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Maximum Permissible Exposure Evaluation

FCC ID: 2BDC6-SWITCHX3

IC: 33486-SWITCHX3

EUT Specification

Product Name:	Smart Module
Trade Mark:	Shelly
Model/Type reference:	Shelly X3 ELEGRP Module
Listed Model(s):	/
Operating Frequency band:	BT: 2402~2480MHz WLAN: 2412~2462MHz
Device category:	☐ Portable (<5mm separation) ☐ Mobile (>20cm separation) ☒ Fixed (>20cm separation) ☐ Others ____
Exposure classification:	☐ Occupational/Controlled exposure (S=5mW/cm ²) ☒ General Population/Uncontrolled exposure (S=1mW/cm ²)
Antenna diversity:	☒ Single antenna ☐ Multiple antennas ☐ Tx diversity ☐ Rx diversity ☐ Tx/Rx diversity
Antenna gain:	BT: 4.26dBi WLAN: 4.26dBi
Evaluation applied:	☒ MPE Evaluation ☐ SAR Evaluation

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) Radiation as specified in §1.1307(b)

Limits for Maximum Permissible Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density(mW/cm ²)	Average Time
(A) Limits for Occupational/Control Exposures				
300-1500	--	--	F/300	6
1500-100000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300-1500	--	--	F/1500	30
1500-100000	--	--	1	30

F = frequency in MHz

Friis transmission formula: $P_d = (P_{out} * G) / (4 * \pi * R^2)$

Where

P_d = Power density in mW/cm²



P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

P_i = 3.1416

R = distance between observation point and center of the radiator in cm

P_d the limit of MPE $1\text{mW}/\text{cm}^2$. If we know the maximum gain of the antenna and total power input to the antenna, through the calculation, We will know the distance where the MPE limit is reached.

RF exposure evaluation Limits for IC

RSS-102 Issue 6 Section 6.6

Field reference level (FRL) exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm (i.e. mobile devices), except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 1 W (adjusted for tune-up tolerance)
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance)
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz
- at or above 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 5 W (adjusted for tune-up tolerance)

FCC Measurement Result

Band	Frequency (MHz)	Antenna Gain (dBi)	Maximum Power (dBm)	Tune up tolerance (dBm)	Max. Tune up Power (dBm)	Power Density at 20cm (mW/cm^2)	Limit (mW/cm^2)	Verdict
BLE	2480	4.26	3.64	4±1	5	0.001679	1.000	PASS
802.11b	2412	4.26	13.23	13±1	14	0.011179	1.000	PASS

The WLAN and BLE can transmit simultaneously

BLE Output power/ Threshold power	WLAN Output power/ Threshold power	Total of the ratios	Limit	Verdict
0.001679/1=0.001679	0.011179/1=0.011179	0.012858	1	PASS

Total E-field strength = $((\text{E-field strength})/(\text{Limit}) + (\text{E-field strength})/(\text{Limit})...) \leq 1$



IC Measurement Result

Band	Frequency (MHz)	Antenna Gain (dBi)	Maximum Power (dBm)	EIRP (dBm)	Tune up tolerance (dBm)	Max. Tune up Power (dBm)	Field reference level (W)	Limit (W)	Verdict
BLE	2480	4.26	3.64	7.9	7±1	8	0.0063	2.74	PASS
802.11b	2412	4.26	13.23	17.49	17±1	18	0.0631	2.68	PASS

The WLAN and BLE can transmit simultaneously

BLE Output power/ Threshold power	WLAN Output power/ Threshold power	Total of the ratios	Limit	Verdict
0.0063/2.74=0.0029	0.0631/2.68=0.0591	0.02584	1	PASS

Total E-field strength = ((E-field strength)/ (Limit) + (E-field strength)/ (Limit)...) ≤ 1

Note:

For a more detailed features description, Please refer to the RF Test Report.

*****THE END*****