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RF Exposure for XPD900 Rev.3

TPCB-3612-01

900 MHz Radio Module

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Revision: 1

Revision History

Revision	Author	Date	Description
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2. Scope

This report provides the FCC and ISED SAR test exemption evaluation for the XPD900 Rev.3 (TPCB-3612-01) radio module.

The required minimum user separation distances are calculated for each antenna used with the XPD900 Rev. 3 radio module using standalone SAR test exclusion for 1-g and 10-g SAR conditions for a portable device. Host devices that integrate the single radio module alone, must adhere to the required user separation distances to be SAR compliant and remain SAR test exempt.

3. Device Under Test Description

Device	Description	Manufacturer	Model (PMN)	Serial No.
Radio Module	900 MHz FHSS data transceiver module	Cooper Industries (Electrical) Inc.	XPD900	1E162921 (Units sent to test lab for C2PC test)
Module PCB Version		3		
Module Assembly Part Number (HVIN)		TPCB-3612-01		
Application Firmware (FVIN)		363001R48762		
Highest frequency generated within the DUT		927.7 MHz		
FCC Existing Certification		FCC: IA9XPD900		
ISED Existing Certification		1338B-XPD900		
Output Power Grant of Certification		FCC: 81 mW (19.08 dBm) ISED: 81.47 mW (19.1 dBm)		
Antenna 1		AKIT-3591-04 (used 6' antenna coaxial cable, the shortest cable is considered to obtain worst case separation distance result). Used W0270 module cable.		
Antenna 3		A0042 (used W0272 module cable, the shortest host cable is used to calculate the worst-case separation distance result. W0288 is longer.)		
Antenna 4		ACAB-2683-07 (used module cable W0272)		

4. Theory

4.1. FCC Requirements

FCC KDB 447498 D01 V06 section 4.3.1 a) and b) is used to evaluate for SAR test exemption.

1. Standalone SAR test exclusion equations

4.3.1 a) For 100 MHz to 6 GHz and test separation distances \leq 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] \cdot [Vf(GHz)] \leq 3.0 for 1-g SAR, and \leq 7.5 for 10-g extremity SAR,

where :

- f(GHz) is the RF channel transmit frequency in GHz*
- Power and distance are rounded to the nearest mW and mm before calculation*
- The result is rounded to one decimal place for comparison*

4.3.1.b) For 100 MHz to 6 GHz and test separation distances $>$ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

1) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm) \cdot (f(MHz)/150)]} mW, for 100 MHz to 1500 MHz

2) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm) \cdot 10]} mW, for $>$ 1500 MHz and \leq 6 GHz

4.2. ISED Requirements

Under 20 cm

RSS-102 Issue 5, table 1 provides the radio module maximum output power for the case where test separation distance is < 200 mm. To obtain the 10-g SAR limits the threshold values in table 1 are multiplied by 2.5.

Linear interpolation is applied when the test frequency is between the values provided in the table (RSS-102 section 2.5.1). Similarly, linear interpolation is used to find separation distances that are not given in table 1. An inquiry was made to the ISED confirming this method.

Over 20 cm

For the case where the test separation distance is greater than 200 mm RF exposure evaluation is not required if the following statement holds (from RSS-102 section 2.5.2). The EIRP derivation needs to be included even if this applies.

at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. 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;

The above formula produces the following limits for over 20 cm separation distance for the XPD900 frequencies of interest.

Frequency (MHz)	Time-averaged Max EIRP (W)
927.7	1.4
902.2	1.37

Table 1 Calculated RF Exposure Limits for > 200mm

From RSS-102 simultaneous transmission is evaluated using RSS-102 section 3.1.2.

5. Evaluation

5.1. FCC RF Exposure Evaluation

5.1.1. FCC Results

Calculating the minimum separation distance using KDB447498 D01 section 4.3.1. a) for each antenna and module combination.

Device	Antenna	Frequency (GHz)	Power at Antenna Port (dBm)	Cable Loss (dB)	Antenna Gain (dBi)	Power Total (dBm)	Power Total (mW)	Duty Cycle	Power (mW)	Threshold Limit 1-g SAR Body	Threshold Limit 10-g SAR Extremity	Calculated Minimum Separation Distance 1-g (mm)	Calculated Minimum Separation Distance 10-g (mm)
XPD900	1	0.9022	19.1	-0.55	5.4	23.93	247.4	0.53	131.1	3	7.5	41.5	16.6
XPD900	1	0.9277	19.1	-0.55	5.4	23.93	247.4	0.53	131.1	3	7.5	42.1	16.8
XPD900	3	0.9022	19.1	-0.1	0.3	19.28	84.8	0.53	45.0	3	7.5	14.2	5.7
XPD900	3	0.9277	19.1	-0.1	0.3	19.28	84.8	0.53	45.0	3	7.5	14.4	5.8
XPD900	4	0.9022	19.1	-0.1	2.54	21.52	142.1	0.53	75.3	3	7.5	23.7	9.5
XPD900	4	0.9277	19.1	-0.1	2.54	21.52	142.1	0.53	75.3	3	7.5	24.1	9.7

Table 2 XPD900 Rev.3 Calculated Required User Separation Distances for Each Antenna

5.1.2. FCC Sample Calculation

Using the equation from KDB 447498 D01 V06 4.3.1 a) for < 50mm separation distance the following shows the calculation to determine the separation distance for 1-g conditions for antenna 1 (row 2 column 13 in Table 2). All antennas were calculated the same way.

