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TECHNICAL REPORT

System Reference document (SRdoc);
Short Range Devices (SRD):
Technical Characteristics for Radio Equipment used for power transfer and communication with associated peripheral devices using the 917,5 MHz RFID interrogator channel

Reference

DTR/ERM-597

Keywords

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document includes necessary information to support the co-operation under the MoU between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications.

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Executive summary

This System Reference document seeks to allow a new use case for the 917,5 MHz channel, presently designated for RFID as per CEPT ERC Recommendation 70-03 annex 11 [i.2] and also covered in ECC Report 200 [i.3].

Presently, four fixed channels in the frequency band 915 MHz to 921 MHz are identified for RFID. This request seeks to use one of those channels (917,5 MHz) for a new purpose.

This new application uses a radiated radio frequency signal from a transmitter, for identifying the presence of a receiver to be charged or powered; and then uses a similar signal at the same frequency for wireless power transmission. Therefore, it is a form of Radio Frequency IDentification (RFID) with Wireless Power Transmission (WPT).

The equipment requires only a single RF channel to operate and one of the centre channels has been identified to minimize interference with adjacent radio services.

The present document includes the necessary information to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT).

Introduction

The present document has been prepared to propose the use of Radio Equipment for power transmission and communication with associated receiver devices, operating at 917,5 MHz.

This Radio Equipment differs from existing RFID systems by the type of communication between the transmitter and receiver, and therefore does not fit within ETSI EN 302 208 [i.1] (latest edition).

The Radio Equipment within the scope of the present document uses low data rate in-band communication at 917,5 MHz.

The occupied bandwidth of the signal at 917,5 MHz is maintained within the existing spectrum mask for RFID. The communication contained in the 917,5 MHz transmission is expected to be used by the transmitter to identify the presence of a receiver device; or by the receiver to identify the presence of a transmitter device.

The application is intended for indoor use to meet the radio characteristics already prescribed by CEPT ERC Recommendation 70-03 [i.2], annex 11, as used by the RFID systems within the scope of ETSI EN 302 208 [i.1] i.e. a maximum ERP of 4 Watts and a maximum occupied bandwidth of 400 kHz. These parameters are as specified in ECC Report 200 [i.3].

1 Scope

The present document describes technical characteristics of Radio Equipment used for power transfer and communication with associated peripheral devices using the 917,5 MHz currently identified as an RFID interrogator channel.

The present document contains the necessary information to support the possible co-existence and compatibility studies if required, and to be conducted by the CEPT/ECC, including:

- Market information
- Technical information
- Regulatory issues

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long-term validity.

The following referenced documents are not necessary for the application of the present document, but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 302 208 (V3.3.1): "Radio Frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W and in the band 915 MHz to 921 MHz with power levels up to 4 W; Harmonised Standard for access to radio spectrum".

[i.2] CEPT ERC Recommendation 70-03 (23 October 2020): "Relating to the use of Short Range Devices (SRD)".

[i.3] Addendum to ECC Report 200 (May 2020): "Additional co-existence studies between SRDs/RFIDs and E-GSM-R in the 900 MHz frequency band".

NOTE: Available at https://docdb.cept.org/download/26ce1d81-2a81/Addendum%20of%20ECC%20Report%20200.pdf.

[i.4] Commission Implementing Decision (EU) 2018/1538 of 11 October 2018 on the harmonisation of radio spectrum for use by short-range devices within the 874-876 and 915-921 MHz frequency bands.

[i.5] ECC Report 200: "Co-existence studies for proposed SRD and RFID applications in the frequency band 870-876 MHz and 915-921 MHz".

[i.6] ERC report 25: "The European Table Of Frequency Allocations And Applications In The Frequency Range 8.3 kHz to 3000 GHz (ECA TABLE)".

[i.7] ETSI EG 203 336 (V1.2.1): "Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".

[i.8] ETSI EN 303 659: "Short Range Devices (SRD) in Data Networks; Radio equipment to be used in the frequency ranges 865-868 MHz and 915-919,4 MHz; Harmonised Standard for access to radio spectrum".

[i.9] ECC Report 313: "Technical study for the coexistence between RMR in the 900 MHz range and other applications in adjacent bands".

[i.10] CEPT/ERC/Recommendation 74-01E: "Spurious Emissions".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

client device: receiving end of the communication link e.g. mobile part/energy receiving part of the energy from the transmitter, comprising the combination of an antenna, communication device and/or energy storage in one housing

contact charger: device where RF energy is generated and transferred by close coupling to the secondary (client device) device by means of radiation to power a device, or to charge or re-charge the battery or energy source for a device

load: See term for *client device*.

receiver: device that receives an RF signal or RF power transmission from a transmitter device

short distance charger: device where RF energy is generated and transferred by means of radio waves to power a device, or to charge or re-charge the battery or energy source for a device where the operating distance is not expected to be greater than 40 cm

transmitter: device that sends an RF signal and/or RF power to a receiver device

NOTE 1: The transmitter is made up of a combination of an individual antenna or antenna array, communication device and/or connection to an AC power supply. The configuration is application specific.

NOTE 2: Other expressions: charger or charging pad.

Wireless Power Transmission (WPT): transmission of electrical energy from a power source (Transmitter) to an electrical load (client device) via electric and/or magnetic fields or waves between a primary and a secondary device

3.2 Symbols

For the purposes of the present document, the following symbols apply:

E	electric field strength
f	frequency
P	Power

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BLE	Bluetooth® Low Energy
CEPT	European Conference of Postal and Telecommunications Administrations
EAS	Electronic Article Surveillance
ECC	Electronic Communications Committee
ERC	European Radiocommunications Committee
e.r.p/ERP	Effective Radiated Power
ISM	Industrial Scientific Medical
RF	Radio Frequency

RFID	Radio Frequency Identification
SRD	Short Range Device
UHF	Ultra High Frequency
WPT	Wireless Power Transmission

4 Comments on the System Reference Document

4.1 Statements by ETSI members

ETSI members making comments should endeavour to reach consensus amongst themselves, to minimize the number of comments. If consensus cannot be reached on a clause, then it is divided into two sections: one for the proponents and one for comments on the text of the proponents. Such statements should be clearly attributable to the ETSI member(s) making these statements.

ITRON:

"Some members expressed concern at the principle of using SRD communications bands for high power, far-field wireless power transfer, given this band is not an ISM (Industrial Scientific and Medical) band, and in several European countries is used for military and/or railway communications".

