



**Federal Communications Commission
Office of Engineering and Technology
Laboratory Division**

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**RF EXPOSURE CONSIDERATIONS FOR LOW POWER CONSUMER WIRELESS POWER
TRANSFER APPLICATIONS**

1. INTRODUCTION

Using radio frequencies for wireless power transfer in consumer devices has become a feasible alternative to conventional AC power lines and adapters. While different designs and implementations are possible for Wireless Power Transfer (WPT), inductive coupling techniques are commonly used for such applications. This method requires one or more primary inductive coils with operating frequency and power level determined by the specific application requirements. Coils may be employed in portable applications such as charging pads, permanently embedded in furniture or installed in vehicles. RF exposure potential to users and bystanders is expected to vary according to factors inherent to the design of individual systems, which generally requires different evaluation considerations to show compliance. This document primarily deals with low power, closely coupled, inductive power transfer techniques; however, all technologies that use frequencies above 9 kHz, are also subject to FCC rules. High power devices, devices designed for power transfer at distance, operations with high leakage fields, magnetic resonance power devices that rely on loose inductive coupling and coupling at distance, and medical devices are not covered under this KDB Publication. Individual KDB inquiries¹ must be filed for each of these types of devices to obtain further guidance for compliance evaluations.

2. PART 15 AND PART 18 REQUIREMENTS

- a) Depending on the operating configurations, wireless power transfer devices may need to be approved under Part 15, Part 18 or both. Devices authorized under Part 15 may not transmit in the 90-110 kHz band, which is restricted under Section 15.205.

Part 18 of the rules permit devices operating in the Industrial, Scientific and Medical (ISM) band to generate and use RF energy locally to perform work. For consumer devices this operation must be in close proximity and the RF energy must not be used for communications. Systems that use load impedance changes also called load modulation on the client device at the fundamental transfer frequency with limited communication for the sole purpose of load management may be authorized under Part 18. The load modulation must be integral to transfer system power management and control, and must be used only to the extent necessary to enable safe and efficient operation such as rapid shut-down in response to over-voltage conditions, reporting of charging status and identification of invalid devices. For devices authorized under Part 18 such load modulation may not be used to communicate any other information, such as prioritization of devices for charging and the transfer of any other data, for example extended system data, images or music. For such designs, both Part 15 and Part 18 requirements must be satisfied for equipment approval. Similarly, devices that use a secondary

¹ KDB inquiries are filled at <http://www.fcc.gov/labhelp> using the links Submit an Inquiry Reply to an Inquiry Response located on the page left.

frequency for load management, control and data functions must be authorized according to both Part 15 and Part 18 requirements, as appropriate.

- b) If a wireless power system designed to work with client devices is also capable of transmitting on frequencies other than the primary transfer frequency during the wireless power transfer process, as in the case of a cellular phone with a Bluetooth headset, EMC compliance must also be evaluated with all the system transmitters active simultaneously. The charger may still be authorized under Part 18, provided that it meets the criteria in the prior paragraph, however the inclusion of operations outside of Part 18 for EMC testing may require certification under the authorizing Rule Part.
- c) For WPT systems designed to provide power over a distance; for example, to facilitate charging multiple client devices simultaneously or for loosely coupled systems that permit operation at distance, the requirement to generate and use RF energy locally as specified in Section 18.107(c) may not be met. For any system where there is a separation distance between the primary and client; for example, where the client devices are not inserted or placed directly on the charger, prior approval from the FCC is required for authorization under Part 18.
- d) Although categorically excluded from routine RF exposure evaluation, Part 18 devices are not exempted from RF exposure compliance. When exposure concerns arise; for example, due to evolving products and operations, RF exposure evaluation may be requested under the provisions of Sections 1.1307 (c) and (d) to determine compliance. Because of significant variations in design and operating characteristics, the procedures required to evaluate RF exposure compliance for wireless power transfer are considered according to the exposure potentials of individual implementations.

