Laird

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# Test Report # 317347 D

| | |
|---|---|
| **Equipment Under Test:** | KOLO Gen2 KOLO Gen2 WiFi Module |
| **Requirement:** | FCC 1.1037, 2.1091, 2.1093, ISED Canada RSS-102 for a module |
| **Test Date(s):** | October 12th, 2020 |
| **Prepared for:** | Georgia Pacific<br>Attn: Randall Duval<br>1915 Marathon Avenue<br>Neenah, WI 54956 |

**Report Issued by:** Zach Wilson, EMC Engineer

Signature: Zach Wilson

Date: 9/23/2021

**Report Reviewed by:** Adam Alger, Laboratory Manager

Signature: Adam O Alger

Date: 8/3/2021

**Report Constructed by:** Zach Wilson, EMC Engineer

Signature: Zach Wilson

Date: 7/29/2021

# CONTENTS

## 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:

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*

**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

On **October 12th, 2020** the Equipment Under Test (EUT), **KOLO Gen2 WiFi Module**, as provided by **Georgia Pacific** was tested to the following requirements:

| Requirement | Description | Specification | Method | Result |
|---|---|---|---|---|
| FCC Part 1.1307, 2.1091, 2.1093 | RF Exposure and equipment authorization requirements | Reported | FCC KDB 447498 | Reported |
| ISED Canada RSS-102 | Radio Frequency Radiation Exposure Evaluation | Reported | RSS-102 Section 2.5.2 | Reported |

**Notice:**

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

# 2 CLIENT INFORMATION

| | |
|---|---|
| **Company Name** | Georgia Pacific |
| **Contact Person** | Randall Duval |
| **Address** | 1915 Marathon Avenue<br>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 3.3VDC. The antenna port was terminated at 50Ω for radiated testing. The chip antenna version was tested for radiated emissions with emissions being lower than those produced by the terminated method.

Model Variants:

a. **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.

b. **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.

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 |
|---|---|---|
| UNII-1: 36, 40, 44, 48<br>UNII 2A: 52, 56, 64<br>UNII 2C: 100, 116, 140<br>UNII 3: 149, 157, 165 | 802.11a<br>802.11n HT20 | 6Mbps, 54Mbps<br>MCS0, MCS7 |

| 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 5 | Chip | Yageo | ANT5320LL24R2455A | 3.5 |
| WLAN 5 | Flexible (FlexPIFA) | Laird | 001-0016 | 3.0 |
| WLAN 2.4 | Flexible (FlexPIFA) | Laird | 001-0016 | 2.5 |
| WLAN 2.4 | Chip | Yageo | ANT5320LL24R2455A | 2.2 |

## 2.8 Distance to End User

The 2.4 GHz and 5 GHz WLAN radios will be further than 20cm from the end user per the manufacturer.

# 3 References

| Publication | Edition | Date |
| --- | --- | --- |
| CFR 47 Part 15 | - | 2021 |
| ANSI C63.10 | - | 2013 |
| RSS-247 | 2 | 2017 |
| RSS GEN | 5 | 2014 |
| RSS-102 | 5 | 2015 |
| CFR 47 Part 1 and 2 | - | 2021 |

# 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 |

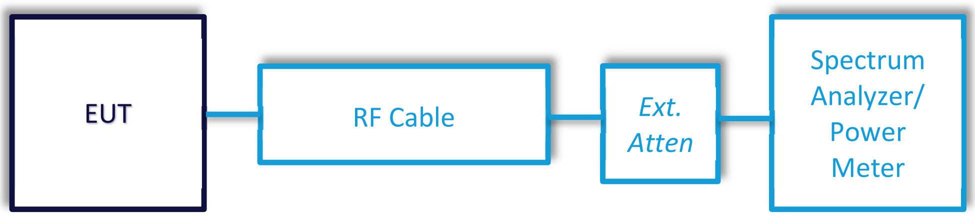
| Parameter | ETSI U.C. ± | U.C. ± |
|---|---|---|
| Radio Frequency, from F0 | $1x10^{-7}$ | $0.55x10^{-7}$ |
| Occupied Channel Bandwidth | 5 % | 2 % |
| RF conducted Power (Power Meter) | 1.5 dB | 1.2 dB |
| RF conducted emissions (Spectrum Analyzer) | 3.0 dB | 1.7 dB |
| All emissions, radiated | 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.<br><br>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)<br>Margin (dB) = Limit (dBm) – Corrected Reading (dBm) |

