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EMC testing of the Tektelic Communication Inc. BLE Sensor GEN2 in accordance with FCC Part 15.247, ANSI C63.4: 2014 and ANSI C63.10: 2013 as referenced by KDB 558074 D01 15.247 Measurement Guidance v05r02.

FCC ID: 2ALEPT0006940

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Lidle

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REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2021-03-03	I. Akram	Initial draft submitted for review.
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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 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. BLE Sensor GEN2 test sample, referred to herein as the EUT (Equipment Under Test).

The samples have been provided by the customer.

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

1.2 Applicant

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

1.3 Test Sample Description

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

Product Name:		BLE Sensor GEN2		
	Frequency Band	902 – 928 MHz		
LoRa Radio	Type of Modulation	Chirp Spread Spectrum		
	BW/Frequency Range	Hybrid 125kHz, 902.3 – 914.9 MHz		
	Associated Antenna	Mfr: Fractus Antennas S.L, p/n: NN02-224,		
		omni-directional, Gain 2.8dBi		
	Detachable/Non Detachable	Internal Non-Detachable (Compliant to 15.203 requirement)		
Model# / Serial#		T0007378 / 2048A0224		
Power su	pply:	Internal Battery		

<u>Note:</u> All three channels / axis for four worse selected variants (T0007125, T0007128, T0007296, T0007378) were evaluated. Worse Channel / Axis and variant were selected for detail analysis for radiated emission. Differences in variant are given in product family document.

1.4 General Test Conditions

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

Data presented in this report, is for the 125 kHz Hybrid transmission mode. Test results for DTS 500 kHz 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.

Modulation mode: Hybrid 125 kHz

Hybrid 125 kHz DTS and frequency hopping system, are meets part 15.247's requirements for hybrid system. The channels selected for the test are around **Low: 902.3 MHz**, **Mid: 908.7 MHz** and **High: 914.9 MHz** in the frequency range.

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 KDB 558074 D01 15.247 Measurement Guidance v05r02.

The EUT was also tested as an unintentional radiator, as reported separately.

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 Uncertainty of Measurement:

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

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

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

2.0 TEST CONCLUSION

STATEMENT OF COMPLIANCE

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

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

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 Average Tx Power = 18.68 dBm = (0.074 Watt)										
2.1	AC Conducted Emissions (Tx)	15.207	BLE Sensor GEN2	none	see § 2.1	n/a					
2.2	Occupied Bandwidth	15.247(a)(1) 15.247(2)(2)	BLE Sensor GEN2	none	see § 2.2	Compliant					
2.3	Max Output average Power Conducted	15.247(b)	BLE Sensor GEN2	none	see § 2.3	Compliant					
2.4	Power Spectral Density	15.247(e) 15.247(f)	BLE Sensor GEN2	none	see § 2.4	Compliant					
2.5	Band Edge	15.247(d)	BLE Sensor GEN2	none	see § 2.5	Compliant					
2.6	Conducted Spurious Emission (Non-Restricted Band Operation)	15.247(d)	BLE Sensor GEN2	none	see § 2.6	Compliant					
2.7	Minimum channel separation	15.247(a)(1)	BLE Sensor GEN2	none	see § 2.7	Compliant					
2.8	Average time of Occupancy for hybrid System	15.247(f)	BLE Sensor GEN2	none	see § 2.8	Compliant					
2.9	EUT Position	ANSI C63.4	BLE Sensor GEN2	none	see § 2.9	Assessed					
2.10	Radiated Spurious Emission (Restricted Band Operation) (Tx Mode)	15.205, 15.209 15.247(d)	BLE Sensor GEN2	none	see § 2.10	Compliant					
2.11	RF Exposure	15.247(i)	BLE Sensor GEN2	none	see § 2.11	Exempt					

Refer to the test data for applicable test conditions.

2.1 AC Power Line Conducted Emissions – N/A

Test Lab: Electronics Test Centre, Airdrie

Test Personnel:

EUT BLE Sensor GEN2

Standard: FCC Part 15.207

Date:

Basic Standard: ANSI C63.10: 2013

EUT status: Not Applicable

Comments: BLE Sensor GEN2 is internal battery powered and there is no direct connection to Main.

2.2 Channel Occupied Bandwidth (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	EUT: BLE Sensor GEN2
Test Personnel: Imran Akram	Standard: FCC PART 15.247
Date: 2020-12-23 (23.1°C,9.0% 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 &7.8.7 / KDB 558074 D01 15.247 Measurement Guidance v05r02

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

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

Use the following spectrum analyzer settings:					
Span	between two times and five times the channel center frequency OBW				
RBW	1% to 5% of the OBW				
VBW	approximately three times RBW				
Sweep	auto				
Detector function	peak				
Trace	Trace max hold				
Allow the trace to stabilize. The automated 99% BW function of the spectrum analyzer is					
engaged, 20 dB O	BW 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 (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
MXE EMI Receiver	Keysight Technologies Inc	N9038A FW A 25.05	6130	2020-05-27	2021-05-27
Temp/Humidity	Extech	42270	5892	2020-04-07	2021-04-07
Attenuator	FairView Microwave	SA18N5WA-10	6886	2020-02-01	2021-02-01
DC Blocker	MCL	BLK-89-S+	-	2020-02-01	2021-02-01
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2020-02-01	2021-02-01

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.

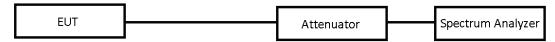
The EUT modified to provide the direct access to antenna port for conducted measurements.

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	139.0	126.19
Mid	908.7	138.9	126.16
High	914.9	138.2	125.93

Low Channel (Hybrid Mode)

Keysight Spect	rum Analyzer - Occupied BW						
x dB -20.0	RF 50 Ω AC		SENSE:INT Center Freq: 902.300	ALIGN AU	Radio Sto	AM Dec 23, 2020 : None	Meas Setup
		#IFGain:Low	Trig: Free Run #Atten: 30 dB	Avg Hold:>100	/100 Radio De	vice: BTS	Avg/Hold Nu
10 dB/div	Ref Offset 10.5 dB Ref 37.50 dBm						<u>On</u>
27.5 17.5							Avg Mo Exp Repo
-2.50							
-12.5					Marken and M		
-42.5 -52.5	manna					a pur for the second se	% of OBW Pow 99.00
Center 902 #Res BW 3	2.3000 MHz 3 kHz		#VBW 30 ki	Hz		400.0 kHz 41.07 ms	Power Re Total Powe
Occupi	ied Bandwidth		Total F	ower	34.9 dBm		
Transm	12 it Freq Error	6.19 kł 329		BW Power	99.00 %		-20.00
	ndwidth	139.0 k			-20.00 dB		
sg					STATUS		

Mid Channel (Hybrid Mode)



High Channel (Hybrid Mode)

Keysight Spectrum Analyzer - Occupied BW RF 50 Ω AC		SENSE:INT	ALIGN AUTO	05:49:41 AM Dec 23, 2020	
enter Freg 914.900000 N	H7 Cent	er Freq: 914.90000		Radio Std: None	Frequency
	Trig:	Free Run /	Avg Hold:>100/100		
	#IFGain:Low #Atte	en: 40 dB		Radio Device: BTS	
0 dB/div Ref 37.50 dBm					
og					Center Fre
					914.900000 Mi
					914.900000 Mi
50					
50					
2.5					
2.5	1		March I	m.	
5 may my Month of the Red	¥			Monor from the contract	
2.5					
2.5					
enter 914.9000 MHz Res BW 3 kHz	;	#VBW 30 kHz		Span 400.0 kHz Sweep 41.07 ms	CF Ste 40.000 ki
Occupied Bandwidth	1	Total Pov	ver 36.	0 dBm	<u>Auto</u> Ma
	25.93 kHz				Freq Offs
Transmit Freq Error	841 Hz	% of OBV	V Power 99	9.00 %	0
x dB Bandwidth	138.2 kHz	x dB	-20	.00 dB	
à			STATU	ie l	

2.3 Max Average Output Power (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	EUT: BLE Sensor GEN2
Test Personnel: Imran Akram	Standard: FCC PART 15.247
Date: 2020-12-23 (23.1°C,9.0% 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 / 558074 D01 15.247 Measurement Guidance v05r02

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

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

Outp	ut 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.

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 (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
MXE EMI Receiver	Keysight Technologies Inc	N9038A FW A 25.05	6130	2020-05-27	2021-05-27
Temp/Humidity	Extech	42270	5892	2020-04-07	2021-04-07
Attenuator	FairView Microwave	SA18N5WA-10	6886	2020-02-01	2021-02-01
DC Blocker	MCL	BLK-89-S+	-	2020-02-01	2021-02-01
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2020-02-01	2021-02-01

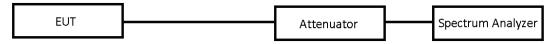
2.3.4 Test Sample Verification, Configuration & Modifications

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 port for conducted measurements.

For compliance purposes EUT met requirements without any modification **Test setup diagrams for Peak Power testing:**

Conducted:

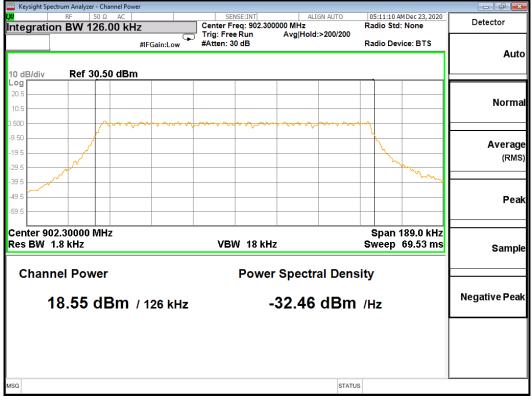


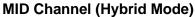
2.3.5 Average Output Power Data (Hybrid Mode)

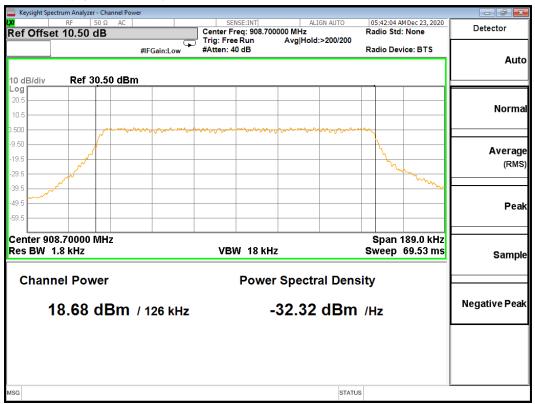
Lora 125 KHz

Channel	Freq. [MHz]	Out Put Power (dBm)	Out Put Power Limit (dBm)	Margin (dB)
Low	902.3	18.55	30	44.45
Mid	908.7	18.68	30	11.32
High	914.9	18.68	30	11.32

Low Channel (Hybrid Mode)







High Channel (Hybrid Mode)



2.4 **Power Spectral Density (Hybrid Mode)**

Test Lab: Electronics Test Centre, Airdrie

Test Personnel: Imran Akram

Date: 2020-12-23 (23.1°C,9.0% RH)

EUT: BLE Sensor GEN2 Standard: FCC PART 15.247 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 / 558074 D01 15.247 Measurement Guidance v05r02

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

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

Use the following s	spectrum analyzer settings:
Span	At least 1.5 times the OBW channel center frequency.
RBW	Set RBW to: 3
VBW	Set VBW ≥ 3 × RBW].
Sweep	auto
Detector function	Power averaging (RMS) or sample detector (when RMS not available).
Trace	Employ trace averaging (rms) mode over a minimum of 100 traces.
Ensure that the nu	imber of measurement points in the sweep $\geq [2 \times \text{span} / \text{RBW}]$. Allow the

trace to stabilize. Use the peak marker function to determine the maximum amplitude level.

