

Test Report Prepared By:

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

sales@etc-mpbtech.com
<http://www.etc-mpb.com>

Telephone: 1-403-912-0037

ETC Report #: t29e22a141-DTS Release2

Report date: March 7, 2022

Test Date: February 04, 07, 08, and 11, 2022

**EMC testing of the Tektelic Communication Inc. Kona Micro Gateway in
accordance with FCC Part 15.247 and ANSI C63.10: 2013 as referenced by FCC
OET KDB 558074 D01 15.247 Meas Guidance v05r02.**

FCC ID: 2ALEPT0008073

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

Prepared for: Tektelic Communication Inc.

7657 10th Street NE
Calgary, Alberta
Canada
T2E 8X2

Telephone: 1-403-338-6910



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



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

REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2022-02-18	I. Akram	Initial draft submitted for review.
Release1	2022-03-01	I. Akram	Sign Off
Release2	2022-03-07	I. Akram	Update Firmware Version in Section1.3
			Sign Off

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
2.1.1	Test Guidance: ANSI C63.10-2013, Clause 6.2	8
2.1.2	Deviations From The Standard:	8
2.1.3	Test Equipment.....	8
2.1.4	Test Sample Verification, Configuration & Modifications	9
2.1.5	Conducted Emissions Data:.....	10
2.2	6dB Bandwidth	13
2.2.1	Test Guidance: ANSI C63.10-2013, Clause 11.8 / FCC OET KDB 55807413	
2.2.2	Deviations From The Standard:	13
2.2.3	Test Equipment.....	13
2.2.4	Test Sample Verification, Configuration & Modifications	13
2.2.5	Channel Occupied Bandwidth Data:	14
2.3	Max Average Output Power	16
2.3.1	Test Guidance: ANSI C63.10-2013, Clause 11.9.2.2.2/ FCC OET KDB 558074 16	
2.3.2	Deviations From The Standard:	16
2.3.3	Test Equipment.....	16
2.3.4	Test Sample Verification, Configuration & Modifications	17
2.3.5	Max Output Power Data.....	17
2.4	Power Spectral Density	20
2.4.1	Test Guidance: ANSI C63.10-2013, Clause 11.10.3 / FCC OET KDB 558074 20	
2.4.2	Deviations From The Standard:	21
2.4.3	Test Equipment.....	21
2.4.4	Test Sample Verification, Configuration & Modifications	21
2.4.5	Peak PSD Data.....	21
2.5	Band Edge Attenuation	24
2.5.1	Test Guidance: ANSI C63.10-2013 Clause 11.13.2 & 6.10.4, 6.10.6 / FCC OET KDB 558074	24
2.5.2	Deviations From The Standard:	24
2.5.3	Test Equipment.....	25
2.5.4	Test Sample Verification, Configuration & Modifications	25
2.5.5	Band Edge Data.....	25

2.6	Conducted Spurious Emissions (Non-Restricted Band)	27
2.6.1	Test Guidance: ANSI C63.10-2013, Clause 6.7	27
2.6.2	Deviations From The Standard:	27
2.6.3	Test Equipment.....	27
2.6.4	Test Sample Verification, Configuration & Modifications	27
2.6.5	Conducted Emissions Data:.....	28
2.7	EUT Positioning Assessment.....	31
2.8	Radiated Spurious Emissions / Co-Location within restricted band.....	32
2.8.1	Test Guidance: ANSI C63.10-2013, Clause 13.4.2	33
2.8.2	Deviations From The Standard:	33
2.8.3	Test Equipment.....	33
2.8.4	Test Sample Verification, Configuration & Modifications	34
2.8.5	Radiated Emissions Data:.....	35
2.9	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. Kona Micro Gateway 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.:

Product Name:			*Kona Micro Gateway
Lora Radio	Frequency Range		903 – 927.5 MHz
	Type of Modulation		LoRa 500KHz DTS
	Associated Antennas	LoRa	SUZHOU WUTONG COMMUNICATION CO.,LTD 860M Antenna, Omni directional, Gain 0.4 dBi
		3G/4G	Antenova, PCB antenna CU9013-ANT1 Gain(peak) 0.51dBi
Firmware HAL version ID #			HAL version 5.0.0-r2
Model# / Serial#			T0007915 Rev B0, / 2208K0002
Power supply:			(100 – 240)AC/DC Adaptor (12VDC@1A) / POE

*This product is a Kona Micro Gateway is a LoRa base station. It may incorporate a 3G/4G backhaul module, FCC ID: XMR201906EG21G.

This model contains all of the equipment options in this family of products. This model represents model number and. This model was chosen as a worst-case condition for emission testing.

Detail differences between the models are given in Kona Micro Gateway 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.

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	Modifications	Config.	Result
2.1	AC Conducted Emissions (Tx)	15.207	Kona Micro Gateway	none	see § 2.1	Compliant
2.2	6dB Bandwidth	15.247(a)	Kona Micro Gateway	none	see § 2.2	Compliant
2.3	Max Output Power	15.247(d)	Kona Micro Gateway	none	see § 2.3	Compliant
2.4	Power Spectral Density	15.247(e)	Kona Micro Gateway	none	see § 2.4	Compliant
2.5	Band Edge	15.247(d)	Kona Micro Gateway	none	see § 2.5	Compliant
2.6	Conducted Spurious Emission (Non-Restricted Band)	15.247(d)	Kona Micro Gateway	none	see § 2.6	Compliant
2.7	EUT Position	ANSI C63.4	Kona Micro Gateway	none	see § 2.7	assessed
2.8	Radiated Spurious Emission (Restricted Band)	15.205, 15.209 15.247(d)	Kona Micro Gateway	none	see § 2.8	Compliant
2.9	RF Exposure	15.247(i)	Kona Micro Gateway	none	see § 2.9	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: Kona Micro Gateway
Test Personnel: Branden Van Hee	Standard: FCC Part 15.207
Date: 2022-02-07(19.0 C,15.9 % RH)	Basic Standard: ANSI C63.10: 2013
EUT status: Compliant	

Specification: Part15-207

Frequency (MHz)	Quasi-Peak Limit (dBµV)	Average Limit (dBµV)
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 – 30	60	50
Criteria: The conducted emissions produced by a device shall not exceed the limits as specified.		

2.1.1 Test Guidance: ANSI C63.10-2013, Clause 6.2

Before any testing is performed, the Ambient (measurement noise floor) is recorded, and a QC check is performed to show that the system is functioning correctly.

Testing starts with a scan, performed under software control. After this is complete, the list of frequencies of interest is generated. These frequencies are then investigated for quasi-peak and average amplitude, as applicable. Emissions measured with a QP detector that fall below the Average limit are deemed to meet both requirements.

2.1.2 Deviations From The Standard:

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

2.1.3 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	N/A
EMI receiver	Keysight Technologies Inc.	N9038A (FW A.25.05)	6130	2021-06-18	2022-06-18
LISN	Com-Power	LI-215A	6180	2020-06-30	2022-06-30
Temp/RH logger	Extech	42270	5892	2021-04-06	2022-04-06

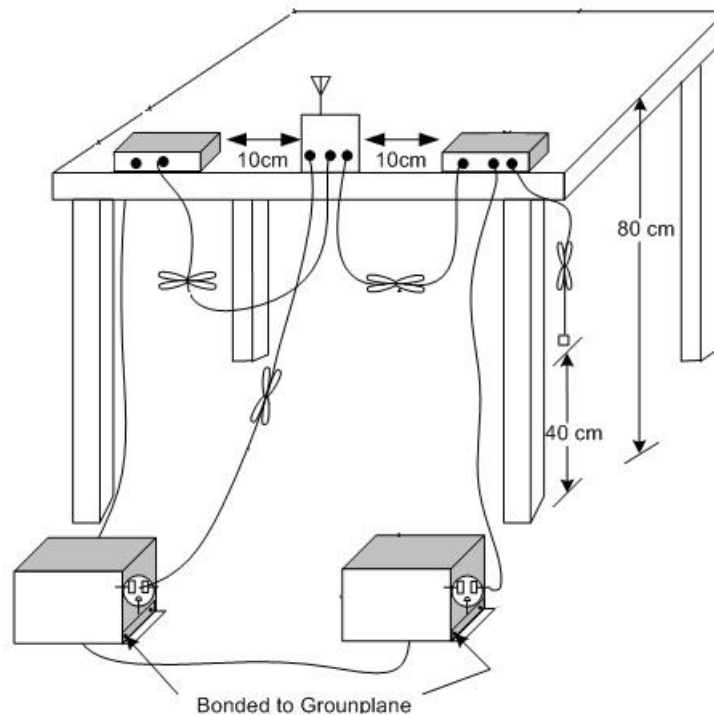
2.1.4 Test Sample Verification, Configuration & Modifications

The EUT was set to selected channels with test-specific software. The output was modulated as in normal operation. Configuration in Tx mode. GSM/LoRa radios are transmitting simultaneously.

The EUT was powered via an AC to DC Adaptor; manufacturer is Shenzhen Click Technology Co., LTD Model#CPS012D120100U and POE adaptor manufacturer is PowerDsine Model#3501G.

The EUT met the requirements without modification.

Test setup diagram:



2.1.5 Conducted Emissions Data:

The EUT was evaluated in all transmit mode. No mode of transmission showed emission worst then another. The plots are from the DTS mode using LOW-channel.

Freq. Marker	Freq. (MHz)	Raw reading (dBμV)	Det.	LISN Factor (dB/m)	Cable Loss (dB)	Corrected Reading (dBμV)	FCC 15.207 Limit (dBμV)	Delta (dB)	L / N
1	0.206	30.94	AV	0	.1	31.04	53.35	-22.31	L
2	0.414	32.86	AV	0	.2	33.06	47.57	-14.51	L
3	7.83	22.34	AV	0	.5	22.84	50	-27.16	L
4	16.23	35.56	AV	0	.9	36.46	50	-13.54	L
5	18.24	32.33	AV	0	.9	33.23	50	-16.77	L
1	0.181	23.72	AV	.1	.1	23.92	54.45	-30.53	N
2	0.388	29.8	AV	0	.2	30	48.09	-18.09	N
3	7.98	23.6	AV	0	.5	24.1	50	-25.9	N
4	16.23	35.45	AV	0	.9	36.35	50	-13.65	N
5	26.61	22.91	AV	.1	1.2	24.21	50	-25.79	N

Av = Average Detector

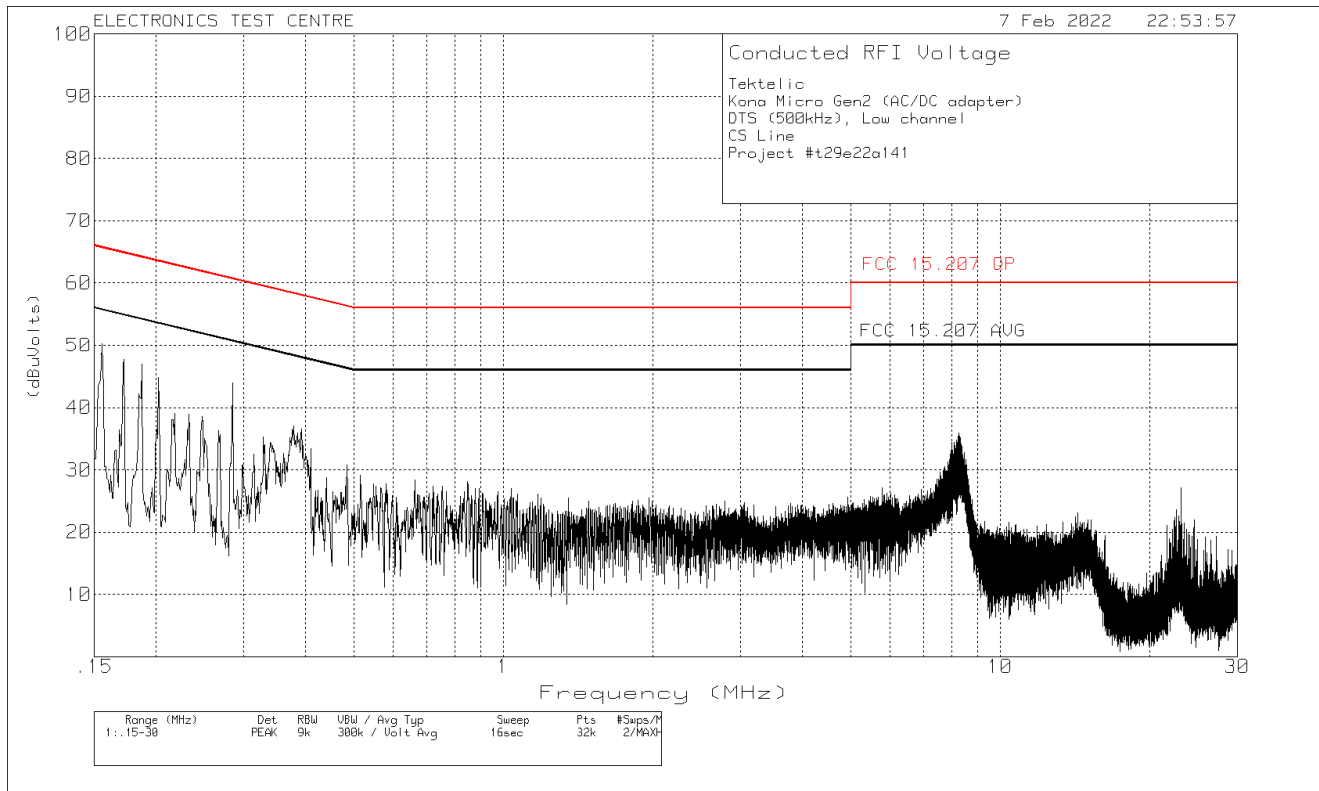
Raw Reading in dBμV + LISN Factor in dB + Gain/Loss Factor in dB = Corrected Reading dbμV.

