

## Test Report (pdf copy) Testing of the Shot Scope Smart Wristband. 13.56MHz

## For

## Shot Scope Technologies Ltd

Document number 12018/TR/2	10000
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Issue	Description	Issue by	Date
2	Issue two	MR	1 <sup>st</sup> June 2016

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### 1..... Introduction

Name and address of laboratory:	York EMC Services Ltd		
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	Methley Road		
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Name and address of client:

Shot Scope Technologies Ltd ETTC 3rd Floor Alrick Bulding The King's Buildings, The University of Edinburgh Edinburgh EH9 3JL UK

The test results contained in this test report relate only to the unit(s) tested.

Equipment under test	Shot Scope Smart Wristband.
Model	SS01
Manufacturer	Shot Scope Technologies Ltd.
PCB number (RFID device)	SSM-MAIN-01 v1.0.
No. tested of each item	One

## FCC Grantee Code 2AHWR. FCC ID: 2AHWR-SS01.

Customer supplied test plan ref.	N/A		
Date of receipt of EUT	22 <sup>nd</sup> March 2016		
Method of receipt	Brought by customer		
Date(s) of test(s)	22 <sup>nd</sup> March 2016 and 23 <sup>rd</sup> March 201		
Date(s) when EUT was out of	None		
laboratory's control			
Method of disposal	Taken by customer		
Personnel witnessing tests	Lewis Allision		

Any other relevant information: The apparatus also contains a Broadcom Bluetooth module:

## FCC ID: QDS-BRCM1078 – Limited Modular Approval. This test report only covers the 13.56MHz operation of the product.

## 2 Test Specification

#### 2.1 Environment

The Shot Scope Smart Wristband is a Golfing aid designed to predict trajectory of a golf ball. It contains a 13.56MHz RFID device.

### 2.2 Relevant standards

Test Standard	Relevant Section	Class/limit	Test Order
CFR 47 Part 15C & ANSI C63.10-2013	Section 15.225(a) Field strength within the band 13.553MHz-13.567MHz	As specified in Section 15.225(a)	1
	Section 15.225(a) Field strength within the bands 13.410MHz- 13.552MHz and 13.567MHz to 13.710MHz	As specified in Section 15.225(b)	2
	15.225(b) Field strength within the bands 13.110MHz- 13.410MHz and 13.710MHz to 14.010MHz	As specified in Section 15.225(c)	3
	Section 15.225(d) Field Strength outside the band 13.110MHz-14.010MHz	As specified in Section 15.209	4
	Section 15.225(e) Frequency tolerance of the carrier signal	As specified in Section 15.225(e)	5
	Section 15.207 Mains conducted emissions	As specified in Section 15.207(a)	-
		Test not applicable	

## 3 Test Results

#### 3.1 Mains conducted emissions

This test was not applicable. The apparatus cannot transmit while charging.

#### 3.2 Field strength within the band 13.553MHz-13.567MHz

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting.	1

Test standard	Test description	Class/limit
CFR 47 Part 15C Section 15.225(a) & ANSI C63.10-2013	Radiated emissions	As specified in section 15.225(a)

Results	Mode	Table	Comments		
	4	3.2.1	Open Area Test Site result (parallel polarisation)		
			Open Area Test Site (OATS) (perpendicular polarisation)		

Freq	Rx	CL	Antenn a factor	Result at 10m	Distance correction	Result at 30m	Limit At 30m	Margin	Result
(MHz)	(dBµV)	(dB)	dB/m	(dBµV/m)	(40dB/decade)	(dBµV/m)	(dBµV/m)	(dB)	
13.56	25.73	0.2	20	45.93	19.0	26.93	84.0	-57.1	Below limit

Table 3.2.1 Receiving antenna parallel position, receiving antenna at 1m measurement height,

Freq	Rx	CL	Antenn a factor	Result at 10m	Distance correction factor	Result at 30m	Limit At 30m	Margin	Result
(MHz)	(dBµV)	(dB)	dB/m	(dBµV/m)	(40dB/decade)	(dBµV/m)	(dBµV/m)	(dB)	
13.56	31.75	0.2	20	51.95	19.0	32.95	84	-51.05	Below limit

Table 3.2.2 Receiving antenna perpendicular polarisation, receiving antenna at 1m measurementheight,

Rx = Test receiver reading (voltage dBµV) before the addition of cable loss and antenna factor.

