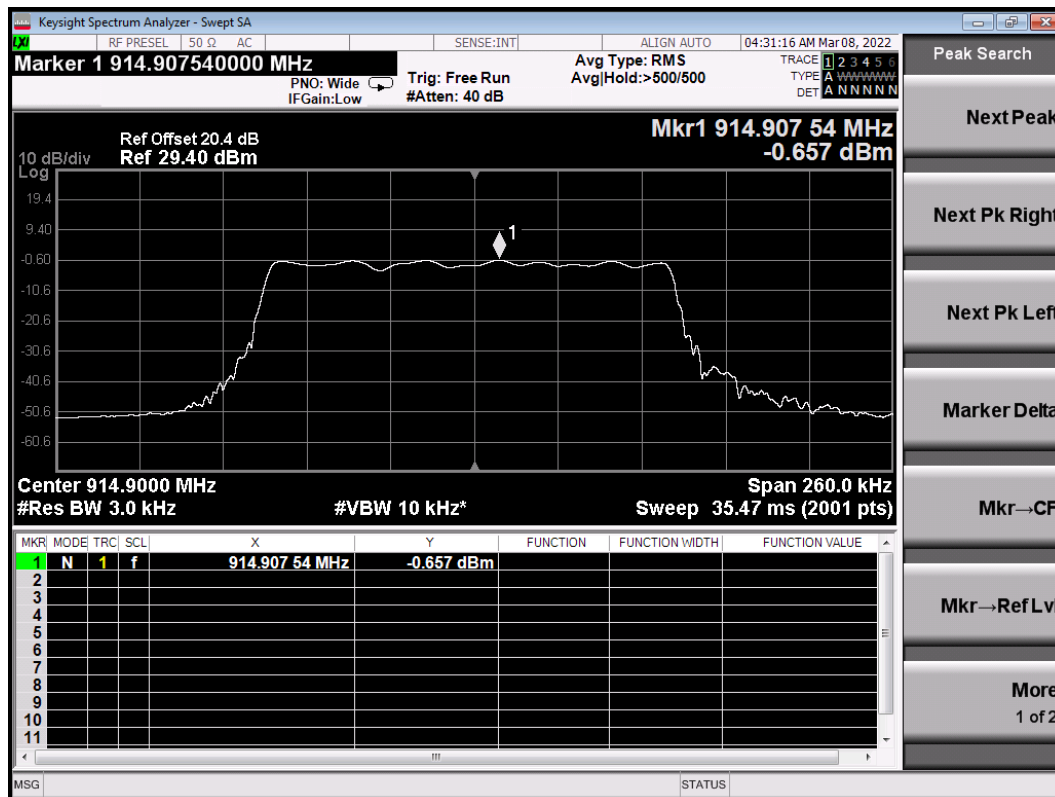
#### Screen Capture from Spectrum Analyzer: Low Channel



### Screen Capture from Spectrum Analyzer: MID Channel



### Screen Capture from Spectrum Analyzer: High Channel



## 2.5 Band Edge Attenuation

Test Lab: Electronics Test Centre, Airdrie

EUT: Breeze-V

Test Personnel: Imran Akram

Standard: FCC PART 15.247

Basic Standard: ANSI C63.10: 2013

Date: 2022-03-08 (20.7°C, 14.2% RH)

**EUT status: Compliant**

### Specification: FCC Part 15.247(d)

**Criteria:** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### 2.5.1 Test Guidance: ANSI C63.10-2013 Clause 6.10.4 & 7.8.6, 6.10.6 / FCC OET KDB 558074

This measurement is performed at the low and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

#### Use the following spectrum analyzer settings:

Span	Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
Attenuation	Auto (at least 10 dB preferred).
RBW	100 kHz
VBW	300 kHz
Sweep	Coupled
Detector function	peak
Trace	max hold
Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.	

## 2.5.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

## 2.5.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
MXE EMI Receiver	Agilent	N9010A FW A.25.05	6130	2021-06-18	2022-06-18
Temp/Humidity	Extech	42270	5892	2021-04-05	2022-04-15
Attenuator	Mini-Circuits®	BWS102W263	6932	Cal. before each use	
Coaxial Cables (RF)	Huber+Suhner	Enviroflex 400	-	Cal. before each use	

## 2.5.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

### Test setup diagrams for Band Edge Attenuation testing:

Conducted:

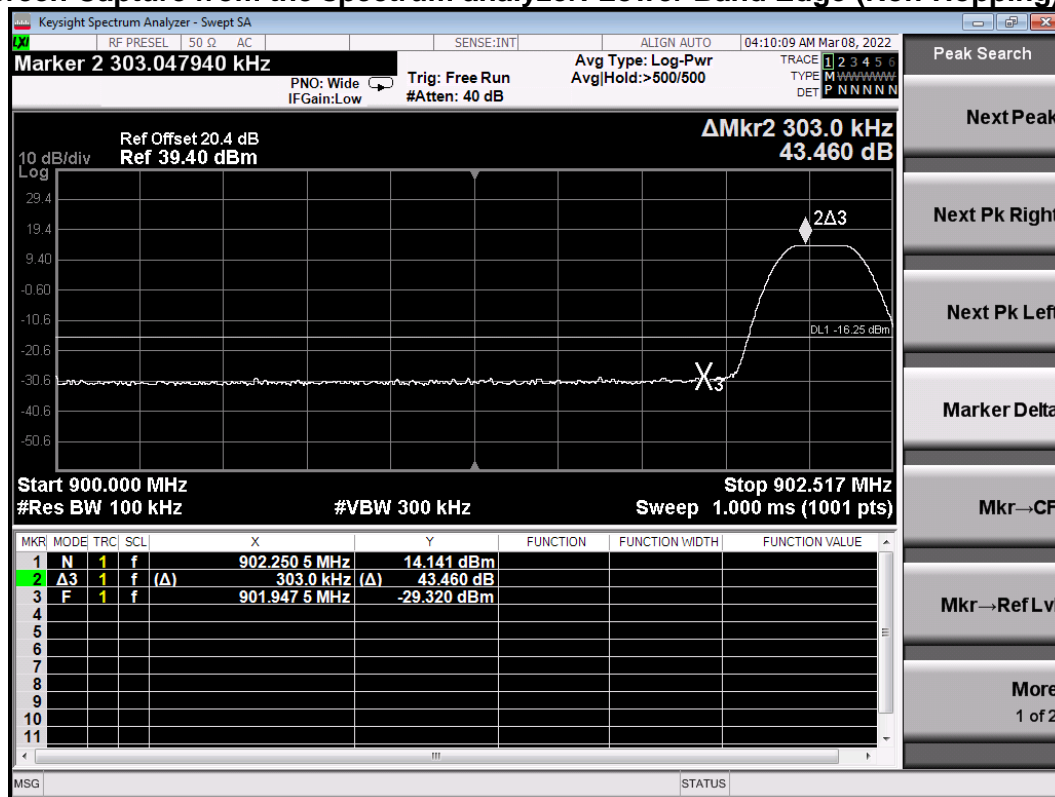


## 2.5.5 Band Edge Data

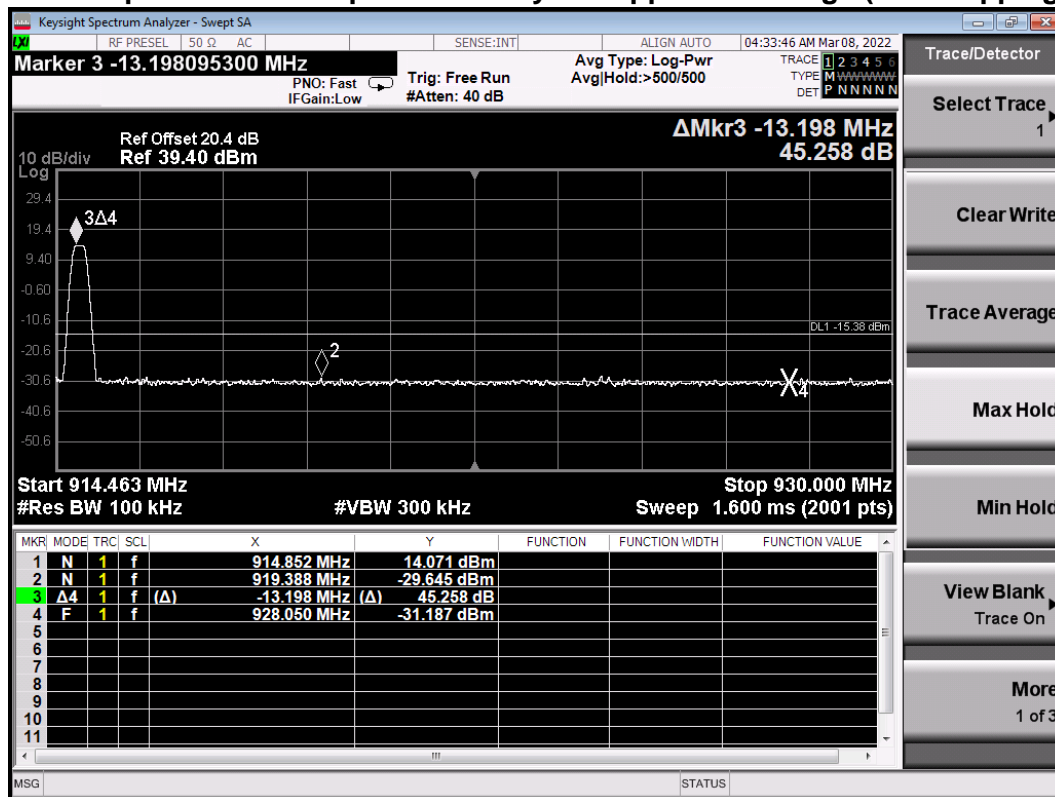
### Worse Case Data

Mode of operation	Channel	Attenuation at Band Edge	Attenuation Limit at Band Edge
Lora 125KHz (Non-Hopping)	902.3	43.460 dBc	30 dBc
	914.9	45.258 dBc	30 dBc
Lora 125KHz (Hopping)	902.3	52.188 dBc	30 dBc
	914.9	54.236 dBc	30 dBc

