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Title: General RF Exposure Policies for Equipment Authorization

Short Title: General RF Exposure Guidance

Reason: Revision: Update of General RF Exposure Procedures

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Keyword/Subject: Mobile and Portable Device, RF Exposure, Equipment Authorization Procedures, 1.1307, 2.1091, and 2.1093

First Category: Radio Frequency (RF) Exposure

Second Category: General RF Safety Questions

Third Category:

Question: What are the RF exposure requirements and procedures for mobile and portable devices?

Answer: Attachment below, [447498 D01 General RF Exposure Guidance v05](#), describes the general RF exposure evaluation requirements and certain test guidance for mobile and portable device equipment authorization.

447498 D01 General RF Exposure Guidance v05 replaces the previous attachment, [447498 D01 Mobile Portable RF Exposure v04](#)

Mobile and portable device RF exposure and equipment authorization requirements are in FCC rule Sections 1.1307, 2.1091, and 2.1093.

A Mobile Multi-transmitter MPE Estimation [XLS] MPE spreadsheet is available at:
<http://www.fcc.gov/oet/ea/presentations/files/oct05/MPE-mobile.xls> for estimating MPE limits for multiple antennas.

Attachment List:

[447498 D01 General RF Exposure Guidance v05](#)

Attachment

Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

I. Introduction

This document is a part of the *published KDB procedures*.¹ It describes the general RF exposure evaluation requirements and certain test guidance that may be applicable to all the *published KDB procedures*. It also serves as the entry point for the RF exposure guidance described in the other *published KDB procedures*, listed below, that are available through the KDB system.

- Product related KDB: Handset & Accessories (648474 DR01), Laptop/Notebook/Netbook & Tablet (616217 DR01), USB Dongles (447498 D02), UMPC Mini-Tablets (941225 D07), Occupational PTT Two-Way Radios (643646 DR01)
- Wireless technology related KDB: 3GPP/3GPP2 Technologies (941225 D01 to D04, D06; 941225 D05 LTE DR04), 802.11 (248227), WiMax (615223), Wireless Charging Applications (680106)
- Test methodology related KDB: SAR Measurement and Reporting Requirements (865664 DR01)
- Equipment approval policy related KDB: TCB Exclusion List (628591 DR01), Permit-But-Ask (PBA) Procedures (388624 D01; 388624 D02 List DR02), Permissive Change Policies (178919 DR02), Modular Approval Policies (996369), SAR Numbers Listing (690783 v01r01), etc.

In general, the *published KDB procedures* and other FCC policies are applied to prepare devices for equipment authorization with respect to [mobile](#) (2.1091) and [portable](#) (2.1093) RF exposure conditions. Guidance in the most recent revision of the *published KDB procedures*, TCB workshop updates and Supplement C, whichever is the latest at the time when device testing begins, must be applied. When there are questions regarding the applicability of these procedures the FCC Laboratory should be contacted by submitting inquiries through the KDB system. For new and evolving products the FCC should be contacted to determine if existing test guidance is sufficient for the evaluation of such devices. The test procedures in this document are applicable for equipment approval submitted either to a TCB or directly to the FCC for approval. In addition, some test and reporting guidance is also provided for equipment that is required to be submitted directly to the FCC for approval (See KDB 628591, TCB Exclusion List).

II. General TCB Approval Requirements

Equipment approved by a TCB must satisfy all applicable requirements in the *published KDB procedures* and other equipment approval policies required for TCB approval; for example, the [equipment approval policy related KDB publications](#) (I., bullet 4).

¹ Guidance for RF exposure evaluation is available from the [FCC website](#) through the [OET-Lab Knowledge Database \(KDB\) system](#). These are collectively referred to in this document as the *published KDB procedures* that provide RF exposure test and evaluation support for specific products, wireless technologies, test methodologies and equipment approval policies.

If submitted to a TCB for approval, devices that are categorically excluded from routine RF exposure evaluation must apply the *published KDB procedures*.

In general, when the *published KDB procedures* are not followed the [PBA procedures](#) (388624) are required to qualify for TCB approval. Deviations to these procedures must be confirmed through a KDB inquiry. When a device requires substantial FCC involvement to complete the review and approval process, the equipment may be subject to FCC approval only. This typically involves new technologies and emerging products that require substantial test and approval considerations. It is usually determined during the KDB inquiry process when test requirements are considered.

III. General RF Exposure Policies for Equipment Authorization

- A. Equipment authorization for devices that are categorically excluded from routine RF exposure evaluation, when filed directly with the FCC, are generally not required to include RF Exposure test results to demonstrate compliance. In some cases, the FCC may require RF Exposure testing to be performed ([§1.1307\(c\) and \(d\)](#)).
- B. The RF exposure requirements for transmitters and antennas 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.
- C. Mobile and portable exposure conditions and host platform approval requirements include:
 - 1. Standalone and [simultaneous transmission](#) (V.C.1.) use conditions for mobile and portable exposure conditions must be determined according to the host platform and product configuration requirements.
 - 2. A transmitter or module approved only for use in *mobile exposure host* platforms must be restricted to hosts and product configurations that do not require standalone and simultaneous transmission operations in portable exposure conditions for all transmitters incorporated in the host or product.²
 - 3. A transmitter or module approved for use in *portable exposure host* platforms may be used for standalone operations in mobile exposure host platforms when the same identical antenna and transmitter required for portable exposure conditions are used. Further equipment approval is not required.³
 - 4. A transmitter or module approved for use in *mixed mobile and portable exposure* host platforms may be used for standalone and simultaneous transmission operations in mobile and/or portable exposure conditions according to the approved operating configurations and exposure conditions in the qualified host configurations.⁴
 - 5. When simultaneous transmission [mobile exposure test exclusion](#) (VII.B.2.) applies, a transmitter or module approved for use in *portable exposure host* platforms may be used for simultaneous

² A *mobile exposure host* platform requires all transmitters in a host to operate in mobile exposure conditions.

³ A *portable exposure host* platform requires a host to support portable exposure conditions for all transmitters incorporated in it.

⁴ A *mixed mobile and portable exposure* host platform enables a host to incorporate transmitters to operate in qualified mobile or portable exposure conditions for standalone and simultaneous transmission operations.

transmission operations in *mixed mobile and portable exposure host* platforms according to Class I permissive change requirements. Further equipment approval is not required.

- D. A host device incorporating multiple transmitters and antennas that transmit simultaneously in mixed mobile and portable exposure conditions are required to apply the *published KDB procedures*. A transmitter or module approved for use in *mixed mobile and portable exposure host* platforms must address RF exposure compliance according to the operating configurations and exposure conditions of the transmitters required by the host(s).
 - 1. Some tests may not be required when MPE or SAR test exclusion applies.
 - 2. When tests are required, the results must be sufficiently conservative to demonstrate compliance for all standalone and simultaneous transmission operations required by the host platforms and product configurations.
 - 3. The host platform configurations and exposure conditions must be supported by the test results or exclusion conditions.
- E. Simultaneous transmission and standalone operation restrictions
 - 1. Transmitters approved for use in dedicated host or product configurations must operate in the specific standalone and simultaneous transmission conditions that were tested for equipment approval. Separate approvals are required for other host and product configurations.
 - 2. Transmitters approved only for use in standalone operations cannot be used in simultaneous transmission operations without further evaluation, through test exclusion provisions, or equipment approval. When MPE and SAR test exclusions are applicable to the simultaneous transmission operations in the hosts and product configurations and no other testing and equipment approval filing is required, the simultaneous transmission operations and test exclusion conditions must be fully documented in the grantee's records according to Class I permissive change requirements.
- F. Transmitters and modules approved for use in simultaneous transmission operations must be restricted to the host platform and product configurations tested or evaluated for equipment approval. When simultaneous transmission applies, approval for standalone operations is required.
- G. Transmitters operating in consumer products must satisfy the general population exposure limits for mobile and portable RF exposure conditions as appropriate.
 - 1. The test configurations used to qualify for test exclusion or for compliance testing must be sufficient for all required operations to demonstrate compliance.
 - 2. Provided the required accessories are used, a device should operate transparently without specific user intervention to maintain compliance.
 - 3. Caution statements or warning labels are only acceptable for alerting users to avoid exposures in certain unintended use conditions that are not required for device operations.
 - 4. Device operating instructions and certain installation requirements must be supported by the test configurations and results, and cannot be used as a substitute for the test requirements.

