

INTERNATIONAL STANDARD



**Information technology – Home electronic system (HES) interfaces –
Part 3: Modular communications interface for energy management**

(<https://standards.iteh.ai>)
Document Preview

ISO/IEC 10192-3:2017

<https://standards.iteh.ai/catalog/standards/iso/e6a8a768-d728-46bc-91a0-e806c7224bbe/iso-iec-10192-3-2017>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2017 ISO/IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about ISO/IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

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

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

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

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

[ISO/IEC 10192-3:2017](https://standards.iteh.ai/catalog/standards/iso/e6a8a768-d728-46bc-91a0-e806c7224bbe/iso-iec-10192-3-2017)

<https://standards.iteh.ai/catalog/standards/iso/e6a8a768-d728-46bc-91a0-e806c7224bbe/iso-iec-10192-3-2017>

INTERNATIONAL STANDARD



**Information technology – Home electronic system (HES) interfaces –
Part 3: Modular communications interface for energy management**

Document Preview

ISO/IEC 10192-3:2017

<https://standards.iteh.ai/catalog/standards/iso/e6a8a768-d728-46bc-91a0-e806c7224bbe/iso-iec-10192-3-2017>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 35.200

ISBN 978-2-8322-5099-0

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

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	8
1 Scope.....	10
2 Normative references	10
3 Terms, definitions and abbreviated terms	11
3.1 Terms and definitions.....	11
3.2 Abbreviated terms.....	11
4 Conformance.....	12
5 Physical/electrical Interface	12
5.1 Form factors	12
5.2 Removal and exchange of a UCM	12
5.3 Block diagram	12
6 Serial protocol	13
6.1 Protocol data unit.....	13
6.2 Message Type field.....	13
6.3 Payload length field	14
6.4 Checksum field	15
6.5 Bit and byte order	15
6.5.1 Bit order within a byte.....	15
6.5.2 Byte order for multi-byte messages.....	15
6.6 Message synchronization and timing.....	15
6.6.1 Message sequencing	15
6.6.2 Link layer timing	15
6.6.3 Randomized link layer retries.....	17
6.6.4 Application layer timing.....	17
6.7 SGD handling of conflicting messages	18
7 Simple Protocol	18
8 Link layer.....	19
8.1 Use of link layer messages	19
8.2 Link layer ACK/NAK.....	19
8.3 Message Type “supported query”	20
9 Data-link messages	21
9.1 Message format	21
9.2 Interface power limit negotiation	23
9.3 Bit rate negotiation.....	24
9.4 Power-up and state reset	25
9.5 Security	25
9.6 Setting slot numbering	25
10 Basic DR application (Message Type = 0x08, 0x01)	26
10.1 Basic DR application commands	26
10.1.1 Message format.....	26
10.1.2 Basic message fixed length	30
10.1.3 Event Duration field	30
10.1.4 Grouped messages.....	31
10.2 Usage and details of basic DR application messages.....	31
10.2.1 Request for power level (Opcode 0x06)	31

10.2.2	Relative price commands (Opcode 0x07 and 0x08).....	32
10.2.3	Time remaining in present price period (Opcode 0x09)	33
10.2.4	Operating state monitoring (Opcodes 0x12 and 0x13).....	33
11	Intermediate DR application (Message Type = 0x08, 0x02).....	35
11.1	Intermediate DR message set	35
11.2	Usage and details of Intermediate DR application messages	38
11.2.1	Info request	38
11.2.2	Get/Set UTC time	41
11.2.3	Get/Set energy price	42
11.2.4	Get/Set tier	44
11.2.5	Get/Set temperature offset.....	45
11.2.6	Get/Set set point.....	46
11.2.7	Autonomous cycling.....	47
11.2.8	Demand reduction – terminate cycling	49
11.3	Demand response event schedules.....	49
11.3.1	Function	49
11.3.2	Send scheduled events request	50
11.4	Energy consumption	50
11.4.1	Function	50
11.4.2	Commodity read	50
11.4.3	Get/Set CommodityType	53
12	Commissioning and network messages (Message Type = 0x08, 0x04)	55
13	Pass-Through Mode	55
13.1	Pass-Through method.....	55
13.1.1	General	55
13.1.2	Full Encapsulation in the Message Payload	56
13.1.3	Message Type Field	56
13.1.4	Message Type Support Query.....	56
13.1.5	Maximum Message Length Negotiation.....	56
13.1.6	Pass-Through mode protocols	56
13.2	Pass-Through mode protocols.....	56
13.2.1	USNAP 1.0 protocol Pass-Through	56
13.2.2	SEP1.0 or 1.1 Pass-Through	57
13.2.3	ClimateTalk Pass-Through.....	57
13.2.4	General Internet Protocol Pass-Through	57
13.2.5	ISO/IEC 14543-4-3 Pass-Through	58
13.2.6	ISO/IEC 14543-3-1 Pass-Through	58
13.2.7	ISO/IEC 14908-1 Pass-Through.....	59
13.2.8	SunSpec Pass-Through	59
14	Typical communication exchanges.....	59
15	General security principles	60
16	Load management event randomization.....	60
Annex A	(normative) Low voltage DC form factor	62
A.1	General.....	62
A.2	Limitations	62
A.3	Power for UCM	62
A.4	Mechanical interface	62
A.4.1	DC form factor board layout.....	62

