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INTERNATIONAL STANDARD

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Communication networks and systems for power utility automation – Part 7-410: Basic communication structure – Hydroelectric power plants – Communication for monitoring and control

Réseaux et systèmes de communication pour l'automatisation des systèmes électriques – Partie 7-410: Structure de communication de base – Centrales hydroélectriques – Communication pour le contrôle-commande

IEC 61850-7-410:2012

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

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FOREWORD

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International Standard IEC 61850-7-410 has been prepared by technical committee 57: Power systems management and associated information exchange.

This second edition cancels and replaces the first edition published in 2007, and constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

a) The logical nodes in IEC 61850-7-410:2007 that were not specific to hydropower plants have been transferred to IEC 61850-7-4:2010 and have been removed from this edition of IEC 61850-7-410.

b) The definitions of logical nodes in this edition of IEC 61850-7-410 have been updated using the format introduced in IEC 61850-7-4:2010.

c) Most of the modelling examples and background information that was included in IEC 61850-7-410:2007 has been transferred to IEC/TR 61850-7-510.

d) However, this edition of IEC 61850-7-410 includes additional general-purpose logical nodes that were not included in IEC 61850-7-4:2010, but are required in order to represent the complete control and monitoring system of a hydropower plant.

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

FDIS	Report on voting
57/1274/FDIS	57/1289/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.

A list of all the parts in the IEC 61850 series, published 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 stability 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

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-410: Basic communication structure – Hydroelectric power plants – Communication for monitoring and control

1 Scope

This part of IEC 61850 specifies the additional common data classes, logical nodes and data objects required for the use of IEC 61850 in a hydropower plant.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC/TS 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-7-1, *Communication networks and systems for power utility automation – Part 7-1: Basic communication structure – Principles and models*

IEC 61850-7-2:2010, *Communication networks and systems for power utility automation – Part 7-2: Basic information and communication structure – Abstract communication service interface (ACSI)*

IEC 61850-7-3:2010, *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure for substations and feeder equipment – Common data classes*

IEC 61850-7-4:2010, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in IEC 61850-2 apply.

4 Abbreviated terms

The terms listed in Table 1 are used to build concatenated Data Object Names in this document. IEC 61850-7-410 inherits all the abbreviated terms described in Clause 4 of IEC 61850-7-4:2010.

NOTE Data Object Names in the logical nodes representing PSS filter functions follow names in IEEE 421.5 as closely as possible. These names are not included in Table 1.

Table 1 – Abbreviated terms

Term	Description	Term	Description
Act	Action, activity, active, activate[a]	Lkg	Leakage
Atr	Actuator	Lub	Lubrication
BG	Before Gain	Man	Manual (- operation selected)
Brg	Bearing	Mnt	Maintenance
Brk	Brake	Ndl	Needle (used in Pelton turbines)
Bt	Heartbeat	Nhd	Net head
BtB	Back-to-Back	Nrm	Normal
Cam	Cam, e.g. rotating non-circular disk	Nxt	Next
Cap	Capacity, capability[a]	Off	Device disengaged (= off)
Cbr	Calibration	On	Device applied (= on)
Cff	coefficient	Operate	Operate order to any device
Cm	Centimetres	Opn	Open, opened, opening[a]
Cmpl	Completed, completion, complete	Pe	Electric power
Cnd	Condenser, synchronous compensator	Pmp	Pump
Crl	Correlation	Polytr	Polytropic
Crp	Creeping, slow movement	Prec	Precondition, initial status
Cwb	Crowbar	Prt	Priority
De	Remove	Psk	Penstock
Deg	Degrees, for angle indication in °	Pss	PSS, power system stabiliser function
Dfl	Deflector (used in Pelton turbines)	Qu	Queue
Dia	Diaphragm	Rb	Runner blade
Dith	Dither	Reg	Regulation
Dn	Down, below, downstream, lowest	Req	Requested
Drtb	Draft tube	Rng	Range
Droop	Droop	Rpt	Repeat, repetition
Dtc	Detection	Rtg	Rating, rated
Dvc	Device	Rwy	Runaway, e.g. in runaway speed
Dw	Delta Omega	Saf	Safety
Ena	Enable, allow operation[a]	Sft	Soft (as in soft start)
Fa	"Fire all" sequence (to thyristors)	Shft	Shaft
Fbc	Field breaker configuration	Sld	Solidity
Fir	Fire	SM	Servo, servo-motor
Flm	Flame	SNL	Speed-no-load, connected but not generating
Flsh	Flashing (e.g. field flashing)	Spir	Spiral
Flt	Fault	Srv	Service
Flw	Flow, flowing	Stl	Still, not moving
Fst	Fast	Stnd	Stand, standing
Gdv	Guide vane	Syn	Synchronous, synchronism
Grd	Gradient	Twt	Tailwater, water level at outlet
Gte	Gate, dam gate	Tp	Test Point
Hd	Head	Trb	Turbine
Hwt	Headwater, water level at intake	Trg	Trigger
Hys	Hysteresis	Unt	Unit, production unit
I	Intermediate	Up	Up, above, upstream, upper
J	Joint	Vsi	Voltage stabilizer input
Lft	Lifting, lift	Vst	Voltage stabilizer terminal (output)
Lo	Low, lower (position) [a]		
Lkd	Locked		

