

Multimedia home network — Network interfaces for network adapter

National foreword

This British Standard is the UK implementation of EN 62480:2009. It is identical to IEC 62480:2008.

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Multimedia home network - Network interfaces for network adapter (IEC 62480:2008)

Réseaux résidentiels multimédia -
Interfaces de réseau
relatifs aux adaptateurs de réseaux
(CEI 62480:2008)

Multimedia-Heimnetzwerk -
Netzwerkschnittstellen
für Netzwerkadapter
(IEC 62480:2008)

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Foreword

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Endorsement notice

The text of the International Standard IEC 62480:2008 was approved by CENELEC as a European Standard without any modification.

CONTENTS

INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	10
4 Network Adapter communication interfaces and requirements	12
4.1 Overview	12
4.2 Requirement of functions.....	14
4.3 Mechanical and physical characteristics for a Network Adapter	15
4.3.1 Network Adapter.....	15
4.3.2 Network Adapter communication interface	16
4.4 Electrical characteristics.....	16
4.4.1 Network Adapter.....	16
4.4.2 Network Adapter communication interface	16
4.5 Logical requirements	18
4.5.1 Network Adapter.....	18
4.5.2 Network Adapter communication interface	18
4.6 Network Adapter communication software protocols	20
4.6.1 Equipment interface data recognition service software protocol	20
4.6.2 Communication software protocol for object generation type	29
4.6.3 Communication software protocol for peer-to-peer type	84
Annex A (informative) Application object.....	85
Annex B (informative) Access to the application object in the Node	89
Annex C (normative) Property map description format	94
Annex D (informative) Composite messages	95
Annex E (informative) Connector shape	96
Bibliography.....	103
Figure 1 – The specified portions	9
Figure 2 – Network Adapter communication software hierarchy.....	12
Figure 3 – Example of the equipment interface data recognition sequence	13
Figure 4 – Network Adapter functions	15
Figure 5 – Logic level.....	17
Figure 6 – Character composition	19
Figure 7 – Timing requirements	19
Figure 8 – Format of equipment interface data recognition service.....	21
Figure 9 – Format of request command.....	22
Figure 10 – Format of response command	24
Figure 11 – Format of request command.....	25
Figure 12 – Format of response command	25

Figure 13 – Sequence of equipment interface data recognition service	26
Figure 14 – Status change diagram	27
Figure 15 – Format of object generation type commands	31
Figure 16 – Operation of IASet (IASetM).....	33
Figure 17 – Operation of IASetup (IASetMup)	34
Figure 18 – Operation of IAGet (IAGetM)	35
Figure 19 – Operation of IAGetup (IAGetMup)	36
Figure 20 – Network Adapter status changes	37
Figure 21 – Format of request command.....	39
Figure 22 – Format of response command	40
Figure 23 – Format of request command.....	41
Figure 24 – Format of response command	42
Figure 25 – Format of request command.....	43
Figure 26 – Format of response command	43
Figure 27 – Format of request command.....	44
Figure 28 – Format of response command	44
Figure 29 – Format of object data	45
Figure 30 – Format of equipment inquiry data	47
Figure 31 – Format of request command.....	47
Figure 32 – Format of response command	48
Figure 33 – Format of request command.....	49
Figure 34 – Format of response command	49
Figure 35 – Format of request command.....	50
Figure 36 – Format of response command	51
Figure 37 – Format of Object Data	51
Figure 38 – Format of equipment inquiry data	53
Figure 39 – Format of request command.....	54
Figure 40 – Format of response command	55
Figure 41 – Format of request command.....	56
Figure 42 – Format of response command	57
Figure 43 – Format of request command.....	58
Figure 44 – Format of response command	59
Figure 45 – Format of request command.....	60
Figure 46 – Format of response command	61
Figure 47 – Format of request command.....	62
Figure 48 – Format of response command	63
Figure 49 – Format of request command.....	64
Figure 50 – Format of response command	65
Figure 51 – Format of request command.....	67
Figure 52– Format of Response Command	68
Figure 53 – Format of request command.....	70
Figure 54 – Format of response command	71
Figure 55 – Format of request command.....	72

Figure 56 – Format of response command	73
Figure 57 – Communication error notification command	74
Figure 58 – Equipment interface data confirmation sequence	75
Figure 59 – Initialization sequence	77
Figure 60 – Object construction sequence (1)	78
Figure 61 – Object construction sequence (2)	79
Figure 62 – Equipment status access request sequence	80
Figure 63 – Equipment status notification request sequence	80
Figure 64 – Element designation equipment status access request sequence	81
Figure 65 – Element designation equipment status notification request sequence	81
Figure 66 – Object access request sequence	82
Figure A.1 – Device object configuration example	86
Figure B.1 – Service primitive (obtain other node status: synchronous type)	89
Figure B.2 – Service primitive (obtain other node status: asynchronous type)	90
Figure B.3 – Example of object view	90
Figure B.4 – Service primitive (control other node functions)	91
Figure B.5 – Example of object view	91
Figure B.6 – Service primitive (notify other nodes of self-node status: synchronous type)	92
Figure B.7 – Service primitive (notify other nodes of self-node status: asynchronous type)	92
Figure B.8 – Example of object view	92
Figure B.9 – Example of AOJ configuration in a Node	93
Figure C.1 – Property map description format	94
Figure D.1 – Part of the non-composite messages type packet	95
Figure D.2 – Part of the composite messages type packet	95
Figure E.1 – Type B Socket (Network-ready equipment side)	99
Figure E.2 – Type B plug (Network Adapter side)	100
Figure E.3 – Mating of Type B connector	101
Figure E.4 – Type A connector pin arrangement for Network Adapter communication interfaces – Pin assignment 1	101
Figure E.5 – Type B connector pin arrangement for Network Adapter communication interfaces – Pin assignment 2	102
Table 1 – Acceptable combinations of types supported by Network Adapters and types supported by Network-ready equipment	13
Table 2 – Specifications for supplying power – Network-ready equipment (Class 1)	17
Table 3 – Specifications for supplying power – Network-ready equipment (Class 2)	17
Table 4 – Specifications for supplying power – Network-ready equipment (Class 3)	17
Table 5 – Specifications for Supplying Power – Network Adapter	17
Table 6 – Timing requirements	19
Table 7 – Definition of states	28
Table 8 – Object generation type interface command codes	32
Table 9 – Classification of internal services	33
Table 10 – Communication sequences (object generation type)	73

Table 11 – Timeout values	84
Table A.1 – Format of the AOJ.....	85
Table A.2 – List of class codes by group code	87
Table A.3 – APC allocation table.....	88
Table E.1 – Physical specifications for Type B connector.....	97

INTRODUCTION

There are several obstacles to the spread of networked appliances that can be overcome by the concept of a Network Adapter described in this standard. As Home Networking technology is rapidly evolving, network functions which are pre-installed in home electrical appliances can easily become obsolete and may be difficult to upgrade. Many appliances strictly limit resources such as the CPU, power capacity, and memory to achieve cost savings. If all network functions are embedded in Home Networked appliances, this could result in a higher cost for new appliances and an additional barrier to wide adoption of such systems. In addition, when consumers want to add a new appliance to the network, they are forced to choose equipment with the same interconnecting systems as the existing network or add a router or gateway which can interconnect different systems.

To solve these problems, the network functions are divided into two parts. Since functions from OSI layer 1 to 7 (refer to ISO/IEC 7498 in Bibliography) are necessary to network home electrical appliances (including both multimedia equipment and household appliances such as televisions, computers, refrigerators, washing machines, and sensors), network functions from OSI layer 1 to 6 and most of layer 7 reside in an external Network Adapter and only a small part of layer 7 resides in the home appliances.