"Belgium, Finland, UK, Switzerland all only allow two RFID channels, and therefore this system would take out 50 % over the capacity of the band, rendering RFID commercially worthless, and probably undermining the market in other countries where three channels are available".

Ministry of Economic Affairs (Netherlands):

"The Netherlands is of the opinion that the frequency band 915-921 MHz and any other band outside the regular ISM bands should not be used for beam WPT."

"All frequency ranges with telecommunications applications should be avoided, specially the 915-921 MHz and 870-876 MHz bands which are in use by military applications in The Netherlands."

"Also the deployment of these relatively high power devices cannot be compared with RFID and NAP's in these bands and is likely incompatible."

"The ISM frequency bands 433.050-434.790 MHz, 2,400-2,483,5 GHz and 5,725-5,875 GHz as indicated in the radio regulations may be used for that."

"We are also urging to use a low bandwidth in these bands typical 100 Hz or lower to avoid unnecessary interference to Short range Device applications."

"Also using the high power charger signal to send telemetry about the charging process cannot be considered spectrum efficient in our opinion."

Nedap N.V.:

"ETSI EN 302 208 defines the high band channels 3, 6, 9 and 12 in the range 916.1 to 920.9MHz.
Not all EU countries allow 4 channels. Many countries allow only 3 channels, or worst case only two channels (Belgium ?)
This will result that for EAS systems when surrounded by a WPT system only one channel will be left, assuming that the WPT channel cannot be used for RFID. For a correct operating EAS system at least 2 channels, but better 3 channels shall be available."

"If WPT is employed on channel 6 in a store with the carrier 100% of the time on, almost certainly this channel cannot be used anymore for EAS applications due to interference. This will reduce the overall performance of this EAS application."

"Section 8.8 Conclusions states natural geographically separation. Especially in smaller stores this will probably not be the case. In a store employing UHF RFID in the 916.1 to 920.9MHz band and WPT at channel 6 will very likely interfere with the EAS system.
When there is a WPT channel active, the tags that receiving this will indeed be able to start up earlier, but due to the high amount of power, these tags will not be able to receive any information from their base system."

AIM:

"Regarding the RFID testing the most relevant test is not performed, charging co-located at the same channel as the RFID reader, also not tested if there is any interference to the other two RFID lowers channels from the charging channel. Is there any interference to a RFID reader operating at 865-868MHz and a charger operating at the 917 MHz range."

"There is no information on how the reader reports successful vs. failed read attempts, it is possible that the reader is doing some smoothening or averaging of the results, hence even 10/10 doesn't mean that all the reads at the radio level were successful."

"This is such a new use case, it will need additional studies and this should be acknowledged in the SRdoc, not just claim it has the same interference potential as RFID."

"This is a nomadic application, only when in use it is fixed. It is not like (fixed) RFID. Needs studies."

"The EC Decision (EU) 2018/1538 is referring to radio devices as there are Non-specific short range devices, Wide data transmission devices, RFID devices and not to Wireless Power Transfer.

NOTE: At this moment not clear what the density will be."

FEIG ELECTRONIC GmbH:

"No coexistence measurements were made with RFID readers operating on the EU upper band. There are only simple tests with a reader that operates on the FCC band with hopping and a reader that operates in the EU lower band. The present coexistence measurement is therefore not meaningful.
The coexistence measurement should be repeated with an RFID reader on the upper band. The RFID reader should be operated on all channels of the upper band. Additionally, transponders from different manufacturers (e.g. NXP, Impinj, Alien, ...) should be used for the test."

Ericsson:

"Ericsson´s concerns about WPT in this frequency range: Expected density of these devices per household is high. Active charging time during a day must be considered. Suggested power level 4 W is >10 dB higher than for a regular UE in cellular communication. Because proposed frequency separation is much smaller, any UE duplex filter will have less suppression of a blocker. Proposed spurious emission limit -36dBm/100 kHz is >20dB above the allowed UE emissions in its own receiving band."

Federal Ministry of Economic Affairs and Energy/BMWi (Germany):

"BMWi is of the view that the frequency band 915-921 MHz should not be used for beam WPT applications."

"The frequency band 915-921 MHz is allocated to the mobile service (except aeronautical mobile service) on ITU level (Region 1) and on CEPT level. Based on this allocation in a number of CEPT countries including Germany these bands or parts thereof cannot be made available for SRD/RFID or WPT because of military radio applications and/or a designation for railway communication systems (extended GSM-R bands). Sharing of SRDs/RFID with those incumbent applications is in general not feasible (see ECC Report 200)."

Ministère de l'Economie et des Finances (France)

"The Ministère de l'Economie et des Finances (France) is of the view that the frequency band 915-921 MHz should not be used for beam WPT applications."

"In fact, the band 915-919.4 MHz is EU harmonised for various SRD applications. Therefore, the use of beam WPT applications in 915-919.4 MHz would compete with existing applications for spectrum access and have to coexist with adjacent ones as RMR. In specific context, current regulatory framework includes particular provisions (usage may be limited to professional users and subject to individual authorisation as to administer geographical sharing). Similar provisions cannot be for mass market WPT devices and ISM band should be used for such applications."

ETSI TC RT:

- *"The deployment of these high-power charging devices cannot be compared with regular/normal RFID applications with much lower duty cycles in these bands and is likely to be incompatible with adjacent RMR applications."*
- *"The use case for the proposed RF power transmission may differ significantly from that considered in previous studies for the regular RFID devices. For example, the use in trains for charging traveler's wireless device (mobile phones and various other consumer devices) and the growing availability of 230V ac power sockets in trains for traveler usage may well increase the deployment density."*

"This combined with the 100% duty cycle needs further co-existence analyses."

- *"Existing sharing and compatibility studies in ECC Report 313 are highlighting for the GSM-R carrier at 919.6 MHz that in some worst-case scenarios, the GSM-R cab-radio receiving at 919,6 MHz may face interference already from 25 mW SRD resulting in receiver blocking. When taking into account the RF power transmission at 917,5 MHz with up to 4 W (e.r.p.) and 100% duty cycle, significantly more interference issues to existing GSM-R radio applications are to be expected."*
- *"ECC Report 313 considered for the future FRMCS cab-radios that a spurious emission limit of -36 dBm/100 kHz from fixed RFID interrogators in a professional usage with low duty cycle is necessary to ensure co-existence between RFID interrogators and RMR cab-radios. Due to the proposed high RF power transmission at 917,5 MHz of up to 4 W (e.r.p.) and 100% duty cycle, significant blocking effects for the FRMCS cab-radios are expected."*
- *"ERC Recommendation (70-03) noted that the use of SRD is usually covered by general / non-exclusive authorizations on a non-protected and non-interference basis."*

"From today´s perspective, it is not clear to the rail sector how the proposed WPT with 4 W RF power transmission can result in a non-interference basis for existing and new railway radio equipment. Given the likelihood of significant blocking effects on RMR devices, rail sector requests that further co-existence analyses be performed on the proposed RF power transmission prior to progressing the TR 104 774 to CEPT."

