ISO/IEC 14543-4-2

Edition 1.0 2008-05

INTERNATIONAL STANDARD

Information technology – Home electronic system (HES) architecture – Part 4-2: Communication layers – Transport, network and general parts of data link layer for network enhanced control devices of HES Class 1

ISO/IEC 14543-4-2:2008(E)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE T

ICS 35.200

ISBN 2-8318-9815-3

CONTENTS

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

Part 4-2: Communication layers – Transport, network and general parts of data link layer for network enhanced control devices of HES Class 1

FOREWORD

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International Standard ISO/IEC 14543-4-2 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.

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 second title page.

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

INTRODUCTION

This part of ISO/IEC 14543 specifies the media independent requirements for the data link layer and the requirements for the network layer and the transport layer for Home Electronic System. This standard stipulates the communication stack for providing the services specified in ISO/IEC 14543-4-1. It can be used as the communication stack on the physical layers as specified in ECHONET [1] Specifications. This part of ISO/IEC 14543 is based on ECHONET[1] specifications.

ISO/IEC 14543 *Information technology – Home Electronic System (HES) architecture*, currently consists of 13 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 – Power line 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 4-1: *Communication layers – Application layer for network enhanced control devices of HES Class 1*
Part 4-2: *Communication layers – Transport, network and general parts of data link layer for network enhanced control devices of HES Class 1 (this standard)*
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 are under preparation.

1 Echonet™ is the trade name of a product supplied by ECHONET Consortium. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC or ISO of the product named. Equivalent products may be used if they can be shown lo lead to the same results.

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

Part 4-2: Communication layers – Transport, network and general parts of data link layer for network enhanced control devices of HES Class 1

1 Scope

This part of ISO/IEC 14543 specifies the services and protocol in a manner independent of the physical layer for the data link layer and for the network layer and the transport layer for usage in network enhanced home electronic systems Class 1.

ISO/IEC 14543-4 is designed to enable the use of power line and wireless protocols as transmission media. Slow transmission speeds discourage large data transfers, and it is desirable to reduce the mounting load on simple devices. In light of this situation, this part of ISO/IEC 14543 specifies the frame format for the communications middleware block to minimize message size while fulfilling the requirements of the communications layer structure.

This part of ISO/IEC 14543 specifies the protocol difference absorption processing block and a part of the communications processing block. Figure 1 shows the relationship between the protocol of ISO/IEC 14543-4 and HES reference model based on ISO/IEC 7498.

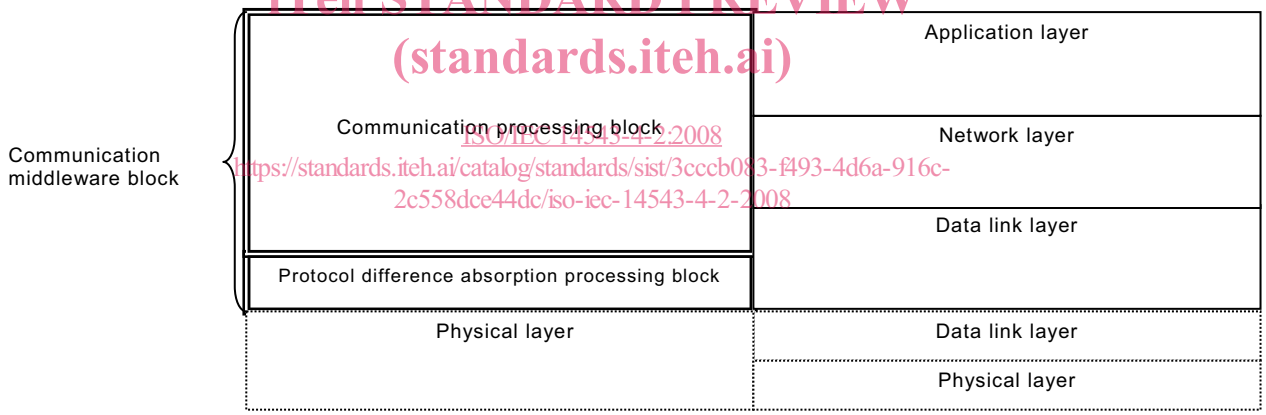

Figure 1 – Relationship between the protocol of ISO/IEC 14543-4 and OSI reference model

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 7498 (all parts), *Information technology – Open systems interconnection – Basic reference model*

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

ISO/IEC 24767-2, *Information technology – Home network security – Part 2: Internal security services* (under consideration)

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1
application data (ADATA)
data region for messages exchanged by communications middleware

NOTE The maximum size is 256 bytes.

