

1.1. RF EXPOSURE REQUIREMENTS [§§ 15.247(i), 1.1310 & 2.1091]

FCC has specified the general guidance for meeting RF Exposure requirements in KDB 447498 D01 General RF Exposure Guidance v06, 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) The 1-g body and 10-g extremity SAR Test Exclusion Thresholds in 4.3 should be applied to determine SAR test requirements.

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

Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition(s), listed below, is (are) satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The minimum test separation distance defined in 4.1 f) is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander. To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified, typically in the SAR measurement or SAR analysis report, by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting are required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops and tablets, etc.

4.3.1 (a) 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:

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

where

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

- f(GHz) is the RF channel transmit frequency in GHz.
- Power and distance are rounded to the nearest mW and mm before calculation³¹
- The result is rounded to one decimal place for comparison
- The values 3.0 and 7.5 are referred to as numeric thresholds

Radio#1 WIFI Radio:

Max frequency: 2.48 GHz
Max power 16.62 dbm,
Antenna gain 2 dBi and duty Cycle of 3.458% @ 5 mm separation distance.
Power= 16.62+2=18.62 dBm=72.77mW at 100%
Power after duty cycle=0.03458*72.77=2.52 mW

Relative to Numeric Threshold

$$= \frac{[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}]}{}$$

$$= (2.52)/5 \times (\sqrt{2.48}) < 3 \quad = \mathbf{0.793} < \mathbf{3}, \text{ satisfies the exclusion threshold for STAND ALONE}$$

Radio#2 UHF Mic Radio:

Max frequency: 616 MHz
Max power 16.41 mW,
Antenna gain 0 dBi and @ 5 mm separation distance.
Power= 16.41 mW

Relative to Numeric Threshold

$$= \frac{[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}]}{}$$

$$= (16.41)/5 \times (\sqrt{0.616}) \quad = \mathbf{2.58} < \mathbf{3}, \text{ satisfies the exclusion threshold for STAND ALONE}$$

*616 MHz rather than 608 MHz is used as a worst case for purpose of calculation.

Simultaneous transmission SAR test exclusion considerations

4.32 (b) When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

- 1) $[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}/x]$ W/kg, for test separation distances ≤ 50 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 ≤ 0.4 W/kg. When SAR is estimated,

the peak SAR location is assumed to be at the feed-point or geometric center of the antenna, whichever provides a smaller antenna separation distance, and this location must be clearly identified

in test reports. The estimated SAR is used only 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. When SAR to peak location separation ratio test exclusion is applied, the highest reported SAR for simultaneous transmission can be an estimated standalone SAR if the estimated SAR is the highest among the simultaneously transmitting antennas (see also KDB Publication 690783 D01). For situations where the estimated SAR is overly conservative for certain conditions, the test lab may choose to perform standalone SAR measurements, then use the measured SAR to determine simultaneous transmission SAR test exclusion. Estimated SAR values at selected frequencies, distances, and power levels are illustrated in Appendix D

1. WIFI Radio:

Max frequency: 2.48 GHz
Max power 16.62 dbm,
Antenna gain 2 dBi and duty Cycle of 3.458%
@ 5 mm separation distance.
Power= 16.62+2=18.62 dBm=72.77mW at 100%
Power after duty cycle=0.03458*72.77=2.52

Estimated SAR₁ [2.52/5].[√2.48/7.5]=[0.504*0.2099]=0.106 W/kg

2. UHF Mic Radio:

Max frequency: 616 MHz
Max power 16.41 mW,
Antenna gain 0 dBi and duty Cycle of 100% @ 5 mm separation distance.

Power =16.41 mW

Estimated SAR₂ [16.41/5].[√0.616/7.5]=[3.2820*0.1046]=0.343W/kg

4.32 c) When the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR to peak location separation ratio. The simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SAR to peak location separation ratio to qualify for test exclusion. The ratio is determined by $(SAR_1 + SAR_2)^{1/3}/R_i$, rounded to two decimal digits, and must be ≤ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion. When 10-g SAR applies, the ratio must be ≤ 0.10 . SAR1 and SAR2 are the highest reported or estimated SAR values for each antenna in the pair, and R_i is the separation distance in mm between the peak SAR locations for the antenna pair. The antennas in all antenna pairs that do not qualify for simultaneous transmission SAR test exclusion must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Publication 865664 D01.



Peak SAR location distance measured at feed points of antenna pairs: $r_1 = 25.02\text{mm}$ $r_2 = 44.59\text{mm}$

SAR to peak location separation ratio (SPLSR) = $(\text{Estimated SAR}_1 + \text{Estimated SAR}_2)^{1.5}/R_i$

SPLSR = $(0.106 + 0.343)^{1.5}/25.02 = 0.012$ must be ≤ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion