

FCC Test Report

Report No.: AGC00174230501FE02

FCC ID : XBE-COL50-2

APPLICATION PURPOSE: Original Equipment

PRODUCT DESIGNATION: Control Box

BRAND NAME : LINAK

MODEL NAME : COL50-2

APPLICANT : LINAK A/S

DATE OF ISSUE : Aug. 29, 2023

STANDARD(S) : FCC Part 15.247

REPORT VERSION: V1.0

Attestation of Global Compliance (Shenzhen) Co., Ltd



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REPORT REVISE RECORD

Report Version	n Revise Time	Issued Date	Valid Version	Notes
V1.0	/	Aug. 29, 2023	Valid	Initial Release

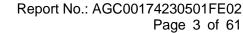




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1. VERIFICATION OF COMPLIANCE

Applicant	LINAK A/S
Address	Group Headquarters Smedevænget 8, Guderup DK-6430 Nordborg, Denmark
Manufacturer	LINAK A/S
Address	Group Headquarters Smedevænget 8, Guderup DK-6430 Nordborg, Denmark
Factory	LINAK A/S
Address	Group Headquarters Smedevænget 8, Guderup DK-6430 Nordborg, Denmark
Product Designation	Control Box
Brand Name	LINAK
Test Model	COL50-2
Date of receipt of test item	May 25, 2023
Date of test	May 25, 2023 to Aug. 29, 2023
Deviation	No any deviation from the test method
Condition of Test Sample	Normal
Test Result	Pass
Report Template	AGCRT-US-BLE/RF

We hereby certify that:

The above equipment was tested by Attestation of Global Compliance (Shenzhen) Co., Ltd. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10 (2013) and the energy emitted by the sample EUT tested as described in this report is in compliance with radiated emission limits of FCC part 15.247.

Prepared By	Thea Huang	
	Thea Huang (Project Engineer)	Aug. 29, 2023
Reviewed By	Calin Lin	
	Calvin Liu (Reviewer)	Aug. 29, 2023
Approved By	Max Zhang	
	Max Zhang (Authorized Officer)	Aug. 29, 2023



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2. GENERAL INFORMATION

2.1. PRODUCT DESCRIPTION

The EUT is designed as a "Control Box". It is designed by way of utilizing the GFSK technology to achieve the system operation.

A major technical description of EUT is described as following

Operation Frequency	2.402 GHz to 2.480GHz		
RF Output Power	BLE GFSK 1Mbps:-5.072dBm (Max); BLE GFSK 2Mbps:-1.237dBm (Max)		
Bluetooth Version	V5.1		
Modulation	BLE ⊠GFSK 1Mbps ⊠GFSK 2Mbps		
Number of channels	40 Channels		
Antenna Designation	PCB Antenna (Comply with requirements of the FCC part 15.203)		
Antenna Gain	-0.102dBi		
Hardware Version	10908007-E		
Software Version	02023502		
Power Supply	DC 25.7V by battery or AC 100-240V 50/60Hz		

2.2. TABLE OF CARRIER FREQUENCYS

Frequency Band	Channel Number	Frequency
	0	2402 MHz
	1	2404 MHz
2400~2483.5MHz	:	·
	38	2478 MHz
	39	2480 MHz



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2.3. RELATED SUBMITTAL(S)/GRANT(S)

This submittal(s) (test report) is intended for **FCC ID: XBE-COL50-2** filing to comply with the FCC Part 15.247 requirements.

2.4. TEST METHODOLOGY

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10 (2013). Radiated testing was performed at an antenna to EUT distance 3 meters.

2.5. SPECIAL ACCESSORIES

Refer to section 5.2.

2.6. EQUIPMENT MODIFICATIONS

Not available for this EUT intended for grant.

2.7. ANTENNA REQUIREMENT

This intentional radiator is designed with a permanently attached antenna of an antenna to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

For more information of the antenna, please refer to the APPENDIX B: PHOTOGRAPHS OF EUT.

2.8 DUTY CYCLE

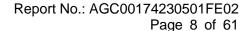
The maximum achievable duty cycles for all modes were determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW=8MHz, VBW=50MHz. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

Test Mode	Frequency	Duty Cycle	
BLE GFSK 1Mbps	2402MHz	15.80%	

Test Graphs of Duty Cycle



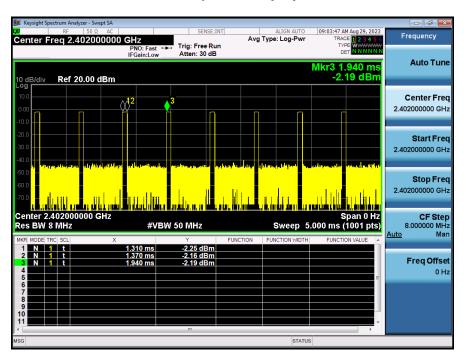
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Test Mode	Frequency	Duty Cycle
BLE GFSK 2Mbps	2402MHz	9.52%

Test Graphs of Duty Cycle



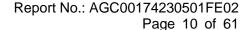


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3. MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement y ±U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Item	Measurement Uncertainty
Uncertainty of Conducted Emission for AC Port	$U_c = \pm 3.1 \text{ dB}$
Uncertainty of Radiated Emission below 1GHz	$U_c = \pm 4.0 \text{ dB}$
Uncertainty of Radiated Emission above 1GHz	$U_c = \pm 4.8 \text{ dB}$
Uncertainty of total RF power, conducted	$U_c = \pm 0.8 \text{ dB}$
Uncertainty of RF power density, conducted	$U_c = \pm 2.6 \text{ dB}$
Uncertainty of spurious emissions, conducted	$U_c = \pm 2.7 \%$
Uncertainty of Occupied Channel Bandwidth	$U_c = \pm 2 \%$



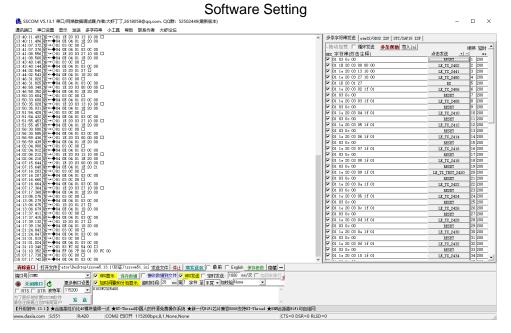


4. DESCRIPTION OF TEST MODES

NO.	TEST MODE DESCRIPTION
1	BLE GFSK 1Mbps_Low channel TX
2	BLE GFSK 1Mbps_Middle channel TX
3	BLE GFSK 1Mbps_High channel TX
4	BLE GFSK 2Mbps_Low channel TX
5	BLE GFSK 2Mbps_Middle channel TX
6	BLE GFSK 2Mbps_High channel TX

Note:

- 1. Only the result of the worst case was recorded in the report, if no other cases.
- 2. For Radiated Emission, 3axis were chosen for testing for each applicable mode.
- 3. For Conducted Test method, a temporary antenna connector is provided by the manufacture.



