Test Report # 319154 A

Equipment Under Test:	ST60-2230C
Test Date(s):	7/9/2020
Prepared for:	Laird Connectivity Attn: Jay White W66 N220 Commerce Ct. Cedarburg, WI 53012

Report Issued by: Shane Dock, EMC Engineer

Signature:

Date: 7/15/2020

Report Reviewed by: Adam Alger, Quality Manager

Signature:

Date: 7/15/2020

Report Constructed by: Shane Dock, EMC Engineer

Signature:

Date: 7/13/2020

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Laird Connectivity Test Services in Review

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

ACCREDITED
TESTING CERT #1255.01

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

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Federal Communications Commission (FCC) – USA

Accredited Test Firm Registration Number: 953492

Recognition of two 3 meter Semi-Anechoic Chambers

Government of Canada

Innovation, Science and Economic Development Canada

Accredited U.S. Identification Number: US0218

Recognition of two 3 meter Semi-Anechoic Chambers

1 Test Report Summary

During **7/9/2020** the Equipment Under Test (EUT), **ST60-2230C-PU**, as provided by **Laird Connectivity** was tested to the following requirements:

FCC Part 15.247 (Pursuant to a Class II Permissive Change)

Requirements	Description	Method	Compliant
FCC Part 15.247 RSS-247	Radiated Emissions 1000-25000 MHz	ANSI C63.10	Pass
FCC Part 15.247 RSS-247	RF Conducted Output Power	ANSI C63.10	Pass

Note: Testing was done pursuant to KDB 178919.

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	Less than 0.1 dB below limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

2 CLIENT INFORMATION

Company Name	Laird Connectivity
Contact Person	Jay White
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	Series 60
Model Number	ST60-2230C-PU
Serial Number	Engineering Sample
FCC/IC ID:	FCC: SQG-60SIPT IC: 3147A-60SIPT

2.2 Product Description

802.11 ac/a/b/g/n + Bluetooth 4.2 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

EUT is a Laird Connectivity module powered with 120 VAC at 60 Hz. This testing is aimed at adding a Radiall R380500150 monopole antenna to the original filing. The 2.4 GHz WLAN radio was programmed through its low, mid, and high channels at a variety of data rates. The 6 MBPS data rate was utilized for spurious emissions, and the band edges were done at 1 MBPS, 6 MBPS, and MCS0 (HT20 and HT40).

3 REFERENCES

Publication	Edition	Date	AMD 1
FCC Part 15	-	2020	-
RSS-247	2	2017	-
ANSI C63.10	-	2014	-
KDB 178919	-	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 ±
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

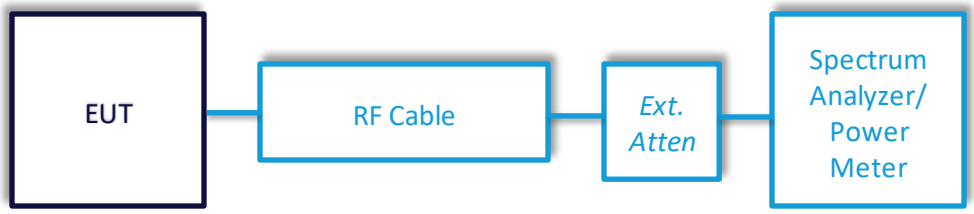
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
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 Antenna Port Conducted Emissions

Operator	Shane Dock		
Temperature	23.8 degrees Celsius	**R.H. %**	54.80%
Test Date	7/9/2020	**Location**	Conducted RF Bench
Requirement	FCC Part 15.247 RSS-247	**Method**	ANSI C63.10 Section 11.9.2.2.2

Limits:

30 dBm

Test Parameters

Frequency	2412-2462 MHz	**Setup**	EUT connected to Spectrum Analyzer and in Modulated Tx mode. EUT Duty Cycle = 100%.
RBW	390 kHz	**VBW**	3 MHz
Detector(s)	RMS	**Settings**	Trace Averaging

Instrumentation

Date : 3-Dec-2019 Test : Conducted Power Output Job : C-3250

PE : Shane Dock Customer : ARRI Quote : 319154

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/24/2019	9/5/2020	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	12/9/2019	12/9/2020	Active Verification

EUT Parameters

Input Power	Unit powered with 120 VAC	**Mode**	Modulated Tx Mode 802.11n MCS0 HT20
Frequency	2412-2462 MHz	**Channel**	1, 6, 11
Notes	EUT Tested in MIMO Mode from each antenna port		