NOTE: ETSI TR 104 774 does not exist. Statement made by ETSI TC RT above is a direct copy of their e-mail. This might be a typing error, they may be referring to the present document instead.

5 Presentation of the system or technology

5.1 The Technology

This equipment is intended to be interoperable, in that the transmitter will work with a range of receiver or load devices, supplied by multiple equipment manufacturers. The transmitter equipment uses an RF signal to interrogate the receiver or load and provide the appropriate RF power transmission at 917,5 MHz.

The use case is aimed at consumer and similar applications, and intended for indoor use. The most common application is expected to be the wireless charging of batteries in the receiver device, such that the receiver may be considered as a load for charging. The radio equipment may transfer power to one receiver or multiple receivers within the radiated field. At the time of writing the present document, it is anticipated that a maximum of 2 or 3 devices would be charged at any one time.

At the time of writing the present document, two types of systems are anticipated. Contact systems whereby the receiver is placed directly in contact or very close proximity (e.g. max 1 cm distance) to the transmitter and; Short distance charger systems, whereby the receiver is placed in an area near to the transmitter. For short distance charger the working distance is expected to be approximately 40 cm.

The radio equipment output power is limited to 4 Watts ERP per charging area or transmission; regardless of how many receiver load devices are placed in the charging area.

As further explained in the 'Principle of Operation' (below), the communication contained in the 917,5 MHz transmission is expected to be used by the transmitter to identify the presence of a receiver device; or by the receiver to identify the presence of a transmitter device. Additional information exchanges, such as detailed acquisition procedures, load charge status, transmission duration commands, etc., are expected to be achieved by the use of other radio, such as Bluetooth Low Energy (BLE) or similar.

The radio equipment only requires one frequency (channel) for operation.

Low data-rate, limited signal bandwidth and short range communication allow for nearby channel re-use. Based on the simple nature of the communication implemented by the system, loss or corruption of received information due to interference between similar systems is not anticipated to be a problem.

The radio equipment transmitter is expected to have a beacon mode to identify the presence of a receiver, or for the receiver to identify the presence of the transmitter, and this RF identification signal will have a limited duty cycle. In beacon mode it is expected that the on-time will be approximately 10 ms followed by 990 ms off-time.

Beacon mode will stop when charging mode is ON. If additional receivers are placed into the charging zone, the additional receiver will utilize the RF energy of the primary receiver. Once the primary receiver is charged/ removed from charging zone, the beaconing resumes and will identify the additional/new receiver. Once authenticated, the transmitter will begin charging. If the additional receiver is full before the primary receiver, the transmitter will remain off as there is no receiver requesting charge even though it may still be in the charging zone.

For the wireless transfer of power, the radio equipment transmitter will transmit when the presence of the receiver has been identified. Other radio applications incorporated into the equipment, such as Bluetooth Low Energy (BLE), are expected to be used to enhance communication between the transmitter and receiver; i.e. to check that the correct type of receiver is present, that the receiver is ready to receive the power transfer, and to cease the transmission when no more power transmission is required. In this way, the transmitter is expected to transmit only when needed.

Summary of the system parts:

Transmitter:

Contains an RF transmitter at 917,5 MHz. Also, assumed to contain another radio, such as BLE.

Receiver:

Contains a receiving antenna, for the reception of a signal for power transmissions and battery charging. The antenna will be tuned for maximum efficiency at 917,5 MHz. Also, assumed to contain another radio, such as BLE.

5.2 Principle of Operation

Two types of system are considered:

"Contact" systems where the receiver is placed on the transmitter.

"Short distance" systems where the receiver is placed within a localised area of the transmitter; such as ≤ 40 cm typically.

The 917,5 MHz signal is primarily intended for wireless power transmission, such as wireless battery charging. The communication system at 917,5 MHz is within scope of the RED and defined as radio communication because it includes an RFID beaconing mode for the transmitter and receiver to identify the location of each other.

The equipment may implement an additional solution to provide more control of the power transmission. In the two examples provided below, this solution is achieved through the inclusion of Bluetooth Low Energy (BLE) communication. Small wearable equipment such as hearing aids typically include Bluetooth®.

Contact systems:

Step 1: Transmitter is transmitting a beacon signal at 917,5 MHz, with limited duty cycle.

Step 2: Receiver is placed onto the transmitter.

Step 3: The receiver reflects the power back to the transmitter, which the transmitter detects and identifies.

Step 4: Transmitter is ready to begin transmission of power at 917,5 MHz with 100 % duty cycle.

Step 5: Transmitter initiates a BLE pairing process, for enhanced control over the charging process.

Step 6: Receiver equipment receives the BLE pairing request and establishes pairing with the transmitter.

Step 7: Data exchange over BLE; such as "is this correct receiver?", "is power transmission needed?", "is power transmission being received?", etc.

Step 7a: If transmitter BLE does not receive a BLE reply from the receiver, then it assumes the object placed on it is not a receiver, so the 917,5 MHz transmitter returns to beacon mode - Step 1.

Step 7b: If transmitter BLE establishes connection with receiver BLE but the receiver BLE says " Charge not needed"; the 917,5 MHz transmitter returns to beacon mode - Step 1.

Step 7c: If transmitter BLE establishes connection with receiver BLE but the receiver BLE says "No power transmission at 917,5 MHz is received"; then it is assumed that the receiver is in the room (BLE connection) but not correctly placed on the transmitter; therefore the 917,5 MHz transmitter returns to beacon mode - Step 1.

Step 7d: If transmitter BLE establishes connection with receiver BLE and the receiver BLE says "Charge needed and Receiving power transmission at 917,5 MHz"; then it is assumed that the correct receiver is on the transmitter, and the 917,5 MHz transmitter continues power transmission at 100 % duty cycle - Step 8.

Step 8: Transmitter transmits RF power at 100 % duty cycle at 917,5 MHz. BLE communication maintained.