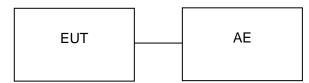


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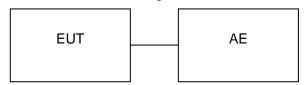
5. SYSTEM TEST CONFIGURATION

5.1. CONFIGURATION OF TESTED SYSTEM

Radiated Emission Configure:



Conducted Emission Configure:



5.2. EQUIPMENT USED IN TESTED SYSTEM

Item	Equipment	Model No.	ID or Specification	Remark
1	Control Box	COL50-2	XBE-COL50-2	EUT
2	Control Box	USB TO TTL	N/A	AE
3	AC Input Cable	N/A	1.4m unshielded	AE

5.3. SUMMARY OF TEST RESULTS

FCC RULES	DESCRIPTION OF TEST	RESULT
15.247 (b)(3)	Peak Output Power	Compliant
15.247 (a)(2)	6 dB Bandwidth	Compliant
15.247 (d)	Conducted Spurious Emission	Compliant
15.247 (e)	Maximum Conducted Output Power Density	Compliant
15.209	Radiated Emission	Compliant
15.207	Conducted Emission	Compliant



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6. TEST FACILITY

Test Site	Attestation of Global Compliance (Shenzhen) Co., Ltd
Location	1-2/F, Building 19, Junfeng Industrial Park, Chongqing Road, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China
Designation Number	CN1259
FCC Test Firm Registration Number	975832
A2LA Cert. No.	5054.02
Description	Attestation of Global Compliance (Shenzhen) Co., Ltd is accredited by A2LA

TEST EQUIPMENT OF CONDUCTED EMISSION TEST

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Due
TEST RECEIVER	R&S	ESPI	101206	Aug. 04, 2022	Aug. 03, 2023
TEST RECEIVER	R&S	ESPI	101206	Jun. 03, 2023	Jun. 02, 2024
LISN	R&S	ESH2-Z5	100086	Jun. 08, 2022	Jun. 07, 2023
LISN	R&S	ESH2-Z5	100086	Jun. 03, 2023	Jun. 02, 2024
Test software	R&S	ES-K1(Ver.V1.71)	N/A	N/A	N/A

TEST EQUIPMENT OF RADIATED EMISSION TEST

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Due
TEST RECEIVER	R&S	ESCI	10096	Feb. 18, 2023	Feb. 17, 2024
EXA Signal Analyzer	Aglient	N9010A	MY53470504	Aug. 04, 2022	Aug. 03, 2023
EXA Signal Analyzer	Aglient	N9010A	MY53470504	Jun. 01, 2023	May 31, 2024
2.4GHz Filter	EM Electronics	2400-2500	N/A	Mar. 22, 2022	Mar. 21, 2024
Horn antenna	SCHWARZBECK	BBHA 9170	#768	Oct. 31, 2021	Oct. 30, 2023
Active loop antenna (9K-30MHz)	ZHINAN	ZN30900C	18051	Mar. 12, 2022	Mar. 11, 2024
Double-Ridged Waveguide Horn	ETS LINDGREN	3117	00034609	Mar. 23, 2023	Mar. 22, 2024
Broadband Preamplifier	ETS LINDGREN	3117PA	00225134	Sep. 02, 2022	Sep. 01, 2024
ANTENNA	SCHWARZBECK	VULB9168	494	Jan. 05, 2023	Jan. 04, 2025
Test software	Tonscend	JS32-RE (Ver.2.5)	N/A	N/A	N/A



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7. PEAK OUTPUT POWER

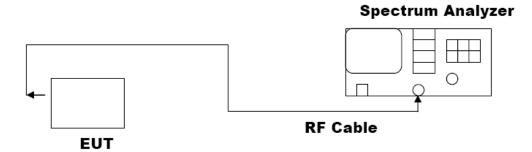
7.1. MEASUREMENT PROCEDURE

For peak power test:

- 1. Connect EUT RF output port to the Spectrum Analyzer
- 2. RBW ≥ DTS bandwidth
- 3. VBW≥3*RBW.
- 4. SPAN≥VBW.
- 5. Sweep: Auto.
- 6. Detector function: Peak.
- 7. Trace: Max hold.

Allow trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power, after any corrections for external attenuators and cables.

7.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION) PEAK POWER TEST SETUP





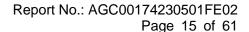
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7.3. LIMITS AND MEASUREMENT RESULT

7.01 2 7.112						
Test Data of Conducted Output Power						
Test Mode Test Channel Peak Power Limits (MHz) (dBm) Pass or Fail						
	2402	-5.072	≤30	Pass		
GFSK 1M	2440	-6.735	≤30	Pass		
	2480	-8.263	≤30	Pass		

Test Graphs of Conducted Output Power



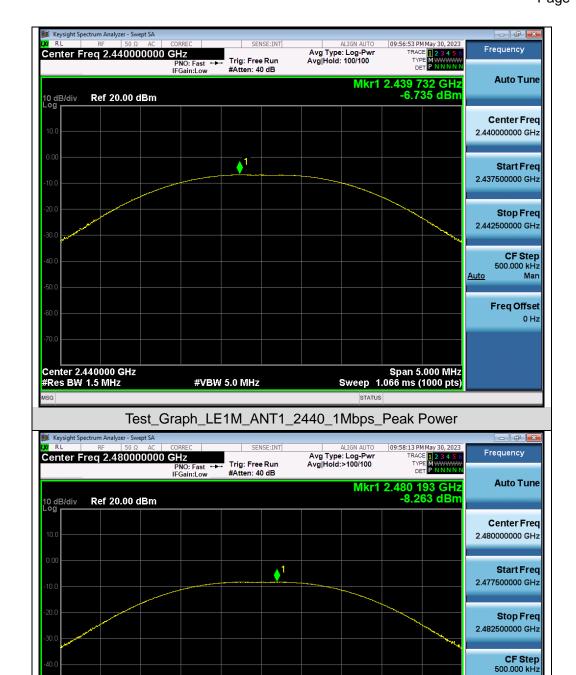


Auto

Span 5.000 MHz Sweep 1.066 ms (1000 pts) Man

Freq Offset





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Test_Graph_LE1M_ANT1_2480_1Mbps_Peak Power

#VBW 5.0 MHz

Center 2.480000 GHz #Res BW 1.5 MHz

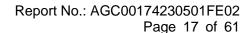


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Test Data of Conducted Output Power						
Test Mode	Test Channel (MHz)	Peak Power (dBm)	Limits (dBm)	Pass or Fail		
	2402	-1.237	≤30	Pass		
GFSK 2M	2440	-1.347	≤30	Pass		
	2480	-1.561	≤30	Pass		

Test Graphs of Conducted Output Power

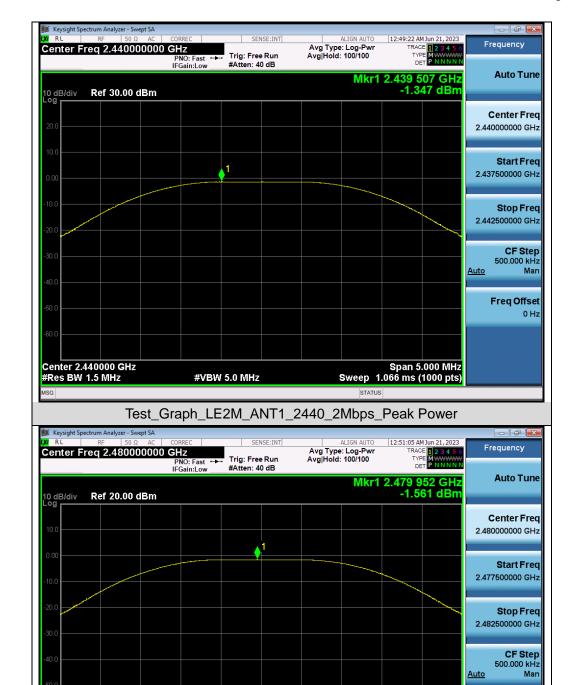




Freq Offset

Span 5.000 MHz Sweep 1.066 ms (1000 pts)





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Test_Graph_LE2M_ANT1_2480_2Mbps_Peak Power

#VBW 5.0 MHz

Center 2.480000 GHz #Res BW 1.5 MHz



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8. BANDWIDTH

8.1. MEASUREMENT PROCEDURE

6dB bandwidth:

- 1. Connect EUT RF output port to the Spectrum Analyzer
- 2. Set the EUT Work on the top, the middle and the bottom operation frequency individually.
- 3. Set SPA Centre Frequency = Operation Frequency, RBW= 100 kHz, VBW ≥ 3×RBW.
- 4. Set SPA Trace 1 Max hold, then View.