Data

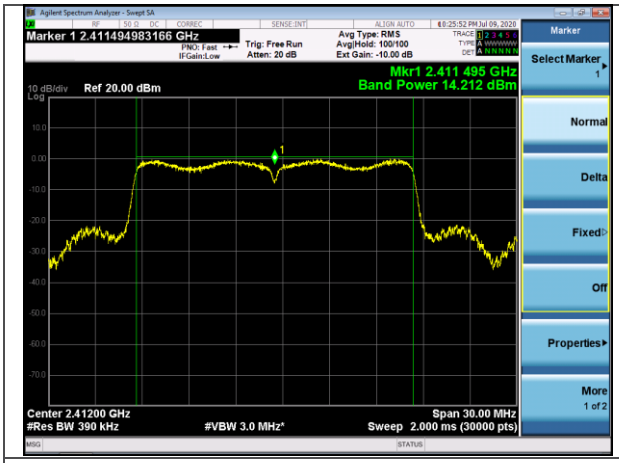
Table

Antenna Port	Frequency (MHz)	Measured POut (dBm)	Limit (dBm)	Margin (dB)
0	2412	14.2	30.0	15.8
1	2412	14.5	30.0	15.5
0	2437	17.8	30.0	12.2
1	2437	18.1	30.0	11.9
0	2462	11.8	30.0	18.2
1	2462	12.3	30.0	17.7

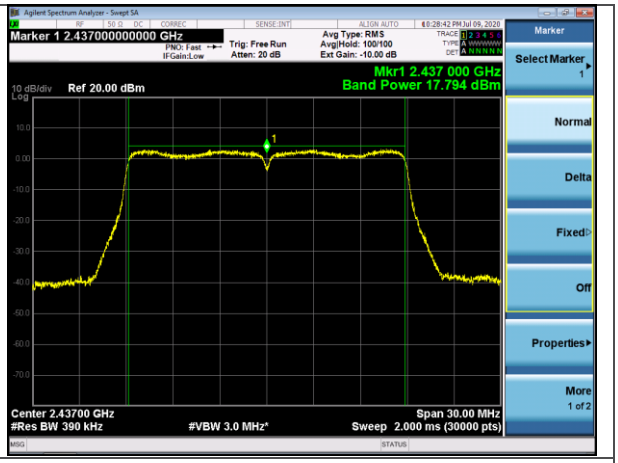
Worst Case Margin (Mid Channel): 17.8 dBm + 18.1 dBm = 21.0 dBm

30 dBm – 21.0 dBm = 9.0 dB.

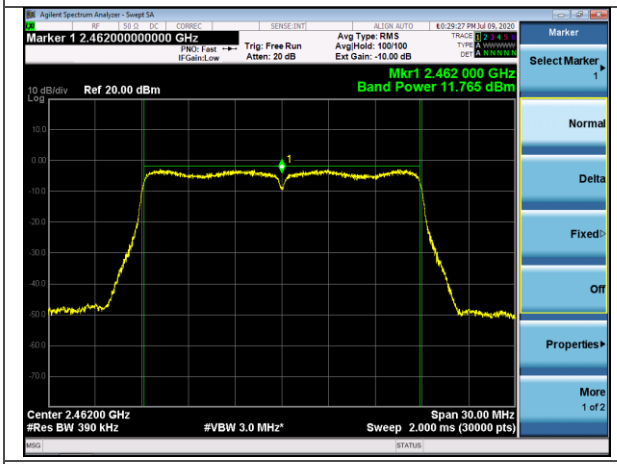
Plots



Low Channel Ant 0



Mid Channel Ant 0



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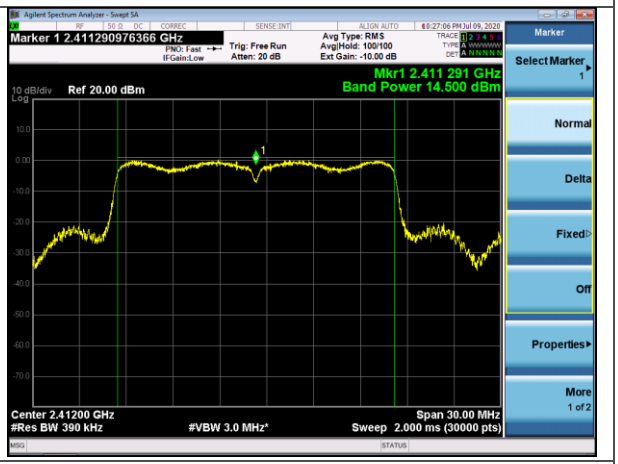
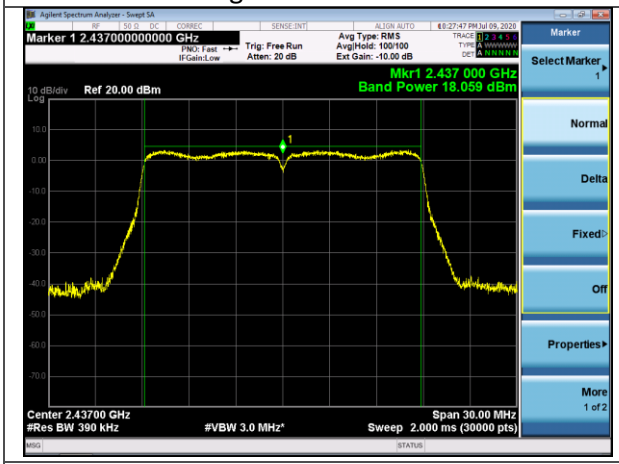