The advantages of applying this standard are:

- Users can upgrade a Home Network by simply changing the Network Adapters.

NOTE 1 For example, when an end-user wants to have higher QoS media.

- An electrical appliance without embedded network functions can be connected to an existing Home Network with a Network Adapter.

NOTE 2 For example, when an end-user wants to utilize some of the network application functions (i.e. energy conservation, etc) on an appliance which does not have all of the network function integrated.

- By selecting Network Adapters which use the same interconnecting system as the existing Home Network, routers or the gateways can be avoided.

NOTE 3 For example, when an end-user's network is a powerline network, but the appliance the user wants to connect to has only an RF network connection.

NOTE 4 For example, when an end-user's network is based on home networking standard "A" (layer 1-7), but the appliance the user wants to connect utilizes a home networking standard "B" (layer 1-7).

- Home appliance manufacturers can produce products that can be connected to Home Networks with minimal cost increases since most of the network functions are not required to be embedded in the appliance.

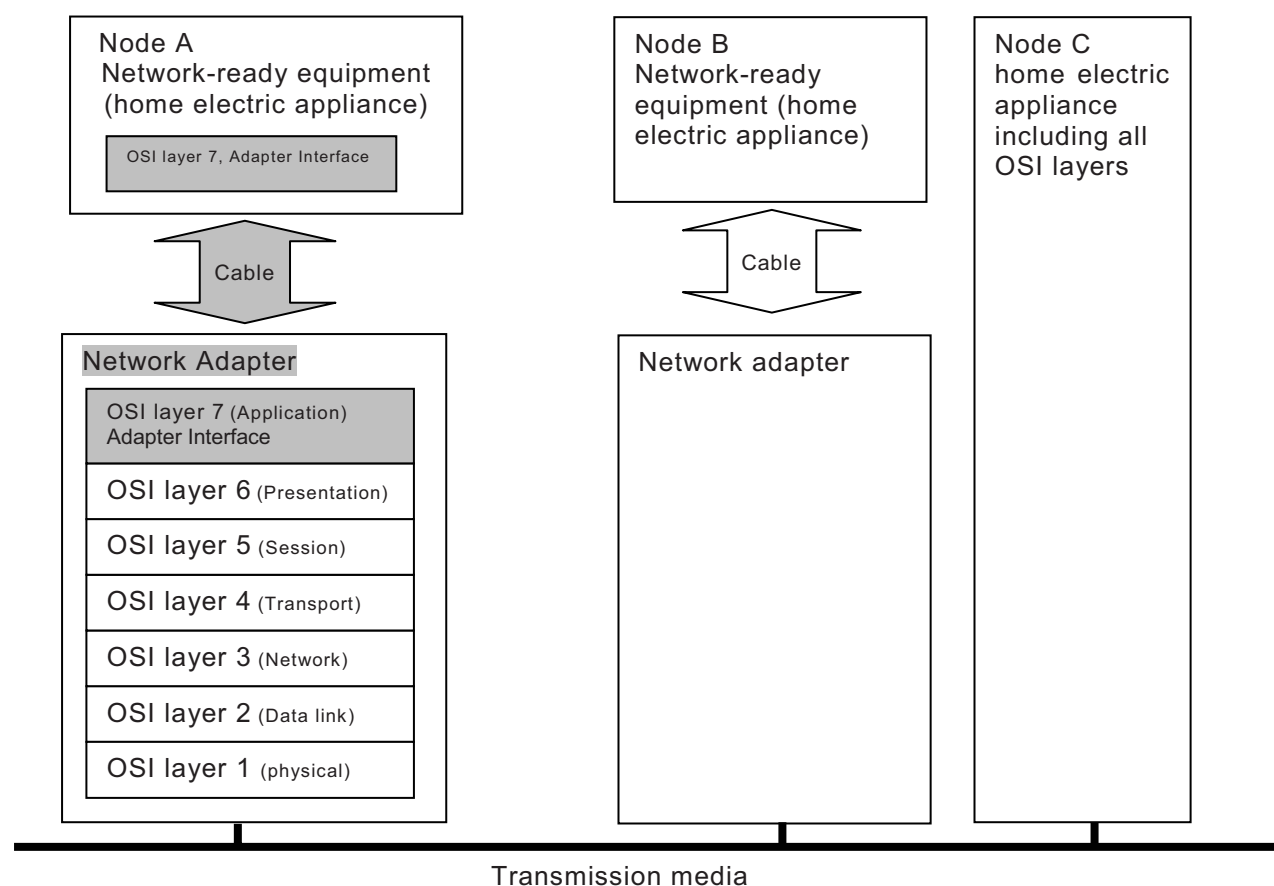
NOTE 5 This standard is helpful for standardizing the manufacturing process for including the network function in appliances- especially when the market has a low penetration of appliances that are network-ready.

- Device objects are based on the same object-oriented methodology used in almost all existing network protocols.

MULTIMEDIA HOME NETWORK – NETWORK INTERFACES FOR NETWORK ADAPTER

1 Scope

This International Standard specifies the requirements for the characteristics of the Network Adapter itself and the interface between the Network Adapter and Network-ready equipment as shown in Figure 1. Data exchanged between the Network Adapter and Network-ready equipment are basically for HES Class1. This standard does not specify the Home Networking Protocol by OSI layer 1-6 in the Network Adapter and any implementation of the software stack and hardware.



NOTE Gray colored portions are standardized.

Figure 1 – The specified portions

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.

None.

3 Terms and definitions

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

3.1

Application Property Data

ADT

data value related to Application Property Code, such as status notification or specific setting and control; data size, code value, and data format for ADT are specified

3.2

Application Object

AOJ

a model of information to be disclosed to the network from information owned by the communications processing block, or an access procedure model. 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. X1, X2 and X3 are assigned for AOJ code

3.3

Application Property Code

APC

1 octet code for the Application Property of the Application Object

3.4

cold start

method for starting the Home Network node by starting initial setting processing while abandoning previous information related to Network addresses and Application Object data. Cold start (1) re-acquires all information, especially information related to Network addresses, cold start (2) re-acquires only lower layer address, and cold start (3) re-acquires only upper layer addresses. If the address is fixed, cold start (1), cold start (2), and cold start (3) are the same.

3.5

Device object

helps the device operation functions of Application Objects to facilitate status confirmation and control between devices via communications and prepared for appliances such as air conditioner Application Objects, refrigerator objects, etc., with the Application Object definitions for such Application Objects to be specified separately and individually as classes.

3.6

Get/GetM

request for reading the property value of Application Object. Get is for non-element type property values. GetM is for element type property values; in this case, the element number is given

3.7

HES Class1

home electronic systems with transport capabilities for telecontrol applications such as control, monitoring, measurement, alarm and low speed data transfer. These capabilities are typically provided for by single packet-mode, low bandwidth channel and digital transmission

3.8

Home Network

generic name for various equipment-type Home Network standards for mainly household appliances; specifically, it refers to CEBus, Konnex, ECHONET, LonTalk, etc.

3.9

Network Adapter

Network Adapter contains the network functions from OSI layer 1 to 6, most of layer 7 and the Network Adapter communication interface. Network-ready equipment can communicate with a Home Network when connected via a Network Adapter

3.10

Network-ready equipment

network-ready equipment contains part of the network functions of OSI layer 7 and the Network Adapter communication interface. Network-ready equipment cannot function as part of a Home Network unless it is connected with a Network Adapter

3.11

Node

a communication node conforming to a Home Network standard. In a Home Network, this is a Home Network communication function to be uniquely identified by a Network address. There is no distinction between the application functions of nodes. The term node is used to describe the function of one communication terminal on a Home Network. This is referred to as node herein unless otherwise specified.

