

Test Report # 319220 A

Equipment Under Test: Bluetooth 5.0 BLE Data Module

Test Date(s): 1/20/2020 – 12/18/2020

Prepared for: ATTN: Jonathan Kaye
Laird Connectivity
W66 N220 Commerce Ct.
Cedarburg, WI 53012

Report Issued by: Shane Dock, EMC Engineer

Signature:



Date: 2/17/2021

Report Reviewed by: Adam Alger, Quality Manager

Signature: 

Date: 01/12/2021

Report Constructed by: Shane Dock, EMC Engineer

Signature:



Date: 8/12/2020

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Company: Laird Connectivity	Page 1 of 32	Name: Bluetooth 5.0 BLE Data Module
Report: 319220 A		Model: BL654
Job: C-3290		Serial: See Section 2

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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

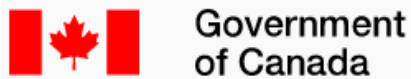
Scope of accreditation includes all test methods listed herein unless otherwise noted



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

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Report: 319220A		Model: BL654
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1 TEST REPORT SUMMARY

During **1/20/20 - 12/18/20** the Equipment Under Test (EUT), **Bluetooth 5.0 BLE Data Module**, as provided by **Laird Connectivity** was tested to the following requirements:

FCC Part 15.247

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2) ISED: RSS-247 5.2 (a)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Pass
FCC: 2.1049 ISED: RSS-GEN 6.7	Occupied Bandwidth	Reported	ANSI C63.10	Pass
FCC: 15.247 (b)(3) ISED: RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (e) ISED: RSS-247 5.2 (b)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Pass
FCC: 15.247 (d) ISED: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Pass
FCC: 15.247 (d) ISED: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	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	2 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	Jonathan Kaye
Address	W66N220 Commerce Court Cedarburg, WI 53086

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Bluetooth 5.0 BLE Data Module
Model Number	BL654
Serial Number	180916101621 180523200079 180927206472
FCC/IC ID's	FCC: SQGBL654 IC: 3147A-BL654

2.2 Product Description

802.15.4 Data Module

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Additional Information

The EUT is a devkit for a BL654 powered by 3 AAA batteries and programmed via serial connection program (PuTTY). The original filing did not include the proprietary 802.15.4 radio, and this testing is pursuant to a permissive change to add this to the filing. The EUT was tested on channels 11, 18, 25, and 26 with the cabinet radiation method, with a maximum antenna gain of 2.0 dBi. From here, 11, 18, and 25 are referred to as the low mid, and high channels of the full power channels. Power settings tested for each channel are included below.

- Low, Mid, High Channel: -40 dBm, 8 dBm
- Channel 26: -40 dBm, -8 dBm

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3 REFERENCES

Publication	Edition	Date	AMD 1
FCC Part 15	-	2020	-
RSS-247	2	2017	-
RSS-GEN	5	2018	2019
ANSI C63.10	-	2013	-
KDB 178919 D01	6	2015	-

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

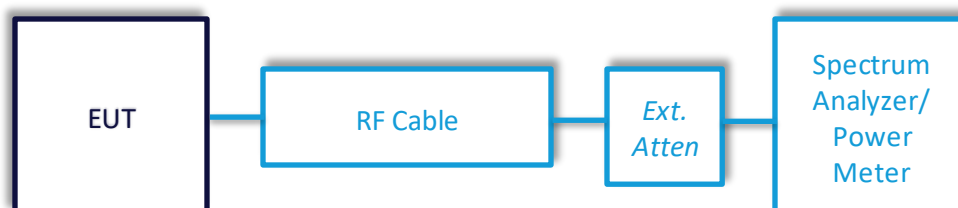
Parameter	ETSI U.C. \pm	U.C. \pm
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %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

5 TEST DATA

5.1 Antenna Port Conducted Emissions

<p>Description of Measurement</p>	<p>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.</p> <p>The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.</p>
<p>Example Calculations</p>	<p>Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm)</p> <p>Margin (dB) = Limit (dBm) – Corrected Reading (dBm)</p> <p>For Conducted Tx Measurements: Limit (dBm) = Limit (dBuV/m) – 95.2 dB</p> <p>Peak Value (dBm) = Peak Measurement (dBm) + Antenna Gain (dBi)</p> <p>-80 dBm = -78 dBm + 2 dBi</p> <p>Average Value (dBm) = Average Measurement (dBm) + Antenna Gain (dBi) + Duty Cycle Correction Factor (dB)</p> <p>-80 dBm = -75 dBm + 2 dBi + 3 dBi</p>

Block Diagram



5.1.1 Antenna Port Conducted Emissions

Operator	Jon Dillely	QA	Shane Dock
Temperature	23.9 degrees Celsius	R.H. %	18.5% RH
Test Date	1/20/2020 – 12/18/2020	Location	Conducted Bench
Requirement	FCC 15.247 RSS-247	Method	ANSI C63.10–BW: Section 6.9, 11.8 Pout: Section 11.9.1.1 PSD: Section 11.10.2 Tx Spurious, Restricted bands: 11.11 Tx Spurious, nonrestricted: 11.12

Limits:

DTS Bandwidth: > 500 kHz
Pout: 30 dBm
PSD: < 8 dBm/3 kHz
Tx Spurious: 20 dBc
Cabinet Conducted: -41.2 dBm (Average), -21.2 dBm (Peak)

Instrumentation



Date : 10-Aug-2020 Test : FCC Tx Job : C-3290
 PE : Shane Dock Customer : Laird Connectivity Quote : 319220

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	12/9/2019	1/9/2021	Active Calibration
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

December



Date : 10-Aug-2020 Test : FCC Tx Job : C-3290
 PE : Shane Dock Customer : Laird Connectivity Quote : 319220

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960172	Cable	A.H. Systems, Inc	SAC-26G-1	387	12/9/2019	1/9/2021	Active Calibration
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

EUT Parameters

Input Power	3x AAA Batteries	Mode	Modulated Tx
Frequency	2400-2483.5 MHz	Channel	Low, Mid, High

Data

Table – Bandwidth

Channel	99% BW (kHz)	6 dB BW (kHz)
26	2281.1	1192
25	2272.9	1195
18	2271.4	1209
11	2280.3	1181

Table – Output Power

Frequency (MHz)	Channel	Power Setting (dBm)	Pout Measured (dBm)	Pout Limit (dBm)	Pout Margin (dB)
2405.49	11	8	7.5	30.0	22.5
2405.04	11	-40	-35.9	30.0	65.9
2439.57	18	8	7.6	30.0	22.4
2440.19	18	-40	-35.9	30.0	65.9
2475.49	25	8	7.7	30.0	22.3
2475.76	25	-40	-35.9	30.0	65.9
2479.65	26	-8	-6.6	30.0	36.6
2480.17	26	-40	-36.1	30.0	66.1

Table – PSD

Channel	Power Setting (dBm)	PSD Measured (dBm)	PSD Limit (dBm)	PSD Margin (dB)
11	8	-5.8	8.0	17.9
11	-40	-53.3	8.0	88.0
18	8	-7.8	8.0	45.9
18	-40	-54.0	8.0	86.5
25	8	-5.6	8.0	44.6
25	-40	-53.6	8.0	84.9
26	-8	-20.9	8.0	53.9
26	-40	-54.4	8.0	85.5

Table – Tx Spurious, Non-Restricted bands

Frequency (MHz)	Channel	Power Setting	Peak Measurement (dBm)	Limit (dBm)	Margin (dB)
192.03	26	-8dBm	-80.9	-26.9	54.0
1935.90	26	-8dBm	-75.1	-26.9	48.2
2351.97	26	-8dBm	-70.9	-26.9	44.0
2483.88	26	-8dBm	-50.9	-26.9	24.0
5177.59	26	-8dBm	-67.2	-26.9	40.3
192.00	26	-40dBm	-80.7	-59.8	20.9
2483.84	26	-40dBm	-77.9	-59.8	18.1
825.69	25	-40dBm	-76.0	-60.0	16.0
1883.76	25	-40dBm	-71.2	-60.0	11.2
5187.59	25	-40dBm	-64.8	-60.0	4.8
2287.71	25	8dBm	-59.6	-12.5	47.1
2347.00	25	8dBm	-61.7	-12.5	49.2
2483.90	25	8dBm	-55.0	-12.5	42.5
7423.68	25	8dBm	-51.2	-12.5	38.7
2277.47	11	8dBm	-63.2	-12.7	50.5
2399.91	11	8dBm	-44.0	-12.7	31.3
7213.66	11	8dBm	-50.5	-12.7	37.8
128.01	11	-40dBm	-80.2	-59.9	20.3
5181.34	11	-40dBm	-63.6	-59.9	3.7
1883.49	18	-40dBm	-65.7	-60.1	5.6
5172.59	18	-40dBm	-64.6	-60.1	4.5
2247.73	18	8dBm	-61.7	-12.6	49.1
2376.22	18	8dBm	-57.7	-12.6	45.1
2491.63	18	8dBm	-61.4	-12.6	48.8
7318.66	18	8dBm	-50.1	-12.6	37.5

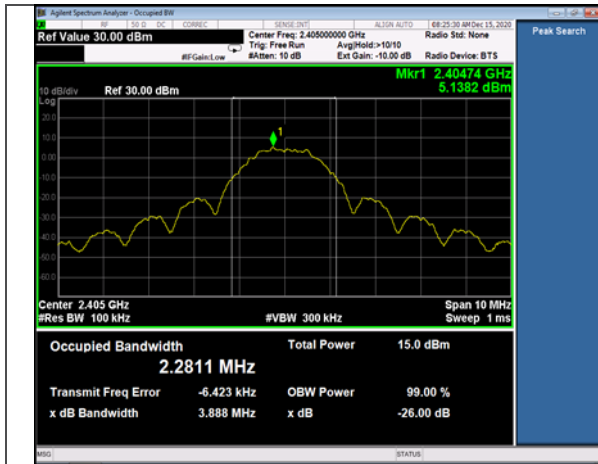
Table –Tx Spurious, Restricted Bands

Frequency (MHz)	Channel	Peak Measurement (dBm)	Antenna Gain (dBi)	Corrected Measurement (dBm)	Limit (dBm)	Margin (dB)
2212.88	11	-54.3	2.0	-52.3	-21.2	31.1
2340.44	11	-50.1	2.0	-48.1	-21.2	26.9
5181.09	11	-56.8	2.0	-54.8	-21.2	33.6
12022.5	11	-56.9	2.0	-54.9	-21.2	33.7
2247.86	18	-53.9	2.0	-51.9	-21.2	30.7
2375.37	18	-50.2	2.0	-48.2	-21.2	27.0
2492.17	18	-51.2	2.0	-49.2	-21.2	28.0
7321.6	18	-44.3	2.0	-42.3	-21.2	21.1
12197.6	18	-57.0	2.0	-55.0	-21.2	33.8
2483.59	25	-45.1	2.0	-43.1	-21.2	21.9
2283.84	25	-53.9	2.0	-51.9	-21.2	30.7
2347.45	25	-55.5	2.0	-53.5	-21.2	32.3
7426.41	25	-44.6	2.0	-42.6	-21.2	21.4
12372.6	25	-56.9	2.0	-54.9	-21.2	33.7
2351.5	26	-60.9	2.0	-58.9	-21.2	37.7
2483.5	26	-40.9	2.0	-38.9	-21.2	17.7

