Helios Sports, Inc.

Report of FCC and ISED Canada Intentional Radiator Testing

Prepared For:	***Bill Near***
Company	***Helios Sports, Inc.***
Applicable Models	***Helios Core (HC1)***
Test Laboratory	***Core Compliance Testing Services, LLC 79 River Road Hudson, NH 03051***
Test Dates	**October 13 – November 18, 2020**
Tested & Reviewed By	***Ken MacGrath, Manager*** ***George Correia, Test Engineer***
Signature, Manager	
Signature, Test Engineer	

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1.0 GENERAL INFORMATION

1.1 Product Description

Equipment Under Test (EUT): Helios Core (HC1)

Manufacturer: Helios Sports, Inc.
Applicable Models: Helios Core (HC1)
Serial Number: 12C841B8 (BLE Identifier)
Power Supply: (1) Lithium Ion coin cell, 3.7V, 125mAh

EUT Technical Specifications:

A) Channels, Operating Frequency and Modulation

Tested Channel	Operating Frequency (MHz)	Modulation Type
1	2402	GFSK
2	2440	GFSK
3	2480	GFSK

B) Rated output power: 1.208 milliwatts (+0.82 dBm). Refer to section 4.0 of this report.

C) Antenna Designation: PCB trace antenna based on a Texas Instruments 2.4GHz inverted F antenna. It is non-user replaceable (fixed), 3.3dBi (max).

D) This report documents the results for the Helios Core (HC1) device which is a wearable sensor and communications device.

E) FCC ID: 2AXW5-HC1
IC ID: 26567-HC1

F) Maximum Permissible Exposure (MPE): The EUT meets the MPE requirements by exclusion with reference to FCC Part 2.1091 for mobile devices and FCC KDB 447498 D01 General RF Exposure Guidance v06, and FCC KDB 865664 D02 RF Exposure Reporting v01r02 and per RSS-102, Issue 5, March 2015, Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), Section 2.5.1 and 2.5.2.

1.2 Applicable Documents and Standards

This test report is based on the following standards.

- FCC CFR47, Part 15, Subpart C, Section 15.247
- FCC CFR47, Part 15, Subpart C, Section 15.209
- Industry Canada RSS-247, Issue 2, February 2017, Spectrum Management and Telecommunications, Radio Standards Specification, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices
- RSS-GEN, Issue 5, March 2019, Amendment 1, Spectrum Management and Telecommunications, Radio Standards Specification, General Requirements for Compliance of Radio Apparatus
- ANSI C63.10: 2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- ANSI C63.4: 2014

Maximum Permissible Exposure

- FCC Part 2.1091, Radiofrequency radiation exposure evaluation: mobile devices
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 865664 D02 RF Exposure Reporting v01r02
- RSS-102, Issue 5, March 2015, Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), Section 2.5

1.3 Test Dates

October 13 – November 18, 2020

1.4 Test Methodology

Testing was done according to the standards listed in section 1.2. Radiated testing was performed at an antenna-to-EUT distance of 3-meters.

1.5 Test Facility

The Alternative Open Area Test Site (OATS) and ferrite lined shielded chamber used to collect the radiated emissions data is located at Core Compliance Testing Services, 79 River Road, Hudson, NH. Radiated prescans are done in the ferrite lined shielded chamber and all final radiated emissions testing is done in the OATS which conforms to the site attenuation characteristics defined by ANSI C63.4-2014, MP5 and OST-55. The test facility is A2LA accredited to ISO 17025 (certificate # 2778.01) and is an ISED Canada registered wireless test site (site # 11794A-1).

1.6 Test Equipment List

All equipment used in the testing process has up to date calibrations traceable to the National Institute of Standards and Technology (NIST). Refer to the Table 1 below for a complete list of equipment used during the test.

Table 1: Test Equipment

Asset #	Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
3	Preamplifier 8447F OPT H64	Agilent/HP	8447F-H64	3113A07400	12/27/19	12/27/21
15	Horn Antenna	EMCO	3115	9906-5841	N/A	N/A
17	Antenna, Bilog (Green)	Schaffner-Chase	CBL6112B	2602	1/7/19	1/17/21
17a	Attenuator, 4db Pad	Huber-Suhner	6804.17. A	1001701788		
18	Antenna, Bilog (Yellow)	Chase	CBL6140	1041	N/A	N/A
19	Pre-amplifier	HP/Agilent	08449B	3008A01322	3/2/20	3/2/22
23	Cable, 25 meters (Violet)	MegaPhase	GC29-N1N1-984	N/A	9/24/2020	9/24/2022
30	Semi-Anechoic chamber	Keene Ray Proof	N/A	8298	11/13/20	11/13/21
84	Spectrum Analyzer	Agilent	E4407B	US41192608	12/28/19	12/28/21
103	Loop Antenna	Com-Power	AL-130	121056	5/6/20	5/6/22
109	Alternative Open Area Test Site	Strongwell	10 Meter	None	10/6/20	10/6/22
114	Humidity Alert	Control Company	4040	122171578	9/25/20	9/25/21
126	DRG Horn Antenna 700M-18GHz	A.H. Systems	SAS-571	782	5/6/20	5/6/22
133	Horn Antenna 15-26.5 GHz	Schwarzbeck	BBHA9170	9170	7/24/19	7/24/21
134	Temperature/Humidity/ Pressure Meter	Extech	SD700	A075084	12/3/18	12/3/20
135	Single Line LISN	Teseq	NNB51	43204	2/4/20	2/4/21
136	Cable, 3.6m	W.L. Gore	0XQ01Q01144.0	364760	12/27/19	12/27/21
161	Receiver	Rohde & Schwarz	ESW44	101604	5/18/20	6/10/21
151	Preamplifier	HP	8447D	2944A06316	N/A	N/A
154	N-Type Cable, 8m (Green)	Utiflex	Micro-coax	N/A	12/3/2019	12/3/2020

All equipment used for testing has been calibrated according to methods and procedures defined by the National Institute of Standards and Technology (NIST).

1.7 Measurement Uncertainty

10m Site Radiated Emissions up to 1GHz, Expanded Uncertainty	3.94
3m Site Radiated Emissions up to 1GHz, Expanded Uncertainty	3.51
3m Site Radiated Emissions 1-18GHz, Expanded Uncertainty	3.71
Conducted Emissions up to 30MHz, Expanded Uncertainty	1.83
Telco Conducted Emissions up to 30MHz, Expanded Uncertainty	1.85

The measurement uncertainty of radiated emissions data is based on the test equipment used and the OATS site attenuation data. The measurement uncertainty of conducted emissions and Telco conducted emissions data is based on the test equipment used.

1.8 Equipment Modifications

The firmware was modified to provide continuous transmit at maximum power (+5 dBm) with BLE modulation at 1Mbps and 2Mbps data rates applied at the low (2402MHz), middle (2440MHz), and high (2480MHz) channels.

2.0 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing was based on the requirements as given in the applicable standards and was operated in a manner which intends to maximize its emissions characteristics in a continuous transmit application as detailed in section 2.2.

For Conducted Emissions, a Motorola SPN5970A Power Adapter was connected to a Choetech Model T511-S Fast Wireless Charging Pad. A Helios Core (HC1) was placed on the charging pad during the conducted emissions measurements.

2.2 EUT Exercise

The EUT has been tested under operating conditions and was programmed to allow it to remain in continuous transmitting mode.

Voltage variation testing was initially done to determine the worst case voltage in the 3.7 – 4.2 VDC battery range. The voltage was varied by charging the unit fully and then letting it discharge to lower voltages. The test was done at the low channel which gave the highest measured output of all the channels. The following data was recorded and the worst case of 4.2VDC (fully charged) was used for all subsequent testing given in this report.

Power Supply Voltage (VDC)	Channel Frequency (MHz)	Measured Output (dBµV)
3.7	2402	94.1
3.9	2402	94.3
4.2	**2402**	**94.4**
4.2	2440	94.2
4.2	2480	92.4

Testing with and without an accessory strap was done to determine the worst case emissions. It was determined that without the strap gave slightly higher readings. All subsequent testing of the EUT was done without the strap.

Power Supply Voltage (VDC)	Channel Frequency (MHz)	Without Strap Measured Output (dBµV)	With Strap Measured Output (dBµV)
4.2	2402	**92.4**	91.5
4.2	2402	**94.2**	93.8
4.2	2402	**94.4**	94.0

The EUT was operated as follows:

Transmit Channel	Transmit Freq. (MHz)	Transmit Power Level	Test Mode	Modulation
Low	2402	+5dBm (max)	BLE mode @ 1Mbps data rate	GFSK
	2402	+5dBm (max)	BLE mode @ 2Mbps data rate	GFSK
Mid	2440	+5dBm (max)	BLE mode @ 1Mbps data rate	GFSK
	2440	+5dBm (max)	BLE mode @ 2Mbps data rate	GFSK
High	2480	+5dBm (max)	BLE mode @ 1Mbps data rate	GFSK
	2480	+5dBm (max)	BLE mode @ 2Mbps data rate	GFSK

3.0 SUMMARY OF TEST RESULTS

Table 2: Test Summary

Rules	Description Of Test	Test Report Section	Result
FCC 15.247 (b) (3) RSS-247, 5.4 (d)	Peak Output Power (1 W)	4.0	*Pass*
FCC 15.247 (a) (2) RSS-247, 5.2 (a)	6dB Bandwidth (≥500kHz)	5.0	*Pass*
FCC 15.247 (d) RSS-247, 5.5	100 kHz Band Edge Measurements	6.0	*Pass*
FCC 15.247 (e) RSS-247, 5.2 (b)	Peak Power Spectral Density (8dBm/3kHz)	7.0	*Pass*
FCC 15.209 (a) - (f) RSS-GEN, 8.9	Unintentional/Spurious Emissions	8.0	*Pass*
FCC 15.203 FCC 15.247 (4) (i) RSS-GEN, 6.8 RSS-247, 5.4 (f) (ii)	Antenna Requirement	9.0	*Pass*
FCC Part 2.1091 FCC KDB 447498 D01 RSS-102, Issue 5, March 2015, Section 2.5	Maximum Permissible Exposure (MPE)	10.0	*Pass*
FCC 15.207 (a) RSS-GEN, 8.8	Conducted Emissions	N/A	**N/A*

*No connection to AC power.

4.0 PEAK OUTPUT POWER MEASUREMENT

4.1 Applicable Standards

FCC 15.247 (b) (3), RSS-247, 5.4 (d). For systems using digital modulation techniques in the 2400 – 2483.5 MHz band, the maximum peak conducted output power is 1.0 Watt.

4.2 Measurement Procedure

Place the EUT on a 1.5m high polystyrene stand and set it into transmitting mode. Measurements were made with typical modulation applied.

Utilizing the radiated emissions method, the EUT was set up on a three meter OATS. The field strength was maximized by rotating the turntable and adjusting the antenna height. Measurements were further optimized for vertical and horizontal polarization of the receive antenna.

The peak field strength for each transmit frequency was recorded.

To convert field strength at 3 meters to power in Watts, the following formula was

Used: $P = (E \times d)^2 / (30 \times G)$

Where:
P = Power in Watts
E = Field strength in V/m
d = Measurement distance in meters
G = Numerical Gain of Antenna

Repeat the above procedures for each of the low, mid, and high frequency channels.

4.3 Measurement Results Summary

Channel	Frequency (MHz)	Reading (dBµV)	Cable Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Power Calculation (mW)	[2]EIRP (dBm)
Low	2402.000	95.8	9.4	37.8	28.7	96.1	63460	1.0	1.208151	0.82
Mid	2440.000	94.6	9.5	37.8	28.8	95.1	56559	1.0	0.959669	-0.18
High	2480.000	94.1	9.5	37.8	29.0	94.8	54828	1.0	0.901823	-0.45

*Field strength includes cable loss, preamplifier gain, and antenna factor as shown below each of the following plots. The antenna numerical gain was set to 1.0 in the tables in this section because the antenna is an integral part of the EUT and EIRP data was used in the power calculations.

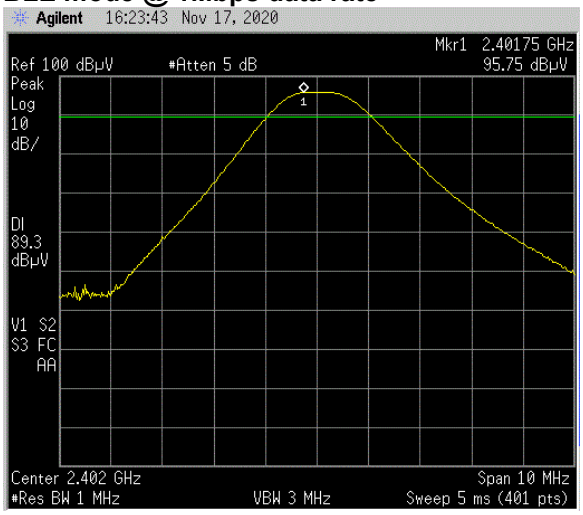
4.4 Peak Output Power Test Results

The peak output power plots are shown on the following pages.

