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EMC testing of the Tektelic Communication Inc. Kona Micro Indoor Gateway in accordance with FCC Part 15.247, ANSI C63.4: 2014 and ANSI C63.10: 2013 as referenced by FCC OET KDB 558074 D01 DTS Measurement Guidance v04. FCC ID: 2ALEPT0005281

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REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2018-02-01	I. Akram	Initial draft submitted for review.
Release 1	2018-02-28	M. Rousseau	Sign off
Release 2	2018-03-05	I. Akram	Updated position assessment in Section 2.7

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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 ANSI C63.4-2014 and ANSI C63.10-2013. All test procedures, limits, criteria, and results described in this report apply only to the Tektelic Communication Inc. Kona Micro Indoor Gateway test sample, referred to herein as the EUT (Equipment Under Test).

This report does not imply product endorsement by the Electronics Test Centre, SCC, NAVLP, 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 Indoor Gateway
Lora Radio	**Frequency Range**		923.3 – 927.5 MHz
	Type of Modulation		LoRa 500KHz DTS
	Associated Antennas	**LoRa**	Airgain ET830DBLTRPSMA Embedded Antenna, omni directional, 2.7 dBi
		3G/4G	Pulse Electronics W3907B0100 LTE Diversity Antenna, omni directional, 1.7 to 4.2 dBi
Model# / Serial#			T0005126* / 647FDA00523A
Power supply:			(100 – 240)AC/DC Adaptor (12VDC@1A)

This product is a Kona micro indoor gateway is a LoRa base station. It may incorporate a 3G/4G backhaul module, FCC ID N7NEM7355. Antenna information from vendor are provided in Appendix A.

*This model contains all of the equipment options in this family of products. This model represents model number T0005126, T0004855, T0005203 and T0005204. This model was chosen as a worst-case condition for emission testing.

All models use identical electrical host board. The only electrical difference is the 3G/4G module (on model T0004855 and T0005204). The other variation is implemented battery backup.

1.4 General Test Conditions and Assumptions

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 Scope of Testing

Tests were performed in accordance with FCC Part 15.247, ANSI C63.4-2014, and ANSI C63.10-2013 as referenced in FCC KDB 558074 D01 v04 for DTS.

1.5.1 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.

1.5.2 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.

1.5.3 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.

1.5.4 EUT Functionality

The Kona Micro Indoor gateway (GW) is designed for enterprise and lightweight industrial application. The GW operates in the ISM band 902 MHz–928 MHz, with receive occupying 902 MHz–915 MHz and transmit occupying 923 MHz–928 MHz. The Kona Micro indoor is a full-duplex module that allows for simultaneous TX and RX operation. The Micro Indoor Gateway houses a single PCBA which provides all the functionality required by the product with the exception of an optional pre-certified 3G/4G cellular modem

Radio Antenna port conducted emission testing is performed with duty cycle ≥98%. For radiated spurious emission pre scan was performed near low, mid and high channels low channel produce the highest emission, so it was used for detail analysis for spurious emission.

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.

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 Indoor Gateway	none	see § 2.1	**Compliant**
2.2	Occupied Bandwidth	15.247(a)	Kona Micro Indoor Gateway	none	see § 2.2	**Compliant**
2.3	Max Output Power	15.247(d)	Kona Micro Indoor Gateway	none	see § 2.3	**Compliant**
2.4	Power Spectral Density	15.247(e)	Kona Micro Indoor Gateway	none	see § 2.4	**Compliant**
2.5	Band Edge	15.247(d)	Kona Micro Indoor Gateway	none	see § 2.5	**Compliant**
2.6	Conducted Spurious	15.247(d)	Kona Micro Indoor Gateway	none	see § 2.6	**Compliant**
2.7	EUT Position	ANSI C63.4	Kona Micro Indoor Gateway	-	-	**n/a**
2.8	Radiated Spurious	15.205, 15.209 15.247(d)	Kona Micro Indoor Gateway	none	see § 2.8	**Compliant**
2.9	Radiated Emission (Rx Mode)	15.109	Kona Micro Indoor Gateway	none	see § 2.9	**Compliant**
2.10	AC Conducted Emission (Rx Mode)	15.107	Kona Micro Indoor Gateway	none	see § 2.10	**Compliant**
2.11	Antenna Requirements	FCC 15.203	Kona Micro Outdoor Gateway	none	-	**Compliant**
2.12	RF Exposure	15.247(i)	Kona Micro Indoor Gateway	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: Kona Micro Indoor Gateway**
Test Personnel: Imran Akram/ Bushra Muharram	**Standard: FCC Part 15.207**
Date: 2018-01-31(21.6C,11.5% RH)	**Basic Standard: ANSI C63.4: 2014**

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 C63.4-2014, Clause 7.3.1

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 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with UKAS (United Kingdom Accreditation Service) document “Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” As based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

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

Test Method	Frequency	Uncertainty
Conducted Emissions Level	150 KHz – 30 MHz	±2.7 dB

2.1.4 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	N/A
EMI receiver	Agilent	N9038A	6130	2017-06-20	2018-06-20
LISN	Com-Power	LI-150A	6121	2017-07-07	2019-07-07
LISN	Com-Power	LI-150A	6122	2017-07-07	2019-07-07
Temp/RH logger	Extech	42270	5892	2017-04-06	2018-04-06

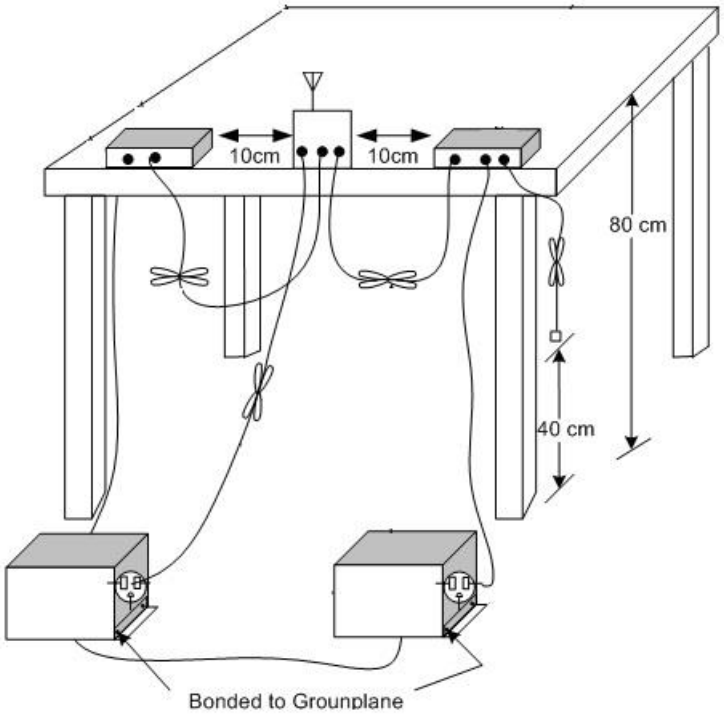
2.1.5 Test Sample Verification, Configuration & Modifications

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.

The EUT met the requirements without modification.

Test setup diagram:



2.1.6 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 mid-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	.35249	28.15	AV	0	10	38.15	48.9	-10.75	L
2	16.2281	30.63	AV	.1	10.1	40.83	50	-9.17	L
1	.35249	32.79	PK	0	10	42.79	48.9	-6.14	L
2	16.2281	34.51	PK	.1	10.1	44.71	50	-5.29	L
1	.35249	22.76	AV	0	10	32.76	48.9	-16.17	N
2	16.228	30.93	AV	.1	101	41.13	50	-8.87	N
3	17.6936	30.75	AV	.1	10.3	41.15	50	-8.85	N
4	18.2431	30.36	AV	.1	10.3	40.76	50	-9.24	N
1	.35249	33.1	PK	0	10	43.1	48.9	-5.77	N
2	16.228	34.68	PK	.1	101	44.88	50	-5.15	N
3	17.6936	34.23	PK	.1	10.3	44.63	50	-5.37	N
4	18.2431	33.72	PK	.1	10.3	44.12	50	-5.88	N

Av = Average Detector

PK = Peak Detector

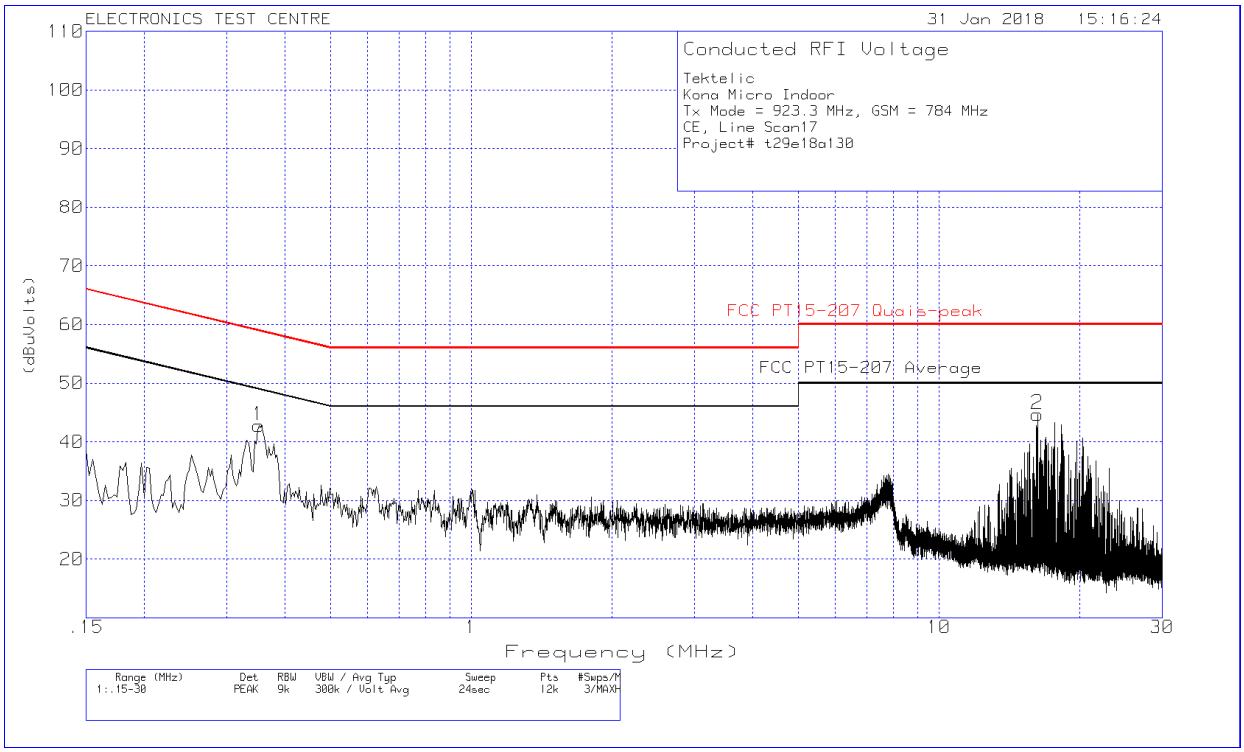
Raw Reading in dBµV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dbµV/m.

Note: When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.

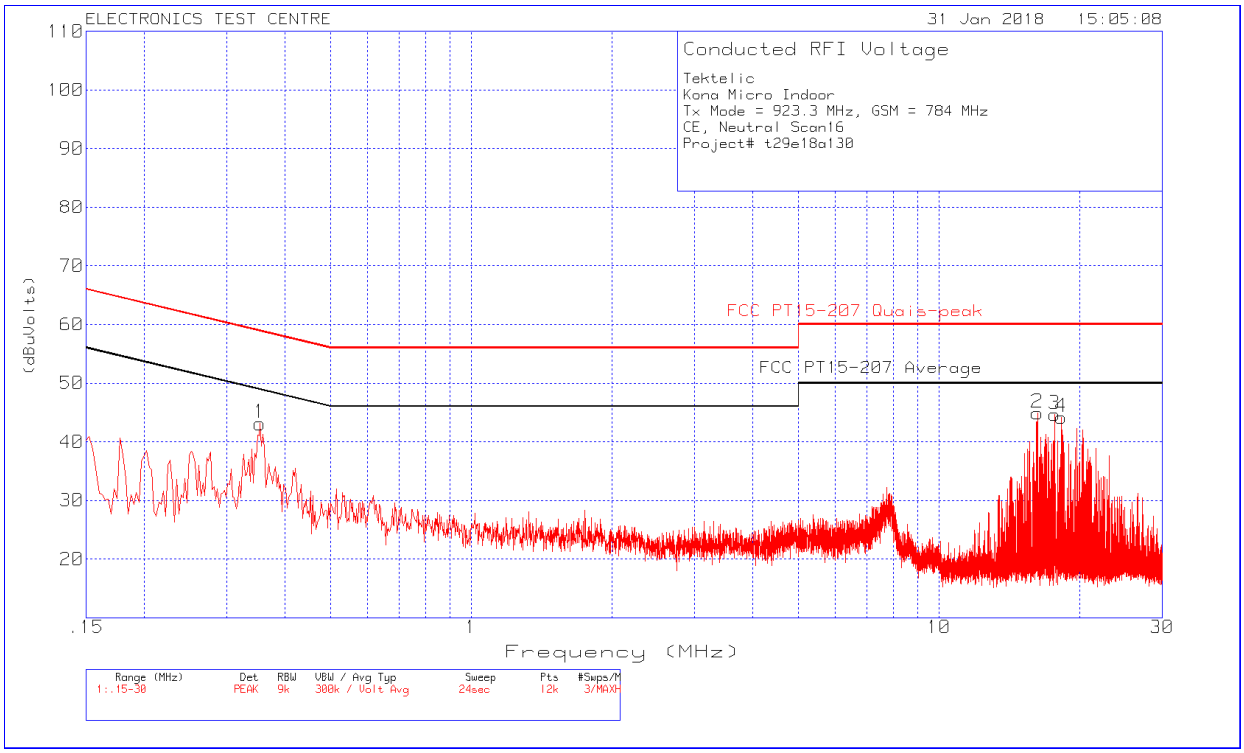
Negative values for Delta indicate compliance.

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

Plot of Conducted Emissions: Line



Plot of Conducted Emissions: Neutral



2.2 Channel Occupied Bandwidth

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Micro Indoor Gateway**
Test Personnel: Imran Akram/ Bushra Muharram	**Standard: FCC PART 15.247**
Date: 2018-01-29 (19.9°C,8.4% 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 6.9.2 & 6.9.3/ FCC OET KDB 558074 Section 8 Option 2

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, with out the need for any further corrections.

For DTS the spectrum analyzer is set for a frequency span ≥ (2 * OBW), ≤ (5 * OBW), selected to clearly display the channel. The RBW is set to 100 kHz. The VBW is set to ≥ (3 * 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:

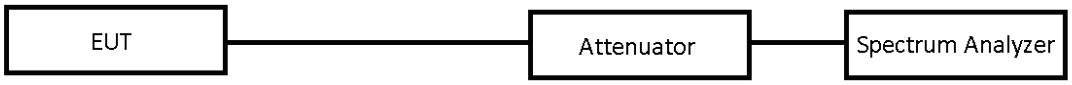
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	2018-04-06
Attenuator	JFW	50FH-020-10	-	Monitored	
DC Blocker	MCL	BLK-89-S+	-	Monitored	

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:

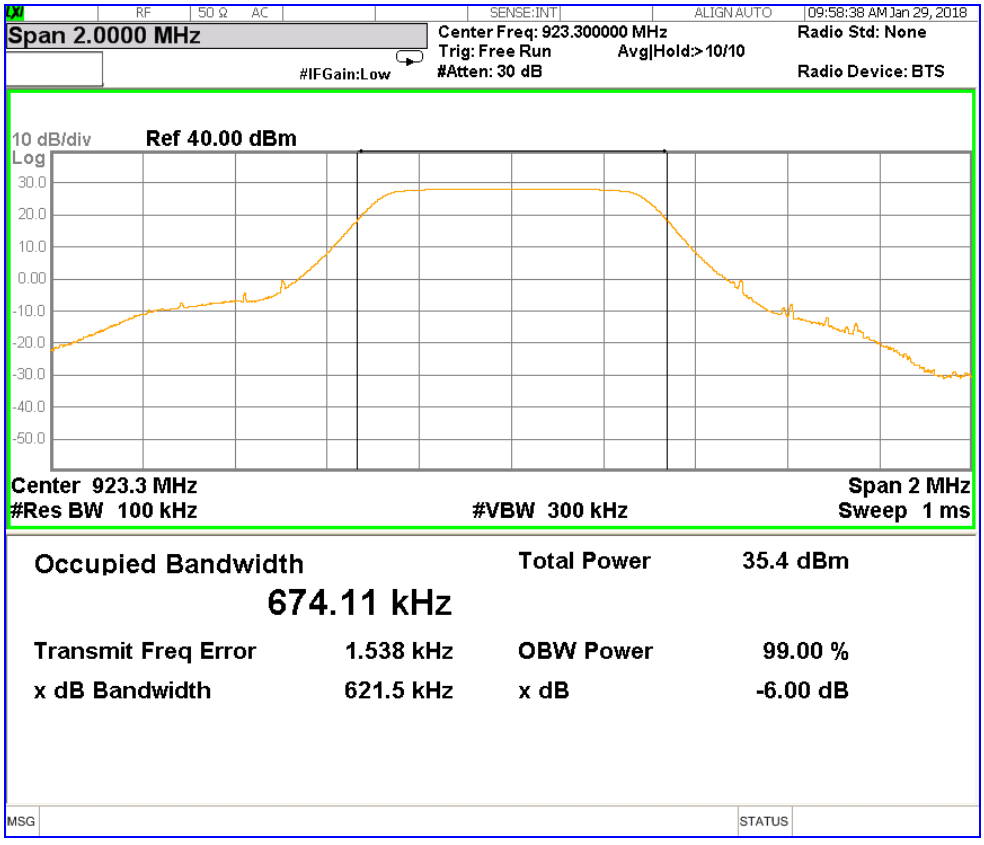
Conducted:



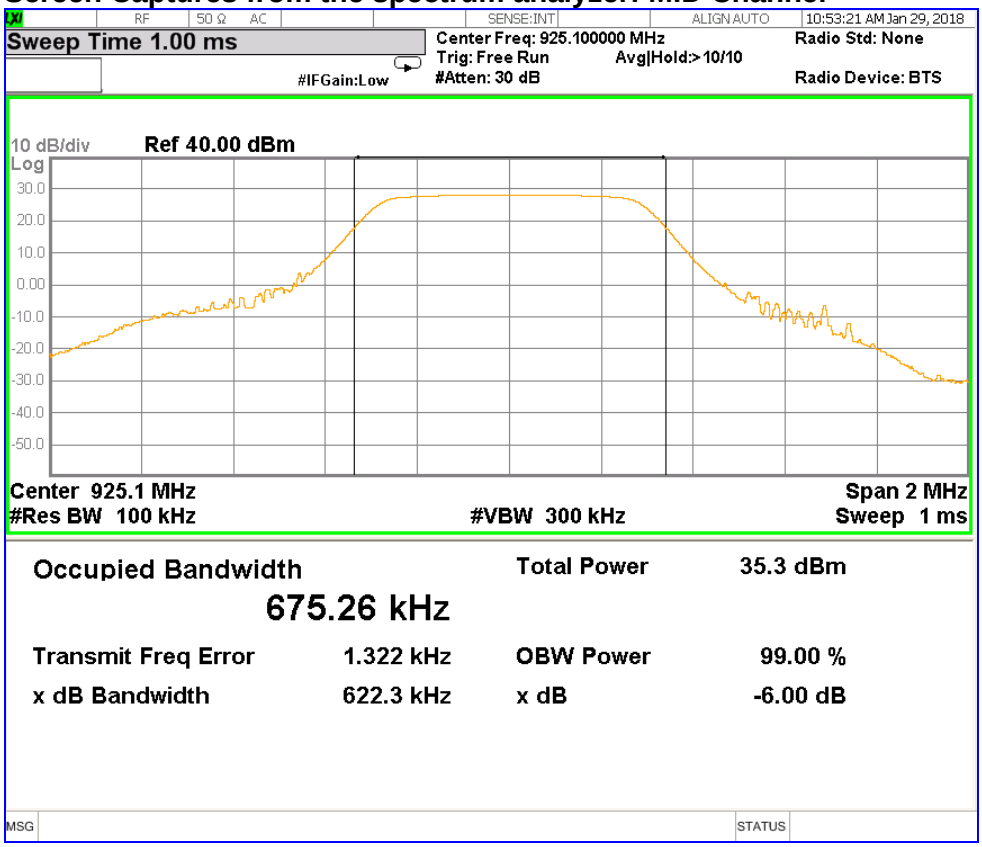
2.2.5 Channel Occupied Bandwidth Data:

Mode of operation	Channel	Freq. [MHz]	6 dB OBW [kHz]	99% OBW [KHz]
LoRa 500 KHz	Low	923.3	621.5	674.11
	Mid	925.1	622.3	675.26
	High	927.5	621.2	673.16