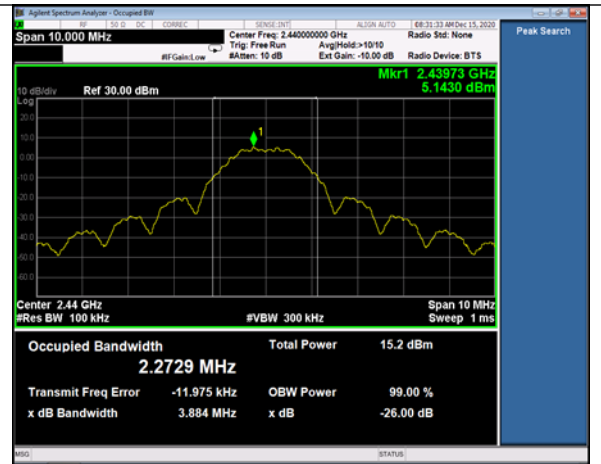
Frequency (MHz)	Channel	Average Measurement (dBm)	Duty Cycle Correction (dB)	Antenna Gain (dBi)	Corrected Measurement (dBm)	Limit (dBm)	Margin (dB)
2212.83	11	-63.5	3.0	2.0	-58.5	-41.2	17.3
2340.76	11	-59.1	3.0	2.0	-54.1	-41.2	12.9
5145.2	11	-70.1	3.0	2.0	-65.1	-41.2	23.9
12027.42	11	-63.9	3.0	2.0	-58.9	-41.2	17.7
2247.89	18	-62.5	3.0	2.0	-57.5	-41.2	16.3
2375.86	18	-59.9	3.0	2.0	-54.9	-41.2	13.7
2492.11	18	-62.8	3.0	2.0	-57.8	-41.2	16.6
7321.52	18	-50.6	3.0	2.0	-45.6	-41.2	4.4
12197.73	18	-64.2	3.0	2.0	-59.2	-41.2	18.0
2483.54	25	-56.4	3.0	2.0	-51.4	-41.2	10.2
2282.81	25	-62.5	3.0	2.0	-57.5	-41.2	16.3
2347.28	25	-65.6	3.0	2.0	-60.6	-41.2	19.4
7423.63	25	-51.4	3.0	2.0	-46.4	-41.2	5.2
12377.37	25	-63.6	3.0	2.0	-58.6	-41.2	17.4
2352.15	26	-71.4	3.0	2.0	-66.4	-41.2	25.2
2483.51	26	-49.8	3.0	2.0	-44.8	-41.2	3.6