Occupied bandwidth:

- 1. Connect EUT RF output port to the Spectrum Analyzer
- 2, Set the EUT Work on the top, the middle and the bottom operation frequency individually.
- 3. Set Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hoping channel
 The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video
 bandwidth (VBW) shall be approximately three times RBW; Sweep = auto; Detector function = peak
- 4. Set SPA Trace 1 Max hold, then View.

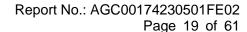
Note: The EUT was tested according to ANSI C63.10 for compliance to FCC PART 15.247 requirements.

8.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)

The same as described in section 7.2.

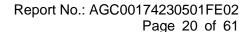
8.3. LIMITS AND MEASUREMENT RESULTS

Test Data of Occupied Bandwidth and DTS Bandwidth						
Test Mode	Test Channel 99% Occupied -6dB Limits (MHz) Bandwidth (MHz) Bandwidth (MHz) Pass or Fa					
	2402	1.047	0.506	≥0.5	Pass	
GFSK 1M	2440	1.075	0.653	≥0.5	Pass	
	2480	1.070	0.648	≥0.5	Pass	



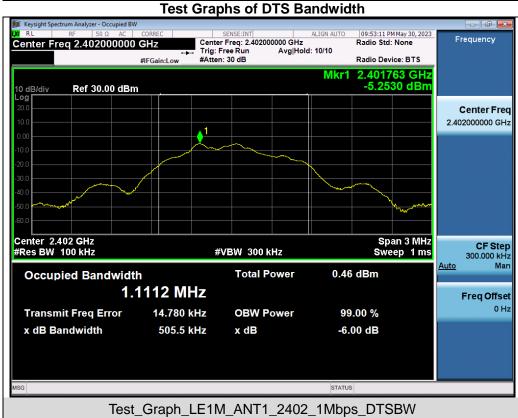




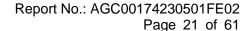








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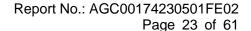


Test_Graph_LE1M_ANT1_2480_1Mbps_DTSBW



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Test Data of Occupied Bandwidth and DTS Bandwidth						
Test Mode Test Channel 99% Occupied -6dB Limits (MHz) Pass or Fail						
	2402	2.030	0.854	≥0.5	Pass	
GFSK 2M	2440	2.029	0.842	≥0.5	Pass	
	2480	2.031	0.840	≥0.5	Pass	

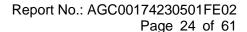




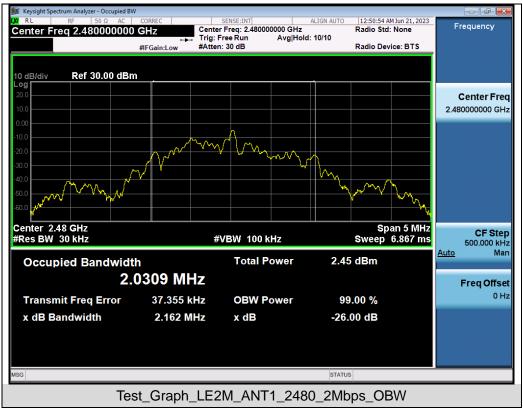
Test Graphs of Occupied Bandwidth 12:38:49 AM Jun 21, 2023 Radio Std: None SENSE:INT Center Freq: 2.402000000 GHz
Trig: Free Run Avg|Hol
#Atten: 30 dB Frequency Avg|Hold: 10/10 Ref 30.00 dBm Center Freq 2.402000000 GHz Center 2.402 GHz #Res BW 30 kHz Span 5 MHz Sweep 6.867 ms **CF Step** #VBW 100 kHz 500,000 kHz Man Auto **Total Power** 2.74 dBm **Occupied Bandwidth** 2.0299 MHz Frea Offset 0 Hz 36.386 kHz **OBW Power** 99.00 % **Transmit Freq Error** x dB Bandwidth 2.166 MHz x dB -26.00 dB Test_Graph_LE2M_ANT1_2402_2Mbps_OBW 12:48:42 AM Jun 21, 2023 Radio Std: None Center Freq: 2.440000000 GHz
Trig: Free Run Avg|Hol Frequency Freq 2.440000000 GHz Avg|Hold: 10/10 Radio Device: BTS Ref 30.00 dBm Center Freq 2.440000000 GHz Span 5 MHz Sweep 6.867 ms Center 2.44 GHz #Res BW 30 kHz CF Step 500.000 kHz **#VBW 100 kHz Total Power** 2.50 dBm **Occupied Bandwidth** 2.0285 MHz Freq Offset 0 Hz **Transmit Freq Error** 37.945 kHz **OBW Power** 99.00 % x dB Bandwidth -26.00 dB 2.162 MHz x dB

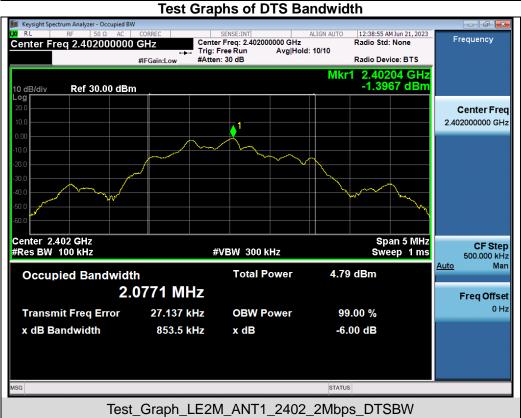
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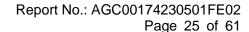
Test_Graph_LE2M_ANT1_2440_2Mbps_OBW















Test_Graph_LE2M_ANT1_2480_2Mbps_DTSBW

x dB

-6.00 dB

839.8 kHz

x dB Bandwidth



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9. CONDUCTED SPURIOUS EMISSION

9.1. MEASUREMENT PROCEDURE

- 1. Connect EUT RF output port to the Spectrum Analyzer
- 2, Set the EUT Work on the top, the middle and the bottom operation frequency individually.
- 3. Set SPA Trace 1 Max hold, then View.

Note: The EUT was tested according to ANSI C63.10 for compliance to FCC PART 15.247 requirements.

9.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)

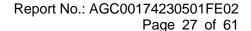
The same as described in section 7.2.

9.3. MEASUREMENT EQUIPMENT USED

The same as described in section 6.

9.4. LIMITS AND MEASUREMENT RESULT

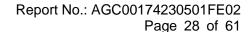
LIMITS AND MEASUREMENT RESULT					
Anniinalda Linniin	Measurement Result				
Applicable Limits	Test Data	Criteria			
In any 100 kHz Bandwidth Outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produce by the intentional radiator shall be at least 20 dB below that in 100KHz bandwidth within the band that contains the highest level of the desired power.	At least -20dBc than the reference level	PASS			



