



IEC 61850-7-420

Edition 1.0 2009-03

INTERNATIONAL STANDARD

**Communication networks and systems for power utility automation –
Part 7-420: Basic communication structure – Distributed energy resources
logical nodes**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XD**

ICS 33.200

ISBN 2-8318-1026-4

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	12
2 Normative references	12
3 Terms, definitions and abbreviations	13
3.1 Terms and definitions	13
3.2 DER abbreviated terms	18
4 Conformance.....	20
5 Logical nodes for DER management systems.....	22
5.1 Overview of information modelling (informative)	20
5.1.1 Data information modelling constructs	20
5.1.2 Logical devices concepts.....	21
5.1.3 Logical nodes structure	22
5.1.4 Naming structure	22
5.1.5 Interpretation of logical node tables.....	23
5.1.6 System logical nodes LN Group: L (informative).....	24
5.1.7 Overview of DER management system LN.....	27
5.2 Logical nodes for the DER plant ECP logical device.....	29
5.2.1 DER plant electrical connection point (ECP) logical device (informative).....	29
5.2.2 LN: DER plant corporate characteristics at the ECP Name: DCRP.....	31
5.2.3 LN: Operational characteristics at ECP Name: DOPR.....	31
5.2.4 LN: DER operational authority at the ECP Name: DOPA.....	32
5.2.5 LN: Operating mode at ECP Name: DOPM	33
5.2.6 LN: Status information at the ECP Name: DPST	34
5.2.7 LN: DER economic dispatch parameters Name: DCCT	35
5.2.8 LN: DER energy and/or ancillary services schedule control Name: DSCC.....	36
5.2.9 LN: DER energy and/or ancillary services schedule Name: DSCH	37
5.3 Logical nodes for the DER unit controller logical device	38
5.3.1 DER device controller logical device (informative)	38
5.3.2 LN: DER controller characteristics Name: DRCT.....	38
5.3.3 LN: DER controller status Name: DRCS	39
5.3.4 LN: DER supervisory control Name: DRCC	40
6 Logical nodes for DER generation systems.....	42
6.1 Logical nodes for DER generation logical device	42
6.1.1 DER generator logical device (informative)	42
6.1.2 LN: DER unit generator Name: DGEN	42
6.1.3 LN: DER generator ratings Name: DRAT	44
6.1.4 LN: DER advanced generator ratings Name: DRAZ	45
6.1.5 LN: Generator cost Name: DCST.....	46
6.2 Logical nodes for DER excitation logical device.....	47
6.2.1 DER excitation logical device (informative)	47
6.2.2 LN: Excitation ratings Name: DREX.....	47
6.2.3 LN: Excitation Name: DEXC	48
6.3 Logical nodes for DER speed/frequency controller	49

6.3.1	Speed/frequency logical device (informative)	49
6.3.2	LN: Speed/Frequency controller Name: DSFC	49
6.4	Logical nodes for DER inverter/converter logical device	50
6.4.1	Inverter/converter logical device (informative)	50
6.4.2	LN: Rectifier Name: ZRCT	51
6.4.3	LN: Inverter Name: ZINV	53
7	Logical nodes for specific types of DER	55
7.1	Logical nodes for reciprocating engine logical device	55
7.1.1	Reciprocating engine description (informative)	55
7.1.2	Reciprocating engine logical device (informative)	55
7.1.3	LN: Reciprocating engine Name: DCIP	56
7.2	Logical nodes for fuel cell logical device	57
7.2.1	Fuel cell description (informative)	57
7.2.2	Fuel cell logical device (informative)	59
7.2.3	LN: Fuel cell controller Name: DFCL	60
7.2.4	LN: Fuel cell stack Name: DSTK	61
7.2.5	LN: Fuel processing module Name: DFPM	62
7.3	Logical nodes for photovoltaic system (PV) logical device	63
7.3.1	Photovoltaic system description (informative)	63
7.3.2	Photovoltaics system logical device (informative)	65
7.3.3	LN: Photovoltaics module ratings Name: DPVM	67
7.3.4	LN: Photovoltaics array characteristics Name: DPVA	68
7.3.5	LN: Photovoltaics array controller Name: DPVC	69
7.3.6	LN: Tracking controller Name: DTRC	70
7.4	Logical nodes for combined heat and power (CHP) logical device	72
7.4.1	Combined heat and power description (informative)	72
7.4.2	Combined heat and power logical device (informative)	75
7.4.3	LN: CHP system controller Name: DCHC	76
7.4.4	LN: Thermal storage Name: DCTS	77
7.4.5	LN: Boiler Name: DCHB	78
8	Logical nodes for auxiliary systems	78
8.1	Logical nodes for fuel system logical device	78
8.1.1	Fuel system logical device (informative)	78
8.1.2	LN: Fuel characteristics Name: MFUL	80
8.1.3	LN: Fuel delivery system Name: DFLV	80
8.2	Logical nodes for battery system logical device	81
8.2.1	Battery system logical device (informative)	81
8.2.2	LN: Battery systems Name: ZBAT	82
8.2.3	LN: Battery charger Name: ZBTC	83
8.3	Logical node for fuse device	84
8.3.1	Fuse logical device (informative)	84
8.3.2	LN: Fuse Name: XFUS	84
8.4	Logical node for sequencer	85
8.4.1	Sequencer logical device	85
8.4.2	LN: Sequencer Name: FSEQ	85
8.5	Logical nodes for physical measurements	86
8.5.1	Physical measurements (informative)	86
8.5.2	LN: Temperature measurements Name: STMP	86

