Intertek
731 Enterprise Drive
Lexington, KY 40510

Tel 859 226 1000
Fax 859 226 1040

www.intertek.com

Stress Engineering Services, INC.
TEST REPORT

SCOPE OF WORK
EMC TESTING – IGROWTH GENERATION 2

REPORT NUMBER
104662109LEX-001b

ISSUE DATE

7/7/2021

PAGES
24

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

EMC TEST REPORT

(FULL COMPLIANCE)

Report Number: 104662109LEX-001b
Project Number: G104662109

Report Issue Date: 7/7/2021

Model(s) Tested: iGrowth Generation 2

Standards: FCC Part 15B
FCC Part 15.225
FCC Part 15.215
RSS-210 Issue 10
ICES-003 Issue 7

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

Client:
Stress Engineering Services, INC.
7030 Stress Engineering Way
Mason, OH 45040
USA

Report prepared by

Brandon Norris,
Engineer

Report reviewed by

Bryan Taylor,
Team Leader

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

Section	Test full name	Result
6	Radiated Emissions (Transmitters Idle) (ANSI C63.4:2014)	Pass
7	Radiated Spurious Emissions (Transmitters Active) (ANSI C63.10:2013, RSS-210 Issue 10)	Pass
8	Conducted Emissions (ANSI C63.10:2013, ANSI C63.4:2014)	Pass
9	Frequency Stability (ANSI C63.10:2013, RSS-210-Issue 10)	Pass
10	Occupied Bandwidth (ANSI C63.10:2013, RSS-Gen Issue 5)	Pass
11	Antenna Requirement (FCC Part 15.203, RSS-Gen Issue 5)	Pass

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Stress Engineering Services, INC.
Address:	7030 Stress Engineering Way Mason, OH 45040 USA
Contact:	Joe Bullard
Email:	Joseph.bullard@stress.com
Manufacturer Information	
Manufacturer Name:	Stress Engineering Services, INC.
Manufacturer Address:	7030 Stress Engineering Way Mason, OH 45040 USA

4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	iGrowth Generation 2
Model Number	3284
Serial Number	BT2.0-P00005
Hardware Version	B1
Supported Transmit Bands	B2, B4, B5, B12, B13, B25, B26, RFID 13.56MHz
Embedded Module	Particle B402
Embedded Module hardware Version	1.0.0
Embedded Module Software Version	bsom-at-pass-through@2.0.0+mono
Embedded Module FCCID	2AEMIB402
Test Start Date	6/02/2021
Test End Date	6/14/2021
Device Received Condition	Good
Test Sample Type	Production
Rated Voltage	6VDC
Description of Equipment Under Test (provided by client)	
2nd Generation bathroom tissue consumption monitoring device for consumer research studies.	

4.1 Variant Models:

There were no variant models covered by this evaluation.

5 System Setup and Method

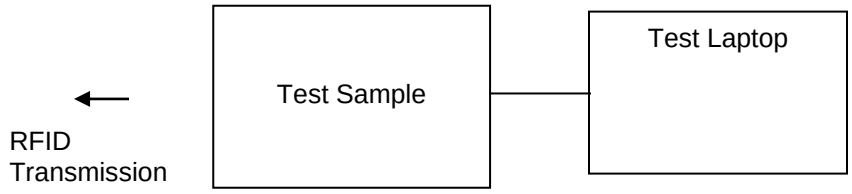
5.1 Method:

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

No.	Descriptions of EUT Exercising
1	During the testing the iGrowth Generation 2 was transmitting a 13.5MHz RFID signal.
2	Idle mode with the RFID radio not transmitting.

Cables					
Qty	Description	Length (m)	Shielding	Ferrites	Termination
1	USB	1	None	None	Test Laptop

5.2 EUT Block Diagram:



6 Radiated Emissions

6.1 Method

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

TEST SITE: 10m ALSE

Site Designation: 10m Chamber

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	3.9dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.0dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.7dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.7dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

6.2 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

6.3 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/5/2020	10/5/2021
EMI Test Receiver	8131	Rhode & Schwarz	ESW44	1/15/2020	1/15/2022
Bilog Antenna (30MHz-1GHz)	7085	SunAR	JB6	9/4/2020	9/4/2021
Horn Antenna	4001	ETS	3117	6/18/2020	6/18/2021
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			12/21/2020	12/21/2021
3m Cable Preamplifier	3918	Rohde & Schwarz	TS-PR18	12/21/2020	12/21/2021
3m Cable Preamp→Chamber	2588			12/21/2020	12/21/2021
3m Cable Chamber→Control Room	2593			12/21/2020	12/21/2021
3m Cable Control Room→Receiver	2592			12/21/2020	12/21/2021