Negative values for Delta indicate compliance.

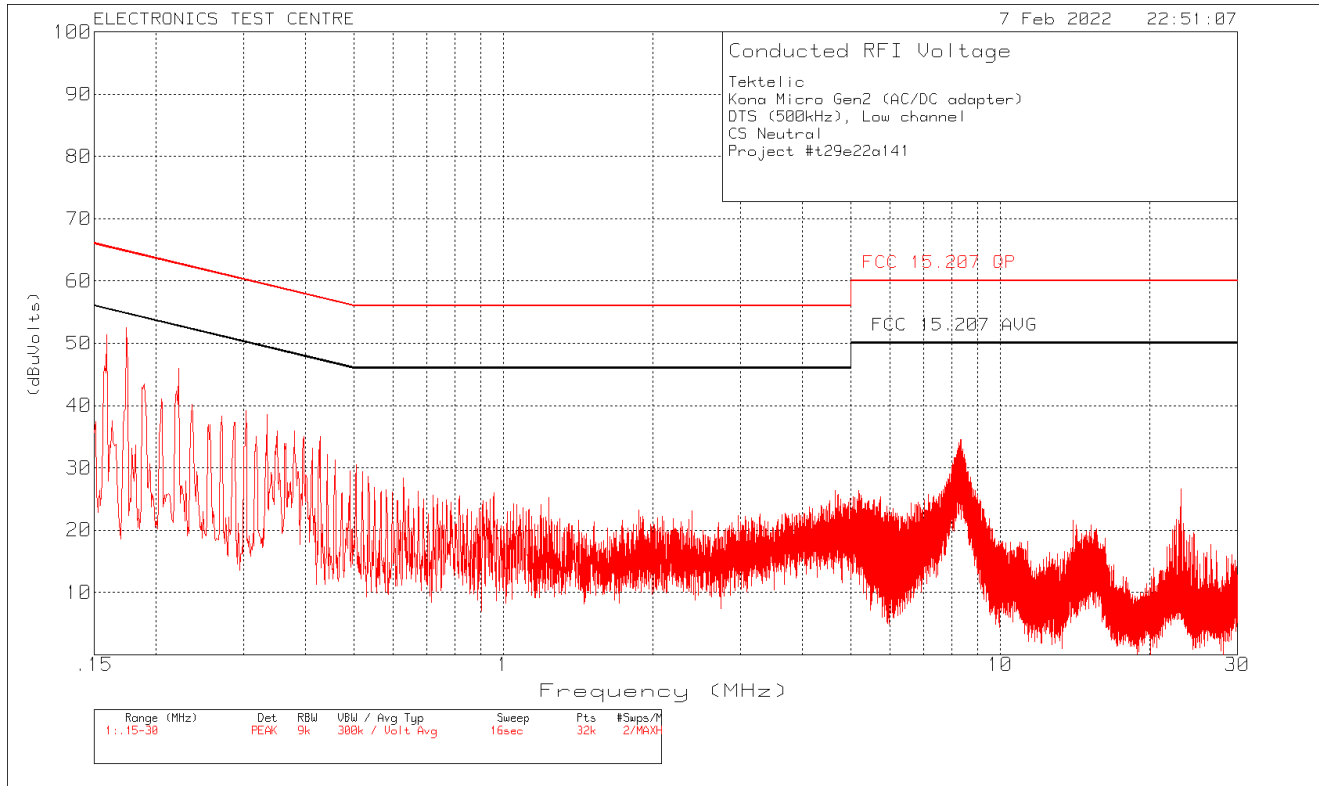
The Ground Bond was measured and found to be 1.25 mΩ.

AC/DC Adaptor

Plot of Conducted Emissions: Line 500KHz Mode

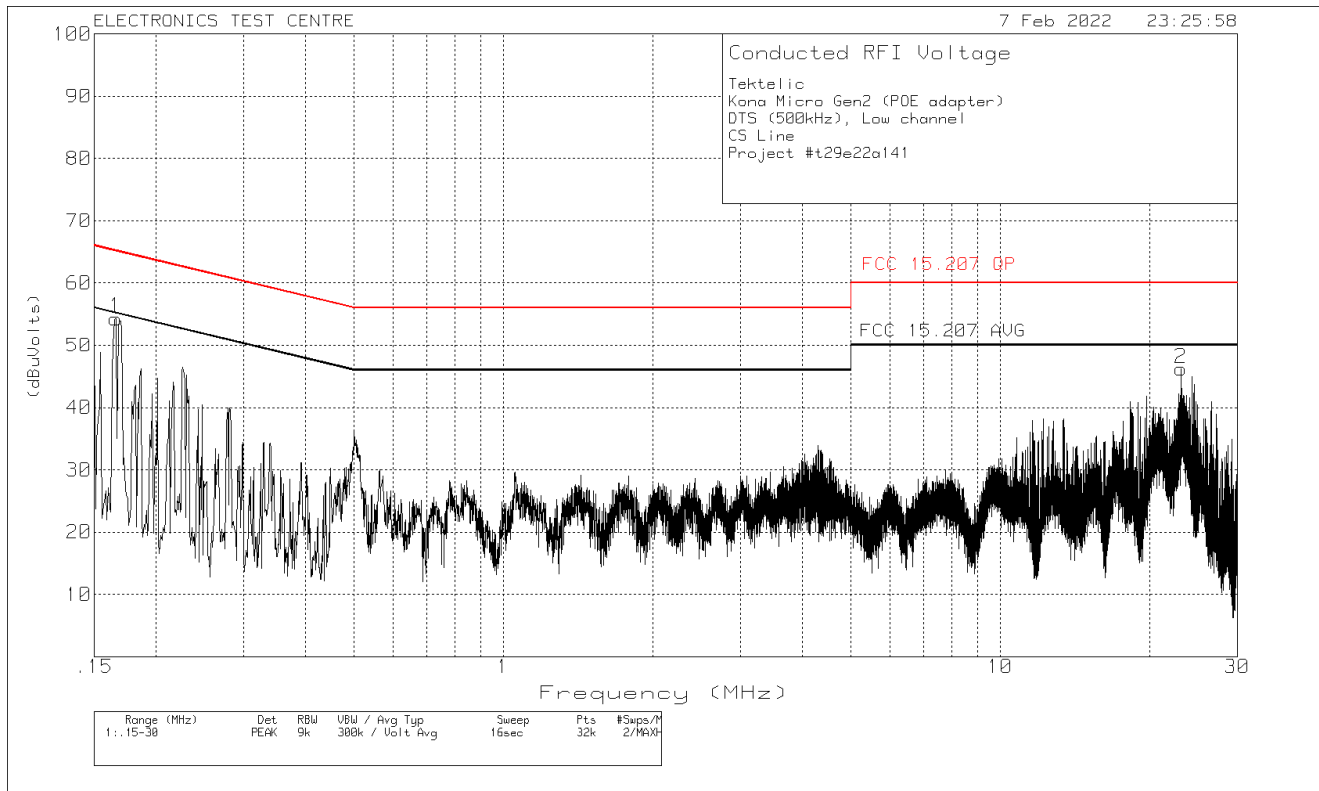


Plot of Conducted Emissions: Neutral 500 KHz Mode

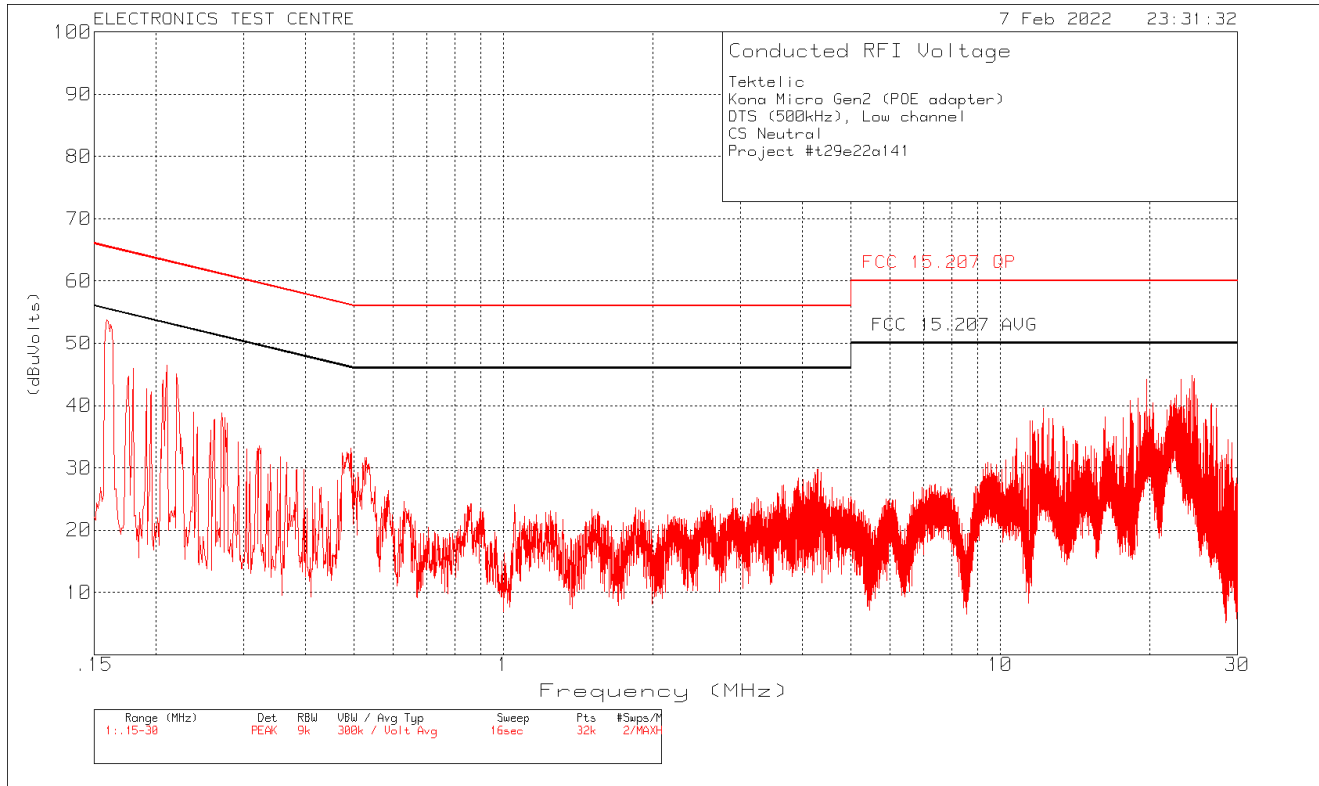


POE Adaptor

Plot of Conducted Emissions: Line 500 KHz Mode



Plot of Conducted Emissions: Neutral 500 KHz Mode



2.2 6dB Bandwidth

Test Lab: Electronics Test Centre, Airdrie	EUT: Kona Micro Gateway
Test Personnel: Imran Akram	Standard: FCC PART 15.247
Date: 2022-02-08 (20.7°C, 11.3 % RH)	Basic Standard: ANSI C63.10-2013 FCC OET KDB 558074
EUT status: Compliant	

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

Criteria: Systems using digital modulation techniques may operate in the 902-928 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.2.1 Test Guidance: ANSI C63.10-2013, Clause 11.8 / 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.

For DTS the spectrum analyzer is set for a frequency span $\geq (2 * \text{OBW})$, $\leq (5 * \text{OBW})$, selected to clearly display the channel. The RBW is set to 100 kHz. The VBW is set to $\geq (3 * \text{RBW})$. The Peak detector is used, with the trace set to Max Hold.