Worst Case Plots – 8 dBm

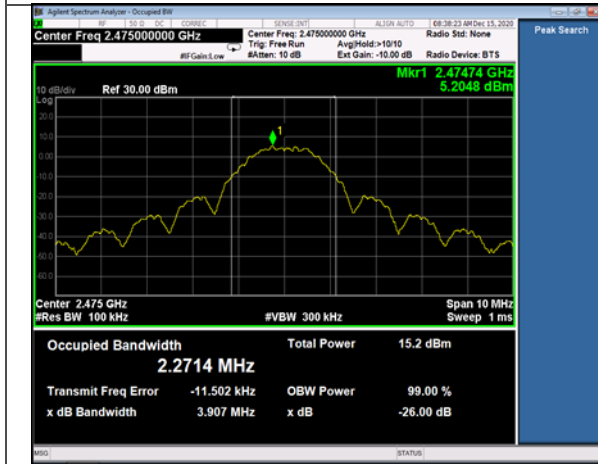
Occupied Bandwidth



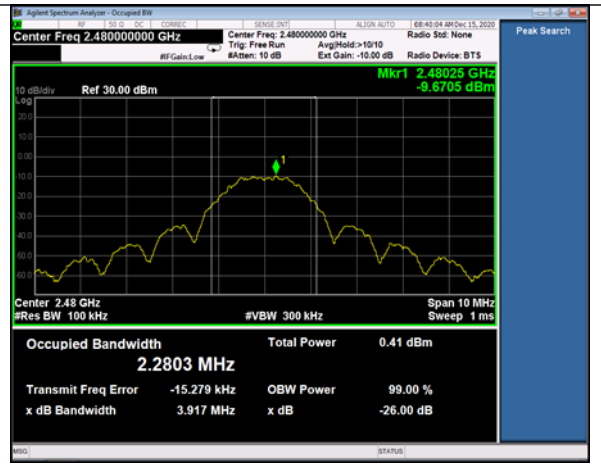
Low Channel 99% BW



Mid Channel 99% BW

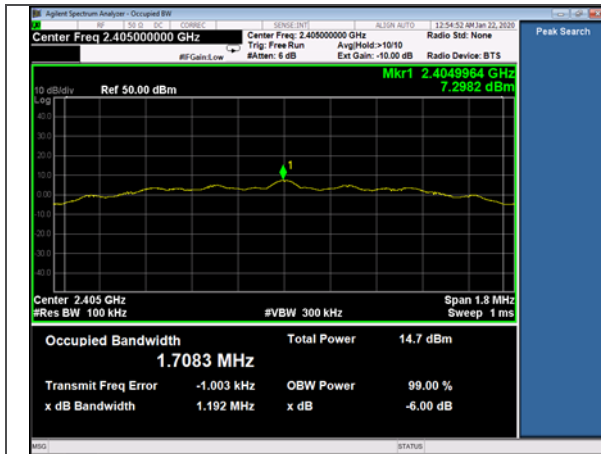


High Channel 99% BW

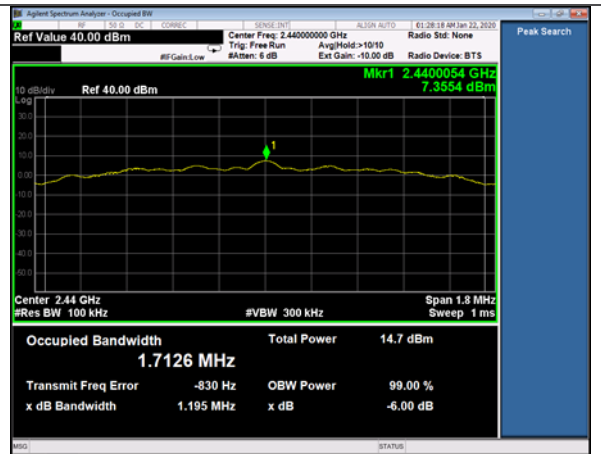


Channel 26 99% BW

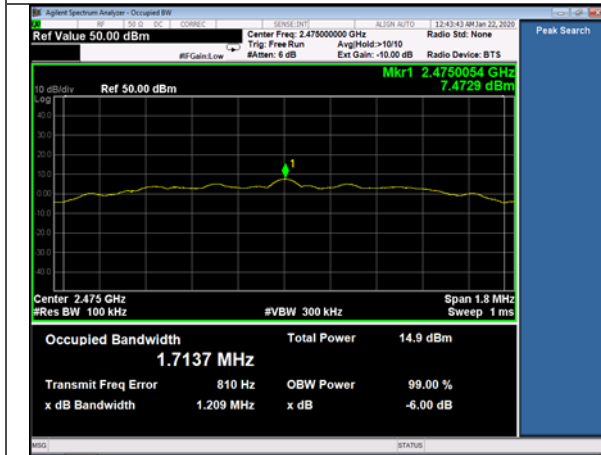
DTS Bandwidth



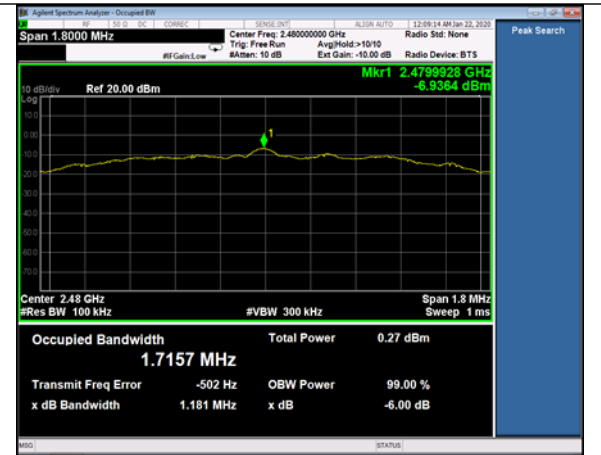
Low Channel DTS BW



Mid Channel DTS BW

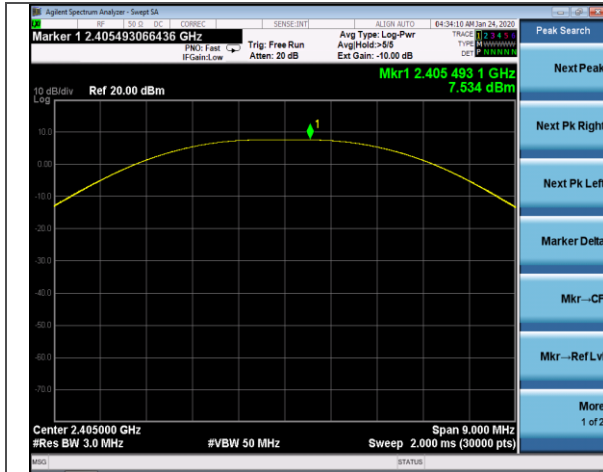


High Channel DTS BW

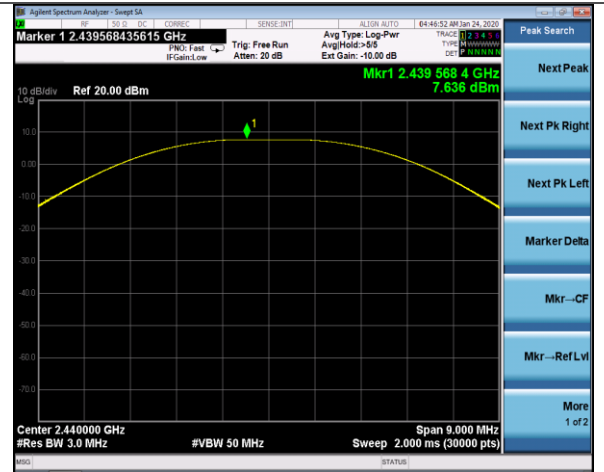


Channel 26 DTS BW

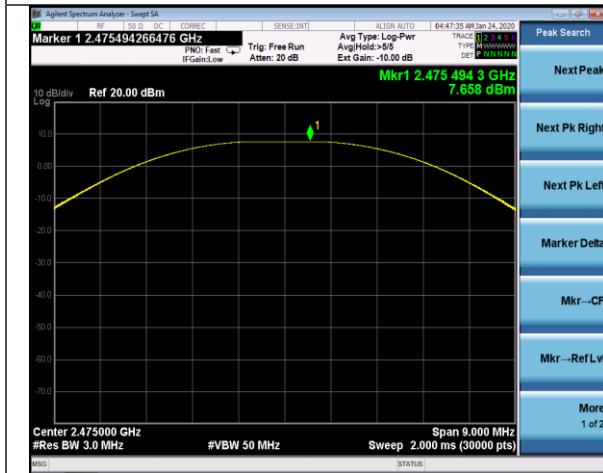
Conducted Output Power



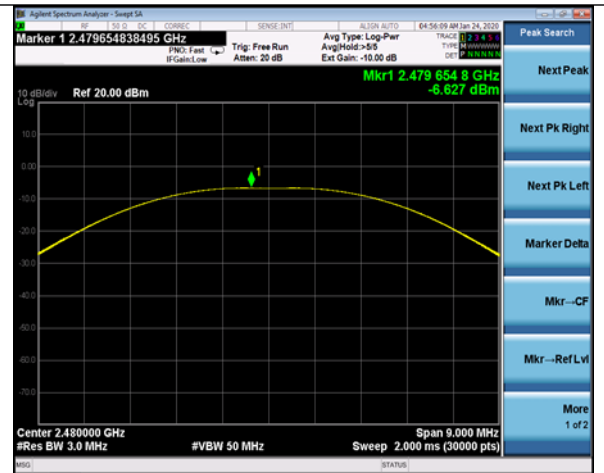
Low Channel



Mid Channel



High Channel



Channel 26

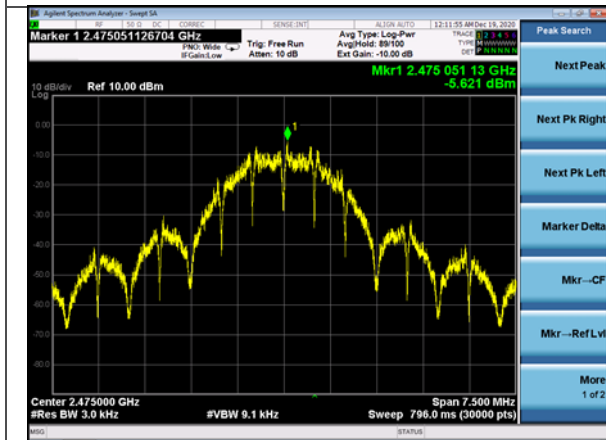
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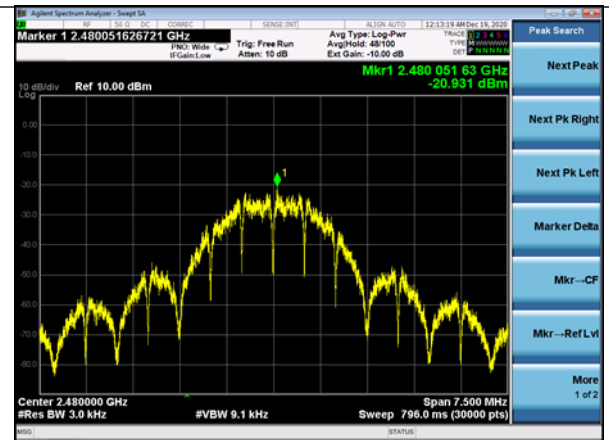
Low Channel



Mid Channel

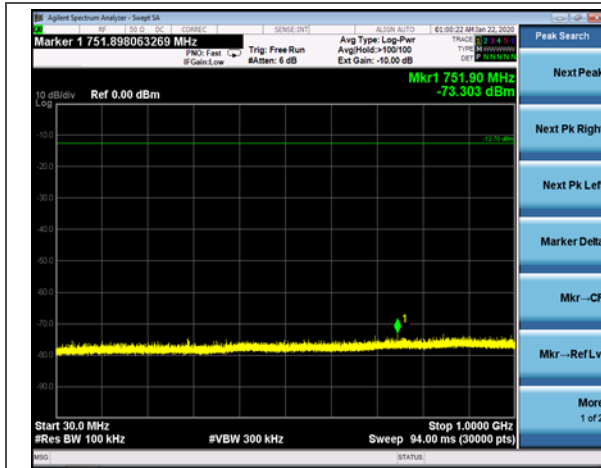


High Channel

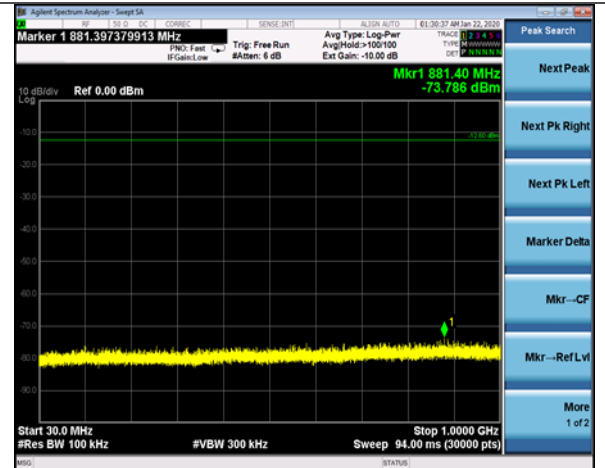


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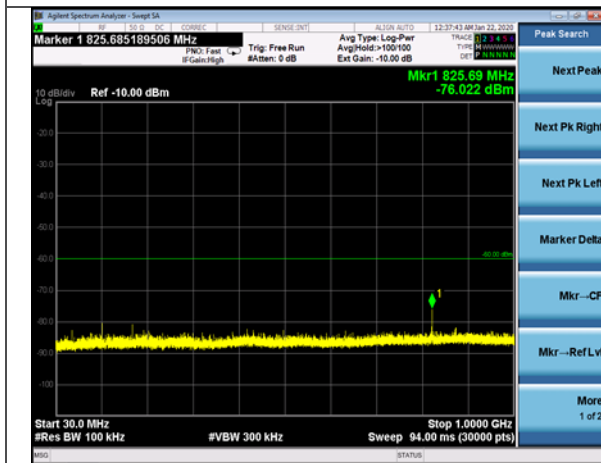
Conducted Tx Spurious – 30-1000 MHz