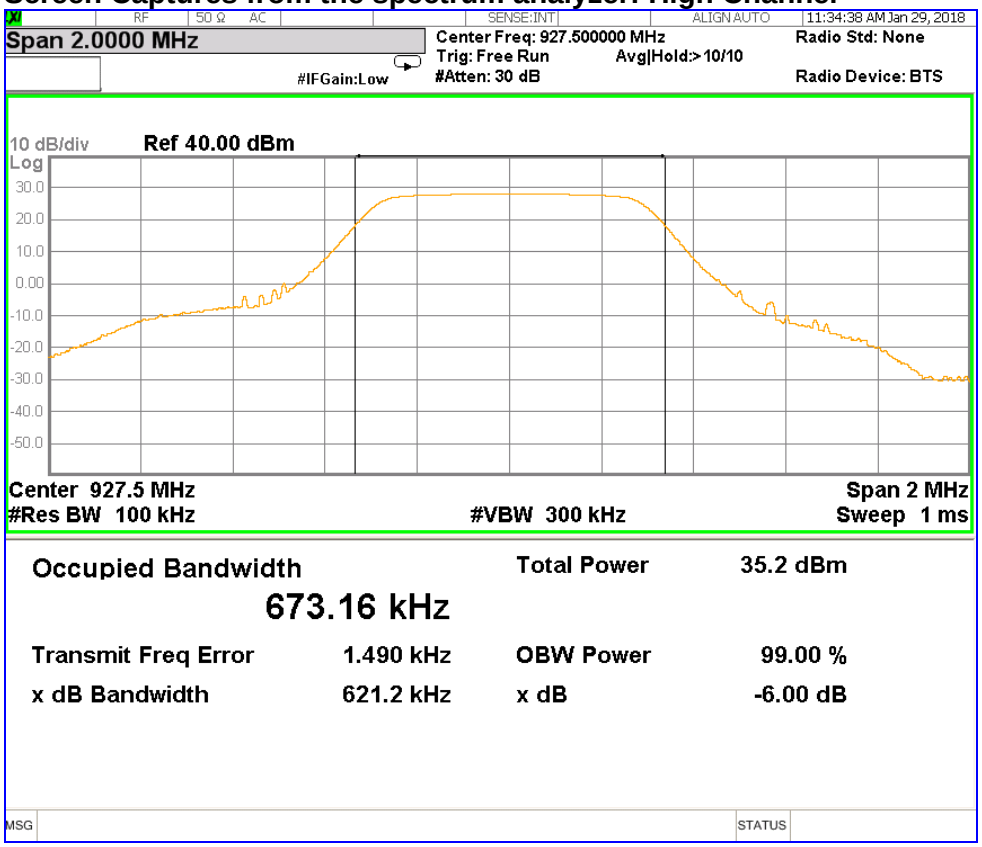
Screen Captures from the spectrum analyzer: Low Channel



Screen Captures from the spectrum analyzer: MID Channel



Screen Captures from the spectrum analyzer: High Channel



2.3 Max Output Power

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Micro IndoorGateway**
Test Personnel: : Imran Akram/ Bushra Muharram	**Standard: FCC PART 15.247**
Date: 2018-01-29 (19.9°C,8.4% 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 11.9.1.1, Clause 7.8.5 / FCC OET KDB 558074 Section 9.2.2.2

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, with out 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
EMI receiver	Agilent	N9038A	6130	2017-06-20	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	2018-04-06
Attenuator	JFW	50FH-020-10		Monitored	
DC Blocker	MCL	BLK-89-S+		Monitored	

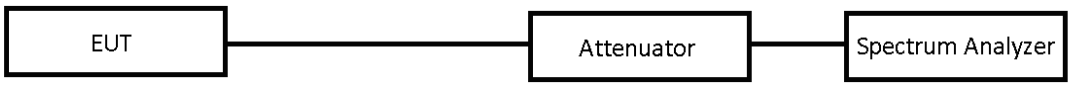
2.3.4 Test Sample Verification, Configuration & Modifications

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:

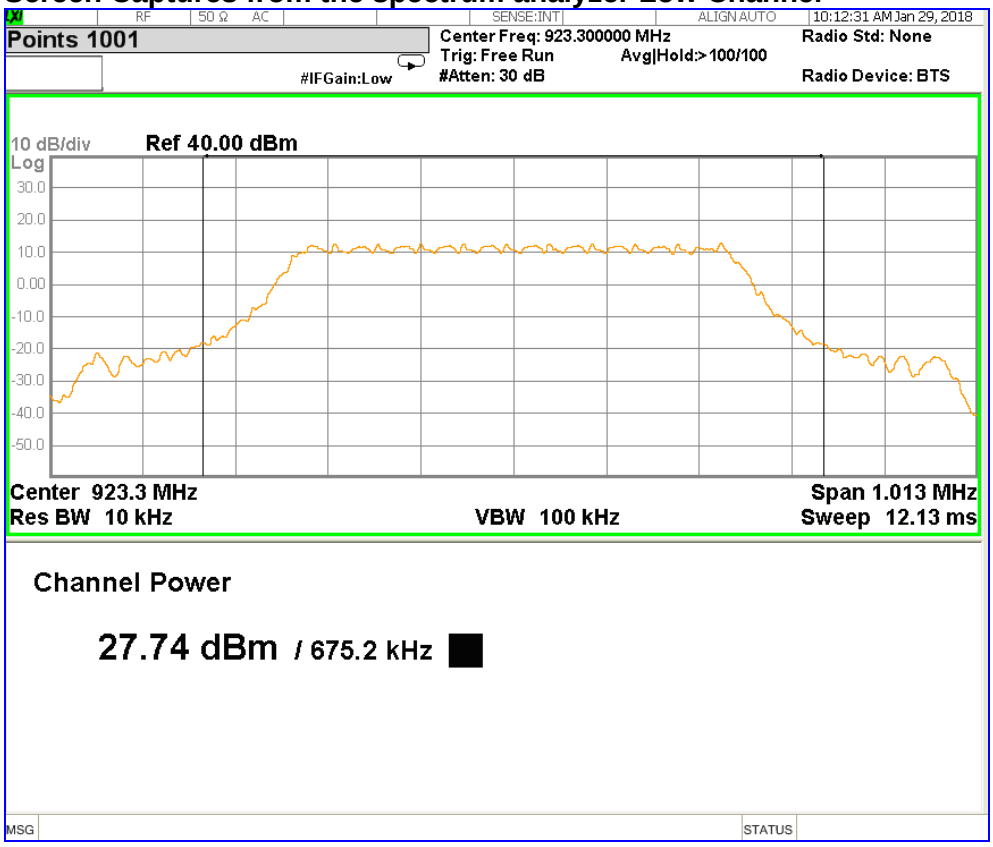


2.3.5 Max Output Power Data

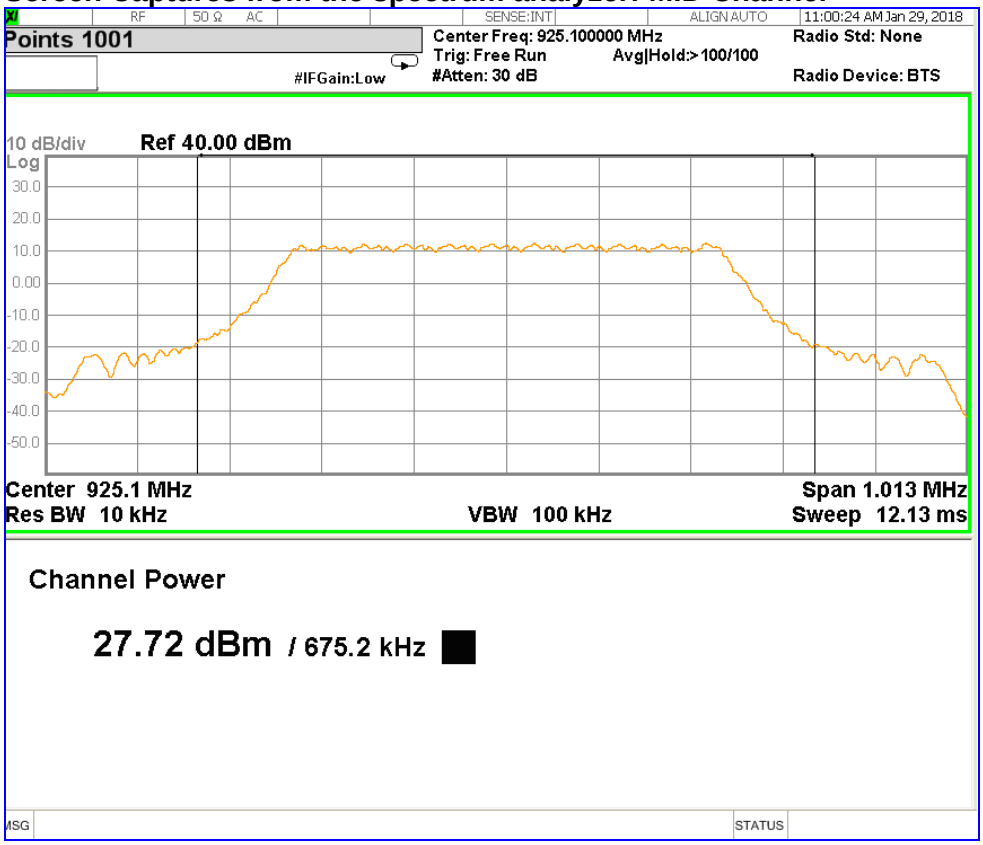
Mode of Operation	Channel	Freq. [MHz]	Out Put Power (dBm)	Out Put Power Limit (dBm
LoRa 500 KHz	Low	923.3	27.74	30
	Mid	925.1	27.72	30
	High	927.5	27.65	30

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

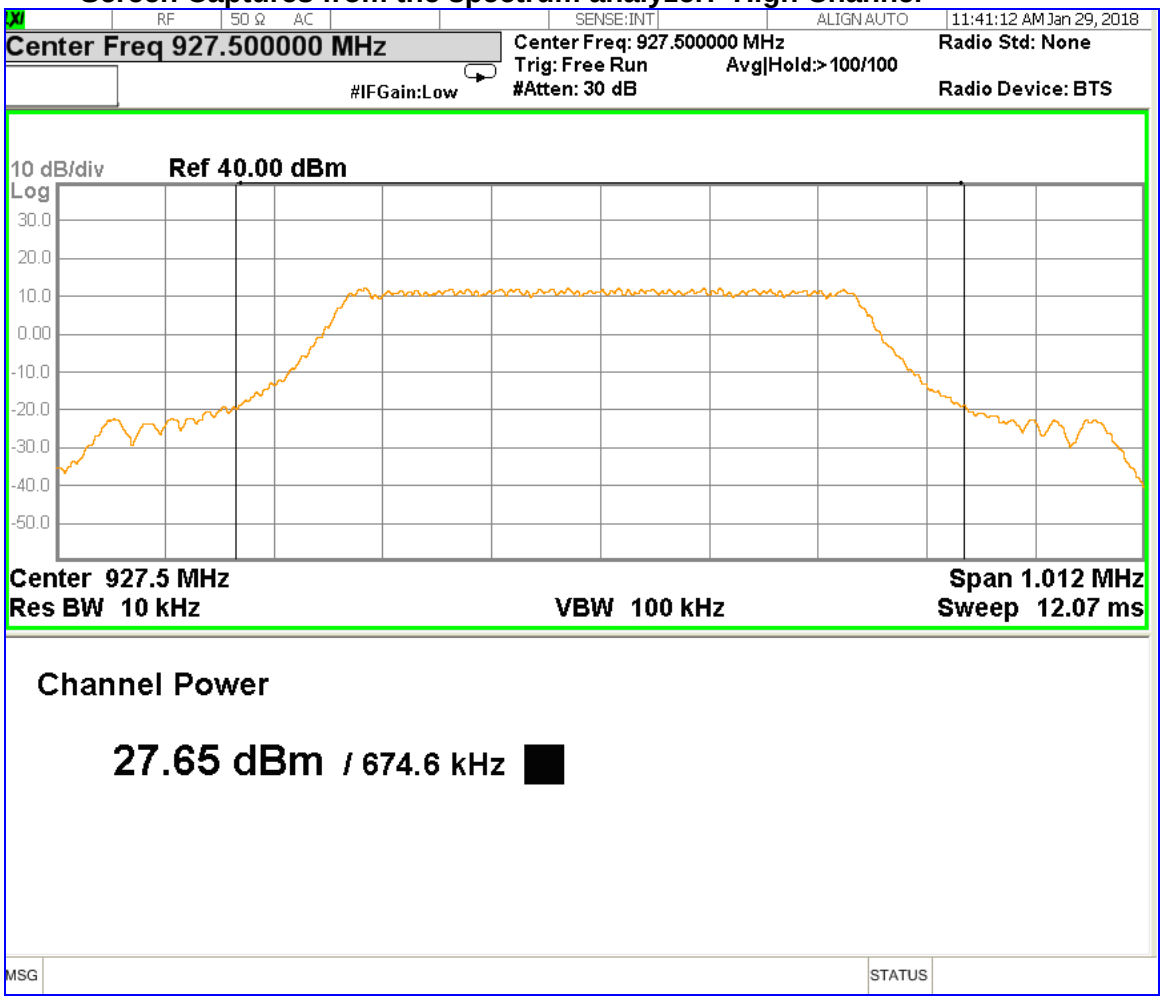
Screen Captures from the spectrum analyzer Low Channel



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 Indoor Gateway**
Test Personnel: : Imran Akram/ Bushra Muharram	**Standard: FCC PART 15.247**
Date: 2018-01-29 (19.9°C,8.4% RH)	**Basic Standard: ANSI C63.10: 2013**

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 11.10.2 / FCC OET KDB 558074 10.3

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, with out the need for any further corrections.

The spectrum analyzer is set for a frequency span of (1.5*OBW)) centered on a channel. The RBW is set to 3 kHz and VBW is set to 10 kHz. The RMS average detector is used, with the trace set to average Hold. The marker is placed on the highest peak of the resulting trace.

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

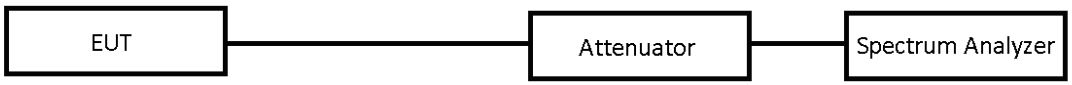
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9010A	6678	2017-05-11	2018-05-11
Temp/Humidity	Extech	42270	5892	2017-04-06	2018-04-06
Attenuator	JFW	50FH-020-10		Monitored	
DC Blocker	MCL	BLK-89-S+		Monitored	

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.

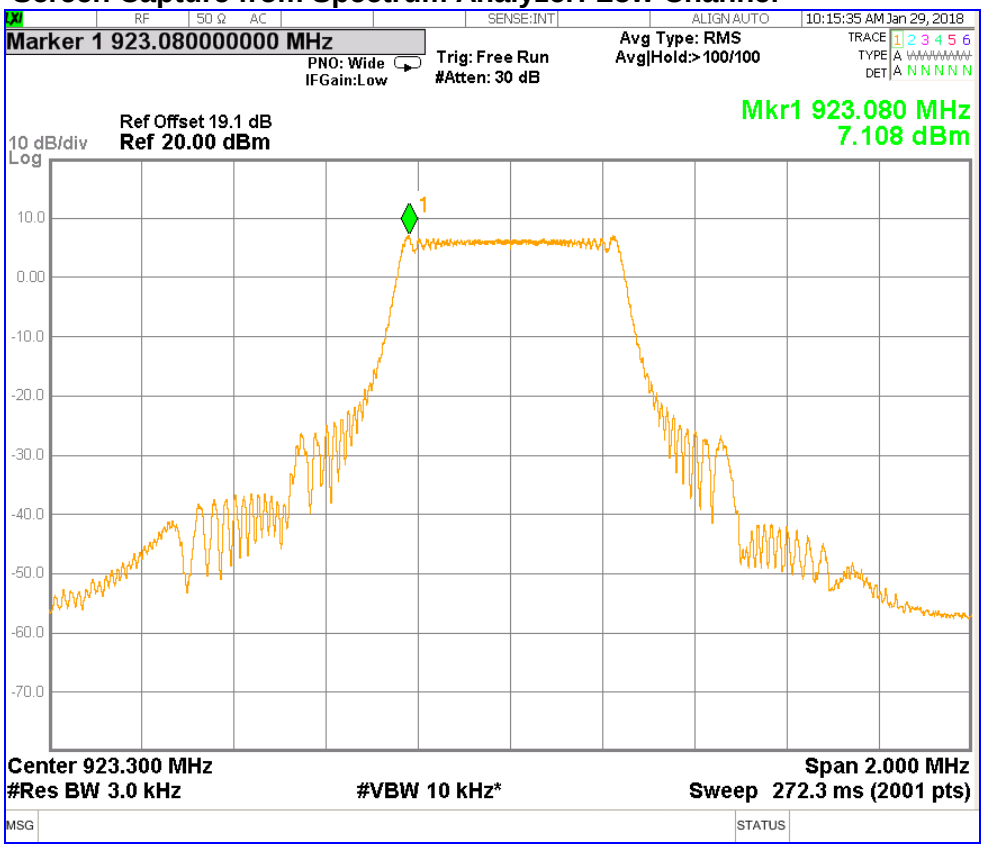
Test setup diagrams for Peak Power Spectral Density testing:
Conducted:



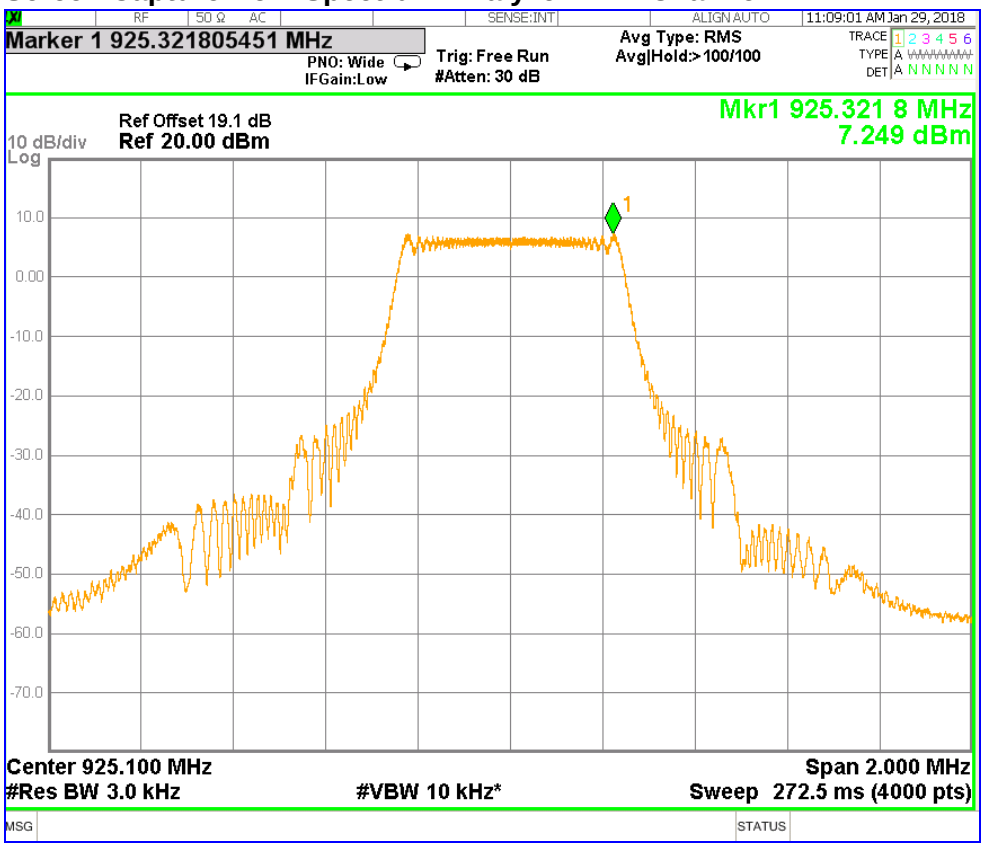
2.4.5 Peak PSD Data

Mode of operation	Channel	Freq. [MHz]	PSD (dBm)	PSD Limit (dBm
LoRa 500 KHz	Low	923.3	7.108	8
	Mid	925.1	7.249	8
	High	927.5	7.021	8

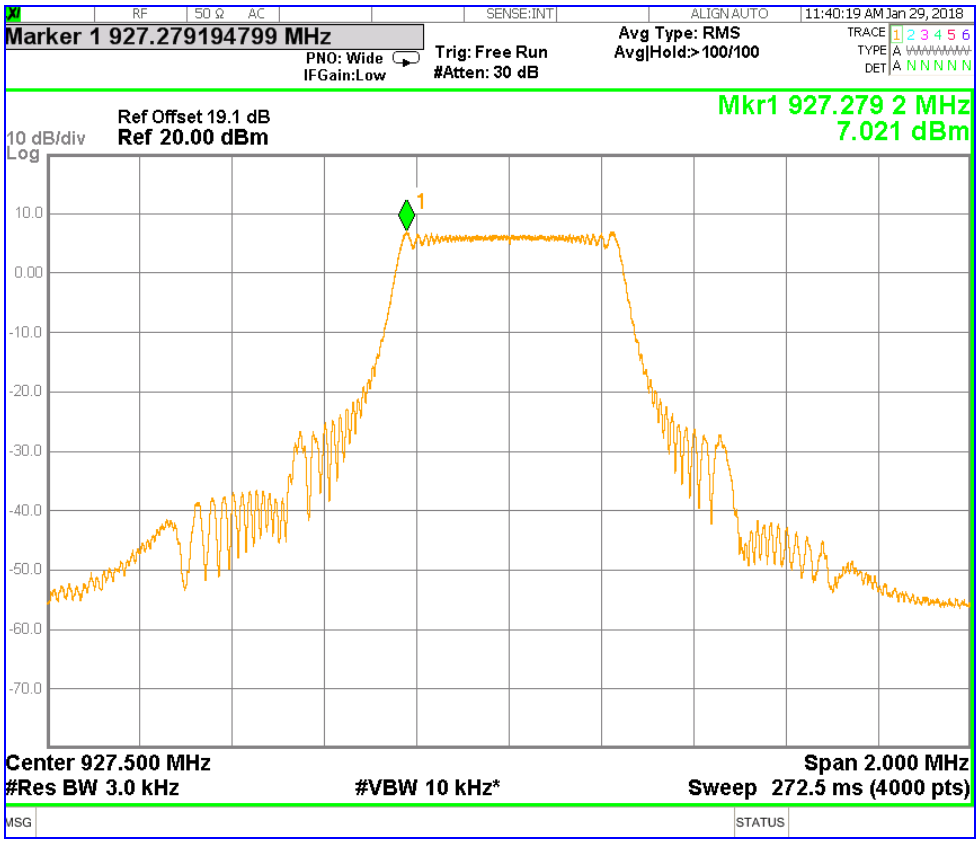
Screen Capture from Spectrum Analyzer: Low Channel



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 Indoor Gateway**
Test Personnel: Imran Akram/ Bushra Muharram	**Standard: FCC PART 15.247**
Date: 2018-01-29 (19.9°C,8.4% RH)	**Basic Standard: ANSI C63.10: 2013**

