Intertek
731 Enterprise Drive
Lexington, KY 40510

Tel 859 226 1000
Fax 859 226 1040

www.intertek.com

Aquana LLC
MPE REPORT

SCOPE OF WORK
MPE CALCULATION
ON THE SV-1 SMART VALVE

REPORT NUMBER
103553976LEX-004

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

TEST REPORT

Report Number:	**103553976LEX-004**
Project Number:	**G103553976**
Report Issue Date:	**10/30/2018**
Product Name:	**Smart Valve**
Model:	**SV-1**
FCC Standards:	**FCC Part 1.1310 Limits for Maximum Permissible Exposure (MPE)**
Industry Canada Standards:	**RSS-102 Issue 5**

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

Client:
Aquana LLC
1099 Plunkton Rd
Warren, VT 05674

Report prepared by

Bryan Taylor, Team Leader

Report reviewed by

Brian Lackey, Project Engineer

MPE Calculation

§ 1.1310: The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

RSS-102 Issue 5 Exposure Limits:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
$0.003\text{-}10^{21}$	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

1.1 Test Procedure

An MPE evaluation for was performed in order to show that the device was compliant with §2.1091. The maximum power density was calculated for each transmitter at a separation distance of 20cm. The calculation was performed using the maximum gain from the internal and external antennas declared by the manufacturer.

For each transmitter the maximum RF exposure at a 20 cm distance using the formula:

$$Conducted\,Power_{mW} = 10^{Conducted Power(dBm)/10}$$

$$PowerDensity = \frac{Conducted\,Power_{mW} \times Ant.Gain}{4\pi \times (20_{cm})^2}$$

1.2 Results:

The calculated maximum power density at 20cm distance is less that the limit for general population / uncontrolled exposure.

Additionally the BLE radio could transmit simultaneously with either the LoRa or the WiFi radios. For simultaneously transmitting radios, compliance with the MPE criteria is shown by summing the ratios of the stand-alone power density to limit values. If the sum of the ratios is less than 1 it is deemed to comply.

BLE PD to Limit = 0.0001 / 1 = 0.0001
LoRa PD to Limit = 0.0035 / 0.6063 = 0.0057
WiFi PD to Limit = 0.007 / 1 = 0.007

The sum of the ratios for BLE + LoRa = 0.0058 which is less than 1
The sum of the ratios for BLE + WiFi = 0.0127 which is less than 1

BLE	Value	Unit	Comments
Frequency	2402	MHz	
Distance	20	cm	
Maximum Scaled Power	3.242	dBm	Measured conducted power
TX Antenna Gain	3.18	dBi	From datasheet, or calculated from peak radiated field strength and measured conducted power
Source Based Duty Cycle	100	%	Percent of time transmitter is active
EIRP	**6.422**	**dBm**	Maximum Scaled Power x Antenna Gain
Source Based Output Power	**6.4**	**dBm**	EIRP x Duty Cycle
Power Density @ Distance	**0.0001**	**mW/cm^2**	(Source Based Output Power, mW) / (4π x (distance, cm)^2)
FCC Limit	**1.0000**	**mW/cm^2**	1. x f^0

FCC Calculation

BLE	Value	Unit	Comments
Frequency	2402	MHz	
Distance	20	cm	
Maximum Scaled Power	3.242	dBm	Measured conducted power
TX Antenna Gain	3.18	dBi	From datasheet, or calculated from peak radiated field strength and measured conducted power
Source Based Duty Cycle	100	%	Percent of time transmitter is active
EIRP	**6.422**	**dBm**	Maximum Scaled Power x Antenna Gain
Source Based Output Power	**6.4**	**dBm**	EIRP x Duty Cycle
Power Density @ Distance	**0.0001**	**W/m^2**	((Source Based Output Power, mW) / (4π x (distance, cm)^2))x.1
ISED Limit	**5.3508**	**W/m^2**	1. x f^0

ISED Calculation
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LoRa	Value	Unit	Comments
Frequency	909.4	MHz	
Distance	20	cm	
Maximum Scaled Power	19.4	dBm	Measured conducted power
TX Antenna Gain	3	dBi	From datasheet, or calculated from peak radiated field strength and measured conducted power
Source Based Duty Cycle	100	%	Percent of time transmitter is active
EIRP	**22.4**	**dBm**	Maximum Scaled Power x Antenna Gain
Source Based Output Power	**22.4**	**dBm**	EIRP x Duty Cycle
Power Density @ Distance	**0.0035**	**mW/cm^2**	(Source Based Output Power, mW) / (4π x (distance, cm)^2)
FCC Limit	**0.6063**	**mW/cm^2**	.0007 x f^1

FCC Calculation

LoRa	Value	Unit	Comments
Frequency	909.4	MHz	
Distance	20	cm	
Maximum Scaled Power	19.4	dBm	Measured conducted power
TX Antenna Gain	3	dBi	From datasheet, or calculated from peak radiated field strength and measured conducted power
Source Based Duty Cycle	100	%	Percent of time transmitter is active
EIRP	**22.4**	**dBm**	Maximum Scaled Power x Antenna Gain
Source Based Output Power	**22.4**	**dBm**	EIRP x Duty Cycle
Power Density @ Distance	**0.0035**	**W/m^2**	((Source Based Output Power, mW) / (4π x (distance, cm)^2))x.1
ISED Limit	**2.7552**	**W/m^2**	.0007 x f^1

ISED Calculation

WiFi	Value	Unit	Comments
Frequency	2462	MHz	
Distance	20	cm	
Maximum Scaled Power	22.44	dBm	Measured conducted power
TX Antenna Gain	3	dBi	From datasheet, or calculated from peak radiated field strength and measured conducted power
Source Based Duty Cycle	100	%	Percent of time transmitter is active
EIRP	**25.44**	**dBm**	Maximum Scaled Power x Antenna Gain
Source Based Output Power	**25.4**	**dBm**	EIRP x Duty Cycle
Power Density @ Distance	**0.0070**	**mW/cm^2**	(Source Based Output Power, mW) / (4π x (distance, cm)^2)
FCC Limit	**1.0000**	**mW/cm^2**	1. x f^0

FCC Calculation

WiFi	Value	Unit	Comments
Frequency	2462	MHz	
Distance	20	cm	
Maximum Scaled Power	22.44	dBm	Measured conducted power
TX Antenna Gain	3	dBi	From datasheet, or calculated from peak radiated field strength and measured conducted power
Source Based Duty Cycle	100	%	Percent of time transmitter is active
EIRP	**25.44**	**dBm**	Maximum Scaled Power x Antenna Gain
Source Based Output Power	**25.4**	**dBm**	EIRP x Duty Cycle
Power Density @ Distance	**0.0070**	**W/m^2**	((Source Based Output Power, mW) / (4π x (distance, cm)^2))x.1
ISED Limit	**5.4418**	**W/m^2**	1. x f^0

ISED Calculation