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First Category: Radio Frequency (RF) Exposure

Second Category: Specific Absorption Rate

Third Category: Non-handset SAR

Question: What are the SAR evaluation considerations for laptop, notebook, netbook and tablet computers?

Answer:

The attachment below - [616217 D04 SAR for laptop and tablets v01](#)- describes the SAR evaluation requirements for laptop, notebook, netbook and tablet computers.

616217 D04 SAR for laptop and tablets v01 replaces previous attachments:

- 616217 D01 SAR for Laptop with Screen Ant v01r0
- 616217 D02 SAR Policy Laptop with Screen Ant v01r01
- 616217 D03 SAR Supp Note and Netbook Laptop v01

Attachment List:

[616217 D04 SAR for laptop and tablets v01](#)

**SAR Evaluation Considerations
for
Laptop, Notebook, Netbook and Tablet Computers**

I. Introduction

This document describes the SAR evaluation requirements for laptop and tablet computers. The laptop platform also includes notebook and netbook computers. The procedures are applicable when the overall diagonal dimension of the keyboard or display section of a laptop or tablet is > 20 cm. The RF exposure test requirements for transmitters and antennas operating in standalone and simultaneous transmission configurations are considered. The test reduction and exclusion provisions in KDB 447498 are used. When tests are required, the procedures in this document must be applied in conjunction with the required *published KDB procedures* to test the different wireless technologies.¹ These equipment approval guidelines are only applicable for incorporating transmitters and modules in laptop and tablet computers that operate in the 700 MHz – 6 GHz bands.²

This document supersedes all previous versions of KDB 616217. The test requirements are aimed at minimizing the test and approval process for incorporating transmitters and modules in recent generation laptop and tablet computers. It also establishes the documentation required for the supply chain, including grantees of individual transmitters, host manufacturers and OEM/ODM integrators, and end users to comply with RF exposure requirements. Two host platforms are considered in these procedures, the laptop and tablet platforms. Laptop platform includes laptop, notebook and netbook computers. The tablet platform also applies to certain laptop computer configurations that can operate in tablet mode. The test configurations and minimum separation distances applicable to the tablet platform are expected to satisfy both laptop and tablet host platform requirements; therefore, transmitters approved for the tablet platform, when applicable, may also be used in the laptop platforms.

The operating and exposure characteristics of a transmitter may vary in different host configurations. When multiple transmitters are incorporated in a host computer, the aggregate exposure is dependent on the antenna configurations required by the host implementation. The transmitters incorporated in a typical host computer are usually supplied by different manufacturers, typically each providing a different wireless technology. A host manufacturer may also choose to have multiple suppliers for a specific transmitter, sometimes with certain design variations, requiring different antennas or varying antenna configurations in different host models. These types of host configurations can often introduce additional concerns in the tests required to support equipment approval.

The RF exposure evaluation required for individual transmitter modules must be sufficiently conservative to enable the transmitters to be incorporated in a multitude of host configurations for both standalone and simultaneous transmission operations without requiring additional equipment approval. The RF exposure conditions for laptop computers are generally associated with the antennas installed in the display screen and keyboard compartment. The exposure conditions for tablet computers are normally associated with the

¹ See KDB 447498 for *published KDB procedures*.

² Some 700 MHz bands may start slightly below 700 MHz.

display portion only; where, if a keyboard exists it would be folded below the display. The SAR test reduction and exclusion criteria for standalone and simultaneous transmission operations can be established conservatively according to these operating configurations and exposure conditions; with respect to the maximum output power of each transmitter, antenna proximity to users and other simultaneous transmitting antennas installed in the host. When tests are necessary, the configurations described in this document are required for transmitters and modules to demonstrate RF exposure compliance, for incorporation into qualified laptop and tablet hosts. The required *published KDB procedures* must be used to setup individual transmitters for testing.

II. Equipment Approval and RF Exposure Testing Approaches

Transmitters approved as modules may be incorporated into qualified laptop and tablet host computers by applying the *modular approach* described in this document without the need for further equipment approval. Alternatively, the host manufacturer may choose to use the *dedicated host approach* to apply for equipment approval for all transmitters incorporated in the host device under one FCC ID. In this case, the grantee is solely responsible for the installation, operation and disclosure requirements of all transmitters incorporated in the host device. When appropriate, a *mixed approach* that applies both the modular and dedicated host approach may also be used; the requirements for both approaches must be satisfied by all responsible parties to incorporate transmitters in qualified host devices to streamline the testing and approval process.

