ELECTRONICS TEST CENTRE
MPB TECHNOLOGIES INC.

ACCREDITED
TESTING CERT#2750.01

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ETC Report #: t29e18a126-DSS_FCC Release 4 Report date: June 27, 2018

Test Dates: January 11,12,15 of 2018

EMC testing of the Tektelic Communication Inc. Kona Home Sensor

in accordance with FCC Part 15.247, ANSI C63.4: 2014 and ANSI C63.10: 2013 as referenced by FCC DA-00-705 rel. March 30, 2000.

FCC ID: 2ALEPT0005370

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REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2018-01-24	I. Akram	Initial draft submitted for review.
DRAFT2	2018-04-24	I. Akram	Updated the format/ corrected typo error
Release 1	2018-06-08	M. Rousseau	Sign off
Release 2	2018-06-13	I. Akram/ M. Rousseau	Added Month for testing at first page. Added Cable/amplifier cal. Date/ Sign off
Release 3	2018-06-17	M. Rousseau	Clarify in section 1.5.3 that DTS 500kHz is non-hopping.
Release 4	2018-06-27	I. Akram/ M. Rousseau	DTS and Hybrid mode test data are reported in 2 separated reports as per TCB request. All tests not germane under Hybrid modulation for FCC part 15.247 were removed. Sign off

TABLE OF CONTENTS

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 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 Home Sensor 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 Home Sensor
LoRa Radio	**Frequency Band**	902 – 928 MHz
	Type of Modulation	Chirp Spread Spectrum
	BW/Frequency Range	
	BW/Frequency Range	Hybrid 125kHz, 902.3 – 914.9 MHz
	Associated Antenna	Pulse Engineering W3012 Ceramic SMT Gain = 2.0 dBi, omni directional
	Detachable/Non Detachable	soldered to PCB board
Model# / Serial#		T0004886 / 1751D0010
Power supply:		Internal Battery

Note: All three models **T0004893 (Base), T0004885 (PIR)** and **T0004886 (External Connector)** were evaluated. **T0004886** was chosen since it provided the worst emission results.
All three model use identical electrical host board. The difference arse
Base – No PIR, No digital external Input
PIR - with Motion Sensor, No digital external Input
External Connector - With digital external input connector.

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.

In this report, the EUT is only tested for the 125kHz Hybrid transmission mode. Test results regarding DTS 500kHz transmission mode is provided in the separate 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, ANSI C63.10: 2013 as referenced in FCC DA 00 705 rel. March 30, 2000.

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.

Modulation mode: Hybrid 125kHz

Hybrid 125kHz DTS and frequency hopping system, which meets part 15.247's requirements for hybrid system. The channels used for the test are:

Low = 902.3 MHz

MID = 908.5 MHz

High. = 914.9 MHz

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
Frequency Range = 902.3 – 914.9 MHz 125 KHz Hybrid Mode Max. Conducted Tx Power=17.20 dBm (0.0525 Watt)						
2.1	AC Conducted Emissions (Tx)	15.207	Kona Home Sensor	none	see § 2.1	**N/A Internal Battery powered**
2.2	Occupied Bandwidth	15.247(a)(1) 15.247(2)(2)	Kona Home Sensor	none	see § 2.2	**Compliant**
2.3	Max Output Power Conducted	15.247(b)	Kona Home Sensor	none	see § 2.3	**Compliant**
2.4	Power Spectral Density	15.247(e) 15.247(f)	Kona Home Sensor	none	see § 2.4	**Compliant**
2.5	Band Edge	15.247(d)	Kona Home Sensor	none	see § 2.5	**Compliant**
2.6	Conducted Spurious	15.247(d)	Kona Home Sensor	none	see § 2.6	**Compliant**
2.7	Minimum channel separation	15.247(a)(1)	Kona Home Sensor	none	see § 2.7	**Compliant**
2.8	Average time of Occupancy for hybrid System	15.247(f)	Kona Home Sensor	none	see § 2.9	**Compliant**
2.9	EUT Position	ANSI C63.4	Kona Home Sensor	none	see § 2.10	**Assessed**
2.10	Radiated Spurious (Tx Mode)	15.205, 15.209 15.247(d)	Kona Home Sensor	none	see § 2.11	**Compliant**
2.11	RF Exposure	15.247(i)	Kona Home Sensor	none	see § 2.13	**Exempt**

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 Home Sensor**
Test Personnel:	**Standard: FCC Part 15.207**
Date:	**Basic Standard: ANSI C63.4: 2014**
EUT status: N/A	
Comments = EUT is internal battery powered	

2.2 Channel Occupied Bandwidth (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-01-15 (20.7°C,11.8 % RH)	**Basic Standard: ANSI C63.10-2013**

EUT status: Compliant

Specification: FCC 15.215 (c)

Criteria: For hybrid system there is no limit for the 20dB or 99% bandwidth.

2.2.1 Test Guidance: ANSI C63.10-2013, Clause 6.9.2 & 6.9.3

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 Hybrid the nominal IF filter bandwidth (3 dB RBW) is set in the range of 1% to 5% of the OBW and video bandwidth (VBW) is set approximately three times RBW.

The automated 99% BW function of the spectrum analyzer is engaged, 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	Interval	Cal. Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	1 year	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	1 year	2018-04-06
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

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.

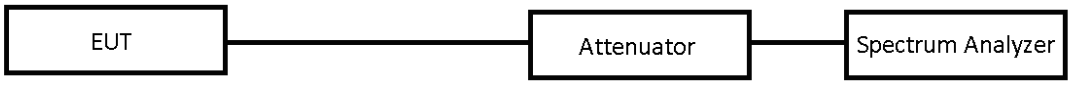
The EUT modified to provide the direct access to antenna trace for conducted measurements.

For compliance purposes EUT met requirements without any modification

There is no Deviation and exclusions from test specifications.

Test setup diagrams for Occupied Bandwidth testing:

Conducted:

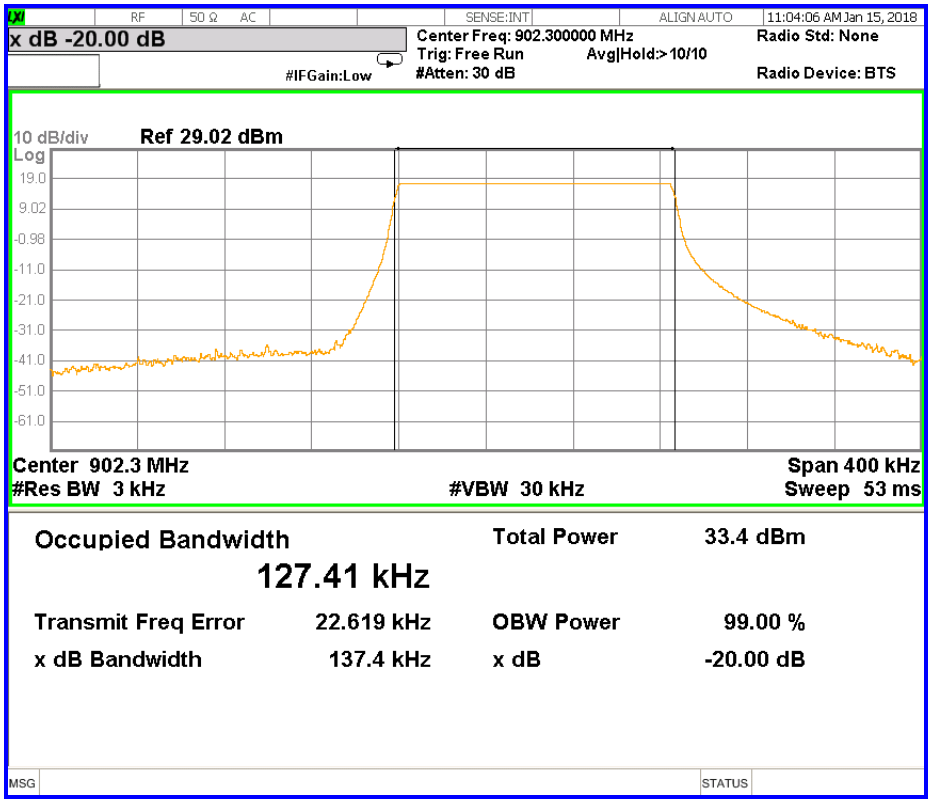


2.2.5 Channel Occupied Bandwidth Data: (Hybrid Mode)

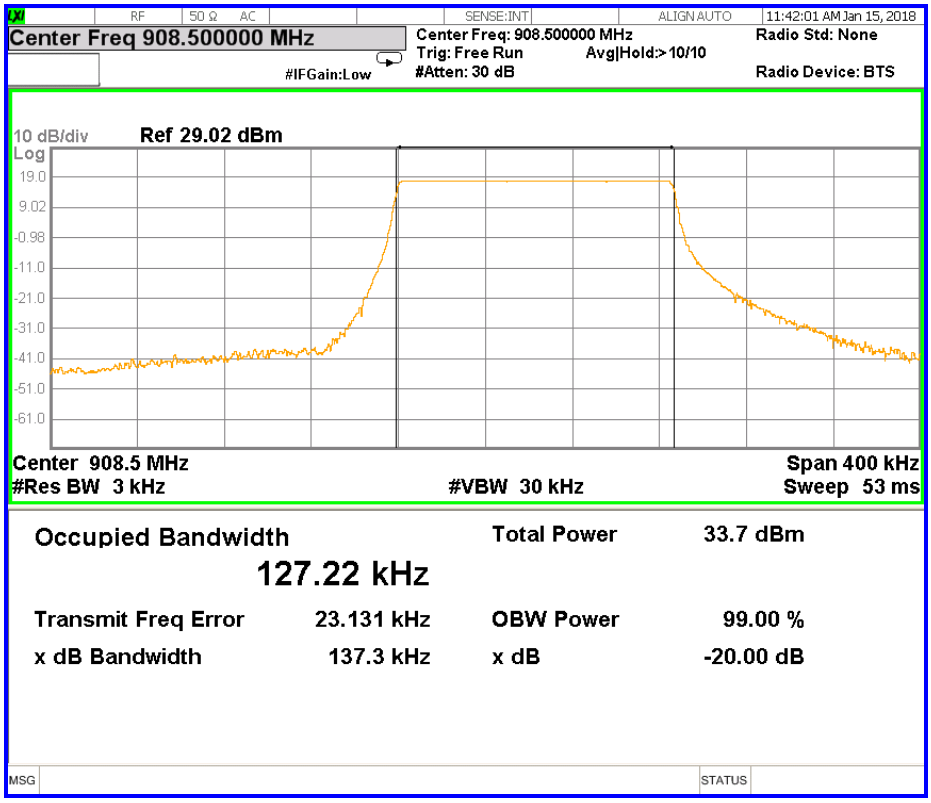
LoRa 125 KHz Channels

Channel	Freq. [MHz]	20 dB OBW [kHz]	99% OBW [KHz]
Low	902.3	137.4	127.41
Mid	908.5	137.3	127.22
High	914.9	137.2	127.25

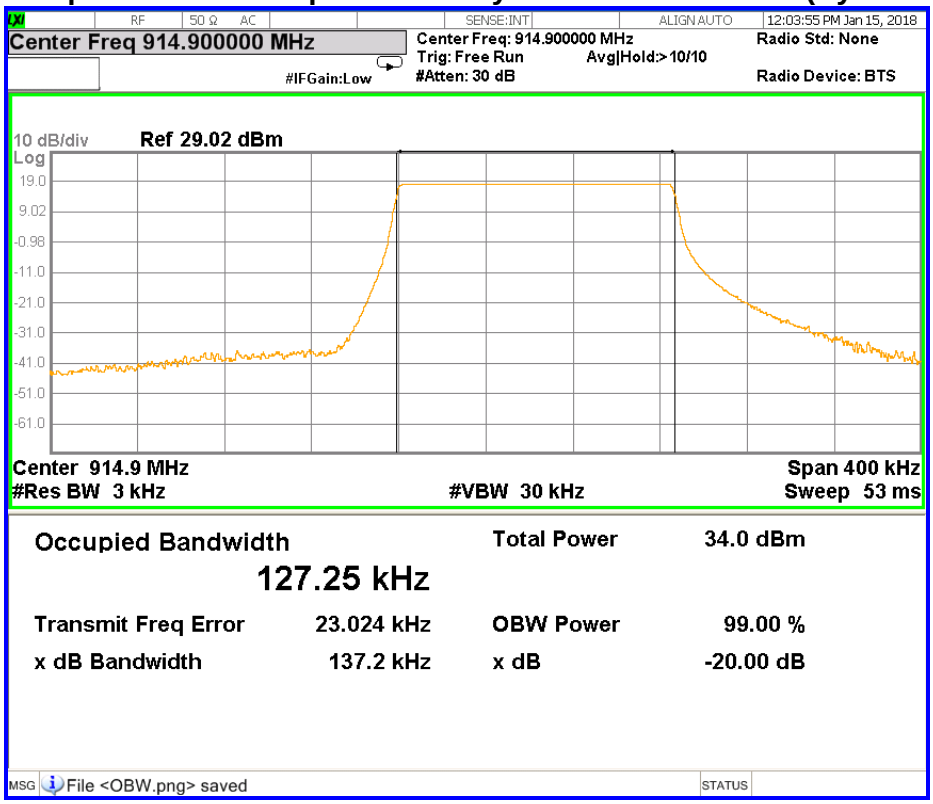
Screen captures from the spectrum analyzer 125 KHz Channel (Hybrid Mode)



Screen captures from the spectrum analyzer 125 KHz Channel (Hybrid Mode)



Screen captures from the spectrum analyzer 125 KHz Channel (Hybrid Mode)



2.3 Max Average Output Power (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-01-15 (20.7°C,11.8 % RH)	**Basic Standard: ANSI C63.10: 2013**

EUT status: Compliant

Specification: FCC Part 15.247(b, 2)

Criteria	For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels

2.3.1 Test Guidance: ANSI C63.10-2013, Clause 11.9.2.2.2, Clause 7.8.5

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	Interval	Cal. Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	1 year	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	1 year	2018-04-06
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

2.3.4 Test Sample Verification, Configuration & Modifications

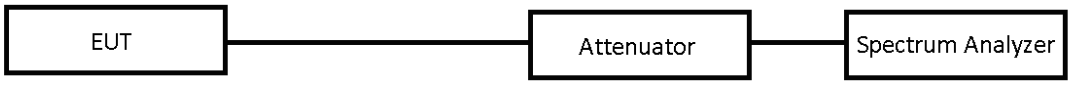
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT modified to provide the direct access to antenna trace for conducted measurements.