The automated 99% BW function of the spectrum analyzer is engaged, and the 6 dB OBW and/or 20 dB OBW 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
EXA Signal Analyzer	Agilent	N9010A FW A.14.16	6678	2021-07-22	2022-07-22
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:

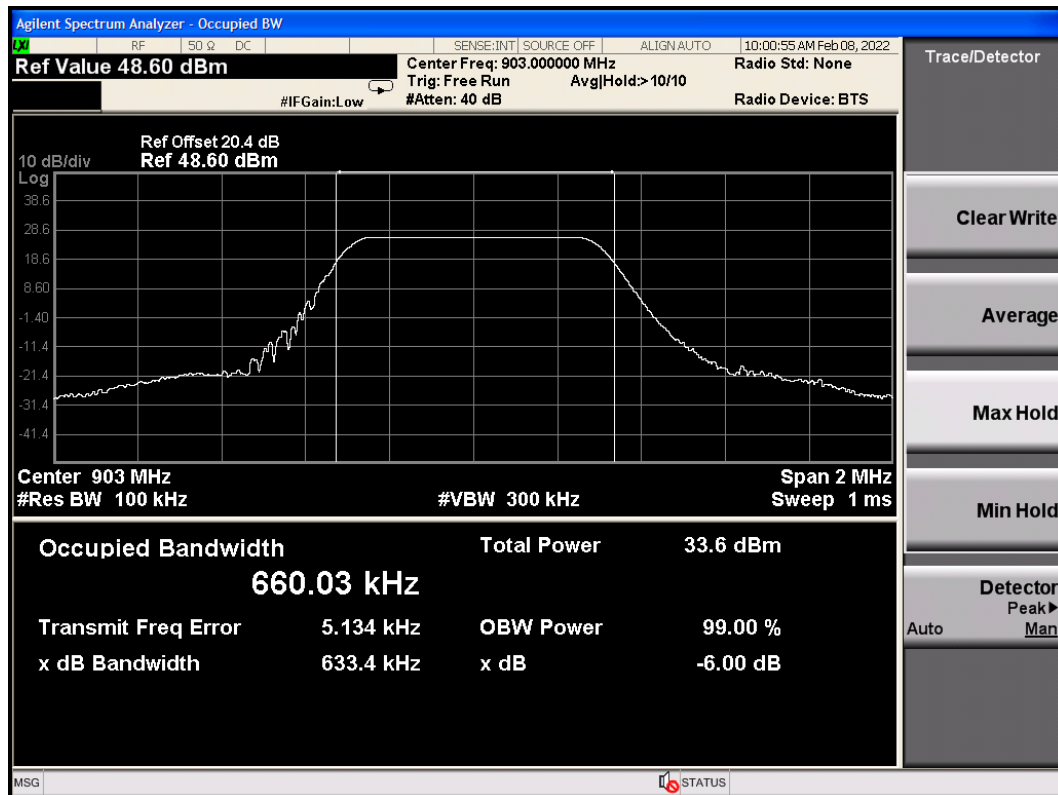
Conducted:



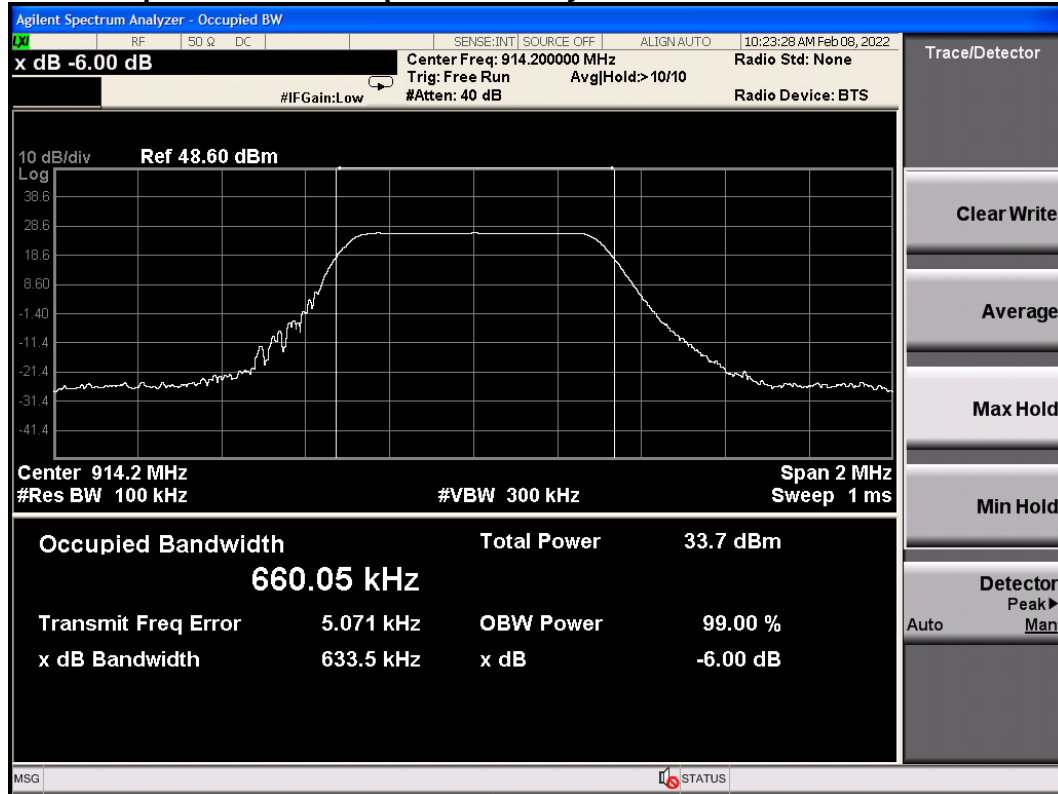
2.2.5 Channel Occupied Bandwidth Data:

Mode of operation	Channel	Freq. [MHz]	6 dB BW [kHz]	Limit BW [KHz]
LoRa 500 KHz	Low	903	633.4	≥ 500
	Mid	914.2	633.5	
	High	927.5	633.4	

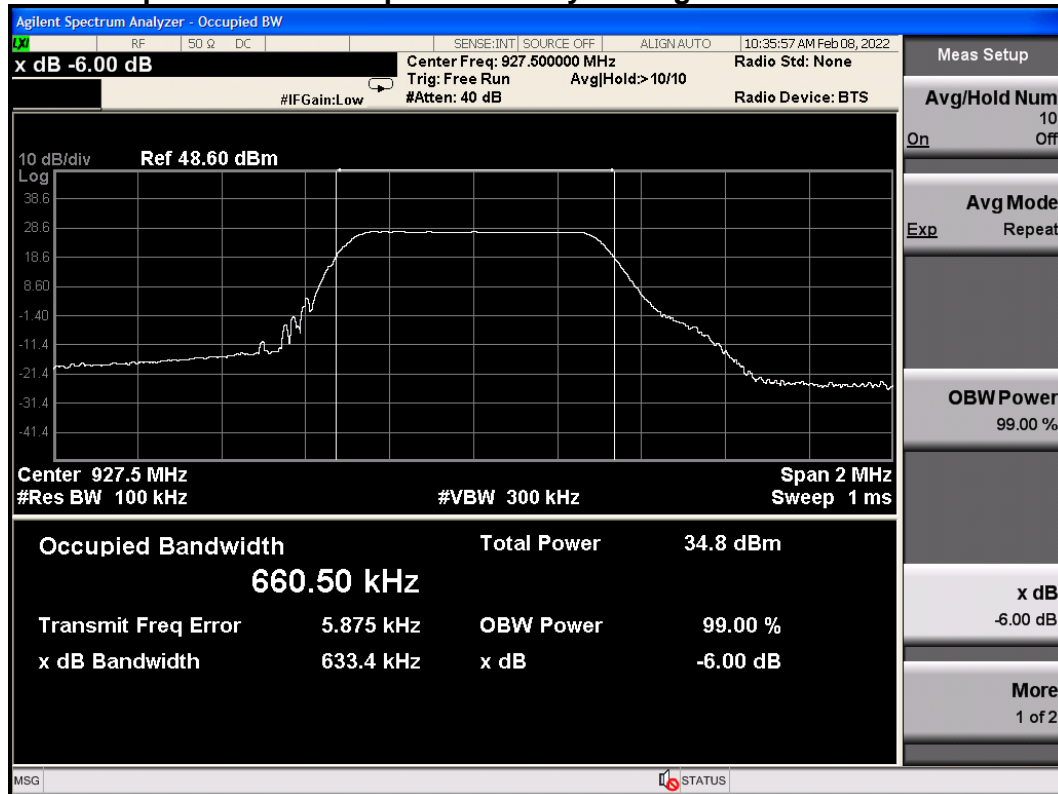
Screen Captures from the spectrum analyzer: Low Channel



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: Kona Micro Gateway
Test Personnel: : Imran Akram	Standard: FCC PART 15.247
Date: 2022-02-08 (20.7°C, 11.3 % RH)	Basic Standard: ANSI C63.10: 2013 FCC OET KDB 558074
EUT status: Compliant	

Specification: FCC Part 15.247(b, 3)

Criteria (3) For systems using digital modulation in the 902-928 MHz bands: 1 Watt.

2.3.1 Test Guidance: ANSI C63.10-2013, Clause 11.9.2.2.2/ 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
EXA Signal Analyzer	Agilent	N9010A FW A.14.16	6678	2021-07-22	2022-07-22
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:

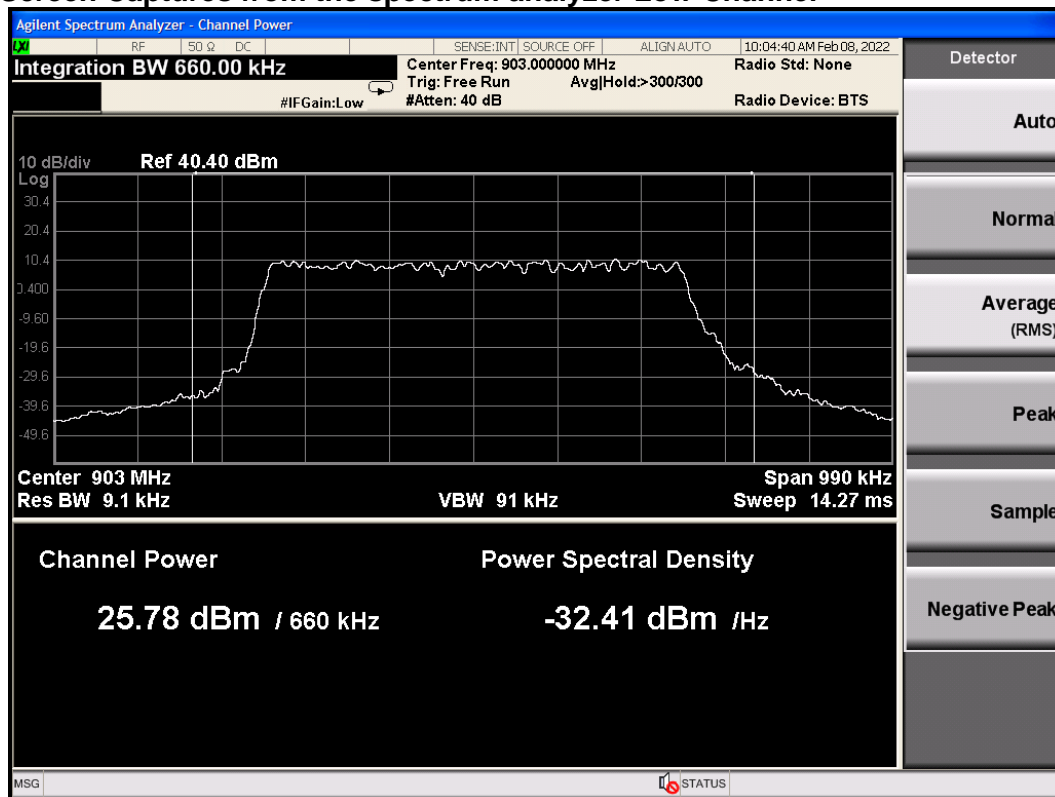


2.3.5 Max Output Power Data

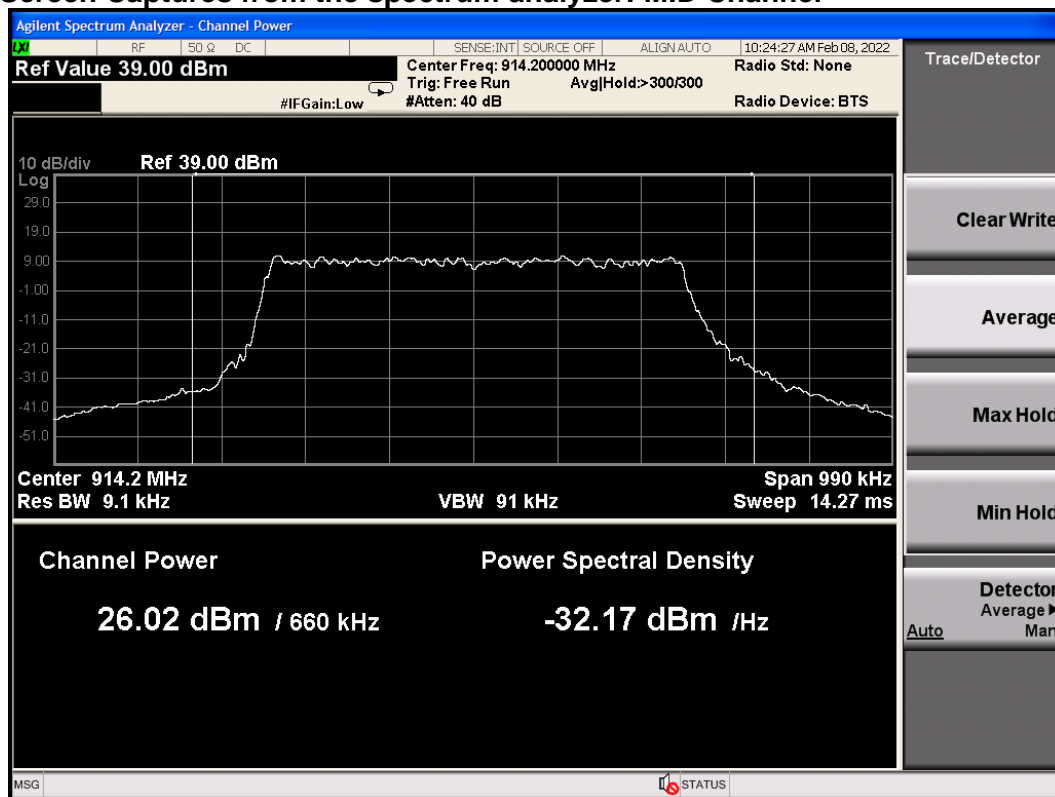
Mode of Operation	Channel	Freq. [MHz]	Out Put Power (dBm)	Out Put Power Limit (dBm)
LoRa 500 KHz	Low	903	25.78	30
	Mid	914.2	26.02	30
	High	927.5	25.63	30

Output Power Method AVGSA-1 For DTS	
Span	≥ 1.5 times the OBW
RBW	1 – 5 % of the OBW, ≤ 1 MHz
VBW	$\geq 3 \times$ RBW
Number of Points in sweep	$\geq 2 \times$ Span / RBW
Sweep time	Auto
Detector	RMS (Power Averaging)
Sweep trigger	Free Run (Duty Cycle $\geq 98\%$)
Trace Average	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.

