



Test Report No. 9612327916

For MUV Interactive Ltd

Equipment Under Test:

Brand Mark: Bird

***Model: Thimble V1.3,
FCC ID: 2AKCX-TH1***

***From The Standards Institution
Of Israel
Industry Division
Electronics & Telematics Laboratory
EMC Branch***



Certificate Number: AT-1359



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Model: Thimble V1.3

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1. Applicant information

Applicant:	MUV Interactive Ltd.
Address:	Medinat ha Yehudim 99, Herzliya, P.O.B. 4676677, Israel
Sample for test selected by:	The customer
The date of tests:	27 September, 5, 13 October 2016

Equipment under test information

Description of Equipment Under Test (EUT):	Transmit system for motion and finger navigation.
Brand mark:	Bird
Model:	Thimble V1.3
Hardware version:	1.3.5
Software version:	5.2.0

2. Test performance

Location: SII EMC Branch

Purpose of test: Apparatus compliance verification in accordance with emission requirements

Test specifications: 47CFR part 15.247, 15.205, 15.207, 15.209 and part 1 §1.1310

This Test Report contains 31 pages and may be used only in full.

This Test Report applies only to the specimen tested and may not be applied to other specimens of the same product.

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FCC 47 CFR Part 15, Subpart C, 2015	Radio Frequency Devices Subpart C – Intentional Radiators
IC RSS – 247 issue 1, 2015	Radio Standard Specification, Issue 1, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.4: 2014	American National Standard for Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10: 2013	American National Standard for Testing of Unlicensed Wireless Devices.
RSS – Gen , 2014	Radio Standard Specification, Issue 4, General Requirements for Compliance of Radio Apparatus
FCC OET KDB 558074, April 2017	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

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The EUT was found to comply with requirements of: 47CFR Part 15, §§ 15.247, 15.203, 15.205, 15.207, 15.209 and IC RSS - 247.

Transmitter characteristics	Subclasses
Minimum 6 dB bandwidth	15.247(a)(2); RSS-247 section 5.2(1)
Maximum output power	15.247(b)(3); RSS-247 section 5.4(4)
Peak power spectral density	15.247(e); RSS-247 section 5.2(2)
Out of band spurious emissions radiated	15.205, 15.247(d); RSS-247 section 5.5
Unwanted radiated emissions below 1 GHz	15.209; RSS-247 section 3.1
Conducted emissions on AC power line	15.207; RSS-Gen section 8.8
Antenna Requirement	15.203

Electronics and
Telematics Laboratory

April 2016

Name: Eng. Yuri Rozenberg
Position: Head of EMC Branch.

Name: Michael Feldman.
Position: Test engineer.

Measurement uncertainty.

The test equipment was calibrated according to its recommended procedures and is within the manufacturer's published limit of error.

The laboratory calibrates its standards by a third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements.

In the following table the uncertainty calculation is given.

Test description	Calculated uncertainty U_{LAB}
Conducted measurements	
Frequency error	37.6 Hz
Spurious emission	± 2.98 dB
Radiated emissions	
Electric field strength in a SAR at 3 m distance 30 MHz – 1.0 GHz	± 4.32 dB
Electric field strength in a FAR at 3 m distance 1.0 GHz – 18 GHz	± 4.47
Substitution measurements	
In a FAR at 3 m distance 1.0 GHz – 18 GHz	± 3.41 dB

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4. Equipment under test description.

*The description provided by applicant.

4.1 General description

Thimble consists of several sensors, motion and finger navigation. CPU collects data from all of the sensors and transmits through ZigBee communication to Base Unit. Both ends are based on Freescale MC13234 chip.

Base Unit collects data from IR Camera sensor, and transmits it together with Thimble data to client application (PC or mobile device) through Bluetooth RN42 Microchip module. Client application receives data from Base Unit and uses it for emulating input devices (mouse, etc).

Used of permanent, industrial epoxy to make the enclosure fixed prior before shipping to fulfil the 15.203 antenna requirements.

EUT technical characteristics

Assigned frequency band	2400 MHz – 2483.5 MHz	Carrier frequencies.
Operating frequency range	2405 MHz – 2480 MHz	Flow - 2405 MHz Fmidl – 2445 MHz Fhigh – 2480 MHz
RF channel spacing:	5 MHz	
Type of modulation:	Q-QPSK up to 250 Kbit	
Antenna information		
Radio Device	Antenna Type	Manufacturer
Thimble	Internal on PCB	MUV Interactive.
Model	Antenna gain, dBi	
ANT-2A	0	

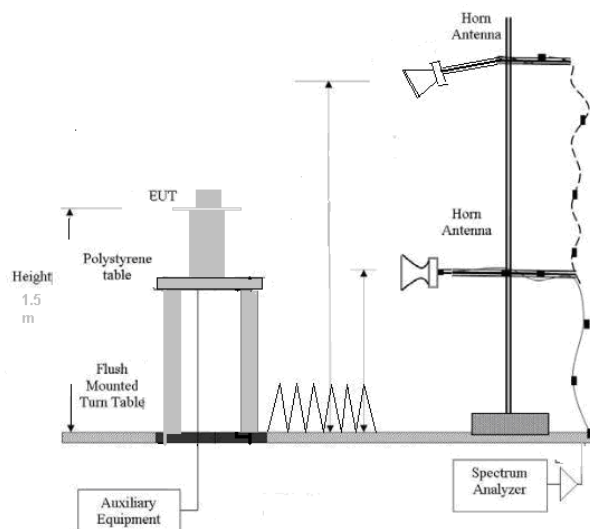


Fig.1. RE test setup above 1 GHz.

