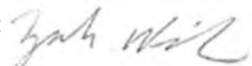


Test Report # 319325 A

Equipment Under Test:	KOLO Gen2 WiFi Module
Requirement(s):	FCC 15.247, FCC 15.207, FCC 15.209, RSS-247, RSS-GEN
Test Date(s):	October 12 th , - June 18 th , 2021
Prepared for:	Georgia Pacific Attn: Randall Duval 1915 Marathon Avenue Neenah, WI 54956

Report Issued by: Zach Wilson, EMC Engineer

Signature: 

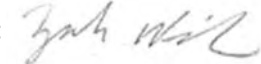
Date: 9/21/2021

Report Reviewed by: Adam Alger, Laboratory Manager

Signature: 

Date: 7/27/2021

Report Constructed by: Zach Wilson, EMC Engineer

Signature: 

Date: 6/10/2021

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Company: Georgia Pacific	Page 1 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

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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

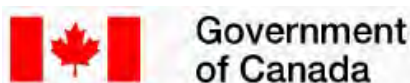
Scope of accreditation includes all test methods listed herein unless otherwise noted



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

Company: Gerogia Pacific	Page 3 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **October 12th – June 18th, 2021** the Equipment Under Test (EUT), **KOLO Gen2 WiFi Module**, as provided by **Georgia Pacific** was tested to the following requirements **Federal Communications Commission and Innovation, Science and Economic Development Canada**:

DTS

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2) IC: RSS-247 5.2 (a)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Pass
FCC: 2.1049 IC: RSS-GEN 6.7	Occupied Bandwidth	Reported	ANSI C63.10	Pass
FCC: 15.247 (b)(3) IC: RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (e) IC: RSS-247 5.2 (b)	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	30 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
FCC: 15.207 IC: RSS-GEN 8.8	AC Power Line Conducted Emissions	0.150-30 MHz	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	Below specified limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

Company: Georgia Pacific	Page 4 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

2 CLIENT INFORMATION

Company Name	Georgia Pacific
Contact Person	Randall Duval
Address	1915 Marathon Avenue Neenah, WI 54956

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	KOLO Gen2 WiFi Module
Model Number	ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Serial Number	Engineering Sample
FCC ID	2AALY-530GP
IC ID	21620-530GP

2.2 Product Description

The 530GP is a module consisting of the Texas Instruments CC3135 WLAN 2.4/5 GHz and the Laird BL654 BLE module. The radios are not capable of simultaneous transmission. Multiple antenna options and model variants are available and listed below. The device is powered by 5.9VDC. The antenna port was terminated at 50Ω for radiated testing.

Model Variants:

- HVIN ASM-0000001220:** This variant of the module has an onboard Wi-Fi chip antenna on the PCB of the daughter card. No external antenna is used on this variant.
- HVIN ASM-0000001303:** This variant of the module has an onboard Wi-Fi chip antenna on the PCB of the daughter card and is identical to ASM-0000001220 other than the FFC cable connector on the PCB at position J7 being mounted vertically. No external antenna is used on this variant.

Company: Georgia Pacific	Page 5 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

- c. **HVIN ASM-0000000791:** This variant of the module has an external antenna connected to the Wi-Fi/BLE daughter card via u.FL connector on the daughter card. The antenna is mounted within the end device housing and is fully contained within the end device. The external antenna provides improved range for connectivity between the end device and the Wi-Fi access point.
- d. **HVIN ASM-0000001327:** This variant of the module has an external antenna connected to the Wi-Fi/BLE daughter card via u.FL connector on the daughter card and is identical to ASM-0000000791 other than the FFC cable connector on the PCB at position J7 being mounted vertically.

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 Channels and Data Rates

Channels	Protocol	Data Rate
1-11	802.11b	1 Mbps, 11 Mbps
1-11	802.11g	6 Mbps, 54 Mbps
1-11	802.11n HT20	MCS0, MCS7

2.6 Radio Programming

The WLAN radios were programmed using the Texas Instruments CC31XX/CC32XX Radio Tool v1.0.3.15.

2.7 Antennas

Radio	Antenna Type	Manufacturer	Model Number	Peak Gain (dBi)
WLAN 2.4	Flexible (FlexPIFA)	Laird	001-0016	2.50
WLAN 2.4	Chip	Yageo	ANT5320LL24R2455A	2.17

3 REFERENCES

Publication	Edition	Date
FCC CFR	-	2021
ANSI C63.10	-	2013
RSS-Gen	5	2018
RSS-247	2	2017

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 %

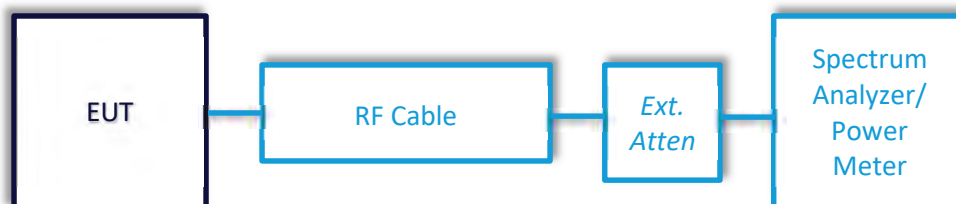
Company: Gerogia Pacific	Page 8 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

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	Shane Dock
Temperature	21.1°C	R.H. %	55%
Test Date	10/12/2020	Location	Conducted RF Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §11.8.2

Limits: Bandwidth greater than 500 kHz

Test Parameters

Frequency	2412, 2437, 2462 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

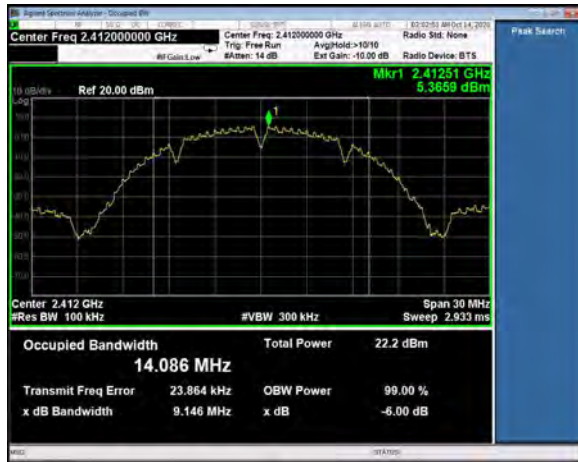
EUT Parameters

Input Power	5.9VDC	Mode	WLAN TX
Channel	1, 6, 11		

Data Table

Protocol	Data Rate	Channel	6 dB BW (kHz)	Limit (kHz)	Margin (kHz)
802.11b	1Mbps	1	9146.0	500.0	8646.0
802.11b	1Mbps	6	9580.0	500.0	9080.0
802.11b	1Mbps	11	9149.0	500.0	8649.0
802.11b	11Mbps	1	9132.0	500.0	8632.0
802.11b	11Mbps	6	9102.0	500.0	8602.0
802.11b	11Mbps	11	9096.0	500.0	8596.0
802.11g	6Mbps	1	15130.0	500.0	14630.0
802.11g	6Mbps	6	15140.0	500.0	14640.0
802.11g	6Mbps	11	15130.0	500.0	14630.0
802.11g	54Mbps	1	16500.0	500.0	16000.0
802.11g	54Mbps	6	16460.0	500.0	15960.0
802.11g	54Mbps	11	16420.0	500.0	159420.0
802.11n	MCS0	1	15130.0	500.0	14630.0
802.11n	MCS0	6	15130.0	500.0	14630.0
802.11n	MCS0	11	15130.0	500.0	14630.0
802.11n	MCS7	1	17580.0	500.0	17080.0
802.11n	MCS7	6	17620.0	500.0	17120.0
802.11n	MCS7	11	17690.0	500.0	17190.0

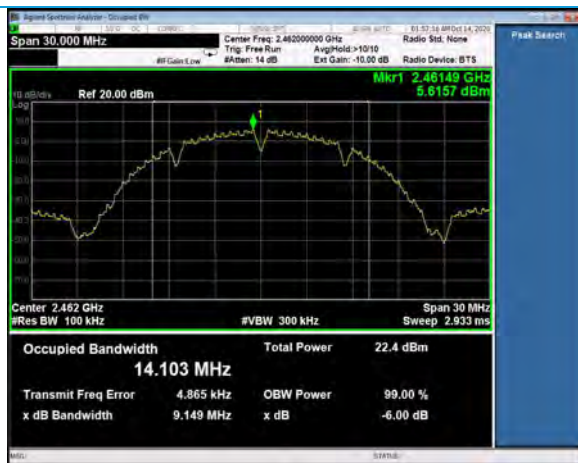
Plots



6 dB Bandwidth, Channel 1, 802.11b, 1Mbps



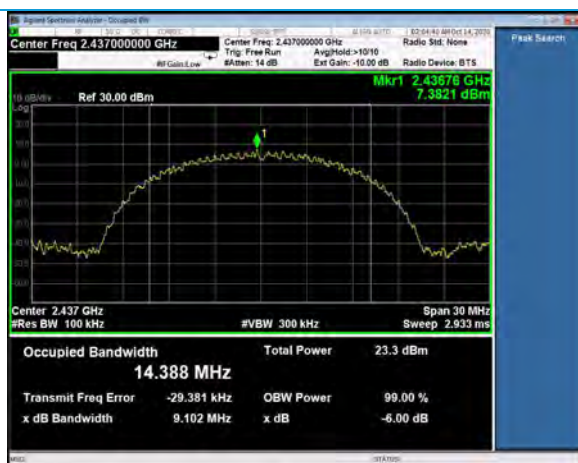
6 dB Bandwidth, Channel 6, 802.11b, 1 Mbps



6 dB Bandwidth, Channel 11, 802.11b, 1Mbps



6 dB Bandwidth, Channel 1, 802.11b, 11Mbps



6 dB Bandwidth, Channel 6, 802.11b, 11Mbps



6 dB Bandwidth, Channel 11, 802.11b, 11Mbps

Company: Gerogia Pacific

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Job: C-3397

Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

Serial: Engineering Sample



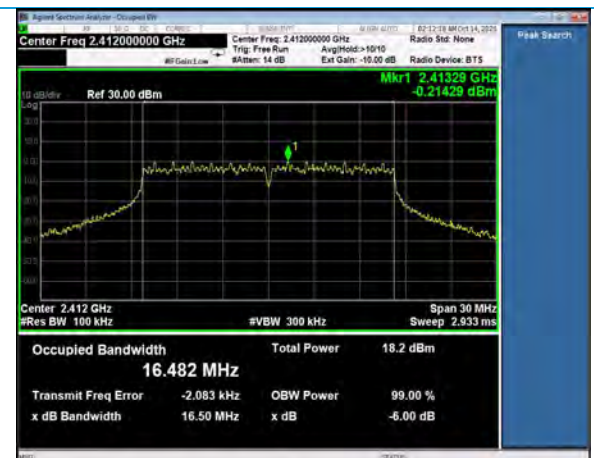
6 dB Bandwidth, Channel 1, 802.11g, 6Mbps



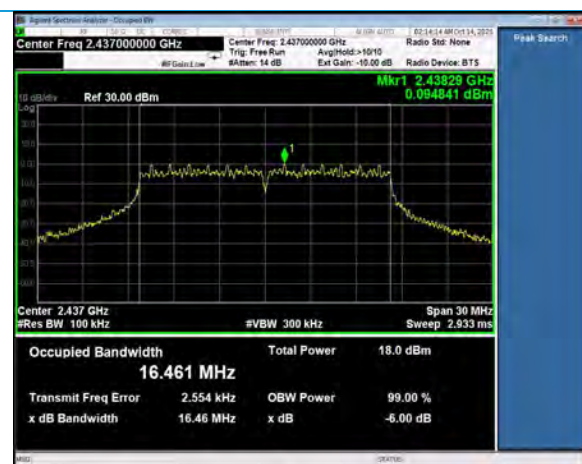
6 dB Bandwidth, Channel 6, 802.11g, 6Mbps



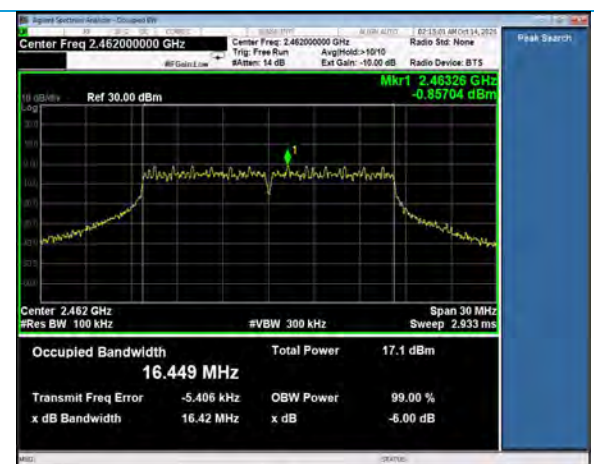
6 dB Bandwidth, Channel 11, 802.11g, 6Mbps



6 dB Bandwidth, Channel 1, 802.11g, 54Mbps



6 dB Bandwidth, Channel 6, 802.11g, 54Mbps



6 dB Bandwidth, Channel 11, 802.11g, 54Mbps

Company: Gerogia Pacific

Report: TR319295 A

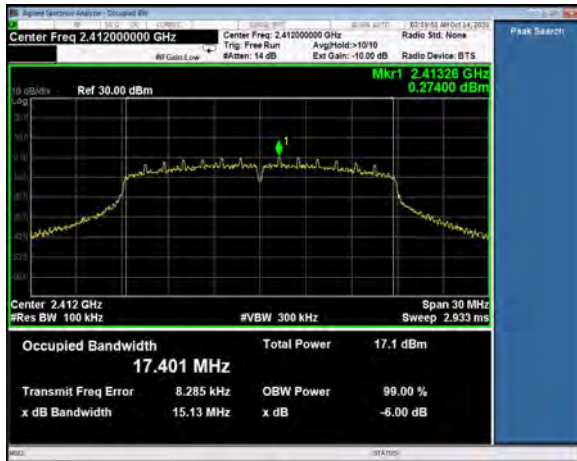
Job: C-3397

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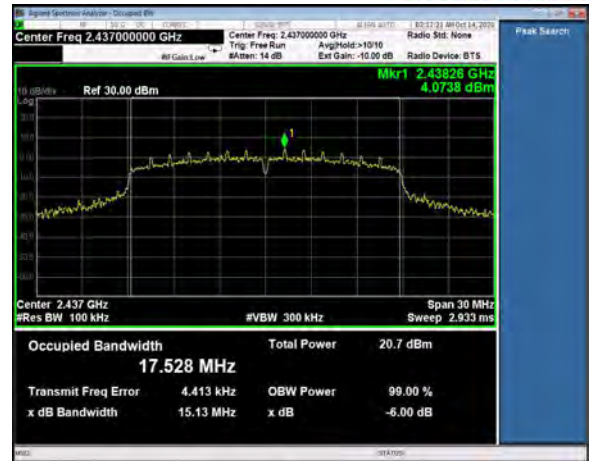
Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

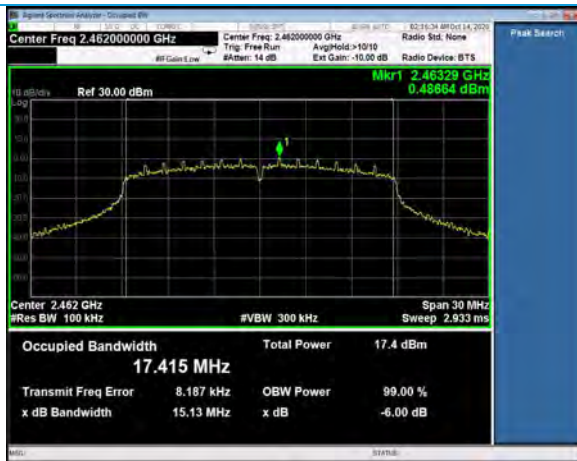
Serial: Engineering Sample



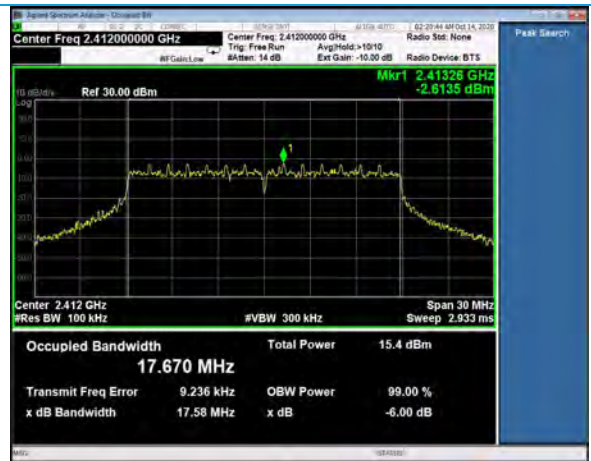
6 dB Bandwidth, Channel 1, 802.11n, MCS0