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, with out 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 ≥ (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:

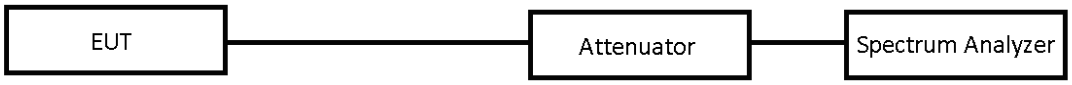
Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	2018-04-06
Attenuator	JFW	50FH-020-10		Monitored	
DC Blocker	MCL	BLK-89-S+		Monitored	

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:

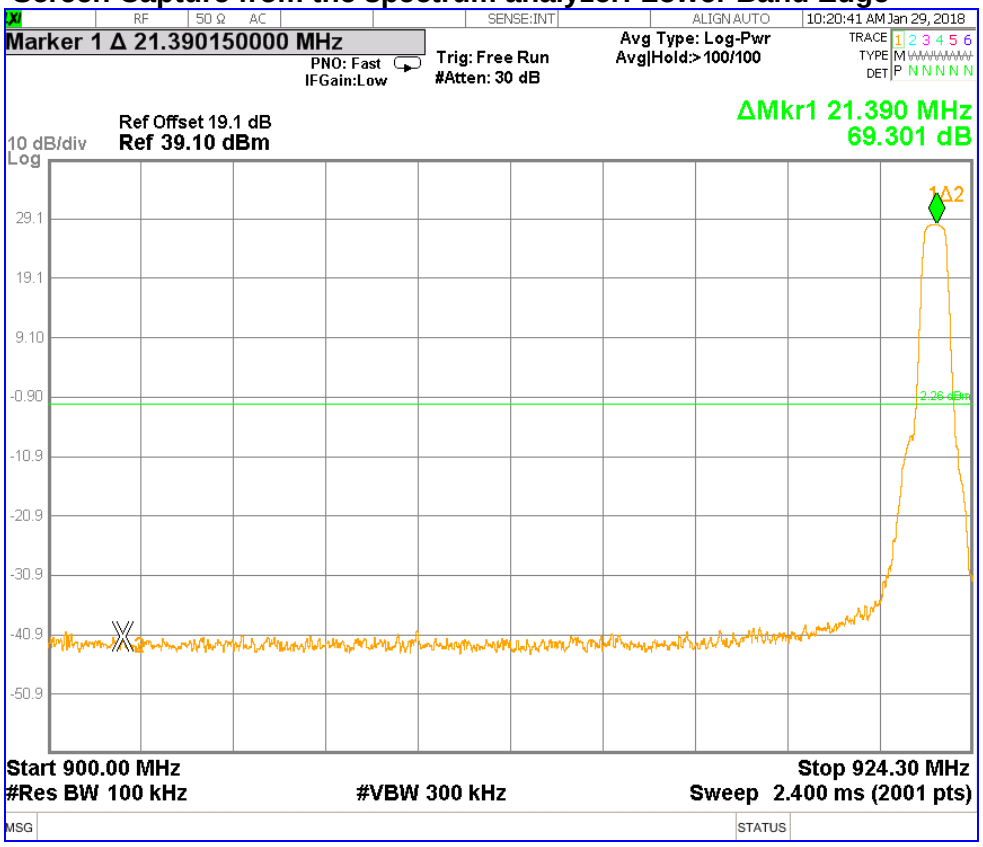


2.5.5 Band Edge Data

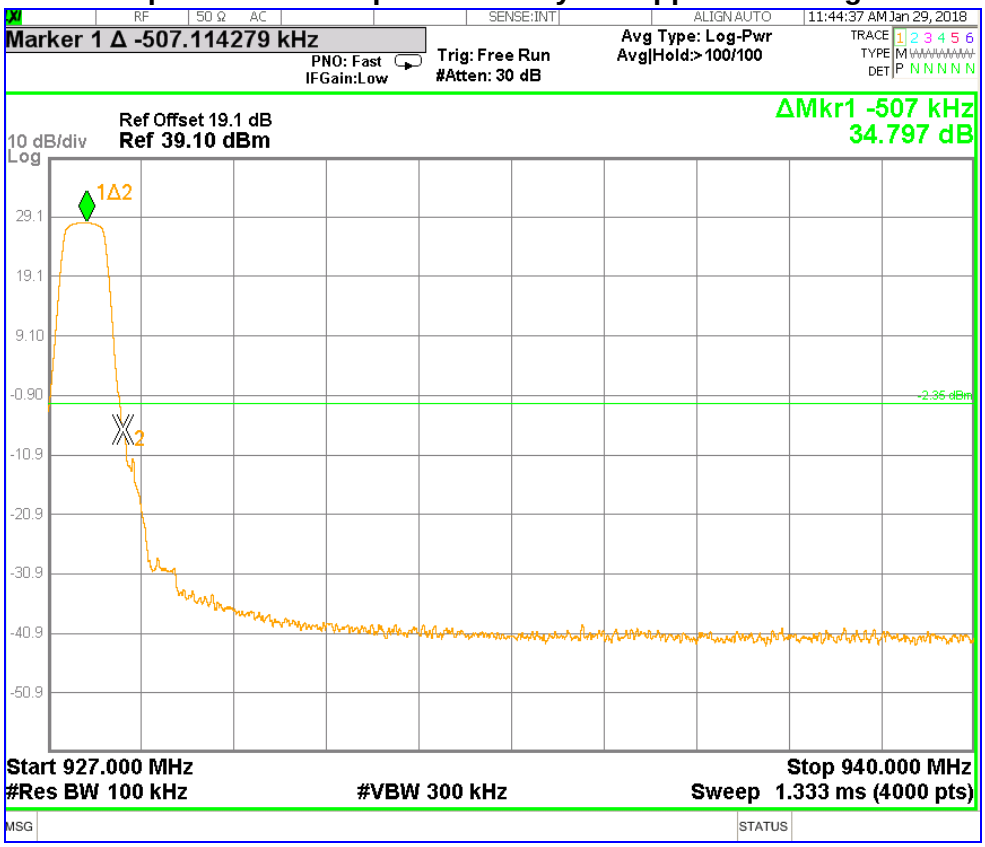
Worse Case Data

Mode of operation	Channel	Attenuation at Band Edge	Attenuation Limit at Band Edge
Lora 500KHz	923.3	69.301 dBc	30 dBc
	927.5	34.797 dBc	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

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Micro Indoor Gateway**
Test Personnel: Imran Akram/ Bushra Muharram	**Standard: FCC PART 15.247**
Date: 2018-01-29 (19.9°C,8.4% 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, with out 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

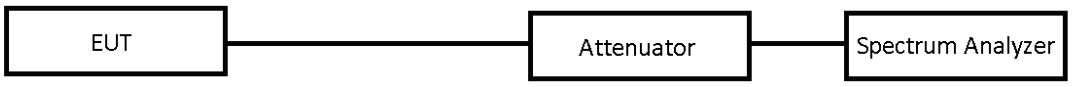
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	2018-04-06
Attenuator	JFW	50FH-020-10		Monitored	
DC Blocker	MCL	BLK-89-S+		Monitored	

2.6.4 Test Sample Verification, Configuration & Modifications

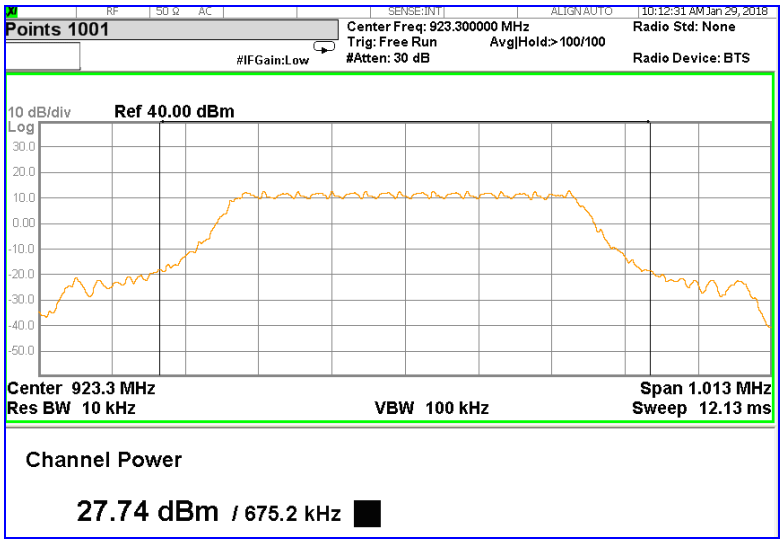
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

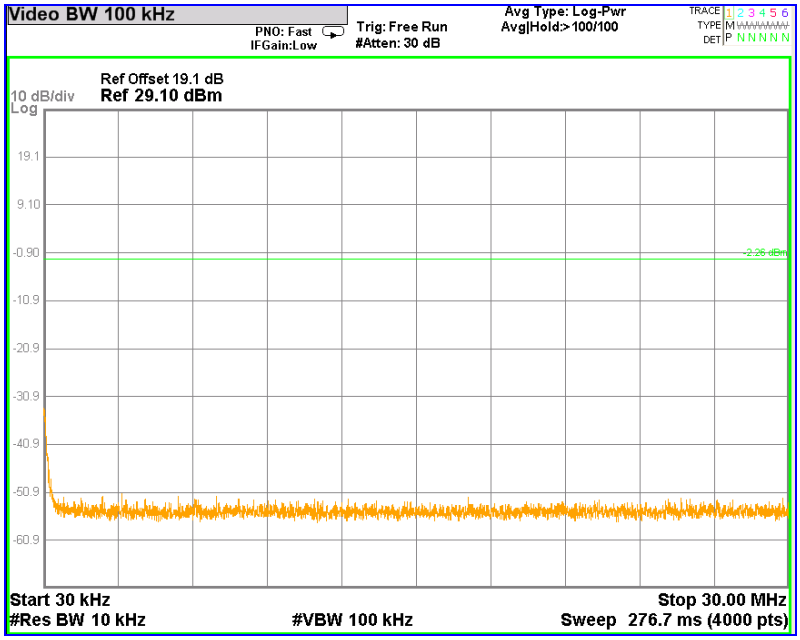
Test setup diagram for Conducted Spurious Emissions testing:

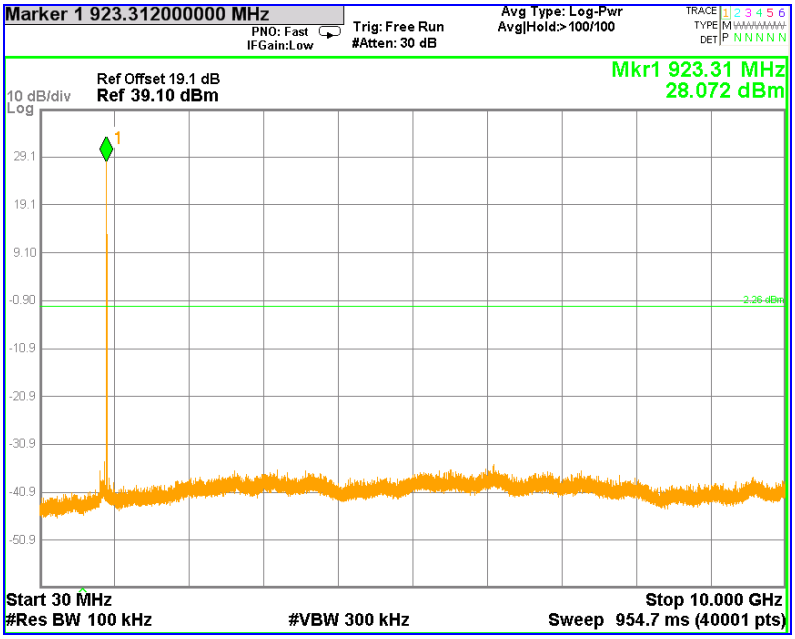


2.6.5 Conducted Emissions Data:

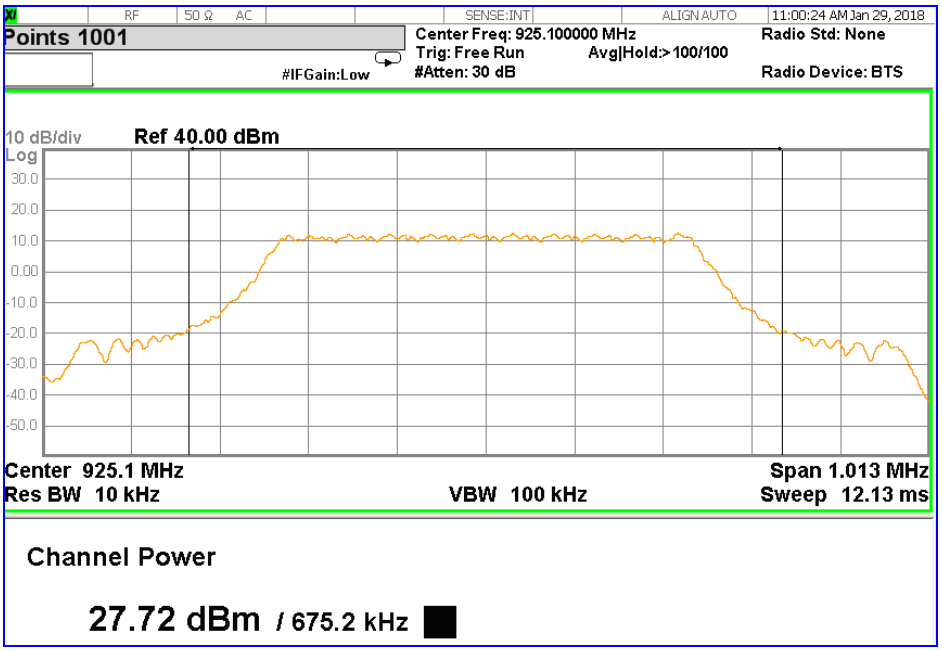
Low Channel

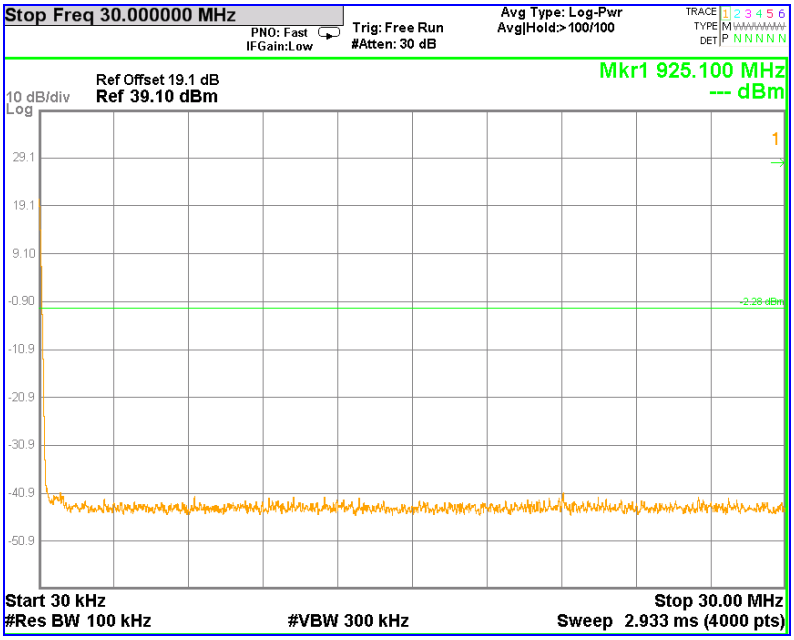


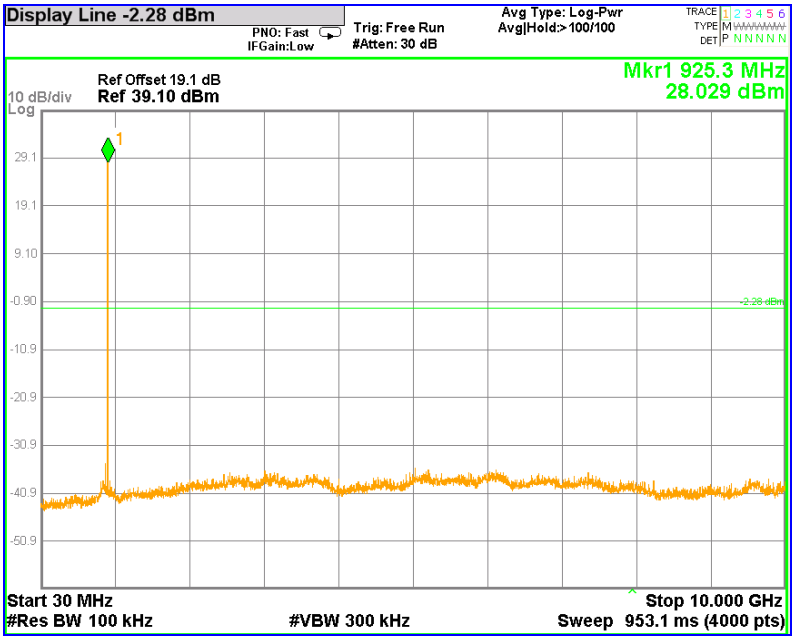




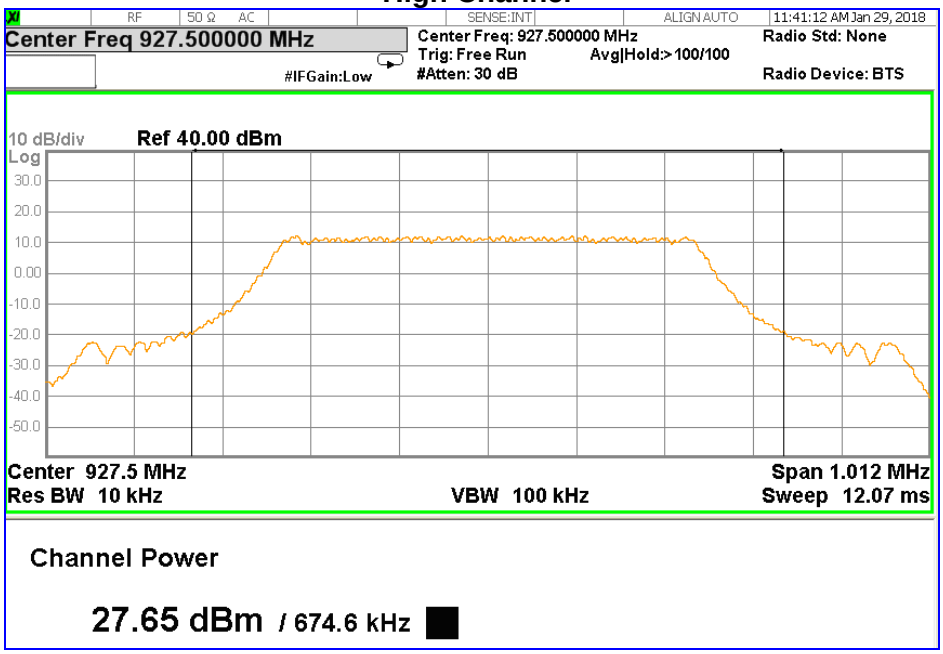
MID Channel

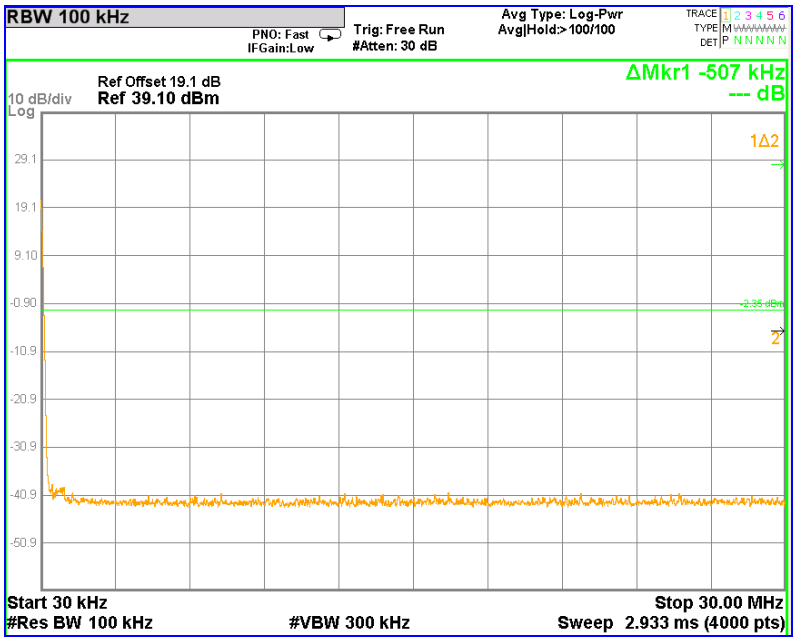

RF 50 Ω AC
SENSE:INT
ALIGN AUTO
11:00:24 AM Jan 29, 2018
Points 1001
Center Freq: 925.100000 MHz
Trig: Free Run
Avg|Hold:>100/100
#IFGain:Low
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
10 dB/div
Log
Ref 40.00 dBm
30.0
20.0
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
Center 925.1 MHz
Res BW 10 kHz
VBW 100 kHz
Span 1.013 MHz
Sweep 12.13 ms
Channel Power
27.72 dBm / 675.2 kHz

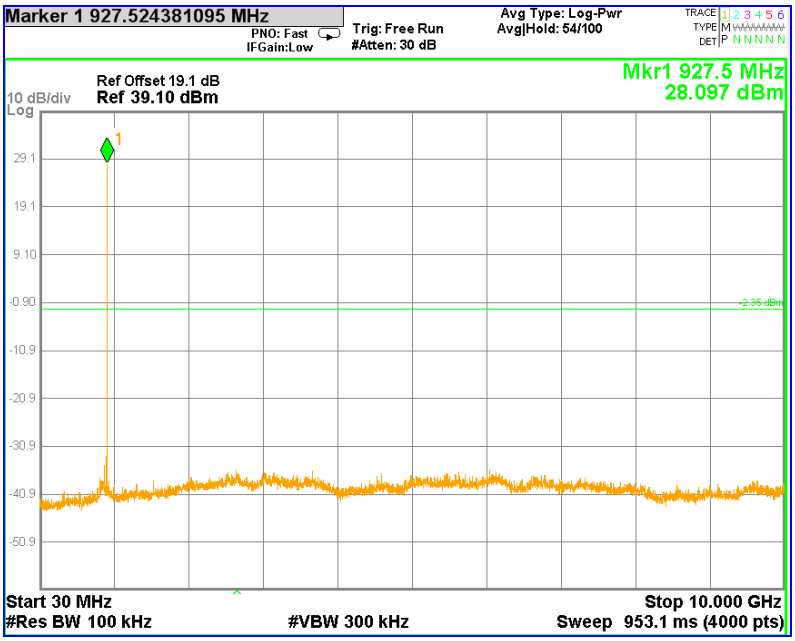

Stop Freq 30.000000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M
DET P N N N N N
Mkr1 925.100 MHz
--- dBm
Ref Offset 19.1 dB
10 dB/div
Log
Ref 39.10 dBm
29.1
19.1
9.10
-0.90
-10.9
-20.9
-30.9
-40.9
-50.9
-2.28 dBm
Start 30 kHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 30.00 MHz
Sweep 2.933 ms (4000 pts)


Display Line -2.28 dBm
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M
DET P N N N N N
Mkr1 925.3 MHz
28.029 dBm
Ref Offset 19.1 dB
10 dB/div
Log
Ref 39.10 dBm
29.1
19.1
9.10
-0.90
-10.9
-20.9
-30.9
-40.9
-50.9
-2.28 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 10.000 GHz
Sweep 953.1 ms (4000 pts)

High Channel







2.7 *EUT Positioning Assessment*

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Micro Indoor Gateway**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-01-30/2018-03-05	**Basic Standard: ANSI C63.4-2014**

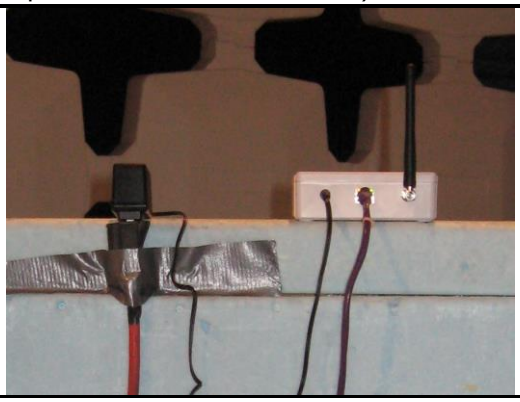
EUT Two Orientation Evaluated with external Antenna

Specification: ANSI C63.4-2014, Clause 6.3.2.1/ANSI C63.10-2013, Clause 6.3.1

ANSI C63.4: 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. For testing purposes, ceiling- and wall-mounted devices also shall be positioned on a tabletop. 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 shall be carried out for various axes orientations to determine the attitude having maximum or near-maximum emission level.

