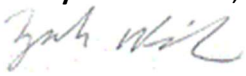
Test Report # 319325 C

Equipment Under Test:	KOLO Gen2 WiFi Module
Requirement(s):	FCC 15.407, RSS-247, DFS
Test Date(s):	June 6th, 2021
Prepared for:	Georgia Pacific Attn: Randall Duval 1915 Marathon Avenue Neenah, WI 54956

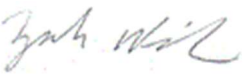
Report Issued by: Zach Wilson, EMC Engineer

Signature:  Date: 9/23/2021

Report Reviewed by: Adam Alger, Laboratory Manager

Signature:  Date: 8/3/2021

Report Constructed by: Zach Wilson, EMC Engineer

Signature:  Date: 6/10/2021

CONTENTS

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:

Certificate #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025:2017 with Electrical (EMC) Scope

A2LA Certificate Number: 1255.01

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

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Federal Communications Commission (FCC) – USA

Accredited Test Firm Registration Number: 953492

Recognition of two 3 meter Semi-Anechoic Chambers

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 **6/9/2021** the Equipment Under Test (EUT), **KOLO Gen2 WiFi Module**, as provided by **Georgia Pacific** was tested to the following requirements:

FCC	ISED Canada	Test Description	Method	Result
15.407 (h)(2)	RSS-247 Section 6.3	Dynamic Frequency Selection	FCC KDB 905462 D02	Pass Note
15.407 (h)(2)(ii)	RSS-247 Section 6.3	Channel Availability Check Time	FCC KDB 905462 D02	N/A Note
15.407 (h)(2)(iii)	RSS-247 Section 6.3	Channel Move Time	FCC KDB 905462 D02	Pass
15.407 (h)(2)(iv)	RSS-247 Section 6.3	Non-Occupancy period	FCC KDB 905462 D02	Pass

Note 1: The EUT is a client only device.

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 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:

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

Channel 64, 5230 MHz, 802.11a, 6Mbps

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

2.8 KDB 905462 Information

Complete description of the U-NII device	
a) The operating frequency range(s) of the equipment.	5180-5240 MHz, 5260-5320MHz, 5500-5700MHz, 5745-5825 MHz
b) The operating modes (Master and/or Client) of the U-NII device. Bridge modes and MESH modes, as applicable, must be included in the description.	Client with no radar detection capability
c) For Client devices, indicate whether or not it has radar detection capability and indicate the FCC identifier for the Master U-NII Device that is used with it for DFS testing.	Client with no radar detection capability. Master used with testing, FCC ID: LDK102061, LDK102062 IC: 2461B-102061, 2461B-102062
d) List the highest and the lowest possible power level (equivalent isotropic radiated power (EIRP)) of the equipment.	Highest EIRP = 14.0 dBm + 3.5 dBi = 17.5 dBm Lowest EIRP = 7.1 dBm + 3.5 dBi = 10.6 dBm
e) List all antenna assemblies and their corresponding gains.	Refer to section 2.7 of this report
1) If radiated tests are to be performed, the U-NII Device should be tested with the lowest gain antenna assembly (regardless of antenna type). The report should indicate which antenna assembly was used for the tests. For devices with adjustable output power, list the output power range and the maximum EIRP for each antenna assembly.	Not Applicable
2) If conducted tests are to be performed, indicate which antenna port/connection was used for the tests and the antenna assembly gain that was used to set the DFS Detection Threshold level during calibration of the test setup.	Not Applicable- EUT Client only
i) Indicate the calibrated conducted DFS Detection Threshold level.	Not Applicable- EUT Client only
ii) For devices with adjustable output power, list the output power range and the maximum EIRP for each antenna assembly.	No adjustable power. Maximum EIRP = 17.5 dBm
iii) Indicate the antenna connector impedance. Ensure that the measurement instruments match (usually 50 Ohms) or use a minimum loss pad and take into account the conversion loss.	50 ohms
3) Antenna gain measurement verification for tested antenna.	Not Applicable- EUT Client only
i) Describe procedure	Not Applicable- EUT Client only
ii) Describe the antenna configuration and how it is mounted	Not Applicable- EUT Client only
iii) If an antenna cable is supplied with the device, cable loss needs to be taken into account. Indicate the maximum cable length and either measure the gain with this cable or adjust the measured gain accordingly. State the cable loss.	Antenna cable was accounted in the gain measurement.