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR, and } \leq 7.5 \text{ for 10-g extremity SAR}$$

Solve for minimum separation distance, D_{min}

$$D_{\min} = \frac{P_{\max}}{\text{Threshold Limit}} \times \sqrt{\text{Frequency}}$$

$$D_{\min} = \frac{131 \text{ mW}}{3} \times \sqrt{0.9277 \text{ GHz}}$$

$$D_{\min} = 42.1 \text{ mm}$$

5.1.3. FCC Conclusions

The XPD900 Rev.3 radio module in stand-alone operation is exempt from SAR testing provided the user separation distances are maintained as shown in the results section of Table 2 and when operated at the maximum operating grant power of 19.1 dBm. Table 3 is a summary of the separation distances required for each antenna.

Antenna	Required 1-g Separation Distance (mm)	Required 10-g Separation Distance (mm)
1	42.1	16.8
3	14.4	5.8
4	24.1	9.7

Table 3 FCC - Summary of User Separation Distance Required for Each Antenna

5.2. ISED RF Exposure Evaluation

5.2.1. ISED Results

From RSS-102 section 2.5.1, “*SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1*”.

Calculating the exemption limits from RSS-102 Table 1 for the frequencies of interest, for the case where the test separation distance is ≤ 200 mm. The frequencies of interest (927.7 MHz, 902.2 MHz, and 2.48 GHz) is linear interpolated from RSS-102 Table 1.

Frequency (MHz)	Exemption Limit 1-g (mW)									
	Separation Distances (mm)									
	≤5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	≥50 mm
902.2	16.37	28.74	40.49	53.67	66.56	81.20	95.85	112.57	129.56	148.99
927.7	16.13	28.26	39.91	53.17	66.39	81.65	97.31	115.45	134.32	156.20
2480	3.94	6.97	15.03	30.06	52.09	83.09	123.03	172.91	234.71	308.46

Table 4 Calculated ISED 1-g Limits

Frequency (MHz)	Exemption Limit 10-g (mW)									
	Separation Distances (mm)									
	≤5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	≥50 mm
902.2	40.92	71.85	101.21	134.19	166.40	203.00	239.62	281.43	323.89	372.48
927.7	40.32	70.65	99.78	132.93	165.98	204.13	243.27	288.61	335.80	390.50
2480	9.86	17.43	37.57	75.14	130.21	207.71	307.57	432.29	586.79	771.14

Table 5 Calculated ISED 10-g Limits

Required ISED 1-g and 10-g Separation Distances

Calculating the user separation distance required for each antenna for 1-g and 10-g conditions.

Antenna	Power (mW)	1-g Separation Distance for 902.2 MHz (mm)	1-g Separation Distance for 927.7 MHz (mm)	10-g Separation Distance for 902.2 MHz (mm)	10-g Separation Distance for 927.7 MHz (mm)
1	131.15	45.4	44.2	19.5	19.7
3	44.95	16.7	16.9	5.7	5.8
4	75.29	28.0	27.9	10.6	10.8

Table 6 ISED User Separation Distances for Each Antenna

5.2.2. ISED Sample Calculation

This is a sample calculation for the required separation distances presented in Table 6 (row 2, column 4) for a 1-g SAR condition at 927.7 MHz, antenna 1, and 131.15 mW power. The data is from Table 4 for 40 mm at 115.45 mW, and 45 mm at 134.32 mW.

Find the slope and intercept of the line using Table 4 limit values:

$$y = mx + b$$

$$40\text{mm} = \frac{45\text{ mm} - 40\text{ mm}}{134.32\text{ mW} - 115.45\text{ mW}} \times 115.45\text{mW} + b$$

$$b = 9.4091\text{ mm}$$

$$m = 0.26497\text{ mm/mW}$$

Solve for the separation distance at 131.15 mW (power from Table 2 for this example):

$$y = mx + b$$

$$y = (0.26497)(131.15) + 9.4091$$

$$y = 44.2\text{ mm}$$

5.2.3. ISED Conclusion

The XPD900 Rev.3 module when operated at its maximum grant power of 19.1 dBm is SAR test exempt provided the user separation distances are maintained from each antenna as listed in Table 7.

User Separation Distance Required for SAR Exemption			
Antenna	1-g (mm)	10-g (mm)	Test Exempt
1	45.4	19.7	Yes
3	16.9	5.8	Yes
4	28.0	10.8	Yes

Table 7 ISED Summary of Minimum Required User Separation Distances

6. Summary of XPD900 Rev.3 User Separation Distance Requirements for SAR Exemption

The following is a summary of the user separation distance requirements for the XPD900 Rev.3 module for each antenna based on the most stringent regulator's requirements. Refer to the specific FCC or ISED conclusion sections in this document for that country's specific separation details.

The following separation distances are required when a single radio is used in a host product to maintain the SAR test exemption for both FCC and ISED. Additional analysis and evaluation is required for the host implementation if there is an additional radio, for example a blue tooth module.

Antenna	Module Power (dBm)	Required User Separation Distance (mm)	Classification (g)	Use	Most Stringent Requirement
1	19.1	45.4	1	Body worn	ISED
		19.7	10	Handheld	ISED
3	19.1	16.9	1	Body worn	ISED
		5.8	10	Handheld	FCC and ISED
4	19.1	28	1	Body	ISED
		10.8	10	Handheld	ISED

Table 8 User Separation Distance Required to Meet FCC and ISED Requirements for Each Antenna