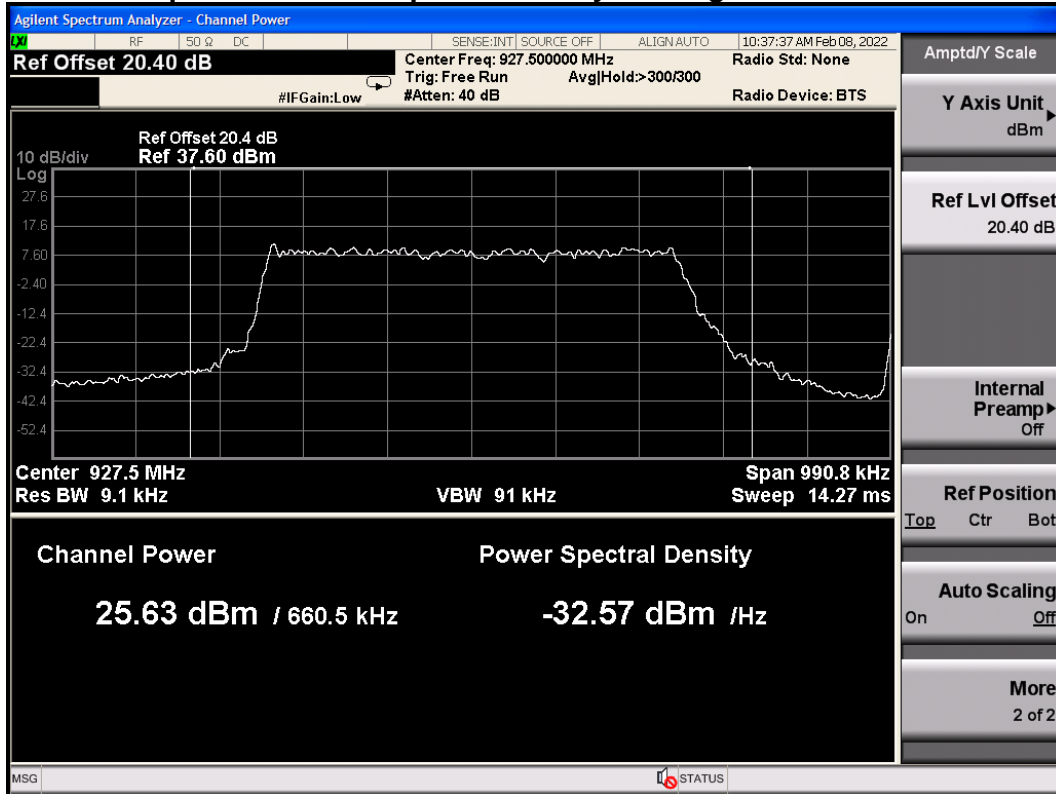
Screen Captures from the spectrum analyzer Low Channel



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: Kona Micro Gateway

Test Personnel: : Imran Akram

Standard: FCC PART 15.247

Basic Standard: ANSI C63.10: 2013

Date: 2022-02-08 (20.7°C, 11.3 % RH)

EUT status: Compliant

Specification: FCC Part 15.247(e)

Criteria For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna 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.

Output Power Method AVGPDS-1 For DTS	
Span	≥ 1.5 times the OBW
RBW	$3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
VBW	$\geq 3 \times \text{RBW}$
Number of Points in sweep	$\geq 2 \times \text{Span} / \text{RBW}$
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)
PSD measured	Use the peak marker function to determine the maximum amplitude level.
If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).	

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

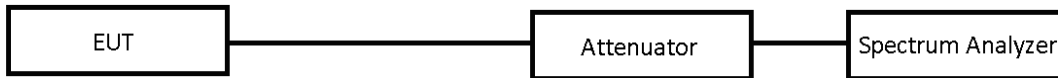
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EXA Signal Analyzer	Agilent	N9010A FW A.14.16	6678	2021-07-22	2022-07-22
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.

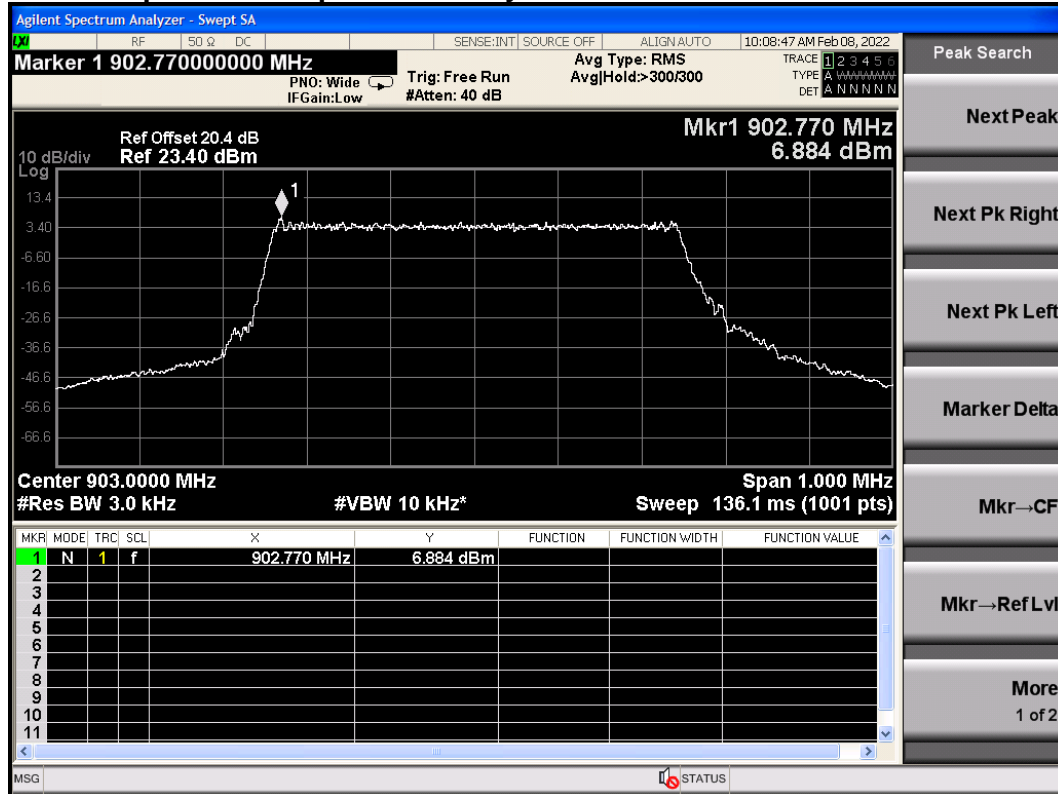
Test setup diagrams for Peak Power Spectral Density testing:
Conducted:



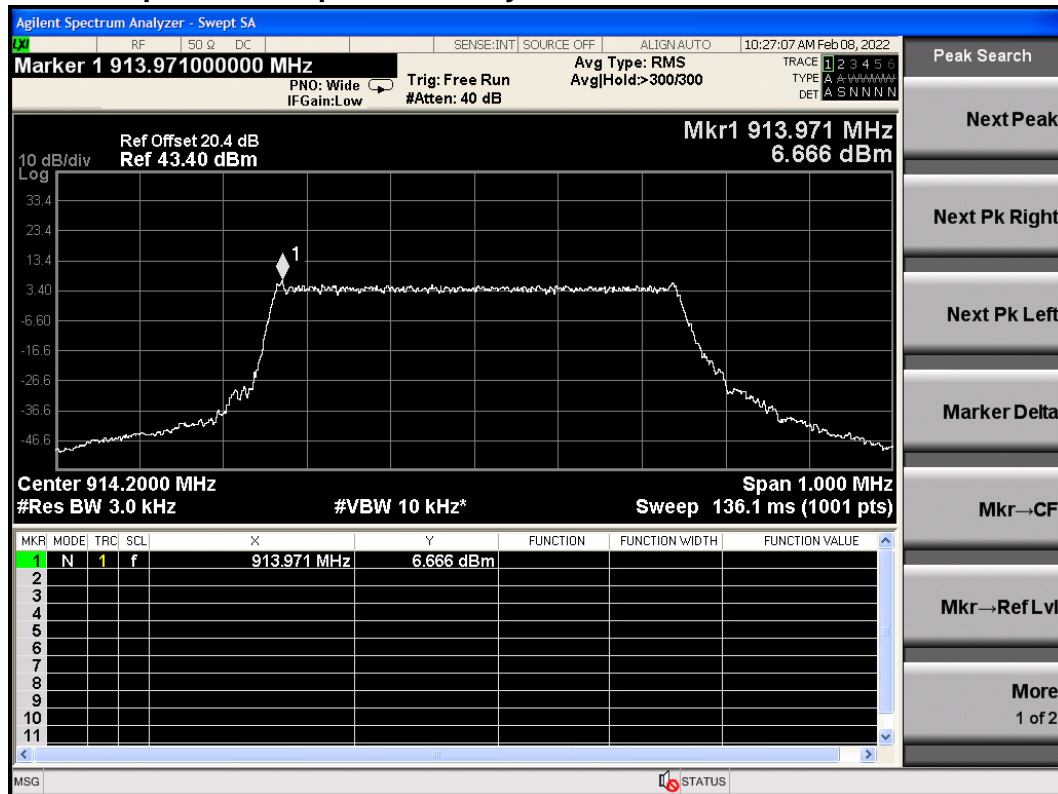
2.4.5 Peak PSD Data

Mode of operation	Channel	Freq. [MHz]	PSD (dBm)	PSD Limit (dBm)
LoRa 500 KHz	Low	903	6.884	8
	Mid	914.2	6.666	8
	High	927.5	6.350	8

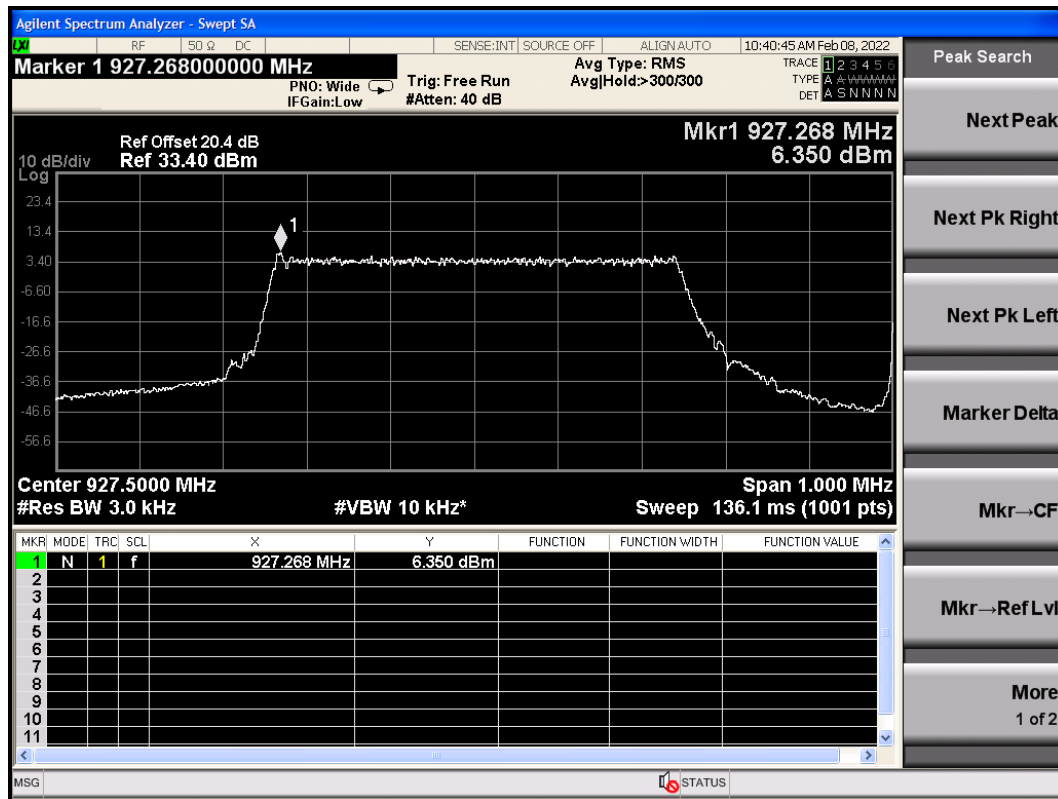
Screen Capture from Spectrum Analyzer: Low Channel



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: Kona Micro Gateway

Test Personnel: Imran Akram

Standard: FCC PART 15.247

Basic Standard: ANSI C63.10: 2013

Date: 2022-02-08 (20.7°C, 11.3 % 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 11.13.2 & 6.10.4, 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.

The spectrum analyzer is set for a frequency span to show the band edge and the nearest channel. The RBW is set to ≥ 100 kHz. The VBW is set to $\geq (\text{RBW} * 3)$. The Peak detector is used, with the trace set to Max Hold.