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5. Test results

5.1 Transmitter characteristics

5.1.1 Transmitter 6 dB occupied bandwidth.

Method of measurement 558074 D01 DTS Meas Guidance. Section 8.1
Operating Frequency Range 2405– 2480 MHz
Detector used Peak
Resolution bandwidth 100 kHz
Video bandwidth > 3 x RBW.
Trace mode Max Hold.
Sweep time: Auto couple.
Ambient Temperature 24° C Relative Humidity 55% Air Pressure 1011 hPa

The minimum 6 dB occupied bandwidth shall be at least 500 kHz.

Carrier frequency, MHz	Measured 6 dB occupied bandwidth, MHz	Limit, kHz	Reference to plot#
2405	1.46	500	1
2445	1.42	500	2
2480	1.68	500	3

TEST EQUIPMENT USED:

1	3	14				
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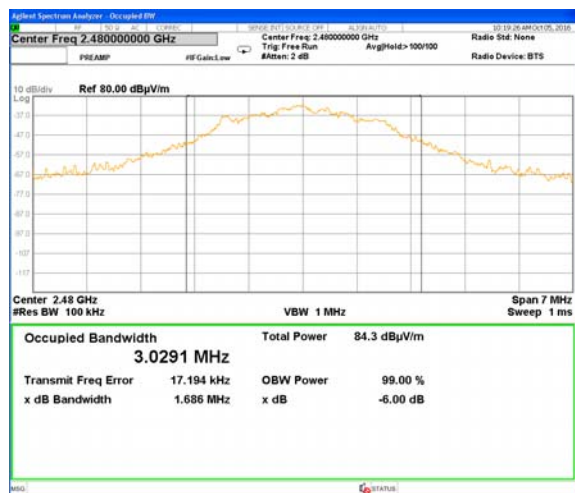
FCC ID: 2AKCX-TH1



Plot # 1



Plot # 2



Plot # 3

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Method of measurement	558074 D01 DTS Meas Guidance. Section 3.				
Operating Frequency Range	2405– 2480 MHz				
Detector used	RMS				
Resolution bandwidth	1 MHz				
Video bandwidth	3 x RBW.				
Trace mode	Max Hold.				
Ambient Temperature	24° C	Relative Humidity	55%	Air Pressure	1011 hPa

For Digital Transmit System the peak conducted output power in the 2400 – 2483.5 MHz band shall not exceed 1W (30 dBm) with antennas gain that do not exceed 6 dBi. or 4W (36 dBm) EIRP.

Carrier frequency, MHz	Field strength, dBμV/m	99% OBW, MHz	*Conducted output power, dBm	Conducted power limit, dBm	**EIR power, dBm	EIRP limit, dBm	Reference to plot #
2405	80.58	2.90	-10.0	30	-10.0	36	10
2445	79.16	2.89	-11.5	30	-11.5	36	11
2480	78.68	3.02	-11.7	30	-11.7	36	12

*The maximum conducted output power = EIR power – Antenna gain.

Thimble antenna gain = 0 dBi.

**EIR power = E Field strength (dBμV/m@3m) - 95.2 + (10 Log OBW).

Measured field straight level was converted to EIRP level and compute by integrating across the occupied bandwidth. The measurement of EIRP provided after verification according to ANSI/TIA-603-D-2010 substitution test method. EUT was replaced by generator and substitution antenna. Result calculated from generator output level, substitution antenna gain and loss of connected cable was used for EIRP calculation.

Transmitter was operated at continuous transmit mode at bottom, middle and top of the 2400 – 2483.5 MHz frequency band.

TEST EQUIPMENT USED:

