

5.6. RF EXPOSURE REQUIREMENTS @ 1.1310, 2.1091 & 2.1093

5.6.1. Limits

FCC has specified the general guidance for meeting RF Exposure requirements in KDB 447498 D01 General RF Exposure Guidance v05r02, the following are the applicable sections for this module summarized from this guidance.

- 1) The RF exposure requirements for devices operating in mobile and portable exposure conditions are different. When both exposure conditions apply to a device, compliance is determined according to the rules and policies established for both exposure conditions. Equipment authorization for devices that are categorically excluded from routine RF exposure evaluation according to §2.1091(c) and §2.1093(c).
- 2) Standalone and simultaneous transmission use conditions for mobile and portable exposure conditions must be determined according to the host platform and product operating configuration requirements
- 3) Transmitter modules must be approved according to one of the following host platform exposure conditions, with respect to the product configurations tested or evaluated for equipment approval for incorporation in qualified host products. The approved host platform exposure condition(s) must be identified on the grant of equipment certification. When transmitter modules are incorporated in host devices that qualify for RF exposure test exclusion and no other testing or equipment approval is required, the standalone and simultaneous transmission configurations and test exclusion conditions must be fully documented in the grantee's records.
- 4) (a) *Mobile exposure host* platform evaluation procedures can only be applied if all transmitters in the host devices support mobile exposure conditions. Transmitters and modules approved only for use in the *mobile exposure host* platform cannot operate in hosts and product configurations that require standalone or simultaneous transmission operations in portable exposure conditions. The *portable exposure host* platform or the *mixed mobile and portable exposure* platform is required to support portable exposure conditions in qualified host configurations.
- 5) (b) *Portable exposure host* platform evaluation procedures can only be applied if all transmitters in the host devices support portable exposure conditions. Transmitters and modules approved for use in the *portable exposure host* platform may be used for standalone operations in *mobile exposure host* platforms, without further equipment approval, only when the same identical transmitter and antenna required for portable exposure conditions are used.
- 6) Transmitters operating in consumer products must satisfy the general population exposure limits required for either mobile or portable RF exposure conditions as appropriate. The test configurations used to qualify for test exclusion or used for compliance testing must be sufficiently conservative for all required operations to demonstrate compliance.
- 7) As required by §§ 2.1033(b)(3) and 2.1033(c)(3), users and installers shall be furnished with the required operating and installation instructions. These are reviewed for acceptance during equipment approval. The applicable instructions must be provided to installers, integrators and end users to ensure proper installation and operation of the devices for meeting compliance.
- 8) Extremity exposure conditions: Devices that are designed or intended for use on extremities or mainly operated in extremity only exposure conditions; i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation. 10-g extremity SAR Test Exclusion Thresholds in section 4.3 should be applied to determine SAR test requirements.

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September 28, 2015

- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Appendix A

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distances are illustrated in the following Table. The equation and threshold in section 4.3.1 must be applied to determine SAR test exclusion.

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	SAR Test Exclusion Threshold (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	

Note: 10-g Extremity SAR Test Exclusion Power Thresholds are 2.5 times higher than the 1-g SAR Test Exclusion Thresholds indicated above. These thresholds do not apply, by extrapolation or other means, to occupational exposure limits.

In order to verify the SAR test exclusion as specified in Sec 4.3.1; for Standalone SAR test exclusion consideration and Sec 4.3.2; for Simultaneous transmission SAR test exclusion considerations for this module to be qualified with only the specified host (tap shoes), the following calculations performed. SAR extremity exposure condition applied.

Standalone SAR test exclusion threshold condition for each radio is verified as per below.

- 1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:

$$\left[\frac{(\text{max. power of channel, including tune-up tolerance, mW})}{(\text{min. test separation distance, mm})} \right] \cdot [\sqrt{f_{\text{GHz}}}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR,}^{25} \text{ where}$$

- f_{GHz} is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation²⁶
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

1. **UHF Radio: 697.8 MHz with Max 81.1 mw conducted power**

$$= (81.1)/(X) (\sqrt{.6978}) < 7.5$$

So minimum separation distance X = 9.1 mm so we use **10 mm**.

2. **802.15.4 Radio: 2.48 GHz with Max 0.7 mw conducted power @ 10 mm separation distance**

$$= (.7)/10 \times (\sqrt{2.48}) < 7.5$$

= **0.11** < 7.5, so it comfortably satisfies with 10 mm separation distance.

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Since it is possible that both radios can transmit simultaneously, we shall also verify the **Simultaneous transmission SAR test exclusion** condition as given in Sec 4.3.2 as shown below for the 10mm separation distance from the user.

- 2) When the standalone SAR test exclusion of section 4.3.1 is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following to determine simultaneous transmission SAR test exclusion:³⁰

- $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) \cdot [\sqrt{f_{\text{GHz}}/x}] \text{ W/kg}$ for test separation distances $\leq 50 \text{ mm}$;
where $x = 7.5$ for 1-g SAR, and $x = 18.75$ for 10-g SAR.