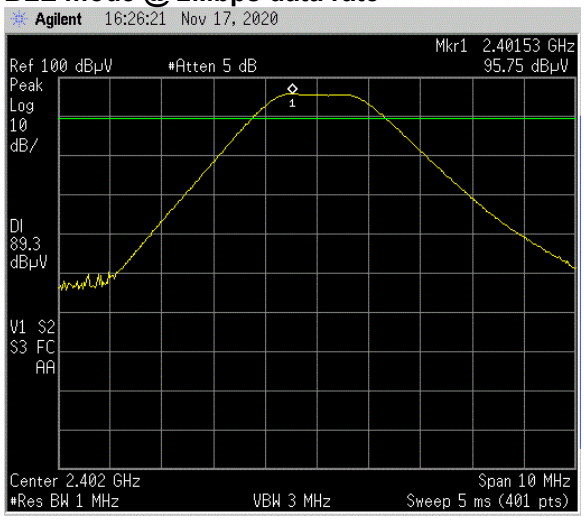
4.4 Peak Output Power Test Results (continued)

Peak Power Output Data Plot (Low – 2402MHz)

BLE mode @ 1Mbps data rate



BLE mode @ 2Mbps data rate



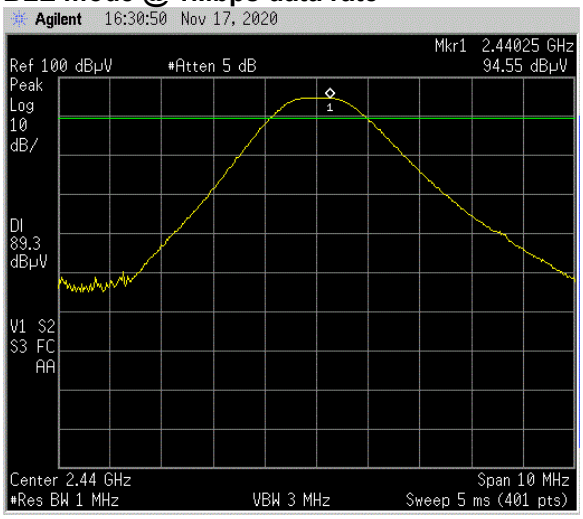
Operating Mode	Channel	Frequency (MHz)	Reading (dBµV)	Cable Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Power Calculation (mW)	[2]EIRP (dBm)
BLE, 1Mbps	Low	2402.000	95.8	9.4	37.8	28.7	96.1	63460	1.0	1.208151	0.82
BLE, 2Mbps	Low	2402.000	95.8	9.4	37.8	28.7	96.1	63460	1.0	1.208151	0.82

*EIRP calculation Ref: 4.2

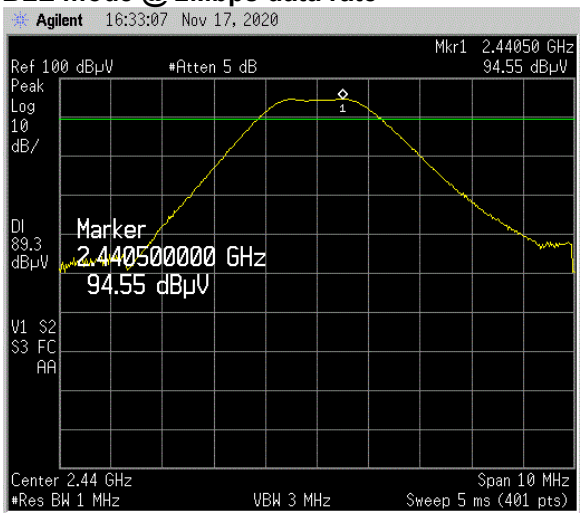
4.4 Peak Output Power Test Results (continued)

Peak Power Output Data Plot (Mid – 2440MHz)

BLE mode @ 1Mbps data rate



BLE mode @ 2Mbps data rate



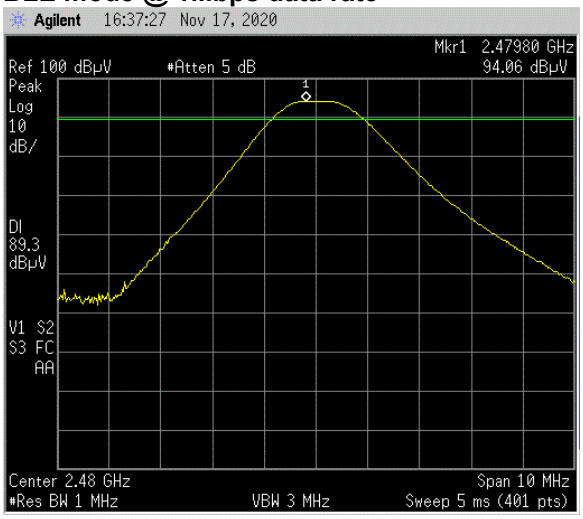
Operating Mode	Channel	Frequency (MHz)	Reading (dBµV)	Cable Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Power Calculation (mW)	[2]EIRP (dBm)
BLE, 1Mbps	Mid	2440.000	94.6	9.5	37.8	28.8	95.1	56559	1.0	0.959669	-0.18
BLE, 2Mbps	Mid	2440.000	94.6	9.5	37.8	28.8	95.1	56559	1.0	0.959669	-0.18

*EIRP calculation Ref: 4.2

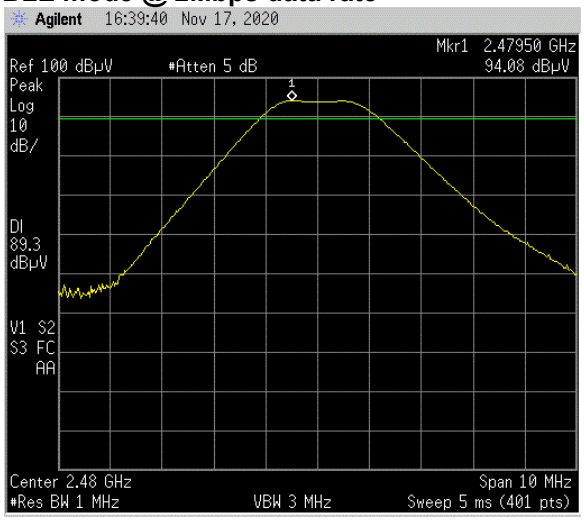
4.4 Peak Output Power Test Results (continued)

Peak Power Output Data Plot (High – 2480MHz)

BLE mode @ 1Mbps data rate



BLE mode @ 2Mbps data rate



Operating Mode	Channel	Frequency (MHz)	Reading (dBµV)	Cable Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Power Calculation (mW)	[2]EIRP (dBm)
BLE, 1Mbps	High	2480.000	94.1	9.5	37.8	29.0	94.8	54702	1.0	0.897679	-0.47
BLE, 2Mbps	High	2480.000	94.1	9.5	37.8	29.0	94.8	54828	1.0	0.901823	-0.45

*EIRP calculation Ref: 4.2

4.5 Peak Output Power Measurement Conclusion

The EUT meets the peak output power requirement of FCC 15.247 (b) (3) and RSS-247, 5.4 (d). The maximum peak power output power was 1.208 mW which is under the 1.0 Watt limit (+30 dBm).

5.0 6dB BANDWIDTH

5.1 Applicable Standards

FCC 15.247 (a) (2), RSS-247, 5.2 (a). For systems using digital modulation techniques in the 2400 – 2483.5 MHz band, the minimum 6 dB bandwidth shall be at least 500 kHz.

5.2 Measurement Procedure

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points that are attenuated by 6 dB, relative to the peak of the fundamental frequency.

These measurements were performed at the low, mid, and high channel frequencies.

5.3 Measurement Results Summary

Channel	Bandwidth (kHz)
1 - Low – 2402MHz	705
2 - Mid – 2440MHz	755
3 - High – 2480MHz	755

Note that the worst case 6dB bandwidth results are given above and these occurred when using BLE mode at 1Mbps data rate.

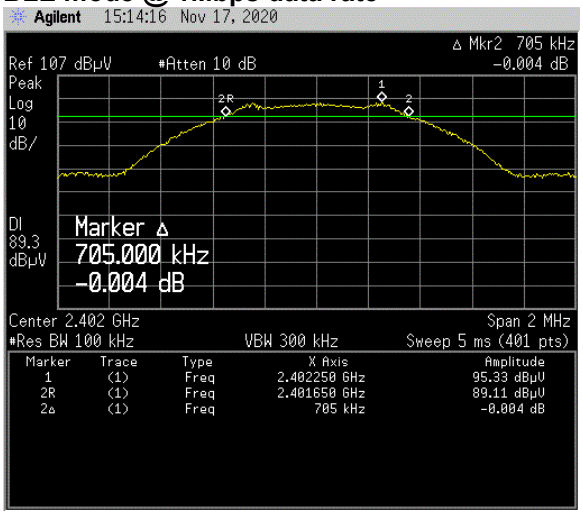
5.4 6dB Bandwidth Test Results

The 6dB bandwidth plots are shown on the following pages.

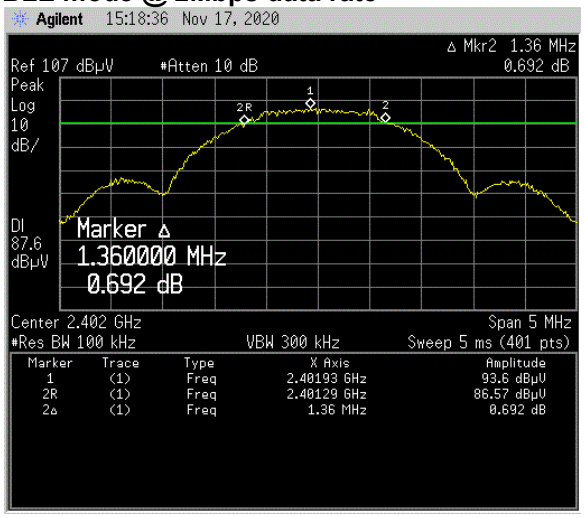
5.4 6dB Bandwidth Test Results (continued)

6dB Bandwidth Data Plot (Low – 2402MHz)

BLE mode @ 1Mbps data rate



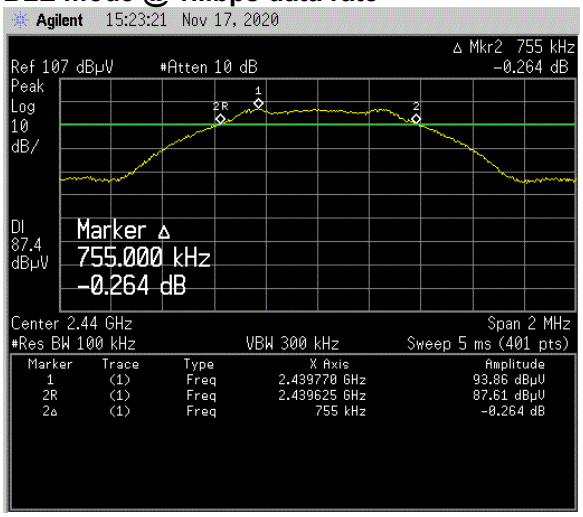
BLE mode @ 2Mbps data rate



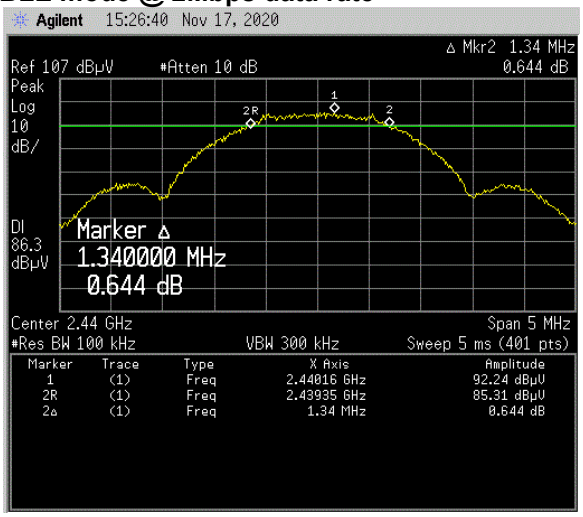
5.4 6dB Bandwidth Test Results (continued)

6dB Bandwidth Data Plot (Mid – 2440MHz)

BLE mode @ 1Mbps data rate



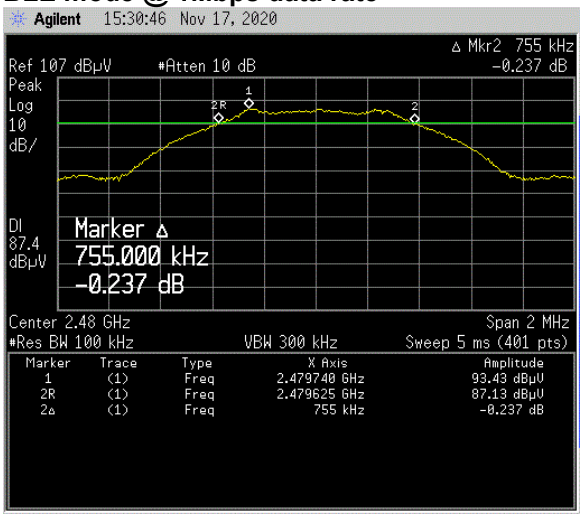
BLE mode @ 2Mbps data rate



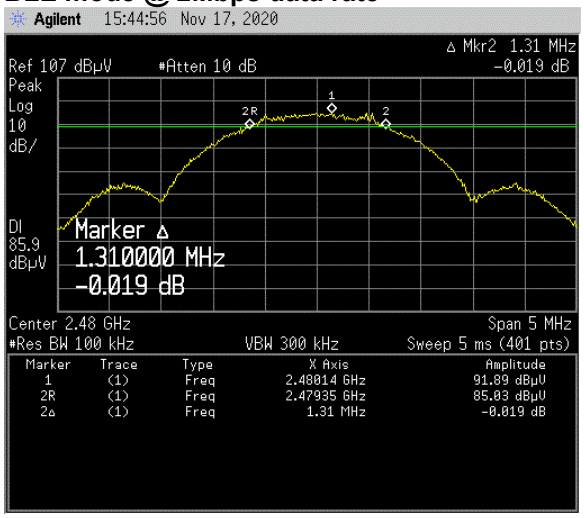
5.4 6dB Bandwidth Test Results (continued)

6dB Bandwidth Data Plot (High – 2480MHz)

BLE mode @ 1Mbps data rate



BLE mode @ 2Mbps data rate



5.5 6dB Bandwidth Measurement Conclusion

The EUT meets the 6dB bandwidth requirements of FCC 15.247 (a) (2) and RSS-247, 5.2 (a). The worst case 6dB bandwidth of the EUT occurred when in BLE mode at a 1Mbps data rate at 2402MHz and was 705kHz which meets the 500kHz minimum bandwidth requirement.