Low Channel Ant 1



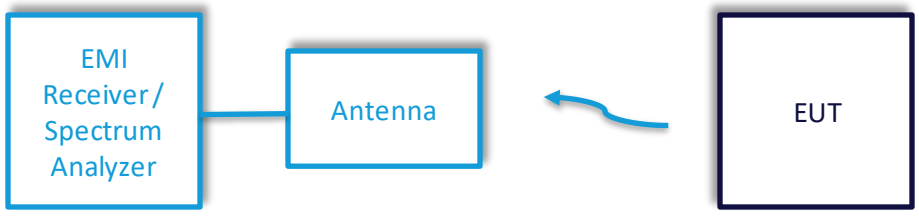
Mid Channel Ant 1

High Channel Ant 1

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

Operator	Shane Dock		
Temperature	23.8 degrees Celsius	**R.H. %**	54.80%
Test Date	7/9/2020	**Location**	Chamber 5
Requirement	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

Above 1 GHz, the limit is an average limit. There is a peak limit 20 dB above limits shown.

Test Parameters

Frequency	1000-25000 MHz	**Distance**	3 m
Detector(s)	Average, Peak	**Table height**	150 cm
RBW	1 MHz	**VBW**	3 MHz (10 Hz Average)
Notes	All data rates had a continuous duty cycle.		

Instrumentation

Date : 3-Dec-2019 Test : Radiated Emissions Job : C-3250

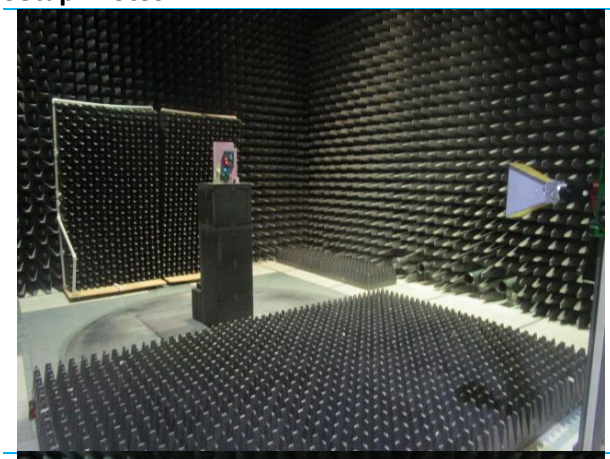
PE : Shane Dock Customer : ARRI Quote : 319154

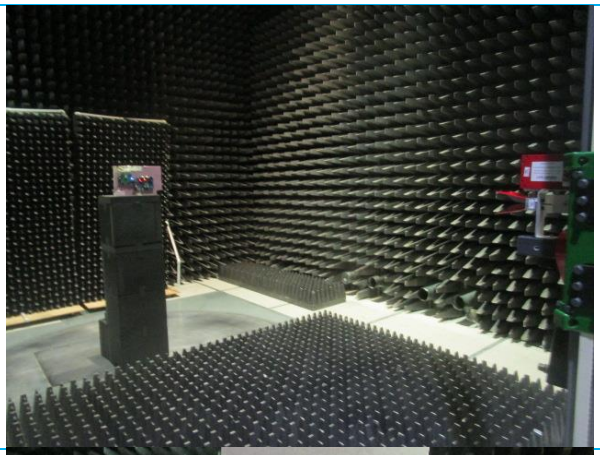
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960007	Antenna - Double Ridge Horn	EMCO	3115	9311-4138	10/7/2019	10/7/2020	Active Calibration
2	AA 960176	Cable	A.H. Systems, Inc	SAC-26G-6	395	12/9/2019	12/9/2020	Active Verification
3	AA 960153	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-04	4/22/2019	9/3/2020	Active Calibration
4	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/24/2019	9/5/2020	Active Calibration
5	AA 960174	Antenna - Small Horn	ETS Lindgren	3116C-PA	00206880	11/7/2019	11/7/2020	Active Calibration