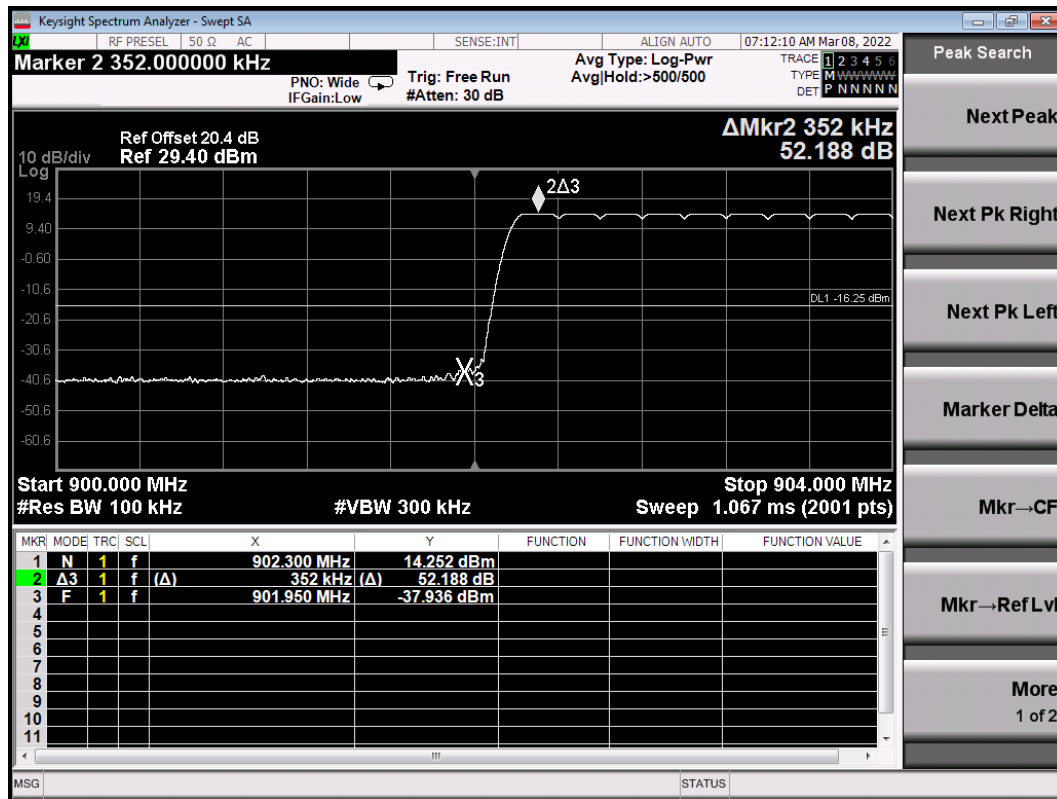
## Screen Capture from the spectrum analyzer: Lower Band Edge (Non-Hopping)



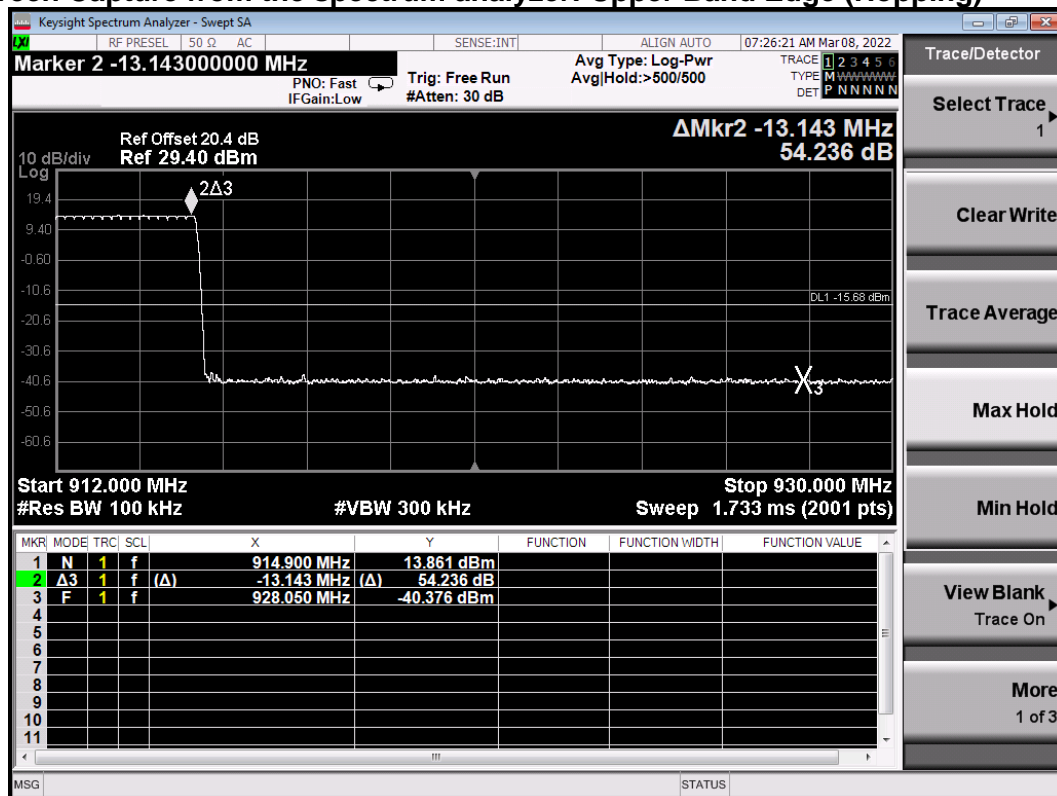
## Screen Capture from the spectrum analyzer: Upper Band Edge (Non-Hopping)



## Screen Capture from the spectrum analyzer: Lower Band Edge (Hopping)



## Screen Capture from the spectrum analyzer: Upper Band Edge (Hopping)



## 2.6 Conducted Spurious Emissions (Non- Restricted Band)

Test Lab: Electronics Test Centre, Airdrie	EUT: Breeze-V
Test Personnel: Imran Akram	Standard: FCC PART 15.247
Date: 2022-03-08 (20.7°C,14.2% RH)	Basic Standard: ANSI C63.4-2014 FCC OET KDB 558470 v04 DTS

**EUT status: Compliant**

### Specification: FCC Part 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

#### 2.6.1 Test Guidance: ANSI C63.10-2013, Clause 6.7, 7.8.8 / 558074 D01 15.247 Measurement Guidance v05r02

This measurement is performed at the low, mid and high frequencies, with modulation. The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Use the following spectrum analyzer settings:

Span	Set the center frequency and span to encompass frequency range to be measured.
RBW	100 kHz
VBW	300 kHz
Sweep	Auto Coupled
Detector function	peak
Trace	max hold

Allow the trace to stabilize. Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified in

#### 2.6.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

### 2.6.3 Test Equipment

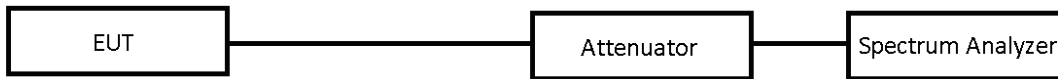
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
MXE EMI Receiver	Agilent	N9010A FW A.25.05	6130	2021-06-18	2022-06-18
Temp/Humidity	Extech	42270	5892	2021-04-05	2022-04-15
Attenuator	Mini-Circuits®	BWS102W263	6932	Cal. before each use	
Coaxial Cables (RF)	Huber+Suhner	Enviroflex 400	-	Cal. before each use	

### 2.6.4 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

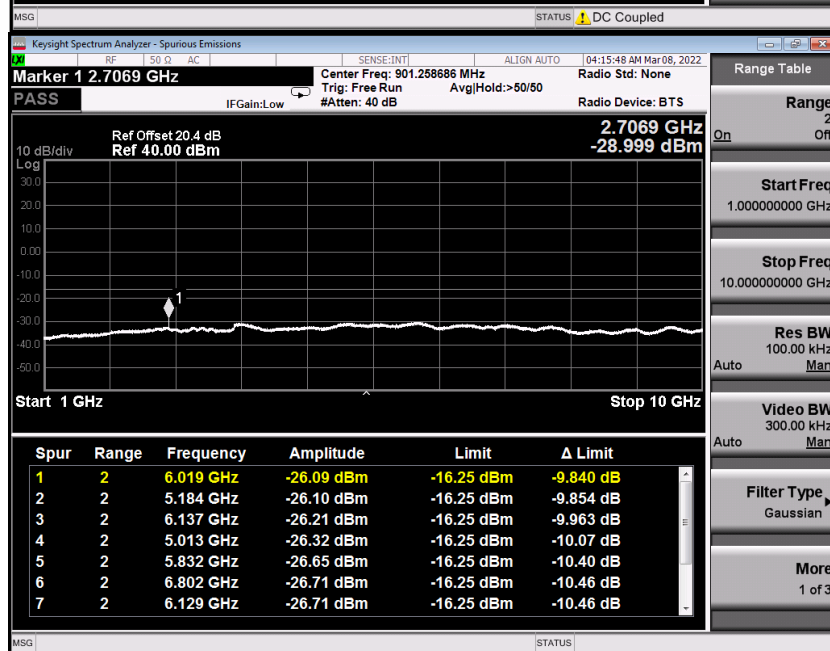
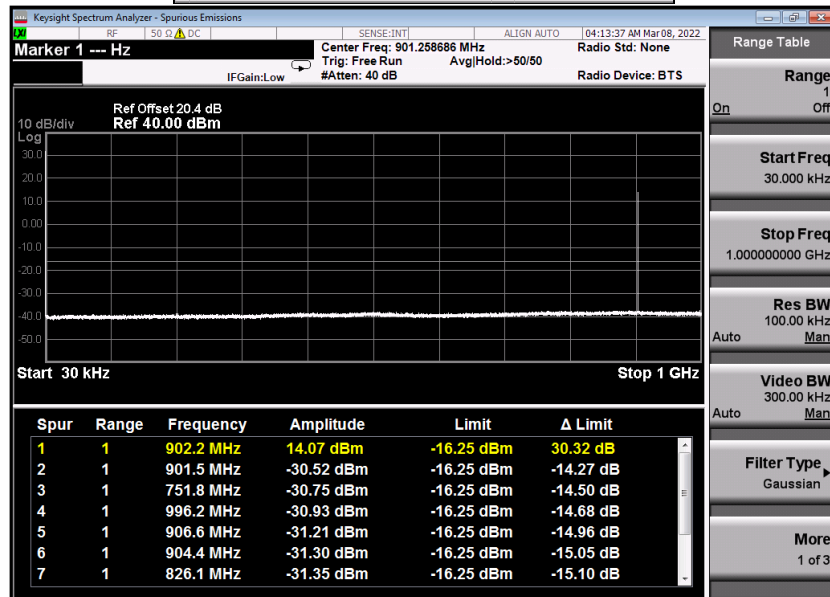
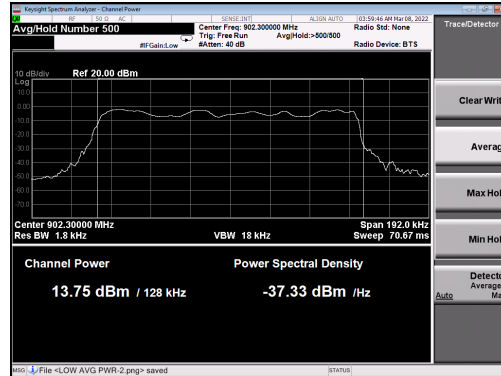
**Test setup diagram for Conducted Spurious Emissions testing:**