**Block Diagram**



### 5.1.1 Antenna Port Conducted Emissions

**Data – 5 GHz WLAN**

| Protocol | Data Rate | Channel | Measured Output Power (dBm) | Duty Cycle Correction Factor (dB) | Corrected Conducted Output Power (dBm) |
|---|---|---|---|---|---|
| 802.11a | 6Mbps | 36 | 4.1 | 5.4 | 9.5 |
| 802.11a | 6Mbps | 40 | 5.9 | 5.4 | 11.3 |
| 802.11a | 6Mbps | 44 | 6.0 | 5.4 | 11.4 |
| 802.11a | 6Mbps | 48 | 5.6 | 5.4 | 11.0 |
| 802.11a | 6Mbps | 52 | 6.3 | 5.4 | 11.7 |
| 802.11a | 6Mbps | 56 | 6.5 | 5.4 | 11.9 |
| 802.11a | 6Mbps | 64 | 6.4 | 5.4 | 11.8 |
| 802.11a | 6Mbps | 100 | 6.2 | 5.4 | 11.6 |
| 802.11a | 6Mbps | 116 | 8.3 | 5.4 | 13.7 |
| 802.11a | 6Mbps | 140 | 3.4 | 5.4 | 8.8 |
| 802.11a | 6Mbps | 149 | 7.6 | 5.4 | 13.0 |
| 802.11a | 6Mbps | 157 | 8.6 | 5.4 | 14.0 |
| 802.11a | 6Mbps | 165 | 6.4 | 5.4 | 11.8 |

| Protocol | Data Rate | Channel | Measured Output Power (dBm) | Duty Cycle Correction Factor (dB) | Corrected Conducted Output Power (dBm) |
|---|---|---|---|---|---|
| 802.11a | 54Mbps | 36 | -4.2 | 12.5 | 8.3 |
| 802.11a | 54Mbps | 40 | -3.6 | 12.5 | 8.9 |
| 802.11a | 54Mbps | 44 | -3.3 | 12.5 | 9.2 |
| 802.11a | 54Mbps | 48 | -4.2 | 12.5 | 8.3 |
| 802.11a | 54Mbps | 52 | -2.8 | 12.5 | 9.7 |
| 802.11a | 54Mbps | 56 | -3.2 | 12.5 | 9.3 |
| 802.11a | 54Mbps | 64 | -1.2 | 12.5 | 11.3 |
| 802.11a | 54Mbps | 100 | -1.1 | 12.5 | 11.4 |
| 802.11a | 54Mbps | 116 | -1.7 | 12.5 | 10.8 |
| 802.11a | 54Mbps | 140 | -3.3 | 12.5 | 9.2 |
| 802.11a | 54Mbps | 149 | -1.5 | 12.5 | 11.0 |
| 802.11a | 54Mbps | 157 | -0.7 | 12.5 | 11.8 |
| 802.11a | 54Mbps | 165 | -1.5 | 12.5 | 11.0 |

| Protocol | Data Rate | Channel | Measured Output Power (dBm) | Duty Cycle Correction Factor (dB) | Corrected Conducted Output Power (dBm) |
|---|---|---|---|---|---|
| 802.11n | MCS0 | 36 | 4.2 | 5.4 | 9.6 |
| 802.11n | MCS0 | 40 | 5.9 | 5.4 | 11.3 |
| 802.11n | MCS0 | 44 | 6.1 | 5.4 | 11.5 |
| 802.11n | MCS0 | 48 | 5.4 | 5.4 | 10.8 |
| 802.11n | MCS0 | 52 | 6.4 | 5.4 | 11.8 |
| 802.11n | MCS0 | 56 | 6.9 | 5.4 | 12.3 |
| 802.11n | MCS0 | 64 | 6.6 | 5.4 | 12.0 |
| 802.11n | MCS0 | 100 | 5.9 | 5.4 | 11.3 |
| 802.11n | MCS0 | 116 | 8.4 | 5.4 | 13.8 |
| 802.11n | MCS0 | 140 | 3.3 | 5.4 | 8.7 |
| 802.11n | MCS0 | 149 | 7.8 | 5.4 | 13.2 |
| 802.11n | MCS0 | 157 | 8.6 | 5.4 | 14.0 |
| 802.11n | MCS0 | 165 | 6.3 | 5.4 | 11.7 |