- H. Occupational exposure limits do not apply to consumer devices and radio services supporting public networks and Part 15 unlicensed operations.
 - 1. Occupational exposure limits only apply to “*work-related*” use conditions. Users must be “*fully aware of*” and be able to “*exercise control over*” their exposure to qualify for the higher exposure limits.
 - (i) Mandatory RF exposure training is required and, when applicable, detailed training instructions incorporated in manuals, in conjunction with conspicuous permanent labeling on the device, may be considered as acceptable training for workers to qualify a device for using occupational exposure limits, provided it can be demonstrated that users are required to adhere to the training instructions and are able to mitigate compliance concerns by applying the instructions.
 - (ii) The training information must be included in the equipment authorization application.
 - 2. Additional equipment approval considerations to satisfy occupational exposure requirements are not required for devices authorized in accordance with general population exposure limits.
- I. Operating and installation instructions are required by §§ 2.1033(b)(3) and 2.1033(c)(3).
 - 1. The acceptable standalone and simultaneous transmission operations allowed for the host platform configurations and exposure conditions, including any restrictions, must be fully described in the equipment approval and required OEM integration instructions.
 - 2. The information must be sufficient for the typical users and consumers, who are generally unskilled, to install and operate the equipment to ensure RF exposure compliance.
 - 3. When professional installation, OEM integration or assembly by a third-party is expected, the installation instructions and assembly requirements submitted for equipment approval must be provided to the integrators to clearly identify the specific requirements necessary to maintain RF exposure compliance.
 - (i) The grantee of a transmitter or the manufacturer is responsible for ensuring installers and integrators have a clear understanding of the compliance requirements and, if necessary, to provide further support to fulfill grantee responsibilities.
 - (ii) The integrators must be fully informed of their obligations and verify the resolution of any issues and concerns with each transmitter manufacturer or grantee.
 - (iii) The disclosure requirements for the entire supply chain, including grantees of individual transmitters, host manufacturers and OEM/ODM integrators, and the end users must be fully documented for a transmitter module.
 - 4. The instructions required for standalone products and modular transmitters are generally different due to varying host configurations, which must be considered in the instructions to ensure RF exposure compliance for both standalone and simultaneous transmission operations.
 - 5. Installation instructions and operating requirements are reviewed for acceptance during equipment approval and must be provided to the responsible parties.

IV. General RF Exposure Test Guidance

A. General test requirements

1. The general test methodologies of [Supplement C 01-01](#) to [OET Bulletin 65](#) and [IEEE Std 1528-2003](#) should be applied in conjunction with the *published KDB procedures*.⁵ The applicable test procedures established in the final releases of the IEEE and IEC SAR measurement standards are typically reviewed by the FCC and considered for incorporation in the *published KDB procedures* to allow for use after the implementations are fully validated in commercial SAR systems.
2. Unless it is specified differently in the *published KDB procedures*, the source-based time-averaging requirements of §§ 2.1091(d)(2) and 2.1093(d)(5) should be applied for test reduction and test exclusion considerations. Time-averaged maximum conducted output power applies to SAR and, as required by §§ 2.1091(c), time-averaged ERP applies to MPE.
3. Antenna gain is a far-field parameter. Depending on the operating frequency and antenna separation distance required, this usually does not apply to portable exposure conditions. In general, antenna gain is not directly related to near-field exposure conditions, which are highly dependent on the RF current distribution characteristics of individual transmitters, antennas and host device configurations. It would be inappropriate to assume lower gain antennas always produce lower SAR.
4. All devices must be evaluated in the required operating modes and test configurations; at the maximum rated output power, within the tune-up tolerance range specified for the product, and within 2 dB of the maximum tune-up tolerance limit.
 - (i) When tune-up tolerances are not required to be reported for equipment approval, RF exposure compliance must be determined with equivalent criteria and with respect to the highest maximum output power allowed for production units.
 - (ii) The measured results, when scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested, must be compliant. This must be documented in test reports for the highest measured results in each frequency band and for all scaled SAR results > 1.5 W/kg or MPE results within 5% of the applicable limits.⁶
 - (iii) The device samples tested must have the same physical, mechanical and thermal characteristics and operational tolerances expected for production units to ensure compliance. These factors often interact with each other and cannot be dealt with separately; therefore, they must be considered collectively by testing representative device samples.
5. The test setup used must not perturb the antennas and radiating structures of a test device or influence the device in manners that are inconsistent with the required test protocols; for example, field perturbations due to apparatuses used to secure test devices that are physically very small, such as

⁵ While the fundamental SAR measurement concepts described in Supplement C and IEEE Std 1528 should be applied, additional test requirements in the *published KDB procedures* must be applied to test recent generation products and wireless technologies.

⁶ When different tune-up tolerances are specified for different wireless modes and operating configurations, compliance must be determined separately according to the highest measured results for each condition in each frequency band. Separate scaling considerations are required when there are large variations in maximum output power across the channels in an operating mode or frequency band.

USB dongles, thin edges of devices or field scattering from nearby objects.⁷ When necessary, a device should be secured with lossless foam material to provide ≥ 2.5 cm separation from the holding apparatuses to minimize potential perturbations.

B. SAR test requirements for typical exposure conditions

1. Head exposure conditions

- (i) Devices that are designed to transmit next to the ear and operate according to the handset procedures in IEEE Std 1528-2003 and OET Bulletin 65 Supplement C 01-01, or conditions described in the *published KDB procedures* must be tested using the SAM phantom defined in IEEE Std 1528-2003.
- (ii) Other head exposure conditions; for example, in front of the face, should be tested using a flat phantom according to the appropriate *published KDB procedures*.

2. Body-worn accessory exposure conditions

- (i) Devices that support transmission with body-worn accessories must be tested for body-worn accessory SAR compliance.
 - (a) SAR evaluation is required for body-worn accessories supplied with the device.
 - (i) All body-worn accessories containing metallic components either supplied with the product or available as an option from the device manufacturer must be tested in conjunction with the device.
 - (ii) Body-worn accessories that do not contain metallic or conductive components may be tested selectively according to worst-case exposure configurations, typically according to the smallest separation distance supported by the group of body-worn accessories.
 - (b) A conservative minimum separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users should be used to test for body-worn accessory SAR compliance for consumer handsets. The distance should be determined according to the device form-factor and types of body-worn accessories users may acquire and fully justified in the SAR report.
 - (c) Body-worn accessory SAR compliance must be based on a single minimum separation distance for all wireless and operating modes applicable to the body-worn accessories used by the device, according to the relevant voice and/or data mode transmissions and operations.

If a body-worn accessory supports voice only operations in its normal and expected use conditions; for example, belt-clips and holsters for cellphones, testing of data mode for body-worn compliance is not required. These must be determined by the wireless technologies and operating characteristics of an individual device; and must be clearly explained in test reports to support the SAR results.

⁷ Influences of the hand holding a handset on the measured head SAR are under investigation in on-going SAR measurement standards committee projects, which could lead to different test device holding apparatus requirements for handset testing in the future.

- (d) Specific information must be included in operating manuals to enable users to acquire body-worn accessories that meet the minimum separation distance requirements.
- (i) All unsupported body-worn accessories and operating configurations must be clearly disclosed to users through conspicuous instructions in the user guide or manual to ensure such operations are avoided.
- For example, carrying a device closer than the minimum separation distance, such as in-pockets or using a lanyard, while operating in speaker mode or transmitting through a wired or Bluetooth headset must be avoided if SAR was not tested.
- (ii) All body-worn accessories containing metallic components must be clearly identified in the operating manual. The instruction must inform users to avoid using other body-worn accessories containing metallic components to ensure RF exposure compliance.
- (iii) Instructions on how to place and orient a device in body-worn accessories, in accordance with the test results, should also be included in the user instructions.
- (iv) Users must be fully informed about the operating requirements and restrictions, to the extent that the typical user can easily understand the information, to acquire the required body-worn accessories to maintain compliance.
- (e) Devices that are designed or intended to be operated on the body of users using other accessories, such as lanyards and straps, or without requiring additional body-worn accessories must be tested for SAR compliance using a conservative minimum separation distance required for normal use. A distance ≤ 5 mm should be utilized.