8.5.3	LN: Pressure measurements Name: MPRS	87
8.5.4	LN: Heat measured values Name: MHET	87
8.5.5	LN: Flow measurements Name: MFLW	88
8.5.6	LN: Vibration conditions Name: SVBR	90
8.5.7	LN: Emissions measurements Name: MENV	90
8.5.8	LN: Meteorological conditions Name: MMET	91
8.6	Logical nodes for metering	91
8.6.1	Electric metering (informative)	91
9	DER common data classes (CDC)	92
9.1	Array CDCs	92
9.1.1	E-Array (ERY) enumerated common data class specification	92
9.1.2	V-Array (VRY) visible string common data class specification	92
9.2	Schedule CDCs	93
9.2.1	Absolute time schedule (SCA) settings common data class specification	93
9.2.2	Relative time schedule (SCR) settings common data class specification	94
	Annex A (informative) Glossary	96
	Bibliography	98

	Figure 1 – Example of a communications configuration for a DER plant	10
	Figure 2 – IEC 61850 modelling and connections with CIM and other IEC TC 57 models	11
	Figure 3 – Information model hierarchy	21
	Figure 4 – Example of relationship of logical device, logical nodes, data objects, and common data classes	22
	Figure 5 – Overview: Conceptual organization of DER logical devices and logical nodes	28
	Figure 6 – Illustration of electrical connection points (ECP) in a DER plant	29
	Figure 7 – Inverter / converter configuration	50
	Figure 8 – Example of a reciprocating engine system (e.g. Diesel Gen-Set)	55
	Figure 9 – Example of LNs in a reciprocating engine system	56
	Figure 10 – Fuel cell – Hydrogen/oxygen proton-exchange membrane fuel cell (PEM)	58
	Figure 11 – PEM fuel cell operation	58
	Figure 12 – Example of LNs used in a fuel cell system	59
	Figure 13 – Example: One line diagram of an interconnected PV system	64
	Figure 14 – Schematic diagram of a large PV installation with two arrays of several sub-array	65
	Figure 15 – Example of LNs associated with a photovoltaics system	66
	Figure 16 – Two examples of CHP configurations	73
	Figure 17 – CHP unit includes both domestic hot water and heating loops	74
	Figure 18 – CHP unit includes domestic hot water with hybrid storage	74
	Figure 19 – CHP unit includes domestic hot water without hybrid storage	74
	Figure 20 – Example of LNs associated with a combined heat and power (CHP) system	75

