Intertek
731 Enterprise Drive
Lexington, KY 40510

Tel 859 226 1000
Fax 859 226 1040

www.intertek.com

Apollo America Inc.
TEST REPORT

SCOPE OF WORK
EMC TESTING – CALLISTO

REPORT NUMBER
104139907LEX-001

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9/28/2020

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DOCUMENT CONTROL NUMBER
Non-Specific EMC Report Shell Rev. December 2017

EMC TEST REPORT

(FULL COMPLIANCE)

Report Number: 104139907LEX-001
Project Number: G104139907

Report Issue Date: 9/28/2020

Model(s) Tested: Callisto

Standards: FCC Part 15.231
RSS-210 Issue 10
FCC Part 15 Subpart B
ICES-003 Issue 6
RSS-Gen Issue 5

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Dr.
Lexington, KY 40510
USA

Client:
Apollo America Inc.
25 Corporate Drive
Auburn Hills, MI 48326-2919
USA

Report prepared by

Bryan Taylor, Team Leader

Report reviewed by

Brian Lackey, Staff Engineer

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Page	Test full name	FCC Reference	IC Reference	Result
9	Duty Cycle Correction Factor (ANSI C63.10: 2013)	ANSI C63.10: 2013	ANSI C63.10: 2013	---
14	Transmission Timing Measurements (ANSI C63.10: 2013)	§ 15.231(a)	RSS-210 Issue 10 (A.1.1)	Pass
16	Occupied Bandwidth (ANSI C63.10: 2013)	§ 15.231(c)	RSS-210 Issue 10 (A.1.3)	Pass
19	Radiated Emissions (Fundamental and Spurious) (ANSI C63.10: 2013)	§ 15.231(b)	RSS-210 Issue 10 (A.1.2)	Pass
30	Antenna Requirement per FCC Part 15.203	§ 15.203	RSS-Gen Issue 5 (7.1.2)	Pass
31	Radiated Emissions (Transmitters Idle) (ANSI C63.4: 2014)	§ 15.109	ICES-003 Issue 6	Pass
---	Conducted Emission Limits (ANSI C63.4: 2014, ANSI C63.10: 2013)	§ 15.207, 15.107	ICES-003 Issue 5 , RSS-Gen Issue 6 (7.2.4)	NA[1]

1 The Callisto is battery powered and has no direct or indirect connections to the AC mains.

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Apollo America Inc.
Address:	25 Corporate Drive Auburn Hills, MI 48326-2919 USA
Contact:	John Schertel
Telephone:	248-332-3900
Email:	John.schertel@apollo-fire.com
Manufacturer Information	
Manufacturer Name:	Apollo America Inc.
Manufacturer Address:	25 Corporate Drive Auburn Hills, MI 48326-2919 USA

4 Description of Equipment under Test and Variant Models

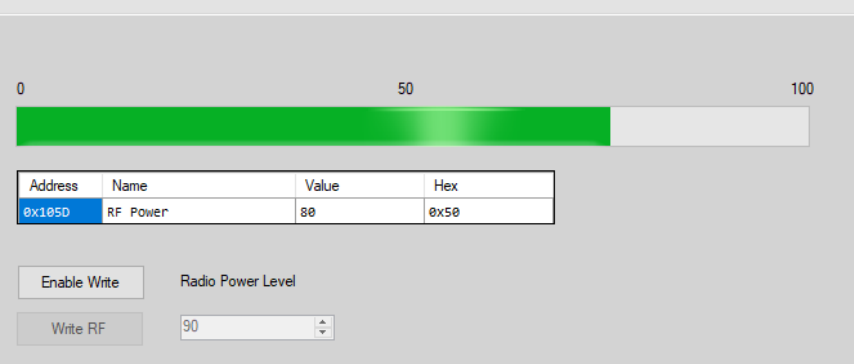
Equipment Under Test	
Product Name	Callisto
Model Number	Callisto
Serial Number	Test sample 1
Receive Date	8/15/2020
Test Start Date	9/3/2020
Test End Date	9/10/2020
Device Received Condition	Good
Test Sample Type	Production
Rated Voltage	3VDC
Transmit Frequency	345MHz

Description of Equipment Under Test (provided by client)

The Wireless Combination Smoke, Heat and Carbon Monoxide Detector is a 2xCR123A battery powered wireless detector intended for use with a compatible wireless alarm system. The detector consists of a photoelectric smoke sensor,thermistor heat sensor and electrochemical carbon monoxide sensor coupled to a wireless transmitter, which communicates with the control panel. When fire or carbon monoxide is detected, the detector sounds a loud local alarm and the built in transmitter sends a signal to the control panel. The Wireless Combination Smoke, Heat and Carbon Monoxide Detector contains an integrated fixed 41°F (5°C) temperature freeze sensor that will send a warning signal based on temperature detected. This detector is designed to provide protection with 70-foot spacing capability. The detector can send alarm, tamper and battery condition messages to the system's receiver. The frequency of transmission is 345MHz.

5 Description of EUT Exercising

During the testing the output power of the Callisto was set using an external programming tool provided by Apollo America Inc. The power setting on the programming tool that was used throughout the testing is shown below:



No.	**Descriptions of EUT Exercising**
1	Transmitting a continuous signal at 345MHz
2	Transmitting a normal duty cycle signal at 345MHz
3	Idle Mode

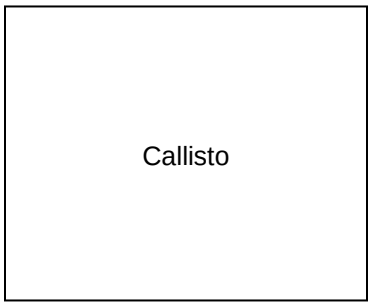
6 System Setup and Method

6.1 Method:

Configuration as required by ANSI C63.4:2014, and ANSI C63.10:2013.

Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
No cables were connected to the test sample during this evaluation					

6.2 EUT Block Diagram:



7 Duty Cycle Correction Factor

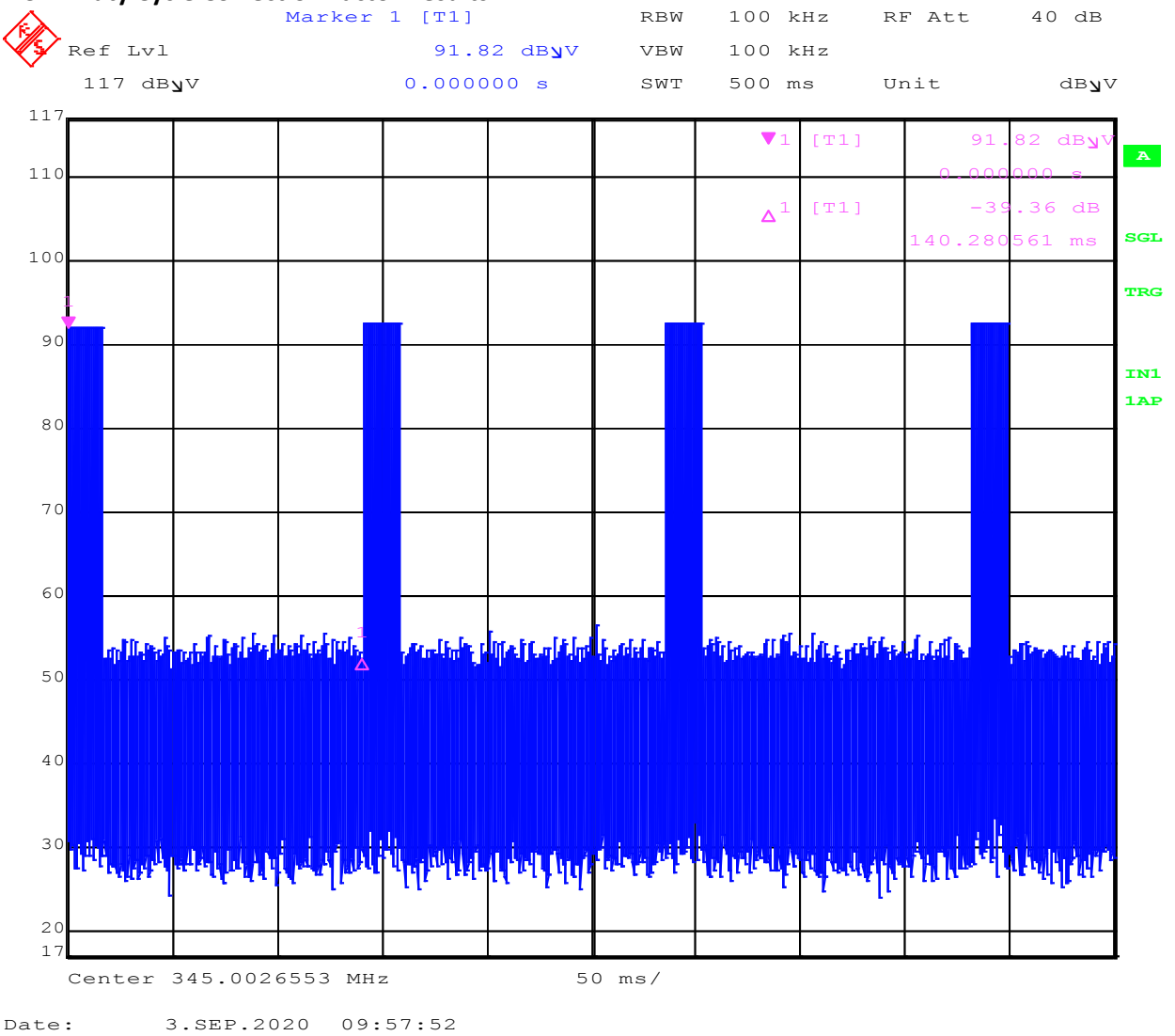
7.1 Test Procedure

ANSI C63.10: 2013 Section 7.5 was followed for measuring the duty cycle and calculating the duty cycle correction factor. When necessary the duty cycle correction factor was used to compute the average value of pulsed emissions during the radiated testing.

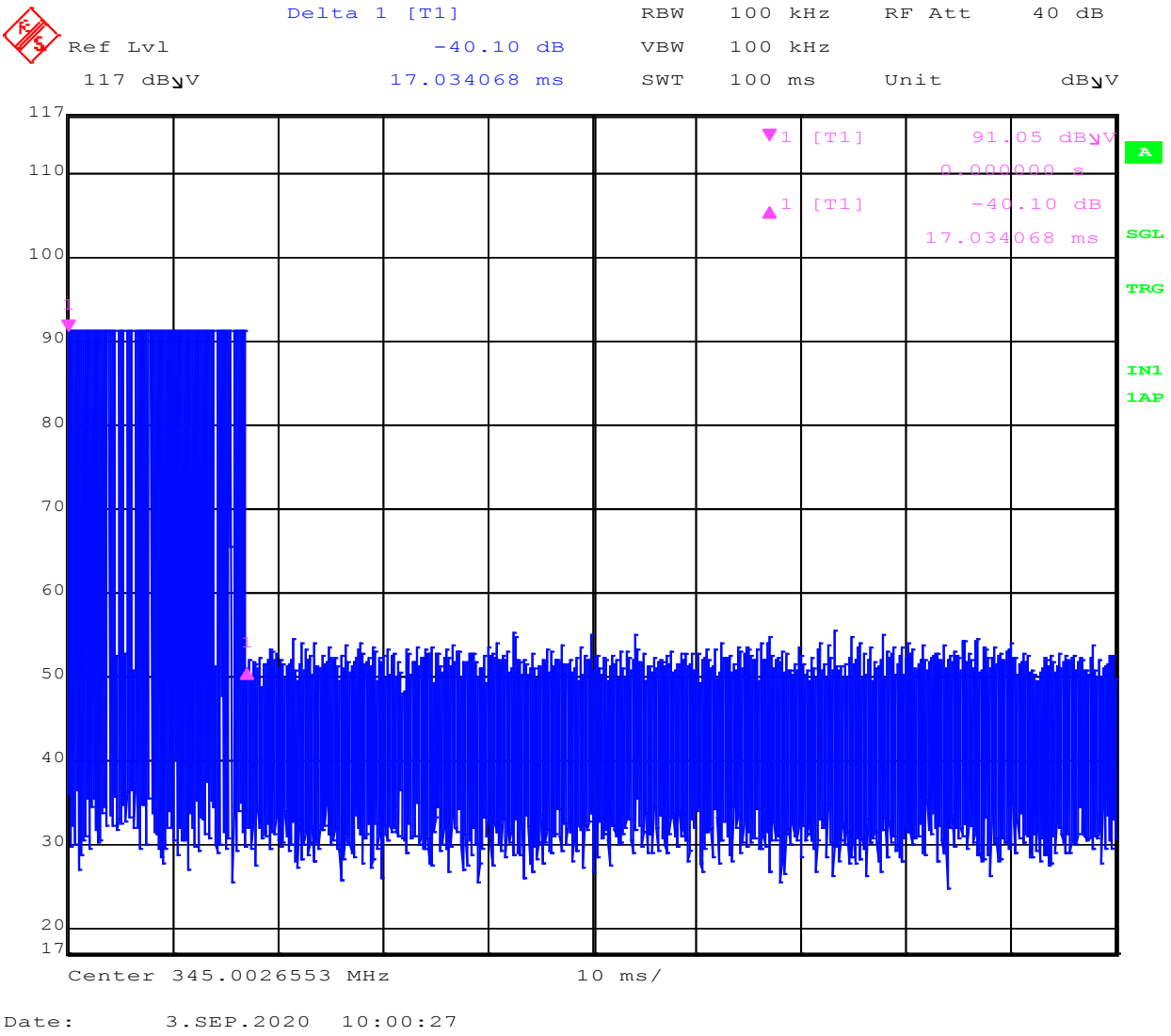
7.2 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	2327	Rohde & Schwarz	ESI26	9/30/2019	9/30/2020

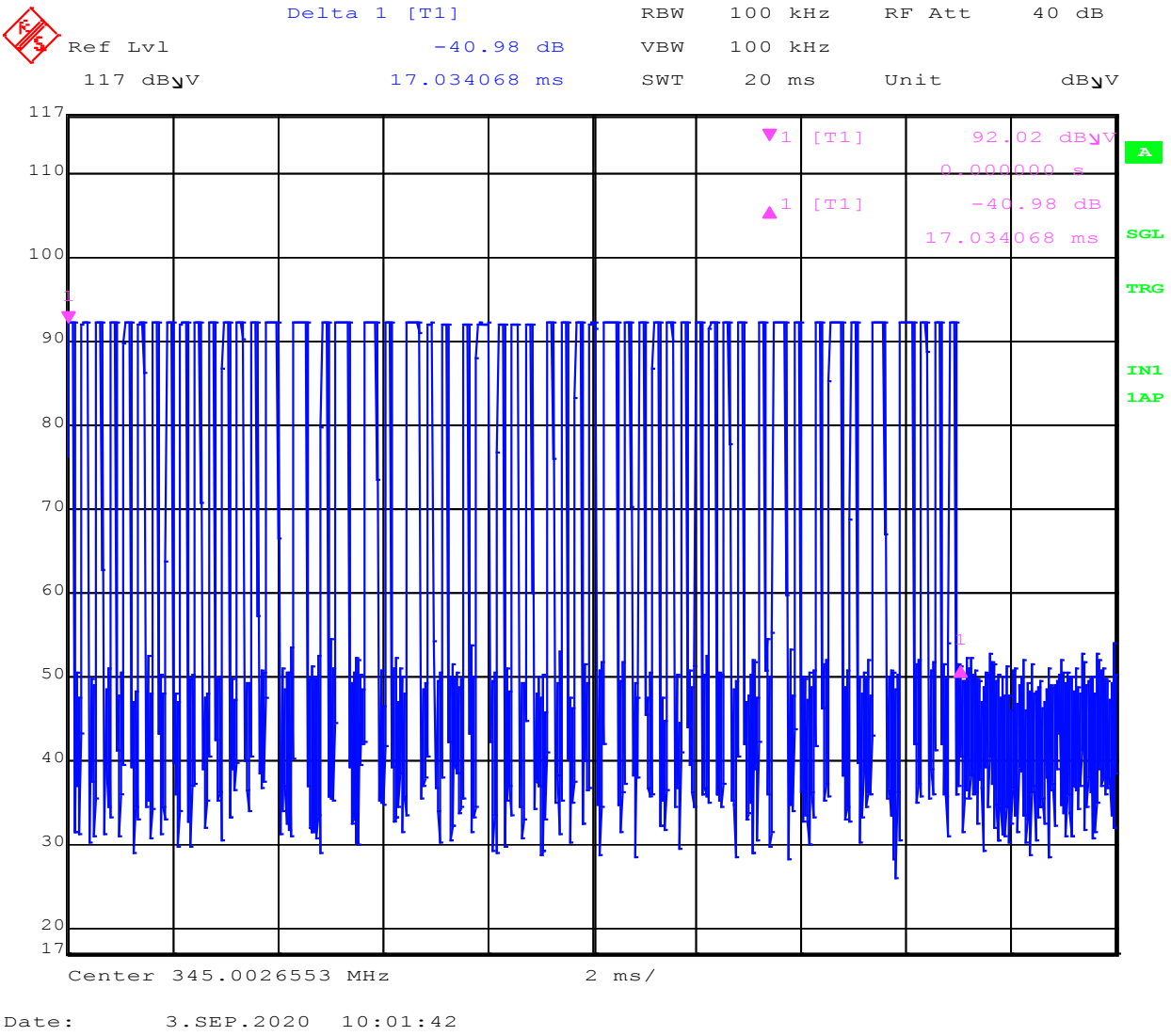
7.3 Duty Cycle Correction Factor Results