3. **Extremity exposure conditions**

- (i) Devices that are designed or intended for use on or to be operated only by the extremities, i.e., hands, wrists, feet and ankles, may require extremity and body SAR evaluation.⁸
- (ii) When guidance is unavailable in the *published KDB procedures*, the following SAR test exclusions are applicable for extremity use conditions, in the frequency range of 100 MHz to 6 GHz, when the minimum separation distance from the antenna and radiating structures or outer surface of a device to the extremity is ≥ 5 mm and ≤ 50 mm.⁹
- (a) Extremity SAR is not required for devices that are designed or intended to only operate on or by extremities meeting the following threshold:

$$\left[\frac{(\text{max. power of channel, including tolerance, mW})}{(\text{min. extremity separation distance, mm})} \right] \cdot [\sqrt{f_{\text{GHz}}}] \leq 7.5.^{10}$$

⁸ Extremity SAR is generally not required for the maximum output power levels required by cellphones.

⁹ Separation distances from antenna and radiating structures apply to host devices with large form factors where the exposure influence contributed by the host is negligible. For smaller form factor devices, the outer surface of the host should be used to determine the separation distance. This applies to all similar circumstances in this document.

¹⁰ See “SAR test exclusion considerations” section for additional details.

- (b) Body SAR is not required for devices that are designed or intended to operate on or by extremities when the [SAR Exclusion Threshold](#) [IV.C.1.(ii)(a)] conditions are satisfied by the maximum output power and minimum separation distance requirements.
- (c) The minimum separation is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor and platform requirements, to any part of the extremity or body of a user or bystander. This distance must be fully explained and conservatively justified in the equipment approval filing, typically in the SAR measurement or SAR analysis report.
- (iii) When extremity SAR testing is required, a flat phantom must be used when the exposure conditions are more conservative than the actual use conditions; otherwise, a KDB inquiry is required to determine the phantom and test requirements.
- (iv) These procedures do not address when extremity and/or body SAR testing is required for devices with irregular shapes or form factors, and/or unusual operating configurations and exposure conditions. For such devices it is necessary to contact the FCC to determine the appropriate SAR measurement procedures.

4. **Transmitters implanted in the body of a user**

When the maximum total available power at the antenna port or radiating structures of an implanted transmitter is ≤ 1.0 mW, SAR test exclusion may be approved by the FCC as part of the PBA process.¹¹ The maximum available output power requirement must be fully justified in a SAR analysis report, in lieu of the SAR evaluation, according to the design and implementation requirements and fully supported by power measurement results.

C. **General SAR Test Reduction and Exclusion Guidance**

1. **SAR test exclusion considerations**

- (i) SAR test exclusion considerations for certain specific devices and exposure conditions are described separately in this document; for example, [extremities](#) (IV.B.3.), [implants](#) (IV.B.4.) and [handheld PTT two-way radios](#) (VI.A.). Additional provisions are also available in the *published KDB procedures*.
- (ii) Unless it is required by the *published KDB procedures*, standalone SAR evaluation by measurement or numerical simulation is not required when the following [SAR Exclusion Threshold](#) [IV.C.1.(ii)(a)] condition is satisfied by the source-based time-averaged maximum conducted output power of the RF channel, including tune-up tolerance, and the minimum separation distance required for the exposure conditions.

$$(a) \left[\frac{(\text{max. power of channel, including tolerance, mW})}{(\text{min. separation distance, mm})} \right] \cdot [\sqrt{f_{(\text{GHz})}}] \leq 3.0; \text{ where:}^{12}$$

¹¹ That is, the worst case power conditions under all operating circumstances.

¹² This is equivalent to $\left[\frac{(\text{max. power of channel, including tolerance, mW})}{(60/\sqrt{f_{(\text{GHz})}} \text{ mW})} \right] \cdot [20 \text{ mm}/(\text{min. separation distance, mm})] \leq 1.0$; also see Appendix A for approximate exclusion threshold values at selected frequencies and distances.

- f is the RF channel transmit frequency in GHz
 - power and distance are rounded to the nearest mW and mm before calculation¹³
 - The result is rounded to one significant digit for comparison
- (b) This test exclusion applies only when the minimum separation distance is ≥ 5 mm and ≤ 50 mm, and the frequency range is between 100 MHz and 6 GHz.
- (c) The minimum separation distance must be fully justified by the operating configurations and exposure conditions of the transmitter and applicable host platform configurations to qualify for SAR test exclusion.
- (i) For some host configurations; for example, laptop display screens, the distance may be determined by the smallest distance from the antenna and radiating structures of the device to users and bystanders.
- (ii) For other host configurations, such as tablets and handsets, the outer housing of the device should be used to determine the minimum separation distance.
- (d) 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 a SAR report, to qualify for the test exclusion.
- (iii) The following should be applied to determine simultaneous transmission SAR test exclusion.
- (a) When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, simultaneous transmission SAR test exclusion also applies to that antenna under the following conditions.
- The standalone SAR of an antenna is estimated by the following equation and used to determine simultaneous transmission SAR test exclusion, according to the sum of 1-g SAR or SAR to peak location separation ratio requirements
- (i) $(\text{max. power of channel, including tolerance, mW})/(\text{min. separation distance, mm}) \cdot [\sqrt{f_{\text{(GHz)}}/7.5}]$ W/kg; rounded to two significant digits¹⁴
- (ii) the peak SAR location is assumed to be at the feed-point or geometric center of the antenna, whichever is more conservative, and it must be clearly identified in the test reports
- (b) The measured and estimated standalone SAR for all applicable simultaneous transmitting antennas must be analyzed in each operating mode and exposure condition to determine simultaneous transmission SAR test exclusion according to one of the following conditions.

¹³ Unless stated otherwise, the same rounding requirements apply to all similar equations in this document.

¹⁴ The standalone SAR Exclusion Threshold is configured to limit the estimated SAR to approximately ≤ 0.4 W/kg, according to substantially conservative conditions. When the estimated SAR is overly conservative for certain conditions, test labs may choose to perform standalone SAR measurements and use the measured SAR to qualify for simultaneous transmission SAR test exclusion. Also see Appendix B for estimated SAR values at selected frequencies, distances and power levels.

- (i) The sum of the 1-g SAR for all simultaneous transmitting antennas in a specific test operating mode and exposure condition is ≤ 1.6 W/kg; for example, head, body-worn accessory or hotspot use are typical operating modes and each may require testing in multiple exposure conditions, such as touch, tilt, left and right for head or different edges for hotspot mode, etc.
- (ii) The applicable simultaneous transmitting antennas must be considered one pair at a time to determine the SAR to peak location separation ratio for the operating modes and exposure conditions. The ratio for each antenna pair must be ≤ 0.04 .

- 1. The antenna separation distance between each pair of simultaneous transmitting antennas, (R_i), must be $\geq 25 \cdot (\text{SAR}_1 + \text{SAR}_2)^{1.5}$ mm, round to the nearest mm.

This condition is satisfied when the SAR to peak location separation ratio determined by $(\text{SAR}_1 + \text{SAR}_2)^{1.5} / R_i$ is ≤ 0.04 ; where SAR_1 and SAR_2 are the highest measured or estimated SAR for the antennas, in a specific test operating mode and exposure condition.

- 2. When standalone SAR is measured, the peak location is determined by the actual x, y and z coordinates in the 1-g SAR reported by the SAR measurement system for each SAR peak location, based on the extrapolated and interpolated results in the zoom scan measurement.
 - a. When 1-g SAR is measured for both antennas in the pair, the peak location separation distance is computed by the square root of $[(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2]$.
 - b. If necessary, the SAR system manufacturer should be contacted to determine how to obtain the peak SAR location coordinates.
- 3. When standalone SAR is not required and SAR is estimated for the test exclusion, the peak location is determined according to the feed-point or geometric center of the antenna, whichever is more conservative.
 - a. Due to curvatures on the SAM phantom, when one of the SAR values is estimated, the separation distance between a measured and an assumed peak location needs further consideration.
 - b. The peak location of the measured peak should be projected onto the test device to determine the separation of that peak to the feed-point or geometric center of the assumed peak. The projection should be through the point normal to the phantom surface, corresponding to a straight line connecting the measured peak location and the test device.
 - c. While flat phantoms are not expected to have these issues, the same projection approach should be applied.
 - d. When necessary, the projections should be illustrated on the SAR plots to support the distance used to qualify for SAR test exclusion.