6.0 100kHz BAND EDGE MEASUREMENTS

6.1 Applicable Standards

FCC 15.247 (d), RSS-247, 5.5. In any 100kHz bandwidth outside the frequency bands in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions, which fall in the restricted bands, as defined in FCC 15.205 (a) and RSS-GEN, 8.10, must also comply with the radiated emission limits specified in FCC 15.209 (a) and RSS-GEN, 8.9.

6.2 Measurement Procedure

- Place the EUT on a 1.5m high polystyrene stand and set it in transmitting mode with modulation.
- Set the center frequency of the spectrum analyzer to the operating frequency.
- Set the spectrum analyzer RBW= 100kHz, VBW=300KHz, Span=10MHz, Sweep Auto
- Mark the peak, 2.402 GHz, Low channel and record the maximum level. The lower band edge is 2.400GHz. The upper band edge is 2.4835 GHz.
- Set the delta marker to the next lower frequency of spurious emission outside of the band and record the peak.
- Repeat the above procedures at 2.480 GHz, High channel and measure the next highest spurious emission and record the level.

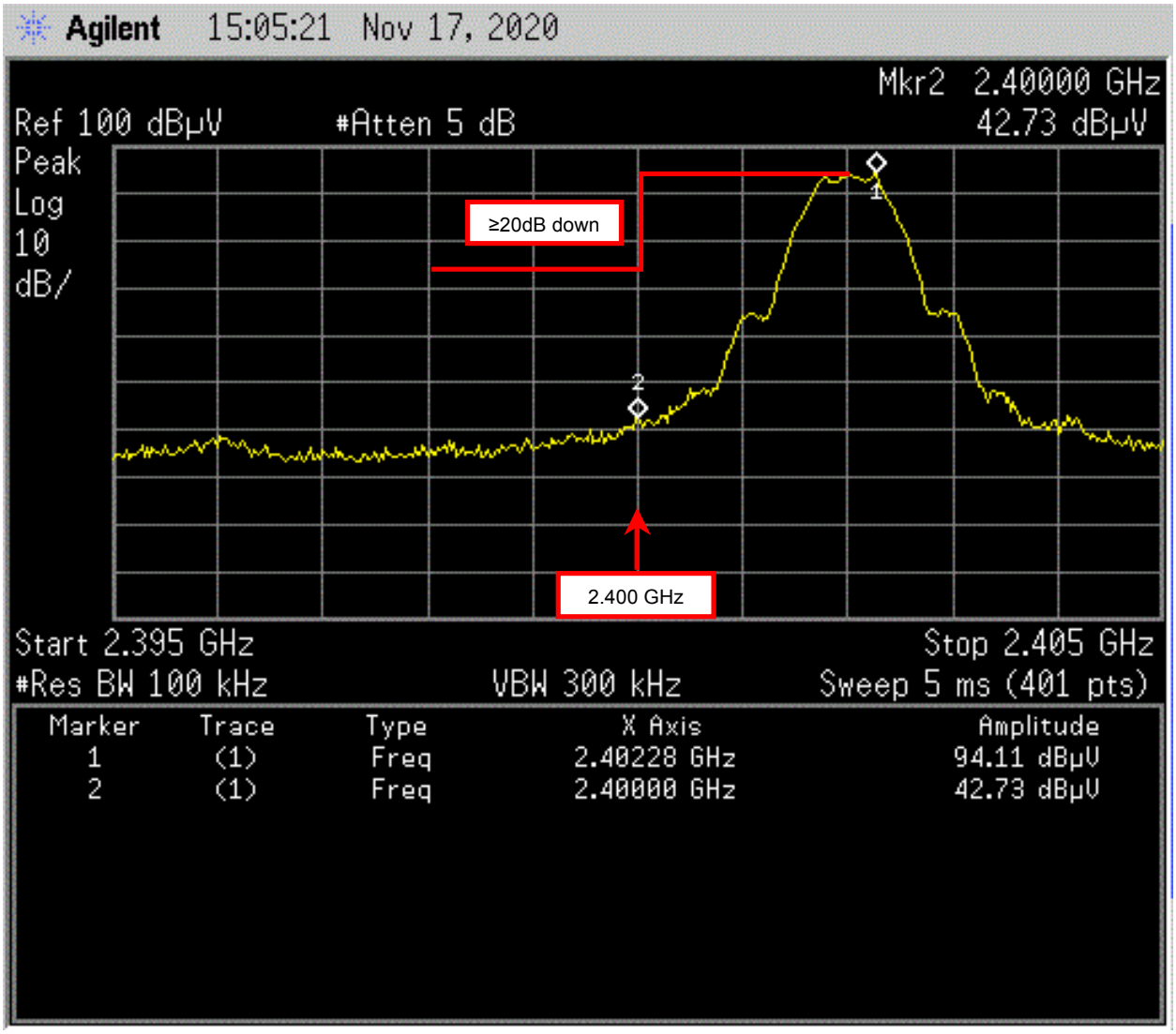
6.3 100kHz Band Edge Measurement Test Results

The 100kHz band edge measurement plots are shown on the following pages.

6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (Low – 2402MHz)

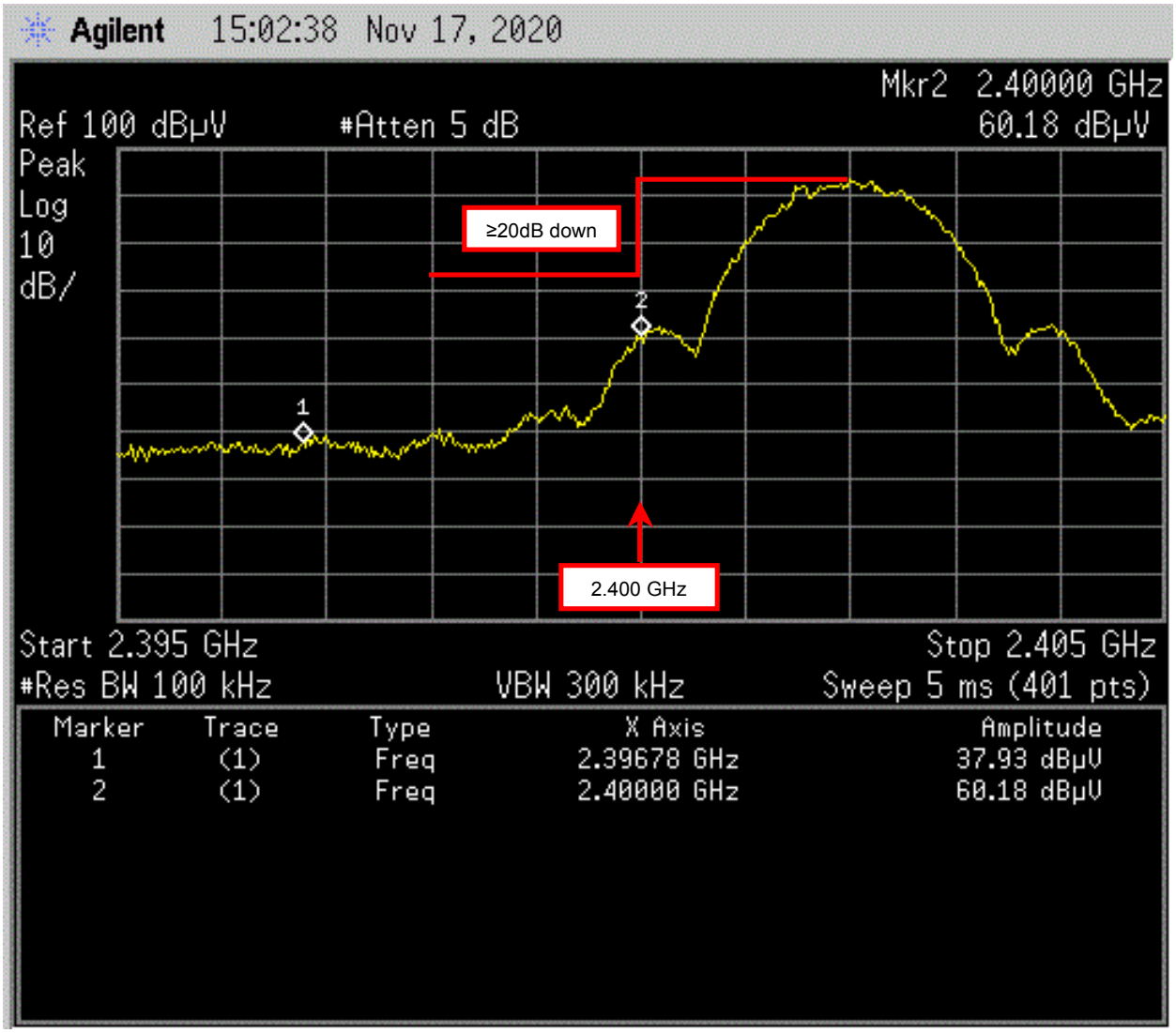
BLE mode @ 1Mbps data rate



6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (Low – 2402MHz)

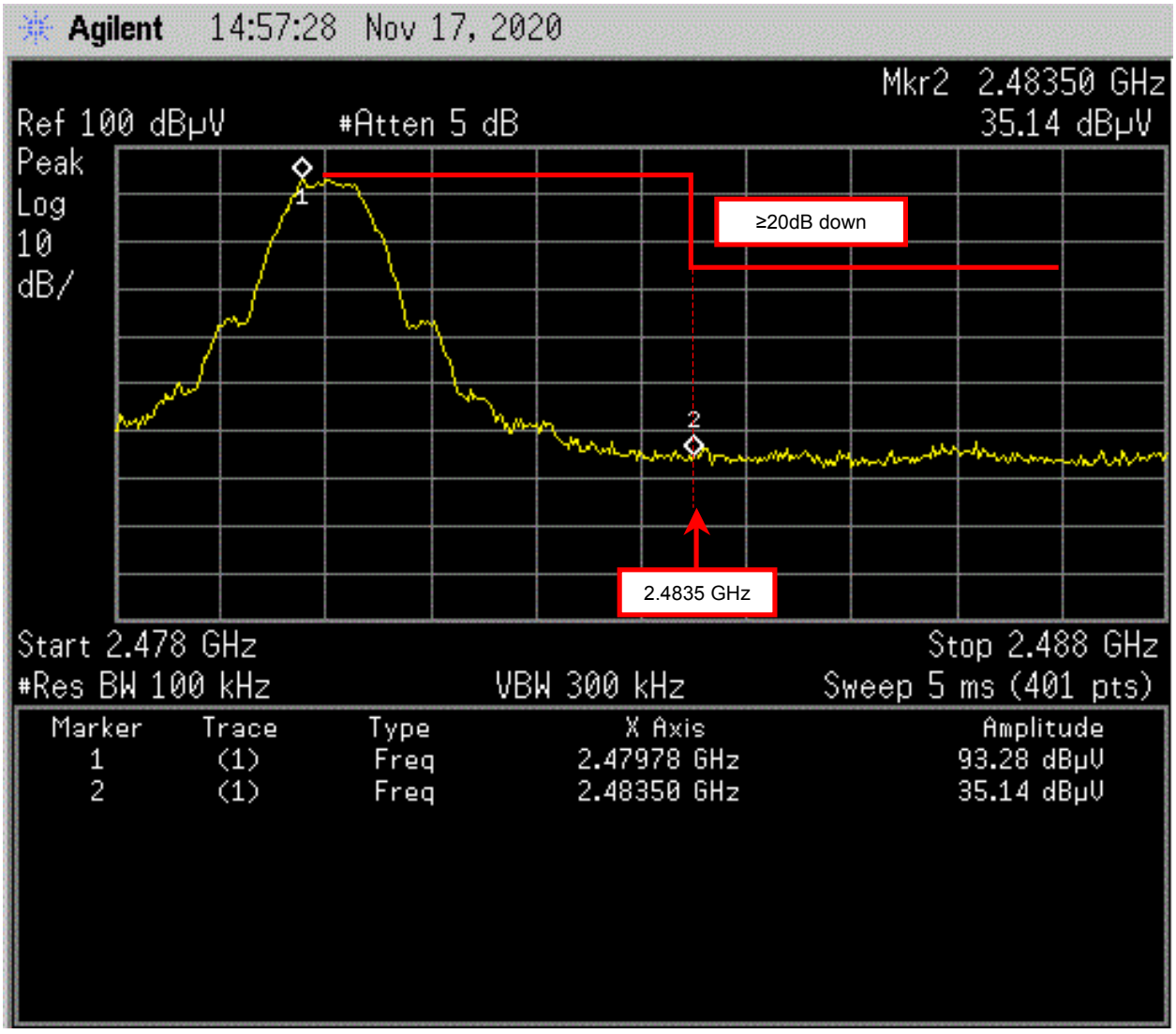
BLE mode @ 2Mbps data rate



6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (High – 2480MHz)