f) Test sequences or messages that should be used for communication between Master and Client Devices, which are used for Channel loading.	EUT and Master running 'Iperf' to stream data
1) Stream the test file from the Master Device to the Client Device for IP based systems or frame based systems which dynamically allocate the talk/listen ratio.	EUT and Master running 'Iperf' to stream data
2) For frame based systems with fixed talk/listen ratio, set the ratio to the worst case (maximum) that is user configurable during this test as specified by the manufacturer and stream the test file from the Master to the Client.	Not applicable
3) For other system architectures, supply appropriate Channel loading methodology.	Not applicable
g) Transmit Power Control description—Provide a description.	Not Applicable
h) System architectures, data rates, U-NII Channel bandwidths — Indicate the type(s) of system architecture (e.g. IP based or Frame based) that the U-NII device employs. Each type of unique architecture must be tested.	Channel bandwidths: 20MHz Data rates: 6 MBPS - MCS7
i) The time required for the Master Device and/or Client Device to complete its power-on cycle.	Client device takes less than 10 seconds to boot up
j) Manufacturer statement confirming that information regarding the parameters of the detected Radar Waveforms is not available to the end user.	See Software security exhibit
k) The manufacturer is permitted to select the first channel either manually or randomly. The manufacturer may also block DFS channels from use.	Not applicable-EUT client device only

Complete description of the Radar Waveform calibration	
a) Description of calibration setup—Block diagram of equipment setup, clearly identifying if a radiated or conducted method was used.	Not Applicable- EUT client device only
b) Description of calibration procedure	Not Applicable- EUT client device only
1) Verify DFS Detection Threshold levels	Not Applicable- EUT client device only
i) Indicate DFS Detection Threshold levels used.	Not Applicable- EUT client device only
ii) Consider output power range and antenna gain.	Not Applicable- EUT client device only
2) For the Short Pulse Radar Types, spectrum analyzer plots of the burst of pulses on the Channel frequency should be provided.	Supplied in this report
3) For the Long Pulse Radar Type, spectrum analyzer plot of a single burst (1-3 pulses) on the Channel frequency should be provided.	Not Applicable- EUT client device only
4) Describe method used to generate frequency hopping signal.	Not Applicable- EUT client device only
5) The U-NII Detection Bandwidth	Not Applicable- EUT client device only
6) For the Frequency Hopping waveform, a spectrum analyzer plot showing 9 pulses on one frequency within the U-NII Detection Bandwidth should be provided.	Not Applicable- EUT client device only
7) Verify use of vertical polarization for testing when using a radiated test method.	Not applicable- testing performed conducted
c) When testing a Client Device with radar detection capability, verify that the Client Device is responding independently based on the Client Device's self-detection rather than responding to the Master Device. If required, provide a description of the method used to isolate the client from the transmissions from the Master Device to ensure Client Device self-detection of the Radar Waveform.	Not Applicable- EUT client device only without radar detection capability