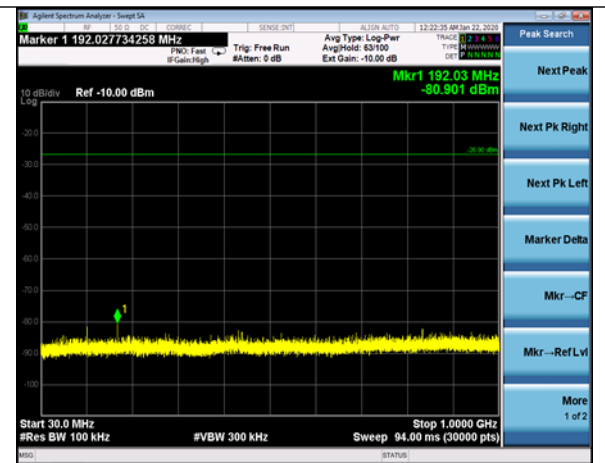
Low Channel



Mid Channel

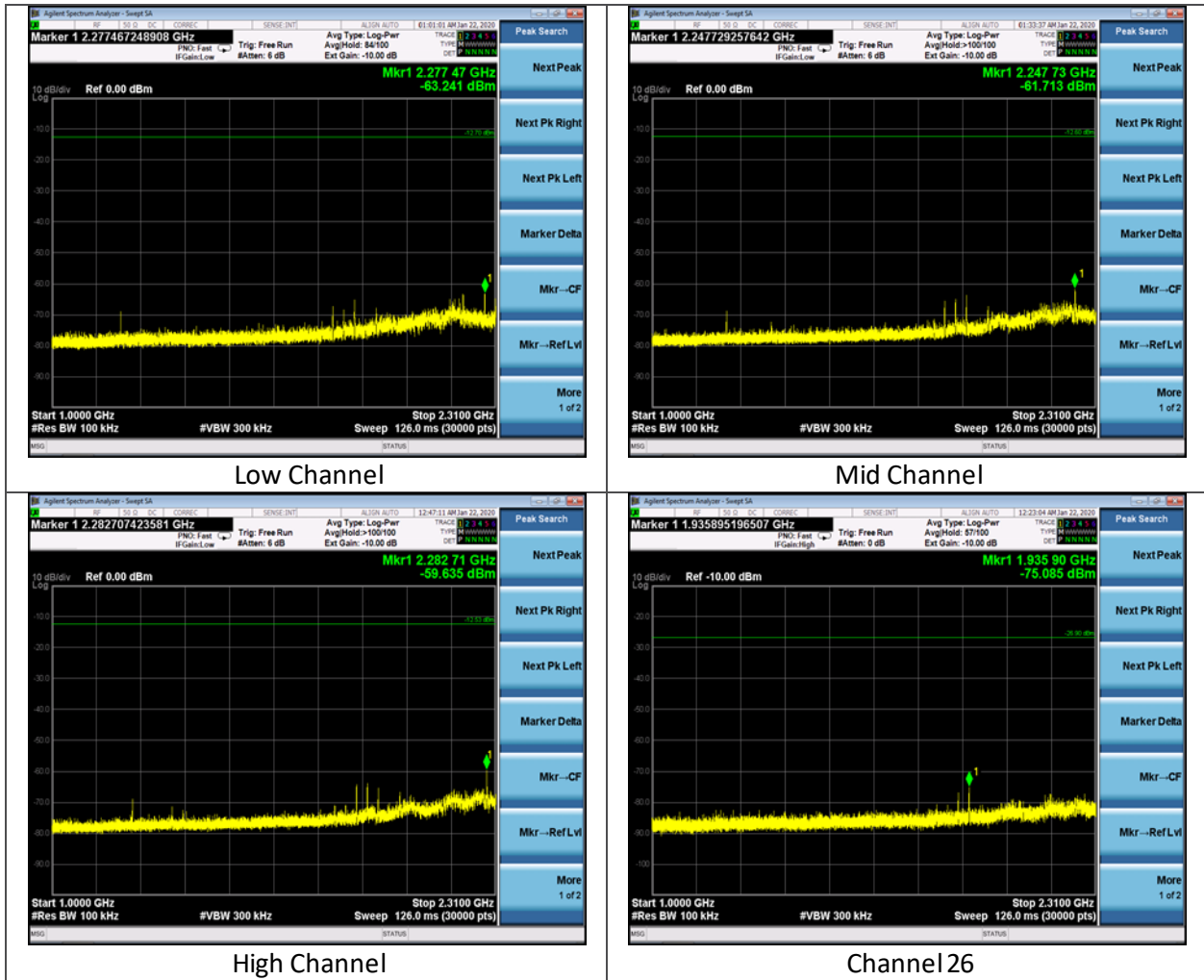


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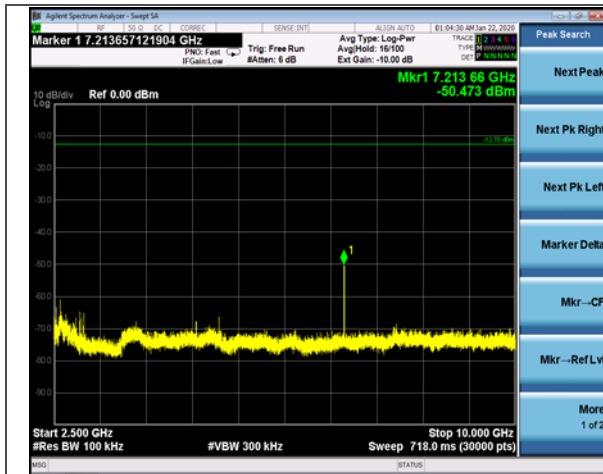


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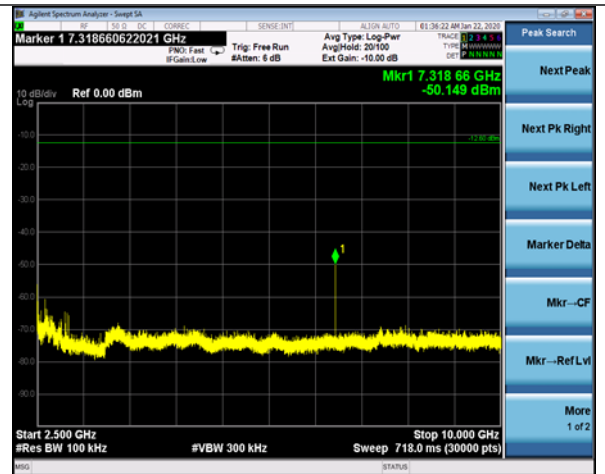
Conducted Tx Spurious – 1000-2310 MHz