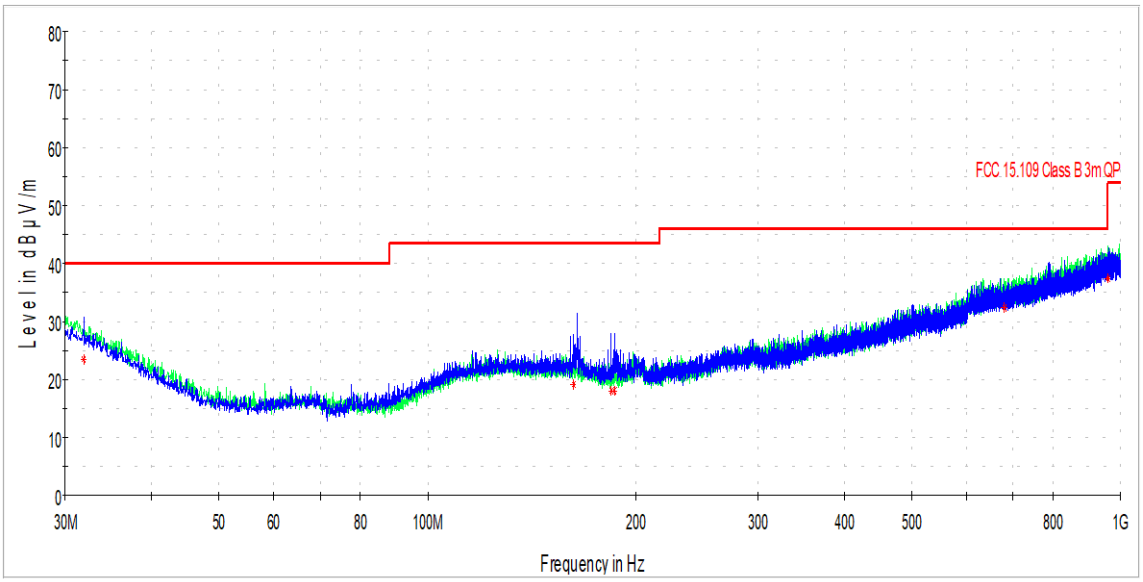
6.4 Software Utilized:

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

6.5 Results:

The sample tested was found to Comply.