2.4.2 Deviations From The Standard:

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

2.4.3 Test Equipment

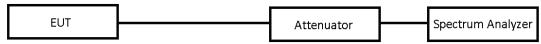
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
MXE EMI Receiver	Keysight Technologies Inc	N9038A FW A 25.05	6130	2020-05-27	2021-05-27
Temp/Humidity	Extech	42270	5892	2020-04-07	2021-04-07
Attenuator	FairView Microwave	SA18N5WA-10	6886	2020-02-01	2021-02-01
DC Blocker	MCL	BLK-89-S+	-	2020-02-01	2021-02-01
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2020-02-01	2021-02-01

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)

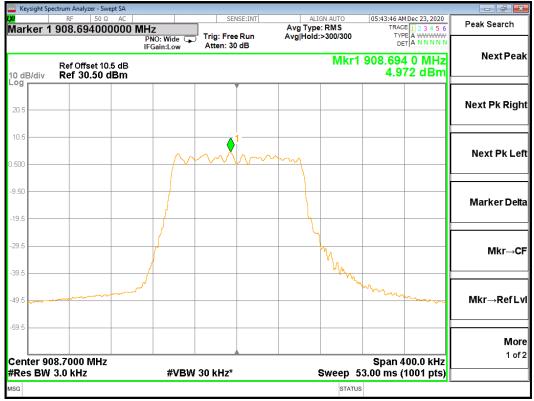
125 KHz Channels

Channel	Freq. [MHz]	PSD (dBm/3kHz)	PSD Limit (dBm/3kHz)
Low	902.3	4.392	8
Mid	908.7	4.972	8
High	914.9	4.431	8

Low Channel (Hybrid Mode)



Mid Channel (Hybrid Mode)



High Channel (Hybrid Mode)

Keysight Spectrum Analyzer - Swe					- đ <mark>×</mark>
⊈ RF 50 Ω Marker 1 914.930904		SENSE:INT	ALIGN AUTO Avg Type: RMS Avg Hold:>300/300	05:53:30 AM Dec 23, 2020 TRACE 1 2 3 4 5 6 TYPE A WWWWW	Peak Search
Ref Offset 10. 0 dB/div Ref 20.50 d		Atten: 20 dB		14.930 904 MHz 4.431 dBm	NextPeal
og 10.5			1		Next Pk Righ
3.50			\mathcal{M}		Next Pk Le
29.5					Marker Delt
19.5	mm		Why	harmon -	Mkr→C
99.5					Mkr→RefL
enter 914.9000 MHz Res BW 3.0 kHz	#VBW	30 kHz*	Sweep 53.	Span 400.0 kHz 33 ms (100001 pts)	Moi 1 of
6G			STATUS		

2.5 Band Edge Attenuation (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie

Test Personnel: Imran Akram

Date: 2020-12-23 (23.1°C,9.0% RH) 2021-01-15 EUT: BLE Sensor GEN2 Standard: FCC PART 15.247 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 §15.209(a) (see §15.205(c)).

2.5.1 Test Guidance: ANSI C63.10-2013 Clause 6.10.4, 6.10.6 & 7.8.6 / 558074 D01 15.247 Measurement Guidance v05r02

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

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

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

2.5.2 Deviations From The Standard:

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

2.5.3 Test Equipment

Testing was performed with the following equipment:

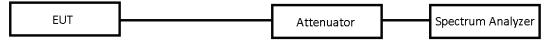
Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
MXE EMI Receiver	Keysight Technologies Inc	N9038A FW A 25.05	6130	2020-05-27	2021-05-27
Temp/Humidity	Extech	42270	5892	2020-04-07	2021-04-07
Attenuator	FairView Microwave	SA18N5WA-10	6886	2020-02-01	2021-02-01
DC Blocker	MCL	BLK-89-S+	-	2020-02-01	2021-02-01
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2020-02-01	2021-02-01

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	902.3	48.467 dBc	30 dBc
Channels	914.9	61.515 dBc	30 dBc
Lora 125KHz	902.3	59.424 dBc	30 dBc
Channels (Hopping)	914.9	70.417 dBc	30 dBc

Non-hopping Lower Band Edge (125 KHz)

						er - Swept SA		ght Spect	
5 6 Peak Search	23:02 AM Dec 23, 2020 TRACE 1 2 3 4 5 6	PALIGN AUTO	Av	SENSE:	z	50 Ω AC	RF 421.	er 1 Z	lark
Next Pea	1 421.5 kHz 48.467 dB	id:>300/300	n Avg	Trig: Free Ru Atten: 40 dB	PNO: Wide G IFGain:Low	et 10.5 dB	Ref Offs		
Next Pk Rig						.50 dBm	Ref 4u	div	0 dB .0g 30.5 - 20.5 -
Next Pk Le	DL1-11.46 dBm								10.5 -500 - 3.50 -
Marker Del					~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			^>	19.5 29.5 39.5
	902.5000 MHz ms (1001 pts)			300 kHz	#\/B\/		000 M 00 kHz		
			FUNCTION	48.467 dB -29.759 dBm	421.5 kHz (Δ) 000 0 MHz	×		DE TRC 2 1	KR M 1 / 2
■ Mkr→RefL	E								3 4 5 6 7
Moi 1 of									8 9 10
	•								

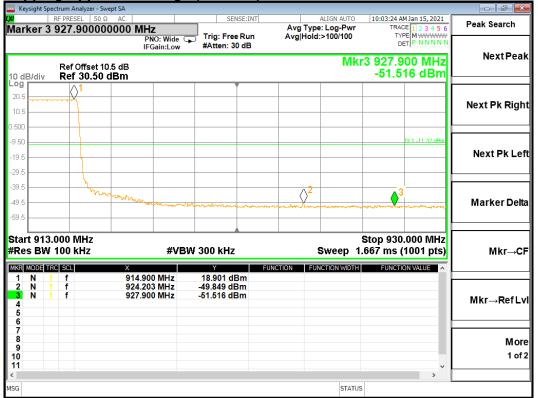
Non-hopping Upper Band Edge (125 KHz)

									m Analyzer - S		
Peak Search	M Jan 15, 2021 DE 1 2 3 4 5 6 PE M WWWWW	TRAC	ALIGN AUTO : Log-Pwr :>100/100		NSE:INT			00000 M	RESEL 50		w Marl
NextPeak	50 MHz 67 dBm	r <mark>2 928.0</mark>		Avgino		Atten: 40	PNO: Wide IFGain:Low	10.5 dB	ef Offset ' ef 40.50		10 dE
Next Pk Right											Log 30.5 20.5
Next Pk Left	DL111.32.dBm										0.500 -9.50 -19.5
Marker Delta	manana	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	n	-hanana	~~~~	mann		man			-29.5 -39.5 -49.5
Mkr→CF	.000 MHz 1001 pts) 0NVALUE	.533 ms (CTION F		W 300 kHz	#VE	X	0 kHz	914.00 BW 10	#Re
Mkr→RefLvl						18.748 dl -42.767 dl	900 MHz 050 MHz		f		
More 1 of 2	~										7 8 9 10 11
L	-	5	STATU								MSG