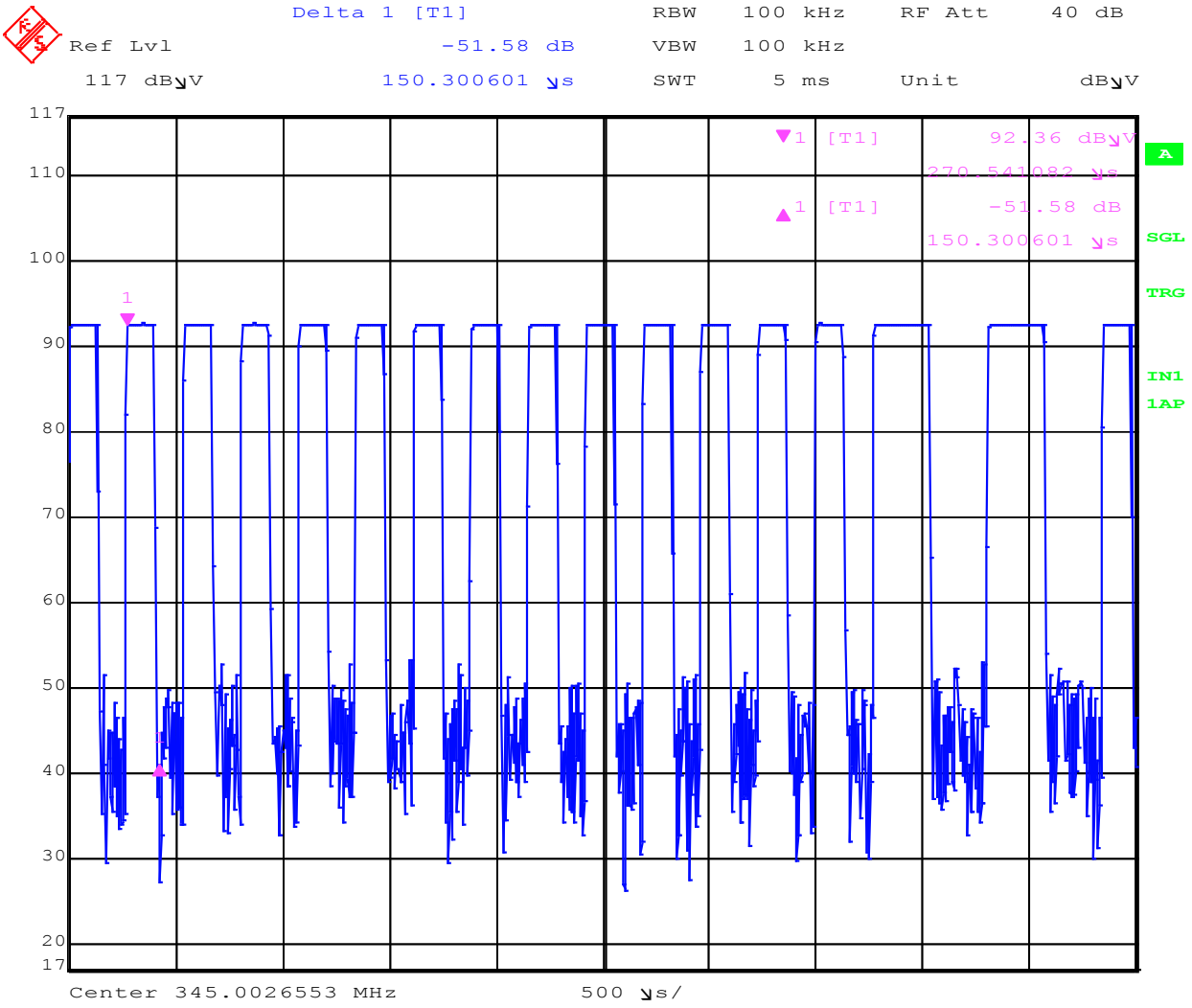
Pulse train is regular and exceeds 100mS including blanking intervals (140mS)



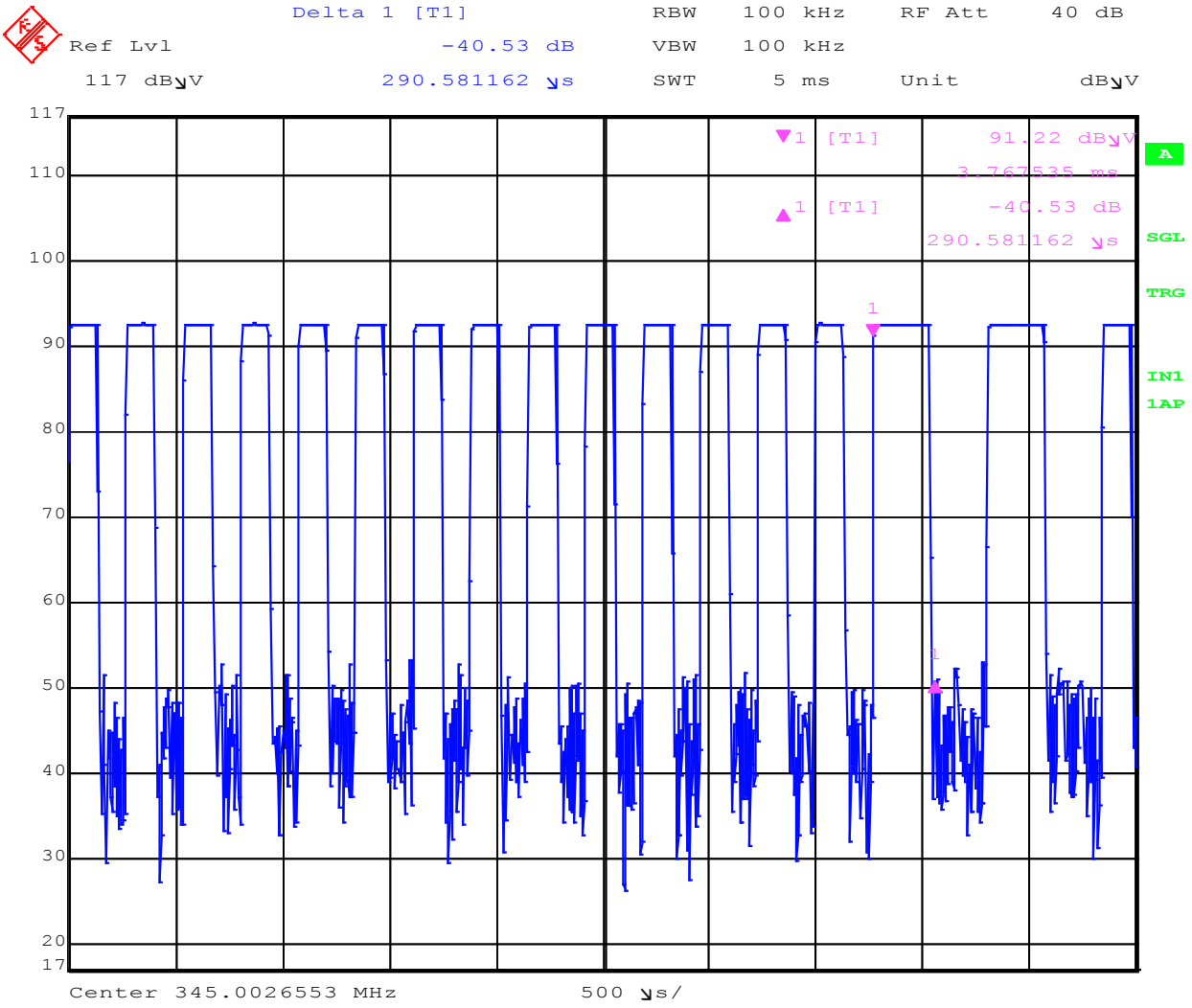
One pulse in 100mS



Number of short and long pulses in one pulse train
11 long pulses
40 short pulses



Short pulse = 0.27mS



Long pulse = 0.76mS

On Time = 0.27mS x 40 pulses + 0.76mS x 11 pulses
On Time = 19.16mS
Duty Cycle over 100mS = 19.16mS / 100mS = 0.1916

Duty Cycle Correction Factor = 20log(0.1916) = -14.35dB

8 Transmission Timing

§ 15.231(a):

The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

8.1 Test Procedure

The sample was set up in its normal operating mode. A small antenna connected to a spectrum analyzer was placed in close proximity to the sample. The scope was configured to trigger when the sample transmitted data. Conditions 1, 2, and 3 above were used to evaluate compliance.

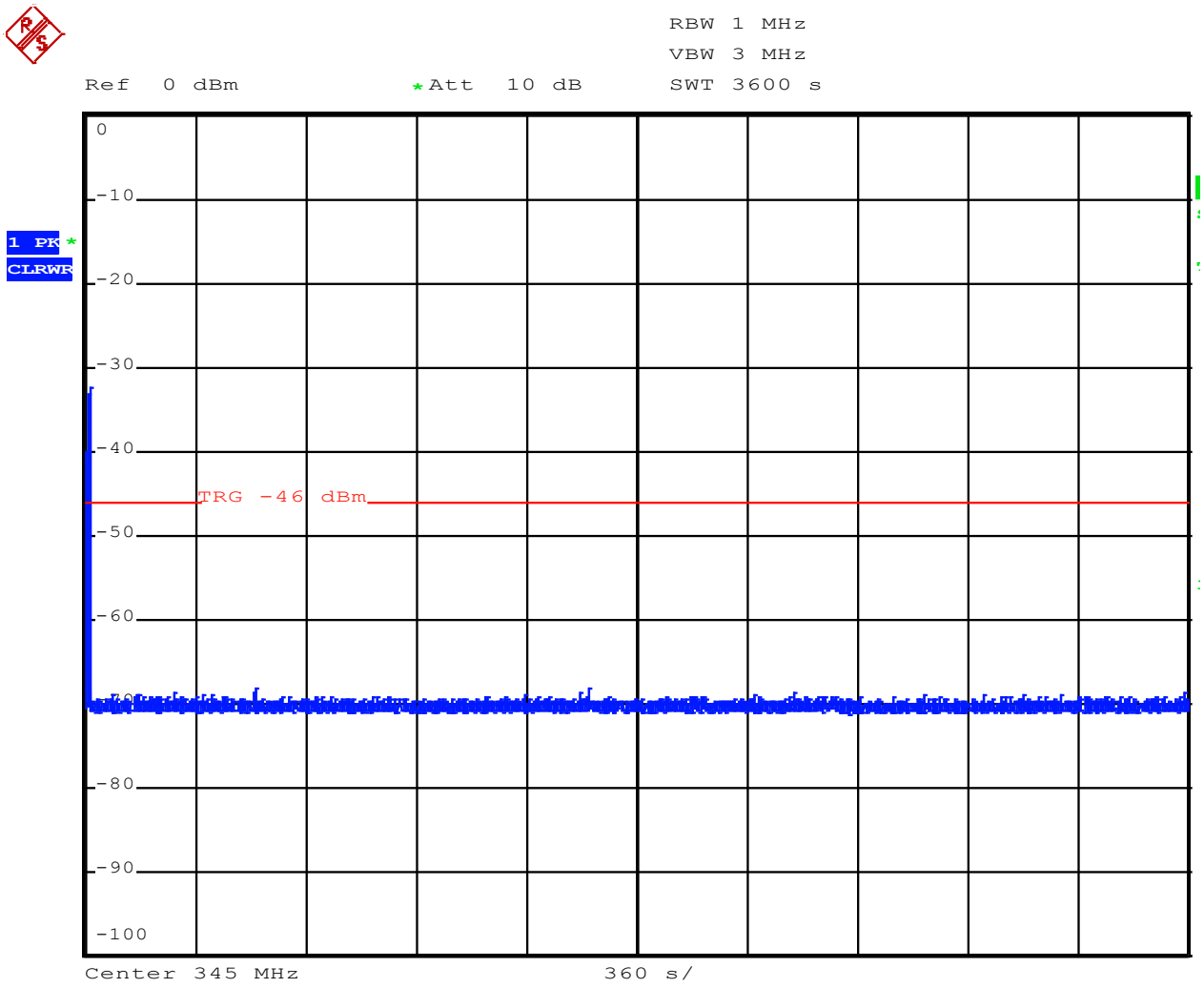
8.2 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3065	Rohde & Schwarz	FSP3	9/18/2019	9/18/2020

8.1 Transmission Timing Results

The Callisto is an automatically triggered transmitter used in alarm situations involving detection of fire, smoke, carbon monoxide and safety of life. It does not transmit at regular predetermined intervals.