The attenuation is measured with the Marker Delta function.

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:

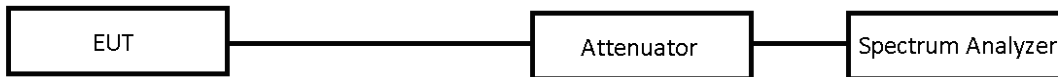
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EXA Signal Analyzer	Agilent	N9010A FW A.14.16	6678	2021-07-22	2022-07-22
Temp/Humidity	Extech	42270	5892	2021-04-05	2022-04-15
Attenuator	Mini-Circuits	BWS102W263	6932	Cal. before each use	
Coaxial Cables (RF)	Huber+Suhner	Enviroflex 400	-	Cal. 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:

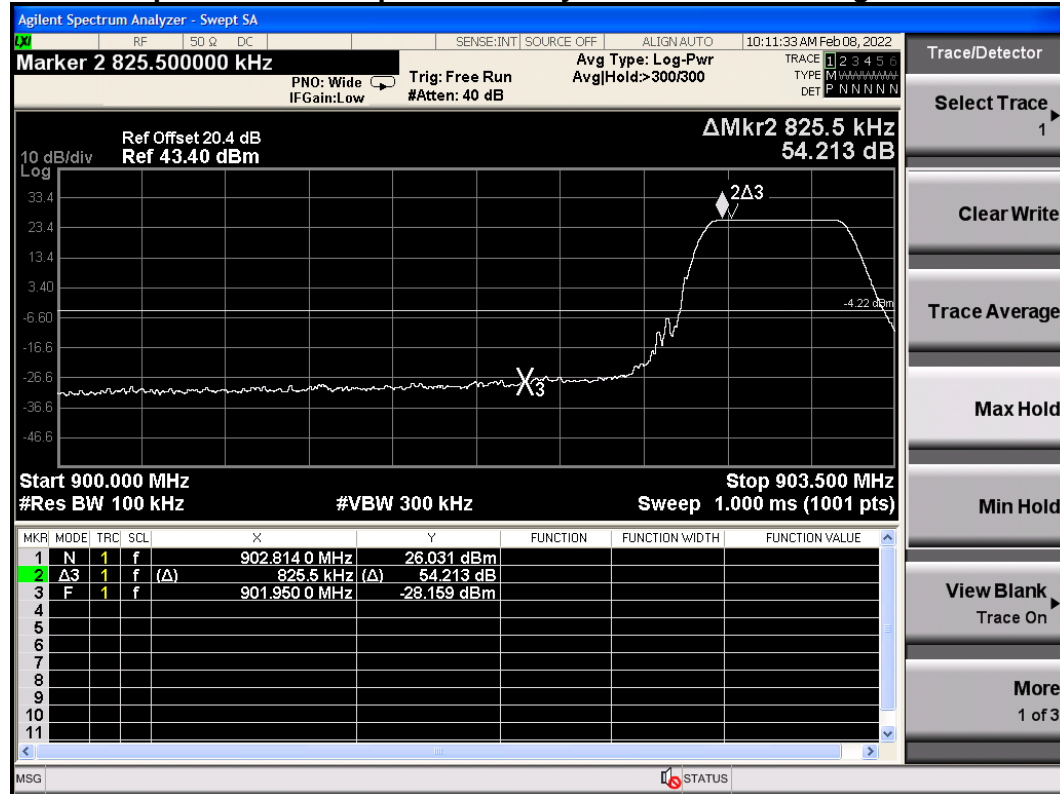


2.5.5 Band Edge Data

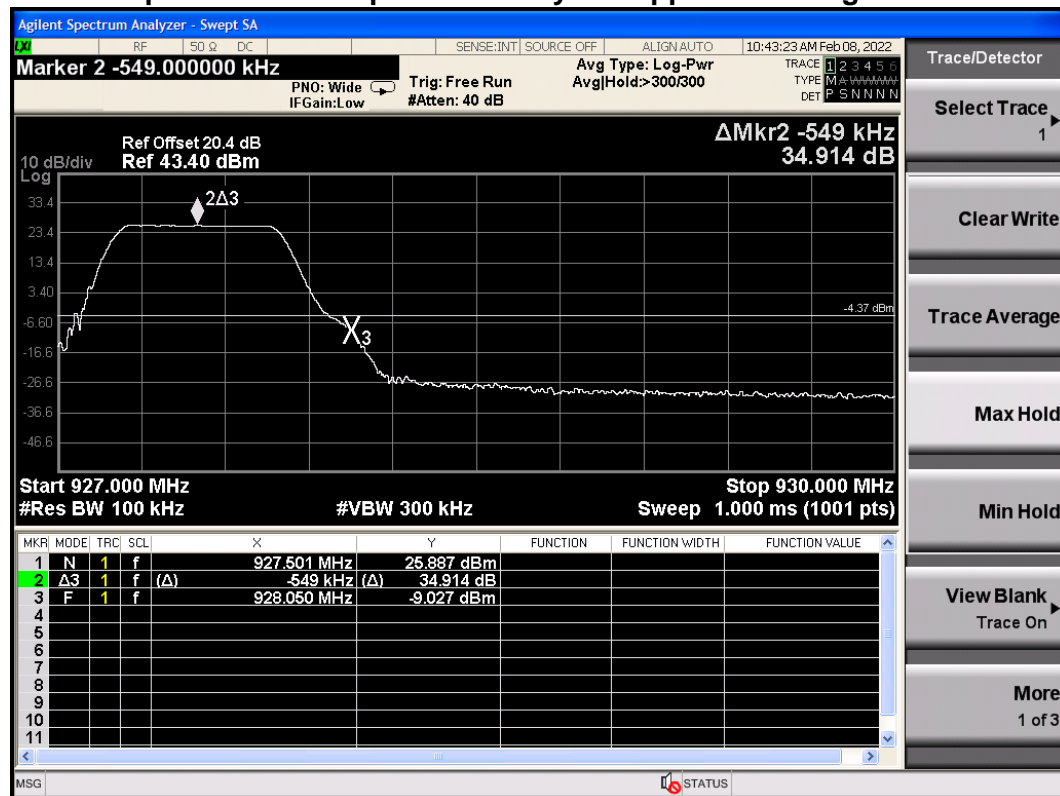
Worse Case Data

Mode of operation	Channel	Attenuation at Band Edge	Attenuation Limit at Band Edge
Lora 500KHz	903	54.213dBc	30 dBc
	927.5	34.914dBc	30 dBc

Screen Capture from the spectrum analyzer: Lower Band Edge



Screen Capture from the spectrum analyzer: Upper Band Edge



2.6 Conducted Spurious Emissions (Non-Restricted Band)

Test Lab: Electronics Test Centre, Airdrie	EUT: Kona Micro Gateway
Test Personnel: Imran Akram	Standard: FCC PART 15.247
Date: 2022-02-08 (20.7°C, 11.3 % 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

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.

The spectrum analyzer is stepped through the spectrum in frequency spans selected to ensure acceptable frequency resolution. The RBW is set to 100 kHz. The VBW is set to ≥ 300 kHz. The Peak detector is used, with the trace set to Max Hold.

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
EXA Signal Analyzer	Agilent	N9010A FW A.14.16	6678	2021-07-22	2022-07-22
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

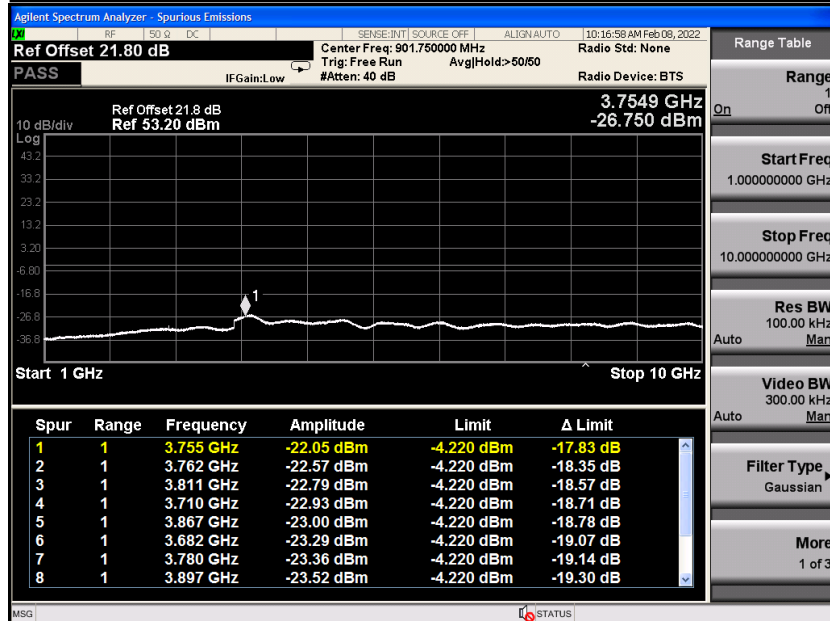
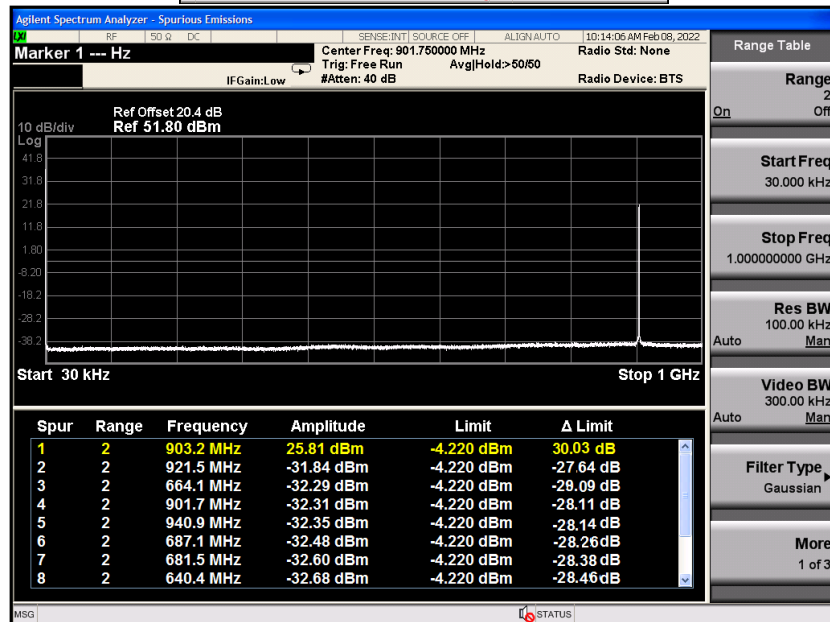
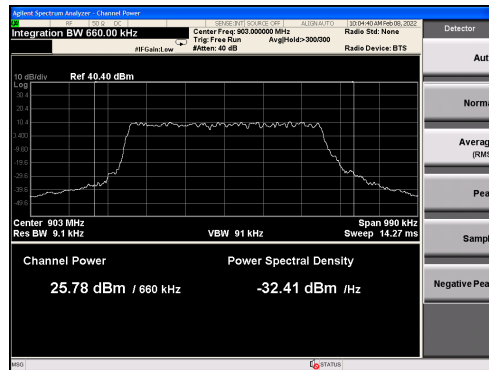
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagram for Conducted Spurious Emissions testing:

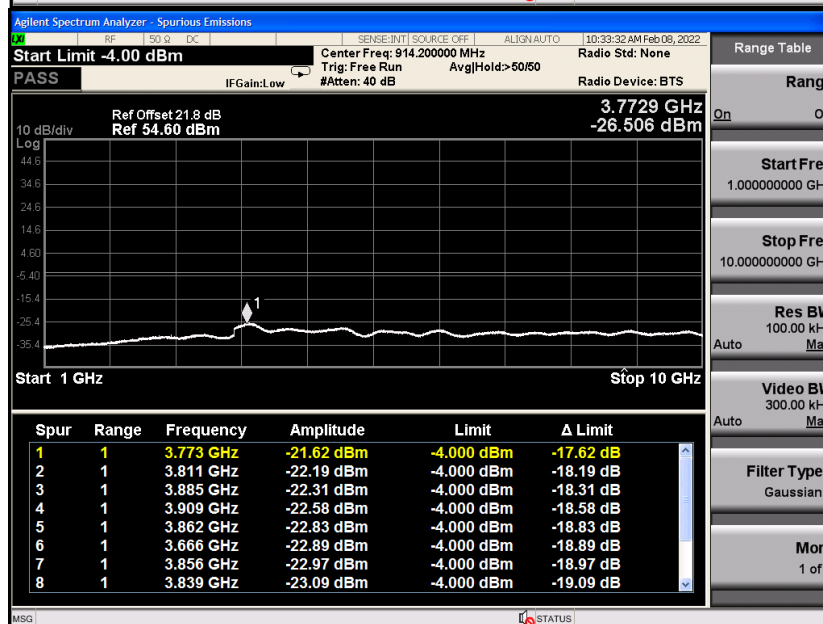
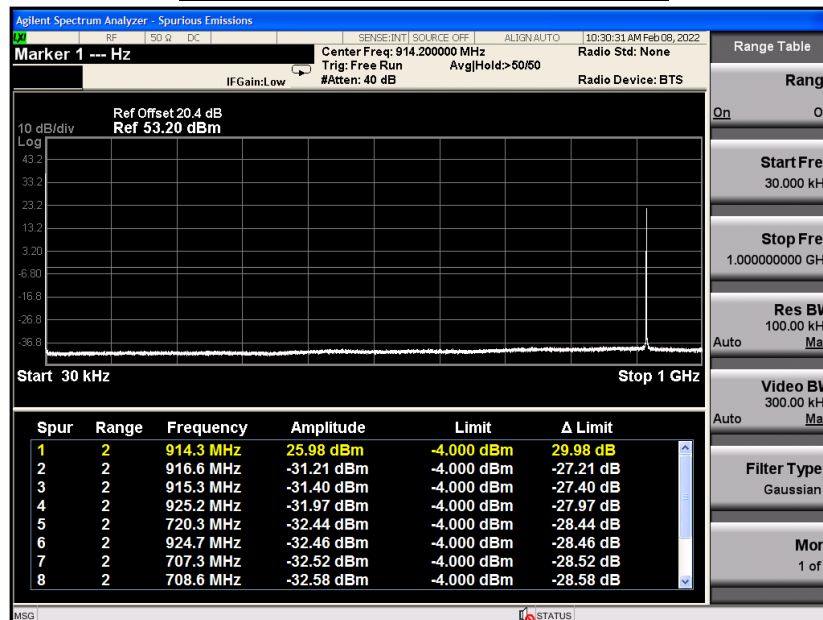
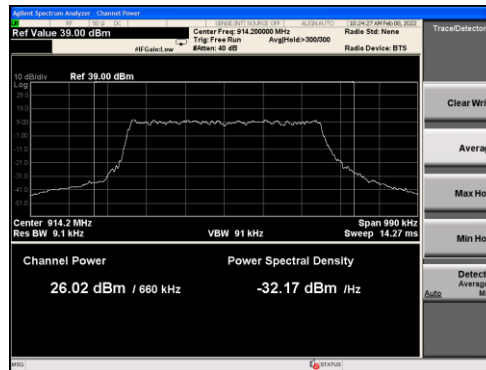