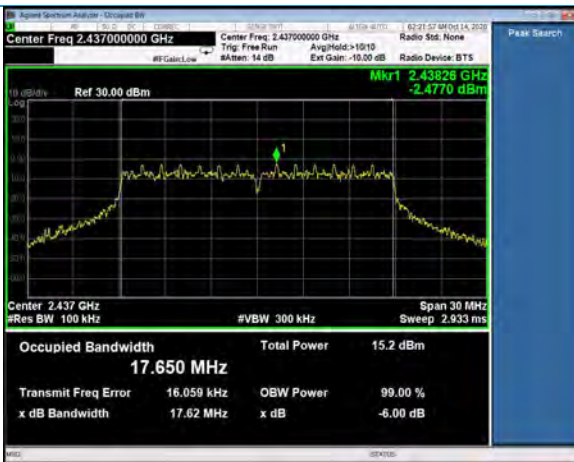
6 dB Bandwidth, Channel 6, 802.11n, MCS0



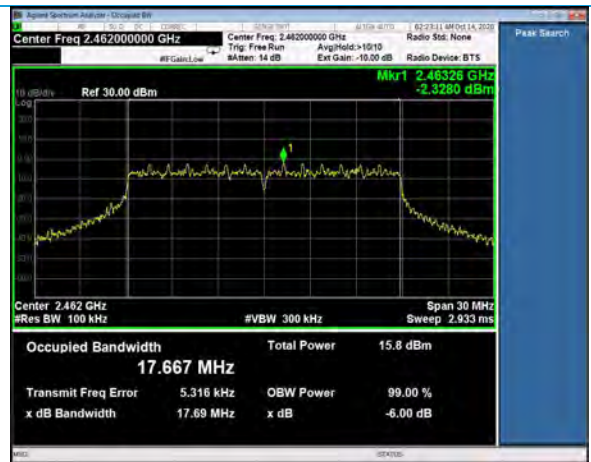
6 dB Bandwidth, Channel 11, 802.11n, MCS0



6 dB Bandwidth, Channel 1, 802.11n, MCS7



6 dB Bandwidth, Channel 6, 802.11n, MCS7



6 dB Bandwidth, Channel 11, 802.11n, MCS7

Company: Gerogia Pacific

Report: TR319295 A

Job: C-3397

Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

Serial: Engineering Sample

5.1.2 99% Bandwidth

Operator	Jon Dille	QA	Shane Dock
Temperature	21.1°C	R.H. %	55%
Test Date	10/12/2020	Location	Conducted RF Bench
Requirement	15.1049, RSS-GEN	Method	ANSI C63.10 §6.9.3

Limits: Reported

Test Parameters

Frequency	2412, 2437, 2462 MHz	Setup	Conducted
RBW	200 kHz	VBW	620 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

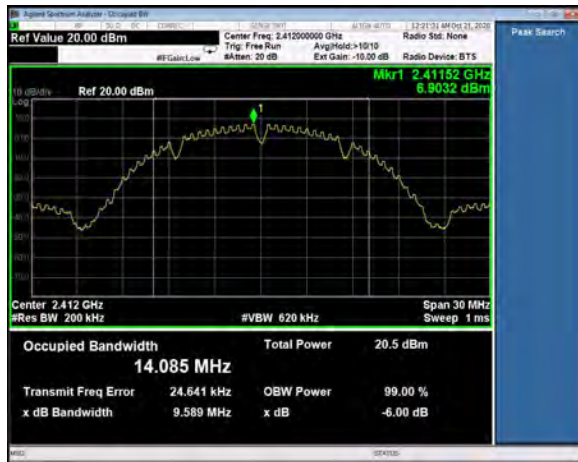
EUT Parameters

Input Power	5.9VDC	Mode	WLAN TX
Channel	1, 6, 11		

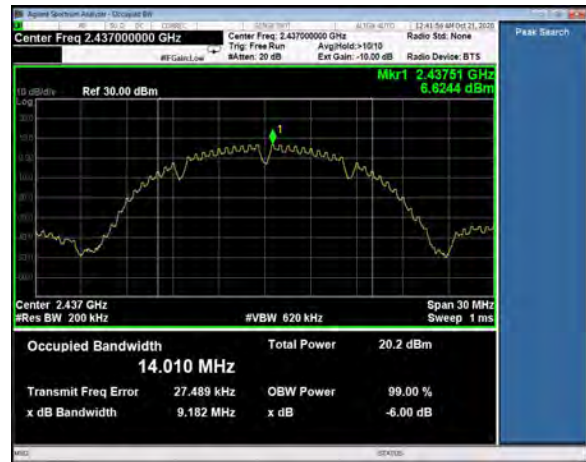
Data Table

Protocol	Data Rate	Channel	99% BW (kHz)
802.11b	1Mbps	1	14085.0
802.11b	1Mbps	6	14010.0
802.11b	1Mbps	11	13987.0
802.11b	11Mbps	1	14333.0
802.11b	11Mbps	6	14309.0
802.11b	11Mbps	11	14327.0
802.11g	6Mbps	1	16362.0
802.11g	6Mbps	6	16917.0
802.11g	6Mbps	11	16337.0
802.11g	54Mbps	1	16639.0
802.11g	54Mbps	6	16626.0
802.11g	54Mbps	11	16632.0
802.11n	MCS0	1	17435.0
802.11n	MCS0	6	17636.0
802.11n	MCS0	11	17436.0
802.11n	MCS7	1	17798.0
802.11n	MCS7	6	17808.0
802.11n	MCS7	11	17798.0

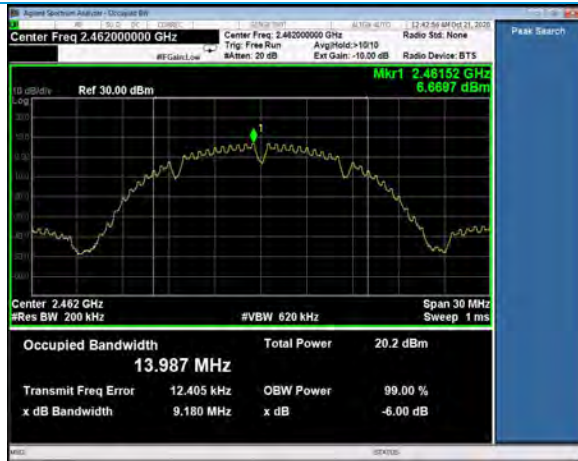
Plots



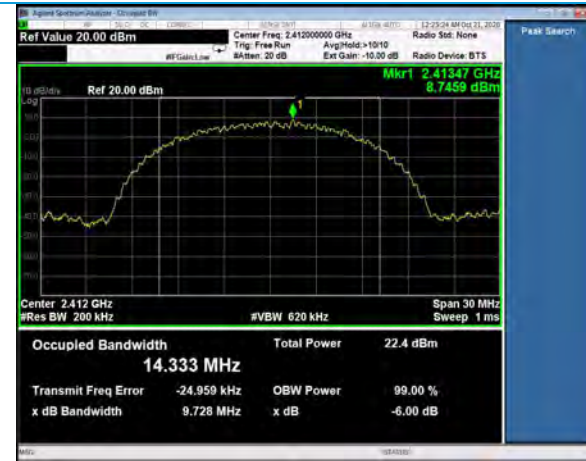
99% Bandwidth, Channel 1, 802.11b, 1Mbps



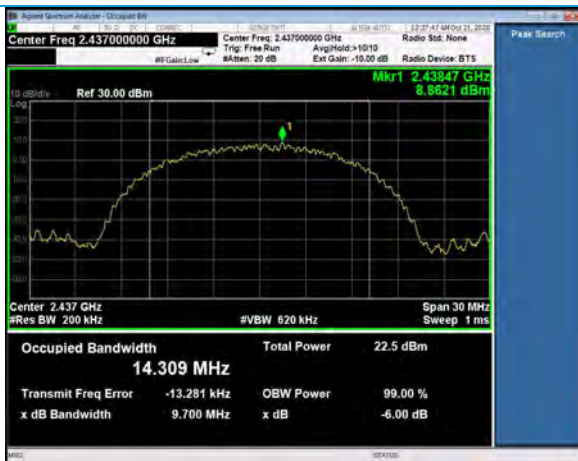
99% Bandwidth, Channel 6, 802.11b, 1Mbps



99% Bandwidth, Channel 11, 802.11b, 1Mbps



99% Bandwidth, Channel 1, 802.11b, 11Mbps



99% Bandwidth, Channel 6, 802.11b, 11Mbps



99% Bandwidth, Channel 11, 802.11b, 11Mbps

Company: Gerogia Pacific

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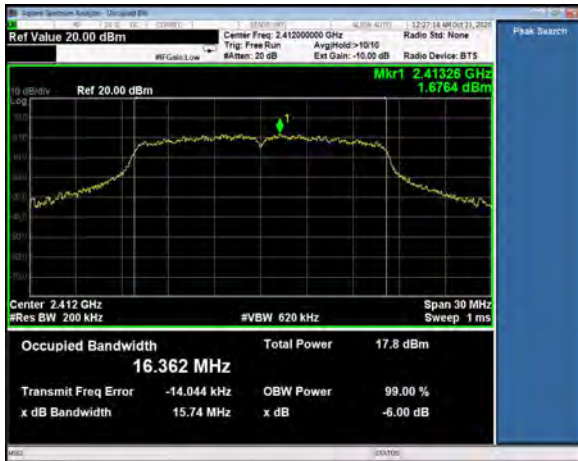
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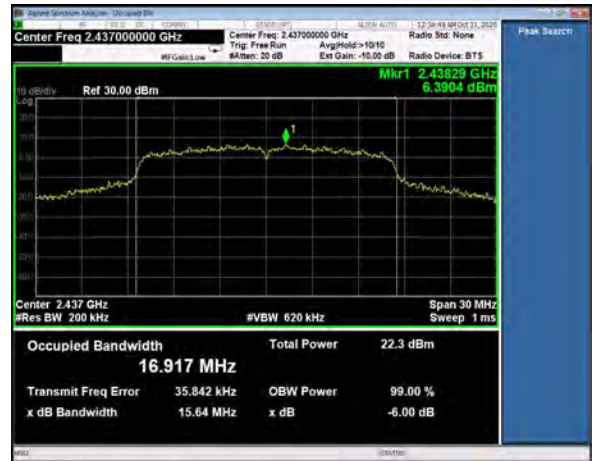
Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

Serial: Engineering Sample



99% Bandwidth, Channel 1, 802.11g, 6Mbps



99% Bandwidth, Channel 6, 802.11g, 6Mbps



99% Bandwidth, Channel 11, 802.11g, 6Mbps



99% Bandwidth, Channel 1, 802.11g, 54Mbps



99% Bandwidth, Channel 6, 802.11g, 54Mbps



99% Bandwidth, Channel 11, 802.11g, 54Mbps

Company: Gerogia Pacific

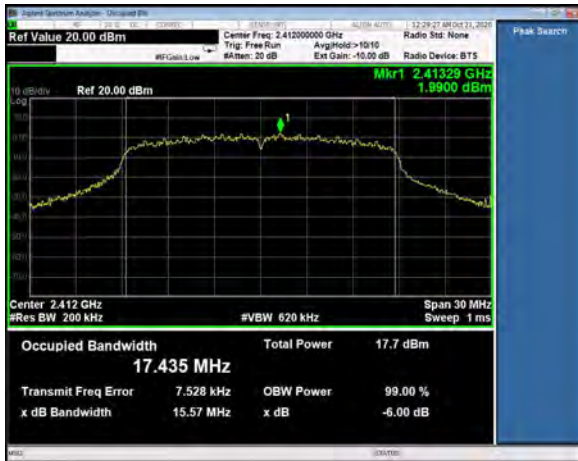
Report: TR319295 A

Job: C-3397

Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

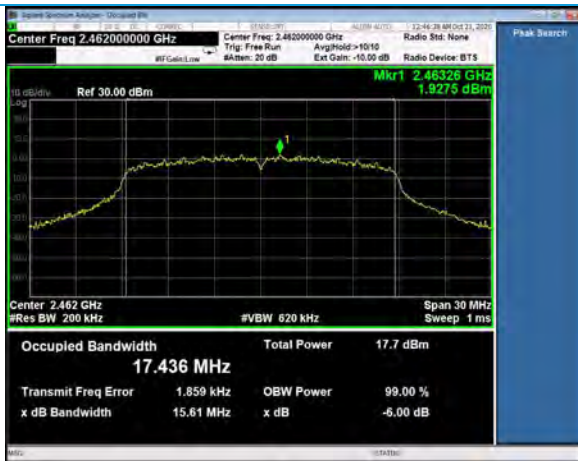
Serial: Engineering Sample



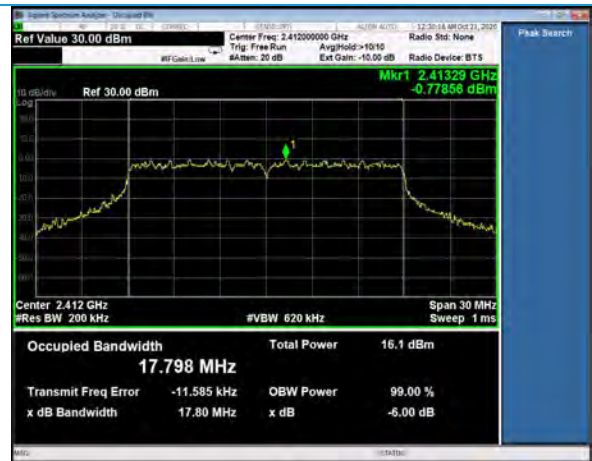
99% Bandwidth, Channel 1, 802.11n, MCS0



99% Bandwidth, Channel 6, 802.11n, MCS0



99% Bandwidth, Channel 11, 802.11n, MCS0



99% Bandwidth, Channel 1, 802.11n, MCS7



99% Bandwidth, Channel 6, 802.11n, MCS7



99% Bandwidth, Channel 11, 802.11n, MCS7

5.1.3 Fundamental Emission Output Power

Operator	Jon Dilley	QA	Shane Dock
Temperature	21.1°C	R.H. %	55%
Test Date	10/12/2020	Location	Conducted RF Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §11.9.2.2.4 AVGSA-2

Limits: 30dBm/1W

Test Parameters

Frequency	2412, 2437, 2462 MHz	Setup	Conducted
RBW	510 kHz	VBW	1.6 MHz
Detector(s)	RMS	Sweep Time	Auto
Number of Traces	100	Correction Factor Example Calculation	10LOG(1/D), where D=duty cycle

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	5.9VDC	Mode	WLAN TX
Channel	1, 6, 11		

802.11b, 1Mbps, Duty Cycle



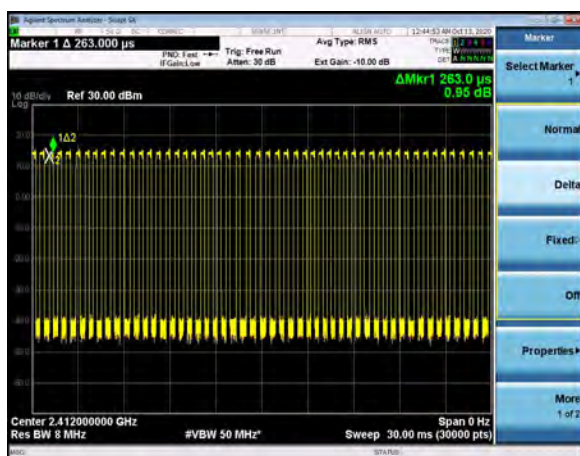
On Time = 991μs

Observation Period = 1474μs

Constant Duty Cycle = 67%

Duty Cycle Correction Factor = 1.7 dB

802.11b, 11Mbps, Duty Cycle



On Time = 263μs

Observation Period = 545μs

Constant Duty Cycle = 48%

Duty Cycle Correction Factor = 3.2 dB

Company: Gerogia Pacific	Page 21 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