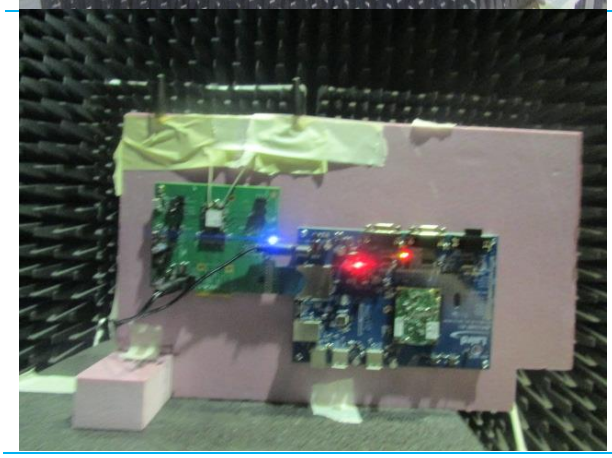
EUT Parameters

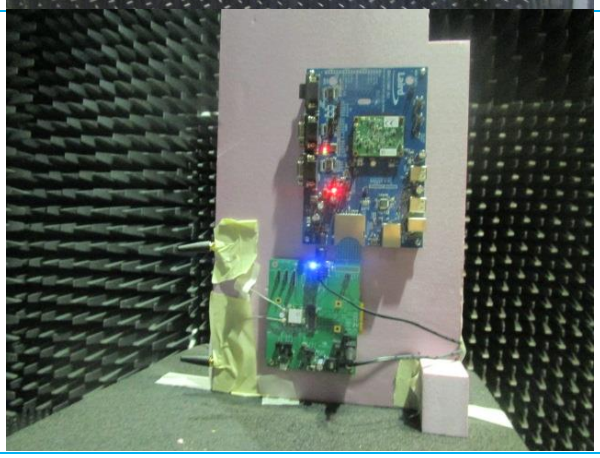
Input Power	120 VAC, 60 Hz	**Mode**	Modulated Tx Mode for 1 MBPS, 6 MBPS, MCS0 HT20 and HT40
EUT	EUT Tested in 3 orientations. All data rates tested for band edges, only MCS0 HT20 tested for spurious emissions	**EUT**	All data rates found to be continuous

Setup Photos









Table

Band Edges (Emissions below 2.3 GHz are not a function of the transmitter.)

Frequency (MHz)	Orientation	Polarization	Height (cm)	Azimuth (degrees)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Note
2386.2	H	H	106.4	176.3	47.8	54.0	6.2	1 MBPS
2486.8	H	H	106.4	176.3	43.9	54.0	10.1	1 MBPS
2388.6	H	H	106.4	176.3	43.4	54.0	10.6	6 MBPS
2484.4	H	H	106.4	176.3	48.6	54.0	5.4	6 MBPS
2390.0	H	H	106.4	176.3	45.5	54.0	8.5	MCS0 HT20
2484.7	H	H	106.4	176.3	46.7	54.0	7.3	MCS0 HT20
2387.2	H	H	106.4	176.3	44.5	54.0	9.5	MCS0 HT40
2485.1	H	H	106.4	176.3	49.1	54.0	4.9	MCS0 HT40

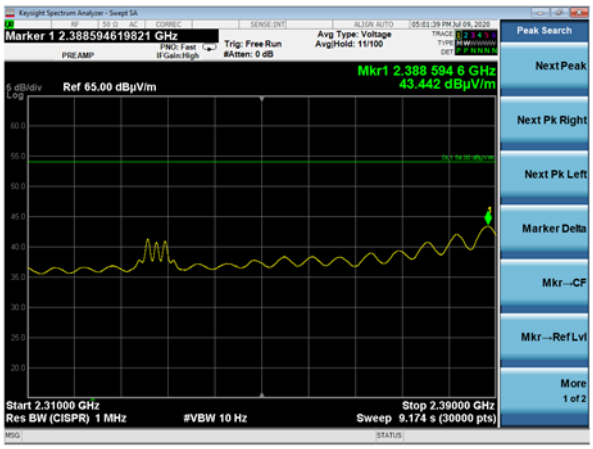
Frequency (MHz)	Orientation	Polarization	Height (cm)	Azimuth (degrees)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Note
2386.6	H	H	106.4	176.3	54.0	74.0	20.0	1 MBPS
2488.5	H	H	106.4	176.3	52.2	74.0	21.8	1 MBPS
2389.3	H	H	106.4	176.3	60.1	74.0	13.9	6 MBPS
2484.4	H	H	106.4	176.3	64.2	74.0	9.8	6 MBPS
2389.7	H	H	106.4	176.3	59.0	74.0	15.0	MCS0 HT20
2485.3	H	H	106.4	176.3	62.8	74.0	11.2	MCS0 HT20
2386.2	H	H	106.4	176.3	56.6	74.0	17.4	MCS0 HT40
2484.8	H	H	106.4	176.3	62.7	74.0	11.3	MCS0 HT40