- (c) For simultaneous transmission test exclusion to apply, the maximum output power, duty factor and other applicable parameters used in the standalone SAR tests must be the same or more conservative than those required for simultaneous transmission.
- (i) When the maximum output power is reduced in an operating mode or exposure condition during simultaneous transmission, often due to SAR or other implementation requirements, the higher output power standalone SAR may be applied to determine simultaneous transmission SAR test exclusion.
- (ii) When simultaneous transmission SAR test exclusion does not apply, SAR measurements must be performed at the maximum output power required in the power reduction modes for simultaneous transmission, within the tune-up tolerance requirements, to apply the volume scan post-processing procedures.

2. **SAR test reduction considerations**

- (i) When the frequency channels required for SAR testing are not specified in the *published KDB procedures*, the following equation must be applied to each wireless mode and operating configuration to determine the number of channels that require testing. Any further reduction in test channels requires a KDB inquiry to qualify for TCB approval.

$$N_c = \text{Round} \left\{ \left[100 (f_{\text{high}} - f_{\text{low}}) / f_c \right]^{0.5} \times (f_c / 100)^{0.2} \right\}; \text{ where}$$

- N_c is the number of test channels, rounded to the nearest integer;
 - f_{high} and f_{low} are the highest and lowest channel frequencies within the transmission band,
 - f_c is the mid-band channel frequency, and
 - frequencies are in MHz.
- (ii) When multiple channels are required for SAR testing, where the 1-g SAR for the mid-band channel, or the channel with the highest output power, and the transmission bandwidth corresponding to all channels in the frequency band are satisfied for the following conditions, testing of the other channels in the band is not required.¹⁵
- (a) ≤ 0.8 W/kg and transmission band ≤ 100 MHz
- (b) ≤ 0.6 W/kg and, 100 MHz $<$ transmission bandwidth ≤ 200 MHz
- (c) ≤ 0.4 W/kg and transmission band > 200 MHz
- (d) These test reduction provisions are only applicable when: the highest maximum output power of all transmission channels in a frequency band is not higher than the channel tested

¹⁵ Supplement C 01-01 and IEEE Std. 1528-2003 require the middle channel to be tested first. This generally applies to wireless devices that are designed to operate in technologies with tight tolerances for maximum output power variations across channels in the band. When the maximum output power variation across the required test channels is $> 1/2$ dB, instead of the middle channel, the highest output power channel must be used.

for SAR,¹⁶ or the measured SAR is scaled to the upper tune-up tolerance limit to account for the highest maximum output expected for production units

D. SAR evaluation using numerical simulation

1. The following are required for SAR simulations to be acceptable for demonstrating compliance using the FDTD method:¹⁷
 - (i) The most recent draft standard IEEE P1528.1 and draft IEC 62704-1 must be applied, including the numerical code validation requirements.¹⁸
 - (ii) Any difference in the numerical codes and algorithms, including the gram-averaging requirements, used in the SAR simulations and those required by the IEEE and IEC drafts must be fully explained in the SAR report. The differences must be demonstrated to be insignificant to ensure the simulated results are acceptable for demonstrating compliance.
 - (iii) The [tissue dielectric parameters](#) available at the FCC/OET website should be applied when heterogeneous anatomical human models are used. The head and body tissue dielectric parameters required for SAR measurements are required when homogeneous models are used.
 - (iv) Due to certain simplified assumptions required to model complex transmitters, devices and anatomically-equivalent human models, and also due to limitations associated with various constraints required for simulation and modeling, it is necessary to confirm the validity of the transmitter and human models against field strength and/or SAR measurement results in selected test configurations. Details of a transmitter model used in the simulation and its validity must be fully justified and explained in the SAR report. When applicable, comparisons of simulated and measured return loss and field strength results in free-space conditions etc. may be considered..
 - (v) A detailed test report is required, similar to that required for SAR measurements and in accordance with the FDTD reporting guidelines in Supplement C 01-01.
2. When other numerical computation methods are used in accordance with certain specific FCC provisions, the equivalent considerations required for the FDTD method must be applied.¹⁹

V. RF Exposure Guidance for Modules and Peripheral Transmitters

A. RF exposure equipment approval considerations for transmitter modules

1. The following equipment approval guidelines are required to incorporate peripheral transmitters and modules in other products and host devices.²⁰

¹⁶ Maximum output power variation across all channels in a frequency band may be determined by measurements or according to the design and specifications of production units.

¹⁷ It may be necessary to discuss with the FCC Laboratory to determine appropriate parameters to be used in the numerical simulation approach taken for a specific device or applying other numerical simulation methods besides FDTD.

¹⁸ Draft IEC 62704-1 and draft standard IEEE P1528.1 are join projects; draft IEC 62704-1 is expected to replace draft standard IEEE P1528.1.

¹⁹ For example, see ET Docket No. 10-166, DA 11-192.

- (i) Transmitters and modules incorporated in host devices for standalone operations only, with no other transmitters in the host, must remain compliant for all host configurations.
- (ii) When transmitters and modules are incorporated in host devices for standalone and simultaneous transmission operations, with other transmitters in the host, all transmitters in the host must be compliant for the standalone and simultaneous transmission operations required for all host configurations.
 - (a) Whether additional equipment approval is required for the transmitters already existing in the host device typically depends on influences of the newly added transmitter(s) to existing transmitters, with respect to the host device form factor, transmitter/antenna configurations and exposure conditions, etc.
 - (i) Some preliminary assessment is normally required to determine if Class I or Class II permissive change applies. For example; adding a modular transmitter with its antenna in the display of a laptop computer may introduce little or no issues to the existing transmitters when the antennas are installed sufficiently far apart from each other in the host device. However, if the same transmitter module is incorporated in a tablet or handset, reevaluation of the transmitters in the host is generally necessary.
 - (ii) The modular approach is often not appropriate for host devices that have RF energy coupling concerns due to close proximity of the transmitters and antennas in the host device and to the users.
 - (iii) The correct approach is to test the host with all transmitters incorporated in it; therefore, certain complex influences among the transmitters can be taken into consideration in the normally required SAR measurements and are rendered transparent to the process.
 - (iv) When high SAR is expected due to close proximity between antennas and users, the modular approach is also not appropriate because of difficulties to ensure compliance for all host configurations that may not be easily assessed in advance.
 - (b) When additional equipment approval is required, compliance can be addressed according to one of the following provisions.
 - (i) Compliance of individual transmitters in host devices may be addressed through Class II permissive changes submitted by the grantee of the corresponding transmitter to enable a transmitter module to be incorporated in qualified host devices.²¹
 - (ii) Compliance of all transmitters in a host device may be addressed using a new equipment approval filing submitted by the host device manufacturer, where all transmitters are approved under the host FCC ID.
 - (iii) The manufacturer of the host device, the transmitter with the highest maximum output power, or the most recently added transmitter that triggers the additional approval

²⁰ A peripheral transmitter requires a host to support its operations; it cannot operate independently by itself. Peripheral transmitters can be attached to hosts through user accessible external standard interface connections or incorporated internally within the host device.

²¹ See KDB 178919, Permissive Change Policies.

requirements, may apply for a change of FCC ID for the transmitter modules that require additional approval, and address all subsequent concerns under its direct responsibility through Class II permissive changes to enable such transmitter modules to be incorporated in qualified host devices.²²

- (iv) The host device manufacturer may also consider a mixed modular and dedicated host approach, to address compliance for transmitters with higher output power and SAR in dedicated host configurations and using the modular approach for certain low power transmitters that have low SAR or do not require any SAR testing.