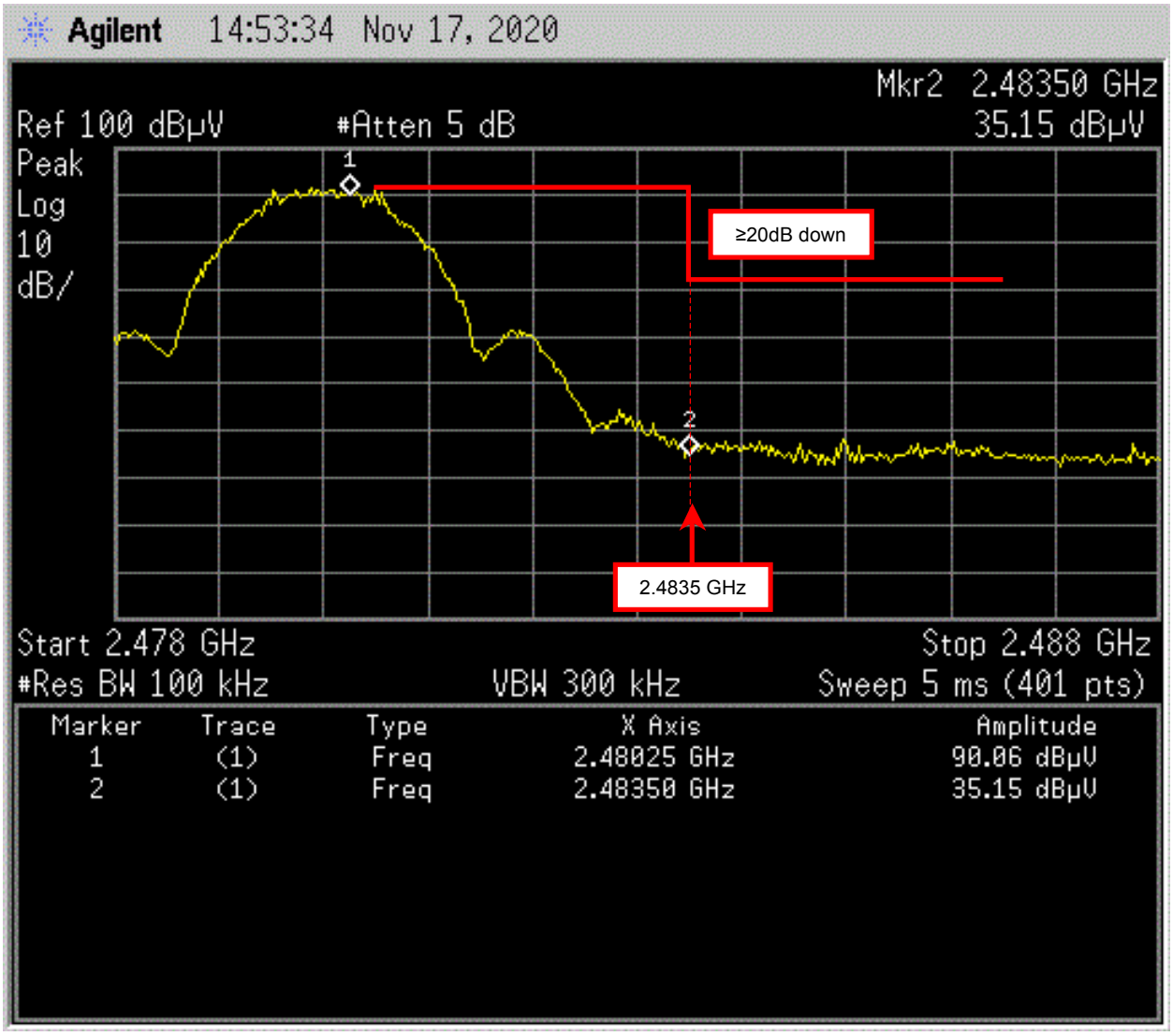
BLE mode @ 1Mbps data rate



6.3 100kHz Band Edge Measurement Test Results (continued)

100kHz Band Edge Measurement Data (High – 2480MHz)

BLE mode @ 2Mbps data rate



6.4 100kHz Band Edge Measurement Conclusion

The EUT meets the 100kHz band edge measurement requirements of FCC 15.247 (d) and RSS-247, 5.5.

7.0 PEAK POWER SPECTRAL DENSITY

7.1 Applicable Standards

FCC 15.247 (e), RSS-247, 5.2 (b). For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3kHz band during any time of continuous transmission.

7.2 Measurement Procedure

- Place the EUT on a 1.5m high polystyrene stand and set it in continuous transmit mode with modulation.
- Set the spectrum analyzer RBW = 3kHz, VBW = 10kHz, Span = 1MHz, Sweep = Auto.
- Record the maximum reading.
- Repeat above procedures for low, mid, and high frequency channels.

7.3 Peak Power Spectral Density Measurement Results

This data table and the plots on the following pages show the Peak Power Spectral Density test results.

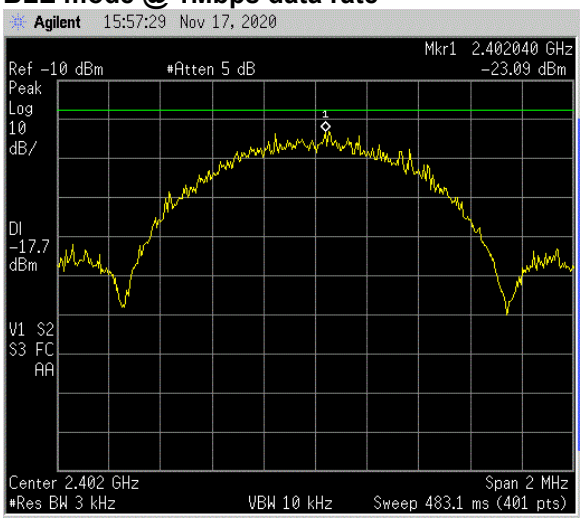
CH	Channel Frequency (GHz)	Maximum Limit (dBm)	Peak Power Spectral Density (dBm)
1 - Low	2.402	8.0	-11.0
2 - Mid	2.440	8.0	-13.8
3 - High	2.480	8.0	-13.9

Note that the worst case peak power spectral density results are given above and these occurred when using BLE mode at 1Mbps data rate.

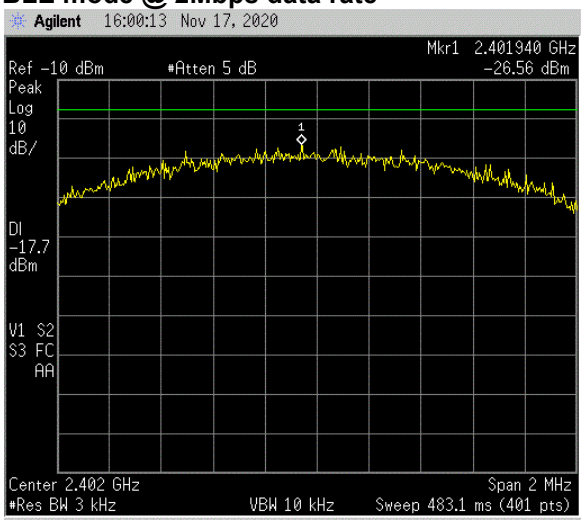
7.3 Peak Power Spectral Density Measurement Results (continued)

Power Spectral Density Test Plot (Low – 2402MHz)

BLE mode @ 1Mbps data rate



BLE mode @ 2Mbps data rate

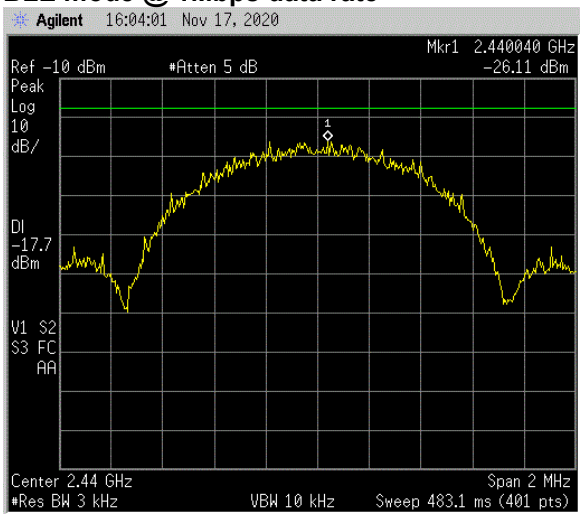


Channel	Operating Mode	Frequency (MHz)	Reading (dBm)	Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBm/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Calculation (mW)	[2]EIRP (dBm/MHz)	Limit (dBm/MHz)
Low	BLE 1Mbps	2402.0	-23.1	9.4	37.8	28.7	-22.8	16237	1.000	0.079	-11.0	8.0
Low	BLE 2Mbps	2402.0	-26.6	9.4	37.8	28.7	-26.3	10889	1.000	0.036	-14.5	8.0

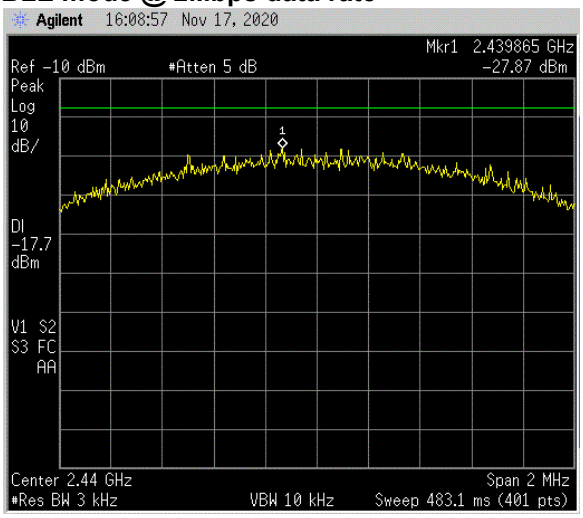
7.3 Peak Power Spectral Density Measurement Results (continued)

Power Spectral Density Test Plot (Mid – 2440MHz)

BLE mode @ 1Mbps data rate



BLE mode @ 2Mbps data rate

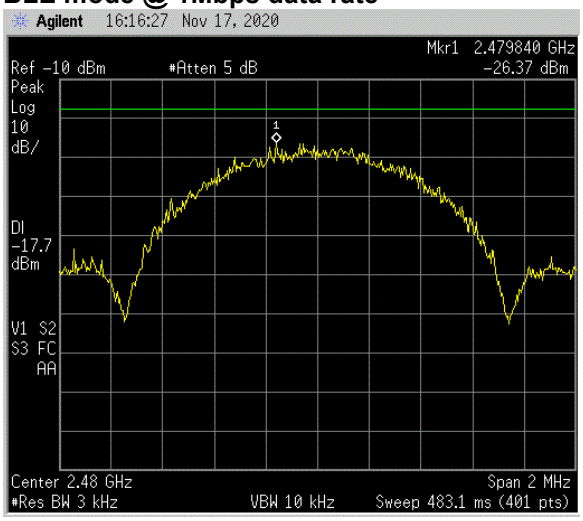


Channel	Operating Mode	Frequency (MHz)	Reading (dBm)	Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBm/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Calculation (mW)	[2]EIRP (dBm/MHz)	Limit (dBm/MHz)
Mid	BLE 1Mbps	2440.0	-26.1	9.5	37.8	28.8	-25.6	11735	1.000	0.041	-13.8	8.0
Mid	BLE 2Mbps	2440.0	-27.9	9.5	37.8	28.8	-27.4	9583	1.000	0.028	-15.6	8.0

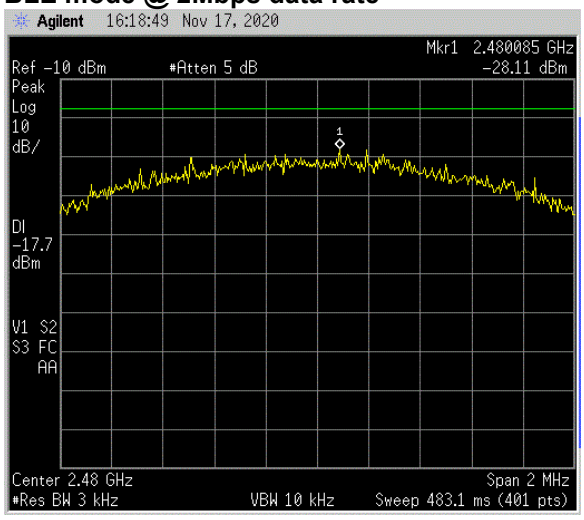
7.3 Peak Power Spectral Density Measurement Results (continued)

Power Spectral Density Test Plot (High – 2480MHz)

BLE mode @ 1Mbps data rate



BLE mode @ 2Mbps data rate



Channel	Operating Mode	Frequency (MHz)	Reading (dBm)	Loss (dB)	Preamp Gain (dB)	A.F. (dB)	Field Strength (dBm/m)	Field Strength (µV/m)	[1]Antenna Numerical Gain	Calculation (mW)	[2]EIRP (dBm/MHz)	Limit (dBm/MHz)
High	BLE 1Mbps	2480.0	-26.4	9.5	37.8	29.0	-25.7	11655	1.000	0.041	-13.9	8.0
High	BLE 2Mbps	2480.0	-28.1	9.5	37.8	29.0	-27.4	9539	1.000	0.027	-15.6	8.0

7.4 Peak Power Spectral Density Measurement Conclusion

The EUT meets the peak power spectral density requirements of FCC 15.247 (e) and RSS-247, 5.2 (b). The maximum power spectral density measured was -11.0 dBm which is under the 8 dBm limit.