6.6 Plots/Data: Radiated Emissions, 30MHz – 1GHz (Transmitter Idle)

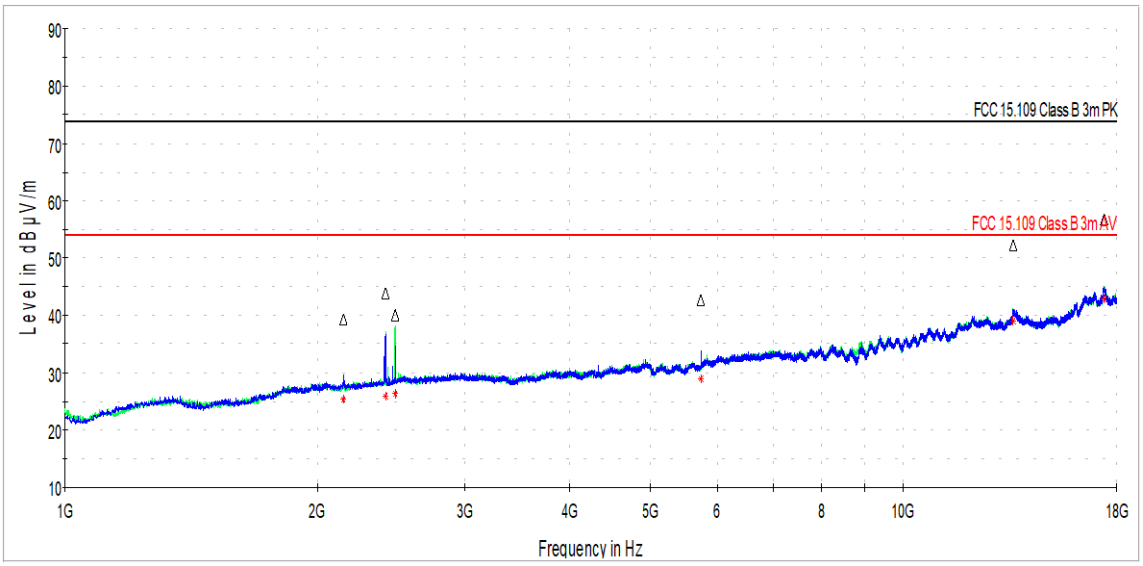


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.940000	23.37	40.00	16.63	120.000	294.0	V	-2.0	26
162.674444	19.08	43.52	24.44	120.000	400.0	V	0.0	22
184.337778	17.96	43.52	25.56	120.000	248.0	V	190.0	20
186.116111	17.98	43.52	25.54	120.000	160.0	V	133.0	20
680.169444	32.42	46.02	13.60	120.000	99.0	H	314.0	33
959.745000	37.47	46.02	8.55	120.000	293.0	H	148.0	38

Test Personnel:	Brandon Norris	Test Date:	6/10/2021
Supervising/Reviewing Engineer: (Where Applicable)	N/A	Limit Applied:	Class B
Product Standard:	FCC Part 15B ICES-003 Issue 7	Ambient Temperature:	23.7 °C
Input Voltage:	6VDC	Relative Humidity:	57.1 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	982.1 mbar

Deviations, Additions, or Exclusions: None
Note: The limits used above are for FCC Part 15B and are more restrictive than the ICES-003 Issue 7 limits.

6.7 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/m)
2149.500000	39.22	73.98	34.76	1000.000	230.0	V	24.0	4
2411.000000	43.78	73.98	30.20	1000.000	293.0	H	320.0	5
2475.000000	39.98	73.98	34.00	1000.000	100.0	H	0.0	6
5737.500000	42.71	73.98	31.27	1000.000	100.0	V	175.0	11
13533.000000	52.10	73.98	21.88	1000.000	100.0	H	190.0	21
17404.500000	56.73	73.98	17.25	1000.000	100.0	H	223.0	25

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2149.500000	25.34	53.98	28.64	1000.000	230.0	V	24.0	4
2411.000000	25.84	53.98	28.14	1000.000	293.0	H	320.0	5
2475.000000	26.23	53.98	27.75	1000.000	100.0	H	0.0	6
5737.500000	28.82	53.98	25.16	1000.000	100.0	V	175.0	11
13533.000000	39.13	53.98	14.85	1000.000	100.0	H	190.0	21
17404.500000	42.90	53.98	11.08	1000.000	100.0	H	223.0	25

Test Personnel:	Brandon Norris	Test Date:	6/10/2021
Supervising/Reviewing Engineer: (Where Applicable)	N/A	Limit Applied:	Class B
Product Standard:	FCC Part 15B ICES-003 Issue 7	Ambient Temperature:	23.9 °C
Input Voltage:	6VDC	Relative Humidity:	55.7 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	982.1 mbar

Deviations, Additions, or Exclusions: None

7 Radiated Emissions (RFID)

7.1 Method

Tests are performed in accordance with ANSI C63.10:2013.

TEST SITE: 10m ALSE

Site Designation: 10m Chamber

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 3m	0.09-30 MHz	3.2dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.0dB	6.3 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

7.2 Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor to the Receiver Amplitude (including preamplifier) 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

7.3 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/5/2020	10/5/2021
Magnetic Loop Antenna	2366	ETS	6502	7/17/2020	7/17/2021
Bilog Antenna	7085	SunAR	JB6	9/4/2020	9/4/2021
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
Coaxial Cable	3339			12/21/2020	12/21/2021
Coaxial Cable	2593			12/21/2020	12/21/2021
Coaxial Cable	2592			12/21/2020	12/21/2021

