

Test Report # 319353 A (Hybrid Operation)

Equipment Under Test: KOLO LoRa Module

Test Date(s): June 3rd, 2019 to October 7th, 2020

Prepared for: Georgia Pacific
 Attn: Kim Cannon
 1915 Marathon Avenue
 Neenah, WI 54956

Report Issued by: Zach Wilson, EMC Engineer

Signature: *Zach Wilson*

Date: 11/9/2020

Report Reviewed by: Adam Alger, Quality Manager

Signature: *Adam Alger*

Date: 10/9/2020

Report Constructed by: Zach Wilson, EMC Engineer

Signature: *Zach Wilson*

Date: 10/8/2020

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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

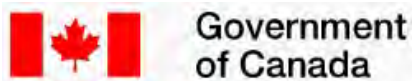
Scope of accreditation includes all test methods listed herein unless otherwise noted



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: Georgia Pacific	Page 3 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **June 3rd, 2019 to October 7th, 2020**, the Equipment Under Test (EUT), **KOLO LoRa Module**, as provided by **Georgia Pacific** was tested to the following requirements of the **Federal Communications Commission** and **Innovation, Science and Economic Development Canada** :

FCC 15.247 Hybrid Operation

Requirement	Description	Specification	Method	Result
FCC: 15.247 (f) FCC: 15.247 (a)(1)(i) IC: RSS 247 5.3 (a)	Average Time of Occupancy for a Hybrid System and Number of Hopping Frequencies, Channel Separation	FHSS	ANSI C63.10	Compliant
FCC: 15.247 (b)(3) IC: RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (f) IC: RSS-247 5.2 (b)	Power Spectral Density of a Hybrid System	8 dBm / 3 kHz	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc Peak 30 dBc Average	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: 2.1049 IC: RSS-GEN	99% Occupied Bandwidth	Reported	ANSI C63.10	Reported
FCC: 2.1055 (d) IC: RSS-GEN 6.11	Frequency Stability	Reported	ANSI C63.10	Reported

Notice:

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

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

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

2 CLIENT INFORMATION

Company Name	Georgia Pacific
Contact Person	Kim Cannon
Address	1915 Marathon Avenue Neenah, WI 54956

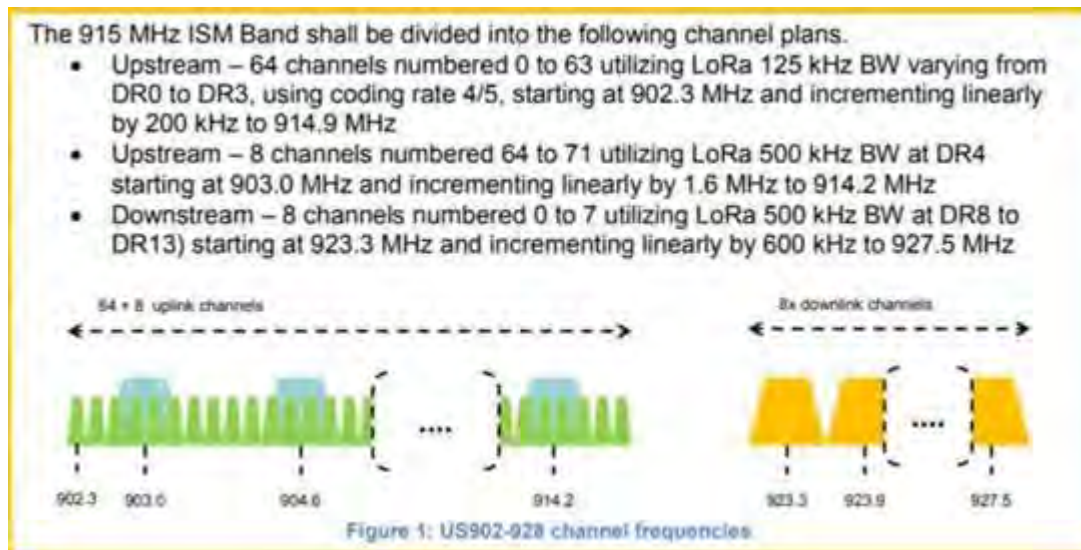
2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	KOLO LoRa Module
Model Number	ASM-0000001076
Serial Number	Engineering Sample
LoRa Radio FCC ID	2AALY-531GP
LoRa Radio IC ID	21620-531GP

2.2 Product Description

The EUT contains a LoRa radio with the below channel plan, data rates, and nominal bandwidths.



The EUT uses a Molex 206764 flexible dipole antenna with a U.FL connector and a peak gain of 1.3 dBi.

The EUT input voltage was 3.3 VDC provided by a lab power supply. The EUT can also be powered by removable batteries.

Company: Georgia Pacific	Page 5 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample

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 Radio Programming Information

EUT programmed using Tera Term v4.99. The radio manufacturer provided the commands to put the radio into the correct test modes. The firmware version was PRT-0000000174. The tested channels were:

Frequency (MHz)	Nominal Channel Bandwidth (kHz)
902.3	125
903.0	500
907.8	500
908.7	125
914.2	500
914.9	125

2.6 Radio Power Information

The end user will have the capability of changing the power levels. The minimum power setting is -17 . The maximum power setting is 14. The EUT was tested at both power levels.

2.7 Simultaneous Transmission

A Laird BL654 is on the PCB with the customer LoRa radio. The BL654’s microprocessor is used at all times. The BL654’s BLE radio function was disabled during LoRa only testing. A separate report containing simultaneous transmission with the LoRa radio and BLE radio is available upon request. No intermodulation was discovered during the simultaneous radiated emissions testing.

3 REFERENCES

Publication	Edition	Date
CFR Title 47	-	2020
ANSI C63.10	-	2013
RSS 247	2	2017
RSS GEN	5	2019

4 UNCERTAINTY SUMMARY

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

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

Measurement Type	Configuration	Uncertainty ±
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

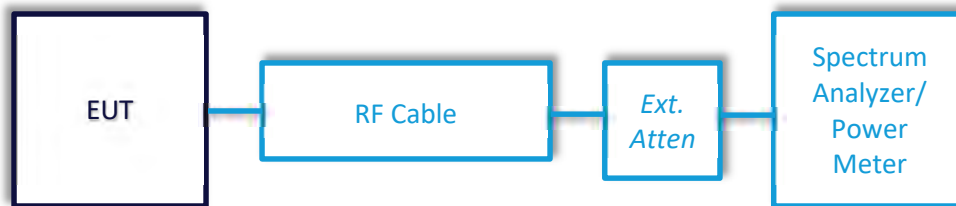
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	1x10 ⁻⁷	0.55x10 ⁻⁷
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

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

Block Diagram



5.1.1 99% Bandwidth

Operator	Aidi Zainal, Zach Wilson	QA	Anthony Smith
Temperature	22.1°C, 21.0°C	R.H. %	40.8, 44.1
Test Date	6/3/2019, 10/7/2020	Location	Conducted Radio Bench
Requirement	FCC 2.1049, RSS-GEN	Method	ANSI C63.10 6.9.3


Limits:

Reported

Test Parameters


Frequency	903.0, 907.8, 914.2 MHz		
RBW	99%: 10 kHz	VBW	99%: 100 kHz
Detector(s)	Max hold with peak detector.	Span	99%: 2 MHz
Notes	Lower power bandwidths same as higher power.		

Instrumentation



Date: 6-Oct-2020 Test: Unit Unintentional Job: C-3372
 PE: Zach Wilson Customer: Georgia Pacific Quote: 319535

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Cable	Gore	EKD01D010720	5800373	12/9/2019	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration



Date: 3-Jun-2019 Test: Conducted Radio Job: C-3372
 PE: Zach Wilson Customer: Georgia Pacific Quote: 318246

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960172	Cable	A.H. Systems, Inc	SAC-26G-1	387	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2018	7/14/2021	Active Calibration

EUT Parameters

Input Power	3.3 VDC	Mode	Single Channel
Frequency (MHz)	902.3, 903.0, 907.8, 908.7, 914.2, 914.9	Data Rates	DR4, DR0, DR3
Power Settings	14		

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Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample

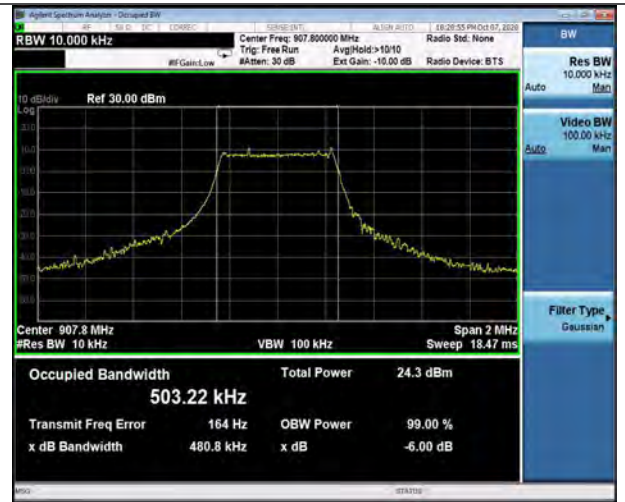
Data Tables

Frequency (MHz)	Data Rate	Power Setting	99% OBW (kHz)
903.0	DR4	14.0	503.1
907.8	DR4	14.0	503.2
914.2	DR4	14.0	503.3
902.3	DR3	14.0	126.5
902.3	DR0	14.0	124.9
908.7	DR3	14.0	126.6
908.7	DR0	14.0	124.8
914.9	DR3	14.0	126.7
914.9	DR0	14.0	124.6

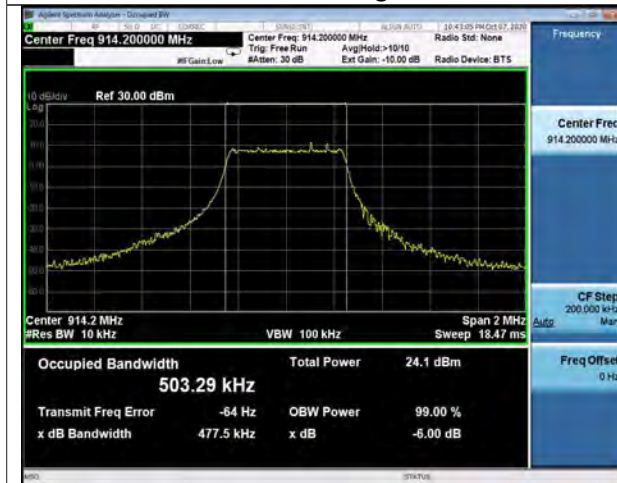
Plots



99% BW, DR4 Low Channel
Power Setting 14



99% BW, DR4 Mid Channel
Power Setting 14



99% BW, DR4 High Channel
Power Setting 14



OBW, DR3 Low Channel



OBW, DR3 Mid Channel



OBW, DR3 High Channel



OBW, DR0 Low Channel



OBW, DR0 Mid Channel



OBW, DR0 High Channel

5.1.2 Power Spectral Density of a Hybrid System

Operator	Aidi Zainal	QA	Anthony Smith
Temperature	22.1°C	R.H. %	40.8
Test Date	10/6/2020	Location	Conducted Radio Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 11.10.2, Option 2


Limits:

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Test Parameters


Frequency	903.0, 907.8, 914.2 MHz (500kHz Channels) 902.3, 908.7, 914.9 MHz (125kHz Channels)		
RBW	3 kHz	VBW	10 kHz (500kHz Channels) 30kHz (125 kHz Channels)
Detector(s)	Max hold with peak detector (500kHz Channels) RMS (125kHz channels)	Span	1 MHz

Instrumentation



Date: 6-Oct-2020 Test: Unit Unintentional Job: C-3372
PE: Zach Wilson Customer: Georgia Pacific Quote: 319535

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Cable	Gore	EKD01D010720	5800373	12/9/2019	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration



Date: 7-Oct-2020 Test: Conducted Radio Job: C-3372
PE: Zach Wilson Customer: Georgia Pacific Quote: 318246

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Cable	Gore	EKD01D010720	5800373	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2018	7/14/2021	Active Calibration

EUT Parameters

Input Power	3.3 VDC	Mode	Single Channel
Power Settings	Maximum: 14	Data Rates	DR4 500kHz Channels DR0, DR3 125 kHz Channels