A. Modular approach

When applying the *modular approach*, host manufacturers and OEM integrators are required to adhere to all installation requirements and operating restrictions to incorporate transmitters in host devices. Each transmitter manufacturer must provide all relevant instructions required to ensure compliance for subsequent integration and use. The transmitter manufacturer is also responsible for ensuring integrators have a clear understanding of the compliance requirements and, if necessary, to provide further assistance to fulfill grantee responsibilities. The integrators must be fully informed of their obligations, and verify the resolution of any issues and concerns with each transmitter manufacturer. The disclosure requirements for the entire supply chain, including user operating instructions for the host devices, must be fully documented for a transmitter module and submitted for equipment approval.

The equipment approval and basic RF exposure test requirements, including test reduction and test exclusion provisions, are described in KDB 447498. When test exclusions are applied and Class I permissive change is considered, the grantee is responsible for maintaining records of all required documentation. OEM integrators and third-parties must work closely with transmitter grantees to ensure that the necessary installation and implementation requirements and restrictions for incorporating the transmitters and antennas in qualified host configurations have been satisfied.

The procedures in this document should be applied for transmitters and modules to qualify for the laptop and tablet host platforms, including separation distances and test setup. When the laptop and tablet host platform test requirements for the *modular approach* are satisfied for the antenna and host configurations in qualified hosts, testing in a representative host may not be required. The SAR procedures for transmitters and modules in KDB 447498 are used to determine if a modular transmitter may be approved for use in single and multiple host platforms, or without host platform restrictions. When the highest measured SAR for a host platform is ≤ 0.8 W/kg, with respect to the procedures in this document and KDB 447498, testing in representative hosts is optional. When the highest measured SAR for a host platform is > 0.8 W/kg and ≤ 1.2 W/kg, testing in a representative host is required to enable higher SAR configurations to qualify under the *modular approach* for which some basic platform test requirements may not be fully satisfied. When certain SAR configurations can only be tested with specific host

configurations, testing in dedicated hosts may provide the approval option to include these other OEM integration alternatives. When the highest measured SAR is > 1.2 W/kg, testing in a dedicated host is required for equipment approval.

When SAR is tested in representative host devices and the highest measured standalone SAR for certain specific operating configurations and exposure conditions are ≤ 1.2 W/kg, the additional test results for a transmitter module measured in one or more dedicated hosts may be applied to enable the transmitter to be incorporated in similar or more conservative host configurations and exposure conditions that satisfy the same test requirements. It is expected that many of the higher SAR conditions may not be easily tested in the initial equipment approval when certain specific antenna or host configurations are not available in early-on host product implementations. There may be circumstances that when a transmitter module is tested without a representative host the test conditions could be overly conservative for certain antenna or operating configurations. By testing available hosts on an incremental basis and adding the optional configurations through Class II permissive changes, the qualified host configurations and exposure conditions may be expanded according to the following considerations:

1. The module transmitter manufacturer must update the OEM integration instructions and installation requirements for each subsequent Class II permissive change to accommodate the additional antenna and host configurations. These are reviewed for acceptance during equipment approval.
2. The type of material surrounding the antenna location for the hosts used in the tests must be similar to those required in the actual implementations. Separate hosts should be tested to support different antenna surrounding materials that are expected to introduced SAR differences; for example, non-conductive plastics vs. conductive plastic or metallic materials.
3. Any operating restrictions to be relaxed and/or configurations to be added through subsequent host testing and Class II permissive changes must be clearly identified; for example;
 - (i) to enable antennas to be installed in specific or new configurations to address adjacent edge SAR in some laptop keyboards or tablets.

Note: the two ends of an antenna associated with different adjacent edges on a host should be treated separately for antennas with asymmetrical structures or radiating characteristics.

- (ii) to allow antennas with asymmetrical physical structures or radiating characteristics to be installed in hosts requiring different antenna rotations or orientations.