This approach enables the presence of low power transmitters and associated influences introduced by the hardware to be taken into consideration during the normal SAR testing of the higher output transmitters in the dedicated host, without requiring separate testing for the low power transmitters in the host device.

2. Transmitters and modules for incorporation into host devices are approved according to the following combinations of operating configurations and exposure conditions, which should be clearly identified on the grant of equipment authorization:
 - (i) for standalone operations only, without simultaneous transmission
 - (a) in either mobile or portable exposure conditions and with or without host platform restrictions, as supported by the test results²³
 - (b) in dedicated host or product configurations
 - (ii) for standalone and simultaneous transmission operations
 - (a) in either mobile only or portable only exposure conditions and with or without host platform restrictions, as supported by the test results
 - (b) in mobile and portable exposure conditions, in qualified hosts and product configurations that support mixed mobile and portable exposure conditions
 - (c) in dedicated host and product configurations
3. Unless a transmitter or module is designed to operate in host devices that do not support portable exposure conditions or simultaneous transmission operations, seeking equipment approval for mobile exposure conditions or standalone operations in the initial equipment approval may require new filings to qualify for other operating and exposure conditions due to testing and approval difficulties. Therefore, initial filings for mobile only exposure conditions are highly discouraged to avoid subsequent equipment difficulties.

²² Change of ID requires coordination between an original grantee and the third-party applicant.

²³ The platform restriction may need to identify whether multiple standalone transmitters should be allowed to operate in qualified host configurations, with respect to the supporting test results. Transmitters and antennas in device with small form factors can influence the SAR characteristics of adjacent transmitters and antennas due to close proximity, even when they are not transmitting simultaneously; therefore, collocation for these types of standalone transmitters and antennas in a host may need to be limited to low SAR conditions or require demonstration of no SAR influence concerns.

4. The qualified installation and use conditions must be clearly identified in the equipment approval and OEM integration requirements, including all restrictions, to support the grant conditions.

B. SAR evaluation of transmitters and modules used in portable exposure conditions for standalone operations

1. Peripheral transmitters, such as USB dongles, internal and external plug-in cards, and generic modules intended for incorporation into specific host platforms or unknown devices should apply the following procedures to determine SAR evaluation requirements for standalone operations in qualified host devices that do not support simultaneous transmission.²⁴ When the requirements in [V.B.2](#) and [V.B.3](#) are applied in conjunction with the *published KDB procedures*, additional SAR evaluation is generally not required to incorporate the transmitter into qualified host devices for standalone operations according to the exposure conditions tested for compliance.
 - (i) When the highest measured 1-g SAR is ≤ 0.4 W/kg, transmitters and modules may be used in portable exposure conditions with no restriction for host platforms. This applies to both OEM installed and user accessible external peripheral transmitters.
 - (a) Unless the [SAR Exclusion Threshold](#) [IV.C.1.(ii)(a)] at 5 mm is satisfied, SAR evaluation is required. The antenna and radiating structures or the permanently integrated housing must be positioned at 5 mm from the phantom for all applicable test configurations.

When additional separation is necessary to maintain compliance; for example, through specific installation requirements or restricted use conditions, these configurations must be defined as a separate platform as discussed [V.B.1.\(ii\)](#) and [V.B.1.\(iii\)](#).
 - (b) In addition, the procedures in [V.B.3](#) must be applied.
 - (ii) When the highest measured 1-g SAR is > 0.4 and ≤ 0.8 W/kg, transmitters and modules may be approved for use in multiple host platforms according to the operating configurations and exposure conditions of the host family attributes and requirements.
 - (a) Typical platforms may include certain handheld devices, laptop/notebook/netbook and tablet computers etc.
 - (b) Each host platform must be tested independently for SAR compliance.
 - (c) When specific test requirements are unavailable in the *published KDB procedures*, the most conservative exposure conditions must be tested for each host platform, according to the operating and exposure characteristics of the host family attributes.²⁵

²⁴ Standalone portable exposure conditions apply to single or multiple transmitters installed in the same device that do not transmit simultaneously. Other equipment authorization requirements, such as limited modular approval [§ 15.212(b)] and composite system [§ 15.31(k)] may also apply.

²⁵ The host families within the platform should be tested independently when different host family attributes can introduce changes to SAR characteristics, due to varying operating configurations and exposure conditions where the most conservative exposure conditions are different.

- (d) The multiple host platforms may be approved under one FCC ID. Additional platforms may be added through subsequent Class II permissive changes provided that all test, approval and installation requirements are satisfied under the same approval criteria and category.
- (iii) When the highest measured 1-g SAR is > 0.8 and ≤ 1.2 W/kg, transmitters and modules may be approved for use in a single host platform according to the operating configurations and exposure conditions of the specific host type.
 - (a) The operating and exposure characteristics of the host configurations within the platform must be substantially equivalent and clearly documented in both the equipment authorization filings and all OEM and installation instructions.
 - (b) When specific test requirements are unavailable in the *published KDB procedures*, the most conservative exposure conditions for the host platform must be determined and tested.
 - (c) A separate FCC ID is required for each host platform to enable the testing and compliance issues to be reasonably managed. All subsequent Class II permissive changes must be within the scope of the defined host configurations and exposure conditions in the initial equipment approval.
- (iv) When the highest 1-g SAR tested for a host platform is > 1.2 W/kg, the following should be considered.
 - (a) The transmitter or module must be tested in a dedicated host and equipment approval is limited to the specific host configurations tested for compliance.
 - (b) Peripheral transmitters are normally designed to operate in multiple hosts, for single or multiple platform use, according to the interface connection requirements. For devices operating with user accessible external interface connections, it is generally not acceptable to restrict this type of operations to a dedicated host. Hence, device design changes are often necessary for user accessible external peripheral transmitters to satisfy SAR compliance requirements.

2. Additional requirements for testing transmitters and modules.

- (i) Except when certain specific provisions are available in the *published KDB procedures*, all power control and related operating functions that may influence the SAR characteristics of a transmitter or host device must be fully contained within the approved transmitter. When control of certain transmitter functions and parameters is shared or provided by the host device or through other mechanisms, and when SAR compliance can become of concern, equipment approval may need to be restricted to a dedicated host.
- (ii) When testing is required for a host platform and test requirements have not been given in the *published KDB procedures*, the antenna(s) and radiating structures or outer housing of the module and internally installed peripheral transmitters that are incorporated as an integral part of a host device must be tested according to the minimum separation distance required for all applicable operating configurations required by the host platform. The minimum test separation distance must be fully justified in the SAR report. All required operating restrictions must be clearly explained in test reports to support the test setup and results.

- (iii) Except when it is defined in the *published KDB procedures*, peripheral transmitters that operate through user accessible external interface connections, such as ExpressCard or SDIO, must be tested according to the operating configurations and exposure conditions required by the host platform.
- (a) A minimum test separation distance must be determined conservatively for all applicable operating configurations according to the interface connection implementations available for the host platform. Certain less conservative conditions that do not require testing to show compliance must be fully justified in the SAR report.
 - (b) A test separation distance of 5 mm should be considered for tablets and similar host devices that are normally used next to users; for example, UMPC mini-tablets and normal size tablets. A test distance of 10 mm may be considered for user accessible external card slots when smaller distances are not supported by host devices in the platform.
 - (c) A KDB inquiry should be submitted to determine the test separation distances required for other products and configurations.
 - (iv) For peripheral transmitters that must be connected to a user accessible external interface through a cable or adapter, when it can be ensured that smaller distances are not applicable for normal operations, the antenna and radiating structures or outer housing of a peripheral transmitter must be tested in all applicable orientations against the phantom at an appropriate test separation distance ≤ 15 mm. The same consideration must be applied when a cable, adapter or accessory antenna is supplied with the transmitter to offer alternative connection and use conditions. A KDB inquiry is required to determine if other test separation distances are acceptable for specific product configurations and to qualify for TCB approval.
3. Transmitters and modules with no host platform restrictions must apply the following procedures to determine if additional SAR evaluation is required to address RF energy coupling enhancements at increased separation distances.
- (i) The tip of the SAR probe is positioned at the peak SAR location of the zoom scan for the highest SAR measured of each test configuration, at a distance of half the probe tip diameter (rounded to the nearest mm) from the phantom surface. With the probe tip fixed at this location, the test device is positioned in direct contact with the phantom, and subsequently moved away from the phantom in 5 mm increments. Single-point SAR (not 1-g SAR) is measured for each of the device positions until the SAR is < 50 % of that measured with the device in contact with the phantom.