Data Tables

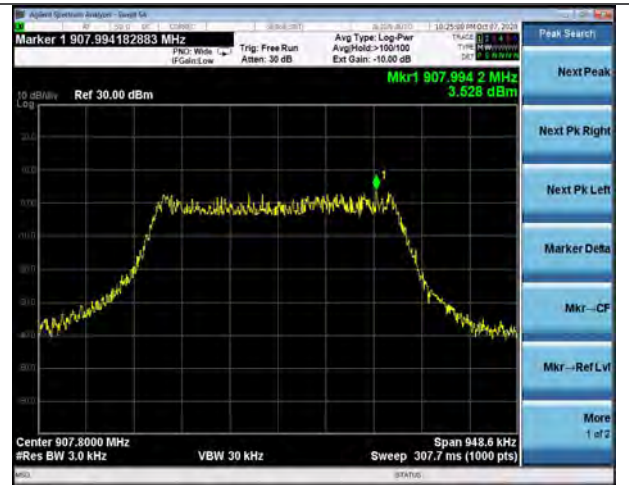
PSD						
Frequency (MHz)	Data Rate	Power Setting	DTS BW (kHz)	Peak Power Spectral Density (dBm/3kHz)	PSD Limit (dBm/3kHz)	Margin (dBm)
903.0	DR4	14.0	637.0	2.8	8.0	5.2
907.8	DR4	14.0	632.4	3.5	8.0	4.5
914.2	DR4	14.0	631.3	3.1	8.0	4.9

PSD						
Frequency (MHz)	Data Rate	Measured Power Spectral Density (dBm/3kHz)	Duty cycle correction (dB)	Corrected Power Spectral Density (dBm/3kHz)	PSD Limit (dBm/3kHz)	PSD Margin (dB)
902.3	DR0	-7.2	11.0	3.8	8.0	4.2
902.3	DR3	-8.1	11.0	2.9	8.0	5.1
908.7	DR0	-8.6	11.0	2.5	8.0	5.5
908.7	DR3	-8.2	11.0	2.8	8.0	5.2
914.9	DR0	-7.9	11.0	3.1	8.0	4.9
914.9	DR3	-7.4	11.0	3.6	8.0	4.4

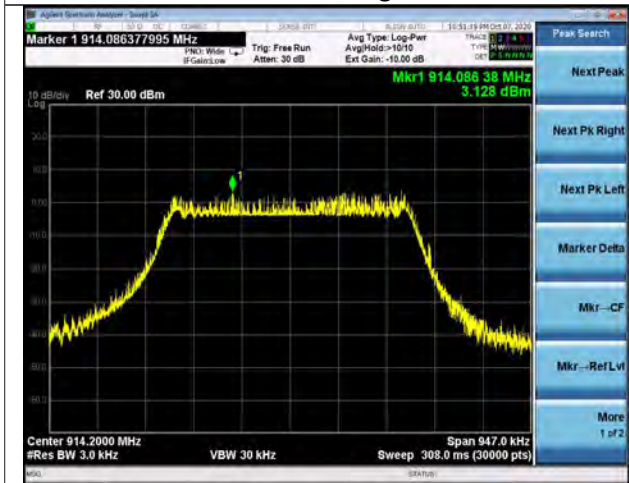
Plots



PSD, DR4 Low Channel
Power Setting 14

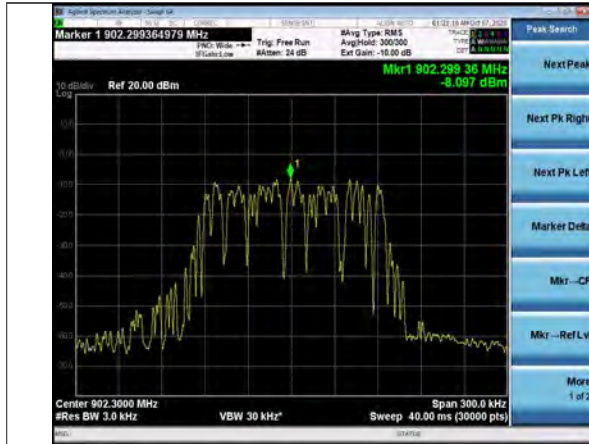


PSD, DR4 Low Channel
Power Setting 14

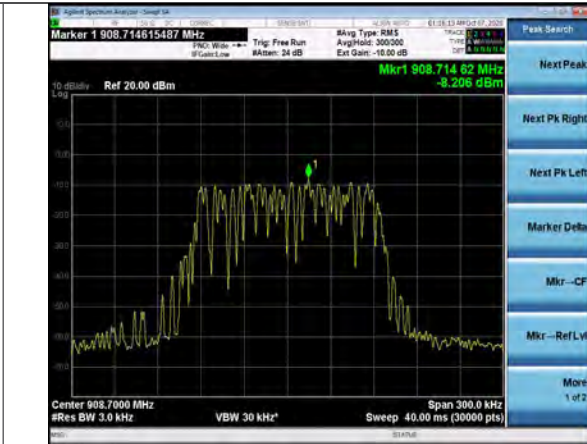


PSD, DR4 Mid Channel
Power Setting 14

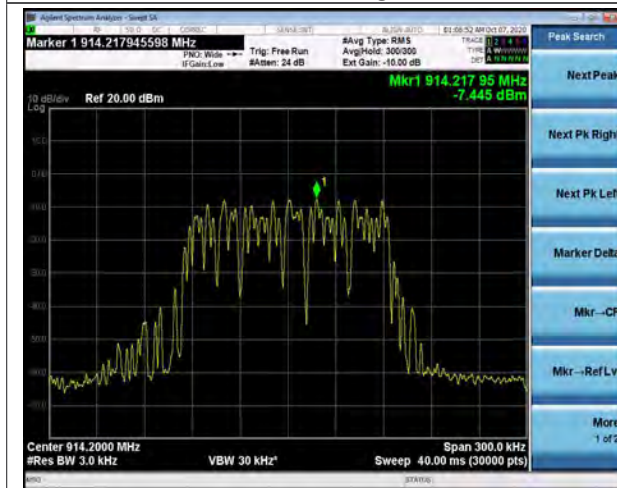
Company: Georgia Pacific	Page 16 of 55	Name: KOLO LoRa Module
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Job: C-3372		Serial: Engineering Sample



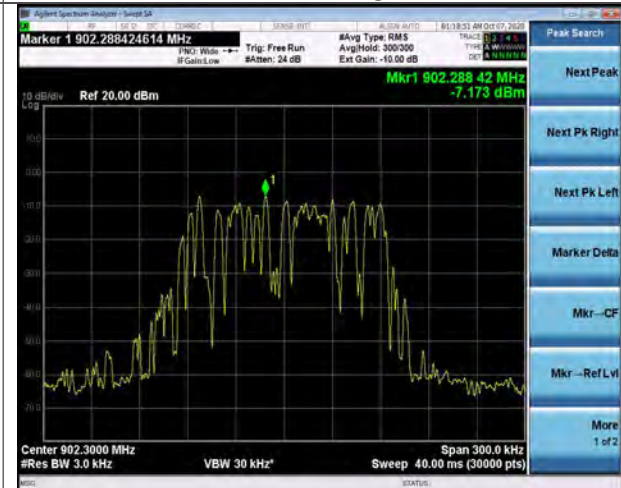
PSD, DR3, 902.3 MHz
Power Setting 14



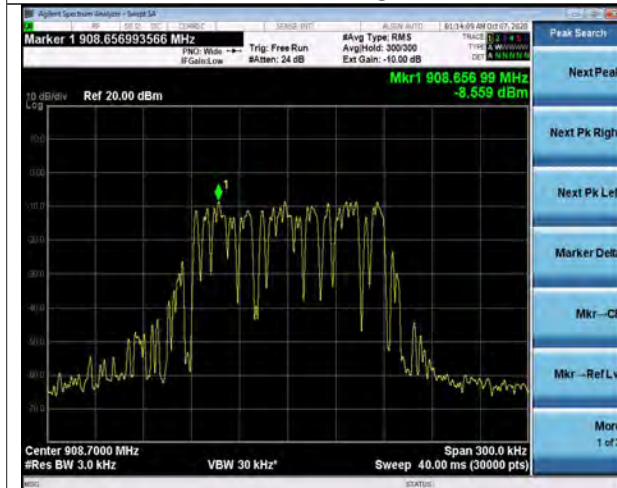
PSD, DR3, 908.7 MHz
Power Setting 14



PSD, DR3, 914.9 MHz
Power Setting 14



PSD, DR0, 902.3 MHz
Power Setting 14



PSD, DR0, 908.7 MHz
Power Setting 14



PSD, DR0, 914.9 MHz
Power Setting 14

5.1.3 Transmitter Output Power

Operator	Aidi Zainal	QA	Anthony Smith
Temperature	21.0°C, 22.1°C	R.H. %	41.0, 40.8
Test Date	10/6/2020 – 10/7/2020	Location	Conducted Radio Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 11.9.1.1 (500 kHz) ANSI C63.10 11.9.2.2.1 (125 kHz)

Limits:

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W

Test Parameters

Frequency	903.0, 907.8, 914.2 MHz (500kHz Channels) 902.3, 908.7, 914.9 MHz (125kHz Channels)		
RBW	1 MHz (500 kHz Channels) 3 kHz (125 kHz Channels)	VBW	3 MHz (500 kHz Channels) 30 kHz (125 kHz Channels)
Detector(s)	Peak (500 kHz Channels) RMS (125 kHz Channels)	Span	3 MHz (500 kHz Channels) 300 kHz (125 kHz Channels)

Instrumentation



Date: 6-Oct-2020 Test: Unit Unintentional Job: C-3372
PE: Zach Wilson Customer: Georgia Pacific Quote: 319535

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Cable	Gore	EKD01D010720	5800373	12/9/2019	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration

EUT Parameters

Input Power	3.3 VDC	Mode	Single Channel
Power Settings	Maximum: 14 Minimum: -17	Data Rates	DR4 (500 kHz Channels) DR0, DR3 (125 kHz Channels)

Data Tables

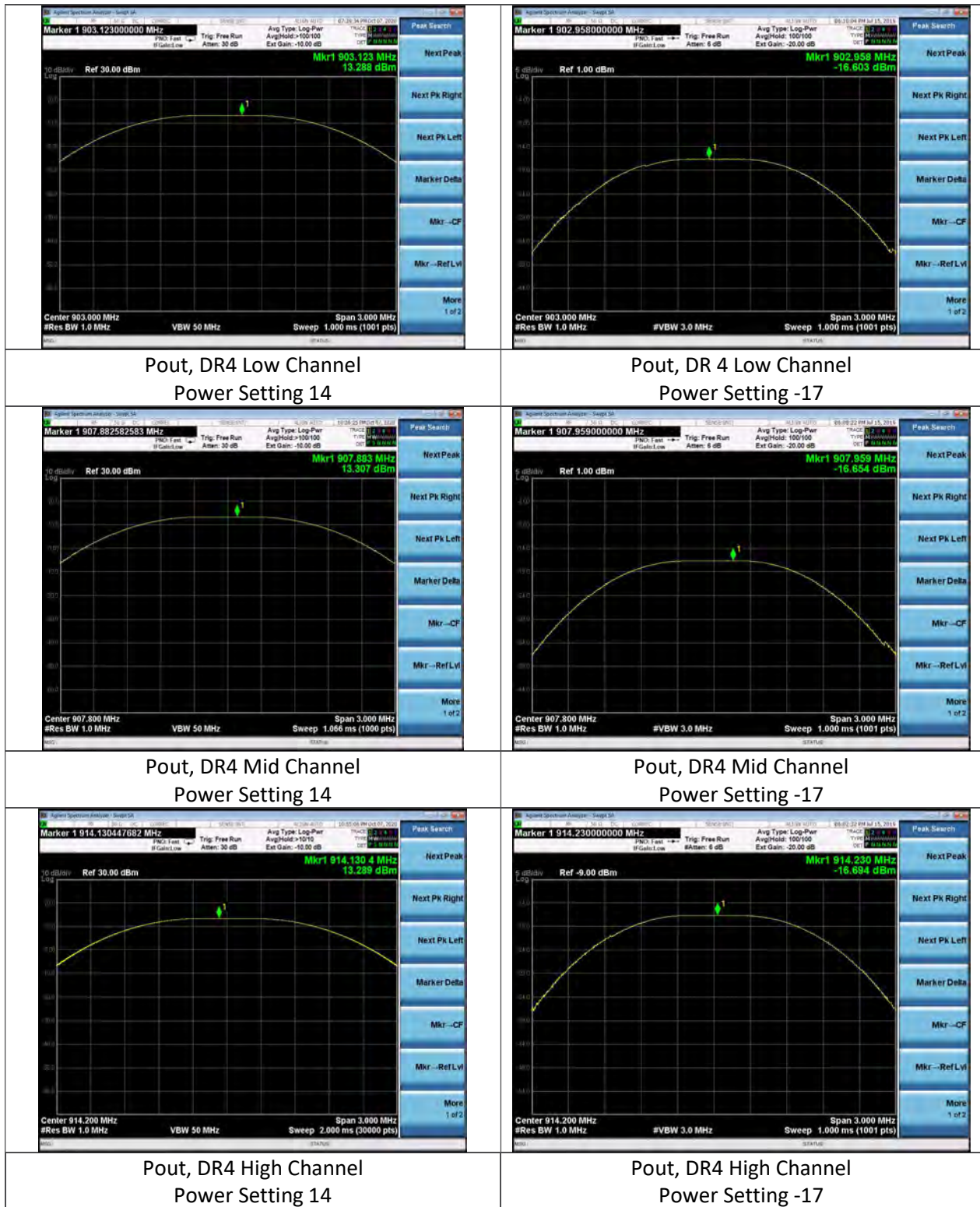
Frequency (MHz)	Data Rate	Power Setting	Peak Output Power (dBm)	Peak Output Power Limit (dBm)	Margin (dBm)
903.0	DR4	14.0	13.3	30.0	16.7
907.8	DR4	14.0	13.3	30.0	16.7
914.2	DR4	14.0	13.3	30.0	16.7