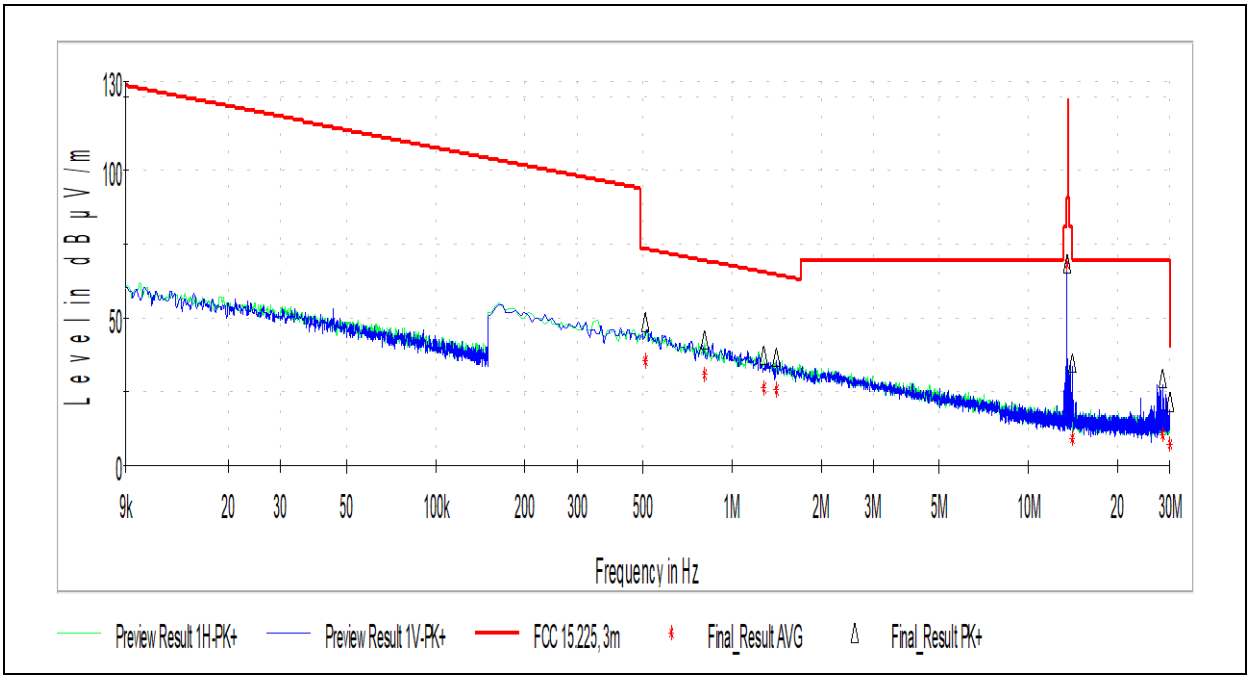
7.4 Software Utilized:

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

7.5 Results:

The sample tested was found to Comply.