3.12

Node Profile Object

the Application object that represents Node related data, such as the operating state, manufacturer data, address information, and the Device object list in the node, etc. These are specified to enable manipulation (read/write) by application software and other nodes

3.13

NRZ method

non return to Zero method. This is one of the coding methods, in which 0 corresponds to low level on the signal line, and 1 corresponds to high level on the signal line

3.14

Set/SetM

request for writing the property value of an Application Object. **Set** is for non-element type property values. **SetM** is for element type property values. In the latter case, the element number and setting value are given

3.15

Abbreviations

ADT	Application Property Data
AOJ	Application Object
APC	Application Property Code
CN	Command Number Code
DL	Data Length Code
FCC	Frame Check Code
FD	Frame Data
FN	Frame Number
FT	Frame Type

4 Network Adapter communication interfaces and requirements

4.1 Overview

In this standard, two types of protocol specifications for Network Adapter communication interface software are provided to minimize the burden placed on Network-ready equipment in relation to network-related processing. The first is an object generation type and the second is a peer-to-peer type.

a) Object generation type

AOJ related data are exchanged between the Network Adapter and Network-ready equipment using a standardized communication method. AOJ related data preinstalled in the Network-ready equipment (at least one) is configured in the Network Adapter using a standardized procedure.

b) Peer-to-peer type

AOJ related data are exchanged between the Network Adapter and Network-ready equipment using a vendor-defined communication method. The communication method is not defined in this standard.

One appropriate type for the Network Adapter communication interface is selected after equipment interface data recognition service. Figure 2 shows the Network Adapter communication software hierarchy. Each box in the figure is described later.

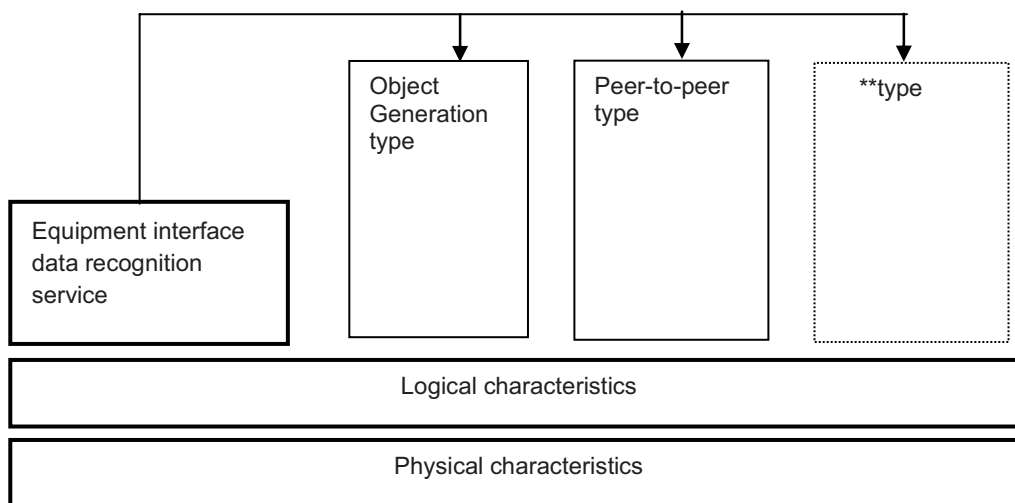


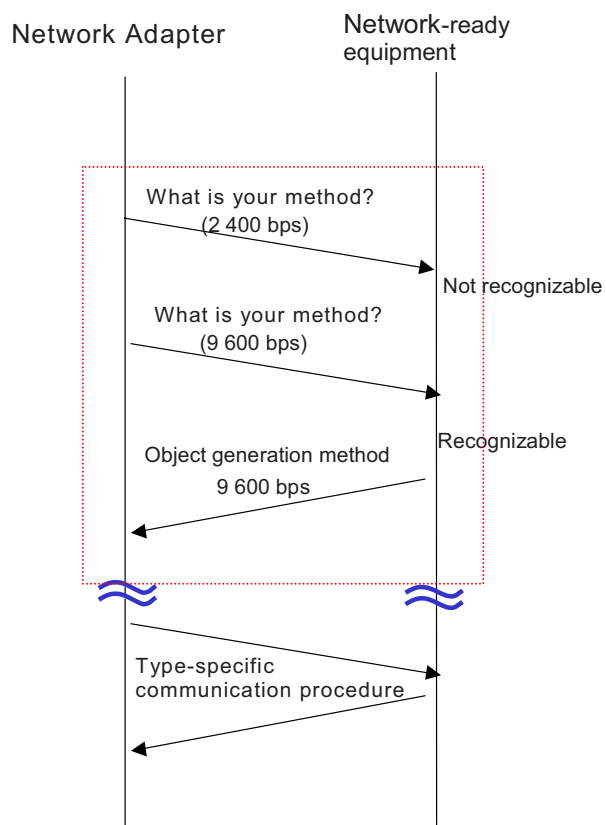
Figure 2 – Network Adapter communication software hierarchy

Table 1 shows examples of acceptable combinations (i.e. combinations with which communication is possible) of types supported by Network Adapters and types supported by Network-ready equipment.

Table 1 – Acceptable combinations of types supported by Network Adapters and types supported by Network-ready equipment

Network Adapter	Network-ready equipment
Object generation type	Object generation type
Peer-to-peer type	Peer-to-peer type

Figure 3 shows an example of an equipment interface data recognition service. The Network Adapter inquires the communication type to the Network-ready equipment at 2 400/9 600 bps.



NOTE 1 The figure shows a case where the Network-ready equipment is capable of handling 9 600 bps communication and object generation method.

NOTE 2 This standard does not define the transmission speed confirmation order.

Figure 3 – Example of the equipment interface data recognition sequence

4.2 Requirement of functions

The four defined functions for a Network Adapter are shown below. All four functions, except for b), shall be required for a Network Adapter as OSI layer 1-7. Only function d) is defined in this standard. All other functions are defined according to the appropriate Home Network protocols. The only function required for Network-ready equipment shall be d).

a) Message input and output function

A function to input and output electronic messages to and from the transmission medium in accordance with the lower-layer communication protocol specifications. This function is performed by lower-layer communication software and, therefore, requires a transceiver capable of handling each Home Network lower-layer communication protocol.

b) Protocol difference absorption function

This function is performed by the protocol difference absorption processing section and allows the necessary conversions to be made between the Home Network lower-layer communication software and Home Network communications processing section protocol.