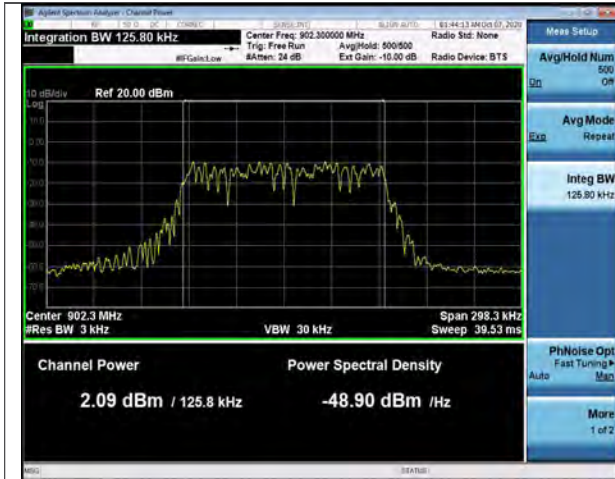
Frequency (MHz)	Data Rate	Power Setting	Peak Output Power (dBm)	Peak Output Power Limit (dBm)	Margin (dBm)
903.0	DR4	-17.0	-16.6	30.0	46.6
907.8	DR4	-17.0	-16.7	30.0	46.7
914.2	DR4	-17.0	-16.7	30.0	46.7

Data Rate	Observation Period (ms)	On Time (ms)	Duty Cycle %	Duty Cycle Correction (dB)
DR3	585.9	46.42	7.9	11.0
DR0	585.9	46.41	7.9	11.0

Average Output Power							
Frequency (MHz)	Data Rate	Power Setting	Measured Average Power (dBm)	Duty cycle correction (dB)	Corrected Average Power (dBm)	Average Output Power Limit (dBm)	Margin (dB)
902.3	DR3	14	2.1	11.0	13.1	30.0	16.9
902.3	DR0	14	2.3	11.0	13.3	30.0	16.7
908.7	DR3	14	2.4	11.0	13.4	30.0	16.6
908.7	DR0	14	2.4	11.0	13.4	30.0	16.6
914.9	DR3	14	2.0	11.0	13.0	30.0	17.0
914.9	DR0	14	2.1	11.0	13.1	30.0	16.9

Plots

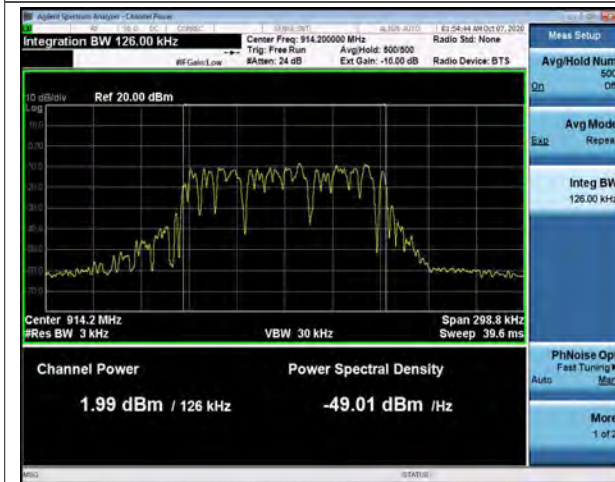




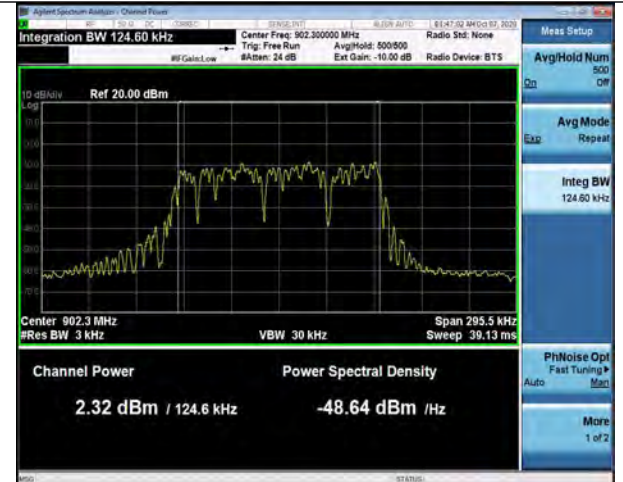
Output Power, DR3, 902.3 MHz
Power Setting 14



Output Power, DR3, 908.7 MHz
Power Setting 14



Output Power, DR3, 914.9 MHz
Power Setting 14



Output Power, DR0, 902.3 MHz
Power Setting 14



Output Power, DR0, 908.7 MHz
Power Setting 14



Output Power, DR0, 914.9 MHz
Power Setting 14

5.1.4 Conducted RF Spurious Emissions (500 kHz Channels)

Operator	Zach Wilson, Aidi Zainal	QA	Jeysson Gonzalez, Anthony Smith
Temperature	22.0°C, 22.1°C	R.H. %	41.0, 40.8
Test Date	6/3/2019, 10/7/2020	Location	Conducted Radio Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 11.12 and 11.13

Limits:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.


Power Setting 14 Limit: 13.2dBm-20.0dBm = -6.8dBm

Power Setting -17 Limit: -21.4dBm-20.0dBm = -41.4dBm

Test Parameters


Frequency	903.0, 907.8, 914.2 MHz		
RBW	100 kHz	VBW	1 MHz
Detector(s)	Max hold with peak detector.		
Example Calculations	Limit (dBm) = Reference Level (dBm) – 20 (dB)		
Notes	No emissions within 6dB of limit.		

Instrumentation



Date: 7-Jun-2019 Test: Unit Unintentional Job: C-3372
 PE: Zach Wilson Customer: Georgia Pacific Quote: 319535

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960172	Cable	A.H. Systems, Inc	SAC-26G-1	387	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2018	7/14/2021	Active Calibration



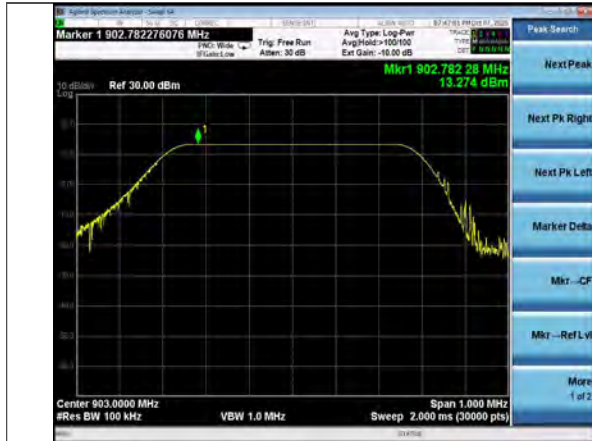
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No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
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Company: Georgia Pacific	Page 22 of 55	Name: KOLO LoRa Module
Report: TR319535 A		Model: ASM-0000001076
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EUT Parameters

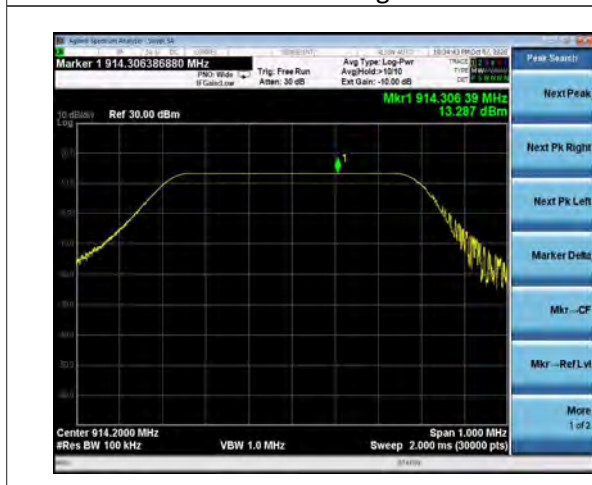
Input Power	3.3 VDC	Mode	Single Channel DTS
Frequency	903.0 (Low), 907.8 (Mid), 914.2 (High) MHz	Data Rates	DR4
Power Settings	Maximum: 14 Minimum: -17		



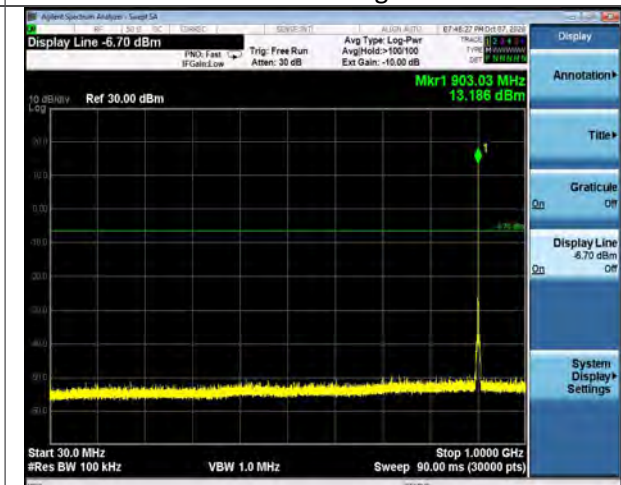
Low Channel Reference Level
Power Setting 14



Mid Channel Reference Level
Power Setting 14



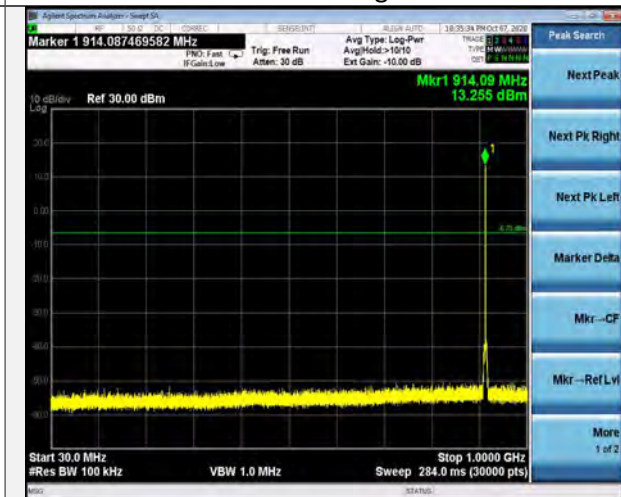
High Channel Reference Level
Power Setting 14



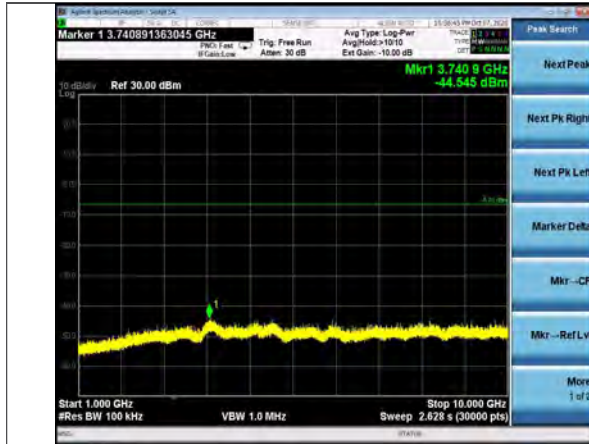
30-1000 MHz, DR4, Low Channel
Power Setting 14