Hopping Lower Band Edge (125 KHz)

Keysight Spectrum Analyzer					
K RF PRESEL 5		SENSE:INT	ALIGN AUTO Avg Type: Log-Pwr	10:18:38 AM Jan 15, 2021 TRACE 1 2 3 4 5 6	Peak Search
Ref Offset	PNO: Wide ⊂ IFGain:Low t 10.5 dB	☐ Trig: Free Run Atten: 30 dB	Avg Hold:>100/100	2 901.900 MHz -40.714 dBm	NextPeak
20.5 10.5					Next Pk Right
-9.50 -19.5 -29.5			2 Charles	DL1 -11.45 dBm	Next Pk Left
-39.5 -49.5 -59.5	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	man month			Marker Delta
Start 900.000 MHz Res BW 27 kHz MKR MODE TRC SCL	Х			Stop 903.000 MHz .800 ms (1001 pts) FUNCTION VALUE	Mkr→CF
1 N 1 f 2 N 1 f 3 4 5 7	902.300 MHz 901.900 MHz	18.710 dBm -40.714 dBm			Mkr→RefLvi
7 8 9 10 11				×	More 1 of 2
MSG			STATUS		

Hopping Upper Band Edge (125 KHz)



2.6 Conducted Spurious Emissions in non-restricted frequency bands (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie

Test Personnel: Imran Akram

Date: 2020-12-23 (23.1°C,9.0% RH)

EUT: BLE Sensor GEN2 Standard: FCC PART 15.247

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.

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

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

Use the following s	Use the following spectrum analyzer settings:							
Span	Set the center frequency and span to encompass frequency range to be measured.							
RBW	100 kHz							
VBW	300 kHz							
Sweep	Auto Coupled							
Detector function	peak							
Trace	max hold							
Allow the trace to	stabilize. Use the neak marker function to determine the maximum amplitude							

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

2.6.2 Deviations From The Standard:

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

2.6.3 Test Equipment

Testing was performed with the following equipment:

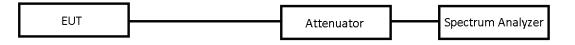
Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
MXE EMI Receiver	Keysight Technologies Inc	N9038A FW A 25.05	6130	2020-05-27	2021-05-27
Temp/Humidity	Extech	42270	5892	2020-04-07	2021-04-07
Attenuator	FairView Microwave	SA18N5WA-10	6886	2020-02-01	2021-02-01
DC Blocker	MCL	BLK-89-S+	-	2020-02-01	2021-02-01
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2020-02-01	2021-02-01

2.6.4 Test Sample Verification, Configuration & Modifications

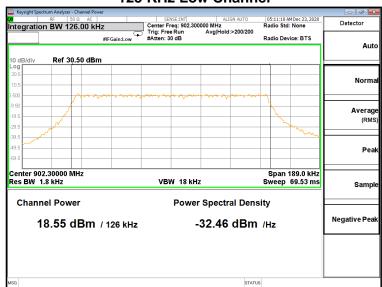
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

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

Test setup diagram for Conducted Spurious Emissions testing:

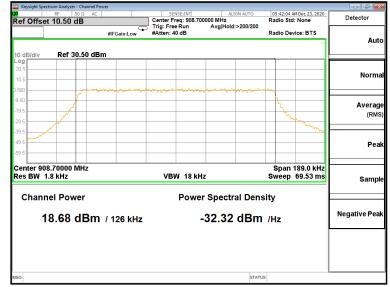


2.6.5 Conducted Emissions Data: (Hybrid Mode) 125 KHz Low Channel



Seysigh	nt Spectrum Analyzer - Swept SA					Keysight Spectrum Analyzer - Swept SA	- # 🐱
<mark>w</mark> Markei	r 1 89.954989 kHz	PNO: East Trig: Free Run	Avg Type: Log-Pwr	05:24:39 AM Dec 23, 2020 TRACE 1 2 3 4 5 6	Peak Search	№ № SERISE:INT ALIGN AUTO 05:31:37 AUDec 23, 05:31:37 AUDec 23, Avg Type: Log-Pwr TRACE TRACE 2 Marker 2 2,706990900000 GHz Trig: Free Run Avg Type: Log-Pwr TRACE 2	5 6 Trace/Detector
		PNO: Fast Frig: Free Run IFGain:Low Atten: 40 dB	Avginola. 63/300	TYPE MWWWWW DET P NNNNN		PNO: Fest PIC: Free Run Avg Hold:>10/10 TYPE MHW IFGain:Low Atten: 40 dB	Select Trace
10 dB/di	Ref Offset 10.5 dB iv Ref 40.50 dBm			Mkr1 90 kHz -33.784 dBm	NextPeak	Ref Offset 10.5 dB Mkr2 2.706 99 G 10 dB/div Ref 40.50 dBm -23.332 dB	
20.5					Next Pk Right		Clear Write
0.500				DL1 -11.46 dBm	Next Pk Left		Trace Average
-29.5	Woosfast of Julius Course is at Albert of Albert	Janaja Net King an Jan Mid Alitya ka Angela Angela	all real movements of the real statement and see	18 the by district in state on the bill	Marker Delta	23.5 Image: Control of the state of the sta	Max Hold
		#VBW 300 kHz		Stop 30.00 MHz 75.9 ms (4000 pts) EUNCTION VALUE	Mkr→CF	Start 30 MHz Stop 18.000 C #Res BW 100 kHz #VBW 300 kHz Sweep 1.720 s (100001 Mmrg Mode Track Science x Y Function width Function width	ts) Min Hold
1 N 2 3 4 5 6		90 kHz -33.784 dBm		E	Mkr→RefLvl	1 N 1 f 1.804 54 GHz -30.389 dBm 22 N 1 f 2.706 99 GHz -23.332 dBm 4 5 6	Uiew Blank Trace On
7 8 9 10 11					More 1 of 2	7 8 9 10 11	More 1 of 3
MSG			STATUS	DC Coupled		MSG STATUS	