Step 9: Continued communication over BLE link influences next step:

Step 9a: If receiver does not require more charge (for example, battery is full); this is communicated by BLE link and the transmitter ceases power transmission and reverts to beacon mode - Step 1.

Step 9b: If receiver stops receiving charge, it is assumed that the receiver has been removed from the transmitter. This is communicated by the BLE link, the transmitter ceases power transmission and reverts back to beacon mode - Step 1.

Short Distance systems:

Step 1: Transmitter is transmitting a beacon signal at 917,5 MHz, with limited duty cycle.

Step 2: Receiver is placed in the area near the transmitter.

Step 3: Due to the tuned nature of the receiver antenna, the receiver charging circuits identify a pulse at 917,5 MHz and therefore know they are in the presence and charging area of a transmitter.

Step 4: Receiver initiates a BLE pairing process, for enhanced control over the charging process.

Step 5: Transmitter receives the BLE pairing request and becomes ready to transmit power at 917,5 MHz.

Step 6: Data exchange over BLE; such as "is this correct receiver?", and "is power transmission needed?"

Step 6a: If transmitter BLE receives information that the receiver is the correct type and requires charge, then transmitter begins power transmission at 917,5 MHz with 100 % duty cycle.

Step 7: Continued data exchange over BLE; such as "is power transfer being received?"

Step 7a: If transmitter BLE does not receive confirmation from the receiver that power transmission at 917,5 MHz is being received, then it assumes the receiver is not within the charging area; therefore the 917,5 MHz transmitter returns to beacon mode - Step 1.

Step 7b: If transmitter BLE establishes connection with receiver BLE but the receiver BLE says "Charge not needed"; then it is assumed the battery is 'full' and the 917,5 MHz transmitter returns to beacon mode - Step 1.

Step 7c: If transmitter BLE establishes connection with receiver BLE but the receiver BLE says "No power transmission at 917,5 MHz is received"; then it is assumed that the receiver is in the room (BLE connection) but not in the transmitter charging area, and the 917,5 MHz transmitter returns to beacon mode - Step 1.

Step 7d: If transmitter BLE establishes connection with receiver BLE and the receiver BLE says "Charge needed and Receiving power transmission at 917,5 MHz"; then it is assumed that the correct receiver is in the transmitter charging area, and the 917,5 MHz transmitter continues power transmission at 100 % duty cycle - Step 8.

Step 8: Transmitter transmits RF power at 100 % duty cycle at 917,5 MHz. BLE communication maintained.

Step 9: Continued communication over BLE link influences next step:

Step 9a: If receiver does not require more charge (for example, battery is full); this is communicated by BLE link and the transmitter ceases power transmission and reverts to beacon mode - Step 1.

Step 9b: If receiver stops receiving charge, it is assumed that the receiver has been removed from the transmitter charging area. This is communicated by the BLE link, the transmitter ceases power transmission and reverts back to beacon mode - Step 1.

6 Market information

6.1 General

This system is intended for low power communication and intelligent wireless power transmission or charging of consumer, medical and/or industrial equipment, and marketed for use in indoor environments.

A primary market for these devices is for use with small wearable technologies such as hearing aids or personal health devices and other medical devices, which have a critical requirement for intelligent and simple charging for users who are reliant on their wearable technology. An example would be hearing aids. It can be important or critical that wearable or similar devices are correctly charged overnight for use in the morning.

Presently, wired chargers with small plugs can be difficult for some users to physically connect, especially for those who may have physically impaired motor skills or vision. Also, physical connectors require intrusion into the enclosure of a wearable device, which can be an issue for hygiene and moisture ingress protection. The technology within scope of the present document aims to solve the problems by wirelessly identifying the location and status of the client item, and charging its battery without the need for physical connection.

At the time of writing the present document, it is anticipated that there would be a maximum of one WPT radio equipment per location, for charging multiple target loads as necessary. For example, in a domestic environment it is anticipated that there would typically be one WPT device per home. In an office environment, it is anticipated that there would typically be one WPT device per room, or per desk, depending on application. Hearing aids are typically not charged via wires. Users have to swap batteries out every few days. This is an expensive requirement for the average user who is on limited budget but also problematic for arthritic hands, changing small batteries out, putting upside down, dropping on the floor, etc. Pets, children and even elderly suffer when they accidentally ingest the batteries too: https://harboraudiology.com/2018/10/the-dangers-of-swallowing-a-hearing-aid-battery/.

Other small wearable technologies may be considered for application of this technology, such as earphones, watches, fitness trackers, etc.

The choice of radio frequency band for this intended service is based on the most efficient solution for the use case. The frequency selected has been chosen such that it is high enough to cover a small physical area, but low enough to require the minimum amount of power necessary to achieve the end goal.

Table 1: Summary information on use case details

Application area	Charging of small consumer devices (assisted listening devices, etc.).
Power level of the transmission	4 Watts (36 dBm) ERP.
Frequency	917,5 MHz.
Use-cases	Radio Frequency identification of associated equipment and wireless power transmission.
Power transfer scenario	Energy transfer from the charging pad to the load device (receiver) device typically over a distance of < 40 cm, in an indoor environment.
Energy coupling technique	RF beam.
Activity Factor	Communication in the beacon mode is active at approximately 1 % duty cycle. Power transmission mode is 100 % duty cycle, when needed.
Expected density	It is not currently known exact numbers on density however the following is estimated • Typically no more than 3 per house for domestic environments • Typically one per office or desk for commercial environments Based on the details considered in ECC Report 200 [i.5] where there is a table entry for 'Metropolitan utilities, such as Smart Metering/M3N', this number has been increased 3 fold since there would only be a single utility meter per dwelling as opposed to a maximum of 3 as indicated above. Based on this calculation, gives a maximum density of 6 000 per square km.
Current regulation	4 Watts ERP as specified in CEPT ECC Recommendation 70-03, annex 11 [i.2].
Comments on regulation	The current limits specified in CEPT ECC Recommendation 70-03, annex 11 [i.2] are sufficient.

7 Technical information

7.1 Detailed technical description

7.1.1 General

The technology supports the use for charging of consumer devices and similar products (such as assisted listening devices) either via contact or at a very short distance.

The power transfer takes place at 917,5 MHz and uses in-band communication for the initial identification of associated devices; then it is anticipated that another technology (such as Bluetooth®) could be used to exchange detailed information between the two parts of the system; known as the transmitter and receiver. The 917,5 MHz signal is expected to identify the presence or status of the load and transmit power to charge the load accordingly.