3. RF EXPOSURE REQUIREMENTS

- a) Consumer wireless power transfer devices approved under Parts 15 and 18 in some cases have to demonstrate compliance with RF exposure requirements. The potential for exposure must be assessed according to the operating configurations of the wireless system and the exposure conditions of users and bystanders. RF exposure must be evaluated with the client device(s) being charged by the primary at maximum output power. The RF exposure requirements must be determined in conjunction with the device operating characteristics, according to the mobile and portable exposure requirements in Sections 2.1091 and 2.1093 of the rules.
 - (1) SAR and MPE limits do not cover the frequency range for wireless power transfer applications which operate below 100 kHz and 300 kHz respectively; therefore, RF exposure compliance needs to be determined with respect to Sections 1.1307 (c) and (d) of the FCC rules.
 - (2) Evaluation of RF Exposure test data for determining compliance of wireless power transfer (WPT) systems (both portable and not) operating at frequencies below 100 kHz is provided on a case-by-case basis following a KDB inquiry. In these situations, a WPT device may be considered acceptable when supporting data from measurements and/or numerical simulations show that, for all the positions of space relevant for the body exposure, the external (unperturbed) temporal peak field strengths do not exceed the following reference levels:
 - 83 V/m for the electric field
 - and
 - 90 A/m for the magnetic field.
- b) Based on the design and implementation of the power transfer application, it must be clearly identified if mobile or portable RF exposure conditions apply. Devices that are installed to provide separation of at least 20 cm from users and bystanders may qualify for mobile exposure conditions. For some

conditions where users and bystanders may be exposed at closer than 20 cm, Section 2.1091(d) (4) of the rules may apply.

- c) For devices designed for typical desktop applications, such as wireless charging pads, RF exposure evaluation should be conducted assuming a user separation distance of 15 cm. E and H field strength measurements or numerical modeling may be used to demonstrate compliance. Measurements should be made from all sides and the top of the primary/client pair, with the 15 cm measured from the center of the probe(s) to the edge of the device. Emissions between 100 kHz to 300 kHz should be assessed versus the limits at 300 kHz in Table 1 of Section 1.1310: 614 V/m and 1.63 A/m. Below 100 kHz, applicable reference levels for maximum instantaneous exposure field strengths are defined in clause 3.a).(2).
- d) Portable exposure conditions from 100 kHz to 6 GHz are determined with respect to SAR requirements. Existing SAR systems and test procedures are generally intended for measurements above several MHz. While numerical modeling can be an alternative, the constraints of substantial computational resources at low frequencies could introduce further limitations. Under these circumstances, including operations below 100 kHz, the Commission may consider a combination of analytical analysis, field strength, radiated and conducted power measurements, in conjunction with some limited numerical modeling to assess compliance.
- e) Depending on the operating frequency, existing SAR and MPE measurement procedures may be adapted to evaluate wireless power transfer devices for compliance with respect to mobile or portable exposure conditions. If the grantee or its test lab have any questions regarding RF exposure evaluation, they should contact the FCC Laboratory with sufficient system operating configuration details to determine if RF exposure evaluation is necessary and, if required, how to apply specific test procedures. Below 100 MHz, when SAR testing is required and the device is operating at close proximity to persons, information on device design, implementation, operating configurations, exposure conditions of users and bystanders are needed to determine the evaluation and testing requirements. In addition, the influence of nearby objects may also need consideration according to the wireless power transfer system implementation; for example, the effects of placing the device, its coils or radiating elements on or near metallic surfaces.

4. CONSIDERATIONS FOR INDUCTIVE TRANSFER TECHNIQUES

- a) The RF output power of wireless power transfer systems can vary substantially according to design and implementation requirements. Proportionally higher RF power is typically required to operate these devices at lower frequencies; for example, 100 kHz (LF) vs. 900 MHz (UHF). In addition, different energy coupling or radiating elements are used to provide acceptable operating efficiency for the intended transfer applications and use conditions. The potential for exposure from devices that use inductive loops may vary according to the coil coupling efficiencies of both the primary and secondary loops in the charging and client devices. When energy is tightly coupled between the transmitting and receiving coils with sufficiently small leakage fields in the surrounding, the coils may operate at relatively high-power levels with minimal impact to exposure potentials.
- b) For charging systems that allow multiple client devices to be charged simultaneously and devices designed to transfer power across short distances to the client device, the range of energy transfer efficiencies and the magnitude of surrounding fields can vary widely due to different loading conditions. The influences of these varying operating conditions to RF exposure must be addressed according to the combinations and types of client devices.