Complete description of test procedure	
a) Description of deviations to the procedures or equipment described in this document.	No deviations during test
b) Description of DFS test procedure and test setup used to monitor the U-NII device and Radar Waveform transmissions. Provide a block diagram of the signal monitoring equipment setup.	Provided in this report
1) List of equipment	In report
2) Test setup photos	Test setup photos exhibit
c) Description of DFS test procedure and test setup used to generate the Radar Waveforms.	In report
1) Block diagram of equipment setup	In report
2) List of equipment	In report
3) Test setup photos	Test setup photos exhibit
4) For each of the waveforms that were used for each signal type, supply the characteristics (pulse width, pulse repetition interval, number of pulses per burst, modulation).	Radar type 0 in KDB905462 D02
5) For selecting the waveform parameters from within the bounds of the signal type, describe how they were selected (i.e., manually or randomly).	Manually using arbitrary waveform generator and signal generator
6) Channel loading description including data type, timing plots, percentage of channel loading calculation, and protocol.	In report
d) The DFS tests are to be performed on U-NII Channel(s). Refer to Table 2 for additional requirements for devices with multiple bandwidth modes.	Testing performed on UNII channel with 20MHz bandwidth
1) List each Channel frequency that was used for the tests.	5320 MHz
2) Data Sheet showing the U-NII Detection Bandwidth for the Channel(s) used during the test.	Not Applicable-EUT client device only
3) Plot of RF measurement system showing its nominal noise floor in the same bandwidth which is used to perform the Channel Availability Check, initial radar bursts, In-Service Monitoring, and 30 minute Non-Occupancy Period tests.	Not Applicable-EUT client device only
e) Timing plot(s) showing compliance with the Channel Availability Check Time requirement of 60 seconds at start up.	Not Applicable-EUT client device only
1) The plot should show the Initial Tpower-up time.	Not Applicable-EUT client device only
2) The plot should include the Initial Tpower-up period in addition to 60 second period.	Not Applicable-EUT client device only

f) Timing plot(s) showing compliance with the Initial DFS radar detection requirements during the 60 second initial Channel Availability Check at start up.	Not Applicable-EUT client device only
1) Plot for DFS radar detection for Radar Waveforms applied 6 seconds after the Initial Tpower-up time period. The minimum length of the plot should be 1.5 minutes after the Tpower-up time period. The plot should show the radar burst at the appropriate time. This test is only required once and Radar Type 0 should be used for the test.	Not Applicable-EUT client device only
2) Plot for DFS radar detection for Radar Waveforms applied 6 seconds before end of the 60 second Channel Availability Check Time. The minimum length of the plot should be 1.5 minutes after the Tpower-up time period. The plot should show the radar burst at the appropriate time. This test is only required once and Radar Types 0 should be used for the test.	Not Applicable-EUT client device only
3) The minimum time resolution of the plots should be sufficient to show the Radar Waveform bursts (overall, not individual pulses within the burst).	In report
g) Verification that when the device is "off" that the RF energy emitted is below the FCC rules for unintentional radiators:	Verified
For the plots of U-NII RF activity versus time, the device is considered to be "off" or not transmitting when intentional U-NII signals (beacons, data packets or transmissions, or control signals) are below the FCC rules for unintentional radiation due to device leakage, oscillator noise, clocks, and other unintentional RF generators.	
h) Spectrum Analyzer, VSA, or some other data gathering Instrument plots showing compliance with the Channel Move Time requirements during in the In-Service Monitoring. The plots need to show U-NII device transmissions on the Channel in the form of RF activity on the vertical axis versus time on the horizontal axis. Only one 10 second plot needs to be reported for Radar Type 0. The plot for the Short Pulse Radar Types should start at the end of the radar burst. The Channel Move Time will be calculated based on the plot of Radar Type 0. The plots need to show U-NII device transmissions on the Channel in the form of RF activity on the vertical axis versus time on the horizontal axis. Sufficient resolution should be used.	In report
1) The plots and/or data must show the U-NII Device's compliance with the 200 milliseconds limit on data transmission and compliance with the 60 millisecond aggregate limit found in Table 4.	In report
2) Indicate the total number of times the test was performed.	Not Applicable-EUT client device only
3) Indicate a detect/not detect for each waveform within a signal type and the number of failures and the number of successful radar detection times within the time limit. Sample data sheets are shown in Tables 8-11.	Not Applicable-EUT client device only
4) Verify compliance with the minimum percentage of successful detection requirements found in Tables 5-7.	Not Applicable-EUT client device only
i) Spectrum Analyzer plot(s) showing compliance with the 30 minute Non-Occupancy Period requirement. Only one plot is required. This is a separate test that is performed in addition to the other In-Service Monitoring tests.	In report

3 REFERENCES

Publication	Edition	Date
FCC eCFR		2021
RSS 247	2	2017
RSS GEN	5	2018
ANSI C63.10		2013
FCC KDB 905462 D02 v02	-	2016

