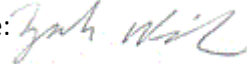


Test Report # 319416 A

Equipment Under Test:	LC840PA
Requirement(s):	FCC 15.247, RSS-247
Test Date(s):	April 21 st – May 4 th , 2021
Prepared for:	Johnathan Kaye Laird Connectivity 50 S. Main Street, #1100 Akron, OH 44308

Report Issued by: Zach Wilson, EMC Engineer

Signature: 

Date: 12/20/2021

Report Reviewed by: Adam Alger, Laboratory Manager

Signature: 

Date: 12/20/2021

Report Constructed by: Zach Wilson, EMC Engineer

Signature: 

Date: 5/10/2021

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CONTENTS

Contents	2
Laird Connectivity Test Services in Review	3
1 Test Report Summary	4
2 Client Information	5
2.1 Equipment Under Test (EUT) Information	5
2.2 Product Description	5
2.3 Modifications Incorporated for Compliance.....	5
2.4 Deviations and Exclusions from Test Specifications	5
2.5 Power Settings	5
2.6 Antenna Options	5
2.7 Channels Used.....	6
3 References	7
4 Uncertainty Summary	8
5 Test Data	9
5.1 Antenna Port Conducted Emissions.....	9
5.2 Radiated Emissions	35
6 Revision History	48

Laird Connectivity Test Services in Review

The Laird Connectivity, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:



A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025:2017 with Electrical (EMC) Scope

A2LA Certificate Number: 1255.01

Scope of accreditation includes all test methods listed herein unless otherwise noted



Federal Communications Commission (FCC) – USA

Accredited Test Firm Registration Number: 953492

Recognition of two 3 meter Semi-Anechoic Chambers



Innovation, Science and Economic Development Canada

Accredited U.S. Identification Number: US0218

Recognition of two 3 meter Semi-Anechoic Chambers

Company: Laird Connectivity	Page 3 of 48	Name: LC840PA
Report: TR319416 A		Model: LC840PA
Job: C-3420		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **April 21st – May 4th, 2021** the Equipment Under Test (EUT), **LC840PA**, as provided by **Laird Connectivity, Inc.** was tested to the following requirements of the **Federal Communications Commission** and **Innovation, Science and Economic Development Canada**:

FCC 15.247 / RSS-247 (DTS)

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2) IC: RSS-247 5.2 (1)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Pass
FCC: 2.1049 IC: RSS-GEN 6.6	Occupied Bandwidth	Reported	ANSI C63.10	Pass
FCC: 15.247 (b)(3) IC: RSS-247 5.4 (4)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (e) IC: RSS-247 5.2 (2)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Pass
FCC: 2.1055 (d) IC: RSS-GEN 6.11	Frequency Stability	Reported	ANSI C63.10	Pass

Notice:

The results relate only to the item tested as configured and described in this report. Any additional configurations, modes of operation, or modifications made to the equipment under test after the specified test date(s) are at the decision of the client and may not apply to the data seen in this test report.

The decision rule for Pass / Fail assessment to the specification or standard listed in this test report has been agreed upon by the client and laboratory to be as follows:

Measurement Type	Rule
Emissions – Amplitude	1 dB below specified limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

2 CLIENT INFORMATION

Company Name	Laird Connectivity
Contact Person	Johnathan Kaye
Address	50 S. Main Street, #1100 Akron, OH 44308

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	LC840PA
Model Number	LC840PA
Serial Number	Engineering Sample
FCC ID	SQG-LC840PA
IC ID	3147A-LC840PA

2.2 Product Description

Module based off the Laird BL654 PA Bluetooth v5 Power Amplified Module with an added 802.15.4 protocol. Only 802.15.4 radio is enabled in the firmware. The highest gain antenna used is 2 dBi.

2.3 Modifications Incorporated for Compliance

Duty cycle limited to 58.3% via firmware. The client understands the modifications.

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Power Settings

Tested at maximum and minimum power settings. Maximum power setting of “neg4dBm” and minimum power setting of “neg40dBm”.

2.6 Antenna Options

There are two versions of the module. One version has an ipex-mh4 connection for multiple antenna options. During radiated testing, this version had the antenna port terminated.

Company: Laird Connectivity	Page 5 of 48	Name: LC840PA
Report: TR319416 A		Model: LC840PA
Job: C-3420		Serial: Engineering Sample

The second version of the module has an integrated trace antenna.

Ant. No.	Manufacturer	Model	Laird Part Number	Type	Connector	Gain (dBi)	Remarks
1	Laird	NanoBlue	EBL2400A1-10MH4L	PCB Dipole	IPEX MHF4	2	Connector Type Antenna
2	Laird	FlexPIFA	001-0022	PIFA	IPEX MHF4	2	Connector Type Antenna
3	Laird	2.4GHz Dipole Antenna	001-0001	Dipole	RP-SMA Male	2	Connector Type Antenna
4	Mag.Layers	EDA-8709-2 G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2	Connector Type Antenna
5	Laird	mFlexPIFA	EFA2400A3S-10MH4L	PIFA	IPEX MHF4	2	Connector Type Antenna
6	Laird	Laird NFC	0600-00061	NFC	N/A	---	Printed PCB Antenna & Connector Type Antenna
7	Laird	BL654 PCB printed antenna	NA	Printed PCB	N/A	0	Printed PCB Antenna

2.7 Channels Used

Low Channel (11): 2405 MHz

Mid Channel (19): 2445 MHz

High Channel (25): 2475 MHz

3 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2
FCC eCFR	-	2021	-	-
RSS-247	2	2017	-	-
RSS-GEN	5	2018	2019	2021
ANSI C63.10	-	2013	-	-
KDB 558074 D01	v05r02	2019	-	-

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of $k = 2$.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty $\pm$
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

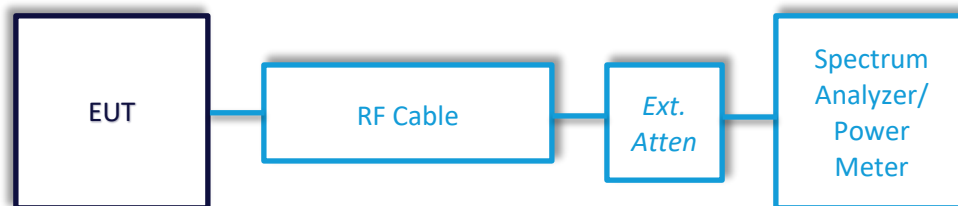
Parameter	ETSI U.C. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

Block Diagram



5.1.1 DTS Bandwidth (6dB)

Operator	Jon Dilley	QA	Adam Alger
Temperature	22.0°C, 22.1°C	R.H. %	48.4%, 44.4%
Test Date	5/3/2021, 5/4/2021	Location	Conducted Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §11.8.2

Limits: Bandwidth greater than 500 kHz

Test Parameters

Frequency	2405, 2445, 2475 MHz	Setup	Conducted
RBW	100 kHz	VBW	300 kHz
Detector(s)	Max hold with peak detector	Sweep Time	Auto

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	2/3/2021	2/3/2022	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

EUT Parameters

Input Power	3 AAA Batteries/4.5 VDC	Mode	802.15.4 Transmit
Channel	11, 19, 25		

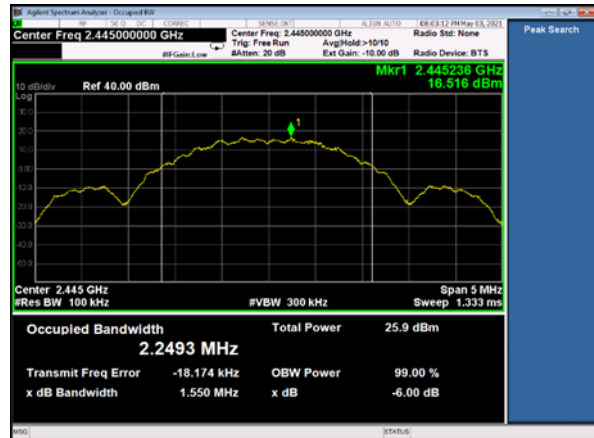
Data Table

Channel	Power Setting	6 dB BW (kHz)	Limit (kHz)	Margin (kHz)
11	neg4dBm	1502.0	≥ 500.0	1002.0
19	neg4dBm	1550.0	≥ 500.0	1050.0
25	neg4dBm	1546.0	≥ 500.0	1046.0
11	neg40dBm	1502.0	≥ 500.0	1002.0
19	neg40dBm	1473.0	≥ 500.0	973.0
25	neg40dBm	1506.0	≥ 500.0	1006.0

Plots



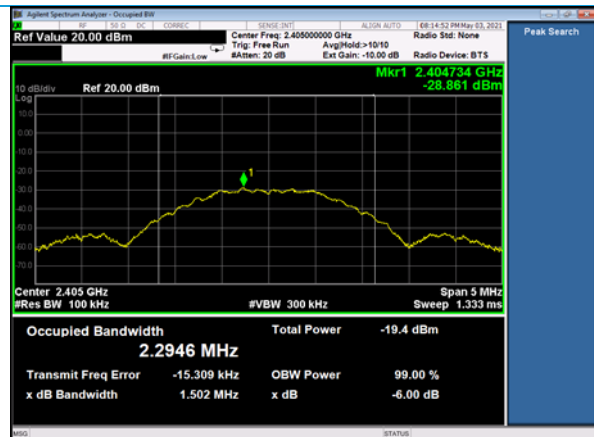
DTS BW, Channel 11, neg4dBm



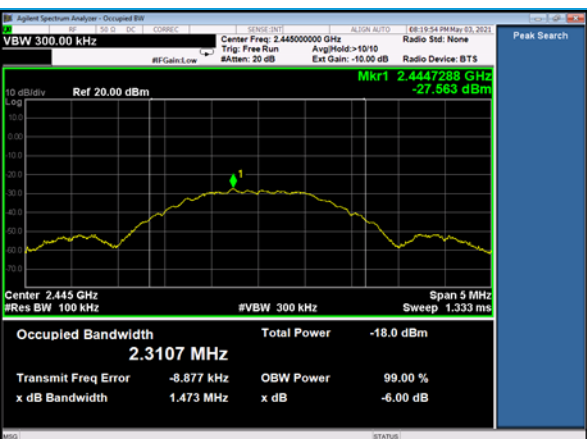
DTS BW, Channel 19, neg4dBm



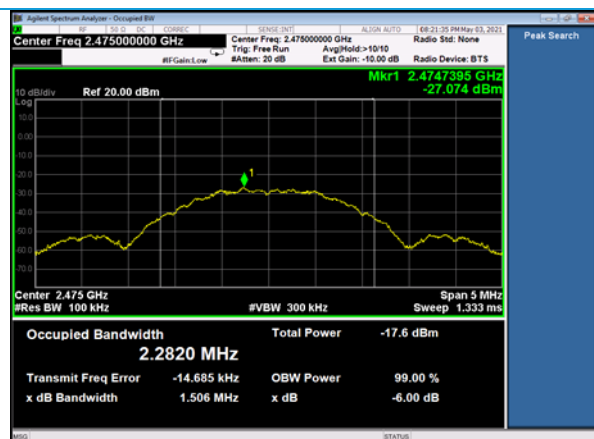
DTS BW, Channel 25, neg4dBm



DTS BW, Channel 11, neg40dBm



DTS BW, Channel 19, neg40dBm



DTS BW, Channel 25, neg40dBm

5.1.2 99% Bandwidth

Operator	Jon Dilley	QA	Adam Alger
Temperature	22.0°C, 22.1°C	R.H. %	48.4%, 44.4%
Test Date	5/3/2021, 5/4/2021	Location	Conducted Bench
Requirement	15.1049, RSS-GEN	Method	ANSI C63.10 §6.9.3

Limits: Reported

Test Parameters

Frequency	2405, 2445, 2475 MHz	Setup	Conducted
RBW	30 kHz	VBW	91 kHz
Detector(s)	Max hold with peak detector	Sweep Time	Auto

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	2/3/2021	2/3/2022	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

EUT Parameters

Input Power	3 AAA Batteries/4.5 VDC	Mode	802.15.4 Transmit
Channel	11, 19, 25		

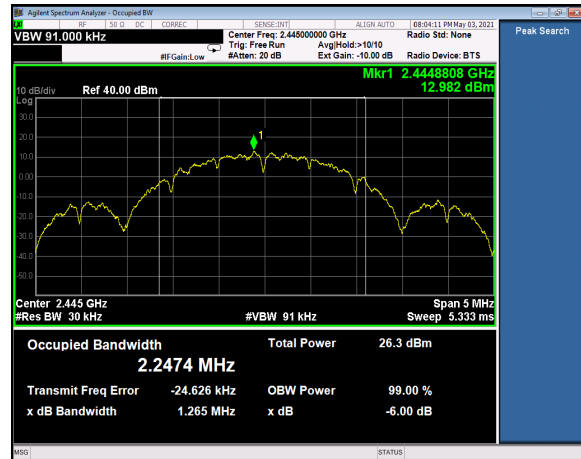
Data Table

Channel	Power Setting	99% BW (kHz)
11	neg4dBm	2236.0
19	neg4dBm	2247.4
25	neg4dBm	2244.0
11	neg40dBm	2279.2
19	neg40dBm	2281.4
25	neg40dBm	2280.8

