

**INTERNATIONAL  
STANDARD**

**ISO/IEC  
14543-3-6**

First edition  
2007-01

---

---

**Information technology –  
Home electronic system (HES) architecture –**

**Part 3-6:  
Media and media dependent layers –  
Twisted pair for network based control of  
HES Class 1**



Reference number  
ISO/IEC 14543-3-6:2007(E)

This document is a preview generated by EVS

# INTERNATIONAL STANDARD

# ISO/IEC 14543-3-6

First edition  
2007-01

This document is a preview generated by EVIS

---

---

## Information technology – Home electronic system (HES) architecture – Part 3-6: Media and media dependent layers – Twisted pair for network based control of HES Class 1

Copyright © 2007 ISO/IEC, Geneva — All rights reserved

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 the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland  
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: [inmail@iec.ch](mailto:inmail@iec.ch) Web: [www.iec.ch](http://www.iec.ch)



PRICE CODE

W

*For price, see current catalogue*

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references.....	9
3 Terms, definitions and abbreviations.....	10
3.1 Definitions.....	10
3.2 Abbreviations.....	13
4 Conformance.....	14
5 Requirements for HES Class 1, Twisted Pair Type 0 (TP0).....	14
5.1 Datagram service.....	14
5.1.1 Transmission method.....	14
5.1.2 Transceiver characteristics.....	15
5.1.3 Physical layer services – Physical data service.....	16
5.1.4 Physical layer protocol.....	17
5.2 Medium definition.....	18
5.2.1 Topology.....	18
5.2.2 Line.....	18
5.2.3 Line connection.....	18
5.2.4 Repeater.....	18
5.2.5 Medium installation requirements.....	18
5.2.6 General hardware requirements.....	19
5.3 Power feeding service.....	19
5.3.1 General.....	19
5.3.2 Power feeding device types.....	19
5.3.3 Factor C (current consumption).....	19
5.3.4 Line power supply general requirements.....	20
5.3.5 Power supply voltage.....	20
5.3.6 Dynamic characteristics.....	21
5.3.7 Distributed power supply (DPS).....	23
5.4 Data link layer type Twisted Pair Type 0.....	28
5.4.1 Frame formats.....	28
5.4.2 Medium access control.....	33
5.4.3 L_Data service and protocol.....	34
5.4.4 L_Busmon service.....	37
5.4.5 L_Service_Information service.....	37
5.5 Full Twisted Pair Type 0 frame structure.....	37
6 Requirements for HES Class 1, Twisted Pair Type 1 (TP1-64 & TP1-256).....	38
6.1 Physical layer requirements – Overview.....	38
6.2 Requirements for analogue bus signals.....	40
6.2.1 General.....	40
6.2.2 Specification of logical “1”.....	41
6.2.3 Specification of logical “0” (Single).....	41
6.2.4 Specification of logical “0” (overlapping).....	43
6.2.5 Analogue requirements within a transmitted character.....	44
6.2.6 Simultaneous sending / collision behaviour.....	45
6.3 Medium attachment unit (MAU).....	45

6.3.1	General .....	45
6.3.2	Requirements within a physical segment .....	45
6.3.3	Remote powered devices (RPD).....	52
6.4	Twisted Pair Type 1 bus cable .....	53
6.4.1	Requirements .....	53
6.4.2	Measurement of continuous magnetic and electrical interference, respectively transient induced differential voltages .....	54
6.5	Topology .....	55
6.5.1	Physical segment .....	55
6.5.2	Bridge.....	55
6.5.3	Router, sub-line, main line and zone .....	56
6.5.4	Gateways to other networks .....	57
6.6	Services of the physical layer type Twisted Pair Type 1 .....	58
6.6.1	General .....	58
6.6.2	Physical_Data service.....	58
6.6.3	Physical_Reset service .....	60
6.7	Behaviour of the physical layer type Twisted Pair Type 1 entity.....	60
6.8	Data link layer type Twisted Pair Type 1 .....	61
6.8.1	General .....	61
6.8.2	Frame formats .....	61
6.8.3	Medium access control .....	67
6.8.4	Data link layer services .....	70
6.8.5	Data link layer protocol .....	73
6.8.6	State machine of data link layer .....	75
6.8.7	Parameters of data link layer.....	76
6.8.8	Reflections on the system behaviour in case of L_Poll_Data configuration faults .....	76
6.8.9	Data link layer of a bridge .....	77
6.8.10	Data link layer of a router.....	77
6.8.11	Externally accessible bus monitor and data link layer interface .....	77
	Bibliography .....	78
	Figure 1 – NRZ line code.....	14
	Figure 2 – Character format .....	15
	Figure 3 – Transmitter rising and falling edges .....	16
	Figure 4 – Repeater maximum transition time.....	18
	Figure 5 – TP0 power supply gauge.....	21
	Figure 6 – Power supply dynamic internal resistor measuring test set-up .....	21
	Figure 7 – Falling edge and over-current measurements.....	22
	Figure 8 – TP0 Network with distributed power supply .....	23
	Figure 9 – Voltage/Current gauge of one node.....	24
	Figure 10 – Voltage/Current gauge of entire distributed power supply with 6 to 8 supply nodes.....	26
	Figure 11 – Common part of frame structure .....	28
	Figure 12 – Control field.....	29
	Figure 13 – CTRL_E field .....	30