A.4.2	Module configuration	63
A.4.3	Form factor	66
A.4.4	Housing materials	66
A.4.5	Connector type	66
A.4.6	Pin assignments	67
A.5	Electrical interface	67
A.5.1	Electrical Interface Levels	67
A.5.2	Signal timing	67
A.5.3	Interface circuits	68
A.6	Data transfer protocol	68
A.6.1	Control signals	68
A.6.2	Clock and data rate	69
A.6.3	Multiple slots	69
A.7	Link layer data flow	69
A.8	Messages	69
A.8.1	Frame structure	69
A.8.2	Message synchronization (frame delimiting)	69
A.8.3	Message filling (inter-message byte filling)	69
A.8.4	Command/Response encoding	70
A.8.5	Checksum calculation	70
A.8.6	Master/Slave	70
A.8.7	Flow control	70
A.8.8	Error detection and recovery	70
A.9	Operation	71
A.9.1	Transaction sequence	71
A.9.2	SPI data transfer state machine	74
A.9.3	SGD transmitter operation	75
A.9.4	SGD device receiver operation	75
A.9.5	UCM operations	76
Annex B (informative)	Description of DC form factor applications	77
B.1	General	77
B.2	Applications of ISO/IEC 24379	77
B.3	Physical Form Factor Review	77
B.4	Observations with regard to UCM and ATA confusion	78
B.4.1	General	78
B.4.2	ATA into Smart Grid Device	78
B.4.3	Universal Communication Module into ATA device bay	78
B.5	Conclusion	78
Annex C (normative)	AC form factor	79
C.1	General	79
C.2	Physical form	79
C.2.1	AC SGD and AC UCM connector	79
C.2.2	AC enclosure requirements	84
C.3	AC power	87
C.4	Obtaining message sync	89
Annex D (normative)	Fletcher checksum	90
D.1	Checksum method	90
D.2	Calculating the checksum	90
D.3	Decoding the checksum	90

Annex E (informative) Example Visual Basic code	91
Annex F (informative) Guideline for computing average price.....	92
F.1 Average Price versus Time Varying Charges	92
F.2 Relative price command.....	92
F.3 Explanation for non-regulated utilities	93
F.4 Summary	93
Annex G (informative) Product safety considerations	95
Bibliography.....	96

Figure 1 – Illustrations of the modular communications interface (MCI) concept.....	9
Figure 2 – Modular communications interface (MCI) block diagram	13
Figure 3 – Link layer timing	16
Figure 4 – Application layer timing	17
Figure 5 – Non-linear event duration scaling	31
Figure 6 – Non-linear relative price scaling	33
Figure 7 – Illustration of energy storage capacity	53
Figure 8 – Internet Protocol Pass-Through (IPv6)	58
Figure 9 – Illustration of randomization of events by communications modules	61
Figure A.1 – DC form factor PCB dimensions.....	63
Figure A.2 – DC form factor housing dimensions – top view.....	64
Figure A.3 – DC form factor housing dimensions – side view	65
Figure A.4 – DC form factor housing dimensions – end view	66
Figure A.5 – Pin assignment	67
Figure A.6 – SPI Mode 0 bit timing.....	67
Figure A.7 – SPI transaction sequence: SGD-initiated message to the UCM	71
Figure A.8 – SPI transaction sequence: UCM-initiated message to the SGD	72
Figure A.9 – SPI data transfer state machine	74
Figure C.1 – Panel-mount AC connector form factor (device side shown) and pin-out	80
Figure C.2 – PCB-mount AC UCM connector (housing).....	80
Figure C.3 – Cable AC UCM connector (housing)	81
Figure C.4 – Panel mount AC SGD connector form factor dimensions.....	82
Figure C.5 – PCB mount connector dimensions	83
Figure C.6 – Cable connector dimensions	83
Figure C.7 – Contact dimensions for cable connector and PCB mount connector	84
Figure C.8 – Reserved area and dimensions on SGD (receptacle).....	85
Figure C.9 – Right side and top view of maximum UCM dimensions.....	86
Figure C.10 – Left side and bottom view of maximum UCM dimensions	87
Figure C.11 – Typical RS-485 polarity and byte transfer	88
Figure C.12 – RS-485 connections.....	88