Table 1 – Interpretation of logical node tables.....	23
Table 2 – LPHD class	25
Table 3 – Common LN class	26
Table 4 – LLN0 class	27
Table 5 – DER plant corporate characteristics at the ECP, LN (DCRP)	31
Table 6 – Operational characteristics at the ECP, LN (DOPR)	32
Table 7 – DER operational authority at the ECP, LN (DOPA)	33
Table 8 – Operating mode at the ECP, LN (DOPM).....	34
Table 9 – Status at the ECP, LN (DPST).....	35
Table 10 – DER Economic dispatch parameters, LN (DCCT)	35
Table 11 – DER energy schedule control, LN (DSCC).....	36
Table 12 – DER Energy and ancillary services schedule, LN (DSCH)	37
Table 13 – DER controller characteristics, LN DRCT	38
Table 14 – DER controller status, LN DRCS	39
Table 15 – DER supervisory control, LN DRCC.....	40
Table 16 – DER unit generator, LN (DGEN)	42
Table 17 – DER Basic Generator ratings, LN (DRAT).....	44
Table 18 – DER advanced generator ratings, LN (DRAZ).....	46
Table 19 – Generator cost, LN DCST	47
Table 20 – Excitation ratings, LN (DREX)	47
Table 21 – Excitation, LN (DEXC).....	48
Table 22 – Speed/frequency controller, LN (DSFC).....	49
Table 23 – Rectifier, LN (ZRCT).....	51
Table 24 – Inverter, LN (ZINV).....	53
Table 25 – Reciprocating engine, LN (DCEP).....	57
Table 26 – Fuel cell controller, LN (DFCL).....	60
Table 27 – Fuel cell stack, LN (DFSTK)	61
Table 28 – Fuel cell processing module, LN (DFPM).....	62
Table 29 – Photovoltaic module characteristics, LN (DPVM)	67
Table 30 – Photovoltaic array characteristics, LN (DPVA)	68
Table 31 – Photovoltaic array controller, LN (DPVC).....	69
Table 32 – Tracking controller, LN (DTRC)	70
Table 33 – CHP system controller, LN (DCHC)	76
Table 34 – CHP thermal storage, LN (DCTS).....	77
Table 35 – CHP Boiler System, LN (DCHB)	78
Table 36 – Fuel types	79
Table 37 – Fuel characteristics, LN (MFUL)	80
Table 38 – Fuel systems, LN (DFLV)	81
Table 39 – Battery systems, LN (ZBAT).....	82
Table 40 – Battery charger, LN (ZBTC).....	83
Table 41 – Fuse, LN (XFUS).....	84
Table 42 – Sequencer, LN (FSEQ).....	85
Table 43 – Temperature measurements, LN (STMP).....	86

Table 44 – Pressure measurements, LN (MPRS)	87
Table 45 – Heat measurement, LN (MHET).....	88
Table 46 – Flow measurement, LN (MFLW)	89
Table 47 – Vibration conditions, LN (SVBR).....	90
Table 48 – Emissions measurements, LN (MENV)	91
Table 49 – E-Array (ERY) common data class specification	92
Table 50 – V-Array (VRY) common data class specification	92
Table 51 – Schedule (SCA) common data class specification	93
Table 52 – Schedule (SCR) common data class specification	94

Currently in preview, click buy full version

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**COMMUNICATION NETWORKS AND
SYSTEMS FOR POWER UTILITY AUTOMATION –**
**Part 7-420: Basic communication structure –
Distributed energy resources logical nodes**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC 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.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC 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 undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees 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, use of, or reliance upon, this IEC Publication or any other 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 IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61850-7-420 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

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

FDIS	Report on voting
57/981/FDIS	57/988/RVD

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

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

In Clauses 5 to 8 of this document, each subclause contains an initial informative clause, followed by normative clauses. Specifically, any subclause identified as informative is informative; any clause with no identification is considered normative.

A list of all parts of the IEC 61850 series, under the general title: *Communication networks and systems for power utility automation*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

Currently in preview, click buy full version

INTRODUCTION

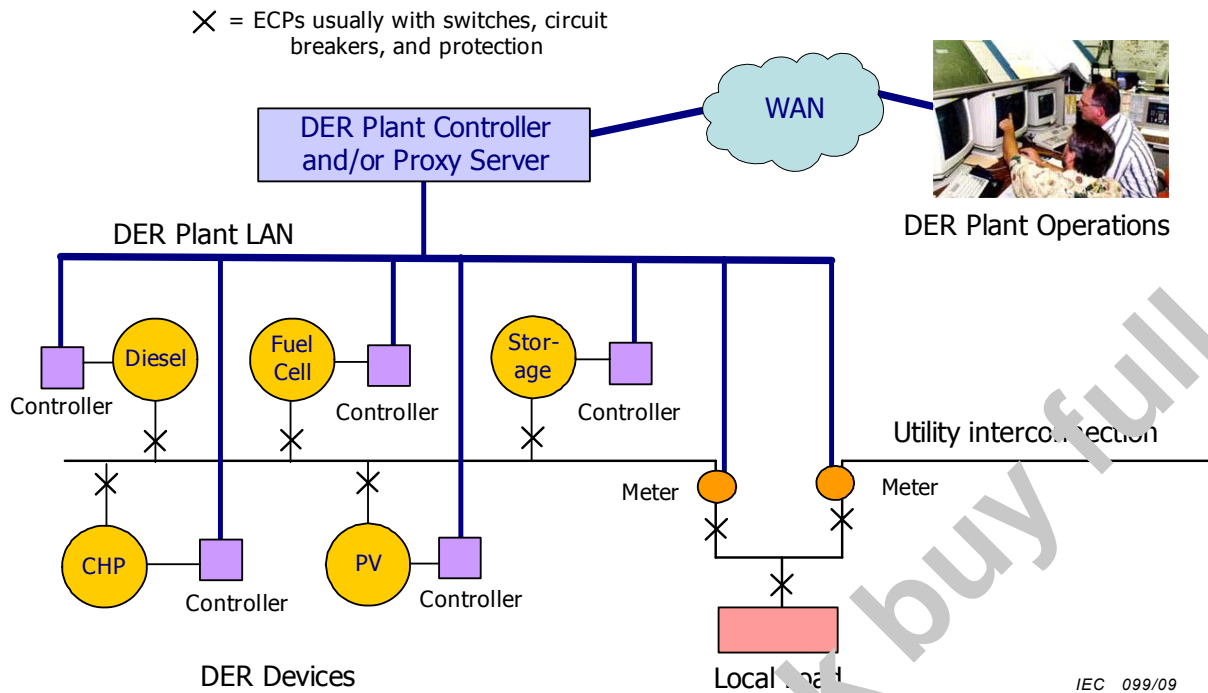
Increasing numbers of DER (distributed energy resources) systems are being interconnected to electric power systems throughout the world. As DER technology evolves and as the impact of dispersed generation on distribution power systems becomes a growing challenge - and opportunity, nations worldwide are recognizing the economic, social, and environmental benefits of integrating DER technology within their electric infrastructure.