7.6 Radiated Spurious Emissions (Below 30MHz)

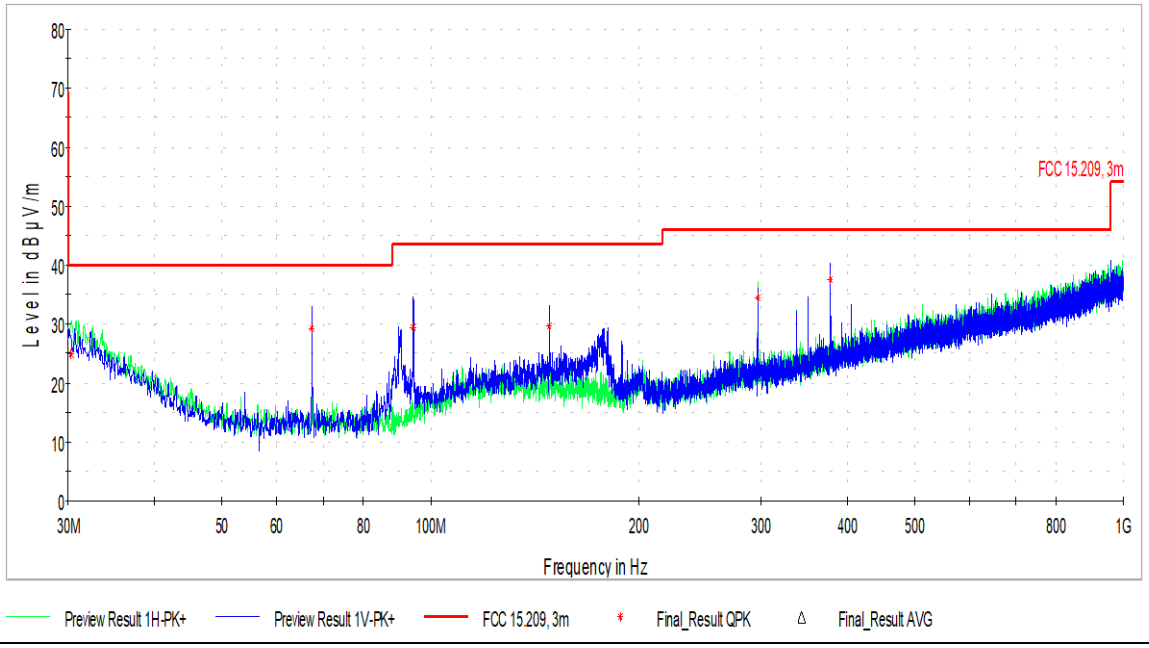


Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB/m)
0.509956	35.61	73.45	37.85	9.000	154.0	12
0.808456	31.17	69.46	38.29	9.000	296.0	12
1.278155	26.58	65.50	38.92	9.000	329.0	12
1.409846	25.65	64.65	39.00	9.000	173.0	12
13.499096	68.32	90.50	22.18	9.000	54.0	11
14.056588	9.18	69.50	60.32	9.000	64.0	11
28.261677	10.75	69.50	58.75	9.000	24.0	9
30.000000	7.51	40.00	32.49	9.000	52.0	9

Test Personnel:	Brandon Norris	Test Date:	6/11/2021
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	FCC Part 15.225
Product Standard:	FCC Part 15C RSS-210 Issue 10	Ambient Temperature:	24.2 °C
Input Voltage:	6VDC	Relative Humidity:	56.1 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	978.7 mbar

Deviations, Additions, or Exclusions: None

7.7 Radiated Spurious Emissions (30MHz – 1GHz)



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.323333	24.91	40.00	15.09	120.000	100.0	H	57.0	29
67.452778	29.32	40.00	10.68	120.000	100.0	V	46.0	15
94.451111	29.34	43.50	14.16	120.000	100.0	V	0.0	18
148.447778	29.64	43.50	13.86	120.000	100.0	V	271.0	22
296.965556	34.33	46.00	11.67	120.000	190.0	H	174.0	24
377.960556	37.54	46.00	8.46	120.000	192.0	V	302.0	26

Test Personnel:	Bryan Taylor	Test Date:	6/4/2021
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	FCC Part 15.209
Product Standard:	FCC Part 15C RSS-210 Issue 10	Ambient Temperature:	24.9 °C
Input Voltage:	6VDC	Relative Humidity:	46.9 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4 mbar

Deviations, Additions, or Exclusions: None

8 Frequency Stability

8.1 Test Limits

FCC Part 15.225:

> (e) The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to + 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

RSS-210 Issue 9 § B.6:

> Carrier frequency stability shall be maintained to ±0.01% (±100 ppm).

8.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

8.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3981	Rohde & Schwarz	FSU	9/22/2020	9/22/2021
Environmental Chamber	2150	Thermotron	SE-600-3-3	2/24/2021	2/24/2022

8.4 Test Results

The sample tested was found to be **compliant**.

8.5 Test Data

Voltage %	Voltage (VDC)	Temp (°C)	Measured Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	Limit (%)
100%	6	-30	13,499,997	-3	0.0000	0.01
100%	6	-20	13,500,037	37	0.0003	0.01
100%	6	-10	13,500,074	74	0.0005	0.01
100%	6	0	13,500,072	72	0.0005	0.01
100%	6	10	13,500,050	50	0.0004	0.01
100%	6	20	13,500,021	21	0.0002	0.01
100%	6	30	13,499,967	-33	-0.0002	0.01
100%	6	40	13,499,925	-75	-0.0006	0.01
100%	6	50	13,499,901	-99	-0.0007	0.01
115%	6.9	20	13,499,990	-10	-0.0001	0.01
85%	5.1	20	13,499,984	-16	-0.0001	0.01

Test Personnel:	Brandon Norris	Test Date:	6/3/2021
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.225 RSS-210 Issue 9	Ambient Temperature:	22.5C
Input Voltage:	6VDC	Relative Humidity:	41.1%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	984.6mbar

Deviations, Additions, or Exclusions: None

9 Occupied Bandwidth

9.1 Test Limits

15.215(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

9.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

9.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3981	Rohde & Schwarz	FSU	9/22/2020	9/22/2021