When simultaneous transmission applies to a host device, additional equipment approval is not required when the simultaneous transmission SAR test exclusion provisions in KDB 447498 are satisfied. The grantee is responsible for maintaining all Class I permissive change records. When simultaneous transmission SAR or MPE testing is required, the equipment approval and test procedures in KDB 447498 for mobile and portable exposure conditions and modular transmitters must be considered to incorporate modular transmitters in qualified host devices.

Host manufacturers and OEM integrators must also apply the simultaneous transmission SAR test exclusion provisions in KDB 447498 for transmitters/antennas operating from external card slots and/or interface connections, to determine compliance for the host computer configurations. Users can use any transmitter that is capable of operating with an external interface connection; the SAR for these types of user accessible external peripheral transmitters must be assumed to be 1.6 W/kg for the compliance analysis. The host device must support the minimum separation distance determined using the SAR to

peak location separation ratio criteria in KDB 447498 to avoid additional equipment approval requirements due to these user accessible transmitters; for example, ExpressCard, Card Bus and USB devices. The analysis must be based on conservative separation distance considerations and clearly explained in the SAR report and OEM integration requirements.

B. Dedicated host approach

When the *dedicated host approach* is applied, compliance for all transmitters in the host device must be addressed by the host manufacturer or grantee for both standalone and simultaneous transmission operations, with respect to the transmitter and antenna installation requirements and operating configurations of the specific host device. Compliance for simultaneous transmission due to external user accessible peripheral transmitters that plug into external card slots and interface connections must also be considered, according to the requirements described for the *modular approach*.

C. Mixed approach

When the *mixed approach* is applied, requirements for both modular and dedicated host approaches must be considered for the corresponding transmitters incorporated in the host device.

III. Host platforms

Regardless of simultaneous transmission requirements, transmitters must be each evaluated independently for standalone SAR compliance, according to the required rules and policies to determine RF exposure compliance, for use in laptop and tablet host platforms. Transmitters and modules incorporated in host devices that operate in both laptop and tablet host platforms must satisfy the requirements for both platforms and be tested according to the modular transmitter procedures in KDB 447498.

When applying the *modular approach*, the transmitters and modules must each qualify for incorporation into the host device. If a transmitter does not qualify for incorporation in certain host configurations, additional equipment approval is required for that modular transmitter. The host manufacturers and OEM integrators should consider the SAR test exclusion provisions in KDB 447498, to incorporate transmitters and antennas using host configurations that do not require further testing for standalone and simultaneous transmission SAR compliance. The assembly and integration must adhere to the specific instructions and requirements of all transmitters and modules for incorporation in qualified hosts. When further testing is required for simultaneous transmission, the approval procedures described in KDB 447498 should be considered, to determine which responsible party should be addressing the compliance concerns.

A transmitter module must be tested for SAR according to the platform test requirements, without using a representative host for the initial equipment approval. These test results are used to determine if additional testing with representative hosts is required for certain specific configurations with SAR > 0.8 W/kg, either with the initial filing or through subsequent Class II permissive change approvals. The initial testing without representative hosts is also required before results for configurations that can only be tested in dedicated hosts are accepted. All SAR data, for testing with and without representative or dedicated hosts, must be included in SAR reports, to determine host platform qualifications.

A. Laptop host platform test requirements

The required minimum test separation distance for incorporating transmitters and antennas into laptop, notebook or netbook computer displays is determined with the display screen opened at an angle of 90° to the keyboard compartment. If a computer has other operating configurations that require a different or

more conservative display to keyboard angle for normal use, a KDB inquiry should be submitted to determine the test requirements.

When the *modular approach* is applied, transmitters and modules must have been tested without using a representative host and approved to operate in the display and/or keyboard of qualified laptop computers for standalone operations with the following minimum user test separation distance and antenna installation requirements:

1. ≤ 25 mm between the antenna and user for incorporation in the display screen
2. ≤ 5 mm between the keyboard and user, for incorporation in the keyboard compartment, for bottom and edge exposure conditions
3. the antennas used must have been tested for equipment approval, and
4. the antenna polarization, physical orientation, rotation and installation configurations used must have been tested for compliance
5. when the SAR Exclusion Threshold in KDB 447498 applies, a minimum separation distance of 25 mm is required for to determine test exclusion for the display, and 5 mm for the keyboard compartment

B. Tablet host platform test requirements

Early generation tablets often operate with the display folded on top of the keyboard. The majority of recent generation tablets are designed with an interactive display that may not require a physical keyboard. Both configurations are used in similar manners that require SAR evaluation for the bottom and edges of the tablet. The antennas in tablets are typically located near the bottom and along the edges of the devices; therefore, SAR evaluation is required for these configurations. Exposures from antennas through the front surface of the display section of a tablet are generally limited to the user's hands. Exposures to hands for typical consumer transmitters used in tablets are not expected to exceed the extremity SAR limit; therefore, SAR evaluation for the front surface of tablet display screens are generally not necessary, except when continuous operations with hands next to the antenna(s) are required.

