

FCC RF Exposure Evaluation

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Portable Device

Refer Standard: KDB 447498 D01 General RF Exposure Guidance v06

FCC Part 2 §2.1093

1. Evaluation method

According to KDB447498 D01 General RF Exposure Guidance v06 Section 4.3.1 Standalone SAR test exclusion considerations: "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, listed below, is 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 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 of section 4.1). To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, typically in the SAR measurement or SAR analysis report, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for the 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 & tablets etc. "

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [f \text{ (GHz)}] \leq 3.0$$
 for 1-g SAR and ≤ 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
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to f in section 4.1 is applied to determine SAR test exclusion.

For frequencies below 100 MHz, the following may be considered for SAR test exclusion (also illustrated in Appendix C):

- 1) For test separation distances > 50 mm and < 200 mm, the power threshold at the corresponding test separation distance at 100 MHz in step b) is multiplied by $[1 + \log(100/f(\text{MHz}))]$
- 2) For test separation distances ≤ 50 mm, the power threshold determined by the equation in c) 1) for 50 mm and 100 MHz is multiplied by $\frac{1}{2}$
- 3) SAR measurement procedures are not established below 100 MHz.

When SAR test exclusion cannot be applied, a KDB inquiry is required to determine SAR evaluation requirements for any SAR test results below 100 MHz to be acceptable.

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)
$$\left[\frac{\text{max. power of channel, including tune-up tolerance, mW}}{\text{separation distance, mm}} \right] \cdot \left[\frac{f(\text{GHz})}{x} \right] \text{ W/kg, for test separation distances } \leq 50 \text{ mm;}$$
 Where $x = 7.5$ for 1-g SAR and $x = 18.75$ for 10-g SAR.
- 2) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distance is $> 50 \text{ mm}$.

When one of the following test exclusion conditions is satisfied for all combinations of simultaneous transmission configurations, further equipment approval is not required to incorporate transmitter modules in host devices that operate in the mixed mobile and portable host platform exposure conditions. The grantee is responsible for documenting this according to Class I permissive change requirements. Antennas that qualify for standalone SAR test exclusion must apply the estimated standalone SAR to determine simultaneous transmission test exclusion.

- a) The $\left[\sum \text{of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance)} / 1.6 \text{ W/kg} \right] + \left[\sum \text{of MPE ratios} \right] \leq 1.0$.
- b) The SAR to peak location separation ratios of all simultaneously transmitting antenna pairs operating in portable device exposure conditions are all ≤ 0.04 , and the $\left[\sum \text{of MPE ratios} \right] \leq 1.0$.

2. Refer Evaluation Method

[ANSI C95.1-1999](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[FCC KDB publication 447498 D01 General RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

[FCC CFR 47 part1 1.1310](#): Radiofrequency radiation exposure limits.

[FCC CFR 47 part2 2.1093](#): Radiofrequency radiation exposure evaluation: portable devices

3. Conducted Power Results

3.1 Test Setup



3.2 Test Equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
1	Power Meter	R&S	NRVS	100444	2017-06-17	2018-06-16
2	Power Sensor	R&S	NRV-Z32	10057	2017-06-17	2018-06-16

Remark: all calibration period of equipment list is one year.

3.3 Test Procedure

- a. The EUT was directly connected to the power meter and antenna output port as show in the block diagram Test Setup.
- b. Setup EUT work at duty cycle more than 98%;
- c. Read power sensor values in Peak detector;

3.4 Measure Results

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
			Antenna 1
GFSK	0	2402	-2.081
	19	2440	-2.268
	39	2480	-2.651

Test Mode	Channel	Frequency (MHz)	Field Strength of Fundamental (dBuV/m)
RFID	1	914.75	97.85

4. Manufacturing Tolerance

GFSK (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	-2.0	-2.0	-2.0
Tolerance \pm (dB)	1.0	1.0	1.0

5. Evaluation Results

5.1 Standalone

Antenna 1

Band/Mode	f (GHz)	Antenna Distance (mm)	RF output power		SAR Test Exclusion Threshold	SAR Test Exclusion
			dBm	mW		
GFSK(LE)	2.450	5	-1.0	0.7943	0.2 < 3.0	Yes

Remark:

1. Output power including tune up tolerance;
2. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to f) in section 4.1 is applied to determine SAR test exclusion.

Antenna 2

According to KDB 412172 D01 Determining ERP and EIRP format;

$$\text{eirp} = p_t \times g_t = (E \times d)^2 / 30$$

Where:

p_t = transmitter output power in watts,

g_t = numeric gain of the transmitting antenna (unitless),

E = electric field strength in V/m,

d = measurement distance in meters (m).

$$\text{EIRP} = 1.8286 \text{ mW} = 2.6212 \text{ dBm}$$

$$\text{Conducted power} = \text{EIRP} - \text{Antenna gain} = 2.6212 - 1.00 = 1.6212 \text{ dBm} = 1.4525 \text{ mW}$$

Band/Mode	f (GHz)	Antenna Distance (mm)	RF output power		SAR Test Exclusion Threshold	SAR Test Exclusion
			dBm	mW		
RFID	0.91475	5	1.6212	1.4525	0.3 < 3.0	Yes

5.2 Simultaneous Transmission for SAR Exclusion

The sample support one BT modular and one RFID modular, two modular support two difference antennas, need consider simultaneous transmission;

5.2.1 Estimation Standalone SAR

Antenna 0

Band/Mode	f (GHz)	Antenna Distance (mm)	RF output power		Estimation SAR Values (W/kg)
			dBm	mW	
BT LE	2.50	5	-1.0	0.7943	0.0332

Antenna 1

Band/Mode	f (GHz)	Antenna Distance (mm)	RF output power		Estimation SAR Values (W/kg)
			dBm	mW	
RFID	0.91475	5	1.6212	1.4525	0.0370

6.2.2 Estimation Simultaneous Transmission SAR

Σ of (the highest measured or estimated SAR_{BT}+SAR_{RFID})/1.6 = (0.0332+0.0370)/1.6 = 0.1 < 1.0;

6. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1093 for the uncontrolled RF Exposure and SAR Exclusion Threshold per KDB 447498 v06.

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