2.6.5 Conducted Emissions Data:

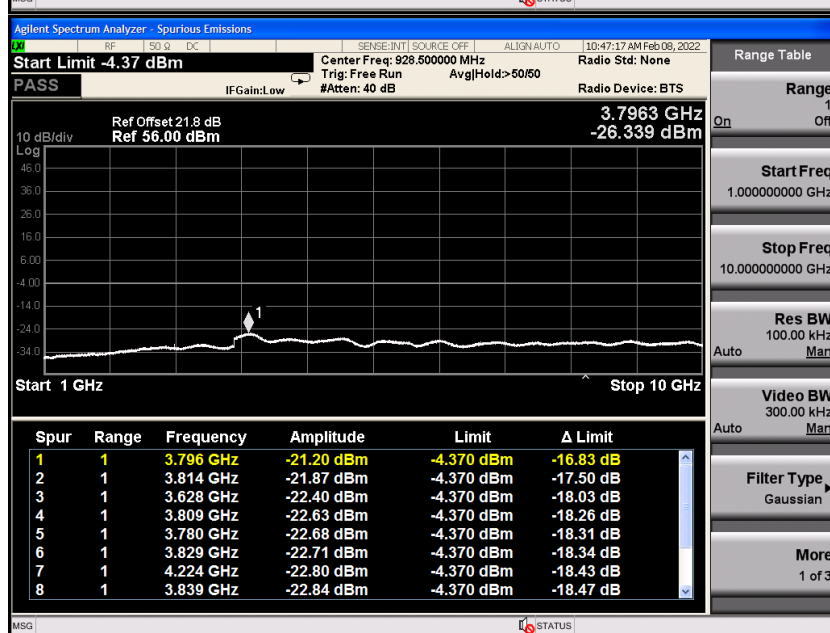
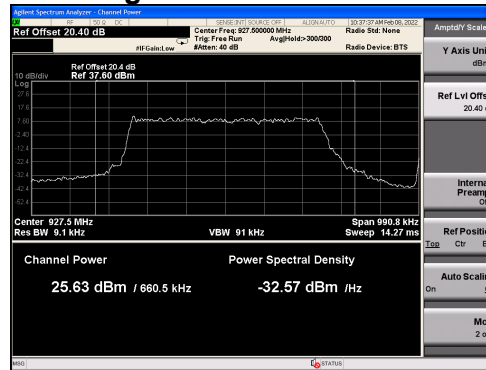
Low Channel



MID Channel



High Channel



2.7 EUT Positioning Assessment

Test Lab: Electronics Test Centre, Airdrie

EUT: Kona Micro Gateway

Test Personnel: Imran Akram/ Janet Mijares

Standard: FCC PART 15.247

Date: 2022-02-04 (21.0° C, 8.2 % RH)

Basic Standard: ANSI C63.4-2014

Comments: Unit real life installation is either wall mount or Table Top. Both positions were assed. Table top 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.

2.8 Radiated Spurious Emissions / Co-Location within restricted band

Test Lab: Electronics Test Centre, Airdrie EUT: Kona Micro Gateway
Test Personnel: Imran Akram Standard: FCC PART 15.247/15.209
Date: 2022-02-04/07/11 (20.7° C, 11.13 % RH) Basic Standard: ANSI C63.10-2013

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. 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	12.290000 - 12.293000	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:

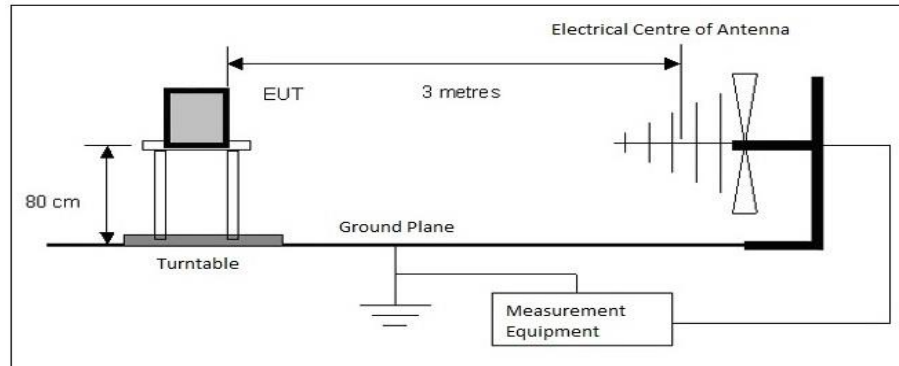
Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2021-06-18	2022-06-18
Loop Antenna	EMCO	6502	10868	2021-05-11	2023-05-11
Biconilog Antenna	AR	JB1	6905	2021-10-29	2023-10-29
DRG 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
High Pass Filter	K&L	4DH21	-	2021-05-11	2022-05-11

2.8.4 Test Sample Verification, Configuration & Modifications

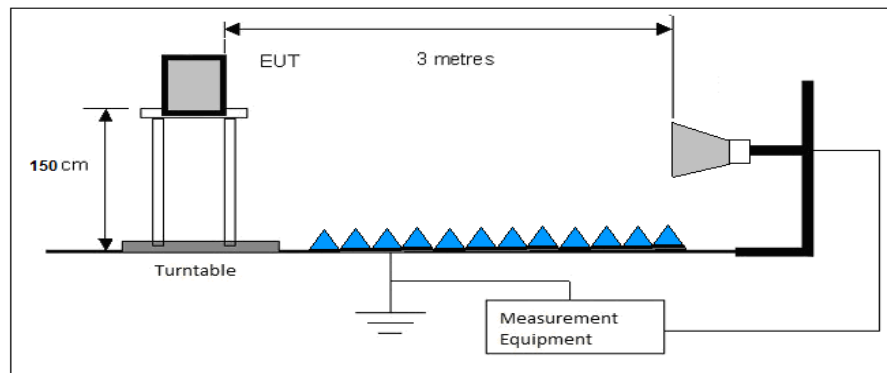
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. Both radios transmitting simultaneously, pre-approved GSM module is transmitting at 784 MHz and LoRa radio transmitting at low Channel 903.0 MHz.

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 903 MHz was selected as the worst-case condition for detailed examination.
- In Transmit mode, the EUT was assessed up to 10.0 GHz.

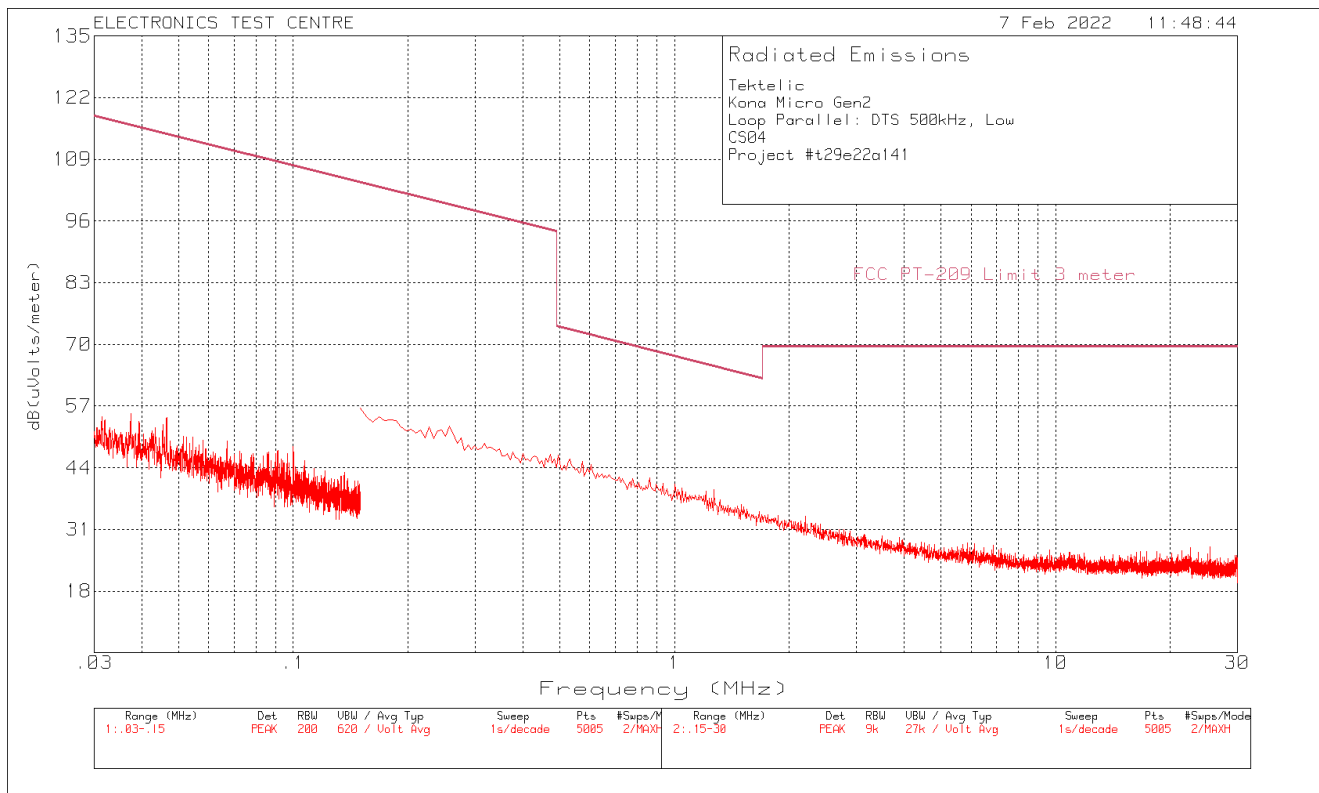
Negative values for Delta indicate compliance.