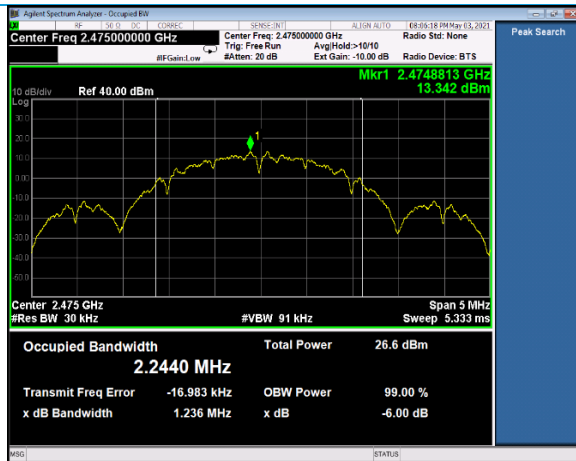
Plots



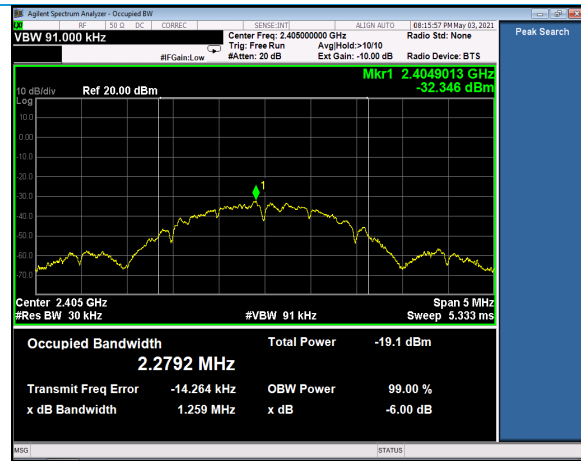
99% BW, Channel 11, neg4dBm



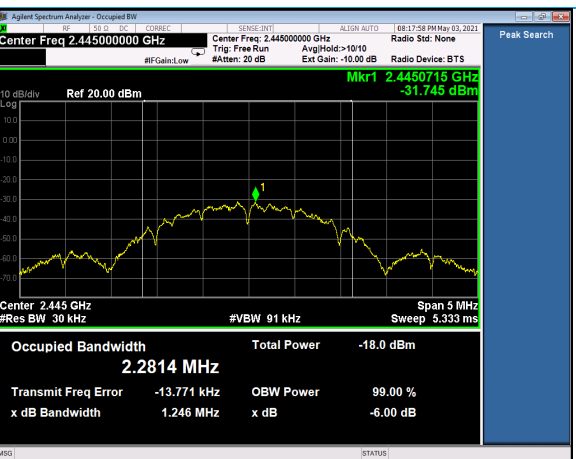
99% BW, Channel 19, neg4dBm



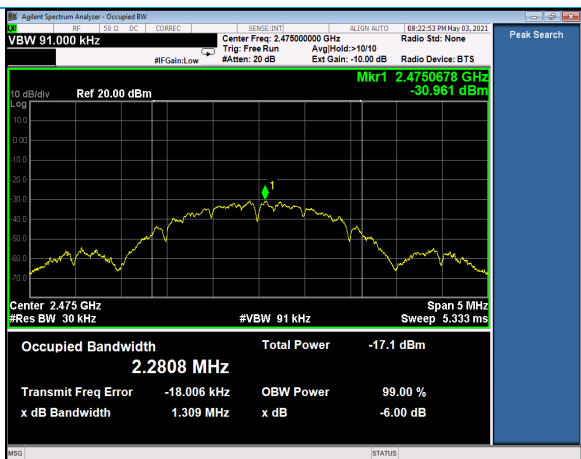
99% BW Channel 25, neg4dBm



99% BW, Channel 11, neg40dBm



99% BW, Channel 19, neg40dBm



99% BW, Channel 25, neg40dBm

5.1.3 Fundamental Emission Output Power

Operator	Jon Dille	QA	Adam Alger
Temperature	22.0°C, 22.1°C	R.H. %	48.4%, 44.4%
Test Date	5/3/2021, 5/4/2021	Location	Conducted Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §11.9.1.1

Limits: 30dBm/1W

Test Parameters

Frequency	2405, 2445, 2475 MHz	Setup	Conducted
RBW	3 MHz	VBW	50 MHz
Detector(s)	Max hold with peak detector	Sweep Time	Auto

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	2/3/2021	2/3/2022	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

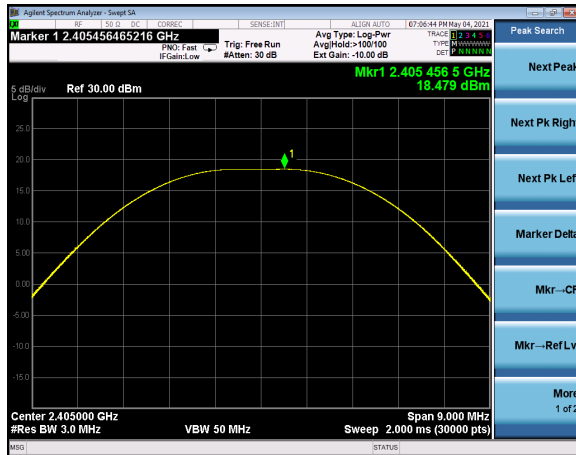
EUT Parameters

Input Power	3 AAA Batteries/4.5 VDC	Mode	802.15.4 Transmit
Channel	11, 19, 25		

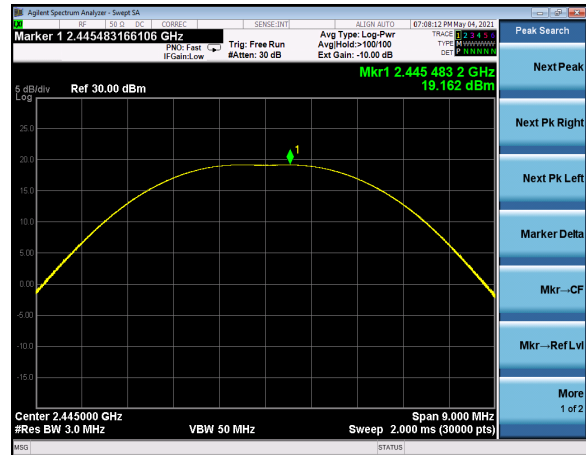
Data Table

Channel	Power Setting	Conducted Output Power (dBm)	Output Power Limit (dBm)	Margin (dB)
11	neg4dBm	18.5	30.0	11.5
19	neg4dBm	19.2	30.0	10.8
25	neg4dBm	19.3	30.0	10.7
11	neg40dBm	-26.4	30.0	56.4
19	neg40dBm	-25.1	30.0	55.1
25	neg40dBm	-24.3	30.0	54.3

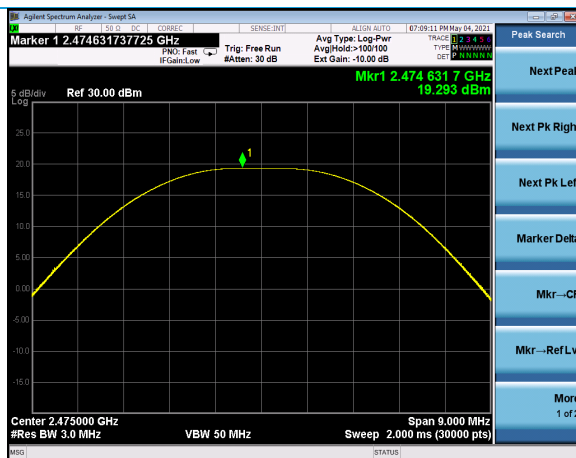
Plots



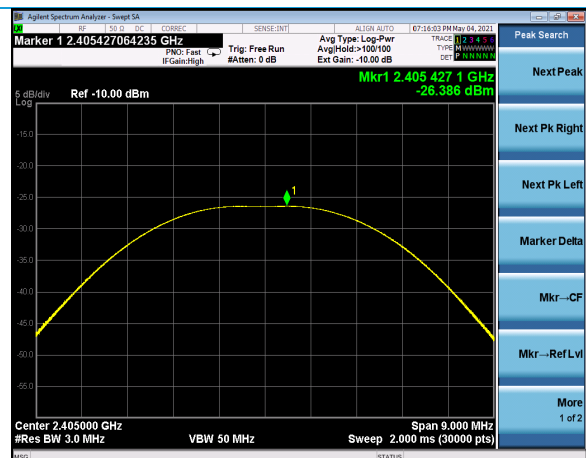
Output Power, Channel 11, neg4dBm



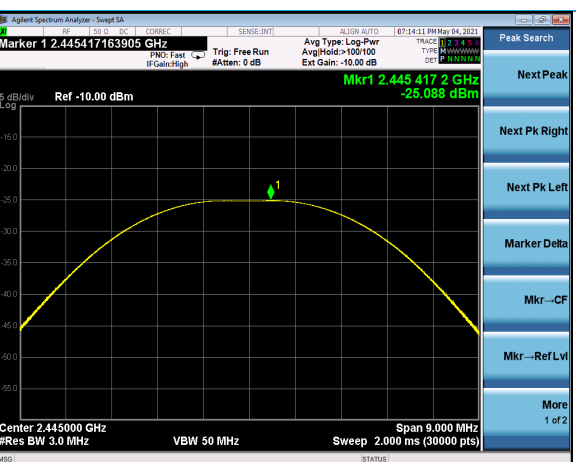
Output Power, Channel 19, neg4dBm



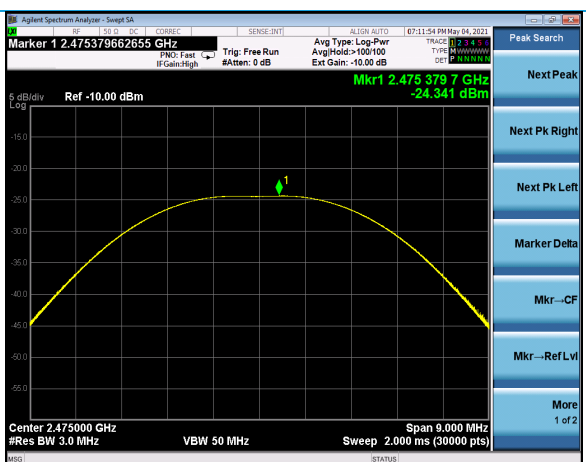
Output Power, Channel 25, neg4dBm



Output Power, Channel 11, neg40dBm



Output Power, Channel 19, neg40dBm



Output Power, Channel 25, neg40dBm

5.1.4 Maximum Power Spectral Density

Operator	Jon Dille	QA	Adam Alger
Temperature	22.0°C, 22.1°C	R.H. %	48.4%, 44.4%
Test Date	5/3/2021, 5/4/2021	Location	Conducted Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §11.10.2

Limits: 8dBm/3kHz

Test Parameters

Frequency	2405, 2445, 2475 MHz	Setup	Conducted
RBW	3 kHz, 51 kHz	VBW	9.1 kHz, 160 kHz
Detector(s)	Max hold with peak detector	Sweep Time	Auto

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	2/3/2021	2/3/2022	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

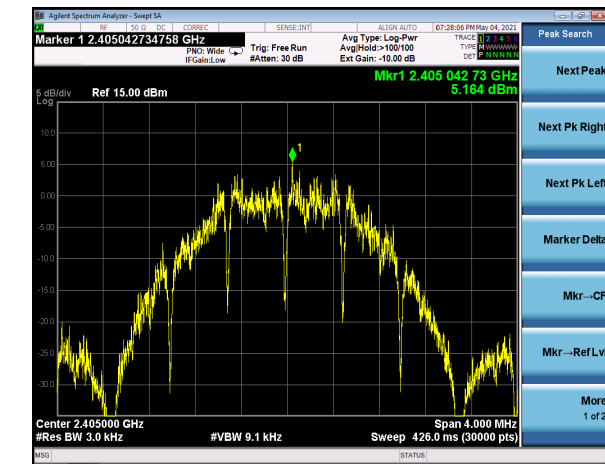
EUT Parameters

Input Power	3 AAA Batteries/4.5 VDC	Mode	802.15.4 Transmit
Channel	11, 19, 25		

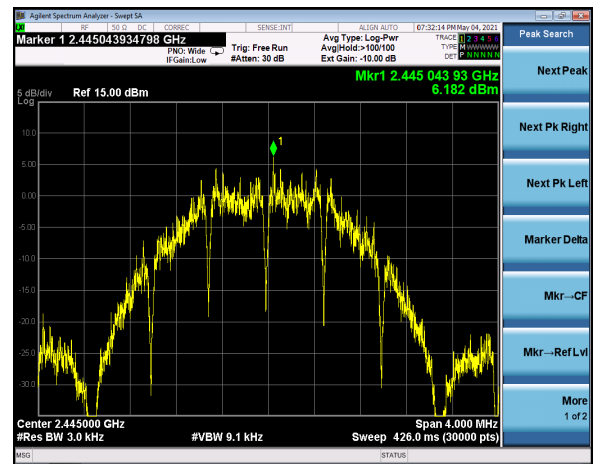
Data Table

Channel	Power Setting	Peak PSD Reading (dBm)	PSD Limit (dBm)	Margin (dB)
11	neg4dBm	5.2	8.0	2.8
19	neg4dBm	6.2	8.0	1.8
25	neg4dBm	5.3	8.0	2.7
11	neg40dBm	-30.2	8.0	38.2
19	neg40dBm	-29.8	8.0	37.8
25	neg40dBm	-28.5	8.0	36.5

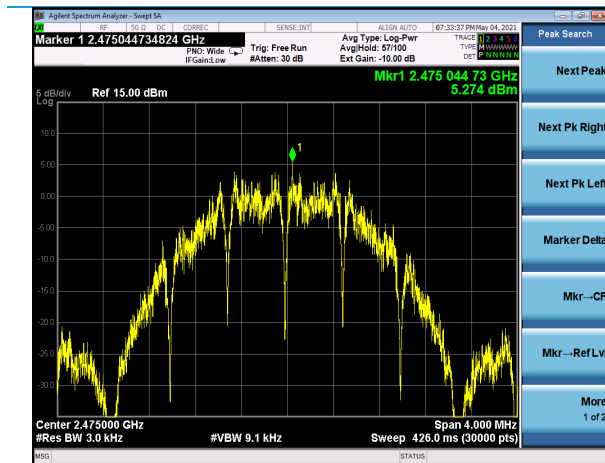
Plots



PSD, Channel 11, neg4dBm



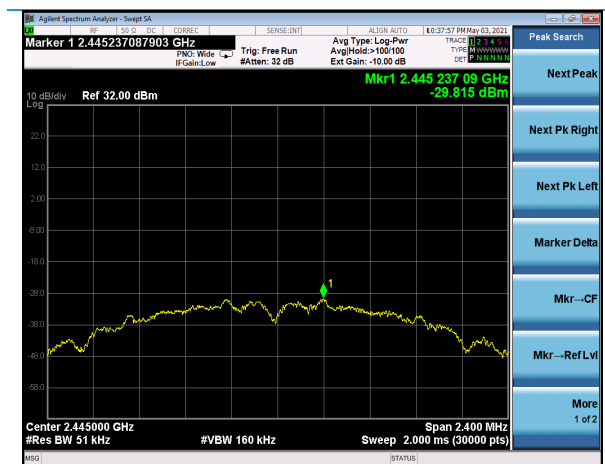
PSD, Channel 19, neg4dBm



PSD, Channel 25, neg4dBm



PSD, Channel 11, neg40dBm



PSD, Channel 19, neg40dBm



PSD, Channel 25, neg40dBm

5.1.5 Conducted Transmitter Emissions

Operator	Jon Dilley	QA	Adam Alger
Temperature	22.0°C, 22.1°C	R.H. %	48.4%, 44.4%
Test Date	5/3/2021, 5/4/2021	Location	Conducted Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §11.10.2

