

## ISO/IEC 14543-3-11

Edition 1.0 2016-02

# INTERNATIONAL



Information technology – Home electronic system (HES) architecture – Part 3-11: Frequency modulated wireless short-packet (FMWSP) protocol optimised for energy harvesting – Architecture and lower layer protocols



## THIS PUBLICATION IS COPYRIGHT PROTECTED Copyright © 2016 ISO/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 ISO/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.

IEC Central Office	Tel.: +41 22 919 02 11
3, rue de Varembé	Fax: +41 22 919 03 00
CH-1211 Geneva 20	info@iec.ch
Switzerland	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 corrigenda or an amendment might have been published.

## IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

## IEC publications search - www.iec.ch/searchpub

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 It also gives information on projects, replaced and withdrawn publications.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 also once a month by email.

### Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

## IEC Glossary - std.iec.ch/glossary

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

## 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: csc@iec.ch.





Edition 1.0 2016-02

## **INTERNATIONAL STANDARD** CUNONIS



Information technology – Home electronic system (HES) architecture – Part 3-11: Frequency modulated wireless short-packet (FMWSP) protocol optimised for energy harvesting – Architecture and lower layer protocols

**INTERNATIONAL** ELECTROTECHNICAL COMMISSION

ICS 35.200

ISBN 978-2-8322-3194-4

Warning! Make sure that you obtained this publication from an authorized distributor.

## CONTENTS

FC	DREWO	RD	4		
IN	INTRODUCTION				
1	Scop	e	7		
2	Norm	ative references	7		
3	Term	s, definitions and abbreviations	8		
	3.1	Terms and definitions	8		
	3.2	Abbreviations	12		
4	Conf	ormance	12		
5	Archi	tecture	13		
	5.1	Generic protocol description	13		
	5.1.1	Overview	13		
	5.1.2	Physical layer	13		
	5.1.3	Data link layer	13		
	5.1.4	Network layer	14		
	5.1.5	Transport layer	14		
	5.1.6	Session layer	14		
	5.1.7	Presentation layer	14		
	5.1.8	Application layer	14		
	5.2	Data unit description	14		
6	Laye	r 1 – Physical layer	14		
	6.1	Overview	14		
	6.2	General description	14		
	6.3	Physical specifications for a FMWSP transmitter	16		
	6.4	Physical specifications for a FMWSP receiver	17		
	6.5	Packet structure	17		
-	6.6	Relationship between a packet and a telegram	18		
1	Laye	r 2 – Data link layer	19		
	7.1	Overview	19		
	7.2	Structure of a telegram of length less than 8 B	19		
	7.3	Structure of a telegram length of more than 7 B	20		
0	7.4	Data Integrity	22		
0	Laye		23		
	8.1	Media appage	23		
	0.2	Conoral	20 22		
	0.2.1		23 23		
	823	Random access	23 23		
	8.3	Repeater	24		
Ar	Annex A (informative) Examples of how to evaluate the bash value				
Ri	Bibliography				

Figure 1 – Illustration of a frequency modulated signal and various associated physical parameters	.15
Figure 2 – The packet structure for the FMWSP protocol	.18
Figure 3 – Relationship between a packet and a telegram	.19

ISO/IEC 14543-3-11:2016 - 3 -© ISO/IEC 2016 Figure 4 – Structure of a telegram length of less than 8 B.....19 Figure 5 – Structure of a telegram length of more than 7 B ......20 Figure A.1 – C code program ......25 

Table 2 - Requirements for a FMWSP transmitter	17
Table 3 – Requirements for a FMWSP receiver	17
Table 4 – Packet field values of the FMWSP protocol	
Table 5 – Field values and meaning of a telegram with less than 8 B of length	19
Table 6 – Header (HDR) description	21
Fable 7 – Extended header (EXHDR) description	22
Fable 8 – Extended telegram type (ETELTYP) description	

## INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

## Part 3-11: Frequency modulated wireless short-packet (FMWSP) protocol optimised for energy harvesting – Architecture and lower layer protocols

## FOREWORD

- ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and nongovernmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.
- 2) The formal decisions or agreements of IEC and ISO 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 and ISO member bodies.
- 3) IEC, ISO and ISO/IEC publications have the form of recommendations for international use and are accepted by IEC National Committees and ISO member bodies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC, ISO and ISO/IEC publications is accurate, IEC or ISO 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 and ISO member bodies undertake to apply IEC, ISO and ISO/IEC publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any ISO, IEC or ISO/IEC publication and the corresponding national or regional publication should be clearly indicated in the latter.
- 5) ISO and IEC do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. ISO or IEC are 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 ISO or its directors, employees, servants or agents including individual experts and members of their technical committees and IEC National Committees or ISO member bodies 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 of, use of, or reliance upon, this ISO/IEC publication or any other IEC, ISO or ISO/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 ISO/IEC publication may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 14543-3-11 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

The list of all currently available parts of the ISO/IEC 14543 series, under the general title *Information technology – Home electronic system (HES) architecture*, can be found on the IEC web site and ISO web site.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

## INTRODUCTION

Various electrically controlled sensors and switches are used in homes and similar environments for many different applications. Examples of such applications are lighting, heating, energy management, blinds control, different forms of security control and entertainment (audio and video).