Figure 14 – Format 1s, L_Data_Standard frame format with standard field-name abbreviations .....	30
Figure 15 – Format 1e, L_Data_Extended frame format with standard fieldname abbreviations .....	31
Figure 16 – EFF field.....	31
Figure 17 – Format 2, Short acknowledgement frame format .....	32
Figure 18 – Transmission definition .....	37
Figure 19 – Format 1s, Full L_Data_Standard request frame format .....	37
Figure 20 – Format 1e, Full L_Data_Extended request frame format.....	38
Figure 21 – Logical structure of physical layer type TP1.....	40
Figure 22 – Octet mapped to a serial character .....	40
Figure 23 – “1”-Bit frame.....	41
Figure 24 – “0”-Bit frame.....	42
Figure 25 – Delayed logical “0”.....	43
Figure 26 – Overlapping of two logical “0” (example) .....	44
Figure 27 – Method of transmitting.....	47
Figure 28 – Example of transmitter characteristics.....	48
Figure 29 – Example of a diagram of a TP1-64 transmitter.....	49
Figure 30 – Example of a diagram of a TP1-256 transmitter ( $I_{limit} 0,4 A$ ).....	49
Figure 31 – Relation between framed data and asynchronous signal.....	50
Figure 32 – Relation between digital signal and serial bit stream.....	51
Figure 33 – Example of light dimmer .....	52
Figure 34 – Physical segments.....	55
Figure 35 – Physical segments combined to a line.....	56
Figure 36 – Lines combined to a zone .....	56
Figure 37 – Network topology.....	58
Figure 38 – Control field.....	62
Figure 39 – Frame fields with standard fieldname abbreviations.....	62
Figure 40 – Format 1s, L_Data_Standard frame format.....	63
Figure 41 – Check octet .....	63
Figure 42 – Frame fields with standard fieldname abbreviations.....	64
Figure 43 – Format 1e, L_Data_Extended frame format.....	64
Figure 44 – Extended control field .....	65
Figure 45 – Format 3 - L_Poll_Data request frame format.....	65
Figure 46 – L_Poll_Data response frame format .....	66
Figure 47 – Format 2 - Short acknowledgement frame format .....	67
Figure 48 – Character timing .....	67
Figure 49 – Priority operation .....	68
Figure 50 – Guarantee of access fairness.....	70
Figure 51 – State machine of data link layer .....	76

Table 1 – Electrical data encoding .....	15
Table 2 – Transceiver characteristics – Sending part .....	16
Table 3 – Transceiver characteristics – Receiving part .....	16
Table 4 – Mandatory and optional requirements for physical layer services .....	16
Table 5 – Physical-Result parameter .....	17
Table 6 – Requirements for the TP0 line.....	18
Table 7 – General hardware requirements .....	19
Table 8 – Current consumption requirements .....	20
Table 9 – Power supply voltage .....	20
Table 10 – Requirements for one supplying DPS device .....	24
Table 11 – Requirements for entire DPS.....	26
Table 12 – Possible cable lengths depending on number of DPS devices connected (for a typical cable).....	27
Table 13 – Priority of frames – FT .....	34
Table 14 – Requirements for acknowledgement wait time, frame re-transmission.....	36
Table 15 – Requirements for full wait time, frame re-transmission .....	36
Table 16 – System parameters of physical layer Type TP1-64 and TP1-256.....	39
Table 17 – Analogue and digital signal of a logical “1” .....	41
Table 18 – Analogue and digital signal of logical “0” .....	42
Table 19 – Limits within a character .....	44
Table 20 – Unit currents for standard devices .....	46
Table 21 – Dynamic requirements of a TP1-64 transmitter .....	48
Table 22 – Dynamic requirements of a TP1-256 transmitter .....	48
Table 23 – Requirements for the receiver .....	50
Table 24 – Requirements for bit coding .....	51
Table 25 – Requirements for the bit decoding unit .....	52
Table 26 – Requirements for TP1 cable.....	53
Table 27 – Requirements for character coding.....	68
Table 28 – Requirements for character decoding .....	68
Table 29 – Priority sequence, in descending order of importance.....	69