The manufacturers of DER devices are facing the age-old issues of what communication standards and protocols to provide to their customers for monitoring and controlling DER devices, in particular when they are interconnected with the electric utility system. In the past, DER manufacturers developed their own proprietary communication technology. However, as utilities, aggregators, and other energy service providers start to manage DER devices which are interconnected with the utility power system, they are finding that coping with these different communication technologies present major technical difficulties, implementation costs, and maintenance costs. Therefore, utilities and DER manufacturers recognize the growing need to have one international standard that defines the communication and control interfaces for all DER devices. Such standards, along with associated guidelines and uniform procedures would simplify implementation, reduce installation costs, reduce maintenance costs, and improve reliability of power system operations.

The logical nodes in this document are intended for use with DER, but may also be applicable to central-station generation installations that are comprised of groupings of multiple units of the same types of energy conversion systems that are represented by the DER logical nodes in this document. This applicability to central-station generation is strongest for photovoltaics and fuel cells, due to their modular nature.

Communications for DER plants involve not only local communications between DER units and the plant management system, but also between the DER plant and the operators or aggregators who manage the DER plant as a virtual source of energy and/or ancillary services. This is illustrated in Figure 1.

Example of a Communications Configuration for a DER Plant



Key

- CHP combined heat and power
- WAN wide area network
- DER distributed energy resources
- PV photovoltaics
- LAN local area network

Figure 1 – Example of a communications configuration for a DER plant

In basic terms, “communications” can be separated into four parts:

- information modelling (the types of data to be exchanged – nouns),
- services modelling (the read, write, or other actions to take on the data – verbs),
- communication protocols (mapping the noun and verb models to actual bits and bytes),
- telecommunication media (fibre optics, radio systems, wireless systems, and other physical equipment).

This document addresses only the IEC 61850 information modelling for DER. Other IEC 61850 documents address the services modelling (IEC 61850-7-2) and the mapping to communication protocols (IEC 61850-8-x). In addition, a systems configuration language (SCL) for DER (IEC 61850-6-x) would address the configuration of DER plants.

The general technology for information modelling has developed to become well-established as the most effective method for managing information exchanges. In particular, the IEC 61850-7-x information models for the exchange of information within substations have become International Standard. Many of the components of this standard can be reused for information models of other types of devices.