No additional transmissions occurred once the device was triggered for an observation period of 1 hour as shown in the spectrum plot below:



Date: 10.SEP.2020 16:37:43

9 Occupied Bandwidth

9.1 Test Limits

§ 15.231(c): The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

9.2 Test Procedure

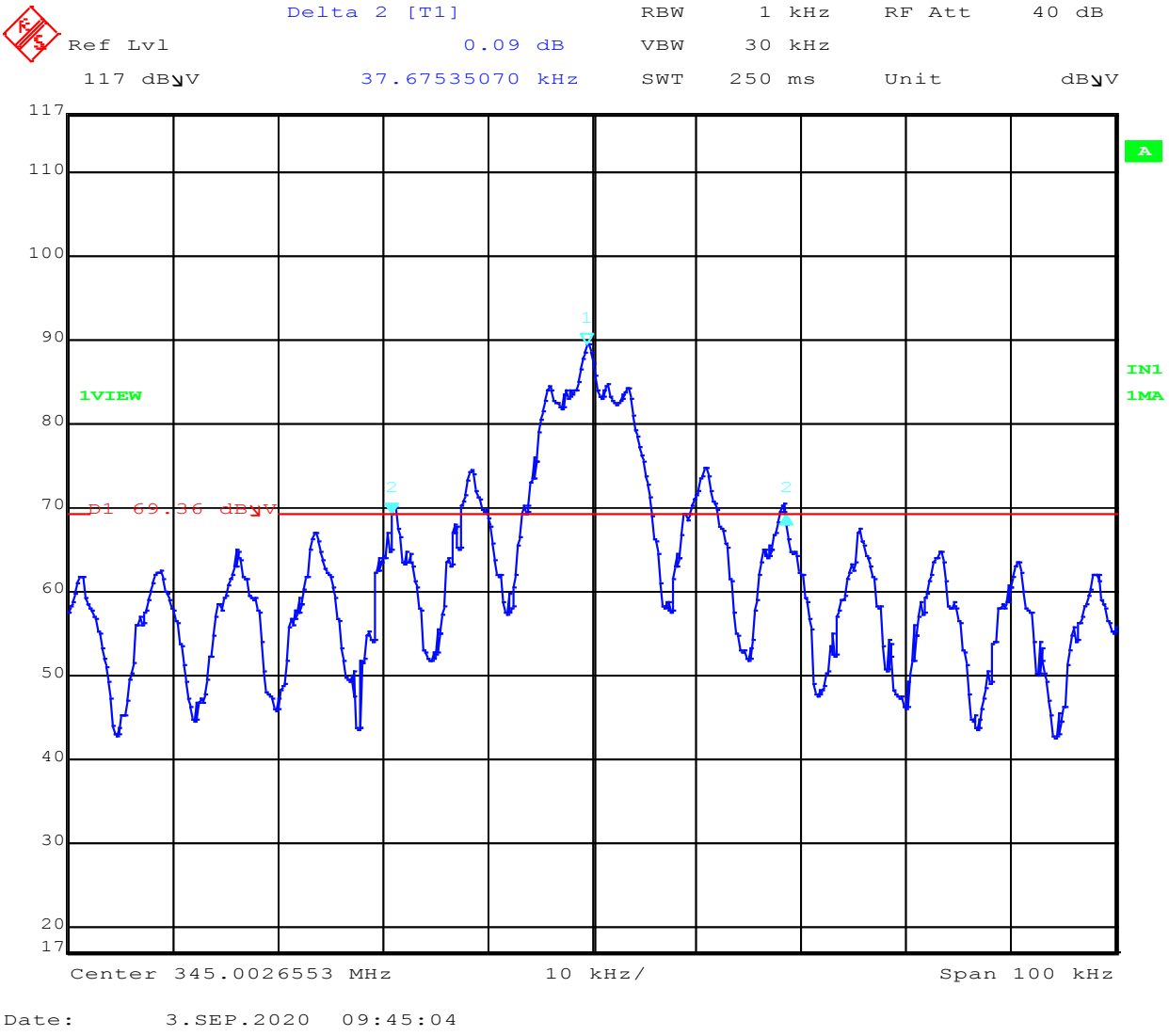
ANSI C63.10: 2013

9.3 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	2327	Rohde & Schwarz	ESI26	9/30/2019	9/30/2020

9.4 Results: 20dB Bandwidth Measurement

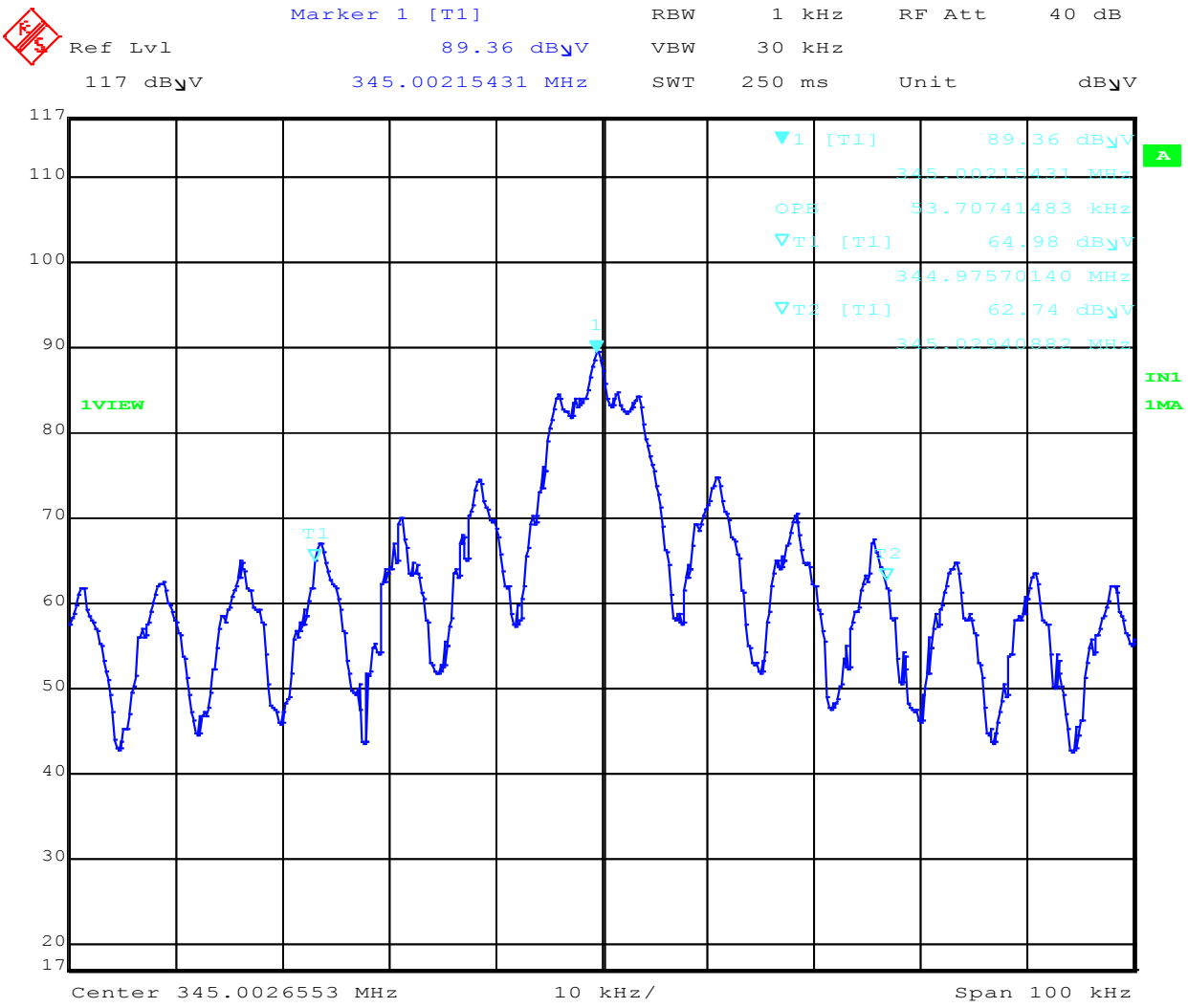
The Callisto was compliant with the 20dB bandwidth emission limitation. The 20dB down bandwidth measurement was not wider than 0.25% of the fundamental transmit frequency.