1	2	3	5	8	9	14
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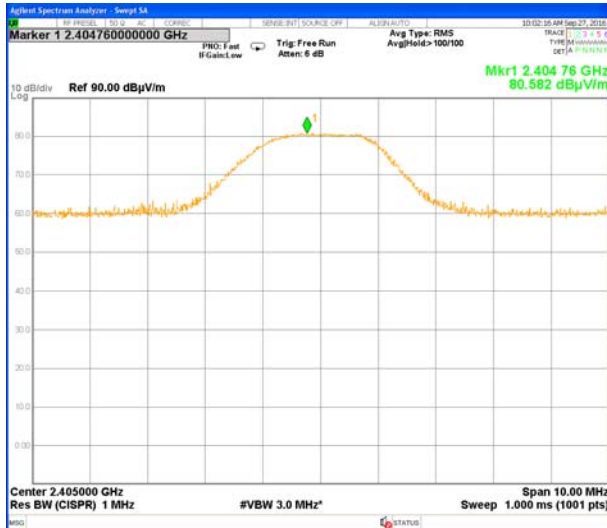
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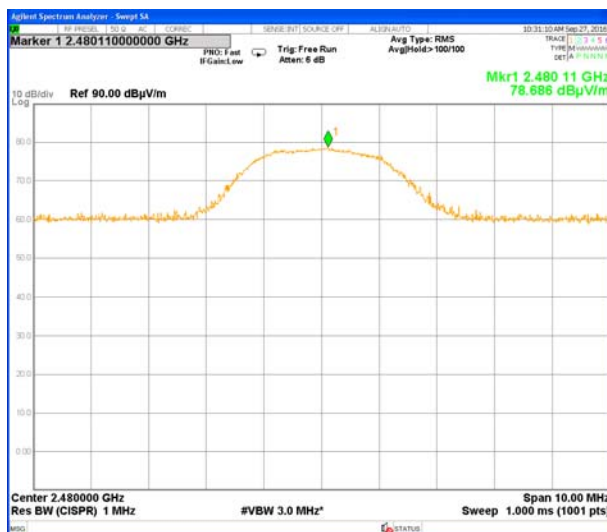
FCC ID: 2AKCX-TH1



Plot # 4. Carrier frequency – 2405 MHz



Plot # 5. Carrier frequency – 2445 MHz



Plot # 6. Carrier frequency – 2480 MHz.

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5.1.3 Power spectral density test

Operating Frequency Range: 2405– 2480 MHz
Detector used: RMS
Resolution bandwidth: 10 kHz
Video bandwidth: 3 x RBW.
Trace mode: Max Hold.
Duty cycle during the test: 11%
Ambient Temperature 24° C **Relative Humidity** 55% **Air Pressure** 1011 hPa

For digitally modulated systems, the power spectral density, conducted from the intentional radiator to the antenna, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Carrier frequency, MHz	Field strength, dBμV/m	*Conducted PSD, dBm	Conducted PSD limit, dBm/3 kHz	Reference to plot #
2405	66.9	-24.0	8	16
2445	65.2	-25.7	8	17
2480	66.3	-24.6	8	18

*The maximum conducted to antenna PSD:

EIR power – Antenna gain. Thimble antenna gain = 0 dBi.

$EIRP = E \text{ Field strength (dB}\mu\text{V/m@3m)} - 95.2 + 10 \text{ Log (3 kHz RBW/ 10 kHz RBW)} + 10 \text{ Log (1/x)}$.

Where x = duty cycle.

TEST SUMMARY

The EUT was found complies with standard requirement.

TEST EQUIPMENT USED:

1	3	14				
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Plot # 7



Plot # 8



Plot # 9



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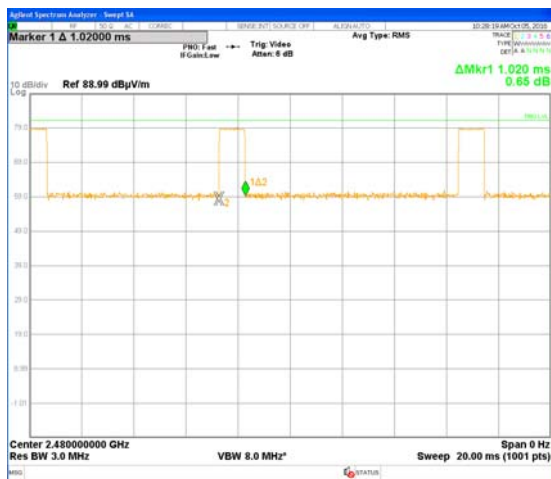
FCC ID: 2AKCX-TH1

Duty cycle correction factor during the PSD test

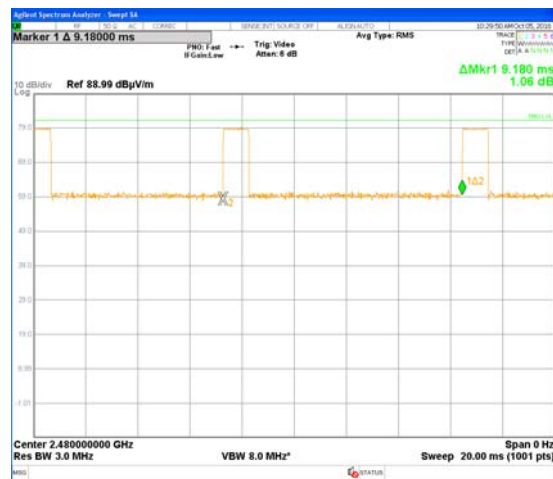
Tx on / (Tx on + Tx off)

1.02 ms / 9.18 ms = 0.11 ms

10 Log (1/0.11) = 9.5 dB



Plot # 10



Plot # 11

**Test report No:** 9612327916**Page 14 of 31 Pages****Brand Mark:** Bird**Model:** Thimble V1.3**FCC ID:** 2AKCX-TH1**5.1.4 Radiated emissions according to §§ 15.247(d), 15.205(a)**

Method of measurement	558074 D01 DTS Meas Guidance. Sec. 12.1.					
Operating Frequency Range	2405– 2480 MHz					
Detector used:	Trace 1 – Peak; Trace 2 - RMS					
Resolution bandwidth	1 MHz/100 kHz					
Video bandwidth	3x RBW.					
Trace mode:	Trace 1 – Max hold; Trace 2 – Power averaging.					
Ambient Temperature	24° C	Relative Humidity	55%	Air Pressure	1011 hPa	

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

In addition, radiated emissions, which fall in the restricted bands, as, defined in Section 15.205(a) must also comply with the radiated emission limits specified in Section 15.209(a).