802.11g, 6Mbps, Duty Cycle



On Time = 320μs

Observation Period = 1118μs

Constant Duty Cycle = 29%

Duty Cycle Correction Factor = 5.4 dB

802.11g, 54Mbps, Duty Cycle



On Time = 35μs

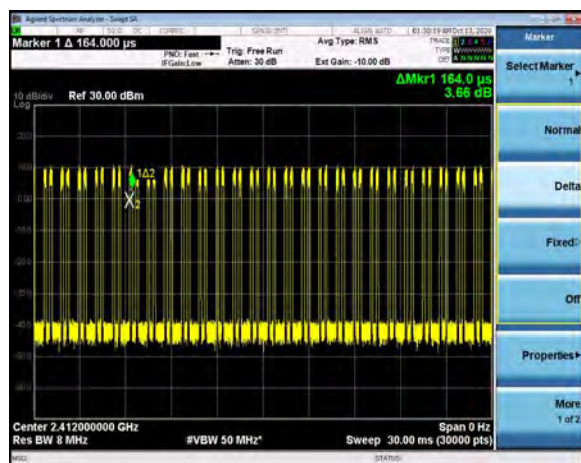
Observation Period = 646μs

Constant Duty Cycle = 0.5%

Duty Cycle Correction Factor = 12.7 dB

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802.11n, MCS0, Duty Cycle



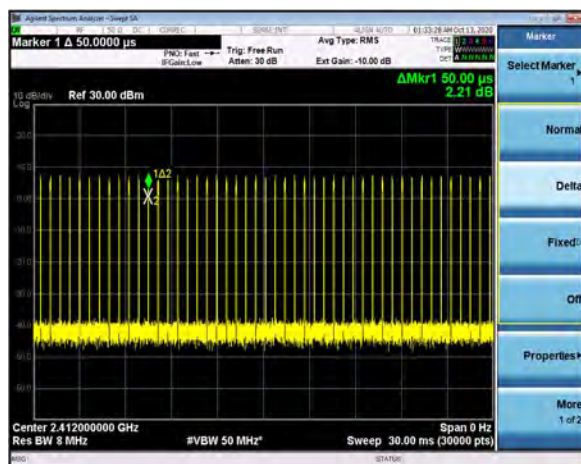
On Time = 328μs

Observation Period = 1153μs

Constant Duty Cycle = 28%

Duty Cycle Correction Factor = 5.5 dB

802.11n, MCS7, Duty Cycle



On Time = 50μs

Observation Period = 585μs

Constant Duty Cycle = 0.8%

Duty Cycle Correction Factor = 11.0 dB

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Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
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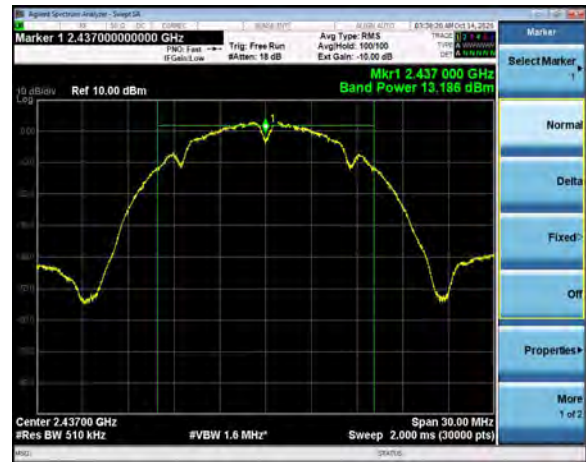
Data Table

Protocol	Data Rate	Channel	Measured Output Power (dBm)	Duty Cycle Correction Factor (dB)	Conducted Output Power (dBm)	Output Power Limit (dBm)	Margin (dB)
802.11b	1Mbps	1	13.1	1.7	14.8	30.0	15.2
802.11b	1Mbps	6	13.2	1.7	14.9	30.0	15.1
802.11b	1Mbps	11	13.9	1.7	15.6	30.0	14.4
802.11b	11Mbps	1	11.6	3.2	14.8	30.0	15.2
802.11b	11Mbps	6	11.9	3.2	15.1	30.0	14.9
802.11b	11Mbps	11	12.0	3.2	15.2	30.0	14.8
802.11g	6Mbps	1	4.7	5.4	10.1	30.0	19.9
802.11g	6Mbps	6	9.4	5.4	14.8	30.0	15.2
802.11g	6Mbps	11	4.8	5.4	10.2	30.0	19.8
802.11g	54Mbps	1	-2.2	12.7	10.5	30.0	19.5
802.11g	54Mbps	6	-1.8	12.7	10.9	30.0	19.1
802.11g	54Mbps	11	-2.1	12.7	10.6	30.0	19.4
802.11n	MCS0	1	4.9	5.5	10.4	30.0	19.6
802.11n	MCS0	6	8.3	5.5	13.8	30.0	16.2
802.11n	MCS0	11	4.9	5.5	10.4	30.0	19.6
802.11n	MCS7	1	-2.5	11.0	8.5	30.0	21.5
802.11n	MCS7	6	-2.2	11.0	8.8	30.0	21.2
802.11n	MCS7	11	-2.2	11.0	8.8	30.0	21.2

Plots



Output Power, Channel 1, 802.11b, 1Mbps



Output Power, Channel 6, 802.11b, 1Mbps



Output Power, Channel 11, 802.11b, 1Mbps



Output Power, Channel 1, 802.11b, 11Mbps



Output Power, Channel 6, 802.11b, 11Mbps



Output Power, Channel 11, 802.11b, 11Mbps

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Serial: Engineering Sample



Output Power, Channel 1, 802.11g, 6Mbps



Output Power, Channel 6, 802.11g, 6Mbps



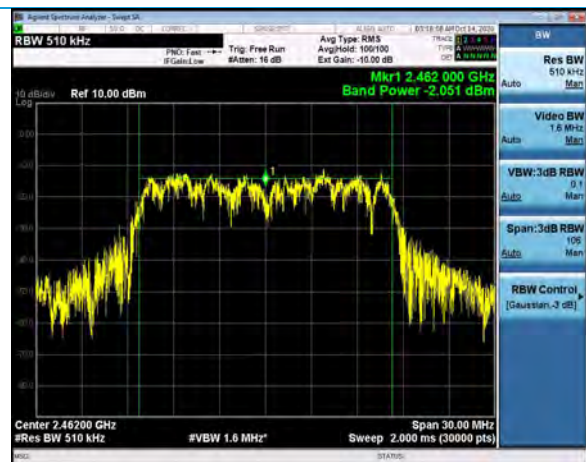
Output Power, Channel 11, 802.11g, 6Mbps



Output Power, Channel 1, 802.11g, 54Mbps



Output Power, Channel 6, 802.11g, 54Mbps



Output Power, Channel 11, 802.11g, 54Mbps

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Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

Serial: Engineering Sample



Output Power, Channel 1, 802.11n, MCS0



Output Power, Channel 6, 802.11n, MCS0



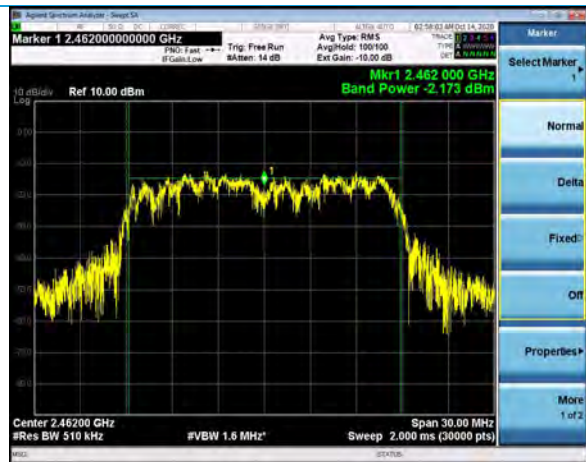
Output Power, Channel 11, 802.11n, MCS0



Output Power, Channel 1, 802.11n, MCS7



Output Power, Channel 6, 802.11n, MCS7



Output Power, Channel 11, 802.11n, MCS7

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Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

Serial: Engineering Sample

5.1.4 Maximum Power Spectral Density

Operator	Jon Dilley	QA	Shane Dock
Temperature	21.1°C	R.H. %	55%
Test Date	10/12/2020	Location	Conducted RF Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §11.10.2

Limits: 8dBm/3kHz

Test Parameters

Frequency	2412, 2437, 2462 MHz	Setup	Conducted
RBW	100kHz	VBW	300kHz
Detector(s)	RMS	Sweep Time	4ms
Number of Traces	100	Correction Factor Example Calculation	10LOG(1/D), where D=duty cycle

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	5.9VDC	Mode	WLAN TX
Channel	1, 6, 11		

Data Table

Protocol	Data Rate	Channel	Measured PSD (dBm/kHz)	Duty Cycle Correction Factor (dB)	Conducted PSD (dBm/kHz)	PSD Limit (dBm/kHz)	Margin (dB)
802.11b	1Mbps	1	-2.2	1.7	-0.4	8.0	8.4
802.11b	1Mbps	6	-2.3	1.7	-0.6	8.0	8.6
802.11b	1Mbps	11	-3.0	1.7	-1.2	8.0	9.2
802.11b	11Mbps	1	-4.9	3.2	-1.7	8.0	9.7
802.11b	11Mbps	6	-4.1	3.2	-0.9	8.0	8.9
802.11b	11Mbps	11	-3.9	3.2	-0.8	8.0	8.8
802.11g	6Mbps	1	-10.6	5.4	-5.2	8.0	13.2
802.11g	6Mbps	6	-7.2	5.4	-1.8	8.0	9.8
802.11g	6Mbps	11	-12.5	5.4	-7.1	8.0	15.1
802.11g	54Mbps	1	-14.5	12.7	-1.8	8.0	9.8
802.11g	54Mbps	6	-15.4	12.7	-2.7	8.0	10.7
802.11g	54Mbps	11	-16.4	12.7	-3.7	8.0	11.7
802.11n	MCS0	1	-12.9	5.5	-7.4	8.0	15.4
802.11n	MCS0	6	-9.4	5.5	-3.9	8.0	11.9
802.11n	MCS0	11	-12.0	5.5	-6.5	8.0	14.5
802.11n	MCS7	1	-14.6	11.0	-3.6	8.0	11.6
802.11n	MCS7	6	-18.5	11.0	-7.4	8.0	15.4
802.11n	MCS7	11	-16.8	11.0	-5.7	8.0	13.7

Plots



PSD, Channel 1, 802.11b, 1Mbps



PSD, Channel 6, 802.11b, 1Mbps



PSD, Channel 11, 802.11b, 1Mbps



PSD, Channel 1, 802.11b, 11Mbps



PSD, Channel 6, 802.11b, 11Mbps

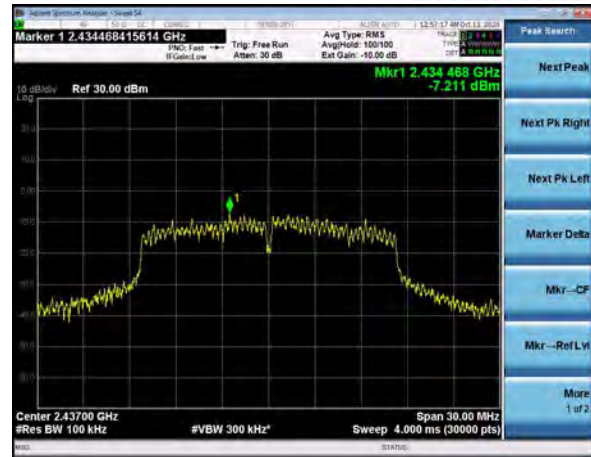


PSD, Channel 11, 802.11b, 11Mbps

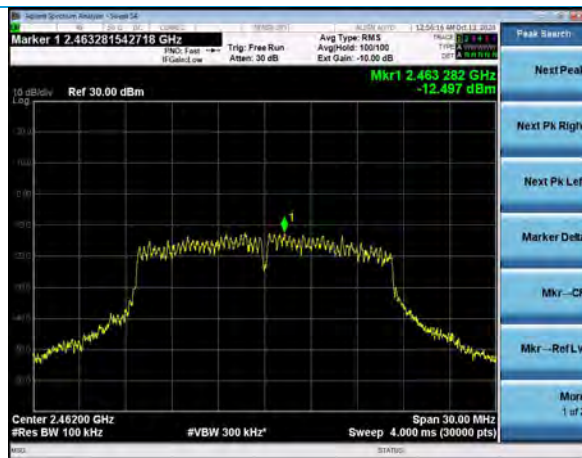
Company: Gerogia Pacific		Name: KOLO Gen2 WiFi Module
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Job: C-3397		Serial: Engineering Sample



PSD, Channel 1, 802.11g, 6Mbps



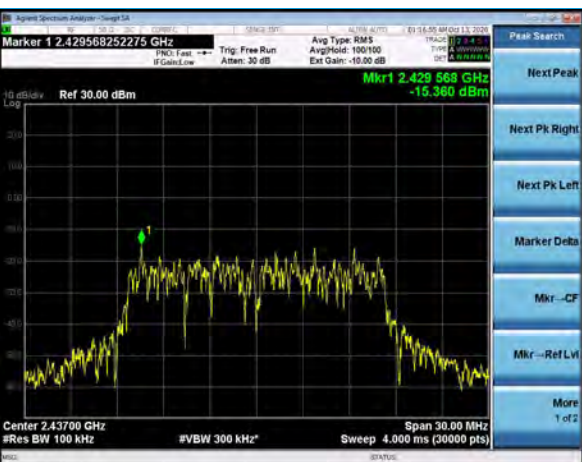
PSD, Channel 6, 802.11g, 6Mbps



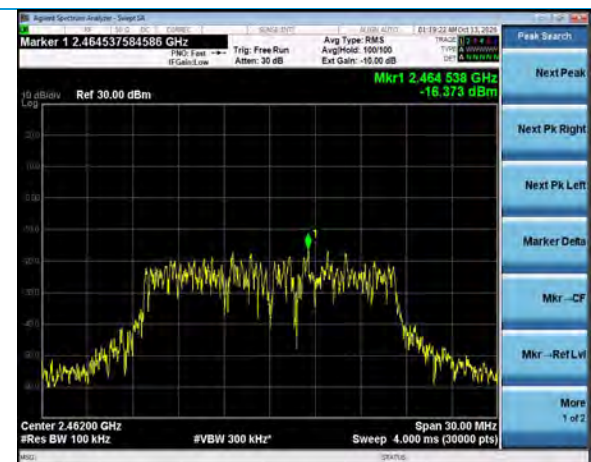
PSD, Channel 11, 802.11g, 6Mbps



PSD, Channel 1, 802.11g, 54Mbps

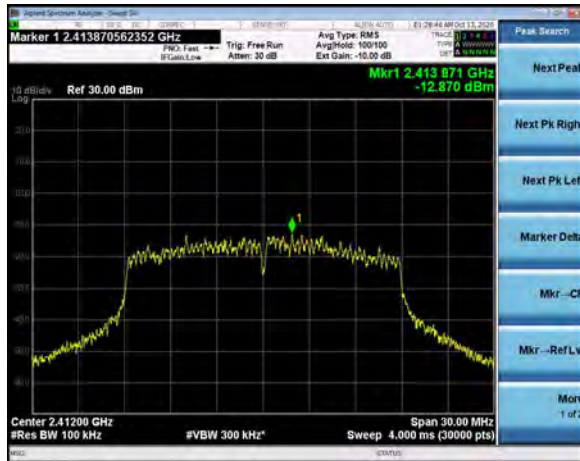


PSD, Channel 6, 802.11g, 54Mbps



PSD, Channel 11, 802.11g, 54Mbps

Company: Gerogia Pacific		Name: KOLO Gen2 WiFi Module
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Job: C-3397		Serial: Engineering Sample



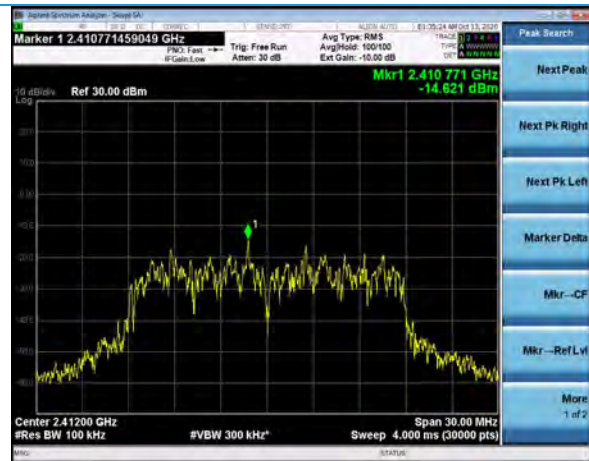
PSD, Channel 1, 802.11n, MCS0



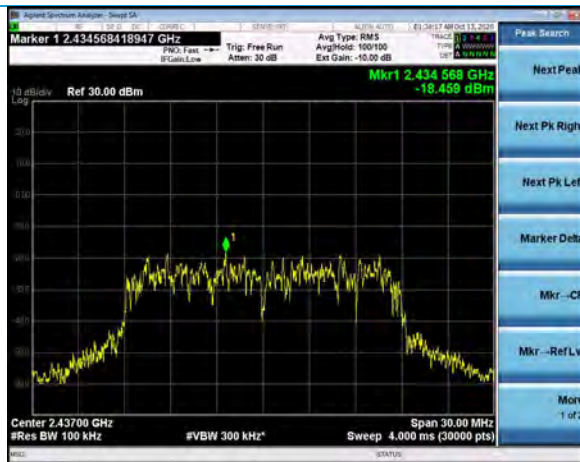
PSD, Channel 6, 802.11n, MCS0



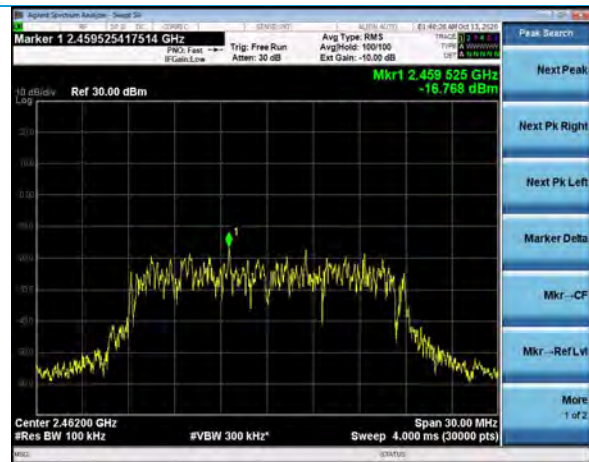
PSD, Channel 11, 802.11n, MCS0



PSD, Channel 1, 802.11n, MCS7



PSD, Channel 6, 802.11n, MCS7



PSD, Channel 11, 802.11n, MCS7

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Job: C-3397		Serial: Engineering Sample