125 KHz MID Channel



🔤 Keysight Spe	ectrum Analyzer - Swept SA						🔤 Keys		m Analyzer - Swept S								
<mark>ø</mark> Marker 1	RF 50 Ω Δ DC 74.966242 kHz		SENSE:	Avg Type: L	AUTO/NO RF 05:45:47 AM Dec 23, 2020 og-Pwr TRACE 1 2 3 4 5 6 0/10 TYPE M MARAAAAA	Trace/Detector	<mark>⊯</mark> Mark		RF 50 Ω / 726187100	000 GHz			ALIGN Avg Type: Avg Hold:>	Log-Pwr	TRAC	M Dec 23, 2020 DE 1 2 3 4 5 6 PE M WWWWW	Peak Search
		PNO: Fast G	Atten: 40 dB		DET P NNNN	Select Trace				PNO: Fa IFGain:L					DI	ET P NNNNN	Next Peak
10 dB/div	Ref Offset 10.5 dB Ref 40.50 dBm				Mkr1 75 kHz -34.200 dBm	1	10 dB	R Bidiv R	Ref Offset 11.5 (Ref 41.50 dB	dB m				Mkr2 2.	726 18 -23.7	7 1 GHz 20 dBm	
20.5						Clear Write	Log 31.5 - 21.5 - 11.5 -										Next Pk Right
-9.50					D11-1131 dBm	Trace Average	1.50			2						DI 1 -10.31 #Pm	Next Pk Left
-29.5	land descer and a fearly south to be	المراجع المراجع المراجع		a Caller of a social di Ukira de	en belande belande belande bereide	Max Hold	-28.5 - -38.5 - -48.5 -		↓ ↓								Marker Delta
Start 30 k #Res BW	Hz 10 kHz		V 300 kHz	Sw	Stop 30.00 MHz veep 275.9 ms (4000 pts)	Min Hold	#Res	1 30 MH: 5 BW 10	0 kHz	#	VBW 300 kH	FUN	Swe	ep 953.	.3 ms (10	.000 GHz 0001 pts)	Mkr→CF
1 N 1 2 3 4 5 6	f	75 kHz	-34.200 dBm		E	View Blank Trace On	1 2 3 4 5 6	N 1 N 1	f 1. f 2.	817 321 9 GH: 726 187 1 GH:	z -32.959 o z -23.720 o					E	Mkr→RefLvl
7 8 9 10 11						More 1 of 3	7 8 9 10 11									-	More 1 of 2
MSG			m		STATUS 1 DC Coupled		MSG				m			STATUS		Þ	

125 KHz High Channel

Keysight Spectrum Analyzer - Channel Power RF 50 Ω AC	SENSE:INT ALIGN AUT		Detector
	Center Freq: 914.900000 MHz Trig: Free Run Avg Hold:>200/:		Bettettor
#FGain:Low	#Atten: 40 dB	Radio Device: BTS	Au
Ref Offset 10.5 dB dB/div Ref 29.50 dBm			
bg			
50			Norn
	man and a marked and a second	nnn	
15			
0.5		\sim	Avera
0.5		m.	(RI
0.5		- Winne	
0.5			Pe
0.5			
enter 914.9000 MHz		Span 200.0 kHz	
es BW 1.8 kHz	VBW 18 kHz	Sweep 73.6 ms	Sam
Channel Power	Power Spectral D	ensity	
18.68 dBm / 126 kH	-32.33 dB) m ///-	Negative Pe
10.00 UBIII / 126 KH	z -52.55 ub	DIII /HZ	
3		STATUS	

🔤 Keysight Spe	ectrum Analyzer - Swept SA						- @ *	- Key:	sight Spectr	ım Analyzer - Swept SA							
₩ Start Free	RF 50 Ω ▲ DC q 30.000 kHz		SENSE:	Avg T	ALIGN AUTO ype: Log-Pwr bld:>10/10	05:57:14 AM Dec 23, 2020 TRACE 1 2 3 4 5 6	Trace/Detector	(X) Disp	olay Lin	RF 50 Ω AC e 1 -11.32 dBn		SENSE:INT	Avg T	ALIGN AUTO	06:00:39 AM TRACE	123456	Trace/Detector
		PNO: Fast C IFGain:Low	Trig: Free Ri Atten: 40 dB		5id:>10/10	TYPE MWWWWW DET P N N N N N	Select Trace				PNO: Fast (IFGain:Low	Trig: Free Run Atten: 40 dB	Avg Ho	old:>10/10	DET	PNNNN	Select Trace
10 dB/div	Ref Offset 10.5 dB Ref 40.50 dBm					Mkr1 82 kHz -33.831 dBm	1*	10 dE	3/div	Ref Offset 11.5 dB Ref 41.50 dBm				Mkr2 2	2.744 831 -24.70		1
30.5 20.5							Clear Write	Log 31.5 - 21.5 - 11.5 -									Clear Write
0.500 -9.50 -19.5						01.111.32 dBm	Trace Average	1.50 -8.50 -18.5			▲ ²				P	L111-32-0Bm	Trace Average
-29.5 -39.5 -49.5	aythin an an an an an an an an an	Hill Lands Lines II. and		. en de angeliter til i de angeli	udi hila secolari angar	nudtiveden og beder blande bæle	Max Hold	-28.5 -38.5 -48.5		♦						-	Max Hold
Start 30 k #Res BW	Hz 10 kHz		W 300 kHz			Stop 30.00 MHz 75.9 ms (4000 pts)	Min Hold	#Res	t 30 MH s BW 10	00 kHz	#VB	W 300 kHz	FUNCTION		Stop 10.0 3.3 ms (100	001 pts)	Min Hold
	f	82 kHz	-33.831 dBm			E	View Blank Trace On		N 1	f 1.829	684 7 GHz 831 0 GHz	-34.043 dBm -24.703 dBm	PONCHON	FORCHORIMUTE	Ponento	E	View Blank Trace On
7 8 9 10 11							More 1 of 3	7 8 9 10 11									More 1 of 3
MSG			m		STATUS	DC Coupled		MSG				m		STATU	JS	•	

2.7 Channel Separation (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie

Test Personnel: Imran Akram

EUT: BLE Sensor GEN2 Standard: FCC Part 15.247

Date: 2021-01-15 (21.0°C,17.8% 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 / 558074 D01 15.247 Measurement Guidance v05r02

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

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

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

2.7.2 Deviations From The Standard:

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

2.7.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
MXE EMI Receiver	Keysight Technologies Inc	N9038A FW A 22.08	6906	2019-10-29	2020-10-29
Temp/Humidity	Extech	42270	5892	2019-04-05	2020-04-05
Attenuator	FairView Microwave	SA18N5WA-10	6886	2020-02-01	2021-02-01
DC Blocker	MCL	BLK-89-S+	-	2020-02-01	2021-02-01
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2020-02-01	2021-02-01

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.