ANSI C63.10: External antenna(s) shall be positioned for maximum radiated emissions. If the EUT is equipped with or uses an adjustable antenna, then the EUT antenna shall be manipulated through typical positions and lengths during exploratory testing to maximize emission levels. For high-gain antennas or antennas that are not structurally supported by the EUT, a nonmetallic supporting structure shall be used**.**EUTs with integral antennas shall be evaluated in their normal orientation. Where EUTs are designed to be installed in one of two orientations (such as wireless access points that can be located horizontally on a table or mounted vertically to the wall), these devices shall be tested in both orientations. EUTs that can be operated in multiple orientations (such as handheld, portable, or modular devices) shall be tested in three orientations.

1st Orientation



Frequency [MHz]		Field Strength [dBµv/m]
923.3	**H**	**120.93**
	V	**120.45**
925.1	H	118.3
	V	119.2
927.5	H	117.3
	V	119.14

2nd Orientation

Frequency [MHz]		Field Strength [dBµv/m]
923.3	H	120.9
	V	120.31
925.1	H	119.2
	V	120.1
927.5	H	118.9
	V	120.35

2.8 Radiated Spurious Emissions / Co-Location

Test Lab: Electronics Test Centre, Airdrie

Test Personnel: Imran Akram
Henry Cookeygam
Bushra Muharram

Date: 2018-01-30/31 (18.9° C,17% RH)

EUT: Kona Micro Indoor Gateway

Standard: FCC PART 15.247/15.209

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 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with UKAS (United Kingdom Accreditation Service) document “Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” as based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

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

Test Method	Frequency	Uncertainty
Radiated Emissions Level	30 MHz – 1 GHz	±4.6 dB
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.31 dB

2.8.4 Test Equipment

Testing was performed with the following equipment:

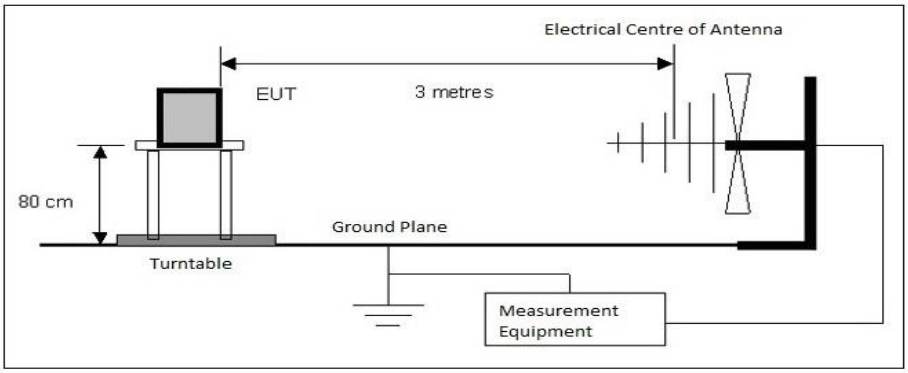
Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A	6130	2017-06-20	2018-06-20
Loop Antenna	EMCO	6502	10868	2017-03-29	2019-03-29
Biconilog Antenna	ARA	LPB-2520/A	4318	2016-05-18	2018-05-18
DRG Horn	EMCO	3115	19357	2016-08-24	2018-08-24
Humidity/Temp Logger	Extech Ins. Corp.	42270	5892	2017-04-06	2018-04-06
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800-21-5P	4354	Monitored	
Pre-Amplifier	hp	8447D	9291	Monitored	

2.8.5 Test Sample Verification, Configuration & Modifications

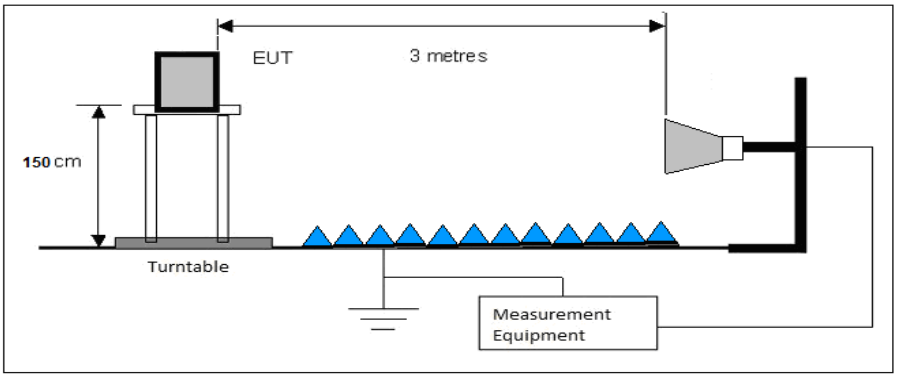
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. Both radios transmitting simultaneously, pre-approved GSM module is transmitting at 784 MHz and LoRa radio transmitting at low Channel 923.3 MHz.

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):



2.8.6 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 923.3 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.

Spurious Emission

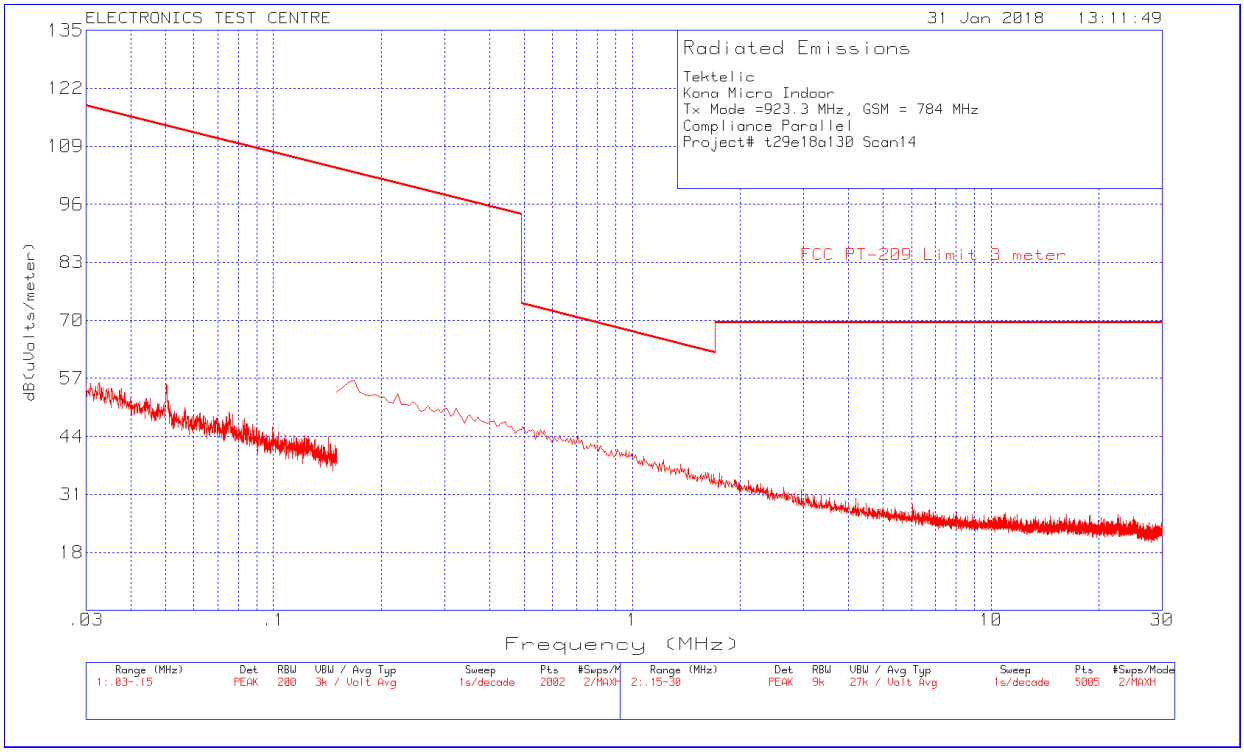
Freq. Marker	Freq. [MHz]	Raw reading [dBμv]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBμv/m]	FCC 15.209 Limit [dBμv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
30 – 1000 MHz											
1	32.3286	9.86	QP	21.7	.5	32.06	40	-7.94	0	387	Horizontal
2	42.9442	15.73	QP	20.4	.5	36.63	40	-3.37	324	104	Vertical
3	66.2977	20.38	QP	12.1	.7	33.18	40	-6.82	308	106	Vertical
4	81.2066	23.86	QP	10.9	.7	35.46	40	-4.54	306	122	Vertical
5	106.6926	22.68	QP	13.7	.8	37.18	43.5	-6.32	296	105	Vertical
6	907.518	9.99	QP	26.8	2.3	39.09	46.02	-6.93	7	100	Vertical
1300 – 3600 MHz -											
7	1708.0	25.42	AV	27.4	-21.5	31.32	54	-22.68	95	223	Vertical
7	1708	28.94	PK	27.4	-21.5	34.84	54	-22.68	95	223	Vertical
3600 – 10000 MHz											
1	5199.4	23.82	AV	33.7	-24.8	32.72	54	-21.28	8	337	Horizontal
1	5199.4	34.15	PK	33.7	-24.8	43.05	54	-10.95	8	337	Horizontal

*** Restricted Band**

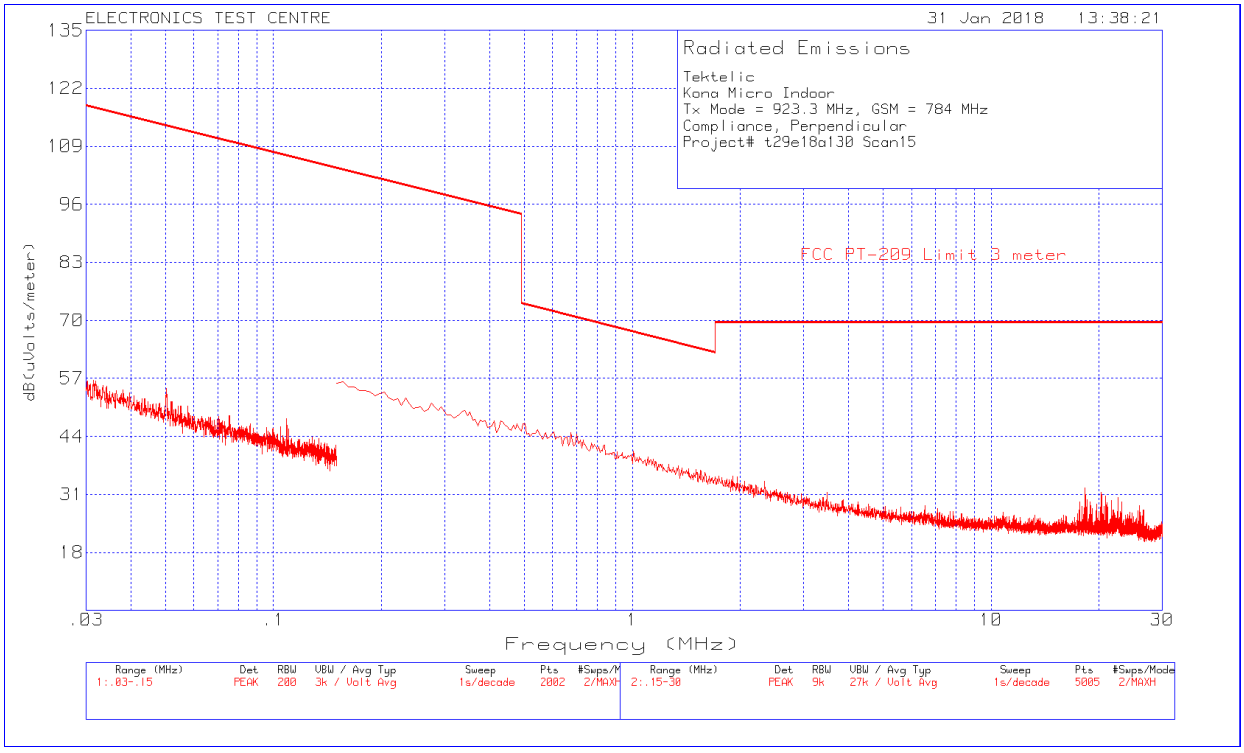
Harmonics Emission Values

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
LoRa Carrier	923.3	99.08	PK	26.8	2.3	125.1	125.23	-0.13	148	152	Horizontal
		91.32		26.8	2.3	120.42	125.23	-4.81	333	106	Vertical
GSM Carrier	784	79.59	PK	24.8	2.2	106.59	125.23	-18.64	252	100	Horizontal
		71.54		24.8	2.2	98.54	125.23	-26.69	350	125	Vertical
1300 – 3600 MHz - Harmonics											
1	1568.4	43.42	PK	25.6	-21.5	47.52	20 dBc	-59.07	300	250	Horizontal
2	1846.5	40.09	PK	27.6	-20.9	46.79	20 dBc	-78.31	280	250	Horizontal
3	2357.2	44.82	PK	28.5	-26.8	46.52	20 dBc	-60.07	340	100	Horizontal
4	1570.7	42.75	PK	25.6	-21.5	46.85	20 dBc	-51.69	360	250	Vertical
5	1846.5	42.56	PK	27.6	-20.9	49.26	20 dBc	-75.84	220	100	Vertical
6	2357.2	43.7	PK	28.5	-26.8	45.4	20 dBc	-53.14	120	100	Vertical
3600 – 10000 MHz - Harmonics											
2	6463.1	42.04	PK	34.5	-28	48.54	20 dBc	-76.56	60	100	Horizontal
3	7386.8	44.92	PK	36.5	-22.9	58.52	20 dBc	-66.58	320	100	Horizontal
4	8311.5	42.0	PK	37	-26.7	52.3	20 dBc	-72.8	220	249	Horizontal
5	5539.9	40.25	PK	34.1	-24.8	49.55	20 dBc	-70.87	80	100	Vertical
6	6462.6	49.21	PK	34.5	-28	55.71	20 dBc	-64.71	300	249	Vertical
7	7386.3	51.37	PK	36.5	-22.9	64.97	20 dBc	-55.45	260	399	Vertical
8	8308.0	49.1	PK	37	-26.7	59.4	20 dBc	-61.02	120	100	Vertical

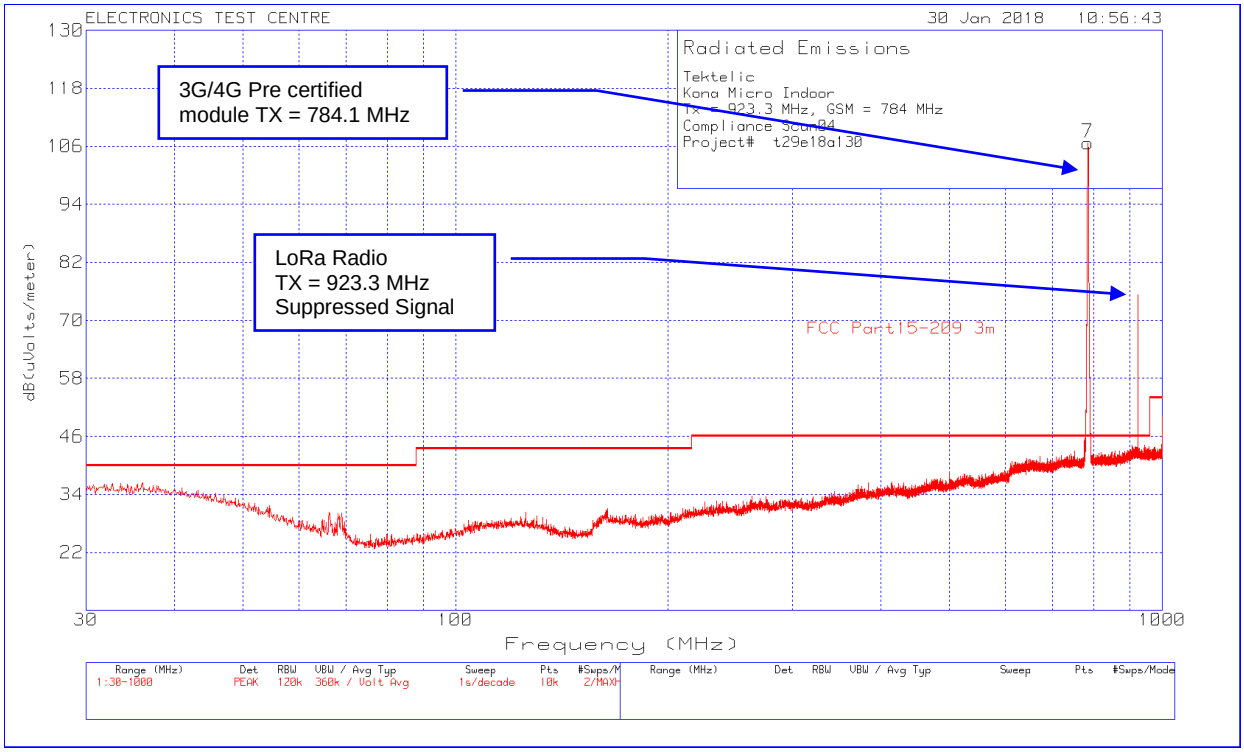
Plot of Radiated Emissions: Measuring Antenna Parallel



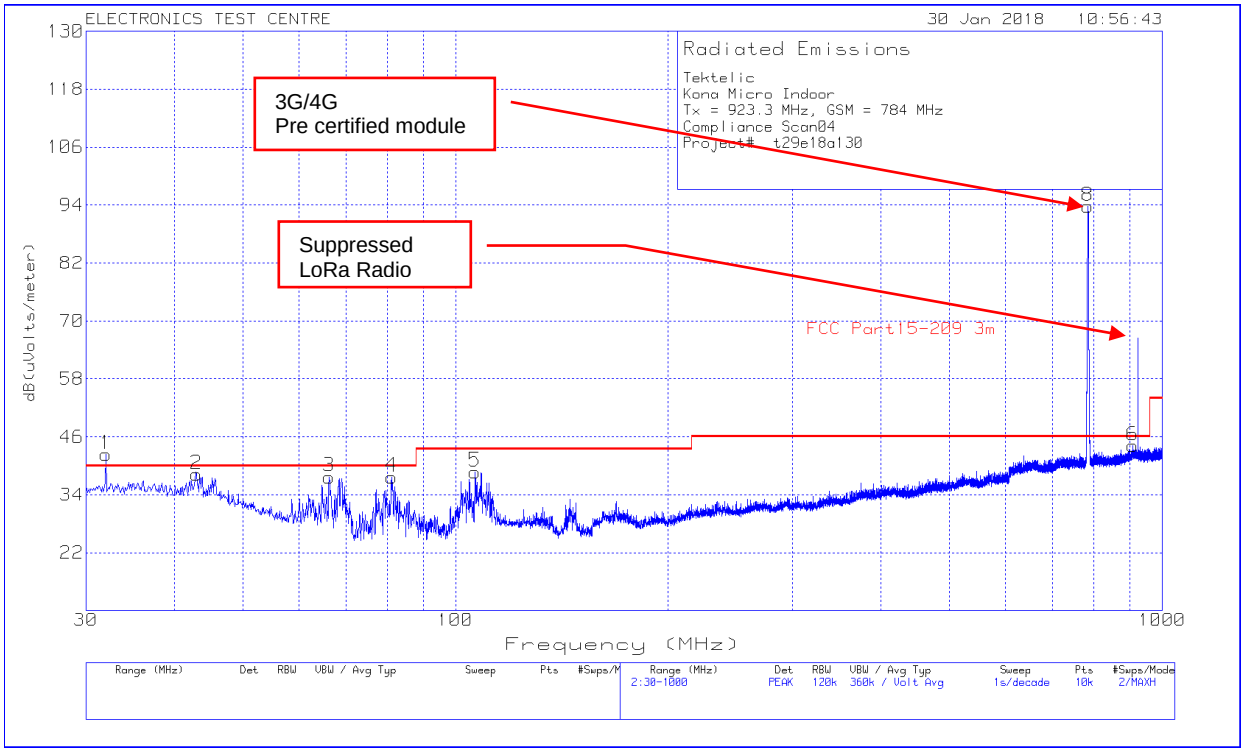
Plot of Radiated Emissions: Measuring Antenna Perpendicular