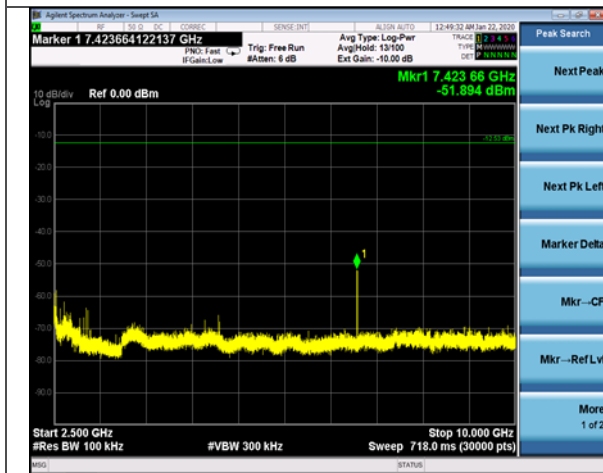
Conducted Tx Spurious – 2500-10000 MHz



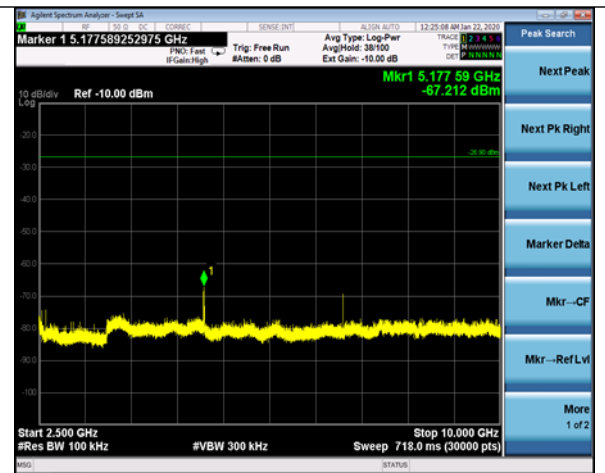
Low Channel



Mid Channel

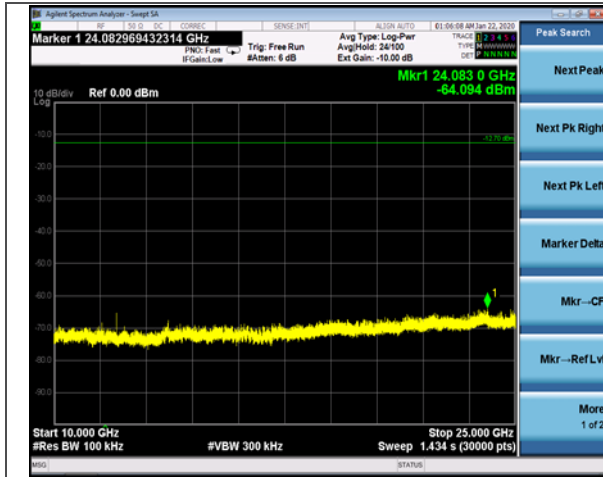


High Channel

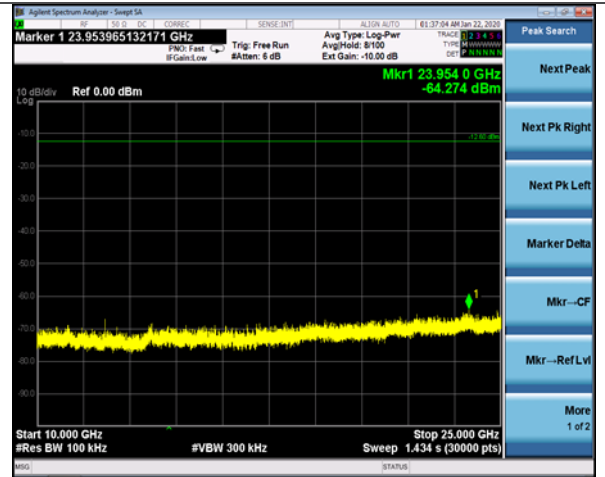


Channel 26

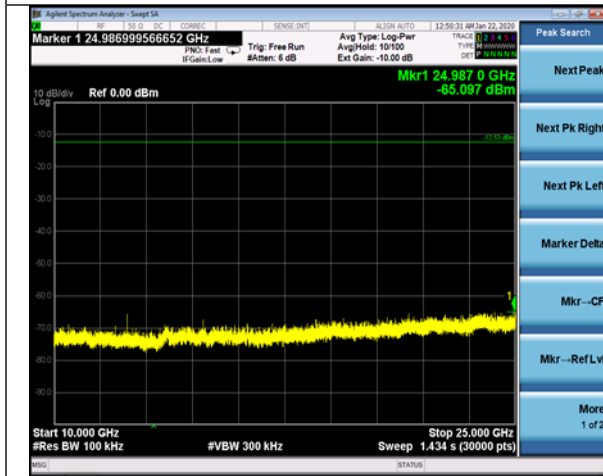
Conducted Tx Spurious – 10000-25000 MHz



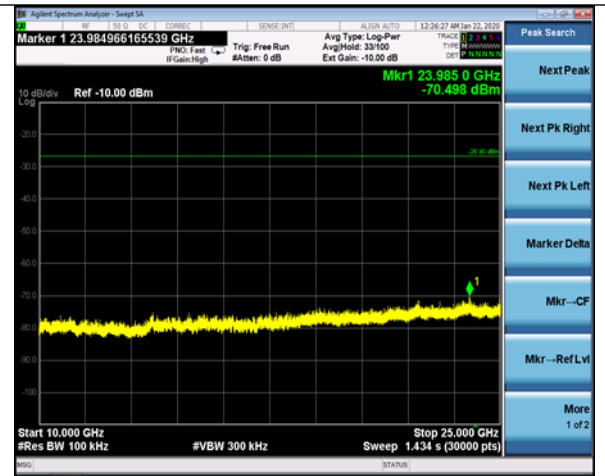
Low Channel



Mid Channel

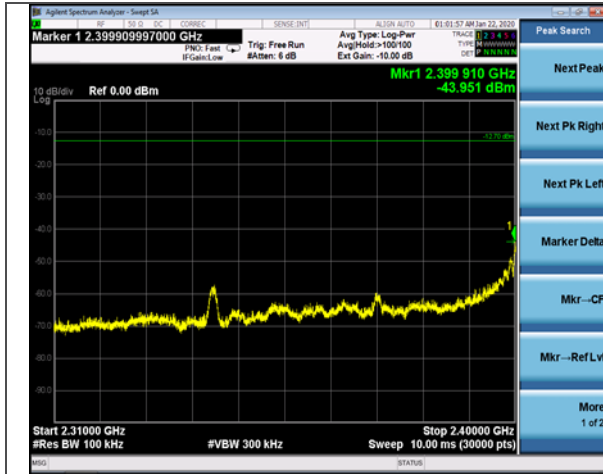


High Channel

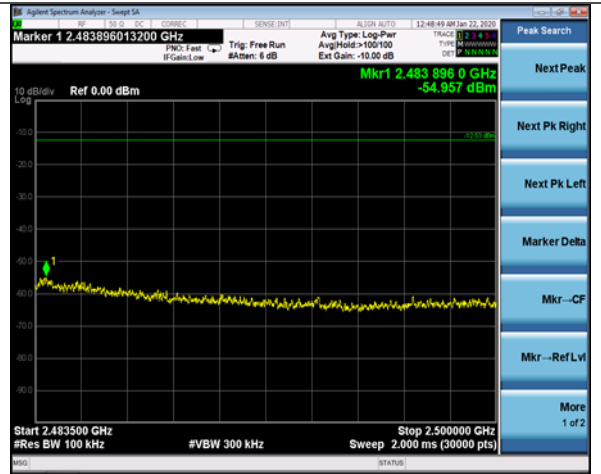


Channel 26

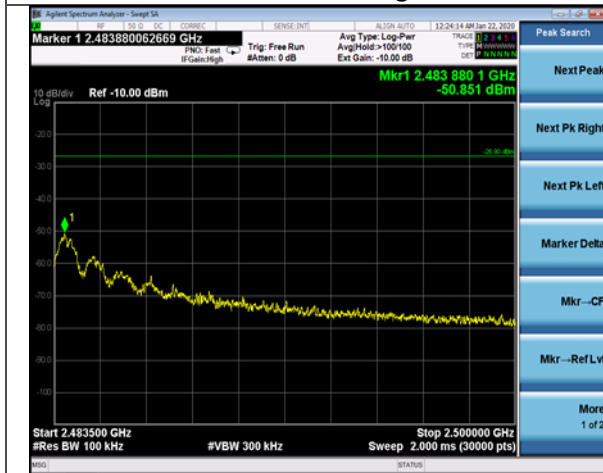
Conducted Tx Spurious – Band Edge



Lower Band Edge



Upper Band Edge

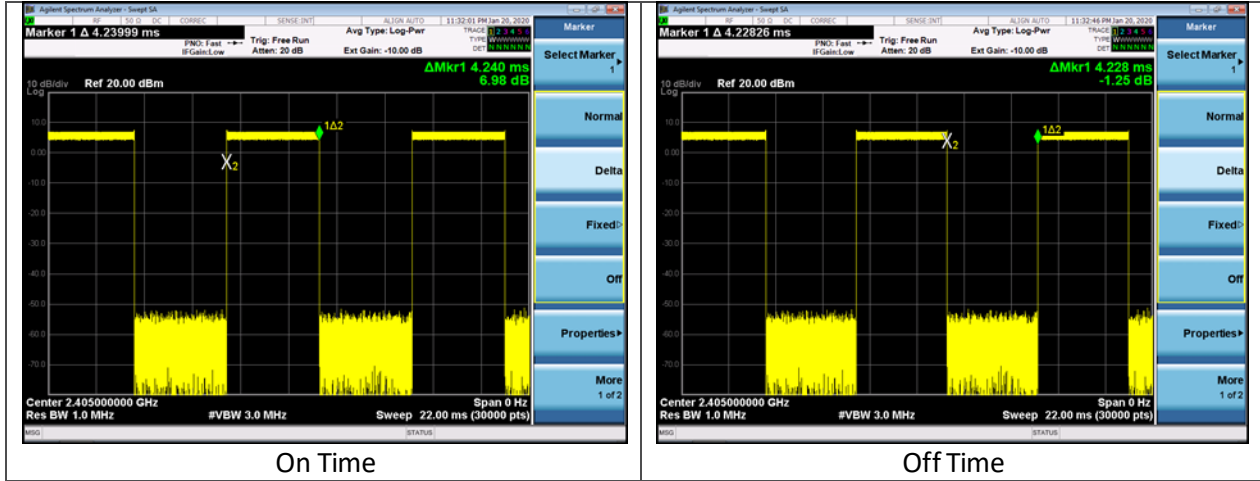


Upper Band Edge (Channel 26)

Cabinet Radiation Duty Cycle Plots

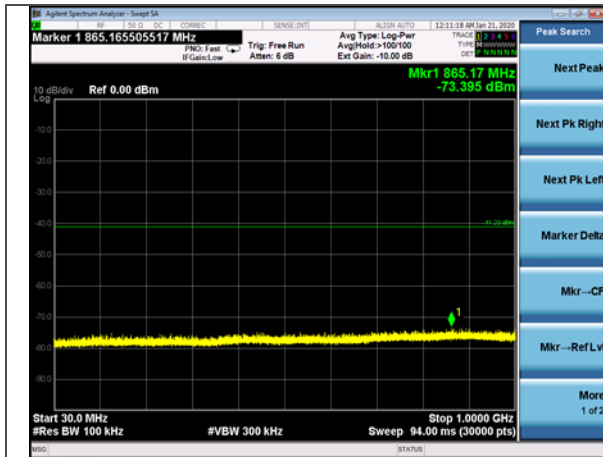
Duty Cycle = $4.240 \text{ ms} / (4.240 + 4.228 \text{ ms}) = 0.5007$

Duty Cycle Correction Factor = $10 * \log(1/D) = 3.0 \text{ dB}$

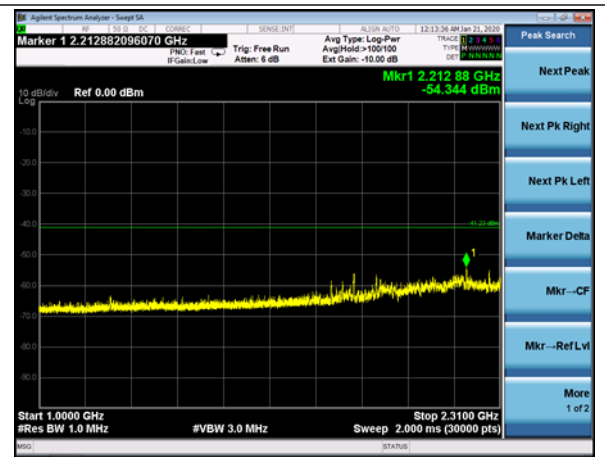


Company: Laird Connectivity	Page 22 of 32	Name: Bluetooth 5.0 BLE Data Module
Report: 319220A		Model: BL654
Job: C-3290		Serial: See Section 2

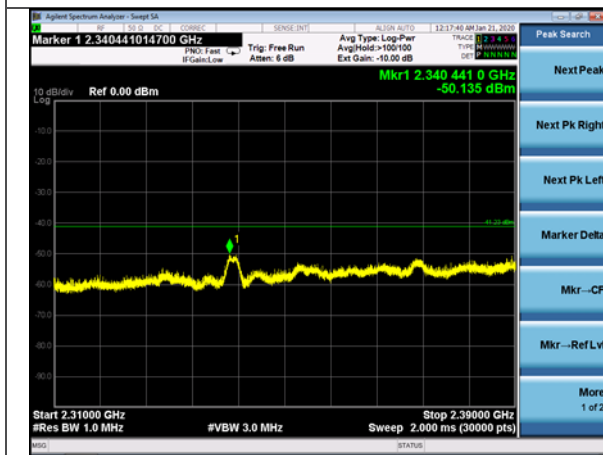
Channel 11 Tx Spurious – Non-restricted bands