20dB Down Bandwidth = 37.67kHz

Limit:
0.25% of 345,000kHz = 862.5kHz

9.5 Results: 99% dB Bandwidth Measurement



99% BW = 53.71kHz

Limit:
0.25% of 345,000kHz = 862.5kHz

10 Radiated Fundamental and Spurious Emissions (Transmitter)

10.1 Test Limits

§ 15.231(a): The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

(b) In addition to the provisions of §15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emissions (microvolts/meter)
40.66-40.70	2,250	225
70-130	1,250	125
130-174	[1]1,250 to 3,750	[1]125 to 375
174-260	3,750	375
260-470	[1]3,750 to 12,500	[1]375 to 1,250
Above 470	12,500	1,250

[1]Linear interpolations.

(1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

(2) Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in §15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of §15.205 shall be demonstrated using the measurement instrumentation specified in that section.

(3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in §15.209, whichever limit permits a higher field strength.

Part 15.205(a): Restricted Bands of Operations

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	[2]
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

Part 15.209(a): Field Strength Limits for Restricted Bands of Operation

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

10.2 Test Procedure

ANSI C63.10: 2013

10.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBµV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBµV/m
Level in µV/m = Common Antilogarithm [(38.78 dBµV/m)/20] = 86.89 µV/m

10.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	9/18/2019	9/18/2020
Preamplifier (1-18GHz)	3918	Rohde & Schwarz	TS-PR18	12/6/2019	12/6/2020
Magnetic Loop Antenna	2366	ETS	6502	7/17/2020	7/17/2021
Bilog Antenna	40527	Teseq	CBL6112D	6/8/2020	6/8/2021
Horn Antenna (1-18GHz)	3780	ETS	3117	6/18/2020	6/18/2021
System Controller	121701-1	Sunol Sciences	SC99V	Time of Use	Time of Use

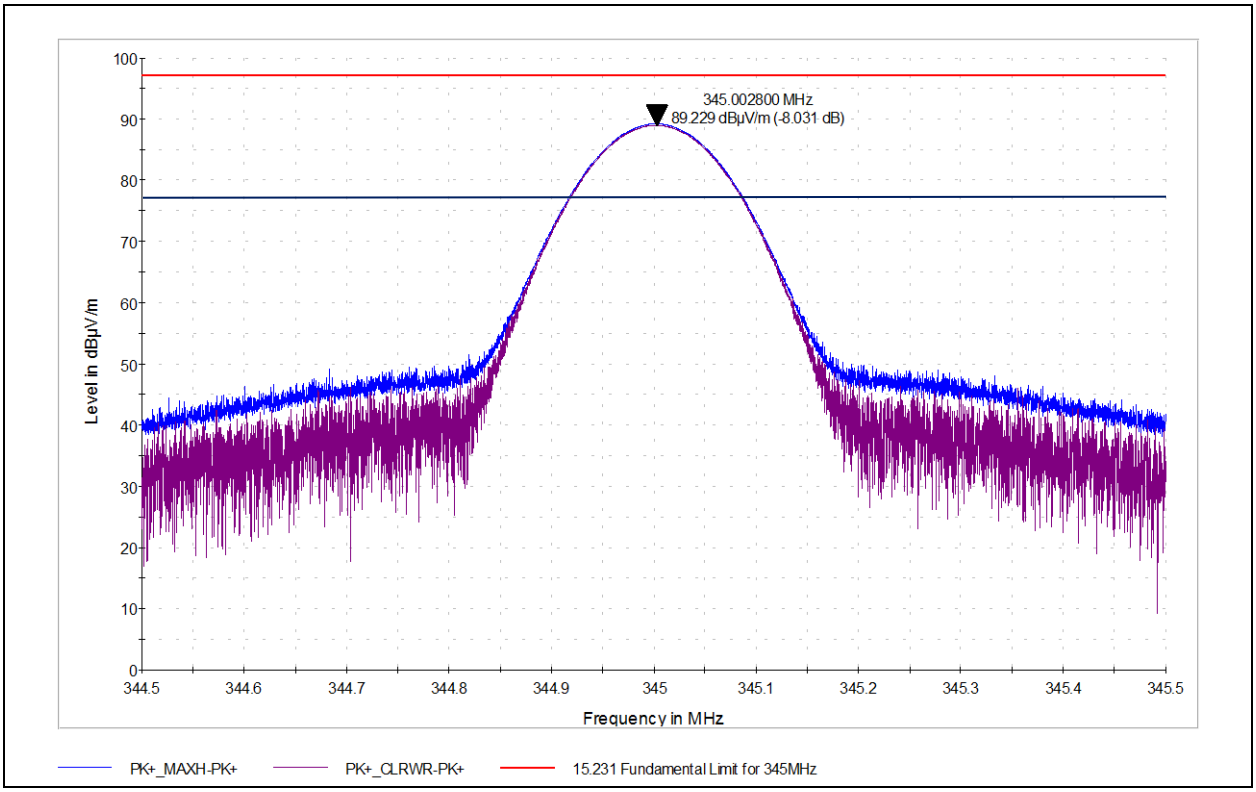
10.5 Software Utilized:

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

10.6 Test Results:

All fundamental and spurious emissions not falling into the restricted bands met the limits outlined in FCC Part 15.231(b). Additionally, all emissions falling within restricted bands of operation were found to be below the limit specified in Part 15.209(a). The emissions listed in the following tables are the worst case emissions and were investigated with the sample positioned in three orthogonal axis in order to report the highest possible field strength.

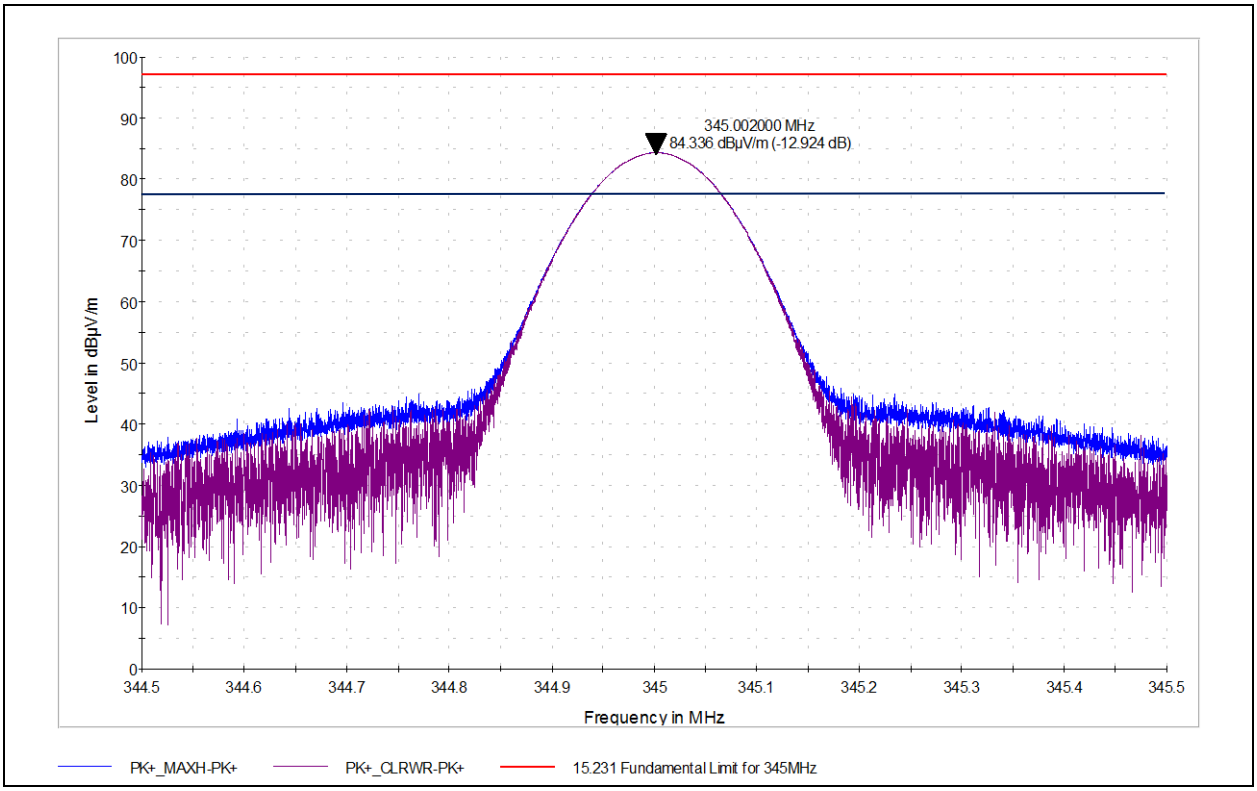
10.7 Plots/Data: Radiated Emissions, Fundamental Transmission



Z-axis
Horizontal Polarity
Peak Detector
Peak Limit = 97.26dBuV/m

Test Personnel:	Bryan Taylor	Test Date:	9/4/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	15.231
Product Standard:	FCC Part 15C, RSS-210	Ambient Temperature:	25.3 °C
Input Voltage:	3VDC	Relative Humidity:	52.0 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	986.1 mbar

Deviations, Additions, or Exclusions: The plot above shows peak results. The average limit is also shown although the plot does not include duty cycle correction factor. See the tabular data results that follow for the corrected average measurements.



Y-axis
Vertical Polarity
Peak Detector
Peak Limit = 97.26dBuV/m

Test Personnel:	Bryan Taylor	Test Date:	9/4/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	15.231
Product Standard:	FCC Part 15C, RSS-210	Ambient Temperature:	25.3 °C
Input Voltage:	3VDC	Relative Humidity:	52.0 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	986.1 mbar

Deviations, Additions, or Exclusions: The plot above shows peak results. The average limit is also shown although the plot does not include duty cycle correction factor. See the tabular data results that follow for the corrected average measurements.