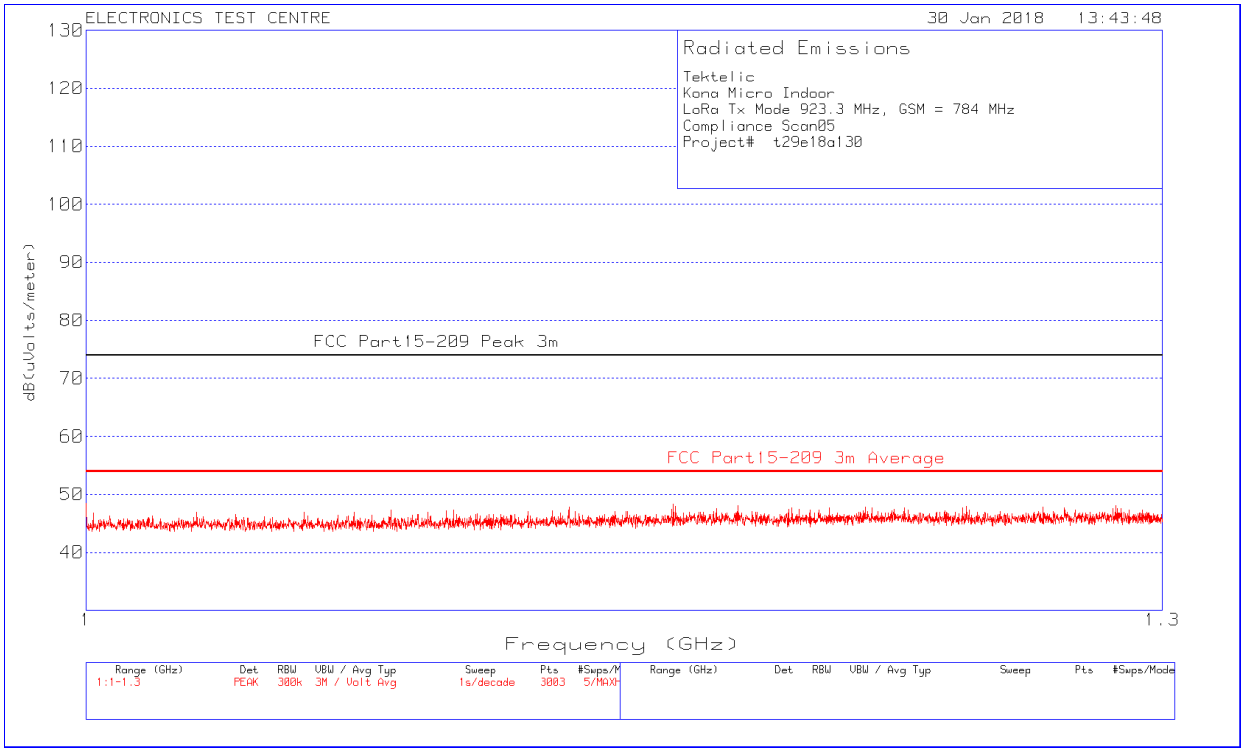
Plot of Radiated Emissions: Horizontal polarization



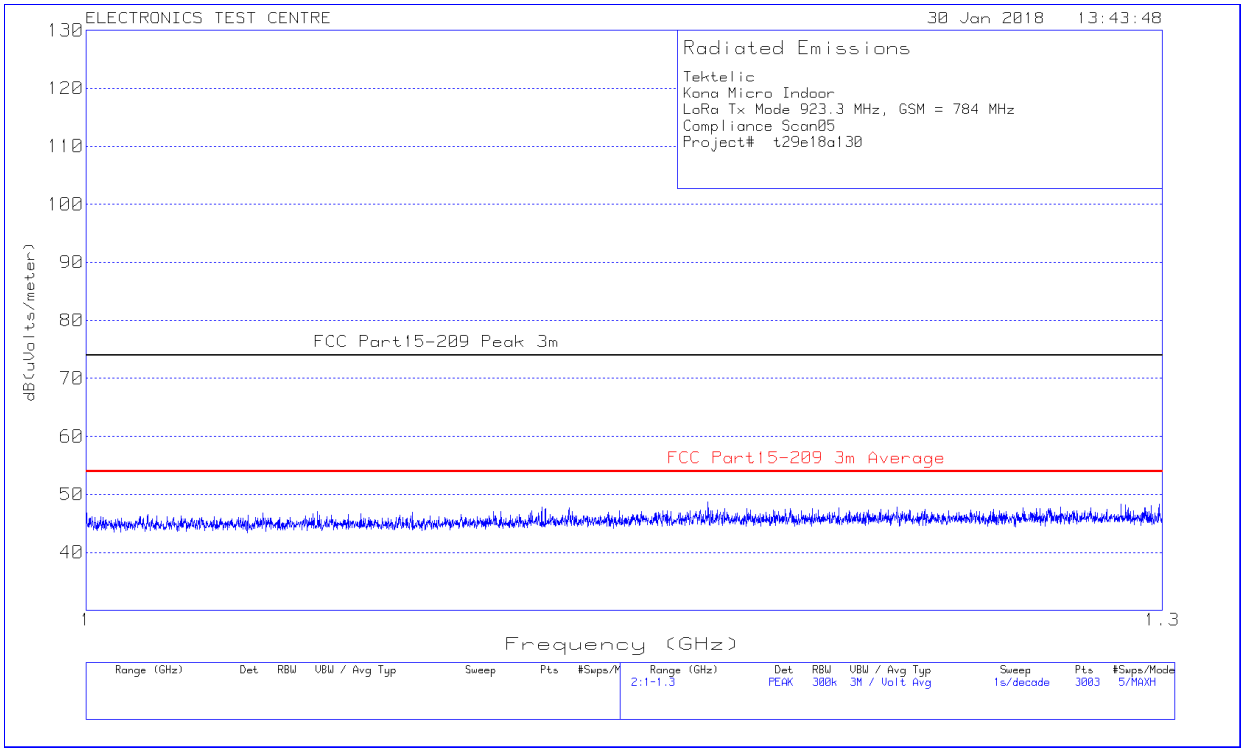
Plot of Radiated Emissions: Vertical polarization



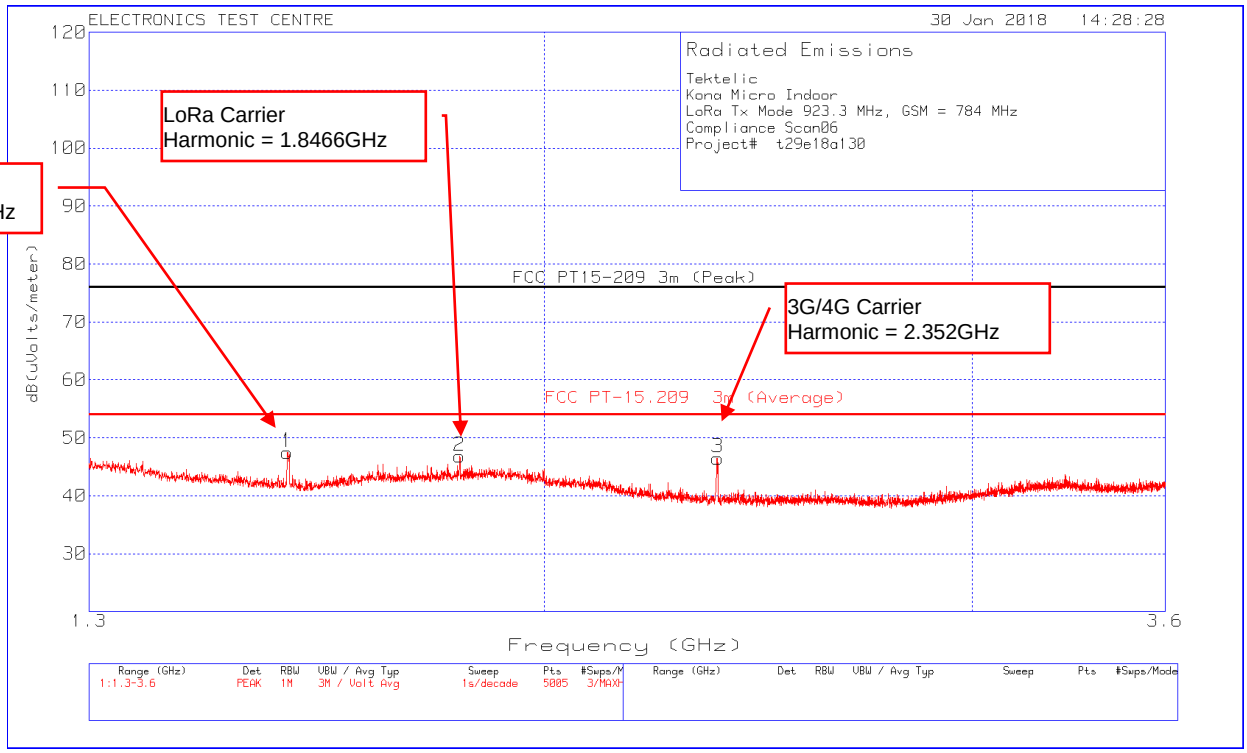
Plot of Radiated Emissions: Horizontal polarization



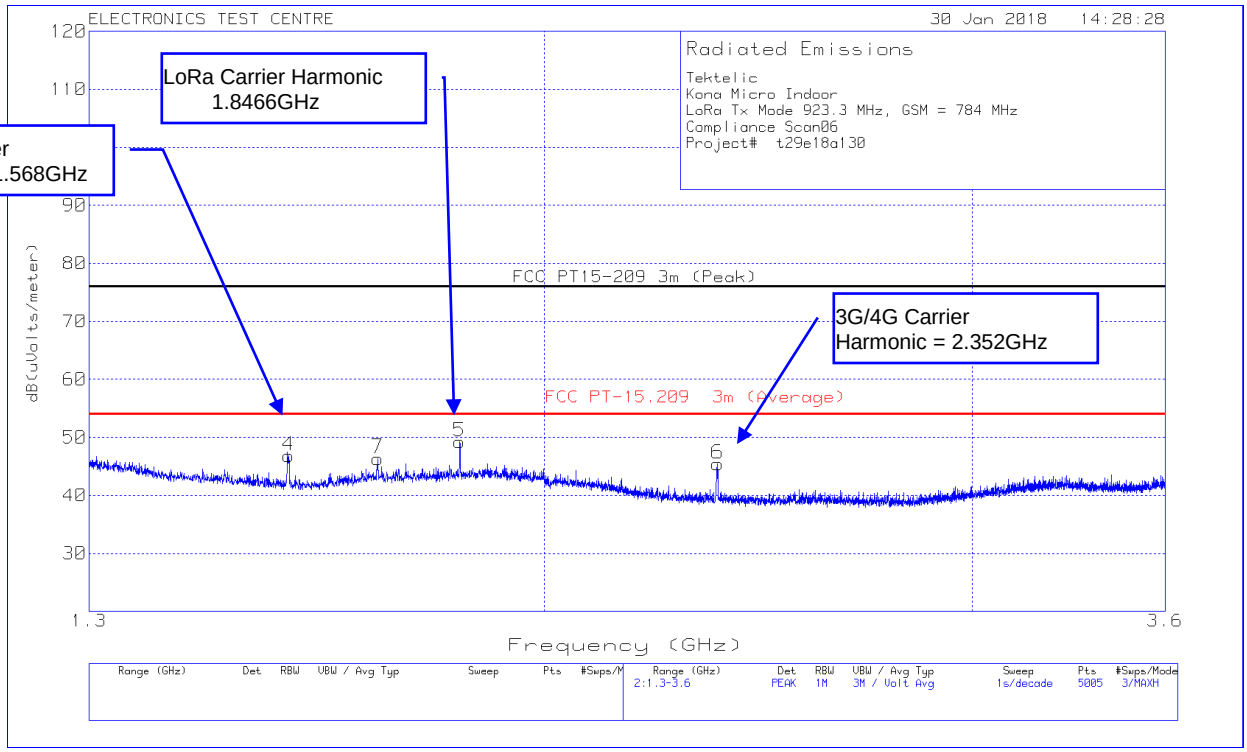
Plot of Radiated Emissions: Vertical polarization



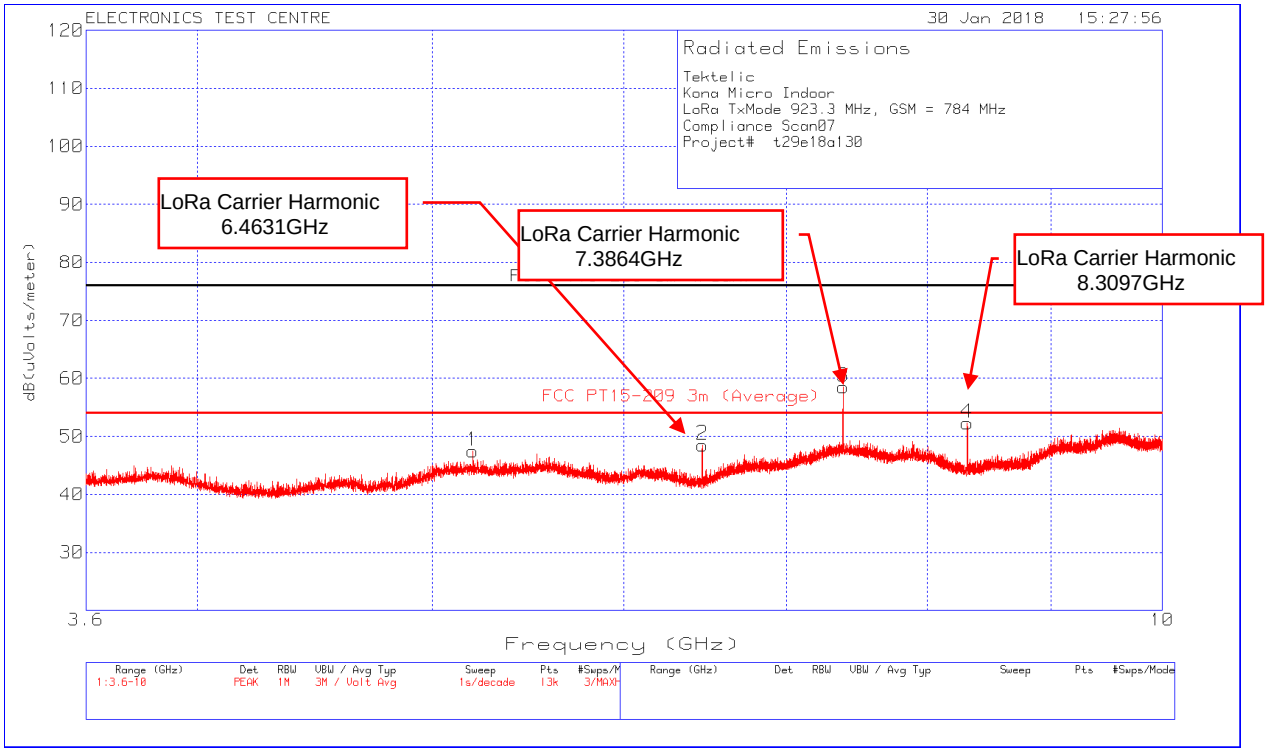
Plot of Radiated Emissions: Horizontal polarization



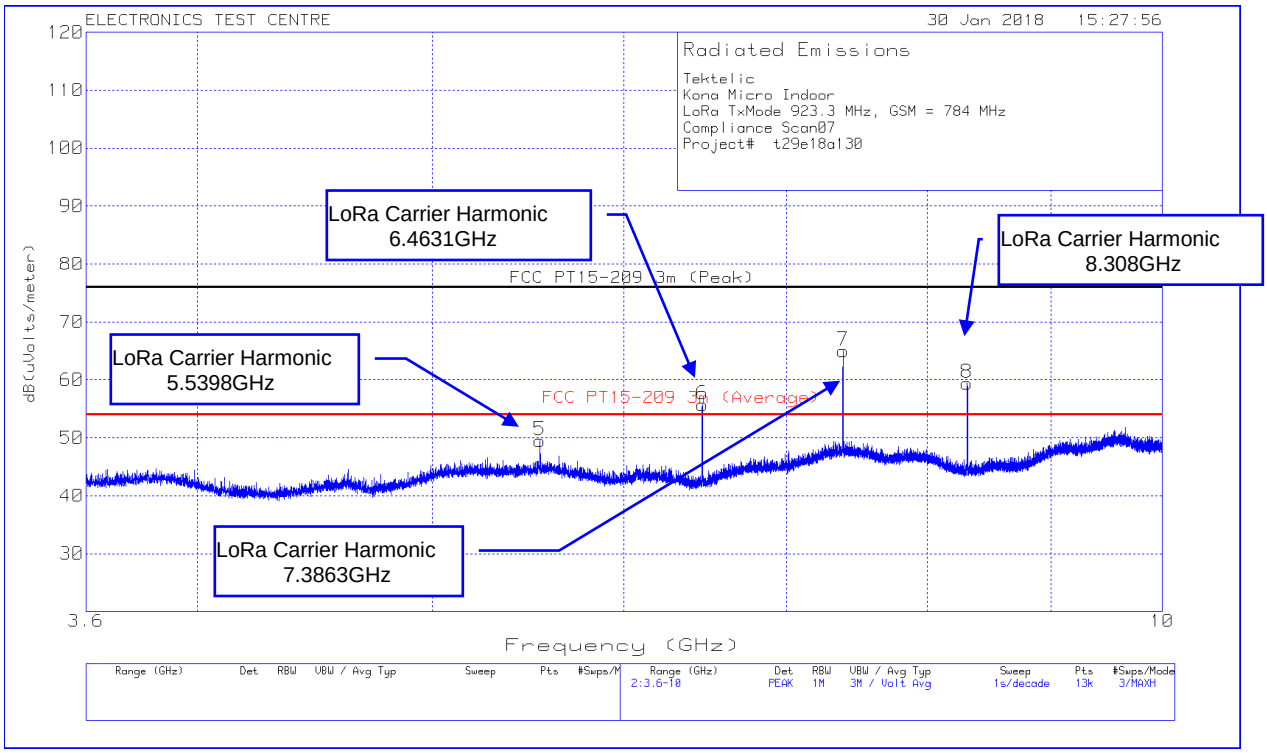
Plot of Radiated Emissions: Vertical polarization



Plot of Radiated Emissions: Horizontal polarization



Plot of Radiated Emissions: Vertical polarization



2.9 Radiated Emissions (Rx Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Micro Indoor Gateway**
Test Personnel: Imran Akram **Bushra Muharram**	**Standard: FCC Part15.109** **Basic Standard: ANSI C63.4-2014**
Date: 2018-01-31 (19.7° C,13.0% RH)	

EUT status: Compliant

Specification: FCC PART 15.109

Frequency	FCC Class B Limit (3 m)
30 – 88 MHz	40 dBµV/m (QP)
88 – 216 MHz	43.52 dBµV/m (QP)
216 – 960 MHz	46.02 dBµV/m (QP)
960 – 1000 MHz	53.98 dBµV/m (QP)
Above 1000 MHz	53.98 dBµV/m (Avg.)
Criteria: The radiated emissions produced by a device, measured at a distance of 3 meters, shall not exceed the limits as specified.	

2.9.1 Test Guidance:

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 and a resolution bandwidth of 1 MHz.

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.

All frequencies having peak emissions within 6 dB 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.

Above 1 GHz, measurements are recorded with Peak and/or Average detectors, as applicable.