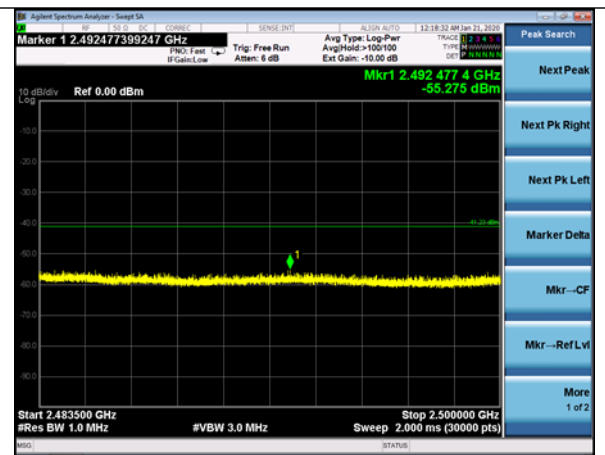
30-1000 MHz



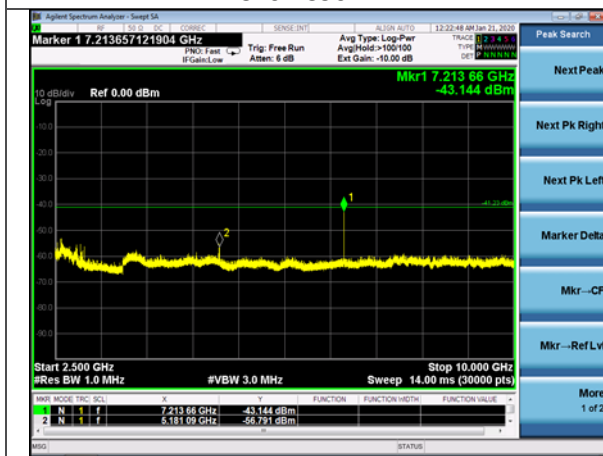
1000-2310 MHz



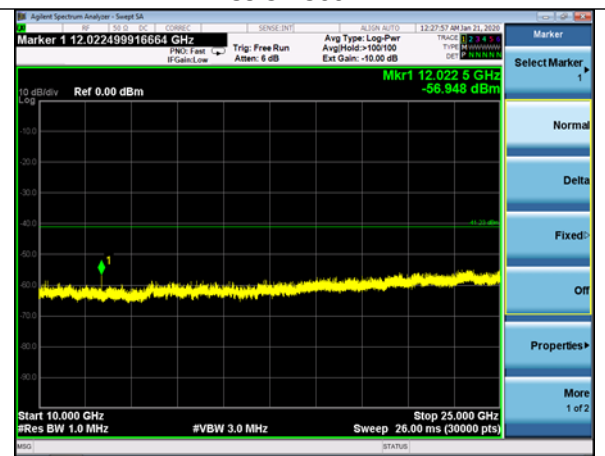
2310-2390 MHz



2483.5-2500 MHz

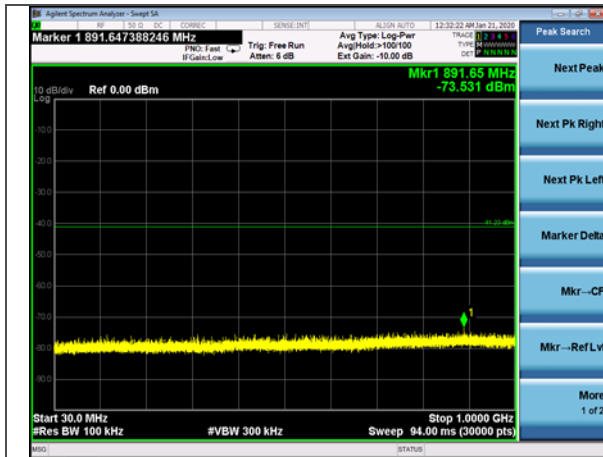


2.5-10 GHz

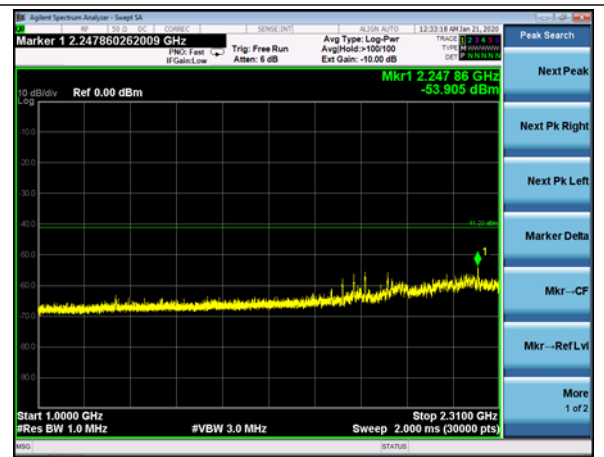


10-25 GHz

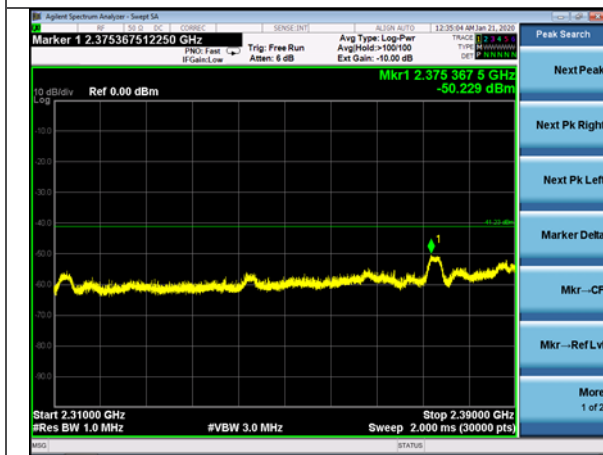
Channel 18 Tx Spurious – Non-restricted bands



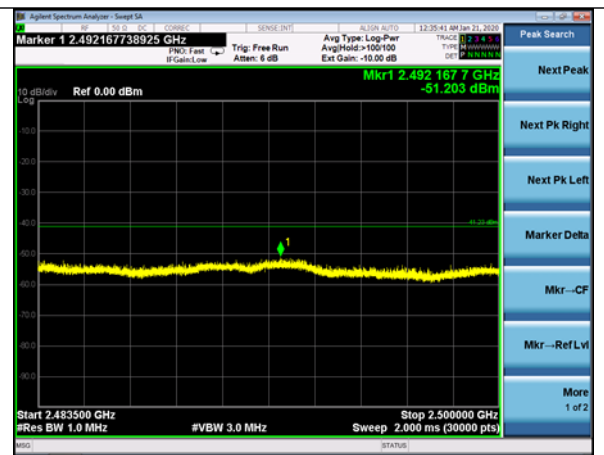
30-1000 MHz



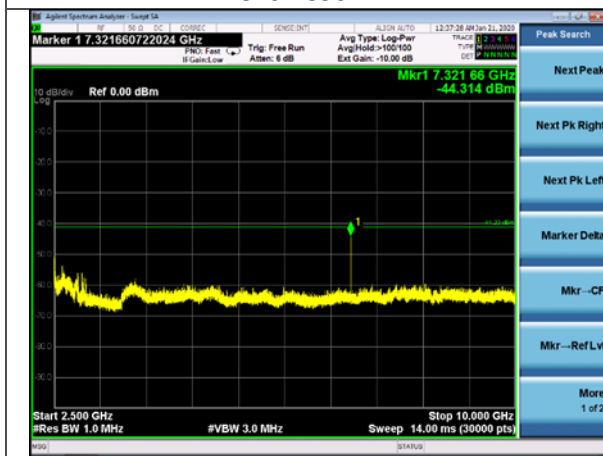
1000-2310 MHz



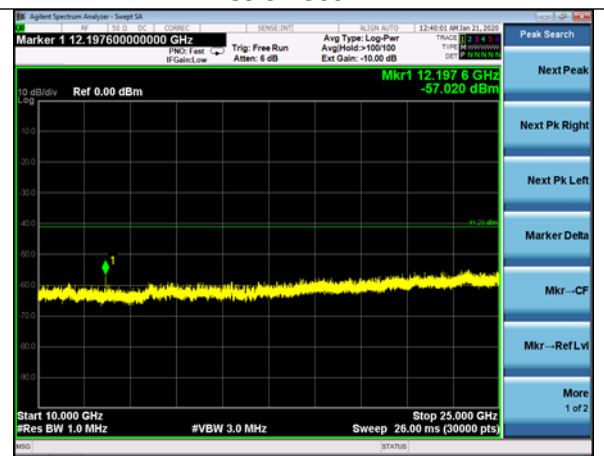
2310-2390 MHz



2483.5-2500 MHz

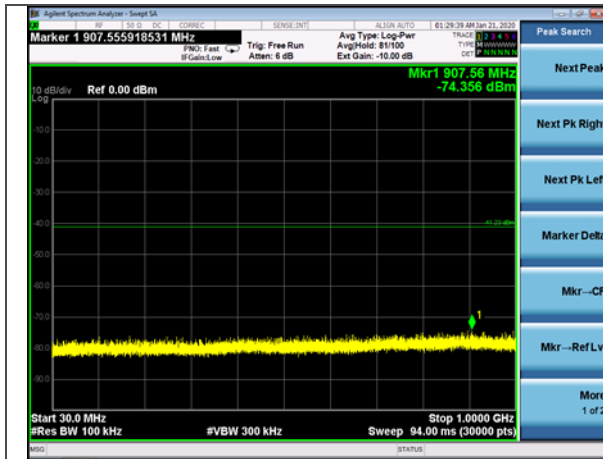


2.5-10 GHz

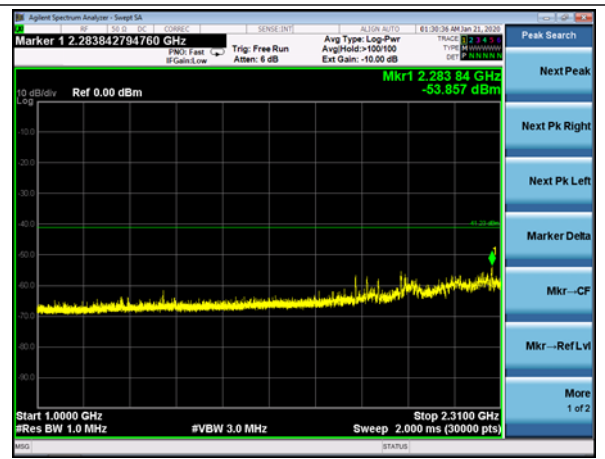


10-25 GHz

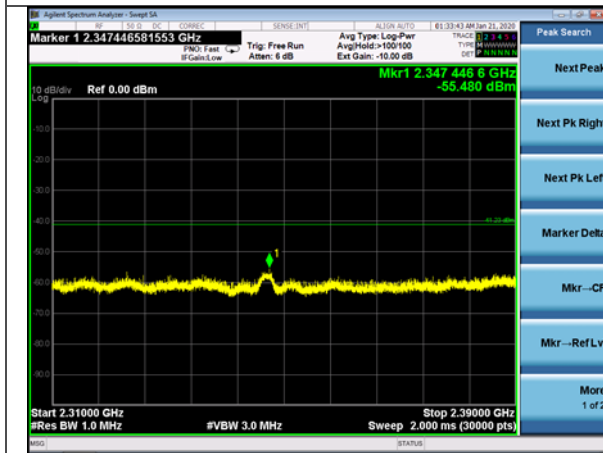
Channel 25 Tx Spurious – Non-restricted bands