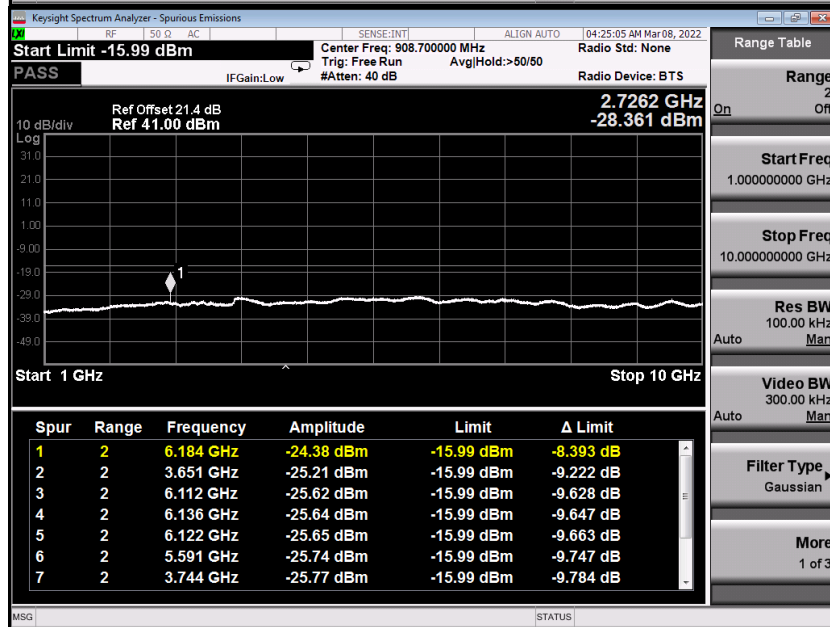
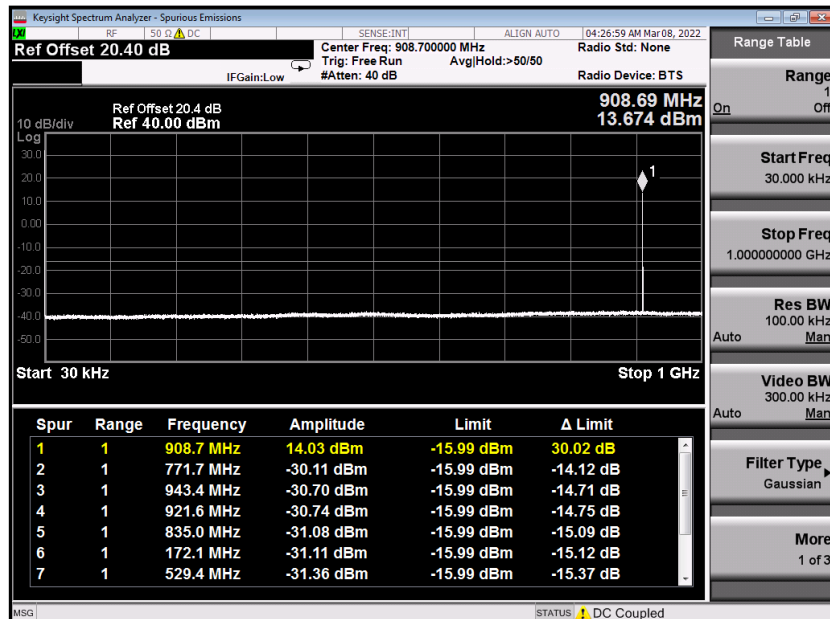
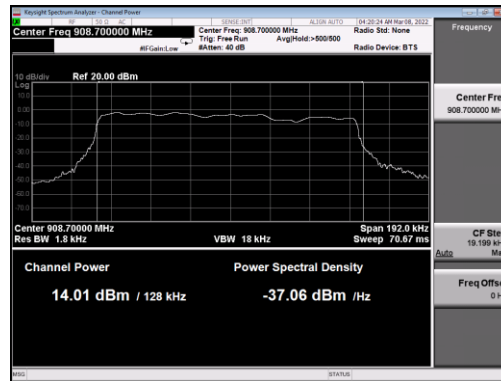
### 2.6.5 Conducted Emissions Data:



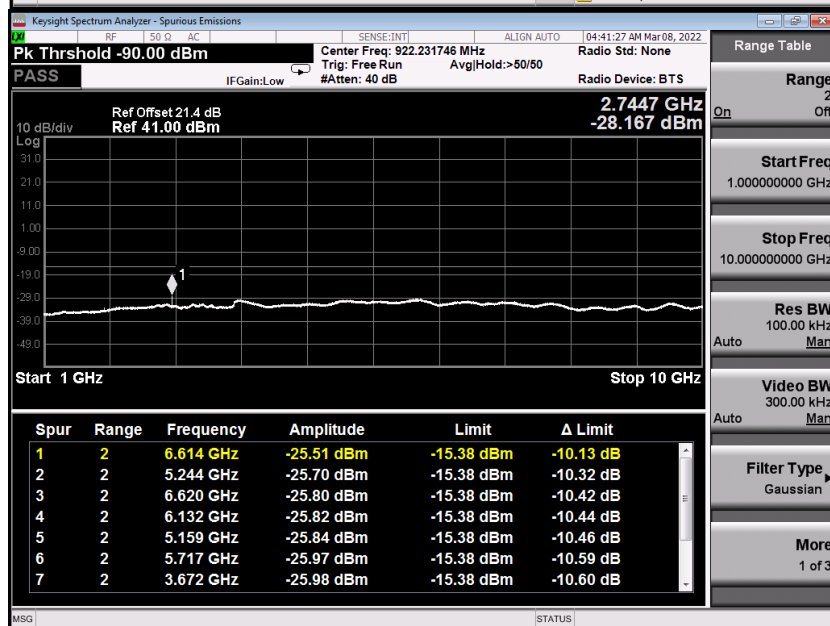
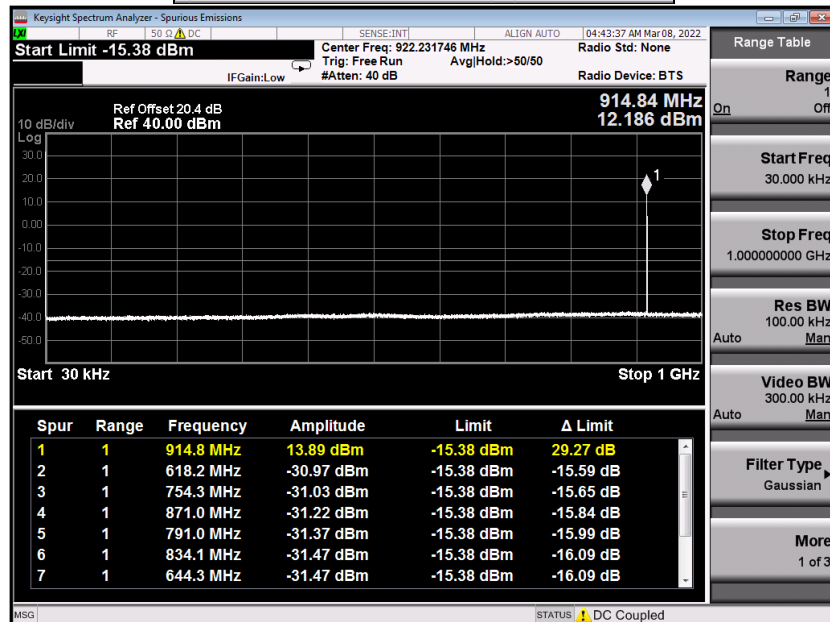
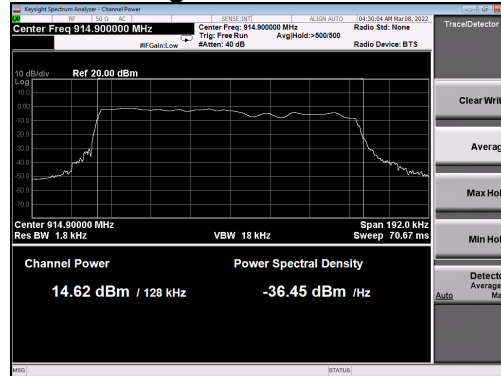
## Low Channel



## MID Channel



## High Channel



## 2.7 Channel Separation (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie

EUT: Breeze-V

Test Personnel: Imran Akram

Standard: FCC Part 15.247

Date: 2022-03-08 (20.7°C, 14.2% RH)

Basic Standard: ANSI C63.10: 2013

**EUT status: Compliant**

### Specification: FCC Part 15.247(a, 1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

#### 2.7.1 Test Guidance: ANSI 63.10 Clause 7.8.2 / 558074 D01 15.247 Measurement Guidance v05r02

This measurement is performed with the EUT transmitter frequency hopping function active.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

The spectrum analyzer is set for a frequency span wide enough to capture at least two adjacent channels. The RBW is set to at least 1% of the span. The Peak detector is used, with the trace set to Max Hold. Channel Separation is displayed with the Marker Delta function.