Carrier frequency 2405 MHz

Frequency, MHz	Radiated emissions, dB μ V/m	Peak limit, dB μ V/m	Avg limit, dB μ V/m	Margin, dB	Note	Note	Reference to plot#
2339.9	53.4	74	-	>20	*RB	Detector peak	12
2341.3	44.9	-	54	9.1	RB	Detector average	12
2494.3	54.8	74.0	-	19.2	RB	Detector peak	14
2494.3	42.4	-	54	11.6	RB	Detector average	14
4810.0	54.5	74.0	-	19.5	RB	Detector peak	15
4810.0	44.1	-	54	9.9	RB	Detector average	15

*RB – restricted band

Carrier frequency 2445 MHz

Frequency, MHz	Radiated emissions, dB μ V/m	Peak limit, dB μ V/m	Avg limit, dB μ V/m	Margin, dB	Note	Note	Reference to plot#
2369.1	53.3	74	-	>20	RB	Detector peak	18
2378.8	41.4	-	54	12.6	RB	Detector average	18
2390.7	44.3	55.3	-	11.0	Band edge	Detector peak.	20
4890.5	57.5	74	-	16.5	RB	Detector peak	22
4890.5	45.6	-	54	8.4	RB	Detector average	22

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Carrier frequency 2480 MHz

Frequency, MHz	Radiated emissions, dB μ V/m	Peak limit, dB μ V/m	Avg limit, dB μ V/m	Margin, dB	Note	Note	Reference to plot#
2387.2	51.5	74	-	>20	*RB	Detector peak	25
2367.7	40.0	-	54	14.0	RB	Detector average.	25
2483.5	59.3	74	-	14.7	RB	Detector peak	28
2483.5	44.8	-	54	9.2	RB	Detector average	28
5377.0	58.9	74	-	15.1	RB	Detector peak	29
5377.0	47.3	-	54	6.7	RB	Detector average	29

*RB – restricted band

TEST SUMMARY

All emissions outside of the 2400 – 2483.5 MHz frequency band were found below 15.247(d) limits.

TEST EQUIPMENT USED:

1	3	4	10	14	15	
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Carrier frequency – 2405 MHz.



Plot # 12



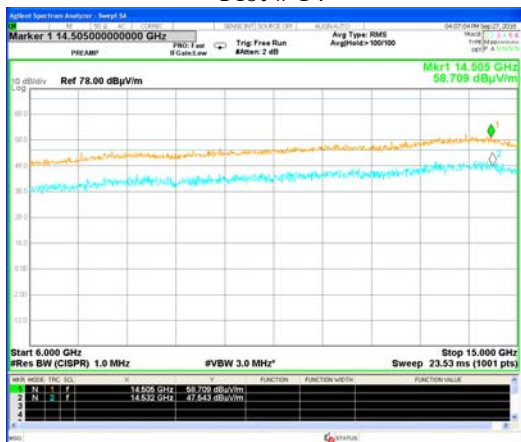
Plot # 13



Plot # 14



Plot # 15



Plot # 16.



Plot # 17.



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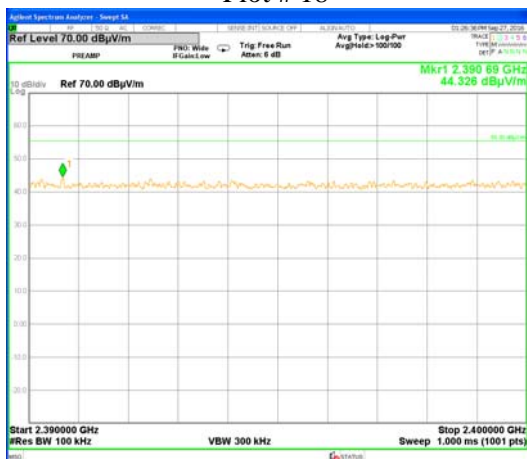
Brand Mark: Bird

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Carrier frequency - 2445 MHz.





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Plot # 24

Carrier frequency 2480 MHz.