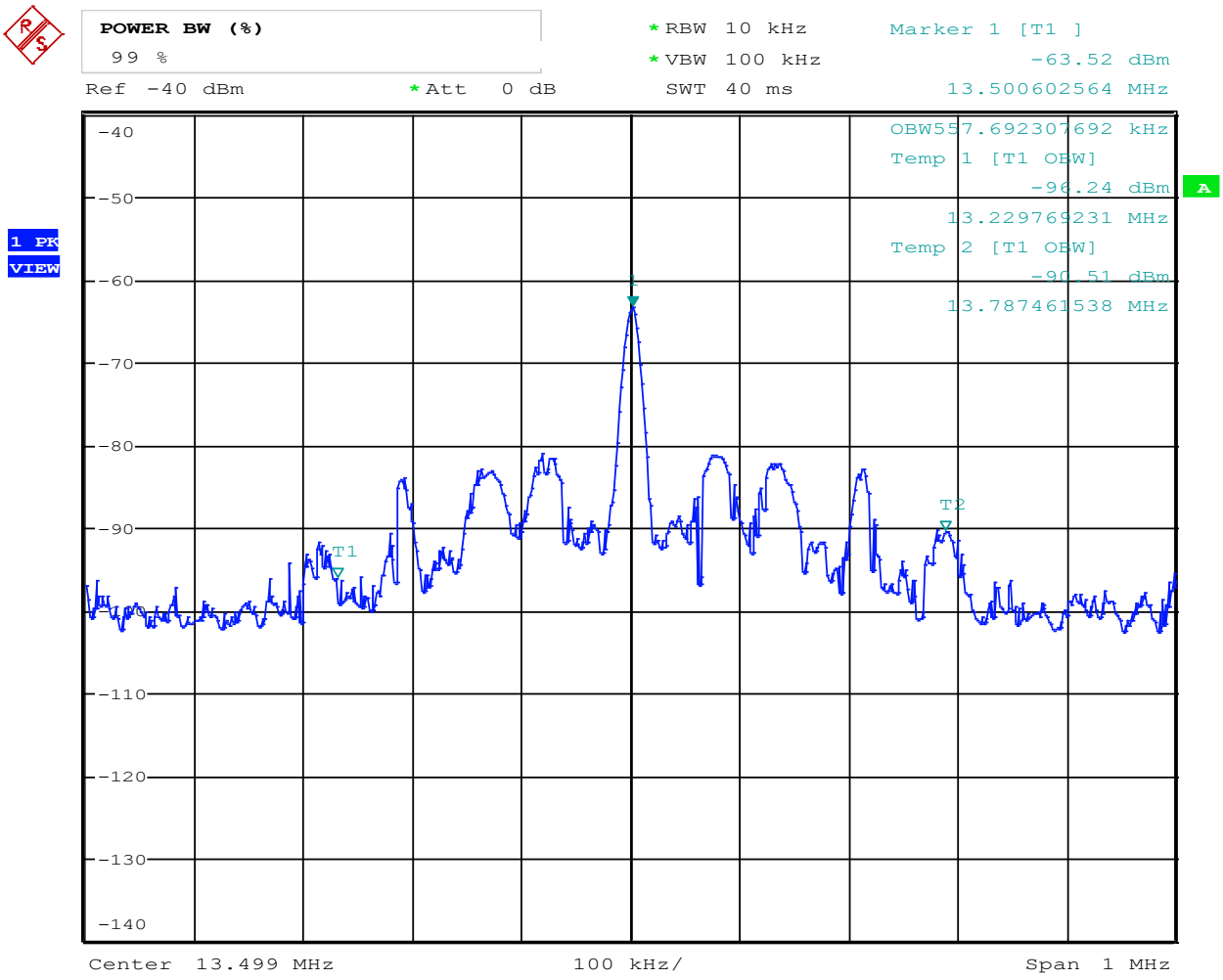
9.4 Test Results

The sample tested was found to be **compliant**. The 99% power bandwidth was measured as was the 20dB down bandwidth. The 20dB bandwidth was entirely within the transmit band 13.11MHz – 14.01MHz as required by FCC Part 15.215.