2.9.2 Deviations From The Standard:

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

2.9.3 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with UKAS (United Kingdom Accreditation Service) document “Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” as based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

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

Test Method	Frequency	Uncertainty
Radiated Emissions Level	30 MHz – 1 GHz	±4.6 dB
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.31 dB

2.9.4 Test Equipment

Testing was performed with the following equipment:

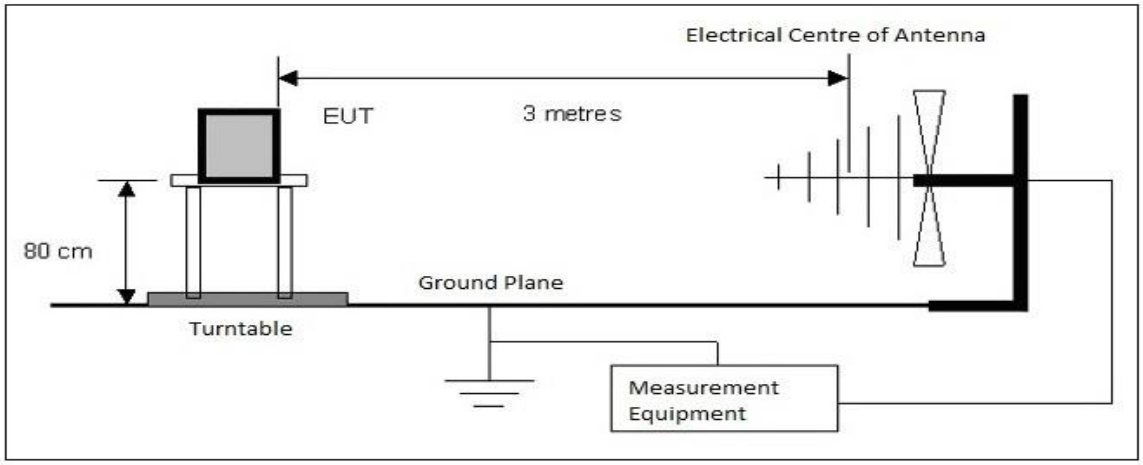
Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A	6130	2017-06-20	2018-06-20
Loop Antenna	EMCO	6502	10868	2017-03-29	2019-03-29
Biconilog Antenna	ARA	LPB-2520/A	4318	2016-05-18	2018-05-18
DRG Horn	EMCO	3115	19357	2016-08-24	2018-08-24
Standard Gain Horn	QuinStar Tech. Inc.	QWH-KPRS00	6163	2016-08-22	2018-08-22
Humidity/Temp Logger	Extech Ins. Corp.	42270	5892	2017-04-06	2018-04-06
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800-21-5P	4354	Monitored	
Low Noise Amplifier (18 – 26 GHz)	MITEQ	JS44-01002650-33-3P	6163	Monitored	
Pre-Amplifier	hp	8447D	9291	Monitored	

2.9.5 Test Sample Verification, Configuration & Modifications

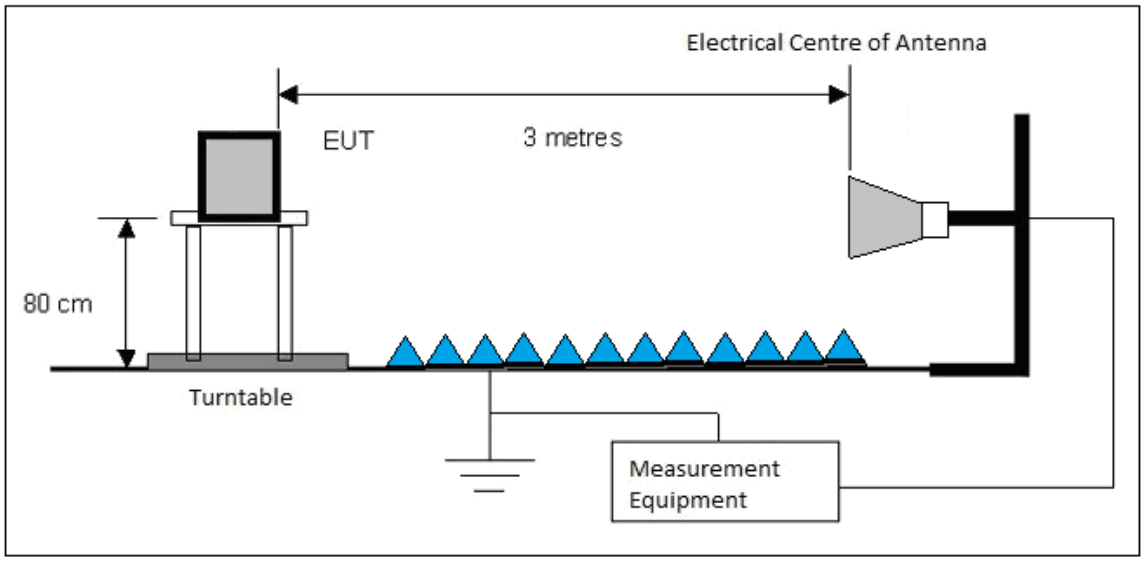
The EUT was set to a RX mode with test-specific software.

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):



2.9.6 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.

Freq. Marker	Freq. [MHz]	Raw reading [dBµv]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBµv/m]	FCC 15.109 Limit [dBµv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
30 – 1000 MHz											
1	374.9922	35.85	QP	19.6	-21.4	34.05	46.02	-11.97	98	241	Horizontal
2	500.0028	37.69	QP	21.2	-20.5	38.39	56.02	-7.63	10	101	Horizontal
3	999.9995	38.72	QP	27.1	-18.6	47.22	53.97	-6.75	338	206	Horizontal
4	42.9331	36.22	QP	20.4	-24.3	32.32	40	-7.68	330	107	Vertical
5	145.2485	42.86	QP	12.5	-22.8	32.56	43.52	-10.96	331	100	Vertical
6	375.002	42.57	QP	19.6	-21.3	40.87	56.02	-5.15	354	100	Vertical
7	999.9985	44.21	QP	27.1	-18.6	52.71	53.97	-1.26	358	100	Vertical
1300 – 3600 MHz -											
1	1	53.95	Av	24.1	-35.9	42.15	53.97	-11.82	37	100	Horizontal
2	1.125	52.19	Av	24.9	-35.7	41.39	53.97	-12.58	147	116	Horizontal
3	1	57.34	Av	24.1	-35.9	45.54	53.97	-8.43	201	245	Vertical
4	1.125	50.13	Av	24.9	-35.7	39.33	53.97	-14.64	217	388	Vertical

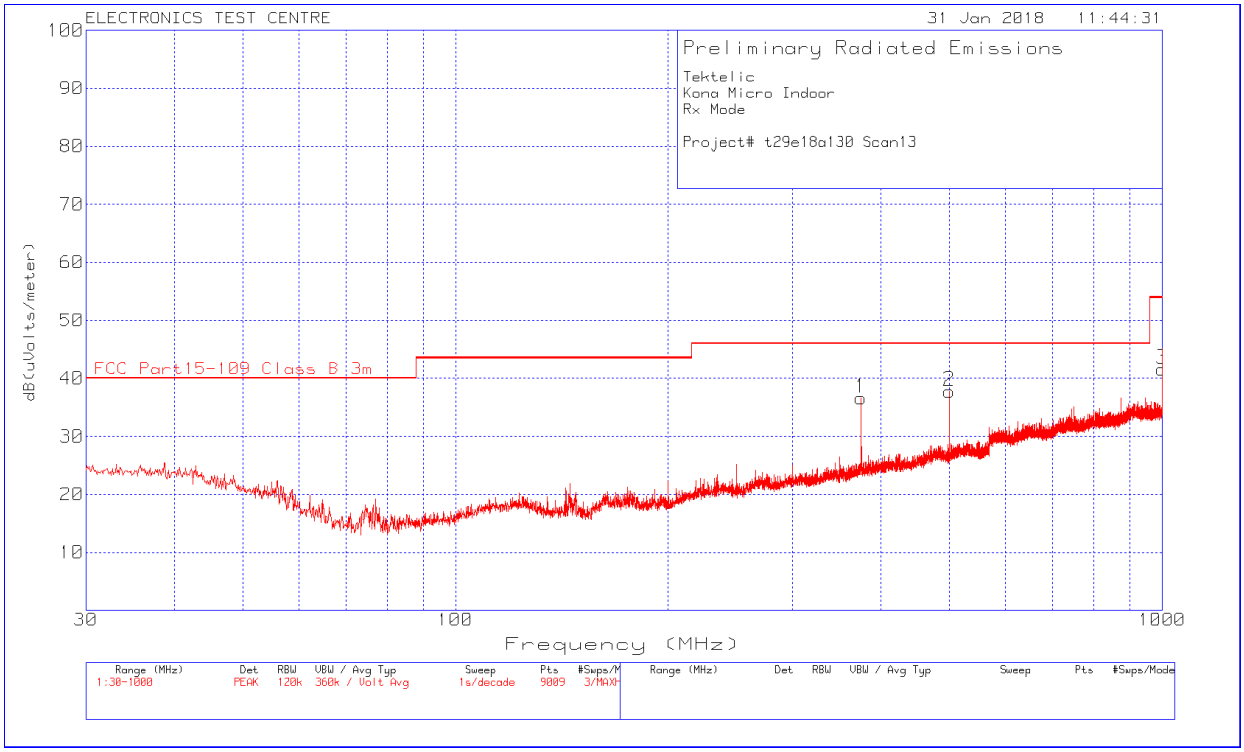
QP = Quasi-Peak Detector
AV = Average Detector

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:

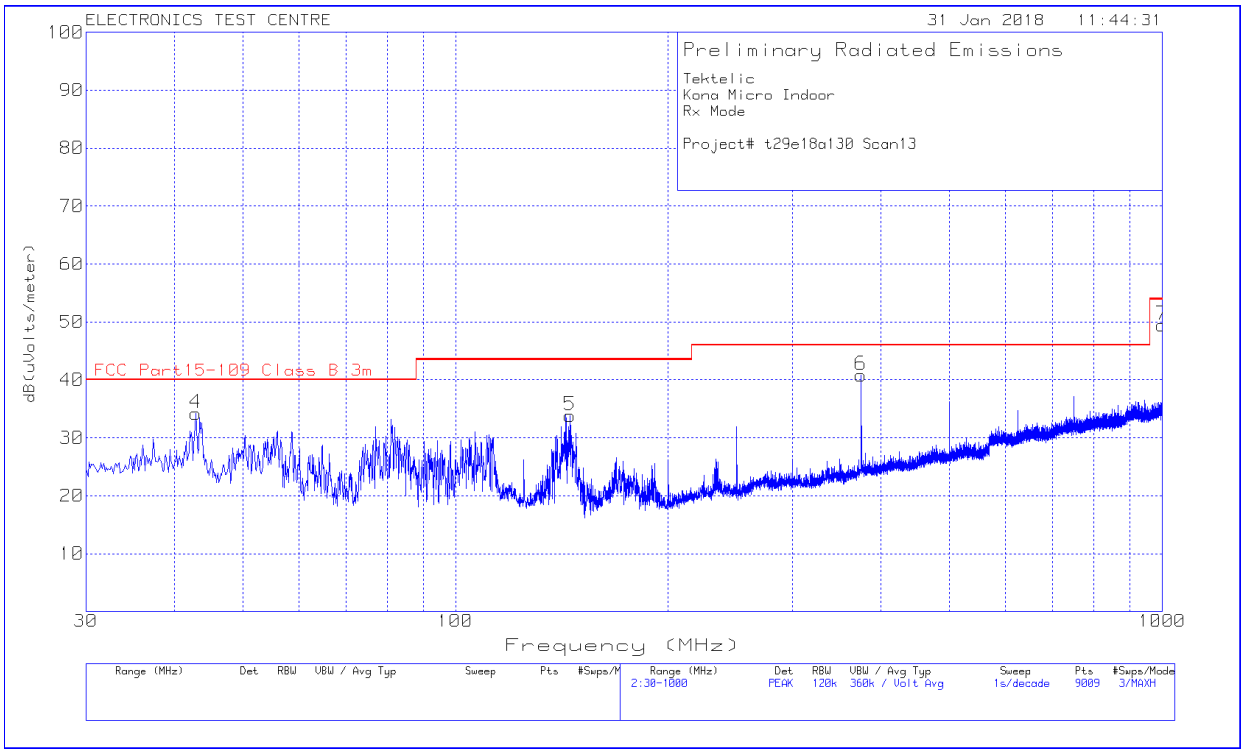
- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.

In receive mode, the EUT was assessed up to 5th harmonic of the highest internal frequency.

Plot of Radiated Emissions: Horizontal polarization

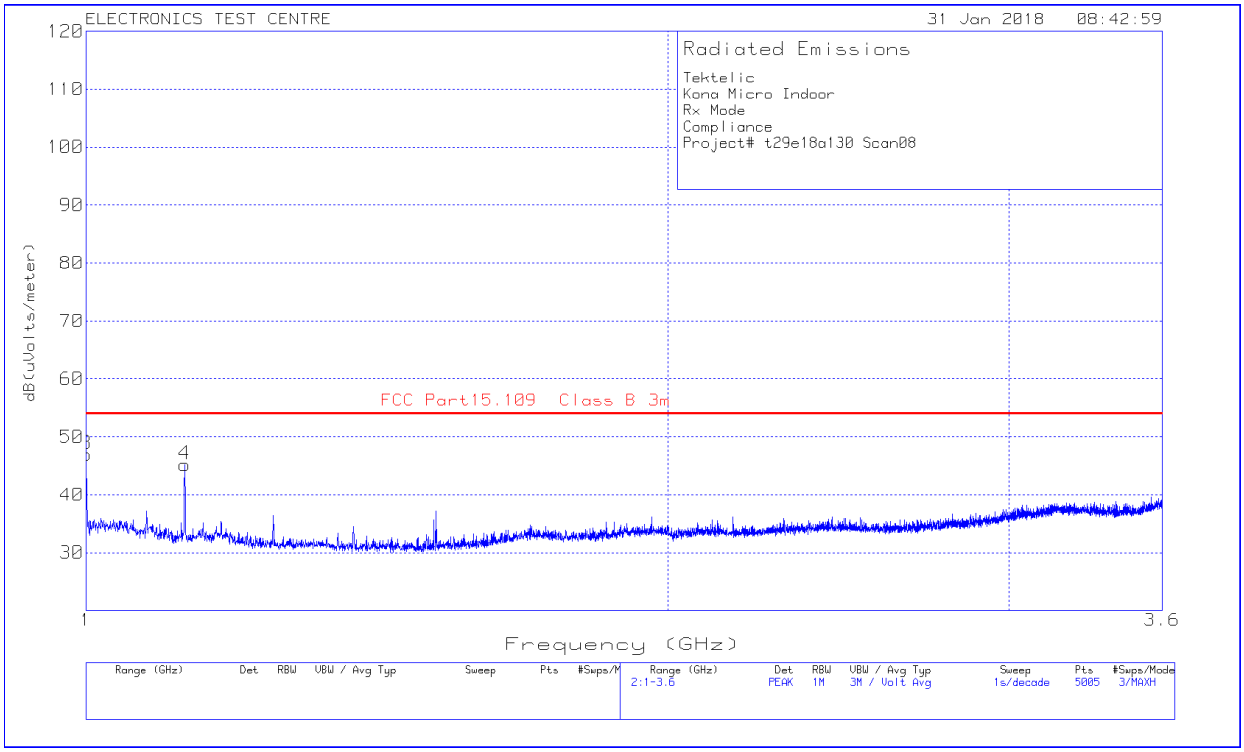


Plot of Radiated Emissions: Vertical polarization

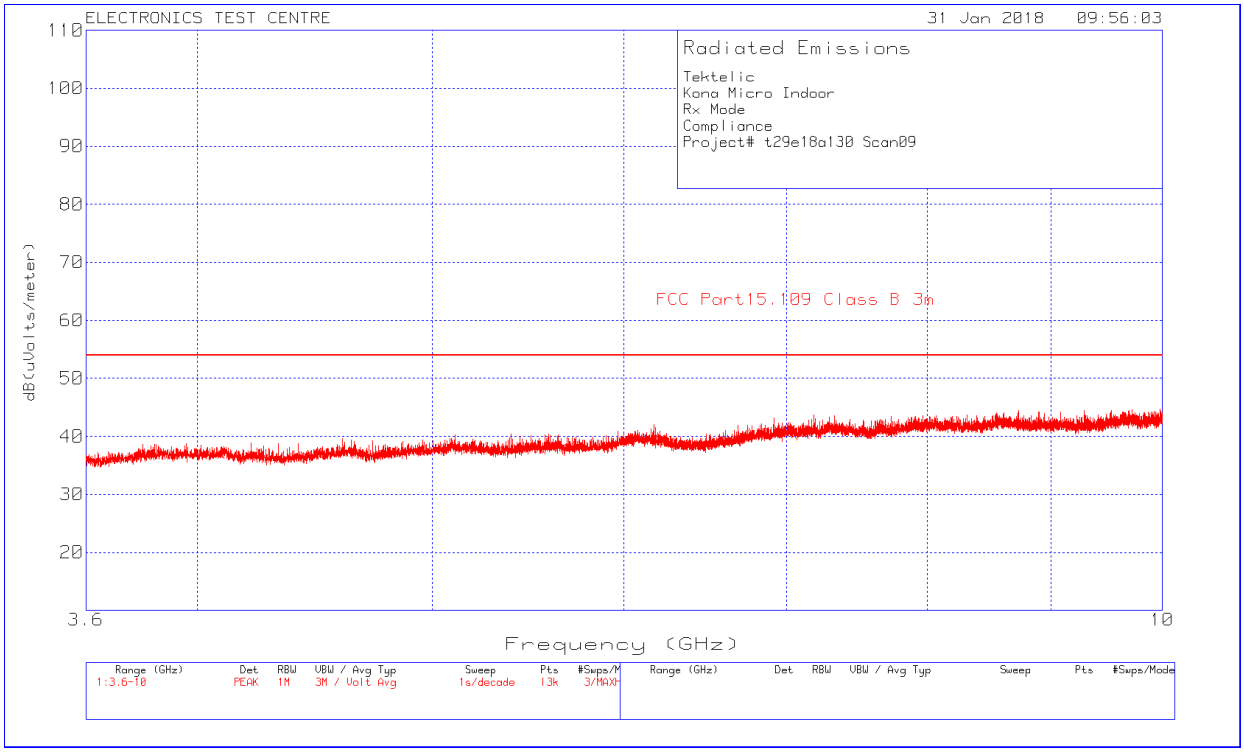


Plot of Radiated Emissions: Horizontal polarization

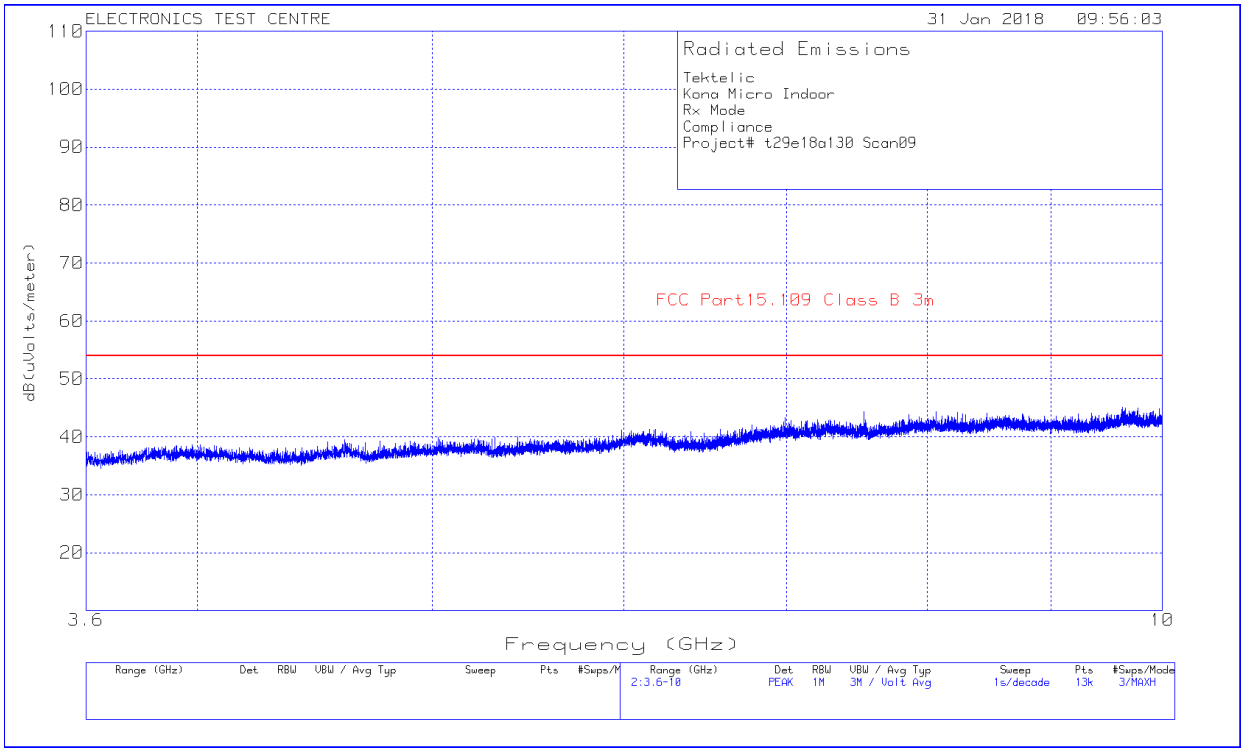
Plot of Radiated Emissions: Vertical polarization



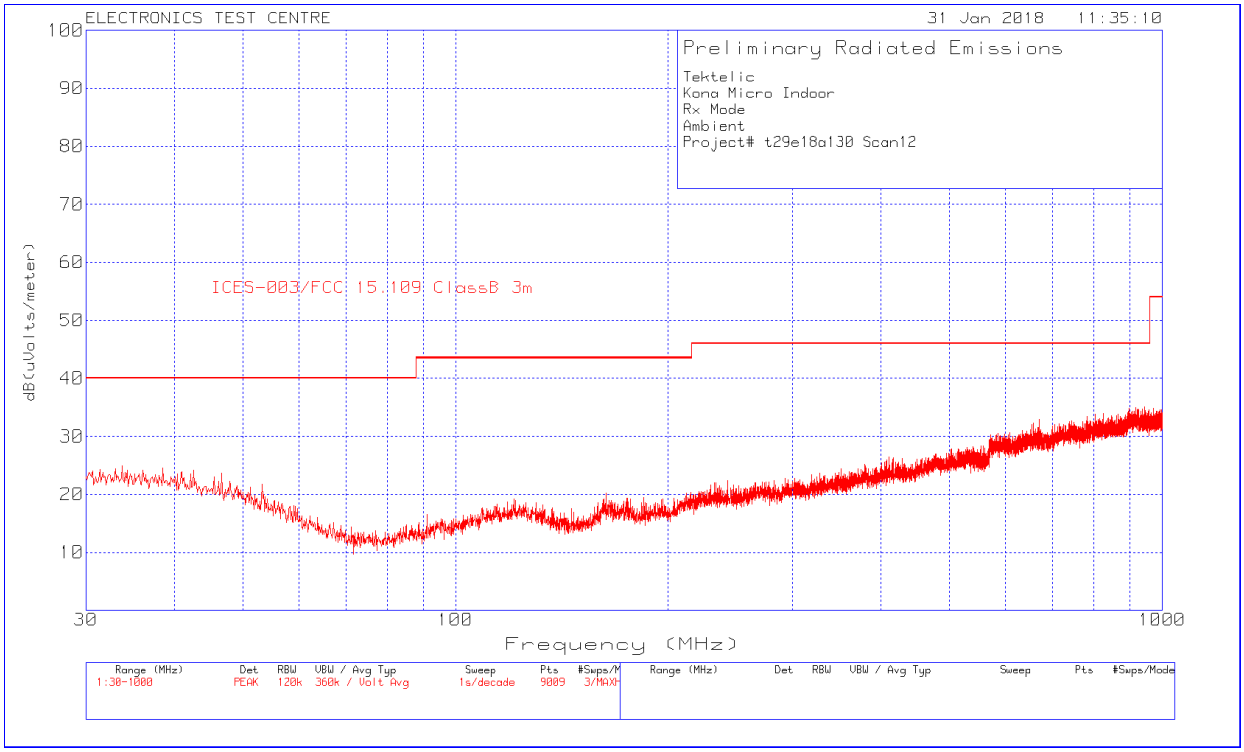
Plot of Radiated Emissions: Horizontal polarization