Limits:

100/300 kHz BW = -30dBc

Test Parameters

Frequency	30 MHz – 25 GHz	Setup	Conducted
RBW	100 kHz, 1 MHz	VBW	300 kHz
Detector(s)	Max hold with peak detector for plots. Reduced VBW of 10Hz for average measurements.	Sweep Time	Auto

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	2/3/2021	2/3/2022	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

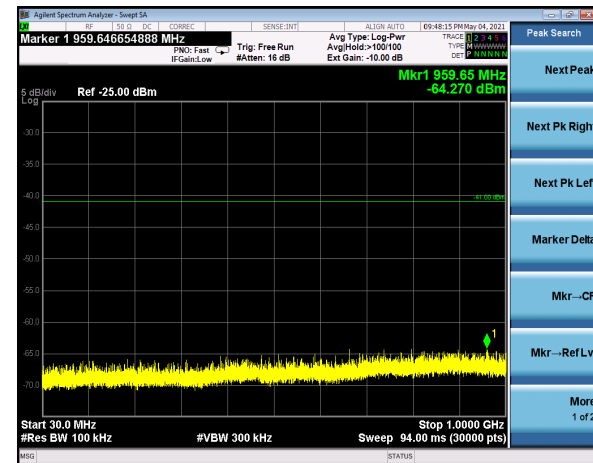
EUT Parameters

Input Power	3 AAA Batteries/4.5 VDC	Mode	802.15.4 Transmit
Channel	11, 19, 25		

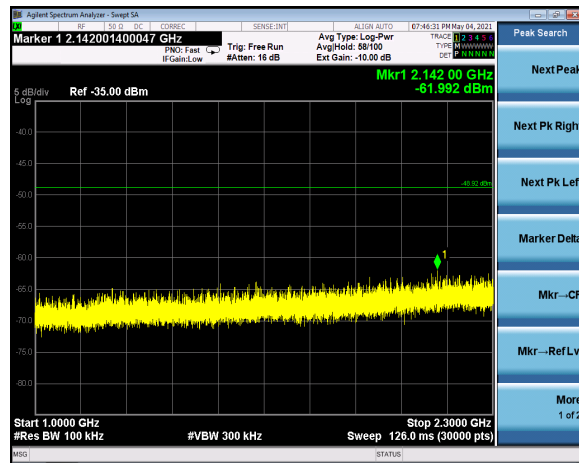
Data Table

Channel	Power Setting	Emission Frequency (MHz)	Peak Reading (dBm)	Peak Limit (dBm)	Peak Margin (dB)
11	neg4dBm	2400.0	-32.8	-4.0	28.8
19	neg4dBm	2400.0	-39.9	-3.6	36.3
25	neg4dBm	2400.0	-39.9	-3.5	36.4
11	neg40dBm	2400.0	-65.3	-48.9	16.4
19	neg40dBm	2400.0	-65.2	-47.6	17.6
25	neg40dBm	2483.5	-66.5	-47.0	19.5

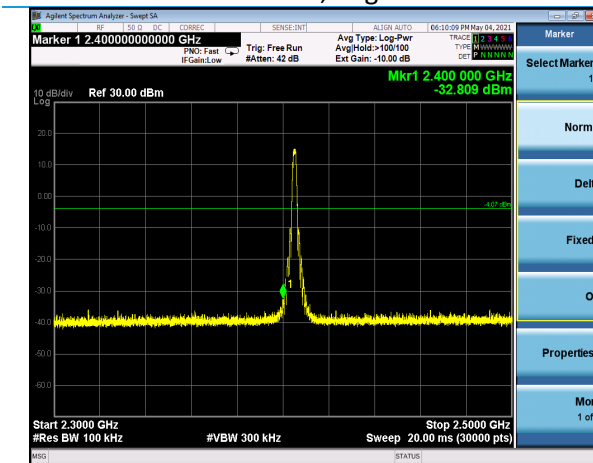
Plots



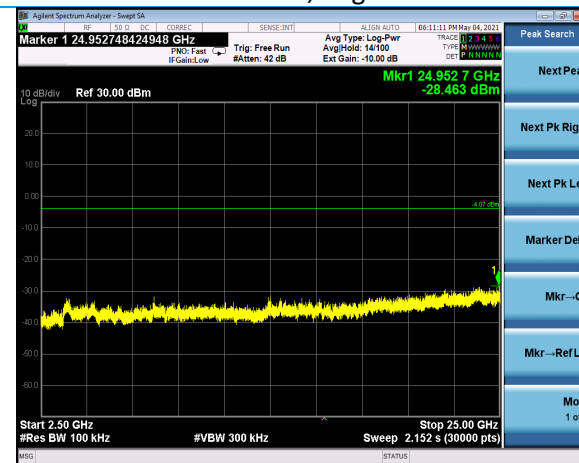
Conducted TX Spurious 30-1000 MHz
Channel 11, neg4dBm



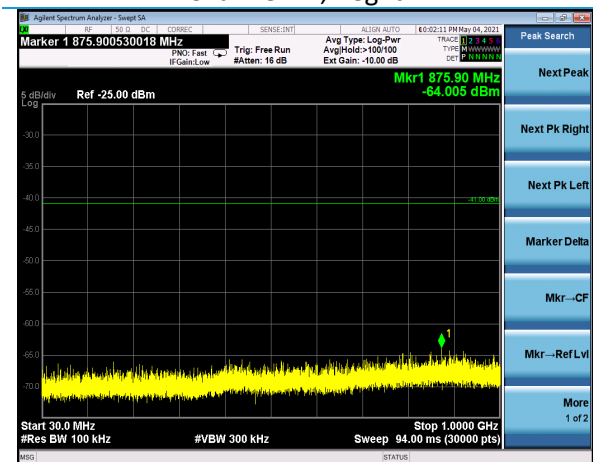
Conducted TX Spurious 1-2.3 GHz
Channel 11, neg4dBm



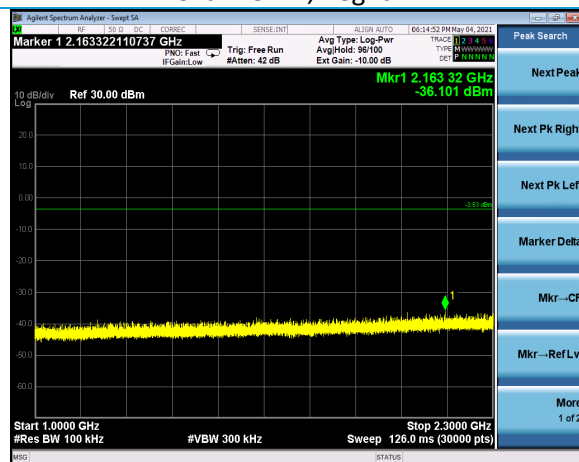
Conducted TX Spurious 2.3-2.5 GHz
Channel 11, neg4dBm



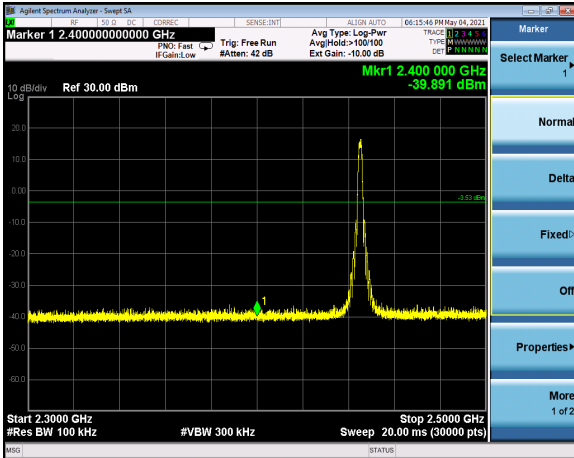
Conducted TX Spurious 2.5-25 GHz
Channel 11, neg4dBm



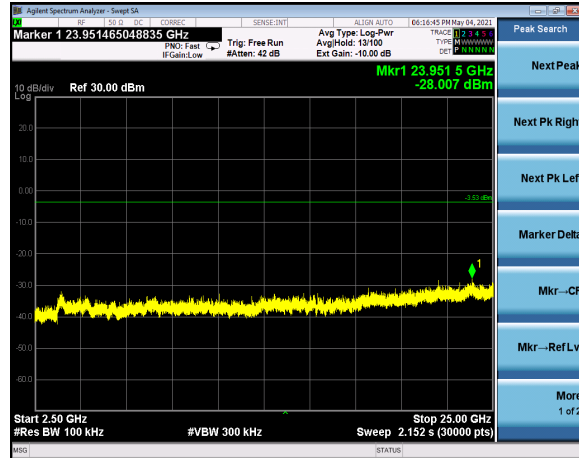
Conducted TX Spurious 30-1000 MHz
Channel 19, neg4dBm



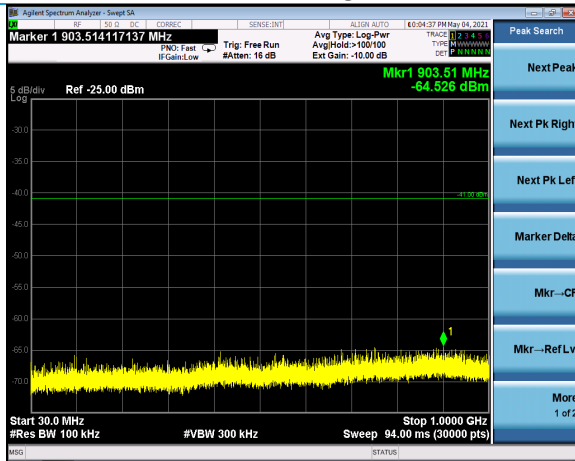
Conducted TX Spurious 1-2.3 GHz
Channel 19, neg4dBm



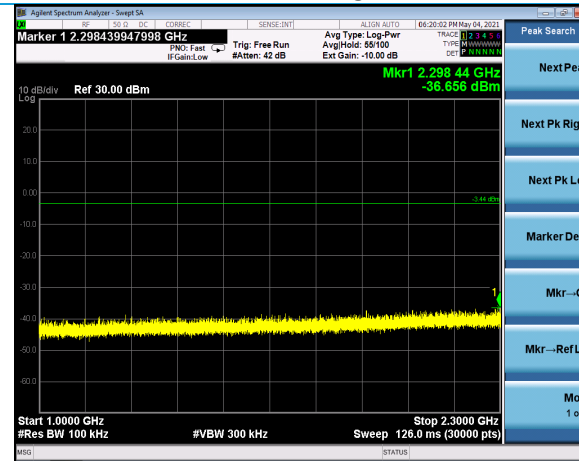
Conducted TX Spurious 2.3-2.5 GHz
Channel 19, neg4dBm



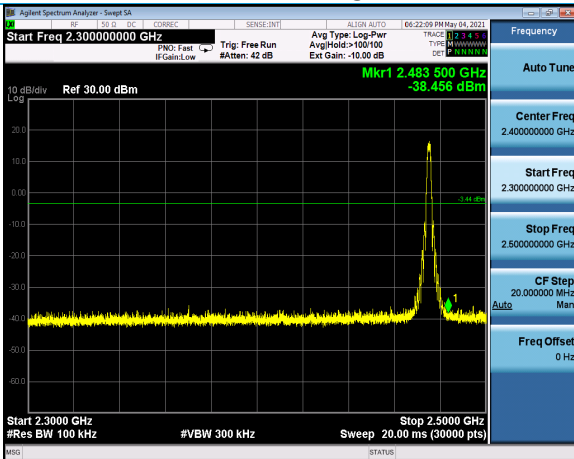
Conducted TX Spurious 2.5-25 GHz
Channel 19, neg4dBm



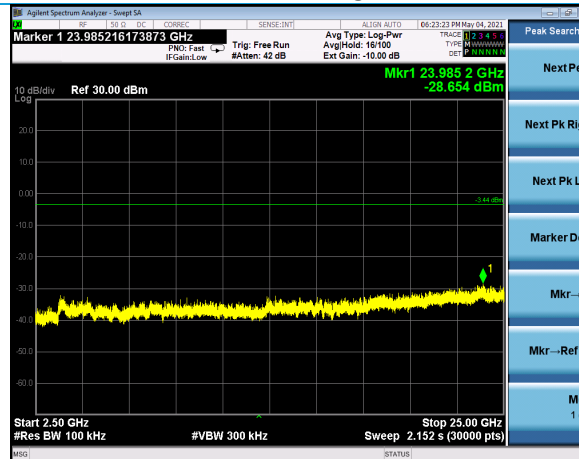
Conducted TX Spurious 30-1000 MHz
Channel 25, neg4dBm