Plot # 25



Plot # 26



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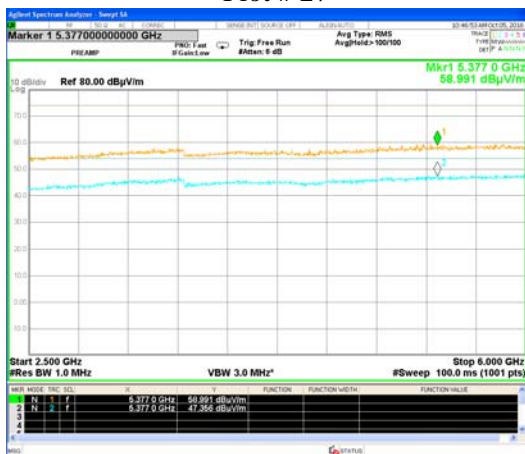
FCC ID: 2AKCX-TH1



Plot # 27



Plot # 28



Plot # 29



Plot # 30



Plot # 31

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5.2 Radiated emissions test according to § 15.209

Method of measurement	ANSI C63.10 §6.5				
Detectors used	CISPR Quasi-Peak				
Resolution bandwidth	9 kHz/120 kHz				
Video bandwidth	>3 x RBW.				
Trace mode	Free run				
Ambient Temperature	24° C	Relative Humidity	55%	Air Pressure	1009 hPa

TEST DESCRIPTION:

The measurements were performed at 3 m test distance in Anechoic chamber. The EUT was arranged on a polystyrene table 0.8 m height placed on the turn - table. The Active Loop antenna in 9 kHz to 30 MHz frequency band and Biconilog antenna in 30 MHz – 1.0 GHz frequency band were used. The emission level was maximized by initially rotating turntable through 360°, varying the antenna height between 1 m and 4 m, rerouting EUT cables and changing antenna polarization from vertical to horizontal.

REQUIREMENTS:

EUT radiated emission shall not exceed value required in section 15.209

TEST RESULT:

Test results are presented in a table below and in plots ## 32, 33

TEST EQUIPMENT USED:

1	6	14	16			
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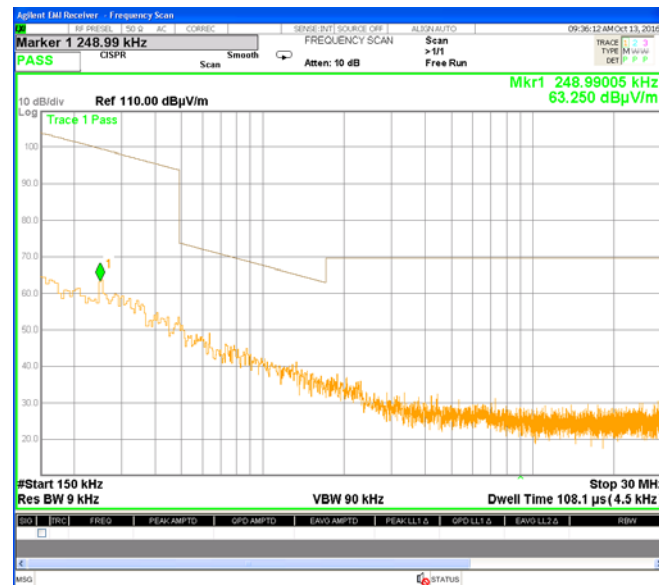
Brand Mark: Bird

Model: Thimble V1.3

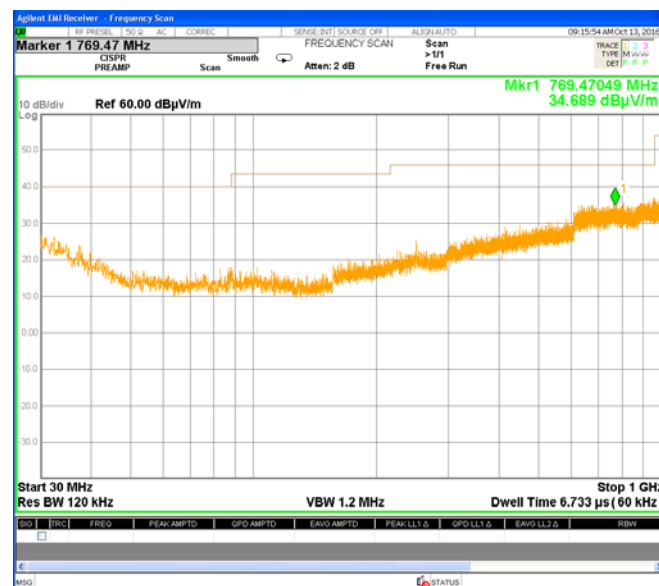
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Thimble test results present in plots 32, 33 and are at least 15 dB below the limit.



Plot # 32. Investigation result in 0.15 – 30 MHz frequency range.



Plot # 33. Investigation result in 30 - 1000 MHz frequency range.

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Method of measurement	ANSI C63.10 §6.2		
Ambient Temperature	23 ⁰ C	Relative Humidity	54% Air Pressure 1008 hPa

Frequency, MHz	Conducted limit, dB μ V	
	QP	AVRG
0.15 - 0.5	66 - 56*	56 - 46*
0.5 - 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

EUT was placed on a wooden table in a shielded chamber at a height of 80 cm from the floor and 40 cm from the vertical reference plane. The measurements were performed at mains terminals by means of LISN, connected to spectrum analyzer. The measurements were made with quasi-peak and average (CISPR) detectors.