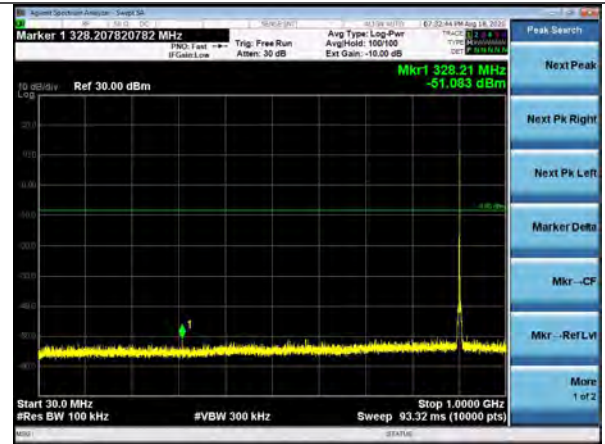
1-10 GHz, DR4, Low Channel
Power Setting 14



30-1000 MHz, DR4, High Channel
Power Setting 14



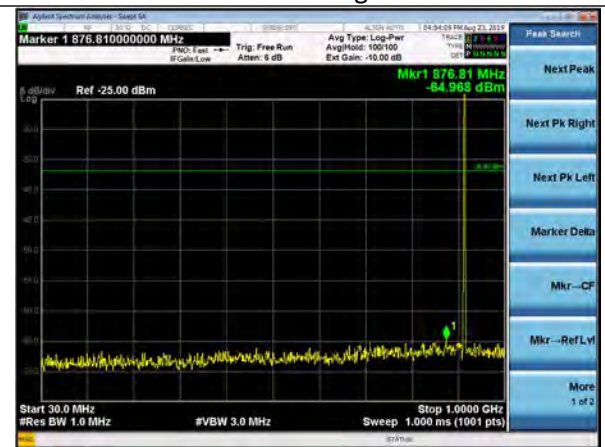
1-10 GHz, DR4, High Channel
Power Setting 14



30-1000 MHz, DR4, Low Channel
Power Setting -17



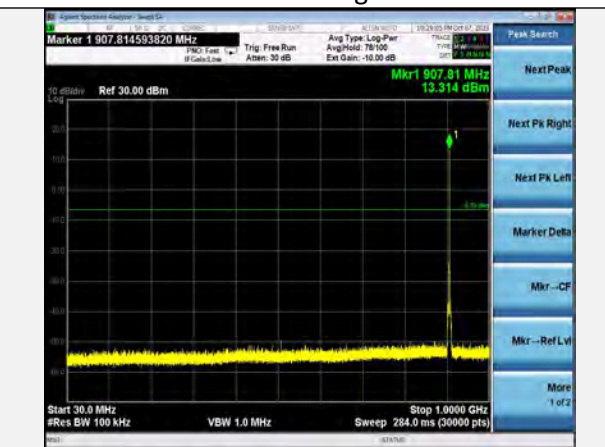
1-10 GHz, DR4, Low Channel
Power Setting -17



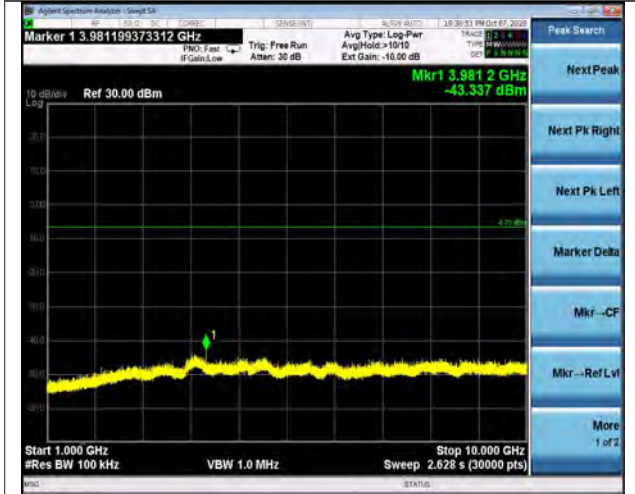
30-1000 MHz, DR4, High Channel
Power Setting -17



1-10 GHz, DR4, High Channel
Power Setting -17



30-1000 MHz, DR4, Mid Channel
Power Setting 14



1-10 GHz, DR4, High Channel
Power Setting 14

Company: Georgia Pacific	Page 26 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample

5.1.5 Conducted Spurious Emissions (125 kHz Channels)

Operator	Zach Wilson, Aidi Zainal, QA: Anthony Smith		
Temperature	21.3°C, 21.0°C, 22.4°C	R.H. %	40.6, 44.1
Test Date	7/15/2019, 10/8/2020	Location	Conducted Radio Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 7.8.8

Test Parameters

Frequency	30 MHz – 10 GHz	Setup	Conducted
RBW	100 kHz	VBW	300 kHz
Detector(s)	Peak Detector with Max Hold		
Example Calculation	Highest Output Power (dBm) – 30 (dBm) = Limit (dBm)		
Notes	Limit Line shown on plots is not correct, please see below for correct limits. No emissions within 10dB of limit for high power setting, plots only for that setting.		
Notes	Visual Inspection of the lower band edge up to 902 MHz completed. Data for emissions closest to the limit near the band edge margin in table.		


Limits: 30dBc Reference Plot

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies

Power Setting 14 Limit: 13.3dBm-30dBm= -16.7dBm

Power Setting -17 Limit: -6.9dBm-30dBm= -36.9dBm

Instrumentation



Date: 3-Jun-2019	Test: Conducted Radio	Job: C-3372
PE: Zach Wilson	Customer: Georgia Pacific	Quote: 318246

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960172	Cable	A.H. Systems, Inc	SAC-26G-1	387	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2018	7/14/2021	Active Calibration

Company: Georgia Pacific	Page 27 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample



Date: 7-Oct-2020 Test: Conducted Radio Job: C-3372
 PE: Zach Wilson Customer: Georgia Pacific Quote: 318246

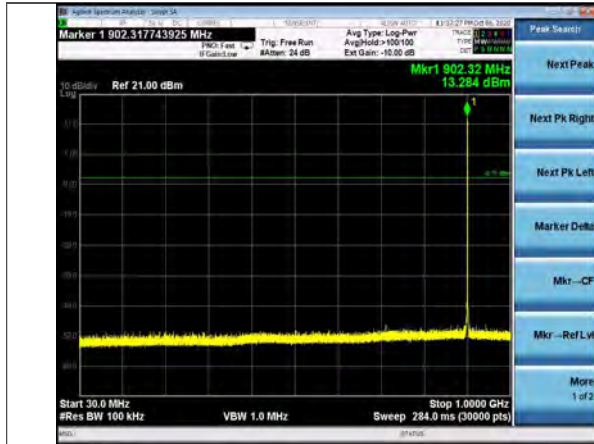
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Cable	Gore	EKD01D010720	5800373	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2018	7/14/2021	Active Calibration

EUT Parameters

Input Power	3.3 VDC	Mode	125 kHz BW TX Single Channel and Hopping
Frequency	902.3 MHz (Low) 914.9 MHz (High)	Data Rates	DR0, DR3
Power Settings	Maximum: 14 Minimum: -17		

Data Table

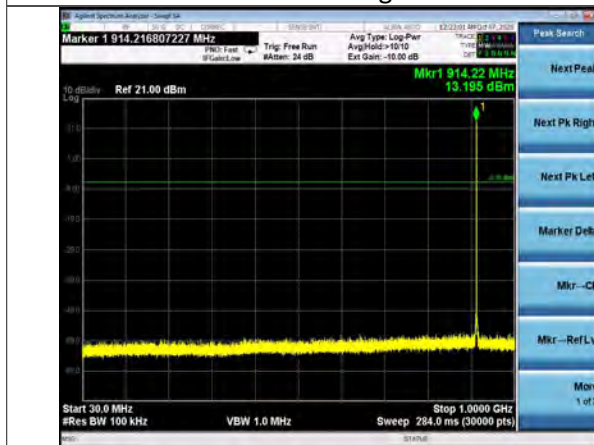
Conducted Spurious Emissions -						
Frequency (MHz)	Fundamental Frequency (MHz)	Data Rate	Power Setting (dBm)	Peak Reading (dBm)	Peak Limit (dBm)	Peak Margin (dB)
609.7	914.2	DR3	14.0	-51.9	-16.7	35.2
609.9	903.0	DR0	-17.0	-66.2	-41.4	24.8
612.7	903.0	DR3	-17.0	-66.4	-41.4	25.0
613.2	903.0	DR0	14.0	-52.2	-16.7	35.5
890.6	902.3	Hopping	14.0	-32.8	-16.7	16.1
896.3	902.3	Hopping	14.0	-30.9	-16.7	14.2
985.4	914.2	Hopping	14.0	-50.4	-16.7	33.7
995.4	903.0	Hopping	14.0	-51.7	-16.7	35.0
1043.2	914.2	DR3	-17.0	-64.9	-41.4	23.5
1046.5	914.2	DR0	-17.0	-64.3	-41.4	22.9
1224.4	914.2	Dr3	14.0	-50.3	-16.7	33.6
1225.8	903.0	DR0	14.0	-50.3	-16.7	33.6
2746.0	914.2	DR3	14.0	-42.1	-16.7	25.4
3655.0	914.2	Hopping	-17.0	-59.2	-41.4	17.8
3772.0	903.0	DR0	14.0	-44.0	-16.7	27.3
3799.0	903.0	Hopping	-17.0	-59.6	-41.4	18.2



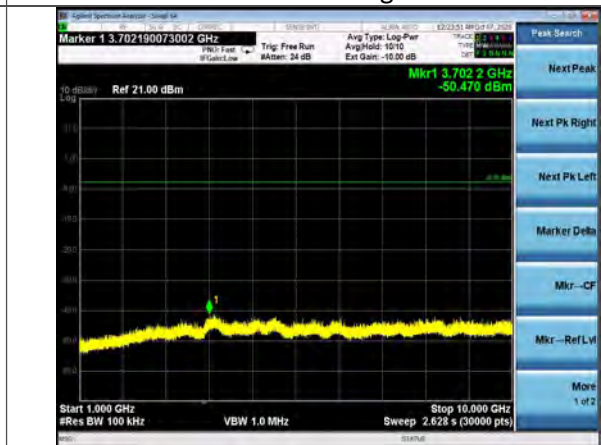
30-1000 MHz, DR0, 902.3 MHz
Power Setting 14



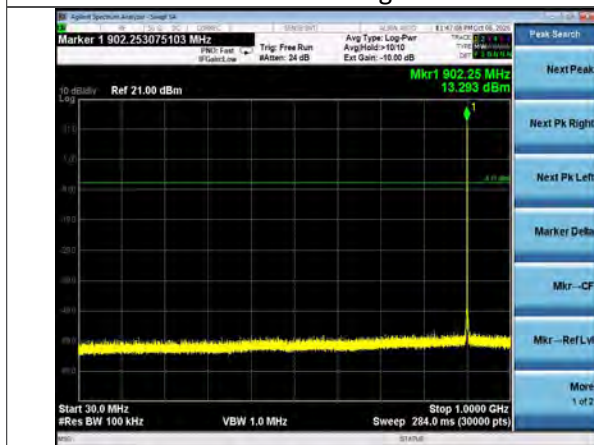
1-10 GHz, DR0, 902.3 MHz
Power Setting 14



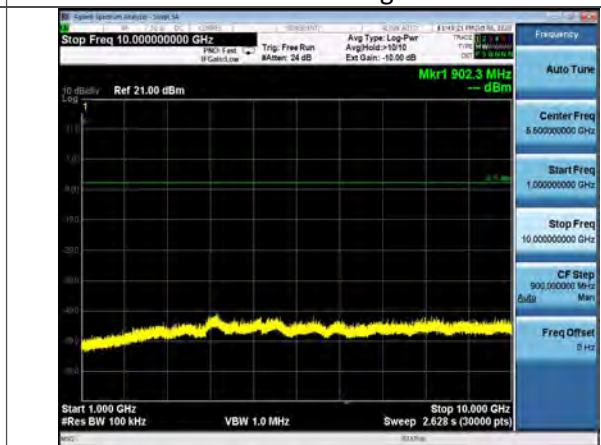
30-1000 MHz, DR0, 914.9 MHz
Power Setting 14



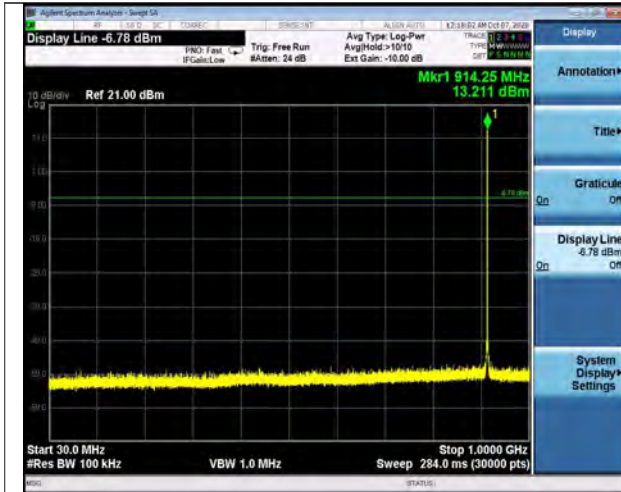
1-10 GHz, DR3, 914.9 MHz
Power Setting 14



30-1000 MHz, DR3, 902.3 MHz
Power Setting 14



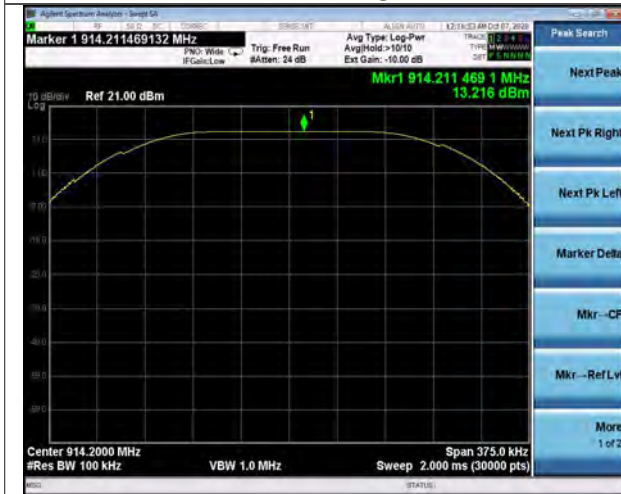
1-10 GHz, DR3, 902.3 MHz
Power Setting 14



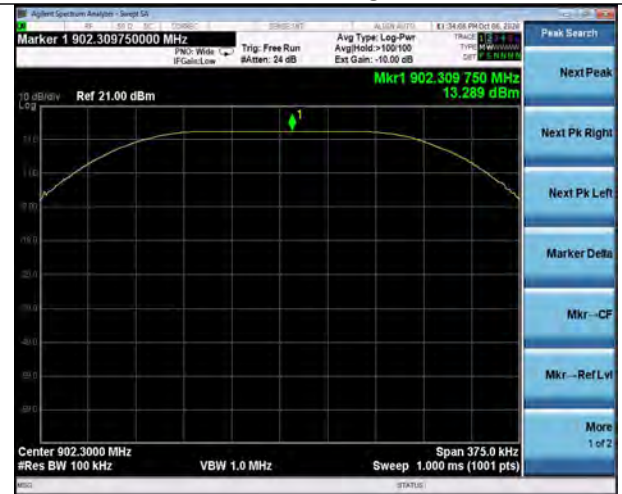
30-1000 MHz, DR3, 914.9 MHz
Power Setting 14



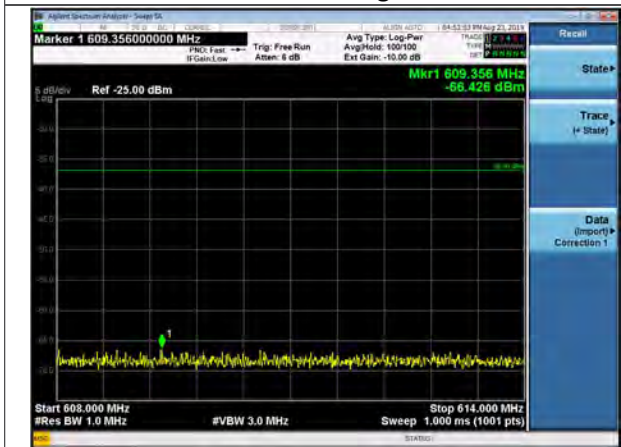
1-10 GHz, DR3, 914.9 MHz
Power Setting 14



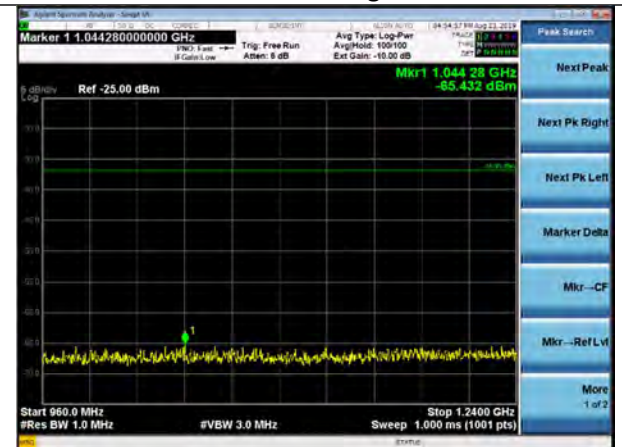
DR0 Reference Level
Power Setting 14



DR3 Reference Level
Power Setting 14



608-614 MHz, DR3 Low Channel
Power Setting -17



960-1240 MHz, DR3 High Channel
Power Setting -17

5.1.6 Conducted Spurious Emissions (500 kHz Channels)

Operator	Zach Wilson, Aidi Zainal, QA: Anthony Smith		
Temperature	21.3°C, 21.0°C, 22.4°C	R.H. %	40.6, 44.1
Test Date	7/15/2019, 10/8/2020	Location	Conducted Radio Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 7.8.8

Test Parameters

Frequency	30 MHz – 10 GHz	Setup	Conducted
RBW	100 kHz	VBW	300 kHz
Detector(s)	Peak Detector with Max Hold		
Example Calculation	Highest Output Power (dBm) – 30 (dBm) = Limit (dBm)		
Notes	Limit Line shown on plots is not correct, please see below for correct limits. No emissions within 10dB of limit for high power setting, plots only for that setting.		
Notes	Visual inspection of band edge up to 903MHz. No plots taken. Data in table.		

Limits: 30dBc Reference Plot

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies

Power Setting 14 Limit: 13.3dBm-30dBm= -16.7dBm

Power Setting -17 Limit: -6.9dBm-30dBm= -36.9dBm

Instrumentation



Date: 3-Jun-2019	Test: Conducted Radio	Job: C-3372
PE: Zach Wilson	Customer: Georgia Pacific	Quote: 318248

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2018	7/14/2021	Active Calibration



Date: 7-Oct-2020

Test: Conducted Radio

Job: C-3372

PE: Zach Wilson

Customer: Georgia Pacific

Quote: 318246

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Cable	Gore	EKD01D010720	5800373	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY63400296	7/14/2018	7/14/2021	Active Calibration

EUT Parameters

Input Power	3.3 VDC	Mode	125 kHz BW TX Single Channel and Hopping
Frequency	902.3 MHz (Low) 914.9 MHz (High)	Data Rates	DR0, DR3
Power Settings	Maximum: 14 Minimum: -17		

Data Table

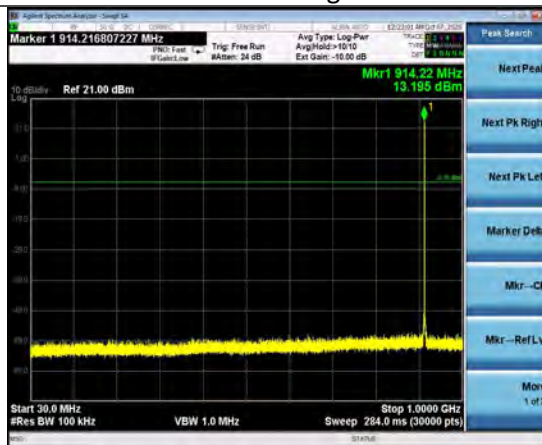
Conducted Spurious Emission						
Frequency (MHz)	Fundamental Frequency (MHz)	Data Rate	Power Setting (dBm)	Peak Reading (dBm)	Peak Limit (dBm)	Peak Margin (dB)
328.2	903.0	DR4	14.0	-61.1	-16.7	44.4
610.1	914.2	DR13	14.0	-62.9	-16.7	46.2
895.6	903.0	DR13	14.0	-36.7	-16.7	20.0
967.4	914.2	DR13	14.0	-61.8	-16.7	45.1
1232.8	914.2	DR13	14.0	-62.0	-16.7	45.3
2746.0	914.2	DR13	14.0	-58.9	-16.7	42.2



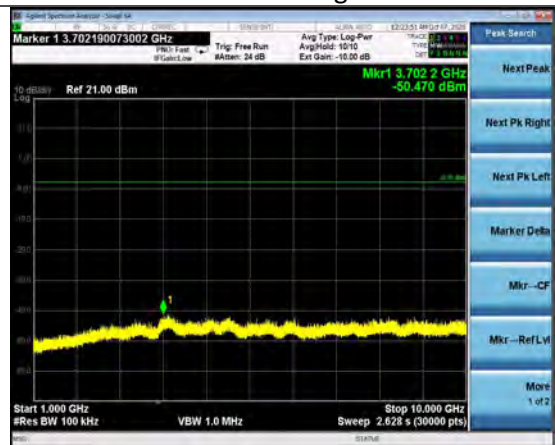
30-1000 MHz, DR0, 902.3 MHz
Power Setting 14



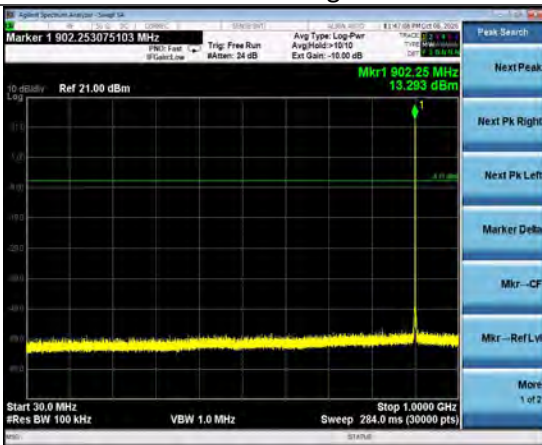
1-10 GHz, DR0, 902.3 MHz
Power Setting 14



30-1000 MHz, DR0, 914.9 MHz
Power Setting 14



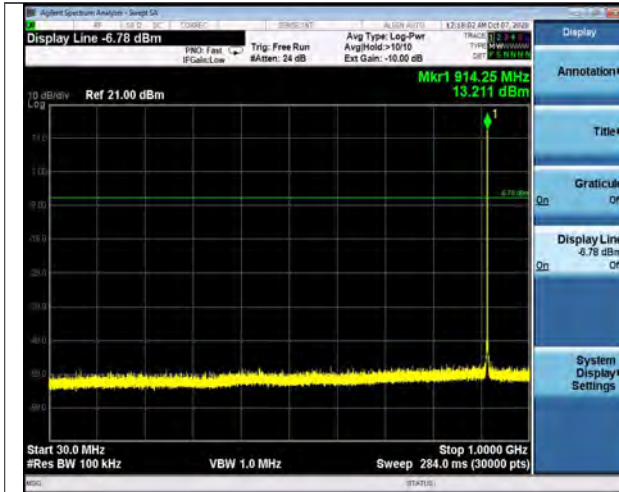
1-10 GHz, DR3, 914.9 MHz
Power Setting 14



30-1000 MHz, DR3, 902.3 MHz
Power Setting 14



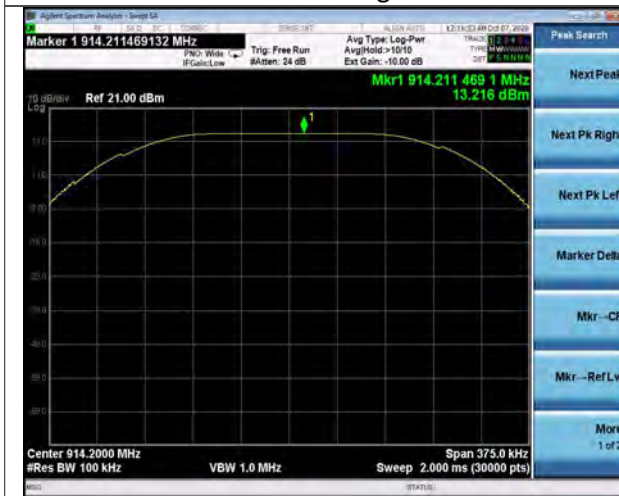
1-10 GHz, DR3, 902.3 MHz
Power Setting 14