[a] Extended description of IEC 61850-7-4

5 Logical node classes

5.1 Logical node groups

Logical nodes are grouped together with nodes of similar or related functions having the same first letter. Table 2 shows presently assigned letters, letters marked "reserved" may be used in future extensions to the standard series. Names of logical nodes shall start with the letter of

the group to which the LN belongs. E.g. most of the logical nodes, defined in this document, are specific for hydropower use and thus have names that start with the letter H.

Table 2 – List of logical node groups

A	Automatic control functions
B	Reserved
C	Control functions
D	Functions specific to distributed energy resources (DER)
E	Reserved
F	Logical nodes representing functional blocks
G	Generic references
H	Functions specific to hydropower plants
I	Interface and archiving functions
J	Reserved
K	Kinetic energy, mechanical devices and equipment
L	Physical devices and common logical nodes
M	Metering and measurement
N	Reserved
O	Reserved
P	Electrical protections
Q	Power quality
R	Protection related functions
S	Supervision and monitoring
T	Sensors and transmitters (including instrument transformers)
U	Reserved
V	Reserved
W	Functions specific to wind power plants
X	Switchgear
Y	Power transformers
Z	Power system equipment

5.2 Interpretation of logical node tables

The interpretation of the headings for the logical node tables is presented in Table 3.

Table 3 – Interpretation of logical node tables

Data Object Name	Function of the Data Object
Common Data Class	Common Data Class that defines the structure of the Data Object. See IEC 61850-7-3.
Explanation	Short explanation of the data and how it is used.
T	Transient Data – the status of data with this designation is momentary and shall be logged or reported to provide evidence of their momentary state. Some T may be only valid on a modelling level. The TRANSIENT property of DATA only applies to BOOLEAN process data attributes (FC=ST) of that DATA. Transient DATA is identical to normal DATA, except that for the process state change from TRUE to FALSE no event may be generated for reporting and for logging.
M/O	This column defines whether data, data sets, control blocks or services are mandatory (M) or optional (O) for the instantiation of a specific logical node. In some cases a data object can be instantiated; this is marked by “multi”, i.e. Omulti or Mmulti. Instantiation shall be made by numbers 01 to 99, added directly after the data object name. The part of the data object that is instatiated is marked by {inst} in the data object explanation The attributes for data that are instantiated may also be mandatory or optional based on the CDC (Attribute Type) definition in IEC 61850-7-3. Where the letter C is used for “conditional”, at least one of the items of data labelled with C shall be used from each category where C occurs.

All data object names are listed alphabetically in Clause 8. Despite some overlapping, the data in the logical node classes are grouped for the convenience of the reader into some of the following categories.

Common logical node information
Common logical node information is information independent of the dedicated function represented by the LN class. Mandatory data (M) are common to all LN classes; optional data (O) are valid for a reasonable subset of LN classes.

Status information
Status information is data which shows either the status of the process or of the function allocated to the LN class. This information is produced locally and cannot be changed remotely unless substitution is applicable. Data such as “start” or “trip” are listed in this category. Most of these data are mandatory. The data can only be read and not set from an external source.