Keysight Spectrum Analyzer - Swept SA 09:21:34 AM Jan 15, 2021 SENSE:INT ALIGN AUTO Marker TRACE 1 2 3 4 5 6 TYPE MWWWW DET P NNNN Marker 1 Δ 200.000000 kHz Avg Type: Log-Pwr Avg|Hold: 100/100 Tria: Free Run PNO: Wide + #Atten: 30 dB IFGain:Low Marker Table ΔMkr1 200 kHz On Off Ref Offset 10.5 dB Ref 30.50 dBm 0.087 dB 10 dB/div Log <u>1Δ2</u> 20.5 Marker Count ₩2 10.5 [Off] .500 -9.50 Couple Markers 19.5 On Off 29.5 39.5 49.5 -59.5 Center 908.7000 MHz Span 1.000 MHz #Res BW 100 kHz #VBW 300 kHz Sweep 1.000 ms (1001 pts) MKR MODE TRC SCL FUNCTION FUNCTION WIDTH FUNCTION VALUE 1 Δ2 2 F 3 f (Δ) f 200 kHz (Δ) 0.087 dB 908.401 MHz 16.841 dBm All Markers Off 4 5 7 8 9 10 More 2 of 2 < > STATUS MSG

Screen Captures from the spectrum analyzer: Hybrid 125 KHz

2.8 Time of Occupancy (Hybrid Mode)

Test Lab: Electronics Test Centre, Airdrie	EUT: BLE Sensor GEN2
Test Personnel: Imran Akram	Standard: FCC PART 15.247
Date: 2021-01-15 (21.0°C,17.8% 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 / 558074 D01 15.247 Measurement Guidance v05r02

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

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

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

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

2.8.2 Deviations From The Standard:

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

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
MXE EMI Receiver	Keysight Technologies Inc	N9038A FW A 22.08	6906	2019-10-29	2020-10-29
Temp/Humidity	Extech	42270	5892	2019-04-05	2020-04-05
Attenuator	FairView Microwave	SA18N5WA-10	6886	2020-02-01	2021-02-01
DC Blocker	MCL	BLK-89-S+	-	2020-02-01	2021-02-01
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2020-02-01	2021-02-01

2.8.3 Test Equipment

Testing was performed with the following equipment:

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:

EUT]	Attenuator		Spectrum Analyzer
-----	---	------------	--	-------------------

2.8.5 Dwell Time Data:

Measured Dwell time = 370.8 ms

Window of measurement is equal to number of hopping channels multiple by $400ms = 0.4 \times 64 = 25.6Sec$

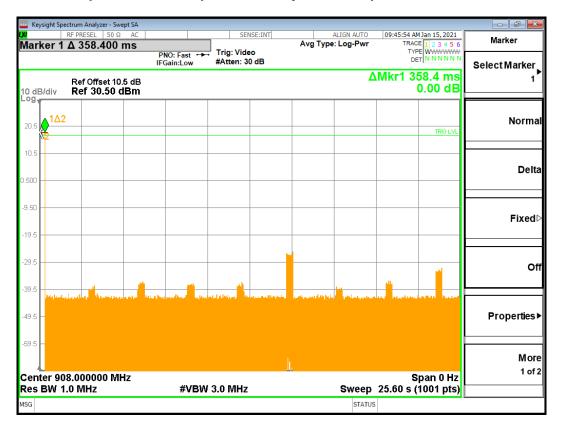
Number of events in 25.6Sec = 1

Margin = 400 - 370.8 = 29.2 ms

Keysight Spectrum Analyzer - Swept SA ALTGN AUTO 09:26:47 AM Jan 15, 2021 TRACE 1 2 3 4 5 6 Peak Search Marker 1 370.800 ms Trig Delay-100.0 ms Avg Type: Log-Pwr Avg|Hold: 13/100 Trig: Video PNO: Fast #Atten: 30 dB DET P NNNN IEGain:Low **NextPeak** ΔMkr1 370.8 ms Ref Offset 10.5 dB -0.053 dB 10 dB/div Ref 30.50 dBm _og ∧1∆2 20.5 \mathbb{K}_{2} Next Pk Right 10.5 .500 9.50 Next Pk Left 19.5 -29.5 -39.5 -49.5 Marker Delta 59.5 Span 0 Hz Center 908.700000 MHz Res BW 1.0 MHz #VBW 3.0 MHz Sweep 600.0 ms (1001 pts) Mkr→CF FUNCTION VALUE MKR MODE TRC SCL FUNCTION FUNCTION WIDTH Y 1 Δ2 2 F t (Δ) t -0.053 dB 370.8 ms (Δ) 2 3 98.40 ms 18.542 dBm Mkr→RefLvl 4 5 7 8 9 10 More 1 of 2 ISG STATUS

Screen Capture from the spectrum analyzer: sweep time in 600ms

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



Note: sweep time accuracy is +/-12.8ms on this screen.

2.9 EUT Positioning Assessment

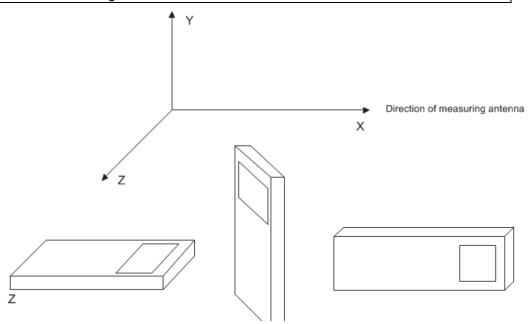
Test Lab: Electronics Test Centre, Airdrie	EUT: BLE Sensor GEN2
Test Personnel: I. Akram /Janet Mijares	Standard: FCC PART 15.247
Date: 2020-12-21/22 (20.5°C,8.9% RH)	Basic Standard: ANSI C63.4-2014

X-Axis Found worse

Comments: EUT oriented in three axis's and X- 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.