For most tablets, the display orientation may rotate to enable viewing in portrait and landscape modes; i.e., two each, primary and secondary. In some device configurations, the display may be disabled in selected orientations to discourage users from rotating a tablet edge containing an antenna towards the user. As tablet designs continue to expand to provide the flexibility needed to support interactive use, the display orientations can become unclear in some applications. Disabling the display in certain orientations may no longer be sufficient for ensuring RF exposure compliance. Tablets often apply various sensing mechanisms to determine display rotation while the device is positioned in or transitioning through different vertical and horizontal orientations and various tilted conditions. During interactive use, the transmissions from antenna(s) incorporated along an edge associated with a disabled display orientation may continue to transmit through some of these spatial orientations or at certain tilt angles when the tablet edge is at close proximity to its users or nearby persons. Unless there are acceptable means to ensure compliance; for example, reducing the maximum output power, the transmitter must be disabled for these circumstances rather than not supporting a certain display orientation.

Both the bottom surface and edges of tablets can operate directly next to users; hence, higher SAR is generally expected and the *modular approach* may only apply to lower power transmitters incorporated in tablets. When higher output power transmitters are incorporated in tablets and the SAR of the modular transmitter in the required tablet test configurations is > 1.2 W/kg, KDB 447498 requires testing in a dedicated host. While all transmitters may be addressed in a single FCC ID approval with the *dedicated host approach*, the *mixed approach* may also be applied to incorporate lower power transmitters using the *modular approach* to qualify for tablet host platform.

When the *modular approach* is applied, transmitters and modules must have been tested without using a representative host and approved to operate in the tablet platform with the following minimum tablet to user test separation distance and antenna installation requirements for standalone operations:

1. ≤ 5 mm between the tablet and user for bottom and edge exposure conditions
2. the antennas used must have been tested for equipment approval, and
3. the antenna polarization, physical orientation, rotation and installation configurations used must have been tested for compliance
4. when the SAR Exclusion Threshold in KDB 447498 applies, a minimum separation distance of 5 mm is required to determine test exclusion for the tablet platform

The antennas embedded in tablets are typically ≤ 5 mm from the outer housing. When the *dedicated host approach* is applied, the bottom surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required with the edge containing the antenna rotated $\pm 90^\circ$. The SAR Exclusion Threshold in KDB 447498 should be applied to determine SAR test exclusion for adjacent edge configurations. When testing is required, the tablet should be positioned with the adjacent edge positioned against the phantom, where the edge containing the antenna is perpendicular to the phantom.

For tablets with a curved or contoured bottom surface or edge construction, a KDB inquiry is required to determine the applicable tablet test setup requirements. When proximity sensors are incorporated on the bottom or edges of a tablet, near curved or contoured regions, additional considerations for the operation and triggering of the sensors, besides the procedures in this document, are also required. A KDB inquiry is recommended to ensure the required tablet setup and test results are applicable.

The simultaneous transmission SAR test exclusion provisions in KDB 447498 should be applied to determine if the enlarged zoom scan measurement and volume scan post-processing procedures are required. SAR test exclusion must be determined for the bottom surface and each edge separately, according to the simultaneous transmission requirements for each exposure position, which may involve antennas transmitting simultaneously on adjacent or multiple edges. Due to the different tablet orientations required for testing, when SAR to peak location separation ratio exclusion is applied to antennas on adjacent edges the peak SAR locations reported by the SAR measurement system are referenced to different physical phantom and device locations. Therefore, the peak location separation must be determined manually with respect to a common origin on the device; for example, with respect to the same physical edge location of the tablet. The details must be clearly explained in the test reports.

The hotspot mode SAR procedures for handsets and UMPC mini-tablets generally do not apply to normal size tablets. The standalone and simultaneous transmission SAR tests for normal size tablets are more

conservative than hotspot mode use configurations; therefore, additional testing for hotspot SAR is not required.