8.0 UNINTENTIONAL/SPURIOUS RADIATED EMISSION TEST

8.1 Radiated Emissions

Preliminary testing was done in a ferrite lined shielded enclosure for frequency identification from the EUT. These scans are exploratory emission tests only that are voluntarily submitted. All final measurements were done on the OATS.

For the OATS testing, the EUT was placed on a turntable per ANSI C63.10, clause 6.3.1. The turntable was rotated 360 degrees to determine the position of maximum emission level. The EUT is set 3m away from the receiving antenna which was varied from 1m to 4m in height during the final OATS measurements, to find the highest emissions level. Each frequency of emission was maximized by changing the polarization of the receiving antenna both horizontal and vertical. In order to find out the maximum emissions, the relative positions of the transmitter (EUT) was rotated through three orthogonal axes according to the requirements in ANSI C63.10, clause 5.10.1.

8.2 Prescan Radiated Emissions

The radiated emissions prescan testing was performed in the 3 meter ferrite lined shielded chamber.

The EUT was placed on a 0.8m high polystyrene table for all measurements.

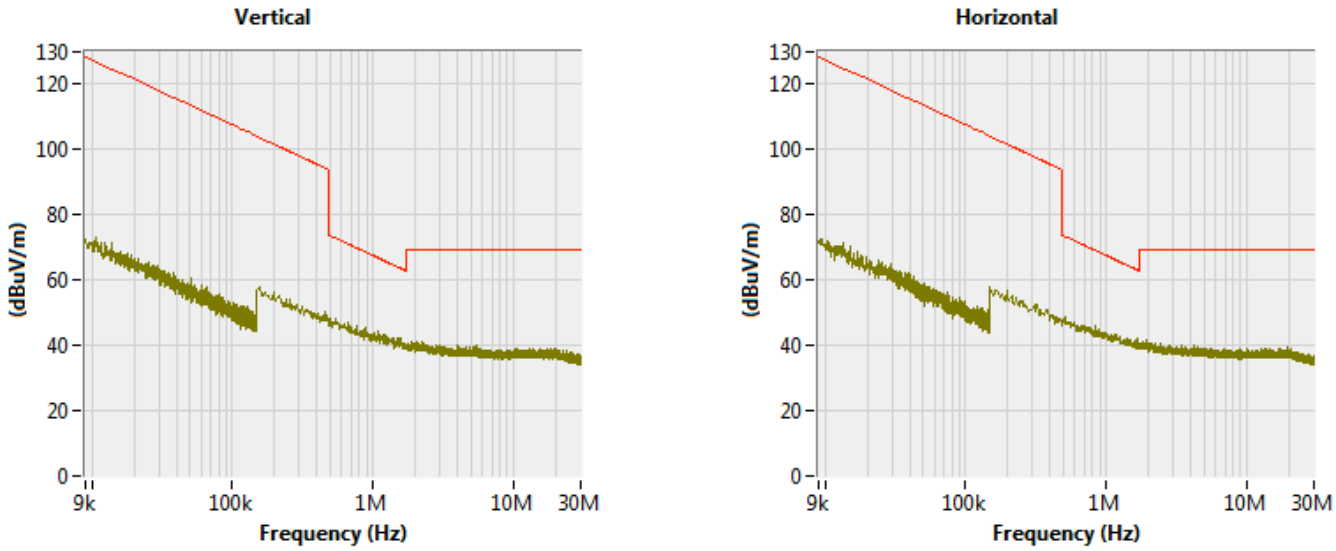
8.3 Prescan Measurement Procedure

- Prescans from 9kHz to 25GHz were done in the ferrite-lined shielded chamber for EUT frequency identification. These scans are exploratory emission tests only that are voluntarily submitted.

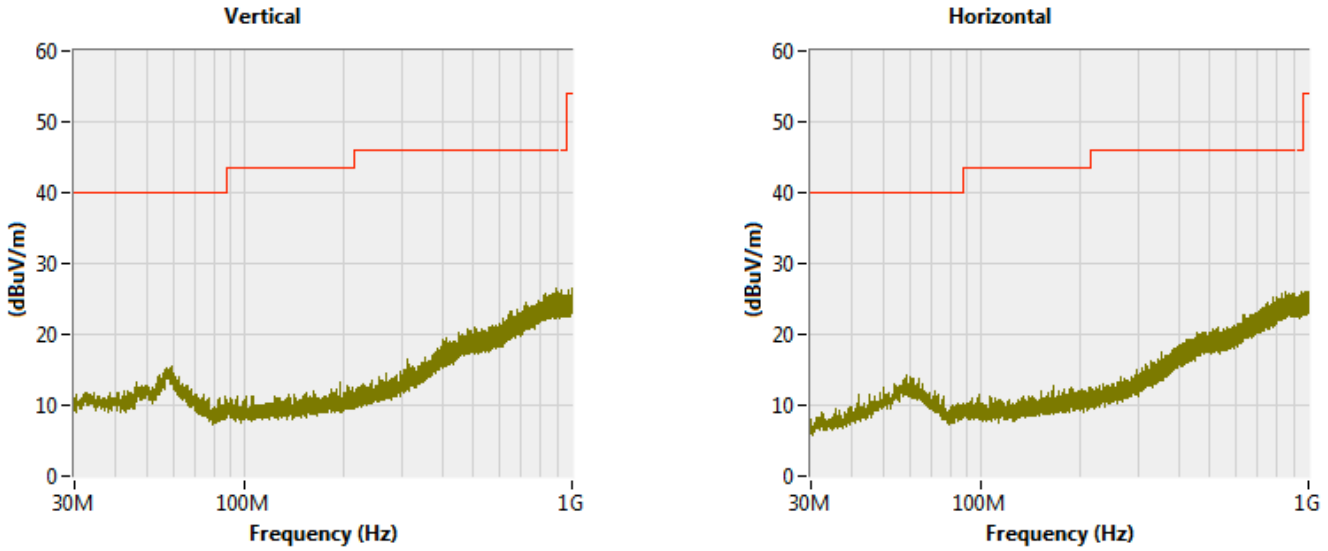
8.4 Prescan Measurement Results

The following plots show a summary of the prescan data that was collected.

8.4 Prescan Measurement Results (continued)

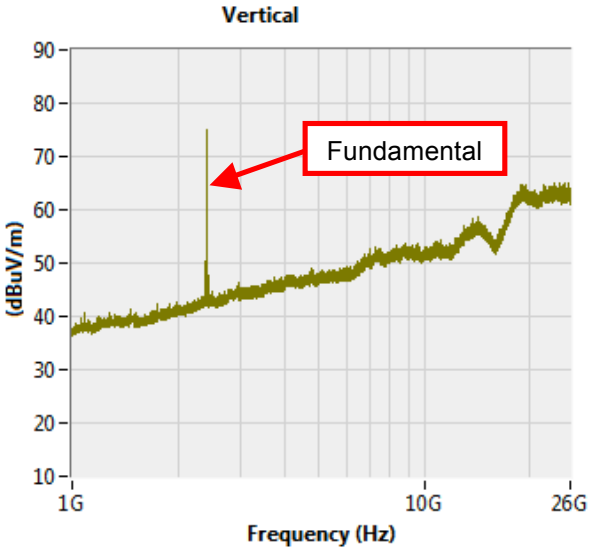


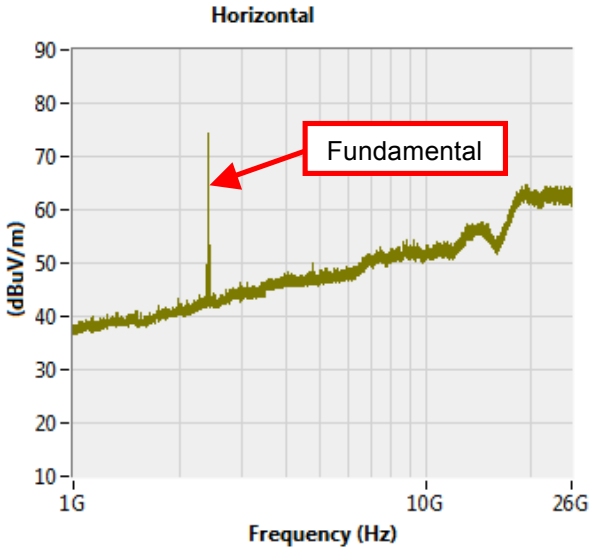
9kHz – 30MHz, Antenna: Magnetic Loop



30 - 1000MHz, Antenna: BiLog

8.4 Prescan Measurement Results (continued)





1-26GHz, Antenna: Horn

8.5 Radiated Emissions Applicable Standards

FCC 15.209 (a) – (f), RSS-GEN, 8.9. Emissions outside the authorized bands shall not exceed the radiated emission limits specified in FCC 15.209(a) – (f) and RSS-GEN, 8.9, and according to FCC 15.33(a)(1) and ANSI C63.10, section 5.5, for an intentional radiator operating below 10GHz, the frequency range of measurements shall encompass from the lowest frequency generated in the device or at least 30MHz to the tenth harmonic of the highest fundamental frequency or 40GHz, whichever is lower.

8.6 Radiated Emissions EUT Setup

The radiated emission tests were performed on the 3 meter open area test site.

The EUT was placed on an 80cm polystyrene table for measurements up to and including 1GHz and it was placed on a 1.5m high polystyrene stand for measurements above 1GHz.

8.7 Radiated Emissions Measurement Procedure

- The 80cm polystyrene table and 1.5m stand, when used, was placed on a turntable which is flush with the ground plane.
- The turntable was rotated 360 degrees to determine the position of maximum emission level.
- The EUT was 3m away from the receiving antenna which was varied from 1m to 4m to obtain the maximum emissions level.
- The data was recorded for at least the six highest emissions to ensure EUT compliance.
- Each emission was maximized by changing the polarization of the receiving antenna both horizontal and vertical.
- Emissions were measured with the EUT transmitting at the low, mid, and high frequencies with modulation applied.
- The worst case modes of operation were tested for spurious and unintentional emissions. Refer to Section 8.12 for determination of worst case emission modes and orientation.

8.8 Radiated Emissions Test Setup Photos

Refer to photos in the Tsup document.

8.9 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation is as follows:

$$FS = RA + AF + CL - AG$$

Where:
FS = Field Strength
RA = Reading Amplitude
AF = Antenna Factor
CL = Cable Attenuation Factor (Cable Loss)
AG = Amplifier Gain

8.10 Limit Extrapolation Method for Frequencies Below 30MHz

For radiated emissions results below 30MHz, the limit was adjusted based on a 40dB/decade extrapolation factor for distance (Reference: FCC Part 15.31 f 2). The field strength limit is calculated and converted to dBµV/m and then the 3m Limit Adjustment was added to this to get the 3 meter limit shown in the 9kHz - 30MHz results tables. For RSS-GEN, the field strength limit is calculated and converted to dBµA/m and then the 3m Limit Adjustment was added to this to get the 3 meter limit shown in the 9kHz - 30MHz results tables.

Limits per FCC Part 15.209

Frequency (MHz)	Field strength limit (microvolts/meter)	Measurement distance (meters)	3m Limit Adjustment (dB)	3m Limit (dBµV/m)
0.009-0.490	2400/F(kHz)	300	80	128.5 - 93.8
0.490-1.705	24000/F(kHz)	30	40	73.8 – 62.9
1.705-30.0	30	30	40	69.5 – 69.5
30.0	100	3	N/A	40.0

For example: At 32 kHz, the field strength limit is 2400/32 = 75 µV/m. This converts to 37.5 dBµV/m. To this is added the 3m Limit Adjustment of 80dB. Therefore the 3m limit at 32 kHz is 117.5 dBµV/m.