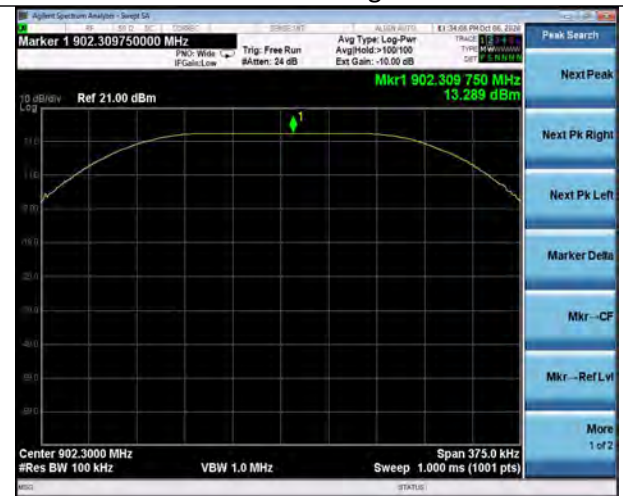
30-1000 MHz, DR3, 914.9 MHz
Power Setting 14



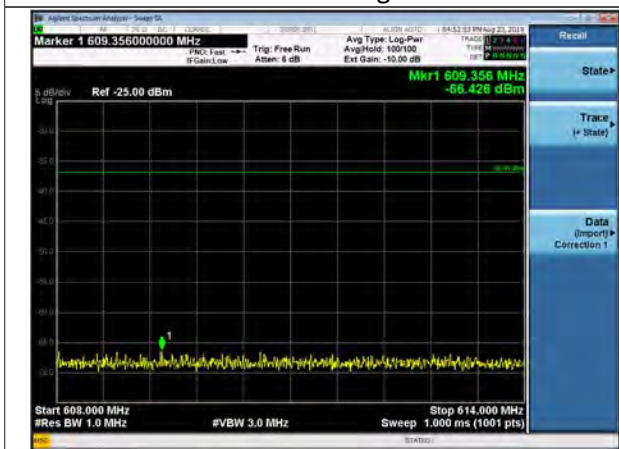
1-10 GHz, DR3, 914.9 MHz
Power Setting 14



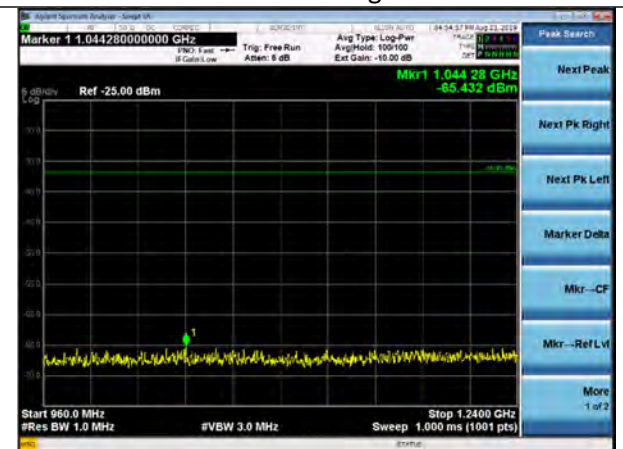
DR0 Reference Level
Power Setting 14



DR3 Reference Level
Power Setting 14



608-614 MHz, DR3 Low Channel
Power Setting -17



960-1240 MHz, DR3 High Channel
Power Setting -17

5.1.7 Average Time of Occupancy for a Hybrid System, Number of Hopping Frequencies, Channel Separation

Operator	Zach Wilson		
Temperature	21.0 C	R.H. %	44.1
Test Date	6/3/2019	Location	Conducted Radio Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 7.8.4


Test Parameters

Frequency	902.3 MHz (Channel 0)	Setup	Conducted
RBW	100 kHz	VBW	# of Hopping Channels: 30 kHz TX Time: 100 kHz
Detector(s)	Peak Detector with Max Hold	Span	0 Hz

Requirement

With the digital transmission operation of the hybrid system turned off, the frequency hopping operation shall have an average time of occupancy on any frequency not exceeding 0.4 seconds within a duration in seconds equal to the number of hopping frequencies multiplied by 0.4.

Instrumentation



Date: 3-Jun-2019 Test: Conducted Radio Job: C-3372
 PE: Zach Wilson Customer: Georgia Pacific Quote: 318246

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960172	Cable	A.H. Systems, Inc	SAC-26G-1	387	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400298	7/14/2018	7/14/2021	Active Calibration

EUT Parameters

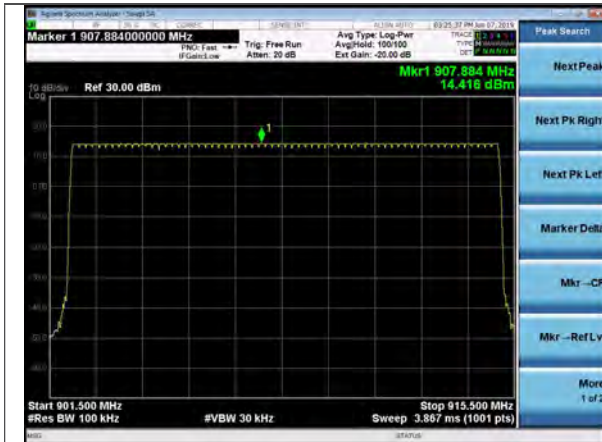
Input Power	3.3 VDC	Mode	125 kHz BW TX Hopping
Frequency	902.3 MHz (Channel 0)	Data Rates	DR0, DR3
Power	14		

Data Table

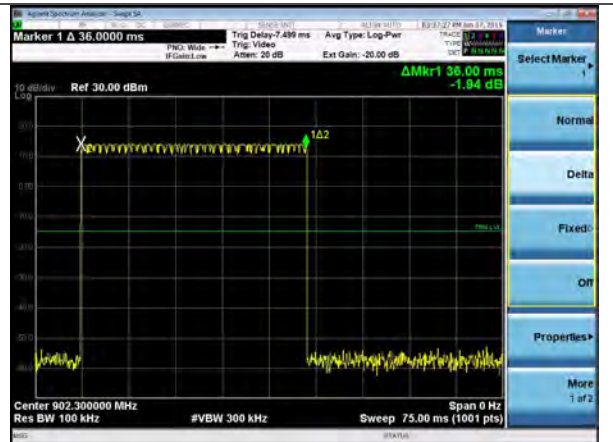
Average Time of Occupancy								
Frequency (MHz)	Data Rate	Power Setting	Transmit Time per Hop (ms)	Hops in 25.6s	Number of Channels	Time of Occupancy (ms)	Limit (ms)	Margin (ms)
902.3	DR3	14	36.0	1.0	64.0	36.0	400.0	364.0
902.3	DR0	14	247.5	1.0	64.0	247.5	400.0	152.5

Channel Frequency Separation				
Frequency (MHz)	Data Rate	Channel Separation (kHz)	20 dB OWB (kHz)	Margin (kHz)
902.3, 902.5	DR3	194.8	141.4	53.4
902.3, 902.5	DR0	200.0	137.7	62.3

Plots



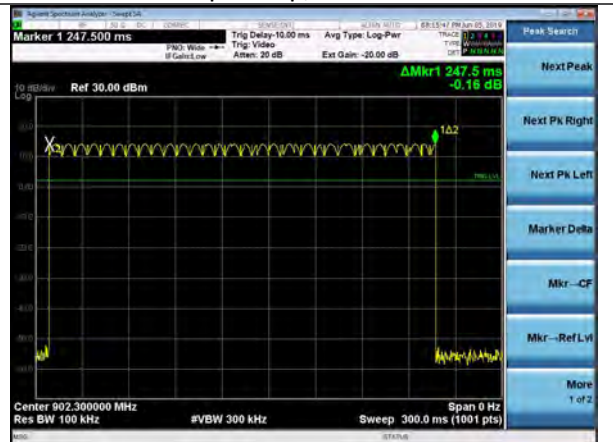
Number of Hopping Channels



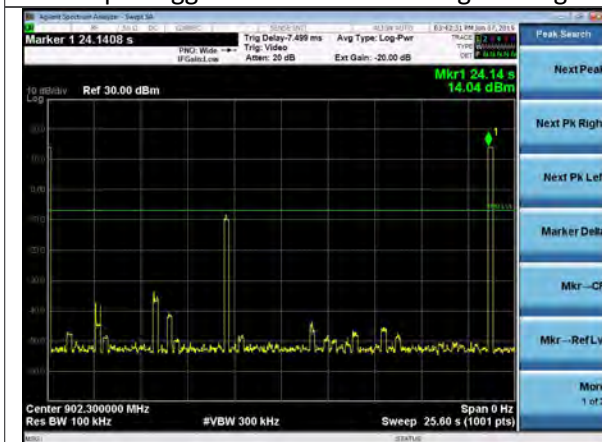
Transmit Time per Hop, DR3 Maximum Power



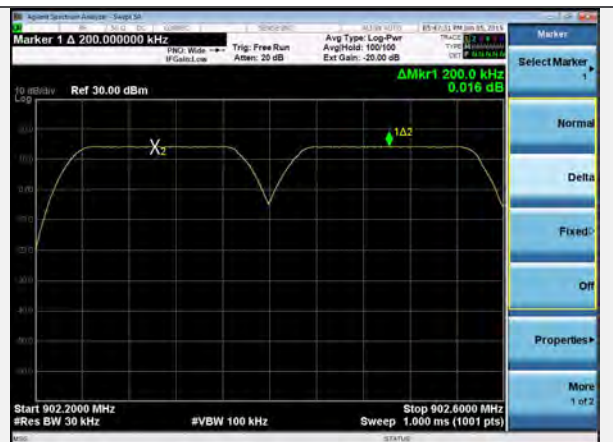
Hops per 25.6s, DR3 Maximum Power
Adjacent channel showing up near the end of the sweep. Trigger level was not set high enough.



Transmit Time per Hop, DR0 Maximum Power



Hops per 25.6s, DR0 Maximum Power
Adjacent channel showing up near the end of the sweep. Trigger level was not set high enough.



Channel Separation, DR0


5.1.8 Frequency Stability

Operator	Zach Wilson	QA	Jeysson Gonzalez
Temperature	21.0°C	R.H. %	44.1%
Test Date	6/3/2019	Location	Conducted Radio Bench
Requirement	FCC 2.1055, RSS GEN	Method	ANSI C63.10 6.8

Test Parameters

Frequency	903.0, 914.2 MHz		
RBW	300 kHz	VBW	1 MHz
Detector(s)	Max hold with peak detector.	Span	0 Hz
Temperatures Tested	Nominal: 20°C Low: -20°C High: 50°C		

Instrumentation



Date: 7-Jun-2019 Test: Unit Unintentional Job: C-3372
 PE: Zach Wilson Customer: Georgia Pacific Quote: 319535

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960172	Cable	A.H. Systems, Inc	SAC-26G-1	387	12/9/2018	12/9/2020	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2018	7/14/2021	Active Calibration
3	DC 000210C	Chamber - Environmental	Thermotron	S-8C	28133	12/19/2018	12/19/2020	Active Verification

EUT Parameters

Input Power	2.6 VDC, 3.3 VDC, 3.8 VDC	Mode	Single Channel DTS
Frequency	903.0 (Low), 914.2 (High) MHz	Data Rates	DR4
Power Settings	14		

Data

Temperature (°C)	Input Power (VDC)	Channel	Data Rate	Power Setting (dBm)	Frequency Reading (Hz)	Frequency Deviation (Hz)
20	2.6	Low	DR4	14	903067947	446
20	3.0	Low	DR4	14	903068393	0
20	3.8	Low	DR4	14	903026342	42051
20	2.6	High	DR4	14	914214525	19277
20	3.0	High	DR4	14	914233802	0
20	3.8	High	DR4	14	914217330	16472
-20	3.0	Low	DR4	14	903141790	73397
-20	3.0	High	DR4	14	914398840	165038
50	3.0	Low	DR4	14	903011846	56547
50	3.0	High	DR4	14	914931158	697356

Plots



Nominal Temp/Power, Low Channel



Nominal Temp/Power, High Channel



Low Power, Nominal Temp, Low Channel



Low Power, Nominal Temp, High Channel



High Power, Nominal Temp, Low Channel



High Power, Nominal Temp, High Channel

Company: Georgia Pacific	Page 42 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-000001076
Job: C-3372		Serial: Engineering Sample



Nominal Power, Low Temp, Low Channel



Nominal Power, Low Temp, High Channel



Nominal Power, High Temp, Low Channel



Nominal Power, High Temp, High Channel

Company: Georgia Pacific	Page 43 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-000001076
Job: C-3372		Serial: Engineering Sample

5.2 Radiated Emissions

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

Block Diagram



5.2.1 Radiated Emissions (500 kHz Channels)

Operator	Braden Smith, Anthony Smith, Jon Dilley	QA	Zach Wilson, Jeysson Gonzalez, Shane Dock
Temperature	23.3°C, 25.1°C, 24.3°C	R.H. %	48.2%, 42.2%, 44.0%
Test Date	5/23-5/30/2019, 7/31/2020	Location	Chamber 3
Requirement	FCC 15.209	Method	ANSI C63.10

Limits: 15.209

Frequency (MHz)	Quasi Peak Limit (dBµV/m)	Peak Limit (dBµV/m)	Quasi Peak Limit (dBµV/m)
30-88	40	-	-
88-216	43.5	-	-
216-960	46	-	-
960-1000	54	-	-
1000-10000	-	74	54

Test Parameters

Frequency	30-10000 MHz	Distance	3m
Detector(s)	Max peak hold for plots. Quasi peak detector for measurements under 1 GHz. Average measurements taken at 50 Hz VBW.	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: 3 MHz Peak, 50 Hz Average obtained from fundamental duty cycle.
Notes	Plots shown are of power setting 14. Power setting -17 tested but emissions seen were equal or lower than power setting 14 emissions.	Orientations	Side, Flat, Vertical. Side had worst case emissions and is shown in the plots.