Table 1 – Protocol data unit format	13
Table 2 – Message type assignments	14
Table 3 – Message timing requirements.....	16
Table 4 – Basic/Intermediate DR application layer timing parameters	18

Table 5 – Mandatory message summary	19
Table 6 – ACK/NAK Packet.....	19
Table 7 – Link layer NAK codes	20
Table 8 – Message type “supported query”	20
Table 9 – Data-link message format.....	21
Table 10 – Data-link command set	22
Table 11 – Interface power level indicator codes.....	23
Table 12 – Bit rate indicator	25
Table 13 – Basic application data format	26
Table 14 – Basic DR application command set.....	27
Table 15 – Operating state codes	34
Table 16 – Operating-state codes for usage conditions	35
Table 17 – Intermediate DR application command set (command byte description)	36
Table 18 – Intermediate DR application command set.....	37
Table 19 – Response code values	38
Table 20 – Commissioning and network messages	55
Table 21 – Pass-Through message.....	56
Table 22 – USNAP1.0 over serial.....	56
Table 23 – SEP1.0 or 1.1 over serial.....	57
Table 24 – ClimateTalk over serial.....	57
Table 25 – ISO/IEC 14543-4-3 over serial.....	58
Table 26 – ISO/IEC 14543-3-1 over serial.....	59
Table 27 – ISO/IEC 14908-1 over serial.....	59
Table 28 – SunSpec over serial	59
Table A.1 – Low voltage interface signal definitions	68
Table A.2 – SPI physical timing requirements	73

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) INTERFACES –

Part 3: Modular communications interface for energy management

FOREWORD

- 1) ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.
- 2) The formal decisions or agreements of IEC and ISO on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees and ISO member bodies.
- 3) IEC, ISO and ISO/IEC publications have the form of recommendations for international use and are accepted by IEC National Committees and ISO member bodies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC, ISO and ISO/IEC publications is accurate, IEC or ISO cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees and ISO member bodies undertake to apply IEC, ISO and ISO/IEC publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any ISO, IEC or ISO/IEC publication and the corresponding national or regional publication should be clearly indicated in the latter.
- 5) ISO and IEC do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. ISO or IEC are not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or ISO or its directors, employees, servants or agents including individual experts and members of their technical committees and IEC National Committees or ISO member bodies for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication of, use of, or reliance upon, this ISO/IEC publication or any other IEC, ISO or ISO/IEC publications.
- 8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this ISO/IEC publication may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 10192-3 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

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.

A list of all parts in the ISO/IEC 10192 series, published under the general title *Information technology – Home electronic system (HES) interfaces*, can be found on the IEC and ISO websites.

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

INTRODUCTION

Utilities world-wide are investing heavily in smart grid infrastructures for energy that extend to homes and businesses with the goal of improving grid reliability and efficiency through increased consumer awareness and participation. This document provides a solution for grid connections within the home through a modular communications interface (MCI) enabling any product to connect to a variety of demand-response systems. Such systems may include Advanced Metering Infrastructure (AMI), Smart Energy Profile (SEP), IEC PAS 62746-10-1:2014 (OpenADR 2.0) and/or home or building networks such as protocols specified in the ISO/IEC 14543 series. The concept is simple: encourage manufacturers to build an MCI into their products that can accept a simple communications module. Consumers and programme managers are then free to select whatever communications solution works best for their particular environment.

The MCI is based on the ISO/IEC 8482 interface (commonly referenced as RS-485) and the Serial Peripheral Interface (SPI) supported by most silicon chips. The messages conveyed through the MCI to the end-device use either an externally specified command set (called the “Pass-Through mode”) or the demand response (DR) application command set specified in this document as the Simple Protocol. The DR command set is intended for devices that cannot process one of the “pass-through” command sets. This document specifies options for the Pass-Through mode based on protocols commonly used in grid applications such as Internet Protocol (IP), IEC PAS 62746-10-1:2014 (OpenADR 2.0), SEP, and ISO/IEC 14543 series protocols. Network security is supported at the application layer in the Pass-Through mode in addition to network or application layer security.

The MCI specified in this document may use either of the following connectors:

- an AC powered form, which uses the ISO/IEC 8482 interface over a physical connector defined in this document;
- a DC powered form, which uses the Serial Peripheral Interface over a connector defined in ISO/IEC 24739-3. The use of this connector is discussed in Annex A and Annex B.