8.10 Limit Extrapolation Method for Frequencies Below 30MHz (continued)

Limits per RSS-GEN Table 6

Frequency (MHz)	Field strength limit (microamps/meter)	Measurement distance (meters)	3m Limit Adjustment (dB)	3m Limit (dBµA/m)
0.009-0.490	6.37/F(kHz)	300	80	77.0 – 42.3
0.490-1.705	63.7/F(kHz)	30	40	22.3 – 11.4
1.705-30.0	0.08	30	40	18.1 – 18.1

For example: At 32 kHz, the field strength limit is 6.37/32 = 0.2 µA/m. This converts to -14.0 dBµA/m. To this is added the 3m Limit Adjustment of 80dB. Therefore the 3m limit at 32 kHz is 66.0 dBµA/m.

8.11 Duty Cycle Correction Factor

A duty cycle correction factor has been calculated and used to determine the average field strength from the peak field strength as given on the following pages.

The following duty cycle analysis was provided by Helios Sports, Inc.

BLE Event Details

Stage	Time (ms)
Header, Preamble, CRC (us)	92
251-Byte PDU (us)	2008
Total TX time (us)	2100
Shortest Connection Interval (us)	45000
Duty Cycle (%)	4.667%
Duty Cycle Correction Factor (dB)	**-26.62**

Duty Cycle Correction Factor (ref: ANSI C63.10, 7.5)
δ(dB) = 20log(Δ) = 20 log (0.04667) = -26.62 dB

8.12 Worst Case mode and orientation determination

	Frequency (MHz)	PK Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	3m Antenna Factor (dB)	25m Cable Factor (dB)	8m Cable Factor (dB)	HP8449B Factor (dB)	PK Net (dBµV/m)
1Mbps (12C841B8)	2402.0	95.90	270.0	1.7	H	28.7	6.6	2.8	37.8	96.19
1Mbps (12C841B8)	2440.0	94.40	270.0	2.1	H	28.8	6.7	2.8	37.8	94.90
1Mbps (12C841B8)	2480.0	94.06	270.0	1.6	H	29.0	6.7	2.8	37.8	94.84
						#N/A	#N/A	#N/A	#N/A	#N/A
2Mbps (12C841B8)	2402.0	95.12	270.0	1.7	H	28.7	6.6	2.8	37.8	95.41
2Mbps (12C841B8)	2440.0	94.40	270.0	2.1	H	28.8	6.7	2.8	37.8	94.90
2Mbps (12C841B8)	2480.0	94.08	270.0	1.6	H	29.0	6.7	2.8	37.8	94.86

The worst case operating modes were 2402 and 2440 MHz at 1Mbps data rate and 2480MHz at 2Mbps data rate was also chosen. The worst case orientation is with the Helios logo on the device facing up.

8.13 Measurement Result – Radiated Emissions Data Tables

The data tables on the following page show the Radiated Emissions test results.

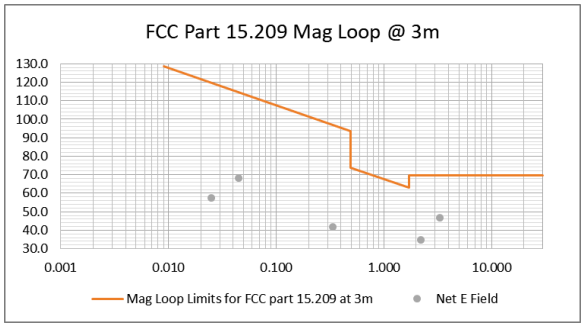
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

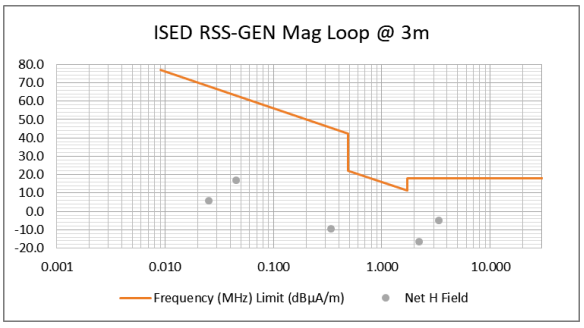
3-Meter Magnetic Loop Radiated Emissions Results

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2402MHz, 1Mbps
EUT Voltage: Fully charged (100%)
Temperature (°C): 16.1
Relative Humidity (%): 64
Test Distance: **3 meters**
Frequency Range: **9kHz-30MHz**
Antenna Asset #: **103**
Detector used: **Quasi-peak (QP) for all except as follows:**
Average (AVG) 9-90kHz and 110-490kHz
Antenna Polarity: **V=plane of loop perpendicular to EUT face;**
H=plane of loop parallel to EUT face

Frequency (MHz)	Detector (QP or AV)	Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Mag Loop E Factor (dB)	Mag Loop H Factor (dB)	25m Cable Factor (dB)	Net E Field (dBµV/m)	Net H Field (dBµA/m)	FCC 15.209 Limit ($dB_{\mu}V/m$)	FCC 15.209 Margin ($dB_{\mu}V/m$)	ISED RSS-GEN Limit ($dB_{\mu A}/m$)	ISED RSS-GEN Margin (dBµA/m)
0.025	AV	42.7	0.0	1.0	V	14.6	-36.8	0.1	57.4	5.9	119.6	-62.2	68.1	-62.1
0.045	AV	54.0	315.0	1.0	V	14.2	-37.2	0.1	68.2	16.8	114.6	-46.3	63.0	-46.2
0.337	AV	28.4	270.0	1.0	V	13.5	-37.9	0.1	42.0	-9.4	97.1	-55.0	45.5	-54.9
2.209	QP	20.4	270.0	1.0	V	14.2	-37.2	0.3	34.9	-16.5	69.5	-34.6	18.1	-34.6
3.329	QP	32.1	315.0	1.0	V	14.3	-37.2	0.3	46.7	-4.8	69.5	-22.9	18.1	-22.9
17.534	QP	11.4	0.0	1.0	V	14.1	-37.4	0.6	26.1	-25.4	69.5	-43.4	18.1	-43.4

NOTES:
Use the detector shown based on the frequency.
EN55032 has no limits below 30MHz.
RBW=200Hz from 9kHz to 150kHz
RBW=9kHz from 150kHz to 30MHz





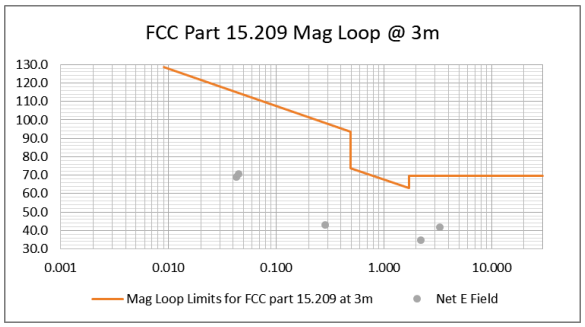
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

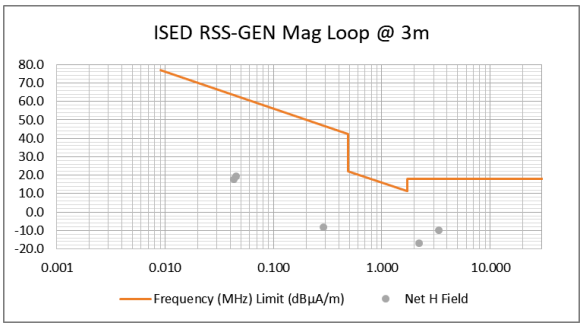
3-Meter Magnetic Loop Radiated Emissions Results

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2440MHz, 1Mbps
EUT Voltage: Fully charged (100%)
Temperature (°C): 17.6
Relative Humidity (%): 65
Test Distance: **3 meters**
Frequency Range: **9kHz-30MHz**
Antenna Asset #: **103**
Detector used: **Quasi-peak (QP) for all except as follows:**
Average (AVG) 9-90kHz and 110-490kHz
Antenna Polarity: **V=plane of loop perpendicular to EUT face;**
H=plane of loop parallel to EUT face

Frequency (MHz)	Detector (QP or AV)	Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Mag Loop E Factor (dB)	Mag Loop H Factor (dB)	25m Cable Factor (dB)	Net E Field (dBµV/m)	Net H Field (dBµA/m)	FCC 15.209 Limit ($dB_{\mu}V/m$)	FCC 15.209 Margin (dBµV/m)	ISED RSS-GEN Limit ($dB_{\mu A}/m$)	ISED RSS-GEN Margin (dBµA/m)
0.043	AV	54.8	0.0	1.0	V	14.3	-37.1	0.1	69.1	17.7	115.0	-45.9	63.5	-45.7
0.045	AV	56.5	315.0	1.0	V	14.2	-37.3	0.1	70.7	19.3	114.5	-43.8	63.0	-43.7
0.287	AV	29.4	270.0	1.0	V	13.5	-37.9	0.1	43.0	-8.4	98.4	-55.4	46.9	-55.3
2.211	QP	20.1	270.0	1.0	V	14.2	-37.2	0.3	34.6	-16.8	69.5	-34.9	18.1	-34.8
3.329	QP	27.0	315.0	1.0	V	14.3	-37.2	0.3	41.6	-9.9	69.5	-27.9	18.1	-27.9
20.000	QP	13.0	0.0	1.0	V	14.2	-37.3	0.7	27.9	-23.6	69.5	-41.7	18.1	-41.7

NOTES:
Use the detector shown based on the frequency.
EN55032 has no limits below 30MHz.
RBW=200Hz from 9kHz to 150kHz
RBW=9kHz from 150kHz to 30MHz





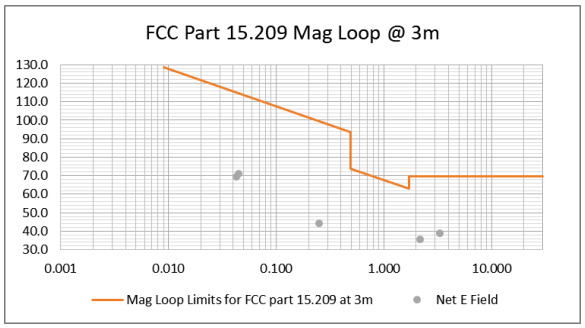
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

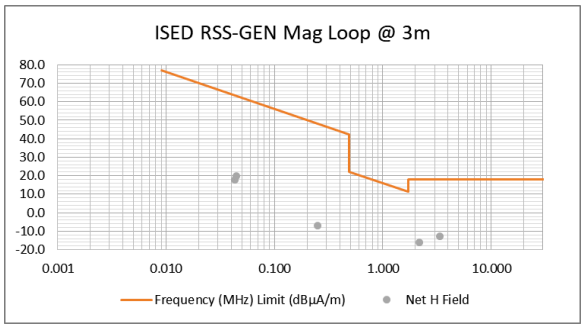
3-Meter Magnetic Loop Radiated Emissions Results

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2480MHz, 2Mbps
EUT Voltage: Fully charged (100%)
Temperature (°C): 17.6
Relative Humidity (%): 65
Test Distance: **3 meters**
Frequency Range: **9kHz-30MHz**
Antenna Asset #: **103**
Detector used: **Quasi-peak (QP) for all except as follows:**
Average (AVG) 9-90kHz and 110-490kHz
Antenna Polarity: **V=plane of loop perpendicular to EUT face;**
H=plane of loop parallel to EUT face

Frequency (MHz)	Detector (QP or AV)	Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Mag Loop E Factor (dB)	Mag Loop H Factor (dB)	25m Cable Factor (dB)	Net E Field (dBµV/m)	Net H Field (dBµA/m)	FCC 15.209 Limit ($dB_{\mu}V/m$)	FCC 15.209 Margin (dBµV/m)	ISED RSS-GEN Limit ($dB_{\mu A}/m$)	ISED RSS-GEN Margin (dBµA/m)
0.043	AV	55.1	0.0	1.0	V	14.3	-37.1	0.1	69.4	18.0	115.0	-45.6	63.5	-45.4
0.045	AV	57.0	315.0	1.0	V	14.2	-37.2	0.1	71.2	19.8	114.6	-43.4	63.1	-43.2
0.251	AV	30.8	270.0	1.0	V	13.5	-37.9	0.1	44.4	-7.0	99.6	-55.2	48.1	-55.1
2.171	QP	20.9	270.0	1.0	V	14.2	-37.2	0.3	35.4	-16.0	69.5	-34.1	18.1	-34.0
3.329	QP	24.3	315.0	1.0	V	14.3	-37.2	0.3	38.9	-12.6	69.5	-30.6	18.1	-30.6
17.774	QP	12.1	0.0	1.0	V	14.1	-37.4	0.6	26.8	-24.7	69.5	-42.7	18.1	-42.7

NOTES:
Use the detector shown based on the frequency.
EN55032 has no limits below 30MHz.
RBW=200Hz from 9kHz to 150kHz
RBW=9kHz from 150kHz to 30MHz