Contact and short-distance charging systems use limited bandwidth and short range transmissions to achieve their purpose while minimising interference to other radio services and applications. It is not in the interest of the WPT device to transmit over a greater distance or for longer duration than necessary.

7.1.2 Contact charging

Contact charging transmitters use limited spectrum, typically occupied bandwidth ≤ 400 kHz, to identify and transfer RF energy to the receiver, known as a client device. The contact transmitter is inactive or in a beaconing mode until an authorized client device has been identified, authenticated, and determined to be in contact with the charger pad. Client device identification and authentication can be performed by sending data in band through the operating frequency (917,5 MHz) or via an alternative form of communication, such as Bluetooth®.

7.1.3 Short distance charger Charging

Short distance charging transmitters use limited spectrum, typically occupied bandwidth of 400 kHz or less, to transfer RF energy to the receiver, known as a client device over a maximum distance of 40 cm. These devices rely on directional antennas to transmit RF energy to the intended charging area for the client device(s). For short distance chargers, once a client device is detected, authenticated and found to be within the authorized charging area, the transmitter power control system manages transmit power for effective power delivery. This control can be enhanced via an alternative form of communication, such as Bluetooth®.

7.2 Technical parameters and implications on spectrum use

7.2.1 Status of technical parameters

7.2.1.0 EC and ECC documents

EC Implementing Decision (EU) 2018/1538 [i.4] identifies the following characteristics:

3	916,1-918,9 MHz (10)	Radio Frequency Identification (RFID) devices (2)	Interrogator transmissions at 4 W e.r.p. only permitted at the centre frequencies 916,3 MHz, 917,5 MHz, 918,7 MHz	Techniques to access spectrum and mitigate interference that provide an appropriate level of performance to comply with the essential requirements of Directive 2014/53/EU shall be used. If relevant techniques are described in harmonised standards or parts thereof the references of which have been published in the *Official Journal of the European Union* under Directive 2014/53/EU, performance at least equivalent to these techniques shall be ensured. Bandwidth: ≤ 400 kHz	(5) (6) (7)	1 February 2019

For the current European allocation in the frequency bands, see ERC report 25 [i.6] and/or efis database available at https://www.efis.dk/.

This allocation is identified in CEPT ECC Recommendation 70-03, Annex 11 [i.2].

7.2.1.1 Existing sharing and compatibility studies

Sharing and compatibility studies have already been conducted by CEPT to assess the impact on primary radio services and some inter SRD compatibility:

- ECC Report 200 [i.5];
- Addendum to ECC Report 200 [i.3]; and
- ECC Report 313 [i.9].

From Addendum to ECC Report 200 [i.3], it is clear that the band 915-921 MHz will not be available in all countries due to the use of the band in some countries for military and GSM-R. For example, ECC Report 200 [i.3] concludes for countries where bands 870-876/915-921 MHz or parts of the band are used for TRR (Tactical Radio Relay) and/or UAS (Unmanned Aircraft System) may consider introduction of SRD/RFIDs only with certain additional considerations, such as:

- For countries that in time of peace allow the use of TRR/UAS anywhere across their territory, especially in urban areas, sharing between RFID (band 915-921 MHz) and TRR will not be feasible.

But work from ECC Report 200 was used by the EC to formulate the EC implementing Decision (EU) 2018/1538 [i.4], which includes the entry for RFID at 917,5 MHz with 4 Watts and 400 kHz bandwidth. However, EC Decision 2018/1538 has in all entries the following note (referred to as note 6 in the document [i.4]), which allows member states to not implement the entry:

- *"In Member States where parts or all of this frequency range are used for public order and public security purposes and defence and coordination is not possible, Member States may decide not to implement this entry partially or entirely, in accordance with Article 1(4) of Decision 676/2002/EC and Article 3(2) of this Decision."*

Addendum [i.3] complements ECC Report 200 [i.5] and assesses separation distances between E-GSM-R applications operating in the frequency bands 873-876 MHz/918-921 MHz and SRDs/RFIDs operating in the frequency bands 874-874,4 MHz/915-919,4 MHz.

Report 313 [i.9] considers some outdoor worst case scenarios reflecting rare RFID use in private railway sidings where the interrogator is at height and 20 to 25 meters from the cab radio. Such a scenario has an extremely low probability for power charging devices.

7.2.1.2 New Sharing and compatibility issues

Practical coexistence measurements have taken place and a summary will be made available to CEPT.

7.2.2 Transmitter parameters

7.2.2.1 Transmitter Output Power/Radiated Power

The transmitter output power and/or radiated power will be based on the same technical characteristics as those defined in ETSI EN 302 208 [i.1] which in turn are based on those defined in ECC Commission Implementing Decision (EU) 2018/1538 [i.4]. See also annexes B and C.

7.2.2.2 Antenna Characteristics

The antenna characteristics are application specific; however, the antennas are designed such that the signal is directional towards the intended operating area and not for long range communications.

Transmitter antenna gain should be designed based on application and not to exceed 4 Watts ERP at 917,5 MHz. The radiation efficiency of the transmitter antenna should be minimized at the higher order harmonics.

The transmitter antenna is located within the same enclosure as the other parts of the transmitter device.

The antenna radiation pattern highlighted below demonstrates how the e-field is concentrated into a forward direction and how quickly the energy decays with distance. Further details are provided in Annex B.