For compliance purposes EUT met requirements without any modification

Test setup diagrams for Peak Power testing:

Conducted:



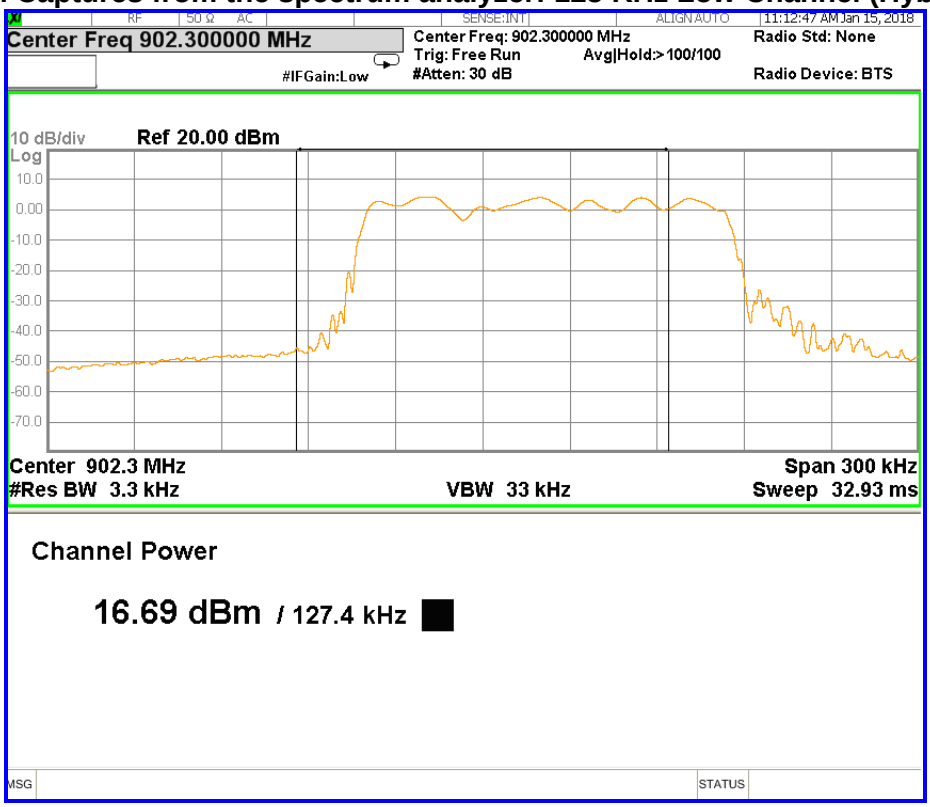
2.3.5 Peak Output Power Data (Hybrid Mode)

Lora 125 KHz

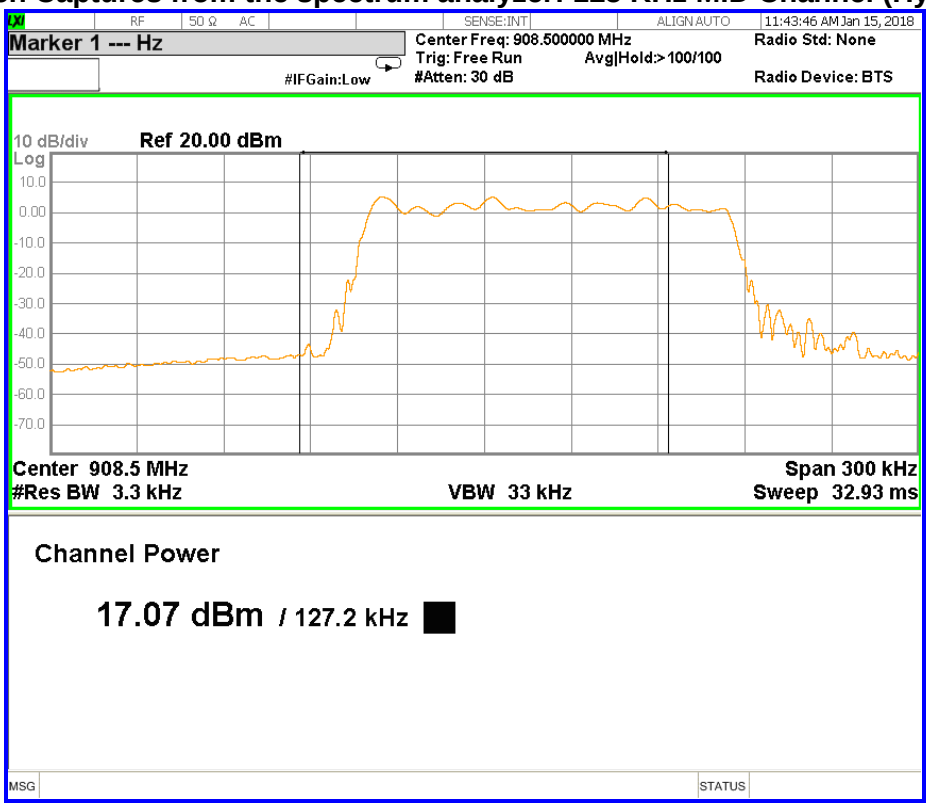
Channel	Freq. [MHz]	Out Put Power (dBm)	Out Put Power Limit (dBm	Margin (dB)
Low	902.3	16.69	30	13.31
Mid	908.5	17.07	30	12.93
High	914.9	17.20	30	12.8

Output Power Method AVGSA-1	
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.

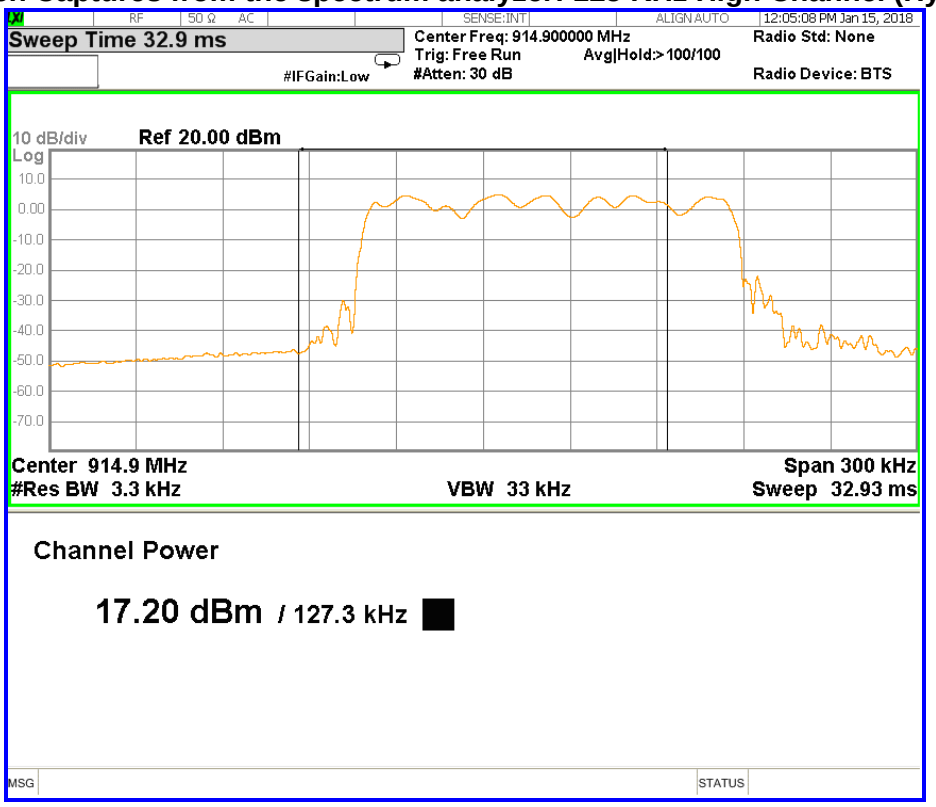
Screen Captures from the spectrum analyzer: 125 KHz Low Channel (Hybrid Mode)



Screen Captures from the spectrum analyzer: 125 KHz MID Channel (Hybrid Mode)



Screen Captures from the spectrum analyzer: 125 KHz High Channel (Hybrid Mode)



2.4 Power Spectral Density (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-01-15 (20.7°C,11.8 % RH)	**Basic Standard: ANSI C63.10: 2013**

EUT status: Compliant

Specification: FCC Part 15.247(f)

Criteria For Hybrid system, 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

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 at least (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

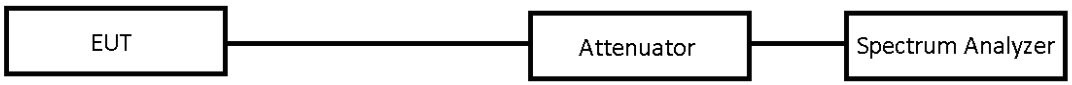
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	1 year	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	1 year	2018-04-06
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

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:

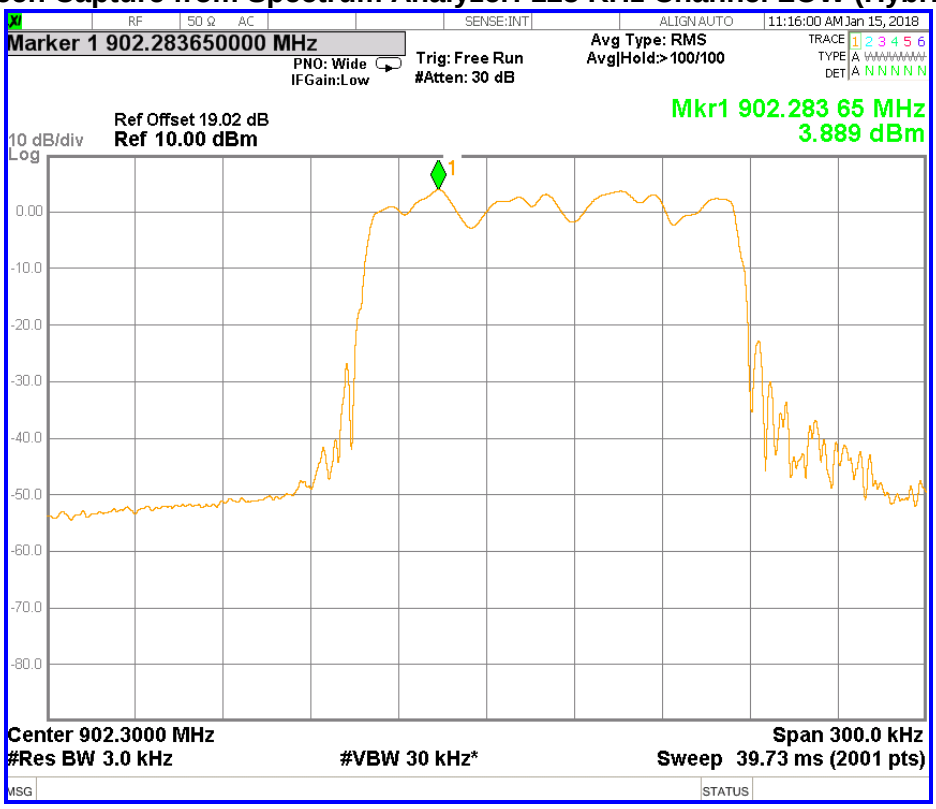


2.4.5 Peak PSD Data (Hybrid Mode)

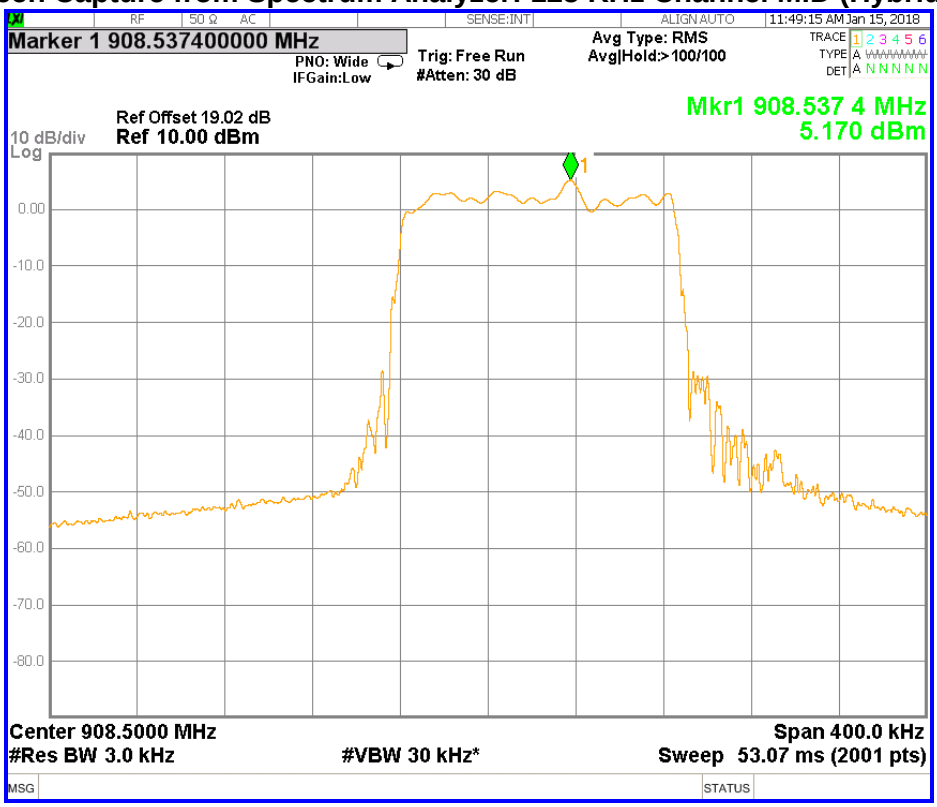
125 KHz Channels

Channel	Freq. [MHz]	PSD (dBm/3KHz)	PSD Limit (dBm/3KHz)
Low	902.3	3.889	8
Mid	908.5	5.170	8
High	914.9	5.741	8

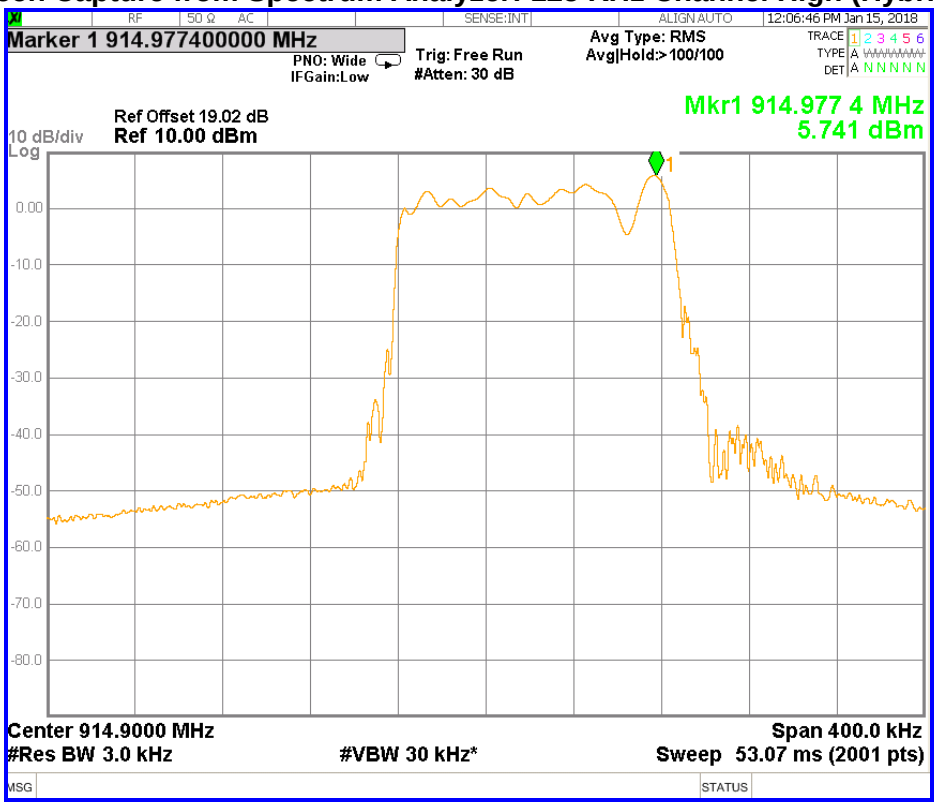
Screen Capture from Spectrum Analyzer: 125 KHz Channel LOW (Hybrid Mode)



Screen Capture from Spectrum Analyzer: 125 KHz Channel MID (Hybrid Mode)



Screen Capture from Spectrum Analyzer: 125 KHz Channel High (Hybrid Mode)



2.5 Band Edge Attenuation (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-01-15 (20.7°C,11.8 % 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

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:

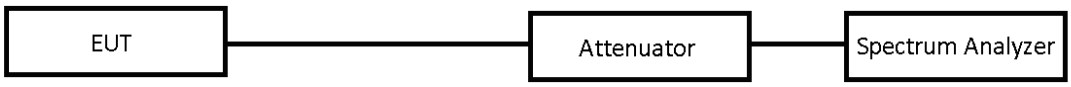
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	1 year	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	1 year	2018-04-06
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

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:

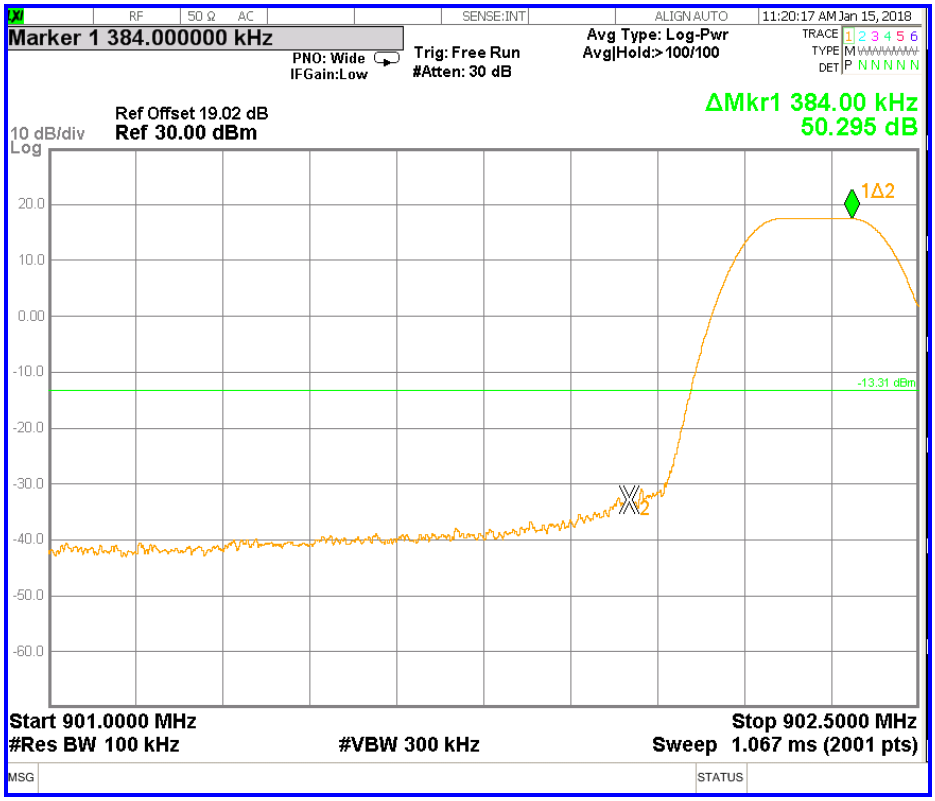
Conducted:



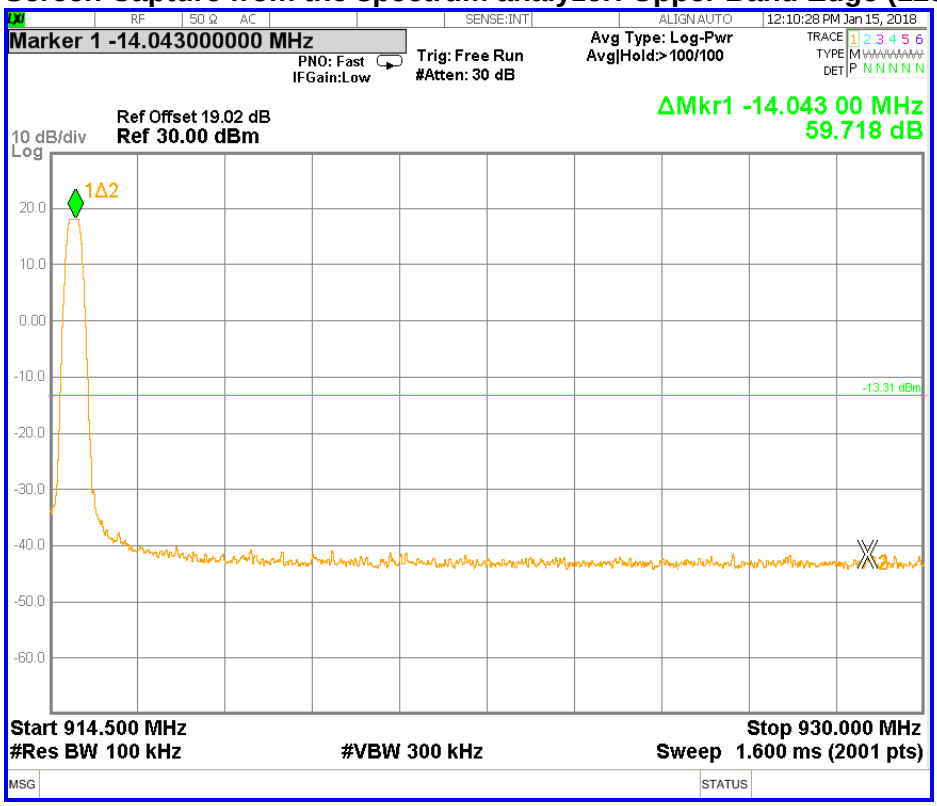
2.5.5 Band Edge Data (Hybrid Mode)

Modulation	Channel	Attenuation at Band Edge	Attenuation Limit at Band Edge
Lora 125KHz Channels	902.3	50.295 dBc	20 dBc
	914.9	59.718 dBc	20 dBc
Lora 125KHz Channels (Hopping)	902.3	51.721 dBc	20 dBc
	914.9	60.084 dBc	20 dBc

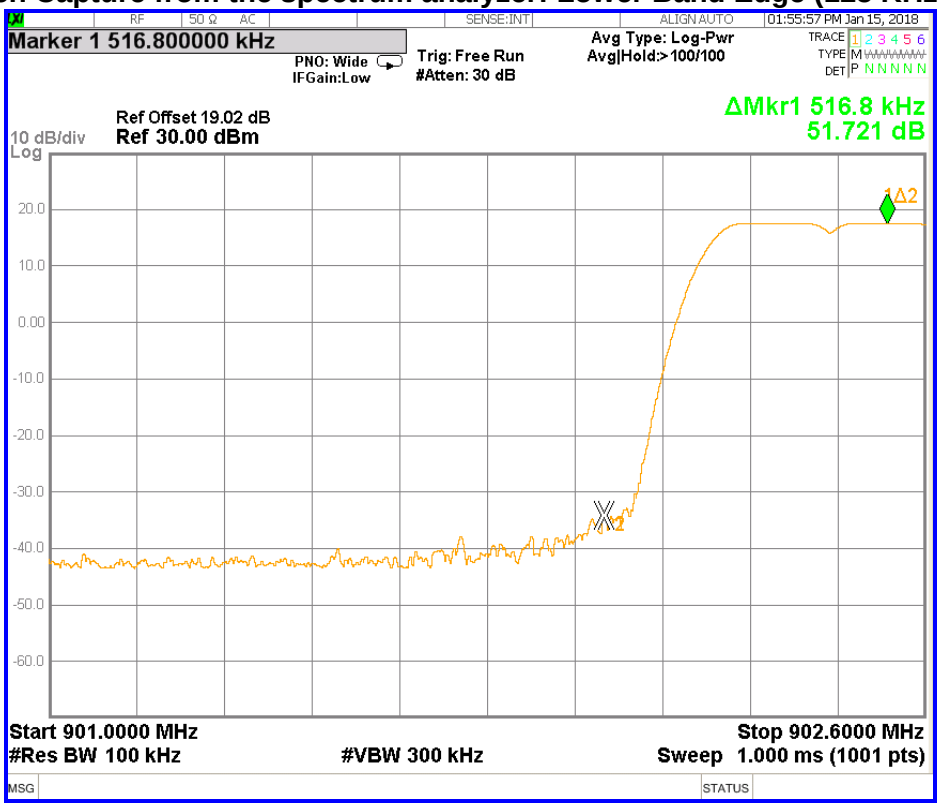
Screen Capture from the spectrum analyzer: Lower Band Edge (125 KHz)