This document is a preview generated by EVS

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

## Part 3-6: Media and media dependent layers – Twisted pair for network based control of HES Class 1

### FOREWORD

- 1) ISO (International Organization for Standardization) and IEC (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. Their preparation is entrusted to technical committees; any ISO and IEC member body interested in the subject dealt with may participate in this preparatory work. International governmental and non-governmental organizations liaising with ISO and IEC also participate in this preparation.
- 2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.
- 3) 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 and ISO member bodies.
- 4) IEC, ISO and ISO/IEC Publications have the form of recommendations for international use and are accepted by IEC 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.
- 5) In order to promote international uniformity, IEC 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 Publication and the corresponding national or regional publication should be clearly indicated in the latter.
- 6) ISO and IEC provide no marking procedure to indicate their approval and cannot be rendered responsible for any equipment declared to be in conformity with an ISO/IEC Publication.
- 7) All users should ensure that they have the latest edition of this publication.
- 8) 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 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.
- 9) 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.

IEC and ISO draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent primarily concerning activities as described in clause 5: Requirements for HES Class 1, Twisted Pair Type 0 (TP0).

Schneider Electric Industries SAS has informed IEC and ISO that they have the patent applications or granted patents as listed below:

EP 0370 921 B1, EP 0911 777 A1.

IEC and ISO draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent primarily concerning activities as described in 6.2: Requirements for analogue bus signals and 6.3: Medium attachment unit (MAU).

Siemens AG (Regensburg) has informed IEC and ISO that they have the patent applications or granted patents as listed below:

EP 0365 696 B1, EP 0487 759 B1, EP 0489 194 B1, EP 0643 893 B1, EP 0770 285 B1, EP 0854 587 A1, EP 0858 142 A1, EP 0858 194 A1, WO 00/42694 A1.



IEC and ISO draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent primarily concerning activities as described in 5.3.7: Distributed power supply (DPS).

Siemens Schweiz AG has informed IEC and ISO that they have the patent applications or granted patents as listed below:

EP-B-0'749'070

ISO and IEC take no position concerning the evidence, validity and scope of these putative patent rights. The holders of these putative patent rights have assured IEC and ISO that they are willing to negotiate free licences or licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statements of the holders of these putative patent rights are registered with IEC and ISO. Information may be obtained from:

Schneider Electric Industries SAS  
Systems and Architectures – EDA (Electrical Distribution Architecture)  
PLM-A Plant – 2 chemin des sources - Meylan  
F-38050 Grenoble cedex 9  
France

Siemens AG  
A and D ET BC  
Siemensstr. 10  
D-93055 Regensburg  
Germany

Siemens Schweiz AG  
Building Technologies Group  
Intellectual Property  
Gubelstr. 22  
CH-6300 Zug  
Switzerland

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC and ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 14543-3-6 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This International Standard is a product family standard. It shall be used in conjunction with ISO/IEC 14543-2-1, 14543-3-3, 14543-3-4, 14543-3-5 and 14543-3-7.

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

## INTRODUCTION

The reference model for Open System Interconnection (OSI), specified in ISO/IEC 7498, assigns the functions that are needed for communications between two entities that are connected by medium to seven logical layers. This International Standard specifies interconnection of entities used for home and building control via the medium twisted pair. It specifies the medium and medium dependent functions such as the cable, the connectors and the transmission technology in terms of the Physical Layer and the Data Link Layer according to ISO/IEC 7498.