#### 2.7.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

#### 2.7.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
MXE EMI Receiver	Agilent	N9010A FW A.25.05	6130	2021-06-18	2022-06-18
Temp/Humidity	Extech	42270	5892	2021-04-05	2022-04-15
Attenuator	Mini-Circuits®	BWS102W263	6932	Cal. Before each use	
Coaxial Cables (RF)	Huber+Suhner	Enviroflex 400	-	Cal. Before each use	

#### 2.7.4 Test Sample Verification, Configuration & Modifications

EUT configuration for Channel Separation testing:

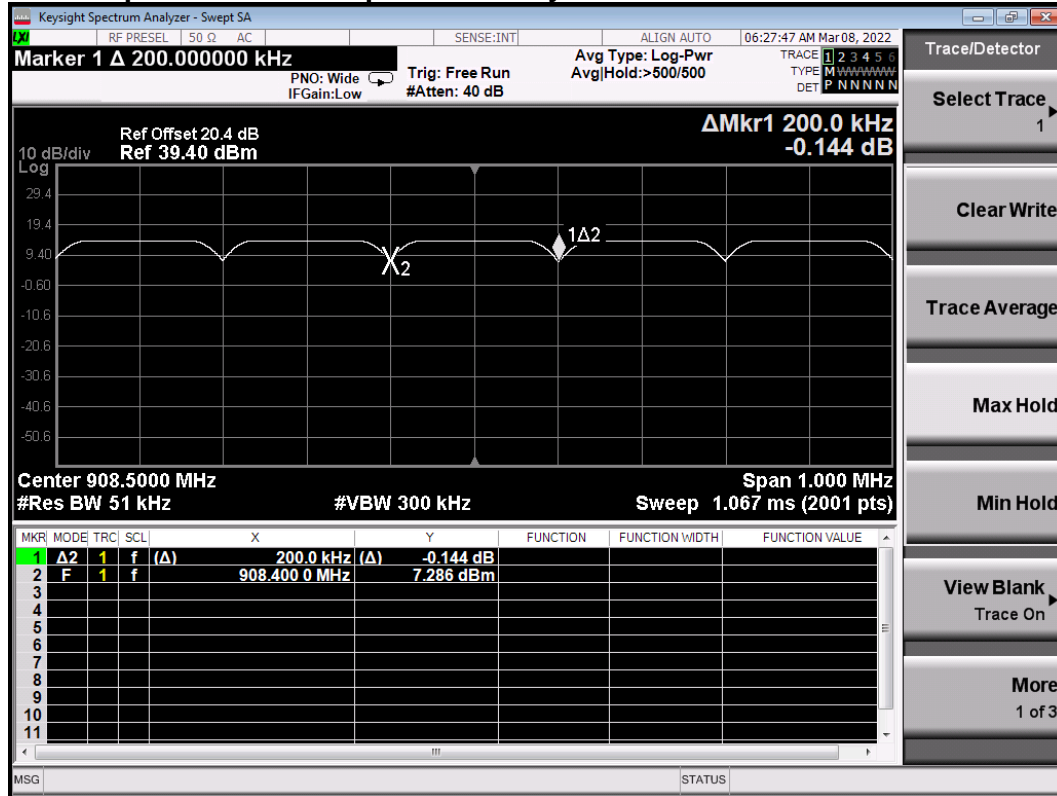


## 2.7.5 Channel Separation Data:

The channel separation **Compliant** for this device.

Channel separation measured = 200 KHz

### Screen Captures from the spectrum analyzer:



## 2.8 Time of Occupancy (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie

EUT: Breeze-V

Test Personnel: Imran Akram

Standard: FCC PART 15.247

Date: 2022-03-08 (20.7°C, 14.2% RH)

Basic Standard: ANSI C63.10: 20013

**EUT status: Compliant**

### Specification: FCC Part 15.247 (f)

The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4

#### 2.8.1 Test Guidance: ANSI 63.10 Clause 7.8.4 / 558074 D01 15.247 Measurement Guidance v05r02

This measurement is performed with the EUT frequency hopping function active.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

The spectrum analyzer is set for Peak detection over a 0 Hz frequency span (time domain) centered on a hopping channel. The RBW shall be  $\leq$  Channel spacing and where possible RBW should be set  $\gg 1/T$ , where T is the expected dwell time per channel. VBW  $\geq$  RBW. The sweep time is adjusted to clearly capture one transmission. The Dwell time is measured with the Marker Delta function.

Another sweep is set to capture enough transmission events to calculate the number of events within the specified period of time. The Peak detector is used, with the trace set to Max Hold.

#### 2.8.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

#### 2.8.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
MXE EMI Receiver	Agilent	N9010A FW A.25.05	6130	2021-06-18	2022-06-18
Temp/Humidity	Extech	42270	5892	2021-04-05	2022-04-15
Attenuator	Mini-Circuits®	BWS102W263	6932	Cal. before each use	
Coaxial Cables (RF)	Huber+Suhner	Enviroflex 400	-	Cal. before each use	

#### 2.8.4 Test Sample Verification, Configuration & Modifications

The EUT was operating in normal mode. The EUT met the requirements without modification.

#### EUT configuration for Dwell Time testing:



### 2.8.5 Dwell Time Data:

Measured Dwell time = 370.8 ms

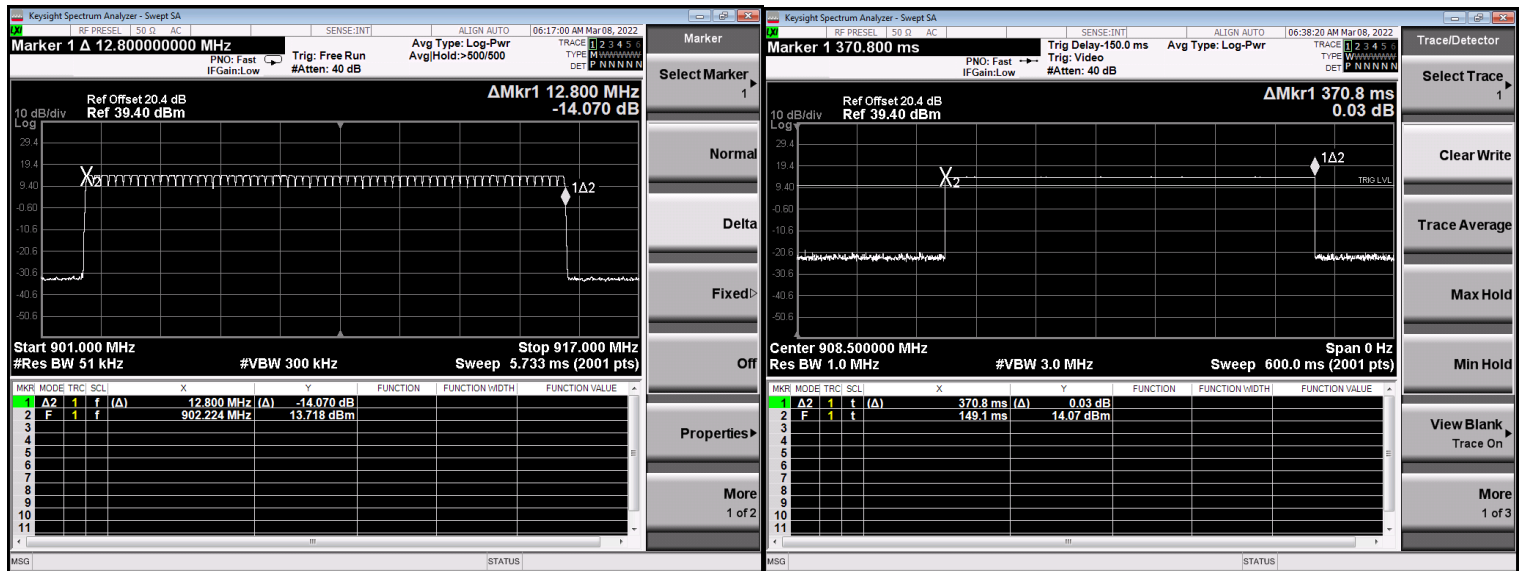
Window of measurement is equal to number of hopping channels multiple by 400ms =