3.1.2
application data counter (ADC)
indicates the size of the ADATA region

NOTE The size is variable in 1-byte increments.

3.1.3
application object (AOJ)
model of information to be disclosed to the network from information owned by the communications processing block or an access procedure model

NOTE The information or control target owned by each device is specified as a property and the operating method (setting, browsing) for this is specified as a service. AOJs are used when class or instance is not considered.

3.1.4
application programming interface (API)
assembly of interface functions for middleware

NOTE API makes it easy to operate middleware for designers.

3.1.5
application property value data (APD)
is a data value related to the application property code (APC), such as a status notification or specific setting and control by an application service code (ASC)

NOTE Detailed specifications are provided for the size, code value, etc. of the APD for each APC.

3.1.6
communications middleware block
this middleware is arranged from data link layer to application layer and performs communications processing according to the ISO/IEC 14543-4 protocol

NOTE The major features of ISO/IEC 14543-4 are implemented by communications middleware.

3.1.7
communications processing block
one processing block for the communications middleware; this block performs communication protocol processing to facilitate remote device control/monitoring processing for application software, stores information for the above and controls various information on the self-device as well as other device statuses

3.1.8
DA data
node address of the destination of messages between lower-layer communications software

3.1.9
data link address (DLA)
address permitting unique identification of a node in a home network

NOTE This is a logical address that is defined separately from the Node address native to lower-layer communications software; it consists of a NetID and NodeID.

3.1.10
data link data
data that is composed of DHD, SDLA, DDLA, ADC and ADATA

3.1.11
data link frame
frame that is composed of DDC, DHD, SDLA, DDLA, ADC and ADATA

3.1.12
data link data counter (DDC)
specifies the order of split messages, indicates the end split of messages and stipulates split-transmission message identifiers

3.1.13
data link header (DHD)
four kinds of data are included:

- the first data is the message format for the ADATA/PADATA section;
- the second specifies secure message or plain message;
- the third specifies whether DDLA is a broadcast address or an individual address;
- and the fourth constitutes a routing hop counter

3.1.14
data link router
node used to connect subnets

NOTE It connects the subnets of different lower-layer communications protocols (for different protocols, regardless of transmission media type) or divides the same protocol into subnets. The lower-layer communications protocol is connected seamlessly on the system using routing processing based on data link addresses as a function.

3.1.15
data link split frame
messages exchanged between protocol difference absorption processing blocks are called data link split frames

3.1.16
hardware address
address defined based on a medium-specific addressing scheme, such as an ISO/IEC 8802-3 address; this is a unique value for a node among the same kind of transmission medium

3.1.17
NetID
SUBNET identifier that is also a component of a data link address

3.1.18
node
communication node conforming to ISO/IEC 14543-4

NOTE In ISO/IEC 14543-4, this is a communications function to be uniquely identified by a Data Link Address. There is no distinction between the application functions of nodes. The term “node” is used to describe the function of one communication terminal.

3.1.19
node address
address to implement layer-2 communication in transmission media

NOTE In ISO/IEC 14543-4, this does not signify an Ethernet MAC [2] address.

3.1.20
NodeID
identifier used to identify a node uniquely within the SUBNET

NOTE This is a logical address converted from the Node address native to the lower-layer communications software. This is also a component of the data link address.

3.1.21
protocol difference absorption processing block
one processing block of the communications middleware

NOTE This block is intended to absorb differences of multiple protocols, including power lines and low-power wireless, to configure a single network. The block performs address translation, communication type conversion, data division and data assembly.

3.1.22
SA data
node address of the source of messages between lower-layer communications software

3.1.23
SUBNET
group of nodes using the same lower-layer communications protocol

NOTE Each subnet has a NetID; different subnets can be connected by a data link router.

3.2 Abbreviations

ADATA	Application Data
ADC	Application Data Counter
AOJ	Application Object
APD	Application Property Value Date
API	Application Programming Interface
DDLA	Destination Data Link Address
DDC	Data Link Data Counter
DHD	Data Link Header
DLA	Data Link Address
DSDATA	Data Link Split Data
PADATA	Plain Application Data
SDLA	Source Data Link Address

4 Conformance

Products that claim conformance to this International Standard shall provide communication layers with a frame format in conformance with clause 5 and 6.4 of this standard.

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2 Ethernet™ is the trade name of a product supplied by Xerox Corporation. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results. For technical specifications of the MAC address see ISO/IEC 8802-3.