EUT Parameters

Company: Georgia Pacific	Page 45 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample

Input Power	3VDC (Two D Batteries)	Mode	LoRa Tx
Data Rate	DR4		
Power Settings	Maximum: 14 Minimum: -17		

Instrumentation



Date: 28-Jul-2020

Test: Radiated Emissions

Job: C-3372

PE: Zach Wilson

Customer: Georgia Pacific

Quote: 318246

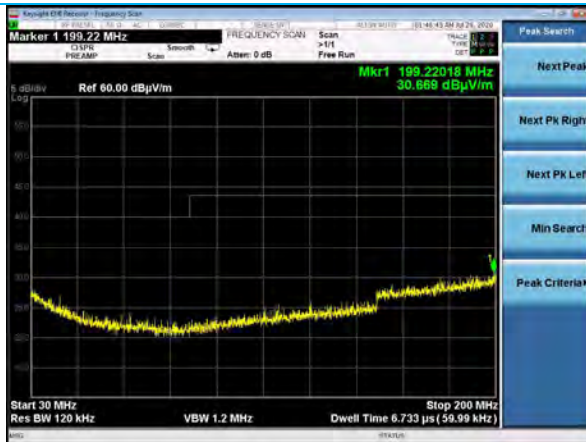
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	7/13/2018	7/13/2021	Active Calibration
2	AA 960007	Antenna - Double Ridge Horn	EMCO	3115	3311-4138	10/7/2018	10/7/2020	Active Calibration
3	AA 960195	Antenna - Log Periodic	A.H. Systems, Inc	SAS-512-2	557	7/24/2018	7/24/2021	Active Calibration
4	AA 960150	Antenna - Bi-conical	ETS Lindgren	3110B	0003-3346	10/9/2018	10/9/2020	Active Calibration
5	EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	7/14/2018	7/14/2021	Active Calibration
6	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2018	7/14/2021	Active Calibration
7	EE 960160	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S-	977711030	10/7/2018	10/7/2020	Active Calibration

Data Tables

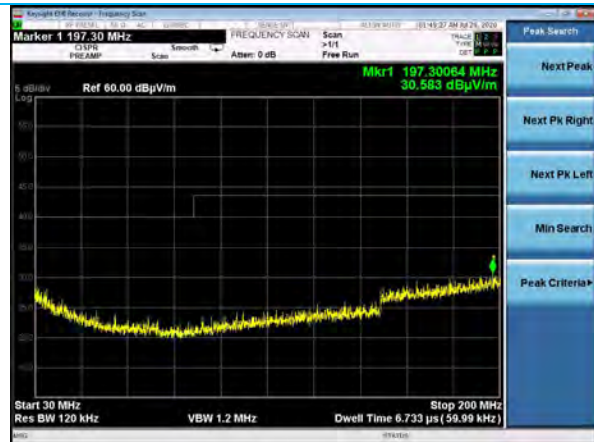
Frequency (MHz)	Antenna Polarity	EUT Orientation	Channel	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBμV/m)	Quasi-Peak Limit (dBμV/m)	Quasi-Peak Margin (dB)
197.4	Vertical	Flat	Low	100	0	24.7	43.5	18.8
199.5	Horizontal	Flat	Low	100	0	24.9	43.5	18.6
322.1	Horizontal	Flat	Low	100	254	27.0	46.0	19.0
322.1	Vertical	Flat	Low	148	164	23.9	46.0	22.1
322.7	Horizontal	Flat	Low	100	248	26.5	46.0	19.5
323.5	Vertical	Flat	High	115	0	23.9	46.0	22.1
609.2	Horizontal	Flat	High	174	0	35.5	46.0	10.5
881.3	Horizontal	Flat	Low	150	0	29.9	46.0	16.1
965.9	Horizontal	Flat	High	100	0	32.7	54.0	21.3
997.1	Horizontal	Flat	High	100	0	30.5	54.0	23.5

Frequency (MHz)	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)
1000.0	Vertical	Side	154	205	34.4	54.0	19.6	46.4	74.0	27.6
1231.7	Vertical	Side	154	205	29.7	54.0	24.3	42.0	74.0	32.0
2709.0	Vertical	Flat	150	199	36.2	54.0	17.8	44.1	74.0	29.9
1828.0	Horizontal	Flat	150	200	29.9	54.0	24.1	40.1	74.0	33.9

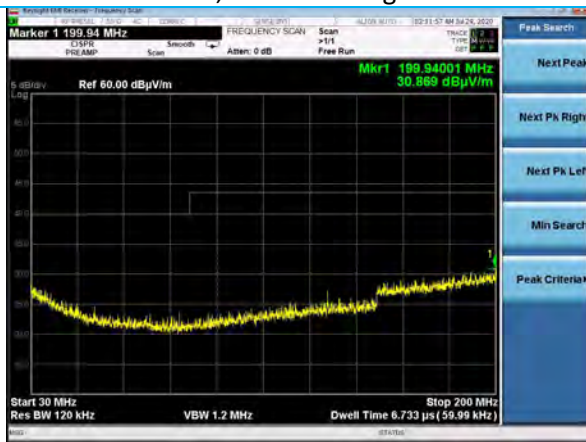
Plots



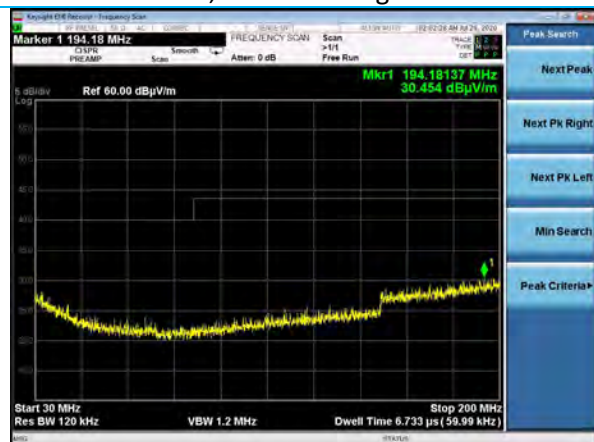
30-200MHz, Horizontal Antenna, Low Channel DR4, Power Setting 14



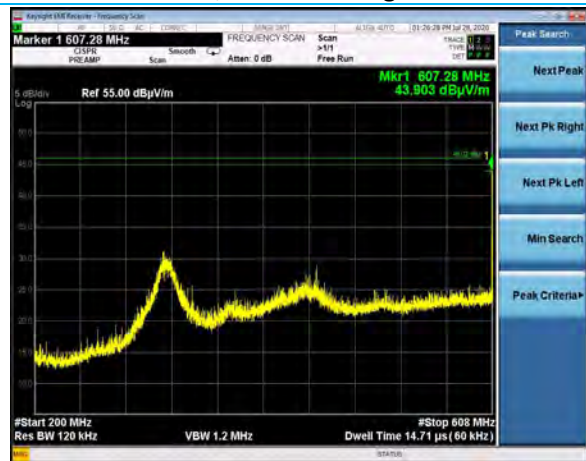
30-200MHz, Vertical Antenna, Low Channel DR4, Power Setting 14



30-200MHz, Horizontal Antenna, High Channel DR4, Power Setting 14



30-200MHz, Vertical Antenna, High Channel DR4, Power Setting 14



200-608 MHz, Horizontal Antenna, Low Channel DR4, Power Setting 14

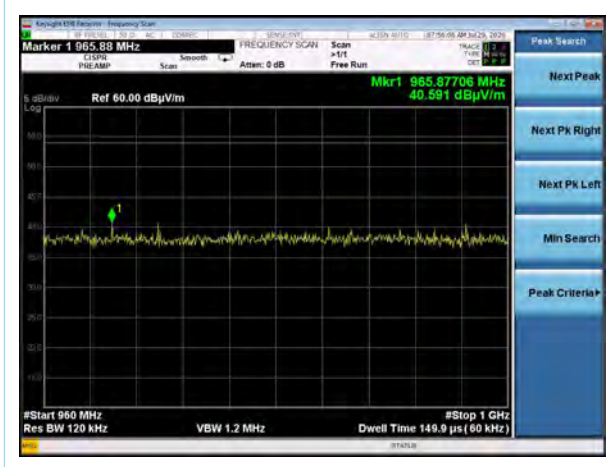


608-614 MHz, Horizontal Antenna, Low Channel DR4, Power Setting 14

Company: Georgia Pacific	Page 47 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-000001076
Job: C-3372		Serial: Engineering Sample



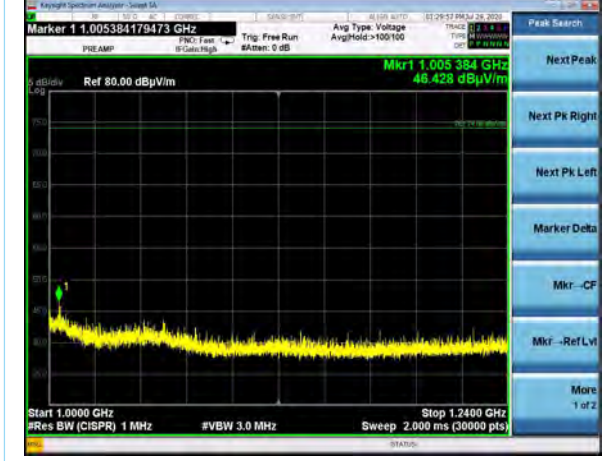
608-614 MHz, Vertical Antenna, High Channel DR4, Power Setting 14



960-1000 MHz, Horizontal Antenna, High Channel DR4, Power Setting 14



860-900 MHz, Low Channel DR4, Power Setting 14



1000-1240 MHz, Vertical Antenna, High Channel DR4, Power Setting 14



1.24-10 GHz, Horizontal Antenna, Low Ch, 500k, DR4, EUT Vertical



1.24-10 GHz, Vertical Antenna, Low Ch, 500k, DR4, EUT Vertical

Company: Georgia Pacific	Name: KOLO LoRa Module
Report: TR319353 A	Model: ASM-0000001076
Job: C-3372	Serial: Engineering Sample



DR4 Duty Cycle

Company: Georgia Pacific	Page 49 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample

5.2.2 Radiated Emissions (125 kHz Channels)

Operator	Jon Dilley	QA	Shane Dock
Temperature	23.7°C	R.H. %	44.1%
Test Date	7/28/2020	Location	Chamber 3
Requirement	FCC 15.209, RSS GEN	Method	ANSI C63.10 Section 6.3


Limits

Frequency (MHz)	Quasi Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Limit (dBµV/m)
30-88	40	-	-
88-216	43.5	-	-
216-960	46	-	-
960-1000	54	-	-
1000-10000	-	54	74

Test Parameters

Frequency	30 MHz – 10 GHz	Distance	3m
Detector(s)	Peak Detector with Max Hold for Plots. Quasi peak detector for measurements under 1 GHz. Average measurements taken with a 50 Hz VBW per the duty cycle.	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 Average: 50 Hz

Instrumentation



Date: 28-Jul-2020 Test: Radiated Emissions Job: C-3372
PE: Zach Wilson Customer: Georgia Pacific Quote: 319353