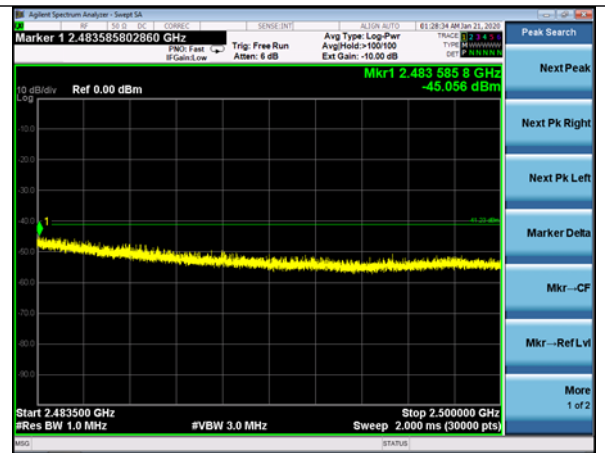
30-1000 MHz



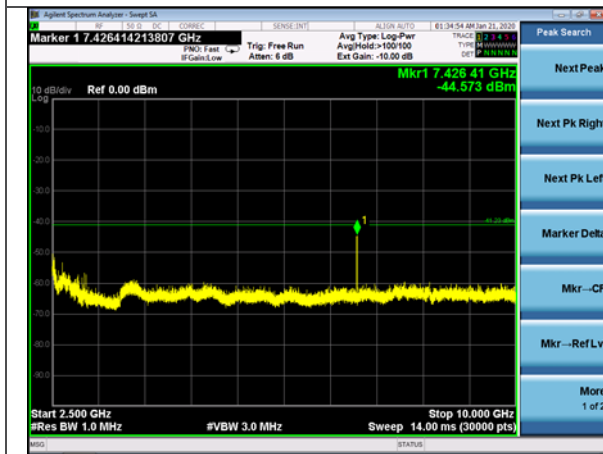
1000-2310 MHz



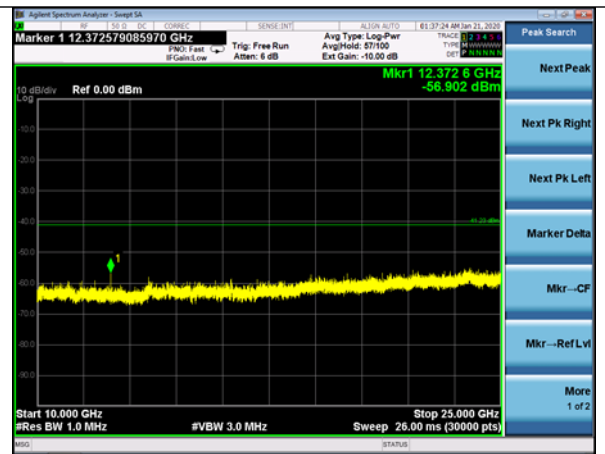
2310-2390 MHz



2483.5-2500 MHz

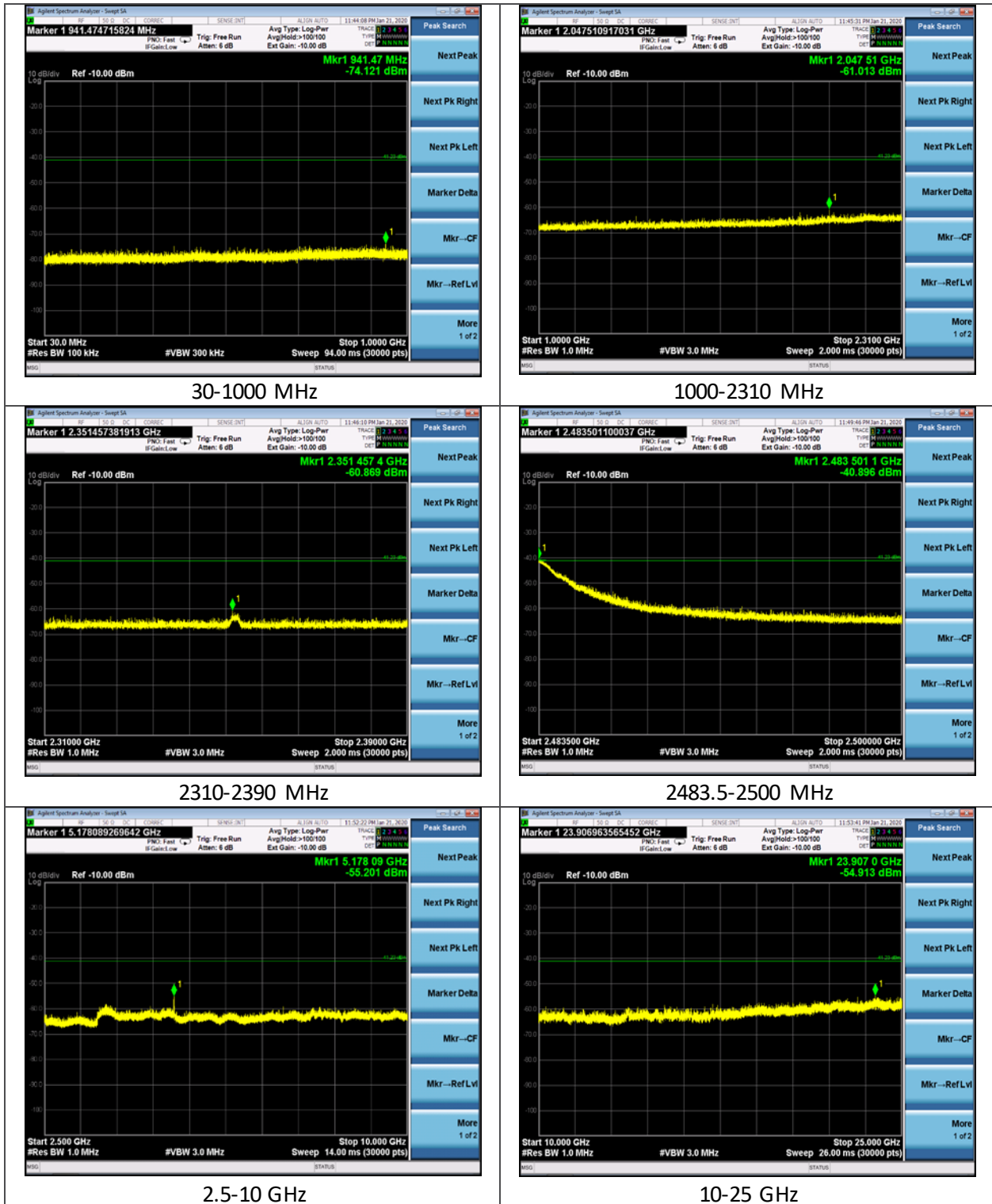


2.5-10 GHz



10-25 GHz

Channel 26 Tx Spurious – Non-restricted bands



5.2 Radiated Emissions

<p>Description of Measurement</p>	<p>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.</p> <p>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.</p> <p>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.</p>
<p>Example Calculations</p>	<p>Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m)</p> <p>Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m)</p> <p>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</p>

Block Diagram



5.2.1 Radiated Emissions

Operator	Jon Dilley	QA	Shane Dock
Temperature	23.9°C	R.H. %	18.50%
Test Date	1/20/2020 – 1/22/2020	Location	Chamber 3
Requirement	FCC 15.247 RSS-247	Method	ANSI C63.10

Limits:

Frequency (MHz)	Field Strength (dBµV/m) at 3 meters
30-88	40.0
88-216	43.5
216-960	46.0
Above 960	54.0

Test Parameters

Frequency	30-1000 MHz; 1-25 GHz	Distance	3 m
Detector(s)	Quasi-Peak (<1GHz); Peak & Average (>1GHz)	Table height	80 cm (<1 GHz); 1.5 m (>1GHz)
RBW	120 kHz (<1GHz); 1 MHz (>1 GHz)	VBW	1.2 MHz (<1GHz); 3 MHz Peak (>1 GHz)
Notes	Antenna Port terminated with a 50 ohm termination. 1 kHz used for Average measurements (Signal was continuous).		

Instrumentation



Date : 10-Aug-2020

Test : FCC Tx

Job : C-3290

PE : Shane Dock

Customer : Laird Connectivity

Quote : 319220

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	7/29/2019	7/29/2020	Active Calibration
2	AA 960163	Antenna - Log Periodic	A.H. Systems, Inc	SAS-512-2	500	10/28/2019	10/28/2020	Active Calibration
3	AA 960128	Antenna - Biconical	ETS Lindgren	3110B	00062899	10/9/2019	10/9/2020	Active Calibration
4	RE 19001	Analyzer - EMI Receiver	Keysight	N9038A	MY50010111	9/23/2019	9/23/2020	Active Calibration
5	AA 960171	Cable	A.H. Systems, Inc	SAC-26G-6	386	12/9/2019	12/9/2020	Active Verification
6	AA 960007	Antenna - Double Ridge Horn	EMCO	3115	9311-4138	10/7/2019	10/7/2020	Active Calibration
7	AA 960153	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-04	4/22/2019	9/3/2020	Active Calibration
8	EE 960160	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	977711030	10/7/2019	10/7/2020	Active Calibration

EUT Parameters

Input Power	Unit Powered by 3x AAA Batteries	Mode	Modulated Tx Mode
EUT	Low, Mid, High Channels		

Table

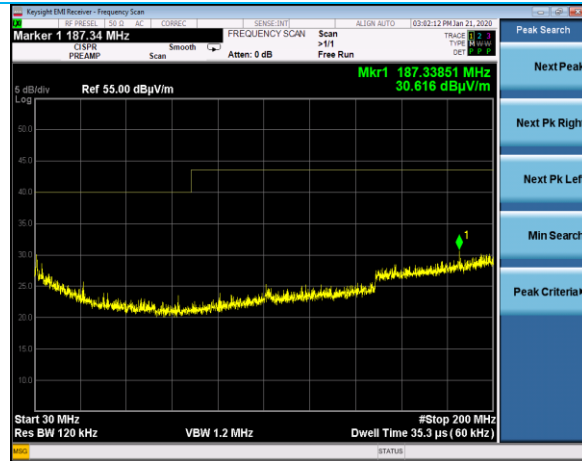
Frequency (MHz)	Band Edge	Antenna Polarity	EUT Orientation	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Channel
2373.3	Lower	Horizontal	Flat	51.3	74.0	22.7	11
2493.5	Upper	Horizontal	Flat	46.7	74.0	27.3	25
2497.1	Upper	Horizontal	Flat	47.0	74.0	27.0	26

Frequency (MHz)	Band Edge	Antenna Polarity	EUT Orientation	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Channel
2383.8	Lower	Horizontal	Flat	39.2	54.0	14.8	11
2495.3	Upper	Horizontal	Flat	35.7	54.0	18.3	25
2497.8	Upper	Horizontal	Flat	35.5	54.0	18.5	26

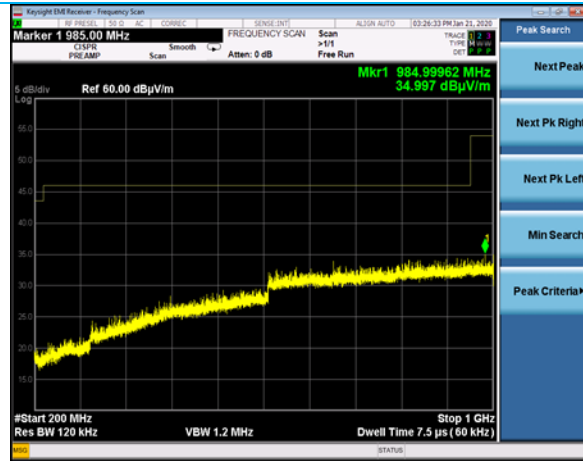
Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Note
7423.55	Vertical	Vertical	190	50	36.2	54.0	17.8	45.9	74.0	28.1	Channel 25
7423.76	Horizontal	Vertical	250	315	38.2	54.0	15.8	47.3	74.0	26.7	Channel 25
7426.26	Horizontal	Horizontal	165	288	38.4	54.0	15.6	48.4	74.0	25.6	Channel 25
7423.76	Vertical	Horizontal	150	320	33.5	54.0	20.5	43.9	74.0	30.1	Channel 25
7423.63	Vertical	Flat	250	0	37.9	54.0	16.1	46.8	74.0	27.2	Channel 25
7423.57	Horizontal	Flat	100	124	34.9	54.0	19.1	45.1	74.0	28.9	Channel 25
7321.29	Horizontal	Horizontal	150	290	38.4	54.0	15.6	47.7	74.0	26.3	Channel 18

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)	Note
12372.56	Vertical	Vertical	150	0	41.1	54.0	12.9	50.6	74.0	23.4	Channel 25
12372.51	Horizontal	Vertical	118	30	40.6	54.0	13.4	49.6	74.0	24.4	Channel 25
12377.27	Horizontal	Horizontal	125	344	41.3	54.0	12.7	51.3	74.0	22.7	Channel 25
12377.24	Vertical	Horizontal	100	30	40.6	54.0	13.4	50.4	74.0	23.6	Channel 25
12377.32	Vertical	Flat	265	239	41.6	54.0	12.4	51.0	74.0	23.0	Channel 25
12372.72	Horizontal	Flat	300	121	39.7	54.0	14.3	48.4	74.0	25.6	Channel 25
12027.32	Vertical	Flat	260	9	42.0	54.0	12.0	51.5	74.0	22.5	Channel 11
12197.53	Vertical	Flat	250	10	43.3	54.0	10.7	52.2	74.0	21.8	Channel 18