Spurious Emissions

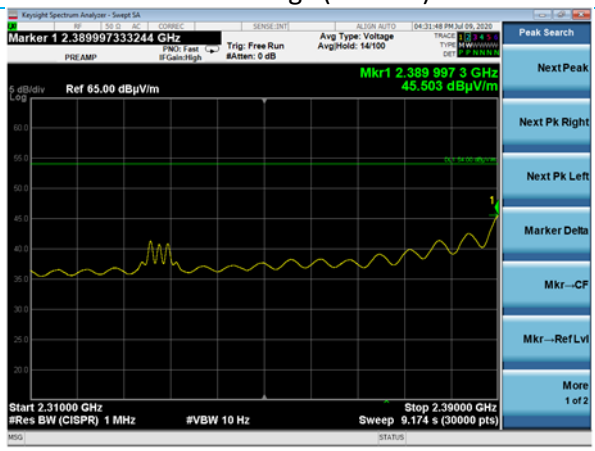
Frequency (MHz)	Orientation	Polarization	Height (cm)	Azimuth (degrees)	Peak Reading (dBµV)	Average Reading (dBµV)	Peak Limit (dBµV)	Average Limit (dBµV)	Peak Margin (dB)	Average Margin (dB)	Note
7383.9	H	V	208.0	14.5	47.0	35.3	74.0	54.0	27.0	18.7	High
7383.9	H	H	156.8	335.3	54.6	42.6	74.0	54.0	19.4	11.4	High
7383.9	V	V	150.6	327.0	53.8	41.4	74.0	54.0	20.2	12.6	High
7383.9	V	H	192.0	125.8	47.7	35.5	74.0	54.0	26.3	18.5	High
7383.9	F	V	126.4	300.0	48.7	35.3	74.0	54.0	25.3	18.7	High
7383.9	F	H	151.0	312.3	54.4	41.9	74.0	54.0	19.6	12.1	High
7311.6	H	H	125.7	12.8	52.8	40.4	74.0	54.0	21.2	13.6	High
4868.7	H	H	100.0	48.0	48.5	35.8	74.0	54.0	25.5	18.2	Mid
4868.7	H	V	177.0	223.3	47.3	35.4	74.0	54.0	26.7	18.6	Mid
4821.2	H	H	287.9	54.3	45.6	34.2	74.0	54.0	28.4	19.8	Low
4821.2	H	V	183.2	225.0	44.6	33.3	74.0	54.0	29.4	20.7	Low

Band Edges Plots

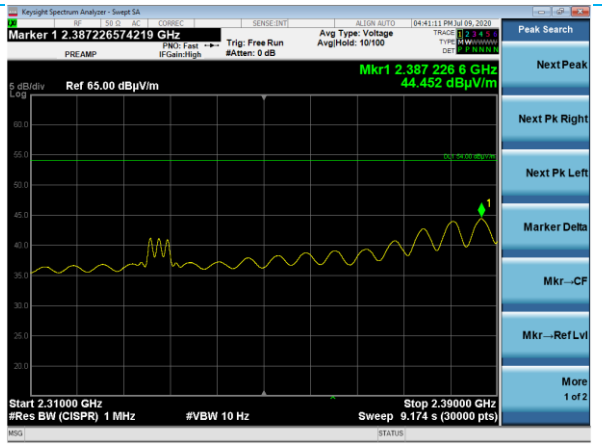
LBE Average (1 MBPS)



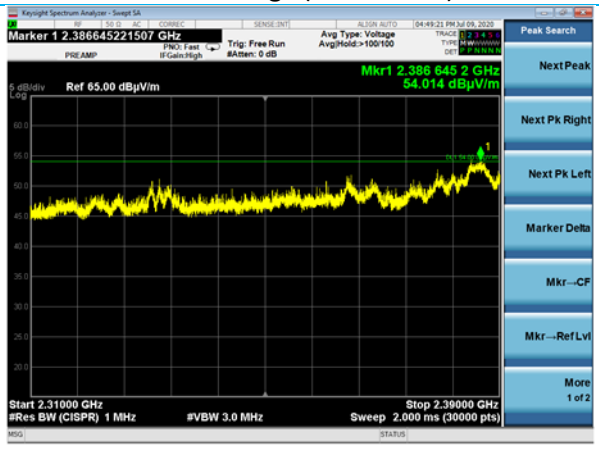
LBE Average (6 MBPS)