$$0.4 \times 64 = 25.6 \text{ Sec}$$

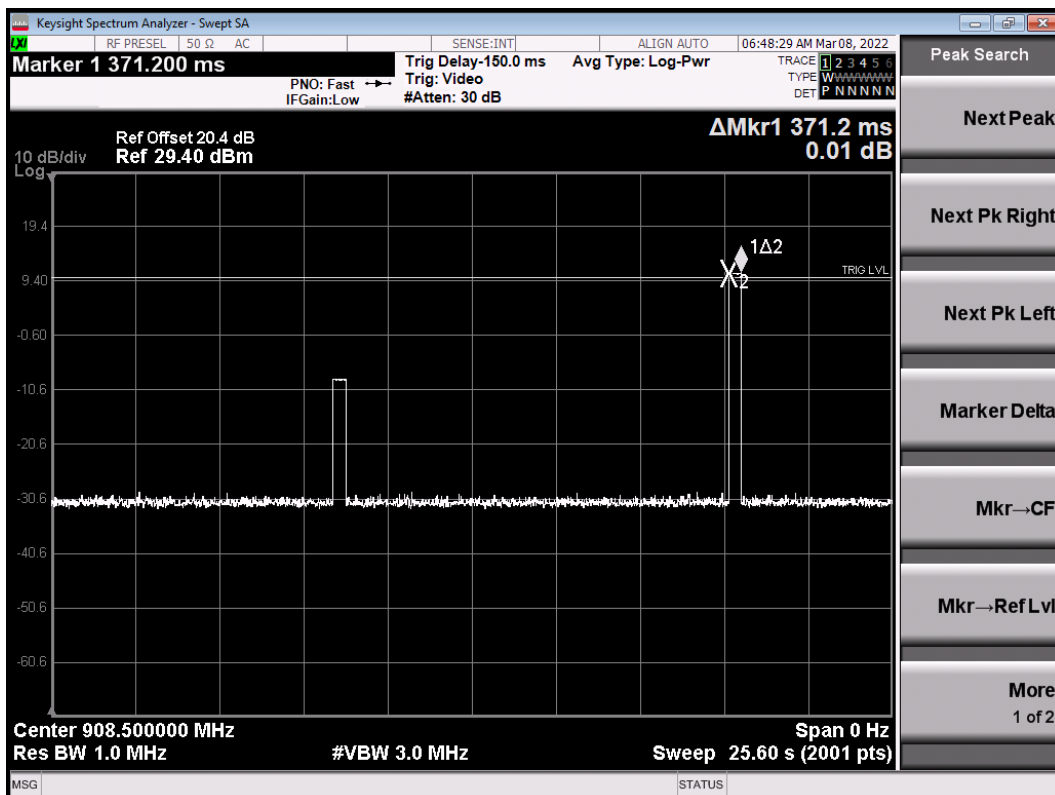
Number of events in 25.6 Sec = 1

### Screen Capture from the spectrum analyzer: sweep Time in 3.2 Sec

Measure number OF Channels= 64



### Screen Capture from the spectrum analyzer: sweep Time in 25.6 Sec



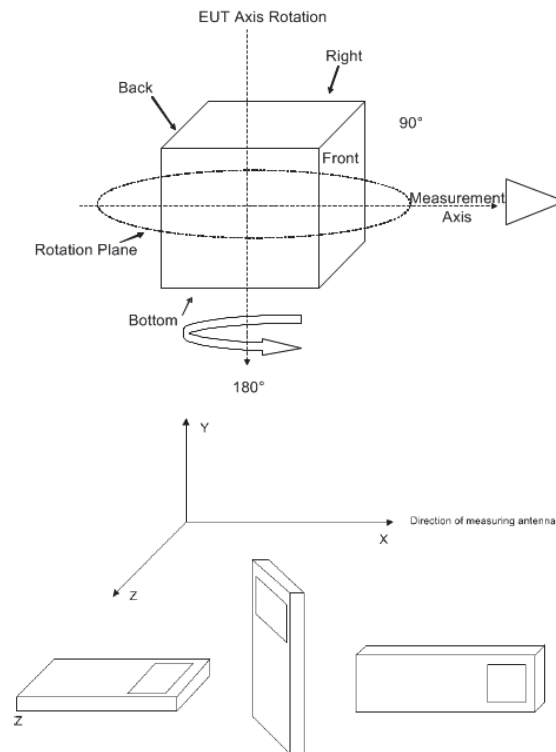
## 2.9 EUT Positioning Assessment

<b>Test Lab:</b> Electronics Test Centre, Airdrie	<b>EUT:</b> Breeze-V
<b>Test Personnel:</b> Imran Akram/Janet	<b>Standard:</b> FCC PART 15.247
<b>Date:</b> 2022-02-28 (19.7° C, 14.1 % RH)	<b>Basic Standard:</b> ANSI C63.4-2014

**Comments:** Z-Axis position found worse

### Specification: ANSI C63.4-2014, Clause 6.3.2.1

Portable, small, lightweight, or modular devices that may be handheld, worn on the body, or placed on a table during operation shall be positioned on a non-conducting platform, the top of which is 80 cm above the reference ground plane. The preferred area occupied by the EUT arrangement is 1 m by 1.5 m, but it may be larger or smaller to accommodate various sized EUTs (see Figure 6, Figure 7, and Figure 9). For testing purposes, ceiling- and wall-mounted devices also shall be positioned on a tabletop (see also 6.3.4 and 6.3.5). In making any tests involving handheld, body-worn, or ceiling-mounted equipment, it is essential to recognize that the measured levels may be dependent on the orientation (attitude) of the three orthogonal axes of the EUT. Thus, exploratory tests as specified in 8.3.1 shall be carried out for various axes orientations to determine the attitude having maximum or near-maximum emission level.



Refer to Test Setup photo exhibit.



## 2.10 Radiated Spurious Emissions (Restricted Band)

Test Lab: Electronics Test Centre, Airdrie	EUT: Breeze-V
Test Personnel: Imran /Janet / Branden	Standard: FCC PART 15.247/15.209
	Basic Standard: ANSI C63.10-2013
Date: 2022-02-28 (20.7° C,11.13 % RH)	
2022-03-01 (19.8° C,16.0 % RH)	
<b>EUT status: Compliant</b>	

### Specification: FCC PART 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### Restricted Bands of Operation:

MHz	MHz	MHz	MHz	MHz	GHz	GHz
0.0900000 - 0.1100000	8.2910000 - 8.2940000	16.804250 - 16.804750	162.01250 - 167.17000	1660.0000 - 1710.0000	3.6000000 - 4.4000000	14.470000 - 14.500000
0.4950000 - 0.5050000	8.3620000 - 8.3660000	25.500000 - 25.670000	167.72000 - 173.20000	1718.8000 - 1722.2000	4.5000000 - 5.1500000	15.350000 - 16.200000
2.1735000 - 2.1905000	8.3762500 - 8.3867500	37.500000 - 38.250000	240.00000 - 285.00000	2200.0000 - 2300.0000	5.3500000 - 5.4600000	17.700000 - 21.400000
4.1250000 - 4.1280000	8.4142500 - 8.4147500	73.000000 - 74.600000	322.00000 - 335.40000	2310.0000 - 2390.0000	7.2500000 - 7.7500000	22.010000 - 23.120000
4.1772500 - 4.1777500	12.2900000 - 12.2930000	74.800000 - 75.200000	399.90000 - 410.00000	2483.5000 - 2500.0000	8.0250000 - 8.5000000	23.600000 - 24.000000
4.2072500 - 4.2077500	12.519750 - 12.520250	108.00000 - 121.94000	608.00000 - 614.00000	2655.0000 - 2900.0000	9.0000000 - 9.2000000	31.200000 - 31.800000
5.6770000 - 5.6830000	12.576750 - 12.577250	123.00000 - 138.00000	960.00000 - 1240.0000	3260.0000 - 3267.0000	9.3000000 - 9.5000000	36.430000 - 36.500000
6.2150000 - 6.2180000	13.360000 - 13.410000	149.90000 - 150.05000	1300.0000 - 1427.0000	3332.0000 - 3339.0000	10.600000 - 12.700000	Above 38.600000
6.2677500 - 6.2682500	16.420000 - 16.423000	156.52475 - 156.52525	1435.0000 - 1626.5000	3345.8000 - 3358.0000	13.250000 - 13.400000	
6.3117500 - 6.3122500	16.694750 - 16.695250	156.70000 - 156.90000	1645.5000 - 1646.5000	3500.0000 - 3600.0000		

 US only
  Canada 108 – 138 MHz
  Canada 960 – 1427 MHz
  Canada only

### 2.8.1 Test Guidance: ANSI C63.10-2013, Clause 13.4.2

From 9 kHz to 150 kHz (resolution bandwidth of 200 Hz) and from 150 kHz to 30 MHz (resolution bandwidth 9 kHz) measurements are performed with a loop antenna (as per KDB 460108).

From 30 MHz to 1000 MHz, measurements are performed with a broadband biconilog antenna and a resolution bandwidth of 120 kHz.

Above 1000 MHz, measurements are performed with a DRG Horn antenna or a Standard Gain horn, and a resolution bandwidth of 1 MHz. The EUT is raised to 150 cm above the ground plane, and the area between the EUT and the antenna mast is covered with RF absorbent material.

The scan is performed at discreet increments of turntable azimuth and antenna height, which are selected in accordance with the applicable standard in order to assure capture of frequencies of interest. Optimization is performed based on the scan data.

Frequencies having peak emissions within 10dB of the limits are optimized. The EUT is rotated in azimuth over 360 degrees and the direction of maximum emission is noted.

Antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum emission. Then the maximum level is measured with the appropriate detector and recorded. Up to 1 GHz, measurements are performed with a Quasi-Peak detector. Above 1 GHz, measurements are recorded with Peak and/or Average detectors, as applicable.

### 2.8.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

### 2.8.3 Test Equipment

Testing was performed with the following equipment:

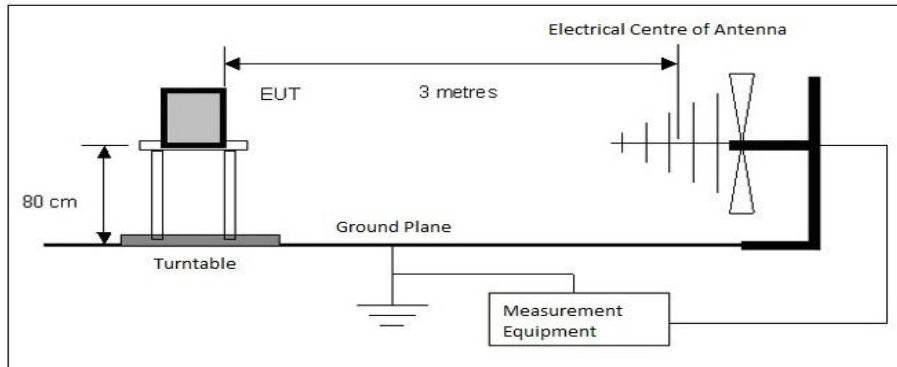
Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2021-06-18	2022-06-8
Loop Antenna	EMCO	6502	10868	2021-05-11	2023-05-11
Biconilog Antenna	AR	JB1	6905	2021-10-29	2023-10-21
DRG Horn	EMCO	3115	19357	2020-09-29	2022-09-29
Humidity/Temp Logger	Extech Ins. Corp.	42270	5892	2021-04-06	2022-04-06
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800- 21-5P	4354	2021-05-11	2022-05-11
Pre-Amplifier (30 – 1400 MHz)	HP	8447D	9291	2021-05-11	2022-05-11
RE Cable below 1GHz	Insulated Wire Inc.	KPS-1501A- 3600-KPA- 01102006	4419	2021-05-11	2022-05-11
Re Cable Above 1 GHz	A.H. System Inc.	SAC-26G-8.23	6187	2021-05-11	2022-05-11
0.9GHz Notch Filter	Microtronics	BRM20784	6947	2021-05-11	2022-05-11