This SAR estimation formula has been considered, in conjunction with the *SAR Test Exclusion Thresholds*, to result in substantially conservative SAR values of $\leq 0.4 \text{ W/kg}$. When SAR is

1. UHF Radio: 697.8 MHz @ 81.1 mw conducted power

$$= (81.1)/(10) (\sqrt{697.8/18.75}) = 0.36 \text{ W/kg} < 0.4 \text{ W/kg}$$

2. 802.15.4 Radio: 2.48 GHz @ .7 mw

$$= (0.7)/(10) (\sqrt{2.48/18.75}) = 0.006 \text{ W/kg} < 0.4 \text{ W/kg}$$

The estimated SAR is only used to determine simultaneous transmission SAR test exclusion; it should not be reported as the standalone SAR. When SAR is estimated, it must be applied to determine the sum of 1-g SAR test exclusion.

Combined Estimated SAR = 0.366 W/kg < 0.4 W/kg

So we demonstrate compliance with SAR exclusion threshold when final installation of this module into the qualified host shall always maintain more than 10mm separation distance from the user feet.

RF Exposure Compliance:

This module is a low-power device and complies with applicable RF exposure requirements as a mobile device. For portable application, it is limited only to the specified host (tap shoe) configurations as shown below as acceptable and approved with this filing.

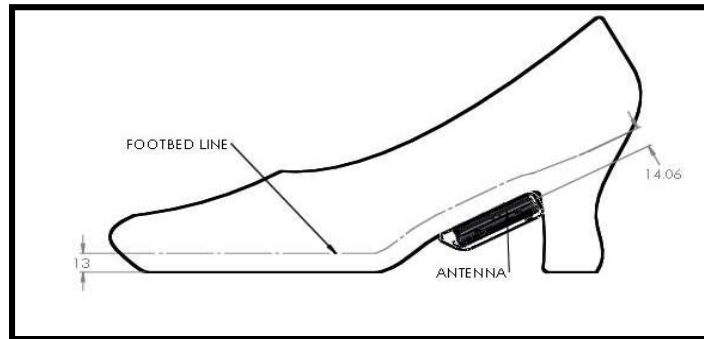


Figure 1 -High Heel Antenna Spacing

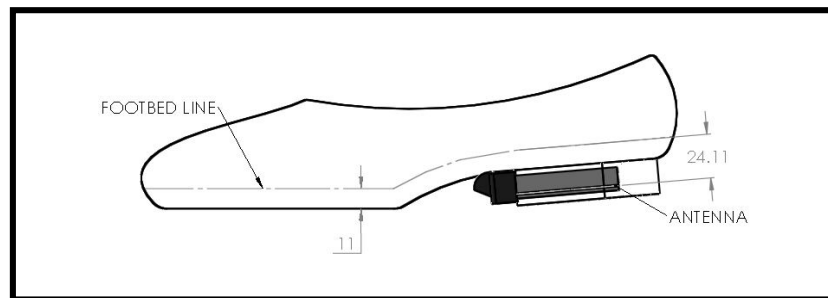


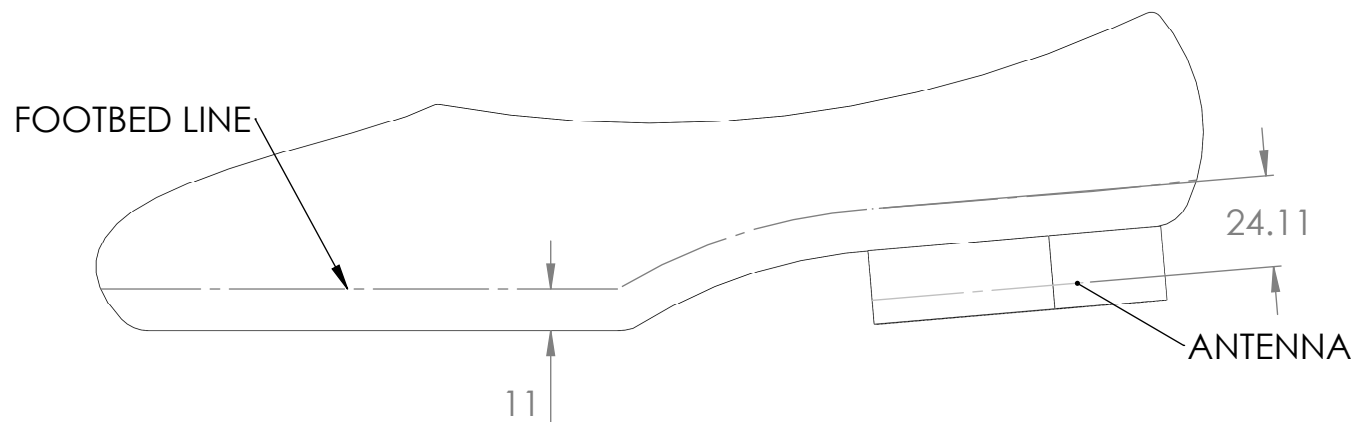
Figure 2 - Low Heel Antenna Spacing

RF Exposure Warning:

The applicant hereby affirms that installation of this module will only be performed on shoe models that have a minimum 10 mm separation distance from the outside surface/antenna of the module to the closest surface of the foot.