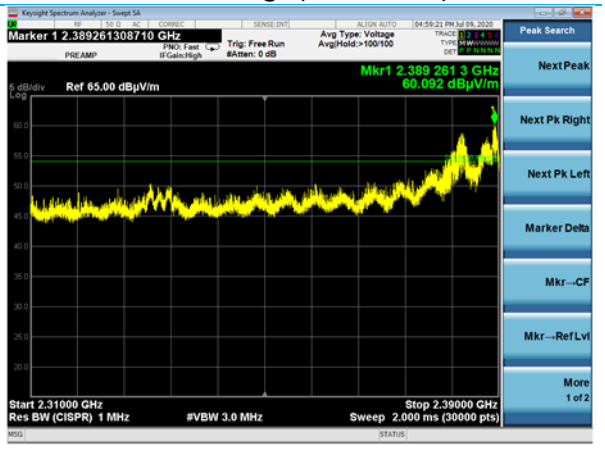
LBE Average (MCS0 HT20)



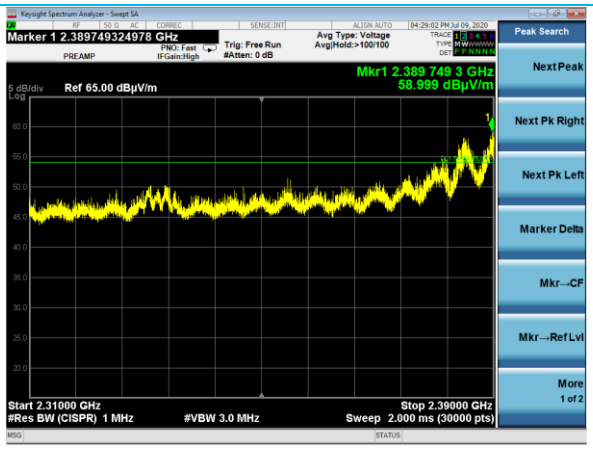
LBE Average (MCS0 HT40)



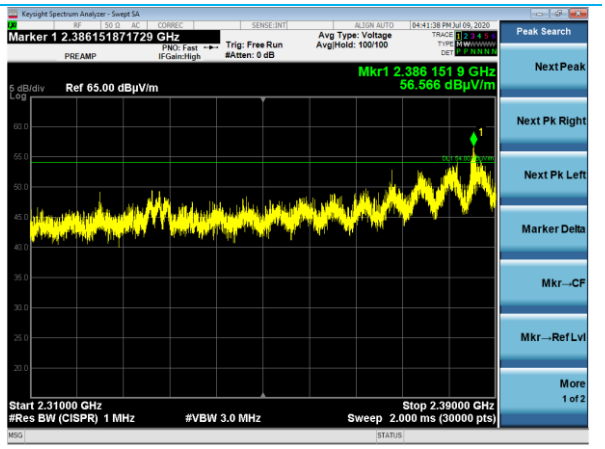
LBE Peak (1 MBPS)



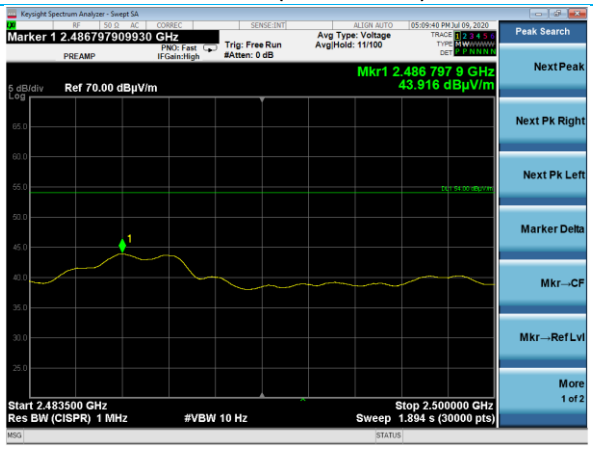
LBE Peak (6 MBPS)



LBE Peak (MCS0 HT20)