Currently, ISO/IEC 14543, *Information technology – Home Electronic System (HES) architecture*, consists of the following parts:

- Part 2-1: *Introduction and device modularity*
  - Part 3-1: *Communication layers – Application layer for network based control of HES Class 1*
  - Part 3-2: *Communication layers – Transport, network and general parts of data link layer for network based control of HES Class 1*
  - Part 3-3: *User process for network based control of HES Class 1*
  - Part 3-4: *System management – Management procedures for network based control of HES Class 1*
  - Part 3-5: *Media and media dependent layers – Powerline for network based control of HES Class 1*
  - Part 3-6: *Media and media dependent layers – Twisted pair for network based control of HES Class 1*
  - Part 3-7: *Media and media dependent layers – Radio frequency for network based control of HES Class 1*
  - Part 4: *Home and building automation in a mixed-use building (technical report)*
  - Part 5-1: *Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Core protocol (under consideration)*
  - Part 5-2: *Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Device certification (under consideration)*
- Additional parts may be added later.*

This document is a review generated by EVS

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

## Part 3-6: Media and media dependent layers – Twisted pair for network based control of HES Class 1

### 1 Scope

This part of ISO/IEC 14543 defines the mandatory and optional requirements for the medium specific physical and data link layer for twisted pair for network based control of HES Class 1 in its two variations called TP0 and TP1.

NOTE Data link layer interface and general definitions, which are media independent, are specified in ISO/IEC 14543-3-2.

### 2 Normative references

The following referenced documents are indispensable for the application 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.

ISO/IEC 14543-2-1, *Information technology – Home Electronic System (HES) architecture – Part 2-1: Introduction and device modularity*

ISO/IEC 14543-3-2, *Information technology – Home electronic system (HES) architecture – Part 3-2: Communication layers – Transport, network and general parts of data link layer for network based control of HES Class 1*

ISO/IEC 14543-3-3, *Information technology – Home Electronic System (HES) architecture – Part 3-3: User process for network based control of HES Class 1*

ISO/IEC 14543-3-4, *Information technology – Home Electronic System (HES) architecture – Part 3-4: System management – Management procedures for network based control of HES Class 1*

ISO/IEC 14543-3-5, *Information technology – Home Electronic System (HES) architecture – Part 3-4: Media and media dependent layers – Powerline for network based control of HES Class 1*

ISO/IEC 14543-3-7, *Information technology – Home Electronic System (HES) architecture – Part 3-6: Media and media dependent layers – Radio frequency for network based control of HES Class 1*

IEC 60189-2, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 2: Cables in pairs, triples, quads and quintuples for inside installations*

IEC 60227-2, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 2: Test methods*

IEC 60245-2, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 2: Test methods*

IEC 60332-1 (all subparts), *Tests on electric and optical fibre cables – Part 1: Test for a vertical flame propagation for a single insulated wire or cable*

IEC 60754-2, *Test on gases evolved during combustion of electric cables – Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

EN 50090-2-2, *Home and Building Electronic Systems (HBES) – Part 2-2: System overview – General technical requirements*

### 3 Terms, definitions and abbreviations

#### 3.1 Definitions

For the purposes of this part the terms and definitions given in ISO/IEC 14543-2-1 and the following apply.

##### 3.1.1

#### **HES Class 1 Twisted Pair Type 0**

Twisted Pair medium Twisted Pair Type 0 (TP0) is a physical layer specification for data and power transmission on a single twisted pair, allowing asynchronous character-oriented data transfer in a half duplex bi-directional communication mode, using a specifically unbalanced/unsymmetrical base-band signal coding with collision avoidance under SELV conditions

##### 3.1.2

#### **HES Class 1 Twisted Pair Type 1**

Twisted Pair medium Twisted Pair Type 1 (TP1) is a physical layer specification for data and power transmission on a single twisted pair, allowing asynchronous character-oriented data transfer in a half duplex bi-directional communication mode, using a specifically balanced/symmetrical base-band signal coding with collision avoidance under SELV conditions

##### 3.1.3

#### **distributed power supply**

the bus is powered in a distributed way by a number of the devices connected to the line (compared to a centralised power supply)

##### 3.1.4

#### **Logical Tag Extended HEE**

usage of the L\_Data\_Extended frame dedicated to extended group addressing

##### 3.1.5

#### **Remote Powered Devices**

remote Powered Bus Devices (RPD) do not extract their energy for the application circuit and the bus controller from the bus but from another independent source of energy, for example, mains. Owing to the reduced DC power consumption of RPD, a bus line equipped with such devices requires less power from the installed Power Supply Unit (PSU). The connection of bus-controller and application to the same electrical potential reduces the effort of galvanic separation in RPD