CL = total cable loss between antenna and test receiver (dB)

Result at 10m = Field strength (dB $\mu$ V/m) at a measurement distance of 10m, calculated as follows:

Field strength  $(dB\mu V/m) = Rx (dBmV) + CL(dB) + Antenna factor (dB/m)$ 

Result at 30m : Section 15.225(a) of CFR 47 Part 15(c), States the limit to be 15,848uV/m at a test distance of 30m. The above measurement was performed at a test distance of 10m and hence the result at 10m was scaled using the extrapolation factor of **40dB/decade as stated in section 15.31(f)(2)**.

$$15,485\mu\text{V/m} \equiv 84\text{dBuV/m},$$

For the specified measurement distance of 30m the correction will be:

Correction =  $40*\log(10/30) = -19dB$ 

Note 3: The above measurements were taken using a Quasi peak detector.

Modifications	Required for this test	Modification state
	None	0

# 3.3 Field strength within the band 13.410MHz to 13.553MHz and 13.567MHz to 13.710MHz and 13.110MHz to 13.410MHz and 13.710 to 14.0.0MHz

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting	1

Test standard	Test description	Class/limit
CFR 47 Part 15C Section 15.225(b) and 15.225(c) & ANSI C63.10-2013	Radiated emissions	As specified in section 15.225(b) and 15.225(c)

Results	Mode	Figure	Comments		
	R01		Chamber measurement at 3m. Data extrapolated to 30m		
I		R02	Chamber measurement 3m. Data extrapolated to 30m		

No emissions were detected that were within 20dB of the specification limit.

Modifications	Required for this test	Modification state
	None	0

#### 3.4 Field Strength outside the band 13.110MHz-14.010MHz

Mode of operation	Description	Mode No.
	13.56MHz RFID device continuously transmitting	1

Test standard	Test description	Class/limit
CFR 47 Part 15C:2008 Section 15.225(d) & ANSI C63.10-2013	Radiated emissions	As specified in Section 47CFR15.209

Results	Mode	Figure	Frequency Range	Comments
		R03	9kHz to 30MHz	Chamber measurement at 3m
	1	R04	9kHz to 30MHz Chamber measurement at 3n	
		R05	30MHz to 1GHz	Chamber measurement at3m

#### 3.4.1 Measurements between 9kHz and 30MHz

Chamber measurements (scans) were first performed to obtain the radiated frequency data. The worse case frequencies were then measured at 10m using a loop antenna. No ground plane was used.

Freq (MHz)	Pol	Field strength at 10m	Specification distance (m)	Extrapolation (dB)	Field strength at Specificatio n distance	Limit at specificatio n distance (dBuV/m)	Result
0.009	Par.	47.2	300	-59	-11.8	48.5	Below limit
20.000	Par.	27.1	30	-19	8.0	30	Below limit
30.000	Par.	26.6	30	-19	7.5	30	Below limit
0.009	Perp.	42.0	300	-59	-17.1	48.5	Below limit
20.000	Perp.	29.5	30	-19	7.9	30	Below limit
30.000	Perp.	26.48	30	-19	7.4	30	Below limit

# No radiated spurious emissions were detected from the product. The above representative noise floor emissions were taken.

Measurements were performed in the absence of a ground plane at a 10m measurement distance.

The detector used was a quasi-peak detector.