At least three repeated measurements should be made at each device position. The highest of the three single-point SAR values is reported for each position. When there are noticeable fluctuations, $> 15\%$, more measurements should be made for each position to ensure a representative high range value is recorded.
 - (ii) If the highest measured single-point SAR among all positions is 25% greater than that measured with the device positioned at 5 mm from the phantom, a complete 1-g SAR evaluation is required for the configuration that produced the highest single-point SAR. When this subsequent 1-g SAR is > 0.45 W/kg, the unrestricted host platform cannot be applied.

4. Detailed OEM integration and installation requirements must be included in the equipment approval filing. Grantee responsibilities and third party obligations to incorporate or use the transmitter in approved host platforms and configurations etc. must be clearly identified in the instructions. The approved and required antenna configurations in qualified host platform(s), such as separation distances to users and other antennas, antenna polarization and orientation requirements in different host configurations, must be fully specified in the installation requirements.
5. Documentation for requiring acceptable operating instructions are provided to end users of all final host products must also be included in the equipment approval.

C. SAR evaluation of transmitters and modules used in portable exposure conditions for simultaneous transmission operations

1. Except for network hand-offs, SAR compliance for simultaneous transmission must be considered when the maximum duration of overlapping transmissions is greater than 30 seconds.
2. The [simultaneous transmission SAR test exclusion](#) [IV.C.1.(iii)] procedures should be considered to streamline test requirements.
3. When simultaneous transmission SAR evaluation is required, the enlarged zoom scan measurement and volume scan post-processing procedures described in KDB 865664 DR01 must be applied to determine compliance.
4. The following conditions require a KDB inquiry to determine simultaneous transmission SAR test exclusion and SAR measurement requirements.
 - (i) When coherent signals are involved in the simultaneous transmission, such as certain phased array, beam-forming or similar configurations.
 - (ii) When different maximum output power levels are applied to the individual antennas of transmitter/MIMO chains of simultaneous transmission configurations, or there is more than 1 dB variation in maximum output power, across all channels in a frequency band, for a transmitter or antenna in a simultaneous transmission configuration.²⁶

VI. SAR Test Guidance for Unique Hosts and Exposure Conditions

A. Handheld push-to-talk (PTT) two-way radios

1. The operating configurations of handheld PTT two-way radios generally require SAR testing for in-front-of the face and body-worn accessory exposure conditions.
2. A duty factor of 50% should be applied to radios with maximum operating duty factors $\leq 50\%$ to determine compliance. Radios with higher duty factors must apply the maximum duty factor supported by the device to determine compliance.²⁷

²⁶ All channels include those that are not required for testing. Maximum output power variations may be determined by combinations of measurements, design specifications and other analyses, etc.

²⁷ The 50% duty factor only applies to radios in exposure conditions that operate with a mechanical PTT button.

- (i) For example, up to 100% duty factor may be required for certain radios that support operator-assisted PSTN calls and radios with Bluetooth or voice activated transmission capabilities.
 - (ii) When TDMA applies, such inherent duty factor should also be taken into consideration.
3. The following SAR test exclusions may be applied to PTT radios operating from 100 MHz to 1 GHz according to general population exposure requirements.²⁸
- (i) SAR is not required for in-front-of the face or body-worn accessory exposure conditions when the [SAR Exclusion Threshold](#) [IV.C.1.(ii)(a)] conditions are met.
 - (a) Maximum power is determined by the duty factor compensated maximum conducted output power to determine SAR test exclusion.
 - (b) When a body-worn accessory is not supplied with the PTT radio, a separation distance ≤ 10 mm must be applied to determine if body-worn accessory SAR test exclusion may be applied.
 - (ii) A test separation distance of 25 mm must be applied for in-front-of the face SAR test exclusion and SAR measurements.
 - (iii) When body-worn accessory SAR testing is required, the considerations for [body-worn accessory](#) (IV.B.2.) should be applied.
 - (iv) PTT two-way radios that support held-to-ear operating mode must also be tested according to the [exposure configurations required for handsets](#) [IV.B.1.(i)]. This generally does not apply to devices such as cellphones with PTT option, which already have more conservative SAR results for the applicable wireless modes, at 100% duty factor, to support compliance for next to the ear use.

B. Wrist watch and wrist-worn transmitters

- 1. Unless [extremity SAR Test Exclusion](#) (IV.B.3.) and 1-g [SAR Test Exclusion](#) [IV.C.1.(ii)(a)] apply, transmitters that are built-in within a wrist watch or similar wrist-worn devices should be tested for SAR compliance.
 - (i) Voice communication is usually accomplished in speaker mode with the device worn on the wrist and positioned next to the mouth
 - (ii) 1-g SAR applies for next to the mouth exposure and 10-g SAR applies to wrist-worn conditions.
- 2. SAR for next to the mouth use is evaluated with the front of the device positioned at 10 mm from a flat phantom. The wrist bands should be strapped together to represent normal use conditions.
- 3. SAR for wrist exposure is evaluated with the back of the devices positioned in direct contact against the flat phantom. The wrist bands should be unstrapped and touching the phantom.
 - (i) The space introduced by the watch or wrist bands and the phantom must be representative of actual use conditions; otherwise, if applicable, the neck or a curved head region of the SAM

²⁸ Occupational handheld PTT two-way radios must apply the procedures in KDB 643646.

phantom may be used, provided the device positioning and SAR probe access issues have been addressed through a KDB inquiry.

- (ii) For other device positioning and SAR measurement difficulties it may be necessary address through a KDB inquiry for the test results to be acceptable; for example, when electronic circuitry and/or antenna(s) are incorporated in the wrist bands.
4. The procedures are only applicable to devices that are worn on the wrist and cannot support other use conditions. This must be fully demonstrated in both the test reports and user manuals.

C. Low transmission duty factor devices

1. When devices transmit intermittently, in data mode only, the time-averaged exposure can be low.
 - (i) The duty factor may not be source-based if the sporadic transmissions are not periodic, inherently built-in within the device or cannot be easily determined.
 - (ii) The duty factor can be operation-based or non-periodic; for example, location trackers, emergency alert responders, point of sales devices (POS), certain black & white display e-Readers, and devices supporting location-based services.
 - (iii) Voice-mode communication generally does not qualify for low duty factor considerations. Exceptions may be considered under the PBA process.
2. SAR measurement is not required for low transmission duty factor devices, operating in data modes, under the following conditions:
 - (i) when an acceptable worst case or most conservative transmission duty factor has been determined and the [SAR Exclusion threshold](#) [IV.C.1.(ii)(a)] conditions are satisfied for the duty factor adjusted maximum output power and minimum separation distance required for all applicable operating configurations.
 - (a) Supporting details for determining the duty factor, with respect to the design and implementation of the device, operating configurations and exposure conditions, have been fully documented in a SAR analysis report to qualify for the SAR test exclusion.
 - (i) Different analyses may apply to specific devices and circumstances; for example, the transmission and duty factor restrictions required by different networks and infrastructures and ad-hoc implementations used in individual devices can be different.
 - (ii) The exposure conditions for devices with different form-factors, design and implementation requirements can have substantial variations.
 - (b) When SAR evaluation is required, the duty factor determined in the SAR analysis may be applied to scale the measured SAR to determine compliance.

D. After-market accessories

1. Transmitters and devices are approved for use according to the operating configurations and RF exposure conditions assessed for equipment approval.

- (i) After-market accessories that do not contain any transmitters and have potential to change the RF exposure characteristics of approved host devices are typically assessed in conjunction with the host to determine compliance.
- (a) Compliance for optional accessories available from the original transmitter manufacturer can be addressed with respect to Class I and Class II permissive change requirements.