Spurious Emission

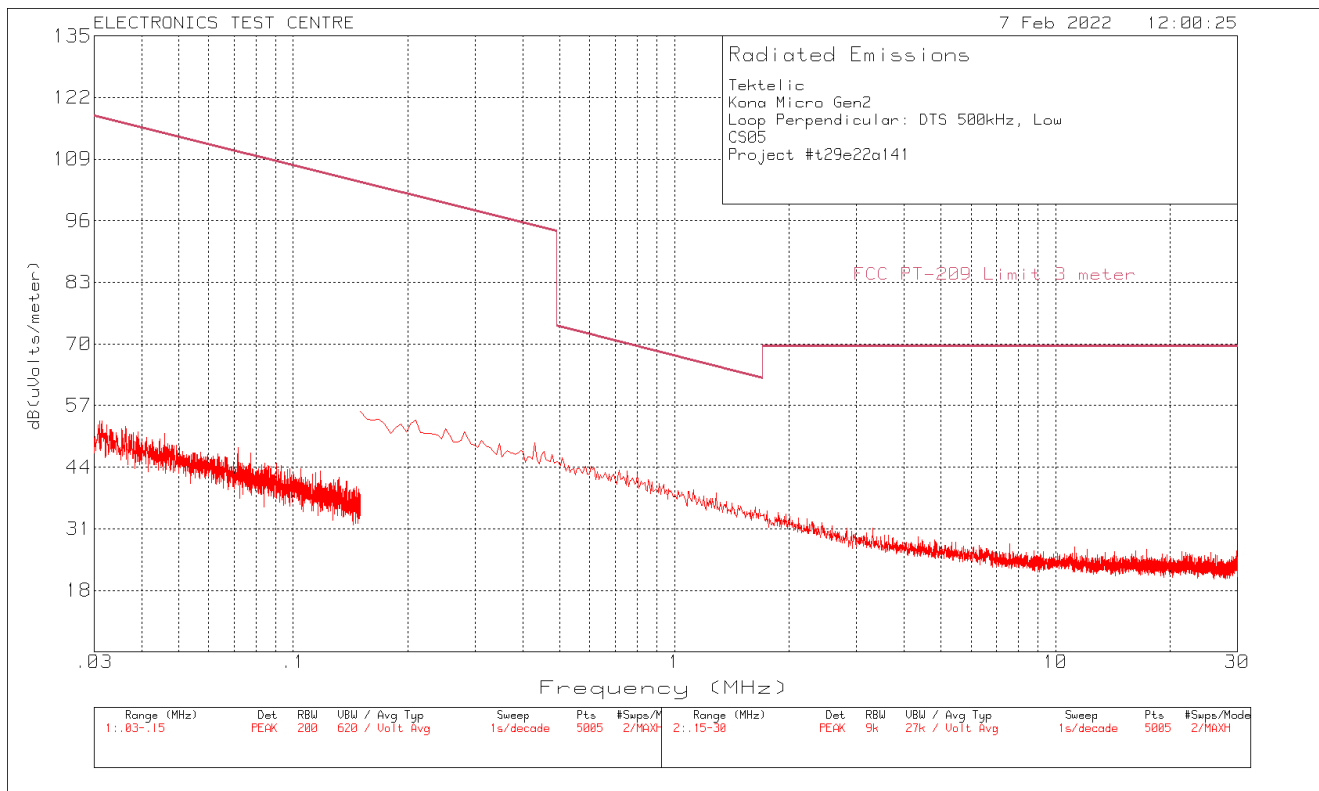
Freq. Marker	Freq. [MHz]	Raw reading [dBμV]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBμV/m]	FCC 15.209 Limit [dBμV/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	*120.83	21.7	QP	17.7	2.7	42.16	43.52	-1.36	75	103	Vertical
1	*1023.9	31.94	AV	24.2	-19.5	36.64	54	-17.36	166	189	Horizontal
1	*1023.9	40.84	PK	24.2	-19.5	45.54	74	-28.46	166	189	Horizontal
2	*1024.0	39.64	AV	24.2	-19.5	44.34	54	-9.66	246	113	Vertical
2	*1024.0	46.01	PK	24.2	-19.5	50.71	74	-23.29	246	113	Vertical
1	*2709.3	47.09	AV	29.1	-33.2	42.99	54	-11.01	218	222	Horizontal
1	*2709.3	60.04	PK	29.1	-33.2	55.94	74	-18.06	218	222	Horizontal
2	*2709.3	56.65	AV	29.1	-33.2	52.55	54	-1.45	336	234	Vertical
2	*2709.3	69.34	PK	29.1	-33.2	65.24	74	-8.76	336	234	Vertical
3	*5417.4	35.13	AV	33.9	-30.5	38.53	54	-15.47	226	200	Vertical
3	*5417.4	46.22	PK	33.9	-30.5	49.62	74	-24.38	226	200	Vertical
4	*7223.6	29.77	AV	35.9	-27.7	37.97	54	-16.03	89	207	Vertical
4	*7223.6	42.59	PK	35.9	-27.7	50.79	74	-23.21	89	207	Vertical
5	*8127.4	32.19	AV	36.6	-26.4	42.39	54	-11.61	205	379	Vertical
5	*8127.4	45.52	PK	36.6	-26.4	55.72	74	-18.28	205	379	Vertical
6	*9030.4	24.33	AV	37.6	-26.5	35.43	54	-18.57	220	217	Vertical
6	*9030.4	38.24	PK	37.6	-26.5	49.34	74	-24.66	220	217	Vertical

* Restricted Band

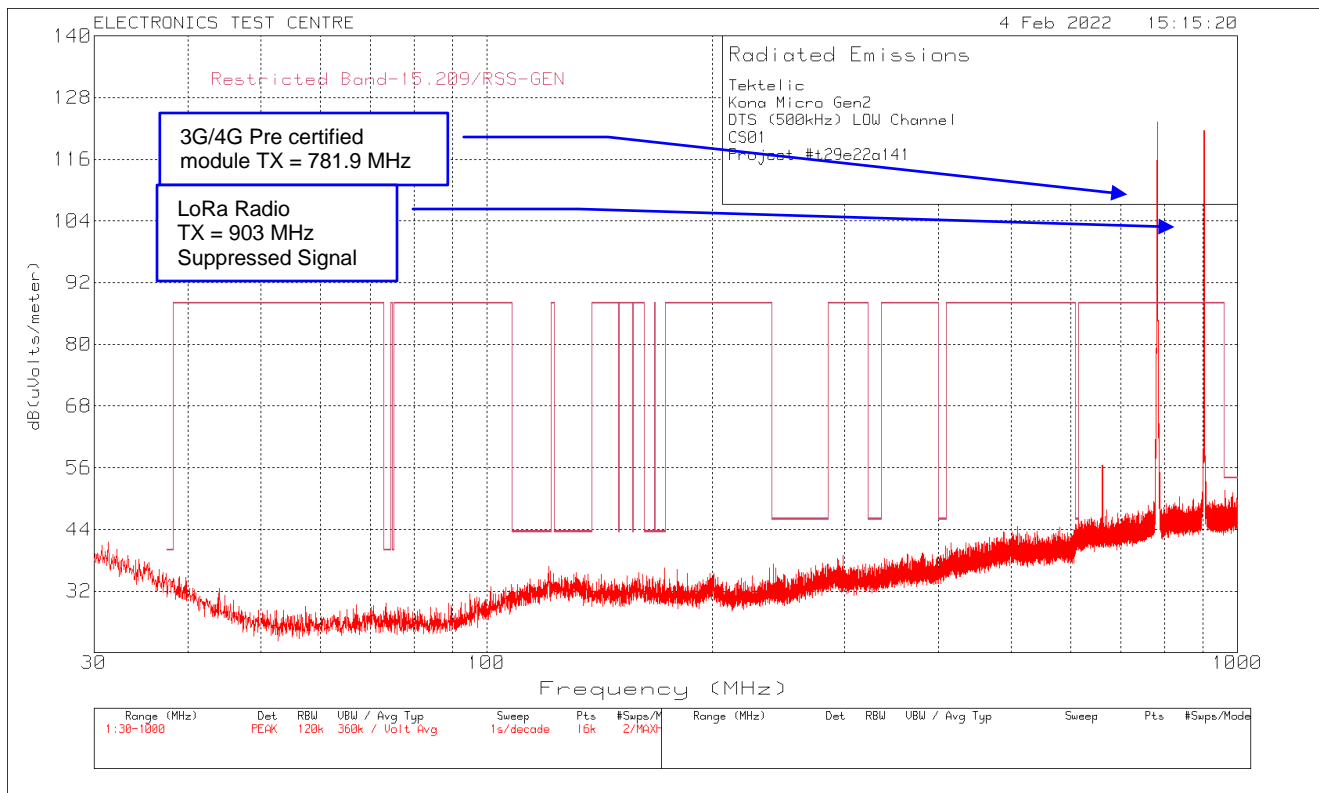
Plot of Radiated Emissions: Measuring Antenna Parallel



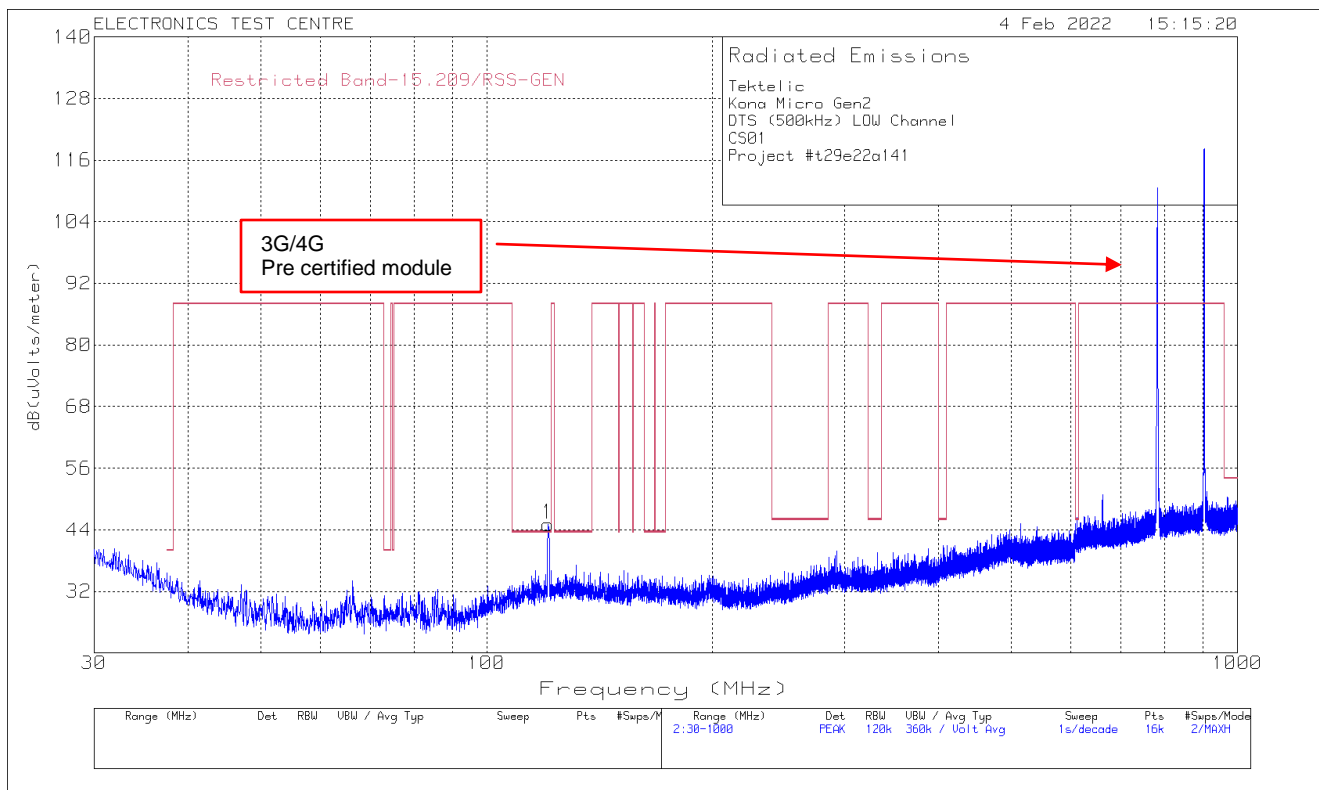
Plot of Radiated Emissions: Measuring Antenna Perpendicular



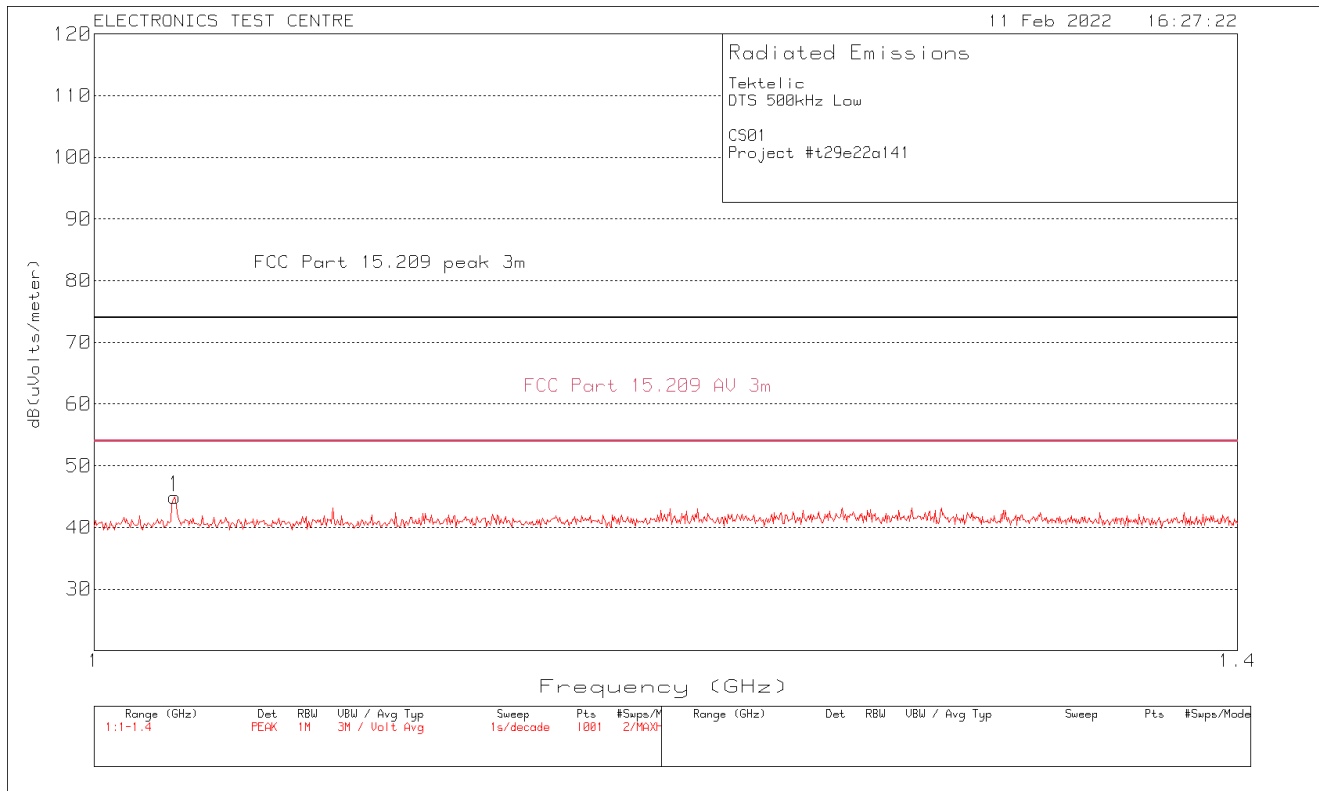
Plot of Radiated Emissions: Horizontal polarization