AC main line test was performed for Thimble unit connected to USB port of auxiliary laptop.

TEST RESULTS:

Thimble test results in charging mode present in plots # 34, 35.

TEST EQUIPMENT USED:

7	12	13			
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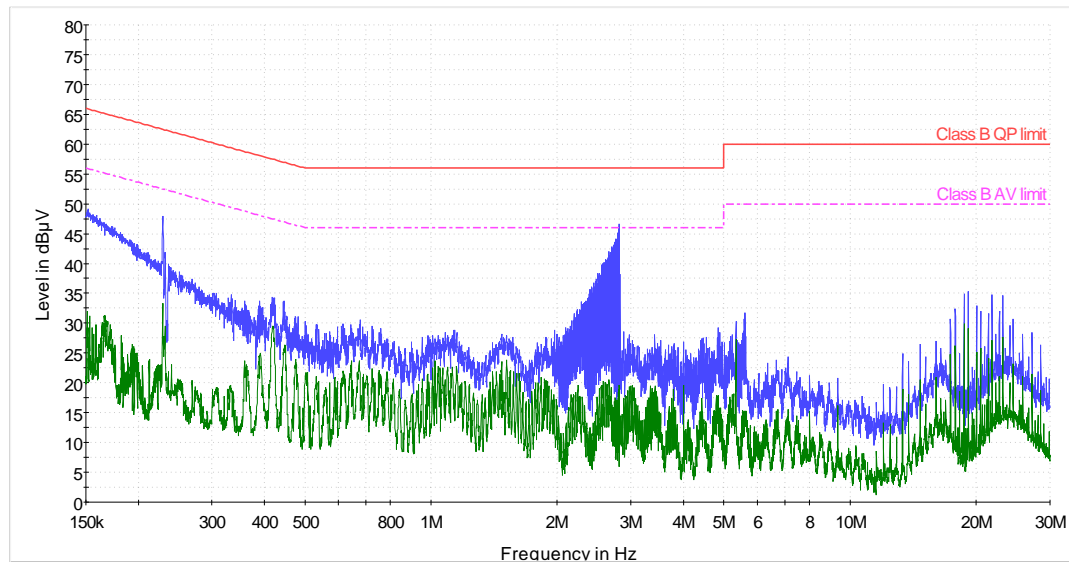
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Frequency MHz	QP dBμV	Limit QP dB	Margin dB	Avg. dBμV	Limit Avg dB	Margin dB
0.229	30.8	62.5	-31.6	20.6	52.5	-31.9
2.61	33.6	56.0	-22.4	14.9	46.0	-31.0
2.80	43.2	56.0	-12.8	15.5	46.0	-30.5



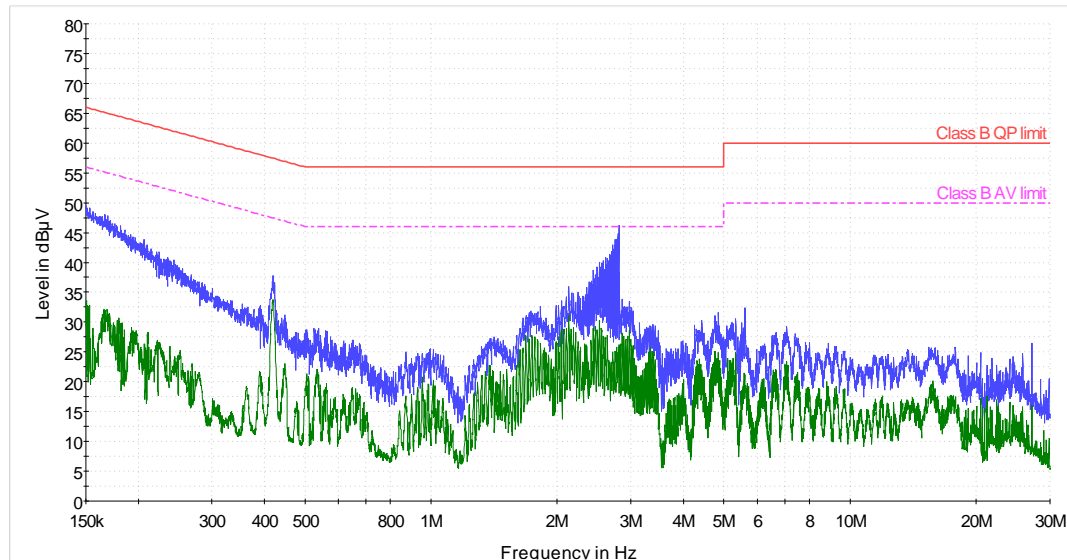
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Plot # 35. AC line conducted emissions test. Line Neutral.