5.1.5 Conducted Transmitter Emissions

Operator	Jon Dille, Anthony Smith	QA	Shane Dock
Temperature	21.1°C, 22.8°C	R.H. %	55%, 57%
Test Date	10/12/2020, 6/18/2021	Location	Conducted RF Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §11.10.2

Limits:

100/300 kHz BW = 30dBc (see tables and plots below for reference levels and limits)

Terminated Method = -41.2 dBm Average, -21.2 dBm Peak

Test Parameters

Frequency	30 MHz – 25 GHz	Setup	Conducted
RBW	100 kHz, 1 MHz	VBW	300 kHz, 3 MHz
Detector(s)	Max hold with peak detector for plots. Reduced VBW of 10Hz for average measurements.	Sweep Time	Auto
Notes	Spurious emissions outside of restricted bands showed no significant difference when channel was changed.		
Example Calculation	Terminated Antenna Port Restricted Band Limit (dBm) = Restricted Band Radiated Limit (dBμV/m @ 3m) – 95.2		
Restricted Band Limit Calculations	Terminated Antenna Port Restricted Band Average Limit (dBm) = 54.0 (dBμV/m @ 3m) – 95.2 = -41.2 (dBm) Terminated Antenna Port Restricted Band Peak Limit (dBm) = 74.0 (dBμV/m @ 3m) – 95.2 = -21.2 (dBm)		

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

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

EUT Parameters

Input Power	5.9VDC	Mode	WLAN TX
Channel	1, 6, 11		

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Reference Limit Plots



Reference Plot, 802.11b, 1Mbps
Channel 1, 5.0 dBm



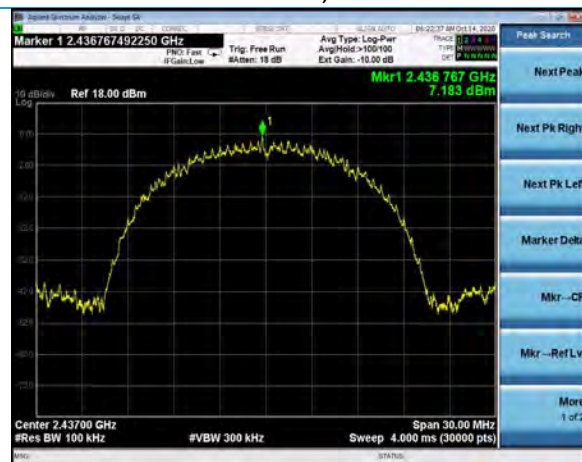
Reference Plot, 802.11b, 1Mbps
Channel 6, 5.3 dBm



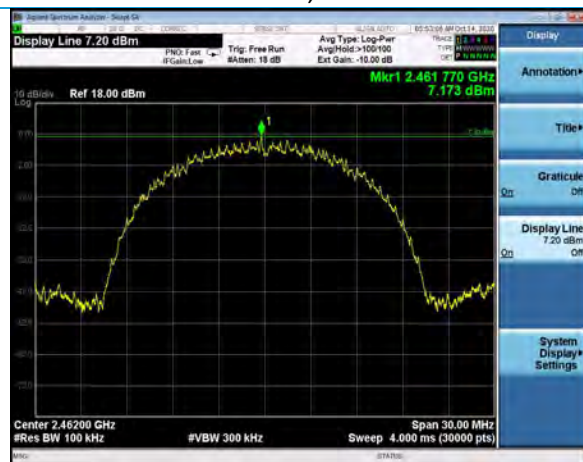
Reference Plot, 802.11b, 1Mbps
Channel 11, 5.4 dBm



Reference Plot, 802.11b, 11Mbps
Channel 1, 7.0 dBm



Reference Plot, 802.11b, 11Mbps
Channel 6, 7.2 dBm



Reference Plot, 802.11b, 11Mbps
Channel 11, 7.2 dBm

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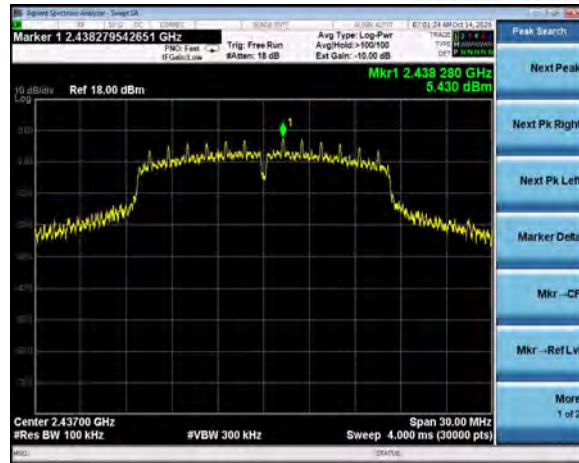
Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

Serial: Engineering Sample



Reference Plot, 802.11g, 6Mbps
Channel 1, 0.5 dBm



Reference Plot, 802.11g, 6Mbps
Channel 6, 5.4 dBm



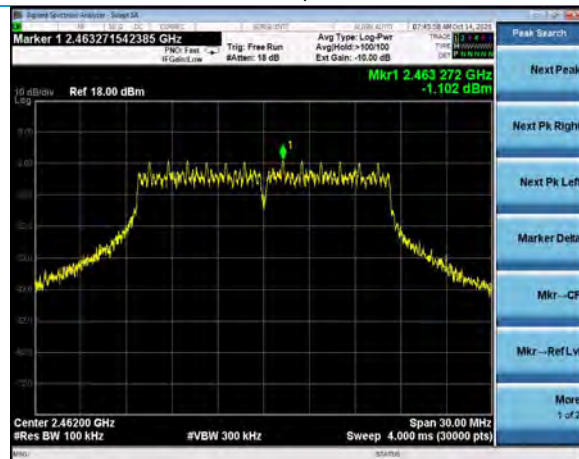
Reference Plot, 802.11g, 6Mbps
Channel 11, 0.0 dBm



Reference Plot, 802.11g, 54Mbps
Channel 1, -1.1 dBm

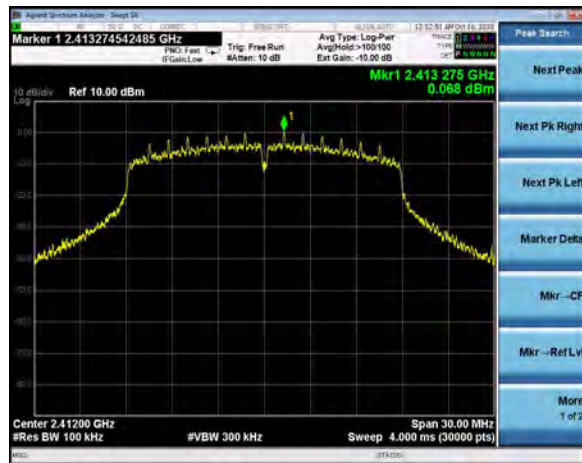


Reference Plot, 802.11g, 54Mbps
Channel 6, -0.6 dBm



Reference Plot, 802.11g, 54Mbps
Channel 11, -1.1 dBm

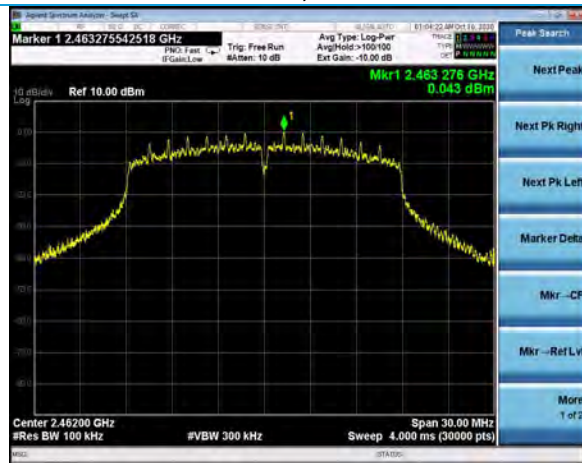
Company: Gerogia Pacific	Name: KOLO Gen2 WiFi Module
Report: TR319295 A	Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397	Serial: Engineering Sample



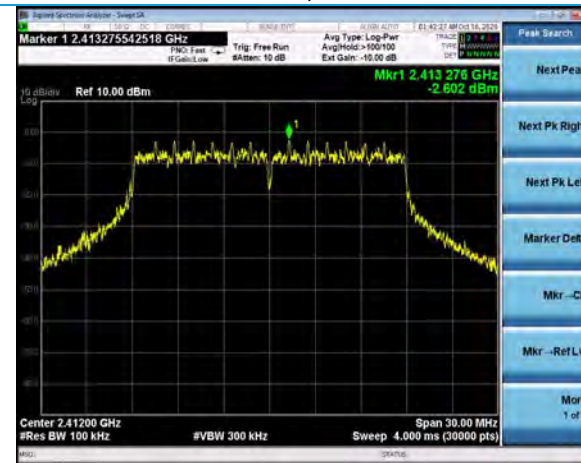
Reference Plot, 802.11n, MCS0
Channel 1, 0.7 dBm



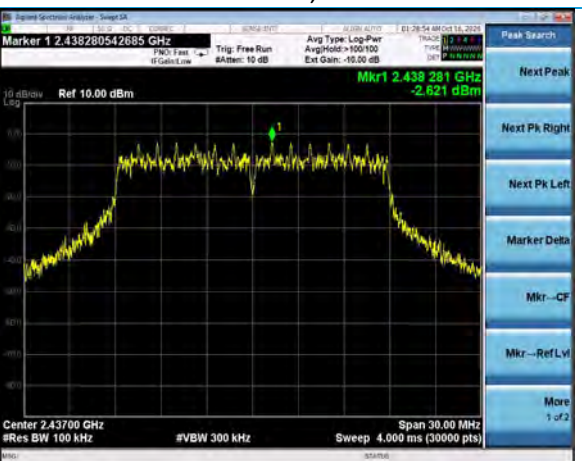
Reference Plot, 802.11n, MCS0
Channel 6, 3.8 dBm



Reference Plot, 802.11n, MCS0
Channel 11, 0.0 dBm



Reference Plot, 802.11n, MCS7
Channel 1, -2.6 dBm



Reference Plot, 802.11n, MCS7
Channel 6, -2.6 dBm



Reference Plot, 802.11n, MCS7
Channel 11, -2.7 dBm

Company: Georgia Pacific		Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

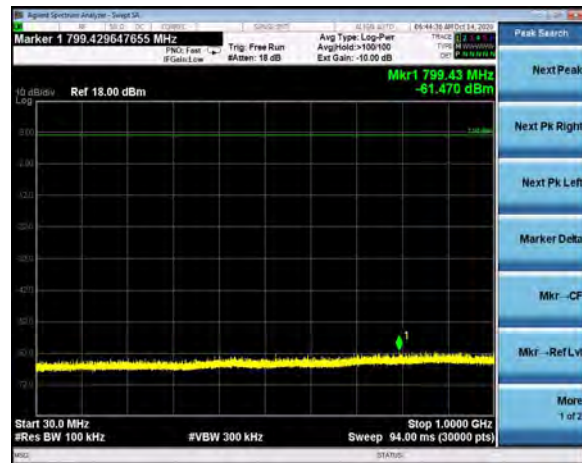
Limits

Conducted Spurious 30dBc Limits				
Protocol	Data Rate	Channel	Reference Level (dBm)	30 dBc Limit (dBm)
802.11b	1 Mbps	1	5.0	-25.0
802.11b	1 Mbps	6	5.3	-24.7
802.11b	1 Mbps	11	5.4	-24.6
802.11b	11 Mbps	1	7.0	-23.0
802.11b	11 Mbps	6	7.2	-22.8
802.11b	11 Mbps	11	7.2	-22.8
802.11g	6 Mbps	1	0.5	-29.5
802.11g	6 Mbps	6	5.4	-24.6
802.11g	6 Mbps	11	0.0	-30.0
802.11g	54 Mbps	1	-1.1	-31.1
802.11g	54 Mbps	6	-0.6	-30.6
802.11g	54 Mbps	11	-1.1	-31.1
802.11n	MCS0	1	0.7	-29.3
802.11n	MCS0	6	3.8	-26.2
802.11n	MCS0	11	0.0	-30.0
802.11n	MCS7	1	-2.6	-32.6
802.11n	MCS7	6	-2.6	-32.6
802.11n	MCS7	11	-2.7	-32.7

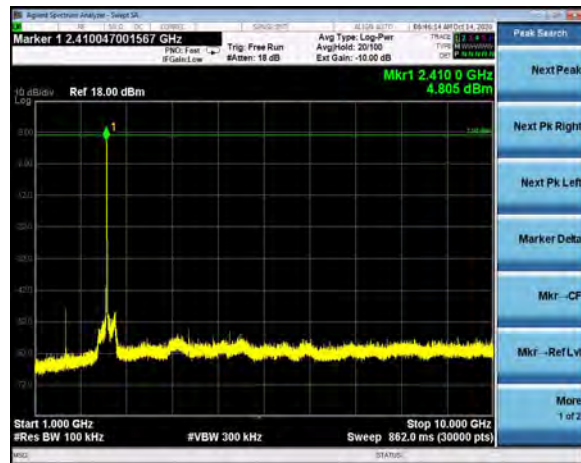
Data Tables

Protocol	Data Rate	Channel	Frequency of Emission (MHz)	Peak Reading (dBm)	-30dBc Limit (dBm)	Peak Margin (dB)
802.11b	1Mbps	1	2397.0	-36.3	-25.0	11.3
802.11b	11Mbps	1	2396.0	-40.1	-23.0	17.1
802.11g	6Mbps	1	2399.8	-32.1	-29.5	2.6
802.11g	54Mbps	1	2399.4	-32.5	-31.1	1.4
802.11n	MSC0	1	2399.7	-29.8	-29.3	0.5
802.11n	MCS7	1	2400.0	-33.3	-32.6	0.7
802.11b	1Mbps	11	2483.8	-47.0	-24.6	22.4
802.11b	11Mbps	11	2484.5	-48.8	-22.8	26.0
802.11g	6Mbps	11	2484.5	-48.8	-30.0	18.8
802.11g	54Mbps	11	2483.9	-47.2	-31.1	16.1
802.11n	MSC0	11	2484.5	-47.0	-30.0	17.0
802.11n	MCS7	11	2483.9	-49.6	-32.7	16.9