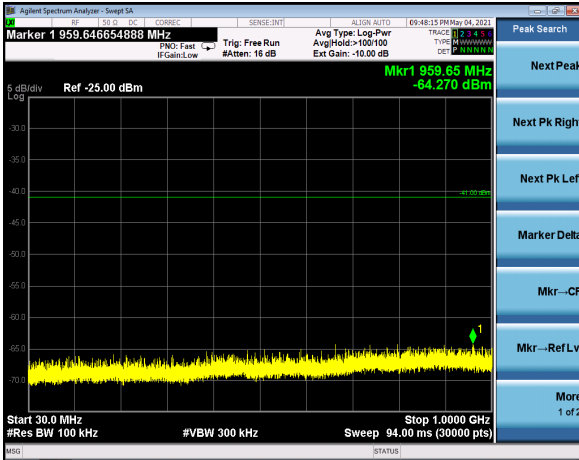
Conducted TX Spurious 1-2.3 GHz
Channel 25, neg4dBm



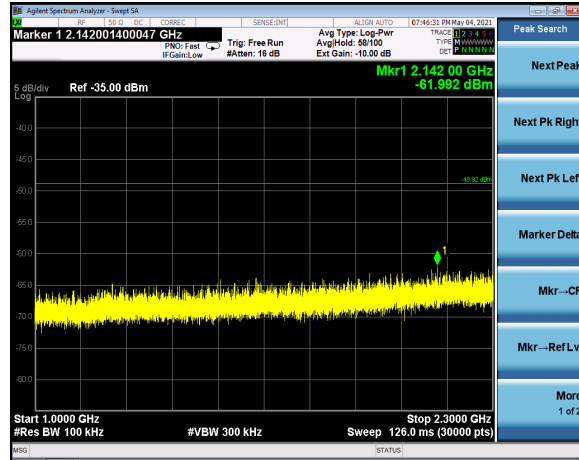
Conducted TX Spurious 2.3-2.5 GHz
Channel 25, neg4dBm



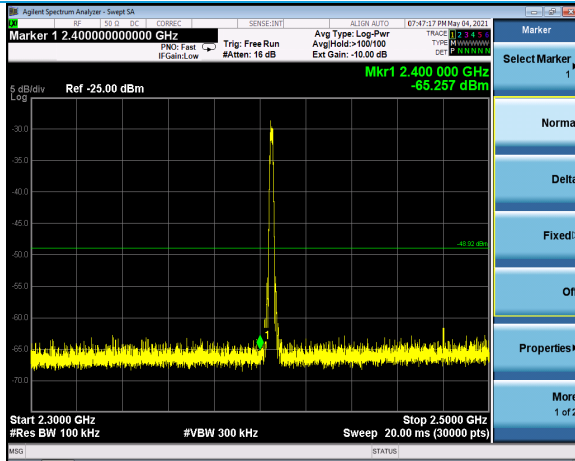
Conducted TX Spurious 2.5-25 GHz
Channel 25, neg4dBm



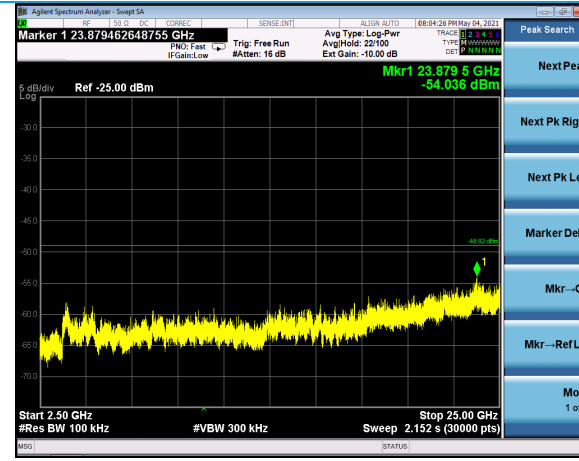
Conducted TX Spurious 30-1000 MHz
Channel 11, neg40dBm



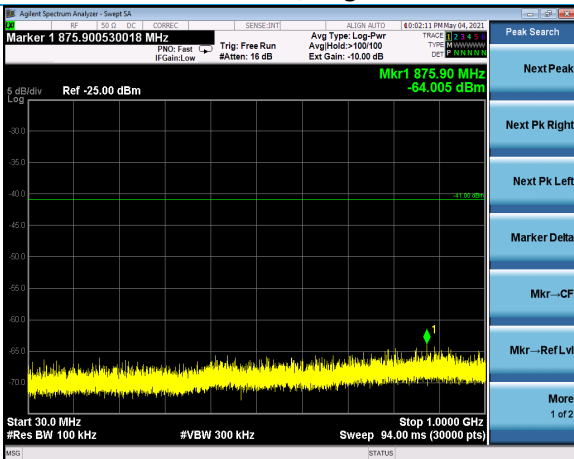
Conducted TX Spurious 1-2.3 GHz
Channel 11, neg40dBm



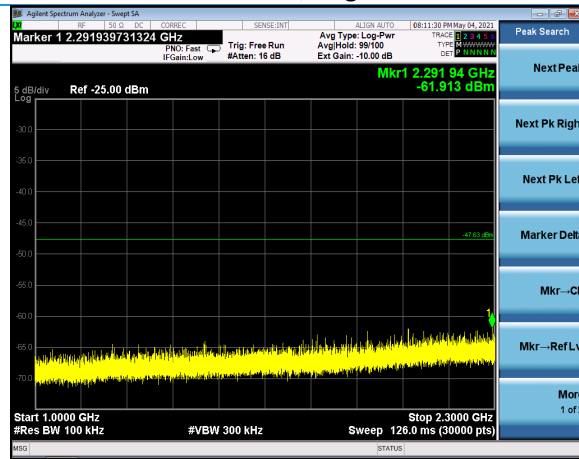
Conducted TX Spurious 2.3-2.5 GHz
Channel 11, neg40dBm



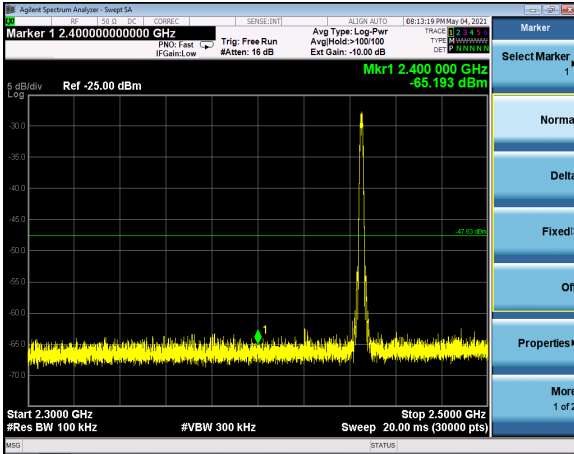
Conducted TX Spurious 2.5-25 GHz
Channel 11, neg40dBm



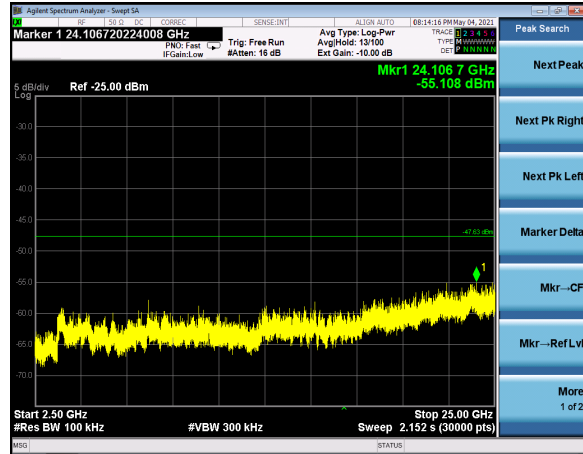
Conducted TX Spurious 30-1000 MHz
Channel 19, neg40dBm



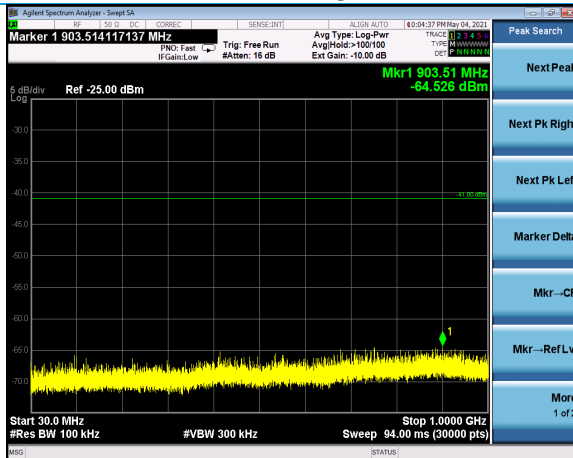
Conducted TX Spurious 1-2.3 GHz
Channel 19, neg40dBm



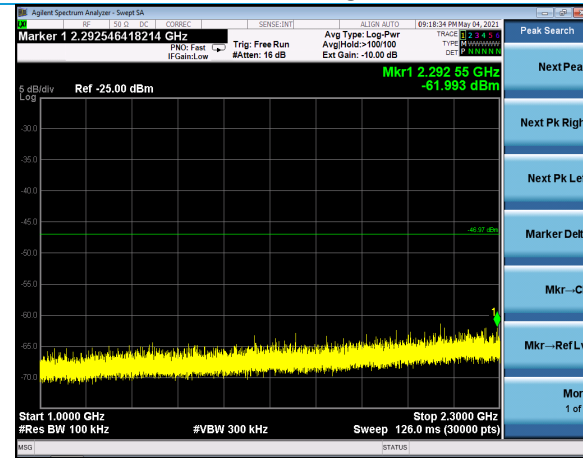
Conducted TX Spurious 2.3-2.5 GHz
Channel 19, neg40dBm



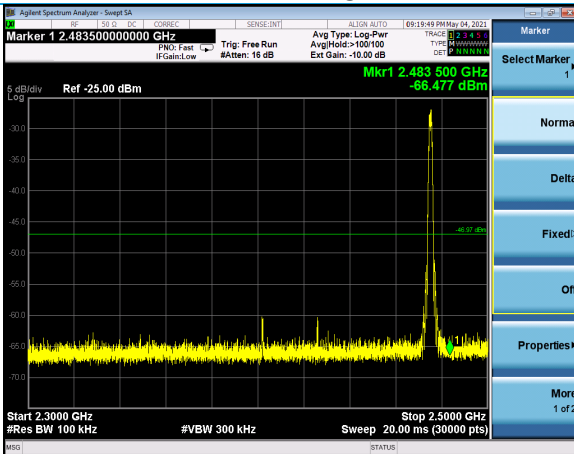
Conducted TX Spurious 2.5-25 GHz
Channel 19, neg40dBm



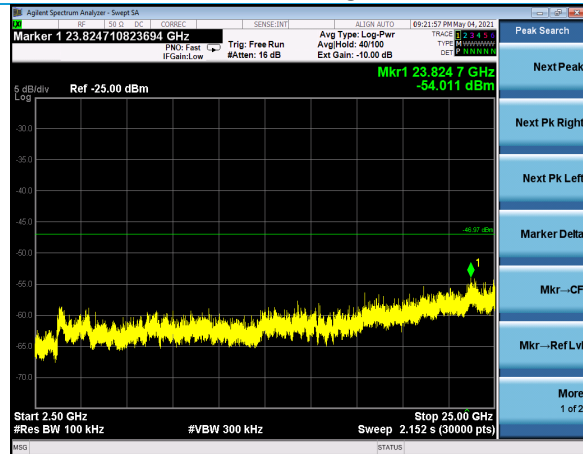
Conducted TX Spurious 30-1000 MHz
Channel 25, neg40dBm



Conducted TX Spurious 1-2.3 GHz
Channel 25, neg40dBm

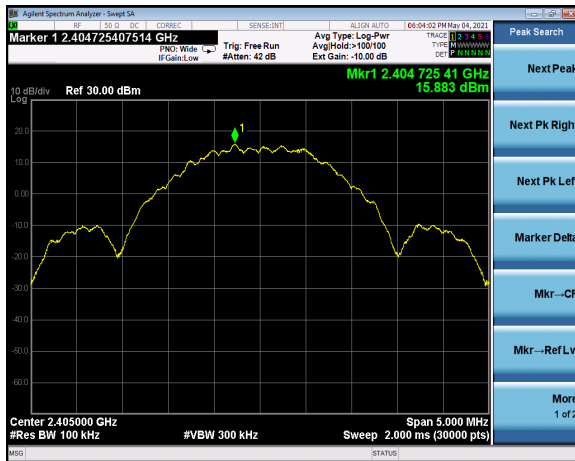


Conducted TX Spurious 2.3-2.5 GHz
Channel 25, neg40dBm

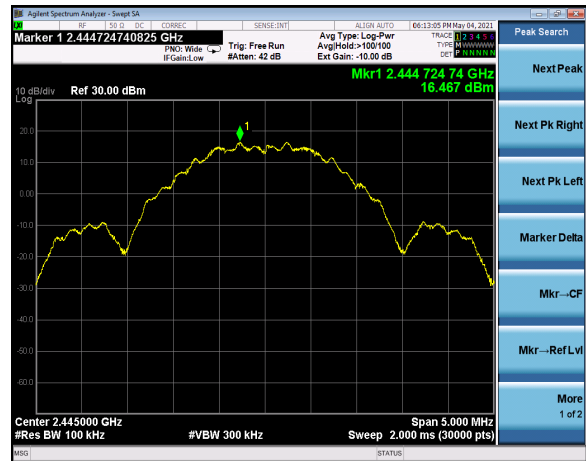


Conducted TX Spurious 2.5-25 GHz
Channel 25, neg40dBm

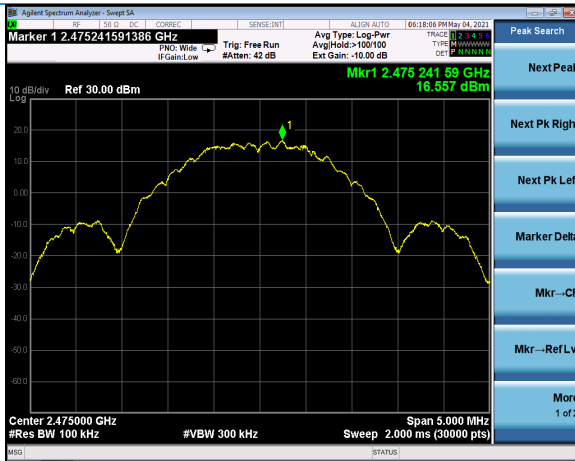
Company: Laird Connectivity		Name: LC840PA
Report: TR319416 A	Page 27 of 48	Model: LC840PA
Job: C-3420		Serial: Engineering Sample