5 Frame format of communication layers

Figure 2 shows the frame format of the communication layers. In this document (ISO/IEC 14543-4-2) DDC, DHD, SDLA and DDLA are described. ADC and ADATA are described in ISO/IEC 14543-4-1. When property value data of 2 bytes or larger comprises application property value data (APD), the most significant value in the sequence is stored first. Bit 7 is the most significant bit and bit 0 is the least significant bit of the octet.

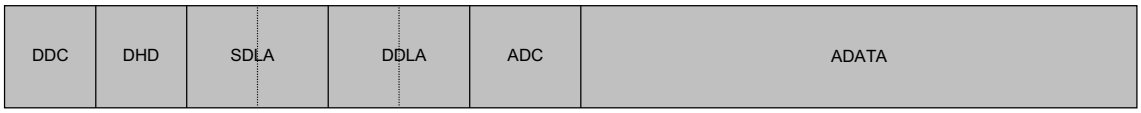


Figure 2 – Data link frame format of communication layers

6 Requirements for the physical layer and independent data link layer

6.1 Requirements for the physical layer

When two or more home network systems reside close together, the communications between home network systems must not mix. Therefore, each transmission media shall specify the principles for identifying each home network system, such as including in each communication message a house code that can identify each home network system.

The physical layer shall have the following functions.

- A function to maintain the uniqueness of the nodes' node addresses within the subnet
- A function to serve as a container for data link frame format shown in Figure 2
- An intra-subnet communication function
- A function to allow the individual nodes to retain their own profiles and report them to the network layer. The items of the profile are as follows:
  - Node address length
  - Node address mask pattern

    In the special case of a NULL value for a Node address, a special conversion rule is applied.
  - Node address
  - Maximum message length
  - Lower-layer communications software ID (+ Transmission medium ID)
  - Broadcast function ID

    A flag which shows broadcast function or no broadcast function.
  - Transmission rate
- A function to allow the individual nodes to retain their own statuses and report them to the network layer. The compulsory status items are as follows:
  - Stop

    A state in which no lower-layer communications software operations are performed.
  - Initialization

    A state in which the lower-layer communications software is initialized.
  - Normal operation

    A state in which data is transmitted to or received from a transmission medium as the primary function of the lower-layer communications software.

– Error stop

A state in which operation is stopped by the occurrence of an error.

– Suspension

A state in which operation is paused by an instruction from the communications middleware.

6.2 Functions of the data link layer

ISO/IEC 14543-4 was designed to enable the use of power line and wireless protocols as transmission media. Slow transmission speeds discourage large data transfers, and it is desirable to reduce the mounting load on simple devices. In light of this situation, this part of ISO/IEC 14543 specifies the frame format for the communications middleware block to minimize message size while fulfilling the requirements of the communications layer structure.

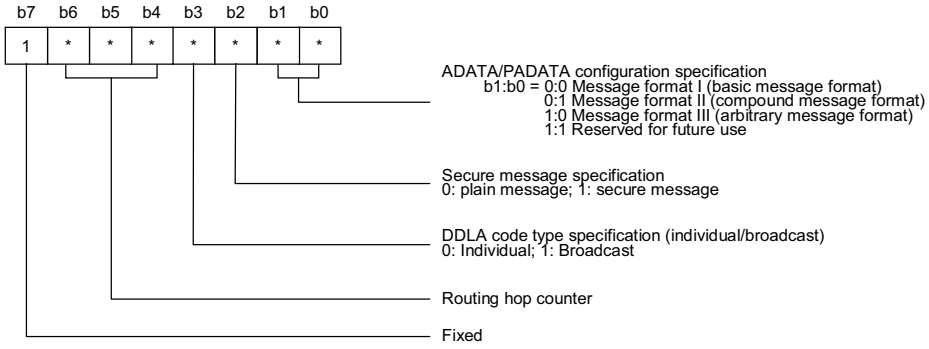
6.3 Possible media and their impact on layer-2

The data link layer is defined for the following media:

- Power lines
- Specific low electric power radio
- Twisted pair cable
- IrDA_Control [3]
- LonTalk® [4]
- Bluetooth™ [5]
- Ethernet

6.4 Data link layer services

6.4.1 Data link header



Note: When b7 = 0, b0 to b6 will be specified separately (reserved for future use).