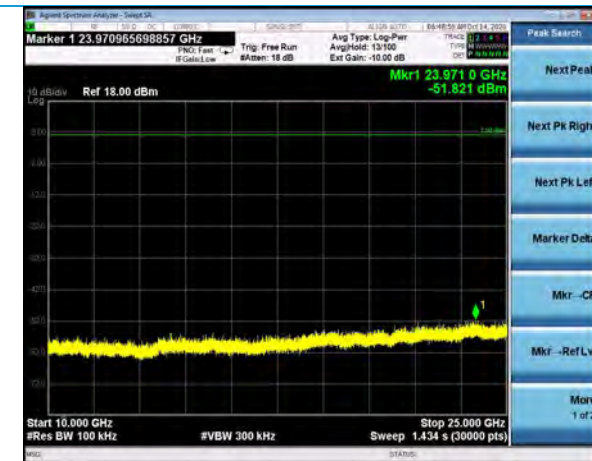
Plots



30-1000 MHz, Channel 1, 802.11b, 1Mbps



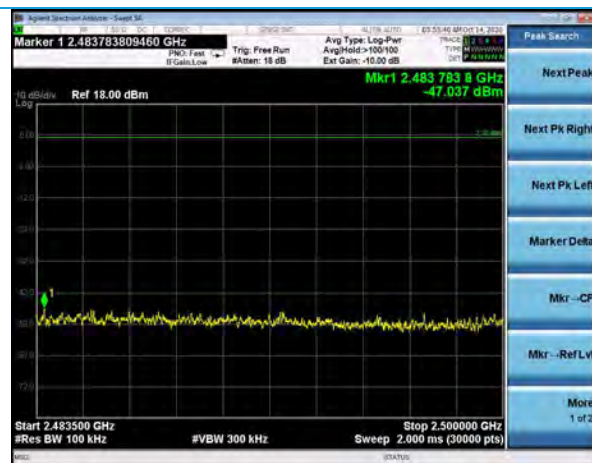
1-10 GHz, Channel 1, 802.11b, 1Mbps



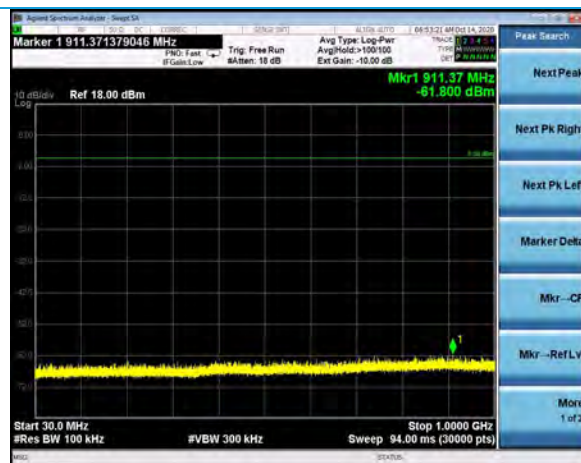
10-25 GHz, Channel 1, 802.11b, 1Mbps



2310-2390 MHz, Channel 1, 802.11b, 1Mbps

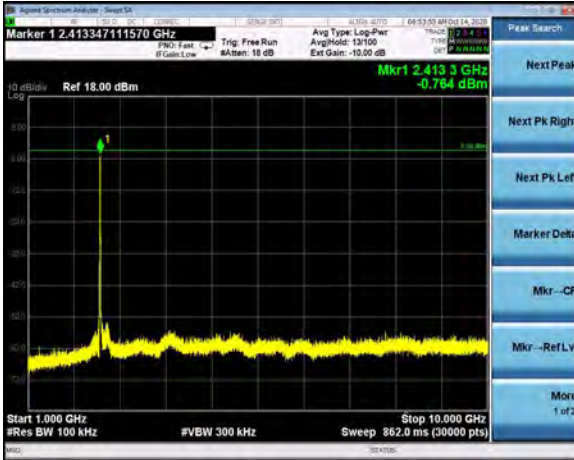


2483.5-2500 MHz, Channel 11, 802.11b, 1Mbps



30-1000 MHz, Channel 1, 802.11b, 11Mbps

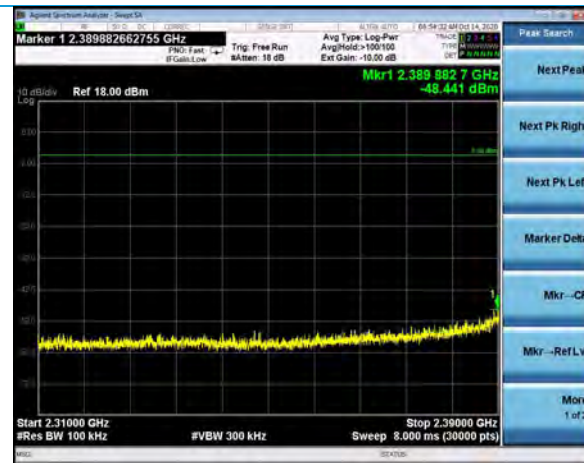
Company: Gerogia Pacific		Name: KOLO Gen2 WiFi Module
Report: TR319295 A	Page 39 of 64	Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample



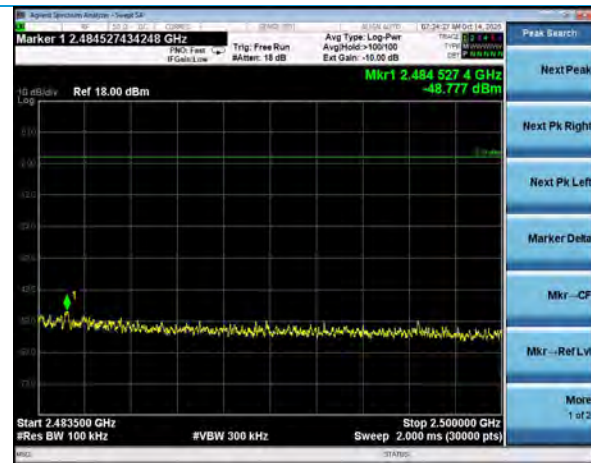
1-10 GHz, Channel 1, 802.11b, 11Mbps



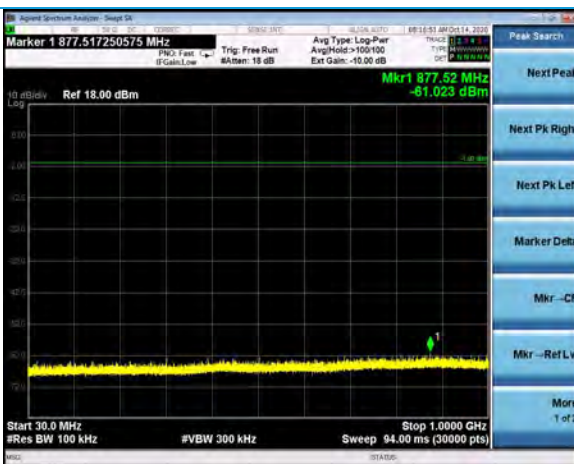
10-25 GHz, Channel 1, 802.11b, 11Mbps



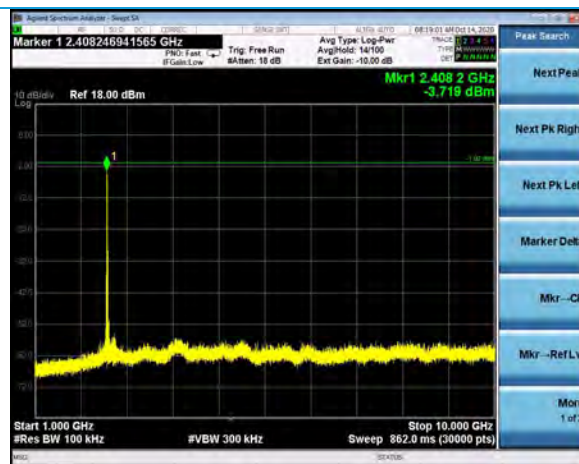
2310-2390 MHz, Channel 1, 802.11b, 11Mbps



2483.5-2500 MHz, Channel 11, 802.11b, 11Mbps



30-1000 MHz, Channel 1, 802.11g, 6Mbps



1-10 GHz, Channel 1, 802.11g, 6Mbps

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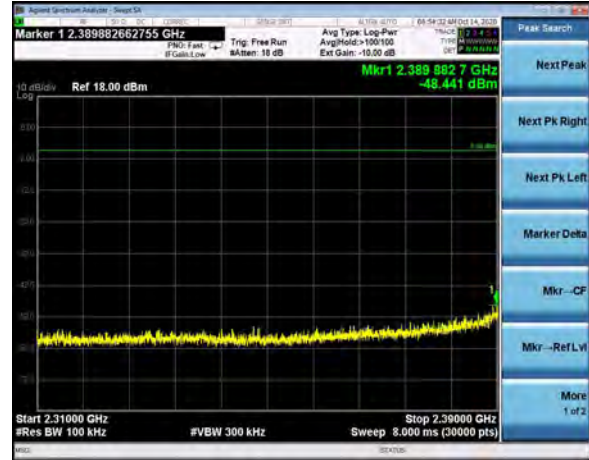
Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

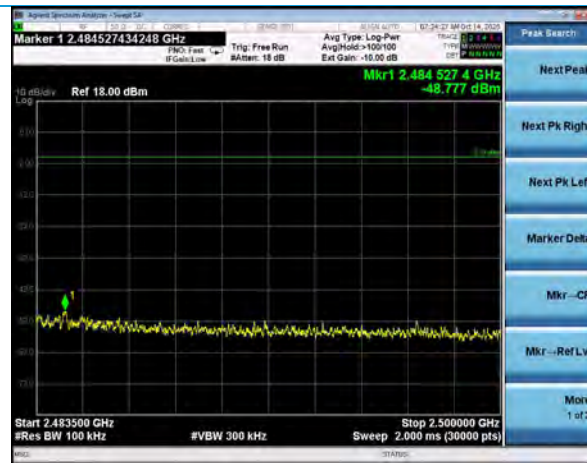
Serial: Engineering Sample



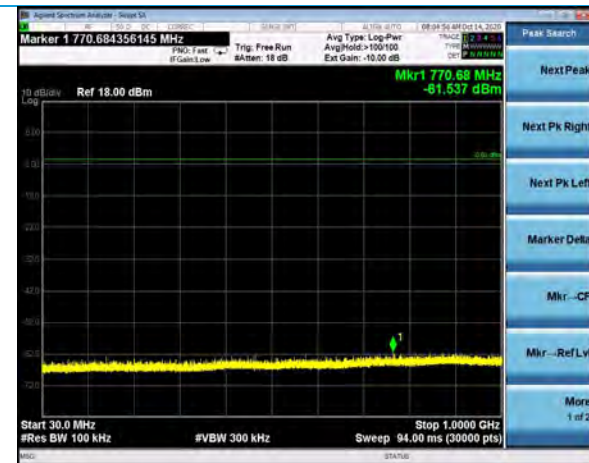
10-25 GHz, Channel 1, 802.11g, 6Mbps



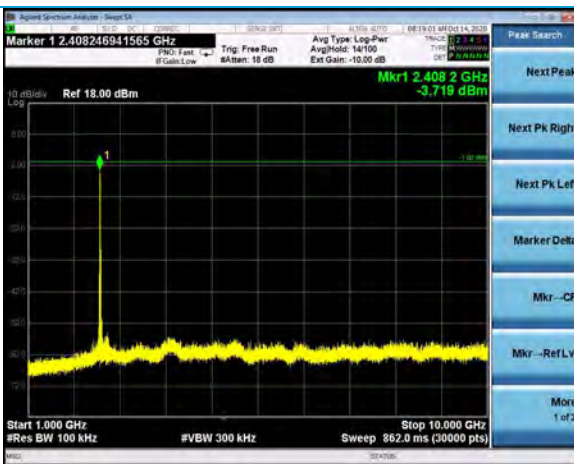
2310-2390 MHz, Channel 1, 802.11g, 6Mbps



2483.5-2500 MHz, Channel 11, 802.11g, 6Mbps



30-1000 MHz, Channel 1, 802.11g, 54Mbps



1-10 GHz, Channel 1, 802.11g, 54Mbps



10-25 GHz, Channel 1, 802.11g, 54Mbps

Company: Gerogia Pacific

Report: TR319295 A

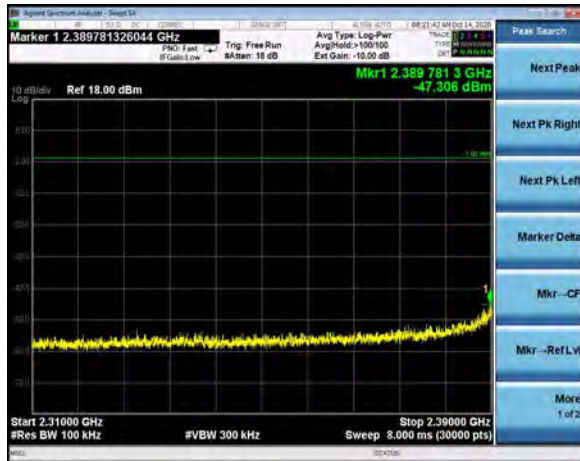
Job: C-3397

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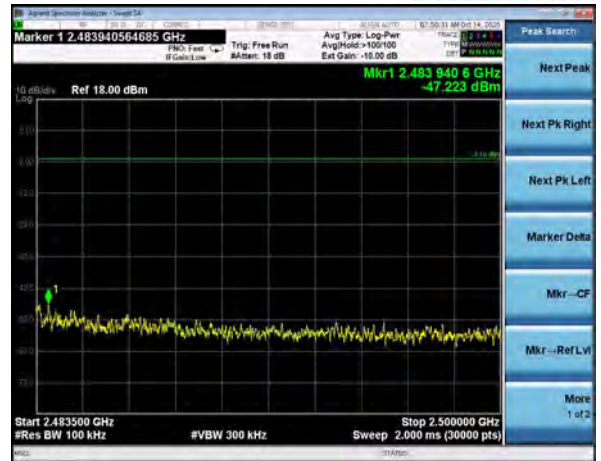
Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

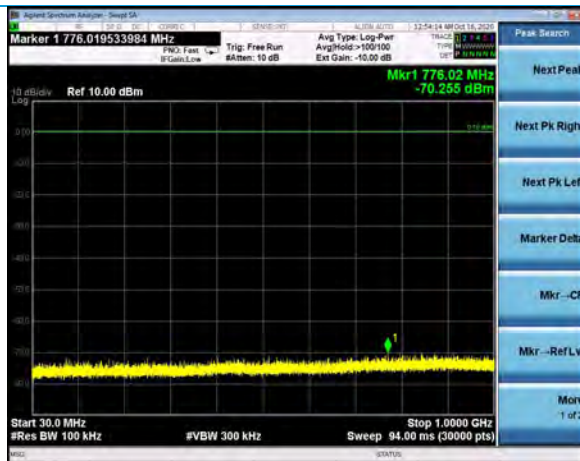
Serial: Engineering Sample



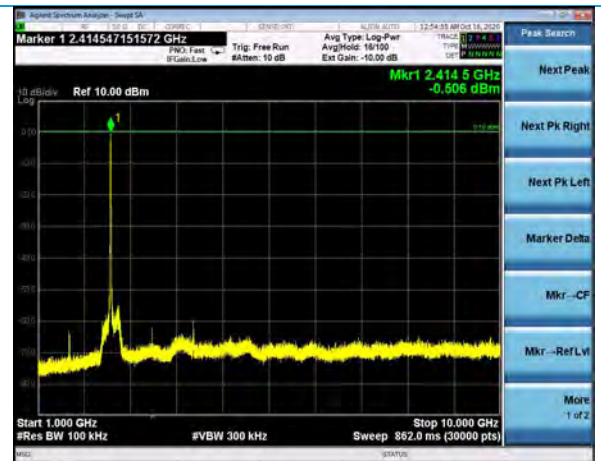
2310-2390 MHz, Channel 1, 802.11g, 54Mbps



2483.5-2500 MHz, Channel 1, 802.11g, 54Mbps



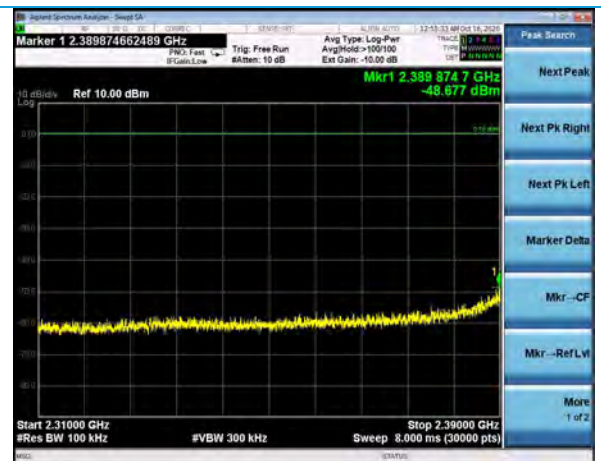
30-1000 MHz, Channel 1, 802.11n, MCS0



1-10 GHz, Channel 1, 802.11n, MCS0



10-25 GHz, Channel 1, 802.11n, MCS0



2310-2390 MHz, Channel 1, 802.11n, MCS0

Company: Gerogia Pacific

Report: TR319295 A

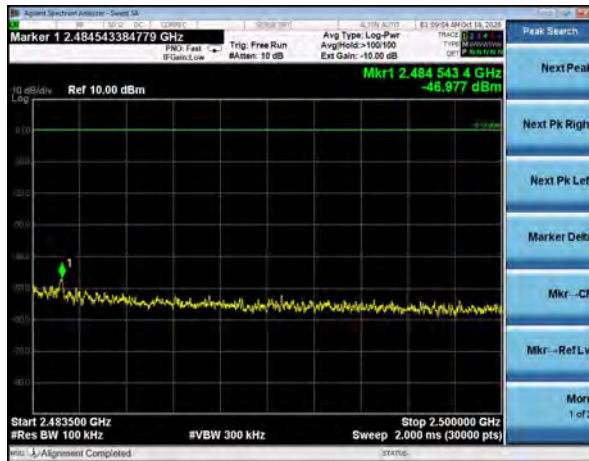
Job: C-3397

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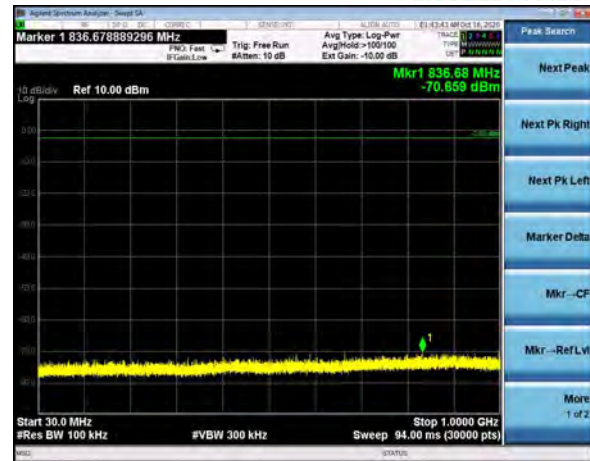
Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