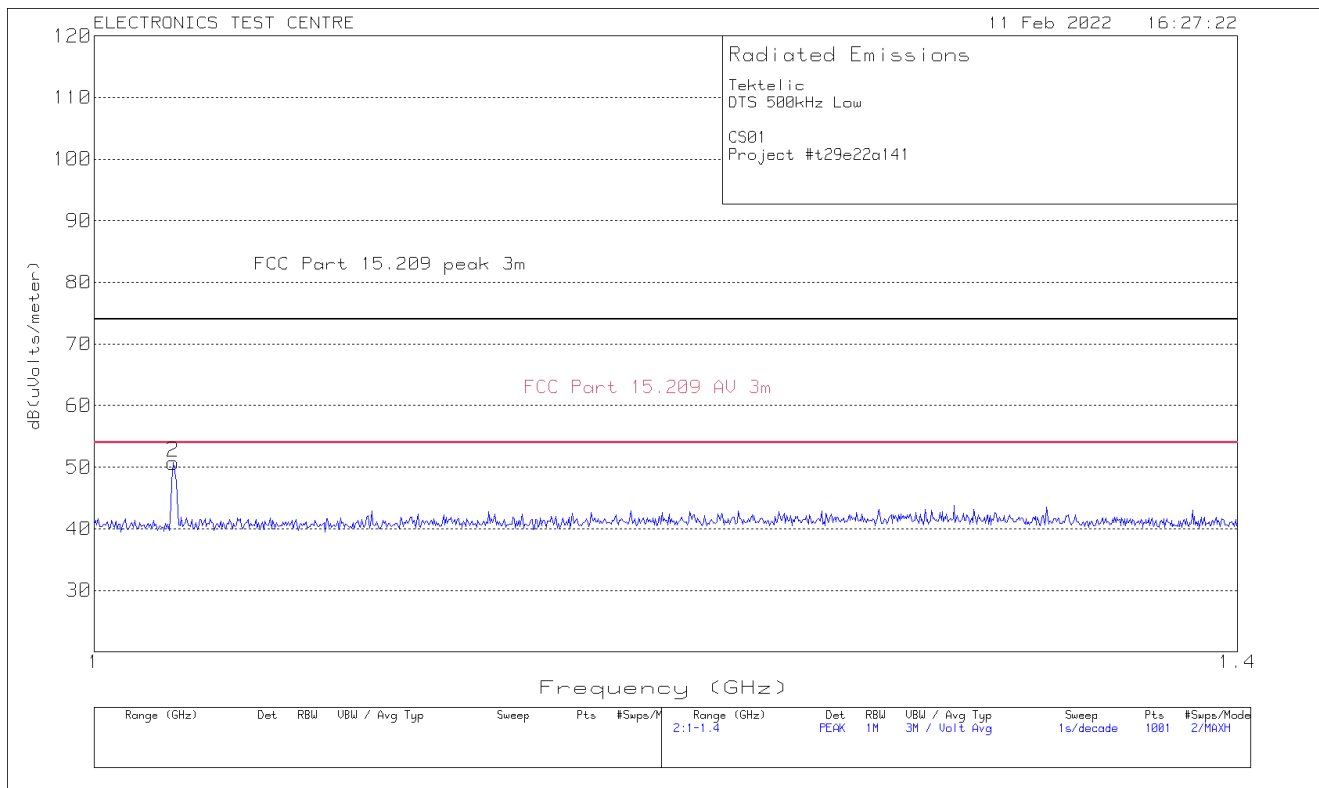
Plot of Radiated Emissions: Vertical polarization



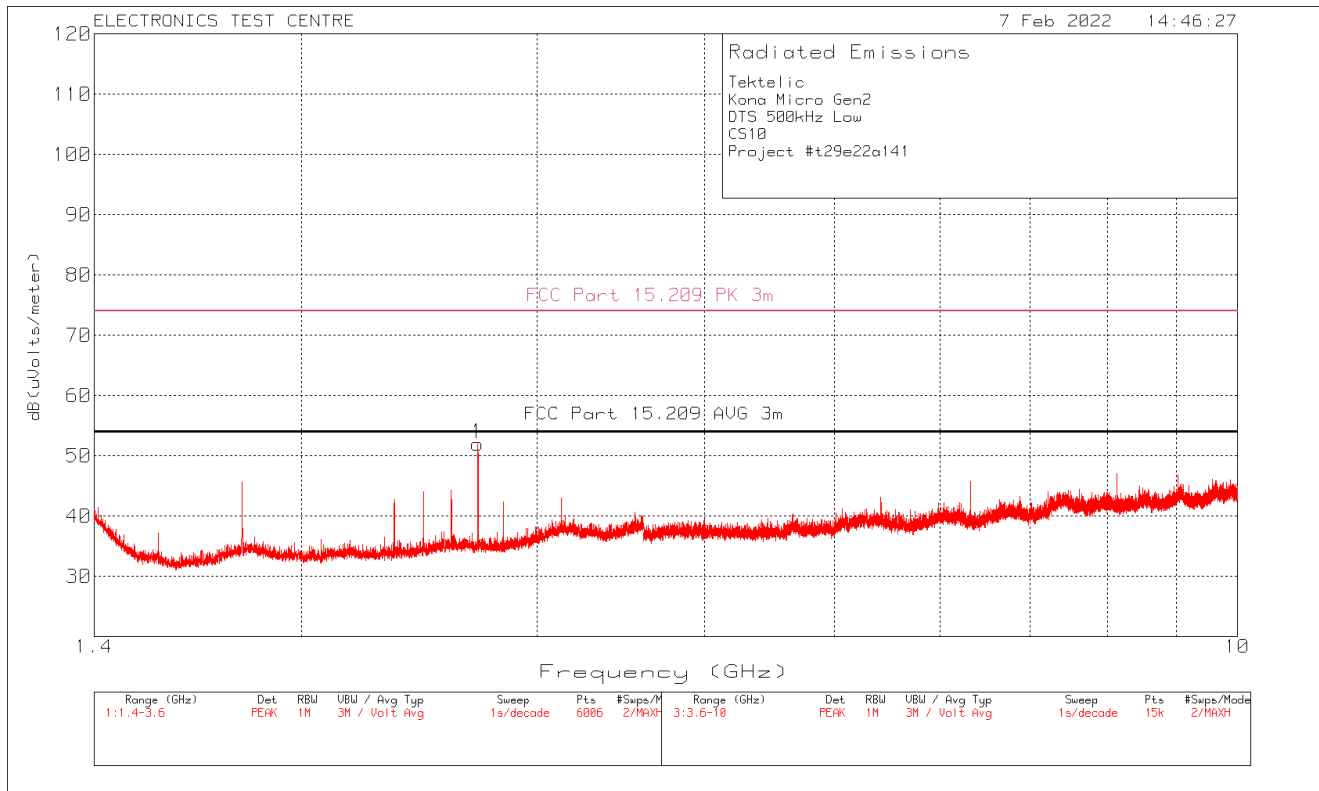
Plot of Radiated Emissions: Horizontal polarization



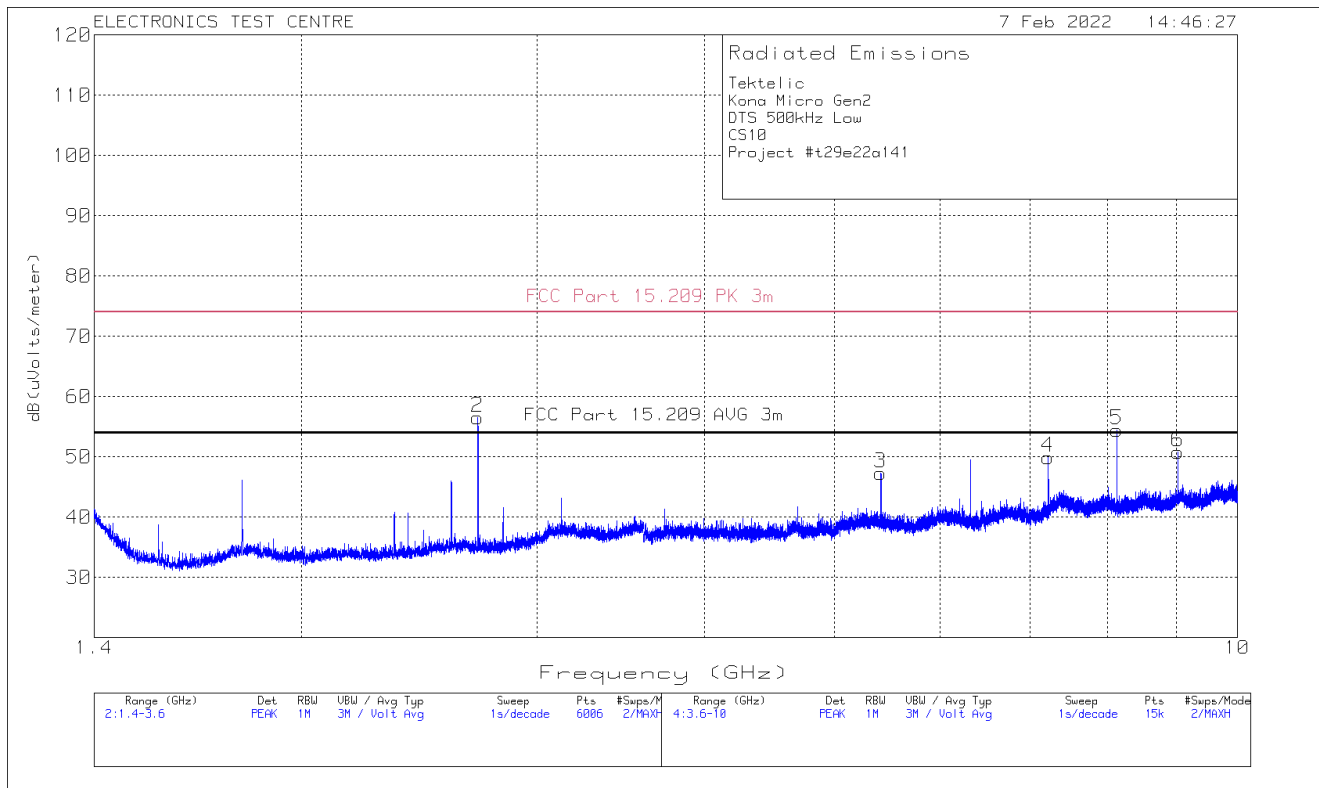
Plot of Radiated Emissions: Vertical polarization



Plot of Radiated Emissions: Horizontal polarization



Plot of Radiated Emissions: Vertical polarization



2.9 RF Exposure

Test Lab: Electronics Test Centre, Airdrie	EUT: Kona Micro Gateway
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 Kona Micro Gateway 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.

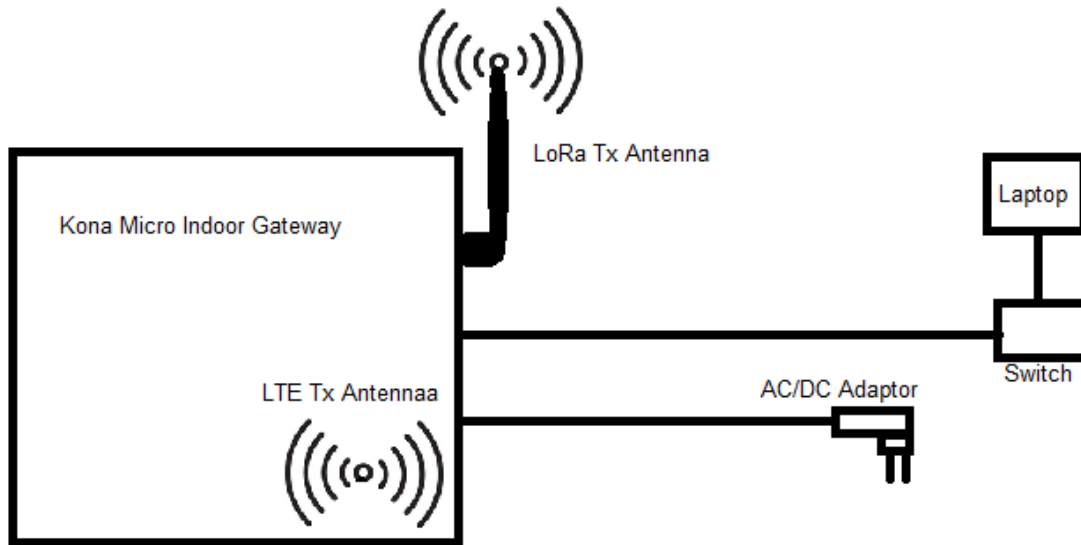
3.2 Grounding Plan

The Kona Micro Gateway was placed at the center of the test chamber turntable on top of an 80-cm high polystyrene foam table below 1GHz and at 1.5m high polystyrene foam table above 1 GHz. The EUT was grounded according to Tektelic Communication Inc. specifications.

3.3 Power Supply

All EUT power was supplied by an AC/DC adaptor.

Appendix A – Test Setup Block Diagram



End of Document