4 UNCERTAINTY SUMMARY

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

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

Measurement Type	Configuration	Uncertainty ±
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

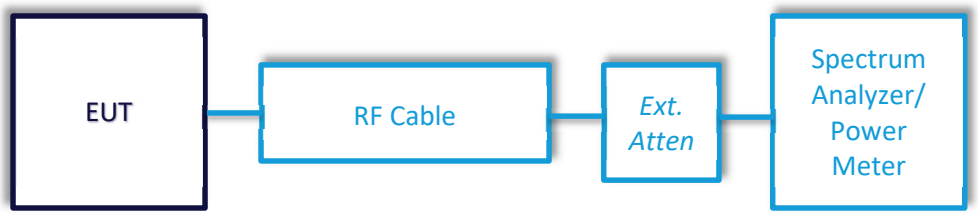
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %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

5 TEST DATA

5.1 Antenna Port Conducted Emissions

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

Block Diagram



5.1.1 Antenna Port Conducted Emissions – DFS

Operator	Anthony Smith
QA	Adam Alger
Test Date	6/9/2021
Location	Conducted Radio Bench
Temp. / R.H.	23.1°C/49%
Rule	FCC Part 15.407 (h) / RSS-247 6.3
Method	FCC KDB 905462 D02

Requirements

Client without Radar Detection Requirements Prior to Use of a Channel

1. Non-Occupancy Period

    minimum 30 minutes

Client without Radar Detection Requirements During Normal Operation

1. Channel Closing Time

    200 ms + an aggregate of 60 ms over remaining 10 second period using Radar Type 0 starting at beginning of Channel move time plus any additional control signals not counting quiet periods during the remaining 10 second period.

2. Channel Move Time

    10 seconds using Radar Type 0

Radar Type 0

    Pulse width = 1 µsec

    PRI = 1428 µsec

Number of Pulses = 18

Master Info	**FCC ID: LDK102061, LDK102062** **IC: 2461B-102061, 2461B-102062**

Test Parameters

Frequency	5230 MHz
Bandwidth	RBW 3 MHz, VBW 3 MHz
Detectors	Peak
EUT Setup	Client with no monitoring; Conducted Setup for Client with injection at the Master
EUT Power	5.9VDC
Notes	EUT Setup to connect to Master and perform data streaming using 'I-Perf'. Channel loading (26.24%) shown to be greater than 17%.

Instrumentation

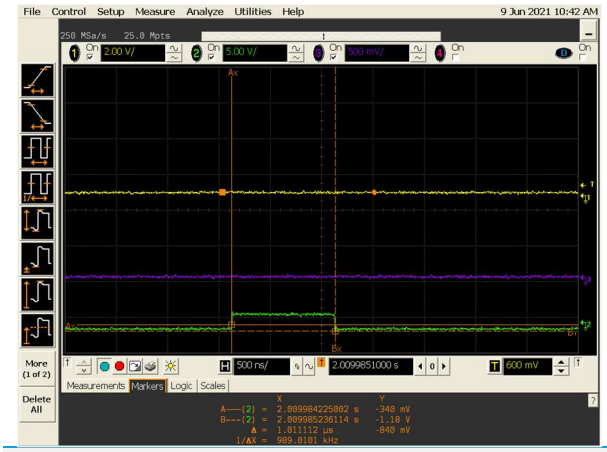
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	7/14/2020	7/14/2021	Active Calibration
2	CC 000710C	Oscilloscope	Agilent	MSO8104A	MY45001068	7/15/2020	7/15/2021	Active Calibration
3	CC 000259C	Generator - Function / Arbitrary Waveform	Agilent	33250A	US40000583	7/16/2020	7/16/2022	Active Calibration
4	CC 000314C	Vector Signal Generator	Agilent	E4438C	US 41469143	7/31/2020	7/31/2022	Active Calibration
5	AA 960182	RF Splitter/Combiner	Mini-Circuits	ZFSC-2-10G+	F707701704	6/7/2018	6/7/2021	Active Verification
6	AA 960183	RF Splitter/Combiner	Mini-Circuits	ZFSC-2-10G+	F707701704	6/7/2018	6/7/2021	Active Verification
7	EE 960183	RF Splitter/Combiner	mini-circuits	ZFSC-2-10G +	S F707601702	6/8/2018	6/8/2021	Active Verification
8	EE 960184	RF Splitter/Combiner	mini-circuits	ZFSC-2-10G +	S F707601702	6/7/2018	6/7/2021	Active Verification