Frequency MHz	QP dBμV	Limit QP dB	Margin dB	Avg. dBμV	Limit Avg. dB	Margin dB
0.42	34.4	57.4	-23.0	32.7	47.4	-14.7
2.52	33.5	56.0	-22.5	29.0	46.0	-17.0
2.97	30.9	56.0	-25.1	26.7	46.0	-19.3

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No	Description	Manufacturer information			Due Calibration date
		Name	Model	Serial No	
1	MXE EMI Receiver 20 Hz -26.5 GHz	Agilent	N9038A	SII 650114	March 2017
2	Cable RF 1m	Huber-Suhner	Sucoflex 104	21325/4PE	October 2017
3	Double Ridged Guide Antenna 0.75 – 18 GHz	ETS-Lindgren	3115	00143138	December 2016
4	Broadband Horn antenna 15 – 40 GHz	Schwarzbeck Mess-Electronik	BBHA 9170	9170-341	December 2016
5	Double Ridged Waveguide Horn Antenna 1 – 18 GHz	ETS-Lindgren	3117	00139055	December 2016
6	Antenna Biconilog 26 – 6000 MHz	ETS-Lindgren	31142D	0146490	December 2016
7	Spectrum analyzer 20 Hz-40 GHz	Rohde&Schwarz	ESU 40	100168	November 2017
8	MXG Signal Generator 100 KHz - 20 GHz	Agilent	N5183A	6501148	May 2017
9	Attenuator 3 dB DC – 12.4 GHz	HP	8491A	50469	October 2017
10	USB preamplifier 2 GHz – 50 GHz	Keysight	U7227F	MY55380004	January 2017
11	EMI Receiver 9 kHz-6.5 GHz	HP	8546A+85460A	SII 4068	May 2017
12	LISN 9 kHz – 30 MHz	Mess-Electronic	NSLK 8128 4x32 (50A)	SII 6677	February 2017
13	Transient limiter 0.009-200 MHz	HP	11947A	3107105	August 2017
14	Cable RF 4m	Huber-Suhner	Sucoflex 104PE	21329/4PE	October 2017
15	Cable RF 0.5m	Huber-Suhner	Multiflex 141	520201	October 2017
16	Active Loop antenna 1.0 kHz – 30 MHz	ETS-Lindgren	6507	00144641	December 2016



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Cable Loss (Mast 6 m set cable.)

Point	Frequency (MHz)	Cable Loss (dB)	Point	Frequency (MHz)	Cable Loss (dB)
1	30	0.3	21	1000	2.5
2	50	0.4	22	1100	2.6
3	100	0.6	23	1200	2.8
4	150	0.8	24	1300	2.9
5	200	1.0	25	1400	3.1
6	250	1.1	26	1500	3.2
7	300	1.2	27	1600	3.3
8	350	1.3	28	1700	3.5
9	400	1.5	29	1800	3.6
10	450	1.6	30	1900	3.7
11	500	1.7	31	2000	3.9
12	550	1.8	32	2100	4.0
13	600	1.9	33	2200	4.1
14	650	1.9	34	2300	4.2
15	700	2.0	35	2400	4.4
16	750	2.1	36	2500	4.6
17	800	2.1	37	2600	4.7
18	850	2.2	38	2700	4.8
19	900	2.3	39	2800	4.9
20	950	2.4	40	2900	5.0



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Antenna factor

Biconilog Antenna, ETS-Lindgren mod. 31142D, S/N: 0146490 3 m calibration.

f / MHz	AF / dB/m	f / MHz	AF / dB/m	f / MHz	AF / dB/m
30	18.7	250	12.0	2750	31.0
35	15.7	300	13.8	3000	31.2
40	12.9	400	16.2	3250	32.7
45	10.6	500	18.6	3500	34.5
50	9.0	600	20.2	3750	34.3
60	7.3	700	21.8	4000	34.5
70	7.7	800	22.9	4250	35.3
80	8.2	900	24.1	4500	35.5
90	9.2	1000	24.8	4750	36.1
100	9.4	1250	26.9	5000	37.4
120	8.5	1500	30.2	5250	38.4
140	8.5	1750	28.5	5000	39.9
160	9.1	2000	28.9	5750	38.2
180	10.5	2250	29.8	6000	39.1
200	10.9	2500	32.5	-	-



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Antenna Factor**Double Ridged Guide Antenna mfr ETS-Lindgren model 3115 1m calibration**

Point	Frequency (MHz)	Antenna Factor (dB/m)
1	1000	23.7
2	1500	25.5
3	2000	28.5
4	2500	28.1
5	3000	29.6
6	3500	31.1
7	4000	32.5
8	4500	32.5
9	5000	33.5
10	5500	34.7
11	6000	36.1
12	6500	36.5
13	7000	37.3
14	7500	38.0
15	8000	37.3
16	8500	37.9
17	9000	38.1
18	9500	38.5
19	10000	38.7
20	10500	38.8
21	11000	38.6
22	11500	38.8
23	12000	38.9
24	12500	39.3
25	13000	40.2
26	13500	40.6
27	14000	40.6
28	14500	40.4
29	15000	39.6
30	15500	39.5
31	16000	39.8
32	16500	40.4
33	17000	41.3
34	17500	42.6
35	18000	43.2