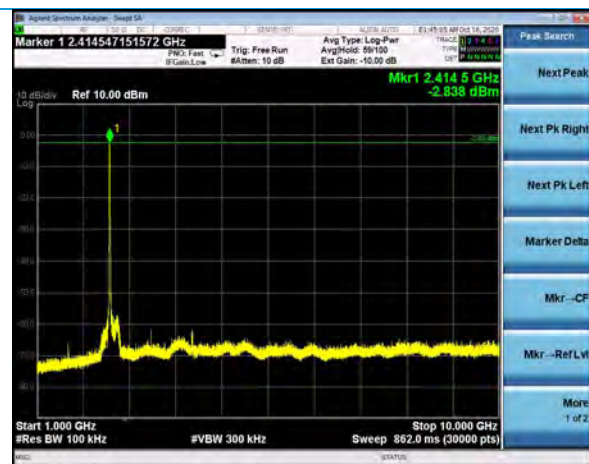
Serial: Engineering Sample



2483.5-2500 MHz, Channel 11, MCS0



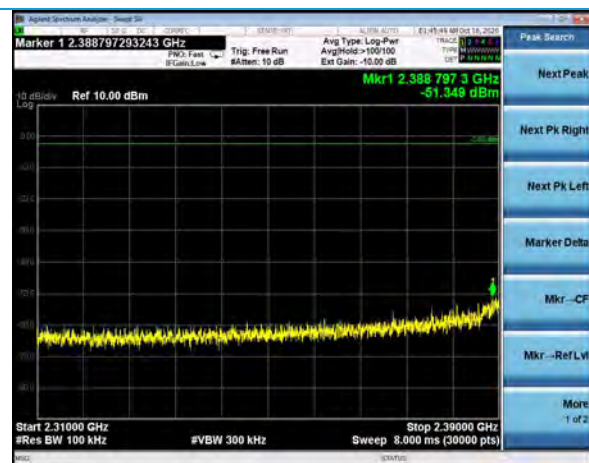
30-1000 MHz, Channel 1, 802.11n, MCS7



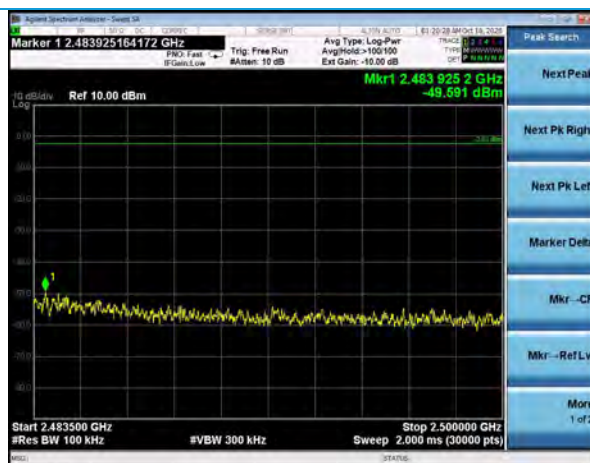
1-10 GHz, Channel 1, 802.11n, MCS7



10-25 GHz, Channel 1, 802.11n, MCS0

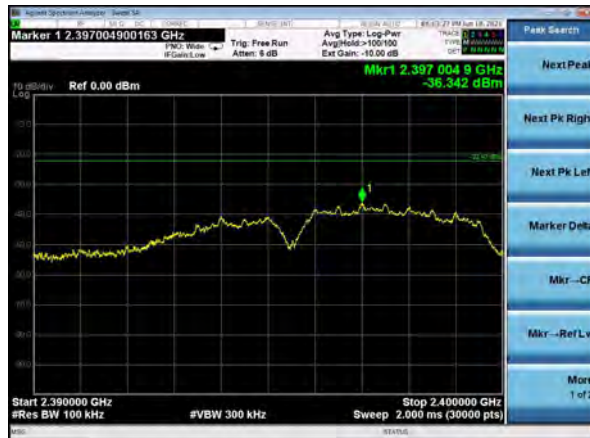


2310-2390 MHz, Channel 1, 802.11n, MCS7



2483.5-2500 MHz, Channel 11, 802.11n, MCS7

Company: Gerogia Pacific	Page 43 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
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2390-2400 MHz, Channel 1, 802.11b, 1 Mbps



2390-2400 MHz, Channel 1, 802.11b, 11 Mbps



2390-2400 MHz, Channel 1, 802.11g, 6 Mbps



2390-2400 MHz, Channel 1, 802.11g, 54 Mbps



2390-2400 MHz, Channel 1, 802.11n, MCS0



2390-2400 MHz, Channel 1, 802.11n, MCS7

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Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

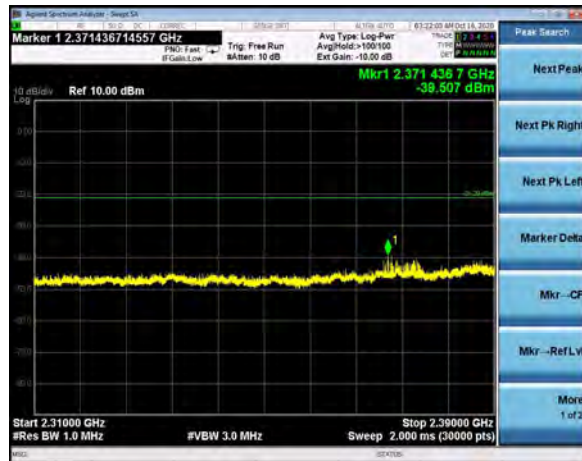
Serial: Engineering Sample

Terminated Antenna Port Method Data

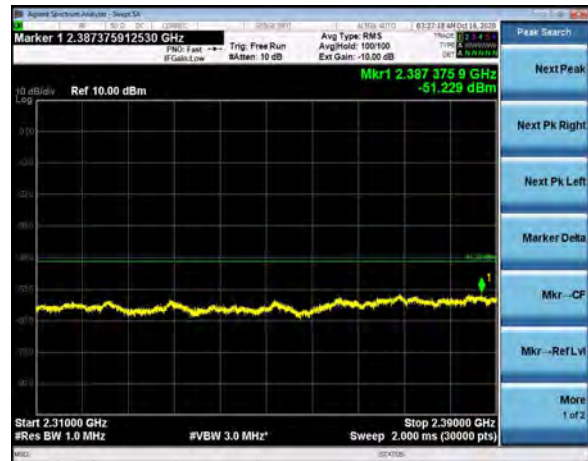
Channel	Protocol	Data Rate	Frequency (MHz)	Peak Reading (dBm)	Antenna Gain (dBm)	Corrected Peak Reading (dBm)	Peak Limit (dBm)	Margin (dB)
1	802.11b	1Mbps	2371.4	-39.5	2.5	-37.0	-21.2	15.8
11	802.11b	1Mbps	2486.9	-38.2	2.5	-35.7	-21.2	14.5
1	802.11b	11Mbps	2437	-37.1	2.5	-34.6	-21.2	13.4
11	802.11b	11Mbps	2488	-35.8	2.5	-33.3	-21.2	12.1
1	802.11g	6Mbps	2389.9	-36.1	2.5	-33.6	-21.2	12.4
11	802.11g	6Mbps	2483.7	-34.1	2.5	-31.6	-21.2	10.4
1	802.11g	54Mbps	2388.7	-32.9	2.5	-30.4	-21.2	9.2
11	802.11g	54Mbps	2484	-32.4	2.5	-29.9	-21.2	8.7
1	802.11n	MCS0	2388.5	-34.3	2.5	-31.8	-21.2	10.6
11	802.11n	MCS0	2483.6	-34	2.5	-31.5	-21.2	10.3
1	802.11n	MCS7	2389.8	-35.8	2.5	-33.3	-21.2	12.1
11	802.11n	MCS7	2389.8	-58.7	2.5	-56.2	-21.2	35.0

Channel	Protocol	Data Rate	Frequency (MHz)	Average Reading (dBm)	Antenna Gain (dBm)	Corrected Average Reading (dBm)	Average Limit (dBm)	Margin (dB)
1	802.11b	1Mbps	2387.4	-51.2	2.5	-48.7	-41.2	7.5
11	802.11b	1Mbps	2486.4	-48.9	2.5	-46.4	-41.2	5.2
1	802.11b	11Mbps	2389.8	-50.7	2.5	-48.2	-41.2	7.0
11	802.11b	11Mbps	2489.1	-49.1	2.5	-46.6	-41.2	5.4
1	802.11g	6Mbps	2389.6	-52.4	2.5	-49.9	-41.2	8.7
11	802.11g	6Mbps	2483.9	-51.9	2.5	-49.4	-41.2	8.2
1	802.11g	54Mbps	2389.1	-51.7	2.5	-49.2	-41.2	8.0
11	802.11g	54Mbps	2483.9	-51.4	2.5	-48.9	-41.2	7.7
1	802.11n	MCS0	2389.7	-54.1	2.5	-51.6	-41.2	10.4
11	802.11n	MCS0	2483.5	-50.9	2.5	-48.4	-41.2	7.2
1	802.11n	MCS7	2389.8	-58.7	2.5	-56.2	-41.2	15.0
11	802.11n	MCS7	2484.7	-55.9	2.5	-53.4	-41.2	12.2

Terminated Antenna Port Method Plots



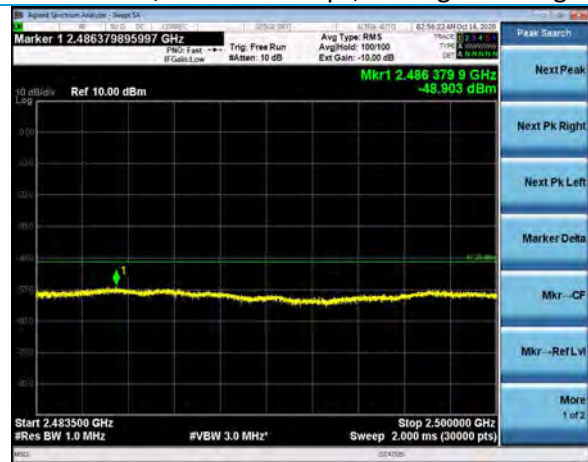
2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11b 1Mbps, Peak Reading



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11b 1Mbps, Average Reading



2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11b 1Mbps, Peak Reading

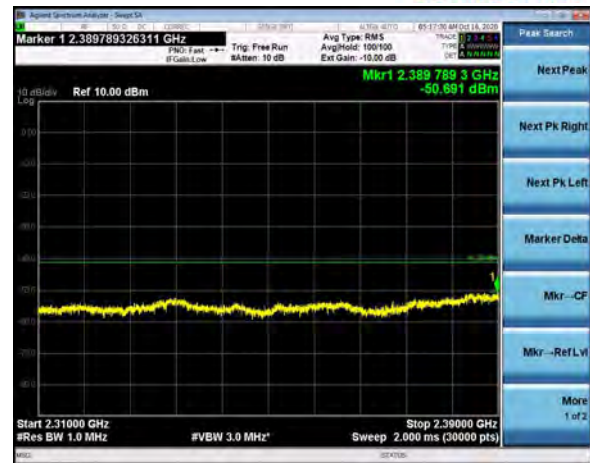


2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11b 1Mbps, Average Reading

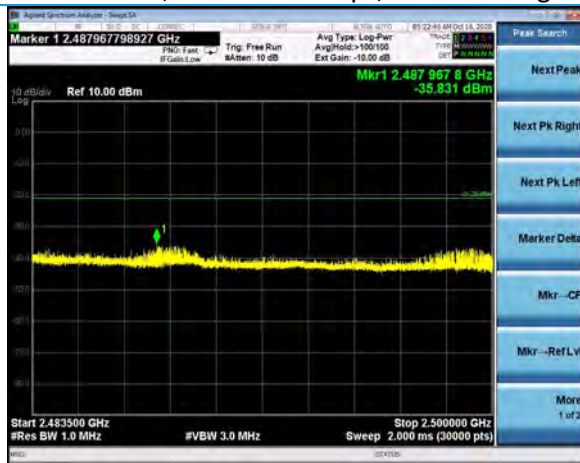
Company: Gerogia Pacific	Page 46 of 64	Name: KOLO Gen2 WiFi Module
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Job: C-3397		Serial: Engineering Sample



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11b 11Mbps, Peak Reading



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11b 11Mbps, Average Reading

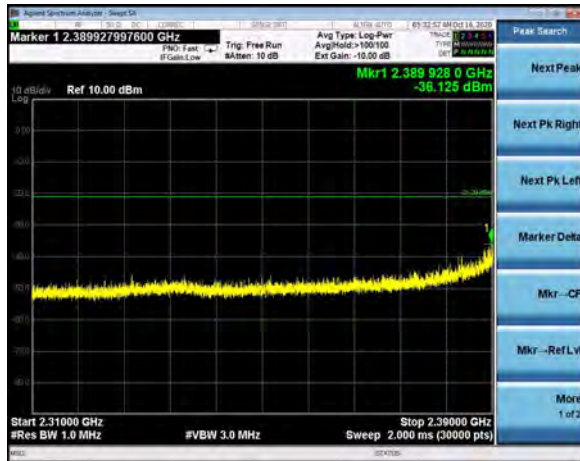


2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11b 11Mbps, Peak Reading

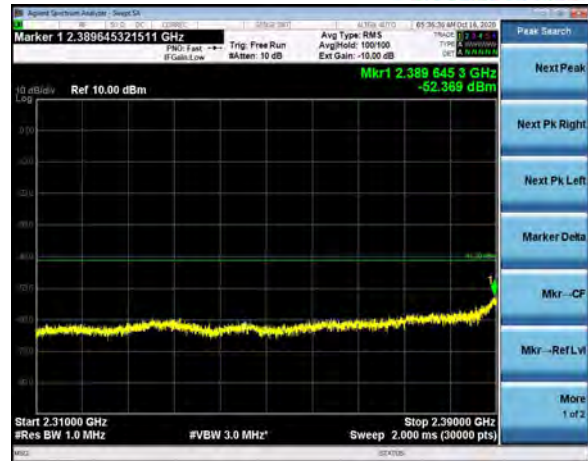


2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11b 11Mbps, Average Reading

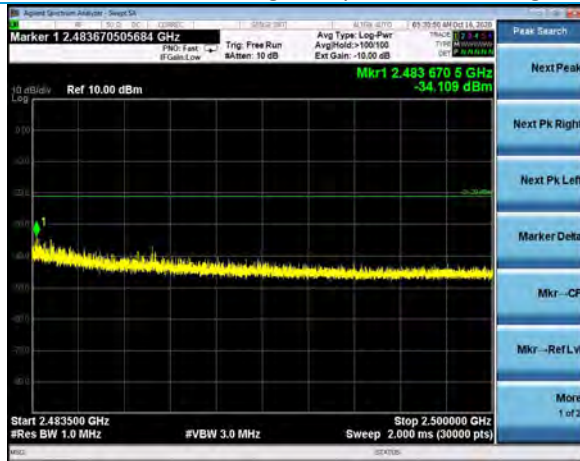
Company: Gerorgia Pacific	Page 47 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample



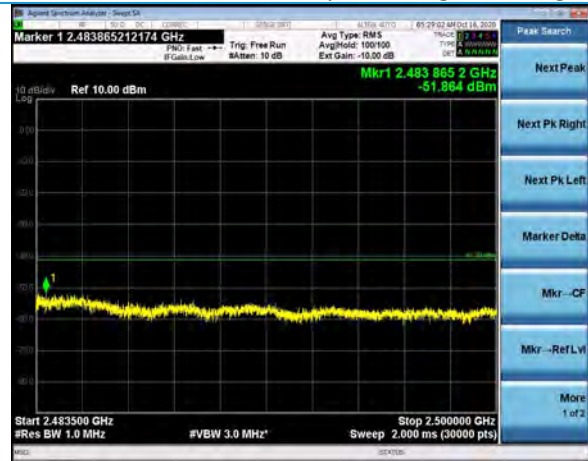
2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11g 6Mbps, Peak Reading