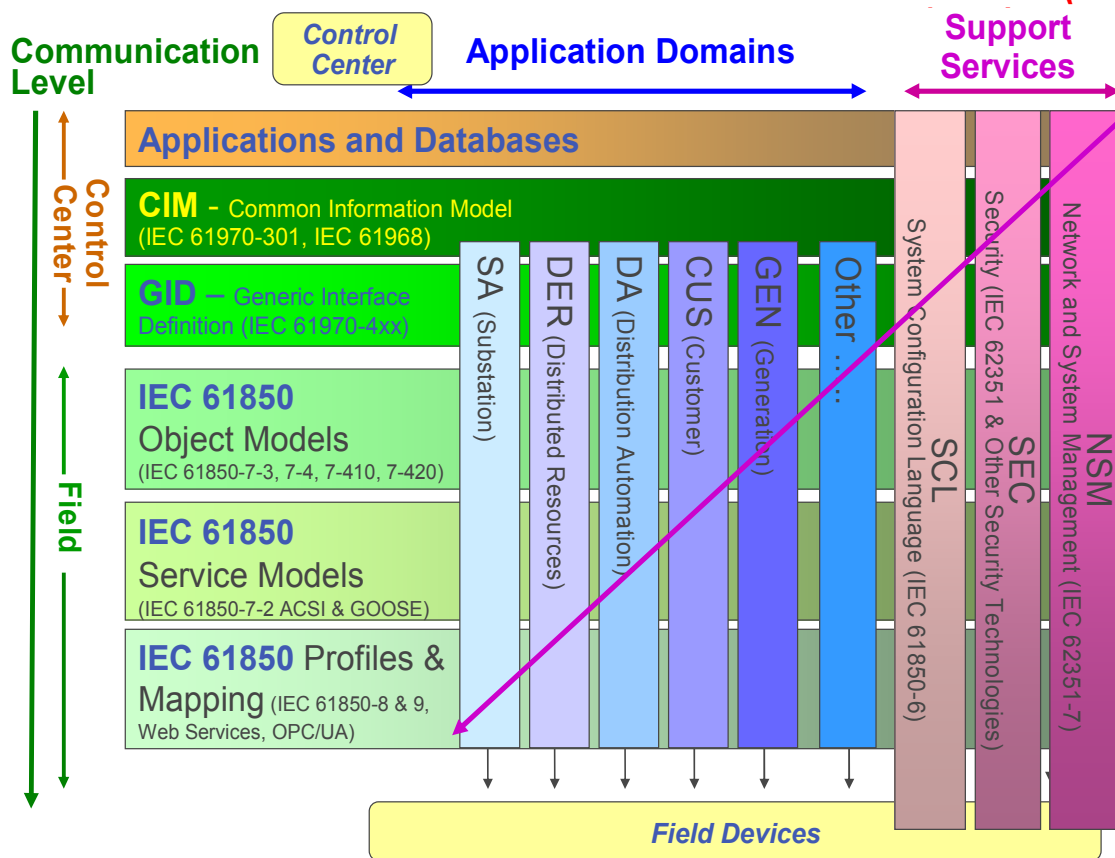
In addition to the IEC 61850 standards, IEC TC 57 has developed the common information model (CIM) that models the relationships among power system elements and other

information elements so that these relationships can be communicated across systems. Although this standard does not address these CIM relationships for DER, it is fully compatible with the CIM concepts.

The interrelationship between IEC TC 57 modelling standards is illustrated in Figure 2. This illustration shows as horizontal layers the three components to an information exchange model for retrieving data from the field, namely, the communication protocol profiles, the service models, and the information models. Above these layers is the information model of utility-specific data, termed the common information model (CIM), as well as all the applications and databases needed in utility operations. Vertically, different information models are shown:

- substation automation (IEC 61850-7-4),
- large hydro plants (IEC 61850-7-410),
- distributed energy resources (DER) (IEC 61850-7-420),
- distribution automation (under development),
- advanced metering infrastructure (as pertinent to utility operations) (pending).

IEC 61850 Models and the Common Information Model (CIM)



IEC 100/09

Figure 2 – IEC 61850 modelling and connections with CIM and other IEC TC 57 models

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-420: Basic communication structure – Distributed energy resources logical nodes

1 Scope

This International Standard defines the IEC 61850 information models to be used in the exchange of information with distributed energy resources (DER), which comprise dispersed generation devices and dispersed storage devices, including reciprocating engines, fuel cells, microturbines, photovoltaics, combined heat and power, and energy storage.

The IEC 61850 DER information model standard utilizes existing IEC 61850-7-4 logical nodes where possible, but also defines DER-specific logical nodes where needed.

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.

IEC 61850-7-2:2003, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substations and feeder equipment – Abstract communication service interface (ACSI)* ¹⁾

IEC 61850-7-3:2003, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substations and feeder equipment – Common data classes* ¹⁾

IEC 61850-7-4:2003, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substations and feeder equipment – Compatible logical node classes and data classes* ¹⁾

IEC 61850-7-410, *Communication networks and systems for power utility automation – Part 7-410: Hydroelectric power plants – Communication for monitoring and control*

ISO 4217, *Codes for the representation of currencies and funds*

¹⁾ A new edition of this document is in preparation.