#### 2.8.4 Test Sample Verification, Configuration & Modifications

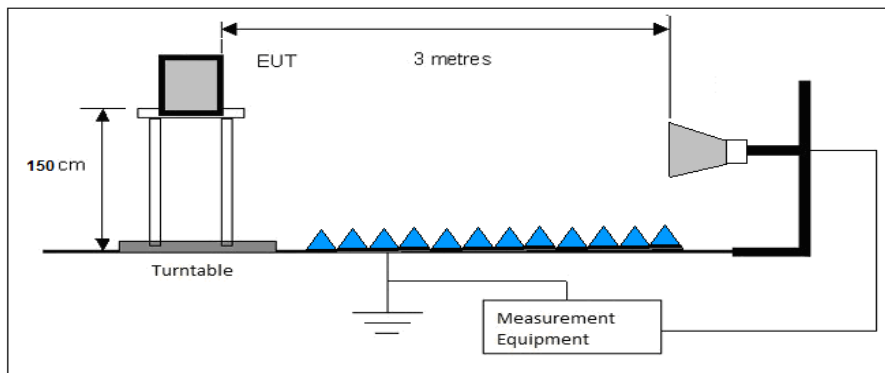
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. LoRa radio is transmitting at Low Channel 902.3 MHz.

The EUT met the requirements without modification.

##### Test setup diagram for Radiated Spurious Emissions testing (below 1GHz):



##### Test setup diagram for Radiated Spurious Emissions testing (above 1GHz):



## 2.8.5 Radiated Emissions Data:

The emissions data are presented in tabular form, showing turntable azimuth, antenna height and polarization, the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value of the limit at the frequency investigated, and the Delta between the result and the limit.

**Meter Reading in dBμV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dBμV/m.**

**Delta = Field Strength – Limit**

### Notes:

- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum EUT emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discreet increments of height and azimuth, while the reported measurement is obtained with the appropriate Quasi Peak or Average detector after the height and azimuth have been adjusted for maximum emission.
- Preliminary scans were performed for all channels in Transmit modes. The LOW band channel 902.3 MHz was selected as the worst-case condition for detailed examination.
- In Transmit mode, the EUT was assessed up to 10.0 GHz.

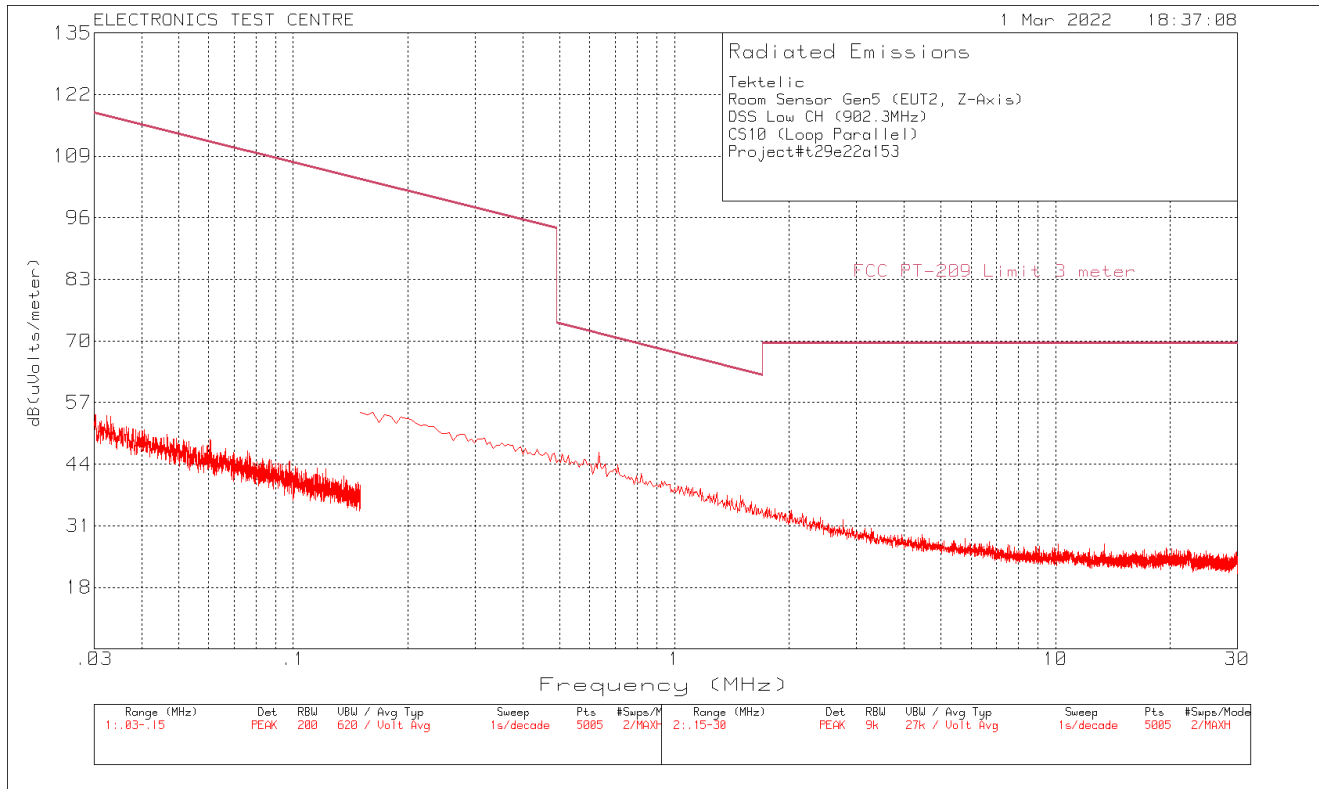
**Negative values for Delta indicate compliance.**

Freq. Marker	Freq. [MHz]	Raw reading [dBμv]	Det	Antenna Factor [dB/m]	Pre amp Gain/Cable Loss [dB]	Corrected Reading [dBμv/m]	FCC 15.247 Limit [dBμv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	*5413.3	35.93	AV	33.9	-30.9	38.93	54	-15.07	240	360	Horizontal
1	*5413.3	44.85	PK	33.9	-30.9	47.85	74	-26.15	240	360	Horizontal
2	*5413.3	36.15	AV	33.9	-30.9	39.15	54	-14.85	275	353	Vertical
2	*5413.3	44.93	PK	33.9	-30.9	47.93	74	-26.07	275	353	Vertical

