

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Parasitic communication protocol for radio-frequency wireless power transmission

Protocole de communication parasite pour le transfert d'énergie sans fil par rayonnement radiofréquence





THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Parasitic communication protocol for radio-frequency wireless power transmission

Protocole de communication parasite pour le transfert d'énergie sans fil par rayonnement radiofréquence

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.240.99

ISBN 978-2-8322-5700-5

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms, definitions and abbreviated terms	8
3.1 Terms and definitions.....	9
3.2 Abbreviated terms.....	9
4 Overview	10
5 Communication procedures for RF WPT	11
5.1 General.....	11
5.2 Communication procedures for parasitic downlink communication.....	12
5.3 Communication procedures for parasitic uplink communication.....	13
5.4 Backscatter downlink/uplink data flow	14
5.5 WPT process	15
6 Physical layer	16
6.1 Modulation/coding method	16
6.1.1 General	16
6.1.2 Downlink modulation method	16
6.1.3 Uplink modulation method	17
6.1.4 Downlink coding method.....	17
6.1.5 Uplink coding method	18
6.2 Frame structure	18
6.2.1 General	18
6.2.2 Downlink frame structure	18
6.2.3 Uplink frame structure.....	20
7 Datalink layer	21
7.1 Message definition.....	21
7.1.1 General	21
7.1.2 Select step	24
7.1.3 Inventory step.....	26
7.1.4 Access step.....	29
7.2 Data encoding.....	31
7.2.1 General	31
7.2.2 QAM encoding.....	31
7.2.3 Miller encoding	32
8 RF WPT control protocol.....	33
8.1 Wireless charging architecture	33
8.1.1 General	33
8.1.2 Power control purpose of RF WPT	34
8.1.3 HIE-AP operation control	34
8.1.4 SSN operation control.....	35
8.2 RF WPT process.....	36
8.2.1 General	36
8.2.2 General WPT management.....	37
8.2.3 SSN control	38
8.2.4 SSN static parameter.....	39

8.2.5 SSN dynamic parameter	40
Annex A (informative) Regulation and certification	42
Bibliography	43
Figure 1 – Usage of RF-WPT	10
Figure 2 – RF-WPT structure of using parasitic Wi-Fi communication technology	11
Figure 3 – Parasitic downlink/uplink communication procedures	12
Figure 4 – Specific parasitic downlink communication procedures	13
Figure 5 – Specific parasitic uplink communication procedures	14
Figure 6 – Data flow during parasitic downlink/uplink communication	15
Figure 7 – RF WPT access procedures	15
Figure 8 – RF WPT control protocol	16
Figure 9 – PIE method packet configuration	17
Figure 10 – Modulation and coding of the downlink preamble	17
Figure 11 – Modulation and coding of the downlink preamble	18
Figure 12 – Modulation and coding of the uplink preamble	18
Figure 13 – Modulation and coding of the uplink payload	18
Figure 14 – Physical layer structure of the downlink frame	19
Figure 15 – Physical layer structure of the uplink frame	20
Figure 16 – Model of command transmission between the STA and SSN	22
Figure 17 – Diagram of sequential command transmission between the STA and SSN	22
Figure 18 – SSN memory structure	24
Figure 19 – Message exchange in the select step	25
Figure 20 – CRC-16 circuit example	26
Figure 21 – Message exchange method of the inventory step	27
Figure 22 – Basic functions for FM encoding	31
Figure 23 – State diagram for FM encoding generation	31
Figure 24 – Basic functions for Miller encoding	32
Figure 25 – State diagram for FM0 encoding generation	32
Figure 26 – Encoding theory combining basic Miller functions	33
Figure 27 – Basic configuration of the RF wireless charging network of the proposed standard	34
Figure 28 – HIL AP operation in RF WPT in the proposed standard	35
Figure 29 – SSN operation in RF WPT in the proposed standard	35
Figure 30 – Operating range of the rectified battery voltage	36
Figure 31 – RF WPT information acquisition and control protocol of the proposed standard	37
Table 1 – Downlink preamble structure	19
Table 2 – Downlink payload structure	19
Table 3 – Downlink frame check CRC	20
Table 4 – Uplink preamble structure	20
Table 5 – Uplink frame detection field structure	21
Table 6 – Downlink payload structure	21

Table 7 – CMD list	23
Table 8 – Responses for each CMD	23
Table 9 – Select CMD	25
Table 10 – Valid response	26
Table 11 – Query CMD field	27
Table 12 – QueryRep CMD field	28
Table 13 – QueryAdj CMD field	28
Table 14 – Valid_Query response field	28
Table 15 – Ack CMD field	29
Table 16 – Valid_Ack response field list	29
Table 17 – Read CMD field	30
Table 18 – Data field of the response to the read command	30
Table 19 – Write CMD field	30
Table 20 – Data field of the response to the write command	30
Table 21 – WPT CMD field	37
Table 22 – WPT sub-CMD list	38
Table 23 – SSN control field	38
Table 24 – Detailed WPT field description	38
Table 25 – Response to the SSN control CMD	39
Table 26 – SSN static parameter field	39
Table 27 – Rectifier maximum power field	39
Table 28 – Rectifier minimum constant voltage	39
Table 29 – Rectifier maximum constant voltage	39
Table 30 – Rectifier minimum constant voltage	40
Table 31 – SSN dynamic parameter field	40
Table 32 – Rectifier dynamic voltage field	40
Table 33 – Rectifier dynamic current field	40
Table 34 – Output dynamic voltage of the battery terminal	40
Table 35 – Output dynamic current of the battery terminal	41
Table 36 – Battery temperature of the SSN	41
Table 37 – SSN critical state field	41
Table 38 – Rectifier desired minimum voltage	41

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PARASITIC COMMUNICATION PROTOCOL FOR RADIO-FREQUENCY WIRELESS POWER TRANSMISSION

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62980 has been prepared by technical area 15: Wireless power transfer, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/3797/FDIS	100/3818/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

Currently in preview, click buy full version

INTRODUCTION

This document provides a parasitic backscatter communication protocol for battery-free internet-of-things (IoT) devices and sensors for radio-frequency (RF) wireless power transmission (WPT) without additional infrastructure.

Currently in preview, click buy full version

PARASITIC COMMUNICATION PROTOCOL FOR RADIO-FREQUENCY WIRELESS POWER TRANSMISSION

1 Scope

This document defines procedures for transferring power to non-powered IoT devices using the existing ISM band communication infrastructure and RF WPT and a protocol for a two-way, long-distance wireless network in which IoT devices and APs communicate using backscatter modulation of ISM-band signals. Three components are required for two-way, long-distance wireless communication using backscatter modulation of ISM-band signals:

- an STA that transmits wireless power and data packets to SSNs by forming ISM band signal channels between HIE-APs,
- a battery-free SSN that changes the sensitivity of the channel signals received from the STA using backscatter modulation, and
- an HIE-AP that practically decodes the channel signals whose sensitivity was changed by the SSN.

In this document, the procedures for CW-type RF WPT using communication among these three components are specified based on application of the CSI or FCSI detection method of ISM-band communication.

This document proposes a convergence communication protocol that can deploy sensors, which can operate at low power (dozens of microwatts or less) without batteries, collect energy, and perform communication, to transmit power to SSNs using RF WPT based on parasitic communication. This method can be applied to application service areas such as domestic IoT, the micro-sensor industry, and industries related to environmental monitoring in the future.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 63006:2019, *Wireless Power Transfer (WPT) – Glossary of terms*

IEC TR 63230:2020, *Radio frequency beam wireless power transfer (WPT) for mobile devices*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>