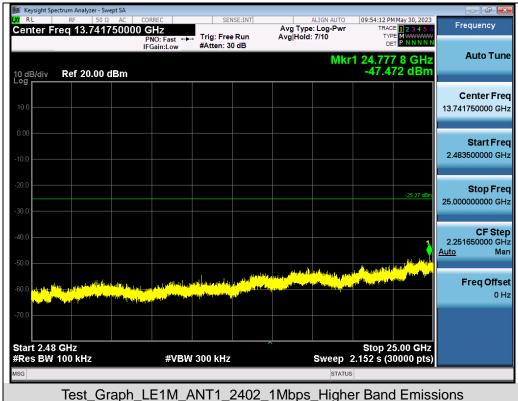


Test Graphs of Spurious Emissions in Non-Restricted Frequency Bands

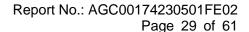








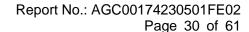






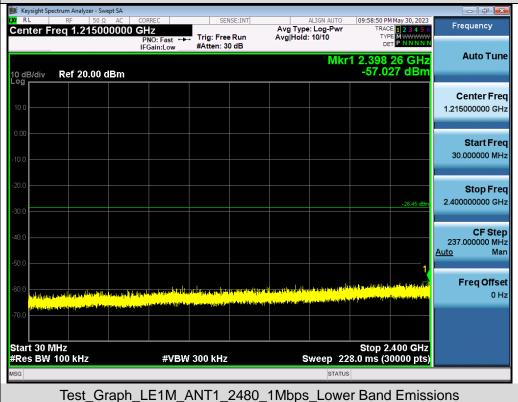


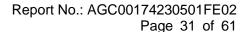










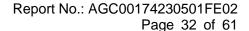




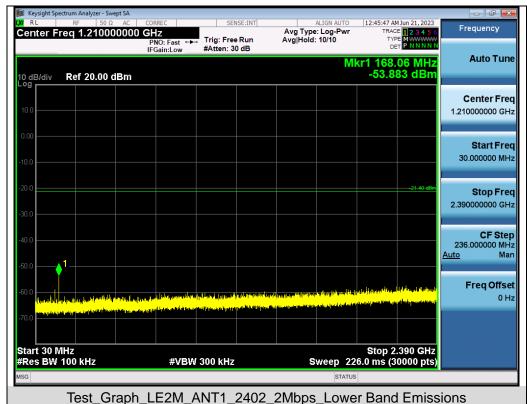


Test Graphs of Spurious Emissions in Non-Restricted Frequency Bands

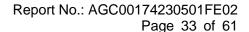














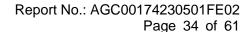


Test_Graph_LE2M_ANT1_2440_2Mbps_Lower Band Emissions

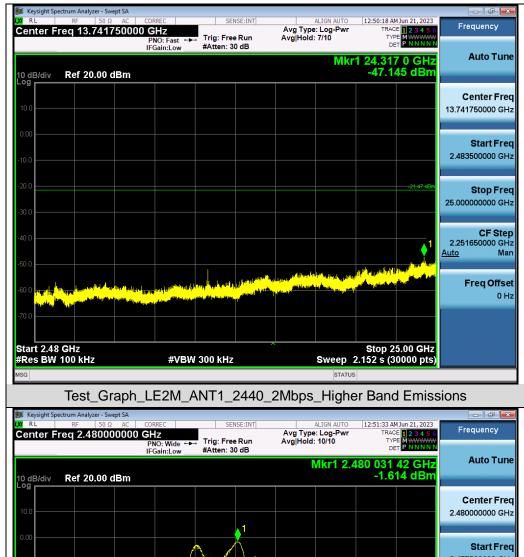
#VBW 300 kHz

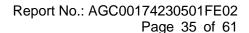
Stop 2.400 GHz Sweep 228.0 ms (30000 pts)

Start 30 MHz #Res BW 100 kHz

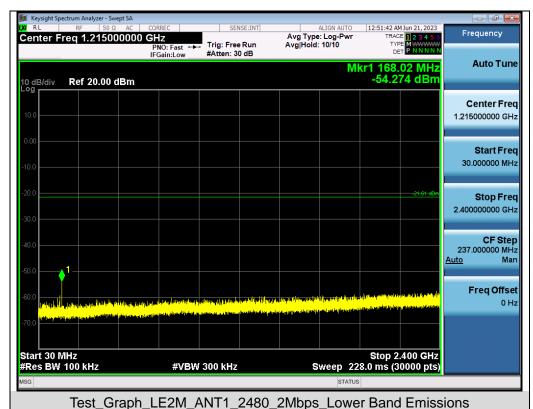




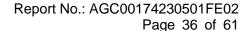










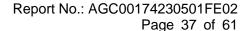




Test Graphs of Band Edge Emissions in Non-Restricted Frequency Bands Avg Type: Log-Pwr Avg|Hold: 100/100 Frequency Center Freq 2.398500000 GHz Trig: Free Run #Atten: 30 dB TYPE **Auto Tune** Mkr2 2.400 000 0 GHz -55.356 dBm Ref 20.00 dBm Center Freq 2.398500000 GHz Start Freq 2.390000000 GHz Stop Freq 2.407000000 GHz Stop 2.407000 GHz 2.000 ms (30000 pts) Start 2.390000 GHz #Res BW 100 kHz CF Step 1.700000 MHz **#VBW** 300 kHz Auto Man -5.016 dBm -55.356 dBm Freq Offset 0 Hz Test_Graph_LE1M_ANT1_2402_1Mbps_Lower Band Edge Emissions Avg Type: Log-Pwr Avg|Hold: 100/100 Frequency Center Freq 2.487500000 GHz PNO: Fast ---IFGain:Low Trig: Free Run #Atten: 30 dB **Auto Tune** Mkr2 2.483 500 0 GHz -61.322 dBm Ref 20.00 dBm Center Frea 2.487500000 GHz Start Freq 2.475000000 GHz Stop Freq 2 500000000 GHz Stop 2.50000 GHz Sweep 4.000 ms (30000 pts) Start 2.47500 GHz #Res BW 100 kHz **CF Step #VBW** 300 kHz 2.500000 MHz <u>Auto</u> 2.480 025 2 GHz 2.483 500 0 GHz -8.324 dBm -61.322 dBm Freq Offset 0 Hz

Any report having not been signed by authorized approver, or having been altered without authorization, or having not been stamped by the "Dedicated Testing/Inspection Stamp" is deemed to be invalid. Copying or excerpting portion of, or altering the content of the report is not permitted without the written authorization of AGC. The test results presented in the report apply only to the tested sample. Any objections to report issued by AGC should be submitted to AGC within 15days after the issuance of the test report. Further enquiry of validity or verification of the test report should be addressed to AGC by agc01@agccert.com.

Test_Graph_LE1M_ANT1_2480_1Mbps_Higher Band Edge Emissions





Test Graphs of Band Edge Emissions in Non-Restricted Frequency Bands Frequency Avg Type: Log-Pwi Avg|Hold: 100/100 Center Freq 2.398500000 GHz Trig: Free Run #Atten: 30 dB TYPE **Auto Tune** Mkr2 2.400 000 0 GHz -33.879 dBm Ref 20.00 dBm Center Freq 2.398500000 GHz Start Freq 2.390000000 GHz Stop Freq 2.407000000 GHz Stop 2.407000 GHz 2.000 ms (30000 pts) Start 2.390000 GHz #Res BW 100 kHz CF Step 1.700000 MHz #VBW 300 kHz Auto Man -1.211 dBm -33.879 dBm -51.422 dBm Freq Offset 0 Hz Test_Graph_LE2M_ANT1_2402_2Mbps_Lower Band Edge Emissions Avg Type: Log-Pwr Avg|Hold: 100/100 Frequency Center Freq 2.487500000 GHz PNO: Fast ---IFGain:Low Trig: Free Run #Atten: 30 dB **Auto Tune** Mkr2 2.483 500 0 GHz -59.830 dBm Ref 20.00 dBm Center Frea 2.487500000 GHz Start Freq 2.475000000 GHz Stop Freq 2 500000000 GHz Stop 2.50000 GHz Sweep 4.000 ms (30000 pts) Start 2.47500 GHz #Res BW 100 kHz **CF Step** #VBW 300 kHz 2.500000 MHz <u>Auto</u> Freq Offset 0 Hz

Any report having not been signed by authorized approver, or having been altered without authorization, or having not been stamped by the "Dedicated Testing/Inspection Stamp" is deemed to be invalid. Copying or excerpting portion of, or altering the content of the report is not permitted without the written authorization of AGC. The test results presented in the report apply only to the tested sample. Any objections to report issued by AGC should be submitted to AGC within 15days after the issuance of the test report. Further enquiry of validity or verification of the test report should be addressed to AGC by agc01@agccert.com.

Test_Graph_LE2M_ANT1_2480_2Mbps_Higher Band Edge Emissions



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10. MAXIMUM CONDUCTED OUTPUT POWER SPECTRAL DENSITY

10.1. MEASUREMENT PROCEDURE

- (1). Connect EUT RF output port to the Spectrum Analyzer
- (2). Set the EUT Work on the top, the middle and the bottom operation frequency individually.
- (3). Set the SPA Trace 1 Max hold, then View.