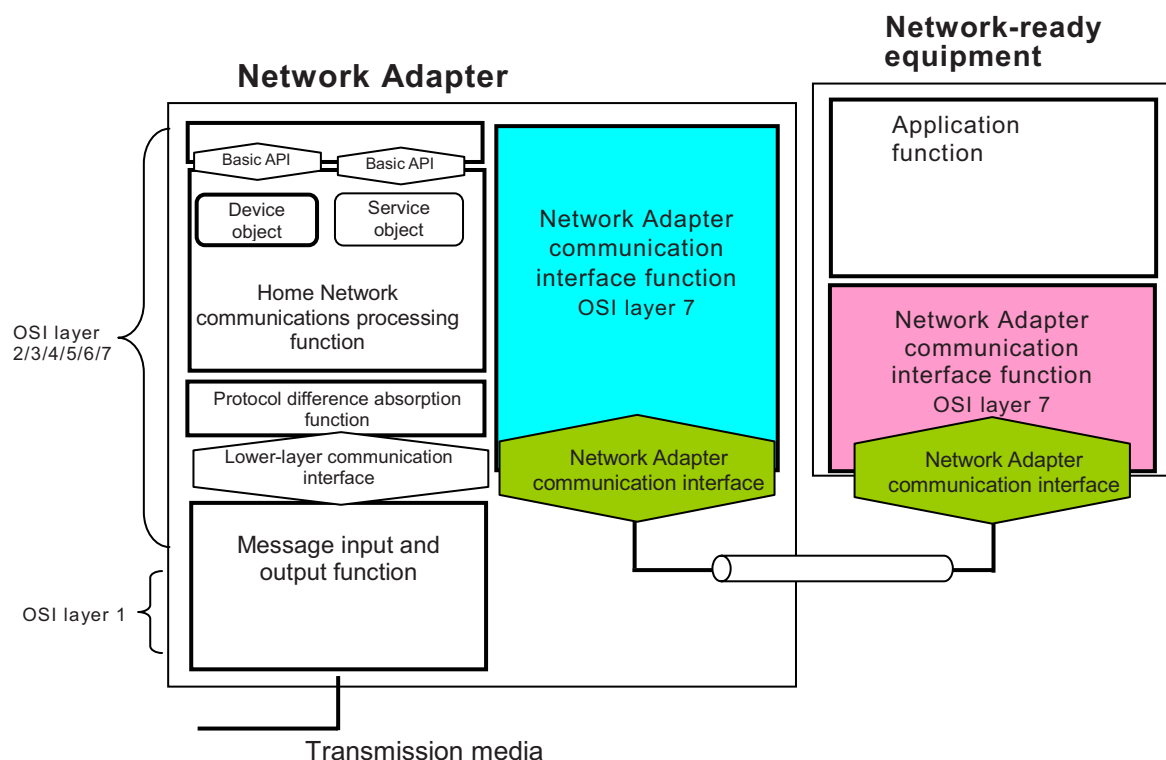
c) Home Network communications processing function

A function to be performed by the communications processing section which handles the transmission frame, objects, etc.

d) Network Adapter communication interface function

This function performs the necessary communications between the Network Adapter and Network-ready equipment and is defined in this standard. It performs communications between the Network-ready equipment application function and the Home Network communications processing function in the Network Adapter.

Figure 4 shows the Network Adapter functions.



NOTE OSI layer diagram corresponds to the left side diagram inside the Network Adapter.

Figure 4 – Network Adapter functions

4.3 Mechanical and physical characteristics for a Network Adapter

Mechanical and physical characteristics for a Network Adapter are defined in 4.3.1 and 4.3.2.

4.3.1 Network Adapter

The shape and display section are specified as below.

a) Shape

Only the connector described in 4.3.2 is defined in this standard.

b) Display section

Where LEDs are provided as a means of indicating the operation status of a Network Adapter, it is recommended that the minimum requirements listed below be satisfied. For status indication using a method not described herein, the specifications for the individual products are used.

- Number of LEDs: one (used to indicate the operation status)
- LED colour: green
- LED status indication

In operation: ON (solid)
Initial processing: Slow blinking
Abnormal state: Rapid blinking
Not operating: OFF

NOTE 1 Initial processing indicates an unrecognized status as specified in 4.6.1.4

NOTE 2 Slow blinking – repeated on-off sequence with approximately 2 s in the ON state followed by approximately 0,5 s in the OFF state.

NOTE 3 Rapid blinking – repeated ON-OFF sequence with approximately 0,5 s in the ON state followed by approximately 0,5 s in the OFF state.

4.3.2 Network Adapter communication interface

This subclause defines the mechanical and physical characteristics required for Network Adapter communication interface.

a) Transmission medium

The recommended transmission medium for Network Adapter communication interface is as follows:

Eight multi-conductor cables (conductor diameter is not specified).

b) Cable length

In the case of an open collector, the length for which a guarantee is provided shall be 2 m at the maximum.

c) Connection style

One-to-one connection of a Network Adapter and a corresponding piece of Network-ready equipment.

4.4 Electrical characteristics

Electrical characteristics for a Network Adapter is defined in 4.4.1 and 4.4.2.

4.4.1 Network Adapter

The Electrical characteristics required for OSI layer 1-7 are defined according to the appropriate Home Network protocols.

4.4.2 Network Adapter communication interface

This subclause defines the electrical characteristics requirements for Network Adapter communication interface.

a) Cable characteristics impedance

Not specified.

b) Signal transmission speed

For signals used by the equipment interface data recognition service of a Network Adapter communication interface, the two transmission speeds specified below shall be implemented for the Network Adapter. The Network-ready equipment shall be equipped with either of the two transmission speeds.

Transmission speeds: 2 400 bps, 9 600 bps

c) Signal transmission method and waveform of transmitted signals

The signal transmission method and the waveform of transmitted signals shall be as follows (the interface points are the connector pins).

- Transmission method: base band transmission
- Waveform: single-current NRZ method

- Logic level: see Figure 5

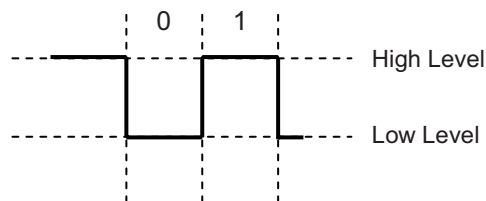


Figure 5 – Logic level

d) Output pin specifications

Type 1 or Type 2 shall be selected.

Type 1: open collector

Type 2: 3,3 V CMOS

e) Specifications for supplying power

Three classes are specified for supplying power to Network-ready equipment as shown in the following tables: Table 2; Table 3; and Table 4. One method for supplying power to Network Adapters is specified in Table 5. The supplying and receiving functions are optional for both Network-ready equipment and Network Adapters.

Table 2 – Specifications for supplying power – Network-ready equipment (Class 1)

Supply voltage	4,5 to 15 V
Supply capacity	1 200 mVA or more

Table 3 – Specifications for supplying power – Network-ready equipment (Class 2)

Supply voltage	4,5 to 5,5 V
Supply capacity	300 mVA or more

Table 4 – Specifications for supplying power – Network-ready equipment (Class 3)

Supply voltage	3 to 4,5 V
Supply capacity	300 mVA or more

Table 5 – Specifications for Supplying Power – Network Adapter

Supply voltage	3,0 to 5,5 V
Supply capacity	100 mVA or more

f) Reset

A reset pin (RST) to electrically reset the Network Adapter from the Network-ready equipment shall be implemented in the Network Adapter. Implementation in the Network-ready equipment is optional. The High, Low, and Low → High states of the RST pin shall correspond to normal operation, deactivation of the Network Adapter, and reset start, respectively.

4.5 Logical requirements

Logical requirements for Network Adapters are defined in 4.5.1 and 4.5.2.

4.5.1 Network Adapter

The Logical requirements for OSI layer 1-7 are defined according to the appropriate Home Network protocols.