| Protocol | Data Rate | Channel | Measured Output Power (dBm) | Duty Cycle Correction Factor (dB) | Corrected Conducted Output Power (dBm) |
|---|---|---|---|---|---|
| 802.11n | MCS7 | 36 | -4.1 | 11.2 | 7.1 |
| 802.11n | MCS7 | 40 | -3.3 | 11.2 | 7.9 |
| 802.11n | MCS7 | 44 | -3.2 | 11.2 | 8.0 |
| 802.11n | MCS7 | 48 | -3.6 | 11.2 | 7.6 |
| 802.11n | MCS7 | 52 | -2.9 | 11.2 | 8.3 |
| 802.11n | MCS7 | 56 | -2.5 | 11.2 | 8.7 |
| 802.11n | MCS7 | 64 | -1.0 | 11.2 | 10.2 |
| 802.11n | MCS7 | 100 | -0.7 | 11.2 | 10.5 |
| 802.11n | MCS7 | 116 | -1.0 | 11.2 | 10.2 |
| 802.11n | MCS7 | 140 | -2.1 | 11.2 | 9.1 |
| 802.11n | MCS7 | 149 | -1.3 | 11.2 | 9.9 |
| 802.11n | MCS7 | 157 | -0.9 | 11.2 | 10.3 |
| 802.11n | MCS7 | 165 | -1.5 | 11.2 | 9.7 |

Data – 2.4 GHz WLAN

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

# 6 EXCLUSION CALCULATION

## 6.1 Highest Power Test Cases

5 GHz WLAN: 14.0 dBm at 5320 MHz (Tune up Tolerance = +/- 2 dB)

2.4 GHz WLAN: 15.6 dBm at 2450 MHz (Tune up Tolerance = +/- 2 dB)

Antenna Gain: 2.5 dBi @ 2.4 GHz, 3.5 dBi @ 5 GHz

## 6.2 FCC – 5 GHz WLAN

Worst Case Scenario: 14.0 dBm at 5320 MHz
Tune-Up Tolerance: 2.0 dB
Total Power: 16.3 dBm = 42.7 mW
Peak Antenna Gain: 3.5 dBi

**Prediction of MPE limit at a given distance**

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

| | | |
|---|---|---|
| Maximum peak output power at antenna input terminal: | 16.30 | (dBm) |
| Maximum peak output power at antenna input terminal: | 42.658 | (mW) |
| Antenna gain(typical): | 3.5 | (dBi) |
| Numeric Antenna Gain: | 2.239 | (numeric) |
| Prediction distance: | 20 | (cm) |
| Prediction frequency: | 5320 | (MHz) |
| MPE limit for uncontrolled exposure at prediction frequency: | 1.0 | (mW/cm^2) |
| Power density at prediction frequency: | 0.018999 | (mW/cm^2) |

**Result**

The EUT's 5GHz WLAN radio complies with the FCC MPE limits at a 20cm separation distance as the power density of **0.018999 mW/cm^2** is lower than the MPE limit of **1.0 mW/cm^2**.

## 6.3 ISED Canada – 5 GHz WLAN

**Per Section 2.5.2:**
Maximum EIRP Limit = (f(MHz)^0.6834)*1.31*10^-2 W = 4.6 W

**Result**
The EUT's 5GHz WLAN radio meets ISED's MPE Exemption limit at 20 cm as the maximum **95.5 mW EIRP** is less than **4.6 W.**

## 6.4 FCC – 2.4 GHz WLAN

Worst Case Scenario: 15.6 dBm at 2450 MHz
Tune-Up Tolerance: 2.0 dB
Total Power: 17.6 dBm = 57.5 mW
Peak Antenna Gain: 2.5 dBi

**Prediction of MPE limit at a given distance**

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

| | | |
|---|---|---|
| Maximum peak output power at antenna input terminal: | 17.60 | (dBm) |
| Maximum peak output power at antenna input terminal: | 57.544 | (mW) |
| Antenna gain(typical): | 3.5 | (dBi) |
| Numeric Antenna Gain: | 2.500 | (numeric) |
| Prediction distance: | 20 | (cm) |
| Prediction frequency: | 2450 | (MHz) |
| MPE limit for uncontrolled exposure at prediction frequency: | 1.0 | (mW/cm^2) |
| Power density at prediction frequency: | 0.028620 | (mW/cm^2) |

**Result**

The EUT's 2.4GHz WLAN radio complies with the FCC MPE limits at a 20cm separation distance as the power density of **0.02862 mW/cm^2** is lower than the MPE limit of **1.0 mW/cm^2**.

## 6.5 ISED Canada - 2.4 GHz WLAN

**Per Section 2.5.2:**
Maximum EIRP Limit = (f(MHz)^0.6834)*1.31*10^-2 W = 2.7 W

**Result**
The EUT’s 2.4 GHz WLAN radio meets ISED’s MPE Exemption limit at 20 cm as the maximum **102.3 mW EIRP** is less than **2.7 W**.

# 7 Revision History

| Version | Date | Notes | Person |
|---|---|---|---|
| 0 | 7/29/2021 | Initial Draft | Zach Wilson |
| 1 | 9/23/2021 | Revised per TCB review | Zach Wilson |

**END OF REPORT**