Frequency (MHz)	MaxPeak (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
345	89.229	97.26	8.031	120	100	H	92	25.31
345	84.336	97.26	12.924	120	175	V	47	25.31

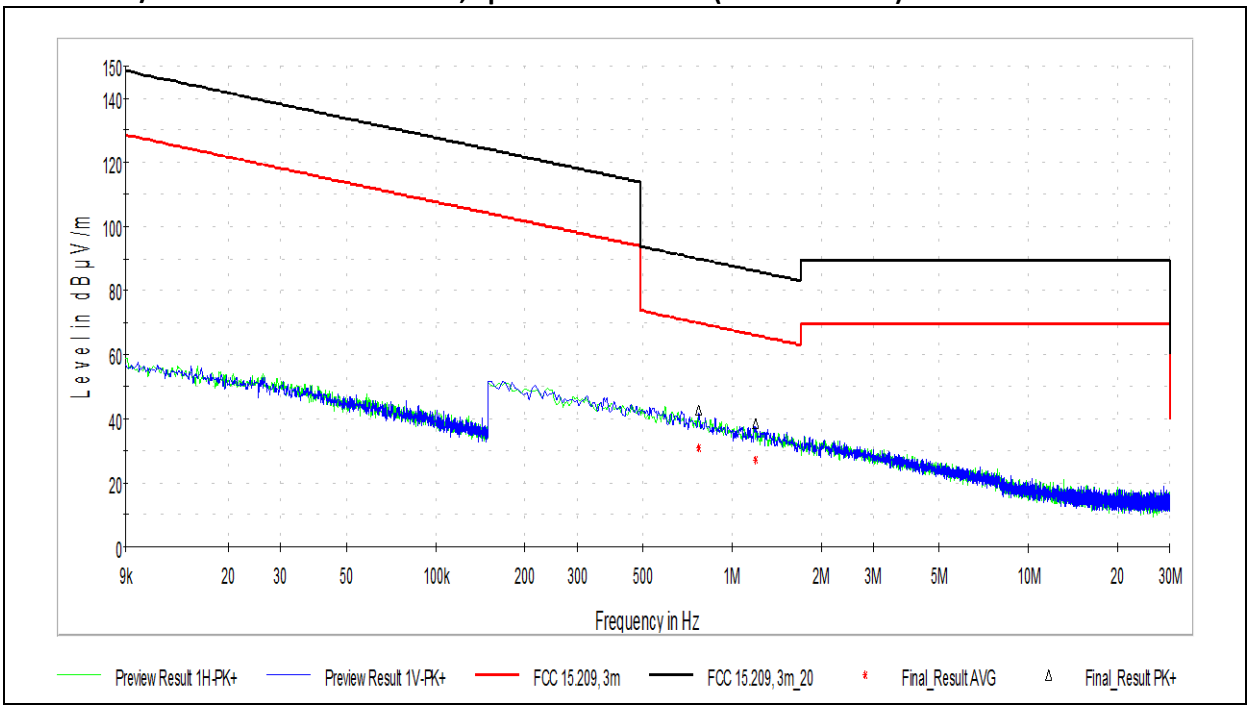
Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
345	74.879	77.26	2.381	120	100	H	92	25.31
345	69.986	77.26	7.274	120	175	V	47	25.31

Average measurements are calculated from peak measurements and the application of the duty cycle correction factor.

Test Personnel:	Bryan Taylor	Test Date:	9/4/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	15.231
Product Standard:	FCC Part 15C, RSS-210	Ambient Temperature:	25.3 °C
Input Voltage:	3VDC	Relative Humidity:	52.0 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	986.1 mbar

Deviations, Additions, or Exclusions: None

10.8 Plots/Data: Radiated Emissions, Spurious Emissions (9kHz – 30MHz)



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB)
0.768949	42.84	89.90	47.06	9.000	136.0	12.6
1.199140	38.46	86.05	47.59	9.000	309.0	12.7

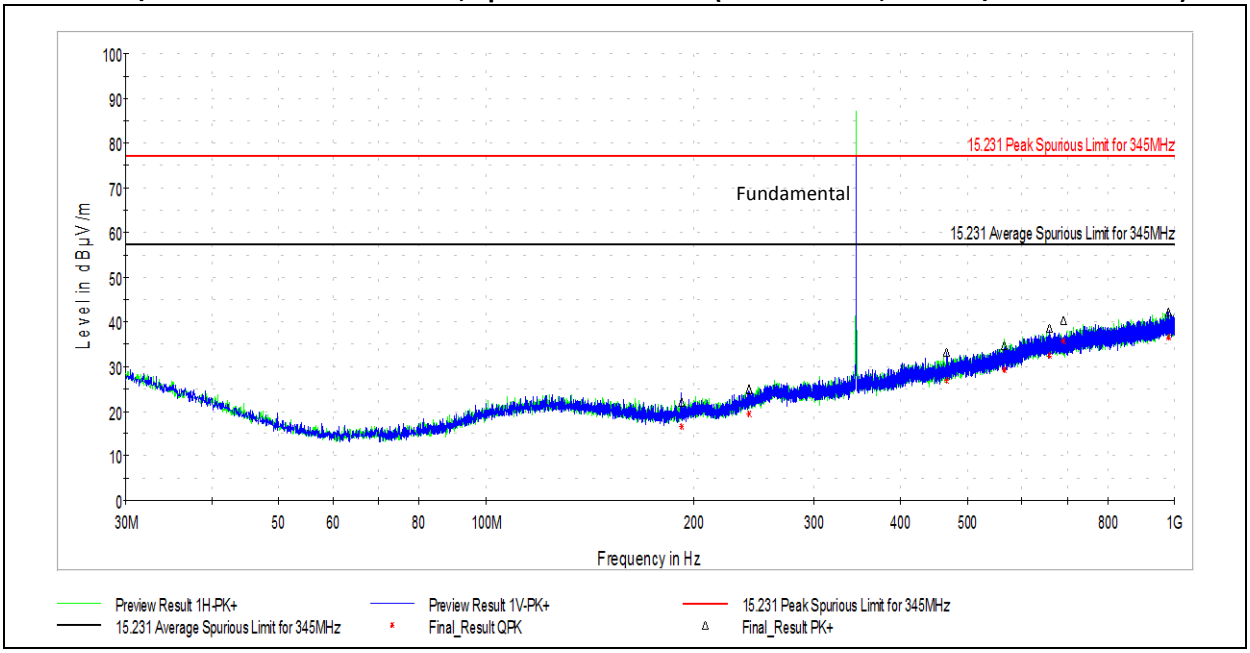
Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB)
0.768949	28.49	69.9	41.41	9.000	136	12.6
1.19914	24.11	66.05	41.94	9.000	309	12.7

Average measurements are calculated from peak measurements and the application of the duty cycle correction factor.

Test Personnel:	Bryan Taylor	Test Date:	9/8/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	15.209
Product Standard:	FCC Part 15C, RSS-210	Ambient Temperature:	26.6 °C
Input Voltage:	3VDC	Relative Humidity:	40.7 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	997.8 mbar

Deviations, Additions, or Exclusions: The results obtained above were measured in a 10m semi-anechoic chamber which has been correlated to measurements on an open area site.

10.9 Plots/Data: Radiated Emissions, Spurious Emissions (30MHz-1GHz, 15.231 / RSS-210 Limits)



Frequency (MHz)	MaxPeak (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
192.313333	22.09	77.26	55.17	120	104.9	V	190.0	18.8
241.244445	24.95	77.26	52.31	120	178.0	V	244.0	21.8
466.446111	33.27	77.26	43.99	120	400.0	V	292.0	28.7
565.655556	34.67	77.26	42.59	120	153.7	H	311.0	30.9
658.182778	38.58	77.26	38.68	120	178.2	V	7.0	32.5
690.031111	40.29	77.26	36.97	120	107.1	H	145.0	32.7
980.330556	42.28	77.26	34.98	120	400.0	V	109.0	36.4

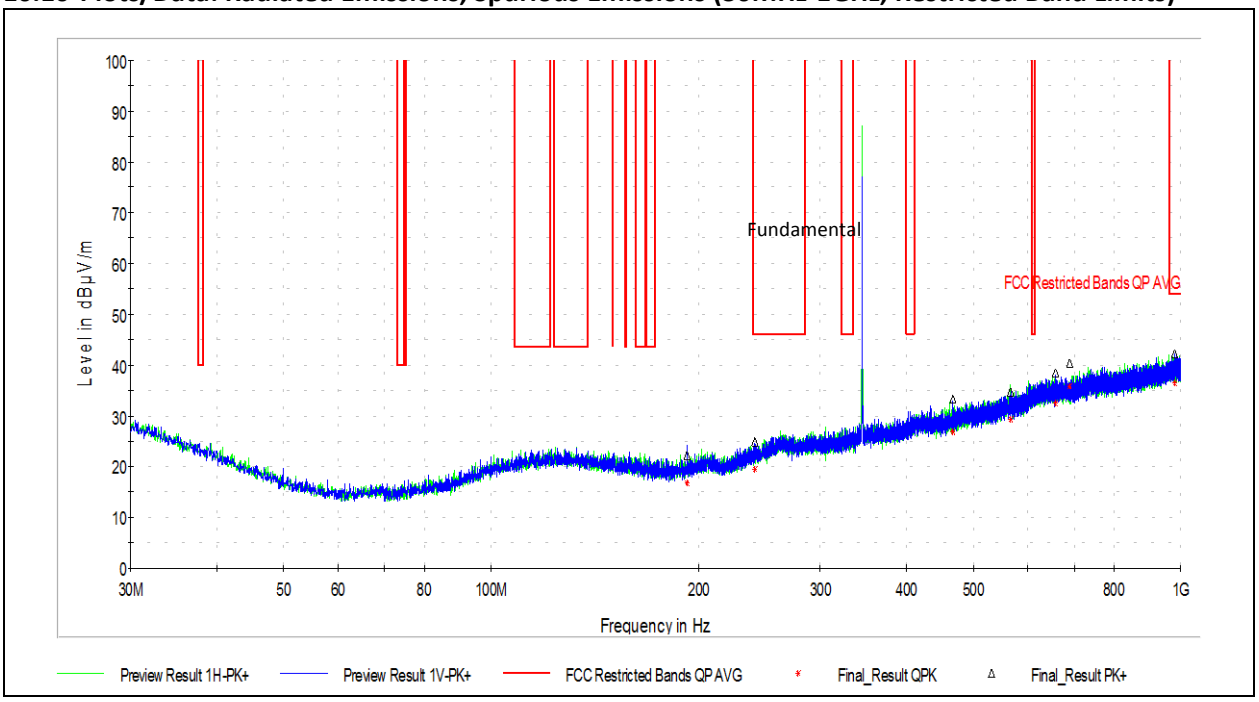
Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
192.3133	7.74	57.26	49.52	120	104.9	V	190	18.8
241.2444	10.6	57.26	46.66	120	178	V	244	21.8
466.4461	18.92	57.26	38.34	120	400	V	292	28.7
565.6556	20.32	57.26	36.94	120	153.7	H	311	30.9
658.1828	24.23	57.26	33.03	120	178.2	V	7	32.5
690.0311	25.94	57.26	31.32	120	107.1	H	145	32.7
980.3306	27.93	57.26	29.33	120	400	V	109	36.4