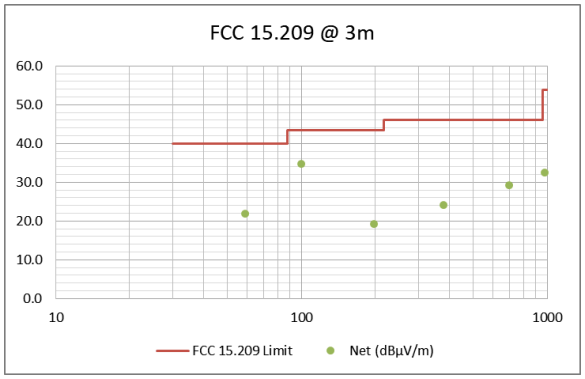
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

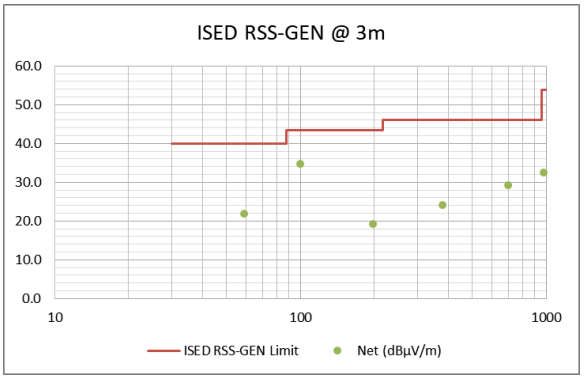
3-Meter Radiated Emissions Results

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2402MHz, 1Mbps
EUT Voltage: Fully charged (100%)
Temperature (°C): 15.1
Relative Humidity (%): 64
Test Distance: **3 meters**
Frequency Range: **30-1000MHz**
Antenna Asset #: **17**

Frequency (MHz)	QP Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	3m Antenna Factor (dB)	25m Cable Factor (dB)	Net (dBµV/m)	FCC Part 15.209 QP Limit (dBµV/m)	FCC Part 15.209 QP Margin (dBµV/m)	ISED RSS-GEN QP Limit (dBµV/m)	ISED RSS-GEN QP Margin (dBµV/m)
59.2	10.4	0.0	1.0	V	10.4	1.2	22.0	40.0	-18.0	40.0	-18.0
100.0	18.3	270.0	1.0	V	15.0	1.5	34.7	43.5	-8.8	43.5	-8.8
196.7	3.3	270.0	1.0	V	13.9	2.0	19.2	43.5	-24.3	43.5	-24.3
378.5	1.8	315.0	1.7	H	19.7	2.7	24.1	46.0	-21.9	46.0	-21.9
701.1	1.9	270.0	1.9	V	23.6	3.6	29.1	46.0	-16.9	46.0	-16.9
976.5	2.3	315.0	1.4	H	26.1	4.3	32.6	53.9	-21.3	53.9	-21.3

NOTES:
RBW=120kHz
Scanned 30-1000 MHz





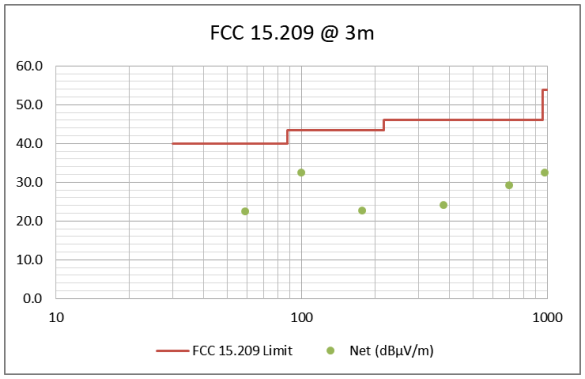
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

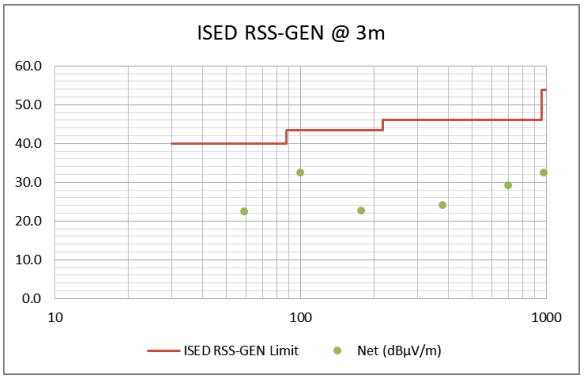
3-Meter Radiated Emissions Results

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2440MHz, 1Mbps
EUT Voltage: Fully charged (100%)
Temperature (°C): 15.4
Relative Humidity (%): 64
Test Distance: **3 meters**
Frequency Range: **30-1000MHz**
Antenna Asset #: **17**

Frequency (MHz)	QP Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	3m Antenna Factor (dB)	25m Cable Factor (dB)	Net (dBµV/m)	FCC Part 15.209 QP Limit (dBµV/m)	FCC Part 15.209 QP Margin (dBµV/m)	ISED RSS-GEN QP Limit (dBµV/m)	ISED RSS-GEN QP Margin (dBµV/m)
58.9	10.9	0.0	1.0	V	10.4	1.2	22.5	40.0	-17.5	40.0	-17.5
100.0	16.1	270.0	1.0	V	15.0	1.5	32.6	43.5	-10.9	43.5	-10.9
176.3	7.3	180.0	1.3	H	13.6	1.9	22.7	43.5	-20.8	43.5	-20.8
378.5	1.8	270.0	1.5	H	19.7	2.7	24.2	46.0	-21.8	46.0	-21.8
701.2	1.9	270.0	1.0	V	23.6	3.6	29.2	46.0	-16.8	46.0	-16.8
978.1	2.3	315.0	1.5	H	26.0	4.3	32.6	53.9	-21.3	53.9	-21.3

NOTES:
RBW=120kHz
Scanned 30-1000 MHz





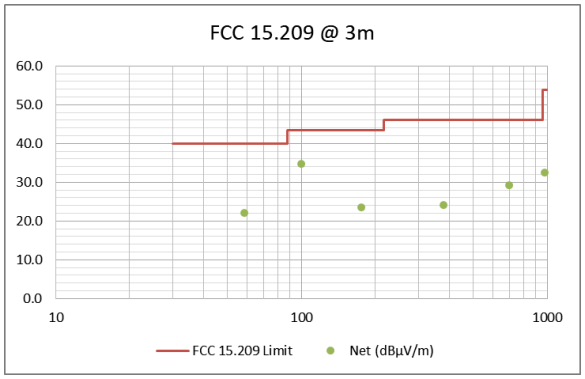
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

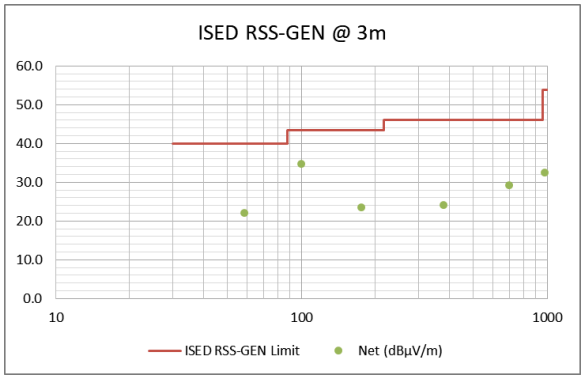
3-Meter Radiated Emissions Results

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2480MHz, 2Mbps
EUT Voltage: Fully charged (100%)
Temperature (°C): 15.1
Relative Humidity (%): 62
Test Distance: **3 meters**
Frequency Range: **30-1000MHz**
Antenna Asset #: **17**

Frequency (MHz)	QP Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	3m Antenna Factor (dB)	25m Cable Factor (dB)	Net (dBµV/m)	FCC Part 15.209 QP Limit (dBµV/m)	FCC Part 15.209 QP Margin (dBµV/m)	ISED RSS-GEN QP Limit (dBµV/m)	ISED RSS-GEN QP Margin (dBµV/m)
58.5	10.5	0.0	1.0	V	10.5	1.2	22.1	40.0	-17.9	40.0	-17.9
100.0	18.4	270.0	1.0	V	15.0	1.5	34.8	43.5	-8.7	43.5	-8.7
175.1	8.0	270.0	1.0	V	13.7	1.9	23.6	43.5	-19.9	43.5	-19.9
378.5	1.8	315.0	1.6	H	19.7	2.7	24.2	46.0	-21.8	46.0	-21.8
699.6	2.0	270.0	1.4	V	23.6	3.6	29.2	46.0	-16.8	46.0	-16.8
979.1	2.3	270.0	1.6	H	26.0	4.3	32.6	53.9	-21.3	53.9	-21.3

NOTES:
RBW=120kHz
Scanned 30-1000 MHz





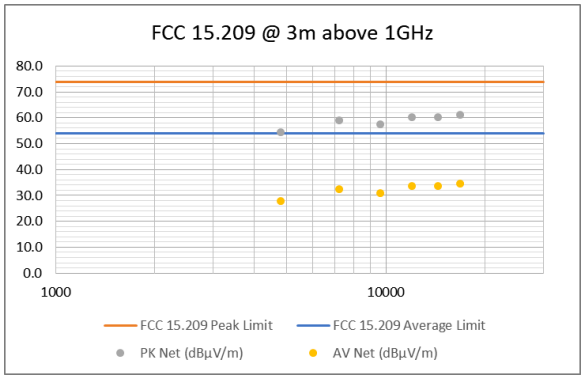
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

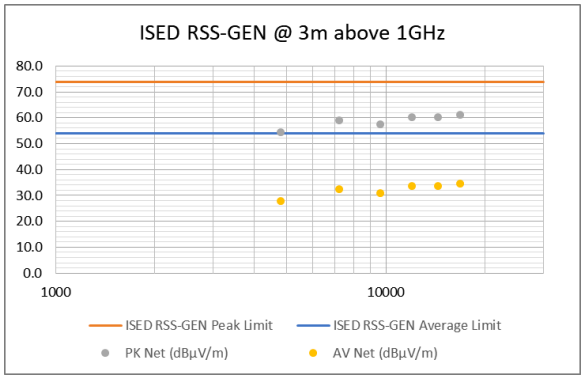
3-Meter Radiated Emissions Results 1-25GHz with Duty Cycle Correction Factor

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2402MHz, 1Mbps
EUT Voltage: Fully charged (100%)
Temperature (°C): 15.1
Relative Humidity (%): 42
Test Distance: **3 meters**
Frequency Range: **>1.0 GHz**
Antenna Asset #: **126**

Frequency (MHz)	PK Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Duty Cycle Correction (dBµV)	3m Antenna Factor (dB)	25m Cable Factor (dB)	8m Cable Factor (dB)	HP8449B Factor (dB)	PK Net (dBµV/m)	AV Net (dBµV/m)	FCC Part 15.209 PK Limit (dBµV/m)	FCC Part 15.209 PK Margin (dBµV/m)	FCC Part 15.209 AV Limit (dBµV/m)	FCC Part 15.209 AV Margin (dBµV/m)	ISED RSS-GEN PK Limit (dBµV/m)	ISED RSS-GEN PK Margin (dBµV/m)	ISED RSS-GEN AV Limit (dBµV/m)	ISED RSS-GEN AV Margin (dBµV/m)
4804.5	45.4	180.0	1.3	H	-26.6	33.0	9.5	4.0	37.5	54.4	27.8	73.9	-19.5	53.9	-26.1	73.9	-19.5	53.9	-26.1
7206.8	41.7	225.0	1.5	H	-26.6	38.5	11.5	5.1	37.8	59.1	32.5	73.9	-14.8	53.9	-21.4	73.9	-14.8	53.9	-21.4
9607.0	38.4	270.0	1.3	V	-26.6	37.8	13.4	6.1	38.2	57.5	30.9	73.9	-16.4	53.9	-23.0	73.9	-16.4	53.9	-23.0
12011.8	35.7	247.5	1.2	V	-26.6	39.5	15.3	7.4	37.5	60.3	33.7	73.9	-13.6	53.9	-20.2	73.9	-13.6	53.9	-20.2
14412.0	29.9	202.5	1.3	V	-26.6	41.5	16.8	8.3	36.2	60.3	33.7	73.9	-13.6	53.9	-20.2	73.9	-13.6	53.9	-20.2
16814.0	28.7	180.0	1.3	V	-26.6	41.5	18.2	9.0	36.2	61.3	34.7	73.9	-12.6	53.9	-19.2	73.9	-12.6	53.9	-19.2

NOTES:
RBW=1MHz
Scanned 1 to 25 GHz
8m Cable Factor using Asset #154, dark green 8m cable.
Enter Duty Cycle Correction Factor as a negative number (e.g., -20).