Note: The method of PKPSD in the KDB 558074 item 8.4 was used in this testing.

10.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)

Refer to Section 7.2.

10.3. MEASUREMENT EQUIPMENT USED

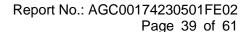
Refer to Section 6.

10.4. LIMITS AND MEASUREMENT RESULT

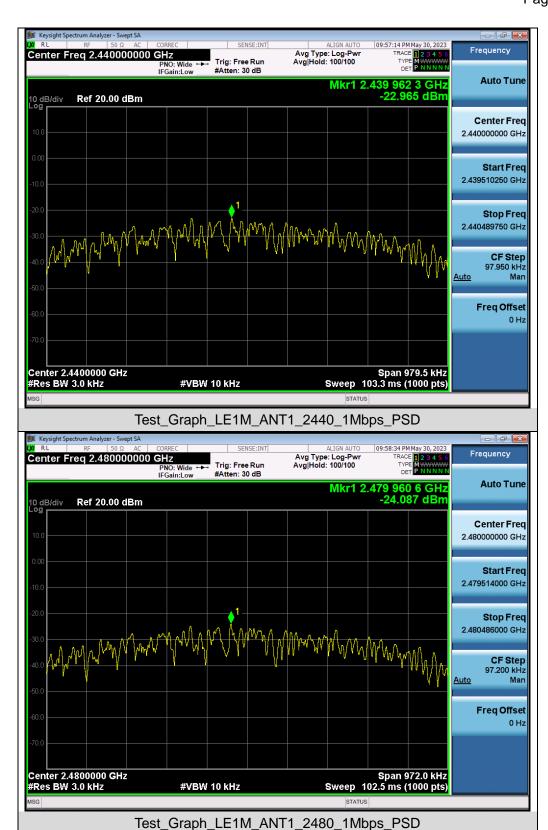
Test Data of Conducted Output Power Spectral Density							
Test Mode	Test Channel (MHz)	Power density (dBm/3kHz)	Limit (dBm/3kHz)	Pass or Fail			
	2402	-22.901	≤8	Pass			
GFSK 1M	2440	-22.965	≤8	Pass			
	2480	-24.087	≤8	Pass			

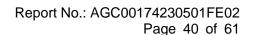
Test Graphs of Conducted Output Power Spectral Density







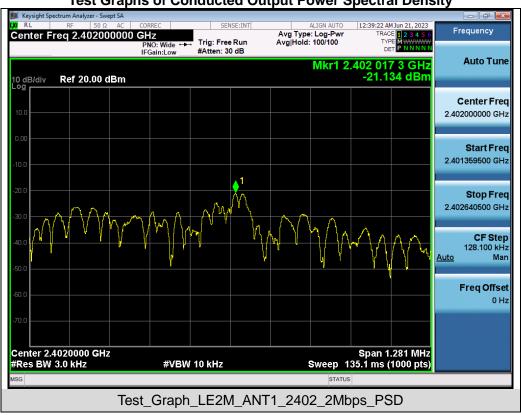


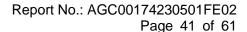




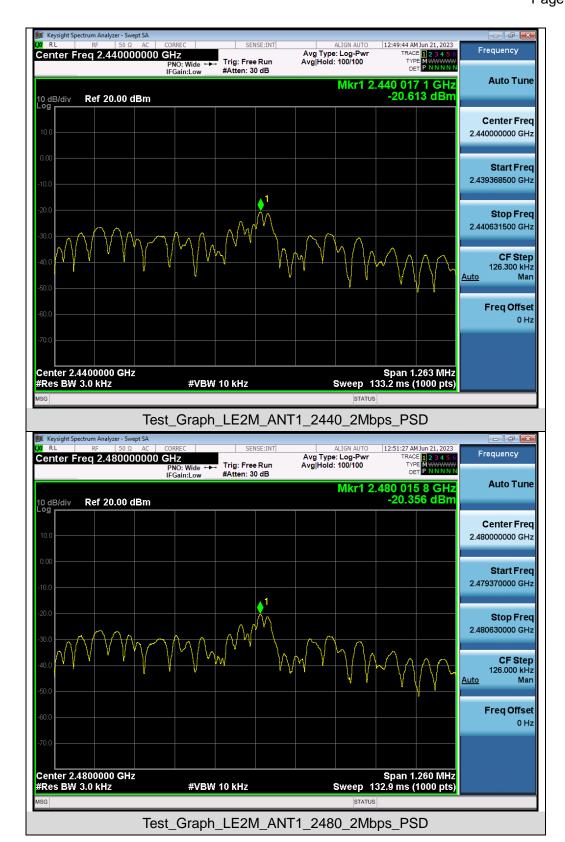
Test Data of Conducted Output Power Spectral Density							
Test Mode	Test Channel (MHz)	Power density (dBm/3kHz)	Limit (dBm/3kHz)	Pass or Fail			
	2402	-21.134	≤8	Pass			
GFSK 2M	2440	-20.613	≤8	Pass			
	2480	-20.356	≤8	Pass			

Test Graphs of Conducted Output Power Spectral Density









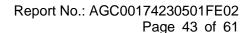


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11. RADIATED EMISSION

11.1. MEASUREMENT PROCEDURE

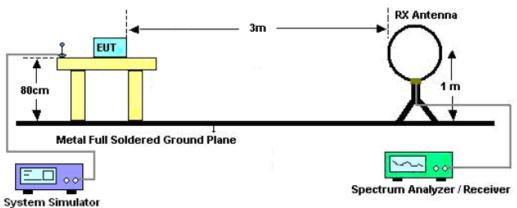
- 1. The EUT was placed on the top of the turntable 0.8 or 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
- 2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
- 3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
- 4. For each suspected emission, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
- 5. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
- 6. For emissions above 1GHz, use 1MHz RBW and 3MHz VBW for peak reading. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.
- 7. When the radiated emissions limits are expressed in terms of the average value of the emissions, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum values.
- 8.If the emissions level of the EUT in peak mode was 3 dB lower than the average limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
- 9. For testing above 1GHz, the emissions level of the EUT in peak mode was lower than average limit (that means the emissions level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
- 10. In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be QP measured by receiver. High Low scan is not required in this case.



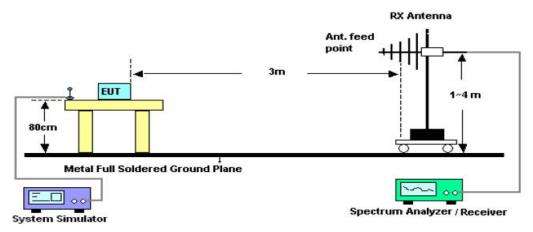


11.2. TEST SETUP

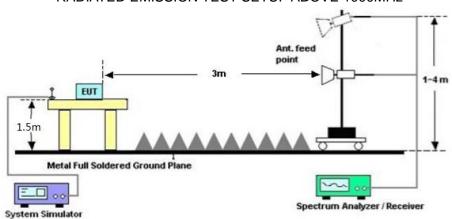
Radiated Emission Test-Setup Frequency Below 30MHz



RADIATED EMISSION TEST SETUP 30MHz-1000MHz



RADIATED EMISSION TEST SETUP ABOVE 1000MHz





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11.3. LIMITS AND MEASUREMENT RESULT

15.209 Limit in the below table has to be followed

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
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

Note: All modes were tested for restricted band radiated emission, the test records reported below are the worst result compared to other modes.