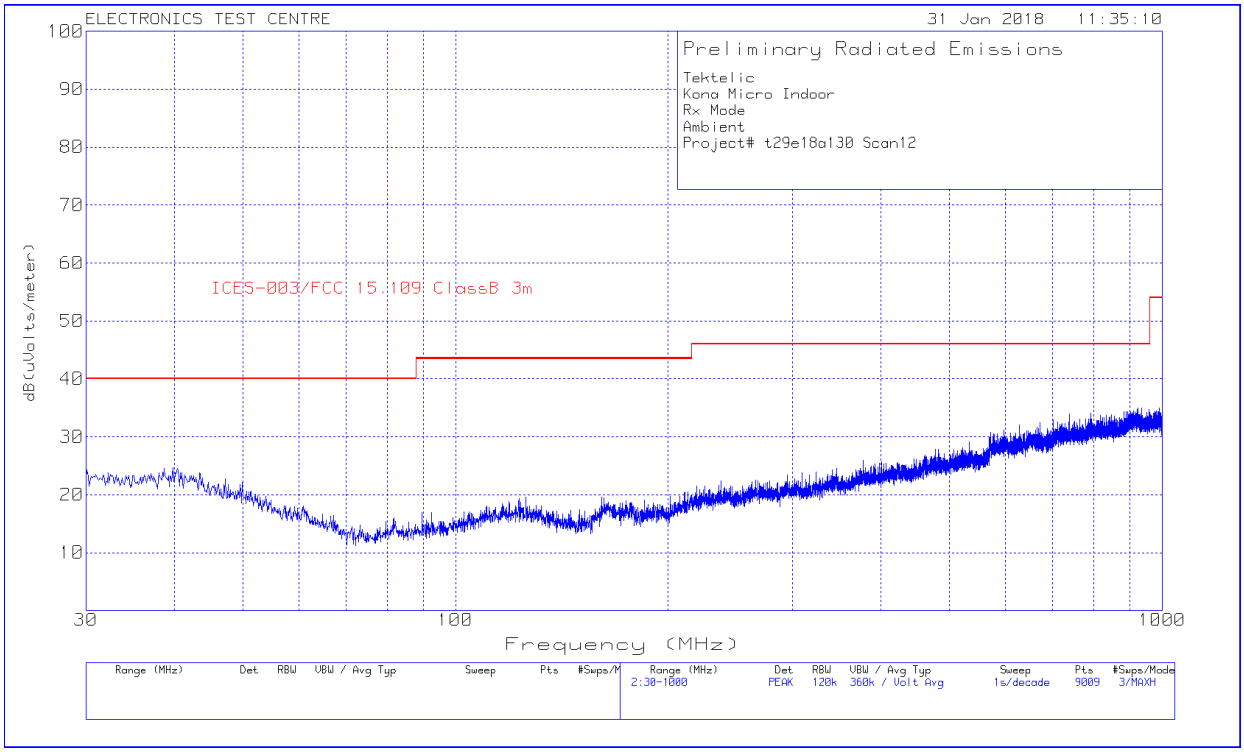
Plot of Radiated Emissions: Vertical polarization



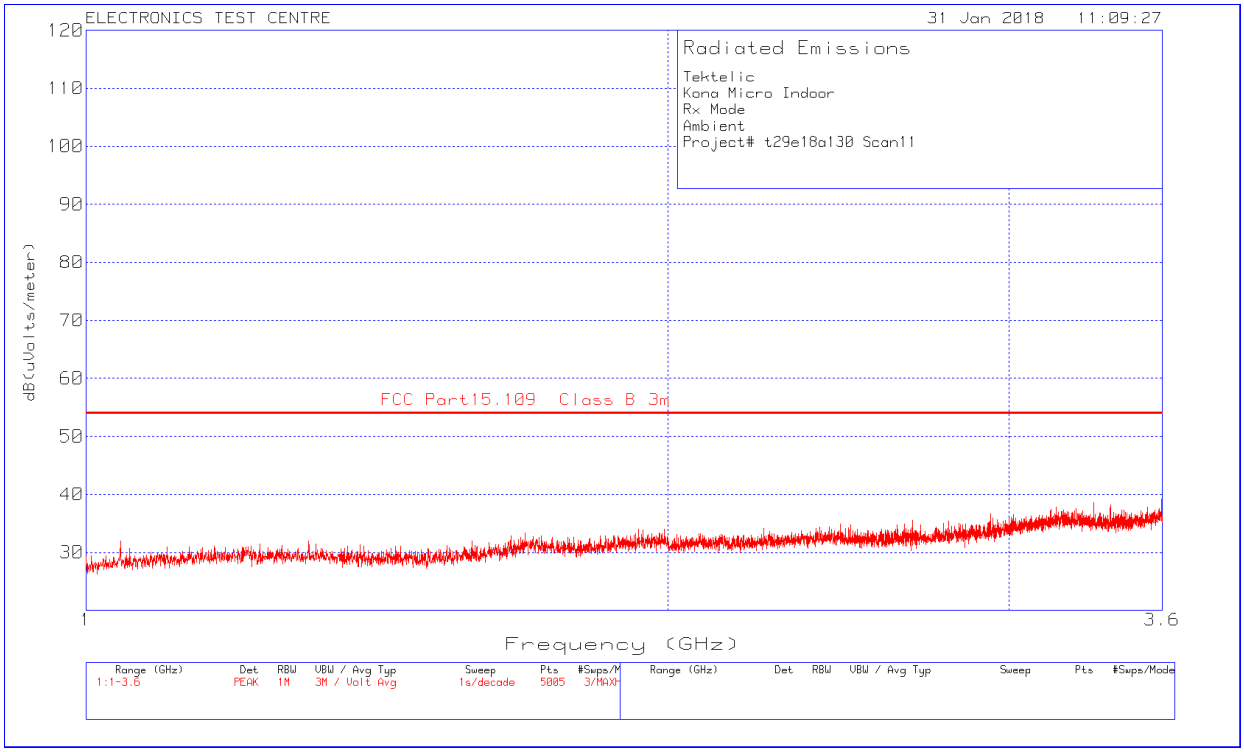
Plot of Radiated Emissions: Horizontal polarization Ambient



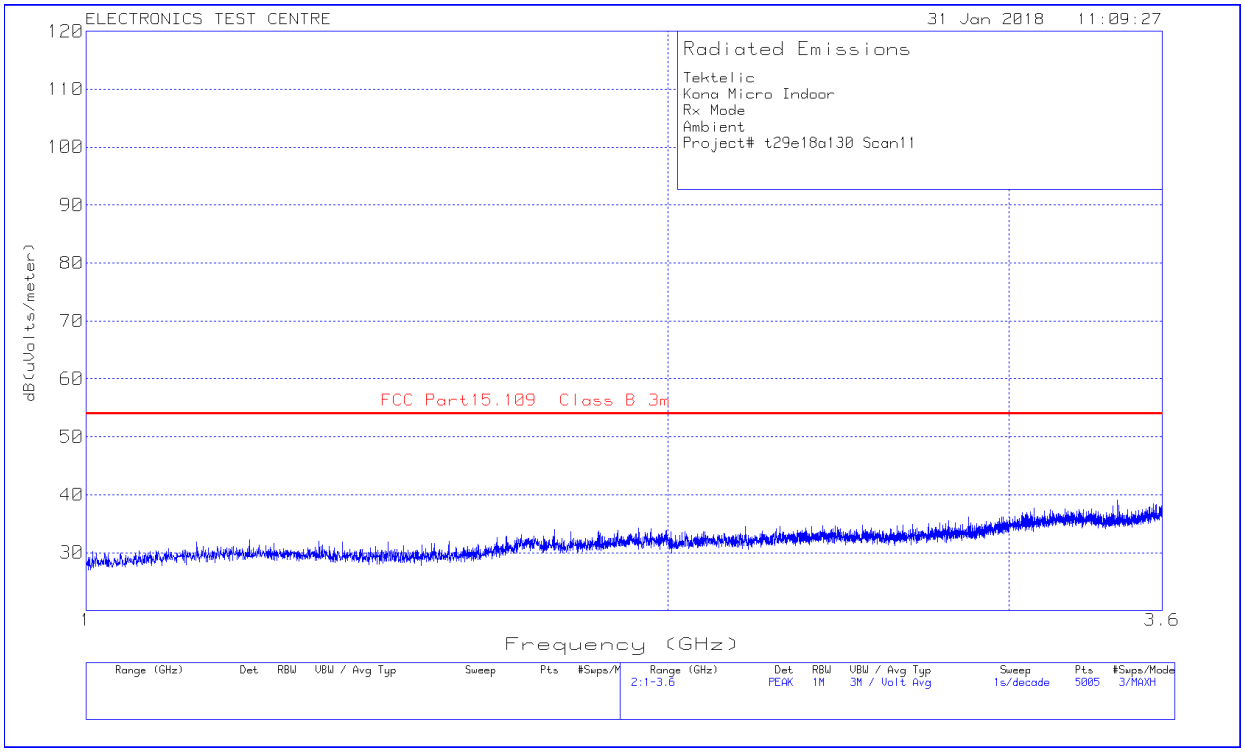
Plot of Radiated Emissions: Vertical polarization Ambient



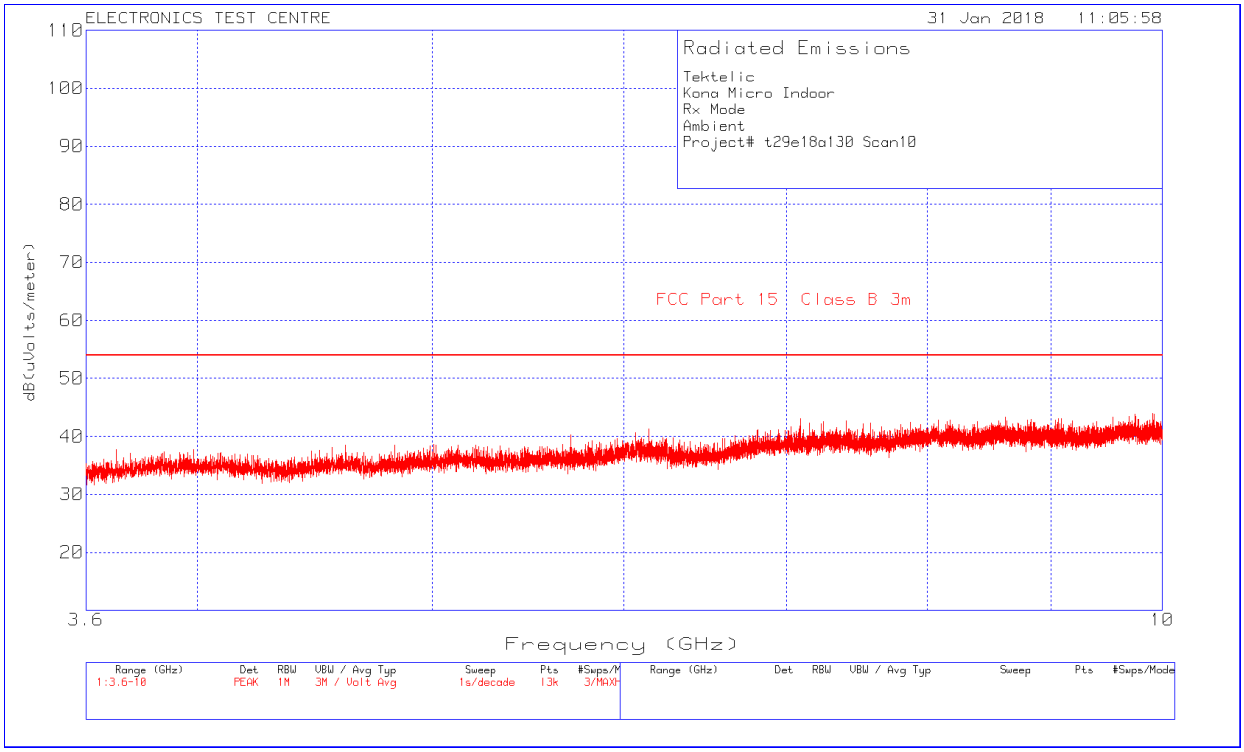
Plot of Radiated Emissions: Horizontal polarization Ambient



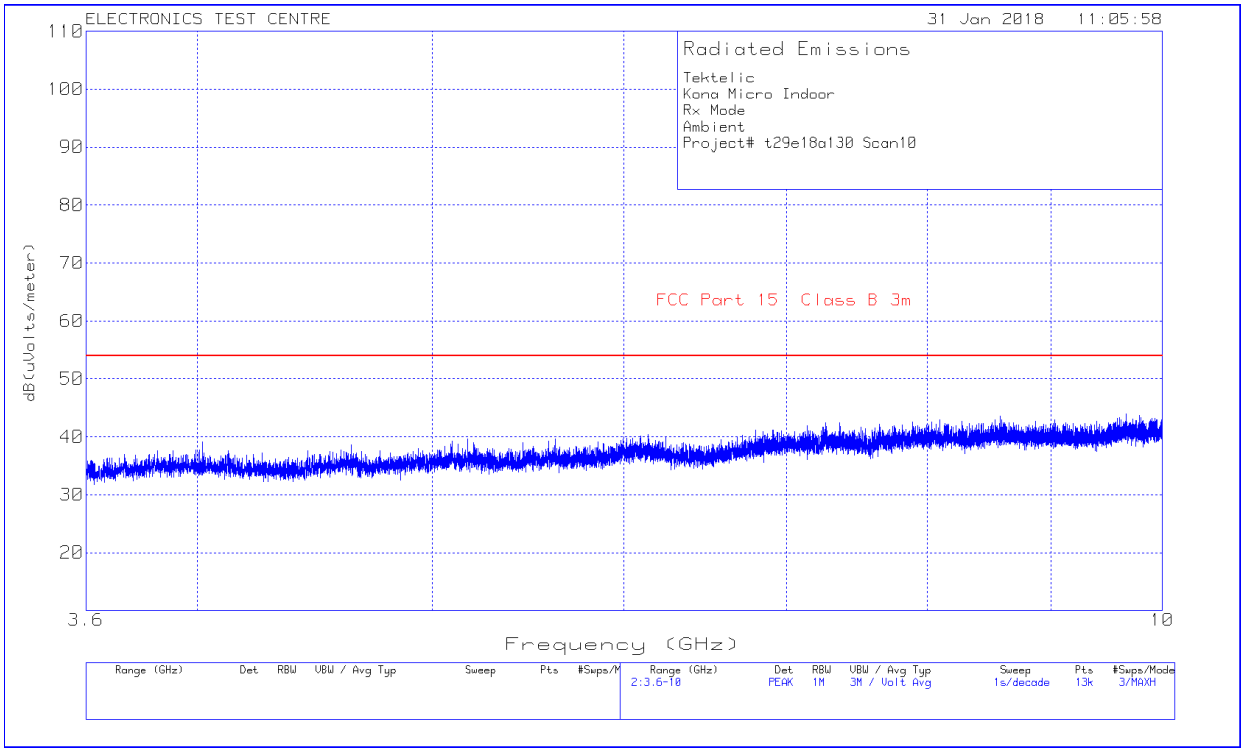
Plot of Radiated Emissions: Vertical polarization Ambient



Plot of Radiated Emissions: Horizontal polarization Ambient



Plot of Radiated Emissions: Vertical polarization Ambient



2.10 Conducted Emissions (Rx Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Micro Indoor Gateway**
Test Personnel: Imran Akram **Bushra Muharram**	**Standard: FCC Part 15.107**
	Basic Standard: ANSI C63.4: 2014
Date: 2018-01-31 (19.7° C,13.0% RH)	**Class: B**

EUT status: Compliant

Specification: FCC PT-15.107 Class B

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.		

2.10.1 Test Guidance:

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.

2.10.2 Deviations From The Standard:

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

2.10.3 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with:

UKAS (United Kingdom Accreditation Service) document

“Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” As based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

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

Test Method	Frequency	Uncertainty
Conducted Emissions Level	9 KHz – 150 KHz	±2.8 dB
Conducted Emissions Level	150 KHz – 30 MHz	±2.7 dB

2.10.4 Test Equipment

Testing was performed with the following equipment:

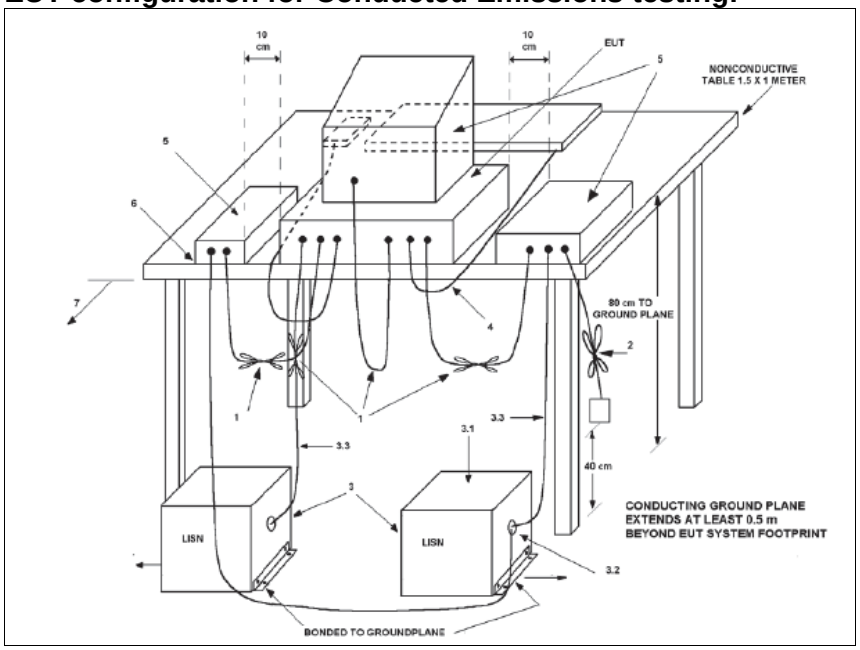
Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A	6130	2017-06-20	2018-06-20
LISN	Com-Power	LI-150A	6121	2017-07-07	2019-07-07
LISN	Com-Power	LI-150A	6122	2017-07-07	2019-07-07
Temperature/Humidity Logger	Extech Ins. Corp.	42270	5892	2017-04-06	2018-04-06

2.10.5 Test Sample Verification, Configuration & Modifications

Kona Micro indoor gateway is configured in Rx mode (both GSM/LoRa). EUT is power up by AC/DC adaptor; ; manufacturer is Shenzhen Click Technology Co., LTD Model#CPS012D120100U.

The EUT met the requirements without modification.

EUT configuration for Conducted Emissions testing:



2.10.6 Conducted Emissions Data:

The emissions data is presented in tabular form, showing the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value(s) of limit at the frequency measured, and the Delta between the result and the limit.

Freq. Marker	Freq. (MHz)	Raw reading (dBµv)	Det.	LISN Factor (dB)	Cable Loss (dB)	Corrected Reading (dBµV)	FCC 15.107 Class B Limit (dBµV)	Delta (dB)	L / N
1	.34607	27.69	AV	0	9.9	37.59	49.06	-11.47	L
2	16.2279	30.6	AV	.1	10.1	40.8	50	-9.2	L
1	.36267	22.11	AV	0	10	32.11	48.67	-16.56	N
2	16.2278	31.21	AV	.1	10.1	41.41	50	-8.59	N
3	18.2432	30.87	AV	.1	10.3	41.27	50	-8.73	N
4	18.2431	30.36	AV	.1	10.3	40.76	50	-9.24	N

AV = Average Detector

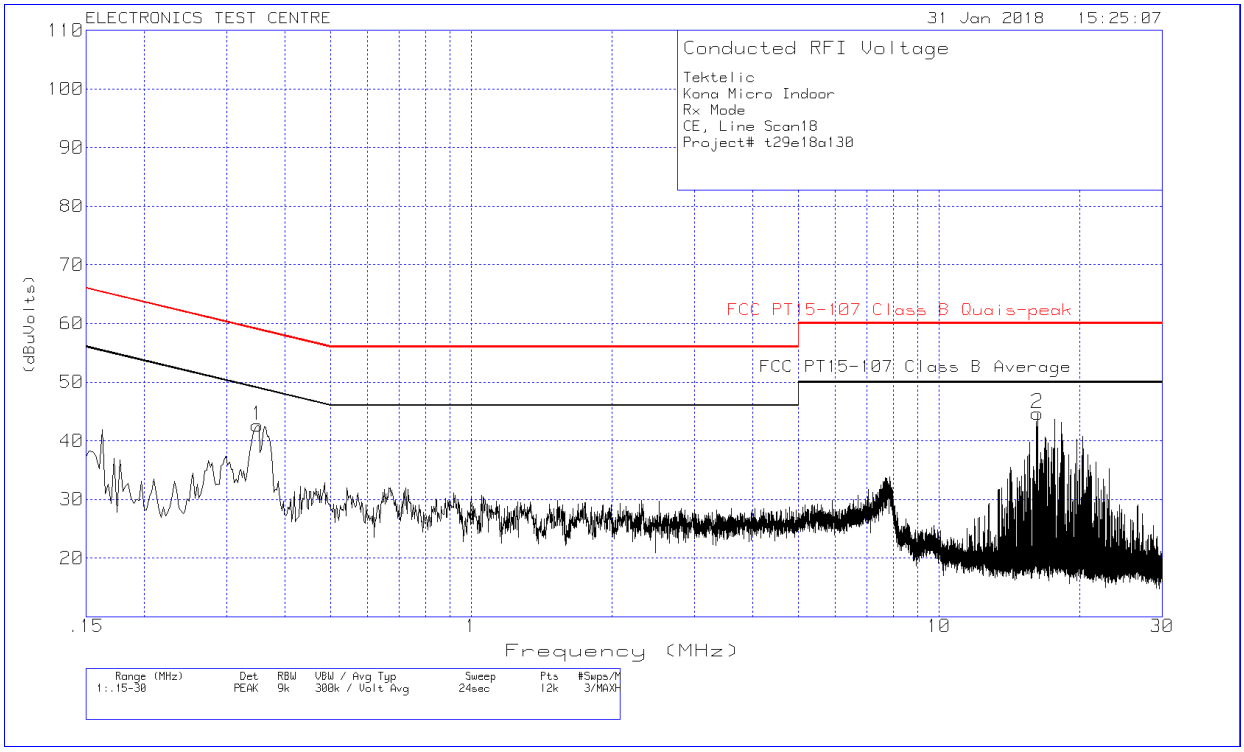
Raw Reading in dBµV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dbµV/m.