In most cases the device, e.g., a switch initiating an action, and the device, e.g., a lamp, are installed at different places. The distance can be bridged by wires, infrared or radio transmission. Presently equipment at both ends of a wireless transmission link needs to be powered by line or battery.

While wireless transmissions are especially attractive to retrofit homes, power maintenance of battery-driven devices is a burden. In addition, these batteries require scarce materials. Since the command and control messages sent by control and sensor devices in homes are very short, they can be powered using new techniques for energy harvesting, provided they use a wireless protocol that operates on relatively low power. Energy available in the environment of a device is captured and stored (harvested) to power operation of the device. Examples of energy sources are mechanical actuation, solar radiation, temperature differences, etc. If this is executed at least one device in the link neither needs a battery nor a wire. Energy harvesting devices need very limited power and use an energy efficient radio protocol to send data to other conventionally powered devices in the home. In order to ensure interoperability of such devices from different sources within a home, an international standard for a protocol is required that uses the little power that energy harvested devices can provide and at the same time spans distances to be bridged within a home environment.

Several such devices used within a home may come from different sources. They are required to interwork with each other using a common internal network (in this standard called a home network) and supporting a home automation system. When a home automation system meets ISO/IEC HES standards, it is called a Home Electronic System (HES).

Two alternative technologies are supported by the ISO/IEC 14543 series of standards. The two standards, ISO/IEC 14543-3-10 and ISO/IEC 14543-3-11, are optimised for energy harvesting based on similar techniques, but with different modulation schemes. ISO/IEC 14543-3-10 and ISO/IEC 14543-3-11 specify two lower layer wireless short-packet protocols, where the former uses an amplitude modulated signal and ISO/IEC 14543-3-11 a frequency modulated signal.

Amplitude modulated wireless communications are more energy efficient but less adapted to mobile devices. This is due to the fact that the impedance of a mobile antenna is affected by the environment of the mobile device, e.g., when the device is held in the hand or moved to metal surface. Changes in impedance affect the amplitude linearity of the radio frequency output amplifier, but have no impact on the frequency itself. Thus, an AM wireless system is more sensitive to changes in environment than a FM wireless system. Also frequencies above 800 MHz are better suited for mobile devices, since they require smaller antennas. Thus, the frequency 315 MHz is not used in this standard, which together makes the FM wireless system more efficient for mobile devices.

Compared to the AM wireless system, the FM wireless system provides more flexibility in the size of various pieces of information that can be transmitted. This includes the possibility to have larger payloads, different lengths of the identifiers of originators and destinations, and greater variability of structures and lengths of the telegram types. In addition, the number of steps a telegram can be repeated is increased from 2 to 15.

AM and FM wireless system are efficient enough to

- support energy harvested products for sensors and switches that do not require cables and batteries, and
- extend the life of battery-operated devices.

Both an AM and a FM system can be active at the same time, since each system is so

## INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

## Part 3-11: Frequency modulated wireless short-packet (FMWSP) protocol optimised for energy harvesting – Architecture and lower layer protocols

## 1 Scope

This part of ISO/IEC 14543 specifies a frequency modulated wireless protocol for lowpowered devices such as energy harvested devices in a home environment. This wireless protocol is specifically designed to keep the energy consumption of such sensors and switches extremely low.

The design is characterised by

- keeping the communications very short, infrequent and mostly unidirectional, and
- using communication frequencies that provide a good range even at low transmit power and avoid collisions from disturbers.

This allows the use of small and low cost energy harvesters that can compete with similar batteries-powered devices. The messages sent by energy harvested devices are received and processed mainly by line-powered devices such as relay switch actuators, repeaters or gateways. Together these form part of a home automation system, which, when conforming to the ISO/IEC 14543 series of standards, is defined as a Home Electronic System.

This part of ISO/IEC 14543 specifies OSI Layers 1 to 3 of the Frequency Modulated Wireless Short-Packet (FMWSP) protocol. It makes use of a frequency modulated signal well adapted to mobile devices and also supports high frequency wireless communications.

The FMWSP protocol system consists of two, and optionally three types of components that are specified in this standard. These are the transmitter, the receiver and optionally the repeater. Repeaters are needed when the transmitter and the receiver are located such that no good direct communication between them can be established. By direct communications the functional distance of the system is up to 300 m line-of-sight including the Fresnel zone and up to 30 m in buildings.

Since wireless communications may be overheard by receivers outside the intended environment, users should be aware of the risks this might cause before installing any wireless system. In contrast to listening devices, however, protection against malicious attacks for the technology in this standard can partly be handled in the upper layers, and is thus not treated here.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 7498-1, Information technology – Open systems interconnection – Basic Reference Model – Part 1: The Basic Model