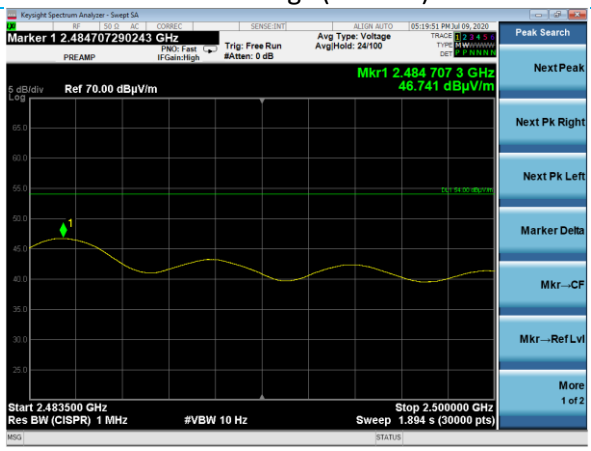


LBE Peak (MCS0 HT40)



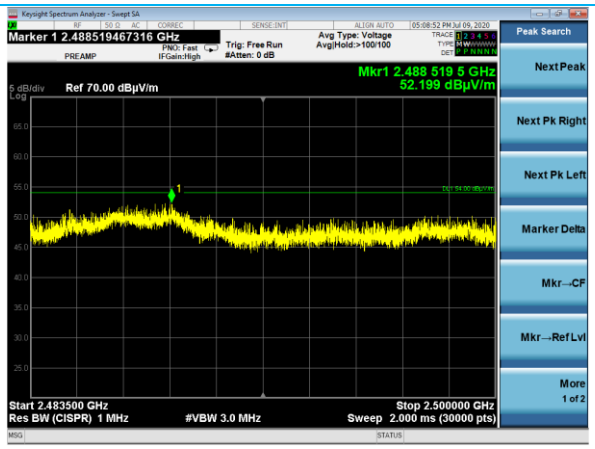
UBE Average (1 MBPS)

UBE Average (6 MBPS)

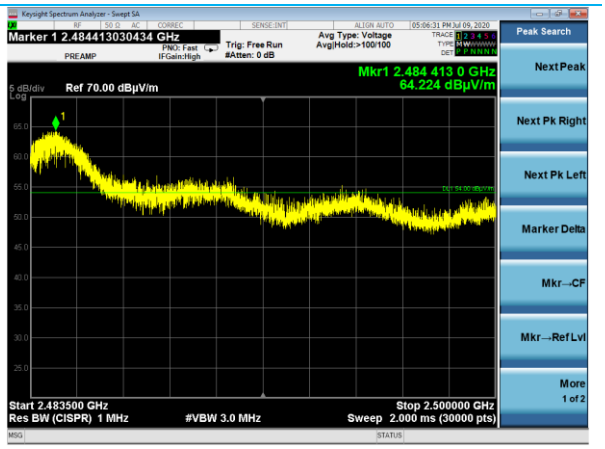


UBE Average (MCS0 HT20)

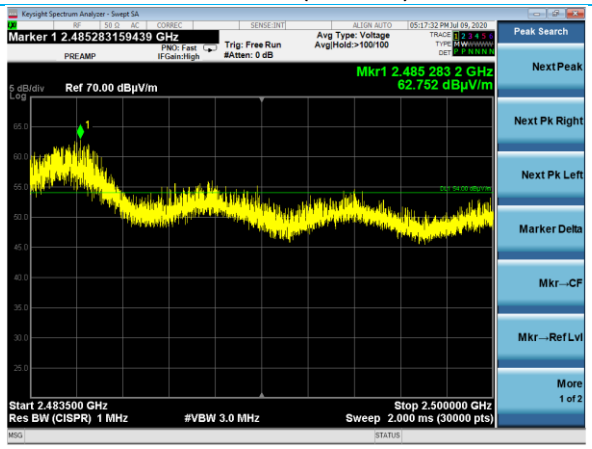
UBE Average (MCS0 HT40)



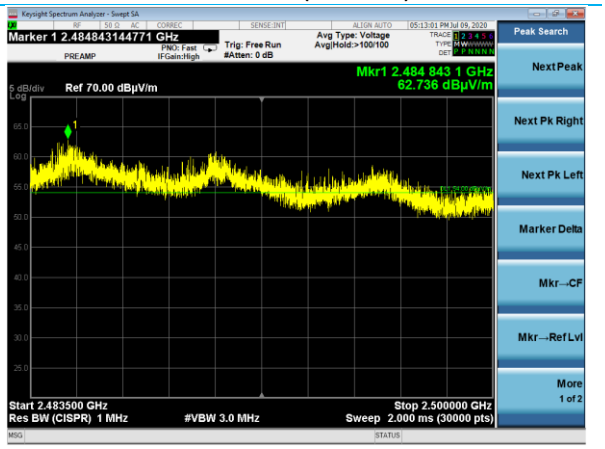
UBE Peak (1 MBPS)