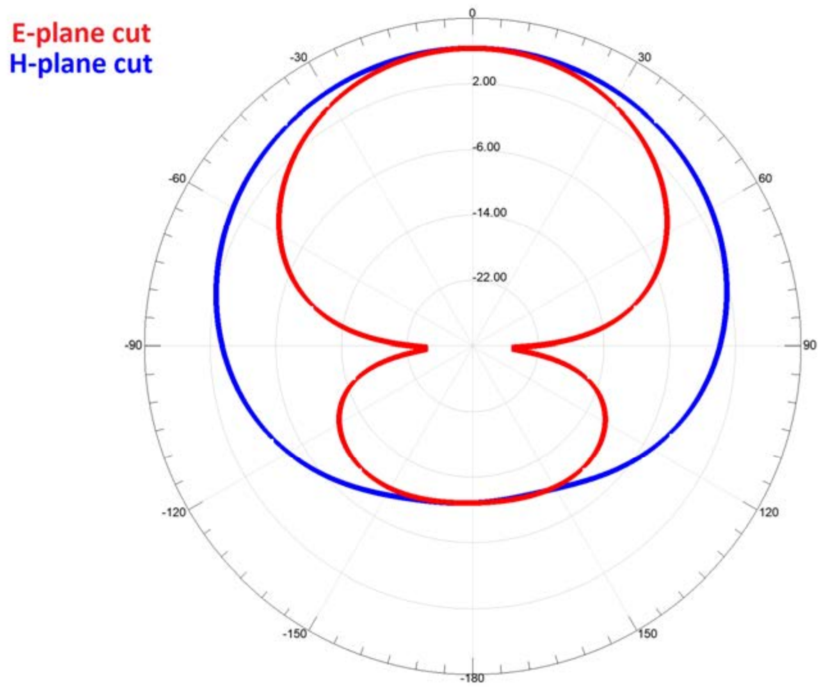

Figure 1: Typical Antenna Radiation Pattern

7.2.2.3 Operating Frequency

The proposal defines a centre frequency of 917,5 MHz in the RFID designated channel. Of all the high-power RFID channels defined, 917,5 MHz is the one that has been selected as it sits in the middle of the designated band and ensures maximum separation from adjacent bands and services whilst only occupying a single RFID channel.

These devices are expected to have a good frequency accuracy and stability in line with existing and emerging standards in this band such as ETSI EN 302 208 [i.1] and ETSI EN 303 659 [i.8].

7.2.2.4 Bandwidth

The 917,5 MHz transmitter signal fits within the spectral mask defined in ETSI EN 302 208 [i.1] for the 915 MHz to 921 MHz band. This identifies a maximum occupied bandwidth of ≤ 400 kHz. The occupied bandwidth was measured in Proposed Spectral Mask (figure A.2).

7.2.2.5 Unwanted Emissions

The unwanted emissions of the charging devices meet the limits CEPT/ERC/Recommendation 74-01E [i.10], which is consistent with the requirements for other types of RFID equipment as specified in ETSI EN 302 208 [i.1].

7.2.2.6 Transmitter Timing

The WPT contains a beacon for the system to identify when the transmitter and receiver are in the presence of each other. It is anticipated that this RFID beacon mode would transmit for typically 10 ms in a 990 ms period, with an on-time of some 1 % duty cycle.

When connectivity between the transmitter and receiver has been established, the wireless power transmission signal is expected to transmit at 100 % duty cycle, for a length of time necessary to complete the necessary power transfer. The timing of the wireless power transmission is dependent on the receiver/load itself. A receiver with a small charging load would require a short time, whereas a receiver with a large charging load would take longer Receiver loads closer to the WPT radio equipment will charge more quickly. Based on the receiver load applications available at the time of writing the present document, the full charge time could be estimated between 30 minutes to 6 hours.

Power transfer times can be minimised by incorporating mechanisms into the radio equipment, to monitor the status of the receiver and limit the transmitter timing to only the minimum time necessary, and to feedback information about correct placement of the receiver within the charging area. In the present document, the example of a BLE link is provided, other technologies or solutions can be used.

7.3 Information on relevant standard(s)

The technical requirements for the devices described in the present document will be based on those contained in ETSI EG 203 336 [i.7].

8 Radio spectrum request and justification

The present document requests the use of an existing RFID designated channel, limited to a single channel bandwidth of 400 kHz at a frequency of 917,5 MHz. The effective and efficient radio characteristics of the charging system are intended to meet the parameters of those already in use and defined within ECC Commission Implementing Decision (EU) 2018/1538 [i.4]. The existing RFID standard ETSI EN 302 208 [i.1] defines the use of RFID with in-band (same band) back-scatter from the tag. The radio equipment system described in the present document does not include back-scatter from the tag as its only communication link and does not fit within the scope and technical requirements of ETSI EN 302 208 [i.1].

The present document provides information for modification to the existing technical requirements and regulations, to allow an alternative form of radio identification, communication and wireless power transmission within the 917,5 MHz RFID channel.

9 Regulations

9.1 Current regulations

Current regulations are contained in EC implementing Decision (EU) 2018/1538 [i.4].

3	916,1-918,9 MHz [10]	Radio Frequency Identification (RFID) devices [2]	Interrogator transmissions at 4 W e.r.p. only permitted at the centre frequencies 916,3 MHz, 917,5 MHz, 918,7 MHz	Techniques to access spectrum and mitigate interference that provide an appropriate level of performance to comply with the essential requirements of Directive 2014/53/EU shall be used. If relevant techniques are described in harmonised standards or parts thereof the references of which have been published in the *Official Journal of the European Union* under Directive 2014/53/EU, performance at least equivalent to these techniques shall be ensured. Bandwidth: ≤ 400 kHz	[5] [6] [7]	1 February 2019

9.2 Proposed Regulation and Justification

An example of proposed new entry to Table 11 in Annex 11 of CEPT ECC Recommendation 70-03 [i.2] is shown here:

Frequency Band		***Power***	***Spectrum Access***	***Modulation/Bandwidth***	***Notes***
x	*915-921 MHz*	*4 W (e.r.p.)*	*Duty Cycle ≤ 1 % (beaconing mode)*	*≤ 400 kHz*	*For Radio Equipment used for power transfer and communication with associated peripheral devices over very short distances. (note 5)*
NOTE 5: In some countries, usage may be limited such that installation and operation are performed only by professional users and individual authorisation may be required, e.g. to administer geographical sharing and/or the application of mitigation techniques to ensure protection of radio services. NOTE 6: Transmissions in sub-band x) at 4 W e.r.p, are only permitted on a single channel centred at 917,5 MHz with a maximum bandwidth of 400 kHz.					

Annex A: Proposed Spectral Mask and Frequency

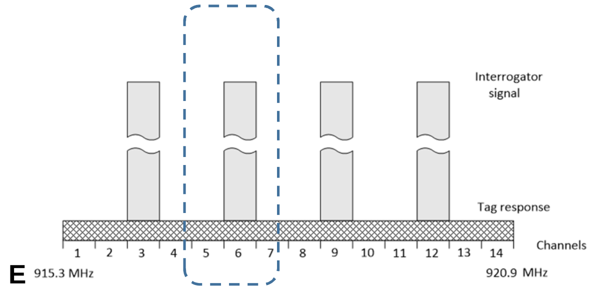

Figure A.1: Graphical illustration of channel plan highlighted in EC implementing Decision (EU) 2018/1538 [i.4], Annex

Figure A.1 is a graphical illustration of the information contained in EC implementing Decision (EU) 2018/1538 [i.4], Annex and ETSI EN 302 208 [i.1] with the proposed single frequency requested by the present document of f_c = 917,5 MHz.