- c) Besides typical consumer devices, such as small consumer electronic products, cell phones and laptop computers, inductive wireless power transfer techniques have been applied to medical devices and implants, powered mobility devices, and electric automobiles. For these different implementations it is necessary in each case to examine the design and operational details to assess RF exposure concerns and to determine if evaluation or analysis may be needed to show compliance. These require case-by-case consideration through KDB inquiries.
- d) Wireless power system designed to work with client devices such as cell phones and laptop computers require that the appropriate receiving hardware to charge batteries according to the specific wireless charging implementation. When added as aftermarket or optional accessories, the additional hardware may modify the RF exposure characteristics of client devices and introduce changes to the original emission, HAC compatibility and SAR characteristics evaluated without the charging hardware. If a client device may be used while it is being charged, additional exposure concerns due to influences of transmitters operating simultaneously may also need to be addressed. It may be necessary to document if such evaluation has taken place and if there is any change in the documented characteristics of such devices. These are dependent on the design and exposure characteristics of individual client devices, which may require additional evaluation or analysis for the client devices during equipment certification.

5. EQUIPMENT APPROVAL CONSIDERATIONS

- a) Because of the anticipated design, implementation and operating variations in inductive wireless power transfer applications and complexities in evaluating RF exposure compliance, the discussion above should be used to determine the types of information necessary for inclusion in inquiries to the FCC Laboratory seeking RF exposure guidance on individual wireless power devices.
- b) Inductive wireless power transfer applications with supporting field strength results and meeting all of the following requirements are not required to submit a KDB inquiry for devices approved using SDoC² or a PAG³ for equipment approved using certification to address RF exposure compliance. However, the responsible party is required to keep a copy of the test report in accordance with KDB 865664 D02. A copy of the test report is to be submitted with the application if the device is approved using certification.
 - (1) Power transfer frequency is less than 1 MHz
 - (2) Output power from each primary coil is less than or equal to 15 watts.
 - (3) The system may consist of more than one source primary coils, charging one or more clients. If more than one primary coil is present, the coil pairs may be powered on at the same time.
 - (4) Client device is placed directly in contact with the transmitter.
 - (5) Mobile exposure conditions only (portable exposure conditions are not covered by this exclusion).
 - (6) The aggregate H-field strengths anywhere at or beyond 15 cm surrounding the device, and 20 cm away from the surface from all coils that by design can simultaneously transmit, and while those coils are simultaneously energized, are demonstrated to be less than 50% of the applicable MPE limit.

² Supplier's Declaration of Conformity (SDoC) Equipment Authorization Procedure: CFR Title 47 Part 2 Subpart J

³ CFR Title 47 §2.964 Pre-approval guidance (PAG) procedure for Telecommunication Certification Bodies.

- c) In all other cases, unless excluded by 5. b) above, an RF exposure evaluation report must be reviewed and accepted through a KDB inquiry to enable authorization of the equipment. When evaluation is required to show compliance; for example, using field strength, power density, SAR measurements or computational modeling etc., the specific authorization requirements will be determined based on the results of the RF exposure evaluation.
- d) When excluded by 5. b) above, equipment approval may be processed according to normal procedures by a TCB, if certification is required, or a Supplier's Declaration of Conformity (SDoC) when allowed.

Change Notice:

04/09/2018: 680106 D01 RF Exposure Wireless Charging Apps v03 replaces 680106 D01 RF Exposure Wireless Charging Apps v02. Updates to section 5 on equipment authorization considerations.

01/27/2021: 680106 D01 RF Exposure Wireless Charging Apps v03r01 replaces 680106 D01 RF Exposure Wireless Charging Apps v03. Updates to Section 3 on RF exposure requirements and Section 5 on equipment approval considerations.