The MCI applies to devices that may include an energy management hub, an energy management controller, an energy management agent, a residential gateway, an energy services interface, a sensor, a thermostat, an appliance or other consumer products. A physical connection from a communication module to residential smart grid devices and options for a communications protocol including application messages are specified. The specific residential devices to use an MCI are not specified. For energy management the choice depends on the system and the network topology. If a hub topology is chosen, the MCI may be located on the hub. The connection between the hub and end-devices such as appliances is not specified.

Communication messages specified in this document for the DR command set support direct load control, time-of-use (TOU), critical-peak-pricing (CPP), real-time pricing (RTP), peak time rebates, various types of block rates, and a range of ancillary services. The functionality of the removable MCI modules can be tailored by utilities or other load managing entities to provide support for the unique needs in a given region or service territory without impacting the end-devices. Figure 1 illustrates the general concept of the MCI.

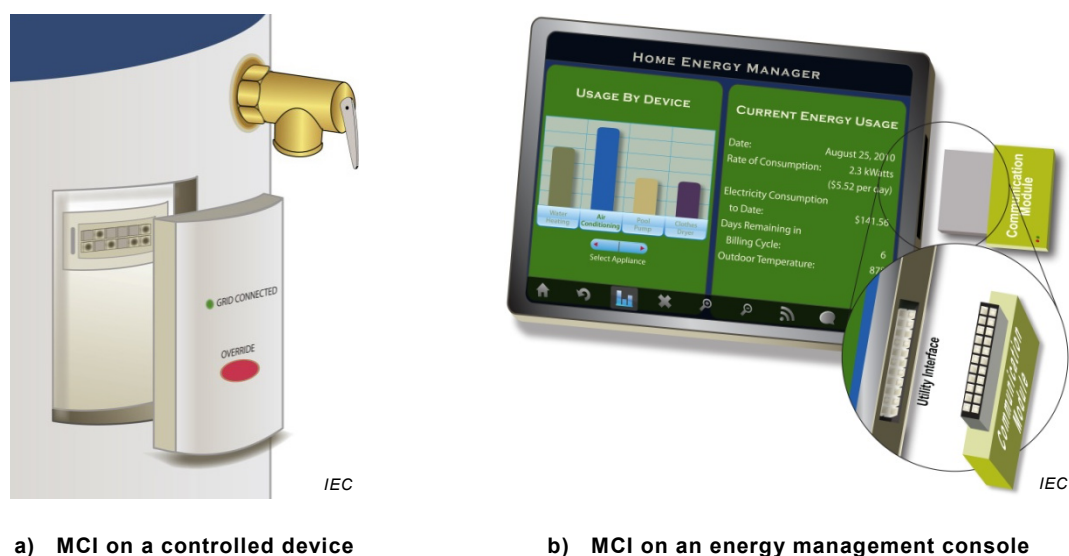


Figure 1 – Illustrations of the modular communications interface (MCI) concept

This document enables a new generation of “smart grid ready” products that limit risks and constraints of proprietary communication technologies and evolving standards. This approach simplifies home area network (HAN) device and network interoperability, fosters programme and product innovation and opens DR programmes to a broader range of consumer products, while facilitating customer choice and a competitive market landscape.

(<https://standards.iteh.ai>)
Document Preview

ISO/IEC 10192-3:2017

<https://standards.iteh.ai/catalog/standards/iso/e6a8a768-d728-46bc-91a0-e806c7224bbe/iso-iec-10192-3-2017>

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) INTERFACES –

Part 3: Modular communications interface for energy management

1 Scope

This part of IEC 10192 specifies a UCM (Universal Communications Module) that transfers energy management data via a home network between an end-device and an energy management agent (specified in ISO/IEC 15067-3) or an energy service provider. This document specifies the mechanical, electrical and logical characteristics of the interfaces of UCM to an end-device (hereafter referred to as an SGD – Smart Grid Device) and a choice of interfaces to a home communications network.

This document specifies the physical and data-link characteristics of the interface between the UCM and the SGD, along with certain higher-layer and application layer elements as needed to assure interoperability over a broad range of device capabilities. It specifies a mechanism through which network, transport and application layer messages specified in other documents listed in this document may be passed through the interface. For those end-devices that cannot process one of the “pass-through” command sets, a Simple Protocol is specified according to the OSI (Open System Interconnect) reference model (ISO/IEC 7498-1) including application layer messaging for energy management.

The UCM specified in this document is intended to be installable by the purchaser, home occupant or professional installer. The connectors are integrated in a way that allows for easy, plug-in installation. However, the manufacturer may choose to pre-install a module during production or have installation handled by a manufacturer representative or professional installer.