IV. Modular Approach SAR Test Setup Considerations

The options available for incorporating transmitter modules in qualified host configurations are determined by the test conditions applied to individual transmitters during equipment certification. Transmitters and modules intended for incorporation in laptop and tablet host computer platforms using the *modular approach* must follow the requirements defined in this document, and according to the standalone and simultaneous transmission test procedures for transmitter modules in KDB 447498. The SAR Exclusion Threshold in KDB 447498 should be applied to determine if SAR (and MPE) testing is required for the test configurations.

A. Standalone SAR testing

The test distances required for laptop and tablet host platform testing without using a representative host must be applied to determine SAR compliance for modular transmitters to qualify for incorporation into these platforms. The following general guidance should be considered to test the standalone SAR of transmitter modules when testing without a representative host.

1. The transmitter should be controlled by a representative host computer, and operating with the actual firmware, software drivers and other associated device operating software required for testing the wireless technologies.
2. All tested configurations and supported antenna installation requirements must be clearly identified in the OEM integration and installation requirements, such as physical antenna orientation and rotational configurations, installation in defined locations of the host device in the platform, minimum and maximum antenna cable length, and other restrictions.
3. For implementations that require an antenna to be connected to the transmitter through RF cable(s), the antenna assembly, which is typically the standalone antenna, must be tested independently for SAR.
 - (i) The same type of antenna cable specified in the installation requirements must be used to connect the antenna to the transmitter for testing.
 - (a) The shortest antenna cable required by the host platform(s) must be used in the SAR tests.
 - (i) The antenna must be at least 10 cm away from the host computer and other supporting equipment in the SAR measurement setup.
 - (ii) When the shortest cable cannot be used in the SAR setup, the measured SAR must be scaled up to account for cable loss differences.
 - (iii) The antenna cable must be routed and oriented according to the actual implementations.
 - (b) The antennas must be tested in the mounting and installation orientations supported by the actual implementations used in the host platform.
 - (i) Testing in both horizontal and vertical mounting orientations are required, for subsequent installation in the horizontal and vertical edges of laptop and tablet computers. These test

configurations also address the parallel and perpendicular configurations for adjacent edge exposure conditions.

- (ii) When the antenna structure is asymmetrical and can be rotated with respect to the antenna axis for installation in hosts, so that an antenna surface can be mounted facing in, out, up or down in the host device, these rotational configurations should be considered for testing and fully defined in the installation instructions.
- (c) The antenna must be mounted on lossless foam material during SAR testing to qualify for installation in hosts with low-loss materials near the antenna. The antenna must be mounted on conductive material with the same characteristics as those used in the hosts, to qualify for installation in hosts with such material near the antenna.

The range of acceptable antenna backing/mounting/support material properties or exact requirements must be clearly justified and specified in the OEM installation requirements.

- 4. For implementations where the antenna is built-in as an integral part of the transmitter or module, where it is fixed and cannot be re-oriented with respect to the transmitter assembly:
 - (i) When feasible, the transmitter/antenna assembly should be tested independently as a detached assembly.
 - (a) The transmitter/antenna assembly must be at least 10 cm away from the host computer and other supporting equipment used in the SAR measurement setup.
 - (b) The interface cable required for connecting the assembly to the host computer must be routed and oriented similar to the actual implementations. If an interface cable is only required for testing but not used in the actual implementations, the cable should be oriented perpendicular to the E-field, to minimize field perturbation during the SAR measurements.
 - (c) The transmitter/antenna assembly must be tested in all installation orientations and rotations required by the host computer configurations.
 - (ii) If it is not feasible to test the transmitter/antenna assembly outside the host device, the installation must be limited to the host configurations tested and clearly identified in the installation instructions.

B. Simultaneous transmission SAR test exclusion compliance requirements

When transmitters and antennas transmit simultaneously in laptop and tablet computers, the following procedures must be applied by the host manufacturer and OEM integrator, in conjunction with the requirements in KDB 447498, to determine simultaneous transmission SAR test exclusion requirements to qualify for Class I permissive change. All simultaneous transmission configurations must be clearly identified in the Class I permissive change documentation and kept in the grantee's own record. The following information must be included:

- 1. FCC ID of each transmitter, maximum average conducted output power in each transmission mode and frequency band, operating configurations and exposure conditions approved for the individual transmitters.