Refer to Test Setup photo exhibit.

2.10 Radiated Spurious Emissions in restricted frequency bands (TX Mode)

Test Lab: Electronics Test Centre, Airdrie	EUT: BLE Sensor GEN2
Test Personnel: Imran Akram/ Janet Mijares	Standard: FCC PART 15.247
Date: 2021-01-14 (20.1°C,10.7 % 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)).

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 Test Equipment

Testing was performed with the following equipment:

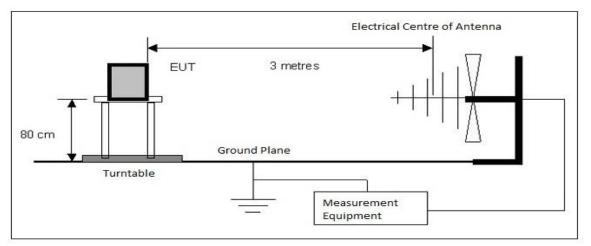
Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)	
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A		
EMI receiver Agilent		N9038A (FW A.25.05)	6130	2019-05-10	2020-05-10	
Loop Antenna	EMCO	6502	10868	2019-04-11	2021-04-11	
Biconilog Antenna	ARA	LPB-2520/A	4318	2018-09-19	2020-09-19	
DRG Horn	DRG Horn EMCO 3115		19357	2018-09-12	2020-09-12	
Humidity/Temp Logger			5892	2019-04-05	2020-04-05	
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800- 21-5P	4354	2020-01-03	2021-01-03	
Pre-Amplifier (30 – 1300 MHz)	HP	8447D	9291	2020-01-03	2021-01-03	
RE Cable below 1GHz	Insulated Wire Inc.	KPS-1501A- 3600-KPA- 01102006	4419	2020-01-03	2021-01-03	
Re Cable Above 1 GHz	A.H. System Inc.	SAC-26G-8.23	6187	2020-01-03	2021-01-03	
High Pass Filter	igh Pass Filter K&L 4DH21		-	2020-01-03	2021-01-03	

2.10.4 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 Radiated Spurious Emissions testing (below 1GHz):



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

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	(²)
13.36 - 13.41			

FCC Part 15.205 Restricted Bands of Operation:

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz, ² Above 38.6

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in 15.209 shall be demonstrated based on the average value of the measured emissions.

Specification: FCC15.209 Radiated emission limits.

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (m)			
0.009 - 0.490	2400 / F(KHz)	300			
0.490 - 1.705	24000 / F(KHz)	30			
1.705 - 30.0	30	30			
30 - 88	100	3			
88 – 216	150	3			
216 - 960	200	3			
Above 960	500	3			

2.10.5 Radiated Emissions Data:

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

Meter Reading in dB μ V + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in db μ V/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 Low band channel 902.3 MHz was selected as the worst-case condition for detailed examination.
- In Transmit mode, the EUT was assessed up to 10.0 GHz.

Negative values for Delta indicate compliance.

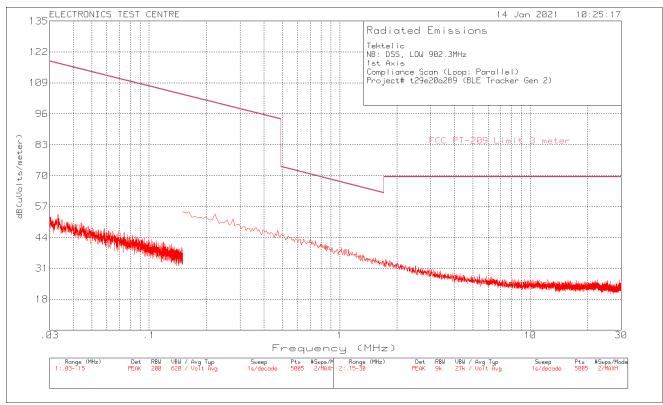
Band	Freq. Marker	Freq. [MHz]	Raw reading [dBµv]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBµv/m]	FCC 15.209 Limit [dBµv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
	Frequency Range 1400 – 10000 MHz											
RB	2	8121.5	26.77	AV	36.7	-27.3	36.17	54	-17.83	104	318	Horizontal
RB	2	8121.5	39.16	PK	36.7	-27.3	48.56	74	-25.44	104	318	Horizontal
RB	1	5413.8	37.15	AV	34	-31.1	40.05	54	-13.95	142	399	Vertical
RB	1	5413.8	43.15	PK	34	-31.1	46.05	74	-27.95	142	399	Vertical

AV: Average Detector, PK: Peak Detector,

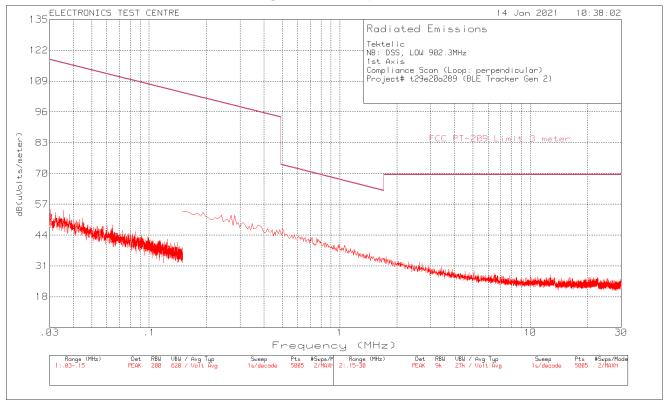
* Restricted Band (RB)

Non Restricted Band (NRB)