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11b 1Mbps, Average Reading

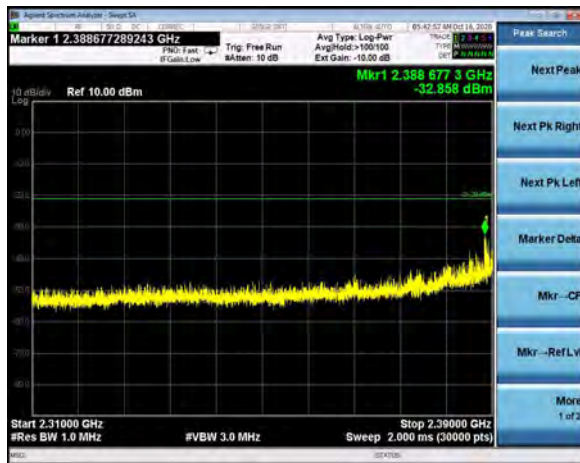


2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11g 6Mbps, Peak Reading

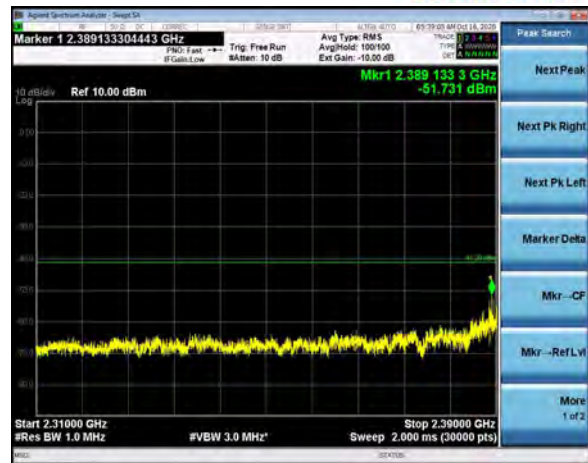


2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11g 6Mbps, Average Reading

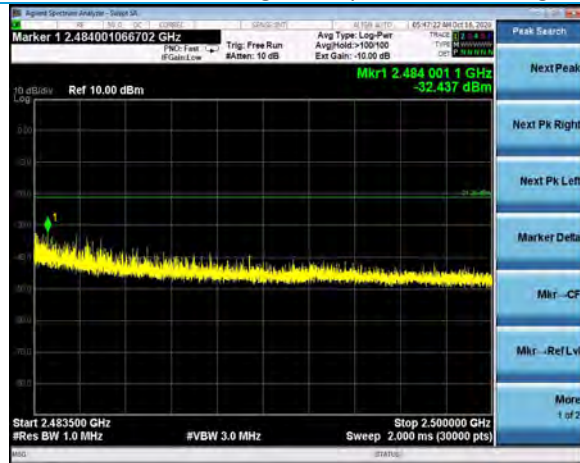
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Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample



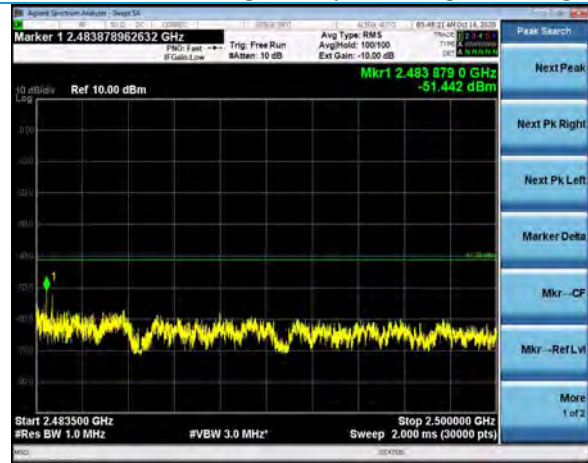
2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11g 54Mbps, Peak Reading



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11g 54Mbps, Average Reading

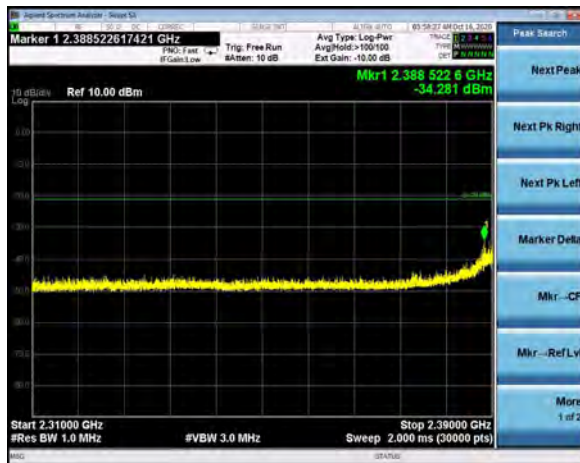


2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11g 54Mbps, Peak Reading



2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11g 54Mbps, Average Reading

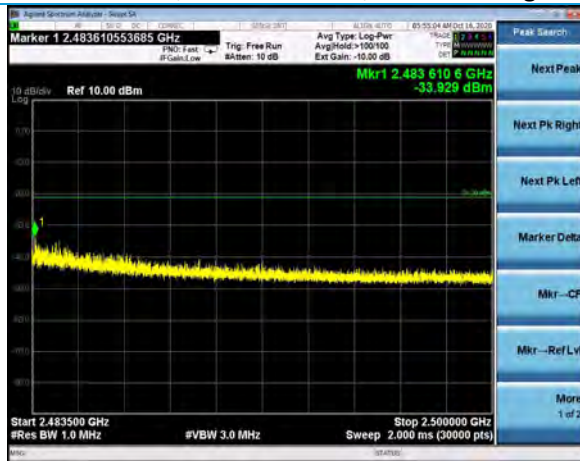
Company: Gerogia Pacific	Page 49 of 64	Name: KOLO Gen2 WiFi Module
Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample



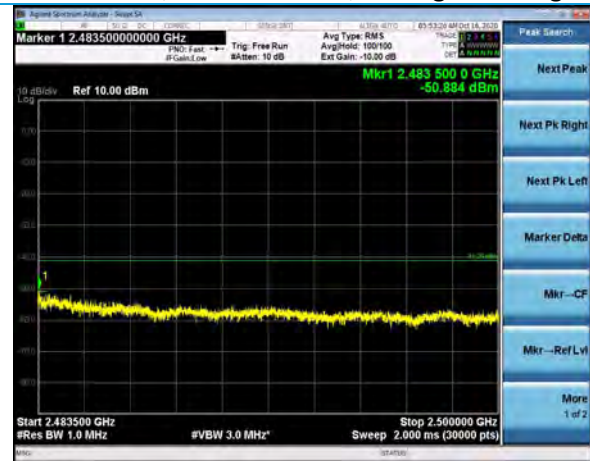
2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11n MCS0, Peak Reading



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11n MCS0, Average Reading

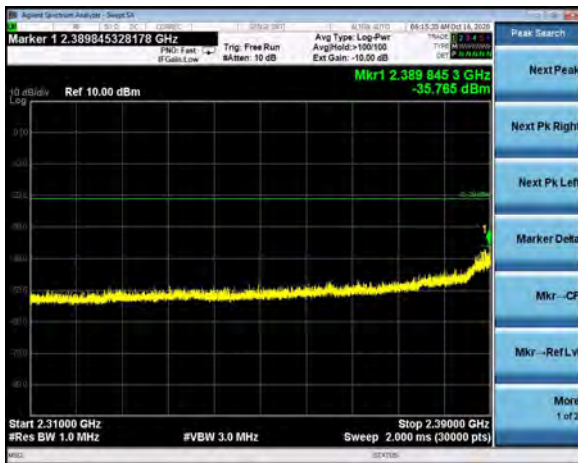


2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11n MCS0, Peak Reading

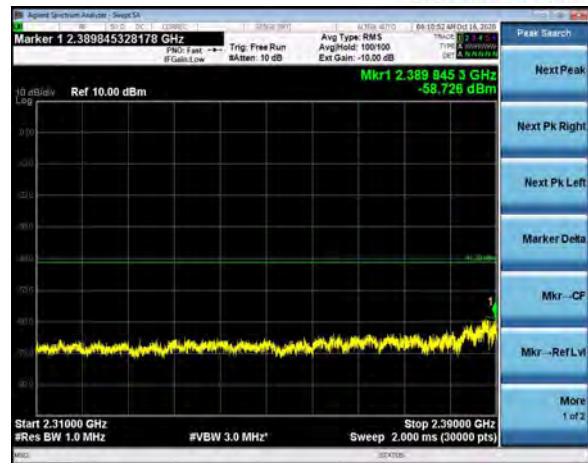


2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11n MCS0, Average Reading

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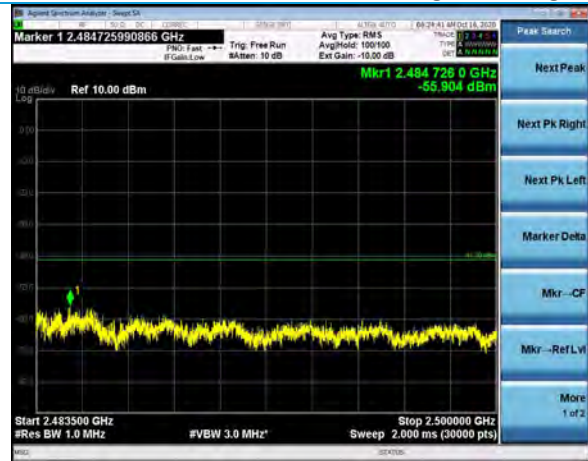
2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11n MCS7, Peak Reading



2.31-2.39 GHz, Terminated Method, 1 MHz RBW
Channel 1, 802.11n MCS7, Average Reading



2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11n MCS7, Peak Reading



2.4835-2.5 GHz, Terminated Method, 1 MHz RBW
Channel 11, 802.11n MCS7, Average Reading

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Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

5.1.6 Frequency Stability

Operator	Jon Dille	QA	Shane Dock
Temperature	21.1°C	R.H. %	55%
Test Date	10/12/2020	Location	Conducted RF Bench
Requirement	FCC 15.1055 (d) (1)	Method	ANSI C63.10 §6.8.2

Limits: Reported

Test Parameters

Frequency	2412, 2437, 2462 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	5.1, 5.9, 6.9 VDC	Mode	WLAN TX CW
Channel	1, 6, 11		

Data Table

Protocol	Data Rate	Channel	5.1 VDC Freq. (Hz)	5.9 VDC Freq. (Hz)	6.9 VDC Freq. (Hz)	Deviation (Hz)
802.11b	1Mbps	1	2412018526	2412004258	2412001092	17434
802.11b	1Mbps	6	2437005225	2437004525	2437001492	3733
802.11b	1Mbps	11	2462017876	2462013242	2462011109	6767

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Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		Serial: Engineering Sample

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	Braden Smith, Jon Dille	QA	Anthony Smith, Shane Dock
Temperature	22.8°C to 24.8°C	R.H. %	25.7% to 42.3%
Test Date	10/12/2020 – 11/30/2020	Location	Chamber 3, Chamber 5
Requirement	FCC 15.209, RSS-GEN	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)	Max hold with peak detector for plots. Quasi peak detector for measurements below 1 GHz. Peak detector for measurements above 1 GHz. Average measurements taken with a reduced VBW of (see data table below).	Table height	Below 1 GHz: 80cm Above 1 GHz: 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: see data table
Notes	1Mbps for spurious, all rates for Band Edges. Worst case data reported.		

EUT Parameters

Input Power	5.9 VDC via DC Power Supply	Mode	WLAN TX Modulated
Channel	1, 6, 11	Data Rate	1Mbps for spurious, all rates for Band Edges
Notes	Antenna port terminated with a 50Ω u.fl-SMA termination.		

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Report: TR319295 A		Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327
Job: C-3397		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 960195	Antenna - Log Periodic	A.H. Systems, Inc	SAS-512-2	557	7/24/2020	7/24/2021	Active Calibration
3	AA 960194	Antenna - Biconical	A.H. Systems, Inc	SAS-540	780	9/21/2020	9/22/2021	Active Calibration
4	LSC-500	Cable	Chamber 5 Emissi -		-	9/14/2020	9/14/2021	Active Verification
5	AA 960007	Antenna - Double Ridge Horn	EMCO	3115	9311-4138	9/21/2020	9/21/2021	Active Calibration
6	EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	7/14/2020	7/14/2021	Active Calibration
7	LSC-300	Cable	Chamber 3 Emissi -		-	8/9/2020	8/9/2021	Active Verification
8	AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	12/27/2019	12/27/2020	Active Calibration
9	EE 960159	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	691801732	12/27/2019	12/27/2020	Active Calibration
10	AA 960176	Cable	A.H. Systems, Inc	SAC-26G-6	395	12/9/2019	12/9/2020	Active Verification
11	AA 960153	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-04	7/16/2020	7/16/2021	Active Calibration

Data Tables

Data Rate	On Time	Average VBW
1Mbps	991 us	1.1 kHz
11Mbps	263 us	3.9 kHz
6Mbps	160 us	6.8 kHz
54Mbps	35 us	30 kHz
MCS0	164 us	6.2 kHz
MCS7	50 us	20 kHz

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBμV/m)	Quasi-Peak Limit (dBμV/m)	Quasi-Peak Margin (dB)
43.0	Vertical	Vertical	100	0	19.0	40.0	21.0
84.9	Vertical	Horizontal	100	0	18.4	40.0	21.6
192.3	Vertical	Vertical	100	0	23.9	43.5	19.6
200.0	Vertical	Horizontal	100	0	27.9	43.5	15.6
375.0	Vertical	Horizontal	100	0	27.8	46.0	18.2
840.2	Vertical	Vertical	100	0	29.6	46.0	16.4

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Frequency (MHz)	EUT Orientation	Antenna Polarity	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
2571.0	Flat	Horizontal	169.0	113.0	42.0	54.0	12.0	52.7	74.0	21.3	1
2619.1	Flat	Horizontal	169.0	150.0	40.3	54.0	13.7	51.9	74.0	22.1	6
2620.3	Horizontal	Horizontal	150.0	0.0	43.2	54.0	10.8	53.6	74.0	20.4	11
2620.8	Flat	Horizontal	169.0	150.0	44.6	54.0	9.4	54.8	74.0	19.2	11
2621.2	Vertical	Horizontal	150.0	260.0	42.9	54.0	11.1	53.9	74.0	20.1	11
2621.3	Horizontal	Vertical	150.0	208.0	41.9	54.0	12.1	52.6	74.0	21.4	11
2621.4	Vertical	Vertical	143.0	115.0	43.3	54.0	10.7	53.7	74.0	20.3	11
2622.9	Flat	Vertical	150.0	15.0	41.5	54.0	12.5	52.4	74.0	21.6	11

Frequency (MHz)	EUT Orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Frequency [Peak] (MHz)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel	Data Rate (Mbps)
2357.847	Flat	Horizontal	102	135	40.03	54.0	14.0	2368.311	47.52	74.0	26.5	1	54
2360.260	Flat	Horizontal	102	135	39.34	54.0	14.7	2378.453	47.27	74.0	26.7	1	MCS7
2360.983	Flat	Horizontal	102	135	37.92	54.0	16.1	2339.241	47.62	74.0	26.4	1	6
2375.056	Flat	Horizontal	102	135	36.84	54.0	17.2	2385.685	48.06	74.0	25.9	1	11
2384.931	Flat	Horizontal	102	135	35.84	54.0	18.2	2360.503	47.87	74.0	26.1	1	1
2389.845	Flat	Horizontal	102	135	37.87	54.0	16.1	2341.321	47.38	74.0	26.6	1	MCS0
2483.861	Flat	Horizontal	102	135	37.67	54.0	16.3	2498.516	48.18	74.0	25.8	11	MCS0
2485.256	Flat	Horizontal	102	135	37.22	54.0	16.8	2492.724	48.29	74.0	25.7	11	11
2488.870	Flat	Horizontal	102	135	39.13	54.0	14.9	2492.333	48.49	74.0	25.5	11	MCS7
2494.067	Flat	Horizontal	102	135	36.09	54.0	17.9	2495.429	48.98	74.0	25.0	11	1
2494.449	Flat	Horizontal	102	135	40.19	54.0	13.8	2486.939	47.97	74.0	26.0	11	54
2498.206	Flat	Horizontal	102	135	38.09	54.0	15.9	2498.908	48.05	74.0	25.9	11	6

Frequency (MHz)	EUT Orientation	Antenna Polarity	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
4019.2	Flat	Horizontal	101.0	130.0	46.0	54.0	8.0	50.4	74.0	23.6	1
4060.9	Flat	Horizontal	101.0	130.0	42.7	54.0	11.3	47.9	74.0	26.1	6
4102.3	Vertical	Vertical	170.0	350.0	39.5	54.0	14.6	45.1	74.0	28.9	11
4102.5	Horizontal	Vertical	150.0	75.0	39.9	54.0	14.1	46.7	74.0	27.3	11
4102.5	Vertical	Horizontal	168.0	35.0	36.7	54.0	17.3	44.3	74.0	29.7	11
4102.6	Flat	Vertical	148.0	82.0	36.2	54.0	17.8	44.5	74.0	29.5	11
4102.6	Horizontal	Horizontal	100.0	0.0	39.1	54.0	14.9	46.2	74.0	27.8	11
4102.6	Flat	Horizontal	104.0	129.0	40.6	54.0	13.5	46.6	74.0	27.4	11
4824.0	Flat	Horizontal	105.0	91.0	35.9	54.0	18.1	43.6	74.0	30.4	1
4874.0	Flat	Horizontal	113.0	92.0	32.6	54.0	21.4	41.3	74.0	32.7	6
4924.0	Horizontal	Vertical	199.0	285.0	35.8	54.0	18.2	43.0	74.0	31.0	11
4924.0	Horizontal	Horizontal	333.0	347.0	37.1	54.0	16.9	44.1	74.0	29.9	11
4924.0	Vertical	Vertical	100.0	34.0	38.5	54.0	15.5	44.2	74.0	29.8	11
4924.0	Flat	Vertical	150.0	34.0	34.7	54.0	19.3	41.9	74.0	32.1	11
4924.0	Vertical	Horizontal	201.0	67.0	33.5	54.0	20.5	42.1	74.0	31.9	11
4924.0	Flat	Horizontal	100.0	87.0	39.2	54.0	14.8	44.3	74.0	29.7	11
7385.2	Horizontal	Horizontal	178.0	260.0	35.9	54.0	18.1	46.5	74.0	27.5	11
7385.2	Vertical	Vertical	100.0	145.0	36.8	54.0	17.2	45.8	74.0	28.2	11
7385.3	Horizontal	Vertical	114.0	250.0	36.9	54.0	17.1	46.2	74.0	27.8	11
7386.7	Vertical	Horizontal	333.0	31.0	40.7	54.0	13.3	47.8	74.0	26.2	11
7386.8	Flat	Horizontal	100.0	316.0	39.8	54.0	14.2	46.5	74.0	27.5	11
7386.9	Flat	Vertical	100.0	302.0	38.8	54.0	15.2	46.5	74.0	27.5	11