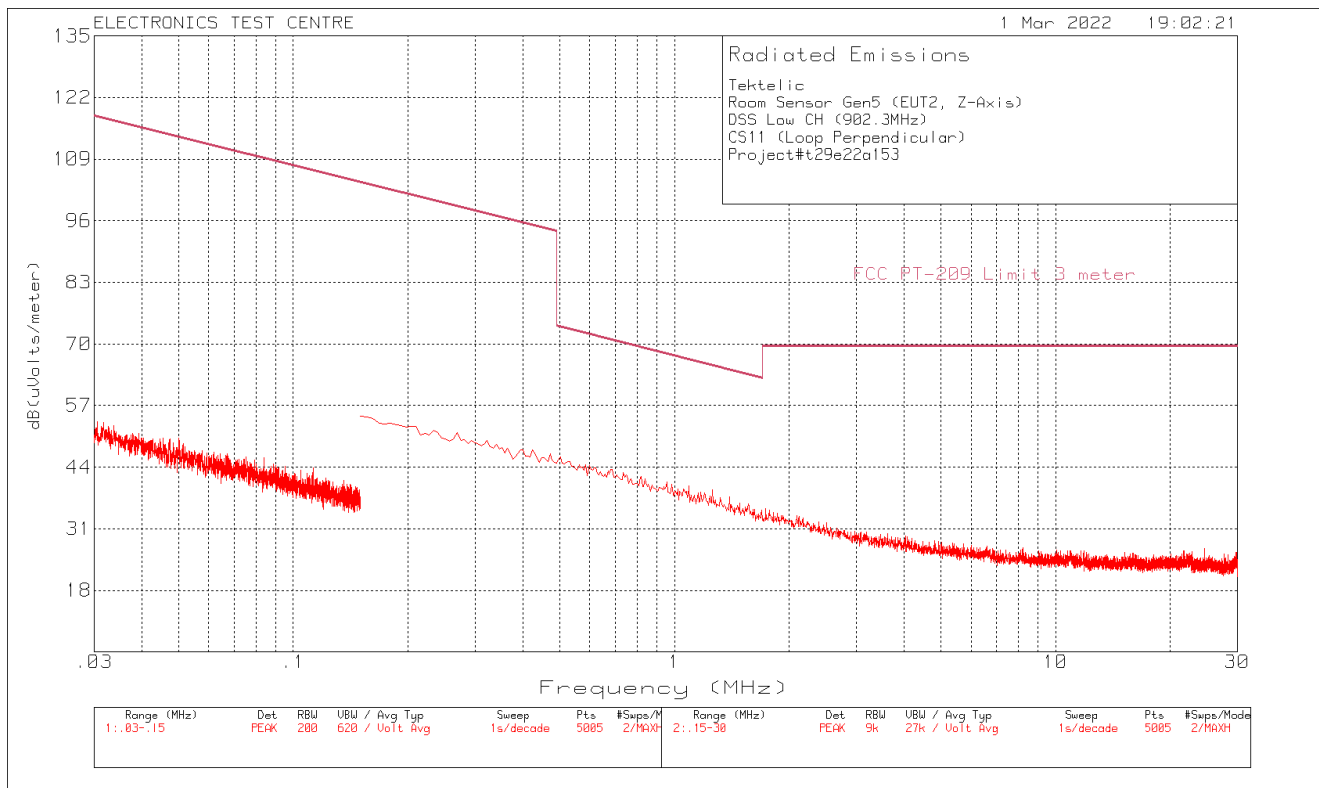
### Spurious Emission

**\* Restricted Band**

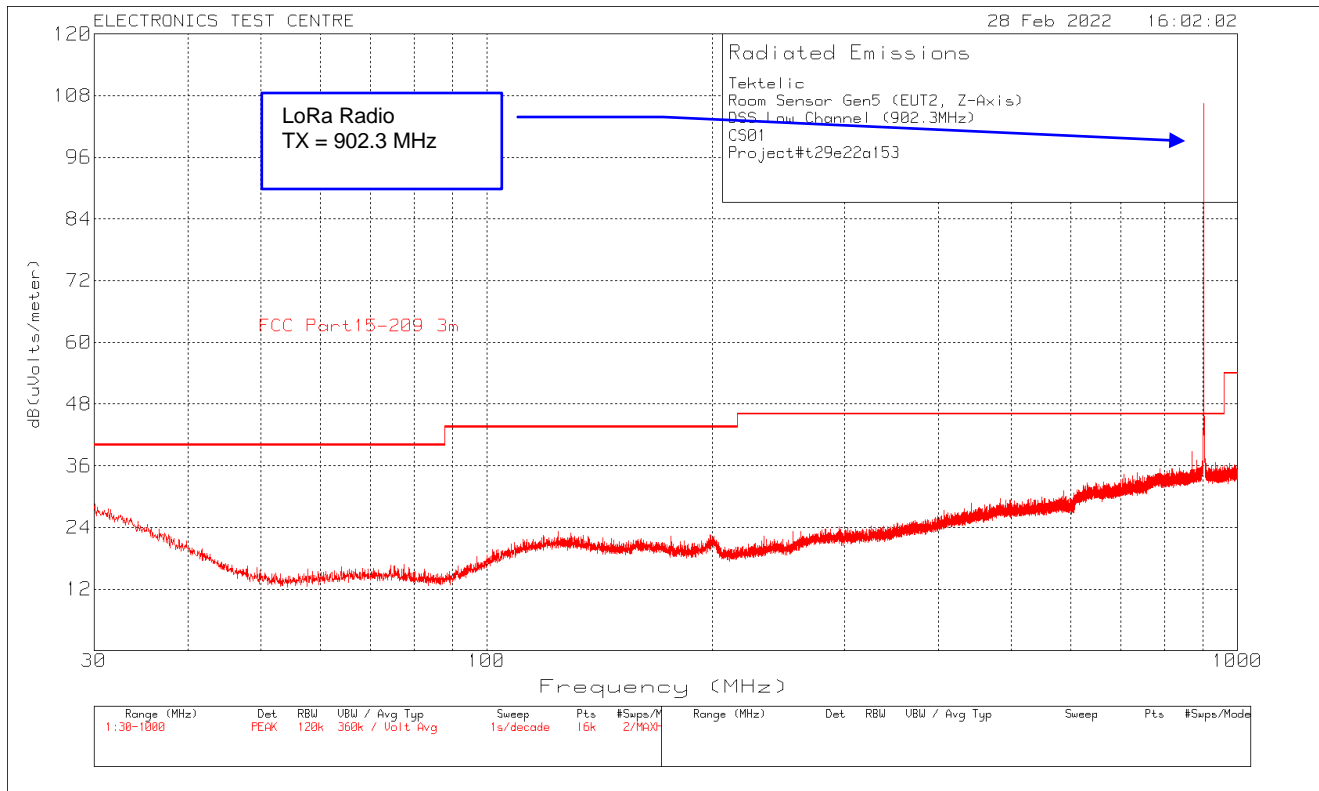
## Plot of Radiated Emissions: Measuring Antenna Parallel



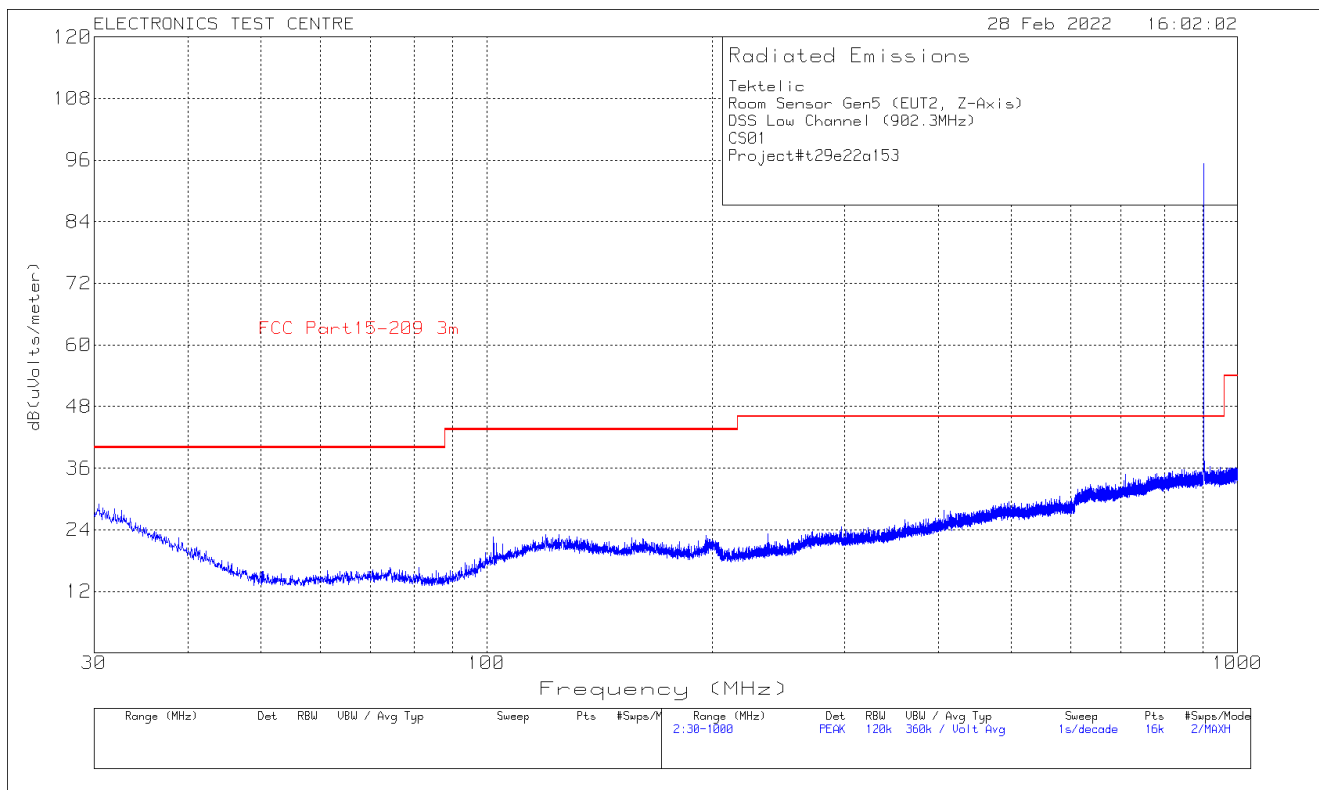
## Plot of Radiated Emissions: Measuring Antenna Perpendicular



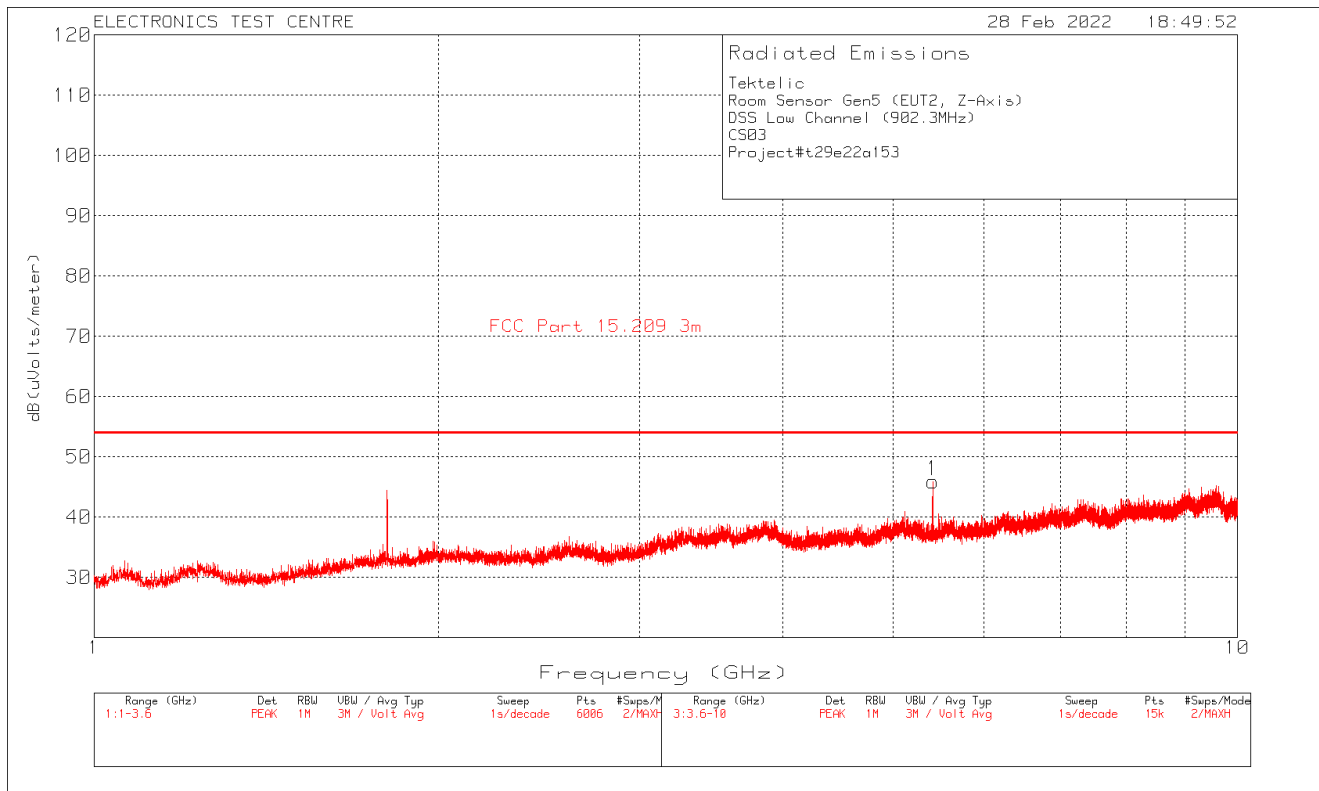
## Plot of Radiated Emissions: Horizontal polarization