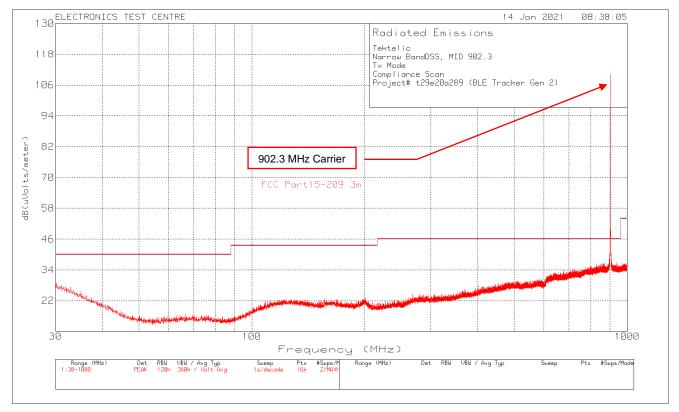




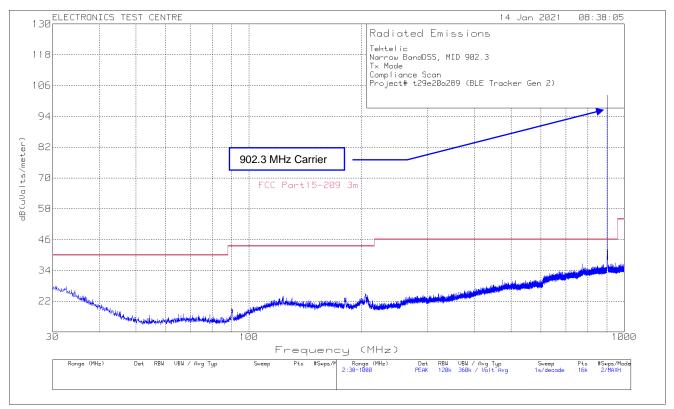
Plot of Radiated Emissions: Measuring Antenna Perpendicular



Plot of Radiated Emissions: Horizontal polarization



Plot of Radiated Emissions: Vertical polarization

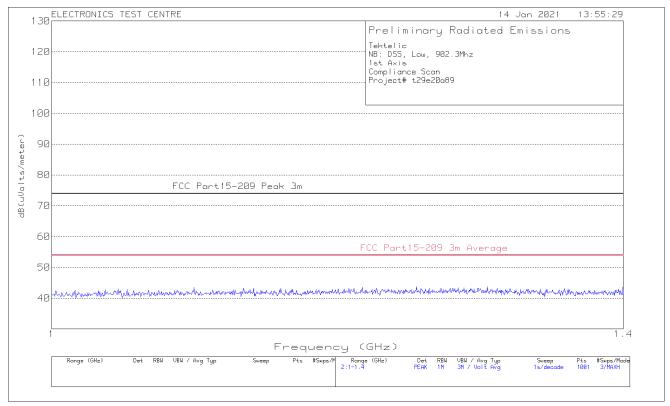


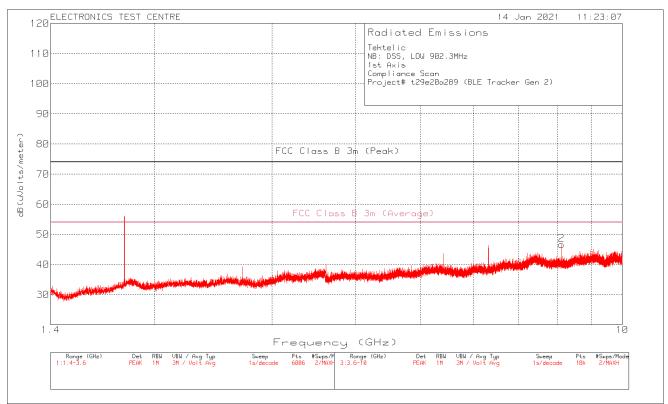
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Plot of Radiated Emissions: Horizontal polarization



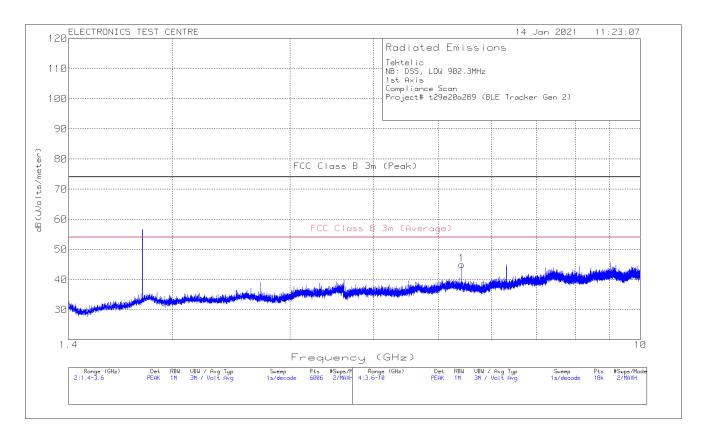
Plot of Radiated Emissions: Vertical polarization





Plot of Radiated Emissions: Horizontal polarization

Plot of Radiated Emissions: Vertical polarization



2.11 RF Exposure

Test Lab: Electronics Test Centre, Airdrie

Test Personnel:

Date:

EUT: BLE Sensor GEN2 Standard: FCC PART 15.247

EUT status: Exempt

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

3.0 TEST FACILITY

3.1 Location

The BLE Sensor GEN2 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.

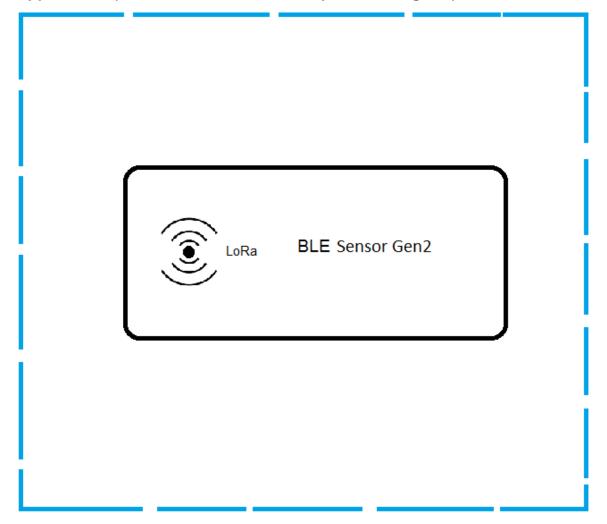
3.2 Grounding Plan

The BLE Sensor GEN2 was placed at the center of the test chamber turntable on top of polystyrene foam table. No provision is made within the BLE Sensor GEN2 for an earth ground connection.

3.3 Power Supply

All EUT power was supplied by a DC power supply (3.6V).

Appendix A (Worse Emission test setup Block Diagram)



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