Frequency (MHz)	EUT Orientation	Antenna Polarity	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
19823.6	Vertical	Vertical	150	0	37.5	54.0	16.5	48.3	74.0	25.7	11
24566.8	Vertical	Horizontal	150	0	38.9	54.0	15.1	50.0	74.0	24.0	11

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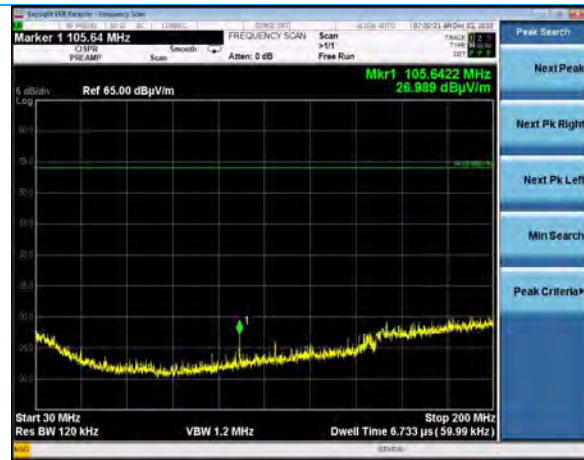
Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

Serial: Engineering Sample

Plots

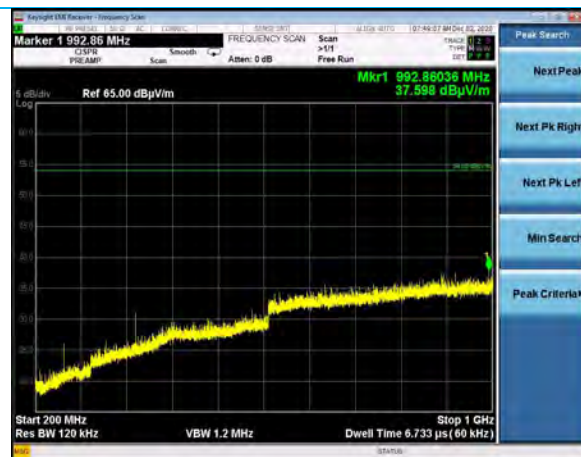


30-200 MHz, Horizontal Antenna, Vertical EUT
Channel 11

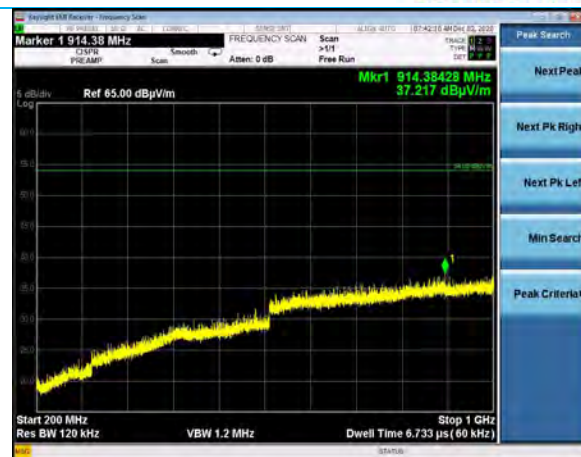


30-200 MHz, Vertical Antenna, Vertical EUT
Channel 11

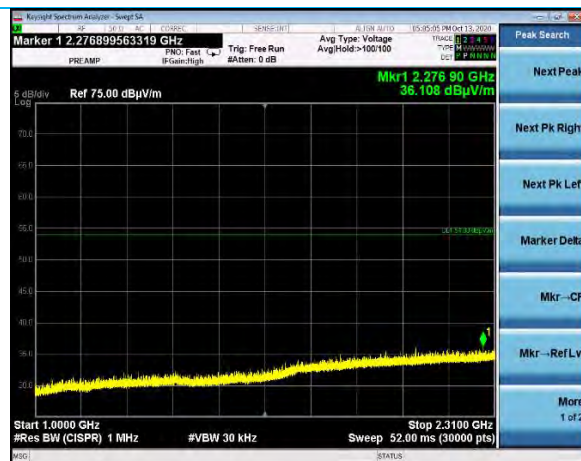
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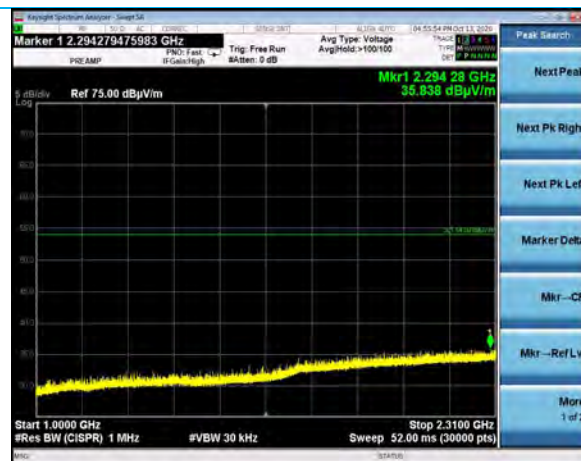
200-1000 MHz, Horizontal Antenna, Vertical EUT
Channel 11



200-1000 MHz, Vertical Antenna, Vertical EUT
Channel 11

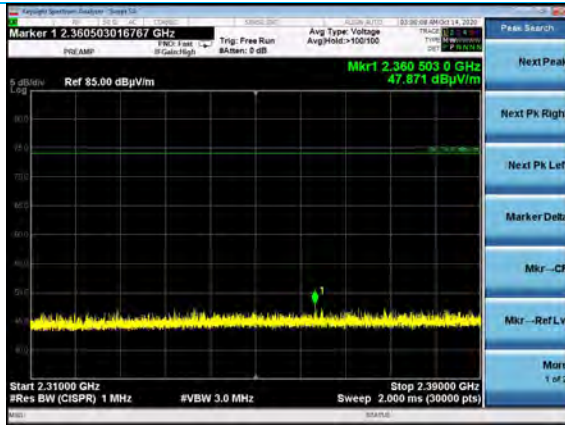


1000-2310 MHz, Horizontal Antenna, Vertical EUT
Channel 11

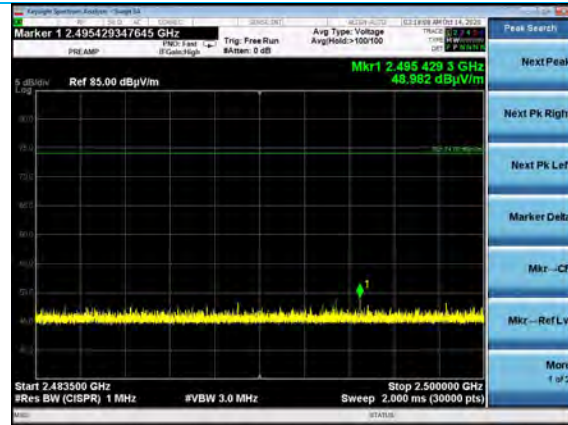


1000-2310 MHz, Vertical Antenna, Vertical EUT
Channel 11

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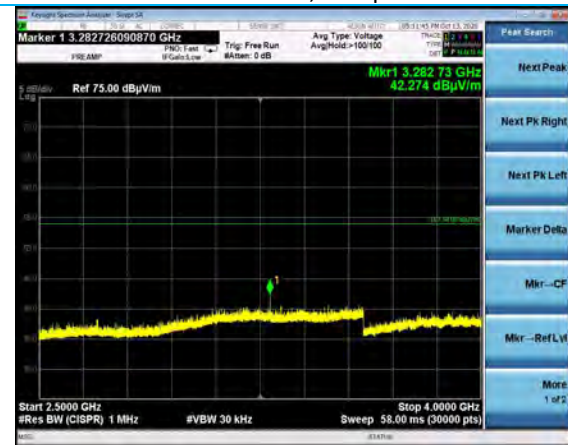
2310-2390 MHz, Horizontal Antenna, Flat EUT
Channel 1, 1Mbps



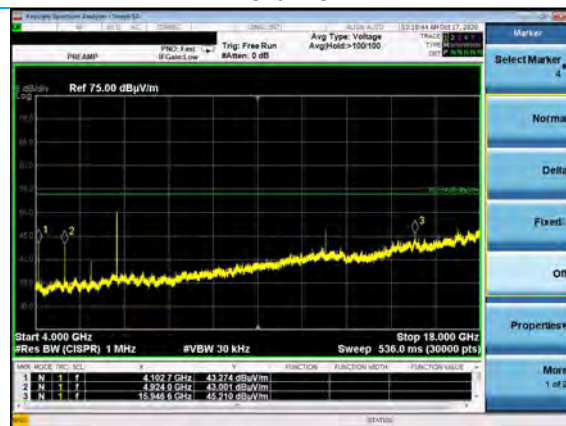
2483.5-2500 MHz, Horizontal Antenna, Flat EUT
Channel 11, 1Mbps



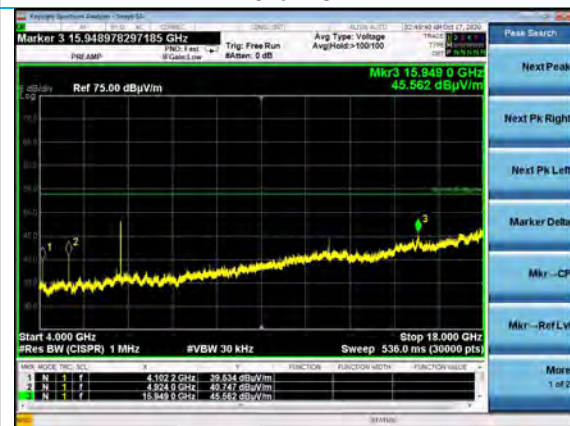
2500-4000 MHz, Horizontal Antenna, Vertical EUT
Channel 11



2500-4000 MHz, Vertical Antenna, Vertical EUT
Channel 11



4-18 GHz, Horizontal Antenna, Vertical EUT
Channel 11



4-18 GHz, Vertical Antenna, Vertical EUT
Channel 11

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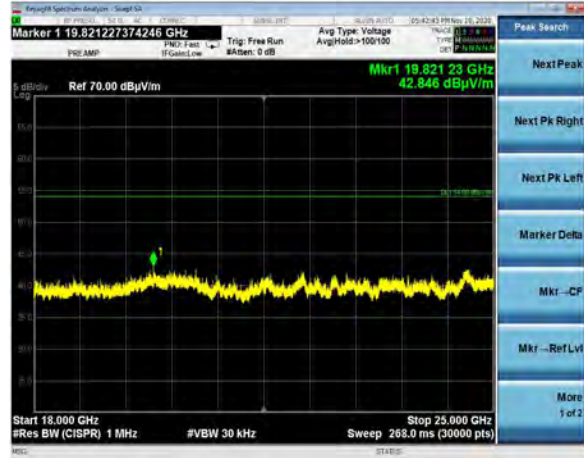
Name: KOLO Gen2 WiFi Module

Model: ASM-0000001220, ASM-0000001303, ASM-0000000791, ASM-0000001327

Serial: Engineering Sample



18-25 GHz, Horizontal Antenna, Vertical EUT
Channel 11



18-25 GHz, Vertical Antenna, Vertical EUT
Channel 11

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5.3 AC Mains Conducted Emissions

A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains.

Description of Measurement

The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values.

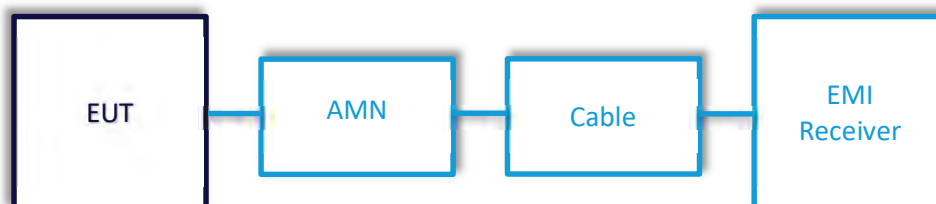
Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)

Example Calculations

Measurement (dBμV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBμV)

Margin (dB) = Limit (dBμV) - Corrected Reading (dBμV)

Block Diagram



5.3.1 AC Mains Conducted Emissions

Operator	Jon Dille	QA	Shane Dock
Temperature	21.8°C	R.H. %	20.60%
Test Date	12/16/2020	Location	Conducted Bench Area
Requirement	FCC 15.207, RSS-GEN	Method	ANSI C63.10

Limits:

Frequency (MHz)	Quasi-peak Limit (dBμV)	Average Limit (dBμV)
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

Test Parameters

Frequency	0.15-30 MHz	Distance	40cm from VGP
Detector(s)	Max hold with peak detector for plots. Quasi peak and average detectors for final measurement.	Table height	80cm
RBW	9 kHz	VBW	90 kHz

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960089	LISN	COM-POWER	LI-215A	191943	7/13/2020	7/13/2021	Active Calibration
2	EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	7/14/2020	7/14/2021	Active Calibration
3	LSC-202	Cable	Micro-Coax	UFB311A-0-1440-70L	64639 224071-004	12/9/2020	12/9/2021	Active Verification

EUT Parameters

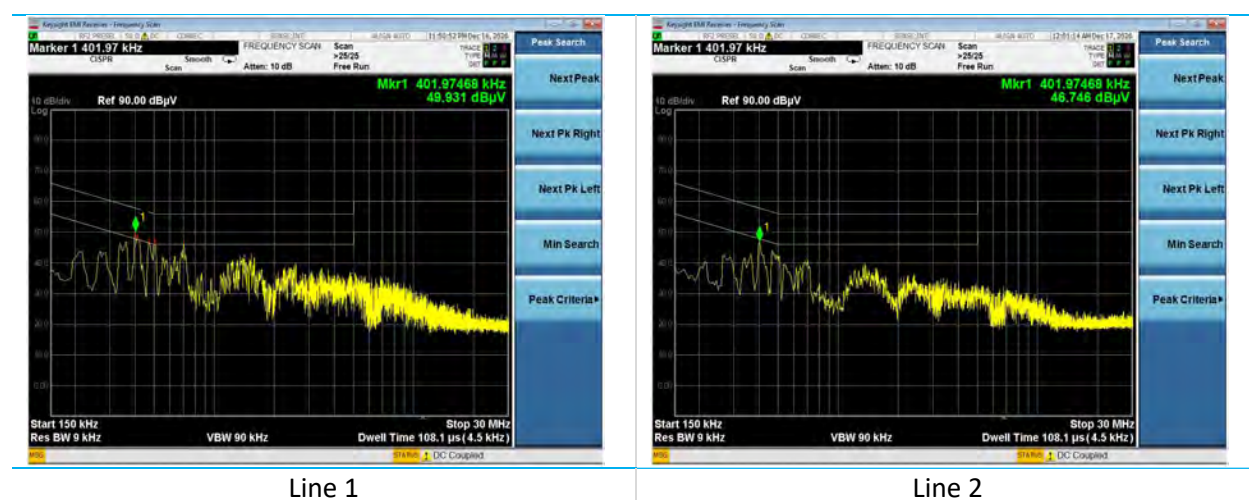
Input Power	5.9VDC via AC/DC power supply	Mode	WLAN TX
Channel	11	Data Rate	1Mbps
Notes	No difference in emission when channels/data rates are changed.		

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Data Table

Line	Frequency (MHz)	Quasi-Peak Reading (dBμV)	Quasi-Peak Limit (dBμV)	Quasi-Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)
1	0.356	47.4	58.8	11.4	32.3	48.8	16.5
1	0.464	44.9	56.6	11.7	27.5	46.6	19.1
1	0.658	46.5	56.0	9.5	31.1	46.0	14.9
2	0.338	43.7	59.2	15.5	33.4	49.2	15.8
2	0.676	42.3	56.0	13.7	28.9	46.0	17.1
2	1.049	36.9	56.0	19.1	23.1	46.0	22.9

Plots



6 REVISION HISTORY

Version	Date	Notes	Person
0	6/15/2021	Initial Draft	Zach Wilson
1	7/19/2021	Revised per internal review	Zach Wilson
2	7/26/2021	Revised per internal review	Zach Wilson

END OF REPORT

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