Cable Loss**Type: Sucoflex 104PE; Ser.No.21329/4PE; 4 m length**

Point	Frequency (GHz)	Cable Loss (dB)
0	0.0-1.8	1.67
1	1.8 – 3.6	2.39
2	3.6 – 5.4	3.04
3	5.4-7.2	3.58
4	7.2-9.0	4.06
5	9.0-10.8	4.49
6	10.8-12.6	4.91
7	12.6-14.4	5.31
8	14.4-16.2	5.66
9	16.2-18.00	6.01



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Antenna Factor**Broadband Horn Antenna model BBHA 9170 1m calibration**

Point	Frequency (GHz)	Antenna Factor (dB/m)
1	15.0	38.5
2	16.0	37.7
3	17.0	38.1
4	18.0	37.9
5	19.0	38.0
6	20.0	38.0
7	21.0	37.9
8	22.0	38.2
9	23.0	39.6
10	24.0	39.6
11	25.0	39.3
12	26.0	39.5
13	27.0	39.6
14	28.0	39.6
15	30.0	40.1
16	32.0	41.2
17	34.0	41.5
18	35.0	41.9
19	36.0	42.2
20	38.0	43.8
21	40.0	43.2

Antenna Factor**For Antenna Loop MFR ETS Lindgren, Type/Model 6507, S/N: 00144641**

No.	Frequency MHz	Magnetic antenna factor, dBS/m	Electric antenna factor, dB/m
1	9	-21.5	30.0
2	10	-22.0	29.5
3	20	-27.7	23.8
4	50	-32.2	19.4
5	75	-33.0	18.5
6	100	-33.4	18.2
7	150	-33.6	17.9
8	250	-33.7	17.9
9	500	-33.8	17.8
10	750	-33.8	17.7
11	1000	-33.8	17.7
12	2000	-33.7	17.9
13	3000	-33.8	17.8
14	4000	-34.0	17.5
15	5000	-34.3	17.2
16	10000	-35.2	16.4
17	15000	-35.8	15.8
18	20000	-36.0	15.6
19	25000	-36.2	15.3
20	30000	-36.4	15.2



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APPENDIX B Photo of the test setups.

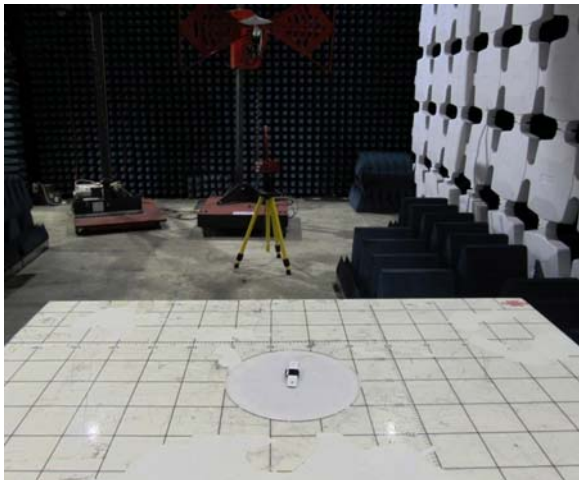


Photo 1.



Photo 2.

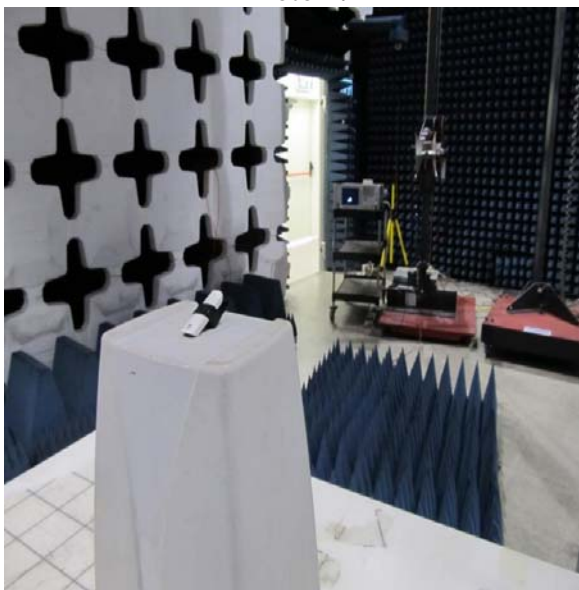


Photo 3.



Photo 4.

Radiated emission test setups.



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APPENDIX C Abbreviations and acronyms.

The following abbreviations and acronyms are applicable to this test report:

AC	alternating current
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μ V)	decibel referred to one microvolt
dB(μ V/m)	decibel referred to one microvolt per meter
EBW	emission bandwidth.
EMC	electromagnetic compatibility
EUT	equipment under test
GHz	gigahertz
H	height
Hz	hertz
kHz	kilohertz
L	length
LNA	low noise amplifier
m	meter
Mbps	megabit per second
MHz	megahertz
NA	not applicable
OFDM	Orthogonal Frequency Division Multiple Access
PRBS	pseudo random binary sequence
QP	quasi-peak
RF	radio frequency
RE	radiated emission
SA	spectrum analyzer
rms	root mean square
W	width

End of document.