Testing Tomorrow's Technology

Application for Certification

Per
Title 47 USC Part 2, Subpart J, Equipment Authorization Procedures, Paragraph 2.907, Certification and Part 15, Subpart C, Intentional Radiators, Paragraph 15.225, Operation within the band 13.110 to 14.010 MHz
And
Innovation, Science, and Economic Development Canada Certification Per
ICRSS-Gen General Requirements for Radio Apparatus
And
RSS-210 License-Exempt Radio Apparatus: Category I Equipment, Annex B (B.6), Devices Operating in Frequency Bands for any Application (Band 13.110-14.010 MHz)

For the

Skeg Product Development

IntelliHead Model: IHB

UST Project: 18-0197
Issue Date: October 26, 2018

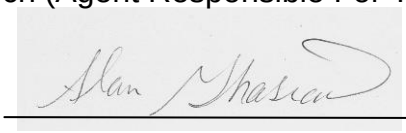
Number of Pages in this report: 15

3505 Francis Circle Alpharetta, GA 30004
PH: 770-740-0717 Fax: 770-740-1508
www.ustech-lab.com

Testing Tomorrow's Technology

I certify that I am authorized to sign for the test facility and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US Tech (Agent Responsible For Test):

By: 

Name: Alan Ghasiani

Title: President – Consulting Engineer

Date: October 26, 2018

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TESTING

NVLAP LAB CODE 200162-0

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MEASUREMENT/TECHNICAL REPORT

COMPANY NAME: Skeg Product Development
PRODUCT: IntelliHead
FCC ID: 2AQ2P-IHB
IC: 24263-IHB
DATE: November 16, 2018

This report concerns (check one): Original grant X
Class II change_____

Equipment type: 13.56 MHz NFC radio module

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until:_____
date

N.A. agrees to notify the Commission by N.A.
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

US Tech
3505 Francis Circle
Alpharetta, GA 30004

Phone Number: (770) 740-0717
Fax Number: (770) 740-1508

Table of Contents

Paragraph Title Page

List of Figures

Figure **Title** **Page**

List of Tables

Tables **Title** **Page**

1. General Information

This report is prepared as a means of presenting test data to be used by a Telecom Certification Body in determination of whether this product is permitted for unlicensed dissemination to the general public according to the Innovation, Science, and Economic Development Canada and FCC Rules and Regulations for RF Devices Intentional Radiators.

1.1 Product Description

The Equipment under Test (EUT) is the Skeg Product Development Model IntelliHead NFC radio module. The radio module is used within the IntelliHead IHB unit. The IHB unit is a self-contained automatic internet connected beverage pouring unit that is designed as a drop in replacement for traditional bar-top taps or as a mobile unit when combined with the IntelliKeg (a separate product to be used with IntelliHead system). The IHB is a fully integrated smart, high speed cashless serve system. The NFC radio module is used to track and charge customers each time they fill up their cups with beverage that is being dispensed by the IntelliHead.

The board has two identical NFC radios on board. One radio is designed to read RFID tags on the base of the IntelliCup the other radio is designed to read RFID tags on the handle of the IntelliCup.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on July 23, 2018 in good operating condition.

1.3 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

a) Certification of the transmitter.
b) Verification as a Class A digital device.

2. Tests and Measurements

2.1 Configuration of Tested System

The Test sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* to show compliance to CFR 47, Part 15.225 & RSS-210, B.6.

All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the resolution bandwidth or off throughout the evaluation process. There were no interconnecting cables to manipulate in an attempt to maximize emissions; however, the physical position of the EUT was varied through the three mutually exclusive orthogonal planes in an attempt to maximize the emissions. The worse case position is the position used for final measurements and is gathered in this test report. A block diagram of the tested system is shown in Figure 1.

2.2 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and registered with the FCC, under site registration number US5301. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1 and is also a NVLAP accredited test lab; lab code 200162-0.