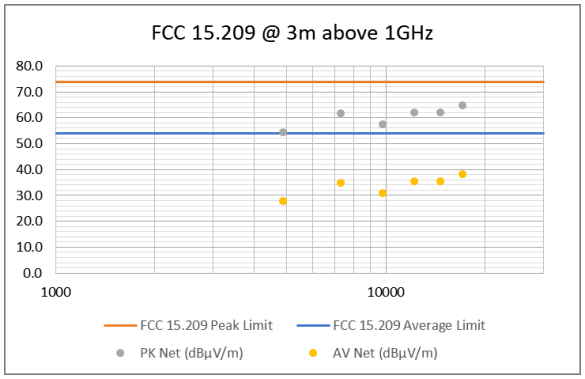
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

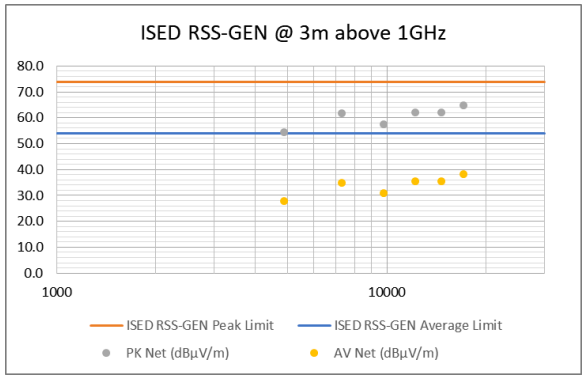
3-Meter Radiated Emissions Results 1-25GHz with Duty Cycle Correction Factor

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2440MHz, 1Mbps
EUT Voltage: Fully charged (100%)
Temperature (°C): 15.4
Relative Humidity (%): 43
Test Distance: **3 meters**
Frequency Range: **>1.0 GHz**
Antenna Asset #: **126**

Frequency (MHz)	PK Reading (dBµV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Duty Cycle Correction (dBµV)	3m Antenna Factor (dB)	25m Cable Factor (dB)	8m Cable Factor (dB)	HP8449B Factor (dB)	PK Net (dBµV/m)	AV Net (dBµV/m)	FCC Part 15.209 PK Limit (dBµV/m)	FCC Part 15.209 PK Margin (dBµV/m)	FCC Part 15.209 AV Limit (dBµV/m)	FCC Part 15.209 AV Margin (dBµV/m)	ISED RSS-GEN PK Limit (dBµV/m)	ISED RSS-GEN PK Margin (dBµV/m)	ISED RSS-GEN AV Limit (dBµV/m)	ISED RSS-GEN AV Margin (dBµV/m)
4879.5	45.1	45.0	1.8	H	-26.6	33.2	9.6	4.1	37.5	54.4	27.8	73.9	-19.5	53.9	-26.1	73.9	-19.5	53.9	-26.1
7320.8	43.6	225.0	1.8	H	-26.6	39.0	11.6	5.1	37.9	61.6	35.0	73.9	-12.3	53.9	-18.9	73.9	-12.3	53.9	-18.9
9761.0	38.2	292.5	1.4	V	-26.6	37.8	13.6	6.2	38.3	57.4	30.8	73.9	-16.5	53.9	-23.1	73.9	-16.5	53.9	-23.1
12200.0	36.6	225.0	1.3	V	-26.6	39.8	15.4	7.5	37.2	62.1	35.5	73.9	-11.8	53.9	-18.4	73.9	-11.8	53.9	-18.4
14639.8	31.1	225.0	1.3	V	-26.6	42.0	17.0	8.4	36.4	62.0	35.4	73.9	-11.9	53.9	-18.5	73.9	-11.9	53.9	-18.5
17080.0	30.3	270.0	1.3	V	-26.6	42.8	18.4	9.1	35.9	64.7	38.1	73.9	-9.2	53.9	-15.8	73.9	-9.2	53.9	-15.8

NOTES:
RBW=1MHz
Scanned 1 to 25 GHz
8m Cable Factor using Asset #154, dark green 8m cable.
Enter Duty Cycle Correction Factor as a negative number (e.g., -20).





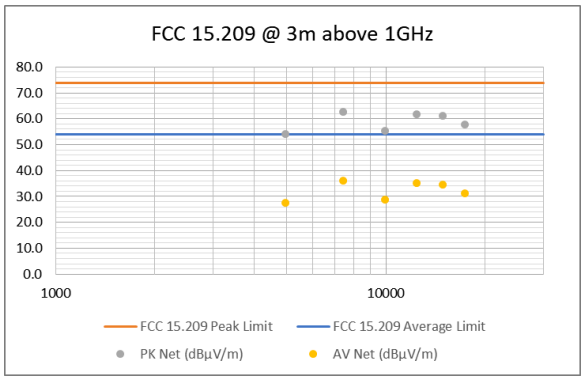
8.13 Measurement Result – Radiated Emissions Data Tables (continued)

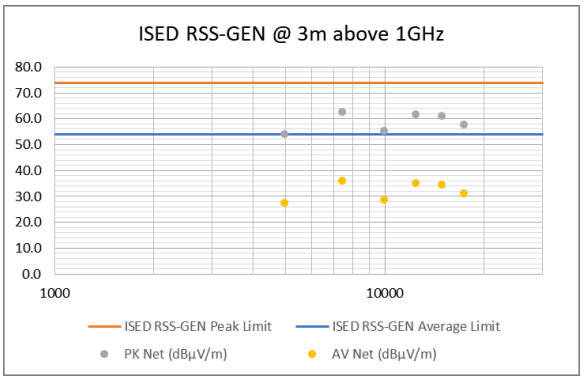
3-Meter Radiated Emissions Results 1-25GHz with Duty Cycle Correction Factor

Date: 11/18/2020
Test Engineer: GC
Customer: Helios Hockey
Product: Helios Core 12C841B8
Configuration: Continuous transmit at max power, 2480MHz, 2Mbps (except as noted below)
EUT Voltage: Fully charged (100%)
Temperature (°C): 15.4
Relative Humidity (%): 44
Test Distance: **3 meters**
Frequency Range: **>1.0 GHz**
Antenna Asset #: **126**

Frequency (MHz)	PK Reading (dBuV)	Azimuth (deg)	Ant. Ht. (m)	Ant. Polarity	Duty Cycle Correction (dBuV)	3m Antenna Factor (dB)	25m Cable Factor (dB)	8m Cable Factor (dB)	HP8449B Factor (dB)	PK Net (dBuV/m)	AV Net (dBuV/m)	FCC Part 15.209 PK Limit (dBuV/m)	FCC Part 15.209 PK Margin (dBuV/m)	FCC Part 15.209 AV Limit (dBuV/m)	FCC Part 15.209 AV Margin (dBuV/m)	ISED RSS-GEN PK Limit (dBuV/m)	ISED RSS-GEN PK Margin (dBuV/m)	ISED RSS-GEN AV Limit (dBuV/m)	ISED RSS-GEN AV Margin (dBuV/m)
4959.0	44.7	180.0	1.9	H	-26.6	33.4	9.7	4.1	37.5	54.2	27.6	73.9	-19.7	53.9	-26.3	73.9	-19.7	53.9	-26.3
7441.5	44.2	225.0	1.8	H	-26.6	39.4	11.7	5.2	37.9	62.6	36.0	73.9	-11.3	53.9	-17.9	73.9	-11.3	53.9	-17.9
9918.0	35.8	225.0	1.5	V	-26.6	37.9	13.7	6.2	38.3	55.3	28.7	73.9	-18.6	53.9	-25.2	73.9	-18.6	53.9	-25.2
12397.8	35.3	225.0	1.3	V	-26.6	40.3	15.6	7.6	36.9	61.8	35.2	73.9	-12.1	53.9	-18.7	73.9	-12.1	53.9	-18.7
14879.9	30.6	180.0	1.3	V	-26.6	41.9	17.1	8.4	36.7	61.3	34.7	73.9	-12.6	53.9	-19.2	73.9	-12.6	53.9	-19.2
17359.9	22.1	180.0	1.3	V	-26.6	43.7	18.7	9.2	35.9	57.9	31.3	73.9	-16.0	53.9	-22.6	73.9	-16.0	53.9	-22.6

NOTES:
RBW=1MHz
Scanned 1 to 25 GHz
8m Cable Factor using Asset #154, dark green 8m cable.
Enter Duty Cycle Correction Factor as a negative number (e.g., -20).





8.14 Unintentional/Spurious Radiated Emissions Measurement Conclusion

The EUT meets the unintentional/spurious radiated emissions requirements of FCC 15.209 (a) through (f) and RSS-GEN, 8.9. The worst case unintentional/spurious radiated emission measured was 34.8 dBµV/m (QP) at 100.0MHz. The FCC/RSS-GEN limit at that frequency is 43.5 dBµV/m (150.0 microvolts/meter).

9.0 ANTENNA REQUIREMENT

9.1 Applicable Standards

FCC 15.203, 15.247 (4) (i), RSS-GEN, 6.8, RSS-247, 5.4 (f) (ii). An intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

Systems operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

9.2 Antenna Connected Construction

The directional gain of the antenna used for transmitting is +3.3dBi (max), and the antenna is permanently mounted to the EUT (PCB trace) with no consideration of replacement. It is based on a TI 2.4-GHz Inverted F Antenna design.

9.3 Antenna Requirement Conclusion

The EUT antenna meets the requirements of FCC 15.203, 15.247 (4) (i), RSS-GEN, 6.8, and RSS-247, 5.4 (f) (ii).

10.0 MAXIMUM PERMISSIBLE EXPOSURE

10.1 Applicable Standards

FCC Part 2.1091, KDB 447498 D01 General RF Exposure Guidance v06 and RSS-102, Issue 5, March 2015, Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), Section 2.5. An intentional radiator shall be evaluated for radiofrequency radiation exposure to persons. This EUT is considered a mobile device in that it is intended to be used in other than fixed locations and to generally be used in such a way that a separation distance of less than or equal to 5mm is likely since the device is intended to be worn by a person.

10.2 MPE Calculations

General SAR test exclusion guidance is given in KDB 447498 D01 General RF Exposure Guidance v06, section 4.3. It states that for 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] X [√f(GHz)]

≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR, where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- The values 3.0 and 7.5 are referred to as numeric thresholds in step b) below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

Using this equation for determining the 1-g and 10-g SAR and using the worst case peak power measurements at the three channels tested and the worst case separation distance of 5.0 mm, the following was determined:

Channel	Frequency (MHz)	EIRP (mW)	EIRP (dBm)	*Minimum Test Separation Distance (mm)	SAR Test Exclusion Calculation (mW)	1-g SAR Exclusion if ≤ 3.0	10-g SAR Exclusion if ≤ 7.5
Low	2402.000	1.208151	0.82	5.00	0.310	EXCLUDED	EXCLUDED
Mid	2440.000	0.959669	-0.18	5.00	0.312	EXCLUDED	EXCLUDED
High	2480.000	0.901823	-0.45	5.00	0.315	EXCLUDED	EXCLUDED

10.2 MPE Calculations (continued)

Additionally, conducted peak power measurements were made at the three channels and these values were used for the SAR exclusion calculations.

Channel	Frequency (MHz)	Conducted Power (dBm)	Conducted Power (mW)	*Minimum Test Separation Distance (mm)	SAR Test Exclusion Calculation (mW)	1-g SAR Exclusion if ≤ 3.0	10-g SAR Exclusion if ≤ 7.5
Low	2402.000	3.4	2.17	5.00	0.620	EXCLUDED	EXCLUDED
Mid	2440.000	3.1	2.06	5.00	0.625	EXCLUDED	EXCLUDED
High	2480.000	2.9	1.97	5.00	0.630	EXCLUDED	EXCLUDED

RSS-102, Issue 5, March 2015, Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), Section 2.5.1 and 2.5.2 as applicable to this device, were also used to determine if the SAR exclusion would be met. The worst case peak power measurements at the three channels tested and the worst case separation distance of 5.0 mm was used to make the following determination.

Channel	Frequency (MHz)	EIRP (mW)	EIRP (dBm)	*Minimum Test Separation Distance (mm)	RSS-102, 2.5.1 Limit (mW)	RSS-102, 2.5.2 Calculation (W)	RSS-102, 2.5.1 Exclusion	RSS-102, 2.5.2 Exclusion	Excluded if 2.5.1 or 2.5.2 shows Exclusion
Low	2402.000	1.208151	0.82	5.00	4.26	2.68	EXCLUDED	EXCLUDED	EXCLUDED
Mid	2440.000	0.959669	-0.18	5.00	4.05	2.71	EXCLUDED	EXCLUDED	EXCLUDED
High	2480.000	0.901823	-0.45	5.00	3.94	2.74	EXCLUDED	EXCLUDED	EXCLUDED

Additionally, conducted peak power measurements were made at the three channels and these values were used for the SAR exclusion calculations.

Channel	Frequency (MHz)	Conducted Power (dBm)	Conducted Power (mW)	*Minimum Test Separation Distance (mm)	RSS-102, 2.5.1 Limit (mW)	RSS-102, 2.5.2 Calculation (W)	RSS-102, 2.5.1 Exclusion	RSS-102, 2.5.2 Exclusion	Excluded if 2.5.1 or 2.5.2 shows Exclusion
Low	2402.000	3.4	2.17	5.00	4.26	2.68	EXCLUDED	EXCLUDED	EXCLUDED
Mid	2440.000	3.1	2.06	5.00	4.05	2.71	EXCLUDED	EXCLUDED	EXCLUDED
High	2480.000	2.9	1.97	5.00	3.94	2.74	EXCLUDED	EXCLUDED	EXCLUDED

10.3 MPE Conclusion

Since the worst case peak power is below the SAR test exclusion power thresholds, the EUT is excluded from the SAR evaluation.

11.0 PHOTOGRAPHS

Helios Sports, Inc.

Helios Core (HC1)

Additional Photographs can be found in separate documents:

HC1 Tsup.pdf
HC1 Intpho.pdf
HC1 Extpho.pdf.

END OF TEST REPORT