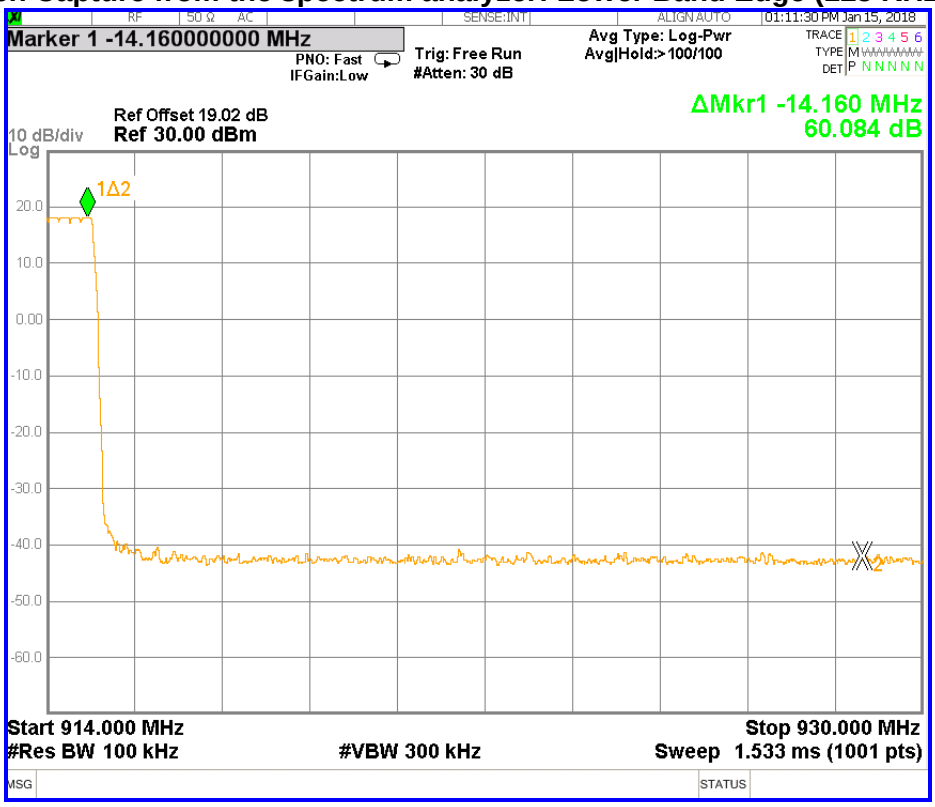
Screen Capture from the spectrum analyzer: Upper Band Edge (125 KHz)



Screen Capture from the spectrum analyzer: Lower Band Edge (125 KHz Hopping)



Screen Capture from the spectrum analyzer: Lower Band Edge (125 KHz Hopping)



2.6 Conducted Harmonic and Spurious Emissions (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-01-15 (20.7°C,11.8 % RH)	**Basic Standard: ANSI C63.4-2014**

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:

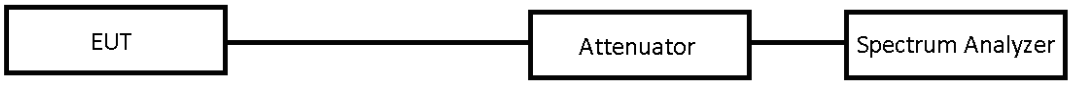
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	1 year	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	1 year	2018-04-06
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

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.

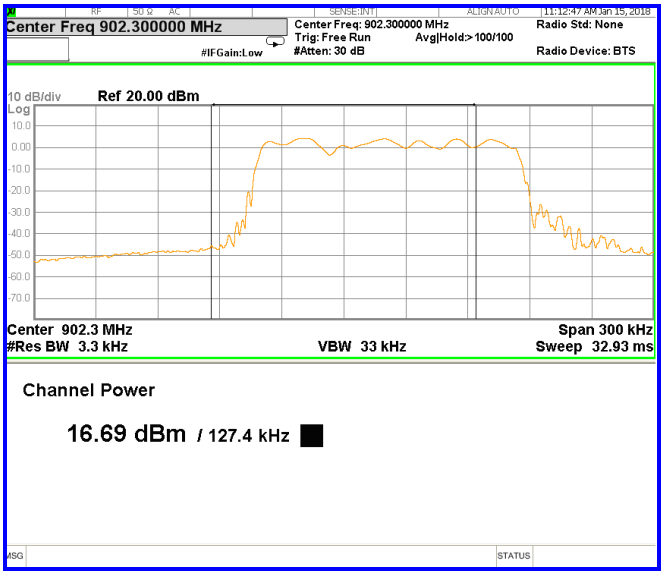
The EUT modified to provide the direct access to antenna trace for conducted measurements.

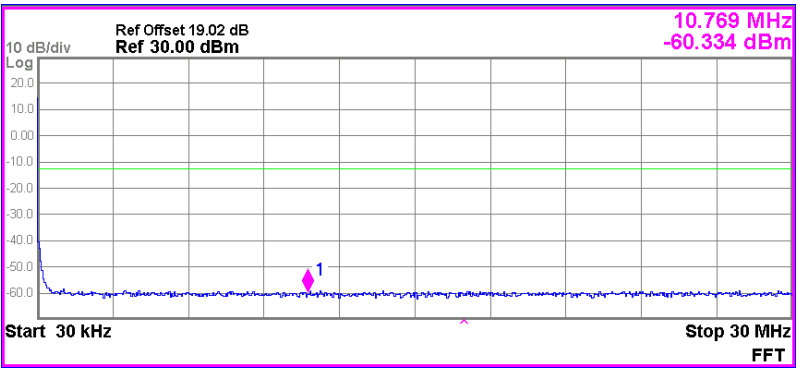
Test setup diagram for Conducted Spurious Emissions testing:

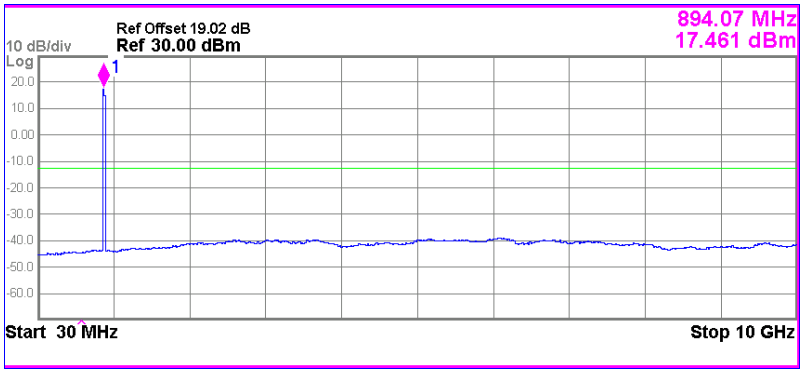


2.6.5 Conducted Emissions Data: (Hybrid Mode)

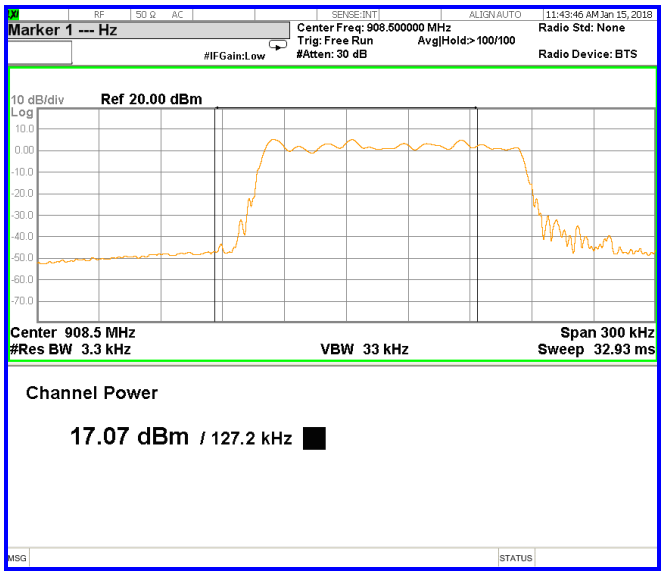
125 KHz Low Channel

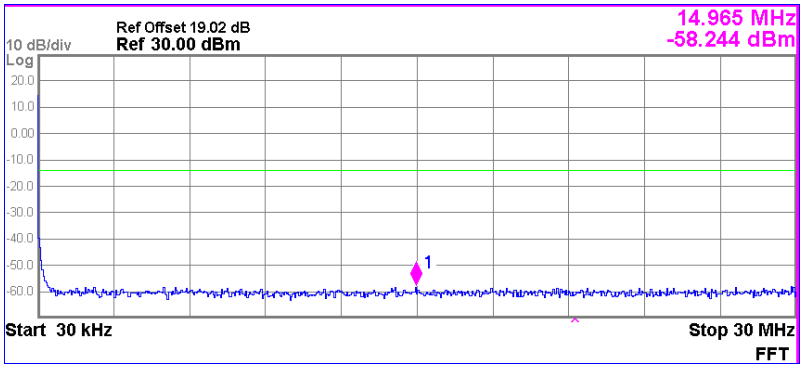


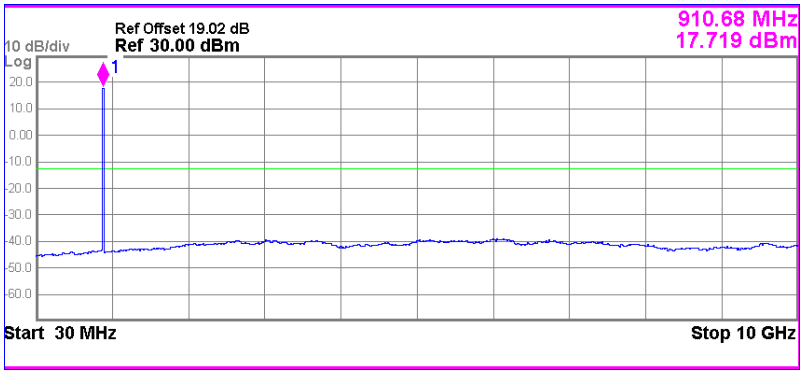




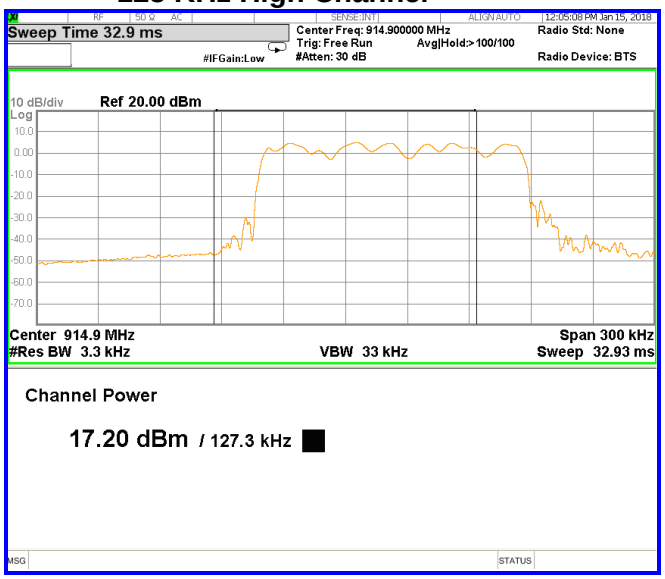
125 KHz MID Channel

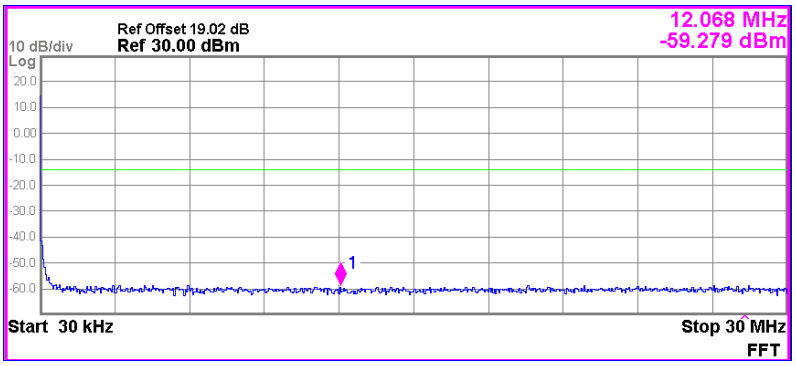


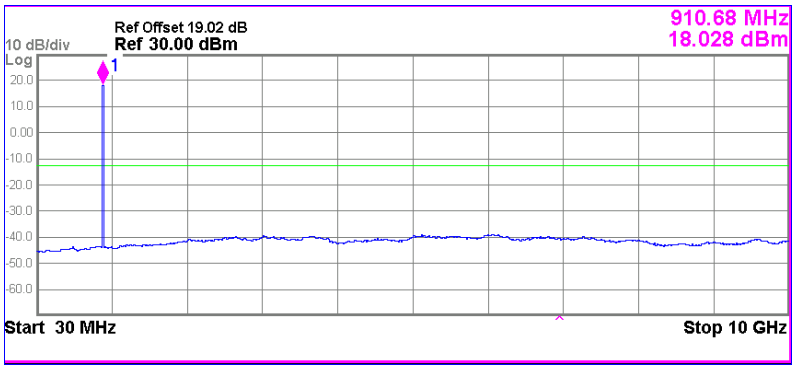




125 KHz High Channel







2.7 Channel Separation (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram	**Standard: FCC Part 15.247**
Date: 2018-01-15 (20.7°C,11.8 % RH)	**Basic Standard: ANSI C63.10: 2013**

EUT status: Compliant

Specification: FCC Part 15.247(a, 1)

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

2.7.1 Test Guidance: ANSI 63.10 Clause 7.8.2/FCC DA 00-705

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

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, with out the need for any further corrections.