11.4. TEST RESULT

Radiated emission below 30MHz

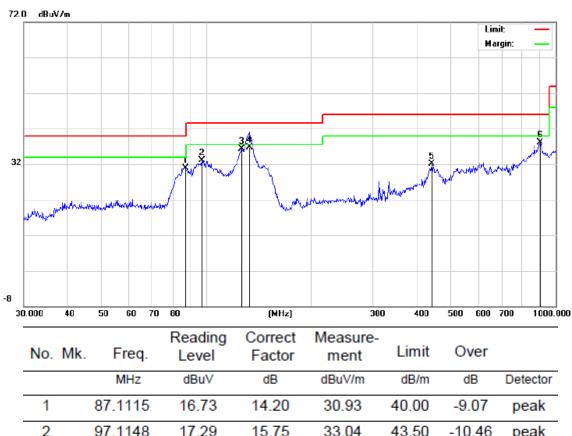
The amplitude of spurious emissions from 9kHz to 30MHz which are attenuated more than 20 dB below the permissible value need not be reported.



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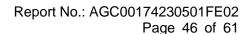
Radiated emission from 30MHz to 1000MHz

EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Horizontal



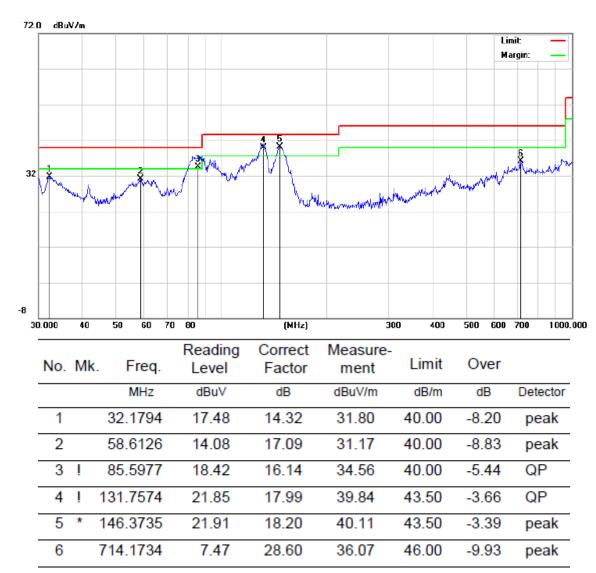
No.	Mk.	Freq.	Level	Factor	ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1		87.1115	16.73	14.20	30.93	40.00	-9.07	peak
2		97.1148	17.29	15.75	33.04	43.50	-10.46	peak
3		126.3285	20.29	16.02	36.31	43.50	-7.19	peak
4	*	132.6850	21.02	15.64	36.66	43.50	-6.84	QP
5		441.7425	6.99	25.04	32.03	46.00	-13.97	peak
6		903.3093	6.74	31.34	38.08	46.00	-7.92	peak

RESULT: PASS





EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Vertical



RESULT: PASS Note:

- 1. Factor=Antenna Factor + Cable loss, Over=Measurement-Limit.
- 2. All test modes had been tested. The BLE GFSK 2Mbps mode 4 is the worst case and recorded in the report.



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Radiated emission above 1GHz

EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Type	
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	- Value Type	
4804.000	43.62	0.08	43.7	74	-30.3	peak	
4804.000	35.41	0.08	35.49	54	-18.51	AVG	
7206.000	38.35	2.21	40.56	74	-33.44	peak	
7206.000	31.39	2.21	33.6	54	-20.4	AVG	

Remark:

Factor = Antenna Factor + Cable Loss – Pre-amplifier.

EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Vertical

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Type
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4804.000	44.78	0.08	44.86	74	-29.14	peak
4804.000	34.41	0.08	34.49	54	-19.51	AVG
7206.000	38.26	2.21	40.47	74	-33.53	peak
7206.000	30.59	2.21	32.8	54	-21.2	AVG
		_				

Factor = Antenna Factor + Cable Loss - Pre-amplifier.



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EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 5	Antenna	Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Type
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4880.000	44.69	0.14	44.83	74	-29.17	peak
4880.000	35.45	0.14	35.59	54	-18.41	AVG
7320.000	39.32	2.36	41.68	74	-32.32	peak
7320.000	31.58	2.36	33.94	54	-20.06	AVG
emark:						

Factor = Antenna Factor + Cable Loss - Pre-amplifier.

EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 5	Antenna	Vertical

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	- Value Type
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4880.000	45.48	0.14	45.62	74	-28.38	peak
4880.000	38.51	0.14	38.65	54	-15.35	AVG
7320.000	40.72	2.36	43.08	74	-30.92	peak
7320.000	32.63	2.36	34.99	54	-19.01	AVG

Remark:

Factor = Antenna Factor + Cable Loss - Pre-amplifier.



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EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 6	Antenna	Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Type
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4960.000	44.87	0.22	45.09	74	-28.91	peak
4960.000	35.63	0.22	35.85	54	-18.15	AVG
7440.000	38.49	2.64	41.13	74	-32.87	peak
7440.000	29.52	2.64	32.16	54	-21.84	AVG
Remark:						

Factor = Antenna Factor + Cable Loss – Pre-amplifier.

EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 6	Antenna	Vertical

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Value Type
(MHz)	(dBµV)	(dB)	(dBµV/m)	(dBµV/m)	(dB)	value Type
4960.000	42.89	0.22	43.11	74	-30.89	peak
4960.000	34.41	0.22	34.63	54	-19.37	AVG
7440.000	38.75	2.64	41.39	74	-32.61	peak
7440.000	29.36	2.64	32	54	-22	AVG
Remark:						

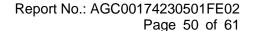
Factor = Antenna Factor + Cable Loss – Pre-amplifier.

RESULT: PASS

The amplitude of other spurious emissions from 1G to 25 GHz which are attenuated more than 20 dB below the permissible value need not be reported.

Factor = Antenna Factor + Cable loss - Amplifier gain, Margin=Level-Limit.

The "Factor" value can be calculated automatically by software of measurement system.



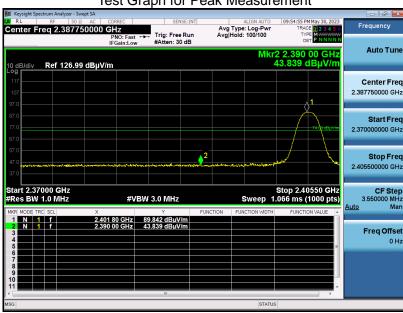


BLE GFSK 1Mbps:

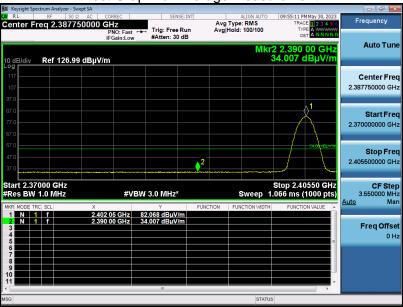
Test result for band edge emission at restricted bands

EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 1	Antenna	Horizontal

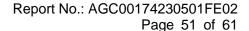
Test Graph for Peak Measurement







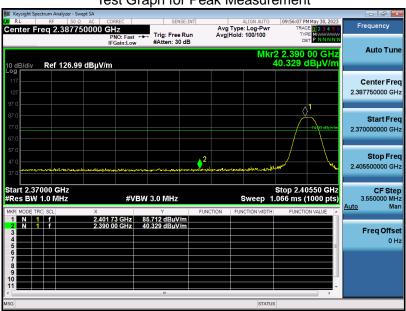
RESULT: PASS

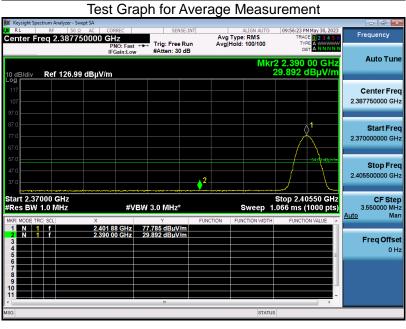




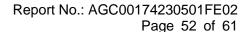
EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 1	Antenna	Vertical