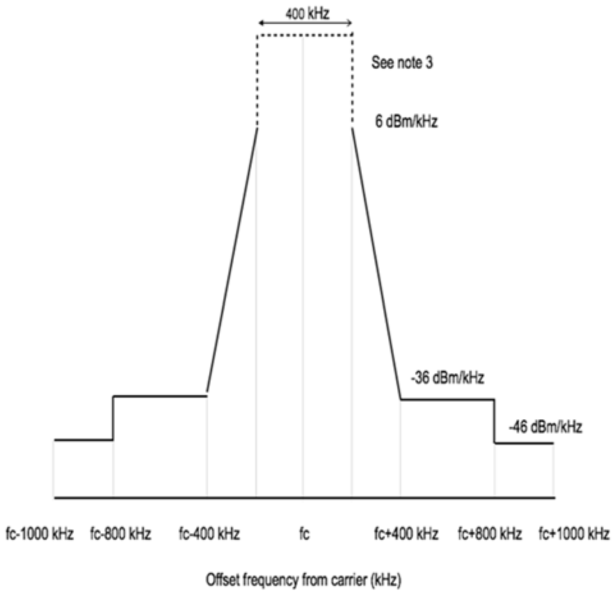

Figure A.2: Proposed Spectral Mask

The proposed spectral mask is the same as that defined in ETSI EN 302 208 [i.1] with a bandwidth not exceeding 400 kHz.

Annex B: Plots of Devices

B.1 Typical Spectrum Mask plots

The following plots show the performance associated with an existing product (from the USA) showing that the transmitter emissions fall within the spectrum mask defined in ETSI EN 302 208 [i.1].

Normal Condition (Temperature: 23°C, Humidity: 46%)	Measured Power (dBm)	ERP (dBm)	Limit (dBm)	Margin (dB)
Normal condition, 917.5MHz	30.00	30.00	36	-6.00

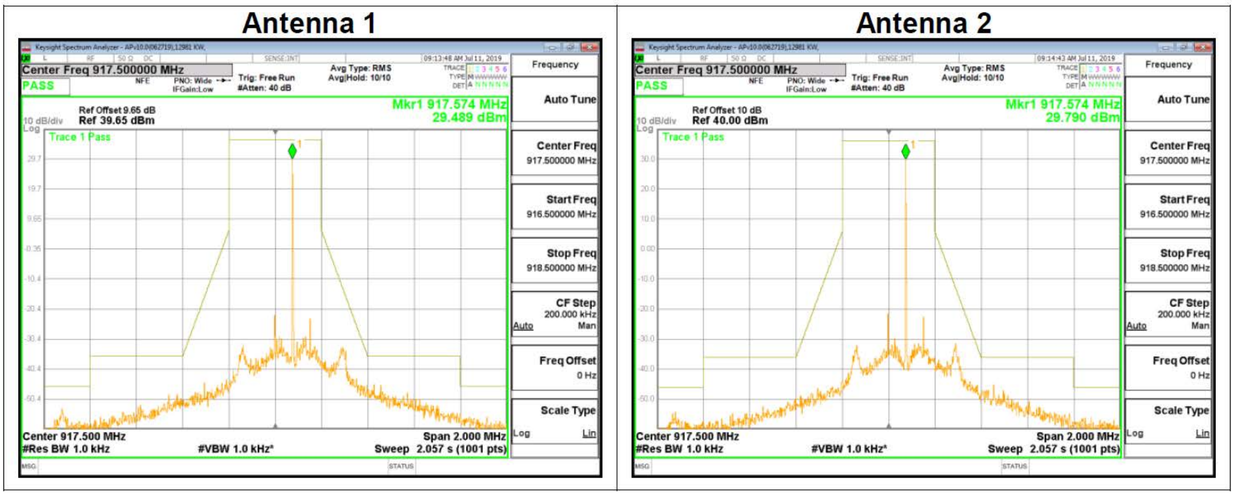

Figure B.1: Transmitter Spectrum Mask at 917,5 MHz

Table B.1: Radiated Emissions Below 1 GHz

Marker	Frequency (MHz)	Meter Reading (dBm)	Det	AF PRE01840 52 (dB/m)	Amp/Cbl (dB)	Amp/Cbl (dB)	T1846 BRF (dB)	Corrected Reading (dBm)	ETSI Tx Below 1GHz	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	85.096	-57.44	Pk	13.2	-31.1	9.7	.5	-65.14	-36	-29.14	0-360	199	H
	84.9028	-68.38	RMS	13.2	-31.1	9.7	.5	-76.08	-36	-40.08	285	222	H
2	181.029	-49.57	Pk	17.1	-30.4	6.4	.5	-55.97	-54	-1.97	0-360	99	H
	180.901	-58.8	RMS	17.1	-30.4	6.4	.5	-65.2	-54	-11.2	359	121	H
3	861.29	-65.36	Pk	27.7	-27.3	9.8	.5	-54.66	-54	-0.66	0-360	99	H
	861.3178	-66.79	RMS	27.7	-27.2	9.8	.5	-55.99	-54	-1.99	226	142	H
4	181.611	-51.95	Pk	17.1	-30.4	9	.5	-55.75	-54	-1.75	0-360	100	V
	181.3741	-62.58	RMS	17.1	-30.4	9.1	.5	-66.28	-54	-12.28	277	100	V
5	192.184	-52.47	Pk	17.3	-30.4	8.1	.5	-56.97	-54	-2.97	0-360	100	V
	192.0346	-63.05	RMS	17.3	-30.4	8.1	.5	-67.55	-54	-13.55	271	100	V
6	861.29	-65.49	Pk	27.7	-27.3	6.4	.5	-58.19	-54	-4.19	0-360	199	V
	861.3498	-65.07	RMS	27.7	-27.2	6.4	.5	-57.67	-54	-3.67	204	216	V