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

2.7.2 Deviations From The Standard:

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

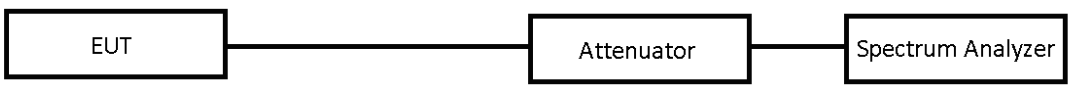
2.7.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	1 year	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	1 year	2018-04-06
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

2.7.4 Test Sample Verification, Configuration & Modifications

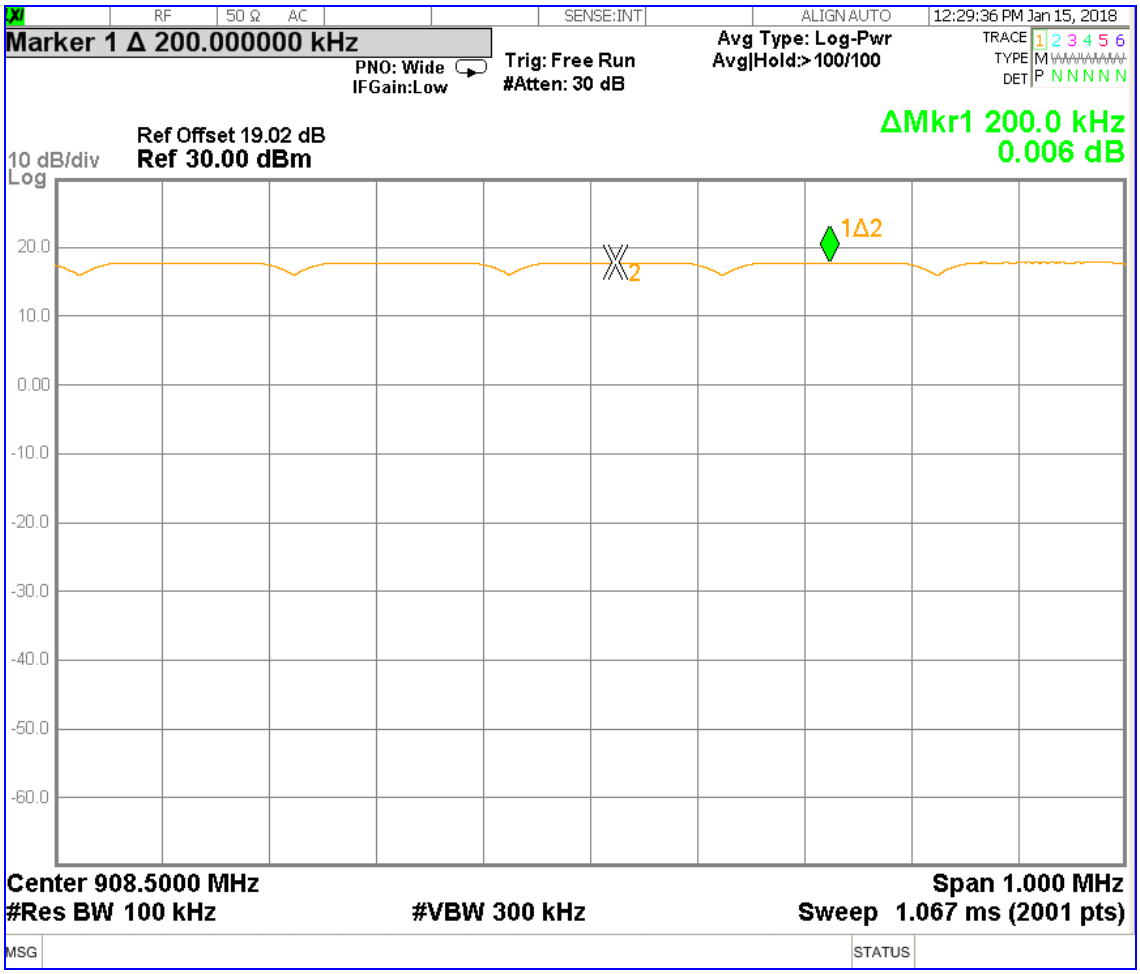
EUT configuration for Channel Separation testing:



2.7.5 Channel Separation Data:

Compliant: The channel separation measured for this device is 200 kHz.

Screen Captures from the spectrum analyzer: Hybrid 125 KHz



2.8 Time of Occupancy (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-01-15 (20.7°C,11.8 % RH)	**Basic Standard: ANSI C63.10: 20013**

EUT status: Compliant

Specification: FCC Part 15.247 (f)

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

2.8.1 Test Guidance: ANSI 63.10 Clause 7.8.4 / FCC DA-00-0705

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

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, with out the need for any further corrections.

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

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

2.8.2 Deviations From The Standard:

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

2.8.3 Test Equipment

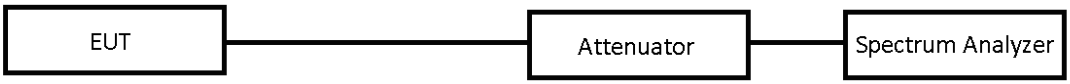
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
EMI receiver	Agilent	N9038A	6130	2017-06-20	1 year	2018-06-20
Temp/Humidity	Extech	42270	5892	2017-04-06	1 year	2018-04-06
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

2.8.4 Test Sample Verification, Configuration & Modifications

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

EUT configuration for Dwell Time testing:



2.8.5 Dwell Time Data:

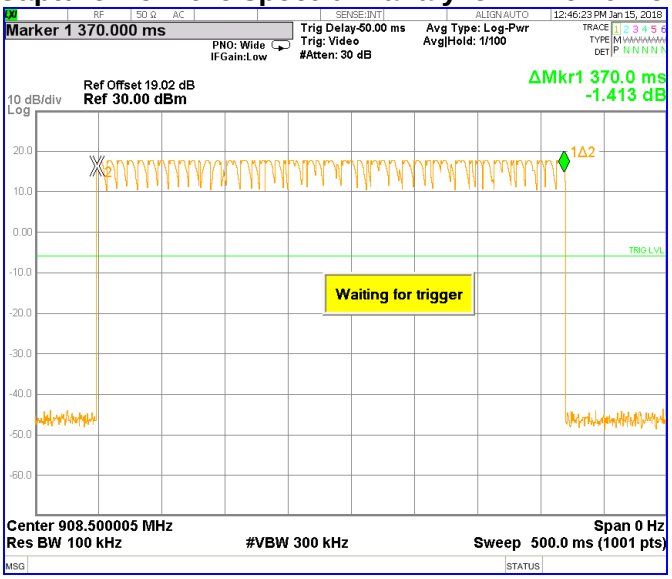
Measured Dwell time = 370 ms

Window of measurement is equal to number of hopping channels multiple by 400ms = **0.4 x 64** = 25.6Sec

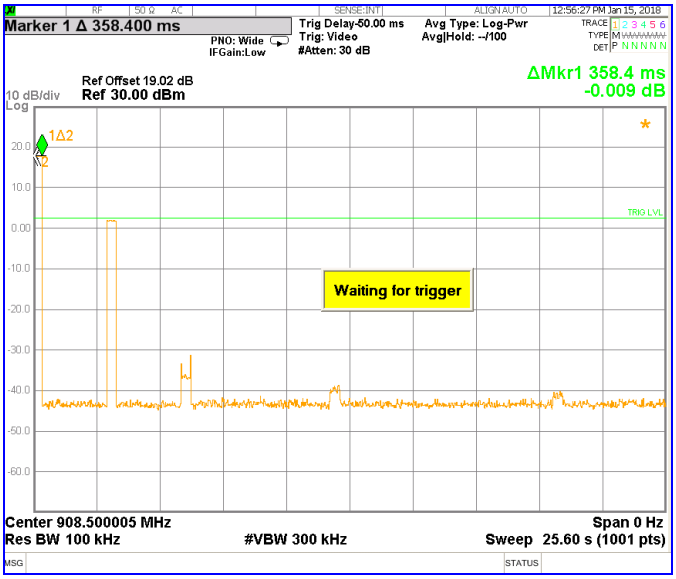
Number of events in 25.6Sec = 1

Margin = 400 – 370 = **30 ms**

Screen Capture from the spectrum analyzer: Dwell time in 500ms



Screen Capture from the spectrum analyzer: Dwell Time in 25.6 Sec



2.9 EUT Positioning Assessment

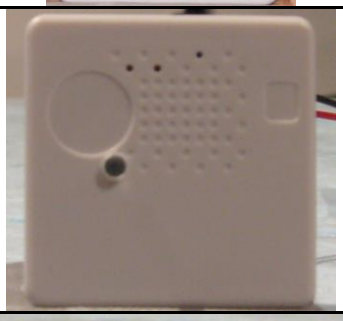
Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram **Bushra Muharram**	**Standard: FCC PART 15.247**
Date: 2018-01-11(19.9°C,10.8 % RH)	**Basic Standard: ANSI C63.4-2014**

3rd Axis Found worse

Comments: EUT oriented in three axis's and 3rd axis found to be worse emission axis. .

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.

1st Axis	
2nd Axis	
3rd Axis	

2.10 Radiated Spurious Emissions (Tx Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel: Imran Akram Bushra Muharram	**Standard: FCC PART 15.247**
Date: 2018-01-11/12 (20.7°C,7.8 % 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

2.10.1 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 discrete 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.

2.10.2 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
Radiated Emissions Level	30 MHz – 1 GHz	±4.6 dB
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.31 dB

2.10.4 Test Equipment

Testing was performed with the following equipment:

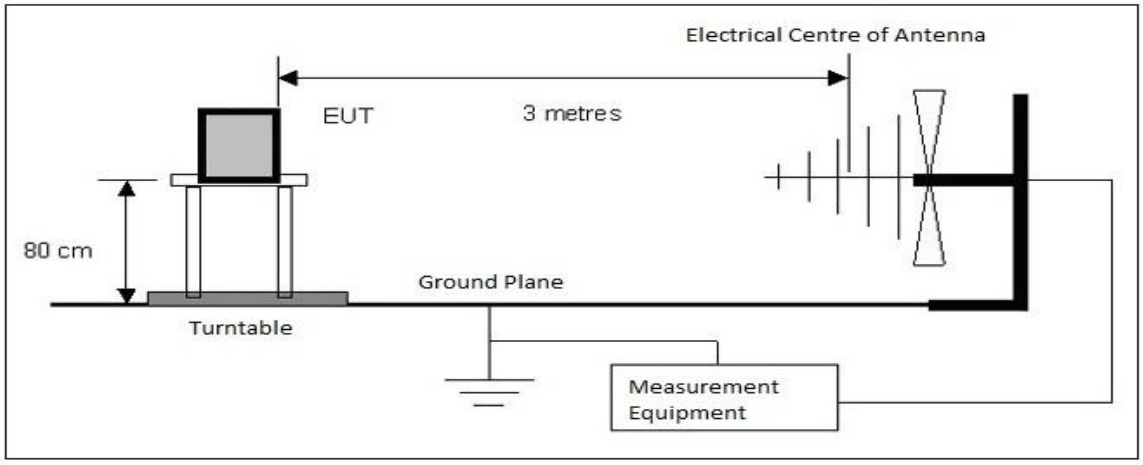
Equipment	Manufacturer	Model #	Asset #	Calibration Date	Interval	Calibration Due
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A		
EMI receiver	Agilent	N9038A	6130	2017-06-20	1yr	2018-06-20
Loop Antenna	EMCO	6502	10868	2017-03-29	2yr	2019-03-29
Biconilog Antenna	ARA	LPB-2520/A	4318	2016-05-18	2yr	2018-05-18
DRG Horn	EMCO	3115	19357	2016-08-24	2yr	2018-08-24
Humidity/Temp Logger	Extech Ins. Corp.	42270	5892	2017-04-06	1yr	2018-04-06
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800-21-5P	4354	2018-01-03	1yr	2019-01-03
Pre-Amplifier (30 – 1300 MHz)	hp	8447D	9291	2018-01-03	1yr	2019-01-03
RE Cable below 1GHz	Insulated Wire Inc.	KPS-1501A-3600-KPA-01102006	4419	2018-01-03	1yr	2019-01-03
Re Cable Above 1 GHz	A.H. System Inc.	SAC-26G-8.23	6187	2018-01-03	1yr	2019-01-03

2.10.5 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.