When there are no equivalent test configurations in the original approval of a device to enable the SAR distribution and exposure conditions of a newly introduced accessory to be compared, SAR degradation remains undetermined. Accessories that have potential to influence the SAR characteristics of a host and have never been identified in previous equipment approval generally require a Class II permissive change for inclusion in the equipment authorization. Subsequent changes and modifications to the accessory can be addressed with respect to Class I and Class II permissive change requirements.

- (b) Third-party accessory suppliers should consult with the original host equipment manufacturer to determine accessory approval options; for example, through a Class I or Class II permissive change submitted by the original host grantee.
 - (i) If applicable, a change of FCC ID followed by a Class II permissive change from the third-party accessory manufacturer may be considered.²⁹
 - (ii) Separate equipment approval does not apply to accessories that do not contain any transmitter. The accessories would not qualify to operate with intended hosts until the hosts have demonstrated compliance and are approved to operate with the accessory or it is known the accessory has no relevance to the RF exposure characteristics of the hosts.
- (c) The assessment required to determine if Class I or Class II permissive change applies may include, analysis of the relevant parameters, such as separation distance, metallic content, changes to exposure conditions etc. and preliminary measurements; for example, measurements using the highest SAR configurations with equivalent SAR distributions and exposure conditions reported in the earlier equipment approval.

2. Separate equipment approval is required for third-party accessories that contain transmitter(s).

- (i) If the transmitter in the accessory supports standalone operations, with or without the host equipment, both conditions must be assessed for RF exposure compliance. Some accessories with built-in transmitters are designed to support host devices that do not contain transmitters; therefore, separate host approval is not required.
- (ii) Simultaneous transmission operations for all transmitter combinations must be addressed for the accessory and also with the accessory operating in conjunction with the host equipment.
- (iii) Typical host devices may include handsets, music players, and other small consumer electronic devices. Accessories may include various attachments in the form of snap-on sleeves, plug-in components, host carriers containing built-in transmitters and other active or passive strap-on or carrying accessories.

²⁹ Change of ID requires coordination between the original grantee and third-party.

- (iv) Due to significant variations in the types of accessory and host use conditions, a KDB inquiry is necessary to determine the test requirements.

E. Other consumer electronic devices

1. The exposure conditions for transmitters and modules incorporated in certain consumer electronic devices, such as printers, cameras and camcorders may vary according to the installation and operating configurations required by the host products.
2. Details of the transmitter and antenna configurations, antenna to user separation distance, device operating configurations, etc. are required to determine [SAR test exclusion](#) [IV.C.1.(ii)(a)] or SAR measurement requirements for each host product. These must be fully explained in the Class I permissive change documentation or equipment approval filing. When SAR tests are required, a KDB inquiry is recommended to confirm the test setup.
3. Unless the transmitter is used in a specific/dedicated host device, the [standalone](#) (V.B.) and [simultaneous transmission](#) (V.C.) SAR procedures for transmitters and modules should be applied.

VII. RF Exposure Evaluation Guidance for Mobile Conditions

A. Transmitters used in mobile exposure conditions for standalone operations

1. Devices operating in standalone mobile exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously.
2. A minimum separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to qualify for mobile exposure limits. The distance must be fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2).
3. When it is difficult to determine the use conditions of a device as either portable or mobile (§ 2.1091(d)(4)), a KDB inquiry must be submitted to determine acceptable SAR test requirements.
4. Cable losses and other attenuations considered for determining compliance must be representative of the most conservative operating configurations and exposure conditions.
5. When the categorical exclusion provision of § 2.1091(c) applies, the minimum separation distance may be estimated, if applicable, by simple calculations according to plane-wave equivalent conditions to ensure the transmitter and its antenna(s) operate in manners that meet or exceed this distance.³⁰
 - (i) The maximum radiated power, according to the maximum antenna gain, must be applied to calculate field strength and power density to establish the minimum separation distance.
 - (ii) When the estimated separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

³⁰ The type of calculations used to estimate the minimum separation distance for MPE compliance must be appropriate for the type of antenna(s) and exposure conditions evaluated.

6. When routine evaluation is required, MPE measurement or computational modeling should be used to determine compliance to qualify for TCB approval.
 - (i) MPE compliance must be assessed in all directions surrounding the antenna and radiating structures of the device according to the following.
 - (a) Except when certain sectors of an antenna are permanently blocked or restricted from access by nature of the installation conditions.
 - (b) When symmetrical exposure conditions are expected; for example, from an omni-directional antenna, such conditions must be clearly demonstrated in test reports to avoid testing in all directions.
 - (c) RF exposure evaluation equipment designed to measure the orthogonal field components with isotropic sensors is required to determine the total exposure field.³¹
 - (d) Either peak or spatially averaged results may be applied to determine compliance; with respect to plane-wave equivalent power density limits when ≥ 300 MHz and electric and magnetic field strength limits when < 300 MHz.
 - (ii) Depending on the radiating characteristics of an antenna, evaluation points in horizontal planes should be along radials from the antenna that are approximately 45° apart. The direction of maximum exposure should be aligned to one of the radials. At > 60 cm from the antenna, the evaluation points should be along radials that are $\leq 30^\circ$ apart.

Spatial averaging in horizontal planes is not required and should not be applied; except when the exposed person is aligned with the horizontal plane, which requires a KDB inquiry to determine the measurement and spatial averaging requirements.
 - (iii) The evaluation points in the vertical direction should extend at least 10 cm beyond the exposed portions of a person's body or until the evaluated results are $< 10\%$ of the MPE limit. For exposures next to the ground, the evaluation points should generally be ≥ 10 cm from the ground.
 - (a) The spatial resolution of the evaluation points should be ≤ 10 cm.
 - (b) The evaluated points in the vertical direction may be spatially averaged to determine compliance.
7. When the antenna of a device transmits in multiple frequency bands, users and bystanders generally would not know which frequency band is transmitting at any specific time. The most restrictive separation distance among all frequency bands is required for the antenna installation to ensure compliance.
 - (i) When specific antennas are not identified in the installation requirements, where users and installers may choose antennas with different gain requirements, the maximum antenna gain allowed for each frequency band must be determined according to the most restrictive separation distance required for all frequency bands.

³¹ Additional information on test equipment is available in OET Bulletin 65.

- (ii) The required antenna type, radiating characteristics, antenna gain and the requirement of a unique minimum separation distance must be fully explained in the operating and installation instructions. Installers should be cautioned that failure to comply with the specific antenna requirements can result in operations that exceed FCC RF exposure limits.
8. The minimum separation distances required for a device to comply with mobile exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements.

B. Transmitters used in mobile exposure conditions for simultaneous transmission operations

1. When transmitters are incorporated in host devices that only operate in mobile exposure conditions and the following conditions are satisfied, further equipment approval is not required. These are considered as Class I permissive changes and must be fully documented by the grantee.³²
- (i) All antennas and other radiating structures within the host are compliant with mobile exposure requirements for standalone transmission.
 - (ii) The minimum separation distance required for each simultaneous transmitting antenna installed in the host device is greater than or equal to that approved for use in the standalone mobile exposure conditions.
 - (iii) The sum of the MPE ratios, determined from calculated or measured field strengths or power density with respect to the applicable frequency dependent MPE limits, for all simultaneous transmitting antennas incorporated in the host device, is ≤ 1.0 .
 - (a) The MPE ratio of each antenna is determined at the minimum separation distance required by the operating configurations and exposure conditions of the host device. This is the ratio of the peak or spatially averaged field strengths or power density, at the minimum separation distance, to the MPE limit at the test frequency.
 - (b) Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field conditions.
2. For host devices containing transmitters and modules that operate in mixed mobile and portable exposure conditions, further equipment approval is not required when one of the following test exclusion conditions is satisfied for all combinations of simultaneous transmission configurations. Antennas that qualify for standalone [SAR test exclusion](#) [IV.C.1.(ii)(a)] must apply the [estimated standalone SAR](#) [IV.C.1.(iii)(a)] to qualify for simultaneous transmission SAR test exclusion.
- (i) The $[\sum \text{ of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance) / 1.6 W/kg} + [\sum \text{ of MPE ratios}]]$ is ≤ 1.0 . [see also VII.B.1.(iii)(a)]

³² For simple antenna configurations, the Excel spreadsheet at <http://transition.fcc.gov/oet/ea/presentations/files/oct05/MPE-mobile.xls> may be used to estimate the MPE compliance boundary.