4.5.2 Network Adapter communication interface

This subclause defines the logical requirements for Network Adapter communication interface.

a) Control method

The control method shall be a RTS/CTS-based method. RTS shall correspond to signals to notify the other side that transmission will be started or that no message can be received and CTS shall correspond to signals that the other side sends either to indicate its status as to whether or not messages can be received or to notify that it will start communicating. The RTS/CTS control procedure for transmitting an electronic message shall be as follows:

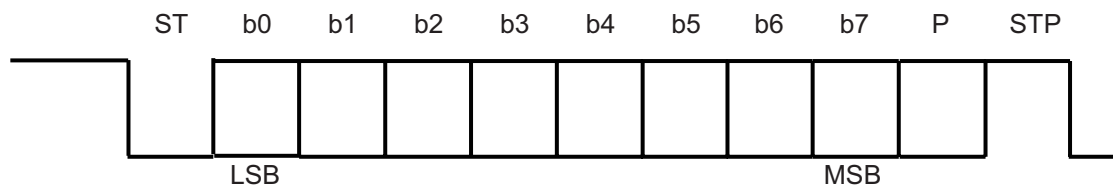
- If no message can be received, RTS is set to High Level. If messages can be received, RTS is set to Low Level.
- A check is made before transmission to confirm that CTS is Low Level.
(No message is sent if CTS is High Level.)
- Data are output to TXD.

Service requests shall be handled in the order they are transmitted. In the event of a service request collision, the service request from the Network Adapter shall be handled first. A CTS status change during a frame transmission shall not require the sending side to abort transmission of the frame. If the sending side aborts transmission of the frame, that frame shall be considered invalid and the prescribed subsequent processing shall be performed. RTS/CTS function is required for the Network Adapter side and is optional for the Network-ready equipment side.

b) Synchronization method

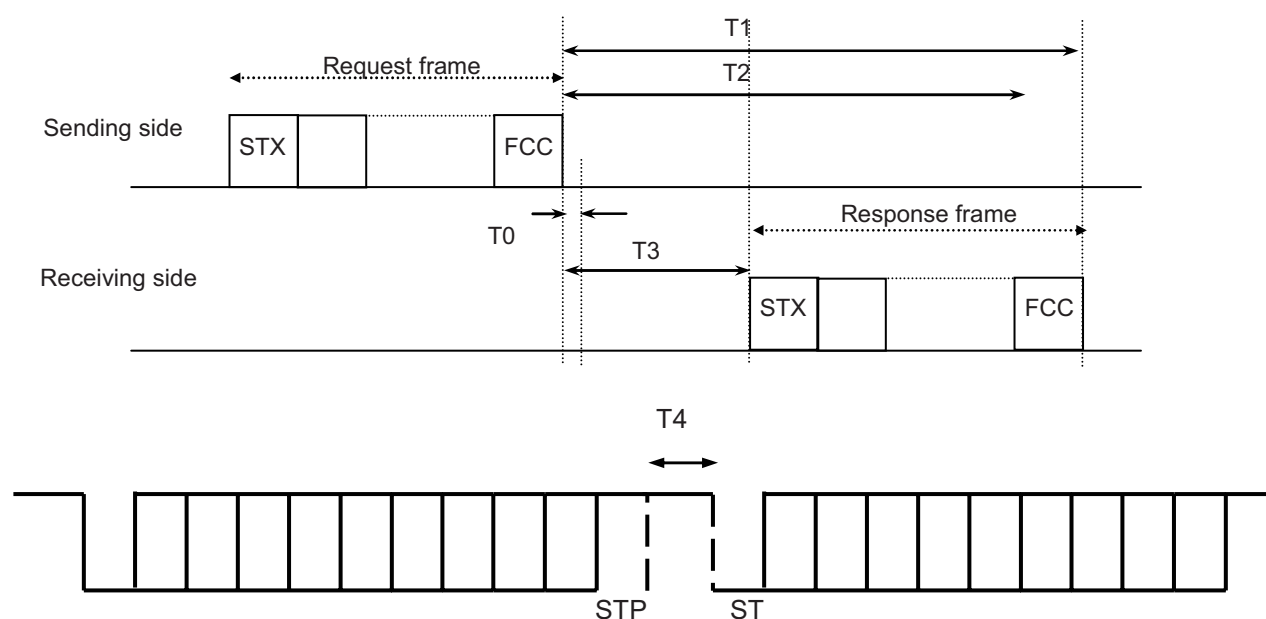
Synchronization shall be achieved using a character-by-character start-stop synchronization method. The following requirements shall be satisfied:

- Character composition (see Figure 6) A total of 11 bits
 - Start bit (ST): 1 bit
 - Data: 8 bits
 - Parity: 1 bit
 - Stop bit (STP): 1 bit
- Data transmission order: LSB first
- Start bit: logical 0
- Stop bit: logical 1
- Parity: even number parity

**Figure 6 – Character composition**

c) Timing requirements

The timing requirements for execution of the Network Adapter communication software protocols are as shown in Figure 7 and Table 6. The Network Adapter sends a request frame and the Network-ready equipment receives it and sends back a response frame, vice versa.

**Figure 7 – Timing requirements****Table 6 – Timing requirements**

Symbol	Name	Requirement
T0	Receiving side frame synchronization confirmation (frame completion / start position detection)	9 600 bps or less: No message is received for 10 ms or more. More than 9 600 bps: No message is received for a period equal to 3-character composition length or more.
T1	Response waiting timeout	300 ms from the end of the frame sent by itself
T2	Retransmission inhibition time	300 ms from the end of the frame sent by itself
T3	Response transmission inhibition time (T4 confirmation time)	9 600 bps or less: 10 ms or more More than 9 600 bps: a period equal to 3-character composition length or more
T4	Sending side character composition interval	9 600 bps or less: less than 10 ms More than 9 600 bps: less than a period equal to 3-character composition length

d) Control code (STX)

Header code. This shall be fixed at 0x02.

e) Data part (DATA)

The data part shall be the part sandwiched between the Network Adapter communication interface STX and the FCC. The specific content varies depending on what type is selected for the Network Adapter communication interface (for details, refer to 4.6).

f) Check code (FCC)

The check code, which is used to detect frame transmission errors, shall be the 2's complement of the total value of the characters contained in the data part.

g) Frame completion detection

If, after a stop bit is detected, the start bit of the next character is not detected for a period that is shorter than 3 field lengths (this period shall be 10 ms in the case of a transmission speed that is less than 9 600 bps), it is assumed that transmission of the frame has completed.

h) Error detection

The receiving terminal shall detect the following types of errors:

- Octet reception errors

Each octet shall have a parity bit. Even number parity shall be used. If a parity error is detected while receiving an octet during a frame reception session, the receiving terminal shall consider the frame being received as an invalid frame and discard it (the frame shall be discarded upon completion of reception or upon reception timeout).

- FCC errors

An FCC check shall be made every time the reception of a frame is completed. FCC shall be the 2's complement of the sum of the content of the data part.

If the FCC code is valid, the frame shall be considered a valid frame.

If the FCC code is invalid, the frame shall be considered invalid and discarded.

i) Error control

No ACK/NAK error control shall be provided.

4.6 Network Adapter communication software protocols

The Network Adapter communication software protocol differs depending on the type of Network Adapter. The requirements for each of the following three protocols are defined in the following sections, with one section dedicated to each:

- Equipment interface data recognition service software protocol;
- Communication software protocol for object generation type
- Communication software protocol for peer-to-peer type

4.6.1 Equipment interface data recognition service software protocol

This section provides the service specifications for recognizing the equipment interface data of Network-ready equipment connected to a Network Adapter.

4.6.1.1 Frame composition

Figure 8 shows the frame composition for executing the equipment interface data recognition service. The frame type code (FT), command number code (CN), frame number code (FN), data length code (DL), and frame data (FD) sections comprise the Network Adapter communication interface protocol data.

1 octet	2 octets	1 octet	1 octet	2 octets	Up to 16 octets	1 octet
STX	FT	CN	FN	DL	FD	FCC

- STX (control code)

Header code. For equipment interface data recognition service software protocols, this shall be fixed at 0x02.

- FT

Indicates the frame type. Frames for equipment interface data recognition shall be fixed at 0xFFFF.