For measurements in the band 0.009MHz to 0.490MHz the specified measurement distance is 300m. The distance correction will be:

Correction = 
$$40*\log(10/300) = -59dB$$

For measurements in the band 0.490MHz to 30MHz the specified measurement distance is 30m. The distance correction will be:

The measurements were calculated as follows:

Field strength (dBuV/m) = Receiver voltage reading (dBuV)+Antenna factor (dB/m)+Cable loss + extrapolation (dB)

Example:

At 20MHz

## At 30m field strength = receiver reading (7.1dBuV) + Antenna factor (20dB/m) + extrapolation (-19dB) = 8.0dBuV/m

The limit was calculated according to 47CFR15.209 table:

Between 0.009MHz and 0.490MHz

Limit (dBuV/m) at 300m = 20log<sub>10</sub>(2400/F)

Between 0.490MHz and 30MHz

```
Limit (dBuV/m) at 300m = 20log<sub>10</sub>(24000/F)
```

Where F is frequency in kHz.

#### 3.4.2 Measurements between 30MHz and 1GHz:

Chamber measurements (scans) were first performed to obtain the radiated frequency data. The worse case frequencies were then measured on an Open Area Test Site (OATS) at a distance of 3 meters.

Frequency (MHz)	Polarity (H/V)	Height (m)	Angle (degrees)	Det	Meas distance (m)	E field @ spec distance (dBuV/m)	E field Limit (dBuV/m)	Margin (dB)	Result
30.000	V	1	6	Qp	3	29.7	40.0	-10.3	Below limit
400.000	v	1	0	Qp	3	20.9	46.0	-25.1	Below limit
510.000	v	1	0	Qp	3	23.7	46.0	-22.3	Below limit
650.000	v	1	195	Qp	3	27.0	46.0	-19.0	Below limit
650.000	Н	1	195	Qp	3	30.4	46.0	-15.6	Below limit
700.000	v	1	0	Qp	3	27.5	46.0	-18.5	Below limit
800.000	V	1	0	Qp	3	31.0	46.0	-15.0	Below limit
800.000	Н	5	203	Qp	3	30.4	46.0	-15.6	Below limit
900.000	v	1	0	Qp	3	32.0	46.0	-14.0	Below limit

Open Area test Data 30MHz to 1GHz

Notes:

Det = detector, Qp = Quasi-Peak

Pol = position of receive antenna, below 30MHz perp = loop antenna plane perpendicular to equipment under test.

Above 30MHz, V = Vertical, H = horizontal

## No radiated spurious emissions were detected from the product. The above representative noise floor emissions were taken.

These measurements were made at the specified measurement distance of 3m at an Open Area Test Site (OATS), with direct application of the limit and no data extrapolation.

Field strength (dBuV/m) = Receiver voltage reading (dBuV)+Antenna factor (dB/m)+Cable loss (dB)

Modifications	Required for this test	Modification state	
	None	0	

#### 3.5 Frequency tolerance of the carrier signal

Mode of operation	Description	Mode No.
	13.56MHz RFID device	1

Test standard	Test description	Class/limit
CFR 47 Part 15C:2008 Section 15.225(e) & ANSI C63.10-2013 Clause 6.8.1	Frequency tolerance of the carrier signal	As specified in Section 15.225(e)

Results	Mode	Figure	Result	Comments
	1	5.3.1 to 5.3.35	Pass	The frequency tolerance as specified in section 15.225(e) is +/-0.01%, which for a frequency of 13.56MHz is (+/-1.356kHz).

#### Procedure:

For frequency stability with respect to supply voltage the procedures of ANSIC63.10 Section 6.8.2 were followed. The measurements were performed at ambient room temperature.

For frequency stability with respect to ambient temperature the procedure of ANSI C63.10 Section 6.8.1 was followed.

The spectrum analyser screen captures are contained within Appendix 5.

Supply voltag	ge (V dc)	Frequency (MHz)	Nominal	Deviation	Limit	Result	Screen Capture
Nom	3.7	13.55982725	13.56	0.00127397	0.01	Within limit	Screen33
Nom+115	4.25	13.55981188	13.56	0.00138729	0.01	Within limit	Screen34
Nom-85	3.14	13.55981005	13.56	0.0014008	0.01	Within limit	Screen35

Table 3.5.1 Frequency deviation from nominal of the carrier with battery supply voltage.