The EUT met the requirements without modification.

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



Above 1GHz, the EUT is raised using a low permittivity material (polystyrene) to a height of 1.5m.

2.10.6 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:

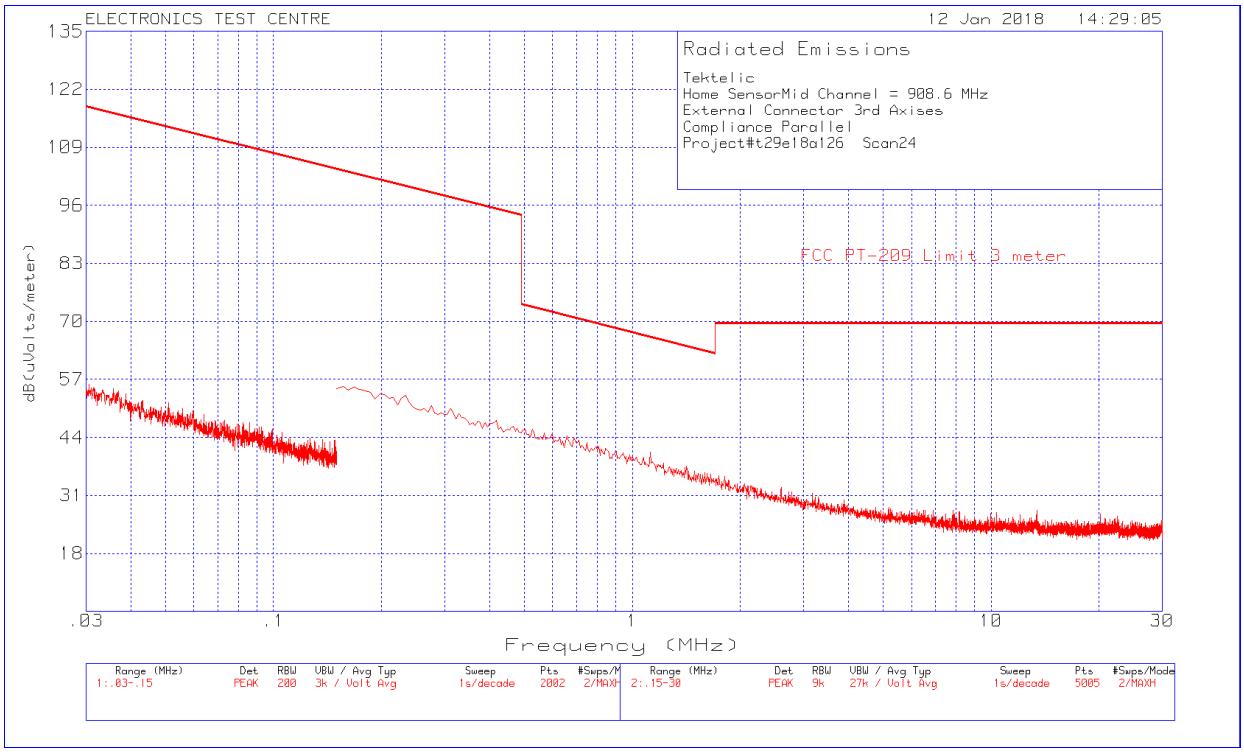
- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum EUT emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discrete 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 MID band channel 908.6 MHz was selected as the worst-case condition for detailed examination.
- In Transmit mode, the EUT was assessed up to 10.0 GHz.

Negative values for Delta indicate compliance.

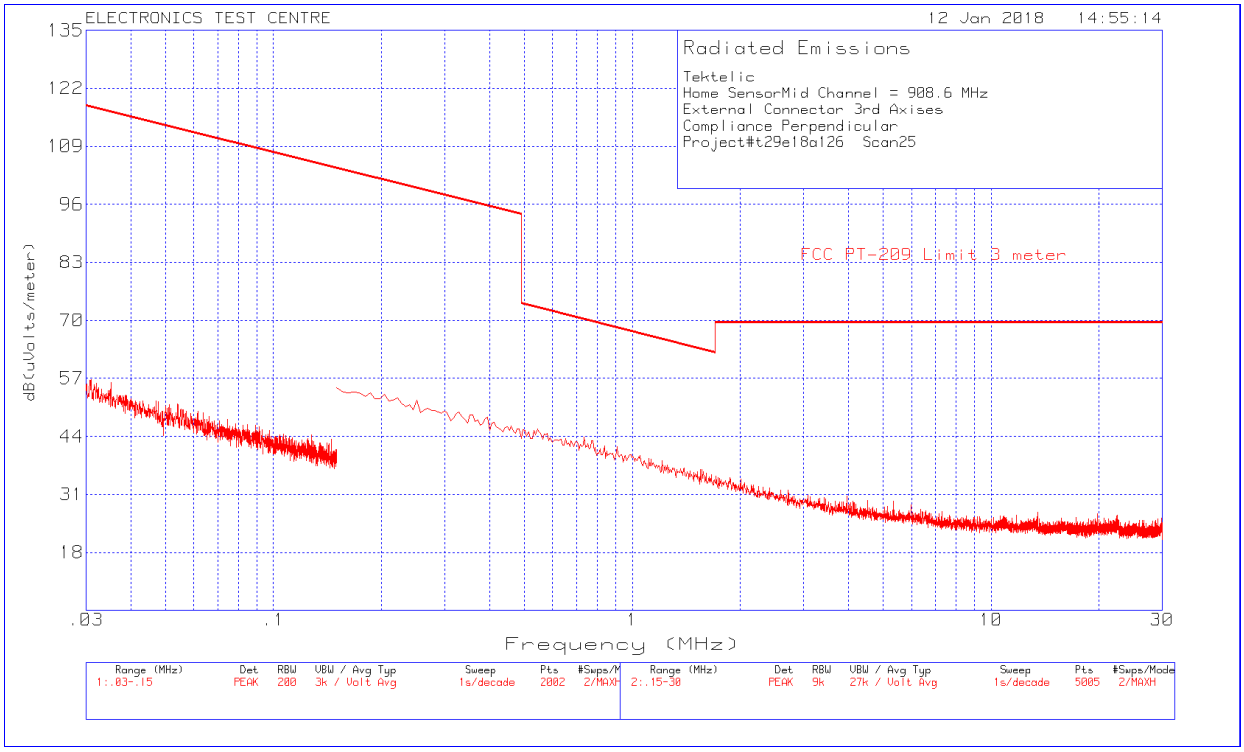
Freq. Marker	Freq. [MHz]	Raw reading [dBμv]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBμv/m]	FCC 15.209 Limit [dBμv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	908.6214	103.67	PK	26.8	-18.5	111.97	125.23	-13.26	358	100	Horizontal
2	908.6085	96.28	PK	26.8	-18.5	104.58	125.23	-20.65	65	100	Vertical
Frequency Range 1 – 3.6 GHz											
1	1817.3	51.51	PK	27.5	-22.1	56.91	-20dBc	-55.06	170	113	Horizontal
2	2725.8	58.49	PK	29.2	-28.2	59.49	-20dBc	-52.48	327	190	Horizontal
3	1817.3	53.92	PK	27.5	-22.1	59.42	-20dBc	-45.16	195	102	Vertical
4	2725.8	57.14	PK	29.2	-28.2	58.14	-20dBc	-46.44	17	237	Vertical
Frequency Range 3.6 – 10.0 GHz											
1	3634.1	49.73	PK	31.7	-27.7	53.73	-20dBc	-58.24	300	250	Horizontal
2	4542.6	46.87	PK	32.8	-26.2	53.47	-20dBc	-58.5	360	100	Horizontal
3	5451.6	44.25	PK	34	-28.6	49.65	-20dBc	-62.32	60	100	Horizontal
4	6360.7	47.05	PK	34.5	-24.5	57.05	-20dBc	-54.92	340	250	Horizontal
5	7269.2	43.15	PK	36.3	-26.8	52.65	-20dBc	-59.32	220	100	Horizontal
6	81771	41.5	PK	36.7	-23.7	54.5	-20dBc	-57.47	180	250	Horizontal
7	9086.2	41.15	PK	37.4	-26.2	52.35	-20dBc	-59.62	40	250	Horizontal
8	3634.1	49.47	PK	31.7	-27.7	53.47	-20dBc	-51.11	20	100	Vertical
9	4542.6	46.75	PK	32.8	-26.2	53.35	-20dBc	-51.23	340	249	Vertical
10	5452.2	47.77	PK	34	-28.6	53.17	-20dBc	-51.41	120	100	Vertical
11	6360.7	51.53	PK	34.5	-24.5	61.53	-20dBc	-43.05	360	100	Vertical
12	7269.2	47.99	PK	36.3	-26.8	57.49	-20dBc	-47.09	200	100	Vertical
13	8178.2	42.53	PK	36.7	-23.7	55.53	-20dBc	-49.05	60	100	Vertical
14	9086.2	45.42	PK	37.4	-26.2	56.62	-20dBc	-47.96	300	249	Vertical
15	6430.0	39.24	PK	34.5	-24.7	49.04	-20dBc	-55.54	127	229	Vertical
15	6430.0	25.8	AV	34.5	-24.7	35.6	54	-18.4	127	229	Vertical

*** Restricted Band**

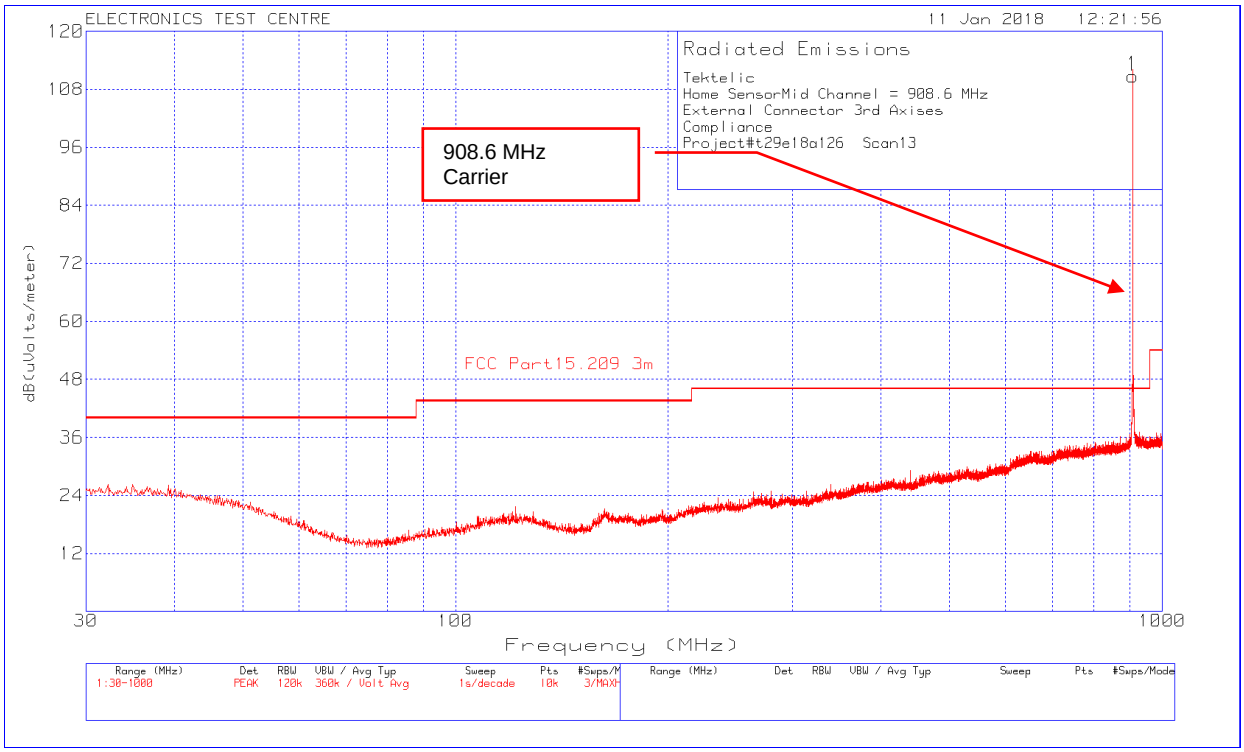
Plot of Radiated Emissions: Measuring Antenna Parallel