- CN

The command number code shall be a 1-octet code that specifies a defined service (equipment interface data recognition service software protocols for Network Adapter communication interface).

- FN

A number assigned by the requesting side (0x01 to 0xFF). A response frame shall have the same number as the corresponding request frame. For Network-ready equipment that is not designed to use frame numbers, this shall be fixed at 0x00.

- DL

The data length code shall be a 2-octet code that indicates the size of the frame data (FD) section that follows. The size shall be measured in octets and be expressed using hexadecimal notation. For this service, the maximum value of a DL shall be 0x0010. The data order shall be big-endian.

- FD

The frame data section is a field of data that is defined by the frame type (FT) and command number code (CN). The data order for data having 2 octets or more shall be big-endian. The specific composition shall be defined on a CN-by-CN basis.

- FCC

A 1-octet check code shall be used as the frame check code.

Figure 8 – Format of equipment interface data recognition service

4.6.1.2 Commands

This subclause describes the commands used for the equipment interface data recognition service for each of the Network Adapter communication interface.

a) Equipment interface data request and response commands (required)

This sequence is shown in Figure 13. These commands shall be used to allow the Network Adapter to acquire information on the type of Network Adapter communication interface implemented in the Network-ready equipment. First, the Network Adapter shall send an equipment interface data request to the Network-ready equipment until the equipment interface data response is received, with repetitive attempts using two speeds. A

order in which the available speeds are repeated, the number of attempts, and the interval (minimum T1 in Figure 7) are beyond the scope of these specifications. The optimal method for the characteristics of the Network Adapter will be used. If an equipment interface data response is received and communication in accordance with that response is possible, the Network Adapter shall move to the equipment interface data recognition notification service. The direction of request commands is from the Network Adapter to the Network-ready equipment. Figure 9 below shows the format of request command.

1 octet	2 octets	1 octet	1 octet	2 octets	1 octet
STX	FT	CN	FN	DL	FCC

STX: 0x02

FT: 0xFFFF

CN: 0x00

FN: 0x**

DL: 0x0000

FCC: 0x**

Figure 9 – Format of request command

Figure 10 below shows the format of response command.

1 octet	2 octets	1 octet	1 octet	2 octets	1 octet	1 octet	0 or 8 octets	1 octet
STX	FT	CN	FN	DL	FD(0)	FD(1)	FD(2)	FCC

STX: 0x02

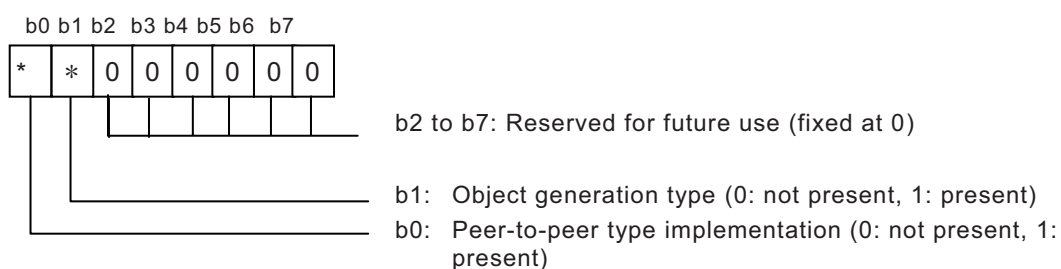
FT: 0xFFFF

CN: x80

FN: Value at the time of the request (0x00 if the function is not implemented)

DL: n + 2

FD(0): type of Network Adapter



FD(1): transmission speed

0x00	2 400 bps
0x01	4 800 bps
0x02	9 600 bps
0x03	19,2 Kbps
0x04	38,4 Kbps
0x05	57,6 Kbps
0x06	115 Kbps
0x07– 0xFF	Not defined (reserved for future use)

FD(2): Method-specific definition area (n octets)

- Object generation type: Not present (0 octet)
- Peer-to-peer type (8 octets)

FD(2)			
1 octet	3 octets	2 octets	2 octets
Interface data	Manufacturer code	AOJ code	Type code

Interface data (1 octet)

b0	b1	b2	b3	b4	b5	b6	b7
*	*	*	*	*	*	*	*

b7, b6: Communication sequence
b7, b6: 0, 1= Adapter polling
1, 1= Bidirectional
1, 0 & 0, 0= Not defined

b5: Flow control: 0= without, 1= with
 b4: ACK/NAK response: 0= without, 1= with
 b3: Downloading: 0= without, 1= with
 b2 to b0: Not defined

Manufacturer code (3 octets)
 - defined by each Home Network Standard Association/Consortium if required
 AOJ code (2 octets)
 - AOJ code of the AOJ in the Network-ready equipment
 Type code (2 octets)
 - defined by each manufacturer

FCC: 0x**

Figure 10 – Format of response command

- b) Equipment interface data recognition notification command and equipment interface data recognition notification acceptance response command (required)

This sequence is shown in Figure 13. The Network Adapter shall notify the Network-ready equipment if it can handle the communication method specified by the Network-ready equipment using an equipment interface data recognition notification. This notification shall be made within 300 ms (T_i) after the receipt of the equipment interface data response. If the Network Adapter can handle the communication method specified by the Network-ready equipment, it shall so notify and wait for an equipment interface data recognition notification acceptance response. If the Network Adapter cannot handle the communication method specified by the Network-ready equipment, it shall so notify and enter the connection not possible state. Upon receipt of an equipment interface data recognition notification, the Network-ready equipment shall check the content of the notification. If the value indicates that the Network Adapter can handle the communication method specified by the Network-ready equipment, the Network-ready equipment shall send an equipment interface data recognition notification acceptance response to the Network Adapter within 300 ms (T_i) and enter the unconfirmed state. If the value indicates that the Network Adapter cannot handle the communication method specified by the Network-ready equipment, the Network-ready equipment shall wait for an equipment interface data request. If the Network Adapter receives an equipment interface data recognition notification acceptance response within 300 ms (T_i) after the transmission of an equipment interface data recognition notification, it shall enter the unconfirmed state. If the Network Adapter does not receive an equipment interface data recognition notification acceptance response within 300 ms (T_i) after the transmission of an equipment interface data recognition notification, it shall send an equipment interface data request again. The direction of request commands is from Network Adapter to Network-ready equipment.

Figure 11 below shows the format of request command.

1 octet	2 octets	1 octet	1 octet	2 octets	1 octet	1 octet
STX	FT	CN	FN	DL	FD(0)	FCC

STX: 0x02

FT: 0xFFFF

CN: 0x01

FN: 0x**

DL: 0x0001

FD(0):Result

0x01: Not supported

0x00: Supported

0x02:Current speed OK, but Request speed NG

0x11:Peer to Peer type acceptable

0x12:Object construction type acceptable

Others: Not defined (reserved for future use)

FCC: 0x**

Figure 11 – Format of request command

Figure 12 below shows the format of response command.

1 octet	2 octets	1 octet	1 octet	2 octets	1 octet
STX	FT	CN	FN	DL	FCC

STX: 0x02

FT: 0xFFFF

CN: 0x81

FN: Value at the time of the request (0x00 if the function is not implemented)

DL: 0x0000

FCC: 0x**

Figure 12 – Format of response command

4.6.1.3 Equipment interface data recognition service sequence

Figure 13 shows the total operation sequence of this service. Figure 14 shows how the Network Adapter and Network-ready equipment change their states. As shown in these figures, both the Network Adapter and Network-ready equipment shall stay in the unrecognized state until the equipment interface data recognition service has been successfully executed. Successive attempts to execute the equipment interface data recognition service shall be made using one (available) transmission speed after another until the Network-ready equipment's communication method is confirmed (recognized). The equipment interface data recognition service shall use that method for communication thereafter. If either the Network-ready equipment or the Network Adapter are reset after a start, a system shall be provided to perform an appropriate recovery action (such as repeating attempts) for each communication method. The Network-ready equipment or the Network Adapter, as the case may be, shall shift to the unrecognized state, as shown in Figure 14, when an unsuccessful communication state (such as that due to imperfect synchronization) is detected and the intended result is not achieved. The transition time to shift to the respective

method ($= T_{\text{trans}}$, see Figure 13) after an equipment interface data recognition service shall be 500 ms or more.

