



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

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Draft Laboratory Division Publications Report

Title: RF Exposure Wireless Charging

Short Title: RF Exposure Wireless Charging

Reason: Update published Attachment 680106 D01 RF Exposure Wireless Charging Apps v03r01 to 680106 D01 RF Exposure Wireless Charging Apps v04 to clarify compliance limits for devices using low power, closely coupled, inductive power transfer techniques.

Publication: 680106

Keyword/Subject: Wireless Power Transfer (WPT)

Draft Note: Either this draft document (680106 Exposure Wireless Charging Apps DR04 44611) or the published version (680106 D01 RF Exposure Wireless Charging Apps v03r01) may currently be used for demonstrating compliance. However, whichever version is used must be followed in its entirety, mixing and matching is not permitted.

Question: What rules regulate short distance wireless inductive coupled charging pads or charging devices?

Answer:

Wireless power transfer (WPT) devices operating at frequencies above 9 kHz are intentional radiators and a resubject to either Part 15 and/or Part 18 of the FCC rules. The specific applicable rule part depends on how the device operates, and if there is communication between the charger and device being charged.

Devices specifically intended for use for wireless power transfer, or inductive charging, require FCC guidance for frequency exposure review. This includes Part 18 devices. It may be necessary for the responsible party(manufacturer) to seek guidance from the FCC on specific WPT devices by submitting a KDB inquiry ,<http://www.fcc.gov/labhelp>.

The inquiry should include the following:

complete product description, including coil diameters , number of turns and current;
FCC Rule Part(s) the device will operate under and the basis for selecting the Rule Part(s);
planned equipment authorization procedure (i.e., SDoC or certification);

- drawings, illustrations;
- frequency of operation;
- radiated power;

- operating configurations; and
- conditions for human exposure.

Intentional radiators transmitting information must be certified under the appropriate Part 15 Rules and will generally require an equipment certification. A WPT device may operate in two different modes: charging and communications. It is possible for the device to be approved under Part 18 for the charging mode and Part 15 for the communications mode, if it can be shown that (1) the device complies with the relevant rule parts; and (2) the functions are independent. Part 18 consumer devices can be authorized using either certification or SDoC, once the appropriate RF exposure evaluation has been completed.

Finally, it is possible that the power charging function could be approved under Part 15 rather than Part 18 if the device meets all of the requirements of the appropriate Part 15 rule.

Attachment [680106 D01 RF Exposure Wireless Charging Apps v04](#) provides general guidance on the information necessary to determine RF exposure evaluation and compliance requirements when submitting a wireless charging application inquiry.

Attachment List:

[680106 D01 RF Exposure Wireless Charging Apps v04](#)

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

(a) 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 subject to FCC rules. Unless otherwise specified herein, high power devices and devices designed for power transfer at distance are not covered under this KDB Publication, as are operations with high leakage fields, magnetic resonance power devices that rely on loose inductive coupling and coupling at distance, and medical devices. Individual KDB inquiries¹ must be filed for each of these types of devices to obtain further guidance for compliance evaluations.

(b) 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 permits devices operating in the Industrial, Scientific and Medical (ISM) band to generate and use RF energy locally to perform work. For consumer devices authorized under Part 18, this operation must take place under acceptable conditions and the RF energy generally may not be used for communications. A limited exception to this general prohibition is made for systems that use load impedance changes also called load modulation on the client device at the fundamental transfer frequency for limited communication for the sole purpose of load management. 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

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.

equipment approval. Similarly, devices that use a secondary 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) is subject to additional review. 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, Section 5, below, describes the prior approval requirements 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.

(c) 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.

- (1) 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. SAR and MPE limits do not cover the frequency range for wireless power transfer applications which operate below 100 kHz and 300 kHz respectively. Accordingly, RF exposure compliance determination needs to take into account Sections 1.1307(c) and (d) of the 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, as discussed in Section 2.1091(d) (4) of the rules. Devices that are installed to provide separation of at least 20 cm from users and bystanders may qualify for mobile exposure conditions, in which case supporting consideration related to installation and use case conditions need to be provided.
- 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.