Neg4dBm, channel 11, reference plot
15.9 dBm



Neg4dBm, channel 19, reference plot
16.5 dBm



Neg4dBm, channel 25, reference plot
16.6 dBm



Neg40dBm, channel 11, reference plot
-28.9 dBm



Neg40dBm, channel 19, reference plot
-27.6 dBm



Neg40dBm, channel 25, reference plot
-27.0 dBm

5.1.6 Conducted Transmitter Emissions – Terminated Method

Operator	Jon Dille	QA	Adam Alger
Temperature	22.0°C, 22.1°C	R.H. %	48.4%, 44.4%
Test Date	5/3/2021, 5/4/2021	Location	Conducted Bench
Requirement	FCC 15.209	Method	ANSI C63.10 §11.12.2

Limits:

Frequency (MHz)	Quasi Peak Limit (dBμV/m)	Average Limit (dBm)	Peak Limit (dBm)
30-88	40.0	-	-
88-216	43.5	-	-
216-960	46.0	-	-
960-1000	54.0	-	-
1000-25000	-	54.0	74.0

Test Parameters

Frequency	30 MHz – 25 GHz	Setup	Conducted
RBW	100 kHz, 1 MHz	VBW	300 kHz, 3 MHz, 10 Hz
Detector(s)	Max hold with peak detector for plots. Reduced VBW of 10Hz for average measurements.	Sweep Time	Auto
Convert Conducted EIRP to Field Strength	E Field Strength (dBμV/m) = EIRP – 20log(d) + 104.8		

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	2/3/2021	2/3/2022	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

EUT Parameters

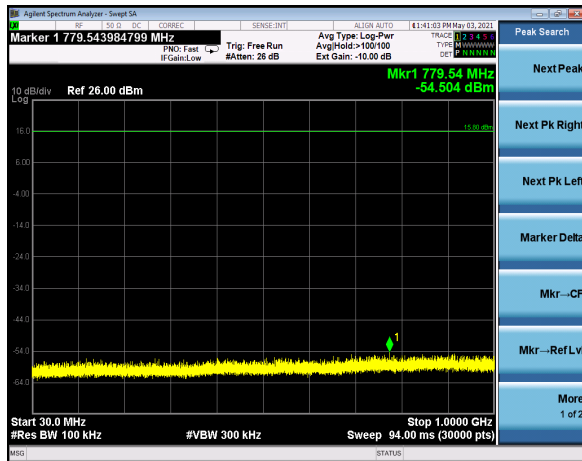
Input Power	3 AAA Batteries/4.5 VDC	Mode	802.15.4 Transmit
Channel	11, 19, 25		

Terminated Antenna Port Method, neg4dBm Power Setting

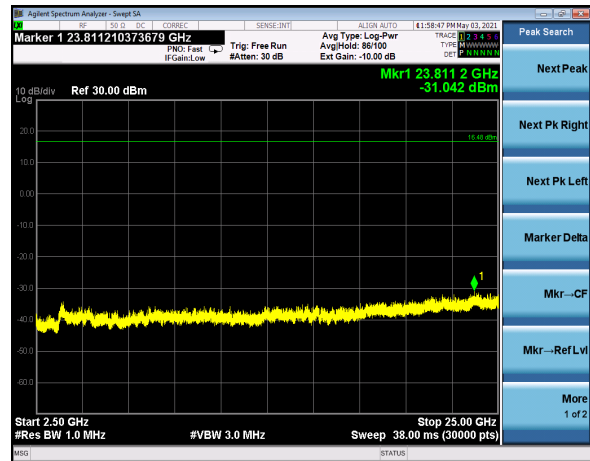
Channel	Power Setting	Frequency (MHz)	Quasi-peak Reading (dBm)	Antenna Gain (dBi)	Ground Plane Reflection Factor (dB)	Corrected and Converted Quasi-peak Reading (dBμV/m)	Quasi-peak Limit (dBμV/m)	Margin (dB)
11	neg4dBm	779.5	-59.0	2.0	4.7	43.0	46.0	3.0

Channel	Power Setting	Frequency (MHz)	Peak Reading (dBm)	EIRP (dBm)	Corrected and Converted Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)
11	neg4dBm	2390.0	-40.4	-38.4	56.9	74.0	17.1
25	neg4dBm	2483.6	-33.0	-31.0	64.3	74.0	9.7
25	neg4dBm	23811.2	-31.0	-29.0	66.3	74.0	7.7

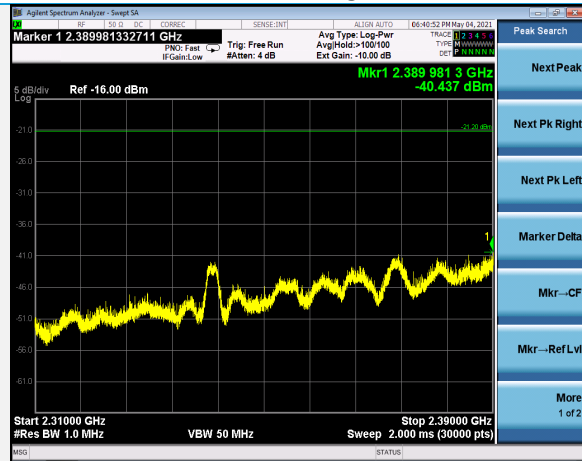
Channel	Power Setting	Frequency (MHz)	Average Reading (dBm)	EIRP (dBm)	Corrected and Converted Average Reading (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)
11	neg4dBm	2373.1	-48.6	-46.6	48.7	54.0	5.4
25	neg4dBm	2483.5	-45.3	-43.3	52.0	54.0	2.0
25	neg4dBm	23811.2	-51.0	-49.0	46.3	54.0	7.7



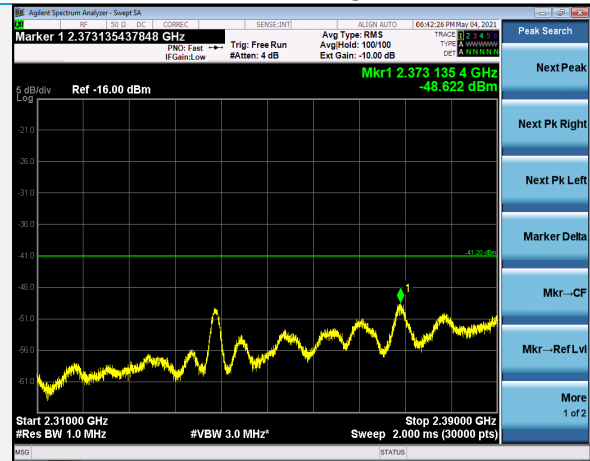
30-1000 MHz, Terminated Method
Channel 11, neg4dBm



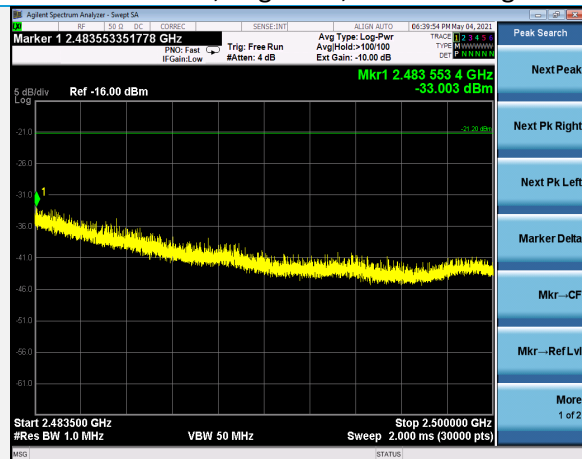
2.5-25 GHz, Terminated Method
Channel 25, neg4dBm



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 11, neg4dBm, Peak Reading



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 11, neg4dBm, Average Reading



2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 25, neg4dBm, Peak Reading



2.4835-2.5 GHz, Terminated Method, 10 Hz RBW
Channel 25, neg4dBm, Average Reading

Terminated Antenna Port Method, neg40dBm Power Setting

Channel	Power Setting	Frequency (MHz)	Quasi-peak Reading (dBm)	Antenna Gain (dBi)	Ground Plane Reflection Factor (dB)	Corrected and Converted Quasi-peak Reading (dBμV/m)	Quasi-peak Limit (dBμV/m)	Margin (dB)
11	neg40dBm	959.7	-64.3	2.0	4.7	37.7	46.0	8.3

Channel	Power Setting	Frequency (MHz)	Peak Reading (dBm)	EIRP (dBm)	Corrected and Converted Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)
11	neg40dBm	2315.5	-52.9	-50.9	44.4	74.0	29.6
25	neg40dBm	2494.1	-51.3	-49.3	46.0	74.0	28.0
25	neg40dBm	23752.5	-45.2	-43.2	54.1	74.0	19.9

Channel	Power Setting	Frequency (MHz)	Average Reading (dBm)	EIRP (dBm)	Corrected and Converted Average Reading (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)
11	neg40dBm	2318.9	-63.6	-61.6	33.7	54.0	20.3
25	neg40dBm	2495.0	-63.0	-61.0	34.3	54.0	19.7
25	neg40dBm	24023.5	-53.2	-51.2	44.1	54.0	9.9

5.1.7 Frequency Stability

Operator	Jon Dille	QA	Adam Alger
Temperature	22.1°C	R.H. %	44.4%
Test Date	5/4/2021	Location	Conducted Bench
Requirement	FCC 15.1055 (d) (1)	Method	ANSI C63.10 §6.8.2

Limits: Reported

Test Parameters

Frequency	2405, 2445, 2475 MHz	Setup	Conducted
RBW	3 MHz	VBW	50 MHz
Detector(s)	Peak detector with clear write	Sweep Time	Auto

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	2/3/2021	2/3/2022	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

EUT Parameters

Input Power	3.8 VDC, 4.5 VDC (battery powered only)	Mode	802.15.4 Transmit
Channel	11, 19, 25		

Data Table

Channel	DC Voltage (VDC)	Center Frequency (Hz)
11	4.5	2404980766.3
11	3.8	2404980726.7
19	4.5	2444980355.2
19	3.8	2444980343.8
25	4.5	2474980025.5
25	3.8	2474980034.2

5.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m) Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m) Example at 4000 MHz: Reading = 40 dBμV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBμV/m Average Limit = 20 log (500) = 54 dBμV/m Margin = 54 dBμV/m - 50.8 dBμV/m = 3.2 dB

Block Diagram



5.2.1 Radiated Emissions – Trace Antenna

Operator	Anthony Smith, Braden Smith	QA	Jon Dilley, Anthony Smith
Temperature	22.2°C	R.H. %	26%
Test Date	4/21/2021-5/1/2021	Location	Chamber 3/Chamber 5
Requirement	FCC 15.209, FCC 15.247	Method	ANSI C63.10

Limits:

Frequency (MHz)	Quasi Peak Limit (dBμV/m)	Average Limit (dBμV/m)	Peak Limit (dBμV/m)
30-88	40.0	-	-
88-216	43.5	-	-
216-960	46.0	-	-
960-1000	54.0	-	-
1000-25000	-	54.0	74.0

Test Parameters

Frequency	30-25000 MHz	Distance	3m
Detector(s)	Quasi peak detector for measurements under 1 GHz. Peak detector for final measurement above 1 GHz. Average measurements with a reduced VBW of 10 Hz.	Table height	150cm
RBW	Below 1 GHz: 120 kHz Above 1 GHz: 1 MHz	VBW	Below 1 GHz: 1.2 MHz Above 1 GHz Peak: 3 MHz Above 1 GHz Avg: 10 Hz
Average Measurements	Duty cycle limited by manufacturer to 58.3%. All measurements taken with 100% constant DC test mode and corrected by the maximum operational duty cycle per KDB 558074 D01 Answer 3, option c.		
Example Calculations	Duty Cycle Correction Factor DCCF (dB) = 20*LOG(DC)		
	Measured Average – DCCF = Correct Average Reading		

EUT Parameters

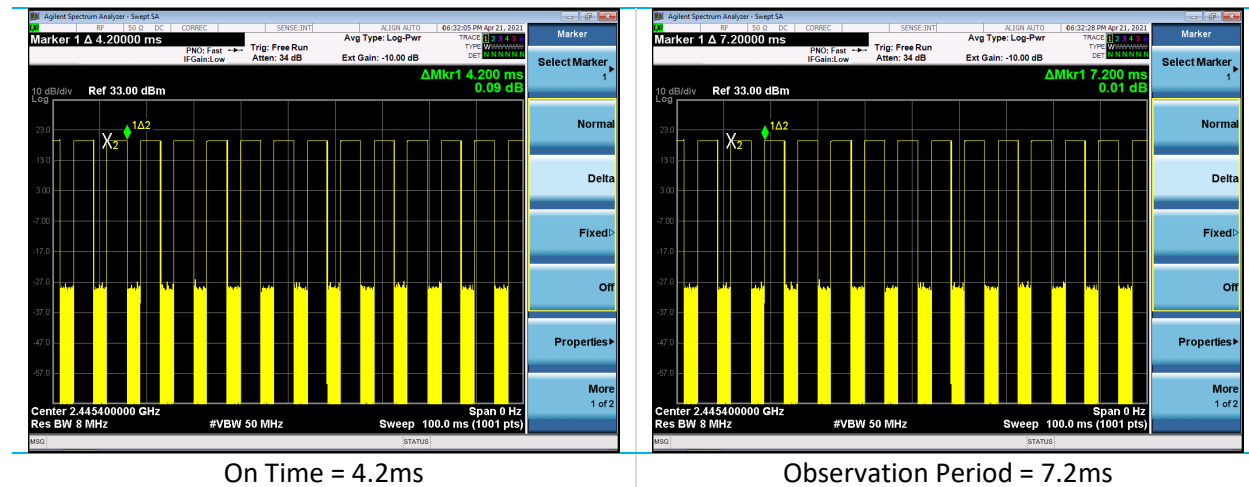
Input Power	3 AAA Batteries/4.5 VDC	Mode	802.15.4 100% Continuous Transmit
Channel	11, 19, 25	EUT Orientations	Vertical, Horizontal, Flat