(ii) The SAR to peak location separation ratios [IV.C.4.(iii)(b)(ii)] for all simultaneous transmitting antenna pairs operating in portable exposure conditions are all ≤ 0.04 and the $[\sum \text{ of MPE ratios}]$ is ≤ 1.0 . [see also VII.B.1.(iii)(a)]

3. When RF exposure test exclusion does not apply, simultaneous transmission evaluation is required for mixed mobile and portable exposure conditions. The enlarged zoom scan measurement and volume scan post-processing procedures in KDB 865664 must be applied to test the simultaneous transmitting antennas operating in portable exposure conditions for each simultaneous transmission configuration.

The $[(\text{highest measured simultaneous transmission SAR, adjusted for maximum tune-up tolerance}) / 1.6 \text{ W/kg}] + [\sum \text{ of MPE ratios}]$ must be ≤ 1.0 [see also VII.B.1.(iii)(a)]; otherwise, compliance must be determined by the FCC on a case-by-case basis with respect to antenna-to-antenna and antenna-to-user separation, device form factor, operating requirements and exposure conditions etc.

4. The antenna installation and operating requirements for the host device must satisfy the minimum separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

Appendix A SAR Exclusion Thresholds

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Distances are illustrated in the following Table.

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	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	
MHz	30	35	40	45	50	mm
150	232	271	310	349	387	SAR Test Exclusion Threshold (mW)
300	164	192	219	246	274	
450	134	157	179	201	224	
835	98	115	131	148	164	
900	95	111	126	142	158	
1500	73	86	98	110	122	
1900	65	76	87	98	109	
2450	57	67	77	86	96	
3600	47	55	63	71	79	
5200	39	46	53	59	66	
5400	39	45	52	58	65	
5800	37	44	50	56	62	

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.

Appendix B Applying Estimated SAR for Simultaneous Transmission SAR Exclusion

The following Table illustrates the approximate SAR values estimated at selected frequencies, distances and power levels for determining simultaneous transmission SAR test exclusion when standalone SAR is not required.

Estimated SAR higher than 0.4 W/kg do not apply; therefore, they are not indicated								
Red numbers in "mW" column are the approximate maximum output power at the SAR Exclusion Threshold for standalone SAR test exclusion. Top row indicates different levels of test device maximum output power								
MHz	10	25	50	100	150	200	mW	Min. Distance
150	0.1	0.3					39	5 (mm)
300	0.1	0.4					27	
450	0.2						22	
835	0.2						16	
900	0.3						16	
1500	0.3						12	
1900	0.4						11	
2450							10	
3600							8	
5100							7	
5400							6	
5800							6	
MHz	10	25	50	100	150	200	mW	10 (mm)
150	0.1	0.1	0.3				77	
300	0.1	0.2	0.4				55	
450	0.1	0.2					45	
835	0.1	0.3					33	
900	0.1	0.3					32	
1500	0.2						24	
1900	0.2						22	
2450	0.2						19	
3600	0.3						16	
5100	0.3						13	
5400	0.3						13	
5800	0.3						12	
MHz	10	25	50	100	150	200	mW	15 (mm)
150	0.0	0.1	0.2	0.3			116	
300	0.0	0.1	0.2				82	
450	0.1	0.1	0.3				67	
835	0.1	0.2					49	
900	0.1	0.2					47	
1500	0.1	0.3					37	
1900	0.1	0.3					33	
2450	0.1	0.3					29	
3600	0.2						24	
5100	0.2						20	
5400	0.2						19	
5800	0.2						19	
MHz	10	25	50	100	150	200	mW	20 (mm)
150	0.0	0.1	0.1	0.3	0.4		155	
300	0.0	0.1	0.2	0.4			110	
450	0.0	0.1	0.2				89	
835	0.1	0.2	0.3				66	

900	0.1	0.2	0.3				63	
1500	0.1	0.2					49	
1900	0.1	0.2					44	
2450	0.1	0.3					38	
3600	0.1	0.3					32	
5100	0.2	0.4					27	
5400	0.2	0.4					26	
5800	0.2						25	
MHz	10	25	50	100	150	200	mW	25 (mm)
150	0.0	0.1	0.1	0.2	0.3		194	
300	0.0	0.1	0.1	0.3			137	
450	0.0	0.1	0.2	0.4			112	
835	0.0	0.1	0.2				82	
900	0.1	0.1	0.3				79	
1500	0.1	0.2	0.3				61	
1900	0.1	0.2	0.4				54	
2450	0.1	0.2					48	
3600	0.1	0.3					40	
5100	0.1	0.3					33	
5400	0.1	0.3					32	
5800	0.1	0.3					31	
MHz	10	25	50	100	150	200	mW	30 (mm)
150	0.0	0.0	0.1	0.2	0.3	0.3	232	
300	0.0	0.1	0.1	0.2	0.4		164	
450	0.0	0.1	0.1	0.3			134	
835	0.0	0.1	0.2				98	
900	0.0	0.1	0.2				95	
1500	0.1	0.1	0.3				73	
1900	0.1	0.2	0.3				65	
2450	0.1	0.2	0.3				57	
3600	0.1	0.2					47	
5100	0.1	0.3					40	
5400	0.1	0.3					39	
5800	0.1	0.3					37	
MHz	10	25	50	100	150	200	mW	35 (mm)
150	0.0	0.0	0.1	0.1	0.2	0.3	271	
300	0.0	0.1	0.1	0.2	0.3		192	
450	0.0	0.1	0.1	0.3	0.4		157	
835	0.0	0.1	0.2	0.3			115	
900	0.0	0.1	0.2	0.4			111	
1500	0.0	0.1	0.2				86	
1900	0.1	0.1	0.3				76	
2450	0.1	0.1	0.3				67	
3600	0.1	0.2	0.4				55	
5100	0.1	0.2					46	
5400	0.1	0.2					45	
5800	0.1	0.2					44	
MHz	10	25	50	100	150	200	mW	40 (mm)
150	0.0	0.0	0.1	0.1	0.2	0.3	310	
300	0.0	0.0	0.1	0.2	0.3	0.4	219	
450	0.0	0.1	0.1	0.2	0.3		179	
835	0.0	0.1	0.2	0.3			131	
900	0.0	0.1	0.2	0.3			126	

1500	0.0	0.1	0.2				98	
1900	0.0	0.1	0.2				87	
2450	0.1	0.1	0.3				77	
3600	0.1	0.2	0.3				63	
5100	0.1	0.2	0.4				53	
5400	0.1	0.2	0.4				52	
5800	0.1	0.2					50	
MHz	10	25	50	100	150	200	mW	
150	0.0	0.0	0.1	0.1	0.2	0.2	349	45 (mm)
300	0.0	0.0	0.1	0.2	0.2	0.3	246	
450	0.0	0.0	0.1	0.2	0.3	0.4	201	
835	0.0	0.1	0.1	0.3			148	
900	0.0	0.1	0.1	0.3			142	
1500	0.0	0.1	0.2	0.4			110	
1900	0.0	0.1	0.2				98	
2450	0.0	0.1	0.2				86	
3600	0.1	0.1	0.3				71	
5100	0.1	0.2	0.3				60	
5400	0.1	0.2	0.3				58	
5800	0.1	0.2	0.4				56	
MHz	10	25	50	100	150	200	mW	
150	0.0	0.0	0.1	0.1	0.2	0.2	387	50 (mm)
300	0.0	0.0	0.1	0.1	0.2	0.3	274	
450	0.0	0.0	0.1	0.2	0.3	0.4	224	
835	0.0	0.1	0.1	0.2	0.4		164	
900	0.0	0.1	0.1	0.3	0.4		158	
1500	0.0	0.1	0.2	0.3			122	
1900	0.0	0.1	0.2	0.4			109	
2450	0.0	0.1	0.2				96	
3600	0.1	0.1	0.3				79	
5100	0.1	0.2	0.3				66	
5400	0.1	0.2	0.3				65	
5800	0.1	0.2	0.3				62	