The module integrator must:

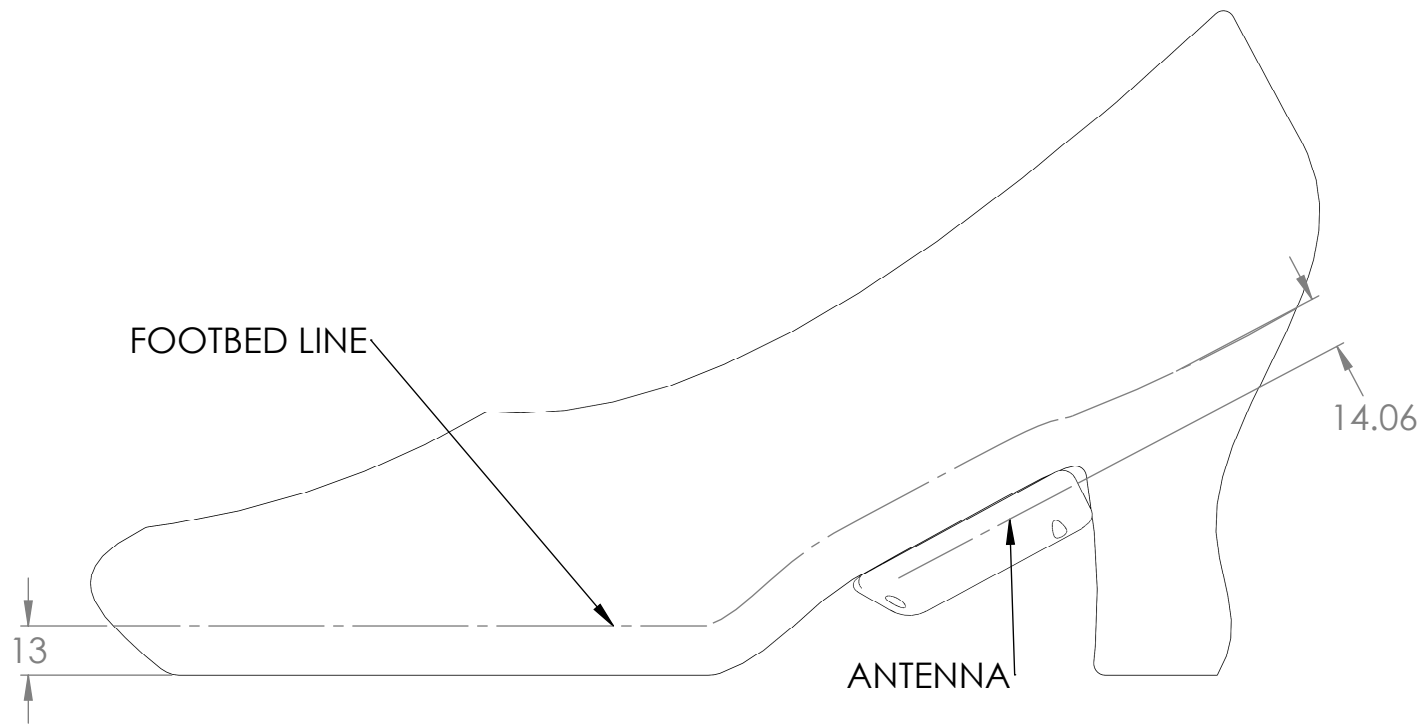
- 1) Ensure that the QT-5000 module antenna is mounted in such a way that the minimum spacing of 10 mm is maintained between the antenna and the wearer at all times.
- 2) Ensure that the minimum spacing between the wearer and the module antenna must be in free space or non-metallic material.



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UNLESS OTHERWISE SPECIFIED:		NAME	DATE	Q5X TITLE: QT-5000-MODULE MOUNTING				
DIMENSIONS ARE IN MM		DRAWN	AN				24/09/15	
TOLERANCES: TWO PLACE DECIMAL ± 0.10		CHECKED						
		ENG APPR.						
		MFG APPR.						
		Q.A.			SIZE A DWG. NO. 001 REV 1			
		COMMENTS:						
MATERIAL	N/A							
FINISH	N/A							
DO NOT SCALE DRAWING					SCALE: 1:2		WEIGHT:	SHEET 1 OF 1



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UNLESS OTHERWISE SPECIFIED:		NAME	DATE	Q5X TITLE: QT-5000 MODULE MOUNTING			
DIMENSIONS ARE IN MM		DRAWN	AN				24/09/15
TOLERANCES: TWO PLACE DECIMAL ± 0.10		CHECKED					
		ENG APPR.					
		MFG APPR.					
		Q.A.			SIZE A DWG. NO. 002 REV 1 SCALE: 1:2 WEIGHT: SHEET 1 OF 1		
		COMMENTS:					
MATERIAL	N/A						
FINISH	N/A						
DO NOT SCALE DRAWING							