2.3 Test Equipment

Table 1. EUT and Peripherals

EUT MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
NFC radio board Skeg Product Development (EUT)	IntelliHead	Engineering Sample	Pending: FCC ID: 2AQ2P-IHB IC: 24263-IHB	N/A
PERIPHERAL MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC/IC ID:**	**CABLES P/D**
Raspberry Pi (development board)	Raspberry Pi 3B	Various	Various	N/A
Meanwell Power Supply	GST40A12	None	None	1.5 m U P

S= Shielded, U=Unshielded, P= Power line, D= Data line

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	9/22/2018
SPECTRUM ANALYZER*	E4407B	AGILENT	US41442935	8/17/2019
SPECTRUM ANALYZER	DSA815	RIGOL	DSA8A18030 0138	10/11/2018
LOOP ANTENNA	6502	EMCO	9810-3246	1/22/2020 2 yr cal
BICONNICAL ANTENNA	3110B	EMCO	9306-1708	5/22/2019 2 yr cal
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	5/01/2019 2 yr cal
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	3/07/2019
LISN	9247-50-TS-50-N	SOLAR ELECTRONICS	955824/ 955825	3/19/2019
CALCULATION PROGRAM	N/A	N/A	Ver. 6.0	NOT REQUIRED

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

(*) Spectrum Analyzer used to perform occupied bandwidth measurement on pg. 14

2.4 EUT Antenna Description (FCC Sec. 15.203, RSS-Gen 6.8)

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 Skeg Product Development, Model IntelliHead incorporates the antennas detailed in Table 3.

Table 3. Antenna Description

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	TYPE OF CONNECTOR
None	Skeg Product Development	PCB coil	NFC	u.fl connector

2.5 Modifications to Equipment

No modifications were needed to bring the EUT into compliance with the FCC Part or IC RSS requirements.

2.6 Test Procedure

The EUT was configured as shown in the following block diagram(s) and photograph(s). The sample was tested per ANSI C63.10:2013. Conducted and radiated emissions data were taken with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz depending on the frequency range of testing, 150 kHz-30 MHz or 30 MHz to 1000 MHz, respectively. All measurements are peak unless stated otherwise. The video filter on the spectrum analyzer was set to 3x the RBW throughout the evaluation process. Interconnecting cables were manipulated as necessary to maximize emissions. The EUT was rotated 360 degrees with the turntable to maximize emissions. The physical position of the EUT was varied through the three mutually exclusive orthogonal planes in an attempt to maximize the emissions. The worst case data is presented in the test report.

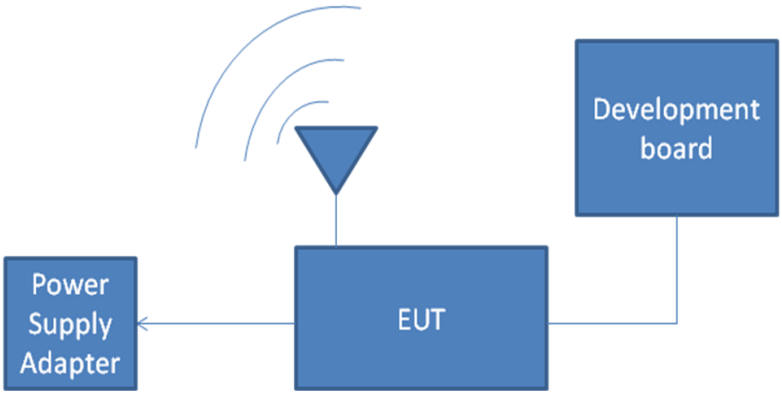

Figure 1. Block Diagram of Test Configuration

2.7 Transmitter Output Power (RSS Gen, 6.12)

Transmit output power measurements shall be carried out before the unwanted emissions test. The transmitter output power value, obtained from this test serves as the reference level used to determine the unwanted emissions. For comparative purposes the measurements of emission power and unwanted emissions can be in peak or average provided that the same parameter is used when measuring both.

The following formula may be used to convert field strength (FS) in volts/meter to transmitter output power (TP) in watts:

$TP= (FS \times D)^2 / (30 \times G)$

D= distance in meters between the two antennas and G= antenna gain numeric

2.8 Intentional Radiator, Power Line Conducted Emissions (47 CFR 15.207)(RSS Gen, 8.8)

Power line conducted emissions testing for license exempt devices was performed according to ANSI C63.10:2013. The test data is presented in the sections below.