Average measurements are calculated from peak measurements and the application of the duty cycle correction factor.

Test Personnel:	Bryan Taylor	Test Date:	9/4/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	15.231
Product Standard:	FCC Part 15C, RSS-210	Ambient Temperature:	25.3 °C
Input Voltage:	3VDC	Relative Humidity:	52.0 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	986.1 mbar

Deviations, Additions, or Exclusions: None

10.10 Plots/Data: Radiated Emissions, Spurious Emissions (30MHz-1GHz, Restricted Band Limits)



Frequency (MHz)	MaxPeak (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
980.330556	42.28	74.00	31.72	120	400.0	V	109.0	36.4

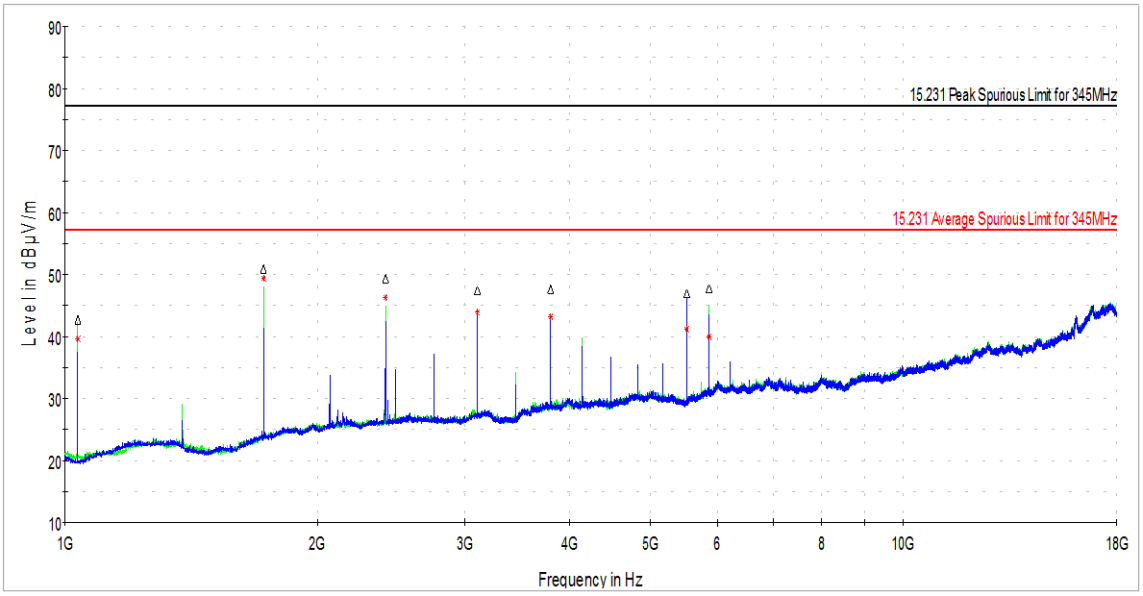
Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
980.3306	27.93	54.00	26.07	120	400	V	109	36.4

Average measurements are calculated from peak measurements and the application of the duty cycle correction factor.

Test Personnel:	Bryan Taylor	Test Date:	9/4/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Restricted Band Limits
Product Standard:	FCC Part 15C, RSS-210	Ambient Temperature:	25.3 °C
Input Voltage:	3VDC	Relative Humidity:	52.0 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	986.1 mbar

Deviations, Additions, or Exclusions: None

10.11 Plots/Data: Radiated Emissions, Spurious Emissions (1GHz – 18GHz, 15.231 / RSS-210 Limits)



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1034.500000	42.60	77.26	34.66	1000	274.0	H	64.0	-3.1
1725.000000	50.84	77.26	26.42	1000	261.0	H	36.0	0.5
2415.000000	49.30	77.26	27.96	1000	350.0	H	29.0	3.8
3105.000000	47.46	77.26	29.80	1000	294.0	V	222.0	5.2
3795.000000	47.64	77.26	29.62	1000	326.0	V	224.0	6.7
5520.000000	46.90	77.26	30.36	1000	323.0	V	118.0	9.2
5865.000000	47.86	77.26	29.40	1000	394.0	H	204.0	10.0

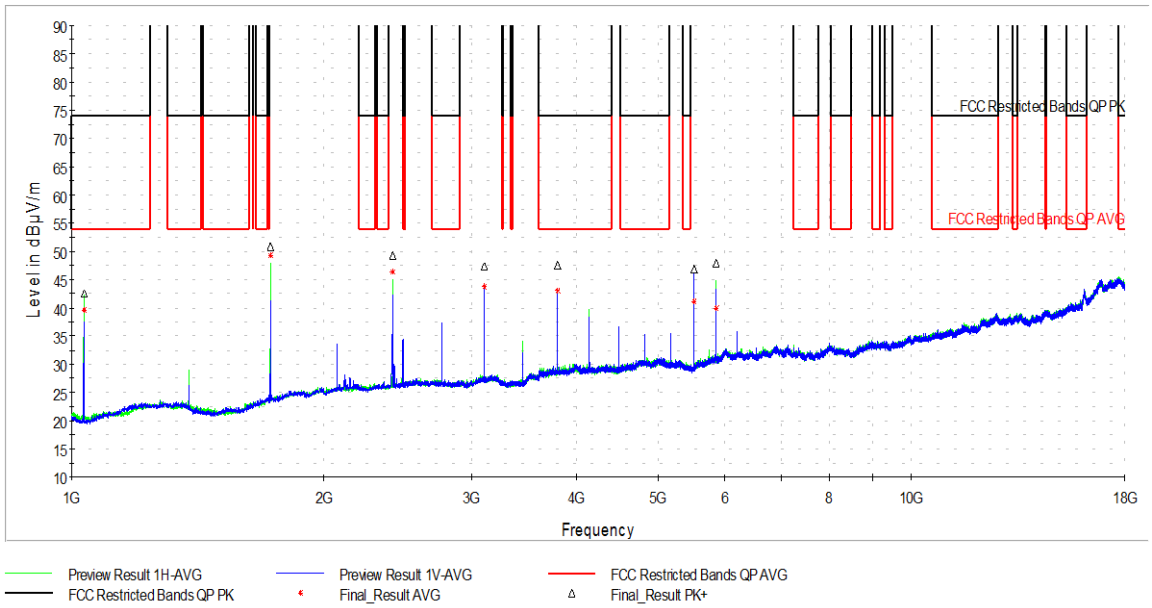
Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1034.5	28.25	57.26	29.01	1000	274	H	64	-3.1
1725	36.49	57.26	20.77	1000	261	H	36	0.5
2415	34.95	57.26	22.31	1000	350	H	29	3.8
3105	33.11	57.26	24.15	1000	294	V	222	5.2
3795	33.29	57.26	23.97	1000	326	V	224	6.7
5520	32.55	57.26	24.71	1000	323	V	118	9.2
5865	33.51	57.26	23.75	1000	394	H	204	10

Average measurements are calculated from peak measurements and the application of the duty cycle correction factor.

Test Personnel:	Bryan Taylor	Test Date:	9/4/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	15.231
Product Standard:	FCC Part 15C, RSS-210	Ambient Temperature:	25.3 °C
Input Voltage:	3VDC	Relative Humidity:	52.0 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	986.1 mbar

Deviations, Additions, or Exclusions: None

10.12 Plots/Data: Radiated Emissions, Spurious Emissions (1GHz – 18GHz, Restricted Band Limits)



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1034.500000	42.60	74.00	31.40	1000	274.0	H	64.0	-3.1
3795.000000	47.64	74.00	26.36	1000	326.0	V	224.0	6.7

Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1034.5	28.25	54.00	25.75	1000	274	H	64	-3.1
3795	33.29	54.00	20.71	1000	326	V	224	6.7

Average measurements are calculated from peak measurements and the application of the duty cycle correction factor.

Test Personnel:	Bryan Taylor	Test Date:	9/4/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Restricted Band Limits
Product Standard:	FCC Part 15C, RSS-210	Ambient Temperature:	25.3 °C
Input Voltage:	3VDC	Relative Humidity:	52.0 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	986.1 mbar

Deviations, Additions, or Exclusions: None

11 Antenna Requirement per FCC Part 15.203

11.1 Test Limits

§ 15.203: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

11.2 Results:

The sample tested met the antenna requirement. The antenna used was permanently attached to the PCB.