Test Graph for Peak Measurement





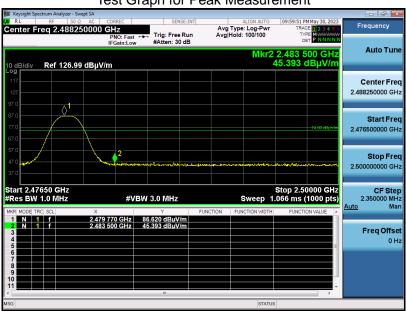
RESULT: PASS

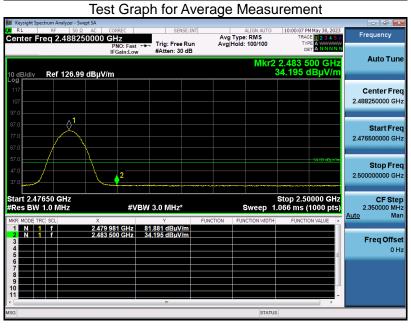




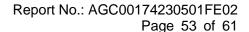
EUT Control Box **Model Name** COL50-2 25° C **Temperature Relative Humidity** 55.4% 960hPa **Test Voltage** Normal Voltage **Pressure Test Mode** Mode 3 **Antenna** Horizontal

Test Graph for Peak Measurement





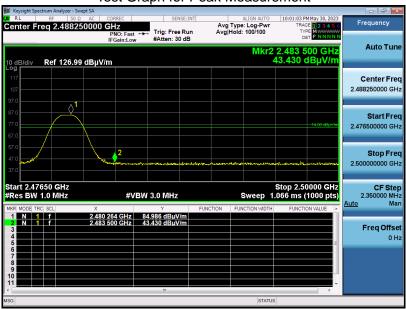
RESULT: PASS

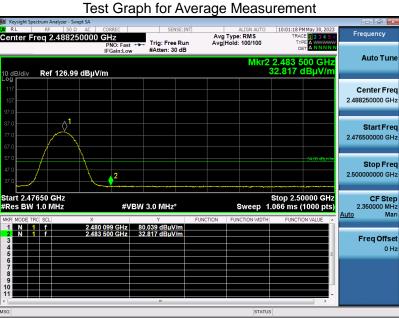




EUT Control Box **Model Name** COL50-2 25° C **Temperature Relative Humidity** 55.4% 960hPa **Pressure Test Voltage** Normal Voltage **Test Mode** Mode 3 **Antenna** Vertical

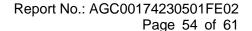
Test Graph for Peak Measurement





RESULT: PASS

Note: The factor had been edited in the "Input Correction" of the Spectrum Analyzer.



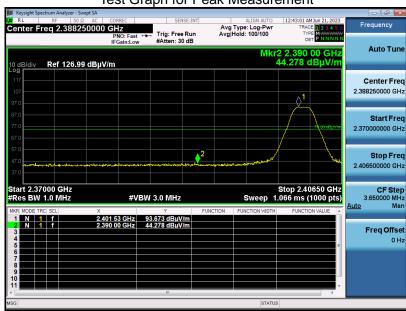


BLE GFSK 2Mbps:

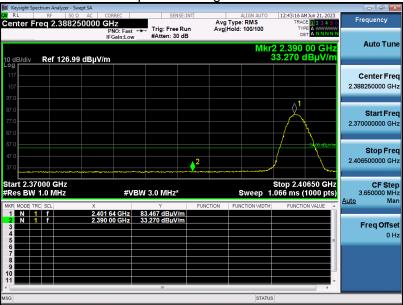
Test result for band edge emission at restricted bands

EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Horizontal

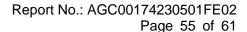
Test Graph for Peak Measurement







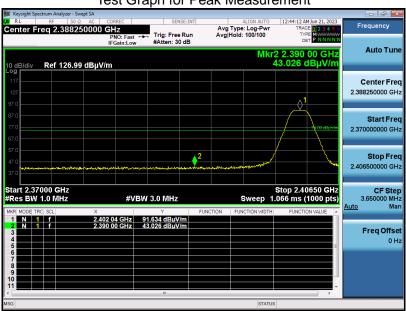
RESULT: PASS

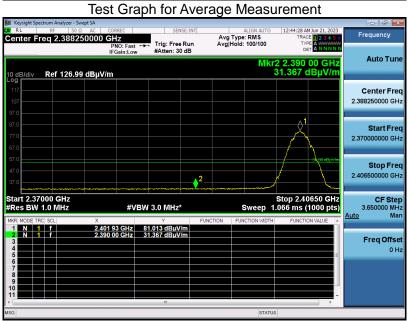




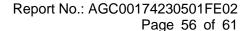
EUT	Control Box	Model Name	COL50-2
Temperature	25° C	Relative Humidity	55.4%
Pressure	960hPa	Test Voltage	Normal Voltage
Test Mode	Mode 4	Antenna	Vertical

Test Graph for Peak Measurement





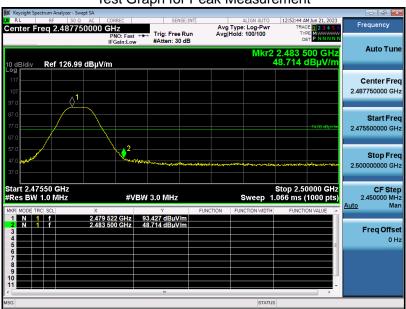
RESULT: PASS

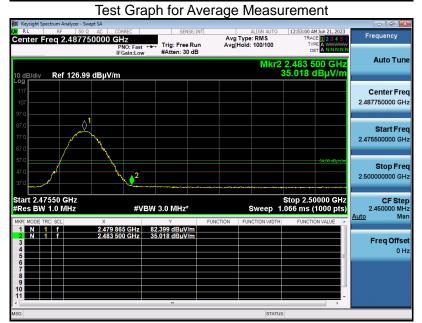




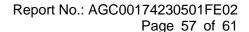
EUT Control Box **Model Name** COL50-2 25° C **Temperature Relative Humidity** 55.4% 960hPa **Test Voltage** Normal Voltage **Pressure Test Mode** Mode 6 **Antenna** Horizontal

Test Graph for Peak Measurement





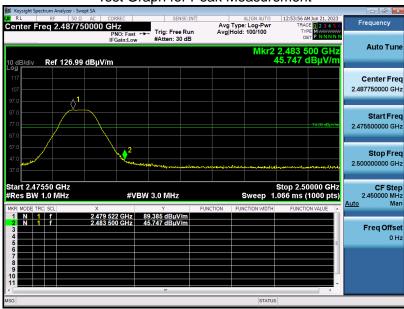
RESULT: PASS

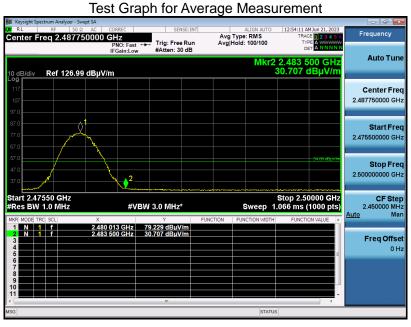




EUT Control Box **Model Name** COL50-2 25° C **Temperature Relative Humidity** 55.4% 960hPa **Pressure Test Voltage** Normal Voltage **Test Mode** Mode 6 **Antenna** Vertical

Test Graph for Peak Measurement





RESULT: PASS

Note: The factor had been edited in the "Input Correction" of the Spectrum Analyzer.