Company: Laird Connectivity	Page 36 of 48	Name: LC840PA
Report: TR319416 A		Model: LC840PA
Job: C-3420		Serial: Engineering Sample

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	7/14/2020	7/14/2021	Active Calibration
2	AA 960163	Antenna - Log Periodic	A.H. Systems, Inc.	SAS-512-2	500	7/24/2020	7/24/2021	Active Calibration
3	AA 960005	Antenna - Biconical	EMCO	93110B	9601-2280	9/21/2020	9/22/2021	Active Calibration
4	LSC-300	Cable	Chamber 3 Emissic-	-	-	8/9/2020	8/9/2021	Active Verification
5	AA 960176	Cable	A.H. Systems, Inc.	SAC-26G-6	395	2/3/2021	2/3/2022	Active Verification
6	AA 960174	Antenna - Small Horn	ETS Lindgren	3116C-PA	00206880	11/11/2020	11/11/2021	Active Calibration
7	EE 960198	Meter - Hygro-Thermometer	Control Company	90080-03	180045460	3/13/2020	3/14/2022	Active Calibration
8	AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	12/7/2020	12/7/2021	Active Calibration
9	EE 960159	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	691801732	12/7/2020	12/7/2021	Active Calibration

Maximum Operational Duty Cycle Information



$$DC = (4.2/7.2) * 100 = 58.3\%$$

$$DCCF = 20 * \text{LOG}(0.583) = -4.7 \text{ dB}$$

Data Tables

Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBμV/m)	Quasi Peak Limit (dBμV/m)	Quasi Peak Margin (dB)	Peak Reading (dBμV/m)	Channel	Power Setting
198.0	Horizontal	Vertical	100	0	18.9	43.5	24.6	26.3	19	neg4dBm
198.1	Vertical	Vertical	100	0	18.9	43.5	24.6	25.2	19	neg4dBm
972.0	Horizontal	Vertical	100	0	23.5	54.0	30.5	30.3	19	neg4dBm
977.4	Vertical	Vertical	100	0	23.7	54.0	30.3	30.3	19	neg4dBm

Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Power
2341.1	Horizontal	Vertical	249	154	44.1	54.0	9.9	53.9	74.0	20.1	11	neg4dBm
2341.0	Vertical	Vertical	303	90	43.3	54.0	10.7	53.2	74.0	20.8	11	neg4dBm
2341.0	Horizontal	Side	150	135	42.2	54.0	11.8	52.9	74.0	21.1	11	neg4dBm
2341.0	Vertical	Side	369	345	44.0	54.0	10.0	53.8	74.0	20.2	11	neg4dBm
2341.0	Vertical	Flat	400	325	39.7	54.0	14.3	50.8	74.0	23.2	11	neg4dBm
2341.0	Horizontal	Flat	205	323	43.8	54.0	10.2	54.1	74.0	19.9	11	neg4dBm

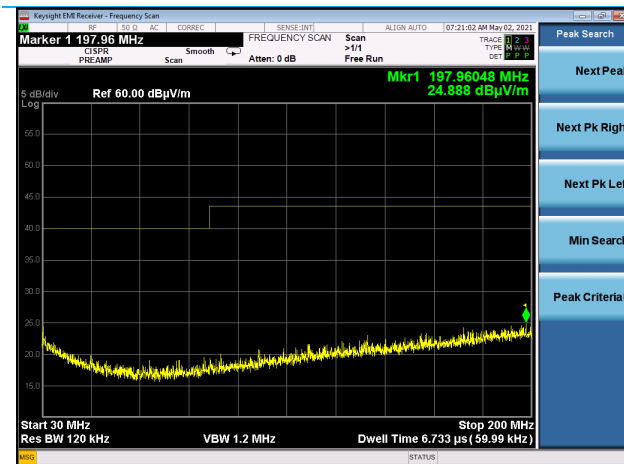
Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Power
4889.0	V	Vertical	100	0	30.5	54.0	23.5	41.0	74.0	33.0	Mid 19	neg4dBm
4889.0	H	Vertical	150	47	35.5	54.0	18.5	45.4	74.0	28.6	Mid 19	neg4dBm
4889.0	H	Side	150	295	30.2	54.0	23.8	42.2	74.0	31.8	Mid 19	neg4dBm
4889.0	V	Side	222	30	31.0	54.0	23.0	40.5	74.0	33.5	Mid 19	neg4dBm
4889.0	V	Flat	340	87	33.7	54.0	20.3	45.1	74.0	28.9	Mid 19	neg4dBm
4889.0	H	Flat	150	0	27.7	54.0	26.3	40.9	74.0	33.1	Mid 19	neg4dBm
4810.0	H	Vertical	150	48	40.1	54.0	13.9	45.9	74.0	28.1	Low 11	neg4dBm
4950.9	H	Vertical	150	51	29.9	54.0	24.1	41.4	74.0	32.6	High 25	neg4dBm

Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Power
7333.6	V	Vertical	242	24	37.9	54.0	16.1	46.9	74.0	27.1	Mid 19	neg4dBm
7333.6	H	Vertical	224	102	40.0	54.0	14.1	48.6	74.0	25.4	Mid 19	neg4dBm
7333.6	H	Side	245	295	40.7	54.0	13.3	51.6	74.0	22.4	Mid 19	neg4dBm
7333.6	V	Side	152	348	39.1	54.0	14.9	50.3	74.0	23.7	Mid 19	neg4dBm
7333.6	V	Flat	306	164	39.5	54.0	14.5	50.2	74.0	23.8	Mid 19	neg4dBm
7333.6	H	Flat	230	260	34.5	54.0	19.5	46.1	74.0	27.9	Mid 19	neg4dBm
7214.9	H	Side	245	295	44.9	54.0	9.1	49.5	74.0	24.5	Low 11	neg4dBm
7423.6	H	Side	245	295	36.8	54.0	17.2	48.3	74.0	25.7	High 25	neg4dBm

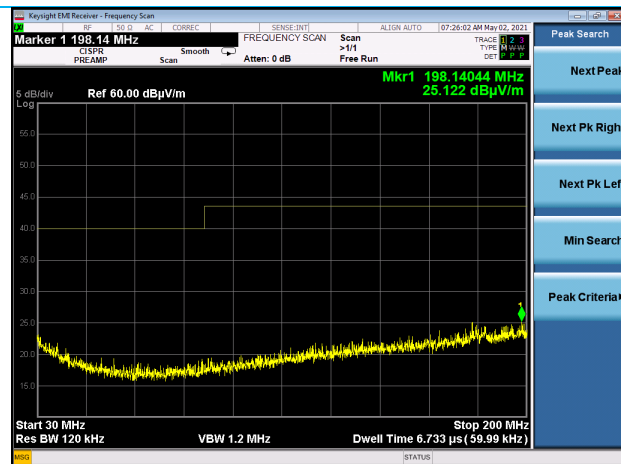
Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Power
14672.8	V	Vertical	150	0	42.0	54.0	12.0	51.4	74.0	22.6	Mid 19	neg4dBm
14672.8	H	Vertical	100	346	47.2	54.0	6.9	55.3	74.0	18.7	Mid 19	neg4dBm
14672.8	H	Side	150	339	42.1	54.0	11.9	51.9	74.0	22.1	Mid 19	neg4dBm
14672.8	V	Side	150	0	47.0	54.0	7.0	55.4	74.0	18.6	Mid 19	neg4dBm
14672.8	V	Flat	334	96	42.3	54.0	11.7	51.4	74.0	22.6	Mid 19	neg4dBm
14672.8	H	Flat	354	227	39.4	54.0	14.7	49.8	74.0	24.2	Mid 19	neg4dBm
14432.8	H	Vertical	100	0	42.7	54.0	11.4	52.0	74.0	22.0	Low 11	neg4dBm
14846.9	H	Vertical	150	350	41.5	54.0	12.5	51.1	74.0	22.9	High 25	neg4dBm

Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Duty Cycle Correction (dB)	Corrected Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Power Setting
19243.8	Horizontal	Vertical	230	297	54.3	-4.7	49.6	54.0	4.4	61.7	74.0	12.3	Low 11	neg4dBm
19563.8	Vertical	Vertical	156	17	50.5	-4.7	45.8	54.0	8.2	58.6	74.0	15.4	Mid 19	neg4dBm
19563.8	Horizontal	Vertical	217	298	57.6	-4.7	52.9	54.0	1.1	64.8	74.0	9.2	Mid 19	neg4dBm
19563.8	Vertical	Side	252	336	52.4	-4.7	47.7	54.0	6.3	60.3	74.0	13.7	Mid 19	neg4dBm
19563.8	Vertical	Flat	356	273	57.2	-4.7	52.5	54.0	1.5	64.9	74.0	9.1	Mid 19	neg4dBm
19563.8	Horizontal	Side	236	54	52.7	-4.7	48.0	54.0	6.1	60.3	74.0	13.7	Mid 19	neg4dBm
19563.8	Horizontal	Flat	343	235	46.1	-4.7	41.4	54.0	12.6	55.5	74.0	18.5	Mid 19	neg4dBm
19795.9	Horizontal	Vertical	204	292	57.9	-4.7	53.2	54.0	0.8	65.2	74.0	8.8	High 25	neg4dBm

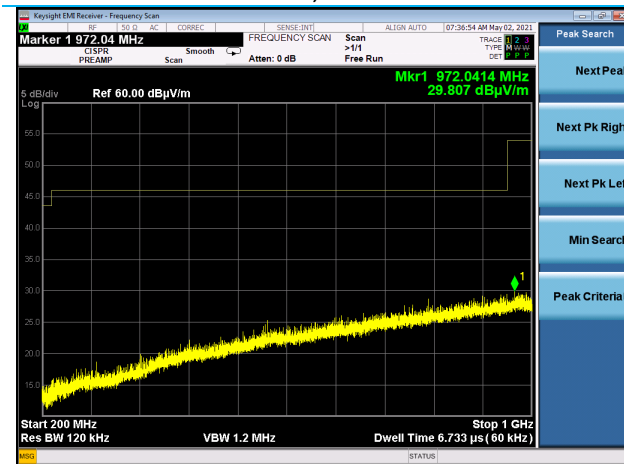
Plots



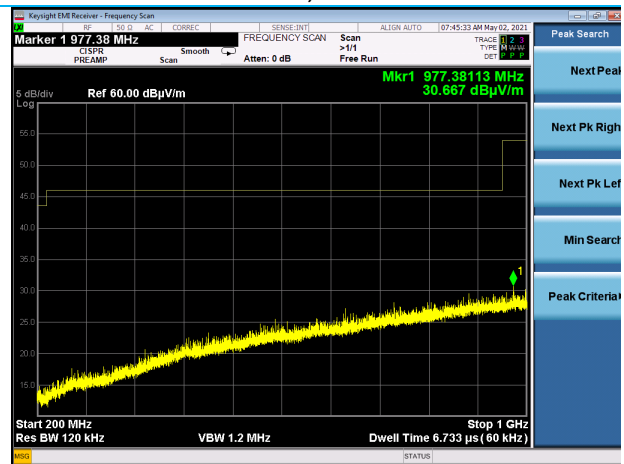
30-200 MHz, Horizontal Antenna
Vertical EUT, Channel 19



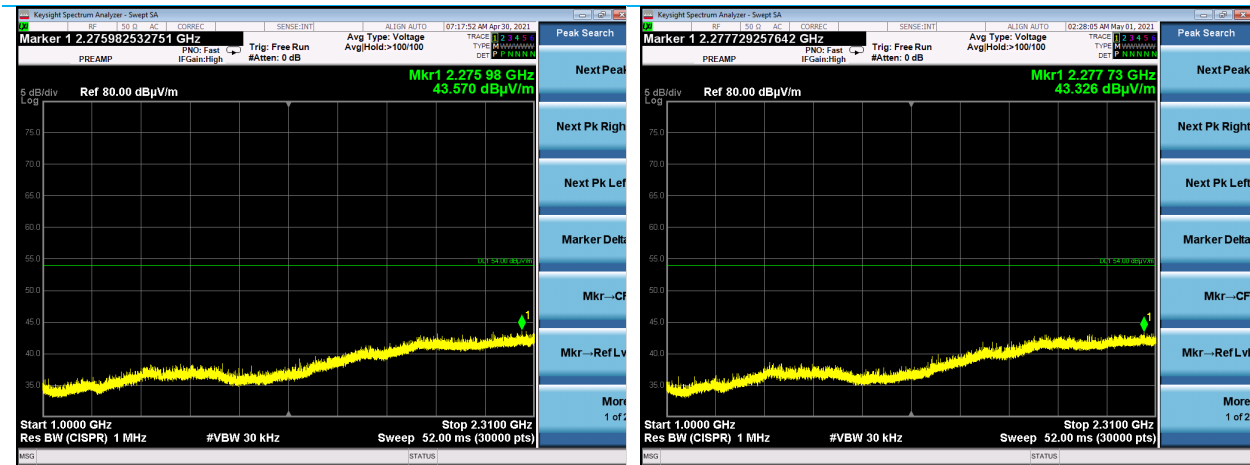
30-200 MHz, Vertical Antenna
Vertical EUT, Channel 19