2.9 Field Strength of Fundamental (47 CFR 15.225, RSS-210, B.6)

The results of the measurements for peak fundamental emissions are given in Table 4. The EUT emissions measurement was started by setting up the Antenna in the vertical orientation at a distance of 3 meters from the EUT and at a height of 1.0 meters above the ground. The EUT's major axis was set normal to the direction of the measuring antenna.

The Spectrum Analyzer (SA) displays were set to: Channel A free-running, Channel B to Max-Hold. Choose a frequency or frequency range and scan it at a coupled rate. When a signal is detected, raise and lower the antenna to maximize the signal.

When the signal has been maximized, the antenna height is fixed the turn-table is rotated through 360 degrees to further maximize the signal.

When all signals have been maximized for antenna height and direction, the EUT case is carefully maneuvered in each of the three mutually exclusive orthogonal planes while observing the same Max-hold/free-running SA display indication. When the EUT position is found that further maximizes the signal, record the antenna height, rotation orientation, EUT orthogonal position and signal strength on the data sheet for that particular frequency.

Next, the measurement antenna is re-oriented to a Horizontal polarization at 1 meter height and the process described above is repeated. All signals within 6 dB of the limit are recorded.

Finally, the collected data is input into the calculation spread sheet. The spread sheet is designed to calculate for the true value that is collected. The spread sheet takes into account the SA reading, the antenna correction factor, cable losses and duty cycle factors. See the data tables herein.

2.10 Limits for Operation within the Band 13.110-14.010 MHz (CFR15.225, RSS-210, B.6)

This limit versus frequency table is as follows (test distance = 3.0 meters):

Frequency (MHz)	Field Strength @ 30m (uV/m)	Field Strength @ 30m (dBuV/m)	Field Strength @ 3m (dBuV/m)
13.553-13.567	15848	84	124
13.410-13.553	334	50.5	90.5
13.567-13.710	334	50.5	90.5
13.110-13.410	106	40.5	80.5
13.710-14.010	106	40.5	80.5
Any emissions outside of the band 13.110-14.010 MHz shall not exceed the limits in 15.209			

Note: formula 1: dBuV/m= 20 log (uV/m)
2: 3m distance = (dBuV/m@30m) + 40 log (30/3)

The frequency spectrum above the fundamental to its 10^{th} harmonic shall be examined and measured for signals falling into the restricted bands of 15.205. If average emissions measurements are employed, the provisions in 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Spurious and harmonics shall meet the requirements of the above table or the requirements of 15.209, whichever requirement permits a higher field strength.

Table 4. Intentional Radiated Emissions Fundamental

Tested By:	Test: Part 15C, Para 15.231	Client: Skeg Product Development
AF	Project: 18-0197	Model: IntelliHead

Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	PK Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Method
NFC Radio 1 (base scanner)							
13.56	33.82	11.60	45.42	124.0	3 meter	78.6	**PK**
13.56	33.28	11.60	44.88	124.0	3 meter	79.1	**AVG**
NFC Radio 2 (handle scanner)							
13.56	31.40	11.60	43.00	124.0	3 meter	81.0	**PK**
13.56	30.55	11.60	42.15	124.0	3 meter	81.9	**AVG**

No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 13.56:

Magnitude of Measured Frequency	33.82	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	11.60	dB/m
Corrected Result	45.42	dBuV/m

Test Date: July 25, 2018
Tested By

Signature: Afzal Fazal Name: Afzal Fazal

2.11 Radiated Spurious Emissions other than Fundamental (CFR 15.209, 15.225, RSS-Gen 8.8, 8.9)

The EUT was placed in a state representative of how the device will function under normal operation. The radiated spurious emissions were measured over the frequency range of 9 KHz to 30MHz and 30 MHz to the 10th harmonic of the fundamental frequency of the intentional transmitter or 1000 MHz whichever is higher. The test results are shown below.