Data Tables

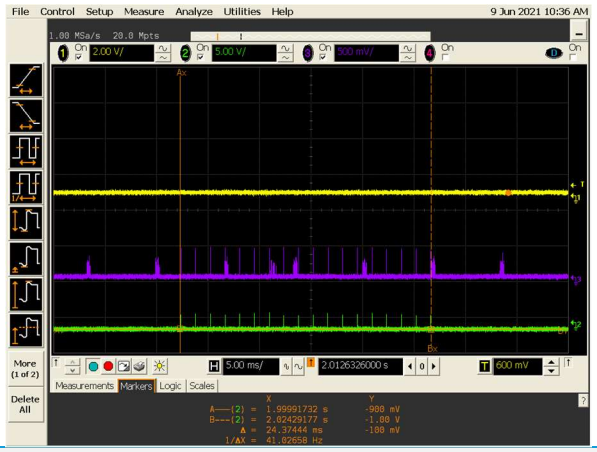
SCS pulses 1-7, Time (us)	SCS Pulses 8-18, Time (us)	Final SCS pulse, Time (us)	SCS Total Time (us)	SCS Total Time (ms)
3376.1	4745.0	8705.0	16826.1	16.8261

Loading Observation Period (ms)	Channel Loading On Time (ms)	Channel Loading
100.00	26.24	26.24%