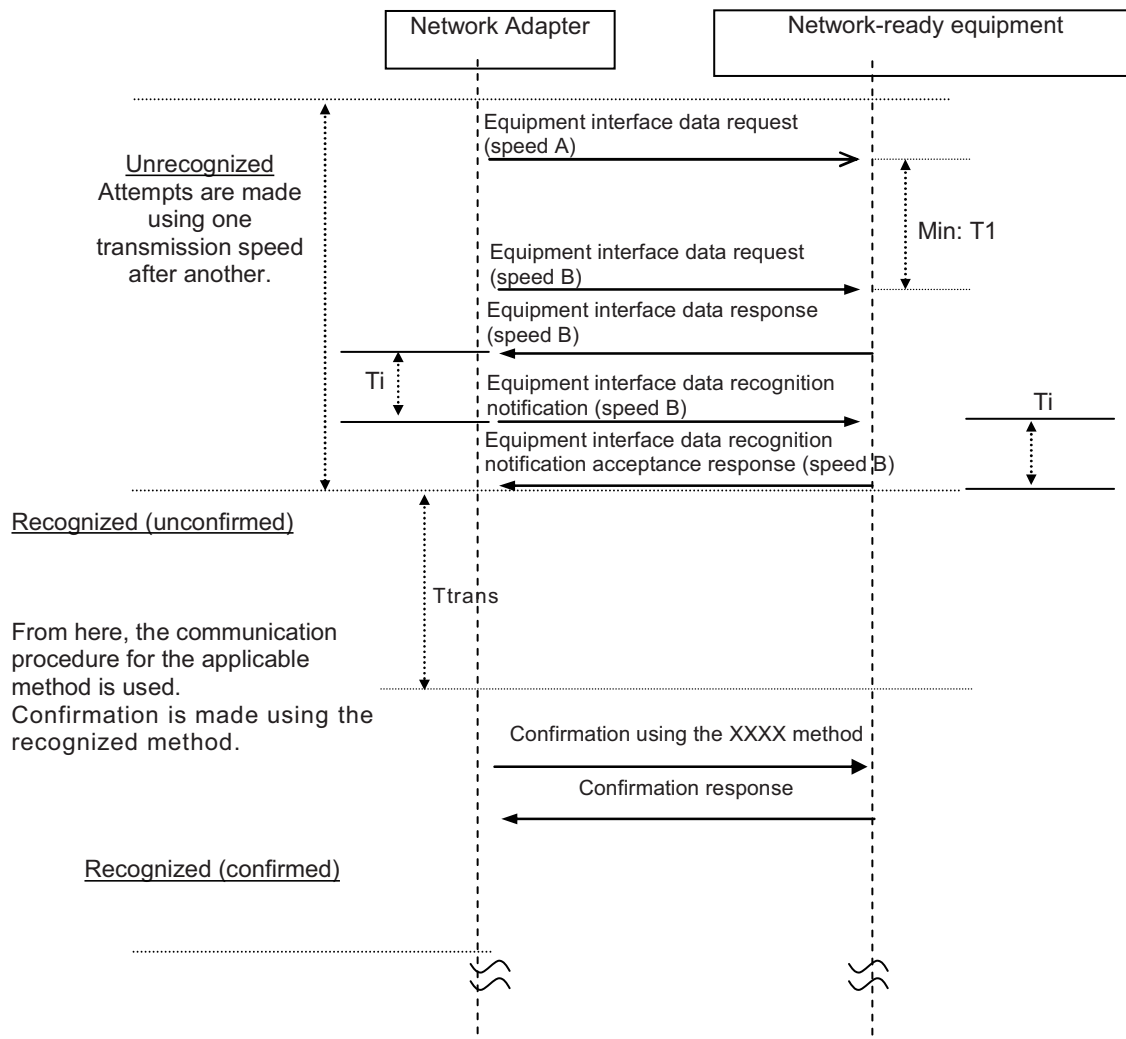


Figure 13 – Sequence of equipment interface data recognition service

4.6.1.4 Status change diagram for all types

The following five states are defined below: recognized, unrecognized, unconfirmed, confirmed, and connection not possible. The recognized state consists of the unconfirmed and confirmed states. The status change and definition of each state follows in Figure 14 and Table 7. The unsuccessful communication state is specified by the communication procedure for the respective communication protocol. The Network Adapter may perform the confirmation processing again upon detection of an unsuccessful communication state. Whether to start from the unrecognized state or from the recognized state upon power-on is determined based on the implementation.