200-1000 MHz, Horizontal Antenna
Vertical EUT, Channel 19

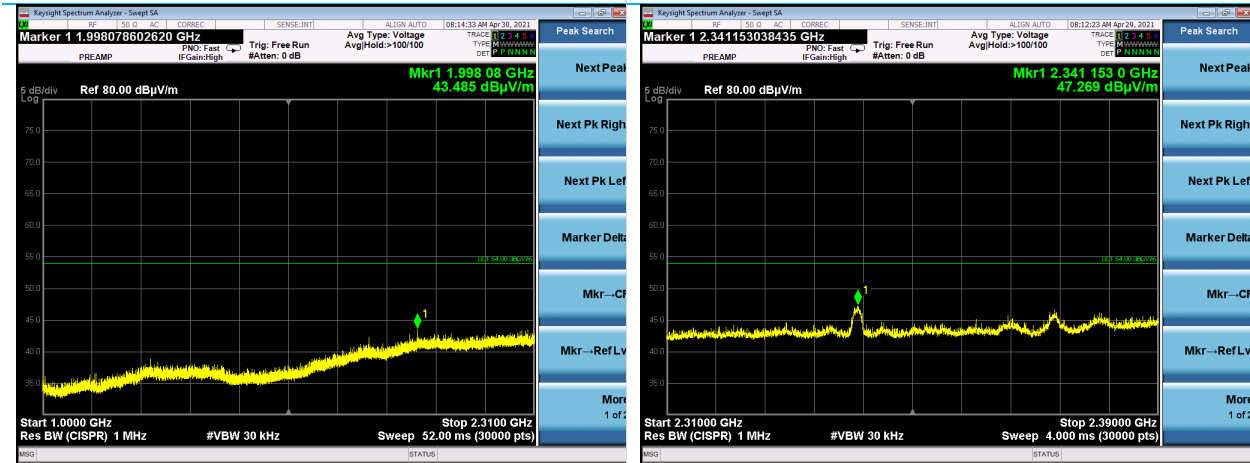


200-1000 MHz, Vertical Antenna
Vertical EUT, Channel 19



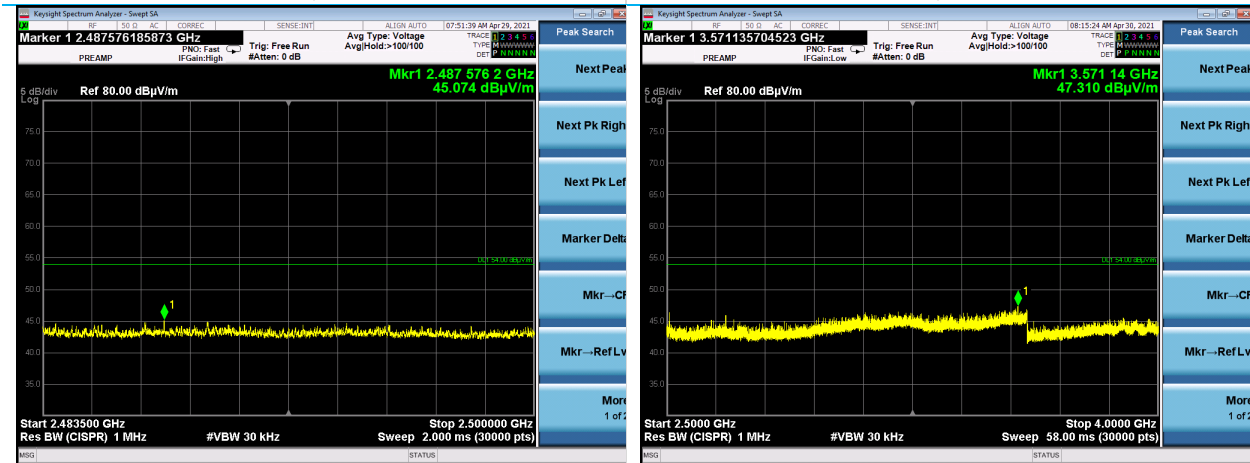
1-2.31 GHz, Horizontal Antenna
Vertical EUT, Channel 11

1-2.31 GHz, Horizontal Antenna
Vertical EUT, Channel 19



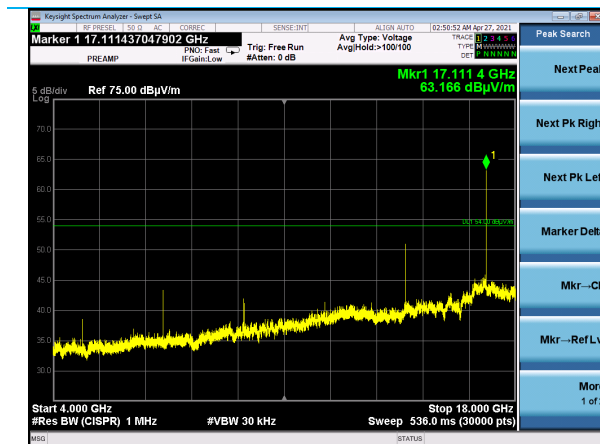
1-2.31 GHz, Horizontal Antenna
Vertical EUT, Channel 25

2.31-2.39 GHz, Horizontal Antenna
Vertical EUT, Channel 11

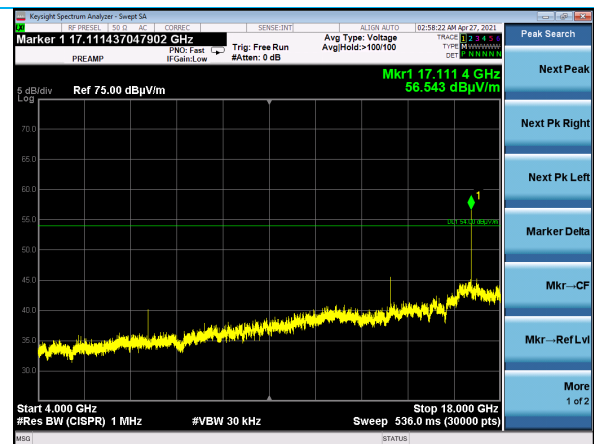


2.4835-2.5 GHz, Horizontal Antenna
Vertical EUT, Channel 25

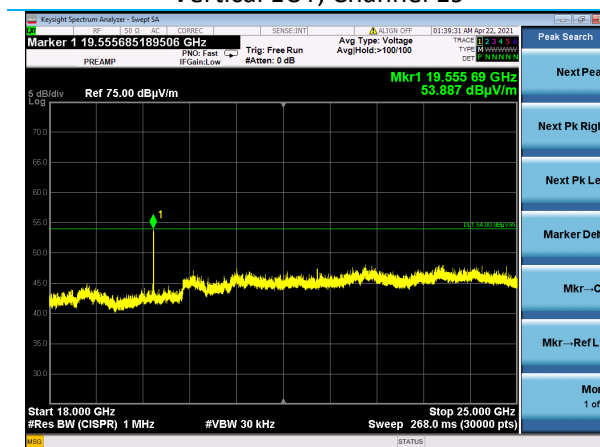
2.5-4 GHz, Horizontal Antenna
Vertical EUT, Channel 19



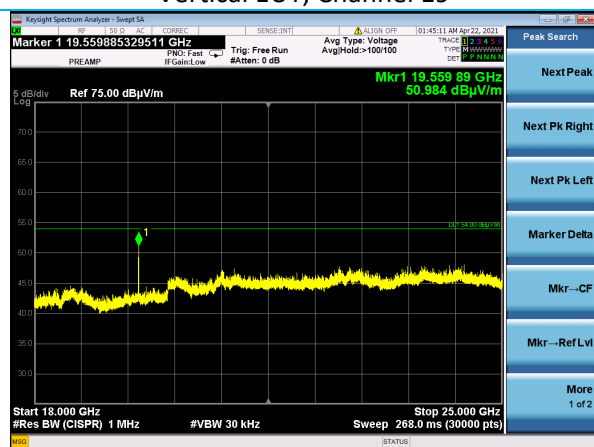
4-18 GHz, Horizontal Antenna
Vertical EUT, Channel 19



4-18 GHz, Vertical Antenna
Vertical EUT, Channel 19



18-25 GHz, Horizontal Antenna
Vertical EUT, Channel 19



18-25 GHz, Vertical Antenna
Vertical EUT, Channel 19

5.2.2 Radiated Emissions – Cabinet Radiation

Operator	Anthony Smith, Braden Smith	QA	Jon Dilley, Anthony Smith
Temperature	22.2°C	R.H. %	26%
Test Date	4/21/2021-5/1/2021	Location	Chamber 3/Chamber 5
Requirement	FCC 15.209, FCC 15.247	Method	ANSI C63.10

Limits:

Frequency (MHz)	Quasi Peak Limit (dBμV/m)	Average Limit (dBμV/m)	Peak Limit (dBμV/m)
30-88	40.0	-	-
88-216	43.5	-	-
216-960	46.0	-	-
960-1000	54.0	-	-
1000-25000	-	54.0	74.0

Test Parameters

Frequency	30-25000 MHz	Distance	3m
Detector(s)	Quasi peak detector for measurements under 1 GHz. Peak detector for final measurement above 1 GHz. Average measurements with a reduced VBW of 10 Hz.	Table height	150cm
RBW	Below 1 GHz: 120 kHz Above 1 GHz: 1 MHz	VBW	Below 1 GHz: 1.2 MHz Above 1 GHz Peak: 3 MHz Above 1 GHz Avg: 10 Hz

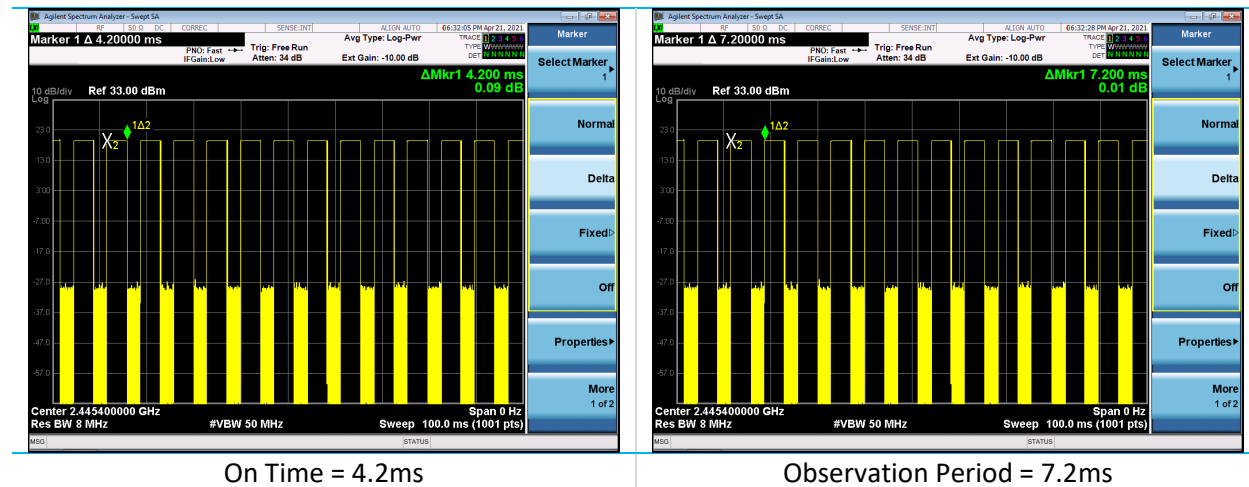
EUT Parameters

Input Power	3 AAA Batteries/4.5 VDC	Mode	802.15.4 100% Continuous Transmit
Channel	11, 19, 25		

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	7/14/2020	7/14/2021	Active Calibration
2	AA 960163	Antenna - Log Periodic	A.H. Systems, Inc.	SAS-512-2	500	7/24/2020	7/24/2021	Active Calibration
3	AA 960005	Antenna - Biconical	EMCO	93110B	9601-2280	9/21/2020	9/22/2021	Active Calibration
4	LSC-300	Cable	Chamber 3 Emissic-	-	-	8/9/2020	8/9/2021	Active Verification
5	AA 960176	Cable	A.H. Systems, Inc.	SAC-26G-6	395	2/3/2021	2/3/2022	Active Verification
6	AA 960174	Antenna - Small Horn	ETS Lindgren	3116C-PA	00206880	11/11/2020	11/11/2021	Active Calibration
7	EE 960198	Meter - Hygro-Thermometer	Control Company	90080-03	180045460	3/13/2020	3/14/2022	Active Calibration
8	AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	12/7/2020	12/7/2021	Active Calibration
9	EE 960159	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	691801732	12/7/2020	12/7/2021	Active Calibration