Figure 3 – Configuration of DHD

The combination of b1 and b0 specifies the message format for the ADATA/PADATA section. When b1:b0 = 0:0, it indicates message format I (basic message format), which allows one

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3 IrDA™ is the trade name of products supplied by the Infrared Data Association. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the products named. Equivalent products may be used if they can be shown to lead to the same results.

4 LonTalk® is the trade name of a product supplied by Echelon Corporation. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

5 Bluetooth™ is the trade name of a product supplied by Bluetooth SIG, Inc. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

message to operate on one property of one object. When b1:b0 = 0:1, it indicates message format II (compound message format), which allows one message to operate on two or more properties of one object. When b1:b0 = 1:0, it indicates message format III (arbitrary message format), whose ADATA/PADATA section is in an arbitrary format.

Bit b2 indicates whether or not the ADATA section is encrypted. When b2 = 1, it means that the ADATA section is encrypted. When b2 = 0, it means that the ADATA section is not encrypted. Detailed information about encrypted and other secure messages is given in ISO/IEC 24767-2.

Bit b3 specifies whether the DDLA (Destination Data Link Address) shown in Figure 2 is a broadcast address or an individual address. When b3 = 1, it indicates that a broadcast address is stipulated by the DDLA code. When b3 = 0, it indicates that an individual address is stipulated by the DDLA code. Broadcast address codes are discussed in 6.4.2.2.

Bits b4, b5 and b6 constitute a routing hop counter, which can be manipulated only by data link routers. When a message received at one subnet of a data link router is forwarded to another subnet, the counter is incremented. For every transmission from an ordinary node, a hop count of 0 is used. The relationship between b4, b5 and b6 and the hop count is shown in Table 1 below. The number of hops can be set to a value between 0 and 7.

Table 1 – Number of hop counts

b6	b5	b4	Hop count (Router passes)
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

6.4.2 Data link address

6.4.2.1 General

The data link address was introduced to conceal differences in lower-layer transmission media from the communications processing block and the application software. The basic requirement for the address is that it uniquely identifies a node. The data link address is a logical address defined separately from the node address unique to each given transmission medium.

A data link address consists of (1) an address (hereafter referred to as a NodeID) determined based on an address (hereafter referred to as a node address) that enables communication in Layer-2 of the transmission medium and (2) an address (hereafter referred to as a NetID) that specifies the subnet.

Specifically, it consists of a NetID and a NodeID that uniquely correspond to the node address, as shown in Figure 4. The NodeID is logically assigned so as to be unique within the subnet.

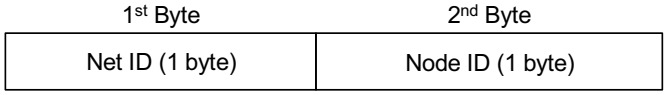

Figure 4 – Configuration of SDLA and DDLA for individual address

The NetID signifies a subnet identifier. The NetID of each node is set based on subnet information held in data link routers. Until the NetID of a node is set by a data link router, the NetID is set to 0x00, indicating NetID not specified, and the node can communicate only within the subnet to which the node belongs.

Table 2 – NetID codes

	NetID (HEX)	Meaning	Remarks
1	0x00	NetID not specified	
2	0x01 to 0x8F	NetID assigned codes	
3	0x90 to 0xFF	Codes available to user (manually assigned codes)	Used, for example, when a system manager for an apartment complex or building is present.

The NodeID is an identifier used to uniquely identify a node within a subnet. The NodeID is converted from a node address such that it is unique within the subnet. Each type of lower-layer communications software has its own conversion specifications.

6.4.2.2 Source/destination data link address (SDLA/DDLA)

This subclause provides detailed specifications for the source data link address (SDLA) and destination data link address (DDLA).

Figure 4 shows the configuration of the source data link address (SDLA) and the destination data link address (DDLA) prevailing when an individual address is stipulated by setting b3 of DHD to 0. When b3 of DHD is set to 1 to specify a broadcast, the destination data link address (DDLA) becomes a code indicating a broadcast message for specific data link address groups (including a general broadcast). In this case, the SDLA configuration is as shown in Figure 4, the DDLA configuration is as shown in Figure 5 and Table 3 and the broadcast target requirement code is as shown in Figure 6 and Figure 7.

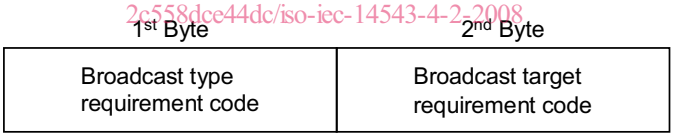

Figure 5 – DDLA (broadcast-stipulated) address configuration