9.5 Test Data

RBW	VBW	99% BW
10kHz	100kHz	557.69kHz

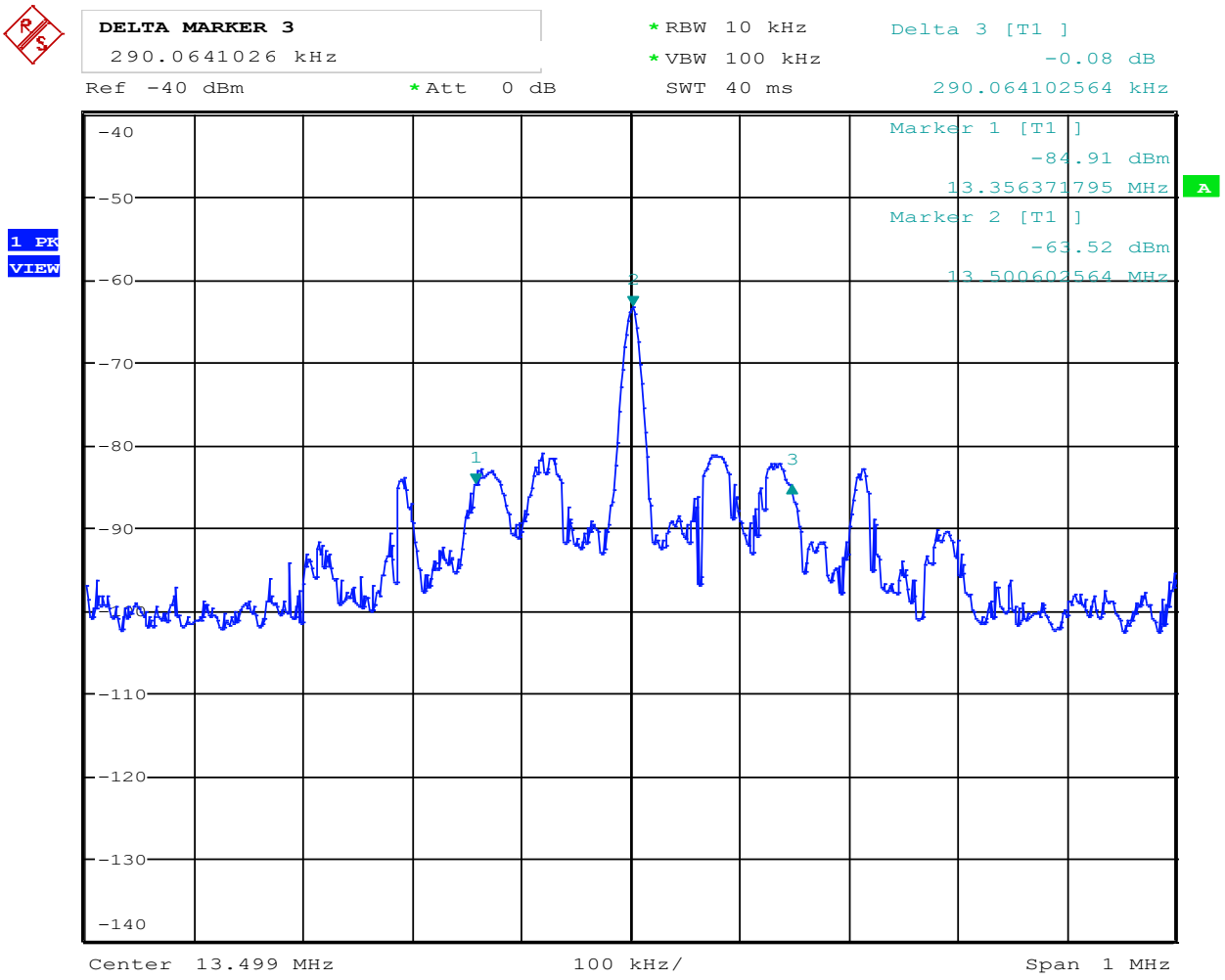
99% Occupied Bandwidth



Test Personnel:	Brandon Norris	Test Date:	6/3/2021
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	RSS-210 Issue 9	Ambient Temperature:	24.7 °C
Input Voltage:	6VDC	Relative Humidity:	45.9 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	978.6 mbar

Deviations, Additions, or Exclusions: None

RBW	VBW	20dB BW
10kHz	100kHz	290.06kHz



Date: 3.JUN.2021 20:21:48

20dB Bandwidth

Test Personnel:	Brandon Norris	Test Date:	6/3/2021
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.215c	Ambient Temperature:	24.7 °C
Input Voltage:	6VDC	Relative Humidity:	45.9 %
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	978.6 mbar

Deviations, Additions, or Exclusions: None

10 Antenna Requirement

10.1 Test Limits

FCC Part 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, 15.221, or §15.236. 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.

RSS-Gen Issue 5 § 6.8:

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the license-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

License-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the license-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of license-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

10.2 Test Results

The device was found to be **compliant**. The device uses a permanently attached antenna.

11 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	7/7/2021	104662109LEX-001b	BN	BCT	Original Issue