The scope of this document does not include safety related construction, performance, marking or instruction requirements. UCM products should additionally comply with applicable product safety standard(s). Examples of such standards are presented in Annex G.

NOTE Some regulatory authorities require that appliances intended for participation in energy management, such as thermostats, be user installable.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 8482, *Information technology – Telecommunications and information exchange between systems – Twisted pair multipoint interconnections*

ISO/IEC 14543-3-1, *Information technology – Home electronic system (HES) architecture – Part 3-1: Communication layers – Application layer for network based control of HES Class 1*

ISO/IEC 14543-4-3, *Information technology – Home electronic system (HES) architecture – Part 4-3: Application layer interface to lower communications layers for network enhanced control devices of HES Class 1*

ISO/IEC 14908-1, *Information technology – Control network protocol – Part 1: Protocol stack*

ISO/IEC 24739-3, *Information technology – AT attachment with packet interface-7 – Part 3: Serial transport protocols and physical interconnect (ATA/ATAPI-7 V3)*

ISO 4217, *Codes for the representation of currencies*

IEC PAS 62746-10-1:2014, *Systems interface between customer energy management system and the power management system – Part 10-1: Open Automated Demand Response (OpenADR 2.0b Profile Specification)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

3.1.1

average price

equivalent constant price for electricity as determined by the energy service provider

3.1.2

hot-swappable

connected and removed under load

3.1.3

Pass-Through mode

use of one of the following application layer protocols: Advanced Metering Infrastructure (AMI), Smart Energy Profile (SEP), IEC PAS 62746-10-1:2014 (OpenADR 2.0) and/or home or building networks specified in the ISO/IEC 14543 series

3.1.4

relative price

ratio of the current price to the average price, where “Average_Price” is calculated as specified in Annex F

3.1.5

smart grid device

end-device that is being informed of energy grid conditions

3.1.6

universal communications module

communications device that provides communication connectivity to a smart grid device

3.2 Abbreviated terms

AMI	Advanced Metering Infrastructure
AP	Average Price
ATA	Advanced Technology Attachment
CPP	Critical Peak Price
DR	Demand Response
HVAC	Heating, Ventilation and Air Conditioning
IP	Internet Protocol
LS	Least Significant
MS	Most Significant
OpenADR	Automated Demand Response specification from the OpenADR Alliance
PCB	Printed Circuit Board
PLC	Power Line Carrier

PoE	Power over Ethernet
RBDS	Radio Broadcast Data System
RDS	Radio Data System
SEP	Smart Energy Profile
SGD	Smart Grid Device
SPI	Serial Peripheral Interface (data transfer standard originally specified by Motorola (Freescale))
TVC	Time Varying Charges
UCM	Universal Communications Module
UTC	Universal Coordinated Time
0x00 to 0xFF	Two digit (8 bit) hexadecimal numbers ranging from 0 to 255 decimal
b0, b1 .. b15	Bit values within a hexadecimal number. b0 is the least significant bit.

4 Conformance

In order to conform to this document a UCM shall transfer energy management data between an end-device and an energy management agent or an energy service provider via a home network, provide an interface to the device (as specified in Clause 5 with a DC interface as specified in Annex A or an AC interface as specified in Annex C) and provide an interface to a home network as specified in Clause 6.

The messaging format shall be one of the protocols referenced in Clause 13 or the Simple Protocol specified in Clauses 7, 8, 9, 10, 11 and 12.

5 Physical/electrical Interface

5.1 Form factors

Two physical form factors are specified. End-device manufacturers may choose either, and communications module providers who wish to cover all products may offer two module versions. For both form factors, the communications protocol across the socket interface is the same, as described herein. Also in both cases, the power for the UCM is provided by the SGD. One form factor provides a low voltage DC supply and an SPI serial data interface. This form factor is specified in Annex A. This option might be attractive in cases where the end-device has no AC power source or when smaller socket size is required.

The second form factor provides AC service voltage for a single phase (typically 120 V or 240 V depending on the country and the appliance) and an ISO/IEC 8482-based serial interface. This form factor is specified in Annex C. This option might be attractive in cases where the end-device does not provide a DC power supply, where compatibility with PLC communications modules is desired or where communications module access to line frequency is needed.

NOTE 1 ISO/IEC 8482 was originally developed as RS-485 and TIA-485.

5.2 Removal and exchange of a UCM

It is assumed that UCMs will be removed or exchanged without turning off the SGD. Therefore, the UCM shall be hot-swappable.

5.3 Block diagram

Figure 2 shows the block diagram of the MCI.