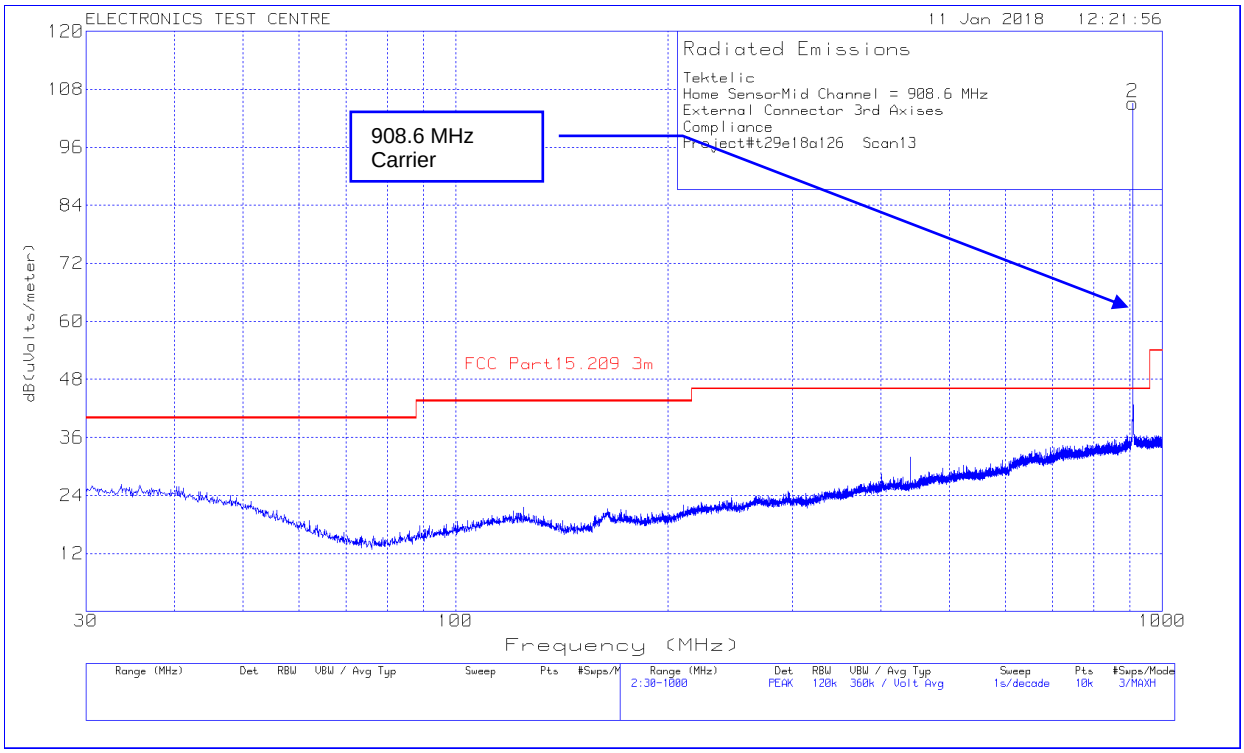
Plot of Radiated Emissions: Measuring Antenna Perpendicular



Plot of Radiated Emissions: Horizontal polarization

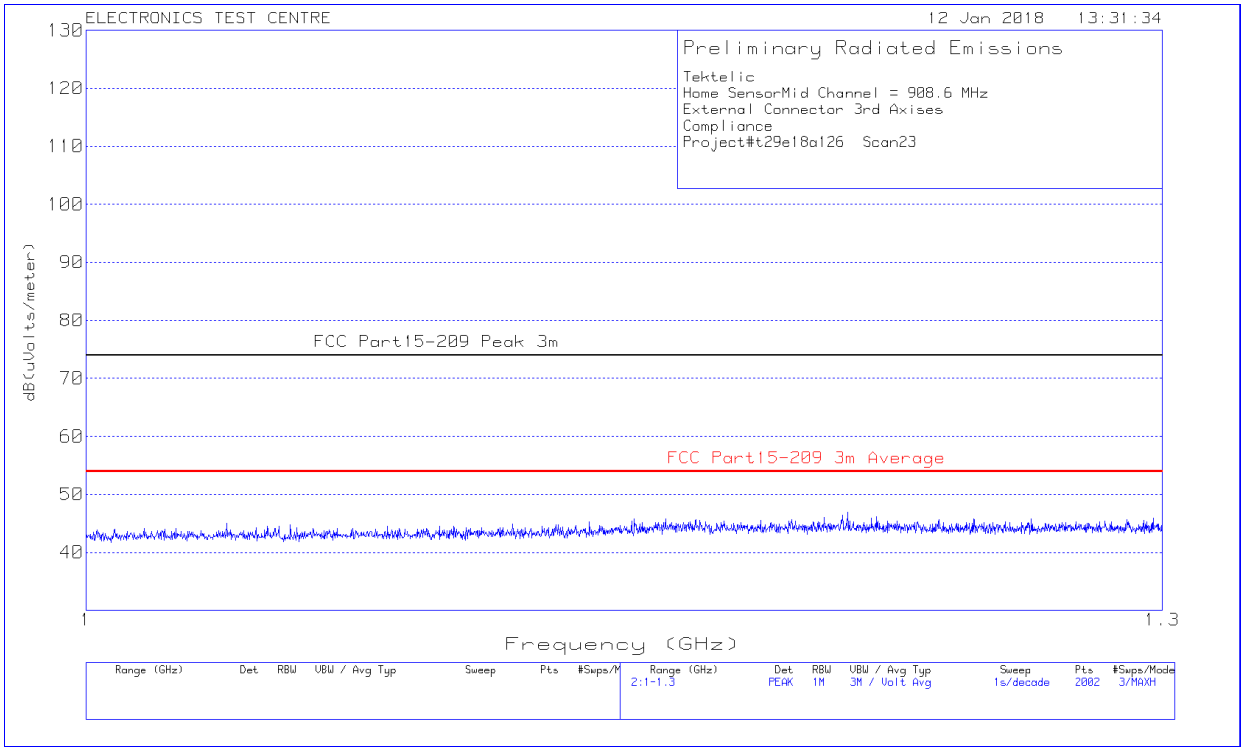


Plot of Radiated Emissions: Vertical polarization

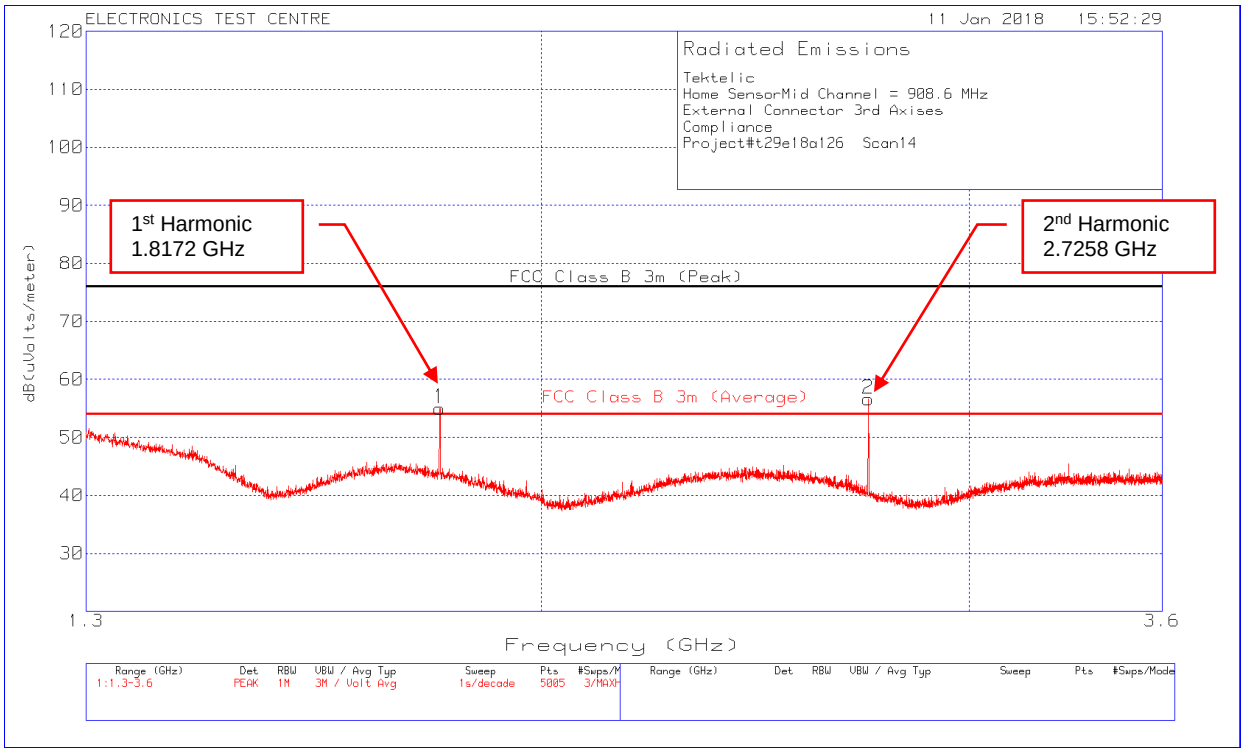


Plot of Radiated Emissions: Horizontal polarization

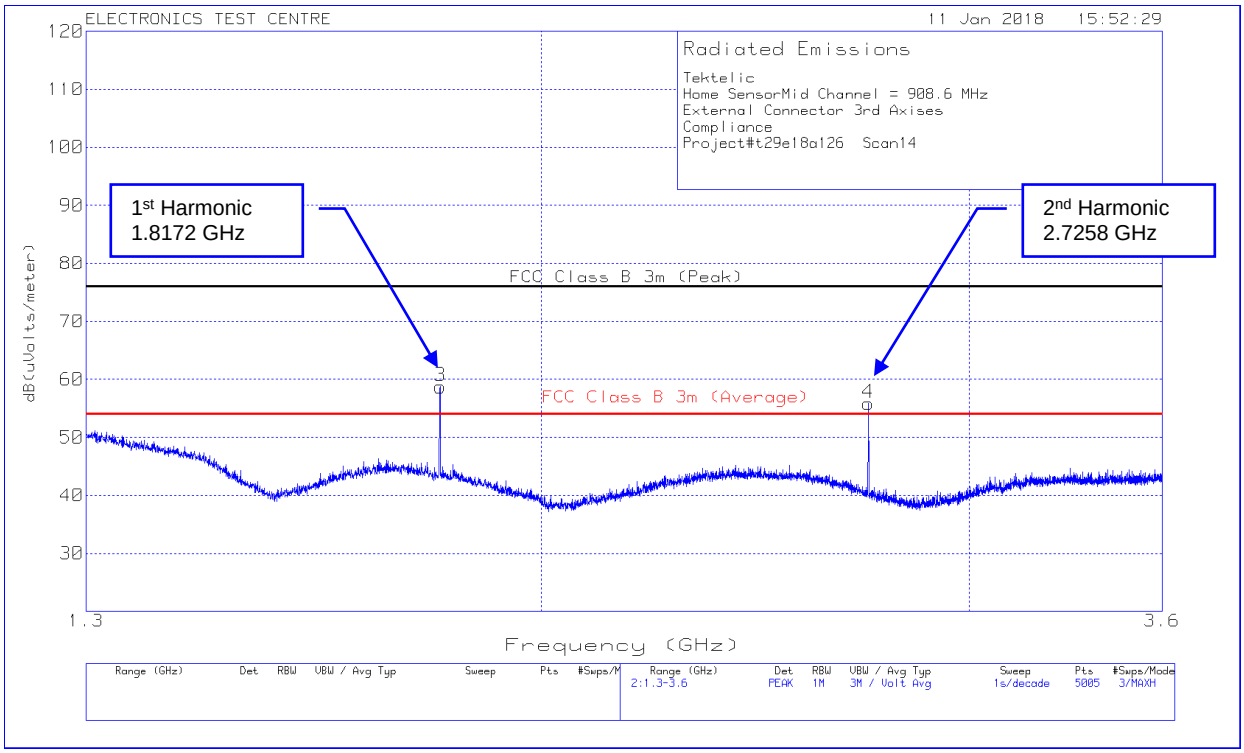
Plot of Radiated Emissions: Vertical polarization