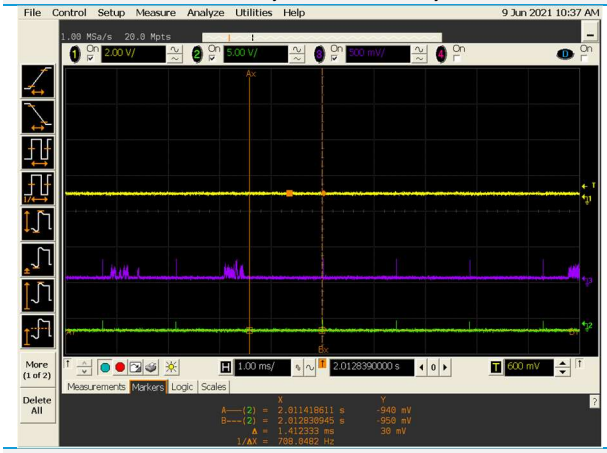
Plots



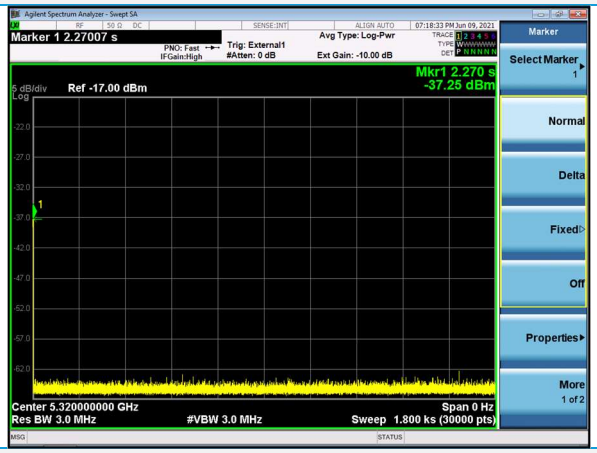
Radar Pulse, Pulse Width, 1us



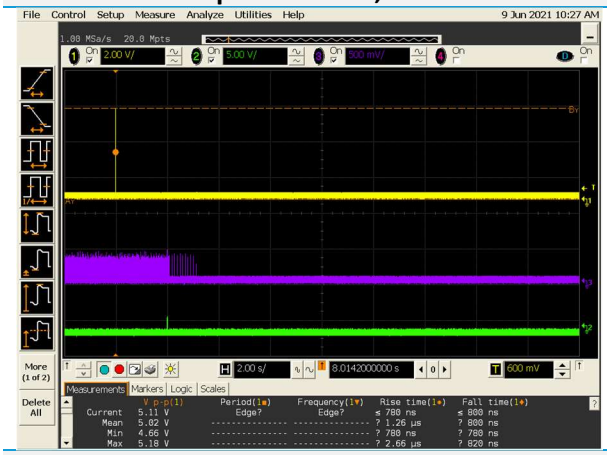
18 Pulses



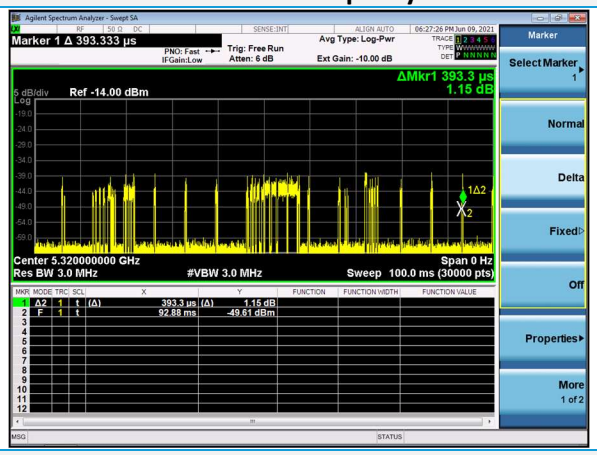
Pulse Repetition Rate, 1.4286ms



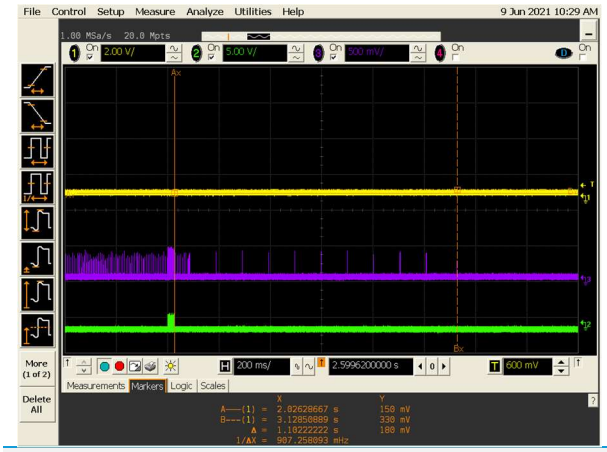
30 Minute Non-Occupancy Period



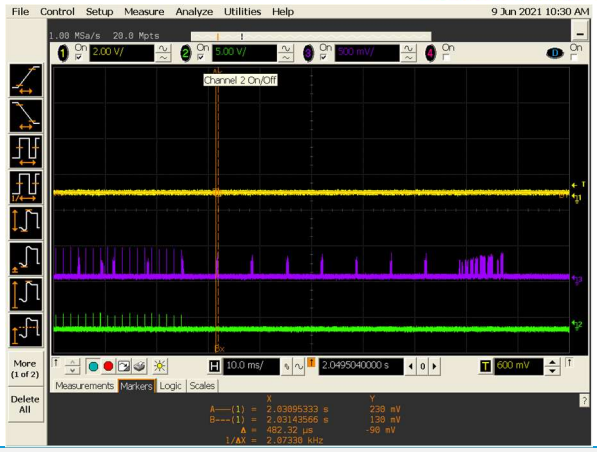
Channel Move Time



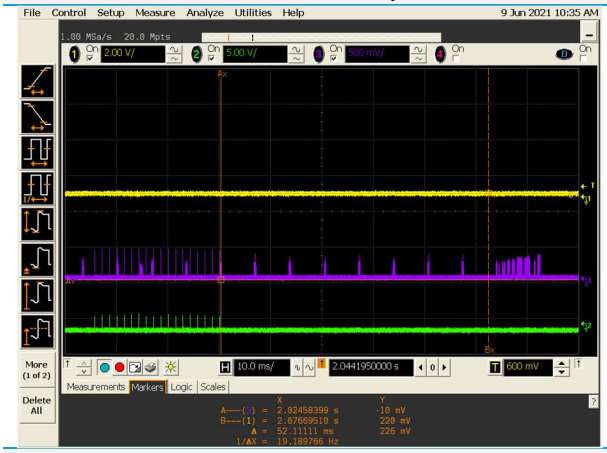
Channel Loading, On Time = 26.24ms,
Observation Period = 100.00ms
Loading = 26.24%