Note: ANSI C63.10 Clause 5.13 states "for battery-operated equipment tests shall be performed using a variable power supply".

Temp. C	Time	Frequency (MH)	Nominal (MHz)	Deviation %	Limit 47CFR15.225 (e) %	Result	Screen Capture #
	Startup	13.559753	13.56	0.001821534	0.01	Within limit	1
50	2min	13.55975	13.56	0.001843658	0.01	Within limit	2
50	5min	13.55975	13.56	0.001843658	0.01	Within limit	3
	10min	13.55975	13.56	0.001843658	0.01	Within limit	4
	Startup	13.559752	13.56	0.001828909	0.01	Within limit	5
40	2min	13.559755	13.56	0.001806785	0.01	Within limit	6
40	5min	13.559758	13.56	0.001784661	0.01	Within limit	7
	10min	13.559759	13.56	0.001777286	0.01	Within limit	8
	Startup	13.559793	13.56	0.001526549	0.01	Within limit	9
20	2min	13.559787	13.56	0.001570796	0.01	Within limit	10
30	5min	13.559784	13.56	0.00159292	0.01	Within limit	11
	10min	13.559783	13.56	0.001600295	0.01	Within limit	12
	Startup	13.5598	13.56	0.001474926	0.01	Within limit	13
20	2min	13.559814	13.56	0.001371681	0.01	Within limit	14
20	5min	13.559819	13.56	0.001334808	0.01	Within limit	15
	10min	13.559824	13.56	0.001297935	0.01	Within limit	16
	Startup	13.559845	13.56	0.001143068	0.01	Within limit	17
40	2min	13.559862	13.56	0.001017699	0.01	Within limit	18
10	5min	13.559865	13.56	0.000995575	0.01	Within limit	19
	10min	13.559865	13.56	0.000995575	0.01	Within limit	20
	Startup	13.559884	13.56	0.000855457	0.01	Within limit	21
•	2min	13.559892	13.56	0.00079646	0.01	Within limit	22
U	5min	13.5599	13.56	0.000737463	0.01	Within limit	23
	10min	13.559904	13.56	0.000707965	0.01	Within limit	24
	Startup	13.559921	13.56	0.000582596	0.01	Within limit	25
10	2min	13.559925	13.56	0.000553097	0.01	Within limit	26
-10	5min	13.559926	13.56	0.000545723	0.01	Within limit	27
	10min	13.559929	13.56	0.000523599	0.01	Within limit	28
	Startup	13.559939	13.56	0.000449853	0.01	Within limit	29
20	2min	13.55994	13.56	0.000442478	0.01	Within limit	30
-20	5min	13.55994	13.56	0.000442478	0.01	Within limit	31
	10min	13.559941	13.56	0.000435103	0.01	Within limit	32

Table 3.5.2 Frequency deviation from nominal of the carrier with temperature.

Modifications	Required for this test	Modification state
	None	0

## 4 Summary

### 4.1 Emissions

	CFR 47 Part 15C:2008
Test Standard	& ANSI C63.10-2013

Relevant Section	Class/limit	Result Summary
Section 15.225(a) Field strength within the band 13.553MHz- 13.567MHz	As specified in Section 15.225(a)	Complies
Section 15.225(a) Field strength within the bands 13.410MHz- 13.552MHz and 13.567MHz to 13.710MHz	As specified in Section 15.225(b)	Complies
15.225(b) Field strength within the bands 13.110MHz- 13.410MHz and 13.710MHz to 14.010MHz	As specified in Section 15.225(c)	Complies
Section 15.225(d) Field Strength outside the band 13.110MHz- 14.010MHz	As specified in Section 15.209	Complies
Section 15.225(e) Frequency tolerance of the carrier signal	As specified in Section 15.225(e)	Complies
Section 15.207 Mains conducted emissions	As specified in Section 15.207(a)	-
	Test not applicable	

## 5 Appendices

#### 5.1 Appendix 1 Field strength within the band 13.553MHz-13.567MHz test results



Fig 5.1.1 Radiated emissions result (Chamber R01), 13.110MHz to 14.010MHz Parallel polarisation 3m measurement distance. Data extrapolated to values expected at the distances in Section 47CFR15.209.