(d) 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.

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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

The considerations in section 5.1 apply to Part 18 devices that deliver energy to their design targets through non-conducted electromagnetic coupling (thus radiated and/or inductive EM fields) up to and including one meter distance (measured between the farthest points between the transmitting and receiving structures). Additional requirements for Part 18 devices that deliver energy to their design targets through non-conducted electromagnetic coupling at a distance greater than one meter are provided in section 5.2, below.

5.1. Part 18 Wireless Power Transfer Devices up to 1 Meter Distance

- a) Because the design, implementation and operating variations in inductive wireless power transfer applications will vary between systems and each may result in different complexities related to evaluating RF exposure compliance, the same information as described above (e.g., in section 4.c)) should be provided in KDB inquiries for individual WPT device guidance on appropriate RF exposure compliance procedures.
- b) A KDB inquiry for inductive wireless power transfer applications that contains supporting field strength results and that meets all of the following requirements is not required. This applies to RF exposure compliance for devices subject to both SDoC² procedures or that require a PAG³ for equipment seeking approval using the certification procedures. However, the responsible party is required to keep a copy of the test report in accordance with KDB 865664 D02. RF Exposure exhibit supporting compliance is to be submitted with the application if the device is approved using certification.

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.

- (1) The power transfer frequency is below 1 MHz.
 - (2) The output power from each primary coil is less than or equal to 15 watts.
 - (3) Each client device is placed directly in contact with the transmitter.
 - (4) Only mobile exposure conditions apply (portable exposure conditions are not covered by this exclusion).
 - (5) The aggregate H-field strength 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.
 - (6) For systems with more than one primary coil, the conditions specified in (5) must be met when the system is fully loaded and all coils are powered at the same time.
- c) In all other cases, i.e., unless excluded by clause 5.1.b) above, an RF exposure evaluation report must be reviewed and accepted through a KDB inquiry to authorize the equipment. When evaluation is required to show compliance; for example, using field strength, power density, SAR measurements or computational modeling etc., the authorized operating conditions will be determined based on the results of the RF exposure evaluation.
- d) When excluded by clause 5.1.b) above, equipment approval may be processed according to normal procedures by a TCB.

1.1 5.2. Part 18 Wireless Power Transfer Devices Beyond 1 Meter Distances

Part 18 devices that would otherwise meet the requirements of Section 5.1 may be permitted to deliver electromagnetic energy to a target located at a distance beyond one meter from the transmitter if the following conditions are satisfied. In all cases, such devices must be approved under the certification procedures (not SDoC) and are subject to pre-approval guidance (PAG), as detailed in KDB Publication 388624-D02. This requirement will enable the Commission to better monitor and provide oversight regarding devices' use conditions.

- (e) The applicant must demonstrate that the RF field in all locations anywhere at or beyond one meter is at or below the level that would be present within 1 meter when all devices being charged are within 1 meter of the transmitter. In other words, the RF emissions must be unaffected by the placement of the load/target device.
- (f) The devices may only operate indoors (i.e., the interior of a fully enclosed, weatherproof structure).
- (g) The indoor operations must be configured (e.g., through proper positioning of transmitter and/or attenuating material structures) such that when measured outdoors, the maximum fundamental and unwanted radiated emissions of the Part 18 device on any non-ISM frequency meet the limits in Part 15 of the Commission's rules. The distance specified in Part 15 ([§ 15.209\(a\)](#)) for evaluating field strength is to be measured from the outer surface of the structure delimiting the indoor operations.

- (h) Devices shall professionally installed (i.e., by persons who have the necessary training and qualifications to follow manufacturer-provided guidance and conduct necessary measurements and calculations to verify that conditions (2), (3) and (4), stated above, have been met).

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.

XX/XX/2022: 680106 D01 RF Exposure Wireless Charging Apps v04 replaces 680106 D01 RF Exposure Wireless Charging Apps v03r01 to clarify compliance limits for devices using low power, closely coupled, inductive power transfer techniques.