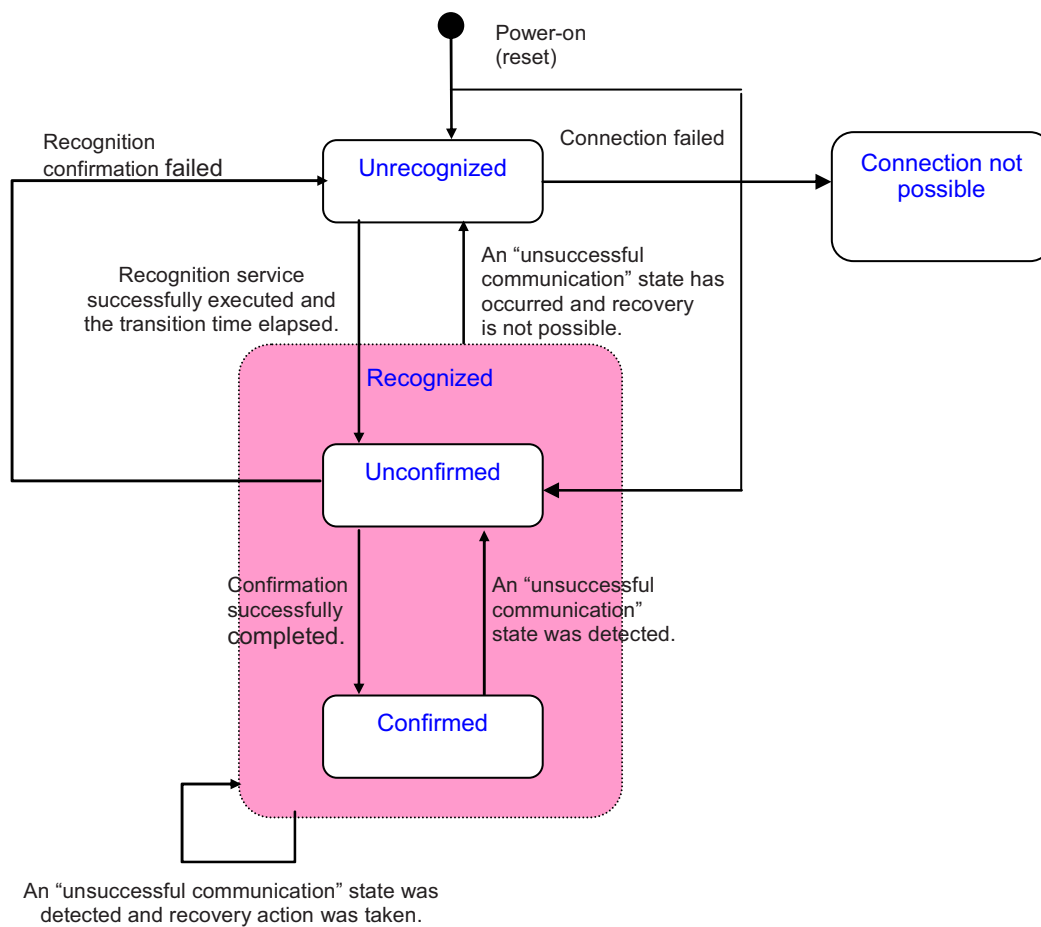


Figure 14 – Status change diagram

Table 7 – Definition of states

State	Definition	Notes
Unrecognized	The process of recognizing that the communication method has not been completed. After the detection of an unsuccessful communication state.	Network-ready equipment side: Waiting for a recognition service request from the Network Adapter. If the equipment interface data recognition notification from the Network Adapter indicates that the Network Adapter cannot handle the communication method specified by the Network-ready equipment, the Network-ready equipment will wait for an Equipment interface data request. If the Network Adapter can handle the communication method specified by the Network-ready equipment, the Network-ready equipment will send an equipment interface data recognition notification acceptance response and enter the unconfirmed state.
		Network Adapter side: When attempting to make a recognition service request to the Network-ready equipment, the Network Adapter continues to make attempts on an as-available basis at certain intervals until the recognition process is completed, with repetitive attempts using two speeds A and B. If an equipment interface data response is received and communication in accordance with that response is possible, an Equipment interface data recognition notification is sent to the Network-ready equipment to notify, and after receiving the corresponding acceptance response, the unconfirmed state is entered. If communication using the received information is not possible, an equipment interface data recognition notification is sent to the Network-ready equipment to notify and the connection not possible state is entered. The order in which the available speeds are repeated, the number of attempts and the interval (minimum T1 in Figure 7) are beyond the scope of these specifications. The optimal method for the characteristics of the Network Adapter is used.
Connection not possible	The state to which a shift is made if there is no communication method that is acceptable to both the Network Adapter and the Network-ready equipment.	The communication not possible abort processing is performed.

State		Definition		Notes
Recognized	Un-confirmed	The communication method recognition process has been completed and communication is being performed using the communication procedure for the applicable method.	Whether or not it is possible to communicate successfully using the communication procedure for the applicable method has not been confirmed. Network Adapter side: Confirmation is made using the confirmation method for the applicable method.	If, after detecting an unsuccessful communication state and performing an appropriate recovery processing, recovery is not possible, a shift to the unrecognized state shall be made.
	Confirmed		It has been confirmed that communication is possible using the communication procedure for the applicable method.	

4.6.1.5 Error processing

If a state should occur that falls under any one of items a) to c) below, the Network Adapter shall give the Node profile object or Device object a setting value indicating the occurrence of such an abnormal state and make an error announcement to the other nodes.

a) Communication not possible

The equipment interface data recognition service has determined that communication with the Network-ready equipment is not possible. After setting the error property (APC = 0x89) of the Node profile object to 0x03E9 (Network Adapter recognition error), the error status property (APC = 0x88) is set to 0x41.

b) Setting error

The setting of a parameter during the confirmed state has failed and it has been determined that continuing the setting operation is not possible. The error property (APC = 0x89) of the Node profile object is set to one of the three values listed below depending on the error-causing factor, and the error status property (APC = 0x88) is set to 0x41. The factors that are considered as error-causing factors differ among communication methods.

Error code:

0x03EA: Object error

0xE3EB: Adapter initialization error

0x03EC: Other setting error

c) Unsuccessful communication

Cases in which communication with the Network-ready equipment is not possible during the confirmed state. After setting the Device object error property (APC = 0x89) for the equipment in question to 0x03E9 (unsuccessful communication), the error status property (APC = 0x88) is set to 0x41. The definition of unsuccessful communication state differs among communication methods.

4.6.2 Communication software protocol for object generation type

This subclause defines the communication software protocol for cases in which the communication interface between the Network Adapter and Network-ready equipment is an object generation type interface.

Network Adapters are divided into the following two types:

- basic Network Adapter, and
- advanced Network Adapter.

An advanced Network Adapter shall be capable of handling address information on other nodes located in the network on the Network Adapter interface; however, a basic Network Adapter is not capable of handling such address information. An advanced Network Adapter shall also be capable of distinguishing whether or not there is a vacancy in relation to elements before handling array properties. In addition to the above-mentioned advanced Network Adapter functions, an advanced Network Adapter shall have all the functions required for a basic Network Adapter.

If a basic Network Adapter is connected to a piece of Network-ready equipment that demands processing which corresponds to an advanced Network Adapter, the Network-ready equipment shall satisfy the following requirements.

- The Network-ready equipment indicates that the status of other nodes cannot be referenced or altered. The method of the indication is not stipulated (LED, LCD, etc.).
- Notifications to be sent with the addressees specified are sent as simultaneous broadcasting notifications.
- Responses to requests from other nodes are sent using basic Network Adapter communication frames.

This standard defines the requirements for basic Network Adapters including the necessary support for advanced Network Adapters. A basic Network Adapter shall be capable of (1) internally generating and managing at least three Device objects, and (2) providing at least 1 kB of memory as the domain to store property values in case of implementing three Device objects. In cases where the Network Adapter generates and manages four or more Device objects, an optional command shall be used and 2 kB of memory shall be set aside as the domain to store property values.

4.6.2.1 Frame composition

Figure 15 specifies the composition of the frame for object generation type commands. The frame type code (FT), command number code (CN), frame number code (FN), data length code (DL), and frame data (FD) sections comprise the Network Adapter communication interface protocol data. The composition shown in Figure 15 is the same as that for the equipment interface data recognition command format.

1 octet	2 octets	1 octet	1 octet	2 octets	n octets	1 octet
STX	FT	CN	FN	DL	FD	FCC

- STX

Control code. This shall be fixed at 0x02.

- FT

Indicates the frame type.

b15 to b12: version

Indicates the frame version number. This shall be 0000.

b11 to b8: Reserved for future use (0000)

b7 to b0: type

Indicates the frame type for various commands.

0x00: Equipment interface data confirmation frame

0x01: Adapter initialization frame

0x02: Object construction frame

0x03: Basic regular Home Network frame

0x04: Reserved for future use for extended Home Network frame

0x05 to 0xDF: Reserved for future use

0xE0 to 0xFE: User defined area

0xFF: Error notification frame

NOTE 0xFFFF is for the equipment interface data recognition frame.

- CN

The command number code (CN) shall be a 1-octet code that specifies a defined service (object generation type software protocols for Network Adapter communication interface). This version defines the commands shown in Table 8. The CN with no command name assigned shall be reserved for future use.

- FN

A number shall be assigned by the requesting side (0x01 to 0xFF), according to the order. A response frame shall have the same number as the corresponding request frame. For Network-ready equipment that is not designed to use frame numbers, this shall be fixed at 0x00.

- DL

The data length code shall be a 2-octet code that indicates the size of the FD section that follows. The size shall be measured in octets and be expressed using hexadecimal notation. For example, if the FD section has 20 octets, the DL is 0x0014, which indicates 20 octets. The data order shall be big-endian.

- FD

The frame data section is a field of data that is defined by FT and CN. The data order for data having 2 octets or more shall be big-endian. The specific composition shall be defined on a CN-by-CN basis.

- FCC

A 1-octet check code shall be used as the frame check code.

Figure 15 – Format of object generation type commands