Table 5. Spurious Radiated Emissions, 9 kHz - 30 MHz

9 kHz to 30 MHz, 15.209 limits							
Test: Radiated Emissions				**Client:** Skeg Product Development			
Project: 18-0197				**Model:** IntelliHead			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
Worst case emissions from both NFC 1 & 2							
0.50	23.56	11.54	35.10	48.0	3 meter	12.9	**AVG**
1.85	11.74	11.77	23.51	48.0	3 meter	24.5	**AVG**
27.12	16.74	9.66	26.40	69.5	3 meters	43.1	**PK**
No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic.							

Sample Calculation at 0.500 MHz:

Magnitude of Measured Frequency	23.56	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	11.54	dB/m
Corrected Result	35.10	dBuV/m

Test Date: July 25, 2018
Tested By

Signature: Afzal Fazal Name: Afzal Fazal

Table 6. Spurious Radiated Emissions

>30 MHz 15.209 Limits							
Test: Radiated Emissions				**Client:** Skeg Product Development.			
Project: 18-0197				**Model:** IntelliHead			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
NFC Radio 1							
73.70	48.55	-17.61	30.94	40.0	3m./HORZ	9.1	**PK**
30.00	48.26	-12.32	35.94	40.0	3m./HORZ	4.1	**PK**
67.80	42.44	-17.49	24.95	40.0	3m./HORZ	15.0	**PK**
81.36	44.92	-17.37	27.55	40.0	3m./HORZ	12.5	**PK**
122.04	42.00	-14.81	27.19	43.5	3m./HORZ	16.3	**PK**
135.60	42.96	-13.98	28.98	43.5	3m./HORZ	14.5	**PK**
NFC Radio 2							
67.80	41.17	-17.49	23.68	40.0	3m./HORZ	16.3	**PK**
81.36	43.10	-17.37	25.73	40.0	3m./HORZ	14.3	**PK**
108.48	41.85	-15.93	25.92	43.5	3m./HORZ	17.6	**PK**
122.04	39.68	-14.81	24.87	43.5	3m./HORZ	18.6	**PK**
135.60	42.48	-13.98	28.50	43.5	3m./HORZ	15.0	**PK**
40.68	43.37	-15.99	27.38	40.0	3m./VERT	12.6	**PK**
67.80	42.87	-18.19	24.68	40.0	3m./VERT	15.3	**PK**
81.36	42.84	-17.77	25.07	43.5	3m./VERT	18.4	**PK**
135.60	45.16	-13.68	31.48	43.5	3m./VERT	12.0	**PK**
All other emissions greater than 20 dB below the applicable limit.							

Sample Calculation at 73.70 MHz:

Magnitude of Measured Frequency	48.55	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-17.61	dB/m
Corrected Result	30.94	dBuV/m

Test Date: July 25, 2018
Tested By

Signature: Afzal Fazal Name: Afzal Fazal

2.12 Power Line Conducted Emissions (CFR 15.207, RSS-Gen 8.8, 8.9)

Table 7. Power Line Conducted Emissions

150 KHz to 30 MHz						
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
0.1523	47.08	0.50	47.58	55.9	8.3	**PK**
0.6483	35.47	0.14	35.61	46.0	10.4	**PK**
1.9930	36.10	0.16	36.26	46.0	9.7	**PK**
5.9580	32.58	0.26	32.84	50.0	17.2	**PK**
19.9600	35.98	0.63	36.61	50.0	13.4	**PK**
20.9670	35.95	0.65	36.60	50.0	13.4	**PK**
0.3093	43.61	0.35	43.96	50.0	6.0	**PK**
0.6500	36.24	0.28	36.52	46.0	9.5	**PK**
1.7330	38.14	0.31	38.45	46.0	7.6	**PK**
5.9330	33.78	0.41	34.19	50.0	15.8	**PK**
18.9600	31.12	0.69	31.81	50.0	18.2	**PK**
20.3670	34.64	0.72	35.36	50.0	14.6	**PK**

Sample Calculation at 0.1523 MHz:

Magnitude of Measured Frequency	47.08	dBuV
+ (LISN+CL-PA)	0.50	dB
Corrected Result	47.58	dBuV

Test Date: July 27, 2018
Tested By

Signature: Afzal Fazal Name: Afzal Fazal

2.13 Bandwidth of Fundamental (CFR15.215)

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. 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.