Table B.2: Radiated Emissions Above 1 GHz

Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AF PRE0190811 (dB/m)	Amp/Cbl (dB)	Amp/Cbl (dB)	T1852 HP Fltr (dB)	Corrected Reading (dBm)	ETSI TX Above 1GHz	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1.835	-40.47	Pk	25.8	-35.4	11.9	0.7	-37.47	-30	-7.47	0-360	250	H
	1.835	-42.6	RMS	25.8	-35.4	11.9	0.7	-39.6	-30	-9.6	133	228	H
2	2.753	-34.45	Pk	28.9	-35	10.4	0.7	-29.45	-30	0.55	0-360	101	H
	2.753	-42.56	Av	28.9	-35	10.4	0.7	-37.56	-30	-7.56	354	157	H
	2.753	-45.67	RMS	28.9	-35	10.4	0.7	-40.67	-30	-10.67	354	157	H
3	4.588	-52.39	Pk	32.3	-31.1	10.1	0.7	-40.39	-30	-10.39	0-360	250	H
	4.588	-54.95	RMS	32.3	-31.1	10.1	0.7	-42.95	-30	-12.95	243	228	H
4	1.835	-35.57	Pk	25.8	-35.4	11.2	0.7	-33.27	-30	-3.27	0-360	201	V
	1.835	-36.19	RMS	25.8	-35.4	11.2	0.7	-33.89	-30	-3.89	243	145	V
5	2.753	-46.37	Pk	28.9	-35	10.9	0.7	-40.87	-30	-10.87	0-360	201	V
	2.753	-49.49	RMS	28.9	-35	10.9	0.7	-43.99	-30	-13.99	86	162	V
6	4.588	-55.58	Pk	32.3	-31.1	10.6	0.7	-43.08	-30	-13.08	0-360	201	V
	4.588	-57.15	RMS	32.3	-31.1	10.7	0.7	-44.55	-30	-14.55	249	102	V

B.2 Typical decay of field strength with distance

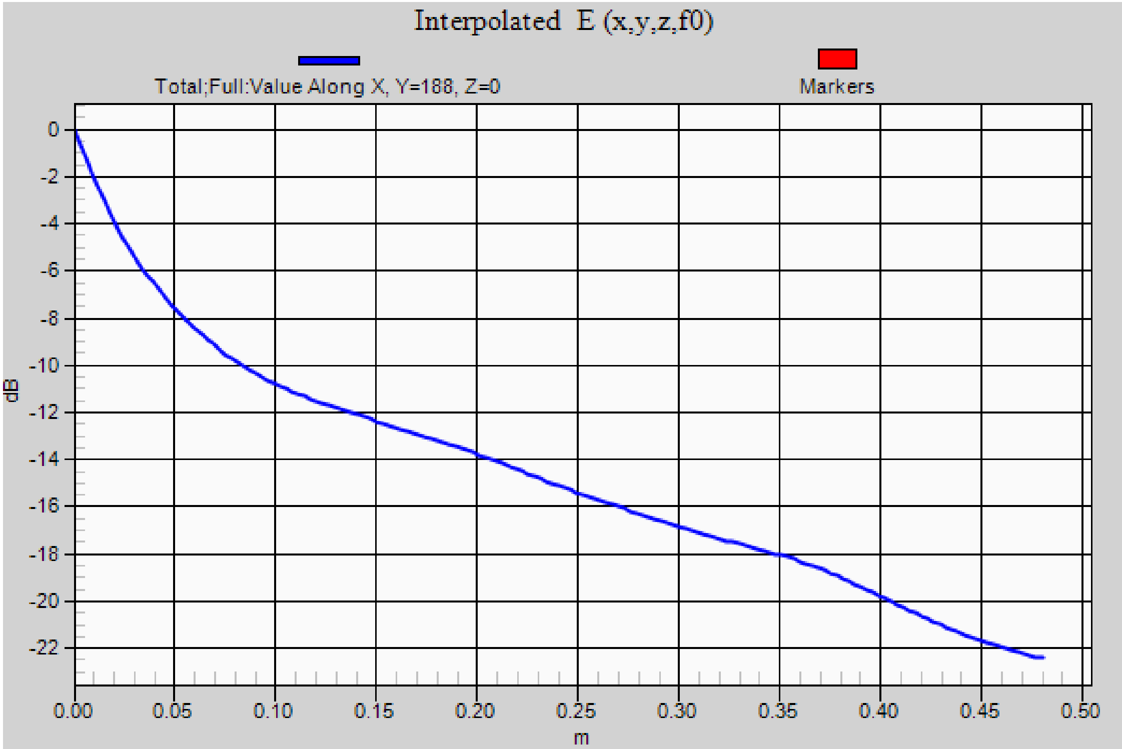

Figure B.2: Decay of field strength with distance

In the plot above it shows Electric Field "E-Field" testing of a non-beamforming wireless power transmission at a distance device. Electric Field is defined mathematically as a vector field that associates to each point in space the force per unit of charge exerted on an infinitesimal positive test charge at rest at that point (V/m). The E-Field test is measured by using a DASY6 SAR system with a 3-Dimensional infinitesimal probe. The device was placed in an open area and then the DASY6 SAR system measured the E-Field from 0 to 0,5 meters in the direction of the transmission. As seen in Plot 2 the transmission power of the device is 10 dB lower than the maximum power at 0,08 meters and 20 dB lower than the maximum power at 0,4 meters. The center frequency of the device is 917,5 MHz which has a wavelength of 0,327 meters. At 0,327 meters the transmission power of the device is 17 dB lower than the maximum power of the device. This demonstrates that the device transmits and uses power in the intended charging area and only radiates minimal power into the environment.

Annex C: Bibliography

- ETSI TR 103 493 V1.1.1 (2019-02): "System Reference document (SRdoc); Wireless Power Transmission (WPT) systems operating below 30 MHz".
- Question ITU-R 210-3/1: "Wireless power transmission".

NOTE: Available at http://www.itu.int/pub/R-QUE-SG01.210.

- Recommendation ITU-R SM.2392-0 (08/2016): "Applications of wireless power transmission via radio frequency beam".
- Recommendation ITU-R SM.1056-1: "Limitation of radiation from industrial, scientific and medical (ISM) equipment (Question ITU-R 70/1)".
- Recommendation ITU-R SM.2180 (09/2010): "Impact of industrial, scientific and medical (ISM) equipment on radiocommunication services".
- Recommendation ITU-R SM.2028-1: "Monte Carlo simulation methodology for the use in sharing and compatibility studies between different radio services or systems (Question ITU-R 211/1)".
- EN 55011:2016&A1:2017&A11:2020: "Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics -Limits and methods of measurement".
- Commission Implementing Decision (EU) 2017/1483 of 8 August 2017 amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices and repealing Decision 2006/804/EC (notified under document C(2017) 5464).
- Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

History

Document history		
V1.1.1	February 2022	Publication