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Edition 2.0 2020-03

INTERNATIONAL STANDARD

colour inside

Information technology – Home electronic system (HES) architecture – Part 3-10: Amplitude modulated wireless short-packet (AMWSP) protocol optimized for energy harvesting – Architecture and lower layer protocols

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INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

Part 3-10: Amplitude modulated wireless short-packet (AMWSP) protocol optimized for energy harvesting – Architecture and lower layer protocols

FOREWORD

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International Standard ISO/IEC 14543-3-10 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 and ISO websites.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

The text of this standard is based on the following documents:

CDV	Report on voting
JTC1-SC25/2842/CDV	JTC1-SC25/2864/RVC

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

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 harvesting devices can provide and at the same time spans distances to be bridged within a home environment.

Several such devices used within a home often come from different sources. They are required to interwork with each other using a common internal network (in this document 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).

Alternative transmission technologies are specified by ISO/IEC 14543 (all parts). ISO/IEC 14543-3-10 and ISO/IEC 14543-3-11 are optimized 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: ISO/IEC 14543-3-10 uses an amplitude modulated (AM) signal and ISO/IEC 14543-3-11 a frequency modulated (FM) signal.

Amplitude modulated wireless communications are more energy efficient but less adapted to mobile devices. This is because the impedance of a mobile antenna is affected by the environment of the mobile device, for example, 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 an 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 the FM specification, which 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. The number of steps a telegram can be repeated is two for the AM wireless system and 15 for the FM wireless system.

They are both efficient enough to

- support energy harvesting products for sensors and switches that require neither cabling nor batteries, and
- extend the life of battery-operated devices.

Both an AM and an FM system can be active at the same time, since each system is so constructed that only permitted messages are accepted. Collisions can be avoided by listen-before-talk (LBT) technology or overcome by redundant transmissions.

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

Part 3-10: Amplitude modulated wireless short-packet (AMWSP) protocol optimized for energy harvesting – Architecture and lower layer protocols

1 Scope

This part of ISO/IEC 14543 specifies a wireless protocol for low-powered devices such as energy harvesting 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 characterized 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 harvesting devices that can compete with similar battery-powered devices. The messages sent by energy harvesting 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 ISO/IEC 14543 (all parts), is defined as a home electronic system.

This document specifies OSI Layers 1 to 3 of the amplitude modulated wireless short-packet (AMWSP) protocols.

The AMWSP protocol system consists of two and optionally three types of components that are specified in this document. These are the transmitter, the receiver and optionally the repeater. Repeaters are needed when the transmitter and the receiver are located in such a way that no good direct communication between them can be established.

Protection against malicious attacks is handled in the upper layers and thus not treated in this document.

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.

ETSI EN 300 220-1 V3.1.1, *Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 1: Technical characteristics and methods of measurement*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
amplitude shift keying envelope
ASK envelope
envelope of the modulated signal

3.1.2
bit duration
time between transitions of the mesial amplitude of an ASK envelope in an alternating sequence

Note 1 to entry Figure 2 shows this in detail.

3.1.3
bit duration error
deviation of bit duration from specified bit duration

3.1.4
byte
ordered set of eight binary digits, operated on as an entity

Note 1 to entry: The non-qualified term "byte" designates an 8-bit byte.

[SOURCE: IEC 60050-702:2016, 702-05-09]

3.1.5
collision
state which exists when two wireless transmitters use the same wireless channel and transmit data at the same time

3.1.6
cyclic redundancy check
CRC
integrity hash algorithm based on a polynomial division

3.1.7
DATA
application payload data transmitted in the telegram

3.1.8
energy harvesting device
device able to capture and store (harvest) energy from the environment to power its operations

Note 1 to entry Examples of energy sources are mechanical actuation, solar radiation, temperature differences, etc.

3.1.9
frame
set of data to be transmitted as a complete unit on the physical layer

Note 1 to entry A frame contains the necessary protocol control and synchronization data for transmission between network nodes.

3.1.10
HASH
field in which the hash value for the data integrity control of each transmitted telegram and subtelegram is specified

3.1.11
high nibble
upper four bits of the byte

Note 1 to entry The *N* value from the byte 0x*NM*.

3.1.12
high state amplitude
amplitude corresponding to the physical high state level

3.1.13
high state level
level of the ASK envelope that represents the high state amplitude

Note 1 to entry The definition aligns with IEEE 194-1977, 5.2.2.5, static levels. Figure 2 gives an illustration.

3.1.14
identity of the destination device
DESTID
unique identity of the destination device of an AMWSP telegram consisting of four bytes

3.1.15
identity of the transmitting device
TXID
unique identity of the AMWSP protocol transmitting device consisting of four bytes

3.1.16
inverse bits
INV
bits added by the encoding procedure into a subframe behind the third and the sixth bit to reduce the DC content of the data

3.1.17
listen before talk
LBT
technique of checking the occupancy of the wireless channel before transmitting any frames

3.1.18
low nibble
lower four bits of the byte

Note 1 to entry The *M* value from the byte 0x*NM*.

3.1.19
low state amplitude
amplitude corresponding to the physical low state level

3.1.20
low state level
level of the ASK envelope that represents the low state amplitude

Note 1 to entry The definition aligns with IEEE 194-1977, 5.2.2.5, static levels. Figure 2 gives an illustration.

3.1.21
mesial power level
median between high state level and low state level of an ASK envelope

Note 1 to entry Figure 2 gives an illustration.

3.1.22
negative overshoot
difference between minimum peak level and low state level of an ASK envelope after a transition from a high state to a low state has occurred

Note 1 to entry Figure 2 gives an illustration.

3.1.23
negative undershoot
difference between maximum peak level and low state level of an ASK envelope after a transition from a high state to a low state has occurred

Note 1 to entry Figure 2 gives an illustration.

3.1.24
nibble
four-bit aggregation or half a byte

3.1.25
positive overshoot

difference between maximum peak level and high state level of ASK envelope after a transition from a low state to a high state has occurred

Note 1 to entry Figure 2 gives an illustration.

3.1.26
positive undershoot
difference between minimum peak level and high state level of ASK envelope after a transition from a low state to a high state has occurred

Note 1 to entry Figure 2 gives an illustration.

3.1.27
receiving device maturity time
RX maturity time
maximum time, determined at the receiving device, between the end of the first subtelegram and the end of the last subtelegram belonging to the same telegram

3.1.28
repeated telegram
telegram transmitted by a repeater

3.1.29
repeater
device that receives telegrams and sends refreshed signals to any AMWSP receiver

3.1.30
subframe
subtelegram byte expanded by protocol control and synchronization information

3.1.31
subtelegram
smallest interpreted data unit containing the fields telegram type (RORG), payload (DATA), transmitter identity (TXID), STATUS and HASH