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	7/14/2019	7/14/2021	Active Calibration
2	AA 960078	Antenna - Log Periodic	EMCO	93146	9701-4855	9/21/2019	9/22/2021	Active Calibration
3	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	7/31/2019	7/13/2021	Active Calibration
4	LSC-500	Cable	Chamber 5 Emiss -			9/14/2019	9/14/2021	Active Verification
5	AA 960195	Antenna - Log Periodic	A.H. Systems, Inc	SAS-512-2	557	7/24/2019	7/24/2021	Active Calibration
6	AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	12/27/2019	12/27/2020	Active Calibration
7	EE 960159	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	681801732	12/27/2019	12/27/2020	Active Calibration
8	LSC-500	Cable	Chamber 5 Emiss -			9/14/2019	9/14/2021	Active Verification
9	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	7/13/2019	7/13/2021	Active Calibration
10	AA 960155	Filter - High Pass Filter 900 MHz	KVM	HPF-L-14185	7272-03	7/16/2019	7/16/2021	Active Calibration

Company: Georgia Pacific	Page 50 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample

EUT Parameters

Input Power	3VDC (2 D Batteries)	Mode	Lora Tx Single Channel and Hopping, 125 kHz BW
Data Rates	DR3, DR0	Power Settings	Maximum: 14 Minimum: -17
Channels	Low (902.3 MHz), Mid (908.7 MHz), High (914.9 MHz)		
EUT Orientations	Vertical, Side, Flat		

Data Tables

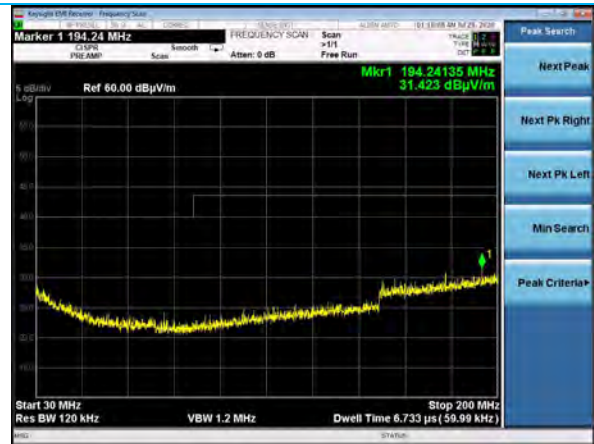
Frequency (MHz)	Antenna Polarity	Channel	Data Rate	Power Setting	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Margin (dB)	Note
195.1	Horizontal	Low	DR3	14.0	100	0	24.5	43.5	19.0	Noise Floor
194.2	Vertical	Low	DR3	-17.0	100	0	24.6	43.5	18.9	Noise Floor
894.3	Horizontal	Hopping	Dr3	14.0	100	0	36.4	54.0	17.6	
965.9	Horizontal	High	DR0	14.0	100	0	32.7	54.0	21.3	
988.7	Horizontal	Hopping	DR3	-17.0	100	0	30.3	54.0	23.7	
997.1	Horizontal	High	DR0	-17.0	100	0	30.5	54.0	23.5	
997.2	Horizontal	Hopping	DR3	14.0	100	0	33.2	54.0	20.8	

Frequency (MHz)	Antenna Polarity	EUT Orientation	Channel	Power Setting	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)
2744.7	Horizontal	Vertical	High	14	120	290	29.8	54.0	24.2	40.2	74.0	33.8
2744.7	Vertical	Vertical	High	14	187	38	32.9	54.0	21.1	42.0	74.0	32.0
2744.7	Vertical	Side	High	14	100	39	32.3	54.0	21.7	41.8	74.0	32.2
2744.7	Horizontal	Side	High	14	300	255	31.8	54.0	22.2	41.4	74.0	32.6
2744.7	Horizontal	Flat	High	14	100	338	31.0	54.0	23.0	40.8	74.0	33.2
2744.7	Vertical	Flat	High	14	129	315	31.0	54.0	23.0	41.6	74.0	32.4
2706.9	Vertical	Vertical	Low	14	165	26	30.2	54.0	23.8	39.8	74.0	34.2

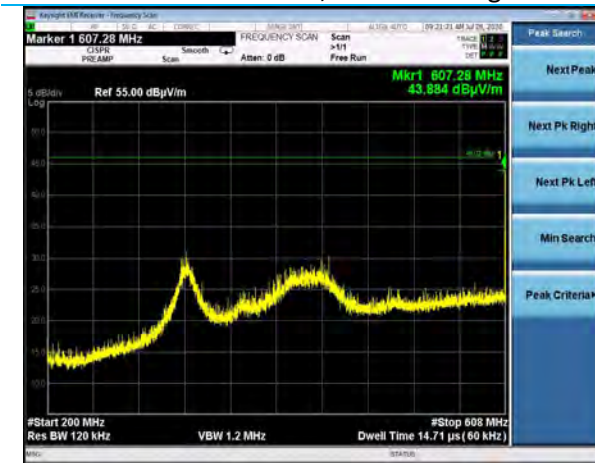
Plots



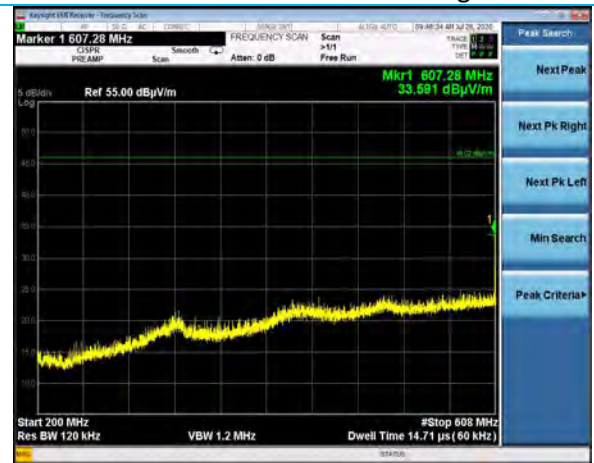
30-200 MHz, EUT Side, Hopping, DR3
Horizontal Antenna, Power Setting 14



30-200 MHz, EUT Side, Hopping, DR3,
Vertical Antenna Power Setting 14



200-608 MHz, EUT Side, Hopping, DR3
Horizontal Antenna, Power Setting 14



200-608 MHz, EUT Side, Hopping, DR3
Vertical Antenna, Power Setting 14

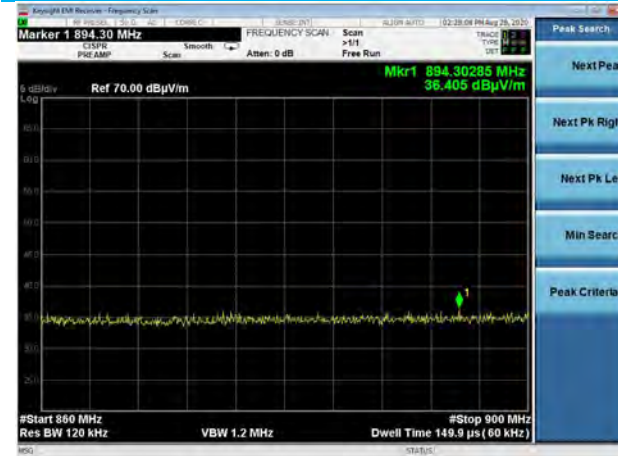


608-614 MHz, EUT Side, Hopping, DR3
Horizontal Antenna, Power Setting -17

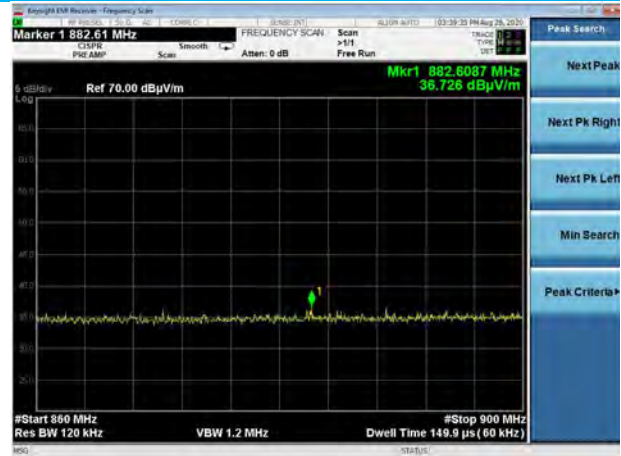


608-614 MHz, EUT Side, Hopping, DR3
Vertical Antenna, Power Setting 14

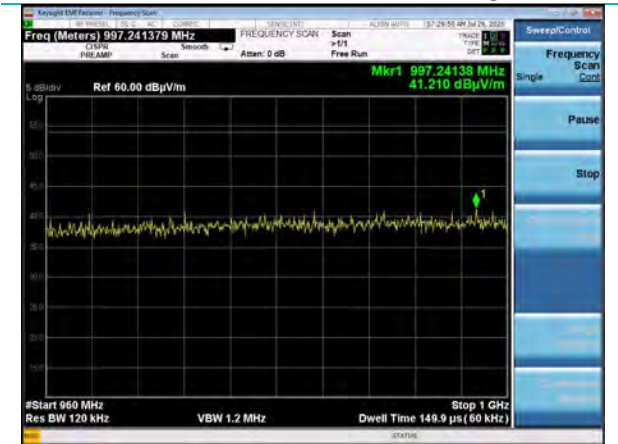
Company: Georgia Pacific		Name: KOLO LoRa Module
Report: TR319353 A	Page 52 of 55	Model: ASM-000001076
Job: C-3372		Serial: Engineering Sample



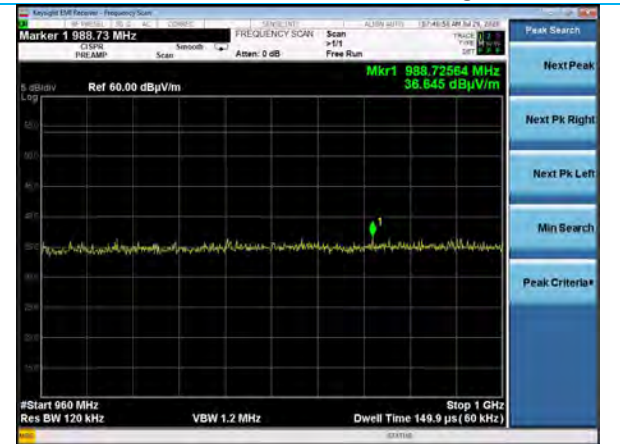
860-900 MHz, EUT Side, Hopping, DR0
Horizontal Antenna, Power Setting 14



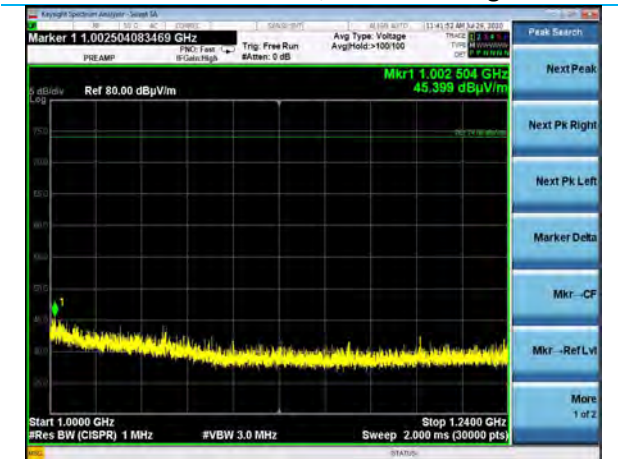
860-900 MHz, EUT Side, Hopping, DR0
Vertical Antenna, Power Setting -17



960-1000 MHz, EUT Side, Hopping, DR0
Horizontal Antenna, Power Setting 14



960-1000 MHz, EUT Side, Hopping, DR0
Vertical Antenna, Power Setting -17



1000-1240 MHz, EUT Side, High Channel, DR3,
Vertical Antenna, Power Setting 14



1000-1240 MHz, EUT Side, High Channel, DR3,
Vertical Antenna, Power Setting -17

Company: Georgia Pacific		Name: KOLO LoRa Module
Report: TR319353 A	Page 53 of 55	Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample



1.24-10 GHz, EUT Vertical, High Channel
 Vertical Antenna, DR3, Power Setting 14
 Reduced VBW



1.24-10 GHz, EUT Vertical, High Channel
 Horizontal Antenna, DR3, Power Setting 14
 Reduced VBW

Company: Georgia Pacific	Page 54 of 55	Name: KOLO LoRa Module
Report: TR319353 A		Model: ASM-0000001076
Job: C-3372		Serial: Engineering Sample

6 REVISION HISTORY

Version	Date	Notes	Person
v0.1	10-6-2020	Initial Draft	Zach Wilson
v0.2	10-8-2020	Revised per internal review	Zach Wilson

END OF REPORT