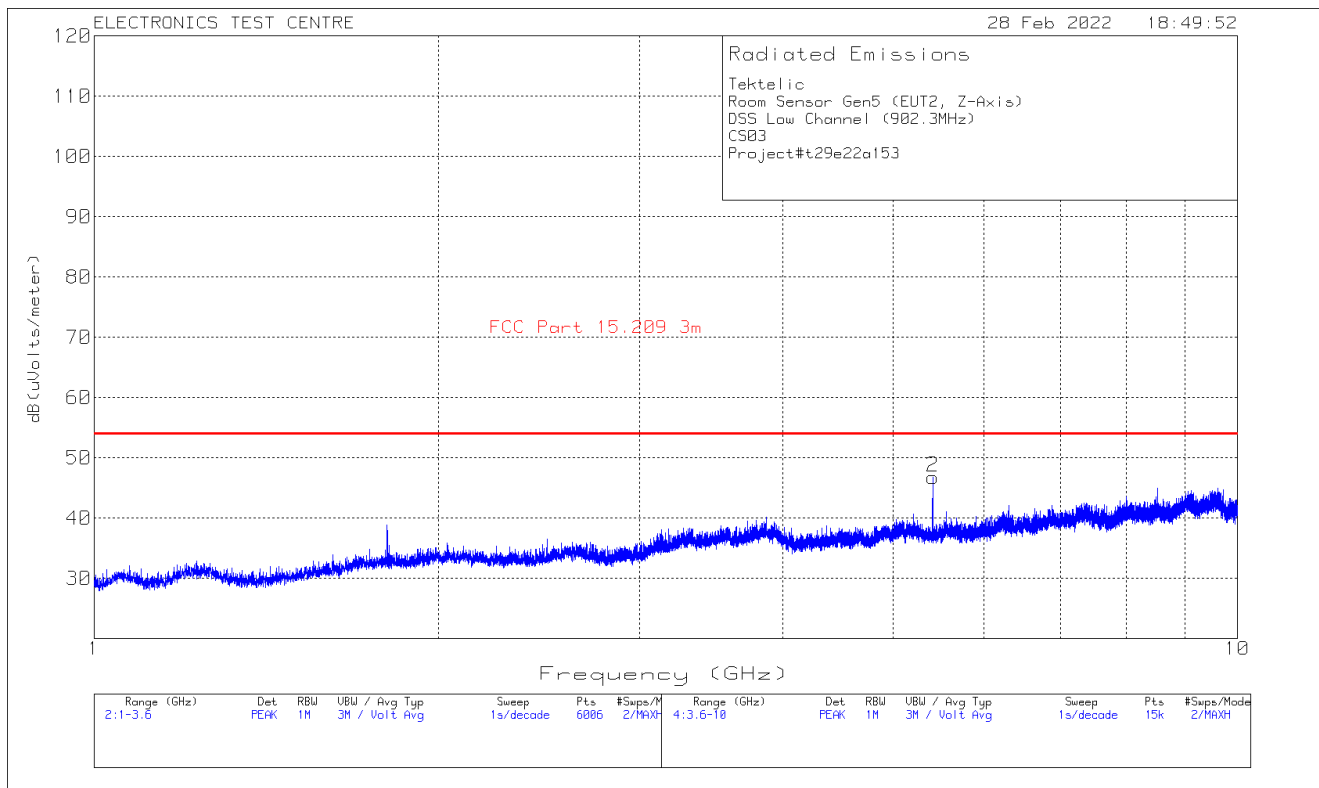
## Plot of Radiated Emissions: Vertical polarization



## Plot of Radiated Emissions: Horizontal polarization



## Plot of Radiated Emissions: Vertical polarization



## 2.11 RF Exposure

Test Lab: Electronics Test Centre, Airdrie	EUT: Breeze-V
Test Personnel:	Standard: FCC PART 15.247
Date:	
EUT status: Compliant	

**Compliant:** RF exposure assessment to be provided in a separate Exhibit.



## **3.0 TEST FACILITY**

### **3.1 Location**

The Breeze-V was tested at the Electronics Test Centre laboratory located in Airdrie, Alberta, Canada. The Radio Frequency Anechoic Chamber (RFAC), identified as Chamber 1, has a usable working space measuring 10.6 m long x 7.3 m wide x 6.5 m high.

Measurements taken at this site are accepted by Industry Canada as evidence of conformity per registration file # 2046A. This site is also listed with the FCC under Registration Number CA2046.

The floor, walls and ceiling consist of annealed steel panels. The walls and ceiling are covered with ferrite tile, augmented by RF absorbant foam material on the end wall nearest the turntable, and on the adjacent walls and the ceiling. The chamber floor supports a 15 cm high internal floor, constructed of annealed steel panels, that forms the ground plane, and is bonded to the chamber walls.

The 3-m diameter turntable is flush-mounted with the floor. A sub-floor cable-way is provided to route cables between the turntable pit and EUT support equipment located in the Control Room. Cables reach the EUT through an opening in the centre of the turntable.

Test instrumentation and EUT support equipment is located in the Control Room, consisting of two shielded vestibules joined together at the side of the main room. Cables are routed through bulkhead panels between the rooms and the test chamber as required. Power feeds are routed into the main room and vestibules through line filters providing at least 100 dB of attenuation between 10 kHz and 10 GHz.

Either floor mounted or table-top equipment can be tested at this facility.

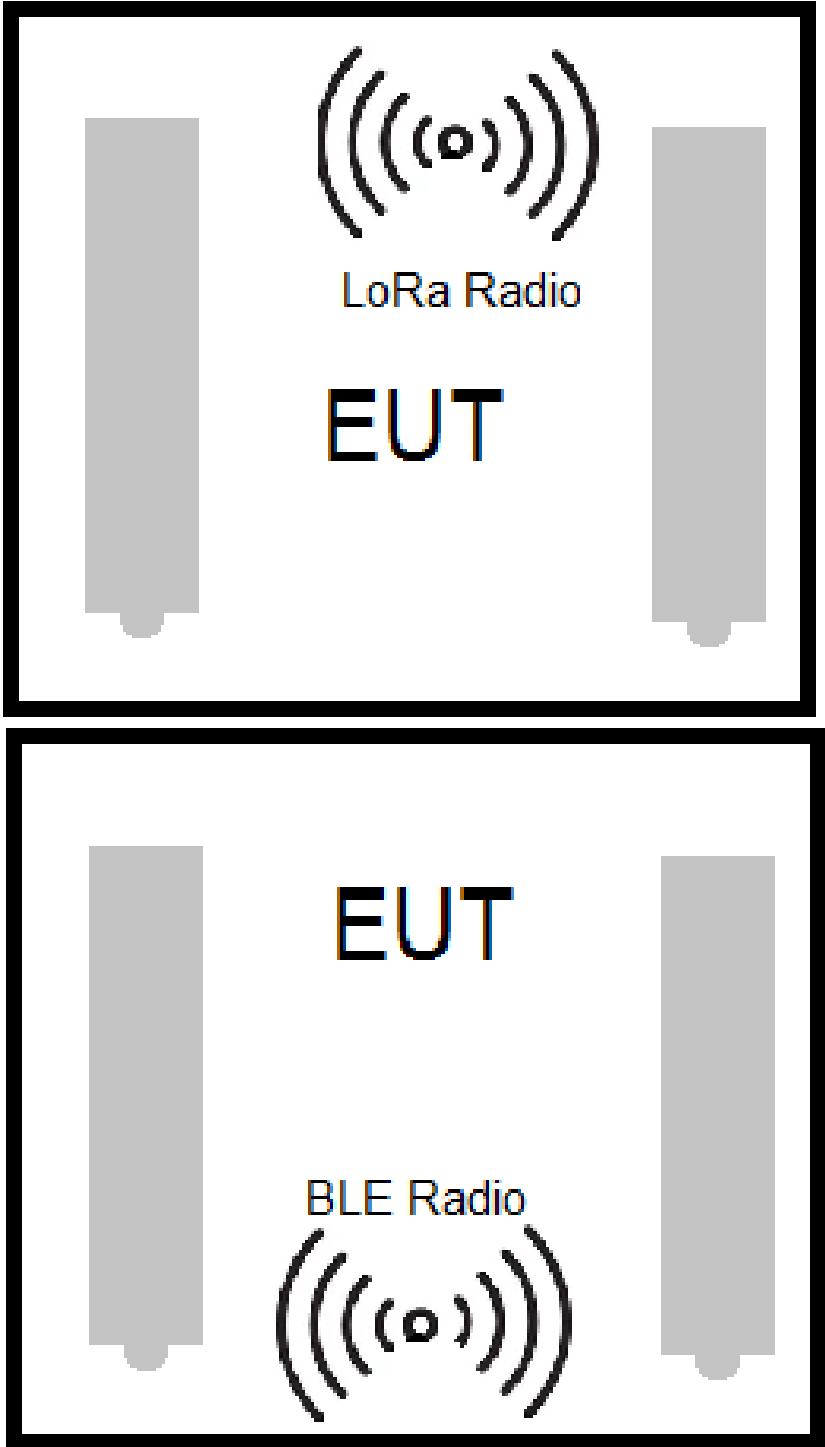
### **3.2 Grounding Plan**

The Breeze-V was placed at the center of the test chamber turntable on top of a polystyrene foam table. The EUT was grounded according to Tektelic Communication Inc. specifications.

### **3.3 Power Supply**

All EUT power was supplied by internal battery.

Appendix A – Test Setup Block Diagram



# End of Document