2. Applicable antenna configurations; as identified in diagrams, drawings and/or photos, including the range of antenna-to-user and antenna-to-antenna separation distances required for each transmitter.
3. The model and type of host device(s), physical dimensions, and antenna locations in each host.
4. The antenna manufacturer(s) and specification details.
5. Other relevant information and restrictions required by the equipment certifications of the individual transmitters, for the host to be fully compliant.
6. Calculations, analyses and explanations showing how simultaneous transmission SAR exclusion applies; therefore, Class I permissive change applies.
7. When multiple equipment approval grants exist for a transmitter; for example, multiple Class II permissive changes, the grant date and other details for the specific grant(s) that applies for the specific configuration must be fully identified in the Class I permissive change. Similar considerations may also apply when multiple Class I permissive changes are involved.

When simultaneous transmission SAR measurement is required, separate equipment approval is necessary. This should be considered with respect to the approval considerations described for *modular approach*, *dedicated host approach* and *mixed approach* and other requirements in KDB 447498.

V. Proximity Sensor Considerations

Because of the operating configurations and exposure conditions required by tablets, proximity sensors are often used in host devices to reduce the maximum output power in selected wireless and operating modes to ensure SAR compliance. Depending on the design and construction of individual tablets, both single and multiple proximity sensors have been used to trigger power reduction. A sensor may be collocated or overlapping with a specific antenna or located adjacent to one or more antennas, to facilitate triggering. Power reduction may be required for any combinations of the bottom surface and adjacent edges or only the bottom surface or a specific edge. The sensors are typically triggered by capacitance changes induced by objects in the vicinity of the sensing element. The triggering sensitivity for objects approaching a sensor is often different from the conditions when objects are retracting from the sensor; therefore, the separation distances for activating power reduction and returning to maximum power could be different. In addition, the triggering distance is often influenced by both external conditions and the triggering sensitivity settings applied in each tablet implementation.

When sensors are designed to provide sensing coverage in multiple directions and orientations to cover bottom and edge sensing through different tilt orientations, the triggering sensitivity may vary for these situations. The triggering variations and hysteresis effect must be evaluated separately according to the tissue-equivalent medium required for each frequency band, to identify the proper SAR test separation distance. The most conservative triggering distance expected for production units, including hysteresis effects, must be used in the SAR measurements. Both the normal maximum output power and reduced maximum output power levels and triggering conditions must be confirmed for the applicable sensor and antenna combinations to verify proper triggering at the specified triggering distances.

Due to the operating characteristics for these types of proximity sensor designs and the substantially flexible interactive use conditions allowed by tablets, if the tilt angle of the tablet with respect to the bottom or specific edges can result in the release of sensor triggering and enable the transmitter to resume normal full power while the edge is maintaining the required separation, these conditions must also be assessed to

determine if additional SAR evaluation is necessary. A KDB inquiry describing the implementation details is required to determine further test guidance. If the following procedures for determining triggering distances and antenna/sensor coverage are not applicable to the specific device implementation then a PBA is required.

A. Procedures for determining triggering distances

The following procedures are applied to determine proximity sensor triggering distances for the bottom surface or individual edges of a tablet. In steps 1) to 8), conducted power is monitored qualitatively to identify the general triggering characteristics; step 9) requires quantitative power measurements versus spacing.

1. The relevant transmitter should be set to operate at its normal maximum output power.
2. The entire bottom or edge of the tablet is positioned below a flat phantom filled with tissue-equivalent medium required for the test frequency range, and positioned at least 20 mm further than the distance that triggers power reduction.
3. It should be ensure that the cables required for power measurements are not interfering with the proximity sensor.
4. The bottom or edge is moved toward the phantom in 3 mm steps until the sensor triggers.
5. The bottom or edge is then moved back (further away) from the phantom by at least 5 mm.
6. The bottom or edge is again moved toward the phantom, but in 1 mm steps, until it is at least 5 mm past the triggering point or touching the phantom.
7. If the tablet is not touching the phantom, it is moved in 3 mm steps until it touches the phantom to confirm that the sensor remains triggered and the maximum power stays reduced.
8. The process is then reversed by moving the tablet away from the phantom, to determine the triggering point, until it is at least 10 mm beyond the triggering point and returned to the normal maximum power level.
9. The measured output power within ± 5 mm of the triggering points, or until touching the phantom, for movements to and from the phantom should be tabulated in the SAR report.
10. If the sensor design and implementation allow additional variations for triggering distance tolerances, multiple samples should be tested to determine the most conservative distance required for SAR evaluation.
11. To ensure all production units are compliant, it is generally necessary to reduce the triggering distance determined from the triggering tests by 1 mm, or more if necessary, and use the adjusted distance to perform the SAR measurements. The triggering point with the smallest distance for movements to and from the phantom, minus 1 mm, should be selected as the test separation distance used for measuring SAR for the bottom or specific edges of the tablet.