Maximum Operational Duty Cycle Information



$$DC = (4.2/7.2) * 100 = 58.3\%$$

$$DCCF = 20 * \text{LOG}(0.583) = -4.7 \text{ dB}$$

Data Tables

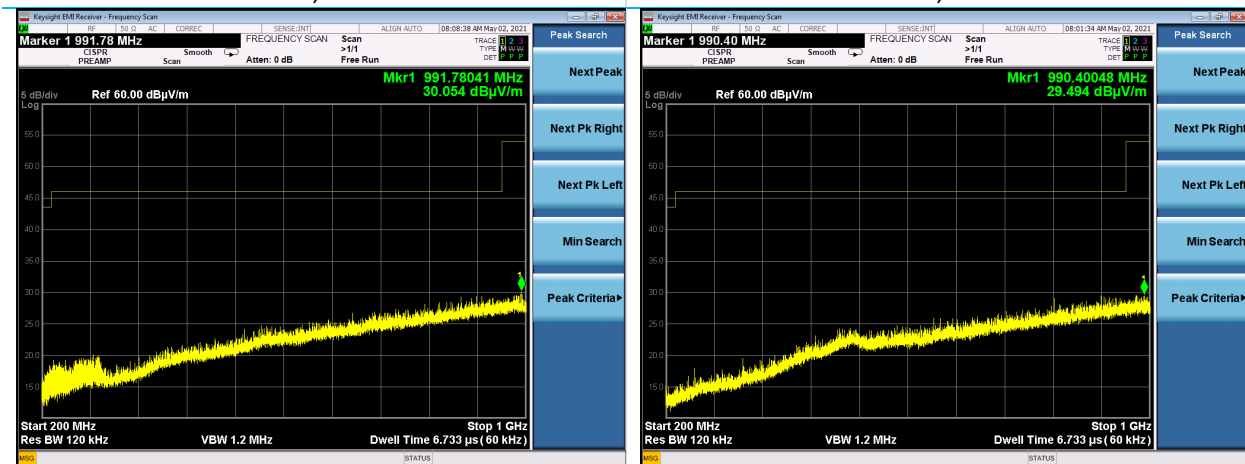
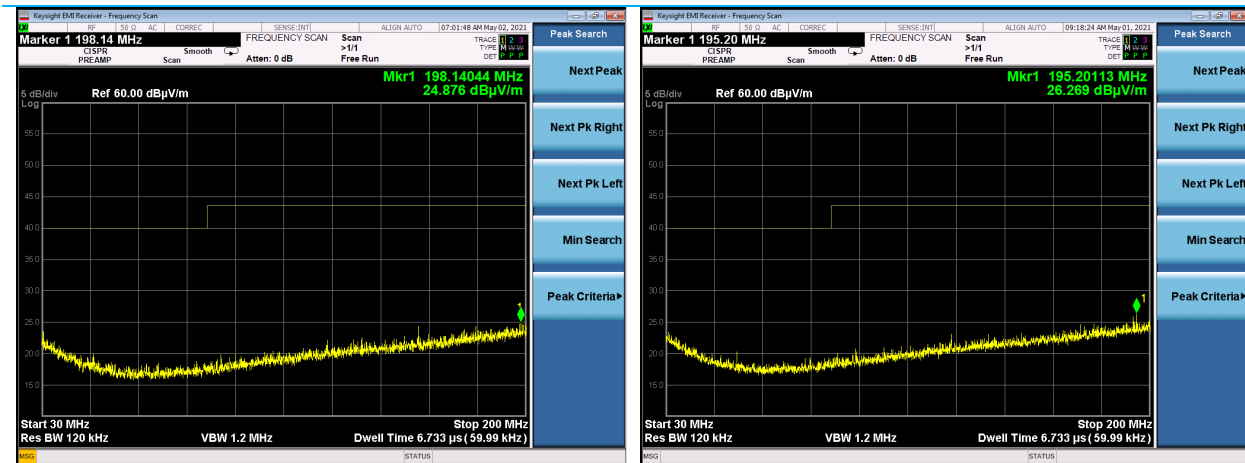
Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBμV/m)	Quasi Peak Limit (dBμV/m)	Quasi Peak Margin (dB)	Peak Reading (dBμV/m)	Channel	Power Setting
193.1	Vertical	Vertical	100	0	18.6	43.5	24.9	24.5	19	neg4dBm
292.8	Horizontal	Vertical	100	260	13.1	54.0	40.9	19.6	19	neg4dBm
506.0	Vertical	Vertical	100	0	18.5	46.0	27.5	25.0	19	neg4dBm

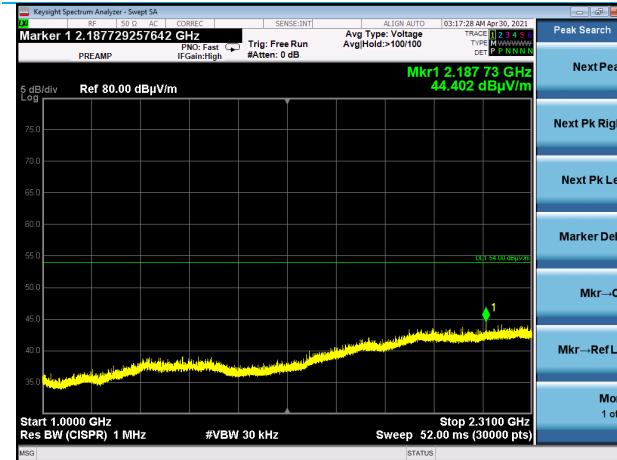
Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Power Setting
2386.5	Horizontal	Vertical	150	0	37.6	54.0	16.4	49.6	74.0	24.4	11	neg4dBm

Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Power Setting
14432.8	Horizontal	Vertical	205	299	42.1	54.0	11.9	51.8	74.0	22.2	Low 11	neg4dBm
14432.8	Vertical	Vertical	150	0	36.8	54.0	17.2	47.7	74.0	26.3	Low 11	neg4dBm
14432.8	Vertical	Side	150	355	36.6	54.0	17.5	47.7	74.0	26.3	Low 11	neg4dBm
14432.8	Horizontal	Side	150	0	36.7	54.0	17.3	47.7	74.0	26.3	Low 11	neg4dBm
14432.8	Horizontal	Flat	150	221	35.5	54.0	18.5	46.7	74.0	27.3	Low 11	neg4dBm
14432.8	Vertical	Flat	341	78	38.5	54.0	15.5	48.4	74.0	25.6	Low 11	neg4dBm

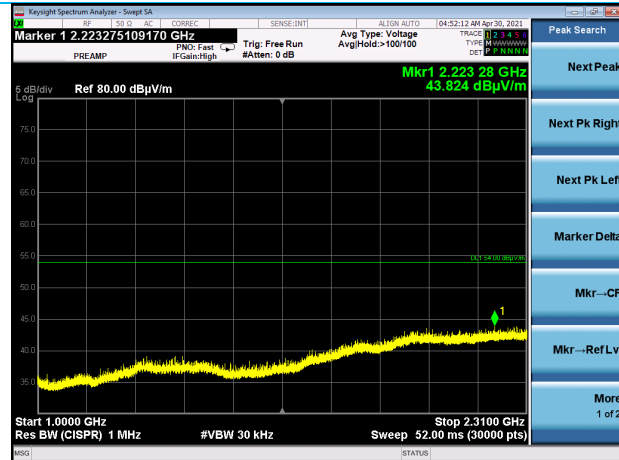
Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Power Setting
19556.0	Horizontal	Vertical	244	60	49.1	54.0	4.9	57.9	74.0	16.1	Mid 19	neg4dBm
19244.0	Horizontal	Vertical	150	304	47.1	54.0	6.9	55.5	74.0	18.5	Low 11	neg4dBm
19795.8	Horizontal	Vertical	319	315	51.4	54.0	2.6	59.6	74.0	14.4	High 25	neg4dBm

Plots

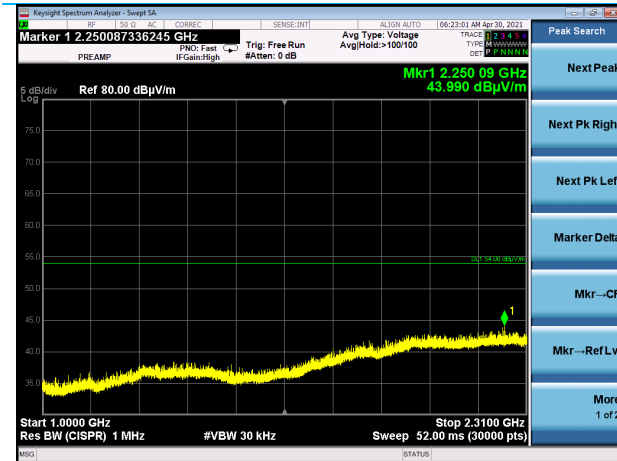




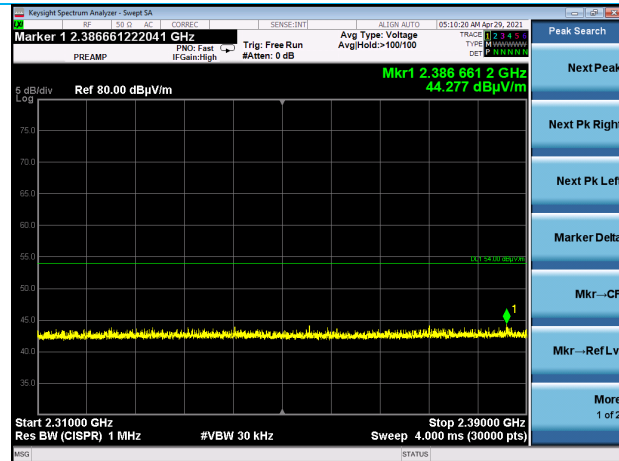
1-2.31 GHz, Horizontal Antenna
Vertical EUT, Channel 11



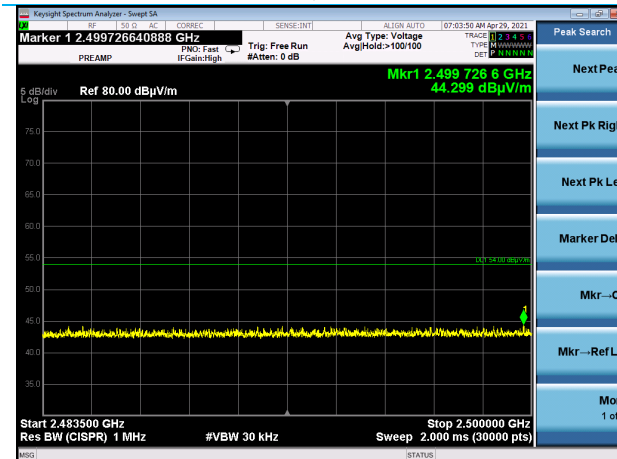
1-2.31 GHz, Horizontal Antenna
Vertical EUT, Channel 19



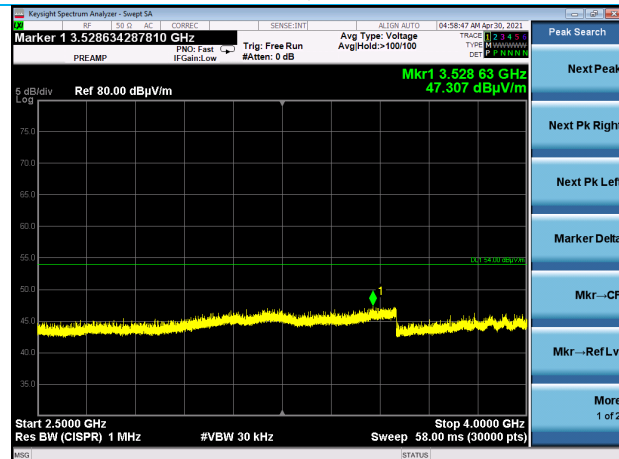
1-2.31 GHz, Horizontal Antenna
Vertical EUT, Channel 25



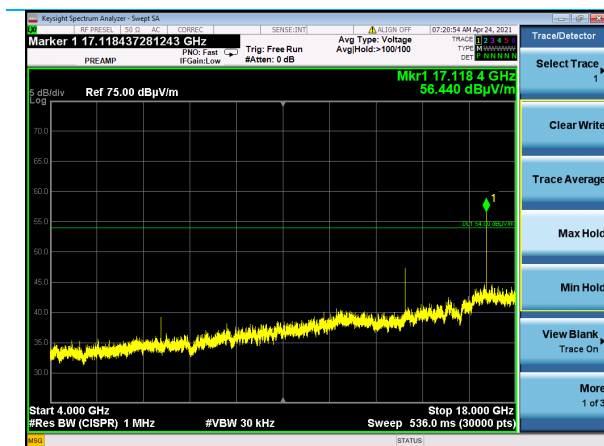
2.31-2.39 GHz, Horizontal Antenna
Vertical EUT, Channel 11



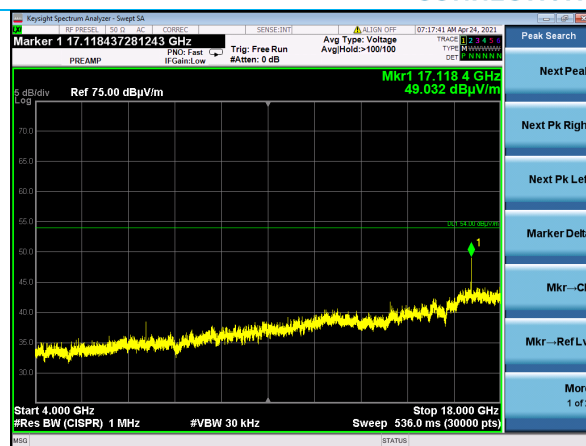
2.4835-2.5 GHz, Horizontal Antenna
Vertical EUT, Channel 25



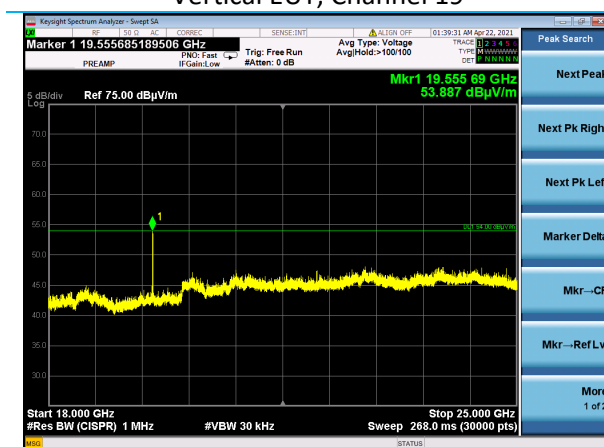
2.5-4 GHz, Horizontal Antenna
Vertical EUT, Channel 19



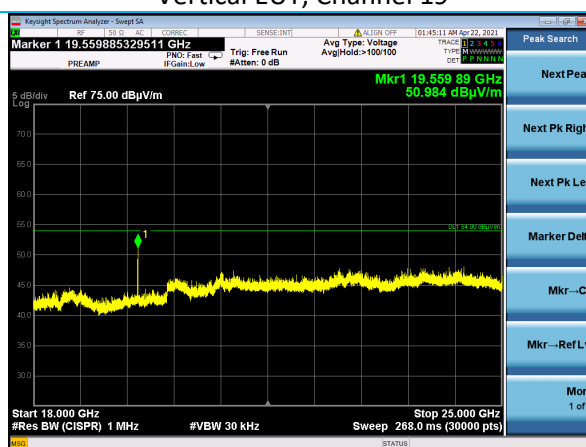
4-18 GHz, Horizontal Antenna
Vertical EUT, Channel 19



4-18 GHz, Vertical Antenna
Vertical EUT, Channel 19



18-25 GHz, Horizontal Antenna
Vertical EUT, Channel 19



18-25 GHz, Vertical Antenna
Vertical EUT, Channel 19

6 REVISION HISTORY

Version	Date	Notes	Person
0	5/14/2021	Initial Draft	Zach Wilson
1	5/18/2021	Revised per internal review	Zach Wilson
2	12/15/2021	Sent to TCB	Zach Wilson
3	12/20/2021	Updated per TCB review	Zach Wilson

END OF REPORT