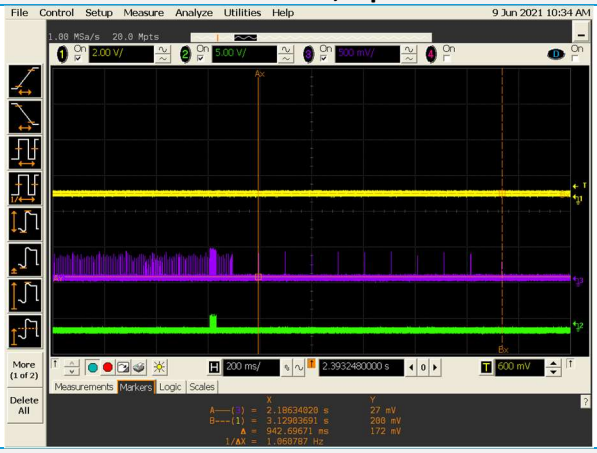
SCS Post 10s Move Time, 1102.0ms



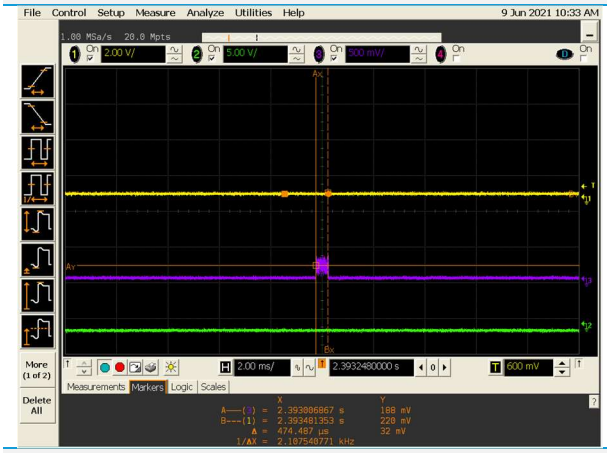
First Seven SCS, 7 pulses



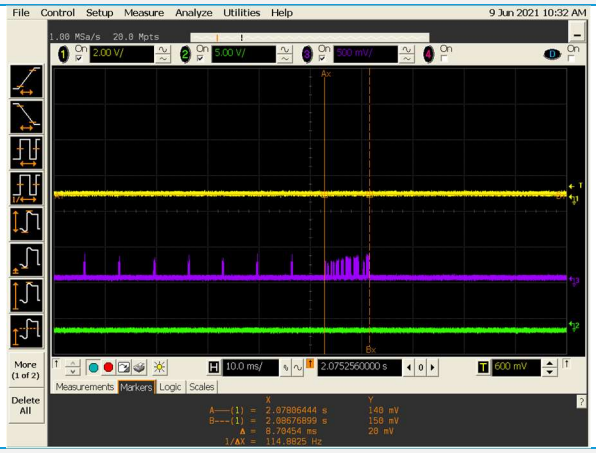
First Seven SCS, Each Pulse = 482.3us
Total SCS time of 3376.1us



SCS Pulses 8-18, 10 Pulses



SCS Pulses 10-18, Each Pulse = 474.5us
Total SCS time of 4745.0us



Final SCS Burst, 8705us

6 REVISION HISTORY

Version	Date	Notes	Person
0	7/26/2021	Initial Draft	Zach Wilson
1	7/29/2021	Revised per internal review	Zach Wilson
2	9/23/2021	Revised per TCB review	Zach Wilson

END OF REPORT