UBE Peak (6 MBPS)

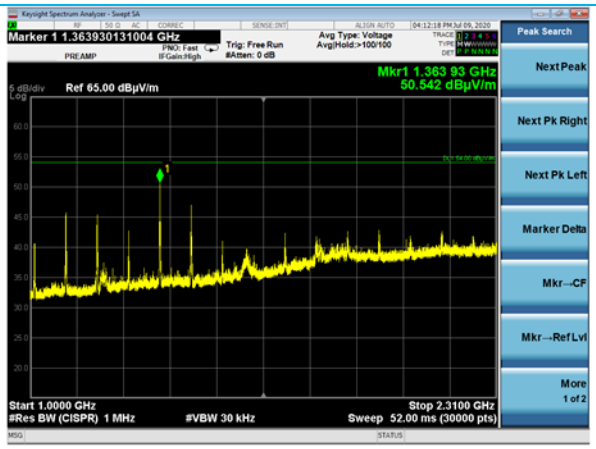


UBE Peak (MCS0 HT20)

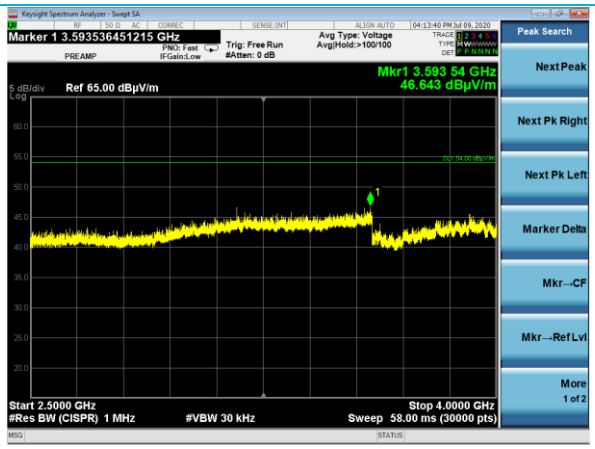


UBE Peak (MCS0 HT40)

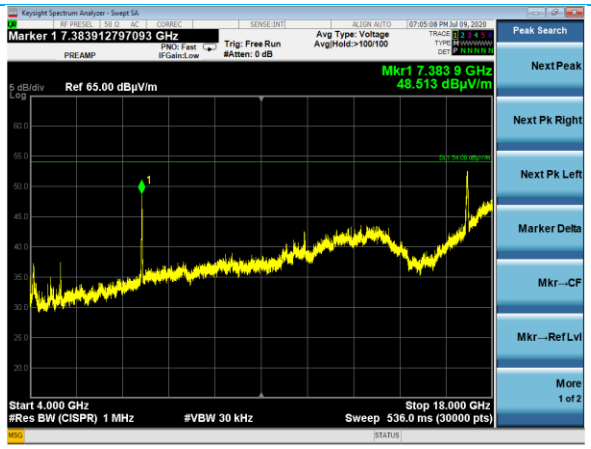
Spurious Plots



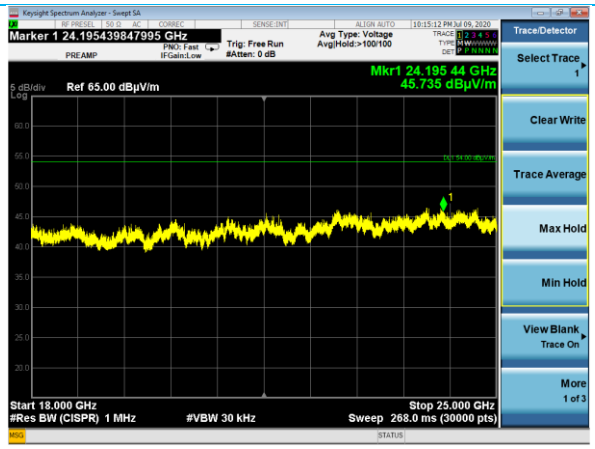
1.00 – 2.31 GHz Vertical Polarization



2.5 – 4.0 GHz Vertical Polarization



4 – 18 GHz Horizontal Polarization



18 – 25 GHz Horizontal Polarization

6 Revision History

Version	Date	Notes	Person
0	7/13/2020	First Draft	Shane Dock
1	7/14/2020	Revised Draft	Shane Dock
2	7/15/2020	Final Draft	Shane Dock

END OF REPORT