12 Radiated Emissions, (Idle Mode)

12.1 Method

Tests are performed in accordance with ANSI C63.4:2014.

TEST SITE: 10m ALSE

Site Designation: 10m Chamber

12.2 Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG

Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

12.1 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	9/18/2019	9/18/2020
Preamplifier (1-18GHz)	3918	Rohde & Schwarz	TS-PR18	12/6/2019	12/6/2020
Bilog Antenna	40527	Teseq	CBL6112D	6/8/2020	6/8/2021
Horn Antenna (1-18GHz)	3780	ETS	3117	6/18/2020	6/18/2021
System Controller	121701-1	Sunol Sciences	SC99V	Time of Use	Time of Use

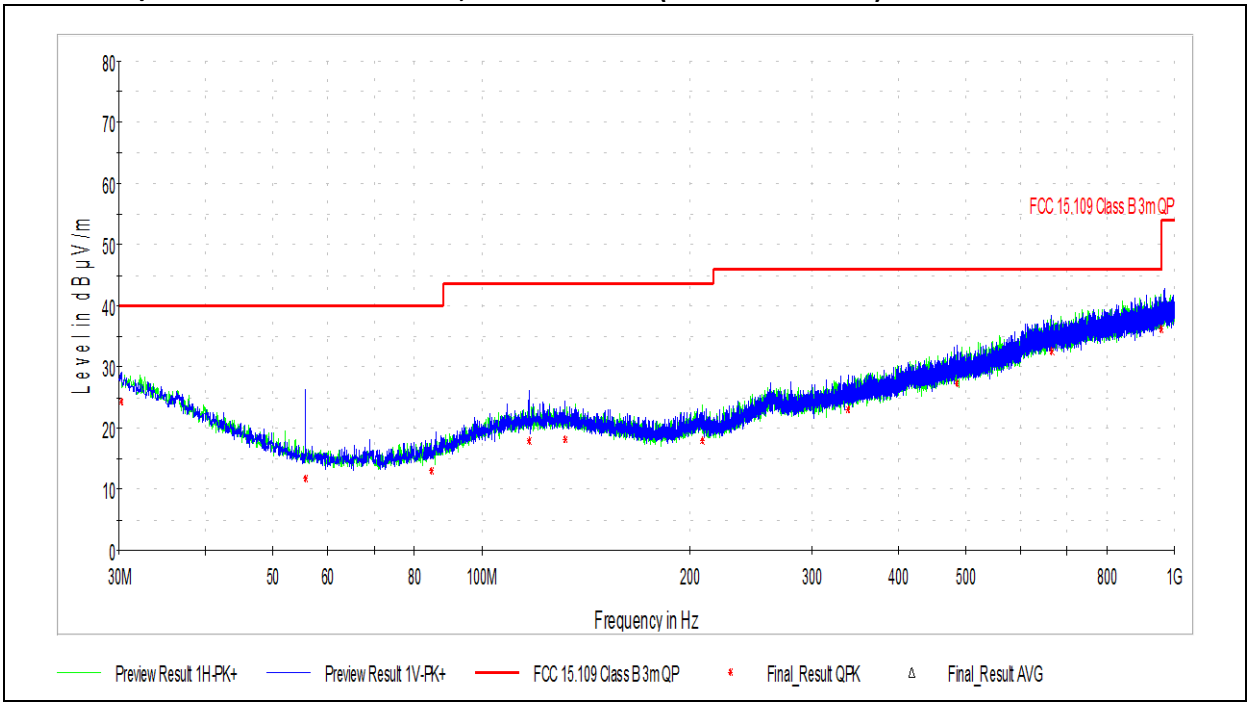
12.2 Software Utilized:

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

12.3 Results:

The sample tested was found to Comply.

12.4 Plots/Data: Radiated Emissions, 30MHz – 1GHz (Transmitters Idle)

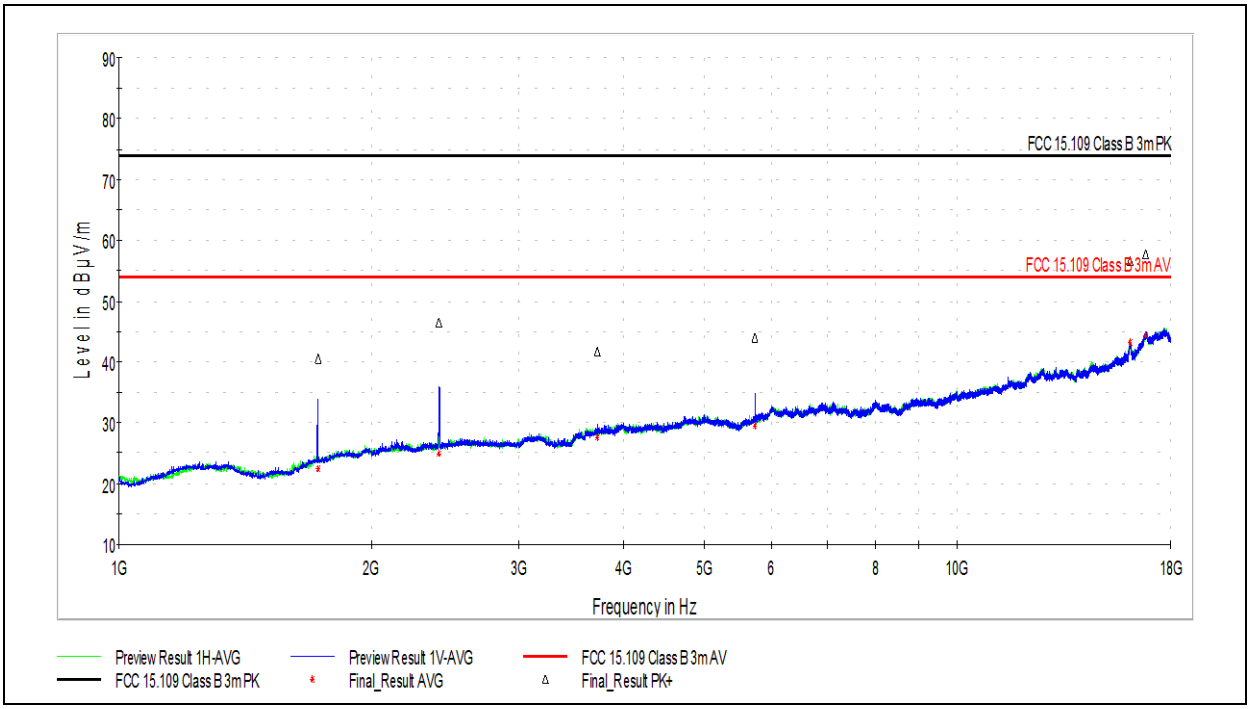


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.215556	24.34	40.00	15.66	120.000	106.3	V	240.0	26.7
55.705000	11.76	40.00	28.24	120.000	100.1	V	147.0	14.5
84.589445	12.99	40.00	27.01	120.000	400.0	V	17.0	16.0
117.030556	17.95	43.52	25.57	120.000	104.9	V	292.0	20.9
132.065556	18.17	43.52	25.35	120.000	118.0	V	167.0	21.0
208.156667	17.86	43.52	25.66	120.000	297.9	H	27.0	19.8
337.813333	23.00	46.02	23.02	120.000	130.6	V	53.0	25.0
485.361111	27.23	46.02	18.79	120.000	400.0	V	82.0	29.0
664.164444	32.49	46.02	13.53	120.000	104.8	V	341.0	32.6
956.942778	36.27	46.02	9.75	120.000	179.4	H	341.0	36.2

Test Personnel:	Bryan Taylor	Test Date:	9/3/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15B, ICES-003	Ambient Temperature:	25.5 °C
Input Voltage:	3VDC	Relative Humidity:	50.6 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	984 mbar

Deviations, Additions, or Exclusions: None

12.5 Plots/Data: Radiated Emissions, 1GHz – 18GHz (Transmitters Idle)



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1729.000000	40.50	73.98	33.48	1000.000	100.0	V	169.0	0.5
2410.000000	46.56	73.98	27.42	1000.000	117.0	V	170.0	3.7
3720.500000	41.63	73.98	32.35	1000.000	100.0	V	270.0	6.6
5742.000000	43.91	73.98	30.07	1000.000	134.0	V	0.0	9.6
16091.000000	56.67	73.98	17.31	1000.000	410.0	H	296.0	25.5
16801.500000	57.79	73.98	16.19	1000.000	100.0	V	333.0	26.1

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1729.000000	22.42	53.98	31.56	1000.000	100.0	V	169.0	0.5
2410.000000	24.81	53.98	29.17	1000.000	117.0	V	170.0	3.7
3720.500000	27.58	53.98	26.40	1000.000	100.0	V	270.0	6.6
5742.000000	29.53	53.98	24.45	1000.000	134.0	V	0.0	9.6
16091.000000	43.16	53.98	10.82	1000.000	410.0	H	296.0	25.5
16801.500000	44.41	53.98	9.57	1000.000	100.0	V	333.0	26.1

Test Personnel:	Bryan Taylor	Test Date:	9/3/2020
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15B, ICES-003	Ambient Temperature:	25.5 °C
Input Voltage:	3VDC	Relative Humidity:	50.6 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	984 mbar

Deviations, Additions, or Exclusions: None

13 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of k = 2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

Parameter	Uncertainty	Notes
Radiated emissions, 30 to 1000 MHz	±4.0dB	
Radiated emissions, 1 to 18 GHz	±4.7dB	
Radiated emissions, 18 to 40 GHz	±4.7dB	
Power Port Conducted emissions, 150kHz to 30 MHz	±2.8dB	

14 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	9/28/2020	104139907LEX-001	BCT	BL	Original Issue