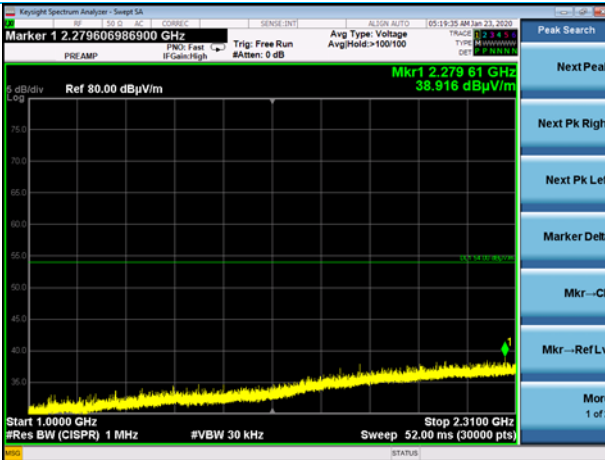
Plots



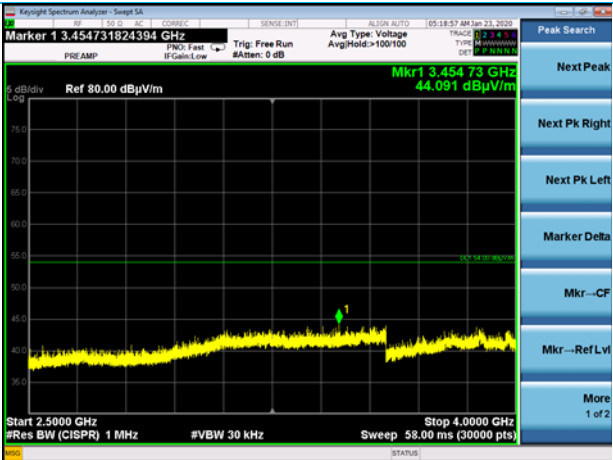
30-200 MHz Vertical Polarization



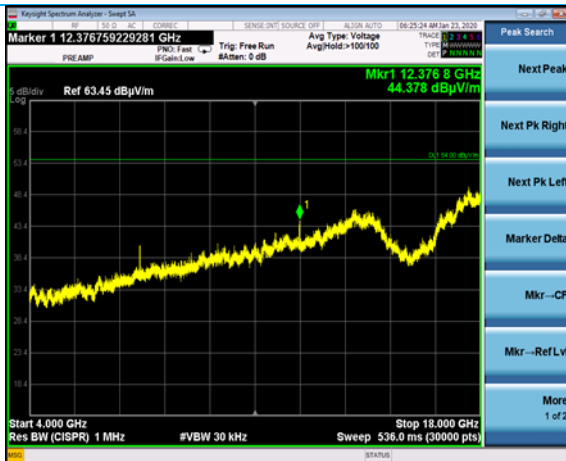
200-1000 MHz Vertical Polarization



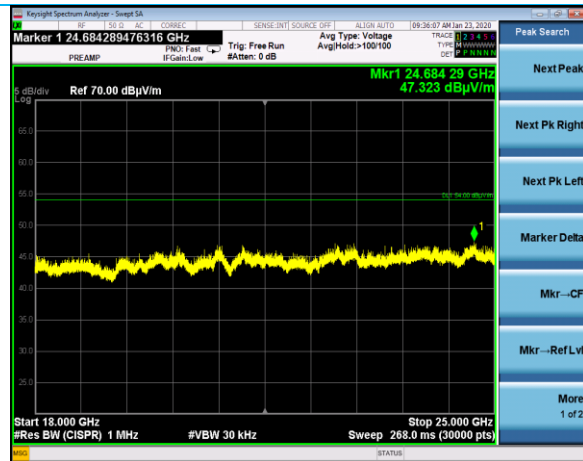
1000-2310 MHz Horizontal Polarization



2500-4000 MHz Horizontal Polarization

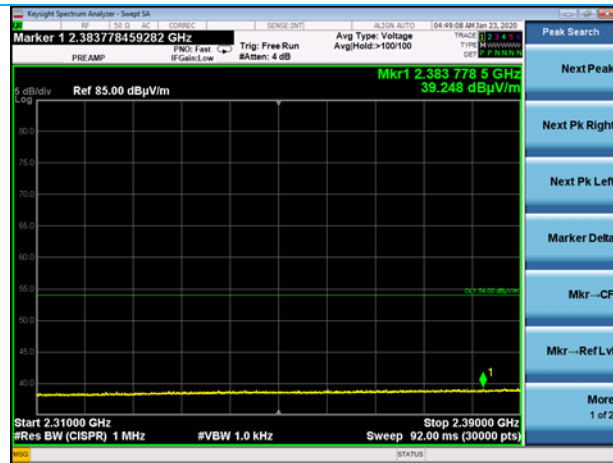


4-18 GHz Horizontal Polarization

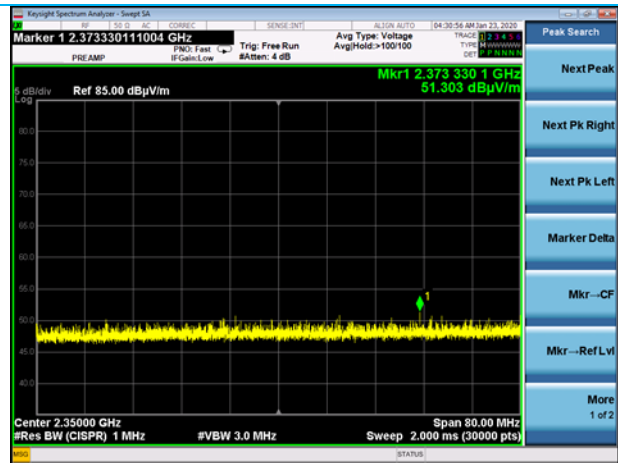


18-25 GHz Vertical Polarization

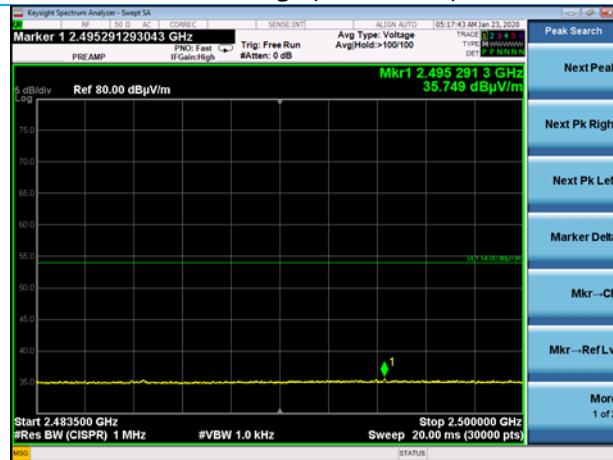
Plots – Band Edges



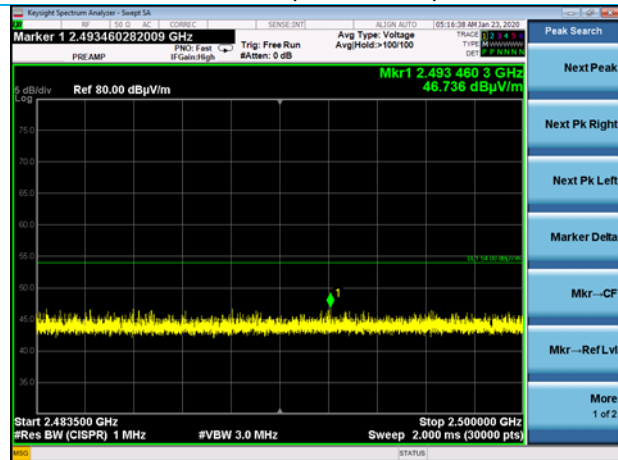
LBE Average (Channel 11)



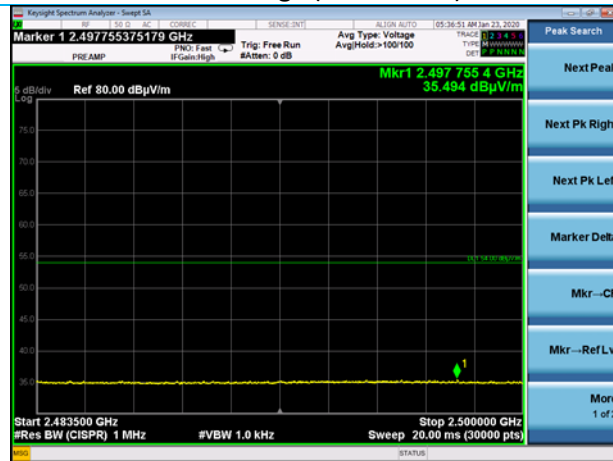
LBE Peak (Channel 11)



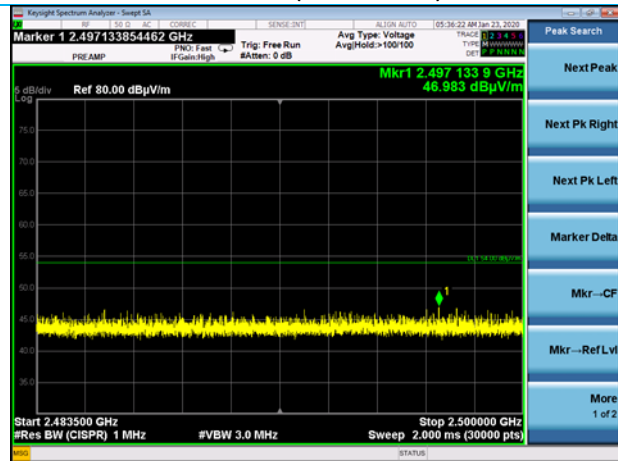
UBE Average (Channel 25)



UBE Peak (Channel 25)



UBE Average (Channel 26)



UBE Peak (Channel 26)

Company: Laird Connectivity	Page 31 of 32	Name: Bluetooth 5.0 BLE Data Module
Report: 319220A		Model: BL654
Job: C-3290		Serial: See Section 2

6 REVISION HISTORY

Version	Date	Notes	Person
0	8/12/2020	First Draft	Shane Dock
1	12/11/2020	Updated Draft	Shane Dock
2	12/14/2020	Second Draft	Shane Dock
3	1/12/2021	Third Draft	Shane Dock
4	1/12/2021	Final Draft	Shane Dock
5	2/17/2021	TCB Responses	Shane Dock

END OF REPORT