Note: When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.

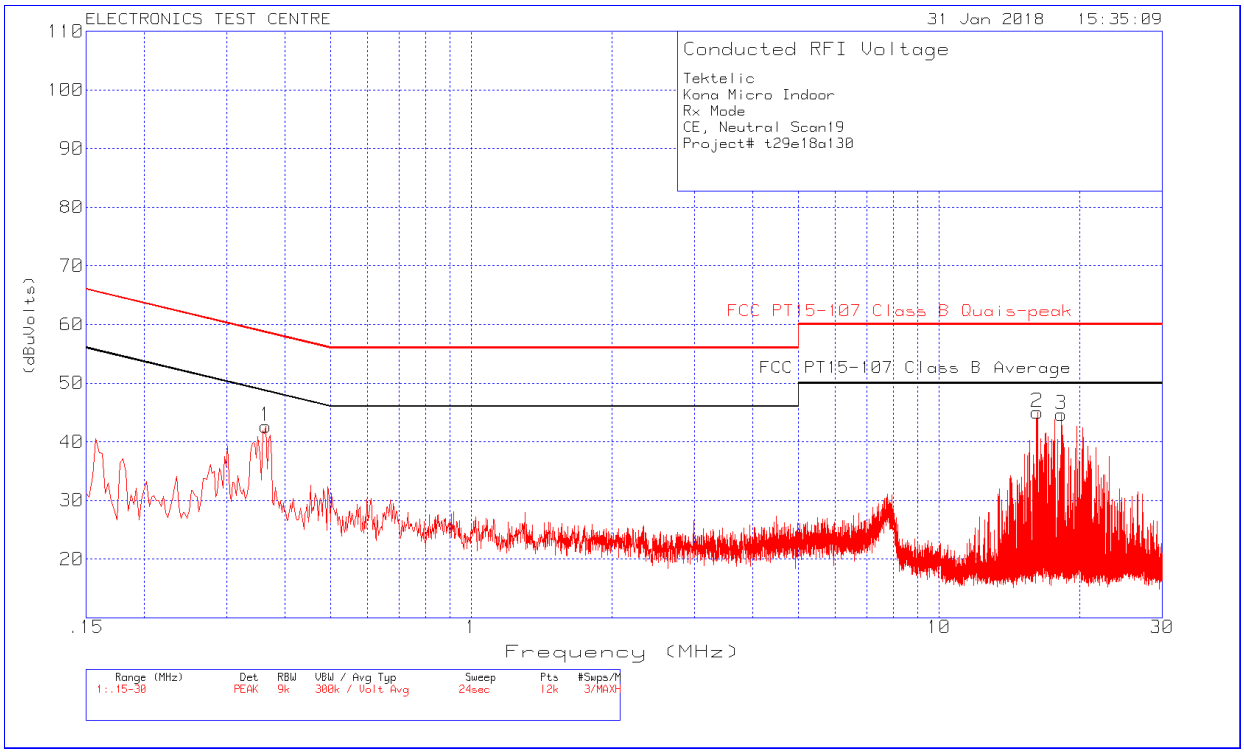
Negative values for Delta indicate compliance.

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

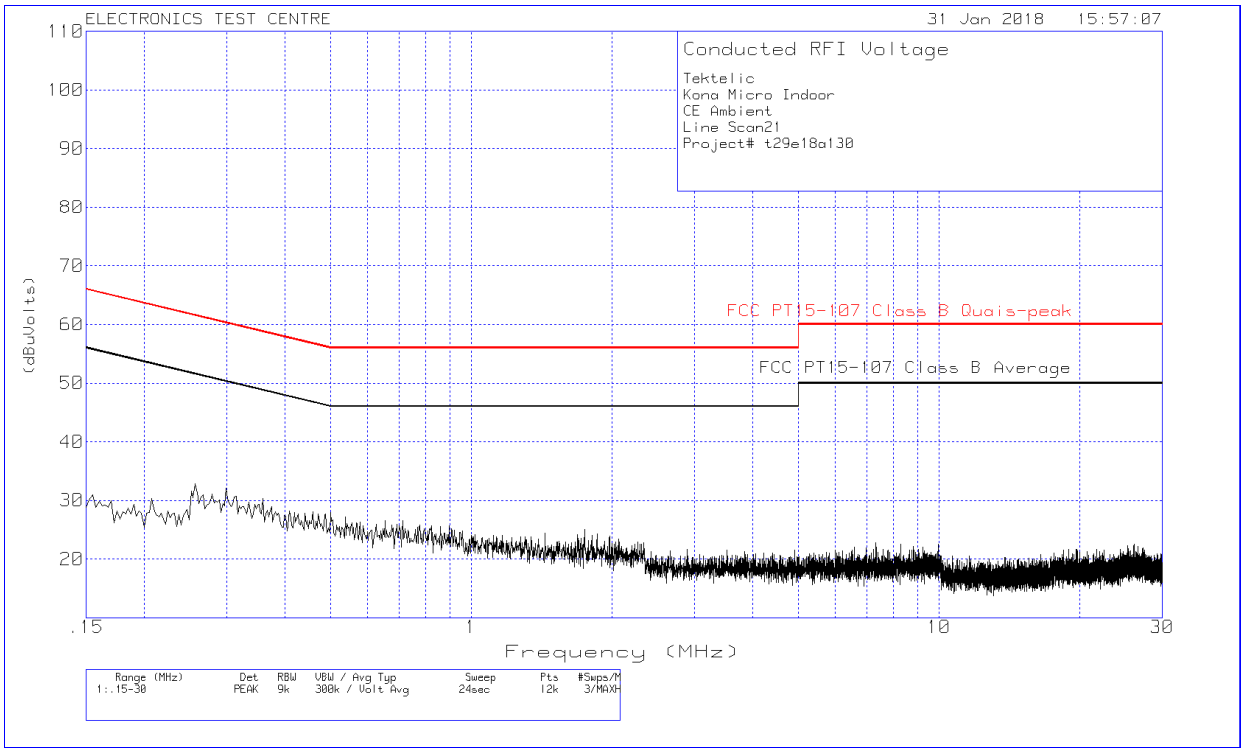
Plot of Conducted Emissions: Line



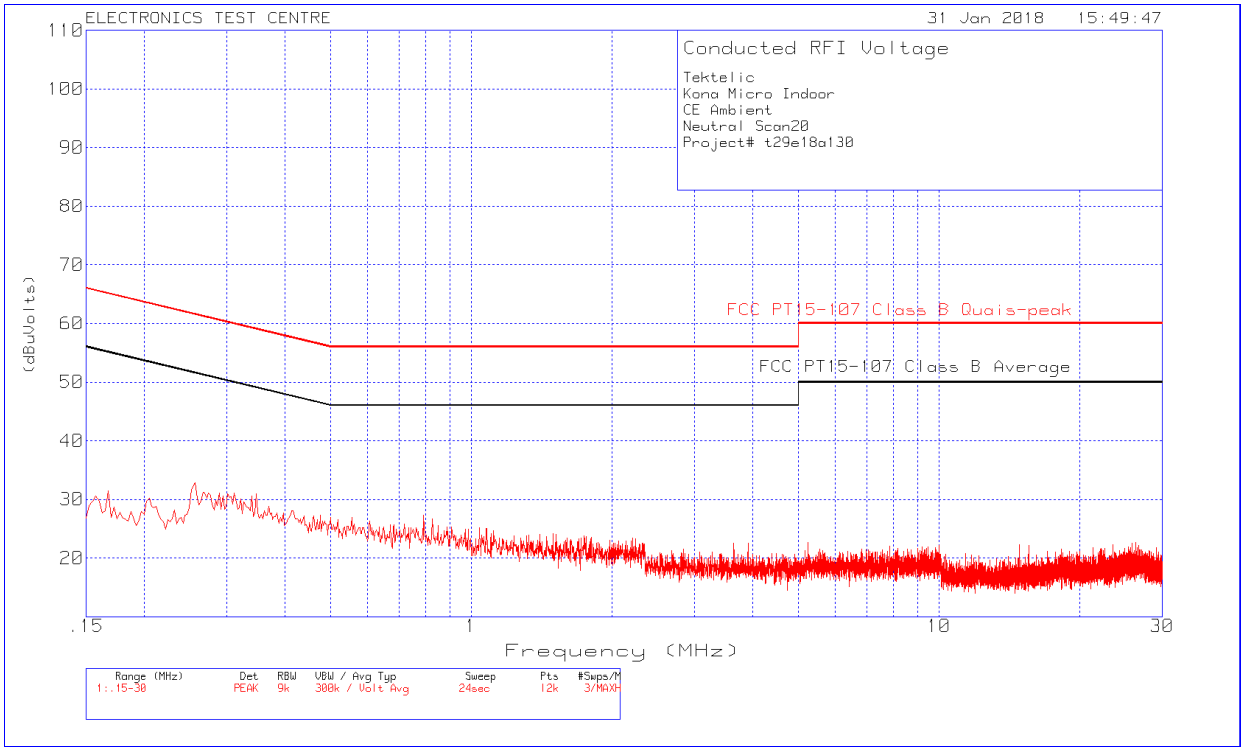
Plot of Conducted Emissions: Neutral



Plot of Line Ambient:



Plot of Neutral Ambient:



2.11 Antenna Requirements

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Micro Outdoor Gateway**
Test Personnel: Imran Akram	**Standard: FCC Part15.203**

EUT status: Compliant

FCC Part15.203 Requirements

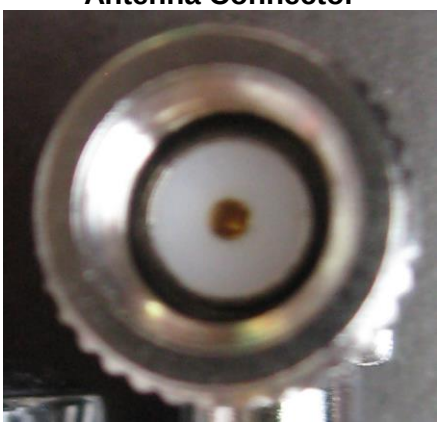
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. **The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions** of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

2.11.1 EUT Antenna

The Kona micro indoor gateway GSM module has internal antenna and LoRa radio and associated antenna has reverse polarity SMA connector.

Radio Connector

Antenna Connector



2.12 RF Exposure

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Micro Indoor 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 Indoor Gateway was tested for emissions 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 Indoor Gateway was placed at the centre of the test chamber turntable on top of an 80-cm high polystyrene foam table. 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 – 3G/4G Module Antenna

PulseLARSEN Antennas

TECHNICAL DATA SHEET

Series: Gemini

Description: LTE Diversity FPC Antenna

PART NUMBER: W3907B0100

Features:

- 2G / 3G / 4G Div Ant for MiMo
- Used as pair for W3906B0100
- Can be used as Primary antenna
- 698-3600MHz
- Global LTE Bands:
  - B1-B23, B25-B29, B33-B42
  - N.A.; Europe, Asia (incl. Jap.)
- Foldable for tight spaces

Applications:

- Challenging RF Environments Demanding:
  - Highest Peak Gain
  - Lowest ECC (Envelope Correlation Coeff.).
- Matched to Radio Modules from:
  - Sierra Wireless, Telit, Huawei, Gemalto, uBlox, ZTE, and others.
- Security, Video, Graphics
- IoT, SmartGrid, Meters, Remote Monitoring, Sensor Networks

All dimensions are in mm / inches

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RoHS COMPLIANT

In the effort to improve our products, we reserve the right to make changes judged to be necessary.

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PulseLARSEN Antennas

TECHNICAL DATA SHEET

Series: Gemini

Description: LTE Diversity FPC Antenna

PART NUMBER: W3907B0100

ELECTRICAL SPECIFICATIONS

Frequency	698-960/1427.9-1510.9/1559-1610/ 1695-2200/2300-2700/3400-3600 MHz
Nominal Impedance	50Ω
Return loss(698-960MHz)	-6dB
Return loss(1427.9-1510.9/1559-1610/ 1695-2200/2300-2700/3400-3600MHz)	-7.5dB
Average Total Efficiency (698-960MHz)	55%
Average Total Efficiency (1427.9-1510.9MHz)	60%
Average Total Efficiency (1559-1610MHz)	60%
Average Total Efficiency (1695-2200MHz)	65%
Average Total Efficiency (2300-2700MHz)	70%
Average Total Efficiency (3400-3600MHz)	65%

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RoHS COMPLIANT

PulseLARSEN Antennas

TECHNICAL DATA SHEET

Series: Gemini

Description: LTE Diversity FPC Antenna

PART NUMBER: W3907B0100

ELECTRICAL SPECIFICATIONS

Peak Gain (698-960MHz)	2.9dBi
Peak Gain (1427.9-1510.9MHz)	1.7dBi
Peak Gain (1559-1610MHz)	1.8dBi
Peak Gain (1695-2200MHz)	3.4dBi
Peak Gain (2300-2700MHz)	3.8dBi
Peak Gain (3400-3600MHz)	4.2dBi
Radiation Pattern	Omni
Polarization	Linear
Power withstanding	3W

(*) All RF parameters measured on 2mm thick PC plate

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RoHS COMPLIANT

PulseLARSEN Antennas

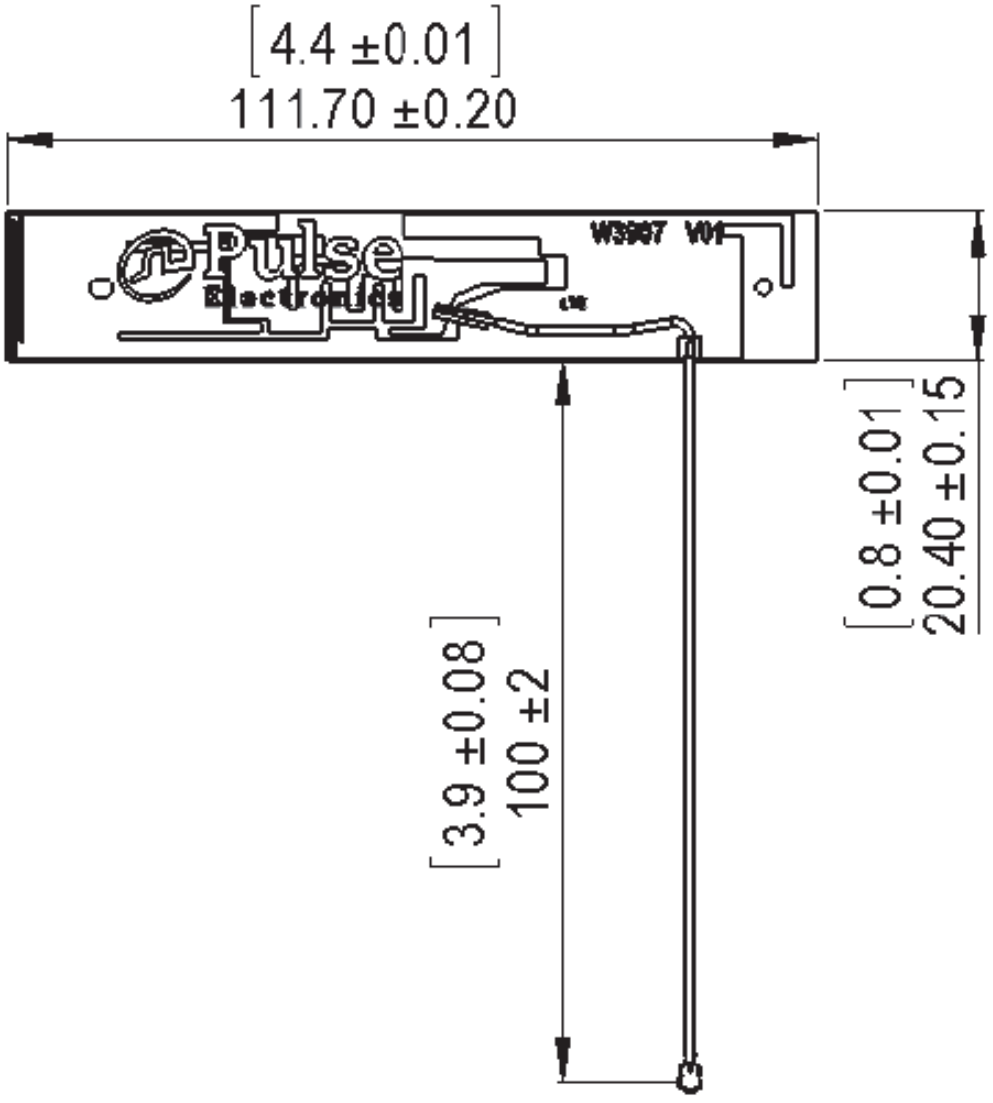
TECHNICAL DATA SHEET

Description: LTE Diversity FPC Antenna

Series: Gemini

PART NUMBER: W3907B0100

MECHANICAL DRAWING



Issue: 1741

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Appendix B – LoRa Antenna

Airgain)))

Airgain ET830DBLTRPSMA
Engineering Data Sheet

1. Airgain ET830DBLTRPSMA Embedded Antenna

The Model ET830DBLTRPSMA dipole Antenna provides an Omni-directional high performance antenna solution for 900MHz (ISM Band) LoRa, and LTE applications. This antenna was designed to accommodate most access point applications, and small client station applications.

2. Features

The Model ET830DBLTRPSMA DipoleAntenna is defined by the following features:

- LTE standards
- 868-928MHz (ISM Band)
- External Dipole antenna

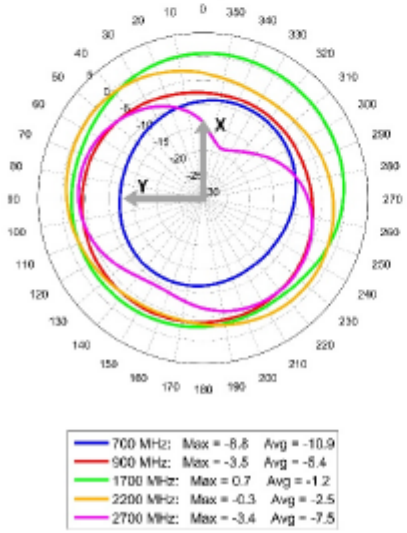
Figure 1: Model ET830DBLTRPSMA Embedded Antenna

Specifications and Interface

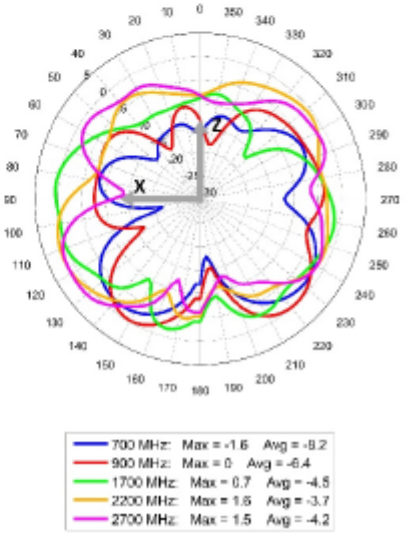
Standard	LTE
Frequency range	0.7 to 2.7 GHz
VSWR	5:1 for 0.7 to 0.9 G 2.5:1 for 1.7 to 2.7 G
Feed impedance	50 ohms
Power handling	30 dBm
Interface	RP SMA Female Connector
Antenna dimensions	Φ8mm×116mm×18mm
Weight	16.9g
Temperature range	-30 °C --- +70 °C
Cover material(color)	Plastic(Black)
Humidity range	5%~95%

Radiation Patterns

ET830DBLTRPSMA_LTE Azimuth XY



ET830DBLTRPSMA_LTE Side to Side XZ



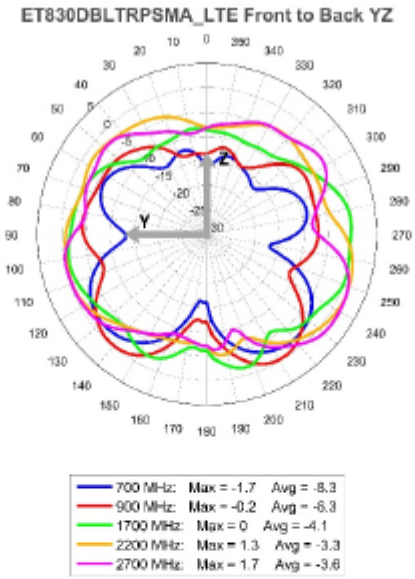
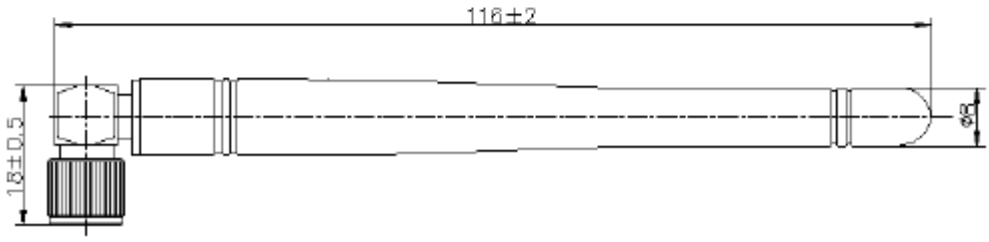


Figure 2: Model ET830DBLTRPSMA Measured Radiation Patterns

Dimensions



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