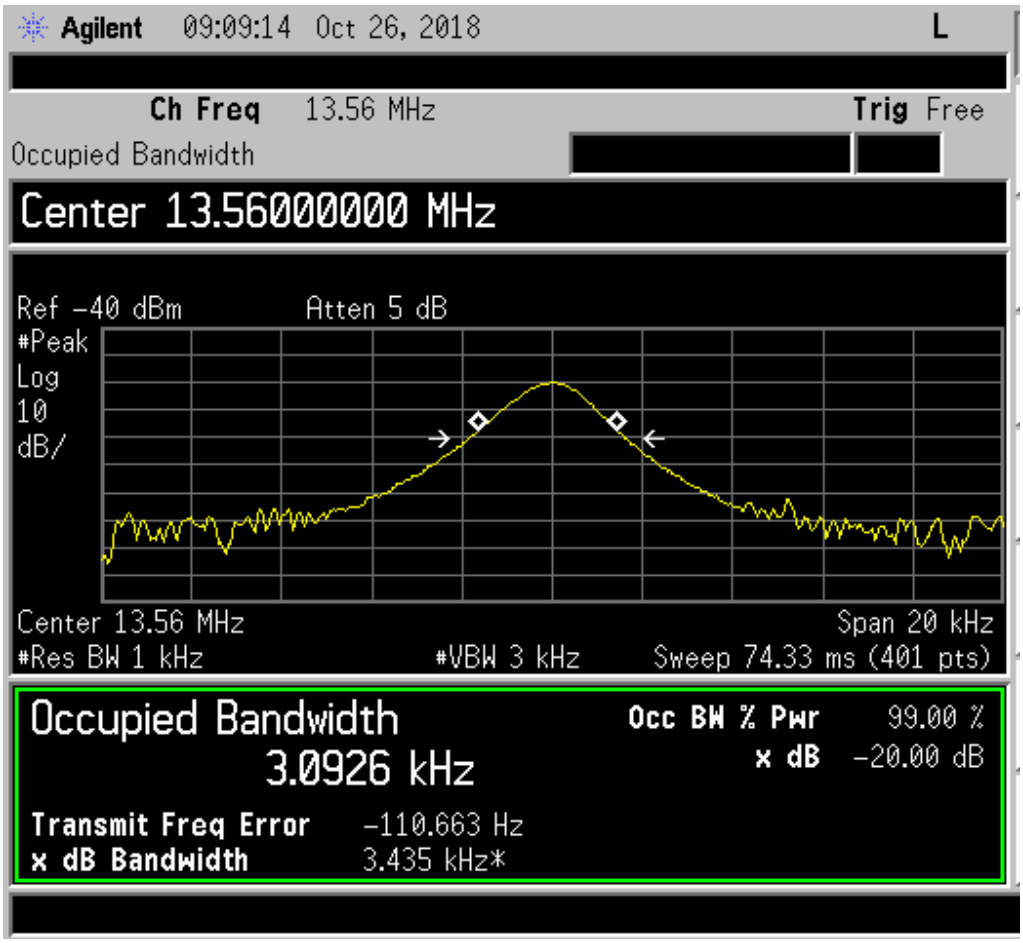

Figure 2. EUT Bandwidth Measurement (20 dB & 99%)

2.14 Frequency Stability

The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency over a temperature variation of -30 degrees to +50 degrees C

< 0.01% = 100 PPM = 0.0001

Table 8. Frequency Deviation/Stability

Temperature (degrees C)	Measured Frequency (MHz)	Deviation (ppm)		
13.5602610				
-30	13.5601850	-5.6	13.5601760	13.5601680
-20	13.5602040	-4.2	13.5602040	13.5602150
-10	13.5602490	-0.9	13.5602490	13.5602490
0	13.5602490	-0.9	13.5602490	13.5602490
10	13.5602490	-0.9	13.5602460	13.5602460
20	13.5602040	-4.2	13.5602018	13.5602200
30	13.5602110	-3.7	13.5602050	13.5602020
40	13.5601900	-5.2	13.5601870	13.5601840
50	13.5601550	-7.8	13.5601550	13.5601580

Test date: July 27, 2018

Tested By
Signature: Afzal Fazal Name: Afzal Fazal