B. Procedures for determining antenna and sensor coverage

Proximity sensors are not normally designed to cover the entire bottom surface or edges of a tablet. The sensing regions are usually limited to a small region near the sensor element. If a sensor is spatially offset

from the antenna(s), it is necessary to verify sensor triggering for conditions where the antenna is next to the user, but the sensor is laterally further away. The following procedures are used to determine if additional SAR measurements may be necessary due to sensor and antenna offset.

1. The bottom surface or edge of the tablet is positioned at the test separation distance required for bottom or edge triggering with both the antenna and sensor pad located at least 20 mm laterally outside the edge (boundary) of the phantom, along the direction of maximum antenna and sensor offset.
2. The similar sequence of steps applied to determine triggering distance are used to verify full/partial bottom and edge triggering by moving the tablet (sensor and antenna) horizontally toward the phantom while maintaining the same vertical separation between the bottom or edge and the phantom.
3. After the exact location where power reduction triggering is determined, with respect to the sensor and antenna, the tablet movement should be continued until both the sensor and antenna(s) are fully under the phantom and at least 20 mm inside the projection of the phantom edge.
4. The process is then repeated from the other end of the antenna with the tablet rotated 180° for that bottom surface or edge.
5. For bottom surface triggering, when the sensor is also offset laterally from the antenna, in the direction perpendicular to that tested in steps 1- 4, these steps should be repeated with the tablet rotated 90°.
6. The triggering points should be documented graphically with the antenna and sensor clearly identified, and including all relevant dimensions.
7. If an antenna is located at the corner of a tablet, both edges must be tested for sensor triggering coverage.
8. If the subsequently measured peak SAR location for the antenna is not between the triggering points, determined from opposite ends and/or sides of the antenna, additional SAR tests may be required for conditions where only part of the bottom or edge of a tablet corresponding to the antenna is in proximity to the user and the sensor may not be triggering as desired.
 - (i) This may include situations where the sensor coverage region is too small for the antenna, the sensor is located too far away from the antenna, the sensor location is insufficient to cover multiple antennas or the antenna is at the corner of a tablet etc.
 - (ii) A KDB inquiry must be submitted to determine if additional tests are required and the test configurations to use.

C. Modular transmitter manufacturer and host manufacturer responsibilities

When a transmitter requires proximity sensor to trigger power reduction and the *modular approach* is used, additional equipment approval requirements must be considered. The proximity sensor is generally not an integral part of the transmitter module because power reduction triggering requirements are usually dependent on the individual tablet requirements. Under such circumstances, the implementation, operation and control of sensor triggering to determine transmitter output power may not be fully controlled by the transmitter manufacturer (grantee). The preferred equipment approval approach is to

have all transmitters authorized under a single FCC ID for the host tablet. Alternatively, a change of ID (§ 2.933) may be applied to enable a modular transmitter to operate in the tablet with certain control functions residing outside the transmitter and implemented by the tablet manufacturer. A subsequent Class II permissive change (§ 2.1043) after the change of ID is required to incorporate the transmitter into the tablet, detailing the joint responsibility between the tablet host and transmitter manufacturers and all conditions of implementation, for ensuring compliance. The new FCC ID (from the §§ 2.933 and 2.1043 filings) is only applicable to the specific tablet host implementation and for the specific type of sensor and antenna configurations, which must be clearly identified in the subsequent permissive changes, any inapplicable grant conditions inherited from the change of ID that could introduce conflicts should be omitted. A separate FCC ID is required for each tablet with different sensor and antenna configurations.