Settings
Settings are data which are needed for the function to operate. Since many settings are dependent on the implementation of the function, only a commonly agreed minimum is standardised. They may be changed remotely, but normally not very often. The setting can not always be read back; whether it is possible or not depends on the data class used for the setting.

Measured values
Measured values are analogue data measured from the process or calculated in the functions such as currents, voltages, power, etc. This information is produced locally and cannot be changed remotely unless substitution is applicable.

Controls
Controls are data which are changed by commands such as switchgear state (ON/OFF), tap changer position or reset-able counters. They are typically changed remotely, and are changed during operation much more than settings. Data objects under controls cannot be read back.

5.3 Summary of logical nodes to be used in hydropower plants

5.3.1 General

This document specifies the compatible logical node classes to be used in hydropower plants listed in Tables 4 to 12. For other logical node classes that might be of use also in hydropower plants, see IEC 61850-7-4.

5.3.2 Group A – Automatic functions

Table 4 – Logical nodes for automatic functions

LN Class	Description
ACTM	Control mode selection. Overall LN for controllers with different possible modes.
AJCL	Joint control function, to balance total power from different sources.
APSS	PSS Control. Common information of a PSS function.
APST	PSS 2A/B filter. Represents a filter according to IEEE 421.5-2005.
APSF	PSS 4B filter. Represents a filter according to IEEE 421.5-2005.

5.3.3 Group F – Functional blocks

Table 5 – Logical nodes representing functional blocks

LN Class	Description
FHBT	Heart-beat. This LN represents the heart-beat function of a controlling device. I.e. the function used to ensure that a specific device or program in a device is running.
FSCH	Scheduler. This LN represents a task scheduler that will perform predefined tasks at given times.
FXPS	Functional priority status. This LN is used to specify in which order devices should be started or activated.

5.3.4 Group H – Hydropower specific logical nodes

Table 6 – Hydropower specific logical nodes

LN Class	Description
HBRG	Turbine – generator shaft bearing. This LN holds data pertaining to bearings, such as temperatures and lubrication oil flows.
HCOM	Combinator (3D-CAM or 2D-CAM), optimises the relation between net head, guide vanes and runner blades. It is used in power plants with Kaplan turbines with moveable runner blades. The combinatory function will also use the FCSD LN to hold the relation curves for different net heads.
HDAM	Hydropower dam. A logical node that is used to represent the physical aspects of the dam.
HDFL	Deflector control. This logical node represents the deflector control of a Pelton turbine
HDLS	Dam leakage supervision. Represents a device that will supervise and give alarm in case of dam leakage. The actual measurement can be based on water flow.
HEBR	Electrical brake. This logical node represents an electrical brake system of a turbine.
HGPI	Gate position indicator. A device that provides the position of a dam gate. The position is given either as an angular displacement in case of sector gates or as distance from fully closed position in case of straight gates. For aperture gates and valves where the position is given as percent of full opening, either the HVLV or the SPOS logical nodes are recommended.
HGOV	Governor control. A logical node that represents the overall control of a turbine governor and the various control modes.
HGTE	Dam gate. This LN is intended to hold information about the gate. It can also present a calculated water flow through the gate, in which case the FCSD LN shall be included in the same logical device, to provide the relations. Note that in this LN the position set-point is listed under *Controls* instead of *Settings*. The normal way of controlling a gate is to send a position set-point.