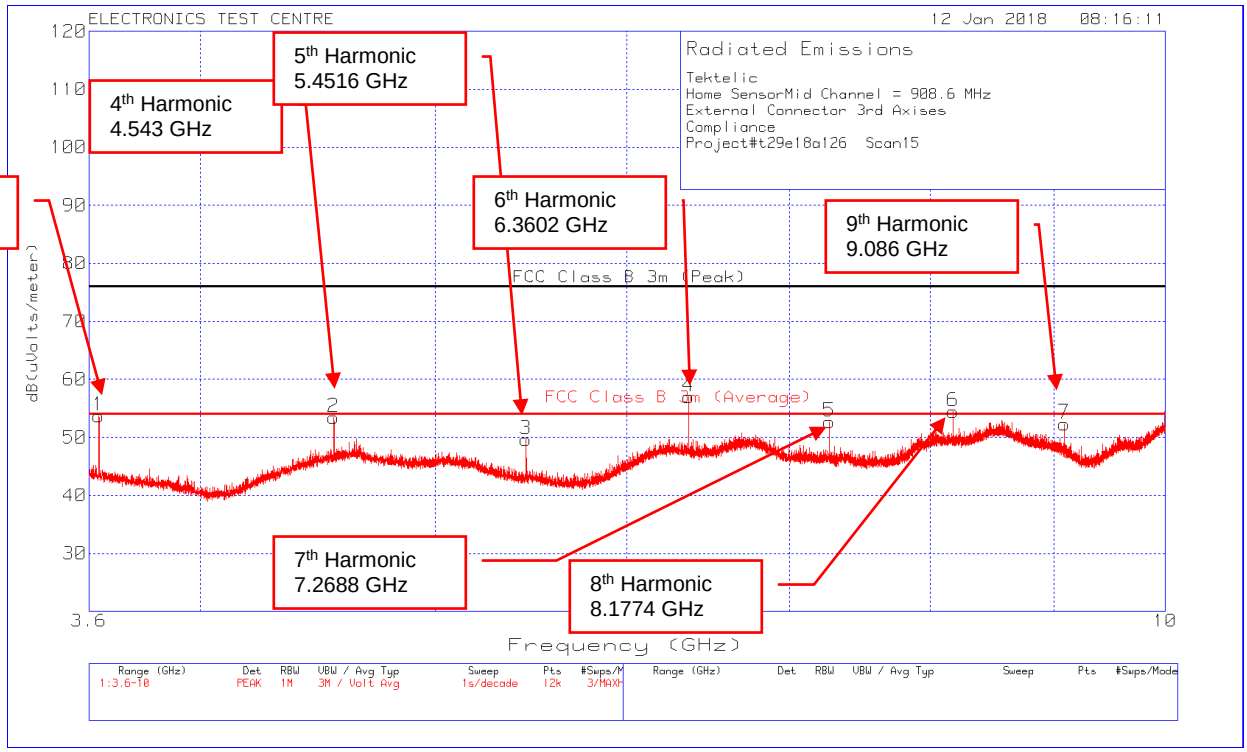
Plot of Radiated Emissions: Horizontal polarization



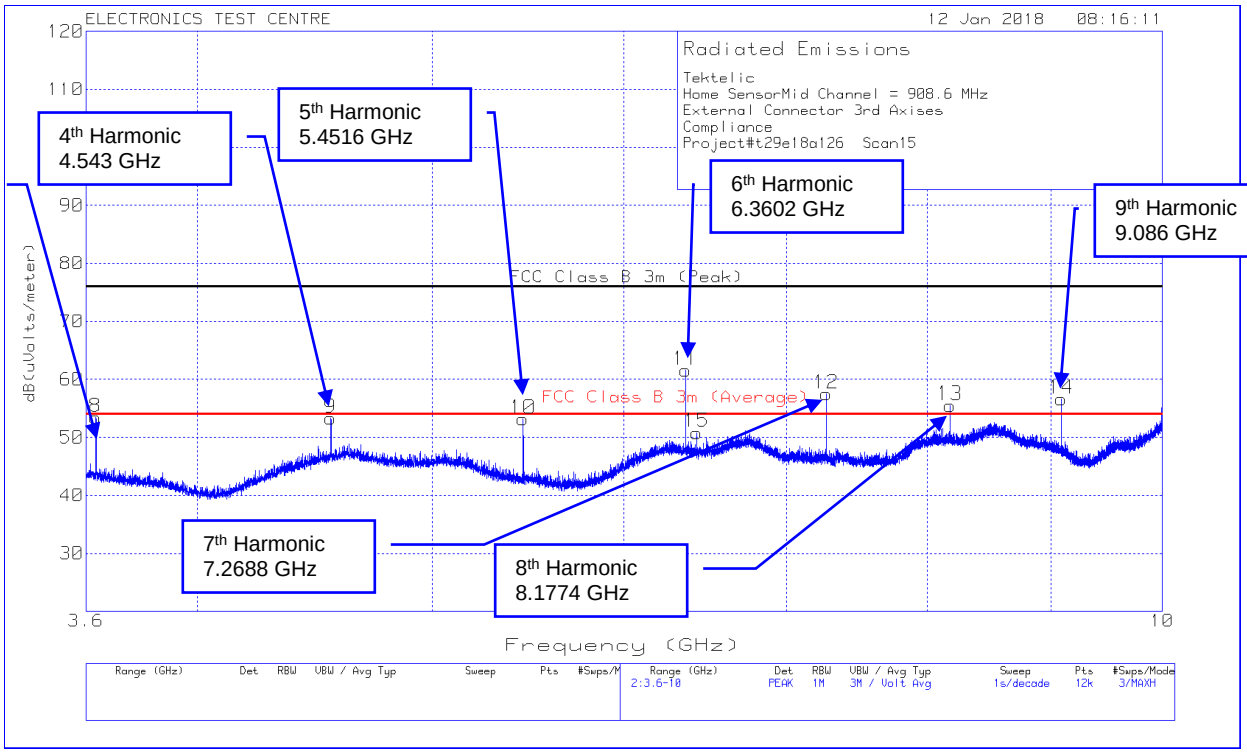
Plot of Radiated Emissions: Vertical polarization



Plot of Radiated Emissions: Horizontal polarization



Plot of Radiated Emissions: Vertical polarization



2.11 RF Exposure

Test Lab: Electronics Test Centre, Airdrie	**EUT: Kona Home Sensor**
Test Personnel:	**Standard: FCC PART 15.247**
Date:	

EUT status: Exempt

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

3.0 TEST FACILITY

3.1 Location

The Kona Home Sensor 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 Home Sensor 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

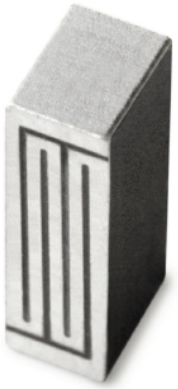
All EUT power was supplied by an internal rechargeable battery. There is no EUT function while the battery is charging.

Appendix A – Antenna

W3012 Datasheet version 1.2. ISM 900 MHz Ceramic Antenna. (01/08).

ISM 900 MHz Ceramic Antenna

Ground cleared under antenna, clearance area 10.80 mm x 8.25 mm. Pulse Part Number: W3012



Features

- Omni directional radiation
- Low profile
- Compact size W x L x H (10 x 3.2 x 4 mm)
- Low weight (600 mg)
- Lead free materials
- Fully SMD compatible
- Lead free soldering compatible
- Tape and reel packing
- RoHS Compliant Product

Applications

- ISM 900 Band

Electrical specifications @ +25 °C

Note: Electrical characteristics depend on test board (GP) size and antenna positioning on GP and Ground Clearance area size.

ISM 902 – 928 MHz

Typical performance (test board size 100 x 37 mm, PWB ground clearance area 10.80 mm x 8.25)

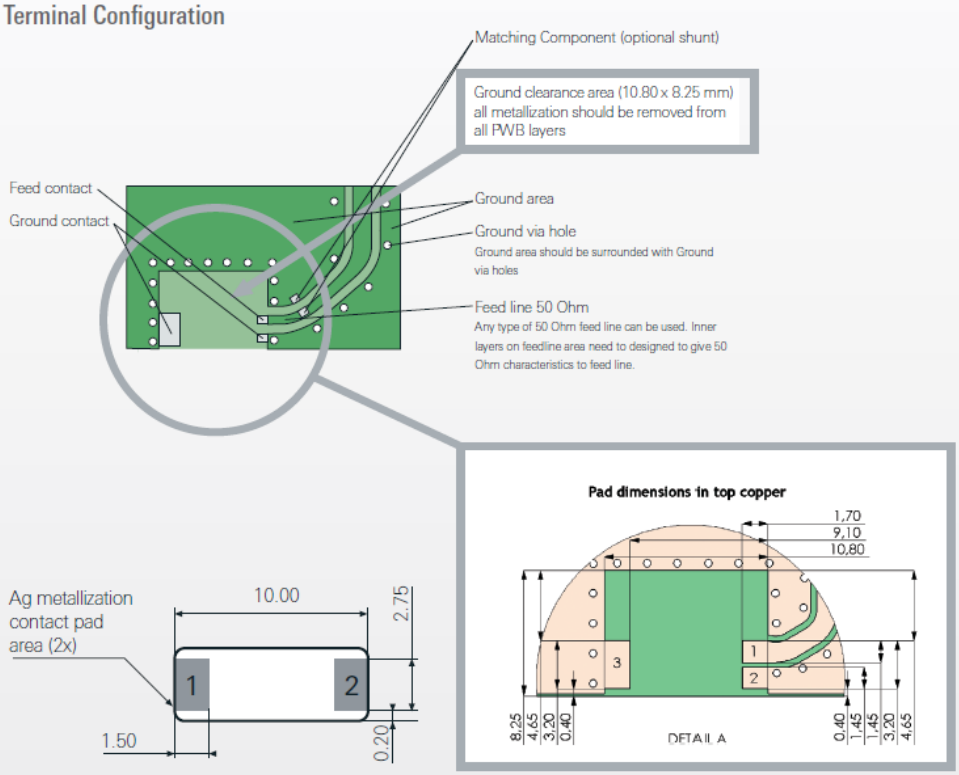
Frequency Range [MHz]	RHCP Gain [dBic]	Max Gain [dBi]	Efficiency [%] / [dB]	Return loss min. [dB]	Impedance [Ω]	Operating Temperature [°C]
902 – 928	0.85 (Peak) 0.5 (Band edges)	2 (peak) 0.5 (band edges)	70 / -1,55 (peak) 50 / -3 (band edges)	-6	50	-40 to +85

W3012 Datasheet version 1.2. ISM 900 MHz Ceramic Antenna. (01/08).

ISM 900 MHz Ceramic Antenna

Ground cleared under antenna, clearance area 10.80 mm x 8.25 mm. Pulse Part Number: W3012

Terminal Configuration



Antenna features

No.	Terminal name	Terminal Dimensions
1	Feed / GND	1.5 x 2.75 mm
2	Feed / GND	1.5 x 2.75 mm

Antenna is symmetrical.
Either of terminals 1 or 2 can be feed / GND

PWB features

No.	Terminal name	Terminal Dimensions
1	Feed	1,7 x 1,45 mm
2	GND	1,7 x 1,45 mm
3	GND	1,7 x 3,20 mm

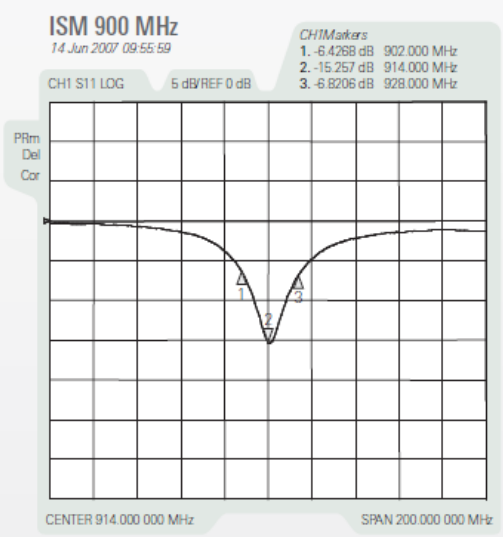
ISM 900 MHz Ceramic Antenna

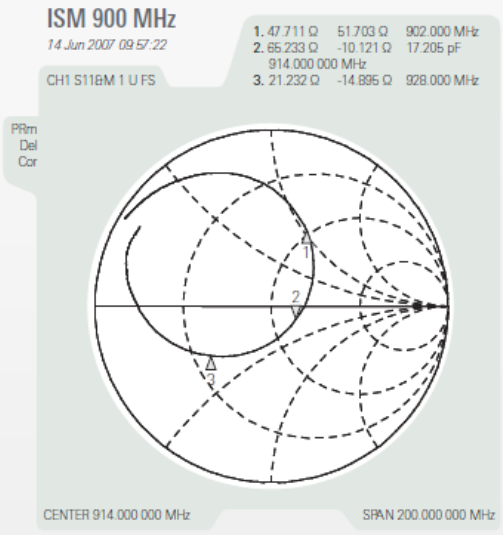
Ground cleared under antenna, clearance area 10.80 mm x 8.25 mm. Pulse Part Number: W3012

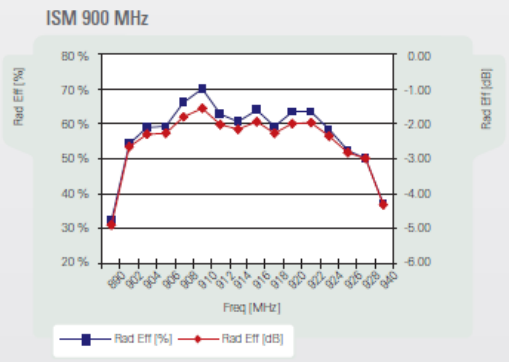
Typical Electrical Characteristics (T=25 °C)

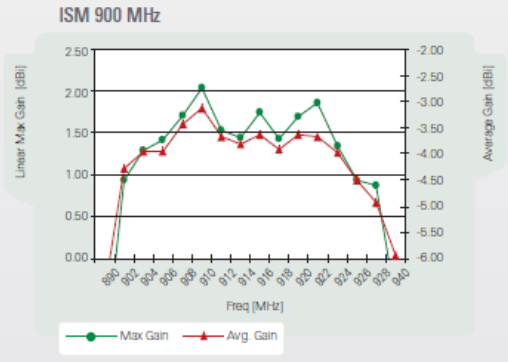
Measured on the 100 x 37mm test board

Typical Return Loss S11/ impedance









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