Fig 5.1.1 Radiated emissions result (Chamber R02), 13.110MHz to 14.010MHz Parallel polarisation 3m measurement distance. Data extrapolated to values expected at the distances in Section 47CFR15.209.

#### 5.2 Appendix 2 Field Strength outside the band 13.110MHz-14.010MHz



Fig 5.2.1 Radiated emissions result (Chamber R03), 9kHz to 30MHz parallel polarisation 3m measurement distance. Data extrapolated to values expected at the distances in Section 47CFR15.209.



Fig 5.2.2 Radiated emissions result (Chamber R04), 9kHz to 30MHz perpendicular polarisation 3m measurement distance. Data extrapolated to values expected at the distances in Section 47CFR15.209.



Fig 5.2.3 Radiated emissions result (Chamber R05), 30MHz to 1GHz vertical and horizontal polarisation combined plot, 3m measurement distance

#### 5.3 Appendix 3 Frequency tolerance of the carrier signal



Figure 5.3.1 – Screen capture 1



Figure 5.3.2 – Screen capture 2



Figure 5.3.3 – Screen capture 3



Figure 5.3.4 – Screen capture 4



Figure 5.3.5 – Screen capture 5



Figure 5.3.6 – Screen capture 6



Figure 5.3.7 – Screen capture 7



Figure 5.3.8 – Screen capture 8



Figure 5.3.9 – Screen capture 9



Figure 5.3.10 – Screen capture 10



Figure 5.3.11 – Screen capture 11



Figure 5.3.12 – Screen capture 12



Figure 5.3.13 – Screen capture 13



Figure 5.3.14 – Screen capture 14



Figure 5.3.15 – Screen capture 15



Figure 5.3.16 – Screen capture 16



Figure 5.3.17 – Screen capture 17



Figure 5.3.18 – Screen capture 18



Figure 5.3.19 – Screen capture 19



Figure 5.3.30 – Screen capture 20



Figure 5.3.21 – Screen capture 21



Figure 5.3.22 – Screen capture 22



Figure 5.3.23 – Screen capture 23



Figure 5.3.24 – Screen capture 24



Figure 5.3.25 – Screen capture 25



Figure 5.3.26 – Screen capture 26



Figure 5.3.27 – Screen capture 27



Figure 5.3.28 – Screen capture 28



Figure 5.3.29 – Screen capture 29



Figure 5.3.30 – Screen capture 30



Figure 5.3.31 – Screen capture 31



Figure 5.3.32 – Screen capture 32



Figure 5.3.33 – Screen capture 33



Figure 5.3.34 – Screen capture 34



Figure 5.3.35 – Screen capture 35

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## 5.4 Appendix 4 EUT test configurations

Test set up photographs are not included in this test report at the request of the customer.

## 5.5 Appendix 5 Equipment used

Equipment	York EMC Asset No.	Cal Type	Cal date	Cal Period (Months)
Keysight PXA Spectrum analyser	C0338	UKAS	28 <sup>th</sup> January 2016	12
R&S ESVS30 Test receiver	78107	UKAS	9 <sup>th</sup> February 2016	12
JTS Environmental test chamber	C0108	UKAS	8 <sup>th</sup> January 2014	36
Screened loop antenna	78128	UKAS	20 <sup>th</sup> March 2014	36
Bilog antenna	78707	UKAS	13 <sup>th</sup> January 2016	12

## 5.6 Appendix 6 Customers test equipment used

Equipment	Serial number	Cal status
None	N/A	N/A

## 5.7 Appendix 7 Modification States

Modification state	Modification
0	As supplied by the customer.

## 5.8 Appendix 8 Test Report History

Issue	Modification details
1	Original issue of the test report
2	References to ANSIC63.4 replaced with ANSIC63.10 – correction of a typographical error