LN Class	Description
HITG	Intake gate. This LN can be used to represent intake gates. The gates will almost never be placed in any other position than fully closed or fully open. However to cater for step-wise or other controls, the gate is normally provided with a number of position switches.
HJCL	Power plant joint control function. In plants with more than one gate or several turbines, this LN will represent the joint control function that is used to supervise the total water flow or to maintain a constant water level. The LN shall be instantiated to provide one instance for each gate and each turbine to be supervised.
HLKG	Leakage supervision. This LN can be used to measure any leakage in the plant, it is more generic than HDLS
HLVL	Water level indicator. The LN represents the water level sensing device. The output is a distance including an offset from a base level (commonly the distance above sea).
HMBR	Mechanical brake for the generator shaft. This is a LN for the brake control. The brake is used for stopping the unit during shut-down and to hold the shaft still, once the unit is stopped.
HNDL	Needle control. A specialised LN that represents the control of needles in Pelton turbines.
HNHD	Net head data. A LN that can be used to present the calculated net head data (difference between upper and lower water levels) in a hydropower plant.
HOTP	Dam overtopping protection. A protection function that will act by opening one or more gates in case of a risk for overtopping the dam. The protection will sometimes include its own water measurement device; hence an optional measured value for water level.
HRES	Water reservoir. A logical node that is used to represent the logical function of a reservoir. If the content is to be calculated, the FSCD LN shall be used to provide the relation between water level and content.
HSEQ	Start / stop sequencer. A simple LN that only presents what the sequencer is doing (inactive – starting – stopping) and in case it is active, what step it is presently working on.
HSPD	Speed monitoring. This LN is normally located in a stand-alone logical device, separated from but monitoring the turbine governor. It will also act as a placeholder for various speed limits and set-points used by the start sequencer and other control functions.
HSST	Surge shaft or surge tank. A function that is used to mitigate pressure surges in the system.
HTGV	Guide vanes (wicket gate). This logical node represents the physical device of guide vanes in a hydropower turbine.
HTRB	Runner blades. This logical node represents the physical device of runner blades in e.g. a Kaplan turbine where the runner blades can be controlled.
HTRK	Trash rack, used to prevent floating debris getting into the turbine.
HTUR	Turbine. This logical node holds extended rating plate data for a turbine in a hydropower plant.
HUNT	Hydropower production unit. This LN represents the physical device of the turbine and generator combination in a hydropower plant. It is intended as an extended rating plate that allows temporary settings of data. It also acts as a placeholder for the current operating conditions of the unit.
HVLV	Valve. This logical node represents a large valve, e.g. a valve in a penstock, butterfly or ball type valve.
HWCL	Water control function. This LN will represent one physical device that can modify the water flow though the plant, either a gate or a turbine. In case of a plant with a joint control function, the HJCL LN will provide the flow set-point to be used by HWCL.

5.3.5 Group I – Interface and archiving

Table 7 – Logical nodes for interface and archiving

LN Class	Description
IFIR	Generic fire detection and alarm function.
IHND	Generic physical human – machine interface. E.g. a push-button or another physical device that can be used as input to a controller.

5.3.6 Group K – Mechanical and non-electrical primary equipment

Table 8 – Logical nodes for mechanical and non-electric primary equipment

LN Class	Description
KHTR	Heater. The LN represents a heater, cubicle heater or any other heater that can be controlled.

5.3.7 Group P – Protection functions

NOTE Most of the logical nodes that represent protective functions are defined in the substation part of the document series.

Table 9 – Logical nodes for protections

LN Class	Description
PRTR	Rotor protection. Field short-circuit protection.

5.3.8 Group R – Protection related functions

Table 10 – Logical nodes for protection related functions

LN Class	Description
RFBC	Field breaker configuration.

5.3.9 Group S – Supervision and monitoring

Table 11 – Logical nodes for supervision and monitoring

LN Class	Description
SFLW	Media flow supervision. This logical node represents a generic media flow supervision system that can provide alarm and trip signals. In an application, the LN shall be instantiated with one instance per flow being measured.
SLEV	Media level supervision. This logical node represents a generic level supervision system that can provide alarm and trip signals. In an application, the LN shall be instantiated with one instance per surface being measured.
SPOS	Device position supervision. This logical node represents a generic position supervision system that can provide alarm and trip signals. In an application, the LN shall be instantiated with one device being measured.
SPRS	Media pressure supervision. This logical node represents a generic pressure supervision system that can provide alarm and trip signals. In an application, the LN shall be instantiated with one instance per pressure point being measured.

5.3.10 Group X – Switchgear

Table 12 – Logical nodes for switchgear

LN Class	Description
XFFL	Field flashing. A logical node to represent the switching control for start excitation (field flashing) of a generator.

5.4 Automatic control logical nodes LN group A

5.4.1 Modelling remarks

Logical nodes in this group are intended for automatic control functions of general use, i.e. not for any specific area of technology. The logical nodes APSS, APST and APSF below are intended for use in power system stabilizer (PSS) control functions used for large generators.