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12. LINE CONDUCTED EMISSION TEST

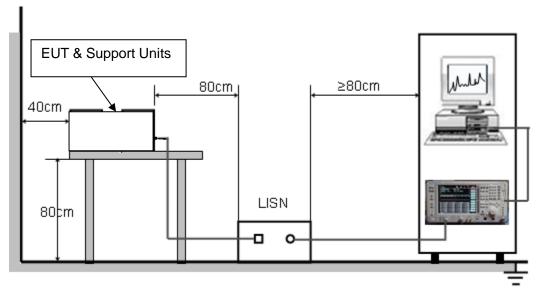
12.1. LIMITS OF LINE CONDUCTED EMISSION TEST

Francisco	Maximum RF Line Voltage			
Frequency	Q.P.(dBuV)	Average(dBuV)		
150kHz~500kHz	66-56	56-46		
500kHz~5MHz	56	46		
5MHz~30MHz	60	50		

Note:

- 1. The lower limit shall apply at the transition frequency.
- 2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

12.2. BLOCK DIAGRAM OF LINE CONDUCTED EMISSION TEST





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12.3. PRELIMINARY PROCEDURE OF LINE CONDUCTED EMISSION TEST

- 1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. When the EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10 (see Test Facility for the dimensions of the ground plane used). When the EUT is a floor-standing equipment, it is placed on the ground plane which has a 3-12 mm non-conductive covering to insulate the EUT from the ground plane.
- 2. Support equipment, if needed, was placed as per ANSI C63.10.
- 3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.
- 4. All support equipment received AC120V/60Hz power from a LISN, if any.
- 5. The EUT received AC 120V/60Hz power through a Line Impedance Stabilization Network (LISN).
- 6. The test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
- 7. Analyzer / Receiver scanned from 150 kHz to 30MHz for emissions in each of the test modes.
- 8. During the above scans, the emissions were maximized by cable manipulation.
- 9. The test mode(s) were scanned during the preliminary test.

Then, the EUT configuration and cable configuration of the above highest emission level were recorded for reference of final testing.

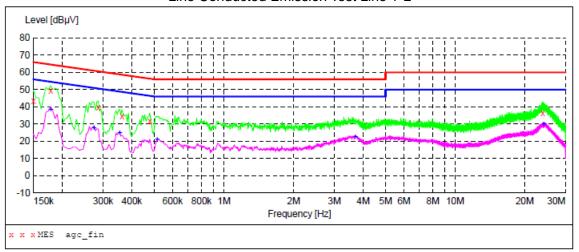
12.4. FINAL PROCEDURE OF LINE CONDUCTED EMISSION TEST

- 1. EUT and support equipment was set up on the test bench as per step 2 of the preliminary test.
- 2. A scan was taken on both power lines, Line 1 and Line 2, recording at least the six highest emissions. Emission frequency and amplitude were recorded into a computer in which correction factors were used to calculate the emission level and compare reading to the applicable limit. If EUT emission level was less 2dB to the A.V. limit in Peak mode, then the emission signal was re-checked using Q.P and Average detector.
- 3. The test data of the worst case condition(s) was reported on the Summary Data page.



12.5. TEST RESULT OF LINE CONDUCTED EMISSION TEST

Line Conducted Emission Test Line 1-L



MEASUREMENT RESULT: "agc fin"

2023/6/12 21:01

2020,	0,12 21.	0.1					
Fr	equency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line
0	.150000	43.20	4.5	66	22.8	QP	L1
0	.178000	49.20	4.5	65	15.4	QP	L1
0	.286000	39.70	4.5	61	20.9	QP	L1
0	.362000	34.40	4.5	59	24.3	QP	L1
0	.478000	31.80	4.5	56	24.6	QP	L1
23	.874000	36.30	6.6	60	23.7	QP	L1

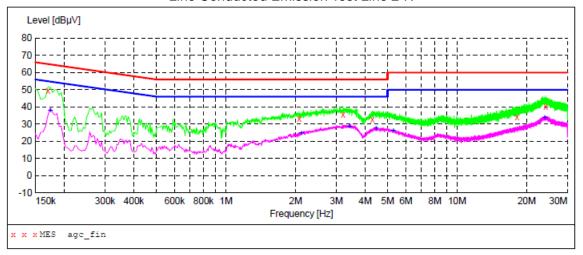
MEASUREMENT RESULT: "agc_fin2"

2023/6/12 21:01

202	3/0/12 21.	OI.					
	Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line
	0.178000	38.30	4.5	55	16.3	AV	L1
	0.274000	27.50	4.5	51	23.5	AV	L1
	0.354000	24.70	4.5	49	24.2	AV	L1
	0.514000	21.10	4.5	46	24.9	AV	L1
	3.698000	22.60	4.7	46	23.4	AV	L1
	24.162000	29.70	6.7	50	20.3	AV	L1



Line Conducted Emission Test Line 2-N



MEASUREMENT RESULT: "agc_fin"

2023/6/12 21 Frequency	Level			_	Detector	Line
MHz	dΒμV	dB	dΒμ∇	dB		
0.170000	49.60	4.5	65	15.4	QP	N
2.074000	33.40	4.6	56	22.6	QP	N
3.210000	35.40	4.7	56	20.6	QP	N
4.298000	32.50	4.7	56	23.5	QP	N
18.122000	34.30	5.5	60	25.7	QP	N
24.162000	40.20	6.7	60	19.8	QP	N

MEASUREMENT RESULT: "agc_fin2"

2023/6/12 21 Frequency MHz		Transd dB	Limit dBµV	Margin dB	Detector	Line
0.174000	37.70	4.5	55	17.1	AV	N
2.118000	24.60	4.6	46	21.4	AV	N
3.422000	28.50	4.7	46	17.5	AV	N
4.458000	27.40	4.7	46	18.6	AV	N
5.298000	26.20	4.7	50	23.8	AV	N
23.910000	33.50	6.7	50	16.5	AV	N

RESULT: PASS

Note: All the test modes had been tested, the BLE GFSK 2Mbps mode 4 was the worst case. Only the data of the worst case would be record in this test report.



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APPENDIX A: PHOTOGRAPHS OF TEST SETUP

Refer to the Report No.: AGC00174230501AP02

APPENDIX B: PHOTOGRAPHS OF EUT Refer to the Report No.: AGC00174230501AP03

----END OF REPORT----



Conditions of Issuance of Test Reports

- 1. All samples and goods are accepted by the Attestation of Global Compliance (Shenzhen) Co., Ltd (the "Company") solely for testing and reporting in accordance with the following terms and conditions. The company provides its services on the basis that such terms and conditions constitute express agreement between the company and any person, firm or company requesting its services (the "Clients").
- 2. Any report issued by Company as a result of this application for testing services (the "Report") shall be issued in confidence to the Clients and the Report will be strictly treated as such by the Company. It may not be reproduced either in its entirety or in part and it may not be used for advertising or other unauthorized purposes without the written consent of the Company. The Clients to whom the Report is issued may, however, show or send it, or a certified copy thereof prepared by the Company to its customer, supplier or other persons directly concerned. The Company will not, without the consent of the Clients, enter into any discussion or correspondence with any third party concerning the contents of the Report, unless required by the relevant governmental authorities, laws or court orders.
- 3. The Company shall not be called or be liable to be called to give evidence or testimony on the Report in a court of law without its prior written consent, unless required by the relevant governmental authorities, laws or court orders.
- 4. In the event of the improper use of the report as determined by the Company, the Company reserves the right to withdraw it, and to adopt any other additional remedies which may be appropriate.
- 5. Samples submitted for testing are accepted on the understanding that the Report issued cannot form the basis of, or be the instrument for, any legal action against the Company.
- 6. The Company will not be liable for or accept responsibility for any loss or damage however arising from the use of information contained in any of its Reports or in any communication whatsoever about its said tests or investigations.
- 7.Clients wishing to use the Report in court proceedings or arbitration shall inform the Company to that effect prior to submitting the sample for testing.
- 8. The Company is not responsible for recalling the electronic version of the original report when any revision is made to them. The Client assumes the responsibility to providing the revised version to any interested party who uses them.
- 9. Subject to the variable length of retention time for test data and report stored hereinto as otherwise specifically required by individual accreditation authorities, the Company will only keep the supporting test data and information of the test report for a period of six years. The data and information will be disposed of after the aforementioned retention period has elapsed. Under no circumstances shall we provide any data and information which has been disposed of after retention period. Under no circumstances shall we be liable for damage of any kind, including (but not limited to) compensatory damages, lost profits, lost data, or any form of special, incidental, indirect, consequential or punitive damages of any kind, whether based on breach of contract of warranty, tort (including negligence), product liability or otherwise, even if we are informed in advance of the possibility of such damages.